1
00:00:07,550 --> 00:00:03,350
NASA's Jet Propulsion Laboratory

2
00:00:09,980 --> 00:00:07,560
presents the von Karman lecture a series

3
00:00:12,350 --> 00:00:09,990
of talks by scientists and engineers who

4
00:00:24,460 --> 00:00:12,360
are exploring our planet our solar

5
00:00:29,269 --> 00:00:27,109
hello everybody welcome to the von

6
00:00:33,410 --> 00:00:29,279
Karman series from NASA's Jet Propulsion

7
00:00:35,869 --> 00:00:33,420
Laboratory I'm Preston dykes well this

8
00:00:39,259 --> 00:00:35,879
is our monthly series of public talks

9
00:00:42,140 --> 00:00:39,269
and discussions usually brought to you

10
00:00:44,960 --> 00:00:42,150
live from our von Karman auditorium at

11
00:00:48,020 --> 00:00:44,970
JPL and hence the name of the series but

12
00:00:50,420 --> 00:00:48,030
like so many other shows and live events

13
00:00:52,970 --> 00:00:50,430

right now we're coming to you remotely

14
00:00:56,510 --> 00:00:52,980
from our homes spread out across the Los

15
00:00:58,670 --> 00:00:56,520
Angeles area so thank you so much for

16
00:01:00,740 --> 00:00:58,680
joining us in trying something a little

17
00:01:03,349 --> 00:01:00,750
different and especially if you're

18
00:01:05,450 --> 00:01:03,359
watching us live because we feel like

19
00:01:06,650 --> 00:01:05,460
shared experiences like this are

20
00:01:09,139 --> 00:01:06,660
important right now

21
00:01:11,240 --> 00:01:09,149
so and if you're watching live on

22
00:01:13,880 --> 00:01:11,250
Facebook and YouTube you can submit

23
00:01:15,850 --> 00:01:13,890
questions via the chat and we'll work in

24
00:01:18,710 --> 00:01:15,860
some of those questions during our show

25
00:01:21,410 --> 00:01:18,720
okay and to help us with that I am

26
00:01:24,680 --> 00:01:21,420
really grateful to have my colleague

27
00:01:26,480 --> 00:01:24,690
from JPL Shannon 4e who is part of the

28
00:01:30,650 --> 00:01:26,490
NASA earth public engagement team hey

29
00:01:31,820 --> 00:01:30,660
Shannon hi everybody thanks for watching

30
00:01:33,320 --> 00:01:31,830
I'll be sharing your questions with our

31
00:01:35,059 --> 00:01:33,330
guests at several points in the show so

32
00:01:36,410 --> 00:01:35,069
keep them coming and in the YouTube and

33
00:01:37,910 --> 00:01:36,420
the facebook chats and if you're not

34
00:01:41,210 --> 00:01:37,920
seeing the chat window just refresh your

35
00:01:43,460 --> 00:01:41,220
browser and it should appear all right

36
00:01:45,350 --> 00:01:43,470
well thanks Shannon I just want to note

37
00:01:48,260 --> 00:01:45,360
that since this is an experiment and we

38
00:01:49,969 --> 00:01:48,270

are recording live if we run into any

39
00:01:51,650 --> 00:01:49,979
technical challenges we will roll with

40
00:01:54,710 --> 00:01:51,660
them and we hope you'll hang in there

41
00:01:57,410 --> 00:01:54,720
with us as well so that brings me to a

42
00:02:00,020 --> 00:01:57,420
program note we had planned to bring you

43
00:02:02,930 --> 00:02:00,030
two speakers tonight with one of them

44
00:02:05,479 --> 00:02:02,940
being a scientist on NASA's Delta X

45
00:02:07,190 --> 00:02:05,489
mission but unfortunately due to a

46
00:02:09,859 --> 00:02:07,200
technical issue we weren't able to have

47
00:02:11,690 --> 00:02:09,869
them join us but we will still have a

48
00:02:13,520 --> 00:02:11,700
great discussion with our other speaker

49
00:02:15,890 --> 00:02:13,530
and will actually talk a little bit

50
00:02:18,559 --> 00:02:15,900
about the Delta X mission anyway and

51
00:02:21,910 --> 00:02:18,569
hopefully we can share more about that

52
00:02:29,119 --> 00:02:21,920
really exciting mission in future show

53
00:02:30,920 --> 00:02:29,129
so perhaps because of the extraordinary

54
00:02:33,740 --> 00:02:30,930
situation that we're all in right now

55
00:02:36,700 --> 00:02:33,750
around the world it feels like a

56
00:02:39,220 --> 00:02:36,710
particularly relevant time

57
00:02:41,800 --> 00:02:39,230
remember our shared responsibility for

58
00:02:44,350 --> 00:02:41,810
planet Earth and remember that in the

59
00:02:44,920 --> 00:02:44,360
biggest sense we really are all in this

60
00:02:48,460 --> 00:02:44,930
together

61
00:02:51,280 --> 00:02:48,470
and so to that end we're coming up on

62
00:02:53,290 --> 00:02:51,290
Earth Day and that's on April 22nd and

63
00:02:55,510 --> 00:02:53,300

it's not just any Earth Day this is the

64
00:02:58,210 --> 00:02:55,520
fiftieth anniversary of Earth Day this

65
00:03:00,610 --> 00:02:58,220
year and Shannon you've been deeply

66
00:03:02,470 --> 00:03:00,620
involved in NASA's planning for what

67
00:03:03,820 --> 00:03:02,480
we're calling Earth Day at home

68
00:03:07,420 --> 00:03:03,830
so can you tell us what NASA has got

69
00:03:09,370 --> 00:03:07,430
planned yeah well like we do every year

70
00:03:10,870 --> 00:03:09,380
NASA plans to observe Earth Day and

71
00:03:12,610 --> 00:03:10,880
share a variety of resources about the

72
00:03:14,410 --> 00:03:12,620
beauty and wonder of our amazing home

73
00:03:15,850 --> 00:03:14,420
planet and what we're doing at NASA to

74
00:03:18,580 --> 00:03:15,860
study and better understand it's

75
00:03:20,770 --> 00:03:18,590
changing how it's changing and so you

76
00:03:22,360 --> 00:03:20,780
can visit nasa.gov slash Earth Day to

77
00:03:23,950 --> 00:03:22,370
find all of our Earth Day resources in

78
00:03:25,930 --> 00:03:23,960
one place and you can also follow us on

79
00:03:27,550 --> 00:03:25,940
at NASA Earth on social media channels

80
00:03:30,790 --> 00:03:27,560
and follow along with all of our Earth

81
00:03:34,480 --> 00:03:30,800
Day activities on hashtag Earth Day at

82
00:03:37,270 --> 00:03:34,490
home fantastic

83
00:03:39,580 --> 00:03:37,280
so to connect to Earth Day as Shannon

84
00:03:42,490 --> 00:03:39,590
talked about we're talking this month

85
00:03:44,680 --> 00:03:42,500
about observing our home planet and

86
00:03:47,050 --> 00:03:44,690
we're fortunate to have with us a NASA

87
00:03:49,780 --> 00:03:47,060
earth scientist who is helping to lead

88
00:03:52,090 --> 00:03:49,790

an important mission to learn more about

89
00:03:54,040 --> 00:03:52,100
planet Earth and we'll talk with him

90
00:03:56,610 --> 00:03:54,050
about his mission and also the bigger

91
00:04:00,310 --> 00:03:56,620
picture of the whys and how's of

92
00:04:02,560 --> 00:04:00,320
studying earth from above and below and

93
00:04:08,110 --> 00:04:02,570
so I want to welcome our guest Paul

94
00:04:10,840 --> 00:04:08,120
Rozin Paul Sundaram hey Paul Paul serves

95
00:04:13,570 --> 00:04:10,850
as the project scientist for NASA's nice

96
00:04:17,350 --> 00:04:13,580
our mission so great to have you with us

97
00:04:21,250 --> 00:04:17,360
Paul thank you so I want to start off

98
00:04:23,740 --> 00:04:21,260
really big picture why is it that we

99
00:04:25,390 --> 00:04:23,750
need to study our home planet it seems

100
00:04:29,050 --> 00:04:25,400
like it's pretty well explored at least

101
00:04:31,510 --> 00:04:29,060
the land surface what what else do we

102
00:04:35,320 --> 00:04:31,520
need to understand about Earth beyond

103
00:04:36,820 --> 00:04:35,330
just keeping up with the weather well it

104
00:04:38,920 --> 00:04:36,830
is true that people have been living on

105
00:04:40,630 --> 00:04:38,930
the earth for a very long time and we've

106
00:04:44,950 --> 00:04:40,640
measured quite a few things on the earth

107
00:04:47,080 --> 00:04:44,960
over over the centuries so I like to

108
00:04:50,500 --> 00:04:47,090
think of it in terms of medical research

109
00:04:53,880 --> 00:04:50,510
we're very familiar with our bodies

110
00:04:57,280 --> 00:04:53,890
and our minds yet we continue to study

111
00:05:00,100 --> 00:04:57,290
our bodies and our minds and invest very

112
00:05:02,190 --> 00:05:00,110
heavily in doing that when we're Wells

113
00:05:04,780 --> 00:05:02,200

we don't usually think very much about

114
00:05:07,090 --> 00:05:04,790
what's going on with our bodies but when

115
00:05:10,750 --> 00:05:07,100
we're sick and when we recover we often

116
00:05:12,910 --> 00:05:10,760
want to understand why that's the case

117
00:05:14,920 --> 00:05:12,920
and we want to figure out ways to

118
00:05:18,100 --> 00:05:14,930
prevent ourselves from getting sick in

119
00:05:20,560 --> 00:05:18,110
the future at this particular time as

120
00:05:24,490 --> 00:05:20,570
you mentioned with the corona virus

121
00:05:27,430 --> 00:05:24,500
epidemic biological forces on our bodies

122
00:05:29,200 --> 00:05:27,440
are at the forefront of our mind right

123
00:05:31,390 --> 00:05:29,210
now but there's other forces as well

124
00:05:33,130 --> 00:05:31,400
there's stresses of everyday life

125
00:05:36,250 --> 00:05:33,140
there's environmental stresses

126
00:05:40,090 --> 00:05:36,260
there's geophysical stresses such as

127
00:05:42,720 --> 00:05:40,100
earthquakes and volcanoes sea level rise

128
00:05:46,690 --> 00:05:42,730
of many many factors that go into

129
00:05:48,550 --> 00:05:46,700
understanding us as human beings and the

130
00:05:51,580 --> 00:05:48,560
same is true for the earth itself

131
00:05:55,470 --> 00:05:51,590
there's inputs and outputs there's

132
00:05:58,600 --> 00:05:55,480
energy and sources and energy sinks and

133
00:06:00,550 --> 00:05:58,610
it's a very complex system just as our

134
00:06:03,250 --> 00:06:00,560
bodies and minds are very complex

135
00:06:05,920 --> 00:06:03,260
systems so it's important for us to

136
00:06:08,110 --> 00:06:05,930
study the oceans study the atmospheres

137
00:06:10,420 --> 00:06:08,120
study the solid earth the crust and how

138
00:06:12,190 --> 00:06:10,430

it changes with time study the ice

139
00:06:13,690 --> 00:06:12,200
sheets and have a change and how they

140
00:06:17,380 --> 00:06:13,700
interact with the oceans and the

141
00:06:19,960 --> 00:06:17,390
atmosphere in order to answer some very

142
00:06:24,670 --> 00:06:19,970
important questions to all of us what's

143
00:06:26,440 --> 00:06:24,680
going to happen to to my house when the

144
00:06:29,860 --> 00:06:26,450
next earthquake occurs here in

145
00:06:33,520 --> 00:06:29,870
California if there's a drought in a

146
00:06:34,390 --> 00:06:33,530
particular country or region what does

147
00:06:38,590 --> 00:06:34,400
that mean

148
00:06:40,240 --> 00:06:38,600
in terms of this year versus 10 years is

149
00:06:42,490 --> 00:06:40,250
this a permanent condition as our

150
00:06:45,610 --> 00:06:42,500
climate changing in the sense that we

151
00:06:48,250 --> 00:06:45,620
would expect this forever when the

152
00:06:50,830 --> 00:06:48,260
Amazon burns as we observed last summer

153
00:06:52,960 --> 00:06:50,840
how is that actually changing things is

154
00:06:55,780 --> 00:06:52,970
it a long-term effect or a small term

155
00:06:58,930 --> 00:06:55,790
effect this is all very complex system

156
00:07:00,790 --> 00:06:58,940
science at the earth level and there's a

157
00:07:03,970 --> 00:07:00,800
lot at stake in these observations so

158
00:07:06,280 --> 00:07:03,980
it's extremely important to study

159
00:07:08,860 --> 00:07:06,290
well you know everyone who's watching

160
00:07:11,860 --> 00:07:08,870
may not be aware that NASA actually

161
00:07:14,350 --> 00:07:11,870
studies earth both from high up in space

162
00:07:16,810 --> 00:07:14,360
in orbit and also down from closer to

163
00:07:18,880 --> 00:07:16,820

the ground from using airplanes and and

164
00:07:23,350 --> 00:07:18,890
and surface instruments and boats and

165
00:07:26,500 --> 00:07:23,360
things so why that kind of gets to the

166
00:07:28,660 --> 00:07:26,510
theme of our show so why is it important

167
00:07:31,720 --> 00:07:28,670
to study Earth from different vantage

168
00:07:35,620 --> 00:07:31,730
points you know from from space and from

