Julia Horne

Archean Biogeochemistry: Investigating Environmental Controls on Archean Earth's Habitability

1
00:00:00,240 --> 00:00:10,850
[Music]

2
00:00:18,089 --> 00:00:13,890
hi I'm Julia Horne

3
00:00:20,220 --> 00:00:18,099
I'm here as a graduate student from the

4
00:00:23,070 --> 00:00:20,230
school of Earth and shine earth and

5
00:00:25,710 --> 00:00:23,080
ocean sciences in the University of

6
00:00:27,769 --> 00:00:25,720
Victoria in Canada I'm here to talk to

7
00:00:29,700 --> 00:00:27,779
you about our Keon biogeochemistry

8
00:00:31,230 --> 00:00:29,710
investigating environmental controls on

9
00:00:33,240 --> 00:00:31,240
Archaean earth's habitability which is

10
00:00:35,280 --> 00:00:33,250
different than the program has listed

11
00:00:39,000 --> 00:00:35,290
because I changed the title because I

12
00:00:41,370 --> 00:00:39,010
can and my supervisor at University of

13
00:00:43,830 --> 00:00:41,380

Victoria is Colin Goldblatt and he is

14
00:00:47,280 --> 00:00:43,840
actually an alumnus of the a Brad

15
00:00:48,990 --> 00:00:47,290
conventions or conch meetings so he was

16
00:00:51,630 --> 00:00:49,000
very excited that I could come and visit

17
00:00:56,779 --> 00:00:51,640
you and he wanted to highlight but he

18
00:01:01,650 --> 00:00:56,789
has an AB grad Khan oh nine shirt so

19
00:01:03,990 --> 00:01:01,660
yeah so thank you amber for explaining

20
00:01:06,870 --> 00:01:04,000
the faint young Sun paradox so I do not

21
00:01:10,020 --> 00:01:06,880
have to it is kind of central to my

22
00:01:13,429 --> 00:01:10,030
interest in Archaean earth and the earth

23
00:01:16,140 --> 00:01:13,439
Earth's development of habitability so

24
00:01:20,070 --> 00:01:16,150
it's a little bit complex to look at

25
00:01:22,830 --> 00:01:20,080
this figure on the left but what I want

26
00:01:24,690 --> 00:01:22,840
you to take a note of is that the major

27
00:01:25,230 --> 00:01:24,700
outgoing radiation from the Earth's

28
00:01:29,789 --> 00:01:25,240
surface

29
00:01:32,580 --> 00:01:29,799
Thermal IR is in the attend well 8 to 13

30
00:01:34,770 --> 00:01:32,590
micron vapor window where neither carbon

31
00:01:38,910 --> 00:01:34,780
dioxide nor water vapor necessarily

32
00:01:40,770 --> 00:01:38,920
absorb that much radiation so this is

33
00:01:43,710 --> 00:01:40,780
where most of the heat is lost from the

34
00:01:46,649 --> 00:01:43,720
planet and basically the faint young Sun

35
00:01:48,719 --> 00:01:46,659
paradox since it requires at least 30 to

36
00:01:50,399 --> 00:01:48,729
15 watts per meter squared of additional

37
00:01:54,330 --> 00:01:50,409
radiative forcing to keep the planet

38
00:01:56,420 --> 00:01:54,340

habitable in the Archaean it needs a

39
00:01:59,969 --> 00:01:56,430
greenhouse gas to plug this hole so

40
00:02:03,120 --> 00:01:59,979
there are many greenhouse gases as you

41
00:02:06,569 --> 00:02:03,130
probably know one of our favorites is in

42
00:02:10,109 --> 00:02:06,579
the modern day is co2 ch4 has also been

43
00:02:15,790 --> 00:02:10,119
proposed to fill in this gap but nh3

44
00:02:19,000 --> 00:02:15,800
ammonia is uniquely good for this kind

45
00:02:22,720 --> 00:02:19,010
of greenhouse gas forcing because it

46
00:02:27,120 --> 00:02:22,730
fills almost exactly the 8 to 13 micron

47
00:02:30,190 --> 00:02:27,130
vapor window it is theoretically

48
00:02:32,320 --> 00:02:30,200
proposed to be abundant or at least way

49
00:02:34,390 --> 00:02:32,330
more abundant than a modern-day in a

50
00:02:37,270 --> 00:02:34,400
reducing or subtly reducing atmosphere

51
00:02:39,790 --> 00:02:37,280
which is what the Archaean earth should

52
00:02:42,880 --> 00:02:39,800
have been it's a very low oxygen in the

53
00:02:45,790 --> 00:02:42,890
atmosphere when they say reducing and it

