



1
00:00:04,470 --> 00:00:02,470
um this is an artist's rendering of what

2
00:00:06,789 --> 00:00:04,480
a first human mission to a near-earth

3
00:00:08,629 --> 00:00:06,799
object could look like in the mid-20s we

4
00:00:10,070 --> 00:00:08,639
could actually go to the kind of objects

5
00:00:11,669 --> 00:00:10,080
that we think are built are made of the

6
00:00:13,910 --> 00:00:11,679
building chemical blocks that could have

7
00:00:16,070 --> 00:00:13,920
helped seed life on planets

8
00:00:18,390 --> 00:00:16,080
there are a class of these small objects

9
00:00:20,550 --> 00:00:18,400
called near-earth objects that are

10
00:00:21,990 --> 00:00:20,560
we think made of carbonaceous materials

11
00:00:24,390 --> 00:00:22,000
those things certainly collided with

12
00:00:25,750 --> 00:00:24,400
early earth and early mars

13
00:00:27,189 --> 00:00:25,760

now the interesting thing about this is

14

00:00:29,269 --> 00:00:27,199

we don't know enough to design this

15

00:00:30,390 --> 00:00:29,279

mission now so there are artists and

16

00:00:32,069 --> 00:00:30,400

engineers who come up with what we'd

17

00:00:34,069 --> 00:00:32,079

like to do but since we haven't

18

00:00:35,190 --> 00:00:34,079

characterized these objects except for

19

00:00:36,709 --> 00:00:35,200

the one

20

00:00:38,150 --> 00:00:36,719

we don't know what we would do but one

21

00:00:39,670 --> 00:00:38,160

of the things we feel we would have to

22

00:00:41,110 --> 00:00:39,680

do is we wouldn't go land because

23

00:00:43,430 --> 00:00:41,120

there's no landing on an object that you

24

00:00:45,110 --> 00:00:43,440

bounce off of i mean kind of be hopeless

25

00:00:47,270 --> 00:00:45,120

almost futile so what we would do is

26
00:00:48,709 --> 00:00:47,280
send people down on rope chains and they

27
00:00:50,790 --> 00:00:48,719
would go and tether themselves to the

28
00:00:52,709 --> 00:00:50,800
surface it's kind of like climbing the

29
00:00:54,310 --> 00:00:52,719
wall of a rock you know in the grand

30
00:00:55,830 --> 00:00:54,320
canyon but knowing that if you fall off

31
00:00:57,189 --> 00:00:55,840
you're going to float away i mean a

32
00:00:59,029 --> 00:00:57,199
little less risky but you wouldn't want

33
00:01:01,029 --> 00:00:59,039
to float away in free space so here you

34
00:01:02,549 --> 00:01:01,039
see a couple of women tethered to a

35
00:01:04,469 --> 00:01:02,559
piece of an asteroid again we don't know

36
00:01:05,590 --> 00:01:04,479
that they look like this so one of the

37
00:01:08,469 --> 00:01:05,600
things you're going to see in the next

38
00:01:10,870 --> 00:01:08,479

decade is missions to asteroids by

39

00:01:12,469 --> 00:01:10,880

robots to see what they're really like

40

00:01:13,990 --> 00:01:12,479

sampling them

41

00:01:15,910 --> 00:01:14,000

understanding how to operate around them

42

00:01:17,910 --> 00:01:15,920

it's a very important step so you can

43

00:01:19,590 --> 00:01:17,920

see the last here's a woman and a guy

44

00:01:21,749 --> 00:01:19,600

coming off on their tether thing flying

45

00:01:23,670 --> 00:01:21,759

back little rocket packs

46

00:01:25,190 --> 00:01:23,680

back to the mother ship to come home

47

00:01:28,230 --> 00:01:25,200

so this is an artist rendering of what

48

00:01:29,670 --> 00:01:28,240

might happen some of you could be in the

49

00:01:31,510 --> 00:01:29,680

position of helping to make these kind

50

00:01:33,350 --> 00:01:31,520

of missions happen so i want to remind

51
00:01:35,190 --> 00:01:33,360
you before i go to mars that we actually

52
00:01:36,950 --> 00:01:35,200
have a constellation of 14 satellites in

53
00:01:39,109 --> 00:01:36,960
earth orbit and you might say well

54
00:01:41,190 --> 00:01:39,119
