



SPACESTATION LIVE

Solar Occultation

1
00:00:11,509 --> 00:00:09,030
the international space station support

2
00:00:13,669 --> 00:00:11,519
laboratories where research in a range

3
00:00:16,310 --> 00:00:13,679
of scientific disciplines is conducted

4
00:00:17,830 --> 00:00:16,320
and is also a stable platform orbiting

5
00:00:19,109 --> 00:00:17,840
the earth that supports a number of

6
00:00:20,950 --> 00:00:19,119
instruments that are looking down and

7
00:00:22,310 --> 00:00:20,960
gathering data about the planet in its

8
00:00:24,070 --> 00:00:22,320
systems

9
00:00:25,830 --> 00:00:24,080
one new such instrument is scheduled to

10
00:00:27,750 --> 00:00:25,840
fly on the station later this year on a

11
00:00:29,349 --> 00:00:27,760
dragon cargo ship

12
00:00:31,990 --> 00:00:29,359
dr joseph

13
00:00:33,990 --> 00:00:32,000

zudoni at the langley research center is

14

00:00:36,389 --> 00:00:34,000

the project scientist for the

15

00:00:39,270 --> 00:00:36,399

stratospheric aerosol and gas experiment

16

00:00:40,790 --> 00:00:39,280

known as sage iii and he recently talked

17

00:00:43,510 --> 00:00:40,800

with langley's

18

00:00:48,229 --> 00:00:43,520

kristen de medio about what sage will be

19

00:00:51,670 --> 00:00:49,190

well we're

20

00:00:53,110 --> 00:00:51,680

primarily an ozone and aerosol measuring

21

00:00:55,590 --> 00:00:53,120

system

22

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

the sage series sage three is the third

23

00:00:59,349 --> 00:00:57,360

in the series

24

00:01:01,670 --> 00:00:59,359

has been going on for a number of years

25

00:01:02,790 --> 00:01:01,680

40 over 40 years now

26

00:01:05,509 --> 00:01:02,800

and

27

00:01:08,070 --> 00:01:05,519

the data is vital for

28

00:01:09,429 --> 00:01:08,080

measuring ozone seeing how it's changing

29

00:01:11,590 --> 00:01:09,439

with time

30

00:01:13,030 --> 00:01:11,600

and also aerosols which i'll get into in

31

00:01:14,630 --> 00:01:13,040

a little bit but they're

32

00:01:16,469 --> 00:01:14,640

important for climate

33

00:01:18,630 --> 00:01:16,479

can you tell me a little bit about what

34

00:01:21,190 --> 00:01:18,640

efforts this project has grown from

35

00:01:24,070 --> 00:01:21,200

so as i said this started uh 44 almost

36

00:01:26,230 --> 00:01:24,080

41 years ago with

37

00:01:29,030 --> 00:01:26,240

this little device this is the

38

00:01:30,550 --> 00:01:29,040

stratospheric aerosol measurement

39

00:01:33,190 --> 00:01:30,560

sam

40

00:01:36,870 --> 00:01:33,200

and it flew on apollo soyuz in the

41

00:01:39,109 --> 00:01:36,880

summer of 75 1975.

