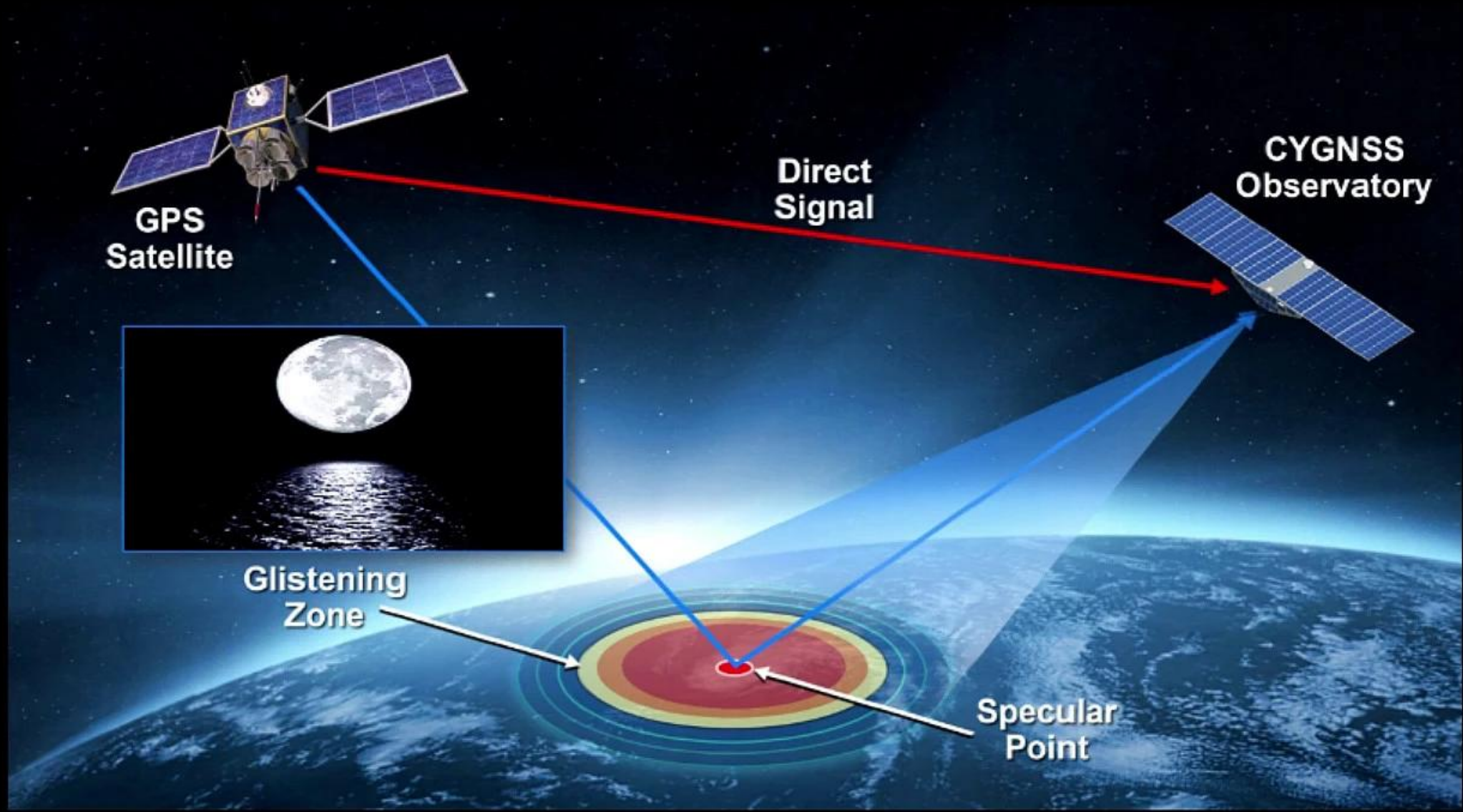
GPS
Satellite
Direct
Signal
CYGNSS
Observatory
Glistening
Zone
Specular
Point

1
00:00:04,150 --> 00:00:02,149
good afternoon i'm sean potter from

2
00:00:06,230 --> 00:00:04,160
nasa's office of communications and

3
00:00:08,549 --> 00:00:06,240
we're here today to tell you about

4
00:00:10,549 --> 00:00:08,559
nasa's first earth science small

5
00:00:12,789 --> 00:00:10,559
satellite constellation

6
00:00:14,910 --> 00:00:12,799
the cyclone global navigation satellite

7
00:00:17,349 --> 00:00:14,920
system otherwise known as

8
00:00:19,189 --> 00:00:17,359
cygnus scheduled to launch december 12th

9
00:00:20,310 --> 00:00:19,199
from cape canaveral air force station in

10
00:00:22,150 --> 00:00:20,320
florida

11
00:00:23,349 --> 00:00:22,160
cygnus will use a fleet of eight micro

12
00:00:25,429 --> 00:00:23,359
satellites

13
00:00:27,589 --> 00:00:25,439

to look inside tropical storms and

14
00:00:28,870 --> 00:00:27,599
hurricanes in a way no mission has done

15
00:00:30,710 --> 00:00:28,880
before

16
00:00:32,630 --> 00:00:30,720
to start things off today i'd like to

17
00:00:34,709 --> 00:00:32,640
introduce thomas zerbukin associate

18
00:00:46,150 --> 00:00:34,719
administrator for nasa's science mission

19
00:00:49,910 --> 00:00:48,389
i'm really excited to be here today and

20
00:00:51,910 --> 00:00:49,920
talk to you about this mission and

21
00:00:54,470 --> 00:00:51,920
especially about earth signs because see

22
00:00:56,470 --> 00:00:54,480
nasa's work on earth science is making a

23
00:00:59,110 --> 00:00:56,480
difference in people's lives

24
00:01:01,830 --> 00:00:59,120
all around the world every day

25
00:01:04,070 --> 00:01:01,840
earth signs help save lives it also

26
00:01:06,310 --> 00:01:04,080
helps grow companies and create an

27
00:01:09,990 --> 00:01:06,320
awareness of environmental challenges

28
00:01:11,590 --> 00:01:10,000
that affect our lives today and tomorrow

29
00:01:13,750 --> 00:01:11,600
today you'll hear about a mission that

30
00:01:16,310 --> 00:01:13,760
does just that

31
00:01:18,469 --> 00:01:16,320
sickness is a first mission of its kind

32
00:01:21,350 --> 00:01:18,479
that will gather never-before-seen

33
00:01:23,670 --> 00:01:21,360
details on the formation and intensity

34
00:01:24,950 --> 00:01:23,680
of tropical cyclones and hurricanes

35
00:01:26,950 --> 00:01:24,960
globally

36
00:01:29,190 --> 00:01:26,960
clearly it's a mission that is not only

37
00:01:30,870 --> 00:01:29,200
vital for public safety

38
00:01:33,030 --> 00:01:30,880

but also one of

39
00:01:35,670 --> 00:01:33,040
100 nasa missions in the agency's

40
00:01:38,390 --> 00:01:35,680
portfolio that inspired a nation

41
00:01:40,710 --> 00:01:38,400
and excite and encourage young people

42
00:01:42,950 --> 00:01:40,720
around the world to pursue

43
00:01:44,870 --> 00:01:42,960
careers in science and technology

44
00:01:46,950 --> 00:01:44,880
engineering and math

45
00:01:49,910 --> 00:01:46,960
cygnus will do what existing satellite

46
00:01:52,550 --> 00:01:49,920
technology can't in terms of measuring

47
00:01:55,109 --> 00:01:52,560
surface wind speeds inside hurricanes

48
00:01:57,590 --> 00:01:55,119
and tropical cyclones to improve our

49
00:01:58,709 --> 00:01:57,600
ability to predict how these deadly

50
00:02:01,510 --> 00:01:58,719
storms

51
00:02:03,910 --> 00:02:01,520
develop and evolve it's truly a mission

52
00:02:06,950 --> 00:02:03,920
that will be vital for our earth right

53
00:02:09,589 --> 00:02:06,960
now from today's response to natural

54
00:02:14,150 --> 00:02:09,599
disasters to tomorrow's air quality and

55
00:02:19,589 --> 00:02:14,160
much more nasa is working for you 24 7.