54
00:02:48,340 --> 00:02:45,800
has a few cons some some detractions it

55
00:02:50,200 --> 00:02:48,350
is soluble in water so theoretically it

56
00:02:53,410 --> 00:02:50,210
can get rained out but if you have a

57
00:02:56,260 --> 00:02:53,420
constant supply of ammonia from you know

58
00:02:58,360 --> 00:02:56,270
biological or geologic systems you can

59
00:03:00,970 --> 00:02:58,370
kind of perpetuate its atmospheric

60
00:03:02,860 --> 00:03:00,980
partial pressure it is also photolytic

61
00:03:05,350 --> 00:03:02,870
li destroyed irreversibly in the

62
00:03:07,330 --> 00:03:05,360
atmosphere so incoming radiation breaks

63
00:03:13,300 --> 00:03:07,340

it apart hydrogen escapes you left to

64
00:03:15,070 --> 00:03:13,310
die nitrogen yay kind of so anyway I'll

65
00:03:17,650 --> 00:03:15,080
get a little bit more into the model

66
00:03:20,230 --> 00:03:17,660
details later but a background model was

67
00:03:23,920 --> 00:03:20,240
developed by a previous undergrad

68
00:03:26,380 --> 00:03:23,930
student who found that just working with

69
00:03:27,970 --> 00:03:26,390
nitrogen only biogeochemical systems you

70
00:03:29,680 --> 00:03:27,980
can get at least three watts per meter

71
00:03:31,750 --> 00:03:29,690
squared which is about a tenth of what

72
00:03:33,850 --> 00:03:31,760
we need as a baseline but it's not

73
00:03:35,860 --> 00:03:33,860
insignificant so this is still very

74
00:03:38,790 --> 00:03:35,870
promising and I decided to take the

75
00:03:41,970 --> 00:03:38,800
project on and move forward with it so

76
00:03:44,500 --> 00:03:41,980
most of you probably don't use

77
00:03:47,020 --> 00:03:44,510
biogeochemical models so I'll explain

78
00:03:48,250 --> 00:03:47,030
them a little bit to you so you can kind

79
00:03:51,010 --> 00:03:48,260
of understand where I'm coming from

80
00:03:52,990 --> 00:03:51,020
so they model development just like

81
00:03:54,640 --> 00:03:53,000
everything just starts when you have a

82
00:03:55,990 --> 00:03:54,650
question and you're defining what kind

83
00:03:58,240 --> 00:03:56,000
of species or systems you're

84
00:04:01,090 --> 00:03:58,250
investigating so for me it was not only

85
00:04:03,940 --> 00:04:01,100
the nitrogen biogeochemical species but

86
00:04:05,500 --> 00:04:03,950
also carbon can i biogeochemical species

87
00:04:07,750 --> 00:04:05,510
because I want to understand what other

88
00:04:10,240 --> 00:04:07,760

greenhouse gases may interact in order

89
00:04:11,860 --> 00:04:10,250
to promote habitability so once you

90
00:04:14,860 --> 00:04:11,870
identify those species you have to

91
00:04:16,690 --> 00:04:14,870
quantify fluxes and build OD ease or

92
00:04:18,699 --> 00:04:16,700
ordinary differential equations so

93
00:04:20,710 --> 00:04:18,709
fluxes are just mass movement from one

94
00:04:22,570 --> 00:04:20,720
reservoir to the other reservoirs can be

95
00:04:25,200 --> 00:04:22,580
anything from the atmosphere to the

96
00:04:28,860 --> 00:04:25,210
surface ocean to sediments and the deep

97
00:04:30,210 --> 00:04:28,870
ocean and Oh des are these ordinary

98
00:04:32,850 --> 00:04:30,220
differential equations are just

99
00:04:34,800 --> 00:04:32,860
describing how these reservoirs and the

100
00:04:37,290 --> 00:04:34,810
species within them change over time

101
00:04:39,150 --> 00:04:37,300
simple enough you set that up you run

102
00:04:41,550 --> 00:04:39,160
your model over a geologically relevant

103
00:04:43,140 --> 00:04:41,560
amount of time so anywhere from a

104
00:04:46,740 --> 00:04:43,150
hundred million to a billion years

105
00:04:50,879 --> 00:04:46,750
basically what I run not in real time

106
00:04:53,779 --> 00:04:50,889
obviously and you have to validate your

107
00:04:55,110 --> 00:04:53,789
