
NASA
HELIOPHYSICS
EARTH
SCIENCE UNCUT
NASA
EARTH
PLANETS
NASA
HELIOPHYSICS
NASA

1
00:00:27,269 --> 00:00:25,349
hey welcome to nasa science uncut i'm

2
00:00:28,950 --> 00:00:27,279
tom wagner your host and today we're

3
00:00:30,790 --> 00:00:28,960
going to be talking about the arctic and

4
00:00:32,950 --> 00:00:30,800
our goal is to get kind of behind the

5
00:00:34,870 --> 00:00:32,960
headlines and talk about what changes

6
00:00:36,630 --> 00:00:34,880
are going on there how we know what we

7
00:00:38,630 --> 00:00:36,640
know and what the world holds in store

8
00:00:40,150 --> 00:00:38,640
for us and to do that i've got three

9
00:00:42,549 --> 00:00:40,160
great friends from nasa who are also

10
00:00:44,389 --> 00:00:42,559
fantastic scientists laura koenig from

11
00:00:46,869 --> 00:00:44,399
nasa goddard who's an expert in polar

12
00:00:48,869 --> 00:00:46,879
snow and ice thorsten marcus also from

13
00:00:51,110 --> 00:00:48,879

nasa goddard who's an expert in sea ice

14
00:00:53,029 --> 00:00:51,120
at the north and the south pole and also

15
00:00:54,549 --> 00:00:53,039
waleed abdullahi who's the nasa chief

16
00:00:56,229 --> 00:00:54,559
scientist right here in headquarters and

17
00:00:57,910 --> 00:00:56,239
has spent his career starting how

18
00:00:59,349 --> 00:00:57,920
changes in the major ice sheets affects

19
00:00:59,990 --> 00:00:59,359
sea level

20
00:01:01,510 --> 00:01:00,000
so

21
00:01:03,510 --> 00:01:01,520
thank you very much for coming guys

22
00:01:04,710 --> 00:01:03,520
thank you thank you and uh so to start

23
00:01:06,710 --> 00:01:04,720
us off we just want to talk really

24
00:01:09,830 --> 00:01:06,720
quickly about what the goal of nasa

25
00:01:12,390 --> 00:01:09,840
science uncut is and our producer cedric

26
00:01:15,190 --> 00:01:12,400
harris actually said to me he said when

27
00:01:17,030 --> 00:01:15,200
we go and film nasa science tv a lot of

28
00:01:18,230 --> 00:01:17,040
times the most interesting conversations

29
00:01:19,590 --> 00:01:18,240
happen when the scientists think the

30
00:01:21,030 --> 00:01:19,600
cameras are off

31
00:01:22,469 --> 00:01:21,040
and so what we want to do is try to

32
00:01:24,149 --> 00:01:22,479
recreate that here and just have a

33
00:01:25,749 --> 00:01:24,159
conversation about the changes that are

34
00:01:27,429 --> 00:01:25,759
going on in the arctic

35
00:01:28,789 --> 00:01:27,439
but before we get to that what we really

36
00:01:30,710 --> 00:01:28,799
want to start off with i think is the

37
00:01:33,590 --> 00:01:30,720
question that a lot of viewers have

38
00:01:35,749 --> 00:01:33,600

what's it like working at nasa and so

39
00:01:36,550 --> 00:01:35,759
walid why did you take it away first

40
00:01:39,030 --> 00:01:36,560
sure

41
00:01:40,950 --> 00:01:39,040
it's great working at nasa particularly

42
00:01:43,350 --> 00:01:40,960
as a scientist because

43
00:01:45,429 --> 00:01:43,360
we are really at the forefront of some

44
00:01:48,550 --> 00:01:45,439
of society's greatest achievements in

45
00:01:51,109 --> 00:01:48,560
human exploration in scientific research

46
00:01:53,510 --> 00:01:51,119
in technology and engineering so

47
00:01:55,749 --> 00:01:53,520
they're it's so stimulating in so many

48
00:01:58,149 --> 00:01:55,759
ways and as an earth science

49
00:02:00,069 --> 00:01:58,159
particularly one who studies cold places

50
00:02:01,749 --> 00:02:00,079
that are kind of hard to get to

51
00:02:03,670 --> 00:02:01,759
there's a special

52
00:02:05,749 --> 00:02:03,680
thrill because the satellite and

53
00:02:08,550 --> 00:02:05,759
airborne perspective give us a way of

54
00:02:11,270 --> 00:02:08,560
looking at these places that we can't

55
00:02:13,030 --> 00:02:11,280
achieve any other way and really reveal

56
00:02:15,430 --> 00:02:13,040
the secrets that have been

57
00:02:17,750 --> 00:02:15,440
hidden from humans for thousands of

58
00:02:18,790 --> 00:02:17,760
years yeah how about you laura what's it

59
00:02:20,470 --> 00:02:18,800
like because you kind of you know you

60
00:02:22,229 --> 00:02:20,480
just started a few years ago at nasa

61
00:02:24,630 --> 00:02:22,239
right i started four years ago and i

62
00:02:26,869 --> 00:02:24,640
came right out of my phd program came

63
00:02:29,589 --> 00:02:26,879

right here to nasa and i couldn't have

64
00:02:32,150 --> 00:02:29,599
wished for anything better actually it's

65
00:02:34,470 --> 00:02:32,160
such a great place to work it's exciting

66
00:02:36,150 --> 00:02:34,480
we have twice a year aircraft flying

67
00:02:38,390 --> 00:02:36,160
over the polar regions new data coming

68
00:02:40,790 --> 00:02:38,400
in all the time on top of that i get to

69
00:02:41,910 --> 00:02:40,800
work with some of the my colleagues who

70
00:02:44,869 --> 00:02:41,920
are just

71
00:02:46,790 --> 00:02:44,879
the greatest scientists in the field and

72
00:02:48,550 --> 00:02:46,800
it has just been an honor and a pleasure

73
00:02:50,949 --> 00:02:48,560
to come here and work at nasa look at

74
00:02:52,470 --> 00:02:50,959
new data all the time okay now thorson

75
00:02:54,309 --> 00:02:52,480
you run some major missions so tell us

76
00:02:57,190 --> 00:02:54,319
what it's really like to work in that

77
00:02:58,229 --> 00:02:57,200
okay enough with uh yeah well i i think

78
00:02:59,830 --> 00:02:58,239
overall

79
00:03:02,390 --> 00:02:59,840
being a scientist and maybe being at

80
00:03:05,509 --> 00:03:02,400
nasa in particular is extremely playful

81
00:03:07,750 --> 00:03:05,519
we just play around with data we take

82
00:03:09,270 --> 00:03:07,760
measurements try to find

83
00:03:10,390 --> 00:03:09,280
make sense of all the data that we are

84
00:03:13,110 --> 00:03:10,400
collecting

85
00:03:14,630 --> 00:03:13,120
and walid mentioned polar regions

86
