
AB
GRAD
CON23

1
00:00:04,230 --> 00:00:10,930
[Music]

2
00:00:15,470 --> 00:00:13,910
good morning everybody my name is Hector

3
00:00:18,710 --> 00:00:15,480
I'm going to be talking about the

4
00:00:20,150 --> 00:00:18,720
climates of gl513b this is a work I've

5
00:00:22,070 --> 00:00:20,160
been doing with Rory Barnes from

6
00:00:24,050 --> 00:00:22,080
University of Washington and Russell

7
00:00:26,150 --> 00:00:24,060
Dietrich and Maria damaso

8
00:00:28,130 --> 00:00:26,160
to give you an outline I'm gonna first

9
00:00:31,310 --> 00:00:28,140
give you an introduction and convince

10
00:00:33,170 --> 00:00:31,320
you why we study gl5 for Team B uh I'm

11
00:00:34,490 --> 00:00:33,180
gonna show you what are the factors that

12
00:00:36,410 --> 00:00:34,500
we consider that affect habitability

13
00:00:38,990 --> 00:00:36,420

then I'll show you the methods that we

14
00:00:40,729 --> 00:00:39,000
use and then the results follow my

15
00:00:43,310 --> 00:00:40,739
conclusion and the Future Works that are

16
00:00:46,490 --> 00:00:43,320
deemed important to continue doing

17
00:00:48,770 --> 00:00:46,500
so why study this planet in 2022 uh

18
00:00:49,810 --> 00:00:48,780
Maria damaso and his collaborators they

19
00:00:52,729 --> 00:00:49,820
discover

20
00:00:55,069 --> 00:00:52,739
gl514b and what's particular about it

21
00:00:58,069 --> 00:00:55,079
it's that it has a high eccentricity

22
00:01:00,170 --> 00:00:58,079
eccentricity it's how circular the orbit

23
00:01:01,790 --> 00:01:00,180
is and when it's a higher centricity

24
00:01:03,470 --> 00:01:01,800
that means that the circuit the orbit is

25
00:01:06,890 --> 00:01:03,480
kind of like a noble shape

26
00:01:08,929 --> 00:01:06,900
and usually when we study exoplanets we

27
00:01:11,929 --> 00:01:08,939
look for planets that are within the

28
00:01:14,330 --> 00:01:11,939
habitable zone and this planet because

29
00:01:15,649 --> 00:01:14,340
it's very oval shape it kind of Falls in

30
00:01:18,230 --> 00:01:15,659
and out of the Habit also so that makes

31
00:01:19,609 --> 00:01:18,240
it a particular object to study it also

32
00:01:21,890 --> 00:01:19,619
as you can see from the properties it

33
00:01:24,289 --> 00:01:21,900
also orbits a Android star which is one

34
00:01:27,530 --> 00:01:24,299
of which is the most abundant star in

35
00:01:30,230 --> 00:01:27,540
our galaxy and universe and with that in

36
00:01:31,969 --> 00:01:30,240
mind uh when we look at the uh the

37
00:01:33,590 --> 00:01:31,979
multiple orbits that could happen in

38
00:01:35,569 --> 00:01:33,600

this planet uh these are just

39
00:01:38,149 --> 00:01:35,579
simulations of what are 0.45

40
00:01:40,789 --> 00:01:38,159
eccentricity orb would look like uh we

41
00:01:42,350 --> 00:01:40,799
see that they all go in in and out of

42
00:01:43,670 --> 00:01:42,360
this green shaded region which is the

43
00:01:46,429 --> 00:01:43,680
habitable zone that we consider the

44
00:01:49,490 --> 00:01:46,439
habitable is one of the of the star and

45
00:01:51,590 --> 00:01:49,500
the dash line is just uh the best fit

46
00:01:52,969 --> 00:01:51,600
orbit we still see it that all of them

47
00:01:55,249 --> 00:01:52,979
go through in and out so that's what

48
00:01:56,810 --> 00:01:55,259
makes it uh very important to study for

49
00:01:57,710 --> 00:01:56,820
habitability since we've never done that

50
00:02:00,069 --> 00:01:57,720
before

51
00:02:02,389 --> 00:02:00,079
and another reason why we want to study

52
00:02:04,730 --> 00:02:02,399
gl519b in this graph I'm showing you

53
00:02:07,550 --> 00:02:04,740
here a plot of the eccentricity over the

54
00:02:08,630 --> 00:02:07,560
