1
00:00:12,190 --> 00:00:10,370
good afternoon my name is Dwayne brown

2
00:00:15,200 --> 00:00:12,200
with NASA's Office of Communications

3
00:00:17,300 --> 00:00:15,210
welcome to NASA headquarters today you

4
00:00:20,210 --> 00:00:17,310
will hear new details about the

5
00:00:24,080 --> 00:00:20,220
structure of solar storms but also hear

6
00:00:27,580 --> 00:00:24,090
how they impact here on earth today's

7
00:00:32,990 --> 00:00:27,590
briefing materials on the internet at

8
00:00:37,310 --> 00:00:33,000
WWDC gov / stereo in addition to ww na

9
00:00:39,170 --> 00:00:37,320
SI g / sun earth all one word will have

10
00:00:41,330 --> 00:00:39,180
brief presentations from our presenters

11
00:00:43,819 --> 00:00:41,340
then we will open it up with questions

12
00:00:46,729 --> 00:00:43,829
Donna here in Washington on NASA centers

13
00:00:50,350 --> 00:00:46,739

in the phone lines I'd like to introduce

14
00:00:55,069 --> 00:00:50,360
you to today's participants first up

15
00:00:57,680 --> 00:00:55,079
Lika guhathakurta lead program

16
00:01:00,799 --> 00:00:57,690
scientists vanessa is living with a star

17
00:01:06,260 --> 00:01:00,809
program and also program scientist for

18
00:01:09,890 --> 00:01:06,270
stereo craig de force staff scientists

19
00:01:15,280 --> 00:01:09,900
southwest research institute boulder

20
00:01:19,130 --> 00:01:15,290
colorado Dave web research physicists

21
00:01:24,649 --> 00:01:19,140
Institute for scientific research Boston

22
00:01:28,039 --> 00:01:24,659
College and Alicia winery research

23
00:01:30,740 --> 00:01:28,049
scientists National Oceanic and

24
00:01:33,289 --> 00:01:30,750
Atmospheric Administration in the

25
00:01:35,990 --> 00:01:33,299
University of Colorado also in Baltimore

26
00:01:40,670 --> 00:01:36,000
with that I'll turn it over to Lika

27
00:01:43,270 --> 00:01:40,680
thank you stereo is a mission in NASA's

28
00:01:47,149 --> 00:01:43,280
the heliophysics division and

29
00:01:50,660 --> 00:01:47,159
heliophysics is an emerging new science

30
00:01:53,030 --> 00:01:50,670
discipline the goal of this division is

31
00:01:56,330 --> 00:01:53,040
to understand the Sun as a magnetic

32
00:02:00,200 --> 00:01:56,340
variable star and its effect on earth as

33
00:02:02,929 --> 00:02:00,210
well as the entire solar system as you

34
00:02:05,840 --> 00:02:02,939
might know we live in the outer

35
00:02:10,309 --> 00:02:05,850
atmosphere of this star which at times

36
00:02:12,470 --> 00:02:10,319
can be stormy and turbulent giving rise

37
00:02:13,760 --> 00:02:12,480
to the phenomenon of space weather that

38
00:02:16,790 --> 00:02:13,770

we hear about so

39
00:02:20,210 --> 00:02:16,800
fill these days so the three main

40
00:02:23,420 --> 00:02:20,220
objectives of this division is to really

41
00:02:26,120 --> 00:02:23,430
understand the basic plasma physics

42
00:02:30,230 --> 00:02:26,130
processes from Sun to earth and the

43
00:02:33,230 --> 00:02:30,240
solar system which is vast very complex

44
00:02:36,410 --> 00:02:33,240
very dynamic to understand the physics

45
00:02:40,160 --> 00:02:36,420
of the interaction between sun's

46
00:02:42,530 --> 00:02:40,170
magnetic field and Earth's own which is

47
00:02:46,220 --> 00:02:42,540
where space weather phenomenon is felt

48
00:02:49,220 --> 00:02:46,230
and then also to develop the scientific

49
00:02:52,430 --> 00:02:49,230
understanding necessary to really create

50
00:02:55,130 --> 00:02:52,440
these are forecasting capabilities of

51
00:02:59,240 --> 00:02:55,140
this extreme dynamic conditions in space

52
00:03:02,660 --> 00:02:59,250
that is experienced by human or robotic

53
00:03:04,670 --> 00:03:02,670
Explorer wherever we choose to go this

54
00:03:07,700 --> 00:03:04,680
is accomplished in a variety of ways we

55
00:03:10,090 --> 00:03:07,710
have a research portfolio along with a

56
00:03:13,610 --> 00:03:10,100
set of flight programs that provide

57
00:03:16,040 --> 00:03:13,620
unique observations from really

58
00:03:19,850 --> 00:03:16,050
strategically located vantage point

59
00:03:22,250 --> 00:03:19,860
which is very important for gaining the

60
00:03:25,430 --> 00:03:22,260
physics understanding that we are

61
00:03:28,310 --> 00:03:25,440
seeking the flight programs are three

62
00:03:31,280 --> 00:03:28,320
the Explorer program which are typically

63
00:03:34,010 --> 00:03:31,290

small missions led by individual

64
00:03:36,620 --> 00:03:34,020
principal investigators focusing on you

65
00:03:39,470 --> 00:03:36,630
know subset of very small questions to

66
00:03:41,360 --> 00:03:39,480
which we can find scientific answers

67
00:03:44,630 --> 00:03:41,370
then we have two strategic lines

68
00:03:47,750 --> 00:03:44,640
solar-terrestrial pro and that goes

69
00:03:50,420 --> 00:03:47,760
after really science questions for

70
00:03:52,460 --> 00:03:50,430
science say and stereo mission is

71
00:03:54,500 --> 00:03:52,470
actually part of this program and

72
00:03:56,240 --> 00:03:54,510
finally we have living with a star

73
00:03:59,270 --> 00:03:56,250
program which is another strategic

74
00:04:03,440 --> 00:03:59,280
flight program line where we actually

75
00:04:05,600 --> 00:04:03,450
look for missions that have really go

76
00:04:07,670 --> 00:04:05,610
after cutting edge science as well as

77
00:04:10,610 --> 00:04:07,680
look for relevance to life and society

78
00:04:13,190 --> 00:04:10,620
Solar Dynamics Observatory is an example

79
00:04:16,849 --> 00:04:13,200
in that category if I could have the

80
00:04:21,190 --> 00:04:16,859
first systems observatory slide what you

81
00:04:24,530 --> 00:04:21,200
are looking at there is the heliophysics

82
00:04:26,750 --> 00:04:24,540
system observatory we call it evolving

83
00:04:27,570 --> 00:04:26,760
heliophysics system observatory because

84
00:04:30,749 --> 00:04:27,580
we are

85
00:04:33,990 --> 00:04:30,759
continually retooling it replenishing it

86
00:04:36,809 --> 00:04:34,000
and so the white satellites there are

87
00:04:40,020 --> 00:04:36,819
our operating missions and the ones in

88
00:04:42,689 --> 00:04:40,030

yellow are really our future missions

89
00:04:45,659 --> 00:04:42,699
that we are developing right now there

90
00:04:49,200 --> 00:04:45,669
are about 16 such operating missions and

91
00:04:52,350 --> 00:04:49,210
so just looking at that you realize that

92
00:04:57,540 --> 00:04:52,360
we have been studying this system for a

93
00:05:00,200 --> 00:04:57,550
while but it is a really vast distance

94
00:05:03,330 --> 00:05:00,210
and a very complicated dynamic

95
00:05:07,140 --> 00:05:03,340
environment so just a decade or two is

96
00:05:10,379 --> 00:05:07,150
not sufficient to fully understand this

97
00:05:13,680 --> 00:05:10,389
system and so what we try to do is we

98
00:05:16,219 --> 00:05:13,690
try to bring in our new missions with

99
00:05:19,589 --> 00:05:16,229
new which lent to new scientific

100
00:05:21,659 --> 00:05:19,599
insights and retire some of the old ones

101
00:05:24,480 --> 00:05:21,669
from which we have already gained the

102
00:05:27,409 --> 00:05:24,490
science understanding that we need and

103
00:05:31,019 --> 00:05:27,419
in this context I think stereo is

104
00:05:33,869 --> 00:05:31,029
playing a really vital role with his

105
00:05:37,230 --> 00:05:33,879
imaging capability as well as it's in

106
00:05:40,200 --> 00:05:37,240
situ measurement capital what you also

107
00:05:42,149 --> 00:05:40,210
see in this picture what might appear to

108
00:05:45,629 --> 00:05:42,159
you is that there are just a large

109
00:05:47,610 --> 00:05:45,639
number of spacecraft so just to kind of

110
00:05:50,760 --> 00:05:47,620
give you a perspective the distance

111
00:05:53,309 --> 00:05:50,770
between the Sun and Earth is 93 million

112
00:05:56,670 --> 00:05:53,319
miles well it's not really obvious in

113
00:05:59,879 --> 00:05:56,680

this picture but if you can imagine the

114
00:06:02,490 --> 00:05:59,889
Sun being the size of a basketball in

115
00:06:05,399 --> 00:06:02,500
comparison then the earth would be like

116
00:06:07,050 --> 00:06:05,409
a pinhead and now you take these two

