
airborne science

1
00:00:00,003 --> 00:00:03,440
>>Flashing across California desert skies, the airplanes you see

2
00:00:03,440 --> 00:00:07,544
here are writing new chapters in the story
of man made flight....there she goes!

3
00:00:07,544 --> 00:00:12,082
>>This is my first opportunity
to greet you as deputy administrator

4
00:00:12,082 --> 00:00:15,752
of the National Aeronautics
and Space Administration.

5
00:00:16,086 --> 00:00:18,722
>>Together, you and I must make our new agency

6
00:00:18,722 --> 00:00:20,056
>>A most unusual place

7
00:00:20,090 --> 00:00:22,926
>>An organization that can challenge
conventional wisdom.

8
00:00:22,926 --> 00:00:26,530
>>We can engineer anything we can write the requirements for.

9
00:00:26,530 --> 00:00:27,931
>>We're going to make your idea work.

10
00:00:27,931 --> 00:00:30,500
This particular idea is quite disruptive.

11
00:00:31,168 --> 00:00:35,439
>>A typical flight, of course, starts
under the wing of the B-52 mothership.

12

00:00:35,605 --> 00:00:41,044
>>This sleek, high speed machine
would have made Rube Goldberg proud.

13
00:00:41,178 --> 00:00:44,047
>>The manner in which we fly
reentry from space,

14
00:00:44,047 --> 00:00:48,051
on the space shuttle was
pioneered on the X-15.

15
00:00:48,051 --> 00:00:53,657
>>The X-31 pretty much wrote the book on thurst vectoring, along with its sister program, the F-18 HARV.

16
00:00:53,657 --> 00:00:55,826
>>An observation of an occulation is

17
00:00:55,826 --> 00:00:58,795
one of the more challenging
missions that SOFIA can do.

18
00:00:59,596 --> 00:01:18,782
[Music/Background sound]

19
00:01:19,616 --> 00:01:23,987
>>Right now, we are looking
at the dawn of a new era of aviation.

20
00:01:27,023 --> 00:01:31,361
[Music/Background sound]

21
00:01:38,031 --> 00:01:41,234
[Music]

22
00:01:41,234 --> 00:01:45,038
>>Since the telescope was invented in 1610,
the astronomer's lens

23

00:01:45,038 --> 00:01:47,874
has been partially obscured
by the Earth's atmosphere.

24
00:01:48,074 --> 00:01:50,877
He has always carried his telescopes
as high as he could.

25
00:01:51,177 --> 00:01:54,047
>>The Earth
seen whole is a compelling reminder

26
00:01:54,047 --> 00:01:57,750
of the need to safeguard
our earthly resources.

27
00:01:57,750 --> 00:02:01,654
>>To predict, and perhaps someday to control
changes in weather and climate

28
00:02:02,455 --> 00:02:05,225
is of the utmost importance
to man everywhere.

29
00:02:06,593 --> 00:02:07,594
>>...the ocean...

30
00:02:07,594 --> 00:02:08,728
>>...the air and atmosphere...

31
00:02:08,728 --> 00:02:12,966
>>...fresh water, ice packs, crops, forests,
mineral deposits...

32
00:02:12,966 --> 00:02:13,666
>>....pollution...

33
00:02:13,666 --> 00:02:16,402
Each has its own type of impact,
but always

34
00:02:16,402 --> 00:02:17,804
they will be there.

35
00:02:17,904 --> 00:02:19,672
[Music]

36
00:02:19,706 --> 00:02:21,307
>>...the X-15 aircraft...

37
00:02:21,307 --> 00:02:22,942
>>...she's not the queen of the hangar anymore,

38
00:02:22,942 --> 00:02:24,577
although she's still hard at work...

39
00:02:24,577 --> 00:02:26,679
>>...carrying a heavy payload of instruments,

40
00:02:27,113 --> 00:02:29,616
undertaking studies of the near space
environment

41
00:02:29,816 --> 00:02:33,853
possible before only with unmanned
satellite and rocket-borne probes.

42
00:02:34,087 --> 00:02:36,389
>>There's hardly
any atmospheric pressure at all.

43
00:02:36,556 --> 00:02:39,459
So that's when some of those high
altitude experiments were performed.

44
00:02:39,592 --> 00:02:42,695
One of the airplanes had wingtip pods
on with experiments out there.

45
00:02:42,695 --> 00:02:43,963
Sometimes a camera,

46
00:02:43,963 --> 00:02:47,667
sometimes a sampling device for high
altitude or micrometeorite...

47
00:02:47,667 --> 00:02:51,971
>>Dryden's SR-71 was used as a science camera platform.

48
00:02:52,138 --> 00:02:55,241
An upward looking ultraviolet video
camera studied

49
00:02:55,275 --> 00:02:58,178
a variety of celestial objects
in wavelengths

50
00:02:58,344 --> 00:03:01,981
which are blocked by the atmosphere
to ground-based astronomers

51
00:03:05,652 --> 00:03:06,519
>>Every object

52
00:03:06,519 --> 00:03:10,823
on land or sea emits
visible light, heat and other radiation

53
00:03:10,823 --> 00:03:12,125
which can be measured.

