



1
00:00:00,500 --> 00:00:04,484
We're of course celebrating tonight
Earth science in general

2
00:00:04,504 --> 00:00:10,573
which really exemplifies the idea
that everything at NASA leads, really,

3
00:00:10,593 --> 00:00:15,362
to the ultimate goal of protecting
and improving life on Earth.

4
00:00:15,382 --> 00:00:17,664
So I'm going to quickly talk about,
kind of, the view of Earth,

5
00:00:17,684 --> 00:00:21,184
and I'm going to talk about a kind of zoom in zoom out, right?

6
00:00:21,204 --> 00:00:26,873
Because for us to understand the Earth
we must see it in the broader context.

7
00:00:26,893 --> 00:00:31,895
And of course closest to the Earth
are terrestrial planets in our environment

8
00:00:31,915 --> 00:00:35,298
and each one of those planets tells a story.

9
00:00:35,318 --> 00:00:40,020
A story of how a planet can end up with a different destiny.

10
00:00:40,040 --> 00:00:42,624
When we study those planets,

11
00:00:42,644 --> 00:00:45,959
we learn about the processes that shaped the Earth,

12

00:00:45,979 --> 00:00:50,580

about our past, and about our future.

13

00:00:50,600 --> 00:00:54,200

Very similar to the Earth, for example, is Mars.

14

00:00:54,220 --> 00:00:58,555

That started together with the Earth but looks very, very different.

15

00:00:58,575 --> 00:01:05,195

We know now that Mars, of course, was very wet and it lost a lot of the water, and we know now,

16

00:01:05,215 --> 00:01:08,098

from actually one of the Goddard-built spacecraft,

17

00:01:08,118 --> 00:01:11,518

that a lot of the reasons it lost that water is because of

18

00:01:11,538 --> 00:01:13,070

the scavenging from the solar wind,

19

00:01:13,090 --> 00:01:15,182

kind of ripping off, over millions of years,

20

00:01:15,202 --> 00:01:17,607

water out of the atmosphere.

21

00:01:17,627 --> 00:01:21,055

On the surface of Mars, of course we landed with,

22

00:01:21,075 --> 00:01:24,470

you know, Curiosity rover near Gale Crater

23

00:01:24,490 --> 00:01:27,117

and we really went into kind of a beach environment,

24

00:01:27,137 --> 00:01:33,590

with rivers and what used to be lake beds and so forth.

25

00:01:33,610 --> 00:01:37,944

We're learning about this and the amazing landscapes there,

26

00:01:37,964 --> 00:01:42,432

and really thinking about what could be in the future here,

27

00:01:42,452 --> 00:01:44,918

of an Earth where the the Sun gets hotter and hotter, for example,

28

00:01:44,938 --> 00:01:51,274

as we go in kind of astronomical timescales going forward.

29

00:01:51,294 --> 00:01:55,361

When we look at the outside of the solar system, and you already mentioned Cassini,

30

00:01:55,381 --> 00:02:02,085

we're looking at this amazing planet Saturn and its rings, one of the most majestic planets,

31

00:02:02,105 --> 00:02:04,921

just absolutely amazing when you see him in a telescope.

32

00:02:04,941 --> 00:02:09,976

I remember as a kid looking at it, like there it is, you know the rings – it's amazing.

33

00:02:09,996 --> 00:02:15,932

Well what's even more stunning is that there's moons out there, Titan and Enceladus,

34

00:02:15,952 --> 00:02:19,252

that we're now really thinking about in the context of the Earth,

35

00:02:19,272 --> 00:02:21,805

because of the fact that they have oceans

36
00:02:21,825 --> 00:02:25,475
and they spurt out organics, in the case of Enceladus.

37
00:02:25,495 --> 00:02:30,346
Something that gives us an entirely new
perspective as to where we should look for life

38
00:02:30,366 --> 00:02:32,532
and how in fact we should do that.

39
00:02:32,552 --> 00:02:36,586
You can zoom back even more and what you look at is a galaxy

40
00:02:36,606 --> 00:02:40,440
and you remember that in that galaxy are billions

41
00:02:40,460 --> 00:02:42,926
and hundreds of billions of stars.

42
00:02:42,946 --> 00:02:44,694
Well how many of them are like the Earth?

43
00:02:44,714 --> 00:02:47,514
I remember when I did my Ph.D. in '96,

44
00:02:47,534 --> 00:02:50,817
ah we thought well perhaps there's planets —

45
00:02:50,837 --> 00:02:55,138
you know '96 is one year after '95, for those of us geeks.

46
00:02:55,158 --> 00:03:00,994
Like you said, '95 is the time the first extrasolar planet was announced.

47
00:03:01,014 --> 00:03:03,897
So we thought, well perhaps 10% of these stars

48

00:03:03,917 --> 00:03:07,350

may or may not have planets,

49

00:03:07,370 --> 00:03:10,887

perhaps even less. Well... oh no.

50

00:03:10,907 --> 00:03:14,824

There's well, many, many more of those now.

51

00:03:14,844 --> 00:03:19,679

And this next thing is just one example that we actually discovered with Spitzer

52

00:03:19,699 --> 00:03:24,033

where we basically have a small star
with seven planets going around it.

53

00:03:24,053 --> 00:03:27,720

This is Spitzer following up on a ground-based observation.

54

00:03:27,740 --> 00:03:31,691

Three of those, we think, are in the habitable zone

55

00:03:31,711 --> 00:03:35,478

based on just a distance and temperature of the host star.

56

00:03:35,498 --> 00:03:39,732

We now know, based on Kepler and other observations, that

57

00:03:39,752 --> 00:03:41,618

it's very common to have planets.

58

00:03:41,638 --> 00:03:43,770

Every average star will have a planet.

59

00:03:43,790 --> 00:03:48,285

Many of them will have Earth-like planets.

60

00:03:48,305 --> 00:03:51,755

So it's an abundance of Earth-like planets,

61

00:03:51,775 --> 00:03:53,563

potential Earth-like planets here.

62

00:03:53,583 --> 00:03:55,642

But we have one home

63

00:03:55,662 --> 00:03:57,664

and that home was recently visited

64

00:03:57,684 --> 00:04:00,987

by a spacecraft also led out of Goddard, OSIRIS-Rex –

65

00:04:01,007 --> 00:04:04,282

it's actually on the way to a little body out there

66

00:04:04,302 --> 00:04:07,023

that it's gonna collect matter with,

67

00:04:07,043 --> 00:04:09,412

Bennu, and bringing it back.

