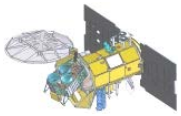
Model Function and Rain Impact

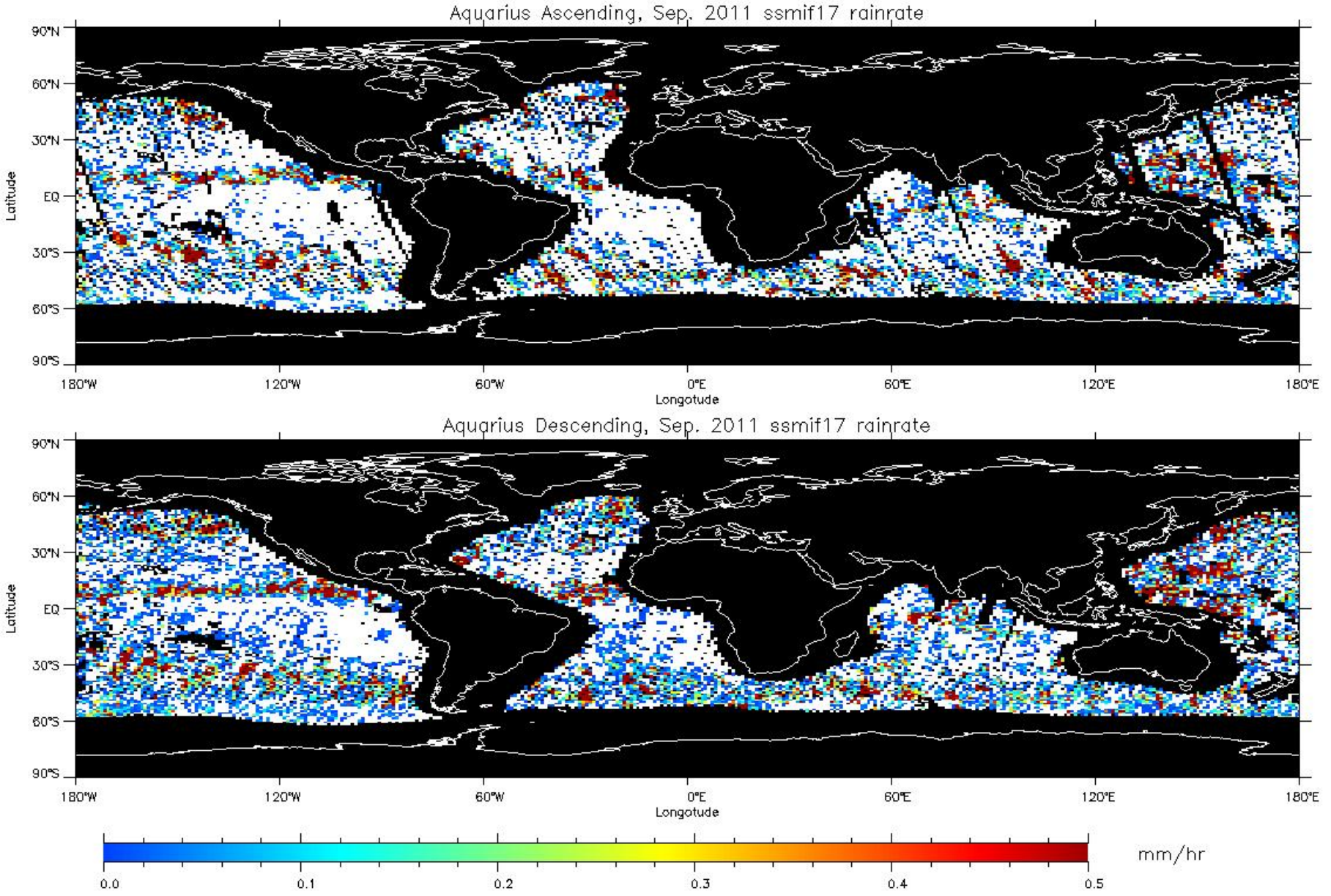
Wendy Tang, Simon Yueh, Akiko Hayashi

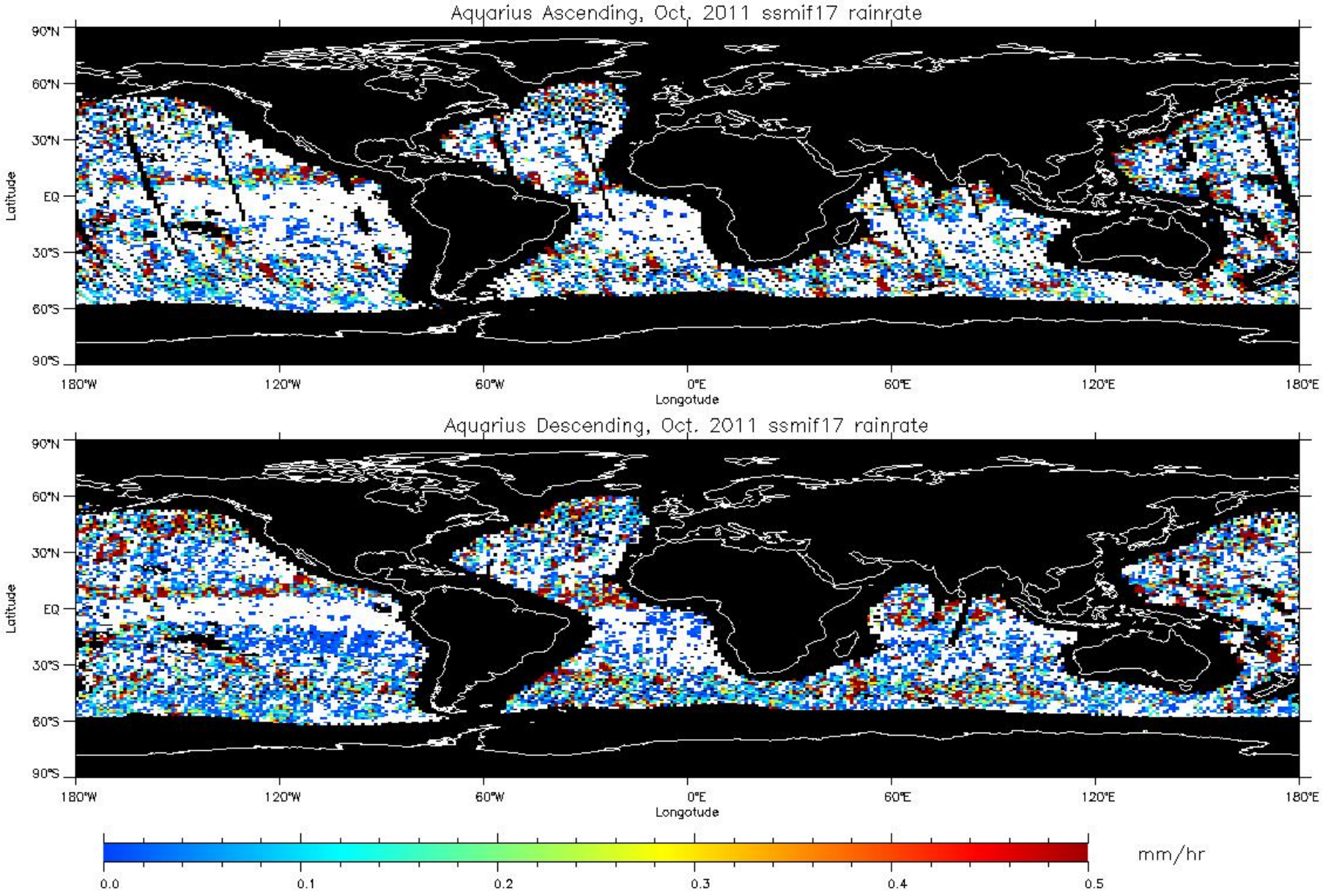
March 27, 2012

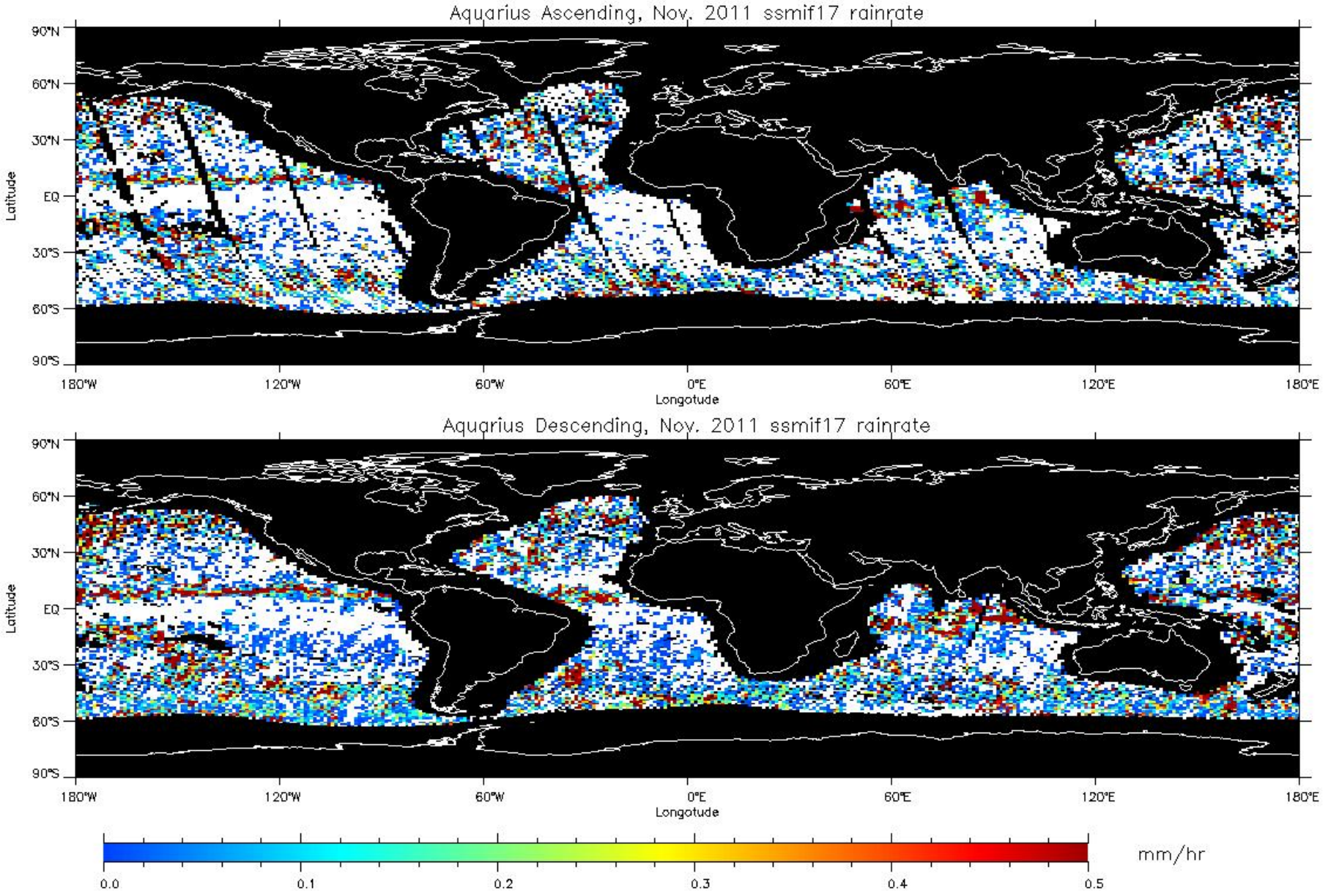


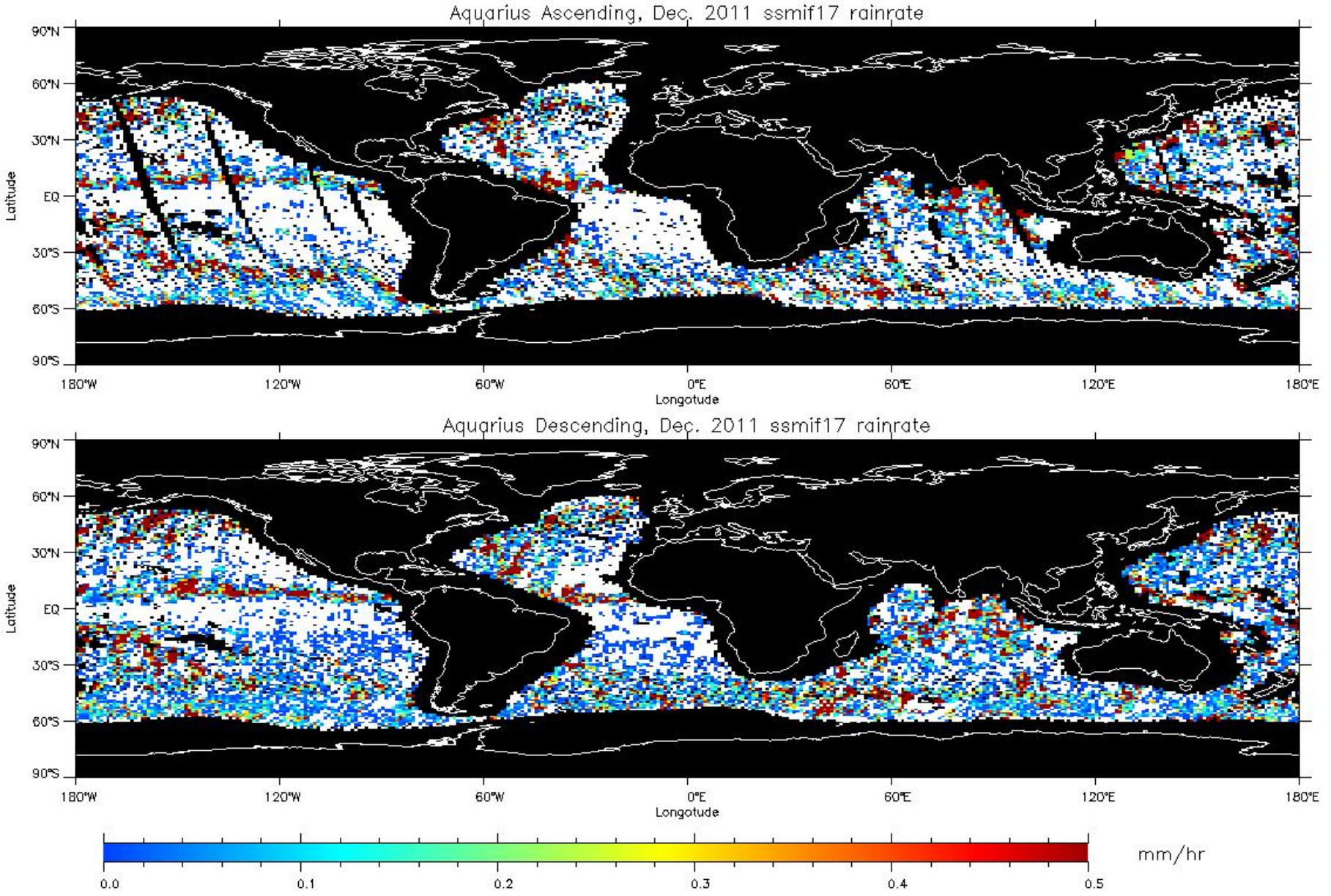
Motivation and outline

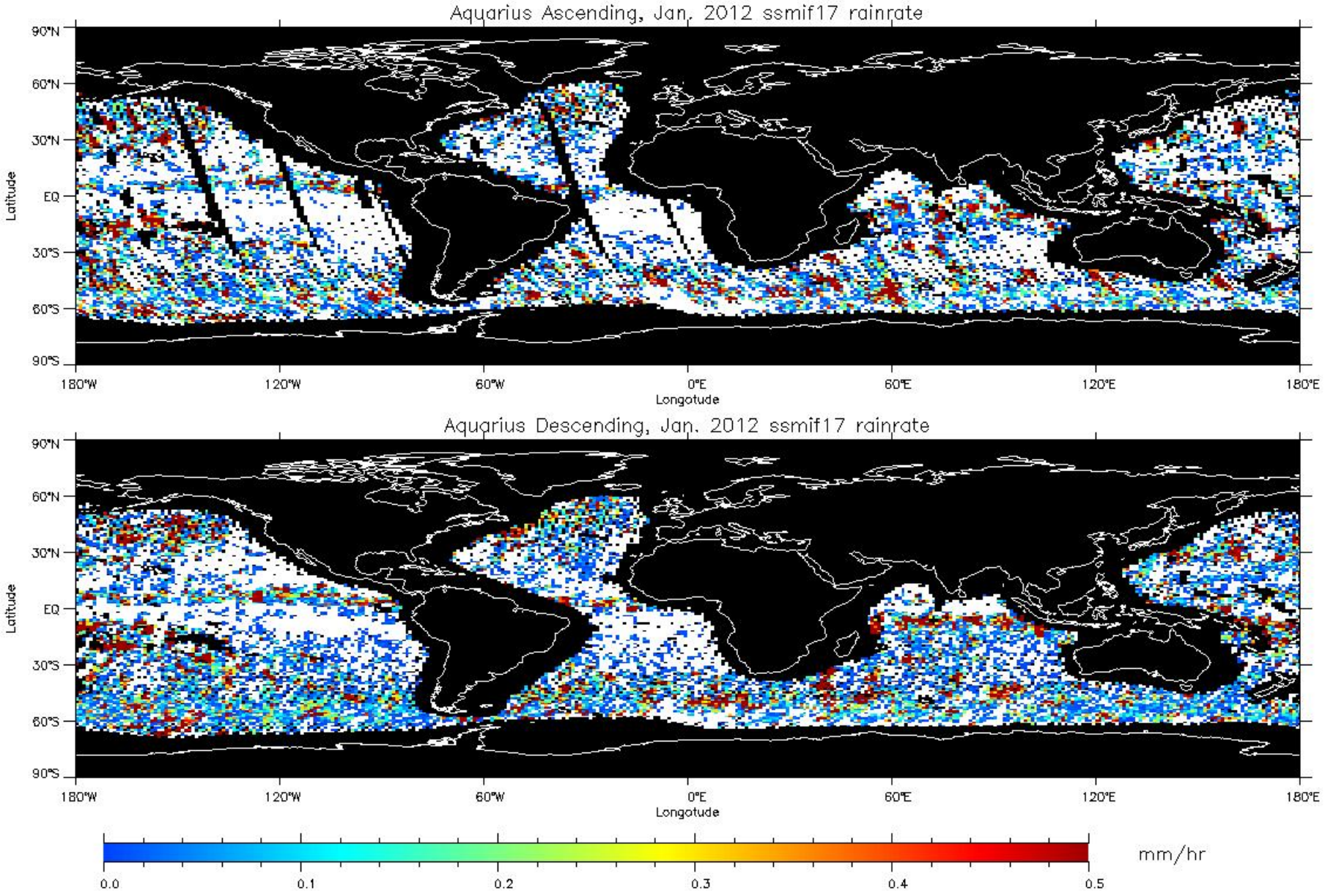
- Can the ocean surface rain explain some Ascending/Descending asymmetry observed?
- Build model function use rain free data using SSMIf17 matchups as rain filter
- Analyze the residual dTB
  - Ascending vs. descending
  - H-pol vs. V-pol
  - Temporal variation
  - Spatial distribution
  - Sensitivity to salinity change

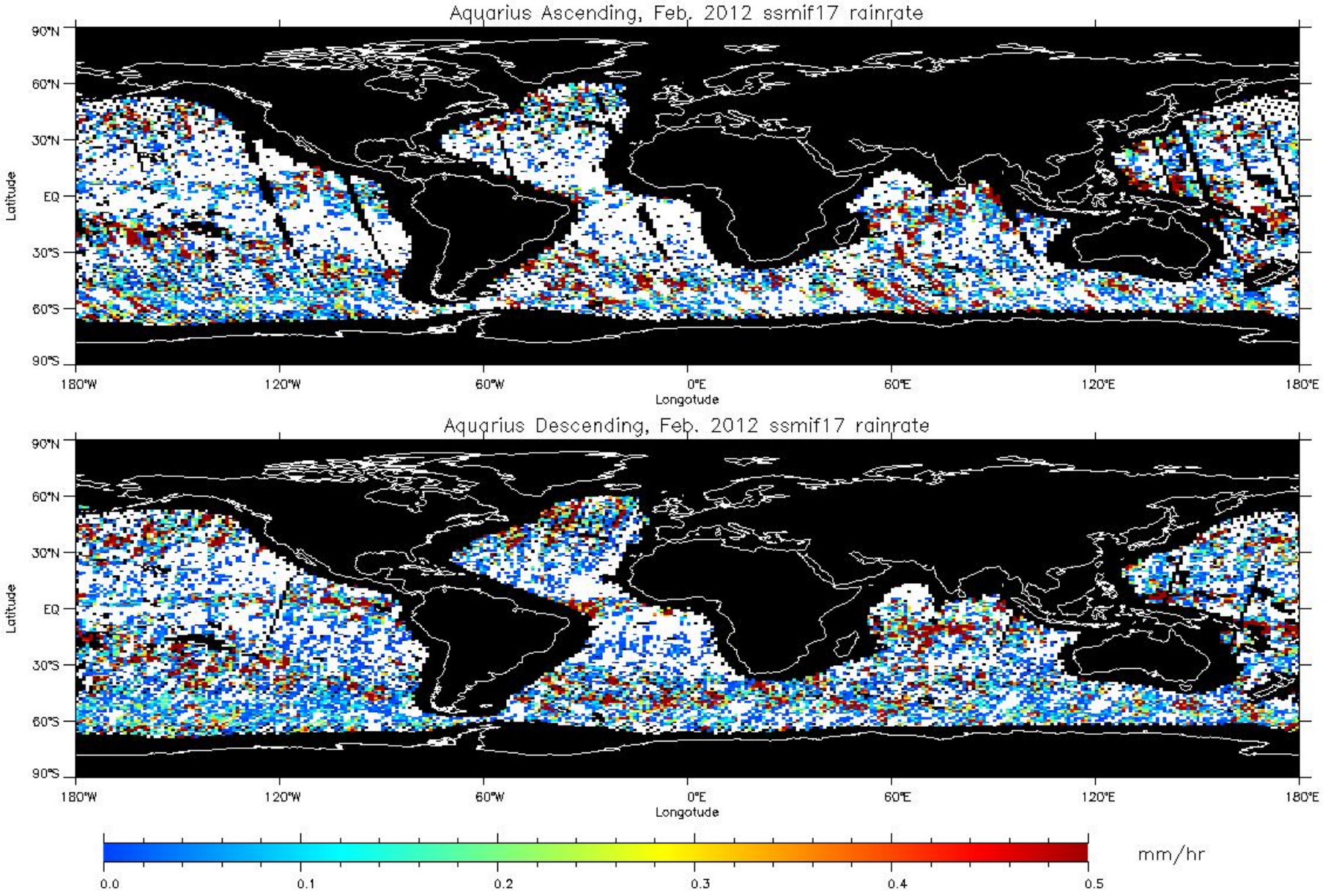

Aquarius Ascending, Sep. 2011 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude
Aquarius Descending, Sep. 2011 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude
0.0
0.1
0.2
0.3
0.4
0.5
mm/hr


