1
00:00:06,150 --> 00:00:04,390
good morning and welcome to nasa's jet

2
00:00:09,270 --> 00:00:06,160
propulsion laboratory we are so excited

3
00:00:11,430 --> 00:00:09,280
to have you here for the nasa social

4
00:00:12,390 --> 00:00:11,440
talking about earth now thank you for

5
00:00:20,470 --> 00:00:12,400
coming

6
00:00:25,429 --> 00:00:22,870
for those of you watching at home uh we

7
00:00:27,349 --> 00:00:25,439
have a hundred people here at jet

8
00:00:30,230 --> 00:00:27,359
propulsion laboratory today and for

9
00:00:33,510 --> 00:00:30,240
tomorrow and uh they have come from 22

10
00:00:35,430 --> 00:00:33,520
states and two additional countries

11
00:00:37,670 --> 00:00:35,440
outside the united states and they are

12
00:00:39,270 --> 00:00:37,680
going to spend the next two days

13
00:00:40,869 --> 00:00:39,280

speaking directly with our scientists

14
00:00:43,190 --> 00:00:40,879
and our engineers getting a behind the

15
00:00:45,110 --> 00:00:43,200
scenes look at what we do here at jpl

16
00:00:47,590 --> 00:00:45,120
also they can learn a little bit more

17
00:00:49,190 --> 00:00:47,600
about our missions how they work and

18
00:00:50,709 --> 00:00:49,200
feel more involved because this is your

19
00:00:53,990 --> 00:00:50,719
space program

20
00:00:56,790 --> 00:00:54,000
uh so far to date nasa has held 72 of

21
00:00:58,790 --> 00:00:56,800
these events since 2009 they're held

22
00:01:00,869 --> 00:00:58,800
around the country at ten different nasa

23
00:01:04,630 --> 00:01:00,879
centers and several affiliated

24
00:01:07,030 --> 00:01:04,640
facilities uh we've had almost five

25
00:01:08,710 --> 00:01:07,040
thousand participants at these seventy

26
00:01:10,950 --> 00:01:08,720
two events i think we'll kick it over

27
00:01:12,310 --> 00:01:10,960
the five thousand mark a little later

28
00:01:13,670 --> 00:01:12,320
this month when the maven mission

29
00:01:16,070 --> 00:01:13,680
launches from florida and they're doing

30
00:01:17,590 --> 00:01:16,080
a nasa social there as well

31
00:01:19,670 --> 00:01:17,600
these events like i said sometimes

32
00:01:21,510 --> 00:01:19,680
you're coming in to learn about missions

33
00:01:22,710 --> 00:01:21,520
that are planned for launch and i will

34
00:01:23,910 --> 00:01:22,720
say we're going to talk about three

35
00:01:25,830 --> 00:01:23,920
missions that we'll be launching in

36
00:01:26,789 --> 00:01:25,840
2014. these are all earth science

37
00:01:29,030 --> 00:01:26,799
missions

38
00:01:31,109 --> 00:01:29,040

and in 2014 we will be holding nasa

39
00:01:32,550 --> 00:01:31,119
socials at those launches

40
00:01:34,149 --> 00:01:32,560
so for those of you here and those of

41
00:01:35,749 --> 00:01:34,159
you watching if you've never been to one

42
00:01:38,310 --> 00:01:35,759
of these events

43
00:01:40,550 --> 00:01:38,320
watch for these coming up follow nasa

44
00:01:41,830 --> 00:01:40,560
social on twitter and you will get a

45
00:01:43,510 --> 00:01:41,840
heads up when we're going to be doing

46
00:01:46,389 --> 00:01:43,520
registration for those because i think

47
00:01:48,069 --> 00:01:46,399
everyone should come to at least one

48
00:01:49,590 --> 00:01:48,079
um so for the next two hours we'll be

49
00:01:50,870 --> 00:01:49,600
talking about these earth missions a lot

50
00:01:53,030 --> 00:01:50,880
of you

51
00:01:55,190 --> 00:01:53,040
may not have even known that nasa does a

52
00:01:57,190 --> 00:01:55,200
lot of earth missions but there you know

53
00:01:59,990 --> 00:01:57,200
in fact about one third of what we do

54
00:02:01,830 --> 00:02:00,000
here at jpl is done to study earth you

55
00:02:04,950 --> 00:02:01,840
probably don't even realize that a lot

56
00:02:07,910 --> 00:02:04,960
of that data is getting to you through

57
00:02:09,749 --> 00:02:07,920
weather and climate forecasters

58
00:02:13,190 --> 00:02:09,759
in some cases the national hurricane

59
00:02:15,910 --> 00:02:13,200
center can use data from nasa missions

60
00:02:18,229 --> 00:02:15,920
it's going to policy makers it's going

61
00:02:19,990 --> 00:02:18,239
to businesses this is all data that

62
00:02:21,990 --> 00:02:20,000
again we're putting it out there but we

63
00:02:23,430 --> 00:02:22,000

want you to know exactly what is there

64
00:02:26,710 --> 00:02:23,440
how we're studying earth and how it

65
00:02:28,070 --> 00:02:26,720
makes a difference for all of us here

66
00:02:30,550 --> 00:02:28,080
for the next two hours we're actually

67
00:02:31,910 --> 00:02:30,560
going to be showing you views of our

68
00:02:36,390 --> 00:02:31,920
home planet

69
00:02:37,509 --> 00:02:36,400
and we'll start with the first one

70
00:02:39,190 --> 00:02:37,519
and i hope i will see that on the

71
00:02:42,470 --> 00:02:39,200
monitor

72
00:02:44,309 --> 00:02:42,480
uh views of our home planet taken by

73
00:02:46,790 --> 00:02:44,319
missions across the solar system

74
00:02:49,589 --> 00:02:46,800
starting with this one

75
00:02:51,350 --> 00:02:49,599
this view seen by the crew on apollo 8

76
00:02:53,670 --> 00:02:51,360
it was a picture that wasn't even in the

77
00:02:55,190 --> 00:02:53,680
plan to be taken but the astronauts

78
00:02:57,430 --> 00:02:55,200
grabbed their cameras black and white in

79
00:03:00,390 --> 00:02:57,440
color and they snapped that image

80
00:03:02,070 --> 00:03:00,400
that was christmas eve 1968.

