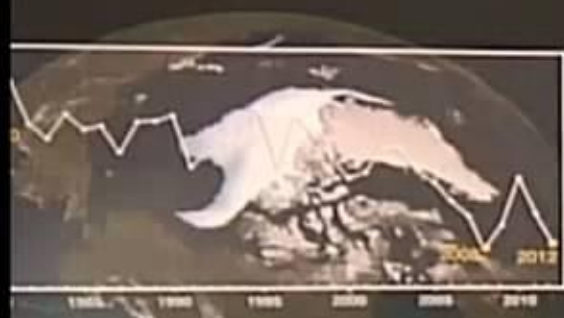


# What's Shrinking In The Arctic?

## Decline In Multi-year Arctic Sea Ice Area



## Glaciers On The Move

Godthabs Glacier in West Greenland



## 2011 Sea Ice Minimum

September 2011 Monthly Average



1  
00:00:07,749 --> 00:00:05,590  
hi everybody and welcome to washington

2  
00:00:10,070 --> 00:00:07,759  
dc we're here on the national mall to

3  
00:00:12,390 --> 00:00:10,080  
celebrate the big earth day celebration

4  
00:00:14,470 --> 00:00:12,400  
going on all weekend here on the mall my

5  
00:00:17,109 --> 00:00:14,480  
name is steve cole from nasa's office of

6  
00:00:19,029 --> 00:00:17,119  
communications and we have five earth

7  
00:00:21,750 --> 00:00:19,039  
scientists from nasa here to talk to you

8  
00:00:23,429 --> 00:00:21,760  
about how earth is changing how we see

9  
00:00:25,670 --> 00:00:23,439  
it from space and a lot of the new

10  
00:00:27,910 --> 00:00:25,680  
technology that we've been using to keep

11  
00:00:31,189 --> 00:00:27,920  
an eye on earth and how it's doing

12  
00:00:33,430 --> 00:00:31,199  
uh we're being broadcast on nasa tv

13  
00:00:35,030 --> 00:00:33,440

online on ustream we're going to take

14

00:00:38,069 --> 00:00:35,040

questions from the audience after each

15

00:00:41,110 --> 00:00:38,079

speaker and also online uh through the

16

00:00:43,430 --> 00:00:41,120

chat at ustream so our moderator for

17

00:00:45,510 --> 00:00:43,440

today for all the talks is tom wagner

18

00:00:49,110 --> 00:00:45,520

from nasa headquarters tom thank you

19

00:00:52,630 --> 00:00:50,950

my name is tom wagner i'm the cryosphere

20

00:00:53,910 --> 00:00:52,640

program scientist at nasa headquarters

21

00:00:55,990 --> 00:00:53,920

which means i'm in charge of studying

22

00:00:57,910 --> 00:00:56,000

the ice and sea level rise and change at

23

00:00:59,510 --> 00:00:57,920

the earth's poles and what we've got for

24

00:01:01,270 --> 00:00:59,520

you today is we've got five about four

25

00:01:03,349 --> 00:01:01,280

of our top earth scientists are here to

26

00:01:05,030 --> 00:01:03,359

tell you about the status of the earth

27

00:01:06,469 --> 00:01:05,040

from space the kinds of latest

28

00:01:07,750 --> 00:01:06,479

scientific results that we're seeing

29

00:01:09,830 --> 00:01:07,760

about the earth to give us kind of a

30

00:01:10,950 --> 00:01:09,840

checkup and report and so what we're

31

00:01:12,469 --> 00:01:10,960

going to do is we're going to have the

32

00:01:13,590 --> 00:01:12,479

speakers come up and talk for about 10

33

00:01:15,350 --> 00:01:13,600

minutes and then we're going to take

34

00:01:17,590 --> 00:01:15,360

questions live from you guys here in the

35

00:01:19,030 --> 00:01:17,600

audience and also online so all you kids

36

00:01:20,550 --> 00:01:19,040

out there when you're listening to talk

37

00:01:21,429 --> 00:01:20,560

think of things that you want to ask

38

00:01:23,109 --> 00:01:21,439

them

39

00:01:24,789 --> 00:01:23,119

now our first speaker is going to tell

40

00:01:26,870 --> 00:01:24,799

us about the human fingerprint of what

41

00:01:29,350 --> 00:01:26,880

we see from space his name is dr pierre

42

00:01:36,550 --> 00:01:29,360

sellars and he's also a nasa astronaut

43

00:01:43,350 --> 00:01:40,550

hi everybody is this working

44

00:01:46,789 --> 00:01:43,360

okay so how's everybody doing

45

00:01:48,710 --> 00:01:46,799

good anyone here want to go into space

46

00:01:50,469 --> 00:01:48,720

yeah anyone see the shuttle when it was

47

00:01:52,710 --> 00:01:50,479

flying around washington

48

00:01:55,670 --> 00:01:52,720

yeah okay i actually rode that thing

49

00:01:57,350 --> 00:01:55,680

into orbit which is very nice nice ride

50

00:01:58,389 --> 00:01:57,360

you get tremendous view looking down the

51

00:02:00,310 --> 00:01:58,399

world

52

00:02:03,270 --> 00:02:00,320

and then you can jump out of your

53

00:02:04,389 --> 00:02:03,280

spaceship a little white spacesuit and

54

00:02:05,670 --> 00:02:04,399

look down

55

00:02:06,870 --> 00:02:05,680

and at night

56

00:02:08,550 --> 00:02:06,880

you can really tell that there are

57

00:02:10,550 --> 00:02:08,560

people down there and the way you can

58

00:02:12,150 --> 00:02:10,560

tell is because the earth kind of looks

59

00:02:13,750 --> 00:02:12,160

like this

60

00:02:15,510 --> 00:02:13,760

now this is made up of a whole lot of

61

00:02:17,670 --> 00:02:15,520

photos taken on the night side from

62

00:02:20,309 --> 00:02:17,680

satellites and you can really tell where

63

00:02:21,670 --> 00:02:20,319

the people are you can tell where seven

64

00:02:24,309 --> 00:02:21,680

billion people

65

00:02:27,270 --> 00:02:24,319

that's all of you lot including me where

66

00:02:29,830 --> 00:02:27,280

seven billion people are living and

67

00:02:31,910 --> 00:02:29,840

working and doing stuff

68

00:02:33,350 --> 00:02:31,920

and you can tell where they're doing it

69

00:02:34,309 --> 00:02:33,360

so if you look carefully you can see

70

00:02:36,309 --> 00:02:34,319

that

71

00:02:37,910 --> 00:02:36,319

really densely populated areas like the

72

00:02:40,470 --> 00:02:37,920

east coast

73

00:02:42,309 --> 00:02:40,480

and europe tons and tons of people lots

74

00:02:44,390 --> 00:02:42,319

of city lights

75

00:02:45,830 --> 00:02:44,400

all kinds of people and then big chunks

76

00:02:47,589 --> 00:02:45,840

of the world like the middle of the

77

00:02:48,949 --> 00:02:47,599

amazon basin which my friend is going to

78

00:02:50,630 --> 00:02:48,959

talk about in a minute

79

00:02:52,630 --> 00:02:50,640

deserts of africa

80

00:02:54,390 --> 00:02:52,640

and the middle of australia

81

00:02:57,110 --> 00:02:54,400

very lonely places

82

00:02:58,710 --> 00:02:57,120

now one thing here this is very helpful

83

00:03:00,710 --> 00:02:58,720

if you want to rent a house somewhere in

84

00:03:02,149 --> 00:03:00,720

the world

85

00:03:03,350 --> 00:03:02,159

the bits with lots of lights are really

86

00:03:05,670 --> 00:03:03,360

expensive

87

00:03:06,869 --> 00:03:05,680

this is just so you know you look here's

88

00:03:07,990 --> 00:03:06,879

new york

89

00:03:10,149 --> 00:03:08,000

london

90

00:03:11,830 --> 00:03:10,159

tokyo they're really bright and the

91

00:03:13,830 --> 00:03:11,840

rents are sky high

92

00:03:15,350 --> 00:03:13,840

and i've been up to this place here this

93

00:03:17,830 --> 00:03:15,360

is actually an in which settlement and

94

00:03:19,190 --> 00:03:17,840

one light bulb is bravely glowing there

95

00:03:20,229 --> 00:03:19,200

and i got a really cheap bed for the

96

00:03:21,430 --> 00:03:20,239

night

97

00:03:22,869 --> 00:03:21,440

good to know

98

00:03:25,110 --> 00:03:22,879

okay the other things that's really

99

00:03:27,589 --> 00:03:25,120

interesting to note

100

00:03:29,910 --> 00:03:27,599

yeah okay can you hear me in the back

101  
00:03:32,470 --> 00:03:29,920  
i'll wave my arms all right the other

102  
00:03:33,990 --> 00:03:32,480  
thing is that lots of people live around

103  
00:03:35,670 --> 00:03:34,000  
the coasts

104  
00:03:37,030 --> 00:03:35,680  
all around the world lots of people like

105  
00:03:40,229 --> 00:03:37,040  
to live around the coast that's where

106  
00:03:41,910 --> 00:03:40,239  
the cities are to do trade ship things

107  
00:03:43,670 --> 00:03:41,920  
in and out and all the rest of it and

108  
00:03:46,070 --> 00:03:43,680  
with sea level rise that could be a

109  
00:03:47,110 --> 00:03:46,080  
little bit of a problem so keep your eye

110  
00:03:49,750 --> 00:03:47,120  
on that

111  
00:03:50,630 --> 00:03:49,760  
other things that you can see from space

112  
00:03:52,789 --> 00:03:50,640  
this

113  
00:03:55,350 --> 00:03:52,799

is a man-made island

114

00:03:57,429 --> 00:03:55,360

that is being built off dubai it's kind

115

00:03:59,589 --> 00:03:57,439

of tourist resort and all the rest of it

116

00:04:01,429 --> 00:03:59,599

some luxury homes and you can see this

117

00:04:03,429 --> 00:04:01,439

actually for out of your window from a

118

00:04:04,789 --> 00:04:03,439

space shuttle and they've been building

119

00:04:05,830 --> 00:04:04,799

it steadily and now this is what it

120

00:04:07,670 --> 00:04:05,840

looks like

121

00:04:10,309 --> 00:04:07,680

like a big palm tree

122

00:04:12,949 --> 00:04:10,319

quite amazing so people are actually

123

00:04:15,270 --> 00:04:12,959

changing the landscape that you can see

124

00:04:18,629 --> 00:04:15,280

with your naked eye from orbit

125

00:04:20,710 --> 00:04:18,639

the last thing i can show you here is

126

00:04:22,950 --> 00:04:20,720

uh some of the impacts that people have

127

00:04:25,749 --> 00:04:22,960

on the environment that are not so good

128

00:04:27,749 --> 00:04:25,759

this is mountain top mining in west

129

00:04:29,430 --> 00:04:27,759

virginia i think and what you can see is

130

00:04:30,870 --> 00:04:29,440

the technique here is you just shave off

131

00:04:31,909 --> 00:04:30,880

the top of the mountain to get at the

132

00:04:33,270 --> 00:04:31,919

coal

133

00:04:35,350 --> 00:04:33,280

and you can see what it does to the

134

00:04:37,350 --> 00:04:35,360

landscape over time

135

00:04:39,030 --> 00:04:37,360

makes quite a mess

136

00:04:41,350 --> 00:04:39,040

because the trees don't grow back very

137

00:04:43,270 --> 00:04:41,360

quickly the rain hits it and all this

138

00:04:45,110 --> 00:04:43,280

stuff washes off

139

00:04:46,950 --> 00:04:45,120

so you can see a lot from up there you

140

00:04:48,870 --> 00:04:46,960

can see what everybody's doing

141

00:04:51,189 --> 00:04:48,880

seven billion people now moving up to

142

00:04:53,510 --> 00:04:51,199

about nine and a half billion during my

143

00:04:54,550 --> 00:04:53,520

lifetime and then probably coming down

144

00:04:56,469 --> 00:04:54,560

slowly

145

00:04:57,909 --> 00:04:56,479

but all of them busy and all of them

146

00:05:03,350 --> 00:04:57,919

with the lights on

147

00:05:06,629 --> 00:05:04,710

anybody wants to know what it's like to

148

00:05:09,430 --> 00:05:06,639

fly in space

149

00:05:11,350 --> 00:05:09,440

very exciting let me tell you

150

00:05:12,950 --> 00:05:11,360

the launch really gets your attention

151  
