



Michael Meyer

Lead Scientist, Mars Exploration Program, NASA HQ

MARS

1
00:00:02,100 --> 00:00:08,309
GOOD AFTERNOON.

2
00:00:08,309 --> 00:00:13,000
TODAY YOU WILL HEAR THE FIRST OF
WHAT WILL CERTAINLY BE MANY MORE

3
00:00:13,000 --> 00:00:21,700
FINDINGS FROM MARS ATMOSPHERE
VOLATILE EVOLUTION MISSION OR

4
00:00:21,700 --> 00:00:25,970
MAVEN.

5
00:00:25,970 --> 00:00:28,150
SENDING HUMANS TO THE RED
PLANET.

6
00:00:28,150 --> 00:00:34,300
LADIES AND GENTLEMEN, MAVEN IS
HELPING ANSWER A QUESTION ASKED

7
00:00:34,300 --> 00:00:39,079
BY SCIENTISTS FOR DECADES, WHERE
DID THE ATMOSPHERE AND THE WATER

8
00:00:39,079 --> 00:00:40,079
GO?

9
00:00:40,079 --> 00:00:44,339
COULD THE SAME THING HAPPEN TO
EARTH?

10
00:00:44,339 --> 00:00:49,620
WE'LL HAVE BRIEF PRESENTATIONS
AND OPEN UP A QUESTION STARTING

11
00:00:49,620 --> 00:00:53,539
HERE AT NASA HEADQUARTERS AND GO

TO OUR PHONE LINES ACROSS THE

12

00:00:53,539 --> 00:00:57,570
COUNTRY AND ACROSS THE WORLD.

13

00:00:57,570 --> 00:01:07,710
SOCIAL MEDIA, IS A BUZZ WITH
MARS AND THE MAVEN MISSION.

14

00:01:07,710 --> 00:01:10,340
SEND QUESTIONS IN TO †#ASKNASA.

15

00:01:10,340 --> 00:01:14,990
WE'LL GET TO SOME OF YOUR
QUESTIONS ON SOCIAL MEDIA.

16

00:01:14,990 --> 00:01:19,659
WE'LL HAVE AN HOUR LONG SESSION
AND PERHAPS LONGER TO SEND IN

17

00:01:19,659 --> 00:01:22,890
YOUR QUESTIONS AND HAVE SOME OF
THE SCIENTISTS ANSWER YOUR

18

00:01:22,890 --> 00:01:24,920
QUESTIONS FROM ALL OVER THE
WORLD.

19

00:01:24,920 --> 00:01:26,220
#ASKNASA.

20

00:01:26,220 --> 00:01:28,640
AND OF COURSE YOU'LL BE ABLE TO
FOLLOW ALL OF THIS INFORMATION

21

00:01:28,640 --> 00:01:35,000
AND MUCH, MUCH MORE ON THE WEB
AT NASA.GOV/MAVEN.

22

00:01:35,000 --> 00:01:42,570
AND THE JOURNEY TO MARS.

23
00:01:42,570 --> 00:01:45,799
LET ME INTRODUCE YOU TO OUR
FOLKS HERE AND ALSO JOINING US

24
00:01:45,799 --> 00:01:48,219
FROM IOWA AND COLORADO.

25
00:01:48,219 --> 00:01:53,880
FIRST, MICHAEL MEYER LEAD
SCIENTIST, NAS KA EXPLORATION

26
00:01:53,880 --> 00:01:57,189
PROGRAM.

27
00:01:57,189 --> 00:02:08,929
BRUCE JAKOSKY, AT THE LABORATORY
FOR ATMOSPHERE AND SPACE PHYSICS

28
00:02:08,929 --> 00:02:14,720
AT THE UNIVERSITY OF COLORADO
BOULDER.

29
00:02:14,720 --> 00:02:19,500
AND JOINING US FROM IOWA CITY,
JASPER HALEKAS, THE MAVEN SOLAR

30
00:02:19,500 --> 00:02:23,530
WIND ION ANALYZING INSTRUMENT
LEAD FROM THE UNIVERSITY OF

31
00:02:23,530 --> 00:02:26,830
IOWA.

32
00:02:26,830 --> 00:02:31,750
AND OVER AT COLORADO,
YAXUE†DONG.

33

00:02:31,750 --> 00:02:35,040

MAVEN SCIENCE TEAM MEMBER.

34

00:02:35,040 --> 00:02:40,430

AND DAVE BRAIN

MAVEN†CO-INVESTIGATOR.

35

00:02:40,430 --> 00:02:41,430

SO LET'S GET STARTED.

36

00:02:41,430 --> 00:02:44,010

I'LL TOSS IT TO MICHAEL.

37

00:02:44,010 --> 00:02:45,010

>> THANKS.

38

00:02:45,010 --> 00:02:48,400

THE NASCAR MARS EXPLORATION
PROGRAM IS FOCUSED ON FINDING

39

00:02:48,400 --> 00:02:49,450

WATER.

40

00:02:49,450 --> 00:02:52,200

WATER IS THE PRIME INGREDIENT
NEEDED FOR LIFE.

41

00:02:52,200 --> 00:02:57,060

IT'S A MAJOR FABRIC IN THE
CLIMATE AND SHAPING GEOLOGY AND

42

00:02:57,060 --> 00:03:01,640

IS A CRITICAL RESOURCE FOR
FUTURE HUMAN EXPLORATION.

43

00:03:01,640 --> 00:03:05,600

WE HAVE VISUAL EVIDENCE OF WATER
ON MARS FROM ORBIT.

44
00:03:05,600 --> 00:03:11,610
WE HAVE ROVERS THAT FOUND ROCKS
THAT FORMED AND WE HAVE FOUND

45
00:03:11,610 --> 00:03:18,680
EVIDENCE THAT ANCIENT MARS HAD
ENOUGH WATER TO SUPPORT LIFE.

46
00:03:18,680 --> 00:03:21,260
SO WE LOOKED FOR WATER AND WE
FOUND IT.

47
00:03:21,260 --> 00:03:26,930
IF YOU LOOK AT MARS TODAY, IT'S
A COLD, DRY DESERT PLANET.

48
00:03:26,930 --> 00:03:29,620
WHAT HAPPENED?

49
00:03:29,620 --> 00:03:31,190
MARS LOST IT'S ATMOSPHERE.

50
00:03:31,190 --> 00:03:33,730
HOW DID THAT HAPPEN?

51
00:03:33,730 --> 00:03:37,110
>> THE ATMOSPHERE OF MARS COULD
HAVE FROZEN OUT.

52
00:03:37,110 --> 00:03:40,110
IT COULD HAVE BEEN TURNED INTO
ROCKS.

53
00:03:40,110 --> 00:03:44,540
IT COULD HAVE BEEN KNOCKED OFF
BY ASTEROIDS OR COMETS OR

54
00:03:44,540 --> 00:03:47,580
STRIPPED FROM THE PLANET BY THE

SOLAR WIND.

55

00:03:47,580 --> 00:03:54,110

TO ANSWER THIS QUESTION, NASA
HAS SENT THE MISSION TO MARS.

56

00:03:54,110 --> 00:03:58,040

THAT MISSION WAS DESIGNED TO
LOOK AT THE UPPER ATMOSPHERIC

57

00:03:58,040 --> 00:04:06,850

PROCESSES AND GET A BETTER
HANDLE ON ATMOSPHERIC LOSS.

58

00:04:06,850 --> 00:04:12,420

SO WHAT HAPPENED†-- SO WE ARE
LOOKING AT A MISSION THAT IS

59

00:04:12,420 --> 00:04:16,560

NEARING IT'S†-- COMPLETING IT'S
TIME.

60

00:04:16,560 --> 00:04:22,570

IT HAS BEEN UNDERBUDGET AND ON
TIME AND IS BEHAVING

61

00:04:22,570 --> 00:04:24,380

BEAUTIFULLY.

62

00:04:24,380 --> 00:04:28,690

SO TO ANSWER THE QUESTION, WHAT
HAPPENED TO THE MARS ATMOSPHERE

63

00:04:28,690 --> 00:04:30,440

I'LL QUOTE BOB DYLAN.

64

00:04:30,440 --> 00:04:34,510

THE ANSWER MY FRIEND IS BLOWING
IN THE WIND.

65

00:04:34,510 --> 00:04:37,900

AND TO GIVE US MORE DETAIL I'LL
TURN THE MIC OVER TO THE

66

00:04:37,900 --> 00:04:41,830

PRINCIPLE INVESTIGATION, BRUCE
JAKOSKY.

67

00:04:41,830 --> 00:04:43,200

>> THANK YOU.

68

00:04:43,200 --> 00:04:48,610

IT'S BEEN ORBITING SINCE
SEPTEMBER 2014.

69

00:04:48,610 --> 00:04:52,600

WE'RE COMING UP ON THE END OF
THE ONE YEAR PRIMARY MISSION.

70

00:04:52,600 --> 00:04:57,150

THE MISSION LASTS FOR ANOTHER
TEN DAYS AND WILL BE BEGINNING

71

00:04:57,150 --> 00:05:01,530

AN EXTENDED MISSION AFTER THAT
THE SPACECRAFT AND ALL THE

72

00:05:01,530 --> 00:05:05,510

SCIENCE INSTRUMENTS ARE WORKING
WELL AND WE'RE HERE TO TELL YOU

73

00:05:05,510 --> 00:05:07,880

TODAY ABOUT SOME OF THE RESULTS
THAT HAVE COME OUT FROM THE

74

00:05:07,880 --> 00:05:13,860

FIRST SIX MONTHS OR SO OF DATA
ANALYSIS IT'S TAKEN A LONG TIME

75

00:05:13,860 --> 00:05:19,690
BECAUSE THEY'RE NOT INSTRUMENTS
THAT CAN BE INTERRUPTED.

76
00:05:19,690 --> 00:05:24,730
THEY REQUIRE ANALYSIS TO MAKE
SURE THAT WE UNDERSTAND WHAT'S

77
00:05:24,730 --> 00:05:26,450
COMING OUT OF THAT.

78
00:05:26,450 --> 00:05:29,770
IT'S TAKEN AWHILE TO GET HERE
BUT WE HAVE RESULTS WE THINK ARE

79
00:05:29,770 --> 00:05:31,180
EXCITING.

80
00:05:31,180 --> 00:05:35,070
WE'RE GOING TO TALK ABOUT THE
HISTORY OF CLIMATE ON MARS.

81
00:05:35,070 --> 00:05:38,070
MAVEN WAS DESIGNED TO UNDERSTAND
THE CHANGES IN CLIMATE.

82
00:05:38,070 --> 00:05:43,900
IF WE CAN ROLL THE FIRST VIDEO
PLEASE, TODAY'S PLANET IS A

83
00:05:43,900 --> 00:05:46,440
COLD, DRY, DESERT-LIKE
ENVIRONMENT.

84
00:05:46,440 --> 00:05:48,680
THE ATMOSPHERE IS THIN.

85
00:05:48,680 --> 00:05:51,420
IT'S NOT CAPABLE OF
SUSTAINING†LIQUID WATER AT THE

86

00:05:51,420 --> 00:05:55,170

SURFACE TODAY.

87

00:05:55,170 --> 00:05:59,830

HOWEVER ANCIENT MARS WE SEE A
DIFFERENT TYPE OF SURFACE.

88

00:05:59,830 --> 00:06:04,930

ONE THAT HAD VALLEYS THAT LOOK
LIKE THEY'RE CARVED BY WATER.

89

00:06:04,930 --> 00:06:09,160

LAKES THAT WERE STANDING FOR
LONG PERIOD OF TIME.

90

00:06:09,160 --> 00:06:12,450

WE SEE AN ENVIRONMENT THAT WAS
MUCH MORE ABLE TO SUPPORT LIQUID

91

00:06:12,450 --> 00:06:13,450

WATER.

92

00:06:13,450 --> 00:06:15,330

THE CLIMATE MUST HAVE BEEN VERY
DIFFERENT.

93

00:06:15,330 --> 00:06:18,419

WARMER AND WETTER AND THE
ATMOSPHERE MUST HAVE BEEN

94

00:06:18,419 --> 00:06:22,390

THICKER AT THAT TIME IN ORDER TO
SUSTAIN WARMER CLIMATE.

95

00:06:22,390 --> 00:06:25,870

WHAT HAPPENED TO THE CARBON
DIOXIDE FROM THE EARLY

96

00:06:25,870 --> 00:06:26,870

ATMOSPHERE?

97

00:06:26,870 --> 00:06:29,210

WHAT HAPPENED TO THE WATER FROM
EARLY MARS?

98

00:06:29,210 --> 00:06:33,520

MAVEN IS EXPLORING THE ABILITY
OF THE ATMOSPHERIC GASES TO GO

99

00:06:33,520 --> 00:06:36,570

TO THE TOP OF THE ATMOSPHERE
WHERE THEY CAN BE STRIPPED AWAY

100

00:06:36,570 --> 00:06:39,630

BY THE SOLAR WIND.

101

00:06:39,630 --> 00:06:42,260

WE'RE STUDYING THE TOP OF THE
ATMOSPHERE BECAUSE THAT'S THE

102

00:06:42,260 --> 00:06:46,800

CONDUIT THROUGH WHICH THE GAS
HAS TO TRAVEL TO GO FROM THE

103

00:06:46,800 --> 00:06:49,970

MAIN PART OF THE ATMOSPHERE TO
WHERE IT CAN GET REMOVED TO

104

00:06:49,970 --> 00:06:51,470

SPACE.

105

00:06:51,470 --> 00:06:58,780

WE'RE GOING TO LOOK AT A LOT OF
DIFFERENT PROCESSES BUT WE'RE

106

00:06:58,780 --> 00:07:03,430

GOING TO FOCUS LARGELY TODAY ON
THE ABILITY OF THE SOLAR WIND TO

107

00:07:03,430 --> 00:07:04,650

STRIP THE GAS AWAY.

