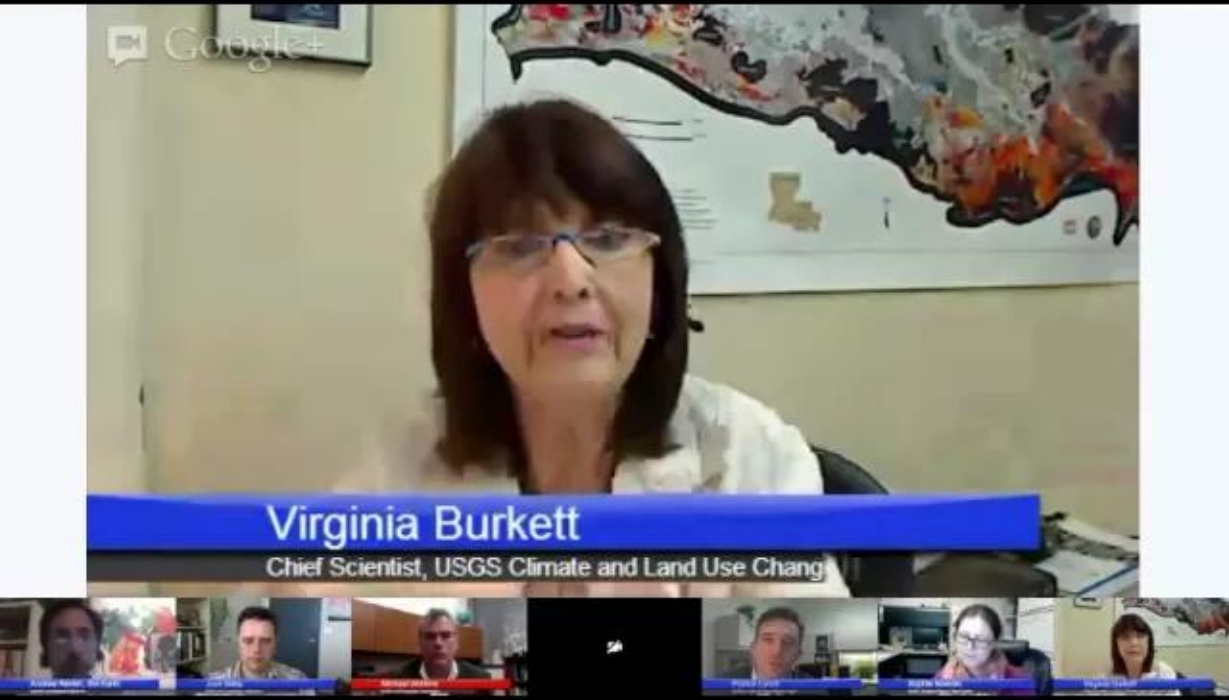
Google+
Virginia Burkett
Chief Scientist, USGS Climate and Land Use Chang