model so what happens is that I have two

108
00:04:58,080 --> 00:04:55,120
parameterizations and this

109
00:05:00,719 --> 00:04:58,090
parameterization is based on key

110
00:05:02,760 --> 00:05:00,729
insights into our difference the

111
00:05:04,200 --> 00:05:02,770
difference between the modern planet the

112
00:05:07,080 --> 00:05:04,210
modern earth I should say and the

113
00:05:09,180 --> 00:05:07,090

Archaean earth which is oxygenation so

114
00:05:14,820 --> 00:05:09,190
the PD acity of oxygen partial pressure

115
00:05:16,710 --> 00:05:14,830
of co2 the amount of continental erosion

116
00:05:20,149 --> 00:05:16,720
per year would have been lower

117
00:05:22,800 --> 00:05:20,159
without oxidative erosion etc etc so

118
00:05:25,170 --> 00:05:22,810
parameterizing it at modern-day running

119
00:05:28,170 --> 00:05:25,180
that model I should get modern outputs

120
00:05:29,939 --> 00:05:28,180
for reservoir and flux estimates so if I

121
00:05:31,950 --> 00:05:29,949
do I just seen my fluxes because you can

122
00:05:33,810 --> 00:05:31,960
always improve and then I can run the

123
00:05:36,890 --> 00:05:33,820
tests on my Archaean parameterization

124
00:05:40,290 --> 00:05:36,900
because essentially my fluxes are valid

125
00:05:41,969 --> 00:05:40,300
of course if they don't agree you have

126
00:05:43,770 --> 00:05:41,979
to recalculate your fluxes modify your

127
00:05:45,570 --> 00:05:43,780
OD ease you might have to add more boxes

128
00:05:47,610 --> 00:05:45,580
which you definitely do usually you have

129
00:05:49,890 --> 00:05:47,620
to rerun the model you go into this loop

130
00:05:53,399 --> 00:05:49,900
of sadness from which it appears you

131
00:05:56,610 --> 00:05:53,409
will never return but you do kind of

132
00:05:59,010 --> 00:05:56,620
usually in the end you end up with

133
00:06:01,110 --> 00:05:59,020
something that can be represented in a

134
00:06:03,089 --> 00:06:01,120
schematic like this where all of the

135
00:06:05,459 --> 00:06:03,099
arrows are fluxes that I calculate all

136
00:06:07,219 --> 00:06:05,469
of the species are tracked in the model

137
00:06:09,749 --> 00:06:07,229
I don't want you to get overwhelmed by

138
00:06:11,279 --> 00:06:09,759

the details in it and obviously there

139
00:06:13,920 --> 00:06:11,289
are a lot more fluxes and species that I

140
00:06:15,120 --> 00:06:13,930
could include format more accuracy but I

141
00:06:19,080 --> 00:06:15,130
don't want to be in that loop of sadness

142
00:06:21,810 --> 00:06:19,090
anymore I want to move on so just note

143
00:06:23,570 --> 00:06:21,820
that like there's a lot going on there

144
00:06:25,620 --> 00:06:23,580
are a lot of interplaying

145
00:06:28,200 --> 00:06:25,630
reactions between the carbon and

146
00:06:29,490 --> 00:06:28,210
nitrogen system and I include phosphate

147
00:06:32,010 --> 00:06:29,500
because it's going to be the key

148
00:06:35,070 --> 00:06:32,020
nutrient for my biological systems in

149
00:06:36,530 --> 00:06:35,080
the Archaean yes there's oxygen in here

150
00:06:37,970 --> 00:06:36,540
the oxygen is

151
00:06:40,100 --> 00:06:37,980
they kept at a low level for the

152
00:06:42,830 --> 00:06:40,110
Archaean parameterization and it's it's

153
00:06:45,530 --> 00:06:42,840
included in like nitrate and phosphate

154
00:06:46,910 --> 00:06:45,540
species because I need to compare with

155
00:06:50,390 --> 00:06:46,920
modern-day and if I don't include them

156
00:06:52,160 --> 00:06:50,400
that doesn't work so once I run the

157
00:06:54,380 --> 00:06:52,170
model at my two different

158
00:06:57,230 --> 00:06:54,390
parameterizations again this figure is

159
00:07:00,050 --> 00:06:57,240
kind of hard to look at I know because I

160
00:07:02,330 --> 00:07:00,060
look at it a lot the black dots are the

