# Venus

Thick $CO_2$ atmosphere

In habitable zone

Microbial life in atmosphere?

1
00:00:08,750 --> 00:00:05,800
[Music]

2
00:00:12,410 --> 00:00:08,760
hi I'm Sarah black I just finished my

3
00:00:14,450 --> 00:00:12,420
third year of my PhD here at CU I'm in

4
00:00:16,580 --> 00:00:14,460
the geology department and I study

5
00:00:19,599 --> 00:00:16,590
hydrothermal alteration in Costa Rica

6
00:00:23,210 --> 00:00:19,609
and Iceland as analogs for Mars so

7
00:00:24,320 --> 00:00:23,220
planetary science and Mars so first

8
00:00:28,099 --> 00:00:24,330
things today I wanted to start talking

9
00:00:29,540 --> 00:00:28,109
about Pluto and Charon if you have been

10
00:00:30,589 --> 00:00:29,550
paying a tall attention to the news in

11
00:00:33,920 --> 00:00:30,599
the past year you've probably heard

12
00:00:36,440 --> 00:00:33,930
something about these up until July of

13
00:00:38,209 --> 00:00:36,450

last year the most we knew about Pluto

14
00:00:41,090 --> 00:00:38,219
and Charon was that they were out there

15
00:00:42,590 --> 00:00:41,100
and that was really it the best images

16
00:00:45,200 --> 00:00:42,600
we had were like couple pixels across

17
00:00:47,569 --> 00:00:45,210
from Hubble and that was all we knew we

18
00:00:50,900 --> 00:00:47,579
expected that Pluto and Charon would be

19
00:00:52,490 --> 00:00:50,910
these really cold icy bodies that were

20
00:00:54,889 --> 00:00:52,500
just covered in craters geologically

21
00:00:56,209 --> 00:00:54,899
dead and not really much interesting to

22
00:00:57,709 --> 00:00:56,219
look at there but as we have learned

23
00:01:00,950 --> 00:00:57,719
over the last several years of space

24
00:01:02,599 --> 00:01:00,960
exploration we at least expected to be

25
00:01:05,990 --> 00:01:02,609
surprised in this case and it turned out

26
00:01:07,609 --> 00:01:06,000
we were surprised so these are our newer

27
00:01:08,929 --> 00:01:07,619
images of Pluto and Charon much better

28
00:01:10,789 --> 00:01:08,939
than the couple pixels that we had

29
00:01:13,280 --> 00:01:10,799
before so the large one here is Pluto

30
00:01:15,410 --> 00:01:13,290
and then that one right there is sharing

31
00:01:18,920 --> 00:01:15,420
the moon it's a binary system so they're

32
00:01:21,590 --> 00:01:18,930
orbiting together like that and in July

33
00:01:22,820 --> 00:01:21,600
2015 of last year we had our closest

34
00:01:25,969 --> 00:01:22,830
approach of the New Horizons mission

35
00:01:27,469 --> 00:01:25,979
which took outstanding data and we're

36
00:01:29,300 --> 00:01:27,479
still getting data back it takes about

37
00:01:30,649 --> 00:01:29,310
16 months with the data rate the data

38
00:01:33,200 --> 00:01:30,659

download rate that we have so at this

39
00:01:34,789 --> 00:01:33,210
point we really only have a fraction of

40
00:01:35,870 --> 00:01:34,799
the data that we're getting back from

41
00:01:37,280 --> 00:01:35,880
this mission so there are new

42
00:01:39,859 --> 00:01:37,290
interesting things to come in the future

43
00:01:41,510 --> 00:01:39,869
so I just wanted to do a quick overview

44
00:01:44,270 --> 00:01:41,520
of some of the interesting things that

45
00:01:46,700 --> 00:01:44,280
we've seen at Pluto and Charon starting

46
00:01:49,190 --> 00:01:46,710
with we expected this place to be

47
00:01:51,920 --> 00:01:49,200
geologically dead more or less and if

48
00:01:54,770 --> 00:01:51,930
you are familiar with geology principles

49
00:01:58,340 --> 00:01:54,780
the older a surface is the more craters

50
00:02:00,530 --> 00:01:58,350
it will have so when we have this this

51
00:02:02,660 --> 00:02:00,540
is one of the high-res images of Pluto

52
00:02:05,510 --> 00:02:02,670
this is Sputnik Planum the bright side

53
00:02:08,419 --> 00:02:05,520
of the heart and on Sputnik Planum

54
00:02:10,100 --> 00:02:08,429
there's no craters at all which means

55
00:02:11,540 --> 00:02:10,110
that this is actually something that

56
00:02:13,580 --> 00:02:11,550