81
00:03:05,110 --> 00:03:02,080
a lot of people feel that was the most

82
00:03:07,030 --> 00:03:05,120
important environmental image ever taken

83
00:03:09,509 --> 00:03:07,040
because we had never seen our planet

84
00:03:11,509 --> 00:03:09,519
like that before we'd never seen it just

85
00:03:13,750 --> 00:03:11,519
out there in space and see how fragile

86
00:03:15,509 --> 00:03:13,760
it is and it's probably no coincidence

87
00:03:16,949 --> 00:03:15,519
that you know just a little over a year

88
00:03:18,470 --> 00:03:16,959

later the first earth day was

89
00:03:20,869 --> 00:03:18,480
established

90
00:03:22,470 --> 00:03:20,879
people started taking a

91
00:03:25,270 --> 00:03:22,480
more increased interest in what we're

92
00:03:27,430 --> 00:03:25,280
doing and not long after that nasa

93
00:03:29,990 --> 00:03:27,440
started sending up fleets of satellites

94
00:03:33,509 --> 00:03:30,000
to study different elements of earth

95
00:03:35,750 --> 00:03:33,519
csat went up in 1978 to study our oceans

96
00:03:38,869 --> 00:03:35,760
and since then we have sent up a fleet

97
00:03:40,789 --> 00:03:38,879
of satellites bringing back earth data

98
00:03:48,390 --> 00:03:40,799
and to explain you what we do today to

99
00:03:51,190 --> 00:03:49,589
quietly

100
00:03:54,070 --> 00:03:51,200
like a night bird

101
00:03:56,630 --> 00:03:54,080
floating soaring wingless

102
00:03:57,750 --> 00:03:56,640
we glide from shore to shore

103
00:03:59,030 --> 00:03:57,760
curving

104
00:04:01,350 --> 00:03:59,040
and falling

105
00:04:02,309 --> 00:04:01,360
but not quite touching

106
00:04:04,949 --> 00:04:02,319
earth

107
00:04:06,390 --> 00:04:04,959
a distant memory seen in an instant of

108
00:04:07,830 --> 00:04:06,400
repose

109
00:04:09,350 --> 00:04:07,840
crescent-shaped

110
00:04:11,110 --> 00:04:09,360
ethereal

111
00:04:13,670 --> 00:04:11,120
beautiful

112
00:04:15,270 --> 00:04:13,680
like apollo 15 astronaut our warden who

113
00:04:17,030 --> 00:04:15,280

uttered these words

114
00:04:19,509 --> 00:04:17,040
sometimes you have to step back to see

115
00:04:23,749 --> 00:04:19,519
just how delicate our planet is and to

116
00:04:28,070 --> 00:04:26,469
hello i'm dr amber jenkins and i work

117
00:04:30,150 --> 00:04:28,080
with the scientists who study our home

118
00:04:32,950 --> 00:04:30,160
planet here at nasa's jet propulsion

119
00:04:35,270 --> 00:04:32,960
laboratory i'm here in jpl's space

120
00:04:36,870 --> 00:04:35,280
flight operations facility the nerve

121
00:04:39,350 --> 00:04:36,880
center for an amazing array of deep

122
00:04:41,670 --> 00:04:39,360
space missions but there's more to jpl

123
00:04:43,670 --> 00:04:41,680
than just studying other planets we also

124
00:04:45,189 --> 00:04:43,680
keep an eye on our home planet earth

125
00:04:48,070 --> 00:04:45,199
with nearly a dozen instruments that

126
00:04:50,310 --> 00:04:48,080
watch over the land sea ice and the

127
00:04:51,830 --> 00:04:50,320
atmosphere

128
00:04:54,629 --> 00:04:51,840
let's take a look at the satellites and

129
00:04:56,550 --> 00:04:54,639
instruments jpl builds for nasa

130
00:04:58,629 --> 00:04:56,560
they take many different paths to get

131
00:05:00,710 --> 00:04:58,639
their data a bit like bees buzzing

132
00:05:02,790 --> 00:05:00,720
around a hive

133
00:05:05,189 --> 00:05:02,800
some of jpl satellites are small enough

134
00:05:07,189 --> 00:05:05,199
to fit inside the trunk of a car

135
00:05:09,670 --> 00:05:07,199
some are much bigger

136
00:05:11,670 --> 00:05:09,680
and each one tells us something unique

137
00:05:16,870 --> 00:05:11,680
about the pieces of the puzzle of planet

138
00:05:21,189 --> 00:05:18,950

about 70 percent of the earth's surface

139
00:05:22,950 --> 00:05:21,199
is covered by water

140
00:05:26,550 --> 00:05:22,960
the oceans are home to some of the most

141
00:05:28,469 --> 00:05:26,560
amazing plants and animals in the world

142
00:05:30,469 --> 00:05:28,479
millions of people depend on the oceans

143
00:05:36,710 --> 00:05:30,479
for food

144
00:05:41,670 --> 00:05:38,710
the oceans store energy in the form of

145
00:05:43,350 --> 00:05:41,680
heat when the jason-2 mission uses radar

146
00:05:44,950 --> 00:05:43,360
to bounce microwaves off the ocean's

147
00:05:47,350 --> 00:05:44,960
surface and measure the height of the

148
00:05:50,550 --> 00:05:47,360
seas all over the globe we can see

149
00:05:54,790 --> 00:05:52,390
our oceans have been getting warmer in

150
00:05:58,550 --> 00:05:54,800
recent decades causing them to expand

151
00:06:02,710 --> 00:06:00,790
in this map we've exaggerated the peaks

152
00:06:05,270 --> 00:06:02,720
and troughs so you can see how water

153
00:06:07,590 --> 00:06:05,280
temperatures affect sea surface height

154
00:06:09,830 --> 00:06:07,600
the blues are areas of cool water and

155
00:06:11,670 --> 00:06:09,840
the reds show regions of warmer water

156
00:06:14,469 --> 00:06:11,680
where sea level has risen

157
00:06:17,909 --> 00:06:14,479
the amount of heat stored by the oceans

158
00:06:19,990 --> 00:06:17,919
can have a huge impact on our climate

159
00:06:21,670 --> 00:06:20,000
knowing the facts and the places where

160
00:06:23,830 --> 00:06:21,680
warm and cool water are at any

161
00:06:25,749 --> 00:06:23,840
particular time give scientists a

162
00:06:28,629 --> 00:06:25,759
fantastic tool for tracking climate

163
00:06:30,790 --> 00:06:28,639

change all over the world

164
00:06:33,110 --> 00:06:30,800
at jpl we also care about what's going

165
00:06:37,350 --> 00:06:33,120
on on the land and how ice and glaciers

166
00:06:41,270 --> 00:06:39,350
everything is constantly changing even

167
00:06:43,270 --> 00:06:41,280
gravity

168
00:06:45,189 --> 00:06:43,280
nasa's twin grey satellites show how

169
00:06:46,150 --> 00:06:45,199
gravity changes from one month to the

170
00:06:48,070 --> 00:06:46,160
next

171
00:06:49,589 --> 00:06:48,080
this time red is where the planet's

172
00:06:51,830 --> 00:06:49,599
gravity field has grown slightly

173
00:06:54,230 --> 00:06:51,840
stronger blue shows where the gravity

174
00:06:56,230 --> 00:06:54,240
field has become slightly weaker we can

175
00:06:58,550 --> 00:06:56,240
really exaggerate the differences to see

176
00:07:00,950 --> 00:06:58,560
them better by watching how gravity

177
00:07:02,710 --> 00:07:00,960
changes we can track how water and ice

178
00:07:05,589 --> 00:07:02,720
move around the planet

179
00:07:07,909 --> 00:07:05,599
see that blue hole covering greenland

180
00:07:11,670 --> 00:07:07,919
it tells us that the ice in this area is

181
00:07:16,550 --> 00:07:13,589
okay we've looked at the land and at the

182
00:07:18,629 --> 00:07:16,560
sea what about the atmosphere with its

183
00:07:21,670 --> 00:07:18,639
hurricanes

184
00:07:24,150 --> 00:07:21,680
and ever-changing nature

185
00:07:26,950 --> 00:07:24,160
heirs is an infrared instrument that

186
00:07:29,189 --> 00:07:26,960
flies on board nasa's aqua satellite it

187
00:07:31,270 --> 00:07:29,199
helps create global maps of air and

188
00:07:33,350 --> 00:07:31,280

surface temperature

189
00:07:35,189 --> 00:07:33,360
of carbon dioxide

190
00:07:37,029 --> 00:07:35,199
and of water vapour

191
00:07:39,670 --> 00:07:37,039
these are important greenhouse gases

192
00:07:41,990 --> 00:07:39,680
that can change our climate

193
00:07:44,629 --> 00:07:42,000
check out this 3d view of carbon dioxide

194
00:07:46,790 --> 00:07:44,639
at 18 000 feet above sea level warmer

195
00:07:50,150 --> 00:07:46,800
colors like yellow and red show hot

196
00:07:52,390 --> 00:07:50,160
spots where there is more carbon dioxide

197
00:07:54,629 --> 00:07:52,400
where is all this red coming from

198
00:07:57,510 --> 00:07:54,639
it comes from both natural processes and

199
00:07:59,909 --> 00:07:57,520
human activities you add carbon dioxide

200
00:08:01,670 --> 00:07:59,919
into the air every time you drive a car

201
00:08:06,710 --> 00:08:01,680
or use electricity made from burning

202
00:08:10,950 --> 00:08:09,110
jpl has many ways to take the pulse of

203
00:08:12,790 --> 00:08:10,960
our planet from space

204
00:08:14,790 --> 00:08:12,800
our scientists and engineers work with

205
00:08:18,150 --> 00:08:14,800
space agencies and institutes around the

206
00:08:19,749 --> 00:08:18,160
world to track earth's vital signs

207
00:08:21,990 --> 00:08:19,759
new missions will be going up soon to

208
00:08:25,670 --> 00:08:22,000
bring back even more clues about the

209
00:08:29,350 --> 00:08:25,680
oceans land ice atmosphere and how our

210
00:08:34,230 --> 00:08:31,270
i hope you've enjoyed our little tour

211
00:08:36,230 --> 00:08:34,240
remember our planet a small blue dot in

212
00:08:39,350 --> 00:08:36,240
the vastness of space is all that we

213
00:08:54,070 --> 00:08:39,360

have so let's take good care of it earth

214
00:08:54,080 --> 00:08:58,870
all right

215
00:09:04,230 --> 00:09:00,790
so that gives you just a little bit of a

216
00:09:06,070 --> 00:09:04,240
taste of um of what we do and the first

217
00:09:07,990 --> 00:09:06,080
guest that i am going to introduce to

218
00:09:10,389 --> 00:09:08,000
talk to you is the gentleman who is in

219
00:09:12,470 --> 00:09:10,399
fact the deputy director of our earth

220
00:09:13,829 --> 00:09:12,480
science directorate so he knows every

221
00:09:16,949 --> 00:09:13,839
one of these missions and everything

222
00:09:20,230 --> 00:09:16,959
coming up uh he is jim graf he has been

223
00:09:22,230 --> 00:09:20,240
at jpl since 1974 working on various

224
00:09:24,389 --> 00:09:22,240
missions i first met jim in 1999 when

225
00:09:26,389 --> 00:09:24,399
you were working on quickscat which was

226
00:09:27,750 --> 00:09:26,399
an effort to get satellite in space to

227
00:09:29,910 --> 00:09:27,760
study winds that had to be done within

228
00:09:31,030 --> 00:09:29,920
about a year's time and they managed to

229
00:09:32,790 --> 00:09:31,040
do that

230
00:09:34,949 --> 00:09:32,800
following quick scat

231
00:09:37,110 --> 00:09:34,959
jim left earth and went to mars for a

232
00:09:38,710 --> 00:09:37,120
little while he actually was the project

233
00:09:41,110 --> 00:09:38,720
manager for the spacecraft there at the

234
00:09:42,230 --> 00:09:41,120
back of the room the mars reconnaissance

235
00:09:44,870 --> 00:09:42,240
orbiter

236
00:09:46,150 --> 00:09:44,880
and uh following that after spying on

237
00:09:48,150 --> 00:09:46,160
mars for a little while that mission is

238
00:09:49,990 --> 00:09:48,160

still going by the way many many

239
00:09:51,430 --> 00:09:50,000
incredible images of the surface of mars

240
00:09:52,710 --> 00:09:51,440
come from that but jim decided to come

241
00:09:55,350 --> 00:09:52,720
back to earth

242
00:09:57,269 --> 00:09:55,360
and take up this position leading really

243
00:09:58,870 --> 00:09:57,279
the directorate of of with all these

244
00:10:00,150 --> 00:09:58,880
different missions as deputy director so

245
00:10:05,030 --> 00:10:00,160
jim graf

246
00:10:08,550 --> 00:10:06,790
welcome to jpl

247
00:10:10,470 --> 00:10:08,560
and they've given me 10 minutes so i've

248
00:10:11,990 --> 00:10:10,480
got a lot of material to get through

249
00:10:13,829 --> 00:10:12,000
then we're going to have a question and

250
00:10:16,069 --> 00:10:13,839
answer right after that so if you've got

251
00:10:18,389 --> 00:10:16,079
some questions just let me know

252
00:10:20,710 --> 00:10:18,399
let's start with the first image please

253
00:10:22,870 --> 00:10:20,720
uh that's our planet earth

254
00:10:25,030 --> 00:10:22,880
but that planet is very difficult to

255
00:10:26,790 --> 00:10:25,040
understand it's very complex

256
00:10:28,389 --> 00:10:26,800
and when you start looking at a planet

257
00:10:30,069 --> 00:10:28,399
you have to start realizing you're

258
00:10:33,350 --> 00:10:30,079
measuring a lot of different variables

259
00:10:35,269 --> 00:10:33,360
or items to understand what's happening

260
00:10:37,350 --> 00:10:35,279
and you have to you have to measure them

261
00:10:39,190 --> 00:10:37,360
over 3d you got to worry about what's

262
00:10:40,550 --> 00:10:39,200
happening in the atmosphere at different

263
00:10:43,430 --> 00:10:40,560

layers in the atmosphere you have to

264
00:10:44,949 --> 00:10:43,440
worry about the surface and essentially

265
00:10:46,949 --> 00:10:44,959
what what about the land surface what

266
00:10:48,470 --> 00:10:46,959
about the water surface and then you

267
00:10:50,710 --> 00:10:48,480
have to worry about what goes on

268
00:10:52,069 --> 00:10:50,720
underneath the surface of the land

269
00:10:54,630 --> 00:10:52,079
and i'm going to tell you a little bit

270
00:10:57,110 --> 00:10:54,640
about what we measure as we go and we

271
00:10:59,110 --> 00:10:57,120
look at this in a 3d version the other

272
00:11:01,030 --> 00:10:59,120
thing to keep in mind is

273
00:11:03,030 --> 00:11:01,040
you're looking at this temporally you're

274
00:11:05,670 --> 00:11:03,040
looking at it over time it's not just

275
00:11:07,030 --> 00:11:05,680
what's happening right now this instant

276
00:11:09,269 --> 00:11:07,040
it's what happens

277
00:11:12,389 --> 00:11:09,279
over this this week

278
00:11:14,150 --> 00:11:12,399
over this month the year and the decade

279
00:11:16,310 --> 00:11:14,160
all of that plays into understanding

280
00:11:17,829 --> 00:11:16,320
what's going on with earth and then just

281
00:11:19,269 --> 00:11:17,839
when you think you got it all worked out

282
00:11:20,949 --> 00:11:19,279
and you're making the right measurements

283
00:11:21,750 --> 00:11:20,959
and you think you've got time scales

284
00:11:24,069 --> 00:11:21,760
down

285
00:11:25,990 --> 00:11:24,079
mother earth comes along and throws a

286
00:11:28,870 --> 00:11:26,000
little monkey wrench into you throws up

287
00:11:31,430 --> 00:11:28,880
a volcano throws an el nino and pretty

288
00:11:34,150 --> 00:11:31,440

soon you say okay all bets are off so

289
00:11:35,910 --> 00:11:34,160
this is a very very complex system

290
00:11:38,550 --> 00:11:35,920
that we have to on don't have to

291
00:11:40,230 --> 00:11:38,560
understand your planet is really giving

292
00:11:42,069 --> 00:11:40,240
us fits and we're doing everything we

293
00:11:43,269 --> 00:11:42,079
can to try to understand what's

294
00:11:45,350 --> 00:11:43,279
happening here

295
00:11:47,030 --> 00:11:45,360
so let's start talking about

296
00:11:48,949 --> 00:11:47,040
some of the three-dimensional

297
00:11:52,230 --> 00:11:48,959
measurements that we do make

298
00:11:54,230 --> 00:11:52,240
this is a picture of a graph that's

299
00:11:55,750 --> 00:11:54,240
called the keeling curve i don't know

300
00:11:57,430 --> 00:11:55,760
how many of you are familiar with it but

301
00:12:00,389 --> 00:11:57,440
the keeling curve actually measures the

302
00:12:03,030 --> 00:12:00,399
amount of co2 carbon dioxide

303
00:12:05,030 --> 00:12:03,040
directly above mauna loa

304
00:12:06,150 --> 00:12:05,040
keeling went out there in 1958 and he

305
00:12:07,910 --> 00:12:06,160
started saying i'm going to start

306
00:12:10,550 --> 00:12:07,920
measuring this and he he just put a

307
00:12:13,269 --> 00:12:10,560
device up started measuring the co2

308
00:12:15,910 --> 00:12:13,279
and watched it over a period of time the

309
00:12:17,430 --> 00:12:15,920
little sawtooth that you see there

310
00:12:19,110 --> 00:12:17,440
the little ones

311
00:12:21,350 --> 00:12:19,120
is the earth breathing that's what

312
00:12:23,030 --> 00:12:21,360
happens on a natural cycle over the

313
00:12:25,750 --> 00:12:23,040

course of a year in the northern

314
00:12:27,990 --> 00:12:25,760
hemisphere co2 goes down the co2 comes

315
00:12:30,069 --> 00:12:28,000
back up but if you look at the general

316
00:12:31,350 --> 00:12:30,079
curve it's going up

317
00:12:34,150 --> 00:12:31,360
if you looked at this curve and were

318
00:12:36,470 --> 00:12:34,160
able to take the measurement back in

319
00:12:38,509 --> 00:12:36,480
pre-industrial age you'd see that all

320
00:12:41,910 --> 00:12:38,519
the way down to about

321
00:12:44,230 --> 00:12:41,920
280 parts per million these are parts

322
00:12:46,550 --> 00:12:44,240
per million that you're measuring there

323
00:12:48,790 --> 00:12:46,560
and yeah it was a big flap in the papers

324
00:12:51,670 --> 00:12:48,800
that on may 2nd

325
00:12:53,030 --> 00:12:51,680
it got to 400 parts per million so what

326
00:12:57,110 --> 00:12:53,040
does that tell you it says the carbon

327
00:12:57,990 --> 00:12:57,120
dioxide in the atmosphere is going up

328
00:12:59,430 --> 00:12:58,000
so

329
00:13:01,030 --> 00:12:59,440
that's a greenhouse gas that's

330
00:13:02,550 --> 00:13:01,040
contributing to heating of the

331
00:13:04,550 --> 00:13:02,560
atmosphere so this is one of the

332
00:13:06,870 --> 00:13:04,560
measurements that we have to make and

333
00:13:08,550 --> 00:13:06,880
one of the one of the

334
00:13:11,110 --> 00:13:08,560
subsequent speakers will be talking

335
00:13:15,030 --> 00:13:11,120
about a spacecraft being launched next

336
00:13:18,150 --> 00:13:15,040
july july 1st called oco

337
00:13:20,629 --> 00:13:18,160
it's the orbiting carbon observatory and

338
00:13:22,949 --> 00:13:20,639

its measurements will be made just like

339
00:13:25,110 --> 00:13:22,959
this but looking down from space

340
00:13:27,430 --> 00:13:25,120
and over the entire sunlit portion of

341
00:13:29,509 --> 00:13:27,440
the globe so it's not just in one place

342
00:13:31,509 --> 00:13:29,519
so we'll start understanding what's

343
00:13:33,750 --> 00:13:31,519
happening where the co2 is coming from

344
00:13:35,990 --> 00:13:33,760
and where the co2 is going to

345
00:13:37,430 --> 00:13:36,000
the sinks and the sources of co2 so

346
00:13:39,189 --> 00:13:37,440
that's one of the important things that

347
00:13:40,550 --> 00:13:39,199
we have there are other elements about

348
00:13:41,590 --> 00:13:40,560
the atmosphere that you have to worry

349
00:13:43,910 --> 00:13:41,600
about

350
00:13:46,069 --> 00:13:43,920
if you sit down here do you like smog

351
00:13:49,110 --> 00:13:46,079
the answer is no that smog is bad well a

352
00:13:50,710 --> 00:13:49,120
big constituent of smog is ozone so we

353
00:13:52,470 --> 00:13:50,720
don't want ozone down here in the

354
00:13:54,389 --> 00:13:52,480
troposphere down here where we breathe

355
00:13:56,310 --> 00:13:54,399
our air however

356
00:13:58,389 --> 00:13:56,320
if you go up into the stratosphere above

357
00:14:00,470 --> 00:13:58,399
well above where the planes fly all of a

358
00:14:02,790 --> 00:14:00,480
sudden you do want your ozone there

359
00:14:04,550 --> 00:14:02,800
because you talk about the ozone hole if

360
00:14:06,389 --> 00:14:04,560
the ozone's not up there then we get the

361
00:14:08,389 --> 00:14:06,399
high energy radiation particles that

362
00:14:10,150 --> 00:14:08,399
come down and that's not good for us so

363
00:14:11,590 --> 00:14:10,160

when we start making measurements about

364
00:14:14,310 --> 00:14:11,600
our planet what we're really trying to

365
00:14:16,870 --> 00:14:14,320
do is understand these different

366
00:14:18,790 --> 00:14:16,880
chemistries all over the globe

367
00:14:20,150 --> 00:14:18,800
and in some cases they're beneficial

368
00:14:21,590 --> 00:14:20,160
some cases they're not we've got to

369
00:14:23,430 --> 00:14:21,600
measure them high we have to measure

370
00:14:25,670 --> 00:14:23,440
them low we have to measure them over a

371
00:14:27,269 --> 00:14:25,680
period of time to see what's happened

372
00:14:29,110 --> 00:14:27,279
in the next view graph i'm going to move

373
00:14:30,710 --> 00:14:29,120
from the atmosphere i'm going to move to

374
00:14:33,110 --> 00:14:30,720
the water

375
00:14:35,269 --> 00:14:33,120
and this is an interesting chart this

376
00:14:38,790 --> 00:14:35,279
has been compiled

377
00:14:41,590 --> 00:14:38,800
by our sister agency uh canes the space

378
00:14:43,350 --> 00:14:41,600
agency from france as well as nasa here

379
00:14:46,069 --> 00:14:43,360
and represents three missions that we've

380
00:14:48,949 --> 00:14:46,079
flown to date starting in about 19 i

381
00:14:51,350 --> 00:14:48,959
think was 92 we got launched

382
00:14:51,990 --> 00:14:51,360
topex poseidon and jason one and jason

383
00:14:53,910 --> 00:14:52,000
ii

384
00:14:55,590 --> 00:14:53,920
we do that because the spacecraft wear

385
00:14:57,990 --> 00:14:55,600
out when they're up there so we have to

386
00:15:00,150 --> 00:14:58,000
get new spacecraft up there to continue

387
00:15:02,230 --> 00:15:00,160
the measurement so over this 20-year

388
00:15:04,550 --> 00:15:02,240

period what you're measuring is the

389
00:15:07,030 --> 00:15:04,560
height of the of the oceans the average

390
00:15:08,949 --> 00:15:07,040
height of sea surface

391
00:15:09,670 --> 00:15:08,959
and what does it tell you it tells you

392
00:15:11,670 --> 00:15:09,680
that

393
00:15:15,030 --> 00:15:11,680
the level the mean level of the oceans

394
00:15:16,470 --> 00:15:15,040
have rising about three millimeters

395
00:15:18,550 --> 00:15:16,480
per year

396
00:15:21,110 --> 00:15:18,560
on the average that's a little bit more

397
00:15:22,949 --> 00:15:21,120
than one tenth of an inch over the

398
00:15:26,230 --> 00:15:22,959
20-year period

399
00:15:28,790 --> 00:15:26,240
we've seen about two plus inches of rise

400
00:15:30,069 --> 00:15:28,800
in the average height of the oceans

401
00:15:31,749 --> 00:15:30,079
this is very important if you're

402
00:15:33,829 --> 00:15:31,759
starting to say hey what's going to

403
00:15:35,749 --> 00:15:33,839
happen in 30 years

404
00:15:37,749 --> 00:15:35,759
and what's going to happen to the ports

405
00:15:40,710 --> 00:15:37,759
and the beaches as the sea level

406
00:15:43,189 --> 00:15:40,720
continues to rise as we get storm surge

407
00:15:45,430 --> 00:15:43,199
on top of high tides so all of that

408
00:15:48,069 --> 00:15:45,440
plays into what's happening in this in

409
00:15:49,749 --> 00:15:48,079
this planet as you heard in the movie

410
00:15:51,910 --> 00:15:49,759
there's actually

411
00:15:53,829 --> 00:15:51,920
three components to this rise that we're

412
00:15:56,230 --> 00:15:53,839
thinking of the first one is the fact

413
00:15:58,150 --> 00:15:56,240

that as the planet gets warmer the

414
00:16:00,389 --> 00:15:58,160
oceans get warmer as the ocean if water

415
00:16:02,389 --> 00:16:00,399
gets warmer it actually expands

416
00:16:04,310 --> 00:16:02,399
so that contributes to some of it

417
00:16:07,030 --> 00:16:04,320
another portion of it

418
00:16:09,030 --> 00:16:07,040
is that you have a lot of loss in

419
00:16:12,230 --> 00:16:09,040
greenland and in antarctica they're

420
00:16:14,629 --> 00:16:12,240
steadily losing ice and snow that is

421
00:16:16,790 --> 00:16:14,639
coming off of the land and for going

422
00:16:18,310 --> 00:16:16,800
into the water as it melts so that's

423
00:16:20,069 --> 00:16:18,320
increasing

424
00:16:22,069 --> 00:16:20,079
the sea level then the last one of

425
00:16:23,910 --> 00:16:22,079
course is you have glaciers all around

426
00:16:26,470 --> 00:16:23,920
the world in mountains that are melting

427
00:16:28,230 --> 00:16:26,480
and falling back from the ocean

428
00:16:29,990 --> 00:16:28,240
as they go up the go up into the

429
00:16:31,829 --> 00:16:30,000
mountains and melt that water comes down

430
00:16:33,269 --> 00:16:31,839
and that contributes so that's that

431
00:16:36,310 --> 00:16:33,279
whole rise there

432
00:16:38,710 --> 00:16:36,320
but remember what i said you got to

433
00:16:40,710 --> 00:16:38,720
measure it over a period of time and

434
00:16:42,870 --> 00:16:40,720
mother nature does throw a little bit of

435
00:16:44,870 --> 00:16:42,880
a monkey wrench into you if you look in

436
00:16:46,389 --> 00:16:44,880
the upper portion up there

437
00:16:47,990 --> 00:16:46,399
you'll see a dip

438
00:16:50,150 --> 00:16:48,000

on that curve

439
00:16:51,430 --> 00:16:50,160
you say okay the ocean's been rising

440
00:16:53,749 --> 00:16:51,440
you're measuring it and all of a sudden

441
00:16:55,430 --> 00:16:53,759
it dips where's the water go

442
00:16:57,030 --> 00:16:55,440
so some of our scientists were able to

443
00:16:58,790 --> 00:16:57,040
find that out

444
00:17:02,230 --> 00:16:58,800
it turns out if you remember back in

445
00:17:05,350 --> 00:17:02,240
2010 2011 there were tremendous floods

446
00:17:07,429 --> 00:17:05,360
down in australia also flooding was

447
00:17:10,230 --> 00:17:07,439
happening in south america the water

448
00:17:13,829 --> 00:17:10,240
actually evaporated out of the oceans

449
00:17:15,909 --> 00:17:13,839
moved and landed on the land itself

450
00:17:18,630 --> 00:17:15,919
and so we saw that dip but what happened

451
00:17:20,630 --> 00:17:18,640
when all that water flowed off

452
00:17:22,150 --> 00:17:20,640
it went back into the ocean and we went

453
00:17:24,470 --> 00:17:22,160
back up to the curve that we're looking

454
00:17:26,390 --> 00:17:24,480
at here so it's very important to be

455
00:17:28,309 --> 00:17:26,400
able to measure this over a long time

456
00:17:30,549 --> 00:17:28,319
series

457
00:17:31,430 --> 00:17:30,559
we have a mission going up also in the

458
00:17:33,029 --> 00:17:31,440
next

459
00:17:35,029 --> 00:17:33,039
we were talking about five missions that

460
00:17:36,789 --> 00:17:35,039
will be launched in a period of about 12

461
00:17:38,549 --> 00:17:36,799
months starting next spring

462
00:17:40,870 --> 00:17:38,559
and one of them is jason 3 which will

463
00:17:43,830 --> 00:17:40,880

continue this time series

464
00:17:45,750 --> 00:17:43,840
and give us a continued uh

465
00:17:47,909 --> 00:17:45,760
assessment of what's happening

466
00:17:50,549 --> 00:17:47,919
the other players in that now are not

467
00:17:51,830 --> 00:17:50,559
just canes the french agency and nasa

468
00:17:54,549 --> 00:17:51,840
but also

469
00:17:56,549 --> 00:17:54,559
you met sat over in europe and noah here

470
00:17:58,150 --> 00:17:56,559
who produces your weather forecasts are

471
00:18:00,710 --> 00:17:58,160
also supporting this activity because

472
00:18:04,070 --> 00:18:00,720
this is a very important measurement

473
00:18:07,510 --> 00:18:05,830
okay so we've talked about the

474
00:18:09,510 --> 00:18:07,520
atmosphere we've talked about the water

475
00:18:11,909 --> 00:18:09,520
let's go ahead and talk about

476
00:18:14,549 --> 00:18:11,919
the land the surface itself what you're

477
00:18:16,150 --> 00:18:14,559
seeing here is a small image and it

478
00:18:17,510 --> 00:18:16,160
might looks it might look strange to you

479
00:18:19,190 --> 00:18:17,520
but let me see if i can explain to you

480
00:18:21,510 --> 00:18:19,200
what you're looking at it's a it's a

481
00:18:24,230 --> 00:18:21,520
land image from taiwan

482
00:18:25,909 --> 00:18:24,240
and we flew overhead with us with a

483
00:18:28,150 --> 00:18:25,919
radar that looked at the surface and

484
00:18:29,510 --> 00:18:28,160
measured the contours of the surface

485
00:18:31,350 --> 00:18:29,520
shortly thereafter there was an

486
00:18:33,669 --> 00:18:31,360
earthquake and we came back overhead

487
00:18:35,990 --> 00:18:33,679
again and measured the change so those

488
00:18:38,070 --> 00:18:36,000

little undulations in those concentric

489
00:18:39,190 --> 00:18:38,080
circles

490
00:18:40,230 --> 00:18:39,200
represent

491
00:18:42,870 --> 00:18:40,240
actually

492
00:18:45,430 --> 00:18:42,880
modulations increase in height each one

493
00:18:47,190 --> 00:18:45,440
of those cycles is about an inch so it's

494
00:18:49,350 --> 00:18:47,200
gone up an inch

495
00:18:52,070 --> 00:18:49,360
over a course of five or ten kilometers

496
00:18:54,470 --> 00:18:52,080
and because of the earthquake it's moved

497
00:18:56,789 --> 00:18:54,480
the earth it's squashed it it's moved it

498
00:18:58,390 --> 00:18:56,799
up it's made changes to it we're

499
00:19:00,390 --> 00:18:58,400
starting to be able now with our

500
00:19:02,390 --> 00:19:00,400
instrumentation to be able to measure

501
00:19:03,669 --> 00:19:02,400
those changes

502
00:19:05,190 --> 00:19:03,679
let's talk about

503
00:19:09,110 --> 00:19:05,200
going under

504
00:19:13,990 --> 00:19:11,190
this is aetna

505
00:19:16,150 --> 00:19:14,000
you guys know about aetna

506
00:19:18,630 --> 00:19:16,160
it just erupted last week you saw

507
00:19:20,870 --> 00:19:18,640
pictures of lava coming up and you saw

508
00:19:22,789 --> 00:19:20,880
uh your planes were diverted away from

509
00:19:24,549 --> 00:19:22,799
it that's on the island of sicily what

510
00:19:25,990 --> 00:19:24,559
you're looking at is a

511
00:19:26,950 --> 00:19:26,000
is a time

512
00:19:31,029 --> 00:19:26,960
lapse

513
00:19:32,870 --> 00:19:31,039

of of the magma chamber inside the the

514
00:19:34,710 --> 00:19:32,880
mountain actually coming and pushing the

515
00:19:37,190 --> 00:19:34,720
mountain up and down

516
00:19:39,190 --> 00:19:37,200
the range is plus six to minus four

517
00:19:42,710 --> 00:19:39,200
inches so you got a 10 inch range that's

518
00:19:44,150 --> 00:19:42,720
happening over this 10 10 year period

519
00:19:45,510 --> 00:19:44,160
so as we fly overhead with our

520
00:19:47,190 --> 00:19:45,520
spacecraft

521
00:19:50,150 --> 00:19:47,200
we're able to make measurements here and

522
00:19:52,310 --> 00:19:50,160
actually measure the height of of the

523
00:19:53,990 --> 00:19:52,320
magma chamber and what's happening and

524
00:19:55,830 --> 00:19:54,000
so when you get to the red you've gone

525
00:19:57,669 --> 00:19:55,840
up about six inches

526
00:19:59,029 --> 00:19:57,679
so this is the whole this is this is

527
00:20:00,950 --> 00:19:59,039
what happens when you talk about the

528
00:20:03,750 --> 00:20:00,960
subsurface the whole

529
00:20:05,350 --> 00:20:03,760
world is moving on the surface and under

530
00:20:08,710 --> 00:20:05,360
the surface and we have to understand

531
00:20:11,110 --> 00:20:08,720
what those those elements are

532
00:20:12,789 --> 00:20:11,120
if we go to the next few graph

533
00:20:15,029 --> 00:20:12,799
we'll bring it back home

534
00:20:17,270 --> 00:20:15,039
what happens in our own la basin here

535
00:20:19,190 --> 00:20:17,280
what you're looking at is aquifers that

536
00:20:22,230 --> 00:20:19,200
are underneath the basin that are

537
00:20:25,350 --> 00:20:22,240
actually charging recharging of water

538
00:20:26,870 --> 00:20:25,360

and then the water gets pumped out

539
00:20:30,149 --> 00:20:26,880
so you're actually looking at the earth

540
00:20:32,149 --> 00:20:30,159
here as it takes in water and lets it go

541
00:20:33,990 --> 00:20:32,159
the average height is going up about two

542
00:20:36,390 --> 00:20:34,000
inches and down about two inches as you

543
00:20:37,669 --> 00:20:36,400
go over the course of the seven or so

544
00:20:38,789 --> 00:20:37,679
years that we've been making these

545
00:20:41,110 --> 00:20:38,799
measurements

546
00:20:42,950 --> 00:20:41,120
i must admit i must say that a lot of

547
00:20:46,630 --> 00:20:42,960
these measurements that you've seen come

548
00:20:49,830 --> 00:20:46,640
from ers one spacecraft earth resources

549
00:20:50,549 --> 00:20:49,840
satellite which comes from europe

550
00:20:51,830 --> 00:20:50,559
so

551
00:20:53,350 --> 00:20:51,840
you've got

552
00:20:55,669 --> 00:20:53,360
magma

553
00:20:58,230 --> 00:20:55,679
you've got moving you've got water

554
00:20:59,590 --> 00:20:58,240
moving under the uh under the surface

555
00:21:02,789 --> 00:20:59,600
you've got the surface moving you've got

556
00:21:04,630 --> 00:21:02,799
the atmosphere it's a completely dynamic

557
00:21:05,669 --> 00:21:04,640
system that we're trying to understand

558
00:21:07,270 --> 00:21:05,679
here

559
00:21:09,669 --> 00:21:07,280
each one of these measurements is a

560
00:21:11,110 --> 00:21:09,679
great in its own and helps us

561
00:21:12,950 --> 00:21:11,120
but we want to put it together so the

562
00:21:15,510 --> 00:21:12,960
next view graph

563
00:21:17,750 --> 00:21:15,520

we gotta start thinking about cycles

564
00:21:20,230 --> 00:21:17,760
again what i said is if you look at sea

565
00:21:22,390 --> 00:21:20,240
level rise that has impacts on the ports

566
00:21:24,950 --> 00:21:22,400
and what's happening there

567
00:21:26,230 --> 00:21:24,960
sea level what happens water evaporates

568
00:21:28,390 --> 00:21:26,240
goes into the it goes into the

569
00:21:30,390 --> 00:21:28,400
atmosphere what happens then

570
00:21:32,230 --> 00:21:30,400
well that affects our weather one of the

571
00:21:33,750 --> 00:21:32,240
biggest parameters we have that goes

572
00:21:36,230 --> 00:21:33,760
into your weather forecast is

573
00:21:38,950 --> 00:21:36,240
understanding what the water vapor is so

574
00:21:41,510 --> 00:21:38,960
in a on a scale this is this is really

575
00:21:43,990 --> 00:21:41,520
uh influences us on a daily basis and we

576
00:21:45,430 --> 00:21:44,000
want to make that measurement then it

577
00:21:47,350 --> 00:21:45,440
rains and we want to understand where

578
00:21:50,630 --> 00:21:47,360
it's raining and then you get the fresh

579
00:21:52,230 --> 00:21:50,640
water that's that stores

580
00:21:53,830 --> 00:21:52,240
and you want to measure what the heights

581
00:21:55,190 --> 00:21:53,840
the lakes are and the rivers are you

582
00:21:57,029 --> 00:21:55,200
want to know how much fresh water we

583
00:21:58,710 --> 00:21:57,039
have out there and then again it goes

584
00:22:01,270 --> 00:21:58,720
into the groundwater

585
00:22:03,750 --> 00:22:01,280
you were measuring aquifers

586
00:22:05,669 --> 00:22:03,760
as the aquifers increasing or decreasing

587
00:22:07,430 --> 00:22:05,679
which way are they generally going a lot

588
00:22:09,190 --> 00:22:07,440

of aquifers around the world are

589
00:22:12,310 --> 00:22:09,200
actually going down in the amount of

590
00:22:14,070 --> 00:22:12,320
water that they have in them as we pump

591
00:22:16,549 --> 00:22:14,080
more and more water out of it there's

592
00:22:18,070 --> 00:22:16,559
not enough recharge associated with it

593
00:22:20,230 --> 00:22:18,080
then you have soil moisture because

594
00:22:21,990 --> 00:22:20,240
that's critical to growing so you talk

595
00:22:23,590 --> 00:22:22,000
about cycles

596
00:22:25,190 --> 00:22:23,600
you've got to understand not just the

597
00:22:26,390 --> 00:22:25,200
individual

598
00:22:28,870 --> 00:22:26,400
elements but you want to understand the

599
00:22:30,470 --> 00:22:28,880
whole cycle and this is only one cycle

600
00:22:32,149 --> 00:22:30,480
there's the energy cycle there's the

601
00:22:34,390 --> 00:22:32,159
carbon cycle there's a whole bunch of

602
00:22:36,470 --> 00:22:34,400
them all of them working

603
00:22:38,710 --> 00:22:36,480
with one another or against one another

604
00:22:41,750 --> 00:22:38,720
at different times so understanding the

605
00:22:43,669 --> 00:22:41,760
planet here is really a challenging task

606
00:22:45,590 --> 00:22:43,679
next few graph

607
00:22:47,270 --> 00:22:45,600
so we talked about

608
00:22:49,270 --> 00:22:47,280
understanding the planet well we have to

609
00:22:51,510 --> 00:22:49,280
understand the planet

610
00:22:53,830 --> 00:22:51,520
not just on our vantage point

611
00:22:56,149 --> 00:22:53,840
but from a global perspective what

612
00:22:57,750 --> 00:22:56,159
happens here affects us now and we

613
00:22:58,789 --> 00:22:57,760

certainly want to know what what's

614
00:23:04,549 --> 00:22:58,799
happening

615
00:23:06,630 --> 00:23:04,559
the planet

616
00:23:09,909 --> 00:23:06,640
for instance el nino

617
00:23:12,070 --> 00:23:09,919
you have activity in the pacific ocean

618
00:23:14,070 --> 00:23:12,080
that affects our rainfall here

619
00:23:15,830 --> 00:23:14,080
our rainfall in the midwest

620
00:23:17,430 --> 00:23:15,840
when we say there's an el nino you can

621
00:23:19,990 --> 00:23:17,440
have more rain or less rain depending

622
00:23:22,870 --> 00:23:20,000
upon what's happening so you can't just

623
00:23:24,950 --> 00:23:22,880
say hey i'm going to look at my little

624
00:23:26,710 --> 00:23:24,960
area of the planet you have to look at

625
00:23:28,950 --> 00:23:26,720
the entire planet

626
00:23:30,630 --> 00:23:28,960
scale is important it's very important

627
00:23:33,350 --> 00:23:30,640
to understand what's happening all

628
00:23:34,549 --> 00:23:33,360
around when a volcano goes up

629
00:23:36,630 --> 00:23:34,559
what happens

630
00:23:38,070 --> 00:23:36,640
it spews into the atmosphere a lot of

631
00:23:39,510 --> 00:23:38,080
particles

632
00:23:41,110 --> 00:23:39,520
and that affects the sunlight that

633
00:23:42,870 --> 00:23:41,120
actually comes through

634
00:23:44,549 --> 00:23:42,880
and gets down to the planet it's to the

635
00:23:46,630 --> 00:23:44,559
surface here so a volcano on the other

636
00:23:47,990 --> 00:23:46,640
side of the of the planet can actually

637
00:23:50,390 --> 00:23:48,000
affect us here

638
00:23:51,830 --> 00:23:50,400

scale is very very important

639
00:23:54,310 --> 00:23:51,840
next view graph

640
00:23:55,590 --> 00:23:54,320
so what do we do from space we make lots

641
00:23:58,070 --> 00:23:55,600
of measurements

642
00:23:59,590 --> 00:23:58,080
we try to make uniform calibrated ones

643
00:24:00,870 --> 00:23:59,600
if you went out if you took a thousand

644
00:24:02,789 --> 00:24:00,880
people and you said okay you all have

645
00:24:04,310 --> 00:24:02,799
your own device go out here here and

646
00:24:06,070 --> 00:24:04,320
here and here and make your measurement

647
00:24:07,830 --> 00:24:06,080
i'll bet you those devices would not be

648
00:24:09,590 --> 00:24:07,840
well calibrated and when you get all

649
00:24:12,310 --> 00:24:09,600
your data back you'd be measuring well

650
00:24:15,029 --> 00:24:12,320
am i measuring a change on the phenomena

651
00:24:17,190 --> 00:24:15,039
i was trying to measure or

652
00:24:18,789 --> 00:24:17,200
is it because

653
00:24:21,350 --> 00:24:18,799
joe blow over here didn't have the right

654
00:24:23,190 --> 00:24:21,360
calibration in space we calibrate one

655
00:24:25,190 --> 00:24:23,200
instrument we spent a lot of time making

656
00:24:27,269 --> 00:24:25,200
it happen and then we apply that over

657
00:24:29,750 --> 00:24:27,279
the entire globe so we get a good

658
00:24:32,470 --> 00:24:29,760
calibrated sense of what we're looking

659
00:24:35,029 --> 00:24:32,480
at we can have frequent coverage

660
00:24:37,350 --> 00:24:35,039
we try to have a real global view of

661
00:24:38,870 --> 00:24:37,360
things and we create that long time

662
00:24:41,510 --> 00:24:38,880
series that i've been telling you about

663
00:24:43,990 --> 00:24:41,520

it's not just enough to look at it today

664
00:24:45,430 --> 00:24:44,000
we've got to look at it over a decade or

665
00:24:47,430 --> 00:24:45,440
longer

666
00:24:48,870 --> 00:24:47,440
so what are we doing about that next few

667
00:24:50,630 --> 00:24:48,880
graph

668
00:24:52,630 --> 00:24:50,640
nasa has got a fleet up here and i

669
00:24:55,269 --> 00:24:52,640
haven't counted them but there's like 15

670
00:24:56,710 --> 00:24:55,279
17 different spacecraft that are flying

671
00:24:58,070 --> 00:24:56,720
up there right now

672
00:25:00,070 --> 00:24:58,080
all of them are looking at different

673
00:25:01,029 --> 00:25:00,080
phenomena some on the space on the

674
00:25:02,470 --> 00:25:01,039
surface

675
00:25:04,470 --> 00:25:02,480
of the planet some looking at the

676
00:25:06,470 --> 00:25:04,480
atmosphere some looking at the sun

677
00:25:08,230 --> 00:25:06,480
to understand what the sun's input is to

678
00:25:10,549 --> 00:25:08,240
us

679
00:25:12,950 --> 00:25:10,559
so i'm trying to look under the surface

680
00:25:15,669 --> 00:25:12,960
at the changes that are manifesting

681
00:25:17,830 --> 00:25:15,679
itself so it's a very complex system of

682
00:25:19,990 --> 00:25:17,840
which jpl has contributed a tremendous

683
00:25:21,830 --> 00:25:20,000
number of instruments and spacecraft to

684
00:25:23,269 --> 00:25:21,840
this endeavor

685
00:25:26,149 --> 00:25:23,279
what are we going to do in the future

686
00:25:27,590 --> 00:25:26,159
let's look at the next view graph

687
00:25:30,310 --> 00:25:27,600
we have

688
00:25:31,669 --> 00:25:30,320

five launches coming up from jpl and

689
00:25:33,510 --> 00:25:31,679
there are two more from our sister

690
00:25:36,630 --> 00:25:33,520
centers that will be happening in the

691
00:25:38,710 --> 00:25:36,640
period starting next spring till

692
00:25:40,630 --> 00:25:38,720
spring of 15.

