
NASA

1
00:00:01,310 --> 00:00:29,200
[Music]

2
00:00:35,360 --> 00:00:32,780
good afternoon everyone take a look that

3
00:00:38,479 --> 00:00:35,370
is NASA's next earth mission to space on

4
00:00:41,570 --> 00:00:38,489
top of a Falcon 9 rocket at Space Launch

5
00:00:44,570 --> 00:00:41,580
Complex 4e at Vandenberg Air Force Base

6
00:00:47,329 --> 00:00:44,580
in California inside are the twin

7
00:00:49,250 --> 00:00:47,339
satellites of Grace follow on a mission

8
00:00:52,189 --> 00:00:49,260
that will add to our understanding of

9
00:00:54,560 --> 00:00:52,199
Earth's ever-changing water cycle there

10
00:00:57,500 --> 00:00:54,570
are lots of eyes on this launch we have

11
00:00:59,719 --> 00:00:57,510
cameras on the pad and multiple teams of

12
00:01:01,820 --> 00:00:59,729
people in the SpaceX control room in

13
00:01:04,340 --> 00:01:01,830

Hawthorne California and Mission Support

14
00:01:06,320 --> 00:01:04,350
people here at Vandenberg we have folks

15
00:01:08,179 --> 00:01:06,330
watching in the earth orbiting mission

16
00:01:10,130 --> 00:01:08,189
Operations Center at NASA's Jet

17
00:01:12,830 --> 00:01:10,140
Propulsion Laboratory and Pasadena

18
00:01:15,560 --> 00:01:12,840
California this is their mission - and

19
00:01:18,380 --> 00:01:15,570
we have cameras at the German Space

20
00:01:21,260 --> 00:01:18,390
Operations Center outside of Munich

21
00:01:23,870 --> 00:01:21,270
that's G sock G sock will be the base of

22
00:01:26,539 --> 00:01:23,880
Mission Operations of grace follow-on

23
00:01:29,060 --> 00:01:26,549
because this mission is a German and

24
00:01:31,940 --> 00:01:29,070
u.s. partnership between NASA and the

25
00:01:34,399 --> 00:01:31,950
German Research Center for geosciences

26
00:01:36,889 --> 00:01:34,409
and you know what the weather seems to

27
00:01:40,399 --> 00:01:36,899
be cooperating for today's launch the

28
00:01:43,309 --> 00:01:40,409
30th Space Wing weather squadron here at

29
00:01:46,429 --> 00:01:43,319
Vandenberg tells us things are looking

30
00:01:49,940 --> 00:01:46,439
good there is only a small chance of

31
00:01:53,569 --> 00:01:49,950
Violation less than 10% which means were

32
00:01:55,700 --> 00:01:53,579
90 percent a go for launch ground winds

33
00:01:58,399 --> 00:01:55,710
out of the southwest are the only

34
00:02:02,719 --> 00:01:58,409
concern but overall it's simply a

35
00:02:04,609 --> 00:02:02,729
gorgeous day to launch a rocket hello

36
00:02:07,459 --> 00:02:04,619
everyone I'm je Hill with NASA

37
00:02:10,880 --> 00:02:07,469
communications I'll be your commentator

38
00:02:13,460 --> 00:02:10,890

for today's launch broadcast with me is

39
00:02:16,420 --> 00:02:13,470
Sammy Paoli he's director for the Office

40
00:02:18,860 --> 00:02:16,430
of safety and mission success at JPL but

41
00:02:22,040 --> 00:02:18,870
previously he served as the deputy

42
00:02:24,470 --> 00:02:22,050
project manager for grace follow-on so

43
00:02:26,570 --> 00:02:24,480
he's here to help provide insight and

44
00:02:28,850 --> 00:02:26,580
also to help us along understanding

45
00:02:31,280 --> 00:02:28,860
what's going on with the launch so the

46
00:02:33,890 --> 00:02:31,290
first question I have is this

47
00:02:36,920 --> 00:02:33,900
is called a rideshare can you explain

48
00:02:38,179 --> 00:02:36,930
sure the grace follow-on team was able

49
00:02:40,699 --> 00:02:38,189
to establish a collaborative

50
00:02:43,550 --> 00:02:40,709
cost-sharing agreement with iridium

51
00:02:46,759 --> 00:02:43,560
where we took capacity that they had on

52
00:02:49,069 --> 00:02:46,769
launch vehicle and NASA GFC or would be

53
00:02:51,170 --> 00:02:49,079
able to launch the grace follow-on twin

54
00:02:53,509 --> 00:02:51,180
satellites while iridium would be able

55
00:02:56,020 --> 00:02:53,519
to launch five of their communication

56
00:02:58,819 --> 00:02:56,030
satellites to satisfy the constellation

57
00:03:02,539 --> 00:02:58,829
literally sharing the ride to low-earth

58
00:03:05,330 --> 00:03:02,549
orbit yes so this is also a partnership

59
00:03:06,740 --> 00:03:05,340
between Germany and the US can you talk

60
00:03:10,099 --> 00:03:06,750
about who did what

61
00:03:12,530 --> 00:03:10,109
sure the NASA G of the agreement

62
00:03:14,300 --> 00:03:12,540
actually made it very clear early on of

63
00:03:15,860 --> 00:03:14,310

the roles and responsibilities on this

64
00:03:17,179 --> 00:03:15,870
mission which made it much simpler for

65
00:03:19,729 --> 00:03:17,189
the team to actually focus on their work

66
00:03:21,649 --> 00:03:19,739
and get things done as far that

67
00:03:23,929 --> 00:03:21,659
agreement and JPL was responsible for

68
00:03:27,409 --> 00:03:23,939
the development and build and test of

69
00:03:29,929 --> 00:03:27,419
the two spacecraft and also the build of

70
00:03:34,550 --> 00:03:29,939
the microwave instrument and the laser

71
00:03:37,219 --> 00:03:34,560
ranging interferometer the great G of Z

72
00:03:40,099 --> 00:03:37,229
was responsible for the launch vehicle

73
00:03:42,289 --> 00:03:40,109
service and also the mission operations

74
00:03:44,119 --> 00:03:42,299
and also the optical components that go

75
00:03:46,640 --> 00:03:44,129
into the laser ranging interferometer

76
00:03:49,009 --> 00:03:46,650
and we have some video the show of the

77
00:03:51,289 --> 00:03:49,019
road to launch for this spacecraft in

78
00:03:54,550 --> 00:03:51,299
the video that this is a video that this

79
00:03:58,009 --> 00:03:54,560
shows the the construct or the

80
00:04:00,020 --> 00:03:58,019
fabrication of the two spacecraft at the

81
00:04:02,719 --> 00:04:00,030
iridium facility and Germany in

82
00:04:05,180 --> 00:04:02,729
Friedrichshafen Germany these are very

83
00:04:08,809 --> 00:04:05,190
delicate spacecraft of course that rely

84
00:04:11,059 --> 00:04:08,819
on very precise measurements of of the

85
00:04:12,920 --> 00:04:11,069
gravity field after they're tested they

86
00:04:16,370 --> 00:04:12,930
were shipped over to then de Broglie Air

87
00:04:20,870 --> 00:04:16,380
Force Base for a completion of the

88
00:04:22,399 --> 00:04:20,880

overall integration and into the multi

89
00:04:24,439 --> 00:04:22,409
satellite dispenser that I'll show you

90
00:04:26,300 --> 00:04:24,449
in a minute this is the air force

91
00:04:28,820 --> 00:04:26,310
personnel actually helping us offload

92
00:04:30,740 --> 00:04:28,830
the spacecraft this is at the Harris

93
00:04:33,350 --> 00:04:30,750
processing facility here at Vandenberg

94
00:04:35,990 --> 00:04:33,360
where we processed the spacecraft you

95
00:04:37,610 --> 00:04:36,000
see them unloaded here on the multi

96
00:04:40,279 --> 00:04:37,620
satellite dispenser which allows them to

97
00:04:41,640 --> 00:04:40,289
be deployed at the same time from the

98
00:04:44,850 --> 00:04:41,650
launch vehicle

99
00:04:48,210 --> 00:04:44,860
all right so throughout these events

100
00:04:50,790 --> 00:04:48,220
we'll be hearing from the the team the

101
00:04:53,010 --> 00:04:50,800
SpaceX launch team but the team itself

102
00:04:55,409 --> 00:04:53,020
will have certain communications that

103
00:04:57,540 --> 00:04:55,419
you'll be hearing on a special network

104
00:04:59,100 --> 00:04:57,550
with the team members you're monitoring

105
00:05:01,379 --> 00:04:59,110
it Sammy is monitoring it for

106
00:05:03,810 --> 00:05:01,389
communications so we will be checking

107
00:05:04,830 --> 00:05:03,820
back with you throughout to get updates

108
00:05:07,710 --> 00:05:04,840
on the mission sure

109
00:05:09,240 --> 00:05:07,720
all right thanks Sammy well let's tell

110
00:05:11,730 --> 00:05:09,250
you a bit more about the mission now

111
00:05:14,550 --> 00:05:11,740
it's called grace follow-on because it's

112
00:05:17,760 --> 00:05:14,560
following the footsteps of an innovative

113
00:05:19,500 --> 00:05:17,770

mission that lasted 15 years it was

114
00:05:22,340 --> 00:05:19,510
called the Gravity Recovery and climate

115
00:05:24,930 --> 00:05:22,350
experiment or grace and grace

116
00:05:27,659 --> 00:05:24,940
revolutionized our understanding of how

117
00:05:30,600 --> 00:05:27,669
water moves around our planet and grace

118
00:05:40,740 --> 00:05:30,610
follow-on aims to keep the information

119
00:05:43,230 --> 00:05:40,750
coming and continue the legacy water is

120
00:05:45,570 --> 00:05:43,240
one of the main indicators of how the

121
00:05:48,839 --> 00:05:45,580
planet is responding to our evolving

122
00:05:50,610 --> 00:05:48,849
climate we build our civilization around

123
00:05:52,500 --> 00:05:50,620
the climate that we had and the water

124
00:05:54,689 --> 00:05:52,510
resources that we have and if those are

125
00:05:58,620 --> 00:05:54,699
