AbSciCon 2019

1
00:00:00,790 --> 00:00:07,320
[Music]

2
00:00:11,250 --> 00:00:09,290
[Applause]

3
00:00:13,980 --> 00:00:11,260
well thank you very much for this

4
00:00:15,840 --> 00:00:13,990
introduction and before diving into

5
00:00:17,940 --> 00:00:15,850
carbon dioxide reservoirs of habitable

6
00:00:21,420 --> 00:00:17,950
exoplanet water worlds let me introduce

7
00:00:23,190 --> 00:00:21,430
you what a water world is and an

8
00:00:25,080 --> 00:00:23,200
exoplanet water world will be a planet

9
00:00:27,600 --> 00:00:25,090
that has accreted a significant fraction

10
00:00:29,850 --> 00:00:27,610
of volatiles more specifically water

11
00:00:32,820 --> 00:00:29,860
without retaining a large hydrogen

12
00:00:35,760 --> 00:00:32,830
helium atmosphere so on the side you

13
00:00:38,220 --> 00:00:35,770

have examples of two interior structures

14
00:00:45,990 --> 00:00:38,230
of the suppliant water world on the left

15
00:00:47,490 --> 00:00:46,000
here okay so here you have an example of

16
00:00:48,960 --> 00:00:47,500
a water world that will be young or

17
00:00:52,440 --> 00:00:48,970
close to its star and all of the

18
00:00:55,680 --> 00:00:52,450
volatiles of vaporized in a envelope

19
00:00:56,760 --> 00:00:55,690
above the silicon and iron core and most

20
00:00:58,709 --> 00:00:56,770
of the liquid current literature

21
00:01:01,470 --> 00:00:58,719
actually focused on habitable water

22
00:01:03,660 --> 00:01:01,480
worlds where the water is condensed as

23
00:01:06,180 --> 00:01:03,670
high-pressure water ice and possibly

24
00:01:08,279 --> 00:01:06,190
this water world those habitable water

25
00:01:09,840 --> 00:01:08,289
worlds possess a global liquid water

26
00:01:13,800 --> 00:01:09,850
ocean in contact with a thinner

27
00:01:16,410 --> 00:01:13,810
atmosphere so there are several ways to

28
00:01:18,270 --> 00:01:16,420
form water worlds the habitable water

29
00:01:19,830 --> 00:01:18,280
walls could form beyond the snowline of

30
00:01:21,899 --> 00:01:19,840
their stars they could accumulate a

31
00:01:23,250 --> 00:01:21,909
comet-like amount of volatiles and then

32
00:01:25,760 --> 00:01:23,260
migrate inward and sides with the

33
00:01:27,840 --> 00:01:25,770
habitable zone of the star and

34
00:01:29,460 --> 00:01:27,850
accumulation a later accumulation of

35
00:01:32,100 --> 00:01:29,470
water by impact between planetary

36
00:01:35,070 --> 00:01:32,110
embryos is also possible and both of

37
00:01:37,469 --> 00:01:35,080
those mechanism has been played out as a

38
00:01:40,230 --> 00:01:37,479

robust production of numerical

39
00:01:44,789 --> 00:01:40,240
simulation of water wall formation a

40
00:01:47,460 --> 00:01:44,799
third mechanism would be a sub Neptune

41
00:01:51,870 --> 00:01:47,470
planets that would migrate closer to

42
00:01:54,899 --> 00:01:51,880
store close enough that it's envelope

43
00:01:58,200 --> 00:01:54,909
will be evaporating so the star would be

44
00:01:59,880 --> 00:01:58,210
an M dwarf a young and Worf and Worf

45
00:02:02,999 --> 00:01:59,890
would be a star that is cooler than the

46
00:02:05,280 --> 00:02:03,009
Sun and rather than the Sun and also

47
00:02:07,469 --> 00:02:05,290
during the young stages of M dwarf they

48
00:02:09,270 --> 00:02:07,479
are very active and this activity would

49