00:03:16,390 --> 00:03:14,640
i mean

87
00:03:18,390 --> 00:03:16,400
i think you know my career at nasa has

88
00:03:20,710 --> 00:03:18,400

been fantastic i had nasa gave me the

89
00:03:22,949 --> 00:03:20,720
opportunity to as laura said fly over

90
00:03:24,309 --> 00:03:22,959
the poles i flew over the arctic i flew

91
00:03:26,309 --> 00:03:24,319
with the antarctic i went on an

92
00:03:29,110 --> 00:03:26,319
icebreaker and took measurements on the

93
00:03:30,229 --> 00:03:29,120
sea ice right next to penguins

94
00:03:35,270 --> 00:03:30,239
it's it's

95
00:03:36,309 --> 00:03:35,280
playful it's and you do exploration you

96
00:03:39,990 --> 00:03:36,319
know

97
00:03:42,710 --> 00:03:40,000
exploring

98
00:03:44,309 --> 00:03:42,720
you know the the ice in it itself

99
00:03:45,750 --> 00:03:44,319
so the reason that we're all here today

100
00:03:47,509 --> 00:03:45,760
too is to talk about what's been going

101
00:03:49,110 --> 00:03:47,519
on in the arctic right where all of you

102
00:03:50,229 --> 00:03:49,120
guys have gone and worked and things and

103
00:03:51,830 --> 00:03:50,239
what we really want to hear about is

104
00:03:53,910 --> 00:03:51,840
your personal perspective on these

105
00:03:55,750 --> 00:03:53,920
things so let's just recap what's gone

106
00:03:57,670 --> 00:03:55,760
on in the last year the sea ice melted

107
00:03:59,910 --> 00:03:57,680
back to the lowest that it's ever been

108
00:04:01,110 --> 00:03:59,920
the entire surface of the greenland ice

109
00:04:02,630 --> 00:04:01,120
sheet melted

110
00:04:04,949 --> 00:04:02,640
what does this mean are we taking the

111
00:04:06,630 --> 00:04:04,959
arctic to a new state laura what do you

112
00:04:10,949 --> 00:04:06,640
think

113
00:04:13,750 --> 00:04:10,959

the arctic right now

114
00:04:15,830 --> 00:04:13,760
are just a continuation of this warming

115
00:04:18,310 --> 00:04:15,840
that we've seen and we'll continue to

116
00:04:20,229 --> 00:04:18,320
see into the future

117
00:04:22,069 --> 00:04:20,239
like walid when you started working at

118
00:04:23,590 --> 00:04:22,079
nasa right i mean it was a different

119
00:04:25,590 --> 00:04:23,600
time we didn't have this kind of change

120
00:04:28,230 --> 00:04:25,600
going on in the arctic

121
00:04:30,150 --> 00:04:28,240
that's right we were first we had only

122
00:04:33,189 --> 00:04:30,160
recently developed the tools that let us

123
00:04:35,030 --> 00:04:33,199
even look at this kind of change so

124
00:04:37,189 --> 00:04:35,040
you know it takes time to build up

125
00:04:39,350 --> 00:04:37,199
observations to assess the meaning of

126
00:04:41,749 --> 00:04:39,360
what we're seeing and yes when i first

127
00:04:43,510 --> 00:04:41,759
started we could watch the ice grow and

128
00:04:45,749 --> 00:04:43,520
shrink we could watch it melt and

129
00:04:48,070 --> 00:04:45,759
re-freeze um

130
00:04:49,909 --> 00:04:48,080
but it was through this persistent

131
00:04:52,870 --> 00:04:49,919
observation that we've been able to

132
00:04:54,870 --> 00:04:52,880
watch that turn into a trend into a

133
00:04:56,790 --> 00:04:54,880
trend of increased melting into a trend

134
00:05:00,150 --> 00:04:56,800
of decreased sea ice covered into a

135
00:05:02,710 --> 00:05:00,160
trend of lost ice mass on the ice sheets

136
00:05:04,469 --> 00:05:02,720
contributing to sea level rise so yeah

137
00:05:07,830 --> 00:05:04,479
i've been lucky

138
00:05:09,749 --> 00:05:07,840

in a sense to have been a part of the

139
00:05:11,990 --> 00:05:09,759
transition where we went from first

140
00:05:13,029 --> 00:05:12,000
figuring out how to look at these kinds

141
00:05:13,749 --> 00:05:13,039
of things

142
00:05:15,510 --> 00:05:13,759
to

143
00:05:16,390 --> 00:05:15,520
actually looking

144
00:05:23,350 --> 00:05:16,400
and

145
00:05:25,029 --> 00:05:23,360
transition so we should probably break

146
00:05:26,870 --> 00:05:25,039
it apart right like so when we talk

147
00:05:29,110 --> 00:05:26,880
about the change in the arctic first

148
00:05:30,870 --> 00:05:29,120
let's just start with the sea ice right

149
00:05:32,310 --> 00:05:30,880
floating ice on the cap of the polar

150
00:05:34,230 --> 00:05:32,320
ocean

151
00:05:36,550 --> 00:05:34,240
thorsten what's been going on with this

152
00:05:37,510 --> 00:05:36,560
thing and how do we study it well

153
00:05:39,430 --> 00:05:37,520
you know

154
00:05:41,110 --> 00:05:39,440
the cool thing about nasa is and you

155
00:05:43,110 --> 00:05:41,120
know the only

156
00:05:45,830 --> 00:05:43,120
uh the only way to study the polar

157
00:05:47,590 --> 00:05:45,840
regions on a frequent enough level is

158
00:05:48,950 --> 00:05:47,600
from satellites so in looking at

159
00:05:52,469 --> 00:05:48,960
satellites

160
00:05:54,790 --> 00:05:52,479
means to look at the you know at the

161
00:05:55,830 --> 00:05:54,800
polar regions on a daily basis

162
00:05:57,830 --> 00:05:55,840
and

163
00:05:59,909 --> 00:05:57,840

we've learned so much from from the

164
00:06:01,909 --> 00:05:59,919
satellites and the the arctic the sea

165
00:06:03,990 --> 00:06:01,919
ice it's not like a frozen lake this

166
00:06:06,150 --> 00:06:04,000
just melts and freezes over it's a

167
00:06:09,350 --> 00:06:06,160
highly dynamic system it opens and

168
00:06:10,870 --> 00:06:09,360
closes isis leaving

169
00:06:12,950 --> 00:06:10,880
the arctic or the antarctic system

170
00:06:14,870 --> 00:06:12,960
through currents along greenland or you

171
00:06:17,670 --> 00:06:14,880
know we've had satellite measurements

172
00:06:19,029 --> 00:06:17,680
since the 70s right and i mean what but

173
00:06:20,629 --> 00:06:19,039
why is it so important what's going on

174
00:06:22,870 --> 00:06:20,639
with arctic sea ice now like what's

175
00:06:24,870 --> 00:06:22,880
