1
00:00:00,600 --> 00:00:01,701
[atmospheric music]

2
00:00:01,735 --> 00:00:03,937
>> Narrator: NASA's Jet
Propulsion Laboratory presents

3
00:00:05,337 --> 00:00:08,341
the Von Karman Lecture, a
series of talks by scientists

4
00:00:08,374 --> 00:00:11,411
and engineers who are
exploring our planet,

5
00:00:11,444 --> 00:00:14,848
our solar system, and
all that lies beyond.

6
00:00:28,094 --> 00:00:29,829
>> Good evening,
ladies and gentlemen.

7
00:00:29,862 --> 00:00:31,064
How is everyone tonight?

8
00:00:31,931 --> 00:00:32,732
[audience applauding]

9
00:00:32,765 --> 00:00:33,933
Good, excellent.

10
00:00:33,966 --> 00:00:35,568
Oh, thank you,
you're far too kind.

11
00:00:35,601 --> 00:00:37,970
Well thank you everyone,
both here in the house

12
00:00:38,003 --> 00:00:41,040
and on camera and on the
internet and all that

13
00:00:41,073 --> 00:00:42,575
for joining us tonight.

14
00:00:42,608 --> 00:00:46,579
So, tonight we celebrate the
60th anniversary of Explorer 1,

15
00:00:46,612 --> 00:00:48,548
the first US satellite,

16
00:00:48,581 --> 00:00:52,418
which also made the first
science discovery in space

17
00:00:52,451 --> 00:00:54,554
and paved the way
for six decades

18
00:00:54,587 --> 00:00:56,589
of earth science discoveries.

19
00:00:56,622 --> 00:00:59,425
As you can see, our
setup tonight is a
little bit different,

20
00:00:59,458 --> 00:01:01,928
we'll be using a
panel format hosted by

21
00:01:01,961 --> 00:01:03,930
JPL's Blaine Baggett.

22
00:01:03,963 --> 00:01:05,798

But with our usual
lecture format,

23
00:01:05,831 --> 00:01:08,234
you'll be able to ask
questions after the show.

24
00:01:08,267 --> 00:01:11,938
Blaine is a JPL fellow and a
laboratories documentarian.

25
00:01:11,971 --> 00:01:14,774
His productions, many
involving space themes,

26
00:01:14,807 --> 00:01:17,376
have been recognized
by virtually

27
00:01:17,409 --> 00:01:19,245
every major awards competition,

28
00:01:19,278 --> 00:01:23,783
including the DuPont Columbia
Award for Journalism,

29
00:01:23,816 --> 00:01:26,486
the Peabody Award,
and local, national,

30
00:01:26,519 --> 00:01:28,488
and international Emmys.

31
00:01:28,521 --> 00:01:30,923
Ladies and gentlemen, please
help me welcome tonight's host,

32
00:01:30,956 --> 00:01:32,358
Mr. Blaine Baggett.

33
00:01:32,391 --> 00:01:35,662
[audience applauding]

34
00:01:42,234 --> 00:01:43,436
>> Good evening.

35
00:01:43,469 --> 00:01:45,872
And let me also extend
my welcome to you

36
00:01:45,905 --> 00:01:48,374
to NASA's Jet
Propulsion Laboratory

37
00:01:48,407 --> 00:01:51,644
here in La Canada, California.

38
00:01:51,677 --> 00:01:56,482
We are going to
celebrate Explorer 1,

39
00:01:56,515 --> 00:01:59,252
the very first US satellite,

40
00:01:59,285 --> 00:02:02,421
and the satellite that
gave the entire world

41
00:02:02,454 --> 00:02:05,391
the very first space
science discovery.

42
00:02:06,792 --> 00:02:10,029
It was a discovery, not
just any science discovery,

43
00:02:10,062 --> 00:02:15,068
but one that helps to explain
why you and I can walk

44
00:02:15,968 --> 00:02:18,104
on the surface of this planet.

45
00:02:18,137 --> 00:02:21,541
So I think you'll be very
interested in knowing about it.

46
00:02:21,574 --> 00:02:24,544
And then in the second
half of our show,

47
00:02:24,577 --> 00:02:28,014
we're going to
speed ahead 60 years

48
00:02:28,047 --> 00:02:31,250
and spend some
time learning about

49
00:02:31,283 --> 00:02:35,321
what do we know about the
vital signs of our planet now?

50
00:02:35,354 --> 00:02:38,658
And what NASA is doing
to understand that.

51
00:02:38,691 --> 00:02:42,261
So to begin, let me
introduce our historian,

52
00:02:42,294 --> 00:02:44,230
Dr. Erik Conway.

53
00:02:44,263 --> 00:02:46,432
Will you come on board here?

54
00:02:46,465 --> 00:02:47,500

Erik.

55
00:02:47,533 --> 00:02:50,703
[audience applauding]

56
00:02:54,240 --> 00:02:55,141
Good evening, Erik.

57
00:02:55,174 --> 00:02:56,108
>> Good evening.

58
00:02:56,141 --> 00:02:59,212
>> Just my small introduction.

59
00:02:59,245 --> 00:03:02,848
Erik is our official historian
here at the laboratory.

60
00:03:02,881 --> 00:03:05,084
You know, he's a
published author,

61
00:03:05,117 --> 00:03:09,722
he's written things about
Mars, about aviation,

62
00:03:09,755 --> 00:03:11,657
and about our own planet.

63
00:03:11,690 --> 00:03:16,529
So just as a context
about how JPL got started,

64
00:03:16,562 --> 00:03:18,264
for one and then
we'll leap ahead,

65
00:03:18,297 --> 00:03:22,935
is that JPL started

as a small group of

66
00:03:22,968 --> 00:03:26,939
a handful of students,
some of them Caltech,

67
00:03:26,972 --> 00:03:30,576
who wanted to build
rockets in the 1930s,

68
00:03:30,609 --> 00:03:33,346
and that got serious during

69
00:03:33,379 --> 00:03:36,315
the drumbeats of World
War II coming along,

70
00:03:36,348 --> 00:03:38,251
there was funding from the Army,

71
00:03:38,284 --> 00:03:42,288
and it was actually an Army
exercise to build rockets

72
00:03:42,321 --> 00:03:43,589
to begin, wasn't it?

73
00:03:43,622 --> 00:03:45,124
>> Yep, yep.

74
00:03:45,157 --> 00:03:47,460
The lab basically started as
a student research project,

75
00:03:47,493 --> 00:03:51,597
and then kind of grew
like topsy after '39.

76
00:03:51,630 --> 00:03:52,531

Yeah.

77
00:03:52,564 --> 00:03:54,900
>> And we're gonna leap ahead to

78
00:03:54,933 --> 00:03:58,037
this iconic image we
have up here for us,

79
00:03:58,070 --> 00:04:03,076
which is the celebration of
the success of Explorer 1.

80
00:04:04,643 --> 00:04:07,113
And let's start off Erik
by, who's that fellow

81
00:04:07,146 --> 00:04:08,881
on the far right
that we see here?

82
00:04:10,282 --> 00:04:12,919
>> So the gentleman on the
far right is Verner Von Brown.

83
00:04:14,286 --> 00:04:18,257
He got his start designing
and building rockets

84
00:04:18,290 --> 00:04:20,092
for Nazi Germany.

85
00:04:20,125 --> 00:04:22,795
Started really in the '30s,

86
00:04:22,828 --> 00:04:25,831
began to be successful
really in the mid '40s,

87

00:04:25,864 --> 00:04:29,435
and was able to get his V1 and
V2 rockets to a state where

88
00:04:29,468 --> 00:04:33,406
he could bombard
London during the war,

89
00:04:33,439 --> 00:04:38,344
and after the war,
he and a large group

90
00:04:38,377 --> 00:04:41,914
of his engineers and
scientists with him

91
00:04:41,947 --> 00:04:46,319
decided to surrender to
US forces in Germany,

92
00:04:46,352 --> 00:04:48,220
basically because
they figured they

93
00:04:48,253 --> 00:04:49,522
would be better treated for us,

94
00:04:49,555 --> 00:04:51,457
and that we were more
likely to be able

95
00:04:51,490 --> 00:04:54,460
to afford their ambitions
to build space rockets.

96
00:04:54,493 --> 00:04:55,928
>> And that's indeed
what happened,

97
00:04:55,961 --> 00:05:00,132

they went to the United States,
to I guess first New Mexico,

98
00:05:00,165 --> 00:05:02,735
and they were launching
these V2s as experiments

99
00:05:02,768 --> 00:05:03,903
in the United States.

100
00:05:03,936 --> 00:05:05,371
>> That's right.

101
00:05:05,404 --> 00:05:09,175
The US didn't just abscond with
Von Brown and his engineers,

102
00:05:09,208 --> 00:05:11,344
we also brought back
about 100 of the V2s

103
00:05:11,377 --> 00:05:13,646
that had been built in
various stages of repair,

104
00:05:13,679 --> 00:05:15,748
and they were shipped to
White Sands proving ground

105
00:05:15,781 --> 00:05:19,552
in New Mexico, where the
Army had them reassembled

106
00:05:20,919 --> 00:05:23,189
and began test launching them
along with instrumentation

107
00:05:23,222 --> 00:05:26,926
prepared with the help of
a group of US scientists

108
00:05:26,959 --> 00:05:29,329
known as the Rocket
Research Panel.

109
00:05:30,696 --> 00:05:34,433
>> And then they
move on to Alabama?

110
00:05:34,466 --> 00:05:37,070
>> Yeah, they eventually
land in Huntsville, Alabama,

111
00:05:38,537 --> 00:05:42,875
but White Sands is where they
first came into collaboration

112
00:05:42,908 --> 00:05:45,511
with JPL, which
was also developing

113
00:05:45,544 --> 00:05:48,147
its ballistic
missiles for the Army

114
00:05:48,180 --> 00:05:50,649
via test launches
at White Sands.

115
00:05:50,682 --> 00:05:53,352
>> And how about let's go
back to the image here,

116
00:05:53,385 --> 00:05:56,422
and what about the
fellow on the far left?

117
00:05:56,455 --> 00:05:59,258
>> So the gentleman on the
far left is a New Zealander

118
00:05:59,291 --> 00:06:01,961
who came to Caltech
to get his PhD

119
00:06:01,994 --> 00:06:05,531
in electrical engineering,
did cosmic ray research,

120
00:06:05,564 --> 00:06:08,534
and then began working
part time initially at JPL

121
00:06:08,567 --> 00:06:12,338
on telemetry for the missile
program here at the lab,

122
00:06:12,371 --> 00:06:14,740
became the Corporal
missile program director,

123
00:06:14,773 --> 00:06:17,843
Corporal was a JPL
liquid-fueled rocket

124
00:06:17,876 --> 00:06:20,513
being developed as a, we would
now call it a short range

125
00:06:20,546 --> 00:06:22,882
ballistic missile
with a nuclear warhead

126
00:06:22,915 --> 00:06:24,917
for deployment in Europe,

127
00:06:24,950 --> 00:06:26,519
he became the Corporal
program director

128
00:06:26,552 --> 00:06:29,622
and then in 1954 he
became the JPL director.

129
00:06:29,655 --> 00:06:30,923
>> So you've got
these two groups,

130
00:06:30,956 --> 00:06:33,692
one in Alabama, one here at JPL,

131
00:06:33,725 --> 00:06:35,728
that are both building rockets,

132
00:06:35,761 --> 00:06:40,767
and they somehow
merged their ambitions.

133
00:06:42,234 --> 00:06:43,903
>> Merged not just in terms
of their ambitions, though,

134
00:06:43,936 --> 00:06:46,038
but in terms of the
actual hardware.

135
00:06:47,272 --> 00:06:49,175
One of the things
that was known to be

136
00:06:49,208 --> 00:06:51,377
possible theoretically
but hadn't been done

137
00:06:52,511 --> 00:06:54,013
as of the late 1940s is staging.

138
00:06:54,046 --> 00:06:56,048
We do it all the time now.

139
00:06:56,081 --> 00:06:59,952
But here you're looking at
the actual first product

140
00:06:59,985 --> 00:07:03,856
of the union of JPL
and Von Brown's folks

141
00:07:03,889 --> 00:07:06,525
in what was called
a bumper whack.

142
00:07:06,558 --> 00:07:10,496
Literally the lower half
of this rocket is a V2

143
00:07:10,529 --> 00:07:14,233
and the upper half of it is
a JPL-built whack Corporal.

144
00:07:14,266 --> 00:07:16,669
There were eight of these flown,

145
00:07:16,702 --> 00:07:19,205
the first six at White Sands,

146
00:07:19,238 --> 00:07:21,807
and the last two
at Cape Canaveral.

147
00:07:21,840 --> 00:07:26,846
And this one is known as
bumper whack number eight,

148
00:07:28,280 --> 00:07:30,850
which was launched from
the cape in July of 1950.

149

00:07:30,883 --> 00:07:35,221
>> And this was the very
first ever launch of a rocket

150
00:07:35,254 --> 00:07:36,088
from the cape.

151
00:07:37,122 --> 00:07:38,257
>> Yep.

152
00:07:38,290 --> 00:07:39,458
>> Amazing, yes.

153
00:07:39,491 --> 00:07:42,495
And so they get this
notion that they want to

154
00:07:42,528 --> 00:07:44,197
launch a satellite into space.

155
00:07:45,230 --> 00:07:46,131
Okay.

156
00:07:46,164 --> 00:07:46,999
>> They kept working together

157
00:07:47,933 --> 00:07:49,602
after this bumper whack program.

158
00:07:49,635 --> 00:07:51,103
The Army had them working,

159
00:07:51,136 --> 00:07:53,372
because of the pressures on
all the US armed services

160
00:07:54,640 --> 00:07:56,542
to develop ICBMs, they
had a research project

161
00:07:56,575 --> 00:07:59,945
to figure out whether
you can bring warheads

162
00:07:59,978 --> 00:08:02,081
back from space intact.

163
00:08:03,415 --> 00:08:04,984
Which was known as the
reentry test vehicle program,

164
00:08:05,017 --> 00:08:06,819
it was classified
for a long time,

165
00:08:06,852 --> 00:08:10,656
they build I believe it
was nine sets of hardware

166
00:08:10,689 --> 00:08:14,860
that were a Redstone rocket
and a set of upper stages,

167
00:08:14,893 --> 00:08:17,630
solid shield upper
stages developed by JPL,

168
00:08:17,663 --> 00:08:20,466
to hurl a warhead a few
thousand miles downrange

169
00:08:20,499 --> 00:08:22,935
and fast enough to
prove that you could

170
00:08:22,968 --> 00:08:24,837
bring this warhead
back from space.

171
00:08:24,870 --> 00:08:27,339
And they also believed
that that set of equipment

172
00:08:27,372 --> 00:08:29,074
could be used to
orbit a satellite.

173
00:08:29,107 --> 00:08:32,177
They proposed this
as Project Orbiter.

174
00:08:32,210 --> 00:08:33,746
>> But Eisenhower,
who's president,

175
00:08:33,779 --> 00:08:35,915
we're in the midst
of the Cold War here,

176
00:08:35,948 --> 00:08:40,019
has other agendas, and
let's roll a video,

177
00:08:40,052 --> 00:08:43,088
a clip from a documentary
that's been done

178
00:08:43,121 --> 00:08:44,524
on Explorer 1.

179
00:08:51,597 --> 00:08:53,165
[suspenseful music]

180
00:08:53,198 --> 00:08:55,568
>> Narrator: Nikita Khrushchev
had rejected Eisenhower's

181
00:08:55,601 --> 00:08:58,137

open skies proposal
to use airplanes

182
00:08:58,170 --> 00:09:00,339
for mutual reconnaissance.

183
00:09:00,372 --> 00:09:03,142
How hostile, Eisenhower worried,

184
00:09:03,175 --> 00:09:06,712
would the Soviet Union be to
a satellite flying overhead?

185
00:09:08,180 --> 00:09:10,849
>> The great
question hanging over

186
00:09:10,882 --> 00:09:14,019
the inauguration
of the Space Age

187
00:09:14,052 --> 00:09:17,256
was, is it legal

188
00:09:18,790 --> 00:09:22,528
to orbit satellites over the
territory of other countries?

189
00:09:24,529 --> 00:09:29,535
Is outer space subject to
the same air space laws

190
00:09:31,003 --> 00:09:33,138
that airplanes have to obey?

191
00:09:33,171 --> 00:09:37,209
It's not legal to fly U2
airplanes over the Soviet Union

192

00:09:37,242 --> 00:09:40,045
if the Soviet Union
doesn't permit it.

193
00:09:40,078 --> 00:09:42,715
Their air space is an extension

194
00:09:42,748 --> 00:09:45,785
of international sovereignty,
extending upward.

195
00:09:47,085 --> 00:09:49,288
[speaking foreign language],
in the Latin phrase.

196
00:09:49,321 --> 00:09:51,023
Even unto the heavens.

197
00:09:52,457 --> 00:09:55,094
>> Narrator: In 1955,
a potential solution

198
00:09:55,127 --> 00:09:57,129
to the problem appeared.

199
00:09:57,162 --> 00:10:00,399
Physicist James Van Allen was
helping spearhead an effort

200
00:10:00,432 --> 00:10:02,935
to launch a satellite
to study the Earth

201
00:10:02,968 --> 00:10:05,738
as part of a worldwide
science effort called

202
00:10:05,771 --> 00:10:08,908
the International
Geophysical Year, or IGY.

203
00:10:10,308 --> 00:10:13,112
Eisenhower immediately
seized on the opportunity.

204
00:10:15,480 --> 00:10:19,318
>> So that fellow is
the fellow we see here

205
00:10:19,351 --> 00:10:21,053
in the center of this picture.

206
00:10:21,086 --> 00:10:22,921
So tell us about James Van Allen

207
00:10:22,954 --> 00:10:24,957
and the role that he's
playing in this story.

208
00:10:24,990 --> 00:10:28,460
>> So Van Allen is another
early cosmic ray researcher,

209
00:10:28,493 --> 00:10:32,464
and along with JPL
director William Pickering

210
00:10:32,497 --> 00:10:35,034
was a member of the
Rocket and Research Panel

211
00:10:35,067 --> 00:10:37,202
that was flying
instruments on these V2s.

212
00:10:37,235 --> 00:10:41,073
He's also a developer
of small rockets

213

00:10:41,106 --> 00:10:45,244
to do cosmic ray research,
even a thing that...

214
00:10:46,211 --> 00:10:49,381
Called a rockoon, of all things.

215
00:10:49,414 --> 00:10:51,850
Literally a balloon
with a rocket under it,

216
00:10:51,883 --> 00:10:54,019
you sent the balloon up,
when it got high enough,

217
00:10:54,052 --> 00:10:55,220
launched the rocket.

218
00:10:55,253 --> 00:10:57,022
So Van Allen was
already deeply involved

219
00:10:57,055 --> 00:10:59,892
in this kind of rocket
research, and he knew Pickering.