108

00:07:04,650 --> 00:07:08,080

IF WE CAN ROLL THE SECOND VIDEO,
PLEASE, WE'RE LOOKING AT THE

109

00:07:08,080 --> 00:07:12,150

SOLAR WIND AS IT IMPINGES ON THE
PLANET.

110

00:07:12,150 --> 00:07:16,090

IT'S STREAMING OUT FROM THE SUN
AT ABOUT 1 MILLION MILES AN HOUR

111

00:07:16,090 --> 00:07:21,000

AND IS ABLE TO GRAB IONS FROM
THE PLANET AND STRIP THEM AWAY

112

00:07:21,000 --> 00:07:23,710

FROM THE PLANET OR KNOCK THEM
INTO THE PLANET AT VERY HIGH

113

00:07:23,710 --> 00:07:26,800

SPEED AND KNOCK OTHER STUFF OFF.

114

00:07:26,800 --> 00:07:30,660

WE'RE GOING TO BE TALKING TODAY
ABOUT THE ROLE OF THE SOLAR WIND

115

00:07:30,660 --> 00:07:33,850

IN STRIPPING THE ATMOSPHERE AND
WE'LL BE HEARING ABOUT THE

116

00:07:33,850 --> 00:07:38,530

BEHAVIOR OF THE SOLAR WIND AND
THE CONSEQUENCES OF LOSS TO

117

00:07:38,530 --> 00:07:39,530
SPACE.

118
00:07:39,530 --> 00:07:40,530
DWAYNE.

119
00:07:40,530 --> 00:07:42,630
>> THANK YOU, BRUCE.

120
00:07:42,630 --> 00:07:44,620
LET'S GET INTO MORE OF THOSE
DETAILS.

121
00:07:44,620 --> 00:07:47,590
LET'S GO TO THE UNIVERSITY OF
IOWA AND IOWA CITY AND JASPER

122
00:07:47,590 --> 00:07:48,750
HALEKAS.

123
00:07:48,750 --> 00:07:51,050
>> THANK YOU.

124
00:07:51,050 --> 00:07:56,010
I'D LIKE TO SET THE STAGE BY
DESCRIBING HOW MARS INTERACTS

125
00:07:56,010 --> 00:07:57,010
WITH IT'S ENVIRONMENT.

126
00:07:57,010 --> 00:08:00,570
IF I COULD HAVE MY FIRST GRAPHIC
PLEASE, MARS HAS SOMETHING IN

127
00:08:00,570 --> 00:08:05,090
COMMON WITH EARTH AND THAT'S THE
INFLUENCE OF THE SUN.

128
00:08:05,090 --> 00:08:09,139

AS YOU SEE, ALL OF THE PLANETS,
MARS AND EARTH AND THE OTHERS

129

00:08:09,139 --> 00:08:19,730

INCLUDED ARE INPINGED UPON BY
THE PARTICLES IN THE WIND.

130

00:08:19,730 --> 00:08:22,740

THEY IMPACT ALL OF THE PLANETS
IN OUR SOLAR SYSTEM.

131

00:08:22,740 --> 00:08:25,810

NOW THE EARTH AND MARS HAVE
SOMETHING VERY DIFFERENT

132

00:08:25,810 --> 00:08:32,149

HOWEVER, THE EARTH HAS A STRONG
GLOBAL MAGNETIC FIELD AND THAT

133

00:08:32,149 --> 00:08:36,349

LARGELY SHIELDS THE ATMOSPHERE.

134

00:08:36,349 --> 00:08:40,199

ON THE LEFT, MARS HAS NO SUCH
GLOBAL MAGNETIC FIELD AND IT'S

135

00:08:40,199 --> 00:08:43,779

UPPER ATMOSPHERE IS COMPLETELY
EXPOSED.

136

00:08:43,779 --> 00:08:51,319

AS A RESULT IT CAN INTERACT AND
STRETCH PORTIONS OF IT AWAY INTO

137

00:08:51,319 --> 00:08:54,329

SPACE.

138

00:08:54,329 --> 00:08:56,749

IT'S STILL THICK ENOUGH TO STOP
THE SOLAR WIND FROM HITTING THE

139

00:08:56,749 --> 00:09:00,990

SURFACE OF MARS.

140

00:09:00,990 --> 00:09:04,660

I'M ABOUT TO SHOW YOU A MOVIE†--
IF I COULD HAVE MY SECOND

141

00:09:04,660 --> 00:09:08,420

GRAPHIC PLEASE, THE MOVIE YOU'RE
ABOUT TO SEE SHOWS THE

142

00:09:08,420 --> 00:09:11,940

TRAJECTORIES OF THE SOLAR WIND
AS THEY PASS BY MARS.

143

00:09:11,940 --> 00:09:15,540

IT WILL BE COMING IN FROM RIGHT
TO LEFT AND YOU SEE THAT IT'S

144

00:09:15,540 --> 00:09:19,329

DEFLECTED AROUND MARS IN A
SHAPE.

145

00:09:19,329 --> 00:09:22,019

YOU MIGHT NOTICE THAT THAT SHAPE
IS VERY REMINISCENT OF THE

146

00:09:22,019 --> 00:09:26,550

SHOCKWAVE AND THAT'S NO ACCIDENT
AT ALL.

147

00:09:26,550 --> 00:09:30,089

IT'S THE SAME KIND OF A
SHOCKWAVE THAT'S FORMED.

148

00:09:30,089 --> 00:09:32,629

BEHIND THE SOLAR WIND
TRAJECTORIES YOU'RE SEEING

149

00:09:32,629 --> 00:09:36,800

ACTUAL DATA TAKEN FROM THE
MISSION AT MARS.

150

00:09:36,800 --> 00:09:39,630

THE COLORS THERE ARE SHOWING THE
DENSITY OF THE SOLAR WIND

151

00:09:39,630 --> 00:09:43,600

PLASMAS, NUMBER OF CHARGED
PARTICLES FROM THE SOLAR WIND

152

00:09:43,600 --> 00:09:46,769

AND THE VECTORS SHOW THE
DIRECTION THAT THE SOLAR WIND IS

153

00:09:46,769 --> 00:09:47,769

FLOWING.

154

00:09:47,769 --> 00:09:50,390

THIS DATA SHOWS EXACTLY WHAT YOU
JUST SAW IN THE SIMULATED SOLAR

155

00:09:50,390 --> 00:09:54,970

WIND WHICH IS THAT THE SOLAR
WIND COMES IN AND YOU SEE THE

156

00:09:54,970 --> 00:09:58,779

DENSITY JUMP UP FROM BLUE TO RED
THERE AND IS DEFLECTED AROUND

157

00:09:58,779 --> 00:10:09,129

MARS BUT THAT CONTINUES IN PAST
THAT OUTER BOUNDARY AND AT THAT

158

00:10:09,129 --> 00:10:10,709

POINT THE RUBBER HITS THE ROAD.

159

00:10:10,709 --> 00:10:14,089

THERE'S A SECOND BOUNDARY THERE
WHERE THE SOLAR WIND INTERACTS

160
00:10:14,089 --> 00:10:15,929
DIRECTLY WITH THE UPPER
ATMOSPHERE.

161
00:10:15,929 --> 00:10:19,029
THIS IS UNLIKE ANYTHING WE HAVE.

162
00:10:19,029 --> 00:10:22,699
AS A RESULT OF THE MAGNETIC AND
ELECTRIC FIELDS CARRIED WITH THE

163
00:10:22,699 --> 00:10:24,339
SOLAR WIND FLOWS.

164
00:10:24,339 --> 00:10:29,730
IONS SOMEBODY ACCELERATED UP TO
ESCAPED VELOCITY AND BEYOND AND

165
00:10:29,730 --> 00:10:32,209
WE BELIEVE THIS IS AN IMPORTANT
PROCESS BY WHICH THE MARS

166
00:10:32,209 --> 00:10:34,720
ATMOSPHERE IS TODAY.

167
00:10:34,720 --> 00:10:41,769
THIS CHANGES WITH HOW HARD THE
SOLAR WIND IS BLOWING.

168
00:10:41,769 --> 00:10:45,010
THIS INTERACTION PICTURE
EXPANDS.

169
00:10:45,010 --> 00:10:49,129
THE SOLAR WIND AND STRONG GAIL
FORCE WIND THEN IT'S COMPRESSED

170

00:10:49,129 --> 00:10:50,680

DOWNWARD TO THE SURFACE.

171

00:10:50,680 --> 00:10:55,100

THE NATURAL QUESTION IS WHAT
DOES THAT DO TO THE LOSS RATE OF

172

00:10:55,100 --> 00:10:57,300

ATMOSPHERE TO MARS.

173

00:10:57,300 --> 00:10:59,819

WE CONDUCTED AN EXPERIMENT TO
TRY TO ANSWER THAT OR RATHER

174

00:10:59,819 --> 00:11:04,880

NATURE HAS CONDUCTED THE
WONDERFUL EXPERIMENT FOR US.

175

00:11:04,880 --> 00:11:15,059

IT LAUNCHED PARTICLES OUTWARD.

176

00:11:15,059 --> 00:11:21,379

THE CHARGED PARTICLES FROM THE
SUN STREAM OUTWARD AT DOUBLE

177

00:11:21,379 --> 00:11:24,389

THEIR NORMAL VELOCITY INSTEAD OF
THE NORMAL 1 MILLION MILES AN

178

00:11:24,389 --> 00:11:25,699

HOUR.

179

00:11:25,699 --> 00:11:30,480

THIS BUBBLE JETS OUT AT 2
MILLION MILES PER HOUR CARRYING

180

00:11:30,480 --> 00:11:32,689

A TREMENDOUS AMOUNT OF ENERGY.

181
00:11:32,689 --> 00:11:36,720
IT CARRIES IT'S OWN SHOCKWAVES.

182
00:11:36,720 --> 00:11:42,259
SO YOU HAVE TWO JET PLANES EACH
WITH THEIR OWN SHOCKWAVE

183
00:11:42,259 --> 00:11:45,480
APPROACHING EACH OTHER BUT ONE
OF THEM IS TENS OF THOUSANDS

184
00:11:45,480 --> 00:11:47,189
BIGGER THAN THE OTHER ONE.

185
00:11:47,189 --> 00:11:50,189
IF YOU ACTUALLY DID THIS THINGS
WOULDN'T GO WELL FOR THE SMALL

186
00:11:50,189 --> 00:11:51,490
PLANE.

187
00:11:51,490 --> 00:11:56,189
MARS WHICH IS THE SMALL PLANE IS
MORE ROBUST BUT STRONGLY

188
00:11:56,189 --> 00:11:59,769
IMPACTED BY THE ENERGY DELIVERED
BY THIS EVENT.

189
00:11:59,769 --> 00:12:04,249
IT COMPRESSES THE PROTECTED
REGION AROUND THE PLANET DOWN TO

190
00:12:04,249 --> 00:12:08,459
ABOUT 2-THIRDS OF ITS NORMAL
SIZE AND AS A RESULT MORE OF THE

191
00:12:08,459 --> 00:12:11,560
ATMOSPHERE IS EXPOSED AS THESE

FIELDS STRIP AWAY PARTICLES.

192

00:12:11,560 --> 00:12:18,950

IN FACT WE SEE THIS GOES UP BY A
FACT OF THE OF BETWEEN 10 AND 20

193

00:12:18,950 --> 00:12:23,269

SO IT HAS AN ENORMOUS IMPACT ON
THE UPPER ATMOSPHERE OF MARS.

194

00:12:23,269 --> 00:12:26,860

NOW I'M GOING TO THROW IT TO THE
OVER TO UNIVERSITY OF COLORADO

195

00:12:26,860 --> 00:12:29,920

AND SHE WILL TELL YOU ABOUT THE
PROCESSES AND THE CHANNELS BY

196

00:12:29,920 --> 00:12:35,170

WHICH THE CHARGED PARTICLES ARE
ACTUALLY LOST IN SPACE.

197

00:12:35,170 --> 00:12:37,100

>> THANK YOU.

198

00:12:37,100 --> 00:12:42,180

SO HE TALKED ABOUT INTERACTION.

199

00:12:42,180 --> 00:12:46,069

NEXT WE'RE GOING TO TALK ABOUT
THE CONSEQUENCE OF THIS

200

00:12:46,069 --> 00:12:47,779

INTERACTION.

201

00:12:47,779 --> 00:12:50,069

AND CAN I HAVE THE VIDEO PLEASE?

202

00:12:50,069 --> 00:12:52,690

FIRST WE'LL SHOW A SIMULATION
VIDEO.

203

00:12:52,690 --> 00:12:57,870

WE'RE LOOKING AT THE WIND HERE
AND IT ALSO CARRYING A

204

00:12:57,870 --> 00:13:00,059

MAGNIFICENT FIELD.

205

00:13:00,059 --> 00:13:04,020

THE MOVING MAGNET WILL GENERATE
AN ELECTRIC FIELD IN THE

206

00:13:04,020 --> 00:13:09,189

OPPOSITE DIRECTION IN THIS VIDEO
AND THIS WILL CAUSE THE IONS TO

207

00:13:09,189 --> 00:13:11,779

MOVE AND ESCAPE FROM MARS.

208

00:13:11,779 --> 00:13:17,089

SOME ARE ACTIVATED BY THIS FIELD
VERY QUICKLY.

209

00:13:17,089 --> 00:13:23,950

YOU CAN SEE THEY FORM THESE THAT
LOOK LIKE A FUN DANE FROM THE

210

00:13:23,950 --> 00:13:25,199

TOP OF MARS.

