Results

Name	Observed value (µmol/L)	Model result (µmol/L)
Biomass carbon	N/a	1.9
Biomass nitrogen	N/a	0.29
Biomass phosphorus	N/a	0.06
Inorganic nitrogen	86300	86300
Inorganic phosphorus	0.051	0.0002
SO2	1930	2670
H2S	2220	1440
Sx	0.625	37.6

1
00:00:12,580 --> 00:00:08,620
yeah this is going to be a little bit

2
00:00:14,260 --> 00:00:12,590
different from what we've just seen so

3
00:00:16,029 --> 00:00:14,270
you may be wondering okay why the

4
00:00:17,680 --> 00:00:16,039
atmosphere of Venus Venus is supposed to

5
00:00:21,040 --> 00:00:17,690
be pretty much totally not suitable

6
00:00:22,840 --> 00:00:21,050
right well it is the surface definitely

7
00:00:25,930 --> 00:00:22,850
is but the upper atmosphere is actually

8
00:00:27,580 --> 00:00:25,940
relatively earth-like at about 51 257

9
00:00:29,050 --> 00:00:27,590
kilometres above the surface you've got

10
00:00:31,810 --> 00:00:29,060
about temperatures between 30 and 80

11
00:00:32,770 --> 00:00:31,820
degrees Celsius so on the warm side but

12
00:00:36,060 --> 00:00:32,780
definitely still within the habitable

13
00:00:38,140 --> 00:00:36,070

range and the pressure varies from about

14
00:00:40,630 --> 00:00:38,150
one-tenth of the Earth's atmosphere to

15
00:00:43,030 --> 00:00:40,640
almost a full earth atmosphere normal

16
00:00:45,160 --> 00:00:43,040
pressure we also have detectable

17
00:00:47,530 --> 00:00:45,170
quantities of nitrogen usually neither

18
00:00:49,270 --> 00:00:47,540
in the form of nitrogen gas or an

19
00:00:51,130 --> 00:00:49,280
unknown but potentially very large

20
00:00:54,610 --> 00:00:51,140
amount of nitrous oxide produced by

21
00:00:56,860 --> 00:00:54,620
lightning activity and also phosphorus

22
00:01:01,270 --> 00:00:56,870
in the form of phosphoric acid both of

23
00:01:05,280 --> 00:01:01,280
those have witches came from I think the

24
00:01:07,179 --> 00:01:05,290
Vega missions you also have a lot of

25
00:01:10,590 --> 00:01:07,189
different possible sources of energy

26
00:01:12,580 --> 00:01:10,600
either sunlight or the redox gradients

27
00:01:15,850 --> 00:01:12,590
between various oxidized and reduced

28
00:01:18,399 --> 00:01:15,860
sulfur and I'm also oxidized reduce

29
00:01:20,230 --> 00:01:18,409
carbon compounds as well which is kind

30
00:01:23,950 --> 00:01:20,240
of set up by the newly complex bonita

31
00:01:25,780 --> 00:01:23,960
nap i'm mr. chemistry and also from

32
00:01:28,210 --> 00:01:25,790
historical point of view it's thought

33
00:01:31,450 --> 00:01:28,220
based on the tutorial hydrogen ratios

34
00:01:34,030 --> 00:01:31,460
that Venus probably had in ocean early

35
00:01:36,160 --> 00:01:34,040
on in its history which may have been a

36
00:01:39,210 --> 00:01:36,170
good location for microbes to evolve and

37
00:01:41,740 --> 00:01:39,220
then eventually or at least potentially

38
00:01:45,850 --> 00:01:41,750

adapt and colonize the atmosphere as the

39
00:01:49,420 --> 00:01:45,860
planet became less hospitable so we

40
00:01:53,080 --> 00:01:49,430
decided to try to test this idea I built

41
00:01:57,100 --> 00:01:53,090
it using xpp OTT which is a nice small

42
00:01:59,649 --> 00:01:57,110
free little package for modeling

43
00:02:00,999 --> 00:01:59,659
differential equations the initial

44
00:02:02,890 --> 00:02:01,009
parameters for the atmosphere were based

45
