



1
00:00:00,790 --> 00:00:07,320

[Music]

2
00:00:11,549 --> 00:00:09,230

[Applause]

3
00:00:13,379 --> 00:00:11,559

yes thank you very much and good morning

4
00:00:15,180 --> 00:00:13,389

everyone my name is he asked to attend a

5
00:00:17,760 --> 00:00:15,190

BA from the University of Tokyo in Japan

6
00:00:19,650 --> 00:00:17,770

and I'm PhD student in university of

7
00:00:21,840 --> 00:00:19,660

tokyo and we are working with these

8
00:00:23,999 --> 00:00:21,850

people and so today I'd like to talk

9
00:00:26,849 --> 00:00:24,009

about the global carbon cycle in the

10
00:00:30,239 --> 00:00:26,859

areas so in the areas especially in the

11
00:00:33,120 --> 00:00:30,249

Archaean D from 4 billion years ago to

12
00:00:35,610 --> 00:00:33,130

the 2.5 years ago the solar luminosity

13
00:00:37,920 --> 00:00:35,620

was just around 80% relativity present

14

00:00:40,099 --> 00:00:37,930

on the other hand this figure shows the

15

00:00:42,990 --> 00:00:40,109

reconstructed sea water temperature and

16

00:00:45,209 --> 00:00:43,000

which suggests that in the area in the

17

00:00:48,240 --> 00:00:45,219

areas the surface temperature was warmer

18

00:00:50,849 --> 00:00:48,250

warm or even hot environment exceeding

19

00:00:53,459 --> 00:00:50,859

50 degrees so to achieve such warm our

20

00:00:55,799 --> 00:00:53,469

Eve hot environment under the dimension

21

00:00:59,279 --> 00:00:55,809

and greenhouse gases are considered to

22

00:01:03,090 --> 00:00:59,289

be necessary so the most Green has a

23

00:01:08,460 --> 00:01:03,100

most possible greenhouse gases carbon

24

00:01:11,550 --> 00:01:08,470

dioxide but the warm sea is too warm to

25

00:01:13,350 --> 00:01:11,560

pass the warmest parts of surface

26
00:01:22,200 --> 00:01:13,360
temperature much warmer at the present

27
00:01:28,649 --> 00:01:22,210
Emma co2 only co2 is not only co2 only

28
00:01:30,960 --> 00:01:28,659
with co2 also yeah only always and to

29
00:01:32,969 --> 00:01:30,970
achieve such warm environment only with

30
00:01:34,410 --> 00:01:32,979
co2 it's difficult in a range of a

31
00:01:37,170 --> 00:01:34,420
reconstructed path see what a

32
00:01:40,319 --> 00:01:37,180
temperature so and another greenhouse

33
00:01:45,120 --> 00:01:40,329
gas that is considered to be compensated

34
00:01:47,550 --> 00:01:45,130
see the insufficient green greenhouse

35
00:01:49,620 --> 00:01:47,560
warming is missing missing is produced

36
00:01:59,359 --> 00:01:49,630
by similar machines in the early ocean

37
00:02:01,620 --> 00:01:59,369
and in the area and it's produced by the

38
00:02:04,230 --> 00:02:01,630

microbiology in the areas on decomposing

39

00:02:06,690 --> 00:02:04,240

the organic carbon but missing is a

40

00:02:09,480 --> 00:02:06,700

highly reactive photochemical reactive

41

00:02:11,490 --> 00:02:09,490

species so that to achieve high machine

42

00:02:13,470 --> 00:02:11,500

level in the atmosphere a much amount of

43

00:02:17,640 --> 00:02:13,480

missing should be produced from the

44

00:02:20,110 --> 00:02:17,650

ocean so in the early years anoxic or us

45

00:02:23,240 --> 00:02:20,120

the balance between sealed

46

00:02:25,010 --> 00:02:23,250

balance between shield to Anzio and

47

00:02:27,410 --> 00:02:25,020

missing was different from the present

48

00:02:29,030 --> 00:02:27,420

condition so to consider the climate

49

00:02:31,520 --> 00:02:29,040