changing that can have a profound impact

126
00:06:00,689 --> 00:05:58,630
on how we operate our society grace and

127
00:06:02,279 --> 00:06:00,699
grace follow on measure the motion of

128
00:06:04,409 --> 00:06:02,289
water around the earth and they measure

129
00:06:06,149 --> 00:06:04,419
that in all forms of water water that's

130
00:06:07,800 --> 00:06:06,159
stored underground water in the ocean

131
00:06:09,990 --> 00:06:07,810
water that's frozen in the form of

132
00:06:18,899 --> 00:06:10,000
glaciers so all of that together grace

133
00:06:22,409 --> 00:06:18,909
can measure grace fall one is a mission

134
00:06:23,850 --> 00:06:22,419
to measure how water is distributed on

135
00:06:25,920 --> 00:06:23,860
the planet and how that changes from

136
00:06:27,779 --> 00:06:25,930
month to month grace stands for Gravity

137
00:06:29,070 --> 00:06:27,789
Recovery and climate experiment

138
00:06:31,950 --> 00:06:29,080

it's a follow-on mission to this mission

139
00:06:33,870 --> 00:06:31,960
called grace that we launched in 2002

140
00:06:35,219 --> 00:06:33,880
and that mission just ended a few months

141
00:06:36,960 --> 00:06:35,229
ago and grace fall is going to pick up

142
00:06:39,839 --> 00:06:36,970
and continue that science legacy even

143
00:06:41,040 --> 00:06:39,849
though grace flew for 15 years climate

144
00:06:43,020 --> 00:06:41,050
is one of those things which takes place

145
00:06:44,310 --> 00:06:43,030
on decadal timescales

146
00:06:46,320 --> 00:06:44,320
it's really important that we look at

147
00:06:48,240 --> 00:06:46,330
these trends over longer time for so we

148
00:06:50,480 --> 00:06:48,250
can establish the forces which are

149
00:06:53,390 --> 00:06:50,490
driving them

150
00:06:56,059 --> 00:06:53,400
one follows the other and between them

151
00:06:59,050 --> 00:06:56,069
they accurately track a distance between

152
00:07:02,510 --> 00:06:59,060
the two satellites and as they fly over

153
00:07:04,219 --> 00:07:02,520
changes in mass on the earth they move

154
00:07:06,980 --> 00:07:04,229
back and forth and we track those little

155
00:07:09,140 --> 00:07:06,990
changes very accurately and we do that

156
00:07:11,990 --> 00:07:09,150
with Global Positioning System satellite

157
00:07:16,460 --> 00:07:12,000
information and with star cameras that

158
00:07:18,860 --> 00:07:16,470
are on board the two spacecraft I think

159
00:07:27,980 --> 00:07:18,870
there's an increasing awareness and

160
00:07:31,070 --> 00:07:27,990
consciousness around the earth all these

161
00:07:34,520 --> 00:07:31,080
have long-term ramifications on how we

162
00:07:36,379 --> 00:07:34,530
live the grace all our measurements give

163
00:07:38,540 --> 00:07:36,389

us very clear and tangible information

164
00:07:42,640 --> 00:07:38,550
so we can make sound decisions in the

165
00:07:48,649 --> 00:07:45,890
now there wouldn't even be a grace

166
00:07:52,100 --> 00:07:48,659
follow-on had the original mission not

167
00:07:54,350 --> 00:07:52,110
been such a game changer with me now is

168
00:07:57,050 --> 00:07:54,360
Frank Webb he's the project scientist

169
00:07:59,450 --> 00:07:57,060
for grace follow-on what exactly did we

170
00:08:01,999 --> 00:07:59,460
learn from grace so grace was very

171
00:08:03,860 --> 00:08:02,009
revolutionary in that it provided us

172
00:08:06,020 --> 00:08:03,870
with the first global comprehensive view

173
00:08:08,060 --> 00:08:06,030
of how our water system where how our

174
00:08:10,249 --> 00:08:08,070
water cycle works from the global water

175
00:08:13,730 --> 00:08:10,259
cycle is a very important component of

176
00:08:16,279 --> 00:08:13,740
our complex climate system so we have

177
00:08:18,680 --> 00:08:16,289
video of some of the things we saw over

178
00:08:21,260 --> 00:08:18,690
a 15 year period we can roll that video

179
00:08:23,510 --> 00:08:21,270
right now what did you see here so in

180
00:08:26,270 --> 00:08:23,520
this in this in this map we just seen

181
00:08:27,770 --> 00:08:26,280
our global water trends and the water

182
00:08:29,420 --> 00:08:27,780
cycle is composed of many components and

183
00:08:30,770 --> 00:08:29,430
that's water in different reservoirs on

184
00:08:32,750 --> 00:08:30,780
earth it's water locked up it's ice

185
00:08:35,839 --> 00:08:32,760
water in the ground is groundwater water

186
00:08:38,540 --> 00:08:35,849
in the oceans and rivers in the soil in

187
00:08:40,579 --> 00:08:38,550
floodplains and so with grace we're able

188
00:08:42,529 --> 00:08:40,589

to over 15 years look at the trends in

189
00:08:44,540 --> 00:08:42,539
those waters and those water reservoirs

190
00:08:47,389 --> 00:08:44,550
and see whether they're gaining or

191
00:08:48,829 --> 00:08:47,399
losing water mass essentially and you

192
00:08:50,420 --> 00:08:48,839
know in this in this chart here you can

193
00:08:53,360 --> 00:08:50,430
also see you know some of the big

194
00:08:55,730 --> 00:08:53,370
changes and this is in Greenland Africa

195
00:08:57,670 --> 00:08:55,740
let's talk about that the big change is

196
00:09:01,310 --> 00:08:57,680
the big surprises or was that a surprise

197
00:09:03,460 --> 00:09:01,320
well so when when grace was launched we

198
00:09:06,280 --> 00:09:03,470
knew that you know mass moves and

199
00:09:08,200 --> 00:09:06,290
in ice sheets inand in oceans you know

200
00:09:10,540 --> 00:09:08,210
game water or lose water we know exactly

201
00:09:11,980 --> 00:09:10,550
how much was hatch was being lost even

202
00:09:14,410 --> 00:09:11,990
in Greenland we didn't know what the

203
00:09:15,940 --> 00:09:14,420
sign of the change was so with grace

204
00:09:17,850 --> 00:09:15,950
we're able to actually measure the

205
00:09:20,620 --> 00:09:17,860
amount of water that was being lost and

206
00:09:23,970 --> 00:09:20,630
what the rate was and where in Greenland

207
00:09:26,290 --> 00:09:23,980
was being lost so here we have the video

208
00:09:28,000 --> 00:09:26,300
so in this video you see on the left is

209
00:09:30,820 --> 00:09:28,010
an after Greenland and the browner

210
00:09:32,080 --> 00:09:30,830
colors show places where more masses has

211
00:09:34,270 --> 00:09:32,090
been lost from Greenland over the

212
00:09:36,610 --> 00:09:34,280
lifetime of grace and you see there's a

213
00:09:39,010 --> 00:09:36,620

lot of ice being lost from southern

214
00:09:41,470 --> 00:09:39,020
Greenland it gets brown and brown her as

215
00:09:42,640 --> 00:09:41,480
the time so he goes on it goes on on the

216
00:09:43,960 --> 00:09:42,650
right you see the plot is for the

217
00:09:45,820 --> 00:09:43,970
monthly changes you can see sort of

218
00:09:48,220 --> 00:09:45,830
seasonal changes but see overall there's

219
00:09:50,110 --> 00:09:48,230
a there's a overall loss of mass in

220
00:09:53,710 --> 00:09:50,120
Greenland and it's losing mass at about

221
00:09:55,960 --> 00:09:53,720
281 Giga tons of water each year and

222
00:09:59,530 --> 00:09:55,970
let's talk about that a Giga ton I mean

223
00:10:00,550 --> 00:09:59,540
give me a lay person that I do how much

224
00:10:03,250 --> 00:10:00,560
water are we talking about

225
00:10:05,260 --> 00:10:03,260
yeah a Giga tons kind of a strange unit

226
00:10:07,420 --> 00:10:05,270
but some mass units house it's amount of

227
00:10:11,680 --> 00:10:07,430
water that would fill a comic a

228
00:10:13,450 --> 00:10:11,690
kilometer cube of a kilometer cube so in

229
00:10:15,760 --> 00:10:13,460
this animation here you just see a cube

230
00:10:17,020 --> 00:10:15,770
of water a kilometer each side and we

231
00:10:19,150 --> 00:10:17,030
see here at the end you know there's

232
00:10:21,900 --> 00:10:19,160
Empire State Building for for reference

233
00:10:24,610 --> 00:10:21,910
so that's one Giga ton and now grace

234
00:10:27,090 --> 00:10:24,620
follow-on showed our graces gives me

235
00:10:32,320 --> 00:10:27,100
great showed that Greenland was losing

236
00:10:35,380 --> 00:10:32,330
281 Giga tons of water a year so 281 of

237
00:10:37,270 --> 00:10:35,390
those per year all right Frank I'm sure

238
00:10:39,220 --> 00:10:37,280

you're excited about this moment there's

239
00:10:42,310 --> 00:10:39,230
standing bike thanks so much for joining

240
00:10:44,590 --> 00:10:42,320
us thank you all right well it is about

241
00:10:47,260 --> 00:10:44,600
25 minutes past the hour we are keeping

242
00:10:49,300 --> 00:10:47,270
our eye on the clock for 1247 Pacific

243
00:10:51,610 --> 00:10:49,310
time that is lunchtime but meantime

244
00:10:55,010 --> 00:10:51,620
let's talk about some quick facts about

245
00:11:36,670 --> 00:11:35,890
[Music]

246
00:11:57,170 --> 00:11:36,680
[Applause]

247
00:12:54,150 --> 00:12:48,740
[Music]