orbital period of the planet uh so how

55
00:02:11,869 --> 00:02:08,640
long it takes the planet to go around

56
00:02:13,970 --> 00:02:11,879
the its Hoster uh the size of the of the

57
00:02:15,589 --> 00:02:13,980
bubbles it shows how much solar

58
00:02:17,630 --> 00:02:15,599
installation or how much of radiation

59
00:02:19,910 --> 00:02:17,640
from the start is falling into into the

60
00:02:21,949 --> 00:02:19,920
planet uh on the top right corner you

61
00:02:23,690 --> 00:02:21,959
can see the bubble for what would be

62
00:02:26,210 --> 00:02:23,700
like an earth installation so how much

63
00:02:28,250 --> 00:02:26,220

uh sunlight we receive the bigger the

64
00:02:31,369 --> 00:02:28,260
bubble the more radiation the planet is

65
00:02:33,710 --> 00:02:31,379
receiving uh gray gray dots represent we

66
00:02:37,430 --> 00:02:33,720
don't have data for for the installation

67
00:02:39,530 --> 00:02:37,440
so they don't show any any uh any

68
00:02:41,570 --> 00:02:39,540
information about that but in particular

69
00:02:43,550 --> 00:02:41,580
when we look at gl514b which is in the

70
00:02:45,410 --> 00:02:43,560
middle uh in the middle of these graphs

71
00:02:48,470 --> 00:02:45,420
on the top side we see that it's almost

72
00:02:50,509 --> 00:02:48,480
unique to it and when we have an orbital

73
00:02:54,410 --> 00:02:50,519
period that long around an mdorf it

74
00:02:56,270 --> 00:02:54,420
gives us a an idea uh a better view to

75
00:02:58,430 --> 00:02:56,280
use Next Generation telescopes such as

76
00:03:00,650 --> 00:02:58,440
ground telescopes to to studying them

77
00:03:02,390 --> 00:03:00,660
and be able to directly observe them if

78
00:03:03,890 --> 00:03:02,400
the planet is too close to the star the

79
00:03:06,470 --> 00:03:03,900
planet would be really hard to to see

80
00:03:07,850 --> 00:03:06,480
with direct observation uh there's

81
00:03:10,309 --> 00:03:07,860
another planet that is really far away

82
00:03:11,869 --> 00:03:10,319
which we see it at 250 orbital periods

83
00:03:13,430 --> 00:03:11,879
on the right side but it has a lower

84
00:03:15,110 --> 00:03:13,440
eccentricity so that way that's why we

85
00:03:17,509 --> 00:03:15,120
don't care much to study that one there

86
00:03:19,729 --> 00:03:17,519
is a planet with 0.5 uh uh greater than

87
00:03:22,790 --> 00:03:19,739
0.5 x in 360 but it has a shorter

88
00:03:24,410 --> 00:03:22,800

orbital period uh than gl514b so it

89
00:03:25,910 --> 00:03:24,420
might be really hard to direct observe

90
00:03:28,250 --> 00:03:25,920
and we want a planet that we can study

91
00:03:30,170 --> 00:03:28,260
in the future

92
00:03:32,990 --> 00:03:30,180
and with that in mind the Next

93
00:03:35,149 --> 00:03:33,000
Generation telescope such as the uh such

94
00:03:38,390 --> 00:03:35,159
as the oh my God uh the extremely large

95
00:03:41,509 --> 00:03:38,400
telescope uh it it would be a telescope

96
00:03:44,210 --> 00:03:41,519
that should be able to observe uh gl513b

97
00:03:46,009 --> 00:03:44,220
this graph is just showing uh what is

98
00:03:47,750 --> 00:03:46,019
the maximum angular separation that the

99
00:03:49,970 --> 00:03:47,760
planet needs in order to be observed and

100
00:03:52,309 --> 00:03:49,980
the planet to start flux ratio uh

101
00:03:53,930 --> 00:03:52,319
meaning that the bigger planet to start

102
00:03:56,330 --> 00:03:53,940
flux ratio that means we can observe it

103
00:03:58,250 --> 00:03:56,340
better and in the Dutch line that

104
00:04:00,110 --> 00:03:58,260
represents the boundary to be observed

105
00:04:02,030 --> 00:04:00,120
uh to to the planets that could be

106