56
00:02:23,350 --> 00:02:21,350
all right thank you very much thomas now

57
00:02:24,949 --> 00:02:23,360
before we introduce our panelists i'd

58
00:02:27,830 --> 00:02:24,959
like to take just a moment here to go

59
00:02:29,589 --> 00:02:27,840
over a few brief housekeeping notes

60
00:02:31,990 --> 00:02:29,599
if you're interested in finding out any

61
00:02:34,150 --> 00:02:32,000
information about this mission you can

62
00:02:35,270 --> 00:02:34,160
do so by visiting our special mission

63
00:02:40,070 --> 00:02:35,280

website

64
00:02:44,710 --> 00:02:43,270
cygnus and that's spelled c-y-g-n-s

65
00:02:46,550 --> 00:02:44,720
all lowercase

66
00:02:47,990 --> 00:02:46,560
and if you're following us on social

67
00:02:50,309 --> 00:02:48,000
media and would like to ask a question

68
00:02:53,270 --> 00:02:50,319
for our panelists you can do so using

69
00:02:54,550 --> 00:02:53,280
the hashtag asknasa

70
00:02:56,949 --> 00:02:54,560
and now i'd like to introduce our

71
00:02:59,430 --> 00:02:56,959
panelists of cygnus mission experts

72
00:03:02,070 --> 00:02:59,440
directly to my left is christine

73
00:03:03,670 --> 00:03:02,080
boniksen cygnus program executive here

74
00:03:05,670 --> 00:03:03,680
at nasa headquarters

75
00:03:07,830 --> 00:03:05,680
to her left is john shearer cygnus

76
00:03:10,550 --> 00:03:07,840
project manager at the southwest

77
00:03:13,190 --> 00:03:10,560
research institute in san antonio

78
00:03:14,550 --> 00:03:13,200
next to john is chris ruff cygnus

79
00:03:17,030 --> 00:03:14,560
principal investigator from the

80
00:03:19,750 --> 00:03:17,040
university of michigan in ann arbor and

81
00:03:22,149 --> 00:03:19,760
finally we have mary morris a phd

82
00:03:24,390 --> 00:03:22,159
student in the climate and space

83
00:03:26,949 --> 00:03:24,400
studies department at the university of

84
00:03:28,229 --> 00:03:26,959
michigan so we'll start things off with

85
00:03:30,710 --> 00:03:28,239
christine

86
00:03:32,390 --> 00:03:30,720
thank you sean this is a really good day

87
00:03:34,309 --> 00:03:32,400
for earth science could you bring up my

88
00:03:36,550 --> 00:03:34,319

first slide please

89
00:03:38,550 --> 00:03:36,560
what earth science has worked for many

90
00:03:40,229 --> 00:03:38,560
many years on

91
00:03:41,990 --> 00:03:40,239
looking at all the processes on the

92
00:03:44,149 --> 00:03:42,000
earth and as you see here we've got a

93
00:03:47,670 --> 00:03:44,159
number of satellites that are up there

94
00:03:49,589 --> 00:03:47,680
trying to do that but science and

95
00:03:51,509 --> 00:03:49,599
technology has progressed a great deal

96
00:03:53,509 --> 00:03:51,519
over the last few years

97
00:03:55,509 --> 00:03:53,519
and there's a lot of new ideas on how to

98
00:03:58,550 --> 00:03:55,519
use that technology

99
00:04:00,789 --> 00:03:58,560
and as part of that next slide please

100
00:04:03,030 --> 00:04:00,799
we launched the earthventure class

101
00:04:05,030 --> 00:04:03,040
program now there are three strands to

102
00:04:08,309 --> 00:04:05,040
that there's the sub suborbital where we

103
00:04:11,030 --> 00:04:08,319
do investigations with aircraft balloons

104
00:04:12,470 --> 00:04:11,040
grounds ground in situ measurements we

105
00:04:16,069 --> 00:04:12,480
have instruments that we put on the

106
00:04:17,590 --> 00:04:16,079
earth's on iss and on to other payloads

107
00:04:19,749 --> 00:04:17,600
and we've also got full missions of

108
00:04:21,189 --> 00:04:19,759
which cygnus is our flagship mission for

109
00:04:24,550 --> 00:04:21,199
this

110
00:04:26,710 --> 00:04:24,560
includes building the satellites it

111
00:04:29,030 --> 00:04:26,720
includes getting it in to operations and

112
00:04:32,310 --> 00:04:29,040
operating it in the case of cygnus for

113
00:04:33,430 --> 00:04:32,320

two full years with a very minimal

114
00:04:37,749 --> 00:04:33,440
cost

115
00:04:40,710 --> 00:04:37,759
cygnus will be launched and operated

116
00:04:46,550 --> 00:04:40,720
for 162 million dollars including all

117
00:04:51,590 --> 00:04:49,430
like all space missions cygnus has

118
00:04:53,590 --> 00:04:51,600
a portion that goes into space and a

119
00:04:55,670 --> 00:04:53,600
portion that stays here on the ground

120
00:04:58,390 --> 00:04:55,680
next slide please

121
00:05:00,790 --> 00:04:58,400
what you see behind me are the pieces of

122
00:05:04,310 --> 00:05:00,800
cygnus that go into space

123
00:05:05,830 --> 00:05:04,320
on the left is the instrument

124
00:05:08,469 --> 00:05:05,840
in the center you see the fully

125
00:05:10,870 --> 00:05:08,479
assembled spacecraft and if you want to

126
00:05:13,749 --> 00:05:10,880
know how exactly how big that is at the

127
00:05:15,510 --> 00:05:13,759
far end of the table here is a model of

128
00:05:17,670 --> 00:05:15,520
the full-size spacecraft that we're

129
00:05:19,590 --> 00:05:17,680
talking about

130
00:05:22,150 --> 00:05:19,600
then what you the big column you see at

131
00:05:24,230 --> 00:05:22,160
the end this is the deployment module

132
00:05:26,790 --> 00:05:24,240
that will when we launch have eight

133
00:05:27,990 --> 00:05:26,800
spacecraft locked onto this to get us

134
00:05:29,590 --> 00:05:28,000
into orbit

135
00:05:31,670 --> 00:05:29,600
next slide

136
00:05:33,189 --> 00:05:31,680
the ground segment consists of three

137
00:05:34,310 --> 00:05:33,199
pieces there's the communication

138
00:05:35,830 --> 00:05:34,320

stations

139
00:05:37,590 --> 00:05:35,840
where we get our data down and we

140
00:05:39,350 --> 00:05:37,600
control our satellites there's the

141
00:05:41,270 --> 00:05:39,360
mission operations center that's going

142
00:05:42,950 --> 00:05:41,280
to be in boulder colorado

143
00:05:44,790 --> 00:05:42,960
and then the science operations center

144
00:05:47,270 --> 00:05:44,800
up at the university of michigan and

145
00:05:50,150 --> 00:05:47,280
you'll hear about all of these as

146
00:05:52,390 --> 00:05:50,160
we as we go through this presentation

147
00:05:54,469 --> 00:05:52,400
what i want to leave you with is that

148
00:05:58,150 --> 00:05:54,479
cygnus as a flagship mission in addition

149
00:06:00,790 --> 00:05:58,160
to being low cost came in on schedule on

150
00:06:02,790 --> 00:06:00,800
cost and on science

151
00:06:04,550 --> 00:06:02,800
with that i will turn it over to john

152
00:06:06,950 --> 00:06:04,560
shearer who will tell us how we got to

153
00:06:08,870 --> 00:06:06,960
this point okay thank you yes i'm john

154
00:06:09,990 --> 00:06:08,880
shearer i'm the sickness project manager

155
00:06:11,670 --> 00:06:10,000
i'd like to tell you a little bit about

156
00:06:13,430 --> 00:06:11,680
the mission uh first off let's talk

157
00:06:14,790 --> 00:06:13,440
about a little bit about the observatory

158
00:06:17,110 --> 00:06:14,800
as chris said this is a full-size

159
00:06:19,510 --> 00:06:17,120
mock-up of the spacecraft over here it

160
00:06:21,909 --> 00:06:19,520
weighs about 64 pounds

161
00:06:23,830 --> 00:06:21,919
and uh it's basically when it's when the

162
00:06:26,070 --> 00:06:23,840
solar rays are stowed it's about the

163
00:06:27,270 --> 00:06:26,080

size of a carry-on suitcase and you know

164
00:06:29,110 --> 00:06:27,280
to me that's one of the neatest things

165
00:06:30,629 --> 00:06:29,120
about this we're doing real science with

166
00:06:32,309 --> 00:06:30,639
a spacecraft that can literally sit on

167
00:06:33,749 --> 00:06:32,319
your desk right here and not just one of

168
00:06:35,110 --> 00:06:33,759
them but we'll have eight they'll be

169
00:06:37,029 --> 00:06:35,120
orbiting in the tropics where the

170
00:06:37,990 --> 00:06:37,039
hurricanes are and every 90 minutes

171
00:06:40,309 --> 00:06:38,000
they'll be

172
00:06:41,270 --> 00:06:40,319
making another measurement next slide

173
00:06:43,909 --> 00:06:41,280
please

174
00:06:45,590 --> 00:06:43,919
so each spacecraft has a payload called

175
00:06:48,230 --> 00:06:45,600
the delay doppler mapping instrument on

176
00:06:51,029 --> 00:06:48,240
board it's basically a fancy gps

177
00:06:53,510 --> 00:06:51,039
receiver that's capable of tracking four

178
00:06:55,830 --> 00:06:53,520
different gps signals simultaneously and

179
00:06:58,150 --> 00:06:55,840
then we have two large uh antennas that

180
00:07:00,550 --> 00:06:58,160
are facing downward looking towards the

181
00:07:03,430 --> 00:07:00,560
to the ocean and then an upward facing

182
00:07:05,510 --> 00:07:03,440
antenna also the whole payload weighs 7

183