117
00:06:08,999 --> 00:06:07,060
objects and you put them at the two

118
00:06:11,249 --> 00:06:09,009
extreme ends of a basketball court

119
00:06:13,619 --> 00:06:11,259
that's what you're looking at that's the

120
00:06:16,680 --> 00:06:13,629
distance and if you think about it in

121
00:06:20,640 --> 00:06:16,690
that terms then these few satellite

122
00:06:22,740 --> 00:06:20,650
observations are really nothing it is

123
00:06:25,800 --> 00:06:22,750
like measuring the ocean currents with

124
00:06:28,230 --> 00:06:25,810
just few buoys and it's very difficult

125
00:06:29,969 --> 00:06:28,240
to get a full perspective of the ocean

126
00:06:32,640 --> 00:06:29,979
current if you are trying to do that so

127
00:06:34,529 --> 00:06:32,650
you understand the enormity and the

128
00:06:37,949 --> 00:06:34,539
complexity that we are trying to

129
00:06:41,129 --> 00:06:37,959
understand ah with these satellites and

130
00:06:44,580 --> 00:06:41,139
what what stereo is doing is really

131
00:06:47,429 --> 00:06:44,590
with its our imaging instruments it's

132
00:06:50,040 --> 00:06:47,439
actually giving us a perspective on the

133
00:06:53,159 --> 00:06:50,050
turbulent solar wind and solar storms

134
00:06:56,719 --> 00:06:53,169
and it is really giving us a picture

135
00:07:01,110 --> 00:06:56,729
which is a global image which replicates

136
00:07:04,559 --> 00:07:01,120
ort of the buoys in some sense if I

137
00:07:08,640 --> 00:07:04,569
could have now a picture of the stereo

138
00:07:11,839 --> 00:07:08,650

perspective and what stereo mission was

139
00:07:15,480 --> 00:07:11,849
launched about five years ago October of

140
00:07:17,760 --> 00:07:15,490
2006 are the two spacecraft are kind of

141
00:07:20,730 --> 00:07:17,770
launched from Earth orbit and one

142
00:07:23,399 --> 00:07:20,740
spacecraft known as stereo a not a very

143
00:07:26,100 --> 00:07:23,409
imaginative name but it's kind of

144
00:07:28,860 --> 00:07:26,110
leading the earth orbit stereo-b is

145
00:07:31,350 --> 00:07:28,870
lagging behind and they are drifting at

146
00:07:34,769 --> 00:07:31,360
a rate of about 22 degrees per year and

147
00:07:36,559 --> 00:07:34,779
what these two spacecraft do is

148
00:07:39,149 --> 00:07:36,569
initially they gave us a

149
00:07:42,300 --> 00:07:39,159
three-dimensional view of the solar wind

150
00:07:46,019 --> 00:07:42,310
and solar storms and as the drift away

151
00:07:48,269 --> 00:07:46,029
now they give us unique vision of the

152
00:07:51,719 --> 00:07:48,279
storms that are coming towards us and

153
00:07:55,170 --> 00:07:51,729
the picture that you see is essentially

154
00:07:57,389 --> 00:07:55,180
a schematic cartoon of the particular

155
00:07:59,670 --> 00:07:57,399
storm that we are going to discuss in

156
00:08:03,149 --> 00:07:59,680
detail in this press conference which

157
00:08:06,510 --> 00:08:03,159
took place in December of 2008 the two

158
00:08:10,589 --> 00:08:06,520
stereo spacecraft had a angular width of

159
00:08:12,719 --> 00:08:10,599
about 45 degrees stereo two spacecraft

160
00:08:15,869 --> 00:08:12,729
achieved its opposition meaning they

161
00:08:18,389 --> 00:08:15,879
were 180 degrees apart in early februari

162
00:08:20,429 --> 00:08:18,399
of this year and they continue to drift

163
00:08:24,089 --> 00:08:20,439

they will eventually go behind the sign

164
00:08:28,019 --> 00:08:24,099
but today they are about 164 degrees are

165
00:08:31,260 --> 00:08:28,029
behind so just five years ago if you

166
00:08:34,139 --> 00:08:31,270
think about it solar wind was largely

167
00:08:37,319 --> 00:08:34,149
invisible to us we could measure it with

168
00:08:40,350 --> 00:08:37,329
our spacecraft like ace and win at Earth

169
00:08:43,290 --> 00:08:40,360
orbit and solar storms could be viewed

170
00:08:47,220 --> 00:08:43,300
with spacecraft like Soho very close to

171
00:08:50,490 --> 00:08:47,230
the Sun with stereos pipe telescopes

172
00:08:52,920 --> 00:08:50,500
today we are actually witnessing the

173
00:08:54,900 --> 00:08:52,930
solar wind we can see them solar wind

174
00:08:57,810 --> 00:08:54,910
and solar storm blow

175
00:08:59,700 --> 00:08:57,820
doing all the way from Sun to earth

176
00:09:03,050 --> 00:08:59,710
which which which is pretty incredible

177
00:09:05,850 --> 00:09:03,060
when you think about it sheer

178
00:09:10,800 --> 00:09:05,860
observations from stereo have improved

179
00:09:14,130 --> 00:09:10,810
our ability to predict arrival of solar

180
00:09:16,430 --> 00:09:14,140
storms at all hugely and you will hear

181
00:09:19,170 --> 00:09:16,440
about it in detail a little bit later

182
00:09:21,300 --> 00:09:19,180
but the physics knowledge that we have

183
00:09:23,490 --> 00:09:21,310
gained from such observation is pretty

184
00:09:26,430 --> 00:09:23,500
impressive too now what you have to

185
00:09:30,050 --> 00:09:26,440
remember that we are now able to provide

186
00:09:34,250 --> 00:09:30,060
constraints for our models models need

187
00:09:37,160 --> 00:09:34,260
input data input like density velocity

188
00:09:40,290 --> 00:09:37,170

magnetic field strength its direction

189
00:09:42,630 --> 00:09:40,300
shape of these structures which really

190
00:09:45,030 --> 00:09:42,640
give us a sense of the magnetic topology

191
00:09:48,660 --> 00:09:45,040
that bound these structures and with

192
00:09:52,280 --> 00:09:48,670
this we are actually able to do much

193
00:09:56,880 --> 00:09:52,290
better modeling and that is really very

194
00:09:59,130 --> 00:09:56,890
important you know sometimes you but

195
00:10:01,260 --> 00:09:59,140
we've seen many solar storms and you

196
00:10:04,560 --> 00:10:01,270
think maybe all of them are traveling

197
00:10:08,040 --> 00:10:04,570
and arrive at earth that's not the case

198
00:10:11,610 --> 00:10:08,050
a lot of stuff goes on between the Sun

199
00:10:14,450 --> 00:10:11,620
and Earth some solar storms are kind of

200
00:10:17,970 --> 00:10:14,460
deflected or eaten away by solar beam

201
00:10:22,340 --> 00:10:17,980
some storms actually speed up in their

202
00:10:25,350 --> 00:10:22,350
transit some slowdown you know some

203
00:10:28,200 --> 00:10:25,360
storms have their structure kind of

204
00:10:30,240 --> 00:10:28,210
distorted by the environment of the

205
00:10:33,720 --> 00:10:30,250
solar wind that they are traveling

206
00:10:36,900 --> 00:10:33,730
through and so it is it's a NN stereo is

207
00:10:39,180 --> 00:10:36,910
actually observing all of these all the

208
00:10:41,820 --> 00:10:39,190
way from the beginning to the end and so

209
00:10:45,500 --> 00:10:41,830
to give a really detailed description of

210
00:10:49,500 --> 00:10:45,510
one such storm is Craig de Forest

211
00:10:51,540 --> 00:10:49,510
Gilligan so the news today is that for

212
00:10:54,690 --> 00:10:51,550
the first time we've been able to image

213
00:10:57,330 --> 00:10:54,700

a coronal mass ejection with lots of

214
00:10:58,950 --> 00:10:57,340
detail and a photometric quality all the

215
00:11:01,200 --> 00:10:58,960
way through its entire lifecycle from

216
00:11:03,330 --> 00:11:01,210
the inside of the solar corona until it

217
00:11:06,030 --> 00:11:03,340
impacted the earth three days and 93

218
00:11:08,140 --> 00:11:06,040
million miles later now this was enabled

219
00:11:11,110 --> 00:11:08,150
by new processing methods

220
00:11:12,850 --> 00:11:11,120
that were applied to archival data from

221
00:11:16,840 --> 00:11:12,860
the International seki instrument

222
00:11:19,150 --> 00:11:16,850
onboard stereo so I'd like to introduce

223
00:11:22,930 --> 00:11:19,160
a movie of the science we've combined

224
00:11:25,060 --> 00:11:22,940
five separate cameras views into one

225
00:11:26,380 --> 00:11:25,070
frame and I'll just give you the the

226
00:11:28,510 --> 00:11:26,390
movie to start with so if we could roll

227
00:11:30,400 --> 00:11:28,520
the science movie here on the right side

228
00:11:32,350 --> 00:11:30,410
of the frame you see the lower solar

229
00:11:34,810 --> 00:11:32,360
corona and you'll see a coronal mass

230
00:11:36,820 --> 00:11:34,820
