
AbSciCon
2019

1
00:00:00,790 --> 00:00:07,320
[Music]

2
00:00:11,680 --> 00:00:09,150
[Applause]

3
00:00:13,900 --> 00:00:11,690
thank you very much everyone for staying

4
00:00:15,459 --> 00:00:13,910
here until the end of the conference my

5
00:00:17,980 --> 00:00:15,469
name is Herman Martinez from the

6
00:00:19,300 --> 00:00:17,990
University of Michigan although I will

7
00:00:22,450 --> 00:00:19,310
be moving to the lunar and planetary

8
00:00:26,620 --> 00:00:22,460
Institute in Houston in only one week so

9
00:00:30,460 --> 00:00:26,630
last week with you meet I'll keep the

10
00:00:32,650 --> 00:00:30,470
affiliation anyway so first of all I

11
00:00:34,870 --> 00:00:32,660
want to thank the conveners for inviting

12
00:00:37,810 --> 00:00:34,880
me to give this talk I also want to

13
00:00:40,750 --> 00:00:37,820

thank my collaborators Eric Fisher and

14
00:00:42,580 --> 00:00:40,760
nilton Brenner for I want to acknowledge

15
00:00:45,160 --> 00:00:42,590
their contribution to this work I also

16
00:00:46,810 --> 00:00:45,170
want to thank NASA for the funding and

17
00:00:48,760 --> 00:00:46,820
the Mars Science Laboratory and the Mars

18
00:00:51,190 --> 00:00:48,770
Tony and 20 mission also for the funding

19
00:00:53,950 --> 00:00:51,200
and as you can see today I'll be talking

20
00:00:56,230 --> 00:00:53,960
about bra information on Mars and in the

21
00:01:01,630 --> 00:00:56,240
icy worlds through lab experiments and

22
00:01:04,950 --> 00:01:01,640
instrument development okay so why are

23
00:01:10,300 --> 00:01:04,960
brands that important do you know whoa

24
00:01:12,819 --> 00:01:10,310
so pretty much life requires three main

25
00:01:15,580 --> 00:01:12,829
ingredients to evolve we need water we

26
00:01:18,130 --> 00:01:15,590
need a source of energy and we need

27
00:01:21,849 --> 00:01:18,140
nutrients and raw materials so we know

28
00:01:25,749 --> 00:01:21,859
that on earth a diverse array of micro

29
00:01:27,669 --> 00:01:25,759
organisms thrive seen in brains and as

30
00:01:30,279 --> 00:01:27,679
far east as for instance we have brain

31
00:01:32,469 --> 00:01:30,289
habitats found in in in Antarctica blood

32
00:01:35,080 --> 00:01:32,479
falls there was a previous token on

33
00:01:37,719 --> 00:01:35,090
these we also have a bacterial brain

34
00:01:40,480 --> 00:01:37,729
pool that were found on a deep sea mud

35
00:01:44,919 --> 00:01:40,490
volcano in the eastern Mediterranean

36
00:01:47,609 --> 00:01:44,929
so could brine form of Mars and in the

37
00:01:51,069 --> 00:01:47,619
icy wolves and eat brains form in these

38
00:01:54,279 --> 00:01:51,079

worlds could micro organisms thrive in

39
00:01:57,609 --> 00:01:54,289
such brains so that's the topic of my of

40
00:02:00,639 --> 00:01:57,619
my talk today so let's start by

41
00:02:03,279 --> 00:02:00,649
reviewing the evidence for the evidence

42
00:02:06,550 --> 00:02:03,289
of brain on Mars so currently there are

43
00:02:08,529 --> 00:02:06,560
four with like surface features that

44
00:02:12,990 --> 00:02:08,539
have been a kata sized to contain brine

45
00:02:19,900 --> 00:02:13,000
on on current Mars ok oops sorry

46
00:02:22,089 --> 00:02:19,910
here so on low and mid latitudes we have

47
00:02:24,910 --> 00:02:22,099
the Ghoulies we have the Eris

48
00:02:27,580 --> 00:02:24,920
we have Islamist weeks then at northern

49
00:02:30,699 --> 00:02:27,590
latitudes we have the co2 yet and in

50
00:02:32,470 --> 00:02:30,709
addition to these surface features we

51
00:02:34,059 --> 00:02:32,480
also have these asteroids that were

52
00:02:36,069 --> 00:02:34,069
found on these threats of the Phoenix

53
00:02:37,809 --> 00:02:36,079
lander and that were hypothesized to be

54
00:02:41,020 --> 00:02:37,819
brine that grew by the liquid sense of

55
00:02:43,000 --> 00:02:41,030
course for every of these features and

56
00:02:44,679 --> 00:02:43,010
not only what mechanisms have been

57
00:02:47,319 --> 00:02:44,689
proposed for their formation and

58
00:02:48,940 --> 00:02:47,329
evolution also dry mechanisms and indeed

59
00:02:51,459 --> 00:02:48,950
for some of these guys that right

60
00:02:53,199 --> 00:02:51,469
mechanism is the most widely accepted

61
00:02:55,360 --> 00:02:53,209
mechanism but that is a you know like

62
00:03:02,349 --> 00:02:55,370
that's a different topic for a different

63
00:03:06,520 --> 00:03:02,359

presentation so okay so how would brine

64
00:03:07,270 --> 00:03:06,530
form on Mars two mechanisms have been

65
00:03:10,839 --> 00:03:07,280
suggested

66
00:03:12,729 --> 00:03:10,849
so formation by salt absorbing

67
00:03:14,979 --> 00:03:12,739
atmospheric water vapor in a process

68
00:03:18,039 --> 00:03:14,989
called deliquescent and then the typical

69
00:03:22,149 --> 00:03:18,049
process which sees formation by salt

70
00:03:23,619 --> 00:03:22,159
melting water ice so here I want to

71
00:03:26,170 --> 00:03:23,629
illustrate the process of deliquescent

72
00:03:29,349 --> 00:03:26,180
so here I'm showing the stability

73
00:03:31,449 --> 00:03:29,359
diagram for sodium magnesium and calcium

74
00:03:34,030 --> 00:03:31,459
perchlorate these are these are very

75
00:03:35,890 --> 00:03:34,040
relevant salts for Mars because they are

76
00:03:39,460 --> 00:03:35,900
widespread on the planet and they have

77
00:03:41,110 --> 00:03:39,470
very low detecting values so here I'm

78
00:03:42,969 --> 00:03:41,120
showing on the y-axis the temperature

79
00:03:47,099 --> 00:03:42,979