still has some kind of active

57
00:02:14,990 --> 00:02:13,590
resurfacing or very recent research

58
00:02:17,990 --> 00:02:15,000
same process going on it's a very young

59
00:02:20,750 --> 00:02:18,000
surface we did not expect to see this so

60
00:02:23,930 --> 00:02:20,760
the surface of Pluto could potentially

61
00:02:25,309 --> 00:02:23,940
still be actively resurfacing itself and

62
00:02:27,830 --> 00:02:25,319
doing things instead of just sitting

63
00:02:30,710 --> 00:02:27,840

there and getting hit with meteors we

64
00:02:32,630 --> 00:02:30,720
also on Charon you can see going across

65
00:02:35,750 --> 00:02:32,640
right here there's this huge Canyon

66
00:02:38,000 --> 00:02:35,760
system and this is just a doomed info

67
00:02:39,949 --> 00:02:38,010
section of it this is serenity casma

68
00:02:42,619 --> 00:02:39,959
it's been named there's a humongous

69
00:02:45,110 --> 00:02:42,629
canyon system on Charon which has some

70
00:02:47,479 --> 00:02:45,120
kind of implications about Sharon's

71
00:02:48,740 --> 00:02:47,489
cooling and expanding history which

72
00:02:53,180 --> 00:02:48,750
you'll hear more about later this

73
00:02:55,490 --> 00:02:53,190
afternoon we also saw signatures of

74
00:02:58,130 --> 00:02:55,500
methane ammonia carbon dioxide and water

75
00:03:00,050 --> 00:02:58,140
Isis on the surface we can look at the

76
00:03:02,380 --> 00:03:00,060
type of light that is reflected off of a

77
00:03:05,600 --> 00:03:02,390
surface and look at the wavelengths and

78
00:03:07,460 --> 00:03:05,610
determine what the composition is of

79
00:03:10,009 --> 00:03:07,470
that surface and you can see that we

80
00:03:12,920 --> 00:03:10,019
have several areas it's not homogeneous

81
00:03:16,490 --> 00:03:12,930
so this the surface of this isn't Pluto

82
00:03:18,440 --> 00:03:16,500
this right here is the bright part of

83
00:03:21,020 --> 00:03:18,450
that heart there and the surface of

84
00:03:23,300 --> 00:03:21,030
Pluto is not homogeneous it has areas

85
00:03:25,280 --> 00:03:23,310
that are more methane rich or more water

86
00:03:27,259 --> 00:03:25,290
ice rich or more co2 rich so this has

87
00:03:29,300 --> 00:03:27,269
implications for the geologic history of

88
00:03:31,610 --> 00:03:29,310

this area and how these materials became

89
00:03:35,660 --> 00:03:31,620
segregated into different locations on

90
00:03:37,970 --> 00:03:35,670
this planet don't really want to call it

91
00:03:41,000 --> 00:03:37,980
a planet get in trouble but you know

92
00:03:42,289 --> 00:03:41,010
what it's Pluto all right and the other

93
00:03:43,789 --> 00:03:42,299
thing that we found that got a lot of

94
00:03:46,580 --> 00:03:43,799
people excited myself included because

95
00:03:48,920 --> 00:03:46,590
I'm a volcanologist is things like this

96
00:03:50,659 --> 00:03:48,930
down here who zoomed in that look like

97
00:03:54,099 --> 00:03:50,669
they could potentially be cryovolcanoes

98
00:03:57,050 --> 00:03:54,109
or ice volcanism on the surface of Pluto

99
00:04:00,199 --> 00:03:57,060
so Pluto and Charon a lot cooler than we

100
00:04:01,849 --> 00:04:00,209
thought they might be so moving quickly

101
00:04:04,460 --> 00:04:01,859
to Venus you'll hear a little bit about

102
00:04:07,039 --> 00:04:04,470
Venus today as well Venus has a really

103
00:04:08,509 --> 00:04:07,049
thick carbon dioxide atmosphere makes it

104
00:04:10,400 --> 00:04:08,519
really difficult to do geology there

105
00:04:11,870 --> 00:04:10,410
because we can't see through it but we

106
00:04:13,309 --> 00:04:11,880
really like to look at the atmosphere of

107
00:04:17,060 --> 00:04:13,319
Venus because that in itself is pretty

108
00:04:18,170 --> 00:04:17,070
interesting as well so astrobiology you

109
00:04:21,319 --> 00:04:18,180
guys probably all know about the

110
00:04:23,240 --> 00:04:21,329
habitable zone so Venus is right here

111
00:04:26,029 --> 00:04:23,250
kind of on the edge of the habitable

112
00:04:26,930 --> 00:04:26,039
