

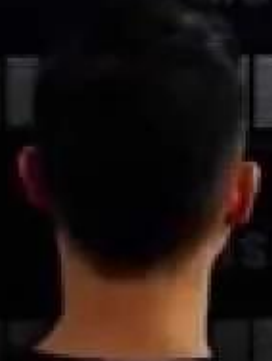
2065



World Expected



World Avoided



1
00:00:16,000 --> 00:00:14,230
tell a real scientific and I think

2
00:00:19,420 --> 00:00:16,010
public policies success story

3
00:00:21,580 --> 00:00:19,430
and it's about the ozone layer you can

4
00:00:23,890 --> 00:00:21,590
see the globe here we divide the

5
00:00:25,599 --> 00:00:23,900
atmosphere and variety of layers the

6
00:00:27,939 --> 00:00:25,609
troposphere is the lowest layer it's

7
00:00:29,890 --> 00:00:27,949
where all of our weather occurs the

8
00:00:31,329 --> 00:00:29,900
stratosphere is the next layer up and

9
00:00:32,920 --> 00:00:31,339
that's what I'm gonna really focus on

10
00:00:35,980 --> 00:00:32,930
because that's where most of our

11
00:00:37,990 --> 00:00:35,990
atmospheric ozone is located now ozone

12
00:00:40,240 --> 00:00:38,000
is critical in our atmosphere because it

13
00:00:42,490 --> 00:00:40,250

screams ultraviolet radiation

14

00:00:47,050 --> 00:00:42,500

ultraviolet radiation these are

15

00:00:49,510 --> 00:00:47,060

energetic solar photons there are they

16

00:00:51,370 --> 00:00:49,520

are strong enough to break the bonds of

17

00:00:55,180 --> 00:00:51,380

biologically active molecules like DNA

18

00:00:57,430 --> 00:00:55,190

for example so if you decrease the

19

00:01:01,270 --> 00:00:57,440

amount of ozone which is screening this

20

00:01:03,940 --> 00:01:01,280

UV radiation you get more at the surface

21

00:01:06,340 --> 00:01:03,950

and what that will do is that you get

22

00:01:08,260 --> 00:01:06,350

you sunburn a little more quickly

23

00:01:10,599 --> 00:01:08,270

for example person like me I'm not

24

00:01:12,069 --> 00:01:10,609

though for about 15 minutes and I'll get

25

00:01:14,709 --> 00:01:12,079

a sunburn but it does a lot of other

26

00:01:16,749 --> 00:01:14,719

things it impacts crops it can cause

27

00:01:18,819 --> 00:01:16,759

cataracts there's a famous study of

28

00:01:21,849 --> 00:01:18,829

watermen out here on the Chesapeake Bay

29

00:01:24,730 --> 00:01:21,859

in which they found that their amount of

30

00:01:27,190 --> 00:01:24,740

time on the bay was proportional to the

31

00:01:28,690 --> 00:01:27,200

cataracts that they got longer you were

32

00:01:30,669 --> 00:01:28,700

out there the more cataracts you're not

33

00:01:33,130 --> 00:01:30,679

but that's extended exposure over the

34

00:01:38,020 --> 00:01:33,140

years so zone is really a critical mass

35

00:01:40,389 --> 00:01:38,030

of our atmosphere in 1974 these two

36

00:01:43,270 --> 00:01:40,399

gentlemen on the right this is sherry

37

00:01:45,520 --> 00:01:43,280

Rowland and this is Mario Molina they

38

00:01:47,440 --> 00:01:45,530

proposed that there were a class of

39

00:01:49,929 --> 00:01:47,450

gases being emitted into our atmosphere

40

00:01:54,090 --> 00:01:49,939

they could destroy the ozone layer

41

00:01:56,679 --> 00:01:54,100

these are chlorofluorocarbons or CFCs so

42

00:01:59,020 --> 00:01:56,689

they proposed this and it was quite

43

00:02:01,499 --> 00:01:59,030

controversial at the time they took a

44

00:02:03,249 --> 00:02:01,509

lot of heat because this

45

00:02:06,789 --> 00:02:03,259

chlorofluorocarbon industry the chemical

46

00:02:09,370 --> 00:02:06,799

industry there is used in a variety of

47

00:02:10,990 --> 00:02:09,380

different kinds of products you can see

48

00:02:13,990 --> 00:02:11,000

some of these like many of us remember

49

00:02:16,220 --> 00:02:14,000

used to be used as a propellant for hair

