
NASA
SCIENCE LIVE
VIRTUAL EDITION
WE'RE GOING TO
VENUS

1
00:01:37,190 --> 00:00:42,950
[Music]

2
00:01:38,870 --> 00:01:37,200
hello and welcome to another episode of

3
00:01:40,950 --> 00:01:38,880
nasa science live

4
00:01:42,870 --> 00:01:40,960
my name is karen fox and i'm nasa's

5
00:01:45,270 --> 00:01:42,880
senior science communications officer

6
00:01:46,789 --> 00:01:45,280
and your host for today's episode

7
00:01:48,310 --> 00:01:46,799
it's exciting to think about all we can

8
00:01:50,469 --> 00:01:48,320
learn from these two new missions to

9
00:01:51,590 --> 00:01:50,479
explore venus and later in the show you

10
00:01:53,109 --> 00:01:51,600
will have the chance to hear from

11
00:01:55,109 --> 00:01:53,119
scientists about each of these new

12
00:01:57,510 --> 00:01:55,119
missions ask them your questions and

13
00:01:59,350 --> 00:01:57,520

learn why venus is such a fascinating

14
00:02:01,190 --> 00:01:59,360
planet to study

15
00:02:03,429 --> 00:02:01,200
but first we have two special guests

16
00:02:05,510 --> 00:02:03,439
here to tell you more let's hear about

17
00:02:08,790 --> 00:02:05,520
this exciting announcement from nasa's

18
00:02:11,190 --> 00:02:08,800
new administrator bill nelson and nasa

19
00:02:13,430 --> 00:02:11,200
science associate administrator thomas

20
00:02:15,190 --> 00:02:13,440
zurbukin

21
00:02:16,470 --> 00:02:15,200
well i'm so excited to be here with you

22
00:02:19,350 --> 00:02:16,480
on camera

23
00:02:21,270 --> 00:02:19,360
our new administrator uh senator bill

24
00:02:23,190 --> 00:02:21,280
nelson i'm just so glad to be working

25
00:02:26,790 --> 00:02:23,200
with you and learning about your passion

26
00:02:29,510 --> 00:02:26,800
you have for all things space and also

27
00:02:31,830 --> 00:02:29,520
of space science and we're here because

28
00:02:33,030 --> 00:02:31,840
of those two discovery missions focused

29
00:02:34,470 --> 00:02:33,040
on venus

30
00:02:36,630 --> 00:02:34,480
indeed i'm

31
00:02:40,309 --> 00:02:36,640
just honored to be here with such a

32
00:02:43,270 --> 00:02:40,319
notable scientist as yourself dr z

33
00:02:45,430 --> 00:02:43,280
uh and we're proud to have you a part of

34
00:02:48,869 --> 00:02:45,440
the nasa family

35
00:02:51,190 --> 00:02:48,879
now tell us a little bit about these two

36
00:02:53,190 --> 00:02:51,200
missions to venus

37
00:02:55,910 --> 00:02:53,200
so first of all you just said their

38
00:02:59,030 --> 00:02:55,920

missions to venus now be aware we have

39
00:03:02,149 --> 00:02:59,040
not been on venus for over 30 years here

40
00:03:03,589 --> 00:03:02,159
at nasa and so basically of all

41
00:03:04,710 --> 00:03:03,599
rocky planets that are in our

42
00:03:06,630 --> 00:03:04,720
neighborhood

43
00:03:09,190 --> 00:03:06,640
it's the one planet we know the least

44
00:03:12,790 --> 00:03:09,200
amount so the two planet the two uh

45
00:03:15,350 --> 00:03:12,800
missions called veritas and davinci plus

46
00:03:18,390 --> 00:03:15,360
will map the surface of venus at 100

47
00:03:19,270 --> 00:03:18,400
times the resolution we know today and

48
00:03:21,589 --> 00:03:19,280
will

49
00:03:23,750 --> 00:03:21,599
analyze the atmosphere

50
00:03:26,229 --> 00:03:23,760
that has the whole history of the that

51
00:03:28,710 --> 00:03:26,239
very thick atmosphere of venus really

52
00:03:32,949 --> 00:03:28,720
making the first such measurements ever

53
00:03:35,430 --> 00:03:32,959
so as we move away from the sun

54
00:03:37,830 --> 00:03:35,440
there's mercury and then there's venus

55
00:03:41,270 --> 00:03:37,840
with a very thick atmosphere and the

56
00:03:44,789 --> 00:03:41,280
next one out is earth

57
00:03:47,270 --> 00:03:44,799
with a habitable atmosphere

58
00:03:50,630 --> 00:03:47,280
and then comes mars

59
00:03:51,670 --> 00:03:50,640
with a very minimal atmosphere

60
00:03:54,630 --> 00:03:51,680
so

61
00:03:57,589 --> 00:03:54,640
we're going to find out why

62
00:04:00,630 --> 00:03:57,599
venus has such a thick atmosphere and

63
00:04:02,710 --> 00:04:00,640

why it traps all that heat like the

64
00:04:05,589 --> 00:04:02,720
greenhouse effect

65
00:04:09,190 --> 00:04:05,599
that it can even melt

66
00:04:11,030 --> 00:04:09,200
lead on the surface tell us about that

67
00:04:13,270 --> 00:04:11,040
it's absolutely incredible and what's so

68
00:04:16,150 --> 00:04:13,280
hustling about it is we think that if we

69
00:04:18,310 --> 00:04:16,160
looked at let's take venus earth and

70
00:04:20,629 --> 00:04:18,320
mars three billion years ago they would

71
00:04:23,510 --> 00:04:20,639
be roughly the same modest type

72
00:04:24,390 --> 00:04:23,520
atmosphere and and as you said correctly

73
00:04:26,710 --> 00:04:24,400
the

74
00:04:29,030 --> 00:04:26,720
planet venus went a really horrible

75
00:04:31,590 --> 00:04:29,040
track right kind of trapping this and

76
00:04:33,909 --> 00:04:31,600
frankly we don't know today why that is

77
00:04:35,270 --> 00:04:33,919
we know the greenhouse effect is a

78
00:04:36,710 --> 00:04:35,280
really important part and of course

79
00:04:39,510 --> 00:04:36,720
that's something we worry about

80
00:04:42,710 --> 00:04:39,520
tremendously at earth as well enormously

81
00:04:46,550 --> 00:04:42,720
because we are heating up the more we

82
00:04:49,030 --> 00:04:46,560
put things like co2 and methane up in

83
00:04:52,390 --> 00:04:49,040
the upper atmosphere it's going to trap

84
00:04:54,790 --> 00:04:52,400
that heat and we'll continue to see the

85
00:04:56,390 --> 00:04:54,800
effects of heating of the earth

86
00:04:59,510 --> 00:04:56,400
as we

87
00:05:00,870 --> 00:04:59,520
learn more about venus how is it that we

88
00:05:03,749 --> 00:05:00,880

learn enough

89
00:05:07,430 --> 00:05:03,759
to be able to discover more

90
00:05:09,590 --> 00:05:07,440
solar systems and other galaxies

91
00:05:11,110 --> 00:05:09,600
with other planets that we call

92
00:05:13,510 --> 00:05:11,120
exoplanets

93
00:05:15,590 --> 00:05:13,520
i love that kind of when we made this

94
00:05:17,590 --> 00:05:15,600
election we were focused on that just

95
00:05:19,510 --> 00:05:17,600
the same way as you're indicating we

96
00:05:21,749 --> 00:05:19,520
have over 6 000 planets that we've

97
00:05:24,870 --> 00:05:21,759
discovered and so many of them are what

98
00:05:26,870 --> 00:05:24,880
we will call venus so they're like

99
00:05:28,790 --> 00:05:26,880
a little bit like you know rocky planets

100
00:05:31,510 --> 00:05:28,800
like the earth but they have very strong

101
00:05:33,749 --> 00:05:31,520
atmospheres and frankly we don't know

102
00:05:37,510 --> 00:05:33,759
our venus so how could we understand

103
00:05:39,270 --> 00:05:37,520
these other venuses all over that galaxy

104
00:05:42,870 --> 00:05:39,280
around other stars

105
00:05:45,110 --> 00:05:42,880
well i'm so excited about this not only

106
00:05:48,469 --> 00:05:45,120
are we going to send humans

107
00:05:50,150 --> 00:05:48,479
back out into the cosmos further out of

108
00:05:53,029 --> 00:05:50,160
low earth orbit

109
00:05:56,230 --> 00:05:53,039
but we're also going to be concentrating

110
00:05:58,230 --> 00:05:56,240
on science and part of our science

111
00:05:59,510 --> 00:05:58,240
is that we're looking at planetary

112
00:06:03,029 --> 00:05:59,520
science

113
00:06:04,309 --> 00:06:03,039

to find out what's out there is there

114
00:06:08,150 --> 00:06:04,319
more

115
00:06:10,790 --> 00:06:08,160
life out there this is an exciting time

116
00:06:15,350 --> 00:06:10,800
to be at nasa

117
00:06:17,430 --> 00:06:15,360
now at this time and i couldn't be more

118
00:06:19,830 --> 00:06:17,440
excited about all of these topics with

119
00:06:22,070 --> 00:06:19,840
humans going away from earth frankly

120
00:06:23,510 --> 00:06:22,080
we're opening up new ways of doing

121
00:06:25,110 --> 00:06:23,520
science as well

122
00:06:27,350 --> 00:06:25,120
and and so we're really excited about

123
00:06:29,749 --> 00:06:27,360
we're cheering on the humans out of the

124
00:06:31,670 --> 00:06:29,759
science director just like our own

125
00:06:34,870 --> 00:06:31,680
robotic ambassadors that are going all

126
00:06:37,450 --> 00:06:34,880
over the solar system thank you dr z and

127
00:06:40,870 --> 00:06:37,460
thank you for joining us today

128
00:06:45,430 --> 00:06:42,950
as you've heard there is so much we can

129
00:06:47,670 --> 00:06:45,440
learn by studying venus from insights

130
00:06:49,909 --> 00:06:47,680
into the evolution of planets to clues

131
00:06:51,589 --> 00:06:49,919
about planets outside our solar system

132
00:06:54,150 --> 00:06:51,599
there's so much to gain

133
00:06:57,270 --> 00:06:54,160
let's take a deeper dive into this

134
00:06:59,830 --> 00:06:57,280
mysterious planet

135
00:07:02,080 --> 00:06:59,840
mysteries abound in our universe but bit

136
00:07:03,589 --> 00:07:02,090
by bit we are unlocking its secrets

137
00:07:05,430 --> 00:07:03,599
[Music]

138
00:07:07,430 --> 00:07:05,440

we now know that our galaxy contains

139
00:07:09,830 --> 00:07:07,440
billions of other planets

140
00:07:12,160 --> 00:07:09,840
but how can we learn more about them

141
00:07:15,350 --> 00:07:12,170
what traits do these exoplanets have

142
00:07:16,950 --> 00:07:15,360
[Music]

143
00:07:19,589 --> 00:07:16,960
what are they made of

144
00:07:23,189 --> 00:07:19,599
what are their environments like

145
00:07:23,199 --> 00:07:27,029
are they habitable

146
00:07:31,110 --> 00:07:29,189
and can planets lose habitability over

147
00:07:32,790 --> 00:07:31,120
time

148
00:07:34,000 --> 00:07:32,800
imagine we could study one of these

149
00:07:37,350 --> 00:07:34,010
planets up close

150
00:07:39,990 --> 00:07:37,360
[Music]

151
00:07:41,589 --> 00:07:40,000
we find one at similar size mass and

152
00:07:44,070 --> 00:07:41,599
composition as earth

153
00:07:46,230 --> 00:07:44,080
by all accounts this planet appears very

154
00:07:48,230 --> 00:07:46,240
similar to our own

155
00:07:49,990 --> 00:07:48,240
we discover evidence that this world may

156
00:07:52,150 --> 00:07:50,000
have once had liquid water oceans and

157
00:07:55,670 --> 00:07:52,160
volcanoes a setting that could have been

158
00:07:59,510 --> 00:07:57,830
but over time something drastic happened

159
00:08:02,390 --> 00:07:59,520
to this environment

160
00:08:03,990 --> 00:08:02,400
this planet sun grew brighter and hotter

161
00:08:06,790 --> 00:08:04,000
increasing the temperature here to the

162
00:08:08,950 --> 00:08:06,800
point that the oceans boiled away

163
00:08:10,869 --> 00:08:08,960

and then gradually volcanic gases

164
00:08:12,710 --> 00:08:10,879
created a thick atmosphere with clouds

165
00:08:14,550 --> 00:08:12,720
of sulfuric acid

166
00:08:16,230 --> 00:08:14,560
that once friendly environment

167
00:08:17,909 --> 00:08:16,240
was gone

168
00:08:19,830 --> 00:08:17,919
but all is not lost

169
00:08:21,589 --> 00:08:19,840
the remnants of such a world may hold

170
00:08:24,869 --> 00:08:21,599
the key to understanding planetary

171
00:08:26,710 --> 00:08:24,879
evolution and habitability

172
00:08:29,670 --> 00:08:26,720
the twist is that this isn't science

173
00:08:31,510 --> 00:08:29,680
fiction this planet does exist and if we

174
00:08:33,430 --> 00:08:31,520
want to learn more about the past

175
00:08:35,269 --> 00:08:33,440
present and possible future of our

176
00:08:37,829 --> 00:08:35,279
planet and the billions of similar

177
00:08:41,509 --> 00:08:37,839
exoplanets out there this mysterious one

178
00:08:46,470 --> 00:08:43,190
and it doesn't reside in some distant

179
00:08:47,470 --> 00:08:46,480
solar system truth be told it sits right

180
00:08:49,829 --> 00:08:47,480
next door

181
00:08:52,310 --> 00:08:49,839
[Music]