Aquarius Ascending, Oct. 2011 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude
Aquarius Descending, Oct. 2011 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude
0.0
0.1
0.2
0.3
0.4
0.5
mm/hr


Aquarius Ascending, Nov. 2011 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude
Aquarius Descending, Nov. 2011 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude
0.0
0.1
0.2
0.3
0.4
0.5
mm/hr


Aquarius Ascending, Dec. 2011 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude
Aquarius Descending, Dec. 2011 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude
0.0
0.1
0.2
0.3
0.4
0.5
mm/hr

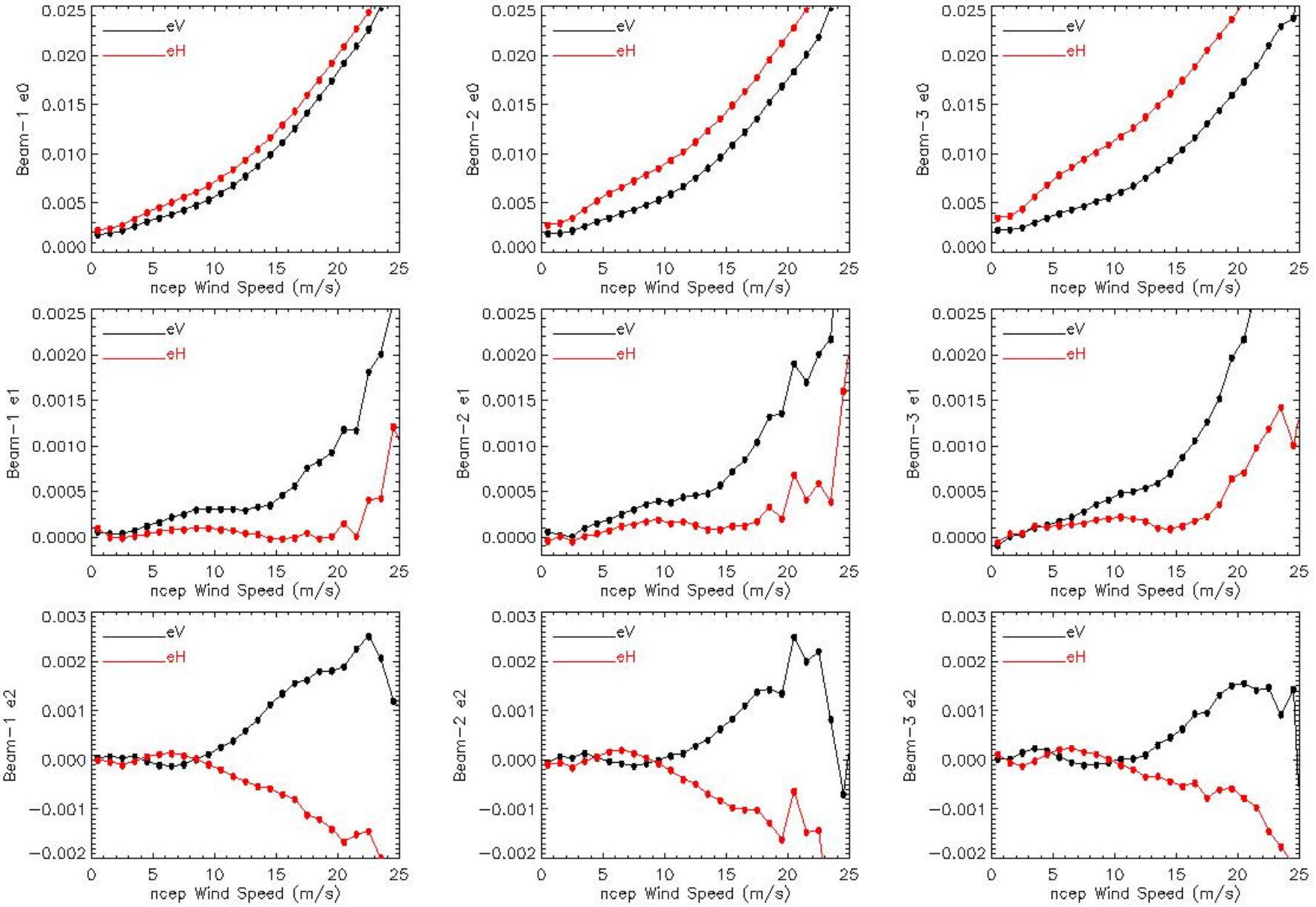

Aquarius Ascending, Jan. 2012 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude
Aquarius Descending, Jan. 2012 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude
0.0
0.1
0.2
0.3
0.4
0.5
mm/hr


Aquarius Ascending, Feb. 2012 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude
Aquarius Descending, Feb. 2012 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude
0.0
0.1
0.2
0.3
0.4
0.5
mm/hr

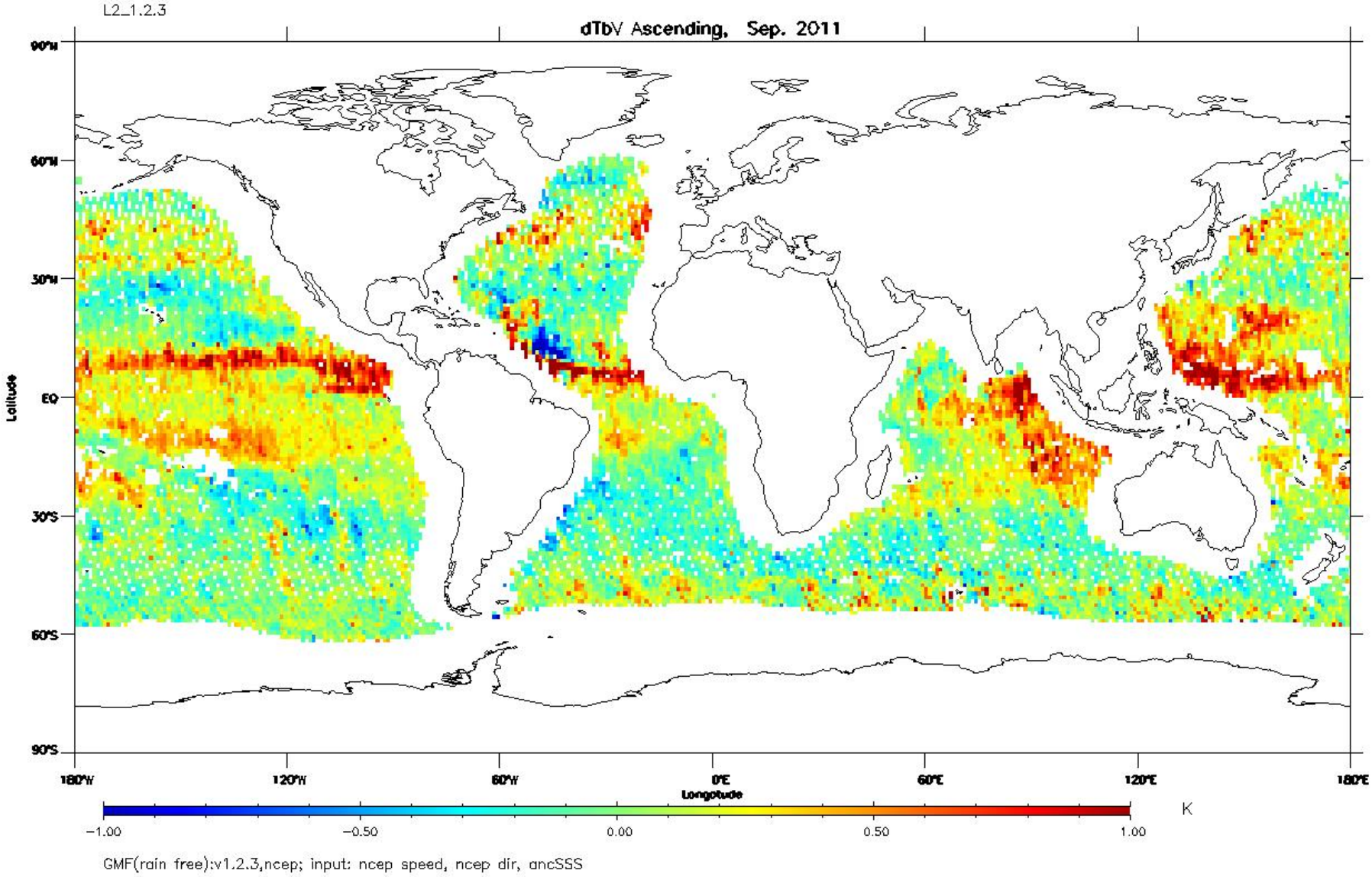
Emissivity GMF

$$E_{V,H} = a_0^{V,H} + a_1^{V,H}\cos(f) + a_2^{V,H}\cos(2f)$$

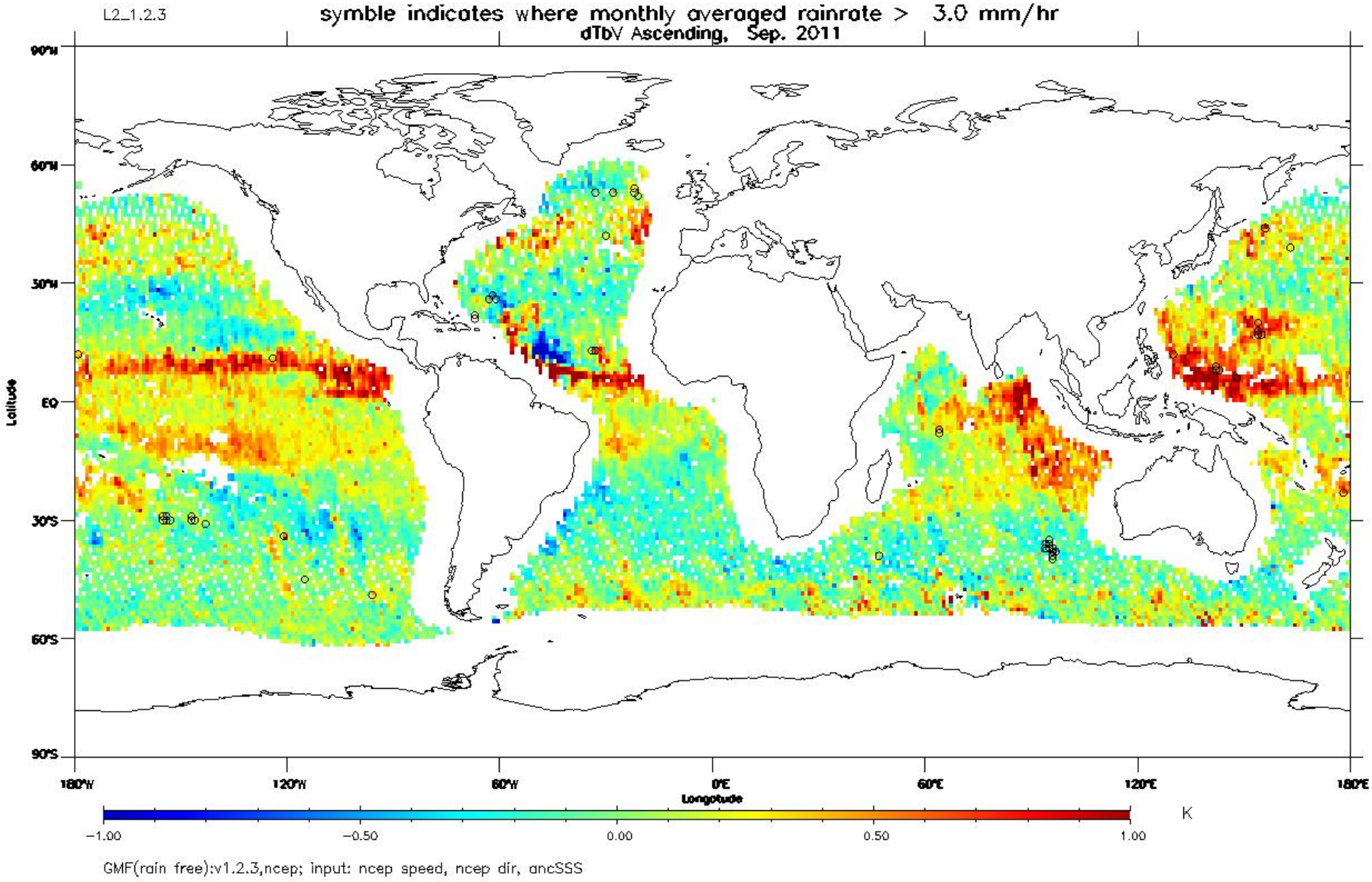
v1.2.3, wdir_ncep,rain1 2011237_2012071



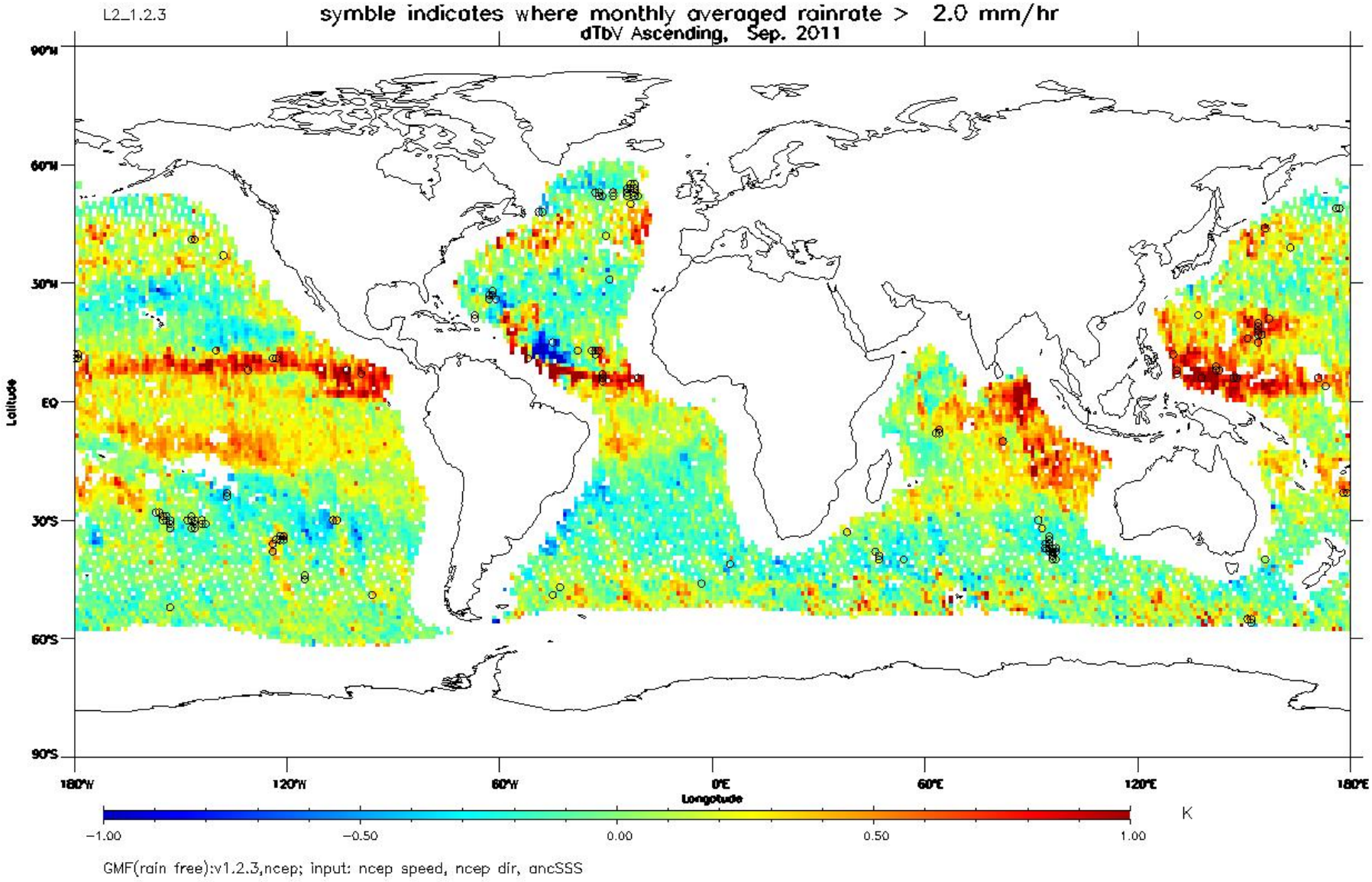
Model input: anc_SSS, anc_surf_temperature, anc_wind_speed



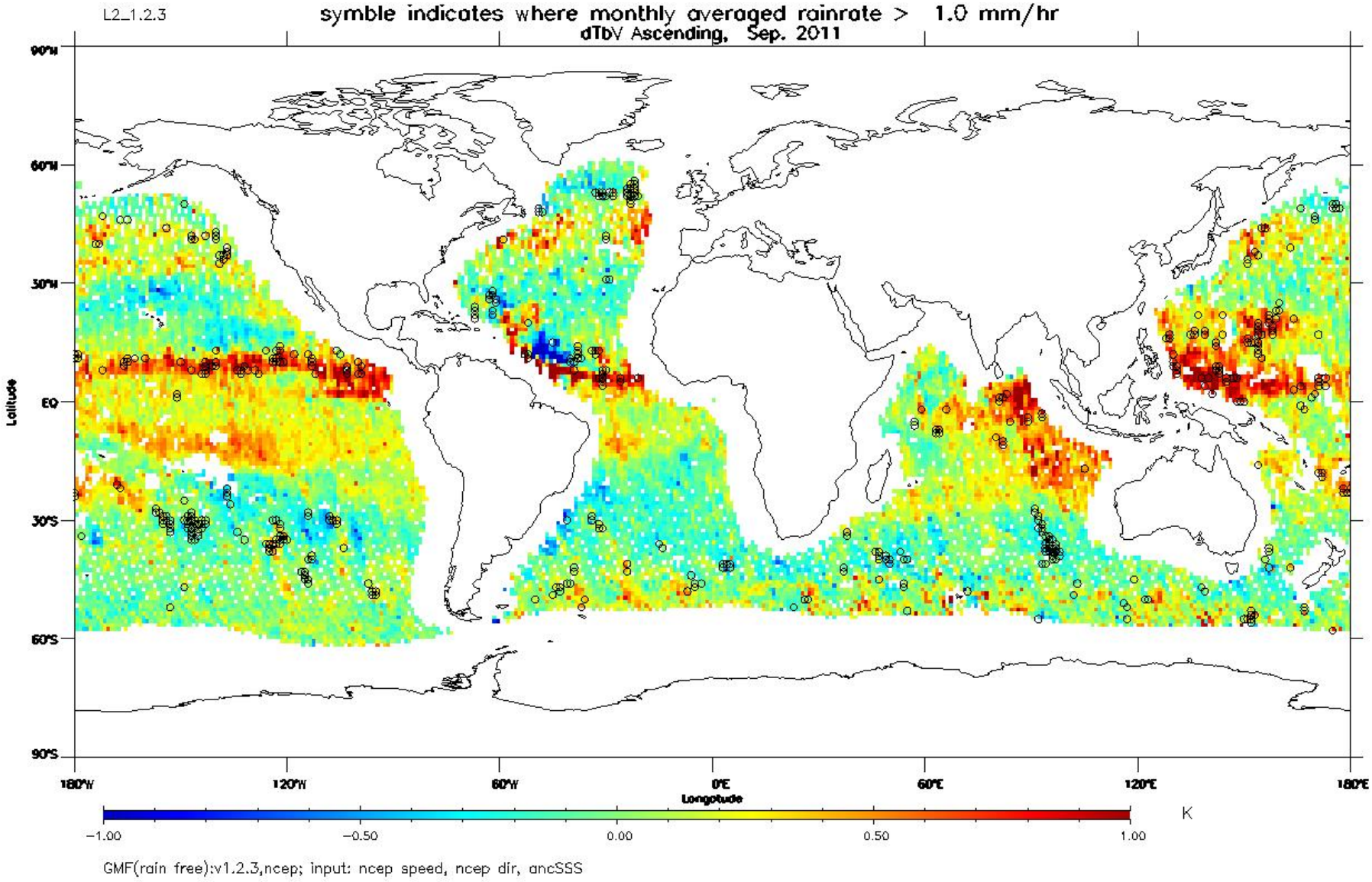
Association with rainrate?