00:07:07,749 --> 00:07:05,520
pounds and on takes 12 watts of power

184
00:07:10,070 --> 00:07:07,759
okay next slide

185
00:07:12,390 --> 00:07:10,080
so chris will talk about how we use

186
00:07:15,029 --> 00:07:12,400
reflected gps to measure the wind speed

187
00:07:17,189 --> 00:07:15,039
but from an engineering standpoint doing

188
00:07:18,790 --> 00:07:17,199

this is really an enabling technology

189
00:07:20,870 --> 00:07:18,800
for cygnus

190
00:07:23,350 --> 00:07:20,880
because the sigma spacecraft don't have

191
00:07:25,110 --> 00:07:23,360
to generate the signal or transmit the

192
00:07:27,589 --> 00:07:25,120
signal all they have to do is receive

193
00:07:29,670 --> 00:07:27,599
the signal it takes very little power

194
00:07:31,589 --> 00:07:29,680
the cygnus spacecraft operate on about

195
00:07:33,589 --> 00:07:31,599
60 watts of power equivalent to a 60

196
00:07:35,189 --> 00:07:33,599
watt light bulb in your house

197
00:07:37,670 --> 00:07:35,199
and what that allows is a small

198
00:07:40,070 --> 00:07:37,680
spacecraft small solar rays and allows

199
00:07:42,710 --> 00:07:40,080
us to launch eight very small spacecraft

200
00:07:44,629 --> 00:07:42,720
on a single low-cost launch vehicle

201
00:07:46,790 --> 00:07:44,639
next slide

202
00:07:48,550 --> 00:07:46,800
as chris said the eight mark sets get

203
00:07:50,150 --> 00:07:48,560
attached to the deployment module which

204
00:07:51,110 --> 00:07:50,160
stays actually attached to the launch

205
00:07:56,230 --> 00:07:51,120
vehicle

206
00:07:58,550 --> 00:07:56,240
correct orbit altitude and orientation

207
00:08:00,230 --> 00:07:58,560
the launch vehicle will send a signal to

208
00:08:02,950 --> 00:08:00,240
the deployment module

209
00:08:04,230 --> 00:08:02,960
to release the eight microsets next

210
00:08:06,070 --> 00:08:04,240
slide

211
00:08:08,950 --> 00:08:06,080
so now i'm going to walk through some

212
00:08:11,589 --> 00:08:08,960
photos of the construction and test of

213
00:08:14,150 --> 00:08:11,599

the constellation and the flight segment

214
00:08:15,830 --> 00:08:14,160
this is a picture early on of one of the

215
00:08:17,749 --> 00:08:15,840
eight microsats under construction you

216
00:08:20,550 --> 00:08:17,759
can see the structure uh internal to the

217
00:08:23,670 --> 00:08:20,560
microsat and one of the nader facing

218
00:08:25,430 --> 00:08:23,680
science antennas next slide

219
00:08:28,070 --> 00:08:25,440
as we went through integration each

220
00:08:30,469 --> 00:08:28,080
component was integrated to the microsat

221
00:08:32,709 --> 00:08:30,479
and following each integration step

222
00:08:34,310 --> 00:08:32,719
we performed a functional test to make

223
00:08:36,790 --> 00:08:34,320
sure that that particular component or

224
00:08:38,550 --> 00:08:36,800
subsystem worked correctly and also to

225
00:08:40,870 --> 00:08:38,560
make sure that it played correctly with

226
00:08:43,190 --> 00:08:40,880
the microsat so this this picture

227
00:08:45,430 --> 00:08:43,200
actually shows a very good um shot of

228
00:08:46,790 --> 00:08:45,440
this the overall scale of a microset you

229
00:08:47,990 --> 00:08:46,800
have two other ones in the background

230
00:08:49,750 --> 00:08:48,000
there also

231
00:08:51,910 --> 00:08:49,760
next slide

232
00:08:53,190 --> 00:08:51,920
we did solar ray deployment tests many

233
00:08:54,949 --> 00:08:53,200
many times

234
00:08:56,389 --> 00:08:54,959
throughout the integration test campaign

235
00:08:59,190 --> 00:08:56,399
we did them under at different

236
00:09:00,870 --> 00:08:59,200
temperatures under vacuum pre and post

237
00:09:02,630 --> 00:09:00,880
environmental tests

238
00:09:04,070 --> 00:09:02,640

next slide

239
00:09:06,630 --> 00:09:04,080
one of the environmental tests that we

240
00:09:08,710 --> 00:09:06,640
did was called a thermal vacuum test

241
00:09:10,710 --> 00:09:08,720
this is a shot of four different

242
00:09:11,670 --> 00:09:10,720
microsets going into the thermal vacuum

243
00:09:14,870 --> 00:09:11,680
chamber

244
00:09:16,790 --> 00:09:14,880
basically simulated the vacuum

245
00:09:19,030 --> 00:09:16,800
environment of space and then we would

246
00:09:20,630 --> 00:09:19,040
cycle the chamber to the different

247
00:09:22,470 --> 00:09:20,640
predicted extreme temperatures that

248
00:09:24,150 --> 00:09:22,480
we'll see in space again just to make

249
00:09:27,670 --> 00:09:24,160
sure that when we get on orbit

250
00:09:29,590 --> 00:09:27,680
everything works correctly next slide

251
00:09:31,590 --> 00:09:29,600
because cygnus is a

252
00:09:33,509 --> 00:09:31,600
sensitive rf

253
00:09:35,030 --> 00:09:33,519
receiver payload

254
00:09:37,030 --> 00:09:35,040
one of the tests we did was what we call

255
00:09:40,949 --> 00:09:37,040
the plugs out test where we took a

256
00:09:43,269 --> 00:09:40,959
microsat and put it in a rf anechoic

257
00:09:44,710 --> 00:09:43,279
chamber which is an rf quiet room

258
00:09:45,829 --> 00:09:44,720
and literally unplugged it from

259
00:09:48,230 --> 00:09:45,839
everything so we were running the

260
00:09:50,070 --> 00:09:48,240
microsat over rf with the batteries just

261
00:09:52,470 --> 00:09:50,080
like it is on orbit and to make sure

262
00:09:54,150 --> 00:09:52,480
that the noise floor was low enough for

263
00:09:55,910 --> 00:09:54,160

us to make the sensitive measurements

264
00:09:58,470 --> 00:09:55,920
that we need for the science

265
00:09:59,990 --> 00:09:58,480
next slide

266
00:10:02,069 --> 00:10:00,000
one of the final tests we did before

267
00:10:04,550 --> 00:10:02,079
delivery to vandenberg was a flight

268
00:10:06,550 --> 00:10:04,560
segment vibration test this is a shot

269
00:10:08,310 --> 00:10:06,560
showing the eight microsats

270
00:10:09,670 --> 00:10:08,320
mounted to the deployment module on the

271
00:10:11,350 --> 00:10:09,680
adapter cone

272
00:10:13,030 --> 00:10:11,360
on a vibration table

273
00:10:14,710 --> 00:10:13,040
we shook the flight segment to the

274
00:10:16,630 --> 00:10:14,720
predicted flight levels and then

275
00:10:18,630 --> 00:10:16,640
following that test

276
00:10:20,150 --> 00:10:18,640
we deployed each microset from the

277
00:10:22,069 --> 00:10:20,160
deployment module to make sure that that

278
00:10:23,750 --> 00:10:22,079
still worked we then did a functional

279
00:10:25,990 --> 00:10:23,760
test on each microset and then that

280
00:10:27,190 --> 00:10:26,000
included a deployment of each solar

281
00:10:28,790 --> 00:10:27,200
array

282
00:10:30,550 --> 00:10:28,800
next slide

283
00:10:32,790 --> 00:10:30,560
so this is what we call our

284
00:10:34,630 --> 00:10:32,800
cherry on top photograph this was taken

285
00:10:36,470 --> 00:10:34,640
about a week ago out at vandenberg this

286
00:10:39,030 --> 00:10:36,480
is a picture of the flight segment with

287
00:10:41,430 --> 00:10:39,040
eight micro sets mounted on top of the

288
00:10:43,509 --> 00:10:41,440

pegasus rocket

289
00:10:45,910 --> 00:10:43,519
as of today there's one side of the

290
00:10:47,829 --> 00:10:45,920
fairing on and the second half of it is

291
00:10:49,509 --> 00:10:47,839
scheduled to go on next monday

292
00:10:50,389 --> 00:10:49,519
next slide

293
00:10:52,550 --> 00:10:50,399
so

294
00:10:55,190 --> 00:10:52,560
the pegasus launch system is a little

295
00:10:57,350 --> 00:10:55,200
bit uh unique from a lot of rockets that

296
00:10:58,310 --> 00:10:57,360
i think most people are typical or are

297
00:11:00,389 --> 00:10:58,320
used to

298
00:11:02,949 --> 00:11:00,399
it's an air launch system uh the rocket

299
00:11:06,230 --> 00:11:02,959
which you see here in this picture uh

300
00:11:08,310 --> 00:11:06,240
hangs off of a l-1011 airplane uh the

301
00:11:10,949 --> 00:11:08,320
airplane takes the whole rocket up to

302
00:11:12,710 --> 00:11:10,959
about forty thousand feet uh drops the

303
00:11:14,949 --> 00:11:12,720
the payload the rocket and then five

304
00:11:16,389 --> 00:11:14,959
seconds later the rocket engines ignite

305
00:11:18,949 --> 00:11:16,399
next slide

306
00:11:21,590 --> 00:11:18,959
this is a picture showing the pegasus

307
00:11:23,509 --> 00:11:21,600
mounted on the bottom side of the l-1011

308
00:11:24,949 --> 00:11:23,519
ready for takeoff

309
00:11:26,550 --> 00:11:24,959
okay

310
00:11:28,790 --> 00:11:26,560
next please

311
00:11:30,790 --> 00:11:28,800
so now i've got a video an artist's

312
00:11:33,030 --> 00:11:30,800
rendition of the deployment sequence

313
00:11:34,550 --> 00:11:33,040

