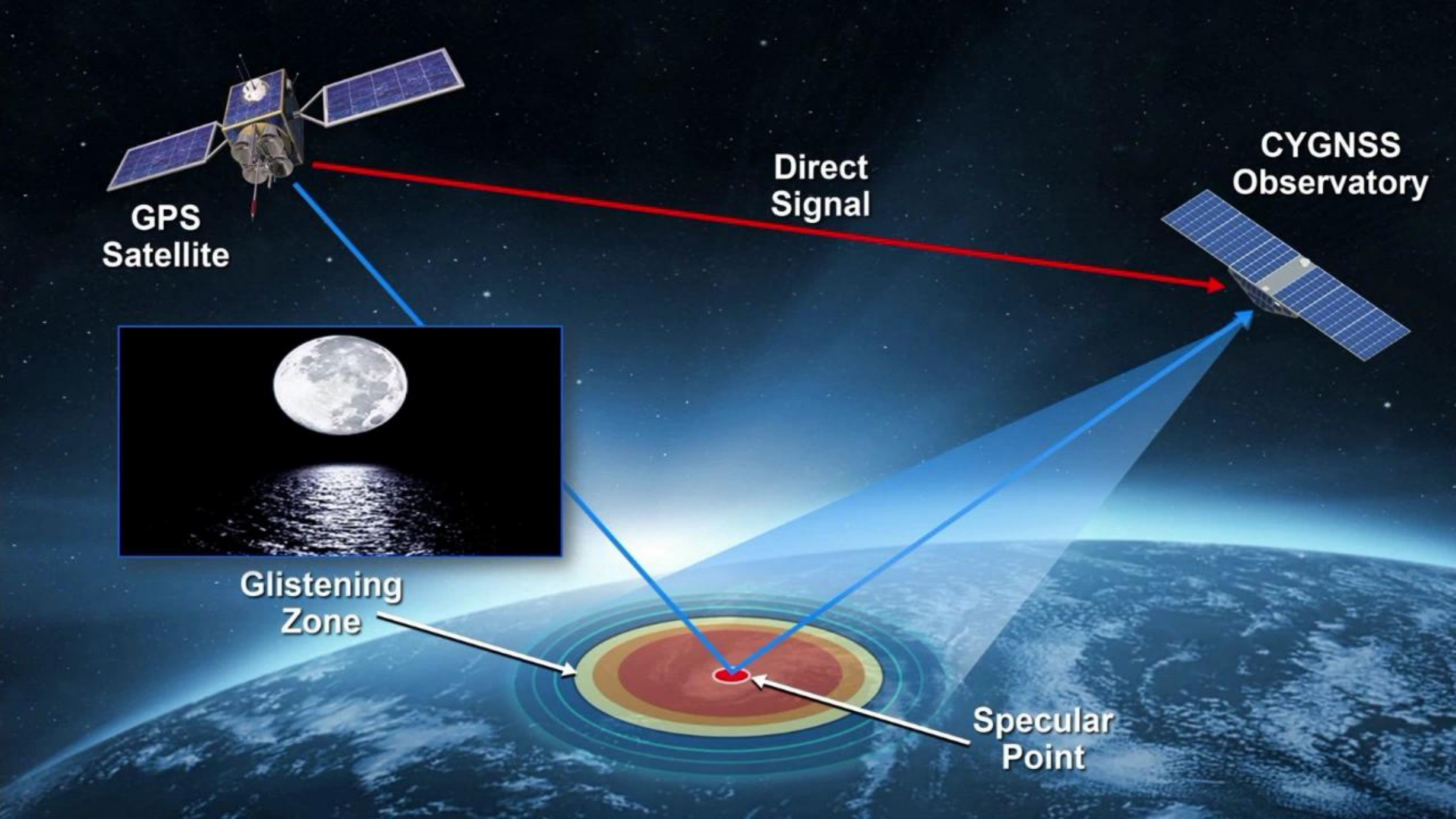
GPS
Satellite
Direct
Signal
CYGNSS
Observatory
Glistening
Zone
Specular
Point

1
00:00:05,430 --> 00:00:30,870
[Music]