169
00:07:37,360 --> 00:07:35,630
closer to the surface well there's many

170
00:07:39,790 --> 00:07:37,370
different reasons for it I'll try to

171
00:07:42,160 --> 00:07:39,800
summarize quickly some things you simply

172
00:07:44,710 --> 00:07:42,170
can't measure very easily from space or

173
00:07:47,980 --> 00:07:44,720
as well as you could do from say the

174
00:07:51,580 --> 00:07:47,990
ground an example might be if you want

175
00:07:55,270 --> 00:07:51,590
to study the age of a tree by measuring

176
00:07:59,350 --> 00:07:55,280
tree rings it's much more simple to get

177
00:08:01,270 --> 00:07:59,360
a tree coring device and cut a hole into

178
00:08:03,790 --> 00:08:01,280
the tree and look at the Rings or if

179
00:08:05,590 --> 00:08:03,800
you're looking at the ages of the ice

180
00:08:08,080 --> 00:08:05,600
sheets over the last two hundred

181
00:08:10,120 --> 00:08:08,090
thousand years it's easier to drill a

182
00:08:12,370 --> 00:08:10,130
hole and core the ice and look at the

183
00:08:14,650 --> 00:08:12,380
layers of the ice than it is to measure

184
00:08:16,630 --> 00:08:14,660
that from space there are space

185
00:08:19,420 --> 00:08:16,640
techniques to do those kinds of things

186
00:08:22,300 --> 00:08:19,430
but certainly an in situ in-place

187
00:08:24,630 --> 00:08:22,310
measurements such as that is quite

188
00:08:26,590 --> 00:08:24,640

effective and very quite cost effective

189
00:08:28,570 --> 00:08:26,600
however if you want to do that

190
00:08:30,610 --> 00:08:28,580
everywhere it's very difficult to send

191
00:08:32,620 --> 00:08:30,620
an army of people to every tree in the

192
00:08:35,350 --> 00:08:32,630
entire forest of the Amazon or the Congo

193
00:08:38,890 --> 00:08:35,360
or of the northeastern United States and

194
00:08:40,840 --> 00:08:38,900
measure such a such detailed set of

195
00:08:44,650 --> 00:08:40,850
measurements so we often then go up to

196
00:08:46,750 --> 00:08:44,660
the air or we go up to space in the air

197
00:08:48,370 --> 00:08:46,760
we will look for some other techniques

198
00:08:50,920 --> 00:08:48,380
some other instrument that could be a

199
00:08:54,130 --> 00:08:50,930
proxy for something like measuring the

200
00:08:55,930 --> 00:08:54,140
tree rings the age of a tree and some of

201
00:08:59,710 --> 00:08:55,940
the measurements we'll talk about later

202
00:09:03,550 --> 00:08:59,720
today are related to that in air we

203
00:09:06,370 --> 00:09:03,560
would perhaps focus on things that are

204
00:09:08,800 --> 00:09:06,380
best observed in a way that satellites

205
00:09:10,660 --> 00:09:08,810
from space could not do so for example

206
00:09:12,910 --> 00:09:10,670
we're going to talk about a mission

207
00:09:14,620 --> 00:09:12,920
later Delta X mission briefly I

208
00:09:17,590 --> 00:09:14,630
understand the speakers are not here

209
00:09:20,430 --> 00:09:17,600
tonight but in that particular

210
00:09:24,910 --> 00:09:20,440
case it's an airborne mission to look at

211
00:09:27,430 --> 00:09:24,920
Delta regions of rivers and they are

212
00:09:30,759 --> 00:09:27,440
extremely dynamic and they can change

213
00:09:33,819 --> 00:09:30,769

with the tides they can change on a

214
00:09:36,370 --> 00:09:33,829
daily basis as the weather conditions

215
00:09:38,530 --> 00:09:36,380
are changing so you need to sample those

216
00:09:43,740 --> 00:09:38,540
in space and time

217
00:09:48,069 --> 00:09:43,750
quite quite effectively quite quite fast

218
00:09:50,590 --> 00:09:48,079
effectively so that's very difficult to

219
00:09:52,900 --> 00:09:50,600
do from space because you are fixed in a

220
00:09:55,300 --> 00:09:52,910
particular set of orbits and so that

221
00:09:57,999 --> 00:09:55,310
particular observation is best suited to

222
00:10:00,069 --> 00:09:58,009
an airborne system from space of course

223
00:10:01,900 --> 00:10:00,079
we get the vantage point of looking at

224
00:10:03,790 --> 00:10:01,910
the entire planet

225
00:10:08,460 --> 00:10:03,800
assuming we pick an orbit that's

226
00:10:12,879 --> 00:10:08,470
associated with that and and there's a

227
00:10:16,030 --> 00:10:12,889
there's a particular orbit that we use

228
00:10:17,889 --> 00:10:16,040
and we can have a swath that will cover

229
00:10:21,460 --> 00:10:17,899
the entire Earth and then give us that

230
00:10:22,990 --> 00:10:21,470
global perspective so that's the reason

231
00:10:25,329 --> 00:10:23,000
why we sometimes look on the earth

232
00:10:27,910 --> 00:10:25,339
sometimes we look on in air and

233
00:10:29,199 --> 00:10:27,920
sometimes we look in space yeah it

234
00:10:32,259 --> 00:10:29,209
sounds like it sounds like you really do

235
00:10:34,059 --> 00:10:32,269
need a multi-faceted perspective to kind

236
00:10:37,300 --> 00:10:34,069
of see the big picture is what you're

237
00:10:38,650 --> 00:10:37,310
saying that's exactly right and I think

238
00:10:40,540 --> 00:10:38,660

Shannon you've got our first question

239
00:10:45,100 --> 00:10:40,550
from the live audience once you go ahead

240
00:10:46,689 --> 00:10:45,110
I do yeah so Chris on YouTube asks do we

241
00:10:48,999 --> 00:10:46,699
ever consider the Earth's carrying

242
00:10:55,889 --> 00:10:49,009
capacity world population and its impact

243
00:11:00,370 --> 00:10:55,899
on climate change yes we certainly do

244
00:11:03,879 --> 00:11:00,380
worry about that food security is is one

245
00:11:06,819 --> 00:11:03,889
very important factor in sustainability

246
00:11:11,259 --> 00:11:06,829
of the human condition and food security

247
00:11:13,540 --> 00:11:11,269
is related to agricultural production

248
00:11:15,879 --> 00:11:13,550
and agricultural production is related

249
00:11:20,040 --> 00:11:15,889
to how we treat our environment and

250
00:11:24,490 --> 00:11:20,050
climate and that kind of thing so yes

251
00:11:29,679 --> 00:11:27,549
so Paul earth is earth science is one of

252
00:11:30,510 --> 00:11:29,689
those areas where NASA collaborates a

253
00:11:34,740 --> 00:11:30,520
lot with

254
00:11:37,020 --> 00:11:34,750
other other agencies like NOAA and the

255
00:11:38,820 --> 00:11:37,030
u.s. geologic survey as well as other

256
00:11:41,730 --> 00:11:38,830
countries but we'll talk a little more

257
00:11:44,220 --> 00:11:41,740
about that in a minute but for if other

258
00:11:46,350 --> 00:11:44,230
government agencies are are studying

259
00:11:48,660 --> 00:11:46,360
Earth and observing it what why does

260
00:11:52,590 --> 00:11:48,670
NASA do that - what is our role in the

261
00:11:55,380 --> 00:11:52,600
story well the simple answer is that

262
00:11:59,250 --> 00:11:55,390
nASA has a charter to study earth

263
00:12:02,040 --> 00:11:59,260

science from space using new

264
00:12:04,140 --> 00:12:02,050
technologies that are developed through

265
00:12:06,990 --> 00:12:04,150
the space program driven by those

266
00:12:09,600 --> 00:12:07,000
science requirements that's the simple

267
00:12:10,950 --> 00:12:09,610
answer now of course it's a little bit

268
00:12:13,830 --> 00:12:10,960
more complex than that

269
00:12:16,440 --> 00:12:13,840
NOAA has satellites they measure whether

270
00:12:18,240 --> 00:12:16,450
it's an operational agency to measure

271
00:12:20,880 --> 00:12:18,250
the weather it's not really science

272
00:12:23,010 --> 00:12:20,890
driven some science can be done with

273
00:12:25,740 --> 00:12:23,020
their satellites but generally speaking

274
00:12:29,220 --> 00:12:25,750
they take proven techniques proven

275
00:12:30,720 --> 00:12:29,230
satellites fly them and give us the

276
00:12:33,030 --> 00:12:30,730
weather on the weather channel every

277
00:12:35,840 --> 00:12:33,040
every night that's one of their main

278
00:12:38,340 --> 00:12:35,850
roles NSF the National Science

279
00:12:39,870 --> 00:12:38,350
Foundation they have a charter to do

280
00:12:42,090 --> 00:12:39,880
earth science as well as many other

281
00:12:45,270 --> 00:12:42,100
sciences but they generally are not a

282
00:12:47,160 --> 00:12:45,280
spacefaring agency they are they have

283
00:12:49,020 --> 00:12:47,170
programs that are related to those but

284
00:12:51,510 --> 00:12:49,030
that's not their charter to actually do

285
00:12:54,570 --> 00:12:51,520
that with new technologies and USGS

286
00:12:57,030 --> 00:12:54,580
similarly has a mandate to monitor

287
00:12:59,340 --> 00:12:57,040
everything about the country basically

288
00:13:02,910 --> 00:12:59,350

not necessarily the globe although they

289
00:13:06,210 --> 00:13:02,920
do have global initiatives as well about

290
00:13:08,160 --> 00:13:06,220
water quality and management of forests

291
00:13:12,030 --> 00:13:08,170
and things like that they tend to be

292
00:13:14,400 --> 00:13:12,040
less focused on this charter of whole

293
00:13:16,590 --> 00:13:14,410
system science using new technology from

294
00:13:19,910 --> 00:13:16,600
space so NASA does have a unique role in

295
00:13:22,140 --> 00:13:19,920
this capacity all right well let's

296
00:13:25,560 --> 00:13:22,150
Shannon you got another question once

297
00:13:28,110 --> 00:13:25,570
you go ahead I do and I might be getting

298
00:13:30,900 --> 00:13:28,120
a little head of myself here but Venetia

299
00:13:34,050 --> 00:13:30,910
on YouTube asks how will we benefit from

300
00:13:36,110 --> 00:13:34,060
nice arse mission research why don't we

301
00:13:40,380 --> 00:13:36,120
come back to that one in just a minute

302
00:13:43,800 --> 00:13:40,390
look I think about that as we go forward

303
00:13:44,220 --> 00:13:43,810
so so how about this let's answer that

304
00:13:48,390 --> 00:13:44,230
question

305
00:13:51,360 --> 00:13:48,400
right now alright let's get started then

306
00:13:53,460 --> 00:13:51,370
talking about these two examples these

307
00:13:55,980 --> 00:13:53,470
kind of specific examples from the many

308
00:13:58,430 --> 00:13:55,990
and I mean many different science

309
00:14:02,430 --> 00:13:58,440
missions and programs that NASA supports

310
00:14:04,770 --> 00:14:02,440
these are two upcoming missions nice R

311
00:14:06,770 --> 00:14:04,780
and Delta X meaning they're still in

312
00:14:09,450 --> 00:14:06,780
development getting ready to to deploy

313
00:14:12,660 --> 00:14:09,460

and there are very different types of

314
00:14:14,910 --> 00:14:12,670
missions and so together they give a

315
00:14:17,640 --> 00:14:14,920
sense of the wide range of methods and

316
00:14:19,590 --> 00:14:17,650
and perspectives that nASA uses to help

317
00:14:23,040 --> 00:14:19,600
understand how our planet works and how

318
00:14:24,950 --> 00:14:23,050
it changes so let's let's answer that

319
00:14:27,590 --> 00:14:24,960
question let's talk about nice R palla

320
00:14:31,350 --> 00:14:27,600
starting with what is it

321
00:14:33,510 --> 00:14:31,360
well nice R is a fantastic mission that

322
00:14:35,940 --> 00:14:33,520
I have the honor and privilege to be the

323
00:14:38,790 --> 00:14:35,950
project scientist for nice R is an

324
00:14:41,910 --> 00:14:38,800
acronym so it's a set of words that are

325
00:14:45,990 --> 00:14:41,920
put together into an acronym n stands

326
00:14:48,480 --> 00:14:46,000
for NASA so that's another acronym the

327
00:14:50,790 --> 00:14:48,490
AIA stands for is Rho which is another

328
00:14:54,330 --> 00:14:50,800
acronym stands for the Indian Space

329
00:14:57,450 --> 00:14:54,340
Research Organization and the S stands

330
00:15:01,560 --> 00:14:57,460
for synthetic the a stands for aperture

331
00:15:05,160 --> 00:15:01,570
and the R stands for radar so NASA is

332
00:15:08,130 --> 00:15:05,170
Rho synthetic aperture radar mission

333
00:15:10,200 --> 00:15:08,140
very complicated we tried to come up

334
00:15:12,990 --> 00:15:10,210
with a better name but it was very

335
00:15:14,430 --> 00:15:13,000