happening that's such a big deal what is

176
00:06:27,110 --> 00:06:24,880
we've been monitoring this like it melts

177
00:06:29,510 --> 00:06:27,120
every year right it melts every year it

178
00:06:31,430 --> 00:06:29,520
you know it grows grows back every year

179
00:06:33,990 --> 00:06:31,440
and we've been moni monitoring as you

180
00:06:36,390 --> 00:06:34,000
said uh the arctic sea and the antarctic

181
00:06:37,749 --> 00:06:36,400
cia center 70s late 70s

182
00:06:39,990 --> 00:06:37,759
and we

183
00:06:42,629 --> 00:06:40,000
we saw early on when i started when i

184
00:06:45,189 --> 00:06:42,639
was a phd scientist we saw there's a

185
00:06:46,870 --> 00:06:45,199
slight decline in the sea ice but you

186
00:06:49,430 --> 00:06:46,880
know there's

187
00:06:52,790 --> 00:06:49,440
the climate changes all the time

188
00:06:55,350 --> 00:06:52,800

it started like in the 2000s when those

189
00:06:57,270 --> 00:06:55,360
changes became more and more profound

190
00:06:59,430 --> 00:06:57,280
you know they became bigger they became

191
00:07:01,830 --> 00:06:59,440
more they had everything right so when

192
00:07:03,350 --> 00:07:01,840
we talk about the decline right throw it

193
00:07:05,110 --> 00:07:03,360
open for anybody to talk about what do

194
00:07:07,110 --> 00:07:05,120
we mean by decline like i say every year

195
00:07:08,710 --> 00:07:07,120
we know that the sea ice it grows it

196
00:07:10,469 --> 00:07:08,720
melts it actually goes all the way out

197
00:07:12,469 --> 00:07:10,479
from outside the arctic right up around

198
00:07:14,629 --> 00:07:12,479
greenland up around alaska the summer

199
00:07:17,189 --> 00:07:14,639
months it melts back and lately it's

200
00:07:19,350 --> 00:07:17,199
been melting back more than ever right

201
00:07:20,629 --> 00:07:19,360
it's also thinner now than ever

202
00:07:22,150 --> 00:07:20,639
right so but

203
00:07:23,510 --> 00:07:22,160
i think it's hard for people to put that

204
00:07:24,790 --> 00:07:23,520
in context you know because they know

205
00:07:26,230 --> 00:07:24,800
that it's always been this natural

206
00:07:28,150 --> 00:07:26,240
variation thing what is it that's going

207
00:07:29,990 --> 00:07:28,160
on right now that's so special sure well

208
00:07:31,990 --> 00:07:30,000
well the arctic grows as you said and

209
00:07:34,790 --> 00:07:32,000
shrinks and grows and shrinks and over

210
00:07:37,830 --> 00:07:34,800
time we've seen that it's shrinking

211
00:07:40,230 --> 00:07:37,840
to smaller and smaller levels

212
00:07:42,230 --> 00:07:40,240
and what's significant about that is a

213
00:07:45,830 --> 00:07:42,240

couple things one just in terms of

214
00:07:47,749 --> 00:07:45,840
recovery from that new ice is inherently

215
00:07:50,070 --> 00:07:47,759
thinner and more vulnerable than that

216
00:07:51,830 --> 00:07:50,080
old ice that used to survive the summer

217
00:07:52,950 --> 00:07:51,840
mouth season

218
00:07:54,869 --> 00:07:52,960
if you

219
00:07:56,950 --> 00:07:54,879
throw into the mix the fact that this

220
00:07:59,270 --> 00:07:56,960
sea ice

221
00:08:00,790 --> 00:07:59,280
traps energy in the ocean it's a barrier

222
00:08:03,189 --> 00:08:00,800
between the ocean and the atmosphere so

223
00:08:05,430 --> 00:08:03,199
it affects weather it affects climate it

224
00:08:08,390 --> 00:08:05,440
affects ocean circulation it affects the

225
00:08:10,469 --> 00:08:08,400
movement of air in the atmosphere so

226
00:08:11,670 --> 00:08:10,479
human civilization has never known a

227
00:08:13,990 --> 00:08:11,680
time

228
00:08:15,749 --> 00:08:14,000
when there has not been sea ice in the

229
00:08:17,909 --> 00:08:15,759
arctic in the summer

230
00:08:19,510 --> 00:08:17,919
and we appear to be approaching that

231
00:08:21,270 --> 00:08:19,520
time yeah right i mean the whole history

232
00:08:22,550 --> 00:08:21,280
of explorers looking for the north

233
00:08:24,150 --> 00:08:22,560
passage right all getting trapped

234
00:08:25,990 --> 00:08:24,160
because there was too much ice now they

235
00:08:27,990 --> 00:08:26,000
can go through how they can do it it's a

236
00:08:29,510 --> 00:08:28,000
summer sale

237
00:08:32,550 --> 00:08:29,520
and so

238
00:08:35,589 --> 00:08:32,560

this sets up potentially a very new

239
00:08:37,589 --> 00:08:35,599
environment for human civilization that

240
00:08:40,149 --> 00:08:37,599
we are not familiar with we have an

241
00:08:42,709 --> 00:08:40,159
experience we don't exactly know what to

242
00:08:44,310 --> 00:08:42,719
expect so the significance of the trend

243
00:08:46,630 --> 00:08:44,320
we're seeing is that it seems to be

244
00:08:49,030 --> 00:08:46,640
taking us to a new place

245
00:08:50,710 --> 00:08:49,040
where we've got no experience

246
00:08:52,790 --> 00:08:50,720
when you say no experience like we're

247
00:08:54,710 --> 00:08:52,800
talking about changing weather patterns

248
00:08:56,470 --> 00:08:54,720
over north america we're talking about

249
00:08:58,389 --> 00:08:56,480
you know we look we're trying to get

250
00:09:00,389 --> 00:08:58,399
beyond the headlines right which is we

251
00:09:02,230 --> 00:09:00,399
talk about changing in the ocean right

252
00:09:03,590 --> 00:09:02,240
how's the arctic connected i mean it's

253
00:09:05,430 --> 00:09:03,600
hard to believe that changes at the top

254
00:09:06,790 --> 00:09:05,440
of the planet affect us in other parts

255
00:09:09,430 --> 00:09:06,800
of the world

256
00:09:11,750 --> 00:09:09,440
oh it affects us uh profoundly i mean

257
00:09:13,750 --> 00:09:11,760
the very ocean circular the gulf stream

258
00:09:16,150 --> 00:09:13,760
you know something that we are warm

259
00:09:17,910 --> 00:09:16,160
water coming up along the east coast so

260
00:09:19,509 --> 00:09:17,920
so you have very different temperatures

261