248
00:12:56,430 --> 00:12:54,160
it is 27 minutes past the hour very soon

249
00:12:58,800 --> 00:12:56,440
now we hope to get a status report on

250
00:13:01,290 --> 00:12:58,810
the satellites we're having Sammy

251
00:13:03,420 --> 00:13:01,300
listening for us on the team to find out

252
00:13:07,440 --> 00:13:03,430
some important information right around

253
00:13:09,150 --> 00:13:07,450
this period from t 22 t 16 is kind of an

254
00:13:11,190 --> 00:13:09,160
important moment for the team is it not

255
00:13:12,990 --> 00:13:11,200
it is no this is a time where we of

256
00:13:14,280 --> 00:13:13,000
course we hear of confirmation from the

257
00:13:17,570 --> 00:13:14,290
launch vehicle that the propellant

258
00:13:20,550 --> 00:13:17,580
loading is continuing the liquid oxygen

259
00:13:22,500 --> 00:13:20,560
loading is initiated and then also we

260
00:13:24,000 --> 00:13:22,510
hear confirmations of commitments from

261
00:13:26,100 --> 00:13:24,010
the launch team from the grace follow-on

262
00:13:28,530 --> 00:13:26,110
launch team about the status of their

263
00:13:30,420 --> 00:13:28,540

system and readiness for launch so every

264
00:13:33,570 --> 00:13:30,430
minute or so in the next couple of

265
00:13:36,420 --> 00:13:33,580
minutes you'll be hearing from people in

266
00:13:38,220 --> 00:13:36,430
the control room giving these status

267
00:13:40,530 --> 00:13:38,230
reports are these goal for launches

268
00:13:43,020 --> 00:13:40,540
correct so every subsystem will report

269
00:13:44,670 --> 00:13:43,030
to the grace follow-on project manager

270
00:13:46,560 --> 00:13:44,680
for the satellite for the Mission

271
00:13:49,290 --> 00:13:46,570
Operations Center and such and they will

272
00:13:50,640 --> 00:13:49,300
report to him the status of availability

273
00:13:52,770 --> 00:13:50,650
of the assets that they have the

274
00:13:55,740 --> 00:13:52,780
personnel and the systems are all go

275
00:13:57,360 --> 00:13:55,750
forward for launch and about t 20 I

276
00:13:59,610 --> 00:13:57,370
understand is that usually the time

277
00:14:01,170 --> 00:13:59,620
where they decide to go to internal

278
00:14:02,700 --> 00:14:01,180
power when they go to internal power

279
00:14:04,590 --> 00:14:02,710
what does that mean so the spacecraft

280
00:14:07,920 --> 00:14:04,600
are now powered by you they're plugged

281
00:14:09,390 --> 00:14:07,930
into a power supply essentially and T 20

282
00:14:11,310 --> 00:14:09,400
they're given the order or the command

283
00:14:13,530 --> 00:14:11,320
to go to internal power which means the

284
00:14:15,060 --> 00:14:13,540
spacecraft now will be disconnected from

285
00:14:17,790 --> 00:14:15,070
the external power will be operating on

286
00:14:21,060 --> 00:14:17,800
their own internal battery power once we

287
00:14:23,640 --> 00:14:21,070
get these goes this the the rocket

288
00:14:25,470 --> 00:14:23,650

itself and the spacecraft everything is

289
00:14:27,840 --> 00:14:25,480
automated from this point on it is it

290
00:14:28,630 --> 00:14:27,850
not correct pretty much opera automated

291
00:14:30,699 --> 00:14:28,640
there are

292
00:14:32,949 --> 00:14:30,709
of course notifications throughout if

293
00:14:36,370 --> 00:14:32,959
there is a problem in the launch vehicle

294
00:14:38,259 --> 00:14:36,380
process they have a an ability to halt

295
00:14:40,540 --> 00:14:38,269
the launch but we don't anticipate that

296
00:14:43,180 --> 00:14:40,550
at all everything has been nominal on

297
00:14:44,800 --> 00:14:43,190
every measurement that we've seen and

298
00:14:46,930 --> 00:14:44,810
have you heard any communications yeah

299
00:14:49,750 --> 00:14:46,940
not yet you will will get confirmation

300
00:15:30,130 --> 00:14:49,760
just second all right so as we watch the

301
00:15:34,430 --> 00:15:32,900
all right Sammy we do have something now

302
00:15:37,640 --> 00:15:34,440
correct we just received confirmation

303
00:15:40,580 --> 00:15:37,650
that the the spacecraft are green from

304
00:15:42,440 --> 00:15:40,590
that go for launch and the Mission

305
00:15:42,890 --> 00:15:42,450
Operations Center is green and go for

306
00:15:44,720 --> 00:15:42,900
launch

307
00:15:49,730 --> 00:15:44,730
and that confirmation was provided to

308
00:15:51,260 --> 00:15:49,740
the launch vehicle we'll be getting a

309
00:15:52,490 --> 00:15:51,270
final confirmation from the launch

310
00:15:55,010 --> 00:15:52,500
vehicle at this point that they are

311
00:17:07,699 --> 00:15:55,020
ready for launch all right okay standing

312
00:17:11,939 --> 00:17:10,650
all right Sammy as we're standing by one

313
00:17:15,030 --> 00:17:11,949

of the things about this particular

314
00:17:18,150 --> 00:17:15,040
launch this is an instantaneous launch

315
00:17:20,880 --> 00:17:18,160
what do we mean by that so in order to

316
00:17:22,980 --> 00:17:20,890
place the the iridium satellites in

317
00:17:24,990 --> 00:17:22,990
particular in the right orbital plane

318
00:17:28,439 --> 00:17:25,000
where they are actually inserted to

319
00:17:30,210 --> 00:17:28,449
complete a constellation then there's a

320
00:17:32,669 --> 00:17:30,220
specific time that we must launch

321
00:17:35,820 --> 00:17:32,679
otherwise we will have to spend a very

322
00:17:38,240 --> 00:17:35,830
large amount of propellant in order to

323
00:17:41,280 --> 00:17:38,250
get the satellites into the right place

324
00:17:44,730 --> 00:17:41,290
and right now it's it's an instantaneous

325
00:17:47,010 --> 00:17:44,740
launch for this for this occasion in in

326
00:17:48,990 --> 00:17:47,020
normal launches for or if you do not

327
00:17:50,549 --> 00:17:49,000
have to insert the satellite into a

328
00:17:52,500 --> 00:17:50,559
constellation you have a little more

329
00:17:54,299 --> 00:17:52,510
leeway you have a little open window but

330
00:17:57,870 --> 00:17:54,309
in this case we have to get into those

331
00:18:00,150 --> 00:17:57,880
same slot we don't make that time then

332
00:18:01,680 --> 00:18:00,160
we just scrub and turnaround it again

333
00:18:03,330 --> 00:18:01,690
tomorrow if there are if there is an

334
00:18:05,220 --> 00:18:03,340
issue and we are not able to make that

335
00:18:07,580 --> 00:18:05,230
time then we'll have to scrub and go for

336
00:18:09,990 --> 00:18:07,590
tomorrow tomorrow will also be another

337
00:18:29,370 --> 00:18:10,000
instantaneous launch window all right

338
00:18:29,380 --> 00:19:15,200

you

339
00:19:20,519 --> 00:19:18,360
as we wait for launch NASA and the

340
00:19:23,130 --> 00:19:20,529
German Research Center for geosciences

341
00:19:26,039 --> 00:19:23,140
share the responsibility for developing

342
00:19:29,100 --> 00:19:26,049
and launching grace follow-on for the

343
00:19:31,409 --> 00:19:29,110
Mission Operations GFC subcontracted the

344
00:19:33,360 --> 00:19:31,419
work to the German space agency which

345
00:19:34,350 --> 00:19:33,370
operates the German Space Operations

346
00:19:36,090 --> 00:19:34,360
Center

347
00:19:38,940 --> 00:19:36,100
ji-suk and it's outside of Munich

348
00:19:41,120 --> 00:19:38,950
Germany that is where much of the grace

349
00:19:44,549 --> 00:19:41,130
follow-on team is right now including

350
00:19:45,750 --> 00:19:44,559
systems engineer Neil daya who is with

351
00:19:50,490 --> 00:19:45,760
us via Skype

352
00:19:53,070 --> 00:19:50,500
hey Neil how you doing I'm just fine

353
00:19:56,490 --> 00:19:53,080
so tell people why so much of the team

354
00:19:58,440 --> 00:19:56,500
is out there in Germany okay most of a

355
00:19:59,730 --> 00:19:58,450
lot of a team is here because this is

356
00:20:01,169 --> 00:19:59,740
the Center for where all the

357
00:20:02,940 --> 00:20:01,179
communications from the satellites are

358
00:20:04,799 --> 00:20:02,950
going to come down we have ground

359
00:20:07,799 --> 00:20:04,809
stations all over the world but this is

360
00:20:08,909 --> 00:20:07,809
the Mission Operations Center and so all

361
00:20:10,919 --> 00:20:08,919
the information is going to come down

362
00:20:12,600 --> 00:20:10,929
here so we need experts around for all

363
00:20:15,299 --> 00:20:12,610

the different aspects of the spacecraft

364
00:20:17,549 --> 00:20:15,309
and Mission Control here all right

365
00:20:19,649 --> 00:20:17,559
so can you describe to me who's in the

366
00:20:22,019 --> 00:20:19,659
room the control room beneath you and

367
00:20:25,590 --> 00:20:22,029
what are their jobs how many people how

368
00:20:27,840 --> 00:20:25,600
many teams are there we got a bunch of

369
00:20:30,810 --> 00:20:27,850
teams but the overall people as Sam you

370
00:20:31,830 --> 00:20:30,820
said earlier we have GFC which is

371
00:20:34,919 --> 00:20:31,840
responsible for the Mission Operations

372
00:20:36,570 --> 00:20:34,929
and Mission Operations is here as part

373
00:20:38,789 --> 00:20:36,580
of GFC is responsibility

374
00:20:40,289 --> 00:20:38,799
geez Hawking deal are responsible for

375
00:20:41,610 --> 00:20:40,299
the flight operations and this is their

376
00:20:44,490 --> 00:20:41,620
mystery control room so a lot of this

377
00:20:46,200 --> 00:20:44,500
room is that with the jisang people but

378
00:20:48,330 --> 00:20:46,210
then Airbus is responsibly doing the

379
00:20:50,490 --> 00:20:48,340
spacecraft design build and testing of

380
00:20:52,230 --> 00:20:50,500
the spacecraft so all their subsystem

381
00:20:54,600 --> 00:20:52,240
experts and their management are also

382
00:20:56,700 --> 00:20:54,610
here and we've got enough people in here

383
00:20:58,320 --> 00:20:56,710
to staff two shifts and then on top of

384
00:20:59,220 --> 00:20:58,330
that we have JPL people that are

385
00:21:02,970 --> 00:20:59,230
responsible for the overall management

386
00:21:04,320 --> 00:21:02,980
we have JPL for the instruments and then

387
00:21:05,850 --> 00:21:04,330
we have our Quality Assurance people

388
00:21:08,250 --> 00:21:05,860

also all right

389
00:21:11,460 --> 00:21:08,260
so Neil we will be checking back with

390
00:21:13,830 --> 00:21:11,470
you soon and with other members of the G

391
00:21:18,090 --> 00:21:13,840
sock team thanks for joining us for

392
00:21:20,520 --> 00:21:18,100
right now all right JPL's Mike Meacham

393
00:21:23,310 --> 00:21:20,530
recently interviewed Neil on the unique

394
00:21:24,250 --> 00:21:23,320
design of the grace missions unlike most

395
00:21:25,930 --> 00:21:24,260
earth

396
00:21:28,450 --> 00:21:25,940
serving satellites which point their

397
00:21:31,000 --> 00:21:28,460
instruments towards our planet the grace

398
00:21:33,970 --> 00:21:31,010
twin satellites work as one instrument

399
00:21:37,000 --> 00:21:33,980
that look at each other to see

400
00:21:39,190 --> 00:21:37,010
gravitational changes on the surface you

401
00:21:43,630 --> 00:21:39,200
have to admit it is some crazy

402
00:21:45,940 --> 00:21:43,640
engineering here on earth we all know

403
00:21:47,860 --> 00:21:45,950
about gravity but what you might not

404
00:21:49,420 --> 00:21:47,870
realize is that depending on where you

405
00:21:55,590 --> 00:21:49,430
are on the planet the strength of

406
00:22:01,480 --> 00:21:55,600
gravity is different examples up here

407
00:22:03,760 --> 00:22:01,490
gravity is stronger water also has mass

408
00:22:05,860 --> 00:22:03,770
and the earth has a whole lot of water

409
00:22:08,320 --> 00:22:05,870
it's moving around it's changing phases

410
00:22:10,120 --> 00:22:08,330
if you can track the change in gravity

411
00:22:11,350 --> 00:22:10,130
you can track the change in mass and

412
00:22:13,990 --> 00:22:11,360
that means you're understanding the

413
00:22:15,340 --> 00:22:14,000

movement of water NASA's about to send

414
00:22:17,560 --> 00:22:15,350
the grace fall on mission which will

415
00:22:19,540 --> 00:22:17,570
continue to do just that let's learn

416
00:22:23,870 --> 00:22:19,550
about it on this episode of crazy in

417
00:22:23,880 --> 00:22:29,110
[Music]