68

00:04:09,432 --> 00:04:11,698

But when it flew by Earth it took this picture

69

00:04:11,718 --> 00:04:14,022

and it reminded us that, you know,

70

00:04:14,042 --> 00:04:17,170

coming from this deep space, coming to Earth,

71

00:04:17,190 --> 00:04:19,489

how beautiful our planet really is

72

00:04:19,509 --> 00:04:24,711

but also how fragile that planet is, as we're living on it.

73

00:04:24,731 --> 00:04:27,113

It reminds us all these stories,

74

00:04:27,133 --> 00:04:29,548

I think many of us were in Australia when they flew overhead

75

00:04:29,568 --> 00:04:33,469

some of us were in California,
there at the top of the picture,

76

00:04:33,489 --> 00:04:36,823

and that's really kind of zooming back in

77

00:04:36,843 --> 00:04:40,827

and you know the talks will be
zooming into our beautiful planet

78

00:04:40,847 --> 00:04:44,501

that is such an important planet and subject

79

00:04:44,521 --> 00:04:47,784

very worthy of our study and full attention.

80

00:04:47,804 --> 00:04:50,534

So with that I want to introduce

81

00:04:50,554 --> 00:04:52,789

Marshall Shepherd, our next speaker.

82

00:04:52,809 --> 00:04:54,714

And of course Dr. Marshall Shepherd

83

00:04:54,734 --> 00:04:57,961

is a leading international expert in weather and climate

84

00:04:57,981 --> 00:04:58,778

[audience chuckles]

85

00:04:58,798 --> 00:05:03,128

and is the Georgia Athletic -- you like that picture, right? --

86

00:05:03,148 --> 00:05:04,050

[audience chuckles]

87

00:05:04,070 --> 00:05:07,971

the Georgia Athletic Association Distinguished Professor.

88

00:05:07,991 --> 00:05:09,970

That means,

89

00:05:09,990 --> 00:05:12,015

in kind-of academic-speak

90

00:05:12,035 --> 00:05:14,827

the best of the best type of professor

91

00:05:14,847 --> 00:05:18,059

at the University of Georgia

92

00:05:18,079 --> 00:05:22,385

and you're also an Associate Department Head, of course.

93

00:05:22,405 --> 00:05:27,707

You were 2013 president of the American Meteorological Society,

94

00:05:27,727 --> 00:05:30,512

the nation's largest and oldest professional

95

00:05:30,532 --> 00:05:34,276

science society in atmospheric and related sciences,

96

00:05:34,296 --> 00:05:38,768

and prior to the University of Georgia,

Dr. Shephard spent 12 years as a

97

00:05:38,788 --> 00:05:40,814

researcher at NASA Goddard

98

00:05:40,834 --> 00:05:43,906

and was the deputy project scientist of GPM.

99

00:05:43,926 --> 00:05:45,600

It's actually that mission

100

00:05:45,620 --> 00:05:48,244

that helped make predictions for the very storms that

101

00:05:48,264 --> 00:05:51,981

were going over the house of my father-in-law,

102

00:05:52,001 --> 00:05:54,588

and you know for me this is really personal,

103

00:05:54,608 --> 00:05:56,677

when I look at these missions now,

104

00:05:56,697 --> 00:05:58,788

of course them being in our portfolio,

105

00:05:58,808 --> 00:06:01,240

but them affecting our lives in a direct fashion,

106

00:06:01,260 --> 00:06:04,823

he's safe, in part because of these predictions

107

00:06:04,843 --> 00:06:06,796

that came from that mission

108

00:06:06,816 --> 00:06:09,766

that you were directly working with, Marshall.

109

00:06:09,786 --> 00:06:13,069

I also want to say that of course

110

00:06:13,089 --> 00:06:16,606

Dr. Shepherd received his BS, MS, and PhD

111

00:06:16,626 --> 00:06:20,810

in meteorology at the Florida State
University and he was the first

112

00:06:20,830 --> 00:06:23,450

African-American to receive a PhD from

113

00:06:23,470 --> 00:06:26,599

Florida State University Department of Meteorology,

114

00:06:26,619 --> 00:06:30,036

one of the nation's oldest and most respected.

115

00:06:30,056 --> 00:06:32,472

\h
I'm just excited to welcome you, Marshall.

116

00:06:32,492 --> 00:06:40,430

[applause]

117

00:06:40,450 --> 00:06:44,617

Thank you, and good evening.
Now go far enough into space

118

00:06:44,637 --> 00:06:50,373

and Earth looks like any other star or planet in our night sky.

119

00:06:50,393 --> 00:06:52,959

But of course we know it's not.

120

00:06:52,979 --> 00:06:57,547

Ccome closer and we see a planet bursting with color.

121

00:06:57,567 --> 00:06:59,932

It's bursting with life.

122

00:06:59,952 --> 00:07:03,453

It's covered by just the right amount of ocean,

123

00:07:03,473 --> 00:07:06,305

just the right amount of forested continents.

124

00:07:06,325 --> 00:07:13,079

It's protected by a dynamic yet thin atmosphere
that roils with weather and storms.

125

00:07:13,099 --> 00:07:18,684

Now we understand the cosmic odds that allow us
to carve out our lives here on Earth.

126

00:07:18,704 --> 00:07:24,590

Yet there is so much more to learn about our home planet.

127

00:07:24,610 --> 00:07:29,095

The world gets more populated more complicated every day.

128

00:07:29,115 --> 00:07:32,782

How are we going to improve life on Earth?

129

00:07:32,802 --> 00:07:36,936

How are we going to safeguard this planet?

130

00:07:36,956 --> 00:07:41,974

Who is going to lead the continuing discovery on Earth?

131

00:07:41,994 --> 00:07:47,380

As Thomas showed us, NASA's exploration of our
solar system and deep space is taking us

132

00:07:47,400 --> 00:07:50,700

closer than ever to planets than before.

133

00:07:50,720 --> 00:07:54,187

But that view from space is also vital

134

00:07:54,207 --> 00:07:58,925

to understanding the most complex planet we know.

135

00:07:58,945 --> 00:08:02,345

Earth.

136

00:08:02,365 --> 00:08:07,617

To take on Earth's challenges,
we need not only the vantage point of space,

137

00:08:07,637 --> 00:08:15,575

but we also need the technology, grit, and quest for discovery
that we use to explore the universe as only NASA can.

138

00:08:15,595 --> 00:08:22,715

Now it's important to note here that Earth Science
has been at the core of NASA's mission since the beginning.

139

00:08:22,735 --> 00:08:25,885

Let's take a look at the Space Act that created NASA.

140

00:08:25,905 --> 00:08:29,939

It talks about "for the benefit of all mankind."