161
00:07:04,340 --> 00:07:02,340
model output for my modern

162
00:07:07,220 --> 00:07:04,350
parameterization so I'm comparing that

163
00:07:09,440 --> 00:07:07,230

to these green blue and red symbols that

164
00:07:11,870 --> 00:07:09,450
are literature compiled literature

165
00:07:14,420 --> 00:07:11,880
estimates from different researchers for

166
00:07:15,980 --> 00:07:14,430
reservoirs in the modern day so I want

167
00:07:19,880 --> 00:07:15,990
to see how those black dots fit in with

168
00:07:21,470 --> 00:07:19,890
those circle symbols and the gray dots

169
00:07:23,900 --> 00:07:21,480
which you may or may not be able to see

170
00:07:25,730 --> 00:07:23,910
are simply just the plots of my Archaean

171
00:07:29,120 --> 00:07:25,740
parameterization results for my

172
00:07:31,340 --> 00:07:29,130
reservoir sizes so suffice to say that

173
00:07:33,410 --> 00:07:31,350
there the parameterization certainly

174
00:07:35,300 --> 00:07:33,420
does matter and you'll get very

175
00:07:38,300 --> 00:07:35,310
different reservoir outputs depending on

176
00:07:39,740 --> 00:07:38,310
your parameterization and the privation

177
00:07:42,530 --> 00:07:39,750
of the Archaean system is basically

178
00:07:44,390 --> 00:07:42,540
included over here I won't go over it

179
00:07:46,340 --> 00:07:44,400
too much because you guys probably have

180
00:07:48,020 --> 00:07:46,350
a little bit of an idea how different

181
00:07:51,940 --> 00:07:48,030
the Archaean earth would have been from

182
00:07:53,930 --> 00:07:51,950
the present earth a very important

183
00:07:56,320 --> 00:07:53,940
parameterization is this extended

184
00:07:59,090 --> 00:07:56,330
ammonia atmospheric lifetime so

185
00:08:02,780 --> 00:07:59,100
atmospheric ammonia is photolytic li

186
00:08:05,150 --> 00:08:02,790
destroyed today at a rate about it lasts

187
00:08:07,820 --> 00:08:05,160
for maybe five days in the atmosphere so

188
00:08:09,890 --> 00:08:07,830

in the are can we assume that lasts for

189
00:08:11,960 --> 00:08:09,900
at least 10 years some people would say

190
00:08:13,640 --> 00:08:11,970
that's too high some people would say

191
00:08:16,360 --> 00:08:13,650
that's way too low so it's a happy

192
00:08:20,180 --> 00:08:16,370
medium for me to make that assumption

193
00:08:22,760 --> 00:08:20,190
and as I said that schematic before

194
00:08:24,830 --> 00:08:22,770
there are a lot of interacting reactions

195
00:08:27,590 --> 00:08:24,840
between the two systems nitrogen and

196
00:08:29,180 --> 00:08:27,600
carbon and you have to before you run

197
00:08:30,890 --> 00:08:29,190
any tests on this model you have to

198
00:08:32,690 --> 00:08:30,900
consider those reactions you know what

199
00:08:34,670 --> 00:08:32,700
to perturb in order for it to be Geo

200
00:08:38,240 --> 00:08:34,680
physically relevant or biologically

201
00:08:39,560 --> 00:08:38,250
relevant this is a feedback diagram I'm

202
00:08:43,159 --> 00:08:39,570
going to highlight some freeze you don't

203
00:08:45,440 --> 00:08:43,169
have to look at it too long so what

204
00:08:47,000 --> 00:08:45,450
we're trying to get at is increasing the

205
00:08:47,990 --> 00:08:47,010
global temperature through partial

206
00:08:50,150 --> 00:08:48,000
pressure of

207
00:08:51,830 --> 00:08:50,160
house gasses so if you increase the

208
00:08:54,650 --> 00:08:51,840
global temperature increase continental

209
00:08:56,090 --> 00:08:54,660
erosion kind of continental erosion will

210
00:08:58,750 --> 00:08:56,100
increase the flux of alkalinity

211
00:09:02,120 --> 00:08:58,760
bicarbonate to the ocean that will

212
00:09:04,360 --> 00:09:02,130
increase the pH and it was said in a

213
00:09:08,480 --> 00:09:04,370

talk yesterday I forget by who sorry

214
00:09:12,380 --> 00:09:08,490