ejection form down in the corona and be

231
00:11:39,430 --> 00:11:36,830
launched into space crossing the entire

232
00:11:42,370 --> 00:11:39,440
solar system until it becomes a 50

233
00:11:44,680 --> 00:11:42,380
million mile high wall of plasma about

234
00:11:47,110 --> 00:11:44,690
to envelop the earth now for a sense of

235
00:11:49,060 --> 00:11:47,120
scale the earth on your screen would be

236
00:11:50,260 --> 00:11:49,070
microscopic we've actually drawn a

237
00:11:52,180 --> 00:11:50,270
little icon on there because you

238
00:11:54,430 --> 00:11:52,190

wouldn't be able to see it otherwise the

239
00:11:56,950 --> 00:11:54,440
scale of these these events is simply

240
00:11:58,930 --> 00:11:56,960
immense for the first time we're able to

241
00:12:01,000 --> 00:11:58,940
actually track through these outer

242
00:12:04,210 --> 00:12:01,010
regions of the of the image here on the

243
00:12:06,100 --> 00:12:04,220
left hand side in black and white as the

244
00:12:11,350 --> 00:12:06,110
structure evolves into stores before

245
00:12:13,510 --> 00:12:11,360
impact so for 40 years or more we've

246
00:12:16,300 --> 00:12:13,520
understood that the Sun occasionally

247
00:12:18,160 --> 00:12:16,310
hurls billion ton clouds of material and

248
00:12:20,560 --> 00:12:18,170
123 million miles an hour into

249
00:12:22,000 --> 00:12:20,570
interplanetary space when those clouds

250
00:12:23,140 --> 00:12:22,010
impact the earth they cause space

251
00:12:26,260 --> 00:12:23,150
weather effects that affect our

252
00:12:29,080 --> 00:12:26,270
technology cause Aurora's that sort of

253
00:12:32,230 --> 00:12:29,090
thing ah but until now we couldn't see

254
00:12:34,180 --> 00:12:32,240
any detail in these structures after

255
00:12:36,460 --> 00:12:34,190
about ten degrees from the Sun the

256
00:12:37,960 --> 00:12:36,470
result is that everything outside of

257
00:12:40,900 --> 00:12:37,970
that has been extrapolation so we've

258
00:12:43,150 --> 00:12:40,910
been unable to connect the very detailed

259
00:12:44,770 --> 00:12:43,160
structures we see at the earth back to

260
00:12:49,030 --> 00:12:44,780
the solar structures that gave rise to

261
00:12:51,280 --> 00:12:49,040
them in the first place but now we can

262
00:12:53,590 --> 00:12:51,290
identify which parts of the CM e came

263
00:12:55,930 --> 00:12:53,600

from the Sun and which parts were swept

264
00:12:58,120 --> 00:12:55,940
up from the solar wind in its path we

265
00:13:00,160 --> 00:12:58,130
can see how the CM e is modified as it

266
00:13:04,090 --> 00:13:00,170
propagates and grows across the solar

267
00:13:06,100 --> 00:13:04,100
system and we can get a first look it

268
00:13:09,280 --> 00:13:06,110
held a magnetic structure that drives

269
00:13:10,960 --> 00:13:09,290
the CM e changes and evolves as it

270
00:13:13,900 --> 00:13:10,970
pushes the bright material in front of

271
00:13:16,740 --> 00:13:13,910
it sweeping up solar wind to impact the

272
00:13:19,240 --> 00:13:16,750
planets our spacecraft at sample it up

273
00:13:21,970 --> 00:13:19,250
so to track cmi's we've been mentioning

274
00:13:23,440 --> 00:13:21,980
there are five cameras we have

275
00:13:25,480 --> 00:13:23,450
combined and they have vastly different

276
00:13:27,070 --> 00:13:25,490
scales so I'd like to show you what we

277
00:13:29,170 --> 00:13:27,080
did to prepare these images so you could

278
00:13:31,150 --> 00:13:29,180
see them we if we could roll the zoom

279
00:13:33,670 --> 00:13:31,160
movie please we begin with an

280
00:13:36,370 --> 00:13:33,680
ultraviolet telescope image of the Sun

281
00:13:38,290 --> 00:13:36,380
we zoom out until we can see Venus in

282
00:13:40,660 --> 00:13:38,300
the earth more than 45 degrees away from

283
00:13:43,150 --> 00:13:40,670
the Sun however we can't see the corona

284
00:13:45,790 --> 00:13:43,160
so we've distorted the coordinate system

285
00:13:48,120 --> 00:13:45,800
into radial coordinates which allows us

286
00:13:51,070 --> 00:13:48,130
to see the entire system in one screen

287
00:13:52,570 --> 00:13:51,080
the the scale changes drastically from

288
00:13:54,400 --> 00:13:52,580

the right to the left on the right hand

289
00:13:57,160 --> 00:13:54,410
side we have the Sun on the left hand

290
00:14:00,490 --> 00:13:57,170
side we're looking at whole planets and

291
00:14:02,890 --> 00:14:00,500
the distances between them now the outer

292
00:14:04,990 --> 00:14:02,900
cameras the outer four cameras in that

293
00:14:06,670 --> 00:14:05,000
field of view the sepia tone and the

294
00:14:08,650 --> 00:14:06,680
black and white measure ordinary

295
00:14:10,780 --> 00:14:08,660
sunlight has been scattered off of free

296
00:14:17,110 --> 00:14:10,790
electrons in the plasma clouds in the

297
00:14:18,760 --> 00:14:17,120
solar system close to the Sun that that

298
00:14:20,590 --> 00:14:18,770
light is easy to measure it's relatively

299
00:14:22,600 --> 00:14:20,600
bright compared to the stars but by the

300
00:14:25,030 --> 00:14:22,610
time the cloud reaches Venus it's 10

301
00:14:27,550 --> 00:14:25,040
billion times fainter than the surface

302
00:14:29,050 --> 00:14:27,560
of the full moon it's about a thousand

303
00:14:30,760 --> 00:14:29,060
times fainter than the Galaxy or the

304
00:14:32,700 --> 00:14:30,770
star field in deep space behind the

305
00:14:35,860 --> 00:14:32,710
images so it was a tremendous

306
00:14:37,660 --> 00:14:35,870
achievement to separate the two signals

307
00:14:39,820 --> 00:14:37,670
it was very difficult to separate the

308
00:14:44,710 --> 00:14:39,830
the signal from the clouds from the star

309
00:14:46,660 --> 00:14:44,720
field that's super imposed upon it it's

310
00:14:48,850 --> 00:14:46,670
a testament to the quality of the

311
00:14:50,920 --> 00:14:48,860
instruments from NRL and the rutherford

312
00:14:52,660 --> 00:14:50,930
labs that we're able to drill this far

313
00:14:55,780 --> 00:14:52,670

into the data and actually find

314
00:14:58,330 --> 00:14:55,790
something there at the bottom so moving

315
00:15:00,340 --> 00:14:58,340
back to the science let's review the

316
00:15:02,200 --> 00:15:00,350
data that I showed you at the beginning

317
00:15:05,140 --> 00:15:02,210
and slower motion now pay close

318
00:15:07,120 --> 00:15:05,150
attention not just to the bright front

319
00:15:08,980 --> 00:15:07,130
as it sweeps across but to the Dark Void

320
00:15:12,520 --> 00:15:08,990
behind it and I'll narrate as we run the

321
00:15:14,620 --> 00:15:12,530
gauge movie here so again we'll see the

322
00:15:17,140 --> 00:15:14,630
event form in the lower Corona it's

323
00:15:18,910 --> 00:15:17,150
visible in the ultraviolet and we'll see

324
00:15:20,950 --> 00:15:18,920
it propagate through the brown toned

325
00:15:23,260 --> 00:15:20,960
lower Corona and out into the

326
00:15:25,510 --> 00:15:23,270
heliosphere growing and distorting as it

327
00:15:27,670 --> 00:15:25,520
moves you can see the the dark region

328
00:15:29,080 --> 00:15:27,680
behind the front is full of magnetic

329
00:15:31,990 --> 00:15:29,090
field and that's what's driving the

330
00:15:33,430 --> 00:15:32,000
event as it picks up material from the

331
00:15:35,150 --> 00:15:33,440
surrounding solar wind and gains

332
00:15:37,639 --> 00:15:35,160
brightness in front

333
00:15:39,889 --> 00:15:37,649
magnetic field the magnetic flux rope

334
00:15:41,420 --> 00:15:39,899
that's doing the pushing distorts when

335
00:15:43,610 --> 00:15:41,430
the whole event hits the earth the wind

336
00:15:45,710 --> 00:15:43,620
gauge pegs at 20 atoms per cubic

337
00:15:49,009 --> 00:15:45,720
centimeter and then returns back to

338
00:15:51,170 --> 00:15:49,019

normal levels indicating that in fact we

339
00:15:52,939 --> 00:15:51,180
are measuring the appropriate thing that

340
00:15:55,400 --> 00:15:52,949
gauge is driven by in-situ measurements

341
00:15:57,650 --> 00:15:55,410
from NASA's wind spacecraft that was

342
00:16:04,369 --> 00:15:57,660
actually at the earth and detecting the

343
00:16:06,619 --> 00:16:04,379
this event as it went by so to sum up we