54
00:03:12,125 --> 00:03:13,893
>>High above the ground,

55
00:03:13,927 --> 00:03:15,929
We can more clearly see nature at work.

56

00:03:15,929 --> 00:03:21,267
>>>...advancing our understanding
of the Earth as an integrated system.

57
00:03:21,434 --> 00:03:25,838
>>Earth observations, stratospheric sampling,
and testing of future shuttle

58
00:03:25,838 --> 00:03:27,574
or satellite instruments.

59
00:03:27,574 --> 00:03:29,509
>>If it takes $1,000,000,000
to launch a satellite.

60
00:03:29,509 --> 00:03:32,178
You want to make very certain
that your instrument works properly.

61
00:03:32,779 --> 00:03:35,415
>>Plane and satellite complement each other.

62
00:03:35,415 --> 00:03:41,221
>>Not only for validation, but also to acquire data
that you simply can't get from satellites-

63
00:03:41,387 --> 00:03:42,522
vertical profiles,

64
00:03:42,522 --> 00:03:43,957
high-resolution measurements...

65
00:03:43,957 --> 00:03:45,358
>>...in-situ data...

66
00:03:45,358 --> 00:03:47,660
>>actually sample rather than to try

67
00:03:47,694 --> 00:03:50,463

to observe this
from 100 kilometers away in space.

68
00:03:51,197 --> 00:03:53,466
>>The sophisticated airborne research
platforms

69
00:03:53,566 --> 00:03:57,870
support scientific investigators
involved in a wide variety of disciplines.

70
00:03:58,438 --> 00:04:00,840
[Music]

71
00:04:00,873 --> 00:04:01,574
>>Our first

72
00:04:01,574 --> 00:04:05,445
goal is to under-fly the ER-2
up and down the Scandinavian coastline...

73
00:04:05,445 --> 00:04:09,782
...look at CLO and the nitric acid out in the vortex...

74
00:04:09,782 --> 00:04:11,217
>>With a platform like this,

75
00:04:11,484 --> 00:04:15,455
we can carry thousands of pounds
of instrument aboard this aircraft.

76
00:04:15,655 --> 00:04:19,359
And that means we can put a huge variety
of measurements on board.

77
00:04:19,492 --> 00:04:23,997
And those measurements all together
really pin down how ozone is changing.

78

00:04:23,997 --> 00:04:27,834
>>We're asking the types of questions
now that aren't the first-order questions;

79
00:04:27,834 --> 00:04:31,838
probing in more detail a lot of
the facets of atmospheric chemistry.

80
00:04:32,005 --> 00:04:35,875
We've actually pushed the flying
capability of the platform to the limit.

81
00:04:36,175 --> 00:04:40,280
It represents a critical engineering feat
on the part of the engineers

82
00:04:40,280 --> 00:04:42,982
who work on the ER-2
to integrate these instruments.

83
00:04:43,883 --> 00:04:46,319
>>When we understand
the details of what's happening,

84
00:04:46,319 --> 00:04:50,757
then we can make better predictions
of what this may mean in the next century.

85
00:04:50,857 --> 00:04:54,260
Our job is to give that information
to policymakers for them to make

86
00:04:54,260 --> 00:04:58,131
an informed judgment about what needs to
be done to prevent problems.

87
00:04:58,431 --> 00:05:00,199
[ER-2 taking off]

88
00:05:00,233 --> 00:05:02,135

>>Our purpose is not here to

89
00:05:02,135 --> 00:05:05,605
set new policy,
but to get sound scientific information

90
00:05:05,938 --> 00:05:07,440
on the environment.

91
00:05:07,440 --> 00:05:09,842
>>The U-2 is unique in that it flies at

92
00:05:09,842 --> 00:05:13,913
very high altitudes- above 60,000
feet; from that vantage point,

93
00:05:13,946 --> 00:05:17,650
your view is very similar to that
that you would get from a satellite.

94
00:05:18,384 --> 00:05:21,654
...gather data over the same spots
here in South Africa

95
00:05:21,654 --> 00:05:23,022
when the satellites over-pass,

96
00:05:23,022 --> 00:05:26,192
and then they can use that data
for validation of the satellite data.

97
00:05:26,359 --> 00:05:28,728
>>Plus,
we have the ability to measure in-situ

98
00:05:28,728 --> 00:05:30,163
actually flying through the atmosphere,

99
00:05:30,163 --> 00:05:32,932

getting a true cross section
from the satellite down to the ground.

100
00:05:33,132 --> 00:05:37,170
>>It's not that my flight is directly going
to affect the welfare of any one person

101
00:05:37,170 --> 00:05:40,173
or group of people,
but it's part of an overall larger

102
00:05:40,173 --> 00:05:43,209
effort
to enhance living standards worldwide.

103
00:05:43,609 --> 00:05:45,244
[Music]

104
00:05:45,278 --> 00:05:46,979
>>What we're hoping to be able to see

105
00:05:46,979 --> 00:05:51,084
are the remains of advanced civilizations
beneath the forest cover.

