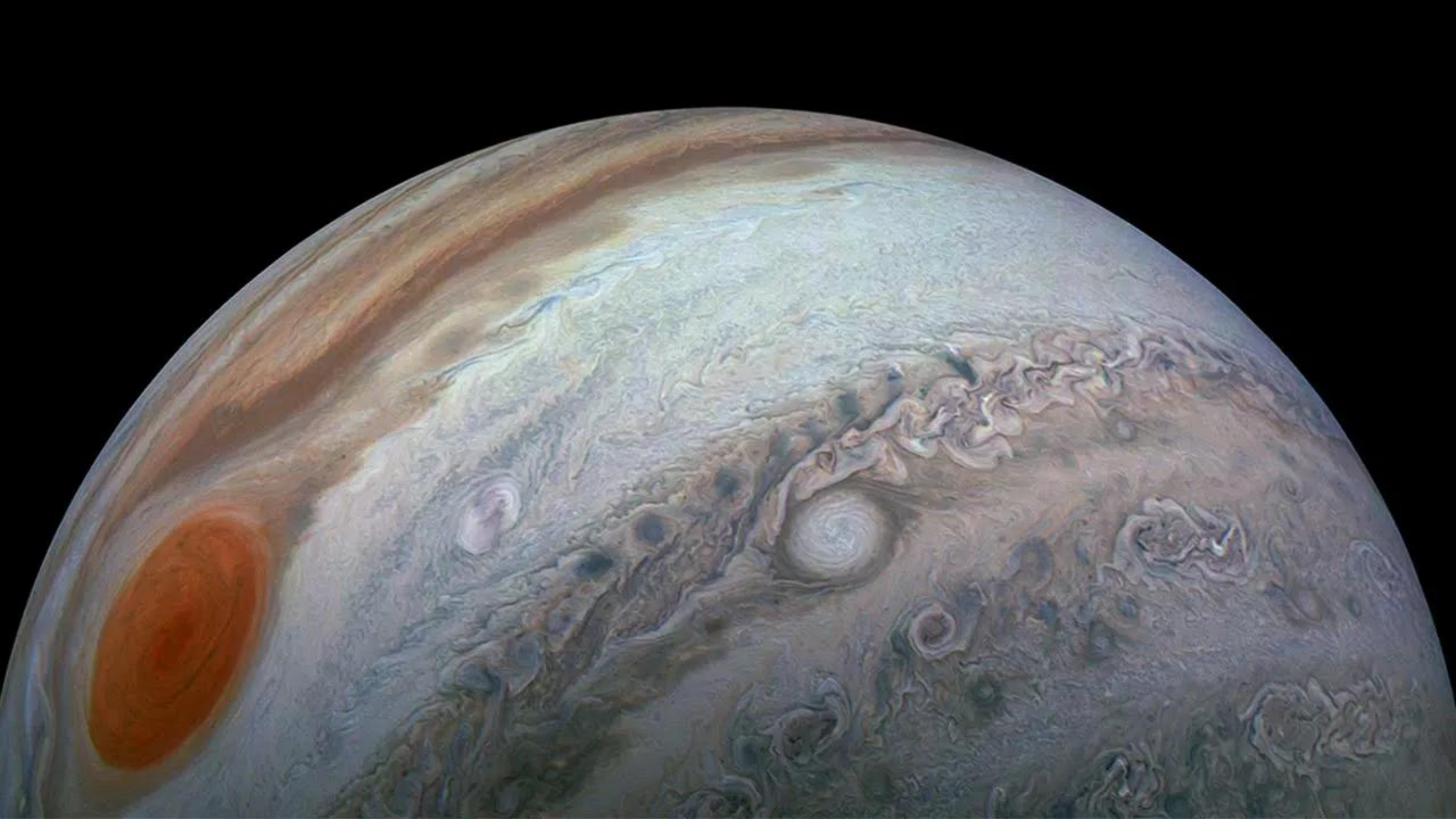

1
00:00:00,000 --> 00:00:17,349
[Music]

2
00:00:21,910 --> 00:00:19,510
welcome to today's discussion on the

3
00:00:24,710 --> 00:00:21,920
latest findings from nasa's juno

4
00:00:27,750 --> 00:00:24,720
spacecraft which has been orbiting and

5
00:00:30,070 --> 00:00:27,760
monitoring jupiter since 2016.

