AbGradCon 2018

1
00:00:00,260 --> 00:00:11,940
[Music]

2
00:00:16,750 --> 00:00:15,039
as per the said I work with dr. Brittany

3
00:00:18,939 --> 00:00:16,760
Schmidt here at Georgia Tech and we do

4
00:00:20,920 --> 00:00:18,949
kind of three-part science so we're NASA

5
00:00:22,810 --> 00:00:20,930
Pew Start program which is about 50/50

6
00:00:24,160 --> 00:00:22,820
science and engineering development for

7
00:00:26,110 --> 00:00:24,170
kind of solar system the ocean world

8
00:00:27,850 --> 00:00:26,120
exploration not give a good introduction

9
00:00:28,990 --> 00:00:27,860
to ocean worlds and is the first talk of

10
00:00:31,390 --> 00:00:29,000
this session I'm going to dive into that

11
00:00:33,670 --> 00:00:31,400
a little bit deeper but we can also do a

12
00:00:35,229 --> 00:00:33,680
lot of climate science and the analog

13
00:00:37,270 --> 00:00:35,239

environments that we work in Antarctica

14
00:00:40,500 --> 00:00:37,280
are kind of relevant for some of the

15
00:00:43,750 --> 00:00:40,510
terrestrial work as well so that said

16
00:00:45,610 --> 00:00:43,760
here you can see this is the edge of the

17
00:00:46,869 --> 00:00:45,620
Ross Ice Shelf and after a couple years

18
00:00:49,209 --> 00:00:46,879
working in Antarctica this is the first

19
00:00:51,880 --> 00:00:49,219
time I saw this just this past November

20
00:00:54,189 --> 00:00:51,890
it's pretty well it's about a 300 meter

21
00:00:55,569 --> 00:00:54,199
thick chunk of ice so the part that's

22
00:00:58,270 --> 00:00:55,579
sticking up here is about 30 meters or a

23
00:00:59,410 --> 00:00:58,280
hundred feet and this is kind of the

24
00:01:00,879 --> 00:00:59,420
system that we're interested in studying

25
00:01:02,770 --> 00:01:00,889
as an analog for ocean world in our

26
00:01:04,329 --> 00:01:02,780
solar system what are the processes that

27
00:01:06,100 --> 00:01:04,339
are going on below the large ice sheets

28
00:01:07,750 --> 00:01:06,110
on earth and how good are those as an

29
00:01:11,170 --> 00:01:07,760
analogue what are the limits of

30
00:01:14,290 --> 00:01:11,180
habitability and sort of non-photo quota

31
00:01:16,450 --> 00:01:14,300
Goshen's alright backing up a little bit

32
00:01:18,670 --> 00:01:16,460
to ocean worlds so the planets moons

33
00:01:19,960 --> 00:01:18,680
that have oceans this kind of breaks our

34
00:01:21,550 --> 00:01:19,970
understanding of the habitable zone a

35
00:01:23,650 --> 00:01:21,560
little bit because most of these places

36
00:01:24,820 --> 00:01:23,660
are places that are not within the sort

37
00:01:26,710 --> 00:01:24,830
of nominal Heather zone where you go

38
00:01:28,180 --> 00:01:26,720

Venus to Mars for our system where so

39
00:01:30,220 --> 00:01:28,190
the exoplanet systems a lot of them are

40
00:01:32,500 --> 00:01:30,230
out by Jupiter or Saturn and their moons

41
00:01:33,580 --> 00:01:32,510
of main planets too so these are

42
00:01:35,140 --> 00:01:33,590
environments that were really interested

43
00:01:36,640 --> 00:01:35,150
in for our solar system that are not

44
00:01:39,790 --> 00:01:36,650
kind of in the traditional habitable

45
00:01:41,320 --> 00:01:39,800
zone so Jonathan we mean 2017 here at a

46
00:01:42,520 --> 00:01:41,330
great kind of review paper on what a lot

47
00:01:44,500 --> 00:01:42,530
of these bodies are and some of the

48
00:01:46,380 --> 00:01:44,510
processes they are affecting though this

49
00:01:49,540 --> 00:01:46,390
is one of the tables that summarizes it

50
00:01:51,340 --> 00:01:49,550
we can focus on those that are extant

51
00:01:53,710 --> 00:01:51,350
here that means that there's good

52
00:01:56,680 --> 00:01:53,720
evidence for places that have currently

53
00:01:58,300 --> 00:01:56,690
habitable environments or oceans so the

54
00:01:59,680 --> 00:01:58,310
reason that this is possible outside of

55
00:02:01,899 --> 00:01:59,690
the habitable zone is from a few

56
00:02:02,950 --> 00:02:01,909
different mechanisms so one you just

57
00:02:05,410 --> 00:02:02,960
have your eminent and heat of formation

58
00:02:07,120 --> 00:02:05,420
so 4.5 billion years ago or so these

59
00:02:07,930 --> 00:02:07,130
bodies form and they've been cooling off

60
00:02:10,029 --> 00:02:07,940
ever since

61
00:02:11,770 --> 00:02:10,039
radioactive decay in the interior from

62
00:02:13,600 --> 00:02:11,780
radiogenic elements that's another way

63
00:02:14,860 --> 00:02:13,610

of just constantly generating heat but

64
00:02:16,510 --> 00:02:14,870
really interesting and foremost these

65
00:02:18,040 --> 00:02:16,520
bodies because they're moons

66
00:02:19,990 --> 00:02:18,050
orbiting their host planets and slightly

67
00:02:21,490 --> 00:02:20,000
eccentric orbits this title dissipation

68
00:02:22,960 --> 00:02:21,500
- basically a stress ball that's getting

69
00:02:24,310 --> 00:02:22,970
squeezed as they spin around in these

70
00:02:25,990 --> 00:02:24,320
eccentric orbits and that frictional

71
00:02:28,780 --> 00:02:26,000
heating actually provides enough heat to

72
00:02:30,280 --> 00:02:28,790
people a lot of these places liquid so

73
00:02:32,590 --> 00:02:30,290
moving on to that yeah these ones were

74
00:02:34,210 --> 00:02:32,600
interested in Europa and saw this and

75
00:02:35,560 --> 00:02:34,220
potentially tighten things a little bit

76
00:02:37,900 --> 00:02:35,570
more complicated because of the pressure

77
00:02:40,390 --> 00:02:37,910
regime and so there's kind of a weird

78
00:02:41,890 --> 00:02:40,400
sandwich of ice ocean and methane on the

79
00:02:44,410 --> 00:02:41,900
surface all kinds of strangeness there

80
00:02:45,730 --> 00:02:44,420
some people here work on that but we're

81
00:02:47,860 --> 00:02:45,740
gonna focus on kind of a simpler model

82
00:02:51,040 --> 00:02:47,870
where like earth you have a rocky core

83
00:02:54,250 --> 00:02:51,050
you have an ocean layer and then an ice

84
00:02:57,400 --> 00:02:54,260
surface so well look at your open as an

85
00:03:00,070 --> 00:02:57,410
example again kind of the the structure

86
00:03:02,050 --> 00:03:00,080
not talked about this a little bit and

87
00:03:03,970 --> 00:03:02,060
then moving on to the zoomed in view of

88
00:03:05,530 --> 00:03:03,980

that this is from the Europa Lander SDT

89
00:03:07,300 --> 00:03:05,540