what's nasa doing for global warming for

55
00:01:42,550 --> 00:01:41,200
climate change we are doing a lot

56
00:01:43,510 --> 00:01:42,560
very often the things you see on the

57
00:01:44,950 --> 00:01:43,520
weather channel every now and the

58
00:01:47,830 --> 00:01:44,960
weather like today it's gonna rain again

59
00:01:49,990 --> 00:01:47,840
sorry um or the the snowmageddon we had

60
00:01:51,190 --> 00:01:50,000
this last winter here great great fun by

61
00:01:53,590 --> 00:01:51,200
the way

62
00:01:55,910 --> 00:01:53,600
is informed by these satellites

63
00:01:58,310 --> 00:01:55,920

we actually can produce a global mosaic

64

00:02:00,389 --> 00:01:58,320

of the entire earth's surface every day

65

00:02:03,030 --> 00:02:00,399

from the terra spacecraft we study the

66

00:02:05,910 --> 00:02:03,040

winds we have exploratory missions we

67

00:02:07,590 --> 00:02:05,920

study the nature of how the oceans work

68

00:02:09,109 --> 00:02:07,600

this is part of what we do here at nasa

69

00:02:11,430 --> 00:02:09,119

goddard we do it in partnership with

70

00:02:12,949 --> 00:02:11,440

other centers like jpl

71

00:02:15,430 --> 00:02:12,959

so the earth is a planet why should we

72

00:02:17,430 --> 00:02:15,440

neglect it and by watching how it moves

73

00:02:18,869 --> 00:02:17,440

and changes particularly its atmosphere

74

00:02:21,110 --> 00:02:18,879

oceans

75

00:02:22,550 --> 00:02:21,120

and land cover very quickly we get a

76

00:02:24,070 --> 00:02:22,560

little impression of how our own planet

77

00:02:26,309 --> 00:02:24,080

works now one thing nasa's done in the

78

00:02:28,470 --> 00:02:26,319

last couple years probably none of you

79

00:02:30,470 --> 00:02:28,480

heard about but i have to feel that i

80

00:02:32,550 --> 00:02:30,480

talk about it we've actually mapped the

81

00:02:35,190 --> 00:02:32,560

polar ice sheets in exquisite detail

82

00:02:37,190 --> 00:02:35,200

this is a flyover rendered completely by

83

00:02:40,630 --> 00:02:37,200

computer of the calibrated landsat

84

00:02:43,110 --> 00:02:40,640

mosaic of antarctica it's a fingerprint

85

00:02:45,750 --> 00:02:43,120

for the state of ground covered ice for

86

00:02:47,670 --> 00:02:45,760

our planet if that changes too much that

87

00:02:50,390 --> 00:02:47,680

tells us something we've watched over

88

00:02:51,830 --> 00:02:50,400

the last 20 years the retreat of not

89

00:02:53,830 --> 00:02:51,840

only mountain glaciers but of the ice

90

00:02:55,670 --> 00:02:53,840

sheet in antarctica pieces the size of

91

00:02:57,589 --> 00:02:55,680

delaware have broken off

92

00:03:00,229 --> 00:02:57,599

this is a

93

00:03:02,710 --> 00:03:00,239

a concern of ours because the runaway

94

00:03:04,229 --> 00:03:02,720

rate of these changes may be normal but

95

00:03:06,309 --> 00:03:04,239

we haven't experienced them as humans

96

00:03:07,830 --> 00:03:06,319

who are aware of it ever in our history

97

00:03:09,750 --> 00:03:07,840

you know middle ages i think people

98

00:03:11,190 --> 00:03:09,760

probably weren't aware of anything but

99

00:03:12,949 --> 00:03:11,200

now they are

100

00:03:15,750 --> 00:03:12,959

we are a living planet we talk we

101
00:03:17,670 --> 00:03:15,760
breathe and when you see recessions of

102
00:03:19,270 --> 00:03:17,680
the the ground lines of ice that are so

103
00:03:21,350 --> 00:03:19,280
rapid we get worried the other thing

104
00:03:23,990 --> 00:03:21,360
we're able to do is take stock of the

105
00:03:27,589 --> 00:03:24,000
biological health of our planet in 2d

106
00:03:29,509 --> 00:03:27,599
this map of the ocean color and related

107
00:03:32,070 --> 00:03:29,519
quantities allows us to see the state of

108
00:03:34,070 --> 00:03:32,080