00:02:05,289 --> 00:02:02,900
on remote sensing observations mostly

46
00:02:07,300 --> 00:02:05,299
from either Pioneer Venus or from Vega

47
00:02:09,940 --> 00:02:07,310
as well as a little bit from Venus

48
00:02:11,860 --> 00:02:09,950
Express mostly the older missions the

49
00:02:15,699 --> 00:02:11,870
initial parameters for our hypothetical

50
00:02:17,740 --> 00:02:15,709
microbes were based on values taken from

51
00:02:18,730 --> 00:02:17,750
terrestrial thermofoil instead of I file

52
00:02:24,130 --> 00:02:18,740
bacteria so

53
00:02:26,430 --> 00:02:24,140
Oh Theo micro spira arm sofa so factotum

54
00:02:29,350 --> 00:02:26,440
bacteria never pronounce it correctly

55
00:02:31,450 --> 00:02:29,360
but you know existing and in some cases

56
00:02:33,730 --> 00:02:31,460
fairly well characterized hershko

57
00:02:39,460 --> 00:02:33,740
bacteria that would survive in a warm

58
00:02:41,680 --> 00:02:39,470
acidic environment so I am in a colleges

59
00:02:43,750 --> 00:02:41,690
I am NOT an atmospheric chemist Wichmann

60
00:02:45,370 --> 00:02:43,760
I made a load of assumptions building

61
00:02:48,430 --> 00:02:45,380
this model just to get it simple enough

62
00:02:51,670 --> 00:02:48,440
that I could actually manage it first

63
00:02:54,520 --> 00:02:51,680

off the atmospheric chemistry was hugely

64
00:02:56,200 --> 00:02:54,530
simplified we assumed a global uniform

65
00:02:58,570 --> 00:02:56,210
distribution so we're not taking

66
00:03:01,570 --> 00:02:58,580
regional variations into account its

67
00:03:03,190 --> 00:03:01,580
setting steady state so we're assuming

68
00:03:04,390 --> 00:03:03,200
one of the weird things about the

69
00:03:07,660 --> 00:03:04,400
venetian atmospheres they've been

70
00:03:08,980 --> 00:03:07,670
noticing a decline in sulfur dioxide but

71
00:03:12,190 --> 00:03:08,990
we're assuming that's being replenished

72
00:03:13,960 --> 00:03:12,200
probably by volcanic activity and we're

73
00:03:16,120 --> 00:03:13,970
ignoring the hundreds and hundreds of

74
00:03:18,760 --> 00:03:16,130
potential side reactions and focusing

75
00:03:20,680 --> 00:03:18,770
only about three or four major reactions

76
00:03:22,360 --> 00:03:20,690
for the purposes of remodel the

77
00:03:24,940 --> 00:03:22,370
microbial growth is based on the monadic

78
00:03:28,090 --> 00:03:24,950
Oh Asian which is a variation on kaylas

79
00:03:34,870 --> 00:03:28,100
menten kinetics in which case you the

80
00:03:37,690 --> 00:03:34,880
growth rate mu is your seminar area the

81
00:03:41,290 --> 00:03:37,700
growth rate mu is derived from you max

82
00:03:44,320 --> 00:03:41,300
which is the maximum growth rate which

83
00:03:48,490 --> 00:03:44,330
is usually empirically obtained times

84
00:03:49,630 --> 00:03:48,500
the substrate whatever the organism

85
00:03:52,060 --> 00:03:49,640
needs to grow on carbon nitrogen

86
00:03:54,040 --> 00:03:52,070
phosphorus / the half saturation

87
00:03:57,310 --> 00:03:54,050
constant which is another empirically

88
00:03:59,830 --> 00:03:57,320

observed value then again plus the

89
00:04:02,650 --> 00:03:59,840
amount of the concentration of substrate

90
00:04:07,510 --> 00:04:02,660
and the whole model for the interactions

91
00:04:10,270 --> 00:04:07,520
is based on stoichiometric relationship

92
00:04:11,950 --> 00:04:10,280