141

00:08:29,959 --> 00:08:34,026

It talks about advanced knowledge of Earth's atmosphere,

142

00:08:34,046 --> 00:08:39,532

the preservation of the role of the United States as a leader.

143

00:08:39,552 --> 00:08:43,286

Now tonight I'm going to talk about things from a hurricane perspective.

144

00:08:43,306 --> 00:08:46,389

We want to share with you a few stories of how NASA is leading

145

00:08:46,409 --> 00:08:48,875

the planetary exploration of Earth

146

00:08:48,895 --> 00:08:56,182

and continuing to provide return on investment to every US citizen.

147

00:08:56,202 --> 00:09:01,404

In particular we want to take a look inside the complex world of water.

148

00:09:01,424 --> 00:09:04,924

Sometimes there's too much, sometimes there's not enough.

149

00:09:04,944 --> 00:09:09,362

So let's pivot now to talk about the hurricane season of 2017.

150

00:09:09,382 --> 00:09:13,432

And by the way, as we speak there's a hurricane possibly developing

151

00:09:13,452 --> 00:09:18,437

down in the Caribbean that will affect the Gulf of Mexico and Gulf states later this weekend.

152

00:09:18,457 --> 00:09:21,691

Now 2017 has been an extraordinary season.

153

00:09:21,711 --> 00:09:26,963

Hurricane Harvey was the first major hurricane to make landfall in the U.S. in over 12 years.

154

00:09:26,983 --> 00:09:30,800

The iPhone and Twitter weren't around then.

155

00:09:30,820 --> 00:09:35,388

It was also the most significant rainfall event in US history.

156

00:09:35,408 --> 00:09:43,462

Hurricane Irma remained a category 5 hurricane longer than any storm on record in the Atlantic.

157

00:09:43,482 --> 00:09:45,881

And of course, Hurricane Maria:

158

00:09:45,901 --> 00:09:52,021

rapid intensification, power, humanitarian crisis.

159

00:09:52,041 --> 00:09:54,707

Now look, I'm a meteorologist

160

00:09:54,727 --> 00:09:59,829

and if you follow me on social media or read some of the contributions I write for Forbes,

161

00:09:59,849 --> 00:10:04,350

many of us knew that these storms were going to do what they did

162

00:10:04,370 --> 00:10:06,085

and that's really tough

163

00:10:06,105 --> 00:10:09,589

as someone that has knowledge to see that happening.

164

00:10:09,609 --> 00:10:12,575

But there is, I guess, a bright side

165

00:10:12,595 --> 00:10:15,461

because we know that science has allowed us

166

00:10:15,481 --> 00:10:17,096

to advance knowledge,

167

00:10:17,116 --> 00:10:22,485

predict these storms, and possibly save lives.

168
00:10:22,505 --> 00:10:25,638
Now this hurricane season I want to highlight two stories.

169
00:10:25,658 --> 00:10:29,525
One, with each of the three major storms that I've talked about

170
00:10:29,545 --> 00:10:35,514
we can see, even in that glimmer of despair, a success story

171
00:10:35,534 --> 00:10:41,354
where the view from space has improved our ability
to forecast or respond to hurricanes.

172
00:10:41,374 --> 00:10:44,907
And the second storyline is that
we saw three major storms

173
00:10:44,927 --> 00:10:48,494
that highlighted absolutely fundamental questions

174
00:10:48,514 --> 00:10:52,214
that NASA is trying to answer
about hurricanes and how they work.

175
00:10:52,234 --> 00:10:54,467
And I'll get to those critical questions in a moment.

176
00:10:54,487 --> 00:10:57,086
But first let me acknowledge our partners.

177
00:10:57,106 --> 00:10:59,255
NASA is a research and development agency

178
00:10:59,275 --> 00:11:03,175
pushing the envelope on technology
and new knowledge generation.

179

00:11:03,195 --> 00:11:08,864

We work very closely with our partners at NOAA, the USGS, other federal agencies,

180

00:11:08,884 --> 00:11:13,869

and in collaboration with many of our industry partners that are here in the room tonight.

181

00:11:13,889 --> 00:11:19,859

That partnership and collaboration is critical to everything that you're going to see tonight.

182

00:11:19,879 --> 00:11:25,831

And so we thank everyone that's represented here from those various entities.

183

00:11:25,851 --> 00:11:31,404

GOES-16 will soon move to become GOES-East in its operational orbit parking.

184

00:11:31,424 --> 00:11:34,340

GOES-S launches next spring

185

00:11:34,360 --> 00:11:39,395

and JPSS-1, our polar orbiting satellite system, launches next month.

186

00:11:39,415 --> 00:11:44,717

They're all a result of partnerships between NASA, NOAA, and industry.

187

00:11:44,737 --> 00:11:48,237

Now let's talk about some of those success stories that I mentioned earlier.

188

00:11:48,257 --> 00:11:51,006

Hurricane Harvey's rainfall:

189

00:11:51,026 --> 00:11:53,976

now, as a meteorologist when I was looking at the forecast models

190

00:11:53,996 --> 00:11:57,930

and I saw them saying three to five feet of rain,

191

00:11:57,950 --> 00:11:59,749

I couldn't believe it.

192

00:11:59,769 --> 00:12:03,786

I literally couldn't believe it. But they were right.

193

00:12:03,806 --> 00:12:06,739

Days out, they were right.

194

00:12:06,759 --> 00:12:10,526

This is a testament to decades of advancement.

195

00:12:10,546 --> 00:12:17,283

This information from these satellites and from advanced models are saving lives.

196

00:12:17,303 --> 00:12:21,637

Let's take a look at Hurricane Irma's track forecast.

197

00:12:21,657 --> 00:12:27,026

This is five days before Hurricane Irma made landfall.

198

00:12:27,046 --> 00:12:29,261

Watch the lines:

199

00:12:29,281 --> 00:12:32,765

the forecasts were spot-on five days out.

200

00:12:32,785 --> 00:12:37,686

Now yes there was a little wiggling back and forth as it neared Florida, but

201

00:12:37,706 --> 00:12:43,692

where we are in meteorology, this was an amazing forecast.

202

00:12:43,712 --> 00:12:47,747

And science got us there.

203

00:12:47,767 --> 00:12:50,249

Now some ways that you might not think of,

204

00:12:50,269 --> 00:12:52,785

and you heard Chris mention this earlier,

205

00:12:52,805 --> 00:12:57,289

Puerto Rico: Maria knocked out power all across that island.

206

00:12:57,309 --> 00:13:01,177

What you're looking at here is a brand-new NASA capability

207

00:13:01,197 --> 00:13:04,814

that gave first responders block-by-block detail

208

00:13:04,834 --> 00:13:07,216

of where power went out.