00:04:04,250 --> 00:04:02,040
observed with the elt the extremely

107
00:04:06,530 --> 00:04:04,260
large telescope and we expect that

108
00:04:10,309 --> 00:04:06,540
gl514me will fall fall within that

109
00:04:12,170 --> 00:04:10,319
boundary so we will plan to use elt to

110
00:04:15,050 --> 00:04:12,180
observe this planet

111
00:04:17,509 --> 00:04:15,060
now I hope I convinced you why study Geo

112
00:04:18,770 --> 00:04:17,519
514b so now uh I want to talk about like

113
00:04:20,330 --> 00:04:18,780

what are some factors affecting

114
00:04:22,129 --> 00:04:20,340
habitability

115
00:04:23,330 --> 00:04:22,139
um so there's many factors when we talk

116
00:04:26,689 --> 00:04:23,340
about habitability there's so many

117
00:04:28,670 --> 00:04:26,699
things that we can think of uh but I we

118
00:04:31,550 --> 00:04:28,680
focus on the ones that we've seen that

119
00:04:33,890 --> 00:04:31,560
in other papers that have shown that uh

120
00:04:36,110 --> 00:04:33,900
these are the most that affect an impact

121
00:04:37,610 --> 00:04:36,120
the habitability and these are the

122
00:04:39,710 --> 00:04:37,620
eccentricity that I mentioned is how

123
00:04:41,510 --> 00:04:39,720
oval or secular that orbit is the

124
00:04:43,850 --> 00:04:41,520
obliquity in which is that tilt of the

125
00:04:46,850 --> 00:04:43,860
rotational axis from the plane of of

126
00:04:49,430 --> 00:04:46,860
orbit from the star system the Precision

127
00:04:51,890 --> 00:04:49,440
angle is the angle of wobbling of that

128
00:04:54,469 --> 00:04:51,900
rotation axis and the partial pressure

129
00:04:56,350 --> 00:04:54,479
of CO2 which is how much CO2 is built up

130
00:05:00,050 --> 00:04:56,360
in the in the atmosphere of the planet

131
00:05:01,430 --> 00:05:00,060
and uh the biggest is atomic attack I

132
00:05:03,530 --> 00:05:01,440
don't go into much details as to why

133
00:05:06,170 --> 00:05:03,540
them but those are the papers that we

134
00:05:07,670 --> 00:05:06,180
mostly Focus uh show the uh these are

135
00:05:10,909 --> 00:05:07,680
the factors affecting habitability that

136
00:05:14,450 --> 00:05:10,919
we want to use for gl514me

137
00:05:17,030 --> 00:05:14,460
we use uh so we're called the planet

138
00:05:19,790 --> 00:05:17,040

which is an open source code that has 11

139
00:05:22,010 --> 00:05:19,800
11 physical processes that simulate

140
00:05:25,249 --> 00:05:22,020
habitability for our planet uh it

141
00:05:27,830 --> 00:05:25,259
includes uh binary systems or includes

142
00:05:29,689 --> 00:05:27,840
the the radiation for the star the or

143
00:05:31,850 --> 00:05:29,699
the services in the orbit these services

144
00:05:33,770 --> 00:05:31,860
in the rotation many others but I want

145
00:05:35,930 --> 00:05:33,780
the one part that we use from the planet

146
00:05:38,150 --> 00:05:35,940
is the one called Poise which is an

147
00:05:39,830 --> 00:05:38,160
energy balance model and what it

148
00:05:42,170 --> 00:05:39,840
essentially means this graph is a good

149
00:05:43,810 --> 00:05:42,180
explanation I did not do this graph uh

150
00:05:47,210 --> 00:05:43,820
tremended

151
00:05:49,610 --> 00:05:47,220
facilitated and what an idea in in

152
00:05:51,770 --> 00:05:49,620
essence what it is it's a balance of all

153
00:05:53,510 --> 00:05:51,780
the incoming solar radiation that comes

154
00:05:55,189 --> 00:05:53,520
to the planet and how much is that it's

155
00:05:58,189 --> 00:05:55,199
either absorbed by the planet or

156
00:06:00,710 --> 00:05:58,199
reflected back to the to the space uh

157
00:06:02,930 --> 00:06:00,720
Poise does now is a cloud free Cloud

158
00:06:05,510 --> 00:06:02,940