220
00:10:59,925 --> 00:11:04,964
Van Allen's cosmic ray
instrument was selected

221
00:11:06,098 --> 00:11:08,367
for the International
Geophysical Year,

222
00:11:08,400 --> 00:11:10,603
orbiting a satellite
after that was approved

223
00:11:11,770 --> 00:11:13,973
by President Eisenhower

in I believe it's '55.

224
00:11:15,440 --> 00:11:18,644
And so he was very involved
in that whole research area,

225
00:11:18,677 --> 00:11:20,345
and in getting it sold.

226
00:11:20,378 --> 00:11:22,748
One of the problems the
International Geophysical Year

227
00:11:22,781 --> 00:11:25,284
scientists had was
that they wanted to do

228
00:11:25,317 --> 00:11:28,187
global measurements,
even in Antarctica.

229
00:11:28,220 --> 00:11:30,055
But from the ground,
the best you can do

230
00:11:30,088 --> 00:11:32,825
is get a bunch of pinpricks
on the surface of the world,

231
00:11:32,858 --> 00:11:35,394
and with a satellite you
could do much better.

232
00:11:35,427 --> 00:11:37,863
So that was the idea of
the IGY satellite program

233
00:11:37,896 --> 00:11:40,432
that Van Allen helps out.

234
00:11:40,465 --> 00:11:42,067
>> So he's advocating that.

235
00:11:42,100 --> 00:11:43,402
>> He was certainly
an advocate of it.

236
00:11:43,435 --> 00:11:46,271
>> And Pickering's gung
ho, as is Von Brown.

237
00:11:46,304 --> 00:11:49,108
But the Russians are
interested in this too.

238
00:11:49,141 --> 00:11:49,975
>> That's right.

239
00:11:50,008 --> 00:11:51,577
That's right, so this...

240
00:11:51,610 --> 00:11:53,011
The International
Geophysical Year

241
00:11:53,044 --> 00:11:57,216
actually had a lot of
Soviet connections.

242
00:11:57,249 --> 00:11:59,351
They had major research fleets,

243
00:11:59,384 --> 00:12:02,020
they wanted to appear
scientifically interested

244
00:12:02,053 --> 00:12:05,157
and progressive, so they
intended to contribute a lot

245
00:12:05,190 --> 00:12:07,493
to the IGY, and they
decided they were gonna

246
00:12:07,526 --> 00:12:08,827
launch their own satellite.

247
00:12:08,860 --> 00:12:10,262
>> And low and behold, they do,

248
00:12:10,295 --> 00:12:12,331
to the shock of
the entire world.

249
00:12:12,364 --> 00:12:13,799
>> To the shock of
the entire world

250
00:12:13,832 --> 00:12:15,834
except the people who
knew a lot about the IGY,

251
00:12:15,867 --> 00:12:17,569
because they actually
announced in advance

252
00:12:17,602 --> 00:12:18,971
that they were gonna do it.

253
00:12:19,004 --> 00:12:20,939
It's just people didn't...

254
00:12:20,972 --> 00:12:24,009
The rest of us
didn't pay attention.

255
00:12:25,377 --> 00:12:30,048
And I think it was very

surprising to most Americans,

256
00:12:30,081 --> 00:12:33,185
even the ones in the know,
that it actually worked.

257
00:12:33,218 --> 00:12:35,221
>> It was a shock,
really, to the system.

258
00:12:36,321 --> 00:12:38,123
People had to take
math, I had to take math

259
00:12:38,156 --> 00:12:39,758
as a result of this, you know?

260
00:12:39,791 --> 00:12:40,592
[audience laughing]

261
00:12:40,625 --> 00:12:42,127
>> Yeah, that's true.

262
00:12:42,160 --> 00:12:43,462
There's a National Defense
Education Act afterwards.

263
00:12:44,896 --> 00:12:49,568
>> So at this point we did
have our own satellite,

264
00:12:49,601 --> 00:12:52,905
our own program, and it was
called Vanguard I think?

265
00:12:52,938 --> 00:12:53,939
>> Yep.

266
00:12:53,972 --> 00:12:55,674

So the Vanguard program,

267
00:12:55,707 --> 00:13:00,245
remember I said earlier I think
that Von Brown and JPL folks

268
00:13:00,278 --> 00:13:03,582
had proposed something
called Project Orbiter.

269
00:13:03,615 --> 00:13:07,820
To use that vehicle
stack, we like to call it

270
00:13:07,853 --> 00:13:09,888
in the space business, but
that rocket they developed

271
00:13:09,921 --> 00:13:13,125
for the reentry test vehicle
program, to orbit a satellite,

272
00:13:13,158 --> 00:13:14,593
and they proposed that as the

273
00:13:14,626 --> 00:13:17,296
International Geophysical
Year's launch vehicle,

274
00:13:17,329 --> 00:13:18,964
and they lost.

275
00:13:18,997 --> 00:13:23,435
You saw in that tape, it's
the wrong word for it,

276
00:13:23,468 --> 00:13:25,971
but you saw in the tape
Eisenhower had this concern

277
00:13:26,004 --> 00:13:27,873
about overflight.

278
00:13:27,906 --> 00:13:30,275
Because he had that
concern about overflight,

279
00:13:30,308 --> 00:13:35,013
he wanted the US IGY
satellite to have

280
00:13:35,046 --> 00:13:38,684
as little connection to
military programs as possible.

281
00:13:38,717 --> 00:13:42,354
And so the naval
research lab proposed

282
00:13:42,387 --> 00:13:44,823
developing a new rocket
that wasn't a result

283
00:13:44,856 --> 00:13:47,726
of the ICBM program for the IGY,

284
00:13:47,759 --> 00:13:49,628
that was called Vanguard,

285
00:13:49,661 --> 00:13:51,496
and that was the
vehicle that got

286
00:13:51,529 --> 00:13:54,633
the blessing of the White House.

287
00:13:54,666 --> 00:13:56,635
>> And then what happened
on the launchpad?

288
00:13:56,668 --> 00:14:00,305
>> Well, there's a reason
that little satellite you saw

289
00:14:00,338 --> 00:14:03,408
is hanging in a museum now
instead of burned up in space.

290
00:14:03,441 --> 00:14:05,044
Their launch vehicle exploded.

291
00:14:06,478 --> 00:14:07,946
>> Blaine: In front of the
whole world on television--

292
00:14:07,979 --> 00:14:10,516
>> Yeah, because the US
didn't keep it all secret,

293
00:14:11,917 --> 00:14:13,752
we had a very public
embarrassment.

294
00:14:13,785 --> 00:14:14,987
>> It was called Flopnik.

295
00:14:16,087 --> 00:14:17,256
[audience laughing]

296
00:14:17,289 --> 00:14:18,991
>> Flopnik and Kaputnik, yeah.

297
00:14:19,024 --> 00:14:20,759
[audience laughing]

298
00:14:20,792 --> 00:14:25,297
>> So at this point,
Eisenhower has really no choice

299
00:14:25,330 --> 00:14:30,336
but to turn to the efforts
of JPL and what was then

300
00:14:31,469 --> 00:14:33,438
I guess Redstone with Von Brown.

301
00:14:33,471 --> 00:14:34,706
>> That's right.

302
00:14:34,739 --> 00:14:37,509
So after the Sputnik
launch in October,

303
00:14:37,542 --> 00:14:39,344
President Eisenhower
had authorized

304
00:14:39,377 --> 00:14:44,383
a backup to be prepared using
the Army JPL Von Brown group's

305
00:14:45,684 --> 00:14:47,686
reentry test vehicle setup.

306
00:14:47,719 --> 00:14:49,254
Like Project Orbiter,

307
00:14:49,287 --> 00:14:52,658
except with Van Allen's
cosmic ray instrument

308
00:14:52,691 --> 00:14:54,993
and a couple of
micrometeorite detectors,

309
00:14:55,026 --> 00:14:59,331
and that launch attempt

is what winds up

310
00:14:59,364 --> 00:15:01,333
pulling JPL out of
the classified world

311
00:15:01,366 --> 00:15:02,935
and back into space science.

312
00:15:02,968 --> 00:15:06,538
>> So let's go back
to that actual time

313
00:15:06,571 --> 00:15:08,707
and see the launch
and see what happened.

314
00:15:13,445 --> 00:15:15,314
>> Narrator: Time, late evening,

315
00:15:15,347 --> 00:15:17,182
Friday, January 31st, 1958.

316
00:15:18,316 --> 00:15:20,319
In a blockhouse at Canaveral,

317
00:15:20,352 --> 00:15:22,321
the countdown to Explorer 1.

318
00:15:23,688 --> 00:15:24,589
>> Announcer: Roger.

319
00:15:24,622 --> 00:15:25,657
Okay, we'll start now.

320
00:15:25,690 --> 00:15:26,558
>> Finished fuel loading.

321

00:15:26,591 --> 00:15:29,194
[noisy typing]

322
00:15:37,635 --> 00:15:40,138
>> Announcer: 10, nine, eight,

323
00:15:40,171 --> 00:15:42,107
seven, six, five, four,

324
00:15:44,442 --> 00:15:47,145
three, two, one,

325
00:15:47,178 --> 00:15:48,447
by command, by command.

326
00:15:54,352 --> 00:15:57,089
[reverent music]

327
00:16:11,002 --> 00:16:15,974
>> So we got a
report from the cape

328
00:16:16,007 --> 00:16:18,076
that the launch
looks pretty good,

329
00:16:18,109 --> 00:16:22,948
and it should fly
over California at
such and such a time.

330
00:16:22,981 --> 00:16:25,951
And so the decision was
made that we would make

331
00:16:25,984 --> 00:16:29,955
no public announcements
about the rocket

332

00:16:29,988 --> 00:16:33,925
until it had actually been
picked up in California.

333
00:16:33,958 --> 00:16:36,995
And so we sat there
for an hour and a half.

334
00:16:37,028 --> 00:16:39,398
The time came and went,

335
00:16:39,431 --> 00:16:43,802
and there was a period
eight minutes there

336
00:16:43,835 --> 00:16:45,570
which was the
longest eight minutes

337
00:16:45,603 --> 00:16:47,239
I've ever spent in my life.

338
00:16:47,272 --> 00:16:49,608
>> Narrator: But finally
JPL received a signal

339
00:16:49,641 --> 00:16:51,410
that the satellite was in orbit.

340
00:16:53,278 --> 00:16:56,014
The United States had a success.

341
00:16:56,047 --> 00:16:58,550
Eisenhower, on a golfing
trip at the time,

342
00:16:58,583 --> 00:17:00,986
was awakened from his
sleep and told the news.

343
00:17:02,454 --> 00:17:04,222
Let's not make too big of
a hullaballoo over this,

344
00:17:04,255 --> 00:17:07,559
he cautioned, and
went back to sleep.

345
00:17:07,592 --> 00:17:10,529
No one took the
president's advice.

346
00:17:12,030 --> 00:17:14,332
>> We were told that
there was going to be

347
00:17:14,365 --> 00:17:17,002
a press conference over at the
National Academy of Sciences

348
00:17:17,035 --> 00:17:18,804
on the other side of the river.

349
00:17:18,837 --> 00:17:23,442
So off we went, and I
remember sitting in that car

350
00:17:23,475 --> 00:17:25,544
with the three of
us in the back seat,

351
00:17:25,577 --> 00:17:29,214
it was sort of a cold, rainy
January night in Washington,

352
00:17:31,549 --> 00:17:34,953
and I remember Carl
Session going on and on,

353

00:17:34,986 --> 00:17:36,588
wonder whether anybody's
gonna be out here

354
00:17:36,621 --> 00:17:40,059
because it's now about
2:00 in the morning.

355
00:17:41,493 --> 00:17:43,628
>> Reporter: In Washington
at the National Academy

356
00:17:43,661 --> 00:17:47,032
of Science, a packed auditorium
of reporters, radio...

357
00:17:47,065 --> 00:17:49,734
>> Man: Von Brown, Van Allen,
and Pickering are there

358
00:17:49,767 --> 00:17:52,037
to lift the satellite aloft.

359
00:17:53,471 --> 00:17:57,342
>> The success of Explorer
and what we learned from it

360
00:17:57,375 --> 00:18:00,078
really does kind of recreate,

361
00:18:00,111 --> 00:18:02,848
in the most fundamental way,

362
00:18:02,881 --> 00:18:05,517
the nature of the
Jet Propulsion Lab,

363
00:18:05,550 --> 00:18:08,987
and moving it from a
rocket development center

364
00:18:09,020 --> 00:18:13,158
to one in which space science
becomes what it really does.

365
00:18:13,191 --> 00:18:15,694
It really put JPL on
the map scientifically.

366
00:18:19,330 --> 00:18:22,000
>> And there you have it, that
moment, the iconic moment,

367
00:18:22,033 --> 00:18:24,369
and what's really
important about it I guess

368
00:18:24,402 --> 00:18:26,304
is the space science as much,

369
00:18:26,337 --> 00:18:30,876
and talk to us about
what that instrument was

370
00:18:30,909 --> 00:18:32,177
and what it did, please.

371
00:18:32,210 --> 00:18:34,813
>> So Van Allen's
instrument fundamentally

372
00:18:34,846 --> 00:18:37,315
is a giker counter, a
cosmic ray instrument,

373
00:18:37,348 --> 00:18:39,684
and it's kind of the
center tube of that thing

374

00:18:39,717 --> 00:18:40,919
that you're seeing.

375
00:18:40,952 --> 00:18:42,120
Well, I'm pointing
to one down there

376
00:18:42,153 --> 00:18:43,288
'cause it's on the
floor, but no, there,

377
00:18:43,321 --> 00:18:44,789
and it's surrounded
by batteries,

378
00:18:44,822 --> 00:18:47,726
because there are no solar
panels on the satellite yet.

379
00:18:47,759 --> 00:18:52,197
And it had an odd behavior
while it was orbiting the Earth,

380
00:18:52,230 --> 00:18:55,100
and that was that it would
have a normal sort of expected

381
00:18:55,133 --> 00:18:57,369
lowish count, and then
it would start to climb,

382
00:18:57,402 --> 00:18:59,237
and then it would
suddenly go to zero.

383
00:18:59,270 --> 00:19:01,006
And it did this in every orbit,

384
00:19:01,039 --> 00:19:04,209
and it was a couple of months

before Van Allen's crew

385
00:19:04,242 --> 00:19:06,044
start to understand
what's going on,

386
00:19:06,077 --> 00:19:08,079
they thought there was something
wrong with the instrument,

387
00:19:08,112 --> 00:19:09,614
and they tried various things.

388
00:19:09,647 --> 00:19:10,849
But what was really happening

389
00:19:10,882 --> 00:19:13,185
was that it was
becoming saturated

390
00:19:13,218 --> 00:19:15,720
when it got to certain
parts of its orbit.

391
00:19:15,753 --> 00:19:19,224
And they tried in the lab to
figure out what you had to do

392
00:19:19,257 --> 00:19:20,692
to cause this to happen,

393
00:19:20,725 --> 00:19:24,196
and they found that if they
zapped it with an X-ray machine,

394
00:19:24,229 --> 00:19:26,464
they would get the same result.

395
00:19:26,497 --> 00:19:31,503

And what that showed was that
there's a point in its orbit

396
00:19:32,604 --> 00:19:34,573
where it's going through
an extremely high

397
00:19:34,606 --> 00:19:36,841
area of radiation, and they
figured that it's radiation

398
00:19:36,874 --> 00:19:39,277
trapped by the Earth's
magnetic field.

399
00:19:39,310 --> 00:19:42,047
>> So we have basically
radiation belts.

400
00:19:42,080 --> 00:19:44,749
>> We have a radiation belt
and radiation shielding

401
00:19:44,782 --> 00:19:49,120
from the magnetic field
that a handful of scientists

402
00:19:49,153 --> 00:19:52,090
had thought might be
true, but just proved it.

403
00:19:52,123 --> 00:19:54,626
>> And because of
that radiation belt,

404
00:19:54,659 --> 00:19:56,194
we're protected.

405
00:19:56,227 --> 00:19:58,230
>> We are protected by it, yeah.

406
00:19:58,263 --> 00:19:59,664
Yeah.

407
00:19:59,697 --> 00:20:01,833
>> Blaine: From the cosmic
rays, and we're able

408
00:20:01,866 --> 00:20:03,568
to walk around here
on the surface.

409
00:20:03,601 --> 00:20:05,170
>> Erik: Might be
key to life on Earth.

410
00:20:05,203 --> 00:20:06,004
Might be.

411
00:20:06,037 --> 00:20:06,938
>> Yeah.

412
00:20:06,971 --> 00:20:08,406
Well, that's a great story.

413
00:20:08,439 --> 00:20:11,042
And then, there's another
thing that happens

414
00:20:11,075 --> 00:20:12,877
as a result of this is

415
00:20:12,910 --> 00:20:15,580
the formation of
our space agency.

416
00:20:15,613 --> 00:20:16,748
>> Yeah.

417
00:20:16,781 --> 00:20:18,516
So President Eisenhower,
having, you know,

418
00:20:18,549 --> 00:20:21,486
it's the Army, his
old service of course.

419
00:20:21,519 --> 00:20:24,923
The Army who had had the
first space science result,

420
00:20:26,057 --> 00:20:29,761
but President Eisenhower
didn't want science

421
00:20:29,794 --> 00:20:32,230
kind of under the
military's thumb,

422
00:20:32,263 --> 00:20:35,900
even if the military
had been a good patron.

423
00:20:35,933 --> 00:20:38,670
And so he put some
thought into the subject

424
00:20:38,703 --> 00:20:42,107
of how to go about making
a civilian space agency

425
00:20:42,140 --> 00:20:45,710
that would be a
scientific agency as well,

426
00:20:45,743 --> 00:20:48,647
and concluded that
the way to go about it

427
00:20:48,680 --> 00:20:51,116
was to take an already
existing organization

428
00:20:51,149 --> 00:20:54,386
known as the National Advisory
Committee on Aeronautics,

429
00:20:54,419 --> 00:20:55,687
or the NACA,

430
00:20:55,720 --> 00:20:58,090
that's actually been
founded right after

431
00:20:59,257 --> 00:21:00,492
the end of World War I,

432
00:21:00,525 --> 00:21:02,894
and convert that into
the new space agency.

433
00:21:02,927 --> 00:21:06,231
And that's four other
centers, but not JPL,

434
00:21:06,264 --> 00:21:09,367
and not the Huntsville
folks, initially.

435
00:21:09,400 --> 00:21:12,737
So at one point it looked
like Caltech and JPL

436
00:21:12,770 --> 00:21:15,106
would just be shut
out of the Space Age.

437
00:21:15,139 --> 00:21:18,143

>> But JPL, particularly
because we're a part

438
00:21:18,176 --> 00:21:20,545
of Caltech to this day,

439
00:21:20,578 --> 00:21:22,747
wanted to get out of
the weapons business

440
00:21:22,780 --> 00:21:24,783
and wanted to get into
the science business.

441
00:21:24,816 --> 00:21:25,984
>> Absolutely.