stability in the areas we need to

50

00:02:34,160 --> 00:02:31,530

consider not only the co2 cycle but also

51
00:02:36,650 --> 00:02:34,170
the cycle of missing and warming by

52
00:02:38,690 --> 00:02:36,660
missing so we investigate C crowbar

53
00:02:41,480 --> 00:02:38,700
carbon budget and carbon cycle under the

54
00:02:43,670 --> 00:02:41,490
anoxic early Earth system in the area by

55
00:02:45,590 --> 00:02:43,680
developing a couple model of atmosphere

56
00:02:47,990 --> 00:02:45,600
photochemistry and marine microbial

57
00:02:50,690 --> 00:02:48,000
ecosystem and global carbon cycle and

58
00:02:52,370 --> 00:02:50,700
this is a schematic of the model we

59
00:02:54,710 --> 00:02:52,380
developed and as you can see we

60
00:02:56,960 --> 00:02:54,720
characterize the poor chemical processes

61
00:03:00,440 --> 00:02:56,970
and marine microbial reactions in the

62
00:03:02,690 --> 00:03:00,450
context of the global carbon cycle so we

63
00:03:05,660 --> 00:03:02,700

explain it's part of the model briefly

64

00:03:08,000 --> 00:03:05,670

so called the photochemical plot model

65

00:03:09,770 --> 00:03:08,010

part we use the Atmos model a

66

00:03:11,600 --> 00:03:09,780

one-dimensional photochemical model if

67

00:03:14,449 --> 00:03:11,610

it is identical to the last bit that

68

00:03:16,670 --> 00:03:14,459

last week I used and so I don't explain

69

00:03:19,040 --> 00:03:16,680

the detail but using this model we can

70

00:03:21,770 --> 00:03:19,050

calculate the vertical structure of many

71

00:03:26,090 --> 00:03:21,780

species and balance between them like

72

00:03:28,820 --> 00:03:26,100

this so and on this photochemical model

73

00:03:30,410 --> 00:03:28,830

we further introduce a chemical reaction

74

00:03:33,259 --> 00:03:30,420

pathway of the marine microbial

75

00:03:36,800 --> 00:03:33,269

ecosystem and we actually as a lower

76
00:03:38,660 --> 00:03:36,810
boundary condition and we assume the

77
00:03:41,120 --> 00:03:38,670
hydrogen based and iron based

78
00:03:43,340 --> 00:03:41,130
photosynthesis as a primary produces the

79
00:03:45,500 --> 00:03:43,350
anoxic environment and we also

80
00:03:48,650 --> 00:03:45,510
considered the Isetta chain which uses

81
00:03:51,590 --> 00:03:48,660
carbon monoxide as an electron donor so

82
00:03:54,949 --> 00:03:51,600
and we assumed that the activity is

83
00:03:55,670 --> 00:03:54,959
limited by the supply of each electron

84
00:03:58,130 --> 00:03:55,680
donor

85
00:04:00,970 --> 00:03:58,140
so we also curve and consider the

86
00:04:04,009 --> 00:04:00,980
activity by heterotrophs that food

87
00:04:06,620 --> 00:04:04,019
decomposes the organic carbon so as you

88
00:04:08,720 --> 00:04:06,630

can see this rip in these reactions the

89

00:04:13,250 --> 00:04:08,730

primary producers constant co2 where

90

00:04:15,500 --> 00:04:13,260

others produce co2 right so we

91

00:04:17,690 --> 00:04:15,510

considered such photo chemical and

92

00:04:19,670 --> 00:04:17,700

microbial reactions in the context of

93

00:04:22,940 --> 00:04:19,680

the global commerce cycle so in the

94

00:04:24,830 --> 00:04:22,950

anoxic areas condition the carbon

95

00:04:26,300 --> 00:04:24,840

dioxide produced by degassing is

96

00:04:29,510 --> 00:04:26,310

considered to be balanced by the

97

00:04:31,969 --> 00:04:29,520

consumption by variable organic carbon

98

00:04:34,909 --> 00:04:31,979

