
AbSciCon
2019

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

2
00:00:12,100 --> 00:00:09,150
[Applause]

3
00:00:14,200 --> 00:00:12,110
thanks for including me in succession a

4
00:00:15,960 --> 00:00:14,210
machine zone from Peking University and

5
00:00:18,400 --> 00:00:15,970
my advisor is dream Yong

6
00:00:20,140 --> 00:00:18,410
today's topic is wind driven ocean

7
00:00:25,150 --> 00:00:20,150
circulation on tidally locked aqua

8
00:00:27,040 --> 00:00:25,160
planets and I want to sorry I want to

9
00:00:28,780 --> 00:00:27,050
focus on two main features of the

10
00:00:31,540 --> 00:00:28,790
associate circulation on these kind of

11
00:00:34,810 --> 00:00:31,550
planets oceans rotation and the

12
00:00:37,660 --> 00:00:34,820
equatorial vertical motion first let me

13
00:00:40,120 --> 00:00:37,670

introduce the research background of our

14
00:00:42,310 --> 00:00:40,130
experiments when we search for life

15
00:00:44,170 --> 00:00:42,320
beyond the solar system we mainly focus

16
00:00:46,570 --> 00:00:44,180
on the planets in the habitable zone

17
00:00:49,570 --> 00:00:46,580
around M dwarfs because we have bounced

18
00:00:52,600 --> 00:00:49,580
several subscribe planet system like the

19
00:00:54,940 --> 00:00:52,610
Trappist one system and because the

20
00:00:57,490 --> 00:00:54,950
habitable zone around M dwarfs are very

21
00:00:59,320 --> 00:00:57,500
close to a star so the planets will

22
00:01:02,980 --> 00:00:59,330
easily get tidally locked due to the

23
00:01:05,530 --> 00:01:02,990
strong tidal force as a result the one

24
00:01:08,140 --> 00:01:05,540
side of the planet will permanently face

25
00:01:11,740 --> 00:01:08,150
the star and the other side will get no

26
00:01:15,429 --> 00:01:11,750
radiation hitting at all so as a result

27
00:01:19,059 --> 00:01:15,439
the climate on the planets were likely

28
00:01:20,950 --> 00:01:19,069
to be an IPO mode because so the open

29
00:01:24,399 --> 00:01:20,960
ocean area will become straight to a

30
00:01:27,999 --> 00:01:24,409
constricted in the day's side around the

31
00:01:30,279 --> 00:01:28,009
substellar point however if we can take

32
00:01:32,859 --> 00:01:30,289
ocean heat transport into consideration

33
00:01:35,440 --> 00:01:32,869
the open ocean area will be largely

34
00:01:38,590 --> 00:01:35,450
expanded because ocean can transport

35
00:01:42,010 --> 00:01:38,600
heat from the substrate point to higher

36
00:01:45,309 --> 00:01:42,020
latitudes and to the next side and we

37
00:01:48,010 --> 00:01:45,319
call it lobster mode because it is like

38
00:01:51,669 --> 00:01:48,020

a lobster with two claws here and a long

39
00:01:54,550 --> 00:01:51,679
tail to the night side and this is very

40
00:01:57,999 --> 00:01:54,560
significant for the habit ility orders

41
00:02:00,489 --> 00:01:58,009
of planet because with ocean heat

42
00:02:03,969 --> 00:02:00,499
transport it can warm the night side and

43
00:02:07,449 --> 00:02:03,979
thus it can protect the atmosphere from

44
00:02:10,510 --> 00:02:07,459
condensing down on the next side and it

45
00:02:13,870 --> 00:02:10,520
can also restrict the thickness of the

46
00:02:16,480 --> 00:02:13,880
ice from thousands of Kip meters if we

47
00:02:19,900 --> 00:02:16,490
don't care take ocean heat transport as

48
00:02:21,370 --> 00:02:19,910
Ken gross as that seek to the order of

49
00:02:24,010 --> 00:02:21,380
tens of meters

50
00:02:26,320 --> 00:02:24,020
so that's the water will not freeze at

51
00:02:28,150 --> 00:02:26,330