and the relative humidity on the x-axis

80
00:03:49,929 --> 00:03:47,109
and then basically like in deliquescent

81
00:03:52,719 --> 00:03:49,939
brain forms when the relative humidity

82
00:03:55,059 --> 00:03:52,729
exceeds a certain threshold called

83
00:03:56,699 --> 00:03:55,069
deliquescent relative humidity so let's

84
00:03:59,979 --> 00:03:56,709
imagine that we start here with

85
00:04:01,899 --> 00:03:59,989
crystalline calcium perchlorate for

86
00:04:04,719 --> 00:04:01,909
instance that's what we would have here

87
00:04:07,509 --> 00:04:04,729
so if we increase the relative humidity

88
00:04:10,390 --> 00:04:07,519

when we crossed that threshold we would

89
00:04:11,860 --> 00:04:10,400
a brain would form and that's again that

90
00:04:14,259 --> 00:04:11,870
the liquid and relative humidity for

91
00:04:15,969 --> 00:04:14,269
this for this results obviously in

92
00:04:18,189 --> 00:04:15,979
melting information the only thing we

93
00:04:20,259 --> 00:04:18,199
need is that the temperature is above

94
00:04:24,629 --> 00:04:20,269
the eutectic value of the salt in

95
00:04:27,149 --> 00:04:24,639
contact with v with the water lives so

96
00:04:30,730 --> 00:04:27,159
okay now that we understand the

97
00:04:33,279 --> 00:04:30,740
mechanism for Brian formation on Mars we

98
00:04:36,259 --> 00:04:33,289
took the next step and we designed our

99
00:04:39,769 --> 00:04:36,269
Michigan Mars environmental

100
00:04:42,379 --> 00:04:39,779
this was funded with with with funding

101
00:04:46,189 --> 00:04:42,389
from the exobiology program and in the

102
00:04:47,989 --> 00:04:46,199
program so in this chamber we use Raman

103
00:04:51,559 --> 00:04:47,999
spectroscopy and a camera to detect

104
00:04:53,539 --> 00:04:51,569
brain formation and we are quite happy

105
00:04:55,819 --> 00:04:53,549
with the performance of the chamber

106
00:04:59,569 --> 00:04:55,829
within that it has great capabilities

107
00:05:00,949 --> 00:04:59,579
that can simulate full the full

108
00:05:02,569 --> 00:05:00,959
environmental the full range of

109
00:05:04,699 --> 00:05:02,579
environmental conditions found on Mars

110
00:05:06,649 --> 00:05:04,709
so we can simulate relative humidity

111
00:05:08,239 --> 00:05:06,659
temperature and pressures that have been

112
00:05:10,429 --> 00:05:08,249
measured in situ on Mars I'll be showing

113
00:05:12,579 --> 00:05:10,439

that and as an example of the

114
00:05:15,199 --> 00:05:12,589
performance of our chamber every

115
00:05:17,839 --> 00:05:15,209
relative humidity sensor that has flown

116
00:05:20,419 --> 00:05:17,849
to Mars has been recalibrated in our

117
00:05:23,299 --> 00:05:20,429
chamber at some point the one at the

118
00:05:27,729 --> 00:05:23,309
Phoenix MSL and also Mars 20 and 20 and

119
00:05:30,769 --> 00:05:27,739
ExoMars so okay Here I am showing

120
00:05:33,439 --> 00:05:30,779
experimental results for deliquescent so

121
00:05:35,329 --> 00:05:33,449
remember just like like crystalline salt

122
00:05:40,129 --> 00:05:35,339
and atmospheric water vapor no ice

123
00:05:43,969 --> 00:05:40,139
involved and so what we did here was to

124
00:05:47,809 --> 00:05:43,979
expose a piece of calcium perchlorate to

125
00:05:50,389 --> 00:05:47,819
environmental conditions at relative

126
00:05:52,609 --> 00:05:50,399
humidity of 100% and temperature of 223

127
00:05:55,309 --> 00:05:52,619
Kelvin so again our sample was a piece

128
00:05:56,929 --> 00:05:55,319
of perchlorate salt exposed to saturated

129
00:05:58,939 --> 00:05:56,939
conditions and obviously we were

130
00:06:02,059 --> 00:05:58,949
expecting deliquescent because these are

131
00:06:04,579 --> 00:06:02,069
conditions favorable for that but what

132
00:06:08,509 --> 00:06:04,589
we found was that so here in the top

133
00:06:10,609 --> 00:06:08,519
figure I'm showing the Raman spectra for

134
00:06:13,609 --> 00:06:10,619
for the sample at different times during

135
00:06:16,279 --> 00:06:13,619
the experiment so in a minute zero and

136
00:06:18,739 --> 00:06:16,289
then like like three hours and a half

137
00:06:21,229 --> 00:06:18,749
later again at these constant conditions

138
00:06:24,409 --> 00:06:21,239

and what we can see is that based on the

139
00:06:27,379 --> 00:06:24,419
Raman spectra brime did not form so

140
00:06:29,600 --> 00:06:27,389
basically the there wasn't any variation

141
00:06:33,439 --> 00:06:29,610
in the spectra except for this shoulder

142
00:06:36,139 --> 00:06:33,449
here which is indicative of a change in

143
00:06:39,529 --> 00:06:36,149
the hydration state we can see that

144
00:06:41,449 --> 00:06:39,539
better in the in the bottom figure Here

145
00:06:43,639 --> 00:06:41,459
I am showing the Gaussian decomposition

146
00:06:45,379 --> 00:06:43,649
of the red curve so we took the Raman

147
00:06:47,569 --> 00:06:45,389
spectra at the end of the experiment we

148
00:06:48,800 --> 00:06:47,579
took the Gaussian decomposition and what

149
00:06:51,379 --> 00:06:48,810
we see is that

150
00:06:53,840 --> 00:06:51,389
spectral Peaks are indicative of the

151
00:06:55,850 --> 00:06:53,850
presence of perchloric salt but none of

152
00:06:57,800 --> 00:06:55,860
those Peaks are telling us that liquid

153
00:07:00,290 --> 00:06:57,810
brine form and same thing with the

154
00:07:02,990 --> 00:07:00,300
images so this is important because here

155
00:07:05,690 --> 00:07:03,000
what we found was that kinetics matter

156
00:07:08,480 --> 00:07:05,700
it's not enough with conditions to be