6
00:00:32,470 --> 00:00:30,080
the juno science team will give us a new

7
00:00:34,630 --> 00:00:32,480
glimpse into how jupiter's atmosphere

8
00:00:37,110 --> 00:00:34,640
operates underneath the top layer of

9
00:00:39,590 --> 00:00:37,120
clouds and what this could tell us about

10
00:00:41,110 --> 00:00:39,600
other giant planets in the universe

11
00:00:43,590 --> 00:00:41,120
i'm required

12
00:00:45,510 --> 00:00:43,600
of nasa's jet propulsion laboratory in

13
00:00:46,950 --> 00:00:45,520

southern california and i'll be your

14
00:00:49,190 --> 00:00:46,960
moderator today

15
00:00:51,670 --> 00:00:49,200
and our speakers are joining us from

16
00:00:54,310 --> 00:00:51,680
locations all around the world

17
00:00:58,150 --> 00:00:54,320
to talk about the latest results are

18
00:00:59,750 --> 00:00:58,160
lucas faganini nasa headquarters

19
00:01:02,709 --> 00:00:59,760
scott bolton

20
00:01:06,469 --> 00:01:02,719
southwest research institute

21
00:01:07,990 --> 00:01:06,479
marzia parisi jpl

22
00:01:10,710 --> 00:01:08,000
karen dewer

23
00:01:12,550 --> 00:01:10,720
wiseman institute of science

24
00:01:15,190 --> 00:01:12,560
lee fletcher

25
00:01:17,910 --> 00:01:15,200
university of leicester

26
00:01:21,429 --> 00:01:17,920
alessandro mora from the institute of

27
00:01:22,950 --> 00:01:21,439
space astrophysics and planetology

28
00:01:24,950 --> 00:01:22,960
we'll be taking questions during the

29
00:01:27,429 --> 00:01:24,960
briefing so if you're a member of the

30
00:01:28,950 --> 00:01:27,439
media on the phone lines press star one

31
00:01:31,190 --> 00:01:28,960
to be put in the queue

32
00:01:32,390 --> 00:01:31,200
and if you're on social media use the

33
00:01:35,350 --> 00:01:32,400
hashtag

34
00:01:39,749 --> 00:01:35,360
juno mission to ask questions

35
00:01:43,590 --> 00:01:41,270
thanks raquel

36
00:01:45,749 --> 00:01:43,600
these are really exciting times

37
00:01:48,069 --> 00:01:45,759
juno was the second mission selected in

38
00:01:50,389 --> 00:01:48,079

nasa's new frontiers program

39
00:01:52,469 --> 00:01:50,399
and since its arrival at jupiter five

40
00:01:55,510 --> 00:01:52,479
years ago the mission has made exciting

41
00:01:57,190 --> 00:01:55,520
discoveries that made us rethink what we

42
00:01:59,350 --> 00:01:57,200
knew about jupiter

43
00:02:01,190 --> 00:01:59,360
including better insights into the

44
00:02:04,310 --> 00:02:01,200
planet's composition

45
00:02:06,950 --> 00:02:04,320
new images of massive cyclones octopus

46
00:02:09,990 --> 00:02:06,960
and even lining in the atmosphere

47
00:02:11,589 --> 00:02:10,000
not to mention a stunning new snapshots

48
00:02:13,350 --> 00:02:11,599
of jupiter

49
00:02:15,030 --> 00:02:13,360
one of the great things about this

50
00:02:17,030 --> 00:02:15,040
mission is the complete set of

51
00:02:19,110 --> 00:02:17,040
instruments that have allowed scientists

52
00:02:21,030 --> 00:02:19,120
to see through the top clouds all the

53
00:02:24,150 --> 00:02:21,040
way down to its cork

54
00:02:26,070 --> 00:02:24,160
in ways not possible before

55
00:02:28,229 --> 00:02:26,080
the good news is that a few months ago

56
00:02:30,470 --> 00:02:28,239
because of this great progress and the

57
00:02:31,750 --> 00:02:30,480
fact that the spacecraft is in good

58
00:02:34,390 --> 00:02:31,760
health

59
00:02:37,030 --> 00:02:34,400
nasa extended its operations for four

60
00:02:38,630 --> 00:02:37,040
more years this is what we call the

61
00:02:41,430 --> 00:02:38,640
extended phase

62
00:02:42,790 --> 00:02:41,440
so juno will provide new observations

63
00:02:44,790 --> 00:02:42,800

that address

64
00:02:46,869 --> 00:02:44,800
new exciting questions raised during

65
00:02:49,270 --> 00:02:46,879
what we call the prime mission

66
00:02:51,750 --> 00:02:49,280
and it will add a few flyweights of

67
00:02:54,630 --> 00:02:51,760
three of the four galilean moons the

68
00:02:56,949 --> 00:02:54,640
volcanic world eel and the ocean worlds

69
00:02:59,270 --> 00:02:56,959
europa and ganymede

70
00:03:01,910 --> 00:02:59,280
jupiter and its moon are fascinating

71
00:03:03,110 --> 00:03:01,920
worlds and they remain a top priority

72
00:03:04,790 --> 00:03:03,120
for nasa

73
00:03:06,869 --> 00:03:04,800
but most importantly

74
00:03:09,750 --> 00:03:06,879
juno continues this journey of

75
00:03:11,750 --> 00:03:09,760
exploration as nasa and the european

76
00:03:13,589 --> 00:03:11,760
space agency get ready for the next

77
00:03:15,350 --> 00:03:13,599
generation of explorers

78
00:03:17,830 --> 00:03:15,360
such as clipper and the jewish mission

79
00:03:20,869 --> 00:03:17,840
that will investigate these ocean worlds

80
00:03:23,030 --> 00:03:20,879
in more detail within the next decade

81
00:03:26,390 --> 00:03:23,040
june is providing incredible scientific

82
00:03:28,390 --> 00:03:26,400
discoveries that inspired and innovate

83
00:03:30,869 --> 00:03:28,400
and i'd like to highlight the great work

84
00:03:33,190 --> 00:03:30,879
of this team of scientists and engineers

85
00:03:35,190 --> 00:03:33,200
that make it possible

86
00:03:37,670 --> 00:03:35,200
i'm really excited to learn more about

87
00:03:38,390 --> 00:03:37,680
the latest scientific results so let's

88
00:03:43,750 --> 00:03:38,400

kick

89
00:03:46,710 --> 00:03:43,760
scott good to see you what's new

90
00:03:50,309 --> 00:03:46,720
hi great to be here thanks lucas um

91
00:03:53,589 --> 00:03:50,319
welcome everyone i'm really excited to

92
00:03:56,390 --> 00:03:53,599
share with you our new results and um

93
00:03:58,470 --> 00:03:56,400
and the excitement of exploration and

94
00:04:01,429 --> 00:03:58,480
discovery uh

95
00:04:04,309 --> 00:04:01,439
that is so common in all of nasa's

96
00:04:07,190 --> 00:04:04,319
missions and juno is no exception

97
00:04:09,190 --> 00:04:07,200
today's focus is actually going to be uh

98
00:04:10,789 --> 00:04:09,200
jupiter's atmosphere in three dimensions

99
00:04:14,070 --> 00:04:10,799
where we're going to look inside the

100
00:04:16,310 --> 00:04:14,080
planet and and how that has led to a

101
00:04:18,550 --> 00:04:16,320
really a new understanding for us

102
00:04:20,629 --> 00:04:18,560
um before i get started let me just give

103
00:04:23,670 --> 00:04:20,639
a quick summary of how

104
00:04:26,310 --> 00:04:23,680
and why jupiter is so important to us

105
00:04:28,310 --> 00:04:26,320
so jupiter is the largest and most

106
00:04:31,270 --> 00:04:28,320
massive of all the planets in our solar

107
00:04:33,590 --> 00:04:31,280
system in fact it's so large and massive

108
00:04:36,070 --> 00:04:33,600
all the other planets could fit inside

109
00:04:40,710 --> 00:04:36,080
and this size is one of the key reasons

110
00:04:44,070 --> 00:04:43,189
because it's so large and massive

111
00:04:46,629 --> 00:04:44,080
it's

112
00:04:49,430 --> 00:04:46,639
thought to have formed first so when we

113
00:04:51,990 --> 00:04:49,440

study jupiter we're taking a look at the

114
00:04:54,230 --> 00:04:52,000
very early part of the solar system how

115
00:04:56,629 --> 00:04:54,240
did planets forms how did where did we

116
00:04:59,110 --> 00:04:56,639
come from how our solar system is made

117
00:05:01,029 --> 00:04:59,120
in general this is really the first step

118
00:05:02,950 --> 00:05:01,039
jupiter forms first and that kind of

119
00:05:03,830 --> 00:05:02,960
leads the way to the rest of our solar

120
00:05:06,550 --> 00:05:03,840
system

121
00:05:09,909 --> 00:05:06,560
and and the giant planets in general

122
00:05:11,510 --> 00:05:09,919
follow suit and probably form a shortly

123
00:05:12,629 --> 00:05:11,520
after jupiter

124
00:05:15,430 --> 00:05:12,639
and so

125
00:05:17,590 --> 00:05:15,440
juno is part of a long history that

126
00:05:19,189 --> 00:05:17,600
nasa's had to study the giant planets

127
00:05:21,909 --> 00:05:19,199
partly for that reason because it's

128
00:05:24,310 --> 00:05:21,919
telling us about our origins and in many

129
00:05:26,629 --> 00:05:24,320
ways do we we may actually have needed a

130
00:05:28,710 --> 00:05:26,639
jupiter to exist in order for jew for

131
00:05:29,590 --> 00:05:28,720
earth to be created and for us to get

132
00:05:32,390 --> 00:05:29,600
life

133
00:05:34,790 --> 00:05:32,400
and so over the years uh starting with

134
00:05:37,350 --> 00:05:34,800
pioneer we flew by jupiter and saturn

135
00:05:40,870 --> 00:05:37,360
and then followed by voyager

136
00:05:42,150 --> 00:05:40,880
and eventually galileo orbited jupiter

137
00:05:47,990 --> 00:05:42,160
and

138
00:05:50,790 --> 00:05:48,000

in depth

139
00:05:52,629 --> 00:05:50,800
and went into an orbit there and and

140
00:05:55,029 --> 00:05:52,639
through those kind of history of

141
00:05:57,990 --> 00:05:55,039
missions we've are able to compare

142
00:06:00,870 --> 00:05:58,000
planets and comparative study is really

143
00:06:03,749 --> 00:06:00,880
a workhorse tool of science it's very

144
00:06:05,430 --> 00:06:03,759
important to understand the similarities

145
00:06:07,909 --> 00:06:05,440
and differences and be able to explain

146
00:06:09,270 --> 00:06:07,919
those with our physical laws or the laws

147
00:06:11,110 --> 00:06:09,280
of nature

148
00:06:12,790 --> 00:06:11,120
and that's going to be a theme in in

149
00:06:14,629 --> 00:06:12,800
what you're going to hear today because

150
00:06:16,550 --> 00:06:14,639
we're going to compare how jupiter's

151
00:06:18,309 --> 00:06:16,560
atmosphere works to the earth and in

152
00:06:21,749 --> 00:06:18,319
some sense even when we look at at

153
00:06:22,629 --> 00:06:21,759
saturn um and the extension doesn't just

154
00:06:24,390 --> 00:06:22,639
stop

155
00:06:26,469 --> 00:06:24,400
uh in our solar system because we're

156
00:06:28,309 --> 00:06:26,479
discovering giant planets elsewhere

157
00:06:30,950 --> 00:06:28,319
throughout the galaxy and other solar

158
00:06:32,550 --> 00:06:30,960
systems and jupiter is our example and

159
00:06:34,390 --> 00:06:32,560
when we get up close and this is the

160
00:06:36,790 --> 00:06:34,400
first planet we've actually been able to

161
00:06:38,950 --> 00:06:36,800
open up and look inside of this is going

162
00:06:39,990 --> 00:06:38,960
to tell us a lot about how giant planets

163
00:06:43,029 --> 00:06:40,000

work

164
00:06:45,590 --> 00:06:43,039
throughout the galaxy

165
00:06:47,909 --> 00:06:45,600
now juno the name itself actually came

166
00:06:50,150 --> 00:06:47,919
from greek or roman mythology that was

167
00:06:50,950 --> 00:06:50,160
the wife and sister of jupiter

168
00:06:53,270 --> 00:06:50,960
and

169
00:06:55,270 --> 00:06:53,280
mythological stories tell us how jupiter

170
00:06:58,070 --> 00:06:55,280
was casting a veil of clouds around

171
00:07:01,189 --> 00:06:58,080
himself to hide his mischief and juno

172
00:07:03,350 --> 00:07:01,199
his wife was able to use her special

173
00:07:05,589 --> 00:07:03,360
powers to park those clouds remove that

174
00:07:07,830 --> 00:07:05,599
bale of clouds look down deep and

175
00:07:09,749 --> 00:07:07,840
actually see his true nature and in many

176
00:07:11,510 --> 00:07:09,759
ways that's what our spacecraft does and

177
00:07:13,350 --> 00:07:11,520
that's where the origin of the name

178
00:07:15,670 --> 00:07:13,360
comes from and so what we're going to

179
00:07:19,510 --> 00:07:15,680
talk about today is a new understanding

180
00:07:22,629 --> 00:07:19,520
of jupiter from the outside looking in

181
00:07:27,430 --> 00:07:25,029
so here you see sort of a traditional

182
00:07:28,309 --> 00:07:27,440
view of jupiter it's got the great red

183
00:07:30,629 --> 00:07:28,319
spot

184
00:07:33,670 --> 00:07:30,639
the common and distinctive zones and

185
00:07:35,830 --> 00:07:33,680
belts those stripes the brownish orange

186
00:07:38,710 --> 00:07:35,840
and white stripes that cross jupiter's

187
00:07:40,390 --> 00:07:38,720
midsection this was our view before juno

188
00:07:43,029 --> 00:07:40,400

this is what we kind of knew and grew

189
00:07:45,510 --> 00:07:43,039
and uh got used to

190
00:07:49,189 --> 00:07:45,520
and this image was taken by cassini

191
00:07:51,830 --> 00:07:49,199
actually on route to uh ju to saturn it

192
00:07:54,309 --> 00:07:51,840
was taken back in december of 2000 and

193
00:07:57,270 --> 00:07:54,319
you can see all these primary features

194
00:07:59,430 --> 00:07:57,280
that we kind of knew and and associate

195
00:08:02,230 --> 00:07:59,440
with jupiter at the time of this picture

196
00:08:04,309 --> 00:08:02,240
nobody knew how deep does that great red

197
00:08:06,150 --> 00:08:04,319
spot go we knew it lasted a long time

198
00:08:08,230 --> 00:08:06,160
but we didn't know how deep or how it

199
00:08:11,029 --> 00:08:08,240
really worked uh the same thing for the

200
00:08:13,430 --> 00:08:11,039
zones and belts and we had no idea what

201
00:08:15,430 --> 00:08:13,440
the polls look like

202
00:08:19,670 --> 00:08:15,440
next image please

203
00:08:21,749 --> 00:08:19,680
and so juno came along arrived in 2016

204
00:08:23,589 --> 00:08:21,759
and we got our first glimpse of the

205
00:08:25,589 --> 00:08:23,599
polls of jupiter and here you see an

206
00:08:27,189 --> 00:08:25,599
image one of the early ones that we took

207
00:08:29,029 --> 00:08:27,199
this is actually a composite of two

208
00:08:31,430 --> 00:08:29,039
images because when you look at the pole

209
00:08:33,190 --> 00:08:31,440
it's only half lit so we cemented

210
00:08:34,230 --> 00:08:33,200
together two images so you could see the

211
00:08:36,389 --> 00:08:34,240
whole thing

212
00:08:38,149 --> 00:08:36,399
and full lit and you see that it's the

213
00:08:40,949 --> 00:08:38,159

zones and belts are gone it's covered

214
00:08:43,190 --> 00:08:40,959
with these giant polar cyclones that was

215
00:08:45,269 --> 00:08:43,200
a big surprise to us

216
00:08:47,990 --> 00:08:45,279
later on in the mission we we used our

217
00:08:49,030 --> 00:08:48,000
gravity uh techniques to actually

218
00:08:50,150 --> 00:08:49,040
uncover

219
00:08:52,230 --> 00:08:50,160
that

220
00:08:54,389 --> 00:08:52,240
the zones and belt structure went all

221
00:08:57,350 --> 00:08:54,399
the way down it was detectable thousands

222
00:08:59,590 --> 00:08:57,360
of miles below the cloud tops and so

223
00:09:01,590 --> 00:08:59,600
gravity represents one of the main

224
00:09:04,790 --> 00:09:01,600
techniques that we open up the planet

225
00:09:07,350 --> 00:09:04,800
and look inside and we can we're really

226
00:09:09,430 --> 00:09:07,360
looking at the distribution of mass

227
00:09:11,750 --> 00:09:09,440
in jupiter and you can see it all the

228
00:09:13,190 --> 00:09:11,760
way down to the middle another technique

229
00:09:15,030 --> 00:09:13,200
is through our measurement of the

230
00:09:17,110 --> 00:09:15,040
magnetic field because part way down

231
00:09:19,350 --> 00:09:17,120
into jupiter

232
00:09:20,829 --> 00:09:19,360
the hydrogen that's in jupiter actually

233
00:09:23,350 --> 00:09:20,839
starts to behave like a fluid and

234
00:09:25,590 --> 00:09:23,360
metallic and we can learn things about

235
00:09:26,790 --> 00:09:25,600
the magnetic field structure about how

236
00:09:29,110 --> 00:09:26,800
jupiter

237
00:09:31,670 --> 00:09:29,120
is structured underneath that surface

238
00:09:33,110 --> 00:09:31,680

layer or the top cloud layer

239
00:09:35,269 --> 00:09:33,120
and then finally the microwave

240
00:09:37,269 --> 00:09:35,279
instrument which is really an instrument

241
00:09:38,949 --> 00:09:37,279
that's central to to this discussion

242
00:09:40,790 --> 00:09:38,959
we'll talk also about the gravity field

243
00:09:43,350 --> 00:09:40,800
but the microwave instrument was

244
00:09:45,269 --> 00:09:43,360
invented literally uh for

245
00:09:47,829 --> 00:09:45,279
this mission and what it does is it

246
00:09:50,310 --> 00:09:47,839
opens it up and shows jupiter in 3d it

247
00:09:52,070 --> 00:09:50,320
opens up and removes the veil of clouds

248
00:09:53,829 --> 00:09:52,080
and lets us peer into

249
00:09:57,430 --> 00:09:53,839
the secrets that jupiter is holding

250
00:09:59,190 --> 00:09:57,440
underneath inside of its atmosphere

251
00:10:01,430 --> 00:09:59,200
next slide please

252
00:10:06,470 --> 00:10:01,440
and so today what you're going to hear

253
00:10:08,949 --> 00:10:06,480
about is uh a number of topics marzia is

254
00:10:10,310 --> 00:10:08,959
going to talk about the great red spot

255
00:10:12,310 --> 00:10:10,320
and i'll talk a little bit about how

256
00:10:13,910 --> 00:10:12,320
that's not the only vortex that has deep

257
00:10:16,470 --> 00:10:13,920
roots i'll talk about the microwave

258
00:10:18,310 --> 00:10:16,480
results from this uh from the great red

259
00:10:20,310 --> 00:10:18,320
spot and she'll talk about the gravity

260
00:10:22,389 --> 00:10:20,320
field measurements and they complement

261
00:10:24,470 --> 00:10:22,399
each other in a very nice way

262
00:10:26,150 --> 00:10:24,480
karen will then talk about a atmospheric

263
00:10:27,590 --> 00:10:26,160

circulation cells and how they're

264
00:10:29,430 --> 00:10:27,600