zone in our solar system and so if life

113
00:04:29,120 --> 00:04:26,940

ever arose

114
00:04:31,220 --> 00:04:29,130
on the surface of Venus which could

115
00:04:35,660 --> 00:04:31,230
possibly have happened maybe it actually

116
00:04:36,950 --> 00:04:35,670
then migrated to the atmosphere so we I

117
00:04:40,040 --> 00:04:36,960
really want to get one of those things

118
00:04:41,420 --> 00:04:40,050
um so maybe life migrated to the

119
00:04:44,360 --> 00:04:41,430
atmosphere of Venus so people like

120
00:04:47,660 --> 00:04:44,370
looking at the composition the structure

121
00:04:50,120 --> 00:04:47,670
of the Venus's atmosphere to try to

122
00:04:51,380 --> 00:04:50,130
figure out is it possible that things

123
00:04:52,940 --> 00:04:51,390
could be living there where could they

124
00:04:54,680 --> 00:04:52,950
be living how could they be living there

125
00:04:56,440 --> 00:04:54,690
what are what could they be doing how

126
00:04:59,030 --> 00:04:56,450
did they get there

127
00:05:01,880 --> 00:04:59,040
and of course moving on to Mars because

128
00:05:04,670 --> 00:05:01,890
we have a whole Mars session so if you

129
00:05:06,860 --> 00:05:04,680
haven't heard NASA's mission objective

130
00:05:08,360 --> 00:05:06,870
with Mars is follow the water so

131
00:05:11,060 --> 00:05:08,370
everything that we are doing right now

132
00:05:15,260 --> 00:05:11,070
for Mars explorations somehow ties back

133
00:05:18,200 --> 00:05:15,270
to water so first off we like looking at

134
00:05:19,730 --> 00:05:18,210
the geology of Mars and things that

135
00:05:22,940 --> 00:05:19,740
we've found so far in this follow the

136
00:05:25,250 --> 00:05:22,950
water theme we've found signal signals

137
00:05:28,700 --> 00:05:25,260
of aqueous alterations so alteration by

138
00:05:30,320 --> 00:05:28,710

water this here is an X Rd an x-ray

139
00:05:32,030 --> 00:05:30,330
diffraction pattern you don't have to

140
00:05:34,220 --> 00:05:32,040
worry about the instrument it just tells

141
00:05:36,680 --> 00:05:34,230
you what types of minerals what types of

142
00:05:40,100 --> 00:05:36,690
materials are present in this rock that

143
00:05:41,540 --> 00:05:40,110
you're analyzing and this X Rd pattern

144
00:05:43,160 --> 00:05:41,550
right here is from the sheet bed mud

145
00:05:46,580 --> 00:05:43,170
stone and Gale Crater or the Curiosity

146
00:05:49,580 --> 00:05:46,590
rover and this has actually in here

147
00:05:51,560 --> 00:05:49,590
don't worry about where but in here this

148
00:05:53,690 --> 00:05:51,570
shows you the signal of clays and

149
00:05:56,450 --> 00:05:53,700
amorphous materials in these rocks and

150
00:05:59,120 --> 00:05:56,460
soils and clays and amorphous materials

151
00:06:00,550 --> 00:05:59,130
are good indicators of aqueous history

152
00:06:03,020 --> 00:06:00,560
in that region

153
00:06:05,540 --> 00:06:03,030
we've also from orbit we can identify

154
00:06:07,310 --> 00:06:05,550
minerals that same thing with Pluto

155
00:06:10,070 --> 00:06:07,320
looking at the reflected light off of a

156
00:06:13,250 --> 00:06:10,080
surface and we've identified salts this

157
00:06:16,130 --> 00:06:13,260
bright green area here is an area of a

158
00:06:19,010 --> 00:06:16,140
salt deposit in a crater on Mars salts

159
00:06:21,140 --> 00:06:19,020
can come from evaporating liquids so

160
00:06:22,670 --> 00:06:21,150
this area here there's also all these

161
00:06:24,500 --> 00:06:22,680
little blue lines around the edges are

162
00:06:26,360 --> 00:06:24,510
things that look like flooville or river

163
00:06:29,390 --> 00:06:26,370

network systems and they all go into

164
00:06:30,890 --> 00:06:29,400
that crater so that was potentially an

165
00:06:32,630 --> 00:06:30,900
old lake that then dried up and left

166
00:06:36,620 --> 00:06:32,640
these salt deposits behind it in the

167
00:06:38,360 --> 00:06:36,630
rock record so we also like to look at

168
00:06:40,670 --> 00:06:38,370