2
00:00:35,190 --> 00:00:32,549
good afternoon and welcome to nasa's

3
00:00:37,270 --> 00:00:35,200
kennedy space center in florida

4
00:00:39,510 --> 00:00:37,280
we're here for the mission science

5
00:00:41,670 --> 00:00:39,520
briefing as part of nasa's

6
00:00:43,590 --> 00:00:41,680
cyclone global navigation satellite

7
00:00:45,510 --> 00:00:43,600
system mission otherwise known as cygnus

8
00:00:46,709 --> 00:00:45,520
i'm sean potter from nasa's office of

9
00:00:49,910 --> 00:00:46,719
communication i'd like to welcome

10
00:00:51,830 --> 00:00:49,920
everybody here today with me are three

11
00:00:53,670 --> 00:00:51,840
scientists who are working on this

12
00:00:56,470 --> 00:00:53,680
mission all from the university of

13
00:00:59,430 --> 00:00:56,480

michigan's department of climate and

14
00:01:01,029 --> 00:00:59,440
space sciences and engineering

15
00:01:02,470 --> 00:01:01,039
at the university of michigan in ann

16
00:01:03,510 --> 00:01:02,480
arbor i'm going to introduce them to you

17
00:01:05,830 --> 00:01:03,520
and then they've got some opening

18
00:01:08,070 --> 00:01:05,840
remarks and we'll take some questions

19
00:01:10,789 --> 00:01:08,080
after that so immediately to my left is

20
00:01:13,590 --> 00:01:10,799
dr chris ruff he is the principal

21
00:01:16,469 --> 00:01:13,600
investigator of the cygnus mission

22
00:01:19,109 --> 00:01:16,479
next to him is aaron ridley he is the

23
00:01:21,429 --> 00:01:19,119
cygnus constellation scientist

24
00:01:24,149 --> 00:01:21,439
and immediately to his left we have mary

25
00:01:27,749 --> 00:01:24,159
morris who is a phd student working with

26
00:01:29,270 --> 00:01:27,759
dr ruff on applications from cygnus data

27
00:01:31,590 --> 00:01:29,280
and they all have some exciting

28
00:01:34,149 --> 00:01:31,600
information to share with you about how

29
00:01:36,390 --> 00:01:34,159
this mission will work and some of the

30
00:01:39,190 --> 00:01:36,400
incredible science that it promises to

31
00:01:41,350 --> 00:01:39,200
bring us and the hurricane forecast

32
00:01:42,630 --> 00:01:41,360
community so we'll start things off with

33
00:01:46,069 --> 00:01:42,640
chris ruff

34
00:01:48,069 --> 00:01:46,079
chris thanks sean um yeah so i wanted to

35
00:01:49,990 --> 00:01:48,079
um start by giving a little bit of

36
00:01:50,870 --> 00:01:50,000
background sort of sets the stage for

37
00:01:52,789 --> 00:01:50,880
what

38
00:01:55,749 --> 00:01:52,799

cygnus is doing and why it's doing it so

39
00:01:56,950 --> 00:01:55,759
cygnus is designed to measure

40
00:01:59,270 --> 00:01:56,960
the winds

41
00:02:02,630 --> 00:01:59,280
over the ocean in hurricanes and i

42
00:02:04,789 --> 00:02:02,640
wanted to first give you examples of

43
00:02:07,030 --> 00:02:04,799
how we measure winds from space over the

44
00:02:09,029 --> 00:02:07,040
ocean today and then how we measure

45
00:02:10,869 --> 00:02:09,039
winds in hurricanes today so if i could

46
00:02:13,030 --> 00:02:10,879
have the first slide yeah so here's an

47
00:02:15,670 --> 00:02:13,040
example of how we measure winds over the

48
00:02:18,790 --> 00:02:15,680
ocean from space today this is a the

49
00:02:21,030 --> 00:02:18,800
nasa trim satellite on the left and then

50
00:02:23,589 --> 00:02:21,040
some of its data products on the right

51
00:02:26,470 --> 00:02:23,599
the top image on the right is the

52
00:02:28,150 --> 00:02:26,480
precipitation data product the rain rate

53
00:02:29,830 --> 00:02:28,160
and the one on the bottom is the wind

54
00:02:32,790 --> 00:02:29,840
over the ocean so trim can measure wind

55
00:02:35,190 --> 00:02:32,800
over the ocean as can cygnus

56
00:02:36,550 --> 00:02:35,200
there's two important characteristics of

57
00:02:38,710 --> 00:02:36,560
these data

58
00:02:39,589 --> 00:02:38,720
that point to current limitations that

59
00:02:41,990 --> 00:02:39,599
we're

60
00:02:44,309 --> 00:02:42,000
planning to overcome with cygnus the

61
00:02:46,070 --> 00:02:44,319
first one is if you look at the

62
00:02:48,309 --> 00:02:46,080
places in the top image where there's

63
00:02:49,910 --> 00:02:48,319

heavy rain particularly near the equator

64
00:02:51,270 --> 00:02:49,920
in the itcz

65
00:02:53,030 --> 00:02:51,280
if you look at the same spot in the

66
00:02:55,190 --> 00:02:53,040
lower image measuring the wind you'll

67
00:02:57,350 --> 00:02:55,200
see that the winds are black there and

68
00:02:59,270 --> 00:02:57,360
the reason for that is the this

69
00:03:01,030 --> 00:02:59,280
satellite as every other satellite up

70
00:03:02,710 --> 00:03:01,040
there now cannot measure wind through

71
00:03:04,149 --> 00:03:02,720
heavy rain that's a fundamental

72
00:03:05,830 --> 00:03:04,159
limitation with these types of

73
00:03:07,750 --> 00:03:05,840
measurements and the reason for that is

74
00:03:09,589 --> 00:03:07,760
the wavelengths that they operate at a

75
00:03:12,470 --> 00:03:09,599
trim operates at an eight millimeter

76
00:03:14,550 --> 00:03:12,480
wavelength and uh raindrops are

77
00:03:16,390 --> 00:03:14,560
typically one to five millimeters in

78
00:03:18,149 --> 00:03:16,400
heavy rain and if the raindrops are

79
00:03:20,630 --> 00:03:18,159
comparable in size to the wavelength of

80
00:03:22,070 --> 00:03:20,640
the electromagnetic waves you get a lot

81
00:03:23,509 --> 00:03:22,080
of scattering a lot of absorption and

82
00:03:25,670 --> 00:03:23,519
you can't penetrate through so we just

83
00:03:27,190 --> 00:03:25,680
can't measure wind under heavy rain from

84
00:03:29,670 --> 00:03:27,200
space that's one limitation the other

85
00:03:30,869 --> 00:03:29,680
one if you look at the captions to these

86
00:03:32,550 --> 00:03:30,879
two images

87
00:03:35,350 --> 00:03:32,560
you'll see these are three day data

88
00:03:38,309 --> 00:03:35,360

products and what that means is the uh

89
00:03:39,910 --> 00:03:38,319
the satellite um orbit takes three days

90
00:03:41,670 --> 00:03:39,920
to come back around the same place so it

91
00:03:44,149 --> 00:03:41,680
takes three days to make a complete

92
00:03:46,309 --> 00:03:44,159
measurement of the entire earth and this

93
00:03:48,869 --> 00:03:46,319
is fine for a lot of applications but

94
00:03:50,309 --> 00:03:48,879
for extreme weather situations like

95
00:03:52,550 --> 00:03:50,319
hurricanes where

96
00:03:54,630 --> 00:03:52,560
things change on the time scale of hours

97
00:03:56,229 --> 00:03:54,640
to maybe a day if you make a new

98
00:03:58,229 --> 00:03:56,239
measurement once every three days it's

99
00:04:00,869 --> 00:03:58,239
very likely that you'll miss important

100
00:04:02,149 --> 00:04:00,879
parts of the evolution of the storm so

101
00:04:03,670 --> 00:04:02,159
those are the two things that we're

102
00:04:05,350 --> 00:04:03,680
trying to overcome with cygnus

103
00:04:06,550 --> 00:04:05,360
measurement through rain and measurement

104
00:04:08,789 --> 00:04:06,560
more often

105
00:04:10,229 --> 00:04:08,799
in hours instead of days

106
00:04:12,309 --> 00:04:10,239
if you go to the next we go to the next

107
00:04:14,949 --> 00:04:12,319
slide here's an example of how we can

108
00:04:17,749 --> 00:04:14,959
measure winds today in hurricanes

109
00:04:19,670 --> 00:04:17,759
this is a an instrument called the sfmr

110
00:04:22,069 --> 00:04:19,680
in the lower left there and it's

111
00:04:23,510 --> 00:04:22,079
installed on the noaa p3 hurricane

112
00:04:25,749 --> 00:04:23,520
hunter airplane so these are airplanes

113
00:04:27,670 --> 00:04:25,759

that fly directly into storms into

114
00:04:29,670 --> 00:04:27,680
hurricanes and they can make

115
00:04:31,670 --> 00:04:29,680
measurements of the ocean surface in

116
00:04:33,510 --> 00:04:31,680
heavy precip um in particular in

117
00:04:35,909 --> 00:04:33,520
hurricanes and the way they do this is

118
00:04:37,990 --> 00:04:35,919
they operate at a much longer wavelength

119
00:04:39,670 --> 00:04:38,000
uh sfmrr operates at about a five

120
00:04:43,110 --> 00:04:39,680
centimeter wavelength which is about 10

121
00:04:44,550 --> 00:04:43,120
times the size of a of a raindrop and

122
00:04:46,790 --> 00:04:44,560
in this case there's some interaction

123
00:04:48,870 --> 00:04:46,800
with the rain but not total attenuation

124
00:04:50,390 --> 00:04:48,880
so you get some interaction with the

125
00:04:53,110 --> 00:04:50,400
rain and you get some interaction with

126
00:04:54,790 --> 00:04:53,120
the surface and by analyzing the data

127
00:04:57,430 --> 00:04:54,800
properly you can correct for the rain

128
00:04:58,950 --> 00:04:57,440
attenuation and measure the wind

129
00:05:01,510 --> 00:04:58,960
and if we go to the next slide this is

130
00:05:04,390 --> 00:05:01,520
an example of a data product measured by

131
00:05:07,510 --> 00:05:04,400
the the noaa p3 hurricane hunter when it

132
00:05:09,430 --> 00:05:07,520
made an overpass of hurricane katrina

133
00:05:11,430 --> 00:05:09,440
about a day before landfall

134
00:05:13,110 --> 00:05:11,440
so there's a an image in the top left of

135
00:05:16,150 --> 00:05:13,120
katrina and if you look closely you can

136
00:05:18,070 --> 00:05:16,160
see a black arrow through the eye that's

137
00:05:20,310 --> 00:05:18,080
the flight line of the airplane and then

138
00:05:21,990 --> 00:05:20,320

in the lower right is the data that were

139
00:05:24,550 --> 00:05:22,000
that was measured to the retrievals that

140
00:05:25,749 --> 00:05:24,560
were estimated from the data during that

141
00:05:27,590 --> 00:05:25,759
overpass

142
00:05:29,350 --> 00:05:27,600
and you can see both the

143
00:05:31,110 --> 00:05:29,360
the rain rate that's retrieved as a

144
00:05:32,629 --> 00:05:31,120
secondary parameter to correct for its

145
00:05:34,469 --> 00:05:32,639
interaction and then the primary

146
00:05:36,230 --> 00:05:34,479
measurement of the wind speed itself you

147
00:05:38,070 --> 00:05:36,240
can see the maximum winds occurring on

148
00:05:39,990 --> 00:05:38,080
the eye wall where the rain is heaviest

149
00:05:41,670 --> 00:05:40,000
and then there's calm winds in the uh in

150
00:05:43,830 --> 00:05:41,680
the eye of the storm

151
00:05:45,909 --> 00:05:43,840
and so it's important note here that

152
00:05:47,590 --> 00:05:45,919
these measurements are made directly

153
00:05:49,270 --> 00:05:47,600
under the airplane only and you need to

154
00:05:50,710 --> 00:05:49,280
fly an airplane out there to make these

155
00:05:53,189 --> 00:05:50,720
measurements so what we're trying to do

156
00:05:55,350 --> 00:05:53,199
with cygnus is combine the global

157
00:05:57,270 --> 00:05:55,360
coverage that you get from a satellite

158
00:05:58,710 --> 00:05:57,280
with the ability to penetrate through

159
00:06:00,550 --> 00:05:58,720
the rain that you get with one of these

160
00:06:02,390 --> 00:06:00,560
hurricane hunter instruments

161
00:06:03,830 --> 00:06:02,400
and and also

162
00:06:05,830 --> 00:06:03,840
improve upon the sampling

163
00:06:07,110 --> 00:06:05,840

characteristics of the the large weather

164
00:06:09,590 --> 00:06:07,120
satellites that take three days to

165
00:06:11,350 --> 00:06:09,600
revisit and and the way to do that is to

166
00:06:13,350 --> 00:06:11,360
operate at long enough wavelengths to

167
00:06:15,350 --> 00:06:13,360
penetrate through the rain and in order

168
00:06:17,029 --> 00:06:15,360
to improve the sampling uh more often

169
00:06:19,189 --> 00:06:17,039
than every few days we need a lot of

170
00:06:21,029 --> 00:06:19,199
satellites and the way to do that in a

171
00:06:22,390 --> 00:06:21,039
cost-cap mission is to make things

172
00:06:24,230 --> 00:06:22,400
cheaper so that you can afford to build

173
00:06:26,550 --> 00:06:24,240
a lot of satellites and that leads me to

174
00:06:28,790 --> 00:06:26,560
the next slide which illustrates the way

175
00:06:30,390 --> 00:06:28,800
we make these measurements so

176
00:06:32,469 --> 00:06:30,400
as you heard in the uh the engineering

177
00:06:35,510 --> 00:06:32,479
briefing earlier

178
00:06:37,749 --> 00:06:35,520
cygnus is basically the receive half of

179
00:06:40,309 --> 00:06:37,759
a radar and the transmit half of the

180
00:06:42,629 --> 00:06:40,319
radar is the gps constellation of

181
00:06:44,469 --> 00:06:42,639
navigation satellites so there's uh 30

182
00:06:46,309 --> 00:06:44,479
gps satellites up there now and they're

183
00:06:47,990 --> 00:06:46,319
constantly transmitting their uh their

184
00:06:49,990 --> 00:06:48,000
signals down to the earth for navigation

185
00:06:52,070 --> 00:06:50,000
purposes they're intentionally designed

186
00:06:54,950 --> 00:06:52,080
to operate at a very long wavelength 19

187
00:06:56,629 --> 00:06:54,960
centimeters uh in order to um be able to

188
00:06:58,390 --> 00:06:56,639

have navigation work when it's raining

189
00:06:59,990 --> 00:06:58,400
heavy like for example when you're

190
00:07:01,270 --> 00:07:00,000
driving in your car your navigation

191
00:07:02,790 --> 00:07:01,280
system works just fine when there's

192
00:07:05,430 --> 00:07:02,800
heavy rain because because it operates

193
00:07:06,950 --> 00:07:05,440
at such a long wavelength so the gps

194
00:07:08,390 --> 00:07:06,960
transmitters are there or the signals

195
00:07:10,629 --> 00:07:08,400
are there all the time and what we've

196
00:07:13,110 --> 00:07:10,639
done with cygnus is we've taken a

197
00:07:15,029 --> 00:07:13,120
commercial navigation receiver and

198
00:07:16,710 --> 00:07:15,039
essentially hacked into it and modified

199
00:07:19,189 --> 00:07:16,720
its processor so that it does both

200
00:07:20,870 --> 00:07:19,199