344
00:16:09,530 --> 00:16:06,629
have the for the first time we've

345
00:16:12,139 --> 00:16:09,540
tracked a complete see me lifecycle from

346
00:16:14,629 --> 00:16:12,149
the interior of the corona out to the to

347
00:16:17,990 --> 00:16:14,639
the earth this was achieved by

348
00:16:21,350 --> 00:16:18,000
reprocessing existing data from really

349
00:16:25,160 --> 00:16:21,360
stunningly high quality archives from

350
00:16:28,069 --> 00:16:25,170
stereo and this should give us new

351
00:16:30,559 --> 00:16:28,079
insights into how solar storms evolve

352
00:16:32,749 --> 00:16:30,569
and connect the events that we can

353
00:16:35,389 --> 00:16:32,759
measure the earth back to their solar

354
00:16:38,059 --> 00:16:35,399
origins with that for more context I'll

355
00:16:41,660 --> 00:16:38,069
hand you over to Dave web okay thank you

356
00:16:43,939 --> 00:16:41,670
craig these movies are very important to

357
00:16:46,970 --> 00:16:43,949
solar wind studies especially those

358
00:16:48,949 --> 00:16:46,980
involve the evolution in interaction of

359
00:16:51,530 --> 00:16:48,959
this material in the inner heliosphere

360
00:16:54,319 --> 00:16:51,540
the other spheric imaging itself bridges

361
00:16:56,780 --> 00:16:54,329
a gap between observations near the Sun

362
00:16:58,639 --> 00:16:56,790
and those much further out at the

363
00:17:01,850 --> 00:16:58,649

distance of the earth or beyond as we've

364
00:17:04,010 --> 00:17:01,860
seen here now the solar wind is the hot

365
00:17:07,399 --> 00:17:04,020
plasma which flows out from the solar

366
00:17:11,149 --> 00:17:07,409
corona of the Sun and is guided by

367
00:17:13,429 --> 00:17:11,159
magnetic field lines that spiral out

368
00:17:17,270 --> 00:17:13,439
from the Sun in a garden hose pattern

369
00:17:21,049 --> 00:17:17,280
because of the rotation of the Sun now

370
00:17:25,340 --> 00:17:21,059
if we could show the movie this is a 3d

371
00:17:27,590 --> 00:17:25,350
simulation model of the solar wind and a

372
00:17:29,570 --> 00:17:27,600
CM e moving out through it that was

373
00:17:33,950 --> 00:17:29,580
taken during the first 10 days of this

374
00:17:35,720 --> 00:17:33,960
month august this view on the left shows

375
00:17:38,299 --> 00:17:35,730
the circular view shows the ecliptic

376
00:17:40,640 --> 00:17:38,309
plane which is the plane that the

377
00:17:44,389 --> 00:17:40,650
planets move in around the Sun so it's

378
00:17:46,700 --> 00:17:44,399
looking down on that plane you can see

379
00:17:48,820 --> 00:17:46,710
the curve the dashed lines are the are

380
00:17:51,759 --> 00:17:48,830
these magnetic field lines that

381
00:17:54,039 --> 00:17:51,769
rotating around with the Sun and the

382
00:17:57,610 --> 00:17:54,049
colors are the density pattern in this

383
00:18:00,700 --> 00:17:57,620
model the brighter colors are denser

384
00:18:03,120 --> 00:18:00,710
structures and the other view on the

385
00:18:07,180 --> 00:18:03,130
right is a north-south cut through the

386
00:18:08,680 --> 00:18:07,190
plane Earth Sun earth plane showing you

387
00:18:10,509 --> 00:18:08,690
kind of the vertical component and this

388
00:18:14,110 --> 00:18:10,519

is a similar to the views that we're

389
00:18:18,130 --> 00:18:14,120
seeing from the H I images that Craig

390
00:18:20,169 --> 00:18:18,140
just showed now the plasma can be

391
00:18:22,299 --> 00:18:20,179
compressed along the original field

392
00:18:25,060 --> 00:18:22,309
lines so that will give you a long

393
00:18:27,639 --> 00:18:25,070
curvilinear density structure which co

394
00:18:29,500 --> 00:18:27,649
rotates with a son now when the CM e

395
00:18:33,220 --> 00:18:29,510
comes out you can see that it distorts

396
00:18:35,560 --> 00:18:33,230
those field lines considerably and it

397
00:18:37,240 --> 00:18:35,570
the seamy itself drags its own plasma

398
00:18:40,240 --> 00:18:37,250
and magnetic fields out in the

399
00:18:41,830 --> 00:18:40,250
heliosphere along with it so these

400
00:18:44,710 --> 00:18:41,840
studies of the solar wind and

401
00:18:47,289 --> 00:18:44,720
co-rotating structures as well as the

402
00:18:49,990 --> 00:18:47,299
CMEs and the interactions the cme's make

403
00:18:51,430 --> 00:18:50,000
with these structures all will benefit

404
00:18:54,009 --> 00:18:51,440
from this kind of imaging that we're

405
00:18:56,169 --> 00:18:54,019
seeing today now we have been able to

406
00:18:59,470 --> 00:18:56,179
image the inner heliosphere before in

407
00:19:03,789 --> 00:18:59,480
the 70s and 80s 1970's and 80's we had

408
00:19:05,980 --> 00:19:03,799
the helios solar probes which road and

409
00:19:09,220 --> 00:19:05,990
were in orbit around the sun but they

410
00:19:10,870 --> 00:19:09,230
had a resolution that was much poor in

411
00:19:13,419 --> 00:19:10,880
time and space than what we're seeing

412
00:19:16,889 --> 00:19:13,429
today there wasn't another instrument

413
00:19:19,149 --> 00:19:16,899

like this until 2003 when the Air Force

414
00:19:21,940 --> 00:19:19,159
build and launched the solar mass

415
00:19:24,370 --> 00:19:21,950
ejection imager into Earth orbit and of

416
00:19:26,680 --> 00:19:24,380
course then the stereo a chives were

417
00:19:29,019 --> 00:19:26,690
seeing now were launched in late two

418
00:19:32,460 --> 00:19:29,029
thousand six data was taken in early in

419
00:19:35,110 --> 00:19:32,470
2007 so it was almost four years later

420
00:19:37,480 --> 00:19:35,120
Smee was very successful but it can't

421
00:19:40,149 --> 00:19:37,490
view within 20 to 30 degrees of the Sun

422
00:19:42,220 --> 00:19:40,159
it has noise because it's in Earth orbit

423
00:19:44,200 --> 00:19:42,230
from particles in Aurora and Earth orbit

424
00:19:48,310 --> 00:19:44,210
and it's also nearing the end of its

425
00:19:49,870 --> 00:19:48,320
life time aside from us me and the H I

426
00:19:51,549 --> 00:19:49,880
instruments are no other telescopes

427
00:19:54,399 --> 00:19:51,559
right now that can view the inner

428
00:19:57,279 --> 00:19:54,409
heliosphere like we're seeing today so

429
00:19:59,529 --> 00:19:57,289
these observations are now achieving a

430
00:20:02,710 --> 00:19:59,539
goal that scientists have had or work

431
00:20:05,080 --> 00:20:02,720
towards for about four decades now

432
00:20:07,080 --> 00:20:05,090
this goal is to observe and understand

433
00:20:09,659 --> 00:20:07,090
the basic structure of the solar wind

434
00:20:13,690 --> 00:20:09,669
the observations allow us to separate

435
00:20:17,080 --> 00:20:13,700
cme's from co and co rotating flows and

436
00:20:20,020 --> 00:20:17,090
also to better visualize and understand

437
00:20:22,570 --> 00:20:20,030
the different parts of a CME for

438
00:20:24,820 --> 00:20:22,580

instance the sheath region which is

439
00:20:27,760 --> 00:20:24,830
plowed ahead of the CMEs moving out in

440
00:20:29,350 --> 00:20:27,770
through the heliosphere has the density

441
00:20:31,840 --> 00:20:29,360
which is likely related to the strength

442
00:20:33,430 --> 00:20:31,850
of the CME falling behind it this has

443
00:20:36,220 --> 00:20:33,440
space weather implications that will

444
00:20:39,730 --> 00:20:36,230
hear about in a minute finally these

445
00:20:43,240 --> 00:20:39,740
images will permit global views of the

446
00:20:46,000 --> 00:20:43,250
solar wind and CMEs and so forth when

447
00:20:48,750 --> 00:20:46,010
this data is put into various kinds of

448
00:20:51,310 --> 00:20:48,760
models such as the one I just showed you

449
00:20:53,010 --> 00:20:51,320
now we'll turn it over to Alicia who

450
00:20:57,070 --> 00:20:53,020
will discuss the space weather aspects

451
00:20:58,750 --> 00:20:57,080
yeah so I'm a researcher at the NOAA

452
00:21:00,909 --> 00:20:58,760
Space Weather Prediction Center or ass

453
00:21:02,919 --> 00:21:00,919
whip see we call it swip see is

454
00:21:04,840 --> 00:21:02,929
responsible for operational space

455
00:21:06,760 --> 00:21:04,850
weather forecasting and so so we

456
00:21:09,520 --> 00:21:06,770
complement the basic research that's

457
00:21:11,860 --> 00:21:09,530
done at NASA they help us understand