182
00:08:54,070 --> 00:08:52,320
this planet is venus

183
00:08:56,870 --> 00:08:54,080
and the more mysteries we can unravel

184
00:09:00,389 --> 00:08:56,880
here the more answers we can find out

185
00:09:03,350 --> 00:09:01,829
it's incredible

186
00:09:05,829 --> 00:09:03,360
and now that we've learned a little bit

187
00:09:08,310 --> 00:09:05,839
about the destination let's hear from

188
00:09:10,389 --> 00:09:08,320

two experts to tell us about these new

189
00:09:12,150 --> 00:09:10,399
missions and remember throughout the

190
00:09:15,509 --> 00:09:12,160
show you can send in your questions

191
00:09:17,110 --> 00:09:15,519
using the hashtag asknasa or commenting

192
00:09:18,389 --> 00:09:17,120
in the stream wherever you're watching

193
00:09:21,269 --> 00:09:18,399
this

194
00:09:24,070 --> 00:09:21,279
we're now joined by two very exciting

195
00:09:25,750 --> 00:09:24,080
guests dr jim garvin the principal

196
00:09:28,949 --> 00:09:25,760
investigator for the da vinci plus

197
00:09:30,389 --> 00:09:28,959
mission and dr sue smrenkar the physic

198
00:09:32,630 --> 00:09:30,399
the principal investigator for the

199
00:09:34,070 --> 00:09:32,640
veritas mission thank you both for being

200
00:09:36,630 --> 00:09:34,080
here

201
00:09:38,790 --> 00:09:36,640
thanks for having us

202
00:09:41,269 --> 00:09:38,800
so first of all congratulations on the

203
00:09:43,269 --> 00:09:41,279
big news it must be so exciting to have

204
00:09:45,110 --> 00:09:43,279
your mission selected uh can you both

205
00:09:46,550 --> 00:09:45,120
tell us how it feels to have gone to

206
00:09:48,070 --> 00:09:46,560
this point why don't we start with dr

207
00:09:50,870 --> 00:09:48,080
garvin

208
00:09:52,790 --> 00:09:50,880
well karen it's beyond enthralling it's

209
00:09:54,790 --> 00:09:52,800
actually beyond words uh for me

210
00:09:57,269 --> 00:09:54,800
personally and for our team on da vinci

211
00:10:00,070 --> 00:09:57,279
plus carrying the name of leonardo to

212
00:10:02,949 --> 00:10:00,080
explore venus this mystery exoplanet

213
00:10:05,030 --> 00:10:02,959

next door it's just mind-boggling we're

214
00:10:07,590 --> 00:10:05,040
going to go back in time to understand a

215
00:10:09,430 --> 00:10:07,600
world that's been a lost horizon and by

216
00:10:10,949 --> 00:10:09,440
bringing ourselves there with the best

217
00:10:12,630 --> 00:10:10,959
of the technologies we have in our

218
00:10:15,190 --> 00:10:12,640
measurement systems we're going to open

219
00:10:16,710 --> 00:10:15,200
up the venus frontier for for everyone

220
00:10:19,269 --> 00:10:16,720
and the people of the planet earth will

221
00:10:22,710 --> 00:10:19,279
go with us so we're ready to go thanks

222
00:10:28,470 --> 00:10:26,230
yeah it's absolutely exhilarating um i

223
00:10:30,710 --> 00:10:28,480
think it must be like what it means to

224
00:10:32,870 --> 00:10:30,720
uh you know get on a rocket and be

225
00:10:34,949 --> 00:10:32,880
strapped in and blast off

226
00:10:37,269 --> 00:10:34,959
away from earth's gravity it's just been

227
00:10:39,750 --> 00:10:37,279
an incredible ride we are

228
00:10:42,150 --> 00:10:39,760
uh super excited the entire team in fact

229
00:10:43,110 --> 00:10:42,160
you know the entire venus community we

230
00:10:45,750 --> 00:10:43,120
we

231
00:10:47,990 --> 00:10:45,760
won the double lottery veritas davinci

232
00:10:50,470 --> 00:10:48,000
together uh it's just

233
00:10:53,350 --> 00:10:50,480
amazingly exciting we so many of us have

234
00:10:55,990 --> 00:10:53,360
spent uh you know decades in fact uh

235
00:10:57,990 --> 00:10:56,000
working to this moment so it's

236
00:11:00,550 --> 00:10:58,000
an incredible ride and we uh yeah we

237
00:11:02,710 --> 00:11:00,560
can't wait to get the keys and start

238
00:11:05,030 --> 00:11:02,720

revving up and building your spacecraft

239
00:11:07,670 --> 00:11:05,040
to take us to venus

240
00:11:09,030 --> 00:11:07,680
well congratulations so here we are we

241
00:11:10,470 --> 00:11:09,040
have just selected these two new

242
00:11:13,670 --> 00:11:10,480
missions to explore the mysteries of

243
00:11:16,470 --> 00:11:13,680
venus could you each explain the goals

244
00:11:18,389 --> 00:11:16,480
of veritas and davinci plus i'd like to

245
00:11:20,150 --> 00:11:18,399
know how they differ and in what areas

246
00:11:22,389 --> 00:11:20,160
will they work together we'll go to dr

247
00:11:23,509 --> 00:11:22,399
strencar first

248
00:11:26,069 --> 00:11:23,519
sure so

249
00:11:28,470 --> 00:11:26,079
you know as you heard about in the

250
00:11:31,590 --> 00:11:28,480
conversation with um

251
00:11:33,350 --> 00:11:31,600
senator nelson and dr subukin

252
00:11:35,670 --> 00:11:33,360
we really want to understand rocky

253
00:11:37,590 --> 00:11:35,680
planets um what makes them habitable

254
00:11:39,910 --> 00:11:37,600
what makes them tick you know both in

255
00:11:42,870 --> 00:11:39,920
our solar system and in other solar

256
00:11:46,389 --> 00:11:42,880
systems veritas and davinci are really

257
00:11:48,949 --> 00:11:46,399
aimed at that we want to uh on veritas

258
00:11:50,150 --> 00:11:48,959
get a global view of the surface of

259
00:11:52,150 --> 00:11:50,160
venus

260
00:11:54,310 --> 00:11:52,160
we'll be peeling back the clouds using

261
00:11:55,750 --> 00:11:54,320
special special instruments to see

262
00:11:58,230 --> 00:11:55,760
through the clouds

263
00:11:59,670 --> 00:11:58,240

and revealing the geologic history uh

264
00:12:01,910 --> 00:11:59,680
we're looking for processes that are

265
00:12:03,509 --> 00:12:01,920
active today and you know really

266
00:12:06,470 --> 00:12:03,519
understanding how the interior venus

267
00:12:08,150 --> 00:12:06,480
from its core to its surface geology to

268
00:12:10,230 --> 00:12:08,160
the volcanoes that help create the

269
00:12:11,750 --> 00:12:10,240
atmosphere how they all interact and

270
00:12:13,829 --> 00:12:11,760
help um

271
00:12:15,829 --> 00:12:13,839
build a powerful planet in the past and

272
00:12:21,190 --> 00:12:15,839
where it went wrong to become this

273
00:12:24,629 --> 00:12:23,829
oh and i'll just say you know sorry

274
00:12:26,790 --> 00:12:24,639
well

275
00:12:28,470 --> 00:12:26,800
sorry for the introduction

276
00:12:30,790 --> 00:12:28,480
i'm thrilled that davinci is there with

277
00:12:32,870 --> 00:12:30,800
us because we really have great synergy

278
00:12:34,150 --> 00:12:32,880
um you know we'll get the global view

279
00:12:35,750 --> 00:12:34,160
and they get the close-up you know this

280
00:12:38,230 --> 00:12:35,760
is just what the mars missions have been

281
00:12:39,190 --> 00:12:38,240
doing for uh decades now having the

282
00:12:41,670 --> 00:12:39,200
global

283
00:12:43,990 --> 00:12:41,680
orbital view and finding super exciting

284
00:12:46,150 --> 00:12:44,000
science targets and uh then going down

285
00:12:47,829 --> 00:12:46,160
to the surface in detail so you know

286
00:12:50,069 --> 00:12:47,839
it's just a great pairing of these two

287
00:12:52,230 --> 00:12:50,079
missions

288
00:12:54,629 --> 00:12:52,240

well thank you and davinci plus is like

289
00:12:56,230 --> 00:12:54,639
a flying rover chemistry lab that

290
00:12:58,230 --> 00:12:56,240
descends to the atmosphere from the

291
00:13:00,710 --> 00:12:58,240
cloud tops to the surface making

292
00:13:02,629 --> 00:13:00,720
measurements by ingesting the atmosphere

293
00:13:04,790 --> 00:13:02,639
and measuring it we're bringing sample

294
00:13:06,710 --> 00:13:04,800
return to venus through our meter scale

295
00:13:09,110 --> 00:13:06,720
probe that will see the surface with

296
00:13:11,670 --> 00:13:09,120
human scale eyes in 3d and

297
00:13:13,430 --> 00:13:11,680
compositionally as we take the plunge

298
00:13:15,430 --> 00:13:13,440
and our spacecraft will unravel the

299
00:13:18,150 --> 00:13:15,440
history of the key chemical constituents

300
00:13:20,069 --> 00:13:18,160
in the atmosphere which are like the the

301
00:13:21,430 --> 00:13:20,079
fingerprints of the processes that zoo

302
00:13:23,190 --> 00:13:21,440
is talking about locally and that

303
00:13:25,829 --> 00:13:23,200
atmospheric record will tell us the

304
00:13:27,829 --> 00:13:25,839
history of past and perhaps lost oceans

305
00:13:30,150 --> 00:13:27,839
we'll measure the cycles of carbon and

306
00:13:32,230 --> 00:13:30,160
oxygen and hydrogen and sulfur and

307
00:13:34,069 --> 00:13:32,240
phosphorus which all put together this

308
00:13:35,509 --> 00:13:34,079
massive atmosphere venus is telling us

309
00:13:37,509 --> 00:13:35,519
something because it has this big

310
00:13:39,990 --> 00:13:37,519
atmosphere we're going to go there back

311
00:13:41,910 --> 00:13:40,000
to that lost horizon with our mission to

312
00:13:44,470 --> 00:13:41,920
connect those dots so we can see venus

313
00:13:46,949 --> 00:13:44,480

up close in a suicide and globally so

314
00:13:49,030 --> 00:13:46,959
she can become the exoplanet next door

315
00:13:50,790 --> 00:13:49,040
that tells us how to discover exo

316
00:13:52,870 --> 00:13:50,800
venuses and how they work beyond our

317
00:13:54,550 --> 00:13:52,880
solar system we literally cannot wait to

318
00:13:56,310 --> 00:13:54,560
get started working together with our

319
00:13:59,350 --> 00:13:56,320
partners at veritas this is going to be

320
00:14:01,590 --> 00:13:59,360
an epic ride trust me

321
00:14:03,590 --> 00:14:01,600
so let's talk more about this planet uh

322
00:14:05,910 --> 00:14:03,600
venus is not the closest planet to the

323
00:14:06,790 --> 00:14:05,920
sun but it is the hottest in our solar

324
00:14:09,990 --> 00:14:06,800
system

325
00:14:13,829 --> 00:14:10,000
between the intense heat of 900 degrees

326
00:14:15,750 --> 00:14:13,839
fahrenheit the corrosive sulfuric clouds

327
00:14:17,910 --> 00:14:15,760
and the crushing atmosphere that is 90

328
00:14:20,230 --> 00:14:17,920
times denser than earth's landing a

329
00:14:22,470 --> 00:14:20,240
spacecraft here is incredibly

330
00:14:24,550 --> 00:14:22,480
challenging of the nine soviet probes

331
00:14:28,310 --> 00:14:24,560
that have achieved the feat none lasted

332
00:14:31,269 --> 00:14:28,320
longer than 127 minutes

333
00:14:33,189 --> 00:14:31,279
so dr garvin can you tell us how da

334
00:14:35,509 --> 00:14:33,199
vinci plus will withstand these harsh

335
00:14:37,670 --> 00:14:35,519
conditions and plunge right down into

336
00:14:39,670 --> 00:14:37,680
venus's atmosphere

337
00:14:42,310 --> 00:14:39,680
well what we're going to do is make our

338
00:14:43,990 --> 00:14:42,320

instruments comfy that's key so the

339
00:14:45,590 --> 00:14:44,000
instruments won't feel that harsh

340
00:14:47,670 --> 00:14:45,600
atmosphere that you can see here the

341
00:14:49,990 --> 00:14:47,680
sulfuric acid the dense pressures the

342
00:14:51,670 --> 00:14:50,000
supercritical fluids near the surface we

343
00:14:53,670 --> 00:14:51,680
will encapsulate our instruments so we

344
00:14:55,990 --> 00:14:53,680
can make those tell-tale measurements

345
00:14:58,710 --> 00:14:56,000
hundreds of times while also imaging

346
00:15:00,949 --> 00:14:58,720
this exotic landscape that today may

347
00:15:02,949 --> 00:15:00,959
look very hostile and alien something

348
00:15:05,030 --> 00:15:02,959
out of star wars or star trek but in the

349
00:15:06,949 --> 00:15:05,040
past may have looked like this an ocean

350
00:15:09,030 --> 00:15:06,959
world perhaps an ocean world that

351
00:15:11,110 --> 00:15:09,040
started life like earth for billions of

352
00:15:12,870 --> 00:15:11,120
years we can read that record through

353
00:15:15,030 --> 00:15:12,880
the measurements we make by protecting

354
00:15:17,030 --> 00:15:15,040
our instruments to give us that wild

355
00:15:18,550 --> 00:15:17,040
ride it will be a magical mystery tour

356
00:15:22,230 --> 00:15:18,560
as we make the measurements to put

357
00:15:26,310 --> 00:15:24,069
fantastic

358
00:15:28,550 --> 00:15:26,320
now dr smartcar i understand that

359
00:15:30,550 --> 00:15:28,560
veritas will charge surface elevations

360
00:15:33,110 --> 00:15:30,560
over nearly the entire planet uh to

361
00:15:35,189 --> 00:15:33,120
create three-dimensional reconstructions

362
00:15:37,189 --> 00:15:35,199
of topography and confirm whether

363
00:15:39,590 --> 00:15:37,199

processes like plate tectonics and

364
00:15:42,310 --> 00:15:39,600
volcanism are still active on venus so

365
00:15:44,069 --> 00:15:42,320
can you explain to us why it's important

366
00:15:46,310 --> 00:15:44,079
to understand these particular aspects

367
00:15:49,030 --> 00:15:46,320
of the planet

368
00:15:51,030 --> 00:15:49,040
sure yeah i mean we're kind of