difficult and we just stuck with that so

336
00:15:16,500 --> 00:15:14,440
it describes that we are in a

337
00:15:19,020 --> 00:15:16,510
partnership with the Indian Space

338
00:15:20,610 --> 00:15:19,030

Research Organization NASA and Israel

339
00:15:23,490 --> 00:15:20,620
are equal partners building this

340
00:15:27,650 --> 00:15:23,500
satellite together and I like to think

341
00:15:33,870 --> 00:15:27,660
of the satellite as a effectively a

342
00:15:36,770 --> 00:15:33,880
radar that makes 3d time-lapse movies of

343
00:15:39,330 --> 00:15:36,780
the earth and we'll talk about the

344
00:15:41,310 --> 00:15:39,340
aspects of that in a bit but first I

345
00:15:43,320 --> 00:15:41,320
thought I'd kick it off by showing an

346
00:15:46,110 --> 00:15:43,330
animation which is kind of like a 3d

347
00:15:48,480 --> 00:15:46,120
animation of the spacecraft itself that

348
00:15:52,350 --> 00:15:48,490
would be graphic number one that could

349
00:15:54,630 --> 00:15:52,360
be brought up so this is showing in two

350
00:15:57,330 --> 00:15:54,640
years from now and we launched in 2022

351
00:16:00,120 --> 00:15:57,340
the spacecraft is

352
00:16:02,850 --> 00:16:00,130
stuffed into an indian space vehicle and

353
00:16:05,940 --> 00:16:02,860
then it has to be deployed so here you

354
00:16:09,180 --> 00:16:05,950
can see the deployment of a very complex

355
00:16:11,940 --> 00:16:09,190
boom with four joints you can see the

356
00:16:15,500 --> 00:16:11,950
boom is now being extended to its nine

357
00:16:19,650 --> 00:16:15,510
meter length and then it rotates up and

358
00:16:23,090 --> 00:16:19,660
gets into its final position to deploy a

359
00:16:27,090 --> 00:16:23,100
12 meter diameter that's 36 feet roughly

360
00:16:29,190 --> 00:16:27,100
reflector gold mesh reflector so this is

361
00:16:31,920 --> 00:16:29,200
a huge system that we are launching into

362
00:16:35,910 --> 00:16:31,930
space 12 meter reflector 9 meter boom

363
00:16:38,910 --> 00:16:35,920

and a 5 meter spacecraft with packed

364
00:16:42,440 --> 00:16:38,920
with a lot electronics 2 radars one from

365
00:16:44,220 --> 00:16:42,450
the NASA one from Israel and a lot of

366
00:16:46,560 --> 00:16:44,230
telecommunications equipment to get a

367
00:16:50,250 --> 00:16:46,570
huge volume of data from space to the

368
00:16:53,850 --> 00:16:50,260
ground so that's what the system is and

369
00:16:55,890 --> 00:16:53,860
these these 3d IMAX movies are to

370
00:16:58,650 --> 00:16:55,900
measure deformation and the technique

371
00:17:01,020 --> 00:16:58,660
that we use for that is by taking an

372
00:17:03,150 --> 00:17:01,030
image comparing it to the image of

373
00:17:05,840 --> 00:17:03,160
another time step and another time step

374
00:17:09,210 --> 00:17:05,850
and another time step and looking at

375
00:17:12,690 --> 00:17:09,220
these images as a meter stick to measure

376
00:17:15,360 --> 00:17:12,700
the motion of the earth two millimeter

377
00:17:18,990 --> 00:17:15,370
precision and the changes in the

378
00:17:20,610 --> 00:17:19,000
reflectivity of the earth to a very very

379
00:17:23,400 --> 00:17:20,620
high precision as well

380
00:17:26,520 --> 00:17:23,410
over time so we can see changes of all

381
00:17:29,420 --> 00:17:26,530
the land and all the ice-covered

382
00:17:33,690 --> 00:17:29,430
surfaces over the life of the mission

383
00:17:37,920 --> 00:17:33,700
Wow so two millimeter precision from yes

384
00:17:40,410 --> 00:17:37,930
that's a problem 8 1 million meters base

385
00:17:42,770 --> 00:17:40,420
you can measure to one thousandth of a

386
00:17:46,590 --> 00:17:42,780
meter precision it's really phenomenal

387
00:17:49,260 --> 00:17:46,600
very cool well tell us more about how

388
00:17:54,030 --> 00:17:49,270

you do it I mean you use you use radar

389
00:17:57,420 --> 00:17:54,040
right yes okay well let's see first of

390
00:18:02,760 --> 00:17:57,430
all let's look at the graphic number

391
00:18:07,950 --> 00:18:02,770
three which shows you an animation now

392
00:18:11,190 --> 00:18:07,960
of how the how the system operates so

393
00:18:12,930 --> 00:18:11,200
we're flying along at 7,500

394
00:18:16,470 --> 00:18:12,940
meters per second and we're sending

395
00:18:18,419 --> 00:18:16,480
pulses to the ground roughly 1,000 times

396
00:18:20,159 --> 00:18:18,429
per second so each one of these little

397
00:18:21,629 --> 00:18:20,169
potato chips you see flying to the

398
00:18:26,129 --> 00:18:21,639
ground is traveling at the speed of

399
00:18:28,110 --> 00:18:26,139
light measuring that then reflects off

400
00:18:31,500 --> 00:18:28,120
the surface and some of that energy goes

401
00:18:35,430 --> 00:18:31,510
back to the radar and is received

402
00:18:37,649 --> 00:18:35,440
now as you collect that data you can see

403
00:18:41,070 --> 00:18:37,659
that as you collect more and more pulses

404
00:18:43,259 --> 00:18:41,080
you can build up resolution of the image

405
00:18:44,850 --> 00:18:43,269
that's in the top right portion of your

406
00:18:46,919 --> 00:18:44,860
image you get a radar image like that

407
00:18:49,080 --> 00:18:46,929
that is high resolution after you

408
00:18:51,539 --> 00:18:49,090
collect enough of these pulses to do so

409
00:18:53,940 --> 00:18:51,549
so that's the synthetic aperture part

410
00:18:57,570 --> 00:18:53,950
it's like having a very large lens in

411
00:18:59,340 --> 00:18:57,580
space that's ten kilometers long it's

412
00:19:01,710 --> 00:18:59,350
not that long but it's synthetically

413
00:19:03,210 --> 00:19:01,720

that long by processing the data in a

414
00:19:05,759 --> 00:19:03,220
particular way to get this

415
00:19:07,860 --> 00:19:05,769
high-resolution imagery then once we

416
00:19:10,680 --> 00:19:07,870
have that image we fly over the same

417
00:19:13,019 --> 00:19:10,690
spot again make another image that looks

418
00:19:15,269 --> 00:19:13,029
just like it and you can think of the

419
00:19:17,279 --> 00:19:15,279
radar wave that we transmit kind of like

420
00:19:19,529 --> 00:19:17,289
a meter stick and we're measuring the

421
00:19:22,200 --> 00:19:19,539
changes in the length of that meter

422
00:19:27,000 --> 00:19:22,210
stick as the earth moves below the

423
00:19:28,879 --> 00:19:27,010
satellite very cool so Shannon did you

424
00:19:31,649 --> 00:19:28,889
you say you have another question for us

425
00:19:33,659 --> 00:19:31,659
yeah actually I'm gonna throw two at you

426
00:19:35,820 --> 00:19:33,669
right now Paul so we have William on

427
00:19:37,830 --> 00:19:35,830
YouTube asks how do we prevent

428
00:19:39,389 --> 00:19:37,840
congestion or collisions around Earth

429
00:19:43,350 --> 00:19:39,399
with so many missions and satellites

430
00:19:50,250 --> 00:19:43,360
observing earth well that's an excellent

431
00:19:54,509 --> 00:19:50,260
question and I wish I had a really good

432
00:19:57,570 --> 00:19:54,519
answer to that but at some level there

433
00:19:59,940 --> 00:19:57,580
is coordination internationally too when

434
00:20:01,970 --> 00:19:59,950
you launch a satellite to make sure that

435
00:20:06,029 --> 00:20:01,980
you're not launching it in a place that

436
00:20:09,210 --> 00:20:06,039
another satellite exists so so there is

437
00:20:12,029 --> 00:20:09,220
that degree of coordination there are

438
00:20:13,440 --> 00:20:12,039

sometimes places where you don't want to

439
00:20:15,090 --> 00:20:13,450
launch the satellite because you know

440
00:20:18,750 --> 00:20:15,100
there's a lot of debris there from

441
00:20:21,049 --> 00:20:18,760
perhaps a collision previous collision

442
00:20:24,590 --> 00:20:21,059
where there's debris all over the place

443
00:20:27,889 --> 00:20:24,600
you want to avoid that but

444
00:20:30,230 --> 00:20:27,899
at some level sometimes these things do

445
00:20:31,940 --> 00:20:30,240
hit other other objects in space and you

446
00:20:33,799 --> 00:20:31,950
do have to be a little bit careful but

447
00:20:35,690 --> 00:20:33,809
from spacecraft to spacecraft it's

448
00:20:37,850 --> 00:20:35,700
pretty well coordinated all the

449
00:20:39,649 --> 00:20:37,860
spacecraft you're tracked everybody

450
00:20:42,080 --> 00:20:39,659
knows where they are and they tend not

451
00:20:45,470 --> 00:20:42,090
to collide space is also extremely large

452
00:20:48,379 --> 00:20:45,480
so it's relatively easy to avoid hitting

453
00:20:51,379 --> 00:20:48,389
another satellite so in addition to

454
00:20:53,330 --> 00:20:51,389
solving the the pressing problems of

455
00:20:55,009 --> 00:20:53,340
space travel you do you do actually have

456
00:20:56,810 --> 00:20:55,019
to worry about that you know to some

457
00:20:58,639 --> 00:20:56,820
extent with with nice are right you're

458
00:21:00,080 --> 00:20:58,649
you you're you will be concerned about

459
00:21:02,509 --> 00:21:00,090
the safe health and safety of your

460
00:21:04,850 --> 00:21:02,519
spacecraft but I guess you're saying we

461
00:21:08,149 --> 00:21:04,860
we do a pretty good job of watching out

462
00:21:11,330 --> 00:21:08,159
for the for the dangerous stuff we do we

463
00:21:14,419 --> 00:21:11,340

do and and in fact there are there are

464
00:21:16,639 --> 00:21:14,429
people who monitor the environment that

465
00:21:19,310 --> 00:21:16,649
we're flying in on a daily basis and

466
00:21:21,919 --> 00:21:19,320
they they will make a recommendation to

467
00:21:23,720 --> 00:21:21,929
the project to tweak the orbit a little

468
00:21:26,029 --> 00:21:23,730
bit to move one side or the other in

469
00:21:27,860 --> 00:21:26,039
order to avoid a piece of space debris

470
00:21:29,899 --> 00:21:27,870
it's generally not another satellite

471
00:21:32,180 --> 00:21:29,909
because we know where they all are but

472
00:21:35,990 --> 00:21:32,190
for space debris sometimes we have to

473
00:21:39,320 --> 00:21:36,000
worry okay hit us again we do track that

474
00:21:41,990 --> 00:21:39,330
and then a little bit earlier point as

475
00:21:44,360 --> 00:21:42,000
Lauren on YouTube was wondering how do

476
00:21:47,570 --> 00:21:44,370
these partnerships and collaborations

477
00:21:51,139 --> 00:21:47,580
start with other countries well that's

478
00:21:53,060 --> 00:21:51,149
also fascinating it's a very long story

479
00:21:56,960 --> 00:21:53,070
for an icer we actually started this

480
00:22:00,009 --> 00:21:56,970
back in 2008 to try to get a partnership

481
00:22:03,169 --> 00:22:00,019
going it's partly a result of

482
00:22:04,909 --> 00:22:03,179
persistence and knowing your colleagues

483
00:22:07,490 --> 00:22:04,919
around the world and trying to line up

484
00:22:10,879 --> 00:22:07,500
your program with their program for this

485
00:22:13,940 --> 00:22:10,889
particular mission we talked to many

486
00:22:17,899 --> 00:22:13,950
different countries trying to find a way

487
00:22:20,330 --> 00:22:17,909
to partner with them NASA told us quite

488
00:22:22,700 --> 00:22:20,340

explicitly you must partner because this

489
00:22:24,669 --> 00:22:22,710
is a very large mission doing very large

490
00:22:26,810 --> 00:22:24,679
science and it's quite expensive so

491
00:22:30,080 --> 00:22:26,820
finding a partner was essential to

492
00:22:32,750 --> 00:22:30,090
making it happen and it just turned up

493
00:22:36,799 --> 00:22:32,760
after talking to maybe four or five six

494
00:22:38,150 --> 00:22:36,809
different possible partners I actually

495
00:22:41,060 --> 00:22:38,160
went to India all

496
00:22:44,360 --> 00:22:41,070
myself for the first time back in 2011

497
00:22:46,580 --> 00:22:44,370
and told them about the mission and it

498
00:22:49,750 --> 00:22:46,590
turned out that they were thinking about

499
00:22:54,470 --> 00:22:49,760
almost the same concept for observation

500
00:22:56,330 --> 00:22:54,480
with the same kind of radar and the

501