442
00:21:26,017 --> 00:21:28,753
So Caltech had never
been very happy

443
00:21:28,786 --> 00:21:31,589
with the decision
that the Army made

444
00:21:31,622 --> 00:21:35,827
to convert JPL into making
weapons for the Cold War.

445
00:21:35,860 --> 00:21:37,562
And particularly not
when they started

446
00:21:37,595 --> 00:21:39,331
making operational
weapon systems,

447
00:21:39,364 --> 00:21:42,767
because it didn't contribute
to the teaching mission

448
00:21:42,800 --> 00:21:44,135
of Caltech.

449
00:21:44,168 --> 00:21:45,770
It's a school, fundamentally,

450
00:21:45,803 --> 00:21:47,772
that's what it's supposed to be.

451
00:21:47,805 --> 00:21:50,742
And so there were
discussions about

452
00:21:50,775 --> 00:21:53,278
how do we get JPL to
do something else?

453
00:21:53,311 --> 00:21:55,180
And this was the opportunity.

454
00:21:55,213 --> 00:22:00,118
So NASA goes into operation
in October of '58,

455
00:22:00,151 --> 00:22:03,221
and Mr. Pickering, Dr.
Pickering, I'm sorry,

456
00:22:03,254 --> 00:22:05,023
I will be crucified for that.

457
00:22:05,056 --> 00:22:06,424
[audience laughing]

458
00:22:06,457 --> 00:22:09,260
Dr. Pickering goes to
Washington to try to sell NASA

459
00:22:09,293 --> 00:22:11,262
and the White House
on the idea of moving

460
00:22:11,295 --> 00:22:13,798
JPL out of the
Army and into NASA,

461
00:22:13,831 --> 00:22:15,100
and they're successful.

462
00:22:15,133 --> 00:22:17,335
So JPL makes the transition

463
00:22:17,368 --> 00:22:19,704
the beginning of
the following year.

464
00:22:19,737 --> 00:22:23,141
But it took Von Brown's
crew another couple of years

465
00:22:23,174 --> 00:22:25,944
to even decide they wanted
to be out of the Army

466
00:22:25,977 --> 00:22:27,112
and move over to NASA.

467
00:22:28,246 --> 00:22:30,181
>> To turn a twist
of the phrase,

468
00:22:30,214 --> 00:22:32,984
the rest is the future.

469
00:22:33,017 --> 00:22:35,120
>> The rest is the future,
and we do things that are

470
00:22:35,153 --> 00:22:37,021
completely different now.

471
00:22:37,054 --> 00:22:38,990
>> Erik, thank you
so much for this.

472
00:22:39,023 --> 00:22:39,924
>> Thanks for having me.

473
00:22:39,957 --> 00:22:41,359
>> Whirlwind tour, thank you.

474
00:22:41,392 --> 00:22:44,563
[audience applauding]

475
00:22:49,734 --> 00:22:51,169
Thank you.

476
00:22:51,202 --> 00:22:54,172
And now we're gonna turn
our attention to some

477
00:22:54,205 --> 00:22:57,275
incredible software that I
couldn't be more proud of

478
00:22:57,308 --> 00:23:00,011
that you can download
on your computer,

479
00:23:00,044 --> 00:23:02,547
in some cases on an application,

480
00:23:02,580 --> 00:23:05,917
that you can see some of the
things that we're doing today

481
00:23:05,950 --> 00:23:09,487
in space exploration,
and to tell us about that

482
00:23:09,520 --> 00:23:12,824
is Mr. Jason Craig, a
visualization specialist

483
00:23:12,857 --> 00:23:14,125
here at the laboratory.

484
00:23:14,158 --> 00:23:15,427
Welcome Jay, Jason.

485
00:23:16,327 --> 00:23:19,498
[audience applauding]

486
00:23:20,465 --> 00:23:21,299
>> Thank you, Blaine.

487
00:23:22,433 --> 00:23:24,169
So if you've been
watching this monitor,

488
00:23:24,202 --> 00:23:25,703
you've seen Explorer 1,

489
00:23:25,736 --> 00:23:27,038
but what you may
not know is this is

490
00:23:27,071 --> 00:23:28,506
not a pre-rendered animation,

491
00:23:28,539 --> 00:23:31,309
this is a live 3D
simulation in real time.

492

00:23:31,342 --> 00:23:33,812
So this is one
second per second,

493
00:23:33,845 --> 00:23:35,947
and I can control
what's going on.

494
00:23:35,980 --> 00:23:37,949
So this is actually
the entire solar system

495
00:23:37,982 --> 00:23:40,084
from 1950 to 2050,

496
00:23:40,117 --> 00:23:42,787
and you're in control
of time and space.

497
00:23:42,820 --> 00:23:44,656
So if I leave Explorer 1,

498
00:23:44,689 --> 00:23:47,058
there's not much
going on out there,

499
00:23:47,091 --> 00:23:48,626
out in the solar system,

500
00:23:48,659 --> 00:23:51,029
but I can turn on the
labels, the orbit lines,

501
00:23:52,330 --> 00:23:54,432
constellations if you like,

502
00:23:54,465 --> 00:23:57,535
and if I hit the now button,
we can see where everything is.

503
00:23:57,568 --> 00:23:59,537
Let's turn off those
constellations.

504
00:23:59,570 --> 00:24:02,607
So I'm gonna use the controls
to show you some cool stuff.

505
00:24:02,640 --> 00:24:04,108
But first and foremost
I want you to know

506
00:24:04,141 --> 00:24:06,311
that this is something
that you can have at home.

507
00:24:06,344 --> 00:24:08,546
So in the back of the
room there are cards

508
00:24:08,579 --> 00:24:09,914
that will tell you
the website to go to,

509
00:24:09,947 --> 00:24:12,617
and you can download
this for your PC or Mac,

510
00:24:12,650 --> 00:24:14,185
laptop or desktop.

511
00:24:14,218 --> 00:24:16,554
And it's called Eyes
on the Solar System,

512
00:24:16,587 --> 00:24:18,256
and it's at eyes.nasa.gov,

513
00:24:18,289 --> 00:24:19,724

eyes like your eyes,

514
00:24:19,757 --> 00:24:22,026
and you actually
get three programs

515
00:24:22,059 --> 00:24:23,495
when you do a quick install.

516
00:24:23,528 --> 00:24:24,729
So I'm showing right now,

517
00:24:24,762 --> 00:24:26,231
I was showing Eyes
on the Solar System,

518
00:24:26,264 --> 00:24:29,100
which is the simulation
of over 120 NASA missions

519
00:24:29,133 --> 00:24:32,136
for 100 years,
and it's accurate.

520
00:24:32,169 --> 00:24:33,538
It's accurate as
it can possibly be,

521
00:24:33,571 --> 00:24:35,907
everything's to scale,
one to one to one.

522
00:24:35,940 --> 00:24:37,442
You also get Eyes on the Earth,

523
00:24:37,475 --> 00:24:39,611
which I'm going to show after
this to show some Earth data,

524

00:24:39,644 --> 00:24:41,746
and you can visit each
and every exoplanet

525
00:24:41,779 --> 00:24:44,048
we've ever found,
which is over 3000.

526
00:24:44,081 --> 00:24:46,584
I wouldn't advise that unless
you've got a lot of free time.

527
00:24:46,617 --> 00:24:48,052
[audience laughing]

528
00:24:48,085 --> 00:24:50,555
But those are just for your
laptop or your desktop,

529
00:24:50,588 --> 00:24:52,624
but we also have
apps for your phone.

530
00:24:52,657 --> 00:24:55,093
So if you have your
phone you can actually

531
00:24:55,126 --> 00:24:56,528
get these right away.

532
00:24:56,561 --> 00:24:58,329
Earth Now, which will be similar
to what I'm about to show

533
00:24:58,362 --> 00:24:59,797
but it's for your phone,

534
00:24:59,830 --> 00:25:02,000
and also one called
Spacecraft 3D,

535
00:25:02,033 --> 00:25:04,035
and I have cards in the
back for that as well.

536
00:25:04,068 --> 00:25:05,870
That's kind of fun,
it's like Pokemon Go

537
00:25:05,903 --> 00:25:07,705
but for NASA spacecraft.

538
00:25:07,738 --> 00:25:08,907
[audience laughing]

539
00:25:08,940 --> 00:25:10,141
So check that out
when you get a chance.

540
00:25:10,174 --> 00:25:11,843
So quick download, you
get three programs.

541
00:25:11,876 --> 00:25:14,646
Now let me show you
some cool, cool stuff.

542
00:25:14,679 --> 00:25:16,981
All right, so back
to the solar system,

543
00:25:17,014 --> 00:25:20,151
let me turn off the
constellations and go back here,

544
00:25:20,184 --> 00:25:22,754
and this is a live view
of the solar system,

545

00:25:22,787 --> 00:25:25,990
we hit now, it's
January 25th, 7:29 PM

546
00:25:26,023 --> 00:25:27,592
at one second per second.

547
00:25:27,625 --> 00:25:30,194
So let me show you,
turn on the orbit lines

548
00:25:30,227 --> 00:25:31,729
so you can see the solar system.

549
00:25:31,762 --> 00:25:34,165
So there it is, this is the
solar system, I'm in control,

550
00:25:34,198 --> 00:25:36,734
we can pull out all the
way to the Voyagers.

551
00:25:36,767 --> 00:25:40,138
The Voyagers, this one
has left the solar system.

552
00:25:40,171 --> 00:25:41,973
But let me go to Mars,
let's take a live,

553
00:25:42,006 --> 00:25:44,843
let's just drop in on
Mars and take a live look.

554
00:25:46,577 --> 00:25:49,414
Any label you see, you double
click and you go on in.

555
00:25:49,447 --> 00:25:51,215
And this is Mars right now,

556
00:25:51,248 --> 00:25:53,785
and those are our missions
at Mars right now.

557
00:25:53,818 --> 00:25:55,553
There's actually quite a few.

558
00:25:55,586 --> 00:25:58,256
And let me fast
forward so you can see.

559
00:25:58,289 --> 00:26:00,925
So that's seven minutes
per second rate.

560
00:26:00,958 --> 00:26:02,961
So we've got a
bunch of orbiters,

561
00:26:02,994 --> 00:26:05,530
we have, you can see
the moon there, Phobos,

562
00:26:05,563 --> 00:26:09,100
and we have two rovers
on Mars right now.

563
00:26:09,133 --> 00:26:12,537
Show you the trails of
each of these orbiters.

564
00:26:12,570 --> 00:26:15,106
So, let's go double click
on one and take a look

565
00:26:15,139 --> 00:26:16,541
and see how it's doing.

566

00:26:16,574 --> 00:26:18,276
Catch MRO here.

567
00:26:18,309 --> 00:26:19,844
Boy, that's fast.

568
00:26:19,877 --> 00:26:21,045
Let's go back to real rate.

569
00:26:21,078 --> 00:26:22,313
Sometimes they
run away from you.

570
00:26:22,346 --> 00:26:23,481
Let's go to Odyssey.

571
00:26:23,514 --> 00:26:25,683
Odyssey's a very
long lasting orbiter.

572
00:26:25,716 --> 00:26:28,486
So there's Odyssey, this
is actually where it is

573
00:26:28,519 --> 00:26:29,988
this very second.

574
00:26:30,021 --> 00:26:32,891
And if you want to go ahead
in time, we just fast forward.

575
00:26:34,959 --> 00:26:36,894
If you go really fast,
you can make yourself ill.

576
00:26:36,927 --> 00:26:38,029
But we're not gonna do that.

577
00:26:38,062 --> 00:26:39,297

[audience laughing]

578
00:26:39,330 --> 00:26:40,765
And let me go back out
and show you something

579
00:26:40,798 --> 00:26:44,836
you may not be aware of is that
beautiful shadows on Saturn.

580
00:26:44,869 --> 00:26:46,771
So we have added this detail,

581
00:26:46,804 --> 00:26:48,339
let me bring up real lighting.

582
00:26:48,372 --> 00:26:52,010
These beautiful ring shadows
on Saturn, they're amazing.

583
00:26:52,043 --> 00:26:53,678
And this is what they
look like right now.

584
00:26:53,711 --> 00:26:54,979
But if we go forward in time,

585
00:26:55,012 --> 00:26:57,115
you can see what happens
with its seasons.

586
00:27:00,017 --> 00:27:02,754
And now it's changed to
the northern hemisphere.

587
00:27:02,787 --> 00:27:04,355
So now we're in 2028.

588
00:27:04,388 --> 00:27:05,623

So just like that we're there.

589
00:27:05,656 --> 00:27:07,058
Let me fast forward some more.

590
00:27:07,091 --> 00:27:10,094
We get back up to the
absolute solstice,

591
00:27:10,127 --> 00:27:11,696
and then it'll go
back down again.

592
00:27:11,729 --> 00:27:12,697
Pretty cool stuff.

593
00:27:13,798 --> 00:27:15,266
But I'm gonna
leave solar system,

594
00:27:15,299 --> 00:27:17,001
because the rest of
this will be Earth,

595
00:27:17,034 --> 00:27:18,569
and I'm gonna switch
to Eyes on the Earth,

596
00:27:18,602 --> 00:27:21,839
so when you install you
get all of these programs,

597
00:27:21,872 --> 00:27:23,641
it'll put a little
icon on your desktop,

598
00:27:23,674 --> 00:27:25,343
and I'm gonna load
Eyes on the Earth

599
00:27:25,376 --> 00:27:27,879
and show you our
Earth fleet right now.

600
00:27:30,915 --> 00:27:34,852
So this is a live look,
if I hit real time,

601
00:27:34,885 --> 00:27:37,355
this is a live look
at our Earth fleet.

602
00:27:37,388 --> 00:27:38,823
And so Eyes on the Solar System,

603
00:27:38,856 --> 00:27:40,391
this is for you,
good tax payers,

604
00:27:40,424 --> 00:27:43,127
you've already paid for it,
you may as well download it.

605
00:27:43,160 --> 00:27:44,395
[audience laughing]

606
00:27:44,428 --> 00:27:45,763
So please check it out
when you get a chance.

607
00:27:45,796 --> 00:27:48,232
I'll turn it back
over to Blaine now.

608
00:27:48,265 --> 00:27:49,233
>> Thank you Jason.

609
00:27:49,266 --> 00:27:50,068
>> You're welcome.

610
00:27:50,101 --> 00:27:53,271
[audience applauding]

611
00:27:55,873 --> 00:27:57,575
>> That's the fastest
trip I've taken

612
00:27:57,608 --> 00:27:59,610
through the solar
system ever, I think.

613
00:27:59,643 --> 00:28:00,845
[audience laughing]

614
00:28:00,878 --> 00:28:03,314
Well, joining me now

615
00:28:03,347 --> 00:28:08,019
are two incredible scientists
here at the laboratory,

616
00:28:09,120 --> 00:28:11,856
Dr. Carmen Boening
and Dr. Erika Podest.

617
00:28:13,257 --> 00:28:15,693
Dr. Boening is a scientist
on the GRACE mission,

618
00:28:15,726 --> 00:28:19,097
she's conducting research on
ocean climate interactions

619
00:28:19,130 --> 00:28:22,366
that include global water
cycle and sea level rise,

620
00:28:22,399 --> 00:28:25,269

and Dr. Podest is working
on the soil moisture

621
00:28:25,302 --> 00:28:28,740
active passive mission,
a mission better known

622
00:28:28,773 --> 00:28:31,476
and easier said as SMAP.

623
00:28:31,509 --> 00:28:34,812
Her research areas
include global carbon

624
00:28:34,845 --> 00:28:37,648
and water cycle changes
and climate change.

625
00:28:37,681 --> 00:28:39,617
So welcome to you two too.

626
00:28:39,650 --> 00:28:40,485
>> Thank you

627
00:28:40,518 --> 00:28:43,688
[audience applauding]

628
00:28:46,056 --> 00:28:48,826
Now, we've got a lot
of ground to cover

629
00:28:48,859 --> 00:28:51,629
and atmosphere and
oceans to cover,

630
00:28:51,662 --> 00:28:53,264
and so let's get right to it.

631
00:28:53,297 --> 00:28:56,067

Jason's gonna continue
to visualize what
we're talking about

632
00:28:56,100 --> 00:28:57,535
as we go through this.

633
00:28:57,568 --> 00:28:59,470
But he's put up on the screen

634
00:28:59,503 --> 00:29:02,740
this armada of
science instruments

635
00:29:02,773 --> 00:29:05,309
that are circling the globe now.

636
00:29:05,342 --> 00:29:10,348
It's quite an impressive
group of missions here.

637
00:29:11,081 --> 00:29:12,583
>> Yeah, absolutely.

638
00:29:12,616 --> 00:29:15,620
So what you're seeing here
is NASA's Earth observing

639
00:29:15,653 --> 00:29:18,856
missions in space,
which consist of 20.

640
00:29:18,889 --> 00:29:22,827
And these missions observe
the different components

641
00:29:22,860 --> 00:29:26,864
of our global environment
as related to the oceans,

642
00:29:26,897 --> 00:29:29,500
the atmosphere,
and the continents,

643
00:29:29,533 --> 00:29:31,936
and together they
provide a picture

644
00:29:31,969 --> 00:29:33,805
of our Earth as a system.

645
00:29:33,838 --> 00:29:35,807
So we can study
almost everything,

646
00:29:35,840 --> 00:29:40,845
from the air we breathe
to the rain and the snow

647
00:29:42,146 --> 00:29:45,349
that provide water for
agriculture or for communities,

648
00:29:45,382 --> 00:29:48,085
to natural disasters
like floods and droughts.

649
00:29:48,118 --> 00:29:53,124
And the study from space
has really revolutionized

650
00:29:53,958 --> 00:29:55,693
our understanding of our planet,

651
00:29:55,726 --> 00:29:58,763
and it's constantly
providing new information

652
00:29:58,796 --> 00:30:02,633

that helps us understand
how the planet functions

653
00:30:02,666 --> 00:30:04,068
and how it's changing.

654
00:30:04,101 --> 00:30:07,171
And all of this is
thanks to the incredible

655
00:30:07,204 --> 00:30:10,374
technological achievement
that's been developed

656
00:30:10,407 --> 00:30:14,512
through decades of experience,
going back to Explorer 1.

657
00:30:14,545 --> 00:30:18,349
>> And I know a favorite
image that you have

658
00:30:18,382 --> 00:30:19,851
is of the Earth as a puzzle.

659
00:30:19,884 --> 00:30:21,452
As a scientist that
makes sense to me,

660
00:30:21,485 --> 00:30:22,887
because there's such mysteries

661
00:30:22,920 --> 00:30:25,189
that you're always
wanting to solve,

662
00:30:25,222 --> 00:30:27,391
but it's a complex system

663

00:30:27,424 --> 00:30:29,493
and a complex puzzle
to solve, isn't it?

664
00:30:29,526 --> 00:30:30,728
>> Yes, absolutely.

665
00:30:30,761 --> 00:30:33,664
So the pieces of the
puzzle are everything.

666
00:30:33,697 --> 00:30:37,501
Urban environments,
biodiversity,
oceans, atmosphere,

667
00:30:37,534 --> 00:30:40,137
everything that
comprises our planet.