369
00:15:53,110 --> 00:15:51,040
exploring the once in future earth in

370
00:15:55,269 --> 00:15:53,120
effect by going to venus

371
00:15:57,509 --> 00:15:55,279
you know as we've talked venus has this

372
00:15:59,829 --> 00:15:57,519
incredible greenhouse atmosphere today

373
00:16:02,550 --> 00:15:59,839
but um you know it was once much more

374
00:16:04,790 --> 00:16:02,560
habitable and by actually studying the

375
00:16:06,230 --> 00:16:04,800
processes that are we believe active on

376
00:16:08,470 --> 00:16:06,240
the surface today

377
00:16:11,269 --> 00:16:08,480
we can in effect go back to the very

378
00:16:12,069 --> 00:16:11,279
early start of earth's history uh you

379
00:16:13,910 --> 00:16:12,079
know

380
00:16:16,710 --> 00:16:13,920
uh earth probably looked a lot like this

381
00:16:19,189 --> 00:16:16,720
as well as venus in its early days uh

382
00:16:21,749 --> 00:16:19,199
and the process that has been the

383
00:16:23,189 --> 00:16:21,759
dominant uh factor controlling the

384
00:16:25,829 --> 00:16:23,199
earth's surface and much of its

385
00:16:28,629 --> 00:16:25,839
atmosphere is plate tectonics so on

386
00:16:31,430 --> 00:16:28,639
earth plates move past each other and

387
00:16:33,990 --> 00:16:31,440
the process of subduction allows plates

388
00:16:37,269 --> 00:16:34,000

to sink into the mantle

389
00:16:38,949 --> 00:16:37,279
and we think that that that step of one

390
00:16:41,350 --> 00:16:38,959
plate sinking into the mantle is the

391
00:16:43,269 --> 00:16:41,360
very first step in plate tectonics that

392
00:16:45,910 --> 00:16:43,279
has you know set earth down this path of

393
00:16:48,550 --> 00:16:45,920
becoming habitable and um you know

394
00:16:50,550 --> 00:16:48,560
developing continents developing oceans

395
00:16:53,030 --> 00:16:50,560
but what about venus we would think the

396
00:16:54,949 --> 00:16:53,040
same process would happen on venus uh

397
00:16:57,670 --> 00:16:54,959
but it so far it seems to have only

398
00:16:59,910 --> 00:16:57,680
given us subduction so we can go back

399
00:17:01,829 --> 00:16:59,920
effectively to the very first billion or

400
00:17:03,829 --> 00:17:01,839
two years of earth's history and

401
00:17:06,150 --> 00:17:03,839
understand that process of how does

402
00:17:07,510 --> 00:17:06,160
plate tectonics this incredibly complex

403
00:17:09,429 --> 00:17:07,520
process how does it start what are the

404
00:17:11,189 --> 00:17:09,439
conditions that allow it to happen and

405
00:17:13,750 --> 00:17:11,199
that's a really important question for

406
00:17:15,909 --> 00:17:13,760
being able to uh you know look at just

407
00:17:17,990 --> 00:17:15,919
the density the size of exoplanets

408
00:17:19,909 --> 00:17:18,000
around other stars and say you know are

409
00:17:23,990 --> 00:17:19,919
they likely to be habitable should they

410
00:17:26,390 --> 00:17:25,029
all right

411
00:17:27,270 --> 00:17:26,400
so why

412
00:17:29,430 --> 00:17:27,280
now

413
00:17:32,549 --> 00:17:29,440

what has advanced in technology since we

414
00:17:34,390 --> 00:17:32,559
visited venus in the 70s and the 80s

415
00:17:35,590 --> 00:17:34,400
i'll start start with dr garvin this

416
00:17:39,029 --> 00:17:35,600
time

417
00:17:40,870 --> 00:17:39,039
well everything technology science

418
00:17:42,710 --> 00:17:40,880
results modeling what we've learned

419
00:17:45,510 --> 00:17:42,720
about our solar system our universe our

420
00:17:47,590 --> 00:17:45,520
planet is is just an amazing paradigm

421
00:17:49,669 --> 00:17:47,600
shift and so what we thought we knew in

422
00:17:52,710 --> 00:17:49,679
the 70s and 80s has been transformed by

423
00:17:55,590 --> 00:17:52,720
venus missions magellan uh the venus

424
00:17:57,669 --> 00:17:55,600
express agasaki from japan but also by

425
00:18:00,150 --> 00:17:57,679
our capabilities we have instruments now

426
00:18:02,470 --> 00:18:00,160
we can encapsulate to measure things a

427
00:18:04,470 --> 00:18:02,480
hundred times finer than we were able to

428
00:18:05,830 --> 00:18:04,480
measure in the 70s and 80s and by

429
00:18:08,070 --> 00:18:05,840
bringing that

430
00:18:09,909 --> 00:18:08,080
powerful transformative knowledge we can

431
00:18:12,310 --> 00:18:09,919
probe venus atmosphere measure her

432
00:18:13,990 --> 00:18:12,320
surface in ways that were unimaginable

433
00:18:16,390 --> 00:18:14,000
30 40 years ago and that's why we're

434
00:18:18,549 --> 00:18:16,400
going back venus is calling us the

435
00:18:20,390 --> 00:18:18,559
questions the science community have now

436
00:18:22,950 --> 00:18:20,400
about past habitability how does a

437
00:18:24,950 --> 00:18:22,960
planet lose habitability i mean i lose

438
00:18:27,350 --> 00:18:24,960

change not habitability we want to

439
00:18:29,430 --> 00:18:27,360
understand how venus lost that because

440
00:18:31,270 --> 00:18:29,440
that's part of our own destiny perhaps

441
00:18:33,350 --> 00:18:31,280
and reading venus record book through

442
00:18:36,150 --> 00:18:33,360
chemistry through landscapes through

443
00:18:38,230 --> 00:18:36,160
global studies like veritas will do will

444
00:18:41,029 --> 00:18:38,240
change everything and if we don't get to

445
00:18:42,549 --> 00:18:41,039
know our exoplanet next door how will

446
00:18:45,190 --> 00:18:42,559
great new missions like the james webb

447
00:18:47,510 --> 00:18:45,200
space telescope connect our solar system

448
00:18:49,750 --> 00:18:47,520
to the exoplanetary systems beyond

449
00:18:51,350 --> 00:18:49,760
that's a key question we can do that

450
00:18:53,430 --> 00:18:51,360
with the modern techniques of today

451
00:18:55,750 --> 00:18:53,440
davinci plus and veritas we'll both do

452
00:18:59,510 --> 00:18:55,760
that in the 21st century i can't wait to

453
00:19:04,789 --> 00:19:02,630
yeah and uh same same holds for veritas

454
00:19:06,789 --> 00:19:04,799
we are building on the discoveries of

455
00:19:07,750 --> 00:19:06,799
past missions and the technologies

456
00:19:09,830 --> 00:19:07,760
developed

457
00:19:11,510 --> 00:19:09,840
to study the earth to study

458
00:19:13,270 --> 00:19:11,520
other planets

459
00:19:14,789 --> 00:19:13,280
we

460
00:19:16,390 --> 00:19:14,799
have to look through the very dense

461
00:19:18,549 --> 00:19:16,400
clouds you've been seeing these images

462
00:19:21,669 --> 00:19:18,559
of venus's cloud cover

463
00:19:23,430 --> 00:19:21,679

we have to use special tools to peer

464
00:19:25,590 --> 00:19:23,440
through those clouds and

465
00:19:27,270 --> 00:19:25,600
we are building on instruments designed

466
00:19:29,510 --> 00:19:27,280
for the earth we're

467
00:19:31,430 --> 00:19:29,520
going to fly the first ever

468
00:19:33,430 --> 00:19:31,440
instrument so-called spectrometer that

469
00:19:36,230 --> 00:19:33,440
kind of look at the composition of the

470
00:19:38,310 --> 00:19:36,240
surface by peering through the clouds so

471
00:19:40,230 --> 00:19:38,320
uh you know from those instruments to

472
00:19:43,110 --> 00:19:40,240
the cloud cover uh we'll be able to get

473
00:19:44,950 --> 00:19:43,120
an entirely entirely new look and yeah

474
00:19:48,070 --> 00:19:44,960
in this image you're seeing uh what the

475
00:19:49,830 --> 00:19:48,080
topography of hawaii looks like

476
00:19:51,750 --> 00:19:49,840
this is what it looks like currently in

477
00:19:53,029 --> 00:19:51,760
the data we have from magellan you know

478
00:19:55,350 --> 00:19:53,039
you can see that there are some high

479
00:19:57,430 --> 00:19:55,360
points there but we'll just going to be

480
00:19:59,270 --> 00:19:57,440
revealing exquisite detail you can see

481
00:20:01,110 --> 00:19:59,280
that the calderas at the top of the

482
00:20:03,350 --> 00:20:01,120
peaks you can see fault lines you can

483
00:20:05,110 --> 00:20:03,360
see individual flows so we'll get a you

484
00:20:07,830 --> 00:20:05,120
know unprecedented look at the surface

485
00:20:10,310 --> 00:20:07,840
of venus

486
00:20:12,710 --> 00:20:10,320
thank you so much we are also getting

487
00:20:13,669 --> 00:20:12,720
questions from online there's so much

488
00:20:15,029 --> 00:20:13,679

interest

489
00:20:16,950 --> 00:20:15,039
and the questions are coming in on

490
00:20:18,470 --> 00:20:16,960
social media so

491
00:20:20,549 --> 00:20:18,480
for everybody watching remember you can

492
00:20:22,310 --> 00:20:20,559
join the conversation by submitting your

493
00:20:24,950 --> 00:20:22,320
questions using

494
00:20:27,110 --> 00:20:24,960
ask nasa or commenting in the stream

495
00:20:29,430 --> 00:20:27,120
wherever you're watching this and let's

496
00:20:31,350 --> 00:20:29,440
start with a few questions now our first

497
00:20:35,029 --> 00:20:31,360
question is from

498
00:20:37,350 --> 00:20:35,039
vanilla sahu on twitter who asks is

499
00:20:40,230 --> 00:20:37,360
there any reason behind naming the

500
00:20:42,789 --> 00:20:40,240
missions da vinci and veritas let's do

501
00:20:45,270 --> 00:20:42,799
da vinci first and then veritas

502
00:20:47,590 --> 00:20:45,280
well who doesn't love leonardo da vinci

503
00:20:49,510 --> 00:20:47,600
the great renaissance thinker innovator

504
00:20:52,070 --> 00:20:49,520
artist scientist technologist he

505
00:20:54,390 --> 00:20:52,080
invented helicopters he painted the mona

506
00:20:56,230 --> 00:20:54,400
lisa so what we want to do in taking his

507
00:20:58,390 --> 00:20:56,240
name which is also the acronym for our

508
00:21:00,710 --> 00:20:58,400
mission deep atmosphere

509
00:21:02,549 --> 00:21:00,720
exploration of venus with

510
00:21:05,830 --> 00:21:02,559
imaging and measurements of chemistry

511
00:21:07,669 --> 00:21:05,840
and noble gases by taking his great name

512
00:21:09,909 --> 00:21:07,679
catalogued in 500 years of history and

513
00:21:12,390 --> 00:21:09,919

applying it forward to venus we want to

514
00:21:14,230 --> 00:21:12,400
see the new venus rising in the view of

515
00:21:15,669 --> 00:21:14,240
of leonardo and leonardo painted the

516
00:21:17,350 --> 00:21:15,679
mona lisa one of the most famous

517
00:21:19,510 --> 00:21:17,360
paintings of all time we think there's a

518
00:21:21,350 --> 00:21:19,520
moan of venus waiting and we want to

519
00:21:26,149 --> 00:21:21,360
discover that together for all of

520
00:21:31,029 --> 00:21:28,310
well veritas is also an acronym it

521
00:21:32,470 --> 00:21:31,039
stands for venus emissivity radar

522
00:21:35,350 --> 00:21:32,480
science

523
00:21:37,350 --> 00:21:35,360
interferometry topography oops

524
00:21:38,470 --> 00:21:37,360
topography interferometry

525
00:21:40,390 --> 00:21:38,480
um

526
00:21:43,350 --> 00:21:40,400
and spectroscopy

527
00:21:46,070 --> 00:21:43,360
but it means truth and you know it's

528
00:21:47,990 --> 00:21:46,080
been so long since we have been to venus

529
00:21:49,830 --> 00:21:48,000
that there are these ideas from about 30

530
00:21:51,430 --> 00:21:49,840
years ago that i like to call myths that

531
00:21:53,029 --> 00:21:51,440
are still floating around about venus

532
00:21:54,630 --> 00:21:53,039
but we've learned so much about the

533
00:21:57,750 --> 00:21:54,640
earth and other planets

534
00:21:59,909 --> 00:21:57,760
that um they are really outdated ideas

535
00:22:01,669 --> 00:21:59,919
and we are excited to

536
00:22:05,110 --> 00:22:01,679
bring new instruments to venus and

537
00:22:07,430 --> 00:22:05,120
reveal the truth about venus

538
00:22:09,230 --> 00:22:07,440

that's a very good answer i like it

539
00:22:12,950 --> 00:22:09,240
um

540
00:22:14,870 --> 00:22:12,960
gupta18 on twitter asks which side of

541
00:22:18,070 --> 00:22:14,880
venus will the exploration be carried

542
00:22:19,830 --> 00:22:18,080
out the warmer sunlit side or the colder

543
00:22:22,070 --> 00:22:19,840
sun hidden side i'll start with dr

544
00:22:25,029 --> 00:22:22,080
smartcar for this one then if dr garvin

545
00:22:28,070 --> 00:22:25,039
you want to add on feel free

546
00:22:30,870 --> 00:22:28,080
uh so as an orbiter we see both the uh

547
00:22:33,190 --> 00:22:30,880
sunlit and the uh dark side of unit so

548
00:22:34,950 --> 00:22:33,200
we're constantly going around the planet

549
00:22:37,510 --> 00:22:34,960
and going from one side to the other in

550
00:22:41,110 --> 00:22:37,520
fact uh one of our instruments likes to

551
00:22:43,510 --> 00:22:41,120
uh primarily image on the cooler night

552
00:22:46,310 --> 00:22:43,520
side our spectrometer that will allow us

553
00:22:48,070 --> 00:22:46,320
to get at the composition of the surface

554
00:22:50,070 --> 00:22:48,080
so that instrument only operates on the

555
00:22:53,190 --> 00:22:50,080
night side because the glare off of the

556