00:09:21,350 --> 00:09:19,519
off the coast of virginia than you do in

262
00:09:23,590 --> 00:09:21,360
massachusetts because you've got the

263
00:09:26,150 --> 00:09:23,600

warm water coming up along the southeast

264
00:09:27,590 --> 00:09:26,160
and then it veers off uh into the

265
00:09:30,150 --> 00:09:27,600
atlantic

266
00:09:32,389 --> 00:09:30,160
that kind of circulation the kuroshio

267
00:09:34,150 --> 00:09:32,399
current in japan these major ocean

268
00:09:37,030 --> 00:09:34,160
circulation patterns

269
00:09:38,630 --> 00:09:37,040
have their roots have their their core

270
00:09:41,110 --> 00:09:38,640
in what's happening in the arctic and

271
00:09:43,350 --> 00:09:41,120
antarctic it's the presence of ice that

272
00:09:44,790 --> 00:09:43,360
sets these things up and allows them to

273
00:09:46,870 --> 00:09:44,800
happen

274
00:09:48,310 --> 00:09:46,880
with that ice going away

275
00:09:51,269 --> 00:09:48,320
we're not sure

276
00:09:53,350 --> 00:09:51,279
what the response is all we can know all

277
00:09:55,190 --> 00:09:53,360
we can expect right now with confidence

278
00:09:57,430 --> 00:09:55,200
is that it'll be different

279
00:09:58,790 --> 00:09:57,440
what different means is still subject to

280
00:10:01,110 --> 00:09:58,800
interpretation

281
00:10:02,550 --> 00:10:01,120
the maps and that's a lot of what we do

282
00:10:04,470 --> 00:10:02,560
right i can say we take it for granted

283
00:10:05,829 --> 00:10:04,480
we see these pictures of the planet from

284
00:10:10,230 --> 00:10:05,839
space

285
00:10:14,870 --> 00:10:12,630
you're all looking at this

286
00:10:16,790 --> 00:10:14,880
i'll be the prop guy well the point is

287
00:10:18,710 --> 00:10:16,800
really most of the time it's dark

288
00:10:20,069 --> 00:10:18,720

especially when you have absolutely zero

289
00:10:22,389 --> 00:10:20,079
sunlight

290
00:10:24,470 --> 00:10:22,399
the way it works many people have seen

291
00:10:26,790 --> 00:10:24,480
these thermal infrared images of houses

292
00:10:29,590 --> 00:10:26,800
of people with a thermal infrared camera

293
00:10:31,269 --> 00:10:29,600
and just like visible light it's not

294
00:10:33,269 --> 00:10:31,279
just a visible spectrum that you have

295
00:10:35,110 --> 00:10:33,279
you have the sunlight also has a portion

296
00:10:38,230 --> 00:10:35,120
in the ultraviolet

297
00:10:40,550 --> 00:10:38,240
and in the same way the thermal infrared

298
00:10:42,230 --> 00:10:40,560
radiation from the earth has a portion

299
00:10:44,790 --> 00:10:42,240
in the microwave range

300
00:10:47,190 --> 00:10:44,800
very very long long wavelength

301
00:10:50,150 --> 00:10:47,200
and we are tapping this radiation to

302
00:10:52,470 --> 00:10:50,160
monitor the polar regions and the and

303
00:10:53,750 --> 00:10:52,480
why this is so why these microwaves are

304
00:10:56,069 --> 00:10:53,760
so great is

305
00:10:57,910 --> 00:10:56,079
they they penetrate clouds

306
00:10:59,750 --> 00:10:57,920
and that's phenomenal they're a they're

307
00:11:01,750 --> 00:10:59,760
a passive sensor we can just have a

308
00:11:03,990 --> 00:11:01,760
microwave free ideometer over the pole

309
00:11:06,470 --> 00:11:04,000
and measure the radiation and we can

310
00:11:09,190 --> 00:11:06,480
measure the radiation through the clouds

311
00:11:11,750 --> 00:11:09,200
so only mike with microwaves we can

312
00:11:14,310 --> 00:11:11,760
actually get daily images of the entire

313
00:11:15,910 --> 00:11:14,320

arctic and the entire antarctic so we

314
00:11:17,269 --> 00:11:15,920
have really good maps oh yeah i mean

315
00:11:18,790 --> 00:11:17,279
this is one thing we know this really

316
00:11:20,949 --> 00:11:18,800
well that we're losing that ice go ahead

317
00:11:22,949 --> 00:11:20,959
well in these maps as torso talking

318
00:11:24,389 --> 00:11:22,959
about they penetrate into the snow so

319
00:11:26,389 --> 00:11:24,399
over the ice sheets and even over

320
00:11:29,269 --> 00:11:26,399
seasonal snow in the u.s we can gain

321
00:11:31,910 --> 00:11:29,279
information from these satellites about

322
00:11:33,190 --> 00:11:31,920
something as small as a snow grain

323
00:11:35,269 --> 00:11:33,200
change

324
00:11:37,910 --> 00:11:35,279
and that's very impressive and i would

325
00:11:39,829 --> 00:11:37,920
say to to the audience you can take a

326
00:11:41,990 --> 00:11:39,839
very cold

327
00:11:44,550 --> 00:11:42,000
ice cube and put it in your microwave

328
00:11:46,310 --> 00:11:44,560
that you have it at home and turn it on

329
00:11:47,590 --> 00:11:46,320
and you'll see that it'll actually the

330
00:11:49,430 --> 00:11:47,600
microwaves will penetrate right through

331
00:11:50,949 --> 00:11:49,440
that ice it won't melt so as long as

332
00:11:53,269 --> 00:11:50,959
it's a very cold ice cube you can have

333
00:11:55,190 --> 00:11:53,279
it in there for 20 seconds it won't melt

334
00:11:57,430 --> 00:11:55,200
and that's exactly what we're using with

335
00:11:59,750 --> 00:11:57,440
these with these satellite sensors to

336
00:12:02,870 --> 00:11:59,760
look at how the ice is changing from

337
00:12:04,069 --> 00:12:02,880
everything from the entire extent

338
00:12:09,350 --> 00:12:04,079

of the

339
00:12:11,829 --> 00:12:09,360
small changes in grain size over the ice

340
00:12:16,389 --> 00:12:11,839
sheets but if you do try the experiment

341
00:12:18,470 --> 00:12:16,399
don't go for like five minutes no no

342
00:12:20,870 --> 00:12:18,480
once there's water it'll it'll absorb

343
00:12:22,470 --> 00:12:20,880
hey yeah so let's change gears so again

344
00:12:24,470 --> 00:12:22,480
the other component of the arctic change

345
00:12:27,269 --> 00:12:24,480
right we talked about the sea ice the

346
00:12:30,470 --> 00:12:27,279
land ice and we've got glaciers in

347
00:12:31,750 --> 00:12:30,480