the Nightside so that will be the liquid

52
00:02:31,660 --> 00:02:28,160
water will be trapped on the night side

53
00:02:34,600 --> 00:02:31,670
to Isis a formal researchers has found

54
00:02:39,690 --> 00:02:34,610
this phenomena and our work is many to

55
00:02:42,190 --> 00:02:39,700
show to the inner mechanism of the

56
00:02:46,810 --> 00:02:42,200
circulation and give a clearer picture

57
00:02:49,210 --> 00:02:46,820
of it so carried out our experiments

58
00:02:51,340 --> 00:02:49,220
earth-like aqua planets with ocean

59
00:02:54,160 --> 00:02:51,350
depths of around a thousand kilometers

60
00:02:56,890 --> 00:02:54,170
the model will use the deceased sm-3

61
00:03:00,520 --> 00:02:56,900
acaba coupling model with active ocean

62
00:03:03,490 --> 00:03:00,530
band and sea ice dynamics because while

63
00:03:08,710 --> 00:03:03,500

simulating aqua planets tidally locked

64
00:03:13,170 --> 00:03:08,720
around ma off so we did some change in

65
00:03:16,300 --> 00:03:13,180
the spectrum and the rotation period and

66
00:03:19,720 --> 00:03:16,310
next to this is the main patch of our

67
00:03:22,570 --> 00:03:19,730
speech the most important feature of

68
00:03:25,480 --> 00:03:22,580
untidily locked aqua planets is the

69
00:03:28,600 --> 00:03:25,490
ocean soup rotation this animation shows

70
00:03:32,260 --> 00:03:28,610
the ocean surface zonal velocity we can

71
00:03:36,190 --> 00:03:32,270
see that at low latitudes the ocean

72
00:03:40,270 --> 00:03:36,200
current is uniformly eastward and it can

73
00:03:46,090 --> 00:03:40,280
reach the about one meter per second we

74
00:03:48,430 --> 00:03:46,100
know that is quite large this week the

75
00:03:51,010 --> 00:03:48,440
oceans of rotation not only just exist

76
00:03:53,650 --> 00:03:51,020
at the surface of the ocean in fact it

77
00:03:58,210 --> 00:03:53,660
can reach until the bottom of the ocean

78
00:04:00,760 --> 00:03:58,220
in our experiment so we want to figure

79
00:04:03,700 --> 00:04:00,770
out what makes this kind of super

80
00:04:06,040 --> 00:04:03,710
rotation because the ocean current is

81
00:04:09,370 --> 00:04:06,050
mainly wind driven so we want to have a

82
00:04:12,640 --> 00:04:09,380
look at the wind stress the wind assess

83
00:04:16,920 --> 00:04:12,650
is shown here it is convergence to the

84
00:04:21,550 --> 00:04:16,930
sub zero point as well as two hot spots

85
00:04:24,400 --> 00:04:21,560
due to the ocean heat transport and we

86
00:04:27,550 --> 00:04:24,410
also noticed that the wind stress on the

87
00:04:30,730 --> 00:04:27,560
west side is stronger than the east side

88
00:04:33,350 --> 00:04:30,740

so if we will calculate the zonal mean

89
00:04:36,260 --> 00:04:33,360
results we'll find that

90
00:04:39,950 --> 00:04:36,270
wind stress the redline is also used in

91
00:04:43,430 --> 00:04:39,960
stored at low latitudes so we may get

92
00:04:45,170 --> 00:04:43,440
the conclusion that the oceans of

93
00:04:48,680 --> 00:04:45,180
rotation is Menem driven by the

94
00:04:51,800 --> 00:04:48,690
atmosphere super rotation however our

95
00:04:53,409 --> 00:04:51,810
story is not that simple because we can

96
00:04:56,270 --> 00:04:53,419
see there are some differences between

97
00:04:59,689 --> 00:04:56,280
the atmosphere and the ocean in

98
00:05:02,420 --> 00:04:59,699
atmosphere we are two Jets while in the

99
00:05:04,730 --> 00:05:02,430
ocean leaves only one jet so there must

100
00:05:08,240 --> 00:05:04,740
be some inner adjustment within the

101
00:05:12,230 --> 00:05:08,250