and the native area of English carbon

99

00:04:37,430 --> 00:04:34,919

that is and continental watering and c4

100

00:04:41,360 --> 00:04:37,440

weathering and here we introduce the

101
00:04:43,130 --> 00:04:41,370
balance of the ecosystem reactions and

102
00:04:45,770 --> 00:04:43,140
photochemical reactions into the

103
00:04:48,100 --> 00:04:45,780
speranza quick over equation by

104
00:04:51,589 --> 00:04:48,110
calculating the necessary flux and

105
00:04:53,810 --> 00:04:51,599
necessary weathering flux to achieve

106
00:04:56,330 --> 00:04:53,820
this balance of equation we can get C

107
00:04:59,600 --> 00:04:56,340
equilibrium co2 level and see what a

108
00:05:01,820 --> 00:04:59,610
team and so fast temperature so we move

109
00:05:04,040 --> 00:05:01,830
on to the results section and first of

110
00:05:06,500 --> 00:05:04,050
all we I shows a result without zero

111
00:05:08,589 --> 00:05:06,510
weathering and and on the last ride I

112
00:05:12,469 --> 00:05:08,599
chose a relative with c4 always I think

113
00:05:15,589 --> 00:05:12,479

so this is a result and this figure

114

00:05:18,350 --> 00:05:15,599

shows is atmospheric co2 missing and

115

00:05:20,930 --> 00:05:18,360

surface temperature and on different co2

116

00:05:23,060 --> 00:05:20,940

degassing rating as you can see we see

117

00:05:25,520 --> 00:05:23,070

simultaneously estimated both the

118

00:05:28,219 --> 00:05:25,530

atmospheric co2 and missing at the same

119

00:05:30,380 --> 00:05:28,229

time of the century and as you can see

120

00:05:32,600 --> 00:05:30,390

on shaded area there is a Mars for

121

00:05:35,839 --> 00:05:32,610

equilibrium exists why it's hot climate

122

00:05:37,820 --> 00:05:35,849

mode which has a high co2 emission level

123

00:05:40,850 --> 00:05:37,830

and the other is cold climate model

124

00:05:47,480 --> 00:05:40,860

which is an unstable solution unstable

125

00:05:50,770 --> 00:05:47,490

equilibrium state and so why this low

126

00:05:54,260 --> 00:05:50,780

co2 condition is unstable to assess this

127

00:05:55,670 --> 00:05:54,270

to understand this I see the each item

128

00:05:58,550 --> 00:05:55,680

of the co2 consumption

129

00:06:02,180 --> 00:05:58,560

processes and so this is a left figure I

130

00:06:04,640 --> 00:06:02,190

should but the horizontal axis will co2

131

00:06:05,330 --> 00:06:04,650

degassing but on the bar and only

132

00:06:07,790 --> 00:06:05,340

quadrivium

133

00:06:11,060 --> 00:06:07,800

it is balanced by the co2 consumption so

134

00:06:13,430 --> 00:06:11,070

if we switch the axis the new vertical

135

00:06:17,810 --> 00:06:13,440

axis corresponds to the co2 consumption

136

00:06:21,080 --> 00:06:17,820

that is balanced by co2 degassing and if

137

00:06:24,800 --> 00:06:21,090

we plot different processes of co2

138

00:06:27,260 --> 00:06:24,810

consumption as you can see on hot

139

00:06:30,080 --> 00:06:27,270

climate model the consumption by

140

00:06:33,020 --> 00:06:30,090

continental weathering is dominant which

141

00:06:35,360 --> 00:06:33,030

is an equilibrium by Walker feedback on

142

00:06:38,810 --> 00:06:35,370

the other hand on unstable cold climate

143

00:06:41,029 --> 00:06:38,820

state in the consumption by a coupled

144

00:06:44,080 --> 00:06:41,039

system of photochemical reactions and

145

00:06:46,960 --> 00:06:44,090

marine microbial reactions are dominant