similar to earth

265
00:10:32,150 --> 00:10:29,440
but on a much larger scale because

266
00:10:33,509 --> 00:10:32,160
jupiter is a monster planet 10 times the

267
00:10:36,550 --> 00:10:33,519
size of

268
00:10:37,590 --> 00:10:36,560
of earth a thousand earths fit inside

269
00:10:39,509 --> 00:10:37,600
jupiter

270
00:10:41,990 --> 00:10:39,519
lee will then talk about the zones and

271
00:10:44,150 --> 00:10:42,000
belts and how they evolve with depth and

272
00:10:45,910 --> 00:10:44,160
alessandro will

273
00:10:47,269 --> 00:10:45,920
talk about the polar cyclones the

274
00:10:49,590 --> 00:10:47,279
stability something that we've been

275
00:10:51,509 --> 00:10:49,600
monitoring since their discovery and how

276
00:10:53,590 --> 00:10:51,519
they kind of evolve and some theories of

277
00:10:55,430 --> 00:10:53,600
how they get developed and form in the

278
00:10:56,790 --> 00:10:55,440
first place and then we'll end the press

279
00:10:58,949 --> 00:10:56,800
conference with some of the latest

280
00:11:00,630 --> 00:10:58,959
images we've had this one is an older

281
00:11:03,030 --> 00:11:00,640
image but it gives you a very good

282
00:11:05,350 --> 00:11:03,040
example of the different perspective you

283
00:11:06,550 --> 00:11:05,360
get from a polar orbiting spacecraft

284
00:11:08,150 --> 00:11:06,560
because

285
00:11:09,829 --> 00:11:08,160
the great red spot is not where you

286
00:11:11,590 --> 00:11:09,839
usually see it in this image and that's

287
00:11:14,870 --> 00:11:11,600
because we're up close and personal

288
00:11:17,590 --> 00:11:14,880

looking from a new view

289
00:11:19,829 --> 00:11:17,600
okay so next slide please so let's start

290
00:11:23,430 --> 00:11:19,839
with the microwave instrument and and

291
00:11:25,910 --> 00:11:23,440
what we're learning about jupiter's uh

292
00:11:28,630 --> 00:11:25,920
great atmosphere and the vortices that

293
00:11:32,150 --> 00:11:28,640
exist inside of jupiter so you see on

294
00:11:34,310 --> 00:11:32,160
the left here uh or a big image of

295
00:11:36,230 --> 00:11:34,320
jupiter and you see this big brown with

296
00:11:38,389 --> 00:11:36,240
the white arrows going around it that is

297
00:11:40,630 --> 00:11:38,399
actually a barge-like

298
00:11:42,150 --> 00:11:40,640
vortex storm even though it's not round

299
00:11:44,630 --> 00:11:42,160
like you normally think of it's kind of

300
00:11:45,829 --> 00:11:44,640
stretched out but it's the the winds are

301
00:11:47,910 --> 00:11:45,839
circulating around in the

302
00:11:51,030 --> 00:11:47,920
counterclockwise direction

303
00:11:52,389 --> 00:11:51,040
and on the right hand side you see how

304
00:11:54,069 --> 00:11:52,399
the microwave

305
00:11:55,990 --> 00:11:54,079
sees this so we're almost using

306
00:11:58,710 --> 00:11:56,000
microwave vision that allows us to look

307
00:12:00,629 --> 00:11:58,720
down deep and at the top layer of that

308
00:12:03,829 --> 00:12:00,639
on the right hand side you see a visible

309
00:12:05,990 --> 00:12:03,839
light image and you see a rough scale

310
00:12:08,230 --> 00:12:06,000
six thousand miles across and the next

311
00:12:11,190 --> 00:12:08,240
layer goes down about six miles it's

312
00:12:13,030 --> 00:12:11,200
actually six miles above the cloud tops

313
00:12:15,030 --> 00:12:13,040

the next layer goes about six miles

314
00:12:17,030 --> 00:12:15,040
below the cloud tops and then we just

315
00:12:18,870 --> 00:12:17,040
get progressively deeper and deeper

316
00:12:19,829 --> 00:12:18,880
we're peeling the layers off like an

317
00:12:22,230 --> 00:12:19,839
onion

318
00:12:24,470 --> 00:12:22,240
looking deep into jupiter

319
00:12:26,470 --> 00:12:24,480
what is interesting to us uh

320
00:12:28,310 --> 00:12:26,480
scientifically was that at the top we

321
00:12:31,269 --> 00:12:28,320
saw this and it looks like a kind of a

322
00:12:33,590 --> 00:12:31,279
bright whitish hue and then um and then

323
00:12:35,190 --> 00:12:33,600
it's by the time it gets to the bottom

324
00:12:37,030 --> 00:12:35,200
it's actually brownish and this is

325
00:12:38,790 --> 00:12:37,040
compared to the to the background

326
00:12:40,870 --> 00:12:38,800
atmosphere so this is showing the

327
00:12:43,350 --> 00:12:40,880
different layers but at the top because

328
00:12:45,590 --> 00:12:43,360
it's whiter it's it's actually warmer

329
00:12:48,150 --> 00:12:45,600
than its surroundings at the bottom when

330
00:12:50,150 --> 00:12:48,160
it's browner it's colder so there's an

331
00:12:52,389 --> 00:12:50,160
inversion something flips in the middle

332
00:12:55,509 --> 00:12:52,399
of this storm and it flips somewhere

333
00:12:58,310 --> 00:12:55,519
near about 50 miles down so

334
00:13:00,310 --> 00:12:58,320
this 50 miles down is about 10 or 15

335
00:13:02,150 --> 00:13:00,320
miles maybe below where we think water

336
00:13:04,550 --> 00:13:02,160
clouds are forming this is the water

337
00:13:06,870 --> 00:13:04,560
condensation level where

338
00:13:09,190 --> 00:13:06,880

water vapor turns into liquid and you

339
00:13:10,870 --> 00:13:09,200
form clouds it's also about where the

340
00:13:13,030 --> 00:13:10,880
sunlight could reach to it can't get

341
00:13:15,670 --> 00:13:13,040
much beyond that and so what we're

342
00:13:16,790 --> 00:13:15,680
seeing is that this storm's roots go

343
00:13:17,829 --> 00:13:16,800
down

344
00:13:21,670 --> 00:13:17,839
past

345
00:13:23,190 --> 00:13:21,680
penetrates that's very different than

346
00:13:25,750 --> 00:13:23,200
the way we think earth's atmosphere

347
00:13:29,110 --> 00:13:25,760
works which is largely driven by

348
00:13:31,350 --> 00:13:29,120
water clouds condensation and sunlight

349
00:13:33,590 --> 00:13:31,360
it also is indication that the ammonia

350
00:13:35,910 --> 00:13:33,600
and water are being moved up and down

351
00:13:38,470 --> 00:13:35,920
and so this cyclone was was really one

352
00:13:39,910 --> 00:13:38,480
of our uh first views we turned the

353
00:13:41,430 --> 00:13:39,920
spacecraft a certain way so we could get

354
00:13:43,269 --> 00:13:41,440
a map of this thing that you see on the

355
00:13:45,670 --> 00:13:43,279
right hand side and you can see that it

356
00:13:48,230 --> 00:13:45,680
goes really deep about 100 miles maybe

357
00:13:49,829 --> 00:13:48,240
200 miles deep and in fact it's visible

358
00:13:52,069 --> 00:13:49,839
in our deepest channel so it could even

359
00:13:53,110 --> 00:13:52,079
go deeper than that

360
00:13:56,069 --> 00:13:53,120
the next

361
00:13:57,829 --> 00:13:56,079
um slide shows another example of a

362
00:14:00,150 --> 00:13:57,839
cyclone this one's a little bit more

363
00:14:02,470 --> 00:14:00,160

round like you might expect when you

364
00:14:04,470 --> 00:14:02,480
compare them to you know storms on the

365
00:14:05,750 --> 00:14:04,480
earth and here you see that it's that

366
00:14:08,310 --> 00:14:05,760
the winds are moving around in a

367
00:14:10,389 --> 00:14:08,320
clockwise direction um so this is an

368
00:14:12,230 --> 00:14:10,399
anti-cyclone it's kind of spinning

369
00:14:14,150 --> 00:14:12,240
around in the opposite direction that

370
00:14:16,389 --> 00:14:14,160
the previous one was

371
00:14:18,870 --> 00:14:16,399
and again if you look to the right you

372
00:14:21,189 --> 00:14:18,880
can see how this evolves with as we

373
00:14:24,150 --> 00:14:21,199
slice through the atmosphere uh with our

374
00:14:26,230 --> 00:14:24,160
microwave eyes at the top it's more

375
00:14:28,550 --> 00:14:26,240
brown than it is to the surrounding so

376
00:14:31,350 --> 00:14:28,560
it's colder and then part way down it

377
00:14:33,110 --> 00:14:31,360
starts to disappear at about 50 miles

378
00:14:34,870 --> 00:14:33,120
but it there's a hint of it that might

379
00:14:37,350 --> 00:14:34,880
be a little bit brighter

380
00:14:38,949 --> 00:14:37,360
and so we think that it goes down 50 60

381
00:14:41,350 --> 00:14:38,959
miles or so

382
00:14:43,829 --> 00:14:41,360
and it's colder at the top and warmer at

383
00:14:45,990 --> 00:14:43,839
the bottom so it's sort of the opposite

384
00:14:47,990 --> 00:14:46,000
of the previous one one is a cyclone one

385
00:14:50,389 --> 00:14:48,000
is an anticyclone they're just different

386
00:14:53,670 --> 00:14:50,399
directions that they're spinning and the

387
00:14:55,110 --> 00:14:53,680
inversion is is opposite um the next

388
00:14:56,550 --> 00:14:55,120

uh

389
00:14:58,629 --> 00:14:56,560
image

390
00:15:01,269 --> 00:14:58,639
is actually the great red spot so this

391
00:15:02,389 --> 00:15:01,279
is of course jupiter's most famous

392
00:15:04,870 --> 00:15:02,399
um

393
00:15:06,949 --> 00:15:04,880
vortex it's gigantic

394
00:15:09,110 --> 00:15:06,959
this thing's the size of the earth it's

395
00:15:11,750 --> 00:15:09,120
been around for centuries we've the

396
00:15:13,670 --> 00:15:11,760
early telescopes images and even hand

397
00:15:15,990 --> 00:15:13,680
drawings show that jupiter had some

398
00:15:18,389 --> 00:15:16,000
giant storm in it so we believe this

399
00:15:21,350 --> 00:15:18,399
thing is really old how it lasts that

400
00:15:22,949 --> 00:15:21,360
long is a is a mystery um and in fact

401
00:15:26,310 --> 00:15:22,959
some people thought well maybe it has

402
00:15:28,310 --> 00:15:26,320
deep roots it's spinning around anti uh

403
00:15:31,030 --> 00:15:28,320
in the anti conquer counterclockwise

404
00:15:33,030 --> 00:15:31,040
direction um but it is an anti-cyclone

405
00:15:34,710 --> 00:15:33,040
this is in the southern hemisphere if

406
00:15:36,790 --> 00:15:34,720
you go to the picture on the right hand

407
00:15:38,710 --> 00:15:36,800
side or the the graphic part on the

408
00:15:40,870 --> 00:15:38,720
right-hand side you see the top layer is

409
00:15:42,710 --> 00:15:40,880
again the visible light now this thing

410
00:15:44,470 --> 00:15:42,720
is about the size of the earth and as

411
00:15:46,710 --> 00:15:44,480
you punch down

412
00:15:49,670 --> 00:15:46,720
into the different layers you see that

413
00:15:52,470 --> 00:15:49,680

it's it's colder right it's it's colder

414
00:15:54,790 --> 00:15:52,480
at the top and warmer at the bottom

415
00:15:56,150 --> 00:15:54,800
so it's consistent with the anticyclone

416
00:15:57,110 --> 00:15:56,160
idea

417
00:16:00,389 --> 00:15:57,120
and it's

418
00:16:02,150 --> 00:16:00,399
it's visible at the bottom channel very

419
00:16:04,870 --> 00:16:02,160
warm but almost the exact same

420
00:16:07,189 --> 00:16:04,880
dimensions as what it is at the very top

421
00:16:09,430 --> 00:16:07,199
so somehow this root is going all the

422
00:16:11,749 --> 00:16:09,440
way down a couple of hundred miles

423
00:16:13,430 --> 00:16:11,759
there's no doubt that the water which

424
00:16:15,269 --> 00:16:13,440
plays a big role on the earth and the

425
00:16:17,910 --> 00:16:15,279
sunlight are important at jupiter as

426
00:16:21,030 --> 00:16:17,920
well but some of the other processes is

427
00:16:23,910 --> 00:16:21,040
linked to this and showing us that these

428
00:16:25,910 --> 00:16:23,920
roots go down deeper than and pass right

429
00:16:28,949 --> 00:16:25,920
through the water cloud like it doesn't

430
00:16:30,870 --> 00:16:28,959
even matter and um and so how that works

431
00:16:33,509 --> 00:16:30,880
is going to require new models and new

432
00:16:35,269 --> 00:16:33,519
ideas to explain

433
00:16:38,069 --> 00:16:35,279
and and so

434
00:16:38,790 --> 00:16:38,079
we couldn't see the very bottom of this

435
00:16:42,230 --> 00:16:38,800
and

436
00:16:44,230 --> 00:16:42,240
able to

437
00:16:46,710 --> 00:16:44,240
investigate that for us

438
00:16:49,189 --> 00:16:46,720

because she's using the gravity field to

439
00:16:51,749 --> 00:16:49,199
kind of put a complementary constraint

440
00:16:53,910 --> 00:16:51,759
on this great red spot even though it

441
00:16:56,150 --> 00:16:53,920
goes down a couple hundred miles or even

442
00:16:59,110 --> 00:16:56,160
a few hundred kilometers it's still a

443
00:17:01,910 --> 00:16:59,120
really tall storm um

444
00:17:05,189 --> 00:17:01,920
it's it's a pancake because it's so wide

445
00:17:07,029 --> 00:17:05,199
at the top but it's the depth of it is

446
00:17:08,870 --> 00:17:07,039
that pancake is much thicker than what

447
00:17:13,669 --> 00:17:08,880
we would have anticipated

448
00:17:18,309 --> 00:17:16,549
thank you scott uh hello everybody uh

449
00:17:19,990 --> 00:17:18,319
thank you so much for joining i'm very

450
00:17:22,309 --> 00:17:20,000
excited to be here

451
00:17:24,710 --> 00:17:22,319
so as promised uh we now continue to

452
00:17:27,429 --> 00:17:24,720
talk about the great red spot

453
00:17:31,350 --> 00:17:27,439
as we have very exciting new results uh

454
00:17:35,909 --> 00:17:33,909
so the hascot said the the red spot is

455
00:17:38,230 --> 00:17:35,919
the largest storm in the solar system

456
00:17:41,110 --> 00:17:38,240
and it has been continuously observed

457
00:17:43,270 --> 00:17:41,120
for at least 200 years and perhaps even

458
00:17:45,110 --> 00:17:43,280
since the 17th century

459
00:17:47,270 --> 00:17:45,120
uh just a heads up here i'm going to

460
00:17:49,270 --> 00:17:47,280
refer to the red spot as a vortex or

461
00:17:51,590 --> 00:17:49,280
cyclone or storm interchangeably but

462
00:17:53,830 --> 00:17:51,600
they all mean the same thing

463
00:17:56,390 --> 00:17:53,840

so the vortex is storming in the

464
00:17:59,750 --> 00:17:56,400
southern hemisphere of jupiter about 20

465
00:18:02,230 --> 00:17:59,760
degrees below the the equator and it is

466
00:18:05,350 --> 00:18:02,240
uh wide enough to swallow the earth so

467
00:18:06,230 --> 00:18:05,360
this is a huge uh feature

468
00:18:08,070 --> 00:18:06,240
um

469
00:18:09,270 --> 00:18:08,080
despite the wealth of information that

470
00:18:11,510 --> 00:18:09,280
we have

471
00:18:13,590 --> 00:18:11,520
about the winds that are surrounding the

472
00:18:15,430 --> 00:18:13,600
great red spot and the dynamics around

473
00:18:17,909 --> 00:18:15,440
in the great red spot we know very

474
00:18:19,990 --> 00:18:17,919
little about its depth

475
00:18:23,190 --> 00:18:20,000
so this issue has fascinated scientists

476
00:18:25,590 --> 00:18:23,200
for decades because some of them they

477
00:18:28,549 --> 00:18:25,600
thought that the great response must be

478
00:18:30,549 --> 00:18:28,559
skin deep so very shallow features other

479
00:18:31,510 --> 00:18:30,559
thought that because of its longevity

480
00:18:33,590 --> 00:18:31,520
then

481
00:18:34,549 --> 00:18:33,600
its roots must go much deeper than we

482
00:18:37,510 --> 00:18:34,559
see

483
00:18:39,990 --> 00:18:37,520
and uh juno the juno mission previously

484
00:18:42,150 --> 00:18:40,000
uh discovered that the jet streams in

485
00:18:45,669 --> 00:18:42,160
which the great red spot is embedded

486
00:18:47,110 --> 00:18:45,679
they are as deep as 3 000 kilometer or 2

487
00:18:49,190 --> 00:18:47,120
000 miles

488
00:18:50,549 --> 00:18:49,200

um but how deep is the great red spot

489
00:18:52,470 --> 00:18:50,559
itself

490
00:18:54,070 --> 00:18:52,480
so if you can please go to the next

491
00:18:57,190 --> 00:18:54,080
slide

492
00:18:59,830 --> 00:18:57,200
so juno had the opportunity uh to answer

493
00:19:02,789 --> 00:18:59,840
this question when it flew twice

494
00:19:05,350 --> 00:19:02,799
over the vortex at very close range

495
00:19:07,669 --> 00:19:05,360
and it did so flying very fast keep in

496
00:19:10,470 --> 00:19:07,679
mind that the speed of the spacecraft is

497
00:19:13,669 --> 00:19:10,480
tens of miles per second

498
00:19:16,070 --> 00:19:13,679
then ideally if jupiter was perfectly

499
00:19:18,150 --> 00:19:16,080
spherical then the trajectory of the

500
00:19:20,070 --> 00:19:18,160
journal spacecraft would be virtually

501
00:19:22,470 --> 00:19:20,080
unperturbed

502
00:19:24,789 --> 00:19:22,480
and this amperature trajectory is here

503
00:19:27,029 --> 00:19:24,799
shown by the blue line however because

504
00:19:29,510 --> 00:19:27,039
of existing asymmetries and mass

505
00:19:31,350 --> 00:19:29,520
anomalies such as the ones that the the

506
00:19:34,390 --> 00:19:31,360
vortex is generating

507
00:19:36,710 --> 00:19:34,400
uh then the local gravity tends to

508
00:19:38,950 --> 00:19:36,720
pull and push away the spacecraft as it

509
00:19:41,190 --> 00:19:38,960
flies over the vortex

510
00:19:43,029 --> 00:19:41,200
and this creates a sort of like bumps in

511
00:19:45,830 --> 00:19:43,039
the road for juno

512
00:19:48,070 --> 00:19:45,840
and these perturbations are

513
00:19:51,430 --> 00:19:48,080

generate a doppler shift on the radio

514
00:19:53,510 --> 00:19:51,440
signals that we relay back to earth so

515
00:19:54,310 --> 00:19:53,520
in the next clip we're going to listen

516
00:19:56,789 --> 00:19:54,320
to

517
00:19:59,909 --> 00:19:56,799
the doppler shift on the radio signals

518
00:20:00,970 --> 00:19:59,919
after it's been converted to sound so

519
00:20:06,760 --> 00:20:00,980
please

520
00:20:06,770 --> 00:20:13,909
[Music]