again the launch vehicle is responsible

314
00:11:36,470 --> 00:11:34,560
for getting us into the correct altitude

315
00:11:38,630 --> 00:11:36,480
and orientation and then we'll send a

316
00:11:41,670 --> 00:11:38,640
signal to the deployment module

317
00:11:43,670 --> 00:11:41,680
and the microsats each have their own

318
00:11:46,710 --> 00:11:43,680
release mechanism and push off springs

319
00:11:49,269 --> 00:11:46,720
they release in opposing pairs

320
00:11:52,230 --> 00:11:49,279
and each pair is released 30 seconds

321
00:11:54,870 --> 00:11:52,240
after the previous pair and then 10

322
00:11:58,550 --> 00:11:54,880
minutes later after separation

323
00:12:00,629 --> 00:11:58,560
the solar rays automatically uh deploy

324
00:12:02,069 --> 00:12:00,639
the the microsets automatically turn on

325
00:12:04,230 --> 00:12:02,079
once they're separated from the

326
00:12:06,069 --> 00:12:04,240
deployment module and now chris we'll

327
00:12:07,269 --> 00:12:06,079
talk about the cygnus science that we're

328
00:12:09,350 --> 00:12:07,279
going to do

329
00:12:13,110 --> 00:12:09,360
okay thanks john yeah i'm chris ruff the

330
00:12:15,269 --> 00:12:13,120
principal investigator on cygnus and um

331
00:12:17,910 --> 00:12:15,279
as you've heard cygnus is designed to

332
00:12:20,710 --> 00:12:17,920
measure winds over the ocean

333
00:12:22,550 --> 00:12:20,720
and it makes the measurements in two

334
00:12:25,670 --> 00:12:22,560
important different ways that are going

335
00:12:26,870 --> 00:12:25,680
to enable it to um to improve on our

336
00:12:29,269 --> 00:12:26,880
ability to

337
00:12:30,629 --> 00:12:29,279
monitor the inner core of hurricanes and

338
00:12:33,030 --> 00:12:30,639

ultimately improve our ability to

339
00:12:35,430 --> 00:12:33,040
forecast hurricanes and i wanted to set

340
00:12:37,509 --> 00:12:35,440
the stage here first by doing like a

341
00:12:39,990 --> 00:12:37,519
quick review of how we measure winds

342
00:12:41,590 --> 00:12:40,000
from space over the ocean today

343
00:12:43,750 --> 00:12:41,600
and this is uh this first slide is an

344
00:12:45,829 --> 00:12:43,760
example of a typical technique that's

345
00:12:48,629 --> 00:12:45,839
used today the satellite on the left is

346
00:12:50,550 --> 00:12:48,639
the nasa trim satellite and one of the

347
00:12:54,550 --> 00:12:50,560
instruments on it is the trim microwave

348
00:12:56,629 --> 00:12:54,560
imager tmi it's the large white antenna

349
00:12:58,790 --> 00:12:56,639
on the top left in the in the picture of

350
00:13:01,110 --> 00:12:58,800
the satellite and these are two data

351
00:13:03,269 --> 00:13:01,120
products that are generated by tmi the

352
00:13:04,550 --> 00:13:03,279
top one is a measurement of the rain or

353
00:13:06,230 --> 00:13:04,560
the precipitate the rain rate the

354
00:13:07,590 --> 00:13:06,240
precipitation

355
00:13:08,949 --> 00:13:07,600
everywhere in the tropics and the bottom

356
00:13:10,470 --> 00:13:08,959
one is a measurement of the ocean wind

357
00:13:13,030 --> 00:13:10,480
speed so this instrument can measure

358
00:13:15,670 --> 00:13:13,040
ocean wind there's two important

359
00:13:16,949 --> 00:13:15,680
limitations in this type of measurement

360
00:13:19,110 --> 00:13:16,959
which are

361
00:13:21,269 --> 00:13:19,120
common to all current techniques that

362
00:13:23,670 --> 00:13:21,279
can measure the wind over the ocean the

363
00:13:25,670 --> 00:13:23,680

first one is the fact that wherever the

364
00:13:27,829 --> 00:13:25,680
rain is heavy in the top picture if you

365
00:13:30,069 --> 00:13:27,839
look down at the same spot in the wind

366
00:13:32,230 --> 00:13:30,079
image it's black and the reason for that

367
00:13:34,230 --> 00:13:32,240
is that these signals that are used

368
00:13:35,750 --> 00:13:34,240
cannot penetrate through rain the reason

369
00:13:37,190 --> 00:13:35,760
they can't is because of the wavelengths

370
00:13:38,710 --> 00:13:37,200
that are used this is a

371
00:13:40,389 --> 00:13:38,720
system that operates at a eight

372
00:13:42,550 --> 00:13:40,399
millimeter radio wavelength and eight

373
00:13:43,990 --> 00:13:42,560
millimeters is about the same size as a

374
00:13:45,350 --> 00:13:44,000
large raindrop so there's too much

375
00:13:47,189 --> 00:13:45,360
interaction with the rain and you can't

376
00:13:48,310 --> 00:13:47,199
penetrate so that's one limitation we

377
00:13:49,509 --> 00:13:48,320
can't see through rain the other

378
00:13:51,110 --> 00:13:49,519
limitation

379
00:13:52,230 --> 00:13:51,120
as you can see in the title to these

380
00:13:54,150 --> 00:13:52,240
slides

381
00:13:56,629 --> 00:13:54,160
these are three-day images and what that

382
00:13:58,310 --> 00:13:56,639
means is it took about three days of

383
00:14:00,710 --> 00:13:58,320
orbiting by this satellite before it

384
00:14:02,230 --> 00:14:00,720
covered the entire world once so it

385
00:14:04,550 --> 00:14:02,240
takes three days to get an image of the

386
00:14:06,870 --> 00:14:04,560
earth and with um

387
00:14:08,389 --> 00:14:06,880
the critical short time scale processes

388
00:14:10,150 --> 00:14:08,399

in a hurricane especially the rapid

389
00:14:11,910 --> 00:14:10,160
intensification phase when a hurricane

390
00:14:13,990 --> 00:14:11,920
transitions from a tropical depression

391
00:14:16,389 --> 00:14:14,000
or storm to a hurricane that typically

392
00:14:18,389 --> 00:14:16,399
happens on time scales of hours to maybe

393
00:14:20,069 --> 00:14:18,399
a full day and if you only sample once

394
00:14:22,069 --> 00:14:20,079
every three days you'll miss it

395
00:14:24,310 --> 00:14:22,079
so the two critical things that we're

396
00:14:25,910 --> 00:14:24,320
trying to do with cygnus are to sample

397
00:14:28,550 --> 00:14:25,920
much more often than once every three

398
00:14:31,110 --> 00:14:28,560
days and to be able to penetrate through

399
00:14:34,230 --> 00:14:31,120
the rain uh the reason for that is that

400
00:14:36,790 --> 00:14:34,240
um the the primary limitation with our

401
00:14:39,189 --> 00:14:36,800
current ability to forecast how strong a

402
00:14:40,150 --> 00:14:39,199
hurricane is going to be in the future

403
00:14:42,629 --> 00:14:40,160
is

404
00:14:44,310 --> 00:14:42,639
our inability to to see what's going on

405
00:14:46,069 --> 00:14:44,320
in the inner core of the hurricane we

406
00:14:47,670 --> 00:14:46,079
can forecast where a hurricane is going

407
00:14:49,590 --> 00:14:47,680
to go fairly well because that's

408
00:14:51,350 --> 00:14:49,600
determined by environmental fields away

409
00:14:53,829 --> 00:14:51,360
from the hurricane which are easy to

410
00:14:55,189 --> 00:14:53,839
measure now with existing satellites but

411
00:14:56,629 --> 00:14:55,199
we can't measure what's happening in the

412
00:14:59,269 --> 00:14:56,639
center of the hurricane which is what

413
00:15:00,629 --> 00:14:59,279

drives its rapid intensification so we

414
00:15:02,949 --> 00:15:00,639
need to be able to penetrate through the

415
00:15:04,150 --> 00:15:02,959
rain and we need to be able to measure

416
00:15:05,990 --> 00:15:04,160
more often

417
00:15:08,470 --> 00:15:06,000
if we can go to the next slide this is

418
00:15:09,910 --> 00:15:08,480
an example of the one way we have today

419
00:15:11,030 --> 00:15:09,920
of measuring the winds inside of a

420
00:15:12,949 --> 00:15:11,040
hurricane and this is this is the

421
00:15:15,030 --> 00:15:12,959
primary standard that's used for

422
00:15:17,829 --> 00:15:15,040
classifying hurricanes today whether

423
00:15:20,230 --> 00:15:17,839
it's a cat one cat two et cetera it's an

424
00:15:21,910 --> 00:15:20,240
instrument called the sfmr and it flies

425
00:15:23,110 --> 00:15:21,920
on the noaa p3 hurricane hunter

426
00:15:24,710 --> 00:15:23,120
airplanes this is a picture of the

427
00:15:26,710 --> 00:15:24,720
instrument in the lower left and then

428
00:15:29,030 --> 00:15:26,720
the installation on the on under the

429
00:15:31,030 --> 00:15:29,040
wing of the airplane these instruments

430
00:15:32,949 --> 00:15:31,040
operate at about a five centimeter

431
00:15:34,389 --> 00:15:32,959
microwave wavelength and that's uh

432
00:15:36,150 --> 00:15:34,399
sufficient that's about ten times the

433
00:15:37,829 --> 00:15:36,160
size of a raindrop so there's some

434
00:15:39,509 --> 00:15:37,839
interaction with the rain but not enough

435
00:15:41,829 --> 00:15:39,519
to completely block the signal so we can

436
00:15:43,509 --> 00:15:41,839