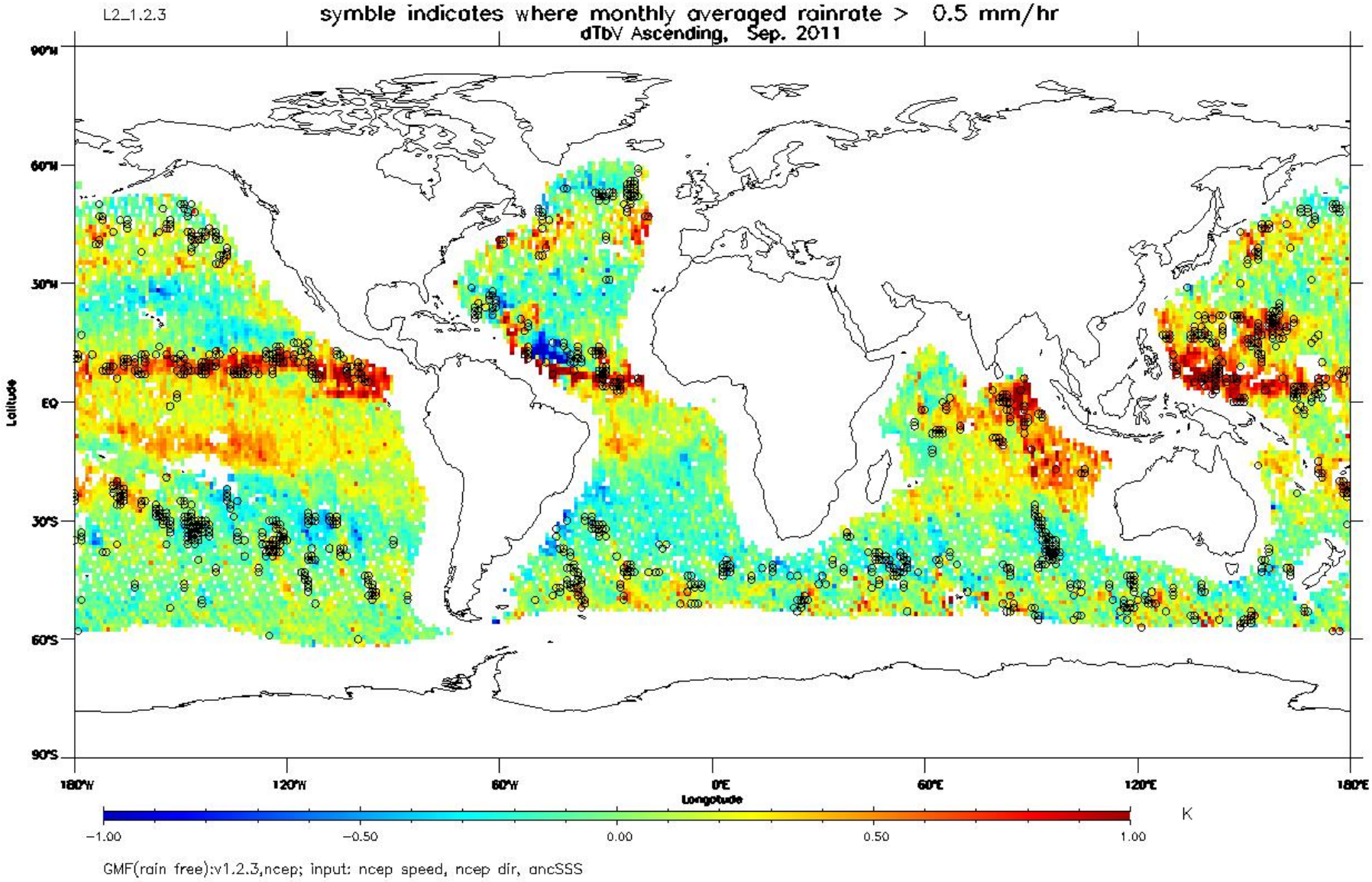
Association with rainrate?



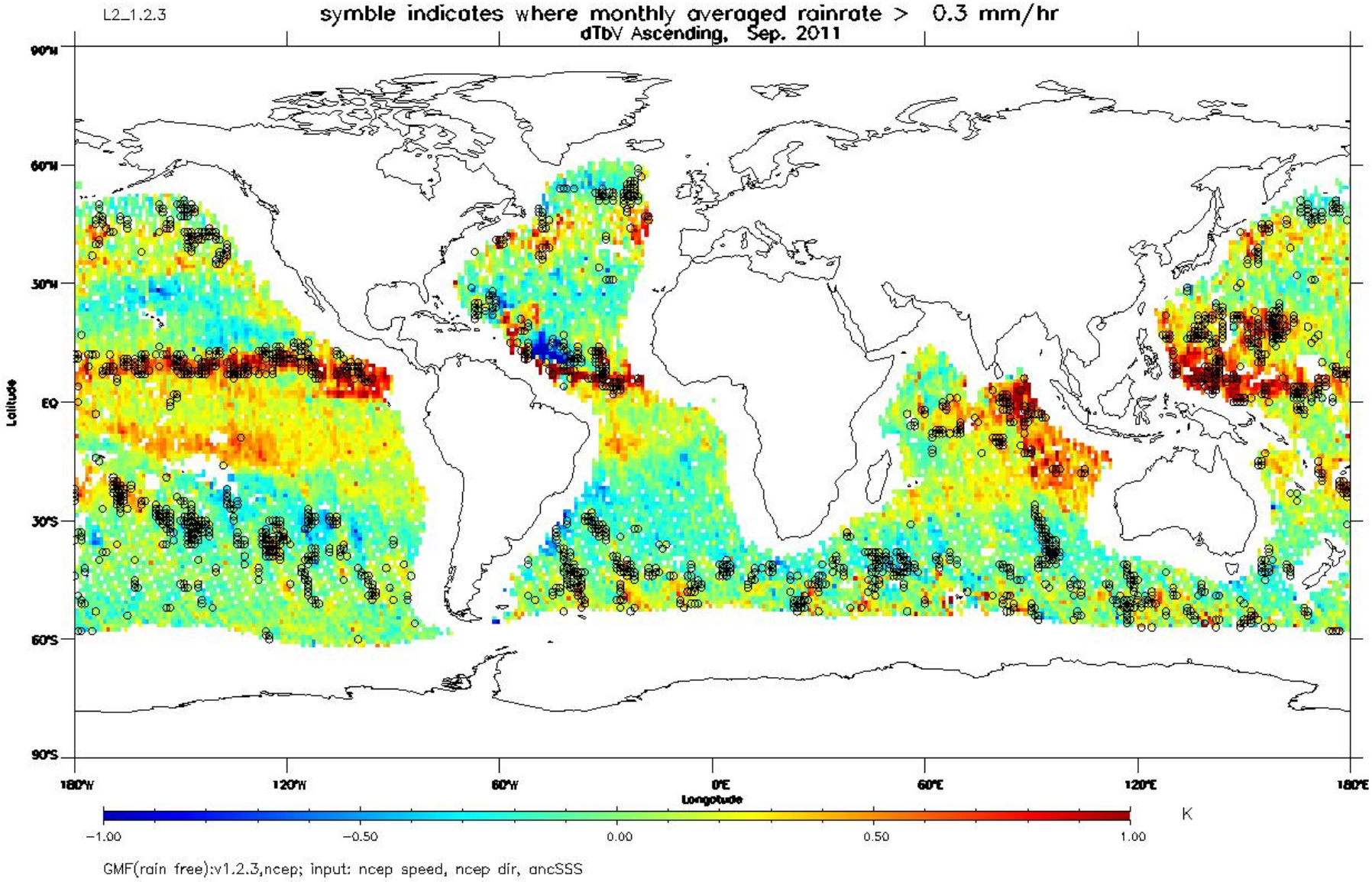
Association with rainrate?



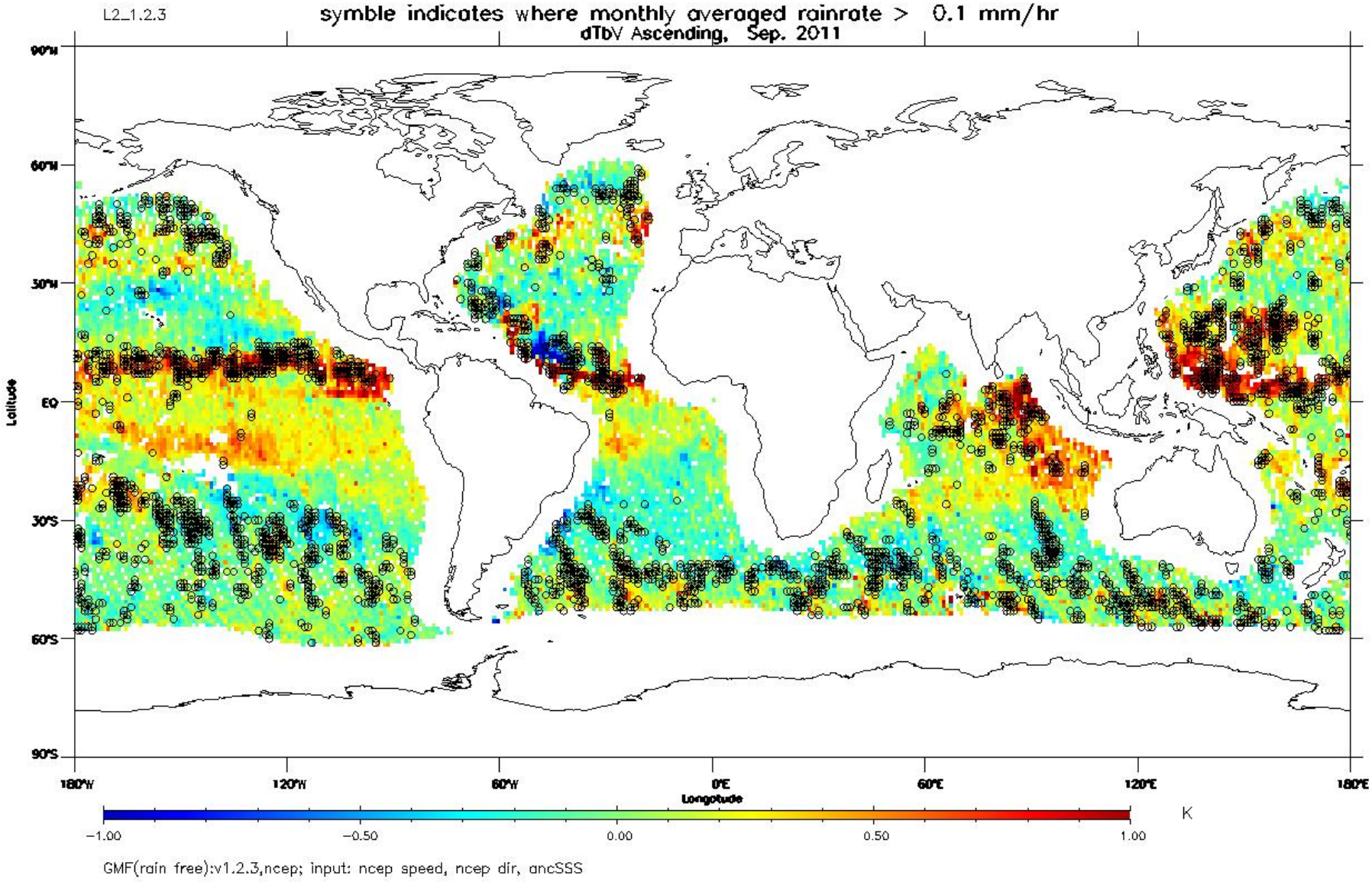
Association with rainrate?

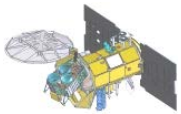


Association with rainrate?



Association with rainrate?



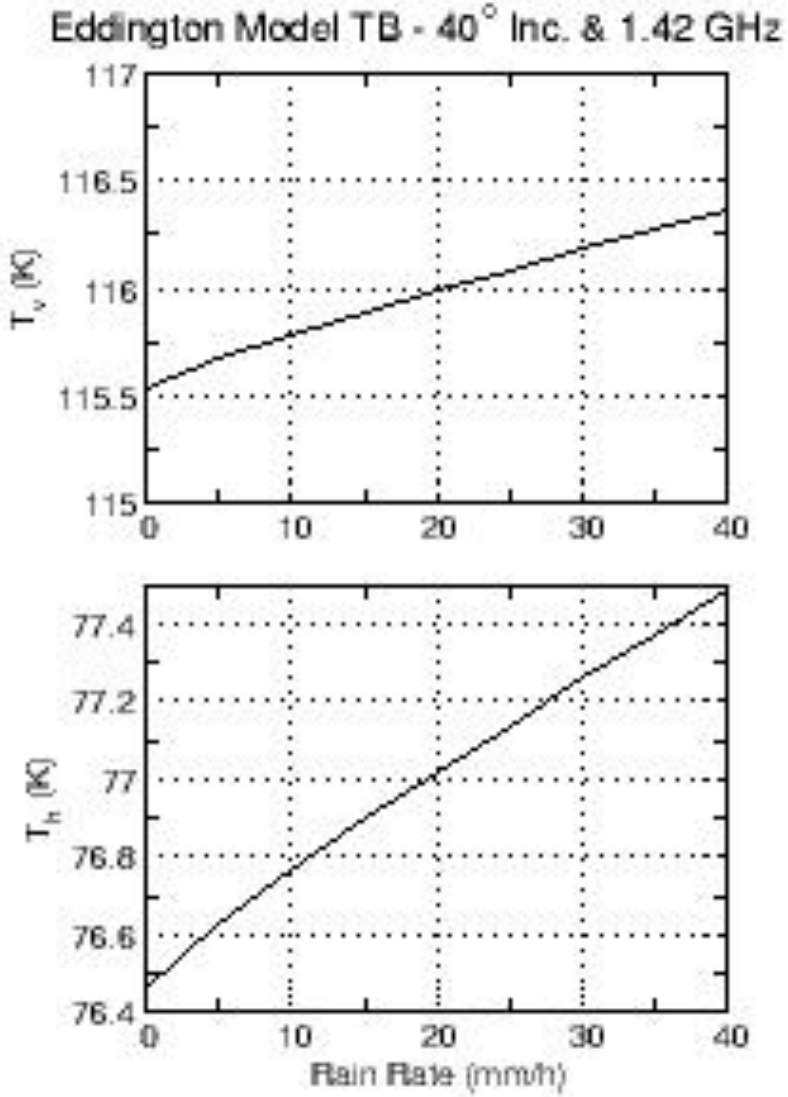


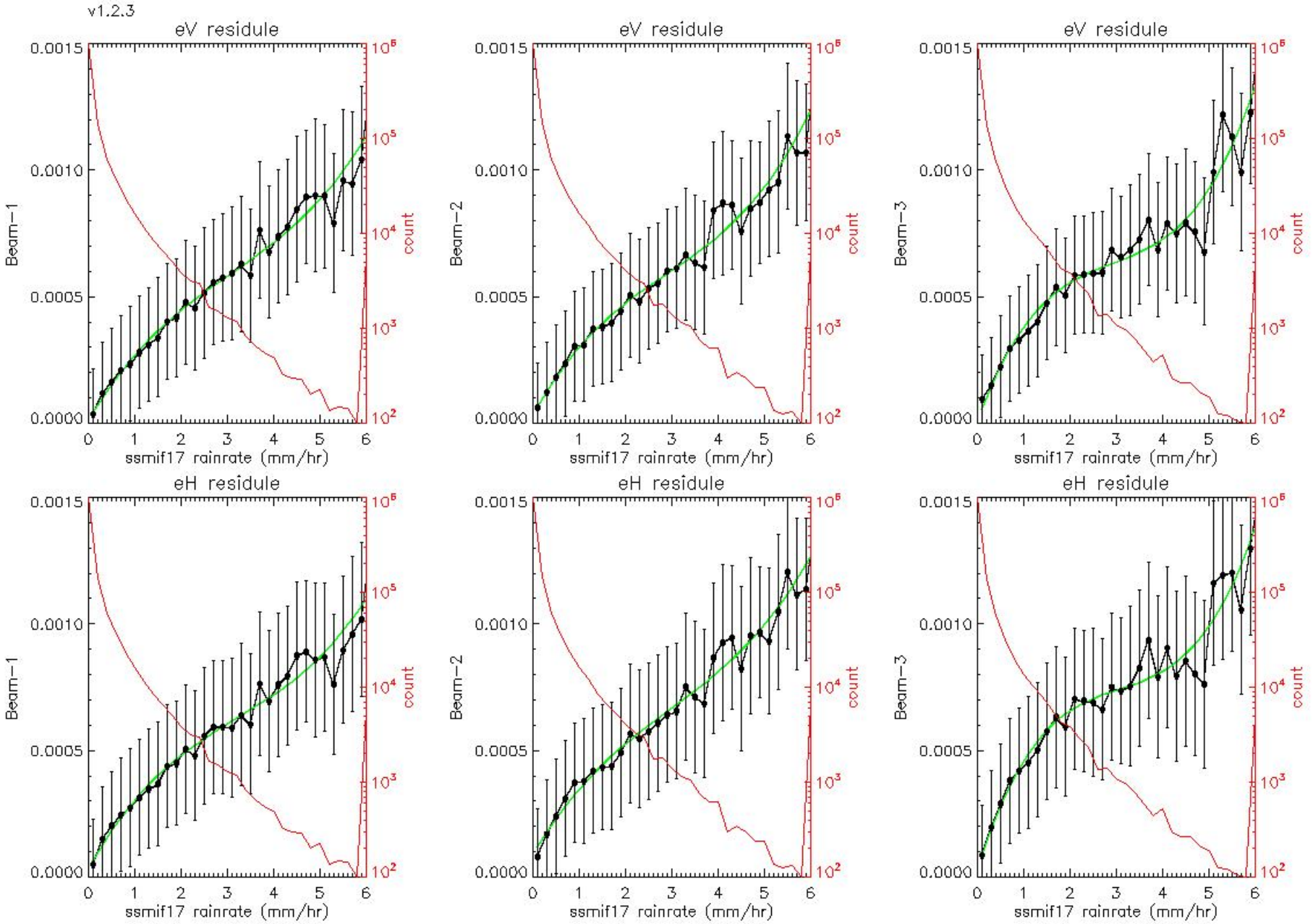
Observations and Hypotheses

- The observed dTB has a spatial pattern, that seems to correlate with the rain in the tropics
  - Delta sigma0 seems to have similar features
- However, dTB could become negative in the areas of rain
- dTB could be contributed by multiple sources
- In any case, there are two hypotheses for the positive correlation of dTB with rain in the tropics
  - Rain caused fresher water surface than the Hycom model SSS
  - Rain emission
  - Rain splash – not yet analyzed