418
00:22:33,440 --> 00:22:31,670
okay everybody we're here with Neil he's

419
00:22:36,050 --> 00:22:33,450
one of the key engineers on the grace

420
00:22:37,010 --> 00:22:36,060
follow-on mission Neil thank you so much

421
00:22:38,720 --> 00:22:37,020
for joining us and answering our

422
00:22:41,180 --> 00:22:38,730
questions why do we call it grace

423
00:22:43,160 --> 00:22:41,190
follow-up so gray stands for Gravity

424
00:22:45,140 --> 00:22:43,170
Recovery and climate experiment we're

425
00:22:47,000 --> 00:22:45,150
using gravity to track water motion

426
00:22:48,230 --> 00:22:47,010
around the planet and the phones because

427
00:22:49,730 --> 00:22:48,240
we've done this before and we're doing

428
00:22:51,170 --> 00:22:49,740
again with two new satellites the

429
00:22:53,480 --> 00:22:51,180
original grace mission was launched in

430
00:22:55,610 --> 00:22:53,490
2002 they lasted for 15 years and

431
00:22:58,280 --> 00:22:55,620
provided amazing science for scientists

432
00:23:00,470 --> 00:22:58,290
both of these missions have two

433
00:23:02,000 --> 00:23:00,480
satellites can you explain to us why we

434
00:23:03,830 --> 00:23:02,010
need two satellites instead of just one

435
00:23:05,750 --> 00:23:03,840
so we need two satellites because we're

436
00:23:07,760 --> 00:23:05,760
trying to measure very precise small

437
00:23:09,830 --> 00:23:07,770
amounts of gravity changes in the earth

438
00:23:11,510 --> 00:23:09,840

the earth is actually lumpy when it

439
00:23:13,370 --> 00:23:11,520
comes to gravity far away from earth

440
00:23:15,290 --> 00:23:13,380
gravity is just a single number but as

441
00:23:17,060 --> 00:23:15,300
you get close to the earth the gravity

442
00:23:18,980 --> 00:23:17,070
changes because the Himalayas have a

443
00:23:21,080 --> 00:23:18,990
little bit more mass certain areas have

444
00:23:23,150 --> 00:23:21,090
less mass and so as a satellite is

445
00:23:24,920 --> 00:23:23,160
orbiting the planet as it comes towards

446
00:23:26,750 --> 00:23:24,930
a large mass like the mountains it

447
00:23:29,120 --> 00:23:26,760
actually will speed up and then as it

448
00:23:30,650 --> 00:23:29,130
leaves it will slow down and so with two

449
00:23:32,930 --> 00:23:30,660
satellites were able to measure the

450
00:23:34,880 --> 00:23:32,940
distance between the two how far apart

451
00:23:36,200 --> 00:23:34,890
are these satellites and just how

452
00:23:37,790 --> 00:23:36,210
precise do they have to have the

453
00:23:39,230 --> 00:23:37,800
knowledge of each other's position we

454
00:23:40,730 --> 00:23:39,240
have the satellites at 200 kilometers

455
00:23:42,230 --> 00:23:40,740
apart but we're measuring down to an

456
00:23:44,210 --> 00:23:42,240
accuracy of a micron level which is

457
00:23:46,370 --> 00:23:44,220
about a tenth of a human hair that is

458
00:23:48,470 --> 00:23:46,380
extremely precise that sounds like a

459
00:23:50,510 --> 00:23:48,480
very hard engineering problem what's the

460
00:23:52,610 --> 00:23:50,520
technology that lets us do this we're

461
00:23:53,330 --> 00:23:52,620
using microwave technologies at about 30

462
00:23:55,220 --> 00:23:53,340
gigahertz

463
00:23:57,230 --> 00:23:55,230

here you see one of the satellites and

464
00:23:58,700 --> 00:23:57,240
200 kilometers away is the other

465
00:24:00,740 --> 00:23:58,710
satellite and what we're doing is we're

466
00:24:02,510 --> 00:24:00,750
firing an RF signal to the other

467
00:24:04,370 --> 00:24:02,520
satellite and the other sites measuring

468
00:24:05,810 --> 00:24:04,380
that and as you move backwards and

469
00:24:07,580 --> 00:24:05,820
forwards relative this sine wave you can

470
00:24:10,070 --> 00:24:07,590
measure the distance changes to the

471
00:24:11,600 --> 00:24:10,080
levels we need it's been well more than

472
00:24:13,610 --> 00:24:11,610
a decade since the original grace

473
00:24:15,350 --> 00:24:13,620
mission I assume we're upgrading some of

474
00:24:17,930 --> 00:24:15,360
these technologies can you describe some

475
00:24:19,520 --> 00:24:17,940
of those sure like technology advances

476
00:24:21,260 --> 00:24:19,530
in general we've upgraded computer

477
00:24:23,720 --> 00:24:21,270
systems we have more efficient solar

478
00:24:25,250 --> 00:24:23,730
cells we have better star cameras and

479
00:24:26,700 --> 00:24:25,260
like everything else in the future we

480
00:24:29,700 --> 00:24:26,710
now have lasers

481
00:24:32,010 --> 00:24:29,710
yes what do lasers actually get for us

482
00:24:33,270 --> 00:24:32,020
so we're actually using the lasers to do

483
00:24:35,250 --> 00:24:33,280
the measurement between the two

484
00:24:37,290 --> 00:24:35,260
satellites we're using RF systems from

485
00:24:38,910 --> 00:24:37,300
the previous missions on top of that we

486
00:24:40,200 --> 00:24:38,920
have this new technology demonstrator

487
00:24:41,790 --> 00:24:40,210
where we're going to fire at laser beams

488
00:24:43,230 --> 00:24:41,800

between each other to make a more

489
00:24:45,240 --> 00:24:43,240
accurate measurement between the two

490
00:24:46,620 --> 00:24:45,250
satellites you know this is without a

491
00:24:48,900 --> 00:24:46,630
doubt one of the coolest missions we've

492
00:24:51,000 --> 00:24:48,910
seen thank you so much for answering our

493
00:24:52,890 --> 00:24:51,010
questions when can we hope to see this

494
00:24:54,810 --> 00:24:52,900
launch so we're hoping to hitch a ride

495
00:24:56,010 --> 00:24:54,820
with SpaceX rocket later this year and

496
00:24:57,690 --> 00:24:56,020
we should be collecting science data

497
00:24:59,160 --> 00:24:57,700
shortly after that all right we'll

498
00:25:00,780 --> 00:24:59,170
certainly check that out and everyone

499
00:25:02,450 --> 00:25:00,790
out there check back soon for some more

500
00:25:09,590 --> 00:25:02,460
crazy engineering

501
00:25:17,580 --> 00:25:15,090
and we are looking at a gorgeous view of

502
00:25:21,360 --> 00:25:17,590
the rocket right now Sammy what is going

503
00:25:27,450 --> 00:25:21,370
on here well you see the rocket readied

504
00:25:30,750 --> 00:25:27,460
for launch and right now this the what

505
00:25:33,720 --> 00:25:30,760
appears like smoke is actually a liquid

506
00:25:37,049 --> 00:25:33,730
oxygen vapor part of the fueling process

507
00:25:39,000 --> 00:25:37,059
that go through for the Falcon 9 and the

508
00:25:43,799 --> 00:25:39,010
there is that what's called the strong

509
00:25:45,600 --> 00:25:43,809
back which is the white structure right

510
00:25:48,570 --> 00:25:45,610
next to the rocket that actually helps

511
00:25:51,299 --> 00:25:48,580
hold the rocket in place right till the

512
00:25:54,090 --> 00:25:51,309
point of launch and it will be pulled

513
00:25:57,450 --> 00:25:54,100

back right as we go through the

514
00:26:01,110 --> 00:25:57,460
countdown well currently we're about

515
00:26:03,480 --> 00:26:01,120
just shy of 7 minutes from launch but as

516
00:26:05,549 --> 00:26:03,490
we get closer and closer to these final

517
00:26:07,740 --> 00:26:05,559
minutes before launch we'd like to take

518
00:26:12,419 --> 00:26:07,750
a moment for this message from NASA's

519
00:26:14,490 --> 00:26:12,429
new administrator Jim Burnstein well I'm

520
00:26:16,769 --> 00:26:14,500
sorry I can't be at Vandenberg today

521
00:26:19,470 --> 00:26:16,779
it's my pleasure to welcome you all to

522
00:26:22,049 --> 00:26:19,480
another of NASA's amazing earth science

523
00:26:24,810 --> 00:26:22,059
launches the grace follow-on mission to

524
00:26:28,110 --> 00:26:24,820
observe our planet's ever-changing water

525
00:26:30,480 --> 00:26:28,120
cycle ice sheets and crust I want to

526
00:26:32,519 --> 00:26:30,490
thank the NASA and commercial teams that

527
00:26:34,500 --> 00:26:32,529
have gotten us to this point and give a

528
00:26:36,269 --> 00:26:34,510
special shout-out to the many scientists

529
00:26:38,340 --> 00:26:36,279
engineers and technicians who have

530
00:26:41,879 --> 00:26:38,350
worked years to make this mission

531
00:26:44,009 --> 00:26:41,889
possible your dedication is remarkable

532
00:26:46,620 --> 00:26:44,019
and it truly is the kind of spirit that

533
00:26:50,100 --> 00:26:46,630
is carrying our space program to new

534
00:26:52,649 --> 00:26:50,110
heights all the time our philosophy on

535
00:26:55,740 --> 00:26:52,659
Mars has been to follow the water and

536
00:26:56,370 --> 00:26:55,750
that has relevance right here on earth

537
00:26:58,649 --> 00:26:56,380
as well

538
00:27:00,720 --> 00:26:58,659

grace follow-on data will provide unique

539
00:27:02,580 --> 00:27:00,730
insights into Earth's changing climate

540
00:27:05,430 --> 00:27:02,590
and it will have far-reaching benefits

541
00:27:08,549 --> 00:27:05,440
to society such as improving water

542
00:27:11,220 --> 00:27:08,559
resource management water is critical to

543
00:27:14,250 --> 00:27:11,230
every aspect of life on Earth for health

544
00:27:17,970 --> 00:27:14,260
for agriculture and for maintaining our

545
00:27:20,549 --> 00:27:17,980
very way of life this mission showcases

546
00:27:21,990 --> 00:27:20,559
a strong partnership between NASA and

547
00:27:25,290 --> 00:27:22,000
the German research

548
00:27:27,000 --> 00:27:25,300
for geosciences while JPL manages the

549
00:27:30,660 --> 00:27:27,010
mission for NASA's science Mission

550
00:27:32,250 --> 00:27:30,670
Directorate in Washington I look forward

551
00:27:33,930 --> 00:27:32,260
to seeing many more earth science

552
00:27:36,630 --> 00:27:33,940
missions during my tenure as NASA

553
00:27:39,720 --> 00:27:36,640
Administrator and working closely with

554
00:27:41,690 --> 00:27:39,730
the team as we study my favorite planet

555
00:27:45,660 --> 00:27:41,700
Earth

556
00:27:48,360 --> 00:27:45,670
all right you are looking at a shot of

557
00:27:50,790 --> 00:27:48,370
the pad we are just less than five

558
00:27:53,670 --> 00:27:50,800
minutes away from launch and we are

559
00:27:56,310 --> 00:27:53,680
standing bystanding quiet to see how

560
00:27:57,990 --> 00:27:56,320
things go together but as far as we know

561
00:27:59,700 --> 00:27:58,000
things are a go just receive

562
00:28:02,700 --> 00:27:59,710
confirmation that fuel loading is now

563
00:28:04,620 --> 00:28:02,710

complete so that's an excellent sign for

564
00:28:07,470 --> 00:28:04,630
preparation for launch all right and

565
00:28:12,180 --> 00:28:07,480
conditions look fabulous look great

566
00:28:17,400 --> 00:28:12,190
weather report strong back will be start

567
00:28:19,380 --> 00:28:17,410
to pull it be pulled back now strong

568
00:28:21,750 --> 00:28:19,390
back is what I described earlier as what

569
00:29:45,760 --> 00:28:21,760
helps hold the rocket up preparation for

570
00:29:45,770 --> 00:29:56,289
verification

571
00:29:56,299 --> 00:30:38,530
and stage 1 locks close-up

572
00:30:48,760 --> 00:30:46,090
Laura's close-up Rock RC countdown one

573
00:30:49,000 --> 00:30:48,770
rock verify range the screen and go for

574
00:31:12,210 --> 00:30:49,010
launch

575
00:31:44,470 --> 00:31:15,550
the vehicle gas closeout started got

576
00:31:58,440 --> 00:31:44,480
closer a FPS is ready for launch f9

577
00:31:58,450 --> 00:32:12,190
LD go for launch

578
00:32:12,200 --> 00:32:22,190
t-minus 30

579
00:32:22,200 --> 00:32:25,660
20

580
00:32:43,940 --> 00:32:33,210
play tanks configured for flight 15 hey

581
00:32:47,070 --> 00:32:45,680
[Music]

582
00:32:52,210 --> 00:32:47,080
[Applause]