693
00:25:41,510 --> 00:25:40,640
first one well i got to tell you they're

694
00:25:43,350 --> 00:25:41,520
all different they're all making

695
00:25:46,070 --> 00:25:43,360
different measurements and they're all

696
00:25:47,990 --> 00:25:46,080
different sizes no one size fits all so

697
00:25:49,430 --> 00:25:48,000
the first one is called race

698
00:25:51,830 --> 00:25:49,440
you can barely see it over here on the

699
00:25:53,909 --> 00:25:51,840
left hand side that's a picture of parts

700
00:25:55,190 --> 00:25:53,919
of it right there in the pictures on the

701
00:25:57,190 --> 00:25:55,200
left

702
00:26:00,230 --> 00:25:57,200
race is what we call a cubesat anybody

703
00:26:02,789 --> 00:26:00,240
here know what a cubesat is

704
00:26:05,430 --> 00:26:02,799
excellent excellent

705
00:26:06,950 --> 00:26:05,440
would you like to see a full-scale

706
00:26:09,190 --> 00:26:06,960
model

707
00:26:12,390 --> 00:26:09,200
of what that spacecraft looks like

708
00:26:15,990 --> 00:26:13,590
that's it

709
00:26:18,390 --> 00:26:16,000
this is 3d printing

710
00:26:20,710 --> 00:26:18,400
that came and created a model what this

711
00:26:22,549 --> 00:26:20,720
will do will be launched

712
00:26:24,549 --> 00:26:22,559
it'll go into space and it'll make water

713
00:26:26,230 --> 00:26:24,559

vapor measurements

714
00:26:28,149 --> 00:26:26,240
a lot of young

715
00:26:29,590 --> 00:26:28,159
engineers at jpl are learning how to

716
00:26:30,950 --> 00:26:29,600
build spacecraft and how to build

717
00:26:32,710 --> 00:26:30,960
instruments and putting this together

718
00:26:35,350 --> 00:26:32,720
with the university of texas and we're

719
00:26:37,669 --> 00:26:35,360
going to fly it next next summer

720
00:26:39,430 --> 00:26:37,679
so that's that's the first one

721
00:26:41,269 --> 00:26:39,440
that's the little one over here these

722
00:26:43,510 --> 00:26:41,279
are roughly the scale by the way the

723
00:26:46,710 --> 00:26:43,520
next one is rapid scat so sometimes we

724
00:26:49,029 --> 00:26:46,720
build new ones sometimes we build

725
00:26:50,549 --> 00:26:49,039
we save money and we try to take parts

726
00:26:52,390 --> 00:26:50,559
of old ones and put them together and

727
00:26:53,750 --> 00:26:52,400
that's what rapid rapidscat is doing and

728
00:26:55,029 --> 00:26:53,760
i believe howard eisen is going to be

729
00:26:56,549 --> 00:26:55,039
talking later

730
00:26:58,310 --> 00:26:56,559
he's in the back of the room about that

731
00:27:00,470 --> 00:26:58,320
so i don't want to steal his thunder on

732
00:27:01,990 --> 00:27:00,480
it but that is a vital measurement to

733
00:27:04,710 --> 00:27:02,000
help us understand

734
00:27:06,950 --> 00:27:04,720
the um the the wind velocity at the

735
00:27:08,470 --> 00:27:06,960
surface of the ocean and we say well

736
00:27:10,470 --> 00:27:08,480
what does that mean well

737
00:27:12,230 --> 00:27:10,480
when at the surface of the ocean drives

738
00:27:13,750 --> 00:27:12,240

the ocean currents the ocean currents

739
00:27:15,110 --> 00:27:13,760
have heat and they distribute that

740
00:27:17,190 --> 00:27:15,120
around the planet so if you want to

741
00:27:18,549 --> 00:27:17,200
understand ocean circulation

742
00:27:20,789 --> 00:27:18,559
and the energy cycle you want to

743
00:27:23,190 --> 00:27:20,799
understand that but it also the weather

744
00:27:25,350 --> 00:27:23,200
forecasters use it for better

745
00:27:26,789 --> 00:27:25,360
water weather forecasting for you as

746
00:27:29,190 --> 00:27:26,799
well as

747
00:27:31,430 --> 00:27:29,200
also for tracking hurricanes and things

748
00:27:34,389 --> 00:27:31,440
so he's got a real challenge trying to

749
00:27:36,950 --> 00:27:34,399
put one of these up very cheaply

750
00:27:38,789 --> 00:27:36,960
the second one is jason iii jason iii as

751
00:27:39,990 --> 00:27:38,799
i mentioned earlier will continue that

752
00:27:41,590 --> 00:27:40,000
vital measurement that we've been

753
00:27:42,630 --> 00:27:41,600
talking about of the height of the

754
00:27:44,950 --> 00:27:42,640
oceans

755
00:27:47,990 --> 00:27:44,960
and continue that for probably another

756
00:27:51,990 --> 00:27:48,000
three to five years after its launch

757
00:27:53,990 --> 00:27:52,000
then we have oco-2 which is uh

758
00:27:57,269 --> 00:27:54,000
we'll measure the

759
00:27:59,350 --> 00:27:57,279
co2 column the carbon dioxide cone

760
00:28:00,789 --> 00:27:59,360
remember like the keating curve only the

761
00:28:02,630 --> 00:28:00,799
inverse

762
00:28:04,630 --> 00:28:02,640
you might say this is two

763
00:28:06,630 --> 00:28:04,640

you might say well what happened to one

764
00:28:08,870 --> 00:28:06,640
we tried to lodge one a couple of years

765
00:28:11,110 --> 00:28:08,880
ago and it didn't make it off the launch

766
00:28:13,110 --> 00:28:11,120
vehicle the actual there was a failure

767
00:28:15,350 --> 00:28:13,120
in the launch and it wound up in the

768
00:28:17,909 --> 00:28:15,360
ocean so we have a second one to go up

769
00:28:20,230 --> 00:28:17,919
to replace that measurement

770
00:28:22,549 --> 00:28:20,240
and the last one in this time period is

771
00:28:24,630 --> 00:28:22,559
smap smap is soil moisture active

772
00:28:26,549 --> 00:28:24,640
passive and if you look at the model in

773
00:28:28,230 --> 00:28:26,559
the corner back there that's a third

774
00:28:30,789 --> 00:28:28,240
scale model of this

775
00:28:32,870 --> 00:28:30,799
that antenna revolves around it's going

776
00:28:34,950 --> 00:28:32,880
to be now that that's two meters that's

777
00:28:37,430 --> 00:28:34,960
the third scale so the full scale one

778
00:28:39,510 --> 00:28:37,440
will be six meters that's about 20 20

779
00:28:41,669 --> 00:28:39,520
feet across and it's going to rotate

780
00:28:43,510 --> 00:28:41,679
once about every four seconds

781
00:28:45,110 --> 00:28:43,520
and that enables us to look at the

782
00:28:46,470 --> 00:28:45,120
entire globe

783
00:28:48,230 --> 00:28:46,480
in three days

784
00:28:50,549 --> 00:28:48,240
because of what we're trying to do and

785
00:28:53,350 --> 00:28:50,559
we're measuring the amount of moisture

786
00:28:55,909 --> 00:28:53,360
in the soil with that with that mission

787
00:28:58,470 --> 00:28:55,919
so those are five missions starting next

788
00:29:00,070 --> 00:28:58,480

spring that we will be putting up to try

789
00:29:01,669 --> 00:29:00,080
to help you

790
00:29:03,510 --> 00:29:01,679
to better understand

791
00:29:05,750 --> 00:29:03,520
your planet here

792
00:29:07,190 --> 00:29:05,760
so that's what i have um take some

793
00:29:12,149 --> 00:29:07,200
questions

794
00:29:17,669 --> 00:29:14,470
because as you can see we have a ton of

795
00:29:19,750 --> 00:29:17,679
great spacecraft and so much science um

796
00:29:21,830 --> 00:29:19,760
questions for jim can be submitted via

797
00:29:23,909 --> 00:29:21,840
social media using the hashtags

798
00:29:26,389 --> 00:29:23,919
nasasocial and earthnow and our social

799
00:29:27,909 --> 00:29:26,399
media team uh of which i am a member

800
00:29:30,070 --> 00:29:27,919
we'll take those we'll get answers from

801
00:29:35,350 --> 00:29:30,080
jim and we'll get back to you online so

802
00:29:39,830 --> 00:29:37,350
and here's your cubesat

803
00:29:41,590 --> 00:29:39,840
all right i am stephanie l smith i am a

804
00:29:43,269 --> 00:29:41,600
member of the social media team here at

805
00:29:45,430 --> 00:29:43,279
the jet propulsion laboratory in the

806
00:29:46,630 --> 00:29:45,440
newsroom and it is my distinct honor to

807
00:29:48,950 --> 00:29:46,640
introduce you to some of the people

808
00:29:50,870 --> 00:29:48,960
behind the missions so as jim mentioned

809
00:29:53,269 --> 00:29:50,880
if you'll direct your attention to the

810
00:29:55,990 --> 00:29:53,279
back of the room to that one-third scale

811
00:29:59,190 --> 00:29:56,000
model of smap which stands for soil

812
00:30:00,710 --> 00:29:59,200
moisture active passive we have two team

813
00:30:03,190 --> 00:30:00,720

members here to tell us a little bit

814
00:30:04,470 --> 00:30:03,200
more about their very unique spacecraft

815
00:30:07,430 --> 00:30:04,480
how it works and the science they're

816
00:30:09,990 --> 00:30:07,440
getting ready to do so we have narendra

817
00:30:12,070 --> 00:30:10,000
das who is a research scientist

818
00:30:14,470 --> 00:30:12,080
and he is joined by his colleague erica

819
00:30:17,990 --> 00:30:14,480
podest also a research scientist on this

820
00:30:19,669 --> 00:30:18,000
map mission take it away narendra hi uh

821
00:30:20,870 --> 00:30:19,679
it's my pleasure and privilege to talk

822
00:30:23,029 --> 00:30:20,880
to you guys

823
00:30:24,070 --> 00:30:23,039
i'm a scientist working for the snap

824
00:30:26,070 --> 00:30:24,080
mission

825
00:30:27,830 --> 00:30:26,080
and as you could see it is already being

826
00:30:29,350 --> 00:30:27,840
introduced this is the satellite which

827
00:30:31,430 --> 00:30:29,360
is being introduced which is the one

828
00:30:34,230 --> 00:30:31,440
third scale model of smap

829
00:30:36,549 --> 00:30:34,240
and as mentioned this is a very unique

830
00:30:39,029 --> 00:30:36,559
satellite because of its antenna size

831
00:30:39,750 --> 00:30:39,039
and the type of work it is going to do

832
00:30:41,750 --> 00:30:39,760
so

833
00:30:43,430 --> 00:30:41,760
let me uh start the satellite a little

834
00:30:46,230 --> 00:30:43,440
bit erica could you please

835
00:30:48,549 --> 00:30:46,240
push that red button so as as it

836
00:30:51,430 --> 00:30:48,559
mentioned as it was mentioned that this

837
00:30:53,190 --> 00:30:51,440
antenna is going to rotate like at least

838
00:30:56,149 --> 00:30:53,200

14 rpm

839
00:30:59,190 --> 00:30:56,159
rotation per minute and while it rotates

840
00:31:00,870 --> 00:30:59,200
it will measure the soil moisture using

841
00:31:03,509 --> 00:31:00,880
two different technology like a

842
00:31:05,990 --> 00:31:03,519
radiometer and a radar so it has a

843
00:31:08,310 --> 00:31:06,000
passive part as well as an active part

844
00:31:10,789 --> 00:31:08,320
so the passive part is basically just

845
00:31:13,830 --> 00:31:10,799
observing the earth's radiation in a

846
00:31:16,389 --> 00:31:13,840
microwave frequency and active part

847
00:31:18,070 --> 00:31:16,399
actually will send an emission towards

848
00:31:20,310 --> 00:31:18,080
the earth's surface at target and

849
00:31:22,789 --> 00:31:20,320
receive what emission is backscattered

850
00:31:25,590 --> 00:31:22,799
and getting back and it reflect to this

851
00:31:27,110 --> 00:31:25,600
receiver and that is how it will measure

852
00:31:29,509 --> 00:31:27,120
uh some of the

853
00:31:32,549 --> 00:31:29,519
variables on the earth's surface and

854
00:31:34,470 --> 00:31:32,559
that variable basically will be held

855
00:31:36,549 --> 00:31:34,480
it's known as brightness temperature and

856
00:31:38,870 --> 00:31:36,559
backscatter that will help us to

857
00:31:42,230 --> 00:31:38,880
retrieve soil moisture so that is how it

858
00:31:45,029 --> 00:31:42,240
gonna work we have a small uh animation

859
00:31:47,269 --> 00:31:45,039
here which i would like stephanie to put

860
00:31:48,950 --> 00:31:47,279
it on the screen

861
00:31:54,549 --> 00:31:48,960
yeah

862
00:31:56,630 --> 00:31:54,559
it says soil moisture active passive so

863
00:32:00,310 --> 00:31:56,640

you see this the same spacecraft which

864
00:32:02,870 --> 00:32:00,320
is already launched uh in future and

865
00:32:05,509 --> 00:32:02,880
which will be about 680 kilometer above

866
00:32:08,149 --> 00:32:05,519
the surface as you could see its antenna

867
00:32:10,630 --> 00:32:08,159
rotating in space and time

868
00:32:13,509 --> 00:32:10,640
uh as the spacecraft go forward it keep

869
00:32:15,830 --> 00:32:13,519
on measuring and you see as the antenna

870
00:32:18,870 --> 00:32:15,840
rotate it scans the earth's surface in a

871
00:32:21,509 --> 00:32:18,880
circular fashion so it covers a quite a

872
00:32:24,389 --> 00:32:21,519
bit of you know a real state when it go

873
00:32:26,070 --> 00:32:24,399
forward in space and time so the swath

874
00:32:29,350 --> 00:32:26,080
it measure it's around thousand

875
00:32:32,230 --> 00:32:29,360
kilometer so every footprint of this

876
00:32:35,509 --> 00:32:32,240
passive measurement is nearly uh

877
00:32:37,669 --> 00:32:35,519
40 40 40 kilometer and the radar

878
00:32:40,149 --> 00:32:37,679
footprint which will be processing here

879
00:32:41,430 --> 00:32:40,159
in jpl will be at three kilometer so you

880
00:32:44,710 --> 00:32:41,440
could see the

881
00:32:46,630 --> 00:32:44,720
the width of the uh swath basically

882
00:32:47,590 --> 00:32:46,640
and it right now passing over the great

883
00:32:48,710 --> 00:32:47,600
lakes

884
00:32:50,990 --> 00:32:48,720
so

885
00:32:54,070 --> 00:32:51,000
this way it will make nearly

886
00:32:57,269 --> 00:32:54,080
14.5 uh revolution around the earth's

887
00:33:00,870 --> 00:32:57,279
surface so in the whole one day

888
00:33:02,710 --> 00:33:00,880

so if you put together all this 14.5

889
00:33:04,789 --> 00:33:02,720
revolution you can see something like

890
00:33:07,430 --> 00:33:04,799
this over the earth's surface but if you

891
00:33:09,909 --> 00:33:07,440
put together all the three days of these

892
00:33:11,830 --> 00:33:09,919
swaths it will cover the whole surface

893
00:33:13,029 --> 00:33:11,840
so three-day is quite a bit of an

894
00:33:15,590 --> 00:33:13,039
optimal

895
00:33:22,230 --> 00:33:15,600
way to measure soil moisture to see its

896
00:33:27,830 --> 00:33:24,470
thank you so much narendra go ahead and

897
00:33:30,630 --> 00:33:27,840
join us on stage here and uh erica

898
00:33:32,950 --> 00:33:30,640
um your research focuses mostly on using

899
00:33:35,110 --> 00:33:32,960
satellites for settling studying wetland

900
00:33:36,710 --> 00:33:35,120
ecosystems and the freeze thaw cycle is

901
00:33:39,430 --> 00:33:36,720
that correct correct yes can you tell us

902
00:33:41,750 --> 00:33:39,440
a little bit more about that sure so uh

903
00:33:43,669 --> 00:33:41,760
our satellites map will not only measure

904
00:33:46,710 --> 00:33:43,679
soil moisture but it's going to measure

905
00:33:48,710 --> 00:33:46,720
the land surface freeze or thaw state so

906
00:33:52,149 --> 00:33:48,720
what does that mean what we're looking

907
00:33:55,190 --> 00:33:52,159
at is whether the surface of the land

908
00:33:57,590 --> 00:33:55,200
the land surface is frozen or thawed and

909
00:34:00,389 --> 00:33:57,600
this is really important to know because

910
00:34:03,190 --> 00:34:00,399
in the northern high latitudes

911
00:34:05,029 --> 00:34:03,200
the seasons drive

912
00:34:06,870 --> 00:34:05,039
whether the vegetation absorbs carbon

913
00:34:08,790 --> 00:34:06,880

dioxide from the atmosphere or if it

914
00:34:11,109 --> 00:34:08,800
releases carbon dioxide into the

915
00:34:13,750 --> 00:34:11,119
atmosphere so when the vegetation is

916
00:34:16,310 --> 00:34:13,760
frozen in the winter time

917
00:34:18,310 --> 00:34:16,320
uh think of it as just frozen sticks and

918
00:34:20,869 --> 00:34:18,320
there's a minimal exchange of gases

919
00:34:22,470 --> 00:34:20,879
between vegetation and the atmosphere

920
00:34:25,270 --> 00:34:22,480
but in the spring

921
00:34:27,589 --> 00:34:25,280
when the land surface thaws and the

922
00:34:29,909 --> 00:34:27,599
vegetation thaws there's an enormous

923
00:34:32,389 --> 00:34:29,919
surge of water in the land surface

924
00:34:33,750 --> 00:34:32,399
you've got snow melting you've got water

925
00:34:35,990 --> 00:34:33,760
on the ground

926
00:34:38,230 --> 00:34:36,000
the trees are thought out and they can

927
00:34:39,990 --> 00:34:38,240
draw water and they start what's called

928
00:34:42,470 --> 00:34:40,000
the growing season

929
00:34:45,750 --> 00:34:42,480
and this is extremely important because

930
00:34:48,310 --> 00:34:45,760
that's when vegetation starts to take in

931
00:34:51,030 --> 00:34:48,320
co2 from the atmosphere now if you

932
00:34:53,270 --> 00:34:51,040
remember jim graff's graph on keeling's

933
00:34:55,589 --> 00:34:53,280
curve you saw that cycle that's the

934
00:34:57,990 --> 00:34:55,599
earth breathing and that's because

935
00:35:00,069 --> 00:34:58,000
primarily of vegetation in the northern

936
00:35:02,069 --> 00:35:00,079
high latitudes that's breathing in the

937
00:35:04,470 --> 00:35:02,079
summertime during the growing season

938
00:35:07,270 --> 00:35:04,480

it's taking in an enormous amount of

939
00:35:08,150 --> 00:35:07,280
carbon dioxide from the atmosphere

940
00:35:09,670 --> 00:35:08,160
so

941
00:35:11,670 --> 00:35:09,680
that's what we're looking at as well

942
00:35:13,270 --> 00:35:11,680
with smap whether the land surface is

943
00:35:15,510 --> 00:35:13,280
frozen or thawed

944
00:35:17,750 --> 00:35:15,520
which will help us assess the growing

945
00:35:20,390 --> 00:35:17,760
season length and the variability in the

946
00:35:22,310 --> 00:35:20,400
growing season from year to year

947
00:35:24,710 --> 00:35:22,320
okay i think we're going to have time

948
00:35:27,030 --> 00:35:24,720
for two questions in the house here we

949
00:35:29,670 --> 00:35:27,040
have a microphone runner jari so if you

950
00:35:31,109 --> 00:35:29,680
have a question for erica or narendra

951
00:35:32,790 --> 00:35:31,119
about smap just go ahead and raise your

952
00:35:34,390 --> 00:35:32,800
hand and she will bring it to you so

953
00:35:36,470 --> 00:35:34,400
that people watching at home can hear

954
00:35:38,710 --> 00:35:36,480
your lovely voice we do need to let

955
00:35:40,870 --> 00:35:38,720
erica get out into the field today she's

956
00:35:42,630 --> 00:35:40,880
going to be doing some field research in

957
00:35:44,550 --> 00:35:42,640
our local mountains for another earth

958
00:35:46,470 --> 00:35:44,560
sensing mission so keeping one eye on

959
00:35:48,069 --> 00:35:46,480
the clock for you because science never

960
00:35:51,109 --> 00:35:48,079
sleeps

961
00:35:52,870 --> 00:35:51,119
any questions about smap there we go hi

962
00:35:55,430 --> 00:35:52,880
um it's actually about the

963
00:35:56,790 --> 00:35:55,440

design of the satellite it looks pretty

964
00:35:57,990 --> 00:35:56,800
unique from the others that we've seen

965
00:35:59,829 --> 00:35:58,000
can you tell us a little bit about how

966
00:36:03,190 --> 00:35:59,839
that design came to be

967
00:36:04,950 --> 00:36:03,200
uh actually uh it has a legacy of

968
00:36:07,349 --> 00:36:04,960
hydros so

969
00:36:08,870 --> 00:36:07,359
uh soil moisture uh

970
00:36:10,310 --> 00:36:08,880
being measured right now it being

971
00:36:12,790 --> 00:36:10,320
measured by some of the existing

972
00:36:15,030 --> 00:36:12,800
satellite has a very coarse spatial

973
00:36:17,030 --> 00:36:15,040
resolution like around

974
00:36:19,270 --> 00:36:17,040
40 to 50 kilometer

975
00:36:21,910 --> 00:36:19,280
which is okay for some of the

976
00:36:24,069 --> 00:36:21,920
applications like climate and weather

977
00:36:26,069 --> 00:36:24,079
but most of the time you know soil

978
00:36:28,550 --> 00:36:26,079
moisture is required in applications

979
00:36:30,630 --> 00:36:28,560
like agriculture applications like

980
00:36:33,750 --> 00:36:30,640
watershed management application like

981
00:36:36,230 --> 00:36:33,760
health drought and landslide flooding

982
00:36:38,870 --> 00:36:36,240
and all kind of so that required a very

983
00:36:41,670 --> 00:36:38,880
high spatial resolution of soil moisture

984
00:36:44,390 --> 00:36:41,680
going from you know one to ten kilometer

985
00:36:47,349 --> 00:36:44,400
so based on the application so based on

986
00:36:48,950 --> 00:36:47,359
the existing technology of radiometer

987
00:36:50,790 --> 00:36:48,960
if you need to measure at that

988
00:36:52,950 --> 00:36:50,800

particular you know space high spatial

989
00:36:55,589 --> 00:36:52,960
resolution you need a huge huge antenna

990
00:36:58,390 --> 00:36:55,599
which is not visible in space so it has

991
00:37:01,589 --> 00:36:58,400
to be done through such a way that it

992
00:37:03,990 --> 00:37:01,599
incorporate radar and radiometer both

993
00:37:06,150 --> 00:37:04,000
but the problem with the radar radar is

994
00:37:08,390 --> 00:37:06,160
that if you measure soil moisture it's

995
00:37:10,870 --> 00:37:08,400
very noisy it's not very accurate

996
00:37:12,630 --> 00:37:10,880
so this kind of you know framework came

997
00:37:15,030 --> 00:37:12,640
into of

998
00:37:17,750 --> 00:37:15,040
existence like which we are doing and

999
00:37:20,069 --> 00:37:17,760
building this satellite what it does it

1000
00:37:22,069 --> 00:37:20,079
merge radiometer as well as radar

1001
00:37:24,950 --> 00:37:22,079
observation so the radiometer

1002
00:37:27,589 --> 00:37:24,960
observation actually is very accurate

1003
00:37:29,430 --> 00:37:27,599
to some extent and it's very optimal but

1004
00:37:31,349 --> 00:37:29,440
it doesn't have the spatial resolution

1005
00:37:34,470 --> 00:37:31,359
radar observation

1006
00:37:36,630 --> 00:37:34,480
on the other hand is very noisy but has

1007
00:37:38,790 --> 00:37:36,640
the advantage of very high spatial

1008
00:37:41,190 --> 00:37:38,800
resolution like one to three kilometer

1009
00:37:43,190 --> 00:37:41,200
so what we are going to do we blend the

1010
00:37:45,990 --> 00:37:43,200
better part of both of them

1011
00:37:47,190 --> 00:37:46,000
to make a spatial resolution of nine

1012
00:37:49,510 --> 00:37:47,200
kilometer

1013
00:37:51,510 --> 00:37:49,520

so which would be very much you know

1014
00:37:54,069 --> 00:37:51,520
good for a lot of applications like for

1015
00:37:56,790 --> 00:37:54,079
agriculture weather

1016
00:37:59,109 --> 00:37:56,800
drought monitoring flood forecasting

1017
00:38:01,510 --> 00:37:59,119
those kind of application that's why

1018
00:38:04,069 --> 00:38:01,520
this spacecraft has both radar and

1019
00:38:07,030 --> 00:38:04,079
diameter mounted and it will use the

1020
00:38:08,870 --> 00:38:07,040
same antenna so once it works like the

1021
00:38:11,589 --> 00:38:08,880
radiometer is on then the radar is on

1022
00:38:13,270 --> 00:38:11,599
the radiometer is on the radar is on so

1023
00:38:16,069 --> 00:38:13,280
that's how this whole technology came

1024
00:38:17,109 --> 00:38:16,079
into being and and to add to narendra's

1025
00:38:18,870 --> 00:38:17,119
answer

1026
00:38:21,910 --> 00:38:18,880
the technology that we're using here

1027
00:38:23,589 --> 00:38:21,920
microwave remote sensing allows us to

1028
00:38:25,349 --> 00:38:23,599
observe the surface of the earth

1029
00:38:28,310 --> 00:38:25,359
regardless of any kind of weather

1030
00:38:29,990 --> 00:38:28,320
condition or day or night conditions and

1031
00:38:32,150 --> 00:38:30,000
that's really unique because with

1032
00:38:34,069 --> 00:38:32,160
optical sensors we have problems

1033
00:38:35,990 --> 00:38:34,079
whenever they're clouds

1034
00:38:37,270 --> 00:38:36,000
so here we don't have to worry about

1035
00:38:39,430 --> 00:38:37,280
that

1036
00:38:42,630 --> 00:38:39,440
except for some very very heavy rainfall

1037
00:38:46,470 --> 00:38:42,640
rest of the time this radar can this

1038
00:38:47,349 --> 00:38:46,480

instrument can monitor 24 7.