521
00:20:18,630 --> 00:20:16,070
so you've heard the frequency going up

522
00:20:21,029 --> 00:20:18,640
and down and this keep in mind these

523
00:20:24,070 --> 00:20:21,039
fluctuations are very small uh we're

524
00:20:27,190 --> 00:20:24,080
talking uh micrometers per second or

525
00:20:29,590 --> 00:20:27,200
uh if you wish we did these are 1000

526
00:20:32,390 --> 00:20:29,600
times uh smaller than the average pace

527
00:20:34,630 --> 00:20:32,400
of a snail so these are very incredible

528
00:20:36,950 --> 00:20:34,640
outstanding accuracies and they are in

529
00:20:38,470 --> 00:20:36,960
part due to our instrumentation in fact

530
00:20:40,470 --> 00:20:38,480
juno is the first

531
00:20:43,909 --> 00:20:40,480
interplanetary mission that you that is

532
00:20:47,110 --> 00:20:43,919
using uh xnka band radio signals to way

533
00:20:49,990 --> 00:20:47,120
for a planetary geodesy

534
00:20:52,390 --> 00:20:50,000
and then we um the perturbations that

535
00:20:55,430 --> 00:20:52,400
you just listened to we matched them to

536
00:20:57,669 --> 00:20:55,440
our model of the great spot and we found

537
00:20:59,510 --> 00:20:57,679
that the best match was for a model uh

538
00:21:01,669 --> 00:20:59,520

where the great red spot is a few

539
00:21:05,029 --> 00:21:01,679
hundred miles deep

540
00:21:09,669 --> 00:21:06,950
so our data indicate that the great red

541
00:21:12,070 --> 00:21:09,679
spot is contained within the first 300

542
00:21:14,549 --> 00:21:12,080
miles or 500 kilometers of jupiter's

543
00:21:16,470 --> 00:21:14,559
atmosphere and this is much deeper than

544
00:21:19,110 --> 00:21:16,480
the visible cloud level

545
00:21:21,190 --> 00:21:19,120
and also of the water condensation level

546
00:21:22,470 --> 00:21:21,200
so in other words uh the great red spot

547
00:21:25,190 --> 00:21:22,480
is as deep

548
00:21:27,909 --> 00:21:25,200
within jupiter as the international

549
00:21:29,430 --> 00:21:27,919
space station is high above our heads so

550
00:21:31,669 --> 00:21:29,440
if we were standing in the eye of the

551
00:21:33,909 --> 00:21:31,679
cyclone we would be immersed in it from

552
00:21:35,590 --> 00:21:33,919
the sea level to beyond the orbit of the

553
00:21:38,070 --> 00:21:35,600
iss

554
00:21:40,710 --> 00:21:38,080
so the the greater spot goes pretty deep

555
00:21:43,029 --> 00:21:40,720
but it is still less deep than the jet

556
00:21:45,669 --> 00:21:43,039
streams that that's around so they go

557
00:21:47,590 --> 00:21:45,679
much deeper down to 2 000 miles and uh

558
00:21:50,310 --> 00:21:47,600
we're going to hear more about the jet

559
00:21:54,789 --> 00:21:50,320
streams from the next speaker karen so

560
00:21:59,190 --> 00:21:56,549
ah thank you martial it's very

561
00:22:01,909 --> 00:21:59,200
interesting stuff so shalom everyone

562
00:22:03,830 --> 00:22:01,919
from tel aviv israel and

563
00:22:07,350 --> 00:22:03,840

let's start we can go to the next slide

564
00:22:10,870 --> 00:22:08,950
so the beautiful banded structure of

565
00:22:12,950 --> 00:22:10,880
jupiter's clouds are embedded in the

566
00:22:16,230 --> 00:22:12,960
east-west jet streams that are now going

567
00:22:18,390 --> 00:22:16,240
to be animated with the black arrows

568
00:22:20,070 --> 00:22:18,400
and three years ago using the general

569
00:22:22,070 --> 00:22:20,080
gravity measurements it was discovered

570
00:22:25,270 --> 00:22:22,080
that the jet streams extend 3 000

571
00:22:27,190 --> 00:22:25,280
kilometers deep or 2 000 miles

572
00:22:29,110 --> 00:22:27,200
however these are just the winds in the

573
00:22:31,590 --> 00:22:29,120
east-west direction

574
00:22:32,630 --> 00:22:31,600
and now using the latest juno microwave

575
00:22:34,070 --> 00:22:32,640
data

576
00:22:36,149 --> 00:22:34,080
we were able to detect the

577
00:22:37,909 --> 00:22:36,159
three-dimensional circulation meaning

578
00:22:40,390 --> 00:22:37,919
the up and down and north and south

579
00:22:42,390 --> 00:22:40,400
movement as well around surrounding

580
00:22:44,230 --> 00:22:42,400
these just streams

581
00:22:46,070 --> 00:22:44,240
now to detect these movements we used

582
00:22:48,870 --> 00:22:46,080
measurements of ammonia gas from the

583
00:22:50,310 --> 00:22:48,880
cloud level to about 200 miles

584
00:22:52,390 --> 00:22:50,320
which revealed that ammonia is being

585
00:22:54,789 --> 00:22:52,400
carried up and down by vertical

586
00:22:57,190 --> 00:22:54,799
velocities which are remarkably aligned

587
00:22:58,950 --> 00:22:57,200
with the jet streams at the cloud level

588
00:23:01,350 --> 00:22:58,960

now the relation between the two is the

589
00:23:03,669 --> 00:23:01,360
atmospheric circulation cells which are

590
00:23:05,110 --> 00:23:03,679
no strangers to us as we have them here

591
00:23:10,070 --> 00:23:05,120
on earth as well

592
00:23:14,149 --> 00:23:12,149
now the atmosphere of earth illustrated

593
00:23:16,470 --> 00:23:14,159
here on the left occupies three

594
00:23:18,310 --> 00:23:16,480
circulation cells in each hemisphere

595
00:23:19,990 --> 00:23:18,320
which influence the cloud distribution

596
00:23:22,230 --> 00:23:20,000
and the climate system

597
00:23:24,950 --> 00:23:22,240
on earth these cells extend from the

598
00:23:26,950 --> 00:23:24,960
surface to about six miles height

599
00:23:29,510 --> 00:23:26,960
and with the new juno data we were able

600
00:23:32,230 --> 00:23:29,520
to detect identify and we were able to

601
00:23:34,470 --> 00:23:32,240
identify similar cells in jupiter except

602
00:23:37,909 --> 00:23:34,480
that the jovian cells begin at the cloud

603
00:23:40,390 --> 00:23:37,919
level and extend to at least 200 miles

604
00:23:42,549 --> 00:23:40,400
and probably much deeper than that

605
00:23:44,549 --> 00:23:42,559
this means that the cells on jupiter are

606
00:23:46,549 --> 00:23:44,559
at least 30 times deeper than the

607
00:23:48,789 --> 00:23:46,559
equivalent cells on earth

608
00:23:51,110 --> 00:23:48,799
the jovian cells

609
00:23:53,110 --> 00:23:51,120
resemble in their governing physics the

610
00:23:55,669 --> 00:23:53,120
middle cell on each hemisphere of earth

611
00:23:57,510 --> 00:23:55,679
called the feral cell

612
00:23:59,669 --> 00:23:57,520
the white arrows represent the jet

613
00:24:01,350 --> 00:23:59,679

stream in the middle of the cell

614
00:24:04,070 --> 00:24:01,360
now different than earth which contain

615
00:24:06,710 --> 00:24:04,080
only one feral cell in each hemisphere

616
00:24:09,029 --> 00:24:06,720
jupiter being much larger 11 times

617
00:24:11,350 --> 00:24:09,039
bigger than earth's and rotates faster

618
00:24:14,149 --> 00:24:11,360
it stays 20 it is 10 hours compared to

619
00:24:16,149 --> 00:24:14,159
earth which is 24 contains eight feral

620
00:24:17,990 --> 00:24:16,159
cell in each hemisphere

621
00:24:20,470 --> 00:24:18,000
the cells in jupiter don't end at the

622
00:24:22,950 --> 00:24:20,480
surface as jupiter has no surface it is

623
00:24:24,789 --> 00:24:22,960
a gaseous giant and yet they are

624
00:24:26,470 --> 00:24:24,799
remarkably similar to the cells we have

625
00:24:31,350 --> 00:24:26,480
here on earth

626
00:24:35,430 --> 00:24:33,669
if we were to approach jupiter and look

627
00:24:38,230 --> 00:24:35,440
below the clouds we would see these

628
00:24:39,590 --> 00:24:38,240
circulation cells illustrated in blue

629
00:24:41,510 --> 00:24:39,600
which stretch around the planet

630
00:24:43,510 --> 00:24:41,520
uniformly

631
00:24:45,830 --> 00:24:43,520
now we are zooming towards the

632
00:24:46,870 --> 00:24:45,840
alternating jet streams and accompanied

633
00:24:48,950 --> 00:24:46,880
cells

634
00:24:51,669 --> 00:24:48,960
each one of the jet streams which is

635
00:24:54,230 --> 00:24:51,679
visible at cloud level extends very deep

636
00:24:56,149 --> 00:24:54,240
and is surrounded by a circulation cell

637
00:24:57,669 --> 00:24:56,159
which rotates according to the direction

638
00:24:58,950 --> 00:24:57,679

of the cell

639
00:25:01,269 --> 00:24:58,960
of the jet

640
00:25:03,830 --> 00:25:01,279
in the orientation show now looking from

641
00:25:05,990 --> 00:25:03,840
east in the northern hemisphere a jet

642
00:25:08,630 --> 00:25:06,000
blowing from west to east is accompanied

643
00:25:10,630 --> 00:25:08,640
by a cell that rotates anti-clockwise

644
00:25:12,310 --> 00:25:10,640
and the jet blown from east to west is

645
00:25:15,110 --> 00:25:12,320
accompanied by a cell that rotates in

646
00:25:17,269 --> 00:25:15,120
the clockwise direction the discovery of

647
00:25:19,590 --> 00:25:17,279
these cells shed light on the unseen

648
00:25:22,070 --> 00:25:19,600
winds below the clouds of jupiter

649
00:25:24,230 --> 00:25:22,080
and speaking on clouds the next speaker

650
00:25:25,110 --> 00:25:24,240
lee will now discuss how the belt and

651
00:25:27,510 --> 00:25:25,120
zone

652
00:25:32,070 --> 00:25:27,520
visible at the cloud level change their

653
00:25:36,870 --> 00:25:33,669
okay thank you so much kevin and

654
00:25:38,390 --> 00:25:36,880
greetings from here in the uk so decades

655
00:25:40,870 --> 00:25:38,400
of observations of jupiter have been

656
00:25:42,870 --> 00:25:40,880
used to explore the famous belts and

657
00:25:45,510 --> 00:25:42,880
zones at the cloud tops as we've just

658
00:25:47,510 --> 00:25:45,520
been hearing and their organization by

659
00:25:49,669 --> 00:25:47,520
the powerful jet streams that kevin was

660
00:25:51,750 --> 00:25:49,679
just mentioning so if we could go to the

661
00:25:54,070 --> 00:25:51,760
first slide please

662
00:25:56,390 --> 00:25:54,080
now a good example of this is the

663
00:25:58,630 --> 00:25:56,400

comparison between visible light and

664
00:26:00,470 --> 00:25:58,640
infrared light so the visible image on

665
00:26:02,630 --> 00:26:00,480
the right hand side here from the hubble

666
00:26:05,029 --> 00:26:02,640
space telescope shows reflection from

667
00:26:07,190 --> 00:26:05,039
those colorful clouds revealing what you

668
00:26:08,630 --> 00:26:07,200
might see if you could look at jupiter

669
00:26:11,269 --> 00:26:08,640
with your own eyes

670
00:26:13,269 --> 00:26:11,279
the image on the left is in the infrared

671
00:26:15,669 --> 00:26:13,279
showing the clouds as dark silhouettes

672
00:26:17,750 --> 00:26:15,679
against the bright internal glow of

673
00:26:20,870 --> 00:26:17,760
jupiter and you can see that the cloudy

674
00:26:23,669 --> 00:26:20,880
white zones block infrared light whereas

675
00:26:25,750 --> 00:26:23,679
the cloud-free reddish brownish belts

676
00:26:28,310 --> 00:26:25,760
they let it pass straight through

677
00:26:31,029 --> 00:26:28,320
so above the clouds we knew that zones

678
00:26:33,190 --> 00:26:31,039
were cold cloudy and enriched in gases

679
00:26:36,230 --> 00:26:33,200
like ammonia and that the neighboring

680
00:26:38,950 --> 00:26:36,240
belts were warm cloud-free and depleted

681
00:26:41,350 --> 00:26:38,960
in ammonia gas but what was happening

682
00:26:44,310 --> 00:26:41,360
beneath these cloud-forming layers was

683
00:26:46,070 --> 00:26:44,320
still a mystery before juno we suspected

684
00:26:47,909 --> 00:26:46,080
that the bands and the winds that we see

685
00:26:50,789 --> 00:26:47,919
at the cloud tops were just the tip of

686
00:26:52,870 --> 00:26:50,799
the iceberg with deeper and unseen

687
00:26:55,269 --> 00:26:52,880
phenomena at work down below these

688
00:26:57,669 --> 00:26:55,279

clouds and part of juno's mission was to

689
00:26:59,510 --> 00:26:57,679
determine what was happening deep within

690
00:27:01,510 --> 00:26:59,520
jupiter's atmosphere so if we can go to

691
00:27:03,830 --> 00:27:01,520
the next slide please

692
00:27:05,750 --> 00:27:03,840
so to understand how the belts and zones

693
00:27:07,830 --> 00:27:05,760
change with depth we needed to exploit

694
00:27:09,750 --> 00:27:07,840
microwave light these clouds are

695
00:27:11,750 --> 00:27:09,760
completely transparent in the microwave

696
00:27:13,990 --> 00:27:11,760
and that allows us to appear deeper than

697
00:27:16,630 --> 00:27:14,000
ever before when we peered through this

698
00:27:18,710 --> 00:27:16,640
veil we got a surprise now ammonia

699
00:27:20,630 --> 00:27:18,720
depletion in the belts should make them

700
00:27:22,710 --> 00:27:20,640
shine brightly and microwave light and

701
00:27:24,710 --> 00:27:22,720
that's that's certainly what they do in

702
00:27:27,110 --> 00:27:24,720
all the channels that sense shallow

703
00:27:28,630 --> 00:27:27,120
pressures and those are the three slices

704
00:27:29,830 --> 00:27:28,640
that you see on the left of this

705
00:27:31,669 --> 00:27:29,840
animation

706
00:27:34,710 --> 00:27:31,679
but the plot thickens as we start to

707
00:27:37,510 --> 00:27:34,720
move deeper below the expected cloud

708
00:27:39,510 --> 00:27:37,520
layers into the warmer deeper atmosphere

709
00:27:41,510 --> 00:27:39,520
as we do for the three microwave

710
00:27:43,909 --> 00:27:41,520
channels on the right now sunlight

711
00:27:46,310 --> 00:27:43,919
doesn't get down this far so we're truly

712
00:27:48,870 --> 00:27:46,320
probing new depths in we see that the

713
00:27:51,350 --> 00:27:48,880

belts that were shining brightly in the

714
00:27:54,070 --> 00:27:51,360
shallow atmosphere have become microwave

715
00:27:55,909 --> 00:27:54,080
dark whereas the zones become microwave

716
00:27:58,230 --> 00:27:55,919
bright and all this is the complete

717
00:28:00,149 --> 00:27:58,240
opposite of what we saw at the cloud

718
00:28:02,230 --> 00:28:00,159
tops and you can see this for yourself

719
00:28:04,470 --> 00:28:02,240
if you follow one of those blue arrows

720
00:28:06,789 --> 00:28:04,480
from left to right across jupiter the

721
00:28:08,870 --> 00:28:06,799
bright bands become dark the edges of

722
00:28:10,789 --> 00:28:08,880
the bands remain the same as those we

723
00:28:12,710 --> 00:28:10,799
see at the cloud tops revealing that

724
00:28:15,590 --> 00:28:12,720
these belts and zones do go hundreds of

725
00:28:18,070 --> 00:28:15,600
miles deep but their character reverses

726
00:28:20,389 --> 00:28:18,080
as we go deeper so let's go to the next

727
00:28:22,230 --> 00:28:20,399
slide please

728
00:28:24,870 --> 00:28:22,240
so we call this transition layer the

729
00:28:26,549 --> 00:28:24,880
jovic line and it appears to be located

730
00:28:28,950 --> 00:28:26,559
near the layer where the temperatures in

731
00:28:31,830 --> 00:28:28,960
the atmosphere are just right for water

732
00:28:34,870 --> 00:28:31,840
clouds to form about 40 miles or 65

733
00:28:37,269 --> 00:28:34,880
kilometers down below the visible clouds

734
00:28:39,029 --> 00:28:37,279
now a klein is a layer within a fluid

735
00:28:41,510 --> 00:28:39,039
where properties change and sometimes

736
00:28:43,590 --> 00:28:41,520
these serve to separate one domain from

737
00:28:46,470 --> 00:28:43,600
another give you an example the earth's

738
00:28:49,110 --> 00:28:46,480

oceans have a thermocline which divides

739
00:28:51,909 --> 00:28:49,120
mixed surface waters from cold and deep

740
00:28:54,389 --> 00:28:51,919
waters below now for jupiter this isn't

741
00:28:56,710 --> 00:28:54,399
a new idea the legendary science fiction

742
00:28:59,510 --> 00:28:56,720
author arthur c clarke envisaged the

743
00:29:02,149 --> 00:28:59,520
voyage of the contiki balloon down into

744
00:29:04,630 --> 00:29:02,159
jupiter's atmosphere in his 1971 short

745
00:29:07,029 --> 00:29:04,640
story and meeting with medusa he

746
00:29:09,590 --> 00:29:07,039
describes the balloon traveling down

747
00:29:12,389 --> 00:29:09,600
towards a jovian thermocline and its

748
00:29:14,630 --> 00:29:12,399
associated bank of clouds and we're

749
00:29:17,190 --> 00:29:14,640
playfully adopting that term here as

750
00:29:19,830 --> 00:29:17,200
well in our case the jovacline appears

751
00:29:22,310 --> 00:29:19,840
to separate jupiter's shallow weather

752
00:29:25,269 --> 00:29:22,320
layers with microwave bright ammonia

753
00:29:28,070 --> 00:29:25,279
depleted belts from deeper layers of

754
00:29:30,230 --> 00:29:28,080
microwave dark ammonia enriched belts

755
00:29:32,630 --> 00:29:30,240
that are down below the water cloud

756
00:29:34,710 --> 00:29:32,640
layer more simply the jovacline may

757
00:29:36,630 --> 00:29:34,720
separate the cloud-forming weather layer

758
00:29:39,350 --> 00:29:36,640
that we all know and love from the

759
00:29:41,510 --> 00:29:39,360
deeper abyss that lies below now this

760
00:29:44,389 --> 00:29:41,520
unexpected result implies something is

761
00:29:45,990 --> 00:29:44,399
moving all of that ammonia around maybe

762
00:29:48,389 --> 00:29:46,000
it's the circulation cells that were

763
00:29:50,789 --> 00:29:48,399

just described by karen or possibly some

764
00:29:53,430 --> 00:29:50,799
other meteorological phenomenon at work

765
00:29:55,350 --> 00:29:53,440
within this deep atmosphere what's clear

766
00:29:58,149 --> 00:29:55,360
is that the microwave light has really

767
00:29:59,990 --> 00:29:58,159
opened a new window onto jupiter's dark

768
00:30:01,350 --> 00:30:00,000
warm and deep atmosphere and that the

769
00:30:03,029 --> 00:30:01,360
results are really going to be

770
00:30:05,110 --> 00:30:03,039
challenging our understanding of this

771
00:30:07,110 --> 00:30:05,120
giant planet for years to come

772
00:30:09,350 --> 00:30:07,120
now this is the story at the middle

773
00:30:11,430 --> 00:30:09,360
latitudes on jupiter at least and now

774
00:30:13,190 --> 00:30:11,440
i'm going to hand over to alessandro

775
00:30:18,230 --> 00:30:13,200
who's going to describe what's happening

776
00:30:22,950 --> 00:30:20,710
thank you lee ingredients from rome so

777
00:30:24,549 --> 00:30:22,960
as you mentioned we have an infrared

778
00:30:26,549 --> 00:30:24,559
camera on board you know

779
00:30:27,669 --> 00:30:26,559
an infrared camera is a very powerful

780
00:30:29,510 --> 00:30:27,679
instrument

781
00:30:31,909 --> 00:30:29,520
because infrared is the light which is

782
00:30:33,990 --> 00:30:31,919
emitted from a body while visible light

783
00:30:37,350 --> 00:30:34,000
is just reflected so there is much more

784
00:30:38,630 --> 00:30:37,360
information in the infrared radiation

785
00:30:40,070 --> 00:30:38,640
for example they can tell the

786
00:30:41,110 --> 00:30:40,080
temperature of your body just by

787
00:30:43,909 --> 00:30:41,120
pointing

788
00:30:46,070 --> 00:30:43,919

an infrared thermometer to you the other

789
00:30:48,149 --> 00:30:46,080
advantage is that in the infrared just

790
00:30:50,470 --> 00:30:48,159
like in a spy movie you can see your

791
00:30:52,549 --> 00:30:50,480
enemies in the dark if you wear some

792
00:30:54,630 --> 00:30:52,559
kind of infrared imager

793
00:30:56,630 --> 00:30:54,640
and this is very useful on a planetary

794
00:30:58,310 --> 00:30:56,640
mission because in this way you can for

795
00:31:00,389 --> 00:30:58,320
example observe the dark side of a

796
00:31:02,310 --> 00:31:00,399
planet or regions where the illumination

797
00:31:03,590 --> 00:31:02,320
is very poor such as the pulse of

798
00:31:05,110 --> 00:31:03,600
jupiter

799
00:31:06,789 --> 00:31:05,120
because in fact thanks to this camera

800
00:31:08,310 --> 00:31:06,799
which is called jiram

801
00:31:09,830 --> 00:31:08,320
and thanks also to other the other

802
00:31:10,950 --> 00:31:09,840
camera on board juno which is called

803
00:31:12,870 --> 00:31:10,960
junocam

804
00:31:15,590 --> 00:31:12,880
you know discovered a very peculiar i

805
00:31:17,190 --> 00:31:15,600
would say unique structure on jupiter on

806
00:31:18,870 --> 00:31:17,200
the poles of jupiter

807
00:31:20,630 --> 00:31:18,880
symmetric structures

808
00:31:22,389 --> 00:31:20,640
now symmetry is really beautiful in

809
00:31:24,470 --> 00:31:22,399
science because every time you see

810
00:31:26,789 --> 00:31:24,480
something symmetric you think that there

811
00:31:28,950 --> 00:31:26,799
should be something hidden below that is

812
00:31:31,029 --> 00:31:28,960
giving uh the symmetry some kind of

813
00:31:33,909 --> 00:31:31,039

force some kind of a hidden mechanism or

814
00:31:35,509 --> 00:31:33,919
law which you want to discover

815
00:31:38,470 --> 00:31:35,519
and so i would like to get to the first

816
00:31:42,230 --> 00:31:40,310
so right after its arrival five years

817
00:31:44,389 --> 00:31:42,240
ago juno discovered that there are

818
00:31:46,630 --> 00:31:44,399
regular polygons with cyclones at the

819
00:31:47,669 --> 00:31:46,640
corners and those are the poles of

820
00:31:49,509 --> 00:31:47,679
jupiter

821
00:31:52,870 --> 00:31:49,519
at the south which is what you are

822
00:31:54,630 --> 00:31:52,880
seeing now we have a pentagon with five

823
00:31:56,230 --> 00:31:54,640
cyclones at the corners and a six

824
00:31:58,630 --> 00:31:56,240
cyclone in the center

825
00:32:00,789 --> 00:31:58,640
and in the north which is not shown here

826
00:32:02,230 --> 00:32:00,799
we have an octagon with

827
00:32:04,630 --> 00:32:02,240
the center

828
00:32:07,269 --> 00:32:04,640
each one by the way is larger than texas

829
00:32:09,190 --> 00:32:07,279
and the velocity of the order of 200

830
00:32:10,870 --> 00:32:09,200
miles per hour

831
00:32:11,669 --> 00:32:10,880
and we were puzzled because of course we

832
00:32:14,230 --> 00:32:11,679
will

833
00:32:15,990 --> 00:32:14,240
we asked ourselves how is it possible we

834
00:32:18,070 --> 00:32:16,000
will be able to observe them until the

835
00:32:20,389 --> 00:32:18,080
end of the juno mission and the result

836
00:32:22,710 --> 00:32:20,399
i'm presenting right now is that yes

837
00:32:25,990 --> 00:32:22,720
they are exceptionally stable so we are

838
00:32:29,909 --> 00:32:26,000

we're still observed in them so after

839
00:32:32,389 --> 00:32:29,919
october 2021 the pentagon for example is

840
00:32:35,190 --> 00:32:32,399
still there almost upper turbot is just

841
00:32:36,549 --> 00:32:35,200
rotated a little bit 15 degrees

842
00:32:39,029 --> 00:32:36,559
now at the earth

843
00:32:41,029 --> 00:32:39,039