106
00:05:52,251 --> 00:05:54,654
>>...multiple sites
all throughout Central America,

107
00:05:54,887 --> 00:05:56,456
from Panama to Mexico...

108
00:05:56,456 --> 00:05:58,124
...they believe that they've discovered
things

109
00:05:58,124 --> 00:06:00,793
that would have taken an archeologist 30
or 40 years

110
00:06:00,793 --> 00:06:01,894
of digging.

111
00:06:02,095 --> 00:06:04,697
[Music/Rainforest sounds]

112
00:06:04,997 --> 00:06:06,933
>>AirSAR is
an instrument that provides

113
00:06:06,999 --> 00:06:09,969
you very detailed information
about the hydrology

114
00:06:09,969 --> 00:06:13,406
of the landscape,
meaning how the streams are located.

115
00:06:13,539 --> 00:06:16,008
What areas
are wetter than the other areas?

116
00:06:16,342 --> 00:06:21,047
>>Having the platform that is movable
and changeable and variable in flight,

117
00:06:21,080 --> 00:06:24,050
and not dependent on the ground
programing is a priceless asset.

118
00:06:24,584 --> 00:06:26,953
>>The DC-8 has a large range.

119
00:06:26,986 --> 00:06:29,155
I don't know that
there are too many other platforms

120
00:06:29,155 --> 00:06:31,124
that could have gotten us out

to the Antarctic

121
00:06:31,124 --> 00:06:35,561
for significant data acquisition,
and then back to Punta Arenas, Chile.

122
00:06:35,561 --> 00:06:39,332
>>We need to understand and map
how the polar ice sheets

123
00:06:39,332 --> 00:06:41,801
and the sea
ice are changing from year to year.

124
00:06:42,769 --> 00:06:45,438
Since we have this opportunity
with a big aircraft

125
00:06:45,438 --> 00:06:49,609
that can carry many different instruments,
we not only measure the ice surface

126
00:06:49,609 --> 00:06:53,212
elevation, but we have also ice
penetrating radar instruments

127
00:06:53,212 --> 00:06:56,849
that allow us to actually
look through the ice, find out how thick

128
00:06:56,849 --> 00:06:58,017
the ice is.

129
00:06:58,317 --> 00:07:00,620
[Music/DC-8 taking off]

130
00:07:00,853 --> 00:07:03,489
>>In this case,
we're measuring the rain and the snow.

131
00:07:03,556 --> 00:07:07,226
>>It is incredibly versatile
and sturdy platform. It allows us

132
00:07:07,226 --> 00:07:11,898
to fly high or low and it can carry
a very nice complement of instruments.

133
00:07:12,165 --> 00:07:17,103
We can provide direct information about
the nature of these fronts and atmospheric rivers.

134
00:07:17,170 --> 00:07:18,738
This information can be analyzed

135
00:07:18,738 --> 00:07:22,008
directly by the modelers to understand
where can they improve

136
00:07:22,375 --> 00:07:23,676
their models?

137
00:07:23,676 --> 00:07:25,812
>>Things that study nature, they don't ever do exactly

138
00:07:25,845 --> 00:07:27,880
what your plan was...

139
00:07:28,915 --> 00:07:32,185
>>Measurements we make in IMPACTS
will help us improve forecasts.

140
00:07:32,318 --> 00:07:35,021
It'll also help us improve
how we measure from space.

141
00:07:35,855 --> 00:07:38,624
>>...winter storms, intense rain activity

142
00:07:38,691 --> 00:07:39,725
on the West Coast...

143
00:07:39,725 --> 00:07:40,827
>>We're trying to get an understanding

144
00:07:40,827 --> 00:07:42,895
of the thermodynamic state
of the atmosphere.

145
00:07:43,496 --> 00:07:47,266
>>NASA's deployed its piloted
DC -8 and unmanned

146
00:07:47,266 --> 00:07:52,338
Global Hawk aircraft in a massive effort
to collect as much data as possible.

147
00:07:52,438 --> 00:07:55,374
>>It costs about $1,000,000
per linear mile of coastline.

148
00:07:55,675 --> 00:07:58,077
to mispredict
the landfall of a major hurricane.

149
00:07:58,344 --> 00:08:01,447
>>We expect that these measurements
will enable hurricane modelers

150
00:08:01,447 --> 00:08:02,849
to improve their track.

151
00:08:02,849 --> 00:08:05,618
The involvement of the Global
Hawk is a game changer.

152
00:08:05,685 --> 00:08:09,522
>>You can use this plane to do

reconnaissance, science is just a different

153
00:08:09,522 --> 00:08:10,556
kind of reconnaissance.

154
00:08:10,556 --> 00:08:15,528
>>A combination of endurance,
range and altitude...

155
00:08:15,528 --> 00:08:16,562
>>We're above the weather,

156
00:08:16,863 --> 00:08:19,866
we can study it with all our sensors
from on top.