668
00:30:40,170 --> 00:30:43,241
And putting this puzzle
together is complicated

669
00:30:43,274 --> 00:30:46,143
because Earth is
a complex system.

670
00:30:46,176 --> 00:30:49,380
There's a lot of interactions
at different scales,

671
00:30:49,413 --> 00:30:52,850
from the local to the
regional to the global scales,

672
00:30:52,883 --> 00:30:55,319
and it's not only that,
but it's understanding

673

00:30:55,352 --> 00:30:58,189
what happens when a
system is altered,

674
00:30:58,222 --> 00:31:02,994
how that impacts other systems,
and then trying to foresee

675
00:31:03,027 --> 00:31:05,997
how things will
evolved in the future.

676
00:31:06,030 --> 00:31:08,833
So even though we
don't know everything,

677
00:31:08,866 --> 00:31:11,502
we have enough
pieces of the puzzle

678
00:31:11,535 --> 00:31:14,639
to know the general direction
where things are heading.

679
00:31:16,173 --> 00:31:19,644
>> So Carmen, we're gonna be
talking a lot about climate,

680
00:31:19,677 --> 00:31:22,980
but I just want to make
sure we're all clear

681
00:31:23,013 --> 00:31:25,850
about the difference
between climate and weather,

682
00:31:25,883 --> 00:31:28,319
because we've had a
lot of cold weather

683

00:31:28,352 --> 00:31:29,820
in this country recently,

684
00:31:29,853 --> 00:31:32,089
and I can imagine a
lot of folks shivering

685
00:31:32,122 --> 00:31:34,458
saying "what do you
mean about the fact

686
00:31:34,491 --> 00:31:36,227
"that the climate is warming?"

687
00:31:36,260 --> 00:31:37,495
What is the difference really?

688
00:31:37,528 --> 00:31:39,230
Just to be clear
between the two.

689
00:31:39,263 --> 00:31:40,765
>> Exactly, yeah.

690
00:31:40,798 --> 00:31:43,100
So there is a big difference
between climate and weather,

691
00:31:43,133 --> 00:31:46,570
and weather is really
what's happening right now

692
00:31:46,603 --> 00:31:49,807
in one place to the
other, and as you said,

693
00:31:49,840 --> 00:31:52,743
it might be very cold
somewhere in the world,

694
00:31:52,776 --> 00:31:55,746
and then at the
same time there is

695
00:31:55,779 --> 00:31:59,183
a lot of heat and
droughts in another place.

696
00:31:59,216 --> 00:32:03,654
So looking at these
things over time,

697
00:32:03,687 --> 00:32:05,790
that is what climate is.

698
00:32:05,823 --> 00:32:10,828
It's really not the hourly
to daily, weekly weather,

699
00:32:11,962 --> 00:32:15,199
but the longterm change.

700
00:32:15,232 --> 00:32:18,302
What happens from year to
year, from decade to decade,

701
00:32:18,335 --> 00:32:20,905
maybe even over centuries.

702
00:32:20,938 --> 00:32:23,975
And that's like so great now

703
00:32:24,008 --> 00:32:26,510
that we have this
fleet of satellites

704
00:32:26,543 --> 00:32:28,679
that we can actually
look at the whole globe

705
00:32:28,712 --> 00:32:30,815
and look at these
different places,

706
00:32:30,848 --> 00:32:32,817
how they develop over time,

707
00:32:32,850 --> 00:32:37,855
and yes, just have this big
picture view of everything.

708
00:32:38,956 --> 00:32:40,691
>> You know, and
you mention decades,

709
00:32:40,724 --> 00:32:43,928
if we just think about
this new century,

710
00:32:43,961 --> 00:32:47,732
just recently NASA
announced something like 17

711
00:32:47,765 --> 00:32:51,502
of the last I think 18
years have been the warmest

712
00:32:51,535 --> 00:32:55,239
in modern records,
and this all goes back

713
00:32:55,272 --> 00:32:58,242
to another basic ideal,
fundamental ideal

714
00:32:58,275 --> 00:33:00,244
of the greenhouse
effect, isn't it?

715
00:33:00,277 --> 00:33:01,746
>> Absolutely.

716
00:33:01,779 --> 00:33:05,983
So the Earth is surrounded
by a layer of gases

717
00:33:06,016 --> 00:33:09,120
called the atmosphere,
and some of these gases

718
00:33:09,153 --> 00:33:12,757
are greenhouse gases,
which trap heat.

719
00:33:12,790 --> 00:33:15,459
The greenhouse effect,
what you're seeing here,

720
00:33:15,492 --> 00:33:19,663
is when the sun heats up
the surface of our planet,

721
00:33:19,696 --> 00:33:24,702
the surface then radiates that
heat back to the atmosphere.

722
00:33:26,103 --> 00:33:27,838
Part of that heat is trapped
by the greenhouse gases

723
00:33:27,871 --> 00:33:30,975
in the atmosphere, and what
you're seeing on the right

724
00:33:31,008 --> 00:33:34,812
is what's called the
normal greenhouse effect,

725

00:33:34,845 --> 00:33:37,415
and what you're seeing on the...

726
00:33:37,448 --> 00:33:40,117
Sorry, on the left, what
you're seeing on the right

727
00:33:40,150 --> 00:33:42,620
is the perturbed
greenhouse effect.

728
00:33:42,653 --> 00:33:45,556
So what's happening is,
think of it as a blanket,

729
00:33:45,589 --> 00:33:49,627
and as we are increasing
the concentration

730
00:33:49,660 --> 00:33:51,629
of greenhouse gases
in the atmosphere,

731
00:33:51,662 --> 00:33:54,265
that blanket is getting thicker,

732
00:33:54,298 --> 00:33:58,035
and therefore the ability
of Earth to trap heat

733
00:33:58,068 --> 00:34:00,704
is increasing, and that's the
perturbed greenhouse effect

734
00:34:00,737 --> 00:34:03,407
that you're seeing on the right.

735
00:34:03,440 --> 00:34:06,610
The greenhouse effect is
natural here on Earth.

736
00:34:06,643 --> 00:34:08,446
If it were not for
the greenhouse effect,

737
00:34:08,479 --> 00:34:11,282
we would not be
able to live here.

738
00:34:11,315 --> 00:34:13,551
So it's very very important.

739
00:34:13,584 --> 00:34:15,820
And what you're
seeing in this graph

740
00:34:15,853 --> 00:34:19,690
are the gases that make
up the greenhouse effect,

741
00:34:19,723 --> 00:34:22,460
which are water
vapor, carbon dioxide,

742
00:34:22,493 --> 00:34:26,297
methane, nitrous oxide,
chlorofluorocarbons,

743
00:34:26,330 --> 00:34:30,534
however, the most important
man-made greenhouse gas

744
00:34:30,567 --> 00:34:33,370
is carbon dioxide, or CO2.

745
00:34:33,403 --> 00:34:37,074
And CO2 can be released
to the atmosphere

746

00:34:37,107 --> 00:34:41,078
either through natural processes
like volcanic eruptions

747
00:34:41,111 --> 00:34:42,813
or through human activities,

748
00:34:42,846 --> 00:34:45,850
such as the
production of cement,

749
00:34:45,883 --> 00:34:48,486
deforestation,
forest degradation,

750
00:34:48,519 --> 00:34:51,255
and the burning of fossil fuels.

751
00:34:52,656 --> 00:34:57,161
And that's one thing that JPL
and NASA can do from space,

752
00:34:58,462 --> 00:35:01,966
is measure the concentration
of carbon dioxide

753
00:35:01,999 --> 00:35:03,501
in the atmosphere.

754
00:35:03,534 --> 00:35:05,936
And what you're seeing
here, this video animation,

755
00:35:05,969 --> 00:35:10,975
is the monthly concentration
of CO2 starting from 2002

756
00:35:12,142 --> 00:35:14,845
and going through
2016 as measured

757
00:35:14,878 --> 00:35:16,714
with a sensor called AIRS,

758
00:35:16,747 --> 00:35:20,284
and it's onboard a NASA
satellite called AQUA.

759
00:35:20,317 --> 00:35:22,419
The colors, the aqua colors,

760
00:35:22,452 --> 00:35:24,588
are lower concentrations of CO2,

761
00:35:24,621 --> 00:35:27,091
and the yellow
and the red colors

762
00:35:27,124 --> 00:35:29,793
represent higher
concentrations of CO2.

763
00:35:29,826 --> 00:35:32,763
CO2 by the way is measured
in parts per million.

764
00:35:32,796 --> 00:35:35,132
And you can see here,
throughout the progression

765
00:35:35,165 --> 00:35:39,370
of this video, that there's
been a change in the colors

766
00:35:39,403 --> 00:35:41,739
from blues to yellows and reds.

767
00:35:41,772 --> 00:35:46,644
So the next graph shows

this quantitatively

768
00:35:46,677 --> 00:35:49,146
throughout the time
period of the video.

769
00:35:49,179 --> 00:35:52,583
And we can see that it's
just a continuous increase

770
00:35:52,616 --> 00:35:55,319
in CO2 concentrations.

771
00:35:55,352 --> 00:35:57,321
Where are we now?

772
00:35:57,354 --> 00:36:01,859
In December of 2017, the
average CO2 concentration

773
00:36:01,892 --> 00:36:04,996
was about 406 parts per million.

774
00:36:06,096 --> 00:36:08,632
But what does that mean?

775
00:36:08,665 --> 00:36:11,035
So let's put things
into perspective.

776
00:36:11,068 --> 00:36:15,606
The next graph shows
reconstructions

777
00:36:15,639 --> 00:36:20,344
of atmospheric CO2
concentration through ice cores,

778
00:36:20,377 --> 00:36:24,081

and we go 500,000 years back.

779
00:36:24,114 --> 00:36:27,551
And we can see that
in this time frame,

780
00:36:27,584 --> 00:36:32,356
CO2 concentrations didn't go
above 300 parts per million.

781
00:36:32,389 --> 00:36:33,591
Okay?

782
00:36:33,624 --> 00:36:34,892
So that puts things
into perspective.

783
00:36:34,925 --> 00:36:38,662
We are living in
unprecedented times.

784
00:36:38,695 --> 00:36:42,132
>> And the interesting thing
to me, looking at this graph,

785
00:36:42,165 --> 00:36:46,270
is that when you start to
begin to see the spike,

786
00:36:46,303 --> 00:36:47,504
a bit hard to see here,

787
00:36:47,537 --> 00:36:49,974
but we're talking
about the beginning

788
00:36:50,007 --> 00:36:51,508
of the Industrial Revolution.

789

00:36:51,541 --> 00:36:53,711
So we're starting to see
machines that are using

790
00:36:53,744 --> 00:36:55,879
carbon based fuels.

791
00:36:55,912 --> 00:36:59,250
And so by the time
you get to 1950,

792
00:36:59,283 --> 00:37:03,220
you're starting to go somewhere
we've never been before.

793
00:37:03,253 --> 00:37:04,355
>> Absolutely yes.

794
00:37:04,388 --> 00:37:07,157
So that low there
right before the spike,

795
00:37:07,190 --> 00:37:10,427
that's around the time when the
Industrial Revolution began,

796
00:37:10,460 --> 00:37:13,664
and you can see this
just very quick increase

797
00:37:13,697 --> 00:37:16,667
in CO_2 concentrations,
and that's right,

798
00:37:16,700 --> 00:37:20,771
in 1950, we surpassed
the 300 part per million.

799
00:37:21,972 --> 00:37:25,309
>> So, our planet,

in spite of this,

800
00:37:25,342 --> 00:37:29,179
is trying to cope with
what we are doing.

801
00:37:29,212 --> 00:37:32,349
Now can you talk about how the
planet's responding to this?

802
00:37:32,382 --> 00:37:36,820
>> Sure, so, first of all,
our planet is very wise.

803
00:37:36,853 --> 00:37:39,590
It tries to keep
itself in balance.

804
00:37:39,623 --> 00:37:42,793
And the oceans,
vegetation, and soils

805
00:37:42,826 --> 00:37:47,331
have mechanisms to take up
to absorb carbon dioxide

806
00:37:47,364 --> 00:37:48,666
from the atmosphere.

807
00:37:48,699 --> 00:37:50,834
However, what's happening is

808
00:37:50,867 --> 00:37:54,638
we are releasing carbon
dioxide too quickly,

809
00:37:54,671 --> 00:37:57,508
and we're not allowing
these mechanisms

810
00:37:57,541 --> 00:38:00,411
to take up that
excess carbon dioxide.

811
00:38:00,444 --> 00:38:02,813
So if you look at the
percentage of carbon dioxide

812
00:38:02,846 --> 00:38:05,749
that's released per year
into the atmosphere,

813
00:38:05,782 --> 00:38:10,788
26% of that CO2 is
absorbed by oceans,

814
00:38:11,955 --> 00:38:15,859
28% by the land surface,
and the rest accumulates

815
00:38:15,892 --> 00:38:18,062
in the atmosphere.

816
00:38:18,095 --> 00:38:21,198
So this next video
animation, it's really cool,

817
00:38:21,231 --> 00:38:24,368
I love it because it
shows our Earth breathing,

818
00:38:24,401 --> 00:38:27,671
and what you see
over land, the green,

819
00:38:27,704 --> 00:38:29,206
means vegetation growth,

820
00:38:29,239 --> 00:38:32,743

and these are measurements
from a sensor called MODUS

821
00:38:32,776 --> 00:38:35,312
onboard NASA's AQUA satellite,

822
00:38:35,345 --> 00:38:38,215
and then what you're
seeing in the atmosphere,

823
00:38:38,248 --> 00:38:40,317
those are CO2 concentrations

824
00:38:40,350 --> 00:38:43,153
measured with AIRS,
also onboard AQUA.

825
00:38:43,186 --> 00:38:45,489
So it starts from January first,

826
00:38:45,522 --> 00:38:49,126
and around May, there's a peak

827
00:38:49,159 --> 00:38:51,528
in atmospheric CO2
concentrations,

828
00:38:51,561 --> 00:38:54,531
and then around
September, October,

829
00:38:54,564 --> 00:38:57,234
there's a minimum in
atmospheric CO2 concentrations,

830
00:38:57,267 --> 00:39:01,705
and what's driving this cycle
is primarily the vegetation

831

00:39:01,738 --> 00:39:03,273
in the northern high latitudes.

832
00:39:03,306 --> 00:39:06,143
So you can see that during
winter, there's no green

833
00:39:06,176 --> 00:39:07,745
in the northern high latitudes.

834
00:39:09,179 --> 00:39:11,181
The land surface freezes,
and there is no exchange

835
00:39:11,214 --> 00:39:13,684
between the vegetation
and the atmosphere.

836
00:39:13,717 --> 00:39:16,487
In the spring when
the thaw rolls around,

837
00:39:16,520 --> 00:39:19,523
vegetation turns on,
it's like a binary switch

838
00:39:19,556 --> 00:39:22,226
and it starts growing,
and it starts taking up

839
00:39:22,259 --> 00:39:24,728
huge amounts of CO2.

840
00:39:24,761 --> 00:39:28,198
Enough so that we can see
that the concentrations

841
00:39:28,231 --> 00:39:30,901
change dramatically.

842
00:39:30,934 --> 00:39:35,940
>> So vegetation, one of the
areas that there's vegetation

843
00:39:37,107 --> 00:39:39,676
is actually in the polar
region that is frozen

844
00:39:39,709 --> 00:39:42,780
that we now call permafrost,

845
00:39:42,813 --> 00:39:45,416
but it's not so
permanent anymore,

846
00:39:45,449 --> 00:39:47,485
and that's a concern
too, isn't it?

847
00:39:48,452 --> 00:39:49,953
>> Yes, absolutely.

848
00:39:49,986 --> 00:39:53,157
So permafrost are soils that
have been permanently frozen

849
00:39:53,190 --> 00:39:56,026
for at least two years,
anywhere from two years

850
00:39:56,059 --> 00:40:00,297
to decades to hundreds or
even thousands of years,

851
00:40:00,330 --> 00:40:02,766
and as you can see
in the figure here,

852
00:40:02,799 --> 00:40:05,536

these ares of
permafrost are primarily

853
00:40:05,569 --> 00:40:07,771
in the northern high latitudes,

854
00:40:07,804 --> 00:40:10,140
especially in Alaska,
Canada, and Russia.

855
00:40:10,173 --> 00:40:12,109
And so permafrost
is like a freezer,

856
00:40:12,142 --> 00:40:15,746
if you put food in your
freezer, it'll be preserved,

857
00:40:15,779 --> 00:40:18,649
but if your freezer breaks,
it'll start to heat up,

858
00:40:18,682 --> 00:40:22,085
and as it heats up, bacteria
starts eating your food,

859
00:40:22,118 --> 00:40:24,221
and the food starts to rot.

860
00:40:24,254 --> 00:40:28,559
And the methane and carbon
dioxide and other gases

861
00:40:28,592 --> 00:40:31,829
and chemicals and nasty
stuff will be produced.

862
00:40:31,862 --> 00:40:33,931
But permafrost is like that.

863
00:40:33,964 --> 00:40:38,302
So permafrost has vegetation
that's trapped in the soil.

864
00:40:38,335 --> 00:40:41,405
Vegetation that has just died
that could not decompose,

865
00:40:41,438 --> 00:40:43,407
and it just freezes.

866
00:40:43,440 --> 00:40:46,844
And as temperatures
increase above zero degrees,

867
00:40:46,877 --> 00:40:49,580
the permafrost starts to thaw,

868
00:40:49,613 --> 00:40:53,550
and that vegetation then
starts to decompose,

869
00:40:53,583 --> 00:40:57,054
and the carbon that's
part of that vegetation

870
00:40:57,087 --> 00:40:58,655
is released into the atmosphere

871
00:40:58,688 --> 00:41:01,024
as carbon dioxide or methane.

872
00:41:01,057 --> 00:41:05,662
And actually, estimates of
how much carbon is stored

873
00:41:05,695 --> 00:41:09,233
in the permafrost
is that it's about

874
00:41:09,266 --> 00:41:12,269
more than twice the
amount of carbon

875
00:41:12,302 --> 00:41:13,737
that's in the atmosphere.

876
00:41:13,770 --> 00:41:16,139
So it's a huge amount,
and it's very concerning.

877
00:41:16,172 --> 00:41:18,542
I do a lot of field
work in Alaska,

878
00:41:18,575 --> 00:41:21,812
and I see the evidence
of melting permafrost.

879
00:41:21,845 --> 00:41:23,847
You see that there are
these slanted trees

880
00:41:23,880 --> 00:41:26,583
because the infrastructure,
the ground just,

881
00:41:26,616 --> 00:41:29,553
as it melts, it
shifts the ground.

882
00:41:29,586 --> 00:41:30,988
And so you have
these slanted trees

883
00:41:31,021 --> 00:41:32,222
that are called drunken trees,

884

00:41:32,255 --> 00:41:34,024
and in some places
it's so prevalent

885
00:41:34,057 --> 00:41:36,260
that you have large
patches of forests

886
00:41:36,293 --> 00:41:38,428
where you see these
slanted trees,

887
00:41:38,461 --> 00:41:40,397
they're called drunken forests.