146

00:06:49,150 --> 00:06:46,970

so and associated with consumption on

147

00:06:51,040 --> 00:06:49,160

these conditions the hydrocarbon haze

148

00:06:53,250 --> 00:06:51,050

that can be seen in the tyrants

149

00:06:57,159 --> 00:06:53,260

atmosphere is formed in the atmosphere

150

00:06:59,379 --> 00:06:57,169

so so then so it is associated with

151

00:07:01,930 --> 00:06:59,389

consumption so I explained this so first

152

00:07:04,690 --> 00:07:01,940

of all I explained the photochemical co2

153

00:07:07,720 --> 00:07:04,700

consumption so this figure shows a net

154

00:07:09,970 --> 00:07:07,730

co2 consumption in the atmosphere by

155

00:07:12,280 --> 00:07:09,980

photochemical reactions and as you can

156

00:07:16,420 --> 00:07:12,290

see on any condition co2 is consumed

157

00:07:20,250 --> 00:07:16,430

within the atmosphere this large

158

00:07:23,350 --> 00:07:20,260

consumption flux is actually but

159

00:07:25,750 --> 00:07:23,360

compensated by the net microbial co2

160

00:07:28,960 --> 00:07:25,760

production from the ocean especially in

161

00:07:31,200 --> 00:07:28,970

the hot climate stable solution but

162

00:07:34,960 --> 00:07:31,210

there is a steering imbalance in the

163

00:07:38,950 --> 00:07:34,970

Annex anoxic unstable so hazy solution

164

00:07:40,450 --> 00:07:38,960

so and this imbalance is equals to the

165

00:07:43,719 --> 00:07:40,460

pre production and removal of

166

00:07:46,540 --> 00:07:43,729

hydrocarbon erazor in the atmosphere so

167

00:07:50,860 --> 00:07:46,550

I explain this using our reaction and

168

00:07:52,270 --> 00:07:50,870

schematic of the reaction pathway so

169

00:07:54,820 --> 00:07:52,280

first of all I explain the co2

170

00:07:57,490 --> 00:07:54,830

consumption in the atmosphere and the

171

00:08:00,550 --> 00:07:57,500

atmosphere co2 is photo dissociated into

172

00:08:02,680 --> 00:08:00,560

co and co reacts with hydroxyl radical

173

00:08:05,440 --> 00:08:02,690

in the end of atmosphere to form co2

174

00:08:08,560 --> 00:08:05,450

alright usually this is balanced but

175

00:08:10,840 --> 00:08:08,570

under anoxic Archaean condition the

176

00:08:15,310 --> 00:08:10,850

strong missing flux from the ocean by

177

00:08:17,110 --> 00:08:15,320

microbiology a consumes consumes the

178

00:08:20,230 --> 00:08:17,120

hydroxyl radical in the lower atmosphere

179

00:08:24,810 --> 00:08:20,240

so that this reaction does not proceed

180

00:08:27,040 --> 00:08:24,820

and that much so that as a result the

181

00:08:31,570 --> 00:08:27,050

atmospheric reaction works as a net

182

00:08:35,469 --> 00:08:31,580

photochemical co2 consumption on any

183

00:08:38,529 --> 00:08:35,479

condition so and this last consumption

184

00:08:40,469 --> 00:08:38,539

flux is compensated by the reaction by a

185

00:08:43,600 --> 00:08:40,479

solutions and methanogens

186

00:08:46,260 --> 00:08:43,610

however I own not hazy condition but

187

00:08:48,950 --> 00:08:46,270

once he is formed in the atmosphere and

188

00:08:52,700 --> 00:08:48,960

part of the meeting

189

00:08:55,670 --> 00:08:52,710

part of the missing is converted to

190

00:08:57,320 --> 00:08:55,680

hydrocarbon aerosol particles and they

191

00:09:00,079 --> 00:08:57,330

settle down in the atmosphere and

192

00:09:02,810 --> 00:09:00,089

finally removed by ring and intestine

193