free energy balance model so that we

159
00:06:08,570 --> 00:06:05,520
don't take into account the the

160
00:06:10,310 --> 00:06:08,580
reflected uh sunlight by the by Claus in

161
00:06:12,350 --> 00:06:10,320
the atmosphere so that means that we

162
00:06:13,790 --> 00:06:12,360
mostly focus on in two parts of the of

163
00:06:16,070 --> 00:06:13,800

the energy balance model which is how

164
00:06:17,870 --> 00:06:16,080
much is absorbed by the by the by the

165
00:06:19,310 --> 00:06:17,880
surface of the planet and on the right

166
00:06:20,930 --> 00:06:19,320
side top side you can see that it says

167
00:06:24,290 --> 00:06:20,940
are going along with variation how much

168
00:06:26,450 --> 00:06:24,300
of that is being radiated by by the

169
00:06:28,450 --> 00:06:26,460
atmosphere itself in in longer

170
00:06:31,730 --> 00:06:28,460
wavelengths

171
00:06:35,270 --> 00:06:31,740
uh in in essence this is the the

172
00:06:38,450 --> 00:06:35,280
equation that we use uh to explain it to

173
00:06:40,909 --> 00:06:38,460
explain it in a in a easy way I would

174
00:06:42,469 --> 00:06:40,919
say that the first term is it represents

175
00:06:44,930 --> 00:06:42,479
that absorption of the heat from the

176
00:06:47,029 --> 00:06:44,940
surface uh the second term represents

177
00:06:48,469 --> 00:06:47,039
how much is being dissipated throughout

178
00:06:50,570 --> 00:06:48,479
the atmosphere so atmospheric

179
00:06:53,390 --> 00:06:50,580
circulation of the heat uh the third

180
00:06:54,290 --> 00:06:53,400
term it just shows the irradiation to

181
00:06:56,570 --> 00:06:54,300
space

182
00:06:57,890 --> 00:06:56,580
and that should all of that although all

183
00:06:59,450 --> 00:06:57,900
of that should balance to the fourth

184
00:07:00,890 --> 00:06:59,460
term which is how much of income in

185
00:07:02,150 --> 00:07:00,900
solar radiation is falling into the

186
00:07:05,150 --> 00:07:02,160
planet

187
00:07:07,909 --> 00:07:05,160
um so another thing that Poise does and

188
00:07:09,469 --> 00:07:07,919

this is good to know is that it not it's

189
00:07:13,070 --> 00:07:09,479
not only an energy balanced model but it

190
00:07:14,930 --> 00:07:13,080
also calculates uh the ice sheets or how

191
00:07:17,150 --> 00:07:14,940
much ice it's flowing around the planet

192
00:07:19,129 --> 00:07:17,160
so is the planet covering full eyes is

193
00:07:21,110 --> 00:07:19,139
the planet is just ice free meaning that

194
00:07:23,990 --> 00:07:21,120
it's all water or is the planet has a

195
00:07:26,029 --> 00:07:24,000
combination of polar caps or other types

196
00:07:28,490 --> 00:07:26,039
of ice configurations which are really

197
00:07:30,650 --> 00:07:28,500
important for habitability since Earth

198
00:07:33,290 --> 00:07:30,660
uh Earth we've seen Earths throughout

199
00:07:34,969 --> 00:07:33,300
time has how much the ice has changed in

200
00:07:37,969 --> 00:07:34,979
that surface

201
00:07:39,890 --> 00:07:37,979
um and another part of the of the V

202
00:07:41,749 --> 00:07:39,900
Planet uh that we think of is that

203
00:07:43,850 --> 00:07:41,759
outgoing language radiation there are

204
00:07:46,070 --> 00:07:43,860
many many ways there are many theories

205
00:07:47,570 --> 00:07:46,080
on how do we calculate that how much of

206
00:07:48,589 --> 00:07:47,580
that radiation is being dissipated to

207
00:07:50,330 --> 00:07:48,599
space

208
00:07:54,230 --> 00:07:50,340
um there's uh in the planet there's

209
00:07:56,450 --> 00:07:54,240
three of them uh from spigo 2009 and

210
00:07:58,909 --> 00:07:56,460
Williams and casting 1997 and Northern

211
00:08:03,290 --> 00:07:58,919
cochle in 1979.