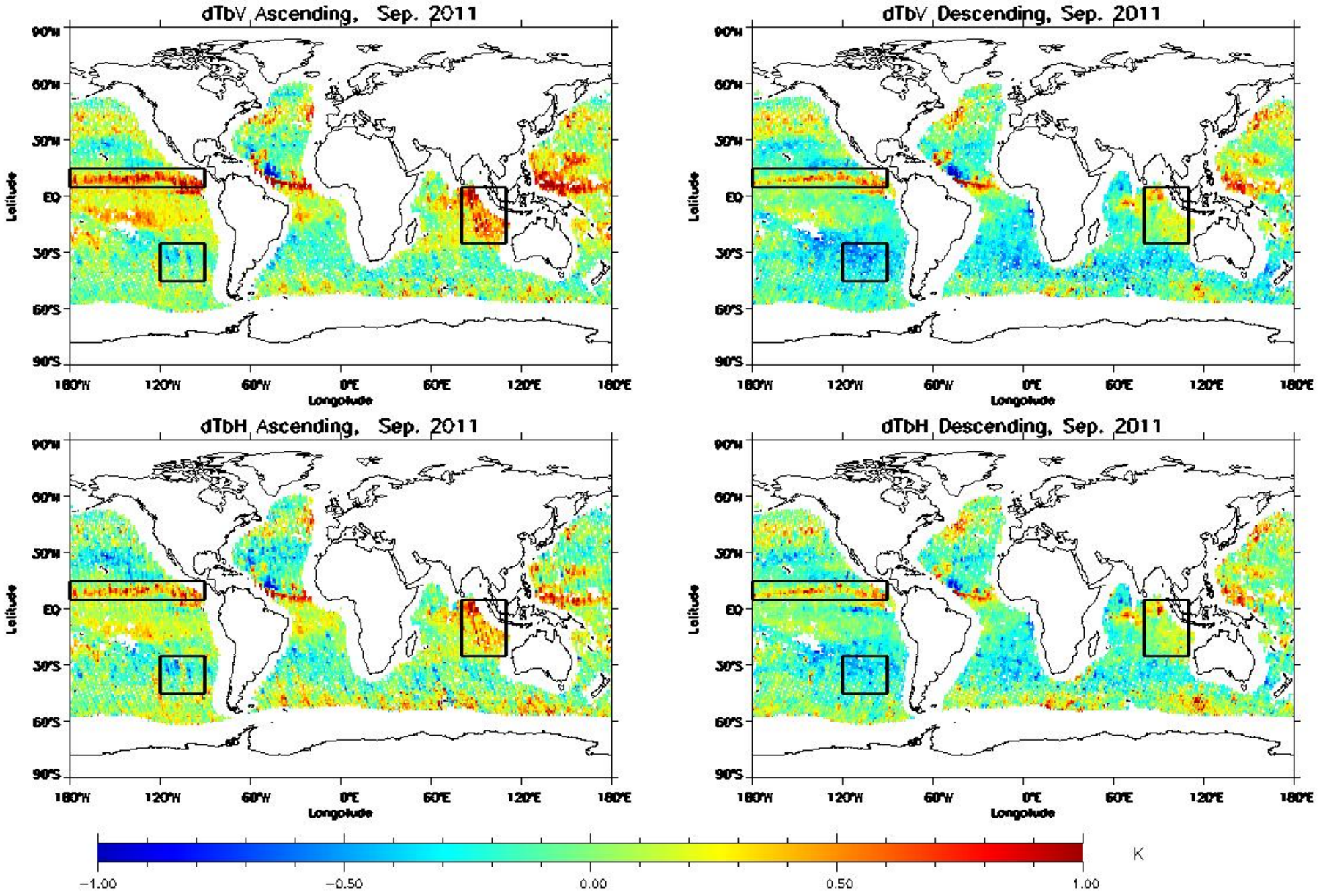
Rain Emission and attenuation

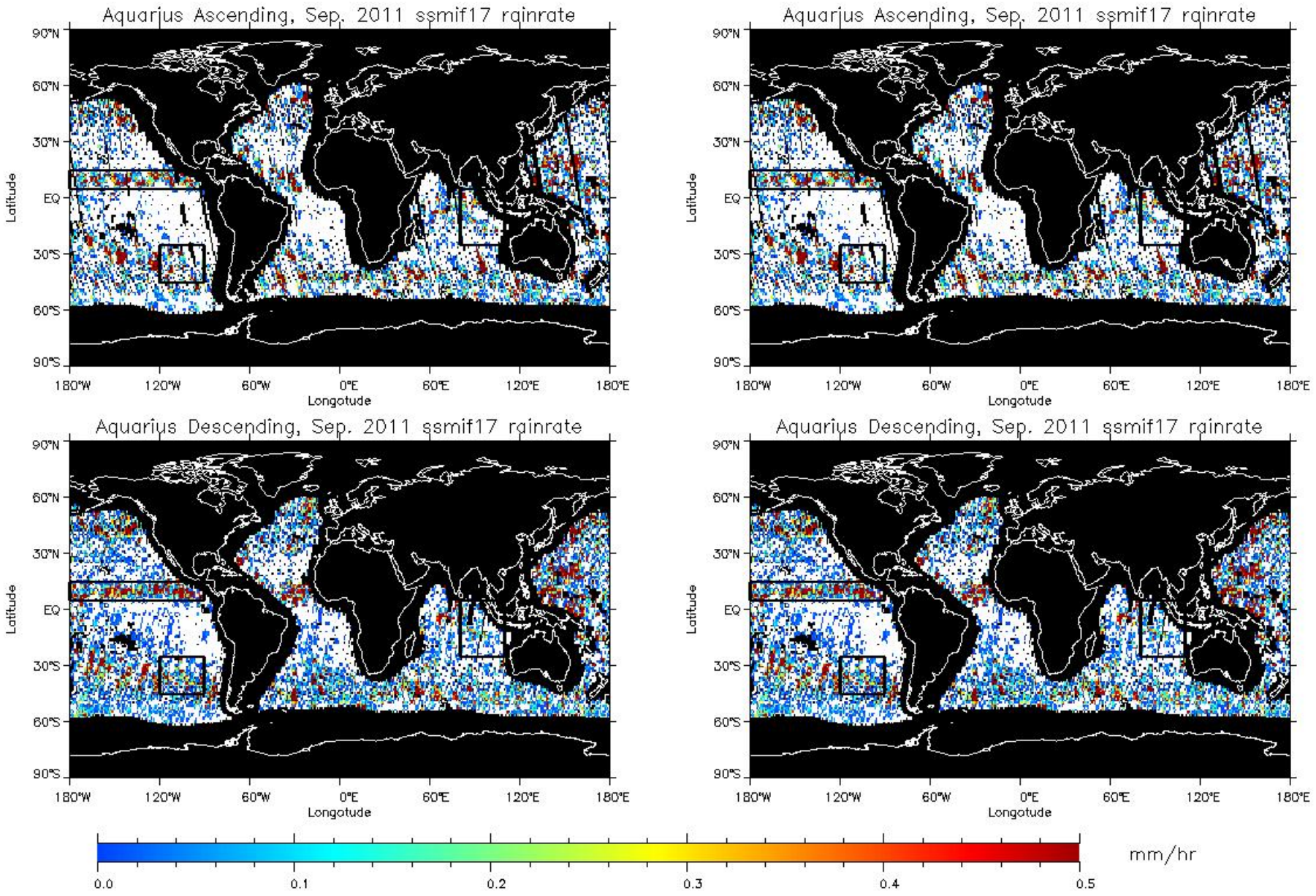
- Use Eddington Radiative Transfer Model (Kummerov) to calculate the ocean TB versus rain rate
- Will need > 40 mm/h to raise the ocean TB by 1 K
- The rain emission effects are much smaller than dTB observed in the tropics
- Rain attenuation is too small for the delta sigma0
- It is unlikely that rain emission is the key source of dTB

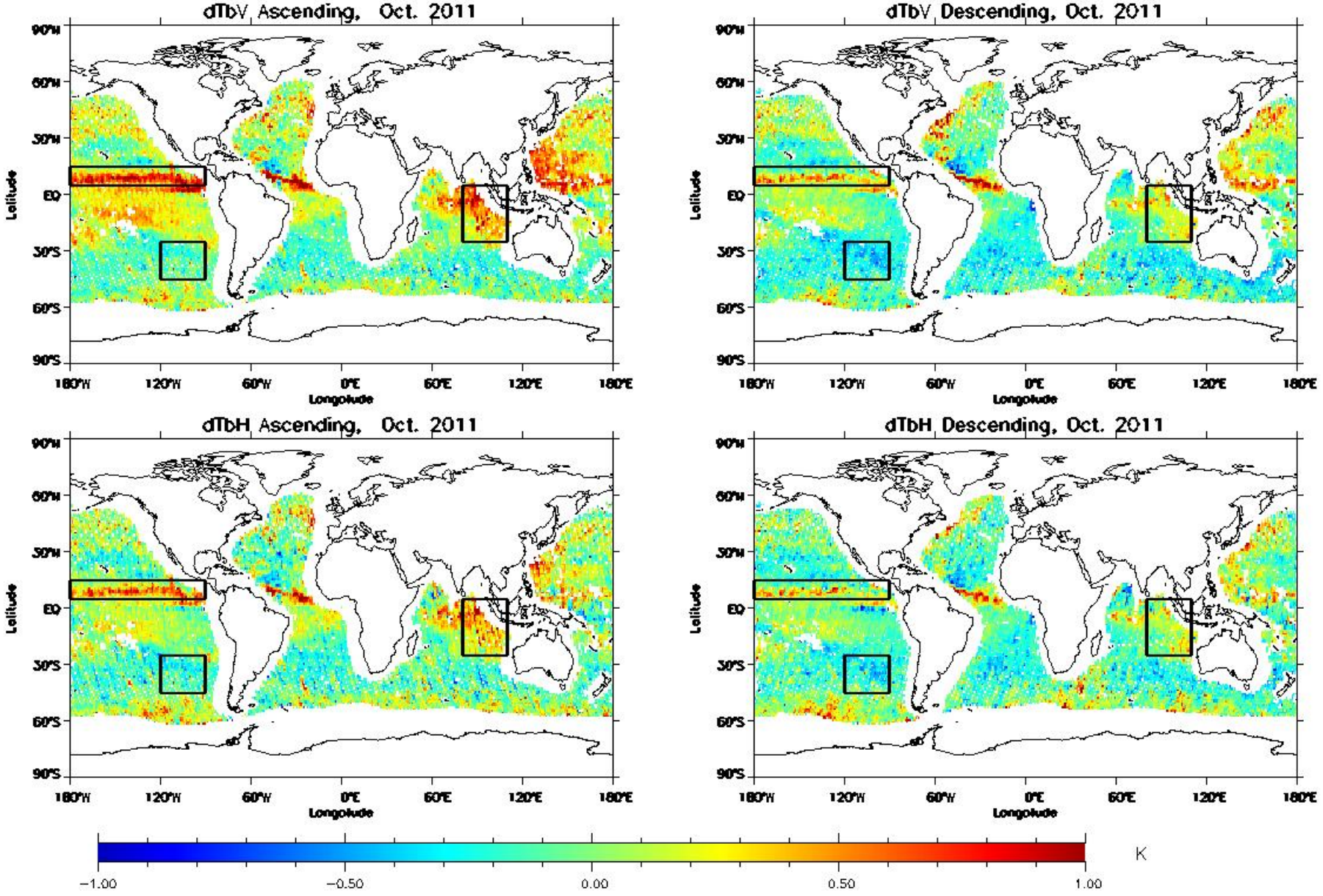


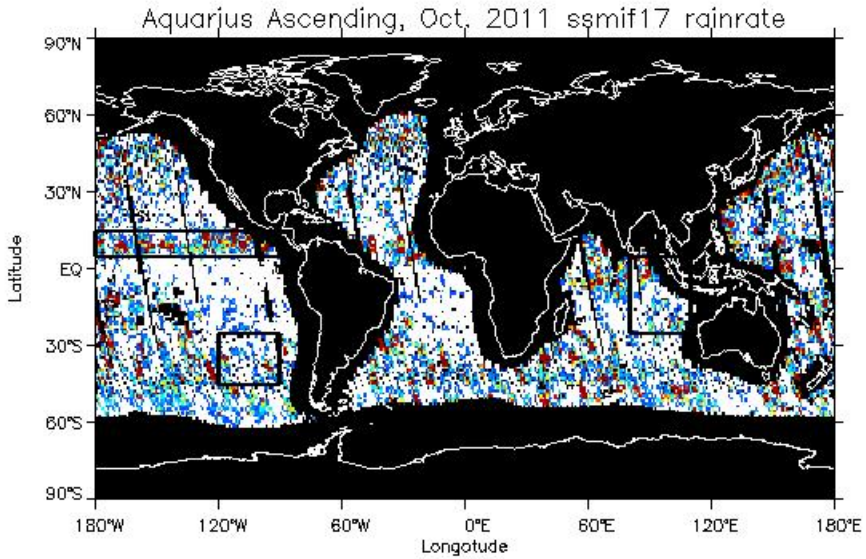


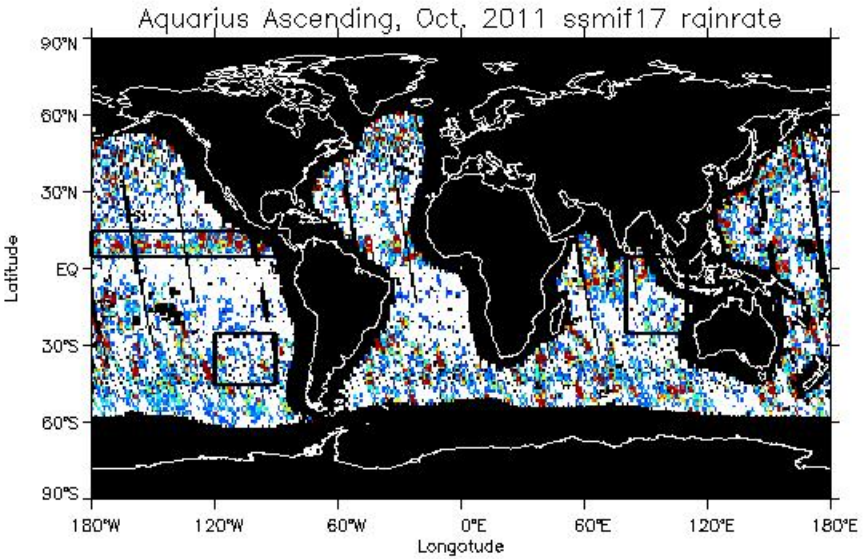
Error bar is +/- (standard deviation)*0.2; Greenlines are 3rd order polynomial fitting

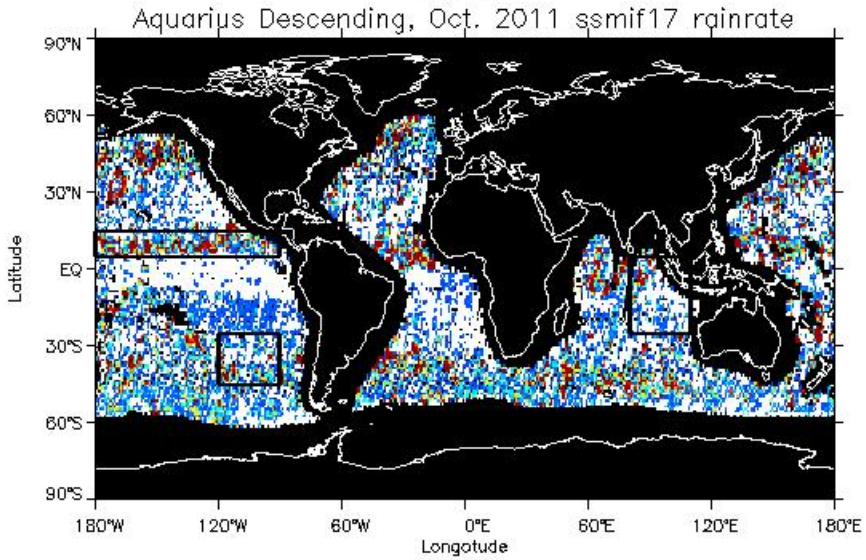

dTbV Ascending, Sep. 2011
dTbV Descending, Sep. 2011
dTbH Ascending, Sep. 2011
dTbH Descending, Sep. 2011
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longolude
−1.00
−0.50
0.00
0.50
1.00
K

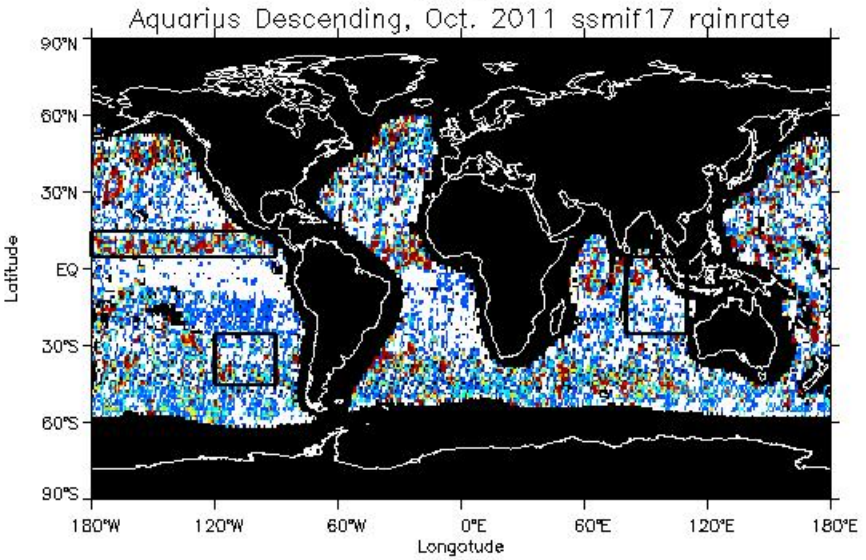

Aquarius Ascending, Sep. 2011 ssmif17 rainrate
Aquarius Ascending, Sep. 2011 ssmif17 rainrate
Aquarius Descending, Sep. 2011 ssmif17 rainrate
Aquarius Descending, Sep. 2011 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude
0.0
0.1
0.2
0.3
0.4
0.5
mm/hr

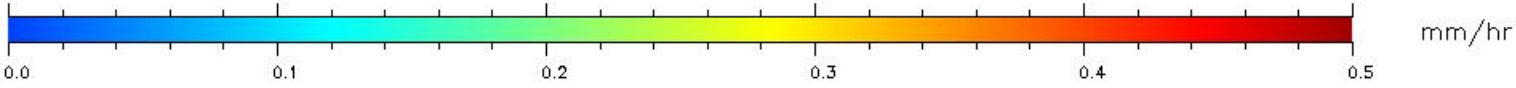

dTbV Ascending, Oct. 2011
dTbV Descending, Oct. 2011
dTbH Ascending, Oct. 2011
dTbH Descending, Oct. 2011
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longitude
−1.00
−0.50
0.00
0.50
1.00
K

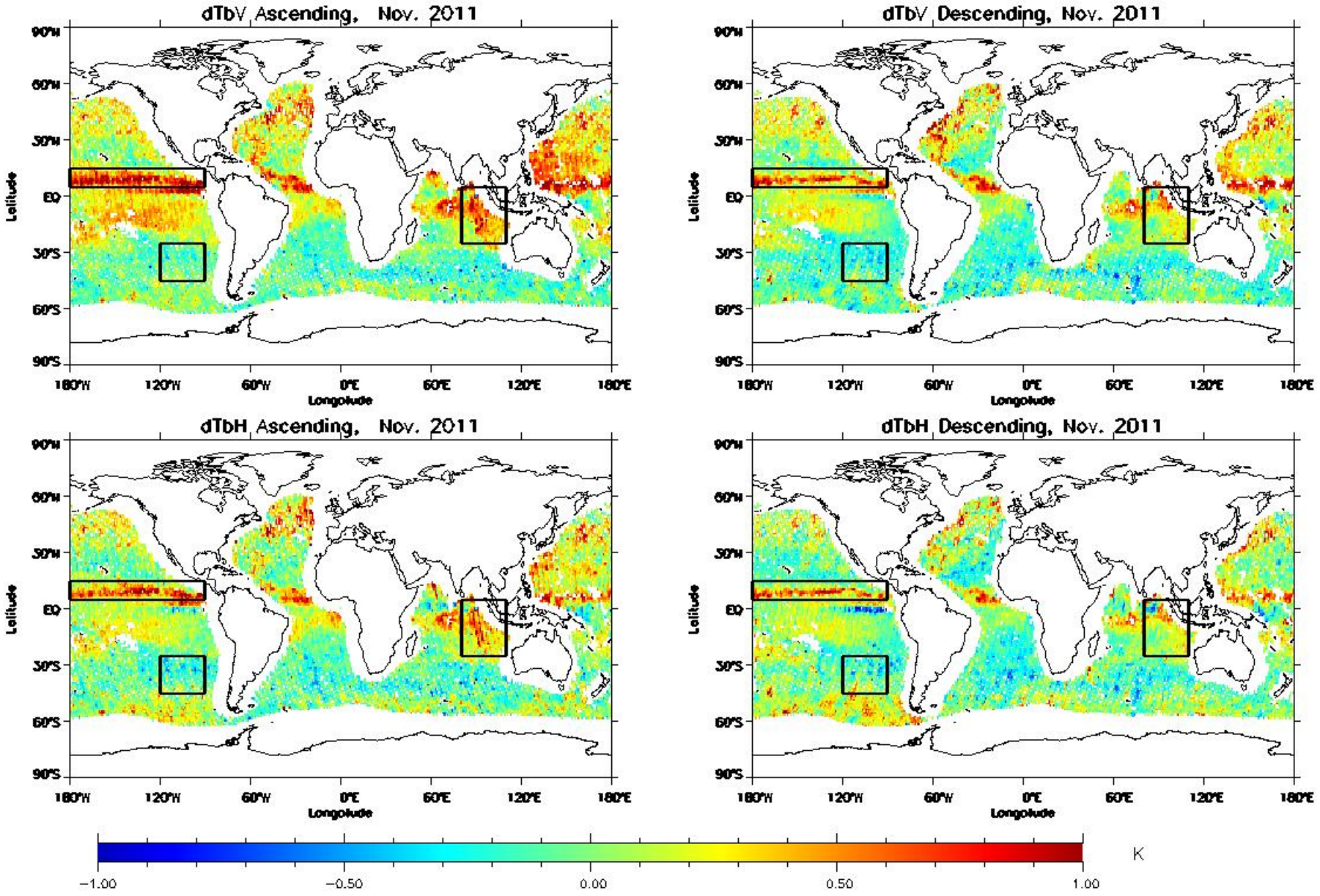

Aquarius Ascending, Oct. 2011 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude

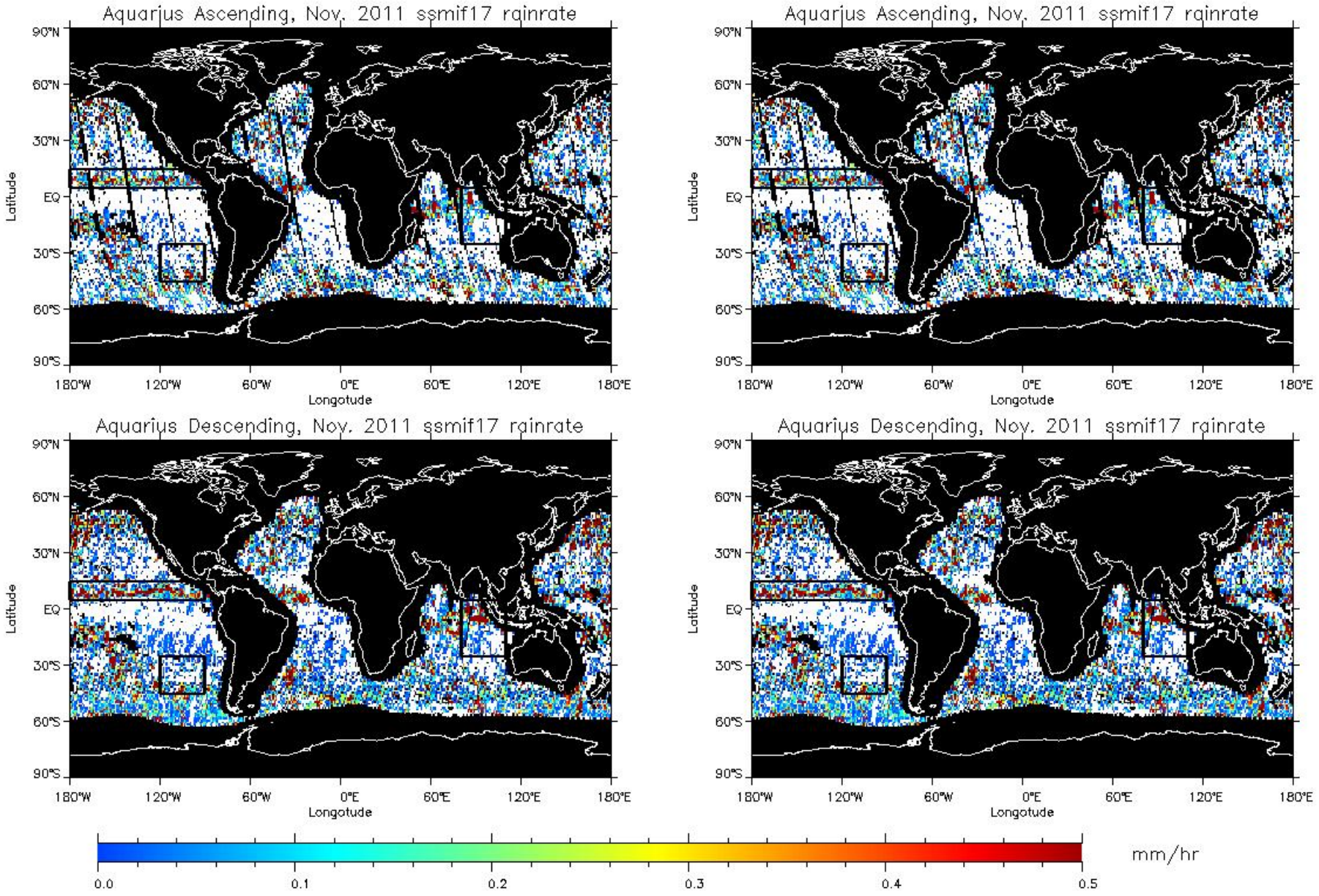

Aquarius Ascending, Oct. 2011 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude

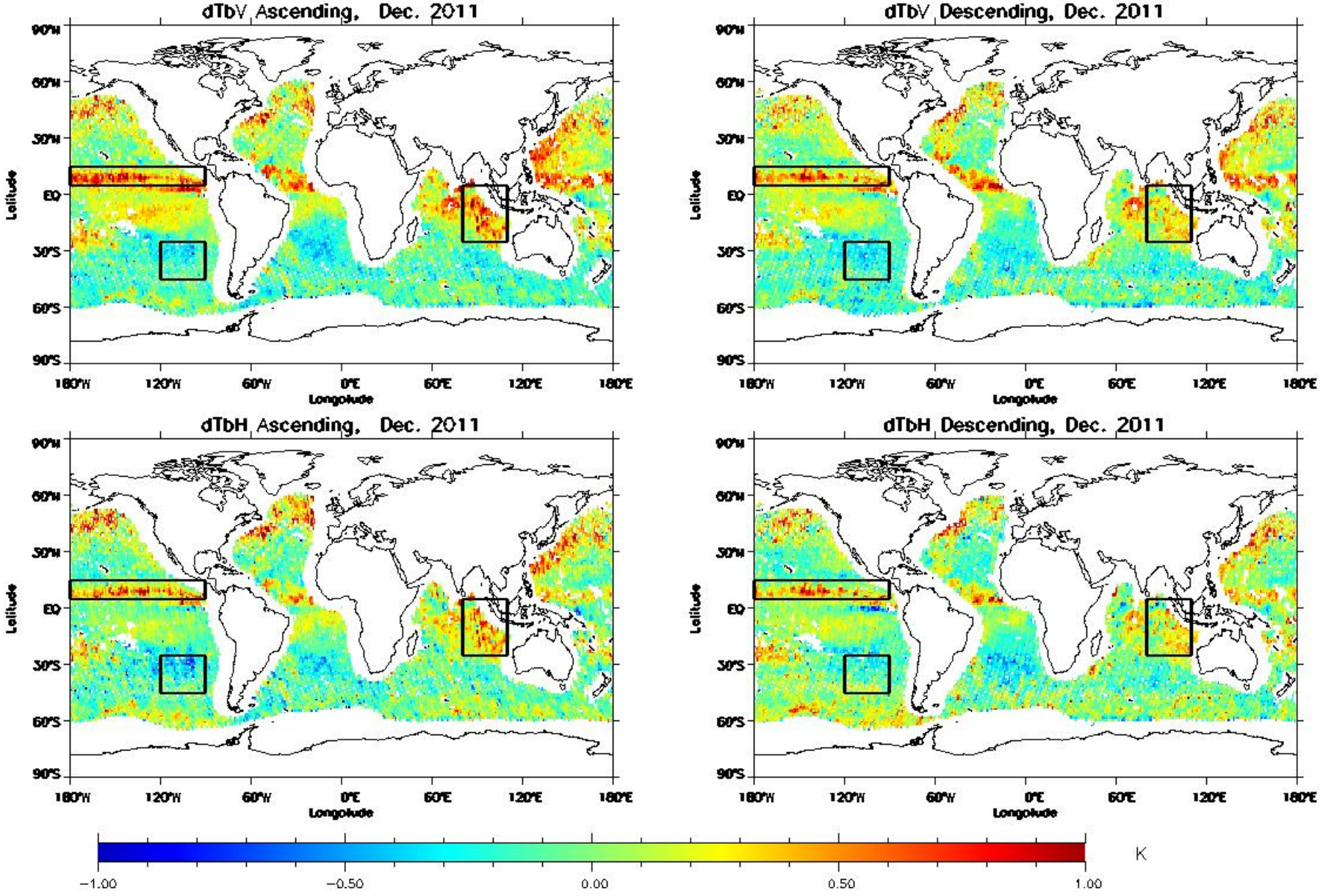

Aquarius Descending, Oct. 2011 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude

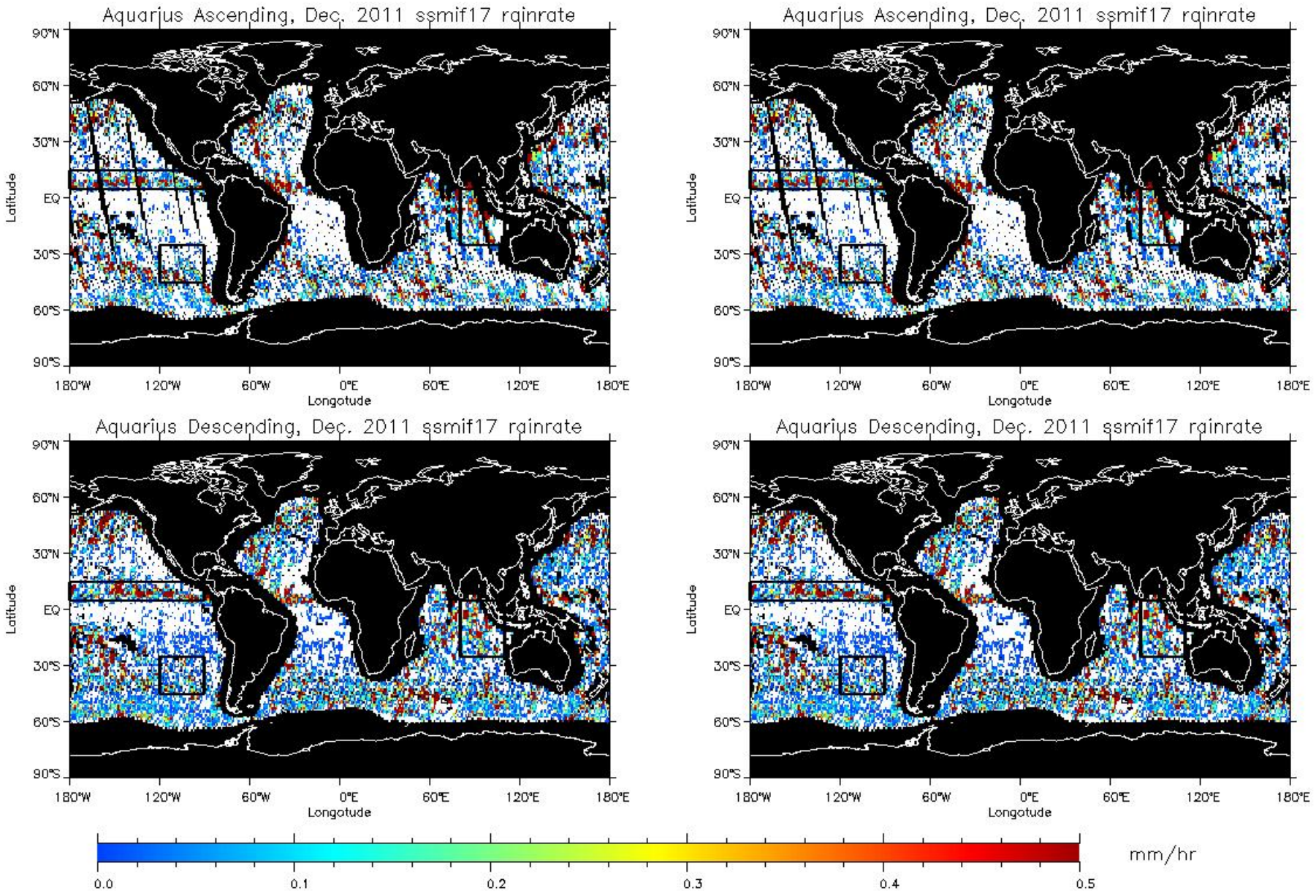

Aquarius Descending, Oct. 2011 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude

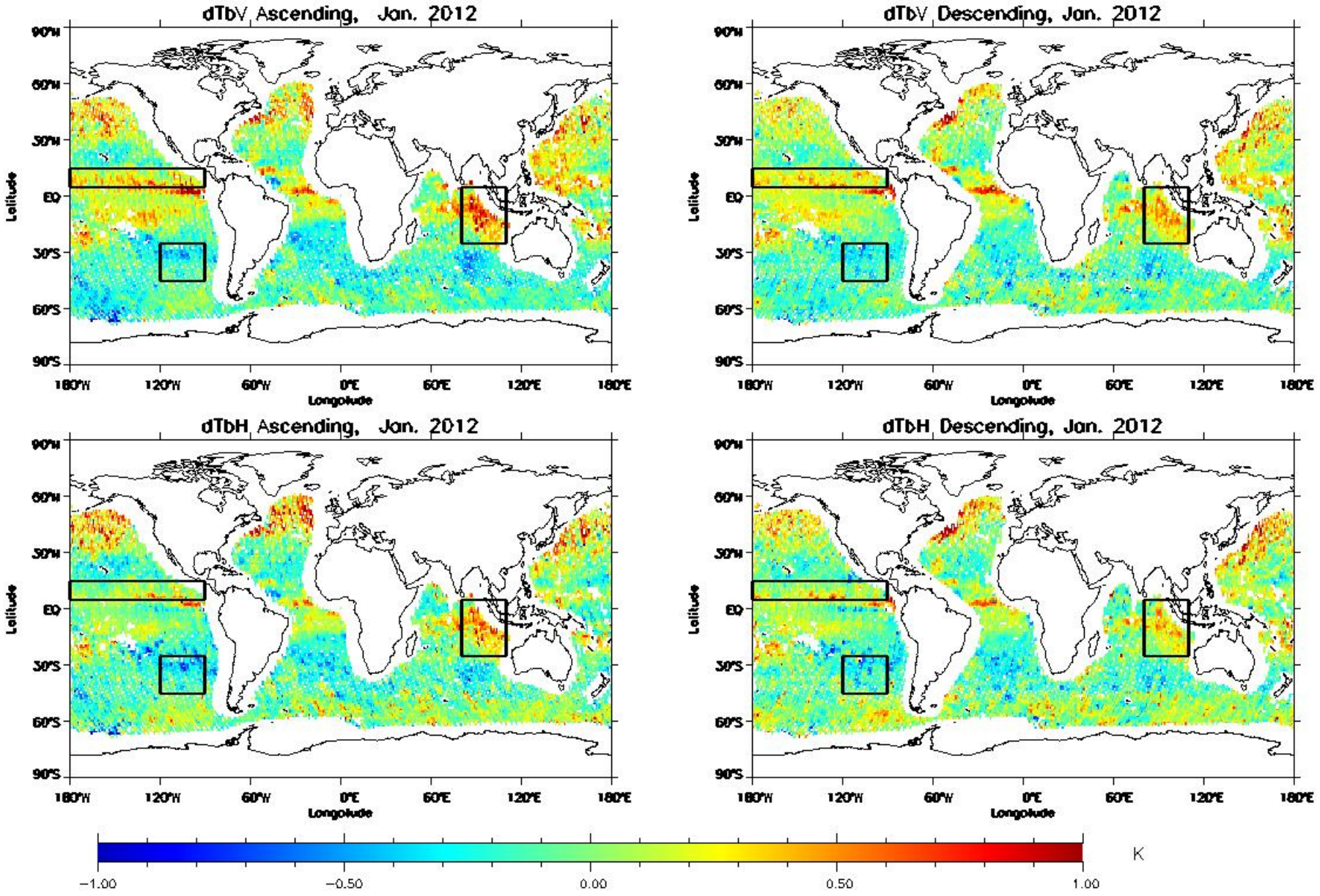

0.0
0.1
0.2
0.3
0.4
0.5
mm/hr

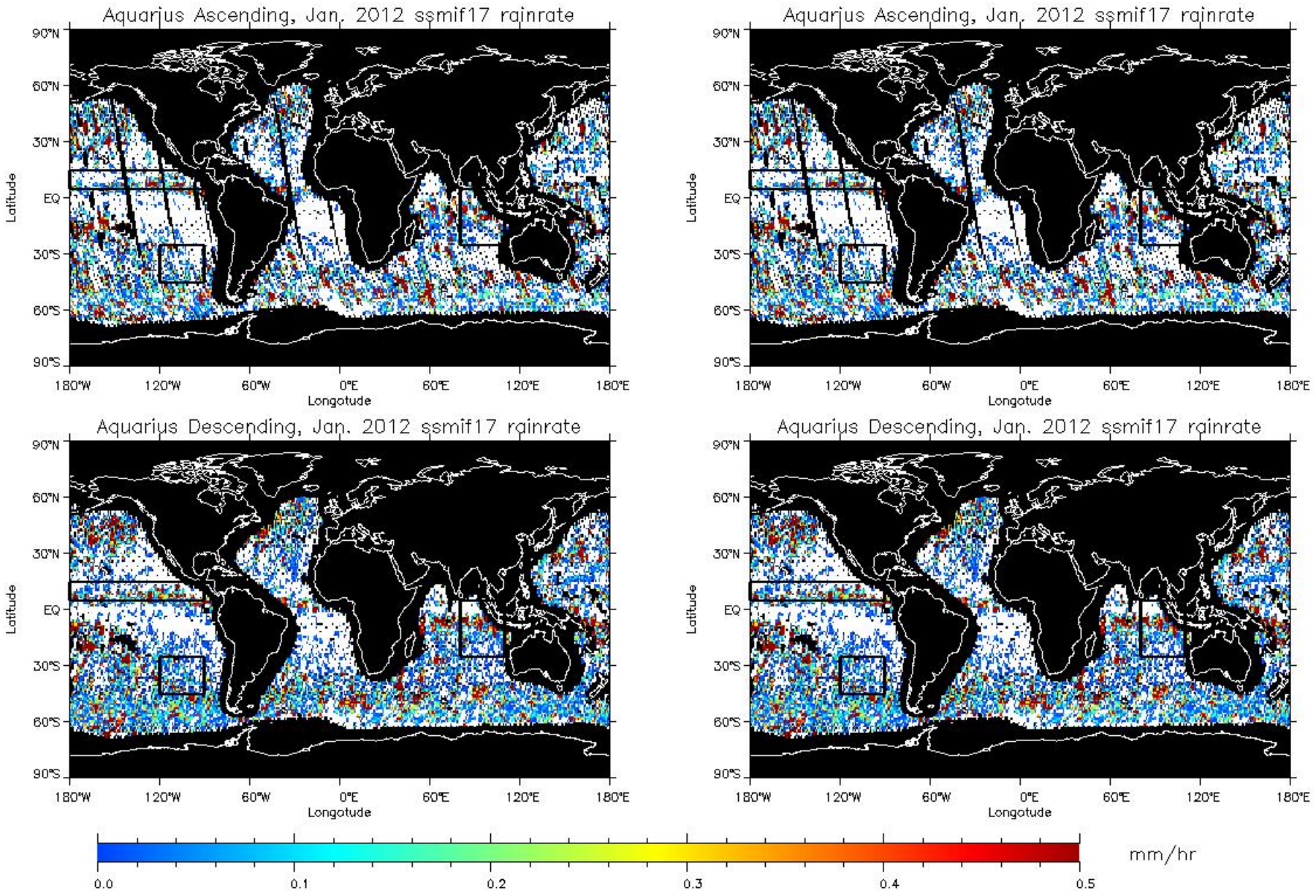

dTbV Ascending, Nov. 2011
dTbV Descending, Nov. 2011
dTbH Ascending, Nov. 2011
dTbH Descending, Nov. 2011
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longolude
−1.00
−0.50
0.00
0.50
1.00
K

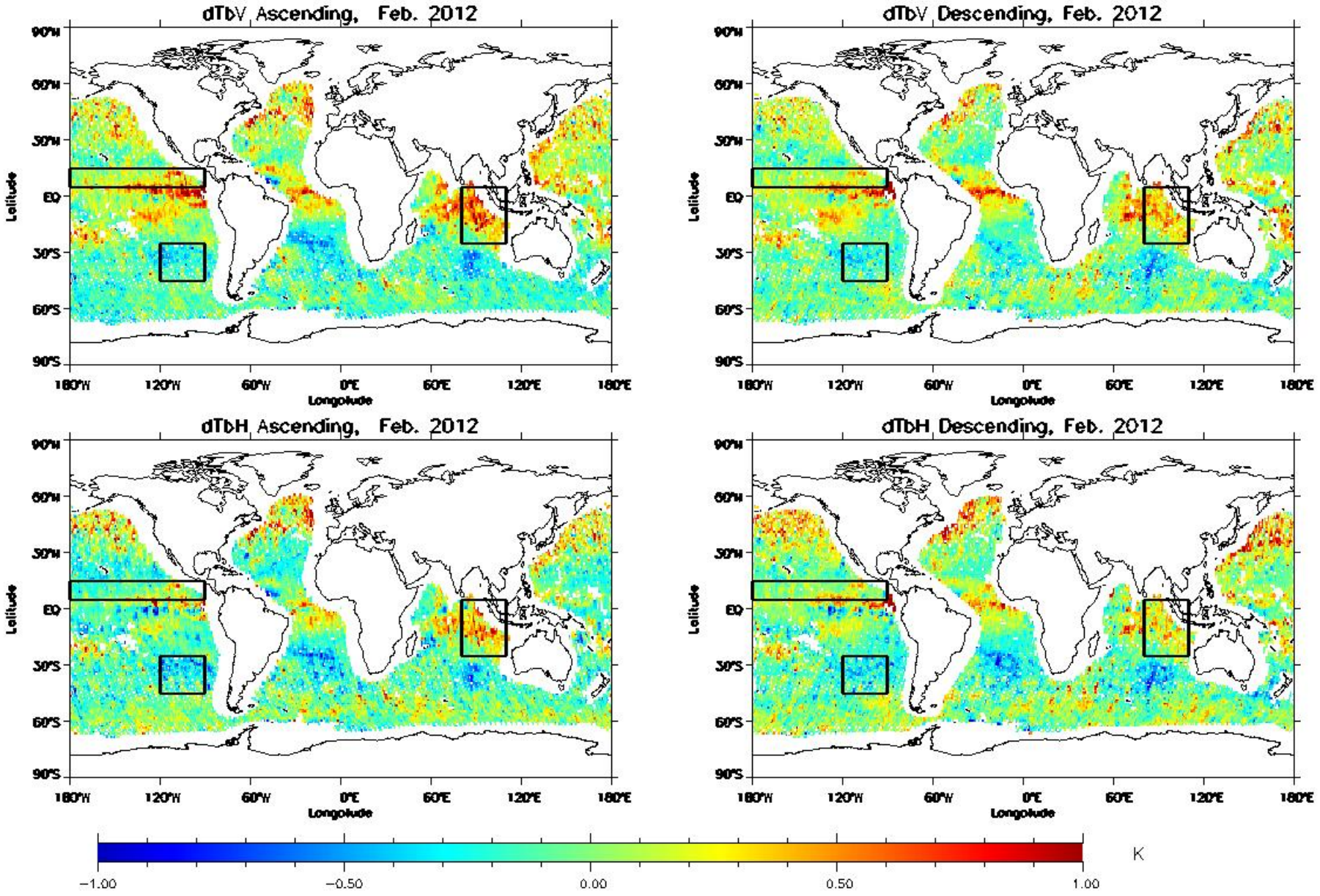

Aquarius Ascending, Nov. 2011 ssmif17 rainrate
Aquarius Ascending, Nov. 2011 ssmif17 rainrate
Aquarius Descending, Nov. 2011 ssmif17 rainrate
Aquarius Descending, Nov. 2011 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude
0.0
0.1
0.2
0.3
0.4
0.5
mm/hr