157
00:07:10,430 --> 00:07:08,490
favorable but maybe it's a matter of

158
00:07:16,720 --> 00:07:10,440
time exposed to those conditions I'll

159
00:07:18,650 --> 00:07:16,730
get into more details later okay so now

160
00:07:20,360 --> 00:07:18,660
regarding ice melting so previous

161
00:07:21,980 --> 00:07:20,370
experiment was for deliquescent now

162
00:07:24,440 --> 00:07:21,990
let's move to the other mechanism let's

163
00:07:26,750 --> 00:07:24,450

move to ice melting so what we did here

164
00:07:29,030 --> 00:07:26,760
was to put a piece of perchlorate salt

165
00:07:31,250 --> 00:07:29,040
on top of water ice so we had

166
00:07:33,710 --> 00:07:31,260
perchlorate I perchlorates Ola and

167
00:07:37,240 --> 00:07:33,720
weatherizing contact and then we

168
00:07:39,770 --> 00:07:37,250
simulated the full diurnal cycle at the

169
00:07:42,500 --> 00:07:39,780
with conditions for the Phoenix landing

170
00:07:44,390 --> 00:07:42,510
site so this is shown here in the figure

171
00:07:46,670 --> 00:07:44,400
on the left and what we did was to

172
00:07:48,770 --> 00:07:46,680
simulate here in red the temperature

173
00:07:50,629 --> 00:07:48,780
inside the chamber which is again like

174
00:07:52,550 --> 00:07:50,639
simulating room temperatures at the

175
00:07:54,890 --> 00:07:52,560
Phoenix landing site and we also

176
00:07:56,390 --> 00:07:54,900
simulated defrost point or or

177
00:07:59,930 --> 00:07:56,400
equivalently the relative humidity

178
00:08:01,820 --> 00:07:59,940
inside the chamber and what we found is

179
00:08:04,310 --> 00:08:01,830
that pretty much a couple of minutes

180
00:08:06,320 --> 00:08:04,320
after the temperature in the chamber

181
00:08:08,360 --> 00:08:06,330
exceeded the eutectic temperature of

182
00:08:11,270 --> 00:08:08,370
calcium perchlorate and that happened

183
00:08:12,620 --> 00:08:11,280
between B and C run there so the

184
00:08:15,560 --> 00:08:12,630
eutectic temperature of calcium

185
00:08:17,210 --> 00:08:15,570
perchlorate is 199 Kelvin so again we

186
00:08:20,629 --> 00:08:17,220
did this in real time we were sitting

187
00:08:22,790 --> 00:08:20,639
there for for 24 hours and or more Eric

188
00:08:25,760 --> 00:08:22,800

Fischer than me but the thing is that

189
00:08:28,879 --> 00:08:25,770
right after at that was like at 4:00

190
00:08:31,640 --> 00:08:28,889
a.m. I think Phoenix local time as soon

191
00:08:33,350 --> 00:08:31,650
as we crossed the eutectic value the

192
00:08:35,899 --> 00:08:33,360
composition or Gaussian decomposition

193
00:08:37,670 --> 00:08:35,909
that the raman spectra told us about the

194
00:08:39,589 --> 00:08:37,680
presence of liquid water and that is

195
00:08:41,719 --> 00:08:39,599
also clearly visible from from these

196
00:08:43,699 --> 00:08:41,729
images I didn't want to go with the

197
00:08:47,300 --> 00:08:43,709
Gaussian the composition but again like

198
00:08:50,150 --> 00:08:47,310
if you decompose like B be a spectra at

199
00:08:52,550 --> 00:08:50,160
all these times basically like from B to

200
00:08:57,020 --> 00:08:52,560
e you clearly see Peaks corresponding to

201
00:08:59,510 --> 00:08:57,030
- water - Brian formation so our first

202
00:09:02,489 --> 00:08:59,520
set of conclusions here is that okay it

203
00:09:04,649 --> 00:09:02,499
is it's obvious conclusions but still

204
00:09:07,529 --> 00:09:04,659
important it is a paramount importance

205
00:09:09,959 --> 00:09:07,539
to note the actual relative humidity and

206
00:09:12,209 --> 00:09:09,969
temperature environment on Mars like the

207
00:09:13,709 --> 00:09:12,219
specific and contemporaneous or

208
00:09:16,199 --> 00:09:13,719
simultaneous values of temperature and

209
00:09:18,209 --> 00:09:16,209
relative humidity are needed we need to

210
00:09:20,459 --> 00:09:18,219
know that and also we need to understand

211
00:09:22,319 --> 00:09:20,469
kinetics because again it's it's a

212
00:09:25,229 --> 00:09:22,329
necessary condition that conditions are

213
00:09:27,599 --> 00:09:25,239

favorable but not sufficient and that's

214
00:09:30,029 --> 00:09:27,609
that this is why again like when we went

215
00:09:31,679 --> 00:09:30,039
with the leak questions or sorry when we

216
00:09:33,689 --> 00:09:31,689
went with ice melting that was like a

217
00:09:39,869 --> 00:09:33,699
forswear process in a couple of minutes

218
00:09:42,569 --> 00:09:39,879
but not with daily questions so okay the

219
00:09:44,579 --> 00:09:42,579
actual relative humidity and temperature

220
00:09:48,209 --> 00:09:44,589
environment is important to know so that

221
00:09:49,559 --> 00:09:48,219
was our next step because I forgot to

222
00:09:51,839 --> 00:09:49,569
mention that but in the previous

223
00:09:53,429 --> 00:09:51,849
experiment we were using simulated data

224
00:09:54,869 --> 00:09:53,439
of relative humidity and room

225
00:09:57,209 --> 00:09:54,879
temperature because those values have

226
00:09:59,579 --> 00:09:57,219
not been measured or were not available

227
00:10:01,709 --> 00:09:59,589
on Mars so the next thing that we did

228
00:10:03,659 --> 00:10:01,719
was to try to get the most realistic

229
00:10:06,419 --> 00:10:03,669
relative humidity and temperature values

230
00:10:07,919 --> 00:10:06,429
so as you know the relative humidity has

231
00:10:10,889 --> 00:10:07,929
only been measured by the Phoenix

232
00:10:13,019 --> 00:10:10,899
mission in 2008 and now by the mars

233
00:10:15,989 --> 00:10:13,029