NASA is currently trying to think if

90
00:03:08,440 --> 00:03:07,310
that's a good idea of saying oh I'll

91
00:03:09,970 --> 00:03:08,450
land into the surface of Europa

92
00:03:14,110 --> 00:03:09,980
something we can do in the next decade

93
00:03:15,280 --> 00:03:14,120
or so but yeah so not talked about how

94
00:03:17,080 --> 00:03:15,290
we know there's an ocean there from a

95
00:03:18,700 --> 00:03:17,090
lot of the magnetometry data and we

96
00:03:19,930 --> 00:03:18,710
think that this ocean layer this Brian

97
00:03:21,580 --> 00:03:19,940
layer here the salty layer that's

98
00:03:22,690 --> 00:03:21,590
conductive is what's driving that

99
00:03:24,400 --> 00:03:22,700
observation and that's very good

100
00:03:26,890 --> 00:03:24,410
evidence for that but above that you

101
00:03:27,970 --> 00:03:26,900
have a cross-device ocean maybe 100

102
00:03:30,880 --> 00:03:27,980
kilometers thick we don't really know

103
00:03:33,100 --> 00:03:30,890
maybe a total length or thickness of

104
00:03:34,990 --> 00:03:33,110
water layer ice and ocean and about 140

105
00:03:36,250 --> 00:03:35,000
kilometers or so and then people are

106
00:03:38,350 --> 00:03:36,260
really interested about what's going on

107
00:03:39,580 --> 00:03:38,360
in the seafloor where are the reductants

108
00:03:41,140 --> 00:03:39,590
where the oxidants coming from this

109
00:03:43,240 --> 00:03:41,150
system is this something where you could

110
00:03:44,800 --> 00:03:43,250
have life what are the limits of

111
00:03:46,930 --> 00:03:44,810
habitability in an ice-covered

112
00:03:51,340 --> 00:03:46,940
ecosystems should they exist on other

113
00:03:58,780 --> 00:03:51,350

planets we use Antarctica as an analogue

114
00:04:08,040 --> 00:03:58,790
to ask that question here all right go

115
00:04:13,520 --> 00:04:10,100
as soon as you're pregnant

116
00:04:14,810 --> 00:04:13,530
okay we're back maybe yeah so my

117
00:04:16,340 --> 00:04:14,820
personal research goals are to

118
00:04:18,229 --> 00:04:16,350
characterize both the physical processes

119
00:04:20,300 --> 00:04:18,239
and the biology underneath I shelves in

120
00:04:22,340 --> 00:04:20,310
Antarctica and look at the intersections

121
00:04:24,530 --> 00:04:22,350
and how these things interact and what

122
00:04:26,060 --> 00:04:24,540
controls both biological systems can

123
00:04:27,350 --> 00:04:26,070
place in the physical systems and the

124
00:04:29,180 --> 00:04:27,360
physical systems place in the biological

125
00:04:31,070 --> 00:04:29,190
systems in terms of looking about

126
00:04:32,540 --> 00:04:31,080
looking at where the habitable

127
00:04:34,340 --> 00:04:32,550
environments are distributed and where

128
00:04:35,900 --> 00:04:34,350
things might live and then take that

129
00:04:37,790 --> 00:04:35,910
extrapolate it to Europa and other

130
00:04:39,530 --> 00:04:37,800
systems like that to guide and provide

131
00:04:41,150 --> 00:04:39,540
context for where you might best want to

132
00:04:42,860 --> 00:04:41,160
land on Europa or look for it in the

133
00:04:46,100 --> 00:04:42,870
ocean look for habitable or bio

134
00:04:47,570 --> 00:04:46,110
signatures in the ocean again in

135
00:04:49,340 --> 00:04:47,580
Antarctica so the processes that we're

136
00:04:51,380 --> 00:04:49,350
really interested in is the this this

137
00:04:51,980 --> 00:04:51,390
depth temperature and salinity dependent

138
00:04:53,450 --> 00:04:51,990

ice box

139
00:04:55,100 --> 00:04:53,460
because as ice is moving around

140
00:04:56,690 --> 00:04:55,110
underneath it's in training organics

141
00:04:59,150 --> 00:04:56,700
it's controlling where things can live

142
00:05:00,620 --> 00:04:59,160
at that ice ocean interface and that's a

143
00:05:02,120 --> 00:05:00,630
process that's likely ongoing at Europe

144
00:05:03,560 --> 00:05:02,130
as well and that can control where

145
00:05:05,150 --> 00:05:03,570
organics are getting incorporated in the

146
00:05:07,640 --> 00:05:05,160
VHL where you might want to land with

147
00:05:09,830 --> 00:05:07,650
the lander we look at the symmetry

148
00:05:11,390 --> 00:05:09,840
basically POG refer it's also kind of an

149
00:05:12,860 --> 00:05:11,400
unconstrained thing it's really hard to

150
00:05:15,200 --> 00:05:12,870
get observations underneath these ice

151
00:05:18,740 --> 00:05:15,210
shelves this is actually report from the

152
00:05:20,870 --> 00:05:18,750
2014 ocean observatory something like

153
00:05:22,220 --> 00:05:20,880
that symposium I think they're like well

154
00:05:23,659 --> 00:05:22,230
how can we understand these problems

155
00:05:26,030 --> 00:05:23,669
usually we drill a hole we put a mooring

156
00:05:28,250 --> 00:05:26,040
down and we can get like kind of one

157
00:05:29,480 --> 00:05:28,260
point measurement of what's going on but

158
00:05:30,800 --> 00:05:29,490
we're trying to expand that a little bit

159
00:05:32,090 --> 00:05:30,810
so we can understand the industry in the

160
00:05:36,140 --> 00:05:32,100
topography in the processes in a broader

161
00:05:37,730 --> 00:05:36,150
spatial scale and then from that how are

162
00:05:39,200 --> 00:05:37,740
we controlling to have lanisha's we have

163
00:05:40,940 --> 00:05:39,210

a few early observations of life

164
00:05:43,610 --> 00:05:40,950
underneath this ice shelf the Ross for

165
00:05:45,080 --> 00:05:43,620
examples a thousand kilometers wide so

166
00:05:46,520 --> 00:05:45,090
there's life under there and it's not

167
00:05:47,930 --> 00:05:46,530
entirely clear what's powering those

168
00:05:50,810 --> 00:05:47,940
ecosystem so we're trying to understand

169
00:05:53,450 --> 00:05:50,820
that the community make up what

170
00:05:55,400 --> 00:05:53,460
microbial systems are providing the sort

171
00:05:56,780 --> 00:05:55,410
of the base of the ecosystem how does

172
00:05:58,550 --> 00:05:56,790
that change from the open ocean to the

173
00:06:00,260 --> 00:05:58,560
back of the shelf and where these

174
00:06:02,020 --> 00:06:00,270
interesting nutrients coming from and

175
00:06:04,430 --> 00:06:02,030
what from that can we apply ocean wells

176
00:06:06,320 --> 00:06:04,440
so this is kind of our field site we do

177
00:06:07,700 --> 00:06:06,330
a lot of field work it's mostly field