00:05:14,790 --> 00:05:12,960

okay

152  
00:05:16,710 --> 00:05:14,800

yeah so now you've had this amazing

153  
00:05:20,310 --> 00:05:16,720

career being a climate change scientist

154  
00:05:24,950 --> 00:05:21,909

so when you were a kid like these guys

155  
00:05:26,390 --> 00:05:24,960

back to school

156  
00:05:28,070 --> 00:05:26,400

that made you go and study those hard

157  
00:05:29,909 --> 00:05:28,080

subjects like math and physics and stuff

158  
00:05:31,909 --> 00:05:29,919

like that to get to so you could do all

159  
00:05:33,749 --> 00:05:31,919

this that's a really good question two

160  
00:05:36,790 --> 00:05:33,759

things made me do it

161  
00:05:38,790 --> 00:05:36,800

one was that when i was a little kid

162  
00:05:40,550 --> 00:05:38,800

the americans which is where i am now

163  
00:05:42,390 --> 00:05:40,560

the americans were preparing to land on

164

00:05:44,150 --> 00:05:42,400

the moon and i saw that all on my little

165

00:05:45,830 --> 00:05:44,160

black and white tv in london and i

166

00:05:47,830 --> 00:05:45,840

thought it was the best things in sliced

167

00:05:49,270 --> 00:05:47,840

bread this was the most exciting thing

168

00:05:50,150 --> 00:05:49,280

that ever happened and you know the

169

00:05:52,390 --> 00:05:50,160

space

170

00:05:53,749 --> 00:05:52,400

exploration is something of our lifetime

171

00:05:55,670 --> 00:05:53,759

it's something of our generation and i

172

00:05:57,510 --> 00:05:55,680

still find it exciting and the other

173

00:06:00,150 --> 00:05:57,520

thing was i had great teachers that got

174

00:06:03,110 --> 00:06:00,160

me really interested in how beautiful

175

00:06:04,710 --> 00:06:03,120

physics biology mathematics is you know

176

00:06:06,629 --> 00:06:04,720

after a while i really appreciate how

177

00:06:08,390 --> 00:06:06,639

beautiful it is and all the cool things

178

00:06:09,749 --> 00:06:08,400

you can do and all the really

179

00:06:11,430 --> 00:06:09,759

interesting jobs you can do all the

180

00:06:12,870 --> 00:06:11,440

scientists around here by the way

181

00:06:14,469 --> 00:06:12,880

they work all the time do you know why

182

00:06:16,710 --> 00:06:14,479

they work all the time because their

183

00:06:19,189 --> 00:06:16,720

jobs are really cool it's fun it's a lot

184

00:06:20,950 --> 00:06:19,199

of fun it beats the heck out of most

185

00:06:22,870 --> 00:06:20,960

jobs so i'd encourage all your kids if

186

00:06:24,550 --> 00:06:22,880

you want an interesting life where enjoy

187

00:06:26,870 --> 00:06:24,560

your work and do good

188

00:06:28,950 --> 00:06:26,880

science much better than latin which i

189

00:06:31,110 --> 00:06:28,960

found very very hard

190

00:06:33,670 --> 00:06:31,120

any questions from out here steve any

191

00:06:35,430 --> 00:06:33,680

questions from online

192

00:06:36,629 --> 00:06:35,440

hey one other one then can you tell us a

193

00:06:37,990 --> 00:06:36,639

little bit i mean since you've been in

194

00:06:39,510 --> 00:06:38,000

space and been over can you tell us a

195

00:06:41,430 --> 00:06:39,520

little about how an image like this is

196

00:06:42,870 --> 00:06:41,440

made i mean that one over there that's

197

00:06:44,790 --> 00:06:42,880

the whole planet but a satellite doesn't

198

00:06:46,629 --> 00:06:44,800

see the whole planet all at once does it

199

00:06:48,550 --> 00:06:46,639

no no it doesn't the satellite basically

200

00:06:51,110 --> 00:06:48,560

is like a lawn mower it goes around the

201  
00:06:53,510 --> 00:06:51,120  
world like this taking long thin stripes

202  
00:06:56,390 --> 00:06:53,520  
of data and then afterwards we use

203  
00:06:58,550 --> 00:06:56,400  
computers and uh people to sort of match

204  
00:07:00,230 --> 00:06:58,560  
up all these stripes of data we get rid

205  
00:07:01,670 --> 00:07:00,240  
of the clouds by coming back if it's

206  
00:07:03,270 --> 00:07:01,680  
cloudy one day we come back another day

207  
00:07:05,909 --> 00:07:03,280  
when it's not cloudy so what you're

208  
00:07:07,270 --> 00:07:05,919  
looking at is a carefully selected set

209  
00:07:09,350 --> 00:07:07,280  
of views

210  
00:07:11,430 --> 00:07:09,360  
cloud-free perfect viewing conditions

211  
00:07:12,870 --> 00:07:11,440  
takes about a year to build this up all

212  
00:07:14,469 --> 00:07:12,880  
stitched together and you can't see the

213  
00:07:16,550 --> 00:07:14,479

lines in between because we do a very

214

00:07:18,309 --> 00:07:16,560

careful job of matching it up

215

00:07:19,990 --> 00:07:18,319

but this is made up of i think about you

216

00:07:21,029 --> 00:07:20,000

know dozens and dozens of different

217

00:07:23,029 --> 00:07:21,039

images

218

00:07:24,309 --> 00:07:23,039

yeah yeah somebody had a question yes

219

00:07:30,629 --> 00:07:24,319

sure we got a question right there the

220

00:07:33,749 --> 00:07:32,710

when's the next person going to space

221

00:07:36,870 --> 00:07:33,759

right

222

00:07:38,150 --> 00:07:36,880

where where well uh

223

00:07:39,110 --> 00:07:38,160

we think

224

00:07:41,189 --> 00:07:39,120

we hope

225

00:07:43,749 --> 00:07:41,199

that in about 20 years we're going to be

226

00:07:44,629 --> 00:07:43,759

sending people to mars to go around mars

227

00:07:45,990 --> 00:07:44,639

okay

228

00:07:47,749 --> 00:07:46,000

which would be very exciting because

229

00:07:50,790 --> 00:07:47,759

that's a long way away and mars is a

230

00:07:52,869 --> 00:07:50,800

planet that's really interesting

231

00:07:55,350 --> 00:07:52,879

i would i would like to go

232

00:07:58,710 --> 00:07:55,360

but probably a bit old

233

00:08:00,790 --> 00:07:58,720

lots of dust what's that lots of dust

234

00:08:02,469 --> 00:08:00,800

lots of dust lots of dust there yeah we

235

00:08:06,230 --> 00:08:02,479

need hey ryan is a question right

236

00:08:09,990 --> 00:08:07,670

i just want to know

237

00:08:10,869 --> 00:08:10,000

how long does it take from earth to uh

238

00:08:14,150 --> 00:08:10,879

mars

239

00:08:16,230 --> 00:08:14,160

right now

240

00:08:17,749 --> 00:08:16,240

we think it'd take about 200 days to get

241

00:08:19,830 --> 00:08:17,759

out there

242

00:08:21,189 --> 00:08:19,840

and uh if you just went to orbit around

243

00:08:23,670 --> 00:08:21,199

they probably spent about two months

244

00:08:26,230 --> 00:08:23,680

there then 200 days to get back if you

245

00:08:29,270 --> 00:08:26,240

wanted to land on there and run around

246

00:08:31,110 --> 00:08:29,280

it'd be 200 days out 500 days there

247

00:08:35,909 --> 00:08:31,120

200 back so it'd be best part of three

248

00:08:41,269 --> 00:08:37,909

so

249

00:08:43,269 --> 00:08:41,279

you have to bear that in mind

250

00:08:45,590 --> 00:08:43,279

all right one more question red shirt in

251  
00:08:45,590 --> 00:08:45,600  
the back

252  
00:08:50,470 --> 00:08:47,509  
can you elaborate on your comment

253  
00:08:52,150 --> 00:08:50,480  
earlier that uh expectation is that

254  
00:08:53,590 --> 00:08:52,160  
earth population will go up to eight or

255  
00:08:55,350 --> 00:08:53,600  
nine million and then or eight or nine

256  
00:08:57,030 --> 00:08:55,360  
billion and then start to come down at

257  
00:08:58,949 --> 00:08:57,040  
that point that that's what all the

258  
00:09:00,470 --> 00:08:58,959  
models and indication indications are

259  
00:09:01,590 --> 00:09:00,480  
telling us we're finding out that as

260  
00:09:03,350 --> 00:09:01,600  
more and more people are getting

261  
00:09:05,430 --> 00:09:03,360  
educated and literate then the families

262  
00:09:08,870 --> 00:09:05,440  
are getting smaller around the world and

263  
00:09:10,790 --> 00:09:08,880

uh we've seen that all over the world so

264

00:09:12,949 --> 00:09:10,800

what just bounced through seven billion

265

00:09:14,710 --> 00:09:12,959

a three to four months ago

266

00:09:15,829 --> 00:09:14,720

and the models tell us that it looks

267

00:09:17,670 --> 00:09:15,839

like it's going to top out somewhere

268

00:09:20,790 --> 00:09:17,680

around about nine and a half billion and

269

00:09:22,470 --> 00:09:20,800

then gradually ramped down slowly

270

00:09:23,670 --> 00:09:22,480

which is better than the 12 billion that

271

00:09:25,829 --> 00:09:23,680

everyone thought it was going to be when

272

00:09:27,350 --> 00:09:25,839

i was a kid you know so

273

00:09:29,990 --> 00:09:27,360

less impact

274

00:09:35,190 --> 00:09:30,000

all right hey pierce thank you very much

275

00:09:38,949 --> 00:09:37,430

hey so our next speaker is dr compton

276

00:09:40,790 --> 00:09:38,959

tucker who's going to give us a checkup

277

00:09:42,870 --> 00:09:40,800

on the health of the world's forest and

278

00:09:44,470 --> 00:09:42,880

tell us how we study those from space

279

00:09:45,990 --> 00:09:44,480

and one of the amazing things is not

280

00:09:47,750 --> 00:09:46,000

only has he studied in the space he's

281

00:09:49,350 --> 00:09:47,760

also spent a lot of time walking around

282

00:09:50,710 --> 00:09:49,360

in the jungles themselves and he may

283

00:09:52,550 --> 00:09:50,720

tell us some of those stories jim take

284

00:09:53,990 --> 00:09:52,560

it away okay thanks tom

285

00:09:55,590 --> 00:09:54,000

one of the really cool things about

286

00:09:57,350 --> 00:09:55,600

working for nasa and using satellite

287

00:09:58,790 --> 00:09:57,360

data to study the earth is you have to

288

00:10:00,550 --> 00:09:58,800

do field work to understand what you're

289

00:10:02,310 --> 00:10:00,560

seeing you can't just look at things

290

00:10:04,389 --> 00:10:02,320

from a distance and say well we see this

291

00:10:06,710 --> 00:10:04,399

or we see that but you have to go there

292

00:10:09,509 --> 00:10:06,720

in person and do field work in control

293

00:10:11,430 --> 00:10:09,519

settings i study tropical forests and i

294

00:10:13,509 --> 00:10:11,440

use satellite data for that and on the

295

00:10:16,630 --> 00:10:13,519

left-hand side we see some strips of

296

00:10:18,150 --> 00:10:16,640

satellite data from from one day in the

297

00:10:21,269 --> 00:10:18,160

1970s

298

00:10:25,990 --> 00:10:21,279

here we have something from from 1984

299

00:10:28,710 --> 00:10:26,000

1992 2001 and 2010.