characterizing the climate of Mars and

169
00:06:44,150 --> 00:06:40,680
in a little bit you'll hear some

170
00:06:46,969 --> 00:06:44,160
about some climate modeling so we really

171
00:06:49,370 --> 00:06:46,979
we see all these geologic signals that

172
00:06:51,740 --> 00:06:49,380
there was water on Mars in the past

173
00:06:55,070 --> 00:06:51,750
there's that theory of warm wet early

174
00:06:57,080 --> 00:06:55,080
Mars but Mars climate modelers keep

175
00:06:58,999 --> 00:06:57,090
coming back at us and saying we cannot

176
00:07:01,279 --> 00:06:59,009
get this model to work it doesn't work

177
00:07:03,710 --> 00:07:01,289
so there's a lot of challenges when it

178
00:07:05,990 --> 00:07:03,720
comes to modeling climates earth or Mars

179
00:07:07,010 --> 00:07:06,000
doesn't matter a lot of challenges when

180
00:07:08,840 --> 00:07:07,020
it comes to this there's a lot of

181
00:07:10,700 --> 00:07:08,850
variables and trying to make all of

182
00:07:11,600 --> 00:07:10,710
these things fit together in a way that

183
00:07:13,820 --> 00:07:11,610
gives us the most accurate

184
00:07:17,300 --> 00:07:13,830
representation of a climate in the

185
00:07:18,770 --> 00:07:17,310
future or in the past so there's many

186
00:07:23,450 --> 00:07:18,780
many variables one of the things you'll

187
00:07:25,610 --> 00:07:23,460
be hearing about is micrometeorites the

188
00:07:26,990 --> 00:07:25,620

other thing its astrobiology so of

189
00:07:29,540 --> 00:07:27,000
course we want to determine if life ever

190
00:07:30,800 --> 00:07:29,550
arose on Mars and there's several

191
00:07:32,480 --> 00:07:30,810
different things that we're looking at

192
00:07:34,010 --> 00:07:32,490
in this field here one of them is

193
00:07:37,010 --> 00:07:34,020
looking at alternative metabolic

194
00:07:39,740 --> 00:07:37,020
pathways like iron and sulfur cycling so

195
00:07:41,839 --> 00:07:39,750
I Mars is very iron rich as you can see

196
00:07:43,279 --> 00:07:41,849
from its red color there's also a lot of

197
00:07:46,189 --> 00:07:43,289
sulfur on the surface and in the rocks

198
00:07:48,920 --> 00:07:46,199
and so it is potentially possible that

199
00:07:50,779 --> 00:07:48,930
microbes that existed on Mars in the

200
00:07:53,140 --> 00:07:50,789
past or present could have these

201
00:07:57,589 --> 00:07:53,150
alternative metabolic pathways that are

202
00:07:59,480 --> 00:07:57,599
cycling sulfur or iron which leads us to

203
00:08:02,000 --> 00:07:59,490
the ultimate question of if there is

204
00:08:03,529 --> 00:08:02,010
life on Mars or was life on Mars how are

205
00:08:05,659 --> 00:08:03,539
we actually going to detect this stuff

206
00:08:07,100 --> 00:08:05,669
can we detect it from orbit how could we

207
00:08:09,200 --> 00:08:07,110
detect it from orbit what would we be

208
00:08:10,640 --> 00:08:09,210
looking for and what about on the

209
00:08:12,499 --> 00:08:10,650
surface you know what would we find on

210
00:08:13,939 --> 00:08:12,509
the surface that would tell us there was

211
00:08:17,240 --> 00:08:13,949
ever anything there or is something

212
00:08:21,379 --> 00:08:17,250
there and detection limits you know how

213
00:08:23,060 --> 00:08:21,389

what is our what is our limit for saying

214
00:08:24,409 --> 00:08:23,070
yes this is definitely something here

215
00:08:29,719 --> 00:08:24,419
this is a signal that we want to dive

216
00:08:35,090 --> 00:08:29,729
more into so I believe that is it for

217
00:08:40,320 --> 00:08:37,230
okay so we have plenty of times for

218
00:08:48,360 --> 00:08:40,330
questions if anybody has any about the

219
00:08:50,820 --> 00:08:48,370
warm-up talk in particular yeah you

220
00:08:54,540 --> 00:08:50,830
mentioned ice full canoes impossible on

221
00:08:57,060 --> 00:08:54,550
Pluto what's the source of that what

222
00:08:59,460 --> 00:08:57,070
causes the volcanism so that one would

223
00:09:02,430 --> 00:08:59,470
be something like there it is something

224