health of biomass growing in the ocean

109
00:03:36,309 --> 00:03:34,080
and these big dark purple and blue zones

110
00:03:38,229 --> 00:03:36,319
are areas where there are less living

111
00:03:40,229 --> 00:03:38,239
things and we can do these kind of

112
00:03:42,229 --> 00:03:40,239
mappings from missions like sea whiffs

113
00:03:44,630 --> 00:03:42,239

from our modus routinely you can see

114

00:03:46,229 --> 00:03:44,640

blooms of of high biological production

115

00:03:48,229 --> 00:03:46,239

in the oceans of course the greens on

116

00:03:50,070 --> 00:03:48,239

land and the deserts one of the things

117

00:03:52,710 --> 00:03:50,080

nasa wants to do in the next decade is

118

00:03:54,630 --> 00:03:52,720

do this in 3d what's the biomass of the

119

00:03:56,630 --> 00:03:54,640

forests how is the carbon system

120

00:03:58,550 --> 00:03:56,640

changing this is critical and so we have

121

00:04:00,470 --> 00:03:58,560

mission plans to do that so the earth is

122

00:04:02,789 --> 00:04:00,480

a planet it's a living planet the only

123

00:04:05,270 --> 00:04:02,799

one we know we're looking for earths so

124

00:04:06,550 --> 00:04:05,280

here's earth in the living planet stage

125

00:04:08,710 --> 00:04:06,560

and this is what we do in our earth

126
00:04:10,710 --> 00:04:08,720
science program again superimposed on

127
00:04:13,110 --> 00:04:10,720
that so what about mars everyone asked

128
00:04:15,830 --> 00:04:13,120
me was mars ever like this

129
00:04:17,270 --> 00:04:15,840
is mars truly the astrobiological planet

130
00:04:20,710 --> 00:04:17,280
that we all know and love well for the

131
00:04:21,749 --> 00:04:20,720
last 15 years all of you who have cared

132
00:04:24,230 --> 00:04:21,759
to notice

133
00:04:25,670 --> 00:04:24,240
have witnessed the greatest robotic era

134
00:04:27,830 --> 00:04:25,680
of exploration of the planet mars in the

135
00:04:29,670 --> 00:04:27,840
history of women and men we are at a

136
00:04:31,830 --> 00:04:29,680
time of every time we go it's a new

137
00:04:33,430 --> 00:04:31,840
revolution in how we see the planet this

138
00:04:34,710 --> 00:04:33,440

fly around i'm showing you now was

139

00:04:37,350 --> 00:04:34,720

something i dreamt about when i first

140

00:04:40,070 --> 00:04:37,360

came to nasa now 25 years ago this is

141

00:04:41,749 --> 00:04:40,080

mars in 3d the hot colors are high the

142

00:04:43,270 --> 00:04:41,759

other colors are low this is the south

143

00:04:45,590 --> 00:04:43,280

polar ice sheet we now know it's made of

144

00:04:46,790 --> 00:04:45,600

water ice before this mission the mars

145

00:04:49,990 --> 00:04:46,800

global surveyor we thought it was all

146

00:04:52,230 --> 00:04:50,000

frozen carbon dioxide dry ice it's water

147

00:04:53,670 --> 00:04:52,240

sorry about that folks um this is the

148

00:04:56,390 --> 00:04:53,680

north polar ice sheet the great hockey

149

00:04:58,310 --> 00:04:56,400

puck um not a puck really but it's a

150

00:04:59,350 --> 00:04:58,320

large ice sheet like greenland on earth

151

00:05:00,870 --> 00:04:59,360

i don't know if any of you ever been to

152

00:05:02,629 --> 00:05:00,880

greenland but if you've flown over it

153

00:05:04,390 --> 00:05:02,639

this is about the same size spiraling

154

00:05:06,070 --> 00:05:04,400

canyons it

155

00:05:07,270 --> 00:05:06,080

the mars atmosphere exchanges itself

156

00:05:10,230 --> 00:05:07,280

with the surface

157

00:05:11,510 --> 00:05:10,240

uh 25 of the atmosphere freezes out and

158

00:05:13,350 --> 00:05:11,520

then re

159

00:05:15,510 --> 00:05:13,360

sublimes into the atmosphere every

160

00:05:17,270 --> 00:05:15,520

single year on the planet mars the mass

161

00:05:19,189 --> 00:05:17,280