we know that cyclones are very fast and

844
00:32:43,029 --> 00:32:41,039
they have a very short lifetime how is

845
00:32:44,389 --> 00:32:43,039
it possible that at jupiter they are so

846
00:32:45,909 --> 00:32:44,399
different

847
00:32:48,310 --> 00:32:45,919
we think that it is because of the

848
00:32:51,830 --> 00:32:48,320
peculiarity of jupiter and i have the

849
00:32:55,750 --> 00:32:53,830
so just like at the earth

850
00:32:57,830 --> 00:32:55,760
cyclones or arrogance are pushed

851
00:32:59,669 --> 00:32:57,840
bollywood following a force that is

852
00:33:02,630 --> 00:32:59,679
called a better drift and this force is

853
00:33:04,710 --> 00:33:02,640
indicated by the blue arrow this force

854
00:33:07,190 --> 00:33:04,720
is due to the rotation of the planet so

855
00:33:09,430 --> 00:33:07,200
the first cyclone that gets to the pole

856
00:33:11,909 --> 00:33:09,440
it occupies the pole and the next one

857
00:33:13,669 --> 00:33:11,919
the next ones are forced to stay at some

858
00:33:15,830 --> 00:33:13,679
equilibrium distance because the first

859
00:33:18,789 --> 00:33:15,840
cyclone has a rejection force which is

860
00:33:20,470 --> 00:33:18,799
indicated by the green arrows they keep

861
00:33:23,509 --> 00:33:20,480
them at a distance

862
00:33:25,909 --> 00:33:23,519
also they interchange mutual forces so

863
00:33:27,430 --> 00:33:25,919

they want to stay at equal distances and

864
00:33:29,509 --> 00:33:27,440
those forces are indicated by the

865
00:33:32,470 --> 00:33:29,519
magenta arrow

866
00:33:34,870 --> 00:33:32,480
so the this way we explain the stability

867
00:33:38,230 --> 00:33:34,880
and the regularity the symmetry of the

868
00:33:40,549 --> 00:33:38,240
cycles next slide please

869
00:33:43,029 --> 00:33:40,559
so in fact a study has been published

870
00:33:44,870 --> 00:33:43,039
recently to explain such stability and

871
00:33:46,950 --> 00:33:44,880
the number of cycles and the most

872
00:33:49,190 --> 00:33:46,960
important thing to me this study is also

873
00:33:53,509 --> 00:33:49,200
able to explain the reason why we do

874
00:33:57,509 --> 00:33:55,110
because at jupiter we have just the

875
00:33:59,350 --> 00:33:57,519
right side of the planet the right

876
00:34:01,110 --> 00:33:59,360
momentum the right

877
00:34:02,870 --> 00:34:01,120
wind speed to achieve this kind of

878
00:34:04,149 --> 00:34:02,880
stability and that's how we don't have

879
00:34:07,750 --> 00:34:04,159
that

880
00:34:09,589 --> 00:34:07,760
final slide please

881
00:34:10,950 --> 00:34:09,599
there is another last consequence of

882
00:34:13,190 --> 00:34:10,960
this

883
00:34:15,430 --> 00:34:13,200
as diagonals they took each other

884
00:34:18,550 --> 00:34:15,440
because juno observed that if one

885
00:34:20,710 --> 00:34:18,560
cyclone is perturbed from its uh

886
00:34:22,310 --> 00:34:20,720
then this perturbation is transmitted to

887
00:34:24,389 --> 00:34:22,320
the other cycle because of this kind of

888
00:34:26,389 --> 00:34:24,399

relaxed forces you can think there are

889
00:34:29,030 --> 00:34:26,399
springs in between that

890
00:34:31,430 --> 00:34:29,040
helps cycles to communicate each other

891
00:34:34,710 --> 00:34:31,440
and after one year this perturbation has

892
00:34:37,669 --> 00:34:34,720
gone from one side to the other and this

893
00:34:39,510 --> 00:34:37,679
gets back to my initial question and i'm

894
00:34:40,550 --> 00:34:39,520
done with this slide

895
00:34:43,270 --> 00:34:40,560
so

896
00:34:45,510 --> 00:34:43,280
we will will we be able to observe them

897
00:34:48,230 --> 00:34:45,520
until the end of juno mission uh how

898
00:34:50,629 --> 00:34:48,240
long will they stay uh this way of

899
00:34:52,149 --> 00:34:50,639
course we don't know nobody knows but

900
00:34:54,230 --> 00:34:52,159
chances are that

901
00:34:56,550 --> 00:34:54,240
not only juno mission but also the

902
00:34:58,150 --> 00:34:56,560
jewish mission in the next decade will

903
00:35:01,030 --> 00:34:58,160
be able to observe

904
00:35:03,430 --> 00:35:01,040
such features because maybe they are

905
00:35:05,349 --> 00:35:03,440
very stable their lifetime can can last

906
00:35:07,430 --> 00:35:05,359
hundreds of years just like the red

907
00:35:09,589 --> 00:35:07,440
greater spot and because i mentioned at

908
00:35:12,870 --> 00:35:09,599
the greater spot it's time to get back

909
00:35:17,349 --> 00:35:14,870
thank you alessandro that was great it's

910
00:35:19,349 --> 00:35:17,359
really exciting the polar cyclones have

911
00:35:20,950 --> 00:35:19,359
been intriguing to me since we first

912
00:35:22,230 --> 00:35:20,960
discovered them and of course we can't

913
00:35:24,310 --> 00:35:22,240

see them from the earth because we're

914
00:35:25,910 --> 00:35:24,320
looking you know from the equatorial

915
00:35:27,510 --> 00:35:25,920
plane and these things are only at the

916
00:35:29,109 --> 00:35:27,520
poles and so

917
00:35:31,190 --> 00:35:29,119
it really took something high up in

918
00:35:34,310 --> 00:35:31,200
latitude to be able to see it like like

919
00:35:36,630 --> 00:35:34,320
juno and what we've seen here today

920
00:35:40,310 --> 00:35:36,640
is is sort of a new understanding of of

921
00:35:42,630 --> 00:35:40,320
jupiter's atmosphere and how it works

922
00:35:44,470 --> 00:35:42,640
and this cell comes from jupiter's

923
00:35:47,589 --> 00:35:44,480
juno's technique of being able to see

924
00:35:49,910 --> 00:35:47,599
inside the polar orbit and also our

925
00:35:50,950 --> 00:35:49,920
ability to look in light that really

926
00:35:53,190 --> 00:35:50,960
isn't

927
00:35:56,310 --> 00:35:53,200
that our eyes aren't capable of seeing

928
00:35:58,950 --> 00:35:56,320
like uh infrared or the microwave vision

929
00:36:01,030 --> 00:35:58,960
that the microwave radiometers see

930
00:36:02,870 --> 00:36:01,040
you know where we can see inside so it's

931
00:36:04,550 --> 00:36:02,880
very important in science to be able to

932
00:36:07,270 --> 00:36:04,560
look at and extend

933
00:36:09,190 --> 00:36:07,280
the human eye into other wavelengths and

934
00:36:11,670 --> 00:36:09,200
this new understanding

935
00:36:14,310 --> 00:36:11,680
applies uh equally to the individual

936
00:36:16,870 --> 00:36:14,320
vortices like the great red spot as well

937
00:36:18,630 --> 00:36:16,880
as the uh the zones and belts although

938
00:36:20,710 --> 00:36:18,640

there's really big differences we see

939
00:36:23,589 --> 00:36:20,720
the the vortices going down hundreds of

940
00:36:26,069 --> 00:36:23,599
miles and um and we see the zones and

941
00:36:27,990 --> 00:36:26,079
boats may be going down thousands um i

942
00:36:30,390 --> 00:36:28,000
mean you know maybe the brakes on those

943
00:36:32,950 --> 00:36:30,400
windstream jet streams aren't really

944
00:36:34,790 --> 00:36:32,960
applied until they run into you know the

945
00:36:36,310 --> 00:36:34,800
magnetic field of jupiter which is

946
00:36:39,190 --> 00:36:36,320
deeper down

947
00:36:41,990 --> 00:36:39,200
but it's just amazing to see how this

948
00:36:43,670 --> 00:36:42,000
evolution works and the similarities a

949
00:36:45,829 --> 00:36:43,680
little bit between the zones and belts

950
00:36:47,349 --> 00:36:45,839
and these vortices is that the water

951
00:36:49,030 --> 00:36:47,359
clouds are playing a role it's where

952
00:36:51,030 --> 00:36:49,040
these inversions start to happen

953
00:36:53,030 --> 00:36:51,040
something's special about water at

954
00:36:56,470 --> 00:36:53,040
jupiter just like sunlight just like

955
00:36:58,390 --> 00:36:56,480
earth but these roots go right past it

956
00:37:00,069 --> 00:36:58,400
and so somehow you have to be

957
00:37:02,310 --> 00:37:00,079
transporting ammonia and water and

958
00:37:04,310 --> 00:37:02,320
things deeper down after it's an all

959
00:37:06,870 --> 00:37:04,320
after they're all gas right there's it's

960
00:37:08,870 --> 00:37:06,880
so warm in jupiter down below there that

961
00:37:11,670 --> 00:37:08,880
it's that stays vapor yet they don't

962
00:37:14,150 --> 00:37:11,680
really mix up together um we've seen

963
00:37:16,150 --> 00:37:14,160

that the circulation cells exist

964
00:37:17,910 --> 00:37:16,160
we've now got evidence of that are very

965
00:37:19,910 --> 00:37:17,920
similar to earth but of course there's

966
00:37:22,950 --> 00:37:19,920
many more of them because jupiter is a

967
00:37:25,589 --> 00:37:22,960
monster planet um the the jovicline

968
00:37:28,069 --> 00:37:25,599
which with archer arthur c clark uh

969
00:37:29,910 --> 00:37:28,079
almost envisioned in this idea and and

970
00:37:32,310 --> 00:37:29,920
we see this inversion in the zones and

971
00:37:34,230 --> 00:37:32,320
belts uh with this with this uh

972
00:37:36,870 --> 00:37:34,240
jovacline almost a little bit like

973
00:37:38,870 --> 00:37:36,880
earth's oceans and then finally the

974
00:37:41,190 --> 00:37:38,880
polar cyclones that alessandra just

975
00:37:43,030 --> 00:37:41,200
talked about and

976
00:37:46,150 --> 00:37:43,040
we wondered since we discovered these

977
00:37:48,390 --> 00:37:46,160
how stable they are um what forms them

978
00:37:50,310 --> 00:37:48,400
and and we've finally got some progress

979
00:37:52,470 --> 00:37:50,320
and made some understanding of of

980
00:37:54,710 --> 00:37:52,480
answers to some of those questions

981
00:37:57,109 --> 00:37:54,720
another big question is how deep are the

982
00:37:58,870 --> 00:37:57,119
roots to these giant polar cyclones and

983
00:38:01,430 --> 00:37:58,880
we hope to be able to to actually

984
00:38:03,030 --> 00:38:01,440
determine that in the extended mission

985
00:38:05,670 --> 00:38:03,040
because we'll be getting closer and

986
00:38:07,670 --> 00:38:05,680
closer to the north pole

987
00:38:09,910 --> 00:38:07,680
in the extended mission and eventually

988
00:38:11,910 --> 00:38:09,920

the microwave vision will tell us how

989
00:38:13,510 --> 00:38:11,920
deep the roots are to these

990
00:38:15,670 --> 00:38:13,520
now i'd like to just spend a little bit

991
00:38:17,510 --> 00:38:15,680
of time showing you some of the most

992
00:38:19,670 --> 00:38:17,520
fascinating new pictures that just came

993
00:38:20,870 --> 00:38:19,680
down in the last week from our last

994
00:38:22,150 --> 00:38:20,880
flyby

995
00:38:24,470 --> 00:38:22,160
of jupiter

996
00:38:27,270 --> 00:38:24,480
next slide please

997
00:38:29,910 --> 00:38:27,280
so this image we call bands of color uh

998
00:38:32,390 --> 00:38:29,920
it's made by a citizen scientist brian

999
00:38:34,870 --> 00:38:32,400
swift all of our our data from junocam

1000
00:38:37,910 --> 00:38:34,880
this is a junocam image is loaded onto a

1001
00:38:40,550 --> 00:38:37,920
website the mission juno website and

1002
00:38:41,910 --> 00:38:40,560
amateurs citizen scientists even

1003
00:38:43,670 --> 00:38:41,920
professionals

1004
00:38:45,510 --> 00:38:43,680
and people from all walks of life school

1005
00:38:48,310 --> 00:38:45,520
children go in and make these pictures

1006
00:38:50,230 --> 00:38:48,320
and post them and brian is uh swift is

1007
00:38:51,910 --> 00:38:50,240
particularly talented at it

1008
00:38:53,750 --> 00:38:51,920
you can see in this image it's a very

1009
00:38:55,670 --> 00:38:53,760
different perspective the the zones and

1010
00:38:57,990 --> 00:38:55,680
belts that we've been talking about are

1011
00:38:59,589 --> 00:38:58,000
just wisps on the horizon at the edge of

1012
00:39:02,069 --> 00:38:59,599
these of this image because you're

1013
00:39:04,470 --> 00:39:02,079

looking at a very unique perspective

1014
00:39:06,230 --> 00:39:04,480
and then you see these two vortices one

1015
00:39:07,990 --> 00:39:06,240
in the forefront that's very large and

1016
00:39:09,990 --> 00:39:08,000
you can see these little pop-up clouds

1017
00:39:12,630 --> 00:39:10,000
in there and the grays and whites and

1018
00:39:15,750 --> 00:39:12,640
then in the distant on the far left you

1019
00:39:17,270 --> 00:39:15,760
see a hint of another kind of cyclone

1020
00:39:18,950 --> 00:39:17,280
that's reddish

1021
00:39:21,349 --> 00:39:18,960
and this is giving us this new unique

1022
00:39:22,790 --> 00:39:21,359
perspective it's a very good example of

1023
00:39:25,910 --> 00:39:22,800
how the storms

1024
00:39:26,950 --> 00:39:25,920
are different on on jupiter next slide

1025
00:39:27,750 --> 00:39:26,960
please

1026
00:39:30,150 --> 00:39:27,760
um

1027
00:39:32,150 --> 00:39:30,160
here's another one also by brian swift

1028
00:39:34,390 --> 00:39:32,160
um and these are called swirling storms

1029
00:39:36,150 --> 00:39:34,400
and so now you're seeing sort of a

1030
00:39:38,470 --> 00:39:36,160
little bit of the smorgasbord that that

1031
00:39:42,069 --> 00:39:38,480
jupiter throws at us you have both the

1032
00:39:43,589 --> 00:39:42,079
the vortices vortex type storms that are

1033
00:39:46,150 --> 00:39:43,599
a little bit roundish and then you have

1034
00:39:47,910 --> 00:39:46,160
these wispy swirling winds this is in

1035
00:39:50,950 --> 00:39:47,920
the north north temperate belt so it's

1036
00:39:52,870 --> 00:39:50,960
in the northern latitudes and you can

1037
00:39:54,470 --> 00:39:52,880
see again these pop-up clouds these

1038
00:39:56,150 --> 00:39:54,480

little white clouds there's almost

1039
00:39:58,470 --> 00:39:56,160
shadows that are visible there so you

1040
00:40:00,550 --> 00:39:58,480
can see that those are resting above

1041
00:40:02,310 --> 00:40:00,560
another cloud base

1042
00:40:04,470 --> 00:40:02,320
these things are where we think there's

1043
00:40:06,630 --> 00:40:04,480
updrafts of ammonia and they get it gets

1044
00:40:10,470 --> 00:40:06,640
up such a high altitude that you

1045
00:40:12,710 --> 00:40:10,480
eventually form ammonia ice clouds and

1046
00:40:14,309 --> 00:40:12,720
although they look tiny in this picture

1047
00:40:16,790 --> 00:40:14,319
jupiter is immense

1048
00:40:19,589 --> 00:40:16,800
and so these these little tiny clouds

1049
00:40:21,670 --> 00:40:19,599
are still 25 to 50 kilometers across so

1050
00:40:22,790 --> 00:40:21,680
these are actually quite big by

1051
00:40:24,550 --> 00:40:22,800
themselves

1052
00:40:26,309 --> 00:40:24,560
not nearly as big as of course the great

1053
00:40:28,870 --> 00:40:26,319
red spot

1054
00:40:30,390 --> 00:40:28,880
and then finally another picture of the

1055
00:40:32,710 --> 00:40:30,400
of jupiter's uh

1056
00:40:35,270 --> 00:40:32,720
storms is something that's just sort of

1057
00:40:38,309 --> 00:40:35,280
clouds being stacked up on our north

1058
00:40:40,870 --> 00:40:38,319
equatorial belt again brian swift

1059
00:40:44,790 --> 00:40:40,880
created a great image here and it really

1060
00:40:47,430 --> 00:40:44,800
shows um a great example of how the

1061
00:40:49,030 --> 00:40:47,440
images from juno can can look in and see

1062
00:40:51,030 --> 00:40:49,040
different layers

1063
00:40:53,990 --> 00:40:51,040

so you can see that the different cloud

1064
00:40:55,829 --> 00:40:54,000
decks even without the microwave vision

1065
00:40:57,829 --> 00:40:55,839
you can see that you're seeing a 3d

1066
00:40:59,589 --> 00:40:57,839
effect here where

1067
00:41:02,630 --> 00:40:59,599
the the light

1068
00:41:05,030 --> 00:41:02,640
tan and gray clouds are sitting above a

1069
00:41:06,790 --> 00:41:05,040
pool of darker gray

1070
00:41:09,109 --> 00:41:06,800
and there's orange storms that are

1071
00:41:11,430 --> 00:41:09,119
peeking out from underneath the dark and

1072
00:41:13,270 --> 00:41:11,440
so you can see shadows actually being

1073
00:41:15,270 --> 00:41:13,280
layered on this so you can tell the

1074
00:41:18,790 --> 00:41:15,280
different altitudes and again at the

1075
00:41:21,430 --> 00:41:18,800
very top are those pop-up clouds and and

1076
00:41:24,630 --> 00:41:21,440
so these filamentary swirls are some of

1077
00:41:27,030 --> 00:41:24,640
the most beautiful um almost van gogh

1078
00:41:30,069 --> 00:41:27,040
like uh like uh

1079
00:41:35,270 --> 00:41:30,079
artistry that jupiter is exhibiting um

1080
00:41:37,990 --> 00:41:35,280
next uh slide is a sort of a teaser

1081
00:41:40,710 --> 00:41:38,000
and that is this is europa actually

1082
00:41:43,670 --> 00:41:40,720
we just got this on the last orbit it's

1083
00:41:45,910 --> 00:41:43,680
it's taken at a distance of about 80 000

1084
00:41:48,390 --> 00:41:45,920
kilometers so we're pretty far away the

1085
00:41:50,630 --> 00:41:48,400
resolution is still about 50 or 60

1086
00:41:52,390 --> 00:41:50,640
kilometers per pixel so it's not the

1087
00:41:54,710 --> 00:41:52,400
best resolution that nasa's ever

1088
00:41:58,069 --> 00:41:54,720

obtained of europa but it was put

1089
00:42:00,790 --> 00:41:58,079
together uh very crafty and very well by

1090
00:42:02,870 --> 00:42:00,800
a citizen scientist named andrea luck

1091
00:42:04,950 --> 00:42:02,880
and and this picture

1092
00:42:07,349 --> 00:42:04,960
um shows the albedo differences the

1093
00:42:09,589 --> 00:42:07,359
color differences that that we see at

1094
00:42:11,270 --> 00:42:09,599
europa even close up you can see those

1095
00:42:12,870 --> 00:42:11,280
almost continent-like things of course

1096
00:42:14,150 --> 00:42:12,880
this is an ice shell

1097
00:42:16,230 --> 00:42:14,160
and

1098
00:42:18,550 --> 00:42:16,240
what's also unique that that we're

1099
00:42:20,710 --> 00:42:18,560
really uh have an advantage of that juno

1100
00:42:22,790 --> 00:42:20,720
has an advantage of is that we're seeing

1101
00:42:24,710 --> 00:42:22,800
uh a new region that we haven't seen

1102
00:42:26,790 --> 00:42:24,720
before the center of this image is

1103
00:42:29,030 --> 00:42:26,800
really the north polar region and we

1104
00:42:30,550 --> 00:42:29,040
haven't been able to see that and so we

1105
00:42:32,710 --> 00:42:30,560
look forward to

1106
00:42:35,349 --> 00:42:32,720
next year about this time we'll be by

1107
00:42:37,349 --> 00:42:35,359
flying by really close just a few

1108
00:42:38,870 --> 00:42:37,359
hundred kilometers above europa's

1109
00:42:41,270 --> 00:42:38,880
surface and we'll get very high

1110
00:42:44,950 --> 00:42:41,280
resolution images but this one already

1111
00:42:46,710 --> 00:42:44,960
is a is a tantalizing example and a

1112
00:42:49,190 --> 00:42:46,720
taste of what's to come

1113
00:42:49,910 --> 00:42:49,200

and so with that i thank you very much

1114
00:42:52,309 --> 00:42:49,920
for

1115
00:42:54,309 --> 00:42:52,319
allowing us to share our excitement and

1116
00:42:55,750 --> 00:42:54,319
for your role in helping to share that

1117
00:42:58,630 --> 00:42:55,760
excitement with the public i turn it

1118
00:43:00,870 --> 00:42:58,640
back to raquel

1119
00:43:03,270 --> 00:43:00,880
thank you scott we'll now move into the

1120
00:43:05,430 --> 00:43:03,280
q a portion and remember if you're a

1121
00:43:07,510 --> 00:43:05,440
member of the media on the phone line

1122
00:43:09,510 --> 00:43:07,520
you can press star one to get into the

1123
00:43:11,510 --> 00:43:09,520
queue to ask your question

1124
00:43:14,150 --> 00:43:11,520
and if you're on social media you can

1125
00:43:16,390 --> 00:43:14,160
ask questions using the hashtag juno

1126
00:43:18,470 --> 00:43:16,400
mission now the first question comes

1127
00:43:20,150 --> 00:43:18,480
from social media we have kevin on

1128
00:43:22,790 --> 00:43:20,160
facebook who asks

1129
00:43:28,069 --> 00:43:22,800
how fast is the atmosphere moving

1130
00:43:32,069 --> 00:43:30,309
so i'll just give you a very quick

1131
00:43:33,589 --> 00:43:32,079
answer that there there what you're

1132
00:43:36,470 --> 00:43:33,599
seeing are clouds when you look at the

1133
00:43:38,390 --> 00:43:36,480
visible images they're mostly clouds but

1134
00:43:40,630 --> 00:43:38,400
you're seeing different layers and so

1135
00:43:43,589 --> 00:43:40,640
there is but everything's they're not

1136
00:43:45,430 --> 00:43:43,599
all vapor the clouds of course can be uh

1137
00:43:47,030 --> 00:43:45,440
have liquid uh because you've got

1138
00:43:48,550 --> 00:43:47,040

condensation of water you've got

1139
00:43:50,550 --> 00:43:48,560
condensation of ammonia you've got a

1140
00:43:52,710 --> 00:43:50,560
couple different molecules in there that

1141
00:43:54,550 --> 00:43:52,720
can create different layers of clouds

1142
00:43:56,630 --> 00:43:54,560
different colors

1143
00:43:58,230 --> 00:43:56,640
and they're swirling around now when you

1144
00:44:00,470 --> 00:43:58,240
say how fast are they moving that's kind

1145
00:44:02,550 --> 00:44:00,480
of a loaded question because the zones

1146
00:44:04,309 --> 00:44:02,560
and belts are blowing

1147
00:44:06,230 --> 00:44:04,319
in different directions

1148
00:44:08,470 --> 00:44:06,240
um and so

1149
00:44:10,470 --> 00:44:08,480
and at different speeds and so it

1150
00:44:13,430 --> 00:44:10,480
depends on where you look how fast

1151
00:44:15,349 --> 00:44:13,440
they're blowing um jupiter itself spins

1152
00:44:17,910 --> 00:44:15,359
around even though it's enormous spins

1153
00:44:20,470 --> 00:44:17,920
around in 10 hours so here it is 10 or

1154
00:44:21,910 --> 00:44:20,480
11 times bigger than earth and it's

1155
00:44:24,150 --> 00:44:21,920
spinning around two and a half times

1156
00:44:26,069 --> 00:44:24,160
faster um for a little bit more

1157
00:44:27,670 --> 00:44:26,079
specifics on exactly how fast the winds

1158
00:44:32,069 --> 00:44:27,680
i'd like to turn to lee and let him talk

1159
00:44:35,910 --> 00:44:34,390
sure thanks scott so it's uh kind of

1160
00:44:37,990 --> 00:44:35,920
hard to get your head around some of the

1161
00:44:41,030 --> 00:44:38,000
speeds that are involved in the motions

1162
00:44:43,030 --> 00:44:41,040
of cloud features across jupiter but

1163
00:44:44,870 --> 00:44:43,040

around the equator we can actually look

1164
00:44:47,349 --> 00:44:44,880
and observe with a telescope over just a

1165
00:44:49,670 --> 00:44:47,359
few hours and you can see those clouds

1166
00:44:50,630 --> 00:44:49,680
zipping along from west to east or east

1167
00:44:53,430 --> 00:44:50,640
to west

1168