1039
00:38:48,950 --> 00:38:47,359
great

1040
00:38:50,630 --> 00:38:48,960
any other quick questions in the house

1041
00:38:53,349 --> 00:38:50,640
yes they're in the back of the room can

1042
00:38:54,870 --> 00:38:53,359
we get a mic runner to you

1043
00:38:59,430 --> 00:38:54,880
keep your hand up

1044
00:38:59,440 --> 00:39:04,550
we'll put the social back in nasa social

1045
00:39:07,589 --> 00:39:06,230
how is this mission going to be ground

1046
00:39:10,630 --> 00:39:07,599
truth

1047
00:39:13,589 --> 00:39:10,640
okay so that's a very big extensive

1048
00:39:16,630 --> 00:39:13,599
program going on called calval program

1049
00:39:18,710 --> 00:39:16,640
called calibration and validation of the

1050
00:39:20,630 --> 00:39:18,720
smap measurement so i'll talk about the

1051
00:39:22,230 --> 00:39:20,640
soil moisture calibration validation

1052
00:39:24,230 --> 00:39:22,240
erika will talk about the freestyle

1053
00:39:26,230 --> 00:39:24,240
validation so in soil moisture

1054
00:39:28,790 --> 00:39:26,240
validation what we do there are various

1055
00:39:31,750 --> 00:39:28,800
way to do it one is uh

1056
00:39:34,069 --> 00:39:31,760
measuring uh the soil moisture in situ

1057
00:39:36,150 --> 00:39:34,079
that means people there are instruments

1058
00:39:37,910 --> 00:39:36,160
there which measure soil moisture in a

1059
00:39:40,790 --> 00:39:37,920
watershed or

1060
00:39:43,829 --> 00:39:40,800
by using some other satellite or by

1061
00:39:46,630 --> 00:39:43,839
using you know some model so our focus

1062
00:39:48,950 --> 00:39:46,640
is mostly using uh

1063
00:39:51,990 --> 00:39:48,960

soil moisture measured on surface so we

1064
00:39:54,310 --> 00:39:52,000
have designated that into the core sides

1065
00:39:57,190 --> 00:39:54,320
as well as candidates sites or sparse

1066
00:40:00,230 --> 00:39:57,200
network so our most focus is on the core

1067
00:40:02,069 --> 00:40:00,240
sides where we do on a great scale size

1068
00:40:04,870 --> 00:40:02,079
or in a watershed we do lots of

1069
00:40:07,030 --> 00:40:04,880
measurement in especially you know

1070
00:40:08,309 --> 00:40:07,040
dispersed way and that provide us you

1071
00:40:10,309 --> 00:40:08,319
know kind of

1072
00:40:12,309 --> 00:40:10,319
average soil moisture in a great scale

1073
00:40:13,910 --> 00:40:12,319
or a pixel scale with at which we will

1074
00:40:16,150 --> 00:40:13,920
be measuring and retrieving soil

1075
00:40:18,550 --> 00:40:16,160
moisture so that kind of you know

1076
00:40:19,670 --> 00:40:18,560
campaign goes on for uh

1077
00:40:21,910 --> 00:40:19,680
uh

1078
00:40:24,309 --> 00:40:21,920
for a month or so

1079
00:40:25,910 --> 00:40:24,319
where people also go and measure soil

1080
00:40:28,309 --> 00:40:25,920
moisture and also we have

1081
00:40:30,150 --> 00:40:28,319
instrumentation so the instrumentation

1082
00:40:32,790 --> 00:40:30,160
advantage of instrumentation is that it

1083
00:40:34,550 --> 00:40:32,800
can go for a longer time period so we

1084
00:40:36,710 --> 00:40:34,560
keep measuring that watershed or the

1085
00:40:38,470 --> 00:40:36,720
grid cell for a long period of time and

1086
00:40:40,309 --> 00:40:38,480
we have some kind of upscaling or

1087
00:40:42,710 --> 00:40:40,319
scaling function we scale that soil

1088
00:40:45,670 --> 00:40:42,720

moisture bring it to satellite scale and

1089
00:40:47,750 --> 00:40:45,680
then validate the soil moisture

1090
00:40:49,589 --> 00:40:47,760
all right thanks so much erica and

1091
00:40:51,589 --> 00:40:49,599
narendra don't forget to tweet your

1092
00:40:57,990 --> 00:40:51,599
questions if you think of more later

1093
00:41:01,349 --> 00:40:59,990
so you know that nasa is keeping an eye

1094
00:41:04,150 --> 00:41:01,359
on the earth with an entire

1095
00:41:06,309 --> 00:41:04,160
constellation of spacecraft i would like

1096
00:41:08,710 --> 00:41:06,319
to introduce my colleague doug ellison

1097
00:41:10,630 --> 00:41:08,720
who is a visualization producer here at

1098
00:41:12,550 --> 00:41:10,640
the jet propulsion laboratory he is

1099
00:41:14,870 --> 00:41:12,560
going to demonstrate for you a free tool

1100
00:41:17,190 --> 00:41:14,880
that you can use at home to see where

1101
00:41:19,190 --> 00:41:17,200
all of nasa's earth-sensing satellites

1102
00:41:22,150 --> 00:41:19,200
are at any given time and another tool

1103
00:41:24,390 --> 00:41:22,160
that shows you data sets so this data is

1104
00:41:25,990 --> 00:41:24,400
yours take it away doug

1105
00:41:29,109 --> 00:41:26,000
thank you stephanie good morning

1106
00:41:32,069 --> 00:41:30,870
so at that movie you saw earlier on the

1107
00:41:33,990 --> 00:41:32,079
introduction movie to a lot of earth

1108
00:41:35,030 --> 00:41:34,000
sciences here at jpl that movie actually

1109
00:41:36,870 --> 00:41:35,040
was done kind of in a very short

1110
00:41:38,390 --> 00:41:36,880
schedule very small budget and we

1111
00:41:39,990 --> 00:41:38,400
cheated we didn't use traditional

1112
00:41:41,750 --> 00:41:40,000
animation software for most of that

1113
00:41:43,670 --> 00:41:41,760

movie we actually used our real-time

1114
00:41:45,750 --> 00:41:43,680
computer game engine tool to make that

1115
00:41:47,190 --> 00:41:45,760
footage and that tool is now one we've

1116
00:41:48,790 --> 00:41:47,200
wrapped up we've put it on the web for

1117
00:41:50,390 --> 00:41:48,800
anyone to use anywhere around the globe

1118
00:41:51,829 --> 00:41:50,400
completely for free and it's called eyes

1119
00:41:53,510 --> 00:41:51,839
on the earth let's let's roll the video

1120
00:41:55,030 --> 00:41:53,520
we've got a little demo for you

1121
00:41:56,870 --> 00:41:55,040
so here's what eyes on the earth looks

1122
00:41:59,109 --> 00:41:56,880
like any mac or pc can use this tool by

1123
00:42:00,950 --> 00:41:59,119
going to eyes.nasa.gov forward slash

1124
00:42:03,589 --> 00:42:00,960
earth and you can see the current

1125
00:42:05,190 --> 00:42:03,599
location of a whole fleet of nasa's

1126
00:42:06,390 --> 00:42:05,200
climate observing spacecraft you see

1127
00:42:07,670 --> 00:42:06,400
something called the a-train down there

1128
00:42:09,750 --> 00:42:07,680
a bunch of spacecraft that will chase

1129
00:42:11,430 --> 00:42:09,760
each other in orbit and you can bring in

1130
00:42:13,910 --> 00:42:11,440
the data these missions are collecting

1131
00:42:16,470 --> 00:42:13,920
in some cases hourly updated there's a

1132
00:42:18,150 --> 00:42:16,480
snapshot of air temperature at 10 000

1133
00:42:20,309 --> 00:42:18,160
feet this is carbon monoxide you can see

1134
00:42:22,390 --> 00:42:20,319
plumes of carbon monoxide from slash and

1135
00:42:23,910 --> 00:42:22,400
burn agriculture there ocean topography

1136
00:42:25,349 --> 00:42:23,920
you've heard about jason ii and soon

1137
00:42:27,670 --> 00:42:25,359
jason 3. they're doing measurements like

1138
00:42:28,950 --> 00:42:27,680

this to track ocean height this is the

1139
00:42:30,710 --> 00:42:28,960
ozone hole this is the medium devozo

1140
00:42:32,150 --> 00:42:30,720
ozone over antarctica and you can see

1141
00:42:34,309 --> 00:42:32,160
the sun the north there's less in the

1142
00:42:35,990 --> 00:42:34,319
south you get a seasonal variation one

1143
00:42:37,670 --> 00:42:36,000
of my favorite data sets the grace

1144
00:42:39,109 --> 00:42:37,680
gravity data set we measure the earth's

1145
00:42:41,109 --> 00:42:39,119
gravity field every month with the grey

1146
00:42:42,950 --> 00:42:41,119
spacecraft this isn't the lumpiness of

1147
00:42:44,710 --> 00:42:42,960
the gravity field this is the lumpiness

1148
00:42:46,150 --> 00:42:44,720
of the change in the gravity field and

1149
00:42:47,750 --> 00:42:46,160
you can see things like the amazon

1150
00:42:49,430 --> 00:42:47,760
rainforest filling up with rainwater and

1151
00:42:51,109 --> 00:42:49,440
getting heavier you see it lightening

1152
00:42:52,630 --> 00:42:51,119
out as that water runs back out into the

1153
00:42:53,910 --> 00:42:52,640
ocean and it can contrast that to

1154
00:42:55,829 --> 00:42:53,920
someone like greenland where you only

1155
00:42:58,390 --> 00:42:55,839
see a trend in one direction the weight

1156
00:43:00,150 --> 00:42:58,400
of ice that is lost from greenland and

1157
00:43:01,270 --> 00:43:00,160
we can also go and ride on board these

1158
00:43:03,190 --> 00:43:01,280
spacecraft you're going to hear about

1159
00:43:03,990 --> 00:43:03,200
the rapid scat mission later on there's

1160
00:43:05,910 --> 00:43:04,000
going to be riding on board the

1161
00:43:07,270 --> 00:43:05,920
international space station in fact the

1162
00:43:08,870 --> 00:43:07,280
bottom left-hand corner there right in

1163
00:43:10,630 --> 00:43:08,880

front of that little white module just

1164
00:43:12,309 --> 00:43:10,640
left of center that's that's where

1165
00:43:13,750 --> 00:43:12,319
rapidscat is going to be and you can

1166
00:43:15,589 --> 00:43:13,760
also look at future missions missions

1167
00:43:17,589 --> 00:43:15,599
that are on the drawing board being

1168
00:43:18,630 --> 00:43:17,599
built being planned here's the smap

1169
00:43:19,990 --> 00:43:18,640
mission you've seen the model at the

1170
00:43:21,349 --> 00:43:20,000
back of the room here's our version of

1171
00:43:22,390 --> 00:43:21,359
it in eyes on the earth spinning at the

1172
00:43:23,910 --> 00:43:22,400
right rate you can have a look at the

1173
00:43:25,589 --> 00:43:23,920
spacecraft see it's solar panels the

1174
00:43:27,589 --> 00:43:25,599
instruments what sort of orbit it's

1175
00:43:29,670 --> 00:43:27,599
going to be in and other future missions

1176
00:43:31,670 --> 00:43:29,680
we get in here as well this one's jason

1177
00:43:33,109 --> 00:43:31,680
iii the latest in a kind of a long line

1178
00:43:35,109 --> 00:43:33,119
of multiple missions dedicated to

1179
00:43:37,750 --> 00:43:35,119
measuring the topography of our oceans

1180
00:43:39,990 --> 00:43:37,760
not just for ocean rise but also warm

1181
00:43:41,109 --> 00:43:40,000
and cold ocean currents as well and

1182
00:43:43,990 --> 00:43:41,119
there's the last spacecraft i think i'm

1183
00:43:45,510 --> 00:43:44,000
going to look at is oco 2

1184
00:43:47,349 --> 00:43:45,520
there we go here's oco 2. you can see

1185
00:43:48,630 --> 00:43:47,359
lots more besides as well some of which

1186
00:43:49,829 --> 00:43:48,640
aren't even off the drawing board yet

1187
00:43:51,910 --> 00:43:49,839
they're more kind of nice to haves

1188
00:43:54,550 --> 00:43:51,920

rather than projects in progress and

1189
00:43:55,750 --> 00:43:54,560
here's the oco 2 mission and its orbit

1190
00:43:57,990 --> 00:43:55,760
takes it over the poles and you can

1191
00:43:59,349 --> 00:43:58,000
watch how that orbit changes but most

1192
00:44:00,870 --> 00:43:59,359
importantly you know you can see the

1193
00:44:02,309 --> 00:44:00,880
spacecraft the important thing is the

1194
00:44:03,750 --> 00:44:02,319
data these missions are collecting we're

1195
00:44:05,510 --> 00:44:03,760
putting in your hands you can have some

1196
00:44:07,109 --> 00:44:05,520
visibility into what the scientists are

1197
00:44:08,309 --> 00:44:07,119
looking at of course the obvious

1198
00:44:10,230 --> 00:44:08,319
question if you're looking at a data set

1199
00:44:11,990 --> 00:44:10,240
like this like carbon monoxide is that's

1200
00:44:13,910 --> 00:44:12,000
great on mac or pc but i want an app for

1201
00:44:16,230 --> 00:44:13,920
that and of course there is one earth

1202
00:44:18,710 --> 00:44:16,240
now on the ios store or the android

1203
00:44:20,470 --> 00:44:18,720
store you can see the exact same data in

1204
00:44:22,230 --> 00:44:20,480
your hand with earth now or on your

1205
00:44:24,230 --> 00:44:22,240
desktop or your laptop with eyes on the

1206
00:44:25,670 --> 00:44:24,240
earth that is our tools to share with

1207
00:44:26,870 --> 00:44:25,680
you the spacecraft and the data these

1208
00:44:28,069 --> 00:44:26,880
missions are collecting thank you very

1209
00:44:32,710 --> 00:44:28,079
much indeed stephanie i'll hand it back

1210
00:44:36,390 --> 00:44:34,230
thanks so much doug

1211
00:44:38,309 --> 00:44:36,400
all right now on to rapid scout which

1212
00:44:39,829 --> 00:44:38,319
doug mentioned we'll be hitching a ride

1213
00:44:42,230 --> 00:44:39,839

on the outside of the international

1214
00:44:44,309 --> 00:44:42,240
space station to tell you a little bit

1215
00:44:45,430 --> 00:44:44,319
more about this very interesting project

1216
00:44:47,270 --> 00:44:45,440
we're going to bring up a couple of

1217
00:44:50,390 --> 00:44:47,280
people from the mission gentlemen if you

1218
00:44:52,150 --> 00:44:50,400
join me on stage with your props

1219
00:44:54,630 --> 00:44:52,160
we have with us

1220
00:45:00,950 --> 00:44:54,640
both the project manager and the project

1221
00:45:04,710 --> 00:45:03,270
so in the blue is howard eisen he is the

1222
00:45:07,589 --> 00:45:04,720
project manager

1223
00:45:09,750 --> 00:45:07,599
and in the green is ernesto rodriguez

1224
00:45:12,870 --> 00:45:09,760
who is the project scientist they'll be

1225
00:45:14,950 --> 00:45:12,880
telling you more about rapidscat um it's

1226
00:45:16,150 --> 00:45:14,960
interesting inception story all the

1227
00:45:17,750 --> 00:45:16,160
parts that

1228
00:45:20,309 --> 00:45:17,760
got that came together to make this

1229
00:45:22,550 --> 00:45:20,319
spacecraft uh and the accelerated time

1230
00:45:24,790 --> 00:45:22,560
scale that it's on and then how it will

1231
00:45:26,870 --> 00:45:24,800
use microwaves yes a low energy version

1232
00:45:29,109 --> 00:45:26,880
of the same microwaves you use to heat

1233
00:45:30,630 --> 00:45:29,119
up a burrito will be used for science

1234
00:45:32,710 --> 00:45:30,640
and they'll tell you more about how it

1235
00:45:34,950 --> 00:45:32,720
will measure wind speed and direction on

1236
00:45:37,109 --> 00:45:34,960
the ocean gentlemen good morning

1237
00:45:39,109 --> 00:45:37,119
everyone

1238
00:45:40,870 --> 00:45:39,119

sometimes we develop brand new

1239
00:45:42,550 --> 00:45:40,880
instruments and brand new spacecraft as

1240
00:45:44,470 --> 00:45:42,560
the need arises sometimes we find

1241
00:45:45,430 --> 00:45:44,480
creative ways to use what we already

1242
00:45:47,990 --> 00:45:45,440
have

1243
00:45:50,309 --> 00:45:48,000
there was a mission that went up in 1999

1244
00:45:53,190 --> 00:45:50,319
called quick scat which did a fantastic

1245
00:45:55,829 --> 00:45:53,200
job of using scatterometry to understand

1246
00:45:57,829 --> 00:45:55,839
the interactions between ocean winds and

1247
00:45:59,030 --> 00:45:57,839
waves and ernesto will share with you

1248
00:46:01,589 --> 00:45:59,040
some of the results from that mission

1249
00:46:03,589 --> 00:46:01,599
and show you how they apply here scat

1250
00:46:05,750 --> 00:46:03,599
but the international space station

1251
00:46:07,510 --> 00:46:05,760
which was essentially completed as an

1252
00:46:08,790 --> 00:46:07,520
assembly about

1253
00:46:10,470 --> 00:46:08,800
three years ago

1254
00:46:12,710 --> 00:46:10,480
wasn't originally designed for a lot of

1255
00:46:14,710 --> 00:46:12,720
external science and the space station

1256
00:46:16,950 --> 00:46:14,720
community wanted to promote that and so

1257
00:46:18,550 --> 00:46:16,960
they offered up opportunities about two

1258
00:46:20,150 --> 00:46:18,560
years ago for people to propose

1259
00:46:21,190 --> 00:46:20,160
instruments we put on the outside of the

1260
00:46:23,589 --> 00:46:21,200
station

1261
00:46:25,750 --> 00:46:23,599
an engineer here named rob gaston who

1262
00:46:27,190 --> 00:46:25,760
had worked on quickscat

1263
00:46:28,710 --> 00:46:27,200

realized there was a lot of leftover

1264
00:46:30,790 --> 00:46:28,720
hardware from kwikscap which could be

1265
00:46:32,550 --> 00:46:30,800
utilized for this purpose and so what

1266
00:46:34,710 --> 00:46:32,560
you're seeing here is kind of a recycled

1267
00:46:35,990 --> 00:46:34,720
mission we've taken flight spare

1268
00:46:37,829 --> 00:46:36,000
hardware

1269
00:46:39,349 --> 00:46:37,839
we've taken engineering models which are

1270
00:46:41,190 --> 00:46:39,359
used in the development of that other

1271
00:46:42,390 --> 00:46:41,200
mission in this case we're applying it

1272
00:46:44,230 --> 00:46:42,400
to a new purpose

1273
00:46:45,829 --> 00:46:44,240
on a new spacecraft

1274
00:46:46,950 --> 00:46:45,839
that being the space station and the

1275
00:46:49,670 --> 00:46:46,960
space station gives us lots of

1276
00:46:52,390 --> 00:46:49,680
advantages because it already acts as

1277
00:46:54,309 --> 00:46:52,400
our host it provides power it provides

1278
00:46:56,309 --> 00:46:54,319
attitude control it provides a

1279
00:46:57,670 --> 00:46:56,319
communication path for us all things

1280
00:46:59,349 --> 00:46:57,680
that we would need to build if we built

1281
00:47:01,510 --> 00:46:59,359
our own free-flying spacecraft like we

1282
00:47:02,870 --> 00:47:01,520
had to do with smap

1283
00:47:05,109 --> 00:47:02,880
so we can roll the video we'll show you

1284
00:47:06,950 --> 00:47:05,119
a little bit about how this mission

1285
00:47:08,309 --> 00:47:06,960
will occur

1286
00:47:11,990 --> 00:47:08,319
of course all of our missions start with

1287
00:47:13,430 --> 00:47:12,000
a launch this is a spacex dragon falcon

1288
00:47:15,190 --> 00:47:13,440

9 is the name of the rocket and the

1289
00:47:18,069 --> 00:47:15,200
spacecraft on top here is called the

1290
00:47:21,030 --> 00:47:19,670
and this was an earlier launch out of

1291
00:47:22,470 --> 00:47:21,040
florida

1292
00:47:23,829 --> 00:47:22,480
they successfully launched out of

1293
00:47:25,109 --> 00:47:23,839
vandenberg a few weeks ago so now

1294
00:47:26,150 --> 00:47:25,119
they're capable of launching out of both

1295
00:47:27,750 --> 00:47:26,160
coasts

1296
00:47:29,990 --> 00:47:27,760
but like all station missions will go up

1297
00:47:31,990 --> 00:47:30,000
out of florida there you see the dragon

1298
00:47:33,190 --> 00:47:32,000
and free flight on its way to the

1299
00:47:35,430 --> 00:47:33,200
station

1300
00:47:36,470 --> 00:47:35,440
there have been two successful missions

1301
00:47:38,230 --> 00:47:36,480
to date

1302
00:47:40,230 --> 00:47:38,240
that have actually brought cargo to the

1303
00:47:41,430 --> 00:47:40,240
station there's our future home the

1304
00:47:42,630 --> 00:47:41,440
space station

1305
00:47:44,630 --> 00:47:42,640
and this is going to highlight the

1306
00:47:48,309 --> 00:47:44,640
columbus module which is actually

1307
00:47:49,510 --> 00:47:48,319
european module that's on the station

1308
00:47:52,549 --> 00:47:49,520
some of the modules are provided by

1309
00:47:54,630 --> 00:47:52,559
japan by the us by different partners

1310
00:47:56,790 --> 00:47:54,640
and here's showing the sequence we're

1311
00:47:58,630 --> 00:47:56,800
inside the dragon this is the dragon and

1312
00:48:00,230 --> 00:47:58,640
it has this area called the trunk and

1313
00:48:02,309 --> 00:48:00,240

the payload gets pulled out and the

1314
00:48:03,829 --> 00:48:02,319
payload actually launches as two

1315
00:48:05,430 --> 00:48:03,839
separate pieces

1316
00:48:06,710 --> 00:48:05,440
you can see one piece being pulled out

1317
00:48:08,549 --> 00:48:06,720
there

1318
00:48:10,390 --> 00:48:08,559
and they're separately brought over to

1319
00:48:12,150 --> 00:48:10,400
the space station and attached the end

1320
00:48:14,630 --> 00:48:12,160
of the columbus module so what you see

1321
00:48:16,470 --> 00:48:14,640
on there now at the end of the arm is

1322
00:48:18,150 --> 00:48:16,480
the instrument portion which has the

1323
00:48:19,910 --> 00:48:18,160
rotating antenna and most of the

1324
00:48:21,270 --> 00:48:19,920
electronics related to the instrument

1325
00:48:22,790 --> 00:48:21,280
what's already installed there is the

1326
00:48:24,710 --> 00:48:22,800
nader adapter which gives us the view

1327
00:48:26,309 --> 00:48:24,720
looking down at the earth and provides

1328
00:48:28,390 --> 00:48:26,319
the direct communication back to the

1329
00:48:30,630 --> 00:48:28,400
space station we've had to actually

1330
00:48:32,790 --> 00:48:30,640
convert protocols we have an instrument

1331
00:48:34,950 --> 00:48:32,800
that was designed to work on a satellite

1332
00:48:38,309 --> 00:48:34,960
built by ball aerospace and we launched

1333
00:48:40,549 --> 00:48:38,319
a similar spacecraft with the japanese

1334
00:48:42,309 --> 00:48:40,559
back in the mid 90s we've had to convert

1335
00:48:44,309 --> 00:48:42,319
that into the kinds of protocols that

1336
00:48:45,750 --> 00:48:44,319
the space station uses and that's what a

1337
00:48:47,750 --> 00:48:45,760
lot of our new hardware development is

1338
00:48:50,390 --> 00:48:47,760

is converting communication protocols

1339
00:48:53,430 --> 00:48:50,400
power sequences things like that

1340
00:48:56,630 --> 00:48:54,710
okay so

1341
00:48:58,230 --> 00:48:56,640
you may be wondering why anybody would

1342
00:49:00,390 --> 00:48:58,240
care about winds of course you've heard

1343
00:49:02,069 --> 00:49:00,400
about hurricanes and those are very very

1344
00:49:03,430 --> 00:49:02,079
important so one of the reasons that

1345
00:49:04,870 --> 00:49:03,440
we'll show you in a video in a little

1346
00:49:06,470 --> 00:49:04,880
bit is

1347
00:49:07,349 --> 00:49:06,480
our instrument is able to measure the

1348
00:49:09,829 --> 00:49:07,359
winds

1349
00:49:12,069 --> 00:49:09,839
every day across the globe and so

1350
00:49:13,030 --> 00:49:12,079
certainly if you're sitting in louisiana

1351
00:49:14,309 --> 00:49:13,040
or

1352
00:49:16,069 --> 00:49:14,319
the east coast

1353
00:49:18,230 --> 00:49:16,079
it's a very important thing but there's

1354
00:49:19,510 --> 00:49:18,240
another reason much more important in my

1355
00:49:21,510 --> 00:49:19,520
mind of course

1356
00:49:23,190 --> 00:49:21,520
uh not to the people that are getting

1357
00:49:25,589 --> 00:49:23,200
hit by the hurricane but in my mind

1358
00:49:26,790 --> 00:49:25,599
anyway we're caring about the winds and

1359
00:49:28,829 --> 00:49:26,800
i don't have a

1360
00:49:31,750 --> 00:49:28,839
cool illustration but i have a cool

1361
00:49:33,349 --> 00:49:31,760
analogy think of the earth as not the

1362
00:49:35,270 --> 00:49:33,359
earth the earth is

1363
00:49:37,510 --> 00:49:35,280

the earth part is almost a an

1364
00:49:40,150 --> 00:49:37,520
afterthought it's really the ocean

1365
00:49:43,190 --> 00:49:40,160
we really live in the water planet

1366
00:49:45,589 --> 00:49:43,200
and the ocean is like a huge flywheel

1367
00:49:47,349 --> 00:49:45,599
it stores all the kinetic energy all the

1368
00:49:49,750 --> 00:49:47,359
motion energy

1369
00:49:51,349 --> 00:49:49,760
it also stores a lot of our heat you

1370
00:49:52,790 --> 00:49:51,359
know even in winter the ocean doesn't

1371
00:49:54,309 --> 00:49:52,800
freeze all the way through and the

1372
00:49:56,470 --> 00:49:54,319
reason that happens is because it has

1373
00:49:58,950 --> 00:49:56,480
all that heat and it also stores a lot

1374
00:50:01,109 --> 00:49:58,960
of the gases that we put out all the co2

1375
00:50:03,349 --> 00:50:01,119
if the ocean were not there right now

1376
00:50:04,230 --> 00:50:03,359
we'd be close to venus

1377
00:50:06,470 --> 00:50:04,240
so

1378
00:50:09,589 --> 00:50:06,480
what's powering this flywheel think of

1379
00:50:12,150 --> 00:50:09,599
the winds as a bunch of unruly mice

1380
00:50:13,670 --> 00:50:12,160
going around and making the flywheel run

1381
00:50:14,870 --> 00:50:13,680
around

1382
00:50:16,870 --> 00:50:14,880
and so

1383
00:50:18,549 --> 00:50:16,880
really understanding these unruly mice

1384
00:50:20,549 --> 00:50:18,559
is what we're trying to do in a global

1385
00:50:22,790 --> 00:50:20,559
sense and they're interesting mice

1386
00:50:24,710 --> 00:50:22,800
because just like regular mice they're

1387
00:50:26,950 --> 00:50:24,720
affected by the sun so when the sun

1388
00:50:29,190 --> 00:50:26,960

comes up they have energy they start to

1389
00:50:30,630 --> 00:50:29,200
get energy and through the day and they

1390
00:50:32,790 --> 00:50:30,640
start to blow they blow in different

1391
00:50:34,309 --> 00:50:32,800
ways during the time of day as they blow

1392
00:50:36,950 --> 00:50:34,319
in different parts of the ocean they

1393
00:50:38,710 --> 00:50:36,960
start to extract water vapor that forms

1394
00:50:40,870 --> 00:50:38,720
clouds the clouds reflect the energy

1395
00:50:43,670 --> 00:50:40,880
back into the

1396
00:50:45,430 --> 00:50:43,680
into space and that keeps us cool it

1397
00:50:47,589 --> 00:50:45,440
also rains so it takes water from one

1398
00:50:50,069 --> 00:50:47,599
place to the other

1399
00:50:53,030 --> 00:50:50,079
but think about the problem of trying to

1400
00:50:54,390 --> 00:50:53,040
monitor these unruly mice globally

1401
00:50:56,309 --> 00:50:54,400
the problem that we have right now is

1402
00:50:58,150 --> 00:50:56,319
that because they're affected by the sun

1403
00:51:00,309 --> 00:50:58,160
you know they have breakfast then they

1404
00:51:02,150 --> 00:51:00,319
get going then they get tired then they

1405
00:51:04,950 --> 00:51:02,160
go to sleep and right now we have a

1406
00:51:07,589 --> 00:51:04,960
bunch of satellites that are only able

1407
00:51:09,030 --> 00:51:07,599
to take snapshots during breakfast

1408
00:51:11,190 --> 00:51:09,040
during lunch

1409
00:51:12,870 --> 00:51:11,200
or in at night

1410
00:51:15,430 --> 00:51:12,880
and there's no way that we have to put

1411
00:51:17,990 --> 00:51:15,440
them together so the space station is

1412
00:51:20,069 --> 00:51:18,000
really cool in the sense that it

1413
00:51:22,870 --> 00:51:20,079

it has an orbit that throughout the

1414
00:51:24,870 --> 00:51:22,880
period of a year will allow it to visit

1415
00:51:27,510 --> 00:51:24,880
all times all places in the earth at

1416
00:51:28,710 --> 00:51:27,520
different times so we'll be able to look

1417
00:51:30,950 --> 00:51:28,720
at the mice

1418
00:51:32,549 --> 00:51:30,960
at all times during their daily cycle

1419
00:51:35,589 --> 00:51:32,559
and also to be able to tie all these

1420
00:51:37,109 --> 00:51:35,599
other satellites that are going on

1421
00:51:39,750 --> 00:51:37,119
at the same time

1422
00:51:41,349 --> 00:51:39,760
and being being able to bring them

1423
00:51:42,630 --> 00:51:41,359
together because right now they're

1424
00:51:44,069 --> 00:51:42,640
telling us different things and we don't

1425
00:51:47,030 --> 00:51:44,079
know how to put it together

1426
00:51:48,470 --> 00:51:47,040
so it's a it's a recycled mission but

1427
00:51:49,589 --> 00:51:48,480
the science that it can do it's really

1428
00:51:52,710 --> 00:51:49,599
really cool

1429
00:51:54,470 --> 00:51:52,720
so there's a video i think that we can

1430
00:51:55,990 --> 00:51:54,480
see right now

1431
00:51:58,870 --> 00:51:56,000
one of the things that you may be

1432
00:52:01,190 --> 00:51:58,880
wondering is how in heaven's name can

1433
00:52:03,829 --> 00:52:01,200
your microwave measure the wind

1434
00:52:05,670 --> 00:52:03,839
well it doesn't it's the real truth what

1435
00:52:07,829 --> 00:52:05,680
it does is when the wind blows over

1436
00:52:10,549 --> 00:52:07,839
water it ruffles the water

1437
00:52:12,230 --> 00:52:10,559
and so those little ruffles in the water

1438
00:52:14,710 --> 00:52:12,240

actually reflect energy back to the

1439
00:52:16,230 --> 00:52:14,720
radar and the more it blows the bigger

1440
00:52:18,150 --> 00:52:16,240
the ruffles are the bigger the energy

1441
00:52:20,549 --> 00:52:18,160
that we get back so by spinning this

1442
00:52:21,750 --> 00:52:20,559
antenna we can actually get the

1443
00:52:23,829 --> 00:52:21,760
different levels of energy that are

1444
00:52:25,109 --> 00:52:23,839
coming back and by spinning it we can

1445
00:52:27,190 --> 00:52:25,119
also watch it from different directions

1446
00:52:28,790 --> 00:52:27,200
so we not only get the wind speed but

1447
00:52:30,549 --> 00:52:28,800
also get the wind direction

1448
00:52:32,630 --> 00:52:30,559
so that allows us to get this global

1449
00:52:34,230 --> 00:52:32,640
view of what's going on so this is you

1450
00:52:35,910 --> 00:52:34,240
know the uh the satellite from which i'm

1451
00:52:37,349 --> 00:52:35,920
project scientist which was a precursor

1452
00:52:39,990 --> 00:52:37,359
to this one for which i'm also project

1453
00:52:42,950 --> 00:52:40,000
scientist it's a low tech in times of

1454
00:52:45,349 --> 00:52:42,960
low tech but it's actually able to get

1455
00:52:46,870 --> 00:52:45,359
this global picture of what the ocean

1456
00:52:50,309 --> 00:52:46,880
what the winds are doing during the

1457
00:52:52,710 --> 00:52:50,319
entire day and this is in 1999 a whole

1458
00:52:55,030 --> 00:52:52,720
hurricane season and what you'll see as

1459
00:52:57,030 --> 00:52:55,040
you start to see names pop up are

1460
00:52:59,109 --> 00:52:57,040
different hurricanes developing and

1461
00:53:00,790 --> 00:52:59,119
moving towards the united states some of

1462
00:53:02,470 --> 00:53:00,800
them hitting the united states some of

1463
00:53:04,710 --> 00:53:02,480

them missing it all together and in

1464
00:53:06,790 --> 00:53:04,720
reality the way we have of dealing with

1465
00:53:08,390 --> 00:53:06,800
them is to send airplanes and we can