888
00:41:40,430 --> 00:41:43,133
So yes, it's very concerning.

889
00:41:43,166 --> 00:41:45,335
>> So if you think about it,

890
00:41:45,368 --> 00:41:46,937
step back in the
last two decades,

891
00:41:46,970 --> 00:41:49,540
it's the Industrial
Revolution is happening

892
00:41:49,573 --> 00:41:53,443
with all the CO2, and now
the question of what's coming

893
00:41:53,476 --> 00:41:57,047
with the release, potentially,
of the permafrost,

894
00:41:57,080 --> 00:41:59,516
will be upsetting
the cycle yet again,

895
00:41:59,549 --> 00:42:01,451
the carbon cycle, won't it?

896
00:42:01,484 --> 00:42:02,753
>> Absolutely, yeah.

897
00:42:02,786 --> 00:42:05,455
So it's a cycle
that intensifies.

898
00:42:05,488 --> 00:42:09,593
>> So Carmen, while we're
in the polar region,

899
00:42:09,626 --> 00:42:13,230
let's talk about also the
ice sheets and glaciers.

900
00:42:13,263 --> 00:42:14,765
What's happening there?

901
00:42:14,798 --> 00:42:15,966
Give us the latest on that.

902
00:42:15,999 --> 00:42:19,937
>> Yeah, so as we see
that it's warming,

903
00:42:19,970 --> 00:42:23,774
I mean, and not
only is permafrost
decreasing, it's melting,

904
00:42:23,807 --> 00:42:26,343
but actually when we
look at the ice sheets,

905
00:42:26,376 --> 00:42:29,012

and we do have quite
a lot of missions,

906
00:42:29,045 --> 00:42:31,214
airborne and satellite missions,

907
00:42:31,247 --> 00:42:35,185
that look at the ice sheets
and see how they're changing,

908
00:42:35,218 --> 00:42:38,355
and so one of the
missions that we have is

909
00:42:38,388 --> 00:42:41,291
a mission that I'm
working on a lot,

910
00:42:41,324 --> 00:42:42,626
it's called the GRACE mission,

911
00:42:42,659 --> 00:42:45,162
it's a gravity recovery
and climate experiment

912
00:42:45,195 --> 00:42:47,898
and we're gonna talk about
that a little bit more later,

913
00:42:47,931 --> 00:42:50,567
but what we see
here in this graph

914
00:42:50,600 --> 00:42:55,205
is what is happening to
Greenland since 2002,

915
00:42:55,238 --> 00:42:59,843
and what you see in these
colors is the white color

916
00:42:59,876 --> 00:43:02,479
is where nothing
much is happening,

917
00:43:02,512 --> 00:43:05,415
and then you see in
some of these areas,

918
00:43:05,448 --> 00:43:08,585
it's actually turning
red, and this is the areas

919
00:43:08,618 --> 00:43:13,090
where the Greenland ice sheet
is losing mass, water mass.

920
00:43:13,123 --> 00:43:15,459
It's melting and it's
going into the ocean,

921
00:43:15,492 --> 00:43:17,861
and when you look at the graph,

922
00:43:17,894 --> 00:43:21,698
that just shows you how much
it is doing that over time

923
00:43:21,731 --> 00:43:23,133
since 2002.

924
00:43:23,166 --> 00:43:26,603
And we've talked about
seasons, so season do a lot,

925
00:43:26,636 --> 00:43:29,272
they also happen in Greenland,

926
00:43:29,305 --> 00:43:33,076

so that's why you see this
up and down and this curve,

927
00:43:33,109 --> 00:43:35,779
so in the winter, there's snow,

928
00:43:35,812 --> 00:43:39,549
so snow increases the
ice mass of Greenland,

929
00:43:39,582 --> 00:43:42,252
but then in the
summer it's melting,

930
00:43:42,285 --> 00:43:46,523
and what you see also here
is it's steadily declining,

931
00:43:46,556 --> 00:43:51,562
so it's melting more than
snow gets onto the ice sheet.

932
00:43:52,996 --> 00:43:55,232
>> Yeah, I think I read
somewhere that the warming

933
00:43:55,265 --> 00:43:58,502
is almost twice as much
in the polar regions

934
00:43:58,535 --> 00:43:59,703
as other places.

935
00:43:59,736 --> 00:44:01,204
>> Yes.

936
00:44:01,237 --> 00:44:02,472
>> Blaine: Is that right?

937

00:44:02,505 --> 00:44:03,940
>> In the northern
polar regions,

938
00:44:03,973 --> 00:44:06,510
because it's amplifying
it in that region.

939
00:44:06,543 --> 00:44:10,313
But if we go to
Antarctica, in the south,

940
00:44:10,346 --> 00:44:12,382
it's slightly different,

941
00:44:12,415 --> 00:44:15,419
and it's a slightly different
environment in Greenland,

942
00:44:15,452 --> 00:44:18,455
the atmosphere is
usually warmer,

943
00:44:18,488 --> 00:44:22,325
in Antarctica it's
actually a lot colder,

944
00:44:22,358 --> 00:44:25,362
and I can say that,
I've been there actually

945
00:44:25,395 --> 00:44:26,863
on a research cruise,

946
00:44:26,896 --> 00:44:30,767
and I've been out there and
I was trying to take pictures

947
00:44:30,800 --> 00:44:32,903
of the environment

and of the icebergs,

948
00:44:32,936 --> 00:44:35,639
and as I was doing that
I took off my glove

949
00:44:35,672 --> 00:44:37,607
and I was trying to
push down the button,

950
00:44:37,640 --> 00:44:40,811
after five minutes I had
to stop with the pictures,

951
00:44:40,844 --> 00:44:42,245
that was it, it was too cold.

952
00:44:42,278 --> 00:44:46,683
But then what you see is
also happening in Antarctica,

953
00:44:46,716 --> 00:44:51,722
there's some regions that
also turn this reddish color,

954
00:44:52,889 --> 00:44:57,027
dark red, and this
is actually why...

955
00:44:58,194 --> 00:44:59,696
This is actually
because the ocean

956
00:44:59,729 --> 00:45:02,666
is affecting the ice
sheet at that point.

957
00:45:02,699 --> 00:45:07,771
It's warming too, and it's
melting the ice from underneath

958
00:45:09,172 --> 00:45:13,343
so more ice is flowing from
the land into the ocean.

959
00:45:14,544 --> 00:45:17,114
>> And let's talk
about the sea rise

960
00:45:17,147 --> 00:45:19,616
and what's happening
with the oceans too.

961
00:45:19,649 --> 00:45:22,652
>> Yes, so in the next picture,

962
00:45:22,685 --> 00:45:27,190
we just see again what it
really looks like, you know?

963
00:45:27,223 --> 00:45:29,860
We looked at the data,
but now here you see

964
00:45:29,893 --> 00:45:32,829
some actual imagery of glaciers

965
00:45:32,862 --> 00:45:35,766
and how they're
decreasing over time.

966
00:45:35,799 --> 00:45:40,804
And so that of course then
contributes to sea level rise,

967
00:45:42,906 --> 00:45:44,341
sea level change.

968
00:45:45,542 --> 00:45:47,944

And so in this animation
that Jason is showing us

969
00:45:47,977 --> 00:45:50,747
with the ice on Earth,

970
00:45:50,780 --> 00:45:54,451
is showing data from
another satellite mission,

971
00:45:54,484 --> 00:45:58,889
this satellite mission, the
first one was launched in 1992

972
00:45:58,922 --> 00:46:00,957
and was called Topex Poseidon,

973
00:46:00,990 --> 00:46:04,294
after that they called
it the JASON missions,

974
00:46:04,327 --> 00:46:06,062
and that's what
they're still called,

975
00:46:06,095 --> 00:46:10,033
we just recently
launched the third JASON,

976
00:46:10,066 --> 00:46:12,736
and what these
satellites are doing,

977
00:46:12,769 --> 00:46:16,206
they are called altimeters,

978
00:46:16,239 --> 00:46:18,608
so they have a radar beam

979

00:46:18,641 --> 00:46:20,644
that they send
down to the surface

980
00:46:20,677 --> 00:46:24,047
and it bounces off the
surface of the ocean,

981
00:46:24,080 --> 00:46:26,349
the satellite receives
that signal back

982
00:46:26,382 --> 00:46:30,587
and by flying over it and
doing that time after time

983
00:46:30,620 --> 00:46:35,626
we can actually see how sea
level is changing over time.

984
00:46:36,459 --> 00:46:37,928
>> It's very fine, I've heard,

985
00:46:37,961 --> 00:46:41,364
it's like the diameter of a
quarter or something, or less?

986
00:46:41,397 --> 00:46:42,632
>> Yes.

987
00:46:42,665 --> 00:46:43,800
>> Blaine: The
edge of a quarter?

988
00:46:43,833 --> 00:46:44,634
>> Yeah, yeah.

989
00:46:44,667 --> 00:46:47,237
So it's that precise.

990
00:46:47,270 --> 00:46:51,908
>> So you have the melting of
the glaciers and the ice sheets

991
00:46:51,941 --> 00:46:55,846
contributing, and the water,
because it's warming up anyway,

992
00:46:55,879 --> 00:46:57,080
it's rising.

993
00:46:57,113 --> 00:46:57,914
>> Carmen: Yes.

994
00:46:57,947 --> 00:46:59,149
Yeah, that's it.

995
00:46:59,182 --> 00:47:00,617
>> And so there's
a concern about

996
00:47:00,650 --> 00:47:04,120
what that will mean to
coastal areas everywhere.

997
00:47:04,153 --> 00:47:09,159
>> Yeah, yeah, exactly,
and what we see currently,

998
00:47:10,260 --> 00:47:14,731
we have about 3.3
millimeters per year,

999
00:47:15,932 --> 00:47:18,368
but over the time that
we have this mission,

1000
00:47:18,401 --> 00:47:21,605
the Topex missions,

it already accumulated

1001
00:47:21,638 --> 00:47:23,340
to a couple of inches,

1002
00:47:23,373 --> 00:47:28,378
and so if you would say that
continues over 100 years

1003
00:47:29,245 --> 00:47:30,413
just at that steady rate,

1004
00:47:30,446 --> 00:47:35,452
we already have a foot
of sea level rise,

1005
00:47:36,853 --> 00:47:38,889
and then when you add all the
other effects that we have

1006
00:47:38,922 --> 00:47:41,057
in the ocean and
along the coasts

1007
00:47:41,090 --> 00:47:44,895
with the tides come on top
of that and the storm surge,

1008
00:47:44,928 --> 00:47:47,230
so that just adds up.

1009
00:47:47,263 --> 00:47:51,434
And as you can also see
here in this animation,

1010
00:47:51,467 --> 00:47:54,037
sea level is not
flat everywhere.

1011

00:47:54,070 --> 00:47:56,640
So coasts are
impacted differently

1012
00:47:56,673 --> 00:47:58,975
just because the ocean is moving

1013
00:47:59,008 --> 00:48:02,479
and distributing the
heat in different ways.

1014
00:48:02,512 --> 00:48:05,582
So in this animation,
the blue colors

1015
00:48:05,615 --> 00:48:10,087
show where sea level
is lower than usual,

1016
00:48:12,355 --> 00:48:15,825
and the red to white
colors is where sea level

1017
00:48:15,858 --> 00:48:17,060
is higher than usual.

1018
00:48:17,093 --> 00:48:19,863
And what we have
here in the Pacific,

1019
00:48:19,896 --> 00:48:23,833
where you see like a lot of
this red and white developing,

1020
00:48:23,866 --> 00:48:27,070
that is what is called the
El Nino southern isolation,

1021
00:48:27,103 --> 00:48:30,974
and that's something that's

very much of interest

1022
00:48:31,007 --> 00:48:32,943
to us here in California,

1023
00:48:32,976 --> 00:48:37,080
because it impacts
our weather so much.

1024
00:48:37,113 --> 00:48:39,582
>> Now, I know
you work on GRACE,

1025
00:48:39,615 --> 00:48:43,153
and it's also one of
my favorite satellites

1026
00:48:43,186 --> 00:48:46,623
because it's so ingenious.

1027
00:48:46,656 --> 00:48:50,493
It's so counterintuitive
about how

1028
00:48:50,526 --> 00:48:53,029
you've come up with
these measurements.

1029
00:48:53,062 --> 00:48:55,198
Very clever what
you scientists do.

1030
00:48:55,231 --> 00:48:56,399
[laughs]

1031
00:48:56,432 --> 00:48:57,867
and I wonder if
you could describe,

1032

00:48:57,900 --> 00:48:59,769
let's just talk for a little
bit about the technology

1033
00:48:59,802 --> 00:49:01,538
of a NASA satellite,
this one in particular.

1034
00:49:01,571 --> 00:49:03,039
>> Yes, yeah.

1035
00:49:03,072 --> 00:49:06,743
And I fell in love with
GRACE when I wrote my thesis,

1036
00:49:06,776 --> 00:49:08,144
that was my first project,

1037
00:49:08,177 --> 00:49:10,313
and I've worked on the
project ever since,

1038
00:49:10,346 --> 00:49:12,716
and I liked it because
it was so unique,

1039
00:49:12,749 --> 00:49:14,651
because it's actually a mission

1040
00:49:14,684 --> 00:49:17,320
that doesn't look down
and scan the Earth,

1041
00:49:17,353 --> 00:49:19,155
it actually has two satellites

1042
00:49:19,188 --> 00:49:21,324
that follow each other in orbit

1043

00:49:21,357 --> 00:49:24,394
and measure each other.

1044
00:49:24,427 --> 00:49:28,932
So I actually brought two
GRACE satellites here,

1045
00:49:28,965 --> 00:49:30,734
which are just phones,

1046
00:49:30,767 --> 00:49:34,371
but they're very similar
to the GRACE satellites

1047
00:49:34,404 --> 00:49:38,274
in terms of like what type
of technology is in here.

1048
00:49:38,307 --> 00:49:40,643
So the phones, when
you flip them right,

1049
00:49:40,676 --> 00:49:42,946
then your screen flips too,

1050
00:49:42,979 --> 00:49:45,982
and so there is a little
instrument in here

1051
00:49:46,015 --> 00:49:47,784
that's called an accelerometer,

1052
00:49:47,817 --> 00:49:50,320
and the GRACE
satellites actually have

1053
00:49:50,353 --> 00:49:52,389
one on each spacecraft too,

1054

00:49:52,422 --> 00:49:56,359
just to see how the
satellites are moving.

1055
00:49:56,392 --> 00:49:58,928
And your phone also
has GPS, right?

1056
00:49:58,961 --> 00:50:00,363
You can navigate with it.

1057
00:50:00,396 --> 00:50:03,566
That's what the
satellites do too.

1058
00:50:03,599 --> 00:50:05,568
They're getting
located in space,

1059
00:50:05,601 --> 00:50:07,404
we want to know where they are,

1060
00:50:07,437 --> 00:50:10,373
and why do we want to
track them so precisely?

1061
00:50:10,406 --> 00:50:13,276
Because we want to
measure the gravity.

1062
00:50:13,309 --> 00:50:17,047
The gravitational pull
on the satellites.

1063
00:50:17,080 --> 00:50:20,450
So what these phones do not have

1064
00:50:20,483 --> 00:50:22,986
is the link between them.

1065
00:50:23,019 --> 00:50:27,724
So the GRACE satellites have
a microwave link between them

1066
00:50:27,757 --> 00:50:32,763
where they can see how
the distance between them

1067
00:50:33,496 --> 00:50:35,765
changes over time.

1068
00:50:35,798 --> 00:50:39,669
And so why would they
change the distance at all?

1069
00:50:39,702 --> 00:50:44,708
So if we imagine some kind
of like heavy thing on Earth,

1070
00:50:45,908 --> 00:50:47,343
and the satellites
are approaching,

1071
00:50:47,376 --> 00:50:51,481
and the first satellite
comes near that mass,

1072
00:50:51,514 --> 00:50:55,552
it's actually getting pulled
by that heavy thing on Earth,

1073
00:50:55,585 --> 00:50:59,522
and the distance between
the satellites increases.

1074
00:50:59,555 --> 00:51:02,559
So now they fly over,
and the second satellite

1075

00:51:02,592 --> 00:51:06,796
gets pulled too, so now the
distance decreases again.

1076
00:51:06,829 --> 00:51:08,565
The first one leaves then

1077
00:51:08,598 --> 00:51:10,934
and gets further
away from the mass

1078
00:51:10,967 --> 00:51:13,570
so the distance increases again.

1079
00:51:13,603 --> 00:51:16,640
So they bounce back and
forth with the gravity field.

1080
00:51:18,074 --> 00:51:21,010
>> And this can show us
not only about the oceans,

1081
00:51:21,043 --> 00:51:22,479
there's a...

1082
00:51:22,512 --> 00:51:24,047
I don't know if Jason
you can show it,

1083
00:51:24,080 --> 00:51:27,984
but the Amazon is an
area that amazes me,

1084
00:51:28,017 --> 00:51:30,287
you fly over it and
you see the seasons,

1085
00:51:31,754 --> 00:51:34,891
the difference there between
the monsoon seasons and not.

1086
00:51:34,924 --> 00:51:37,660
The amount of water, you can
measure the amount of water--

1087
00:51:37,693 --> 00:51:40,830
>> Exactly, and so when you
first think about gravity,

1088
00:51:40,863 --> 00:51:43,166
you think like oh, it's
not changing very much,

1089
00:51:43,199 --> 00:51:47,203
but it's actually
changing quite a bit

1090
00:51:47,236 --> 00:51:49,339
because there's a
lot of water moving,

1091
00:51:49,372 --> 00:51:51,908
and as you said,
here over the Amazon,

1092
00:51:51,941 --> 00:51:55,178
blue again is more water
and red is less water.

1093
00:51:55,211 --> 00:51:57,447
You see the dry
and rainy season,

1094
00:51:57,480 --> 00:52:00,183
how it's changing over time.

1095
00:52:00,216 --> 00:52:04,621
>> And let's bring
this back to California

1096
00:52:04,654 --> 00:52:07,423
and talk about what
we can see with GRACE.

1097
00:52:07,456 --> 00:52:09,359
>> Yeah, so now we can basically

1098
00:52:09,392 --> 00:52:11,794
weigh how the water is
changing everywhere,

1099
00:52:11,827 --> 00:52:15,832
and so we can do that
also for us in California,

1100
00:52:15,865 --> 00:52:20,871
and what we see here is
how our water table then

1101
00:52:21,971 --> 00:52:24,474
is developing over time.

1102
00:52:24,507 --> 00:52:29,513
So now GRACE can actually
not only look at the surface,

1103
00:52:31,047 --> 00:52:32,715
but can actually tell
us something about
the ground water,

1104
00:52:32,748 --> 00:52:35,151
and here in this
graph that's moving,

1105
00:52:35,184 --> 00:52:36,419
this line that's moving

1106
00:52:36,452 --> 00:52:39,622

we see in 2011 how
the drought starts

1107
00:52:39,655 --> 00:52:41,824
and what the GRACE
satellites see.