00:44:56,069 --> 00:44:53,440
hundreds of miles per hour now that's in

1169
00:44:57,750 --> 00:44:56,079
the sort of horizontal uh plane if

1170
00:45:00,150 --> 00:44:57,760
you're talking about motions that might

1171
00:45:02,150 --> 00:45:00,160
be going upwards or going downwards

1172
00:45:04,550 --> 00:45:02,160
they're much slower that you only have

1173
00:45:07,430 --> 00:45:04,560
to have motions that on the order of

1174
00:45:10,069 --> 00:45:07,440
centimeters per hour in order to get

1175
00:45:12,150 --> 00:45:10,079
these things uh um

1176
00:45:17,109 --> 00:45:12,160
moving up and down the ammonia cells as

1177
00:45:20,710 --> 00:45:19,030
great thanks for your answers we have

1178
00:45:25,589 --> 00:45:20,720
someone on the call line now it's

1179
00:45:29,510 --> 00:45:27,190
hi thanks for taking my question this

1180
00:45:31,190 --> 00:45:29,520
one's probably for alessandro so i was

1181
00:45:32,950 --> 00:45:31,200
reading her paper and i understand from

1182
00:45:34,710 --> 00:45:32,960
that as well as your discussion why the

1183
00:45:36,069 --> 00:45:34,720
oscillations around the poles appear to

1184
00:45:38,309 --> 00:45:36,079
be very stable in terms of those

1185
00:45:40,710 --> 00:45:38,319
cyclones but you know that you did see a

1186
00:45:42,630 --> 00:45:40,720
new cyclone formed temporarily in 2019

1187
00:45:46,630 --> 00:45:42,640
so can you explain how that happened

1188
00:45:49,670 --> 00:45:46,640

within a context of all the stability

1189
00:45:50,630 --> 00:45:49,680
basically the the five cyclones are

1190
00:45:53,349 --> 00:45:50,640
probably

1191
00:45:55,910 --> 00:45:53,359
uh as a configuration where they leave

1192
00:45:57,589 --> 00:45:55,920
some kind of free space for an intruder

1193
00:45:59,750 --> 00:45:57,599
to to get in

1194
00:46:01,910 --> 00:45:59,760
but this inclusion may occur only

1195
00:46:04,230 --> 00:46:01,920
sometimes because the configuration

1196
00:46:06,470 --> 00:46:04,240
probably is stable at five maybe not so

1197
00:46:09,109 --> 00:46:06,480
stable at six or maybe

1198
00:46:11,430 --> 00:46:09,119
you need a very huge cycle to get the

1199
00:46:13,990 --> 00:46:11,440
sixth place so either the five

1200
00:46:16,550 --> 00:46:14,000
configuration is stable and six is not

1201
00:46:19,109 --> 00:46:16,560
so that if a six cyclones get in it is

1202
00:46:21,349 --> 00:46:19,119
rejected or maybe you need a very big

1203
00:46:23,670 --> 00:46:21,359
cyclones to get the sixth place and get

1204
00:46:25,510 --> 00:46:23,680
a new co stable configuration with c

1205
00:46:26,829 --> 00:46:25,520
cyclone like a hexagon that we don't

1206
00:46:29,190 --> 00:46:26,839
know still because we need more

1207
00:46:31,910 --> 00:46:29,200
observations and more events like this

1208
00:46:37,589 --> 00:46:31,920
to to develop a consistent theory for

1209
00:46:43,910 --> 00:46:40,230
thank you and up next two on our call

1210
00:46:46,710 --> 00:46:43,920
line is marcia dunn from the ap

1211
00:46:47,910 --> 00:46:46,720
yes hi um question i believe for dr

1212
00:46:50,950 --> 00:46:47,920
bolton

1213
00:46:52,710 --> 00:46:50,960

i'm wondering how many individual storms

1214
00:46:55,430 --> 00:46:52,720
would you estimate that there are at

1215
00:46:57,510 --> 00:46:55,440
jupiter and would you consider from what

1216
00:46:59,910 --> 00:46:57,520
you've been able to analyze so far that

1217
00:47:01,829 --> 00:46:59,920
the great red spot is the deepest or one

1218
00:47:04,470 --> 00:47:01,839
of the deepest

1219
00:47:06,230 --> 00:47:04,480
is regarding its roots and you mentioned

1220
00:47:08,790 --> 00:47:06,240
that you cannot see the bottom of the

1221
00:47:14,390 --> 00:47:08,800
great red spot so i'm wondering how much

1222
00:47:18,550 --> 00:47:16,950
okay so um i'll take the questions in

1223
00:47:19,750 --> 00:47:18,560
reverse order because i i'm not sure

1224
00:47:22,630 --> 00:47:19,760
i'll be able to answer the very first

1225
00:47:24,870 --> 00:47:22,640
one how many storms are there um

1226
00:47:27,910 --> 00:47:24,880
but the great red spot we with the

1227
00:47:30,630 --> 00:47:27,920
microwave eyes right the way we see

1228
00:47:32,630 --> 00:47:30,640
through the clouds um we detected it in

1229
00:47:34,390 --> 00:47:32,640
our deepest channel which was a couple

1230
00:47:35,910 --> 00:47:34,400
hundred miles down

1231
00:47:37,030 --> 00:47:35,920
uh

1232
00:47:39,990 --> 00:47:37,040
now

1233
00:47:41,910 --> 00:47:40,000
marzia looked at the gravity field and

1234
00:47:43,990 --> 00:47:41,920
they're looking at you know the

1235
00:47:46,309 --> 00:47:44,000
concentration of mass that might be

1236
00:47:48,309 --> 00:47:46,319
associated with that great red spot and

1237
00:47:50,069 --> 00:47:48,319
looking at very sensitive measurements

1238
00:47:52,870 --> 00:47:50,079

of the gravity field and the distortions

1239
00:47:55,670 --> 00:47:52,880
of the spacecraft's path um as she

1240
00:47:57,750 --> 00:47:55,680
explained and that put a lower limit on

1241
00:48:00,150 --> 00:47:57,760
it that said that at least the bulk of

1242
00:48:02,230 --> 00:48:00,160
the mass that's associated with that

1243
00:48:03,910 --> 00:48:02,240
storm is sitting in the first 500

1244
00:48:06,870 --> 00:48:03,920
kilometers

1245
00:48:08,790 --> 00:48:06,880
below the cloud tops and so we think we

1246
00:48:11,750 --> 00:48:08,800
bound the problem between the microwave

1247
00:48:14,390 --> 00:48:11,760
it's deeper than 200 miles but probably

1248
00:48:16,630 --> 00:48:14,400
not deeper than say 300. now that

1249
00:48:18,790 --> 00:48:16,640
doesn't mean there's a hard root cut off

1250
00:48:21,430 --> 00:48:18,800
i i you know i think it probably fades

1251
00:48:22,470 --> 00:48:21,440
out gradually and keeps going down

1252
00:48:25,109 --> 00:48:22,480
but

1253
00:48:27,750 --> 00:48:25,119
the bulk of the mass is is sitting in

1254
00:48:29,910 --> 00:48:27,760
above about 300 miles probably maybe and

1255
00:48:32,390 --> 00:48:29,920
there's there's some error bar on that

1256
00:48:35,190 --> 00:48:32,400
maybe it's 350 miles you know we're not

1257
00:48:36,870 --> 00:48:35,200
sure exactly but it's still way below

1258
00:48:38,390 --> 00:48:36,880
the water cloud now whether that's the

1259
00:48:39,349 --> 00:48:38,400
deepest storm

1260
00:48:41,190 --> 00:48:39,359
um

1261
00:48:43,430 --> 00:48:41,200
it's the it's probably the deepest one

1262
00:48:46,150 --> 00:48:43,440
that we've seen i mean the there was

1263
00:48:48,790 --> 00:48:46,160

another vortex the one i showed first

1264
00:48:51,030 --> 00:48:48,800
that i called the barge that we see also

1265
00:48:54,150 --> 00:48:51,040
in the deepest channel but the signal is

1266
00:48:56,470 --> 00:48:54,160
not as uh robust and so we believe it

1267
00:48:58,630 --> 00:48:56,480
was already starting to fade out whereas

1268
00:49:01,030 --> 00:48:58,640
in the great red spot it was still

1269
00:49:03,750 --> 00:49:01,040
really strong and so

1270
00:49:06,390 --> 00:49:03,760
uh we think of the three one three

1271
00:49:08,150 --> 00:49:06,400
vortex storms that we looked at that the

1272
00:49:10,710 --> 00:49:08,160
great red spot was the deepest now

1273
00:49:13,430 --> 00:49:10,720
whether that means it's the deepest

1274
00:49:16,710 --> 00:49:13,440
in any and all over jupiter i'm not sure

1275
00:49:18,710 --> 00:49:16,720
and another candidate might be the polar

1276
00:49:20,150 --> 00:49:18,720
cyclones i mean we'll it'll be very

1277
00:49:21,990 --> 00:49:20,160
interesting to see when we get to the

1278
00:49:25,030 --> 00:49:22,000
top of the planet later in the extended

1279
00:49:25,990 --> 00:49:25,040
mission how deep those go um i wouldn't

1280
00:49:27,910 --> 00:49:26,000
want to

1281
00:49:30,230 --> 00:49:27,920
be too quick to guess

1282
00:49:32,390 --> 00:49:30,240
that we've seen the deepest but the

1283
00:49:35,109 --> 00:49:32,400
great red spot is the largest and that

1284
00:49:37,750 --> 00:49:35,119
makes it special by itself and and you

1285
00:49:40,230 --> 00:49:37,760
might expect that it might be deeper um

1286
00:49:42,069 --> 00:49:40,240
just because of that but i think it's

1287
00:49:44,470 --> 00:49:42,079
it's a little bit too early to guess

1288
00:49:47,030 --> 00:49:44,480

that now the last question and i'm going

1289
00:49:48,549 --> 00:49:47,040
to open this up to lee in a minute too

1290
00:49:51,430 --> 00:49:48,559
which is how many

1291
00:49:52,710 --> 00:49:51,440
storms are on jupiter any given time

1292
00:49:55,510 --> 00:49:52,720
um

1293
00:49:57,109 --> 00:49:55,520
i have you know i would say it's covered

1294
00:49:59,109 --> 00:49:57,119
i mean if you know if you look at the

1295
00:50:01,829 --> 00:49:59,119
high resolution images of

1296
00:50:05,430 --> 00:50:01,839
from junocam um the place is covered

1297
00:50:07,430 --> 00:50:05,440
with just incredibly beautiful swirls um

1298
00:50:09,030 --> 00:50:07,440
vortex storms that are round some of

1299
00:50:11,910 --> 00:50:09,040
them are these filaments just blowing

1300
00:50:13,910 --> 00:50:11,920
around all those are stormy places and

1301
00:50:16,710 --> 00:50:13,920
when you look at all of them you see

1302
00:50:18,950 --> 00:50:16,720
pop-up clouds you see up down drafts i

1303
00:50:20,630 --> 00:50:18,960
mean the zones and belts are are driving

1304
00:50:23,030 --> 00:50:20,640
things the water clouds are driving

1305
00:50:24,390 --> 00:50:23,040
things the sunlight i mean i i hate to

1306
00:50:25,589 --> 00:50:24,400
put a number on it but it wouldn't

1307
00:50:27,670 --> 00:50:25,599
surprise me if

1308
00:50:30,549 --> 00:50:27,680
if jupiter didn't have thousands

1309
00:50:32,790 --> 00:50:30,559
across its body um and

1310
00:50:34,630 --> 00:50:32,800
you know if you were living on jupiter

1311
00:50:36,230 --> 00:50:34,640
it would be a real

1312
00:50:37,910 --> 00:50:36,240
difficult task trying to do a weather

1313
00:50:39,910 --> 00:50:37,920

report

1314
00:50:42,470 --> 00:50:39,920
but lee maybe you can shed some light

1315
00:50:43,910 --> 00:50:42,480
from your insights

1316
00:50:45,750 --> 00:50:43,920
yeah i think you're on the right tracks

1317
00:50:47,670 --> 00:50:45,760
there there scott i mean when there are

1318
00:50:49,510 --> 00:50:47,680
two pieces of information that might

1319
00:50:52,470 --> 00:50:49,520
might help think about how stormy

1320
00:50:55,270 --> 00:50:52,480
jupiter is the first is that even from

1321
00:50:58,230 --> 00:50:55,280
earth from a backyard telescope you can

1322
00:51:01,270 --> 00:50:58,240
see a whole smorgasbord of activity in

1323
00:51:03,510 --> 00:51:01,280
the jovian atmosphere and talented

1324
00:51:05,510 --> 00:51:03,520
amateur astronomers are able to track

1325
00:51:07,589 --> 00:51:05,520
those individual features as they're

1326
00:51:09,430 --> 00:51:07,599
moving around in order to reconstruct

1327
00:51:12,470 --> 00:51:09,440
things like the wind field and they're

1328
00:51:14,069 --> 00:51:12,480
tracking hundreds of these tiny spots

1329
00:51:15,589 --> 00:51:14,079
every single night that's quite

1330
00:51:17,829 --> 00:51:15,599
incredible and the second piece of

1331
00:51:19,990 --> 00:51:17,839
information actually comes back to the

1332
00:51:22,390 --> 00:51:20,000
juno mission itself and that is the

1333
00:51:25,270 --> 00:51:22,400
number of lightning strikes we're able

1334
00:51:27,589 --> 00:51:25,280
to see covering the entire planet and

1335
00:51:29,589 --> 00:51:27,599
actually getting more prevalent as we

1336
00:51:31,510 --> 00:51:29,599
get up to high latitudes and those

1337
00:51:34,470 --> 00:51:31,520
lightning strikes are presumably

1338
00:51:37,030 --> 00:51:34,480

associated with separation of charge

1339
00:51:39,270 --> 00:51:37,040
within thunder clouds cumulonimbus

1340
00:51:41,750 --> 00:51:39,280
clouds like we're familiar with on earth

1341
00:51:44,549 --> 00:51:41,760
and they are happening all of the time

1342
00:51:47,109 --> 00:51:44,559
this world really is an enormous male

1343
00:51:49,270 --> 00:51:47,119
strum of storm activity and just like

1344
00:51:51,829 --> 00:51:49,280
scots i'd hesitate to put a precise

1345
00:51:56,470 --> 00:51:51,839
number of it on it for you but thousands

1346
00:52:00,790 --> 00:51:58,870
thank you for your responses uh up next

1347
00:52:04,230 --> 00:52:00,800
on our phone lines we also have bill

1348
00:52:06,630 --> 00:52:04,240
harwood from cbs news

1349
00:52:09,670 --> 00:52:06,640
um yeah hey thanks very much um i guess

1350
00:52:11,430 --> 00:52:09,680
this is for scott uh two questions um if

1351
00:52:13,430 --> 00:52:11,440
someone who enjoys looking at the great

1352
00:52:16,549 --> 00:52:13,440
red spot with his telescope whenever he

1353
00:52:17,349 --> 00:52:16,559
can is there anything in the data so far

1354
00:52:18,710 --> 00:52:17,359
that

1355
00:52:20,790 --> 00:52:18,720
even hint

1356
00:52:23,030 --> 00:52:20,800
uh and how it's managed to be stable for

1357
00:52:24,309 --> 00:52:23,040
so long is there are there any guesses

1358
00:52:27,910 --> 00:52:24,319
as to

1359
00:52:30,790 --> 00:52:27,920
and why it seems to be shrinking over

1360
00:52:33,589 --> 00:52:30,800
the past few decades and then and also

1361
00:52:34,549 --> 00:52:33,599
speaking of the polar vortexes

1362
00:52:36,470 --> 00:52:34,559
how does

1363
00:52:38,150 --> 00:52:36,480

what's going on at jupiter

1364
00:52:40,150 --> 00:52:38,160
how do we think that compares to what we

1365
00:52:44,870 --> 00:52:40,160
see in the polar regions of saturn which

1366
00:52:48,950 --> 00:52:46,790
yeah those are all really good questions

1367
00:52:50,230 --> 00:52:48,960
bill um

1368
00:52:51,750 --> 00:52:50,240
so

1369
00:52:53,589 --> 00:52:51,760
you know when we look at the great red

1370
00:52:55,670 --> 00:52:53,599
spot uh of course

1371
00:52:58,549 --> 00:52:55,680
we've been observing it for decades with

1372
00:53:01,109 --> 00:52:58,559
with telescopes and nasa missions and

1373
00:53:03,030 --> 00:53:01,119
hubble um you know and then before that

1374
00:53:05,430 --> 00:53:03,040
you had you know even old telescopes

1375
00:53:07,349 --> 00:53:05,440
that that uh you know almost antique

1376
00:53:08,150 --> 00:53:07,359
like type things that were discovering

1377
00:53:09,109 --> 00:53:08,160
it

1378
00:53:11,510 --> 00:53:09,119
and

1379
00:53:13,430 --> 00:53:11,520
what juno is able to do is we we

1380
00:53:14,390 --> 00:53:13,440
we've sensed that it's it seems to be

1381
00:53:15,190 --> 00:53:14,400
shrinking

1382
00:53:17,190 --> 00:53:15,200
um

1383
00:53:19,430 --> 00:53:17,200
and appears to be shrinking since say

1384
00:53:21,750 --> 00:53:19,440
even the days of voyager right

1385
00:53:23,910 --> 00:53:21,760
and and what we're doing is seeing up

1386
00:53:25,829 --> 00:53:23,920
close what's happening

1387
00:53:28,710 --> 00:53:25,839
while that shrinking has happened is

1388
00:53:29,589 --> 00:53:28,720

going on and we see sometimes flecks of

1389
00:53:30,630 --> 00:53:29,599
these

1390
00:53:31,750 --> 00:53:30,640
red

1391
00:53:33,109 --> 00:53:31,760
flecks of

1392
00:53:34,710 --> 00:53:33,119
i don't want to call them paint but

1393
00:53:36,710 --> 00:53:34,720
they're clouds or things that are

1394
00:53:39,589 --> 00:53:36,720
getting caught up in that that and so

1395
00:53:41,430 --> 00:53:39,599
the dynamics are are sora being studied

1396
00:53:43,030 --> 00:53:41,440
and we can see things are changing i

1397
00:53:44,710 --> 00:53:43,040
don't think the theory is very far

1398
00:53:47,190 --> 00:53:44,720
advanced to the sense where we can

1399
00:53:49,510 --> 00:53:47,200
connect all of that to the changes in

1400
00:53:51,670 --> 00:53:49,520
the size except that we're starting to

1401
00:53:52,870 --> 00:53:51,680
see that there are elements of the

1402
00:53:55,109 --> 00:53:52,880
dynamics

1403
00:53:57,670 --> 00:53:55,119
that are telling us that and the depth

1404
00:54:01,030 --> 00:53:57,680
of the route may be a a

1405
00:54:03,030 --> 00:54:01,040
a hint as to its longevity as well um

1406
00:54:05,670 --> 00:54:03,040
you might think that something with the

1407
00:54:08,790 --> 00:54:05,680
really deep root might be able to last

1408
00:54:10,870 --> 00:54:08,800
longer um but keep in mind that you know

1409
00:54:12,710 --> 00:54:10,880
from from the image that marzia showed

1410
00:54:14,549 --> 00:54:12,720
us you know when i lift the great red

1411
00:54:16,950 --> 00:54:14,559
spot out it still kind of looks like a

1412
00:54:20,549 --> 00:54:16,960
pancake the pancakes thicker than we

1413
00:54:22,390 --> 00:54:20,559

would have expected but this is not a uh

1414
00:54:25,430 --> 00:54:22,400
a storm that goes down into the middle

1415
00:54:27,829 --> 00:54:25,440
of jupiter at least not that we've seen

1416
00:54:30,069 --> 00:54:27,839
and and certainly the gravity field data

1417
00:54:31,750 --> 00:54:30,079
doesn't suggest that but it is have a

1418
00:54:33,510 --> 00:54:31,760
deeper route maybe than the other

1419
00:54:36,950 --> 00:54:33,520
vortices and that may be part of its

1420
00:54:39,829 --> 00:54:36,960
longevity um it's also trapped you know

1421
00:54:41,829 --> 00:54:39,839
sort of between these two conveyor belts

1422
00:54:43,750 --> 00:54:41,839
a lot of the vortices are sort of built

1423
00:54:45,270 --> 00:54:43,760
that way you've got the zones and belts

1424
00:54:46,950 --> 00:54:45,280
moving back and forth in different

1425
00:54:48,390 --> 00:54:46,960
directions they're almost like conveyor

1426
00:54:51,030 --> 00:54:48,400
belts of winds

1427
00:54:53,829 --> 00:54:51,040
and and there and things can get sort of

1428
00:54:56,069 --> 00:54:53,839
stabilized in between them right and

1429
00:54:59,430 --> 00:54:56,079
like a ball bearing almost spinning

1430
00:55:02,870 --> 00:54:59,440
around and and so i think all of those

1431
00:55:04,390 --> 00:55:02,880
are kind of hints um on the longevity

1432
00:55:06,230 --> 00:55:04,400
i'm trying to remember

1433
00:55:07,750 --> 00:55:06,240
did you have another follow-up question

1434
00:55:16,549 --> 00:55:07,760
to one of those because you've stacked a

1435
00:55:20,390 --> 00:55:18,069
you know if bill had a follow-up

1436
00:55:22,549 --> 00:55:20,400
question we can have him get back in the

1437
00:55:24,309 --> 00:55:22,559
queue and he can ask it again because we

1438
00:55:26,390 --> 00:55:24,319

do have another caller on the line and

1439
00:55:29,829 --> 00:55:26,400
then we'll just get back to you bill

1440
00:55:33,190 --> 00:55:29,839
when you get on the line up next is rick

1441
00:55:35,750 --> 00:55:33,200
lovett from freelance

1442
00:55:37,349 --> 00:55:35,760
yes thank you my question is uh

1443
00:55:39,990 --> 00:55:37,359
technical i think i know the answer but

1444
00:55:42,390 --> 00:55:40,000
i want to be sure of it um the how were

1445
00:55:44,470 --> 00:55:42,400
the rotations for the circulations of

1446
00:55:48,789 --> 00:55:44,480
the north south felt

1447
00:55:53,750 --> 00:55:48,799
uh determined um is is that doppler on

1448
00:55:57,670 --> 00:55:55,670
uh

1449
00:55:59,670 --> 00:55:57,680
i'm not sure i'm following the question

1450
00:56:01,349 --> 00:55:59,680
it's it's how how do we determine the

1451
00:56:03,349 --> 00:56:01,359
the motion of the zones and belts the

1452
00:56:05,190 --> 00:56:03,359
directions

1453
00:56:06,789 --> 00:56:05,200
so we're not really doing that on juno

1454
00:56:09,109 --> 00:56:06,799
although we can get images that are

1455
00:56:11,190 --> 00:56:09,119
spaced apart and measure some winds but

1456
00:56:13,190 --> 00:56:11,200
i'm going to let lee take a crack at

1457
00:56:14,630 --> 00:56:13,200
that if i interpreted the question right

1458
00:56:16,870 --> 00:56:14,640
you probably

1459
00:56:18,789 --> 00:56:16,880
will be able to best answer it

1460
00:56:19,750 --> 00:56:18,799
rick sounds like he has a actually i

1461
00:56:21,750 --> 00:56:19,760
think maybe

1462
00:56:25,270 --> 00:56:21,760
right person to

1463
00:56:27,270 --> 00:56:25,280

answer that one maybe if uh if you don't

1464
00:56:29,430 --> 00:56:27,280
mind karen i might come across to you we

1465
00:56:31,670 --> 00:56:29,440
were talking about how the motions of

1466
00:56:36,390 --> 00:56:31,680
the zones and belts were measured from

1467
00:56:41,510 --> 00:56:38,470
yes absolutely so thank you rick for

1468
00:56:42,630 --> 00:56:41,520
asking that actually um

1469
00:56:45,349 --> 00:56:42,640
what the

1470
00:56:48,549 --> 00:56:45,359
least showed is the microwave data and

1471
00:56:51,589 --> 00:56:48,559
we were able to interpolate this data as

1472
00:56:52,549 --> 00:56:51,599
a movement of ammonia so in fact we find

1473
00:56:54,789 --> 00:56:52,559
that

1474
00:56:58,309 --> 00:56:54,799
in the polaroid side of the eastward

1475
00:57:00,150 --> 00:56:58,319
jets we find that peaks in ammonia that

1476
00:57:03,190 --> 00:57:00,160
means that ammonia is being carried from

1477
00:57:06,309 --> 00:57:03,200
below towards the surface the cloud deck

1478
00:57:08,230 --> 00:57:06,319
and on the equator side of the jets of

1479
00:57:09,589 --> 00:57:08,240
the eastward jets ammonia is being

1480
00:57:11,670 --> 00:57:09,599
carried down

1481
00:57:13,270 --> 00:57:11,680
by these vertical velocities and then we

1482
00:57:16,470 --> 00:57:13,280
were able to model

1483
00:57:18,069 --> 00:57:16,480
those vertical velocities with the

1484
00:57:20,549 --> 00:57:18,079
measurements from cassini of the

1485
00:57:23,510 --> 00:57:20,559
turbulence in the atmosphere and we were

1486
00:57:25,030 --> 00:57:23,520
able to recreate the data

1487
00:57:26,549 --> 00:57:25,040
using a model describing these

1488
00:57:28,309 --> 00:57:26,559

circulation cells

1489
00:57:30,470 --> 00:57:28,319
so

1490
00:57:32,789 --> 00:57:30,480
we aren't able to measure them using

1491
00:57:33,750 --> 00:57:32,799
doppler shift i think that was your

1492
00:57:35,820 --> 00:57:33,760
question

1493
00:57:36,950 --> 00:57:35,830
uh but we are able to um

1494
00:57:38,950 --> 00:57:36,960
[Music]