42

00:01:40,469 --> 00:01:39,119

very simple little instrument

43

00:01:44,069 --> 00:01:40,479

uh

44

00:01:46,870 --> 00:01:44,079

a diode at the end of this tube is aimed

45

00:01:49,350 --> 00:01:46,880

at the sun lined up with the site here

46

00:01:52,310 --> 00:01:49,360

this was just clipped into the window

47

00:01:57,429 --> 00:01:52,320

of the apollo spacecraft they aimed it

48

00:02:00,630 --> 00:01:57,439

at the sun and let the spacecraft be uh

49

00:02:03,910 --> 00:02:00,640

our platform

50

00:02:06,870 --> 00:02:03,920

it then watched the sun set

51
00:02:09,510 --> 00:02:06,880
and what happens is as that happens

52
00:02:11,990 --> 00:02:09,520
um sunlight

53
00:02:14,470 --> 00:02:12,000
is attenuated by the earth's atmosphere

54
00:02:16,790 --> 00:02:14,480
aerosols in particular

55
00:02:18,470 --> 00:02:16,800
this was a one channel instrument had

56
00:02:20,070 --> 00:02:18,480
made a single single measurement at one

57
00:02:21,589 --> 00:02:20,080
one micron

58
00:02:23,110 --> 00:02:21,599
in the infrared

59
00:02:25,350 --> 00:02:23,120
quickly after that

60
00:02:29,110 --> 00:02:25,360
followed sam ii which was on its own

61
00:02:31,670 --> 00:02:29,120
spacecraft it lasted for over 16 years

62
00:02:32,869 --> 00:02:31,680
shortly thereafter sage one was flown

63
00:02:34,470 --> 00:02:32,879

that had

64

00:02:36,309 --> 00:02:34,480
several channels that measured not only

65

00:02:37,350 --> 00:02:36,319
the aerosol at one micron but it also

66

00:02:39,509 --> 00:02:37,360
measured

67

00:02:41,270 --> 00:02:39,519
ozone for the first time from

68

00:02:43,830 --> 00:02:41,280
in occultation

69

00:02:46,790 --> 00:02:43,840
that lasted uh three years spacecraft

70

00:02:49,270 --> 00:02:46,800
battery systems failed on that

71

00:02:52,470 --> 00:02:49,280
then in 84 we launched sage ii which is

72

00:02:55,270 --> 00:02:52,480
probably our best known

73

00:02:57,110 --> 00:02:55,280
measurement system it lasted 21 years

74

00:02:58,630 --> 00:02:57,120
fabulous data set

75

00:03:00,710 --> 00:02:58,640
important period too because during that

76

00:03:02,869 --> 00:03:00,720

time ozone was first seen to be

77

00:03:05,030 --> 00:03:02,879

declining

78

00:03:06,630 --> 00:03:05,040

in the stratosphere upper stratosphere

79

00:03:07,990 --> 00:03:06,640

so the ozone layer is primarily in the

80

00:03:11,030 --> 00:03:08,000

stratosphere

81

00:03:15,670 --> 00:03:13,589

chlorine compounds freons in particular

82

00:03:17,589 --> 00:03:15,680

were

83

00:03:20,790 --> 00:03:17,599

causing the destruction of ozone in the

84

00:03:28,470 --> 00:03:24,470

and we saw that happening and

85

00:03:30,309 --> 00:03:28,480

by the mid 80s 1980s the

86

00:03:32,470 --> 00:03:30,319

community had come along and noticed

87

00:03:34,070 --> 00:03:32,480

that the ozone was declining started to

88

00:03:35,830 --> 00:03:34,080

take action trying to figure out exactly

89

00:03:36,869 --> 00:03:35,840

what was happening

90

00:03:39,830 --> 00:03:36,879

turned out

91

00:03:42,630 --> 00:03:39,840

pretty clearly from sage data and sbuv

92

00:03:44,470 --> 00:03:42,640

to sbuv data another nasa satellite

93

00:03:46,149 --> 00:03:44,480

system that measures ozone

94

00:03:48,949 --> 00:03:46,159

the pattern was such that we knew it was

95

00:03:53,750 --> 00:03:51,910

montreal protocol was was written up

96

00:03:54,789 --> 00:03:53,760

signed by virtually every country on the

97

00:03:57,429 --> 00:03:54,799

planet

98

00:04:00,550 --> 00:03:57,439

outlawing uh the use of freons

99

00:04:03,190 --> 00:04:00,560

and uh later in the 21 year mission

100

00:04:04,869 --> 00:04:03,200

lifetime of stage 2 the

101

00:04:06,949 --> 00:04:04,879

first evidence that the chlorine

102

00:04:08,789 --> 00:04:06,959