209

00:13:07,236 --> 00:13:11,020

It is produced by scientists at
NASA Goddard and NASA Marshall.

210

00:13:11,040 --> 00:13:15,224

It combines nighttime data from the Suomi NPP satellite

211

00:13:15,244 --> 00:13:18,461

with four other types of satellite data

212

00:13:18,481 --> 00:13:21,347

and the result is a high-definition view of night lights

213

00:13:21,367 --> 00:13:24,467

before and after Maria.

214

00:13:24,487 --> 00:13:28,137

Look at the streets and city blocks that you can see.

215

00:13:28,157 --> 00:13:31,106

But here's what's more important to citizens

216

00:13:31,126 --> 00:13:34,360

particularly our citizens in Puerto Rico.

217

00:13:34,380 --> 00:13:38,881

This map you're looking at
was put directly in the hands of FEMA

218

00:13:38,901 --> 00:13:40,483

and the National Guard last week

219

00:13:40,503 --> 00:13:42,852

directly in their hands

220

00:13:42,872 --> 00:13:45,855

so that they can map out a response strategy.

221

00:13:45,875 --> 00:13:52,161

The first time this satellite data product
has been provided to first responders.

222

00:13:52,181 --> 00:13:56,282

Now let me pivot back to those research questions.

223

00:13:56,302 --> 00:13:59,952

The science is helping us understand them,
and there's still many challenges ahead,

224

00:13:59,972 --> 00:14:03,272

but NASA is there, and our partners are there.

225

00:14:03,292 --> 00:14:07,910

Let's go back to Harvey's rainfall.

The volume of rain raises questions.

226

00:14:07,930 --> 00:14:11,864

Are severe storms more likely
to produce more rainfall in the future?

227

00:14:11,884 --> 00:14:15,968

NASA is in a better position to help figure that question out.

228

00:14:15,988 --> 00:14:21,390

In 2014, NASA, in partnership with
the Japanese space agency, JAXA,

229

00:14:21,410 --> 00:14:24,827

launched the Global Precipitation Measurement
Core Observatory, GPM.

230

00:14:24,847 --> 00:14:33,569

Now this is the most advanced orbiting
rainfall measurement system ever conceived.

231

00:14:33,589 --> 00:14:37,673

NASA is coordinating and fine-tuning
rainfall measurements like never before.

232

00:14:37,693 --> 00:14:41,777

The core satellite has a radar and
passive microwave imager

233

00:14:41,797 --> 00:14:46,365

that helps calibrate a constellation
of satellites, ten of them,

234

00:14:46,385 --> 00:14:51,220

to produce unprecedented global rainfall maps, around the world.

235

00:14:51,240 --> 00:14:56,458

That's weather, folks, that you're seeing,
manifested in rainfall.

236

00:14:56,478 --> 00:15:00,863

And at that scale that GPM can provide,
not only does it provide science,

237

00:15:00,883 --> 00:15:06,435

we can help with landslides, flooding,
and other things that affect society.

238

00:15:06,455 --> 00:15:09,605

That's US leadership.

239

00:15:09,625 --> 00:15:13,876

Now we've heard questions about whether
extreme rainfall events are going to increase,

240

00:15:13,896 --> 00:15:15,261

the physics of a warmer atmosphere

241

00:15:15,281 --> 00:15:17,479

leading to more moisture in the atmosphere,

242

00:15:17,499 --> 00:15:19,081

more big rain events.

243

00:15:19,101 --> 00:15:21,166

In other words, what's the weather going to be like

244

00:15:21,186 --> 00:15:23,619

in the 21st century going forward?

245

00:15:23,639 --> 00:15:26,305

These are questions of the day that scientists will address

246

00:15:26,325 --> 00:15:28,207

and GPM will be there to help.

247

00:15:28,227 --> 00:15:31,860

But rainfall from Harvey was not the

only hallmark of this season.

248

00:15:31,880 --> 00:15:35,898

Let's go back and take another look at that Irma track

249

00:15:35,918 --> 00:15:37,066

and what you'll see -

250

00:15:37,086 --> 00:15:40,586

look at those warm ocean waters that Irma had to tap into,

251

00:15:40,606 --> 00:15:44,373

but look inside the little hurricane symbol you'll see a number.

252

00:15:44,393 --> 00:15:49,511

And what I want to show here is that

Hurricane Irma was a category 5 storm

253

00:15:49,531 --> 00:15:54,967

longer than any storm that we've seen on record in the Atlantic.

254

00:15:54,987 --> 00:15:57,386

Category 5 storm.

255

00:15:57,406 --> 00:16:00,723

What made the storm so strong and for so long?

256

00:16:00,743 --> 00:16:03,575

Well as you saw, lots of ocean heat content

257

00:16:03,595 --> 00:16:06,228

that NASA satellites can provide information for,

258

00:16:06,248 --> 00:16:09,081

and some NOAA satellites as well.

259

00:16:09,101 --> 00:16:11,667

This takes us to our second fundamental question:

260
00:16:11,687 --> 00:16:15,304
how will warm ocean waters affect hurricane intensity?

261
00:16:15,324 --> 00:16:20,059
And here I need to focus on Hurricane Maria.

262
00:16:20,079 --> 00:16:25,497
Maria was a storm that went from a
category 1 to a category 5 storm

263
00:16:25,517 --> 00:16:28,133
in less than 24 hours in September.

264
00:16:28,153 --> 00:16:30,736
Less than 24 hours.

265
00:16:30,756 --> 00:16:33,205
That's rapid intensification

266
00:16:33,225 --> 00:16:35,808
and those of us in my field know that that remains

267
00:16:35,828 --> 00:16:37,926
one of the grand challenges of meteorology

268
00:16:37,946 --> 00:16:39,795
because we've gotten track forecasts

269
00:16:39,815 --> 00:16:41,814
to be pretty good over the last several decades,

270
00:16:41,834 --> 00:16:43,298
but intensity is a challenge.

271
00:16:43,318 --> 00:16:45,534
Why do we get this rapid intensification?

272

00:16:45,554 --> 00:16:49,438

And that's been a theme of the hurricane season this year, by the way.

273

00:16:49,458 --> 00:16:53,942

GPM again can help.

274

00:16:53,962 --> 00:16:57,212

We can pop the hood on these storms.

275

00:16:57,232 --> 00:17:01,100

What do I mean by that?

I like to think of hurricanes as like large heat engines.

276

00:17:01,120 --> 00:17:03,352

And when you see hurricanes with traditional satellites,

277

00:17:03,372 --> 00:17:05,587

you're often looking at the clouds.