1466
00:53:09,670 --> 00:53:08,400
only send airplanes close to the united

1467
00:53:11,670 --> 00:53:09,680
states we don't know whether they're

1468
00:53:13,910 --> 00:53:11,680
coming or not unless we see them all the

1469
00:53:15,910 --> 00:53:13,920
way in africa where they form and so by

1470
00:53:17,829 --> 00:53:15,920
having this instrument at the same time

1471
00:53:20,230 --> 00:53:17,839
as a bunch of other instruments we'll be

1472
00:53:21,910 --> 00:53:20,240
able to get daily and maybe better than

1473
00:53:24,309 --> 00:53:21,920
daily pictures of these hurricanes as

1474
00:53:26,309 --> 00:53:24,319
they move across and so really the power

1475
00:53:29,030 --> 00:53:26,319
of having this global picture not only

1476
00:53:30,549 --> 00:53:29,040
hurricanes but typhoons

1477
00:53:32,710 --> 00:53:30,559
indian monsoon

1478
00:53:33,829 --> 00:53:32,720
all sorts of weather phenomena we are

1479
00:53:36,870 --> 00:53:33,839
able to get

1480
00:53:38,950 --> 00:53:36,880
daily snapshots of things that up until

1481
00:53:41,430 --> 00:53:38,960
and this is hard to believe up until 15

1482
00:53:43,270 --> 00:53:41,440
years ago the best that we had were

1483
00:53:47,589 --> 00:53:43,280
ships with little anemometers going

1484
00:53:52,230 --> 00:53:49,589
thanks so much gentlemen

1485
00:53:54,470 --> 00:53:52,240
so now at this point we can open up the

1486
00:53:57,109 --> 00:53:54,480
floor to questions

1487
00:53:57,990 --> 00:53:57,119
who has questions about our rapid scat

1488
00:54:03,750 --> 00:53:58,000

mission

1489
00:54:07,990 --> 00:54:05,750
well i for one would like to know

1490
00:54:10,390 --> 00:54:08,000
what is the biggest difference between

1491
00:54:13,349 --> 00:54:10,400
quick scat and rapid scat what is this

1492
00:54:15,750 --> 00:54:13,359
is there a huge improvement is it is it

1493
00:54:17,829 --> 00:54:15,760
merely a follow-on what is what is the

1494
00:54:19,670 --> 00:54:17,839
relationship between those two missions

1495
00:54:21,829 --> 00:54:19,680
from a hardware standpoint the core

1496
00:54:23,829 --> 00:54:21,839
instrument is basically the same because

1497
00:54:26,150 --> 00:54:23,839
we're literally using the spares and the

1498
00:54:27,990 --> 00:54:26,160
engineering models that were left over

1499
00:54:29,270 --> 00:54:28,000
we pulled this stuff out of 15 years of

1500
00:54:31,510 --> 00:54:29,280
storage brought it down to our

1501
00:54:33,430 --> 00:54:31,520
spacecraft assembly facility and started

1502
00:54:36,230 --> 00:54:33,440
powering it up and amazingly it all

1503
00:54:38,150 --> 00:54:36,240
powered up and it actually behaved

1504
00:54:39,510 --> 00:54:38,160
in performance testing the same as the

1505
00:54:41,109 --> 00:54:39,520
old hardware did

1506
00:54:43,270 --> 00:54:41,119
so there's a few differences because of

1507
00:54:44,789 --> 00:54:43,280
the the the orbit that we're in we're

1508
00:54:46,710 --> 00:54:44,799
flying on the space station which flies

1509
00:54:48,390 --> 00:54:46,720
lower so we're at 400 kilometers

1510
00:54:50,230 --> 00:54:48,400
altitude instead of 800 so we see a

1511
00:54:52,150 --> 00:54:50,240
narrower swath just because we're

1512
00:54:53,990 --> 00:54:52,160
looking to the side all the time and as

1513
00:54:55,430 --> 00:54:54,000

we move down that means we actually

1514
00:54:57,910 --> 00:54:55,440
cover less area because we're looking

1515
00:55:00,390 --> 00:54:57,920
less to the right or left

1516
00:55:02,150 --> 00:55:00,400
but because we're lower we get a

1517
00:55:04,309 --> 00:55:02,160
stronger reflection we actually go with

1518
00:55:05,990 --> 00:55:04,319
a smaller antenna which is beneficial

1519
00:55:08,150 --> 00:55:06,000
because the room inside this dragon

1520
00:55:09,750 --> 00:55:08,160
capsule is pretty small and so we made a

1521
00:55:11,430 --> 00:55:09,760
couple of changes to deal with that but

1522
00:55:13,670 --> 00:55:11,440
from a performance standpoint we should

1523
00:55:14,950 --> 00:55:13,680
see very similar performance the orbit

1524
00:55:16,390 --> 00:55:14,960
however is different and that has an

1525
00:55:18,390 --> 00:55:16,400
effect on the kinds of things that we

1526
00:55:19,990 --> 00:55:18,400
see and in particular the fact that we

1527
00:55:22,150 --> 00:55:20,000
don't revisit the same place at every

1528
00:55:24,470 --> 00:55:22,160
time of day and ernesto could elaborate

1529
00:55:26,390 --> 00:55:24,480
on that yeah so again as i mentioned

1530
00:55:27,190 --> 00:55:26,400
earlier the fact that we don't revisit

1531
00:55:28,630 --> 00:55:27,200
the

1532
00:55:31,190 --> 00:55:28,640
same time

1533
00:55:33,589 --> 00:55:31,200
of day at the same place allows us to

1534
00:55:34,789 --> 00:55:33,599
both do two things that are unique

1535
00:55:36,549 --> 00:55:34,799
first

1536
00:55:37,750 --> 00:55:36,559
to tie all the satellites there in this

1537
00:55:39,829 --> 00:55:37,760
constellation this international

1538
00:55:41,589 --> 00:55:39,839

constellation that do visit things at

1539
00:55:42,870 --> 00:55:41,599
the same time of day every day

1540
00:55:44,789 --> 00:55:42,880
and the second one is to actually

1541
00:55:47,109 --> 00:55:44,799
understand the processes that are time

1542
00:55:51,910 --> 00:55:47,119
varying as a function of time of day so

1543
00:55:56,390 --> 00:55:54,789
so um one follow-on to that what about

1544
00:55:58,789 --> 00:55:56,400
the budget

1545
00:56:01,109 --> 00:55:58,799
so we're doing this mission um what we

1546
00:56:04,230 --> 00:56:01,119
consider to be on the cheap uh it's

1547
00:56:06,390 --> 00:56:04,240
running about 26 million dollars

1548
00:56:08,549 --> 00:56:06,400
by comparison we took a look at building

1549
00:56:10,630 --> 00:56:08,559
uh just another quick scat like

1550
00:56:12,870 --> 00:56:10,640
spacecraft today to be able to do a

1551
00:56:15,349 --> 00:56:12,880
similar mission and the budget estimates

1552
00:56:16,470 --> 00:56:15,359
ran about 400 million dollars

1553
00:56:18,390 --> 00:56:16,480
fantastic

1554
00:56:19,990 --> 00:56:18,400
okay if we can get our mic runner over

1555
00:56:24,069 --> 00:56:20,000
to sarah mora

1556
00:56:27,510 --> 00:56:26,390
stand up

1557
00:56:30,150 --> 00:56:27,520
um hi

1558
00:56:32,390 --> 00:56:30,160
i'm actually really interested in sort

1559
00:56:34,309 --> 00:56:32,400
of the incubation stage when you're

1560
00:56:35,990 --> 00:56:34,319
trying to brainstorm how are you going

1561
00:56:37,510 --> 00:56:36,000
to get data

1562
00:56:40,150 --> 00:56:37,520
to answer questions that you want to

1563
00:56:41,990 --> 00:56:40,160

answer because i would not have thought

1564
00:56:44,630 --> 00:56:42,000
to do what you're doing with satellites

1565
00:56:45,990 --> 00:56:44,640
to measure what you're measuring that's

1566
00:56:47,829 --> 00:56:46,000
totally fascinating to me and i just

1567
00:56:49,430 --> 00:56:47,839
want to know if there's

1568
00:56:51,750 --> 00:56:49,440
you know some interesting aha moments

1569
00:56:52,630 --> 00:56:51,760
that happen

1570
00:56:55,589 --> 00:56:52,640
i'm going to talk about the history

1571
00:56:57,510 --> 00:56:55,599
scanner on the tree here so

1572
00:56:59,670 --> 00:56:57,520
there's a couple of ways to answer your

1573
00:57:02,549 --> 00:56:59,680
question basically when

1574
00:57:05,589 --> 00:57:02,559
scatter armor started up it was a very

1575
00:57:07,270 --> 00:57:05,599
dedicated small thing that 10 scientists

1576
00:57:10,390 --> 00:57:07,280
in the world understood

1577
00:57:13,270 --> 00:57:10,400
then as we started to see the importance

1578
00:57:15,430 --> 00:57:13,280
especially hurricanes and

1579
00:57:17,109 --> 00:57:15,440
throughout the world people sailing and

1580
00:57:19,829 --> 00:57:17,119
people shipping

1581
00:57:21,910 --> 00:57:19,839
the operational agencies like noaa

1582
00:57:24,150 --> 00:57:21,920
the european center for

1583
00:57:27,510 --> 00:57:24,160
medium range weather forecasting the

1584
00:57:29,190 --> 00:57:27,520
japanese space agency the uk met office

1585
00:57:31,510 --> 00:57:29,200
all started coming to us and said hey

1586
00:57:33,750 --> 00:57:31,520
give us your data we'll put it into into

1587
00:57:36,470 --> 00:57:33,760
our models and so right now we get the

1588
00:57:39,109 --> 00:57:36,480

data directly from the satellites we

1589
00:57:41,910 --> 00:57:39,119
process that about really quickly but an

1590
00:57:43,829 --> 00:57:41,920
hour and put it out there so they can

1591
00:57:46,150 --> 00:57:43,839
use it and so

1592
00:57:47,910 --> 00:57:46,160
when you see the weather forecasters

1593
00:57:49,670 --> 00:57:47,920
they actually have a wealth of data from

1594
00:57:50,470 --> 00:57:49,680
different sources and this is one of

1595
00:57:54,390 --> 00:57:50,480
them

1596
00:57:56,789 --> 00:57:54,400
it also goes into climate models

1597
00:57:59,190 --> 00:57:56,799
all right next question

1598
00:58:01,270 --> 00:57:59,200
down here in front hi i'm anastasia i

1599
00:58:03,829 --> 00:58:01,280
was just wondering um i'm a big fan of

1600
00:58:05,829 --> 00:58:03,839
elon musk and spacex but i wonder how

1601
00:58:07,829 --> 00:58:05,839
everybody works together is it an easy

1602
00:58:09,670 --> 00:58:07,839
collaboration and

1603
00:58:11,589 --> 00:58:09,680
like it just must be amazing that the

1604
00:58:13,349 --> 00:58:11,599
level of details that you have to talk

1605
00:58:15,349 --> 00:58:13,359
to

1606
00:58:17,430 --> 00:58:15,359
the various agencies

1607
00:58:18,470 --> 00:58:17,440
the collaborations are a challenge

1608
00:58:20,630 --> 00:58:18,480
where there's lots of government

1609
00:58:22,789 --> 00:58:20,640
bureaucracy unfortunately it's involved

1610
00:58:24,549 --> 00:58:22,799
for us to work for example with spacex

1611
00:58:26,950 --> 00:58:24,559
they're actually under contract to the

1612
00:58:28,710 --> 00:58:26,960
iss program which is run out of johnson

1613
00:58:30,069 --> 00:58:28,720

space center and so we're supposed to

1614
00:58:32,549 --> 00:58:30,079
talk to somebody at johnson who's

1615
00:58:33,910 --> 00:58:32,559
supposed to talk to somebody at spacex

1616
00:58:35,670 --> 00:58:33,920
and you have that a lot in government

1617
00:58:37,190 --> 00:58:35,680
contracting but fortunately the people

1618
00:58:38,870 --> 00:58:37,200
who are involved are all really good

1619
00:58:41,030 --> 00:58:38,880
people and all really want to do the

1620
00:58:42,789 --> 00:58:41,040
right thing and so you wind up building

1621
00:58:44,630 --> 00:58:42,799
relationships with folks and you wind up

1622
00:58:45,910 --> 00:58:44,640
having the discussions you need to have

1623
00:58:47,670 --> 00:58:45,920
without going through the formal

1624
00:58:49,670 --> 00:58:47,680
channels or you catch up later or you

1625
00:58:51,990 --> 00:58:49,680
copy those people you know nowadays you

1626
00:58:54,309 --> 00:58:52,000
just cc 40 other people in your emails

1627
00:58:55,829 --> 00:58:54,319
and they're considered informed but the

1628
00:58:57,349 --> 00:58:55,839
spacex

1629
00:58:59,990 --> 00:58:57,359
you know

1630
00:59:00,950 --> 00:59:00,000
the the spacex people are really great

1631
00:59:02,870 --> 00:59:00,960
they um

1632
00:59:04,470 --> 00:59:02,880
they're new to this game too they've

1633
00:59:06,309 --> 00:59:04,480
only had a handful of launches they've

1634
00:59:08,230 --> 00:59:06,319
only had a handful of dragons and in

1635
00:59:10,789 --> 00:59:08,240
fact up until now there hasn't actually

1636
00:59:12,870 --> 00:59:10,799
been a science payload delivered through

1637
00:59:14,950 --> 00:59:12,880
the trunk the first one is coming up in

1638
00:59:17,270 --> 00:59:14,960

the spacex three mission which is going

1639
00:59:19,829 --> 00:59:17,280
to have hdev and opals which are two

1640
00:59:20,710 --> 00:59:19,839
technology experiments and so we are the

1641
00:59:24,710 --> 00:59:20,720
first

1642
00:59:27,750 --> 00:59:24,720
science mission really going on the

1643
00:59:31,030 --> 00:59:27,760
station that's looking down at the earth

1644
00:59:34,549 --> 00:59:32,549
let's see bill i think you had your hand

1645
00:59:37,190 --> 00:59:34,559
up and you've got a mic uh how much of

1646
00:59:39,109 --> 00:59:37,200
the uh operations are handled from the

1647
00:59:40,950 --> 00:59:39,119
ground and how much are the astronauts

1648
00:59:42,710 --> 00:59:40,960
doing on board the space station if at

1649
00:59:43,750 --> 00:59:42,720
all and how do you collaborate with them

1650
00:59:45,430 --> 00:59:43,760
so it's pretty interesting the

1651
00:59:47,430 --> 00:59:45,440
astronauts actually hardly even know

1652
00:59:50,309 --> 00:59:47,440
we're there they have no role in our

1653
00:59:52,230 --> 00:59:50,319
operations at all which is in itself

1654
00:59:54,309 --> 00:59:52,240
pretty amazing the the main thing they

1655
00:59:55,670 --> 00:59:54,319
participate in is is understanding the

1656
00:59:57,510 --> 00:59:55,680
safety of adding a payload to the

1657
00:59:59,589 --> 00:59:57,520
station every time you add something to

1658
01:00:00,789 --> 00:59:59,599
the station it presents hazards if we

1659
01:00:02,549 --> 01:00:00,799
fail in a certain way we could bring

1660
01:00:04,789 --> 01:00:02,559
down a power bus

1661
01:00:06,789 --> 01:00:04,799
we're emitting microwave radiation we

1662
01:00:08,390 --> 01:00:06,799
could accidentally radiate an astronaut

1663
01:00:10,470 --> 01:00:08,400

who's doing a spacewalk and so we have

1664
01:00:12,309 --> 01:00:10,480
to put controls in place to make sure

1665
01:00:13,910 --> 01:00:12,319
we're not doing that so they're aware of

1666
01:00:16,309 --> 01:00:13,920
us from that standpoint but they have no

1667
01:00:17,990 --> 01:00:16,319
direct interaction the operations are

1668
01:00:19,670 --> 01:00:18,000
actually handled through marshall in

1669
01:00:21,270 --> 01:00:19,680
huntsville alabama

1670
01:00:23,910 --> 01:00:21,280
and we get basically one of their

1671
01:00:25,190 --> 01:00:23,920
workstations here at jpl so we can do

1672
01:00:27,349 --> 01:00:25,200
all the commanding that we need to do

1673
01:00:28,789 --> 01:00:27,359
here unless it's safety related and

1674
01:00:30,710 --> 01:00:28,799
safety related commands have to be

1675
01:00:32,950 --> 01:00:30,720
issued actually by huntsville

1676
01:00:34,870 --> 01:00:32,960
the robotic installation is actually

1677
01:00:37,750 --> 01:00:34,880
done from the ground also and that's

1678
01:00:39,270 --> 01:00:37,760
controlled by the folks in houston

1679
01:00:42,390 --> 01:00:39,280
all right i think we can take one more

1680
01:00:47,030 --> 01:00:45,349
hi i was wondering uh what do you use uh

1681
01:00:52,150 --> 01:00:47,040
what platform do you use to share your

1682
01:00:58,390 --> 01:00:53,910
i talked about the deck sir could you

1683
01:01:00,870 --> 01:01:00,069
what platform do you use to share the

1684
01:01:02,150 --> 01:01:00,880
data

1685
01:01:05,349 --> 01:01:02,160
so uh

1686
01:01:07,270 --> 01:01:05,359
we have we put it in a computer and we

1687
01:01:09,510 --> 01:01:07,280
allow them to have ftp access so

1688
01:01:11,829 --> 01:01:09,520

basically they just come in and suck it

1689
01:01:13,670 --> 01:01:11,839
into their servers

1690
01:01:15,990 --> 01:01:13,680
nasa has a system of distributed data

1691
01:01:17,430 --> 01:01:16,000
archives around the country and we are

1692
01:01:19,750 --> 01:01:17,440
required to put all of our data into

1693
01:01:21,270 --> 01:01:19,760
that system and uh once authenticated

1694
01:01:23,270 --> 01:01:21,280
everybody can get access to that so

1695
01:01:25,750 --> 01:01:23,280
there's two ways i mean

1696
01:01:27,990 --> 01:01:25,760
what uh howard said is the way we

1697
01:01:30,549 --> 01:01:28,000
distribute it to anybody nasa data is

1698
01:01:32,470 --> 01:01:30,559
free so anybody can download it in fact

1699
01:01:34,710 --> 01:01:32,480
i come from a third world country i know

1700
01:01:35,829 --> 01:01:34,720
that without this freedom of access of

1701
01:01:37,750 --> 01:01:35,839
data

1702
01:01:39,589 --> 01:01:37,760
a lot of the environmental impacts of

1703
01:01:42,150 --> 01:01:39,599
what's going on in south america would

1704
01:01:44,470 --> 01:01:42,160
not be at all monitoring

1705
01:01:47,030 --> 01:01:44,480
so that is a great boon to society in

1706
01:01:49,030 --> 01:01:47,040
general the way we do it for the winds

1707
01:01:52,069 --> 01:01:49,040
though is because they need to get it

1708
01:01:53,910 --> 01:01:52,079
real time we actually allow him in a

1709
01:01:55,910 --> 01:01:53,920
special way to come in and get the data

1710
01:01:58,069 --> 01:01:55,920
from us

1711
01:02:00,069 --> 01:01:58,079
all right and as we thank howard and

1712
01:02:02,390 --> 01:02:00,079
ernesto for their time we are going to

1713
01:02:05,190 --> 01:02:02,400

roll a short video that will give you

1714
01:02:06,870 --> 01:02:05,200
the rapid scat point of view from the

1715
01:02:35,430 --> 01:02:06,880
international space station

1716
01:02:39,190 --> 01:02:37,190
it's beautiful isn't it

1717
01:02:40,789 --> 01:02:39,200
i love the lightning i love the aurora

1718
01:02:41,589 --> 01:02:40,799
and the ocean

1719
01:02:43,750 --> 01:02:41,599
so

1720
01:02:46,230 --> 01:02:43,760
um we've talked a little bit about ocean

1721
01:02:47,910 --> 01:02:46,240
jim graf talked about ocean being very

1722
01:02:49,670 --> 01:02:47,920
key to our understanding of climate

1723
01:02:51,510 --> 01:02:49,680
science and climate modeling

1724
01:02:54,309 --> 01:02:51,520
and here to explain a little bit more

1725
01:02:56,390 --> 01:02:54,319
about why the ocean is so important is a

1726
01:02:58,870 --> 01:02:56,400
jpl oceanographer and climate scientist

1727
01:03:00,630 --> 01:02:58,880
his name is josh willis take note he is

1728
01:03:02,390 --> 01:03:00,640
going to show you an amazing trick to

1729
01:03:04,309 --> 01:03:02,400
allow your friends to explain

1730
01:03:05,270 --> 01:03:04,319
climate science and specific heat of

1731
01:03:09,510 --> 01:03:05,280
water

1732
01:03:13,670 --> 01:03:12,150
hey everybody how's it going

1733
01:03:14,829 --> 01:03:13,680
yeah that was unenthusiastic come on

1734
01:03:17,190 --> 01:03:14,839
how's it going

1735
01:03:19,349 --> 01:03:17,200
hey all right

1736
01:03:20,950 --> 01:03:19,359
look at this beautiful set up here i

1737
01:03:22,950 --> 01:03:20,960
wonder if i can wreck some of it without

1738
01:03:26,150 --> 01:03:22,960

them getting mad at me we're gonna find

1739
01:03:27,670 --> 01:03:26,160
out um okay so my name is josh willis

1740
01:03:30,549 --> 01:03:27,680
i'm a climate scientist and an

1741
01:03:32,950 --> 01:03:30,559
oceanographer here at jpl and i'm also

1742
01:03:36,150 --> 01:03:32,960
the project scientist for the jason-3

1743
01:03:38,390 --> 01:03:36,160
mission uh which is an a follow-on

1744
01:03:41,270 --> 01:03:38,400
mission to the jason's one and two and

1745
01:03:43,829 --> 01:03:41,280
topex poseidon which came before that

1746
01:03:46,230 --> 01:03:43,839
and what that mission does is measure

1747
01:03:47,990 --> 01:03:46,240
the height of the ocean from space and

1748
01:03:49,510 --> 01:03:48,000
it's really an incredible technological

1749
01:03:51,190 --> 01:03:49,520
development even though it's been around

1750
01:03:52,789 --> 01:03:51,200
for 20 years

1751
01:03:55,029 --> 01:03:52,799
this technology has been doing this

1752
01:03:56,710 --> 01:03:55,039
particular job for about 20 years

1753
01:03:58,069 --> 01:03:56,720
essentially they can measure

1754
01:03:59,670 --> 01:03:58,079
the accurate they can measure the height

1755
01:04:02,870 --> 01:03:59,680
of the ocean with an accuracy of about

1756
01:04:04,630 --> 01:04:02,880
one inch from 800 miles in space so

1757
01:04:06,549 --> 01:04:04,640
there's a big footprint and it averages

1758
01:04:09,510 --> 01:04:06,559
over all the waves and stuff like that

1759
01:04:11,670 --> 01:04:09,520
and you can see how tall the ocean is

1760
01:04:14,150 --> 01:04:11,680
from space and this is really important

1761
01:04:17,270 --> 01:04:14,160
to me as an oceanographer because uh

1762
01:04:19,990 --> 01:04:17,280
oceans uh play a huge role in our global

1763
01:04:22,309 --> 01:04:20,000

climate system as you can imagine so

1764
01:04:24,230 --> 01:04:22,319
uh how much of the planet is covered by

1765
01:04:26,390 --> 01:04:24,240
oceans you guys know

1766
01:04:28,069 --> 01:04:26,400
70 is something yes over two-thirds

1767
01:04:31,829 --> 01:04:28,079
that's right over two-thirds of our

1768
01:04:34,390 --> 01:04:31,839
planet is uh is covered by oceans and so

1769
01:04:35,990 --> 01:04:34,400
as you can imagine uh you know uh arthur

1770
01:04:37,510 --> 01:04:36,000
c clark once famously said we shouldn't

1771
01:04:39,829 --> 01:04:37,520
call our planet earth we should call it

1772
01:04:41,270 --> 01:04:39,839
planet ocean because it's more ocean

1773
01:04:43,750 --> 01:04:41,280
than it is earth

1774
01:04:46,710 --> 01:04:43,760
so uh you can imagine that as our

1775
01:04:49,750 --> 01:04:46,720
climate changes as we drive our climate

1776
01:04:50,950 --> 01:04:49,760
into a new realm by adding co2 to the

1777
01:04:52,870 --> 01:04:50,960
atmosphere

1778
01:04:54,710 --> 01:04:52,880
really almost all the changes are

1779
01:04:57,270 --> 01:04:54,720
happening in the oceans

1780
01:04:59,670 --> 01:04:57,280
so if you think about climate change if

1781
01:05:01,430 --> 01:04:59,680
you ask you know where is climate change

1782
01:05:04,309 --> 01:05:01,440
happening the answer really is in the

1783
01:05:06,150 --> 01:05:04,319
oceans we think of it as happening to us

1784
01:05:07,750 --> 01:05:06,160
because we live in the atmosphere we

1785
01:05:10,150 --> 01:05:07,760
think of it happening in the atmosphere

1786
01:05:12,950 --> 01:05:10,160
and a lot of times when we talk about

1787
01:05:14,309 --> 01:05:12,960
global warming we talk about the rise in

1788
01:05:16,549 --> 01:05:14,319

the temperatures

1789
01:05:18,870 --> 01:05:16,559
of uh the whole planet the surface of

1790
01:05:21,430 --> 01:05:18,880
the planet but in fact really it's the

1791
01:05:23,029 --> 01:05:21,440
rise in temperatures of the oceans over

1792
01:05:25,430 --> 01:05:23,039
90 percent

1793
01:05:29,589 --> 01:05:25,440
of the heat that's trapped by greenhouse

1794
01:05:32,230 --> 01:05:29,599
gases is warming the oceans over 90

1795
01:05:34,950 --> 01:05:32,240
percent so in other words the oceans are

1796
01:05:37,589 --> 01:05:34,960
really our barometer for how much we're

1797
01:05:39,430 --> 01:05:37,599
changing the climate and the reasons

1798
01:05:42,230 --> 01:05:39,440
mission the reason that missions like

1799
01:05:44,710 --> 01:05:42,240
jason and jason ii and jason iii are so

1800
01:05:47,349 --> 01:05:44,720
important is because they measure that

1801
01:05:50,230 --> 01:05:47,359
rise in the oceans if you have an

1802
01:05:52,309 --> 01:05:50,240
accuracy of about one inch over a single

1803
01:05:54,870 --> 01:05:52,319
spot on the earth and then you fly

1804
01:05:57,109 --> 01:05:54,880
around the planet for about 10 days you

1805
01:05:58,549 --> 01:05:57,119
cover almost the entire oceans

1806
01:06:00,630 --> 01:05:58,559
then you take this measurement over and

1807
01:06:02,309 --> 01:06:00,640
over and again then in 10 days we can

1808
01:06:05,430 --> 01:06:02,319
essentially measure

1809
01:06:08,069 --> 01:06:05,440
globally averaged sea level essentially

1810
01:06:10,710 --> 01:06:08,079
we can measure the volume of the ocean

1811
01:06:13,430 --> 01:06:10,720
and how it's changing so two-thirds of

1812
01:06:16,309 --> 01:06:13,440
our planet covered by oceans we can see

1813
01:06:18,470 --> 01:06:16,319

those oceans slowly rising and they rise

1814
01:06:20,309 --> 01:06:18,480
for two reasons they rise because

1815
01:06:21,349 --> 01:06:20,319
glaciers and ice sheets are melting of

1816
01:06:23,990 --> 01:06:21,359
course

1817
01:06:25,990 --> 01:06:24,000
in places like greenland and antarctica

1818
01:06:28,150 --> 01:06:26,000
and also lots of tiny little mountain

1819
01:06:30,470 --> 01:06:28,160
glaciers all over the planet

1820
01:06:33,109 --> 01:06:30,480
as the atmosphere heats up as the ocean

1821
01:06:35,109 --> 01:06:33,119
heats up these melt and that melt water

1822
01:06:37,670 --> 01:06:35,119
eventually finds its way back into the

1823
01:06:40,069 --> 01:06:37,680
oceans so we can see this rising of the

1824
01:06:42,069 --> 01:06:40,079
oceans from space from our space

1825
01:06:44,230 --> 01:06:42,079
satellites and i like to say that in

1826
01:06:47,349 --> 01:06:44,240
fact uh this satellite and its

1827
01:06:50,230 --> 01:06:47,359
predecessors jason this one's jason 2 i

1828
01:06:52,549 --> 01:06:50,240
believe or might be jason 3. anyway

1829
01:06:54,230 --> 01:06:52,559
they look almost identical

1830
01:06:56,870 --> 01:06:54,240
these satellites are really our

1831
01:06:58,710 --> 01:06:56,880
yardsticks for measuring global climate

1832
01:07:01,589 --> 01:06:58,720
change because

1833
01:07:04,390 --> 01:07:01,599
the sea level rise represents

1834
01:07:06,230 --> 01:07:04,400
the increase in water it represents the

1835
01:07:08,069 --> 01:07:06,240
melting of glaciers and ice sheets but

1836
01:07:10,789 --> 01:07:08,079
it also represents

1837
01:07:14,069 --> 01:07:10,799
thermal expansion it turns out when

1838
01:07:15,910 --> 01:07:14,079

water gets warm it actually heats up it

1839
01:07:19,270 --> 01:07:15,920
actually expands

1840
01:07:21,510 --> 01:07:19,280
so expanding water is one of the causes

1841
01:07:23,589 --> 01:07:21,520
of global sea level rise

1842
01:07:25,109 --> 01:07:23,599
and we can essentially measure the sum

1843
01:07:28,309 --> 01:07:25,119
of these two things we can measure the

1844
01:07:31,190 --> 01:07:28,319
thermal expansion plus the runoff from

1845
01:07:32,789 --> 01:07:31,200
space using satellites just like this

1846
01:07:34,069 --> 01:07:32,799
one and that's really why they're so

1847
01:07:35,510 --> 01:07:34,079
important they're really our most

1848
01:07:38,710 --> 01:07:35,520
accurate tool

1849
01:07:39,829 --> 01:07:38,720
for measuring global warming you know uh

1850
01:07:42,630 --> 01:07:39,839
recently there's been a lot of

1851
01:07:44,630 --> 01:07:42,640
discussion about a pause in global

1852
01:07:46,230 --> 01:07:44,640
warming that the surface temperatures

1853
01:07:47,910 --> 01:07:46,240
were going up really fast and they seem

1854
01:07:49,910 --> 01:07:47,920
to kind of level off

1855
01:07:52,150 --> 01:07:49,920
and i like to say that paws are for

1856
01:07:54,309 --> 01:07:52,160
kittens and puppies and not global

1857
01:07:56,470 --> 01:07:54,319
warming because in fact global warming

1858
01:07:58,150 --> 01:07:56,480
hasn't really paused if you look at any

1859
01:07:59,270 --> 01:07:58,160
other measure if you look at sea level

1860
01:08:00,870 --> 01:07:59,280
rise

1861
01:08:02,950 --> 01:08:00,880
if you look at the melting of glaciers

1862
01:08:05,430 --> 01:08:02,960
and ice sheets if you look at sea ice

1863
01:08:07,670 --> 01:08:05,440

loss in the arctic all of these things

1864
01:08:10,950 --> 01:08:07,680
are just continuing on they're all still

1865
01:08:13,349 --> 01:08:10,960
happening there is no pause in global

1866
01:08:15,430 --> 01:08:13,359
warming the surface temperature bounces

1867
01:08:17,110 --> 01:08:15,440
around because of natural fluctuations a

1868
01:08:18,950 --> 01:08:17,120
little bit and if you pick the right

1869
01:08:20,630 --> 01:08:18,960
period then you can make it look like

1870
01:08:23,990 --> 01:08:20,640
there's no warming over a period of time

1871
01:08:26,149 --> 01:08:24,000
but in fact better measures of global

1872
01:08:28,550 --> 01:08:26,159
warming like the ones that come from

1873
01:08:31,269 --> 01:08:28,560
these satellites show that sea level

1874
01:08:33,349 --> 01:08:31,279
rise is continuing and in fact there is

1875
01:08:35,669 --> 01:08:33,359
no pause in global warming if anything

1876
01:08:37,030 --> 01:08:35,679
global warming is accelerating

1877
01:08:39,349 --> 01:08:37,040
so uh

1878
01:08:41,669 --> 01:08:39,359
i i know there's a bucket up here and

1879
01:08:44,070 --> 01:08:41,679
you're probably all wondering why this

1880
01:08:45,349 --> 01:08:44,080
bucket is here and uh the bucket's part

1881
01:08:47,749 --> 01:08:45,359
of this demonstration that i've been

1882
01:08:49,910 --> 01:08:47,759
doing for a whole bunch of years now

1883
01:08:52,470 --> 01:08:49,920
i like to uh i like to explain to people

1884
01:08:54,550 --> 01:08:52,480
why it is that the ocean is really so

1885
01:08:57,349 --> 01:08:54,560
important for for measuring global

1886
01:08:59,510 --> 01:08:57,359
warming and like i said before over 90

1887
01:09:02,149 --> 01:08:59,520
percent of the heat

1888
01:09:05,030 --> 01:09:02,159

trapped by greenhouse gases is going

1889
01:09:07,430 --> 01:09:05,040
into the oceans now why is that why is

1890
01:09:08,870 --> 01:09:07,440
all the heat going into the oceans

1891
01:09:11,110 --> 01:09:08,880
yell it out this is a question answer

1892
01:09:12,870 --> 01:09:11,120
part

1893
01:09:14,390 --> 01:09:12,880
because of the heat capacity yes oh

1894
01:09:16,550 --> 01:09:14,400
you've seen this demonstration never

1895
01:09:18,870 --> 01:09:16,560
mind

1896