00:22:55,190 --> 00:22:53,200
clouds is too intense to

557
00:22:57,190 --> 00:22:55,200
allow us to see the surface

558
00:22:59,430 --> 00:22:57,200
on the day side but our radar instrument

559
00:23:01,110 --> 00:22:59,440
can see the surface all the time so for

560
00:23:04,470 --> 00:23:01,120
the most part we

561
00:23:06,870 --> 00:23:04,480
are operating on both sides

562
00:23:09,029 --> 00:23:06,880
well and karen if i may add

563
00:23:11,590 --> 00:23:09,039

for davinci plus we're going in with our

564
00:23:13,350 --> 00:23:11,600
probe our flying rover on the day side

565
00:23:15,909 --> 00:23:13,360
over a mountainous region known as alfa

566
00:23:17,830 --> 00:23:15,919
richo the first radar bright area seen

567
00:23:19,990 --> 00:23:17,840
from earth with radio telescopes like

568
00:23:22,070 --> 00:23:20,000
our sibo and so we're going to land in

569
00:23:24,070 --> 00:23:22,080
this mountain zone it's twice the size

570
00:23:26,070 --> 00:23:24,080
of texas that's pretty big we're going

571
00:23:27,750 --> 00:23:26,080
to come in there and see the atmosphere

572
00:23:29,590 --> 00:23:27,760
on the sunlit side so we have lots of

573
00:23:31,350 --> 00:23:29,600
illumination you might think it's dark

574
00:23:33,270 --> 00:23:31,360
on the day side of venus but it's not

575
00:23:35,750 --> 00:23:33,280
and as ours probe comes through the

576
00:23:37,430 --> 00:23:35,760
clouds roughly at maybe 90 000 feet

577
00:23:39,190 --> 00:23:37,440
we'll start to see that surface and it

578
00:23:41,190 --> 00:23:39,200
will get sharper and sharper we'll

579
00:23:43,909 --> 00:23:41,200
measure its composition we'll see it in

580
00:23:45,590 --> 00:23:43,919
3d using new machine vision methods and

581
00:23:47,350 --> 00:23:45,600
eventually we'll see human scale

582
00:23:49,590 --> 00:23:47,360
features as if we're coming in on a

583
00:23:51,110 --> 00:23:49,600
helicopter or in your backyard drone so

584
00:23:53,029 --> 00:23:51,120
we're going to use the day side but as

585
00:23:55,350 --> 00:23:53,039
we get there we're going to visit venus

586
00:23:57,590 --> 00:23:55,360
twice on flybys taking movies of the

587
00:23:59,830 --> 00:23:57,600
upper cloud dynamics using ultraviolet

588
00:24:01,909 --> 00:23:59,840

cameras so we can track cloud motions to

589
00:24:04,149 --> 00:24:01,919
look at the climatology so while we go

590
00:24:05,990 --> 00:24:04,159
in on the dayside we will also see some

591
00:24:08,470 --> 00:24:06,000
of the big venus that sue's mission will

592
00:24:13,029 --> 00:24:10,390
great thank you our next question is

593
00:24:16,310 --> 00:24:13,039
also a da vinci question it is from

594
00:24:22,149 --> 00:24:19,590
who is from twitter and asks can the da

595
00:24:24,549 --> 00:24:22,159
vinci plus probe capture images of the

596
00:24:26,230 --> 00:24:24,559
surrounding landscape after it lands on

597
00:24:27,990 --> 00:24:26,240
the surface

598
00:24:29,990 --> 00:24:28,000
so the da vinci plus mission does not

599
00:24:31,750 --> 00:24:30,000
require landing we call ourselves a

600
00:24:33,029 --> 00:24:31,760
landerless lander because we make

601
00:24:35,269 --> 00:24:33,039
measurements all the way through the

602
00:24:36,950 --> 00:24:35,279
atmosphere as if we're landing ourselves

603
00:24:38,870 --> 00:24:36,960
and then we don't have to land because

604
00:24:40,630 --> 00:24:38,880
we'll get all of our data as you can see

605
00:24:42,789 --> 00:24:40,640
the probe being released from our mother

606
00:24:44,549 --> 00:24:42,799
spacecraft developed by lockheed martin

607
00:24:47,029 --> 00:24:44,559
we'll get all those data back to our

608
00:24:49,350 --> 00:24:47,039
mother ship back to earth but if we

609
00:24:51,990 --> 00:24:49,360
survive landing we have the capacity to

610
00:24:53,510 --> 00:24:52,000
operate for a few tens of minutes but we

611
00:24:55,190 --> 00:24:53,520
think our final images and final

612
00:24:56,870 --> 00:24:55,200
chemical measurements made maybe a

613
00:24:58,789 --> 00:24:56,880

hundred meters above the surface and

614
00:25:00,390 --> 00:24:58,799
here we're in the clouds flying through

615
00:25:02,549 --> 00:25:00,400
that area about a hundred thousand feet

616
00:25:05,190 --> 00:25:02,559
high will show us features as small as

617
00:25:07,430 --> 00:25:05,200
baseballs hockey pucks on the surface so

618
00:25:09,190 --> 00:25:07,440
we could see that venus almost as if

619
00:25:10,310 --> 00:25:09,200
we've landed and the probe has

620
00:25:12,390 --> 00:25:10,320
instruments that can measure the

621
00:25:14,470 --> 00:25:12,400
chemistry temperature pressure

622
00:25:16,470 --> 00:25:14,480
composition all the way down

623
00:25:19,029 --> 00:25:16,480
literally as a kind of a drive-by

624
00:25:20,789 --> 00:25:19,039
chemical chemistry lab so we don't have

625
00:25:26,310 --> 00:25:20,799
to land to do our mission it would be

626
00:25:30,470 --> 00:25:27,350
all right

627
00:25:31,750 --> 00:25:30,480
uh next one i will uh also start with dr

628
00:25:33,830 --> 00:25:31,760
schmerkar but

629
00:25:36,390 --> 00:25:33,840
you may well want to join in dr garvin

630
00:25:39,110 --> 00:25:36,400
this is from redclix on twitter who's

631
00:25:41,510 --> 00:25:39,120
asking what really inspired nasa to

632
00:25:43,110 --> 00:25:41,520
return back to venus uh it is really

633
00:25:45,590 --> 00:25:43,120
exciting at the same time it's very

634
00:25:47,590 --> 00:25:45,600
challenging to accomplish this hottest

635
00:25:48,870 --> 00:25:47,600
planet destination

636
00:25:52,789 --> 00:25:48,880
what are your thoughts why do you think

637
00:25:57,029 --> 00:25:54,310
um well

638
00:25:59,990 --> 00:25:57,039

so many reasons but um

639
00:26:01,590 --> 00:26:00,000
you know i we heard from the interview

640
00:26:03,990 --> 00:26:01,600
with uh

641
00:26:05,909 --> 00:26:04,000
senator nelson and dr zubukin about the

642
00:26:07,590 --> 00:26:05,919
different atmospheres and the different

643
00:26:09,190 --> 00:26:07,600
uh surface temperatures for venus and

644
00:26:11,510 --> 00:26:09,200
mars and so you know earth is kind of

645
00:26:14,789 --> 00:26:11,520
like the goldilocks planet is just right

646
00:26:15,990 --> 00:26:14,799
you know and uh mars is uh cold and

647
00:26:17,830 --> 00:26:16,000
barren today

648
00:26:18,870 --> 00:26:17,840
uh venus is super hot and earth is just

649
00:26:19,830 --> 00:26:18,880
right so

650
00:26:21,590 --> 00:26:19,840
um

651
00:26:24,710 --> 00:26:21,600
you know we've learned so much in the

652
00:26:26,149 --> 00:26:24,720
past decades about about mars

653
00:26:28,789 --> 00:26:26,159
and of course we're learning new things

654
00:26:31,430 --> 00:26:28,799
about the earth all the time so

655
00:26:33,669 --> 00:26:31,440
we really need new data for venus to be

656
00:26:35,909 --> 00:26:33,679
able to understand what it is that makes

657
00:26:39,110 --> 00:26:35,919
earth unique why is it the only place we

658
00:26:41,750 --> 00:26:39,120
know of yet that has life why is it uh

659
00:26:43,909 --> 00:26:41,760
so so supremely habitable today we need

660
00:26:45,990 --> 00:26:43,919
big data from venus to be able to answer

661
00:26:47,909 --> 00:26:46,000
this mystery and look for

662
00:26:50,390 --> 00:26:47,919
similarly habitable planets around other

663
00:26:52,630 --> 00:26:50,400

stars

664
00:26:55,269 --> 00:26:52,640
well if i may add karen i would say

665
00:26:58,230 --> 00:26:55,279
agree 100 million with sue but it's

666
00:26:59,909 --> 00:26:58,240
because it's time folks if we ignore our

667
00:27:02,149 --> 00:26:59,919
sister next door

668
00:27:03,669 --> 00:27:02,159
what do you think that says i mean i

669
00:27:05,990 --> 00:27:03,679
guess we ignore our neighbors sometimes

670
00:27:08,310 --> 00:27:06,000
but this case we don't want to but she

671
00:27:10,630 --> 00:27:08,320
has so much to tell us and yes she's

672
00:27:11,990 --> 00:27:10,640
hard but the engineers of planet earth

673
00:27:13,909 --> 00:27:12,000
those women and men that make things

674
00:27:16,230 --> 00:27:13,919
possible that we just talk about all the

675
00:27:18,549 --> 00:27:16,240
time they're going to let us do venus

676
00:27:21,029 --> 00:27:18,559
right so we can use what she's trying to

677
00:27:23,590 --> 00:27:21,039
tell us she's been trying literally

678
00:27:25,510 --> 00:27:23,600
wailing at us over the last 30 40 years

679
00:27:26,710 --> 00:27:25,520
to come home to come back and there's

680
00:27:28,870 --> 00:27:26,720
there's venus as you can see from

681
00:27:30,950 --> 00:27:28,880
magellan a beautiful view we need to go

682
00:27:33,029 --> 00:27:30,960
back because the time is right we have

683
00:27:35,590 --> 00:27:33,039
the tools we have the people we have the

684
00:27:37,750 --> 00:27:35,600
models we have the interest and wouldn't

685
00:27:39,990 --> 00:27:37,760
it be horrible if we didn't know our

686
00:27:42,470 --> 00:27:40,000
sister next door and started to see this

687
00:27:44,149 --> 00:27:42,480
plethora of extra exo venuses that dr

688
00:27:45,669 --> 00:27:44,159

cherbuchen was talking about there may

689
00:27:47,750 --> 00:27:45,679
be dozens of them that we see with our

690
00:27:50,549 --> 00:27:47,760
james webb telescope we have to measure

691
00:27:53,269 --> 00:27:50,559
our venus to understand those venuses

692
00:27:55,350 --> 00:27:53,279
that's what it's all about

693
00:27:57,510 --> 00:27:55,360
thank you

694
00:28:00,630 --> 00:27:57,520
the next question is from william on

695
00:28:03,990 --> 00:28:00,640
facebook who asks what materials will be

696
00:28:05,669 --> 00:28:04,000
used to keep the spacecraft from melting

697
00:28:07,350 --> 00:28:05,679
it's probably a davinci

698
00:28:10,070 --> 00:28:07,360
question for starters but veritas may

699
00:28:11,669 --> 00:28:10,080
well have its own thermal constraints to

700
00:28:14,070 --> 00:28:11,679
work with

701
00:28:16,149 --> 00:28:14,080
well venus is hot and hard as as good

702
00:28:18,389 --> 00:28:16,159
question but we're building our

703
00:28:20,870 --> 00:28:18,399
spacecraft is about a meter diameter

704
00:28:22,549 --> 00:28:20,880
spherical or hemispherical titanium

705
00:28:25,110 --> 00:28:22,559
pressure vessel it's like the bath

706
00:28:26,710 --> 00:28:25,120
escapes that carry great ocean ocean

707
00:28:28,310 --> 00:28:26,720
explorers you can see the da vinci probe

708
00:28:30,789 --> 00:28:28,320
there it's about three and a half feet

709
00:28:33,269 --> 00:28:30,799
across it has spin veins so we can take

710
00:28:35,110 --> 00:28:33,279
beautiful images all the way down um

711
00:28:37,029 --> 00:28:35,120
it's made of titanium and inside we use

712
00:28:38,870 --> 00:28:37,039
a phase change material to keep the

713
00:28:40,549 --> 00:28:38,880

temperature just right for those

714
00:28:43,029 --> 00:28:40,559
exquisite instruments that measure the

715
00:28:45,110 --> 00:28:43,039
chemistry and we have other techniques

716
00:28:47,350 --> 00:28:45,120
special kind of seals that allow just

717
00:28:49,430 --> 00:28:47,360
the atmosphere in when we attempt to

718
00:28:51,269 --> 00:28:49,440
make those ingests of atmosphere and at

719
00:28:53,269 --> 00:28:51,279
other times don't let it in so this

720
00:28:55,269 --> 00:28:53,279
technology it's worked before for our

721
00:28:57,430 --> 00:28:55,279
colleagues in russia we used it in the

722
00:29:00,070 --> 00:28:57,440
late 70s we're advancing it to the 21st

723
00:29:04,470 --> 00:29:00,080
century to open that venus frontier so

724
00:29:09,909 --> 00:29:06,310
yeah and we have a much

725
00:29:12,149 --> 00:29:09,919
easier job in the atmosphere than

726
00:29:13,669 --> 00:29:12,159
davinci has going to the surface but

727
00:29:15,590 --> 00:29:13,679
there's still a lot of heat that

728
00:29:18,230 --> 00:29:15,600
reflects off the clouds especially on

729
00:29:21,029 --> 00:29:18,240
the day side so we do have uh extra

730
00:29:23,750 --> 00:29:21,039
material on our solar panels that allow

731
00:29:24,950 --> 00:29:23,760
us to reflect some of that heat and make

732
00:29:26,789 --> 00:29:24,960
sure there's not too much of a

733
00:29:30,310 --> 00:29:26,799
temperature gradient from one side of

734
00:29:33,669 --> 00:29:32,149
great thank you so much we're still

735
00:29:36,470 --> 00:29:33,679
going remember you can send in your

736
00:29:37,669 --> 00:29:36,480
questions to ask nasa

737
00:29:43,909 --> 00:29:37,679
um

738
00:29:46,870 --> 00:29:43,919

up we have a question from at nickbe24

739
00:29:49,190 --> 00:29:46,880
on twitter who asks what data are you

740
00:29:50,950 --> 00:29:49,200
hoping to collect through these missions

741