00:09:07,670 --> 00:09:02,820

and sinks into the ocean by internal

194

00:09:10,610 --> 00:09:07,680

waves so as a result and part of the

195

00:09:13,550 --> 00:09:10,620

dissociated CO_2 is converted to CO and

196

00:09:16,720 --> 00:09:13,560

missing and hydrocarbon hazen removed

197

00:09:19,910 --> 00:09:16,730

from the atmosphere ocean system so that

198

00:09:24,199 --> 00:09:19,920

remember a formation of his works as a

199

00:09:28,280 --> 00:09:24,209

CO_2 formation of his this to see it

200

00:09:30,500 --> 00:09:28,290

decrease in CO_2 level so once your two

201
00:09:33,290 --> 00:09:30,510
lever is decreased the atmosphere gets

202
00:09:37,340 --> 00:09:33,300
more reducing so that haze formation is

203
00:09:39,380 --> 00:09:37,350
enhanced and so this feedback mechanism

204
00:09:43,070 --> 00:09:39,390
works as a positive feedback hole in the

205
00:09:45,380 --> 00:09:43,080
climate system so making the system I so

206
00:09:47,990 --> 00:09:45,390
making this so this makes the system

207
00:09:51,949 --> 00:09:48,000
unstable regardless of the optical

208
00:09:54,949 --> 00:09:51,959
properties of the haze particles and as

209
00:09:56,540 --> 00:09:54,959
a result on low co2 condition she is

210
00:09:58,850 --> 00:09:56,550
constantly in the cup water system of

211
00:10:02,079 --> 00:09:58,860
photochemistry and marine microbial

212
00:10:06,019 --> 00:10:02,089
reactions so that there's a carefully

213
00:10:08,150 --> 00:10:06,029

characteristic shape like a vari and co2

214

00:10:13,100 --> 00:10:08,160

consumption and you if you switch the

215

00:10:19,160 --> 00:10:13,110

axis again hey you get characteristic

216

00:10:20,570 --> 00:10:19,170

shapes of equilibrium so finally if we

217

00:10:23,540 --> 00:10:20,580

consider the uncertainty is the

218

00:10:25,850 --> 00:10:23,550

parameter especially the weathering a

219

00:10:29,140 --> 00:10:25,860

continental weathering efficiency egg

220

00:10:33,010 --> 00:10:29,150

equilibrium can be represented like this

221

00:10:36,890 --> 00:10:33,020

as a result in the anoxic Archaean

222

00:10:39,530 --> 00:10:36,900

Indian aqua corners the hot climate mode

223

00:10:42,140 --> 00:10:39,540

and the robbery frozen state is the only

224

00:10:47,360 --> 00:10:42,150

stable solution and the present climate

225

00:10:51,170 --> 00:10:47,370

state is under hazy unstable solution so

226

00:10:53,900 --> 00:10:51,180

and the hot reconstructs and one

227

00:10:56,120 --> 00:10:53,910

reconstruction by phosphate or even hot

228

00:10:59,870 --> 00:10:56,130

reconstruction by charts a could be

229

00:11:01,210 --> 00:10:59,880

achieved on a present co2 degassing co2

230

00:11:07,420 --> 00:11:01,220

degassing great

231

00:11:10,480 --> 00:11:07,430

and and if the secret was earning who is

232

00:11:13,360 --> 00:11:10,490

effectively working as David's exist

233

00:11:18,100 --> 00:11:13,370

and the surface temperature does not

234

00:11:21,430 --> 00:11:18,110

exist 40 degrees Celsius but the our

235

00:11:24,040 --> 00:11:21,440

main conclusion that also but our main

236

00:11:27,370 --> 00:11:24,050

conclusion that sea anoxic has a

237

00:11:30,820 --> 00:11:27,380

condition it's unstable is unchanged so

238

00:11:32,920 --> 00:11:30,830

and this is a summary so my take home

239

00:11:36,160 --> 00:11:32,930

message is that anoxic has a condition

240