ocean in order to answer this question

102
00:05:14,869 --> 00:05:12,240
we did a more careful analysis on the

103
00:05:18,350 --> 00:05:14,879
momentum budget using the zonal mean

104
00:05:22,219 --> 00:05:18,360
time average donor momentum equation and

105
00:05:24,709 --> 00:05:22,229
we divided the advection terms into mean

106
00:05:28,339 --> 00:05:24,719
circulation stationary Eddy and the

107
00:05:30,920 --> 00:05:28,349
transient at the moment transport as a

108
00:05:33,969 --> 00:05:30,930
result we can find although the wind

109
00:05:37,089 --> 00:05:33,979
stress is not very strong at the equator

110
00:05:40,580 --> 00:05:37,099
the stationary L is the Purple Line is

111
00:05:44,120 --> 00:05:40,590
very strong at the recruiter and it can

112
00:05:46,459 --> 00:05:44,130
compensate for the wind stress and we

113
00:05:49,640 --> 00:05:46,469

can see that as some of them reaches the

114
00:05:52,279 --> 00:05:49,650
maximum and the equator so the

115
00:05:55,580 --> 00:05:52,289
stationary Eddy transport is very

116
00:05:58,820 --> 00:05:55,590
important because it changes from the

117
00:06:04,189 --> 00:05:58,830
atmosphere to Jets into the only one jet

118
00:06:06,860 --> 00:06:04,199
at equator of the ocean and this is all

119
00:06:09,260 --> 00:06:06,870
about the surface oceans of rotation and

120
00:06:12,350 --> 00:06:09,270
let's move to the next part of the

121
00:06:14,269 --> 00:06:12,360
equatorial vertical velocity we know

122
00:06:16,969 --> 00:06:14,279
that the vertical velocity is also very

123
00:06:19,189 --> 00:06:16,979
important to the biology because when

124
00:06:21,920 --> 00:06:19,199
there is upwelling area there will be a

125
00:06:23,689 --> 00:06:21,930
mixing of the ocean and the nutrients

126
00:06:27,890 --> 00:06:23,699
will be transported from the bottom of

127
00:06:30,379 --> 00:06:27,900
the ocean to to upper levels and we

128
00:06:34,159 --> 00:06:30,389
focus on the equatorial area because the

129
00:06:37,279 --> 00:06:34,169
most significant features is in in the

130
00:06:39,499 --> 00:06:37,289
earthly creature and the most important

131
00:06:42,030 --> 00:06:39,509
feature is that there is a downwind area

132
00:06:46,340 --> 00:06:42,040
to the east side and an upwelling area

133
00:06:48,750 --> 00:06:46,350
on the east side and this can be

134
00:06:52,500 --> 00:06:48,760
completely explained by the Ekman

135
00:06:54,210 --> 00:06:52,510
transport because we know that the other

136
00:06:58,310 --> 00:06:54,220
wind stress is convergent through the

137
00:07:00,840 --> 00:06:58,320
subsolar point so the Ekman transport

138
00:07:04,890 --> 00:07:00,850

near the equator will be like this way

139
00:07:07,620 --> 00:07:04,900
so it will converge on the west side and

140
00:07:09,870 --> 00:07:07,630
the diverge on the east side and this

141
00:07:12,300 --> 00:07:09,880
convergence and divergence will cause

142
00:07:15,630 --> 00:07:12,310
the tongue wielding area and the upper

143
00:07:18,840 --> 00:07:15,640
waiting area however we also find that

144
00:07:23,970 --> 00:07:18,850
the momentum transport is very important

145
00:07:25,290 --> 00:07:23,980
to the downwind area we know that the

146
00:07:27,960 --> 00:07:25,300
down wording is caused by the

147
00:07:30,720 --> 00:07:27,970
convergence of the water and we can

148
00:07:33,870 --> 00:07:30,730
divide the convergence into X direction

149
00:07:37,560 --> 00:07:33,880
and y direction the ecumene transport is

150
00:07:40,200 --> 00:07:37,570