583
00:33:03,780 --> 00:32:52,220
follow-on race mission of tracking the

584
00:33:14,700 --> 00:33:06,840
there's one problem

585
00:33:14,710 --> 00:33:28,950
all right we have a liftoff Frankie

586
00:33:28,960 --> 00:33:43,919
powered telemetry nominal

587
00:34:01,020 --> 00:33:47,409
he's going up we're gonna have the first

588
00:34:01,030 --> 00:34:08,159

as it's going the atmosphere right here

589
00:34:18,849 --> 00:34:13,270
so just went through max Q everything is

590
00:34:34,600 --> 00:34:18,859
looking good the next stage is the main

591
00:34:43,930 --> 00:34:37,330
as main engine cutoff is in about 50

592
00:34:46,890 --> 00:34:43,940
seconds main engine cutoff it's the

593
00:34:52,900 --> 00:34:46,900
higher the first stage of the rocket

594
00:35:06,550 --> 00:34:52,910
will stop ignition of course and and be

595
00:35:14,240 --> 00:35:06,560
deployed see an image now from rocket

596
00:35:33,480 --> 00:35:16,460
the main engine cutoff will be the 15

597
00:35:38,730 --> 00:35:36,390
you go we have made a deceleration

598
00:35:41,940 --> 00:35:38,740
confirmed and stays support separation

599
00:35:48,810 --> 00:35:41,950
has been confirmed so the first stage

600
00:35:52,830 --> 00:35:48,820
was deployed can see an image from the

601
00:36:02,140 --> 00:35:52,840
second stage stage wanna have two guys

602
00:36:11,030 --> 00:36:08,210
so it's everything is nominal right

603
00:36:12,440 --> 00:36:11,040
separating separation successfully and

604
00:36:18,520 --> 00:36:12,450
you can see the grace fallen and the

605
00:36:35,750 --> 00:36:21,050
take is following an album on trajectory

606
00:36:35,760 --> 00:36:56,569
it's an image of the second stage

607
00:37:03,349 --> 00:36:59,779
so the second engine will will burn for

608
00:37:07,489 --> 00:37:03,359
approximately eight minutes that will

609
00:37:10,489 --> 00:37:07,499
get the the second stage and the both

610
00:37:12,769 --> 00:37:10,499
the radium and grace follow-on stack up

611
00:37:16,479 --> 00:37:12,779
to the point where grace follow-on will

612
00:37:19,579 --> 00:37:16,489
be separated from from that stack and

613
00:37:22,549 --> 00:37:19,589

then the launch vehicle the second stage

614
00:37:25,339 --> 00:37:22,559
will continue on and deploy the greatly

615
00:37:29,660 --> 00:37:25,349
iridium satellites after another burn

616
00:37:33,769 --> 00:37:29,670
actually all right so we have eight

617
00:37:37,489 --> 00:37:33,779
minutes until the second engine cut off

618
00:37:39,919 --> 00:37:37,499
so we we're going to take some time to

619
00:37:43,640 --> 00:37:39,929
introduce folks to some of the members

620
00:37:45,919 --> 00:37:43,650
of the team well we wait for the end of

621
00:37:48,799 --> 00:37:45,929
the engine burn we thought we would be

622
00:37:51,759 --> 00:37:48,809
able to introduce you to some of the

623
00:37:55,099 --> 00:37:51,769
project managers Phil Morton of JPL and

624
00:37:57,380 --> 00:37:55,109
German research manager project manager

625
00:37:59,870 --> 00:37:57,390
Frank fleckner they're both in the

626
00:38:02,120 --> 00:37:59,880
SpaceX control room at Vandenberg right

627
00:38:04,400 --> 00:38:02,130
now they're monitoring this lunch but we

628
00:38:07,130 --> 00:38:04,410
did talk to them earlier about their

629
00:38:09,429 --> 00:38:07,140
roles and the stories they tell us about

630
00:38:12,199 --> 00:38:09,439
the relationship between the two teams

631
00:38:18,829 --> 00:38:12,209
they tell us is a partnership that goes

632
00:38:20,689 --> 00:38:18,839
way back the data is available and needs

633
00:38:23,630 --> 00:38:20,699
to continue to be available and how do

634
00:38:26,209 --> 00:38:23,640
you use it in a way that helps or

635
00:38:28,400 --> 00:38:26,219
benefits where you live specifically

636
00:38:30,319 --> 00:38:28,410
because you can really track right to

637
00:38:34,509 --> 00:38:30,329
where you live what the future might be

638
00:38:37,339 --> 00:38:34,519

like there are tools now to monitor and

639
00:38:41,299 --> 00:38:37,349
estimate what the future might be like

640
00:38:44,599 --> 00:38:41,309
given the trends that we see I have the

641
00:38:47,239 --> 00:38:44,609
responsibility for the mission with NASA

642
00:38:50,239 --> 00:38:47,249
that's sort of the way a project manager

643
00:38:52,249 --> 00:38:50,249
role is defined so my responsibility is

644
00:38:54,340 --> 00:38:52,259
that the mission comes together and

645
00:38:58,060 --> 00:38:54,350
operates successfully

646
00:39:02,860 --> 00:38:58,070
I have a counterpart dr. Frank fleckner

647
00:39:06,160 --> 00:39:02,870
who said gfz in Germany I was already

648
00:39:09,880 --> 00:39:06,170
the co-pi of the grace mission and I

649
00:39:12,190 --> 00:39:09,890
became the BFG of the project manager

650
00:39:14,590 --> 00:39:12,200
for all its German contributions to the

651
00:39:16,750 --> 00:39:14,600
issue he's a pleasure to work with

652
00:39:19,030 --> 00:39:16,760
he's very knowledgeable on the science

653
00:39:20,560 --> 00:39:19,040
data from grace we talk weekly if not

654
00:39:22,570 --> 00:39:20,570
more it's a pleasure to work with

655
00:39:24,730 --> 00:39:22,580
somebody that you can have a straight

656
00:39:28,600 --> 00:39:24,740
conversation with I know Phil already

657
00:39:30,340 --> 00:39:28,610
forms a great project for 9899 say six

658
00:39:33,490 --> 00:39:30,350
years ago when we started to implement

659
00:39:36,610 --> 00:39:33,500
ways follow on I was very happy to see

660
00:39:39,070 --> 00:39:36,620
Phil again to be the LGP graceful on

661
00:39:41,710 --> 00:39:39,080
project manager because I know him so

662
00:39:46,150 --> 00:39:41,720
long and it's easy to talk with him and

663
00:39:49,450 --> 00:39:46,160

and it's a really different we've taken

664
00:39:50,350 --> 00:39:49,460
the best of their expertise combined it

665
00:39:52,030 --> 00:39:50,360
with the best of ours

666
00:39:53,800 --> 00:39:52,040
you put these groups of people together

667
00:39:55,810 --> 00:39:53,810
you you know and make sure that we're

668
00:39:57,100 --> 00:39:55,820
all heading down the same path heading

669
00:39:58,690 --> 00:39:57,110
towards the same goals

670
00:40:02,260 --> 00:39:58,700
everybody's working so closely together

671
00:40:04,390 --> 00:40:02,270
we are seamless between the teams it

672
00:40:06,550 --> 00:40:04,400
really has worked out well we are one

673
00:40:11,130 --> 00:40:06,560
grace family we know each other since

674
00:40:14,260 --> 00:40:11,140
1986 20 years and so we all get older

675
00:40:16,990 --> 00:40:14,270
during the grace lifetime and it's a

676
00:40:19,540 --> 00:40:17,000
great opportunity to run into a grace

677
00:40:25,349 --> 00:40:19,550
follow-on mission with many of these old

678
00:40:30,989 --> 00:40:28,440
so as we're standing by for the end of

679
00:40:34,319 --> 00:40:30,999
the second engine burn the other things

680
00:40:37,079 --> 00:40:34,329
that we're focusing on is is what

681
00:40:40,349 --> 00:40:37,089
happens after the second engine burn is

682
00:40:42,359 --> 00:40:40,359
done what happens after that so the

683
00:40:44,699 --> 00:40:42,369
first thing that happens is that the

684
00:40:47,249 --> 00:40:44,709
grace follow-ons satellites are

685
00:40:53,910 --> 00:40:47,259
separated they're they're released from

686
00:40:56,039 --> 00:40:53,920
from the multi satellite dispenser as

687
00:40:58,199 --> 00:40:56,049
you see here this animation shows the

688
00:41:00,120 --> 00:40:58,209

the grace follow-on to satellites being

689
00:41:02,249 --> 00:41:00,130
separated the first thing we want to do

690
00:41:03,660 --> 00:41:02,259
is make communication and make sure that

691
00:41:05,630 --> 00:41:03,670
we have contact with the spacecraft so

692
00:41:08,940 --> 00:41:05,640
they will release this s-band antenna

693
00:41:11,069 --> 00:41:08,950
that allows us to have communication but

694
00:41:14,640 --> 00:41:11,079
the spacecraft at this stage are a

695
00:41:18,749 --> 00:41:14,650
little wobbly I would say so they would

696
00:41:21,029 --> 00:41:18,759
have to adjust the internal propulsion

697
00:41:25,049 --> 00:41:21,039
system we'll make adjustments because we

698
00:41:27,329 --> 00:41:25,059
want the spacecraft to come in in a what

699
00:41:29,910 --> 00:41:27,339
we call a safe mode which points the

700
00:41:33,269 --> 00:41:29,920
solar arrays up to the Sun and the

701
00:41:35,339 --> 00:41:33,279
antenna towards Earth and that will take

702
00:41:38,969 --> 00:41:35,349
a few minutes and then the first pass is

703
00:41:41,579 --> 00:41:38,979
going to be over McMurdo Station in

704
00:41:43,769 --> 00:41:41,589
Antarctica that is the first opportunity

705
00:41:45,089 --> 00:41:43,779
that we have communication with the

706
00:41:48,120 --> 00:41:45,099
satellite that is the first opportunity

707
00:41:49,920 --> 00:41:48,130
we anticipate that we would have contact

708
00:41:53,039 --> 00:41:49,930
with both spacecraft at that point but

709
00:41:54,809 --> 00:41:53,049
if that doesn't happen because of any

710
00:41:56,459 --> 00:41:54,819
delay in stability of the spacecraft

711
00:41:58,620 --> 00:41:56,469
then we have another opportunity in

712
00:42:00,599 --> 00:41:58,630
another 45 minutes what kind of

713
00:42:03,660 --> 00:42:00,609

communication are we talking about is it

714
00:42:07,589 --> 00:42:03,670
just a ping saying I'm here on the line

715
00:42:10,229 --> 00:42:07,599
we will actually get a health report

716
00:42:12,749 --> 00:42:10,239
from the spacecraft that tells us the

717
00:42:14,849 --> 00:42:12,759
power condition the computer status the

718
00:42:16,469 --> 00:42:14,859
communication condition pretty much

719
00:42:18,359 --> 00:42:16,479
everything that we need to know about

720
00:42:21,420 --> 00:42:18,369
the health of the spacecraft at that

721
00:42:23,779 --> 00:42:21,430
point so how far off are we from main

722
00:42:29,610 --> 00:42:23,789
engine cutoff then main engine cutoff

723
00:42:36,450 --> 00:42:34,410
looks like it about ten eight nine

724
00:42:48,770 --> 00:42:36,460
minutes okay

725
00:42:48,780 --> 00:43:01,310
cook l OS expected

726
00:43:01,320 --> 00:43:20,980
Tiko

727
00:43:35,050 --> 00:43:29,590
no parking orbit insertion did we lose

728
00:43:37,780 --> 00:43:35,060
the feed so we are looking for second

729
00:43:39,400 --> 00:43:37,790
engine cutoff and a signal for second

730
00:43:42,550 --> 00:43:39,410
engine cutoff and that's a critical

731
00:43:45,070 --> 00:43:42,560
period because that is when the

732
00:43:47,590 --> 00:43:45,080
satellites will be deployed correct the

733
00:43:50,890 --> 00:43:47,600
separation will occur right after main

734
00:43:53,080 --> 00:43:50,900
engine cutoff right after the main

735
00:43:57,609 --> 00:43:53,090
engine cutoff we should we will be

736
00:44:00,160 --> 00:43:57,619
getting confirmation separation from the

737
00:44:01,120 --> 00:44:00,170
launch vehicle actually from the team

738
00:44:04,359 --> 00:44:01,130

correct

739
00:44:08,160 --> 00:44:04,369
they had successful separation and then

740
00:44:11,800 --> 00:44:08,170
after that in about 10 seconds and then

741
00:44:14,410 --> 00:44:11,810
after that we will wait for establishing

742
00:44:16,720 --> 00:44:14,420
communications over McMurdo will we be

743
00:44:18,310 --> 00:44:16,730
able to actually see the satellites

744
00:44:20,050 --> 00:44:18,320
deploy there's a good view actually

745
00:44:21,760 --> 00:44:20,060
we're hoping that we will be able to get

746
00:44:24,550 --> 00:44:21,770
a glimpse of the glace grace follow-on

747
00:44:25,870 --> 00:44:24,560
still a look deployed confirmed the

748
00:44:28,210 --> 00:44:25,880
deployment of the grace follow-on

749
00:44:33,400 --> 00:44:28,220
spacecraft was deployed that's confirmed

750
00:44:40,180 --> 00:44:33,410
deployed successfully excitement in the

751
00:44:41,940 --> 00:44:40,190
rooms here we could hear them yes there

752
00:44:47,470 --> 00:44:41,950
they are

753
00:44:51,040 --> 00:44:47,480
that is the e Mach at JPL yeah we have

754
00:44:55,960 --> 00:44:51,050
folks here in the MDC here at Vandenberg

755
00:44:59,940 --> 00:44:55,970
Air Force Base so far so good

756
00:45:02,080 --> 00:44:59,950
excellent excellent performance now the

757