navigation and it also measures the

201
00:07:22,629 --> 00:07:20,880
distortion of the navigation signal

202
00:07:24,790 --> 00:07:22,639
after it reflects off of the ocean

203
00:07:26,710 --> 00:07:24,800
surface and by looking carefully at the

204
00:07:28,710 --> 00:07:26,720
the nature of the distortion we can back

205
00:07:30,870 --> 00:07:28,720
out the uh the properties of the ocean

206
00:07:33,430 --> 00:07:30,880
surface that are forced by the uh the

207
00:07:35,270 --> 00:07:33,440
local winds and i've got a couple of

208
00:07:37,430 --> 00:07:35,280
series of slides here to illustrate the

209
00:07:38,950 --> 00:07:37,440
interaction between the electromagnetic

210
00:07:40,710 --> 00:07:38,960
signals in the ocean surface to show how

211
00:07:42,950 --> 00:07:40,720
it is that we measure wind so if we can

212
00:07:44,550 --> 00:07:42,960
go to the next slide so here's an

213
00:07:47,270 --> 00:07:44,560

example of uh

214
00:07:49,510 --> 00:07:47,280
specular scattering in the uh in optical

215
00:07:51,589 --> 00:07:49,520
wavelengths so you can see the moon um

216
00:07:53,830 --> 00:07:51,599
above the horizon and then you can see a

217
00:07:55,990 --> 00:07:53,840
reflection of the moon in the lake and

218
00:07:57,990 --> 00:07:56,000
the water uh the lake surface is very

219
00:07:59,749 --> 00:07:58,000
calm there's no wind blowing and because

220
00:08:01,830 --> 00:07:59,759
of that the reflection of the moon is

221
00:08:04,150 --> 00:08:01,840
almost as sharp as the moon itself and

222
00:08:06,230 --> 00:08:04,160
this is called specular reflection and

223
00:08:08,150 --> 00:08:06,240
uh you know electromagnetic terminology

224
00:08:09,670 --> 00:08:08,160
and what that means is mirror-like

225
00:08:12,309 --> 00:08:09,680
reflection where the surface does not

226
00:08:15,110 --> 00:08:12,319
distort the reflection and if the ocean

227
00:08:17,110 --> 00:08:15,120
were perfectly smooth the gps signal

228
00:08:18,790 --> 00:08:17,120
would reflect off of the of the ocean

229
00:08:20,550 --> 00:08:18,800
and be received by cygnus and it would

230
00:08:22,869 --> 00:08:20,560
still look like a regular navigation

231
00:08:24,950 --> 00:08:22,879
signal if there was a nice smooth uh

232
00:08:26,150 --> 00:08:24,960
mirror like specular reflection if we go

233
00:08:27,749 --> 00:08:26,160
to the next slide you'll see what

234
00:08:29,749 --> 00:08:27,759
happens when the wind blows when the

235
00:08:31,350 --> 00:08:29,759
wind blows there's friction at the

236
00:08:33,509 --> 00:08:31,360
oceans at the water surface and that

237
00:08:35,110 --> 00:08:33,519
roughens the surface and uh this is

238
00:08:36,709 --> 00:08:35,120

called diffuse scattering rather than

239
00:08:38,149 --> 00:08:36,719
specular scattering so here's an example

240
00:08:39,990 --> 00:08:38,159
again in the optical wavelengths where

241
00:08:41,750 --> 00:08:40,000
the moon is reflecting off of a

242
00:08:43,350 --> 00:08:41,760
roughened surface and you can see that

243
00:08:45,350 --> 00:08:43,360
the reflection is not a nice sharp

244
00:08:46,630 --> 00:08:45,360
picture of the moon but now it's a

245
00:08:49,030 --> 00:08:46,640
diffuse

246
00:08:51,190 --> 00:08:49,040
version

247
00:08:53,509 --> 00:08:51,200
and this this happens in optical

248
00:08:56,389 --> 00:08:53,519
wavelengths like this and it happens at

249
00:08:57,829 --> 00:08:56,399
radio wave wavelengths like gps as well

250
00:09:00,230 --> 00:08:57,839
and if we go to the next slide you'll

251
00:09:02,230 --> 00:09:00,240
see an example of this so this is uh the

252
00:09:03,269 --> 00:09:02,240
first measurements of gps scattering off

253
00:09:04,949 --> 00:09:03,279
the ocean

254
00:09:07,430 --> 00:09:04,959
measured from space it was measured

255
00:09:09,110 --> 00:09:07,440
about 10 years ago by a technology

256
00:09:11,269 --> 00:09:09,120
demonstration mission that was flown

257
00:09:13,350 --> 00:09:11,279
with a prototype of the cygnus receiver

258
00:09:15,190 --> 00:09:13,360
um this is when it was first you know

259
00:09:17,030 --> 00:09:15,200
like the the details were first worked

260
00:09:18,949 --> 00:09:17,040
out about how to hack into a regular

261
00:09:20,710 --> 00:09:18,959
communication or a navigation uh

262
00:09:23,829 --> 00:09:20,720
receiver to do these type of reflected

263
00:09:25,430 --> 00:09:23,839

measurements and this is a gps 19

264
00:09:27,509 --> 00:09:25,440
centimeter signal scattering off the

265
00:09:29,350 --> 00:09:27,519
ocean surface and you can see that

266
00:09:31,110 --> 00:09:29,360
the specular part of it of the

267
00:09:32,790 --> 00:09:31,120
reflection is that bright red part at

268
00:09:34,550 --> 00:09:32,800
the top and then the yellow kind of

269
00:09:36,230 --> 00:09:34,560
horseshoe shaped part is the diffuse

270
00:09:38,389 --> 00:09:36,240
scattering away from the specular point

271
00:09:40,790 --> 00:09:38,399
due to the roughening of the ocean

272
00:09:43,350 --> 00:09:40,800
surface and in general the rougher the

273
00:09:44,949 --> 00:09:43,360
surfaces due to increased wind speed the

274
00:09:46,550 --> 00:09:44,959
more diffuse scattering there is the

275
00:09:48,790 --> 00:09:46,560
less specular scattering there is and

276
00:09:50,949 --> 00:09:48,800
cygnus makes measurements just like this

277
00:09:52,470 --> 00:09:50,959
every second and from that we can derive

278
00:09:53,430 --> 00:09:52,480
the wind speed

279
00:09:55,910 --> 00:09:53,440
okay

280
00:09:57,750 --> 00:09:55,920
if we go to the next uh the next thing

281
00:10:00,230 --> 00:09:57,760
to play i think is a video this shows

282
00:10:02,150 --> 00:10:00,240
you how the sampling works with cygnus

283
00:10:04,230 --> 00:10:02,160
so there's eight satellites in a single

284
00:10:05,750 --> 00:10:04,240
orbit plane each satellite has antennas

285
00:10:07,190 --> 00:10:05,760
pointing towards the

286
00:10:08,870 --> 00:10:07,200
towards the surface looking at the

287
00:10:12,389 --> 00:10:08,880
scattered signals

288
00:10:14,710 --> 00:10:12,399

and these uh those blue ellipses those

289
00:10:17,110 --> 00:10:14,720
are the locations of the specular points

290
00:10:19,190 --> 00:10:17,120
from the gps transmitters and as soon as

291
00:10:20,550 --> 00:10:19,200
they enter the antenna beam that's

292
00:10:23,509 --> 00:10:20,560
looking down at the ground that's those

293
00:10:25,269 --> 00:10:23,519
red ovals the onboard processor latches

294
00:10:27,110 --> 00:10:25,279
onto them and begins processing and

295
00:10:28,389 --> 00:10:27,120
generating those images of the diffuse

296
00:10:30,230 --> 00:10:28,399
scattering

297
00:10:32,150 --> 00:10:30,240
there's enough processing horsepower on

298
00:10:33,829 --> 00:10:32,160
board to measure four of these specular

299
00:10:36,230 --> 00:10:33,839
points at a time so it's always tracking

300
00:10:37,670 --> 00:10:36,240
where the specular points are and it

301
00:10:39,990 --> 00:10:37,680
takes the best four in the antenna

302
00:10:41,750 --> 00:10:40,000
pattern and processes them into winds so

303
00:10:44,069 --> 00:10:41,760
essentially we're measuring winds along

304
00:10:46,550 --> 00:10:44,079
these blue lines as the satellite orbits

305
00:10:48,470 --> 00:10:46,560
along and you can think of this kind of

306
00:10:50,550 --> 00:10:48,480
like there being

307
00:10:52,630 --> 00:10:50,560
individual airplanes kind of virtual

308
00:10:54,310 --> 00:10:52,640
airplanes p3 airplanes somewhere in the

309
00:10:55,990 --> 00:10:54,320
tropics and underneath of them they're

310
00:10:58,230 --> 00:10:56,000
making winds making measurements of the

311
00:11:00,069 --> 00:10:58,240
winds and with eight satellites and each

312
00:11:03,190 --> 00:11:00,079
satellite able to make four measurements

313
00:11:06,230 --> 00:11:03,200

of the wind it's kind of like having 32

314
00:11:08,790 --> 00:11:06,240
virtual p3 you know airplanes someplace

315
00:11:10,389 --> 00:11:08,800
in the tropics making winds at all times

316
00:11:12,389 --> 00:11:10,399
and if you take all of those winds

317
00:11:14,389 --> 00:11:12,399
aggregate them together you get the data

318
00:11:17,750 --> 00:11:14,399
product that cygnus generates

319
00:11:19,590 --> 00:11:17,760
with eight satellites there's about um

320
00:11:21,670 --> 00:11:19,600
seven hours between measurements at any

321
00:11:24,230 --> 00:11:21,680
given spot in the in the uh in the

322
00:11:26,389 --> 00:11:24,240
tropics on average so

323
00:11:28,150 --> 00:11:26,399
we're able to uh make measurements much

324
00:11:30,630 --> 00:11:28,160
more often than that three-day refresh

325
00:11:33,110 --> 00:11:30,640
rate of the trim satellite and uh i

326
00:11:35,190 --> 00:11:33,120
think i have one last slide here this is

327
00:11:37,110 --> 00:11:35,200
an example from a we have a detailed

328
00:11:39,030 --> 00:11:37,120
software simulator of the mission and of

329
00:11:40,790 --> 00:11:39,040
the interactions of the gps signals with

330
00:11:42,470 --> 00:11:40,800
the ocean surface and this is an example

331
00:11:43,670 --> 00:11:42,480
of the type of product that we're

332
00:11:44,790 --> 00:11:43,680
expecting

333
00:11:47,350 --> 00:11:44,800
this is a

334
00:11:49,750 --> 00:11:47,360
simulated tropical cyclone in the left

335
00:11:51,829 --> 00:11:49,760
and then a transect of the specular

336
00:11:53,910 --> 00:11:51,839
point passing through the eye wall of

337
00:11:56,069 --> 00:11:53,920
the satellite on that black line and

338
00:11:58,069 --> 00:11:56,079

that plays the same role as the flight

339
00:12:00,629 --> 00:11:58,079
line of the airplane in this case and

340
00:12:02,790 --> 00:12:00,639
then on the right we have uh an example

341
00:12:04,310 --> 00:12:02,800
of the the true wind in our simulator

342
00:12:06,150 --> 00:12:04,320
and then the retrieved wind including

343
00:12:07,910 --> 00:12:06,160
all the you know realistic sources of

344
00:12:09,750 --> 00:12:07,920
errors and calibration and noise and so

345
00:12:11,990 --> 00:12:09,760
on that we're expecting and you can see

346
00:12:14,069 --> 00:12:12,000
that it picks up the uh the calm water

347
00:12:16,389 --> 00:12:14,079
and the eye of the hurricane and then

348
00:12:17,750 --> 00:12:16,399
the strongest wind in the uh in the eye

349
00:12:20,230 --> 00:12:17,760
wall as it penetrates through the

350
00:12:22,949 --> 00:12:20,240
maximum wind so that's uh that's the

351
00:12:24,470 --> 00:12:22,959
data product that we're expecting and

352
00:12:26,310 --> 00:12:24,480
i guess i want to say just one other

353
00:12:27,750 --> 00:12:26,320
thing about the the nature of the

354
00:12:29,509 --> 00:12:27,760
satellites and how we're able to do

355
00:12:31,190 --> 00:12:29,519
these measurements it's it's really

356
00:12:32,870 --> 00:12:31,200
critical that we have many of these

357
00:12:35,190 --> 00:12:32,880
satellites in order to get the sampling

358
00:12:37,269 --> 00:12:35,200
down to you know every every seven hours

359
00:12:39,829 --> 00:12:37,279
and uh the way to do that is to make the

360
00:12:41,670 --> 00:12:39,839
individual satellites cheap so the gps

361
00:12:43,110 --> 00:12:41,680
receivers themselves are very low power

362
00:12:45,269 --> 00:12:43,120
and very efficient because they've been

363
00:12:48,069 --> 00:12:45,279

optimized by you know commercial

364
00:12:49,670 --> 00:12:48,079
industry for for commercial navigation

365
00:12:51,430 --> 00:12:49,680
and that makes the satellites be nice

366
00:12:53,829 --> 00:12:51,440
and small and cheap and the other thing

367
00:12:56,150 --> 00:12:53,839
that's really critical about this is

368
00:12:57,990 --> 00:12:56,160
the actual satellite itself has to be

369
00:12:59,910 --> 00:12:58,000
simple in order to keep the price down

370
00:13:01,910 --> 00:12:59,920
and one of the key things that keeps it

371
00:13:03,430 --> 00:13:01,920
simple is the fact that it has no

372
00:13:05,430 --> 00:13:03,440
propulsion

373
00:13:06,870 --> 00:13:05,440
so once these satellites are launched

374
00:13:08,550 --> 00:13:06,880
they're initially very close together

375
00:13:10,310 --> 00:13:08,560
and then they start spreading apart and

376
00:13:12,069 --> 00:13:10,320
we need some way to get them evenly

377
00:13:15,350 --> 00:13:12,079
spaced out around the orbit without

378
00:13:17,750 --> 00:13:15,360
propulsion and the way we do that is uh

379
00:13:19,910 --> 00:13:17,760
this clever trick that professor ridley

380
00:13:22,389 --> 00:13:19,920
next to me figured out and i'll let him

381
00:13:23,269 --> 00:13:22,399
kind of tell his tale

382
00:13:25,430 --> 00:13:23,279
great

383
00:13:27,110 --> 00:13:25,440
thank you very much so as chris just

384
00:13:29,350 --> 00:13:27,120
talked about um

385
00:13:31,910 --> 00:13:29,360
when the satellites are launched they

386
00:13:35,590 --> 00:13:31,920
come off of the pegasus satellite or

387
00:13:37,990 --> 00:13:35,600
pegasus rocket if we really wanted to it

388
00:13:39,750 --> 00:13:38,000

would be great to have eight rockets

389
00:13:40,629 --> 00:13:39,760
actually launching every single one of

390
00:13:42,949 --> 00:13:40,639
these

391
00:13:45,430 --> 00:13:42,959
but it would be extremely expensive and

392
00:13:46,230 --> 00:13:45,440
so the best method is to have them up

393
00:13:49,030 --> 00:13:46,240
there

394
00:13:50,870 --> 00:13:49,040
take them up on one single rocket and as

395
00:13:52,410 --> 00:13:50,880
chris just talked about

396
00:13:53,590 --> 00:13:52,420
i'm gonna use some props here

397
00:13:56,230 --> 00:13:53,600
[Music]