00:09:04,800 --> 00:09:02,440
like warmer ice at depth so it's not

225
00:09:06,390 --> 00:09:04,810
necessarily liquid water but warmer ice

226
00:09:13,080 --> 00:09:06,400
would be less dense and would rise up to

227
00:09:15,660 --> 00:09:13,090
the surface yeah possibly but this is

228
00:09:17,400 --> 00:09:15,670
all very very new data so I'm sure

229
00:09:19,710 --> 00:09:17,410
modeling has possibly already started

230
00:09:22,680 --> 00:09:19,720
but there's no good results of that yet

231
00:09:24,480 --> 00:09:22,690
so yeah but it could be as simple as

232
00:09:34,260 --> 00:09:24,490
just at depth it's warmer and less dense

233
00:09:35,070 --> 00:09:34,270
and then rises up so my question is

234
00:09:36,870 --> 00:09:35,080
pretty simple

235
00:09:39,360 --> 00:09:36,880
what about mercury if we're talking

236
00:09:42,630 --> 00:09:39,370
about the solar system what about it I

237
00:09:44,490 --> 00:09:42,640
mean just I I come from astronomy and

238
00:09:49,650 --> 00:09:44,500

earth science so planetary science to me

239
00:09:52,350 --> 00:09:49,660
is totally different so I guess my my

240
00:09:55,530 --> 00:09:52,360
question is really about Venus - is so

241
00:09:57,180 --> 00:09:55,540
Venus is rough to send a mission - but

242
00:10:00,960 --> 00:09:57,190
there hasn't really been a lot of work

243
00:10:03,840 --> 00:10:00,970
done on trying to figure out Venus for

244
00:10:09,270 --> 00:10:03,850
the last 20 years or so so I guess my

245
00:10:12,450 --> 00:10:09,280
question is why do Venus and Mercury not

246
00:10:13,860 --> 00:10:12,460
mentioned here I guess well I'm in for

247
00:10:15,750 --> 00:10:13,870
this talk in particular I was just gonna

248
00:10:17,370 --> 00:10:15,760
focus on the things that we're covering

249
00:10:20,400 --> 00:10:17,380
in the sessions later but for

250
00:10:23,280 --> 00:10:20,410
astrobiological ii speaking mercury is

251
00:10:24,930 --> 00:10:23,290
too close really to the Sun so it's

252
00:10:27,780 --> 00:10:24,940
still it's not really in that habitable

253
00:10:31,290 --> 00:10:27,790
zone so for Astro biological research

254
00:10:32,990 --> 00:10:31,300
it's just too hot so too hot to have

255
00:10:36,210 --> 00:10:33,000
liquid water stable on the surface and

256
00:10:39,180 --> 00:10:36,220
liquid water right now is our kind of

257
00:10:40,280 --> 00:10:39,190
thing that we're fixated on so you could

258
00:10:43,080 --> 00:10:40,290
argue that maybe there's some other

259
00:10:45,390 --> 00:10:43,090
thing there that would be supporting of

260
00:10:56,380 --> 00:10:45,400
life but for NASA's current astrobiology

261
00:11:02,740 --> 00:11:01,150
I guess is more of a general comment but

262
00:11:04,300 --> 00:11:02,750
I still don't know why we still try to

263
00:11:08,110 --> 00:11:04,310

define the habitable zone based on water

264
00:11:09,990 --> 00:11:08,120
at the surface it seems like seems like

265
00:11:13,990 --> 00:11:10,000
something we should move away from I

266
00:11:16,030 --> 00:11:14,000
agree it I don't I don't know why NASA

267
00:11:18,250 --> 00:11:16,040
made maybe it's because it's detectable

268
00:11:21,730 --> 00:11:18,260
at long range maybe more easily but it

269
00:11:25,120 --> 00:11:21,740
has the concept of a habitable zone to

270
00:11:28,260 --> 00:11:25,130
me is outdated and needs to be revised

271
00:11:32,170 --> 00:11:28,270
absolutely based on what we know about

272
00:11:34,000 --> 00:11:32,180
Earth and vent systems and you know

273
00:11:36,700 --> 00:11:34,010
Europe is going to be way outside the

274
00:11:42,910 --> 00:11:36,710
habitable anyway

275
00:11:46,630 --> 00:11:42,920
just a thought yeah it's very true it's

276
00:11:48,910 --> 00:11:46,640
a it's an overly simplified thing that

277
00:11:52,570 --> 00:11:48,920
they're using as a you know key variable

278
00:11:55,470 --> 00:11:52,580
so yeah I suppose you have to start

279
00:12:01,960 --> 00:12:00,430
any other questions if there aren't