00:22:59,060 --> 00:22:56,340
timing of the program was roughly

502
00:23:02,330 --> 00:22:59,070
equivalent to our timing so we were very

503
00:23:04,730 --> 00:23:02,340
lucky in this case but in general it

504
00:23:06,260 --> 00:23:04,740
requires persistence and coordination at

505
00:23:10,640 --> 00:23:06,270
the international level to make these

506
00:23:12,560 --> 00:23:10,650
happen so we'll come back to the science

507
00:23:14,210 --> 00:23:12,570
I will I know we want to talk about the

508
00:23:15,740 --> 00:23:14,220
science of nicer but let's stick with

509
00:23:18,470 --> 00:23:15,750
that the partnership just for a moment

510
00:23:19,850 --> 00:23:18,480
and just ask what what India's role in

511
00:23:22,450 --> 00:23:19,860
the mission is going to be they're

512
00:23:25,490 --> 00:23:22,460
launching the spacecraft for one thing

513
00:23:27,470 --> 00:23:25,500

yes yes they're an equal partner in

514
00:23:29,300 --> 00:23:27,480
every sense of the word they have a

515
00:23:30,950 --> 00:23:29,310
science team that is joint with our

516
00:23:33,440 --> 00:23:30,960
science team and they have their

517
00:23:35,450 --> 00:23:33,450
objectives tend to focus in India and

518
00:23:38,930 --> 00:23:35,460
the surrounding countries but they also

519
00:23:42,620 --> 00:23:38,940
have objectives globally for looking at

520
00:23:44,710 --> 00:23:42,630
ice sheets and and forests and and other

521
00:23:48,890 --> 00:23:44,720
things like that

522
00:23:51,500 --> 00:23:48,900
they are also building the we call it

523
00:23:54,170 --> 00:23:51,510
the spacecraft bus that part of the

524
00:23:56,930 --> 00:23:54,180
satellite that controls the orbit and

525
00:23:59,500 --> 00:23:56,940
that can has the power system that

526
00:24:04,580 --> 00:23:59,510
provides the power to all of the radars

527
00:24:07,820 --> 00:24:04,590
and they also are providing one of the

528
00:24:12,350 --> 00:24:07,830
two radars so let's see if we could go

529
00:24:14,710 --> 00:24:12,360
back to that that very first graphic I

530
00:24:18,050 --> 00:24:14,720
don't know if you can graphic number one

531
00:24:19,460 --> 00:24:18,060
sort of in the middle I don't know if

532
00:24:22,100 --> 00:24:19,470
you can start in the middle or not but

533
00:24:26,180 --> 00:24:22,110
in any case in that graphic you'll see

534
00:24:28,100 --> 00:24:26,190
that octagonal structure with the little

535
00:24:30,830 --> 00:24:28,110
ladder hanging down that is where the

536
00:24:33,350 --> 00:24:30,840
radar instrument is the cube behind it

537
00:24:36,650 --> 00:24:33,360
is actually the spacecraft bus that's

538
00:24:39,500 --> 00:24:36,660

provided by Israel so JPL NASA is

539
00:24:42,410 --> 00:24:39,510
building the octagonal structure with

540
00:24:44,930 --> 00:24:42,420
the long wavelength radar that NASA is

541
00:24:48,290 --> 00:24:44,940
providing and also in that structure is

542
00:24:51,919 --> 00:24:48,300
mounted the shorter wavelength radar

543
00:24:55,330 --> 00:24:51,929
that the Indians are providing so bus

544
00:24:58,249 --> 00:24:55,340
launch vehicle science team s-band radar

545
00:25:01,430 --> 00:24:58,259
short wavelength radar Mission

546
00:25:03,080 --> 00:25:01,440
Operations they're providing an enormous

547
00:25:05,480 --> 00:25:03,090
and the data is freely and openly

548
00:25:10,100 --> 00:25:05,490
available to the world both in India and

549
00:25:12,129 --> 00:25:10,110
in the US so it's it's a very balanced

550
00:25:14,450 --> 00:25:12,139
partnership they're providing a lot

551
00:25:15,980 --> 00:25:14,460
well these international partnerships

552
00:25:17,539 --> 00:25:15,990
seem to be increasingly important in

553
00:25:19,759 --> 00:25:17,549
space exploration and they're a

554
00:25:21,460 --> 00:25:19,769
wonderful thing and it's one of the

555
00:25:23,629 --> 00:25:21,470
things that I when I first heard about

556
00:25:26,119 --> 00:25:23,639
Shannon talent I think you told me about

557
00:25:28,279 --> 00:25:26,129
nice are and and what's so wonderful

558
00:25:30,139 --> 00:25:28,289
about it in in this context in

559
00:25:31,399 --> 00:25:30,149
particular for Earth Day is it you know

560
00:25:32,450 --> 00:25:31,409
that's a country on the other side of

561
00:25:34,879 --> 00:25:32,460
the planet that we are working

562
00:25:36,529 --> 00:25:34,889
hand-in-hand with for the good of

563
00:25:39,320 --> 00:25:36,539

everybody and that's kind of what we're

564
00:25:42,139 --> 00:25:39,330
all about at NASA just we're just trying

565
00:25:45,580 --> 00:25:42,149
to to learn and to study and provide

566
00:25:48,200 --> 00:25:45,590
information just to help everybody out

567
00:25:51,379 --> 00:25:48,210
it's so it's a fabulous experience

568
00:25:54,259 --> 00:25:51,389
except for the telecoms that occur at

569
00:25:56,749 --> 00:25:54,269
nine o'clock at night they're literally

570
00:25:59,350 --> 00:25:56,759
halfway around the world from Los

571
00:26:02,379 --> 00:25:59,360
Angeles but it's a it's a wonderful

572
00:26:05,239 --> 00:26:02,389
rewarding experience oh that's great

573
00:26:06,710 --> 00:26:05,249
well so let's go back and get into some

574
00:26:08,690 --> 00:26:06,720
of the science because I want you I want

575
00:26:10,220 --> 00:26:08,700
your you are the project scientist

576
00:26:12,649 --> 00:26:10,230
you're the lead scientist on on the

577
00:26:16,159 --> 00:26:12,659
mission so tell us about what nice our

578
00:26:18,470 --> 00:26:16,169
will study what it will observe all

579
00:26:20,359 --> 00:26:18,480
right so I mentioned that it's like a

580
00:26:24,109 --> 00:26:20,369
meter stick so if you could bring up

581
00:26:26,480 --> 00:26:24,119
graphic number five this will show you

582
00:26:28,789 --> 00:26:26,490
an example of one of these 3d movies

583
00:26:31,480 --> 00:26:28,799
that we see so this what you're looking

584
00:26:34,669 --> 00:26:31,490
at here is the Los Angeles basin

585
00:26:36,919 --> 00:26:34,679
breathing so here you can see the some

586
00:26:39,200 --> 00:26:36,929
of the faults in the Los Angeles base

587
00:26:42,220 --> 00:26:39,210
and they're depicted the color here

588
00:26:45,859 --> 00:26:42,230

going from red to blue and back again is

589
00:26:48,649 --> 00:26:45,869
basically the the surface level

590
00:26:51,320 --> 00:26:48,659
elevation of the earth and you can see

591
00:26:54,200 --> 00:26:51,330
it's going up and down on a seasonal

592
00:26:58,519 --> 00:26:54,210
basis a yearly basis as water is

593
00:27:01,700 --> 00:26:58,529
extracted from the LA basin the surface

594
00:27:03,950 --> 00:27:01,710
sinks and as it's reinjected naturally

595
00:27:06,010 --> 00:27:03,960
and by people in the wintertime when it

596
00:27:11,300 --> 00:27:06,020
rains is surface

597
00:27:13,880 --> 00:27:11,310
so this is again about one inch plus or

598
00:27:16,880 --> 00:27:13,890
minus one inch or two and a half

599
00:27:18,890 --> 00:27:16,890
centimeters of motion that we're

600
00:27:21,050 --> 00:27:18,900
measuring from space this is from a

601
00:27:22,970 --> 00:27:21,060
European satellite that flew many years

602
00:27:25,340 --> 00:27:22,980
ago and you can see there's some holes

603
00:27:27,200 --> 00:27:25,350
in the data and it's it's not as

604
00:27:29,030 --> 00:27:27,210
accurate as we would like but

605
00:27:31,760 --> 00:27:29,040
nonetheless it shows you quite clearly

606
00:27:34,280 --> 00:27:31,770
that we can measure down to millimeter

607
00:27:36,380 --> 00:27:34,290
precision the motion of the earth so

608
00:27:39,380 --> 00:27:36,390
we're studying that kind of motion this

609
00:27:42,320 --> 00:27:39,390
happened to be for studying the aquifers

610
00:27:44,420 --> 00:27:42,330
the subsurface water within the Los

611
00:27:46,790 --> 00:27:44,430
Angeles basin but you can see quite

612
00:27:49,310 --> 00:27:46,800
clearly it was related to also the

613
00:27:51,680 --> 00:27:49,320

earthquake system the fault system

614
00:27:53,630 --> 00:27:51,690
that's in the Los Angeles basin so we

615
00:27:56,510 --> 00:27:53,640
use this technique to look at the motion

616
00:27:58,370 --> 00:27:56,520
of the of the tectonic plates to look at

617
00:28:01,160 --> 00:27:58,380
volcanoes actually if you could bring up

618
00:28:03,410 --> 00:28:01,170
gap graphic number six that shows you

619
00:28:05,510 --> 00:28:03,420
something very very interesting I don't

620
00:28:07,310 --> 00:28:05,520
know if you can see it from very clearly

621
00:28:10,940 --> 00:28:07,320
I can barely see it on my screen here

622
00:28:14,330 --> 00:28:10,950
but you can see sort of a bull's-eye

623
00:28:18,040 --> 00:28:14,340
pattern which is again a depiction of

624
00:28:22,550 --> 00:28:18,050
the the elevation the rising of the

625
00:28:25,100 --> 00:28:22,560
surface there due to pressure building

626
00:28:26,840 --> 00:28:25,110
in the magma below the surface in this

627
00:28:28,760 --> 00:28:26,850
particular area so I think it's up in

628
00:28:31,160 --> 00:28:28,770
Oregon someplace but what's very

629
00:28:33,620 --> 00:28:31,170
interesting about this is that the three

630
00:28:36,320 --> 00:28:33,630
peaks where you would expect to see the

631
00:28:39,410 --> 00:28:36,330
bulging because volcanoes tend to have

632
00:28:42,170 --> 00:28:39,420
these beautiful edifice 'iz that then

633
00:28:45,280 --> 00:28:42,180
explode in a in an eruption the three

634
00:28:48,260 --> 00:28:45,290
peaks are not centered on that bullseye

635
00:28:50,870 --> 00:28:48,270
so what we learn by looking at these

636
00:28:52,880 --> 00:28:50,880
kinds of observations is you know what

637
00:28:56,060 --> 00:28:52,890
is happening below the surface it's

638
00:28:58,790 --> 00:28:56,070

clearly not something that we might

639
00:29:01,400 --> 00:28:58,800
might expect that you'd see that bull's

640
00:29:03,950 --> 00:29:01,410
eye pattern centered on one of those

641
00:29:06,920 --> 00:29:03,960
three peaks or maybe all of the three

642
00:29:10,280 --> 00:29:06,930
peaks as the pressure is building so we

643
00:29:12,800 --> 00:29:10,290
study earthquakes we study volcanoes we

644
00:29:16,040 --> 00:29:12,810
study landslides using similar

645
00:29:19,250 --> 00:29:16,050
techniques we study aquifer systems

646
00:29:21,590 --> 00:29:19,260
these are pure scientific questions

647
00:29:24,110 --> 00:29:21,600
understanding the physics the geophysics

648
00:29:27,800 --> 00:29:24,120
of our crust that we live on they're

649
00:29:31,280 --> 00:29:27,810
also very applied problems what do you

650
00:29:36,340 --> 00:29:31,290
do about people living in earthquake

651
00:29:43,160 --> 00:29:36,350
prone areas in volcanic areas how do you

652
00:29:47,390 --> 00:29:43,170
design society around these these these

653
00:29:50,210 --> 00:29:47,400
fit these physical phenomena so that's

654
00:29:52,460 --> 00:29:50,220
one of the three main disciplines that

655
00:29:55,760 --> 00:29:52,470
we have that's enough perhaps for one

656
00:29:57,980 --> 00:29:55,770
mission but we have actually three main

657
00:30:00,980 --> 00:29:57,990
disciplines and then about 20 or 30

658
00:30:03,320 --> 00:30:00,990
other kinds of applications that spin

659
00:30:05,000 --> 00:30:03,330
off from those science disciplines so so

660
00:30:06,800 --> 00:30:05,010
solid earth is one of the main

661
00:30:09,830 --> 00:30:06,810
disciplines that other is the cryosphere

662
00:30:11,150 --> 00:30:09,840
studying the ice sheets and sea ice so

663
00:30:15,770 --> 00:30:11,160

if you could bring up graphic number

664
00:30:20,150 --> 00:30:15,780
seven I think many of you know that that

665
00:30:22,910 --> 00:30:20,160
the ice sheets are intimately related to

666
00:30:26,090 --> 00:30:22,920
the sea level as the ice that's on the

667
00:30:28,670 --> 00:30:26,100