1495
00:57:42,309 --> 00:57:38,960
we are able to model the those

1496
00:57:45,510 --> 00:57:42,319
velocities using the microwave data

1497
00:57:47,670 --> 00:57:45,520
which is a quite astonishing uh tool

1498
00:57:49,750 --> 00:57:47,680
that we have here on juno i hope that

1499
00:57:51,430 --> 00:57:49,760
answers your question

1500
00:57:52,950 --> 00:57:51,440
let me just add something because now i

1501
00:57:54,710 --> 00:57:52,960
understand the question i did

1502
00:57:56,470 --> 00:57:54,720
misinterpret it and what you were

1503
00:57:57,910 --> 00:57:56,480
talking about was the vertical motions

1504
00:57:59,910 --> 00:57:57,920
and i for some reason thought you were

1505
00:58:02,710 --> 00:57:59,920
talking about the sideways motions

1506
00:58:04,950 --> 00:58:02,720
so it isn't done with doppler at all

1507
00:58:06,789 --> 00:58:04,960
the microwave radiometer is is is a

1508
00:58:08,390 --> 00:58:06,799
radiometer which is broadband and

1509
00:58:11,750 --> 00:58:08,400
doesn't have the spectral type

1510
00:58:13,510 --> 00:58:11,760
information that tells us um exactly the

1511
00:58:16,230 --> 00:58:13,520
lines where you could measure a

1512
00:58:18,309 --> 00:58:16,240
particular emission line and measure its

1513
00:58:21,030 --> 00:58:18,319

doppler um and so it's done the way

1514
00:58:23,349 --> 00:58:21,040
karen uh was was discussing there's

1515
00:58:30,470 --> 00:58:23,359
there's the the doppler measurements are

1516
00:58:34,950 --> 00:58:32,069
rick i hope that answered your questions

1517
00:58:39,670 --> 00:58:34,960
for you up next on our phone line is

1518
00:58:41,670 --> 00:58:39,680
marcia smith from space policy online

1519
00:58:44,230 --> 00:58:41,680
thanks so much for taking my question

1520
00:58:46,470 --> 00:58:44,240
and i apologize if i missed this earlier

1521
00:58:48,069 --> 00:58:46,480
or in the press release but uh scott

1522
00:58:49,990 --> 00:58:48,079
could you talk about the health of the

1523
00:58:51,750 --> 00:58:50,000
spacecraft and i thought i heard you

1524
00:58:52,950 --> 00:58:51,760
mention something about an extended

1525
00:58:54,789 --> 00:58:52,960
mission

1526
00:58:56,789 --> 00:58:54,799
how much longer do you anticipate

1527
00:58:58,950 --> 00:58:56,799
getting this kind of data and could you

1528
00:59:00,309 --> 00:58:58,960
also talk more about the citizen science

1529
00:59:01,589 --> 00:59:00,319
component of this

1530
00:59:04,630 --> 00:59:01,599
it looks like you're getting an awful

1531
00:59:06,230 --> 00:59:04,640
lot of good data out of that and how did

1532
00:59:09,990 --> 00:59:06,240
people learn about it and get to

1533
00:59:15,190 --> 00:59:11,990
uh sure that's that's those are great

1534
00:59:17,430 --> 00:59:15,200
questions um so the extended mission

1535
00:59:19,910 --> 00:59:17,440
just started this summer

1536
00:59:22,150 --> 00:59:19,920
technically august 1st

1537
00:59:24,470 --> 00:59:22,160
and we had completed the number of

1538
00:59:26,549 --> 00:59:24,480

orbits that were in our primary mission

1539
00:59:30,309 --> 00:59:26,559
and uh the health of the spacecraft is

1540
00:59:33,190 --> 00:59:30,319
excellent um you know jupiter is is a a

1541
00:59:36,309 --> 00:59:33,200
very dangerous place um with a lot of

1542
00:59:37,910 --> 00:59:36,319
radiation um and and

1543
00:59:40,870 --> 00:59:37,920
we were protected

1544
00:59:44,069 --> 00:59:40,880
like uh like a tank with a lot of armor

1545
00:59:46,390 --> 00:59:44,079
and um and at the moment the the shields

1546
00:59:48,789 --> 00:59:46,400
are holding up if i can borrow something

1547
00:59:51,670 --> 00:59:48,799
from star trek the shields are holding

1548
00:59:54,230 --> 00:59:51,680
and we're not seeing uh any real

1549
00:59:56,630 --> 00:59:54,240
indication of degradation which is great

1550
00:59:58,710 --> 00:59:56,640
and that really is uh

1551
01:00:00,870 --> 00:59:58,720
a marvel and attributed to the great

1552
01:00:04,309 --> 01:00:00,880
engineering that jpl and lockheed martin

1553
01:00:06,789 --> 01:00:04,319
were able to put together um and uh and

1554
01:00:09,510 --> 01:00:06,799
make sure that we could last and so

1555
01:00:11,630 --> 01:00:09,520
um the extended mission is approved all

1556
01:00:13,270 --> 01:00:11,640
the way through um i think september of

1557
01:00:14,549 --> 01:00:13,280
2025

1558
01:00:18,230 --> 01:00:14,559
um

1559
01:00:19,750 --> 01:00:18,240
and that is about uh a bit more than 40

1560
01:00:22,549 --> 01:00:19,760
more orbits

1561
01:00:24,870 --> 01:00:22,559
and that's a lot um we will take a lot

1562
01:00:26,150 --> 01:00:24,880
of radiation by the end of that so i

1563
01:00:28,309 --> 01:00:26,160

don't you know

1564
01:00:31,349 --> 01:00:28,319
we're going to keep our fingers crossed

1565
01:00:33,510 --> 01:00:31,359
uh that we last throughout that but it

1566
01:00:35,190 --> 01:00:33,520
holds a lot of potential not only the

1567
01:00:37,270 --> 01:00:35,200
satellites and the rings but we're going

1568
01:00:39,589 --> 01:00:37,280
to get really far north because our

1569
01:00:41,750 --> 01:00:39,599
orbit progresses in the extended mission

1570
01:00:43,510 --> 01:00:41,760
it gets twisted around by jupiter to

1571
01:00:45,990 --> 01:00:43,520
further and further north

1572
01:00:47,349 --> 01:00:46,000
the perijoves or the close-up approaches

1573
01:00:48,470 --> 01:00:47,359
will be further and further north and

1574
01:00:50,789 --> 01:00:48,480
that's what's going to allow us to

1575
01:00:53,270 --> 01:00:50,799
investigate all of these incredible

1576
01:00:54,069 --> 01:00:53,280
atmospheric phenomena in the north um

1577
01:00:58,150 --> 01:00:54,079
and

1578
01:01:00,630 --> 01:00:58,160
allows us to fly by the satellites so

1579
01:01:03,270 --> 01:01:00,640
it's just a great advantage to have

1580
01:01:05,109 --> 01:01:03,280
something like that um and so the health

1581
01:01:06,470 --> 01:01:05,119
is health and safety or i should say the

1582
01:01:09,670 --> 01:01:06,480
health of the spacecraft and all the

1583
01:01:12,069 --> 01:01:09,680
instruments is uh is still great um and

1584
01:01:14,309 --> 01:01:12,079
so i'm really happy to report on that

1585
01:01:16,150 --> 01:01:14,319
now citizen science is is really

1586
01:01:19,109 --> 01:01:16,160
something close to my heart so i really

1587
01:01:20,630 --> 01:01:19,119
appreciate your question um we spent

1588
01:01:22,390 --> 01:01:20,640

quite a bit of effort to try to make

1589
01:01:24,789 --> 01:01:22,400
sure that we could connect to the public

1590
01:01:27,990 --> 01:01:24,799
and allow them to share the excitement

1591
01:01:29,589 --> 01:01:28,000
of exploration and discovery and so

1592
01:01:33,750 --> 01:01:29,599
there's a website

1593
01:01:38,150 --> 01:01:36,150
and i think that you'll probably be able

1594
01:01:40,309 --> 01:01:38,160
to get that out of the press release or

1595
01:01:42,789 --> 01:01:40,319
they'll post it here somewhere

1596
01:01:45,910 --> 01:01:42,799
but anybody can go to that website it's

1597
01:01:47,670 --> 01:01:45,920
the official juno website that's at my

1598
01:01:50,309 --> 01:01:47,680
home institution southwest research

1599
01:01:52,549 --> 01:01:50,319
institute the nasa website has links to

1600
01:01:55,270 --> 01:01:52,559
it i believe as well and inside that

1601
01:01:58,150 --> 01:01:55,280
website is a place called junocam or

1602
01:02:01,109 --> 01:01:58,160
image processing and the images are

1603
01:02:02,870 --> 01:02:01,119
loaded up as raw data there

1604
01:02:05,430 --> 01:02:02,880
and then there's some tutorials that

1605
01:02:07,750 --> 01:02:05,440
teach people how to take that image and

1606
01:02:09,910 --> 01:02:07,760
turn it into an image of jupiter or

1607
01:02:12,069 --> 01:02:09,920
whatever it is that you want to do a lot

1608
01:02:14,549 --> 01:02:12,079
of the people are are doing artistic

1609
01:02:16,069 --> 01:02:14,559
things some are doing scientific things

1610
01:02:17,670 --> 01:02:16,079
some of them are so scientifically

1611
01:02:19,510 --> 01:02:17,680
important they're making the discoveries

1612
01:02:21,670 --> 01:02:19,520
for us we've included them on our

1613
01:02:24,069 --> 01:02:21,680

science papers they're they've become

1614
01:02:25,589 --> 01:02:24,079
science team members almost um but

1615
01:02:27,910 --> 01:02:25,599
others are expressing themselves

1616
01:02:30,230 --> 01:02:27,920
artistically which is a joy to see

1617
01:02:33,029 --> 01:02:30,240
um and where their imagination i've seen

1618
01:02:34,870 --> 01:02:33,039
pictures with astronauts uh sitting at

1619
01:02:35,829 --> 01:02:34,880
jupiter i mean it's something i want to

1620
01:02:37,910 --> 01:02:35,839
do

1621
01:02:40,309 --> 01:02:37,920
so um

1622
01:02:43,430 --> 01:02:40,319
it's it's a great uh program and what

1623
01:02:45,349 --> 01:02:43,440
happens is they can process that data

1624
01:02:46,789 --> 01:02:45,359
and if they have questions they can pose

1625
01:02:48,950 --> 01:02:46,799
them and learn how to do it we have

1626
01:02:50,789 --> 01:02:48,960
experts that'll help them and then what

1627
01:02:53,829 --> 01:02:50,799
what product they make the images they

1628
01:02:55,829 --> 01:02:53,839
make they can post also um or they can

1629
01:02:57,990 --> 01:02:55,839
take somebody else's image that has been

1630
01:03:00,309 --> 01:02:58,000
made and modify it so there's quite a

1631
01:03:02,230 --> 01:03:00,319
bit of different levels of complexity

1632
01:03:04,870 --> 01:03:02,240
that you can jump into depending on how

1633
01:03:07,349 --> 01:03:04,880
much time you want to spend on it and um

1634
01:03:09,750 --> 01:03:07,359
and mo almost all the imagery that you

1635
01:03:11,670 --> 01:03:09,760
see from coming out of juno uh these

1636
01:03:14,069 --> 01:03:11,680
beautiful images the animations and

1637
01:03:18,549 --> 01:03:14,079
videos that we make are all coming from

1638
01:03:22,710 --> 01:03:20,870

so thanks for your question

1639
01:03:24,710 --> 01:03:22,720
thank you and then up next on the call

1640
01:03:28,069 --> 01:03:24,720
line we have a follow-up from elizabeth

1641
01:03:30,309 --> 01:03:28,079
howell from space.com

1642
01:03:32,950 --> 01:03:30,319
hi this might be for scott thanks again

1643
01:03:35,190 --> 01:03:32,960
um is juno able to see any atmospheric

1644
01:03:38,630 --> 01:03:35,200
changes from the recent asteroid strikes

1645
01:03:42,630 --> 01:03:41,589
so we we looked at that and um it's

1646
01:03:43,589 --> 01:03:42,640
still

1647
01:03:46,630 --> 01:03:43,599
of

1648
01:03:47,990 --> 01:03:46,640
being worked um i almost it was almost

1649
01:03:50,150 --> 01:03:48,000
far enough along that i was going to

1650
01:03:51,109 --> 01:03:50,160
include it in this

1651
01:03:53,029 --> 01:03:51,119
but

1652
01:03:54,870 --> 01:03:53,039
i'm a little hesitant to say too much

1653
01:03:57,270 --> 01:03:54,880
because it's the studies are not done

1654
01:04:01,589 --> 01:03:57,280
yet but we did take a close-up look

1655
01:04:02,630 --> 01:04:01,599
and we don't see a big mark from that um

1656
01:04:05,109 --> 01:04:02,640
but

1657
01:04:07,349 --> 01:04:05,119
i i say it uh

1658
01:04:09,589 --> 01:04:07,359
with um

1659
01:04:12,390 --> 01:04:09,599
with hopefully you'll grant me the right

1660
01:04:15,109 --> 01:04:12,400
to retract my words

1661
01:04:16,789 --> 01:04:15,119
if we if somebody sees something and say

1662
01:04:18,950 --> 01:04:16,799
uh we've got it as soon as we have a

1663
01:04:21,510 --> 01:04:18,960

definitive result we'll we'll certainly

1664
01:04:23,670 --> 01:04:21,520
make that available to everybody and and

1665
01:04:25,430 --> 01:04:23,680
announce it but and at the moment it

1666
01:04:30,950 --> 01:04:25,440
doesn't look like there's a big signal

1667
01:04:39,190 --> 01:04:33,829
great and then up next on the lines is

1668
01:04:42,710 --> 01:04:40,549
hi everyone thank you for taking my

1669
01:04:44,309 --> 01:04:42,720
question uh my question is for dr bolton

1670
01:04:46,150 --> 01:04:44,319
how specifically does the atmosphere

1671
01:04:48,150 --> 01:04:46,160
underneath jupiter's cloud layer power

1672
01:04:49,910 --> 01:04:48,160
the cyclones we see on jupiter and how

1673
01:04:53,270 --> 01:04:49,920
specifically do these intense cyclones

1674
01:04:57,430 --> 01:04:55,750
um i'm not sure i know all of the answer

1675
01:04:59,589 --> 01:04:57,440
to that we do you know this is something

1676
01:05:01,750 --> 01:04:59,599
that we're just studying how exactly

1677
01:05:05,270 --> 01:05:01,760
does the the the cyclones and

1678
01:05:07,109 --> 01:05:05,280
anticyclones get powered and so you know

1679
01:05:08,710 --> 01:05:07,119
on earth the meteorology and the weather

1680
01:05:11,029 --> 01:05:08,720
is very much

1681
01:05:13,670 --> 01:05:11,039
connected to the water condensation the

1682
01:05:16,230 --> 01:05:13,680
water clouds the sunlight coming down

1683
01:05:18,069 --> 01:05:16,240
and warming the atmosphere and it was

1684
01:05:19,750 --> 01:05:18,079
expected that maybe jupiter probably

1685
01:05:22,230 --> 01:05:19,760
worked the same way and no doubt those

1686
01:05:24,630 --> 01:05:22,240
processes are important at jupiter but

1687
01:05:27,190 --> 01:05:24,640
the fact that we see the the roots going

1688
01:05:29,589 --> 01:05:27,200

deeper than those much deeper not just a

1689
01:05:31,990 --> 01:05:29,599
little bit deeper but you know

1690
01:05:34,390 --> 01:05:32,000
tens of miles a hundred miles beyond the

1691
01:05:36,069 --> 01:05:34,400
where the water is um

1692
01:05:38,950 --> 01:05:36,079
tells us that there's another process

1693
01:05:41,829 --> 01:05:38,960
going on and we saw another hint of that

1694
01:05:45,109 --> 01:05:41,839
early in the mission we saw variability

1695
01:05:47,589 --> 01:05:45,119
of ammonia and and water um probably

1696
01:05:48,829 --> 01:05:47,599
going on much deeper than we expected

1697
01:05:53,029 --> 01:05:48,839
and

1698
01:05:55,270 --> 01:05:53,039
lee discussed where you know there's

1699
01:05:56,150 --> 01:05:55,280
lightning going on all over the place

1700
01:05:58,309 --> 01:05:56,160
and

1701
01:05:59,589 --> 01:05:58,319
there was a hypothesis that we put forth

1702
01:06:01,270 --> 01:05:59,599
that that there was something called

1703
01:06:04,390 --> 01:06:01,280
mush balls that might be going up and

1704
01:06:05,670 --> 01:06:04,400
down transporting this ammonia and water

1705
01:06:08,150 --> 01:06:05,680
now um

1706
01:06:10,309 --> 01:06:08,160
that's like a mush ball is sort of like

1707
01:06:12,309 --> 01:06:10,319
a jupiter version of hail

1708
01:06:14,710 --> 01:06:12,319
we call it mush because it's a mixture

1709
01:06:16,630 --> 01:06:14,720
of ammonia and water it's kind of slushy

1710
01:06:18,789 --> 01:06:16,640
and then it has some sort of ice crust

1711
01:06:21,670 --> 01:06:18,799
around it and just like hail on the

1712
01:06:22,950 --> 01:06:21,680
earth uh these things you know

1713
01:06:24,549 --> 01:06:22,960

can get down

1714
01:06:26,950 --> 01:06:24,559
and still be

1715
01:06:29,190 --> 01:06:26,960
intact even though it's too warm for

1716
01:06:31,430 --> 01:06:29,200
them to for ice to exist so on the earth

1717
01:06:33,589 --> 01:06:31,440
you see hail land on your driveway i

1718
01:06:35,270 --> 01:06:33,599
live in texas so we see it pretty common

1719
01:06:37,190 --> 01:06:35,280
you got to hurry up and hide your car

1720
01:06:39,190 --> 01:06:37,200
when they're cut when the hail's coming

1721
01:06:40,789 --> 01:06:39,200
um but it it can come down and bounce

1722
01:06:43,190 --> 01:06:40,799
onto your driveway or street or land on

1723
01:06:45,430 --> 01:06:43,200
your your lawn and there's a chunk of

1724
01:06:48,549 --> 01:06:45,440
ice even though it's warmer

1725
01:06:51,430 --> 01:06:48,559
than freezing out and and so the hail on

1726
01:06:53,589 --> 01:06:51,440
jupiter which we might call mushy balls

1727
01:06:55,829 --> 01:06:53,599
um may transport things down and

1728
01:06:57,109 --> 01:06:55,839
evaporate jupiter gets warmer as you go

1729
01:07:00,470 --> 01:06:57,119
down

1730
01:07:03,670 --> 01:07:00,480
and so once you pass the layer where

1731
01:07:06,870 --> 01:07:03,680
it's too warm for water to condense or

1732
01:07:09,349 --> 01:07:06,880
ammonia ice to form we expect that it

1733
01:07:11,190 --> 01:07:09,359
should be all vapor and and the naive

1734
01:07:12,390 --> 01:07:11,200
thought was well it'll all be mixed up

1735
01:07:14,630 --> 01:07:12,400
but it wasn't

1736
01:07:16,710 --> 01:07:14,640
um so there should could be energy

1737
01:07:18,870 --> 01:07:16,720
things going in from underneath

1738
01:07:20,390 --> 01:07:18,880

um but you probably also have something

1739
01:07:22,710 --> 01:07:20,400
going on from the top that's maybe

1740
01:07:24,230 --> 01:07:22,720
driving things down i think that the

1741
01:07:26,630 --> 01:07:24,240
data is so new

1742
01:07:28,309 --> 01:07:26,640
um that we're that that modelers and

1743
01:07:29,910 --> 01:07:28,319
theoreticians now have to go work this

1744
01:07:30,950 --> 01:07:29,920
out and undoubtedly there may be more

1745
01:07:33,430 --> 01:07:30,960
than one

1746
01:07:35,510 --> 01:07:33,440
uh idea out there um

1747
01:07:36,230 --> 01:07:35,520
i don't know maybe lee you have another

1748
01:07:39,670 --> 01:07:36,240
uh

1749
01:07:41,510 --> 01:07:39,680
something you might want to add to that

1750
01:07:43,750 --> 01:07:41,520
so yeah you asked a really good question

1751
01:07:45,349 --> 01:07:43,760
about the formation of these cyclones

1752
01:07:47,829 --> 01:07:45,359
and how they how they'd last and how

1753
01:07:49,990 --> 01:07:47,839
they're maintained over time and i think

1754
01:07:52,470 --> 01:07:50,000
the thing we can bring that back again

1755
01:07:54,069 --> 01:07:52,480
to our earth-based experience and you're

1756
01:07:56,150 --> 01:07:54,079
familiar with the jet stream that

1757
01:07:57,670 --> 01:07:56,160
whizzes around the northern hemisphere

1758
01:08:00,789 --> 01:07:57,680
here on earth and develops these

1759
01:08:03,430 --> 01:08:00,799
extremely strong meanders that can pull

1760
01:08:05,750 --> 01:08:03,440
regions of high and low pressure either

1761
01:08:08,230 --> 01:08:05,760
side of the jet stream and form

1762
01:08:10,309 --> 01:08:08,240
depressions that then shape the weather

1763
01:08:12,789 --> 01:08:10,319

system certainly that we have here in

1764
01:08:14,789 --> 01:08:12,799
the united kingdom so imagine that those

1765
01:08:17,110 --> 01:08:14,799
jet streams on jupiter only have to

1766
01:08:20,229 --> 01:08:17,120
develop a very very small wiggle or

1767
01:08:22,630 --> 01:08:20,239
meander and you can start to spin up a

1768
01:08:25,349 --> 01:08:22,640
cyclonic depression on one side of those

1769
01:08:27,030 --> 01:08:25,359
jet streams once they're started it's

1770
01:08:29,110 --> 01:08:27,040
actually quite hard to slow them down

1771
01:08:30,630 --> 01:08:29,120
it's quite hard to get rid of them

1772
01:08:32,870 --> 01:08:30,640
because they don't you don't have a

1773
01:08:34,789 --> 01:08:32,880
surface on jupiter that's dissipating

1774
01:08:37,189 --> 01:08:34,799
that energy and getting rid of that

1775
01:08:39,269 --> 01:08:37,199
energy so they can just persist for a

1776
01:08:41,269 --> 01:08:39,279
period of time until they get they

1777
01:08:43,749 --> 01:08:41,279
interact with other storms and with the

1778
01:08:46,789 --> 01:08:43,759
jet streams to potentially dissipate

1779
01:08:48,630 --> 01:08:46,799
later on so they start small

1780
01:08:50,630 --> 01:08:48,640
and they can spin up and then they can

1781
01:08:53,349 --> 01:08:50,640
last for a long period of time but the

1782
01:08:55,110 --> 01:08:53,359
crucial thing is that we then see them

1783
01:08:57,669 --> 01:08:55,120
because of their effects on the

1784
01:09:00,189 --> 01:08:57,679
environment so they change the cloud

1785
01:09:02,390 --> 01:09:00,199
conditions within them they change the

1786
01:09:03,189 --> 01:09:02,400
susceptibility of the atmosphere to

1787
01:09:08,630 --> 01:09:03,199
these

1788
01:09:10,950 --> 01:09:08,640

that can erupt from the deeper layers so

1789
01:09:13,749 --> 01:09:10,960
cyclones when they're there

1790
01:09:15,990 --> 01:09:13,759
start to create meteorology that we can

1791
01:09:17,669 --> 01:09:16,000
then detect with something like juno or

1792
01:09:19,910 --> 01:09:17,679
even with a ground-based telescope

1793
01:09:22,149 --> 01:09:19,920
looking at the incredible dark colors

1794
01:09:23,590 --> 01:09:22,159
within those cycles so really good

1795
01:09:25,110 --> 01:09:23,600
questions and i think you can see from

1796
01:09:29,510 --> 01:09:25,120
my answer that we don't have a complete

1797
01:09:32,550 --> 01:09:31,110
great thank you for your responses we

1798
01:09:34,309 --> 01:09:32,560
also have a

1799
01:09:37,669 --> 01:09:34,319
follow-up question from bill harwood

1800
01:09:39,910 --> 01:09:37,679
with cbs news

1801
01:09:41,749 --> 01:09:39,920
uh yeah thanks guys and scott the other

1802
01:09:43,430 --> 01:09:41,759
question i was trying to ask was for

1803
01:09:45,510 --> 01:09:43,440
anybody on the panel

1804
01:09:47,349 --> 01:09:45,520
have you learned anything from studying

1805
01:09:49,110 --> 01:09:47,359
the polar vortex of the jupiter that

1806
01:09:51,110 --> 01:09:49,120
shed any light at all

1807
01:09:53,269 --> 01:09:51,120
into what might be going on at saturn or

1808
01:09:55,030 --> 01:09:53,279
are these so dissimilar that there's

1809
01:09:58,310 --> 01:09:55,040
there's just nothing much in common

1810
01:10:03,990 --> 01:10:01,510
now i remember the question sorry

1811
01:10:06,310 --> 01:10:04,000
yes in fact um you know i'm going to

1812
01:10:09,590 --> 01:10:06,320
turn to alessandro in a moment because

1813
01:10:12,229 --> 01:10:09,600

he he was reporting on a on a another

1814
01:10:14,229 --> 01:10:12,239
manuscript that that that actually

1815
01:10:16,950 --> 01:10:14,239
looked at that and tried to say you know

1816
01:10:18,709 --> 01:10:16,960
how do i compare uh jupiter and saturn

1817
01:10:22,070 --> 01:10:18,719
and why does jupiter have these polar

1818
01:10:23,350 --> 01:10:22,080
cyclones and saturn doesn't um

1819
01:10:24,950 --> 01:10:23,360
so uh

1820
01:10:26,310 --> 01:10:24,960
and the answer had to do with the forces

1821
01:10:29,110 --> 01:10:26,320
and just the way things were but

1822
01:10:31,750 --> 01:10:29,120
alessandro maybe you want to echo or

1823
01:10:33,990 --> 01:10:31,760
expand on what you presented

1824
01:10:35,750 --> 01:10:34,000
yeah thank you scott so in fact there is

1825
01:10:36,790 --> 01:10:35,760
this new manuscript by colleagues of

1826
01:10:38,870 --> 01:10:36,800
karen

1827
01:10:41,189 --> 01:10:38,880
that's been published recently and you

1828
01:10:42,229 --> 01:10:41,199
explain nicely the reason why we have do

1829
01:10:44,470 --> 01:10:42,239
we do have

1830
01:10:46,630 --> 01:10:44,480
those kind of structures at jupiter we

1831
01:10:48,310 --> 01:10:46,640
don't that's at saturn so think for for

1832
01:10:49,189 --> 01:10:48,320
example at the earth

1833
01:10:51,110 --> 01:10:49,199
change

1834
01:10:53,590 --> 01:10:51,120
the rotation speed of the earth you get

1835
01:10:55,189 --> 01:10:53,600
a different meteorology if you change

1836
01:10:57,189 --> 01:10:55,199