212
00:08:05,029 --> 00:08:03,300
so spigo and and Northern Coakley those

213
00:08:06,710 --> 00:08:05,039

two are going along with radiation

214
00:08:09,469 --> 00:08:06,720
they're just as a function of

215
00:08:11,570 --> 00:08:09,479
temperature and and Williamson Casino

216
00:08:13,909 --> 00:08:11,580
includes a component of partial pressure

217
00:08:16,010 --> 00:08:13,919
of CO2 and we can see in this graph how

218
00:08:19,969 --> 00:08:16,020
much of that outgoing normal radiation

219
00:08:22,129 --> 00:08:19,979
over surface temperature it changes uh

220
00:08:24,050 --> 00:08:22,139
um Hing is a functional temperature but

221
00:08:26,089 --> 00:08:24,060
with the difference that Williams and

222
00:08:28,490 --> 00:08:26,099
casting when we change the partial

223
00:08:30,790 --> 00:08:28,500
pressure of CO2 in this case I'm having

224
00:08:32,350 --> 00:08:30,800
a partial pressure of simulating Earth's

225
00:08:35,149 --> 00:08:32,360
CO2

226
00:08:37,190 --> 00:08:35,159
abundance in the atmosphere and we see

227
00:08:39,829 --> 00:08:37,200
that it kind of it gives a more

228
00:08:41,570 --> 00:08:39,839
realistic version of how much of that

229
00:08:44,690 --> 00:08:41,580
radiation is being dissipated to to

230
00:08:47,090 --> 00:08:44,700
space so that means for our purpose of

231
00:08:49,610 --> 00:08:47,100
this of this study we use uh Williams

232
00:08:52,670 --> 00:08:49,620
and casting 1997 model to simulate how

233
00:08:56,030 --> 00:08:52,680
much radiation is being dissipated

234
00:08:58,009 --> 00:08:56,040
yeah oh and and to say the uh to say

235
00:09:00,310 --> 00:08:58,019
that this William and casting model is

236
00:09:03,769 --> 00:09:00,320
only valid from uh negative

237
00:09:06,050 --> 00:09:03,779
83.15 degrees Celsius to 86.85 degrees

238
00:09:08,509 --> 00:09:06,060

Celsius meaning that anything that goes

239
00:09:11,329 --> 00:09:08,519
if the planet gets too cold or too hot

240
00:09:12,949 --> 00:09:11,339
from those boundaries that means that uh

241
00:09:15,949 --> 00:09:12,959
our calculations of the outgoing lower

242
00:09:18,170 --> 00:09:15,959
radiation are not exactly

243
00:09:19,610 --> 00:09:18,180
um accurate so we deem them as if it's

244
00:09:22,070 --> 00:09:19,620
too cold that the planet is just

245
00:09:23,870 --> 00:09:22,080
completely as Noble and if it's too hot

246
00:09:26,870 --> 00:09:23,880
we just demon as a planet completely ice

247
00:09:31,490 --> 00:09:29,509
in terms of the of many other parameters

248
00:09:34,130 --> 00:09:31,500
so we're talking about partial pressure

249
00:09:35,690 --> 00:09:34,140
CO2 eccentricity obliquity uh and

250
00:09:37,490 --> 00:09:35,700
precision angle there's other other

251
00:09:40,009 --> 00:09:37,500
parameters that go into an energy

252
00:09:42,949 --> 00:09:40,019
balance model and an ice sheet flow

253
00:09:45,110 --> 00:09:42,959
diagram so uh here I am just showing you

254
00:09:47,269 --> 00:09:45,120
most of the other parameters some uh

255
00:09:49,910 --> 00:09:47,279
some of them are arbitrary others are

256
00:09:51,350 --> 00:09:49,920
Earth's value uh so you know as every

257
00:09:52,730 --> 00:09:51,360
model we have to make assumptions and

258
00:09:55,190 --> 00:09:52,740
these are some of the assumptions for

259
00:09:56,630 --> 00:09:55,200
example uh the ebm meaning the energy

260
00:09:58,790 --> 00:09:56,640
balance model we run it seasonally

261
00:10:01,070 --> 00:09:58,800
instead of annually so every season we

262
00:10:03,829 --> 00:10:01,080
check uh that we check that energy

263
00:10:06,530 --> 00:10:03,839

balance we run it every for four years

264
00:10:09,230 --> 00:10:06,540
uh so it's run for four years and we run

265
00:10:11,750 --> 00:10:09,240
it every 500 years to calculate it and

266
00:10:14,449 --> 00:10:11,760
uh we use the Williams and casein olr

267
00:10:16,730 --> 00:10:14,459
model which is outgoing radiation the

268
00:10:18,230 --> 00:10:16,740
initial Global temperature we use 14.85

269
00:10:20,389 --> 00:10:18,240
degrees Celsius which represents a

270
00:10:21,769 --> 00:10:20,399
pretty pre-industrial Earth's

271
00:10:23,630 --> 00:10:21,779
temperature

272
00:10:26,269 --> 00:10:23,640
we have the deposition rate of snow

273
00:10:27,650 --> 00:10:26,279
which is that's from Earth's value uh

274
00:10:29,690 --> 00:10:27,660
and then the heat capacity of the land

275
00:10:32,030 --> 00:10:29,700
of the water and the albedos they all

276