ground melts and disappears that water

668
00:30:30,950 --> 00:30:28,680
tends to go into the sea and that tends

669
00:30:33,830 --> 00:30:30,960
to contribute to the rise of sea level

670
00:30:36,050 --> 00:30:33,840
so understanding the dynamics of the ice

671
00:30:38,420 --> 00:30:36,060
is extremely important for understanding

672
00:30:40,670 --> 00:30:38,430
how the ice sheets are changing and

673
00:30:43,340 --> 00:30:40,680
therefore how the sea level is going to

674
00:30:47,570 --> 00:30:43,350
change so in this graphic you see on the

675
00:30:50,420 --> 00:30:47,580
left of it it's a colorful image of a

676
00:30:53,630 --> 00:30:50,430
glacier happens to be in Greenland

677
00:30:55,550 --> 00:30:53,640
called Jakob saw and glacier and the one

678
00:30:57,440 --> 00:30:55,560
on the left is from one time period I

679
00:31:01,070 --> 00:30:57,450
think around 2000 the one on the right

680
00:31:03,200 --> 00:31:01,080
is from another time period about eight

681
00:31:06,110 --> 00:31:03,210
years later if I recall the numbers and

682
00:31:09,740 --> 00:31:06,120
what you can see is that the the

683
00:31:11,900 --> 00:31:09,750
location of where that color band ends

684
00:31:16,010 --> 00:31:11,910
and turns into gray has changed it's

685
00:31:17,270 --> 00:31:16,020
receded so the ice has receded and the

686
00:31:19,460 --> 00:31:17,280
other thing you can see is that the

687
00:31:21,380 --> 00:31:19,470
color is very different meaning the

688
00:31:23,780 --> 00:31:21,390

velocity color it represents the

689
00:31:26,420 --> 00:31:23,790
velocity of that glacier so the speed at

690
00:31:28,970 --> 00:31:26,430
which the ice is moving you can see that

691
00:31:31,250 --> 00:31:28,980
over that eight-year period the speed of

692
00:31:33,100 --> 00:31:31,260
that glacier especially in the main part

693
00:31:35,850 --> 00:31:33,110
has increased

694
00:31:39,070 --> 00:31:35,860
sniffing Lee so it's shrinking and

695
00:31:41,350 --> 00:31:39,080
receding and this is one glacier out of

696
00:31:43,750 --> 00:31:41,360
hundreds in Greece in Greenland and

697
00:31:48,310 --> 00:31:43,760
maybe hundreds or thousands in

698
00:31:50,770 --> 00:31:48,320
Antarctica where C I where ice has a has

699
00:31:54,490 --> 00:31:50,780
a mechanism for flowing out into the sea

700
00:31:58,390 --> 00:31:54,500
so making these substantial global

701
00:32:00,520 --> 00:31:58,400
measurements as movies allows us to get

702
00:32:03,100 --> 00:32:00,530
a complete picture of their dynamics

703
00:32:05,860 --> 00:32:03,110
over the life of the mission and put

704
00:32:08,919 --> 00:32:05,870
that into geophysical models that allow

705
00:32:11,130 --> 00:32:08,929
us then to predict what might happen to

706
00:32:13,810 --> 00:32:11,140
these ice sheets over time

707
00:32:16,320 --> 00:32:13,820
factoring into other measurements as

708
00:32:19,630 --> 00:32:16,330
well the ocean temperature and

709
00:32:22,060 --> 00:32:19,640
accumulation of snow in the winter and

710
00:32:25,450 --> 00:32:22,070
and and things like that

711
00:32:28,270 --> 00:32:25,460
so that's another major thing it's just

712
00:32:30,880 --> 00:32:28,280
really amazing if I can joke I think I

713
00:32:33,640 --> 00:32:30,890

think what's baffle or or are really

714
00:32:37,570 --> 00:32:33,650
just astounding is that you can measure

715
00:32:39,610 --> 00:32:37,580
that that kind of movement of the solid

716
00:32:43,210 --> 00:32:39,620
earth and and what you're talking about

717
00:32:47,440 --> 00:32:43,220
nicely ice now the cryosphere with such

718
00:32:49,120 --> 00:32:47,450
precision and and and and and what

719
00:32:52,240 --> 00:32:49,130
you're really looking for is is change

720
00:32:55,750 --> 00:32:52,250
over time like you say right that's

721
00:32:58,630 --> 00:32:55,760
correct yes so prior to the modern era

722
00:33:01,539 --> 00:32:58,640
people didn't think much about the the

723
00:33:04,299 --> 00:33:01,549
ice sheets they they assumed that you

724
00:33:06,549 --> 00:33:04,309
know it's snowed it accumulated ice the

725
00:33:08,049 --> 00:33:06,559
the gravity pushed the ice out into the

726
00:33:10,990 --> 00:33:08,059
ocean and it was a sort of a steady

727
00:33:12,909 --> 00:33:11,000
state process but as we're learning and

728
00:33:16,539 --> 00:33:12,919
making more and more observations we see

729
00:33:19,450 --> 00:33:16,549
that it changes on a on a seasonal basis

730
00:33:22,150 --> 00:33:19,460
it changes over the years it's driven by

731
00:33:25,780 --> 00:33:22,160
tides and you can see some absolutely

732
00:33:29,350 --> 00:33:25,790
fantastic pure scientific things about

733
00:33:32,260 --> 00:33:29,360
the dynamics of the ice on a daily basis

734
00:33:34,330 --> 00:33:32,270
even so it's a complex system that the

735
00:33:36,520 --> 00:33:34,340
people did not fully appreciate until we

736
00:33:40,350 --> 00:33:36,530
had these kinds of measurements and nice

737
00:33:43,270 --> 00:33:40,360
are unfortunately the existing systems

738
00:33:43,570 --> 00:33:43,280

they'll give you a snapshot over a very

739
00:33:44,890 --> 00:33:43,580
long

740
00:33:48,220 --> 00:33:44,900
period of time they don't give you this

741
00:33:49,960 --> 00:33:48,230
kind of movie like depiction over the

742
00:33:52,480 --> 00:33:49,970
years of the mission to get a really

743
00:33:54,700 --> 00:33:52,490
complete picture of it so is that is

744
00:33:57,700 --> 00:33:54,710
that would that be your elevator pitch

745
00:33:59,950 --> 00:33:57,710
for a nice R is that nice R is makes a

746
00:34:03,520 --> 00:33:59,960
movie of planet Earth that's that's what

747
00:34:06,310 --> 00:34:03,530
we are we make Earth the movie yeah and

748
00:34:08,860 --> 00:34:06,320
the advantage of radar as opposed to

749
00:34:11,440 --> 00:34:08,870
other systems is that it's an active

750
00:34:13,690 --> 00:34:11,450
source meaning we have the power up on

751
00:34:16,720 --> 00:34:13,700
the spacecraft to transmit a signal to

752
00:34:18,730 --> 00:34:16,730
the ground and it's a long wavelength

753
00:34:20,680 --> 00:34:18,740
the radar wavelength is something like

754
00:34:23,830 --> 00:34:20,690
this and that doesn't interact very much

755
00:34:25,090 --> 00:34:23,840
with with rain or clouds so we can

756
00:34:27,640 --> 00:34:25,100
actually see right through the clouds

757
00:34:30,850 --> 00:34:27,650
and since we have our own power source

758
00:34:34,480 --> 00:34:30,860
we also don't have to have the Sun out

759
00:34:36,100 --> 00:34:34,490
so we can measure 24/7 and every

760
00:34:38,110 --> 00:34:36,110
measurement we make is an important

761
00:34:40,240 --> 00:34:38,120
measurement so we get very complete time

762
00:34:42,940 --> 00:34:40,250
series over the life of the mission it's

763
00:34:44,530 --> 00:34:42,950

really quite a powerful technique and we

764
00:34:46,570 --> 00:34:44,540
measures fundamentally different things

765
00:34:48,520 --> 00:34:46,580
from what most other sensors measure

766
00:34:51,430 --> 00:34:48,530
which are more sort of looking at the

767
00:34:53,410 --> 00:34:51,440
chemical structure of plants and land

768
00:34:55,480 --> 00:34:53,420
surface we're looking at the the

769
00:34:57,970 --> 00:34:55,490
physical structure and the motion of

770
00:35:01,840 --> 00:34:57,980
that of that surface so it's really

771
00:35:04,390 --> 00:35:01,850
quite and you said you have was there

772
00:35:08,290 --> 00:35:04,400
one more key pillar of science that you

773
00:35:12,370 --> 00:35:08,300
wanted to get to yes yes and of course

774
00:35:14,610 --> 00:35:12,380
that one has multiple sub disciplines we

775
00:35:19,750 --> 00:35:14,620
call it ecosystems but we're studying

776
00:35:21,730 --> 00:35:19,760
biomass we're studying agricultural area

777
00:35:25,870 --> 00:35:21,740
crop area and how it's changing over

778
00:35:32,890 --> 00:35:25,880
time we're studying wetlands inundation

779
00:35:35,560 --> 00:35:32,900
and we're studying another one it'll

780
00:35:38,740 --> 00:35:35,570
come to me in a second but if you could

781
00:35:42,990 --> 00:35:38,750
bring up graphic number let's see four

782
00:35:45,190 --> 00:35:43,000
please this gives you a notion of our

783
00:35:49,210 --> 00:35:45,200
observation strategy highly accelerated

784
00:35:51,790 --> 00:35:49,220
we cover the earth in 12 days 173 orbits

785
00:35:54,250 --> 00:35:51,800
over the 12 day period and this has

786
00:35:56,500 --> 00:35:54,260
underneath it simulated biomass so

787
00:35:57,350 --> 00:35:56,510
biomass by biomass we mean basically the

788
00:35:59,630 --> 00:35:57,360

stuff

789
00:36:02,240 --> 00:35:59,640
carbon that's in the trees it's directly

790
00:36:05,360 --> 00:36:02,250
related to it we measure the forest

791
00:36:07,490 --> 00:36:05,370
because the forests are a very sensitive

792
00:36:09,170 --> 00:36:07,500
measure of what's going on within the

793
00:36:12,890 --> 00:36:09,180
carbon cycle and it's actually one of

794
00:36:15,830 --> 00:36:12,900
our least well understood measurements

795
00:36:18,920 --> 00:36:15,840
for ecosystems and the carbon cycle at

796
00:36:20,870 --> 00:36:18,930
the scale that we need to know it so you

797
00:36:22,940 --> 00:36:20,880
can see that we're covering the entire

798
00:36:28,070 --> 00:36:22,950
Earth when this finishes it's going to

799
00:36:29,900 --> 00:36:28,080
stop and you'll see two very important

800
00:36:35,060 --> 00:36:29,910
areas where we need to know the biomass

801
00:36:37,190 --> 00:36:35,070
one is the Congo in Africa the other is

802
00:36:41,450 --> 00:36:37,200
of course the Amazon where there's an

803
00:36:43,070 --> 00:36:41,460
enormous amount of biomass now so there

804
00:36:45,950 --> 00:36:43,080
you can see the green areas there that

805
00:36:50,360 --> 00:36:45,960
in South America that's the Amazon and

806
00:36:53,480 --> 00:36:50,370
the green area in in Africa that's the

807
00:36:55,430 --> 00:36:53,490
Congo these areas have pretty dense

808
00:36:56,960 --> 00:36:55,440
biomass and when you think of them you

809
00:37:00,410 --> 00:36:56,970
might think that they are just sort of

810
00:37:04,490 --> 00:37:00,420
they're static but in fact there's a lot

811
00:37:07,760 --> 00:37:04,500
of activity in those in those forests as

812
00:37:09,770 --> 00:37:07,770
you mostly induced by humans cutting

813
00:37:12,740 --> 00:37:09,780

down the trees and and creating

814
00:37:15,200 --> 00:37:12,750
agricultural areas so these two

815
00:37:17,360 --> 00:37:15,210
measurements of biomass biomass change

816
00:37:19,820 --> 00:37:17,370
that was the fourth one biomass change

817
00:37:23,390 --> 00:37:19,830
we mentioned the static biomass biomass

818
00:37:25,640 --> 00:37:23,400
change and the agricultural area around

819
00:37:28,640 --> 00:37:25,650
the world synoptic lis so that we can

820
00:37:31,310 --> 00:37:28,650
understand this carbon dynamic in

821
00:37:32,780 --> 00:37:31,320
exchange of the atmosphere I got to stop

822
00:37:34,310 --> 00:37:32,790
you on the word zoonotic you got to tell

823
00:37:38,810 --> 00:37:34,320
people what the word stenotic means you

824
00:37:44,920 --> 00:37:38,820
don't get away with that synoptic means

825
00:37:51,110 --> 00:37:48,170
okay well I it's a staggering amount of

826
00:37:53,450 --> 00:37:51,120
science and such a wide variety of

827
00:37:57,020 --> 00:37:53,460
things that it's gonna do and Shannon

828
00:37:59,120 --> 00:37:57,030
has questioned about the science on you

829
00:38:02,240 --> 00:37:59,130
wanted to ask about about how you filter

830
00:38:05,000 --> 00:38:02,250
the data right yeah yeah so we have a

831
00:38:07,580 --> 00:38:05,010
question from WFC striker on YouTube and

832
00:38:09,110 --> 00:38:07,590
and he asks or they ask how do you

833
00:38:10,289 --> 00:38:09,120