1
00:00:22,679 --> 00:00:19,690
hi everyone and thanks for joining us

2
00:00:25,990 --> 00:00:22,689
today for a NASA NASA Google+ hangout on

3
00:00:28,450 --> 00:00:26,000
sea-level rise we've gotten a number of

4
00:00:30,849 --> 00:00:28,460
questions from you already online and

5
00:00:33,640 --> 00:00:30,859
we'll be looking for more during today's

6
00:00:36,009 --> 00:00:33,650
hangout you can put them in the comments

7
00:00:38,890 --> 00:00:36,019
section on the Google+ hangout event

8
00:00:40,990 --> 00:00:38,900
page or on twitter using the hashtag sea

9
00:00:43,689 --> 00:00:41,000
level my name is Patrick Lynch I'm with

10
00:00:45,340 --> 00:00:43,699
NASA's earth science news team and I'll

11
00:00:47,130 --> 00:00:45,350
be helping get those questions to our

12
00:00:49,299 --> 00:00:47,140
experts today

13
00:00:51,430 --> 00:00:49,309

today we want to talk about the basic

14
00:00:53,350 --> 00:00:51,440
dilemma of sea level rise which is it

15
00:00:55,690 --> 00:00:53,360
has been rising over the last century or

16
00:00:58,240 --> 00:00:55,700
so and that rise has been accelerating

17
00:01:00,639 --> 00:00:58,250
in recent decades and the questions for

18
00:01:02,729 --> 00:01:00,649
scientists now are how much is it going

19
00:01:06,219 --> 00:01:02,739
to rise how fast will that rise occur

20
00:01:07,810 --> 00:01:06,229
for NASA in particular how can we

21
00:01:11,440 --> 00:01:07,820
measure and have them we predict that

22
00:01:13,650 --> 00:01:11,450
rise accurately and for us and others

23
00:01:15,850 --> 00:01:13,660
who is this going to affect ultimately

24
00:01:18,340 --> 00:01:15,860
we have a great panel today to talk

25
00:01:20,350 --> 00:01:18,350
about just these questions starting in

26
00:01:23,020 --> 00:01:20,360
Pasadena California at the deposition

27
00:01:25,060 --> 00:01:23,030
laboratory Josh Willis is the project

28
00:01:27,580 --> 00:01:25,070
scientist on NASA satellite missions

29
00:01:29,530 --> 00:01:27,590
this study sea level and as a scientist

30
00:01:32,679 --> 00:01:29,540
studies sea level rise in the role of

31
00:01:34,660 --> 00:01:32,689
the ocean and her climate sophie nawicki

32
00:01:37,170 --> 00:01:34,670
at Goddard Space Flight Center in

33
00:01:39,609 --> 00:01:37,180
Greenbelt Maryland

34
00:01:44,140 --> 00:01:39,619
studies in particularly the physics and

35
00:01:46,899 --> 00:01:44,150
modeling of ice sheets and glaciers and

36
00:01:48,999 --> 00:01:46,909
in the long term the contribution that

37
00:01:50,980 --> 00:01:49,009
ice sheets could make to sea-level rise

38
00:01:53,679 --> 00:01:50,990

not just in the coming decades but even

39
00:01:55,330 --> 00:01:53,689
in the coming centuries back in Pasadena

40
00:01:57,969 --> 00:01:55,340
at Jet Propulsion Laboratory we have

41
00:01:59,770 --> 00:01:57,979
Michael Watkins when he is not mission

42
00:02:01,120 --> 00:01:59,780
manager for the Mars Science Laboratory

43
00:02:03,249 --> 00:02:01,130
mission

44
00:02:05,830 --> 00:02:03,259
he is also works on NASA's Earth

45
00:02:07,660 --> 00:02:05,840
observing missions including as project

46
00:02:09,850 --> 00:02:07,670
scientist for the Gravity Recovery and

47
00:02:11,949 --> 00:02:09,860
climate experiment which has given

48
00:02:16,270 --> 00:02:11,959
scientists invaluable data in the last

49
00:02:18,220 --> 00:02:16,280
decade or so on changes in ice sheets in

50
00:02:21,190 --> 00:02:18,230
Greenland and Antarctica and other

51
00:02:23,680 --> 00:02:21,200
places down in many Louisiana we have

52
00:02:25,420 --> 00:02:23,690
Virginia Berkut she's the chief

53
00:02:26,390 --> 00:02:25,430
scientist for global change research at

54
00:02:29,030 --> 00:02:26,400
the USG lab

55
00:02:31,610 --> 00:02:29,040
survey has been a lead author on

56
00:02:33,800 --> 00:02:31,620
multiple UN Intergovernmental Panel and

57
00:02:36,250 --> 00:02:33,810
climate change reports and studies in

58
00:02:38,449 --> 00:02:36,260
particular climate change impacts on

59
00:02:41,330 --> 00:02:38,459
coastal communities and coastal

60
00:02:43,369 --> 00:02:41,340
ecosystems systems and finally in

61
00:02:45,020 --> 00:02:43,379
garrison New York we have Andrew repkin

62
00:02:47,839 --> 00:02:45,030
senior fellow for environmental

63
00:02:50,360 --> 00:02:47,849

understanding at Pace University and dot

64
00:02:52,640 --> 00:02:50,370
Earth blogger for the for The New York

65
00:02:55,069 --> 00:02:52,650
Times so looking forward to getting your

66
00:02:58,490 --> 00:02:55,079
questions to everyone today and I'll

67
00:03:00,080 --> 00:02:58,500
just start us off question for Josh just

68
00:03:02,479 --> 00:03:00,090
from a big-picture perspective can you

69
00:03:04,460 --> 00:03:02,489
give us some of the current state of sea

70
00:03:05,780 --> 00:03:04,470
level rise research what do we know

71
00:03:08,960 --> 00:03:05,790
about what's been happening in recent

72
00:03:11,589 --> 00:03:08,970
decades and and what do we think is

73
00:03:15,020 --> 00:03:11,599
going to happen in the coming decades

74
00:03:17,270 --> 00:03:15,030
yeah sure thank you Patrick it's a real

75
00:03:20,300 --> 00:03:17,280
pleasure to be here and what a what a

76
00:03:22,300 --> 00:03:20,310
super fun way to talk about a really

77
00:03:27,319 --> 00:03:22,310
interesting and really important topic I

78
00:03:31,129 --> 00:03:27,329
think to me global sea level rise is one

79
00:03:34,699 --> 00:03:31,139
of the most compelling pieces of sort of

80
00:03:38,059 --> 00:03:34,709
information we have about how the planet

81
00:03:41,000 --> 00:03:38,069
is changing in a lot of ways sea level

82
00:03:44,089 --> 00:03:41,010
rise is both an indicator of climate

83
00:03:47,659 --> 00:03:44,099
change remember two thirds of the planet

84
00:03:50,750 --> 00:03:47,669
is covered by oceans and if we're

85
00:03:53,000 --> 00:03:50,760
looking for climate change really we

86
00:03:55,219 --> 00:03:53,010
need to be looking in the oceans but

87
00:03:57,680 --> 00:03:55,229
it's also an impact of climate change in

88
00:04:01,039 --> 00:03:57,690

global warming millions of people around

89
00:04:03,379 --> 00:04:01,049
the world live in coastal areas and many

90
00:04:06,289 --> 00:04:03,389
more depend financially on those coastal

91
00:04:10,219 --> 00:04:06,299
areas and billions and billions of

92
00:04:14,539 --> 00:04:10,229
dollars of infrastructure is in the

93
00:04:17,960 --> 00:04:14,549
coastal zone and as sea level rises over

94
00:04:21,500 --> 00:04:17,970
the next 100 years we're gonna have to

95
00:04:25,790 --> 00:04:21,510
make some tough decisions about just how

96
00:04:29,689 --> 00:04:25,800
to deal with that rise and how to manage

97
00:04:33,230 --> 00:04:29,699
it but the big question today I think is

98
00:04:37,040 --> 00:04:33,240
just how quickly our sea level is going

99
00:04:39,679 --> 00:04:37,050
to rise in the last 20 years we've had

100
00:04:41,899 --> 00:04:39,689
about 6 centimeters of sea level rise

101
00:04:43,779 --> 00:04:41,909
that's a few inches so about it it's a

102
00:04:48,139 --> 00:04:43,789
couple inches about an inch per decade a

103
00:04:50,389 --> 00:04:48,149
little faster than that and you know

104
00:04:52,189 --> 00:04:50,399
looking out into the next 100 years

105
00:04:55,129 --> 00:04:52,199
the question is are we going to get

106
00:04:57,109 --> 00:04:55,139
another foot of sea level rise or are we

107
00:05:01,009 --> 00:04:57,119
gonna get another five or six feet of

108
00:05:02,479 --> 00:05:01,019
sea level rise and as of right now we

109
00:05:06,229 --> 00:05:02,489
don't have a good answer to that

110
00:05:09,709 --> 00:05:06,239
question we really have big

111
00:05:11,329 --> 00:05:09,719
uncertainties in terms of just how much

112
00:05:12,850 --> 00:05:11,339
sea level we're going to be facing sea

113
00:05:16,569 --> 00:05:12,860

level rise we're going to be facing so

114
00:05:22,029 --> 00:05:16,579
it's an interesting time but it's also

115
00:05:28,159 --> 00:05:26,509
right and II just to keep it going here

116
00:05:30,799 --> 00:05:28,169
as someone that's written about this a

117
00:05:32,299 --> 00:05:30,809
lot if you have a group of people here

118
00:05:34,369 --> 00:05:32,309
that could answer a lot of questions as

119
00:05:36,559 --> 00:05:34,379
a journalist what would which you're

120
00:05:39,909 --> 00:05:36,569
sort of most pressing questions on sea

121
00:05:42,559 --> 00:05:39,919
level rise to put out there well I guess

122
00:05:45,439 --> 00:05:42,569
one of the key things as Josh just

123
00:05:48,559 --> 00:05:45,449
pointed out is that the unknowns that I

124
00:05:51,139 --> 00:05:48,569
wrote about in 1988 are the unknowns

125
00:05:55,790 --> 00:05:51,149
that we're still looking at right now

126
00:05:57,259 --> 00:05:55,800
that's kind of where as an outside

127
00:06:00,559 --> 00:05:57,269
observer you know you think well we're

128
00:06:01,790 --> 00:06:00,569
doesn't science advance but I guess and

129
00:06:03,259 --> 00:06:01,800
science has advanced maybe you could

130
00:06:06,829 --> 00:06:03,269
describe how many more tools we have now

131
00:06:08,689 --> 00:06:06,839
that we had in 1988 but then given that

132
00:06:09,739 --> 00:06:08,699
say that it's still a hard problem I'd

133
00:06:18,079 --> 00:06:09,749
like to hear a little bit more about

134
00:06:19,939 --> 00:06:18,089
that yeah I think you know we're still

135
00:06:22,369 --> 00:06:19,949
faced with some some really big

136
00:06:25,850 --> 00:06:22,379
challenges in terms of how the ice

137
00:06:27,439 --> 00:06:25,860
sheets are gonna respond and today we

138
00:06:29,379 --> 00:06:27,449

have a lot better tools just for

139
00:06:33,139 --> 00:06:29,389
measuring global sea-level we have

140
00:06:34,850 --> 00:06:33,149
satellite observations that measure sea

141
00:06:38,149 --> 00:06:34,860
level everywhere in the world once every

142
00:06:40,819 --> 00:06:38,159
10 days very accurately and we can

143
00:06:45,079 --> 00:06:40,829
actually see the march of global sea

144
00:06:47,809 --> 00:06:45,089
level rise as it happens but what we

145
00:06:49,219 --> 00:06:47,819
still have trouble with and what what

146
00:06:51,559 --> 00:06:49,229
we're going to continue to have trouble

147
00:06:52,899 --> 00:06:51,569
with is predicting how the great ice

148
00:06:56,169 --> 00:06:52,909
sheets in green

149
00:06:59,799 --> 00:06:56,179
and Antarctica are going to respond to

150
00:07:03,189 --> 00:06:59,809
both the warming atmosphere and to the

151
00:07:06,279 --> 00:07:03,199
warming water recent research suggests

152
00:07:08,100 --> 00:07:06,289
that in fact the ice sheets aren't just

153
00:07:10,929 --> 00:07:08,110
responding to the warming atmosphere

154
00:07:14,969 --> 00:07:10,939
they're responding to changes in the

155
00:07:18,459 --> 00:07:14,979
oceans as well and these ocean ice

156
00:07:20,109 --> 00:07:18,469
interactions are really the crux of the

157
00:07:21,549 --> 00:07:20,119
matter in terms of trying to predict

158
00:07:24,760 --> 00:07:21,559
what's going to happen in the future

159
00:07:26,320 --> 00:07:24,770
there's a whole lot of uncertainty in in

160
00:07:28,119 --> 00:07:26,330
how these things are going to respond

161
00:07:29,619 --> 00:07:28,129
and you bring up a good point we've been

162
00:07:33,399 --> 00:07:29,629
we've been kind of hacking away at this

163
00:07:35,949 --> 00:07:33,409

problem for a long time and there have

164
00:07:39,489 --> 00:07:35,959
been advances but the ice sheets are

165
00:07:42,429 --> 00:07:39,499
still poorly explored poorly understood

166
00:07:44,290 --> 00:07:42,439
and and in some ways poorly measured

167
00:07:47,109 --> 00:07:44,300
there there are some things about them

168
00:07:49,839 --> 00:07:47,119
that we measure well but the sort of

169
00:07:52,119 --> 00:07:49,849
details and the kinds of physics that

170
00:07:55,059 --> 00:07:52,129
are going to determine how fast sea

171
00:07:57,699 --> 00:07:55,069
level rises over the next century we're

172
00:07:59,290 --> 00:07:57,709
still puzzling over those and a lot of

173
00:08:00,659 --> 00:07:59,300
people are working really hard but it's

174
00:08:03,149 --> 00:08:00,669
gonna take some more time

175
00:08:06,329 --> 00:08:03,159
another thing that's related to that is

176
00:08:08,949 --> 00:08:06,339
how to describe that uncertainty that

177
00:08:11,769 --> 00:08:08,959
and when you talk about a range that

178
00:08:13,299 --> 00:08:11,779
could be from essentially a yawn you

179
00:08:15,249 --> 00:08:13,309
know another seven inches in a hundred

180
00:08:17,549 --> 00:08:15,259
years or fifteen inches which is a

181
00:08:21,040 --> 00:08:17,559
little more than what we've seen so far

182
00:08:22,809 --> 00:08:21,050
to like five feet in a hundred years the

183
00:08:25,419 --> 00:08:22,819
difference is really big in terms of how

184
00:08:26,739 --> 00:08:25,429
societies would want to react and when

185
00:08:29,799 --> 00:08:26,749
you took when you look carefully what

186
00:08:31,119 --> 00:08:29,809
scientists say like Stefan Rahmstorf in

187
00:08:33,370 --> 00:08:31,129
Germany who's been quite aggressive

188
00:08:35,740 --> 00:08:33,380

about you know worrying about global

189
00:08:38,100 --> 00:08:35,750
warming at the same time he said the

190
00:08:40,300 --> 00:08:38,110
high end of that range is implicitly

191
00:08:42,339 --> 00:08:40,310
extremely unlikely that's how he put it

192
00:08:45,309 --> 00:08:42,349
in a science perspective a couple years

193
00:08:47,980 --> 00:08:45,319
ago that I wrote about on earth I just

194
00:08:49,269 --> 00:08:47,990
posted a link to it so but scientists

195
00:08:51,429 --> 00:08:49,279
are very reluctant to sort of rules

196
00:08:53,860 --> 00:08:51,439
something out so society is stuck with

197
00:08:55,540 --> 00:08:53,870
this like you know how quickly do we

198
00:08:57,699 --> 00:08:55,550
move away from shorelines how quickly do

199
00:09:00,309 --> 00:08:57,709
we stop start buying up coastal property

200
00:09:03,069 --> 00:09:00,319
to get people out of ridiculous and

201
00:09:06,079 --> 00:09:03,079
leave vulnerable zones we're stuck kind

202
00:09:08,569 --> 00:09:06,089
of with this inability to have a

203
00:09:10,460 --> 00:09:08,579
that conversation play out in a way

204
00:09:12,230 --> 00:09:10,470
that's that sort of our conventional

205
00:09:15,249 --> 00:09:12,240
norms and society can get I don't know

206
00:09:18,499 --> 00:09:15,259
if you've seen any any way to get

207
00:09:20,960 --> 00:09:18,509
progress on that it seems like this the

208
00:09:22,610 --> 00:09:20,970
high end seems durably uncertain yes and

209
00:09:24,530 --> 00:09:22,620
you're I can take a little crack at that

210
00:09:27,920 --> 00:09:24,540
and then you know then ended up the

211
00:09:29,540 --> 00:09:27,930
Sofia major you know we spent a lot of

212
00:09:31,100 --> 00:09:29,550
time trying to just understand what is

213
00:09:33,049 --> 00:09:31,110

currently happening right I mean the

214
00:09:35,509 --> 00:09:33,059
first steps were predicting something is

215
00:09:38,119 --> 00:09:35,519
is understanding it it's measuring it

216
00:09:39,379 --> 00:09:38,129
and so we've in the last I would say 10

217
00:09:40,850 --> 00:09:39,389
years or 20 years you know since since

218
00:09:43,009 --> 00:09:40,860
you know you first started writing about

219
00:09:44,809 --> 00:09:43,019
this I think we've made great strides as

220
00:09:46,549 --> 00:09:44,819
Josh indicated in measuring what's

221
00:09:47,569 --> 00:09:46,559
happening today and in particular

222
00:09:49,910 --> 00:09:47,579