00:10:34,370 --> 00:10:32,040
come also from Earth's value

277
00:10:38,090 --> 00:10:34,380
um now the land fraction is analogous is

278
00:10:41,210 --> 00:10:38,100
similar to it so uh so we use a 25 Lan

279
00:10:44,030 --> 00:10:41,220
and the 75 is just water cover uh it's

280
00:10:50,990 --> 00:10:47,569
to outdo our uh our our simulations we

281
00:10:54,110 --> 00:10:51,000
divide it into four simulations uh we

282
00:10:56,210 --> 00:10:54,120
first wanted to find values of CO2 uh

283
00:10:57,829 --> 00:10:56,220
eccentricity obliquity and precision

284
00:10:59,090 --> 00:10:57,839
angle that meet the affiliate protocol

285
00:11:01,490 --> 00:10:59,100
I'll explain to you what the filet

286
00:11:03,050 --> 00:11:01,500
protocol is uh the second simulation we

287
00:11:05,269 --> 00:11:03,060
studied the latitudinal temperature for

288
00:11:06,710 --> 00:11:05,279

viruses eccentricities the third one

289
00:11:08,449 --> 00:11:06,720
with data parameters sweep of

290
00:11:10,250 --> 00:11:08,459
eccentricity and obligories and

291
00:11:13,130 --> 00:11:10,260
therefore one with the parameter sweep

292
00:11:14,750 --> 00:11:13,140
of CO2 and obliquity uh all of this we

293
00:11:16,910 --> 00:11:14,760
run all the simulations for one million

294
00:11:20,329 --> 00:11:16,920
years and I did a total of 960

295
00:11:22,430 --> 00:11:20,339
simulations why 960. just because no

296
00:11:24,170 --> 00:11:22,440
specific reason

297
00:11:25,730 --> 00:11:24,180
um and all of these are just static

298
00:11:27,350 --> 00:11:25,740
simulations meaning that the obliquity

299
00:11:29,269 --> 00:11:27,360
eccentricity and precision angle of the

300
00:11:31,130 --> 00:11:29,279
planet are not evolving over time so

301
00:11:33,170 --> 00:11:31,140
that means that for future work just uh

302
00:11:34,970 --> 00:11:33,180
spoiler we want to do a dynamic

303
00:11:36,710 --> 00:11:34,980
evolution of how we see this

304
00:11:38,389 --> 00:11:36,720
eccentricity oblique and precision angle

305
00:11:40,310 --> 00:11:38,399
evolve because we see that on Earth we

306
00:11:43,069 --> 00:11:40,320
see those values changes

307
00:11:44,810 --> 00:11:43,079
for the first one the the filet protocol

308
00:11:47,389 --> 00:11:44,820
is just a functionality of ice

309
00:11:48,949 --> 00:11:47,399
latitudinal ABM tenacity so it's a

310
00:11:52,550 --> 00:11:48,959
protocol an intern comparison project

311
00:11:54,170 --> 00:11:52,560
from the Cuisines uh project and and

312
00:11:56,930 --> 00:11:54,180
what they want is to do an intern

313
00:11:58,910 --> 00:11:56,940

comparison on the different ebms and the

314
00:12:02,090 --> 00:11:58,920
first Benchmark case is to achieve

315
00:12:03,949 --> 00:12:02,100
Global mean surface of 288 Cummins and

316
00:12:05,750 --> 00:12:03,959
that's what we did and we look for what

317
00:12:07,610 --> 00:12:05,760
are those values and we found many

318
00:12:09,829 --> 00:12:07,620
possibilities but this one I'm showing

319
00:12:11,690 --> 00:12:09,839
you here is just the centricity of 0.45

320
00:12:13,490 --> 00:12:11,700
and obliquity of three degrees a

321
00:12:15,230 --> 00:12:13,500
Precision angle of 90 degrees and a

322
00:12:17,630 --> 00:12:15,240
partial pressure of CO2 or seven seven

323
00:12:21,050 --> 00:12:17,640
bars we noticed that 7 bar CO2 is the

324
00:12:22,670 --> 00:12:21,060
one that gives the most uh the most

325
00:12:25,850 --> 00:12:22,680
stable climates throughout the different

326
00:12:28,970 --> 00:12:25,860
bars uh uh pressure pressure of CO2 in

327
00:12:31,310 --> 00:12:28,980
here uh I'm just showing you how those

328
00:12:34,430 --> 00:12:31,320
the in the first panel is the insulation

329
00:12:36,110 --> 00:12:34,440
is being received per latitude on the

330
00:12:37,730 --> 00:12:36,120
say on the top right panel is the

331
00:12:41,030 --> 00:12:37,740
surface temperature how it varies on the

332
00:12:43,730 --> 00:12:41,040
bottom left is a is a ice melon ice mass

333
00:12:45,949 --> 00:12:43,740
balance meaning that a clear color ice

334
00:12:47,870 --> 00:12:45,959
is being deposited dark color is being

335
00:12:49,550 --> 00:12:47,880
lost and on the right we have the

336
00:12:51,590 --> 00:12:49,560
outgoing language radiation and what we

337
00:12:53,329 --> 00:12:51,600
see is that all of this uh correlates so

338
00:12:54,710 --> 00:12:53,339

we have a validation of our code that is

339
00:12:56,750 --> 00:12:54,720
working as issue

340
00:12:59,090 --> 00:12:56,760