specifically the redfield ratio so

93
00:04:16,740 --> 00:04:11,960
basically it was assumed that the

94
00:04:20,020 --> 00:04:16,750
bacteria to grow would take 106 carbon

95
00:04:23,290 --> 00:04:20,030
16 nitrogen and one phosphorus in that

96
00:04:26,080 --> 00:04:23,300
ratio in order to grow and continue

97
00:04:28,840 --> 00:04:26,090
existing and therefore there was more

98
00:04:30,330 --> 00:04:28,850
carbon that than the ratio allowed it

99
00:04:34,140 --> 00:04:30,340
would just be ignored it would not be

100
00:04:36,570 --> 00:04:34,150
get up as biomass and then for sort of I

101
00:04:39,050 --> 00:04:36,580
guess the metabolic part of the cycle

102
00:04:41,640 --> 00:04:39,060
we've got two major metabolic reactions

103
00:04:42,960 --> 00:04:41,650
by two different microbial populations

104
00:04:47,090 --> 00:04:42,970
the first one is a photosynthetic

105
00:04:49,650 --> 00:04:47,100
reaction in which it's the feta trophic

106
00:04:52,800 --> 00:04:49,660
oxidation of hydrogen sulfide to

107
00:04:55,200 --> 00:04:52,810
elemental sulfur or other forms of

108
00:04:58,770 --> 00:04:55,210
amorphous sulfur and the other one other

109
00:05:02,430 --> 00:04:58,780
half of it is the reduction of sulfur

110
00:05:04,200 --> 00:05:02,440
dioxide back to hydrogen sulfide and the

111
00:05:05,700 --> 00:05:04,210
nice thing about the phototrophic

112
00:05:08,159 --> 00:05:05,710
reaction is it also gives you a

113
00:05:10,020 --> 00:05:08,169

potential way to men extra water which

114
00:05:13,740 --> 00:05:10,030
is fairly scarce and the Venusian

115
00:05:15,510 --> 00:05:13,750
atmosphere so here's just some of the

116
00:05:18,900 --> 00:05:15,520
initial parameters like I said these

117
00:05:20,340 --> 00:05:18,910
came from mostly remote sensing data in

118
00:05:26,430 --> 00:05:20,350
some cases they came from other peoples

119
00:05:29,570 --> 00:05:26,440
models as well and I will explain how

120
00:05:32,159 --> 00:05:29,580
all these numbers work together shortly

121
00:05:33,719 --> 00:05:32,169
and here's the give you an idea the

122
00:05:38,219 --> 00:05:33,729
initial parameters of microbes like you

123
00:05:40,010 --> 00:05:38,229
said mostly based off of known thermo

124
00:05:44,279 --> 00:05:40,020
file sorts of the files in some cases

125
00:05:46,320 --> 00:05:44,289
for example a lot of the half saturation

126
00:05:48,800 --> 00:05:46,330
constants there have not been

127
00:05:51,629 --> 00:05:48,810
characterized for a lot of bacteria so

128
00:05:53,339 --> 00:05:51,639
based off of bacteria it has been

129
00:05:55,830 --> 00:05:53,349
characterized we just essentially

130
00:05:56,940 --> 00:05:55,840
assumed that the a saturation constant

131
00:05:58,710 --> 00:05:56,950
for nitrogen is going to be on an order

132
00:06:00,480 --> 00:05:58,720
of magnitude lower than they have

133
00:06:02,490 --> 00:06:00,490
saturation constant for carbon and the

134
00:06:04,140 --> 00:06:02,500
restoration constant of phosphorus is

135
00:06:09,469 --> 00:06:04,150
going to be an order of magnitude lower

136
00:06:15,240 --> 00:06:09,479
than that so this is sort of like the

137
00:06:17,969 --> 00:06:15,250
very pretty fide view of the model

138
00:06:20,070 --> 00:06:17,979

structurally so essentially for

139
00:06:22,020 --> 00:06:20,080
nutrients which are in this case carbon