300

00:10:30,310 --> 00:10:28,720

this is about 500 miles from top to

301  
00:10:32,630 --> 00:10:30,320  
bottom for each of these strips and the

302  
00:10:34,630 --> 00:10:32,640  
bottom distance is about 110 miles or

303  
00:10:36,790 --> 00:10:34,640  
about the distance from washington dc to

304  
00:10:39,110 --> 00:10:36,800  
philadelphia so you can use satellite

305  
00:10:41,829 --> 00:10:39,120  
data to study for us now this is a false

306  
00:10:43,190 --> 00:10:41,839  
color image looking down if we were in

307  
00:10:44,949 --> 00:10:43,200  
space or we were in the space shuttle

308  
00:10:47,509 --> 00:10:44,959  
and looking down these areas that are

309  
00:10:49,350 --> 00:10:47,519  
bright red would look bright green but

310  
00:10:51,430 --> 00:10:49,360  
we use some wavelengths which our eyes

311  
00:10:53,590 --> 00:10:51,440  
can't see and we have to then represent

312  
00:10:55,590 --> 00:10:53,600  
those in colors so we would never see an

313  
00:10:57,750 --> 00:10:55,600

image like this but all of these red

314

00:10:59,350 --> 00:10:57,760

areas are where we have tropical forests

315

00:11:01,430 --> 00:10:59,360

this is an area where i have worked

316

00:11:03,750 --> 00:11:01,440

extensively i've worked in this area

317

00:11:05,190 --> 00:11:03,760

which is close to santa cruz bolivia

318

00:11:07,590 --> 00:11:05,200

i've been all up through here i've spent

319

00:11:09,509 --> 00:11:07,600

a lot of time in a national park here

320

00:11:12,230 --> 00:11:09,519

and i've also worked up here on the

321

00:11:14,470 --> 00:11:12,240

border where every weekend or every

322

00:11:17,030 --> 00:11:14,480

other week we would go to get supplies

323

00:11:20,150 --> 00:11:17,040

and buy beer and do it on saturday

324

00:11:22,389 --> 00:11:20,160

because that was bingo night in a town

325

00:11:25,030 --> 00:11:22,399

called pimentetta in brazil

326  
00:11:26,710 --> 00:11:25,040  
and we always wanted to enter and would

327  
00:11:28,470 --> 00:11:26,720  
enter the bingo contest because the

328  
00:11:30,550 --> 00:11:28,480  
first prize we weren't interested in

329  
00:11:32,470 --> 00:11:30,560  
that was two frozen chickens but the

330  
00:11:34,790 --> 00:11:32,480  
second prize was a case

331  
00:11:37,910 --> 00:11:34,800  
of a brazilian beer called antarctica

332  
00:11:40,230 --> 00:11:37,920  
beer which you serve at about 33 degrees

333  
00:11:42,710 --> 00:11:40,240  
fahrenheit anyway so we always hope to

334  
00:11:44,310 --> 00:11:42,720  
win second prize uh if we won the first

335  
00:11:45,910 --> 00:11:44,320  
prize we would try and give it away

336  
00:11:47,750 --> 00:11:45,920  
because that was two frozen chickens

337  
00:11:49,829 --> 00:11:47,760  
anyway so in the 1970s when we had our

338  
00:11:52,550 --> 00:11:49,839

first earth day there was almost no

339

00:11:54,069 --> 00:11:52,560

disturbance of all of these red colors

340

00:11:55,670 --> 00:11:54,079

and then you see more of these blue

341

00:11:57,269 --> 00:11:55,680

colors come in and these patterns and

342

00:11:59,750 --> 00:11:57,279

this is because there was tropical

343

00:12:01,590 --> 00:11:59,760

forest clearing into agriculture and

344

00:12:04,069 --> 00:12:01,600

ranches so here we have a little bit of

345

00:12:07,910 --> 00:12:04,079

clearing in brazil here we have more and

346

00:12:09,430 --> 00:12:07,920

now we have a lot in 2001 2010

347

00:12:11,829 --> 00:12:09,440

and then also on the southern end in

348

00:12:14,389 --> 00:12:11,839

bolivia there was almost no

349

00:12:15,910 --> 00:12:14,399

expansion of agriculture into this area

350

00:12:17,350 --> 00:12:15,920

and then we see it starts to expand

351

00:12:19,350 --> 00:12:17,360

there are a few roads there are some

352

00:12:21,670 --> 00:12:19,360

features here and once again this is the

353

00:12:24,550 --> 00:12:21,680

distance from washington dc to

354

00:12:25,990 --> 00:12:24,560

philadelphia about 110 nautical miles

355

00:12:28,389 --> 00:12:26,000

then there's more and then all of a

356

00:12:30,230 --> 00:12:28,399

sudden bang the whole area goes

357

00:12:31,829 --> 00:12:30,240

but this actually is a good area to have

358

00:12:34,550 --> 00:12:31,839

agricultural development because the

359

00:12:36,150 --> 00:12:34,560

soils in this area are very very good

360

00:12:39,110 --> 00:12:36,160

whereas in tropical forests because it

361

00:12:40,310 --> 00:12:39,120

rains so much you tend to have bad soils

362

00:12:42,470 --> 00:12:40,320

up in here

363

00:12:44,069 --> 00:12:42,480

and so most of this area

364

00:12:46,470 --> 00:12:44,079

is still in tropical forests it's a

365

00:12:48,389 --> 00:12:46,480

really cool place to go i've had several

366

00:12:50,710 --> 00:12:48,399

expeditions there

367

00:12:52,790 --> 00:12:50,720

and when you do work in tropical forests

368

00:12:55,350 --> 00:12:52,800

you try and cover up as much of your

369

00:12:57,910 --> 00:12:55,360

body as you can because like today you

370

00:13:00,470 --> 00:12:57,920

perspire and when you sweat you tend to

371

00:13:02,310 --> 00:13:00,480

attract bees and wasps because they want

372

00:13:04,389 --> 00:13:02,320

to get salt

373

00:13:06,470 --> 00:13:04,399

in your perspiration and

374

00:13:08,389 --> 00:13:06,480

you're sort of like a walking salt lip

375

00:13:10,150 --> 00:13:08,399

so every day you have to bathe in rivers

376

00:13:11,910 --> 00:13:10,160

and wash your clothes out

377

00:13:14,870 --> 00:13:11,920

and also wash yourself or else it's

378

00:13:16,550 --> 00:13:14,880

worse the saltier you are

379

00:13:19,110 --> 00:13:16,560

and what bees and wasps do they're

380

00:13:20,629 --> 00:13:19,120

social insects we all know about science

381

00:13:22,389 --> 00:13:20,639

science technology

382

00:13:23,350 --> 00:13:22,399

engineering and math and these are

383

00:13:25,269 --> 00:13:23,360

really

384

00:13:26,870 --> 00:13:25,279

uh excellent areas to study if you're

385

00:13:29,110 --> 00:13:26,880

interested in science and there are many

386

00:13:31,910 --> 00:13:29,120

cool things to do so the bees and wasps

387

00:13:33,990 --> 00:13:31,920

being social insects then communicate

388

00:13:35,990 --> 00:13:34,000

where you are where all this salt is and

389

00:13:37,990 --> 00:13:36,000

it's on you and your clothes so the

390

00:13:39,829 --> 00:13:38,000

first day you might have 10 bees or

391

00:13:41,670 --> 00:13:39,839

wasps the next day 100 the next day a

392

00:13:43,509 --> 00:13:41,680

thousand and then

393

00:13:45,590 --> 00:13:43,519

i'm not exaggerating in the morning when

394

00:13:47,110 --> 00:13:45,600

you wake up after several days at a camp

395

00:13:49,350 --> 00:13:47,120

in the amazon

396

00:13:52,389 --> 00:13:49,360

you can hear as soon as the sun comes up

397

00:13:55,030 --> 00:13:53,910

and it's the bees and wasps coming

398

00:13:57,509 --> 00:13:55,040

they're not trying to bite you but

399

00:13:58,790 --> 00:13:57,519

they're just after the salt

400

00:14:02,150 --> 00:13:58,800

okay so

401

00:14:05,030 --> 00:14:02,160

what i found and my co-workers is in

402

00:14:07,910 --> 00:14:05,040

tropical forests uh in the amazon about

403

00:14:10,870 --> 00:14:07,920

15 of the amazon has been deforested and

404

00:14:12,550 --> 00:14:10,880

about 80 or 85 percent still remains and

405

00:14:15,750 --> 00:14:12,560

that's important because tropical

406

00:14:17,590 --> 00:14:15,760

forests have the greatest biological

407

00:14:20,470 --> 00:14:17,600

diversity or the greatest number of

408

00:14:22,389 --> 00:14:20,480

plants animals and also microbes

409

00:14:24,790 --> 00:14:22,399

bacteria and viruses

410

00:14:26,389 --> 00:14:24,800

on one expedition in this area with one

411

00:14:28,150 --> 00:14:26,399

of my co-workers he came down with hana

412

00:14:30,310 --> 00:14:28,160

virus

413

00:14:32,629 --> 00:14:30,320

he was unconscious for two or three

414

00:14:34,069 --> 00:14:32,639

weeks but when he was unconscious he

415

00:14:35,990 --> 00:14:34,079

stopped smoking

416

00:14:38,949 --> 00:14:36,000

and then he recovered and he has he has

417

00:14:41,110 --> 00:14:38,959

no recollection of going through

418

00:14:42,710 --> 00:14:41,120

smokers withdrawal when you try and stop

419

00:14:44,870 --> 00:14:42,720

smoking that's the only good thing about

420

00:14:47,350 --> 00:14:44,880

that but it's unusual when bad things

421

00:14:49,590 --> 00:14:47,360

happen and

422

00:14:52,150 --> 00:14:49,600

so what these images show is how we are

423

00:14:54,790 --> 00:14:52,160

transforming tropical forests here in

424

00:14:56,629 --> 00:14:54,800

brazil here in bolivia

425

00:14:58,550 --> 00:14:56,639

going from when we had the first earth

426

00:14:59,990 --> 00:14:58,560

day in the 1970s

427

00:15:01,350 --> 00:15:00,000

all the way through to just two years

428

00:15:02,870 --> 00:15:01,360

ago

429

00:15:04,870 --> 00:15:02,880

there is a national park but you can

430

00:15:06,949 --> 00:15:04,880

visit right in here called knoll camp

431

00:15:09,430 --> 00:15:06,959

national park it's a really cool place

432

00:15:10,949 --> 00:15:09,440

i've been there 10 or 15 times there are

433

00:15:13,030 --> 00:15:10,959

very very few people who visited every

434

00:15:15,350 --> 00:15:13,040

year maybe four or five thousand it's a

435

00:15:18,389 --> 00:15:15,360

great place to see river otters to see

436

00:15:21,509 --> 00:15:18,399

jaguars to see monkeys to see wild pigs

437

00:15:23,269 --> 00:15:21,519

or peccaries and lots and lots of really

438

00:15:25,110 --> 00:15:23,279

cool and colorful birds

439

00:15:26,470 --> 00:15:25,120

so i'll stop there and the reason that i

440

00:15:28,790 --> 00:15:26,480

got into this

441

00:15:30,870 --> 00:15:28,800

was i was working in a bank after i got

442

00:15:32,389 --> 00:15:30,880

my bachelor's degree in biology

443

00:15:34,870 --> 00:15:32,399

and i didn't like that bank so i went to

444

00:15:37,430 --> 00:15:34,880

another bank that was also really boring

445

00:15:39,030 --> 00:15:37,440

and so then i said i banking is not for

446

00:15:40,790 --> 00:15:39,040

me i've got to go back to graduate

447

00:15:42,710 --> 00:15:40,800

school and so i did

448

00:15:45,110 --> 00:15:42,720

and then when i finished graduate school

449

00:15:47,350 --> 00:15:45,120

i came to nasa and i've been there ever

450

00:15:50,310 --> 00:15:47,360

since and it's really really cool work

451  
00:15:51,509 --> 00:15:50,320  
because of my background in science

452  
00:15:53,509 --> 00:15:51,519  
and math

453  
00:15:54,790 --> 00:15:53,519  
so i'll stop there and answer any

454  
00:15:57,590 --> 00:15:54,800  
questions from the audience anything

455  
00:15:59,430 --> 00:15:57,600  
about tropical forests dangerous animals

456  
00:16:03,110 --> 00:15:59,440  
bees or wasps i have a lot of first

457  
00:16:06,829 --> 00:16:03,120  
person singular experience yes

458  
00:16:09,430 --> 00:16:06,839  
how many animals would you say are

459  
00:16:12,310 --> 00:16:09,440  
endangered by how many types of species

460  
00:16:13,990 --> 00:16:12,320  
of animals are endangered would you well

461  
00:16:15,509 --> 00:16:14,000  
there are quite a few

462  
00:16:17,430 --> 00:16:15,519  
endangered animals and where they are

463  
00:16:19,829 --> 00:16:17,440

endangered are where you have the

464

00:16:21,590 --> 00:16:19,839

destruction of habitat so even though i

465

00:16:24,230 --> 00:16:21,600

study tropical forests i'm very

466

00:16:25,990 --> 00:16:24,240

interested in identifying areas

467

00:16:27,430 --> 00:16:26,000

which

468

00:16:29,030 --> 00:16:27,440

where the forest is replaced with

469

00:16:31,110 --> 00:16:29,040

agricultural fields

470

00:16:33,189 --> 00:16:31,120

and then a biologist can use that

471

00:16:35,189 --> 00:16:33,199