filter out things that move on earth

834
00:38:12,569 --> 00:38:10,299
that shouldn't be measured

835
00:38:15,029 --> 00:38:12,579
cars people walking around or large

836
00:38:19,019 --> 00:38:15,039
buildings how do we filter that out with

837
00:38:21,239 --> 00:38:19,029
nice art that's a very technical

838
00:38:23,959 --> 00:38:21,249

question but it's a it's a good but it's

839
00:38:31,380 --> 00:38:23,969
a very good question so we actually

840
00:38:34,069 --> 00:38:31,390
what's your least technical answer the

841
00:38:38,429 --> 00:38:34,079
short answer is because we're looking at

842
00:38:40,380 --> 00:38:38,439
these images over time we get something

843
00:38:45,839 --> 00:38:40,390
like 30 images per year from each

844
00:38:48,029 --> 00:38:45,849
vantage point we can cars move from one

845
00:38:51,359 --> 00:38:48,039
day to the next they create a little bit

846
00:38:53,130 --> 00:38:51,369
of noise in our image if it's in one

847
00:38:56,849 --> 00:38:53,140
place one day and another place and

848
00:39:00,029 --> 00:38:56,859
another day then those two cars are

849
00:39:01,769 --> 00:39:00,039
going to that the car will create noise

850
00:39:04,349 --> 00:39:01,779
in the two different places where it is

851
00:39:09,870 --> 00:39:04,359
almost two different days but because

852
00:39:12,089 --> 00:39:09,880
our image pixel size people know what

853
00:39:12,839 --> 00:39:12,099
pixels are right pixel size is fairly

854
00:39:15,479 --> 00:39:12,849
large

855
00:39:17,189 --> 00:39:15,489
if you move just one car out of that

856
00:39:19,979 --> 00:39:17,199
pixel most of the pixel stays the same

857
00:39:22,259 --> 00:39:19,989
and so we can actually still get a

858
00:39:25,349 --> 00:39:22,269
measurement of the motion of that whole

859
00:39:27,120 --> 00:39:25,359
pixel with a little bit of extra noise

860
00:39:29,400 --> 00:39:27,130
because the car is in there so we don't

861
00:39:31,589 --> 00:39:29,410
actually actively filter it out we use

862
00:39:34,709 --> 00:39:31,599
our processing techniques to just accept

863
00:39:37,199 --> 00:39:34,719

a little more noise and and we take many

864
00:39:39,150 --> 00:39:37,209
images in order to reduce that noise

865
00:39:42,059 --> 00:39:39,160
there's many error sources in our

866
00:39:44,370 --> 00:39:42,069
measurement and we use just the volume

867
00:39:46,650 --> 00:39:44,380
of data and the time lapse nature of it

868
00:39:49,799 --> 00:39:46,660
and our knowledge of how the earth is

869
00:39:53,219 --> 00:39:49,809
supposed to move to try to to filter out

870
00:39:55,229 --> 00:39:53,229
that kind of stuff I have a quick

871
00:39:57,689 --> 00:39:55,239
follow-up to that if if you're open

872
00:40:02,339 --> 00:39:57,699
kortnee on facebook asks are there any

873
00:40:07,349 --> 00:40:02,349
areas that nicer will not analyze that's

874
00:40:12,120 --> 00:40:07,359
an excellent question yes in fact we are

875
00:40:15,630 --> 00:40:12,130
unable to reach the very North Pole with

876
00:40:20,069 --> 00:40:15,640
this particular orbit we can measure up

877
00:40:23,519 --> 00:40:20,079
to around 77 degrees north latitude with

878
00:40:24,150 --> 00:40:23,529
the current plan originally we were

879
00:40:26,789 --> 00:40:24,160
going to know

880
00:40:28,680 --> 00:40:26,799
are all the way up to around 82 or so

881
00:40:31,470 --> 00:40:28,690
degrees north latitude very close to the

882
00:40:34,980 --> 00:40:31,480
pole in the north but the science team

883
00:40:35,789 --> 00:40:34,990
made a decision to look only towards the

884
00:40:38,069 --> 00:40:35,799
South Pole

885
00:40:40,859 --> 00:40:38,079
so we image almost all of Antarctica

886
00:40:43,349 --> 00:40:40,869
continuously but we miss the sea ice in

887
00:40:47,069 --> 00:40:43,359
the very northern portion and of course

888
00:40:51,180 --> 00:40:47,079

we are not imaging the oceans we look at

889
00:40:55,559 --> 00:40:51,190
coasts and coastal processes but not the

890
00:40:57,359 --> 00:40:55,569
deep ocean and I can't say more about

891
00:40:58,890 --> 00:40:57,369
why we're not looking at the North if

892
00:41:01,440 --> 00:40:58,900
you want but I think that's probably

893
00:41:04,140 --> 00:41:01,450
enough we'll come back to it if we have

894
00:41:06,450 --> 00:41:04,150
time so I mean it's such an incredible

895
00:41:08,819 --> 00:41:06,460
mission so there's a lot to look forward

896
00:41:11,099 --> 00:41:08,829
to and I'm sure we could talk about nice

897
00:41:15,210 --> 00:41:11,109
are for the whole show but we wanted to

898
00:41:17,220 --> 00:41:15,220
talk a little bit about Delta X so let's

899
00:41:20,010 --> 00:41:17,230
come back down to earth so to speak and

900
00:41:22,260 --> 00:41:20,020
I know that's corny and and talk about

901
00:41:25,500 --> 00:41:22,270
our other earth science mission and

902
00:41:27,960 --> 00:41:25,510
Shannon so as our NASA Earth outreach

903
00:41:31,589 --> 00:41:27,970
specialist what do people need to know

904
00:41:35,760 --> 00:41:31,599
about Delta X absolutely if we can pull

905
00:41:37,680 --> 00:41:35,770
up image number 11 as a NASA JPL led

906
00:41:40,799 --> 00:41:37,690
mission Delta X is one of five earth

907
00:41:44,099 --> 00:41:40,809
ventures kicking off in 2020 over the

908
00:41:46,620 --> 00:41:44,109
last 80 years coastal Louisiana has lost

909
00:41:48,299 --> 00:41:46,630
some 2,000 square miles about five

910
00:41:50,400 --> 00:41:48,309
thousand square kilometres of wetlands

911
00:41:52,740 --> 00:41:50,410
roughly an area the size of the state

912
00:41:56,029 --> 00:41:52,750
state of Delaware or on average about

913
00:41:58,380 --> 00:41:56,039

one football field of land lost per hour

914
00:42:00,630 --> 00:41:58,390
to understand the Mississippi River

915
00:42:02,160 --> 00:42:00,640
Delta is one of the largest river deltas

916
00:42:04,859 --> 00:42:02,170
in the world and is gaining and losing

917
00:42:06,809 --> 00:42:04,869
land the Delta X mission will use

918
00:42:09,180 --> 00:42:06,819
airborne remote sensing and field

919
00:42:13,289 --> 00:42:09,190
in-situ measurements to look at the

920
00:42:15,240 --> 00:42:13,299
water vegetation and sediment soil Delta

921
00:42:17,609 --> 00:42:15,250
X is trying to understand some parts of

922
00:42:21,240 --> 00:42:17,619
the Delta losts and others that gain

923
00:42:22,440 --> 00:42:21,250
land what the role of vegetation and the

924
00:42:23,849 --> 00:42:22,450
channel networks and moving and

925
00:42:28,920 --> 00:42:23,859
retaining those sediments and building

926
00:42:30,960 --> 00:42:28,930
soil but why deltas they're home to half

927
00:42:32,910 --> 00:42:30,970
a billion people they're highly rich in

928
00:42:35,370 --> 00:42:32,920
productive lands acting as nurseries for

929
00:42:36,900 --> 00:42:35,380
fish crustaceans mammals and birds and

930
00:42:37,540 --> 00:42:36,910
they protect inland areas and

931
00:42:39,420 --> 00:42:37,550
infrastructures

932
00:42:41,440 --> 00:42:39,430
from winds and flooding during storms

933
00:42:43,000 --> 00:42:41,450
acting is the first line of defense

934
00:42:46,710 --> 00:42:43,010
against sea level rise the loss of

935
00:42:49,600 --> 00:42:46,720
Delta's will displace millions of people

936
00:42:51,870 --> 00:42:49,610
alright well thank you for stepping in

937
00:42:54,580 --> 00:42:51,880
there Shannon really appreciate you

938
00:42:56,920 --> 00:42:54,590

beefing up your knowledge about Delta X

939
00:42:58,810 --> 00:42:56,930
it really is an incredible mission and

940
00:43:01,140 --> 00:42:58,820
it's going to be making some very real

941
00:43:03,730 --> 00:43:01,150
scientific impact right here in the US

942
00:43:07,660 --> 00:43:03,740
when it gets underway in the near future

943
00:43:09,160 --> 00:43:07,670
so we've got these two really

944
00:43:10,810 --> 00:43:09,170
fascinating missions ones up in space

945
00:43:12,760 --> 00:43:10,820
once down closer to the air with the

946
00:43:16,090 --> 00:43:12,770
airplanes and the boats like Shannon

947
00:43:19,180 --> 00:43:16,100
showed Paul are there connections

948
00:43:21,820 --> 00:43:19,190
between these campaigns or ones like

949
00:43:25,810 --> 00:43:21,830
them are there overlaps between the

950
00:43:28,630 --> 00:43:25,820
science that they'll be doing now

951
00:43:32,350 --> 00:43:28,640
absolutely as I said much earlier in

952
00:43:35,740 --> 00:43:32,360
this broadcast Delta X is an example of

953
00:43:37,420 --> 00:43:35,750
a kind of measurement that we make from

954
00:43:40,290 --> 00:43:37,430
airborne systems that we wish we could

955
00:43:43,090 --> 00:43:40,300
make from space but we simply can't so

956
00:43:46,750 --> 00:43:43,100
Delta X I think has a radar component as

957
00:43:49,540 --> 00:43:46,760
well and it will fly over the Delta and

958
00:43:51,460 --> 00:43:49,550
measure these changes with a very rapid

959
00:43:54,400 --> 00:43:51,470
frequency and at higher resolution that

960
00:43:58,090 --> 00:43:54,410
what nice arc can do so we can use those

961
00:44:01,510 --> 00:43:58,100
kinds of observations as essentially

962
00:44:04,150 --> 00:44:01,520
validation and calibration of our space

963
00:44:06,430 --> 00:44:04,160

board measurements and help with the

964
00:44:10,060 --> 00:44:06,440
modeling because we can do a better time

965
00:44:13,210 --> 00:44:10,070
series analysis on these kinds of very

966
00:44:16,120 --> 00:44:13,220
fast-moving events from the airborne

967
00:44:18,970 --> 00:44:16,130
data and see how that matches with what

968
00:44:22,690 --> 00:44:18,980
we see from space so it's a very

969
00:44:27,670 --> 00:44:22,700
synergistic relationship we actually

970
00:44:31,990 --> 00:44:27,680
have an airborne prototype called called

971
00:44:34,980 --> 00:44:32,000
UAV SAR for the nice our mission which

972
00:44:38,470 --> 00:44:34,990
is radar with similar characteristics -

973
00:44:40,750 --> 00:44:38,480
- and isar but it also it flies all over

974
00:44:42,490 --> 00:44:40,760
the world taking same kinds of

975
00:44:44,680 --> 00:44:42,500
measurements but with this kind of

976
00:44:49,660 --> 00:44:44,690
airborne focus of fast repeat and

977
00:44:51,110 --> 00:44:49,670
high-resolution very cool so since Paul

978
00:44:56,870 --> 00:44:51,120
since these missions

979
00:45:00,010 --> 00:44:56,880
and many other there's a ding you're

980
00:45:04,400 --> 00:45:00,020
very popular since these merchants are

981
00:45:06,650 --> 00:45:04,410
are all about studying change this is

982
00:45:07,790 --> 00:45:06,660
questions a complete set up but I want

983
00:45:09,980 --> 00:45:07,800
to hear what you have to say about it

984
00:45:12,740 --> 00:45:09,990
how do you know you're ever really done

985
00:45:14,870 --> 00:45:12,750
I suspect the answer is that you're you

986
00:45:19,820 --> 00:45:14,880
aren't because you know earth is never

987
00:45:23,720 --> 00:45:19,830
gonna really stop changing right yeah

988
00:45:26,000 --> 00:45:23,730

that's right you probably are never done

989
00:45:27,800 --> 00:45:26,010
there's always more questions to ask

990
00:45:30,530 --> 00:45:27,810
every time that's the nature of science

991
00:45:31,820 --> 00:45:30,540
though right every time you think you've

992
00:45:35,180 --> 00:45:31,830
solved something you've modeled

993
00:45:37,280 --> 00:45:35,190
something you ask the next level of

994
00:45:39,700 --> 00:45:37,290
question think of Newtonian physics

995
00:45:42,350 --> 00:45:39,710
gravity and then going to special

996
00:45:44,660 --> 00:45:42,360
general relativity and trying to

997
00:45:47,210 --> 00:45:44,670
understand the nature of all forces you

998
00:45:49,040 --> 00:45:47,220
know with their science it's the same

999
00:45:51,260 --> 00:45:49,050
thing you're going to come up with a