398
00:13:58,710 --> 00:13:56,240
uh when they come off of the the rocket

399
00:14:00,389 --> 00:13:58,720
they're basically gonna be together all

400
00:14:02,310 --> 00:14:00,399
right they're gonna be spreading apart

401
00:14:03,829 --> 00:14:02,320
very slowly from each other they're

402
00:14:06,629 --> 00:14:03,839
going to be orbiting around the earth at

403
00:14:07,910 --> 00:14:06,639
about 17 000 miles an hour but with

404
00:14:10,470 --> 00:14:07,920
respect to each other they're going to

405
00:14:11,990 --> 00:14:10,480
be moving only about two miles an hour

406
00:14:14,710 --> 00:14:12,000
so they're going to move apart from each

407
00:14:17,269 --> 00:14:14,720
other very very slowly and after about

408
00:14:20,550 --> 00:14:17,279
three months they will basically will

409
00:14:22,550 --> 00:14:20,560
have one will have lapped another one

410
00:14:24,790 --> 00:14:22,560
and it will come around like this and

411
00:14:27,030 --> 00:14:24,800
fly over the other one and we don't

412
00:14:29,670 --> 00:14:27,040
really want that to happen what we want

413
00:14:32,150 --> 00:14:29,680

to happen is for them to basically stay

414
00:14:34,230 --> 00:14:32,160
at about the same distance apart and fly

415
00:14:36,629 --> 00:14:34,240
in tandem with each other we want them

416
00:14:38,949 --> 00:14:36,639
to be spaced about 3 000 kilometers

417
00:14:40,550 --> 00:14:38,959
apart from each other 3000 miles apart

418
00:14:42,389 --> 00:14:40,560
from each other and the way that we're

419
00:14:45,509 --> 00:14:42,399
going to do that

420
00:14:46,870 --> 00:14:45,519
is that as these things come apart uh

421
00:14:50,150 --> 00:14:46,880
from each other

422
00:14:52,150 --> 00:14:50,160
then we're gonna start tilting them up

423
00:14:53,910 --> 00:14:52,160
and this one will go into what's called

424
00:14:56,550 --> 00:14:53,920
high drag mode

425
00:14:59,110 --> 00:14:56,560
all right so what happens is that up it

426
00:15:01,750 --> 00:14:59,120
at about 500 kilometers altitude there's

427
00:15:03,829 --> 00:15:01,760
still a lot of air up there and all

428
00:15:06,069 --> 00:15:03,839
satellites it's the second

429
00:15:08,790 --> 00:15:06,079
largest force that the satellites feel

430
00:15:09,910 --> 00:15:08,800
besides gravity they feel aerodynamic

431
00:15:12,389 --> 00:15:09,920
drag

432
00:15:14,310 --> 00:15:12,399
and so just like a biker

433
00:15:16,949 --> 00:15:14,320
would tuck down

434
00:15:18,790 --> 00:15:16,959
and feel less drag force these

435
00:15:21,110 --> 00:15:18,800
satellites are flying like this and

436
00:15:24,069 --> 00:15:21,120
don't feel very much drag force but when

437
00:15:26,310 --> 00:15:24,079
you tilt it up they feel a lot of drag

438
00:15:28,790 --> 00:15:26,320

and so as one as this one is going

439
00:15:31,829 --> 00:15:28,800
faster than this other one you tilt it

440
00:15:34,310 --> 00:15:31,839
up and you slow it down with respect to

441
00:15:36,629 --> 00:15:34,320
the other one okay and so what we're

442
00:15:40,069 --> 00:15:36,639
going to do is we're going to have uh

443
00:15:42,230 --> 00:15:40,079
meetings every week where we'll decide

444
00:15:44,069 --> 00:15:42,240
which satellite we want to put into high

445
00:15:46,790 --> 00:15:44,079
drag mode

446
00:15:48,870 --> 00:15:46,800
uh i was supposed to show some

447
00:15:51,430 --> 00:15:48,880
pictures that illustrate this a little

448
00:15:53,590 --> 00:15:51,440
bit so if you show the first picture

449
00:15:55,269 --> 00:15:53,600
or the first video this is the

450
00:15:58,550 --> 00:15:55,279
deployment sequence so all the

451
00:16:00,949 --> 00:15:58,560
satellites are on one

452
00:16:03,269 --> 00:16:00,959
rocket they're all bunched together and

453
00:16:05,430 --> 00:16:03,279
they all pop off and they're moving

454
00:16:07,829 --> 00:16:05,440
about two or three miles

455
00:16:10,069 --> 00:16:07,839
an hour away from each other and it will

456
00:16:13,590 --> 00:16:10,079
take them about

457
00:16:15,670 --> 00:16:13,600
three to six months to basically overlap

458
00:16:17,829 --> 00:16:15,680
each other to start lapping each other

459
00:16:19,990 --> 00:16:17,839
you don't want them to lap each other

460
00:16:22,710 --> 00:16:20,000
because if one is above the other one

461
00:16:24,949 --> 00:16:22,720
they're measuring exactly the same thing

462
00:16:27,030 --> 00:16:24,959
on the earth and we don't want that to

463
00:16:29,110 --> 00:16:27,040

happen so we want them to be spaced

464
00:16:29,990 --> 00:16:29,120
apart from each other so if you show the

465
00:16:31,269 --> 00:16:30,000
next

466
00:16:32,150 --> 00:16:31,279
slide

467
00:16:34,470 --> 00:16:32,160
now

468
00:16:37,749 --> 00:16:34,480
the satellites are going to

469
00:16:40,470 --> 00:16:37,759
orbit at 35 degrees inclination the

470
00:16:42,470 --> 00:16:40,480
reason we chose 35 degree inclination is

471
00:16:47,590 --> 00:16:42,480
because that's where most tropical

472
00:16:50,230 --> 00:16:47,600
cyclones uh happen so this plot shows uh

473
00:16:52,389 --> 00:16:50,240
tracks for tropical cyclones for about

474
00:16:55,110 --> 00:16:52,399
10 years and you can see the vast

475
00:16:57,990 --> 00:16:55,120
majority of them are within this white

476
00:17:00,069 --> 00:16:58,000
zone which is between plus and minus 35

477
00:17:02,389 --> 00:17:00,079
degrees we don't want to do something

478
00:17:04,949 --> 00:17:02,399
like a polar orbit because there are no

479
00:17:06,390 --> 00:17:04,959
tropical cyclones up near the poles we

480
00:17:08,069 --> 00:17:06,400
want to stick where the tropical

481
00:17:11,270 --> 00:17:08,079
cyclones are

482
00:17:13,510 --> 00:17:11,280
and so we planned the inclination to be

483
00:17:16,549 --> 00:17:13,520
35 degrees we'll go between plus and

484
00:17:18,230 --> 00:17:16,559
minus 35 we have figured out how to

485
00:17:21,270 --> 00:17:18,240
space these satellites out so they're

486
00:17:24,949 --> 00:17:21,280
equally spaced around the orbit and then

487
00:17:27,510 --> 00:17:24,959
if you go to the next movie it shows how

488
00:17:30,470 --> 00:17:27,520

the coverage uh happens of all these

489
00:17:32,070 --> 00:17:30,480
specular points chris showed just one

490
00:17:35,750 --> 00:17:32,080
small

491
00:17:37,990 --> 00:17:35,760
time slice but this shows 24 hours of

492
00:17:41,669 --> 00:17:38,000
cygnus measurements and you can see that

493
00:17:43,750 --> 00:17:41,679
we cover the entire globe in about 24

494
00:17:46,870 --> 00:17:43,760
hours we actually measure

495
00:17:49,510 --> 00:17:46,880
multiple times over the same place

496
00:17:51,990 --> 00:17:49,520
fairly often with this and you can see

497
00:17:56,390 --> 00:17:52,000
if you look very very closely we have

498
00:17:59,430 --> 00:17:56,400
about 80 to 85 percent uh of the spots

499
00:18:03,510 --> 00:17:59,440
in the plus and minus 35 degree latitude

500
00:18:06,870 --> 00:18:03,520
band covered by cygnus every single day

501
00:18:10,710 --> 00:18:08,870
great now we'll turn it over to mary

502
00:18:13,350 --> 00:18:10,720
morris to talk a little bit about

503
00:18:14,710 --> 00:18:13,360
some of the applications of the cygnus

504
00:18:15,830 --> 00:18:14,720
science

505
00:18:17,830 --> 00:18:15,840
thanks sean

506
00:18:19,909 --> 00:18:17,840
so uh now that we've heard a little bit

507
00:18:21,430 --> 00:18:19,919
about the science and the engineering

508
00:18:23,430 --> 00:18:21,440
aspects of cygnus i'm going to talk to

509
00:18:24,789 --> 00:18:23,440
you all about some of a tool that we've

510
00:18:26,230 --> 00:18:24,799
been developing for the science

511
00:18:27,270 --> 00:18:26,240
applications why should you care about

512
00:18:28,710 --> 00:18:27,280
cygnus

513
00:18:30,470 --> 00:18:28,720

so at the university of michigan we've

514
00:18:32,950 --> 00:18:30,480
been developing this tool called sift or

515
00:18:34,549 --> 00:18:32,960
the storm intersection forecast tool and

516
00:18:36,470 --> 00:18:34,559
the reason that we developed sift is

517
00:18:38,390 --> 00:18:36,480
because we needed a way to predict ahead

518
00:18:40,630 --> 00:18:38,400
of time when we're going to get valuable

519
00:18:42,789 --> 00:18:40,640
storm data and then after we answer that

520
00:18:44,470 --> 00:18:42,799
question we want to know how soon after

521
00:18:45,909 --> 00:18:44,480
we get that data can we then downlink it

522
00:18:48,310 --> 00:18:45,919
to the ground and get it to the user

523
00:18:49,750 --> 00:18:48,320
community as soon as possible

524
00:18:51,029 --> 00:18:49,760
so what we're going to do today is we're

525
00:18:52,470 --> 00:18:51,039
going to do a little experiment we're

526
00:18:53,909 --> 00:18:52,480
going to pretend that cygnus launched a

527
00:18:55,909 --> 00:18:53,919
year ago and we're going to see what we

528
00:18:57,909 --> 00:18:55,919
would have seen during hurricane matthew

529
00:18:59,909 --> 00:18:57,919
a little over a couple of months ago if

530
00:19:02,230 --> 00:18:59,919
cygnus had already been orbiting

531
00:19:03,750 --> 00:19:02,240
so let's go to the video clip and see

532
00:19:06,150 --> 00:19:03,760
this tool in action so what you're

533
00:19:08,390 --> 00:19:06,160
seeing now is sift in sort of a global v

534
00:19:10,549 --> 00:19:08,400
mode each of these colored triangles

535
00:19:12,390 --> 00:19:10,559
represents one of the cygnus satellites

536
00:19:14,470 --> 00:19:12,400
and the dots that surround the satellite

537
00:19:16,390 --> 00:19:14,480
are the specular points that's where our

538
00:19:18,789 --> 00:19:16,400

data are going to be that's where we're

539
00:19:20,630 --> 00:19:18,799
able to measure ocean surface wind speed

540
00:19:23,590 --> 00:19:20,640
what i just turned on are these circles

541
00:19:25,350 --> 00:19:23,600
around our ground stations in hawaii

542
00:19:27,909 --> 00:19:25,360
chile and

543
00:19:29,190 --> 00:19:27,919
australia so when our orbit propagator

544
00:19:31,110 --> 00:19:29,200
predicts that these satellites are going

545
00:19:32,470 --> 00:19:31,120
to be moving over these ground contact

546
00:19:34,390 --> 00:19:32,480
zones that's where we're going to be

547
00:19:36,789 --> 00:19:34,400
able to downlink our data

548
00:19:38,710 --> 00:19:36,799
what i just turned on is one ground

549
00:19:40,150 --> 00:19:38,720
track for one satellite over about an

550
00:19:41,430 --> 00:19:40,160
orbit just to give you guys and again