that there's this reaction in

215
00:09:15,200 --> 00:09:12,390
equilibrium at around 9 pH between

216
00:09:18,200 --> 00:09:15,210
ammonia and ammonium it's protonated

217
00:09:21,950 --> 00:09:18,210
sister species and if so if you increase

218
00:09:25,100 --> 00:09:21,960
that ocean pH you decrease the amount of

219
00:09:26,770 --> 00:09:25,110
hydrogen atoms that are in the water so

220
00:09:29,360 --> 00:09:26,780
you're actually going to force this

221
00:09:31,370 --> 00:09:29,370
speciation more towards ammonia which

222
00:09:33,620 --> 00:09:31,380
increases your partial pressure and your

223
00:09:36,500 --> 00:09:33,630
radiative forcing for ammonia and that's

224
00:09:38,210 --> 00:09:36,510
a positive feedback however if you do

225
00:09:40,010 --> 00:09:38,220
the same thing you increase Continental

226
00:09:41,510 --> 00:09:40,020
erosion you also increase nutrient

227
00:09:43,700 --> 00:09:41,520
transport which in this case is

228
00:09:45,320 --> 00:09:43,710
phosphate and if you do that you

229
00:09:48,170 --> 00:09:45,330
increase primary productivity and

230
00:09:50,180 --> 00:09:48,180
atmospheric co2 drawdown so if you do

231
00:09:52,910 --> 00:09:50,190
that it becomes a negative feedback or

232
00:09:56,090 --> 00:09:52,920
the global temperature so this begs the

233
00:09:58,370 --> 00:09:56,100
question do the co2 and ammonia green

234
00:10:01,520 --> 00:09:58,380
houses potentially negate one another in

235
00:10:02,540 --> 00:10:01,530
the Archaean earth so I gotta have two

236
00:10:04,730 --> 00:10:02,550
questions at this point

237
00:10:07,010 --> 00:10:04,740
one can I get high enough partial

238
00:10:09,140 --> 00:10:07,020

pressure of ammonia to kind of resolve

239
00:10:11,990 --> 00:10:09,150
the faint young Sun paradox cross my

240
00:10:15,140 --> 00:10:12,000
fingers second one is this gonna be a

241
00:10:16,760 --> 00:10:15,150
problem I have the I kind of explained

242
00:10:19,130 --> 00:10:16,770
it to you but if this is a breakdown of

243
00:10:21,590 --> 00:10:19,140
the feedback loop that may or may not be

244
00:10:23,990 --> 00:10:21,600
destructive for the atmospheric

245
00:10:26,650 --> 00:10:24,000
radiative forcing the Archaean

246
00:10:28,760 --> 00:10:26,660
how do I determine which one of these

247
00:10:30,470 --> 00:10:28,770
feedback loops is going to be most

248
00:10:33,970 --> 00:10:30,480
important how do I determine which

249
00:10:37,160 --> 00:10:33,980
parameter values are going to control

250
00:10:39,980 --> 00:10:37,170
basically how much radiative forcing I

251
00:10:41,780 --> 00:10:39,990
can get out of the Archaean earth well

252
00:10:44,150 --> 00:10:41,790
what I do is I take my parameter

253
00:10:47,180 --> 00:10:44,160
assumptions which for the Archaean are

254
00:10:51,370 --> 00:10:47,190
not well constrained at all their way

255
00:10:53,420 --> 00:10:51,380
assumptions and I take basically a

256
00:10:56,570 --> 00:10:53,430
magnitude of values

257
00:10:58,820 --> 00:10:56,580
I choose each one I put them into the

258
00:11:01,400 --> 00:10:58,830
model its kind

259
00:11:04,850 --> 00:11:01,410
to explain because it's you know it's

260
00:11:06,230 --> 00:11:04,860
code but basically I evaluate a bunch of

261
00:11:08,420 --> 00:11:06,240
different values for all of my

262
00:11:12,380 --> 00:11:08,430
assumptions so I assume at least like

263
00:11:15,680 --> 00:11:12,390

three to the eight years of you know for

264
00:11:17,920 --> 00:11:15,690
continental erosion but I go from 10 to

265
00:11:21,080 --> 00:11:17,930
the 8 to 10 to the 9 years in order to

266
00:11:22,670 --> 00:11:21,090
kind of test this area and then I

267
00:11:26,060 --> 00:11:22,680
produce something like this where I show

268
00:11:28,220 --> 00:11:26,070