the gravity of the earth you get a

1837
01:10:59,189 --> 01:10:57,199
different methodology if you change the

1838
01:11:00,870 --> 01:10:59,199

amount of energy the earth gets from the

1839
01:11:02,950 --> 01:11:00,880
sun still you have a different

1840
01:11:03,990 --> 01:11:02,960
methodology so every planet

1841
01:11:06,550 --> 01:11:04,000
has its own

1842
01:11:08,790 --> 01:11:06,560
key quantities and these key quantities

1843
01:11:10,870 --> 01:11:08,800
of course the impact on the meteorology

1844
01:11:12,950 --> 01:11:10,880
so the metrology of jupiter is so

1845
01:11:14,870 --> 01:11:12,960
peculiar because jupiter has the right

1846
01:11:16,950 --> 01:11:14,880
size and the right with spin and the

1847
01:11:19,590 --> 01:11:16,960
right energy to get the size of the

1848
01:11:22,310 --> 01:11:19,600
cyclones they are big enough

1849
01:11:24,630 --> 01:11:22,320
to to maintain this kind of mutual uh

1850
01:11:28,149 --> 01:11:24,640
rejection forces but they don't they're

1851
01:11:29,030 --> 01:11:28,159
not so large to get just one

1852
01:11:29,990 --> 01:11:29,040
actually

1853
01:11:32,070 --> 01:11:30,000
it's the

1854
01:11:32,790 --> 01:11:32,080
case to match

1855
01:11:41,430 --> 01:11:32,800
the

1856
01:11:43,430 --> 01:11:41,440
jupiter and so probably we will have

1857
01:11:45,830 --> 01:11:43,440
this kind of structure even at every

1858
01:11:47,510 --> 01:11:45,840
kind of exoplanet i'm dreaming of uh

1859
01:11:51,590 --> 01:11:47,520
that are the same size of jupiter and

1860
01:11:56,149 --> 01:11:52,830
extra

1861
01:11:58,870 --> 01:11:56,159
cycles great thank you and up next on

1862
01:12:02,950 --> 01:11:58,880
the call line is morgan mcfall johnson

1863
01:12:07,510 --> 01:12:04,950

hi thank you i think this question is

1864
01:12:09,750 --> 01:12:07,520
for scott or martha i wanted to ask

1865
01:12:11,910 --> 01:12:09,760
about the jet streams going so much

1866
01:12:14,070 --> 01:12:11,920
deeper than the great red spot

1867
01:12:16,470 --> 01:12:14,080
was that surprising does it make sense

1868
01:12:19,110 --> 01:12:16,480
for the jet streams to be so deep in the

1869
01:12:21,030 --> 01:12:19,120
spot to be such a pancake in comparison

1870
01:12:26,229 --> 01:12:21,040
and do you have an understanding of

1871
01:12:30,310 --> 01:12:28,070
um well i can just tell you a little bit

1872
01:12:32,229 --> 01:12:30,320
but i think marzia might be able to say

1873
01:12:34,070 --> 01:12:32,239
a bit more because it is through the

1874
01:12:36,149 --> 01:12:34,080
gravity analysis and it was a colleague

1875
01:12:38,630 --> 01:12:36,159
of hers and karen's that that published

1876
01:12:40,070 --> 01:12:38,640
that paper yohi cosby

1877
01:12:41,350 --> 01:12:40,080
um

1878
01:12:45,590 --> 01:12:41,360
now

1879
01:12:47,430 --> 01:12:45,600
going down and we can and and we look at

1880
01:12:49,990 --> 01:12:47,440
the gravity field we see a signature the

1881
01:12:52,550 --> 01:12:50,000
jet streams and the zonal winds on

1882
01:12:54,229 --> 01:12:52,560
jupiter have an asymmetry north to south

1883
01:12:56,470 --> 01:12:54,239
in fact the asymmetry on jupiter is

1884
01:12:59,110 --> 01:12:56,480
almost a theme of this planet and some

1885
01:13:01,030 --> 01:12:59,120
of it wasn't really expected

1886
01:13:02,550 --> 01:13:01,040
the magnetic field is asymmetric the

1887
01:13:04,709 --> 01:13:02,560
gravity field is asymmetric and the

1888
01:13:06,630 --> 01:13:04,719

atmosphere is asymmetric and yet it's a

1889
01:13:09,350 --> 01:13:06,640
giant ball of gas spinning around in 10

1890
01:13:12,229 --> 01:13:09,360
hours and so so a little bit of it is

1891
01:13:14,790 --> 01:13:12,239
surprising that that is able to be so

1892
01:13:16,870 --> 01:13:14,800
asymmetric but when you look at this and

1893
01:13:18,790 --> 01:13:16,880
and you see these jet streams going down

1894
01:13:21,270 --> 01:13:18,800
and they're detected this asymmetry was

1895
01:13:23,430 --> 01:13:21,280
detected in the gravity field at a depth

1896
01:13:25,030 --> 01:13:23,440
of about 2000 miles

1897
01:13:26,790 --> 01:13:25,040
um

1898
01:13:28,950 --> 01:13:26,800
and then below that we think maybe it

1899
01:13:31,030 --> 01:13:28,960
was rotating around as a solid body

1900
01:13:33,669 --> 01:13:31,040
right so above that it's spinning around

1901
01:13:36,070 --> 01:13:33,679
like on cylinders almost where you're

1902
01:13:38,550 --> 01:13:36,080
represented by the jet streams

1903
01:13:40,390 --> 01:13:38,560
now when you look at at that a little

1904
01:13:43,430 --> 01:13:40,400
bit and you say okay well if there's a

1905
01:13:46,229 --> 01:13:43,440
jet stream moving a lot of

1906
01:13:48,550 --> 01:13:46,239
wind a lot of the atmosphere

1907
01:13:50,229 --> 01:13:48,560
down that deep at some point when it

1908
01:13:52,709 --> 01:13:50,239
gets deep enough

1909
01:13:54,310 --> 01:13:52,719
the magnetic field is going to be sensed

1910
01:13:56,070 --> 01:13:54,320
this magnetic field is starting to get

1911
01:13:58,630 --> 01:13:56,080
stronger and stronger and there'll be a

1912
01:14:01,189 --> 01:13:58,640
layer down there where the atmosphere

1913
01:14:03,990 --> 01:14:01,199

becomes more and more ionized and

1914
01:14:06,070 --> 01:14:04,000
charged so to speak and when when that

1915
01:14:08,229 --> 01:14:06,080
happens it's almost like putting the

1916
01:14:09,830 --> 01:14:08,239
brakes on the wind streams or the jet

1917
01:14:10,870 --> 01:14:09,840
streams because

1918
01:14:12,630 --> 01:14:10,880
now

1919
01:14:14,390 --> 01:14:12,640
they don't just move around neutral

1920
01:14:16,790 --> 01:14:14,400
atmosphere if they're going to keep

1921
01:14:19,030 --> 01:14:16,800
moving they've got a they've got a fight

1922
01:14:21,110 --> 01:14:19,040
with the magnetic field which is a force

1923
01:14:23,189 --> 01:14:21,120
to be reckoned with

1924
01:14:25,270 --> 01:14:23,199
and so that's part of why you might see

1925
01:14:26,070 --> 01:14:25,280
those decay

1926
01:14:28,709 --> 01:14:26,080
now

1927
01:14:30,630 --> 01:14:28,719
what stops the

1928
01:14:32,709 --> 01:14:30,640
um

1929
01:14:33,590 --> 01:14:32,719
the great red spot from going down that

1930
01:14:35,910 --> 01:14:33,600
deep

1931
01:14:37,430 --> 01:14:35,920
uh may also be you know the layers get

1932
01:14:39,270 --> 01:14:37,440
higher and higher pressure higher and

1933
01:14:41,669 --> 01:14:39,280
higher temperature and eventually

1934
01:14:44,470 --> 01:14:41,679
whatever is causing these may may lose

1935
01:14:47,270 --> 01:14:44,480
its uh its ability to stay

1936
01:14:48,709 --> 01:14:47,280
as a uh as an intact system

1937
01:14:50,790 --> 01:14:48,719
um

1938
01:14:53,189 --> 01:14:50,800

but it's not clear exactly how that

1939
01:14:54,790 --> 01:14:53,199
works and you know somebody uh an

1940
01:14:56,870 --> 01:14:54,800
earlier question was talking about you

1941
01:14:58,709 --> 01:14:56,880
know how do you form these things how do

1942
01:15:00,310 --> 01:14:58,719
you form the the vortex storms in the

1943
01:15:03,030 --> 01:15:00,320
first place and so there are people that

1944
01:15:04,870 --> 01:15:03,040
are looking at whether you know eddie's

1945
01:15:06,870 --> 01:15:04,880
coming up from beneath

1946
01:15:09,270 --> 01:15:06,880
could actually play a role

1947
01:15:11,750 --> 01:15:09,280
and we don't necessarily have data that

1948
01:15:13,590 --> 01:15:11,760
favors one idea versus the other but

1949
01:15:16,709 --> 01:15:13,600
that is a possibility

1950
01:15:18,550 --> 01:15:16,719
and and um and so it could go they you

1951
01:15:19,990 --> 01:15:18,560
know the great red spot even though the

1952
01:15:21,270 --> 01:15:20,000
most of the mass

1953
01:15:23,270 --> 01:15:21,280
uh

1954
01:15:24,390 --> 01:15:23,280
maybe doesn't go much below 500

1955
01:15:26,149 --> 01:15:24,400
kilometers

1956
01:15:28,709 --> 01:15:26,159
there could still be things going on

1957
01:15:30,950 --> 01:15:28,719
much deeper um marzia do you do you have

1958
01:15:32,229 --> 01:15:30,960
uh any more on the depth of the zones

1959
01:15:35,189 --> 01:15:32,239
and belts

1960
01:15:42,149 --> 01:15:39,830
ah yes kota just a brief comment so

1961
01:15:43,990 --> 01:15:42,159
she mentioned if this was surprising for

1962
01:15:46,630 --> 01:15:44,000
us that i would say

1963
01:15:48,790 --> 01:15:46,640

um in a way yes and in a way no in the

1964
01:15:50,870 --> 01:15:48,800
sense that i think most of the

1965
01:15:54,149 --> 01:15:50,880
scientific community they were thinking

1966
01:15:55,910 --> 01:15:54,159
that the great red spot was very shallow

1967
01:15:57,430 --> 01:15:55,920
there were two schools of thoughts of

1968
01:15:59,189 --> 01:15:57,440
course

1969
01:16:01,350 --> 01:15:59,199
between people that thought you know it

1970
01:16:03,189 --> 01:16:01,360
was gonna stop in really in the first

1971
01:16:06,070 --> 01:16:03,199
layers of the atmosphere and others that

1972
01:16:08,229 --> 01:16:06,080
thought that maybe it will even go all

1973
01:16:10,870 --> 01:16:08,239
the way down to to the center of the

1974
01:16:12,630 --> 01:16:10,880
planet so i i don't think that was it

1975
01:16:13,750 --> 01:16:12,640
was surprising actually to see it goes

1976
01:16:17,189 --> 01:16:13,760
so deep

1977
01:16:18,790 --> 01:16:17,199
and as scott said there are different um

1978
01:16:21,669 --> 01:16:18,800
uh things that contribute to the

1979
01:16:23,430 --> 01:16:21,679
dampening of the flows there are

1980
01:16:25,830 --> 01:16:23,440
reasons that related to the magnetic

1981
01:16:26,870 --> 01:16:25,840
field and the uniform rotation

1982
01:16:28,950 --> 01:16:26,880
adapt

1983
01:16:30,950 --> 01:16:28,960
and obviously there is something at 500

1984
01:16:33,590 --> 01:16:30,960
kilometers that is limiting the the

1985
01:16:34,950 --> 01:16:33,600
circulation of the great red spot

1986
01:16:36,550 --> 01:16:34,960
so i would say

1987
01:16:38,070 --> 01:16:36,560
uh because we have these new

1988
01:16:40,550 --> 01:16:38,080

measurements then

1989
01:16:42,870 --> 01:16:40,560
at this point uh it's more kind of like

1990
01:16:44,790 --> 01:16:42,880
reverse engineering so we know how deep

1991
01:16:46,470 --> 01:16:44,800
the jet streams are and how deep the

1992
01:16:47,350 --> 01:16:46,480
great response is so

1993
01:16:49,830 --> 01:16:47,360
can

1994
01:16:51,990 --> 01:16:49,840
theoreticians explain why

1995
01:16:54,310 --> 01:16:52,000
uh this is uh there is such a difference

1996
01:16:56,390 --> 01:16:54,320
in the depth of uh of the jet streams

1997
01:16:59,750 --> 01:16:56,400
and the greater spot which of course are

1998
01:17:01,350 --> 01:16:59,760
different also the mechanism um

1999
01:17:07,270 --> 01:17:01,360
that govern them

2000
01:17:10,950 --> 01:17:09,110
thank you and we also have some

2001
01:17:13,430 --> 01:17:10,960
questions coming in from social media

2002
01:17:17,030 --> 01:17:13,440
with the juno mission

2003
01:17:19,189 --> 01:17:17,040
kate on youtube asks would the colors in

2004
01:17:23,189 --> 01:17:19,199
jupiter change with different

2005
01:17:29,669 --> 01:17:24,870
i think i would let lee answer that

2006
01:17:33,910 --> 01:17:32,149
that is an absolutely fabulous uh

2007
01:17:35,990 --> 01:17:33,920
question and um

2008
01:17:37,669 --> 01:17:36,000
you know to this day it's one of the uh

2009
01:17:40,310 --> 01:17:37,679
embarrassments maybe of planetary

2010
01:17:42,950 --> 01:17:40,320
science that we still don't know exactly

2011
01:17:45,270 --> 01:17:42,960
what is causing the colors of jupiter

2012
01:17:45,990 --> 01:17:45,280
those beautiful reds and browns that we

2013
01:17:47,830 --> 01:17:46,000

see

2014
01:17:50,550 --> 01:17:47,840
in the cloud decks could be being

2015
01:17:51,910 --> 01:17:50,560
created by compounds that contain things

2016
01:17:54,070 --> 01:17:51,920
like sulfur

2017
01:17:57,270 --> 01:17:54,080
things like phosphorus in the cloud tops

2018
01:18:00,149 --> 01:17:57,280
of jupiter um but we don't know exactly

2019
01:18:02,310 --> 01:18:00,159
what that that signature fingerprint of

2020
01:18:05,110 --> 01:18:02,320
that material might be like

2021
01:18:06,950 --> 01:18:05,120
so yes if you start to change the

2022
01:18:09,030 --> 01:18:06,960
temperature of the atmosphere if you

2023
01:18:11,189 --> 01:18:09,040
warmed it up a lot or if you cooled it

2024
01:18:14,149 --> 01:18:11,199
down a lot you would certainly be

2025
01:18:16,229 --> 01:18:14,159
changing the composition the blend of

2026
01:18:18,390 --> 01:18:16,239
different species that are present

2027
01:18:20,550 --> 01:18:18,400
within the cloud tops that are then

2028
01:18:22,870 --> 01:18:20,560
absorbing and reflecting different

2029
01:18:25,189 --> 01:18:22,880
amounts of light i mean i'll give you a

2030
01:18:27,830 --> 01:18:25,199
good example say we started bringing

2031
01:18:30,390 --> 01:18:27,840
jupiter closer and closer in towards the

2032
01:18:32,790 --> 01:18:30,400
sun this would be bad news for us as

2033
01:18:35,430 --> 01:18:32,800
human race by the way but if we did it

2034
01:18:37,590 --> 01:18:35,440
you would start to evaporate off those

2035
01:18:39,750 --> 01:18:37,600
ammonia clouds they would come back to

2036
01:18:42,149 --> 01:18:39,760
become a vapor and you'd start to

2037
01:18:44,790 --> 01:18:42,159
excavate clouds from deeper and deeper

2038
01:18:47,270 --> 01:18:44,800

down to the extent that those water

2039
01:18:50,310 --> 01:18:47,280
clouds that we keep talking about would

2040
01:18:52,630 --> 01:18:50,320
suddenly become visible and a jupiter

2041
01:18:55,590 --> 01:18:52,640
that is covered in water clouds would

2042
01:18:57,590 --> 01:18:55,600
appear maybe the same sort of whitish

2043
01:18:59,910 --> 01:18:57,600
gray that you sometimes see when you

2044
01:19:02,950 --> 01:18:59,920
look at the globe of the earth when it's

2045
01:19:05,270 --> 01:19:02,960
covered in clouds as well so certainly

2046
01:19:06,790 --> 01:19:05,280
the colors will change with temperature

2047
01:19:09,350 --> 01:19:06,800
and the reason is because the

2048
01:19:12,310 --> 01:19:09,360
atmospheric composition will change as

2049
01:19:13,990 --> 01:19:12,320
you turn that temperature dial uh up and

2050
01:19:16,870 --> 01:19:14,000
down so that's a fabulous question i

2051
01:19:18,870 --> 01:19:16,880
hope i've answered it for you

2052
01:19:21,110 --> 01:19:18,880
yeah let me just add one thing to that

2053
01:19:22,950 --> 01:19:21,120
which is along this exact same line that

2054
01:19:24,950 --> 01:19:22,960
you were saying is is that

2055
01:19:26,550 --> 01:19:24,960
in fact that's what we see right we when

2056
01:19:29,270 --> 01:19:26,560
we look at jupiter and we see these

2057
01:19:30,790 --> 01:19:29,280
beautiful swirls of different colors

2058
01:19:32,709 --> 01:19:30,800
we're seeing

2059
01:19:34,550 --> 01:19:32,719
in many ways one of the things i

2060
01:19:36,470 --> 01:19:34,560
described in one of the later images was

2061
01:19:38,790 --> 01:19:36,480
you're seeing different cloud layers

2062
01:19:40,229 --> 01:19:38,800
and and so those different cloud layers

2063
01:19:42,709 --> 01:19:40,239

are different colors because of the

2064
01:19:45,189 --> 01:19:42,719
composition changes presumably and

2065
01:19:46,709 --> 01:19:45,199
that's changing because as i go down

2066
01:19:49,189 --> 01:19:46,719
into jupiter the temperature and

2067
01:19:51,750 --> 01:19:49,199
pressure are increasing and so that

2068
01:19:54,390 --> 01:19:51,760
changes what condenses where

2069
01:19:57,030 --> 01:19:54,400
um what can exist what the mixtures are

2070
01:19:59,189 --> 01:19:57,040
how it gets mixed up so so lee's right

2071
01:20:01,030 --> 01:19:59,199
you know if you if you moved it in and

2072
01:20:02,830 --> 01:20:01,040
i'm not a big fan of that because we'd

2073
01:20:04,709 --> 01:20:02,840
have to leave

2074
01:20:06,709 --> 01:20:04,719
um and

2075
01:20:09,030 --> 01:20:06,719
but you could if you just turned up the

2076
01:20:11,990 --> 01:20:09,040
heat now also keep in mind

2077
01:20:14,870 --> 01:20:12,000
that jupiter receives uh energy and heat

2078
01:20:16,470 --> 01:20:14,880
from the sun but it's actually warmer in

2079
01:20:20,550 --> 01:20:16,480
the middle because it's still cooling

2080
01:20:26,790 --> 01:20:22,790
so it's it's it's it's radiating out

2081
01:20:31,110 --> 01:20:28,790
if you think of jupiter as any other

2082
01:20:33,910 --> 01:20:31,120
color than what we know it as today we

2083
01:20:37,430 --> 01:20:33,920
also have a caller on the line now leo

2084
01:20:40,870 --> 01:20:37,440
enright with irish tv

2085
01:20:43,750 --> 01:20:40,880
thanks raquel this is kind of a related

2086
01:20:46,790 --> 01:20:43,760
question to scott bolton

2087
01:20:47,830 --> 01:20:46,800
to do with the citizen science image the

2088
01:20:50,629 --> 01:20:47,840

uh

2089
01:20:52,149 --> 01:20:50,639
the swift picture of the northern

2090
01:20:54,310 --> 01:20:52,159
hemisphere

2091
01:20:57,030 --> 01:20:54,320
could you help us to interpret what

2092
01:20:59,510 --> 01:20:57,040
we're seeing i mean if i saw this as a

2093
01:21:03,030 --> 01:20:59,520
picture of the earth or of mars i would

2094
01:21:05,590 --> 01:21:03,040
say okay i know that's high that's low

2095
01:21:06,870 --> 01:21:05,600
you know that sort of thing i mean can

2096
01:21:09,910 --> 01:21:06,880
you say

2097
01:21:11,990 --> 01:21:09,920
what we're seeing here in terms of depth

2098
01:21:15,910 --> 01:21:12,000
are or is that

2099
01:21:19,990 --> 01:21:17,910
well i can to some degree

2100
01:21:21,910 --> 01:21:20,000
not completely but i mean

2101
01:21:25,430 --> 01:21:21,920
actually if you look very close at that

2102
01:21:27,669 --> 01:21:25,440
image and you blow it up on your screen

2103
01:21:29,990 --> 01:21:27,679
because it's pretty high resolution you

2104
01:21:32,310 --> 01:21:30,000
can actually see some of the shadows

2105
01:21:35,110 --> 01:21:32,320
that with that we're analyzing and

2106
01:21:37,350 --> 01:21:35,120
though and when something casts a shadow

2107
01:21:40,310 --> 01:21:37,360
um you'll be able to tell that it's what

2108
01:21:42,870 --> 01:21:40,320
its height is relative to the cloud base

2109
01:21:44,310 --> 01:21:42,880
that's below it and in i don't know

2110
01:21:46,229 --> 01:21:44,320
exactly which image you were talking

2111
01:21:49,189 --> 01:21:46,239
about but but one of them at the end

2112
01:21:51,990 --> 01:21:49,199
that i showed showed multiple layers

2113
01:21:53,110 --> 01:21:52,000

and sort of illustrated that example uh

2114
01:21:54,390 --> 01:21:53,120
very well

2115
01:21:55,430 --> 01:21:54,400
and so

2116
01:21:57,990 --> 01:21:55,440
um

2117
01:22:00,550 --> 01:21:58,000
part of our ability to look at that and

2118
01:22:02,950 --> 01:22:00,560
determine the height of these things has

2119
01:22:05,189 --> 01:22:02,960
to do with the shadows that we're

2120
01:22:07,430 --> 01:22:05,199
analyzing and we're just starting to

2121
01:22:09,590 --> 01:22:07,440
actually you know develop models that

2122
01:22:12,070 --> 01:22:09,600
can go in and really look closely at

2123
01:22:13,030 --> 01:22:12,080
those shadows to try to put constraints

2124
01:22:15,030 --> 01:22:13,040
on them

2125
01:22:16,709 --> 01:22:15,040
because you know before juno came along

2126
01:22:18,950 --> 01:22:16,719
we didn't see a lot of that you didn't

2127
01:22:20,470 --> 01:22:18,960
have these incredible close-ups that

2128
01:22:22,310 --> 01:22:20,480
could tell you all of that you had a

2129
01:22:24,790 --> 01:22:22,320
little bit of it but we're getting a lot

2130
01:22:25,990 --> 01:22:24,800
of it and so we're developing models now

2131
01:22:27,350 --> 01:22:26,000
and i'm sure and there are probably

2132
01:22:29,030 --> 01:22:27,360
scientists that are outside our team

2133
01:22:30,709 --> 01:22:29,040
that are also playing that same game

2134
01:22:32,149 --> 01:22:30,719
because that's going to be very

2135
01:22:34,550 --> 01:22:32,159
important to understanding the

2136
01:22:38,149 --> 01:22:34,560
atmospheric dynamics and

2137
01:22:40,149 --> 01:22:38,159
sometimes you know the clouds part and

2138
01:22:41,510 --> 01:22:40,159

even with a visible image you get to see

2139
01:22:44,550 --> 01:22:41,520
down deep

2140
01:22:46,629 --> 01:22:44,560
and and back in 1995 galileo probe went

2141
01:22:48,629 --> 01:22:46,639
in and measured jupiter trying to

2142
01:22:50,950 --> 01:22:48,639
understand how its composition worked

2143
01:22:52,550 --> 01:22:50,960
and what the structure was like and how

2144
01:22:53,669 --> 01:22:52,560
temperature and pressure changed as you

2145
01:22:55,189 --> 01:22:53,679
went in

2146
01:22:56,709 --> 01:22:55,199
and um

2147
01:22:58,229 --> 01:22:56,719
and some of the results were very

2148
01:23:00,229 --> 01:22:58,239
puzzling to us

2149
01:23:01,910 --> 01:23:00,239
and and one of the results that came out

2150
01:23:03,830 --> 01:23:01,920
was well it went into this place that we

2151
01:23:06,149 --> 01:23:03,840
call the hot spot warmer than everything

2152
01:23:07,990 --> 01:23:06,159
else maybe there was a big downdraft and

2153
01:23:10,709 --> 01:23:08,000
some infrared images sort of supported

2154
01:23:12,709 --> 01:23:10,719
that idea i think today we look at it

2155
01:23:14,390 --> 01:23:12,719
and we think well you know there was a

2156
01:23:16,149 --> 01:23:14,400
those hot spots are in some sense a

2157
01:23:16,950 --> 01:23:16,159
break in the clouds and you get to see

2158
01:23:19,350 --> 01:23:16,960
in

2159
01:23:20,550 --> 01:23:19,360
to the lower layers and the lower layers

2160
01:23:22,390 --> 01:23:20,560
are warmer

2161
01:23:24,229 --> 01:23:22,400
but there may also be downdrafts why is

2162
01:23:26,229 --> 01:23:24,239
there a break in the cloud so

2163
01:23:28,550 --> 01:23:26,239

um i don't know if that's shedding the

2164
01:23:30,790 --> 01:23:28,560
light that you were hoping uh for me to

2165
01:23:34,149 --> 01:23:30,800
explain it it's jupiter's atmosphere is

2166
01:23:36,709 --> 01:23:34,159
incredibly dynamic it's it's not um i'm

2167
01:23:38,550 --> 01:23:36,719
not describing a geologic landscape a

2168
01:23:41,830 --> 01:23:38,560
little bit like mars where i can say

2169
01:23:43,750 --> 01:23:41,840
here's a crater here's a dune

2170
01:23:45,669 --> 01:23:43,760
it's atmospheric dynamics of things

2171
01:23:47,430 --> 01:23:45,679
blowing around but there are different

2172
01:23:51,110 --> 01:23:47,440
layers and you can see those in the

2173
01:23:55,910 --> 01:23:52,870
great thank you for that answer scott

2174
01:23:57,270 --> 01:23:55,920
now that is all the time we have for

2175
01:24:01,430 --> 01:23:57,280
questions today

2176
01:24:05,030 --> 01:24:01,440
please contact immediate line at 818

2177
01:24:07,270 --> 01:24:05,040
four five zero one one for any

2178
01:24:09,669 --> 01:24:07,280
additional or follow-up questions that

2179
01:24:11,510 --> 01:24:09,679
you may have and i'd like to thank the

2180
01:24:13,510 --> 01:24:11,520
panel and all the people that called in

2181
01:24:15,750 --> 01:24:13,520
to submit their questions for more

2182
01:24:17,350 --> 01:24:15,760
information on the mission visit

2183
01:24:18,390 --> 01:24:17,360
nasa.gov

2184
01:24:24,229 --> 01:24:18,400
juno

2185
01:24:30,870 --> 01:24:26,070
you can also follow along on social