01:09:21,669 --> 01:09:18,880
um so yeah exactly the heat capacity of

1897
01:09:23,749 --> 01:09:21,679
the oceans is enormous and water it

1898
01:09:26,630 --> 01:09:23,759
turns out water is just really really

1899
01:09:28,709 --> 01:09:26,640
good at sucking up heat and that's why

1900
01:09:30,470 --> 01:09:28,719
over 90 percent of that heat is winding

1901
01:09:32,149 --> 01:09:30,480
up in the oceans and there's a nice

1902
01:09:33,189 --> 01:09:32,159
little demonstration you can do if you

1903
01:09:34,950 --> 01:09:33,199
take a

1904
01:09:36,229 --> 01:09:34,960
you know you can think of the atmosphere

1905
01:09:37,749 --> 01:09:36,239
i like to say that

1906
01:09:41,189 --> 01:09:37,759
the atmosphere is kind of like a piece

1907
01:09:43,110 --> 01:09:41,199
of tinfoil wrapped around a hot potato

1908
01:09:45,349 --> 01:09:43,120
if you put tin foil in the oven you can

1909
01:09:47,110 --> 01:09:45,359
actually reach into a 400 degree oven

1910
01:09:49,829 --> 01:09:47,120
and pick up the tin foil

1911
01:09:51,349 --> 01:09:49,839
why is that because the 10 the tin foil

1912
01:09:53,349 --> 01:09:51,359
has no heat capacity essentially its

1913
01:09:54,550 --> 01:09:53,359

heat capacity is very small and as soon

1914
01:09:56,470 --> 01:09:54,560
as you touch it it's the same

1915
01:09:58,790 --> 01:09:56,480
temperature as your fingers but if you

1916
01:10:00,870 --> 01:09:58,800
wrap that foil around a hot potato and

1917
01:10:02,870 --> 01:10:00,880
you pick up the potato it will burn you

1918
01:10:04,630 --> 01:10:02,880
and the reason is because it's just

1919
01:10:06,070 --> 01:10:04,640
reflecting the temperature of whatever

1920
01:10:07,830 --> 01:10:06,080
it's touching and that's what the

1921
01:10:10,310 --> 01:10:07,840
atmosphere is like really the atmosphere

1922
01:10:12,709 --> 01:10:10,320
is just doing what the top 100 meters or

1923
01:10:14,149 --> 01:10:12,719
so of the ocean is telling it to do so

1924
01:10:16,470 --> 01:10:14,159
in a lot of ways

1925
01:10:18,709 --> 01:10:16,480
again as we look to trying to understand

1926
01:10:21,590 --> 01:10:18,719
how climate change happens really all

1927
01:10:24,390 --> 01:10:21,600
the action is happening in the oceans so

1928
01:10:27,189 --> 01:10:24,400
if we take a uh if we take a balloon

1929
01:10:28,950 --> 01:10:27,199
and we fill it with air

1930
01:10:44,709 --> 01:10:28,960
like this

1931
01:10:50,149 --> 01:10:48,070
now if i hold a flame to this balloon

1932
01:10:54,709 --> 01:10:50,159
what do you think is going to happen

1933
01:10:58,390 --> 01:10:55,990
that's they're going to get splattered

1934
01:11:01,430 --> 01:10:58,400
somebody said uh i hope not our

1935
01:11:03,830 --> 01:11:01,440
insurance won't cover that um so uh if i

1936
01:11:05,590 --> 01:11:03,840
hold a flame to a balloon it pops right

1937
01:11:07,110 --> 01:11:05,600
you guys ready

1938
01:11:10,950 --> 01:11:07,120

i don't think you're ready

1939
01:11:14,390 --> 01:11:10,960
are you ready here we go one two

1940
01:11:16,550 --> 01:11:14,400
yes i knew i could mess up this set

1941
01:11:18,149 --> 01:11:16,560
um so the reason the balloon filled with

1942
01:11:20,390 --> 01:11:18,159
air pops is because it has a very low

1943
01:11:21,669 --> 01:11:20,400
heat capacity but if you fill a balloon

1944
01:11:23,270 --> 01:11:21,679
with water

1945
01:11:25,750 --> 01:11:23,280
then it turns out you can stand there

1946
01:11:27,110 --> 01:11:25,760
with a flame against it like all day and

1947
01:11:29,510 --> 01:11:27,120
it won't pop

1948
01:11:32,229 --> 01:11:29,520
and i've done this experiment many many

1949
01:11:33,830 --> 01:11:32,239
times and i can assure you that

1950
01:11:37,910 --> 01:11:33,840
the balloon

1951
01:11:40,870 --> 01:11:37,920
has almost no chance of popping

1952
01:11:43,430 --> 01:11:40,880
like

1953
01:11:45,430 --> 01:11:43,440
it's definitely

1954
01:11:49,189 --> 01:11:45,440
how is that for the mic levels um it's

1955
01:11:51,350 --> 01:11:49,199
definitely almost surely not gonna pop

1956
01:11:53,350 --> 01:11:51,360
and ruin this lovely set

1957
01:11:55,030 --> 01:11:53,360
but just in case it does

1958
01:11:57,430 --> 01:11:55,040
we'll put this little balloon here or

1959
01:11:58,950 --> 01:11:57,440
this little bucket here

1960
01:12:00,470 --> 01:11:58,960
now you're all really scared of being on

1961
01:12:01,750 --> 01:12:00,480
the front row

1962
01:12:03,270 --> 01:12:01,760
okay so here we go we're gonna hold the

1963
01:12:05,270 --> 01:12:03,280

flame against the balloon and see what

1964
01:12:14,390 --> 01:12:05,280
happens you guys ready

1965
01:12:14,400 --> 01:12:21,030
really want to get lunch

1966
01:12:27,430 --> 01:12:24,070
click click no one's typing anymore it's

1967
01:12:30,070 --> 01:12:28,149
so

1968
01:12:31,510 --> 01:12:30,080
i could really stand here literally like

1969
01:12:33,510 --> 01:12:31,520
all day i had a friend who's in the

1970
01:12:35,669 --> 01:12:33,520
audience somewhere she put a balloon

1971
01:12:38,149 --> 01:12:35,679
over a bunsen burner

1972
01:12:40,709 --> 01:12:38,159
and it remained intact now

1973
01:12:42,390 --> 01:12:40,719
if you use a blowtorch the balloon will

1974
01:12:43,750 --> 01:12:42,400
pop

1975
01:12:45,189 --> 01:12:43,760
just so you know

1976
01:12:47,350 --> 01:12:45,199
but i could stand here for a really

1977
01:12:48,950 --> 01:12:47,360
really long time and talk to you for the

1978
01:12:50,950 --> 01:12:48,960
entire rest of this segment and the

1979
01:12:52,550 --> 01:12:50,960
balloon wouldn't pop in fact

1980
01:12:55,590 --> 01:12:52,560
the balloon's not even hot if anybody

1981
01:12:58,070 --> 01:12:55,600
wants to touch it yeah

1982
01:12:59,990 --> 01:12:58,080
wow it's not even hot so go home and try

1983
01:13:01,510 --> 01:13:00,000
it someplace safe with your own garbage

1984
01:13:07,350 --> 01:13:01,520
bag

1985
01:13:07,360 --> 01:13:13,669
science

1986
01:13:16,229 --> 01:13:15,189
josh uh we've got some time for

1987
01:13:17,590 --> 01:13:16,239
questions do you have some time for

1988
01:13:19,430 --> 01:13:17,600

questions i have some time for questions

1989
01:13:21,030 --> 01:13:19,440
do you have questions who's got

1990
01:13:23,189 --> 01:13:21,040
questions she's got a question there we

1991
01:13:28,390 --> 01:13:23,199
go wait for a mic runner to come to you

1992
01:13:35,110 --> 01:13:30,709
uh hi i have two questions so if that's

1993
01:13:37,270 --> 01:13:36,550
the first question we'll see what they

1994
01:13:39,910 --> 01:13:37,280
are

1995
01:13:43,270 --> 01:13:39,920
the first question is

1996
01:13:45,750 --> 01:13:43,280
somebody as a scientist who works in

1997
01:13:48,149 --> 01:13:45,760
tracking global climate change

1998
01:13:51,110 --> 01:13:48,159
is there any scientific basis for

1999
01:13:52,870 --> 01:13:51,120
skepticism about climate change that's

2000
01:13:54,390 --> 01:13:52,880
my first question and then my second

2001
01:13:57,110 --> 01:13:54,400
question is

2002
01:13:58,709 --> 01:13:57,120
um how far away are we

2003
01:14:01,270 --> 01:13:58,719
from

2004
01:14:04,229 --> 01:14:01,280
runaway greenhouse effect

2005
01:14:06,790 --> 01:14:04,239
oh okay two great questions so um with

2006
01:14:09,189 --> 01:14:06,800
regard to the skepticism question i

2007
01:14:12,149 --> 01:14:09,199
guess i would say uh that climate

2008
01:14:14,229 --> 01:14:12,159
science is all about skepticism in fact

2009
01:14:16,390 --> 01:14:14,239
as a scientist i'm probably the most

2010
01:14:19,430 --> 01:14:16,400
skeptical person in the room

2011
01:14:22,070 --> 01:14:19,440
but with regards to what's been proven

2012
01:14:25,270 --> 01:14:22,080
in terms of climate science we've proven

2013
01:14:27,430 --> 01:14:25,280

really with on beyond any doubt that

2014
01:14:30,310 --> 01:14:27,440
humans are the biggest factor driving

2015
01:14:33,350 --> 01:14:30,320
climate change today so we've had a very

2016
01:14:35,510 --> 01:14:33,360
stable climate for about 10 000 years

2017
01:14:37,430 --> 01:14:35,520
and then in the last 150 years we've

2018
01:14:39,669 --> 01:14:37,440
started to completely change the

2019
01:14:41,750 --> 01:14:39,679
atmosphere we can measure that we can

2020
01:14:43,910 --> 01:14:41,760
actually take the carbon out of the

2021
01:14:46,870 --> 01:14:43,920
atmosphere and weigh it look at the

2022
01:14:49,189 --> 01:14:46,880
isotopic ratios and see that that carbon

2023
01:14:51,750 --> 01:14:49,199
came from burning fossil fuels and we

2024
01:14:53,990 --> 01:14:51,760
also know from the basic physics of how

2025
01:14:56,390 --> 01:14:54,000
carbon dioxide interacts with light as

2026
01:14:58,149 --> 01:14:56,400
it comes in from the sun and outgoing

2027
01:15:00,310 --> 01:14:58,159
radiation as it goes out from the earth

2028
01:15:03,030 --> 01:15:00,320
we know that that carbon dioxide is

2029
01:15:05,189 --> 01:15:03,040
going to trap extra heat and we also

2030
01:15:07,510 --> 01:15:05,199
know from the climate records that

2031
01:15:09,830 --> 01:15:07,520
things like sea level rise were stable

2032
01:15:12,070 --> 01:15:09,840
for thousands of years we had 2 000

2033
01:15:14,630 --> 01:15:12,080
years with almost no sea level rise and

2034
01:15:16,790 --> 01:15:14,640
then in the last 150 boom

2035
01:15:19,030 --> 01:15:16,800
so we have a really good chain of

2036
01:15:22,310 --> 01:15:19,040
evidence holding together

2037
01:15:23,830 --> 01:15:22,320
our knowledge of human-caused global

2038
01:15:25,669 --> 01:15:23,840

warming so

2039
01:15:27,510 --> 01:15:25,679
if your question is about is there doubt

2040
01:15:30,149 --> 01:15:27,520
that people are causing global warming

2041
01:15:32,550 --> 01:15:30,159
really there's no doubt anymore

2042
01:15:34,550 --> 01:15:32,560
skepticism of course in science is an

2043
01:15:35,590 --> 01:15:34,560
incredibly important part of science

2044
01:15:37,750 --> 01:15:35,600
because

2045
01:15:40,149 --> 01:15:37,760
if i try and publish a result

2046
01:15:42,630 --> 01:15:40,159
immediately what happens is if i say x

2047
01:15:44,390 --> 01:15:42,640
is true then i write it down i send it

2048
01:15:46,630 --> 01:15:44,400
to all my peers who don't really like me

2049
01:15:47,990 --> 01:15:46,640
that much anyway they tell me all the

2050
01:15:49,830 --> 01:15:48,000
things that are wrong with it they send

2051
01:15:51,590 --> 01:15:49,840
it back to me i try and fix it they read

2052
01:15:53,430 --> 01:15:51,600
it again they send it back to me and

2053
01:15:55,669 --> 01:15:53,440
after it goes to this iteration process

2054
01:15:56,870 --> 01:15:55,679
several times finally i published a

2055
01:15:59,189 --> 01:15:56,880
paper that a whole bunch of my

2056
01:16:00,870 --> 01:15:59,199
colleagues can agree on is true

2057
01:16:02,390 --> 01:16:00,880
but that's not the end of the process

2058
01:16:03,830 --> 01:16:02,400
eventually somebody else will publish

2059
01:16:05,270 --> 01:16:03,840
another paper and another paper in

2060
01:16:07,350 --> 01:16:05,280
another paper looking at the same

2061
01:16:09,430 --> 01:16:07,360
results over and over and over again and

2062
01:16:11,669 --> 01:16:09,440
it's through that process that we built

2063
01:16:13,830 --> 01:16:11,679

this tower of knowledge which is really

2064
01:16:15,910 --> 01:16:13,840
hard to knock down with a simple

2065
01:16:17,669 --> 01:16:15,920
i don't really think that's true so in

2066
01:16:19,750 --> 01:16:17,679
terms of is there skepticism well

2067
01:16:21,590 --> 01:16:19,760
skepticism's a part of science but is

2068
01:16:24,709 --> 01:16:21,600
there doubt about human-caused climate

2069
01:16:27,270 --> 01:16:24,719
change i think the answer is no

2070
01:16:28,870 --> 01:16:27,280
runaway greenhouse gas effects

2071
01:16:30,709 --> 01:16:28,880
we're still finding things in the

2072
01:16:33,189 --> 01:16:30,719
climate that might trigger stuff like

2073
01:16:35,189 --> 01:16:33,199
that so we don't have a good idea of

2074
01:16:37,590 --> 01:16:35,199
when that might really happen

2075
01:16:40,149 --> 01:16:37,600
sometimes warming up the climate adds

2076
01:16:41,030 --> 01:16:40,159
more co2 which warms the climate even

2077
01:16:42,070 --> 01:16:41,040
more

2078
01:16:43,510 --> 01:16:42,080
because of

2079
01:16:45,189 --> 01:16:43,520
carbon dioxide trapped in these

2080
01:16:46,790 --> 01:16:45,199
different places so

2081
01:16:49,750 --> 01:16:46,800
i think that

2082
01:16:51,270 --> 01:16:49,760
is sort of uh we don't really know if

2083
01:16:52,950 --> 01:16:51,280
we're close to a runaway greenhouse

2084
01:16:54,950 --> 01:16:52,960
effect

2085
01:16:56,390 --> 01:16:54,960
all right next question

2086
01:16:58,149 --> 01:16:56,400
oh do we have we have a mike on the

2087
01:16:59,430 --> 01:16:58,159
other side of the room thank you with

2088
01:17:02,390 --> 01:16:59,440

regard to

2089
01:17:05,350 --> 01:17:02,400
the ocean height change what kind of

2090
01:17:07,189 --> 01:17:05,360
percentage is coming from the density

2091
01:17:08,630 --> 01:17:07,199
change of the water

2092
01:17:09,910 --> 01:17:08,640
as opposed to

2093
01:17:11,590 --> 01:17:09,920
the

2094
01:17:13,350 --> 01:17:11,600
ice caps melting and runoff and things

2095
01:17:16,149 --> 01:17:13,360
of that nature oh that's a great

2096
01:17:19,110 --> 01:17:16,159
question it's about one third of sea

2097
01:17:20,870 --> 01:17:19,120
level rise today is caused by warming

2098
01:17:23,030 --> 01:17:20,880
and thermal expansion the other two

2099
01:17:25,030 --> 01:17:23,040
thirds is the melting and runoff but

2100
01:17:27,110 --> 01:17:25,040
looking out into the future it's going

2101
01:17:28,790 --> 01:17:27,120
to tilt way more towards

2102
01:17:31,350 --> 01:17:28,800
melting and runoff because there's only

2103
01:17:33,510 --> 01:17:31,360
so the oceans can only absorb the heat

2104
01:17:36,470 --> 01:17:33,520
so quickly but you can melt an ice sheet

2105
01:17:38,149 --> 01:17:36,480
really fast and so uh in the future we

2106
01:17:40,709 --> 01:17:38,159
expect it to be more and more melting

2107
01:17:42,709 --> 01:17:40,719
and less and less thermal expansion or

2108
01:17:45,590 --> 01:17:42,719
density changes

2109
01:17:48,630 --> 01:17:45,600
right

2110
01:17:52,950 --> 01:17:48,640
microphone go

2111
01:17:52,960 --> 01:17:55,990
okay

2112
01:18:00,070 --> 01:17:58,550
all right i love it so many questions

2113
01:18:00,790 --> 01:18:00,080

everyone's so polite

2114
01:18:02,070 --> 01:18:00,800
um

2115
01:18:05,030 --> 01:18:02,080
my question is actually less about the

2116
01:18:06,950 --> 01:18:05,040
science than the outreach um

2117
01:18:07,669 --> 01:18:06,960
when you're doing fact-based work but in

2118
01:18:16,070 --> 01:18:07,679
a

2119
01:18:18,709 --> 01:18:16,080
you turn to to re-ground the

2120
01:18:21,030 --> 01:18:18,719
conversation in facts well so that's a

2121
01:18:22,790 --> 01:18:21,040
fantastic question um

2122
01:18:27,189 --> 01:18:22,800
the tool that i like to use as you might

2123
01:18:29,510 --> 01:18:27,199
have already guessed is comedy um

2124
01:18:33,189 --> 01:18:29,520
i think making things funny uh makes

2125
01:18:35,270 --> 01:18:33,199
them more accessible and and uh less a

2126
01:18:37,830 --> 01:18:35,280
threat less a challenge to

2127
01:18:40,470 --> 01:18:37,840
people's world view but i think you have

2128
01:18:42,229 --> 01:18:40,480
to be cognizant we have to be uh

2129
01:18:43,910 --> 01:18:42,239
thoughtful when we communicate about

2130
01:18:45,510 --> 01:18:43,920
climate science

2131
01:18:47,669 --> 01:18:45,520
especially in this

2132
01:18:49,990 --> 01:18:47,679
however we got here it's a politicized

2133
01:18:51,830 --> 01:18:50,000
topic now and so we have to be a little

2134
01:18:53,669 --> 01:18:51,840
bit thoughtful about how we communicate

2135
01:18:55,430 --> 01:18:53,679
and i i think that you know as

2136
01:18:57,590 --> 01:18:55,440
scientists we often communicate we think

2137
01:18:59,110 --> 01:18:57,600
a lot about uncertainty so if you ask a

2138
01:19:01,030 --> 01:18:59,120

scientist a question

2139
01:19:02,390 --> 01:19:01,040
99 of the time they'll tell you what

2140
01:19:04,550 --> 01:19:02,400
they don't know

2141
01:19:07,189 --> 01:19:04,560
instead of what they do know and i think

2142
01:19:09,830 --> 01:19:07,199
uh the simplest thing we can do to make

2143
01:19:11,830 --> 01:19:09,840
lives make our lives easier is talk more

2144
01:19:13,510 --> 01:19:11,840
about what we do know

2145
01:19:15,830 --> 01:19:13,520
but personally you know in my own

2146
01:19:17,669 --> 01:19:15,840
personal voyage through science and

2147
01:19:19,590 --> 01:19:17,679
science communication i really like

2148
01:19:22,229 --> 01:19:19,600
making people laugh because i think it's

2149
01:19:24,070 --> 01:19:22,239
super fun and also because i think

2150
01:19:26,070 --> 01:19:24,080
people

2151
01:19:30,790 --> 01:19:26,080
it's easier to

2152
01:19:32,310 --> 01:19:30,800
and absorb information especially

2153
01:19:34,149 --> 01:19:32,320
complicated information if you're having

2154
01:19:36,550 --> 01:19:34,159
a little bit of fun and i like to have a

2155
01:19:38,709 --> 01:19:36,560
little bit of fun had a college

2156
01:19:41,910 --> 01:19:38,719
professor in math he used to say it's

2157
01:19:46,149 --> 01:19:43,830
profound profound

2158
01:19:47,910 --> 01:19:46,159
all right

2159
01:19:50,229 --> 01:19:47,920
you there with the microphone what's

2160
01:19:52,070 --> 01:19:50,239
your question yeah so i think a lot of

2161
01:19:53,910 --> 01:19:52,080
us are aware of what's going on on the

2162
01:19:55,830 --> 01:19:53,920
land and i think it's really interesting

2163
01:19:57,430 --> 01:19:55,840

that you're studying the ocean

2164
01:19:59,270 --> 01:19:57,440
some of the other presentations talked

2165
01:20:01,669 --> 01:19:59,280
about how satellites were able to see

2166
01:20:03,590 --> 01:20:01,679
things that say airplanes or boats

2167
01:20:05,189 --> 01:20:03,600
weren't able to see or buoys so i was

2168
01:20:06,149 --> 01:20:05,199
wondering if you know maybe there were

2169
01:20:08,229 --> 01:20:06,159
certain things that you've learned

2170
01:20:10,310 --> 01:20:08,239
through the years from looking down from

2171
01:20:12,790 --> 01:20:10,320
space on the oceans that just were

2172
01:20:14,790 --> 01:20:12,800
interesting to you oh absolutely that's

2173
01:20:16,550 --> 01:20:14,800
a fantastic question and i think it's

2174
01:20:18,390 --> 01:20:16,560
it's one of the reasons why nasa is so

2175
01:20:21,189 --> 01:20:18,400
such a special place to do this kind of

2176
01:20:23,669 --> 01:20:21,199
work because climate science climate

2177
01:20:26,310 --> 01:20:23,679
change is happening to the whole planet

2178
01:20:28,310 --> 01:20:26,320
uh but we can't fly an airplane high

2179
01:20:31,110 --> 01:20:28,320
enough or put enough buoys out to kind

2180
01:20:33,270 --> 01:20:31,120
of see the whole planet all at once

2181
01:20:35,110 --> 01:20:33,280
and satellites allow us to do that

2182
01:20:37,910 --> 01:20:35,120
there's some trade-offs that you have

2183
01:20:39,830 --> 01:20:37,920
like for example our our uh altimeter

2184
01:20:41,590 --> 01:20:39,840
satellites our sea level satellites

2185
01:20:44,550 --> 01:20:41,600
can't see below the surface they can't

2186
01:20:46,629 --> 01:20:44,560
tell us what the temperatures are doing

2187
01:20:47,990 --> 01:20:46,639
and mostly they

2188
01:20:49,990 --> 01:20:48,000

a little bit they can tell us about the

2189
01:20:51,830 --> 01:20:50,000
currents but you can't see below the

2190
01:20:53,510 --> 01:20:51,840
surface of the ocean from space very

2191
01:20:56,310 --> 01:20:53,520
well so you give up something but what

2192
01:20:57,910 --> 01:20:56,320
you get is this big picture and things

2193
01:21:00,390 --> 01:20:57,920
like el nino have really been

2194
01:21:02,790 --> 01:21:00,400
revolutionized so we knew that el ninos

2195
01:21:04,790 --> 01:21:02,800
happened in the pacific ocean and

2196
01:21:06,470 --> 01:21:04,800
just to remind you what an el nino is

2197
01:21:08,070 --> 01:21:06,480
there's a big pool of warm water in the

2198
01:21:10,629 --> 01:21:08,080
western pacific and

2199
01:21:12,950 --> 01:21:10,639
every couple of years it slides over to

2200
01:21:15,590 --> 01:21:12,960
the east and it wreaks havoc on weather

2201
01:21:16,950 --> 01:21:15,600
patterns all around the world and we

2202
01:21:18,709 --> 01:21:16,960
knew that it happened and we kind of

2203
01:21:22,390 --> 01:21:18,719
knew the physics of it from other things

2204
01:21:25,590 --> 01:21:22,400
but satellites showed us how global that

2205
01:21:27,669 --> 01:21:25,600
effect can be so we've seen impacts of

2206
01:21:29,830 --> 01:21:27,679
el nino as far away as antarctica and

2207
01:21:31,189 --> 01:21:29,840
greenland so it really gives and you

2208
01:21:32,870 --> 01:21:31,199
wouldn't you wouldn't even thought to

2209
01:21:34,470 --> 01:21:32,880
look for that if it wasn't for something

2210
01:21:36,390 --> 01:21:34,480
giving you this kind of big picture you

2211
01:21:38,870 --> 01:21:36,400
can see it all at once

2212
01:21:41,189 --> 01:21:38,880
the other thing it gives us is is global

2213
01:21:44,070 --> 01:21:41,199

sea level rise which in my book like i

2214
01:21:45,110 --> 01:21:44,080
said the yardstick of global warming so

2215
01:21:47,910 --> 01:21:45,120
those kinds of things you really

2216
01:21:48,950 --> 01:21:47,920
couldn't do without satellites

2217
01:21:50,310 --> 01:21:48,960
all right

2218
01:21:53,910 --> 01:21:50,320
let's see who's got the mic who's got

2219
01:21:58,470 --> 01:21:54,830
all

2220
01:22:02,310 --> 01:21:59,990
it's a game of hunting mike there we go

2221
01:22:07,350 --> 01:22:02,320
no jelly is right behind you

2222
01:22:11,270 --> 01:22:09,990
next next one's yours actually let's go

2223
01:22:12,870 --> 01:22:11,280
ahead and get the mic into the hand of

2224
01:22:14,870 --> 01:22:12,880
the next person any other questions out

2225
01:22:16,470 --> 01:22:14,880
there in the house for josh

2226
01:22:19,750 --> 01:22:16,480
right here so jerry if you want to bring

2227
01:22:23,750 --> 01:22:20,629
but

2228
01:22:27,669 --> 01:22:23,760
when and where is jason launching

2229
01:22:30,149 --> 01:22:27,679
it's launching in 2015 out of vandenberg

2230
01:22:32,070 --> 01:22:30,159
hopefully unless our budget gets slipped

2231
01:22:33,990 --> 01:22:32,080
again

2232
01:22:36,629 --> 01:22:34,000
i was just wondering i know that most

2233
01:22:38,629 --> 01:22:36,639
astronauts have a combination of diving

2234
01:22:41,270 --> 01:22:38,639
a love for the ocean a love for the air

2235
01:22:43,350 --> 01:22:41,280
as pilots um i wonder if when you become

2236
01:22:44,790 --> 01:22:43,360
an oceanographer if you have a if you're

2237
01:22:47,350 --> 01:22:44,800
a diver yourself

2238
01:22:49,189 --> 01:22:47,360

and you use that for some of your

2239
01:22:51,510 --> 01:22:49,199
i'm the lamest oceanographer in the

2240
01:22:54,790 --> 01:22:51,520
history

2241
01:22:58,629 --> 01:22:54,800
never i haven't i haven't i haven't

2242
01:23:00,709 --> 01:22:58,639
doven divin dived um i don't dive and

2243
01:23:02,790 --> 01:23:00,719
what's even sadder is i spent i spent

2244
01:23:05,669 --> 01:23:02,800
eight eight years in san diego and i

2245
01:23:07,270 --> 01:23:05,679
never learned how to surf so

2246
01:23:08,870 --> 01:23:07,280
anybody want to teach me how to surf

2247
01:23:10,870 --> 01:23:08,880
i'll be happy

2248
01:23:13,030 --> 01:23:10,880
yes all right

2249
01:23:14,310 --> 01:23:13,040
but i do have other hobbies like

2250
01:23:15,430 --> 01:23:14,320
comedy

2251
01:23:17,189 --> 01:23:15,440
that's right

2252
01:23:19,430 --> 01:23:17,199
you do you do improv don't you i do

2253
01:23:21,270 --> 01:23:19,440
improv yes i have show i'm taking

2254
01:23:23,910 --> 01:23:21,280
classes at the second city

2255
01:23:25,830 --> 01:23:23,920
uh in hollywood and uh trying to do

2256
01:23:28,310 --> 01:23:25,840
comedy and science not mutually

2257
01:23:29,830 --> 01:23:28,320
exclusive there are two great tastes

2258
01:23:31,030 --> 01:23:29,840
that taste great together

2259
01:23:32,709 --> 01:23:31,040
right

2260
01:23:34,310 --> 01:23:32,719
okay now

2261
01:23:36,229 --> 01:23:34,320
this is going to go back to pouring

2262
01:23:38,149 --> 01:23:36,239
science question i guess uh so you've

2263
01:23:40,870 --> 01:23:38,159

shown how great the water is absorbing

2264
01:23:42,550 --> 01:23:40,880
heat how long does it take to absorb it

2265
01:23:44,229 --> 01:23:42,560
compared to releasing it

2266
01:23:45,910 --> 01:23:44,239
oh absorbing well

2267
01:23:47,350 --> 01:23:45,920
oh that's a really tough question how

2268
01:23:48,870 --> 01:23:47,360
long does it take for the ocean to spit

2269
01:23:50,709 --> 01:23:48,880
that heat back up right that it's

2270
01:23:53,669 --> 01:23:50,719
absorbing it kind of depends where it

2271
01:23:56,149 --> 01:23:53,679
lands um there's places in the north

2272
01:23:57,910 --> 01:23:56,159
atlantic where water leaves the surface

2273
01:24:00,229 --> 01:23:57,920
of the ocean and it dives down and it

2274
01:24:02,950 --> 01:24:00,239
spreads out underneath the rest of the

2275
01:24:05,270 --> 01:24:02,960
ocean and it takes like 2 000 years to

2276
01:24:07,030 --> 01:24:05,280
get back to the surface so there is that

2277
01:24:09,510 --> 01:24:07,040
time scale in the ocean on the other

2278
01:24:10,870 --> 01:24:09,520
hand if you heat up the tropics in an el

2279
01:24:12,709 --> 01:24:10,880
nino

2280
01:24:14,709 --> 01:24:12,719
then that's going to stay warm for a

2281
01:24:16,390 --> 01:24:14,719
year until some other climate phenomenon

2282
01:24:18,550 --> 01:24:16,400
changes it so it's

2283
01:24:20,629 --> 01:24:18,560
any anywhere depending on where the heat

2284
01:24:23,189 --> 01:24:20,639
goes in anywhere from a year one year to

2285
01:24:28,229 --> 01:24:23,199
2000 years i would say

2286
01:24:31,590 --> 01:24:29,590
are there going to be any efforts in the

2287
01:24:32,790 --> 01:24:31,600
near future to measure heat changes in

2288
01:24:34,870 --> 01:24:32,800

the deep ocean

2289
01:24:36,950 --> 01:24:34,880
yes actually heat changes in the deep

2290
01:24:39,110 --> 01:24:36,960
ocean are really important in the lead

2291
01:24:40,470 --> 01:24:39,120
part of this same question how much heat

2292
01:24:41,750 --> 01:24:40,480
is really getting down there and it's

2293
01:24:43,590 --> 01:24:41,760
going to be down there for a thousand or

2294
01:24:44,870 --> 01:24:43,600
2000 years

2295
01:24:47,270 --> 01:24:44,880
we don't really know because we don't

2296
01:24:48,070 --> 01:24:47,280
have good measurements of the deep ocean

2297
01:24:50,390 --> 01:24:48,080
and

2298
01:24:52,550 --> 01:24:50,400
there's a program called argo which are

2299
01:24:54,629 --> 01:24:52,560
little floats that go up and down in the

2300
01:24:56,709 --> 01:24:54,639
ocean uh little robotic floats that are

2301
01:24:58,390 --> 01:24:56,719
autonomous they drift around and they're

2302
01:25:00,229 --> 01:24:58,400
trying right now they essentially

2303
01:25:02,229 --> 01:25:00,239
measure the top half of the ocean the

2304
01:25:04,390 --> 01:25:02,239
top two kilometers on average the

2305
01:25:06,950 --> 01:25:04,400
ocean's about four thousand meters

2306
01:25:08,709 --> 01:25:06,960
uh four kilometers deep and getting that

2307
01:25:10,470 --> 01:25:08,719
bottom half is kind of a technological

2308
01:25:12,390 --> 01:25:10,480
challenge but there are efforts underway

2309
01:25:13,830 --> 01:25:12,400
at noaa and other places to try and

2310
01:25:16,550 --> 01:25:13,840
develop end scripps institution of

2311
01:25:17,910 --> 01:25:16,560
oceanography to try and develop floats

2312
01:25:19,510 --> 01:25:17,920
that will go down that deep and come

2313
01:25:21,270 --> 01:25:19,520

back and have good data and all that

2314
01:25:23,110 --> 01:25:21,280
stuff so there are efforts

2315
01:25:25,189 --> 01:25:23,120
and we have some tools like you can

2316
01:25:26,790 --> 01:25:25,199
drive a ship around and lower an

2317
01:25:29,830 --> 01:25:26,800
instrument over the side which we've

2318
01:25:31,189 --> 01:25:29,840
been doing for 135 years now we know how

2319
01:25:32,709 --> 01:25:31,199
to do that pretty well but the problem

2320
01:25:35,110 --> 01:25:32,719
with that is getting enough of those

2321
01:25:37,750 --> 01:25:35,120
data to really see the big picture

2322
01:25:39,590 --> 01:25:37,760
and there's lots of work to develop that

2323
01:25:41,030 --> 01:25:39,600
you can kind of figure out a little bit

2324
01:25:44,070 --> 01:25:41,040
of it

2325
01:25:45,910 --> 01:25:44,080
by sort of subtracting a bunch of

2326
01:25:48,070 --> 01:25:45,920
really big signals to get a really small

2327
01:25:50,629 --> 01:25:48,080
number so we can measure the total sea

2328
01:25:52,709 --> 01:25:50,639
level with our json satellites we can

2329
01:25:55,110 --> 01:25:52,719
measure what's going on in the top half

2330
01:25:56,950 --> 01:25:55,120
with argo and then the other thing you

2331
01:25:58,709 --> 01:25:56,960
need to know is how much extra water

2332
01:26:00,629 --> 01:25:58,719
there is and there's another satellite

2333
01:26:02,390 --> 01:26:00,639
called grace

2334
01:26:03,590 --> 01:26:02,400