278

00:17:05,607 --> 00:17:08,157

But as you're going to see in a moment with Maria,

279

00:17:08,177 --> 00:17:10,359

we can now take this satellite data

280

00:17:10,379 --> 00:17:13,062

and we can peer inside the hurricane

281

00:17:13,082 --> 00:17:16,048

and look at the thunderstorms in the eye wall and rain band.

282

00:17:16,068 --> 00:17:20,219

Well if my wife were sitting here right now
she'd say, "so what."

283

00:17:20,239 --> 00:17:22,071

She's just - that's the way she is -

284
00:17:22,091 --> 00:17:23,188
[laughter]

285
00:17:23,208 --> 00:17:26,475
but the reality is there is a huge "so what,"

286
00:17:26,495 --> 00:17:28,627
because when we can see these thunderstorms

287
00:17:28,647 --> 00:17:31,380
developing and growing in the eyewall and rain band

288
00:17:31,400 --> 00:17:34,450
they're showing the heat release that powers this engine

289
00:17:34,470 --> 00:17:37,453
and that may very well be a clue

290
00:17:37,473 --> 00:17:41,173
that will help us with intensity forecasts.

291
00:17:41,193 --> 00:17:42,725
But it's not just satellite data.

292
00:17:42,745 --> 00:17:44,710
The Global Hawk,

293
00:17:44,730 --> 00:17:47,046
suborbital platforms, aircraft

294
00:17:47,066 --> 00:17:48,814
are also providing unique views

295
00:17:48,834 --> 00:17:51,100
and many of these capabilities provided by NASA

296
00:17:51,120 --> 00:17:54,236

and our other partners in the industry.

297

00:17:54,256 --> 00:17:59,341

And I can't not talk about the performance of our forecast models.

298

00:17:59,361 --> 00:18:05,464

Take a look at this model that shows the track of Hurricane Sandy.

299

00:18:05,484 --> 00:18:08,517

Studies have shown that if satellite data

300

00:18:08,537 --> 00:18:11,520

were removed from the models,

301

00:18:11,540 --> 00:18:15,157

we would not have seen that Hurricane Sandy was going to make a left turn

302

00:18:15,177 --> 00:18:18,343

into New Jersey and New York nine days ahead of time.

303

00:18:18,363 --> 00:18:22,030

The satellite data is being ingested into the models.

304

00:18:22,050 --> 00:18:24,249

Now, this last science question is dear to my heart

305

00:18:24,269 --> 00:18:27,269

because it's some of my own research that's sponsored by NASA.

306

00:18:27,289 --> 00:18:31,507

There is something called the "brown ocean."

307

00:18:31,527 --> 00:18:34,676

You might think that storms weaken when they move over land,

308

00:18:34,696 --> 00:18:36,645

but we found something different.

309

00:18:36,665 --> 00:18:37,546

Take a look at this image.

310

00:18:37,566 --> 00:18:40,499

You're seeing soil moisture from SMAP and other things.

311

00:18:40,519 --> 00:18:44,086

The red represents dry soil over Texas and Oklahoma

312

00:18:44,106 --> 00:18:47,840

and look what you see, rainfall over several weeks to months.

313

00:18:47,860 --> 00:18:50,325

Now watch that change over to blue in Texas

314

00:18:50,345 --> 00:18:53,095

that means the soil is getting wetter, it's moistening up.

315

00:18:53,115 --> 00:18:55,047

Here comes Tropical Storm Bill,

316

00:18:55,067 --> 00:18:57,282

moves over that wet soil,

317

00:18:57,302 --> 00:19:00,786

and maintains its strength.

It actually even intensified.

318

00:19:00,806 --> 00:19:03,438

The "brown ocean" was feeding the storm

319

00:19:03,458 --> 00:19:05,791

just like the ocean would. That wet soil,

320

00:19:05,811 --> 00:19:08,844

that's the "brown ocean."

321

00:19:08,864 --> 00:19:12,131

Now I'd like to introduce Dr. Christa Peters-Lidard.

322

00:19:12,151 --> 00:19:15,984

She's a hydrologist at NASA's Goddard Space Flight Center.

323

00:19:16,004 --> 00:19:19,238

Christa has developed hydrological models of the water cycle

324

00:19:19,258 --> 00:19:22,658

that have been widely adopted by the US Air Force weather agency,

325

00:19:22,678 --> 00:19:23,442

NOAA,

326

00:19:23,462 --> 00:19:26,128

and the US Agency for International Development

327

00:19:26,148 --> 00:19:29,715

as critical components for their forecasting systems.

328

00:19:29,735 --> 00:19:34,336

Christa currently serves as a Deputy Director of
NASA Goddard's Earth Science Division

329

00:19:34,356 --> 00:19:39,758

where she oversees five of the thirteen
Goddard Earth science laboratories.

330

00:19:39,778 --> 00:19:42,878

She is a Fellow of the American Meteorological Society

331

00:19:42,898 --> 00:19:45,764

and has been awarded the Arthur S. Fleming medal

332

00:19:45,784 --> 00:19:48,784

given to outstanding federal employees.

333

00:19:48,804 --> 00:19:51,837

She's also a friend and a colleague.

334

00:19:51,857 --> 00:19:59,211

[applause]

335

00:19:59,231 --> 00:20:02,781

Since NASA was created nearly six decades ago,

336

00:20:02,801 --> 00:20:06,084

this agency and the larger science community

337

00:20:06,104 --> 00:20:09,755

has essentially discovered how the Earth works

338

00:20:09,775 --> 00:20:12,007

as an interconnected system,

339

00:20:12,027 --> 00:20:13,725

as a planet,

340

00:20:13,745 --> 00:20:16,879

and we are still discovering.

341

00:20:16,899 --> 00:20:21,133

NASA is converting the space-based view of Earth

342

00:20:21,153 --> 00:20:25,437

into a pixel-level planetary intelligence system

343

00:20:25,457 --> 00:20:29,558

for navigating the challenges of the 21st century.

344

00:20:29,578 --> 00:20:34,880

One of those challenges is coping with drought.

345

00:20:34,900 --> 00:20:38,100
California, 2015.

346
00:20:38,120 --> 00:20:43,438
One of the most productive agricultural
markets in the world was wracked

347
00:20:43,458 --> 00:20:47,376
by a fourth year of drought.

348
00:20:47,396 --> 00:20:50,312
Wildfires burned,

349
00:20:50,332 --> 00:20:53,081
crops wilted,

350
00:20:53,101 --> 00:20:58,904
reservoirs plummeted to half of historical averages.