211

00:13:25,199 --> 00:13:29,379

MEANWHILE, SOME OTHERS IONS WILL
DRIFT AROUND MARS AND EVENTUALLY

212

00:13:29,379 --> 00:13:33,019

ESCAPE IN THE SOLAR WIND
DIRECTION AND THEY WILL FALL

213
00:13:33,019 --> 00:13:38,009
BEHIND MARS AND THE MAVEN
SPACECRAFT IS ABLE TO MEASURE

214
00:13:38,009 --> 00:13:45,269
THE ION COMPETITIONS AND THE
VELOCITIES AND HERE SHOW THE

215
00:13:45,269 --> 00:13:56,899
DATA MATCH THE SIMULATION
RESULTS VERY WELL.

216
00:13:56,899 --> 00:14:00,459
CAN I HAVE THE NEXT GRAPHIC
PLEASE?

217
00:14:00,459 --> 00:14:03,999
>> SO NEXT WE ARE GOING TO TAKE
A CLOSER LOOK AT THE MAVEN DATA.

218
00:14:03,999 --> 00:14:08,910
SO FROM THE DATA WE CAN CLEARLY
IDENTIFY THEM IN THE MOVING

219
00:14:08,910 --> 00:14:10,860
DIRECTIONS.

220
00:14:10,860 --> 00:14:12,819
FIRST.

221
00:14:12,819 --> 00:14:19,549
IN THE UPPER HEMISPHERE MOVING
IN THE ELECTRIC FIELD DIRECTION

222
00:14:19,549 --> 00:14:24,180
AND THE RED AND YELLOW COLORS IN
THIS REGION MEAN THAT THERE ARE

223
00:14:24,180 --> 00:14:27,899

MANY ESCAPING THROUGH THE PLUME.

224

00:14:27,899 --> 00:14:36,199

AND AS SUCH A EXTENTIAL†PLUME
HAS NEVER BEEN IDENTIFIED.

225

00:14:36,199 --> 00:14:41,079

SO MAVEN PROVIDED THE FIRST
OBSERVATION FOR THE PLUME AS A

226

00:14:41,079 --> 00:14:45,019

MAJOR FEATURE OF THE ATMOSPHERE.

227

00:14:45,019 --> 00:14:50,379

AND SECOND, IF YOU LOOK AT THE
NIGHT SIDE OF MARS THEY ARE ALSO

228

00:14:50,379 --> 00:14:59,019

MANY IONS ESCAPING IN THE SOLAR
WIND DIRECTION AND THE

229

00:14:59,019 --> 00:15:03,689

VELOCITIES ARE SIGNIFICANTLY
HIGHER.

230

00:15:03,689 --> 00:15:11,449

AS SHOWN BY THESE LONGER ARROWS
IN THE REGION AND THIRD, THEY

231

00:15:11,449 --> 00:15:13,290

ARE COMING TOWARD MARS.

232

00:15:13,290 --> 00:15:21,579

THEY ARE GENERATED FROM THE
EXTENDED PART OF THE ATMOSPHERE

233

00:15:21,579 --> 00:15:25,709

AND THESE ARE MOVING TOWARD MARS
AND CARRIED BY THE UPSTREAM

234

00:15:25,709 --> 00:15:30,529

SOLAR WIND AND FROM THE
DIFFERENT COLORS IN THESE WE CAN

235

00:15:30,529 --> 00:15:34,249

TELL THAT MOST OF THEM ARE
ESCAPING THROUGH THE PLUME END

236

00:15:34,249 --> 00:15:35,939

OF THE TAIL.

237

00:15:35,939 --> 00:15:40,350

AND THEY'RE THE TWO MAJOR
ESCAPING CHANNELS.

238

00:15:40,350 --> 00:15:45,059

OKAY CAN I HAVE THE NEXT
GRAPHIC, PLEASE?

239

00:15:45,059 --> 00:15:48,040

SO BASED ON ALL OF THESE
OBSERVATIONS, WE CAN ESTIMATE

240

00:15:48,040 --> 00:15:55,199

THE PLUME TO CONTRIBUTE ABOUT
25% TO THE TOTAL AND TAIL ABOUT

241

00:15:55,199 --> 00:16:00,559

75% AND THIS IS THE FIRST TIME
THAT WE CAN CONFIRM FROM

242

00:16:00,559 --> 00:16:04,829

OBSERVATIONS THAT THE PLUME IS
VERY IMPORTANT TO PLANETARY

243

00:16:04,829 --> 00:16:10,629

ESCAPE CHANNEL FROM MARS AND WE
CAN QUANTITATIVELY ESTIMATE THE

244

00:16:10,629 --> 00:16:14,199
CONTRIBUTION FROM THE PLUME TO
THE TOTAL ION.

245
00:16:14,199 --> 00:16:22,069
SO WE'LL HAVE TO TALK ABOUT
THE TOTAL.

246
00:16:22,069 --> 00:16:23,189
>> THANK YOU.

247
00:16:23,189 --> 00:16:28,920
SHE SHOWED THE DIFFERENT PATHS
THAT IONS OR CHARGED PARTICLES

248
00:16:28,920 --> 00:16:32,160
CAN TAKE AS THEY'RE LEAVING THE
PATTERN AND THE NEXT STEP IS TO

249
00:16:32,160 --> 00:16:34,930
BE ABLE TO ADD ALL OF THEM UP TO
FIGURE OUT HOW MANY ARE LEAVING

250
00:16:34,930 --> 00:16:36,609
AT ONCE.

251
00:16:36,609 --> 00:16:39,970
SO IF I CAN HAVE THE FIRST
IMAGE, PLEASE.

252
00:16:39,970 --> 00:16:42,149
ONE WAY OF GETTING AN ANSWER TO
THIS QUESTION OF HOW MANY

253
00:16:42,149 --> 00:16:48,639
PARTICLES ARE LEAVING IS TO
IMAGINE A FEAR AROUND MARS AT

254
00:16:48,639 --> 00:16:54,269
HIGH ALTITUDE ABOVE THE SURFACE

AND EVERY TIME IT PASSES THROUGH

255

00:16:54,269 --> 00:16:58,269

WE CAN LOOK TO OUR OBSERVATIONS
AND ASK WHETHER THERE ARE A LOT

256

00:16:58,269 --> 00:17:01,249

OF PARTICLES LEAVING THE PLANET
OR NOT VERY MANY AT ALL.

257

00:17:01,249 --> 00:17:05,650

A LOT OF PARTICLES ARE INDICATED
BY DARK BLUE COLORS AND NOT VERY

258

00:17:05,650 --> 00:17:08,860

MANY OF THE LIGHTISH BLUE
COLORS.

259

00:17:08,860 --> 00:17:14,650

SO OVERTIME WE CAN PAINT A
PICTURE ON THIS OF WHERE IONS

260

00:17:14,650 --> 00:17:18,190

ARE LEAVING IN ABUNDANCE AND NOT
SO MUCH.

261

00:17:18,190 --> 00:17:20,890

AND THE FIGURE SUGGESTS TWO
THINGS TO ME.

262

00:17:20,890 --> 00:17:24,459

TWO THINGS COME TO MY ATTENTION,
NUMBER ONE T COLORS ARE NOT

263

00:17:24,459 --> 00:17:27,179

EVENLY DISTRIBUTED AROUND THIS
SPHERE.

264

00:17:27,179 --> 00:17:31,850

ON THE NIGHT SIDE YOU SAW DARK

BLUES AND THE TOP AND THE BOTTOM

265

00:17:31,850 --> 00:17:33,490

OF THE PLANET AS WELL.

266

00:17:33,490 --> 00:17:38,250

THIS IS CONSISTENT WHERE THERE'S
MANY CHARGED PARTICLES LEAVING

267

00:17:38,250 --> 00:17:41,039

ON THE NIGHT SIDE AND FROM THE
TOP OF THE PLANET.

268

00:17:41,039 --> 00:17:44,820

BY CONTRAST, IF THE CENTER OF
THE DAY SIDE, YOU SEE LOTS OF

269

00:17:44,820 --> 00:17:47,679

WHITE AND LIGHTER COLORS,
THERE'S NOT VERY MANY CHARGED

270

00:17:47,679 --> 00:17:49,940

PARTICLES LEAVING FROM THAT
LOCATION.

271

00:17:49,940 --> 00:17:54,059

THIS IS ALSO CONSISTENT WITH THE
OBSERVATIONS AND SIMULATIONS

272

00:17:54,059 --> 00:17:56,880

JUST SHOWED.

273

00:17:56,880 --> 00:17:59,930

SO THESE MAPS PROVIDE A
STATISTICAL PICTURE OF WHERE

274

00:17:59,930 --> 00:18:03,559

IONS ARE ESCAPING IN ABUNDANCE
FROM DIFFERENT REGIONS BUT TO

275

00:18:03,559 --> 00:18:06,440

GET A GLOBAL ESCAPE RATE, HOW
MUCH IS ESCAPING FROM THE ENTIRE

276

00:18:06,440 --> 00:18:10,900

PLANET AT ONCE WE HAVE TO ADD UP
THE DATA REPRESENTED ON THOSE

277

00:18:10,900 --> 00:18:12,000

MAPS.

278

00:18:12,000 --> 00:18:13,890

WHEN WE DO THAT, WE GET A
NUMBER.

279

00:18:13,890 --> 00:18:19,190

A FEW OR SEVERAL TIMES 10 TO THE
24 ATMOSPHERIC PARTICLES LEAVING

280

00:18:19,190 --> 00:18:21,510

THE PLANET EVERY SECOND.

281

00:18:21,510 --> 00:18:24,700

THAT'S A REALLY BIG NUMBER AND I
PERSONALLY HAVE A HARD TIME

282

00:18:24,700 --> 00:18:29,120

HAVING ANY INTUITION FOR A
NUMBER THAT HAS 24 IN IT SO IT'S

283

00:18:29,120 --> 00:18:31,919

MORE CONVENIENT FOR ME TO THINK
OF IT IN TERMS OF MASS.

284

00:18:31,919 --> 00:18:36,621

HOW MUCH IS ESCAPING EVERY
SECOND AND WHEN WE DO THAT WE

285

00:18:36,621 --> 00:18:40,880

FIND THAT THERE ARE ROUGHLY 100
GRAMS OF ATMOSPHERE ESCAPING

286

00:18:40,880 --> 00:18:44,659
EVERY SECOND OR ABOUT A QUARTER
POUND OF ATMOSPHERE ESCAPING

287

00:18:44,659 --> 00:18:45,820
EVERY SECOND.

288

00:18:45,820 --> 00:18:50,860
AND I CAN'T HELP BUT IMAGINE
HAMBURGERS FLYING OUT ONE PER

289

00:18:50,860 --> 00:18:56,230
SECOND BUT IT'S CARBON DIOXIDE
AND ATMOSPHERE LEAVING THE

290

00:18:56,230 --> 00:18:57,230
PLANET.

291

00:18:57,230 --> 00:19:01,909
WHICH ARE IMPORTANT FOR WATER
AND CLIMATE OF THE PLANET OVER

292

00:19:01,909 --> 00:19:03,360
ALL.

293

00:19:03,360 --> 00:19:07,470
THIS IS A LOWER LIMIT FOR A
COUPLE OF REASONS.

294

00:19:07,470 --> 00:19:11,860
WE EMITTED LOW ENERGY CHARGED
PARTICLES TO THE MAPS AT THIS

295

00:19:11,860 --> 00:19:16,090
POINT AND ALSO NEUTRAL PART †--
PARTICLES.

296

00:19:16,090 --> 00:19:23,830

WHEN THEY'RE ULTIMATELY INCLUDED
THE ESCAPE RATES WILL GO UP.

297

00:19:23,830 --> 00:19:27,660

THIS IS AVERAGE FOR TODAY'S
CONDITION BUT THERE'S NO

298

00:19:27,660 --> 00:19:31,299

EXPECTATION THAT IT'S BEEN
CONSTANT OVER THE HISTORY OF THE

299

00:19:31,299 --> 00:19:33,220

PLANET AS JASPER MENTIONED.

300

00:19:33,220 --> 00:19:37,420

IF I COULD HAVE THE NEXT GRAPHIC
PLEASE.

301

00:19:37,420 --> 00:19:41,210

IN THE LEFT PANEL OF THE GRAPHIC
YOU SEE MARS UNDER NORMAL

302

00:19:41,210 --> 00:19:45,200

CONDITIONS TODAY WHERE THE SOLAR
WIND IS GOING TOWARD MARS AND

303

00:19:45,200 --> 00:19:54,679

INTERACTING WITH THE ATMOSPHERE
AND THEY'RE ESCAPING THE PLANET.

304

00:19:54,679 --> 00:19:57,419

AND THE RIGHT PANEL OF THE
FIGURE YOU SEE MARS UNDER VERY

305

00:19:57,419 --> 00:19:58,669

DIFFERENT CONDITIONS.

306

00:19:58,669 --> 00:20:02,440

WHEN ONE OF THESE SOLAR STORMS
PASSES BY AND ENGULFS THE

307

00:20:02,440 --> 00:20:03,440
PLANET.

308

00:20:03,440 --> 00:20:06,659
WHEN THAT HAPPENS, AS WE
OBSERVED WITH MAVEN, THE ESCAPE

309

00:20:06,659 --> 00:20:11,639
RATES GO UP AND THEY GO UP BY A
FACTOR OF 10 TO 20 AT LEAST

310

00:20:11,639 --> 00:20:14,970
DURING ONE OF THESE SOLAR STORMS
THAT MAVEN OBSERVED AND IT'S BY

311

00:20:14,970 --> 00:20:20,010
NO STRETCH THE LARGEST SOLAR
STORM THAT MARS HAS EVER SEEN.