information to see what animals there

472

00:16:37,189 --> 00:16:35,199

and plants are being endangered so

473

00:16:39,350 --> 00:16:37,199

that's a big part of what i do is give

474

00:16:40,949 --> 00:16:39,360

this information to people i work with

475

00:16:43,030 --> 00:16:40,959

who are biologists who study different

476

00:16:46,629 --> 00:16:43,040

types of animals perhaps butterflies

477

00:16:47,990 --> 00:16:46,639

perhaps jaguars or plants to tell where

478

00:16:51,829 --> 00:16:48,000

they should focus their studies and

479

00:16:56,629 --> 00:16:51,839

identify those animals at risk

480

00:17:02,389 --> 00:16:58,310

well

481

00:17:03,910 --> 00:17:02,399

see there aren't too many roads in this

482

00:17:05,029 --> 00:17:03,920

area there's one road that goes up like

483

00:17:07,510 --> 00:17:05,039

this

484

00:17:09,750 --> 00:17:07,520

and we have to do a lot of hiking we

485

00:17:11,909 --> 00:17:09,760

also sometimes on rivers go in boats

486

00:17:14,069 --> 00:17:11,919

that are called peki peki boats these

487

00:17:15,990 --> 00:17:14,079

are long dugout canoes with an

488

00:17:18,230 --> 00:17:16,000

industrial sort of lawnmower engine with

489

00:17:22,069 --> 00:17:18,240

a long propeller out the back and the

490

00:17:27,189 --> 00:17:24,549

and so you go down the rivers in boats

491

00:17:28,789 --> 00:17:27,199

like this uh because your first choice

492

00:17:31,029 --> 00:17:28,799

is to go on a road there aren't many

493

00:17:33,510 --> 00:17:31,039

roads so our next choice is by peki peki

494

00:17:35,669 --> 00:17:33,520

boats and the third choice you have to

495

00:17:37,669 --> 00:17:35,679

either make a trail and hike or find an

496

00:17:39,990 --> 00:17:37,679

existing trail and hike so if you like

497

00:17:41,350 --> 00:17:40,000

hiking if you like camping it's a great

498

00:17:43,270 --> 00:17:41,360

way to see some really really cool

499

00:17:44,310 --> 00:17:43,280

places and to encounter some really cool

500

00:17:45,590 --> 00:17:44,320

animals

501  
00:17:56,390 --> 00:17:45,600  
hey we got a couple of questions from

502  
00:18:01,750 --> 00:17:58,630  
well uh

503  
00:18:03,830 --> 00:18:01,760  
we use commercial satellite data where

504  
00:18:05,990 --> 00:18:03,840  
you can see people walking on the ground

505  
00:18:07,510 --> 00:18:06,000  
by the shadows they cast if you're

506  
00:18:09,909 --> 00:18:07,520  
looking straight down unless you were

507  
00:18:11,590 --> 00:18:09,919  
incredibly large like a hippopotamus you

508  
00:18:13,350 --> 00:18:11,600  
probably couldn't see you but you can

509  
00:18:16,230 --> 00:18:13,360  
see their shadow

510  
00:18:18,870 --> 00:18:16,240  
if the sun isn't directly overhead

511  
00:18:20,789 --> 00:18:18,880  
so yes by their shadows is the answer

512  
00:18:23,430 --> 00:18:20,799  
okay another different question about

513  
00:18:26,390 --> 00:18:23,440

deforestation is nasa doing research in

514

00:18:28,230 --> 00:18:26,400

countries like india and china about

515

00:18:29,830 --> 00:18:28,240

deforestation

516

00:18:31,669 --> 00:18:29,840

yes we're doing research on the whole

517

00:18:33,830 --> 00:18:31,679

planet and this information is available

518

00:18:34,950 --> 00:18:33,840

to everyone there are no restrictions on

519

00:18:37,590 --> 00:18:34,960

our data

520

00:18:40,070 --> 00:18:37,600

uh and anyone can get them and so some

521

00:18:43,190 --> 00:18:40,080

of my co-workers are studying

522

00:18:45,750 --> 00:18:43,200

forests in china forests in india

523

00:18:46,870 --> 00:18:45,760

although i primarily work on tropical

524

00:18:48,950 --> 00:18:46,880

forests

525

00:18:51,430 --> 00:18:48,960

in south america and the amazon basin

526

00:18:53,029 --> 00:18:51,440

and also in equatorial africa and

527

00:18:56,070 --> 00:18:53,039

madagascar

528

00:18:57,990 --> 00:18:56,080

but the answer to that is yes

529

00:19:00,150 --> 00:18:58,000

hey jim a question for you you've also

530

00:19:01,909 --> 00:19:00,160

worked on things like diseases and how

531

00:19:03,350 --> 00:19:01,919

we can actually use satellite data like

532

00:19:04,630 --> 00:19:03,360

this to figure out where disease would

533

00:19:05,430 --> 00:19:04,640

go could you tell us a little bit about

534

00:19:07,029 --> 00:19:05,440

that

535

00:19:09,510 --> 00:19:07,039

sure one of the cool things about using

536

00:19:12,230 --> 00:19:09,520

satellite data is you have these every

537

00:19:13,990 --> 00:19:12,240

day for the entire planet day after day

538

00:19:15,909 --> 00:19:14,000

and now we have satellite data for

539

00:19:17,110 --> 00:19:15,919

almost 31 years

540

00:19:19,110 --> 00:19:17,120

and

541

00:19:20,950 --> 00:19:19,120

by looking at certain conditions for

542

00:19:23,669 --> 00:19:20,960

some diseases that are climatically or

543

00:19:26,070 --> 00:19:23,679

ecologically coupled you can then

544

00:19:27,669 --> 00:19:26,080

correlate and associate those data and

545

00:19:30,549 --> 00:19:27,679

how they vary in time with disease

546

00:19:33,510 --> 00:19:30,559

outbreaks so some co-workers of mine and

547

00:19:36,230 --> 00:19:33,520

i started in 1985 working on a disease

548

00:19:38,470 --> 00:19:36,240

called rift valley fever it's from

549

00:19:40,549 --> 00:19:38,480

as the name uh suggests from the rift

550

00:19:43,190 --> 00:19:40,559

valley of africa it's a hemorrhagic

551  
00:19:45,510 --> 00:19:43,200  
fever transmitted by mosquitoes and it

552  
00:19:47,669 --> 00:19:45,520  
occurs in where you have arid and

553  
00:19:50,070 --> 00:19:47,679  
semi-arid vegetation and the satellite

554  
00:19:53,270 --> 00:19:50,080  
data show when it's rained and how

555  
00:19:55,029 --> 00:19:53,280  
persistent the rainfall is and if that

556  
00:19:57,510 --> 00:19:55,039  
persists for more than eight weeks

557  
00:19:59,350 --> 00:19:57,520  
that's an excellent suggestion where you

558  
00:20:00,870 --> 00:19:59,360  
will have rift valley fever outbreaks

559  
00:20:02,710 --> 00:20:00,880  
we'll publish numerous papers on the

560  
00:20:05,270 --> 00:20:02,720  
biology and on using these data for riff

561  
00:20:07,830 --> 00:20:05,280  
valley fever and we can do this with an

562  
00:20:09,510 --> 00:20:07,840  
accuracy of about 60 percent

563  
00:20:11,350 --> 00:20:09,520

two months in advance of the outbreak

564

00:20:13,110 --> 00:20:11,360

which then enables control measures to

565

00:20:14,390 --> 00:20:13,120

be implemented and this is one of the

566

00:20:16,470 --> 00:20:14,400

major things that i've worked on that

567

00:20:18,230 --> 00:20:16,480

i'm really really proud of but it's only

568

00:20:20,070 --> 00:20:18,240

because we approached this

569

00:20:22,870 --> 00:20:20,080

in a systematic way and had satellite

570

00:20:24,950 --> 00:20:22,880

data for 30 years now and so today we're

571

00:20:26,549 --> 00:20:24,960

processing data from yesterday

572

00:20:30,630 --> 00:20:26,559

and we have more information and are

573

00:20:34,549 --> 00:20:33,029

hey so one other one too when you were

574

00:20:36,950 --> 00:20:34,559

kind of in on the ground floor of this

575

00:20:38,549 --> 00:20:36,960

stuff back in the 70s and 80s

576

00:20:39,990 --> 00:20:38,559

what was it like when you first started

577

00:20:42,230 --> 00:20:40,000

out i mean did people believe that you

578

00:20:43,590 --> 00:20:42,240

were able to be able to map forests from

579

00:20:45,110 --> 00:20:43,600

space and even do these kind of

580

00:20:47,270 --> 00:20:45,120

high-tech things you're doing now like

581

00:20:48,549 --> 00:20:47,280

figure out where your disease might go

582

00:20:50,390 --> 00:20:48,559

uh

583

00:20:51,750 --> 00:20:50,400

the simple answer is no i had a lot of

584

00:20:53,669 --> 00:20:51,760

people who told me what you're doing is

585

00:20:55,029 --> 00:20:53,679

really stupid

586

00:20:56,549 --> 00:20:55,039

it won't work i don't know why you're

587

00:20:58,789 --> 00:20:56,559

trying to use satellites this hasn't

588

00:20:59,430 --> 00:20:58,799

been done before you shouldn't even try

589

00:21:00,950 --> 00:20:59,440

it

590

00:21:02,710 --> 00:21:00,960

so

591

00:21:04,470 --> 00:21:02,720

i didn't believe them i thought they

592

00:21:06,789 --> 00:21:04,480

were crazy and i said let's at least

593

00:21:09,669 --> 00:21:06,799

look and see let's experiment because i

594

00:21:10,870 --> 00:21:09,679

really like problems and experimentation

595

00:21:13,590 --> 00:21:10,880

and so

596

00:21:15,029 --> 00:21:13,600

we started some programs we had no idea

597

00:21:17,110 --> 00:21:15,039

if they would work or not

598

00:21:19,190 --> 00:21:17,120

they have turned out to be wildly

599

00:21:21,909 --> 00:21:19,200

successful and now one of them is the

600

00:21:24,230 --> 00:21:21,919

most commonly used technique to study

601  
00:21:25,750 --> 00:21:24,240  
vegetation from space and

602  
00:21:26,950 --> 00:21:25,760  
it's where you use data from weather

603  
00:21:29,029 --> 00:21:26,960  
satellites

604  
00:21:32,149 --> 00:21:29,039  
day after day after day and so now we

605  
00:21:34,070 --> 00:21:32,159  
have almost 31 years of data

606  
00:21:36,310 --> 00:21:34,080  
which we summarize into data every two

607  
00:21:38,630 --> 00:21:36,320  
weeks and this is extremely useful but

608  
00:21:41,110 --> 00:21:38,640  
the simple answer is several people told

609  
00:21:43,430 --> 00:21:41,120  
me we were stupid to do this it wouldn't

610  
00:21:44,870 --> 00:21:43,440  
work and besides why do you want to do

611  
00:21:46,549 --> 00:21:44,880  
this from space when you can go out

612  
00:21:48,310 --> 00:21:46,559  
places and do it on the ground well

613  
00:21:50,470 --> 00:21:48,320

these images show there are no roads

614

00:21:52,390 --> 00:21:50,480

here and in some places you have to do

615

00:21:53,990 --> 00:21:52,400

things from space it's also a good way

616

00:21:55,590 --> 00:21:54,000

to check on other countries and see what

617

00:21:57,190 --> 00:21:55,600

they're doing see if they're complying

618

00:22:00,230 --> 00:21:57,200

with treaty requirements

619

00:22:02,630 --> 00:22:00,240

so as john mccain said we need to see if

620

00:22:05,029 --> 00:22:02,640

some countries are cheating

621

00:22:09,830 --> 00:22:05,039

hey we got another question from online

622

00:22:15,430 --> 00:22:12,149

well i've also published papers on that

623

00:22:16,390 --> 00:22:15,440

and i got into a bit of a battle royale

624

00:22:19,110 --> 00:22:16,400

with some people in the pacific

625

00:22:20,870 --> 00:22:19,120

northwest 20 years ago

626

00:22:23,190 --> 00:22:20,880

so in the pacific northwest where you

627

00:22:24,149 --> 00:22:23,200

have these late successional coniferous

628

00:22:26,230 --> 00:22:24,159

forests

629

00:22:27,990 --> 00:22:26,240

from from from northern california up

630

00:22:30,310 --> 00:22:28,000

through oregon and washington then they

631

00:22:32,310 --> 00:22:30,320

continue into british columbia

632

00:22:33,909 --> 00:22:32,320

there only about 10

633

00:22:35,350 --> 00:22:33,919

of the original old growth forests

634

00:22:37,990 --> 00:22:35,360

remain almost all of those are in

635

00:22:40,630 --> 00:22:38,000

national parks or national forests and

636

00:22:41,590 --> 00:22:40,640

it's also an area where you have a lot

637

00:22:45,350 --> 00:22:41,600

of

638

00:22:46,470 --> 00:22:45,360

where it's

639

00:22:49,430 --> 00:22:46,480

wet

640

00:22:51,750 --> 00:22:49,440

warm and flat and so that's a very good

641

00:22:53,110 --> 00:22:51,760

place to have tree farms and they're in

642

00:22:55,110 --> 00:22:53,120

a rotation where you grow a forest

643

00:22:57,669 --> 00:22:55,120

perhaps for 50 or 60 years then it's

644

00:22:59,110 --> 00:22:57,679

harvested and then they replant so that