science by the Curiosity rover by the

234
00:10:18,269 --> 00:10:15,999
MSL these are the only two sensors the

235
00:10:19,919 --> 00:10:18,279
thing is that the the Phoenix

236
00:10:23,460 --> 00:10:19,929
disappeared with the relative humidity

237
00:10:25,829 --> 00:10:23,470
sensor onboard the Phoenix the original

238
00:10:28,109 --> 00:10:25,839

calibration only partially overlap the

239
00:10:32,099 --> 00:10:28,119
conditions that were later found at the

240
00:10:33,659 --> 00:10:32,109
Phoenix landing site so in 2010 the

241
00:10:36,839 --> 00:10:33,669
process relative humidity data were

242
00:10:38,759 --> 00:10:36,849
removed from the PDS because there were

243
00:10:41,669 --> 00:10:38,769
uncertainties at the lowest temperatures

244
00:10:44,249 --> 00:10:41,679
because those values were not covered a

245
00:10:47,789 --> 00:10:44,259
revised calibration function was

246
00:10:51,179 --> 00:10:47,799
proposed by Aaron Byzantine a couple of

247
00:10:54,179 --> 00:10:51,189
years ago and then more recently we have

248
00:10:55,859 --> 00:10:54,189
conducted a new recalibration using an

249
00:10:58,249 --> 00:10:55,869
engineering unit that will borrowed from

250
00:11:00,449 --> 00:10:58,259
from JPL and we subjected this

251
00:11:02,159 --> 00:11:00,459
engineering unit to the full range of

252
00:11:05,849 --> 00:11:02,169
environmental conditions that were found

253
00:11:08,189 --> 00:11:05,859
at the Phoenix landing site and I'm

254
00:11:10,199 --> 00:11:08,199
going to show results of these relative

255
00:11:11,759 --> 00:11:10,209
humidity values which I think that they

256
00:11:13,649 --> 00:11:11,769
are very important because again we only

257
00:11:15,419 --> 00:11:13,659
have in situ data two points on the

258
00:11:16,410 --> 00:11:15,429
planet and and this is the North Pole

259
00:11:19,530 --> 00:11:16,420
which is

260
00:11:23,639 --> 00:11:19,540
Richard in terms of humidity than get

261
00:11:25,169 --> 00:11:23,649
greater so I think it's important so

262
00:11:28,229 --> 00:11:25,179
these are the results of our

263
00:11:31,410 --> 00:11:28,239

recalibration here I'm showing the whole

264
00:11:33,359 --> 00:11:31,420
set of recalibrated relative humidity

265
00:11:38,069 --> 00:11:33,369
data as a function of the local through

266
00:11:41,249 --> 00:11:38,079
solar time as you remember the Phoenix

267
00:11:44,039 --> 00:11:41,259
mission operated for 150 Sol's pretty

268
00:11:48,059 --> 00:11:44,049
much from day one or sulwon had a solid

269
00:11:52,350 --> 00:11:48,069
longitude of 77 and then Sol 151 was the

270
00:11:55,350 --> 00:11:52,360
latest and ilse best one was 148 so the

271
00:11:57,960 --> 00:11:55,360
tcp was operating during a whole mission

272
00:11:59,629 --> 00:11:57,970
but not continuously as you can see and

273
00:12:03,590 --> 00:11:59,639
that was because of like energetic

274
00:12:06,090 --> 00:12:03,600
demands so what you can see here

275
00:12:09,059 --> 00:12:06,100
hopefully or hopefully you can see that

276
00:12:11,879 --> 00:12:09,069
is that in our recalibration we achieved

277
00:12:14,939 --> 00:12:11,889
saturated conditions only between Souls

278
00:12:18,749 --> 00:12:14,949
90 and 100 corresponding to an Elsa base

279
00:12:20,549 --> 00:12:18,759
of 125 and this is good because that was

280
00:12:22,499 --> 00:12:20,559
the time when two independent

281
00:12:25,499 --> 00:12:22,509
measurements the lidar and the robotic

282
00:12:28,289 --> 00:12:25,509
arm detecting detected near surface fog

283
00:12:31,499 --> 00:12:28,299
so our values are are in agreement with

284
00:12:34,590 --> 00:12:31,509
independent estimations now you might be

285
00:12:36,629 --> 00:12:34,600
wondering how does your recalibration

286
00:12:38,909 --> 00:12:36,639
compared to previous recalibration

287
00:12:41,249 --> 00:12:38,919
that's what I'm showing here here I'm

288
00:12:43,859 --> 00:12:41,259

showing the water vapor pressure from

289
00:12:45,749 --> 00:12:43,869
the from the relative humidity sensor as

290
00:12:48,749 --> 00:12:45,759
a function or as a function of local

291
00:12:51,739 --> 00:12:48,759
through solar time and I'm using in in

292
00:12:55,590 --> 00:12:51,749
in yellow I'm using the values of our

293
00:12:58,069 --> 00:12:55,600
recent recalibration in orange I'm

294
00:13:00,929 --> 00:12:58,079
showing the values from the 2016

295
00:13:04,309 --> 00:13:00,939
recalibration and in blue I'm showing

296
00:13:06,720 --> 00:13:04,319
the values from the original calibration

297
00:13:08,999 --> 00:13:06,730
once again the values in blue were

298
00:13:11,879 --> 00:13:09,009
removed from the PDS the values in

299
00:13:15,600 --> 00:13:11,889
Orleans were added to the PDS in 2017

300
00:13:18,840 --> 00:13:15,610
but and both the Orleans and a and the

301
00:13:22,859 --> 00:13:18,850
blue values used the original pre-flight

302
00:13:25,559 --> 00:13:22,869
calibration so our yellow values here

303
00:13:27,539 --> 00:13:25,569
again come from the recalibration in our

304
00:13:30,119 --> 00:13:27,549
chamber and what you can see is that

305
00:13:31,980 --> 00:13:30,129
while during night time our values are

306
00:13:35,939 --> 00:13:31,990
in excellent agreement with those from

307
00:13:38,539 --> 00:13:35,949
from our own in 2016 during the daytime

308
00:13:41,730 --> 00:13:38,549
our values show one order of magnitude

309
00:13:43,609 --> 00:13:41,740
our one order of magnitude higher so

310
00:13:47,819 --> 00:13:43,619