00:29:53,990 --> 00:29:50,960
we can do dr samarkar again first and

742
00:29:55,110 --> 00:29:54,000
then dr garvin

743
00:29:56,710 --> 00:29:55,120
we are

744
00:29:59,590 --> 00:29:56,720
excited to be collecting a number of

745
00:30:01,909 --> 00:29:59,600
different data sets global topography

746
00:30:02,870 --> 00:30:01,919
global radar images

747
00:30:05,350 --> 00:30:02,880
we will

748
00:30:06,870 --> 00:30:05,360
get data from our spectrometer about the

749
00:30:09,510 --> 00:30:06,880
surface composition

750
00:30:11,590 --> 00:30:09,520
we look for we use that data to look for

751
00:30:14,230 --> 00:30:11,600
recent volcanism we can get a thermal

752
00:30:16,070 --> 00:30:14,240
signature of active volcanism uh we will

753
00:30:18,149 --> 00:30:16,080
be looking for gases coming from

754
00:30:21,669 --> 00:30:18,159
volcanoes and water in particular given

755
00:30:23,830 --> 00:30:21,679
off by active volcanoes so um and and

756
00:30:25,909 --> 00:30:23,840
lastly we take uh gravity data which

757
00:30:27,909 --> 00:30:25,919
tells us about the core uh about the

758
00:30:30,149 --> 00:30:27,919
mantle and i just want to say we're also

759
00:30:31,830 --> 00:30:30,159
taking data to measure active

760
00:30:33,110 --> 00:30:31,840
deformation on the surface so we have a

761
00:30:37,430 --> 00:30:33,120
bunch of different

762
00:30:40,149 --> 00:30:37,440
um ways to see the surface

763
00:30:41,990 --> 00:30:40,159

well on davinci plus our job is to make

764
00:30:44,389 --> 00:30:42,000
hundreds of exquisite chemical

765
00:30:46,149 --> 00:30:44,399
measurements again as i said an order of

766
00:30:47,830 --> 00:30:46,159
magnitude better than ever made before

767
00:30:49,830 --> 00:30:47,840
and hundreds of times we will make a

768
00:30:52,230 --> 00:30:49,840
complete transect of the atmospheric

769
00:30:54,870 --> 00:30:52,240
chemistry we will sniff the inert noble

770
00:30:56,230 --> 00:30:54,880
gases and look at their isotopic ratios

771
00:30:58,149 --> 00:30:56,240
that's a big word sounds like it's out

772
00:31:00,230 --> 00:30:58,159
of jeopardy but it's not it's something

773
00:31:02,710 --> 00:31:00,240
that allow us to piece together the past

774
00:31:04,950 --> 00:31:02,720
history of venus why was atmosphere

775
00:31:06,950 --> 00:31:04,960
changed and and oceans lost and

776
00:31:08,149 --> 00:31:06,960
volcanoes erupting we can read all that

777
00:31:09,590 --> 00:31:08,159
through the measurements we make in the

778
00:31:11,669 --> 00:31:09,600
atmosphere from our chemistry

779
00:31:13,990 --> 00:31:11,679
measurements we'll also take hundreds of

780
00:31:15,990 --> 00:31:14,000
descent images through our surface port

781
00:31:18,230 --> 00:31:16,000
right at the bottom sapphire window will

782
00:31:19,750 --> 00:31:18,240
let us see the service bright and sharp

783
00:31:22,630 --> 00:31:19,760
just like the landings on mars only

784
00:31:23,990 --> 00:31:22,640
we'll do them in 3d with composition so

785
00:31:25,830 --> 00:31:24,000
we'll be able to measure what the rocks

786
00:31:27,350 --> 00:31:25,840
are like locally to compare to sue's

787
00:31:29,590 --> 00:31:27,360
measurements to the global ones from

788
00:31:31,269 --> 00:31:29,600

veritas and in the in the mount in the

789
00:31:32,789 --> 00:31:31,279
mountains of alpha we're thinking these

790
00:31:34,470 --> 00:31:32,799
could be an ancient continent with

791
00:31:36,870 --> 00:31:34,480
evolved rocks like you'd find in the

792
00:31:39,110 --> 00:31:36,880
mountains of new england or the canadian

793
00:31:41,750 --> 00:31:39,120
shield so we'll make those measurements

794
00:31:43,990 --> 00:31:41,760
and pressure temperature accelerations

795
00:31:45,269 --> 00:31:44,000
all the way down it'll be a wild ride

796
00:31:47,430 --> 00:31:45,279
and that data will be a boundary

797
00:31:49,990 --> 00:31:47,440
condition for scientists for generations

798
00:31:54,710 --> 00:31:52,389
thank you so much uh we have a lot more

799
00:31:57,269 --> 00:31:54,720
questions coming in from from social

800
00:31:58,789 --> 00:31:57,279
media and online but all of you sending

801
00:32:01,029 --> 00:31:58,799
your questions are not the only ones

802
00:32:02,070 --> 00:32:01,039
excited about these new solar system

803
00:32:03,909 --> 00:32:02,080
missions

804
00:32:06,870 --> 00:32:03,919
so we're going to hear from some other

805
00:32:09,190 --> 00:32:06,880
veritas and da vinci plus mission team

806
00:32:11,830 --> 00:32:09,200
members

807
00:32:14,630 --> 00:32:11,840
nasi is returning to venus after 30

808
00:32:18,149 --> 00:32:14,640
years we're going back to venus and our

809
00:32:20,470 --> 00:32:18,159
team of managers engineers scientists

810
00:32:23,909 --> 00:32:20,480
technicians and instrument developers

811
00:32:26,950 --> 00:32:23,919
are ready i was extremely excited to get

812
00:32:30,070 --> 00:32:26,960
to compete with other professionals to

813
00:32:32,389 --> 00:32:30,080

try and put a new mission around venus

814
00:32:33,990 --> 00:32:32,399
hi everybody and good morning i'm an

815
00:32:35,909 --> 00:32:34,000
environment right now that is as

816
00:32:38,470 --> 00:32:35,919
different from venus as you can possibly

817
00:32:40,870 --> 00:32:38,480
be we have water we've got ice we have

818
00:32:42,549 --> 00:32:40,880
trees venus is one of the most enigmatic

819
00:32:44,870 --> 00:32:42,559
worlds that we know of

820
00:32:47,190 --> 00:32:44,880
we have so many unanswered questions

821
00:32:49,750 --> 00:32:47,200
about the planet next door how did venus

822
00:32:52,470 --> 00:32:49,760
form did it have oceans

823
00:32:54,149 --> 00:32:52,480
where did the water go how earth and

824
00:32:57,029 --> 00:32:54,159
venus

825
00:32:59,269 --> 00:32:57,039
became so different what makes a rocky

826
00:33:00,870 --> 00:32:59,279
planet become habitable and what makes

827
00:33:03,269 --> 00:33:00,880
it not what

828
00:33:04,870 --> 00:33:03,279
ancient climate may be preserved in the

829
00:33:07,269 --> 00:33:04,880
rock record you know these are the

830
00:33:10,070 --> 00:33:07,279
compelling questions that drive me to

831
00:33:11,830 --> 00:33:10,080
study venus i am passionate about venus

832
00:33:14,870 --> 00:33:11,840
because it's been a puzzle that has

833
00:33:17,110 --> 00:33:14,880
compounded us for so many decades venus

834
00:33:18,789 --> 00:33:17,120
promises those answers we're going deep

835
00:33:21,029 --> 00:33:18,799
into the atmosphere learning about the

836
00:33:22,710 --> 00:33:21,039
atmosphere we're going into orbit to get

837
00:33:25,029 --> 00:33:22,720
some long-term images

838
00:33:28,070 --> 00:33:25,039

and this should be a fantastic mission i

839
00:33:30,549 --> 00:33:28,080
also as a geologist i'm anxious to see

840
00:33:33,350 --> 00:33:30,559
the surface of venus with my own eyes as

841
00:33:35,909 --> 00:33:33,360
it were i imagine what it is to be in

842
00:33:38,789 --> 00:33:35,919
the cloud of venus to travel through

843
00:33:40,310 --> 00:33:38,799
the transparent hot atmosphere below and

844
00:33:42,950 --> 00:33:40,320
especially the environment near the

845
00:33:45,669 --> 00:33:42,960
surface where the air is so thick that

846
00:33:48,549 --> 00:33:45,679
in some way we are between a gas and a

847
00:33:51,029 --> 00:33:48,559
liquid in my wildest dreams we're gonna

848
00:33:53,509 --> 00:33:51,039
find a venus that is even more

849
00:33:56,470 --> 00:33:53,519
volcanically active than what we observe

850
00:33:57,909 --> 00:33:56,480
on earth today the secrets of venus past

851
00:34:00,230 --> 00:33:57,919
habitability

852
00:34:02,630 --> 00:34:00,240
will allow us to understand

853
00:34:04,870 --> 00:34:02,640
the evolution of earth-sized planets

854
00:34:08,230 --> 00:34:04,880
around other stars i am

855
00:34:09,909 --> 00:34:08,240
very inspired and very happy to continue

856
00:34:12,950 --> 00:34:09,919
in the business of

857
00:34:15,349 --> 00:34:12,960
exploration but also the business of

858
00:34:17,669 --> 00:34:15,359
inspiration we're looking forward to

859
00:34:19,270 --> 00:34:17,679
bringing the scientific community and

860
00:34:21,349 --> 00:34:19,280
the public along with us on our

861
00:34:23,430 --> 00:34:21,359
adventure this is a really exciting

862
00:34:25,750 --> 00:34:23,440
mission and i am so proud to be part of

863
00:34:27,990 --> 00:34:25,760

it i can't wait for the data from

864
00:34:29,990 --> 00:34:28,000
davinci working with a beautiful

865
00:34:31,829 --> 00:34:30,000
spacecraft with clever mission design

866
00:34:32,550 --> 00:34:31,839
and state-of-the-art instruments

867
00:34:34,869 --> 00:34:32,560
and

868
00:34:37,829 --> 00:34:34,879
getting just making that happen it would

869
00:34:41,750 --> 00:34:37,839
be tremendous fun and looking forward to

870
00:34:43,990 --> 00:34:41,760
it go veritas and go da vinci plus

871
00:34:46,829 --> 00:34:44,000
it is so great to see all the excitement

872
00:34:49,750 --> 00:34:46,839
and enthusiasm around these new missions

873
00:34:51,909 --> 00:34:49,760
um speaking of excitement and enthusiasm

874
00:34:53,430 --> 00:34:51,919
let's go back to the questions uh from

875
00:34:55,030 --> 00:34:53,440
all of you at home

876
00:34:58,230 --> 00:34:55,040
sending them in

877
00:35:01,109 --> 00:34:58,240
uh we have a canal a on youtube

878
00:35:03,190 --> 00:35:01,119
who asks will there be new technology on

879
00:35:06,870 --> 00:35:03,200
the missions to venus that hasn't

880
00:35:12,950 --> 00:35:09,510
i'll toss to either of you

881
00:35:14,950 --> 00:35:12,960
well i can just say the technology of

882
00:35:16,390 --> 00:35:14,960
encapsulating the next generation kind

883
00:35:18,230 --> 00:35:16,400
of instruments we're flying to venus the

884
00:35:19,910 --> 00:35:18,240
kind they're operating on mars now in

885
00:35:21,990 --> 00:35:19,920
conditions that are a lot more clement

886
00:35:23,510 --> 00:35:22,000
um had to be invented for us to even

887
00:35:25,349 --> 00:35:23,520
have a chance of flying these missions

888
00:35:27,750 --> 00:35:25,359

these are competitively selected

889
00:35:29,589 --> 00:35:27,760
missions by dr zurbukin and and the

890
00:35:31,430 --> 00:35:29,599
colleagues at nasa so we have to compete

891
00:35:33,829 --> 00:35:31,440
for the right and the chance to do that

892
00:35:36,310 --> 00:35:33,839
and so the technologies we invent are

893
00:35:38,470 --> 00:35:36,320
invented now to go to venus and we hope

894
00:35:41,030 --> 00:35:38,480
we can test new technologies as part of

895
00:35:42,710 --> 00:35:41,040
our technology demonstration experiments

896
00:35:44,550 --> 00:35:42,720
to even extend that further and we have

897
00:35:46,870 --> 00:35:44,560
one on davinci plus to measure the

898
00:35:48,790 --> 00:35:46,880
hyperspectral composition of the upper

899
00:35:50,790 --> 00:35:48,800
clouds of venus to see what are the

900
00:35:53,030 --> 00:35:50,800
mystery absorbers like this is the kind

901
00:35:56,870 --> 00:35:53,040
of future casting we want to do at nasa

902
00:36:00,470 --> 00:35:58,390
yeah i mean we

903
00:36:02,870 --> 00:36:00,480
have another technology demonstration on

904
00:36:06,069 --> 00:36:02,880
veritas it's called a deep space atomic

905
00:36:09,190 --> 00:36:06,079
clock and it is incredibly accurate

906
00:36:10,870 --> 00:36:09,200
and by bringing that new technology

907
00:36:14,470 --> 00:36:10,880
development along

908
00:36:16,630 --> 00:36:14,480
we can help improve our ability to

909
00:36:19,109 --> 00:36:16,640
measure the motion of our spacecraft and

910
00:36:21,349 --> 00:36:19,119
use that to sense the interior of the

911
00:36:22,390 --> 00:36:21,359
planet to incense to sense the gravity

912
00:36:25,030 --> 00:36:22,400
field

913
00:36:28,150 --> 00:36:25,040

and it'll help future missions as well

914
00:36:31,030 --> 00:36:28,160
to be able to provide even better data

915
00:36:33,190 --> 00:36:31,040
for the interior of uh perhaps i see

916
00:36:35,190 --> 00:36:33,200
satellite icy moons or

917
00:36:37,589 --> 00:36:35,200
other bodies where they can fly the deep

918
00:36:40,950 --> 00:36:37,599
space atomic clock in the future

919
00:36:43,349 --> 00:36:40,960
and you know veritas has a lot of excess

920
00:36:44,870 --> 00:36:43,359
launch mass so it's entirely possible

921
00:36:47,190 --> 00:36:44,880
that um

922
00:36:49,750 --> 00:36:47,200
nasa will decide to add another payload

923
00:36:51,190 --> 00:36:49,760
on that's uh you know being developed as

924
00:36:53,510 --> 00:36:51,200
we speak and

925
00:36:54,870 --> 00:36:53,520
may be selected in future competition so

926
00:36:57,349 --> 00:36:54,880