458
00:21:13,630 --> 00:21:11,870
these events and then and then and Noah

459
00:21:15,549 --> 00:21:13,640
we try to forecast when one of these

460
00:21:17,710 --> 00:21:15,559
events will happen and the reason we

461
00:21:19,620 --> 00:21:17,720
care is because when one of these CMEs

462
00:21:22,210 --> 00:21:19,630
one of these coronal mass ejections

463
00:21:24,730 --> 00:21:22,220

passed the earth they can cause problems

464
00:21:28,110 --> 00:21:24,740
with satellites we've had a couple cases

465
00:21:32,200 --> 00:21:28,120
where power grids have been disrupted

466
00:21:34,029 --> 00:21:32,210
GPS signals can be made inaccurate when

467
00:21:35,860 --> 00:21:34,039
these storms are passing so it's good to

468
00:21:37,870 --> 00:21:35,870
know in advance some so we can be able

469
00:21:39,789 --> 00:21:37,880
to warn people who rely on these

470
00:21:42,279 --> 00:21:39,799
technologies that there may be problems

471
00:21:43,870 --> 00:21:42,289
the cme's also caused the Aurora so you

472
00:21:47,049 --> 00:21:43,880
know they're not all bad we have some

473
00:21:49,360 --> 00:21:47,059
good benefits from that NASA helps us

474
00:21:51,220 --> 00:21:49,370
with our predictions by providing by

475
00:21:53,200 --> 00:21:51,230
both the basic research to help us

476
00:21:55,630 --> 00:21:53,210
understand these events and by providing

477
00:21:58,510 --> 00:21:55,640
what we call beacon data which is lower

478
00:22:01,060 --> 00:21:58,520
resolution data that can be beamed to

479
00:22:03,250 --> 00:22:01,070
sweep see forecasters instantly so that

480
00:22:07,779 --> 00:22:03,260
they can make their forecast with the

481
00:22:10,240 --> 00:22:07,789
latest observations available now before

482
00:22:12,779 --> 00:22:10,250
stereo was launched we had the Soho

483
00:22:15,610 --> 00:22:12,789
Alaska instrument and that that's how we

484
00:22:16,060 --> 00:22:15,620
observed our cme's and so if we rolled

485
00:22:18,100 --> 00:22:16,070
this

486
00:22:21,220 --> 00:22:18,110
movie we have here we can see some CMI's

487
00:22:23,500 --> 00:22:21,230
it with Alaska this was a very active

488
00:22:25,300 --> 00:22:23,510

time so you see a lot of cmi's these

489
00:22:27,490 --> 00:22:25,310
bubbles of plasma coming out in all

490
00:22:31,270 --> 00:22:27,500
different directions now the forecasters

491
00:22:33,790 --> 00:22:31,280
use this to we can measure the speed of

492
00:22:35,860 --> 00:22:33,800
these CMEs but there are a couple

493
00:22:36,910 --> 00:22:35,870
problems one of them is that the cme's

494
00:22:38,800 --> 00:22:36,920
we care about are the ones that are

495
00:22:40,810 --> 00:22:38,810
coming towards us and so because of the

496
00:22:42,730 --> 00:22:40,820
angle it's a little more difficult to

497
00:22:44,350 --> 00:22:42,740
measure the velocity and you also get

498
00:22:47,650 --> 00:22:44,360
these proton events like you can see

499
00:22:49,630 --> 00:22:47,660
here um the other problem is that soho

500
00:22:51,130 --> 00:22:49,640
image is very close to the Sun and so

501
00:22:54,070 --> 00:22:51,140
you're only seeing the early stages of

502
00:22:55,720 --> 00:22:54,080
these CMEs as they're coming out so you

503
00:22:58,060 --> 00:22:55,730
can measure the velocity but the Sammy

504
00:23:00,490 --> 00:22:58,070
maze speed up or slow down as it heads

505
00:23:02,740 --> 00:23:00,500
out towards the Earth we have models

506
00:23:04,660 --> 00:23:02,750
that try to account for this but there's

507
00:23:07,450 --> 00:23:04,670
still a bit inaccurate we can get a

508
00:23:08,890 --> 00:23:07,460
window of about 12 to 14 hours of when

509
00:23:10,480 --> 00:23:08,900
we think the CMU will get to the earth

510
00:23:13,560 --> 00:23:10,490
and of course you know we'd like to do

511
00:23:16,960 --> 00:23:13,570
better than that with the stereo H I

512
00:23:19,150 --> 00:23:16,970
instruments with stereo what stereos

513
00:23:21,010 --> 00:23:19,160

launched he have a we have a couple of

514
00:23:22,420 --> 00:23:21,020
benefits and one of those is the stereos

515
00:23:24,700 --> 00:23:22,430
moving away from the earth so you get a

516
00:23:27,160 --> 00:23:24,710
side view of the CM e so you can measure

517
00:23:28,870 --> 00:23:27,170
the speed a lot more accurately also

518
00:23:31,090 --> 00:23:28,880
with the H I instruments you're able to

519
00:23:32,770 --> 00:23:31,100
image the CM e although as it goes out

520
00:23:35,830 --> 00:23:32,780
from the Sun much further out towards

521
00:23:38,260 --> 00:23:35,840
the Earth and so just using these images

522
00:23:40,330 --> 00:23:38,270
of these images as they were were able

523
00:23:42,580 --> 00:23:40,340
to improve our predictions to about an

524
00:23:44,800 --> 00:23:42,590
eight-hour window at the earth and we

525
00:23:46,240 --> 00:23:44,810
think that with Craig's technique we can

526
00:23:48,070 --> 00:23:46,250
do even better than that because now

527
00:23:49,810 --> 00:23:48,080
we're able to really see the CM e all

528
00:23:53,470 --> 00:23:49,820
the way out to the earth in detail and

529
00:23:56,380 --> 00:23:53,480
see a lot of the substructures yeah this

530
00:23:58,450 --> 00:23:56,390
is a it's a big advance in and just to

531
00:24:00,370 --> 00:23:58,460
explain that it's like trying to

532
00:24:01,960 --> 00:24:00,380
understand how is hurricanes moving

533
00:24:03,970 --> 00:24:01,970
across the ocean by just having a couple

534
00:24:06,370 --> 00:24:03,980
buoys who are that are measuring wind

535
00:24:09,550 --> 00:24:06,380
speed versus now you know these these

536
00:24:11,380 --> 00:24:09,560
are movies that we can see on the news

537
00:24:13,360 --> 00:24:11,390
of the hurricane actually moving across

538
00:24:14,740 --> 00:24:13,370

the ocean so so that's what it is to us

539
00:24:17,200 --> 00:24:14,750
and now we're actually seeing the sea

540
00:24:19,750 --> 00:24:17,210
enemy moving across the sky and it's

541
00:24:23,500 --> 00:24:19,760
it's really it's amazing to see and it

542
00:24:25,060 --> 00:24:23,510
really helps our predictions so timing

543
00:24:26,320 --> 00:24:25,070
is very important knowing when the event

544
00:24:28,600 --> 00:24:26,330
will get to the earth but the other

545
00:24:29,830 --> 00:24:28,610
thing is whether the CMU will actually

546
00:24:30,789 --> 00:24:29,840
cause problems with the earth

547
00:24:33,220 --> 00:24:30,799
and that has to do with the magnetic

548
00:24:35,110 --> 00:24:33,230
field so the earth has a magnetic field

549
00:24:36,850 --> 00:24:35,120
that's called the magnetosphere and it

550
00:24:39,250 --> 00:24:36,860
has a direction associated with it and

551
00:24:40,990 --> 00:24:39,260
these CMEs have directions to and the

552
00:24:43,930 --> 00:24:41,000
way to understand that is if you've ever

553
00:24:45,460 --> 00:24:43,940
played with a magnet a couple magnets

554
00:24:47,019 --> 00:24:45,470
you know if you turn them one way

555
00:24:49,210 --> 00:24:47,029
they'll repel each other and if you turn

556
00:24:52,210 --> 00:24:49,220
them the other they'll attract so if a

557
00:24:54,549 --> 00:24:52,220
CM e has what we call a northward field

558
00:24:57,220 --> 00:24:54,559
it's more likely well let's roll this

559
00:24:59,289 --> 00:24:57,230
next video actually sova see enemy has a

560
00:25:02,260 --> 00:24:59,299
northward field it's more likely to

561
00:25:04,539 --> 00:25:02,270
bounce off the Earth's magnetosphere and

562
00:25:06,580 --> 00:25:04,549
here we have a CMEs it's leaving the Sun

563
00:25:09,850 --> 00:25:06,590

and this one's gonna have a southward

564
00:25:13,409 --> 00:25:09,860
field so we can see what happens when

565
00:25:15,820 --> 00:25:13,419
when that sort of Sammy hits the earth

566
00:25:17,710 --> 00:25:15,830
here we're going to see these blue lines

567
00:25:19,840 --> 00:25:17,720
of the magnetic field of the earth and

568
00:25:22,240 --> 00:25:19,850
as the sea enemy gets the earth you see

569
00:25:25,960 --> 00:25:22,250
it's actually pulling apart the the

570
00:25:28,690 --> 00:25:25,970
field and it's causes a series a chain