140
00:06:26,490 --> 00:06:22,030
nitrogen phosphorus your cycle between

141
00:06:27,810 --> 00:06:26,500
an inorganic form and a biologically

142
00:06:30,900 --> 00:06:27,820
available form that's been taken up by

143
00:06:32,610 --> 00:06:30,910
the biomass so if it the biomass grows

144
00:06:34,770 --> 00:06:32,620
it takes up the inorganic form and then

145
00:06:37,770 --> 00:06:34,780
when it dies it that form is then

146
00:06:38,370 --> 00:06:37,780
released and presumably oxidized back to

147
00:06:42,870 --> 00:06:38,380
and no guy

148
00:06:44,670 --> 00:06:42,880
form the growth rate is dependent on or

149
00:06:46,290 --> 00:06:44,680
well the grossest have been on the

150
00:06:48,330 --> 00:06:46,300
grocery of the microbes which is

151
00:06:50,460 --> 00:06:48,340
dependent on nutrient availability the

152
00:06:54,510 --> 00:06:50,470
death rate however is fixed it's assumed

153
00:06:56,520 --> 00:06:54,520
that based off of the atmospheric

154
00:06:58,740 --> 00:06:56,530
dynamics of Venus that your average

155
00:07:01,770 --> 00:06:58,750
bacteria is going to be a loft for about

156
00:07:04,830 --> 00:07:01,780
three months before it drops into the

157
00:07:06,630 --> 00:07:04,840
lower atmosphere and here's the

158
00:07:09,030 --> 00:07:06,640
metabolism cycle which like I said is a

159
00:07:12,060 --> 00:07:09,040
lot simpler and we're ignoring a lot of

160
00:07:14,700 --> 00:07:12,070
potential chemistry so basically you

161
00:07:19,350 --> 00:07:14,710
have hydrogen sulfide which is

162
00:07:22,680 --> 00:07:19,360
photosynthetically oxidized or rather oh

163
00:07:24,330 --> 00:07:22,690

wow these two are switched oh no wait no

164
00:07:27,090 --> 00:07:24,340
no that's right yeah it's physically ox

165
00:07:29,880 --> 00:07:27,100
that I know these two are switch never

166
00:07:33,150 --> 00:07:29,890
mind my mistake okay this actually

167
00:07:35,610 --> 00:07:33,160
should go backwards you have hydrogen

168
00:07:37,650 --> 00:07:35,620
sulfide which is oxidized into amorphous

169
00:07:39,960 --> 00:07:37,660
sulfur which then undergoes a photo

170
00:07:42,930 --> 00:07:39,970
livak reaction which splits it it reacts

171
00:07:44,580 --> 00:07:42,940
with other oxygen bearing compounds

172
00:07:46,790 --> 00:07:44,590
which usually have also been

173
00:07:49,920 --> 00:07:46,800
photosynthetic photolytic we split and

174
00:07:52,620 --> 00:07:49,930
forms sulfur dioxide which is then

175
00:07:56,280 --> 00:07:52,630
reduced by hydrogen sulfide sorry about

176
00:07:57,660 --> 00:07:56,290
that so here's the results I don't have

177
00:08:00,090 --> 00:07:57,670
any pretty graphs for you partially

178
00:08:01,740 --> 00:08:00,100
because xpp ott has a very clunky graph

179
00:08:03,780 --> 00:08:01,750
interface but also because it reaches

180
00:08:06,170 --> 00:08:03,790
equilibrium really quickly so it would

181
00:08:09,300 --> 00:08:06,180
have just been a bunch of straight lines

182
00:08:12,540 --> 00:08:09,310
so and we're just kind of measuring it

183
00:08:14,840 --> 00:08:12,550
against what observed values are for the

184
00:08:18,360 --> 00:08:14,850
most part when they're available so we

185
00:08:22,020 --> 00:08:18,370
got about 1.9 micro moles per liter of

186
00:08:23,700 --> 00:08:22,030
atmosphere for biomass carbon so I guess