that's that's a big difference

311
00:13:49,889 --> 00:13:47,829
we think that this is because the orange

312
00:13:52,439 --> 00:13:49,899
values and the blue values were not

313
00:13:54,929 --> 00:13:52,449

calibrated at typical conditions at

314
00:13:57,539 --> 00:13:54,939
daytime they were not calibrated at the

315
00:13:59,549 --> 00:13:57,549
exact pairs of relative humidity and

316
00:14:03,210 --> 00:13:59,559
temperatures that were achieved in in

317
00:14:05,189 --> 00:14:03,220
the Phoenix we also compared our values

318
00:14:08,100 --> 00:14:05,199
with independent measurements from from

319
00:14:11,159 --> 00:14:08,110
orbiters and from the M from the SSI and

320
00:14:15,029 --> 00:14:11,169
our values are in better agreement

321
00:14:17,850 --> 00:14:15,039
values I mean as high as as 1.4 Pascal

322
00:14:21,809 --> 00:14:17,860
so we are confident that these values

323
00:14:25,590 --> 00:14:21,819
are are going to be useful for the

324
00:14:28,109 --> 00:14:25,600
community by the way these are results

325
00:14:30,569 --> 00:14:28,119
of a paper that we submitted to GTR and

326
00:14:34,019 --> 00:14:30,579
that's under review

327
00:14:36,509 --> 00:14:34,029
as soon as at the same time I contacted

328
00:14:38,249 --> 00:14:36,519
the PDS guys and I plan to upload all

329
00:14:40,470 --> 00:14:38,259
the data to the PDS so that the

330
00:14:42,840 --> 00:14:40,480
community has access to the whole set of

331
00:14:48,059 --> 00:14:42,850
data and I hope to do that within the

332
00:14:50,699 --> 00:14:48,069
next weeks that has to be fast ok so now

333
00:14:52,079 --> 00:14:50,709
that we know the actual environmental

334
00:14:54,659 --> 00:14:52,089
conditions from the Phoenix and from the

335
00:14:56,699 --> 00:14:54,669
MSL let's theoretically analyze brain

336
00:14:59,400 --> 00:14:56,709
formation on Mars so what I'm showing

337
00:15:01,889 --> 00:14:59,410
here again is a stability diagram of

338
00:15:04,109 --> 00:15:01,899

Saudi state diagram in terms of

339
00:15:06,809 --> 00:15:04,119
temperature and relative humidity for

340
00:15:09,809 --> 00:15:06,819
sodium sodium magnesium and calcium

341
00:15:12,150 --> 00:15:09,819
perchlorate and then I'm superimposing

342
00:15:13,799 --> 00:15:12,160
in situ values at different heights from

343
00:15:17,279 --> 00:15:13,809
the MSL mission and from the Phoenix

344
00:15:19,109 --> 00:15:17,289
mission okay so basically at different

345
00:15:21,499 --> 00:15:19,119
heights I just did that by using

346
00:15:25,289 --> 00:15:21,509
temperatures at different heights and

347
00:15:28,379 --> 00:15:25,299
what we can see here also sorry for

348
00:15:29,850 --> 00:15:28,389
reference I'm showing here two isobars

349
00:15:34,110 --> 00:15:29,860
which are these dashed

350
00:15:37,049 --> 00:15:34,120
grey lines this is for the isobar of 1.4

351
00:15:40,259 --> 00:15:37,059
pascal which is the highest water vapor

352
00:15:42,110 --> 00:15:40,269
pressure value measured both at the

353
00:15:43,759 --> 00:15:42,120
Phoenix and at the MSL so

354
00:15:45,920 --> 00:15:43,769
this is the highest in situ measurement

355
00:15:50,299 --> 00:15:45,930
of water vapor pressure and this is the

356
00:15:51,920 --> 00:15:50,309
lowest point or 5 to the minus 3 so okay

357
00:15:54,110 --> 00:15:51,930
what we can see is that if we pay

358
00:15:58,429 --> 00:15:54,120
attention to the MSL colors yellow and

359
00:16:02,389 --> 00:15:58,439
purple we do not really cross you know

360
00:16:06,049 --> 00:16:02,399
like the the the area where the liqui

361
00:16:09,799 --> 00:16:06,059
cents would be favored but this is MV R

362
00:16:11,980 --> 00:16:09,809
and in the ground recently edgar rivera

363
00:16:14,809 --> 00:16:11,990

valentin published a paper last year

364
00:16:17,299 --> 00:16:14,819
analyzing the potential for delegations

365
00:16:21,679 --> 00:16:17,309
to happen in the subsurface and there it

366
00:16:25,519 --> 00:16:21,689
was more there was a higher potential so

367
00:16:26,929 --> 00:16:25,529
MSL the surface is very unlikely that

368
00:16:29,239 --> 00:16:26,939
brands form over there at Gale Crater

369
00:16:32,629 --> 00:16:29,249
what about that the Phoenix landing site

370
00:16:36,650 --> 00:16:32,639
so here we are showing in vir

371
00:16:39,319 --> 00:16:36,660
we have some cross there are like a few

372
00:16:40,879 --> 00:16:39,329
souls in which for 10 minutes the

373
00:16:43,519 --> 00:16:40,889
conditions were favorable for brain

374
00:16:45,410 --> 00:16:43,529
formation those are here and then result

375
00:16:47,059 --> 00:16:45,420
from modeling and that is shown in pink

376
00:16:50,119 --> 00:16:47,069
show that yeah like Brian formation

377
00:16:52,009 --> 00:16:50,129
could indeed happen at the ground up be

378
00:16:53,840 --> 00:16:52,019
Phoenix landing site and definitely in

379
00:16:55,400 --> 00:16:53,850
the subsurface so this is basically

380
00:16:57,790 --> 00:16:55,410
telling us that the Phoenix is wetter

381
00:17:00,710 --> 00:16:57,800
than than MSL which we already know so

382
00:17:02,509 --> 00:17:00,720
yeah like ground that the Phoenix yeah

383
00:17:09,319 --> 00:17:02,519
maybe the liquid since at the Abbey MSL

384
00:17:11,260 --> 00:17:09,329
no but based on this so ok another set

385
00:17:14,179 --> 00:17:11,270
of conclusions here so once again

386
00:17:16,730 --> 00:17:14,189
deliquescent is theoretically viable

387
00:17:20,299 --> 00:17:16,740
it's it's it's possible we reach those