551
00:19:43,350 --> 00:19:41,440
additional

552
00:19:44,870 --> 00:19:43,360
ideas of what the sampling properties of

553
00:19:46,470 --> 00:19:44,880
stigmas are going to be

554
00:19:48,470 --> 00:19:46,480
the next thing that we're going to ask

555
00:19:50,630 --> 00:19:48,480
of this tool to do is to tell us where

556
00:19:53,110 --> 00:19:50,640
our data are expected to be over this

557
00:19:55,270 --> 00:19:53,120
time period so i'm about to turn on

558
00:19:57,350 --> 00:19:55,280
the specular points for the same time

559
00:19:58,710 --> 00:19:57,360
period

560
00:19:59,909 --> 00:19:58,720
so each of these colored lines

561
00:20:02,230 --> 00:19:59,919
represents one of the different

562
00:20:04,070 --> 00:20:02,240
satellites

563
00:20:05,510 --> 00:20:04,080

and you can imagine that if we added

564
00:20:07,270 --> 00:20:05,520
time

565
00:20:09,350 --> 00:20:07,280
all these satellites in combination give

566
00:20:11,270 --> 00:20:09,360
us great coverage over the topics where

567
00:20:12,549 --> 00:20:11,280
we expect most of the tropical cyclones

568
00:20:14,470 --> 00:20:12,559
to be

569
00:20:16,149 --> 00:20:14,480
the next aspect of this tool is to

570
00:20:17,590 --> 00:20:16,159
determine when cygnus is going to

571
00:20:18,870 --> 00:20:17,600
intercept hurricane matthew so what i

572
00:20:20,950 --> 00:20:18,880
just turned on

573
00:20:21,830 --> 00:20:20,960
is this red bright circle and that's the

574
00:20:24,070 --> 00:20:21,840
current

575
00:20:25,350 --> 00:20:24,080
position and size of hurricane matthew

576
00:20:27,190 --> 00:20:25,360
according to the national hurricane

577
00:20:28,870 --> 00:20:27,200
center's forecast

578
00:20:30,710 --> 00:20:28,880
hurricane matthew for this time period

579
00:20:32,950 --> 00:20:30,720
is forecasted to move to the west and

580
00:20:35,590 --> 00:20:32,960
then eventually turn to the north the

581
00:20:37,830 --> 00:20:35,600
four the future locations are shown by

582
00:20:39,830 --> 00:20:37,840
the the lighter red colors

583
00:20:41,669 --> 00:20:39,840
so we're using this tool to propagate

584
00:20:44,070 --> 00:20:41,679
the orbit forward

585
00:20:45,750 --> 00:20:44,080
so that we can see where cygnus is going

586
00:20:46,549 --> 00:20:45,760
and where the hurricane is forecasted to

587
00:20:48,070 --> 00:20:46,559
go

588
00:20:49,830 --> 00:20:48,080

right now we're getting pretty close but

589
00:20:51,669 --> 00:20:49,840
hurricane matthew's running away from us

590
00:20:53,590 --> 00:20:51,679
a little bit here but we're starting to

591
00:20:54,390 --> 00:20:53,600
get close and we're going to zoom in

592
00:20:55,510 --> 00:20:54,400
really

593
00:20:58,310 --> 00:20:55,520
um

594
00:21:00,070 --> 00:20:58,320
get a zoomed in view pretty soon

595
00:21:02,390 --> 00:21:00,080
just to see what our data looks like

596
00:21:04,310 --> 00:21:02,400
here so i'm going to turn on all the

597
00:21:06,230 --> 00:21:04,320
specular points for a couple of hours

598
00:21:08,230 --> 00:21:06,240
around this time point now that we know

599
00:21:10,710 --> 00:21:08,240
the sort of general gist of the time

600
00:21:11,590 --> 00:21:10,720
period that we're looking at

601
00:21:13,990 --> 00:21:11,600
so

602
00:21:15,430 --> 00:21:14,000
all those lines are the data

603
00:21:17,190 --> 00:21:15,440
right now you're seeing the satellites

604
00:21:18,870 --> 00:21:17,200
propagate on the bottom right hand

605
00:21:20,710 --> 00:21:18,880
portion of the tool

606
00:21:22,070 --> 00:21:20,720
and right now we're getting

607
00:21:23,750 --> 00:21:22,080
crossovers through that bright red

608
00:21:26,710 --> 00:21:23,760
circle that's the current

609
00:21:28,070 --> 00:21:26,720
position and size of the storm

610
00:21:29,430 --> 00:21:28,080
all of that data in that bright red

611
00:21:31,430 --> 00:21:29,440
circle is stuff that can be used to

612
00:21:34,230 --> 00:21:31,440
answer questions like how intense is the

613
00:21:35,830 --> 00:21:34,240

storm how far out do strong winds extend

614
00:21:37,350 --> 00:21:35,840
what is the destructive potential of the

615
00:21:39,669 --> 00:21:37,360
storm at the time

616
00:21:41,510 --> 00:21:39,679
and that's really valuable data

617
00:21:42,630 --> 00:21:41,520
so let's zoom out and let's look at all

618
00:21:45,350 --> 00:21:42,640
the data

619
00:21:46,950 --> 00:21:45,360
collected over this same time period in

620
00:21:48,630 --> 00:21:46,960
addition to all of the hurricane matthew

621
00:21:50,470 --> 00:21:48,640
data that we're going to get

622
00:21:53,669 --> 00:21:50,480
we're getting data in the environment of

623
00:21:55,029 --> 00:21:53,679
hurricane matthew as well as global data

624
00:21:57,110 --> 00:21:55,039
the next thing that we want to ask of

625
00:21:58,470 --> 00:21:57,120
this tool is how soon after we get that

626
00:22:00,149 --> 00:21:58,480
really valuable data can we then

627
00:22:01,510 --> 00:22:00,159
download it to the ground as soon as

628
00:22:03,510 --> 00:22:01,520
possible

629
00:22:06,149 --> 00:22:03,520
so let's go back to our ground contact

630
00:22:09,029 --> 00:22:06,159
zone view and put the satellites back

631
00:22:10,710 --> 00:22:09,039
into motion and you're going to see that

632
00:22:13,510 --> 00:22:10,720
right after we go over hurricane

633
00:22:15,270 --> 00:22:13,520
matthew's area we go straight towards

634
00:22:17,029 --> 00:22:15,280
the australian ground station where we

635
00:22:18,789 --> 00:22:17,039
can get the data down to the ground

636
00:22:20,710 --> 00:22:18,799
within an hour and that's a really great

637
00:22:22,230 --> 00:22:20,720
data latency for all of our science

638
00:22:23,669 --> 00:22:22,240

applications

639
00:22:25,350 --> 00:22:23,679
so that's all i have today i just wanted

640
00:22:27,270 --> 00:22:25,360
to end by saying this is just one of the

641
00:22:28,789 --> 00:22:27,280
many amazing projects that i've been

642
00:22:30,789 --> 00:22:28,799
able to work on as a student on the

643
00:22:32,070 --> 00:22:30,799
sigfs team and i'm really excited to see

644
00:22:34,950 --> 00:22:32,080
what cygnus does in the future and i

645
00:22:36,549 --> 00:22:34,960
hope you guys all stay tuned thanks

646
00:22:38,230 --> 00:22:36,559
great thank you so much mary and as i

647
00:22:40,950 --> 00:22:38,240
mentioned at the beginning of today's

648
00:22:43,270 --> 00:22:40,960
briefing you are a phd candidate at the

649
00:22:44,789 --> 00:22:43,280
university of michigan working under dr

650
00:22:47,510 --> 00:22:44,799
ruffin as i understand it you're

651
00:22:49,510 --> 00:22:47,520
actually preparing to uh defend your

652
00:22:51,590 --> 00:22:49,520
doctoral dissertation later this month

653
00:22:53,830 --> 00:22:51,600
right december 20th is the date and

654
00:22:55,909 --> 00:22:53,840
you're actually using the cygnus

655
00:22:57,830 --> 00:22:55,919
project as the basis of your research

656
00:23:00,070 --> 00:22:57,840
correct yep great well good luck with

657
00:23:02,070 --> 00:23:00,080
that thanks all right so now we have

658
00:23:04,870 --> 00:23:02,080
some time to take some questions from

659
00:23:07,909 --> 00:23:04,880
folks both here in the audience as well

660
00:23:09,590 --> 00:23:07,919
as on the phone and via social media and

661
00:23:10,870 --> 00:23:09,600
we'll start with questions here in the

662
00:23:12,630 --> 00:23:10,880
audience and then if they're any on the

663
00:23:14,070 --> 00:23:12,640

phone and then social media and just a

664
00:23:16,149 --> 00:23:14,080
quick reminder for people who may be

665
00:23:18,390 --> 00:23:16,159
asking questions via social media that

666
00:23:20,549 --> 00:23:18,400
you can do so by using the hashtag

667
00:23:22,230 --> 00:23:20,559
asknasa but we'll start with some

668
00:23:25,029 --> 00:23:22,240
questions here in the room we'll start

669
00:23:26,789 --> 00:23:25,039
right here in the front row redshirt and

670
00:23:28,070 --> 00:23:26,799
if you could identify yourself uh and

671
00:23:30,870 --> 00:23:28,080
then ask the question thank you bill

672
00:23:32,470 --> 00:23:30,880
jelen with we report space so for mary

673
00:23:34,310 --> 00:23:32,480
when the first one goes over matthew and

674
00:23:36,070 --> 00:23:34,320
then we get the information hour later

675
00:23:39,110 --> 00:23:36,080
we're now waiting until the satellites

676
00:23:41,510 --> 00:23:39,120
come back over matthew so just what's

677
00:23:42,789 --> 00:23:41,520
the guess from one measurement until it

678
00:23:44,870 --> 00:23:42,799
comes back around and is able to

679
00:23:47,190 --> 00:23:44,880
intersect matthew again in your video

680
00:23:49,909 --> 00:23:47,200
how long is that is that so on average

681
00:23:51,510 --> 00:23:49,919
it's about seven hours but for the it

682
00:23:53,830 --> 00:23:51,520
depends on the case and how the

683
00:23:56,149 --> 00:23:53,840
hurricane is moving in addition to these

684
00:23:58,549 --> 00:23:56,159
satellites but in general i found that

685
00:24:00,310 --> 00:23:58,559
when we you know hit the hurricane when

686
00:24:02,070 --> 00:24:00,320
we intersected we hit it really well

687
00:24:05,669 --> 00:24:02,080
we're never just gonna like barely graze

688
00:24:08,149 --> 00:24:05,679

it or you know miss it you know by just

689
00:24:11,190 --> 00:24:08,159
a little bit so um i'm really excited

690
00:24:13,029 --> 00:24:11,200
about all the applications

691
00:24:16,870 --> 00:24:13,039
okay another question uh how about right

692
00:24:21,909 --> 00:24:19,350
rick glasby with wfit i guess i'm a

693
00:24:24,149 --> 00:24:21,919
little confused about the seven hours uh

694
00:24:26,950 --> 00:24:24,159
dr ruff does that mean if i'm standing

695
00:24:29,110 --> 00:24:26,960
in one spot a satellite would pass over

696
00:24:31,110 --> 00:24:29,120
me every seven hours

697
00:24:33,350 --> 00:24:31,120
that's exactly what it means uh so the

698
00:24:35,110 --> 00:24:33,360
sampling for this type of technique

699
00:24:38,310 --> 00:24:35,120
there's a fundamental difference between

700
00:24:41,110 --> 00:24:38,320
it and a typical imager a polar orbiting

701
00:24:43,110 --> 00:24:41,120
wide swath imager um that

702
00:24:44,870 --> 00:24:43,120
typically has an exact repeat orbit and

703
00:24:46,630 --> 00:24:44,880
there's an exact time that it comes back

704
00:24:48,630 --> 00:24:46,640
around any given spot that's the revisit

705