00:45:03,970 --> 00:45:02,090
second stage of the launch vehicle

758
00:45:06,910 --> 00:45:03,980
continues on to deploy the iridium

759
00:45:08,560 --> 00:45:06,920
satellites to do it does and we wish

760
00:45:10,390 --> 00:45:08,570
them the best of luck for that all right

761
00:45:17,430 --> 00:45:10,400
the appointment of the five Iridium

762
00:45:22,900 --> 00:45:20,470
so now we have to wait for the satellite

763
00:45:33,280 --> 00:45:22,910

the grace follow-on spacecraft to

764
00:45:37,890 --> 00:45:33,290
stabilize and I'm getting a message okay

765
00:45:44,170 --> 00:45:40,210
it was another confirmation for the

766
00:45:46,570 --> 00:45:44,180
successful deployment so we have

767
00:45:50,110 --> 00:45:46,580
confirmation that both grace satellites

768
00:45:52,240 --> 00:45:50,120
have indeed then correct both grace on

769
00:45:55,810 --> 00:45:52,250
grace follow-on satellites or spacecraft

770
00:45:59,020 --> 00:45:55,820
were deployed successfully and now the

771
00:46:01,600 --> 00:45:59,030
spacecraft will be stabilizing in their

772
00:46:02,230 --> 00:46:01,610
orbit they'll be getting away from from

773
00:46:05,500 --> 00:46:02,240
each other

774
00:46:10,350 --> 00:46:05,510
that's natural movement that we intended

775
00:46:13,210 --> 00:46:10,360
for the spacecraft to do and once the

776
00:46:15,100 --> 00:46:13,220
communication is established after over

777
00:46:17,110 --> 00:46:15,110
McMurdo we will know exactly what

778
00:46:19,360 --> 00:46:17,120
altitude they're in and what adjustments

779
00:46:20,110 --> 00:46:19,370
additional adjustments may may need to

780
00:46:23,110 --> 00:46:20,120
take place

781
00:46:26,130 --> 00:46:23,120
however the spacecraft in the mode that

782
00:46:29,320 --> 00:46:26,140
they come on once they're released

783
00:46:32,620 --> 00:46:29,330
they're in the safe mode so the solar

784
00:46:41,540 --> 00:46:32,630
arrays face the face the Sun and the

785
00:46:41,550 --> 00:46:53,490
all right

786
00:47:04,020 --> 00:46:55,800
so things are looking good thing too low

787
00:47:10,680 --> 00:47:05,760
throughout this period we will have

788
00:47:13,560 --> 00:47:10,690

check out all the of the spacecraft so

789
00:47:14,970 --> 00:47:13,570
we'll go through internal checks on the

790
00:47:16,680 --> 00:47:14,980
spacecraft and then once who is

791
00:47:18,300 --> 00:47:16,690
communication is established we'll go

792
00:47:20,000 --> 00:47:18,310
through extensive checkout for the

793
00:47:22,670 --> 00:47:20,010
spacecraft of conditioning and

794
00:47:25,500 --> 00:47:22,680
preparation for start of the

795
00:47:28,320 --> 00:47:25,510
instrumentation so it's going to be

796
00:47:30,870 --> 00:47:28,330
another 20 minutes or so before we

797
00:47:34,370 --> 00:47:30,880
expect to have that acquisition of

798
00:47:37,620 --> 00:47:34,380
signal 1:8 the spacecraft goes over

799
00:47:40,620 --> 00:47:37,630
after separation we have about 20 min 22

800
00:47:42,690 --> 00:47:40,630
minutes actually to get signal and that

801
00:47:45,480 --> 00:47:42,700
period lasts about 6 minutes over

802
00:47:48,180 --> 00:47:45,490
McMurdo and we have to make contact with

803
00:47:51,360 --> 00:47:48,190
both spacecraft and there is a period of

804
00:47:53,370 --> 00:47:51,370
time where we have to adjust the antenna

805
00:47:56,430 --> 00:47:53,380
the ground antenna to track the second

806
00:47:58,290 --> 00:47:56,440
spacecraft also alright next key moment

807
00:48:00,840 --> 00:47:58,300
yeah can't wait all right

808
00:48:02,970 --> 00:48:00,850
thanks Danny we've been introducing you

809
00:48:03,900 --> 00:48:02,980
to members of the team and here is

810
00:48:07,230 --> 00:48:03,910
another one

811
00:48:10,860 --> 00:48:07,240
hui yang Winn she's an MIT grad and arts

812
00:48:13,200 --> 00:48:10,870
lover and a JPL science applications

813
00:48:15,450 --> 00:48:13,210

engineer she's part of the JPL team

814
00:48:17,310 --> 00:48:15,460
currently supporting the mission at the

815
00:48:19,560 --> 00:48:17,320
German Space Operations Center near

816
00:48:25,280 --> 00:48:19,570
Munich we spoke to her in March about

817
00:48:29,670 --> 00:48:25,290
the work she's currently doing I work on

818
00:48:33,750 --> 00:48:29,680
spacecraft that measure how much water

819
00:48:36,090 --> 00:48:33,760
there is anywhere on the earth that's

820
00:48:38,610 --> 00:48:36,100
what it doesn't one-sentence because

821
00:48:40,380 --> 00:48:38,620
water doesn't just disappear if it's not

822
00:48:43,050 --> 00:48:40,390
on this part of the world it probably

823
00:48:46,170 --> 00:48:43,060
moved somewhere else so we're tracking

824
00:48:49,830 --> 00:48:46,180
to see where all the water is on the

825
00:48:51,120 --> 00:48:49,840
planet this mission is so simple it

826
00:48:53,700 --> 00:48:51,130
doesn't even matter whether there's

827
00:48:55,980 --> 00:48:53,710
satellites or rocks all you do is just

828
00:48:58,680 --> 00:48:55,990
toss them so that they're in orbit

829
00:49:01,710 --> 00:48:58,690
around the planet and if you can measure

830
00:49:04,770 --> 00:49:01,720
accurately the distance between them I'm

831
00:49:07,080 --> 00:49:04,780
still amazed that we can do an extremely

832
00:49:08,600 --> 00:49:07,090
simple measurement like that and have it

833
00:49:13,010 --> 00:49:08,610
tell us so much

834
00:49:15,860 --> 00:49:13,020
you really have to sort of entirety your

835
00:49:17,900 --> 00:49:15,870
own morals and and your own reasons for

836
00:49:20,270 --> 00:49:17,910
what you do because it's pretty

837
00:49:23,570 --> 00:49:20,280
intensively impactful work in extremely

838
00:49:25,790 --> 00:49:23,580

different ways it's not just about doing

839
00:49:27,530 --> 00:49:25,800
the math and doing the programming look

840
00:49:30,530 --> 00:49:27,540
at the data we're taking right we're

841
00:49:31,850 --> 00:49:30,540
assessing water levels when you look at

842
00:49:34,160 --> 00:49:31,860
water levels you can figure out where

843
00:49:36,260 --> 00:49:34,170
there are severe droughts for us it's

844
00:49:38,360 --> 00:49:36,270
just a little blip on a map of the earth

845
00:49:41,120 --> 00:49:38,370
but for someone who's living there or

846
00:49:41,960 --> 00:49:41,130
trying to you know farm or just live in

847
00:49:45,760 --> 00:49:41,970
that area

848
00:49:51,380 --> 00:49:45,770
it's the blip that affects their entire

849
00:49:54,350 --> 00:49:51,390
life joining us now is deputy project

850
00:49:57,050 --> 00:49:54,360
scientist Felix Lander of JPL you know

851
00:49:59,960 --> 00:49:57,060
listening to who he talked about what

852
00:50:01,700 --> 00:49:59,970
she does and she expresses herself that

853
00:50:04,580 --> 00:50:01,710
you know what she does is not just

854
00:50:06,350 --> 00:50:04,590
looking at ones and zeros as you know a

855
00:50:08,810 --> 00:50:06,360
person that's an engineer on a

856
00:50:10,700 --> 00:50:08,820
spacecraft she sees herself as doing

857
00:50:12,440 --> 00:50:10,710
something that's really helping us

858
00:50:15,470 --> 00:50:12,450
understand our world do you feel that

859
00:50:17,360 --> 00:50:15,480
way - absolutely just like the original

860
00:50:19,430 --> 00:50:17,370
grace mission that grace follow-on will

861
00:50:21,950 --> 00:50:19,440
continue to probe the earth in a very

862
00:50:23,870 --> 00:50:21,960
unique way you know we're tracking very

863
00:50:26,240 --> 00:50:23,880

small distance changes between the two

864
00:50:28,370 --> 00:50:26,250
satellites and that in turn allows us to

865
00:50:30,080 --> 00:50:28,380
measure surface mass changes in

866
00:50:32,960 --> 00:50:30,090
particular those related to water a very

867
00:50:35,570 --> 00:50:32,970
vital resource on the ground give me an

868
00:50:40,670 --> 00:50:35,580
idea what were some of the things that

869
00:50:43,190 --> 00:50:40,680
we discovered and realize before you

870
00:50:45,050 --> 00:50:43,200
know we didn't have grace and now that

871
00:50:47,360 --> 00:50:45,060
we do have grace what do we know now

872
00:50:49,550 --> 00:50:47,370
that we didn't know then yeah over the

873
00:50:52,460 --> 00:50:49,560
15 years we had grace we made a lot of

874
00:50:54,830 --> 00:50:52,470
their unique new measurements and got to

875
00:50:57,010 --> 00:50:54,840
reveal some of the largest mass changes

876
00:50:59,360 --> 00:50:57,020
we already saw a few earlier Greenland

877
00:51:02,570 --> 00:50:59,370
some of the biggest mass changes we

878
00:51:04,940 --> 00:51:02,580
measured are related to water over land

879
00:51:07,070 --> 00:51:04,950
in particular of a big aquifer systems

880
00:51:08,450 --> 00:51:07,080
so for example here in California and I

881
00:51:11,600 --> 00:51:08,460
think we have a small animation that we

882
00:51:14,570 --> 00:51:11,610
can roll right now we measured how the

883
00:51:17,570 --> 00:51:14,580
change in water evolved over time and we

884
00:51:19,760 --> 00:51:17,580
can see these increased water changes

885
00:51:21,740 --> 00:51:19,770
those are relatively wet years then we

886
00:51:22,820 --> 00:51:21,750
slide into multiple years of relatively

887
00:51:26,150 --> 00:51:22,830
dry

888
00:51:27,980 --> 00:51:26,160

climate interrupted by a wet year where

889
00:51:29,930 --> 00:51:27,990
we see an increase but then we also have

890
00:51:32,660 --> 00:51:29,940
this prolonged drought over a few years

891
00:51:34,970 --> 00:51:32,670
where we slid into the steep negative

892
00:51:36,470 --> 00:51:34,980
water storage anomaly and with the grace

893
00:51:39,860 --> 00:51:36,480
satellites we can really accurately

894
00:51:41,510 --> 00:51:39,870
track that water and inform decision

895
00:51:43,970 --> 00:51:41,520
makers how much ground water is being

896
00:51:46,910 --> 00:51:43,980
pumped for agriculture so the whole

897
00:51:48,620 --> 00:51:46,920
point of having grace follow-on come on

898
00:51:52,670 --> 00:51:48,630
the heels of grace is to keep that

899
00:51:54,830 --> 00:51:52,680
information flow coming so when you

900
00:51:57,500 --> 00:51:54,840
think about it now what next I mean

901
00:51:59,780 --> 00:51:57,510
we're - from now we've just launched

902
00:52:02,600 --> 00:51:59,790
when do we get that science yeah so

903
00:52:04,880 --> 00:52:02,610
we're really trying hard to spin up our

904
00:52:07,460 --> 00:52:04,890
satellites to check out our instruments

905
00:52:09,320 --> 00:52:07,470
so over the next few days the satellites

906
00:52:11,960 --> 00:52:09,330
will drift into their final science

907
00:52:13,310 --> 00:52:11,970
configuration they need to be 220

908
00:52:15,260 --> 00:52:13,320
kilometers apart so this will happen

909
00:52:18,020 --> 00:52:15,270
over the next few days then our

910
00:52:20,660 --> 00:52:18,030
engineers through the German Space

911
00:52:23,330 --> 00:52:20,670
Operations Center will one-by-one power

912
00:52:25,340 --> 00:52:23,340
up our instruments and check them out

913
00:52:25,880 --> 00:52:25,350

and make sure everything performs as

914
00:52:28,070 --> 00:52:25,890
intended

915
00:52:29,960 --> 00:52:28,080
we'll do some calibrations and in about

916
00:52:32,060 --> 00:52:29,970
six to seven months from now we're ready

917
00:52:34,550 --> 00:52:32,070
to release our first graceful all data

918
00:52:37,520 --> 00:52:34,560
set six to seven months that's right oh

919
00:52:37,910 --> 00:52:37,530
and that's fantastic thanks Felix my

920
00:52:40,550 --> 00:52:37,920
pleasure

921
00:52:43,250 --> 00:52:40,560
all right well you may not realize this

922
00:52:45,740 --> 00:52:43,260
but you can see Grace and eventually

923
00:52:48,890 --> 00:52:45,750
grace follow-on information on your own

924
00:52:50,450 --> 00:52:48,900
computer or mobile phone using a program

925
00:52:51,590 --> 00:52:50,460
developed by NASA's Jet Propulsion

926
00:52:54,200 --> 00:52:51,600
Laboratory

927
00:52:56,330 --> 00:52:54,210
it's called eyes on earth and with it

928
00:52:58,880 --> 00:52:56,340
you can trace the movement of water

929
00:53:01,760 --> 00:52:58,890
around the globe using gravity maps from

930
00:53:04,730 --> 00:53:01,770
the grey satellites all you need is the

931
00:53:38,000 --> 00:53:04,740
NASA eyes program which requires just a

932
00:55:13,760 --> 00:53:58,300
[Music]