388
00:17:23,539 --> 00:17:20,309

conditions but another important topic

389
00:17:25,610 --> 00:17:23,549
is kinetics so basically like whether

390
00:17:26,990 --> 00:17:25,620
the equations is rapid enough to occur

391
00:17:29,200 --> 00:17:27,000
during those times because we are

392
00:17:31,490 --> 00:17:29,210
talking about very low temperatures and

393
00:17:33,880 --> 00:17:31,500
another interesting thing that came up

394
00:17:37,570 --> 00:17:33,890
was that result from our recalibration

395
00:17:40,399 --> 00:17:37,580
showed that the water vapor pressure

396
00:17:42,830 --> 00:17:40,409
varies by two order of magnitude during

397
00:17:45,610 --> 00:17:42,840
a diurnal cycle so we have a super

398
00:17:48,500 --> 00:17:45,620
strong variation right at the surface

399
00:17:50,870 --> 00:17:48,510
and this is definitely suggesting that

400
00:17:54,049 --> 00:17:50,880
the regulate plays a significant role in

401
00:17:55,340 --> 00:17:54,059
in this exchange so let me get back to

402
00:17:59,180 --> 00:17:55,350
the to the

403
00:18:01,790 --> 00:17:59,190
and and and and here

404
00:18:04,400 --> 00:18:01,800
so basically be I'm going to talk about

405
00:18:06,800 --> 00:18:04,410
the potential exchange of h2o between

406
00:18:09,740 --> 00:18:06,810
the regolith and and the atmosphere as

407
00:18:13,190 --> 00:18:09,750
you know the regolith of Mars consists

408
00:18:15,530 --> 00:18:13,200
of a loosely packed porous material

409
00:18:17,630 --> 00:18:15,540
which allows for the exchange of h2o

410
00:18:20,330 --> 00:18:17,640
between the regolith and the atmosphere

411
00:18:22,520 --> 00:18:20,340
we know that this exchange can occur via

412
00:18:25,100 --> 00:18:22,530
physisorption salt hydrogen brain

413
00:18:26,630 --> 00:18:25,110

information and frost formation we all

414
00:18:29,420 --> 00:18:26,640
know what brain formation is impressed

415
00:18:31,580 --> 00:18:29,430
formation also salt hydration just in

416
00:18:33,860 --> 00:18:31,590
case physisorption is when when water

417
00:18:37,130 --> 00:18:33,870
molecules get physically attached to the

418
00:18:39,260 --> 00:18:37,140
surface of soil grains and minerals and

419
00:18:41,870 --> 00:18:39,270
obviously salt hydration is like changes

420
00:18:43,940 --> 00:18:41,880
in the hydration estate so okay we have

421
00:18:46,150 --> 00:18:43,950
these four mechanisms to exchange water

422
00:18:48,710 --> 00:18:46,160
between the surface and the atmosphere

423
00:18:51,470 --> 00:18:48,720
getting back to to the same figure

424
00:18:53,090 --> 00:18:51,480
so today stability diagram what we have

425
00:18:54,500 --> 00:18:53,100
learned from MSL and Phoenix

426
00:18:58,160 --> 00:18:54,510
measurements and I think that this is

427
00:18:59,780 --> 00:18:58,170
very relevant is that only or not only

428
00:19:02,210 --> 00:18:59,790
sorry that when when the temperature is

429
00:19:04,340 --> 00:19:02,220
above 220 so let's let's do this

430
00:19:06,080 --> 00:19:04,350
horizontal line here the relative

431
00:19:08,690 --> 00:19:06,090
humidity is very low it's already like

432
00:19:12,170 --> 00:19:08,700
around 10% and it's only when the

433
00:19:14,750 --> 00:19:12,180
temperature ranges between 180 and 220

434
00:19:16,280 --> 00:19:14,760
that we have the whole range of relative

435
00:19:19,340 --> 00:19:16,290
humidity conditions that we have like

436
00:19:20,780 --> 00:19:19,350
between 10 and 100 and this is important

437
00:19:23,570 --> 00:19:20,790
because most of the experiments

438
00:19:26,270 --> 00:19:23,580

previously performed showed that for

439
00:19:28,460 --> 00:19:26,280
temperatures above 220 yeah like all

440
00:19:30,140 --> 00:19:28,470
these processes could work you know like

441
00:19:31,580 --> 00:19:30,150
they they would take place within

442
00:19:34,580 --> 00:19:31,590
minutes or within seconds

443
00:19:37,520 --> 00:19:34,590
but once again above 220 Kelvin relative

444
00:19:41,630 --> 00:19:37,530
humidity is very low so I think that

445
00:19:43,730 --> 00:19:41,640
it's very very important to basically

446
00:19:46,220 --> 00:19:43,740
like expand these experimental results

447
00:19:48,350 --> 00:19:46,230
and and and do them but at temperatures

448
00:19:50,990 --> 00:19:48,360
between 180 and 220 because again that

449
00:19:53,510 --> 00:19:51,000
where we have the variation in in

450
00:19:55,220 --> 00:19:53,520
relative humidity so I think that that's

451
00:19:56,860 --> 00:19:55,230
that's gonna be important for the water

452
00:20:06,620 --> 00:19:56,870
cycle of Mars

453
00:20:14,450 --> 00:20:12,950
that's fine so once we analyzed and we

454
00:20:14,960 --> 00:20:14,460
have to keep analyzing brain formation

455
00:20:17,659 --> 00:20:14,970
on Mars

456
00:20:20,360 --> 00:20:17,669
we took the next logical step and we

457
00:20:22,490 --> 00:20:20,370
developed this sensor to search for

458
00:20:26,780 --> 00:20:22,500
brands of Mars and beyond this is

459
00:20:29,419 --> 00:20:26,790
results this suite of sensors is shown

460
00:20:31,460 --> 00:20:29,429
in a paper that Milton recently that we

461
00:20:33,169 --> 00:20:31,470
published Milton we know is the first

462
00:20:36,140 --> 00:20:33,179
author on astrobiology so you can find

463
00:20:39,490 --> 00:20:36,150

the details there and this is basically

464
00:20:42,230 --> 00:20:39,500
the modern aqueous habitat habitat

465
00:20:43,909 --> 00:20:42,240
recognizance sweet and it's basically