00:02:11,819 --> 00:02:09,280
allow just an evaporation of this

50
00:02:13,890 --> 00:02:11,829
hydrogen and helium envelope leaving

51
00:02:16,680 --> 00:02:13,900
more heavy volatiles at the at the

52
00:02:19,319 --> 00:02:16,690
surface of the planet so actually

53
00:02:20,760 --> 00:02:19,329
low-density planets in the water bowl

54
00:02:23,010 --> 00:02:20,770
size range

55
00:02:26,550 --> 00:02:23,020
has been detected in abundance by

56
00:02:28,950 --> 00:02:26,560
ground-based and space-based and mask

57
00:02:31,110 --> 00:02:28,960
diagram with all of the crosses are a

58
00:02:35,820 --> 00:02:31,120
sample of exoplanet that has been

59
00:02:37,920 --> 00:02:35,830
detected and here as a guide of the eye

60
00:02:39,450 --> 00:02:37,930
you have a line that represent a mass in

61
00:02:41,760 --> 00:02:39,460
the radius of the planet will be a

62
00:02:43,590 --> 00:02:41,770
hundred percent of ayran here you will

63
00:02:46,740 --> 00:02:43,600

be a planet that will have an iron true

64
00:02:49,650 --> 00:02:46,750
silicate an earth like iron two silicate

65
00:02:51,270 --> 00:02:49,660
ratio and here will be a planet that

66
00:02:53,670 --> 00:02:51,280
will have an earthlike core with

67
00:02:57,990 --> 00:02:53,680
equivalent amount of water on top of it

68
00:02:59,520 --> 00:02:58,000
so solar system planets are here

69
00:03:02,790 --> 00:02:59,530
represented by diamonds you have this

70
00:03:05,280 --> 00:03:02,800
earth Venus and Uranus and Neptune that

71
00:03:07,350 --> 00:03:05,290
are here and you see that there is a

72
00:03:09,000 --> 00:03:07,360
potential sample of planets here that

73
00:03:12,990 --> 00:03:09,010
could have a significant fraction of

74
00:03:16,800 --> 00:03:13,000
water in there in their interior

75
00:03:18,360 --> 00:03:16,810
structures so there has been a status

76
00:03:20,730 --> 00:03:18,370
achill analysis of this exoplanet

77
00:03:23,760 --> 00:03:20,740
population that has been performed in

78
00:03:25,890 --> 00:03:23,770
the past years however their results do

79
00:03:29,120 --> 00:03:25,900
not provide a smoking gun for Waterworld

80
00:03:31,260 --> 00:03:29,130
detection and here you have seven

81
00:03:32,850 --> 00:03:31,270
potential Waterworld targets that have

82
00:03:34,860 --> 00:03:32,860
been detected a couple of years ago

83
00:03:37,700 --> 00:03:34,870
those are a Trappist one a planetary

84
00:03:41,120 --> 00:03:37,710
system that possess potentially five

85
00:03:44,970 --> 00:03:41,130
water rich water wells that will be

86
00:03:47,010 --> 00:03:44,980
observed probably by the next surveys so

87
00:03:50,580 --> 00:03:47,020
then back to the carbon dioxide

88
00:03:52,770 --> 00:03:50,590

reservoirs don't following the mechanism

89
00:03:55,410 --> 00:03:52,780
of formation of water worlds they could

90
00:03:57,690 --> 00:03:55,420
have come at like carbon dioxide rich

91
00:03:59,280 --> 00:03:57,700
composition because usually they form

92
00:04:01,110 --> 00:03:59,290
from a material that is far from the

93
00:04:04,230 --> 00:04:01,120
from the horse star and beyond the snow

94
00:04:07,410 --> 00:04:04,240
line so this figure here is just to show

95
00:04:10,980 --> 00:04:07,420
the possible range of co2 to water ratio

96
00:04:13,740 --> 00:04:10,990
inside of the Comets and to show that

97