uh so that's why we wanted to do this as

341
00:13:01,069 --> 00:12:59,100
our first simulation we're just trying

342
00:13:02,470 --> 00:13:01,079
to like uh do kind of like a sanity

343
00:13:05,090 --> 00:13:02,480
shake for a code

344
00:13:07,310 --> 00:13:05,100
we then did a studio latitudinal

345
00:13:09,230 --> 00:13:07,320
temperature for various eccentricities

346
00:13:12,230 --> 00:13:09,240
and in here I'm just showing remember

347
00:13:14,810 --> 00:13:12,240
that eccentricity is 0.45 but if we look

348
00:13:18,230 --> 00:13:14,820
at the error value of of their

349
00:13:20,569 --> 00:13:18,240
calculation is plus minus 0.4.15 to 0.14

350
00:13:22,430 --> 00:13:20,579
so if we want to study this to three

351
00:13:26,210 --> 00:13:22,440
sigma confidence that means we had to do

352
00:13:28,069 --> 00:13:26,220
a range of of 0.03 eccentricity to 0.9

353
00:13:30,410 --> 00:13:28,079
eccentricity so that's what I'm showing

354
00:13:32,090 --> 00:13:30,420
here how the different temperatures uh

355
00:13:33,710 --> 00:13:32,100
of the planet vary through the one

356
00:13:35,509 --> 00:13:33,720
million year calculation on the top one

357
00:13:38,810 --> 00:13:35,519
it looks weird yes it is weird and it's

358
00:13:40,850 --> 00:13:38,820
because the simulation gets too cold and

359
00:13:42,829 --> 00:13:40,860
it goes out of boundary for our

360
00:13:44,930 --> 00:13:42,839
simulation of the Williams and casting

361
00:13:47,150 --> 00:13:44,940
so that means the plan is just really

362
00:13:49,370 --> 00:13:47,160
cool and it doesn't

363
00:13:50,389 --> 00:13:49,380

um it doesn't get to to run anymore

364
00:13:53,030 --> 00:13:50,399
because it just fell out of the

365
00:13:54,470 --> 00:13:53,040
boundaries so for that one uh the planet

366
00:13:57,350 --> 00:13:54,480
falls out of boundaries has Noble State

367
00:13:58,970 --> 00:13:57,360
the second one is uh we get a global

368
00:14:01,009 --> 00:13:58,980
means surface temperature of 26 degrees

369
00:14:03,470 --> 00:14:01,019
so it's really hot meaning it's a nice

370
00:14:06,170 --> 00:14:03,480
free state and for the last one we have

371
00:14:07,190 --> 00:14:06,180
a 0.9 eccentricity but the planet gets

372
00:14:10,850 --> 00:14:07,200
too close to the start of the beginning

373
00:14:11,810 --> 00:14:10,860
so it's it's so hot that it's just for a

374
00:14:14,509 --> 00:14:11,820
lot of boundaries from the other side

375
00:14:16,370 --> 00:14:14,519
however because the planet eccentricity

376
00:14:18,230 --> 00:14:16,380
is so long that means its Winters are

377
00:14:20,449 --> 00:14:18,240
very long so when we're able to lower

378
00:14:22,129 --> 00:14:20,459
the eccentricity so that the code could

379
00:14:23,690 --> 00:14:22,139
run we see that the global mean

380
00:14:25,910 --> 00:14:23,700
temperature is about six degrees so it's

381
00:14:27,710 --> 00:14:25,920
not that warm so it's a we get as a

382
00:14:29,769 --> 00:14:27,720
noble State even though it's a global

383
00:14:32,629 --> 00:14:29,779
temperature of 6 degrees

384
00:14:33,829 --> 00:14:32,639
simulation three and I'm Amazon uh this

385
00:14:35,269 --> 00:14:33,839
is just a parameter sweep of

386
00:14:38,810 --> 00:14:35,279
eccentricities and obliquities how those

387
00:14:40,610 --> 00:14:38,820
eccentricity obliquity affects the uh

388
00:14:42,710 --> 00:14:40,620

the state of the planet we see ice

389
00:14:44,870 --> 00:14:42,720
freeze the dark blue uh snowball will be

390
00:14:46,610 --> 00:14:44,880
the gray part purple is a polar ice cup

391
00:14:47,810 --> 00:14:46,620
ice caps and the outer boundaries is the

392
00:14:50,509 --> 00:14:47,820
region whether it's too hot or too cold

393
00:14:51,530 --> 00:14:50,519
and we see that at least polar ice caps

394
00:14:53,329 --> 00:14:51,540
are formed this is important because

395
00:14:55,189 --> 00:14:53,339
Earth has ice caps so that's what we're

396
00:14:56,090 --> 00:14:55,199
trying to achieve if we can see ice caps

397
00:14:57,949 --> 00:14:56,100
in the planet

398
00:15:00,590 --> 00:14:57,959
uh so this shows up for different

399
00:15:02,509 --> 00:15:00,600
accents Regional obliquity that happens

400
00:15:03,590 --> 00:15:02,519
and we look at the global mean

401
00:15:06,350 --> 00:15:03,600
temperature for those different

402
00:15:10,009 --> 00:15:06,360
centricities and obliquities and in we

403
00:15:12,889 --> 00:15:10,019
get a 14.85 degree celsius at Atomic

404
00:15:14,329 --> 00:15:12,899