157
00:08:19,899 --> 00:08:24,103
>>Satellites in low-Earth orbit
only provide a very brief glimpse...

158
00:08:24,504 --> 00:08:25,605
>>With the Global Hawk,

159
00:08:25,605 --> 00:08:28,975
the expectation is that
because of its 30 hour flight duration,

160
00:08:29,408 --> 00:08:32,678
we're going to be able to be out
over the storm for up to 20 hours or so.

161
00:08:32,945 --> 00:08:35,548
>>Similar remote sensors
that you might fly on a satellite-

162
00:08:35,548 --> 00:08:38,417
and then you're bringing it down
to a 60,000 foot level.

163

00:08:38,451 --> 00:08:41,921
That's like putting the whole storm
up into higher resolution

164
00:08:41,988 --> 00:08:44,624
[Music]

165
00:08:44,624 --> 00:08:48,628
>>We will start sending out specific flights
to address things

166
00:08:48,628 --> 00:08:51,831
like air quality,
aerosol over polluted areas...

167
00:08:51,931 --> 00:08:53,599
[Music]

168
00:08:53,633 --> 00:08:57,470
>>Measuring the atmosphere from pole to pole, doing vertical profiles

169
00:08:57,470 --> 00:09:00,740
from approximately
42,000 feet down to 500.

170
00:09:01,574 --> 00:09:04,277
>>What does the atmosphere look like?
We'll quantify

171
00:09:04,443 --> 00:09:05,578
100 gases.

172
00:09:05,578 --> 00:09:09,348
>>...250 different
chemicals and ultrafine aerosols.

173
00:09:09,515 --> 00:09:11,551
Most can't be measured
by satellites at all.

174
00:09:11,584 --> 00:09:13,920
>>Where does ozone go to be removed
from the atmosphere?

175
00:09:13,953 --> 00:09:16,289
>>We can do things for climate
and air quality

176
00:09:16,289 --> 00:09:18,524
if we decide we want to do something about that.

177
00:09:19,692 --> 00:09:20,660
>>ASCENDS is a mission

178
00:09:20,660 --> 00:09:23,863
to measure atmospheric carbon dioxide

179
00:09:23,896 --> 00:09:25,898
during all times of the day and night,

180
00:09:26,165 --> 00:09:27,466
[Music]

181
00:09:27,466 --> 00:09:28,901
>>You don't realize how fun it is

182
00:09:28,901 --> 00:09:30,503
to be flying 500 feet off the ground;

183
00:09:30,503 --> 00:09:33,239
this big DC-8 that kind of scares everybody
in the neighborhood.

184
00:09:33,272 --> 00:09:34,240
[Music]

185
00:09:34,574 --> 00:09:36,242
>>The DC-8 has

186
00:09:36,242 --> 00:09:40,346
some of the best measurements of CO2,
methane and other greenhouse gases.

187
00:09:40,346 --> 00:09:43,583
>>We get to see where
the different layers are

188
00:09:43,616 --> 00:09:46,352
as we change altitudes
during the campaign...

189
00:09:46,886 --> 00:09:50,623
>>What happens when this air mass
gets up into the stratosphere?

190
00:09:50,756 --> 00:09:53,159
>>...from the overshooting
cloud tops of thunderstorms,

191
00:09:53,159 --> 00:09:57,263
see how far different chemicals
have penetrated into the stratosphere?

192
00:09:57,363 --> 00:10:02,001
When things get that high of altitude,
it gets into more of the global airstream

193
00:10:02,001 --> 00:10:05,972
and things can go down stream very quickly
and start circulating around the globe.

194
00:10:05,972 --> 00:10:09,175
>>I can't think of another airplane
that could carry this many sensors

195
00:10:09,775 --> 00:10:12,578
and fly at those altitudes
and do that kind of a mission.

196
00:10:13,012 --> 00:10:16,015
>>The ER-2 acts like a steerable satellite
for us.

197
00:10:16,048 --> 00:10:18,985
By studying the interactions
between clouds and aerosols,

198
00:10:19,452 --> 00:10:22,188
we can better forecast models of climate.

199
00:10:22,355 --> 00:10:25,358
[Music/Background sound]

200
00:10:25,725 --> 00:10:30,596
>>These atmospheric trace gases are important
because they affect the formation

201
00:10:30,596 --> 00:10:33,666
and destruction of ozone
in our atmosphere.

202
00:10:34,033 --> 00:10:38,738
>>How winds couple with convective systems
to really either inhibit or accelerate

203
00:10:38,738 --> 00:10:39,805
their growth.

204
00:10:39,939 --> 00:10:43,309
>>Never before
have we been able to fly a system

205
00:10:43,309 --> 00:10:46,345
that can measure
water vapor, winds and aerosols

206
00:10:46,345 --> 00:10:47,546

all simultaneously.

207
00:10:47,546 --> 00:10:51,217
We're trying to measure every 300 feet
as we go up in the atmosphere

208
00:10:51,450 --> 00:10:54,720
and about every couple of miles
that the plane is moving along.