see both the rain and the surface below

437
00:15:45,670 --> 00:15:43,519
it and these instruments can measure the

438
00:15:46,790 --> 00:15:45,680

weight the wind and hurricanes and if we

439
00:15:48,389 --> 00:15:46,800
go to the next slide you'll see an

440
00:15:50,790 --> 00:15:48,399
example of measurements made by this

441
00:15:53,430 --> 00:15:50,800
instrument this is a hurricane katrina

442
00:15:56,150 --> 00:15:53,440
about a day before it made landfall and

443
00:15:57,749 --> 00:15:56,160
that black arrow

444
00:15:59,829 --> 00:15:57,759
through the through the hurricane in the

445
00:16:01,749 --> 00:15:59,839
uh in the picture is uh the flight line

446
00:16:03,670 --> 00:16:01,759
of the airplane the uh the flight line

447
00:16:05,189 --> 00:16:03,680
of the p3 and then in the lower right

448
00:16:07,110 --> 00:16:05,199
are the measurements made as it was

449
00:16:09,910 --> 00:16:07,120
flying through the hurricane you can see

450
00:16:11,910 --> 00:16:09,920
that it's able to distinguish the uh the

451
00:16:14,230 --> 00:16:11,920
peak wind or right on the eye wall up

452
00:16:16,150 --> 00:16:14,240
about 65 meters per second and it's also

453
00:16:17,749 --> 00:16:16,160
able to see the uh rain and retrieve the

454
00:16:19,590 --> 00:16:17,759
rain rate because of its uh its

455
00:16:21,350 --> 00:16:19,600
wavelength so

456
00:16:23,350 --> 00:16:21,360
this instrument in principle would give

457
00:16:25,590 --> 00:16:23,360
us what we need the problem is you can't

458
00:16:28,389 --> 00:16:25,600
scale this type of measurement to space

459
00:16:29,670 --> 00:16:28,399
it would take about a 20 meter antenna

460
00:16:31,110 --> 00:16:29,680
in order to make this measurement from

461
00:16:32,710 --> 00:16:31,120
space and that's why these airplanes get

462
00:16:34,230 --> 00:16:32,720
down to about two three kilometers

463
00:16:36,870 --> 00:16:34,240

altitude when they fly into the into the

464
00:16:38,550 --> 00:16:36,880
hurricane um so it's not practical we

465
00:16:39,990 --> 00:16:38,560
actually could fly a 20 meter antenna

466
00:16:42,150 --> 00:16:40,000
but we could never fly a large

467
00:16:43,990 --> 00:16:42,160
constellation of things that big and a

468
00:16:45,910 --> 00:16:44,000
constellation of ant of satellites is

469
00:16:47,910 --> 00:16:45,920
what's necessary in order to get the the

470
00:16:49,910 --> 00:16:47,920
revisit time of the measurements down to

471
00:16:51,670 --> 00:16:49,920
the um our time scale so we need to do

472
00:16:53,749 --> 00:16:51,680
two things with cygnus to improve on

473
00:16:55,269 --> 00:16:53,759
what we have today we need to be able to

474
00:16:57,030 --> 00:16:55,279
work at a long wavelength to get through

475
00:16:58,550 --> 00:16:57,040
the rain and we need to make the

476
00:17:00,230 --> 00:16:58,560
instruments small enough so that we can

477
00:17:02,310 --> 00:17:00,240
afford a constellation of these to get

478
00:17:03,910 --> 00:17:02,320
the revisit time and that leads me to

479
00:17:05,270 --> 00:17:03,920
the next slide which sort of walks

480
00:17:07,029 --> 00:17:05,280
through the measurement principle that

481
00:17:09,189 --> 00:17:07,039
cygnus uses it's a completely different

482
00:17:11,510 --> 00:17:09,199
um technique than than the types of

483
00:17:13,909 --> 00:17:11,520
instruments that are on orbit today um

484
00:17:16,309 --> 00:17:13,919
yeah as john was mentioning it's a gps

485
00:17:18,549 --> 00:17:16,319
biostatic radar so the transmitters g is

486
00:17:20,949 --> 00:17:18,559
the constellation of gps satellites and

487
00:17:23,829 --> 00:17:20,959
the receiver is our cygnus observatories

488
00:17:26,230 --> 00:17:23,839

and for each pair a cygnus receiver and

489
00:17:27,990 --> 00:17:26,240
a gps transmitter there's one unique

490
00:17:29,830 --> 00:17:28,000
spot on the ground where we can make our

491
00:17:32,150 --> 00:17:29,840
measurement called the specular point

492
00:17:34,070 --> 00:17:32,160
and if the ocean were perfectly smooth

493
00:17:35,590 --> 00:17:34,080
all of the reflection would originate

494
00:17:37,029 --> 00:17:35,600
from that one spot on the ground and

495
00:17:39,350 --> 00:17:37,039
we'd be able to measure the wind right

496
00:17:40,870 --> 00:17:39,360
there um in this next picture here

497
00:17:42,789 --> 00:17:40,880
you'll see an example of specular

498
00:17:44,950 --> 00:17:42,799
reflection specular reflection means

499
00:17:47,029 --> 00:17:44,960
perfect mirror reflection in you know

500
00:17:48,470 --> 00:17:47,039
electromagnetic ease and this is an

501
00:17:50,310 --> 00:17:48,480
example of specular reflection at

502
00:17:51,830 --> 00:17:50,320
optical wavelengths where the moon you

503
00:17:53,350 --> 00:17:51,840
can see in the sky and then the

504
00:17:55,190 --> 00:17:53,360
reflection of the moon in the lake is

505
00:17:56,870 --> 00:17:55,200
almost as sharp as the moon itself and

506
00:17:59,430 --> 00:17:56,880
it's because the lake surface is so

507
00:18:01,350 --> 00:17:59,440
caught is so smooth that you get a nice

508
00:18:02,950 --> 00:18:01,360
mirror-like specular reflection in the

509
00:18:05,750 --> 00:18:02,960
next image you'll see what happens when

510
00:18:08,310 --> 00:18:05,760
the wind blows and the surface roughens

511
00:18:10,549 --> 00:18:08,320
you get uh diffuse scattering instead of

512
00:18:12,310 --> 00:18:10,559
specular scattering and it spreads out

513
00:18:14,150 --> 00:18:12,320

over a region called the glistening zone

514
00:18:16,630 --> 00:18:14,160
that surrounds the specular point so if

515
00:18:19,110 --> 00:18:16,640
we could image this type of reflection

516
00:18:21,190 --> 00:18:19,120
at long microwave wavelengths then we'd

517
00:18:22,950 --> 00:18:21,200
be able to back out the wind speed and

518
00:18:24,470 --> 00:18:22,960
in this next image here you'll see an

519
00:18:26,470 --> 00:18:24,480
example of that this was a measurement

520
00:18:28,789 --> 00:18:26,480
made about 10 years ago by a technology

521
00:18:31,029 --> 00:18:28,799
demonstration satellite mission which

522
00:18:33,909 --> 00:18:31,039
flew a prototype of the cygnus payload

523
00:18:35,669 --> 00:18:33,919
on it and it's a it's a measurement of

524
00:18:37,190 --> 00:18:35,679
this the diffuse scattering from the

525
00:18:39,110 --> 00:18:37,200
ocean surface

526
00:18:40,870 --> 00:18:39,120
and you can see the specular point uh

527
00:18:42,870 --> 00:18:40,880
that red hot spot near the top and then

528
00:18:44,789 --> 00:18:42,880
the yellow horseshoe thing going away

529
00:18:46,950 --> 00:18:44,799
from it is the diffuse scattering due to

530
00:18:48,950 --> 00:18:46,960
the roughness and this is the uh the raw

531
00:18:50,470 --> 00:18:48,960
data that cygnus measures is these delay

532
00:18:52,710 --> 00:18:50,480
doppler maps that show the diffuse

533
00:18:54,549 --> 00:18:52,720
scattering away from the uh away from

534
00:18:56,470 --> 00:18:54,559
the specular point and one last point i

535
00:18:58,070 --> 00:18:56,480
want to make here is that the gps

536
00:19:00,070 --> 00:18:58,080
satellites were intentionally designed

537
00:19:01,909 --> 00:19:00,080
to work in heavy rain because the you

538
00:19:03,669 --> 00:19:01,919

know like the navigation system in your

539
00:19:05,430 --> 00:19:03,679
car or your cell phone works just fine

540
00:19:07,510 --> 00:19:05,440
when it's raining hard and it does that

541
00:19:10,150 --> 00:19:07,520
by operating at a very long wavelength

542
00:19:12,150 --> 00:19:10,160
19 centimeter wavelength which is plenty

543
00:19:14,070 --> 00:19:12,160
long enough to be able to avoid

544
00:19:15,750 --> 00:19:14,080
scattering and absorption by the rain so

545
00:19:16,870 --> 00:19:15,760
this signal is going to work just fine

546
00:19:18,870 --> 00:19:16,880
in heavy rain

547
00:19:20,070 --> 00:19:18,880
okay the next slide

548
00:19:22,230 --> 00:19:20,080
this is a

549
00:19:24,390 --> 00:19:22,240
video that gives you an idea of how the

550
00:19:26,630 --> 00:19:24,400
sampling works so we've got eight

551
00:19:28,150 --> 00:19:26,640
satellites in a in a single orbit plane

552
00:19:30,150 --> 00:19:28,160
and here they are evenly spread out

553
00:19:31,750 --> 00:19:30,160
around the orbit plane each satellite

554
00:19:33,909 --> 00:19:31,760
has two antennas looking down at the

555
00:19:35,990 --> 00:19:33,919
earth those are those red ovals to

556
00:19:37,750 --> 00:19:36,000
either side of the sub-satellite point

557