00:24:51,110 --> 00:24:48,640
time that's sort of the standard

706
00:24:53,909 --> 00:24:51,120
approach to temporal sampling with low

707
00:24:56,390 --> 00:24:53,919
earth orbiting satellites with cygnus

708
00:24:58,630 --> 00:24:56,400
our orbits and the orbits of the gps

709
00:25:00,549 --> 00:24:58,640
satellites are completely asynchronous

710
00:25:02,710 --> 00:25:00,559
so the location and the location of the

711
00:25:04,390 --> 00:25:02,720
sample and the time of the sample it's

712
00:25:05,590 --> 00:25:04,400
determined by the relative locations of

713
00:25:07,110 --> 00:25:05,600

those two satellites you know the

714
00:25:08,789 --> 00:25:07,120
specular point on the ground is formed

715
00:25:10,950 --> 00:25:08,799
by exactly where those two satellites

716
00:25:13,110 --> 00:25:10,960
are at any given time because the orbits

717
00:25:15,510 --> 00:25:13,120
are asynchronous the locations of the

718
00:25:17,590 --> 00:25:15,520
samples move around all over the place

719
00:25:19,750 --> 00:25:17,600
and they're not really deterministic

720
00:25:21,750 --> 00:25:19,760
the right way to analyze it is to treat

721
00:25:23,909 --> 00:25:21,760
the sampling properties as a as a

722
00:25:26,149 --> 00:25:23,919
statistical property a random process

723
00:25:28,230 --> 00:25:26,159
and then calculate probability

724
00:25:29,909 --> 00:25:28,240
distributions and statistics of samples

725
00:25:31,909 --> 00:25:29,919
that's that's that's a a clean

726
00:25:33,750 --> 00:25:31,919
mathematical way to handle the sampling

727
00:25:35,750 --> 00:25:33,760
properties so there's a statistical

728
00:25:37,830 --> 00:25:35,760
distribution of how often you'll come

729
00:25:39,990 --> 00:25:37,840
back to the same place and the average

730
00:25:42,710 --> 00:25:40,000
of that statistic is

731
00:25:43,909 --> 00:25:42,720
seven hours

732
00:25:47,990 --> 00:25:43,919
all right i think we had a question here

733
00:25:52,630 --> 00:25:50,230
uh jim siegel i'm with celebration news

734
00:25:54,310 --> 00:25:52,640
and space flight insider also i'm a

735
00:25:57,909 --> 00:25:54,320
graduate of the university of michigan

736
00:26:02,789 --> 00:26:00,950
i'm interested in how i can explain to

737
00:26:05,510 --> 00:26:02,799
my readers

738
00:26:08,630 --> 00:26:05,520

what the uh what the advantage or the

739
00:26:11,269 --> 00:26:08,640
outcome of having this in space is for

740
00:26:13,590 --> 00:26:11,279
them in non-technical terms say somebody

741
00:26:16,549 --> 00:26:13,600
from michigan state how would i describe

742
00:26:18,630 --> 00:26:16,559
that how would i describe

743
00:26:20,630 --> 00:26:18,640
what what um

744
00:26:22,390 --> 00:26:20,640
what what what does this do that that

745
00:26:25,990 --> 00:26:22,400
they're not going to get today from the

746
00:26:30,630 --> 00:26:27,909
do you i mean you're you're much better

747
00:26:32,950 --> 00:26:30,640
but i could try yeah uh so um if you

748
00:26:35,190 --> 00:26:32,960
look at the the the general

749
00:26:36,950 --> 00:26:35,200
characteristics of hurricane forecasts

750
00:26:39,510 --> 00:26:36,960
today and over the last you know a

751
00:26:41,430 --> 00:26:39,520
couple of decades hurricane forecasts of

752
00:26:43,510 --> 00:26:41,440
the location of the storm the storm

753
00:26:44,549 --> 00:26:43,520
track forecast have been steadily

754
00:26:46,230 --> 00:26:44,559
improving

755
00:26:48,710 --> 00:26:46,240
over the decades

756
00:26:51,510 --> 00:26:48,720
and the forecast of the intensity which

757
00:26:54,070 --> 00:26:51,520
is the maximum sustained wind have not

758
00:26:56,630 --> 00:26:54,080
improved anywhere near as much as the

759
00:26:57,990 --> 00:26:56,640
as the forecast of the location so being

760
00:26:59,750 --> 00:26:58,000
able to predict where a storm is going

761
00:27:01,669 --> 00:26:59,760
to make landfall has gotten steadily

762
00:27:02,870 --> 00:27:01,679
better and being able to predict how

763
00:27:04,710 --> 00:27:02,880

strong it's going to be when it does

764
00:27:06,950 --> 00:27:04,720
make landfall has not improved anywhere

765
00:27:09,190 --> 00:27:06,960
near as much and the general consensus

766
00:27:10,789 --> 00:27:09,200
on why that is which has been um you

767
00:27:12,310 --> 00:27:10,799
know backed up by a lot of simulation

768
00:27:13,830 --> 00:27:12,320
study computer simulation studies is

769
00:27:15,029 --> 00:27:13,840
because of our inability to measure

770
00:27:17,909 --> 00:27:15,039
what's going on in the middle of the

771
00:27:19,669 --> 00:27:17,919
storm and that's what the focus of the

772
00:27:21,669 --> 00:27:19,679
of the of the types of differences

773
00:27:23,269 --> 00:27:21,679
between cygnus and previous satellites

774
00:27:25,269 --> 00:27:23,279
that that was what we really focused on

775
00:27:26,950 --> 00:27:25,279
was trying to address that need so what

776
00:27:28,310 --> 00:27:26,960
we're hoping in the end will happen with

777
00:27:29,750 --> 00:27:28,320
this data and we've done a lot of

778
00:27:31,750 --> 00:27:29,760
simulations that tell us that this

779
00:27:33,590 --> 00:27:31,760
should happen is that our ability to

780
00:27:35,350 --> 00:27:33,600
forecast how strong the hurricane is

781
00:27:38,950 --> 00:27:35,360
going to be when it makes landfall will

782
00:27:43,110 --> 00:27:40,310
i think we had another question next to

783
00:27:46,470 --> 00:27:44,350
jason ryan also at

784
00:27:47,750 --> 00:27:46,480
spaceflightinsider.com uh i'm not sure

785
00:27:49,190 --> 00:27:47,760
who to fill this tube i hope you can

786
00:27:51,750 --> 00:27:49,200
help me out now you mentioned the lack

787
00:27:54,149 --> 00:27:51,760
of a thrusters uh or propulsion system

788
00:27:55,350 --> 00:27:54,159

on the uh spacecraft that help reduce

789
00:27:57,269 --> 00:27:55,360
cost can you give us a couple other

790
00:27:59,510 --> 00:27:57,279
examples of ways that costs were cut for

791
00:28:00,789 --> 00:27:59,520
this particular mission thank you

792
00:28:03,029 --> 00:28:00,799
hmm

793
00:28:05,190 --> 00:28:03,039
uh well

794
00:28:08,630 --> 00:28:05,200
the one of the things is uh the number

795
00:28:11,830 --> 00:28:08,640
of spacecraft so in theory we could have

796
00:28:14,310 --> 00:28:11,840
flown more spacecraft the pegasus rocket

797
00:28:17,110 --> 00:28:14,320
would have allowed us to fly maybe one

798
00:28:19,909 --> 00:28:17,120
or two more spacecraft

799
00:28:22,789 --> 00:28:19,919
but as you have more mass you come

800
00:28:24,950 --> 00:28:22,799
closer and closer to the limits of the

801
00:28:27,350 --> 00:28:24,960
of the rocket you also come closer and

802
00:28:29,990 --> 00:28:27,360
closer to the limits of your budget and

803
00:28:31,990 --> 00:28:30,000
so we made some hard decisions when we

804
00:28:34,470 --> 00:28:32,000
were doing the mission planning to

805
00:28:36,070 --> 00:28:34,480
figure out exactly how many spacecraft

806
00:28:39,830 --> 00:28:36,080
would be the optimal number of

807
00:28:42,070 --> 00:28:39,840
spacecraft for the cost for the mass and

808
00:28:44,389 --> 00:28:42,080
for the science return you would you

809
00:28:46,389 --> 00:28:44,399
would like to have as many satellites as

810
00:28:49,269 --> 00:28:46,399
physically possible up there but you

811
00:28:51,110 --> 00:28:49,279
have to live within the realism of the

812
00:28:53,990 --> 00:28:51,120
mass constraints and the dollar

813
00:28:55,669 --> 00:28:54,000

constraints and so that was a big

814
00:28:57,110 --> 00:28:55,679
trade-off that we made

815
00:28:58,470 --> 00:28:57,120
i can give you one other example of a

816
00:29:01,510 --> 00:28:58,480
trade-off

817
00:29:03,110 --> 00:29:01,520
when you design satellite architectures

818
00:29:05,750 --> 00:29:03,120
there's

819
00:29:07,909 --> 00:29:05,760
often a desire to make them as reliable

820
00:29:09,909 --> 00:29:07,919
as possible and the way you do that is

821
00:29:11,590 --> 00:29:09,919
by having redundant systems you have the

822
00:29:12,950 --> 00:29:11,600
same thing in the satellite more than

823
00:29:14,470 --> 00:29:12,960
once so that if one of them breaks you

824
00:29:16,389 --> 00:29:14,480
can switch to the other one and if you

825
00:29:17,909 --> 00:29:16,399
don't do that then you have things

826
00:29:20,549 --> 00:29:17,919
called single string failures where if

827
00:29:21,590 --> 00:29:20,559
that fails you're dead okay and

828
00:29:24,470 --> 00:29:21,600
with the

829
00:29:27,110 --> 00:29:24,480
cygnus satellite there's very very few

830
00:29:27,990 --> 00:29:27,120
parts that are redundant just a couple

831
00:29:31,269 --> 00:29:28,000
and

832
00:29:32,710 --> 00:29:31,279
reason for that is we have eight

833
00:29:34,870 --> 00:29:32,720
satellites we need six to meet our

834
00:29:36,630 --> 00:29:34,880
science requirements and so we have

835
00:29:38,630 --> 00:29:36,640
redundancy at the constellation level

836
00:29:40,789 --> 00:29:38,640
but the individual satellites are not

837
00:29:42,950 --> 00:29:40,799
redundant hardly at all and it made them

838
00:29:44,310 --> 00:29:42,960

much easier to make to to build and

839
00:29:46,470 --> 00:29:44,320
because of that we could afford more of

840
00:29:48,149 --> 00:29:46,480
them so we've moved the redundancy to

841
00:29:50,630 --> 00:29:48,159
the constellation and that had a big

842
00:29:53,669 --> 00:29:52,230
okay i think we've got one more on this

843
00:29:57,269 --> 00:29:53,679
side and then we'll see we've got some

844
00:30:01,990 --> 00:29:59,750
hi ken kramer universe today northeast

845
00:30:03,990 --> 00:30:02,000
astronomy forum kind of to follow up on

846
00:30:05,590 --> 00:30:04,000
this if you had the budget

847
00:30:07,110 --> 00:30:05,600
and you could launch let's say a second

848
00:30:09,430 --> 00:30:07,120
series of eight satellites could you

849
00:30:11,510 --> 00:30:09,440
maneuver them to get the data back like

850
00:30:14,870 --> 00:30:11,520
every three hours or so and would that

851
00:30:14,880 --> 00:30:17,510
go ahead

852
00:30:21,590 --> 00:30:20,070
so with um with the orbit plane that we

853
00:30:25,110 --> 00:30:21,600
have right now

854
00:30:27,510 --> 00:30:25,120
you have just one orbit around the earth

855
00:30:29,510 --> 00:30:27,520
if you actually had two satellites or

856
00:30:31,830 --> 00:30:29,520
two planes then you could have an orbit

857
00:30:35,110 --> 00:30:31,840