312

00:20:20,010 --> 00:20:25,429
THIS IS EXCITING TO ME TO THINK
THAT EVENTS LIKE THIS INCREASE

313

00:20:25,429 --> 00:20:31,370
IT BECAUSE SOLAR STORMS ARE MORE
COMMON AND MORE INTENSE EARLIER

314

00:20:31,370 --> 00:20:33,179
IN SOLAR SYSTEM HISTORY.

315

00:20:33,179 --> 00:20:39,120
SO LONG AGO WE EXPECT ESCAPE TO
HAVE BEEN HAPPENING ALL THE TIME

316

00:20:39,120 --> 00:20:42,419
AND STRIPPING AWAY LOTS OF
ATMOSPHERE FROM THE PLANET.

317

00:20:42,419 --> 00:20:45,740

THIS IMPLIES THAT NOT ONLY IS
THE MARS ATMOSPHERE ESCAPING

318

00:20:45,740 --> 00:20:49,669

TODAY AND HAS BEEN OVERTIME BUT
MUCH OF THAT ATMOSPHERE MAY HAVE

319

00:20:49,669 --> 00:20:52,010

BEEN LOST EARLY ON.

320

00:20:52,010 --> 00:20:54,730

SO THE MAVEN OBSERVATIONS ARE
TEACHING US HOW THE ATMOSPHERE

321

00:20:54,730 --> 00:20:58,690

OF MARS HAS EVOLVED AND
UNDERSTANDING WILL NOT ONLY HELP

322

00:20:58,690 --> 00:21:01,880

US TO UNDERSTAND THE MARS
ATMOSPHERE BUT I'M HOPEFUL THAT

323

00:21:01,880 --> 00:21:04,529

THEY WILL HELP US TO UNDERSTAND
HOW ATMOSPHERE IS EVERYWHERE

324

00:21:04,529 --> 00:21:07,509

INTERACT WITH THEIR STAR AND
THEIR SPACE ENVIRONMENT.

325

00:21:07,509 --> 00:21:10,470

INCLUDING PLANETS ORBITING OTHER
STARS.

326

00:21:10,470 --> 00:21:12,299

WITH THAT, I'LL PASS IT BACK TO
YOU.

327

00:21:12,299 --> 00:21:13,559

>> THANKS, DAVE.

328

00:21:13,559 --> 00:21:18,039

FOR SOME REASON I HAVE A CRAVING
FOR A HAMBURGER.

329

00:21:18,039 --> 00:21:21,670

THANK YOU UNIVERSITY OF COLORADO
AND UNIVERSITY OF IOWA.

330

00:21:21,670 --> 00:21:24,309

BEFORE WE OPEN IT UP FOR
QUESTIONS STARTING HERE AND

331

00:21:24,309 --> 00:21:27,700

ACROSS THE COUNTRY, GIVE THE
PRINCIPAL INVESTIGATOR AN

332

00:21:27,700 --> 00:21:31,460

OPPORTUNITY TO SUMMARIZE WHY
THESE FINDINGS ARE SO

333

00:21:31,460 --> 00:21:32,929

SIGNIFICANT.

334

00:21:32,929 --> 00:21:33,960

>> THANK YOU.

335

00:21:33,960 --> 00:21:37,221

WHAT WE HAVE SEEN IS THAT FOR
THE FIRST TIME WE HAVE

336

00:21:37,221 --> 00:21:40,750

MEASUREMENTS THAT TELL US NOT
ONLY THE ESCAPE RATE OF GAS OUT

337

00:21:40,750 --> 00:21:44,190

THE TOP OF THE ATMOSPHERE AND

LOSS TO SPACE BUT THE PROCESSES

338

00:21:44,190 --> 00:21:45,470

THAT CONTROL IT.

339

00:21:45,470 --> 00:21:49,019

AND THIS IS IMPORTANT BECAUSE IF
WE WANT TO LOOK BACKWARD IN TIME

340

00:21:49,019 --> 00:21:52,840

WE CAN'T JUST EXTRAPOLATE THE
PROCESS OR ESCAPE RATE WITHOUT

341

00:21:52,840 --> 00:21:56,029

UNDERSTANDING HOW ESCAPE IS
OCCURRING.

342

00:21:56,029 --> 00:22:00,830

WHEN WE LOOK AT THE PROCESSES,
WE SEE THAT MANY OF THEM WOULD

343

00:22:00,830 --> 00:22:02,760

HAVE BEEN GREATER IN THE PAST.

344

00:22:02,760 --> 00:22:07,570

THE ESCAPE RATE TODAY, 100 GRAMS
PER SECOND IS NOT A VERY LARGE

345

00:22:07,570 --> 00:22:08,570

NUMBER.

346

00:22:08,570 --> 00:22:10,789

IT'S ENOUGH TO REMOVE THE ENTIRE
ATMOSPHERE IN A COUPLE OF

347

00:22:10,789 --> 00:22:14,690

BILLION YEARS BUT NOT ENOUGH TO
ACCOUNT FOR THE THICK EARLY

348

00:22:14,690 --> 00:22:15,690
ATMOSPHERE.

349

00:22:15,690 --> 00:22:19,130
HOWEVER, WHEN WE ACCOUNT FOR THE
GREATER LOSS RATES EARLY IN

350

00:22:19,130 --> 00:22:23,140
HISTORY, WE THINK THAT LOSS TO
SPACE, STRIPPING BY THE SOLAR

351

00:22:23,140 --> 00:22:28,139
WIND WAS AN IMPORTANT PROCESS IN
THE CHANGING CLIMATE OF MARS.

352

00:22:28,139 --> 00:22:30,570
AND THAT'S WHAT WE'RE REALLY
TRYING TO AIM AT.

353

00:22:30,570 --> 00:22:32,789
WE'RE CONTINUING THE
OBSERVATIONS.

354

00:22:32,789 --> 00:22:34,029
WE HAVE AN EXTENDED MISSION.

355

00:22:34,029 --> 00:22:38,090
WE WILL BE LOOKING AT THE SECOND
HALF OF THE FIRST MARS YEAR THAT

356

00:22:38,090 --> 00:22:41,269
WE HAVE BEEN THERE AND WE'LL BE
LOOKING AT THE CHANGING

357

00:22:41,269 --> 00:22:43,750
CONDITIONS THROUGH THE SOLAR
CYCLE.

358

00:22:43,750 --> 00:22:48,780
SO I'M LOOKING FORWARD TO MUCH

IMPROVED UNDERSTANDING.

359

00:22:48,780 --> 00:22:50,559

>> OKAY.

360

00:22:50,559 --> 00:22:59,370

I WANT TO RECOGNIZE ANOTHER
MEMBER OF AN INCREDIBLE TEAM OF

361

00:22:59,370 --> 00:23:05,139

PROGRAM SCIENTISTS HE MAY CHIME
IN ON SOME OF THE QUESTIONS WE

362

00:23:05,139 --> 00:23:06,139

HAVE.

363

00:23:06,139 --> 00:23:09,429

WE HAVE A NUMBER OF MEDIA ON THE
PHONE AND SOCIAL MEDIA IS ABUZZ

364

00:23:09,429 --> 00:23:10,429

WITH THE QUESTIONS.

365

00:23:10,429 --> 00:23:16,870

ARE THERE ANY MEDIA HERE OR IN
WASHINGTON?

366

00:23:16,870 --> 00:23:22,299

LET'S SEE IF WE CAN†-- LET'S
JUST GO TO SOCIAL MEDIA AND

367

00:23:22,299 --> 00:23:26,789

WHAT'S THE BUZZ OUT THERE IN THE
SOCIAL MEDIA WORLD?

368

00:23:26,789 --> 00:23:34,720

>> SO THIS QUESTION WAS ASKED,
IS THE SAME EFFECT OCCURRING TO

369

00:23:34,720 --> 00:23:38,440
THE EARTH NOW OR COULD IT HAPPEN
IN THE FUTURE?

370
00:23:38,440 --> 00:23:41,720
>> LET ME TURN TO DAVE.

371
00:23:41,720 --> 00:23:44,150
>> DAVE DID YOU COPY THAT
QUESTION?

372
00:23:44,150 --> 00:23:46,230
>> I DID.

373
00:23:46,230 --> 00:23:48,770
CAN THE SAME KIND OF THINGS
HAPPEN TO EARTH NOW OR IN THE

374
00:23:48,770 --> 00:23:49,919
FUTURE?

375
00:23:49,919 --> 00:23:52,379
AND THE ANSWER IS MOSTLY YES.

376
00:23:52,379 --> 00:23:56,940
EARTH IS LOSING ATMOSPHERE PART
CAR LENGTHS BUT EARTH HAS A BIG

377
00:23:56,940 --> 00:24:01,259
GLOBAL MAGNETIC FIELD THAT
SHIELDS IT FROM THE WIND.

378
00:24:01,259 --> 00:24:07,200
SO SOME METHOD OR PATHWAYS THAT
PARTICLES CAN TAKE ARE CHOKED

379
00:24:07,200 --> 00:24:09,440
OFF COMPARED TO MARS.

380

00:24:09,440 --> 00:24:11,840
OTHER PROCESSES THAT WE OBSERVE
AT MARS AND ARE OBSERVING WITH

381
00:24:11,840 --> 00:24:14,039
MAVEN DO OCCUR AT EARTH.

382
00:24:14,039 --> 00:24:17,220
THE LOSS OF PATRIOT CAR LENGTHS
THAT LACK ANY ELECTRIC CHARGE

383
00:24:17,220 --> 00:24:20,620
AND ESCAPE OUT OF THE POLAR
REGIONS OF EARTH'S MAGNETIC

384
00:24:20,620 --> 00:24:25,470
FIELD SO THERE'S THINGS THAT WE
CAN COMPARE BETWEEN WHAT WE'RE

385
00:24:25,470 --> 00:24:28,950
OBSERVING WITH MAVEN AND WHAT'S
GOING ON AT EARTH EVEN TODAY AND

386
00:24:28,950 --> 00:24:32,549
THEN THE SECOND PART OF THAT
QUESTION IS EARTH IN THE FUTURE

387
00:24:32,549 --> 00:24:36,720
AND IT MAY BE THAT SOME DAY A
LONG TIME FROM NOW, EARTH'S

388
00:24:36,720 --> 00:24:40,779
MAGNETIC FIELD SHUTS OFF BECAUSE
OF A LACK OF INTERIOR HEAT IN

389
00:24:40,779 --> 00:24:41,809
THE PLANET.

390
00:24:41,809 --> 00:24:45,059
WHEN THAT HAPPENS, EARTH BECOMES

LIKE A LARGE VERSION OF MARS

391

00:24:45,059 --> 00:24:48,030
WITH ALL THE SAME ESCAPE
PROCESSES OCCURRING.

392

00:24:48,030 --> 00:24:50,440
BETWEEN NOW AND THEN THERE'S
TIME PERIODS WHEN THE EARTH'S

393

00:24:50,440 --> 00:24:54,649
MAGNETIC FIELD REVERSES AND
THOSE CAN TAKE A COUPLE OF

394

00:24:54,649 --> 00:24:56,480
HUNDRED YEARS AT A TIME.

395

00:24:56,480 --> 00:24:58,970
DURING THOSE TIME PERIODS,
EARTH'S ATMOSPHERE IS LEFT

396

00:24:58,970 --> 00:25:01,539
LARGELY EXPOSED TO THE SOLAR
WIND.

397

00:25:01,539 --> 00:25:04,910
HOWEVER 100 OR 200 YEARS IS A
RELATIVELY SHORT TIME IN THE

398

00:25:04,910 --> 00:25:10,100
GRAND SCHEME OF THINGS SO THE
ATMOSPHERIC ESCAPE SHOULD NOT BE

399

00:25:10,100 --> 00:25:14,769
SIGNIFICANT ENOUGH TO REALLY
DAMAGE OR IMPAIR THE CLIMATE OF

400

00:25:14,769 --> 00:25:17,129
EARTH IN A LARGE WAY.

401

00:25:17,129 --> 00:25:22,630

LET ME ALSO ADD THAT MOST OF THE
STRIPPING BY THE SOLAR WIND AT

402

00:25:22,630 --> 00:25:26,659

MARS WAS THOUGHT TO HAVE TAKEN
PLACE VERY EARLY IN THE HISTORY

403

00:25:26,659 --> 00:25:29,899

OF THE SOLAR SYSTEM WHEN THE SUN
WAS MUCH MORE ACTIVE.

404

00:25:29,899 --> 00:25:32,629

WHEN THE SOLAR WIND WAS MORE
INTENSE.

405

00:25:32,629 --> 00:25:35,480

SO TODAY THE RATE OF LOSS IS
LOW.

406

00:25:35,480 --> 00:25:39,929

DURING THOSE TIMES WHEN THE
EARTH MIGHT BE LOSING ATMOSPHERE

407

00:25:39,929 --> 00:25:41,419

THE RATE OF LOSS WOULD BE LOW.

408

00:25:41,419 --> 00:25:43,919

SO WE DON'T HAVE ANYTHING TO
WORRY ABOUT IN TERMS OF THE

409

00:25:43,919 --> 00:25:47,320

EARTH'S ATMOSPHERE DISAPPEARING
ON US.

410

00:25:47,320 --> 00:25:49,110

>> TWO MORE QUESTIONS AND THEN
WE'LL GO TO THE PHONE LINES.

411

00:25:49,110 --> 00:25:50,110
>> GREAT.

412
00:25:50,110 --> 00:25:53,460
THIS ONE FROM IS TREY ON TWITTER
AND HE ASKS CAN YOU SIMPLIFY

413
00:25:53,460 --> 00:25:55,639
WHAT HAPPENED TO THE ATMOSPHERE
AND WATER ON MARS?

414
00:25:55,639 --> 00:25:59,720
IS THERE AN EASY TO UNDERSTAND
ANLAGE?