which measures essentially weighs the

2335
01:26:05,430 --> 01:26:03,600
ocean

2336
01:26:07,030 --> 01:26:05,440
so using all three of those you can kind

2337
01:26:09,910 --> 01:26:07,040
of infer what's going on in the deep

2338
01:26:11,350 --> 01:26:09,920

ocean if the signal is really big but

2339
01:26:12,229 --> 01:26:11,360
right now we don't have a long enough

2340
01:26:14,229 --> 01:26:12,239
time

2341
01:26:16,149 --> 01:26:14,239
span of all those data sets to see what

2342
01:26:17,510 --> 01:26:16,159
the signals are down there so maybe

2343
01:26:19,189 --> 01:26:17,520
someday we could do that with a

2344
01:26:21,030 --> 01:26:19,199
combination of other data sets but the

2345
01:26:22,550 --> 01:26:21,040
right way to do it is to stick little

2346
01:26:25,830 --> 01:26:22,560
floats down there uh and people are

2347
01:26:30,470 --> 01:26:27,750
okay this is the dumbest question on

2348
01:26:31,750 --> 01:26:30,480
earth so yes i apologize in advance wow

2349
01:26:34,310 --> 01:26:31,760
i didn't know we were gonna set records

2350
01:26:36,790 --> 01:26:34,320
today this is awesome right i'll do my

2351
01:26:39,350 --> 01:26:36,800
best bring it on um i've heard a lot

2352
01:26:41,110 --> 01:26:39,360
about you know the danger of the oceans

2353
01:26:42,870 --> 01:26:41,120
rising and and all of that but i'm just

2354
01:26:44,870 --> 01:26:42,880
wondering how far out

2355
01:26:47,430 --> 01:26:44,880
has that been projected hypothetically

2356
01:26:49,189 --> 01:26:47,440
if everybody moved away from the coasts

2357
01:26:51,350 --> 01:26:49,199
and the ice caps melted

2358
01:26:53,669 --> 01:26:51,360
would it cover land

2359
01:26:56,390 --> 01:26:53,679
how far do i have to go inland before my

2360
01:26:58,070 --> 01:26:56,400
property value goes back up right

2361
01:26:59,350 --> 01:26:58,080
or or where is the next beachfront

2362
01:27:01,910 --> 01:26:59,360
property okay where's the next peach

2363
01:27:03,990 --> 01:27:01,920

front property futures and so uh the

2364
01:27:06,070 --> 01:27:04,000
numbers are kind of like this

2365
01:27:07,669 --> 01:27:06,080
sometime in the next hundred years we'll

2366
01:27:10,470 --> 01:27:07,679
probably get between

2367
01:27:12,950 --> 01:27:10,480
two feet and five or six feet of global

2368
01:27:14,629 --> 01:27:12,960
sea level rise so it depends a lot on

2369
01:27:15,430 --> 01:27:14,639
what coast you live on

2370
01:27:17,910 --> 01:27:15,440
and

2371
01:27:20,550 --> 01:27:17,920
doing a better job of between two feet

2372
01:27:22,550 --> 01:27:20,560
and five or six feet we can't really do

2373
01:27:25,030 --> 01:27:22,560
that yet we just don't have the

2374
01:27:27,030 --> 01:27:25,040
scientific understanding of things like

2375
01:27:28,950 --> 01:27:27,040
these ice sheets so

2376
01:27:30,790 --> 01:27:28,960
greenland is covered and antarctica are

2377
01:27:33,990 --> 01:27:30,800
covered by these giant

2378
01:27:36,470 --> 01:27:34,000
uh just blobs of ice they're so big and

2379
01:27:39,030 --> 01:27:36,480
so heavy they push the land down and in

2380
01:27:40,709 --> 01:27:39,040
some places they actually are below sea

2381
01:27:43,189 --> 01:27:40,719
level so there's water up against the

2382
01:27:45,430 --> 01:27:43,199
side of them kind of eating away at them

2383
01:27:47,990 --> 01:27:45,440
and how all those things interact the

2384
01:27:49,990 --> 01:27:48,000
atmosphere dumping snow on the top

2385
01:27:51,590 --> 01:27:50,000
the ice sitting on the land which can

2386
01:27:53,510 --> 01:27:51,600
come up when the ice disappears the

2387
01:27:55,750 --> 01:27:53,520
water coming in from the side you can

2388
01:27:57,750 --> 01:27:55,760

see it's a really complicated thing and

2389
01:27:59,430 --> 01:27:57,760
so understanding what the ice sheets are

2390
01:28:01,910 --> 01:27:59,440
going to do that's our big uncertainty

2391
01:28:04,149 --> 01:28:01,920
for future sea level rise and right now

2392
01:28:05,910 --> 01:28:04,159
that's what's limiting us from saying

2393
01:28:08,310 --> 01:28:05,920
anything better than somewhere between

2394
01:28:10,390 --> 01:28:08,320
two feet and five feet now what that

2395
01:28:11,910 --> 01:28:10,400
means practically on the beach depends a

2396
01:28:13,430 --> 01:28:11,920
lot on where you live

2397
01:28:15,350 --> 01:28:13,440
in places like new orleans where it's

2398
01:28:17,110 --> 01:28:15,360
sinking another foot of sea level rise

2399
01:28:18,310 --> 01:28:17,120
is a really big deal

2400
01:28:20,149 --> 01:28:18,320
in

2401
01:28:22,310 --> 01:28:20,159
south florida it's also a really big

2402
01:28:24,709 --> 01:28:22,320
deal because the land doesn't rise very

2403
01:28:25,910 --> 01:28:24,719
high as you go in from the water there

2404
01:28:28,310 --> 01:28:25,920
there's a lot of places that are

2405
01:28:30,149 --> 01:28:28,320
vulnerable to even one foot of sea level

2406
01:28:32,149 --> 01:28:30,159
rise and we're almost certain to see one

2407
01:28:34,709 --> 01:28:32,159
foot in the next hundred years probably

2408
01:28:37,270 --> 01:28:34,719
in the next 50 years

2409
01:28:40,870 --> 01:28:37,280
so those are kind of long time scales

2410
01:28:43,110 --> 01:28:40,880
for like a home mortgage right

2411
01:28:45,270 --> 01:28:43,120
but they're not they're not long time

2412
01:28:46,390 --> 01:28:45,280
scales for two home mortgages right so

2413
01:28:48,310 --> 01:28:46,400

your home

2414
01:28:49,910 --> 01:28:48,320
uh you may have to worry about but your

2415
01:28:50,950 --> 01:28:49,920
kid's home and your grandkids home

2416
01:28:53,430 --> 01:28:50,960
they're definitely gonna have to worry

2417
01:28:54,390 --> 01:28:53,440
about sea level rise so it's out there

2418
01:28:56,229 --> 01:28:54,400
um

2419
01:28:58,709 --> 01:28:56,239
uh the thing about sea level rise though

2420
01:29:00,470 --> 01:28:58,719
is that it doesn't you know it global

2421
01:29:01,990 --> 01:29:00,480
sea level rise happens in this steady

2422
01:29:04,149 --> 01:29:02,000
long-term way we're talking about

2423
01:29:05,270 --> 01:29:04,159
numbers 50 years from now 100 years from

2424
01:29:07,189 --> 01:29:05,280
now

2425
01:29:09,590 --> 01:29:07,199
but practically speaking when you live

2426
01:29:11,189 --> 01:29:09,600
on the beach it's not that that gets you

2427
01:29:14,070 --> 01:29:11,199
what happens is you have a little bit of

2428
01:29:16,470 --> 01:29:14,080
extra sea level rise um and then some

2429
01:29:20,229 --> 01:29:16,480
storm that wouldn't have hit you before

2430
01:29:21,590 --> 01:29:20,239
hits you now uh and the the uh instances

2431
01:29:25,590 --> 01:29:21,600
of things like that are starting to

2432
01:29:27,510 --> 01:29:25,600
happen uh like sandy like katrina those

2433
01:29:29,830 --> 01:29:27,520
didn't happen because of global warming

2434
01:29:31,750 --> 01:29:29,840
but they were worse because of a bit of

2435
01:29:32,870 --> 01:29:31,760
extra sea level rise we've already had

2436
01:29:33,830 --> 01:29:32,880
about a foot

2437
01:29:36,310 --> 01:29:33,840
um

2438
01:29:38,709 --> 01:29:36,320

that's essentially man-made

2439
01:29:39,910 --> 01:29:38,719
uh and we'll get another foot and so

2440
01:29:41,910 --> 01:29:39,920
those things are going to happen more

2441
01:29:44,310 --> 01:29:41,920
and more frequently so it kind of

2442
01:29:46,550 --> 01:29:44,320
happens all at once and property values

2443
01:29:48,870 --> 01:29:46,560
uh that's a tough question because that

2444
01:29:50,470 --> 01:29:48,880
that depends on what how risky of people

2445
01:29:52,870 --> 01:29:50,480
think it is to live somewhere and so

2446
01:29:55,430 --> 01:29:52,880
when they start to think that it's risky

2447
01:29:57,189 --> 01:29:55,440
to live in this flood zone

2448
01:29:58,950 --> 01:29:57,199
then the property value goes down

2449
01:30:01,430 --> 01:29:58,960
everybody moves away

2450
01:30:05,430 --> 01:30:01,440
so it's a weird it's a weird thing but

2451
01:30:09,270 --> 01:30:07,990
but i talked a long time okay i think

2452
01:30:10,390 --> 01:30:09,280
we've got oh

2453
01:30:12,629 --> 01:30:10,400
right

2454
01:30:14,950 --> 01:30:12,639
oh you've you've got it you've got it

2455
01:30:17,350 --> 01:30:14,960
and now the floor is yours

2456
01:30:20,390 --> 01:30:17,360
all right bring it on so another

2457
01:30:23,030 --> 01:30:20,400
probably silly question is

2458
01:30:25,110 --> 01:30:23,040
with that knowledge that you just shared

2459
01:30:27,189 --> 01:30:25,120
is this global or this

2460
01:30:30,390 --> 01:30:27,199
sea level rise is it an inevitable

2461
01:30:32,629 --> 01:30:30,400
freight train that our kids just have to

2462
01:30:35,350 --> 01:30:32,639
know where to go buy property or is

2463
01:30:37,030 --> 01:30:35,360

there something that they can really do

2464
01:30:39,189 --> 01:30:37,040
to make the difference between that two

2465
01:30:40,790 --> 01:30:39,199
feet and that five feet

2466
01:30:44,870 --> 01:30:40,800
probably

2467
01:30:47,430 --> 01:30:44,880
certainly if we

2468
01:30:50,070 --> 01:30:47,440
if we curb emissions if we

2469
01:30:51,750 --> 01:30:50,080
don't put as much co2 in the atmosphere

2470
01:30:53,590 --> 01:30:51,760
we'll have less sea level rise in the

2471
01:30:56,229 --> 01:30:53,600
long run

2472
01:30:58,310 --> 01:30:56,239
and it'll have probably happen slower

2473
01:31:00,390 --> 01:30:58,320
but just how much is still really hard

2474
01:31:01,350 --> 01:31:00,400
to say

2475
01:31:02,550 --> 01:31:01,360
but

2476
01:31:05,430 --> 01:31:02,560
that doesn't mean we shouldn't do

2477
01:31:07,669 --> 01:31:05,440
anything about it definitely uh we

2478
01:31:09,669 --> 01:31:07,679
should be trying to curb our emissions

2479
01:31:12,790 --> 01:31:09,679
we should be looking for alternative

2480
01:31:14,550 --> 01:31:12,800
sources of energy and personally i think

2481
01:31:17,430 --> 01:31:14,560
even though jpl may not want me to say

2482
01:31:19,110 --> 01:31:17,440
this i think that um that we should have

2483
01:31:21,030 --> 01:31:19,120
something like a carbon tax because we

2484
01:31:21,830 --> 01:31:21,040
don't really pay the cost

2485
01:31:22,709 --> 01:31:21,840
of

2486
01:31:27,430 --> 01:31:22,719
the

2487
01:31:32,070 --> 01:31:27,440
that cost

2488
01:31:34,149 --> 01:31:32,080

to help ourselves avoid

2489
01:31:35,830 --> 01:31:34,159
the worst potential

2490
01:31:37,270 --> 01:31:35,840
problems that we see down the road so

2491
01:31:38,950 --> 01:31:37,280
yeah there's a lot of stuff we can do we

2492
01:31:41,430 --> 01:31:38,960
can still stave off

2493
01:31:43,430 --> 01:31:41,440
the largest scenarios the the fastest

2494
01:31:45,669 --> 01:31:43,440
warming the most sea level rise but we

2495
01:31:47,350 --> 01:31:45,679
got to do something pretty soon

2496
01:31:48,629 --> 01:31:47,360
all right our last question is right

2497
01:31:50,870 --> 01:31:48,639
down here in front

2498
01:31:52,550 --> 01:31:50,880
hi there my name is govindani and i had

2499
01:31:55,189 --> 01:31:52,560
a question about

2500
01:31:57,270 --> 01:31:55,199
well jason and all these other 17 or so

2501
01:31:59,430 --> 01:31:57,280
satellites that nasa has mapping every

2502
01:32:01,430 --> 01:31:59,440
aspect of the surface of the earth

2503
01:32:02,950 --> 01:32:01,440
are there any places of mystery left on

2504
01:32:03,990 --> 01:32:02,960
the planet that have not been thoroughly

2505
01:32:06,149 --> 01:32:04,000
mapped

2506
01:32:07,750 --> 01:32:06,159
and that's one way that's one side of my

2507
01:32:09,110 --> 01:32:07,760
question of asking are there any places

2508
01:32:10,550 --> 01:32:09,120
where you really don't have as good of

2509
01:32:12,550 --> 01:32:10,560
you on the earth or things that are

2510
01:32:13,350 --> 01:32:12,560
still somewhat mysterious in antarctica

2511
01:32:15,430 --> 01:32:13,360
or

2512
01:32:17,430 --> 01:32:15,440
the arctic that you'd love to get a

2513
01:32:19,910 --> 01:32:17,440

better look at yeah that's a great

2514
01:32:22,149 --> 01:32:19,920
question um the answer is yes i don't

2515
01:32:24,070 --> 01:32:22,159
have a comprehensive list of all the

2516
01:32:25,430 --> 01:32:24,080
places that we can't see but let me tell

2517
01:32:27,750 --> 01:32:25,440
you about one that i think is really

2518
01:32:29,990 --> 01:32:27,760
interesting and will be a uh

2519
01:32:31,750 --> 01:32:30,000
will be an important forefront in in our

2520
01:32:34,629 --> 01:32:31,760
future and it's because of this sea

2521
01:32:37,430 --> 01:32:34,639
level rise question so the places where

2522
01:32:38,790 --> 01:32:37,440
the ocean meets the ice

2523
01:32:41,510 --> 01:32:38,800
the places where

2524
01:32:43,830 --> 01:32:41,520
um oceans are beginning to intrude on

2525
01:32:45,750 --> 01:32:43,840
these ice sheets and eat away at the

2526
01:32:47,830 --> 01:32:45,760
bottom of glaciers that run into the

2527
01:32:49,510 --> 01:32:47,840
into the water

2528
01:32:51,270 --> 01:32:49,520
getting up close to those places and

2529
01:32:53,110 --> 01:32:51,280
understanding what's going on in there

2530
01:32:54,790 --> 01:32:53,120
is really the key to answering this

2531
01:32:57,110 --> 01:32:54,800
difference between two feet and five

2532
01:32:59,030 --> 01:32:57,120
feet of sea level rise so

2533
01:33:00,229 --> 01:32:59,040
uh of course there's frontiers you know

2534
01:33:01,990 --> 01:33:00,239
there's places in the bottom of the

2535
01:33:05,110 --> 01:33:02,000
ocean we haven't been

2536
01:33:07,110 --> 01:33:05,120
it's hard to see the oceanography in

2537
01:33:09,830 --> 01:33:07,120
places like the arctic where

2538
01:33:12,070 --> 01:33:09,840

it's covered by sea ice most of the time

2539
01:33:14,070 --> 01:33:12,080
but to me i think the biggest frontier

2540
01:33:15,910 --> 01:33:14,080
really is looking at this kind of

2541
01:33:18,629 --> 01:33:15,920
junction between

2542
01:33:19,990 --> 01:33:18,639
water and ice and land and air really

2543
01:33:21,669 --> 01:33:20,000
all of them kind of

2544
01:33:22,470 --> 01:33:21,679
coming together to be important in this

2545
01:33:24,470 --> 01:33:22,480
one

2546
01:33:25,830 --> 01:33:24,480
sea level rise problem

2547
01:33:27,350 --> 01:33:25,840
that's really where i think the new

2548
01:33:29,189 --> 01:33:27,360
frontier is and where we're going to

2549
01:33:30,709 --> 01:33:29,199
have to push for new technologies and

2550
01:33:32,149 --> 01:33:30,719
new ways to

2551
01:33:33,430 --> 01:33:32,159
delve into these regions to really

2552
01:33:35,910 --> 01:33:33,440
figure out what's going on and really

2553
01:33:37,830 --> 01:33:35,920
answer this big question of two feet or

2554
01:33:39,669 --> 01:33:37,840
five feet

2555
01:33:40,950 --> 01:33:39,679
all right thank you so much josh for

2556
01:33:43,590 --> 01:33:40,960
answering all of our questions and

2557
01:33:48,070 --> 01:33:43,600
showing us a great party trick

2558
01:33:52,629 --> 01:33:50,310
now for something completely different

2559
01:33:54,790 --> 01:33:52,639
how many of you waved at saturn remember

2560
01:33:57,510 --> 01:33:54,800
the wave it saturn campaign right that

2561
01:33:59,510 --> 01:33:57,520
the uh the cassini spacecraft was out at

2562
01:34:01,510 --> 01:33:59,520
saturn and it swung around to take a

2563
01:34:04,310 --> 01:34:01,520

picture of the whole saturn system but

2564
01:34:05,830 --> 01:34:04,320
guess what earth photobombed the shot so

2565
01:34:28,550 --> 01:34:05,840
let's go ahead and take a look at the

2566
01:34:33,350 --> 01:34:32,310
that's here that's home yay cassini

2567
01:34:35,910 --> 01:34:33,360
and i'm sure that you could pick

2568
01:34:38,310 --> 01:34:35,920
yourself out waving in that shot

2569
01:34:40,550 --> 01:34:38,320
all right so we've talked a lot about

2570
01:34:42,070 --> 01:34:40,560
water and the water cycle what about the

2571
01:34:44,070 --> 01:34:42,080
carbon cycle

2572
01:34:45,990 --> 01:34:44,080
carbon dioxide gas is something that

2573
01:34:47,669 --> 01:34:46,000
we're very interested in studying and

2574
01:34:49,590 --> 01:34:47,679
also looking at the way that carbon

2575
01:34:50,870 --> 01:34:49,600
moves around our planet

2576
01:34:52,870 --> 01:34:50,880
so

2577
01:34:54,470 --> 01:34:52,880
we do want to run a short video for you

2578
01:34:56,470 --> 01:34:54,480
to tell you a little bit more about the

2579
01:34:59,030 --> 01:34:56,480
carbon cycle and about an upcoming

2580
01:35:01,830 --> 01:34:59,040
mission the orbiting carbon observatory

2581
01:35:03,590 --> 01:35:01,840
2 or oco2 so let's go ahead and take a

2582
01:35:05,430 --> 01:35:03,600
look at that video

2583
01:35:07,430 --> 01:35:05,440
when it comes to carbon dioxide in the

2584
01:35:09,350 --> 01:35:07,440
atmosphere we've all heard a lot about

2585
01:35:11,430 --> 01:35:09,360
where it comes from but what happens to

2586
01:35:13,430 --> 01:35:11,440
it once it gets there

2587
01:35:15,430 --> 01:35:13,440
lots of things actually the atmosphere

2588
01:35:17,350 --> 01:35:15,440

oceans forests and soil are all

2589
01:35:19,109 --> 01:35:17,360
constantly trading carbon dioxide with

2590
01:35:20,870 --> 01:35:19,119
each other in a global exchange called

2591
01:35:22,709 --> 01:35:20,880
the carbon cycle

2592
01:35:25,350 --> 01:35:22,719
some parts of this cycle are sources of

2593
01:35:27,189 --> 01:35:25,360
carbon while others are sinks

2594
01:35:28,950 --> 01:35:27,199
all of these natural sources and sinks

2595
01:35:30,950 --> 01:35:28,960
are pretty well balanced just as much

2596
01:35:33,430 --> 01:35:30,960
co2 comes out of the atmosphere as goes

2597
01:35:35,030 --> 01:35:33,440
in but now we've got a problem ever

2598
01:35:37,109 --> 01:35:35,040
since the industrial revolution we've

2599
01:35:39,669 --> 01:35:37,119
been tipping the balance adding a co2

2600
01:35:41,910 --> 01:35:39,679
source without providing a sink to match

2601
01:35:44,070 --> 01:35:41,920
some of this extra co2 is being taken up

2602
01:35:45,910 --> 01:35:44,080
by natural carbon sinks but not all of

2603
01:35:47,990 --> 01:35:45,920
it and on top of that the efficiency and

2604
01:35:50,149 --> 01:35:48,000
availability of these sinks may change

2605
01:35:51,910 --> 01:35:50,159
over time as they react to changing

2606
01:35:54,470 --> 01:35:51,920
climate conditions and as we clear

2607
01:35:56,070 --> 01:35:54,480
forest for agriculture or homes

2608
01:35:57,750 --> 01:35:56,080
if we want to know what's really going

2609
01:36:00,470 --> 01:35:57,760
on with the carbon cycle and how it may

2610
01:36:02,390 --> 01:36:00,480
affect climate we need more information

2611
01:36:04,149 --> 01:36:02,400
after all we can only manage what we can

2612
01:36:05,910 --> 01:36:04,159
measure

2613
01:36:07,910 --> 01:36:05,920

that's where the oco-2 mission the

2614
01:36:09,590 --> 01:36:07,920
orbiting carbon observatory comes in

2615
01:36:11,109 --> 01:36:09,600
nasa's first satellite designed

2616
01:36:13,350 --> 01:36:11,119
specifically to measure the global

2617
01:36:14,390 --> 01:36:13,360
distribution of atmospheric co2 from

2618
01:36:16,470 --> 01:36:14,400
space

2619
01:36:18,149 --> 01:36:16,480
how will it do that by measuring the

2620
01:36:19,109 --> 01:36:18,159
sunlight that bounces off the earth's

2621
01:36:20,629 --> 01:36:19,119
surface

2622
01:36:22,790 --> 01:36:20,639
on its way through the atmosphere this

2623
01:36:25,590 --> 01:36:22,800
sunlight interacts with co2 molecules in

2624
01:36:28,390 --> 01:36:25,600
the air co2 like other gases absorbs

2625
01:36:30,629 --> 01:36:28,400
only certain colors of light oco2 is

2626
01:36:32,070 --> 01:36:30,639
tuned to look at these specific colors

2627
01:36:33,830 --> 01:36:32,080
and by measuring the amount of light

2628
01:36:36,149 --> 01:36:33,840
that's missing in each one we can figure

2629
01:36:37,189 --> 01:36:36,159
out how many co2 molecules got in the

2630
01:36:39,189 --> 01:36:37,199
way

2631
01:36:41,270 --> 01:36:39,199
as oco2 orbits the earth each day it

2632
01:36:42,870 --> 01:36:41,280
will make hundreds of thousands of co2

2633
01:36:44,229 --> 01:36:42,880
measurements this high measurement

2634
01:36:46,470 --> 01:36:44,239
density will give us far more

2635
01:36:48,870 --> 01:36:46,480
information about where and how co2 is

2636
01:36:50,390 --> 01:36:48,880
traded between sources and sinks plus

2637
01:36:52,070 --> 01:36:50,400
measurements collected over weeks and

2638
01:36:54,629 --> 01:36:52,080

months will capture the variations due

2639
01:36:56,950 --> 01:36:54,639
to seasonal changes allowing us to watch

2640
01:36:58,950 --> 01:36:56,960
the planet breathe

2641
01:37:00,790 --> 01:36:58,960
if we can understand better where these

2642
01:37:03,030 --> 01:37:00,800
carbon sinks are and how they store

2643
01:37:04,550 --> 01:37:03,040
carbon dioxide we'll know a lot more

2644
01:37:06,390 --> 01:37:04,560
about the processes that control the

2645
01:37:07,910 --> 01:37:06,400
rise of co2 in the atmosphere and what

2646
01:37:10,070 --> 01:37:07,920
role it might play in our changing

2647
01:37:12,709 --> 01:37:10,080
climate

2648
01:37:20,550 --> 01:37:12,719
so take a deep breath and get ready for

2649
01:37:26,790 --> 01:37:23,189
the orbiting carbon observatory 2 or

2650
01:37:28,870 --> 01:37:26,800
oco-2 is nasa's first dedicated earth

2651
01:37:31,109 --> 01:37:28,880
remote sensing satellite to study

2652
01:37:33,590 --> 01:37:31,119
atmospheric car or to study atmospheric

2653
01:37:35,750 --> 01:37:33,600
carbon dioxide from space we're going to

2654
01:37:38,470 --> 01:37:35,760
meet two people key people behind the

2655
01:37:41,189 --> 01:37:38,480
science of this mission

2656
01:37:43,669 --> 01:37:41,199
first up is anne-marie eldring she is

2657
01:37:45,910 --> 01:37:43,679
the deputy project scientist for oco2

2658
01:37:48,550 --> 01:37:45,920
and she came to california 25 years ago

2659
01:37:51,590 --> 01:37:48,560
to study local air pollution something

2660
01:37:53,189 --> 01:37:51,600
close to my heart and lungs as a local

2661
01:37:55,270 --> 01:37:53,199
and now she's getting ready to take

2662
01:37:57,510 --> 01:37:55,280
global measurements of carbon dioxide

2663
01:37:59,750 --> 01:37:57,520

and greenhouse gases from space

2664
01:38:02,390 --> 01:37:59,760
she is joined by mike gunson the project

2665
01:38:04,310 --> 01:38:02,400
scientist for oco2 he

2666
01:38:06,310 --> 01:38:04,320
manages the global change and energy

2667
01:38:08,310 --> 01:38:06,320
program here at jpl and he's been a

2668
01:38:11,430 --> 01:38:08,320
leader for three different satellite and

2669
01:38:13,990 --> 01:38:11,440
space shuttle based atmosphere

2670
01:38:16,790 --> 01:38:14,000
experiments at jpl to measure earth's

2671
01:38:18,229 --> 01:38:16,800
atmosphere so i will step aside and let

2672
01:38:19,669 --> 01:38:18,239
them tell you more about what they do on

2673
01:38:21,830 --> 01:38:19,679
a day-to-day basis and the science

2674
01:38:24,629 --> 01:38:21,840
they're excited to do with oco2 all

2675
01:38:29,270 --> 01:38:24,639
right thank you very much hi everyone

2676
01:38:32,470 --> 01:38:30,870
and thanks for having us here to talk

2677
01:38:33,510 --> 01:38:32,480
about oco2

2678
01:38:35,669 --> 01:38:33,520
yeah

2679
01:38:39,510 --> 01:38:35,679
any um anybody spell football

2680
01:38:42,830 --> 01:38:41,030
any manchester united supporters out

2681
01:38:45,350 --> 01:38:42,840
there i'm going

2682
01:38:47,990 --> 01:38:45,360
uh i'm sure we can get them excited

2683
01:38:49,830 --> 01:38:48,000
about the soccer at some point

2684
01:38:51,830 --> 01:38:49,840
so this is what i get to deal with on my

2685
01:38:53,510 --> 01:38:51,840
day-to-day basis i'm doing science and

2686
01:38:55,430 --> 01:38:53,520
i'm finding out about the soccer score

2687
01:38:57,270 --> 01:38:55,440
before i come to the office

2688
01:38:58,950 --> 01:38:57,280

that's rather important

2689
01:39:00,709 --> 01:38:58,960
so mike and i are the project scientist

2690
01:39:02,470 --> 01:39:00,719
and the deputy project scientist and our

2691
01:39:04,709 --> 01:39:02,480
goal is to make sure that when this

2692
01:39:06,470 --> 01:39:04,719
satellite this is only a one tenth scale

2693
01:39:07,910 --> 01:39:06,480
it's actually a little bit bigger but

2694
01:39:09,830 --> 01:39:07,920
when our satellite gets them in the

2695
01:39:11,510 --> 01:39:09,840
space that is going to be able to do the

2696
01:39:13,270 --> 01:39:11,520
science that we want to do so making

2697
01:39:15,350 --> 01:39:13,280
sure the instrument's built to the

2698
01:39:16,870 --> 01:39:15,360
specifications and that our team members

2699
01:39:19,030 --> 01:39:16,880
are ready to take that data when it

2700
01:39:21,270 --> 01:39:19,040
arrives do the analysis so we can

2701
01:39:22,709 --> 01:39:21,280
provide the co2 measurements and then

2702
01:39:23,910 --> 01:39:22,719
helping interface with the science

2703
01:39:26,550 --> 01:39:23,920
community that's going to do a lot of

2704
01:39:29,990 --> 01:39:26,560
the work afterwards so that's kind of a

2705
01:39:32,149 --> 01:39:30,000
short description of a project scientist

2706
01:39:34,070 --> 01:39:32,159
very short description

2707
01:39:35,030 --> 01:39:34,080
herding cats comes into it somewhere i'm

2708
01:39:36,390 --> 01:39:35,040
sure

2709
01:39:37,750 --> 01:39:36,400
actually we'd just like to give a call

2710
01:39:39,590 --> 01:39:37,760
out to dave crisp at the back of the

2711
01:39:46,790 --> 01:39:39,600
room he's the science team leader dr

2712
01:39:51,510 --> 01:39:48,629
most of our time is

2713
01:39:53,590 --> 01:39:51,520

inevitably spent in i'm often asked

2714
01:39:54,870 --> 01:39:53,600
what's it like to be a scientist

2715
01:39:56,790 --> 01:39:54,880
and i don't know that a project

2716
01:39:59,510 --> 01:39:56,800
scientist is that much different than

2717
01:40:01,430 --> 01:39:59,520
say the work that josh does except he's

2718
01:40:02,629 --> 01:40:01,440
far funnier about it

2719
01:40:05,350 --> 01:40:02,639
and

2720
01:40:08,070 --> 01:40:05,360
most of my colleagues 95 of it is pretty

2721
01:40:10,070 --> 01:40:08,080
much heavy lifting of grunt work and

2722
01:40:12,149 --> 01:40:10,080
then you get every now and again there's

2723
01:40:13,109 --> 01:40:12,159
about five percent where you learn

2724
01:40:15,910 --> 01:40:13,119
something

2725
01:40:17,270 --> 01:40:15,920
and uh i do have fun every day do you

2726
01:40:19,109 --> 01:40:17,280
have fun every day i have fun every day

2727
01:40:21,109 --> 01:40:19,119
but i'm very excited because in july

2728
01:40:22,870 --> 01:40:21,119
2014 we're actually going to launch this

2729
01:40:24,950 --> 01:40:22,880
thing into space and get real data so

2730
01:40:26,470 --> 01:40:24,960
we've been working for quite some time

2731
01:40:29,830 --> 01:40:26,480
and dave has been working for even

2732
01:40:31,590 --> 01:40:29,840
longer to see the oco2 instrument built

2733
01:40:33,750 --> 01:40:31,600
and launched and actually you may wonder

2734
01:40:35,030 --> 01:40:33,760
why is it oco-2

2735
01:40:36,310 --> 01:40:35,040
if you're a chemist you'll realize

2736
01:40:38,310 --> 01:40:36,320
that's a little bit of a confusing

2737
01:40:40,470 --> 01:40:38,320
nomenclature well really this is the

2738
01:40:42,790 --> 01:40:40,480

second time this this has been built

2739
01:40:44,709 --> 01:40:42,800
because they built an oco instrument and

2740
01:40:46,790 --> 01:40:44,719
launched it into space but the rocket

2741
01:40:48,830 --> 01:40:46,800
did not work properly so the thing went

2742
01:40:51,510 --> 01:40:48,840
back down in the ocean in

2743
01:40:53,109 --> 01:40:51,520
2009 it's swimming with the fishes it is

2744
01:40:55,030 --> 01:40:53,119
and nasa decided this is such an

2745
01:40:56,790 --> 01:40:55,040
important data set that they would go

2746
01:41:00,390 --> 01:40:56,800
ahead and rebuild it so we are the

2747
01:41:07,830 --> 01:41:00,400
rebuild or oco-2 of this a carbon copy

2748
01:41:13,030 --> 01:41:11,109
it burns it burns

2749
01:41:14,629 --> 01:41:13,040
we've uh josh has opened the gates for

2750
01:41:16,470 --> 01:41:14,639
comedy and science

2751
01:41:18,149 --> 01:41:16,480
it's a little bit of a pandora's box

2752
01:41:20,149 --> 01:41:18,159
we've even had a monty python reference

2753
01:41:21,910 --> 01:41:20,159
well how good can it get and now for

2754
01:41:23,030 --> 01:41:21,920
something entirely different now for

2755
01:41:24,550 --> 01:41:23,040
something completely different in the

2756
01:41:25,510 --> 01:41:24,560
show at some point i didn't i thought

2757
01:41:27,030 --> 01:41:25,520
about it

2758
01:41:31,109 --> 01:41:27,040
so

2759
01:41:33,590 --> 01:41:31,119
that we had at the top of this uh

2760
01:41:34,709 --> 01:41:33,600
segment is really jam-packed with

2761
01:41:36,950 --> 01:41:34,719
information

2762
01:41:41,270 --> 01:41:36,960
so uh maybe you could talk a little bit

2763
01:41:42,790 --> 01:41:41,280

more of exactly how oco-2

2764
01:41:44,229 --> 01:41:42,800
looks at carbon dioxide in the

2765
01:41:46,149 --> 01:41:44,239
atmosphere dr gunster would like to

2766
01:41:48,070 --> 01:41:46,159
explain that

2767
01:41:51,430 --> 01:41:48,080
you passing me that one this this is the

2768
01:41:53,910 --> 01:41:51,440
hospital pass okay so um as

2769
01:41:56,070 --> 01:41:53,920
we we've devised a technique that looks

2770
01:41:57,030 --> 01:41:56,080