00:11:54,970 --> 00:11:36,170

in the early Earth is unstable and thank

241

00:11:59,620 --> 00:11:54,980

you very much sorry I didn't explain

242

00:12:02,920 --> 00:11:59,630

that in the hurry annex anoxic rot

243

00:12:05,860 --> 00:12:02,930

reducing atmosphere like that of spider

244

00:12:08,770 --> 00:12:05,870

the hydric haze that is composed of

245

00:12:12,610 --> 00:12:08,780

hydrocarbon particles composting they

246

00:12:23,620 --> 00:12:12,620

are higher altitude of the atmosphere so

247

00:12:26,830 --> 00:12:23,630

I'm in this one I just have a comment

248

00:12:29,020 --> 00:12:26,840

which is that earlier this year with

249

00:12:31,420 --> 00:12:29,030

Kevin's only we published a paper about

250

00:12:35,230 --> 00:12:31,430

xenon fractionation how that's related

251
00:12:39,760 --> 00:12:35,240
to hydrogen escape and methane levels

252
00:12:41,410 --> 00:12:39,770
and one of the kind of conclusions which

253
00:12:44,260 --> 00:12:41,420
may be a little bit hidden in that paper

254
00:12:45,760 --> 00:12:44,270
is that for the most part we don't think

255
00:12:48,490 --> 00:12:45,770
that the early Earth could have been

256
00:12:50,590 --> 00:12:48,500
hazy because that messes up in it

257
00:12:54,970 --> 00:12:50,600
affects the xenon isotopes fractionation

258
00:12:57,100 --> 00:12:54,980
xenon can be taken all into organic haze

259
00:13:00,070 --> 00:12:57,110
particles so that would support your

260
00:13:02,530 --> 00:13:00,080
conclusion oh so for most of the time it

261
00:13:05,750 --> 00:13:02,540
must have been a haze free Atmos mm-hmm

262
00:13:33,880 --> 00:13:05,760
all right thank you very much

263
00:13:36,860 --> 00:13:33,890

ah yeah thank you and this alright so so

264

00:13:39,680 --> 00:13:36,870

if his is not formally the atmosphere

265

00:13:42,500 --> 00:13:39,690

the co2 consumption by photochemical

266

00:13:46,040 --> 00:13:42,510

process is is balanced by this pathway

267

00:13:48,290 --> 00:13:46,050

by a microbiological reactions but if

268

00:13:52,820 --> 00:13:48,300

haze is formed in the atmosphere the

269

00:13:56,000 --> 00:13:52,830

parties and so duties and associated in

270

00:13:59,270 --> 00:13:56,010

Co first and this Co is converted to

271

00:14:04,310 --> 00:13:59,280

missing to form hydrocarbon haze so that

272

00:14:07,160 --> 00:14:04,320

part of C and a part of the this pathway

273

00:14:16,460 --> 00:14:07,170

is depleted because this pathway is

274

00:14:21,860 --> 00:14:16,470

affected so so after it is removed in

275

00:14:26,300 --> 00:14:21,870

dissolution ah so yeah that's a very

276

00:14:30,160 --> 00:14:26,310

good question Matt and edit because this

277

00:14:34,300 --> 00:14:30,170

is so much reduced hydrocarbon and to

278

00:14:38,200 --> 00:14:34,310

own present ocean condition and

279

00:14:42,920 --> 00:14:38,210

basically oxygen is necessary to

280

00:14:50,660 --> 00:14:42,930

decompose such reduced hydrocarbon so we

281

00:14:52,610 --> 00:14:50,670

think that so on anoxic condition the

282

00:14:55,730 --> 00:14:52,620

hydrocarbon haze is difficult to be

283

00:14:59,180 --> 00:14:55,740

decomposed but and I think that's partly

284

00:15:03,620 --> 00:14:59,190

its I think it is partly decomposed and

285

00:15:06,200 --> 00:15:03,630

to some extent and so this is a very

286

00:15:10,560 --> 00:15:06,210

important point so I will assess about