00:04:16,949 --> 00:04:13,750
this range is wide and most of the

98
00:04:22,200 --> 00:04:16,959
current literature focuses on relatively

99
00:04:25,050 --> 00:04:22,210
carbon dioxide for water world's so the

100
00:04:28,590 --> 00:04:25,060
question here is if we actually accretes

101
00:04:30,180 --> 00:04:28,600
a comet-like amount of co2 which which

102
00:04:32,370 --> 00:04:30,190
could be a lot we

103
00:04:34,590 --> 00:04:32,380
err this YouTube would go inside of the

104
00:04:36,900 --> 00:04:34,600
habitable Waterworld and what could be

105
00:04:40,650 --> 00:04:36,910
then the main carbon dioxide reservoir

106
00:04:44,120 --> 00:04:40,660
of those planets so what we did is that

107
00:04:47,070 --> 00:04:44,130
we developed an interior structure of

108
00:04:49,470 --> 00:04:47,080
interest ruction model for what we call

109
00:04:54,090 --> 00:04:49,480
sparkling water world co2 Plus water

110
00:04:56,910 --> 00:04:54,100
world and we try to incorporate the

111
00:05:00,150 --> 00:04:56,920
latest experimental results in our model

112
00:05:02,370 --> 00:05:00,160
so I go very fast I'm honest I won't go

113
00:05:04,350 --> 00:05:02,380

into the detail in the complicated

114
00:05:07,860 --> 00:05:04,360
pressure and temperature like phase

115
00:05:10,740 --> 00:05:07,870
diagram of water plus u2 system I just

116
00:05:13,290 --> 00:05:10,750
say that to account for all of the

117
00:05:15,210 --> 00:05:13,300
phases that could be present here we use

118
00:05:18,150 --> 00:05:15,220
a transfer point or equation of state

119
00:05:20,430 --> 00:05:18,160
that is a state-of-the-art industrial

120
00:05:23,880 --> 00:05:20,440
equation of state for water plus u2

121
00:05:27,210 --> 00:05:23,890
mixtures and one of the first

122
00:05:30,510 --> 00:05:27,220
application of our model is to estimate

123
00:05:32,430 --> 00:05:30,520
how much of co2 can be stored inside of

124
00:05:32,940 --> 00:05:32,440
the water rich layers of those water

125
00:05:36,810 --> 00:05:32,950
worlds

126
00:05:39,150 --> 00:05:36,820
so there is two possible roughly two

127
00:05:43,130 --> 00:05:39,160
possible internal structures for

128
00:05:47,250 --> 00:05:43,140
habitable water world so this is a cold

129
00:05:50,159 --> 00:05:47,260
version of a water world that has a

130
00:05:52,800 --> 00:05:50,169
shallow ocean a sick layer of clathrates

131
00:05:55,770 --> 00:05:52,810
clad raised being a crystalline

132
00:05:59,640 --> 00:05:55,780
structure of water where water from

133
00:06:03,300 --> 00:05:59,650
cages that can entrap molecules here co2

134
00:06:06,390 --> 00:06:03,310
and then a high-pressure ice and a

135
00:06:08,280 --> 00:06:06,400
harder version of a habitable water

136
00:06:11,790 --> 00:06:08,290
world would not have this clad freight

137
00:06:14,340 --> 00:06:11,800
layer and will limit our exploration

138
00:06:17,130 --> 00:06:14,350

temperature to 400k because this has

139
00:06:19,830 --> 00:06:17,140
been shown as a limit and highest

140
00:06:22,530 --> 00:06:19,840
temperature for life as we know it so

141
00:06:24,900 --> 00:06:22,540
the co2 can be dissolved in the ocean

142
00:06:27,600 --> 00:06:24,910
can be stored in clathrates

143
00:06:29,490 --> 00:06:27,610
and for this first results we consider

144
00:06:32,610 --> 00:06:29,500