you my assumption in this black Asterix

269
00:11:30,470 --> 00:11:28,230
if you can see it and it gives me a

270
00:11:32,960 --> 00:11:30,480
contour graph of which of these two

271
00:11:34,880 --> 00:11:32,970
parameters is kind of forcing more

272
00:11:36,800 --> 00:11:34,890
change in the radiative forcing and

273
00:11:39,440 --> 00:11:36,810
personal pressure so these two that's

274
00:11:41,270 --> 00:11:39,450
ammonius partial pressure in log units

275
00:11:44,210 --> 00:11:41,280
can't really read it but and this is co

276
00:11:46,070 --> 00:11:44,220
2 and log units ppm and then these are

277
00:11:47,450 --> 00:11:46,080
their radiative forcings respectively

278
00:11:49,730 --> 00:11:47,460
and this is the combined radiative

279
00:11:53,080 --> 00:11:49,740
forcing what I want you to note is that

280
00:11:55,610 --> 00:11:53,090
if I increase on the x axis here is

281
00:11:59,840 --> 00:11:55,620
ammonia's lifetime in the atmosphere if

282
00:12:01,730 --> 00:11:59,850
I increase that and I well subtly

283
00:12:03,500 --> 00:12:01,740
increase or decrease excuse me the

284
00:12:05,750 --> 00:12:03,510
erosion timescale so if the continents

285
00:12:08,240 --> 00:12:05,760
last longer there's less erosion of the

286
00:12:10,160 --> 00:12:08,250
continents then I can get potentially 20

287
00:12:13,310 --> 00:12:10,170
watts per meter squared out of ammonia I

288
00:12:15,950 --> 00:12:13,320

can get potentially 55 watts per meter

289
00:12:18,290 --> 00:12:15,960
squared of co2 for a total of over 70

290
00:12:23,210 --> 00:12:18,300
watts per meter squared so a reminder I

291
00:12:24,950 --> 00:12:23,220
needed 30 to 50 and so we but of course

292
00:12:27,590 --> 00:12:24,960
this means I can potentially do it I

293
00:12:30,350 --> 00:12:27,600
don't know if these are G or physically

294
00:12:31,820 --> 00:12:30,360
relevant numbers but still and applies

295
00:12:35,540 --> 00:12:31,830
an ammonia solution faint young Sun

296
00:12:38,600 --> 00:12:35,550
paradox so I feel pretty good but I saw

297
00:12:40,640 --> 00:12:38,610
another question don't I but what about

298
00:12:42,650 --> 00:12:40,650
this interaction because I can

299
00:12:46,280 --> 00:12:42,660
parameterize my model this way with

300
00:12:48,560 --> 00:12:46,290
these high high atmospheric ammonia a

301
00:12:51,920 --> 00:12:48,570
lifetime low Continental erosion but

302
00:12:53,330 --> 00:12:51,930
will it actually yield a high partial

303
00:12:55,010 --> 00:12:53,340
pressure of both of those greenhouse

304
00:12:57,890 --> 00:12:55,020
gases enough to solve the faint young

305
00:13:01,430 --> 00:12:57,900
Sun paradox in the model because I don't

306
00:13:03,230 --> 00:13:01,440
know so what I do is I take my model as

307
00:13:06,200 --> 00:13:03,240
its fluxes have evolved to steady state

308
00:13:09,269 --> 00:13:06,210
I perturb them and what I want you to

309
00:13:12,210 --> 00:13:09,279
focus on in this is that these then the

310
00:13:15,119 --> 00:13:12,220
top graph I have the dashed line is the

311
00:13:18,509 --> 00:13:15,129
reference value study state for red is

312
00:13:22,290 --> 00:13:18,519
ammonia and you can't see atmospheric

313
00:13:24,030 --> 00:13:22,300

co2 because it's just so much I made it

314
00:13:26,579 --> 00:13:24,040
so much bigger both of them were

315
00:13:29,400 --> 00:13:26,589
perturbed by 150% and what's important

316
00:13:32,189 --> 00:13:29,410
to note is that co2 and this blue line

317
00:13:34,650 --> 00:13:32,199
does not get drawn down it remains on

318
00:13:36,329 --> 00:13:34,660
it's high perturbed value way above what

319
00:13:38,730 --> 00:13:36,339
we assume partial pressure of co2 would

320
00:13:40,559 --> 00:13:38,740
have been in the air can however even

321