571
00:25:33,220 --> 00:25:28,700
of events which eventually lead to the

572
00:25:35,500 --> 00:25:33,230
Aurora and so obviously we want to be

573
00:25:37,480 --> 00:25:35,510
able to predict what the magnetic field

574
00:25:39,669 --> 00:25:37,490
of these cme's are and up until now we

575
00:25:41,740 --> 00:25:39,679
haven't been able to do that but we have

576
00:25:45,190 --> 00:25:41,750
some indications that using craigs

577
00:25:48,159 --> 00:25:45,200
techniques kirk regza results we were

578
00:25:49,690 --> 00:25:48,169
able to link the structures of the CM e

579
00:25:52,570 --> 00:25:49,700
with the magnetic field that we measure

580
00:25:53,769 --> 00:25:52,580
at the earth and we think that if we

581
00:25:55,960 --> 00:25:53,779
combine that with some additional

582
00:25:57,850 --> 00:25:55,970
observations then we can start to make

583
00:25:59,860 --> 00:25:57,860
some predictions of what the sami

584
00:26:01,299 --> 00:25:59,870
magnetic field will be now this is

585
00:26:03,190 --> 00:26:01,309
pretty preliminary we need to do more

586
00:26:06,159 --> 00:26:03,200
study to be sure but this would be

587
00:26:09,039 --> 00:26:06,169
potentially a pretty groundbreaking so

588
00:26:11,019 --> 00:26:09,049

um to sum up this is a great result

589
00:26:12,760 --> 00:26:11,029
where it's very exciting I mean has

590
00:26:14,919 --> 00:26:12,770
important impacts for space weather

591
00:26:17,830 --> 00:26:14,929
research and so now let me turn this

592
00:26:20,889 --> 00:26:17,840
back to the lega thanks Alicia so you

593
00:26:23,769 --> 00:26:20,899
can see as we approach the peak of this

594
00:26:26,760 --> 00:26:23,779
next solar cycle 24 maybe somewhere in

595
00:26:31,060 --> 00:26:26,770
2013 we now have the necessary tools

596
00:26:33,789 --> 00:26:31,070
data and models to improve the physics

597
00:26:37,240 --> 00:26:33,799
understanding of space weather which is

598
00:26:40,139 --> 00:26:37,250
what we are after however missions like

599
00:26:42,490 --> 00:26:40,149
stereo are really signed satellites

600
00:26:43,810 --> 00:26:42,500
which will not always be there to

601
00:26:45,910 --> 00:26:43,820
provide us with

602
00:26:48,960 --> 00:26:45,920
critical observations in the Sun or

603
00:26:51,030 --> 00:26:48,970
system that is why we invest in physics

604
00:26:54,700 --> 00:26:51,040
understanding and modeling of this

605
00:26:56,950 --> 00:26:54,710
phenomenon and heliophysics system

606
00:26:59,650 --> 00:26:56,960
observatory kind of aid in that process

607
00:27:03,580 --> 00:26:59,660
for example we are now as you heard

608
00:27:06,490 --> 00:27:03,590
earlier able to verify models with

609
00:27:09,100 --> 00:27:06,500
ground truth verification at Earth from

610
00:27:14,230 --> 00:27:09,110
our measurements from our satellites

611
00:27:16,270 --> 00:27:14,240
light is n we indent in this plot that

612
00:27:19,360 --> 00:27:16,280
we have up there that is kind of the

613
00:27:22,150 --> 00:27:19,370

same plot that I showed earlier except

614
00:27:24,820 --> 00:27:22,160
now we have put all our operating

615
00:27:29,710 --> 00:27:24,830
missions and future missions on a solar

616
00:27:31,810 --> 00:27:29,720
cycle our time frame and so operating

617
00:27:34,600 --> 00:27:31,820
machines are 16 operating missions

618
00:27:36,520 --> 00:27:34,610
already going on what you can see is

619
00:27:39,130 --> 00:27:36,530
that there are some future missions

620
00:27:42,640 --> 00:27:39,140
that's coming up that will continue to

621
00:27:45,940 --> 00:27:42,650
really are retool our heliophysics

622
00:27:48,130 --> 00:27:45,950
systems observatory next year we will be

623
00:27:51,280 --> 00:27:48,140
launching radiation belt storm probes

624
00:27:53,800 --> 00:27:51,290
and that's two spacecraft that will be

625
00:27:56,290 --> 00:27:53,810
placed in Earth's radiation belt this is

626
00:27:58,840 --> 00:27:56,300
the Geo space environment which is where

627
00:28:01,930 --> 00:27:58,850
we actually feel the impact of solar

628
00:28:03,910 --> 00:28:01,940
storms and its most important to us and

629
00:28:06,190 --> 00:28:03,920
we will be honest trying to understand

630
00:28:10,360 --> 00:28:06,200
the consequence of a solar storm and

631
00:28:14,290 --> 00:28:10,370
then in distant future in 2018 NASA

632
00:28:16,450 --> 00:28:14,300
plans really a daring mission to the Sun

633
00:28:19,030 --> 00:28:16,460
itself and it is going to a mission

634
00:28:20,950 --> 00:28:19,040
called solar probe plus that is going to

635
00:28:25,270 --> 00:28:20,960
go to the outer atmosphere of the Sun

636
00:28:27,820 --> 00:28:25,280
the corona to really measure the

637
00:28:30,910 --> 00:28:27,830
particles and the plasma much like we do

638
00:28:33,940 --> 00:28:30,920

with ace and wind at Earth to provide

639
00:28:35,950 --> 00:28:33,950
their ground truth a verification for

640
00:28:39,340 --> 00:28:35,960
our models you know the beginning and

641
00:28:42,520 --> 00:28:39,350
the end and this is the environment in

642
00:28:46,120 --> 00:28:42,530
which solar wind is created and solar

643
00:28:48,580 --> 00:28:46,130
storms or propagate so this is this is

644
00:28:50,290 --> 00:28:48,590
an exciting period in heliophysics with

645
00:28:52,810 --> 00:28:50,300
that I'll pass it on to you Duane well

646
00:28:53,920 --> 00:28:52,820
thank you lika and to our panel so we

647
00:28:55,570 --> 00:28:53,930
are now going to open it up for

648
00:28:57,040 --> 00:28:55,580
questions and we're gonna actually go to

649
00:28:57,430 --> 00:28:57,050
the phone lines first and we're gonna

650
00:29:00,730 --> 00:28:57,440
head out

651
00:29:02,049 --> 00:29:00,740
to the west coast and first up is David

652
00:29:08,619 --> 00:29:02,059
Pearlman from the San Francisco

653
00:29:13,539 --> 00:29:08,629
Chronicle David yeah thanks very much

654
00:29:17,289 --> 00:29:13,549
and I have one two part question do sea

655
00:29:20,499 --> 00:29:17,299
mas always originate within active

656
00:29:24,279 --> 00:29:20,509
sunspot regions and then the second part

657
00:29:27,700 --> 00:29:24,289
of that question is are any of you

658
00:29:30,639 --> 00:29:27,710
familiar with a report that's coming out

659
00:29:35,080 --> 00:29:30,649
in science on Friday about the ability

660
00:29:40,720 --> 00:29:35,090
of a Stanford group to predict the onset

661
00:29:43,869 --> 00:29:40,730
of sunspots from hit from the soho

662
00:29:47,980 --> 00:29:43,879
satellite that has been looking at the

663
00:29:51,310 --> 00:29:47,990

interior of the Sun to actually predict

664
00:29:53,320 --> 00:29:51,320
the emergence of sunspots and with

665
00:29:55,450 --> 00:29:53,330
somebody whoever answers this would you

666
00:29:57,450 --> 00:29:55,460
please identify yourself because I don't

667
00:29:59,740 --> 00:29:57,460
have a I'm not in the studio audience

668
00:30:01,840 --> 00:29:59,750
thanks David Craig did you want to take

669
00:30:05,590 --> 00:30:01,850
the first question was are gonna be safe

670
00:30:08,919 --> 00:30:05,600
Oh David will take that Davis here I as

671
00:30:12,100 --> 00:30:08,929
far as the what cme's associated with

672
00:30:13,810 --> 00:30:12,110
her come from back of the Sun many of

673
00:30:15,850 --> 00:30:13,820
them especially the most energetic are

674
00:30:19,029 --> 00:30:15,860
associated with active regions and and

675
00:30:22,600 --> 00:30:19,039
flaring and active regions but many are

676
00:30:24,039 --> 00:30:22,610
also associated with prominent eruptions

677
00:30:27,940 --> 00:30:24,049
or film interruptions which can exist

678
00:30:30,399 --> 00:30:27,950
these are clouds of cool gas that exists

679
00:30:31,840 --> 00:30:30,409
in the solar atmosphere we don't quite

680
00:30:34,090 --> 00:30:31,850
know why they're suspended by the

681
00:30:37,149 --> 00:30:34,100
magnetic field and for some reason they

682
00:30:39,009 --> 00:30:37,159
can erupt and when they erupt they also

683
00:30:42,340 --> 00:30:39,019
conform mass ejections coronal mass

684
00:30:44,470 --> 00:30:42,350
ejections so these can also active