the high-pressure ice is actually pure

145
00:06:34,230 --> 00:06:32,620
water ice so this is an example of

146
00:06:36,990 --> 00:06:34,240
interior structure that we get with our

147
00:06:40,140 --> 00:06:37,000
model here for the cold version I have

148
00:06:42,200 --> 00:06:40,150
the pressure and the composition of co2

149
00:06:46,820 --> 00:06:42,210
inside of the profile

150
00:06:48,260 --> 00:06:46,830
the skills here are different so for the

151
00:06:50,920 --> 00:06:48,270
colder version the shallow ocean

152
00:06:53,990 --> 00:06:50,930
actually store a few percent of co2

153
00:06:56,840 --> 00:06:54,000
while the clap the cigarette layer can

154
00:06:59,360 --> 00:06:56,850
store up to 15 percent of co2 inside of

155
00:07:02,210 --> 00:06:59,370
it for the hottest version there is a

156
00:07:04,580 --> 00:07:02,220
discrepancy between what model predicts

157
00:07:06,530 --> 00:07:04,590
and what actually all of the current

158
00:07:09,730 --> 00:07:06,540
models equation of state of water plus

159
00:07:12,860 --> 00:07:09,740
you would predict and the very recent

160
00:07:15,020 --> 00:07:12,870
experimental experimental data so here

161
00:07:17,840 --> 00:07:15,030
in Y the equation of state would protect

162
00:07:20,870 --> 00:07:17,850
a decrease in solubility of co2 in water

163
00:07:24,470 --> 00:07:20,880

for at saturation for pressures above

164
00:07:26,900 --> 00:07:24,480
100 MPA while the experimental data show

165
00:07:32,230 --> 00:07:26,910
that this solubility increases and reach

166
00:07:36,830 --> 00:07:32,240
up to 20% here at 303 GPA pressure

167
00:07:39,380 --> 00:07:36,840
so what we do is that we compute those

168
00:07:42,410 --> 00:07:39,390
profiles we sum the total amounts of co2

169
00:07:44,060 --> 00:07:42,420
that we get from those profiles and then

170
00:07:47,990 --> 00:07:44,070
we divide by the total amount of

171
00:07:49,610 --> 00:07:48,000
volatiles in the in the hydrosphere of

172
00:07:52,490 --> 00:07:49,620
the planet total amount of volatiles

173
00:07:54,500 --> 00:07:52,500
meaning water plus u2 and then we

174
00:07:56,990 --> 00:07:54,510
compare it to the possible range of

175
00:08:02,270 --> 00:07:57,000
cometary compositions here this range is

176
00:08:05,450 --> 00:08:02,280
shown in gray and this figure shows that

177
00:08:08,570 --> 00:08:05,460
first of all the hot water worlds are

178
00:08:11,420 --> 00:08:08,580
the one that store the most of co2

179
00:08:13,430 --> 00:08:11,430
inside of them so yes sir the y-axis

180
00:08:15,080 --> 00:08:13,440
here is the total planet for that

181
00:08:17,480 --> 00:08:15,090
fraction meaning that here for example

182
00:08:21,710 --> 00:08:17,490
it's a planet that accreted 50% of

183
00:08:24,410 --> 00:08:21,720
volatile by mass so I was saying that

184
00:08:26,360 --> 00:08:24,420
the hot water walls are the one that are

185
00:08:28,930 --> 00:08:26,370
able to store the highest amount of co2

186
00:08:31,670 --> 00:08:28,940
because of this increased solubility of

187
00:08:34,970 --> 00:08:31,680
co2 with depth and this red line takes

188
00:08:37,280 --> 00:08:34,980

account from it and the second a result

189
00:08:40,580 --> 00:08:37,290
that is shown in this figure is that a

190
00:08:43,550 --> 00:08:40,590
planet that has accreted more than 11

191