1000
00:45:54,020 --> 00:45:51,270
model of the ice sheets and that will

1001
00:45:57,340 --> 00:45:54,030
help you predict sea-level rise but then

1002
00:46:00,260 --> 00:45:57,350
the next question is well what about the

1003
00:46:01,850 --> 00:46:00,270
friction on the on the base of that ice

1004
00:46:04,040 --> 00:46:01,860
sheet if we could only measure that a

1005
00:46:06,050 --> 00:46:04,050
little bit more accurately we could

1006
00:46:08,210 --> 00:46:06,060
really drive our model to the next level

1007
00:46:11,870 --> 00:46:08,220
of prediction and get the error bars

1008
00:46:13,610 --> 00:46:11,880
down on that climate climate model to

1009
00:46:18,230 --> 00:46:13,620
the future and be that much more precise

1010
00:46:20,930 --> 00:46:18,240
in how we respond to it and it's there's

1011
00:46:23,300 --> 00:46:20,940
always more questions to answer and this

1012
00:46:26,120 --> 00:46:23,310
seems like one mission begets the next

1013
00:46:27,650 --> 00:46:26,130

mission right you you you you answer the

1014
00:46:29,060 --> 00:46:27,660
questions that you've got as best you

1015
00:46:32,870 --> 00:46:29,070
can with the mission you're flying and

1016
00:46:35,630 --> 00:46:32,880
then there's a there's a a next a

1017
00:46:40,310 --> 00:46:35,640
follow-on that that kind of picks up the

1018
00:46:42,650 --> 00:46:40,320
mantle that's right and actually it

1019
00:46:45,260 --> 00:46:42,660
turns out NASA conducts through the

1020
00:46:49,070 --> 00:46:45,270
National Research Council decadal

1021
00:46:52,340 --> 00:46:49,080
surveys for their earth science plan for

1022
00:46:54,920 --> 00:46:52,350
their coming decade nice arse

1023
00:46:59,060 --> 00:46:54,930
a version of nice I was recommended back

1024
00:47:01,790 --> 00:46:59,070
in 2007 and 2017 a follow-on to nice our

1025
00:47:03,440 --> 00:47:01,800
was already recommended in order to

1026
00:47:04,200 --> 00:47:03,450
focus on exactly these kinds of

1027
00:47:06,630 --> 00:47:04,210
measurements of

1028
00:47:08,490 --> 00:47:06,640
long term because not only are they

1029
00:47:12,150 --> 00:47:08,500
important scientifically to keep that

1030
00:47:14,370 --> 00:47:12,160
time series going but it's also the side

1031
00:47:17,070 --> 00:47:14,380
benefits of studying landslides and

1032
00:47:20,070 --> 00:47:17,080
other hazards agriculture or

1033
00:47:22,380 --> 00:47:20,080
sustainability all of these things they

1034
00:47:24,900 --> 00:47:22,390
they just don't end and they are

1035
00:47:27,660 --> 00:47:24,910
practical applications of this sort of

1036
00:47:31,410 --> 00:47:27,670
whole earth imaging system that will be

1037
00:47:35,250 --> 00:47:31,420
there forever well I want to ask you

1038
00:47:38,040 --> 00:47:35,260

where the information the research goes

1039
00:47:40,320 --> 00:47:38,050
once it's collected so how does it get

1040
00:47:43,710 --> 00:47:40,330
communicated out from the nice our team

1041
00:47:45,990 --> 00:47:43,720
and the NASA folks you work with in a

1042
00:47:49,140 --> 00:47:46,000
way so as to make it useful and

1043
00:47:50,849 --> 00:47:49,150
impactful both for government

1044
00:47:53,780 --> 00:47:50,859
decision-makers and for the public at

1045
00:47:57,000 --> 00:47:53,790
large how do you how do you get it out

1046
00:48:00,329 --> 00:47:57,010
well that's a multi-faceted answer but

1047
00:48:03,000 --> 00:48:00,339
I'll try to keep it simple first of all

1048
00:48:05,520 --> 00:48:03,010
all of our data are free and open to the

1049
00:48:09,540 --> 00:48:05,530
public and they are placed on in an

1050
00:48:11,339 --> 00:48:09,550
archive that happens to be nominally

1051
00:48:14,010 --> 00:48:11,349
located in Alaska at the Alaska

1052
00:48:15,930 --> 00:48:14,020
satellite facility but for nice are we

1053
00:48:18,599 --> 00:48:15,940
will be the first mission to actually

1054
00:48:21,990 --> 00:48:18,609
use cloud-based data distribution

1055
00:48:25,470 --> 00:48:22,000
systems so the data may not be in Alaska

1056
00:48:27,990 --> 00:48:25,480
but it will be managed out of Alaska so

1057
00:48:31,260 --> 00:48:28,000
those all those data there will be

1058
00:48:35,930 --> 00:48:31,270
placed there that they can be taken by

1059
00:48:40,589 --> 00:48:35,940
any body any company or person for use

1060
00:48:44,339 --> 00:48:40,599
for example companies like Google or

1061
00:48:46,800 --> 00:48:44,349
Amazon will often take these data and

1062
00:48:51,480 --> 00:48:46,810
put them into their their search engines

1063
00:48:53,940 --> 00:48:51,490

for geospatial data sets the science is

1064
00:48:55,829 --> 00:48:53,950
done by anybody who wants to write a

1065
00:48:58,520 --> 00:48:55,839
science paper using these data sets

1066
00:49:01,740 --> 00:48:58,530
those are published in journals

1067
00:49:05,670 --> 00:49:01,750
typically and then there is the the

1068
00:49:07,620 --> 00:49:05,680
linkage to our other agencies and isar

1069
00:49:11,370 --> 00:49:07,630
is trying to do something a little bit

1070
00:49:14,940 --> 00:49:11,380
unique in terms of our relationship with

1071
00:49:17,480 --> 00:49:14,950
other agencies in that we are trying to

1072
00:49:19,580 --> 00:49:17,490
create the system not just as a side

1073
00:49:22,990 --> 00:49:19,590
system but also something that is a

1074
00:49:27,080 --> 00:49:23,000
let's say a prototype or a testbed for

1075
00:49:30,920 --> 00:49:27,090
urgent response associated with agencies

1076
00:49:33,920 --> 00:49:30,930
like FEMA or the USGS and in doing this

1077
00:49:36,020 --> 00:49:33,930
we are creating a low latency pathway

1078
00:49:39,320 --> 00:49:36,030
for data to go to those agencies and

1079
00:49:42,770 --> 00:49:39,330
look at things like earthquake damage or

1080
00:49:45,260 --> 00:49:42,780
volcanic damage or landslide damage

1081
00:49:48,680 --> 00:49:45,270
there quickly after an event so that can

1082
00:49:50,630 --> 00:49:48,690
actually be used in a quasi operational

1083
00:49:53,750 --> 00:49:50,640
way without making this an operational

1084
00:49:55,609 --> 00:49:53,760
mission so that's that's the way we go

1085
00:49:58,250 --> 00:49:55,619
about doing it is to try to build these

1086
00:50:01,540 --> 00:49:58,260
partnerships and look for pathways for

1087
00:50:05,270 --> 00:50:01,550
data pipelines into the agencies that's

1088
00:50:07,670 --> 00:50:05,280

fantastic so Shannon I'm sure you've

1089
00:50:10,400 --> 00:50:07,680
been collecting some questions so we've

1090
00:50:12,070 --> 00:50:10,410
got a few minutes left in our hour why

1091
00:50:14,060 --> 00:50:12,080
don't you go ahead and take it away and

1092
00:50:16,690 --> 00:50:14,070
throw some more of those great questions

1093
00:50:19,130 --> 00:50:16,700
at Paul from our online audience

1094
00:50:19,550 --> 00:50:19,140
absolutely so we have a couple for you

1095
00:50:21,740 --> 00:50:19,560
Paul

1096
00:50:23,630 --> 00:50:21,750
we have Robert on YouTube who asks how

1097
00:50:25,609 --> 00:50:23,640
do you decide what to explore on earth

1098
00:50:30,380 --> 00:50:25,619
and the universe as in how do you make

1099
00:50:34,940 --> 00:50:30,390
nice our omission so that's a good

1100
00:50:36,980 --> 00:50:34,950
question this is done through the

1101
00:50:39,980 --> 00:50:36,990
decadal survey process I mentioned

1102
00:50:43,190 --> 00:50:39,990
earlier science community is brought

1103
00:50:46,240 --> 00:50:43,200
together as a community and they meet

1104
00:50:49,220 --> 00:50:46,250
and make recommendations about what the

1105
00:50:51,980 --> 00:50:49,230
big topics are the big things that need

1106
00:50:53,990 --> 00:50:51,990
to be answered for societal benefit they

1107
00:50:58,220 --> 00:50:54,000
write a recommendation and NASA takes

1108
00:51:00,710 --> 00:50:58,230
that recommendation and decides which

1109
00:51:03,620 --> 00:51:00,720
missions they can do with which

1110
00:51:06,230 --> 00:51:03,630
technologies are ready to be applied to

1111
00:51:09,410 --> 00:51:06,240
those science questions and then they go

1112
00:51:12,710 --> 00:51:09,420
ahead and build the mission but you

1113
00:51:14,300 --> 00:51:12,720

mentioned a little quick that you had

1114
00:51:16,520 --> 00:51:14,310
been trying to get this mission going

1115
00:51:18,650 --> 00:51:16,530
for a long time right I mean the the

1116
00:51:20,930 --> 00:51:18,660
dream of doing a mission like nice are a

1117
00:51:27,349 --> 00:51:20,940
nice R has been it's been around for a

1118
00:51:29,390 --> 00:51:27,359
while right yes um I first I wrote my

1119
00:51:29,890 --> 00:51:29,400
first proposal for a nicer like mission

1120
00:51:33,760 --> 00:51:29,900
and Knight

1121
00:51:36,730 --> 00:51:33,770
94 let's put it that way and often it

1122
00:51:39,579 --> 00:51:36,740
takes a long time for these missions to

1123
00:51:42,370 --> 00:51:39,589
come to reality at that time there had

1124
00:51:43,720 --> 00:51:42,380
not been a decadal survey recommending

1125
00:51:46,510 --> 00:51:43,730
this particular mission and the

1126
00:51:50,680 --> 00:51:46,520
technology might argue was perhaps not

1127
00:51:52,779 --> 00:51:50,690
as mature as it is now so NASA in their

1128
00:51:55,829 --> 00:51:52,789
wisdom chose to wait until the

1129
00:51:58,390 --> 00:51:55,839
technology matured and the community was

1130
00:52:03,700 --> 00:51:58,400
clamoring for these observations before

1131
00:52:05,769 --> 00:52:03,710
they decided to fund it so I got another

1132
00:52:07,690 --> 00:52:05,779
one for ya so I know nicer hasn't

1133
00:52:09,010 --> 00:52:07,700
launched yet but with some of the other

1134
00:52:10,529 --> 00:52:09,020
missions that you've worked on and data

1135
00:52:12,789 --> 00:52:10,539
that you've seen what are the major

1136
00:52:14,200 --> 00:52:12,799
marcelo' on Facebook asked what are the

1137
00:52:18,940 --> 00:52:14,210
major differences that you guys have

1138
00:52:20,740 --> 00:52:18,950

seen from the last ten years and now I'm

1139
00:52:22,900 --> 00:52:20,750
sorry I missed the beginning part of it

1140
00:52:25,329 --> 00:52:22,910
with the differences in what between the

1141
00:52:26,950 --> 00:52:25,339
last ten years and now the earth Justin

1142
00:52:28,510 --> 00:52:26,960
yeah and earth and anything that we've

1143
00:52:30,519 --> 00:52:28,520
seen on earth or measured on earth if

1144
00:52:33,279 --> 00:52:30,529
you want to pick a specific scientific

1145
00:52:34,720 --> 00:52:33,289
study maybe something that applied that

1146
00:52:37,299 --> 00:52:34,730
you'll be looking at with nice are that

1147
00:52:40,269 --> 00:52:37,309
you've really been seeing changing in

1148
00:52:43,000 --> 00:52:40,279
the last decade or so certainly I saw I

1149
00:52:45,609 --> 00:52:43,010
think yeah I think the ice sheets is

1150
00:52:47,230 --> 00:52:45,619
really what I'm what I would focus on

1151
00:52:48,730 --> 00:52:47,240
here because they are changing quite

1152
00:52:50,170 --> 00:52:48,740
dramatically and our understanding of

1153
00:52:53,980 --> 00:52:50,180
the ice sheets is changing quite

1154
00:52:55,839 --> 00:52:53,990
dramatically as we as we make these

1155
00:52:57,789 --> 00:52:55,849
observations I'm sorry about the dinging

1156
00:53:01,150 --> 00:52:57,799
my wife is texting my children and I

1157
00:53:12,210 --> 00:53:01,160
thought I turned off the the message app

1158
00:53:16,180 --> 00:53:12,220
but I guess I didn't yeah another one

1159
00:53:21,069 --> 00:53:16,190
for yeah so with the current world

1160
00:53:22,720 --> 00:53:21,079
situation coupe on Facebook asks what

1161
00:53:24,760 --> 00:53:22,730
data points does this give us that we

1162
00:53:29,859 --> 00:53:24,770
may not have been otherwise been able to

1163
00:53:32,819 --> 00:53:29,869

get are we talking the current situation