measuring the ice sheets we've made a

223
00:09:52,910 --> 00:09:49,920
lot of progress we had a mission ice at

224
00:09:54,590 --> 00:09:52,920
that that made some height measurements

225
00:09:56,780 --> 00:09:54,600
of the of the ice sheets and we had this

226
00:09:58,249 --> 00:09:56,790
very cool mission called grace that you

227
00:10:00,259 --> 00:09:58,259
know kind of weighed the ice sheet a

228
00:10:01,670 --> 00:10:00,269
month a month and we're able to see how

229
00:10:04,369 --> 00:10:01,680
these changes were happening in the West

230
00:10:06,710 --> 00:10:04,379
Antarctica and in in Greenland the real

231
00:10:08,179 --> 00:10:06,720
problem is there's a thousand variables

232
00:10:10,160 --> 00:10:08,189
that go into why the ice sheet is

233
00:10:11,989 --> 00:10:10,170
actually melting right it could be that

234
00:10:13,910 --> 00:10:11,999
there's warm water coming up into these

235
00:10:16,460 --> 00:10:13,920
fjords it could be that there's more Sun

236
00:10:18,379 --> 00:10:16,470
you know melting from the from the top

237
00:10:19,759 --> 00:10:18,389
of the ice sheets and so understanding

238
00:10:21,829 --> 00:10:19,769

the physics taking these measurements

239
00:10:23,629 --> 00:10:21,839
and then trying to map that into the

240
00:10:25,669 --> 00:10:23,639
physics is really the problem that that

241
00:10:27,949 --> 00:10:25,679
scientists are wrestling with now so I

242
00:10:29,329 --> 00:10:27,959
think the I think we formed the basis to

243
00:10:31,429 --> 00:10:29,339
answer that question by taking all of

244
00:10:32,989 --> 00:10:31,439
these great measurements but we still

245
00:10:35,059 --> 00:10:32,999
have a big challenge ahead and trying to

246
00:10:38,480 --> 00:10:35,069
sort out all the physics that's going on

247
00:10:40,579 --> 00:10:38,490
and what the biggest drivers in in polar

248
00:10:41,840 --> 00:10:40,589
ice amount really is and then we

249
00:10:43,519 --> 00:10:41,850
continue to make these measures we need

250
00:10:45,199 --> 00:10:43,529
to make more measurements but I would

251
00:10:47,360 --> 00:10:45,209
say that the big progress in the last 20

252
00:10:49,129 --> 00:10:47,370
years hasn't been on prediction it's

253
00:10:51,169 --> 00:10:49,139
really been on measure and so I think

254
00:10:52,699 --> 00:10:51,179
we're now poised to take that next next

255
00:10:54,860 --> 00:10:52,709
step but it but it's really complicated

256
00:10:56,119 --> 00:10:54,870
step and one of the things I like to

257
00:10:57,499 --> 00:10:56,129
joke about is you know we're in the

258
00:10:59,449 --> 00:10:57,509
middle of the final four here on you

259
00:11:01,879 --> 00:10:59,459
know the NCAA tournament you we know

260
00:11:03,590 --> 00:11:01,889
exactly what teams have won up to this

261
00:11:04,970 --> 00:11:03,600
point but that doesn't really help us

262
00:11:07,100 --> 00:11:04,980
say who's gonna win the next game right

263
00:11:08,809 --> 00:11:07,110

because the the the you know that

264
00:11:10,160 --> 00:11:08,819
understanding what makes a team win beat

265
00:11:12,139 --> 00:11:10,170
another team right that's know as the

266
00:11:13,999 --> 00:11:12,149
defense better the offense who's sick

267
00:11:15,410 --> 00:11:14,009
that day you know what who has

268
00:11:16,669 --> 00:11:15,420
home-field advantage all of these kind

269
00:11:18,559 --> 00:11:16,679
of things you know get into this very

270
00:11:20,030 --> 00:11:18,569
complicated equation and they talk about

271
00:11:21,560 --> 00:11:20,040
climate change we're talking up

272
00:11:23,990 --> 00:11:21,570
millions of variables that have to get

273
00:11:25,550 --> 00:11:24,000
sorted out so it really is it it really

274
00:11:27,800 --> 00:11:25,560
is a tough problem and that's really the

275
00:11:30,319 --> 00:11:27,810
big challenge facing us today and just

276
00:11:31,879 --> 00:11:30,329
one more thing before other questions

277
00:11:33,079 --> 00:11:31,889
start to come on and come in I'm trying

278
00:11:36,410 --> 00:11:33,089
to share my screen I'm not sure if you

279
00:11:38,720 --> 00:11:36,420
can see but NASA illustration that josh

280
00:11:41,120 --> 00:11:38,730
is familiar with it relates to this

281
00:11:42,980 --> 00:11:41,130
question of acceleration and on my blog

282
00:11:45,889 --> 00:11:42,990
anytime I post on sea-level rise this

283
00:11:48,559 --> 00:11:45,899
debate erupts about someone will just

284
00:11:50,150 --> 00:11:48,569
say in a presumptive way sea-level rise

285
00:11:51,740 --> 00:11:50,160
is accelerating and that everyone will

286
00:11:54,079 --> 00:11:51,750
point to graphs like this one and say

287
00:11:55,430 --> 00:11:54,089
well show me the acceleration so if you

288
00:11:58,220 --> 00:11:55,440

guys could discuss that a little bit

289
00:12:00,050 --> 00:11:58,230
that would be great yeah I mean the

290
00:12:02,030 --> 00:12:00,060
simple answer there is that that that

291
00:12:06,139 --> 00:12:02,040
time series isn't long enough to see it

292
00:12:10,759 --> 00:12:06,149
so it's it's still small enough that you

293
00:12:13,120 --> 00:12:10,769
know that over 20 years

294
00:12:17,809 --> 00:12:13,130
you can't really see an acceleration

295
00:12:20,769 --> 00:12:17,819
nice little graphic there actually

296
00:12:23,269 --> 00:12:20,779
there's another graphic we could show

297
00:12:25,670 --> 00:12:23,279
there's the one of the 2,000 years of

298
00:12:29,389 --> 00:12:25,680
sea level rise I'm not sure if the NASA

299
00:12:33,189 --> 00:12:29,399
Goddard folks have that one or not that

300
00:12:39,800 --> 00:12:33,199
one but the one in the backup material

301
00:12:42,920 --> 00:12:39,810
2,000 years of sea level rise see if

302
00:12:44,509 --> 00:12:42,930
they can find it then but but the the

303
00:12:47,360 --> 00:12:44,519
short answer is that the acceleration

304
00:12:49,040 --> 00:12:47,370
has happened really over the rates that

305
00:12:52,100 --> 00:12:49,050
we've seen for the last couple of

306
00:12:55,699 --> 00:12:52,110
thousand years in the last two thousand

307
00:12:59,050 --> 00:12:55,709
years sea levels been fairly fairly

308
00:13:04,129 --> 00:12:59,060
stable there been a few periods with

309
00:13:07,490 --> 00:13:04,139
rates of rise that are small but not

310
00:13:10,220 --> 00:13:07,500
insignificant and then if you you know

311
00:13:14,300 --> 00:13:10,230
if you look at the last 150 years then

312
00:13:15,699 --> 00:13:14,310
clearly there's been an increase in the

313
00:13:18,710 --> 00:13:15,709

rate of sea level rise

314
00:13:20,090 --> 00:13:18,720
that's quite dramatic relative to

315
00:13:22,550 --> 00:13:20,100
anything that's happened in the last

316
00:13:25,400 --> 00:13:22,560
couple thousand years so it's in that

317
00:13:28,910 --> 00:13:25,410
sense that over the last 100 or 150

318
00:13:30,370 --> 00:13:28,920
years we've certainly seen an increase

319
00:13:34,110 --> 00:13:30,380
in the rate of sea level rise

320
00:13:37,210 --> 00:13:34,120
if sea level had been rising for

321
00:13:39,639 --> 00:13:37,220
three millimeters per year for the last

322
00:13:45,790 --> 00:13:39,649
two thousand years then we would have

323
00:13:47,759 --> 00:13:45,800
had much higher rates of rise within

324
00:13:50,319 --> 00:13:47,769
that is there any way to discriminate

325
00:13:54,460 --> 00:13:50,329
how much of that was a kind of rebound

326
00:13:56,040 --> 00:13:54,470
from the Little Ice Age versus yeah I

327
00:14:07,420 --> 00:13:56,050
think let's see I think what I'll just

328
00:14:13,389 --> 00:14:07,430
I'm just trying to share this see if

329
00:14:15,280 --> 00:14:13,399
this works yeah here you can see that

330
00:14:19,210 --> 00:14:15,290
basically for the last two thousand

331
00:14:21,819 --> 00:14:19,220
years this is a sea level record from

332
00:14:25,900 --> 00:14:21,829
North Carolina taken in the salt marshes

333
00:14:29,050 --> 00:14:25,910
there that illustrates essentially what

334
00:14:31,930 --> 00:14:29,060
I'm talking about that essentially we

335
00:14:34,509 --> 00:14:31,940
had no sea level rise for the first

336
00:14:38,170 --> 00:14:34,519
millennium of this record dating back

337
00:14:40,240 --> 00:14:38,180
about 2,000 years and then during what's

338
00:14:43,870 --> 00:14:40,250

called the Medieval Warm Period there

339
00:14:45,670 --> 00:14:43,880
was a period of a more rapid rise sea

340
00:14:48,190 --> 00:14:45,680
level rose about 20 centimeters in

341
00:14:51,220 --> 00:14:48,200
several hundred years and then it was

342
00:14:55,180 --> 00:14:51,230
stable again and the the period called

343
00:14:59,069 --> 00:14:55,190
the Little Ice Age saw perhaps a small

344
00:15:02,620 --> 00:14:59,079
decline in sea level a small downturn

345
00:15:05,470 --> 00:15:02,630
but really no significant change in the

346
00:15:07,510 --> 00:15:05,480
rate of sea level and then at the very

347
00:15:09,670 --> 00:15:07,520
end of the record you can see the upturn

348
00:15:12,040 --> 00:15:09,680
which agrees with modern-day tide gauges

349
00:15:16,120 --> 00:15:12,050
and is about two millimeters per year

350
00:15:18,790 --> 00:15:16,130
over most of the last 100 so this is

351
00:15:21,699 --> 00:15:18,800
what we you know what it's sort of the

352
00:15:24,240 --> 00:15:21,709
first effort to to make what you might

353
00:15:28,240 --> 00:15:24,250
call a hockey stick for sea level

354
00:15:29,710 --> 00:15:28,250
controversial term but nevertheless this

355
00:15:31,420 --> 00:15:29,720
is essentially what we're looking at is

356
00:15:34,060 --> 00:15:31,430
a record that's been fairly stable for

357
00:15:35,350 --> 00:15:34,070
about two thousand years and rising

358
00:15:38,650 --> 00:15:35,360
really rapidly

359
00:15:40,810 --> 00:15:38,660
yeah and Josh actually sea level has

360
00:15:43,780 --> 00:15:40,820
been relatively stable for even longer

361
00:15:44,260 --> 00:15:43,790
than that the past six to seven thousand

362
00:15:47,410 --> 00:15:44,270
years

363
00:15:50,290 --> 00:15:47,420

that's when coasts globally

364
00:15:52,450 --> 00:15:50,300
be merged as we know them today and as

365
00:15:55,440 --> 00:15:52,460
sea level rise accelerates will see

366
00:15:58,030 --> 00:15:55,450
another series of transgression we're

367
00:16:00,910 --> 00:15:58,040
like we had in the earlier part of this

368
00:16:01,840 --> 00:16:00,920
interglacial so you're in the past seven

369
00:16:03,850 --> 00:16:01,850
thousand years

370
00:16:06,010 --> 00:16:03,860
that's where US coastlines that's the

371
00:16:07,630 --> 00:16:06,020
time period in which coastlines as we

372
00:16:09,250 --> 00:16:07,640
know them today all of the Mississippi

373
00:16:12,220 --> 00:16:09,260
Delta for example all of Southeast

374
00:16:13,870 --> 00:16:12,230
Louisiana half of that state you know

375
00:16:16,260 --> 00:16:13,880
basically formed during that seven

376
00:16:19,530 --> 00:16:16,270
thousand years of relatively small

377
00:16:23,710 --> 00:16:19,540
changes in mean sea level

378
00:16:26,680 --> 00:16:23,720
great are there any questions that have

379
00:16:28,330 --> 00:16:26,690
come in from the outside world yet we we

380
00:16:30,780 --> 00:16:28,340
do have a number we can get to those in

381
00:16:34,060 --> 00:16:30,790
a second I want to want to follow up on

382
00:16:37,210 --> 00:16:34,070
on what Virginia was saying there and

383
00:16:39,100 --> 00:16:37,220
and that is it has been stable but what

384
00:16:41,860 --> 00:16:39,110
we know still has changed in the past

385
00:16:42,910 --> 00:16:41,870
and I think a lot of people say when you

386
00:16:46,390 --> 00:16:42,920
look at these things over the very long

387
00:16:47,950 --> 00:16:46,400
term well it's changed before you know

388
00:16:50,290 --> 00:16:47,960

what is different this time

389
00:16:51,670 --> 00:16:50,300
I obviously the answer is there's a lot

390
00:16:54,310 --> 00:16:51,680
more people and infrastructure on the

391
00:16:57,100 --> 00:16:54,320
coast but but how do you answer that

392
00:16:58,330 --> 00:16:57,110
very basic question of you know well why

393
00:17:00,190 --> 00:16:58,340
does it matter what's different this

394
00:17:04,810 --> 00:17:00,200
time in terms of looking to the future

395
00:17:06,790 --> 00:17:04,820
and planning for it well one thing

396
00:17:10,030 --> 00:17:06,800
that's different in America one half

397
00:17:12,370 --> 00:17:10,040
roughly of our population lives in

398
00:17:14,140 --> 00:17:12,380
coastal watershed counties and the

399
00:17:17,670 --> 00:17:14,150
infrastructure that's present in the

400
00:17:20,470 --> 00:17:17,680
coast the societal vulnerability is

401
00:17:23,620 --> 00:17:20,480
that's that's where it is for the United

402
00:17:25,540 --> 00:17:23,630
States more than half of our GDP some

403
00:17:29,050 --> 00:17:25,550
studies indicate comes from these

404
00:17:32,980 --> 00:17:29,060
coastal watershed counties so the risk

405
00:17:36,010 --> 00:17:32,990
the exposure for society is much greater

406
00:17:38,860 --> 00:17:36,020
than it has been and in past epochs of

407
00:17:42,940 --> 00:17:38,870
sea-level change what's also different

408
00:17:44,820 --> 00:17:42,950
is the cause in the past the cycle of

409
00:17:47,740 --> 00:17:44,830
the ice ages was really driven by

410
00:17:49,570 --> 00:17:47,750
changes in the amount of energy we got

411
00:17:53,980 --> 00:17:49,580
from the Sun that had to do with small

412
00:17:56,220 --> 00:17:53,990
shifts in the orbit and sort of angle of

413
00:17:59,960 --> 00:17:56,230

the Earth's that relative to the Sun

414
00:18:02,770 --> 00:17:59,970
what's causing it today is human emitted

415
00:18:06,490 --> 00:18:02,780
house gasses and the warming that's

416
00:18:09,050 --> 00:18:06,500
really driven by human caused activity

417
00:18:11,600 --> 00:18:09,060
and if you look at this graphic I

418
00:18:14,990 --> 00:18:11,610
believe that folks can see now the it's

419
00:18:17,570 --> 00:18:15,000
the relative change in mean sea level

420
00:18:19,790 --> 00:18:17,580
that determines whether a coast will be

421
00:18:22,040 --> 00:18:19,800
inundated or not if you look at this

422
00:18:24,590 --> 00:18:22,050
graphic here you'll see parts of the US

423
00:18:27,320 --> 00:18:24,600
Coast the change in sea level looks

424
00:18:29,630 --> 00:18:27,330
higher and that's because the tide gauge

425
00:18:32,270 --> 00:18:29,640
is there and the land surface are

426
00:18:34,460 --> 00:18:32,280
actually sinking with respect to mean

427
00:18:38,140 --> 00:18:34,470
sea level and so you can see in this

428
00:18:41,510 --> 00:18:38,150
graphic you know a much higher rate of

429
00:18:45,080 --> 00:18:41,520
relative sea level rise an increase up

430
00:18:48,620 --> 00:18:45,090
to six to eight inches in the central

431
00:18:50,990 --> 00:18:48,630
Gulf Coast for example so all places are

432
00:18:52,700 --> 00:18:51,000
not equally vulnerable in some parts of

433
00:18:55,460 --> 00:18:52,710
the country like off the Canadian coast

434
00:18:58,490 --> 00:18:55,470
there and off the Bering Straits you can

435
00:19:00,920 --> 00:18:58,500
see that sea level appears to be falling

436
00:19:04,090 --> 00:19:00,930
and that's because of the Glacial

437
00:19:08,030 --> 00:19:04,100
rebound there of the land surface and so

438
00:19:11,150 --> 00:19:08,040

the threat to communities and coastal

439
00:19:13,850 --> 00:19:11,160
ecosystems in some parts of the country

440
00:19:17,590 --> 00:19:13,860
are much less than along that particular

441
00:19:19,850 --> 00:19:17,600
that Atlantic and Gulf Coast shorelines

442
00:19:21,170 --> 00:19:19,860