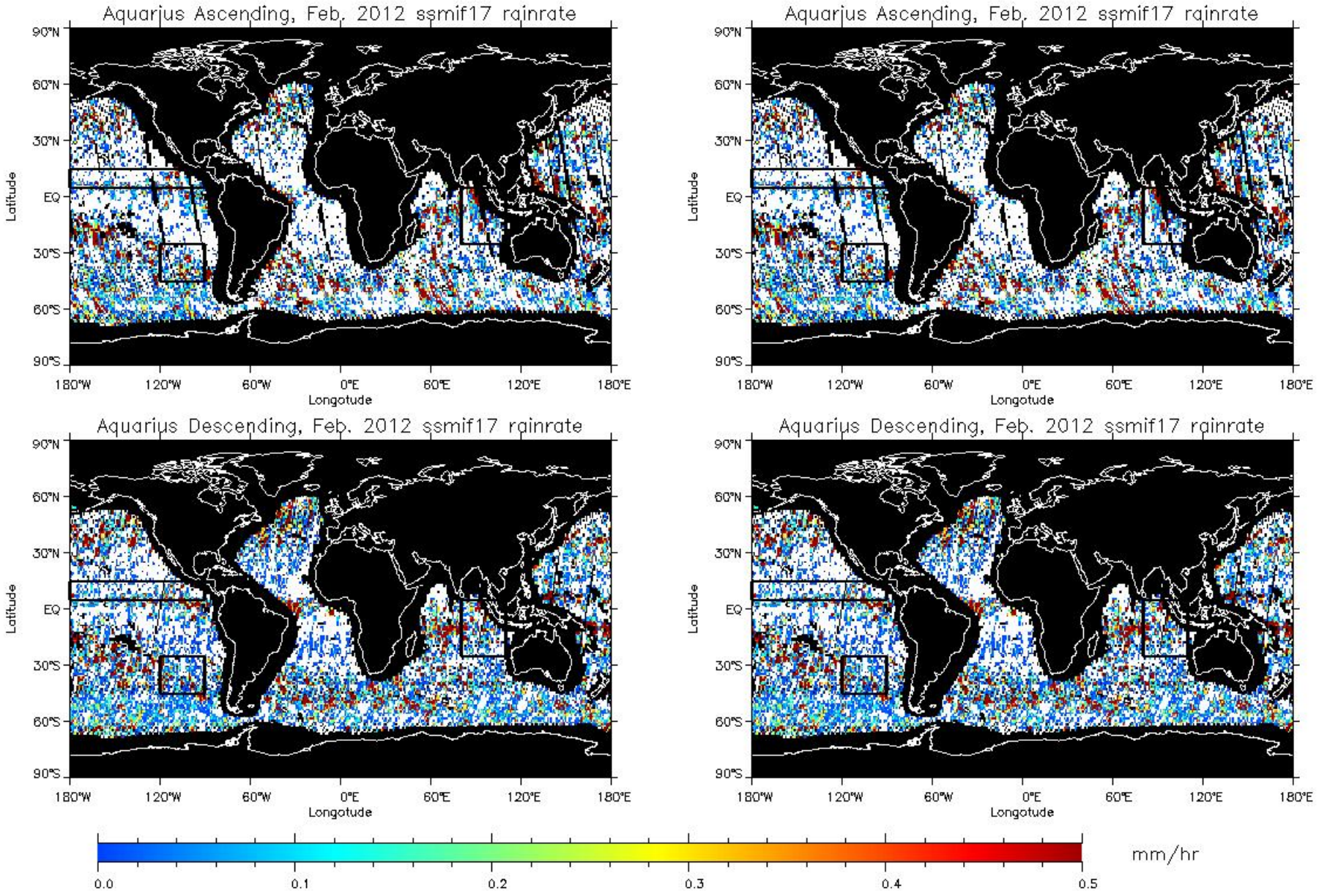

dTbV Ascending, Dec. 2011
dTbV Descending, Dec. 2011
dTbH Ascending, Dec. 2011
dTbH Descending, Dec. 2011
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longolude
−1.00
−0.50
0.00
0.50
1.00
K


Aquarius Ascending, Dec. 2011 ssmif17 rainrate
Aquarius Ascending, Dec. 2011 ssmif17 rainrate
Aquarius Descending, Dec. 2011 ssmif17 rainrate
Aquarius Descending, Dec. 2011 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude
0.0
0.1
0.2
0.3
0.4
0.5
mm/hr

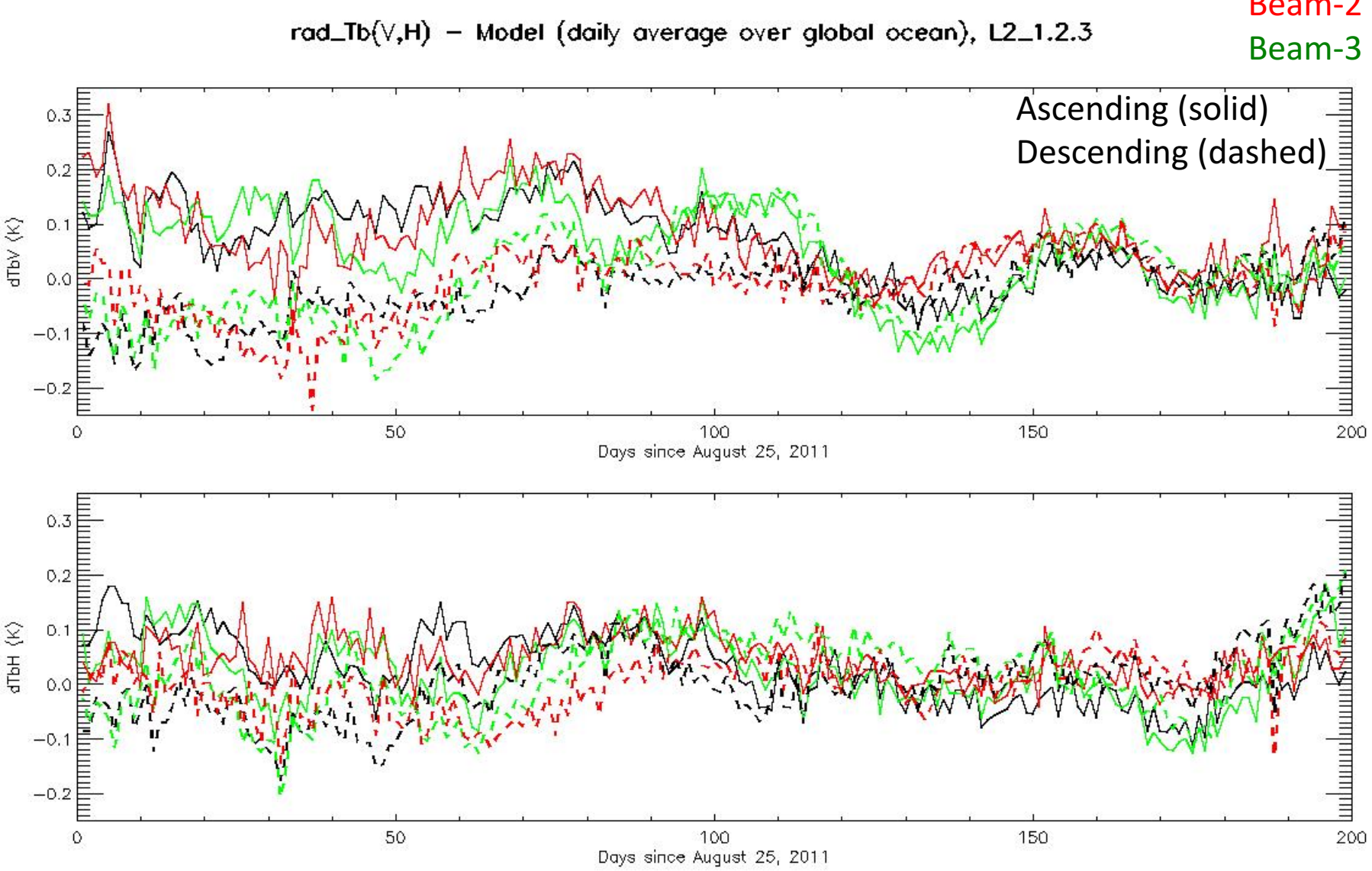

dTbV Ascending, Jan. 2012
dTbV Descending, Jan. 2012
dTbH Ascending, Jan. 2012
dTbH Descending, Jan. 2012
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longolude
−1.00
−0.50
0.00
0.50
1.00
K


Aquarius Ascending, Jan. 2012 ssmif17 rainrate
Aquarius Ascending, Jan. 2012 ssmif17 rainrate
Aquarius Descending, Jan. 2012 ssmif17 rainrate
Aquarius Descending, Jan. 2012 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude
0.0
0.1
0.2
0.3
0.4
0.5
mm/hr


dTbV Ascending, Feb. 2012
dTbV Descending, Feb. 2012
dTbH Ascending, Feb. 2012
dTbH Descending, Feb. 2012
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longitude
−1.00
−0.50
0.00
0.50
1.00
K

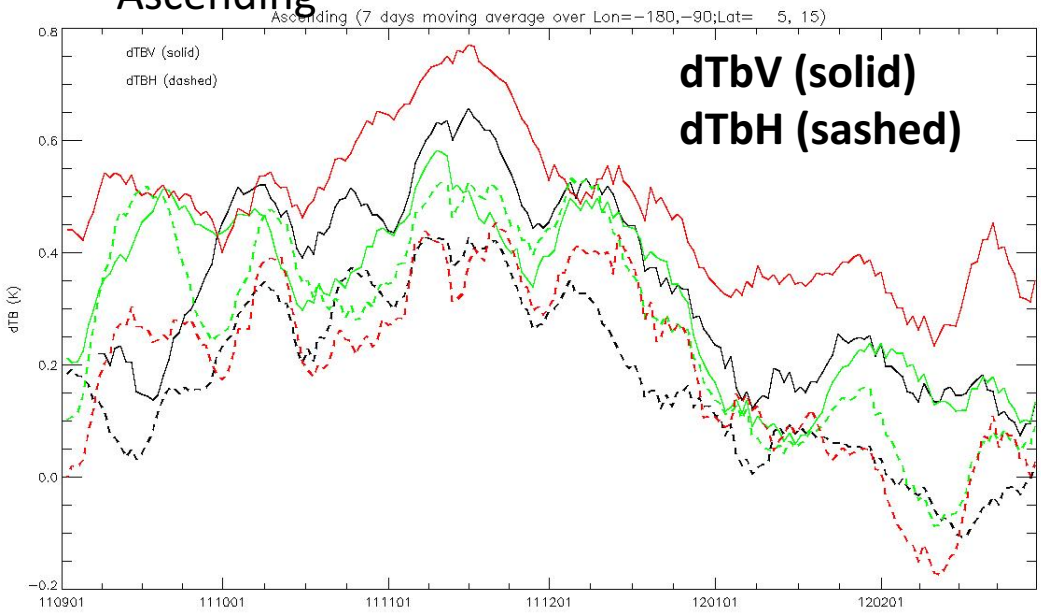

Aquarius Ascending, Feb. 2012 ssmif17 rainrate
Aquarius Ascending, Feb. 2012 ssmif17 rainrate
Aquarius Descending, Feb. 2012 ssmif17 rainrate
Aquarius Descending, Feb. 2012 ssmif17 rainrate
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Latitude
180°W
120°W
60°W
0°E
60°E
120°E
180°E
Longotude
0.0
0.1
0.2
0.3
0.4
0.5
mm/hr

Beam-1
Beam-2
Beam-3



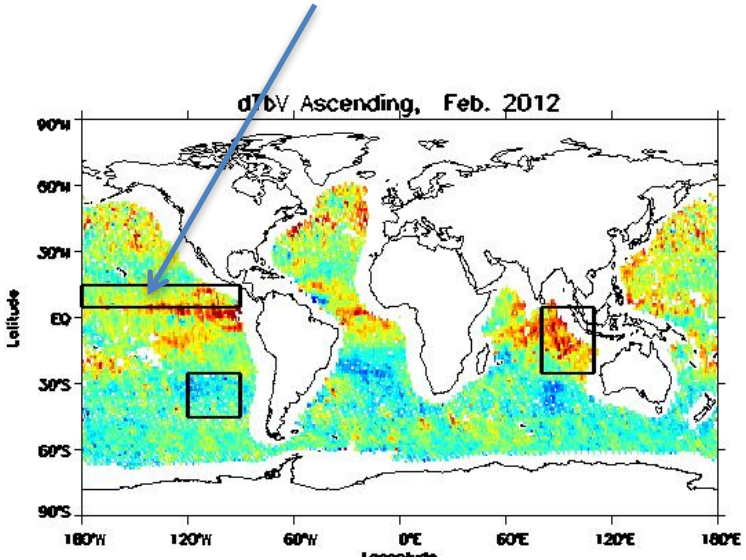
GMF(rain free):v1.2.3,ncep; input: ncep speed, ncep dir, ancSSS

Ascending

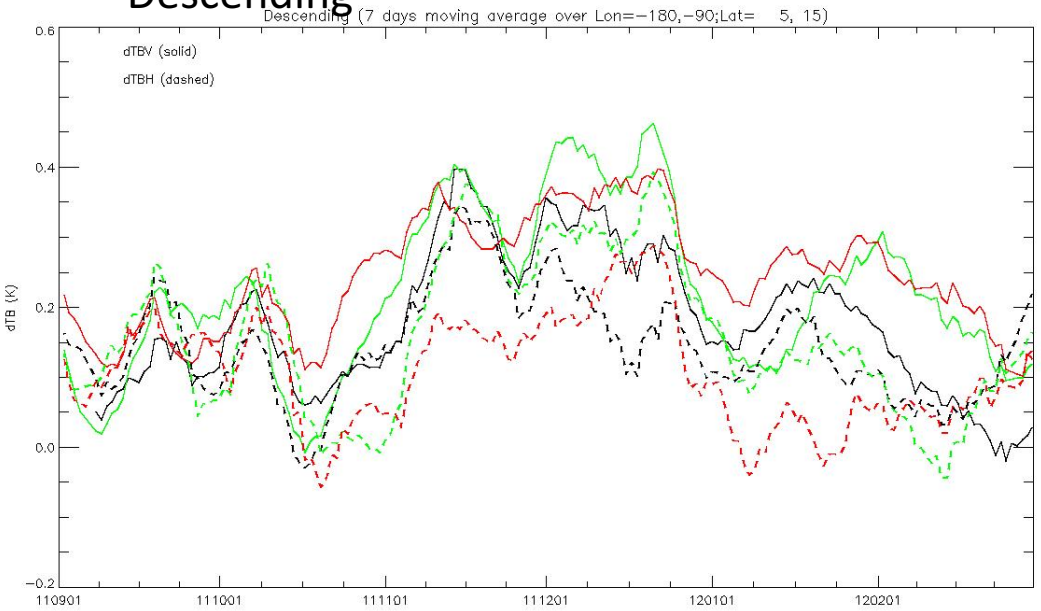


Eastern Equatorial Pacific

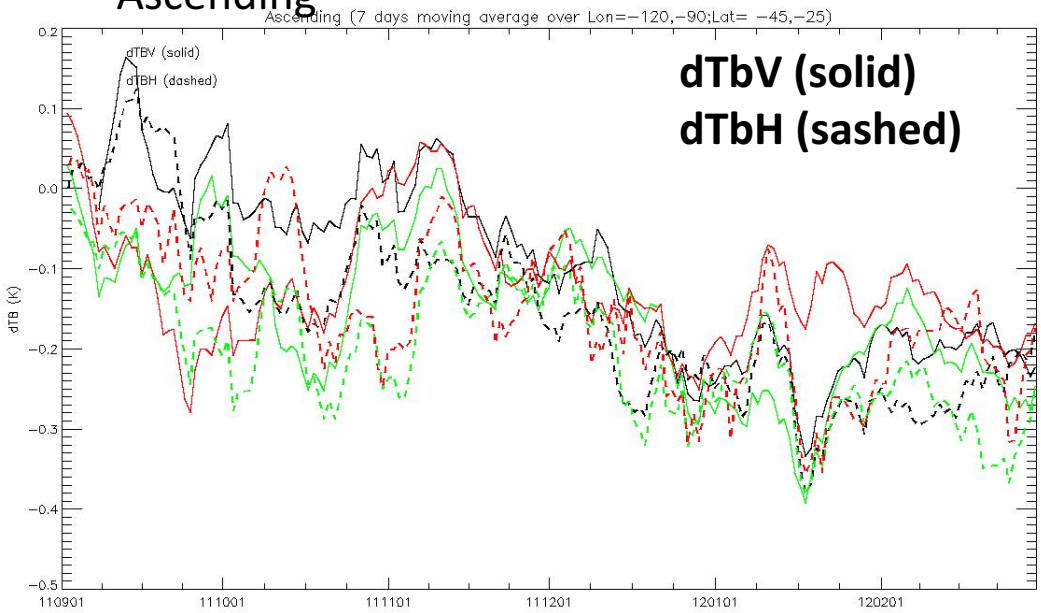
For ascending pass, dTBV is consistently higher than dTBH for beam-1 & 2, but not for beam-3



Descending



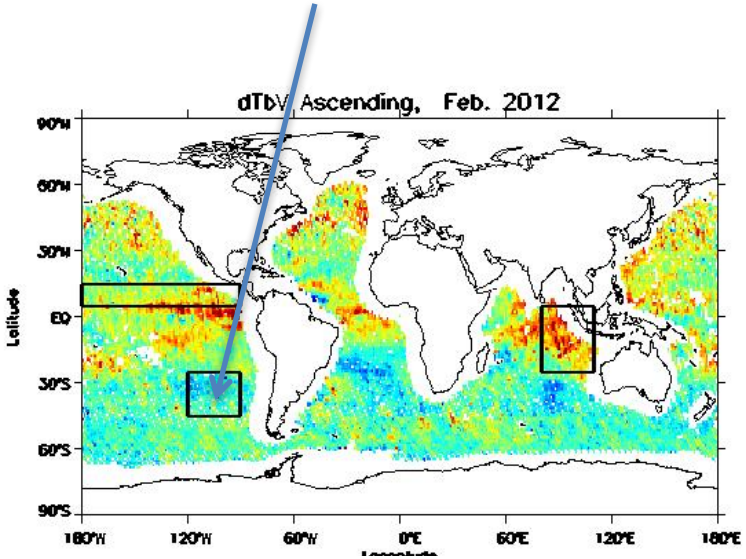
Ascending



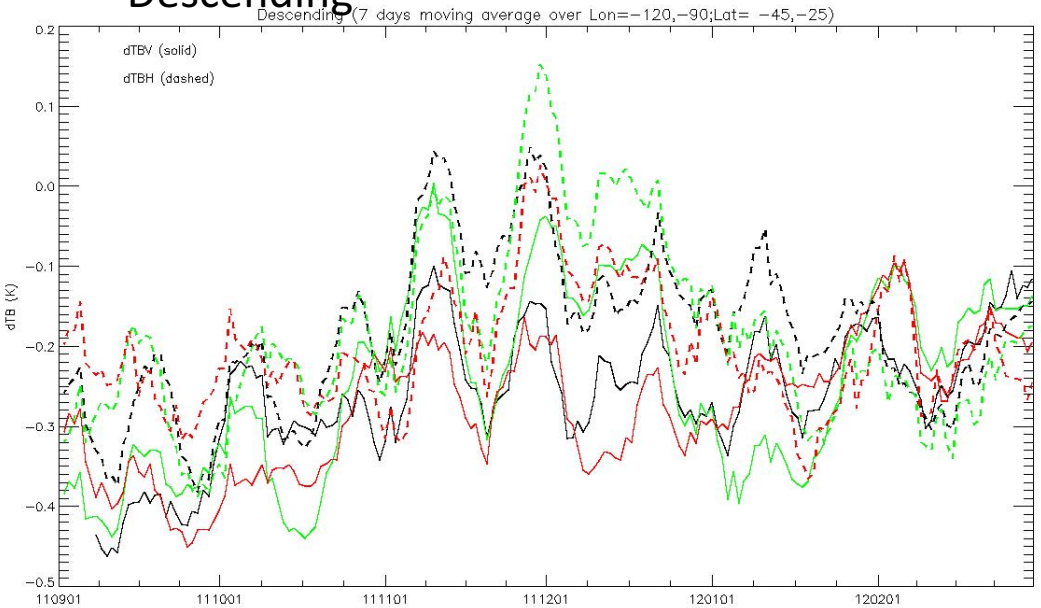
dTbV (solid)
dTbH (sashed)

Southeastern Pacific

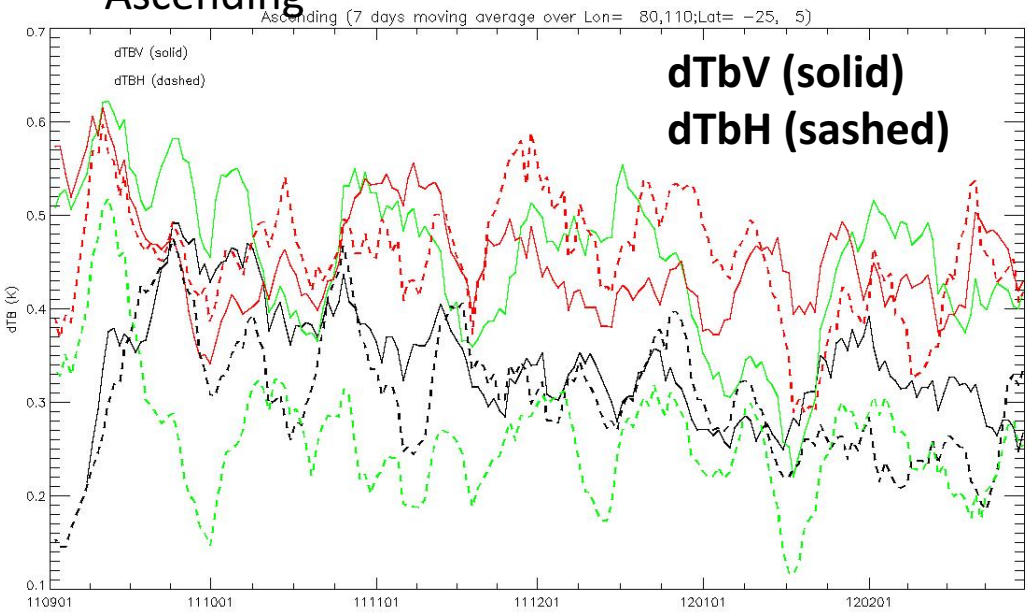
dTB remains negative over time, with an increasing (negative) trend for ascending pass, more stable for descending pass