685
00:30:46,899 --> 00:30:44,480
regions of course tend to be confined to

686
00:30:49,029 --> 00:30:46,909
the lower latitudes of the Sun whereas

687
00:30:52,060 --> 00:30:49,039
promise because can occur anywhere over

688
00:30:57,759 --> 00:30:52,070

the Sun even towards near the poles and

689
00:30:59,590 --> 00:30:57,769
so therefore cmi's can occur anywhere

690
00:31:02,889 --> 00:30:59,600
from the low latitudes to the high

691
00:31:04,690 --> 00:31:02,899
latitudes and near Seoul a minimum it's

692
00:31:07,500 --> 00:31:04,700
more towards the low latitudes so this

693
00:31:09,340 --> 00:31:07,510
can vary over the solar cycle

694
00:31:11,020 --> 00:31:09,350
Craig what did you want to add to that

695
00:31:12,880 --> 00:31:11,030
it was that anyone would ask a question

696
00:31:16,140 --> 00:31:12,890
maybe a second question you want to

697
00:31:18,490 --> 00:31:16,150
answer um yeah yeah like they said the

698
00:31:22,270 --> 00:31:18,500
biggest sammy's do come from active

699
00:31:25,120 --> 00:31:22,280
regions most often and so so we do care

700
00:31:27,010 --> 00:31:25,130
about when there's an active region when

701
00:31:28,960 --> 00:31:27,020
an active region may be emerging and

702
00:31:30,790 --> 00:31:28,970
especially early on when right when they

703
00:31:35,710 --> 00:31:30,800
active region emerges you can often get

704
00:31:37,630 --> 00:31:35,720
a lot of CMI's I'm only partly familiar

705
00:31:40,260 --> 00:31:37,640
with this this new research but it is

706
00:31:43,330 --> 00:31:40,270
pretty exciting to be able to use a

707
00:31:45,160 --> 00:31:43,340
helioseismology to look underneath the

708
00:31:47,860 --> 00:31:45,170
Sun and try to predict when an active

709
00:31:51,940 --> 00:31:47,870
region will appear and i think i will

710
00:31:54,400 --> 00:31:51,950
add to that I I think this is one of the

711
00:31:56,140 --> 00:31:54,410
reason we actually launched Solar

712
00:31:58,660 --> 00:31:56,150
Dynamics Observatory which is the first

713
00:32:01,780 --> 00:31:58,670

mission of living with a star really to

714
00:32:05,620 --> 00:32:01,790
understand helioseismology in greater

715
00:32:08,440 --> 00:32:05,630
detail and penetrate our deeper into the

716
00:32:11,290 --> 00:32:08,450
convection zone where these these

717
00:32:14,350 --> 00:32:11,300
magnetic structures are formed and so

718
00:32:17,830 --> 00:32:14,360
soho MDI has given us the first cut of

719
00:32:20,440 --> 00:32:17,840
good statistics and this result is

720
00:32:24,010 --> 00:32:20,450
actually going to be sharpened by using

721
00:32:27,820 --> 00:32:24,020
the Solar Dynamics Observatory so he'll

722
00:32:29,950 --> 00:32:27,830
uhm I instrument so this is pretty

723
00:32:33,670 --> 00:32:29,960
groundbreaking we are delighted to have

724
00:32:38,130 --> 00:32:33,680
this we will have a online press release

725
00:32:41,260 --> 00:32:38,140
on monday stay tuned craig did you

726
00:32:43,740 --> 00:32:41,270
talking okay and David that was a leaker

727
00:32:47,650 --> 00:32:43,750
talking then of course I was Dave and

728
00:32:49,410 --> 00:32:47,660
Alicia Alyssa okay I'm gonna get that

729
00:32:53,410 --> 00:32:49,420
right I'm determining at any rate okay

730
00:32:59,680 --> 00:32:53,420
next up on the call Peter spots from the

731
00:33:01,320 --> 00:32:59,690
Christian Science Monitor Peter oh thank

732
00:33:03,880 --> 00:33:01,330
ya thanks for doing this and actually uh

733
00:33:06,430 --> 00:33:03,890
Dave scoop me on me on the question

734
00:33:08,440 --> 00:33:06,440
there but i wonder if-if taking both of

735
00:33:10,840 --> 00:33:08,450
these results together if you could just

736
00:33:12,820 --> 00:33:10,850
kind of place this in in a in a kind of

737
00:33:15,220 --> 00:33:12,830
parallel context i mean how does this

738
00:33:17,530 --> 00:33:15,230

how do these developments as

739
00:33:20,620 --> 00:33:17,540
as early as they are but as promising as

740
00:33:22,630 --> 00:33:20,630
they are can you think of a similar time

741
00:33:24,970 --> 00:33:22,640
for example in the history of weather

742
00:33:26,620 --> 00:33:24,980
forecasting where you sort of had the

743
00:33:30,820 --> 00:33:26,630
same sort of potential breakthrough

744
00:33:32,950 --> 00:33:30,830
technologies um coming along just in

745
00:33:37,630 --> 00:33:32,960
trying to draw some kind of parallel for

746
00:33:38,919 --> 00:33:37,640
readers this is Craig DeForest really

747
00:33:42,700 --> 00:33:38,929
you're looking at opposite ends the same

748
00:33:44,830 --> 00:33:42,710
connected system here the Stanford group

749
00:33:46,270 --> 00:33:44,840
is studying the origin of the systems

750
00:33:48,039 --> 00:33:46,280
that give rise to sammys and we're

751
00:33:50,140 --> 00:33:48,049
really studying what happens to see me

752
00:33:52,240 --> 00:33:50,150
after it leaves the Sun and propagates

753
00:33:54,850 --> 00:33:52,250
all the way out to the earth as far as a

754
00:33:57,490 --> 00:33:54,860
parallel with history this really is

755
00:33:59,289 --> 00:33:57,500
like the beginning of space assets for

756
00:34:01,480 --> 00:33:59,299
weather forecasting that for the first

757
00:34:04,419 --> 00:34:01,490
time we're really developing systems

758
00:34:07,450 --> 00:34:04,429
they can get at the root the structure

759
00:34:10,450 --> 00:34:07,460
of what's causing then earth storms and

760
00:34:12,580 --> 00:34:10,460
now space storms around the earth so up

761
00:34:14,800 --> 00:34:12,590
until now we've we've relied on point

762
00:34:15,970 --> 00:34:14,810
measurements and models and and really

763
00:34:18,220 --> 00:34:15,980

for the first time we're beginning to

764
00:34:22,690 --> 00:34:18,230
see a complete predictive system

765
00:34:26,680 --> 00:34:22,700
emerging out of the science did you have

766
00:34:40,740 --> 00:34:26,690
a follow up Peter thank you okay next up

767
00:34:49,860 --> 00:34:43,020
going once going twice and Mike are you

768
00:34:51,899 --> 00:34:49,870
with us okay all right let me take a

769
00:34:54,510 --> 00:34:51,909
question from one of the dot-coms and I

770
00:34:56,639 --> 00:34:54,520
believe this is going to be for all four

771
00:34:58,440 --> 00:34:56,649
of you also we just go down the row here

772
00:35:02,580 --> 00:34:58,450
and the question is with the public

773
00:35:07,020 --> 00:35:02,590
fascination of the Sun how can you

774
00:35:09,360 --> 00:35:07,030
personally tell the public on how we are

775
00:35:15,210 --> 00:35:09,370
more prepared and what we know about the

776
00:35:18,270 --> 00:35:15,220
Sun from past present and future we can

777
00:35:21,630 --> 00:35:18,280
tell a lot actually as I was indicating

778
00:35:24,450 --> 00:35:21,640
that even five years ago are there where

779
00:35:27,720 --> 00:35:24,460
our stuff we didn't know and five years

780
00:35:30,270 --> 00:35:27,730
later with observations from stereo or

781
00:35:34,080 --> 00:35:30,280
solar dynamics observatory are our whole

782
00:35:37,290 --> 00:35:34,090
view of how the Sun behaves as a

783
00:35:39,960 --> 00:35:37,300
magnetic variable star is changing right

784
00:35:43,800 --> 00:35:39,970
in front of our eyes so it's it is a

785
00:35:47,010 --> 00:35:43,810
really dynamic time in the history of

786
00:35:49,440 --> 00:35:47,020
heliophysics where um you know our

787
00:35:50,850 --> 00:35:49,450
observations are ahead of our

788
00:35:53,550 --> 00:35:50,860

theoretical insights and understanding

789
00:35:56,310 --> 00:35:53,560
but we are seeing these things for the

790
00:35:59,670 --> 00:35:56,320
first time and we are grappling as to

791
00:36:03,300 --> 00:35:59,680
what is going on so I don't know what

792
00:36:06,780 --> 00:36:03,310
more to say but this is a very rich time

793
00:36:12,030 --> 00:36:06,790
for understanding heliophysics and space

794
00:36:14,220 --> 00:36:12,040
weather evolution some views uh well I

795
00:36:16,830 --> 00:36:14,230
have to agree with Lika that we're

796
00:36:19,850 --> 00:36:16,840
making tremendous strides when I first

797
00:36:22,320 --> 00:36:19,860