balance of the polar ice sheets

162

00:05:20,870 --> 00:05:19,199

predominantly made of water ice are a

163

00:05:23,270 --> 00:05:20,880

critical barometer of climate history on

164

00:05:26,070 --> 00:05:23,280

mars we think mars has gone through

165

00:05:28,390 --> 00:05:26,080

monumental climate sweeps partly because

166

00:05:30,230 --> 00:05:28,400

its rotational axis the angle axis of

167

00:05:31,990 --> 00:05:30,240

obliquity as some of you may know

168

00:05:33,670 --> 00:05:32,000

actually doesn't wobble a couple degrees

169

00:05:36,070 --> 00:05:33,680

like earth's which causes huge climate

170

00:05:37,990 --> 00:05:36,080

changes over scales of ten thousand to a

171

00:05:40,870 --> 00:05:38,000

hundred thousand years on mars it

172

00:05:42,629 --> 00:05:40,880

wobbles by 20 to 30 degrees so imagine

173

00:05:43,830 --> 00:05:42,639

if the earth's axis you know

174

00:05:45,590 --> 00:05:43,840

went like

175

00:05:47,189 --> 00:05:45,600

well we would have a different climate

176

00:05:49,189 --> 00:05:47,199

state trust me

177

00:05:51,670 --> 00:05:49,199

physics does not lie people try to

178

00:05:54,629 --> 00:05:51,680

legislate it can't change it so mars has

179

00:05:56,390 --> 00:05:54,639

gone through wild climate change and we

180

00:05:58,309 --> 00:05:56,400

now know that by measuring things about

181

00:05:59,590 --> 00:05:58,319

the planet both in 3d and in the

182

00:06:02,309 --> 00:05:59,600

atmosphere

183

00:06:04,390 --> 00:06:02,319

so we did this mapping here at goddard

184

00:06:06,309 --> 00:06:04,400

with our partners at jpl as part of the

185

00:06:08,710 --> 00:06:06,319

mars global surveyor mission we now know

186

00:06:09,990 --> 00:06:08,720

any place we want on mars good to about

187

00:06:12,230 --> 00:06:10,000

a foot or two

188

00:06:14,150 --> 00:06:12,240

that allowed us to send missions to mars

189

00:06:15,990 --> 00:06:14,160

that before this mapping and before we

190

00:06:17,590 --> 00:06:16,000

got to look at the biggest volcano in

191

00:06:19,270 --> 00:06:17,600

the solar system in 3d would not have

192

00:06:20,870 --> 00:06:19,280

been possible i'd like to show this

193

00:06:23,909 --> 00:06:20,880

picture for a minute this is olympus

194

00:06:24,950 --> 00:06:23,919

mods it is six million cubic kilometers

195

00:06:27,590 --> 00:06:24,960

of rock

196

00:06:29,670 --> 00:06:27,600

it has around it a large cliff line an

197

00:06:31,350 --> 00:06:29,680

escarpment that is three to four

198

00:06:32,950 --> 00:06:31,360

kilometers high

199

00:06:34,710 --> 00:06:32,960

when we first saw that in photographs in

200

00:06:37,110 --> 00:06:34,720

1972 people said oh geez i didn't

201
00:06:38,629 --> 00:06:37,120
realize that would happen huh wonder why

202
00:06:41,350 --> 00:06:38,639
and they did a few calculations they

203
00:06:43,510 --> 00:06:41,360
realized big giant volcanoes are too

204
00:06:45,590 --> 00:06:43,520
heavy to hold themselves up and they

205
00:06:47,510 --> 00:06:45,600
collapse some people decide well why

206
00:06:49,430 --> 00:06:47,520
don't we see that on earth i wonder why

207
00:06:50,710 --> 00:06:49,440
let's go look we looked all around the

208
00:06:52,469 --> 00:06:50,720
big volcanoes of hawaii they all have

209
00:06:54,629 --> 00:06:52,479
big flank collapses like that only

210
00:06:56,390 --> 00:06:54,639
they're underwater never saw them what

211
00:06:58,629 --> 00:06:56,400
happens if a whole side of a volcano

212
00:06:59,830 --> 00:06:58,639
like all this part collapses

213
00:07:01,990 --> 00:06:59,840

on earth

214

00:07:03,749 --> 00:07:02,000

it moves stuff if it's underwater what's

215

00:07:06,309 --> 00:07:03,759

it going to move

216