178
00:06:09,680 --> 00:06:07,710
work actually this is Antarctica the

179
00:06:11,450 --> 00:06:09,690
Ross Ice Shelf about a thousand

180
00:06:13,100 --> 00:06:11,460
kilometres from the northern edge at the

181
00:06:15,830 --> 00:06:13,110
bottom here the top the stars are our

182
00:06:17,360 --> 00:06:15,840
field sites we do most of our work right

183
00:06:19,880 --> 00:06:17,370
about here by McMurdo Station which

184
00:06:22,999 --> 00:06:19,890
largest US base next to the New Zealand

185
00:06:24,649 --> 00:06:23,009
days this is another site about midway

186
00:06:26,899 --> 00:06:24,659
and then finally a site at the grounding

187
00:06:28,489 --> 00:06:26,909
zone where the ice goes of float so an

188
00:06:29,839 --> 00:06:28,499

ocean an ice shelf is a sort of a

189
00:06:33,049 --> 00:06:29,849
floating glacier to fly she started with

190
00:06:34,399 --> 00:06:33,059
that but again we're interested in how

191
00:06:35,899 --> 00:06:34,409
things change from the photic ocean we

192
00:06:38,420 --> 00:06:35,909
do photosynthesis driving a lot of life

193
00:06:39,619 --> 00:06:38,430
to the currents they might be dragging

194
00:06:41,089 --> 00:06:39,629
some of that detrital material

195
00:06:43,399 --> 00:06:41,099
underneath empowering the ecosystems to

196
00:06:45,649 --> 00:06:43,409
sort of all the way back at the base of

197
00:06:46,730 --> 00:06:45,659
the ice shelf how things are surviving

198
00:06:50,809 --> 00:06:46,740
back there we know there's there's life

199
00:06:53,109 --> 00:06:50,819
back there so again that gradient okay

200
00:06:55,309 --> 00:06:53,119
so field data what do we use to do this

201
00:06:58,219 --> 00:06:55,319
we've built an underwater vehicle here

202
00:07:00,409 --> 00:06:58,229
at Tech it's almost it's twelve feet

203
00:07:02,149 --> 00:07:00,419
three now meters longer so it's very

204
00:07:03,200 --> 00:07:02,159
small diameter we've designed it to fit

205
00:07:04,549 --> 00:07:03,210
through bore holes because it's very

206
00:07:06,439 --> 00:07:04,559
hard to drive in from the front of the

207
00:07:08,089 --> 00:07:06,449
show if you can't get very far so we've

208
00:07:09,920 --> 00:07:08,099
kind of got this like have robot will

209
00:07:12,499 --> 00:07:09,930
travel model or anyone who's doing a

210
00:07:13,730 --> 00:07:12,509
climate study on earth they're putting a

211
00:07:14,929 --> 00:07:13,740
borehole in putting a mooring in or

212
00:07:16,249 --> 00:07:14,939
something like that we can also go along

213
00:07:18,139 --> 00:07:16,259

and deploy the robot and increase the

214
00:07:19,459 --> 00:07:18,149
science return we've got some standard

215
00:07:22,309 --> 00:07:19,469
sensors here so in the front we have

216
00:07:24,139 --> 00:07:22,319
sonar helps us not run into things Ct is

217
00:07:26,359 --> 00:07:24,149
conductivity and temperature proxy for

218
00:07:28,790 --> 00:07:26,369
salinity and temperature do dissolved

219
00:07:31,610 --> 00:07:28,800
oxygen some camera systems some lasers

220
00:07:33,889 --> 00:07:31,620
for scale get a scale in the imaging

221
00:07:36,589 --> 00:07:33,899
systems and then we've got kind of a

222
00:07:38,749 --> 00:07:36,599
science module here side scan sonar for

223
00:07:40,279 --> 00:07:38,759
mapping the seafloor sea Dom which is

224
00:07:41,689 --> 00:07:40,289
dissolved organic materials which kind

225
00:07:44,029 --> 00:07:41,699
of helps you understand communication

226
00:07:45,290 --> 00:07:44,039
with the open ocean pH ORP which is

227
00:07:46,639 --> 00:07:45,300
interesting if you might try to find a

228
00:07:49,639 --> 00:07:46,649
hydrothermal vent or somewhere we other

229
00:07:52,219 --> 00:07:49,649
a disequilibrium of compounds community

230
00:07:52,639 --> 00:07:52,229
for turbidity also good for hydrothermal

231
00:07:55,009 --> 00:07:52,649
systems

232
00:07:56,989 --> 00:07:55,019
section and again cameras laser scales

233
00:07:58,369 --> 00:07:56,999
lights etc so it's designed to be

234
00:08:00,049 --> 00:07:58,379
modular and we also have some people at

235
00:08:01,459 --> 00:08:00,059
Tech that are helping to develop sensors

236
00:08:03,049 --> 00:08:01,469
for future ocean world exploration like

237
00:08:05,659 --> 00:08:03,059
cell calendars or holographic

238
00:08:09,679 --> 00:08:05,669

microscopes and using Iceland as a sort

239
00:08:10,759 --> 00:08:09,689
of a payload carrier for that okay so

240
00:08:13,279 --> 00:08:10,769
this is kind of what that looks like

241
00:08:14,629 --> 00:08:13,289
from the surface this is out next to

242
00:08:17,329 --> 00:08:14,639
Erebus which is one of the larger

243
00:08:19,879 --> 00:08:17,339
volcanoes and Antarctica we've got our

244
00:08:20,989 --> 00:08:19,889
little are called the a-frame here it's

245
00:08:22,489 --> 00:08:20,999
just an aluminum structure we built

246
00:08:24,290 --> 00:08:22,499
drill a hole in the ice the holes right

247
00:08:26,299 --> 00:08:24,300
down there and then I spin will hang

248
00:08:27,469 --> 00:08:26,309
from here and then dive down below I've

249
00:08:28,459 --> 00:08:27,479
got these little tracked vehicles here

250
00:08:28,830 --> 00:08:28,469
which is kind of how we get around the

251
00:08:31,890 --> 00:08:28,840
ice

252
00:08:32,790 --> 00:08:31,900
generators pens etc and this is what

253
00:08:34,980 --> 00:08:32,800
that looks like underneath the water

254
00:08:36,690 --> 00:08:34,990
which is kind of cool so here you can

255
00:08:38,550 --> 00:08:36,700
see we've got our lights on so recording

256
00:08:40,560 --> 00:08:38,560
some some science data here we've got

257
00:08:42,480 --> 00:08:40,570
side scan sonar running we use a

258
00:08:44,310 --> 00:08:42,490
fiber-optic tether for your live data

259
00:08:46,110 --> 00:08:44,320
recovery of course you can't transmit

260
00:08:47,610 --> 00:08:46,120
other than acoustic signals you can't

261
00:08:51,480 --> 00:08:47,620
really transmit data very very well

262
00:08:53,880 --> 00:08:51,490
through water and then this is what

263
00:08:55,290 --> 00:08:53,890

another way we can get some some data we

264
00:08:57,390 --> 00:08:55,300
can just go out on snow machines drill

265
00:08:59,220 --> 00:08:57,400
some holes is my adviser here dr.