00:08:45,560 --> 00:08:43,560
percent of volatiles by mass are enabled

192
00:08:48,620 --> 00:08:45,570
to reach this comet-like composition

193
00:08:50,360 --> 00:08:48,630
meaning that if for example those planet

194
00:08:52,610 --> 00:08:50,370
actually accreted a comet-like

195
00:08:53,190 --> 00:08:52,620
composition of co2 so a very rich

196
00:08:55,980 --> 00:08:53,200
composition

197
00:09:02,490 --> 00:08:55,990
you chew this excess has to go somewhere

198
00:09:04,380 --> 00:09:02,500
and one of the obvious possibilities for

199
00:09:06,360 --> 00:09:04,390
this huge shoe is just go in the

200
00:09:09,690 --> 00:09:06,370
atmosphere right you have a very sleek

201
00:09:12,060 --> 00:09:09,700
atmosphere of co2 however in that case

202
00:09:14,010 --> 00:09:12,070
the water world would not be habitable

203
00:09:16,530 --> 00:09:14,020
so the radiative transfer simulation

204
00:09:19,200 --> 00:09:16,540
show that if I have more than 100 bars

205
00:09:20,910 --> 00:09:19,210
you chew inside of the inside of the

206
00:09:22,950 --> 00:09:20,920
atmosphere of a water world the

207
00:09:27,450 --> 00:09:22,960
temperature will rise above this 400k

208
00:09:30,900 --> 00:09:27,460
limit and then the habitable the water

209
00:09:34,230 --> 00:09:30,910
world would not be nice for life as we

210
00:09:37,350 --> 00:09:34,240
know it so here we propose that the

211
00:09:40,200 --> 00:09:37,360
carbon dioxide could be stored as co2

212
00:09:44,120 --> 00:09:40,210
ice or as a newly discovered carbonic

213
00:09:48,390 --> 00:09:44,130

acid monohydrate solid because both of

214
00:09:50,880 --> 00:09:48,400
the co2 ice here and this solid have

215
00:09:52,910 --> 00:09:50,890
their identities that are higher than

216
00:09:55,490 --> 00:09:52,920
the densities of high pressure ice

217
00:09:58,230 --> 00:09:55,500
meaning that they will be stable as

218
00:10:00,270 --> 00:09:58,240
stratified stable stored under those

219
00:10:02,460 --> 00:10:00,280
those layer of high pressure ice and

220
00:10:04,200 --> 00:10:02,470
away from the atmosphere and this is and

221
00:10:08,910 --> 00:10:04,210
this is what we want to preserve the

222
00:10:11,340 --> 00:10:08,920
habitability of water world so the

223
00:10:14,130 --> 00:10:11,350
question is how to get those solids

224
00:10:18,120 --> 00:10:14,140
there and we are working on it and this

225
00:10:21,240 --> 00:10:18,130
is kind of a big picture situation to

226
00:10:24,090 --> 00:10:21,250
show you one of the possible mechanism

227
00:10:27,300 --> 00:10:24,100
of what is happening to store the carbon

228
00:10:29,640 --> 00:10:27,310
dioxide inside of this water world and

229
00:10:31,470 --> 00:10:29,650
we think that actually the habitability

230
00:10:33,120 --> 00:10:31,480
of the water world might be determined

231
00:10:36,750 --> 00:10:33,130
during the cooling history of the

232
00:10:40,050 --> 00:10:36,760
planets so here you have an example of a

233
00:10:42,300 --> 00:10:40,060
water world it is of accreting that has

234
00:10:45,840 --> 00:10:42,310
a supercritical water plus u2 envelope

235
00:10:47,850 --> 00:10:45,850
uniformly mixed very hot and depending

236
00:10:49,290 --> 00:10:47,860
on the condition of the cooling of the

237
00:10:52,050 --> 00:10:49,300
water world if those conditions are