645

00:23:01,270 --> 00:22:59,120

is a very good

646

00:23:03,510 --> 00:23:01,280

type of forestry because you have trees

647

00:23:05,430 --> 00:23:03,520

which replace what you cut down and all

648

00:23:06,789 --> 00:23:05,440

the time as that as trees grow they

649

00:23:08,630 --> 00:23:06,799

absorb carbon dioxide from the

650

00:23:11,350 --> 00:23:08,640

atmosphere incorporated into wood so

651  
00:23:13,350 --> 00:23:11,360  
it's a major carbon sink

652  
00:23:14,470 --> 00:23:13,360  
hey one last one jim so we've got all oh

653  
00:23:15,909 --> 00:23:14,480  
i see a question right there in the

654  
00:23:18,470 --> 00:23:15,919  
front

655  
00:23:20,630 --> 00:23:18,480  
how long do you have to stay there

656  
00:23:22,390 --> 00:23:20,640  
well sometimes you get stuck places and

657  
00:23:24,710 --> 00:23:22,400  
you have to stay a long time one time we

658  
00:23:26,630 --> 00:23:24,720  
had to stay someplace for about a month

659  
00:23:30,310 --> 00:23:26,640  
but usually it's maybe three or four

660  
00:23:31,510 --> 00:23:30,320  
weeks and believe me by the time on

661  
00:23:33,909 --> 00:23:31,520  
as you get towards the end of your

662  
00:23:36,310 --> 00:23:33,919  
expedition in tropical forest you're

663  
00:23:38,710 --> 00:23:36,320

really happy to leave but sometimes it

664

00:23:40,710 --> 00:23:38,720

may take five or six days to get out and

665

00:23:43,590 --> 00:23:40,720

some of the places i've worked in this

666

00:23:45,750 --> 00:23:43,600

area what you do there are

667

00:23:48,390 --> 00:23:45,760

abandoned airstrips when there were drug

668

00:23:50,390 --> 00:23:48,400

labs in the area now our drug

669

00:23:52,789 --> 00:23:50,400

enforcement administration has

670

00:23:54,470 --> 00:23:52,799

driven all the drug labs out of these

671

00:23:56,149 --> 00:23:54,480

areas because they would have a drug lab

672

00:23:57,669 --> 00:23:56,159

in tropical forests and you wouldn't

673

00:23:58,870 --> 00:23:57,679

want to go there when the narco people

674

00:24:00,630 --> 00:23:58,880

were there because they're very very

675

00:24:03,350 --> 00:24:00,640

ruthless but anyway they would have a

676  
00:24:06,149 --> 00:24:03,360  
landing strip to fly the refined cocaine

677  
00:24:08,070 --> 00:24:06,159  
out and so we would have planes fly us

678  
00:24:10,070 --> 00:24:08,080  
in after our drug enforcement

679  
00:24:12,149 --> 00:24:10,080  
administration ran them all off

680  
00:24:14,149 --> 00:24:12,159  
fly into their airstrips drop us off and

681  
00:24:15,590 --> 00:24:14,159  
then say okay

682  
00:24:16,789 --> 00:24:15,600  
we're going to come back in three weeks

683  
00:24:18,549 --> 00:24:16,799  
and then we would do field work by

684  
00:24:20,149 --> 00:24:18,559  
hiking from around there if there was

685  
00:24:21,590 --> 00:24:20,159  
bad weather one time we had to stay an

686  
00:24:23,909 --> 00:24:21,600  
extra week

687  
00:24:25,510 --> 00:24:23,919  
so it all depends on where you are or

688  
00:24:27,110 --> 00:24:25,520

sometimes you could be someplace and the

689

00:24:28,710 --> 00:24:27,120

rainy season will start and the rivers

690

00:24:30,149 --> 00:24:28,720

will come up and you have to wait for

691

00:24:32,310 --> 00:24:30,159

the rivers to go down so you can get in

692

00:24:34,070 --> 00:24:32,320

your pacquiao boat and leave so it all

693

00:24:37,350 --> 00:24:34,080

depends but usually

694

00:24:39,190 --> 00:24:37,360

anywhere from two to four weeks

695

00:24:41,029 --> 00:24:39,200

all right hey thank you very much jim

696

00:24:48,710 --> 00:24:41,039

that was really great i'll introduce our

697

00:24:52,630 --> 00:24:51,190

hey our next speaker is dr chris schuman

698

00:24:54,549 --> 00:24:52,640

who's chris has spent a lot of time in

699

00:24:56,149 --> 00:24:54,559

the earth's polar region studying them

700

00:24:57,590 --> 00:24:56,159

being out on the ground with a shovel

701  
00:24:59,750 --> 00:24:57,600  
and digging pits all the way through to

702  
00:25:01,029 --> 00:24:59,760  
using data from space to understand them

703  
00:25:03,350 --> 00:25:01,039  
and he's going to tell us what's going

704  
00:25:04,789 --> 00:25:03,360  
on at the top of the planet chris thanks

705  
00:25:07,190 --> 00:25:04,799  
tom

706  
00:25:10,870 --> 00:25:07,200  
my name is chris shuman my first trip to

707  
00:25:12,830 --> 00:25:10,880  
the polls began in greenland in 1992 as

708  
00:25:14,390 --> 00:25:12,840  
a postdoc for penn state

709  
00:25:17,029 --> 00:25:14,400  
university

710  
00:25:18,310 --> 00:25:17,039  
there i was working at the gisp2 deep

711  
00:25:19,269 --> 00:25:18,320  
core site

712  
00:25:21,750 --> 00:25:19,279  
kind of

713  
00:25:24,549 --> 00:25:21,760

the ultimate climate data record this is

714

00:25:26,310 --> 00:25:24,559

an ice core through the entire center of

715

00:25:28,470 --> 00:25:26,320

the greenland ice sheet

716

00:25:30,549 --> 00:25:28,480

going down almost

717

00:25:32,549 --> 00:25:30,559

more than three thousand meters going

718

00:25:34,070 --> 00:25:32,559

back in time more than a hundred

719

00:25:36,230 --> 00:25:34,080

thousand years

720

00:25:37,350 --> 00:25:36,240

and you can tell that by looking at the

721

00:25:39,830 --> 00:25:37,360

record

722

00:25:41,510 --> 00:25:39,840

in the layers of snow and ice that are

723

00:25:43,830 --> 00:25:41,520

preserved in the ice sheet

724

00:25:46,789 --> 00:25:43,840

my job was to try to calibrate the

725

00:25:49,590 --> 00:25:46,799

thermometer from the ice core

726  
00:25:50,710 --> 00:25:49,600  
to the modern observational record

727  
00:25:52,789 --> 00:25:50,720  
now

728  
00:25:55,190 --> 00:25:52,799  
when i was there in 1992 the first

729  
00:25:57,750 --> 00:25:55,200  
automatic weather station was only put

730  
00:26:01,029 --> 00:25:57,760  
up in 1987 so we only had about five

731  
00:26:03,830 --> 00:26:01,039  
years of overlap with a modern record

732  
00:26:06,630 --> 00:26:03,840  
so what i did was i went back in time

733  
00:26:10,549 --> 00:26:06,640  
using a series of satellites beginning

734  
00:26:13,590 --> 00:26:10,559  
with uh the nimbus series a nasa sensor

735  
00:26:16,549 --> 00:26:13,600  
called smmr the scanning multi-channel

736  
00:26:19,430 --> 00:26:16,559  
microwave radiometer that provides a

737  
00:26:23,269 --> 00:26:19,440  
proxy for temperature through time

738  
00:26:25,110 --> 00:26:23,279

that begins in about in late 1978

739

00:26:27,430 --> 00:26:25,120

and has continued through a whole series

740

00:26:29,590 --> 00:26:27,440

of satellites all the way through today

741

00:26:30,950 --> 00:26:29,600

with another sensor that nasa is flying

742

00:26:33,750 --> 00:26:30,960

called amster

743

00:26:36,789 --> 00:26:33,760

that has enabled us to measure very

744

00:26:39,110 --> 00:26:36,799

consistently certain aspects of the

745

00:26:41,990 --> 00:26:39,120

arctic and the antarctic

746

00:26:44,710 --> 00:26:42,000

including the sea ice cover the frozen

747

00:26:48,710 --> 00:26:44,720

sea surface of the arctic ocean you see

748

00:26:50,070 --> 00:26:48,720

that here illustrated by the 2011 sea

749

00:26:52,710 --> 00:26:50,080

ice minimum

750

00:26:55,269 --> 00:26:52,720

that's from microwave data being

751  
00:26:57,430 --> 00:26:55,279  
gathered multiple times per day each

752  
00:26:59,430 --> 00:26:57,440  
time the satellite goes around it's

753  
00:27:02,070 --> 00:26:59,440  
really amazing the satellites actually

754  
00:27:04,470 --> 00:27:02,080  
go around the whole earth in about 97

755  
00:27:07,110 --> 00:27:04,480  
minutes that's a pretty typical time

756  
00:27:09,750 --> 00:27:07,120  
that's real fast so

757  
00:27:12,789 --> 00:27:09,760  
basically the white area shows the

758  
00:27:15,990 --> 00:27:12,799  
september sea ice cover compared to the

759  
00:27:19,830 --> 00:27:16,000  
long-term median sea ice cover going

760  
00:27:20,789 --> 00:27:19,840  
back over that 1978 through today time

761  
00:27:23,110 --> 00:27:20,799  
period

762  
00:27:25,350 --> 00:27:23,120  
and that's one of the ways that we know

763  
00:27:28,149 --> 00:27:25,360

how the arctic is changing and we can

764

00:27:30,149 --> 00:27:28,159

see that both from the sea ice minimum

765

00:27:32,710 --> 00:27:30,159

over time it looks a little bit like

766

00:27:35,909 --> 00:27:32,720

this plot over here this climate data

767

00:27:37,510 --> 00:27:35,919

record this is actually the decline in

768

00:27:40,630 --> 00:27:37,520

multi-year ice

769

00:27:43,110 --> 00:27:40,640

ice that forms in one year and lasts

770

00:27:45,909 --> 00:27:43,120

through multiple years it doesn't melt

771

00:27:49,110 --> 00:27:45,919

away when the sun comes up in the arctic

772

00:27:52,549 --> 00:27:49,120

when the ci starts to retreat back

773

00:27:54,789 --> 00:27:52,559

so basically it's our eyes in the sky

774

00:27:58,070 --> 00:27:54,799

starting in the 70s that have enabled us

775

00:28:00,710 --> 00:27:58,080

to start assembling these time series

776

00:28:02,950 --> 00:28:00,720

that illustrate the changes that the

777

00:28:04,149 --> 00:28:02,960

whole earth is going through especially

778

00:28:06,710 --> 00:28:04,159

the arctic

779

00:28:08,070 --> 00:28:06,720

i'm just one research scientist at nasa

780

00:28:09,990 --> 00:28:08,080

there's a whole bunch of us that are

781

00:28:13,269 --> 00:28:10,000

working on the cryosphere

782

00:28:14,789 --> 00:28:13,279

the arctic and the antarctic a bunch of

783

00:28:17,510 --> 00:28:14,799

our folks right now are flying on

784

00:28:19,750 --> 00:28:17,520

aircraft missions out of iceland

785

00:28:21,909 --> 00:28:19,760

and uh thule air force base in

786

00:28:24,230 --> 00:28:21,919

northwestern greenland they're gathering

787

00:28:26,149 --> 00:28:24,240

additional data to complement the

788

00:28:27,430 --> 00:28:26,159

pictures that we're gathering from the

789

00:28:28,310 --> 00:28:27,440

satellites

790

00:28:29,990 --> 00:28:28,320

okay

791

00:28:32,149 --> 00:28:30,000

so that's one of the ways that we're

792

00:28:34,470 --> 00:28:32,159

trying to put the whole story together

793

00:28:37,669 --> 00:28:34,480

of how the ice is changing

794

00:28:38,549 --> 00:28:37,679

now being a glaciologist it means i've

795

00:28:39,350 --> 00:28:38,559

seen

796

00:28:44,070 --> 00:28:39,360

the

797

00:28:45,350 --> 00:28:44,080

ice cover those of you that have been to

798

00:28:48,230 --> 00:28:45,360

central park

799

00:28:50,630 --> 00:28:48,240

there's bedrock that's polished there so

800

00:28:53,029 --> 00:28:50,640

18 000 years ago the ice was much

801  
00:28:55,110 --> 00:28:53,039  
farther south pushing up long island

802  
00:28:57,110 --> 00:28:55,120  
carving out the finger lakes making the

803  
00:28:59,909 --> 00:28:57,120  
great lakes wider and deeper

804  
00:29:02,549 --> 00:28:59,919  
and that's part of the story of change

805  
00:29:05,430 --> 00:29:02,559  
what we're seeing though is accelerated

806  
00:29:08,149 --> 00:29:05,440  
change in recent decades where sea ice

807  
00:29:10,230 --> 00:29:08,159  
cover has really started to fall off

808  
00:29:12,870 --> 00:29:10,240  
both in area

809  
00:29:15,350 --> 00:29:12,880  
and in thickness the multi-year ice

810  
00:29:18,310 --> 00:29:15,360  
tends to be thicker and since the big

811  
00:29:21,110 --> 00:29:18,320  
sea ice minimum in 2007

812  
00:29:23,510 --> 00:29:21,120  
we've actually seen a a substantial

813  
00:29:25,909 --> 00:29:23,520

decrease in the overall thickness my

814

00:29:27,909 --> 00:29:25,919

colleague sinead farrell has got some

815

00:29:31,029 --> 00:29:27,919

papers out that really show the changes

816

00:29:34,950 --> 00:29:31,039

in thickness over time using the icesat

817

00:29:37,190 --> 00:29:34,960

time series 2003 through 2009.