meaning is meaning contributed to the y

151
00:07:43,800 --> 00:07:40,210
direction but we have find that the X

152
00:07:45,540 --> 00:07:43,810
directions convergence the blue line has

153
00:07:48,750 --> 00:07:45,550
a large contribution to the down

154
00:07:51,150 --> 00:07:48,760
wheeling so what the cause is this kind

155
00:07:54,240 --> 00:07:51,160
of his own incursions we found that it

156
00:07:56,790 --> 00:07:54,250
is the Eddy momentum transport this

157
00:07:59,970 --> 00:07:56,800
figure shows the momentum transport from

158
00:08:02,490 --> 00:07:59,980
higher latitudes to a liquid and it

159
00:08:06,030 --> 00:08:02,500
reaches the maximum at around a hundred

160
00:08:08,760 --> 00:08:06,040
degree East so this kind of momentum

161
00:08:11,250 --> 00:08:08,770
transport will cause also the donor

162
00:08:13,500 --> 00:08:11,260
velocity to reach maximum here and

163
00:08:15,840 --> 00:08:13,510

because the donor velocity is maximum

164
00:08:17,990 --> 00:08:15,850
here and so it will cause the

165
00:08:20,960 --> 00:08:18,000
convergence east of it and thus

166
00:08:24,030 --> 00:08:20,970
contributed to the down wielding area

167
00:08:26,780 --> 00:08:24,040
now we have a basic picture of the ocean

168
00:08:30,230 --> 00:08:26,790
circulation and hydrological planets

169
00:08:33,690 --> 00:08:30,240
first we can observe that there exists

170
00:08:36,960 --> 00:08:33,700
with a atmosphere protection as well as

171
00:08:39,870 --> 00:08:36,970
options predation and we have some

172
00:08:42,770 --> 00:08:39,880
differences with 2js in the atmosphere

173
00:08:45,240 --> 00:08:42,780
and one jet in the ocean this can be

174
00:08:48,450 --> 00:08:45,250
explained by the eddy momentum transport

175
00:08:49,460 --> 00:08:48,460
which is dominated by the stationary

176
00:08:53,750 --> 00:08:49,470
eddies

177
00:08:56,320 --> 00:08:53,760
and we have this kind of wind stress and

178
00:08:59,210 --> 00:08:56,330
the momentum transport and we will get

179
00:09:01,370 --> 00:08:59,220
the vertical motion of the ocean near

180
00:09:03,320 --> 00:09:01,380
repeater to be a done wheeling area on

181
00:09:06,890 --> 00:09:03,330
the east side and upward in area on the

182
00:09:09,860 --> 00:09:06,900
west east side and this not only occurs

183
00:09:13,100 --> 00:09:09,870
at this experiment it actually occurs in

184
00:09:16,790 --> 00:09:13,110
different conditions experiments for the

185
00:09:20,660 --> 00:09:16,800
tidally locked aqua planets so it's more

186
00:09:23,630 --> 00:09:20,670
widely applied and that's all for my

187
00:09:25,580 --> 00:09:23,640
presentation and some other things is

188
00:09:29,360 --> 00:09:25,590

that we can we notice that the

189
00:09:32,180 --> 00:09:29,370
equatorial super rotation is not strong

190
00:09:34,490 --> 00:09:32,190
as a surface but at the deeper in the

191
00:09:37,160 --> 00:09:34,500
ocean and this is caused by the thermal

192
00:09:40,010 --> 00:09:37,170
wind relationship and it is the same as

193
00:09:43,760 --> 00:09:40,020
what we know the equatorial undercurrent

194
00:09:55,220 --> 00:09:43,770
that occurs on earth specific and that's

195
00:09:56,150 --> 00:09:55,230
all thank you yeah Charlie lineweaver

196
00:09:58,070 --> 00:09:56,160
from the Australian National University

197
00:10:01,430 --> 00:09:58,080
I got the impression that you were

198
00:10:03,320 --> 00:10:01,440
modeling tightly locked rocky planets in

199
00:10:03,650 --> 00:10:03,330
the habitable zones of M dwarfs is that