one of the weirdest examples like that I

443
00:19:22,970 --> 00:19:21,180
think is around Juneau from what I

444
00:19:24,020 --> 00:19:22,980
understand where people are trying to

445
00:19:26,740 --> 00:19:24,030
figure out what to do with all this new

446
00:19:29,750 --> 00:19:26,750
property that who does it belong to yeah

447
00:19:32,120 --> 00:19:29,760
yeah but on the North Slope we've got

448
00:19:34,070 --> 00:19:32,130
not just sea level rise affecting the

449
00:19:36,280 --> 00:19:34,080
coastal communities there but the

450
00:19:40,010 --> 00:19:36,290
temperature another major driver

451
00:19:42,590 --> 00:19:40,020
associated with with the changing

452
00:19:45,260 --> 00:19:42,600
climate here the temperature changes

453
00:19:47,510 --> 00:19:45,270
causing the coastal landscape to

454
00:19:50,900 --> 00:19:47,520
collapse because the sediments are bound

455
00:19:53,590 --> 00:19:50,910
with ice and so a lot of the coastal

456
00:19:57,050 --> 00:19:53,600
landscape there is more vulnerable to

457
00:19:58,490 --> 00:19:57,060
this temperature effect than it is to

458
00:20:00,650 --> 00:19:58,500
changes in mean sea level

459
00:20:02,480 --> 00:20:00,660
coupled with the ice sheet retreat which

460
00:20:05,240 --> 00:20:02,490
is increasing coastal erosion and

461
00:20:08,000 --> 00:20:05,250
they're having to move communities off

462
00:20:09,560 --> 00:20:08,010
the coastline of the northern Alaska

463
00:20:12,770 --> 00:20:09,570

Virginia I wonder if we could follow up

464
00:20:13,850 --> 00:20:12,780
on that and we're gonna look at a

465
00:20:16,070 --> 00:20:13,860
question we

466
00:20:19,880 --> 00:20:16,080
from online but if you could name sort

467
00:20:22,660 --> 00:20:19,890
of let's say three places in in the US

468
00:20:25,400 --> 00:20:22,670
that have a sort of particular

469
00:20:27,140 --> 00:20:25,410
vulnerability to sea-level rise and then

470
00:20:30,380 --> 00:20:27,150
you know beyond here we got a question

471
00:20:32,210 --> 00:20:30,390
from Rana you spawn on Google+ asking

472
00:20:36,080 --> 00:20:32,220
what effect sea level will have on on

473
00:20:39,740 --> 00:20:36,090
South Asian countries on the South Asian

474
00:20:42,789 --> 00:20:39,750
part in our last IPCC report we

475
00:20:45,980 --> 00:20:42,799
highlighted highlighted mega deltas as

476
00:20:48,140 --> 00:20:45,990
hotspots of societal vulnerability and

477
00:20:51,530 --> 00:20:48,150
if you look at that report we've got

478
00:20:53,810 --> 00:20:51,540
these maps showing that the Asian mega

479
00:20:57,770 --> 00:20:53,820
deltas are you know where you got these

480
00:21:01,159 --> 00:20:57,780
intense populations living on the edge

481
00:21:04,400 --> 00:21:01,169
literally in these low-lying Delta X

482
00:21:05,870 --> 00:21:04,410
systems that were formed when sea level

483
00:21:09,380 --> 00:21:05,880
rise when they're sea level was

484
00:21:11,360 --> 00:21:09,390
relatively stable and the moment that

485
00:21:14,780 --> 00:21:11,370
sea level rise starts to accelerate

486
00:21:17,919 --> 00:21:14,790
those landforms start to be transgressed

487
00:21:19,850 --> 00:21:17,929
by the shoreline and the flooding is

488
00:21:21,289 --> 00:21:19,860

exacerbated then and then you couple

489
00:21:24,740 --> 00:21:21,299
that with the propensity for more

490
00:21:27,020 --> 00:21:24,750
intense storms so in Asia I'd say if you

491
00:21:29,390 --> 00:21:27,030
had to pick out a hotspot societally

492
00:21:32,510 --> 00:21:29,400
it's the mega deltas the large Delta's

493
00:21:35,560 --> 00:21:32,520
in China and India and elsewhere

494
00:21:38,600 --> 00:21:35,570
the the vietnam and cambodia

495
00:21:41,870 --> 00:21:38,610
particularly where you've got a low

496
00:21:44,419 --> 00:21:41,880
capacity for moving people out of these

497
00:21:47,120 --> 00:21:44,429
these low-lying areas other hotspots in

498
00:21:50,600 --> 00:21:47,130
America I've mentioned Alaska in our

499
00:21:51,970 --> 00:21:50,610
coastal report that we just produced for

500
00:21:53,990 --> 00:21:51,980
the National Climate Assessment

501
00:21:57,770 --> 00:21:54,000
seventy-nine co-authors on that report

502
00:22:00,770 --> 00:21:57,780
we have several text boxes dealing with

503
00:22:02,750 --> 00:22:00,780
climate change in Alaska and so the

504
00:22:04,310 --> 00:22:02,760
Alaskan coast line for reasons I've

505
00:22:06,230 --> 00:22:04,320
already explained are particularly

506
00:22:08,419 --> 00:22:06,240
vulnerable and if you look at this map

507
00:22:11,570 --> 00:22:08,429
here you can see other places that are

508
00:22:13,430 --> 00:22:11,580
vulnerable in Louisiana and Texas for

509
00:22:17,030 --> 00:22:13,440
example where the land surface is

510
00:22:20,090 --> 00:22:17,040
sinking up to one centimeter per year

511
00:22:22,520 --> 00:22:20,100
and then if you put you know another

512
00:22:23,960 --> 00:22:22,530
half centimeter per year or more on top

513
00:22:26,540 --> 00:22:23,970

of that when you've got these

514
00:22:27,769 --> 00:22:26,550
environments that are no more than one

515
00:22:30,709 --> 00:22:27,779
to two feet above means

516
00:22:33,529 --> 00:22:30,719
level those environments are very likely

517
00:22:35,859 --> 00:22:33,539
to be inundated and lost and again

518
00:22:39,830 --> 00:22:35,869
couple that with changes in storm surge

519
00:22:42,320 --> 00:22:39,840
intensity and which is also projected

520
00:22:44,719 --> 00:22:42,330
increase for this particular ocean basin

521
00:22:48,709 --> 00:22:44,729
where hurricanes form that make landfall

522
00:22:51,769 --> 00:22:48,719
in the Atlantic coasts of America and

523
00:22:57,499 --> 00:22:51,779
along the Gulf Coast then those two

524
00:23:00,619 --> 00:22:57,509
drivers in Louisiana we lost 217 square

525
00:23:03,079 --> 00:23:00,629
miles of coast overnight in Hurricane

526
00:23:04,820 --> 00:23:03,089
Katrina so it's not just sea level rise

527
00:23:07,519 --> 00:23:04,830
that is affecting these low-lying coast

528
00:23:09,829 --> 00:23:07,529
is these other drivers as well like the

529
00:23:12,979 --> 00:23:09,839
temperature in Alaska and the changes in

530
00:23:19,789 --> 00:23:12,989
the these storm surge the intensity or

531
00:23:23,029 --> 00:23:19,799
destructiveness of storms you Patrick we

532
00:23:24,799 --> 00:23:23,039
talked a little bit about uncertainty in

533
00:23:27,349 --> 00:23:24,809
future rates of sea level rise earlier

534
00:23:31,399 --> 00:23:27,359
and I think one of the big places where

535
00:23:34,609 --> 00:23:31,409
that that uncertainty resides is in how

536
00:23:36,979 --> 00:23:34,619
the ice sheets are behaving and so maybe

537
00:23:40,820 --> 00:23:36,989
we could get the sophie to tell us a

538
00:23:43,879 --> 00:23:40,830

little bit about about that and and

539
00:23:47,049 --> 00:23:43,889
what's being understood and what the

540
00:23:49,579 --> 00:23:47,059
future that sort of research entails

541
00:23:51,619 --> 00:23:49,589
yeah I think I wanted to answer back

542
00:23:54,109 --> 00:23:51,629
about your questions about uncertainty

543
00:23:57,709 --> 00:23:54,119
and why is it so hard to predict future

544
00:23:58,999 --> 00:23:57,719
sea-level the vision to some extent that

545
00:24:00,919 --> 00:23:59,009
it might seems like there hasn't been

546
00:24:05,959 --> 00:24:00,929
much progress compared to what you wrote

547
00:24:07,549 --> 00:24:05,969
many years ago is that the we do have

548
00:24:09,739 --> 00:24:07,559
made actually quite a lot of progress

549
00:24:11,570 --> 00:24:09,749
that we understand a bit better how I

550
00:24:14,060 --> 00:24:11,580
should flow and what makes a good I

551
00:24:15,560 --> 00:24:14,070
should model but the problem is the more

552
00:24:17,239 --> 00:24:15,570
and that's - because of all of the

553
00:24:20,060 --> 00:24:17,249
observations that we've made in the

554
00:24:22,219 --> 00:24:20,070
recent years the tricky bit is that the

555
00:24:24,259 --> 00:24:22,229
more we observe ice sheets the more we

556
00:24:26,329 --> 00:24:24,269
realize that this phenomena is that we

557
00:24:29,209 --> 00:24:26,339
don't know that we do know that existed

558
00:24:31,399 --> 00:24:29,219
so on the caption that's on the little

559
00:24:33,019 --> 00:24:31,409
movie that's being flowing like you have

560
00:24:34,909 --> 00:24:33,029
a moon and as being draining so it's

561
00:24:37,369 --> 00:24:34,919
like water forming at the surface of the

562
00:24:41,039 --> 00:24:37,379
ice sheets that's kind of draining into

563
00:24:43,979 --> 00:24:41,049

the base and cruising speed up and

564
00:24:45,840 --> 00:24:43,989
a new process we had no idea existed we

565
00:24:48,779 --> 00:24:45,850
still don't understand how to model it

566
00:24:51,090 --> 00:24:48,789
and then what causes it and then once

567
00:24:52,889 --> 00:24:51,100
you actually understand how it behaves

568
00:24:56,279 --> 00:24:52,899
we will have to find a way to include it

569
00:24:58,590 --> 00:24:56,289
into the model so we have made a lot of

570
00:25:00,539 --> 00:24:58,600
progress we discovered new phenomenons

571
00:25:04,619 --> 00:25:00,549
that we know we need to incorporate in a

572
00:25:05,999 --> 00:25:04,629
models but at the same time we the

573
00:25:08,369 --> 00:25:06,009
more we understand the less you

574
00:25:11,100 --> 00:25:08,379
understand and the other reason is very

575
00:25:13,619 --> 00:25:11,110
hard to make her future predictions is

576
00:25:16,499 --> 00:25:13,629
that and you really need to understand

577
00:25:18,869 --> 00:25:16,509
what the future is going to be what are

578
00:25:21,060 --> 00:25:18,879
going to be your forcing is the ocean is

579
00:25:22,950 --> 00:25:21,070
going to become warmer is the atmosphere

580
00:25:25,019 --> 00:25:22,960
going to become warmer what are the

581
00:25:29,909 --> 00:25:25,029
dominant factors so that's why

582
00:25:32,009 --> 00:25:29,919
projections range by a lot you you

583
00:25:34,590 --> 00:25:32,019
mentioned that some people believe that

584
00:25:36,060 --> 00:25:34,600
there is projection that in 100 years

585
00:25:39,269 --> 00:25:36,070
time it would have only a few

586
00:25:43,049 --> 00:25:39,279
centimeters of future sea-level and

587
00:25:45,119 --> 00:25:43,059
there is also much getting much more

588
00:25:48,090 --> 00:25:45,129

bigger number so sec meters of sea level

589
00:25:50,279 --> 00:25:48,100
rise and that's read that the problem is

590
00:25:52,470 --> 00:25:50,289
is that you you have not entertain in

591
00:25:55,109 --> 00:25:52,480
the ocean models you have some certainty

592
00:25:57,450 --> 00:25:55,119
into the future projection what's going

593
00:25:59,249 --> 00:25:57,460
to be the future and then you also have

594
00:26:02,460 --> 00:25:59,259
some certainty about the current

595
00:26:04,200 --> 00:26:02,470
settings of the ice sheet so for example

596
00:26:06,180 --> 00:26:04,210
what is the bed beneath the ice sheets

597
00:26:08,489 --> 00:26:06,190
look like because that's going to

598
00:26:11,190 --> 00:26:08,499
control how you I should is going to

599
00:26:13,919 --> 00:26:11,200
miss form and can won't water from the

600
00:26:17,279 --> 00:26:13,929
ocean which the base of the ice whereas

601
00:26:19,799 --> 00:26:17,289
you know it's going to to have huge

602
00:26:24,119 --> 00:26:19,809
effects so for this first of all for the

603
00:26:26,039 --> 00:26:24,129
bed NASA is doing a lot of measurements

604
00:26:28,710 --> 00:26:26,049
of bed rocks underneath the ice sheet

605
00:26:30,989 --> 00:26:28,720
with operation IceBridge and that's very

606
00:26:33,840 --> 00:26:30,999
recent observations that I should models

607
00:26:36,149 --> 00:26:33,850
didn't have until now and if you ask me

608
00:26:38,489 --> 00:26:36,159
the data is getting there and it's

609
00:26:41,639 --> 00:26:38,499
beginning amazing but we still need a

610
00:26:43,680 --> 00:26:41,649
lot to understand the current

611
00:26:49,590 --> 00:26:43,690
environment in the current settings in

612
00:26:51,149 --> 00:26:49,600
order to predict future changes and on

613
00:26:53,009 --> 00:26:51,159

to that by the way is that you know I

614
00:26:54,899 --> 00:26:53,019
think some people might think you know

615
00:26:56,820 --> 00:26:54,909
the ice sheets are kind of just stable

616
00:26:58,080 --> 00:26:56,830
and he's working a little bit off you

617
00:26:59,999 --> 00:26:58,090
know but otherwise they're just stable

618
00:27:01,440 --> 00:27:00,009
in fact what really happens is you know

619
00:27:02,879 --> 00:27:01,450
it's snowing a lot and the ice sheets

620
00:27:04,169 --> 00:27:02,889
are growing during the winter and then

621
00:27:05,639 --> 00:27:04,179
they're melting off in the summer and

622
00:27:07,499 --> 00:27:05,649
then growing in the winter and melting

623
00:27:09,599 --> 00:27:07,509
off again this is true in Antarctica and

624
00:27:11,419 --> 00:27:09,609
Greenland both and so it's actually kind

625
00:27:14,820 --> 00:27:11,429
of the balance between those two and if

626
00:27:16,049 --> 00:27:14,830
so people saying if if if the atmosphere

627
00:27:18,810 --> 00:27:16,059
changes and you get a lot more

628
00:27:21,899 --> 00:27:18,820
precipitation then then the amount of

629
00:27:23,580 --> 00:27:21,909
net ice loss is a lot less so in fact

630
00:27:25,049 --> 00:27:23,590
it's not just what's happening right on

631
00:27:27,539 --> 00:27:25,059
the ice sheet it's also how does the

632
00:27:29,279 --> 00:27:27,549
whole climate house precipitation how is

633
00:27:31,739 --> 00:27:29,289
the ocean temperature there's lots of

634
00:27:33,719 --> 00:27:31,749
factors that have to be solved for in in

635
00:27:35,999 --> 00:27:33,729
understanding the future in the future

636
00:27:38,099 --> 00:27:36,009
future of these ice sheets and you know

637
00:27:39,450 --> 00:27:38,109
we talked about just a couple of those

638
00:27:41,279 --> 00:27:39,460

variables like what you know what's the

639
00:27:43,109 --> 00:27:41,289
topography under the ice sheet has been

640
00:27:44,519 --> 00:27:43,119
sophie was talking about but this whole

641
00:27:46,190 --> 00:27:44,529
question of what is the atmosphere doing

642
00:27:48,629 --> 00:27:46,200
and what is the ocean doing are

643
00:27:51,119 --> 00:27:48,639
inseparably coupled to the future the

644
00:27:52,919 --> 00:27:51,129
ice sheets so we have to project not

645
00:27:54,239 --> 00:27:52,929
just the future the ice sheet but the

646
00:27:55,680 --> 00:27:54,249
future of the atmosphere and the future

647
00:28:02,519 --> 00:27:55,690
of the ocean and that's it's a big

648
00:28:03,899 --> 00:28:02,529
challenge but what are the and so if you

649
00:28:05,609 --> 00:28:03,909
listed a bunch of them right there but

650
00:28:09,479 --> 00:28:05,619
but if you were to name sort of the

651
00:28:12,509 --> 00:28:09,489
biggest obstacle to being able to make a

652
00:28:14,639 --> 00:28:12,519
solid projection about the contribution

653
00:28:20,369 --> 00:28:14,649
of of ice sheets to sea-level rise what

654
00:28:22,680 --> 00:28:20,379
what would it be in my mind the there is

655
00:28:24,839 --> 00:28:22,690
the biggest obstacle is not knowing

656
00:28:28,950 --> 00:28:24,849
really the topography beneath the ice

657
00:28:31,830 --> 00:28:28,960
sheets because it affects how much ice

658
00:28:33,570 --> 00:28:31,840
there is available to melt so if you're

659
00:28:35,609 --> 00:28:33,580
making a cake you know it kind of

660
00:28:40,979 --> 00:28:35,619
affects how big your cake is going to be

661
00:28:43,469 --> 00:28:40,989
and also the the way the bedrock is if