818

00:29:39,430 --> 00:29:37,200

we're actually going forward to launch a

819

00:29:41,909 --> 00:29:39,440

new version of icesat

820

00:29:45,029 --> 00:29:41,919

by 2017 that'll try to continue those

821

00:29:47,830 --> 00:29:45,039

measurements the aircraft missions

822

00:29:50,230 --> 00:29:47,840

operation icebridge flying out of thule

823

00:29:52,149 --> 00:29:50,240

flying out of iceland are hoping to

824

00:29:54,549 --> 00:29:52,159

continue some of those measurements

825

00:29:57,029 --> 00:29:54,559

until the next satellite goes up

826  
00:29:59,190 --> 00:29:57,039  
what is happening though is as more and

827  
00:30:01,029 --> 00:29:59,200  
more of the arctic ocean is becoming

828  
00:30:04,389 --> 00:30:01,039  
exposed the sea ice cover is

829  
00:30:07,590 --> 00:30:04,399  
disappearing the albedo changes and that

830  
00:30:10,470 --> 00:30:07,600  
water dark water absorbs more of the

831  
00:30:11,750 --> 00:30:10,480  
solar energy during the arctic summer

832  
00:30:14,070 --> 00:30:11,760  
and that

833  
00:30:15,830 --> 00:30:14,080  
ocean water is warming

834  
00:30:17,669 --> 00:30:15,840  
and that's

835  
00:30:19,669 --> 00:30:17,679  
that's contributing to the overall

836  
00:30:22,310 --> 00:30:19,679  
decrease in area and thickness of the

837  
00:30:26,070 --> 00:30:22,320  
sea ice cover it's also contributing in

838  
00:30:28,549 --> 00:30:26,080

part to the retreat of some of the major

839

00:30:30,710 --> 00:30:28,559

outlet glaciers around greenland where

840

00:30:33,669 --> 00:30:30,720

that warm water can creep up underneath

841

00:30:35,190 --> 00:30:33,679

the ice the floating ice

842

00:30:38,070 --> 00:30:35,200

starts to break up

843

00:30:40,230 --> 00:30:38,080

turns into icebergs and drifts down the

844

00:30:42,549 --> 00:30:40,240

fjord and so what we're seeing is not

845

00:30:45,350 --> 00:30:42,559

just a retreat of the ice front but

846

00:30:47,830 --> 00:30:45,360

we're seeing an acceleration of the ice

847

00:30:49,350 --> 00:30:47,840

out of the interior of the ice sheet out

848

00:30:51,990 --> 00:30:49,360

into the ocean

849

00:30:54,310 --> 00:30:52,000

that's causing the thickness to drop

850

00:30:57,190 --> 00:30:54,320

measurements from icesat have also shown

851  
00:30:58,950 --> 00:30:57,200  
that the elevation of the surface of the

852  
00:31:01,830 --> 00:30:58,960  
greenland ice sheet is decreasing

853  
00:31:03,590 --> 00:31:01,840  
substantially in the past decade or so

854  
00:31:05,669 --> 00:31:03,600  
so these are the kinds of stories that

855  
00:31:08,149 --> 00:31:05,679  
we're trying to get out to everybody

856  
00:31:10,149 --> 00:31:08,159  
because the more ice that moves from the

857  
00:31:12,549 --> 00:31:10,159  
interior of the ice sheets

858  
00:31:14,870 --> 00:31:12,559  
antarctica where i do most of my work

859  
00:31:17,269 --> 00:31:14,880  
the antarctic peninsula we see big

860  
00:31:19,029 --> 00:31:17,279  
glacial changes like this as well the

861  
00:31:22,310 --> 00:31:19,039  
one of the glaciers that i studied down

862  
00:31:25,110 --> 00:31:22,320  
there has lost about 600 feet of

863  
00:31:27,990 --> 00:31:25,120

elevation in a decade after its nearby

864

00:31:30,070 --> 00:31:28,000

ice shelf the larsen bee collapsed

865

00:31:32,710 --> 00:31:30,080

these are really very substantial

866

00:31:34,549 --> 00:31:32,720

changes and we're seeing them through

867

00:31:37,110 --> 00:31:34,559

our own eyes when we can get on the

868

00:31:39,110 --> 00:31:37,120

ground we're seeing them from space when

869

00:31:41,190 --> 00:31:39,120

the satellites go overhead and we're

870

00:31:43,509 --> 00:31:41,200

seeing them from aircraft missions and

871

00:31:45,909 --> 00:31:43,519

that's the kind of science that nasa

872

00:31:48,230 --> 00:31:45,919

does that we hope will excite you and

873

00:31:51,190 --> 00:31:48,240

turn you into scientists down the road

874

00:31:56,950 --> 00:31:51,200

helping us continue this story

875

00:32:01,350 --> 00:31:59,190

chris you talked about greenland can you

876  
00:32:02,870 --> 00:32:01,360  
tell us you know greenland's this big

877  
00:32:03,990 --> 00:32:02,880  
island it's covered with ice can you

878  
00:32:05,830 --> 00:32:04,000  
tell us a little bit about it i mean

879  
00:32:07,750 --> 00:32:05,840  
like i don't think we have a good how

880  
00:32:09,350 --> 00:32:07,760  
thick is that ice how does it behave

881  
00:32:10,470 --> 00:32:09,360  
what's the connection between that and

882  
00:32:11,830 --> 00:32:10,480  
sea level

883  
00:32:15,110 --> 00:32:11,840  
basically

884  
00:32:17,269 --> 00:32:15,120  
greenland has about three kilometers

885  
00:32:19,350 --> 00:32:17,279  
three thousand meters of ice

886  
00:32:21,509 --> 00:32:19,360  
ten thousand feet or so

887  
00:32:23,190 --> 00:32:21,519  
a couple of miles a couple of miles

888  
00:32:26,149 --> 00:32:23,200

of stored in

889

00:32:28,710 --> 00:32:26,159

on top of the island the bedrock beneath

890

00:32:30,870 --> 00:32:28,720

the the ice cover greenland's 80 some

891

00:32:31,750 --> 00:32:30,880

percent covered in ice

892

00:32:34,950 --> 00:32:31,760

and

893

00:32:36,149 --> 00:32:34,960

as that ice moves it flows out towards

894

00:32:38,950 --> 00:32:36,159

the ocean

895

00:32:41,029 --> 00:32:38,960

the ice that's stored on the land is

896

00:32:43,029 --> 00:32:41,039

melting around the margins and it's

897

00:32:45,190 --> 00:32:43,039

flowing into the ocean from these big

898

00:32:48,230 --> 00:32:45,200

outlet glaciers and that's causing sea

899

00:32:50,389 --> 00:32:48,240

level to rise over time as that stored

900

00:32:52,630 --> 00:32:50,399

water from the ice sheet

901  
00:32:54,310 --> 00:32:52,640  
is transferred out into the global ocean

902  
00:32:55,990 --> 00:32:54,320  
but how does that ice flow i mean i

903  
00:32:58,070 --> 00:32:56,000  
picture ice as like ice cubes from my

904  
00:33:00,230 --> 00:32:58,080  
refrigerator which are kind of brittle

905  
00:33:03,110 --> 00:33:00,240  
how does that ice flow like that it's a

906  
00:33:05,269 --> 00:33:03,120  
wonderful bit of physics actually

907  
00:33:08,230 --> 00:33:05,279  
it depends on what the temperature of

908  
00:33:11,029 --> 00:33:08,240  
the ice is but basically the grains of

909  
00:33:12,549 --> 00:33:11,039  
ice can slide past each other just under

910  
00:33:15,509 --> 00:33:12,559  
the pressure

911  
00:33:18,789 --> 00:33:15,519  
of the overlying ice at the gist2 site

912  
00:33:22,070 --> 00:33:18,799  
where i was was started in glaciology

913  
00:33:24,470 --> 00:33:22,080

that three kilometers of ice basically

914

00:33:25,909 --> 00:33:24,480

makes the layers really thin down at the

915

00:33:28,149 --> 00:33:25,919

bottom in part because they're

916

00:33:29,590 --> 00:33:28,159

stretching out and they're being forced

917

00:33:32,549 --> 00:33:29,600

to move away from the center of the

918

00:33:34,070 --> 00:33:32,559

island towards the margins of greenland

919

00:33:36,950 --> 00:33:34,080

and out to sea hey we got a question

920

00:33:39,029 --> 00:33:36,960

from online steve

921

00:33:41,029 --> 00:33:39,039

uh question about sea level

922

00:33:43,029 --> 00:33:41,039

due to the decrease in ice cover over

923

00:33:45,990 --> 00:33:43,039

the poles what regions of the earth are

924

00:33:47,509 --> 00:33:46,000

already now under water

925

00:33:48,789 --> 00:33:47,519

well um

926

00:33:50,549 --> 00:33:48,799

i i

927

00:33:52,149 --> 00:33:50,559

have always wondered how i got into

928

00:33:54,149 --> 00:33:52,159

glaciology when there were these

929

00:33:56,710 --> 00:33:54,159

marvelous careers in carbonate

930

00:33:58,389 --> 00:33:56,720

sedimentology in the bahamas

931

00:34:00,310 --> 00:33:58,399

you know as an earth scientist you know

932

00:34:02,149 --> 00:34:00,320

you think about that and you go

933

00:34:04,870 --> 00:34:02,159

how did i make the choice to wear a

934

00:34:07,269 --> 00:34:04,880

parka and not shower for two months you

935

00:34:08,629 --> 00:34:07,279

know i mean it's really not a logical

936

00:34:11,430 --> 00:34:08,639

choice when you get right down to it

937

00:34:14,069 --> 00:34:11,440

when you could be swimming in the ocean

938

00:34:14,950 --> 00:34:14,079

every day at your research site

939

00:34:17,430 --> 00:34:14,960

okay

940

00:34:20,389 --> 00:34:17,440

uh so some of the the

941

00:34:23,190 --> 00:34:20,399

smaller islands around the world

942

00:34:25,270 --> 00:34:23,200

i i know the bahamas are one place that

943

00:34:27,990 --> 00:34:25,280

we're concerned about sea level rise but

944

00:34:29,750 --> 00:34:28,000

basically it's all the places that piers

945

00:34:32,550 --> 00:34:29,760

showed where the populations are the

946

00:34:35,270 --> 00:34:32,560

whole uh heavily dense the densely

947

00:34:37,909 --> 00:34:35,280

populated coastlines of the world are

948

00:34:38,869 --> 00:34:37,919

places where sea level rise is beginning

949

00:34:41,669 --> 00:34:38,879

to be

950

00:34:45,669 --> 00:34:41,679

measured and really impact insurance

951  
00:34:50,869 --> 00:34:48,069  
what kind of cycles have you seen where

952  
00:34:52,950 --> 00:34:50,879  
new ice is being made and ice is melting

953  
00:34:53,990 --> 00:34:52,960  
back

954  
00:34:55,990 --> 00:34:54,000  
well

955  
00:34:58,550 --> 00:34:56,000  
i've worked in both greenland and

956  
00:35:00,790 --> 00:34:58,560  
antarctica seven times to greenland six

957  
00:35:03,990 --> 00:35:00,800  
times to antarctica the

958  
00:35:06,630 --> 00:35:04,000  
dry high interior of antarctica for

959  
00:35:08,710 --> 00:35:06,640  
example has very little accumulation

960  
00:35:12,550 --> 00:35:08,720  
it's a polar desert but it is

961  
00:35:14,390 --> 00:35:12,560  
accumulating a little bit every year

962  
00:35:16,710 --> 00:35:14,400  
averaged over accumulating snow

963  
00:35:19,349 --> 00:35:16,720

accumulating snow that's right

964

00:35:22,470 --> 00:35:19,359

and so up in the high interior you might

965

00:35:23,829 --> 00:35:22,480

get a centimeter or two it's so dry

966

00:35:27,589 --> 00:35:23,839

that your breath

967

00:35:30,069 --> 00:35:27,599

turns into uh ice crystals because it's

968

00:35:32,310 --> 00:35:30,079

just it's just that easy for them to

969

00:35:33,670 --> 00:35:32,320

form at these low temperatures and

970

00:35:35,910 --> 00:35:33,680

that's the kind of crystals which

971

00:35:38,550 --> 00:35:35,920

accumulate over time they're they're

972

00:35:40,550 --> 00:35:38,560

basically called uh

973

00:35:42,790 --> 00:35:40,560

sometimes horfrost

974

00:35:44,710 --> 00:35:42,800

but they're very very fine crystals but

975

00:35:47,190 --> 00:35:44,720

they build up and what that's what

976

00:35:49,829 --> 00:35:47,200

enables the ice to become so thick in

977

00:35:52,790 --> 00:35:49,839

east antarctica the highest part of the

978

00:35:54,550 --> 00:35:52,800

big polar ice sheets around the margins

979

00:35:56,310 --> 00:35:54,560

in the antarctic peninsula where i'm

980

00:35:58,230 --> 00:35:56,320

doing some of the work it's still

981

00:36:00,630 --> 00:35:58,240

accumulating up in the high part of the

982

00:36:02,790 --> 00:36:00,640

peninsula but because the ocean waters

983

00:36:05,030 --> 00:36:02,800

are so warm nearby

984

00:36:07,990 --> 00:36:05,040

where the glaciers flow down to the

985

00:36:10,630 --> 00:36:08,000

water they really are disintegrating

986

00:36:14,630 --> 00:36:10,640

because of all that warmth being

987

00:36:21,510 --> 00:36:14,640

transferred in into that into that ice

988

00:36:25,270 --> 00:36:23,270

how long do we have to restate the

989

00:36:27,109 --> 00:36:25,280

question can you restate that just a

990

00:36:28,470 --> 00:36:27,119

little bit could you

991

00:36:30,710 --> 00:36:28,480

give us some information about the

992

00:36:32,150 --> 00:36:30,720

feedback loop and

993

00:36:34,470 --> 00:36:32,160

whether or not you think we've reached a

994

00:36:37,030 --> 00:36:34,480

tipping point i think sinead's work

995

00:36:39,430 --> 00:36:37,040

actually speaks speaks very well to that

996

00:36:42,310 --> 00:36:39,440

point where she shows in the arctic sea

997

00:36:45,109 --> 00:36:42,320

ice cover over the arctic ocean that the

998

00:36:47,990 --> 00:36:45,119

thickness change has accelerated

999

00:36:50,390 --> 00:36:48,000

dramatically since 2007 where the arctic

1000

00:36:53,510 --> 00:36:50,400

ocean may be warm enough now that the

1001  
00:36:55,829 --> 00:36:53,520  
thicker ice is is really thinning much

1002  
00:36:59,190 --> 00:36:55,839  
faster all of a sudden so

1003  
00:37:01,670 --> 00:36:59,200  
i'm i'm not sure that it's that it that

1004  
00:37:04,630 --> 00:37:01,680  
we can't that the the arctic climate

1005  
00:37:07,030 --> 00:37:04,640  
system can't recover but i do know that

1006  
00:37:09,190 --> 00:37:07,040  
the change has accelerated not just in

1007  
00:37:11,349 --> 00:37:09,200  
the past decade or so but in the even

1008  
00:37:13,109 --> 00:37:11,359  
the past few years

1009  
00:37:14,950 --> 00:37:13,119  
another question from online

1010  
00:37:17,430 --> 00:37:14,960  
yeah here's a question from you stream

1011  
00:37:18,630 --> 00:37:17,440  
how will the melting ice affect ocean

1012  
00:37:20,390 --> 00:37:18,640  