alaska and small ice caps and things in

348
00:12:32,949 --> 00:12:31,760
alaska and northern canada and then

349
00:12:34,470 --> 00:12:32,959
we've got the major ice sheets of

350
00:12:36,230 --> 00:12:34,480
greenland and we had a big event this

351
00:12:38,310 --> 00:12:36,240
summer which we had

352
00:12:40,389 --> 00:12:38,320
melting all of the surface of greenland

353
00:12:41,670 --> 00:12:40,399
right laura tell us what that event was

354
00:12:44,230 --> 00:12:41,680
like and why it's important and how you

355
00:12:46,790 --> 00:12:44,240
learned about it well first and i did

356
00:12:48,949 --> 00:12:46,800
learn about it from facebook posts from

357
00:12:51,030 --> 00:12:48,959
scientists who were there on the ground

358
00:12:53,190 --> 00:12:51,040
saying hey it's really warm here and

359
00:12:55,030 --> 00:12:53,200
showing the melt runoff so

360
00:12:57,030 --> 00:12:55,040
at the very top of the ice sheet it'll

361
00:12:58,710 --> 00:12:57,040
probably just melt it'll penetrate down

362
00:13:00,550 --> 00:12:58,720
just if you think about a warm day and

363
00:13:02,949 --> 00:13:00,560

seasonal snow at your local ski resort

364
00:13:05,110 --> 00:13:02,959
it'll just penetrate down a little bit

365
00:13:07,269 --> 00:13:05,120
big thick miles thick of ice sitting on

366
00:13:09,030 --> 00:13:07,279
a continent right and you're talking

367
00:13:12,150 --> 00:13:09,040
about just the surface just the very

368
00:13:14,150 --> 00:13:12,160
surface at the highest elevations of the

369
00:13:15,430 --> 00:13:14,160
ice sheets at the lower elevations

370
00:13:17,910 --> 00:13:15,440
there's actually much more melt and

371
00:13:20,870 --> 00:13:17,920
it'll form rivers it'll form lakes and

372
00:13:23,829 --> 00:13:20,880
that'll run off what we saw this this

373
00:13:25,509 --> 00:13:23,839
last summer as well was the rivers that

374
00:13:27,269 --> 00:13:25,519
take that water off the ice sheets were

375
00:13:29,430 --> 00:13:27,279
just swelling and it knocked out some

376
00:13:31,190 --> 00:13:29,440
bridges and so those are all posted on

377
00:13:34,310 --> 00:13:31,200
facebook even before i had seen the

378
00:13:36,310 --> 00:13:34,320
actual satellite the satellite data so

379
00:13:38,069 --> 00:13:36,320
we knew that the satellites were real

380
00:13:39,509 --> 00:13:38,079
and and if i can talk some personal

381
00:13:41,430 --> 00:13:39,519
experiences

382
00:13:42,870 --> 00:13:41,440
i was very surprised it melted at one of

383
00:13:44,389 --> 00:13:42,880
the highest

384
00:13:47,030 --> 00:13:44,399
elevations on the ice sheet a place

385
00:13:48,389 --> 00:13:47,040
called summit station greenland and i've

386
00:13:51,189 --> 00:13:48,399
actually wintered there i've been there

387
00:13:52,629 --> 00:13:51,199
and it was negative 86 degrees celsius

388
00:13:53,670 --> 00:13:52,639

it's very cold

389
00:13:56,310 --> 00:13:53,680
and

390
00:13:58,069 --> 00:13:56,320
i didn't really expect it to melt i know

391
00:14:00,629 --> 00:13:58,079
it has melted there i've drilled ice

392
00:14:04,389 --> 00:14:00,639
cores down and where you see the last

393
00:14:06,710 --> 00:14:04,399
mouth event um is about a 40-story

394
00:14:07,829 --> 00:14:06,720
building deep down into the ice sheet

395
00:14:09,269 --> 00:14:07,839
and you'll see

396
00:14:11,590 --> 00:14:09,279
that the

397
00:14:12,389 --> 00:14:11,600
fern what we call it year-old snow hold

398
00:14:14,069 --> 00:14:12,399
on pause

399
00:14:15,110 --> 00:14:14,079
we talk about ice cores all the time

400
00:14:16,949 --> 00:14:15,120
right

401
00:14:20,150 --> 00:14:16,959
let's just explain really briefly what

402
00:14:23,509 --> 00:14:20,160
an ice core is and what it represents

403
00:14:26,230 --> 00:14:23,519
i think of it like tree rings so people

404
00:14:27,350 --> 00:14:26,240
are pretty familiar with tree rings each

405
00:14:29,670 --> 00:14:27,360
year

406
00:14:32,389 --> 00:14:29,680
the tree grows and creates a new ring

407
00:14:33,350 --> 00:14:32,399
well similarly on the ice sheet

408
00:14:34,870 --> 00:14:33,360
in the

409
00:14:37,030 --> 00:14:34,880
interior of the ice sheet what we call

410
00:14:38,870 --> 00:14:37,040
the accumulation zone with each ear you

411
00:14:41,350 --> 00:14:38,880
get snow that falls and it's very cold

412
00:14:42,870 --> 00:14:41,360
and that snow doesn't melt so it piles

413
00:14:44,710 --> 00:14:42,880

up it makes a layer

414
00:14:47,189 --> 00:14:44,720
each a layer every year

415
00:14:49,189 --> 00:14:47,199
when we're closer to the surface

416
00:14:52,069 --> 00:14:49,199
one thing that the ice sheets do is

417
00:14:53,910 --> 00:14:52,079
they'll compress down so those layers

418
00:14:55,030 --> 00:14:53,920
will compress down over the weight of

419
00:14:56,470 --> 00:14:55,040
the ice

420
00:14:57,990 --> 00:14:56,480
as they build up

421
00:14:59,990 --> 00:14:58,000
and tree rings will just continue to

422
00:15:01,670 --> 00:15:00,000
grow out they don't compress but it'll

423
00:15:04,949 --> 00:15:01,680
compress down and even in the surface we

424
00:15:07,110 --> 00:15:04,959
can count back annual layers and look at

425
00:15:09,509 --> 00:15:07,120
temperature changes changes in the

426
00:15:10,949 --> 00:15:09,519
atmospheric conditions from air that's

427
00:15:13,030 --> 00:15:10,959
been trapped in those ice cores and we

428
00:15:15,110 --> 00:15:13,040
can also see just from the stratigraphy

429
00:15:16,710 --> 00:15:15,120
where are these melt events

430
00:15:18,629 --> 00:15:16,720
so it's like a tape recorder of what's

431
00:15:20,470 --> 00:15:18,639
gone on over the ice and we're saying we

432
00:15:22,629 --> 00:15:20,480
didn't we haven't seen a melt event like

433
00:15:25,509 --> 00:15:22,639
this except for a very very long time