plane here and an orbit plane there and

858
00:30:36,389 --> 00:30:35,120
so it would cut our revisit time like

859
00:30:39,029 --> 00:30:36,399
chris was saying

860
00:30:41,269 --> 00:30:39,039
from seven hours down to say three hours

861
00:30:44,070 --> 00:30:41,279
and so you could basically have data

862
00:30:45,909 --> 00:30:44,080
every three hours of the hurricane and

863
00:30:49,590 --> 00:30:45,919

so it would give you

864
00:30:52,710 --> 00:30:50,870
all right how about over on this side of

865
00:30:54,950 --> 00:30:52,720
the room we have any questions one right

866
00:30:56,789 --> 00:30:54,960
there in the second row

867
00:30:59,190 --> 00:30:56,799
i want to visualize i know it's they're

868
00:31:00,870 --> 00:30:59,200
all in the same plane but how how spread

869
00:31:02,070 --> 00:31:00,880
out is it when everything's all lined up

870
00:31:04,389 --> 00:31:02,080
where you want it when you're

871
00:31:06,789 --> 00:31:04,399
controlling altitude right with drag but

872
00:31:09,029 --> 00:31:06,799
how far apart are they crossways or

873
00:31:10,549 --> 00:31:09,039
normal to the orbit plane if you will

874
00:31:12,549 --> 00:31:10,559
that's a good question so they're

875
00:31:14,230 --> 00:31:12,559
basically in exactly the same orbit

876
00:31:16,310 --> 00:31:14,240
plane

877
00:31:18,950 --> 00:31:16,320
so when when the

878
00:31:20,789 --> 00:31:18,960
rocket kicks them off two will be kicked

879
00:31:22,230 --> 00:31:20,799
off one will be kicked off forward and

880
00:31:24,389 --> 00:31:22,240
one will be kicked off backwards and

881
00:31:26,950 --> 00:31:24,399
they're in the same orbit plane as the

882
00:31:29,909 --> 00:31:26,960
rocket and then two will be kicked off

883
00:31:33,110 --> 00:31:29,919
almost perpendicular to the uh to the

884
00:31:36,549 --> 00:31:33,120
orbit plane but the the velocity along

885
00:31:39,190 --> 00:31:36,559
the orbit plane is 17 000 miles an hour

886
00:31:42,630 --> 00:31:39,200
and the velocity perpendicular is two

887
00:31:45,110 --> 00:31:42,640
miles an hour and so it it makes a very

888
00:31:46,549 --> 00:31:45,120

small change in the inclination not

889
00:31:50,310 --> 00:31:46,559
enough that you'll

890
00:31:51,909 --> 00:31:50,320
ever notice it really at all

891
00:31:55,029 --> 00:31:51,919
okay other questions here in the room

892
00:31:57,029 --> 00:31:55,039
we've got some more on this side

893
00:31:58,630 --> 00:31:57,039
thank you james dean florida dr ruff you

894
00:31:59,990 --> 00:31:58,640
just you know been discussing the

895
00:32:02,070 --> 00:32:00,000
affordability of these satellites i just

896
00:32:04,710 --> 00:32:02,080
want to ask you know what is the uh the

897
00:32:06,630 --> 00:32:04,720
value of each spacecraft and

898
00:32:08,630 --> 00:32:06,640
does that i mean i see what the what's

899
00:32:10,310 --> 00:32:08,640
listed as nasa's investment in this

900
00:32:12,230 --> 00:32:10,320
mission is it

901
00:32:14,149 --> 00:32:12,240
that divided by eight uh what other

902
00:32:15,990 --> 00:32:14,159
investment also is there in the mission

903
00:32:18,230 --> 00:32:16,000
yeah yeah how much they cost loss of

904
00:32:19,269 --> 00:32:18,240
life or something uh yeah the dollar

905
00:32:21,110 --> 00:32:19,279
value

906
00:32:22,710 --> 00:32:21,120
i don't know exactly what the recurring

907
00:32:25,669 --> 00:32:22,720
cost is i mean you know just in general

908
00:32:27,509 --> 00:32:25,679
it costs 10 or more times more to build

909
00:32:28,950 --> 00:32:27,519
the first one than the next seven

910
00:32:31,509 --> 00:32:28,960
because of all the design work if you

911
00:32:33,669 --> 00:32:31,519
really break it up that way and uh i

912
00:32:35,269 --> 00:32:33,679
don't know what the recurring cost is i

913
00:32:37,029 --> 00:32:35,279

should find out in case nasa wants me to

914
00:32:38,870 --> 00:32:37,039
build a bunch more of them i guess it's

915
00:32:40,310 --> 00:32:38,880
certainly it's certainly much it's

916
00:32:41,669 --> 00:32:40,320
certainly much less than an eighth of

917
00:32:43,430 --> 00:32:41,679
the total mission cost because the

918
00:32:45,350 --> 00:32:43,440
recurring cost happens just one or the

919
00:32:49,110 --> 00:32:45,360
non-recurring engineering work happens

920
00:32:51,909 --> 00:32:50,870
okay let's go to one right behind him

921
00:32:54,070 --> 00:32:51,919
and then i think we have one on the

922
00:32:55,990 --> 00:32:54,080
phone

923
00:32:56,870 --> 00:32:56,000
hi stephen clark from space flight now

924
00:32:58,549 --> 00:32:56,880
um

925
00:33:00,789 --> 00:32:58,559
a couple of questions one just to

926
00:33:02,789 --> 00:33:00,799
clarify the three ground stations that

927
00:33:04,549 --> 00:33:02,799
were mentioned in the animation are

928
00:33:07,350 --> 00:33:04,559
those the only three that are being used

929
00:33:09,350 --> 00:33:07,360
in the mission and also um what are the

930
00:33:11,350 --> 00:33:09,360
plans or are there any plans to

931
00:33:13,909 --> 00:33:11,360
operationalize this data if the

932
00:33:15,430 --> 00:33:13,919
demonstration works as you expect

933
00:33:17,750 --> 00:33:15,440
are you in contact with anyone from the

934
00:33:19,110 --> 00:33:17,760
hurricane center or the

935
00:33:21,190 --> 00:33:19,120
national weather service or is that

936
00:33:23,669 --> 00:33:21,200
something that would need a follow-on

937
00:33:26,710 --> 00:33:23,679
mission to operationalize thanks

938
00:33:28,310 --> 00:33:26,720

uh yeah okay i'll take that one so um uh

939
00:33:29,669 --> 00:33:28,320
the first question was how many yeah

940
00:33:31,350 --> 00:33:29,679
those are the only three ground stations

941
00:33:33,750 --> 00:33:31,360
we have that we've contracted with a

942
00:33:35,110 --> 00:33:33,760
private ground station vendor usn and

943
00:33:37,669 --> 00:33:35,120
those are the three stations that we've

944
00:33:40,870 --> 00:33:37,679
contracted to use um so those are sort

945
00:33:42,789 --> 00:33:40,880
of fixed um and then uh the the you know

946
00:33:44,310 --> 00:33:42,799
the cygnus mission it's a kind of

947
00:33:46,230 --> 00:33:44,320
research and discovery mission not an

948
00:33:47,990 --> 00:33:46,240
operational mission and it's a nasa

949
00:33:49,509 --> 00:33:48,000
mission not a no emission that being

950
00:33:51,750 --> 00:33:49,519
said there's a number of noaa

951
00:33:53,669 --> 00:33:51,760
investigators on the cygnus science team

952
00:33:55,110 --> 00:33:53,679
and there are a number of people at the

953
00:33:56,310 --> 00:33:55,120
national hurricane center that are

954
00:33:57,990 --> 00:33:56,320
involved in seconds they know all about

955
00:33:59,269 --> 00:33:58,000
what we're doing what we're doing i've

956
00:34:00,630 --> 00:33:59,279
gone down there a number of times and

957
00:34:01,990 --> 00:34:00,640
briefed them and they're you know very

958
00:34:03,350 --> 00:34:02,000
excited at looking at the data they're

959
00:34:04,710 --> 00:34:03,360
very you know they're careful and

960
00:34:07,350 --> 00:34:04,720
cautious about

961
00:34:09,030 --> 00:34:07,360
using new data types and there's a

962
00:34:10,710 --> 00:34:09,040
careful vetting process that they go

963
00:34:13,190 --> 00:34:10,720

through over a period of years when they

964
00:34:15,829 --> 00:34:13,200
look at the the quality or potential

965
00:34:18,710 --> 00:34:15,839
impact of the uh of the new data sets on

966
00:34:21,030 --> 00:34:18,720
their uh their forecast skill and the

967
00:34:21,990 --> 00:34:21,040
intent is to do that um over the first

968
00:34:24,230 --> 00:34:22,000
you know a couple of years of the

969
00:34:26,470 --> 00:34:24,240
mission and then they're going to decide

970
00:34:28,869 --> 00:34:26,480
what to do next but they you know they

971
00:34:30,629 --> 00:34:28,879
very carefully test out the impact of

972
00:34:33,750 --> 00:34:30,639
new data sets on their on their forecast

973
00:34:35,589 --> 00:34:33,760
skill before they start to use them

974
00:34:36,950 --> 00:34:35,599
we'll go to a question on the phone and

975
00:34:43,669 --> 00:34:36,960
just reminder to please identify

976
00:34:47,109 --> 00:34:45,349
hi this is michael phillips with

977
00:34:49,270 --> 00:34:47,119
weatherboy.com

978
00:34:51,270 --> 00:34:49,280
um with the data that you're collecting

979
00:34:53,669 --> 00:34:51,280
can you talk about how that data will

980
00:34:54,470 --> 00:34:53,679
actually be validated and verified are

981
00:34:56,869 --> 00:34:54,480
you

982
00:34:59,349 --> 00:34:56,879
looking at data from uh sources like the

983
00:35:01,109 --> 00:34:59,359
national hurricane center to verify

984
00:35:02,390 --> 00:35:01,119
um the information you're collecting is

985
00:35:05,349 --> 00:35:02,400
accurate

986
00:35:06,630 --> 00:35:05,359
um yeah so uh we yes we're working with

987
00:35:08,630 --> 00:35:06,640
the um

988
00:35:10,870 --> 00:35:08,640

what are they called aoc the the part of

989
00:35:12,230 --> 00:35:10,880
uh noaa in miami that that flies those

990
00:35:14,470 --> 00:35:12,240
hurricane hunter airplanes they know

991
00:35:17,190 --> 00:35:14,480
what we're doing and we actually went

992
00:35:19,109 --> 00:35:17,200
through a whole training

993
00:35:21,510 --> 00:35:19,119
process this hurt this past hurricane

994
00:35:23,910 --> 00:35:21,520
season using that that tool that um that

995
00:35:26,390 --> 00:35:23,920
mary showed you the sift tool where we

996
00:35:28,550 --> 00:35:26,400
would forecast where we would have made

997
00:35:30,310 --> 00:35:28,560
overpasses of hurricanes like matthew

998
00:35:31,990 --> 00:35:30,320
and a couple of the others this year

999
00:35:33,750 --> 00:35:32,000
where we would have made overpasses and

1000
00:35:35,910 --> 00:35:33,760
when um two or three days in the future

1001
00:35:37,829 --> 00:35:35,920
and also what our heading would be and

1002
00:35:40,230 --> 00:35:37,839
we talked to the uh the people there

1003
00:35:42,230 --> 00:35:40,240
that were flying the p3s the uh the you

1004
00:35:43,589 --> 00:35:42,240
know the navigators on board about what

1005
00:35:45,910 --> 00:35:43,599
we were doing and we worked out a

1006
00:35:47,670 --> 00:35:45,920
procedure to tell them what we would

1007
00:35:48,790 --> 00:35:47,680
like and they're they're very interested

1008
00:35:50,710 --> 00:35:48,800
in this and they want to help and

1009
00:35:52,950 --> 00:35:50,720
they're willing to try as much as