currents

1013  
00:37:23,109 --> 00:37:20,400

well that's actually one of the really

1014

00:37:25,829 --> 00:37:23,119

cool things about the arctic is because

1015

00:37:28,710 --> 00:37:25,839

the formation of sea ice

1016

00:37:32,150 --> 00:37:28,720

basically the air temperatures are so

1017

00:37:33,589 --> 00:37:32,160

cold that the sea surface itself freezes

1018

00:37:34,710 --> 00:37:33,599

solid

1019

00:37:37,109 --> 00:37:34,720

you've probably been to the beach you

1020

00:37:38,870 --> 00:37:37,119

think to yourself no way how could the

1021

00:37:40,950 --> 00:37:38,880

how could an ocean

1022

00:37:42,790 --> 00:37:40,960

freeze solid well it happens and it

1023

00:37:45,910 --> 00:37:42,800

happens really rapidly

1024

00:37:51,349 --> 00:37:45,920

and in doing that it actually

1025

00:37:54,150 --> 00:37:51,359

lets loose this cold briny um byproduct

1026

00:37:55,030 --> 00:37:54,160

where the frozen surface

1027

00:37:56,550 --> 00:37:55,040

it

1028

00:38:00,069 --> 00:37:56,560

basically

1029

00:38:03,030 --> 00:38:00,079

forces off cold salty water that falls

1030

00:38:06,630 --> 00:38:03,040

to deep down and actually drives some of

1031

00:38:09,670 --> 00:38:06,640

the global ocean conveyor belt that cold

1032

00:38:11,990 --> 00:38:09,680

water flows very deep and moves south

1033

00:38:15,349 --> 00:38:12,000

forcing warmer water to flow up from the

1034

00:38:18,870 --> 00:38:15,359

equators to replace it so sea ice is a

1035

00:38:21,109 --> 00:38:18,880

very important part of what balances the

1036

00:38:24,310 --> 00:38:21,119

temperatures around the world

1037

00:38:26,550 --> 00:38:24,320

so we actually saw some indications of

1038

00:38:29,430 --> 00:38:26,560

how important that process is in the

1039

00:38:31,910 --> 00:38:29,440

gist ii ice core record where we saw the

1040

00:38:34,710 --> 00:38:31,920

sudden climate shifts that probably had

1041

00:38:35,750 --> 00:38:34,720

to do with shifts in how sea ice was

1042

00:38:39,190 --> 00:38:35,760

forming

1043

00:38:40,470 --> 00:38:39,200

and they were really uh well i

1044

00:38:42,310 --> 00:38:40,480

i could talk

1045

00:38:44,870 --> 00:38:42,320

at at greater length on just the ice

1046

00:38:47,510 --> 00:38:44,880

core itself but it's one of the ways

1047

00:38:50,230 --> 00:38:47,520

that we actually look back in time

1048

00:38:52,390 --> 00:38:50,240

not just from ground observations but

1049

00:38:55,030 --> 00:38:52,400

from and aircraft observations and

1050

00:38:56,150 --> 00:38:55,040

satellite observations but by going back

1051

00:38:58,870 --> 00:38:56,160

through the layers which have

1052

00:39:00,710 --> 00:38:58,880

accumulated in these big ice sheets

1053

00:39:02,310 --> 00:39:00,720

hey chris one last one can you tell us

1054

00:39:03,750 --> 00:39:02,320

about the different ways that we study

1055

00:39:05,349 --> 00:39:03,760

ice from space you talked a little about

1056

00:39:07,270 --> 00:39:05,359

how we look at microwaves that come off

1057

00:39:08,069 --> 00:39:07,280

the ground but are there other things we

1058

00:39:15,589 --> 00:39:08,079

have

1059

00:39:18,310 --> 00:39:15,599

uh the infrared temperatures of the ice

1060

00:39:20,150 --> 00:39:18,320

sheet surface here's greenland basically

1061

00:39:23,030 --> 00:39:20,160

the infrared signals which are coming

1062

00:39:25,030 --> 00:39:23,040

back to the to the satellite give us an

1063

00:39:26,230 --> 00:39:25,040

indication of the surface temperature of

1064

00:39:29,990 --> 00:39:26,240

the ice sheet

1065

00:39:33,109 --> 00:39:30,000

uh we can actually uh uh look at the

1066

00:39:34,870 --> 00:39:33,119

elevation changes over time by icesat

1067

00:39:36,710 --> 00:39:34,880

which was a laser altimeter which

1068

00:39:39,430 --> 00:39:36,720

measures the surface

1069

00:39:41,109 --> 00:39:39,440

relative to the satellite and we go back

1070

00:39:42,870 --> 00:39:41,119

and we measure that again months later

1071

00:39:44,630 --> 00:39:42,880

but how does that work you say laser

1072

00:39:47,109 --> 00:39:44,640

altimeter what does it actually do it

1073

00:39:49,510 --> 00:39:47,119

actually shoots out a pulse of laser

1074

00:39:52,069 --> 00:39:49,520

energy and by knowing the speed of light

1075

00:39:53,270 --> 00:39:52,079

and where the satellite was on orbit

1076

00:39:55,270 --> 00:39:53,280

and knowing

1077

00:39:57,190 --> 00:39:55,280

how long it took for that pulse of laser

1078

00:39:59,349 --> 00:39:57,200

light to get down to the ice sheet and

1079

00:40:03,349 --> 00:39:59,359

back up to the satellite we determined

1080

00:40:06,230 --> 00:40:03,359

the range to the satellite from when it

1081

00:40:08,630 --> 00:40:06,240

sent out the pulse to when it came back

1082

00:40:11,270 --> 00:40:08,640

so there's a distance and by knowing

1083

00:40:13,109 --> 00:40:11,280

where the satellite is in orbit when we

1084

00:40:15,349 --> 00:40:13,119

took those measurements we actually

1085

00:40:19,430 --> 00:40:15,359

determine the elevation of the spot on

1086

00:40:20,950 --> 00:40:19,440

the ground and so icesat-1 measured 40

1087

00:40:23,990 --> 00:40:20,960

times a second

1088

00:40:25,270 --> 00:40:24,000

about every 172 meters along each orbit

1089

00:40:27,349 --> 00:40:25,280

track

1090

00:40:28,150 --> 00:40:27,359

97 minutes it comes around measures

1091

00:40:29,910 --> 00:40:28,160

again

1092

00:40:33,190 --> 00:40:29,920

and you build up those measurements over

1093

00:40:35,990 --> 00:40:33,200

time and you see the elevation changes

1094

00:40:38,550 --> 00:40:36,000

big changes in the yakum soven glacier

1095

00:40:40,309 --> 00:40:38,560

drainage basin big changes in the coast

1096

00:40:43,510 --> 00:40:40,319

of west antarctica and pine island

1097

00:40:45,430 --> 00:40:43,520

glacier thwaites glacier big changes in

1098

00:40:47,990 --> 00:40:45,440

the area in the antarctic peninsula

1099

00:40:50,550 --> 00:40:48,000

which i was studying of hundreds and

1100

00:40:52,150 --> 00:40:50,560

hundreds of feet in a decade

1101

00:40:53,990 --> 00:40:52,160

by building up those altimetry

1102

00:40:55,030 --> 00:40:54,000

measurements over time great hey thank

1103

00:41:00,309 --> 00:40:55,040

you very much chris you really

1104

00:41:04,870 --> 00:41:02,870

our next speaker

1105

00:41:06,710 --> 00:41:04,880

is ernie hilsen wrath from goddard space

1106

00:41:09,670 --> 00:41:06,720

flight center ernie's had an amazing

1107

00:41:11,030 --> 00:41:09,680

storied 40-year career at nasa and he's

1108

00:41:12,470 --> 00:41:11,040

going to tell us about one of the best

1109

00:41:15,750 --> 00:41:12,480

earth science stories of all because it

1110

00:41:17,589 --> 00:41:15,760

has a happy ending the ozone hall ernie

1111

00:41:19,430 --> 00:41:17,599

thanks a lot tom

1112

00:41:21,109 --> 00:41:19,440

i wanted to share with you my experience

1113

00:41:23,349 --> 00:41:21,119

in working with nasa first i gotta ask

1114

00:41:24,870 --> 00:41:23,359

the question can all of you hear me is

1115

00:41:26,470 --> 00:41:24,880

it louder

1116

00:41:28,870 --> 00:41:26,480

okay i'll try to speak up although this

1117

00:41:31,430 --> 00:41:28,880

microphone i guess is for our web

1118

00:41:32,950 --> 00:41:31,440

audience only and not for the

1119

00:41:35,510 --> 00:41:32,960

not for you people here so i'll try to

1120

00:41:37,510 --> 00:41:35,520

speak up as well as i can and if you

1121

00:41:39,349 --> 00:41:37,520

can't hear me please remind me by just

1122

00:41:41,190 --> 00:41:39,359

doing this

1123

00:41:42,870 --> 00:41:41,200

okay i'll try to speak up

1124

00:41:46,790 --> 00:41:42,880

i joined nasa

1125

00:41:47,990 --> 00:41:46,800

in 1960s after being inspired by

1126  
00:41:49,510 --> 00:41:48,000  
a couple of things something called

1127  
00:41:51,750 --> 00:41:49,520  
sputnik i don't know if any of you

1128  
00:41:54,630 --> 00:41:51,760  
remember sputnik when the russians put a

1129  
00:41:56,069 --> 00:41:54,640  
satellite into orbit i said gee we

1130  
00:41:57,190 --> 00:41:56,079  
i have to do something i want to play a

1131  
00:41:59,670 --> 00:41:57,200  
role in this

1132  
00:42:01,589 --> 00:41:59,680  
then of course john kennedy's uh famous

1133  
00:42:02,950 --> 00:42:01,599  
speech about going to the moon so i

1134  
00:42:05,829 --> 00:42:02,960  
joined nasa

1135  
00:42:07,270 --> 00:42:05,839  
and what i wanted to do was study

1136  
00:42:08,950 --> 00:42:07,280  
astrophysics

1137  
00:42:12,550 --> 00:42:08,960  
i wanted to study the evolution and the

1138  
00:42:14,710 --> 00:42:12,560

formation of stars and and and galaxies

1139

00:42:15,589 --> 00:42:14,720

but as it turns out when i joined the

1140

00:42:16,950 --> 00:42:15,599

group

1141

00:42:18,309 --> 00:42:16,960

i really wasn't going to look at the

1142

00:42:20,390 --> 00:42:18,319

stars in the galaxies i was going to

1143

00:42:22,550 --> 00:42:20,400

look back at the earth

1144

00:42:24,230 --> 00:42:22,560

and i was working on some of the early

1145

00:42:26,390 --> 00:42:24,240

weather satellites nasa was just

1146

00:42:28,950 --> 00:42:26,400

beginning to develop capabilities to

1147

00:42:31,270 --> 00:42:28,960

study the earth's weather

1148

00:42:33,510 --> 00:42:31,280

using its global perspective from space

1149

00:42:34,870 --> 00:42:33,520

to understand uh how the atmosphere

1150

00:42:36,630 --> 00:42:34,880

works and

1151

00:42:38,870 --> 00:42:36,640

and it could be if those data could be

1152

00:42:40,870 --> 00:42:38,880

used to improve our weather forecast and

1153

00:42:42,950 --> 00:42:40,880

we've come a long way in doing weather

1154

00:42:45,270 --> 00:42:42,960

forecasting using satellite data but

1155

00:42:47,750 --> 00:42:45,280

what i'm going to talk to you about is

1156

00:42:50,710 --> 00:42:47,760

by the way it says the whole story nasa

1157

00:42:52,309 --> 00:42:50,720

knows knows how to spell

1158

00:42:54,230 --> 00:42:52,319

that word means two things we're talking

1159

00:42:56,150 --> 00:42:54,240

about the complete story this although

1160

00:42:58,069 --> 00:42:56,160

you can't tell the complete story but

1161

00:43:00,150 --> 00:42:58,079

also the antarctic ozone hole some of

1162

00:43:01,670 --> 00:43:00,160

you may be familiar with this

1163

00:43:03,750 --> 00:43:01,680

um

1164

00:43:04,870 --> 00:43:03,760

if you take a good look at these these

1165

00:43:07,030 --> 00:43:04,880

images here it's really pretty

1166

00:43:08,870 --> 00:43:07,040

spectacular when you think about it in a

1167

00:43:11,030 --> 00:43:08,880

perspective how long it took to this

1168

00:43:12,550 --> 00:43:11,040

data the first image

1169

00:43:13,270 --> 00:43:12,560

of the globe

1170

00:43:15,510 --> 00:43:13,280

the

1171

00:43:18,150 --> 00:43:15,520

earth's atmospheric ozone occurred back

1172

00:43:20,950 --> 00:43:18,160

in the 1970s with one of these early

1173

00:43:22,790 --> 00:43:20,960

weather satellites and at that time

1174

00:43:24,790 --> 00:43:22,800

we were studying ozone not because of it

1175

00:43:26,230 --> 00:43:24,800

was an environmental concern

1176

00:43:28,630 --> 00:43:26,240

but because it was a scientific

1177

00:43:30,309 --> 00:43:28,640

curiosity and also it was a tracer in

1178

00:43:32,309 --> 00:43:30,319

the atmosphere we could use it maybe to

1179

00:43:34,230 --> 00:43:32,319

improve the weather forecast so that was

1180

00:43:37,030 --> 00:43:34,240

in the early 70s

1181

00:43:39,349 --> 00:43:37,040

in the late 70s and 1980s we continued

1182

00:43:41,190 --> 00:43:39,359

with these satellite data and began it

1183

00:43:42,550 --> 00:43:41,200

was discovered that something's really

1184

00:43:44,150 --> 00:43:42,560

peculiar was happening over the

1185

00:43:45,190 --> 00:43:44,160

antarctic

1186

00:43:48,710 --> 00:43:45,200

um

1187

00:43:51,030 --> 00:43:48,720

so at first we knew that the ozone layer

1188

00:43:52,710 --> 00:43:51,040

was in jeopardy it was in trouble

1189

00:43:56,630 --> 00:43:52,720

because the chemist in the laboratory

1190

00:43:58,309 --> 00:43:56,640

realized that gases from aerosol cans

1191

00:43:59,829 --> 00:43:58,319

and refrigerators

1192

00:44:02,870 --> 00:43:59,839

once they get into the atmosphere could

1193

00:44:04,470 --> 00:44:02,880

become activated and destroy ozone

1194

00:44:05,589 --> 00:44:04,480

it was a clear

1195

00:44:07,990 --> 00:44:05,599

clearly a

1196

00:44:09,190 --> 00:44:08,000

proven phenomena that would destroy

1197

00:44:12,069 --> 00:44:09,200

ozone but the appearance of the

1198

00:44:14,550 --> 00:44:12,079

antarctic ozone hole got the worldwide

1199

00:44:16,150 --> 00:44:14,560

attention that something needs needs to

1200

00:44:18,470 --> 00:44:16,160

be done

1201

00:44:20,309 --> 00:44:18,480

what we have here is the pictures of

1202

00:44:22,069 --> 00:44:20,319

global ozone focused on the antarctic

1203

00:44:23,589 --> 00:44:22,079

this white spot here doesn't mean

1204

00:44:25,190 --> 00:44:23,599

there's a part of the whole it means

1205

00:44:26,390 --> 00:44:25,200

that the satellite didn't cover this

1206

00:44:31,510 --> 00:44:26,400

particular

1207

00:44:34,390 --> 00:44:31,520

october 1970 goes through october's all

1208

00:44:35,829 --> 00:44:34,400

the way through october and 2011.