Descending



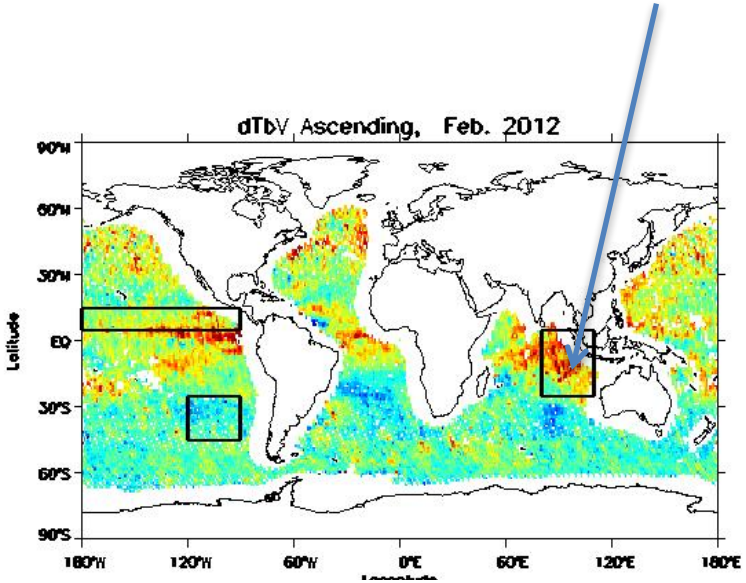
Ascending



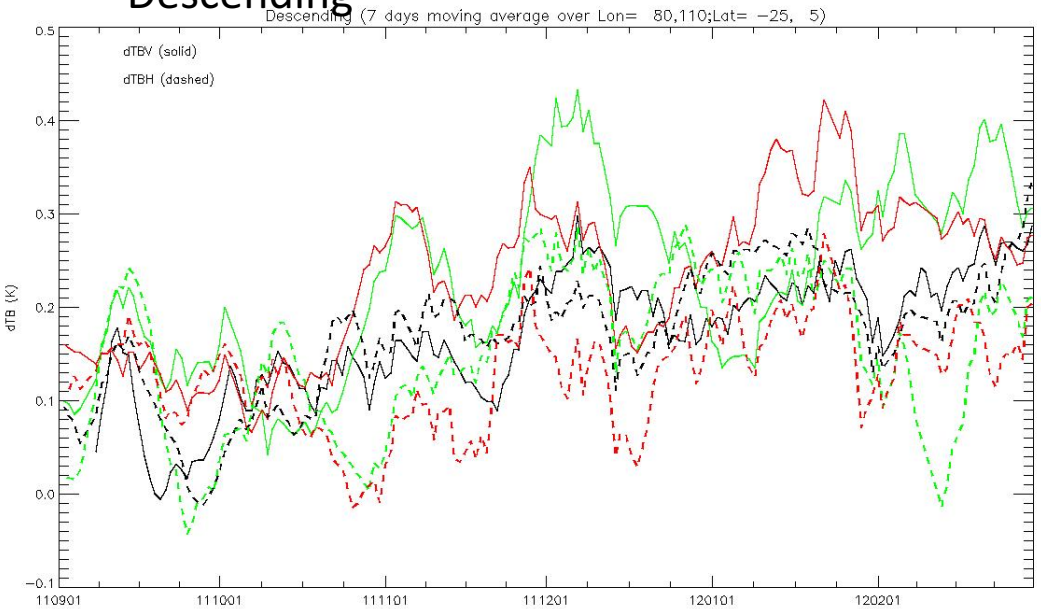
dTbV (solid)
dTbH (sashed)

Bay of Bengal

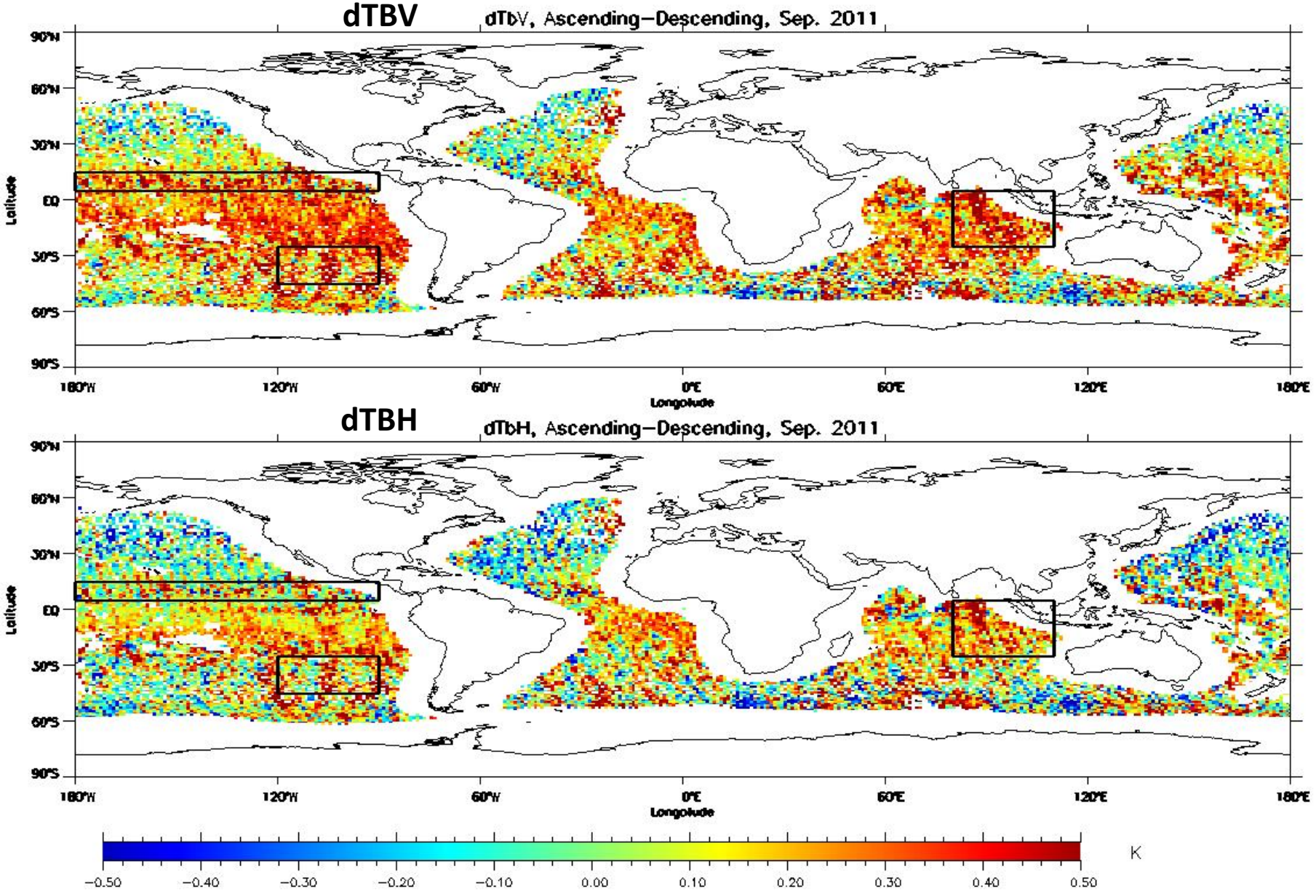
Ascending dTBV is consistently higher than dTBH for beam-3, but no for beam-1 & 2 over the time