415
00:25:59,720 --> 00:26:04,899
>> THE SOLAR WIND STRIPPED IT
AWAY.

416
00:26:04,899 --> 00:26:10,820
WHEN I STEP OUT OF THE SHOWER
INTO THE BREEZE, THE WATER IN MY

417
00:26:10,820 --> 00:26:15,840
HAIR IS JUST WHISKED AWAY BY THE
WIND.

418
00:26:15,840 --> 00:26:20,259
THIS IS AN INCREASINGLY
THEORETICAL CONSTRUCT.

419
00:26:20,259 --> 00:26:22,460
>> OKAY.

420
00:26:22,460 --> 00:26:26,869
ONE MORE.

421
00:26:26,869 --> 00:26:29,110
>> THIS ONE IS FROM DUSTIN.

422

00:26:29,110 --> 00:26:33,239

WHAT'S THE EFFECT OF MARS LOSING
IT'S ATMOSPHERE.

423

00:26:33,239 --> 00:26:42,269

>> PEOPLE TALK ABOUT MARS TAKING
THE CO2, IF THAT'S WHERE ALL THE

424

00:26:42,269 --> 00:26:46,139

CO2 HAD GONE THAT MIGHT BE
POSSIBLE.

425

00:26:46,139 --> 00:26:49,720

BUT WITH IT HAVING BEEN STRIPPED
AWAY TO SPACE, IT'S NOT THERE.

426

00:26:49,720 --> 00:26:53,639

BEEN IT'S REMOVED FROM THE SOLAR
SYSTEM ENTIRELY SO IT'S NOT

427

00:26:53,639 --> 00:26:56,809

POSSIBLE TO BRING IT BACK.

428

00:26:56,809 --> 00:27:04,840

>> WE'LL COME BACK TO SOCIAL
MEDIA AND FOLLOWING THIS WE'LL

429

00:27:04,840 --> 00:27:06,899

HAVE SOME OF THE SCIENTISTS GET
TOGETHER AND ANSWER ALL THE

430

00:27:06,899 --> 00:27:09,570

QUESTIONS IF WE DON'T GET THEM
ANSWERED HERE TODAY BUT LET'S GO

431

00:27:09,570 --> 00:27:13,139

TO THE PHONE LINES AND FIRST UP
WE HAVE THE HOUSTON CHRONICLE.

432

00:27:13,139 --> 00:27:14,360
MIKE TOLSON.

433
00:27:14,360 --> 00:27:15,360
>> YES.

434
00:27:15,360 --> 00:27:17,409
THIS IS FOR BRUCE.

435
00:27:17,409 --> 00:27:24,730
MY QUESTION IS WHETHER ANY OTHER
ELEMENT OR FACTOR COULD HAVE

436
00:27:24,730 --> 00:27:25,730
ALSO CONTRIBUTED?

437
00:27:25,730 --> 00:27:31,871
OF COURSE IN POPULAR FICTION WE
HAVE SEEN THE SPECULATIONS OF AN

438
00:27:31,871 --> 00:27:33,399
ASTEROID IMPACT HAVING DECIMATED
SOME OF THE ATMOSPHERE.

439
00:27:33,399 --> 00:27:44,120
IS THERE ANY OTHER FACTOR THAT
YOU HAVE BEEN ABLE TO DISCERN OR

440
00:27:44,120 --> 00:27:47,340
SPECULATED ABOUT THAT COULD HAVE
CONTRIBUTED TO ATMOSPHERIC LOSS

441
00:27:47,340 --> 00:27:50,190
BESIDES THE SOLAR WIND?

442
00:27:50,190 --> 00:27:53,409
>> THERE ARE A LOT OF PROCESSES
THAT HAVE THE ABILITY TO REMOVE

443

00:27:53,409 --> 00:27:55,240
GAS FROM THE ATMOSPHERE.

444
00:27:55,240 --> 00:27:57,399
MICHAEL MENTIONED SOME OF THEM
AT THE VERY BEGINNING.

445
00:27:57,399 --> 00:28:02,070
IT CAN GO DOWN AND FORM CARBON
BEARING MINERALS OR WATER BEARING

446
00:28:02,070 --> 00:28:04,340
MINERALS.

447
00:28:04,340 --> 00:28:09,220
YOU MENTIONED THE ABILITY OF AN
ASTEROID IMPACT.

448
00:28:09,220 --> 00:28:12,629
WE HAVE BEEN FOCUSED ON
UNDERSTANDING THE PROCESSES

449
00:28:12,629 --> 00:28:16,380
INVOLVING THE SUN AS AN ENERGY
DRIVER AT THE TOP OF THE

450
00:28:16,380 --> 00:28:17,380
ATMOSPHERE.

451
00:28:17,380 --> 00:28:22,240
SO WE SEE EVIDENCE FOR STRIPPING
BY THE SOLAR WIND FOR A PROCESS

452
00:28:22,240 --> 00:28:27,620
CALLED SPATTERING IN WHICH THESE
IONS CAN HIT THE ATMOSPHERE AT

453
00:28:27,620 --> 00:28:31,980
HIGH SPEED AND EJECT OTHER STUFF
OFF THE SPACE.

454

00:28:31,980 --> 00:28:36,169

THERMAL ESCAPE IN WHICH THE
FASTEST HYDROGEN ATOMS THAT COME

455

00:28:36,169 --> 00:28:43,549

FROM WATER CAN BE FAST ENOUGH TO
ESCAPE THE PLANET DIRECTLY.

456

00:28:43,549 --> 00:28:46,320

PHOTO CHEMICAL PROCESSES.

457

00:28:46,320 --> 00:28:49,580

WE'RE TRYING TO PIECE TOGETHER
AN OVERALL PICTURE OF WHAT

458

00:28:49,580 --> 00:28:53,559

HAPPENED TO THE WATER AND THEY
NEED TO LOOK AT MARS AS AN

459

00:28:53,559 --> 00:28:56,679

INTEGRATED SYSTEM WITH A LOT OF
DIFFERENT PROCESSES TAKING

460

00:28:56,679 --> 00:28:57,779

PLACE.

461

00:28:57,779 --> 00:29:01,670

SO WE'RE PUTTING TOGETHER THIS
PIECE OF THE PUZZLE.

462

00:29:01,670 --> 00:29:07,360

YOU CAN DO THEORETICAL MODELS
THAT LOOK AT THE ROLE OF THE

463

00:29:07,360 --> 00:29:08,360

IMPACT.

464

00:29:08,360 --> 00:29:12,169

CERTAINLY THAT WAS AN IMPORTANT
PROCESS BUT IT'S PROBABLY NOT

465

00:29:12,169 --> 00:29:14,730
MUCH OF AN ON GOING PROCESS
TODAY.

466

00:29:14,730 --> 00:29:19,020
SO IT'S VERY HARD TO STUDY.

467

00:29:19,020 --> 00:29:20,830
>> NEXT CALL IS FROM ALLEN.

468

00:29:20,830 --> 00:29:22,669
>> THANK YOU.

469

00:29:22,669 --> 00:29:29,364
ON THIS ISSUE OF HOW QUICKLY THE
PLANET MAY HAVE LAUNCHED IT'S

470

00:29:29,364 --> 00:29:30,429
ATMOSPHERE DUE TO SOLAR STORMS,
VERSUS THE TYPICAL SOLAR

471

00:29:30,429 --> 00:29:39,470
ACTIVITY, IS THERE A WAY TO
TEASE OUT THAT QUESTION, ARE

472

00:29:39,470 --> 00:29:44,590
THOSE SOLAR STORMS FROM THE DAYS
OF THE SOLAR SYSTEM REALLY THE

473

00:29:44,590 --> 00:29:48,770
CULPRIT HERE OR HOW MUCH OF A
FACTOR MIGHT YOU BE ABLE TO FIND

474

00:29:48,770 --> 00:29:50,230
OUT THAT HAPPENED TO BE?

475

00:29:50,230 --> 00:29:51,669

THANK YOU.

476

00:29:51,669 --> 00:29:54,659

>> THAT'S A REALLY GOOD QUESTION
AND I DON'T HAVE A REALLY GOOD

477

00:29:54,659 --> 00:29:56,240

ANSWER, YET.

478

00:29:56,240 --> 00:30:02,500

WHAT WE KNOW IS THAT THE RATE OF
REMOVAL OF GAS DURING A SOLAR

479

00:30:02,500 --> 00:30:07,139

STORM GOES UP BY A FACTOR OF 10
OR 20 IN THE ONE EVENT WE

480

00:30:07,139 --> 00:30:10,179

EXAMPLED IN DETAIL AND THAT
SOLAR STORMS WOULD HAVE BEEN

481

00:30:10,179 --> 00:30:12,669

MORE ABUNDANT EARLY IN HISTORY.

482

00:30:12,669 --> 00:30:17,370

WE ALSO KNOW THAT THE SOLAR WIND
AS A STEADY ON GOING PROCESS CAN

483

00:30:17,370 --> 00:30:20,629

REMOVE GAS AND AT THAT RATE
WOULD HAVE BEEN GREATER EARLY IN

484

00:30:20,629 --> 00:30:21,740

HISTORY.

485

00:30:21,740 --> 00:30:25,210

TOGETHER WE THINK THAT THESE
WOULD HAVE BEEN VERY IMPORTANT

486

00:30:25,210 --> 00:30:29,840

PROCESSES BUT WE HAVEN'T DONE
THAT BACKWARD IN TIME YET SO

487

00:30:29,840 --> 00:30:32,900

IT'S VERY HARD TO GIVE A
QUANTITATIVE ESTIMATE TODAY OF

488

00:30:32,900 --> 00:30:35,330

WHICH WAS THE MOST IMPORTANT
PROCESS.

489

00:30:35,330 --> 00:30:39,460

>> AND ALSO, BRUCE, JUST TO
REMIND EVERYBODY, EARLY ON IN

490

00:30:39,460 --> 00:30:43,270

MARS HISTORY, MARS ACTUALLY DID
HAVE A GLOBAL MAGNETIC FIELD.

491

00:30:43,270 --> 00:30:47,710

SO IT HAD PROTECTION FOR AWHILE
UNTIL IT COOLED OFF ENOUGH THAT

492

00:30:47,710 --> 00:30:50,649

IT STOPPED.

493

00:30:50,649 --> 00:30:58,919

SO THAT PERIOD OF TIME IS UNDER
DEBATE AND EXPERIENCE MUCH MORE

494

00:30:58,919 --> 00:31:02,309

SIGNIFICANT ATMOSPHERE.

495

00:31:02,309 --> 00:31:08,970

>> NEXT UP IS CAMILLE CARLYLE.

496

00:31:08,970 --> 00:31:25,989

>> IS IT THE ONE FROM LAST YEAR

OR THIS PAST MARCH?

497

00:31:25,989 --> 00:31:29,510

>> WE WERE LOOKING AT THE EVENT
IN MARCH OF THIS YEAR.

498

00:31:29,510 --> 00:31:33,369

IT WAS ACTUALLY THREE EVENTS ONE
RIGHT AFTER ANOTHER.

499

00:31:33,369 --> 00:31:34,369

MARS WAS NEVER EASY.

500

00:31:34,369 --> 00:31:39,880

YOU CAN'T EXAMINE A SINGLE EVENT
IN ISOLATION.

501

00:31:39,880 --> 00:31:43,610

WE HAVE TO SEPARATE OUT THE
DIFFERENT EFFECTS.

502

00:31:43,610 --> 00:31:47,769

WE DID SEE AURORA AS A RESULT OF
THIS EVENT THOUGH.

503

00:31:47,769 --> 00:31:52,029

THE PARTICLES DID TRIGGER AURORA
WITH THAT EVENT AS WELL AS THE

504

00:31:52,029 --> 00:31:54,990

EARLIER ONE.

505

00:31:54,990 --> 00:31:57,460

>> NEXT UP IS ERIC BURGER AND
ERIC IF YOU CAN GIVE THE

506

00:31:57,460 --> 00:31:59,799

AFFILIATION BEFORE YOU ASK YOUR
QUESTION, THANK YOU, SIR.

507
00:31:59,799 --> 00:32:00,799
>> YEAH.

508
00:32:00,799 --> 00:32:01,799
THANK YOU FOR DOING THIS.

509
00:32:01,799 --> 00:32:02,799
THIS IS ERIC BURGER.

510
00:32:02,799 --> 00:32:09,179
I WAS WONDERING IF THIS
INFORMATION FROM THE ATMOSPHERIC

511
00:32:09,179 --> 00:32:16,169
LOSS HAS GIVEN YOU ANY BETTER
ESTIMATE OF WHEN MARS WOULD HAVE

512
00:32:16,169 --> 00:32:21,480
BEEN CONDUCIVE FOR WATER, LAKES,
RIVERS, THINGS LIKE THAT THAT

513
00:32:21,480 --> 00:32:26,129
CARVED FEATURES MILLIONS OR
BILLIONS OF YEARS AGO.

514
00:32:26,129 --> 00:32:30,260
>> FROM THE THEOLOGY WE GET A
GOOD ESTIMATE OF THE TIMING IN

515
00:32:30,260 --> 00:32:33,110
WHICH MARS HAD EARLY.

516
00:32:33,110 --> 00:32:39,860
UP UNTIL 3.7†BILLION YEARS AGO
WATER WAS ABUNDANT AND ACTIVE.

517
00:32:39,860 --> 00:32:47,100
SO THE STRIP BIG THE SOLAR WIND
OF THE ATMOSPHERE WOULD HAVE

518

00:32:47,100 --> 00:32:48,830

OCCURRED IN THAT SAME TIME
FRAME.

519

00:32:48,830 --> 00:32:52,950

THAT'S WHEN THE EXTREME ULTRA
VIOLENT PROTONS FROM THE SUN AND

520

00:32:52,950 --> 00:32:55,620

SOLAR WIND WERE MOST INTENSE.