decreases were actually

103

00:04:10,390 --> 00:04:08,799

being seen in the ozone were found so it

104

00:04:11,750 --> 00:04:10,400

was a nice a nice long

105

00:04:13,750 --> 00:04:11,760

nice long

106

00:04:15,190 --> 00:04:13,760

mission

107

00:04:18,469 --> 00:04:15,200

near the end of that time we started to

108

00:04:21,270 --> 00:04:18,479

work on sage iii we built three of those

109

00:04:23,110 --> 00:04:21,280

uh the first one was flown in 2000 on

110

00:04:24,790 --> 00:04:23,120

the russian meteor

111

00:04:26,550 --> 00:04:24,800

lasted five years

112

00:04:28,469 --> 00:04:26,560

and now we're on

113

00:04:30,629 --> 00:04:28,479

the second sage iii and it was always

114

00:04:32,390 --> 00:04:30,639
designed to go on space station

115

00:04:33,749 --> 00:04:32,400
so this next

116

00:04:35,670 --> 00:04:33,759
piece of hardware stage three is

117

00:04:37,430 --> 00:04:35,680
scheduled to fly later this year can you

118

00:04:38,790 --> 00:04:37,440
tell me a little bit more about the

119

00:04:40,150 --> 00:04:38,800
hardware and where it's going to go on

120

00:04:43,510 --> 00:04:40,160
the space station

121

00:04:45,749 --> 00:04:43,520
place there's

122

00:04:47,189 --> 00:04:45,759
lots of places to mount things we're

123

00:04:49,270 --> 00:04:47,199
going out

124

00:04:52,070 --> 00:04:49,280
near the end of one of the arms on a

125

00:04:54,469 --> 00:04:52,080
place called elc-4

126

00:04:57,990 --> 00:04:54,479

our payload comes up on the dragon trunk

127

00:05:01,029 --> 00:04:58,000

in in two pieces this is uh the first of

128

00:05:03,350 --> 00:05:01,039

the pieces it's a nader viewing platform

129

00:05:05,749 --> 00:05:03,360

and all it does is it replicates an

130

00:05:08,150 --> 00:05:05,759

interface that's

131

00:05:09,909 --> 00:05:08,160

vertical relative to the earth and

132

00:05:11,590 --> 00:05:09,919

provides one that's horizontal that's

133

00:05:13,510 --> 00:05:11,600

why it's called nader viewing this flat

134

00:05:15,430 --> 00:05:13,520

place flat plate

135

00:05:18,550 --> 00:05:15,440

faces down towards the earth the second

136

00:05:23,029 --> 00:05:20,950

will also come up on the same flight

137

00:05:25,350 --> 00:05:23,039

and the robotic system will install this

138

00:05:27,110 --> 00:05:25,360

first this will be riding piggyback and

139

00:05:28,629 --> 00:05:27,120

then it'll take this

140

00:05:30,230 --> 00:05:28,639

and install it

141

00:05:31,350 --> 00:05:30,240

like that and then this completed

142

00:05:33,430 --> 00:05:31,360

assembly

143

00:05:36,310 --> 00:05:33,440

is is uh

144

00:05:37,830 --> 00:05:36,320

our hardware it's about 750 pounds if i

145

00:05:38,870 --> 00:05:37,840

record

146

00:05:40,710 --> 00:05:38,880

correctly

147

00:05:44,070 --> 00:05:40,720

the sage instrument itself

148

00:05:48,629 --> 00:05:46,790

and this uh allows us in this

149

00:05:51,590 --> 00:05:48,639

orientation we can see

150

00:05:52,390 --> 00:05:51,600

virtually 360 degrees to the to the

151
00:05:54,150 --> 00:05:52,400
horizon

152
00:05:56,790 --> 00:05:54,160
uh the limb of the earth

153
00:05:57,909 --> 00:05:56,800
we're looking at the uh the thin

154
00:05:59,909 --> 00:05:57,919
thin layer of

155
00:06:03,189 --> 00:05:59,919
air that you can see off at the off at

156
00:06:05,430 --> 00:06:03,199
the horizon and from orbit

157
00:06:07,029 --> 00:06:05,440
the instrument will rotate an azimuth to

158
00:06:08,629 --> 00:06:07,039
find the sun

159
00:06:10,950 --> 00:06:08,639
and then there's a scan mirror in there

160
00:06:12,950 --> 00:06:10,960
which scans the field of view across the

161
00:06:14,710 --> 00:06:12,960
sun up and down so we're making

162
00:06:16,950 --> 00:06:14,720
measurements of the solar brightness the

163