1164
00:53:35,829 --> 00:53:32,829
meaning the coronavirus situation or

1165
00:53:37,599 --> 00:53:35,839
with with with people sort of staying

1166
00:53:39,010 --> 00:53:37,609
inside is it giving us different data

1167
00:53:41,740 --> 00:53:39,020
points that we wouldn't normally be able

1168
00:53:44,099 --> 00:53:41,750
to get in any other situation yes it's

1169
00:53:47,140 --> 00:53:44,109
actually very fascinating

1170
00:53:49,390 --> 00:53:47,150
nice R itself is a radar it doesn't

1171
00:53:53,440 --> 00:53:49,400
measure the atmosphere but already we

1172
00:53:55,270 --> 00:53:53,450
are seeing the impacts on the earth by

1173
00:53:57,780 --> 00:53:55,280
having people staying inside not

1174
00:54:01,480 --> 00:53:57,790
traveling as much the air is cleaner

1175
00:54:03,849 --> 00:54:01,490
their congestion is lower

1176
00:54:06,730 --> 00:54:03,859
I've seen some radar images actually

1177
00:54:10,150 --> 00:54:06,740
over the last several months where

1178
00:54:13,120 --> 00:54:10,160
construction sites which you can see has

1179
00:54:17,500 --> 00:54:13,130
sort of in a change map setting

1180
00:54:22,020 --> 00:54:17,510
construction sites have stopped working

1181
00:54:25,870 --> 00:54:22,030
so you can actually track the impacts of

1182
00:54:28,390 --> 00:54:25,880
humans and their behaviors over this

1183
00:54:31,510 --> 00:54:28,400
cycle and and if this continues for a

1184
00:54:35,260 --> 00:54:31,520
year or so which it may very well at

1185
00:54:38,410 --> 00:54:35,270
some level we can really understand it's

1186
00:54:40,210 --> 00:54:38,420
almost like an experiment in ways in a

1187
00:54:42,550 --> 00:54:40,220
way where you have a stimulus which

1188
00:54:44,890 --> 00:54:42,560

happens to be in this case people

1189
00:54:48,099 --> 00:54:44,900
staying at home and then you can see how

1190
00:54:49,480 --> 00:54:48,109
the earth responds to it using the all

1191
00:54:52,660 --> 00:54:49,490
the satellites that are up there it's

1192
00:54:54,160 --> 00:54:52,670
really quite quite astounding it will be

1193
00:54:55,960 --> 00:54:54,170
very interesting we don't really know

1194
00:54:58,000 --> 00:54:55,970
yet because that we're still early in

1195
00:54:59,890 --> 00:54:58,010
the whole cycle but about a year from

1196
00:55:07,030 --> 00:54:59,900
now you'll see some amazing results

1197
00:55:08,770 --> 00:55:07,040
coming out I think so a question from

1198
00:55:11,200 --> 00:55:08,780
gnome qualm on youtube asks how long

1199
00:55:12,339 --> 00:55:11,210
will it take to process nice our data I

1200
00:55:14,050 --> 00:55:12,349
know we've talked about this in some

1201
00:55:15,849 --> 00:55:14,060
conversations with each other about how

1202
00:55:17,950 --> 00:55:15,859
large the data coming down from nice R

1203
00:55:19,390 --> 00:55:17,960
is so how long is that going to take to

1204
00:55:23,740 --> 00:55:19,400
process for people to start their

1205
00:55:26,819 --> 00:55:23,750
research it will only take a day or two

1206
00:55:31,240 --> 00:55:26,829
for the data to go from the satellite to

1207
00:55:33,819 --> 00:55:31,250
the archive there is about a five or six

1208
00:55:35,640 --> 00:55:33,829
month period when we will be fiddling

1209
00:55:38,140 --> 00:55:35,650
with the data to make sure it's right

1210
00:55:39,880 --> 00:55:38,150
the data those data will still be

1211
00:55:42,670 --> 00:55:39,890
available quickly but they may get

1212
00:55:45,940 --> 00:55:42,680
reprocessed after six months or so but

1213
00:55:49,120 --> 00:55:45,950

once once the firehose firehose of data

1214
00:55:53,650 --> 00:55:49,130
starts after about three months after

1215
00:55:55,450 --> 00:55:53,660
launch that fire hose is ready with lots

1216
00:55:56,740 --> 00:55:55,460
and lots of data with a latency of just

1217
00:55:58,840 --> 00:55:56,750
a couple days

1218
00:56:01,060 --> 00:55:58,850
well did you did you I mean if I missed

1219
00:56:03,780 --> 00:56:01,070
it I apologize but did you tell us that

1220
00:56:08,560 --> 00:56:03,790
huge number that it was something with

1221
00:56:10,120 --> 00:56:08,570
ridiculous amount of data first year you

1222
00:56:11,800 --> 00:56:10,130
told us and when we first started

1223
00:56:12,910 --> 00:56:11,810
talking about this what what what is the

1224
00:56:14,070 --> 00:56:12,920
amount of data you're going to be

1225
00:56:18,010 --> 00:56:14,080
pulling down with this thing

1226
00:56:21,160 --> 00:56:18,020
so we it's hard to put it in terms of

1227
00:56:24,820 --> 00:56:21,170
that most people I think could actually

1228
00:56:28,450 --> 00:56:24,830
imagine but it's basically one petabyte

1229
00:56:32,770 --> 00:56:28,460
of raw data per year petabyte not not

1230
00:56:35,500 --> 00:56:32,780
the CD is what 650 megabytes or

1231
00:56:37,270 --> 00:56:35,510
something like that DVD is 5 gigabyte

1232
00:56:39,430 --> 00:56:37,280
this is a petabyte which is several

1233
00:56:41,530 --> 00:56:39,440
orders of magnitude above those and

1234
00:56:43,510 --> 00:56:41,540
that's just the raw data after we

1235
00:56:47,170 --> 00:56:43,520
process the data it cuts to something

1236
00:56:49,630 --> 00:56:47,180
more like 50 to 100 petabytes though

1237
00:56:51,880 --> 00:56:49,640
it's a huge amount of data by the

1238
00:56:54,160 --> 00:56:51,890

standard it's in fact if you take all of

1239
00:56:56,620 --> 00:56:54,170
nasa's previous missions including

1240
00:56:59,920 --> 00:56:56,630
planetary and space and add them all up

1241
00:57:01,990 --> 00:56:59,930
this is still about a factor of i think

1242
00:57:05,200 --> 00:57:02,000
10 greater than all of that other data

1243
00:57:07,720 --> 00:57:05,210
so it's a very large amount it's amazing

1244
00:57:12,700 --> 00:57:07,730
truly amazing but we don't process it

1245
00:57:15,370 --> 00:57:12,710
and we've shell that is good news well

1246
00:57:18,070 --> 00:57:15,380
we're getting the end of our time but

1247
00:57:21,640 --> 00:57:18,080
before we wrap up we have something kind

1248
00:57:24,910 --> 00:57:21,650
of special to share with you in advance

1249
00:57:27,070 --> 00:57:24,920
of Earth Day when we all try to think

1250
00:57:31,000 --> 00:57:27,080
more about our share and responsibility

1251
00:57:33,220 --> 00:57:31,010
to care for our planet Shannon and

1252
00:57:35,800 --> 00:57:33,230
Shannon here asked some friends to

1253
00:57:37,330 --> 00:57:35,810
answer a question for us so that we

1254
00:57:39,160 --> 00:57:37,340
could share their responses and we asked

1255
00:57:43,180 --> 00:57:39,170
them what does it mean to care for

1256
00:57:45,400 --> 00:57:43,190
something here's what they had to say hi

1257
00:57:47,110 --> 00:57:45,410
Dan Shannon from NASA earth and as we

1258
00:57:49,180 --> 00:57:47,120
observed the 50th anniversary of Earth

1259
00:57:51,160 --> 00:57:49,190
Day of this amazing beautiful planet of

1260
00:57:53,560 --> 00:57:51,170
ours we wanted some of our friends to

1261
00:57:55,840 --> 00:57:53,570
join into the conversation so we had a

1262
00:58:00,160 --> 00:57:55,850
question for them what do you think it

1263
00:58:03,070 --> 00:58:00,170

means to care for something I think what

1264
00:58:04,160 --> 00:58:03,080
it means to care for something is to

1265
00:58:09,620 --> 00:58:04,170
protect it

1266
00:58:13,910 --> 00:58:09,630
and to make it flourish to love lot of

1267
00:58:16,070 --> 00:58:13,920
people for something for you to care for

1268
00:58:19,130 --> 00:58:16,080
something that mean you will treat it

1269
00:58:22,280 --> 00:58:19,140
like a certain baby like you treated

1270
00:58:26,540 --> 00:58:22,290
special means giving my unconditional

1271
00:58:29,740 --> 00:58:26,550
time effort emotional commitment I think

1272
00:58:34,780 --> 00:58:29,750
it means to take care of them and to

1273
00:58:41,000 --> 00:58:38,330
if to take care of it you have to do

1274
00:58:44,300 --> 00:58:41,010
water and Sun and make sure it glows

1275
00:58:49,790 --> 00:58:44,310
grows well it means life to us it means

1276
00:58:53,150 --> 00:58:49,800
when you show like affection or love if

1277
00:58:56,480 --> 00:58:53,160
it's a thing you're you're responsible

1278
00:58:58,309 --> 00:58:56,490
with it when you take care of something

1279
00:59:00,229 --> 00:58:58,319
else

1280
00:59:12,030 --> 00:59:00,239
you connect to something greater than

1281
00:59:20,849 --> 00:59:15,730
well that is outstanding any thoughts on

1282
00:59:24,609 --> 00:59:20,859
that from you guys I mean Shannon

1283
00:59:26,170 --> 00:59:24,619
beautiful yeah celebrate Earth Day just

1284
00:59:29,710 --> 00:59:26,180
remember to take care of our pale blue

1285
00:59:32,319 --> 00:59:29,720
dot and what were you thinking there

1286
00:59:34,299 --> 00:59:32,329
Paul is this gonna say for me when I

1287
00:59:38,410 --> 00:59:34,309
when I thought about this I thought

1288
00:59:41,500 --> 00:59:38,420

respect caring and respect are highly

1289
00:59:45,450 --> 00:59:41,510
related we need to respect our planet to

1290
00:59:47,650 --> 00:59:45,460
take care of it so I think I

1291
00:59:50,380 --> 00:59:47,660
wholeheartedly agree I like how the

1292
00:59:52,450 --> 00:59:50,390
first young person put it that to care

1293
00:59:54,579 --> 00:59:52,460
for something means to protect it but

1294
00:59:56,680 --> 00:59:54,589
also to make it flourish I love that

1295
01:00:00,220 --> 00:59:56,690
well thank you Shannon for putting that

1296
01:00:02,230 --> 01:00:00,230
video together all right well that is a

1297
01:00:04,839 --> 01:00:02,240
great place for us to end this month I

1298
01:00:07,359 --> 01:00:04,849
want to thank Paul Rosen for being with

1299
01:00:09,640 --> 01:00:07,369
us Paul good luck to you and your nice

1300
01:00:11,230 --> 01:00:09,650
our team with the mission and keeping it

1301
01:00:15,460 --> 01:00:11,240
on track during these really

1302
01:00:17,020 --> 01:00:15,470
extraordinary times and thank you

1303
01:00:19,359 --> 01:00:17,030
Shannon for E for helping with the

1304
01:00:21,520 --> 01:00:19,369
questions from our live audience and

1305
01:00:23,410 --> 01:00:21,530
thank you all of you for for watching

1306
01:00:26,260 --> 01:00:23,420
and for submitting your questions and

1307
01:00:28,240 --> 01:00:26,270
again if you'd like information and

1308
01:00:30,970 --> 01:00:28,250
resources from NASA related to Earth Day

1309
01:00:34,900 --> 01:00:30,980
you can go to nasa.gov slash Earth Day

1310
01:00:36,400 --> 01:00:34,910
for a whole slew of materials now and

1311
01:00:38,620 --> 01:00:36,410
over the next several days as we reach

1312
01:00:43,299 --> 01:00:38,630
the 50th anniversary of Earth Day on

1313
01:00:46,770 --> 01:00:43,309

April 22nd okay now remember everybody

1314
01:00:49,539 --> 01:00:46,780
deep breath we're all in this together

1315
01:00:52,510 --> 01:00:49,549
we're hurtling through space on our pale

1316
01:00:54,579 --> 01:00:52,520
blue dot as shannon mentioned and for

1317
01:00:58,839 --> 01:00:54,589
half a century now we have had an annual

1318
01:01:02,260 --> 01:00:58,849
reminder on Earth Day that caring for

1319
01:01:06,309 --> 01:01:02,270
our home planet and all of us on it is

1320
01:01:07,480 --> 01:01:06,319
something that we do together all right

1321
01:01:09,700 --> 01:01:07,490
that's all for this month

1322
01:01:11,980 --> 01:01:09,710
note that we do plan to bring you our

1323
01:01:14,049 --> 01:01:11,990
scheduled show for May which is on

1324
01:01:15,789 --> 01:01:14,059
becoming a NASA engineer and that'll be

1325
01:01:17,440 --> 01:01:15,799
hosted by my colleague Brian White and

1326
01:01:19,280 --> 01:01:17,450
he'll be talking with the wonderful

1327
01:01:22,550 --> 01:01:19,290
Traci drain so

1328
01:01:28,720 --> 01:01:22,560
for that if you can until then stay safe