662
00:28:48,589 --> 00:28:43,479
you is going to affect how the ice is

663
00:28:51,839 --> 00:28:48,599

going to flow so for example if you are

664
00:28:54,149 --> 00:28:51,849
skiing down a very nice group ice

665
00:28:57,629 --> 00:28:54,159
surface it's very easy for you to kind

666
00:28:59,849 --> 00:28:57,639
of slide down your slope but then if you

667
00:29:01,769 --> 00:28:59,859
and if your bedrock is very nice and

668
00:29:03,659 --> 00:29:01,779
smooth it's very easy for you to flow in

669
00:29:06,659 --> 00:29:03,669
the sediments and so you're going to be

670
00:29:08,100 --> 00:29:06,669
reacting very very strongly to any type

671
00:29:11,070 --> 00:29:08,110
of you

672
00:29:12,990 --> 00:29:11,080
your changes but then if you are for

673
00:29:15,390 --> 00:29:13,000
example skiing of us no that's not

674
00:29:19,470 --> 00:29:15,400
really good quality and you have for

675
00:29:21,570 --> 00:29:19,480
example lots of patches of earth and you

676
00:29:23,250 --> 00:29:21,580
know grass sticking out and you are

677
00:29:25,260 --> 00:29:23,260
going to it's going to be much harder

678
00:29:28,890 --> 00:29:25,270
for you to slide into behavior and to

679
00:29:30,480 --> 00:29:28,900
move so really what for me what's

680
00:29:32,600 --> 00:29:30,490
happening beneath the ice sheet where

681
00:29:37,049 --> 00:29:32,610
the bedrock looks like what type of

682
00:29:39,299 --> 00:29:37,059
geology it is is going to always be one

683
00:29:41,940 --> 00:29:39,309
of the factors that contributes I mean

684
00:29:43,650 --> 00:29:41,950
that dominates your response and so the

685
00:29:46,500 --> 00:29:43,660
bed is in my mind the biggest

686
00:29:48,539 --> 00:29:46,510
uncertainty because again at the bed's I

687
00:29:52,409 --> 00:29:48,549
mentioned a bit before the bed the shape

688
00:29:55,919 --> 00:29:52,419

of the bed is going to also affect how

689
00:29:57,600 --> 00:29:55,929
the warm water from the ocean the

690
00:30:00,620 --> 00:29:57,610
warming oceans are going to be able to

691
00:30:05,070 --> 00:30:00,630
reach or not reach the ice sheets so

692
00:30:10,650 --> 00:30:05,080
it's really the conditions of things

693
00:30:13,169 --> 00:30:10,660
that I cannot see I have a follow-up

694
00:30:15,930 --> 00:30:13,179
question related to that so are there

695
00:30:17,850 --> 00:30:15,940
any remote sensing methods that can get

696
00:30:19,830 --> 00:30:17,860
get people down there I did write a

697
00:30:21,600 --> 00:30:19,840
couple years ago about some cool work by

698
00:30:25,340 --> 00:30:21,610
actually a NASA scientist who dropped ik

699
00:30:28,799 --> 00:30:25,350
dropped a camera down a Moulin to try to

700
00:30:30,810 --> 00:30:28,809
get a picture of the underbelly of an

701
00:30:34,140 --> 00:30:30,820
ice sheet but it was very preliminary

702
00:30:37,650 --> 00:30:34,150
obviously very limited and scope so what

703
00:30:39,299 --> 00:30:37,660
else can be done to clarify what that

704
00:30:44,190 --> 00:30:39,309
interface between the ice and the rock

705
00:30:47,330 --> 00:30:44,200
is like so I'll take that one again then

706
00:30:50,730 --> 00:30:47,340
I need the FJ Rossum torch and Mike can

707
00:30:52,980 --> 00:30:50,740
contribute to that too but so at the

708
00:30:55,100 --> 00:30:52,990
moment Nesta has this huge campaign

709
00:30:57,210 --> 00:30:55,110
called operation IceBridge

710
00:31:00,690 --> 00:30:57,220
specifically aircraft they're flying

711
00:31:03,630 --> 00:31:00,700
over agglutinin Antarctica they have

712
00:31:06,630 --> 00:31:03,640
radar and the radar gives them the

713
00:31:10,850 --> 00:31:06,640

returns from the radar system and that's

714
00:31:16,460 --> 00:31:10,860
an idea about how thick the ice sheet is

715
00:31:19,770 --> 00:31:16,470
you can also try to measure from space

716
00:31:21,780 --> 00:31:19,780
what the what the the geothermal heat

717
00:31:25,260 --> 00:31:21,790
flux beneath the ice sheet is

718
00:31:29,340 --> 00:31:25,270
and next ayah again is doing a lot of

719
00:31:32,640 --> 00:31:29,350
work on that and as you said there is

720
00:31:36,740 --> 00:31:32,650
also a lot of ground work with people

721
00:31:40,530 --> 00:31:36,750
dropping things in movements people

722
00:31:42,630 --> 00:31:40,540
drilling ice cores and they're trying to

723
00:31:44,910 --> 00:31:42,640
get sensors down the ice sheets and

724
00:31:46,860 --> 00:31:44,920
reaching the beds so the you're right

725
00:31:50,640 --> 00:31:46,870
there is a lot of different type of

726
00:31:52,500 --> 00:31:50,650
measurements being used and giving us

727
00:31:58,290 --> 00:31:52,510
accurate picture every day

728
00:32:01,050 --> 00:31:58,300
of what is happening down there someone

729
00:32:04,440 --> 00:32:01,060
I remember joking about putting the

730
00:32:07,200 --> 00:32:04,450
rubber duckies down milan's

731
00:32:09,900 --> 00:32:07,210
to see where they come out you know

732
00:32:16,050 --> 00:32:09,910
those little floating yellow ducks oh it

733
00:32:18,720 --> 00:32:16,060
did happen actually did I mean we did

734
00:32:21,480 --> 00:32:18,730
have some field work with the yellow

735
00:32:24,690 --> 00:32:21,490
ducks being put down and also we are

736
00:32:27,300 --> 00:32:24,700
putting dye I mean color the water down

737
00:32:29,190 --> 00:32:27,310
Dumoulin and so we can be quite science

738
00:32:30,300 --> 00:32:29,200

can be fun we can be very creative that

739
00:32:32,340 --> 00:32:30,310
way

740
00:32:33,660 --> 00:32:32,350
the problem is that sometime it doesn't

741
00:32:35,730 --> 00:32:33,670
come out I mean the Ducks don't always

742
00:32:37,530 --> 00:32:35,740
come out of the gas tank or they come

743
00:32:40,980 --> 00:32:37,540
out many years later and another to

744
00:32:45,000 --> 00:32:40,990
observe but the more creative you are I

745
00:32:46,620 --> 00:32:45,010
guess the better it is

746
00:32:49,140 --> 00:32:46,630
it is a hard measurement to make I mean

747
00:32:50,640 --> 00:32:49,150
most emissions we make from space are of

748
00:32:52,500 --> 00:32:50,650
the surface of the earth right or the

749
00:32:53,640 --> 00:32:52,510
surface of the ocean and it actually is

750
00:32:55,470 --> 00:32:53,650
quite challenging for us to make

751
00:32:57,810 --> 00:32:55,480
observations of the you know the bedrock

752
00:32:59,070 --> 00:32:57,820
below the ice you know we were

753
00:33:00,480 --> 00:32:59,080
successful a little bit in kind of

754
00:33:02,370 --> 00:33:00,490
weighing the ice with this grace mission

755
00:33:05,430 --> 00:33:02,380
but a lot of what we know about the deep

756
00:33:07,500 --> 00:33:05,440
ocean and below the ice sheets it has to

757
00:33:08,820 --> 00:33:07,510
come from basically measurements made

758
00:33:10,140 --> 00:33:08,830
maybe from an airplane like an ice

759
00:33:13,530 --> 00:33:10,150
sounder trying to you know trying to

760
00:33:16,740 --> 00:33:13,540
bounce radar waves off off the ground

761
00:33:18,510 --> 00:33:16,750
and ice interface or actually just going

762
00:33:20,460 --> 00:33:18,520
out in the field field and drilling and

763
00:33:22,860 --> 00:33:20,470

and and doing the best you can sort of

764
00:33:24,120 --> 00:33:22,870
in-situ measurements and this is true in

765
00:33:26,550 --> 00:33:24,130
the ocean too a lot of we know what the

766
00:33:28,560 --> 00:33:26,560
deep ocean comes from you know sensors

767
00:33:30,450 --> 00:33:28,570
that we deploy from ships and and

768
00:33:32,100 --> 00:33:30,460
actually you know in the ocean in the

769
00:33:33,660 --> 00:33:32,110
deep ocean so it's actually the hardest

770
00:33:35,340 --> 00:33:33,670
some things for us to measure from space

771
00:33:36,779 --> 00:33:35,350
as good as we are

772
00:33:38,820 --> 00:33:36,789
you know it NASA with making these

773
00:33:40,260 --> 00:33:38,830
measurements is stuff that's below the

774
00:33:42,600 --> 00:33:40,270
surface you know as soon as you get a

775
00:33:47,340 --> 00:33:42,610
meter below the surface it's it's tough

776
00:33:48,720 --> 00:33:47,350
to see it from space yeah let me go

777
00:33:50,250 --> 00:33:48,730
ahead and jump in we've got a number of

778
00:33:53,190 --> 00:33:50,260
questions that have been sent in from

779
00:33:54,570 --> 00:33:53,200
from online these are on different

780
00:33:57,620 --> 00:33:54,580
topics maybe you can just kind of go

781
00:34:02,880 --> 00:33:57,630
through them through them one off here

782
00:34:05,700 --> 00:34:02,890
so Mario Rivera says the word dramatic

783
00:34:08,550 --> 00:34:05,710
is being used here but will this be

784
00:34:12,570 --> 00:34:08,560
comparable with I guess the changes with

785
00:34:15,510 --> 00:34:12,580
the around the Little Ice Age yeah well

786
00:34:16,740 --> 00:34:15,520
excuse me yeah this is Josh we talked

787
00:34:19,830 --> 00:34:16,750
about that just a little bit earlier

788
00:34:22,440 --> 00:34:19,840

actually they're already much bigger the

789
00:34:25,139 --> 00:34:22,450
changes than what occurred during the

790
00:34:29,879 --> 00:34:25,149
Ice Age especially in terms of sea level

791
00:34:33,690 --> 00:34:29,889
rise we have this really amazing record

792
00:34:36,080 --> 00:34:33,700
from North Carolina that shows really

793
00:34:38,609 --> 00:34:36,090
very little change in in sea level there

794
00:34:42,960 --> 00:34:38,619
during what's referred to as Little Ice

795
00:34:46,440 --> 00:34:42,970
Age and then the dramatic roughly two

796
00:34:49,190 --> 00:34:46,450
millimeters per year rise that we've

797
00:34:52,349 --> 00:34:49,200
seen over most of the last 100 years so

798
00:34:54,210 --> 00:34:52,359
we've already really outpaced anything

799
00:34:59,510 --> 00:34:54,220
that's happened during the Little Ice

800
00:35:02,220 --> 00:34:59,520
Age and are off into new territory here

801
00:35:06,150 --> 00:35:02,230
okay I'll throw out another one here

802
00:35:08,550 --> 00:35:06,160
this says Josh you showed the 2000 year

803
00:35:12,180 --> 00:35:08,560
sea level rise record in North Carolinas

804
00:35:13,859 --> 00:35:12,190
who's how was that data collected that's

805
00:35:16,290 --> 00:35:13,869
a that's a great question it's actually

806
00:35:18,840 --> 00:35:16,300
kind of a neat story it turns out that

807
00:35:22,680 --> 00:35:18,850
the coast there as Virginia mentioned

808
00:35:26,310 --> 00:35:22,690
earlier is sinking slightly this is due

809
00:35:29,820 --> 00:35:26,320
to the end of the last ice age about

810
00:35:32,550 --> 00:35:29,830
20,000 years ago there were big ice

811
00:35:35,910 --> 00:35:32,560
sheets over a lot of North America and

812
00:35:38,970 --> 00:35:35,920
these compressed the land there and as

813
00:35:41,370 --> 00:35:38,980

those melted and disappeared then the

814
00:35:44,760 --> 00:35:41,380
land under the ice sheets uplifted and

815
00:35:47,280 --> 00:35:44,770
the land further away started to sink

816
00:35:48,250 --> 00:35:47,290
and the coastline where these was were

817
00:35:50,530 --> 00:35:48,260
collected is

818
00:35:53,530 --> 00:35:50,540
in one of those regions that's slowly

819
00:35:56,410 --> 00:35:53,540
sinking over the past many thousand

820
00:35:58,620 --> 00:35:56,420
years this has been going on and it

821
00:36:01,900 --> 00:35:58,630
turns out that that particular coastline

822
00:36:04,810 --> 00:36:01,910
contains salt marshes and in these

823
00:36:08,920 --> 00:36:04,820
marshes there are small critters that

824
00:36:10,180 --> 00:36:08,930
live in a very narrow band of the the

825
00:36:12,930 --> 00:36:10,190
tidal zone

826
00:36:17,050 --> 00:36:12,940
in addition particularly on that coast

827
00:36:19,570 --> 00:36:17,060
the tidal range is very small and all

828
00:36:23,130 --> 00:36:19,580
this allows researchers to go back and

829
00:36:25,270 --> 00:36:23,140
drill cores down through the sediments

830
00:36:28,480 --> 00:36:25,280
created in this salt marsh and

831
00:36:32,230 --> 00:36:28,490
essentially make a record back in time

832
00:36:35,980 --> 00:36:32,240
over exactly how relative sea level has

833
00:36:40,860 --> 00:36:35,990
changed now we can compute and measure

834
00:36:43,870 --> 00:36:40,870
the sort of ongoing sinking rate and

835
00:36:45,610 --> 00:36:43,880
extrapolating that back over time you

836
00:36:49,420 --> 00:36:45,620
can essentially get the record that I

837
00:36:53,830 --> 00:36:49,430
showed almost you know really one of the

838
00:36:57,670 --> 00:36:53,840

most accurate in both vertical dimension

839
00:37:00,100 --> 00:36:57,680
as well as as well as in time records of

840
00:37:02,050 --> 00:37:00,110
sea level rise anywhere in the last any

841
00:37:05,250 --> 00:37:02,060
anywhere in the world so it's really

842
00:37:06,850 --> 00:37:05,260
kind of an amazing detective story and

843
00:37:10,570 --> 00:37:06,860
researchers are doing a lot of

844
00:37:14,170 --> 00:37:10,580
interesting work to reconstruct how sea

845
00:37:16,120 --> 00:37:14,180
level has changed in in the last several

846
00:37:18,850 --> 00:37:16,130
thousand years and this is one of those

847
00:37:21,670 --> 00:37:18,860
really cool really cool success stories

848
00:37:25,030 --> 00:37:21,680
there but and to follow up with that on

849
00:37:27,220 --> 00:37:25,040
the detective work Tom notes asks what

850
00:37:29,410 --> 00:37:27,230
about post-glacial rebound if we've

851
00:37:30,760 --> 00:37:29,420
talked about a bit but maybe to put a

852
00:37:34,060 --> 00:37:30,770
finer point in that question is how do

853
00:37:36,400 --> 00:37:34,070
you determine how much rise is occurring

854
00:37:38,500 --> 00:37:36,410
due to post-glacial rebound and how much

855
00:37:41,230 --> 00:37:38,510
is occurring due to either thermal

856
00:37:45,550 --> 00:37:41,240
expansion or or you know ice sheets

857
00:37:48,910 --> 00:37:45,560
melting yes how do you sort of divide

858
00:37:52,900 --> 00:37:48,920
the you know yeah I don't mean to sort

859
00:37:54,600 --> 00:37:52,910
of take over the the throne here for so

860
00:37:57,610 --> 00:37:54,610
long answering all these questions but

861
00:38:01,400 --> 00:37:57,620
in that particular case essentially the

862
00:38:06,830 --> 00:38:04,280
thinking has been very accurately

863
00:38:10,010 --> 00:38:06,840

calculated and it's stable over the

864
00:38:12,710 --> 00:38:10,020
course of several thousand years so this

865
00:38:15,800 --> 00:38:12,720
is a place with that a lot of tectonic

866
00:38:18,010 --> 00:38:15,810
activity where you have big changes that

867
00:38:20,750 --> 00:38:18,020
happen all of a sudden really this is a

868
00:38:24,440 --> 00:38:20,760
reaction to that ice that that

869
00:38:27,740 --> 00:38:24,450
disappeared 20,000 years ago and so they

870
00:38:31,670 --> 00:38:27,750
can compute fairly accurately the rate

871
00:38:34,580 --> 00:38:31,680
of the rate of sinking and you can

872
00:38:36,020 --> 00:38:34,590
measure it in present day as well so

873
00:38:39,020 --> 00:38:36,030
it's a combination of all those things

874
00:38:42,410 --> 00:38:39,030
it gives us this sort of sort of model

875
00:38:44,480 --> 00:38:42,420
of how post-glacial rebound is affecting

876
00:38:49,460 --> 00:38:44,490
the local sea level and that can be

877
00:38:50,900 --> 00:38:49,470
removed fairly accurately okay I was

878
00:38:52,220 --> 00:38:50,910
still still getting a bunch here so let

879
00:38:55,040 --> 00:38:52,230
me throw this out on that I think this

880
00:38:57,910 --> 00:38:55,050
is sort of the the question to end all

881
00:39:03,290 --> 00:38:57,920
questions on sea level rise but it is

882
00:39:06,140 --> 00:39:03,300