521

00:32:55,620 --> 00:32:58,850

SO WE THINK THAT THE LOSS OF THE
ATMOSPHERE OCCURRED OVER A FEW

522

00:32:58,850 --> 00:33:04,639

HUNDRED MILLION YEARS FROM ABOUT
4.2 TO MAYBE 3.7†BILLION YEARS

523

00:33:04,639 --> 00:33:07,899

AGO.

524

00:33:07,899 --> 00:33:09,900

>> NEXT UP IS THE TIM CRAMER.

525

00:33:09,900 --> 00:33:10,900

>> CONGRATULATIONS ON THE
RESULTS.

526

00:33:10,900 --> 00:33:22,120

I WAS INTERESTED IN YOUR
UPDATING THINKING WHICH YOU KIND

527

00:33:22,120 --> 00:33:36,710

OF JUST ANSWERED ABOUT WHEN THE
WATER WAS LOST.

528

00:33:36,710 --> 00:33:48,350

MAYBE YOU CAN REVIEW THAT A
LITTLE BIT MORE.

529

00:33:48,350 --> 00:34:02,960
HOW LONG DO YOU THINK†-- HOW
LONG DID IT TAKE TO LOSE THE

530

00:34:02,960 --> 00:34:08,310
MAGNETIC FIELD AND WHAT, HOW OLD
DID THE WATER LAST IN LIQUID

531

00:34:08,310 --> 00:34:10,710
FORM ON THE SURFACE AND WHAT WAS
THE LOSS REQUIRED TO HAVE A

532

00:34:10,710 --> 00:34:11,850
TREMENDOUS LOSS OF WATER?

533

00:34:11,850 --> 00:34:13,550
HOW MUCH MORE DID IT HAVE TO BE?

534

00:34:13,550 --> 00:34:14,850
IF IT'S ONLY A HUNDRED GRAMS A
SECOND PER DAY CAN YOU GIVE US

535

00:34:14,850 --> 00:34:16,880
AN ESTIMATE OF WHAT IT WOULD
HAVE TO BE TO CAUSE A TREMENDOUS

536

00:34:16,880 --> 00:34:17,880
LOSS IN THE PAST?

537

00:34:17,880 --> 00:34:19,690
>> WHAT WE THINK IS THAT THE
EARLY MAGNETIC FIELD THAT MARS

538

00:34:19,690 --> 00:34:20,690
HAD WOULD HAVE PROTECTED THE
PLANET.

539

00:34:20,690 --> 00:34:24,780

AND THE EVIDENCE SUGGESTS THAT
THE MAGNETIC FIELD DISAPPEARED

540

00:34:24,780 --> 00:34:27,580

4.2†BILLION YEARS AGO.

541

00:34:27,580 --> 00:34:31,490

THE AMOUNT OF GAS THAT WOULD
HAVE HAD TO HAVE BEEN REMOVED†--

542

00:34:31,490 --> 00:34:35,230

LET ME START BACK WITH THE
CURRENT MARS ATMOSPHERE WHICH

543

00:34:35,230 --> 00:34:41,870

HAS A THICKNESS OF 6 MILIBARS.

544

00:34:41,870 --> 00:34:45,270

WE THINK YOU WOULD HAVE TO
REMOVE AN AMOUNT OF GAS ABOUT

545

00:34:45,270 --> 00:34:48,120

EQUIVALENT TO WHAT'S IN THE
EARTH'S ATMOSPHERE.

546

00:34:48,120 --> 00:34:53,770

SO THE RATE WOULD HAVE HAD TO
HAVE BEEN A FACTOR OF MAYBE 100

547

00:34:53,770 --> 00:34:57,670

HIGHER IN ORDER TO BE ABLE TO
REMOVE THE GAS EARLY IN THAT

548

00:34:57,670 --> 00:35:00,740

TIME PERIOD.
100 TO 1000 TIMES HIGHER.

549

00:35:00,740 --> 00:35:05,170

THAT'S CONSISTENT WITH WHAT SOME
OF THE MODELS HAVE PREDICTED.

550

00:35:05,170 --> 00:35:09,150

THE LOSS RATE BACK IN EARLY
HISTORY WOULD HAVE BEEN.

551

00:35:09,150 --> 00:35:10,960

>> OKAY.

552

00:35:10,960 --> 00:35:13,620

BACK TO SOCIAL MEDIA AND EMILY
BACK TO YOU.

553

00:35:13,620 --> 00:35:16,850

WE'LL TAKE THREE MORE QUESTIONS
AND THEN OUR PHONE LINES AND

554

00:35:16,850 --> 00:35:18,300

WE'LL WRAP UP.

555

00:35:18,300 --> 00:35:19,300

EMILY.

556

00:35:19,300 --> 00:35:21,140

>> THANK YOU.

557

00:35:21,140 --> 00:35:23,350

HE ASKS HOW DOES THE NEW
INFORMATION LIKE TODAY'S

558

00:35:23,350 --> 00:35:25,990

ANNOUNCEMENT SHAPE FUTURE
RESEARCH ON MARS?

559

00:35:25,990 --> 00:35:28,020

WHAT SHOULD WE LOOK AT NEXT?

560

00:35:28,020 --> 00:35:29,680

>> LET ME GIVE A TRY AT THAT
ONE.

561
00:35:29,680 --> 00:35:32,610
THAT'S AN IMPORTANT QUESTION
BECAUSE ONE OF THE THINGS THAT

562
00:35:32,610 --> 00:35:41,860
WE LEARNED FROM THE WHOLE SUITE
OF MISSIONS THAT WE SENT, MARS

563
00:35:41,860 --> 00:35:47,670
ODYSSEY MOST RECENTLY IS THAT
MARS IS A VERY COMPLEX SYSTEM.

564
00:35:47,670 --> 00:35:51,980
YOU CAN'T STUDY THE GEOLOGY IN
ISOLATION IN EVERYTHING ELSE OR

565
00:35:51,980 --> 00:35:55,070
THE ATMOSPHERE IN ISOLATION FROM
EVERYTHING ELSE.

566
00:35:55,070 --> 00:35:58,570
IT'S A VERY COMPLEXED COUPLE
SYSTEM.

567
00:35:58,570 --> 00:36:02,540
SO WHEN WE WANT TO LEARN, FOR
EXAMPLE, ABOUT LIFE, THE

568
00:36:02,540 --> 00:36:05,510
POTENTIAL FOR LIFE, WE HAVE TO
STUDY THE ATMOSPHERE, THE

569
00:36:05,510 --> 00:36:06,680
GEOLOGY.

570
00:36:06,680 --> 00:36:09,230
NOW WE HAVE TO STUDY THE UPPER

ATMOSPHERE TO LEARN ABOUT THE

571

00:36:09,230 --> 00:36:10,890

HISTORY OF THE CLIMATE.

572

00:36:10,890 --> 00:36:14,760

ALL OF THESE PLAY A ROLE BECAUSE
THE GASES CAN EXCHANGE BETWEEN

573

00:36:14,760 --> 00:36:16,580

ALL OF THE PLACES.

574

00:36:16,580 --> 00:36:21,690

ALL OF THEM REPRESENT IMPORTANT
PROCESSES TO MAVEN IS FILLING A

575

00:36:21,690 --> 00:36:26,420

GAP IN OUR UNDERSTANDING WHERE
WE HAVE REALLY VERY LITTLE IDEA

576

00:36:26,420 --> 00:36:31,870

OF HOW IT OPERATED AND WHAT
PROCESSES PLAYED A ROLE THERE.

577

00:36:31,870 --> 00:36:35,140

THIS FEEDS BACK INTO OUR
UNDERSTANDING OF THE BEHAVIOR OF

578

00:36:35,140 --> 00:36:39,940

THE CLIMATE AS A WHOLE AND WHAT
DROVE CLIMATE CHANGE ON MARS AND

579

00:36:39,940 --> 00:36:44,670

THAT FEEDS BACK INTO ISSUES
RELATED TO THE POTENTIAL FOR

580

00:36:44,670 --> 00:36:45,670

LIFE.

581

00:36:45,670 --> 00:36:49,330
AND I BROUGHT IT BACK TO THE
LIFE QUESTION BECAUSE THAT'S AT

582
00:36:49,330 --> 00:36:54,400
THE CENTER OF SCIENTIFIC
EXPLORATION OF MARS.

583
00:36:54,400 --> 00:37:00,780
MARS APPEARS TO MEET ALL OF THE
CONDITIONS REQUIRED FOR LIFE OR

584
00:37:00,780 --> 00:37:04,240
TO HAVE MET THEM AT THE SURFACE
IN THE PAST AND THAT BEGS THE

585
00:37:04,240 --> 00:37:07,850
QUESTION OF WHETHER THERE WAS
ANY LIFE THERE AND THEN IF THERE

586
00:37:07,850 --> 00:37:15,010
WAS, WHETHER IT'S GENETICALLY
RELATED TO TERRESTRIAL LIFE.

587
00:37:15,010 --> 00:37:19,830
SO AS WE GO INTO THE FUTURE THE
QUESTIONS ABOUT LIFE AND CLIMATE

588
00:37:19,830 --> 00:37:23,280
AND THE HISTORY OF THE PLANET AS
A WHOLE REALLY ARE AT THE CENTER

589
00:37:23,280 --> 00:37:24,700
OF THE EXPLORATION.

590
00:37:24,700 --> 00:37:26,810
>> TWO MORE.

591
00:37:26,810 --> 00:37:27,860
>> SURE.

592

00:37:27,860 --> 00:37:29,180

THIS IS FROM DAKOTA.

593

00:37:29,180 --> 00:37:32,920

HE SORT OF TOUCHED ON THIS AS WELL.

594

00:37:32,920 --> 00:37:35,820

IF THIS EROSION FROM THE SOLAR WIND IS STILL HAPPENING WILL

595

00:37:35,820 --> 00:37:39,850

MARS EVENTUALLY HAVE NO ATMOSPHERE AT ALL?

596

00:37:39,850 --> 00:37:42,420

>> AT THE CURRENT RATE OF ESCAPE IT WOULD LOSE IT'S ENTIRE

597

00:37:42,420 --> 00:37:47,580

ATMOSPHERE IN ANOTHER COUPLE OF BILLION YEARS BUT WE THINK THAT

598

00:37:47,580 --> 00:37:50,870

THE GAS IN THE ATMOSPHERE ISN'T ALL THAT'S THERE.

599

00:37:50,870 --> 00:37:53,280

THERE'S GAS LOCKED UP IN THE POLAR CAPS.

600

00:37:53,280 --> 00:37:58,120

THE ATMOSPHERE EXCHANGES WITH GAS IN THE TOP METER OF THE SUB

601

00:37:58,120 --> 00:38:01,970

SURFACE AND DEEPER TO THE TOP TENS OF METERS.

602

00:38:01,970 --> 00:38:04,440

SO ONE OF THE QUESTIONS ABOUT
MARS IS WHAT IS THE TOTAL

603

00:38:04,440 --> 00:38:05,440

INVENTORY?

604

00:38:05,440 --> 00:38:10,480

HOW MUCH GAS IS THERE ANYWHERE
ON THE PLANET AS WE REMOVE GAS

605

00:38:10,480 --> 00:38:14,630

TO SPACE, WE THINK THAT IT IS
PROBABLY BEING REPLENISHED FROM

606

00:38:14,630 --> 00:38:17,340

THE NONATMOSPHERIC RESERVOIRS.

607

00:38:17,340 --> 00:38:21,740

SO I THINK THE ATMOSPHERE IS NOT
GOING TO DISAPPEAR IN THE NEXT

608

00:38:21,740 --> 00:38:24,870

COUPLE OF BILLION YEARS BUT I
CAN'T TELL YOU EXACTLY WHAT IT'S

609

00:38:24,870 --> 00:38:27,370

GOING TO BE LIKE EITHER.

610

00:38:27,370 --> 00:38:29,100

>> ONE MORE AND THEN WE'LL GO
BACK TO THE PHONES.

611

00:38:29,100 --> 00:38:30,100

>> SURE.

612

00:38:30,100 --> 00:38:32,080

THIS IS FROM WILLIAM.

613

00:38:32,080 --> 00:38:35,380

AND SORT OF BRANCHING OFF OF
THAT, IF THERE WAS LIQUID WATER

614

00:38:35,380 --> 00:38:39,310

FOUND ON MARS WOULDN'T THAT
PROVE THAT THERE'S STILL

615

00:38:39,310 --> 00:38:47,190

ATMOSPHERE THAT IS SUSTAINABLE
TO SOME TYPE OF LIFE?

616

00:38:47,190 --> 00:38:50,400

>> THE QUESTION OF LIQUID WATER
IS AT THE HEART OF THIS AND THE

617

00:38:50,400 --> 00:38:53,990

REASON WE FLEW THE MAVEN MISSION
IS TO UNDERSTAND THE HISTORY OF

618

00:38:53,990 --> 00:38:57,070

LIQUID WATER BY LOOKING AT THE
CLIMATE.

619

00:38:57,070 --> 00:39:02,600

WATER CAN EXIST, COULD HAVE
EXISTED EARLY IN HISTORY AND IT

620

00:39:02,600 --> 00:39:03,600

WAS STABLE.

621

00:39:03,600 --> 00:39:06,430

IT COULD HAVE EXISTED AT THE
SURFACE TODAY.

622

00:39:06,430 --> 00:39:12,920

BUT SOME OF THE RECENT MEASURES
SUGGEST THERE MIGHT EVEN BE

623

00:39:12,920 --> 00:39:18,370
TRACE AMOUNTS OF LIQUID WATER
OCCURRING INTERMITTENTLY.