00:07:07,909 --> 00:07:06,319

water what's the water going to do

217

00:07:09,350 --> 00:07:07,919

it's going to turn into gigantic

218

00:07:12,629 --> 00:07:09,360

tsunamis

219

00:07:14,309 --> 00:07:12,639

affect the coastlines of the pacific in

220

00:07:16,070 --> 00:07:14,319

the united states in the in the east

221

00:07:18,469 --> 00:07:16,080

from other places so we discovered by

222

00:07:20,790 --> 00:07:18,479

looking at mars how some aspects of our

223

00:07:22,309 --> 00:07:20,800

own planet work by just observing them

224

00:07:24,950 --> 00:07:22,319

so this is one of the discoveries where

225

00:07:27,270 --> 00:07:24,960

planets informed our own history on mars

226

00:07:29,670 --> 00:07:27,280

we have a system of giant volcanoes we

227

00:07:32,230 --> 00:07:29,680

have well we also have mars scene now

228

00:07:33,670 --> 00:07:32,240

here where we've taken topography and

229

00:07:35,110 --> 00:07:33,680

imaging from one of our satellites

230

00:07:37,029 --> 00:07:35,120

odyssey and put it together we do have

231

00:07:39,110 --> 00:07:37,039

little mini tornadoes on mars all the

232

00:07:40,710 --> 00:07:39,120

time and what we also have on mars which

233

00:07:43,189 --> 00:07:40,720

is so staggering aside from impact

234

00:07:44,469 --> 00:07:43,199

craters is the solar system's largest

235

00:07:45,909 --> 00:07:44,479

canyon system

236

00:07:49,749 --> 00:07:45,919

you might say well how did little old

237

00:07:51,110 --> 00:07:49,759

mars 38 the size of the earth okay not

238

00:07:53,909 --> 00:07:51,120

big enough to have worked the way the

239

00:07:56,550 --> 00:07:53,919

earth did produce a canyon system here

240

00:07:58,869 --> 00:07:56,560

that makes our own grand canyon dwarf in

241

00:08:00,710 --> 00:07:58,879

comparison how did it do that

242

00:08:04,150 --> 00:08:00,720

why does mars work so different here's

243

00:08:05,909 --> 00:08:04,160

los angeles for scale you can see 7.2

244

00:08:07,270 --> 00:08:05,919

kilometers our grand canyon i'll show

245

00:08:09,189 --> 00:08:07,280

you in a minute would fit in one of

246

00:08:11,029 --> 00:08:09,199

these little spare canyons if any of you

247

00:08:12,390 --> 00:08:11,039

been down in the canyon on a mule i

248

00:08:14,469 --> 00:08:12,400

think you'll know

249

00:08:15,990 --> 00:08:14,479

that was a joke um the mules are a

250

00:08:18,150 --> 00:08:16,000

little bit nasty at times but they are

251

00:08:19,990 --> 00:08:18,160

fine actually um so this is a canyon

252

00:08:21,589 --> 00:08:20,000

system that goes 3000 kilometers across

253

00:08:23,909 --> 00:08:21,599

the midriff to mars

254

00:08:26,629 --> 00:08:23,919

why is that what ripped apart this

255

00:08:29,510 --> 00:08:26,639

planet with a crust and possibly with a

256

00:08:31,350 --> 00:08:29,520

water history unlike anything on earth

257

00:08:33,029 --> 00:08:31,360

that's one of our conundrums one of our

258

00:08:35,430 --> 00:08:33,039

enigmas so here we are flying up one of

259

00:08:37,029 --> 00:08:35,440

those canyons seen from odyssey and our

260

00:08:39,269 --> 00:08:37,039

mars global surveyor the grand canyon

261

00:08:40,949 --> 00:08:39,279

for scale would fit right here

262

00:08:42,550 --> 00:08:40,959

so if any of you've been there it's

263

00:08:44,550 --> 00:08:42,560

pretty big pretty dog you don't want to

264

00:08:46,150 --> 00:08:44,560

fall in they do lose a few every year

265

00:08:47,750 --> 00:08:46,160

i've been told but

266

00:08:49,269 --> 00:08:47,760

so one of the things we learned about

267

00:08:51,590 --> 00:08:49,279

mars then the scales of things that

268

00:08:53,509 --> 00:08:51,600

operate on mars climate are different so