434
00:15:27,590 --> 00:15:25,519
ago but why is this melt like

435
00:15:28,790 --> 00:15:27,600
okay so what so we have some melt form

436
00:15:30,230 --> 00:15:28,800
on the surface of the greenland ice

437
00:15:31,670 --> 00:15:30,240
sheet why is that a big deal i mean

438
00:15:34,310 --> 00:15:31,680

maybe we'll just get more snow this year

439
00:15:37,509 --> 00:15:34,320
what was a you know what do you think

440
00:15:39,350 --> 00:15:37,519
well it's it's indicative of a broader

441
00:15:42,069 --> 00:15:39,360
change

442
00:15:45,189 --> 00:15:42,079
you can imagine

443
00:15:46,389 --> 00:15:45,199
very high altitude ski resorts in the

444
00:15:47,269 --> 00:15:46,399
winter

445
00:15:51,829 --> 00:15:47,279
and

446
00:15:54,389 --> 00:15:51,839
experience some melting

447
00:15:55,990 --> 00:15:54,399
well intrinsically that little bit of

448
00:15:57,990 --> 00:15:56,000
melt i mean it may ruin some of your

449
00:16:00,790 --> 00:15:58,000
skiing but intrinsically that little bit

450
00:16:02,949 --> 00:16:00,800
of mel may not hold meaning

451
00:16:05,509 --> 00:16:02,959
in and of itself but in the context of

452
00:16:08,710 --> 00:16:05,519
what made that happen

453
00:16:10,949 --> 00:16:08,720
uh it holds tremendous meaning so to see

454
00:16:13,509 --> 00:16:10,959
the greenland ice sheet experience a

455
00:16:15,590 --> 00:16:13,519
little bit of surface melt in this way

456
00:16:17,269 --> 00:16:15,600
though not unprecedented we see this in

457
00:16:18,710 --> 00:16:17,279
the historical record as laura had

458
00:16:21,030 --> 00:16:18,720
pointed out

459
00:16:22,949 --> 00:16:21,040
when you take that in the context of all

460
00:16:24,949 --> 00:16:22,959
the other things that are happening on

461
00:16:25,910 --> 00:16:24,959
earth all the other changes that we're

462
00:16:29,110 --> 00:16:25,920
seeing

463
00:16:31,509 --> 00:16:29,120

it's indicative of what appears to be a

464
00:16:34,710 --> 00:16:31,519
shift one thing that's been true of both

465
00:16:36,949 --> 00:16:34,720
greenland and the arctic sea ice cover

466
00:16:39,189 --> 00:16:36,959
is when we have observed changes when

467
00:16:41,749 --> 00:16:39,199
we've developed the capabilities we've

468
00:16:43,910 --> 00:16:41,759
consistently been surprised

469
00:16:45,910 --> 00:16:43,920
the rate of arctic ice decline has just

470
00:16:48,870 --> 00:16:45,920
been faster than we thought

471
00:16:50,870 --> 00:16:48,880
it would be or perhaps even could be

472
00:16:53,829 --> 00:16:50,880
in the case of greenland you know there

473
00:16:55,590 --> 00:16:53,839
was a time when i i was looking at data

474
00:16:58,310 --> 00:16:55,600
this is my eureka moment where i was

475
00:17:00,230 --> 00:16:58,320
looking at data on one glacier the jacob

476
00:17:02,230 --> 00:17:00,240
savannah stream fastest in the world

477
00:17:04,870 --> 00:17:02,240
moves about used to move about seven

478
00:17:06,150 --> 00:17:04,880
kilometers a year and it doubled its

479
00:17:07,750 --> 00:17:06,160
speed

480
00:17:09,510 --> 00:17:07,760
and i didn't believe it it's hard to

481
00:17:11,270 --> 00:17:09,520
believe ice can move like well i didn't

482
00:17:13,829 --> 00:17:11,280
believe my data i didn't believe my

483
00:17:15,750 --> 00:17:13,839
results and i kind of sat on it

484
00:17:19,110 --> 00:17:15,760
what am i doing wrong here how did you

485
00:17:21,750 --> 00:17:19,120
make that measurement uh that was by i

486
00:17:23,189 --> 00:17:21,760
used visible imagery uh so basically

487
00:17:25,189 --> 00:17:23,199
pictures right

488
00:17:27,429 --> 00:17:25,199

and i watched the movement of the

489
00:17:29,669 --> 00:17:27,439
crevasses from year to year

490
00:17:31,430 --> 00:17:29,679
and so it's pretty foolproof you know

491
00:17:32,950 --> 00:17:31,440
you find the crevasse pattern and then

492
00:17:34,789 --> 00:17:32,960
you look at it a year later and you see

493
00:17:36,549 --> 00:17:34,799
how much it moved and you calculate the

494
00:17:38,070 --> 00:17:36,559
distance

495
00:17:41,110 --> 00:17:38,080
there are other ways to get more

496
00:17:43,029 --> 00:17:41,120
comprehensive velocity measurements but

497
00:17:45,029 --> 00:17:43,039
you know when i first saw how much it

498
00:17:47,430 --> 00:17:45,039
moved i thought i must be looking at the

499
00:17:50,390 --> 00:17:47,440
wrong crevasses you know it it just this

500
00:17:53,270 --> 00:17:50,400
this can't be yeah and then it turned

501
00:17:55,270 --> 00:17:53,280
out others were seeing it it and we when

502
00:17:57,270 --> 00:17:55,280
we combined it with how much the ice was

503
00:17:59,270 --> 00:17:57,280
thinning so it's kind of like gum you

504
00:18:01,190 --> 00:17:59,280
stretch it out and and

505
00:18:03,750 --> 00:18:01,200
it will slump it will thin

506
00:18:05,590 --> 00:18:03,760
we we put together a story of

507
00:18:07,750 --> 00:18:05,600
that this was real this was really

508
00:18:09,990 --> 00:18:07,760
happening it wasn't a single glacier in

509
00:18:12,630 --> 00:18:10,000
this case it was but it started

510
00:18:14,710 --> 00:18:12,640
happening everywhere and

511
00:18:16,230 --> 00:18:14,720
this was a total surprise to us we

512
00:18:18,230 --> 00:18:16,240
didn't think it could happen we thought

513
00:18:20,630 --> 00:18:18,240

it was kind of going as fast as it could

514
00:18:22,630 --> 00:18:20,640
go so let's

515
00:18:24,150 --> 00:18:22,640
put it all together right i mean what we

516
00:18:25,350 --> 00:18:24,160
didn't have time to talk about was we we

517
00:18:26,950 --> 00:18:25,360
know that we have these glaciers in

518
00:18:28,470 --> 00:18:26,960
alaska that are melting dramatically

519
00:18:30,310 --> 00:18:28,480
there's incredible footage of that stuff

520
00:18:32,470 --> 00:18:30,320