238
00:10:55,080 --> 00:10:52,060

favorable for co2 to actually rise and

239
00:10:57,030 --> 00:10:55,090
stay in the atmosphere then those water

240
00:10:58,650 --> 00:10:57,040
walls are possibly non habitable because

241
00:11:00,450 --> 00:10:58,660
we will creating those suture rich

242
00:11:03,010 --> 00:11:00,460
atmosphere with very strong greenhouse

243
00:11:06,250 --> 00:11:03,020
effects however if they can

244
00:11:08,650 --> 00:11:06,260
addition are favorable to for this you

245
00:11:12,090 --> 00:11:08,660
to sync and to form those Isis or the

246
00:11:17,160 --> 00:11:12,100
solid then this you will be trapped and

247
00:11:21,700 --> 00:11:17,170
this outcome will be possibly habitable

248
00:11:23,170 --> 00:11:21,710
okay so here's my summary so the

249
00:11:26,050 --> 00:11:23,180
atmosphere the ocean and the clathrate

250
00:11:29,410 --> 00:11:26,060
layer are actually of water worlds are

251
00:11:33,340 --> 00:11:29,420
not enough to store a comet-like amounts

252
00:11:37,240 --> 00:11:33,350
of co2 if if the water wall de created

253
00:11:38,950 --> 00:11:37,250
more than 11% of volatile by mass if you

254
00:11:42,280 --> 00:11:38,960
want to avoid a hot and on habitable

255
00:11:44,050 --> 00:11:42,290
scenario we need to sequester co2 away

256
00:11:47,440 --> 00:11:44,060
from the atmosphere inside of the

257
00:11:48,970 --> 00:11:47,450
high-pressure ice mantle and the

258
00:11:51,040 --> 00:11:48,980
habitability of a water world would

259
00:11:52,900 --> 00:11:51,050
probably depend on the cooling history

260
00:11:54,820 --> 00:11:52,910
of the planet and the extent of the

261
00:11:56,580 --> 00:11:54,830
carpenter said solids are stored inside

262
00:11:58,480 --> 00:11:56,590
of this high-pressure water ice layer

263
00:12:07,510 --> 00:11:58,490

yes thank you

264
00:12:09,580 --> 00:12:07,520
I'll be happy to up any questions for

265
00:12:10,540 --> 00:12:09,590
questions maybe come to the mic if you

266
00:12:11,770 --> 00:12:10,550
in mind because I think they're

267
00:12:14,620 --> 00:12:11,780
streaming thank you

268
00:12:16,690 --> 00:12:14,630
hi great talk thank you I was wondering

269
00:12:18,360 --> 00:12:16,700
if your model consider speciation of

270
00:12:21,430 --> 00:12:18,370
carbon dioxide as things like

271
00:12:25,030 --> 00:12:21,440
bicarbonate and carbonate that's that's

272
00:12:28,840 --> 00:12:25,040
a really good question so the model is

273
00:12:33,940 --> 00:12:28,850
pure water and co2 alright so if there

274
00:12:36,700 --> 00:12:33,950
is no other agents such as a calcium or

275
00:12:38,860 --> 00:12:36,710
like water rock interaction coming from

276
00:12:46,100 --> 00:12:38,870
Wetterich interaction this speciation

277
00:12:52,319 --> 00:12:49,620
so yeah but to lower the pH you need

278
00:12:54,240 --> 00:12:52,329
additional a to higher to put the pH

279
00:12:56,309 --> 00:12:54,250
higher you need additional agents to do

280
00:12:57,990 --> 00:12:56,319
that and the model does not account for

281
00:13:00,660 --> 00:12:58,000
them so that would be that would be

282
00:13:02,670 --> 00:13:00,670
actually great addition but I think we

283
00:13:06,120 --> 00:13:02,680
will hear about salts inside of a

284
00:13:07,800 --> 00:13:06,130
Waterworld later yeah cool see Vance JPL

285