stay tuned we'll see what we actually

927
00:36:58,310 --> 00:36:57,359
launch with

928
00:37:01,589 --> 00:36:58,320
great

929
00:37:03,349 --> 00:37:01,599
uh ziroshuki on youtube asks how are you

930
00:37:06,150 --> 00:37:03,359
going to keep the spacecraft up and

931
00:37:08,150 --> 00:37:06,160
running as long as possible since most

932
00:37:10,870 --> 00:37:08,160
die so fast i'm going to tweak this

933
00:37:13,349 --> 00:37:10,880
slightly um to add just about how long

934
00:37:15,430 --> 00:37:13,359
each mission is expected to to the

935
00:37:17,030 --> 00:37:15,440
lifetime of each mission

936
00:37:20,310 --> 00:37:17,040
but i think it's a starter question for

937
00:37:22,790 --> 00:37:20,320
davinci with going down onto the surface

938
00:37:24,550 --> 00:37:22,800

well our mission is is a little over two

939
00:37:26,950 --> 00:37:24,560
and a half years we actually launch and

940
00:37:28,550 --> 00:37:26,960
fly by venus twice to collect special

941
00:37:30,390 --> 00:37:28,560
atmospheric remote sensing data we're

942
00:37:32,230 --> 00:37:30,400
all about the atmosphere we think that's

943
00:37:33,910 --> 00:37:32,240
the history book of venus that we want

944
00:37:35,510 --> 00:37:33,920
to read and so we'll make these maps of

945
00:37:37,270 --> 00:37:35,520
cloud motions we'll look at the

946
00:37:39,109 --> 00:37:37,280
atmosphere as we look at that of earth

947
00:37:40,390 --> 00:37:39,119
you can see the earth here as we launch

948
00:37:41,589 --> 00:37:40,400
to venus

949
00:37:43,750 --> 00:37:41,599
so we're very excited about that but

950
00:37:45,430 --> 00:37:43,760
then our final mission we release our

951
00:37:47,750 --> 00:37:45,440
probe and you can see us being released

952
00:37:49,430 --> 00:37:47,760
on our transvenous injection

953
00:37:50,870 --> 00:37:49,440
after we launch

954
00:37:53,109 --> 00:37:50,880
but it'll take us about six months to

955
00:37:54,870 --> 00:37:53,119
get the venus we'll fly by venus twice

956
00:37:56,550 --> 00:37:54,880
and then uh going around the sun we'll

957
00:37:58,390 --> 00:37:56,560
come back and we'll release our probe

958
00:38:01,190 --> 00:37:58,400
two days out and then our probe

959
00:38:03,109 --> 00:38:01,200
spacecraft again in an aeroshell will

960
00:38:05,270 --> 00:38:03,119
fly through the atmosphere for about an

961
00:38:07,670 --> 00:38:05,280
hour and reach the surface landing at

962
00:38:09,990 --> 00:38:07,680
about a speed of maybe 20 25 miles an

963
00:38:12,390 --> 00:38:10,000

hour and during that time we'll collect

964
00:38:15,430 --> 00:38:12,400
thousands of data sets of a new type

965
00:38:17,670 --> 00:38:15,440
chemistry imaging composition uh

966
00:38:19,430 --> 00:38:17,680
pressure temperature see the lower

967
00:38:21,829 --> 00:38:19,440
surface of venus for the first time in

968
00:38:23,349 --> 00:38:21,839
this new way and so the overall

969
00:38:25,190 --> 00:38:23,359
probe mission will be about an hour

970
00:38:26,870 --> 00:38:25,200
we've survived in the surface we may

971
00:38:28,390 --> 00:38:26,880
have another couple of tens of minutes

972
00:38:30,310 --> 00:38:28,400
and then our spacecraft will play all

973
00:38:33,589 --> 00:38:30,320
that data back so that's our mission

974
00:38:39,589 --> 00:38:36,630
and for veritas we get to venus very

975
00:38:42,390 --> 00:38:39,599
rapidly in about six months and then we

976
00:38:45,750 --> 00:38:42,400
spend quite a bit of time going from a

977
00:38:48,069 --> 00:38:45,760
big orbit that goes out you know 10 000

978
00:38:51,030 --> 00:38:48,079
kilometers uh and then bringing that

979
00:38:53,270 --> 00:38:51,040
orbit down slowly to being just a few

980
00:38:56,470 --> 00:38:53,280
hundred miles above the surface

981
00:38:57,829 --> 00:38:56,480
so uh we actually use our solar panels

982
00:39:00,870 --> 00:38:57,839
uh to

983
00:39:04,310 --> 00:39:00,880
effectively act like a drag flaps um you

984
00:39:06,470 --> 00:39:04,320
know you have a spoiler in the back of a

985
00:39:08,630 --> 00:39:06,480
racing car well we use our solar panels

986
00:39:11,750 --> 00:39:08,640
instead and we dip gently into the

987
00:39:14,069 --> 00:39:11,760
atmosphere and it slows us down over the

988
00:39:15,990 --> 00:39:14,079

over the course of about a year and in

989
00:39:18,310 --> 00:39:16,000
that time we get into the precise orbit

990
00:39:19,750 --> 00:39:18,320
we need to be in to

991
00:39:22,069 --> 00:39:19,760
get the best performance out of our

992
00:39:23,990 --> 00:39:22,079
instruments so uh you know after about

993
00:39:26,069 --> 00:39:24,000
uh two years we're ready to start taking

994
00:39:27,910 --> 00:39:26,079
our science data and we spend about

995
00:39:28,790 --> 00:39:27,920
three and a half years acquiring science

996
00:39:31,750 --> 00:39:28,800
data

997
00:39:34,310 --> 00:39:31,760
mapping in a series of global houses

998
00:39:36,710 --> 00:39:34,320
around the planet

999
00:39:38,470 --> 00:39:36,720
thank you so much the next one up is a

1000
00:39:41,349 --> 00:39:38,480
davinci question

1001
00:39:43,750 --> 00:39:41,359
john spelman on youtube asks will da

1002
00:39:45,910 --> 00:39:43,760
vinci plus be able to detect phosphate

1003
00:39:47,589 --> 00:39:45,920
molecules what would it mean for future

1004
00:39:50,069 --> 00:39:47,599
emissions if phosphine was actually

1005
00:39:52,230 --> 00:39:50,079
discovered by da vinci

1006
00:39:54,630 --> 00:39:52,240
so first davinci has two analytical

1007
00:39:55,910 --> 00:39:54,640
chemistry experiments one can detect

1008
00:39:57,829 --> 00:39:55,920
phosphine throughout the entire

1009
00:39:59,829 --> 00:39:57,839
atmosphere especially from the lower

1010
00:40:01,670 --> 00:39:59,839
clouds all the way to the surface where

1011
00:40:03,510 --> 00:40:01,680
none of no species with phosphorus have

1012
00:40:05,829 --> 00:40:03,520
been detected so we will be looking for

1013
00:40:07,750 --> 00:40:05,839

that with exquisite detail like the

1014
00:40:09,510 --> 00:40:07,760
measurements being made on mars now with

1015
00:40:10,950 --> 00:40:09,520
our our instrument we also have an

1016
00:40:13,109 --> 00:40:10,960
instrument that's a very special one

1017
00:40:15,270 --> 00:40:13,119
that uses lasers and scattering that

1018
00:40:17,030 --> 00:40:15,280
that can measure lots of great species

1019
00:40:18,870 --> 00:40:17,040
and we can adapt that instrument by

1020
00:40:19,990 --> 00:40:18,880
adding a new channel which is an option

1021
00:40:22,309 --> 00:40:20,000
that we'll be pursuing in the next

1022
00:40:24,150 --> 00:40:22,319
couple years to specifically measure the

1023
00:40:26,470 --> 00:40:24,160
phosphate that's such an exciting

1024
00:40:28,390 --> 00:40:26,480
possibility for venus the bigger point

1025
00:40:30,390 --> 00:40:28,400
though is we will measure the chemical

1026
00:40:32,870 --> 00:40:30,400
context of all those interesting trace

1027
00:40:34,790 --> 00:40:32,880
gases phosphine which smells like swamp

1028
00:40:35,670 --> 00:40:34,800
gas but other ones that might be equally

1029
00:40:37,670 --> 00:40:35,680
interesting that we haven't even

1030
00:40:39,750 --> 00:40:37,680
discovered yet and by producing that

1031
00:40:42,550 --> 00:40:39,760
context we can start to think about

1032
00:40:44,870 --> 00:40:42,560
venus as an astrobiological target so

1033
00:40:46,790 --> 00:40:44,880
it's not just phosphine it's all of the

1034
00:40:48,390 --> 00:40:46,800
context of the chemistry of this rich

1035
00:40:49,510 --> 00:40:48,400
atmosphere that could have had a

1036
00:40:53,829 --> 00:40:49,520
habitable

1037
00:40:56,069 --> 00:40:53,839
past or not but we need the context to

1038
00:40:57,270 --> 00:40:56,079

understand that possibility that's how

1039
00:40:58,390 --> 00:40:57,280
the astrobiology community has

1040
00:41:01,589 --> 00:40:58,400
recommended we work and that's what

1041
00:41:02,630 --> 00:41:01,599
we're going to do with davinci plus

1042
00:41:04,390 --> 00:41:02,640
thank you

1043
00:41:06,870 --> 00:41:04,400
next one is a vulcanology question so

1044
00:41:10,390 --> 00:41:06,880
i'm going to toss this one to dr smrekar

1045
00:41:12,710 --> 00:41:10,400
um srivasa m on youtube asks a

1046
00:41:14,790 --> 00:41:12,720
speculative question about earth if all

1047
00:41:15,910 --> 00:41:14,800
the volcanoes on earth started erupting

1048
00:41:17,829 --> 00:41:15,920
at once

1049
00:41:19,430 --> 00:41:17,839
could that turn earth to look into

1050
00:41:21,750 --> 00:41:19,440
something like venus in just a couple of

1051
00:41:25,190 --> 00:41:21,760
decades

1052
00:41:28,790 --> 00:41:25,200
uh it was a hard one a lot more

1053
00:41:31,910 --> 00:41:28,800
yeah and um you know i will have to uh

1054
00:41:33,030 --> 00:41:31,920
draw on some uh conclusions that i'll

1055
00:41:35,430 --> 00:41:33,040
um

1056
00:41:36,790 --> 00:41:35,440
put together as we speak but

1057
00:41:39,190 --> 00:41:36,800
there are

1058
00:41:41,589 --> 00:41:39,200
about a couple dozen active volcanoes on

1059
00:41:42,790 --> 00:41:41,599
venus and there are many on earth hardly

1060
00:41:44,069 --> 00:41:42,800
and uh

1061
00:41:46,550 --> 00:41:44,079
there are

1062
00:41:49,349 --> 00:41:46,560
many more that haven't erupted recently

1063
00:41:50,950 --> 00:41:49,359

so if we take all of those and put them

1064
00:41:52,950 --> 00:41:50,960
together

1065
00:41:54,870 --> 00:41:52,960
we would certainly have a very big

1066
00:41:56,710 --> 00:41:54,880
impact on our climate

1067
00:41:57,589 --> 00:41:56,720
and we would feel that you know right

1068
00:42:00,470 --> 00:41:57,599
away

1069
00:42:03,190 --> 00:42:00,480
but uh it would not turn us into a venus

1070
00:42:05,190 --> 00:42:03,200
that would take you know probably

1071
00:42:07,349 --> 00:42:05,200
hundreds of millions of years before you

1072
00:42:10,390 --> 00:42:07,359
get to such an extreme point

1073
00:42:12,870 --> 00:42:10,400
as um as venus is and you know really

1074
00:42:15,589 --> 00:42:12,880
the major difference between the climate

1075
00:42:17,829 --> 00:42:15,599
of earth and venus is that on earth

1076
00:42:21,270 --> 00:42:17,839
because we still have our oceans

1077
00:42:23,589 --> 00:42:21,280
um the co2 the carbon dioxide is locked

1078
00:42:26,390 --> 00:42:23,599
up in our rocks and our carbonate rocks

1079
00:42:28,390 --> 00:42:26,400
they that carbonate gas dissolves in the

1080
00:42:29,589 --> 00:42:28,400
ocean and it precipitated out it's just

1081
00:42:32,230 --> 00:42:29,599
sank to the bottom and created these

1082
00:42:33,910 --> 00:42:32,240
carbonate rocks and so uh you know

1083
00:42:36,390 --> 00:42:33,920
unless we release all that carbon

1084
00:42:40,150 --> 00:42:36,400
dioxide back into the atmosphere uh

1085
00:42:42,390 --> 00:42:40,160
we'll never become like venus

1086
00:42:49,750 --> 00:42:42,400
good to know

1087
00:42:49,760 --> 00:42:52,550
like venus

1088
00:42:58,309 --> 00:42:55,430

all right next question lou on facebook

1089
00:43:00,710 --> 00:42:58,319
asks is it true that venus's atmosphere

1090
00:43:02,870 --> 00:43:00,720
smells like rotten eggs

1091
00:43:04,630 --> 00:43:02,880
who wants to take that one

1092
00:43:05,910 --> 00:43:04,640
well i can give a stab and sue can

1093
00:43:08,630 --> 00:43:05,920
obviously finish

1094
00:43:11,109 --> 00:43:08,640
so rotten eggs of course is an acquired

1095
00:43:12,470 --> 00:43:11,119
smell based on gases

1096
00:43:14,470 --> 00:43:12,480
compounds that involve hydrogen and

1097
00:43:15,910 --> 00:43:14,480
sulfur we'll be able to measure those

1098
00:43:18,069 --> 00:43:15,920
but however the most of the absolute

1099
00:43:20,470 --> 00:43:18,079
venus is made of carbon dioxide with

1100
00:43:22,470 --> 00:43:20,480
nitrogen and argon and other inert gases

1101
00:43:24,470 --> 00:43:22,480
so a portion of the atmosphere and the

1102
00:43:26,550 --> 00:43:24,480
clouds you just saw is where we expect

1103
00:43:28,870 --> 00:43:26,560
to find those special

1104
00:43:30,790 --> 00:43:28,880
sulfur and hydrogen compounds

1105
00:43:32,550 --> 00:43:30,800
and that constitutes this really thick

1106
00:43:34,790 --> 00:43:32,560
cloud deck that's very difficult to see

1107
00:43:36,710 --> 00:43:34,800
through needing instruments like sue has

1108
00:43:39,030 --> 00:43:36,720
but we'll be sniffing those with

1109
00:43:40,470 --> 00:43:39,040
instruments not human noses to measure

1110
00:43:42,150 --> 00:43:40,480
what they're made of and tell you

1111
00:43:44,630 --> 00:43:42,160
specifically would they smell like

1112
00:43:46,550 --> 00:43:44,640
rotten eggs or swamp gas or other things

1113
00:43:47,829 --> 00:43:46,560