266
00:09:00,930 --> 00:08:59,230
Schmidt and she's got we call this

267
00:09:02,790 --> 00:09:00,940
Cassini it's one of our labs most

268
00:09:04,530 --> 00:09:02,800
productive sensors it's a CT sensitive

269
00:09:06,150 --> 00:09:04,540
we can just take wherever we go drop it

270
00:09:09,320 --> 00:09:06,160
through the ice somewhere spot and then

271
00:09:12,810 --> 00:09:09,330
we get kind of close point profiles I

272
00:09:15,390 --> 00:09:12,820
really what we're trying to do is

273
00:09:18,030 --> 00:09:15,400
understand those environments across

274
00:09:19,860 --> 00:09:18,040
this gradient and then tie that back to

275
00:09:22,680 --> 00:09:19,870
the processes they're influencing the

276
00:09:24,360 --> 00:09:22,690
biology that can be present there so

277
00:09:26,610 --> 00:09:24,370
starting from the front of the shelf

278
00:09:29,250 --> 00:09:26,620
what we do this is kind of where the the

279
00:09:30,840 --> 00:09:29,260
station is and then this is an overview

280
00:09:32,010 --> 00:09:30,850
of all the historical observations that

281
00:09:34,920 --> 00:09:32,020
have gone on underneath the Ross Ice

282
00:09:36,690 --> 00:09:34,930
Shelf for example so here we've got a

283
00:09:38,070 --> 00:09:36,700
lot of our work at the edges we're kind

284
00:09:40,590 --> 00:09:38,080
of tuning up our systems in practicing

285
00:09:42,449 --> 00:09:40,600
and Zed that's the Antarctic New Zealand

286
00:09:43,710 --> 00:09:42,459
program they just put a borehole in 2017

287
00:09:46,500 --> 00:09:43,720
they're collaborators with us a couple

288
00:09:48,030 --> 00:09:46,510

months ago the Ross Ice Shelf project

289
00:09:49,860 --> 00:09:48,040
there was a massive effort in the late

290
00:09:51,000 --> 00:09:49,870
70s to put a borehole and people really

291
00:09:53,850 --> 00:09:51,010
curious about what's going on in these

292
00:09:55,680 --> 00:09:53,860
ice shelves today went down they found

293
00:09:57,570 --> 00:09:55,690
some fish and things like that and then

294
00:09:59,040 --> 00:09:57,580
next year we're going down with New

295
00:10:01,260 --> 00:09:59,050
Zealand or actually excuse me

296
00:10:03,390 --> 00:10:01,270
I think we just bumped this back to next

297
00:10:04,380 --> 00:10:03,400
next year so we're gonna wait one more

298
00:10:06,180 --> 00:10:04,390
year but then do some drilling at the

299
00:10:08,820 --> 00:10:06,190
grounding zone and kind of expand our

300
00:10:12,180 --> 00:10:08,830
observations that ice bin and so this

301
00:10:13,680 --> 00:10:12,190
process of how water is moving and where

302
00:10:15,540 --> 00:10:13,690
ice is melting at the base of the Shelf

303
00:10:17,460 --> 00:10:15,550
or creating at the base of the shelf

304
00:10:20,280 --> 00:10:17,470
really controls what kind of biology we

305
00:10:22,019 --> 00:10:20,290
biology we observe so at the front you

306
00:10:23,579 --> 00:10:22,029
can see there's kind of lady crystal

307
00:10:24,630 --> 00:10:23,589
textures you have things like amphipods

308
00:10:25,860 --> 00:10:24,640
that are hanging out in the water column

309
00:10:27,150 --> 00:10:25,870
and they're filtered feeding off of

310
00:10:28,829 --> 00:10:27,160
material that's coming in from the open

311
00:10:30,840 --> 00:10:28,839
ocean that's probably not our best

312
00:10:32,610 --> 00:10:30,850
analog for an ocean world not really a

313
00:10:33,470 --> 00:10:32,620

photic bio system that's providing that

314
00:10:35,250 --> 00:10:33,480
kind of material

315
00:10:39,750 --> 00:10:35,260
but the ice is something we're

316
00:10:41,730 --> 00:10:39,760
interested in so 1977 they go down they

317
00:10:42,510 --> 00:10:41,740
find fish 500 kilometers from the open

318
00:10:44,519 --> 00:10:42,520
ocean it's kind of

319
00:10:48,329 --> 00:10:44,529
not a lot of food there for them what

320
00:10:49,680 --> 00:10:48,339
are they eating and then 2015 the wizard

321
00:10:51,389 --> 00:10:49,690
project they drilled at the grounding

322
00:10:52,769 --> 00:10:51,399
zone it was the first time they also

323
00:10:54,180 --> 00:10:52,779
found fish which was even more

324
00:10:56,550 --> 00:10:54,190
surprising so they were pretty shocked

325
00:10:58,380 --> 00:10:56,560
by that you would think that most things

326
00:11:00,000 --> 00:10:58,390
if it's currents that are carrying it in

327
00:11:01,199 --> 00:11:00,010
it'd be pretty pretty munched on by the

328
00:11:03,810 --> 00:11:01,209
time it got all the way back not a lot

329
00:11:06,630 --> 00:11:03,820
of carbon left for for larger kind of

330
00:11:08,160 --> 00:11:06,640
macro fauna and so we're trying to again

331
00:11:09,480 --> 00:11:08,170
break down that system so we're

332
00:11:11,370 --> 00:11:09,490
wondering is there sublation will input

333
00:11:12,660 --> 00:11:11,380
of we know there's a lot of sub glacial

334
00:11:14,130 --> 00:11:12,670
lakes subglacial hydrology that's the

335
00:11:16,860 --> 00:11:14,140
thing we've known about for just quite a

336
00:11:18,030 --> 00:11:16,870
decade now there's meltwater and active

337
00:11:22,079 --> 00:11:18,040
drainage underneath the N Arctic ice

338
00:11:23,940 --> 00:11:22,089

sheet are there methane seeps or vents

339
00:11:25,920 --> 00:11:23,950
hydrothermal or sub pet magazine systems

340
00:11:27,329 --> 00:11:25,930
in turn ether shelf that's been found at

341
00:11:29,220 --> 00:11:27,339