209
00:10:55,054 --> 00:10:57,223
So this is really detailed measurements

210
00:10:57,223 --> 00:11:00,092
that you would really only be able
to get aboard an aircraft like this.

211
00:11:00,693 --> 00:11:03,195
>>The DC-8,
it's really an airborne laboratory.

212
00:11:03,329 --> 00:11:06,232
You're chasing things,
like winds, that are fairly dynamic phenomena.

213
00:11:06,265 --> 00:11:09,502
There's a lot of times when the objectives
will change or the area

214
00:11:09,502 --> 00:11:12,805
that they're wanting to look at is moved
based off of what they're seeing,

215
00:11:12,805 --> 00:11:14,907
and we have to try and
make that happen real time.

216
00:11:16,142 --> 00:11:22,782
[Music]

217
00:11:24,216 --> 00:11:26,852
>>The aircraft will take
off from the Dryden Flight Research Center

218
00:11:27,353 --> 00:11:30,156
and then fly over the western
United States using its infrared

219
00:11:30,156 --> 00:11:33,392
camera to find and actually map out fires.

220
00:11:33,459 --> 00:11:36,996
>>We will get real time information
from that scanner

221
00:11:36,996 --> 00:11:41,067
that's related to the thermal emission
coming from individual fires.

222
00:11:41,067 --> 00:11:44,704
>>The US Forest Service can use that data
to help plan out their resources.

223
00:11:46,138 --> 00:11:48,708
>>The nice thing about the radar
is it can see through smoke,

224
00:11:48,708 --> 00:11:50,242
it can see through clouds,

225
00:11:50,242 --> 00:11:53,879
So it's an all day, all night
imaging technology.

226
00:11:55,681 --> 00:11:58,250
>>The FIREX-AQ team will deploy
throughout the U.S.,

227
00:11:58,451 --> 00:12:00,853

taking measurements
of smoke from wildfires.

228
00:12:01,353 --> 00:12:04,857
>>The purpose of this overflight
was to collect thermal

229
00:12:04,857 --> 00:12:08,961
and visual imagery of some study caves
that we have located in the Mojave Desert.

230
00:12:09,195 --> 00:12:11,097
By being at 3000 feet,

231
00:12:11,097 --> 00:12:14,834
We were able to have good coverage
as far as the landscape is concerned.

232
00:12:14,834 --> 00:12:17,570
Through developing techniques
for detecting caves on Earth,

233
00:12:17,870 --> 00:12:22,475
we can then take those techniques
and use them to look for caves on Mars.

234
00:12:23,109 --> 00:12:26,412
>>There was a earthquake about a week ago
surveying that area

235
00:12:26,412 --> 00:12:29,648
to see what ground movement happened
since the earthquake.

236
00:12:30,549 --> 00:12:33,519
>>The objective is to prove the technique
of simultaneous

237
00:12:33,519 --> 00:12:36,789
measurements of ocean currents

and winds from the same instrument.

238
00:12:36,922 --> 00:12:40,726
Both ocean currents and winds
actually influence Earth's climate

239
00:12:40,726 --> 00:12:42,428
and they influence each other.

240
00:12:42,428 --> 00:12:46,465
This should be a path forward
for the next generation space mission.

241
00:12:47,032 --> 00:12:51,170
>>The main goal of the mission is to measure
as precisely as we can

242
00:12:51,170 --> 00:12:52,705
the vertical exchange

243
00:12:52,705 --> 00:12:56,208
that the structure produces between
the surface and the depths of the ocean.

244
00:12:56,275 --> 00:12:59,044
The structure we're trying to see
are small, and satellites

245
00:12:59,044 --> 00:13:02,148
today are not capable
of having this level of resolution.

246
00:13:02,181 --> 00:13:03,415
That's the beauty of planes.

247
00:13:03,415 --> 00:13:05,951
It allows us to have way higher resolution

248
00:13:06,118 --> 00:13:08,220

[Music]

249
00:13:08,754 --> 00:13:11,891
>>It's pretty a neat mission
where we're flying around at 28,000 feet.

250
00:13:11,924 --> 00:13:14,293
The biggest challenge
we have flying these type of missions out

251
00:13:14,293 --> 00:13:17,930
here are staying on these exact lines
as we fly over the wetlands.

252
00:13:18,264 --> 00:13:22,735
>>The G-3 is an excellent platform
for this work- its speed, its range.,

253
00:13:22,735 --> 00:13:25,271
it's an easy work environment,
as you can see in here.

254
00:13:25,404 --> 00:13:27,773
>>You can go wherever you want,
whenever you want.

255
00:13:27,873 --> 00:13:31,977
>>And also, we can have a different
look angle compared with satellites.

256
00:13:32,077 --> 00:13:33,045
>>Dryden engineers

257
00:13:33,045 --> 00:13:37,049
developed this repeat pass capability,
which is our platform precision autopilot,

258
00:13:37,316 --> 00:13:41,987
which enables us to fly
a line in the sky today, and then tomorrow,

259
00:13:41,987 --> 00:13:43,689
a week from now, a month from now, a year from now,

260
00:13:43,689 --> 00:13:47,326
we can repeat that line every time, to
within plus or minus 5 meters

261
00:13:47,426 --> 00:13:51,297
>>Couples the radar to the flight track of the aircraft.