that would be very exciting to smell and

1114
00:43:50,230 --> 00:43:47,839
i think we'll connect the smells of

1115
00:43:55,750 --> 00:43:50,240
humanity to the measurements of venus if

1116
00:44:00,550 --> 00:43:58,069
well i will leave it at that uh

1117
00:44:01,589 --> 00:44:00,560
the next question is kaden kolbath on

1118
00:44:04,470 --> 00:44:01,599
youtube

1119
00:44:06,470 --> 00:44:04,480
who asks how long does it take to get to

1120
00:44:07,990 --> 00:44:06,480
venus

1121
00:44:09,990 --> 00:44:08,000
dr schmecker mentioned that why don't we

1122
00:44:13,589 --> 00:44:10,000
go to you for this one

1123
00:44:16,630 --> 00:44:13,599
sure um well it depends on um how close

1124
00:44:18,790 --> 00:44:16,640
you are to venus when you launch but uh

1125
00:44:21,190 --> 00:44:18,800
we have different possible trajectories

1126
00:44:24,390 --> 00:44:21,200
that will get us there from anywhere as

1127
00:44:26,470 --> 00:44:24,400
short as uh you know four months to as

1128
00:44:28,950 --> 00:44:26,480
long as nine months but we're hoping for

1129
00:44:34,150 --> 00:44:28,960
a sweet swat sweet spot around six

1130
00:44:39,109 --> 00:44:37,030
all right i'm going to add on uh a

1131
00:44:41,430 --> 00:44:39,119
slight addition to that question from

1132
00:44:43,430 --> 00:44:41,440
future starman on twitter who's also

1133
00:44:44,790 --> 00:44:43,440
asking how long until the missions are

1134
00:44:47,910 --> 00:44:44,800
ready

1135
00:44:53,270 --> 00:44:48,710
well

1136
00:44:55,829 --> 00:44:53,280
we could be as ready as early as 26 um

1137
00:44:57,910 --> 00:44:55,839
nasa has asked us to be ready to launch

1138
00:44:59,990 --> 00:44:57,920

in uh 28

1139
00:45:01,430 --> 00:45:00,000
that works best for their phasing of all

1140
00:45:04,470 --> 00:45:01,440
their various missions so that's our

1141
00:45:07,109 --> 00:45:04,480
goal at the moment

1142
00:45:09,670 --> 00:45:07,119
right nasa has dictated launch scenarios

1143
00:45:11,109 --> 00:45:09,680
for us based on funding profiles which

1144
00:45:13,510 --> 00:45:11,119
we're grateful

1145
00:45:15,990 --> 00:45:13,520
grateful to have and so our missions are

1146
00:45:18,230 --> 00:45:16,000
scheduled for the 28 to 2030 time frame

1147
00:45:20,230 --> 00:45:18,240
to reach venus and so that's going to be

1148
00:45:21,829 --> 00:45:20,240
a great time to go to venus james webb

1149
00:45:23,430 --> 00:45:21,839
will be flying we'll be seeing exo

1150
00:45:25,829 --> 00:45:23,440
venuses maybe they'll look like the

1151
00:45:27,670 --> 00:45:25,839
venus we see here from magellan so we

1152
00:45:30,470 --> 00:45:27,680
can't wait sooner would be better but

1153
00:45:31,750 --> 00:45:30,480
we'll take anything

1154
00:45:32,950 --> 00:45:31,760
all right tell us a little bit more

1155
00:45:34,950 --> 00:45:32,960
about venus we're getting some good

1156
00:45:38,470 --> 00:45:34,960
questions about the planet itself

1157
00:45:41,589 --> 00:45:38,480
sonia on facebook asks does venus have

1158
00:45:45,670 --> 00:45:43,270
uh well i can take that one we're going

1159
00:45:48,230 --> 00:45:45,680
to measure the gravity field of venus

1160
00:45:50,870 --> 00:45:48,240
very precisely and uh absolutely it has

1161
00:45:52,710 --> 00:45:50,880
gravity it's um sorry i keep

1162
00:45:54,150 --> 00:45:52,720
going the wrong direction here

1163
00:45:56,870 --> 00:45:54,160

but um

1164
00:45:59,109 --> 00:45:56,880
i need gravity to hold it in place um

1165
00:46:01,430 --> 00:45:59,119
yeah so

1166
00:46:03,670 --> 00:46:01,440
we are going to measure the gravity it

1167
00:46:05,990 --> 00:46:03,680
is just slightly less than that of the

1168
00:46:06,950 --> 00:46:06,000
earth because it is slightly smaller

1169
00:46:08,069 --> 00:46:06,960
planet

1170
00:46:10,870 --> 00:46:08,079
um so

1171
00:46:14,790 --> 00:46:10,880
the gravity at the surface is about 10

1172
00:46:16,630 --> 00:46:14,800
less than on earth

1173
00:46:20,069 --> 00:46:16,640
all right this one will be for you as

1174
00:46:22,870 --> 00:46:20,079
well dr smrekar robert on facebook asks

1175
00:46:24,790 --> 00:46:22,880
is there evidence that oceans existed or

1176
00:46:26,390 --> 00:46:24,800
are they theoretical

1177
00:46:27,589 --> 00:46:26,400
actually i take it back i think either

1178
00:46:29,990 --> 00:46:27,599
of you can answer that da vinci is

1179
00:46:33,270 --> 00:46:30,000
looking for oceans so i i may toss this

1180
00:46:35,109 --> 00:46:33,280
one to dr garvan i got that backwards

1181
00:46:37,430 --> 00:46:35,119
well uh karen i can take a stab and i

1182
00:46:39,910 --> 00:46:37,440
think sushi it as well so

1183
00:46:40,950 --> 00:46:39,920
the evidence of oceans is recorded in

1184
00:46:43,030 --> 00:46:40,960
the

1185
00:46:45,589 --> 00:46:43,040
measurements that were made from

1186
00:46:46,790 --> 00:46:45,599
spacecraft in the late 70s that involved

1187
00:46:48,790 --> 00:46:46,800
measuring the what are called the

1188
00:46:50,630 --> 00:46:48,800

isotopes of hydrogen and that critical

1189
00:46:53,030 --> 00:46:50,640
ratio of regular hydrogen and heavy

1190
00:46:54,710 --> 00:46:53,040
hydrogen gives us an insight on how much

1191
00:46:56,710 --> 00:46:54,720
water bound

1192
00:46:58,309 --> 00:46:56,720
in hydrogen molecules was present and we

1193
00:47:00,630 --> 00:46:58,319
made that measurement thanks to pioneer

1194
00:47:02,069 --> 00:47:00,640
venus large probe and since then

1195
00:47:03,430 --> 00:47:02,079
atmospheric high atmospheric

1196
00:47:04,950 --> 00:47:03,440
measurements been made by the venus

1197
00:47:07,349 --> 00:47:04,960
express mission and they show a

1198
00:47:09,349 --> 00:47:07,359
possibility of very grand oceans but the

1199
00:47:11,589 --> 00:47:09,359
real exciting thing is like you can see

1200
00:47:13,430 --> 00:47:11,599
here perhaps for billions of years

1201
00:47:15,589 --> 00:47:13,440
through venus history the exciting thing

1202
00:47:17,750 --> 00:47:15,599
is that new atmosphere climate models

1203
00:47:19,990 --> 00:47:17,760
developed by the community around the

1204
00:47:21,589 --> 00:47:20,000
world have shown us the possibility that

1205
00:47:23,589 --> 00:47:21,599
venus works the way we think and again

1206
00:47:25,589 --> 00:47:23,599
as sue said there may be myths about

1207
00:47:27,349 --> 00:47:25,599
what we think until we measure more but

1208
00:47:29,270 --> 00:47:27,359
if it does venus could have harbored

1209
00:47:31,349 --> 00:47:29,280
oceans for three and a half billion

1210
00:47:32,950 --> 00:47:31,359
years what davinci plus will do is

1211
00:47:36,069 --> 00:47:32,960
measure that ratio

1212
00:47:37,829 --> 00:47:36,079
at exquisite exquisite precision ten

1213
00:47:39,589 --> 00:47:37,839

times through the atmosphere from above

1214
00:47:41,190 --> 00:47:39,599
the clouds all the way to the near

1215
00:47:43,270 --> 00:47:41,200
surface and that will set the record

1216
00:47:45,190 --> 00:47:43,280
straight did it have big oceans did it

1217
00:47:46,870 --> 00:47:45,200
when were they lost how were they lost

1218
00:47:48,710 --> 00:47:46,880
why were they lost those are key

1219
00:47:50,309 --> 00:47:48,720
questions we can ask

1220
00:47:52,309 --> 00:47:50,319
through the chemical measurements that

1221
00:47:54,630 --> 00:47:52,319
we will make in context with davinci

1222
00:47:56,630 --> 00:47:54,640
plus

1223
00:47:59,349 --> 00:47:56,640
right and veritas we'll take another

1224
00:48:01,430 --> 00:47:59,359
slice at that question we are looking

1225
00:48:04,069 --> 00:48:01,440
for evidence of

1226
00:48:07,030 --> 00:48:04,079
analogues of earth's continents

1227
00:48:10,309 --> 00:48:07,040
on earth the continents that we live on

1228
00:48:12,150 --> 00:48:10,319
formed when huge amounts of oceanic

1229
00:48:14,390 --> 00:48:12,160
crust that the salted crust iron rich

1230
00:48:16,549 --> 00:48:14,400
crust melted the presence of water and

1231
00:48:18,870 --> 00:48:16,559
so with our instruments we're going to

1232
00:48:20,470 --> 00:48:18,880
determine if these giant plateaus and

1233
00:48:23,030 --> 00:48:20,480
venus are in fact

1234
00:48:25,430 --> 00:48:23,040
uh just like earth's continents and are

1235
00:48:26,950 --> 00:48:25,440
thus telling us about the history of

1236
00:48:29,510 --> 00:48:26,960
past water that

1237
00:48:32,230 --> 00:48:29,520
that crust melted the presence of water

1238
00:48:34,309 --> 00:48:32,240

and you know shows us that there's still

1239
00:48:37,670 --> 00:48:34,319
this history of water locked in the rock

1240
00:48:42,710 --> 00:48:39,829
all right thank you next question is

1241
00:48:44,230 --> 00:48:42,720
from sri anash singh on youtube who has

1242
00:48:47,109 --> 00:48:44,240
another speculative question that we

1243
00:48:49,510 --> 00:48:47,119
cannot specifically answer for nasa but

1244
00:48:51,829 --> 00:48:49,520
it says will for future venus missions

1245
00:48:53,670 --> 00:48:51,839
include a sample return system from

1246
00:48:55,750 --> 00:48:53,680
venus and of course we cannot predict

1247
00:48:57,510 --> 00:48:55,760
what nasa will choose down the road but

1248
00:49:00,230 --> 00:48:57,520
if you know of anybody thinking about it

1249
00:49:03,670 --> 00:49:00,240
or what samples might uh tell us i'd

1250
00:49:07,510 --> 00:49:05,349
well yeah

1251
00:49:09,030 --> 00:49:07,520
now we can move on

1252
00:49:10,790 --> 00:49:09,040
i was just going to say sue did a great

1253
00:49:12,630 --> 00:49:10,800
study for a venus sample return mission

1254
00:49:15,670 --> 00:49:12,640
so i think she could actually

1255
00:49:17,589 --> 00:49:15,680
tell us how we might do that

1256
00:49:20,790 --> 00:49:17,599
well uh there are a number of sample

1257
00:49:23,270 --> 00:49:20,800
return mission studies uh in work and so

1258
00:49:24,950 --> 00:49:23,280
uh it's super challenging you know we're

1259
00:49:28,150 --> 00:49:24,960
looking at trying to do that for mars

1260
00:49:30,549 --> 00:49:28,160
right now and um perhaps the the biggest

1261
00:49:33,430 --> 00:49:30,559
challenge is getting that surface uh

1262
00:49:34,870 --> 00:49:33,440
that sample that that sample to um

1263
00:49:37,349 --> 00:49:34,880

bacteria is getting it off of the

1264
00:49:39,990 --> 00:49:37,359
surface of venus so there are a lot of

1265
00:49:41,990 --> 00:49:40,000
studies underway to uh begin to address

1266
00:49:44,309 --> 00:49:42,000
that question and i'm sure we're gonna

1267
00:49:46,069 --> 00:49:44,319
learn a lot in the coming decades from

1268
00:49:48,549 --> 00:49:46,079
the process of returning samples from

1269
00:49:52,549 --> 00:49:48,559
mars so it's it's in the pipeline in

1270
00:49:55,190 --> 00:49:52,559
terms of developing the approach

1271
00:49:58,309 --> 00:49:55,200
all right that's exciting thank you

1272
00:50:00,790 --> 00:49:58,319
matthew taylor on youtube asks how do

1273
00:50:03,270 --> 00:50:00,800
you think the planetary science gleaned

1274
00:50:09,030 --> 00:50:03,280
from these missions could benefit human

1275
00:50:12,470 --> 00:50:10,870
i'll go to dr garvin first and dr

1276
00:50:13,990 --> 00:50:12,480
smacker please join in if you have other

1277
00:50:15,990 --> 00:50:14,000
thoughts

1278
00:50:18,470 --> 00:50:16,000
well as we explore we learn how to

1279
00:50:20,710 --> 00:50:18,480
extend the limits of our performance so

1280
00:50:22,230 --> 00:50:20,720
at venus we have challenges as we go

1281
00:50:24,390 --> 00:50:22,240
into the atmosphere and those

1282
00:50:26,470 --> 00:50:24,400
technologies can produce new thermal

1283
00:50:27,990 --> 00:50:26,480
regulation systems like the heat shields

1284
00:50:29,990 --> 00:50:28,000
that got the apollo astronauts back from

1285
00:50:31,750 --> 00:50:30,000
the moon developed that were then used

1286
00:50:33,670 --> 00:50:31,760
by the viking project to get into the

1287
00:50:34,710 --> 00:50:33,680
atmosphere of mars to land to exquisite

1288
00:50:37,109 --> 00:50:34,720

landers

1289
00:50:38,870 --> 00:50:37,119
that feed forward is is typical of our

1290
00:50:41,190 --> 00:50:38,880
missions and we want to get the women

1291
00:50:43,270 --> 00:50:41,200
and robots and and next generation to

1292
00:50:44,790 --> 00:50:43,280
the moon and of course to mars so what

1293
00:50:46,790 --> 00:50:44,800
we do in all of our planetary

1294
00:50:48,630 --> 00:50:46,800
exploration is build the piece parts and

1295
00:50:50,790 --> 00:50:48,640
we build them together in a mosaic of

1296
00:50:53,510 --> 00:50:50,800
future capabilities that we can then use

1297
00:50:55,589 --> 00:50:53,520
and some of them extend to i.t solutions

1298
00:50:56,710 --> 00:50:55,599