Larsen B after the Larsen B Ice Shelf

342
00:11:30,720 --> 00:11:29,230
collapse they went over the ship lot

343
00:11:32,370 --> 00:11:30,730
easier when there's no ice and they

344
00:11:33,600 --> 00:11:32,380
found just the whole sea floor was

345
00:11:36,180 --> 00:11:33,610
covered in microbial mats they were

346
00:11:37,829 --> 00:11:36,190
using methane is their carbon source and

347
00:11:39,480 --> 00:11:37,839
then of course the sort of the easiest

348
00:11:42,170 --> 00:11:39,490
one is over just it is enough it's

349
00:11:45,090 --> 00:11:42,180
enough carbon coming in from definition

350
00:11:47,790 --> 00:11:45,100
yeah so from the biological patience the

351
00:11:49,019 --> 00:11:47,800
physical controls exactly the same

352
00:11:50,460 --> 00:11:49,029
diagram but now we're gonna put some

353
00:11:52,079 --> 00:11:50,470
some data that we've collected on it

354
00:11:53,760 --> 00:11:52,089
what we're interested in this kind of

355
00:11:55,139 --> 00:11:53,770
this one two three four process where

356
00:11:56,550 --> 00:11:55,149
you have water that's moving around in

357
00:11:58,560 --> 00:11:56,560
the system and it's driving where ice is

358
00:11:59,940 --> 00:11:58,570
melting and accreted during apnea which

359
00:12:01,860 --> 00:11:59,950
is where you form CIF that's kind of

360
00:12:03,389 --> 00:12:01,870
this region here you're freezing out the

361
00:12:04,740 --> 00:12:03,399
freshwater component and rejecting the

362
00:12:07,019 --> 00:12:04,750
brine component that Brian makes the

363
00:12:08,639 --> 00:12:07,029

water more dense with water sinks the

364
00:12:10,800 --> 00:12:08,649
funny thing about pressure and water

365
00:12:12,269 --> 00:12:10,810
being such a weird compound is as you

366
00:12:13,769 --> 00:12:12,279
increase the pressure you decrease the

367
00:12:15,060 --> 00:12:13,779
freezing point and that's gonna be the

368
00:12:16,620 --> 00:12:15,070
most important thing driving this year

369
00:12:17,760 --> 00:12:16,630
so as you move water around and move it

370
00:12:21,389 --> 00:12:17,770
up and down on the water column

371
00:12:22,980 --> 00:12:21,399
you're gonna melt ice or make ice so

372
00:12:24,630 --> 00:12:22,990
what you do is you move this down and

373
00:12:26,519 --> 00:12:24,640
this is at the surface freezing point

374
00:12:28,920 --> 00:12:26,529
it's about negative two for most ocean

375
00:12:30,240 --> 00:12:28,930
water salinity as you move it down 500

376
00:12:31,650 --> 00:12:30,250
meters thousand meters also in the

377
00:12:33,750 --> 00:12:31,660
freezing point is about negative two and

378
00:12:34,980 --> 00:12:33,760
a half almost three degrees Celsius and

379
00:12:36,389 --> 00:12:34,990
that means that the wording you have is

380
00:12:39,389 --> 00:12:36,399
warm negative two degree weather

381
00:12:41,460 --> 00:12:39,399
relatively warm versus where you are so

382
00:12:43,230 --> 00:12:41,470
when that water influences or interacts

383
00:12:44,850 --> 00:12:43,240
with the bottom of the Shelf here where

384
00:12:46,260 --> 00:12:44,860
the freezing point is is much colder

385
00:12:48,000 --> 00:12:46,270
than that water it's actually melting

386
00:12:49,740 --> 00:12:48,010
the bottom of the shelf but then that

387
00:12:51,780 --> 00:12:49,750
moat water adds fresh water so you had

388
00:12:53,550 --> 00:12:51,790

really salt really salty dense water now

389
00:12:55,680 --> 00:12:53,560
you're adding fresh water that increases

390
00:12:57,510 --> 00:12:55,690
the density or excuse me reduces the

391
00:12:59,700 --> 00:12:57,520
and so now your water is floating back

392
00:13:01,020 --> 00:12:59,710
up this buoyant and starts to come back

393
00:13:01,980 --> 00:13:01,030
up the opposite happens with the

394
00:13:04,470 --> 00:13:01,990
freezing point and now all of a sudden

395
00:13:06,420 --> 00:13:04,480
that water is relatively colder than the

396
00:13:08,160 --> 00:13:06,430
than the depth that it's at and that

397
00:13:09,630 --> 00:13:08,170
makes it super cool and so if you have

398
00:13:10,920 --> 00:13:09,640
supercooled water you can start to to

399
00:13:12,150 --> 00:13:10,930
freeze ice it's like if you ever put

400
00:13:13,980 --> 00:13:12,160
distilled water in the freezer and take

401
00:13:18,420 --> 00:13:13,990
it out and not decided it that kind of

402
00:13:19,740 --> 00:13:18,430
thing and so we found that there's kind

403
00:13:21,630 --> 00:13:19,750
of a difference in patterns and you can

404
00:13:23,460 --> 00:13:21,640
observe these using the the conductivity

405
00:13:24,870 --> 00:13:23,470
and temperature temperature sensors that

406
00:13:27,000 --> 00:13:24,880
we have and you can draw these profiles

407
00:13:29,310 --> 00:13:27,010
and you can characterize the water based

408
00:13:31,410 --> 00:13:29,320
on the freezing point so the top here is

409
00:13:34,560 --> 00:13:31,420
is the the temperature of the water in

410
00:13:36,780 --> 00:13:34,570
Celsius so if you draw the freezing

411
00:13:38,760 --> 00:13:36,790
point here draw the temperature here you

412
00:13:40,260 --> 00:13:38,770
can pick out Oh ice shelf water that's

413
00:13:42,360 --> 00:13:40,270

this water that's coming up that's super

414
00:13:43,920 --> 00:13:42,370
cool that's below the freezing point or

415
00:13:45,960 --> 00:13:43,930
the high salinity shell border that

416