262
00:13:51,297 --> 00:13:56,635
>>Right now, the pilots aren't even flying the airplane.
It's completely hands off

263
00:13:56,635 --> 00:14:01,240
This right here
is actually flying the airplane.

264
00:14:01,240 --> 00:14:04,877
>>Flying these lines over and over,
will allow us to study

265
00:14:05,144 --> 00:14:07,479
the wetland change over time.

266
00:14:07,479 --> 00:14:11,417
>>We can look at how natural deltas form
so that we can understand

267
00:14:11,417 --> 00:14:15,054
more about sediment deposition
and maybe try to reverse

268
00:14:15,321 --> 00:14:18,524
these loss of sediments on many of the other deltas around the world.

269
00:14:19,124 --> 00:14:22,127
>>What we're really out here doing

is we're trying to understand

270
00:14:22,127 --> 00:14:26,065
how much water, how much sediment,
and how much carbon is moving

271
00:14:26,065 --> 00:14:29,301
from North America
out into the coastal ocean.

272
00:14:29,702 --> 00:14:32,938
>>This time around,
we're focused on forested biomes.

273
00:14:33,305 --> 00:14:36,041
The main question
we're trying to answer here

274
00:14:36,041 --> 00:14:40,012
is how much carbon is stored
in the forest ecosystems.

275
00:14:40,145 --> 00:14:43,883
>>These trees are amazing
because they really are the connection

276
00:14:43,883 --> 00:14:46,118
between the land and the sea.

277
00:14:47,720 --> 00:14:48,220
>>Today we

278
00:14:48,220 --> 00:14:51,357
are over the Arizona area
to look at a landslide...

279
00:14:51,423 --> 00:14:54,393
>>...measuring the heights of the levees
against high tide and low tide.

280
00:14:54,727 --> 00:14:58,530
>>We get information
about where the levees are weak.

281
00:14:58,530 --> 00:15:02,334
It's very economical to use science

282
00:15:02,334 --> 00:15:06,405
to determine
where to best use your resources.

283
00:15:06,405 --> 00:15:08,140
We could tell where the sinkhole

284
00:15:08,140 --> 00:15:11,310
is forming
before that catastrophic failure happens.

285
00:15:12,211 --> 00:15:17,049
We can try to image the oil spill
and the effects on the coastline...

286
00:15:17,082 --> 00:15:20,152
>>...looking at glaciers as well as volcanoes,
which will then

287
00:15:20,152 --> 00:15:23,422
go on and help us
do some predictive analysis in the future.

288
00:15:23,455 --> 00:15:26,892
A lot of it is supporting
private organizations, universities,

289
00:15:26,892 --> 00:15:28,127
other NASA centers.

290
00:15:28,127 --> 00:15:32,665
But we actually have the teams

and the tools to be able to take a science

291
00:15:32,665 --> 00:15:37,236
instrument like this UAVSAR pod
and put it up into the environment

292
00:15:37,403 --> 00:15:38,804
where they need it.

293
00:15:40,439 --> 00:15:42,675
>>The ER-2 is a very unique aircraft.

294
00:15:42,741 --> 00:15:45,611
We can get a very wide swath
with these super high-tech instruments.

295
00:15:45,611 --> 00:15:48,981
We're kind of the last step in development
on some of our earth science satellites.

296
00:15:48,981 --> 00:15:52,017
We actually take it up to extreme
altitudes and cold-soak it and put

297
00:15:52,017 --> 00:15:53,185
it in an extreme environment.

298
00:15:53,252 --> 00:15:59,425
[Music/ER-2 taking off]

299
00:16:00,059 --> 00:16:00,659
>>We're here

300
00:16:00,659 --> 00:16:04,396
to study the volcanic plumes
from Kilauea Volcano

301
00:16:04,430 --> 00:16:08,000
and we can have a real impact

on helping people to manage this risk

302
00:16:08,567 --> 00:16:11,203
if we can make the measurements
and give them the information they need.

303
00:16:11,737 --> 00:16:14,039
>>Knowing the spectral signature
of what you're looking for,

304
00:16:14,306 --> 00:16:17,509
can help you ascertain
the health of a system.

305
00:16:17,543 --> 00:16:25,751
>>Different types of coral have different
spectral signatures.
>>We believe we'll be able to say something about where
the coral resides and how healthy it is.

306
00:16:26,185 --> 00:16:29,054
>>We want to make sure
that we're using our technologies

307
00:16:29,555 --> 00:16:33,425
to also help the planet
and understand processes on the planet.

308
00:16:33,892 --> 00:16:35,327
>>This basically gives us

309
00:16:35,327 --> 00:16:38,731
almost the same view of the moon
as Earth-orbiting satellites would have.