Century 0.4 2.5 regardless of the

405
00:15:15,889 --> 00:15:14,339
obliquity so we get kind of like a

406
00:15:17,990 --> 00:15:15,899
stable Clement irregardless of

407
00:15:20,449 --> 00:15:18,000
obligatory for different eccentricities

408
00:15:22,129 --> 00:15:20,459
lastly we did a primary sweep of this

409
00:15:24,110 --> 00:15:22,139
time instead of changing eccentricity we

410
00:15:26,150 --> 00:15:24,120
change the CO2 and we also see that

411
00:15:28,610 --> 00:15:26,160
polar ice caps are formed and on the

412
00:15:30,110 --> 00:15:28,620
right side we get uh we see that how

413
00:15:33,410 --> 00:15:30,120

many of those simulations are either

414
00:15:34,850 --> 00:15:33,420
polar cups uh ice free or Noble and we

415
00:15:37,069 --> 00:15:34,860
see that a lot of them are ice-free and

416
00:15:38,990 --> 00:15:37,079
snowball there's very little of polar

417
00:15:41,389 --> 00:15:39,000
caps but there is still a glimmer of

418
00:15:44,509 --> 00:15:41,399
hope because they still form so that's a

419
00:15:46,250 --> 00:15:44,519
good thing that happens and and then

420
00:15:48,470 --> 00:15:46,260
I'll leave you to the conclusions so I

421
00:15:53,030 --> 00:15:48,480
just want to cut it there but in essence

422
00:15:54,889 --> 00:15:53,040
we did find uh temperature uh conditions

423
00:15:57,710 --> 00:15:54,899
that can give a temporary climate such

424
00:15:59,689 --> 00:15:57,720
as pre-industrial Earth 7 bar CO2 would

425
00:16:02,210 --> 00:15:59,699
be suggested it's a most stable one for

426
00:16:03,769 --> 00:16:02,220
to create those polar ice caps most of

427
00:16:06,290 --> 00:16:03,779
the planet states are funny either ice

428
00:16:08,750 --> 00:16:06,300
ball or snowball and precision angle

429
00:16:09,470 --> 00:16:08,760
does not impact much the eye state of

430
00:16:11,389 --> 00:16:09,480
the planet

431
00:16:14,090 --> 00:16:11,399
and we don't need direct observations to

432
00:16:17,420 --> 00:16:14,100
assess the habitability of gl5 for Timmy

433
00:16:17,420 --> 00:16:17,430
and I'll leave you there thank you

434
00:16:21,470 --> 00:16:18,760
[Applause]

435
00:16:24,050 --> 00:16:21,480
[Music]

436
00:16:27,650 --> 00:16:24,060
character so we have time for one quick

437
00:16:31,250 --> 00:16:29,389
uh great talk

438
00:16:33,230 --> 00:16:31,260

um so it seems like you're suggesting

439
00:16:35,750 --> 00:16:33,240
that uh snowball state is a is a

440
00:16:38,470 --> 00:16:35,760
permanent State and I'm curious as to

441
00:16:40,670 --> 00:16:38,480
whether or not your simulation show any

442
00:16:43,069 --> 00:16:40,680
deviation from that

443
00:16:46,069 --> 00:16:43,079
um because you know we know that that's

444
00:16:48,290 --> 00:16:46,079
a state that has been influxing our

445
00:16:49,910 --> 00:16:48,300
planet so I just I wonder if your

446
00:16:53,210 --> 00:16:49,920
simulations can account for coming out

447
00:16:55,670 --> 00:16:53,220
of a snowball State yeah so this so at

448
00:16:57,949 --> 00:16:55,680
least the simulation what so what is

449
00:16:59,629 --> 00:16:57,959
showing is that the uh what I'm showing

450
00:17:01,610 --> 00:16:59,639
here on the on this histogram plot is

451
00:17:04,850 --> 00:17:01,620
the last state at the at the end of the

452
00:17:06,470 --> 00:17:04,860
simulation uh but uh papers have shown

453
00:17:10,730 --> 00:17:06,480
that one million year is a good enough

454
00:17:13,250 --> 00:17:10,740
time for c for uh simulations uh for

455
00:17:14,569 --> 00:17:13,260
climates to stabilize the thing is that

456
00:17:16,909 --> 00:17:14,579
because we're doing a static Evolution

457
00:17:18,169 --> 00:17:16,919
we don't expect it to change but if we

458
00:17:19,970 --> 00:17:18,179
add the dynamic part which is like

459
00:17:22,069 --> 00:17:19,980
changing obliquity and eccentricity and

460
00:17:23,870 --> 00:17:22,079
precision I go while we're evolving the

461
00:17:25,730 --> 00:17:23,880
planet then that could that could change

462
00:17:27,289 --> 00:17:25,740
uh and it could be it could have been

463
00:17:29,030 --> 00:17:27,299

like a snowball State at one point and

464
00:17:30,950 --> 00:17:29,040
then change to something else but for

465
00:17:32,750 --> 00:17:30,960
this for the static ones we're not we're

466
00:17:41,810 --> 00:17:32,760
not expecting this to change since

467
00:17:44,020 --> 00:17:43,180
[Applause]

468
00:17:46,330 --> 00:17:44,030
[Music]

469
00:17:53,990 --> 00:17:46,340
[Applause]