00:19:39,510 --> 00:19:37,760
and then for each satellite there'll be

558
00:19:42,230 --> 00:19:39,520
a series of specular points and those

559
00:19:44,470 --> 00:19:42,240
are the blue ovals and each specular

560
00:19:46,470 --> 00:19:44,480
point corresponds to one combination of

561
00:19:48,150 --> 00:19:46,480
a transmitter and a receiver so the

562
00:19:49,669 --> 00:19:48,160
satellite is tracking these specular

563
00:19:51,590 --> 00:19:49,679

points and as soon as they enter the

564
00:19:53,669 --> 00:19:51,600
antenna pattern it acquires them and

565
00:19:54,950 --> 00:19:53,679
starts processing the diffuse scattering

566
00:19:57,909 --> 00:19:54,960
measurements or the scattering cross

567
00:19:59,590 --> 00:19:57,919
sections and from those we get the wind

568
00:20:01,350 --> 00:19:59,600
so each of these each of these

569
00:20:03,190 --> 00:20:01,360
satellites has enough

570
00:20:05,190 --> 00:20:03,200
onboard processing power to do four of

571
00:20:07,510 --> 00:20:05,200
these measurements simultaneously so

572
00:20:09,430 --> 00:20:07,520
it's it's as if each satellite was

573
00:20:11,430 --> 00:20:09,440
making the type of measurements that

574
00:20:13,110 --> 00:20:11,440
four different p3 hurricane hunter

575
00:20:15,029 --> 00:20:13,120
airplanes were making and then we have

576
00:20:17,990 --> 00:20:15,039
eight of the satellites and four

577
00:20:19,590 --> 00:20:18,000
measurements each so it's like having 32

578
00:20:21,029 --> 00:20:19,600
virtual airplanes flying around

579
00:20:22,710 --> 00:20:21,039
somewhere in the tropics making

580
00:20:23,909 --> 00:20:22,720
measurements simultaneously that's

581
00:20:25,830 --> 00:20:23,919
that's more or less what the data

582
00:20:27,590 --> 00:20:25,840
product will look like and this is a

583
00:20:29,590 --> 00:20:27,600
this is an illustration of what happens

584
00:20:31,669 --> 00:20:29,600
when you paste all of that together you

585
00:20:33,909 --> 00:20:31,679
get all of these satellites flying in

586
00:20:35,909 --> 00:20:33,919
concert making the measurements and over

587
00:20:38,149 --> 00:20:35,919
time they'll fill in more and more of

588
00:20:40,789 --> 00:20:38,159

the tropics as the earth rotates

589
00:20:42,070 --> 00:20:40,799
underneath of the uh orbit plane

590
00:20:44,390 --> 00:20:42,080
and

591
00:20:45,909 --> 00:20:44,400
in the next video after this it'll show

592
00:20:48,149 --> 00:20:45,919
you what the coverage looks like over

593
00:20:49,990 --> 00:20:48,159
the course of 24 hours so this is the

594
00:20:52,710 --> 00:20:50,000
complete coverage by the full eight

595
00:20:54,230 --> 00:20:52,720
satellite constellation over 24 hours

596
00:20:57,029 --> 00:20:54,240
and how well it fills in the average

597
00:20:59,350 --> 00:20:57,039
revisit time any at any spot in the

598
00:21:01,750 --> 00:20:59,360
tropics is about seven hours so we'll

599
00:21:03,270 --> 00:21:01,760
have a complete refresh of the tropical

600
00:21:06,149 --> 00:21:03,280
wind distribution including under the

601
00:21:07,909 --> 00:21:06,159
heavy precip every seven hours and the

602
00:21:09,750 --> 00:21:07,919
last slide

603
00:21:12,230 --> 00:21:09,760
just gives you an example of a we've we

604
00:21:13,909 --> 00:21:12,240
have a detailed software simulator that

605
00:21:16,070 --> 00:21:13,919
predicts what we expect our measurements

606
00:21:17,909 --> 00:21:16,080
to look like and the top left picture is

607
00:21:20,070 --> 00:21:17,919
a simulated hurricane and then the black

608
00:21:22,070 --> 00:21:20,080
line is a a track of the specular point

609
00:21:24,149 --> 00:21:22,080
as it passes through the eye similar to

610
00:21:27,270 --> 00:21:24,159
the to the flight line of the p3

611
00:21:29,029 --> 00:21:27,280
airplane and then the uh the retrieval

612
00:21:31,590 --> 00:21:29,039
of the wind speed is shown in the lower

613
00:21:33,909 --> 00:21:31,600

right the um the dark blue line is the

614
00:21:36,070 --> 00:21:33,919
the idealized true wind that we fed into

615
00:21:38,310 --> 00:21:36,080
this into this um simulator and then the

616
00:21:39,830 --> 00:21:38,320
dashed line is our expected uh retrieved

617
00:21:42,310 --> 00:21:39,840
wind speed and you can see that it picks

618
00:21:43,990 --> 00:21:42,320
out both the the deep null in the eye of

619
00:21:46,549 --> 00:21:44,000
the hurricane and also the peak wind

620
00:21:48,630 --> 00:21:46,559
speed on the uh on the uh

621
00:21:51,350 --> 00:21:48,640
i guess the southeastern eyewall as it

622
00:21:53,270 --> 00:21:51,360
passes out of the hurricane so uh what

623
00:21:54,950 --> 00:21:53,280
we're hoping is that these type of

624
00:21:56,470 --> 00:21:54,960
measurements will be

625
00:21:58,470 --> 00:21:56,480
absorbed into the national hurricane

626
00:22:00,470 --> 00:21:58,480
center data simulation schemes similar

627
00:22:02,630 --> 00:22:00,480
to the way they use their airplanes now

628
00:22:04,710 --> 00:22:02,640
except that they'll be 24 7 for two

629
00:22:06,870 --> 00:22:04,720
years everywhere in the tropics

630
00:22:09,190 --> 00:22:06,880
and with that i'd like to hand hand the

631
00:22:10,870 --> 00:22:09,200
mic over to my grad student mary who's

632
00:22:12,710 --> 00:22:10,880
working on ways that we can use this

633
00:22:14,070 --> 00:22:12,720
data to do some science

634
00:22:15,830 --> 00:22:14,080
thanks chris

635
00:22:17,590 --> 00:22:15,840
so now that we've heard a little bit

636
00:22:19,350 --> 00:22:17,600
about the science and the engineering

637
00:22:21,190 --> 00:22:19,360
aspects of cygnus i'm going to talk to

638
00:22:22,549 --> 00:22:21,200

you about one of the tools that we've

639
00:22:24,310 --> 00:22:22,559
been developing to address some of the

640
00:22:25,990 --> 00:22:24,320
applications of cygnus

641
00:22:28,470 --> 00:22:26,000
and this tool is called sift or the

642
00:22:30,149 --> 00:22:28,480
storm intersection forecast tool

643
00:22:32,310 --> 00:22:30,159
so we developed stiff because we needed

644
00:22:33,830 --> 00:22:32,320
a way to predict ahead of time when and

645
00:22:35,909 --> 00:22:33,840
where sickness is going to intersect

646
00:22:37,350 --> 00:22:35,919
through storms and get really valuable

647
00:22:38,549 --> 00:22:37,360
hurricane data

648
00:22:40,390 --> 00:22:38,559
and the other thing that we want to

649
00:22:43,190 --> 00:22:40,400
answer with this tool is after we get

650
00:22:44,789 --> 00:22:43,200
that really valuable data how soon after

651
00:22:47,190 --> 00:22:44,799
can we then downlink the data and get it

652
00:22:48,630 --> 00:22:47,200
to the users as soon as possible so

653
00:22:50,630 --> 00:22:48,640
those are the two objectives of this

654
00:22:51,750 --> 00:22:50,640
tool so today we're going to take a time

655
00:22:53,750 --> 00:22:51,760
machine and we're going to pretend that

656
00:22:55,270 --> 00:22:53,760
cygnus launched a year ago and we're

657
00:22:56,789 --> 00:22:55,280
going to do a little experiment to see

658
00:22:58,950 --> 00:22:56,799
what cygnus would have seen if it had

659
00:23:00,950 --> 00:22:58,960
been orbiting during hurricane matthew a

660
00:23:04,630 --> 00:23:00,960
little over a month ago

661
00:23:07,190 --> 00:23:04,640
so let's go to the animation and play it

662
00:23:09,510 --> 00:23:07,200
so what you're seeing now is sift in

663
00:23:11,669 --> 00:23:09,520

sort of a global view mode and each of

664
00:23:13,590 --> 00:23:11,679
these colored triangles represents one

665
00:23:15,510 --> 00:23:13,600
of the cygnus satellites and the dots

666
00:23:17,110 --> 00:23:15,520
that surround each satellite are the

667
00:23:19,270 --> 00:23:17,120
specular points that our orbit

668
00:23:21,270 --> 00:23:19,280
propagator can predict where they are

669
00:23:24,149 --> 00:23:21,280
what i just turned on are all the ground

670
00:23:26,070 --> 00:23:24,159
zone contact zones that we can

671
00:23:28,310 --> 00:23:26,080
whenever a satellite is orbiting over

672
00:23:30,789 --> 00:23:28,320
these circles we can downlink the data

673
00:23:33,590 --> 00:23:30,799
to either our ground stations in hawaii

674
00:23:35,350 --> 00:23:33,600
chile or australia

675
00:23:37,110 --> 00:23:35,360
the other aspect of this tool is we can

676
00:23:39,909 --> 00:23:37,120
plot out where the ground tracks are so

677
00:23:41,990 --> 00:23:39,919
what i just turned on is one ground

678
00:23:44,390 --> 00:23:42,000
track for just about an orbit for just

679
00:23:46,230 --> 00:23:44,400