00:13:42,869 --> 00:13:40,569
though I perturb demonium basically as

322
00:13:44,160 --> 00:13:42,879
soon as like 10 to the negative one

323
00:13:46,980 --> 00:13:44,170
years so as soon as my biological

324
00:13:49,350 --> 00:13:46,990
systems kick in ammonia is drawn down

325
00:13:52,189 --> 00:13:49,360
into the ocean and it's partial pressure

326
00:13:55,110 --> 00:13:52,199
has reduced back down to basically its

327
00:13:56,759 --> 00:13:55,120
original steady state value so that

328
00:13:58,679 --> 00:13:56,769
implies that yes

329
00:14:00,660 --> 00:13:58,689
elevated P co2 in the Archaean should

330
00:14:03,269 --> 00:14:00,670
control the amount of partial pressure

331
00:14:04,860 --> 00:14:03,279
of ammonia in the atmosphere so it

332
00:14:06,540 --> 00:14:04,870
couldn't potentially be an issue for

333
00:14:10,559 --> 00:14:06,550
this faint young Sun solution that I

334
00:14:14,569 --> 00:14:10,569
have proposed however I want to move on

335
00:14:16,829 --> 00:14:14,579
so what happens is that this becomes

336
00:14:19,679 --> 00:14:16,839
basically a stepping stone to a larger

337
00:14:22,170 --> 00:14:19,689
geochemical model so I have a summary of

338
00:14:23,790 --> 00:14:22,180

basically what I've found in this

339
00:14:25,590 --> 00:14:23,800
current work that Archaean

340
00:14:27,360 --> 00:14:25,600
biogeochemical feedbacks are capable of

341
00:14:30,360 --> 00:14:27,370
maintaining modern surface temperatures

342
00:14:31,980 --> 00:14:30,370
so I feel good about that but I want to

343
00:14:33,449 --> 00:14:31,990
understand more about the development of

344
00:14:36,269 --> 00:14:33,459
the Earth's system beyond this faint

345
00:14:38,819 --> 00:14:36,279
young Sun paradox kind of question so

346
00:14:42,329 --> 00:14:38,829
adding oxygen to a biogeochemical model

347
00:14:45,809 --> 00:14:42,339
and the oxygenation events therein would

348
00:14:47,910 --> 00:14:45,819
help a lot with its precision and you

349
00:14:51,150 --> 00:14:47,920
know biogeochemical relevance I want to

350
00:14:53,129 --> 00:14:51,160
include more of a mantel box so I can

351
00:14:55,590 --> 00:14:53,139
get fractionation both biological and

352
00:14:57,419 --> 00:14:55,600
geochemical and I want to trace those

353
00:15:00,569 --> 00:14:57,429
biological and geochemical isotopic

354
00:15:05,340 --> 00:15:00,579
fractionation in nitrogen 1514 and

355
00:15:09,900 --> 00:15:05,350
carbon 1213 and basically tracing them

356
00:15:12,540 --> 00:15:09,910
in in in association with noble gases

357
00:15:15,179 --> 00:15:12,550
which are not fractionated usually with

358
00:15:18,689 --> 00:15:15,189
the geochemical or by biological cycling

359
00:15:20,259 --> 00:15:18,699
can I constrain the evolution of Earth's

360
00:15:23,379 --> 00:15:20,269
major volatiles and not

361
00:15:26,019 --> 00:15:23,389
the evolution of the atmosphere from the

362
00:15:27,460 --> 00:15:26,029
Archaean state to the present so with

363
00:15:29,769 --> 00:15:27,470

that I want to thank you and everybody

364
00:15:45,780 --> 00:15:29,779
at the University of Victoria has helped

365
00:15:53,230 --> 00:15:48,759
is the original source of ammonium in

366
00:15:55,299 --> 00:15:53,240
your oceans nitrogen fixation a source

367
00:15:59,679 --> 00:15:55,309
of ammonium yes it's continental erosion

368
00:16:03,670 --> 00:15:59,689
continental yeah so I I'm gonna take

369
00:16:05,920 --> 00:16:03,680
back you your back to my schematic so I

370
00:16:09,160 --> 00:16:05,930
have a River input of calcium carbonate

371
00:16:11,230 --> 00:16:09,170
phosphate ammonium and organic carbon so

372
00:16:14,009 --> 00:16:11,240
it's sorting that and then I can have

373
00:16:17,049 --> 00:16:14,019
nitrification speciation and

374
00:16:19,119 --> 00:16:17,059