at sunlight reflected off the earth's

2771
01:41:59,910 --> 01:41:57,040
surface

2772
01:42:01,990 --> 01:41:59,920
so that light has come in passed all the

2773
01:42:03,270 --> 01:42:02,000
way through the atmosphere bounced off

2774
01:42:05,109 --> 01:42:03,280
the surface and comes back to the

2775
01:42:07,750 --> 01:42:05,119
satellite in the instrument

2776
01:42:09,590 --> 01:42:07,760
by looking very carefully at different

2777
01:42:11,750 --> 01:42:09,600
colors of that light at different

2778
01:42:14,310 --> 01:42:11,760
wavelengths we can actually find the

2779
01:42:16,709 --> 01:42:14,320
light which is affected by the amount of

2780
01:42:19,910 --> 01:42:16,719
carbon dioxide in the atmosphere

2781
01:42:22,550 --> 01:42:19,920
now we the trick for any experiment like

2782
01:42:24,310 --> 01:42:22,560
this that involves carbon dioxide

2783
01:42:26,470 --> 01:42:24,320
is that we have to be able to do this

2784
01:42:28,950 --> 01:42:26,480
very sensitively

2785
01:42:30,790 --> 01:42:28,960
i think most of you might know

2786
01:42:33,430 --> 01:42:30,800
that the background amount of carbon

2787
01:42:35,430 --> 01:42:33,440
dioxide in the atmosphere past 400 parts

2788
01:42:37,750 --> 01:42:35,440

per million it was uh

2789
01:42:40,709 --> 01:42:37,760
in the news probably in the was it march

2790
01:42:43,750 --> 01:42:40,719
april time frame what we're looking for

2791
01:42:45,189 --> 01:42:43,760
are changes in that amount by one part

2792
01:42:49,350 --> 01:42:45,199
in 400

2793
01:42:50,870 --> 01:42:49,360
so that's a very tiny variations we have

2794
01:42:53,830 --> 01:42:50,880
to be sensitive to

2795
01:42:56,149 --> 01:42:53,840
so we measure that sunlight really well

2796
01:42:59,350 --> 01:42:56,159
we we spend a lot of time as a science

2797
01:43:01,669 --> 01:42:59,360
team characterizing the instrument so we

2798
01:43:03,510 --> 01:43:01,679
know how it performs in

2799
01:43:06,070 --> 01:43:03,520
what exquisite detail is probably the

2800
01:43:08,470 --> 01:43:06,080
best way to describe it that way we can

2801
01:43:10,310 --> 01:43:08,480
discern how carbon dioxide is changing

2802
01:43:12,709 --> 01:43:10,320
so you can know whether it's been put in

2803
01:43:14,870 --> 01:43:12,719
the atmosphere or it's being taken out

2804
01:43:16,229 --> 01:43:14,880
by something at the surface

2805
01:43:18,390 --> 01:43:16,239
most of the carbon dioxide in the

2806
01:43:21,510 --> 01:43:18,400
atmosphere he said going on passing an

2807
01:43:23,109 --> 01:43:21,520
explanation of how this works

2808
01:43:25,669 --> 01:43:23,119
once carbon dioxide gets in the

2809
01:43:27,669 --> 01:43:25,679
atmosphere it's really inert nothing

2810
01:43:29,270 --> 01:43:27,679
affects it while it's in the atmosphere

2811
01:43:31,510 --> 01:43:29,280
the only way you lose it out of the

2812
01:43:33,990 --> 01:43:31,520
atmosphere is if that molecule of carbon

2813
01:43:35,270 --> 01:43:34,000

dioxide collides with the surface a

2814
01:43:36,629 --> 01:43:35,280
plant

2815
01:43:38,390 --> 01:43:36,639
or the ocean

2816
01:43:40,310 --> 01:43:38,400
that will take it out back out of the

2817
01:43:42,550 --> 01:43:40,320
atmosphere so

2818
01:43:44,790 --> 01:43:42,560
it's uh we're looking for very small

2819
01:43:46,550 --> 01:43:44,800
changes in something that's going to be

2820
01:43:48,870 --> 01:43:46,560
with us for a very long time so i was

2821
01:43:51,189 --> 01:43:48,880
impressed with judge's answer by the way

2822
01:43:52,950 --> 01:43:51,199
about you know what does the future for

2823
01:43:56,070 --> 01:43:52,960
hold we're putting stuff into the

2824
01:43:57,109 --> 01:43:56,080
atmosphere at a rate of nuts we as human

2825
01:44:00,070 --> 01:43:57,119
beings

2826
01:44:03,270 --> 01:44:00,080
and we're very we've already bought into

2827
01:44:06,149 --> 01:44:03,280
the changes that that will cause and we

2828
01:44:07,189 --> 01:44:06,159
won't see even if we stop tomorrow we

2829
01:44:08,629 --> 01:44:07,199
won't see

2830
01:44:10,629 --> 01:44:08,639
the effects

2831
01:44:12,310 --> 01:44:10,639
slow down for another decade or two

2832
01:44:13,669 --> 01:44:12,320
because there's a kind of a buy-in

2833
01:44:16,229 --> 01:44:13,679
factor once you put it up there you

2834
01:44:19,910 --> 01:44:16,239
gotta it has a a long-lasting effect

2835
01:44:22,070 --> 01:44:19,920
because it hangs around a very long time

2836
01:44:24,149 --> 01:44:22,080
so we do have the keeling curve

2837
01:44:25,990 --> 01:44:24,159
animation if that would be helpful to

2838
01:44:28,070 --> 01:44:26,000

you in your discussion of co2 would you

2839
01:44:30,709 --> 01:44:28,080
guys like to take a look at it

2840
01:44:32,790 --> 01:44:30,719
all right let's see if the booth can go

2841
01:44:34,550 --> 01:44:32,800
ahead and pull that animation up for us

2842
01:44:36,070 --> 01:44:34,560
so the healing curve you may ask the

2843
01:44:37,590 --> 01:44:36,080
question of why the keeling curve and

2844
01:44:39,430 --> 01:44:37,600
that's because professor keeling down at

2845
01:44:41,590 --> 01:44:39,440
scripps institute started these carbon

2846
01:44:44,950 --> 01:44:41,600
dioxide measurements actually back in

2847
01:44:46,629 --> 01:44:44,960
the 50s in hawaii and this is your an

2848
01:44:49,750 --> 01:44:46,639
animation that's showing you how it

2849
01:44:51,910 --> 01:44:49,760
changes over a few years and you see

2850
01:44:53,510 --> 01:44:51,920
this up and down with the seasons and

2851
01:44:56,310 --> 01:44:53,520
that's basically as mike had said that

2852
01:44:58,629 --> 01:44:56,320
the plants are actually a big drawdown

2853
01:45:01,109 --> 01:44:58,639
of co2 so as they grow in the spring the

2854
01:45:03,030 --> 01:45:01,119
co2 goes down and now you see the fall

2855
01:45:05,590 --> 01:45:03,040
as they start decaying they release that

2856
01:45:07,109 --> 01:45:05,600
co2 back up into the atmosphere so

2857
01:45:09,270 --> 01:45:07,119
especially in the northern hemisphere

2858
01:45:12,629 --> 01:45:09,280
where we have a lot of forest and trees

2859
01:45:14,790 --> 01:45:12,639
you see this annual up and down but on

2860
01:45:16,790 --> 01:45:14,800
top of that the whole curve is growing

2861
01:45:18,470 --> 01:45:16,800
over time and that's because of this

2862
01:45:21,109 --> 01:45:18,480
unbalance that was mentioned in the

2863
01:45:23,750 --> 01:45:21,119

video that as humans put these emissions

2864
01:45:25,430 --> 01:45:23,760
in the natural source the natural

2865
01:45:27,830 --> 01:45:25,440
methods to take it out of the atmosphere

2866
01:45:29,189 --> 01:45:27,840
can't keep up with all that we put in so

2867
01:45:30,390 --> 01:45:29,199
bit by bit we're increasing

2868
01:45:32,790 --> 01:45:30,400
concentration

2869
01:45:35,350 --> 01:45:32,800
and this is just showing i think over

2870
01:45:38,390 --> 01:45:35,360
a 10-year period or so that it increases

2871
01:45:41,430 --> 01:45:38,400
from you know 370 to 380 and as mike

2872
01:45:43,430 --> 01:45:41,440
mentioned we hit 400 this year already

2873
01:45:45,669 --> 01:45:43,440
so the interesting part about that curve

2874
01:45:46,950 --> 01:45:45,679
and it's something that i find i

2875
01:45:49,030 --> 01:45:46,960
probably

2876
01:45:49,990 --> 01:45:49,040
put my arms around about how profound it

2877
01:45:57,189 --> 01:45:50,000
is

2878
01:45:59,750 --> 01:45:57,199
but half of what we've ever burnt

2879
01:46:02,709 --> 01:45:59,760
in terms of oil or coal is still in the

2880
01:46:04,070 --> 01:46:02,719
atmosphere and somehow and the big

2881
01:46:06,709 --> 01:46:04,080
science mystery

2882
01:46:09,189 --> 01:46:06,719
is somehow the earth has managed to

2883
01:46:12,310 --> 01:46:09,199
continue to take 50 percent of what we

2884
01:46:14,790 --> 01:46:12,320
put in out on a continuing basis that's

2885
01:46:16,310 --> 01:46:14,800
kind of the good news it hasn't so we

2886
01:46:18,709 --> 01:46:16,320
can keep putting more and more and more

2887
01:46:21,109 --> 01:46:18,719
in and every year we we burn actually we

2888
01:46:23,510 --> 01:46:21,119

do burn more fossil fuels every year we

2889
01:46:26,390 --> 01:46:23,520
burn more coal we burn more oil

2890
01:46:28,550 --> 01:46:26,400
but half is still being drawn out that's

2891
01:46:30,790 --> 01:46:28,560
kind of a remarkable thing

2892
01:46:32,629 --> 01:46:30,800
just a remarkable fact and what we'd

2893
01:46:34,870 --> 01:46:32,639
like to find out

2894
01:46:37,109 --> 01:46:34,880
is why is that

2895
01:46:39,030 --> 01:46:37,119
and what what's going on that would

2896
01:46:42,229 --> 01:46:39,040
either stop that being true in the

2897
01:46:46,229 --> 01:46:42,239
future or change it today

2898
01:46:48,790 --> 01:46:46,239
because if any of those things slow down

2899
01:46:50,709 --> 01:46:48,800
and we continue burning a lot more

2900
01:46:52,470 --> 01:46:50,719
fossil fuel at the rate we are we could

2901
01:46:55,430 --> 01:46:52,480
see a sudden acceleration in the amount

2902
01:46:56,550 --> 01:46:55,440
of co2 build up the airborne fraction is

2903
01:47:00,550 --> 01:46:56,560
the

2904
01:47:02,070 --> 01:47:00,560
fraction could continue to increase and

2905
01:47:03,109 --> 01:47:02,080
that would be

2906
01:47:03,910 --> 01:47:03,119
not

2907
01:47:07,590 --> 01:47:03,920
very

2908
01:47:11,830 --> 01:47:10,629
well then with that

2909
01:47:13,109 --> 01:47:11,840
oh yeah

2910
01:47:15,830 --> 01:47:13,119
all right we're supposed to be positive

2911
01:47:17,669 --> 01:47:15,840
yeah we've got to be positive now

2912
01:47:19,830 --> 01:47:17,679
let's go ahead and turn things over to

2913
01:47:22,390 --> 01:47:19,840

the house here who's got some questions

2914
01:47:24,870 --> 01:47:22,400
about carbon emissions and oco-2 okay

2915
01:47:27,270 --> 01:47:24,880
here comes bill with the mic

2916
01:47:29,109 --> 01:47:27,280
um i have one quick question and one

2917
01:47:32,550 --> 01:47:29,119
kind of more general question the first

2918
01:47:34,070 --> 01:47:32,560
is between the first oco and the oco-2

2919
01:47:36,070 --> 01:47:34,080
since you had the time were there any

2920
01:47:38,229 --> 01:47:36,080
adjustments you made to what you were

2921
01:47:39,990 --> 01:47:38,239
either going to collect or how the how

2922
01:47:41,910 --> 01:47:40,000
it was going to work and the second is

2923
01:47:44,310 --> 01:47:41,920
we've heard about um

2924
01:47:45,590 --> 01:47:44,320
carbon emissions wind over the water

2925
01:47:47,669 --> 01:47:45,600
water levels

2926
01:47:50,629 --> 01:47:47,679
how do you like what's the process that

2927
01:47:51,990 --> 01:47:50,639
determines what data your limited

2928
01:47:53,109 --> 01:47:52,000
resources are going to be focused on

2929
01:47:56,310 --> 01:47:53,119
collecting

2930
01:48:00,790 --> 01:47:56,320
um if that makes sense money

2931
01:48:03,350 --> 01:48:00,800
yes okay so the first question was

2932
01:48:04,470 --> 01:48:03,360
the changes in the uh okay changing the

2933
01:48:06,390 --> 01:48:04,480
instrument so

2934
01:48:08,470 --> 01:48:06,400
carbon copy

2935
01:48:10,550 --> 01:48:08,480
is our mantra because the

2936
01:48:12,149 --> 01:48:10,560
cost of doing something is going to go

2937
01:48:14,470 --> 01:48:12,159
up if we make changes so the whole

2938
01:48:17,430 --> 01:48:14,480

mentality was keep it the same unless

2939
01:48:19,750 --> 01:48:17,440
for example some of the

2940
01:48:21,590 --> 01:48:19,760
things just couldn't be bought anymore

2941
01:48:23,510 --> 01:48:21,600
so there's a few small changes where

2942
01:48:25,109 --> 01:48:23,520
things could not be obtained but

2943
01:48:26,629 --> 01:48:25,119
generally we didn't do anything just to

2944
01:48:29,830 --> 01:48:26,639
make it better

2945
01:48:31,590 --> 01:48:29,840
this is uh it's kind of unusual for nasa

2946
01:48:34,310 --> 01:48:31,600
we always like you know you you were

2947
01:48:36,390 --> 01:48:34,320
listening to josh and how the jason

2948
01:48:37,750 --> 01:48:36,400
series came about each one of those was

2949
01:48:39,510 --> 01:48:37,760
a little bit better than the preceding

2950
01:48:41,270 --> 01:48:39,520
one but there's a price you pay i mean

2951
01:48:42,790 --> 01:48:41,280
there's a development cost in real

2952
01:48:44,870 --> 01:48:42,800
dollars so

2953
01:48:46,790 --> 01:48:44,880
the plan here to make this

2954
01:48:49,430 --> 01:48:46,800
make this realize this as quickly as

2955
01:48:52,709 --> 01:48:49,440
possible we chose to do everything

2956
01:48:54,629 --> 01:48:52,719
almost to to the letter the same

2957
01:48:57,510 --> 01:48:54,639
in terms of the data that we want to

2958
01:49:00,390 --> 01:48:57,520
collect we there's kind of a

2959
01:49:02,470 --> 01:49:00,400
balancing act because the cloud the

2960
01:49:03,750 --> 01:49:02,480
clouds that are around earth make our

2961
01:49:05,830 --> 01:49:03,760
measurement

2962
01:49:07,830 --> 01:49:05,840
difficult right so mike talked about the

2963
01:49:10,709 --> 01:49:07,840

reflected sunlight so when it's cloudy

2964
01:49:11,830 --> 01:49:10,719
we don't really get to use that data so

2965
01:49:14,070 --> 01:49:11,840
the first thing is we're going to

2966
01:49:15,589 --> 01:49:14,080
measure all around the earth hundreds of

2967
01:49:17,189 --> 01:49:15,599
thousands of times a day but then the

2968
01:49:20,149 --> 01:49:17,199
clouds will probably make 80 percent of

2969
01:49:22,709 --> 01:49:20,159
that data impossible to use so we have

2970
01:49:24,709 --> 01:49:22,719
maybe 20 we can use but then it costs a

2971
01:49:26,629 --> 01:49:24,719
lot to run all the computers to analyze

2972
01:49:28,470 --> 01:49:26,639
it so our goal right now is based on

2973
01:49:31,109 --> 01:49:28,480
what the scientists need to answer these

2974
01:49:34,070 --> 01:49:31,119
questions we'll process as much of the

2975
01:49:35,669 --> 01:49:34,080
data up to maybe six seven percent of it

2976
01:49:37,350 --> 01:49:35,679
and then we're trying to find ways to

2977
01:49:39,750 --> 01:49:37,360
process more like work with the super

2978
01:49:41,910 --> 01:49:39,760
computers or other places where we maybe

2979
01:49:44,709 --> 01:49:41,920
get the capacity to process all the data

2980
01:49:47,109 --> 01:49:44,719
computing whatever resources we can find

2981
01:49:48,790 --> 01:49:47,119
but they're sort of uh basically

2982
01:49:50,470 --> 01:49:48,800
driven by what the scientists need to

2983
01:49:53,109 --> 01:49:50,480
answer the question we've tried to size

2984
01:49:56,070 --> 01:49:53,119
the data that we're going to get

2985
01:49:57,669 --> 01:49:56,080
so the bottom of the date was a dollar

2986
01:49:58,550 --> 01:49:57,679
it was a dollar issue a dollar issue

2987
01:50:00,470 --> 01:49:58,560
yeah

2988
01:50:04,070 --> 01:50:00,480

all right next question

2989
01:50:06,149 --> 01:50:04,080
um so on each upswing of that keeling

2990
01:50:08,070 --> 01:50:06,159
curve i sort of noticed a little bit of

2991
01:50:09,510 --> 01:50:08,080
a saddle point

2992
01:50:10,550 --> 01:50:09,520
before it

2993
01:50:13,189 --> 01:50:10,560
peaked

2994
01:50:15,109 --> 01:50:13,199
during each seasonal rotation could you

2995
01:50:17,350 --> 01:50:15,119
guys explain a little bit about what

2996
01:50:18,470 --> 01:50:17,360
that might be caused by that's a really

2997
01:50:19,990 --> 01:50:18,480
good question

2998
01:50:22,229 --> 01:50:20,000
i've never looked at that in detail

2999
01:50:24,310 --> 01:50:22,239
actually um the

3000
01:50:26,470 --> 01:50:24,320
the i know what the drawdown is due to i

3001
01:50:27,589 --> 01:50:26,480
don't know whether that's because the oh

3002
01:50:29,589 --> 01:50:27,599
dave does

3003
01:50:31,109 --> 01:50:29,599
i bet i'll put five i've got five

3004
01:50:44,070 --> 01:50:31,119
dollars in my pocket that says dave

3005
01:50:49,589 --> 01:50:47,990
intertropical convergence sound movement

3006
01:50:51,510 --> 01:50:49,599
to some extent actually that little that

3007
01:50:53,669 --> 01:50:51,520
little bump and wiggle

3008
01:50:55,510 --> 01:50:53,679
has to do a lot with

3009
01:50:57,510 --> 01:50:55,520
the fact that you're making pretty much

3010
01:50:59,589 --> 01:50:57,520
a single measurement of the atmosphere

3011
01:51:01,109 --> 01:50:59,599
in that curve that's shown there and it

3012
01:51:03,189 --> 01:51:01,119
actually represents changes in the

3013
01:51:05,510 --> 01:51:03,199

atmosphere that are due to changes in

3014
01:51:07,270 --> 01:51:05,520
plants over the whole earth

3015
01:51:09,270 --> 01:51:07,280
now as you probably all know there's a

3016
01:51:12,310 --> 01:51:09,280
lot more land in the north and so what

3017
01:51:13,910 --> 01:51:12,320
we're mostly sensitive to is it's fall

3018
01:51:16,629 --> 01:51:13,920
in the north and the trees are all

3019
01:51:17,830 --> 01:51:16,639
losing their leaves but guess what it's

3020
01:51:20,149 --> 01:51:17,840
spring

3021
01:51:22,229 --> 01:51:20,159
in the southern hemisphere it's smaller

3022
01:51:24,310 --> 01:51:22,239
it makes a smaller impact on the total

3023
01:51:26,870 --> 01:51:24,320
system but a lot of that little wiggle

3024
01:51:28,629 --> 01:51:26,880
you're seeing is the peak growing season

3025
01:51:31,030 --> 01:51:28,639
in the south coming in and influencing

3026
01:51:32,709 --> 01:51:31,040
that carbon dioxide just a little bit

3027
01:51:34,390 --> 01:51:32,719
but you can kind of see how much of an

3028
01:51:36,229 --> 01:51:34,400
impact we have in the northern

3029
01:51:37,910 --> 01:51:36,239
hemisphere with this much larger

3030
01:51:39,669 --> 01:51:37,920
continental area

3031
01:51:41,270 --> 01:51:39,679
compared to the southern hemisphere and

3032
01:51:43,189 --> 01:51:41,280
that also tells you that most of those

3033
01:51:45,350 --> 01:51:43,199
bumps and wiggles have to do with the

3034
01:51:46,629 --> 01:51:45,360
carbon cycle with trees and plants on

3035
01:51:48,790 --> 01:51:46,639
land

3036
01:51:50,870 --> 01:51:48,800
the ocean is kind of steady all year

3037
01:51:52,310 --> 01:51:50,880
long so since you have more ocean in the

3038
01:51:54,070 --> 01:51:52,320

south you don't see a big impact there

3039
01:51:55,350 --> 01:51:54,080
but you do see an impact and it's that

3040
01:51:59,750 --> 01:51:55,360
little

3041
01:52:01,589 --> 01:51:59,760
same kinds of measurements made on the

3042
01:52:03,589 --> 01:52:01,599
north slope of alaska

3043
01:52:06,070 --> 01:52:03,599
the depth of those

3044
01:52:07,589 --> 01:52:06,080
troughs is much deeper because they're

3045
01:52:09,350 --> 01:52:07,599
influenced by

3046
01:52:11,430 --> 01:52:09,360
all the trees and the forests in the

3047
01:52:13,830 --> 01:52:11,440
northern hemisphere and less influenced

3048
01:52:17,189 --> 01:52:13,840
by it takes a while for the influence of

3049
01:52:19,030 --> 01:52:17,199
what goes on further away to reach

3050
01:52:21,189 --> 01:52:19,040
the north slope but the depth and the

3051
01:52:22,790 --> 01:52:21,199
cycle is much bigger if you looked in

3052
01:52:25,510 --> 01:52:22,800
other places like the north slope of

3053
01:52:27,030 --> 01:52:25,520
alaska for example

3054
01:52:28,870 --> 01:52:27,040
all right

3055
01:52:30,790 --> 01:52:28,880
next question so this is more of a

3056
01:52:32,629 --> 01:52:30,800
general question i mean i'm sure nasa

3057
01:52:34,709 --> 01:52:32,639
has a lot of id you know great ideas for

3058
01:52:36,550 --> 01:52:34,719
missions in general for earth science

3059
01:52:38,629 --> 01:52:36,560
how do you guys decide like which

3060
01:52:41,910 --> 01:52:38,639
missions fly like

3061
01:52:44,390 --> 01:52:41,920
or who decides that even so they the one

3062
01:52:46,790 --> 01:52:44,400
strength about nasa and i personally

3063
01:52:48,390 --> 01:52:46,800

believe this is a significant strength

3064
01:52:50,149 --> 01:52:48,400
is its strong relationship to the

3065
01:52:53,030 --> 01:52:50,159
research community

3066
01:52:54,070 --> 01:52:53,040
so nasa unlike other

3067
01:52:56,229 --> 01:52:54,080
bodies

3068
01:52:59,109 --> 01:52:56,239
like department of energy or department

3069
01:53:01,430 --> 01:52:59,119
of interior its primary customer base is

3070
01:53:03,990 --> 01:53:01,440
the research community scientists

3071
01:53:07,189 --> 01:53:04,000
so the way that these things are usually

3072
01:53:08,709 --> 01:53:07,199
selected is by the community coming

3073
01:53:09,750 --> 01:53:08,719
together and saying this is an area of

3074
01:53:11,350 --> 01:53:09,760
interest

3075
01:53:13,510 --> 01:53:11,360
or by

3076
01:53:16,310 --> 01:53:13,520
in this case dave was the leader of a

3077
01:53:18,310 --> 01:53:16,320
proposal to nasa which outlined the

3078
01:53:20,470 --> 01:53:18,320
science value of the mission outlined

3079
01:53:22,229 --> 01:53:20,480
how to do it and that was reviewed by

3080
01:53:23,750 --> 01:53:22,239
the science community and said that's

3081
01:53:28,390 --> 01:53:23,760
something we ought to do

3082
01:53:30,310 --> 01:53:28,400
so the decision making is is really

3083
01:53:32,629 --> 01:53:30,320
a collective one in the science

3084
01:53:35,030 --> 01:53:32,639
community by evaluating how good the

3085
01:53:37,350 --> 01:53:35,040
idea is whether the science questions

3086
01:53:39,589 --> 01:53:37,360
are important and whether it can be done

3087
01:53:41,830 --> 01:53:39,599
and then that usually is the information

3088
01:53:42,870 --> 01:53:41,840

that guides nasa in deciding what steps

3089
01:53:44,470 --> 01:53:42,880
to take

3090
01:53:46,229 --> 01:53:44,480
and i think another important thing is

3091
01:53:48,229 --> 01:53:46,239
to remember is that competition is

3092
01:53:49,510 --> 01:53:48,239
actually important so it's community

3093
01:53:51,109 --> 01:53:49,520
driven but

3094
01:53:53,750 --> 01:53:51,119
a lot of us spend a lot of time we write

3095
01:53:55,990 --> 01:53:53,760
proposals for these types of missions

3096
01:53:57,669 --> 01:53:56,000
and then they get evaluated by a big

3097
01:53:59,270 --> 01:53:57,679
panel and so the one that's the most

3098
01:54:01,109 --> 01:53:59,280
convincing and

3099
01:54:03,030 --> 01:54:01,119
shows that it has good questions and

3100
01:54:04,950 --> 01:54:03,040
they can be answered and they can do it

3101
01:54:06,950 --> 01:54:04,960
in the time and budget so it's a way to

3102
01:54:09,109 --> 01:54:06,960
get the sort of the best bang for the

3103
01:54:10,950 --> 01:54:09,119
buck because everybody's fighting to do

3104
01:54:11,669 --> 01:54:10,960
a really important thing

3105
01:54:14,149 --> 01:54:11,679
with

3106
01:54:16,310 --> 01:54:14,159
the least amount of money

3107
01:54:18,470 --> 01:54:16,320
okay we have time for exactly one last

3108
01:54:20,870 --> 01:54:18,480
question and it needs to be quick and

3109
01:54:22,709 --> 01:54:20,880
this is a challenge to our scientists

3110
01:54:25,189 --> 01:54:22,719
ready

3111
01:54:28,149 --> 01:54:25,199
so where i'm from uh originally southern

3112
01:54:30,149 --> 01:54:28,159
ontario we are into solar energy and

3113
01:54:32,629 --> 01:54:30,159

using solar power my brother has

3114
01:54:34,709 --> 01:54:32,639
solar panels on her

3115
01:54:36,310 --> 01:54:34,719
and and we there are a lot of turbines

3116
01:54:38,070 --> 01:54:36,320
wind turbines i wonder how long it's

3117
01:54:40,149 --> 01:54:38,080
going to take as josh was saying it

3118
01:54:42,390 --> 01:54:40,159
takes like 10 years will you see a

3119
01:54:44,229 --> 01:54:42,400
measurable a measurable notice or

3120
01:54:46,229 --> 01:54:44,239
difference in your measurements in the

3121
01:54:48,550 --> 01:54:46,239
future so that's a it's a really

3122
01:54:50,390 --> 01:54:48,560
interesting question um

3123
01:54:52,470 --> 01:54:50,400
if you look at

3124
01:54:55,750 --> 01:54:52,480
and this is this is not what we can

3125
01:54:58,629 --> 01:54:55,760
really pin down from this experiment but

3126
01:55:01,270 --> 01:54:58,639
if you look at the economic data

3127
01:55:02,709 --> 01:55:01,280
on where fossil fuels are being used

3128
01:55:04,390 --> 01:55:02,719
there's two things

3129
01:55:05,990 --> 01:55:04,400
uh developed countries

3130
01:55:08,390 --> 01:55:06,000
and particular europe in particular but

3131
01:55:12,070 --> 01:55:08,400
in the united states as well our per

3132
01:55:14,149 --> 01:55:12,080
capita use has been steady for decades

3133
01:55:16,390 --> 01:55:14,159
in places like sweden for example it's

3134
01:55:19,109 --> 01:55:16,400
declined they've transitioned to a large

3135
01:55:21,830 --> 01:55:19,119
amount of hydroelectric power

3136
01:55:23,350 --> 01:55:21,840
second the current increase is in the

3137
01:55:25,510 --> 01:55:23,360
developing world

3138
01:55:27,750 --> 01:55:25,520

so now somebody asked me this question

3139
01:55:29,830 --> 01:55:27,760
the other night in at a pasadena forum

3140
01:55:31,510 --> 01:55:29,840
on climate change and i and i had to

3141
01:55:33,910 --> 01:55:31,520
disagree with him afterwards is saying

3142
01:55:35,109 --> 01:55:33,920
it's not it's less about

3143
01:55:39,430 --> 01:55:35,119
us now

3144
01:55:41,589 --> 01:55:39,440
it's really really about china and india

3145
01:55:43,510 --> 01:55:41,599
their per capita used to give a measure

3146
01:55:47,030 --> 01:55:43,520
is a tiny tiny fraction of our per

3147
01:55:50,550 --> 01:55:47,040
capita use so their potential to achieve

3148
01:55:52,390 --> 01:55:50,560
modernize their societies is is huge

3149
01:55:54,070 --> 01:55:52,400
will we see a difference in sustainable

3150
01:55:57,189 --> 01:55:54,080
energy alternatives

3151
01:55:59,189 --> 01:55:57,199
the the trick is you have to use

3152
01:56:01,669 --> 01:55:59,199
if if you don't have anything else you

3153
01:56:03,430 --> 01:56:01,679
have to burn coal to make something to

3154
01:56:08,390 --> 01:56:03,440
replace it

3155
01:56:10,229 --> 01:56:08,400
it takes a long long time to get that

3156
01:56:12,870 --> 01:56:10,239
payback and you can see it if you ever

3157
01:56:15,109 --> 01:56:12,880
install solar solar power that the

3158
01:56:18,070 --> 01:56:15,119
payoff time isn't two to three years

3159
01:56:19,189 --> 01:56:18,080
it's like 10 15 20 years

3160
01:56:21,189 --> 01:56:19,199
so

3161
01:56:23,830 --> 01:56:21,199
in order to get there

3162
01:56:26,390 --> 01:56:23,840
you have to start small but the payoff

3163
01:56:28,709 --> 01:56:26,400

time in replacing and trying to migrate

3164
01:56:31,510 --> 01:56:28,719
away from from

3165
01:56:33,270 --> 01:56:31,520
fossil fuel-based energy is a long

3166
01:56:35,830 --> 01:56:33,280
drawn-out business

3167
01:56:45,030 --> 01:56:35,840
thank you so much please a big round of

3168
01:56:49,669 --> 01:56:47,430
all right so that concludes our speaker

3169
01:56:51,910 --> 01:56:49,679
program for this morning but for those

3170
01:56:53,510 --> 01:56:51,920
of you here in the room this afternoon

3171
01:56:55,030 --> 01:56:53,520
you're going to go down over to our

3172
01:56:56,870 --> 01:56:55,040
clean room where you're going to be able

3173
01:56:59,270 --> 01:56:56,880
to see these spacecraft being built

3174
01:57:00,709 --> 01:56:59,280
rapidscat and smap you'll be able to

3175
01:57:02,229 --> 01:57:00,719
look down in the clean room seeing them

3176
01:57:03,589 --> 01:57:02,239
build them and some of the engineers

3177
01:57:05,189 --> 01:57:03,599
from the mission will be up there in the

3178
01:57:08,070 --> 01:57:05,199
gallery with you to answer some of your

3179
01:57:10,070 --> 01:57:08,080
questions and oco2 is currently being

3180
01:57:11,589 --> 01:57:10,080
built in arizona by our contractor

3181
01:57:14,470 --> 01:57:11,599
orbitals so two out of the three are

3182
01:57:16,870 --> 01:57:14,480
here now as i mentioned at the start

3183
01:57:19,030 --> 01:57:16,880
these missions are launching in 2014 we

3184
01:57:20,629 --> 01:57:19,040
will be holding nasa socials for each

3185
01:57:22,629 --> 01:57:20,639
one of those launches so especially for

3186
01:57:24,629 --> 01:57:22,639
people watching today

3187
01:57:26,229 --> 01:57:24,639
if you like what you see and you want to

3188
01:57:28,070 --> 01:57:26,239

come behind the scenes and learn more

3189
01:57:31,669 --> 01:57:28,080
about our missions please do follow us

3190
01:57:33,189 --> 01:57:31,679
at nasa at nasa jpl or nasa social and

3191
01:57:34,310 --> 01:57:33,199
you will learn when these events are

3192
01:57:36,470 --> 01:57:34,320
coming up

3193
01:57:38,870 --> 01:57:36,480
rapidscat will be launching from the

3194
01:57:39,750 --> 01:57:38,880
east coast from kennedy space center and

3195
01:57:42,149 --> 01:57:39,760
uh

3196
01:57:44,070 --> 01:57:42,159
let's see smap and oco2 will be

3197
01:57:46,310 --> 01:57:44,080
launching from the vandenberg air force

3198
01:57:48,229 --> 01:57:46,320
base here in california

3199
01:57:50,629 --> 01:57:48,239
we're going to show you one more picture

3200
01:57:53,270 --> 01:57:50,639
of earth from space now cassini that was

3201
01:57:54,870 --> 01:57:53,280
taken from i believe 900 million miles

3202
01:57:57,669 --> 01:57:54,880
away

3203
01:58:00,950 --> 01:57:57,679
on valentine's day in 1990

3204
01:58:03,830 --> 01:58:00,960
voyager and that's voyager right there

3205
01:58:06,310 --> 01:58:03,840
looked back to take one last picture

3206
01:58:07,990 --> 01:58:06,320
back at earth that we all know is the