so we need to be able to process data

1299
00:50:58,710 --> 00:50:56,720
especially

1300
00:51:00,390 --> 00:50:58,720
seeing things in new ways with camera

1301
00:51:02,069 --> 00:51:00,400
systems and and systems that measure

1302
00:51:03,750 --> 00:51:02,079
chemistry the environmental health of

1303
00:51:05,589 --> 00:51:03,760
people will depend on some of the kind

1304
00:51:07,430 --> 00:51:05,599
of instruments that will be flying into

1305
00:51:09,349 --> 00:51:07,440
the atmosphere of venus for example we

1306
00:51:11,109 --> 00:51:09,359
need that to keep the crews alive as

1307
00:51:12,870 --> 00:51:11,119
they live on the moon and do their work

1308
00:51:14,950 --> 00:51:12,880
through the artemis program in the

1309
00:51:16,870 --> 00:51:14,960
artemis base camp so there's always a

1310
00:51:19,829 --> 00:51:16,880
feed forward and we and nasa i think do

1311
00:51:22,069 --> 00:51:19,839
a good job about capitalizing on that so

1312
00:51:24,710 --> 00:51:22,079
that's my one cent i'm sure sue will

1313
00:51:26,630 --> 00:51:24,720

have better ones

1314
00:51:29,109 --> 00:51:26,640
no i think he said it well uh really

1315
00:51:31,589 --> 00:51:29,119
every technology that we develop and

1316
00:51:34,069 --> 00:51:31,599
every uh mission that we build and send

1317
00:51:34,790 --> 00:51:34,079
out into outer space uh you know helps

1318
00:51:37,109 --> 00:51:34,800
us

1319
00:51:39,910 --> 00:51:37,119
learn lessons of uh taking the next

1320
00:51:42,390 --> 00:51:39,920
steps so i think i have nothing further

1321
00:51:45,829 --> 00:51:44,150
great well we're talking about the moon

1322
00:51:49,670 --> 00:51:45,839
and bars let's bring it back down to

1323
00:51:51,990 --> 00:51:49,680
earth at anthony c on twitter asks what

1324
00:51:53,109 --> 00:51:52,000
sort of context will these two new

1325
00:51:56,069 --> 00:51:53,119
missions

1326
00:51:58,230 --> 00:51:56,079
provide for climate data collected

1327
00:52:00,390 --> 00:51:58,240
by the upcoming nasa earth system

1328
00:52:01,990 --> 00:52:00,400
observatory missions

1329
00:52:03,670 --> 00:52:02,000
we can tweak that to at least how does

1330
00:52:05,349 --> 00:52:03,680
it help us understand climate if you

1331
00:52:08,069 --> 00:52:05,359
don't know about the eso mission

1332
00:52:12,630 --> 00:52:10,230
well i can take a quick stab so the esl

1333
00:52:14,950 --> 00:52:12,640
mission starting with nysar and other

1334
00:52:16,069 --> 00:52:14,960
missions like clario and pace and and on

1335
00:52:17,589 --> 00:52:16,079
out

1336
00:52:19,430 --> 00:52:17,599
build on the climate history of our own

1337
00:52:21,510 --> 00:52:19,440
planet where we have an exquisite

1338
00:52:22,710 --> 00:52:21,520

capability of modeling and predicting

1339
00:52:24,549 --> 00:52:22,720
and it's just

1340
00:52:26,870 --> 00:52:24,559
it's taking off it's so exciting and we

1341
00:52:28,790 --> 00:52:26,880
apply that to worlds like venus and try

1342
00:52:30,630 --> 00:52:28,800
to back cast and so by making the kind

1343
00:52:32,870 --> 00:52:30,640
of measurements that both davinci plus

1344
00:52:34,790 --> 00:52:32,880
and veritas will be making it venus we

1345
00:52:36,710 --> 00:52:34,800
build the boundary conditions to cast

1346
00:52:38,230 --> 00:52:36,720
those models for venus today those

1347
00:52:39,829 --> 00:52:38,240
models are limited we don't have

1348
00:52:41,510 --> 00:52:39,839
adequate data we don't even know the

1349
00:52:42,950 --> 00:52:41,520
temperature lapse rate from below the

1350
00:52:45,190 --> 00:52:42,960
clouds to the surface well enough to

1351
00:52:47,349 --> 00:52:45,200
constrain some models how does it change

1352
00:52:49,430 --> 00:52:47,359
well we need that for earth of course

1353
00:52:50,390 --> 00:52:49,440
and we need the history of water we need

1354
00:52:52,630 --> 00:52:50,400
all these features we need the

1355
00:52:54,549 --> 00:52:52,640
topography of venus as a primary

1356
00:52:56,950 --> 00:52:54,559
boundary condition we need to know why

1357
00:52:59,030 --> 00:52:56,960
it's very slow rotation will affect

1358
00:53:02,150 --> 00:52:59,040
those kind of climate models so we will

1359
00:53:04,150 --> 00:53:02,160
learn from these missions and apply them

1360
00:53:05,510 --> 00:53:04,160
the lessons we learned for venus apply

1361
00:53:07,589 --> 00:53:05,520
them to earth the same way we learned

1362
00:53:09,589 --> 00:53:07,599
from mars and it's very interesting

1363
00:53:11,270 --> 00:53:09,599

topsy-turvy climate history has also

1364
00:53:12,870 --> 00:53:11,280
shed light on the history of climate on

1365
00:53:15,190 --> 00:53:12,880
earth so there are always these

1366
00:53:19,109 --> 00:53:15,200
connections as we go somewhere and apply

1367
00:53:19,119 --> 00:53:23,109
yeah you know there are there's so many

1368
00:53:26,630 --> 00:53:24,309
yeah if i could just add i mean there's

1369
00:53:27,829 --> 00:53:26,640
so many parallels between venus and

1370
00:53:29,109 --> 00:53:27,839
earth

1371
00:53:32,470 --> 00:53:29,119
you know the

1372
00:53:35,190 --> 00:53:32,480
people who discovered the ozone hole

1373
00:53:37,030 --> 00:53:35,200
on the earth that has a major effect on

1374
00:53:38,549 --> 00:53:37,040
earth's climate were actually people who

1375
00:53:40,150 --> 00:53:38,559
were studying uh the chemistry of

1376
00:53:43,190 --> 00:53:40,160
venus's atmosphere and they decided to

1377
00:53:44,790 --> 00:53:43,200
go and look for ozone and as a process

1378
00:53:47,910 --> 00:53:44,800
and in that process discovered this

1379
00:53:50,390 --> 00:53:47,920
ozone hole and similarly people who have

1380
00:53:53,030 --> 00:53:50,400
proposed using sulfur to try to help

1381
00:53:55,270 --> 00:53:53,040
slow down uh climate change in the earth

1382
00:53:56,870 --> 00:53:55,280
uh you know people studying the climate

1383
00:53:58,710 --> 00:53:56,880
on venus said you know look that's

1384
00:54:01,030 --> 00:53:58,720
really not going to work because we see

1385
00:54:02,549 --> 00:54:01,040
on venus the breakdown of sulfur at the

1386
00:54:04,150 --> 00:54:02,559
top of the atmosphere

1387
00:54:06,230 --> 00:54:04,160
so you know there are parallels to the

1388
00:54:08,470 --> 00:54:06,240

present-day climate but they're also

1389
00:54:10,549 --> 00:54:08,480
parallels to the long-term climate i

1390
00:54:12,069 --> 00:54:10,559
mean you know we think that venus in

1391
00:54:15,510 --> 00:54:12,079
earth has similar amounts of carbon

1392
00:54:17,190 --> 00:54:15,520
dioxide uh altogether but on venus

1393
00:54:19,030 --> 00:54:17,200
that carbon dioxide is in the atmosphere

1394
00:54:20,950 --> 00:54:19,040
making it this incredible

1395
00:54:22,950 --> 00:54:20,960
you know runaway greenhouse that makes

1396
00:54:25,430 --> 00:54:22,960
it uh 900 degrees

1397
00:54:27,670 --> 00:54:25,440
at the surface whereas on earth those

1398
00:54:30,150 --> 00:54:27,680
that same carbon dioxide is locked up in

1399
00:54:33,109 --> 00:54:30,160
the rock record and by studying like

1400
00:54:34,790 --> 00:54:33,119
processes of subduction where where the

1401
00:54:36,069 --> 00:54:34,800
crust goes from the surface back into

1402
00:54:39,030 --> 00:54:36,079
the mantle that's effectively

1403
00:54:40,069 --> 00:54:39,040
sequestering carbon dioxide right and so

1404
00:54:42,230 --> 00:54:40,079
we're going to learn how that process

1405
00:54:43,829 --> 00:54:42,240
may have started on the earth so you

1406
00:54:45,589 --> 00:54:43,839
know we could talk for a long time but

1407
00:54:48,390 --> 00:54:45,599
there are just so many parallels between

1408
00:54:50,470 --> 00:54:48,400
venus and earth and it's all essential

1409
00:54:51,990 --> 00:54:50,480
to really understanding both the present

1410
00:54:54,870 --> 00:54:52,000
day and long-term evolution of the

1411
00:54:59,589 --> 00:54:57,589
all right we are finishing up here with

1412
00:55:00,670 --> 00:54:59,599
some of our last questions

1413
00:55:03,750 --> 00:55:00,680

uh

1414
00:55:06,230 --> 00:55:03,760
davidjohnsonvg on twitter asks when did

1415
00:55:08,630 --> 00:55:06,240
you first find your own interest in

1416
00:55:12,470 --> 00:55:08,640
solar system exploration let's do dr

1417
00:55:17,030 --> 00:55:14,789
uh well you know i was certainly a kid

1418
00:55:20,309 --> 00:55:17,040
when apollo astronauts were landing on

1419
00:55:22,309 --> 00:55:20,319
the moon and of course that was very

1420
00:55:23,589 --> 00:55:22,319
mind-blowing and inspiring

1421
00:55:27,190 --> 00:55:23,599
um

1422
00:55:30,069 --> 00:55:27,200
but i think i did not completely imagine

1423
00:55:32,230 --> 00:55:30,079
planetary geology geophysics as a career

1424
00:55:35,190 --> 00:55:32,240
until i got to college and it was really

1425
00:55:37,030 --> 00:55:35,200
there that i learned i could study how

1426
00:55:39,510 --> 00:55:37,040
processes work in other planets and i

1427
00:55:41,910 --> 00:55:39,520
was completely hooked it was just a

1428
00:55:43,349 --> 00:55:41,920
fascinating idea of being able to do

1429
00:55:45,349 --> 00:55:43,359
that and so

1430
00:55:48,230 --> 00:55:45,359
that led me to uh doing things like

1431
00:55:55,270 --> 00:55:48,240
studying volcanoes on hawaii as a means

1432
00:56:00,069 --> 00:55:58,230
well karen i i like sue i i my mother

1433
00:56:01,910 --> 00:56:00,079
said i was hooked at birth but i don't

1434
00:56:04,549 --> 00:56:01,920
know what that means so we can all

1435
00:56:05,829 --> 00:56:04,559
reflect on that um and so but i was

1436
00:56:07,589 --> 00:56:05,839
looking over the moon as a little kid

1437
00:56:09,190 --> 00:56:07,599
and saying why aren't we there and my

1438
00:56:11,109 --> 00:56:09,200

parents said well it's a long trip and

1439
00:56:13,430 --> 00:56:11,119
you know gas prices not going to work

1440
00:56:16,150 --> 00:56:13,440
but um like sue i was enthralled by

1441
00:56:18,789 --> 00:56:16,160
apollo and saw the apollo 11 landings as

1442
00:56:20,470 --> 00:56:18,799
a young kid and couldn't believe it i

1443
00:56:22,309 --> 00:56:20,480
was able to then transfer that through

1444
00:56:23,990 --> 00:56:22,319
my college experience in high school to

1445
00:56:26,390 --> 00:56:24,000
visit places that reminded me of these

1446
00:56:28,789 --> 00:56:26,400
here the impact says

1447
00:56:30,390 --> 00:56:28,799
in kazakhstan the most recent big impact

1448
00:56:32,789 --> 00:56:30,400
and searching for venus on earth has

1449
00:56:34,549 --> 00:56:32,799
always been one of my passions

1450
00:56:36,150 --> 00:56:34,559
two of my advisors in college in grad

1451
00:56:38,549 --> 00:56:36,160
school told me you better look at venus

1452
00:56:40,789 --> 00:56:38,559
jim even though i was funded by mars so

1453
00:56:42,710 --> 00:56:40,799
i basically reconstructed my whole

1454
00:56:44,390 --> 00:56:42,720
graduate school career to study venus

1455
00:56:46,069 --> 00:56:44,400
and was able to participate in the

1456
00:56:48,950 --> 00:56:46,079
soviet missions to venus like the vendor

1457
00:56:51,430 --> 00:56:48,960
13 lander here that lasted 127 minutes

1458
00:56:53,430 --> 00:56:51,440
this is its sister sitting in moscow

1459
00:56:55,430 --> 00:56:53,440
here we are thinking about venus 15

1460
00:56:58,069 --> 00:56:55,440
years ago when we started the the

1461
00:56:59,589 --> 00:56:58,079
sojourn to become a mission like davinci

1462
00:57:01,829 --> 00:56:59,599
plus we're very excited about actually

1463
00:57:02,789 --> 00:57:01,839

making it work and here the eye of venus

1464
00:57:04,230 --> 00:57:02,799
with me

1465
00:57:05,990 --> 00:57:04,240
looking through the sapphire window that

1466
00:57:08,390 --> 00:57:06,000
we we now look forward to flying to

1467
00:57:09,910 --> 00:57:08,400
venus so i was always dazzled and i

1468
00:57:12,470 --> 00:57:09,920
don't think i can ever let go i can't

1469
00:57:14,549 --> 00:57:12,480
actually stop working on it so my

1470
00:57:16,470 --> 00:57:14,559
family often tell me that so it's a

1471
00:57:19,030 --> 00:57:16,480
science doesn't sleep i can attest to

1472
00:57:22,710 --> 00:57:20,789
thank you so much that is all the time

1473
00:57:26,789 --> 00:57:22,720
we have for today and i really want to

1474
00:57:31,589 --> 00:57:26,799
thank you both for joining us

1475
00:57:37,109 --> 00:57:33,990
and uh if you want more information on

1476
00:57:40,870 --> 00:57:37,119
veritas or da vinci you can visit

1477
00:57:46,950 --> 00:57:44,549
new venus missions

1478
00:57:49,430 --> 00:57:46,960
and you can also follow us on at nasa

1479
00:57:50,630 --> 00:57:49,440
solar system on facebook twitter and

1480
00:58:14,540 --> 00:57:50,640
instagram