00:13:47,940 --> 00:13:45,970
supposed to be warmer on the right-hand

417
00:13:50,040 --> 00:13:47,950
side of the freezing point compared to

418
00:13:51,240 --> 00:13:50,050
compared to the isolation of water

419
00:13:53,820 --> 00:13:51,250
that's coming here from the surface from

420
00:13:55,440 --> 00:13:53,830
the polonium you can track that as you

421
00:13:56,940 --> 00:13:55,450
move back from the shelf and start to

422
00:13:59,120 --> 00:13:56,950
understand the water properties that are

423
00:14:01,440 --> 00:13:59,130
driving ice accretion and ice melt and

424
00:14:02,490 --> 00:14:01,450
then from there start to get at the

425
00:14:06,360 --> 00:14:02,500
processes that might be really relevant

426
00:14:08,010 --> 00:14:06,370
for ocean winds okay so this is one

427
00:14:09,720 --> 00:14:08,020
quick example of some stuff we can do I

428
00:14:11,040 --> 00:14:09,730
went ahead and put a video in a

429
00:14:12,960 --> 00:14:11,050
PowerPoint presentation which is always

430
00:14:15,120 --> 00:14:12,970
risky since you're working it's very

431
00:14:16,500 --> 00:14:15,130
simple basically this is a dive track

432
00:14:18,030 --> 00:14:16,510
where we're tracking the vehicles

433
00:14:19,950 --> 00:14:18,040
position as it goes underneath the ice

434
00:14:21,270 --> 00:14:19,960
and on top of that I can lay all kinds

435
00:14:22,500 --> 00:14:21,280
of data from the other sensors that we

436
00:14:24,750 --> 00:14:22,510
have but can look at trends in dissolved

437
00:14:26,670 --> 00:14:24,760
oxygen trends and dissolved organics

438
00:14:27,840 --> 00:14:26,680

friends and redox with pH and all kinds

439
00:14:29,550 --> 00:14:27,850
of things like that now from there start

440
00:14:31,560 --> 00:14:29,560
to make 3d maps of these environments

441
00:14:32,700 --> 00:14:31,570
which is a pretty good step ahead of the

442
00:14:35,700 --> 00:14:32,710
the one do you kind of mooring

443
00:14:37,890 --> 00:14:35,710
observations yeah so that's what I've

444
00:14:40,260 --> 00:14:37,900
got for today thank you very much I want

445
00:14:41,460 --> 00:14:40,270
to thank it's NASA sponsored work but

446
00:14:43,530 --> 00:14:41,470
there's no way that any of that happens

447
00:14:44,850 --> 00:14:43,540
without the NSF the United States and

448
00:14:47,250 --> 00:14:44,860
our program and our New Zealand

449
00:14:54,300 --> 00:14:47,260
collaborators thank you

450
00:15:09,740 --> 00:14:55,990
Thank You Justin

451
00:15:14,880 --> 00:15:12,960
as a good talk what do you envision for

452
00:15:17,220 --> 00:15:14,890
technology development for undersea

453
00:15:19,230 --> 00:15:17,230
communication on the skill of europa

454
00:15:21,120 --> 00:15:19,240
ocean yeah that's an excellent question

455
00:15:23,310 --> 00:15:21,130
I think that's kind of the biggest

456
00:15:24,870 --> 00:15:23,320
question right now in terms of this is

457
00:15:26,640 --> 00:15:24,880
obviously very long term thing you want

458
00:15:29,250 --> 00:15:26,650
to explore the ocean and ocean world or

459
00:15:31,380 --> 00:15:29,260
into the ocean of an ocean world that's

460
00:15:32,220 --> 00:15:31,390
like a 75 to 100 plus year kind of time

461
00:15:34,560 --> 00:15:32,230
scale in terms of the hardware

462
00:15:36,480 --> 00:15:34,570
development and the communication and

463
00:15:37,980 --> 00:15:36,490

the data relay from the ocean to the

464
00:15:39,810 --> 00:15:37,990
surface and trying to get through

465
00:15:41,100 --> 00:15:39,820
multiple kilometers of ice there's a

466
00:15:42,660 --> 00:15:41,110
crazy problem so people are working on

467
00:15:44,430 --> 00:15:42,670
that but it's not clear exactly what the

468
00:15:46,350 --> 00:15:44,440
best way to solve it is right now on

469
00:15:48,210 --> 00:15:46,360
earth is a little bit easier and we can

470
00:15:50,760 --> 00:15:48,220
do things with both optical and acoustic

471
00:15:52,140 --> 00:15:50,770
modems so optical data in water the

472
00:15:54,720 --> 00:15:52,150
water is very clear you can do it with

473
00:15:55,920 --> 00:15:54,730
pulsed lasers and get actually pretty

474
00:15:57,390 --> 00:15:55,930
good data rates but you're limited to

475
00:15:58,620 --> 00:15:57,400
just a couple hundred meters so not

476
00:16:01,890 --> 00:15:58,630
really good for the scales are looking

477
00:16:03,420 --> 00:16:01,900
at here acoustic you can do a bit better

478
00:16:04,769 --> 00:16:03,430
but of course your frequencies are

479
00:16:08,040 --> 00:16:04,779
different so your data rate is a little

480
00:16:10,200 --> 00:16:08,050
bit lower but you can get acoustic kind

481
00:16:12,270 --> 00:16:10,210
of through if you have like nodes that

482
00:16:13,770 --> 00:16:12,280
can amplify the signal as you go you can

483
00:16:15,300 --> 00:16:13,780
get a couple kilometers amplify a couple

484
00:16:16,770 --> 00:16:15,310
kilometers amplify of course it's

485
00:16:18,390 --> 00:16:16,780
dependent on the temperature and

486
00:16:19,590 --> 00:16:18,400
salinity you need to know the profile of

487
00:16:21,510 --> 00:16:19,600
the water column know your sounds to be

488
00:16:23,520 --> 00:16:21,520

very well so you need a little bit of

489
00:16:26,329 --> 00:16:23,530
data ahead of time to figure out how

490
00:16:28,140 --> 00:16:26,339
exactly to do that but one of the

491
00:16:29,670 --> 00:16:28,150