50

00:02:19,460 --> 00:02:16,230

sprays and do

51
00:02:21,200 --> 00:02:19,470
it was used to make foam products like

52
00:02:23,870 --> 00:02:21,210
these cups that you would get from

53
00:02:25,970 --> 00:02:23,880
McDonald's or other companies it was

54
00:02:28,970 --> 00:02:25,980
used to CFCs were used in air

55
00:02:31,340 --> 00:02:28,980
conditioners and in car air conditioners

56
00:02:34,160 --> 00:02:31,350
was also there's another kind of a gas

57
00:02:36,470 --> 00:02:34,170
called a Halon Halen's are used in fire

58
00:02:39,470 --> 00:02:36,480
extinguishers they contain bromine they

59
00:02:42,350 --> 00:02:39,480
can also destroy ozone so this is

60
00:02:44,390 --> 00:02:42,360
proposed in 1974 and there was a huge

61
00:02:46,340 --> 00:02:44,400
amount of energy and effort that was

62
00:02:49,910 --> 00:02:46,350
going in in the late 70s and the early

63
00:02:52,070 --> 00:02:49,920

80s to see what the impact is on ozone

64

00:02:56,479 --> 00:02:52,080

to measure ozone these gases in

65

00:02:59,930 --> 00:02:56,489

particular now in 1985 there was a

66

00:03:02,360 --> 00:02:59,940

publication of a paper on ozone down

67

00:03:06,290 --> 00:03:02,370

over Antarctica and these three

68

00:03:08,240 --> 00:03:06,300

gentlemen here this is Joe fireman Brian

69

00:03:09,949 --> 00:03:08,250

Gardner and John Shanklin they're

70

00:03:11,600 --> 00:03:09,959

standing in front of an instrument that

71

00:03:14,660 --> 00:03:11,610

measures the total amount of ozone

72

00:03:17,240 --> 00:03:14,670

between the surface and space and they

73

00:03:19,520 --> 00:03:17,250

published their data and you can see it

74

00:03:21,289 --> 00:03:19,530

here this is a measurement this is the

75

00:03:23,509 --> 00:03:21,299

total amount of ozone the bathroom in

76

00:03:26,090 --> 00:03:23,519

space over this station it's Hallie

77

00:03:28,729 --> 00:03:26,100

stationed down in Antarctica and what

78

00:03:31,490 --> 00:03:28,739

they showed was that the level of ozone

79

00:03:35,479 --> 00:03:31,500

was dropping and it was dropping really

80

00:03:37,400 --> 00:03:35,489

fast okay there's an amazing study that

81

00:03:39,830 --> 00:03:37,410

they published and the quality of these

82

00:03:42,890 --> 00:03:39,840

data are such that there was no dispute

83

00:03:45,920 --> 00:03:42,900

to this ozone was going down and it was

84

00:03:47,630 --> 00:03:45,930

going down fast this was a real shock to

85

00:03:51,039 --> 00:03:47,640

the atmospheric community when this

86

00:03:56,030 --> 00:03:51,049

paper was published shortly thereafter

87

00:03:57,949 --> 00:03:56,040

this was in in the in 1985 also a

88

00:03:58,850 --> 00:03:57,959

scientist at the NASA Goddard Space

89

00:04:02,979 --> 00:03:58,860

Flight Center

90

00:04:06,410 --> 00:04:02,989

TK party made an image of what this

91

00:04:08,060 --> 00:04:06,420

don't look like over Antarctica and so

92

00:04:11,000 --> 00:04:08,070

you can see Nrap here in the center

93

00:04:13,670 --> 00:04:11,010

South America Africa Australia and here

94

00:04:15,770 --> 00:04:13,680

in the middle is this very low ozone

95

00:04:18,400 --> 00:04:15,780

area these red colors and yellows you

96

00:04:21,259 --> 00:04:18,410

just see here indicates very low ozone

97

00:04:25,010 --> 00:04:21,269

and it was dubbed the Antarctic ozone

98

00:04:27,529 --> 00:04:25,020

hole so ozone was going down fast and it

99

00:04:28,460 --> 00:04:27,539

was a huge region this is a very large