624
00:39:18,370 --> 00:39:23,750
SO WE HAVE THIS CONTRAST OF
GLOBAL SCALE†LIQUID WATER THAT

625
00:39:23,750 --> 00:39:27,870
EVOLVED ALONG WITH THE CLIMATE
OVER 4 BILLION YEARS AND IS

626
00:39:27,870 --> 00:39:35,080
BEING EXPLORED BY MAVEN AND TINY
AMOUNTS IS IN THE PRESENCE

627
00:39:35,080 --> 00:39:36,080
TODAY.

628
00:39:36,080 --> 00:39:43,690
IT'S ALL PART OF
THE

629
00:39:43,690 --> 00:39:48,020
UNDERSTANDING.

630
00:39:48,020 --> 00:39:49,170
>> THERE'S STILLWATER ON MARS.

631
00:39:49,170 --> 00:39:53,230
WE CERTAINLY HAVE MEASURES
SHOWING THE POLLS AND MID

632
00:39:53,230 --> 00:40:00,280
LATITUDE BUT ALSO MAYBE THERE
COULD BE THAT ON MARS SO IF LIFE

633
00:40:00,280 --> 00:40:05,480
EVER DID GET STARTED PERHAPS THE
HABITABLE PLACE ON MARS TODAY

634

00:40:05,480 --> 00:40:09,660

WOULD BE IN THE SUBSURFACE WHERE
LIQUID WATER IS STILL A

635

00:40:09,660 --> 00:40:10,970

REASONABLE ASSUMPTION.

636

00:40:10,970 --> 00:40:11,970

>> OKAY.

637

00:40:11,970 --> 00:40:16,810

LADIES AND GENTLEMEN, WE'RE
COMING UP ABOUT 15 MINUTES, 20

638

00:40:16,810 --> 00:40:17,810

MINUTES.

639

00:40:17,810 --> 00:40:22,930

WE ARE GOING TO THE PHONE LINES
AND TAKE THREE MORE CALLS AND WE

640

00:40:22,930 --> 00:40:27,160

HAVE A QUESTION HERE AND WE'RE
GOING TO END THE BRIEFING.

641

00:40:27,160 --> 00:40:30,930

BUT SOCIAL MEDIA KEEP THOSE
QUESTIONS COMING IN AT †#ASKNASA.

642

00:40:30,930 --> 00:40:35,160

WE'LL HAVE A TEAM OF SCIENTISTS
ANSWERING QUESTIONS LATER TODAY

643

00:40:35,160 --> 00:40:38,890

AND FOR THE MEDIA THAT WE DON'T
GET TO ON THE PHONE WE WILL MAKE

644

00:40:38,890 --> 00:40:41,490

SURE THAT SCIENTISTS ARE
AVAILABLE TO DO ANY ONE-ON-ONE

645

00:40:41,490 --> 00:40:43,640

INTERVIEWS FOLLOWING THE PRESS
CONFERENCE.

646

00:40:43,640 --> 00:40:47,230

SO LET'S START WITH ADRIEN FROM
THE ATLANTIC.

647

00:40:47,230 --> 00:40:50,290

>> THANK YOU FOR TAKING MY
QUESTION.

648

00:40:50,290 --> 00:40:55,910

I UNDERSTAND THAT THE UNUSUAL
AURORAS ON MARS ALSO INFORM YOUR

649

00:40:55,910 --> 00:40:58,730

UNDERSTANDING OF ATMOSPHERIC
LOSS AND I'M HOPING YOU CAN

650

00:40:58,730 --> 00:41:07,150

DESCRIBE IN VIVID DETAIL WHAT AN
AURORA ON MARS LOOK LIKE.

651

00:41:07,150 --> 00:41:10,900

>> LET ME ASK DAVE IF HE CAN
TAKE THAT ONE AS WELL.

652

00:41:10,900 --> 00:41:12,160

>> SURE.

653

00:41:12,160 --> 00:41:17,530

THAT'S A GREAT QUESTION AND
AURORA ON MARS ARE EXCITING AND

654

00:41:17,530 --> 00:41:20,910

INTERESTING AND THERE ARE

ESSENTIALLY TWO KINDS OF AURORA

655

00:41:20,910 --> 00:41:22,700
ON MARS OBSERVED.

656

00:41:22,700 --> 00:41:27,130
ONE WE KNEW ABOUT BEFORE MAVEN
ARRIVED AND THIS IS FAIRLY

657

00:41:27,130 --> 00:41:32,450
SIMILAR TO NORTH'S AURORA THAT
TAKE PLACE IN SMALL SCALE

658

00:41:32,450 --> 00:41:36,050
MAGNETIC FIELDS THAT ARE
ASSOCIATED WITH SPECIFIC REGION

659

00:41:36,050 --> 00:41:37,370
OF THE MARS CRUST.

660

00:41:37,370 --> 00:41:40,930
THE BIG DIFFERENCE THERE IS THAT
THE AURORA AND MALL MAGNETIC

661

00:41:40,930 --> 00:41:45,270
FIELDS ARE WEAKER THAN THOSE ON
EARTH.

662

00:41:45,270 --> 00:41:51,900
FOR MAVEN, A NEW KIND OF AURORA
FRANKLY SURPRISED US AND THIS

663

00:41:51,900 --> 00:41:56,590
WAS IN A PART OF THE ATMOSPHERE
THAT IS ABOVE REGIONS THAT DON'T

664

00:41:56,590 --> 00:41:59,100
HAVE ANY MAGNETIC FIELD AT ALL.

665

00:41:59,100 --> 00:42:01,820
IT'S STRANGE TO THINK ABOUT,
BASED ON OUR PERSONAL

666
00:42:01,820 --> 00:42:05,340
EXPERIENCE, THOSE THAT DON'T
TAKE PLACE IN MAGNETIC FIELDS.

667
00:42:05,340 --> 00:42:13,660
NOT ONLY DID WE SEE AURORA ON
MARS BUT ALSO THE PARTICLES THAT

668
00:42:13,660 --> 00:42:16,260
WENT CRASHING INTO THE
ATMOSPHERE TO CREATE THEM.

669
00:42:16,260 --> 00:42:20,330
THEY'RE VERY ENERGETIC ELECTRONS
THAT COME FROM THE SUN AND THOSE

670
00:42:20,330 --> 00:42:24,380
INTENSE EVENTS ARE AT LEAST RARE
IN MAVEN'S EXPERIENCE.

671
00:42:24,380 --> 00:42:27,600
THEY ONLY HAPPENED TWO OR THREE
TIMES SINCE WE HAVE BEEN THERE

672
00:42:27,600 --> 00:42:30,290
INCLUDING AROUND CHRISTMAS 2014.

673
00:42:30,290 --> 00:42:33,360
SO AMONG THE TEAM WE'RE CALLING
THOSE THE CHRISTMAS LIGHTS BUT

674
00:42:33,360 --> 00:42:36,250
THEY ALSO HAPPEN DURING THE
SOLAR STORM THAT JASPER TALKED

675
00:42:36,250 --> 00:42:39,040

ABOUT IN HIS COMMENTS AS WELL.

676

00:42:39,040 --> 00:42:43,020

SO WE HAVE SEEN THESE IN ULTRA
VIOLET AND IT'S POSSIBLE THAT

677

00:42:43,020 --> 00:42:47,180

THE NEW AURORA LIGHTS UP THE
ENTIRE NIGHT SKY OVER MUCH OF

678

00:42:47,180 --> 00:42:48,720

THE PLANET.

679

00:42:48,720 --> 00:42:51,980

YOU CAN DO MODEL CALCULATIONS OF
WHETHER THEY WOULD BE VISIBLE TO

680

00:42:51,980 --> 00:42:56,030

THE NAKED EYE AND THOSE ARE
STILL PREMATURE.

681

00:42:56,030 --> 00:43:00,040

BUT A GOOD GUESS IS THAT THEY
MAY BE VISIBLE TO THE NAKED EYE

682

00:43:00,040 --> 00:43:03,450

SO THAT IF YOU'RE STANDING ON
THE NIGHT SIDE OF MARS WHERE

683

00:43:03,450 --> 00:43:06,710

THERE'S NO LIGHT POLLUTION AND
LOOKING UP TO THE SKY, YOU CAN

684

00:43:06,710 --> 00:43:09,060

SEE THE WHOLE SKYLIGHT UP DURING
ONE OF THESE EVENTS.

685

00:43:09,060 --> 00:43:11,599

IT WOULD BE MAGNIFICENT.

686

00:43:11,599 --> 00:43:12,880

>> THANK YOU.

687

00:43:12,880 --> 00:43:15,990

NEXT UP IS FRANK FROM AVIATION
WEEK.

688

00:43:15,990 --> 00:43:18,630

>> THANK YOU.

689

00:43:18,630 --> 00:43:24,330

YOU MENTIONED EARLIER THAT COME
MET IMPACTS MIGHT HAVE HAD A

690

00:43:24,330 --> 00:43:26,130

ROLE IN THE LOSS OF MARS
ATMOSPHERE.

691

00:43:26,130 --> 00:43:30,270

I WONDER IF YOU CAN SAY YET
WHETHER THE PASSAGE OF THE

692

00:43:30,270 --> 00:43:36,580

COMMON SIGHTING SPRING CLOSE TO
MARS LAST FALL MIGHT HAVE HAD

693

00:43:36,580 --> 00:43:39,720

THE SAME KIND OF EFFECT.

694

00:43:39,720 --> 00:43:43,440

>> WE DID HAVE THE OPPORTUNITY
TO OBSERVE ONE COMET PASS BY AS

695

00:43:43,440 --> 00:43:45,820

YOU MENTIONED.

696

00:43:45,820 --> 00:43:50,230

IT PASSED BY 140,000 KILOMETERS
AWAY FROM MARS.

697

00:43:50,230 --> 00:43:53,170

WE WERE ABLE TO MAKE
OBSERVATIONS OF THE EFFECTS IT

698

00:43:53,170 --> 00:43:57,410

HAD ON THE PLANET AT THE TIME.

699

00:43:57,410 --> 00:44:04,400

WE SAW THE DUST THAT WAS
DEPOSITED INTO THE ATMOSPHERE

700

00:44:04,400 --> 00:44:07,250

AND PERHAPS HINTS OF SOME OTHER
THINGS.

701

00:44:07,250 --> 00:44:10,130

THE DUST COMING IN HAS THE
ABILITY TO CHANGE THE

702

00:44:10,130 --> 00:44:15,350

COMPETITION AND TO DRIVE
CHEMICAL PROCESSES IN THE UPPER

703

00:44:15,350 --> 00:44:18,410

ATMOSPHERE BUT COME METS ARE
RELATIVELY RARE.

704

00:44:18,410 --> 00:44:23,190

PERHAPS MORE SIGNIFICANT IS THE
REGULAR INTERPLANETARY DUST

705

00:44:23,190 --> 00:44:24,750

COMING IN ALL THE TIME.

706

00:44:24,750 --> 00:44:28,010

THIS HAS ITS ORIGIN WITH COME
METS BUT IT'S NOT ASSOCIATED

707

00:44:28,010 --> 00:44:30,640
WITH A SPECIFIC COME MET PASSING
BY.

708
00:44:30,640 --> 00:44:33,460
IT'S JUST ALL WAS THERE AND ALL
WAS COMING IN.

709
00:44:33,460 --> 00:44:37,420
MAVEN IN FACT HAS FOR THE FIRST
TIME DETECTED WITH A WE THINK IS

710
00:44:37,420 --> 00:44:41,150
THIS DUST COMING IN FROM
INTERPLANETARY SPACE AND IT

711
00:44:41,150 --> 00:44:44,880
WOULD HAVE THE EFFECT OF
PRODUCING A LONG LIVED, LONG

712
00:44:44,880 --> 00:44:52,180
STANDING LAYER OF METAL IONS IN
THE UPPER ATMOSPHERE AND

713
00:44:52,180 --> 00:44:58,080
CREATING A LAYER AND THE
CHEMICAL PROCESSES DRIVEN BY

714
00:44:58,080 --> 00:45:01,650
THAT MAY BE EFFECTING THE
ATMOSPHERE AS A WHOLE.

715
00:45:01,650 --> 00:45:05,440
SO WE SEE THIS DUST, WHETHER
IT'S FROM COMETS OR

716
00:45:05,440 --> 00:45:12,240
INTERPLANETARY DUST AS A
POSSIBLE DRIVER OF PROCESSES

717

00:45:12,240 --> 00:45:16,420
THAT CAN LEAD TO ESCAPE OR CAN
CONTRIBUTE TO ESCAPE BUT IT'S

718
00:45:16,420 --> 00:45:18,450
NOT A DIRECT CONNECTION.

719
00:45:18,450 --> 00:45:24,240
I COULDN'T TELL YOU TODAY HOW
MUCH ESCAPE IT'S DRIVING.

720
00:45:24,240 --> 00:45:26,750
>> NEXT UP, WE HAVE TRACY WATSON
FROM USA TODAY.

721
00:45:26,750 --> 00:45:29,060
>> HI, THANKS FOR TAKING MY
QUESTION.

722
00:45:29,060 --> 00:45:33,480
I UNDERSTAND YOU QUANTIFIED THE
AMOUNT OF ATMOSPHERIC LOSS BUT

723
00:45:33,480 --> 00:45:37,310
CAN YOU HELP ME OUT TO
UNDERSTAND HOW THIS GETS YOU

724
00:45:37,310 --> 00:45:40,440
CLOSER TO UNDERSTANDING WHAT
HAPPENED EONS AGO BECAUSE FROM

725
00:45:40,440 --> 00:45:44,060
WHAT I HEARD TODAY YOU HAVEN'T
QUANTIFIED WHETHER THE STORMS

726
00:45:44,060 --> 00:45:52,910
WERE ENOUGH TO STRIP AWAY A
LARGE PART OF THE ATMOSPHERE.