just rolled away here how how much rise

883
00:39:08,650 --> 00:39:06,150
becomes significant enough to provoke a

884
00:39:12,170 --> 00:39:08,660
response and how do we plan accordingly

885
00:39:14,480 --> 00:39:12,180
for the medium to long term Virginia why

886
00:39:17,060 --> 00:39:14,490
don't we throw that to you first since

887
00:39:17,960 --> 00:39:17,070
you look mostly at mitigation and

888
00:39:28,740 --> 00:39:17,970

adaptation

889
00:39:35,070 --> 00:39:32,550
still systems often are noted to have a

890
00:39:37,740 --> 00:39:35,080
threshold at which a response is very

891
00:39:41,040 --> 00:39:37,750
evident to us you know just a gradual

892
00:39:44,190 --> 00:39:41,050
increase in sea level may occur and have

893
00:39:47,190 --> 00:39:44,200
very minor impacts on the rate of

894
00:39:49,830 --> 00:39:47,200
erosion or retreat of a shoreline until

895
00:39:51,600 --> 00:39:49,840
a storm comes along and then we see

896
00:39:54,270 --> 00:39:51,610
these dramatic changes I think we have a

897
00:39:58,500 --> 00:39:54,280
graphic showing a dolphin island off of

898
00:40:00,510 --> 00:39:58,510
the Alabama coast you know this is a

899
00:40:03,060 --> 00:40:00,520
real good example of how a threshold has

900
00:40:05,430 --> 00:40:03,070
been breached here the Chandeleur

901
00:40:09,960 --> 00:40:05,440
Islands and I can think of many places

902
00:40:11,760 --> 00:40:09,970
where the responsibility' system may go

903
00:40:15,330 --> 00:40:11,770
along very slow and then all of a sudden

904
00:40:17,640 --> 00:40:15,340
you may have the salinity change to a

905
00:40:20,370 --> 00:40:17,650
point where the forest will die off

906
00:40:23,310 --> 00:40:20,380
we've seen that off of off the Florida

907
00:40:26,310 --> 00:40:23,320
coast for example so there are

908
00:40:30,090 --> 00:40:26,320
thresholds and systems and that's why

909
00:40:32,250 --> 00:40:30,100
it's you can't just project you know us

910
00:40:34,530 --> 00:40:32,260
wide or even globally exactly how much

911
00:40:37,800 --> 00:40:34,540
land will be lost at a certain rate of

912
00:40:40,050 --> 00:40:37,810
sea level rise because each system has

913
00:40:43,830 --> 00:40:40,060

its own internal responses depending

914
00:40:46,500 --> 00:40:43,840
upon the rate of uplift or subsidence

915
00:40:49,140 --> 00:40:46,510
their salinity tolerance of the plants

916
00:40:51,300 --> 00:40:49,150
that bind the soil you know a lot of

917
00:40:53,640 --> 00:40:51,310
variables influence that coastal

918
00:40:55,110 --> 00:40:53,650
response but the question that we have

919
00:40:58,640 --> 00:40:55,120
kind of points to this fact that there

920
00:41:01,320 --> 00:40:58,650
are thresholds in systems and we have

921
00:41:04,170 --> 00:41:01,330
some evidence that thresholds have been

922
00:41:06,690 --> 00:41:04,180
crossed in some US coastal systems in

923
00:41:09,720 --> 00:41:06,700
terms of their ability to keep pace with

924
00:41:12,030 --> 00:41:09,730
sea level rise marshes accumulate

925
00:41:13,890 --> 00:41:12,040
material vertically but it comes to a

926
00:41:15,990 --> 00:41:13,900
point where they can't keep pace if sea

927
00:41:18,510 --> 00:41:16,000
level rise accelerates and they

928
00:41:21,240 --> 00:41:18,520
ultimately they they can be drowned in

929
00:41:25,170 --> 00:41:21,250
place rather than either accreting

930
00:41:26,580 --> 00:41:25,180
vertically or migrating inland one thing

931
00:41:28,080 --> 00:41:26,590
one thing I would add to what Virginia

932
00:41:29,520 --> 00:41:28,090
is saying at Virginia actually mentioned

933
00:41:30,900 --> 00:41:29,530
it earlier and that is that that the

934
00:41:33,840 --> 00:41:30,910
interaction of sea level rise with

935
00:41:35,610 --> 00:41:33,850
storms is also something to really keep

936
00:41:36,930 --> 00:41:35,620
in mind picking these low-lying areas

937
00:41:39,030 --> 00:41:36,940
you know like you know in New Orleans

938
00:41:40,590 --> 00:41:39,040

and the Gulf Coast it's not just a sea

939
00:41:41,770 --> 00:41:40,600
level rise inundating its sea level rise

940
00:41:44,170 --> 00:41:41,780
coupled with storm

941
00:41:45,880 --> 00:41:44,180
or more frequent storms buzzing causing

942
00:41:46,270 --> 00:41:45,890
the some of those two things to to

943
00:41:48,490 --> 00:41:46,280
inundate

944
00:41:49,600 --> 00:41:48,500
much more areas of course the kind of

945
00:41:52,240 --> 00:41:49,610
things you saw with Katrina are with

946
00:41:53,650 --> 00:41:52,250
with other other storm activities you

947
00:41:55,480 --> 00:41:53,660
could certainly get a lot worse and so

948
00:41:56,620 --> 00:41:55,490
those it's not just straight sea-level

949
00:41:58,600 --> 00:41:56,630
you know coming up like a bathtub

950
00:42:01,960 --> 00:41:58,610
filling it's it's that plus storm surge

951
00:42:03,550 --> 00:42:01,970
right I mean let me uh thanks for

952
00:42:04,990 --> 00:42:03,560
throwing that in Michaels that actually

953
00:42:07,000 --> 00:42:05,000
answered a number of questions that had

954
00:42:10,120 --> 00:42:07,010
come in people are asking about the link

955
00:42:12,070 --> 00:42:10,130
between how silver ice will affect other

956
00:42:14,380 --> 00:42:12,080
weather phenomenon we have two questions

957
00:42:15,940 --> 00:42:14,390
here that that kind of go together so

958
00:42:18,790 --> 00:42:15,950
I'll throw these out one is from Bruce

959
00:42:21,610 --> 00:42:18,800
Caron one is from congressional

960
00:42:23,620 --> 00:42:21,620
committee it says are there new NASA

961
00:42:25,810 --> 00:42:23,630
data resources that are planned to help

962
00:42:28,990 --> 00:42:25,820
study sea level changes in the next 10

963
00:42:31,390 --> 00:42:29,000

years and similarly what further

964
00:42:32,770 --> 00:42:31,400
research investments are necessary to

965
00:42:34,540 --> 00:42:32,780
better understand the relationship

966
00:42:38,710 --> 00:42:34,550
between sea level rise and extreme

967
00:42:43,210 --> 00:42:38,720
weather Michael as the as the engineer

968
00:42:44,620 --> 00:42:43,220
may be looking sure so so we have we

969
00:42:46,540 --> 00:42:44,630
have two satellites that have measured

970
00:42:49,420 --> 00:42:46,550
the ice sheets a lot by the way and

971
00:42:51,250 --> 00:42:49,430
that's the ice at and grace and we

972
00:42:53,710 --> 00:42:51,260
actually have replacements for both of

973
00:42:56,290 --> 00:42:53,720
those missions in work by NASA so we

974
00:42:58,420 --> 00:42:56,300
have a an ice at two coming that should

975
00:43:00,250 --> 00:42:58,430
make very detailed measurements of the

976
00:43:01,870 --> 00:43:00,260
elevation of the ice sheets over

977
00:43:03,760 --> 00:43:01,880
Greenland and Antarctica to help us

978
00:43:05,800 --> 00:43:03,770
understand the kind of questions that

979
00:43:07,540 --> 00:43:05,810
sophie was talking about we also have a

980
00:43:09,130 --> 00:43:07,550
grace basically grace - a grace

981
00:43:10,750 --> 00:43:09,140
follow-on mission that's going to

982
00:43:13,420 --> 00:43:10,760
continue doing this weighing of the ice

983
00:43:15,160 --> 00:43:13,430
sheets every month so that again we can

984
00:43:17,560 --> 00:43:15,170
try to understand that glacial

985
00:43:18,820 --> 00:43:17,570
contributions to to sea-level rise and

986
00:43:21,430 --> 00:43:18,830
to try to get a better understanding

987
00:43:23,320 --> 00:43:21,440
what physical climate process is causing

988
00:43:25,510 --> 00:43:23,330

that that I smell

989
00:43:28,270 --> 00:43:25,520
we also continue our series of

990
00:43:30,550 --> 00:43:28,280
observations of the ocean surface we

991
00:43:31,750 --> 00:43:30,560
have a joint series of missions that

992
00:43:34,050 --> 00:43:31,760
have been going for about twenty years

993
00:43:37,330 --> 00:43:34,060
with with with the French Space Agency

994
00:43:38,980 --> 00:43:37,340
we call those the Jason satellites and

995
00:43:41,470 --> 00:43:38,990
they measure the sea surface height very

996
00:43:43,150 --> 00:43:41,480
accurately and the sea surface height is

997
00:43:44,740 --> 00:43:43,160
a combination of how much water's in the

998
00:43:46,990 --> 00:43:44,750
ocean as well as how much is thermally

999
00:43:49,000 --> 00:43:47,000
expanding and by comparing those

1000
00:43:51,490 --> 00:43:49,010
measurements with with race measurements

1001
00:43:54,370 --> 00:43:51,500
and with some Institute measurements of

1002
00:43:55,480 --> 00:43:54,380
the of the temperature and salinity in

1003
00:43:57,220 --> 00:43:55,490
the ocean we can get

1004
00:43:59,140 --> 00:43:57,230
much better idea what's what's driving

1005
00:44:01,540 --> 00:43:59,150
sea level rise from the oceanographic

1006
00:44:03,820 --> 00:44:01,550
perspective as well and so we continue

1007
00:44:05,260 --> 00:44:03,830
these kind of measurements you know for

1008
00:44:07,270 --> 00:44:05,270
the next decade or so we think it will

1009
00:44:09,250 --> 00:44:07,280
help in addition to all of the airborne

1010
00:44:11,740 --> 00:44:09,260
and institutional field campaigns that

1011
00:44:14,500 --> 00:44:11,750
you know that folks are doing to try to

1012
00:44:15,940 --> 00:44:14,510
try to try to get a handle on this and

1013
00:44:17,500 --> 00:44:15,950

you know when I talk about sea level

1014
00:44:19,830 --> 00:44:17,510
rise here you guys Josh said in the very

1015
00:44:23,410 --> 00:44:19,840
beginning of this sea level rise is an

1016
00:44:24,820 --> 00:44:23,420
indicator of what's going on in on the

1017
00:44:26,350 --> 00:44:24,830
earth right it's not it's not the cause

1018
00:44:28,840 --> 00:44:26,360
it's the result of things that are going

1019
00:44:31,810 --> 00:44:28,850
on so in fact we also continue all of

1020
00:44:33,160 --> 00:44:31,820
the weather observations and atmospheric

1021
00:44:34,630 --> 00:44:33,170
observations as well to try to

1022
00:44:37,359 --> 00:44:34,640
understand you know our precipitation

1023
00:44:38,920 --> 00:44:37,369
patterns changing you know is that

1024
00:44:41,830 --> 00:44:38,930
mysteric temperature changing and how do

1025
00:44:43,750 --> 00:44:41,840
those interact with you know kind of

1026
00:44:45,580 --> 00:44:43,760
factors particularly the ice sheets that

1027
00:44:49,600 --> 00:44:45,590
are that are driving sea level sea level

1028
00:44:50,920 --> 00:44:49,610
rise so if I sorry

1029
00:44:53,200 --> 00:44:50,930
well actually this question is for all

1030
00:44:55,930 --> 00:44:53,210
of you but Michael particularly looking

1031
00:44:58,180 --> 00:44:55,940
at these planned projects how many of

1032
00:45:01,930 --> 00:44:58,190
them are secure in terms of our budget

1033
00:45:04,630 --> 00:45:01,940
given what's going on with discussions

1034
00:45:06,700 --> 00:45:04,640
in Washington I think the ones I

1035
00:45:09,340 --> 00:45:06,710
mentioned are pretty secure they're well

1036
00:45:12,190 --> 00:45:09,350
into development so you know the the

1037
00:45:12,790 --> 00:45:12,200
Jason missions the race follow-on and

1038
00:45:14,890 --> 00:45:12,800

icesat-2

1039
00:45:16,810 --> 00:45:14,900
are deep into development and I think

1040
00:45:18,700 --> 00:45:16,820
those are you know very very high

1041
00:45:20,590 --> 00:45:18,710
probability that those will continue and

1042
00:45:22,090 --> 00:45:20,600
in fact the support for earth science is

1043
00:45:24,790 --> 00:45:22,100
actually quite strong now and so there's

1044
00:45:26,380 --> 00:45:24,800
a pretty robust observation program to

1045
00:45:27,970 --> 00:45:26,390
help us you know sort out what's what's

1046
00:45:30,460 --> 00:45:27,980
really going on and I think those

1047
00:45:31,540 --> 00:45:30,470
missions are pretty pretty see Josh did

1048
00:45:33,520 --> 00:45:31,550
you have a comment you're gonna make

1049
00:45:37,980 --> 00:45:33,530
there well yeah and just to tack on to

1050
00:45:42,280 --> 00:45:37,990
that you know I think the you know

1051
00:45:44,410 --> 00:45:42,290
missions being safe is a is sort of a

1052
00:45:47,950 --> 00:45:44,420
relative term we we've continued to

1053
00:45:50,710 --> 00:45:47,960
struggle with budget issues even on the

1054
00:45:53,770 --> 00:45:50,720
Jason missions where they've continued

1055
00:45:58,599 --> 00:45:53,780
to cause delays in the launch and I

1056
00:46:01,900 --> 00:45:58,609
think that you know as an agency NASA

1057
00:46:04,210 --> 00:46:01,910
and its partners are in some ways

1058
00:46:09,699 --> 00:46:04,220
actually struggling to figure out how to

1059
00:46:14,819 --> 00:46:09,709
make ongoing repetitive missions HAP

1060
00:46:19,539 --> 00:46:14,829
and tied together these long records of

1061
00:46:21,130 --> 00:46:19,549
of measurements from space it's a it's

1062
00:46:22,779 --> 00:46:21,140
an engineering challenge but it's it's

1063
00:46:27,999 --> 00:46:22,789

more than that I think it's really a

1064
00:46:30,689 --> 00:46:28,009
challenge to our our our persistence and

1065
00:46:33,989 --> 00:46:30,699
a challenge to our will to keep these

1066
00:46:36,449 --> 00:46:33,999
these missions flying and to make them

1067
00:46:40,899 --> 00:46:36,459
continuous from one mission to the next

1068
00:46:42,969 --> 00:46:40,909
so while you know a lot of as mike says

1069
00:46:46,329 --> 00:46:42,979
a you know a lot of the things on the

1070
00:46:50,279 --> 00:46:46,339
horizon have a positive outlook you know

1071
00:46:54,159 --> 00:46:50,289
we're not we're not ringing alarm bells

1072
00:46:56,620 --> 00:46:54,169
there are still challenges both both

1073
00:47:00,099 --> 00:46:56,630
scientific scientific engineering and

1074
00:47:05,439 --> 00:47:00,109
budgetary so we have to continue to be

1075
00:47:09,609 --> 00:47:05,449
vigilant here and you know press that

1076
00:47:11,789 --> 00:47:09,619
these things carry on making making

1077
00:47:15,429 --> 00:47:11,799
continuous measurements isn't easy and

1078
00:47:17,979 --> 00:47:15,439
it requires a certain will to do so and

1079
00:47:19,449 --> 00:47:17,989
we're still we're still trying to figure

1080
00:47:24,429 --> 00:47:19,459
out how to demonstrate that we actually

1081
00:47:25,979 --> 00:47:24,439
have that we'll just a real quick

1082
00:47:28,149 --> 00:47:25,989
follow-up to that

1083
00:47:30,249 --> 00:47:28,159
Michael you talked about budget being

1084
00:47:31,959 --> 00:47:30,259
secure and you feel okay with that but

1085
00:47:33,999 --> 00:47:31,969
what about the timeline getting to

1086
00:47:38,289 --> 00:47:34,009
Josh's point about continuity of

1087
00:47:40,479 --> 00:47:38,299
measurements if it says the timeline

1088
00:47:41,499 --> 00:47:40,489

seen seen okay well that's it that's a

1089
00:47:42,909 --> 00:47:41,509
good question I think you know we

1090
00:47:44,649 --> 00:47:42,919
started this off talking you know to in

1091
00:47:46,120 --> 00:47:44,659
response to your original question which

1092
00:47:47,919 --> 00:47:46,130
is you know how much do you have to

1093
00:47:50,439 --> 00:47:47,929
measure in order until you understand

1094
00:47:51,759 --> 00:47:50,449
and I think we've had a hard time saying

1095
00:47:53,769 --> 00:47:51,769
you know one missions and now five years

1096
00:47:55,029 --> 00:47:53,779
is enough for ten years enough it may

1097
00:47:56,709 --> 00:47:55,039
turn out because of the complexity of

1098
00:47:58,870 --> 00:47:56,719
the system that we need you know as long

1099
00:48:01,209 --> 00:47:58,880
series of missions and I think Josh's

1100
00:48:03,309 --> 00:48:01,219
point is we're you know we're we have to

1101
00:48:05,109 --> 00:48:03,319
learn how to do that you know as a u.s.