310
00:16:39,064 --> 00:16:41,333
We want to know this
to a high level of accuracy

311
00:16:41,333 --> 00:16:45,237

because we essentially are using the moon
as a benchmark so that Earth observing

312
00:16:45,237 --> 00:16:49,274
satellites can turn and look at the moon
and set the scale on the amount of light they're

313
00:16:49,274 --> 00:16:50,109
measuring from the earth.

314
00:16:50,142 --> 00:16:51,910
[Music]

315
00:16:51,910 --> 00:16:55,948
>>We were beautifully set up to see this, we were just well-positioned,

316
00:16:55,948 --> 00:16:58,417
aircraft performed perfectly...

317
00:16:58,717 --> 00:17:01,620
[Music/G-3 taking off]

318
00:17:01,653 --> 00:17:03,489
>>What Armstrong is doing is to go out there

319
00:17:03,489 --> 00:17:07,826
and facilitate its science missions
such as this Eclipse mission; these involve

320
00:17:07,826 --> 00:17:11,730
detailed logistics, flight planning,
modification of aircraft.

321
00:17:11,730 --> 00:17:15,401
>>We're able to see the eclipse
for a little bit longer than others might.

322
00:17:15,401 --> 00:17:19,671
We control our timing exactly

so that we enter that region of totality

323
00:17:19,671 --> 00:17:21,040
right when it starts,

324
00:17:21,040 --> 00:17:24,009
fly as slow as we can through it
and get the maximum amount of time

325
00:17:24,009 --> 00:17:25,277
on that target.

326
00:17:25,277 --> 00:17:30,382
>>You don't have to be a scientist
to really be transformed

327
00:17:30,382 --> 00:17:32,985
by the beauty of a total solar eclipse.

328
00:17:33,185 --> 00:17:36,188
[Music]

329
00:17:36,889 --> 00:17:37,923
>>If you think about

330
00:17:37,923 --> 00:17:41,727
what our own eyes
are able to see; a rainbow of colors,

331
00:17:41,727 --> 00:17:46,165
but that rainbow is a very,
very tiny sliver

332
00:17:46,165 --> 00:17:50,636
of the much larger types of light
that is out there.

333
00:17:50,903 --> 00:17:55,574
Infrared astronomy allows us to study

objects that are very cold.

334
00:17:55,841 --> 00:17:58,243
>>The center of our galaxy,
in the visual range,

335
00:17:58,243 --> 00:17:59,244
you really can't see much

336
00:17:59,244 --> 00:18:03,115
because it's obscured by this dust
and infrared can see through dust.

337
00:18:03,248 --> 00:18:06,085
>>The Earth's atmosphere blocks
most of the infrared band.

338
00:18:06,085 --> 00:18:08,120
To really get
an infrared view of the universe,

339
00:18:08,120 --> 00:18:11,590
you need to get somehow above
the water vapor in the Earth's atmosphere.

340
00:18:11,690 --> 00:18:15,027
>>It is a 747 plane in which we have put

341
00:18:15,027 --> 00:18:18,330
a two and a half meter infrared telescope.

342
00:18:18,363 --> 00:18:21,500
>>It's the largest telescope
to leave the surface of the earth so far.

343
00:18:22,334 --> 00:18:26,238
>>We'll look at a view that no one's ever seen,
so you're bound find out something.

344

00:18:27,539 --> 00:18:30,109
It's currently operating in a regime
no other instrument

345
00:18:30,109 --> 00:18:31,310
in the world can operate at.

346
00:18:32,744 --> 00:18:34,113
>>What the big advantage is

347
00:18:34,113 --> 00:18:38,317
of a flying observatory like SOFIA is
you can always access the instrument.

348
00:18:38,317 --> 00:18:40,052
You can always upgrade the instrument.

349
00:18:40,052 --> 00:18:42,187
We can make improvements to the telescope.

350
00:18:42,187 --> 00:18:46,024
We can make improvements
to the mission systems onboard.

351
00:18:46,024 --> 00:18:50,362
>>One of the premier observatories
to pioneer large instruments.

352
00:18:50,429 --> 00:18:53,966
>>We're not limited to weight that launch
vehicles require to put something in space;

353
00:18:54,366 --> 00:18:56,635
we can carry instruments
that are hundreds of pounds.

354
00:18:56,935 --> 00:18:58,070
We can give those instruments

355

00:18:58,070 --> 00:19:01,106
much more power that you can generate
from solar collectors in space.

356
00:19:01,874 --> 00:19:03,542
There's also time-unique missions...

357
00:19:03,542 --> 00:19:05,210
>>The shadow of Pluto

358
00:19:05,244 --> 00:19:06,578
passing in front of a background

359
00:19:06,578 --> 00:19:10,115
star is going to be cast
in the middle of the ocean.

360
00:19:10,649 --> 00:19:13,886
>>It's going to have the best position
of any observatory on the planet

361
00:19:14,186 --> 00:19:15,621
for this particular event.

362
00:19:15,621 --> 00:19:19,258
>>A significant technical accomplishment
of the program is the pointing stability

363
00:19:19,258 --> 00:19:20,826
of the telescope itself.