187
00:08:26,610 --> 00:08:23,710
that's kind of probably would be an

188
00:08:28,770 --> 00:08:26,620

upper bound very very rough estimate for

189
00:08:31,620 --> 00:08:28,780
how much biomass chikitsa staying and

190
00:08:34,080 --> 00:08:31,630
then you've got 0 point 29 and point 06

191
00:08:37,440 --> 00:08:34,090
microm old leaders of nitrogen

192
00:08:40,380 --> 00:08:37,450
phosphorus which are again limited by

193
00:08:42,150 --> 00:08:40,390
the redfield ratio the inorganic

194
00:08:43,500 --> 00:08:42,160
nitrogen really didn't change at all

195
00:08:45,450 --> 00:08:43,510
just because there's so much of it

196
00:08:49,230 --> 00:08:45,460
compared to the amount of biomass the

197
00:08:52,150 --> 00:08:49,240
inorganic phosphorus was depleted which

198
00:08:53,860 --> 00:08:52,160
isn't too surprising given that

199
00:08:55,829 --> 00:08:53,870
on earth and presumably the system as

200
00:08:57,879 --> 00:08:55,839
well phosphorus is usually denude

201
00:08:59,889 --> 00:08:57,889
limiting nutrient and I'll talk a little

202
00:09:02,170 --> 00:08:59,899
bit more about that in a bit the sulfur

203
00:09:06,129 --> 00:09:02,180
dioxide was enriched and correspondingly

204
00:09:08,590 --> 00:09:06,139
the hydrogen sulfide was depleted and

205
00:09:12,460 --> 00:09:08,600
also there was a lot more amorphous

206
00:09:16,990 --> 00:09:12,470
sulfur generated than has been measured

207
00:09:18,519 --> 00:09:17,000
so far which is an odd result I just

208
00:09:20,499 --> 00:09:18,529
talked about a little bit more like I

209
00:09:23,139 --> 00:09:20,509
said phosphorus is probably the limiting

210
00:09:24,519 --> 00:09:23,149
nutrient or actually def at least in the

211
00:09:27,970 --> 00:09:24,529
model system is definitely one of the

212
00:09:30,910 --> 00:09:27,980
nutrient if you increase the initial in

213
00:09:33,910 --> 00:09:30,920

organic phosphorus available from 0.05

214
00:09:36,639 --> 00:09:33,920
12 0.078 pretty much doubles the amount

215
00:09:38,499 --> 00:09:36,649
of biomass so very small changes will

216
00:09:42,579 --> 00:09:38,509
result in a major change in the amount

217
00:09:44,230 --> 00:09:42,589
of biomass again much larger quantities

218
00:09:47,259 --> 00:09:44,240
amorphous ober were produced and

219
00:09:49,809 --> 00:09:47,269
observed assuming that the model is even

220
00:09:51,490 --> 00:09:49,819
somewhat resembling of reality that

221
00:09:53,439 --> 00:09:51,500
raises the question of why haven't we

222
00:09:55,749 --> 00:09:53,449
observed more and there are a couple

223
00:09:59,079 --> 00:09:55,759
different ways or that you might be

224
00:10:01,629 --> 00:09:59,089
getting rid of it as a sink abiotic ly

225
00:10:04,210 --> 00:10:01,639
they're coupled a biotic processes again

226
00:10:07,509 --> 00:10:04,220
photo lytic reactions of photochemical

227
00:10:08,980 --> 00:10:07,519
reactions there are a bunch I didn't

228
00:10:11,069 --> 00:10:08,990
wasn't able to take into account

229
00:10:13,179 --> 00:10:11,079
although most of them have very low

230
00:10:16,449 --> 00:10:13,189
reaction rates so that's probably not

231
00:10:18,550 --> 00:10:16,459
too likely a likely explanation might be

232
00:10:20,650 --> 00:10:18,560
nucleation that is they clump together

233
00:10:23,410 --> 00:10:20,660