1209

00:44:38,230 --> 00:44:35,839

and you can see there was a sudden

1210

00:44:41,190 --> 00:44:38,240

increase in the depletion of ozone the

1211

00:44:43,750 --> 00:44:41,200

colors here mean this means high ozone

1212

00:44:46,630 --> 00:44:43,760

this means low ozone so this hole in the

1213

00:44:49,190 --> 00:44:46,640

ozone layer covers the entire antarctic

1214

00:44:51,349 --> 00:44:49,200

region it only lasts for a couple of

1215

00:44:54,150 --> 00:44:51,359

months and then it closes up

1216

00:44:56,630 --> 00:44:54,160

so uh once the world

1217

00:44:58,790 --> 00:44:56,640

the the the scientists the policy makers

1218

00:45:01,030 --> 00:44:58,800

the industrial community realized that

1219

00:45:02,069 --> 00:45:01,040

there was a problem they put a plan into

1220

00:45:03,349 --> 00:45:02,079

effect

1221

00:45:05,510 --> 00:45:03,359

and how this should be done and

1222

00:45:06,710 --> 00:45:05,520

implemented that was to ban through an

1223

00:45:07,829 --> 00:45:06,720

international

1224

00:45:09,589 --> 00:45:07,839

agreement

1225

00:45:12,069 --> 00:45:09,599

amongst all the countries in the world

1226  
00:45:13,510 --> 00:45:12,079  
to ban chlorofluorocarbons this was the

1227  
00:45:16,150 --> 00:45:13,520  
gas that's an aerosol used to be in

1228  
00:45:17,829 --> 00:45:16,160  
aerosol cans and used as a refrigerant

1229  
00:45:18,790 --> 00:45:17,839  
to ban them completely

1230  
00:45:21,190 --> 00:45:18,800  
because

1231  
00:45:22,790 --> 00:45:21,200  
this hole could have spread as a matter

1232  
00:45:23,910 --> 00:45:22,800  
of fact some people have done studies

1233  
00:45:25,829 --> 00:45:23,920  
now

1234  
00:45:27,910 --> 00:45:25,839  
where if this banning of these

1235  
00:45:28,950 --> 00:45:27,920  
chlorofluorocarbons hadn't taken into

1236  
00:45:31,349 --> 00:45:28,960  
place

1237  
00:45:32,390 --> 00:45:31,359  
the whole would not have

1238  
00:45:33,910 --> 00:45:32,400

recovered

1239

00:45:35,829 --> 00:45:33,920

ozone would have remained depleted the

1240

00:45:38,150 --> 00:45:35,839

antarctic ozone hole would have been a

1241

00:45:39,510 --> 00:45:38,160

persistent feature and the ozone layer

1242

00:45:41,589 --> 00:45:39,520

in the upper atmosphere would have been

1243

00:45:43,510 --> 00:45:41,599

twice as low as it is now

1244

00:45:45,430 --> 00:45:43,520

and would cause twice as much uv

1245

00:45:46,390 --> 00:45:45,440

radiation reaching the earth's surface

1246

00:45:47,990 --> 00:45:46,400

causing

1247

00:45:51,030 --> 00:45:48,000

unprecedented amounts of

1248

00:45:53,349 --> 00:45:51,040

problems with diseases plant production

1249

00:45:55,030 --> 00:45:53,359

cancer was one of the big concerns about

1250

00:45:56,150 --> 00:45:55,040

extra ultraviolet radiation getting down

1251  
00:45:57,190 --> 00:45:56,160  
to the ground

1252  
00:45:59,510 --> 00:45:57,200  
so

1253  
00:46:03,190 --> 00:45:59,520  
this is an environmental success that

1254  
00:46:04,390 --> 00:46:03,200  
we're able to recognize a global problem

1255  
00:46:07,190 --> 00:46:04,400  
and

1256  
00:46:09,030 --> 00:46:07,200  
get rally the world's community to come

1257  
00:46:10,790 --> 00:46:09,040  
up with some legislation regulating and

1258  
00:46:12,950 --> 00:46:10,800  
come up with a substitute we don't miss

1259  
00:46:15,510 --> 00:46:12,960  
refrigeration we still have our cans but

1260  
00:46:17,349 --> 00:46:15,520  
we found a reasonable substitute for

1261  
00:46:19,109 --> 00:46:17,359  
freons or chlorofluorocarbons which

1262  
00:46:20,390 --> 00:46:19,119  
destroyed the ozone layer the ozone

1263  
00:46:22,470 --> 00:46:20,400

layer is not going to really recover to

1264

00:46:24,710 --> 00:46:22,480

normal values until

1265

00:46:27,430 --> 00:46:24,720

2060. so we'll continue seeing these

1266

00:46:29,270 --> 00:46:27,440

holes but it's not getting any deep any

1267

00:46:31,829 --> 00:46:29,280

deeper and it looks like it's slowly

1268

00:46:34,550 --> 00:46:31,839

recovering but it'll be 2060 before

1269

00:46:36,630 --> 00:46:34,560

there's a real recovery

1270

00:46:39,430 --> 00:46:36,640

a lot of people ask me uh they get

1271

00:46:41,190 --> 00:46:39,440

confused about climate change the ozone

1272

00:46:42,790 --> 00:46:41,200

hole and want to understand what the

1273

00:46:44,790 --> 00:46:42,800

connection is

1274

00:46:47,270 --> 00:46:44,800

and it's a very difficult

1275

00:46:48,790 --> 00:46:47,280

uh topic to discuss it's just being

1276

00:46:50,470 --> 00:46:48,800

uncovered now

1277

00:46:52,309 --> 00:46:50,480

both ozone

1278

00:46:54,470 --> 00:46:52,319

which is protecting us from ultraviolet

1279

00:46:56,550 --> 00:46:54,480

radiation from the sun carbon dioxide

1280

00:46:58,630 --> 00:46:56,560

which is a greenhouse gas they work very

1281

00:47:00,870 --> 00:46:58,640

different ways in the atmosphere

1282

00:47:03,109 --> 00:47:00,880

but they're very important any changes

1283

00:47:04,630 --> 00:47:03,119

in their quantity that's outside of the

1284

00:47:07,670 --> 00:47:04,640

normal range will have effect on one or

1285

00:47:09,510 --> 00:47:07,680

the other as it turns out climate change

1286

00:47:10,870 --> 00:47:09,520

may slow down

1287

00:47:13,430 --> 00:47:10,880

the recovery

1288

00:47:15,430 --> 00:47:13,440

of atmospheric ozone so the it looks

1289

00:47:17,589 --> 00:47:15,440

like that it won't work the atmospheric

1290

00:47:20,549 --> 00:47:17,599

ozone won't recover quite as fast if

1291

00:47:22,870 --> 00:47:20,559

climate change occurs as predicted ozone

1292

00:47:25,589 --> 00:47:22,880

itself is a greenhouse gas

1293

00:47:27,589 --> 00:47:25,599

and because of the way ozone behaves in

1294

00:47:29,910 --> 00:47:27,599

the atmosphere it changes the weather's

1295

00:47:31,270 --> 00:47:29,920

patterns in the in the upper atmosphere

1296

00:47:33,349 --> 00:47:31,280

which could have an influence on how

1297

00:47:34,390 --> 00:47:33,359

climate change occurs so there's an

1298

00:47:37,589 --> 00:47:34,400

indirect

1299

00:47:39,589 --> 00:47:37,599

uh connection between ozone change

1300

00:47:41,510 --> 00:47:39,599

climate change and ozone depletion and

1301

00:47:43,829 --> 00:47:41,520

how it recovers but it's it's a problem

1302

00:47:46,150 --> 00:47:43,839

that's being being dealt with at the

1303

00:47:47,270 --> 00:47:46,160

present time

1304

00:47:50,230 --> 00:47:47,280

um

1305

00:47:52,470 --> 00:47:50,240

let's see so we continue to monitor

1306

00:47:54,950 --> 00:47:52,480

ozone nasa is committed to continuing it

1307

00:47:57,990 --> 00:47:54,960

these actually these measurements here

1308

00:47:59,829 --> 00:47:58,000

go from 1970 to 2011 that's 40 years of

1309

00:48:02,549 --> 00:47:59,839

data there wasn't a single satellite

1310

00:48:04,470 --> 00:48:02,559

that measured ozone for 40 years

1311

00:48:06,630 --> 00:48:04,480

uh this this is probably the product of

1312

00:48:08,630 --> 00:48:06,640

five different satellites and one of the

1313

00:48:11,589 --> 00:48:08,640

important things that nasa does

1314

00:48:13,349 --> 00:48:11,599

particularly in times of climate change

1315

00:48:17,270 --> 00:48:13,359

is try to put the satellite data sets

1316

00:48:19,670 --> 00:48:17,280

together so you have a continuous

1317

00:48:21,910 --> 00:48:19,680

stream of data whether it's oceans

1318

00:48:23,670 --> 00:48:21,920

whether it's sea levels or antarctic ice

1319

00:48:25,670 --> 00:48:23,680

one of the things that we're really

1320

00:48:27,109 --> 00:48:25,680

concentrating on doing is making sure

1321

00:48:29,190 --> 00:48:27,119

the data are accurate and they're

1322

00:48:30,470 --> 00:48:29,200

accurate over time and we have to deal

1323

00:48:33,030 --> 00:48:30,480

with the fact that these aren't measured

1324

00:48:35,190 --> 00:48:33,040

by the same satellites says

1325

00:48:36,870 --> 00:48:35,200

five satellites over 40 years there was

1326

00:48:38,790 --> 00:48:36,880

a big effort to put this data set

1327

00:48:41,109 --> 00:48:38,800

together to show that how things are

1328

00:48:43,109 --> 00:48:41,119

actually changing at a very low level

1329

00:48:44,710 --> 00:48:43,119

so nasa has been very successful in

1330

00:48:46,630 --> 00:48:44,720

doing that we have partnerships with

1331

00:48:48,710 --> 00:48:46,640

noaa the national oceanographic and

1332

00:48:50,150 --> 00:48:48,720

atmospheric administration are working

1333

00:48:51,990 --> 00:48:50,160

together to collect these data in a

1334

00:48:53,670 --> 00:48:52,000

continuous basis

1335

00:48:55,430 --> 00:48:53,680

so in addition not only is this

1336

00:48:57,589 --> 00:48:55,440

happening united states because of ozone

1337

00:48:59,430 --> 00:48:57,599

has been such a concern globally

1338

00:49:02,710 --> 00:48:59,440

there are other international space

1339

00:49:04,950 --> 00:49:02,720

agencies in europe and japan and even

1340

00:49:06,309 --> 00:49:04,960

the chinese have recently recently

1341

00:49:09,270 --> 00:49:06,319

launched with one of their wettest

1342

00:49:12,390 --> 00:49:09,280

weather satellites that also carry

1343

00:49:13,190 --> 00:49:12,400

instruments to measure ozone change

1344

00:49:15,510 --> 00:49:13,200

so

1345

00:49:17,670 --> 00:49:15,520

i think that tells you what i mean here

1346

00:49:19,990 --> 00:49:17,680

by the whole story about ozone and why

1347

00:49:21,190 --> 00:49:20,000

we have an ozone hole hey thanks ernie

1348

00:49:22,630 --> 00:49:21,200

that's great

1349

00:49:30,150 --> 00:49:22,640

we got a couple of questions right here

1350

00:49:35,270 --> 00:49:33,430

when did uh when did the reverse in uh

1351  
00:49:37,910 --> 00:49:35,280  
policy and that that international

1352  
00:49:40,470 --> 00:49:37,920  
response to the ozone problem occur and

1353  
00:49:44,630 --> 00:49:40,480  
how fast did it occur

1354  
00:49:46,470 --> 00:49:44,640  
um and what how how fast were we able to

1355  
00:49:47,589 --> 00:49:46,480  
measure that it's working

1356  
00:49:49,589 --> 00:49:47,599  
okay you're talking although it's called

1357  
00:49:51,910 --> 00:49:49,599  
a montreal protocol

1358  
00:49:52,950 --> 00:49:51,920  
montreal protocol was when when the

1359  
00:49:54,390 --> 00:49:52,960  
chemist

1360  
00:49:55,270 --> 00:49:54,400  
convinced the world scientists in the

1361  
00:49:57,670 --> 00:49:55,280  
community that indeed

1362  
00:49:59,589 --> 00:49:57,680  
chlorofluorocarbons these can't these

1363  
00:50:02,069 --> 00:49:59,599

gases in these that we're using as a

1364

00:50:03,430 --> 00:50:02,079

refrigerant in the air

1365

00:50:05,030 --> 00:50:03,440

that happened in about in the night

1366

00:50:07,990 --> 00:50:05,040

started in 19

1367

00:50:09,750 --> 00:50:08,000

late 1970s 1980 but the reason i can't

1368

00:50:11,910 --> 00:50:09,760

be specific is because there were

1369

00:50:13,829 --> 00:50:11,920

changes to the protocol it evolved there

1370

00:50:15,750 --> 00:50:13,839

were amendments to the protocol when the

1371

00:50:17,349 --> 00:50:15,760

antarctic ozone hole appeared that was

1372

00:50:18,230 --> 00:50:17,359

the final

1373

00:50:20,710 --> 00:50:18,240

blow

1374

00:50:23,109 --> 00:50:20,720

or the final

1375

00:50:25,349 --> 00:50:23,119

information that happened in about 19

1376

00:50:27,750 --> 00:50:25,359

1984 when the ozone hole was definitely

1377

00:50:28,549 --> 00:50:27,760

there it happened year after year

1378

00:50:30,069 --> 00:50:28,559

and

1379

00:50:32,230 --> 00:50:30,079

after that there was regulation

1380

00:50:34,549 --> 00:50:32,240

throughout the world and ways of dealing

1381

00:50:35,910 --> 00:50:34,559

with emerging countries who couldn't

1382

00:50:37,510 --> 00:50:35,920

immediately dispose of their

1383

00:50:39,430 --> 00:50:37,520

refrigerators to come up with a

1384

00:50:41,990 --> 00:50:39,440

substitute so it happened it was

1385

00:50:44,470 --> 00:50:42,000

uncovered in the 70s regulation was in

1386

00:50:45,990 --> 00:50:44,480

the 1908 early 1980s hey we got a

1387

00:50:46,710 --> 00:50:46,000

question from online

1388

00:50:49,270 --> 00:50:46,720

yeah

1389

00:50:51,589 --> 00:50:49,280

quick question uh what altitude is ozone

1390

00:50:54,549 --> 00:50:51,599

measured what like what altitude is the

1391

00:50:56,150 --> 00:50:54,559

ozone layer at okay uh it'll take me a

1392

00:50:57,910 --> 00:50:56,160

minute to go ahead

1393

00:50:58,950 --> 00:50:57,920

there's there's two kinds of ozone

1394

00:51:02,790 --> 00:50:58,960

people call

1395

00:51:05,510 --> 00:51:02,800

ozone good ozone and bad ozone

1396

00:51:08,870 --> 00:51:05,520

the good ozone is in the stratosphere

1397

00:51:10,309 --> 00:51:08,880

about 20 miles up 40 30 40 kilometers up

1398

00:51:12,790 --> 00:51:10,319

and that's what's shielding the earth

1399

00:51:13,990 --> 00:51:12,800

from ultraviolet radiation to reaching

1400

00:51:16,309 --> 00:51:14,000

the surface of the earth this is the

1401  
00:51:17,670 --> 00:51:16,319  
concern that people have would affect

1402  
00:51:19,670 --> 00:51:17,680  
bio

1403  
00:51:22,069 --> 00:51:19,680  
diversity of the planet when ultraviolet

1404  
00:51:23,430 --> 00:51:22,079  
radiation our bodies were designed any

1405  
00:51:24,950 --> 00:51:23,440  
living organism when the plant is

1406  
00:51:26,790 --> 00:51:24,960  
designed so it doesn't get this

1407  
00:51:28,390 --> 00:51:26,800  
ultraviolet radiation this ultraviolet

1408  
00:51:31,750 --> 00:51:28,400  
radiation gets on mars which is a

1409  
00:51:35,030 --> 00:51:31,760  
problem for anybody who wants to work

1410  
00:51:37,510 --> 00:51:35,040  
because there's no ozone on mars

1411  
00:51:38,870 --> 00:51:37,520  
so there's good ozone that protects life

1412  
00:51:40,790 --> 00:51:38,880  
on this planet and that's why they're

1413  
00:51:43,589 --> 00:51:40,800

concerned about depleting ozone life on

1414

00:51:44,870 --> 00:51:43,599

this planet and then there's bad ozone

1415

00:51:47,190 --> 00:51:44,880

it's the same ozone but it's in the

1416

00:51:50,150 --> 00:51:47,200

lower atmosphere in the near the air the

1417

00:51:51,670 --> 00:51:50,160

air we breathe and that's pollution

1418

00:51:53,990 --> 00:51:51,680

it's uh and it's one of the factors

1419

00:51:55,589 --> 00:51:54,000

everybody here air quality index it's

1420

00:51:57,990 --> 00:51:55,599

really how much ozone is in the air

1421

00:52:00,230 --> 00:51:58,000

that's bad ozone it's a strong oxidant

1422

00:52:02,309 --> 00:52:00,240

and it can affect your lungs it's a

1423

00:52:04,470 --> 00:52:02,319

factor in there's asthma

1424

00:52:06,549 --> 00:52:04,480

asthma severity so there's good ozone

1425

00:52:08,630 --> 00:52:06,559

protecting the life on on the planet by

1426  
00:52:10,630 --> 00:52:08,640  
swinging out ultraviolet as bad ozone at

1427  
00:52:11,910 --> 00:52:10,640  
the ground level caused by pollution all

1428  
00:52:13,750 --> 00:52:11,920  
right hey there was a question from

1429  
00:52:15,829 --> 00:52:13,760  
somebody who left how important is a

1430  
00:52:17,589 --> 00:52:15,839  
subject like mathematics you know to

1431  
00:52:18,710 --> 00:52:17,599  
work like this you know i think a lot of

1432  
00:52:19,990 --> 00:52:18,720  
times people see something like earth

1433  
00:52:21,589 --> 00:52:20,000  
science it sounds exciting get to go

1434  
00:52:23,589 --> 00:52:21,599  
outside but you got these basic subjects

1435  
00:52:25,510 --> 00:52:23,599  
like math and chemistry and physics how

1436  
00:52:26,470 --> 00:52:25,520  
do they play into something like this

1437  
00:52:28,710 --> 00:52:26,480  
well

1438  
00:52:30,069 --> 00:52:28,720

math is sort of the framework for doing

1439

00:52:32,390 --> 00:52:30,079

anything you want anything you want to

1440

00:52:34,069 --> 00:52:32,400

do in science requires you able to

1441

00:52:36,470 --> 00:52:34,079

formulate what you're doing

1442

00:52:38,390 --> 00:52:36,480

i get on a piece of paper on a computer

1443

00:52:40,549 --> 00:52:38,400

nearly everything you do if you have a

1444

00:52:42,790 --> 00:52:40,559

concept of how something how ozone

1445

00:52:44,790 --> 00:52:42,800

depletes the atmosphere you have to have

1446

00:52:47,349 --> 00:52:44,800

a model first i mean the scientific

1447

00:52:49,109 --> 00:52:47,359

method is proposing a model

1448

00:52:50,790 --> 00:52:49,119

testing the parameters doing some

1449

00:52:52,470 --> 00:52:50,800

measurements and then

1450

00:52:54,470 --> 00:52:52,480

see if it agrees with the theory all

1451  
00:52:56,150 --> 00:52:54,480  
this theoretical basis for the models in

1452  
00:52:58,069 --> 00:52:56,160  
doing your science is based on

1453  
00:53:01,190 --> 00:52:58,079  
mathematical techniques

1454  
00:53:03,750 --> 00:53:01,200  
so it's the foundation for doing science

1455  
00:53:05,750 --> 00:53:03,760  
for doing not science doing engineering

1456  
00:53:07,430 --> 00:53:05,760  
mathematics is the foundation for you

1457  
00:53:09,990 --> 00:53:07,440  
can look anywhere you want to around

1458  
00:53:12,390 --> 00:53:10,000  
here mathematics putting up this tent

1459  
00:53:14,870 --> 00:53:12,400  
required mathematical expressions using

1460  
00:53:15,990 --> 00:53:14,880  
this microphone required mathematics

1461  
00:53:16,950 --> 00:53:16,000  
hey any other questions from the

1462  
00:53:18,470 --> 00:53:16,960  
audience

1463  
00:53:20,390 --> 00:53:18,480

all right hey thank you very much ernie

1464

00:53:23,430 --> 00:53:20,400

that was great take that

1465

00:53:28,309 --> 00:53:24,710

before we

1466

00:53:30,870 --> 00:53:28,319

you know take us back for a minute the

1467

00:53:31,990 --> 00:53:30,880

first earth day was back in 1970 and

1468

00:53:33,750 --> 00:53:32,000

that was right you know during the

1469

00:53:35,270 --> 00:53:33,760

apollo program we were first getting our

1470

00:53:37,670 --> 00:53:35,280

pictures back of the earth as this big

1471

00:53:39,430 --> 00:53:37,680

blue marble up in space but we really

1472

00:53:41,430 --> 00:53:39,440

barely had satellites orbiting the earth

1473

00:53:44,069 --> 00:53:41,440

that time and now we're finally at this

1474

00:53:45,750 --> 00:53:44,079

point where we've got 15 satellites in

1475

00:53:47,829 --> 00:53:45,760

orbit right now telling us all these

1476  
00:53:49,270 --> 00:53:47,839  
fascinating things and probably the most

1477  
00:53:50,710 --> 00:53:49,280  
important thing we've learned from all

1478  
00:53:52,710 --> 00:53:50,720  
this work is that the earth is this

1479  
00:53:54,790 --> 00:53:52,720  
great big interconnected systems and

1480  
00:53:56,390 --> 00:53:54,800  
that when we make a change in one place

1481  
00:53:57,910 --> 00:53:56,400  
it translates all the way across the

1482  
00:53:59,910 --> 00:53:57,920  
world and the other thing too is as we

1483  
00:54:01,270 --> 00:53:59,920  
started out with the first talk we are

1484  
00:54:02,950 --> 00:54:01,280  
actually affecting things and we're

1485  
00:54:05,109 --> 00:54:02,960  
affecting things so much that we can see

1486  
00:54:09,190 --> 00:54:05,119  
it in wrapping up does anybody have any

1487  
00:54:12,870 --> 00:54:10,790  
hey we've got one last thing from steve

1488  
00:54:35,390 --> 00:54:12,880

cole take it away

1489

00:54:35,400 --> 00:54:40,950

www.nasa.gov slash

1490

00:54:40,960 --> 00:54:45,270

thank you all for coming