200
00:10:07,280 --> 00:10:03,660
right

201
00:10:10,760 --> 00:10:07,290
yes but actually we is rocky planets

202
00:10:13,910 --> 00:10:10,770
with oceans of around a thousand metres

203
00:10:16,460 --> 00:10:13,920
and we have no lens distribution of this

204
00:10:19,400 --> 00:10:16,470
planet all right and does the things

205
00:10:22,010 --> 00:10:19,410
that your results do they depend very

206
00:10:27,050 --> 00:10:22,020
strongly on how close this thing is to

207
00:10:28,370 --> 00:10:27,060
the to the post on for example is inside

208
00:10:30,620 --> 00:10:28,380
of the habitable zone the outside of

209
00:10:34,610 --> 00:10:30,630
habitable zone yet it's a wide it's semi

210
00:10:37,520 --> 00:10:34,620
wide okay and this is the planets that's

211
00:10:39,230 --> 00:10:37,530
in the middle edge middle range of the

212
00:10:40,670 --> 00:10:39,240
habitable zone and you think it would

213
00:10:43,670 --> 00:10:40,680

change depending on if you a little

214
00:10:47,420 --> 00:10:43,680
closer a little further out yes and

215
00:10:52,960 --> 00:10:47,430
another paper from my advisor Drina

216
00:10:56,810 --> 00:10:52,970
in this about a baby February 2019

217
00:10:58,790 --> 00:10:56,820
points out that if we push the planets

218
00:11:05,920 --> 00:10:58,800
to the inner edge of the habitable zone

219
00:11:09,590 --> 00:11:05,930
then the wind then the temperature

220
00:11:11,600 --> 00:11:09,600
gradients will be weaker so the wind

221
00:11:14,030 --> 00:11:11,610
stress will also be weaker and the ocean

222
00:11:15,830 --> 00:11:14,040
current will be weaker I mean in the

223
00:11:18,440 --> 00:11:15,840
inner edge of the habitable zone the

224
00:11:20,480 --> 00:11:18,450
ocean heat transport we are not so will

225
00:11:24,080 --> 00:11:20,490
be not be so important and the

226
00:11:26,690 --> 00:11:24,090
atmosphere oceans oops ocean transport

227
00:11:28,880 --> 00:11:26,700
we hope atmospheres heat transport will

228
00:11:32,300 --> 00:11:28,890
be more important and on the outer edge

229
00:11:35,150 --> 00:11:32,310
is the reverse and the outer edge we

230
00:11:35,840 --> 00:11:35,160
haven't done much about the research

231
00:11:41,030 --> 00:11:35,850
thank you

232
00:11:43,880 --> 00:11:41,040
I think hey nice talk techno music

233
00:11:46,280 --> 00:11:43,890
University of Chicago so you showed that

234
00:11:47,840 --> 00:11:46,290
the horizontal at a momentum transport

235
00:11:49,610 --> 00:11:47,850
leads a super rotation but as the

236
00:11:54,250 --> 00:11:49,620
vertical momentum transport also

237
00:12:00,290 --> 00:11:54,260
reinforce super rotation actually with

238
00:12:03,350 --> 00:12:00,300

this result is than vertical integrated

239
00:12:06,920 --> 00:12:03,360
and average because we want to wipe out

240
00:12:11,480 --> 00:12:06,930
these two terms and actually if we just

241
00:12:14,150 --> 00:12:11,490
calculate the risk based momentum budget

242
00:12:17,300 --> 00:12:14,160
in difference layers the vertical

243
00:12:21,320 --> 00:12:17,310
momentum transport is has a large

244
00:12:25,150 --> 00:12:21,330
influence but it can but it we know that

245
00:12:28,730 --> 00:12:25,160
it when it is including intergrated

246
00:12:32,600 --> 00:12:28,740
vertically it is we all just to be zero

247
00:12:36,110 --> 00:12:32,610
so we think that the oceans of rotation

248
00:12:41,990 --> 00:12:36,120
can reach the hope the whole depths of

249
00:12:44,480 --> 00:12:42,000
the ocean so we focus on the horizontal