466
00:20:46,909 --> 00:20:43,919
aimed at characterizing the habitability

467
00:20:49,520 --> 00:20:46,919
and and weathering on Mars and beyond it

468
00:20:56,000 --> 00:20:49,530
is composed of these four sensors all of

469
00:20:59,030 --> 00:20:56,010
which have TRL 6 and very quickly here

470
00:21:01,310 --> 00:20:59,040
these environmental sweet responds to

471
00:21:03,200 --> 00:21:01,320
the to be top priorities of the decadal

472
00:21:07,130 --> 00:21:03,210
survey and the science plan

473
00:21:09,289 --> 00:21:07,140
recommendation here we have the the

474
00:21:11,030 --> 00:21:09,299
goals of the of the suite which is

475
00:21:13,640 --> 00:21:11,040
search for wet brains in the shallow

476
00:21:16,669 --> 00:21:13,650
subsurface mostly and characterization

477
00:21:20,090 --> 00:21:16,679
of the Aeolian processes exchange of

478
00:21:22,370 --> 00:21:20,100
material and the effects of regulate

479
00:21:24,980 --> 00:21:22,380
moisture on saltation so it's basically

480
00:21:26,870 --> 00:21:24,990
about like how water and dust is

481
00:21:34,789 --> 00:21:26,880
exchanged between the surface and the

482
00:21:37,730 --> 00:21:34,799
and the atmosphere okay once we did what

483
00:21:40,850 --> 00:21:37,740
we could do on Mars we decided that we

484
00:21:44,419 --> 00:21:40,860
had to move to or we have to move to the

485
00:21:46,640 --> 00:21:44,429
icy walls so with the background that we

486
00:21:49,210 --> 00:21:46,650
have a Mars our plan is to again like

487
00:21:53,210 --> 00:21:49,220
move to the to the to the icy walls and

488
00:21:55,070 --> 00:21:53,220

study pure information in this world so

489
00:21:57,740 --> 00:21:55,080
to give some context we know that the

490
00:22:00,110 --> 00:21:57,750
availability of liquid h2o might be the

491
00:22:03,830 --> 00:22:00,120
best resolved aspect of Europa's

492
00:22:05,870 --> 00:22:03,840
habitability but directly accessing the

493
00:22:07,760 --> 00:22:05,880
ocean is going to be very tricky so we

494
00:22:09,110 --> 00:22:07,770
believe that that justifies the need for

495
00:22:11,299 --> 00:22:09,120
a better understanding of brain

496
00:22:14,750 --> 00:22:11,309
formation in the shallow subsurface of

497
00:22:16,460 --> 00:22:14,760
these worlds we found extremely

498
00:22:18,499 --> 00:22:16,470
encouraging that the eutectic

499
00:22:21,079 --> 00:22:18,509
temperature of solutions of ammonia

500
00:22:23,299 --> 00:22:21,089
and whether we're as low as one sixty

501
00:22:24,799 --> 00:22:23,309
Kelvin also very encouraging that that

502
00:22:28,519 --> 00:22:24,809
you take the temperature of leaf in an

503
00:22:33,009 --> 00:22:28,529
and an ammonia solution can be as low as

504
00:22:35,930 --> 00:22:33,019
90 Kelvin so with this in mind what we

505
00:22:38,749 --> 00:22:35,940
basically like how how would brine form

506
00:22:41,629 --> 00:22:38,759
in the shallow subsurface of Europa or

507
00:22:43,699 --> 00:22:41,639
icy walls like this so what we propose

508
00:22:47,239 --> 00:22:43,709
or what we have publicizes that freeze

509
00:22:50,869 --> 00:22:47,249
thaw cycles could that was the sound so

510
00:22:53,419 --> 00:22:50,879
that's one or two two minutes okay so

511
00:22:56,299 --> 00:22:53,429
but we hypothesizes that freeze thaw

512
00:22:58,309 --> 00:22:56,309
cycles could produce complex brains with

513
00:23:00,439 --> 00:22:58,319

the law with the lowest eutectic

514
00:23:03,579 --> 00:23:00,449
temperature possible for the chemicals

515
00:23:05,959 --> 00:23:03,589
available so what we plan is to use

516
00:23:08,319 --> 00:23:05,969
advantage or knowledge of the elemental

517
00:23:11,719 --> 00:23:08,329
abundance in in carbonaceous chondrite

518
00:23:15,049 --> 00:23:11,729
such as the existence of lithium and an

519
00:23:17,119 --> 00:23:15,059
ammonia so we're gonna pretty much like

520
00:23:18,680 --> 00:23:17,129
to take advantage of all that we know

521
00:23:21,139 --> 00:23:18,690
about the composition of the solution

522
00:23:23,569 --> 00:23:21,149
surface again from from carbonaceous

523
00:23:25,489 --> 00:23:23,579
chondrites and and orbital measurements

524
00:23:27,680 --> 00:23:25,499
and then we're gonna go to our

525
00:23:30,309 --> 00:23:27,690
environmental chamber again and we plan

526
00:23:33,979 --> 00:23:30,319
to experimental ii determine the lowest

527
00:23:36,289 --> 00:23:33,989
detected temperature for a cure

528
00:23:38,779 --> 00:23:36,299
solutions that could exist in the icy

529
00:23:41,089 --> 00:23:38,789
world and we plan to determine the raman

530
00:23:43,579 --> 00:23:41,099
of offset components so this is our next

531
00:23:45,139 --> 00:23:43,589
step basically like move from mars to

532
00:23:46,549 --> 00:23:45,149
the icy walls with what we know when

533
00:23:49,339 --> 00:23:46,559
defin definitely will have to go to

534
00:23:51,409 --> 00:23:49,349
lower temperatures and that's why we

535
00:23:54,559 --> 00:23:51,419
hypothesized these cycles and these

536
00:23:56,569 --> 00:23:54,569
reduction in eutectic temperature that

537
00:23:58,609 --> 00:23:56,579
is pretty much the end of my talk but

538
00:24:01,519 --> 00:23:58,619

since this is an astrobiology conference

539
00:24:03,079 --> 00:24:01,529
i just wanted to let you know that I'm

540
00:24:06,589 --> 00:24:03,089
guessing that you all are interested in

541
00:24:08,989 --> 00:24:06,599
Ubud data as you know UV measurements

542
00:24:11,869 --> 00:24:08,999