00:13:09,059 --> 00:13:07,810
really nice work I'm glad to see you're

286
00:13:10,590 --> 00:13:09,069
using the results from a person it

287
00:13:13,170 --> 00:13:10,600
wasn't at all yeah had a question about

288
00:13:15,620 --> 00:13:13,180

the structure getting a two thousand

289
00:13:18,420 --> 00:13:15,630
kilometer thick high-pressure ice layer

290
00:13:20,189 --> 00:13:18,430
there well so there was the issue of the

291
00:13:22,230 --> 00:13:20,199
thermal profile in such a thick layer I

292
00:13:23,550 --> 00:13:22,240
would expect for a large world you've a

293
00:13:25,199 --> 00:13:23,560
lot of radiogenic heat from the interior

294
00:13:27,210 --> 00:13:25,209
and it would be hard to have a nice

295
00:13:30,300 --> 00:13:27,220
layer that thick there was isothermal

296
00:13:31,559 --> 00:13:30,310
rather than following close to the

297
00:13:33,389 --> 00:13:31,569
liquidus of the - rights

298
00:13:35,939 --> 00:13:33,399
it's just wondering what you did to

299
00:13:39,150 --> 00:13:35,949
model the temperature structure of the

300
00:13:42,180 --> 00:13:39,160
ice so yeah so the parameters of the

301
00:13:44,879 --> 00:13:42,190
model has been kind of optimized to have

302
00:13:47,240 --> 00:13:44,889
a maximum storage of co2 so what this

303
00:13:50,460 --> 00:13:47,250
slide doesn't tell is that the

304
00:13:52,710 --> 00:13:50,470
isothermal profile is only inside of the

305
00:13:54,090 --> 00:13:52,720
ocean and class right layer not inside

306
00:13:55,410 --> 00:13:54,100
of the high-pressure water ice the

307
00:13:57,990 --> 00:13:55,420
high-pressure water ice has an adiabatic

308
00:13:59,370 --> 00:13:58,000
profile actually even even in the ocean

309
00:14:01,079 --> 00:13:59,380
compressibility of the water will lead

310
00:14:02,189 --> 00:14:01,089
to a drastic temperature increase by the

311
00:14:04,110 --> 00:14:02,199
time you get to the high pressure ice

312
00:14:05,220 --> 00:14:04,120
yeah I agree but it also will lead like

313
00:14:07,350 --> 00:14:05,230

the increasing temperatures will

314
00:14:09,720 --> 00:14:07,360
decrease the solubility of Sojo so

315
00:14:12,059 --> 00:14:09,730
keeping those isothermal profile getting

316
00:14:14,550 --> 00:14:12,069
really the Apple level of the maximum of

317
00:14:16,860 --> 00:14:14,560
co2 that you can possibly either setting

318
00:14:19,499 --> 00:14:16,870
upper bound yeah exactly that's good

319
00:14:20,759 --> 00:14:19,509
so just one one quick question is the

320
00:14:22,860 --> 00:14:20,769
high pressure ice in this on the Left

321
00:14:28,679 --> 00:14:22,870
starting at ten mega Pascal or 1 mega

322
00:14:35,059 --> 00:14:28,689
Pascal I think it's starting around 600

323
00:14:37,740 --> 00:14:35,069
MPA okay okay yeah very good thanks I

324
00:14:40,009 --> 00:14:37,750
owe and lemur and I was just wondering

325
00:14:42,509 --> 00:14:40,019
if your model has a sink term for

326
00:14:43,829 --> 00:14:42,519
cations coming up from the silicate

327
00:14:45,030 --> 00:14:43,839
interaction with the high-pressure ice

328
00:14:47,670 --> 00:14:45,040
or if that's something that could be put

329
00:14:51,720 --> 00:14:47,680
in so I know this model my mom does not

330
00:14:52,740 --> 00:14:51,730
account for that yet Thanks well thank

331
00:14:55,290 --> 00:14:52,750
you so much