100

00:04:30,830 --> 00:04:28,470

region

101
00:04:32,570 --> 00:04:30,840
all this this continent of Antarctica is

102
00:04:35,720 --> 00:04:32,580
a large area so there's a large

103
00:04:37,310 --> 00:04:35,730
depletion over a large area and we

104
00:04:39,140 --> 00:04:37,320
didn't actually understand what was

105
00:04:41,510 --> 00:04:39,150
going on at the time but within a couple

106
00:04:43,880 --> 00:04:41,520
of years we figured out it was actually

107
00:04:51,140 --> 00:04:43,890
due to these chlorofluorocarbons inhale

108
00:04:53,690 --> 00:04:51,150
ons so there was a lot of consternation

109
00:04:54,710 --> 00:04:53,700
about this what are we going to do how

110
00:04:57,650 --> 00:04:54,720
can we stop it

111
00:05:00,020 --> 00:04:57,660
what other measurements can we make the

112
00:05:02,720 --> 00:05:00,030
rising concern about the problem amongst

113
00:05:05,000 --> 00:05:02,730

the nations of the world there was

114

00:05:07,280 --> 00:05:05,010

already discussion about should we get

115

00:05:09,740 --> 00:05:07,290

together and create an agreement and in

116

00:05:14,300 --> 00:05:09,750

fact after a couple years they did

117

00:05:17,060 --> 00:05:14,310

create an agreement this is an agreement

118

00:05:20,300 --> 00:05:17,070

called the Montreal Protocol these are

119

00:05:22,130 --> 00:05:20,310

this is a shows a meeting of the parties

120

00:05:27,740 --> 00:05:22,140

to the Montreal Protocol it took place

121

00:05:29,810 --> 00:05:27,750

in Doha and in Peninsula and here you

122

00:05:31,970 --> 00:05:29,820

can see the Montreal Protocol had a

123

00:05:34,190 --> 00:05:31,980

series of agreements the initial one and

124

00:05:36,640 --> 00:05:34,200

then they were added on to further

125

00:05:39,710 --> 00:05:36,650

strengthening regulations of these

126
00:05:41,330 --> 00:05:39,720
chlorofluorocarbons so eventually the

127
00:05:42,920 --> 00:05:41,340
the production of chlorofluorocarbons

128
00:05:46,010 --> 00:05:42,930
and Halen's

129
00:05:47,600 --> 00:05:46,020
was fully agreed to now you can see the

130
00:05:50,630 --> 00:05:47,610
nations of the world there little signs

131
00:05:54,680 --> 00:05:50,640
here here you can see this is me sitting

132
00:05:56,360 --> 00:05:54,690
way in the back of this meeting even

133
00:05:58,550 --> 00:05:56,370
though the scientists we bring them all

134
00:06:00,219 --> 00:05:58,560
the information we're always put at the

135
00:06:02,570 --> 00:06:00,229
back of a meeting when they need us

136
00:06:04,460 --> 00:06:02,580
calling us but we sit in the back and

137
00:06:07,100 --> 00:06:04,470
listen to all the discussions and most

138
00:06:09,440 --> 00:06:07,110

of these discussions are about country's

139

00:06:11,180 --> 00:06:09,450

ability to maybe use a CFC for a short

140

00:06:16,310 --> 00:06:11,190

time there are a lot of different things

141

00:06:19,250 --> 00:06:16,320

going on in these meetings ok so now

142

00:06:21,440 --> 00:06:19,260

what's happened with ozone well first of

143

00:06:24,200 --> 00:06:21,450

all let me talk about chlorine so

144

00:06:27,200 --> 00:06:24,210

chlorine it was going up and up and up

145

00:06:29,450 --> 00:06:27,210

through the 1960s 1970s 1980s these are

146

00:06:31,790 --> 00:06:29,460

the combination of all the CFCs and a

147

00:06:36,409 --> 00:06:31,800

Long's and then the Montreal Protocol

148

00:06:38,990 --> 00:06:36,419

was signed here in 1987 and slowly those

149

00:06:41,159 --> 00:06:39,000