933
00:55:19,740 --> 00:55:16,800
all right we have a successful launch

934
00:55:22,470 --> 00:55:19,750
and a successful deployment of our

935
00:55:24,330 --> 00:55:22,480
satellites we are standing by now for

936
00:55:27,540 --> 00:55:24,340
the first communication with the Greece

937
00:55:29,520 --> 00:55:27,550
follow on satellites hopefully about 10

938
00:55:31,590 --> 00:55:29,530

minutes from now and that's when the

939
00:55:34,830 --> 00:55:31,600
satellites fly over the first ground

940
00:55:36,540 --> 00:55:34,840
station at McMurdo in the Antarctica the

941
00:55:38,820 --> 00:55:36,550
station is part of NASA's near-earth

942
00:55:41,550 --> 00:55:38,830
network of satellite tracking stations

943
00:55:43,950 --> 00:55:41,560
is sort of the Earth observing satellite

944
00:55:46,890 --> 00:55:43,960
equivalent of NASA's Deep Space Network

945
00:55:49,590 --> 00:55:46,900
when that signal comes down it'll go to

946
00:55:52,170 --> 00:55:49,600
Mission Operations at the German Space

947
00:55:54,330 --> 00:55:52,180
Operations Center outside of Munich

948
00:55:58,970 --> 00:55:54,340
that's JSOC and that is where DLR

949
00:56:03,720 --> 00:55:58,980
Sebastian Lo is standing by hi Sebastian

950
00:56:06,990 --> 00:56:03,730
hello to California so we are standing

951
00:56:09,660 --> 00:56:07,000
by for this much very important

952
00:56:12,560 --> 00:56:09,670
acquisition of signal and that's gonna

953
00:56:14,040 --> 00:56:12,570
come in to JSOC where you are correct

954
00:56:16,560 --> 00:56:14,050
that's correct

955
00:56:20,880 --> 00:56:16,570
how does it all work how will you be

956
00:56:23,010 --> 00:56:20,890
listening for this signal so we will

957
00:56:25,080 --> 00:56:23,020
have our first pass in McMurdo roughly

958
00:56:26,400 --> 00:56:25,090
in ten minutes

959
00:56:29,010 --> 00:56:26,410
this will be our first acquisition

960
00:56:30,810 --> 00:56:29,020
station there is the ground station

961
00:56:32,430 --> 00:56:30,820
located we will have two antennae

962
00:56:35,310 --> 00:56:32,440
pointed to the direction where the graze

963
00:56:36,630 --> 00:56:35,320

photons will arise over the horizon and

964
00:56:38,760 --> 00:56:36,640
as soon as they are there they're

965
00:56:40,500 --> 00:56:38,770
hopefully transmitting a signal and we

966
00:56:42,540 --> 00:56:40,510
will then record the signal forwarded

967
00:56:44,040 --> 00:56:42,550
through the ground station to TLR

968
00:56:47,670 --> 00:56:44,050
chuseok and then we will see it on our

969
00:56:49,950 --> 00:56:47,680
screens now there are two satellites do

970
00:56:52,470 --> 00:56:49,960
you anticipate that you will be able to

971
00:56:56,340 --> 00:56:52,480
get both satellites and acquisition of

972
00:56:58,710 --> 00:56:56,350
signal from both that's the plan so the

973
00:57:00,060 --> 00:56:58,720
first one will be chief one we're going

974
00:57:02,730 --> 00:57:00,070
to use the first few minutes of the path

975
00:57:04,050 --> 00:57:02,740
to get some telemetry from the first one

976
00:57:05,820 --> 00:57:04,060
and then after a few minutes we will

977
00:57:07,800 --> 00:57:05,830
switch over to the second one chief -

978
00:57:10,830 --> 00:57:07,810
and hopefully after the end of the

979
00:57:13,590 --> 00:57:10,840
course we saw both of them alright if we

980
00:57:17,730 --> 00:57:13,600
don't hear from both of them is that

981
00:57:20,220 --> 00:57:17,740
going to be any source of concern no

982
00:57:21,200 --> 00:57:20,230
usually not because at the moment we do

983
00:57:23,150 --> 00:57:21,210
not have

984
00:57:25,190 --> 00:57:23,160
good injection information from SpaceX

985
00:57:27,559 --> 00:57:25,200
we will only receive that 60 minutes

986
00:57:29,660 --> 00:57:27,569
after separation so it just might be

987
00:57:31,910 --> 00:57:29,670
that offset of the antenna is a little

988
00:57:33,410 --> 00:57:31,920

bit too much at the moment and then

989
00:57:35,660 --> 00:57:33,420
afterwards we have another station

990
00:57:37,460 --> 00:57:35,670
Pittsburgh it's on the North Pole right

991
00:57:39,650 --> 00:57:37,470
after that there is another one of our

992
00:57:41,089 --> 00:57:39,660
last one and by that time we should

993
00:57:42,559 --> 00:57:41,099
already have a good orbit information

994
00:57:46,069 --> 00:57:42,569
from SpaceX and then we should be able

995
00:57:47,930 --> 00:57:46,079
to find all of them we are very excited

996
00:57:51,020 --> 00:57:47,940
and I'm sure you are too

997
00:57:55,790 --> 00:57:51,030
all eyes are on G sock now thanks for

998
00:57:58,819 --> 00:57:55,800
joining us Sebastian we spoke to another

999
00:58:01,160 --> 00:57:58,829
G sock flight director Kai Muller a few

1000
00:58:04,059 --> 00:58:01,170
months ago while the team was undergoing

1001
00:58:06,770 --> 00:58:04,069
one of their many operation readiness

1002
00:58:09,890 --> 00:58:06,780
readiness test that's something that

1003
00:58:13,790 --> 00:58:09,900
they do quite a bit to prepare for a day

1004
00:58:17,150 --> 00:58:13,800
like today well I've been working for

1005
00:58:18,680 --> 00:58:17,160
the grace mission since early 2013 and

1006
00:58:21,260 --> 00:58:18,690
it makes perfect sense sister to keep on

1007
00:58:22,760 --> 00:58:21,270
working what ways follow-on we've now

1008
00:58:24,589 --> 00:58:22,770
down the last simulation before the

1009
00:58:27,200 --> 00:58:24,599
launch and the past couple of days and

1010
00:58:28,760 --> 00:58:27,210
we are ready to go you can imagine we

1011
00:58:30,799 --> 00:58:28,770
have quite a large number of people

1012
00:58:33,109 --> 00:58:30,809
involved in such a mission there's still

1013
00:58:35,569 --> 00:58:33,119

our performing operations for G offset

1014
00:58:37,010 --> 00:58:35,579
the German gear for sentiment then of

1015
00:58:38,720 --> 00:58:37,020
course we have JPL were the project

1016
00:58:40,760 --> 00:58:38,730
managers for NASA partners from the

1017
00:58:42,890 --> 00:58:40,770
University of Texas who are the main

1018
00:58:44,210 --> 00:58:42,900
scientists behind the project and of

1019
00:58:46,640 --> 00:58:44,220
course we have the partners from Eva's

1020
00:58:48,770 --> 00:58:46,650
who actually took the spacecraft all of

1021
00:58:51,349 --> 00:58:48,780
them have specific tasks that I want to

1022
00:58:52,910 --> 00:58:51,359
see accomplished and to coordinate this

1023
00:58:55,010 --> 00:58:52,920
you need someone at the point where

1024
00:58:56,809 --> 00:58:55,020
everything comes together I take all the

1025
00:58:58,849 --> 00:58:56,819
inputs which are then coordinate with a

1026
00:59:00,920 --> 00:58:58,859
command or board us to load and when to

1027
00:59:02,390 --> 00:59:00,930
send them to the spacecraft everyone

1028
00:59:04,460 --> 00:59:02,400
sits at the exactly the place they're

1029
00:59:07,160 --> 00:59:04,470
supposed to be performs exactly the same

1030
00:59:09,920 --> 00:59:07,170
task in exactly the same way we do it

1031
00:59:12,170 --> 00:59:09,930
for the we launch we meet in a separate

1032
00:59:13,730 --> 00:59:12,180
room to discuss what we've done did

1033
00:59:16,490 --> 00:59:13,740
everything happen we expect it to happen

1034
00:59:18,940 --> 00:59:16,500
did we see any anomalies and so we will

1035
00:59:21,250 --> 00:59:18,950
discuss those and how to proceed

1036
00:59:23,670 --> 00:59:21,260
that repeats over and over again until

1037
00:59:25,770 --> 00:59:23,680
we're through with our plan activities I

1038
00:59:28,300 --> 00:59:25,780

think it's going to be quite networking

1039
00:59:30,910 --> 00:59:28,310
but I think once we're up once then

1040
00:59:31,540 --> 00:59:30,920
orbits we're going to see the separation

1041
00:59:34,960 --> 00:59:31,550
okay

1042
00:59:41,950 --> 00:59:34,970
I think things come down in particularly

1043
00:59:44,859 --> 00:59:41,960
once telemetry concerning all right the

1044
00:59:48,640 --> 00:59:44,869
first acquisition of signal is expected

1045
00:59:51,640 --> 00:59:48,650
at about 120 Pacific time so 20 minutes

1046
00:59:54,490 --> 00:59:51,650
past the hour we expect mission

1047
00:59:57,160 --> 00:59:54,500
operations at ji-suk will acquire that

1048
00:59:59,109 --> 00:59:57,170
signal and NASA will also be looking out

1049
01:00:00,609 --> 00:59:59,119
for this signal folks here in the

1050
01:00:02,920 --> 01:00:00,619
mission directors Center here at

1051
01:00:04,870 --> 01:00:02,930
Vandenberg are also keeping an eye out

1052
01:00:08,230 --> 01:00:04,880
and we are all listening

1053
01:00:10,180 --> 01:00:08,240
Sammy explain to me what folks are doing

1054
01:00:12,790 --> 01:00:10,190
right now this this acquisition of

1055
01:00:17,530 --> 01:00:12,800
signal how will folks here in the MDC

1056
01:00:20,260 --> 01:00:17,540
know so we actually have a simulation

1057
01:00:23,530 --> 01:00:20,270
that we have run and tracked with the

1058
01:00:25,300 --> 01:00:23,540
spacecraft so when we get signal and

1059
01:00:27,280 --> 01:00:25,310
it's immediately fed into the simulation

1060
01:00:31,109 --> 01:00:27,290
and we will get notification here that

1061
01:00:34,240 --> 01:00:31,119
the health of the spacecraft and so the

1062
01:00:37,839 --> 01:00:34,250
as soon as the separation occurs we will

1063
01:00:40,180 --> 01:00:37,849

get that signal but we it shortly will

1064
01:00:43,690 --> 01:00:40,190
be looking at some of the simulation

1065
01:00:45,910 --> 01:00:43,700
here to kind of describe how that occurs

1066
01:00:47,829 --> 01:00:45,920
and over what period but at this point

1067
01:00:50,710 --> 01:00:47,839
the spacecraft as I mentioned before is

1068
01:00:54,339 --> 01:00:50,720
going through internal checks and and

1069
01:00:57,640 --> 01:00:54,349
stabilization after the deployment of

1070
01:01:00,520 --> 01:00:57,650
the antenna the communication system is

1071
01:01:01,660 --> 01:01:00,530
up within four minutes of course the

1072
01:01:04,329 --> 01:01:01,670
first thing that comes up is the

1073
01:01:06,880 --> 01:01:04,339
computer system on board and all the

1074
01:01:09,130 --> 01:01:06,890
subsystems start start powering up as a

1075
01:01:12,460 --> 01:01:09,140
result from that

1076
01:01:14,170 --> 01:01:12,470
so everything so far as far as we know

1077
01:01:16,570 --> 01:01:14,180
is nominal we'll get the first signal

1078
01:01:18,820 --> 01:01:16,580
from the spacecraft over McMurdo and in

1079
01:02:18,930 --> 01:01:18,830
Antarctica all right well we'll be

1080
01:02:25,260 --> 01:02:22,859
samy well while we are waiting for the

1081
01:02:27,859 --> 01:02:25,270
acquisition of signal I have a couple of

1082
01:02:30,240 --> 01:02:27,869
social media questions that have come in

1083
01:02:32,010 --> 01:02:30,250
maybe you can help us out here while we

1084
01:02:35,760 --> 01:02:32,020
have time for you to answer some of them

1085
01:02:38,099 --> 01:02:35,770
from YouTube from space TV a question

1086
01:02:40,140 --> 01:02:38,109
comes in how does the shape of grace

1087
01:02:42,540 --> 01:02:40,150
help it do its job

1088
01:02:46,470 --> 01:02:42,550

the shape so the shape of the spacecraft

1089
01:02:49,230 --> 01:02:46,480
actually was selected to be exactly the

1090
01:02:50,940 --> 01:02:49,240
same as the original Grace and the

1091
01:02:55,109 --> 01:02:50,950
original grace shape was selected to

1092
01:02:58,260 --> 01:02:55,119
minimize the drag for the spacecraft in

1093
01:03:01,109 --> 01:02:58,270
orbit so that in that will result of

1094
01:03:03,960 --> 01:03:01,119
course in efficiency and fuel

1095
01:03:06,450 --> 01:03:03,970
consumption so in the spacecraft lasted

1096
01:03:08,819 --> 01:03:06,460
for 15 years given that it was designed

1097
01:03:11,460 --> 01:03:08,829
only to last for three but we were very

1098
01:03:12,930 --> 01:03:11,470
efficient in the fuel consumption and

1099
01:03:15,300 --> 01:03:12,940
also of course the shape of the

1100