are being measured for the first time at

543
00:24:14,329 --> 00:24:11,879
the surface of Mars by the MSL from the

544
00:24:16,759 --> 00:24:14,339
from the REMS instrument and the Dubey

545
00:24:19,549 --> 00:24:16,769
measurements are UV has been measured

546
00:24:22,009 --> 00:24:19,559
like in six different channels I'm very

547
00:24:24,889 --> 00:24:22,019
quickly what I want to say is that the

548
00:24:26,539 --> 00:24:24,899
current values in the PDS are subjected

549
00:24:29,209 --> 00:24:26,549
to uncertainties due to dust the

550
00:24:30,739 --> 00:24:29,219
position on the UV sensor so due to the

551
00:24:32,600 --> 00:24:30,749
location of the sensor on the deck of

552
00:24:35,330 --> 00:24:32,610
the rover which is facing up

553
00:24:37,280 --> 00:24:35,340
dust has been deposited on the sensor so

554
00:24:38,540 --> 00:24:37,290
what happened this is just like a

555
00:24:41,960 --> 00:24:38,550
picture at the beginning of the mission

556
00:24:44,810 --> 00:24:41,970
and later so what happen is that they do

557
00:24:47,780 --> 00:24:44,820
be measurements as a function of lmst

558
00:24:50,540 --> 00:24:47,790
for two souls separated by exactly one

559
00:24:51,860 --> 00:24:50,550
year and with the same opacity are very

560
00:24:53,720 --> 00:24:51,870
different they should be the same

561
00:24:56,000 --> 00:24:53,730
because it's one year same opacity but

562
00:25:00,350 --> 00:24:56,010
here it's much lower because of the dust

563
00:25:02,720 --> 00:25:00,360

deposition so we have corrected the

564
00:25:05,060 --> 00:25:02,730
values from that's the position by

565
00:25:06,470 --> 00:25:05,070
calculating a desk correction factor you

566
00:25:08,090 --> 00:25:06,480
might not be interested in the details

567
00:25:10,070 --> 00:25:08,100
of this because this is relative

568
00:25:12,230 --> 00:25:10,080
transfer and and and some other things

569
00:25:14,120 --> 00:25:12,240
but the thing is that now we have

570
00:25:16,040 --> 00:25:14,130
produced we have generated a new data

571
00:25:19,460 --> 00:25:16,050
set of UV measurements at Gale Crater

572
00:25:21,470 --> 00:25:19,470
that are free from the effects of dust

573
00:25:24,230 --> 00:25:21,480
deposition this is an example of the

574
00:25:26,299 --> 00:25:24,240
performance this is what we have in the

575
00:25:28,190 --> 00:25:26,309
PDS this is what we are producing now

576
00:25:31,490 --> 00:25:28,200
and the higher value is because we have

577
00:25:33,890 --> 00:25:31,500
removed that effect and these corrected

578
00:25:36,650 --> 00:25:33,900
values have been used for methane

579
00:25:37,730 --> 00:25:36,660
studies you know like this corrected

580
00:25:41,150 --> 00:25:37,740
values were compared to the

581
00:25:43,280 --> 00:25:41,160
concentration of methane and I mean like

582
00:25:45,260 --> 00:25:43,290
whether explain that much better than me

583
00:25:47,890 --> 00:25:45,270
but Ramsey's like this corrected UV

584
00:25:50,960 --> 00:25:47,900
values are very important for us as

585
00:25:54,020 --> 00:25:50,970
astrobiologists people so we'll be

586
00:25:56,980 --> 00:25:54,030
uploading the data shortly and that will

587
00:26:00,850 --> 00:25:56,990
be accessible for the entire community

588
00:26:03,260 --> 00:26:00,860

so this is just the summary but I'll

589
00:26:10,640 --> 00:26:03,270
leave it there thank you very much for

590
00:26:33,290 --> 00:26:10,650
your attention we have time for a

591
00:26:37,850 --> 00:26:35,580
hopefully it was understandable my talk

592
00:26:40,140 --> 00:26:37,860
okay so I'm gonna make something up um

593
00:26:42,390 --> 00:26:40,150
all right so you were talking about the

594
00:26:44,400 --> 00:26:42,400
importance of kinetics which we thus far

595
00:26:47,760 --> 00:26:44,410
haven't accounted for and you did the

596
00:26:49,770 --> 00:26:47,770
experiment at 223 Kelvin and you saw no

597
00:26:51,660 --> 00:26:49,780
deliquescent of calcium perchlorate for

598
00:26:53,580 --> 00:26:51,670
how long was it mmm

599
00:26:58,080 --> 00:26:53,590
to worse and a half something like that

600
00:27:01,020 --> 00:26:58,090
we yeah yeah okay so then next question

601
00:27:02,790 --> 00:27:01,030
would then be do you have plans to

602
00:27:05,400 --> 00:27:02,800
continue these type of kinetic

603
00:27:08,820 --> 00:27:05,410
experiments and increase that delta T to

604
00:27:10,770 --> 00:27:08,830
see we have plans to continue the liquid

605
00:27:13,590 --> 00:27:10,780
since experiments and also likelike

606
00:27:17,700 --> 00:27:13,600
adsorption desorption and commit we have

607
00:27:20,700 --> 00:27:17,710
plans yeah obviously pending funding but

608
00:27:22,760 --> 00:27:20,710
but we have plans yeah thank you thank

609
00:27:37,310 --> 00:27:22,770
you

610
00:27:41,160 --> 00:27:37,320
saw melting with in minutes that

611
00:27:43,470 --> 00:27:41,170
okay what about refreezing when you

612
00:27:45,810 --> 00:27:43,480
cross the the other side did you see

613
00:27:49,020 --> 00:27:45,820

this rapid freezing or was it slowed

614
00:27:51,780 --> 00:27:49,030
down that's a great question not as fast

615
00:27:53,940 --> 00:27:51,790
but we saw refreezing but also with a

616
00:27:56,970 --> 00:27:53,950
minute all right so when we took the

617
00:28:00,419 --> 00:27:56,980
Gaussian decomposition we saw yeah we we

618
00:28:04,440 --> 00:28:00,429
detected that and it was all so fast by

619
00:28:05,920 --> 00:28:04,450
first time in minutes okay okay thank