364
00:19:20,826 --> 00:19:23,929
While you have all the little vibrations
and jumping around of the airplane,

365
00:19:23,996 --> 00:19:27,099
it can actually stay stabilized
on a quarter, three or four miles away.

366

00:19:27,266 --> 00:19:30,335
>>It looks like the telescope is moving,
but the telescope is rock stable

367
00:19:30,335 --> 00:19:32,471
and the aircraft is moving
beneath the telescope.

368
00:19:32,471 --> 00:19:34,139
It's an amazing engineering feat,
I think, that

369
00:19:34,139 --> 00:19:37,976
that door back there, as big of the hole
that it makes when it opens,

370
00:19:37,976 --> 00:19:40,345
you don't even notice it whatsoever.

371
00:19:40,546 --> 00:19:43,282
[Music/Background noise]

372
00:19:43,315 --> 00:19:46,351
>>Hello from SOFIA! I'm flying in the world's

373
00:19:46,451 --> 00:19:51,757
greatest and highest altitude
infrared astronomy telescope ever.

374
00:19:52,191 --> 00:19:54,126
>>It's nice to be able to share
what we're doing

375
00:19:54,126 --> 00:19:57,229
with people who will take it back
to students and hopefully inspire them

376
00:19:57,229 --> 00:20:00,566
to go into science and technology
and engineering.

377
00:20:00,999 --> 00:20:04,303
>>I think that's giving us the opportunity
to gather information

378
00:20:04,303 --> 00:20:06,338
that we may have never had before.

379
00:20:06,338 --> 00:20:08,807
>>I've watched a world class telescope

380
00:20:08,807 --> 00:20:11,376
take data
that no other telescope on earth can take.

381
00:20:11,577 --> 00:20:13,845
>>It really invigorates you.

382
00:20:13,845 --> 00:20:15,981
It stimulates your thinking.

383
00:20:15,981 --> 00:20:17,316
>>We can turn all of these things

384
00:20:17,316 --> 00:20:19,184
into teachable moments in our classroom.

385
00:20:19,184 --> 00:20:21,086
>>Having them see that it's really such a team effort

386
00:20:21,453 --> 00:20:22,554
I think is important.

387
00:20:22,554 --> 00:20:26,725
>>I'm going to be able to take what
I've learned on SOFIA into my chemistry,

388
00:20:26,725 --> 00:20:31,530

and into my biology and into my physics
classes and into my engineering classes.

389
00:20:31,663 --> 00:20:35,300
>>What I learned on SOFIA is
you have to know a little bit

390
00:20:35,300 --> 00:20:39,371
about all of the disciplines
in the sciences to be successful.

391
00:20:39,638 --> 00:20:44,409
>>What an amazing science opportunity
for not only my students, but for myself

392
00:20:44,676 --> 00:20:46,345
to truly grow as a teacher.

393
00:20:46,345 --> 00:20:50,349
>>If I could talk to my high school students
right now, I would just say that

394
00:20:50,349 --> 00:20:54,586
if you look around you, you're
going to see why hard work and science

395
00:20:54,586 --> 00:20:58,724
and math and all kinds of opportunities
out there are worth the effort.

396
00:20:58,757 --> 00:21:02,194
>>I hope that many teachers
will have the same chance

397
00:21:02,394 --> 00:21:06,365
as me- go on a plane
called SOFIA and fly to the stars.

398
00:21:06,965 --> 00:21:18,076
[Music/SOFIA taking off]

399
00:21:23,582 --> 00:21:24,983
>>We're flying on the DC-8.

400
00:21:24,983 --> 00:21:27,686
It's really exciting,
it's a bunch of different real-time measurements.

401
00:21:27,886 --> 00:21:30,589
It's really cool
to see how these are fluctuating

402
00:21:30,589 --> 00:21:33,225
when we're flying over
different environments.

403
00:21:33,225 --> 00:21:36,628
>>Look out the window and you see the city,
you see the smog.

404
00:21:36,895 --> 00:21:41,667
Then you look at the screen here
and you see a direct relationship with the

405
00:21:41,667 --> 00:21:46,305
measurements of these different compounds
that we're looking at. In the classroom,

406
00:21:46,538 --> 00:21:48,740
you don't get that degree of involvement.

407
00:21:48,740 --> 00:21:51,343
>>...really interesting we're seeing today,
very different from what we expected

408
00:21:51,476 --> 00:21:52,944
and what we saw yesterday.

409
00:21:52,944 --> 00:21:54,713

>>An amazing opportunity to,

410
00:21:54,713 --> 00:21:58,550
first of all, do cool stuff like this,
like flying a plane and also conduct

411
00:21:58,550 --> 00:22:02,321
amazing research and build my skillset
and network with people at NASA.

412
00:22:02,321 --> 00:22:07,125
>>You get to dream about, you know,
doing all of this science in the field,

413
00:22:07,526 --> 00:22:09,428
and you literally are doing it right now.

414
00:22:09,428 --> 00:22:11,997
>>This is my first experience with field work really...

415
00:22:12,931 --> 00:22:15,000
>>Highly recommend applying to NASA SARP