regulations began to take hold and in

150

00:06:43,559 --> 00:06:41,169

fact the projection

151
00:06:45,629 --> 00:06:43,569
is that Oh are these ozone depleting

152
00:06:47,249 --> 00:06:45,639
substances are going to decline with

153
00:06:48,959 --> 00:06:47,259
time now this is going to take a long

154
00:06:50,640 --> 00:06:48,969
time because CFCs these

155
00:06:54,899 --> 00:06:50,650
chlorofluorocarbons have long lifetimes

156
00:06:59,249 --> 00:06:54,909
for example I'm CFC 11 has a lifetime of

157
00:07:01,800 --> 00:06:59,259
about 52 years CFC 12 which was used in

158
00:07:04,350 --> 00:07:01,810
your car air conditioners has a lifetime

159
00:07:05,879 --> 00:07:04,360
of over a hundred years so it's going to

160
00:07:07,890 --> 00:07:05,889
take a long time even though the

161
00:07:10,080 --> 00:07:07,900
production and emissions of these gases

162
00:07:11,939 --> 00:07:10,090
has been regulated it's going to take a

163
00:07:17,579 --> 00:07:11,949

long time for them to come out of our

164

00:07:20,219 --> 00:07:17,589

atmosphere so what's happening with

165

00:07:22,800 --> 00:07:20,229

ozone now so this is showing this is in

166

00:07:24,629 --> 00:07:22,810

percentage the change of ozone over time

167

00:07:27,209 --> 00:07:24,639

and percentage you can see the

168

00:07:30,059 --> 00:07:27,219

observations as you go into the 80s you

169

00:07:32,489 --> 00:07:30,069

can see that ozone was going down the

170

00:07:35,100 --> 00:07:32,499

CFCs were increasing the Montreal

171

00:07:37,730 --> 00:07:35,110

Protocol the sign here pretty soon the

172

00:07:40,079 --> 00:07:37,740

chlorine that started to decrease and

173

00:07:41,820 --> 00:07:40,089

you can almost see there's a Mount

174

00:07:43,920 --> 00:07:41,830

Pinatubo effect right here but you can

175

00:07:46,740 --> 00:07:43,930

almost see that ozone isn't going down

176
00:07:49,439 --> 00:07:46,750
anymore and maybe there's a hint that

177
00:07:51,059 --> 00:07:49,449
things are starting to go up we can't

178
00:07:53,219 --> 00:07:51,069
say that as scientists we can't say

179
00:07:55,050 --> 00:07:53,229
that's true yet but I think we're

180
00:07:56,850 --> 00:07:55,060
getting to the point within the next few

181
00:07:59,670 --> 00:07:56,860
years I think we'll actually be able to

182
00:08:01,619 --> 00:07:59,680
say statistically that ozone is

183
00:08:05,700 --> 00:08:01,629
increasing in our atmosphere let's keep

184
00:08:08,369 --> 00:08:05,710
our fingers crossed now the other way of

185
00:08:10,110 --> 00:08:08,379
looking at this is we can use a model to

186
00:08:12,149 --> 00:08:10,120
take a look at what would have happened

187
00:08:13,350 --> 00:08:12,159
to ozone if we've done nothing so I'm

188
00:08:16,019 --> 00:08:13,360

going to show you a little model study

189

00:08:18,300 --> 00:08:16,029

here and on the top left I'm going to

190

00:08:21,149 --> 00:08:18,310

show you the expected world and this is

191

00:08:23,279 --> 00:08:21,159

with the Montreal Protocol CFCs are

192

00:08:25,050 --> 00:08:23,289

going to decline over here is what we

193

00:08:26,909 --> 00:08:25,060

call the world avoided and this is

194

00:08:28,860 --> 00:08:26,919

chlorine going up if you look on the

195

00:08:31,110 --> 00:08:28,870

picture you can see the amount of

196

00:08:33,600 --> 00:08:31,120

chlorine in the expected world and the

197

00:08:35,519 --> 00:08:33,610

amount of chlorine in the world avoided

198

00:08:37,709 --> 00:08:35,529

so you can see here it's four point five

199