351
00:20:58,924 --> 00:21:03,609
But how did this drought spread? How pervasive was it?

352
00:21:03,629 --> 00:21:07,279
From space we track water in the ground,

353
00:21:07,299 --> 00:21:09,965
whether it's a centimeter, a meter,

354
00:21:09,985 --> 00:21:13,619
or a kilometer below the surface.

355
00:21:13,639 --> 00:21:17,406
Let's start with the big picture.

356
00:21:17,426 --> 00:21:19,641
Around the world the GRACE satellites,

357
00:21:19,661 --> 00:21:23,662

which is a partnership between NASA
and the German Space Agency,

358

00:21:23,682 --> 00:21:25,914

have provided unprecedented views

359

00:21:25,934 --> 00:21:29,334

of water storage and natural aquifers.

360

00:21:29,354 --> 00:21:33,155

These underground reserves are so massive

361

00:21:33,175 --> 00:21:36,675

that they affect the Earth's gravity field.

362

00:21:36,695 --> 00:21:38,560

And when their mass changes,

363

00:21:38,580 --> 00:21:43,298

the satellites detect the change in gravity.

364

00:21:43,318 --> 00:21:46,234

Droughts affect deep groundwater stores.

365

00:21:46,254 --> 00:21:48,737

In fact, water users can pump

366

00:21:48,757 --> 00:21:52,808

hundreds of billions of gallons out of their aquifers

367

00:21:52,828 --> 00:21:55,911

to compensate for the lack of rainfall.

368

00:21:55,931 --> 00:22:00,182

And GRACE detects this change.

369

00:22:00,202 --> 00:22:03,785

This view from space has revolutionized our understanding

370

00:22:03,805 --> 00:22:07,539

of water stored beneath the Earth's surface.

371

00:22:07,559 --> 00:22:11,076

But scientists at NASA Goddard can provide a more detailed view

372

00:22:11,096 --> 00:22:13,045

of conditions in the continental US by

373

00:22:13,065 --> 00:22:17,582

combining GRACE data with sophisticated computer models.

374

00:22:17,602 --> 00:22:20,485

These computer models help us decompose the GRACE signal

375

00:22:20,505 --> 00:22:25,023

into the surface, root zone, and shallow groundwater.

376

00:22:25,043 --> 00:22:29,428

And this view can help trigger critical water conservation measures.

377

00:22:29,448 --> 00:22:33,165

Stations on the ground provide a connect-the-dots picture

378

00:22:33,185 --> 00:22:36,968

but the vantage point from space, combined with modeling,

379

00:22:36,988 --> 00:22:41,006

provides a comprehensive view of the California drought:

380

00:22:41,026 --> 00:22:45,427

how it evolved over time, and ultimately ended.

381

00:22:45,447 --> 00:22:49,681

This constantly changing snapshot of shallow groundwater conditions

382

00:22:49,701 --> 00:22:55,287

is now used every week in the US Drought Monitor.

383

00:22:55,307 --> 00:22:58,323

This is the benchmark relied upon by decision-makers

384

00:22:58,343 --> 00:23:03,078

at the local, state, and federal levels.

385

00:23:03,098 --> 00:23:06,214

So GRACE gives us a global view,

386

00:23:06,234 --> 00:23:10,786

and the combination of satellites and modeling gives us a regional view,

387

00:23:10,806 --> 00:23:15,857

but what if I want to know what's happening in a 30 by 30-meter plot of land,

388

00:23:15,877 --> 00:23:19,728

the size of a Landsat pixel?

389

00:23:19,748 --> 00:23:22,230

California's wine industry

390

00:23:22,250 --> 00:23:24,716

provides tens of thousands of jobs,

391

00:23:24,736 --> 00:23:29,171

pays seventeen billion dollars in wages every year,

392

00:23:29,191 --> 00:23:33,475

and is built on intensive agricultural practices.

393

00:23:33,495 --> 00:23:36,828

It is also at the forefront of using the view from space

394

00:23:36,848 --> 00:23:41,400

to save water and be more efficient.

395

00:23:41,420 --> 00:23:44,069

The E&J Gallo company grows grapes

396

00:23:44,089 --> 00:23:49,024

on a hundred thousand acres across California.

397

00:23:49,044 --> 00:23:52,310

Nick Dokoozlian, the company's head of viticulture, said

398

00:23:52,330 --> 00:23:56,114

that during the drought

"we were farming on a fine line.

399

00:23:56,134 --> 00:24:01,453

The model went from commercialization to survival."

400

00:24:01,473 --> 00:24:06,224

They use Landsat which is a joint program of NASA and USGS

401

00:24:06,244 --> 00:24:09,978

to monitor water use and the health of their vines.

402

00:24:09,998 --> 00:24:14,483

With constant care, and a decade's long record of data,

403

00:24:14,503 --> 00:24:17,185

their irrigation strategy was modified,

404

00:24:17,205 --> 00:24:20,071

and the vines made it through.

405

00:24:20,091 --> 00:24:25,377

Not only that, but water usage was cut in half on some acres.

406

00:24:25,397 --> 00:24:28,597

The company uses commercial satellite data, too,

407

00:24:28,617 --> 00:24:30,215

but as Dokoozlian said,

408

00:24:30,235 --> 00:24:40,425

"Landsat is the most robust form of imagery across the state. We trust it more."

409

00:24:40,445 --> 00:24:44,279

In fact the company is moving to a system of irrigation

410

00:24:44,299 --> 00:24:50,385

that is mapped according to 30 by 30-meter Landsat pixels.

411

00:24:50,405 --> 00:24:54,773

Working with IBM and an irrigation company called Netafim,

412

00:24:54,793 --> 00:25:00,245

Gallo is developing what they call "farming by pixel."

413

00:25:00,265 --> 00:25:03,348

Taking the foundational data from Landsat

414

00:25:03,368 --> 00:25:09,488

and converting it into drip by drip irrigation decisions.

415

00:25:09,508 --> 00:25:12,707

The company is also talking with its neighbors,

416

00:25:12,727 --> 00:25:15,336

the water intensive almond growers,

417

00:25:15,356 --> 00:25:18,830

about the possibilities for their industry.

418
00:25:18,850 --> 00:25:22,934
This kind of approach would revolutionize the way people irrigate

419
00:25:22,954 --> 00:25:25,086
across the state of California,

420
00:25:25,106 --> 00:25:26,238
where, by the way,

421
00:25:26,258 --> 00:25:33,245
agriculture brings in receipts of 50 billion dollars per year.

422
00:25:33,265 --> 00:25:38,116
So the next time you enjoy a glass of wine, or some almonds,

423
00:25:38,136 --> 00:25:43,171
you might want to offer a toast to Landsat and to GRACE.