01:03:18,210 --> 01:03:15,310
spacecraft made a big difference for

1101
01:03:18,780 --> 01:03:18,220
that okay here's a question from Jim on

1102
01:03:21,359 --> 01:03:18,790
Twitter

1103
01:03:23,870 --> 01:03:21,369
well the gray satellite passes be

1104
01:03:26,550 --> 01:03:23,880
visible from Earth with the naked eye

1105
01:03:29,460 --> 01:03:26,560
the spacecraft will be in their orbit

1106
01:03:33,660 --> 01:03:29,470
will be at 490 kilometers that's fairly

1107
01:03:37,950 --> 01:03:33,670
high up for a naked eye in if one is

1108
01:03:41,190 --> 01:03:37,960
extremely lucky and they have a very

1109
01:03:43,500 --> 01:03:41,200
high power binoculars or a good

1110
01:03:45,059 --> 01:03:43,510
telescope they may be able to see that

1111
01:03:47,490 --> 01:03:45,069
however they will be moving very fast

1112
01:03:51,630 --> 01:03:47,500
and it'll be very difficult to track

1113
01:03:55,440 --> 01:03:51,640

them okay here is another one from

1114
01:03:58,770 --> 01:03:55,450
YouTube sparker can this method measure

1115
01:04:01,559 --> 01:03:58,780
the absolute amount of water at the

1116
01:04:04,170 --> 01:04:01,569
surface or it can only measure the

1117
01:04:07,220 --> 01:04:04,180
change of water distribution over time

1118
01:04:10,109 --> 01:04:07,230
yeah this method actually is is a is a

1119
01:04:13,050 --> 01:04:10,119
change of water in over time so it's not

1120
01:04:14,400 --> 01:04:13,060
an absolute measurement and it's a

1121
01:04:16,589 --> 01:04:14,410
relative measurement we do this

1122
01:04:18,740 --> 01:04:16,599
measurement every month and we compare

1123
01:04:21,809 --> 01:04:18,750
the results and that's how we get an

1124
01:04:24,660 --> 01:04:21,819
assessment or some knowledge of movement

1125
01:04:26,550 --> 01:04:24,670
of mass whether its water or or land

1126
01:04:28,740 --> 01:04:26,560
mass for example

1127
01:04:32,520 --> 01:04:28,750
so but it's not an absolute measurement

1128
01:04:34,410 --> 01:04:32,530
for from this method meantime salmon we

1129
01:04:36,990 --> 01:04:34,420
have the display that the team is

1130
01:04:39,270 --> 01:04:37,000
watching right now can you two explain

1131
01:04:41,070 --> 01:04:39,280
this to the viewers sure so this is an

1132
01:04:43,500 --> 01:04:41,080
animation of course and as I mentioned

1133
01:04:45,630 --> 01:04:43,510
the data is plugged in so as soon as we

1134
01:04:47,580 --> 01:04:45,640
get confirmation or communication of the

1135
01:04:51,090 --> 01:04:47,590
spacecraft we will get immediate

1136
01:04:53,430 --> 01:04:51,100
confirmation that we have contact so you

1137
01:04:55,140 --> 01:04:53,440
can see here this spacecraft both

1138
01:04:57,450 --> 01:04:55,150

spacecraft are and now in a southern

1139
01:05:04,320 --> 01:04:57,460
lead rejection so they go on south

1140
01:05:06,720 --> 01:05:04,330
towards the Antarctica and we would we

1141
01:05:08,820 --> 01:05:06,730
would they would pass the McMurdo

1142
01:05:15,300 --> 01:05:08,830
Station and that's when we get contact

1143
01:05:17,370 --> 01:05:15,310
with the spacecraft be seeing should be

1144
01:06:37,420 --> 01:05:17,380
hearing confirmation thank you very

1145
01:06:45,080 --> 01:06:41,630
we have here's clapping and applause in

1146
01:06:49,190 --> 01:06:45,090
the room next to us and the sky signal I

1147
01:06:51,590 --> 01:06:49,200
see from gsok I see applause there so I

1148
01:06:53,630 --> 01:06:51,600
understand me let's have an acquisition

1149
01:06:57,680 --> 01:06:53,640
oh we just got confirmation that

1150
01:07:08,590 --> 01:06:57,690
actually I'm receiving it right now that

1151
01:07:13,820 --> 01:07:11,450
so they're they're going through the

1152
01:07:15,950 --> 01:07:13,830
cycle for confirmation the data just

1153
01:07:19,930 --> 01:07:15,960
came through in the simulation I was

1154
01:07:27,470 --> 01:07:21,980
so they'll go through and make sure that

1155
01:07:31,790 --> 01:07:27,480
they have the right confirmation still

1156
01:07:34,790 --> 01:07:31,800
working through that and meantime they

1157
01:07:40,430 --> 01:07:34,800
have to reconfigure hopefully to get the

1158
01:07:42,440 --> 01:07:40,440
second satellite as well right so as

1159
01:07:44,450 --> 01:07:42,450
soon as as soon as that signal is

1160
01:07:46,430 --> 01:07:44,460
completed on one spacecraft they turned

1161
01:07:48,770 --> 01:07:46,440
the antenna to point to the other

1162
01:07:55,599 --> 01:07:48,780
spacecraft and get confirmation from

1163
01:08:09,330 --> 01:08:01,220

so

1164
01:08:13,080 --> 01:08:09,340
confirmation from jisuk now excellent

1165
01:08:15,690 --> 01:08:13,090
alright so let's go over there let's get

1166
01:08:18,810 --> 01:08:15,700
the reaction over a G sock right now I

1167
01:08:21,870 --> 01:08:18,820
understand Neil daya is standing by

1168
01:08:26,010 --> 01:08:21,880
right now via Skype so we got a signal

1169
01:08:27,870 --> 01:08:26,020
hey yes we did we got some signals from

1170
01:08:29,640 --> 01:08:27,880
what we call graceful mom which is

1171
01:08:32,430 --> 01:08:29,650
satellite one and if you can see behind

1172
01:08:34,560 --> 01:08:32,440
me you'll see on the center screen your

1173
01:08:35,700 --> 01:08:34,570
left hand side it's got a green top and

1174
01:08:37,079 --> 01:08:35,710
you'll see a whole bunch of what we call

1175
01:08:39,000 --> 01:08:37,089
it Salameh tree information telling us

1176
01:08:40,950 --> 01:08:39,010
battery state of charge what the

1177
01:08:42,720 --> 01:08:40,960
satellite is currently doing and right

1178
01:08:44,849 --> 01:08:42,730
now it's what we call a real-time only

1179
01:08:46,560 --> 01:08:44,859
mode where it's sending all the data all

1180
01:08:48,270 --> 01:08:46,570
the time and we're just listening at it

1181
01:08:50,820 --> 01:08:48,280
but we're also trying to send commands

1182
01:08:53,370 --> 01:08:50,830
as we go so on the screen on the left

1183
01:08:54,810 --> 01:08:53,380
and the right you'll see a stack that's

1184
01:08:56,280 --> 01:08:54,820
moving and that's the commands that

1185
01:08:58,260 --> 01:08:56,290
we're sending up and also telemetry

1186
01:09:00,420 --> 01:08:58,270
coming down from the satellite are we

1187
01:09:04,290 --> 01:09:00,430
talking about both satellites at this

1188
01:09:05,849 --> 01:09:04,300

point or just the first satellite just

1189
01:09:08,340 --> 01:09:05,859
the first one if you look you can see

1190
01:09:09,599 --> 01:09:08,350
the green header is Grace one and a

1191
01:09:11,400 --> 01:09:09,609
great small one and that's the one

1192
01:09:12,540 --> 01:09:11,410
that's running and the left and the

1193
01:09:14,520 --> 01:09:12,550
right screens are actually command

1194
01:09:16,590 --> 01:09:14,530
stacks for those we have not gotten

1195
01:09:18,750 --> 01:09:16,600
satellite to but I don't know if we've

1196
01:09:20,310 --> 01:09:18,760
transitioned the plan was supposed to be

1197
01:09:21,960 --> 01:09:20,320
for us to acquire and then need to come

1198
01:09:22,950 --> 01:09:21,970
back up but because of the delays and

1199
01:09:25,950 --> 01:09:22,960
everything we're doing this real-time

1200
01:09:27,720 --> 01:09:25,960
right now alright and it would not be a

1201
01:09:30,450 --> 01:09:27,730
surprise if you don't get it right away

1202
01:09:34,230 --> 01:09:30,460
you have another chance at it in 45

1203
01:09:35,640 --> 01:09:34,240
minutes right yes I don't know where

1204
01:09:37,349 --> 01:09:35,650
we're in the time line because we've got

1205
01:09:40,560 --> 01:09:37,359
a set 4 minute period where we're gonna

1206
01:09:42,090 --> 01:09:40,570
listen to grace one and only after that

1207
01:09:43,650 --> 01:09:42,100
are we gonna switch now they've both

1208
01:09:45,000 --> 01:09:43,660
should've been in the same orbit plane

1209
01:09:47,400 --> 01:09:45,010
and they should be following each other

1210
01:09:49,260 --> 01:09:47,410
so the only thing the station has to do

1211
01:09:52,020 --> 01:09:49,270
is to reconfigure for the different

1212
01:09:54,920 --> 01:09:52,030
frequencies of satellite - so how are

1213
01:10:00,660 --> 01:09:54,930

folks feeling there yeah we get it oh

1214
01:10:04,080 --> 01:10:00,670
I'm sorry go ahead you once have said

1215
01:10:07,890 --> 01:10:04,090
you know your job is to make sure that

1216
01:10:09,270 --> 01:10:07,900
you keep your satellites safe and so it

1217
01:10:11,040 --> 01:10:09,280
seems like that's exactly what you're

1218
01:10:14,610 --> 01:10:11,050
doing right now

1219
01:10:16,890 --> 01:10:14,620
yes right now this particular pass is a

1220
01:10:18,840 --> 01:10:16,900
listen-only so we can get understanding

1221
01:10:20,580 --> 01:10:18,850
of this is the ability in the health of

1222
01:10:22,620 --> 01:10:20,590
the satellites and if we need to do

1223
01:10:24,900 --> 01:10:22,630
something right away we can do it on the

1224
01:10:25,980 --> 01:10:24,910
next pass if everything looks good then

1225
01:10:27,960 --> 01:10:25,990
what we'll do is we already have a

1226
01:10:29,130 --> 01:10:27,970
pre-scripted procedure of exactly what

1227
01:10:29,850 --> 01:10:29,140
we're gonna do and when we're going to

1228
01:10:31,230 --> 01:10:29,860
get to it

1229
01:10:34,290 --> 01:10:31,240
coordinated with the passes and we'll

1230
01:10:37,200 --> 01:10:34,300
just run along those all right well the

1231
01:10:39,060 --> 01:10:37,210
launch was here but all eyes are on gsok

1232
01:10:41,880 --> 01:10:39,070
right now because pretty much all

1233
01:10:44,970 --> 01:10:41,890
operations are going to be down your way

1234
01:10:46,980 --> 01:10:44,980
now right yep everything is going to run

1235
01:10:51,380 --> 01:10:46,990
out of this location from here on out

1236
01:10:54,270 --> 01:10:51,390
well thanks Neil we'll be standing by

1237
01:10:57,000 --> 01:10:54,280
meantime that wraps things up here from

1238
01:10:59,970 --> 01:10:57,010

Vandenberg Air Force Base we did get the

1239
01:11:01,770 --> 01:10:59,980
very first signal so we know that we

1240
01:11:03,780 --> 01:11:01,780
have acquisition of signal from the

1241
01:11:07,350 --> 01:11:03,790
satellites we may or may not get the

1242
01:11:09,960 --> 01:11:07,360
second one on this pass but worry not we

1243
01:11:13,440 --> 01:11:09,970
have an opportunity to get it on the

1244
01:11:15,240 --> 01:11:13,450
next pass over the North Pole but before

1245
01:11:18,360 --> 01:11:15,250
we go we want to give our thanks to our

1246
01:11:20,670 --> 01:11:18,370
JPL crew that's at gsok right now Jim

1247
01:11:23,970 --> 01:11:20,680
round Christopher Harrison Kristin why

1248
01:11:26,820 --> 01:11:23,980
both plus the Kennedy Space Center faces

1249
01:11:28,830 --> 01:11:26,830
that our TV crew who have helped us put

1250
01:11:31,680 --> 01:11:28,840
this on for you without them we wouldn't

1251
01:11:34,260 --> 01:11:31,690
even be on the air and of course special

1252
01:11:36,450 --> 01:11:34,270
thanks to Sammy Calley who helped us

1253
01:11:38,880 --> 01:11:36,460
understand all the workings of this and

1254
01:11:40,950 --> 01:11:38,890
this incredible mission if you want to

1255
01:11:45,750 --> 01:11:40,960
learn more about this mission here's the

1256
01:11:51,360 --> 01:11:45,760
website for you it's W WMS a govt slash

1257
01:11:57,000 --> 01:11:51,370
grace fo that's again w w NS a guv

1258
01:11:59,370 --> 01:11:57,010
grace / grace fo / grace fo alright

1259
01:12:02,460 --> 01:11:59,380
that's it for us now before we go here's

1260
01:12:05,520 --> 01:12:02,470
one last look at the launch and a salute

1261
01:12:27,719 --> 01:12:05,530
to the people of grace follow-on thanks

1262
01:12:42,939 --> 01:12:34,649
okay nine eight seven six five four

1263
01:12:45,759 --> 01:12:42,949

three two one and liftoff of grace

1264
01:12:48,399 --> 01:12:45,769
follow-on continuing the legacy of the

1265
01:12:51,969 --> 01:12:48,409
grace mission of tracking the movement