00:08:39,689 --> 00:08:37,719

there it's already a little bit higher

200

00:08:41,759 --> 00:08:39,699

because of the Montreal Protocol it's

201
00:08:43,889 --> 00:08:41,769
this is because the mantra protocol

202
00:08:45,960 --> 00:08:43,899
that's without one and you can see it's

203
00:08:47,309 --> 00:08:45,970
flying by fairly quickly as you can see

204
00:08:50,280 --> 00:08:47,319
the date in the right you can see the

205
00:08:52,590 --> 00:08:50,290
ozone hole appearing every year

206
00:08:54,040 --> 00:08:52,600
chlorine continues to go up in this

207
00:08:55,540 --> 00:08:54,050
world avoided and

208
00:08:58,600 --> 00:08:55,550
now you can actually see it peek down in

209
00:09:02,170 --> 00:08:58,610
about four that's a slow decline is

210
00:09:03,880 --> 00:09:02,180
we're up to 20 22 24 if you look here at

211
00:09:06,519 --> 00:09:03,890
this world avoided you can now start

212
00:09:09,370 --> 00:09:06,529
seeing a little zone hole deep low

213
00:09:12,759 --> 00:09:09,380

values appearing over the Arctic and you

214

00:09:15,400 --> 00:09:12,769

see the very very large ozone loss in

215

00:09:17,440 --> 00:09:15,410

over the Antarctic region if you look at

216

00:09:19,210 --> 00:09:17,450

the expected world you don't see any of

217

00:09:22,389 --> 00:09:19,220

those things and in fact as chlorine

218

00:09:25,120 --> 00:09:22,399

continues to increase you can see ozone

219

00:09:27,220 --> 00:09:25,130

going down now in the tropics and in the

220

00:09:29,410 --> 00:09:27,230

sub tropics so you can see that here

221

00:09:31,600 --> 00:09:29,420

your dominated by reds and oranges the

222

00:09:34,600 --> 00:09:31,610

higher the zone levels in the world

223

00:09:36,810 --> 00:09:34,610

avoided you can see that ozone is

224

00:09:40,930 --> 00:09:36,820

declining and declining and declining

225

00:09:43,870 --> 00:09:40,940

now this is about 40 to 50 times time

226

00:09:46,810 --> 00:09:43,880

you get out to 2065 here this is 40 to

227

00:09:48,910 --> 00:09:46,820

50 times the natural level of chlorine

228

00:09:51,220 --> 00:09:48,920

in our atmosphere chlorine and bromine

229

00:09:54,190 --> 00:09:51,230

combined and this has gone down it's

230

00:09:56,829 --> 00:09:54,200

about it needs to go down to about 1.2

231

00:09:59,829 --> 00:09:56,839

this is about halfway there but you can

232

00:10:00,430 --> 00:09:59,839

see the difference in ozone 65% or

233

00:10:02,530 --> 00:10:00,440

excuse me

234

00:10:05,440 --> 00:10:02,540

about two-thirds of the ozone layer is

235

00:10:08,170 --> 00:10:05,450

destroyed if there had been no Montreal

236

00:10:11,230 --> 00:10:08,180

Protocol if nothing had been done okay

237

00:10:14,290 --> 00:10:11,240

now what does that mean that means huge

238

00:10:16,329 --> 00:10:14,300

impacts on crops for somebody like me I

239

00:10:18,340 --> 00:10:16,339

mentioned that if I go outside fifteen

240

00:10:21,819 --> 00:10:18,350

minutes I'll get a perceptible burn and

241

00:10:24,490 --> 00:10:21,829

that world it's five minutes okay so you

242

00:10:27,030 --> 00:10:24,500

go out and you walk for a quarter of a

243

00:10:30,940 --> 00:10:27,040

mile you would get a perceptible sunburn

244

00:10:32,560 --> 00:10:30,950

so this is an incredibly bad world we

245

00:10:37,540 --> 00:10:32,570

don't want to live in the out world this

246

00:10:38,889 --> 00:10:37,550

is the one that we expect now we can do

247

00:10:41,650 --> 00:10:38,899

is I have already shown we can do these

248