technologies that we actually use for

492
00:16:31,680 --> 00:16:29,680
localizing the robot underwater because

493
00:16:34,680 --> 00:16:31,690
you can't use GPS GPS makes it like this

494
00:16:36,320 --> 00:16:34,690
far through water or ice not great for

495
00:16:39,600 --> 00:16:36,330
the depths we're trying to get to is

496
00:16:41,370 --> 00:16:39,610
acoustic and long baseline transponders

497
00:16:43,860 --> 00:16:41,380
that you basically ping and use that to

498
00:16:45,329 --> 00:16:43,870
triangulate so yeah I think acoustic

499
00:16:47,490 --> 00:16:45,339
technology will really really be the way

500
00:16:49,230 --> 00:16:47,500
forward and probably some there's talk

501
00:16:51,390 --> 00:16:49,240
of like a robot that melts the ice off

502
00:16:52,680 --> 00:16:51,400
and drops off like well pucks behind it

503
00:16:55,199 --> 00:16:52,690
every couple kilometers that our

504
00:16:57,300 --> 00:16:55,209
acoustic modems and amplifiers to get

505
00:16:59,190 --> 00:16:57,310
data back is it'll be a one-way trip for

506
00:17:00,690 --> 00:16:59,200
the robot whenever you get an ocean roll

507
00:17:05,689 --> 00:17:00,700
but you need the data back it's a good

508
00:17:08,280 --> 00:17:05,699
question thank you hey Justin um so

509
00:17:10,980 --> 00:17:08,290
earlier you were telling me how you're

510
00:17:12,510 --> 00:17:10,990
about to go to another expedition to

511
00:17:15,780 --> 00:17:12,520
Antarctica you've been preparing for

512
00:17:18,000 --> 00:17:15,790
that so how's your strategy slightly

513
00:17:19,390 --> 00:17:18,010

different for that and what are some of

514
00:17:20,860 --> 00:17:19,400
your goals that might be

515
00:17:24,760 --> 00:17:20,870
and it's also it's different time of the

516
00:17:26,230 --> 00:17:24,770
year so yeah sure yeah so we generally

517
00:17:28,540 --> 00:17:26,240
when you go to an article you go in the

518
00:17:30,160 --> 00:17:28,550
summer which I guess it's a bit nicer

519
00:17:32,980 --> 00:17:30,170
and the Sun's up it's pretty easy work

520
00:17:35,140 --> 00:17:32,990
they actually 24-hour sunlight this year

521
00:17:36,370 --> 00:17:35,150
our work we're actually integrating a 4k

522
00:17:37,420 --> 00:17:36,380
camera system so we're pretty excited

523
00:17:40,150 --> 00:17:37,430
about that we're gonna get some really

524
00:17:41,680 --> 00:17:40,160
good imagery from the seafloor we did a

525
00:17:43,060 --> 00:17:41,690
couple of sites last year that we want

526
00:17:44,020 --> 00:17:43,070
to return to you underneath the Eric's

527
00:17:46,180 --> 00:17:44,030
place your tongue which is kind of a

528
00:17:47,470 --> 00:17:46,190
good your the miniature I shall do some

529
00:17:49,570 --> 00:17:47,480
practice work and get to the grounding

530
00:17:50,950 --> 00:17:49,580
side of that it's a it's a big ice

531
00:17:52,660 --> 00:17:50,960
stream that's coming off of the side of

532
00:17:54,610 --> 00:17:52,670
Erebus right next to base so we can

533
00:17:56,950 --> 00:17:54,620
drive there in the day kind of do day

534
00:17:58,390 --> 00:17:56,960
trips there and practice doing some of

535
00:18:00,190 --> 00:17:58,400
the acoustic observations and center

536
00:18:02,830 --> 00:18:00,200
observations that we want to do at the

537
00:18:04,660 --> 00:18:02,840
grounding line of the Ross we're excited

538
00:18:06,910 --> 00:18:04,670

about that that's we working on this

539
00:18:08,440 --> 00:18:06,920
year we've got some collaborators at

540
00:18:10,570 --> 00:18:08,450
tech that are building us some sensors

541
00:18:12,220 --> 00:18:10,580
we have a microfluidic system that's

542
00:18:14,320 --> 00:18:12,230
supposed to eventually hopefully measure

543
00:18:17,140 --> 00:18:14,330
cell counts in real time which is very

544
00:18:18,880 --> 00:18:17,150
interesting so that is that's an

545
00:18:22,030 --> 00:18:18,890
expeller and a couple other guys at a

546
00:18:23,560 --> 00:18:22,040
Stockman's lab jeez I think in chemistry

547
00:18:25,540 --> 00:18:23,570
but also has an engineering background

548
00:18:27,220 --> 00:18:25,550
and then we just got a postdoc Andy

549
00:18:29,110 --> 00:18:27,230
Mullen he's gonna be working on a

550
00:18:31,690 --> 00:18:29,120
digital holographic microscope which is

551
00:18:32,860 --> 00:18:31,700
over my head but basically my

552
00:18:35,860 --> 00:18:32,870
understanding is that is a way of

553
00:18:37,840 --> 00:18:35,870
measuring particle volumes kind of in 3d

554
00:18:39,790 --> 00:18:37,850
space as you're as you're transiting

555
00:18:41,560 --> 00:18:39,800
with the robot again in real time so

556
00:18:43,150 --> 00:18:41,570
some of that sensor development that

557
00:18:45,430 --> 00:18:43,160
we're pushing for future ocean world

558
00:18:47,680 --> 00:18:45,440
it's kind of like a Picasso Matisse cold

559
00:18:48,850 --> 00:18:47,690
tech sort of sort of thing we're excited

560
00:18:51,040 --> 00:18:48,860
about testing some of that stuff out

561
00:18:52,299 --> 00:18:51,050
this year as well wow that's very

562
00:18:54,760 --> 00:18:52,309
interesting thank you

563
00:19:02,710 --> 00:18:54,770

yeah thank you are there any more

564
00:19:08,259 --> 00:19:05,600
okay so a few questions first of all

565
00:19:10,519 --> 00:19:08,269
it's always lemon tree why not just use

566
00:19:14,180 --> 00:19:10,529
radar above the ice as opposed to

567