remineralization of ammonium but yeah

375
00:16:21,189 --> 00:16:19,129
its geologically sourced right so then

376
00:16:33,850 --> 00:16:21,199
this would apply more towards like paleo

377
00:16:37,509 --> 00:16:33,860
archaea yes I just had a question about

378
00:16:39,579 --> 00:16:37,519
the increased life time for the ammonia

379
00:16:41,619 --> 00:16:39,589
enemy atmosphere is that just due to

380
00:16:44,129 --> 00:16:41,629
decreased flux or are you also taking

381
00:16:48,400 --> 00:16:44,139
into account like wavelength shifts so

382
00:16:51,220 --> 00:16:48,410
it's kind of a it's an assumption that

383
00:16:52,689 --> 00:16:51,230
we have to make in order for this kind

384
00:16:55,179 --> 00:16:52,699
of system to work that it had a longer

385
00:16:57,429 --> 00:16:55,189
lifetime it's certainly the reduced

386
00:17:00,179 --> 00:16:57,439
solar flux at the time would have

387
00:17:02,590 --> 00:17:00,189
extended its you know just on its face

388
00:17:04,049 --> 00:17:02,600

I'm having a reducing atmosphere also

389
00:17:05,319 --> 00:17:04,059
just would have extended its lifetime

390
00:17:10,600 --> 00:17:05,329
you know

391
00:17:14,679 --> 00:17:10,610
baseline but we don't know whether there

392
00:17:16,809 --> 00:17:14,689
would be like other you know photolytic

393
00:17:19,269 --> 00:17:16,819
reactions that we're not thinking of in

394
00:17:22,510 --> 00:17:19,279
the reducing atmosphere or if wavelength

395
00:17:24,250 --> 00:17:22,520
would kind of come into play I don't

396
00:17:27,490 --> 00:17:24,260
know enough about atmospheric chemistry

397
00:17:28,930 --> 00:17:27,500
in order to really study that but it is

398
00:17:32,169 --> 00:17:28,940
yeah it's a prevailing assumption that

399
00:17:33,909 --> 00:17:32,179
it just had a longer life time and you

400
00:17:36,940 --> 00:17:33,919
know it's possible if we had some sort

401
00:17:39,430 --> 00:17:36,950
of like stratospheric or look you know

402
00:17:41,560 --> 00:17:39,440
upper tropospheric haze or something of

403
00:17:43,299 --> 00:17:41,570
you know reduced organic molecules that

404
00:17:45,430 --> 00:17:43,309
that that would be even more valid that

405
00:17:47,680 --> 00:17:45,440
I could put in even a longer lifetime

406
00:17:56,460 --> 00:17:47,690
for ammonia but I just don't know it

407
00:18:01,540 --> 00:17:59,470
yeah actually a really sweet work um how

408
00:18:03,790 --> 00:18:01,550
do you like estimate biological activity

409
00:18:06,820 --> 00:18:03,800
like how do you know how much life is

410
00:18:10,240 --> 00:18:06,830
around and how hungry it was yeah so

411
00:18:12,850 --> 00:18:10,250
okay yeah so the biological assumptions

412
00:18:15,010 --> 00:18:12,860
are totally based on modern day so we're

413
00:18:18,120 --> 00:18:15,020

saying that they're photosynthesizers in

414
00:18:21,070 --> 00:18:18,130
the ocean if I can get their biological

415
00:18:22,900 --> 00:18:21,080
you know productivity fluxes and then

416
00:18:25,030 --> 00:18:22,910
death fluxes to meet the modern-day

417
00:18:28,450 --> 00:18:25,040
estimate I just say okay it's higher

418
00:18:31,000 --> 00:18:28,460
pco2 it's lower oxygen try to live you

419
00:18:33,040 --> 00:18:31,010
know so it is it's totally theoretical

420
00:18:37,180 --> 00:18:33,050
but it is based off of the fact that I

421
00:18:41,200 --> 00:18:37,190
can model these fluxes and you know at

422
00:18:42,760 --> 00:18:41,210
modern-day so as any good modelers

423
00:18:42,760 --> 00:18:43,690
should tell you everything in this is

424
00:18:56,770 --> 00:18:48,700
but also kind of cool so you know take

425
00:19:01,480 --> 00:18:56,780
it with like a whole lake or thistle any

426
00:19:04,250 --> 00:19:01,490
other questions all right if not let's