00:10:43,630 --> 00:10:41,660

projections of where ozone is going here

249

00:10:46,060 --> 00:10:43,640

we can see the observations this shows a

250

00:10:48,670 --> 00:10:46,070

model projection and now I'll put two

251
00:10:52,990 --> 00:10:48,680
model projections on here the lower one

252
00:10:54,579 --> 00:10:53,000
is is a is a world in which both ozone

253
00:10:56,319 --> 00:10:54,589
depleting substances it has a Montreal

254
00:10:59,110 --> 00:10:56,329
Protocol in it they've been regulated

255
00:11:02,170 --> 00:10:59,120
and Seoul ozone is going up but in one

256
00:11:05,560 --> 00:11:02,180
greenhouse gases are regulated in the

257
00:11:08,889 --> 00:11:05,570
other greenhouse gases continue to go

258
00:11:11,230 --> 00:11:08,899
and in fact ozone continues to go up so

259
00:11:13,629 --> 00:11:11,240
the net impact of increasing greenhouse

260
00:11:15,939 --> 00:11:13,639
gases is that the ozone layer begin to

261
00:11:17,560 --> 00:11:15,949
pile up lots of ozone so instead of a

262
00:11:19,930 --> 00:11:17,570
depleted ozone the world we're gonna go

263
00:11:22,749 --> 00:11:19,940

to an ozone world where there's probably

264

00:11:24,730 --> 00:11:22,759

too much though now what does that mean

265

00:11:27,300 --> 00:11:24,740

for the environment I actually don't

266

00:11:31,449 --> 00:11:27,310

know I don't think we know as scientists

267

00:11:35,400 --> 00:11:31,459

what's going to happen there so let me

268

00:11:38,530 --> 00:11:35,410

say another word about what happened

269

00:11:42,160 --> 00:11:38,540

this is I love this picture this I owned

270

00:11:44,139 --> 00:11:42,170

a 1967 Ford Mustang Fastback it was a

271

00:11:47,530 --> 00:11:44,149

hot car I love this car

272

00:11:50,920 --> 00:11:47,540

it had a CFC air conditioner in it okay

273

00:11:54,040 --> 00:11:50,930

so I was using cfc-12 in that particular

274

00:11:56,559 --> 00:11:54,050

air condition here's a Tesla a modern

275

00:12:00,670 --> 00:11:56,569

Tesla it uses a replacement compound

276

00:12:03,370 --> 00:12:00,680

called an HFC in fact hfc-134a in fact

277

00:12:06,519 --> 00:12:03,380

in all your cars right now you have that

278

00:12:09,550 --> 00:12:06,529

particular refrigerant in your car air

279

00:12:11,650 --> 00:12:09,560

conditioner so this is the compound that

280

00:12:14,079 --> 00:12:11,660

replaced the CFCs now the beauty of this

281

00:12:16,240 --> 00:12:14,089

is this is a hydrogen of fluorine and a

282

00:12:18,280 --> 00:12:16,250

carbon it doesn't have chlorine so it

283

00:12:21,639 --> 00:12:18,290

doesn't destroy the ozone layer

284

00:12:25,480 --> 00:12:21,649

the problem with HF sees though is their

285

00:12:28,829 --> 00:12:25,490

greenhouse gases the particular hfc-134a

286

00:12:32,379 --> 00:12:28,839

is about pound-for-pound it's about

287

00:12:36,939 --> 00:12:32,389

1,400 times more efficient at warming

288

00:12:40,530 --> 00:12:36,949

than co2 so you could take one pound of

289

00:12:43,650 --> 00:12:40,540

this hfc-134a is equivalent to about

290

00:12:47,199 --> 00:12:43,660

1,400 pounds of co2 so the replacement

291

00:12:49,780 --> 00:12:47,209

compounds for the CFCs are greenhouse

292

00:12:51,189 --> 00:12:49,790

gases and the question is what are we

293

00:12:53,889 --> 00:12:51,199

going to actually do about these now

294

00:12:55,949 --> 00:12:53,899

this shows a particular HLC this is hf c

295

00:12:58,660 --> 00:12:55,959

23 you can see these are observations

296

00:13:01,769 --> 00:12:58,670