got interested in this field as a boy

798
00:36:24,390 --> 00:36:22,330
solar physics was was sometimes referred

799
00:36:27,480 --> 00:36:24,400
to as dermatology because we could see

800
00:36:30,030 --> 00:36:27,490
features on the Sun and not the interior

801
00:36:32,400 --> 00:36:30,040
yet but we couldn't really understand

802
00:36:35,430 --> 00:36:32,410
them and over the course of just my

803
00:36:37,830 --> 00:36:35,440
lifetime we've seen the data get better

804
00:36:39,450 --> 00:36:37,840
to be where we're measuring the things

805
00:36:41,040 --> 00:36:39,460
we need to be measuring and we've seen

806
00:36:42,690 --> 00:36:41,050
the models and data processing get

807
00:36:46,230 --> 00:36:42,700
better to where we can really encompass

808
00:36:47,610 --> 00:36:46,240
this phenomenally complex system plasma

809
00:36:50,610 --> 00:36:47,620
physics is extraordinary calm

810
00:36:52,590 --> 00:36:50,620
extraordinarily complicated the physics

811
00:36:54,420 --> 00:36:52,600
of solar flares involves differences in

812
00:36:55,890 --> 00:36:54,430
scale between things the size of

813
00:36:59,490 --> 00:36:55,900

Jupiter and things the size of this

814
00:37:02,280 --> 00:36:59,500
television studio and encompassing that

815
00:37:03,599 --> 00:37:02,290
is just very difficult and we've really

816
00:37:05,460 --> 00:37:03,609
seen a tremendous amount of this puzzle

817
00:37:07,589 --> 00:37:05,470
come together for the Sun and by

818
00:37:11,460 --> 00:37:07,599
extension two stars in general just in

819
00:37:14,010 --> 00:37:11,470
the course of a lifetime well I'll see

820
00:37:16,020 --> 00:37:14,020
that basic context I think for me would

821
00:37:18,030 --> 00:37:16,030
be I've started out in this field in

822
00:37:21,299 --> 00:37:18,040
solar physics in the early 70s with a

823
00:37:22,890 --> 00:37:21,309
Skylab program and at that time we made

824
00:37:24,690 --> 00:37:22,900
many new exciting discoveries about

825
00:37:26,730 --> 00:37:24,700
looking at the Sun itself in detail

826
00:37:28,559 --> 00:37:26,740
coronal mass ejections were kind of

827
00:37:32,150 --> 00:37:28,569
discovered only discovered around that

828
00:37:35,280 --> 00:37:32,160
time so that's 40 years ago and and

829
00:37:36,839 --> 00:37:35,290
since then you know we at that time we

830
00:37:38,640 --> 00:37:36,849
we knew nothing about how these things

831
00:37:40,500 --> 00:37:38,650
really connected with the heliosphere

832
00:37:43,890 --> 00:37:40,510
and the earth and so forth we could only

833
00:37:45,809 --> 00:37:43,900
make a crude guesses at this now with

834
00:37:48,630 --> 00:37:45,819
data like you're seeing today we can

835
00:37:50,130 --> 00:37:48,640
actually as they said try and these

836
00:37:52,190 --> 00:37:50,140
things coming out from the Sun tracked

837
00:37:55,680 --> 00:37:52,200
them all the way to the earth and beyond

838
00:37:57,540 --> 00:37:55,690

and and understand much better what

839
00:37:58,980 --> 00:37:57,550
they're coming what's happening with

840
00:38:01,799 --> 00:37:58,990
them and as far as the system's approach

841
00:38:04,500 --> 00:38:01,809
goes so we made huge strides in my

842
00:38:06,870 --> 00:38:04,510
lifetime or my working life time it's

843
00:38:08,819 --> 00:38:06,880
very exciting to see this and of course

844
00:38:10,500 --> 00:38:08,829
now with that we have these future

845
00:38:13,020 --> 00:38:10,510
missions like Solar Probe will actually

846
00:38:15,359 --> 00:38:13,030
go into the atmosphere of the Sun and

847
00:38:17,339 --> 00:38:15,369
that'll be very exciting so it's a very

848
00:38:21,990 --> 00:38:17,349
exciting time to be doing this work

849
00:38:24,030 --> 00:38:22,000
Alyssa yeah and I'd say that the work

850
00:38:26,069 --> 00:38:24,040
that I do I sort of straddles Eve the

851
00:38:28,200 --> 00:38:26,079
basic research that NASA does and the

852
00:38:30,569 --> 00:38:28,210
predictions that Noah does by being

853
00:38:32,640 --> 00:38:30,579
based in NOAA and so I sort of I could

854
00:38:34,859 --> 00:38:32,650
see both sides of this and and it's very

855
00:38:36,630 --> 00:38:34,869
exciting so I echo what these guys have

856
00:38:38,220 --> 00:38:36,640
said that this is a great time what

857
00:38:40,829 --> 00:38:38,230
we're getting all these new observations

858
00:38:42,870 --> 00:38:40,839
and in this new understanding of how

859
00:38:45,089 --> 00:38:42,880
these events happen and that that's

860
00:38:47,460 --> 00:38:45,099
feeding into our forecasts and our

861
00:38:49,260 --> 00:38:47,470
ability to predict these in advance and

862
00:38:53,339 --> 00:38:49,270
predict you know how powerful they'll be

863
00:38:55,829 --> 00:38:53,349

and and as we become more reliant on

864
00:38:56,789 --> 00:38:55,839
technology you know our satellites and

865
00:38:58,380 --> 00:38:56,799
everything become more and more

866
00:38:59,910 --> 00:38:58,390
important that makes it more important

867
00:39:02,789 --> 00:38:59,920
to be able to predict when these events

868
00:39:05,549 --> 00:39:02,799
will occur so that's if it's an exciting

869
00:39:08,110 --> 00:39:05,559
time okay we're gonna go back and see if

870
00:39:11,050 --> 00:39:08,120
we can take a second

871
00:39:17,020 --> 00:39:11,060
go with Mike wall and space com Mike are

872
00:39:18,310 --> 00:39:17,030
you with us uh yeah yeah I just had a

873
00:39:21,100 --> 00:39:18,320
phone glitch can you guys hear me this

874
00:39:24,100 --> 00:39:21,110
time read you loud and clear okay great

875
00:39:26,590 --> 00:39:24,110
so yeah so actually stereo launched

876
00:39:28,870 --> 00:39:26,600
about 550 about five years ago I was

877
00:39:31,540 --> 00:39:28,880
just wondering why did it take until now

878
00:39:34,090 --> 00:39:31,550
for you guys to sort of be able to see

879
00:39:36,220 --> 00:39:34,100
this in this new way if you see all this

880
00:39:39,580 --> 00:39:36,230
data in this new way I can address that

881
00:39:41,170 --> 00:39:39,590
as a stranger forest this is an

882
00:39:42,910 --> 00:39:41,180
extraordinarily difficult extraction

883
00:39:45,970 --> 00:39:42,920
problem and we've highlighted the

884
00:39:48,190 --> 00:39:45,980
science that we've been doing more than

885
00:39:52,050 --> 00:39:48,200
that the technique of extracting the

886
00:39:54,310 --> 00:39:52,060
data but this is a very challenging

887
00:39:56,560 --> 00:39:54,320
image separation problem that we're

888
00:39:57,730 --> 00:39:56,570

looking these these brightness clouds

889
00:40:00,130 --> 00:39:57,740
that you're seeing in the movie that's

890
00:40:01,480 --> 00:40:00,140
been prepared our fluctuations are less

891
00:40:04,150 --> 00:40:01,490
than a tenth of a percent of the

892
00:40:06,010 --> 00:40:04,160
brightness of a star field image and so

893
00:40:07,810 --> 00:40:06,020
that just a tremendous amount of

894
00:40:10,390 --> 00:40:07,820
extraordinarily careful work was needed

895
00:40:13,450 --> 00:40:10,400
to develop the algorithms and and many

896
00:40:15,850 --> 00:40:13,460
teams have worked on this so as with any

897
00:40:17,200 --> 00:40:15,860
science group we have the final result

898
00:40:19,990 --> 00:40:17,210
but we stand on the shoulders of giants

899
00:40:22,000 --> 00:40:20,000
who prepared the the amazing instruments

900
00:40:24,610 --> 00:40:22,010
that that they can produce the data with

901
00:40:27,010 --> 00:40:24,620
this quality and did the groundwork of

902
00:40:29,410 --> 00:40:27,020
calibrating the instrument so we need to

903
00:40:31,540 --> 00:40:29,420
we need to recognize the folks at NRL

904
00:40:37,030 --> 00:40:31,550
and Rutherford labs for for producing

905
00:40:38,860 --> 00:40:37,040
such a terrific package okay I think

906
00:40:40,200 --> 00:40:38,870
that's going to do it for today I want

907
00:40:45,220 --> 00:40:40,210
to thank you all for joining us today

908
00:40:47,710 --> 00:40:45,230
again you could go to ww a safe / stereo

909
00:40:49,890 --> 00:40:47,720
for information on this incredible

910
00:40:55,900 --> 00:40:49,900
mission and all of the heliophysics