1108
00:52:41,857 --> 00:52:45,929
Like you pull a lot of
water from the ground.

1109
00:52:45,962 --> 00:52:50,099
And then just the,
yeah, from the aquifers,

1110
00:52:50,132 --> 00:52:53,736
and then in the end
we just saw this blip

1111
00:52:53,769 --> 00:52:56,940
that was the rain
we had last year,

1112
00:52:56,973 --> 00:53:00,510
where some of that
groundwater is recovering.

1113
00:53:00,543 --> 00:53:05,114
>> But that, recovering
from just one big rain

1114
00:53:05,147 --> 00:53:08,017
is not going to do it
with the aquifers, is it?

1115
00:53:08,050 --> 00:53:10,687
>> Exactly, so we still
need to be careful

1116
00:53:10,720 --> 00:53:13,523

with our water resources, yes.

1117
00:53:13,556 --> 00:53:15,725
>> And also as a result of this

1118
00:53:15,758 --> 00:53:19,195
we're seeing other impacts
in the bread basket

1119
00:53:19,228 --> 00:53:22,332
of the valley, the
California valley.

1120
00:53:22,365 --> 00:53:23,833
>> That's right.

1121
00:53:23,866 --> 00:53:28,071
So one of the effects of
overdrawing from aquifers

1122
00:53:30,006 --> 00:53:34,344
is that the ground can sink,
it's called subsidence,

1123
00:53:34,377 --> 00:53:36,713
and that's something
that we can measure

1124
00:53:36,746 --> 00:53:38,147
with satellites from space,

1125
00:53:38,180 --> 00:53:39,482
and this is an example of that.

1126
00:53:39,515 --> 00:53:41,484
This is in the central valley,

1127
00:53:41,517 --> 00:53:45,455
and we can measure

the subsidence

1128
00:53:45,488 --> 00:53:47,290
in the order of inches.

1129
00:53:47,323 --> 00:53:49,993
So what you're seeing here,

1130
00:53:50,026 --> 00:53:53,630
the blue areas are areas
where there's been no change,

1131
00:53:53,663 --> 00:53:58,301
but the cyan and the pink areas

1132
00:53:58,334 --> 00:54:00,336
are areas where there's
been some subsidence

1133
00:54:00,369 --> 00:54:02,672
on the order of 12 to 24 inches,

1134
00:54:02,705 --> 00:54:06,376
that's up to 61
centimeters, which is a lot,

1135
00:54:06,409 --> 00:54:10,146
and this is over a
very short time period,

1136
00:54:10,179 --> 00:54:11,915
it's within two years,

1137
00:54:13,316 --> 00:54:14,184
but it's right
during the drought

1138
00:54:15,818 --> 00:54:18,088
when there was a lot of

groundwater being withdrawn.

1139
00:54:20,122 --> 00:54:23,226
>> Blaine: And I think
there's some images too?

1140
00:54:23,259 --> 00:54:25,928
>> That's right, so
here's some examples.

1141
00:54:25,961 --> 00:54:29,532
The one the left is not recent,

1142
00:54:29,565 --> 00:54:32,035
but that really shows
you how much subsidence

1143
00:54:32,068 --> 00:54:35,271
has taken place in the
central valley of California.

1144
00:54:35,304 --> 00:54:37,874
That's actually a
pretty famous picture.

1145
00:54:37,907 --> 00:54:41,177
The person standing
on the bottom

1146
00:54:41,210 --> 00:54:43,713
has the year, which is 1977,

1147
00:54:43,746 --> 00:54:47,917
and at the top you
see it says 1925,

1148
00:54:47,950 --> 00:54:51,254
and there was nine
meters of subsidence

1149
00:54:51,287 --> 00:54:53,456
in that period of time,
that's about 30 feet.

1150
00:54:53,489 --> 00:54:56,292
And then the image on the
right is a bit more recent,

1151
00:54:56,325 --> 00:54:57,527
that's an oil well,

1152
00:54:57,560 --> 00:54:59,862
also in the central
valley of California,

1153
00:54:59,895 --> 00:55:03,066
and three years prior,

1154
00:55:03,099 --> 00:55:08,171
the oil well had been
painted with an orange paint,

1155
00:55:09,305 --> 00:55:11,307
and so within that
three year time frame,

1156
00:55:11,340 --> 00:55:14,844
the ground subsided
one and a half feet.

1157
00:55:16,912 --> 00:55:19,916
>> Another example
of how much change

1158
00:55:19,949 --> 00:55:22,285
is happening right
in front of our eyes.

1159
00:55:22,318 --> 00:55:24,354

>> Erika: Absolutely, yes.

1160
00:55:24,387 --> 00:55:29,392
>> You know, I'm also
interested in the question of,

1161
00:55:30,092 --> 00:55:32,595
with all this going on,

1162
00:55:33,896 --> 00:55:38,902
in how you decided to
get into these fields.

1163
00:55:40,069 --> 00:55:42,171
What made you decide
that you wanted to be

1164
00:55:42,204 --> 00:55:44,140
in this field of work?

1165
00:55:44,173 --> 00:55:45,141
I'm really curious.

1166
00:55:45,174 --> 00:55:46,509
>> Yeah?

1167
00:55:46,542 --> 00:55:47,977
>> Yeah.

1168
00:55:48,010 --> 00:55:51,814
>> So, well, I started off
actually studying mathematics,

1169
00:55:51,847 --> 00:55:56,786
so theoretical mathematics,
and I did my master's in math,

1170
00:55:56,819 --> 00:56:01,090
and then I thought okay, so

what am I gonna do with that?

1171
00:56:01,123 --> 00:56:05,194
Everything was so abstract
and nothing really applied,

1172
00:56:05,227 --> 00:56:07,363
and I really wanted
to do something that

1173
00:56:07,396 --> 00:56:12,402
relates to the world and
has an impact on people,

1174
00:56:13,736 --> 00:56:17,540
so for my PhD then I
decided to switch to physics

1175
00:56:19,208 --> 00:56:24,214
and study the Earth, and
this is how I started off

1176
00:56:25,381 --> 00:56:26,582
with working on
the GRACE mission,

1177
00:56:26,615 --> 00:56:29,018
and wrote my thesis about that,

1178
00:56:29,051 --> 00:56:32,722
and then came because
it's a JPL mission,

1179
00:56:32,755 --> 00:56:34,824
after that I came here.

1180
00:56:34,857 --> 00:56:36,359
>> Blaine: You
moved from Germany.

1181
00:56:36,392 --> 00:56:38,628
>> I moved from Germany to
the US to work here, yes.

1182
00:56:38,661 --> 00:56:41,898
>> Straight from a
student working on GRACE

1183
00:56:41,931 --> 00:56:43,466
and now you're here
as a scientist.

1184
00:56:43,499 --> 00:56:44,300
>> Yes.

1185
00:56:44,333 --> 00:56:45,234
>> That's great.

1186
00:56:45,267 --> 00:56:46,469
How about you, Erika?

1187
00:56:46,502 --> 00:56:49,472
>> So for me, I was born
and raised in Panama,

1188
00:56:49,505 --> 00:56:52,975
and it's a beautiful country
with an exuberant nature,

1189
00:56:53,008 --> 00:56:56,345
and I was fortunate that my
parents were very outdoors.

1190
00:56:56,378 --> 00:57:00,016
So from a very young
age, I was often outside

1191
00:57:00,049 --> 00:57:02,084
surrounded by nature.

1192
00:57:02,117 --> 00:57:07,190
And this developed a curiosity
and a love for nature.

1193
00:57:08,357 --> 00:57:09,559
And I also had a great
interest in technology

1194
00:57:09,592 --> 00:57:11,060
and I remember as
a child thinking

1195
00:57:11,093 --> 00:57:13,095
it'd be great when I grow up

1196
00:57:13,128 --> 00:57:16,933
if I can use technology
to study the environment.

1197
00:57:16,966 --> 00:57:19,735
So years later when
I was in university,

1198
00:57:19,768 --> 00:57:22,805
early in my bachelor's degree
I discovered this field

1199
00:57:22,838 --> 00:57:24,874
called remote sensing,
which includes

1200
00:57:24,907 --> 00:57:27,677
the observation of
Earth from space.

1201
00:57:27,710 --> 00:57:30,313
And so my master's and my PhD

1202

00:57:30,346 --> 00:57:32,381
were focused along those lines,

1203
00:57:32,414 --> 00:57:34,684
and then one thing led
to another in my life,

1204
00:57:34,717 --> 00:57:39,188
and now I observe Earth
from space here at JPL,

1205
00:57:39,221 --> 00:57:40,990
and I'm loving it.

1206
00:57:41,023 --> 00:57:41,791
[audience laughing]

1207
00:57:41,824 --> 00:57:43,192
>> That's great.

1208
00:57:43,225 --> 00:57:45,061
And when you look ahead, I mean,

1209
00:57:45,094 --> 00:57:46,329
there are a lot of
challenges facing us,

1210
00:57:46,362 --> 00:57:50,766
and what do you say to
people that, you know,

1211
00:57:50,799 --> 00:57:55,538
some of this information's
sobering, this is challenging,

1212
00:57:55,571 --> 00:57:59,041
and how do you talk to
people about the future?

1213

00:57:59,074 --> 00:58:00,476
And how do we...

1214
00:58:00,509 --> 00:58:04,080
Sometimes scientists talk about
mitigation and adaptation.

1215
00:58:04,113 --> 00:58:06,449
What do you say?

1216
00:58:06,482 --> 00:58:08,084
How do you look forward?

1217
00:58:08,117 --> 00:58:09,785
>> Yeah, so that's
a great point,

1218
00:58:09,818 --> 00:58:13,489
and I think it's important
for people to understand

1219
00:58:13,522 --> 00:58:15,458
what's going on with our planet.

1220
00:58:15,491 --> 00:58:20,497
And the information that we
get here through satellites

1221
00:58:21,764 --> 00:58:24,233
and what we're understanding
about our Earth

1222
00:58:24,266 --> 00:58:26,168
is very important.

1223
00:58:26,201 --> 00:58:31,207
So I think the most important
thing is we can make a change.

1224

00:58:32,308 --> 00:58:34,744
And we can all
make little changes

1225
00:58:34,777 --> 00:58:37,313
that are beneficial
for our environment.

1226
00:58:37,346 --> 00:58:39,081
Whatever your stance is,

1227
00:58:39,114 --> 00:58:41,851
I think we should all take
care of our environment,

1228
00:58:41,884 --> 00:58:46,722
because a healthy environment
is a healthy human being.

1229
00:58:46,755 --> 00:58:48,525
>> And I know you
like this also,

1230
00:58:49,825 --> 00:58:53,629
this image of the
Earth is in our hands.

1231
00:58:53,662 --> 00:58:55,031
>> Yes.

1232
00:58:55,064 --> 00:58:58,100
Yes, I mean, it's
beautiful because it shows

1233
00:58:58,133 --> 00:58:59,835
the fragility of our planet,

1234
00:58:59,868 --> 00:59:02,271
and we don't have
infinite resources,

1235
00:59:02,304 --> 00:59:04,274
we really do have
to take care of it.

1236
00:59:05,274 --> 00:59:06,676
>> And Carmen, how about you?

1237
00:59:06,709 --> 00:59:08,444
How do you talk to people?

1238
00:59:08,477 --> 00:59:10,279
What do you say to folks?

1239
00:59:10,312 --> 00:59:13,816
>> Yes, I mean,
so being at NASA,

1240
00:59:13,849 --> 00:59:18,855
having the opportunity to look
at all these observations,

1241
00:59:19,588 --> 00:59:22,224
it's just a great thing,

1242
00:59:22,257 --> 00:59:25,428
and I think we contribute
a lot to society

1243
00:59:25,461 --> 00:59:27,930
just by doing these measurements

1244
00:59:27,963 --> 00:59:29,765
and providing this information,

1245
00:59:29,798 --> 00:59:32,802
and I hope people
were able to see that,

1246
00:59:32,835 --> 00:59:36,305
I mean, we're able to
study these remote areas

1247
00:59:36,338 --> 00:59:39,508
that have so much
impact on our lives,

1248
00:59:39,541 --> 00:59:43,980
and so yeah, we have a
great opportunity here,

1249
00:59:44,013 --> 00:59:47,683
and that's what I love
about working here,

1250
00:59:47,716 --> 00:59:51,454
that we do make some impact.

1251
00:59:51,487 --> 00:59:54,557
>> Well, I take great
comfort in knowing

1252
00:59:54,590 --> 00:59:56,959
that you two are doing,
and all your colleagues

1253
00:59:56,992 --> 00:59:59,061
are doing what you do,

1254
00:59:59,094 --> 01:00:00,696
and I just want to thank
you so much for what you do

1255
01:00:00,729 --> 01:00:01,897
and for being here tonight.

1256
01:00:01,930 --> 01:00:02,832
Thank you.

1257
01:00:02,865 --> 01:00:04,200
>> Thank you very much.

1258
01:00:04,233 --> 01:00:07,403
[audience applauding]

1259
01:00:16,645 --> 01:00:20,583
>> You know, we began
this evening talking
about Explorer 1,

1260
01:00:20,616 --> 01:00:23,386
a satellite 60 years
ago that gave us

1261
01:00:23,419 --> 01:00:27,590
the very first space
science discovery,

1262
01:00:27,623 --> 01:00:29,191
and helped answer the question

1263
01:00:29,224 --> 01:00:33,162
of why we live in
such a special place,

1264
01:00:33,195 --> 01:00:35,365
in such special circumstances,

1265
01:00:36,565 --> 01:00:40,636
protected by the Van
Allen radiation belts,

1266
01:00:40,669 --> 01:00:42,271
that we can enjoy life here.

1267
01:00:43,472 --> 01:00:45,742
And we've progressed

to talking about,

1268
01:00:46,842 --> 01:00:48,377
with all this technology
that we now have

1269
01:00:48,410 --> 01:00:51,247
and this fleet of science
instruments that NASA has,

1270
01:00:51,280 --> 01:00:55,251
to understand a very very
changing world that we live in.

1271
01:00:56,552 --> 01:00:59,555
And as we mentioned
a moment ago,

1272
01:00:59,588 --> 01:01:03,592
for scientists and
others involved in this,

1273
01:01:03,625 --> 01:01:07,063
there's mitigation,

1274
01:01:07,096 --> 01:01:10,566
which means changing
your behavior

1275
01:01:10,599 --> 01:01:15,438
to try to address what is
happening to our world,

1276
01:01:15,471 --> 01:01:17,940
and there's adaptation,

1277
01:01:17,973 --> 01:01:21,577
the fact that we will
face the environment,

1278
01:01:21,610 --> 01:01:26,149
a different environment, and
find ways of adapting to it.

1279
01:01:27,316 --> 01:01:32,188
And through all that, we
have NASA to inform us

1280
01:01:33,388 --> 01:01:36,759
as to what information
we need to know

1281
01:01:36,792 --> 01:01:39,228
in order to do those things.

1282
01:01:39,261 --> 01:01:43,099
And I think that is
so comforting to me,

1283
01:01:43,132 --> 01:01:47,636
because even though we have
NASA as a space agency,

1284
01:01:47,669 --> 01:01:52,208
it's still, this is the only
planet we know we can live on.

1285
01:01:53,208 --> 01:01:55,478
Thank you so much for coming,

1286
01:01:55,511 --> 01:01:57,480
we enjoyed it very
much, thank you.

1287
01:01:57,513 --> 01:02:00,616
[audience applauding]

1288
01:02:07,489 --> 01:02:08,691
And thank you, Jason.

1289
01:02:08,724 --> 01:02:10,693
Thank you Dr. Conway.

1290
01:02:10,726 --> 01:02:13,896
[audience applauding]

1291
01:02:18,167 --> 01:02:20,603
And one final thought.

1292
01:02:22,004 --> 01:02:25,274
Run, don't walk,
when you get home,

1293
01:02:25,307 --> 01:02:28,978
not only to these great
software applications

1294
01:02:29,011 --> 01:02:30,579
Jason has told us about,

1295
01:02:30,612 --> 01:02:34,016
but go to our NASA climate site,

1296
01:02:34,049 --> 01:02:37,987
it's www.climate.nasa.gov,

1297
01:02:38,020 --> 01:02:41,924
and there you will find the
vital signs of our Earth

1298
01:02:41,957 --> 01:02:45,528
that you can check like your
blood pressure every single day

1299
01:02:45,561 --> 01:02:48,931
to know what's going
on on our planet.

1300
01:02:48,964 --> 01:02:50,966
Again, thank you very much.

1301
01:02:50,999 --> 01:02:53,402
Those who are here
on Ustream, hold on,

1302
01:02:53,435 --> 01:02:56,605
we'll be back in just a moment
to answer your questions.

1303
01:02:56,638 --> 01:02:57,840
Thank you.

1304
01:02:57,873 --> 01:03:00,977
[audience applauding]

1305
01:03:06,215 --> 01:03:07,049
Okay.

1306
01:03:08,784 --> 01:03:10,853
Again, for those who
weren't here earlier,

1307
01:03:10,886 --> 01:03:13,589
your questions we'll
be happy to answer now.

1308
01:03:18,360 --> 01:03:20,529
If you have a question,
please come up to the mic,

1309
01:03:20,562 --> 01:03:22,265
which is right
here in the center.

1310
01:03:23,565 --> 01:03:25,968
[chattering]

1311
01:04:01,904 --> 01:04:03,139
Okay, why don't we start.

1312
01:04:04,072 --> 01:04:04,907
>> Okay.

1313
01:04:09,177 --> 01:04:13,749
I have a little story to
tell related to this picture.

1314
01:04:13,782 --> 01:04:14,783
If you allow me.

1315
01:04:17,052 --> 01:04:21,224
I was a little boy in
the city of Cairo, Egypt,

1316
01:04:22,557 --> 01:04:27,396
when the Russians and the
American sent those satellites,

1317
01:04:29,998 --> 01:04:34,770
and in Boy Scouts, they
were telling us about

1318
01:04:34,803 --> 01:04:38,174
the orbits and the artificial
satellites and so on.

1319
01:04:39,508 --> 01:04:44,113
And I went to the
American embassy in Cairo,

1320
01:04:45,547 --> 01:04:49,719
and saw this picture, and
I told them what it is,

1321
01:04:51,186 --> 01:04:54,957
and they said oh, this is

Jet Propulsion Laboratory.

1322
01:04:54,990 --> 01:04:55,791
Where?

1323
01:04:55,824 --> 01:04:58,093
In Pasadena, California.

1324
01:04:58,126 --> 01:05:03,065
Okay, and then I asked my
teacher in junior high school,

1325
01:05:03,799 --> 01:05:05,501
and he said well...

1326
01:05:05,534 --> 01:05:08,470
I told him I want to work at
the Jet Propulsion Laboratory.

1327
01:05:08,503 --> 01:05:12,241
He said you have to have a
PhD in order to get there.

1328
01:05:12,274 --> 01:05:14,877
I went back and
asked what is a PhD?