one satellite if you can imagine if we

680
00:23:47,350 --> 00:23:46,240
add time and we turn on all eight

681
00:23:48,870 --> 00:23:47,360
satellites we're going to get great

682
00:23:50,630 --> 00:23:48,880
coverage over the tropics where we

683
00:23:51,430 --> 00:23:50,640
expect most of the tropical cyclones to

684
00:23:52,710 --> 00:23:51,440
be

685
00:23:53,909 --> 00:23:52,720
the next thing that we want to answer

686
00:23:56,710 --> 00:23:53,919
with this tool

687
00:23:58,070 --> 00:23:56,720
is where is all of our data so the next

688
00:24:00,470 --> 00:23:58,080

thing that i'm going to be turning on

689
00:24:01,990 --> 00:24:00,480
here is the tracks of all the specular

690
00:24:04,070 --> 00:24:02,000
points that's where our data is that's

691
00:24:05,430 --> 00:24:04,080
where we're measuring ocean surface wind

692
00:24:07,029 --> 00:24:05,440
speed

693
00:24:08,070 --> 00:24:07,039
so those are the two main aspects of

694
00:24:09,590 --> 00:24:08,080
this tool

695
00:24:11,510 --> 00:24:09,600
the next thing that we want to address

696
00:24:13,590 --> 00:24:11,520
is when are we going to intersect with

697
00:24:15,110 --> 00:24:13,600
hurricane matthew so the next thing that

698
00:24:17,909 --> 00:24:15,120
we're going to turn on

699
00:24:19,350 --> 00:24:17,919
is hurricane matthew's position and size

700
00:24:21,269 --> 00:24:19,360
according to the national hurricane

701
00:24:23,029 --> 00:24:21,279
center's forecast at the initial time

702
00:24:25,269 --> 00:24:23,039
period of this tool

703
00:24:28,230 --> 00:24:25,279
so the bright red circle on the screen

704
00:24:30,070 --> 00:24:28,240
is the initi the current position and

705
00:24:32,149 --> 00:24:30,080
size of the storm

706
00:24:34,470 --> 00:24:32,159
and we're using this tool to propagate

707
00:24:36,870 --> 00:24:34,480
the orbital in time to see where we're

708
00:24:38,710 --> 00:24:36,880
going to intersect the storm first

709
00:24:40,870 --> 00:24:38,720
so as you can see now hurricane matthew

710
00:24:41,669 --> 00:24:40,880
is tracking to the west

711
00:24:44,230 --> 00:24:41,679
and then

712
00:24:46,070 --> 00:24:44,240
it's forecasted to eventually turn north

713
00:24:48,230 --> 00:24:46,080

but we want to see when synthesis is

714
00:24:50,549 --> 00:24:48,240
going to get close we want to zoom in on

715
00:24:51,909 --> 00:24:50,559
the time and place that that's first

716
00:24:53,269 --> 00:24:51,919
going to happen so we can see where our

717
00:24:55,190 --> 00:24:53,279
data is going to be so right now we're

718
00:24:56,390 --> 00:24:55,200
getting pretty close so we're going to

719
00:24:59,750 --> 00:24:56,400
zoom in

720
00:25:03,269 --> 00:25:01,350
so right now you're seeing a zoomed in

721
00:25:05,510 --> 00:25:03,279
view and again the the bright red circle

722
00:25:07,110 --> 00:25:05,520
is where we're interested in currently

723
00:25:09,510 --> 00:25:07,120
so what i'm about to do is i'm going to

724
00:25:11,110 --> 00:25:09,520
turn on all the specular point tracks

725
00:25:13,029 --> 00:25:11,120
over a couple of hours around this time

726
00:25:14,870 --> 00:25:13,039
period and put the satellites back in

727
00:25:15,990 --> 00:25:14,880
animation you can see those

728
00:25:18,470 --> 00:25:16,000
orbiting

729
00:25:20,149 --> 00:25:18,480
to the bottom right of the screen

730
00:25:22,310 --> 00:25:20,159
and right now we're starting to get

731
00:25:23,510 --> 00:25:22,320
really valuable data in that bright red

732
00:25:25,909 --> 00:25:23,520
circle that's where we expect the

733
00:25:27,590 --> 00:25:25,919
highest wind speeds to be and we can do

734
00:25:28,630 --> 00:25:27,600
really interesting stuff with this data

735
00:25:30,230 --> 00:25:28,640
we can say

736
00:25:32,549 --> 00:25:30,240
ask questions like how intense is the

737
00:25:34,310 --> 00:25:32,559
hurricane right now how far out do

738
00:25:36,630 --> 00:25:34,320

strong winds extend

739
00:25:37,909 --> 00:25:36,640
answering questions like how how big is

740
00:25:39,750 --> 00:25:37,919
the storm

741
00:25:41,430 --> 00:25:39,760
so that now that we know where the data

742
00:25:43,990 --> 00:25:41,440
is and when it's happening and we want

743
00:25:46,070 --> 00:25:44,000
to look at all the data that we can get

744
00:25:47,190 --> 00:25:46,080
so right now let's zoom out and

745
00:25:48,870 --> 00:25:47,200
look at all the data that we have

746
00:25:50,470 --> 00:25:48,880
collected over this time period and

747
00:25:52,710 --> 00:25:50,480
you're going to see that we get a lot of

748
00:25:53,830 --> 00:25:52,720
great data near the environment of

749
00:25:55,510 --> 00:25:53,840
hurricane matthew that's going to be

750
00:25:57,510 --> 00:25:55,520
really valuable so the next question

751
00:25:58,470 --> 00:25:57,520
that we want to answer with this tool

752
00:26:00,549 --> 00:25:58,480
is

753
00:26:02,630 --> 00:26:00,559
how soon after we get that data can we

754
00:26:05,990 --> 00:26:02,640
then downlink it to the ground so let's

755
00:26:08,070 --> 00:26:06,000
go back to our ground zone contacts

756
00:26:10,070 --> 00:26:08,080
and put these satellites back in

757
00:26:11,909 --> 00:26:10,080
animation and you're going to see that

758
00:26:14,390 --> 00:26:11,919
after we go over the region of hurricane

759
00:26:16,149 --> 00:26:14,400
matthew our satellites then orbit

760
00:26:18,149 --> 00:26:16,159
directly over the australian ground

761
00:26:19,990 --> 00:26:18,159
station and we can get that data down to

762
00:26:22,870 --> 00:26:20,000
the ground within an hour and that's a

763
00:26:24,710 --> 00:26:22,880

really great day to latency and

764
00:26:26,789 --> 00:26:24,720
it's one of the amazing aspects of

765
00:26:27,990 --> 00:26:26,799
cygnus and using a constellation like

766
00:26:29,990 --> 00:26:28,000
this

767
00:26:32,390 --> 00:26:30,000
so i just like to end by saying that

768
00:26:34,310 --> 00:26:32,400
this is just one of the many amazing

769
00:26:35,909 --> 00:26:34,320
projects that i've been able to work on

770
00:26:37,750 --> 00:26:35,919
as a student as a part of the stigmas

771
00:26:39,750 --> 00:26:37,760
mission and i'm just really excited to

772
00:26:41,830 --> 00:26:39,760
see what we do next with cygnus and see

773
00:26:43,830 --> 00:26:41,840
all the data come down shortly

774
00:26:46,230 --> 00:26:43,840
thanks back to you sean great thank you

775
00:26:47,830 --> 00:26:46,240
mary and before we start taking any

776
00:26:49,830 --> 00:26:47,840
questions i'd just like to hand it back

777
00:26:51,269 --> 00:26:49,840
over to christine boniksen for a few

778
00:26:53,350 --> 00:26:51,279
closing remarks

779
00:26:54,390 --> 00:26:53,360
thank you sean we've provided you a lot

780
00:26:56,149 --> 00:26:54,400
of data

781
00:26:58,390 --> 00:26:56,159
but what i want to leave you with is

782
00:27:01,590 --> 00:26:58,400
that cygnus is a tool

783
00:27:04,230 --> 00:27:01,600
that will provide us 24 7 coverage of

784
00:27:07,110 --> 00:27:04,240
the tropical cyclone zone

785
00:27:09,510 --> 00:27:07,120
and it will improve our knowledge of how

786
00:27:11,510 --> 00:27:09,520
hurricanes grow

787
00:27:13,669 --> 00:27:11,520
so that we can better prepare and

788
00:27:15,750 --> 00:27:13,679

protect the people in the path of each

789
00:27:17,909 --> 00:27:15,760
hurricane as it comes

790
00:27:19,430 --> 00:27:17,919
sean thank you christine thank you to

791
00:27:20,549 --> 00:27:19,440
all of our panelists

792
00:27:22,950 --> 00:27:20,559
all right now we'll take some of your

793
00:27:25,029 --> 00:27:22,960
questions and just a reminder if you are

794
00:27:27,190 --> 00:27:25,039
following us on social media you can ask

795
00:27:30,710 --> 00:27:27,200
questions for our panelists using the

796
00:27:32,630 --> 00:27:30,720
hashtag ask nasa but i think we'll start

797
00:27:34,310 --> 00:27:32,640
with see if we have any questions here

798
00:27:35,669 --> 00:27:34,320
in the room we have one could you uh

799
00:27:37,110 --> 00:27:35,679
please identify yourself in your

800
00:27:38,710 --> 00:27:37,120
affiliation please

801
00:27:40,950 --> 00:27:38,720
yeah i'm matt leonard with government

802
00:27:44,070 --> 00:27:40,960
computer news one thing i want some

803
00:27:45,990 --> 00:27:44,080
clarification on is how the cygnus

804
00:27:48,710 --> 00:27:46,000
satellite interacts with the satellites

805
00:27:51,029 --> 00:27:48,720
that are providing the gps data

806
00:27:54,470 --> 00:27:51,039
so these are providing the gps data and