on the web so we're losing the sea ice

521
00:18:35,909 --> 00:18:32,480
cover we're losing the ice in greenland

522
00:18:37,510 --> 00:18:35,919
right how is it tied up like what's like

523
00:18:38,870 --> 00:18:37,520
you know is it jus is it just that the

524
00:18:41,669 --> 00:18:38,880
planet's warming up i mean what do you

525
00:18:44,070 --> 00:18:41,679
guys put it all together

526
00:18:46,390 --> 00:18:44,080
well the arctic is warming about twice

527
00:18:48,789 --> 00:18:46,400
as fast as the rest of the planet

528
00:18:50,710 --> 00:18:48,799
uh and there are reasons for that it it

529
00:18:52,870 --> 00:18:50,720
wants to be cold it reflects the

530
00:18:55,430 --> 00:18:52,880
incoming sea ice it traps heat in the

531
00:18:57,590 --> 00:18:55,440
ocean so when it's we start to lose the

532
00:18:59,190 --> 00:18:57,600
ice or the ice starts to melt it absorbs

533
00:19:01,590 --> 00:18:59,200
more sunlight that's consistent with the

534
00:19:03,430 --> 00:19:01,600
model it gets out exactly models of

535
00:19:05,350 --> 00:19:03,440
temperature of the planet yeah yes so

536
00:19:08,549 --> 00:19:05,360
there there is

537
00:19:10,630 --> 00:19:08,559
an amplification factor in the arctic so

538
00:19:11,510 --> 00:19:10,640

what you're seeing is the manifestation

539
00:19:13,750 --> 00:19:11,520
of that

540
00:19:15,830 --> 00:19:13,760
coupled with some other complexities

541
00:19:18,150 --> 00:19:15,840
that torsten or laura might be better

542
00:19:19,590 --> 00:19:18,160
able to address than i've been so let me

543
00:19:21,990 --> 00:19:19,600
throw this other thing though you know

544
00:19:23,110 --> 00:19:22,000
on occasion you'll hear people say

545
00:19:25,430 --> 00:19:23,120
things like

546
00:19:27,110 --> 00:19:25,440
well in antarctica at least the sea ice

547
00:19:28,630 --> 00:19:27,120
looks like it's growing

548
00:19:30,390 --> 00:19:28,640
you know

549
00:19:32,070 --> 00:19:30,400
what does that mean and how do you put

550
00:19:33,430 --> 00:19:32,080
that in this context of like you know it

551
00:19:35,110 --> 00:19:33,440
seems like we're losing ice for most of

552
00:19:36,630 --> 00:19:35,120
the planet but we're gaining ice it

553
00:19:37,430 --> 00:19:36,640
seems like at least in the antarctic sea

554
00:19:39,110 --> 00:19:37,440
ice

555
00:19:41,110 --> 00:19:39,120
well well

556
00:19:43,029 --> 00:19:41,120
it's a complicated question in a way

557
00:19:45,909 --> 00:19:43,039
because there are two different answers

558
00:19:48,070 --> 00:19:45,919
a antarctic has a completely different

559
00:19:49,029 --> 00:19:48,080
climate system than the arctic

560
00:19:51,190 --> 00:19:49,039
and

561
00:19:52,390 --> 00:19:51,200
global warming doesn't mean

562
00:19:54,950 --> 00:19:52,400
it's you know

563
00:19:56,950 --> 00:19:54,960

equally warming up everywhere you know

564
00:19:59,190 --> 00:19:56,960
there are some places as well it said

565
00:20:01,350 --> 00:19:59,200
the arctic is you know warming up twice

566
00:20:05,270 --> 00:20:01,360
as fast as the rest of the planet

567
00:20:07,669 --> 00:20:05,280
antarctica is not warming as much as

568
00:20:09,190 --> 00:20:07,679
the arctic yeah and of course the the

569
00:20:11,590 --> 00:20:09,200
whole climate system is different in the

570
00:20:14,070 --> 00:20:11,600
arctic and compared to the antarctic in

571
00:20:15,590 --> 00:20:14,080
the arctic we have polar ocean which is

572
00:20:17,029 --> 00:20:15,600
surrounded by land

573
00:20:18,789 --> 00:20:17,039
in the antarctic it's the other way

574
00:20:20,470 --> 00:20:18,799
around we have a

575
00:20:23,190 --> 00:20:20,480
the pole itself is antarctica a

576
00:20:25,830 --> 00:20:23,200
continent surrounded by water that has

577
00:20:28,310 --> 00:20:25,840
has sea ice occasionally so

578
00:20:30,470 --> 00:20:28,320
you cannot compare you know

579
00:20:31,909 --> 00:20:30,480
that easily arctica and so you can

580
00:20:34,070 --> 00:20:31,919
imagine you can still have a warming

581
00:20:36,710 --> 00:20:34,080
world but have sea ice grow a bit in the

582
00:20:38,630 --> 00:20:36,720
antarctic look here's a good analogy you

583
00:20:41,029 --> 00:20:38,640
can look at the stock market you can

584
00:20:42,870 --> 00:20:41,039
look at the s p 500

585
00:20:44,310 --> 00:20:42,880
and it may be trending up it may be

586
00:20:45,909 --> 00:20:44,320
trending down

587
00:20:47,510 --> 00:20:45,919
if it's trending up

588
00:20:50,230 --> 00:20:47,520

chances are a lot of the stocks are

589
00:20:51,669 --> 00:20:50,240
turning upward but there will be stocks

590
00:20:53,830 --> 00:20:51,679
that are going down

591
00:20:56,950 --> 00:20:53,840
you know and and the converse is also

592
00:21:00,070 --> 00:20:56,960
true so what we look at in in earth

593
00:21:04,149 --> 00:21:00,080
system science is the earth system

594
00:21:06,390 --> 00:21:04,159
and the system does things as a whole

595
00:21:08,789 --> 00:21:06,400
but there's a lot of spatial variability

596
00:21:11,350 --> 00:21:08,799
to it some of which is counter to the

597
00:21:13,510 --> 00:21:11,360
behavior of the system as a whole

598
00:21:15,510 --> 00:21:13,520
but that's in large part due to the

599
00:21:18,149 --> 00:21:15,520
movement of energy from one place to

600
00:21:19,190 --> 00:21:18,159
another all right so where are we headed

601
00:21:20,549 --> 00:21:19,200
i think that's probably the biggest

602
00:21:21,990 --> 00:21:20,559
thing so we take all this knowledge

603
00:21:24,149 --> 00:21:22,000
right the next hundred years what's the

604
00:21:25,990 --> 00:21:24,159
planet going to look like laura

605
00:21:28,630 --> 00:21:26,000
the next hundred years i mean i think

606
00:21:30,789 --> 00:21:28,640
they'll they'll be uh less

607
00:21:32,230 --> 00:21:30,799