00:06:18,230 --> 00:06:16,960

limb darkening curve we look at it above

164

00:06:20,790 --> 00:06:18,240

the atmosphere

165

00:06:22,150 --> 00:06:20,800

and then as the sun sets we watch that

166

00:06:24,950 --> 00:06:22,160

uh light

167

00:06:26,150 --> 00:06:24,960

decrease due to scattering absorption in

168

00:06:28,070 --> 00:06:26,160

the atmosphere

169

00:06:31,270 --> 00:06:28,080

and we're measuring the uh

170

00:06:32,790 --> 00:06:31,280

the spectrum from 290 nanometers past

171

00:06:34,550 --> 00:06:32,800

one micron and then we have another

172

00:06:35,909 --> 00:06:34,560

channel single channel at 15 15

173

00:06:37,670 --> 00:06:35,919

nanometers

174

00:06:39,749 --> 00:06:37,680

and from that

175

00:06:41,670 --> 00:06:39,759

we measure a number of things we see the

176
00:06:42,629 --> 00:06:41,680
spectral fingerprints of gases like

177
00:06:45,189 --> 00:06:42,639
ozone

178
00:06:46,790 --> 00:06:45,199
nitrogen dioxide water vapor

179
00:06:49,110 --> 00:06:46,800
oxygen we measure temperature and

180
00:06:51,350 --> 00:06:49,120
pressure from that a few other trace

181
00:06:52,309 --> 00:06:51,360
species

182
00:06:54,790 --> 00:06:52,319
and then

183
00:06:57,110 --> 00:06:54,800
the broadband residual from all of that

184
00:06:59,189 --> 00:06:57,120
is is due to aerosol

185
00:07:01,189 --> 00:06:59,199
how is the data that ch3 is going to

186
00:07:02,629 --> 00:07:01,199
take going to contribute to our

187
00:07:04,710 --> 00:07:02,639
understanding of the atmosphere and how

188
00:07:06,469 --> 00:07:04,720

we can better protect it so since the

189

00:07:08,550 --> 00:07:06,479

montreal protocol

190

00:07:10,150 --> 00:07:08,560

was enacted and apparently is very

191

00:07:12,070 --> 00:07:10,160

successful we're expecting ozone to

192

00:07:12,790 --> 00:07:12,080

recover

193

00:07:15,670 --> 00:07:12,800

it

194

00:07:18,870 --> 00:07:15,680

minimum value

195

00:07:21,350 --> 00:07:18,880

in in the late late 90s there's no real

196

00:07:23,110 --> 00:07:21,360

clear signal yet despite it being 15

197

00:07:25,749 --> 00:07:23,120

years or more

198

00:07:27,510 --> 00:07:25,759

since that onset of recovery

199

00:07:30,629 --> 00:07:27,520

and it's just because the recovery is

200

00:07:32,550 --> 00:07:30,639

very slow and you need a very precise

201
00:07:34,550 --> 00:07:32,560
measurement in order to see such a small

202
00:07:36,150 --> 00:07:34,560
change that's where occultation is ideal

203
00:07:39,029 --> 00:07:36,160
the the instrument

204
00:07:40,950 --> 00:07:39,039
effectively can degrade with time

205
00:07:45,270 --> 00:07:40,960
but because it makes its measurement of

206
00:07:47,110 --> 00:07:45,280
the sun right before or right after

207
00:07:49,830 --> 00:07:47,120
taking the atmospheric data

208
00:07:51,510 --> 00:07:49,840
any changes that the instrument has

209
00:07:53,029 --> 00:07:51,520
can be taken taken out of that

210
00:07:56,790 --> 00:07:53,039
measurement so it's a very very stable

211
00:08:03,270 --> 00:08:00,270
so that record that we have by by the

212
00:08:05,029 --> 00:08:03,280
2015-2020 time frame so right about now

213
00:08:06,710 --> 00:08:05,039

we expect ozone to have recovered about

214

00:08:08,390 --> 00:08:06,720

halfway

215

00:08:09,990 --> 00:08:08,400

and so we're going to go up there and

216

00:08:11,510 --> 00:08:10,000

we're going to see how how that's how

217

00:08:13,830 --> 00:08:11,520

that's going what the pattern of

218

00:08:15,430 --> 00:08:13,840

recovery is

219

00:08:17,029 --> 00:08:15,440

and then we'll be able to use that to

220

00:08:18,629 --> 00:08:17,039

compare with models

221

00:08:20,469 --> 00:08:18,639

to see whether or not we understand the

222

00:08:22,469 --> 00:08:20,479

reason it's recovering the way it is