1329
01:05:14,910 --> 01:05:18,647
And then where is
Pasadena, California?

1330
01:05:18,680 --> 01:05:21,450
I took the map,
went to my parents,

1331
01:05:21,483 --> 01:05:24,353
I said I'm going to work at
the Jet Propulsion Laboratory,

1332

01:05:24,386 --> 01:05:26,856
and I'm going to have a PhD.

1333
01:05:27,923 --> 01:05:30,459
About a decade and a half later,

1334
01:05:31,560 --> 01:05:35,631
I came to the Jet
Propulsion Laboratory,

1335
01:05:35,664 --> 01:05:40,670
after having studied
jet propulsion in
Cairo and in Germany,

1336
01:05:43,672 --> 01:05:45,474
and in the United States.

1337
01:05:46,875 --> 01:05:51,580
The day I started here, the
moment I looked at this picture,

1338
01:05:52,714 --> 01:05:56,051
starting at JPL, I could
not believe my eyes,

1339
01:05:56,084 --> 01:05:59,021
that I'm really here.

1340
01:05:59,054 --> 01:06:01,657
The moment I met
also Dr. Pickering,

1341
01:06:02,958 --> 01:06:05,594
it's like meeting God.

1342
01:06:05,627 --> 01:06:07,029
[audience laughing]

1343

01:06:07,062 --> 01:06:09,198
And I told him the story,

1344
01:06:10,365 --> 01:06:13,969
and I said, well thank
you for inspiring

1345
01:06:14,002 --> 01:06:16,505
a little boy from Cairo,

1346
01:06:16,538 --> 01:06:18,474
where I was looking at
the sky to try to see

1347
01:06:18,507 --> 01:06:21,110
those artificial satellites,

1348
01:06:21,143 --> 01:06:23,445
and I was inspired.

1349
01:06:23,478 --> 01:06:28,217
Okay, I got my PhD
in jet propulsion,

1350
01:06:28,250 --> 01:06:33,255
and I was introduced
to Dr. Von Brown

1351
01:06:34,122 --> 01:06:36,291
by my professors in Germany.

1352
01:06:36,324 --> 01:06:40,329
Dr. Herbert, Professor
Herbert [mumbling]

1353
01:06:42,964 --> 01:06:45,567
And then I work here
in the United States

1354

01:06:45,600 --> 01:06:50,606
with a student of
Von Karman, himself.

1355
01:06:51,773 --> 01:06:55,511
I mean, here I am,
60 years later,

1356
01:06:55,544 --> 01:06:58,580
after you know,
looking at the sky.

1357
01:06:58,613 --> 01:07:02,184
By the way, I never saw
this artificial satellite

1358
01:07:02,217 --> 01:07:03,252
[audience laughing]

1359
01:07:03,285 --> 01:07:04,820
when I was a little boy.

1360
01:07:04,853 --> 01:07:08,791
And 60 years later, I'm,
you know, celebrating.

1361
01:07:08,824 --> 01:07:11,160
>> Blaine: Thank you for sharing
that, it was a great story.

1362
01:07:11,193 --> 01:07:13,028
[audience applauding]

1363
01:07:13,061 --> 01:07:13,862
Great story.

1364
01:07:13,895 --> 01:07:14,963
All right.

1365

01:07:14,996 --> 01:07:16,598
Thank you sir.

1366
01:07:16,631 --> 01:07:17,466
All right.

1367
01:07:18,433 --> 01:07:19,435
>> Everybody.

1368
01:07:20,569 --> 01:07:21,670
>> Blaine: Thank you.

1369
01:07:21,703 --> 01:07:22,772
Next question, sir.

1370
01:07:24,206 --> 01:07:25,474
>> Well that's a
hard act to follow,

1371
01:07:25,507 --> 01:07:29,278
but a very specific
comment/question.

1372
01:07:30,612 --> 01:07:34,817
In the discussion
of global warming

1373
01:07:34,850 --> 01:07:36,385
and climate change and the CO2,

1374
01:07:39,588 --> 01:07:43,425
I think there's a very
important measurement

1375
01:07:43,458 --> 01:07:47,796
that is rarely discussed
that I think is a mistake,

1376
01:07:47,829 --> 01:07:52,568

and that is the isotopic
signature of the CO2,

1377
01:07:52,601 --> 01:07:56,371
and the fact that the fossil
fuel has been buried so long,

1378
01:07:56,404 --> 01:07:59,441
it has no carbon 14,
it's all decayed.

1379
01:07:59,474 --> 01:08:03,812
And so you can, by
measuring the percentage

1380
01:08:03,845 --> 01:08:08,918
of the CO2 in the atmosphere
that does have carbon 14,

1381
01:08:10,051 --> 01:08:13,589
which is created only
in surface carbon,

1382
01:08:13,622 --> 01:08:18,494
you can prove that it's
not coming from the ocean,

1383
01:08:18,527 --> 01:08:21,430
that the rise in CO2
is not temporary,

1384
01:08:21,463 --> 01:08:24,233
that it's coming from
fossil fuel mostly,

1385
01:08:24,266 --> 01:08:26,635
and from other human activities.

1386
01:08:26,668 --> 01:08:28,337
>> That's known as

the Suess Effect.

1387
01:08:28,370 --> 01:08:30,439
Yeah, the Suess Effect, we just,

1388
01:08:30,472 --> 01:08:32,941
it's not work done
at JPL, that's all.

1389
01:08:32,974 --> 01:08:34,443
[laughs]

1390
01:08:34,476 --> 01:08:35,944
>> Questioner: But it's
rarely, rarely mentioned.

1391
01:08:35,977 --> 01:08:38,013
>> It's rarely mentioned,
it's also really hard to do,

1392
01:08:38,046 --> 01:08:41,350
and so I teach an introduction
to climate policy class

1393
01:08:41,383 --> 01:08:43,051
almost nobody knows about,

1394
01:08:43,084 --> 01:08:46,488
and I do teach it
to my students, but
it's very difficult

1395
01:08:46,521 --> 01:08:48,657
to get them to understand
the measurement,

1396
01:08:48,690 --> 01:08:50,726
and that might be why too,

1397

01:08:50,759 --> 01:08:52,561
it's so rarely mentioned.

1398
01:08:52,594 --> 01:08:53,429
But thank you.

1399
01:08:55,463 --> 01:08:59,034
>> We also have questions
coming in from our Ustreamers,

1400
01:08:59,067 --> 01:09:01,737
and our YouTubers,

1401
01:09:01,770 --> 01:09:05,207
and one here is SpaceTV asks

1402
01:09:05,240 --> 01:09:08,377
is there any technical
program out there

1403
01:09:08,410 --> 01:09:11,113
that's designed to remove
carbon from the atmosphere?

1404
01:09:14,382 --> 01:09:15,651
>> Do you want me to say?

1405
01:09:15,684 --> 01:09:17,452
[audience laughing]

1406
01:09:17,485 --> 01:09:19,087
Okay.

1407
01:09:19,120 --> 01:09:21,523
So lots of ideas.

1408
01:09:21,556 --> 01:09:25,527
One for example is that we
could remove carbon dioxide

1409
01:09:25,560 --> 01:09:29,097
from the atmosphere by dumping
more iron into the oceans,

1410
01:09:29,130 --> 01:09:31,133
and sequestering it that way.

1411
01:09:31,166 --> 01:09:35,404
Problem then is you create
low oxygen zones in the ocean,

1412
01:09:35,437 --> 01:09:37,739
which is bad for sea creatures.

1413
01:09:37,772 --> 01:09:40,742
There are technological ideas

1414
01:09:40,775 --> 01:09:44,479
about pulling CO2 out of the air

1415
01:09:44,512 --> 01:09:46,949
and then turning it
into something else.

1416
01:09:46,982 --> 01:09:48,450
Maybe burying it in the ground,

1417
01:09:48,483 --> 01:09:50,786
but maybe turning it into
some sort of a product.

1418
01:09:51,953 --> 01:09:54,656
The one that probably
gets the most attention

1419
01:09:54,689 --> 01:09:58,627
when there's any
attention is the idea of

1420
01:09:58,660 --> 01:10:01,363
growing crops, burning
them in power plants

1421
01:10:01,396 --> 01:10:03,832
and then sequestering the
CO2 from the power plant.

1422
01:10:03,865 --> 01:10:07,436
That one's called bioenergy
carbon capture and storage.

1423
01:10:07,469 --> 01:10:10,706
So there are ideas, but no
one actually is doing it yet

1424
01:10:10,739 --> 01:10:12,207
on any kind of scale,

1425
01:10:12,240 --> 01:10:15,344
and the economics are really
difficult to see working out.

1426
01:10:16,578 --> 01:10:18,413
>> And question here.

1427
01:10:18,446 --> 01:10:20,382
>> Dr. Gene Nelson.

1428
01:10:20,415 --> 01:10:22,851
First a little comment about
that previous question.

1429
01:10:22,884 --> 01:10:26,088
Dr. James Hanson, a
former NASA scientist,

1430
01:10:26,121 --> 01:10:28,257

recognized a very simple
low tech solution,

1431
01:10:28,290 --> 01:10:30,192
which is called reforestation.

1432
01:10:31,626 --> 01:10:34,529
Anyway, I'm gonna go on to
my question, and that is,

1433
01:10:34,562 --> 01:10:39,568
this is more related to the
history of space exploration,

1434
01:10:40,769 --> 01:10:44,406
and I wanted to find
out what your take is

1435
01:10:44,439 --> 01:10:49,445
as to the reason why
President Eisenhower said,

1436
01:10:51,846 --> 01:10:56,218
when he found out that
the Army could in fact

1437
01:10:56,251 --> 01:11:01,190
put Explorer 1 in
orbit in late 1956,

1438
01:11:02,057 --> 01:11:03,458
why did Eisenhower say no?

1439
01:11:03,491 --> 01:11:05,127
Do you know the real reason?

1440
01:11:05,160 --> 01:11:09,097
Because I'll give you a hint,
it's another space program

1441
01:11:09,130 --> 01:11:11,800
that has its strong
roots in California.

1442
01:11:11,833 --> 01:11:15,904
So let's see what
your take is on this.

1443
01:11:15,937 --> 01:11:19,808
Another space program
based in California.

1444
01:11:19,841 --> 01:11:21,477
I'll give you another hint.

1445
01:11:22,911 --> 01:11:25,347
All the launches were from
Van Den Berg Air Force Base,

1446
01:11:25,380 --> 01:11:26,382
right close by here.

1447
01:11:27,816 --> 01:11:30,552
>> Well, I assume you mean
the Air Force program, but,

1448
01:11:32,287 --> 01:11:36,391
there's a committee
that was put together

1449
01:11:36,424 --> 01:11:39,961
starring Jack James from
JPL and some others,

1450
01:11:39,994 --> 01:11:42,064
as well as a lot of
independent scientists

1451
01:11:42,097 --> 01:11:46,601

to choose which of the
competing proposals

1452
01:11:46,634 --> 01:11:49,404
should be the IGY
launch vehicle.

1453
01:11:49,437 --> 01:11:52,808
And that committee
chose Vanguard,

1454
01:11:52,841 --> 01:11:56,011
not the Eisenhower White House.

1455
01:11:56,044 --> 01:11:57,846
So if that's the incident
you're referring to,

1456
01:11:57,879 --> 01:11:59,247
that committee made the choice

1457
01:11:59,280 --> 01:12:00,883
and the White House blessed it.

1458
01:12:02,050 --> 01:12:03,919
The scientists on the committee

1459
01:12:03,952 --> 01:12:07,656
thought they were getting
more payload out of Vanguard,

1460
01:12:07,689 --> 01:12:10,592
and I think, and Jack
James in the memos he wrote

1461
01:12:10,625 --> 01:12:14,896
said they were really
de-emphasizing the difficulty

1462

01:12:14,929 --> 01:12:19,134
of making a launch
vehicle that was reliable.

1463
01:12:20,335 --> 01:12:22,337
>> As was proved on
December the fifth.

1464
01:12:22,370 --> 01:12:25,607
>> Well, as was proved on,
yeah, by the Vanguard attempt,

1465
01:12:25,640 --> 01:12:28,343
and which the JPL
Von Brown folks knew

1466
01:12:28,376 --> 01:12:31,446
because you know, half
the launches failed.

1467
01:12:31,479 --> 01:12:33,682
It was that bad in
the early Space Age,

1468
01:12:33,715 --> 01:12:36,752
and the earlier you
get, the worse it was.

1469
01:12:36,785 --> 01:12:41,790
Really making rockets reliable
was a huge achievement,

1470
01:12:42,957 --> 01:12:44,760
and we spent, we
the United States,

1471
01:12:44,793 --> 01:12:47,229
forget about the German
investment during World War II,

1472

01:12:47,262 --> 01:12:50,132
we the United States
spent in the 1950s alone

1473
01:12:50,165 --> 01:12:55,170
about a quarter of a
trillion current dollars

1474
01:12:55,937 --> 01:12:57,806
developing rockets.

1475
01:12:57,839 --> 01:13:00,642
It was an enormous investment
for that period of time.

1476
01:13:00,675 --> 01:13:05,013
>> I agree, but the
Corona program really is

1477
01:13:05,046 --> 01:13:09,384
a fascinating story, and
unfortunately it was classified

1478
01:13:09,417 --> 01:13:13,455
until 1993, and really that
story needs to be told,

1479
01:13:13,488 --> 01:13:15,924
so that was my little
plug for Corona.

1480
01:13:15,957 --> 01:13:17,692
>> Oh, you were
talking about Corona,

1481
01:13:17,725 --> 01:13:19,561
Dwayne Day has been
the historian of that.

1482
01:13:19,594 --> 01:13:21,530

>> Questioner: Oh yes
yes, I've talked to Dwayne

1483
01:13:21,563 --> 01:13:23,298
when I was in DC, so.

1484
01:13:23,331 --> 01:13:24,766
>> Yeah.

1485
01:13:24,799 --> 01:13:25,801
>> Some of the Corona's there
in the early space museum

1486
01:13:25,834 --> 01:13:28,403
in Washington.

1487
01:13:28,436 --> 01:13:29,337
Thank you sir.

1488
01:13:29,370 --> 01:13:30,906
We have a question Milan asks,

1489
01:13:30,939 --> 01:13:34,443
I don't know if it's Milan,
Italy or not, maybe so.

1490
01:13:34,476 --> 01:13:37,913
What explorations are planned
for the near and far future?

1491
01:13:37,946 --> 01:13:40,882
Maybe we could start
with GRACE, the followup.

1492
01:13:40,915 --> 01:13:42,083
>> Yeah, exactly.

1493
01:13:42,116 --> 01:13:44,853
So I'm very excited

because we have,

1494
01:13:44,886 --> 01:13:49,858
after we had 15 years of
GRACE from 2002 to now,

1495
01:13:49,891 --> 01:13:53,929
we just ended the mission
because of its long lifetime,

1496
01:13:53,962 --> 01:13:56,932
and so we're decommissioning
those satellites,

1497
01:13:56,965 --> 01:13:58,633
but we want to continue
the measurement

1498
01:13:58,666 --> 01:14:00,769
because we talked about climate

1499
01:14:02,170 --> 01:14:04,940
and how it's evolving over time
over these long time scales.

1500
01:14:04,973 --> 01:14:09,978
So NASA has decided to
again work with the Germans

1501
01:14:11,179 --> 01:14:13,648
on a new couple of
satellites called

1502
01:14:13,681 --> 01:14:15,584
the GRACE follow on mission,

1503
01:14:15,617 --> 01:14:19,287
and those two
satellites are actually

1504
01:14:19,320 --> 01:14:22,891
ready to go up in
space right now,

1505
01:14:22,924 --> 01:14:26,361
they're at the Van Den
Berg Air Force field

1506
01:14:26,394 --> 01:14:29,965
to be launched later this year.

1507
01:14:29,998 --> 01:14:31,066
>> All right.

1508
01:14:31,099 --> 01:14:32,501
Any others?

1509
01:14:32,534 --> 01:14:35,537
>> Yeah, so I can speak to
some of the terrestrial focused

1510
01:14:35,570 --> 01:14:39,608
satellites, or instruments
that will be launched shortly.

1511
01:14:39,641 --> 01:14:42,511
First of all, there are
gonna be two instruments

1512
01:14:42,544 --> 01:14:44,112
on the space station
launched this year.

1513
01:14:44,145 --> 01:14:45,680
One is called Echo Stress,

1514
01:14:45,713 --> 01:14:48,250
and that measures
evapotranspiration,

1515
01:14:48,283 --> 01:14:52,954
and the other one is called
OCO3, and that measures

1516
01:14:52,987 --> 01:14:56,091
CO2 concentrations
in the atmosphere,

1517
01:14:56,124 --> 01:14:57,826
and it's also looking
at something called

1518
01:14:57,859 --> 01:15:01,496
solar induced fluorescence,
which is an indicator of

1519
01:15:01,529 --> 01:15:04,733
photosynthetic
activity of vegetation.

1520
01:15:04,766 --> 01:15:08,436
Then in a couple years, three
or four years down the road,

1521
01:15:08,469 --> 01:15:12,641
there's a radar
satellite called NISAR,

1522
01:15:12,674 --> 01:15:15,544
and that's together with
the Indian Space Agency,

1523
01:15:16,945 --> 01:15:20,181
and then around the same time
frame there's another one

1524
01:15:20,214 --> 01:15:23,852
called HYSPERI, and that's
a hyper spectral sensor.

1525
01:15:23,885 --> 01:15:27,055
By the way, two things that
are really important here.

1526
01:15:27,088 --> 01:15:30,659
International collaboration is
really something fundamental

1527
01:15:30,692 --> 01:15:32,093
in the work that we do.

1528
01:15:32,126 --> 01:15:34,195
And as you heard Carmen
talk about GRACE,

1529
01:15:34,228 --> 01:15:37,232
that's a joint collaboration
between JPL and Germany,

1530
01:15:37,265 --> 01:15:40,468
NISAR is with the
Indian Space Agency

1531
01:15:40,501 --> 01:15:42,337
and we've had many
other missions together

1532
01:15:42,370 --> 01:15:44,439
with other space agencies.

1533
01:15:44,472 --> 01:15:47,943
And the second thing is that
NASA has a free data policy,

1534
01:15:47,976 --> 01:15:49,678
so all of the data
that's collected

1535

01:15:49,711 --> 01:15:52,581
by NASA satellites or
instruments is free.

1536
01:15:52,614 --> 01:15:55,784
You can download it, as
well as data collected

1537
01:15:55,817 --> 01:15:58,921
by NASA instruments,
airborne instruments, sorry.

1538
01:15:59,954 --> 01:16:01,356
>> Sir.

1539
01:16:01,389 --> 01:16:04,059
>> Yeah, well first,
Jason, is the Eyes program

1540
01:16:04,092 --> 01:16:06,027
available for Linux,
or is it only available

1541
01:16:06,060 --> 01:16:07,362
for insecure platforms?