there'll be less ice in the arctic and i

608
00:21:34,950 --> 00:21:32,240
think we're still

609
00:21:37,350 --> 00:21:34,960
discovering a lot so

610
00:21:40,630 --> 00:21:37,360
here at nasa we have all these tools and

611
00:21:42,950 --> 00:21:40,640
wally talked about his his eureka moment

612
00:21:45,110 --> 00:21:42,960
and i think all of us have these eureka

613
00:21:46,870 --> 00:21:45,120

moments of we're looking at new data all

614
00:21:48,230 --> 00:21:46,880
the time and discovering

615
00:21:49,669 --> 00:21:48,240
new things

616
00:21:51,190 --> 00:21:49,679
i've been looking at a lot of data right

617
00:21:53,430 --> 00:21:51,200
now showing that we have a lot more

618
00:21:55,909 --> 00:21:53,440
water liquid water in the greenland ice

619
00:21:57,590 --> 00:21:55,919
sheet than we ever thought about before

620
00:21:59,830 --> 00:21:57,600
and we still need to understand some of

621
00:22:01,590 --> 00:21:59,840
that before we can say exactly what's

622
00:22:02,789 --> 00:22:01,600
going to happen but we come on a few

623
00:22:04,149 --> 00:22:02,799
things for sure

624
00:22:05,430 --> 00:22:04,159
we know that there'll be less there'll

625
00:22:07,110 --> 00:22:05,440
be less ice in greenland there's going

626
00:22:10,470 --> 00:22:07,120
to be more fresh water

627
00:22:13,830 --> 00:22:12,149
they'll be

628
00:22:15,830 --> 00:22:13,840
less sea ice

629
00:22:17,669 --> 00:22:15,840
well i think you know there are model

630
00:22:19,750 --> 00:22:17,679
predictions of what the future will look

631
00:22:21,750 --> 00:22:19,760
like i do think um

632
00:22:25,350 --> 00:22:21,760
the things we can say with high

633
00:22:28,230 --> 00:22:25,360
probability oceans will be higher

634
00:22:29,909 --> 00:22:28,240
in the next hundred years perhaps um a

635
00:22:34,149 --> 00:22:29,919
few feet higher

636
00:22:35,110 --> 00:22:34,159
in the next hundred years

637
00:22:37,590 --> 00:22:35,120
um

638
00:22:41,110 --> 00:22:37,600

the arctic sea ice cover

639
00:22:43,270 --> 00:22:41,120
essentially gone in the summertime

640
00:22:45,350 --> 00:22:43,280
yeah and and

641
00:22:47,029 --> 00:22:45,360
you know the implications on the climate

642
00:22:48,549 --> 00:22:47,039
we don't know for sure

643
00:22:52,230 --> 00:22:48,559
uh we would

644
00:22:54,070 --> 00:22:52,240
we can reasonably expect more intense

645
00:22:56,789 --> 00:22:54,080
weather events whether they be

646
00:22:57,750 --> 00:22:56,799
precipitation events or drought

647
00:22:58,630 --> 00:22:57,760
events

648
00:23:00,710 --> 00:22:58,640
um

649
00:23:03,669 --> 00:23:00,720
you know we it's a big change across the

650
00:23:06,149 --> 00:23:03,679
planet potentially and and the models

651
00:23:08,710 --> 00:23:06,159
say likely yeah

652
00:23:10,549 --> 00:23:08,720
where we can't go is certainly seriously

653
00:23:11,590 --> 00:23:10,559
100 years out all the time you've spent

654
00:23:12,630 --> 00:23:11,600
in the arctic what do you think it's

655
00:23:14,710 --> 00:23:12,640
going to look like going to be

656
00:23:16,710 --> 00:23:14,720
dramatically different oh absolutely i

657
00:23:18,230 --> 00:23:16,720
have no doubt the art object will

658
00:23:20,230 --> 00:23:18,240
certainly be dramatic

659
00:23:21,990 --> 00:23:20,240
the arctic will be ice-free

660
00:23:26,390 --> 00:23:22,000
you know

661
00:23:27,669 --> 00:23:26,400
when and i said i don't know

662
00:23:29,430 --> 00:23:27,679
and you know this is not a good answer

663
00:23:31,190 --> 00:23:29,440

but it's a scientific answer because you

664
00:23:33,750 --> 00:23:31,200
know we will never be able right but is

665
00:23:35,909 --> 00:23:33,760
the idea perfectly predict the future is

666
00:23:37,669 --> 00:23:35,919
whether or not it's ice free in the

667
00:23:38,789 --> 00:23:37,679
summer really important or is it look

668
00:23:40,230 --> 00:23:38,799
there's already massive amounts of

669
00:23:41,909 --> 00:23:40,240
change going on

670
00:23:43,430 --> 00:23:41,919
so it's going to look pretty different

671
00:23:45,430 --> 00:23:43,440
no matter what the ecosystems are

672
00:23:46,950 --> 00:23:45,440
changing we know from we know the ec we

673
00:23:48,310 --> 00:23:46,960
know that there's different organisms

674
00:23:50,230 --> 00:23:48,320
zooming in we know the planktons are

675
00:23:53,029 --> 00:23:50,240
changing look when it's not about when

676
00:23:53,990 --> 00:23:53,039
the last little burg or

677
00:23:55,269 --> 00:23:54,000
flow

678
00:23:56,549 --> 00:23:55,279
is gone

679
00:23:58,710 --> 00:23:56,559
it's

680
00:24:00,549 --> 00:23:58,720
as torsten said you can't say how many

681
00:24:03,350 --> 00:24:00,559
cigarettes before you get cancer you

682
00:24:05,830 --> 00:24:03,360
can't quite say what the square area

683
00:24:08,230 --> 00:24:05,840
what the area will be before we

684
00:24:10,870 --> 00:24:08,240
transition to a new state what you can

685
00:24:13,029 --> 00:24:10,880
say is there's a strong trend that

686
00:24:14,630 --> 00:24:13,039
continues to surprise us we're headed in

687
00:24:18,549 --> 00:24:14,640
a certain direction

688
00:24:19,830 --> 00:24:18,559

with uh potentially um

689
00:24:22,789 --> 00:24:19,840
dramatic

690
00:24:24,950 --> 00:24:22,799
implications and i i

691
00:24:26,789 --> 00:24:24,960
i think we got to get away from that

692
00:24:27,909 --> 00:24:26,799
what is the date on which the last bit

693
00:24:29,830 --> 00:24:27,919
of ice will

694
00:24:32,149 --> 00:24:29,840
you know disappear and focus on the

695
00:24:33,669 --> 00:24:32,159
trend all right hey guys thank you very

696
00:24:35,269 --> 00:24:33,679
much for coming in

697
00:24:36,950 --> 00:24:35,279
we want to thank the viewers thank you

698
00:24:38,630 --> 00:24:36,960
very much for tuning in to this episode