807
00:27:56,789 --> 00:27:54,480
then what is the what data is sickness

808
00:27:59,830 --> 00:27:56,799
uh collecting itself exactly and how is

809
00:28:01,029 --> 00:27:59,840
it using that gps data i know you talked

810
00:28:02,549 --> 00:28:01,039
about it a little bit could you but

811
00:28:03,909 --> 00:28:02,559
could you clarify and dig into it a

812
00:28:05,830 --> 00:28:03,919
little bit

813
00:28:07,990 --> 00:28:05,840

yeah so uh several there's several

814
00:28:10,149 --> 00:28:08,000
different ways that cygnus uses the gps

815
00:28:11,909 --> 00:28:10,159
data i mean the the science way is it

816
00:28:14,070 --> 00:28:11,919
measures the strength of the signal

817
00:28:15,590 --> 00:28:14,080
scattered off the ocean surface as a

818
00:28:18,549 --> 00:28:15,600
function of position that's how it gets

819
00:28:21,110 --> 00:28:18,559
its science it also has a standard

820
00:28:22,789 --> 00:28:21,120
navigation mode there's a small antenna

821
00:28:25,190 --> 00:28:22,799
on the top of cygnus which measures

822
00:28:26,870 --> 00:28:25,200
direct signals from gps and it uses

823
00:28:29,750 --> 00:28:26,880
those for

824
00:28:31,830 --> 00:28:29,760
time synchronization for geolocation for

825
00:28:34,870 --> 00:28:31,840
you know precision orbit determination

826
00:28:37,510 --> 00:28:34,880
and also for a coherent synchronization

827
00:28:40,549 --> 00:28:37,520
of the gps clock with the uh the

828
00:28:45,750 --> 00:28:40,559
reflected signals timing so that we can

829
00:28:50,710 --> 00:28:48,710
okay thank you uh and we're waiting for

830
00:28:52,389 --> 00:28:50,720
questions to come in over the phone and

831
00:28:54,310 --> 00:28:52,399
online and while we're doing that

832
00:28:56,230 --> 00:28:54,320
actually uh chris if you don't mind uh

833
00:28:59,430 --> 00:28:56,240
telling us a little bit more about some

834
00:29:01,110 --> 00:28:59,440
of the the research uh motivations for

835
00:29:04,149 --> 00:29:01,120
this project you talked a little bit

836
00:29:06,389 --> 00:29:04,159
about hurricane intensity being one of

837
00:29:07,669 --> 00:29:06,399
the key factors in this and maybe you

838
00:29:09,510 --> 00:29:07,679

could just talk a little bit about why

839
00:29:10,950 --> 00:29:09,520
that's so important and where we are

840
00:29:13,269 --> 00:29:10,960
today and where we've been historically

841
00:29:16,710 --> 00:29:13,279
when it comes to hurricane

842
00:29:19,350 --> 00:29:16,720
track and intensity forecasts sure so um

843
00:29:21,830 --> 00:29:19,360
there's a very careful detailed record

844
00:29:24,230 --> 00:29:21,840
uh our accounting kept by the national

845
00:29:25,510 --> 00:29:24,240
hurricane center about the skill in of

846
00:29:27,430 --> 00:29:25,520
their hurricane forecast and they've

847
00:29:30,389 --> 00:29:27,440
been doing this for many decades and so

848
00:29:33,110 --> 00:29:30,399
they have records of the error

849
00:29:34,950 --> 00:29:33,120
the statistical error in their forecasts

850
00:29:37,269 --> 00:29:34,960
for both the track of a hurricane which

851
00:29:39,110 --> 00:29:37,279
is the location of the eye and also the

852
00:29:41,190 --> 00:29:39,120
intensity of the hurricane which is the

853
00:29:43,430 --> 00:29:41,200
uh the maximum sustained wind in the

854
00:29:45,190 --> 00:29:43,440
hurricane the the cat one cat two cat

855
00:29:47,750 --> 00:29:45,200
three thing and if you look at those

856
00:29:49,909 --> 00:29:47,760
historical records for the uh hurricane

857
00:29:52,310 --> 00:29:49,919
track skill

858
00:29:54,389 --> 00:29:52,320
the skill has been steadily improving

859
00:29:55,990 --> 00:29:54,399
year in and year out and for example

860
00:29:57,029 --> 00:29:56,000
over the last 20 years

861
00:29:58,950 --> 00:29:57,039
we're about

862
00:30:00,870 --> 00:29:58,960
twice as good or the errors are about

863
00:30:01,669 --> 00:30:00,880

half as big today as they were 20 years

864
00:30:03,110 --> 00:30:01,679
ago

865
00:30:05,590 --> 00:30:03,120
so there's been steady improvement in

866
00:30:06,630 --> 00:30:05,600
hurricane track forecast skill if you

867
00:30:08,630 --> 00:30:06,640
look at the

868
00:30:10,549 --> 00:30:08,640
record for their intensity forecast

869
00:30:12,549 --> 00:30:10,559
there's been very very little

870
00:30:14,310 --> 00:30:12,559
improvement in intensity forecast skill

871
00:30:16,470 --> 00:30:14,320
at all in the last 20 years and the

872
00:30:18,310 --> 00:30:16,480
reason for that is that the uh or one of

873
00:30:20,470 --> 00:30:18,320
the primary reasons for it is that the

874
00:30:21,909 --> 00:30:20,480
satellites are today are just not able

875
00:30:23,590 --> 00:30:21,919
to measure what's going on in the inner

876
00:30:26,789 --> 00:30:23,600
core of the hurricane this has been

877
00:30:28,789 --> 00:30:26,799
identified for many years as a primary

878
00:30:30,710 --> 00:30:28,799
you know lacking ingredient in the

879
00:30:32,149 --> 00:30:30,720
numerical forecasts that are used by the

880
00:30:34,230 --> 00:30:32,159
national hurricane center they wish they

881
00:30:36,470 --> 00:30:34,240
had the information in the inner core of

882
00:30:38,310 --> 00:30:36,480
the storms and they don't and

883
00:30:41,110 --> 00:30:38,320
the exciting thing about cygnus is it

884
00:30:42,950 --> 00:30:41,120
provides a new technology to both make

885
00:30:45,830 --> 00:30:42,960
the measurements in the rain and also to

886
00:30:47,990 --> 00:30:45,840
support the capability for many many

887
00:30:49,909 --> 00:30:48,000
satellites in a constellation because of

888
00:30:52,070 --> 00:30:49,919

the inherent low cost of this particular

889
00:30:54,230 --> 00:30:52,080
remote sensing technique

890
00:30:56,470 --> 00:30:54,240
okay great thank you chris well if we

891
00:30:58,470 --> 00:30:56,480
have uh no more questions

892
00:31:00,710 --> 00:30:58,480
then i'd just like to uh actually i

893
00:31:02,789 --> 00:31:00,720
think we have one question coming in uh

894
00:31:04,549 --> 00:31:02,799
from social media so emily could you

895
00:31:05,909 --> 00:31:04,559
please read that question to us sure

896
00:31:08,149 --> 00:31:05,919
this one is from chris edwards on

897
00:31:10,149 --> 00:31:08,159
twitter and he's asking do the microsats

898
00:31:13,190 --> 00:31:10,159
on cygnus measure rainfall rates as well

899
00:31:16,870 --> 00:31:15,509
uh no no that's that's the great thing

900
00:31:18,630 --> 00:31:16,880
about measuring at such a long

901
00:31:22,070 --> 00:31:18,640
wavelength we have

902
00:31:23,909 --> 00:31:22,080
um negligible interaction with the rain

903
00:31:25,350 --> 00:31:23,919
and actually there's a so we don't

904
00:31:27,029 --> 00:31:25,360
measure rain we couldn't measure rain

905
00:31:28,630 --> 00:31:27,039
we're not sensitive to rain

906
00:31:30,710 --> 00:31:28,640
there's actually there's great value in

907
00:31:32,950 --> 00:31:30,720
knowing what the rain is in a hurricane

908
00:31:35,190 --> 00:31:32,960
because that monitors the conversion of

909
00:31:36,549 --> 00:31:35,200
latent heat back to uh sensible heat

910
00:31:38,549 --> 00:31:36,559
when the when the water vapor

911
00:31:40,230 --> 00:31:38,559
precipitates out but

912
00:31:41,830 --> 00:31:40,240
what we plan on doing is there's a

913
00:31:43,110 --> 00:31:41,840

follow-on to the mission that i showed

914
00:31:45,509 --> 00:31:43,120
the picture of right at the beginning

915
00:31:47,110 --> 00:31:45,519
the trim mission the follow-on to it is

916
00:31:49,350 --> 00:31:47,120
the global precipitation measurement

917
00:31:51,269 --> 00:31:49,360
mission gpm which is up there now and it

918
00:31:54,389 --> 00:31:51,279
has a constellation of instruments that

919
00:31:57,110 --> 00:31:54,399
can measure uh the precip the rain rate

920
00:31:59,350 --> 00:31:57,120
every three hours and the intent is to

921
00:32:01,830 --> 00:31:59,360
match up those precip data products with

922
00:32:04,310 --> 00:32:01,840
the cygnus data products and be able to

923
00:32:08,230 --> 00:32:04,320
uh constrain that air see interaction

924
00:32:11,509 --> 00:32:09,590
wonderful thank you

925
00:32:13,590 --> 00:32:11,519
any more questions from here in the

926
00:32:16,149 --> 00:32:13,600
audience media members

927
00:32:18,149 --> 00:32:16,159
okay if not then i'd just like to thank

928
00:32:20,149 --> 00:32:18,159
everybody for taking the time to join us

929
00:32:22,070 --> 00:32:20,159
today and remind you once again that you