424
00:25:43,191 --> 00:25:49,261
[clapping]

425
00:25:49,281 --> 00:25:51,930
So California survived its historic drought,

426
00:25:51,950 --> 00:25:55,317
and the public and the private sectors are now retooling

427
00:25:55,337 --> 00:25:57,869
their long-term plans for managing water.

428
00:25:57,889 --> 00:26:00,956
And the view from space will help lead the way.

429
00:26:00,976 --> 00:26:03,158
The drought recovery took years

430

00:26:03,178 --> 00:26:07,913
helped in part by massive storms that
stretched across the Pacific this winter and spring

431
00:26:07,933 --> 00:26:12,050
and El Niño driven rain and
snow in the years before that.

432
00:26:12,070 --> 00:26:16,271
But while the local El Niño impact was beneficial

433
00:26:16,291 --> 00:26:21,893
it also reminded us of why we study the
Earth as an interconnected system.

434
00:26:21,913 --> 00:26:28,183
When a giant swell of warm water emerged
in the Pacific Ocean in 2015,

435
00:26:28,203 --> 00:26:31,469
scientists knew to look for impacts.

436
00:26:31,489 --> 00:26:35,106
As El Niño changed the global weather patterns,

437
00:26:35,126 --> 00:26:40,278
Southern Africa went into a severe drought.

438
00:26:40,298 --> 00:26:44,716
On top of already dry conditions,
the region experienced its

439
00:26:44,736 --> 00:26:49,804
lowest rainfall in 35 years.

440
00:26:49,824 --> 00:26:53,074
With the SMAP mission, launched in 2015,

441
00:26:53,094 --> 00:26:58,029

NASA has dedicated soil moisture measurements for the first time,

442

00:26:58,049 --> 00:27:02,067

and SMAP could see the severe drought emerging.

443

00:27:02,087 --> 00:27:06,204

SMAP's highly sensitive microwave radiometer detects the energy

444

00:27:06,224 --> 00:27:10,525

emitted by the soil, depending on how wet or how dry it is.

445

00:27:10,545 --> 00:27:11,793

It's like the old gardener's trick;

446

00:27:11,813 --> 00:27:18,083

you squeeze a handful of dirt and you see if it clumps up or if it falls apart.

447

00:27:18,103 --> 00:27:20,368

Think of SMAP as doing the same thing

448

00:27:20,388 --> 00:27:27,692

with a lot more precision, all around the world, every three days.

449

00:27:27,712 --> 00:27:32,330

SMAP allowed us to see the connection between the Pacific Ocean water temperatures

450

00:27:32,350 --> 00:27:36,051

and the moisture in the soil in southern Africa.

451

00:27:36,071 --> 00:27:37,669

But like with the data in California,

452

00:27:37,689 --> 00:27:43,291

these measurements are now being put to operational use more than ever.

453

00:27:43,311 --> 00:27:48,279

SMAP's data was fed into the USDA's global crop yield forecasts,

454

00:27:48,299 --> 00:27:51,599

the Foreign Agriculture Service reports that help drive

455

00:27:51,619 --> 00:27:56,021

multibillion-dollar commodity markets around the world.

456

00:27:56,041 --> 00:27:59,708

In fact, the scientists for this region said that with SMAP,

457

00:27:59,728 --> 00:28:06,581

they now have the first reliable soil moisture data in 30 years.

458

00:28:06,601 --> 00:28:08,817

As the soils dried out

459

00:28:08,837 --> 00:28:12,220

we also used the Terra and the Aqua satellites

460

00:28:12,240 --> 00:28:17,225

to assess the impact on vegetation across the countries of southern Africa.

461

00:28:17,245 --> 00:28:20,261

These NASA soil moisture and vegetation analyses

462

00:28:20,281 --> 00:28:23,648

were also fed into a USAID program

463

00:28:23,668 --> 00:28:27,652

called the Famine Early Warning Systems Network.

464

00:28:27,672 --> 00:28:29,654

As this drought spread,

465

00:28:29,674 --> 00:28:37,629

nearly 30 million people were
at risk of drastic food shortages.

466

00:28:37,649 --> 00:28:44,853

Four out of ten people did not have access to clean drinking water

467

00:28:44,873 --> 00:28:50,492

The global view provided by NASA
scientists helped inform USAID decisions

468

00:28:50,512 --> 00:28:54,796

about where the agency should send help.

469

00:28:54,816 --> 00:28:58,666

In southern Africa, in 2015 and 2016,

470

00:28:58,686 --> 00:29:05,390

USAID delivered nearly 350 million
dollars of emergency water and food aid

471

00:29:05,410 --> 00:29:09,110

to millions of people.

472

00:29:09,130 --> 00:29:12,664

Our planet's population hit seven billion people in

473

00:29:12,684 --> 00:29:17,719

2011 and we will likely hit 8 billion
in the next decade.

474

00:29:17,739 --> 00:29:21,790

We are more dependent than ever
on our global food system

475

00:29:21,810 --> 00:29:26,111

at a time when we expect droughts
like the ones you've seen tonight,

476

00:29:26,131 --> 00:29:29,814

to happen more frequently,
with more severity,

477

00:29:29,834 --> 00:29:32,734

for longer periods of time.

478

00:29:32,754 --> 00:29:36,938

The challenge is not only feeding a billion people

479

00:29:36,958 --> 00:29:40,708

but minimizing conflict.

480

00:29:40,728 --> 00:29:43,578

The defense and intelligence communities have named the

481

00:29:43,598 --> 00:29:48,933

increased likelihood of conflict due to
food and water shortages

482

00:29:48,953 --> 00:29:56,808

as one of the key threat multipliers
they are watching in the 21st century.

483

00:29:56,828 --> 00:29:59,761

Water drives life,

484

00:29:59,781 --> 00:30:03,214

and the global agriculture
system that depends on it.

485

00:30:03,234 --> 00:30:07,769

If we want to know and predict
what's happening with agriculture locally,

486

00:30:07,789 --> 00:30:11,790

we have to understand this system globally.

487

00:30:11,810 --> 00:30:16,494

And now, to bring us home, here's Marshall.

488

00:30:16,514 --> 00:30:25,537

[clapping]

489

00:30:25,557 --> 00:30:26,905

Well, there they are.

490

00:30:26,925 --> 00:30:29,040

They can't ever say they haven't been on a big screen.

491

00:30:29,060 --> 00:30:30,191

[laughter]

492

00:30:30,211 --> 00:30:32,393

Those are my kids,

493

00:30:32,413 --> 00:30:34,362

and hopefully tonight you see that

494

00:30:34,382 --> 00:30:36,664

this is not about pretty pictures from satellites.