they're increasing the time because we

297

00:13:04,240 --> 00:13:01,779

replaced the CFCs there are many other

298

00:13:08,050 --> 00:13:04,250

HFCS this is the one I talked abouts in

299

00:13:11,139 --> 00:13:08,060

your car air-conditioner 134a this one

300

00:13:14,379 --> 00:13:11,149

32 and 125 these are probably in your

301
00:13:16,809 --> 00:13:14,389
home air conditioning units so all these

302
00:13:17,800 --> 00:13:16,819
HFCS are increasing with time and these

303
00:13:18,100 --> 00:13:17,810
HFCS

304
00:13:22,030 --> 00:13:18,110
are

305
00:13:24,040 --> 00:13:22,040
all powerful greenhouse gases so we

306
00:13:26,590 --> 00:13:24,050
solved the problem that is the problem

307
00:13:28,210 --> 00:13:26,600
of ozone depletion but in fact and in

308
00:13:30,340 --> 00:13:28,220
fact those CFCs were also powerful

309
00:13:33,790 --> 00:13:30,350
greenhouse gases but we replace them

310
00:13:36,639 --> 00:13:33,800
with compounds that are also powerful

311
00:13:39,160 --> 00:13:36,649
greenhouse gases so you could do a lot

312
00:13:41,530 --> 00:13:39,170
for claim it if you figure it out how to

313
00:13:44,019 --> 00:13:41,540

take these compounds and replace them

314

00:13:46,900 --> 00:13:44,029

with compounds that are both friendly to

315

00:13:48,100 --> 00:13:46,910

the ozone layer and friendly to climate

316

00:13:50,470 --> 00:13:48,110

and in fact there are technological

317

00:13:52,900 --> 00:13:50,480

solutions so that goes back to the

318

00:13:55,900 --> 00:13:52,910

Montreal Protocol the Montreal Protocol

319

00:13:57,340 --> 00:13:55,910

could in fact take action on these HF

320

00:14:03,160 --> 00:13:57,350

seasons we don't know that that's gonna

321

00:14:05,019 --> 00:14:03,170

happen it might so let me kind of

322

00:14:07,720 --> 00:14:05,029

summarize where we've been so I told you

323

00:14:09,250 --> 00:14:07,730

a good story we got rid of these CFCs

324

00:14:11,290 --> 00:14:09,260

there now regulated there still exist in

325

00:14:12,940 --> 00:14:11,300

various places around the atmosphere but

326

00:14:13,420 --> 00:14:12,950

they're slowly declining that's a great

327

00:14:16,480 --> 00:14:13,430

story

328

00:14:19,150 --> 00:14:16,490

in fact the outcome of that would have

329

00:14:22,960 --> 00:14:19,160

been an environmental disaster if they

330

00:14:25,210 --> 00:14:22,970

kept growing we used a lot of satellite

331

00:14:27,730 --> 00:14:25,220

information to take a look at the ozone

332

00:14:31,180 --> 00:14:27,740

problem most of the observations you've

333

00:14:33,100 --> 00:14:31,190

seen on this presentation have come from

334

00:14:35,980 --> 00:14:33,110

NASA satellites including the aura

335

00:14:38,530 --> 00:14:35,990

satellite that you can see here now what

336

00:14:41,889 --> 00:14:38,540

is the future hold well the future's in

337

00:14:44,050 --> 00:14:41,899

our own hands we have two things we can

338

00:14:46,210 --> 00:14:44,060

you could regulate these compounds and

339

00:14:48,160 --> 00:14:46,220

that may happen but the one thing we

340

00:14:49,720 --> 00:14:48,170

that we really need to do is we need to

341

00:14:51,939 --> 00:14:49,730

continue to look at the atmosphere to

342

00:14:54,009 --> 00:14:51,949

continue to make measurements of what's

343

00:14:56,530 --> 00:14:54,019

happening to our atmosphere and that's

344

00:14:58,750 --> 00:14:56,540

where satellites like aura and its

345

00:15:00,189 --> 00:14:58,760

follow-ons are crucial to knowing where