1542
01:16:07,395 --> 01:16:09,664
[audience laughing]

1543
01:16:09,697 --> 01:16:12,167
>> Yes, I've gotten
that question before.

1544
01:16:12,200 --> 01:16:14,936
We are developing
Linux right now,

1545
01:16:14,969 --> 01:16:16,905
but we don't have it currently.

1546
01:16:16,938 --> 01:16:18,540
But we're also gonna
move to the web,

1547
01:16:18,573 --> 01:16:20,475
in which case it'll
be fine for Linux.

1548
01:16:21,609 --> 01:16:24,145
>> I remember in 1968 or so

1549
01:16:24,178 --> 01:16:27,082
when Bill Shogrin and
his colleague Miller,

1550
01:16:27,115 --> 01:16:28,950
whose first name I've forgotten,

1551
01:16:28,983 --> 01:16:30,852
discovered mass
concentrations on the moon

1552
01:16:30,885 --> 01:16:34,723
using orbital variations
from a lunar orbiter.

1553
01:16:34,756 --> 01:16:39,761
And I think between that
discovery and the time of GRACE,

1554
01:16:40,828 --> 01:16:43,465
which originally
Bill Shogrin proposed

1555
01:16:43,498 --> 01:16:44,966
shortly after lunar orbiter,

1556
01:16:44,999 --> 01:16:48,103
I think GRACE and KOBI kind

of competed neck and neck

1557
01:16:48,136 --> 01:16:49,938
for the most canceled mission.

1558
01:16:51,372 --> 01:16:54,442
I think KOBI was approved and
canceled more than 70 times.

1559
01:16:54,475 --> 01:16:57,178
I don't know if GRACE has
broken that record or not.

1560
01:16:57,211 --> 01:16:58,580
[laughs]

1561
01:16:58,613 --> 01:17:00,682
>> Yeah, I mean, that
always happens, right?

1562
01:17:00,715 --> 01:17:03,852
That these concepts exist
for a long long time

1563
01:17:03,885 --> 01:17:06,254
and all of a sudden,
yeah, you get the funding

1564
01:17:06,287 --> 01:17:07,756
and you can fly it.

1565
01:17:07,789 --> 01:17:08,623
>> Questioner: Yeah, you
finally realize it's important.

1566
01:17:08,656 --> 01:17:09,924
>> Yeah.

1567
01:17:09,957 --> 01:17:12,293

>> The third is, it's
not so much a question,

1568
01:17:12,326 --> 01:17:13,795
well, maybe it is a question.

1569
01:17:13,828 --> 01:17:16,731
I've been astonished for
the last 30 years or so

1570
01:17:16,764 --> 01:17:20,568
that people have noticed
that human activity

1571
01:17:20,601 --> 01:17:24,439
and especially the use of
carbon in the energy sector

1572
01:17:24,472 --> 01:17:26,074
is affecting the climate,

1573
01:17:26,107 --> 01:17:29,177
are quite worked up about
it and simultaneously oppose

1574
01:17:29,210 --> 01:17:32,147
nuclear power, which is the
only thing that can work

1575
01:17:32,180 --> 01:17:34,549
if you look at an entire system

1576
01:17:34,582 --> 01:17:37,185
and not just you know, solar
panel here, windmill there,

1577
01:17:37,218 --> 01:17:39,354
a dam somewhere in
the waves off Norway.

1578
01:17:39,387 --> 01:17:41,256
If you looked at
the entire system

1579
01:17:41,289 --> 01:17:43,625
as a system quantitatively,

1580
01:17:43,658 --> 01:17:46,695
you reach the conclusion that
nothing but nuclear can work,

1581
01:17:46,728 --> 01:17:49,798
and by the way, nuclear
power's the safest ever way

1582
01:17:49,831 --> 01:17:52,834
to make electricity by
an extremely wide margin.

1583
01:17:52,867 --> 01:17:56,905
43 deaths in 60 years compared
with 30,000 deaths a year

1584
01:17:56,938 --> 01:17:59,040
from coal burning
in the US alone.

1585
01:17:59,073 --> 01:18:01,176
That's not an externality,

1586
01:18:01,209 --> 01:18:03,078
there are no externalities
for nuclear power

1587
01:18:03,111 --> 01:18:05,947
because everything is
put away somewhere,

1588
01:18:05,980 --> 01:18:07,382

there's just no externalities.

1589
01:18:07,415 --> 01:18:09,417
So that's kind of an
astonishment to me

1590
01:18:09,450 --> 01:18:12,487
that people who claim to be
worked up about carbon emissions

1591
01:18:12,520 --> 01:18:14,556
from the energy sector
simultaneously oppose

1592
01:18:14,589 --> 01:18:16,658
the only solution that'll work.

1593
01:18:16,691 --> 01:18:18,359
>> Okay, thank you sir.

1594
01:18:18,392 --> 01:18:21,997
And now another
question we have is

1595
01:18:23,498 --> 01:18:27,469
how long have they been
tracking climate change

1596
01:18:27,502 --> 01:18:28,670
by satellites?

1597
01:18:29,771 --> 01:18:33,908
When did climate change
satellites go up?

1598
01:18:33,941 --> 01:18:36,444
>> So it started with
the LANSAP program

1599

01:18:36,477 --> 01:18:38,280
back in the early '70s.

1600
01:18:39,480 --> 01:18:42,450
>> Well, depends on
which aspect, right?

1601
01:18:42,483 --> 01:18:47,489
The weather satellite data also
extends back into the '70s,

1602
01:18:49,557 --> 01:18:52,694
and some of the early passive
microwave radiometers too.

1603
01:18:54,061 --> 01:18:58,133
But none of those missions
were flown for climate, right?

1604
01:18:58,166 --> 01:19:00,201
They all had a
different purpose.

1605
01:19:00,234 --> 01:19:02,504
So there's climate
data going back,

1606
01:19:02,537 --> 01:19:04,405
satellite based climate
data going back that far,

1607
01:19:04,438 --> 01:19:06,775
but the first satellites
really dedicated for it

1608
01:19:06,808 --> 01:19:09,277
are the Earth observing
system satellites,

1609
01:19:09,310 --> 01:19:12,881

which are post-2000, or
I'm sorry, '99 for Terra.

1610
01:19:13,781 --> 01:19:15,283
>> Blaine: Sir.

1611
01:19:15,316 --> 01:19:16,151
>> Hi.

1612
01:19:17,351 --> 01:19:22,223
It's been suggested
in the last year

1613
01:19:22,256 --> 01:19:26,528
by the current administration
that, you know,

1614
01:19:26,561 --> 01:19:30,899
to further explore and
to put more money into

1615
01:19:30,932 --> 01:19:35,604
exploration outside of
the low Earth orbit area,

1616
01:19:36,737 --> 01:19:39,641
I don't remember
the specifics of it,

1617
01:19:39,674 --> 01:19:43,411
but I remember hearing the
proposal that there should be

1618
01:19:43,444 --> 01:19:46,848
massive cuts to the earth
science program at NASA,

1619
01:19:46,881 --> 01:19:51,386
and as far as I remember
from what I've read,

1620
01:19:51,419 --> 01:19:53,688
those haven't come
to fruition yet,

1621
01:19:53,721 --> 01:19:56,391
but they're still possible,

1622
01:19:56,424 --> 01:19:59,527
and what I was hoping
you guys might be able

1623
01:19:59,560 --> 01:20:03,431
to talk to a little
bit is you know,

1624
01:20:03,464 --> 01:20:08,036
I would assume that you
guys have a contingency plan

1625
01:20:08,069 --> 01:20:10,839
in case all of a sudden
those cuts to earth science

1626
01:20:10,872 --> 01:20:13,274
come through, and what
I would like to know

1627
01:20:13,307 --> 01:20:15,510
and I think it would be really
good to know for all of us

1628
01:20:15,543 --> 01:20:19,714
is you know, should
those cuts happen,

1629
01:20:19,747 --> 01:20:22,450
what would we lose?

1630

01:20:22,483 --> 01:20:24,786
Like what current missions
would we have to shut down,

1631
01:20:24,819 --> 01:20:26,287
what missions in the pipeline

1632
01:20:26,320 --> 01:20:29,557
would we not be able
to see launched,

1633
01:20:29,590 --> 01:20:32,327
and just kind of speak to that,

1634
01:20:32,360 --> 01:20:36,031
what would we lose in slashing
the earth science budget?

1635
01:20:37,198 --> 01:20:40,168
>> I don't want to
dodge that question,

1636
01:20:40,201 --> 01:20:43,571
but I want to answer
it honestly is that

1637
01:20:43,604 --> 01:20:48,610
my experience is that no matter
where you go in the country,

1638
01:20:49,510 --> 01:20:51,279
people are interested in what's,

1639
01:20:51,312 --> 01:20:53,448
and I'm talking about
elected officials,

1640
01:20:53,481 --> 01:20:55,650
are interested in
what's happening

1641
01:20:55,683 --> 01:20:57,151
in their part of the world

1642
01:20:57,184 --> 01:21:00,889
and what our satellites
and science instruments

1643
01:21:00,922 --> 01:21:03,658
can tell them about what's
happening in this world,

1644
01:21:03,691 --> 01:21:05,059
in that part of the world.

1645
01:21:05,092 --> 01:21:08,129
It could be a drought in Texas.

1646
01:21:08,162 --> 01:21:12,901
You know, it can be
concern about sea rise

1647
01:21:14,435 --> 01:21:16,338
in Florida or Louisiana.

1648
01:21:17,939 --> 01:21:22,610
I think that we are,
the country as a whole,

1649
01:21:22,643 --> 01:21:26,314
we're in pretty good
stead now with NASA.

1650
01:21:26,347 --> 01:21:30,018
So I wouldn't lose
any sleep over that.

1651
01:21:30,051 --> 01:21:33,121
I think our elected

officials understand

1652
01:21:33,154 --> 01:21:34,555
that we're providing...

1653
01:21:34,588 --> 01:21:37,592
Our job at NASA is to
provide the information

1654
01:21:37,625 --> 01:21:41,696
so that policy makers
can make good decisions,

1655
01:21:41,729 --> 01:21:45,700
and from what I see,
I think we're doing

1656
01:21:45,733 --> 01:21:47,002
fairly well right now.

1657
01:21:48,202 --> 01:21:49,204
Thank you very much.

1658
01:21:51,439 --> 01:21:52,941
Yes.

1659
01:21:52,974 --> 01:21:54,442
>> Hello.

1660
01:21:54,475 --> 01:21:56,778
I got really excited about
the earlier [mumbles]

1661
01:21:56,811 --> 01:21:58,880
of CO2, which I would
appreciate if I could

1662
01:21:58,913 --> 01:22:00,848
follow up on that with you

1663
01:22:00,881 --> 01:22:02,884
and the gentleman
who brought it up.

1664
01:22:02,917 --> 01:22:06,754
But my question is 60 years ago,

1665
01:22:06,787 --> 01:22:08,556
there was no satellite in space.

1666
01:22:08,589 --> 01:22:10,358
Space was empty.

1667
01:22:10,391 --> 01:22:13,161
It was only like space material.

1668
01:22:13,194 --> 01:22:17,098
And now after 60 years we
have a space junk crisis.

1669
01:22:17,131 --> 01:22:22,137
So I want to have like your
and Erik's opinion about what,

1670
01:22:23,170 --> 01:22:24,539
is there any lessons learned?

1671
01:22:24,572 --> 01:22:26,641
What did we do in
the last 60 years

1672
01:22:26,674 --> 01:22:28,309
and could we have
done it differently?

1673
01:22:28,342 --> 01:22:29,610
It's huge.

1674
01:22:29,643 --> 01:22:33,481
When I was born, space
was touched by humans.

1675
01:22:33,514 --> 01:22:35,350
But when my parents were born,

1676
01:22:35,383 --> 01:22:37,686
space was not touched by humans.

1677
01:22:38,853 --> 01:22:41,923
Yeah, I want to hear
your opinion about it

1678
01:22:41,956 --> 01:22:43,658
and see what's the
lessons learned

1679
01:22:44,825 --> 01:22:47,061
and what could we have
done it differently,

1680
01:22:47,094 --> 01:22:49,263
and if we go back
to 60 years ago,

1681
01:22:49,296 --> 01:22:51,933
as a historian,
or as a scientist,

1682
01:22:51,966 --> 01:22:54,602
do we do everything exactly
the same that we did?

1683
01:22:56,270 --> 01:22:57,472
Thank you.

1684
01:22:57,505 --> 01:22:59,340
>> Okay, sure.

1685
01:22:59,373 --> 01:23:02,610
So, nowadays there is an
international agreement

1686
01:23:02,643 --> 01:23:05,780
to design satellites so
that they can be de-orbited.

1687
01:23:05,813 --> 01:23:08,649
And so what could've
been done differently

1688
01:23:08,682 --> 01:23:11,052
is simply to have done
that earlier, right?

1689
01:23:11,085 --> 01:23:13,021
And done it at the
beginning of the Space Age

1690
01:23:13,054 --> 01:23:15,156
instead of when we
actually did it,

1691
01:23:16,190 --> 01:23:17,091
which is maybe 20 years ago?

1692
01:23:17,124 --> 01:23:19,160
Maybe it's not even that long.

1693
01:23:19,193 --> 01:23:22,330
But I mean, that's the
fundamental solution,

1694
01:23:22,363 --> 01:23:25,533
we didn't learn the
lesson soon enough, yeah.

1695

01:23:25,566 --> 01:23:28,403
>> As you said, yeah, now
we have to have a plan,

1696
01:23:28,436 --> 01:23:31,806
and with the GRACE mission
we had to add that plan,

1697
01:23:31,839 --> 01:23:33,841
and we just decommissioned
the satellites,

1698
01:23:33,874 --> 01:23:36,711
which basically
meant they de-orbit,

1699
01:23:36,744 --> 01:23:38,346
they burn up in the atmosphere,

1700
01:23:38,379 --> 01:23:41,115
and that's how you
get rid of them.

1701
01:23:41,148 --> 01:23:44,519
>> All right, we'll
take one final question.

1702
01:23:44,552 --> 01:23:45,653
>> Thank you.

1703
01:23:45,686 --> 01:23:48,322
Like the lady's
parents just before me,

1704
01:23:48,355 --> 01:23:50,591
when I was born 75 years ago,

1705
01:23:50,624 --> 01:23:53,227
we'd barely touched
the stratosphere.

1706
01:23:53,260 --> 01:23:55,730
I want to know from our guests

1707
01:23:55,763 --> 01:24:00,268
what we can expect
75 years from now.

1708
01:24:00,301 --> 01:24:01,803
I know it's hard to look ahead,

1709
01:24:01,836 --> 01:24:06,040
but the pace of change is
increasing and increasing.

1710
01:24:06,073 --> 01:24:10,378
What's the most far out thing
you can see 75 years from now?

1711
01:24:10,411 --> 01:24:11,279
Any of you.

1712
01:24:13,447 --> 01:24:14,282
>> Wow, okay.

1713
01:24:14,315 --> 01:24:15,516
[laughing]

1714
01:24:15,549 --> 01:24:16,818
So the first thing
that comes to mind,

1715
01:24:16,851 --> 01:24:19,153
and I hope it's not
75 years from now,

1716
01:24:19,186 --> 01:24:21,355
I hope it's 20 years from now,

1717
01:24:21,388 --> 01:24:25,427
is we shouldn't be flushing
drinking water down our toilet.

1718
01:24:27,962 --> 01:24:31,132
[audience applauding]

1719
01:24:34,535 --> 01:24:36,437
>> I think I was thinking a
little further out in space.

1720
01:24:36,470 --> 01:24:38,372
[audience laughing]

1721
01:24:38,405 --> 01:24:41,442
>> Well, if further out in
space is what we're after,

1722
01:24:41,475 --> 01:24:43,344
heck, I figure,
and unfortunately

1723
01:24:43,377 --> 01:24:44,946
I know I won't live to see it,

1724
01:24:44,979 --> 01:24:47,849
but I figure by then we'll
have definitive evidence

1725
01:24:47,882 --> 01:24:49,750
of whether there are
other living planets

1726
01:24:49,783 --> 01:24:51,385
in the neighborhood
of the Earth,

1727
01:24:51,418 --> 01:24:52,920
and I don't mean in

our solar system.

1728
01:24:52,953 --> 01:24:55,189
We already know
that there aren't...

1729
01:24:55,222 --> 01:24:56,724
Well, okay, I'll get into
trouble again for saying that,

1730
01:24:56,757 --> 01:24:58,025
but I'm already pretty
sure there aren't

1731
01:24:58,058 --> 01:24:59,961
other living planets
in our solar system.

1732
01:24:59,994 --> 01:25:01,963
But out there,
that's what I think.

1733
01:25:01,996 --> 01:25:06,300
I think that's the big thing
I would expect in astronomy

1734
01:25:06,333 --> 01:25:07,735
in the next 75 years.

1735
01:25:09,703 --> 01:25:11,706
>> And Blaine if you
will, one final question.

1736
01:25:11,739 --> 01:25:13,941
What happened to Explorer
1, is it still up there?

1737
01:25:13,974 --> 01:25:14,775
>> No.

1738
01:25:14,808 --> 01:25:16,177
De-orbited.

1739
01:25:16,210 --> 01:25:19,481
>> Yeah, it burned up, I
believe it was March 31st, 1970,

1740
01:25:20,981 --> 01:25:23,784
our website should
say it for sure,

1741
01:25:23,817 --> 01:25:27,221
but it was in a highly
elliptical orbit,

1742
01:25:27,254 --> 01:25:28,456
and so it burned up.

1743
01:25:28,489 --> 01:25:29,957
>> Blaine: And Sputnik?

1744
01:25:29,990 --> 01:25:31,225
[laughs]

1745
01:25:31,258 --> 01:25:34,929
>> I think so too, but I
don't remember exactly.

1746
01:25:34,962 --> 01:25:36,698
I think that's
burned up as well.

1747
01:25:38,098 --> 01:25:40,701
>> So following
up on my comment,

1748
01:25:40,734 --> 01:25:43,337
thinking 75 years
into the future

1749
01:25:43,370 --> 01:25:45,506
and what we're learning
about our planet,

1750
01:25:45,539 --> 01:25:49,877
I think our lives will be much
more in tune with our planet.

1751
01:25:49,910 --> 01:25:52,046
You know, as we're learning,

1752
01:25:52,079 --> 01:25:55,750
we'll see a lot of changes
probably in the next 75 years,

1753
01:25:55,783 --> 01:25:58,252
and hopefully we'll
be more efficient,

1754
01:25:58,285 --> 01:26:00,821
more conscientious about
the resources that we use,

1755
01:26:00,854 --> 01:26:03,958
more efficient in the
resources that we use overall.

1756
01:26:05,459 --> 01:26:06,761
>> Okay.

1757
01:26:06,794 --> 01:26:08,729
[audience applauding]

1758
01:26:08,762 --> 01:26:10,097
That's a good way to end.

1759
01:26:10,130 --> 01:26:11,365
You've been a great audience,

thank you very much.

1760
01:26:11,398 --> 01:26:13,768
Thanks for coming to the JPL.