495

00:30:36,684 --> 00:30:39,634

These are about
narratives of society.

496

00:30:39,654 --> 00:30:45,073

It's about their generation
and future generations to come.

497

00:30:45,093 --> 00:30:47,342

The bottom line is this for me:

498

00:30:47,362 --> 00:30:52,730

there is no plan B planet, for them or us.

499

00:30:52,750 --> 00:30:56,043

Now Christa and I have shown you several
in depth stories about water,

500

00:30:56,063 --> 00:30:59,397

and really only a fraction of the water cycle.

501

00:30:59,417 --> 00:31:01,773

Now keep in mind that NASA is applying the

502

00:31:01,793 --> 00:31:04,584

same intensity of monitoring and research

503

00:31:04,604 --> 00:31:09,309

to answer key questions about
other facets of the Earth's system.

504

00:31:09,329 --> 00:31:13,500

For example, what are the trends with
the world's ice sheets and glaciers,

505

00:31:13,520 --> 00:31:17,246

and what does that mean for our coastlines in the future?

506

00:31:17,266 --> 00:31:23,305

What do the ongoing changes to the
Arctic sea ice mean for the region?

507

00:31:23,325 --> 00:31:27,603

Next year NASA launches the
GRACE Follow-On and ICESat-2,

508

00:31:27,623 --> 00:31:31,936

representing major refreshes of our
ice and water monitoring capabilities.

509
00:31:31,956 --> 00:31:34,837
And this is important because in order to detect change

510
00:31:34,857 --> 00:31:39,054
we need to see trends, long-term trends.

511
00:31:39,074 --> 00:31:43,263
How is life on land and in the ocean
changing around the globe?

512
00:31:43,283 --> 00:31:46,217
How is carbon moving through the air and ocean and land?

513
00:31:46,237 --> 00:31:48,949
And then what does this mean for our future climate?

514
00:31:48,969 --> 00:31:52,523
The coming launches of
Landsat 9 and the GEDI lidar

515
00:31:52,543 --> 00:31:58,950
to the International Space Station will
advance these investigations.

516
00:31:58,970 --> 00:32:04,778
How will clouds and aerosols respond to,
and affect changes, in the Earth's system?

517
00:32:04,798 --> 00:32:09,191
This remains one of the biggest question
marks about our climate system.

518
00:32:09,211 --> 00:32:15,077
And there are questions.
That's why we as scientists do what we do.

519
00:32:15,097 --> 00:32:17,293
These questions aren't just scientific mysteries.

520

00:32:17,313 --> 00:32:22,498

Together they add up to a larger question of habitability on the planet.

521

00:32:22,518 --> 00:32:25,247

But there is good news.

522

00:32:25,267 --> 00:32:29,625

The good news is that science has tackled these types of challenges before.

523

00:32:29,645 --> 00:32:35,409

Just last month marked the 30th anniversary of the Montreal Protocol,

524

00:32:35,429 --> 00:32:40,054

an international agreement struck within years of science identifying a crisis:

525

00:32:40,074 --> 00:32:42,295

the ozone hole, which you see here.

526

00:32:42,315 --> 00:32:45,632

Now, note that the blue represents depleted ozone.

527

00:32:45,652 --> 00:32:50,517

That's the ozone hole over the Antarctic region.

528

00:32:50,537 --> 00:32:54,797

It would have never been possible without NASA's confirmation from space

529

00:32:54,817 --> 00:33:01,007

of the size and persistence of that hole.

530

00:33:01,027 --> 00:33:04,946

Now let's walk through a world-avoided simulation,

531

00:33:04,966 --> 00:33:08,321
just to kind of bring home the value of understanding that

532
00:33:08,341 --> 00:33:09,861
that ozone hole was there

533
00:33:09,881 --> 00:33:12,370
and doing something about it.

534
00:33:12,390 --> 00:33:17,415
On the left is the world with the Montreal Protocol.

535
00:33:17,435 --> 00:33:20,511
On the right is what the world's ozone layer would look like

536
00:33:20,531 --> 00:33:22,380
in the northern hemisphere

537
00:33:22,400 --> 00:33:25,811
if we didn't pass the Montreal Protocol.

538
00:33:25,831 --> 00:33:31,242
And keep in mind that blue represents depleted ozone.

539
00:33:31,262 --> 00:33:34,748
Watch what happens as we approach the year 2017,

540
00:33:34,768 --> 00:33:37,231
the year that we're in.

541
00:33:37,251 --> 00:33:39,286
Here at the latitude that we are,

542
00:33:39,306 --> 00:33:42,115
if we didn't pass the Montreal Protocol

543
00:33:42,135 --> 00:33:47,881
we would have about 10% more ozone depletion

544

00:33:47,901 --> 00:33:51,369

or 10% more increases, if you will,

545

00:33:51,389 --> 00:33:53,771

in the damaging UV radiation.

546

00:33:53,791 --> 00:33:58,631

Now UV radiation damages our skin,
first of all it's a health issue,

547

00:33:58,651 --> 00:34:04,297

and crops that we depend on for food.

548

00:34:04,317 --> 00:34:06,904

So science has risen to the challenge before,

549

00:34:06,924 --> 00:34:11,320

and as challenges mount, will need to again.

550

00:34:11,340 --> 00:34:15,937

But choosing to cast our lot with science is
really choosing to put our faith in people.

551

00:34:15,957 --> 00:34:19,521

Yes, we face enormous challenges in the years and decades ahead,

552

00:34:19,541 --> 00:34:23,614

as we push science and society to understand

553

00:34:23,634 --> 00:34:27,546

and manage the resources of our home planet.

554

00:34:27,566 --> 00:34:31,681

There is no better partnership than the one that we see between NASA,

555

00:34:31,701 --> 00:34:32,989

NOAA,

556

00:34:33,009 --> 00:34:34,591

USGS,

557

00:34:34,611 --> 00:34:36,409

other federal agencies

558

00:34:36,429 --> 00:34:39,574

and the vital collaborations with industry partners,

559

00:34:39,594 --> 00:34:43,159

many of which are represented in this room tonight.

560

00:34:43,179 --> 00:34:45,784

This partnership will lead the way

561

00:34:45,804 --> 00:34:47,813

into the 21st century

562

00:34:47,833 --> 00:34:52,298

with optimism that we can solve these challenges together.

563

00:34:52,318 --> 00:34:54,647

Our work has just begun.

564

00:34:54,667 --> 00:34:55,536

Thank you.