1102
00:48:07,899 --> 00:48:05,119
offensive society yeah how are we going

1103
00:48:09,459 --> 00:48:07,909
to invest in long term observations and

1104
00:48:11,259 --> 00:48:09,469
you know until we understand it and how

1105
00:48:12,429 --> 00:48:11,269
well do you have to understand it in

1106
00:48:14,169 --> 00:48:12,439
order to answer pressing societal

1107
00:48:16,359 --> 00:48:14,179
questions you know what when our

1108
00:48:19,059 --> 00:48:16,369
coastlines in jeopardy or other

1109
00:48:21,249 --> 00:48:19,069
ecosystems and and actually you know in

1110
00:48:22,539 --> 00:48:21,259
xop was talking about this too we

1111
00:48:22,870 --> 00:48:22,549
actually don't quite know the answer to

1112
00:48:24,640 --> 00:48:22,880
this

1113
00:48:26,590 --> 00:48:24,650

so we are still learning how much

1114
00:48:28,780 --> 00:48:26,600
observation we need to answer the most

1115
00:48:31,120 --> 00:48:28,790
pressing questions and in that sense

1116
00:48:32,500 --> 00:48:31,130
it's not easy to say one you know just

1117
00:48:34,180 --> 00:48:32,510
find one more mission and that's enough

1118
00:48:35,500 --> 00:48:34,190
and so we're you know I think it's a

1119
00:48:36,880 --> 00:48:35,510
science community and engineering

1120
00:48:39,040 --> 00:48:36,890
community are working together to try to

1121
00:48:40,600 --> 00:48:39,050
get a better answer to that question so

1122
00:48:42,790 --> 00:48:40,610
that it's not an infinite amount of

1123
00:48:45,580 --> 00:48:42,800
money forever but but it's not one more

1124
00:48:48,670 --> 00:48:45,590
mission either I think I wanted to I

1125
00:48:52,120 --> 00:48:48,680
wanted to add to this point Michael that

1126
00:48:55,240 --> 00:48:52,130
you're very right of the difficulty when

1127
00:48:56,320 --> 00:48:55,250
you have a budget that's defined is that

1128
00:48:59,590 --> 00:48:56,330
you have to find the right balance

1129
00:49:02,380 --> 00:48:59,600
between how much you are willing to

1130
00:49:05,380 --> 00:49:02,390
continue observing the way you are and

1131
00:49:07,900 --> 00:49:05,390
the current mission si did for many many

1132
00:49:09,550 --> 00:49:07,910
years and how much you want to develop

1133
00:49:11,470 --> 00:49:09,560
new missions that are going to tell you

1134
00:49:14,620 --> 00:49:11,480
something new and it's a very tough

1135
00:49:17,320 --> 00:49:14,630
balance because the long-term trends for

1136
00:49:19,510 --> 00:49:17,330
example that gives you information on

1137
00:49:21,160 --> 00:49:19,520
the how the surface temperature have

1138
00:49:24,180 --> 00:49:21,170

changed over the ice sheets since the

1139
00:49:26,680 --> 00:49:24,190
70s I extremely important in order to

1140
00:49:29,080 --> 00:49:26,690
understand what's happening and for the

1141
00:49:32,980 --> 00:49:29,090
modeling to test the models so you need

1142
00:49:35,230 --> 00:49:32,990
to continue them and at the same time as

1143
00:49:36,940 --> 00:49:35,240
I mentioned I think before it's too late

1144
00:49:38,950 --> 00:49:36,950
for me the biggest unknown is what's

1145
00:49:41,580 --> 00:49:38,960
happening beneath the bed and so I would

1146
00:49:44,550 --> 00:49:41,590
have never loved next set to invest into

1147
00:49:47,010 --> 00:49:44,560
missions that will tell you more about

1148
00:49:50,680 --> 00:49:47,020
conditions underneath the ice sheet and

1149
00:49:53,410 --> 00:49:50,690
NSM MSV it's a very hard trade-off to

1150
00:49:55,120 --> 00:49:53,420
know really do you need to have

1151
00:49:58,120 --> 00:49:55,130
something new or do you continued a long

1152
00:49:59,830 --> 00:49:58,130
time and it's I think it the right way

1153
00:50:01,570 --> 00:49:59,840
is to come to both because for the

1154
00:50:03,790 --> 00:50:01,580
modeling part of you you need to

1155
00:50:05,020 --> 00:50:03,800
understand the new new observations but

1156
00:50:10,000 --> 00:50:05,030
you also need to make sure you have

1157
00:50:12,370 --> 00:50:10,010
their very long-term trends okay let's

1158
00:50:15,060 --> 00:50:12,380
jump back we have a number of great

1159
00:50:17,260 --> 00:50:15,070
questions coming in here

1160
00:50:19,120 --> 00:50:17,270
tell me hello s is there any evidence

1161
00:50:22,180 --> 00:50:19,130
showing that the North Atlantic conveyor

1162
00:50:25,330 --> 00:50:22,190
belt is being affected by the melting of

1163
00:50:28,540 --> 00:50:25,340

the Greenland ice sheet that's a good

1164
00:50:31,120 --> 00:50:28,550
question the short answer is no there is

1165
00:50:34,420 --> 00:50:31,130
no evidence that the overturning

1166
00:50:36,600 --> 00:50:34,430
circulation which is popularly popularly

1167
00:50:39,270 --> 00:50:36,610
referred to as the conveyor belt

1168
00:50:42,720 --> 00:50:39,280
is is slowing down in response to

1169
00:50:44,520 --> 00:50:42,730
Greenland melting it's been predicted

1170
00:50:48,480 --> 00:50:44,530
that it will slow down over the next

1171
00:50:51,630 --> 00:50:48,490
hundred years but mostly not due to to

1172
00:50:53,460 --> 00:50:51,640
ice loss due to changes in just the

1173
00:50:54,930 --> 00:50:53,470
surface temperature of the oceans and

1174
00:50:59,010 --> 00:50:54,940
and the amount of rainfall on

1175
00:51:04,080 --> 00:50:59,020
evaporation and so forth but this is a

1176
00:51:07,470 --> 00:51:04,090
good point that we expect not just sea

1177
00:51:10,290 --> 00:51:07,480
levels to change but also ocean sort of

1178
00:51:13,380 --> 00:51:10,300
climate conditions to change in the

1179
00:51:15,500 --> 00:51:13,390
coming decades and century and these

1180
00:51:18,720 --> 00:51:15,510
will have implications on rainfall

1181
00:51:21,180 --> 00:51:18,730
regional climate and so forth and and

1182
00:51:23,460 --> 00:51:21,190
may eventually have some feedbacks in

1183
00:51:27,060 --> 00:51:23,470
terms of global climate but we really

1184
00:51:29,820 --> 00:51:27,070
don't yet see any major change in the

1185
00:51:35,940 --> 00:51:29,830
oceans conveyor belt or the overturning

1186
00:51:37,890 --> 00:51:35,950
circulation okay there's not like going

1187
00:51:40,620 --> 00:51:37,900
from Paul Magnus who asked what about

1188
00:51:42,930 --> 00:51:40,630

risk how do we apply the risk of a

1189
00:51:45,660 --> 00:51:42,940
2-meter potential to meter rise compared

1190
00:51:47,160 --> 00:51:45,670
to a five centimeter rise he says I

1191
00:51:51,000 --> 00:51:47,170
don't think people are adequately taking

1192
00:51:53,540 --> 00:51:51,010
into account risk here Virginia again is

1193
00:51:56,099 --> 00:51:53,550
that one that you want to pick up sure

1194
00:51:59,370 --> 00:51:56,109
very good question and a very good point

1195
00:52:02,700 --> 00:51:59,380
you know as has been explained very well

1196
00:52:05,580 --> 00:52:02,710
here we don't know exactly the rate of

1197
00:52:07,530 --> 00:52:05,590
future sea level rise and so what most

1198
00:52:10,890 --> 00:52:07,540
scientists have agreed to is kind of a

1199
00:52:17,190 --> 00:52:10,900
range of plausible changes in mean sea

1200
00:52:18,420 --> 00:52:17,200
level through this century and so what I

1201
00:52:20,780 --> 00:52:18,430
would advise and I work a lot with

1202
00:52:23,250 --> 00:52:20,790
coastal states and communities is

1203
00:52:25,890 --> 00:52:23,260
considering a range of sea level rise

1204
00:52:28,170 --> 00:52:25,900
the question for mr. Magnus is 2

1205
00:52:30,990 --> 00:52:28,180
centimeters versus 5 centimeters

1206
00:52:32,910 --> 00:52:31,000
well I would consider that range spike

1207
00:52:35,609 --> 00:52:32,920
meters I think centimeter versus 5

1208
00:52:39,480 --> 00:52:35,619
meters what is these two meters versus 5

1209
00:52:41,430 --> 00:52:39,490
centimeters yes and the rate of you know

1210
00:52:43,349 --> 00:52:41,440
if we were to pick one number we

1211
00:52:46,109 --> 00:52:43,359
probably give you the wrong number and

1212
00:52:48,450 --> 00:52:46,119
so in our reports then in our

1213
00:52:50,190 --> 00:52:48,460

assessments that we do internationally

1214
00:52:53,490 --> 00:52:50,200
and for the United States

1215
00:52:55,850 --> 00:52:53,500
presenting this range of change that the

1216
00:52:59,670 --> 00:52:55,860
scientists and the the modeling results

1217
00:53:01,350 --> 00:52:59,680
generally agree to in presenting you

1218
00:53:03,210 --> 00:53:01,360
with that range and how do you apply

1219
00:53:05,760 --> 00:53:03,220
that you know why such a large range

1220
00:53:09,390 --> 00:53:05,770
well as mr. Magus point said it depends

1221
00:53:11,730 --> 00:53:09,400
on how much risk that the community or

1222
00:53:13,380 --> 00:53:11,740
the industry is willing or needs to

1223
00:53:16,170 --> 00:53:13,390
consider if you're talking about

1224
00:53:17,880 --> 00:53:16,180
locating a power plant for example in a

1225
00:53:20,730 --> 00:53:17,890
coastal zone you might want to consider

1226
00:53:22,920 --> 00:53:20,740
that higher range is possible it's in

1227
00:53:25,290 --> 00:53:22,930
the literature even though the the mid

1228
00:53:27,000 --> 00:53:25,300
range may be one to four feet you know

1229
00:53:29,520 --> 00:53:27,010
some of the literature suggests it might

1230
00:53:31,470 --> 00:53:29,530
be higher if you're just restoring the

1231
00:53:33,270 --> 00:53:31,480
vegetation on a barrier island that

1232
00:53:35,520 --> 00:53:33,280
doesn't cost a lot of money that 2 meter

1233
00:53:37,890 --> 00:53:35,530
range may not be important to you so

1234
00:53:40,740 --> 00:53:37,900
like you pointed out considering the

1235
00:53:43,770 --> 00:53:40,750
risk you know using this range of

1236
00:53:45,690 --> 00:53:43,780
scenarios is important in Louisiana for

1237
00:53:52,080 --> 00:53:45,700
their their master plan and I said that

1238
00:53:54,440 --> 00:53:52,090

50% of the state was coastal Delta it's

1239
00:53:56,730 --> 00:53:54,450
honest 54 percent of the sales is

1240
00:53:58,350 --> 00:53:56,740
geologic floodplain but a lot of that

1241
00:54:01,140 --> 00:53:58,360
geologic floodplains in the coastal zone

1242
00:54:03,900 --> 00:54:01,150
and in their restoration plans they

1243
00:54:07,260 --> 00:54:03,910
consider two scenarios of sea level rise

1244
00:54:10,080 --> 00:54:07,270
a local range and a more aggressive

1245
00:54:11,940 --> 00:54:10,090
range of sea level rise and for every

1246
00:54:13,970 --> 00:54:11,950
project they have for their coastal

1247
00:54:17,220 --> 00:54:13,980
protection master plan they can analyze

1248
00:54:19,050 --> 00:54:17,230
cost and benefits under the low range II

1249
00:54:21,900 --> 00:54:19,060
and the high range and then they made

1250
00:54:25,440 --> 00:54:21,910
the decisions based upon that both

1251
00:54:30,780 --> 00:54:25,450
ranked the entire range not just of the

1252
00:54:32,820 --> 00:54:30,790
high or the low okay we got a number of

1253
00:54:35,340 --> 00:54:32,830
questions here actually wondering

1254
00:54:39,840 --> 00:54:35,350
whether sea level rise will affect the

1255
00:54:44,100 --> 00:54:39,850
Great Lakes is there any indication that

1256
00:54:47,940 --> 00:54:44,110
that would be the case I think the short

1257
00:54:49,230 --> 00:54:47,950
answer is no no okay different systems

1258
00:54:51,480 --> 00:54:49,240
entirely

1259
00:54:55,440 --> 00:54:51,490
okay can I kind of interject one thing

1260
00:54:57,120 --> 00:54:55,450
that's is related sure you year or so

1261
00:55:00,300 --> 00:54:57,130
ago I think Josh was involved in work

1262
00:55:02,160 --> 00:55:00,310
that showed that one of the big short

1263
00:55:03,990 --> 00:55:02,170

term I think you called it a pothole and

1264
00:55:05,850 --> 00:55:04,000
sea level rises Tran

1265
00:55:08,430 --> 00:55:05,860
was because a lot of water got piled up

1266
00:55:10,380 --> 00:55:08,440
on the continents which is kind of

1267
00:55:12,120 --> 00:55:10,390
relevant in a way you know could you get

1268
00:55:15,360 --> 00:55:12,130
at that that it isn't just thermal

1269
00:55:17,370 --> 00:55:15,370
expansion and and melting glaciers but

1270
00:55:19,260 --> 00:55:17,380
water on short timescales water can

1271
00:55:20,670 --> 00:55:19,270
actually just sort of move onto the land

1272
00:55:22,800 --> 00:55:20,680
if there's a lot of rain and that kind

1273
00:55:24,990 --> 00:55:22,810
of thing could you talk about that yeah

1274
00:55:28,350 --> 00:55:25,000
it was really neat it's kind of one of

1275
00:55:31,710 --> 00:55:28,360
the kind of one of the fun success

1276
00:55:33,990 --> 00:55:31,720
stories of our satellite missions we can

1277
00:55:37,380 --> 00:55:34,000
measure sea-level rise with an accuracy

1278
00:55:39,330 --> 00:55:37,390
of a few millimeters now over over a few

1279
00:55:43,230 --> 00:55:39,340
month period in terms of the global mean

1280
00:55:46,050 --> 00:55:43,240
and between 2010 and 2011 there was

1281
00:55:49,370 --> 00:55:46,060
about a five millimeter half a

1282
00:55:52,560 --> 00:55:49,380
centimeter drop in global sea level and

1283
00:55:55,260 --> 00:55:52,570
so we puzzled about it for a while how

1284
00:55:59,010 --> 00:55:55,270
we wondered well maybe the oceans cooled

1285
00:56:02,130 --> 00:55:59,020
off and shrank a little bit whenever

1286
00:56:04,320 --> 00:56:02,140
water gets warm it expands when it gets

1287
00:56:07,290 --> 00:56:04,330
cold it shrinks and this is a

1288
00:56:09,270 --> 00:56:07,300

contributor to sea-level change but it

1289
00:56:12,780 --> 00:56:09,280
turned out that that wasn't the case it

1290
00:56:15,690 --> 00:56:12,790
turned out that in fact water had been

1291
00:56:18,360 --> 00:56:15,700
evaporated out of the ocean rained down

1292
00:56:20,490 --> 00:56:18,370
over the continents and it was stored

1293
00:56:24,360 --> 00:56:20,500
there for a period of about six months

1294
00:56:26,400 --> 00:56:24,370
or a year and the reason we the reason

1295
00:56:29,310 --> 00:56:26,410
we know this thanks Andy there we go

1296
00:56:30,780 --> 00:56:29,320
yeah the reason we know this is really

1297
00:56:34,080 --> 00:56:30,790