and form aerosols which can then either

234
00:10:27,100 --> 00:10:23,420
drop out of the atmosphere or simply

235
00:10:28,960 --> 00:10:27,110
aren't detected by instrumentation there

236
00:10:31,660 --> 00:10:28,970
could be a faster mechanism conversion

237
00:10:34,439 --> 00:10:31,670
to sulfur dioxide and also one of the

238
00:10:38,949 --> 00:10:34,449

more interesting hypothesis is that is

239
00:10:42,549 --> 00:10:38,959
that Shelton makuu and colleagues 2004

240
00:10:44,139 --> 00:10:42,559
speculated that some of the absorption

241
00:10:45,610 --> 00:10:44,149
features they've seen the Venetian

242
00:10:48,999 --> 00:10:45,620
atmosphere was actually the result of

243
00:10:51,790 --> 00:10:49,009
cyclo off to sulfate which is a very

244
00:10:53,259 --> 00:10:51,800
effective UV protectant and is

245
00:10:56,170 --> 00:10:53,269
relatively easy to synthesize them

246
00:10:57,639 --> 00:10:56,180
Indonesian atmosphere and that bacteria

247
00:10:59,769 --> 00:10:57,649
might have actually been generating it

248
00:11:03,100 --> 00:10:59,779
and sequestering the amorphous sulfur to

249
00:11:04,930 --> 00:11:03,110
essentially mitigate against UV damage

250
00:11:07,030 --> 00:11:04,940
which given

251
00:11:08,140 --> 00:11:07,040
Venus's lack of an ozone there would be

252
00:11:12,070 --> 00:11:08,150
something you would have to worry about

253
00:11:15,910 --> 00:11:12,080
so that would make sense so just to wrap

254
00:11:18,090 --> 00:11:15,920
it up so yeah there theoretically is

255
00:11:22,660 --> 00:11:18,100
enough hydrogen or enough nitrogen

256
00:11:24,430 --> 00:11:22,670
phosphorus and carbon for a microbe like

257
00:11:29,170 --> 00:11:24,440
a terrestrial acidify Oh third a file

258
00:11:31,540 --> 00:11:29,180
thermofoil to survive on the in the

259
00:11:34,480 --> 00:11:31,550
Venusian atmosphere we've got like I

260
00:11:37,230 --> 00:11:34,490
said a small but plausible estimate for

261
00:11:39,550 --> 00:11:37,240
the amount of biomass that is supported

262
00:11:42,190 --> 00:11:39,560
but like I said the conversion of

263
00:11:43,960 --> 00:11:42,200

amorphous salt for to sulfur dioxide is

264
00:11:45,520 --> 00:11:43,970
still really poorly characterized and

265
00:11:48,730 --> 00:11:45,530
that's probably one of the biggest

266
00:11:51,430 --> 00:11:48,740
weakness is a model we sell that would

267
00:11:53,470 --> 00:11:51,440
be again addressing the complex

268
00:11:54,700 --> 00:11:53,480
atmospheric chemistry because as I

269
00:11:56,050 --> 00:11:54,710
mentioned yearly there are hundreds of

270
00:11:57,460 --> 00:11:56,060
reactions some of which are probably

271
00:12:00,070 --> 00:11:57,470
gonna be more relevant than others but

272
00:12:01,720 --> 00:12:00,080
I'm the next stage is to start slowly

273
00:12:04,200 --> 00:12:01,730
including those and seeing how it

274
00:12:06,760 --> 00:12:04,210
affects the model and in particular

275
00:12:09,760 --> 00:12:06,770
there's also a whole set of reactions

276
00:12:11,560 --> 00:12:09,770
involving carbon monoxide and the

277
00:12:14,860 --> 00:12:11,570
formation of carbonyl sulfide which also

278
00:12:18,640 --> 00:12:14,870
may be very relevant to biological

279
00:12:28,829 --> 00:12:18,650
systems so without further ado any

280
00:12:34,150 --> 00:12:31,540
this may be a relatively simple question