1010
00:35:55,510 --> 00:35:52,960
possible within the constraints of their

1011
00:35:57,510 --> 00:35:55,520
charter to underfly us when we go over

1012
00:36:00,150 --> 00:35:57,520
hurricanes and to fly the the flight

1013
00:36:01,750 --> 00:36:00,160

line of the airplane parallel to our um

1014
00:36:03,910 --> 00:36:01,760
ground track our specular point

1015
00:36:05,589 --> 00:36:03,920
transects so that we have as much uh

1016
00:36:07,109 --> 00:36:05,599
match up as or you know coincident match

1017
00:36:08,710 --> 00:36:07,119
up as possible between the uh the

1018
00:36:10,069 --> 00:36:08,720
airborne measurements of the you know

1019
00:36:11,750 --> 00:36:10,079
traditional way of measuring the winds

1020
00:36:13,990 --> 00:36:11,760
and the cygnus measurements so that's

1021
00:36:16,310 --> 00:36:14,000
going to be our primary validation tool

1022
00:36:17,589 --> 00:36:16,320
um in the in the hurricanes themselves

1023
00:36:18,950 --> 00:36:17,599
and then away from the hurricanes

1024
00:36:20,790 --> 00:36:18,960
there's a lot of standard ways to

1025
00:36:23,270 --> 00:36:20,800
validate the quality of wind retrievals

1026
00:36:25,109 --> 00:36:23,280
and we'll be using those as well

1027
00:36:26,790 --> 00:36:25,119
thank you i've got another question from

1028
00:36:29,510 --> 00:36:26,800
a caller on the phone this one from

1029
00:36:33,030 --> 00:36:29,520
jesse at space.com

1030
00:36:34,470 --> 00:36:33,040
i can you guys can hear this yeah good

1031
00:36:36,630 --> 00:36:34,480
all right um you know i was just

1032
00:36:38,310 --> 00:36:36,640
wondering the mission time the total

1033
00:36:40,230 --> 00:36:38,320
it's going to be right a two-year

1034
00:36:42,069 --> 00:36:40,240
mission and then maybe an extend one

1035
00:36:43,030 --> 00:36:42,079
after that and i was just curious if you

1036
00:36:47,670 --> 00:36:43,040
were

1037
00:36:52,870 --> 00:36:49,990
uh yeah we're gonna we're gonna turn on

1038
00:36:55,670 --> 00:36:52,880

um the science mode about uh sometime

1039
00:36:58,390 --> 00:36:55,680
during the second month after launch and

1040
00:37:01,349 --> 00:36:58,400
the intent is to stay on in science mode

1041
00:37:02,950 --> 00:37:01,359
24 7 100 of the time 100 duty cycle for

1042
00:37:04,630 --> 00:37:02,960
the rest of the mission so we'll be

1043
00:37:06,390 --> 00:37:04,640
making measurements over you know

1044
00:37:08,470 --> 00:37:06,400
hurricanes but they don't happen that

1045
00:37:09,750 --> 00:37:08,480
much you know statistically the other 99

1046
00:37:11,430 --> 00:37:09,760
of the time we'll be making measurements

1047
00:37:12,950 --> 00:37:11,440
over the ocean we also make measurements

1048
00:37:14,470 --> 00:37:12,960
over land for that matter which has

1049
00:37:15,910 --> 00:37:14,480
other science applications but yeah

1050
00:37:18,310 --> 00:37:15,920
we'll be running all the time over those

1051
00:37:19,670 --> 00:37:18,320
two years

1052
00:37:22,390 --> 00:37:19,680
okay great do we have any other

1053
00:37:24,310 --> 00:37:22,400
questions here in the room audience if

1054
00:37:27,990 --> 00:37:24,320
not uh we have any on social media i

1055
00:37:31,589 --> 00:37:29,270
all right so got two questions from

1056
00:37:33,750 --> 00:37:31,599
social media here for you uh the first

1057
00:37:37,670 --> 00:37:33,760
is when do you expect the data to start

1058
00:37:38,550 --> 00:37:37,680
being sent back to earth

1059
00:37:40,790 --> 00:37:38,560
um

1060
00:37:42,150 --> 00:37:40,800
well if by data you mean the engineering

1061
00:37:43,510 --> 00:37:42,160
communication with the satellites to

1062
00:37:45,829 --> 00:37:43,520
make sure they're healthy that happens

1063
00:37:47,910 --> 00:37:45,839

the first day within about two hours and

1064
00:37:49,109 --> 00:37:47,920
45 minutes is when we're we are hoping

1065
00:37:50,870 --> 00:37:49,119
or expecting to start getting

1066
00:37:52,630 --> 00:37:50,880
communications

1067
00:37:54,310 --> 00:37:52,640
i think our first light science data is

1068
00:37:55,829 --> 00:37:54,320
going to happen the second week just to

1069
00:37:57,030 --> 00:37:55,839
make sure that it works from an

1070
00:37:59,270 --> 00:37:57,040
engineering kind of functional

1071
00:38:00,630 --> 00:37:59,280
performance perspective and then

1072
00:38:02,390 --> 00:38:00,640
sometime during the second month we'll

1073
00:38:03,030 --> 00:38:02,400
be switching into regular science mode

1074
00:38:06,150 --> 00:38:03,040
and

1075
00:38:07,750 --> 00:38:06,160
just running running in science mode

1076
00:38:09,670 --> 00:38:07,760
okay and our next question and final

1077
00:38:11,829 --> 00:38:09,680
question from social media is

1078
00:38:13,910 --> 00:38:11,839
will cygnus help inform us about weather

1079
00:38:16,710 --> 00:38:13,920
and or climate outside of hurricane

1080
00:38:21,109 --> 00:38:19,190
i'm going gonna let mary answer because

1081
00:38:22,470 --> 00:38:21,119
well she's got her dissertation defense

1082
00:38:23,990 --> 00:38:22,480
in a couple of weeks and i figured this

1083
00:38:25,510 --> 00:38:24,000
is a good chance for me to like throw a

1084
00:38:28,470 --> 00:38:25,520
bunch of science questions at her to get

1085
00:38:29,349 --> 00:38:28,480
her warmed up for it

1086
00:38:31,190 --> 00:38:29,359
um

1087
00:38:32,630 --> 00:38:31,200
so the answer is yes

1088
00:38:34,069 --> 00:38:32,640

there's a lot of different science

1089
00:38:35,349 --> 00:38:34,079
applications that were a lot of the

1090
00:38:36,710 --> 00:38:35,359
members of the science team are actually

1091
00:38:38,550 --> 00:38:36,720
already working on

1092
00:38:40,870 --> 00:38:38,560
so we have an entire section of our

1093
00:38:42,390 --> 00:38:40,880
science team that's working on

1094
00:38:46,470 --> 00:38:42,400
increasing our understanding of tropical

1095
00:38:47,510 --> 00:38:46,480
convection uh the mjo in particular and

1096
00:38:49,910 --> 00:38:47,520
um

1097
00:38:52,550 --> 00:38:49,920
even stuff over land like soil moisture

1098
00:38:54,710 --> 00:38:52,560
and other you know other processes that

1099
00:38:57,190 --> 00:38:54,720
we're interested in looking into seeing

1100
00:38:58,950 --> 00:38:57,200
what the data tell us

1101
00:39:00,790 --> 00:38:58,960
wonderful we have any other follow-up

1102
00:39:07,349 --> 00:39:00,800
questions here in the room

1103
00:39:11,670 --> 00:39:09,190
jim siegel from space flight insider

1104
00:39:13,670 --> 00:39:11,680
again just to follow up from my question

1105
00:39:16,390 --> 00:39:13,680
earlier

1106
00:39:19,190 --> 00:39:16,400
having this cygnus system into the in

1107
00:39:21,670 --> 00:39:19,200
into the um in space is this going to

1108
00:39:23,109 --> 00:39:21,680
either replace some of the hurricane

1109
00:39:25,510 --> 00:39:23,119
hunter

1110
00:39:27,589 --> 00:39:25,520
airplanes that are out there now or is

1111
00:39:29,910 --> 00:39:27,599
it better than what they collect now can

1112
00:39:32,069 --> 00:39:29,920
you give us a a sense of

1113
00:39:34,390 --> 00:39:32,079

how this compares

1114
00:39:36,550 --> 00:39:34,400
in terms of the value of this

1115
00:39:38,630 --> 00:39:36,560
information and the accuracy

1116
00:39:40,310 --> 00:39:38,640
versus what we have today from whatever

1117
00:39:41,430 --> 00:39:40,320
source

1118
00:39:43,190 --> 00:39:41,440
right so i think they're very

1119
00:39:44,630 --> 00:39:43,200
complimentary they're not it's it's not

1120
00:39:46,310 --> 00:39:44,640
going to ever replace those hurricane

1121
00:39:48,870 --> 00:39:46,320
hunter planes for several reasons one is

1122
00:39:50,310 --> 00:39:48,880
the uh the spatial resolution of the

1123
00:39:52,230 --> 00:39:50,320
hurricane hunter measurements is much

1124
00:39:54,870 --> 00:39:52,240
better about five kilometers more about

1125
00:39:57,109 --> 00:39:54,880
20 kilometers um so you get a finer

1126
00:39:58,390 --> 00:39:57,119
finer resolved variation in the wind

1127
00:39:59,190 --> 00:39:58,400
gradients as you pass through the eye

1128
00:40:00,470 --> 00:39:59,200
wall

1129
00:40:01,670 --> 00:40:00,480
but the temporal sampling

1130
00:40:03,030 --> 00:40:01,680
characteristics for signals are much

1131
00:40:05,109 --> 00:40:03,040
better because we have global coverage

1132
00:40:06,309 --> 00:40:05,119
with lots of of uh

1133
00:40:08,150 --> 00:40:06,319
satellites

1134
00:40:09,990 --> 00:40:08,160
another important difference is that you

1135
00:40:12,069 --> 00:40:10,000
know the hurricane hunters have these uh

1136
00:40:13,270 --> 00:40:12,079
that sfmr sensor measuring the wind at

1137
00:40:15,349 --> 00:40:13,280
the surface but they have a lot of other

1138
00:40:16,870 --> 00:40:15,359

sensors as well and in particular

1139
00:40:19,750 --> 00:40:16,880
they're able to measure the vertical

1140
00:40:22,309 --> 00:40:19,760
profiles of the temperature and the uh

1141
00:40:26,630 --> 00:40:22,319
wind and uh the air pressure with drop

1142
00:40:28,390 --> 00:40:26,640
suns and the vertical structure is uh a

1143
00:40:30,309 --> 00:40:28,400
fundamental importance for understanding

1144
00:40:33,349 --> 00:40:30,319
the physical processes in a hurricane

1145
00:40:34,950 --> 00:40:33,359
and also for um for understanding uh

1146
00:40:36,710 --> 00:40:34,960
the or for

1147
00:40:39,589 --> 00:40:36,720
aiding in the prediction software the

1148
00:40:42,230 --> 00:40:39,599
forecasting software so uh

1149
00:40:44,710 --> 00:40:42,240
measuring vertical profiles is hard in

1150
00:40:46,550 --> 00:40:44,720
general from satellites and in heavy

1151
00:40:47,990 --> 00:40:46,560
precip there's really no good way to do

1152
00:40:50,150 --> 00:40:48,000
it now so we we don't know how to

1153
00:40:51,510 --> 00:40:50,160
replace those airplanes now given the

1154
00:40:55,109 --> 00:40:51,520
sort of state of the art of remote

1155
00:40:59,190 --> 00:40:56,390
all right i think that's all the time we

1156
00:41:01,349 --> 00:40:59,200
have for today and just as a reminder

1157
00:41:03,430 --> 00:41:01,359
this mission is scheduled to launch

1158
00:41:04,950 --> 00:41:03,440
monday morning you can watch it live on

1159
00:41:06,230 --> 00:41:04,960
nasa.gov

1160
00:41:08,550 --> 00:41:06,240
and you can find out much more about

1161
00:41:11,190 --> 00:41:08,560
this mission by going to the special

1162
00:41:12,870 --> 00:41:11,200
mission website at nasa.gov