because of one of our other satellite

1298
00:56:36,480 --> 00:56:34,090
missions called grace and grace is a

1299
00:56:39,750 --> 00:56:36,490
gravity mission that essentially weighs

1300
00:56:46,830 --> 00:56:39,760
the continents from space and you can

1301
00:56:51,210 --> 00:56:46,840
see a big loss in Mass in Australia and

1302
00:56:54,150 --> 00:56:51,220
in Brazil and this excuse me a gain in

1303
00:56:55,800 --> 00:56:54,160
mass in Australia in Brazil and a few

1304
00:56:58,560 --> 00:56:55,810
other places on the continents around

1305
00:57:02,490 --> 00:56:58,570
the planet and this gain essentially

1306
00:57:05,130 --> 00:57:02,500
equaled the amount of water lost from

1307
00:57:07,560 --> 00:57:05,140
the oceans so grace actually allowed us

1308
00:57:10,290 --> 00:57:07,570
to see the water disappear from the

1309
00:57:13,020 --> 00:57:10,300
oceans and then reappear over the

1310
00:57:15,790 --> 00:57:13,030
continents and it was in large part due

1311
00:57:19,240 --> 00:57:15,800
to climate

1312
00:57:23,320 --> 00:57:19,250
called El Nino error really the El Nino

1313
00:57:26,230 --> 00:57:23,330

of anemia oscillation in 2011 we had a

1314
00:57:29,950 --> 00:57:26,240
bigot for 2010 we had a big El Nino and

1315
00:57:33,010 --> 00:57:29,960
in 2011 we had a big menina and these

1316
00:57:35,560 --> 00:57:33,020
patterns in the pacific shift the jet

1317
00:57:38,050 --> 00:57:35,570
stream around and changed the regions

1318
00:57:41,470 --> 00:57:38,060
that receive most of the precipitation

1319
00:57:45,090 --> 00:57:41,480
and so in this case it worked in such a

1320
00:57:47,230 --> 00:57:45,100
way that that water was temporarily

1321
00:57:51,430 --> 00:57:47,240
evaporated out of the ocean and stored

1322
00:57:55,060 --> 00:57:51,440
on land was interesting was that because

1323
00:57:58,060 --> 00:57:55,070
we knew where the water kind of went we

1324
00:58:00,220 --> 00:57:58,070
had a good sense that it would run back

1325
00:58:04,210 --> 00:58:00,230
into the ocean fairly quickly and that's

1326
00:58:08,260 --> 00:58:04,220
exactly what happened in 2012 we had

1327
00:58:10,690 --> 00:58:08,270
extremely rapid sea level rise and it

1328
00:58:13,000 --> 00:58:10,700
essentially all the water that was sort

1329
00:58:19,120 --> 00:58:13,010
of temporarily stored one of running

1330
00:58:20,560 --> 00:58:19,130
back into the oceans okay we are we're

1331
00:58:22,260 --> 00:58:20,570
getting up against an hour here so if

1332
00:58:26,380 --> 00:58:22,270
you would do a couple quick questions

1333
00:58:28,600 --> 00:58:26,390
this one is this one is a little offbeat

1334
00:58:31,000 --> 00:58:28,610
but I thought it was an interesting

1335
00:58:36,490 --> 00:58:31,010
question and Michael this may be for you

1336
00:58:39,400 --> 00:58:36,500
I asked if sea level is rising what does

1337
00:58:40,960 --> 00:58:39,410
that mean as far as where say the height

1338
00:58:42,730 --> 00:58:40,970

of something like Mount Everest would be

1339
00:58:44,590 --> 00:58:42,740
calculated from huh

1340
00:58:46,330 --> 00:58:44,600
it's kind of a geek question in other

1341
00:58:48,310 --> 00:58:46,340
words we're always saying everything is

1342
00:58:50,230 --> 00:58:48,320
relative to what's at height above sea

1343
00:58:52,590 --> 00:58:50,240
level at what point does that change and

1344
00:58:57,180 --> 00:58:52,600
at what point does that change the

1345
00:59:00,670 --> 00:58:59,050
yeah that mean that's kind of

1346
00:59:03,280 --> 00:59:00,680
questioning you it's just a matter kind

1347
00:59:05,230 --> 00:59:03,290
of what we help each is to say it right

1348
00:59:07,780 --> 00:59:05,240
now we you know we we do give a height

1349
00:59:10,480 --> 00:59:07,790
above kind of an average surface kind of

1350
00:59:12,370 --> 00:59:10,490
an average mean sea level that means he

1351
00:59:14,860 --> 00:59:12,380
level is not not a real surface it's

1352
00:59:16,000 --> 00:59:14,870
kind of a fictitious surface because

1353
00:59:17,830 --> 00:59:16,010
there's waves and there's you know

1354
00:59:19,780 --> 00:59:17,840
oceanography going on all the time and

1355
00:59:22,450 --> 00:59:19,790
so we kind of have just chosen a

1356
00:59:25,150 --> 00:59:22,460
reference surface for you know for how

1357
00:59:26,800 --> 00:59:25,160
we measure Heights and and you know if

1358
00:59:28,570 --> 00:59:26,810
it changes significantly enough we could

1359
00:59:29,230 --> 00:59:28,580
choose you know fifty years or a hundred

1360
00:59:30,700 --> 00:59:29,240
years from

1361
00:59:33,460 --> 00:59:30,710
we could choose a different reference

1362
00:59:34,570 --> 00:59:33,470
height and there are international

1363
00:59:37,060 --> 00:59:34,580

believe it or not there are

1364
00:59:38,050 --> 00:59:37,070
international organizations that try to

1365
00:59:39,550 --> 00:59:38,060
make all countries have the same

1366
00:59:40,810 --> 00:59:39,560
reference heights and you know reference

1367
00:59:43,270 --> 00:59:40,820
everything to the same kind of zero

1368
00:59:44,950 --> 00:59:43,280
value and and and those international

1369
00:59:47,110 --> 00:59:44,960
organizations need and they try to make

1370
00:59:48,550 --> 00:59:47,120
sure that you know the heights in the US

1371
00:59:50,070 --> 00:59:48,560
and the heights in Germany or the you

1372
00:59:52,630 --> 00:59:50,080
know are reference to the same thing and

1373
00:59:54,550 --> 00:59:52,640
and and those groups will continue to

1374
00:59:56,470 --> 00:59:54,560
meet and and if it's a little rise a

1375
01:00:00,550 --> 00:59:56,480
significant they could they could choose

1376
01:00:02,110 --> 01:00:00,560
a new new reference value okay I've got

1377
01:00:04,810 --> 01:00:02,120
one more question and maybe I'll throw

1378
01:00:07,570 --> 01:00:04,820
it to to Andy for one final question to

1379
01:00:09,070 --> 01:00:07,580
wrap us up here but mine is and I don't

1380
01:00:12,220 --> 01:00:09,080
know if this is for for Sophie and

1381
01:00:16,840 --> 01:00:12,230
Virginia maybe and you may not know the

1382
01:00:19,830 --> 01:00:16,850
answer but coming up soon will be the v

1383
01:00:24,490 --> 01:00:19,840
IPCC report to kind of gives everyone a

1384
01:00:26,260 --> 01:00:24,500
baseline to talk about in terms of a lot

1385
01:00:28,510 --> 01:00:26,270
of climate change indicators and things

1386
01:00:29,710 --> 01:00:28,520
are going on with sea level rise the big

1387
01:00:32,620 --> 01:00:29,720
thing last time was that it did not

1388
01:00:35,140 --> 01:00:32,630

include contribution the projections did

1389
01:00:37,810 --> 01:00:35,150
not see the contribution from Antarctica

1390
01:00:40,600 --> 01:00:37,820
and Greenland can we expect that the

1391
01:00:44,020 --> 01:00:40,610
upcoming report this time will include

1392
01:00:48,730 --> 01:00:44,030
that or do we know I'll say definitely

1393
01:00:52,240 --> 01:00:48,740
yes it will for two I mean because

1394
01:00:54,940 --> 01:00:52,250
basically the fact that the projections

1395
01:00:56,920 --> 01:00:54,950
did not include any me a sheet the

1396
01:00:59,290 --> 01:00:56,930
everyone in the physiology community so

1397
01:01:01,450 --> 01:00:59,300
all of the modelers and the field

1398
01:01:03,240 --> 01:01:01,460
scientists took that kind of badly we

1399
01:01:06,580 --> 01:01:03,250
can I thought that we were not

1400
01:01:08,260 --> 01:01:06,590
contributing her doing a job well and so

1401
01:01:10,150 --> 01:01:08,270
we really focused a task I have here

1402
01:01:12,730 --> 01:01:10,160
some trying to kind of improve our

1403
01:01:16,690 --> 01:01:12,740
understanding in particular there has

1404
01:01:19,870 --> 01:01:16,700
been a huge efforts in Europe's critical

1405
01:01:21,630 --> 01:01:19,880
ice to see there was a lot of scientists

1406
01:01:25,000 --> 01:01:21,640
involved I'm to take for that question

1407
01:01:28,110 --> 01:01:25,010
NASA had its own little effort called

1408
01:01:31,540 --> 01:01:28,120
the sea rise which helps i'm khalid and

1409
01:01:35,790 --> 01:01:31,550
where basically we took all the existing

1410
01:01:39,470 --> 01:01:35,800
Isak models that we had and try to

1411
01:01:43,880 --> 01:01:39,480
understand the future dynamics so

1412
01:01:46,610 --> 01:01:43,890
what we're finding is that it's actually

1413
01:01:50,120 --> 01:01:46,620

quite tricky to include the dynamical

1414
01:01:52,700 --> 01:01:50,130
response because of factors that I had

1415
01:01:54,560 --> 01:01:52,710
mentioned at the beginning such like you

1416
01:01:56,390 --> 01:01:54,570
don't really know the settings or the

1417
01:01:58,220 --> 01:01:56,400
bad effects refining and it's becoming

1418
01:01:59,870 --> 01:01:58,230
quite important you don't really know

1419
01:02:04,520 --> 01:01:59,880
what your fifty four things are going to

1420
01:02:08,360 --> 01:02:04,530
be but you definitely will read in the

1421
01:02:12,040 --> 01:02:08,370
IPCC some of the improvements that we

1422
01:02:15,380 --> 01:02:12,050
have made over the last few years

1423
01:02:19,180 --> 01:02:15,390
okay great well Andy why books on - you

1424
01:02:23,030 --> 01:02:19,190
have a question to maybe wrap us up on

1425
01:02:27,140 --> 01:02:23,040
putting you on the spot on that but well

1426
01:02:29,180 --> 01:02:27,150
you know again 20 20 years ago 25 years

1427
01:02:31,640 --> 01:02:29,190
ago when I wrote my first long global

1428
01:02:36,380 --> 01:02:31,650
warming article and interviewed Kerry

1429
01:02:38,150 --> 01:02:36,390
Emanuel and Bob bottom ire and these

1430
01:02:42,140 --> 01:02:38,160
people about sea level rise the same

1431
01:02:44,570 --> 01:02:42,150
questions were had the same answer was

1432
01:02:49,580 --> 01:02:44,580
there was a rough sense of a three feet

1433
01:02:51,890 --> 01:02:49,590
rise possible by some point in the

1434
01:02:53,570 --> 01:02:51,900
century and we're kind of still there so

1435
01:02:56,810 --> 01:02:53,580
I guess at that's in that sense

1436
01:02:58,460 --> 01:02:56,820
societies I guess it doesn't sound like

1437
01:03:00,200 --> 01:02:58,470
society should stand and wait for

1438
01:03:02,030 --> 01:03:00,210

scientists to come out with some clearer

1439
01:03:05,090 --> 01:03:02,040
answer that we have to find a way to act

1440
01:03:08,150 --> 01:03:05,100
in coastal regions many of which are

1441
01:03:10,490 --> 01:03:08,160
implicitly vulnerable to coastal risks

1442
01:03:14,390 --> 01:03:10,500
like hurricanes New York City had a

1443
01:03:16,970 --> 01:03:14,400
terrible one in 1823 we just have to act

1444
01:03:18,830 --> 01:03:16,980
more wisely in these areas but is there

1445
01:03:20,030 --> 01:03:18,840
anything that this is it actually could

1446
01:03:21,950 --> 01:03:20,040
it'd be better for the science community

1447
01:03:23,840 --> 01:03:21,960
to say you know we're not gonna give you

1448
01:03:26,930 --> 01:03:23,850
a clear answer anytime soon you've got

1449
01:03:28,550 --> 01:03:26,940
to get busy now is that a better way do

1450
01:03:30,800 --> 01:03:28,560
you think to state the case rather than

1451
01:03:32,240 --> 01:03:30,810
and and and all the science is really

1452
01:03:35,360 --> 01:03:32,250
important but I just want to get the

1453
01:03:36,980 --> 01:03:35,370
sense that society too often has this

1454
01:03:38,660 --> 01:03:36,990
expectation well we'll learn more next

1455
01:03:41,060 --> 01:03:38,670
year therefore so we can just wait a

1456
01:03:43,670 --> 01:03:41,070
little longer is that is that it is that

1457
01:03:47,000 --> 01:03:43,680
kind of a not the way we should be

1458
01:03:51,140 --> 01:03:47,010
thinking societally I I think that's a

1459
01:03:53,180 --> 01:03:51,150
great question in the and I I think that

1460
01:03:55,579 --> 01:03:53,190
we have to begin to prepare

1461
01:03:58,069 --> 01:03:55,589
mean it's true that there's uncertainty

1462
01:03:59,900 --> 01:03:58,079
and it's important it's non-trivial

1463
01:04:02,150 --> 01:03:59,910

uncertainty you know there's the

1464
01:04:05,510 --> 01:04:02,160
difference between one foot and five or

1465
01:04:07,700 --> 01:04:05,520
six feet isn't is a big deal

1466
01:04:10,130 --> 01:04:07,710
but we are going to get some more sea

1467
01:04:13,309 --> 01:04:10,140
level rise there's no uncertainty about

1468
01:04:15,050 --> 01:04:13,319
the sign we we're and for centuries if

1469
01:04:17,960 --> 01:04:15,060
not millennia and for centuries if not

1470
01:04:21,319 --> 01:04:17,970
millennia the ocean continues to respond

1471
01:04:23,930 --> 01:04:21,329
to to the atmosphere that we create for

1472
01:04:25,880 --> 01:04:23,940
something like a thousand years and that

1473
01:04:28,579 --> 01:04:25,890
sea low sea level will continue to rise

1474
01:04:31,309 --> 01:04:28,589
over that period as well so we need to

1475
01:04:34,730 --> 01:04:31,319
prepare for sea level rise we can debate

1476
01:04:36,470 --> 01:04:34,740
how quickly and how much but we have to

1477
01:04:39,170 --> 01:04:36,480
start asking ourselves some tough

1478
01:04:41,569 --> 01:04:39,180
questions about what areas we want to

1479
01:04:44,000 --> 01:04:41,579
protect and what areas we need to

1480
01:04:51,109 --> 01:04:44,010
retrieve from it's really only a matter

1481
01:04:53,630 --> 01:04:51,119
of time okay well thanks everyone for

1482
01:04:55,849 --> 01:04:53,640
the panelists for taking part today and

1483
01:04:58,490 --> 01:04:55,859
thanks everyone online for for tuning in

1484
01:05:01,640 --> 01:04:58,500
and sending in some great questions this

1485
01:05:05,839 --> 01:05:01,650
will be archived immediately after we

1486
01:05:08,260 --> 01:05:05,849
wrap up here and available on the NASA

1487
01:05:12,530 --> 01:05:08,270
Explorer youtube account that's

1488
01:05:14,420 --> 01:05:12,540

youtube.com slash NASA Explorer and and

1489
01:05:17,660 --> 01:05:14,430
again thanks a lot we might be looking

1490
01:05:21,890 --> 01:05:17,670
to do a number of other climate topics

1491
01:05:22,780 --> 01:05:21,900
in the coming months so have a good