281
00:12:37,540 --> 00:12:34,160
for you as an ecologist but how do these

282
00:12:39,250 --> 00:12:37,550
my biomasses compared to what we might

283
00:12:42,280 --> 00:12:39,260
find it to rest real sister oh they're

284
00:12:45,009 --> 00:12:42,290
incredibly low um your average plot of

285
00:12:50,290 --> 00:12:45,019
like woodland forest had something like

286
00:12:51,579 --> 00:12:50,300
I think it was six hundred micro moles

287
00:12:54,610 --> 00:12:51,589
of carbon per lead or something like

288
00:12:57,160 --> 00:12:54,620

that you know it's very very low

289
00:13:07,800 --> 00:12:57,170
compared to all but the most marginal

290
00:13:09,639 --> 00:13:07,810
terrestrial environments Thanks it

291
00:13:11,350 --> 00:13:09,649
probably might not be able to be

292
00:13:14,230 --> 00:13:11,360
answered but I was just something to

293
00:13:16,180 --> 00:13:14,240
think about might be the time scales for

294
00:13:17,889 --> 00:13:16,190
reproduction for these organisms versus

295
00:13:19,569 --> 00:13:17,899
the time scales to fall out of the app

296
00:13:21,130 --> 00:13:19,579
that's actually something I left this

297
00:13:24,130 --> 00:13:21,140
kind of an open question but that is

298
00:13:25,449 --> 00:13:24,140
actually going to be a major part of it

299
00:13:28,870 --> 00:13:25,459
and I think another thing I would want

300
00:13:31,030 --> 00:13:28,880
to for the I guess next phase this is

301
00:13:33,699 --> 00:13:31,040
again a very preliminary approximate

302
00:13:36,610 --> 00:13:33,709
model is to actually start include that

303
00:13:37,870 --> 00:13:36,620
and actually look at again what

304
00:13:39,550 --> 00:13:37,880
terrestrial bacteria under similar

305
00:13:41,230 --> 00:13:39,560
environments what's their usual

306
00:13:43,480 --> 00:13:41,240
reproductive rate like because that's

307
00:13:45,699 --> 00:13:43,490
going to make a huge difference on how

308
00:13:46,810 --> 00:13:45,709
fast this stuff is going to grow and how

309
00:13:50,889 --> 00:13:46,820
long it's going to be a persistent

310
00:13:53,740 --> 00:13:50,899
atmosphere I got another probably really

311
00:13:55,980 --> 00:13:53,750
quick one um you said this was based off

312
00:13:58,060 --> 00:13:55,990
of thermo files in a pseudo file

313
00:14:00,579 --> 00:13:58,070

organisms here are those OH min

314
00:14:02,829 --> 00:14:00,589
president Earth's atmosphere oh no these

315
00:14:06,600 --> 00:14:02,839
there some of them are most of them

316
00:14:08,560 --> 00:14:06,610
either come from Hot Springs or from

317
00:14:09,910 --> 00:14:08,570
hydrothermal vents which immediately is

318
00:14:11,500 --> 00:14:09,920
a big change in environment but

319
00:14:15,130 --> 00:14:11,510
unfortunately we don't there but that's

320
00:14:16,750 --> 00:14:15,140
about the closest we have to a analogous

321
00:14:18,550 --> 00:14:16,760
environment to something like the

322
00:14:20,579 --> 00:14:18,560
Venetian ass ok I see though thank you

323
00:14:23,230 --> 00:14:20,589
ideally if we could find a really

324
00:14:26,079 --> 00:14:23,240
weirdly acidic desert that would be

325
00:14:28,810 --> 00:14:26,089
perfect but I don't know if there are

326
00:14:30,100 --> 00:14:28,820
many of those around okay that Cinco

327
00:14:31,530 --> 00:14:30,110
speakers and all the speakers of that