00:19:17,389 --> 00:19:14,190
attaching a sensor to the equipment for

568
00:19:19,639 --> 00:19:17,399
what question so we're trying to map the

569
00:19:22,820 --> 00:19:19,649
underneath the ice I guess China party

570
00:19:24,590 --> 00:19:22,830
yeah sure so it's a very good question

571
00:19:26,149 --> 00:19:24,600
one of the first projects that I worked

572
00:19:27,620 --> 00:19:26,159
on is called simple and that was an

573
00:19:29,090 --> 00:19:27,630
eight step project which you're probably

574
00:19:32,330 --> 00:19:29,100
familiar with Josh's work with Brittany

575
00:19:34,789 --> 00:19:32,340
a bit in the past and that was a don

576
00:19:36,259 --> 00:19:34,799
blankenship is the PI of reason which is

577
00:19:37,250 --> 00:19:36,269
the radar sensor on your upper clipper

578
00:19:40,639 --> 00:19:37,260
supposed to launch in the next five

579
00:19:42,200 --> 00:19:40,649
years if so hopefully and we designed

580
00:19:43,789 --> 00:19:42,210
that entire project or a large component

581
00:19:46,100 --> 00:19:43,799
of it to look at the ice from underneath

582
00:19:48,470 --> 00:19:46,110
to sort of ground truth the radar from

583
00:19:50,450 --> 00:19:48,480
above the radar works great until you

584
00:19:52,009 --> 00:19:50,460
introduce salt into the problem so you

585
00:19:53,330 --> 00:19:52,019
use the radar to kind of get structure

586
00:19:54,980 --> 00:19:53,340
of the ice and define the ice ocean

587
00:19:56,870 --> 00:19:54,990
interface but as soon as you hit any

588
00:19:58,669 --> 00:19:56,880

kind of conductive fluid or conductive

589
00:20:00,470 --> 00:19:58,679
material you lose all of the radar power

590
00:20:03,500 --> 00:20:00,480
and so you just kind of fade off into

591
00:20:06,379 --> 00:20:03,510
nothing so it's very hard to get like a

592
00:20:08,480 --> 00:20:06,389
unique solution for your radar if

593
00:20:09,259 --> 00:20:08,490
there's Brian in the situation so what

594
00:20:11,750 --> 00:20:09,269
we were doing with the underwater

595
00:20:13,850 --> 00:20:11,760
vehicles is basically mirroring the

596
00:20:15,980 --> 00:20:13,860
flight so the the reason instrument

597
00:20:17,870 --> 00:20:15,990
again also they use analog Antarctica as

598
00:20:20,180 --> 00:20:17,880
an analogue they would do over flights

599
00:20:21,680 --> 00:20:20,190
and get a radar profile of the ice in

600
00:20:23,419 --> 00:20:21,690
the ice shelf from above and then we

601
00:20:25,070 --> 00:20:23,429
kind of try to match that radar profile

602
00:20:27,259 --> 00:20:25,080
with the vehicle from underneath and

603
00:20:29,180 --> 00:20:27,269
these are so nice to look up and get the

604
00:20:31,220 --> 00:20:29,190
thickness and the concentrate or the

605
00:20:32,810 --> 00:20:31,230
composition and the overall texture of

606
00:20:34,430 --> 00:20:32,820
the ice cream below and use it as kind

607
00:20:36,379 --> 00:20:34,440
of like a ground truth for the radar and

608
00:20:37,759 --> 00:20:36,389
from there you can get some of the

609
00:20:39,680 --> 00:20:37,769
context and some of the information that

610
00:20:41,690 --> 00:20:39,690
you need to interview to interpret those

611
00:20:43,490 --> 00:20:41,700
radar results when you can't do that so

612
00:20:44,450 --> 00:20:43,500
one reason goes to Europa hopefully this

613
00:20:46,430 --> 00:20:44,460

work will give us a little bit better

614
00:20:48,289 --> 00:20:46,440
idea of how to interpret the bottom part

615
00:20:49,909 --> 00:20:48,299
of those measurements there but anyway

616
00:20:52,519 --> 00:20:49,919
I'm going to give us the thickness of

617
00:20:55,129 --> 00:20:52,529
the ice shelf is a good question cool

618
00:20:57,139 --> 00:20:55,139
thank you one of the question yeah so

619
00:20:58,970 --> 00:20:57,149
the picture you showed us underneath the

620
00:21:00,830 --> 00:20:58,980
ice at the interface you could see the

621
00:21:02,960 --> 00:21:00,840
sun shining - how deep you have to go

622
00:21:05,659 --> 00:21:02,970
and can you go that deep underneath this

623
00:21:07,549 --> 00:21:05,669
ice shell - you guys get away from the

624
00:21:10,159 --> 00:21:07,559
sunlight to try and see you know biology

625
00:21:12,320 --> 00:21:10,169
would be there without something that

626
00:21:14,149 --> 00:21:12,330
might be Don yeah so that photo was

627
00:21:14,480 --> 00:21:14,159
under sea ice which was probably about a

628
00:21:16,940 --> 00:21:14,490
meter

629
00:21:19,160 --> 00:21:16,950
ethic the ice shelf the McMurdo a shelf

630
00:21:20,600 --> 00:21:19,170
which is a smaller side section about 20

631
00:21:24,560 --> 00:21:20,610
meters thick and that's totally a photic

632
00:21:27,700 --> 00:21:24,570
you i'd say maybe upwards of 10 meters

633
00:21:29,720 --> 00:21:27,710
of ice normal kind of mostly fresh ice

634
00:21:31,900 --> 00:21:29,730
anything not thicker than that you don't

635
00:21:34,190 --> 00:21:31,910
have really much light left to drive

636
00:21:36,169 --> 00:21:34,200
photosynthesis the Ross Ice Shelf is

637
00:21:37,730 --> 00:21:36,179
anywhere from 300 meters to a thousand a

638
00:21:39,380 --> 00:21:37,740

thousand meters thick and it's not even

639
00:21:41,180 --> 00:21:39,390
the thickest in America it's large

640
00:21:45,770 --> 00:21:41,190
especially but the Amory Shelf is like

641
00:21:50,590 --> 00:21:45,780
upwards of kilometers day so yeah thank