727
00:45:52,910 --> 00:45:55,210

THANKS.

728

00:45:55,210 --> 00:46:00,030

>> THE IDEAL SITUATION WOULD
HAVE BEEN TO OBSERVE THE SOLAR

729

00:46:00,030 --> 00:46:06,190

WIND EARLY IN MARS HISTORY AS IT
WAS STRIPPING AWAY GAS FROM THE

730

00:46:06,190 --> 00:46:07,190

ATMOSPHERE.

731

00:46:07,190 --> 00:46:11,200

BUT NASA TENDS NOT TO FUND 4
BILLION YEARLONG MISSIONS.

732

00:46:11,200 --> 00:46:14,990

SO WE SETTLE FOR LOOKING AT THE
ATMOSPHERE TODAY, UNDERSTANDING

733

00:46:14,990 --> 00:46:19,770

THE PROCESSES AND TRYING TO
EXTRAPOLATE BACKWARDS IN TIME.

734

00:46:19,770 --> 00:46:24,990

TODAY THE MAIN RESULT THAT WE'RE
TALKING ABOUT IS A MUCH BETTER

735

00:46:24,990 --> 00:46:29,730

UNDERSTANDING OF THE LOSS OUT
THE ATMOSPHERE TODAY AND OF THE

736

00:46:29,730 --> 00:46:31,210

PROCESSES DRIVING IT.

737

00:46:31,210 --> 00:46:34,640

I'M ONLY WAVING MY ARMS A LITTLE
BIT ON WHAT THIS DID OVERTIME

738

00:46:34,640 --> 00:46:38,390

BECAUSE THE TEAM HAS BEEN SO
FOCUSED ON WHAT'S GOING ON TODAY

739

00:46:38,390 --> 00:46:40,950

THAT WE HAVEN'T HAD THE CHANCE
TO DO THAT EXTRAPOLATION

740

00:46:40,950 --> 00:46:44,740

BACKWARD IN TIME BUT ALL THE
INDICATIONS ARE THAT THE LOSS

741

00:46:44,740 --> 00:46:50,000

RATE AT THE GREATER RATE,
APPROPRIATE FOR EARLY IN HISTORY

742

00:46:50,000 --> 00:46:54,520

WOULD HAVE BEEN ADEQUATE TO
REMOVE VERY LARGE ATMOSPHERE AND

743

00:46:54,520 --> 00:46:58,100

TAKE US FROM A WARM, WET PLANET
EARLY IN HISTORY TO THE COLD,

744

00:46:58,100 --> 00:46:59,600

DRY PLANET TODAY.

745

00:46:59,600 --> 00:47:04,950

I'LL HAVE TO ASK YOU TO HANG ON
UNTIL WE CAN DO THAT ANALYSIS

746

00:47:04,950 --> 00:47:08,770

AND THEN WE'LL GIVE YOU A MUCH
MORE QUANTITATIVE ESTIMATE.

747

00:47:08,770 --> 00:47:10,720

>> OKAY.

748

00:47:10,720 --> 00:47:13,510

ONE LAST QUESTION FROM THE PHONE
AND THEN WE'LL COME HERE IN

749

00:47:13,510 --> 00:47:14,510

WASHINGTON.

750

00:47:14,510 --> 00:47:15,510

TOM.

751

00:47:15,510 --> 00:47:16,510

>> CONGRATULATIONS TO THE MAVEN

TEAM.

752

00:47:16,510 --> 00:47:23,450

I'M CURIOUS AFTER DOING ALL OF
THIS INDEPTH STUDY OF CLIMATE

753

00:47:23,450 --> 00:47:28,760

CHANGE, WHAT KIND OF LESSON
DOUSE THINK IT COULD HAVE FOR

754

00:47:28,760 --> 00:47:33,080

PEOPLE THAT ARE STUDYING HOW
EARTH'S CLIMATE IS EVOLVING OR

755

00:47:33,080 --> 00:47:34,710

COULD CHANGE RAPIDLY?

756

00:47:34,710 --> 00:47:38,150

>> THE PROCESSES THAT WE'RE LOOK
AT FOR DRIVING MARS CLIMATE

757

00:47:38,150 --> 00:47:41,620

CHANGE ARE THOUGHT TO BE VERY
DIFFERENT FROM THE PROCESSES

758

00:47:41,620 --> 00:47:43,950

THAT DRIVE EARTH CLIMATE CHANGE.

759

00:47:43,950 --> 00:47:49,290
ESPECIALLY WHEN THE CLIMATE
CHANGE, WHEN YOU USE THOSE WORDS

760
00:47:49,290 --> 00:47:52,640
HERE FOR THE EARTH, MOST PEOPLE
THINK THAT APPLIES TO THE

761
00:47:52,640 --> 00:47:57,150
POTENTIAL FOR HUMAN INDUCED
CLIMATE CHANGE SO IT'S REALLY

762
00:47:57,150 --> 00:47:59,890
COMPARING APPLES AND ORANGES.

763
00:47:59,890 --> 00:48:05,270
THERE'S NOT A DIRECT COMPARISON
THAT I WANT TO MAKE BUT WE DO

764
00:48:05,270 --> 00:48:08,550
GET A BETTER UNDERSTANDING OF
ATMOSPHERE FEARIC PROCESSES IN

765
00:48:08,550 --> 00:48:09,550
GENERAL.

766
00:48:09,550 --> 00:48:11,810
MICHAEL, DO YOU WANT TO ADD
ANYTHING TO THAT?

767
00:48:11,810 --> 00:48:14,200
>> NO, I THINK THAT'S ABOUT
RIGHT.

768
00:48:14,200 --> 00:48:17,990
CERTAINLY MARS, ALL THE CLIMATE
CHANGE THAT WE HAVE SEEN HAS

769
00:48:17,990 --> 00:48:23,420
BEEN INDUSED BY THE FAILURE OF

THE GLOBAL MAGNETIC FIELD ON

770

00:48:23,420 --> 00:48:28,960

MARS AND ACTING MOSTLY WITH THE
SOLAR WIND.

771

00:48:28,960 --> 00:48:31,160

ON EARTH IT'S AN ENTIRELY
DIFFERENT STORY WHERE WE'RE

772

00:48:31,160 --> 00:48:35,730

SEEING THE HEATING OF THE
ATMOSPHERE.

773

00:48:35,730 --> 00:48:37,560

>> OKAY.

774

00:48:37,560 --> 00:48:40,050

IF YOU CAN GIVE YOUR NAME AND
AFFILIATION AND YOUR QUESTION

775

00:48:40,050 --> 00:48:41,050

PLEASE.

776

00:48:41,050 --> 00:48:42,050

>> OKAY.

777

00:48:42,050 --> 00:48:44,130

MARSHA FREEMAN WITH EXECUTIVE
INTELLIGENCE REVIEW.

778

00:48:44,130 --> 00:48:49,190

WE HAD LITTLE ATMOSPHERIC
STATIONS ON THE SURFACE OF MARS

779

00:48:49,190 --> 00:48:52,310

ON A NUMBER OF LANDERS FOR A
NUMBER OF CAREERS AND YOU

780

00:48:52,310 --> 00:48:55,790
MENTIONED THAT SOME OF THE SOLAR
WIND PROCESSES COULD BE

781
00:48:55,790 --> 00:49:02,610
ACCELERATING IONS NOT JUST TO
ESCAPE BUT DOWN.

782
00:49:02,610 --> 00:49:07,000
IS ANY OF THE DATA FROM ANY OF
THE SURFACE INSTRUMENTS USEFUL

783
00:49:07,000 --> 00:49:12,340
FOR THE STUDY YOU ARE DOING AND
CONTINGENT TO THAT WOULD IT BE

784
00:49:12,340 --> 00:49:17,420
HELPFUL TO HAVE BALLOONS OR
SOMETHING IN BETWEEN THE SURFACE

785
00:49:17,420 --> 00:49:19,680
AND AN ORBITER?

786
00:49:19,680 --> 00:49:23,730
>> THERE IS AN EXPERIMENT ON THE
CURIOSITY ROVER THAT IS VERY

787
00:49:23,730 --> 00:49:25,900
RELEVANT TO WHAT MAVEN IS
MEASURING.

788
00:49:25,900 --> 00:49:28,420
IT MAY HAVE MEASURED THE
RADIATION ENVIRONMENT AT THE

789
00:49:28,420 --> 00:49:29,700
SURFACE.

790
00:49:29,700 --> 00:49:33,440
AND THE PARTICLES THAT MAKE IT

TO THE SURFACE ARE THE SAME

791

00:49:33,440 --> 00:49:36,730

PARTICLES THAT HIT THE TOP OF
THE ATMOSPHERE SO ONE OF THE

792

00:49:36,730 --> 00:49:39,150

THINGS WE'RE HOPING TO DO IS TO
COUPLE THOSE MEASUREMENTS

793

00:49:39,150 --> 00:49:43,590

TOGETHER WITH MEASUREMENTS AT
THE TOP AND AT THE BOTTOM OF THE

794

00:49:43,590 --> 00:49:48,000

ATMOSPHERE AND REALLY UNDERSTAND
WHAT THE RADIATION ENVIRONMENT

795

00:49:48,000 --> 00:49:50,510

IS AND WHAT DRIVES IT.

796

00:49:50,510 --> 00:49:55,010

IN TERMS OF CLIMATE, WE HAVE†--
WE'VE HAD MULTIPLE STATIONS AT

797

00:49:55,010 --> 00:49:56,010

THE SURFACE.

798

00:49:56,010 --> 00:49:58,910

WE ALSO HAVE CLIMATE-RELATED
MEASUREMENTS BEING MADE FROM

799

00:49:58,910 --> 00:50:01,040

ORBITING SPACECRAFT.

800

00:50:01,040 --> 00:50:07,630

FOR EXAMPLE, THE MARS CLIMATE
SOUNDER ON THE ORBITER MEASURING

801

00:50:07,630 --> 00:50:11,180

THE PROPERTIES OF THE MAIN PART
OF THE ATMOSPHERE.

802

00:50:11,180 --> 00:50:15,410

ALL OF THIS COUPLES TOGETHER AND
BY MEASURING THE DIFFERENT

803

00:50:15,410 --> 00:50:19,380

PIECES OF THE ATMOSPHERE, AT THE
SAME TIME OR EVEN AT DIFFERENT

804

00:50:19,380 --> 00:50:22,620

TIMES, WE CAN UNDERSTAND THE
COUPLING BETWEEN THEM.

805

00:50:22,620 --> 00:50:26,360

TO GIVE YOU ONE EXAMPLE, BY
UNDERSTANDING THE LOWER

806

00:50:26,360 --> 00:50:30,640

ATMOSPHERE, WE UNDERSTAND THE
WAYS IN WHICH ATMOSPHERIC WAVES

807

00:50:30,640 --> 00:50:33,880

GENERATED IN THE BOTTOM PART OF
THE ATMOSPHERE CAN WORK THEIR

808

00:50:33,880 --> 00:50:37,260

WAY UP INTO THE TOP OF THE
ATMOSPHERE AND DEPOSIT ENERGY

809

00:50:37,260 --> 00:50:38,730

AND MIX THINGS UP.

810

00:50:38,730 --> 00:50:41,390

AND THAT'S AN IMPORTANT
COMPONENT OF UNDERSTANDING THE

811

00:50:41,390 --> 00:50:43,240

BEHAVIOR OF THE UPPER
ATMOSPHERE.

812

00:50:43,240 --> 00:50:46,510

SO, AGAIN, I WANT TO COME BACK
TO THIS THEME OF MARS AS A VERY

813

00:50:46,510 --> 00:50:51,020

COMPLEX SYSTEM IN WHICH ALL THE
PIECES ARE COUPLED TOGETHER.

814

00:50:51,020 --> 00:50:54,500

AND WE NEED TO UNDERSTAND EACH
ONE SEPARATELY BUT ALSO HOW THEY

815

00:50:54,500 --> 00:50:57,390

COUPLE TOGETHER.

816

00:50:57,390 --> 00:50:59,920

>> OKAY.

817

00:50:59,920 --> 00:51:01,690

WELL WE'RE GOING TO WRAP UP
HERE.

818

00:51:01,690 --> 00:51:06,550

LET ME FIRST THANK OUR FOLKS
THAT JOINED US FROM OUR

819

00:51:06,550 --> 00:51:07,550

UNIVERSES.

820

00:51:07,550 --> 00:51:10,770

FIRST, JASPER FROM THE
UNIVERSITY OF IOWA AND IOWA

821

00:51:10,770 --> 00:51:11,770

CITY.

822

00:51:11,770 --> 00:51:13,050

THANK YOU, AGAIN.

823

00:51:13,050 --> 00:51:17,480

AND OF COURSE OUR FOLKS AT THE
UNIVERSITY OF COLORADO.

824

00:51:17,480 --> 00:51:23,540

AGAIN, KEEP THOSE QUESTIONS
COMING IN ON SOCIAL MEDIA

825

00:51:23,540 --> 00:51:24,540

AT†#ASKNASA.

826

00:51:24,540 --> 00:51:27,440

A TEAM OF SCIENTISTS WILL BE
ANSWERING YOUR QUESTIONS AS

827

00:51:27,440 --> 00:51:28,720

QUICKLY AS POSSIBLE.

828

00:51:28,720 --> 00:51:32,650

FOR MEDIA, WE WILL BE TAKING
YOUR CALLS AND REQUESTS AND SET

829

00:51:32,650 --> 00:51:36,400

UP TEAM MEMBERS TO ANSWER YOUR
QUESTIONS AND OF COURSE ALL OF

830

00:51:36,400 --> 00:51:43,070

THIS INFORMATION AND MORE IS
ONLINE AT NASA.GOV/MAVEN.