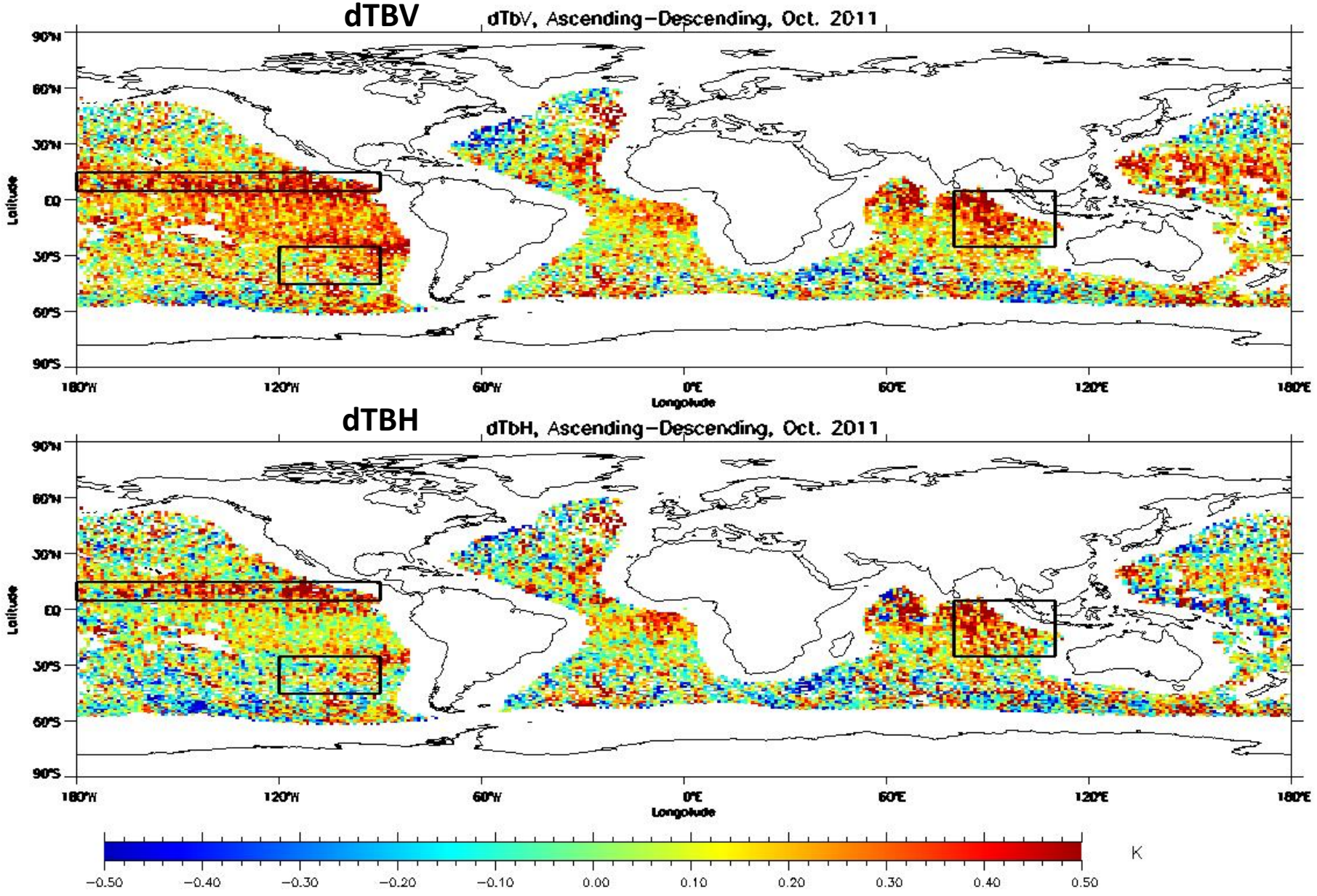
Descending



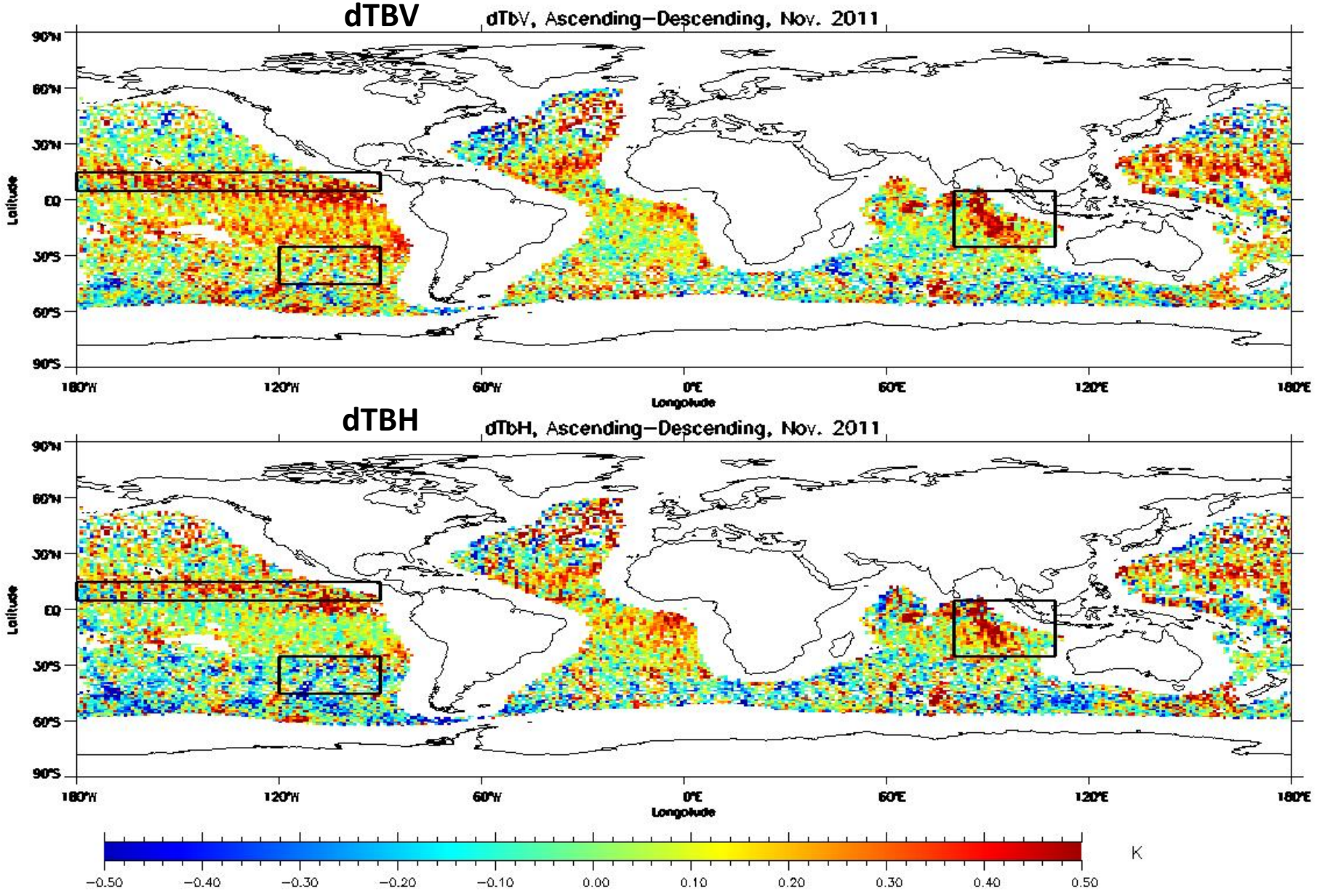
Ascending - Descending **Sep. 2011**



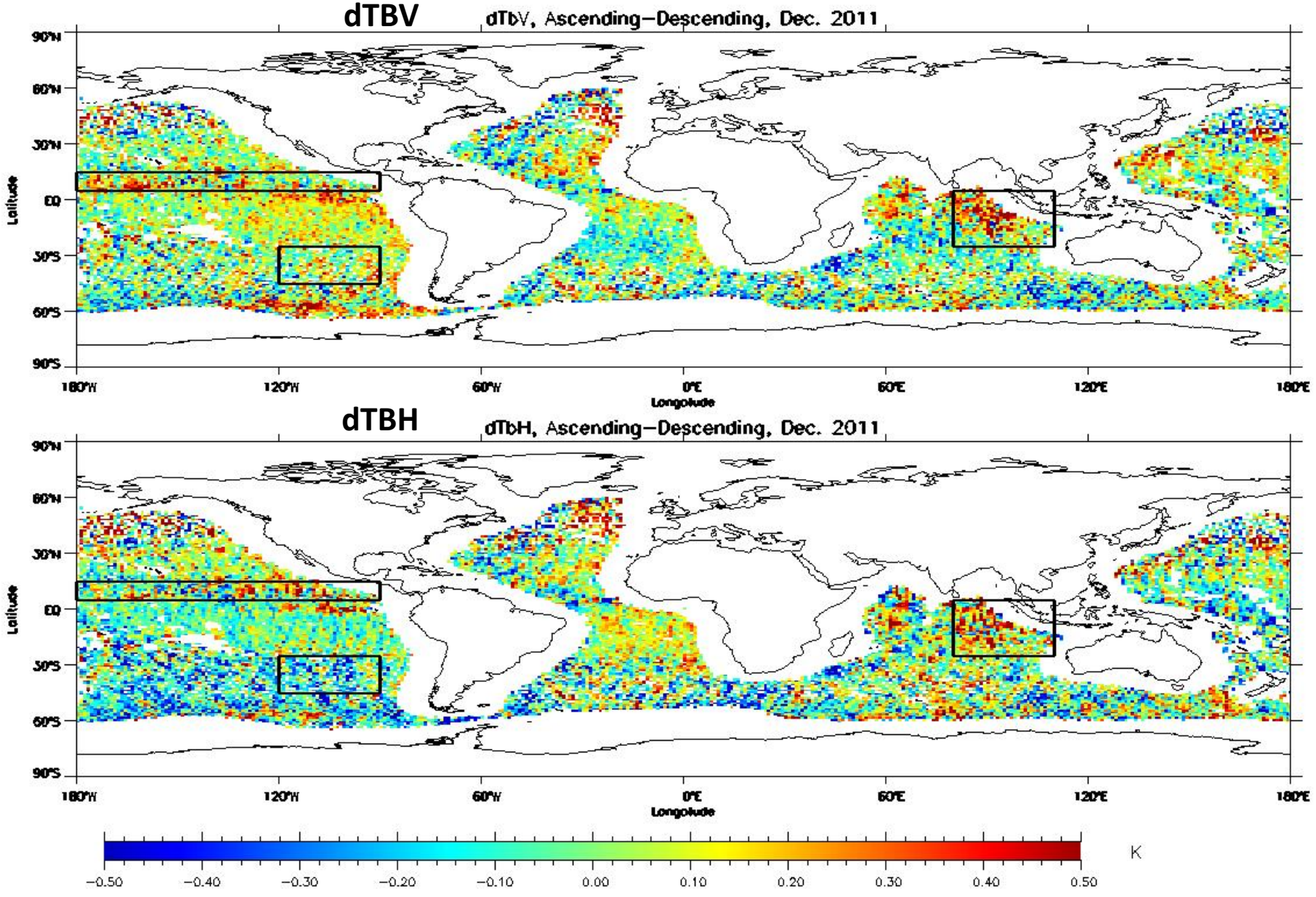
Ascending - Descending **Oct. 2011**



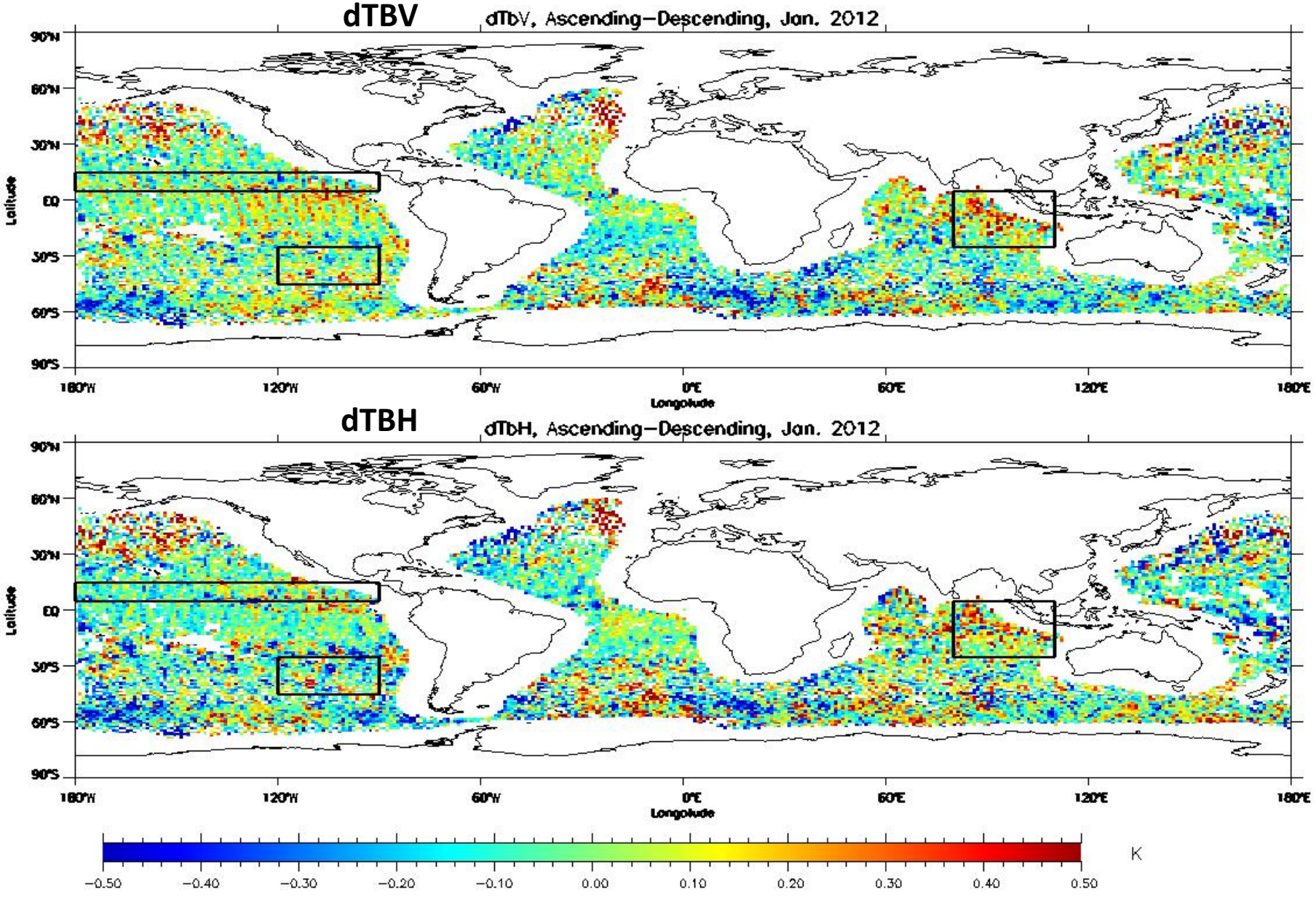
Ascending - Descending **Nov. 2011**



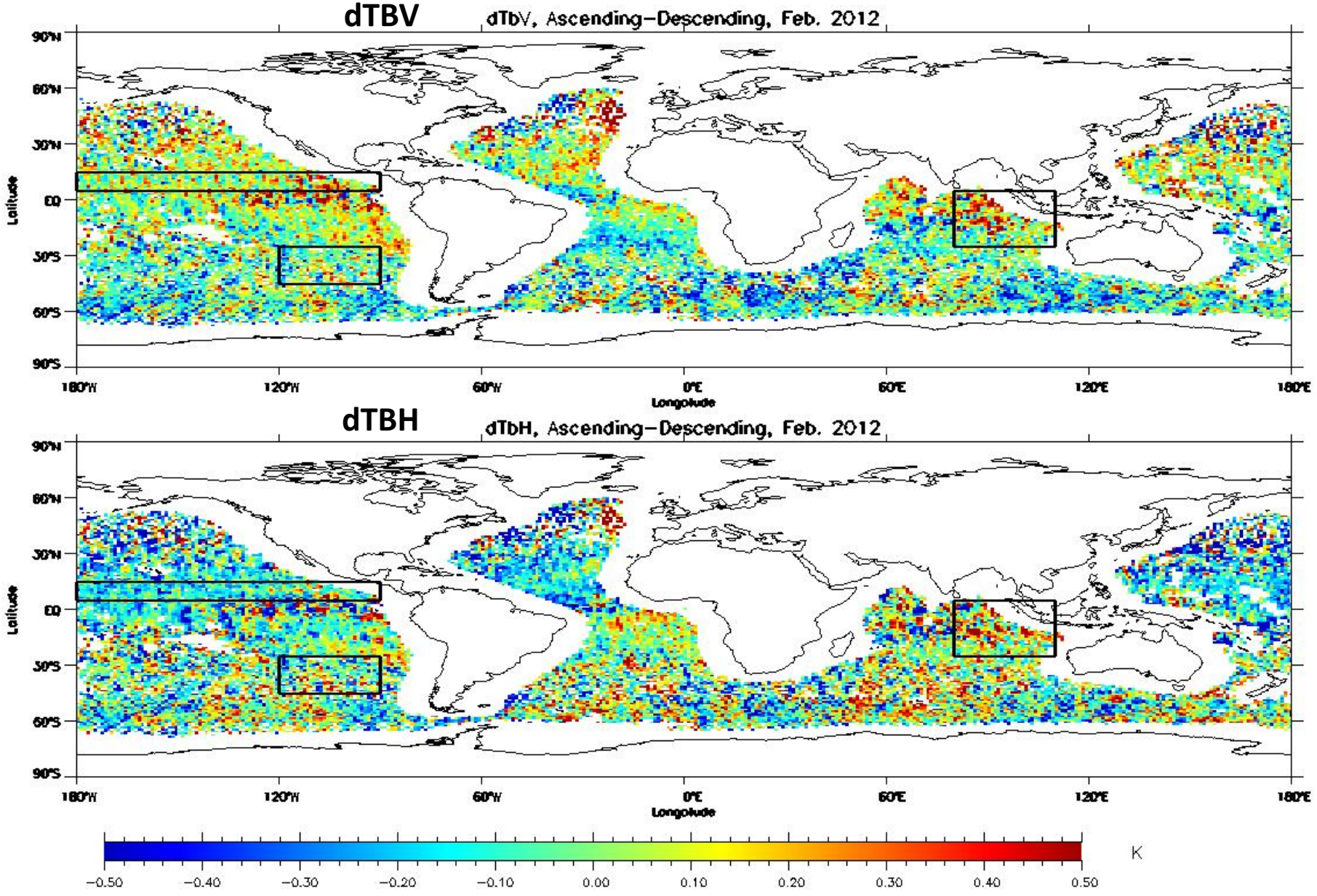
Ascending - Descending **Dec. 2011**

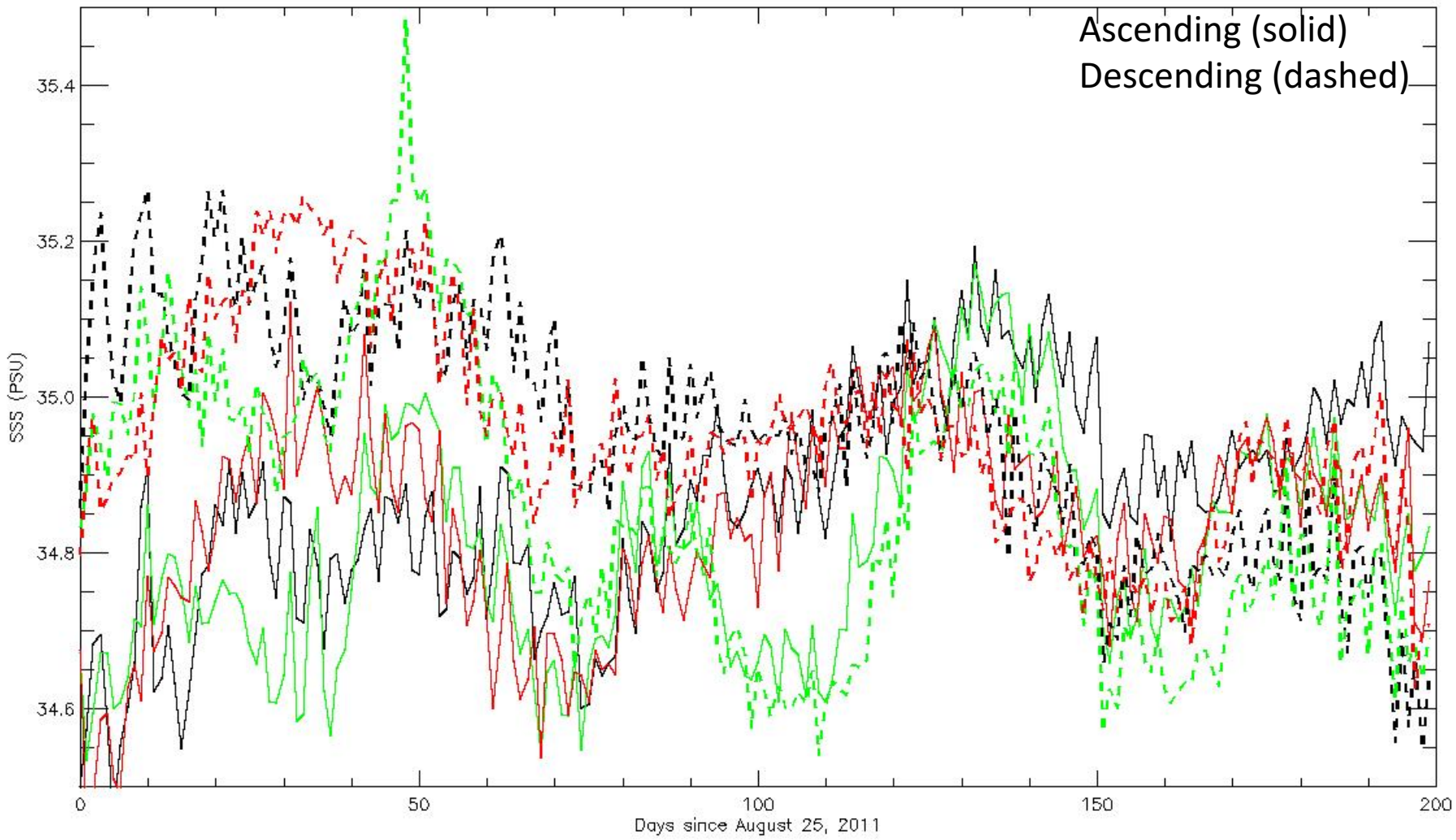


Ascending - Descending **Jan. 2011**



Ascending - Descending **Feb. 2011**

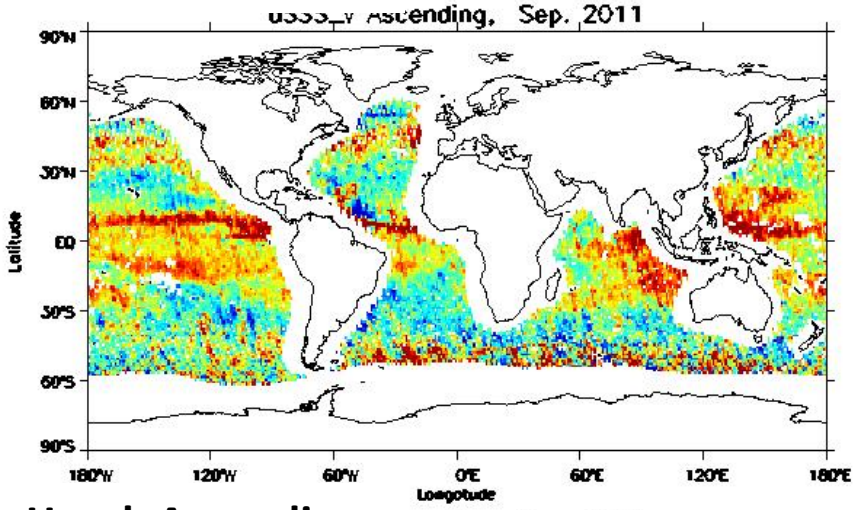



Beam-1
Beam-2
Beam-3
SSS (daily average over global ocean), L2_1.2.3
Ascending (solid)
Descending (dashed)
SSS (PSU)
35.4
35.2
35.0
34.8
34.6
0
50
100
150
200
Days since August 25, 2011

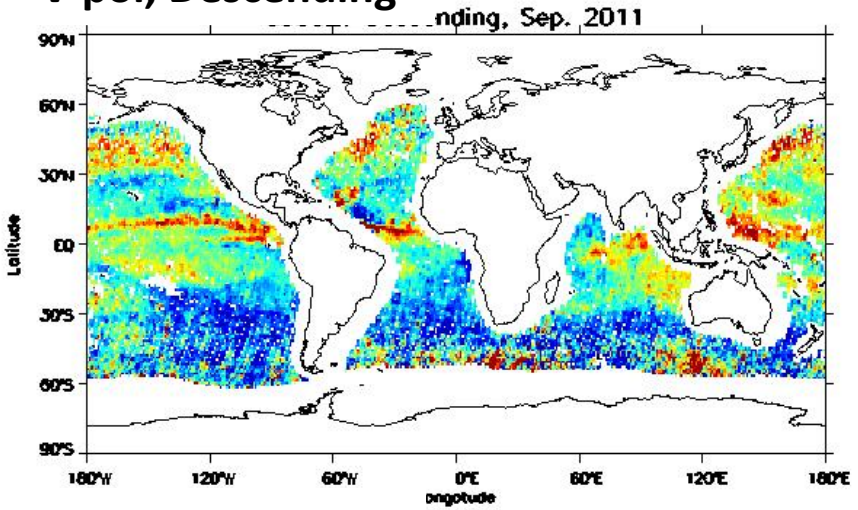
$$dSSS = dTB(anc_SSS)/(dTB(anc_SSS) - dTB(anc_SSS-1))$$

Sep., 2011

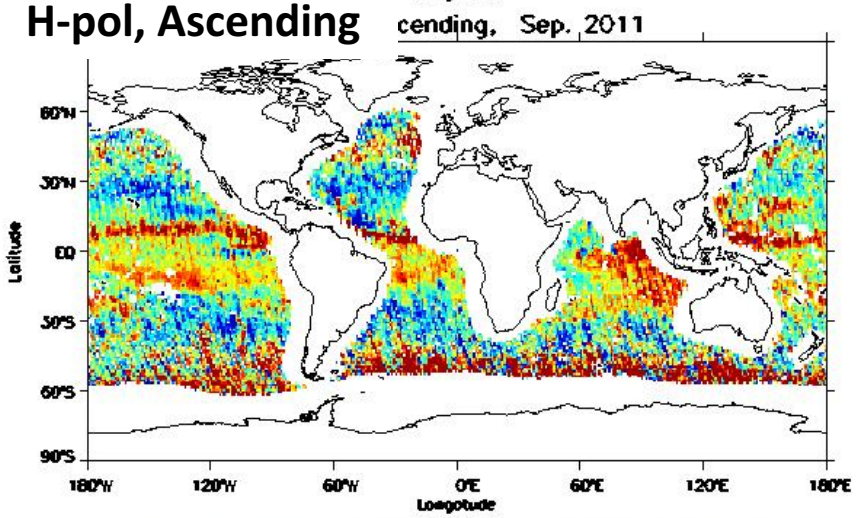
V-pol, Ascending



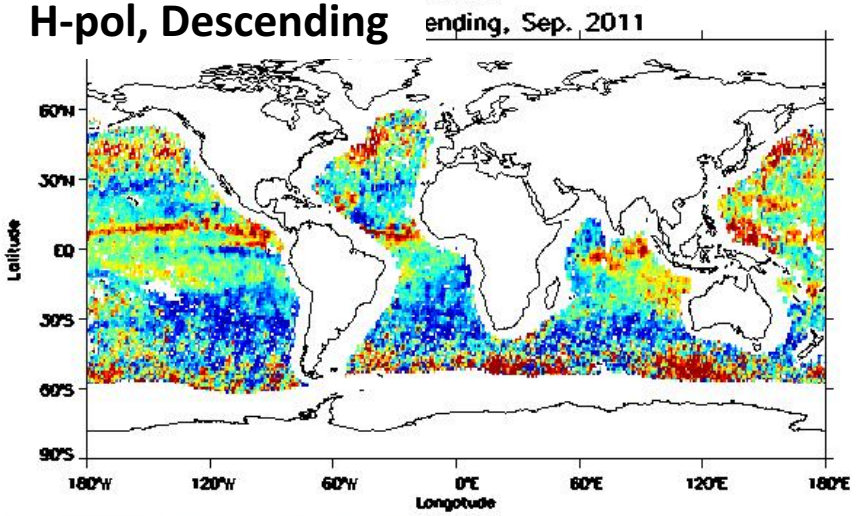
V-pol, Descending

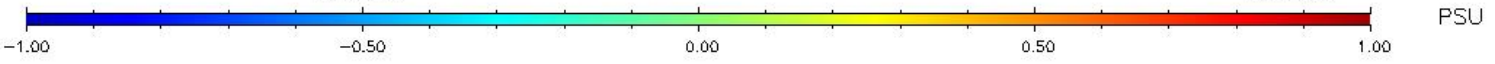


H-pol, Ascending



H-pol, Descending

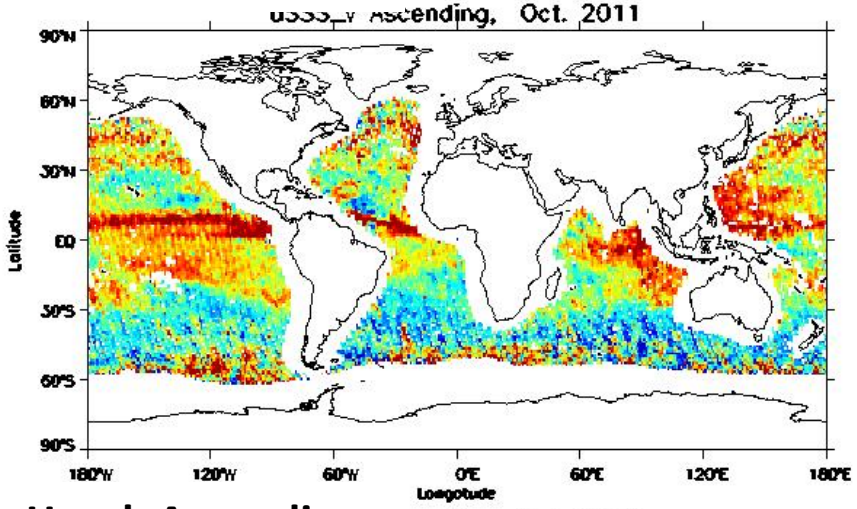




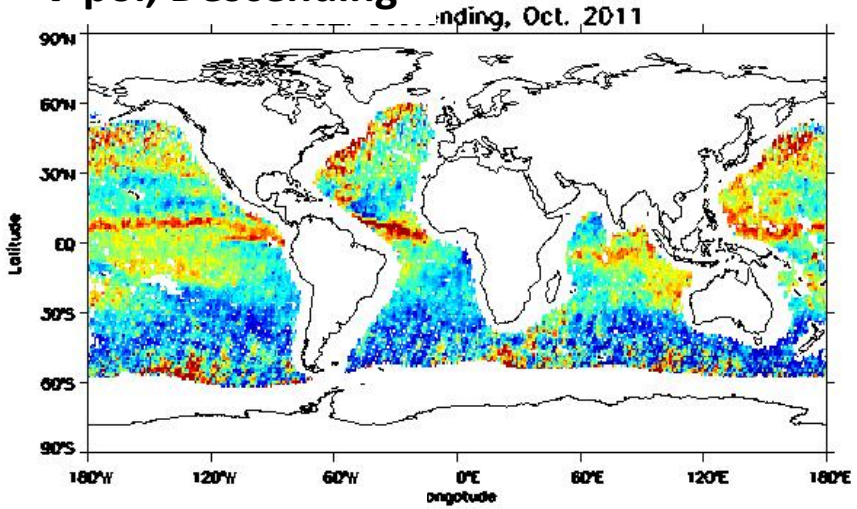
$$dSSS = dTB(anc_SSS)/(dTB(anc_SSS) - dTB(anc_SSS - 1))$$

Oct., 2011

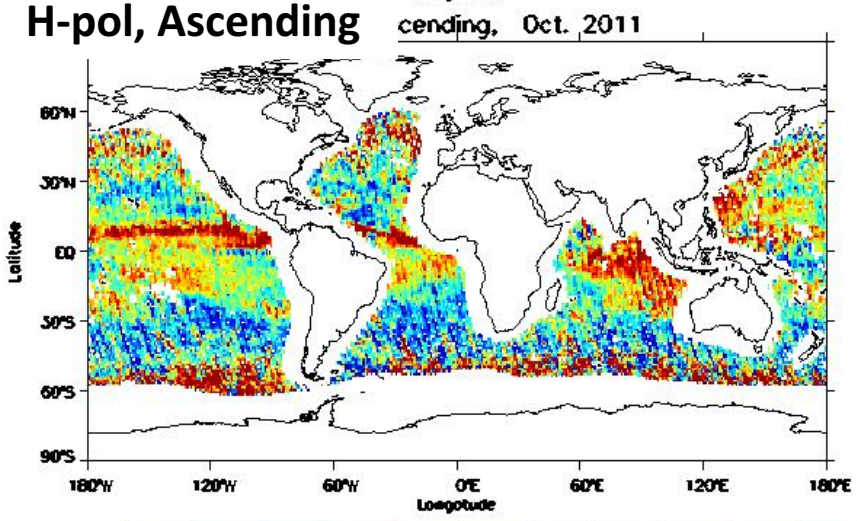
V-pol, Ascending



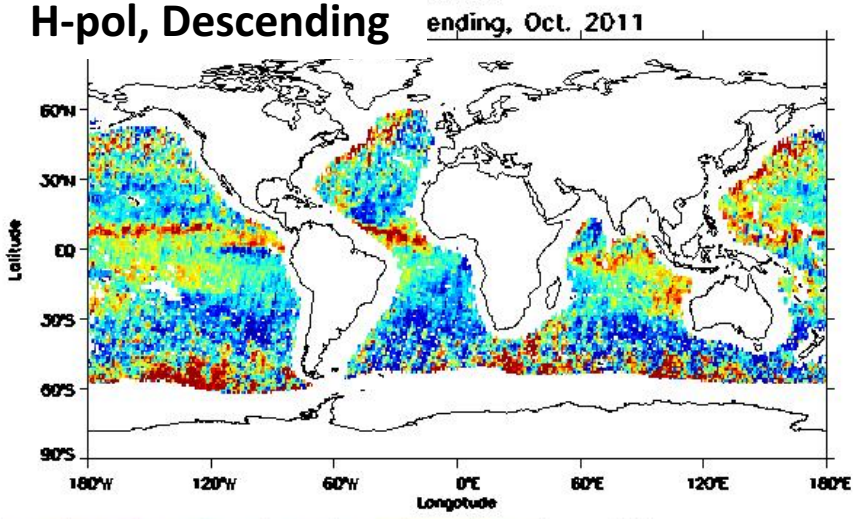
V-pol, Descending



H-pol, Ascending



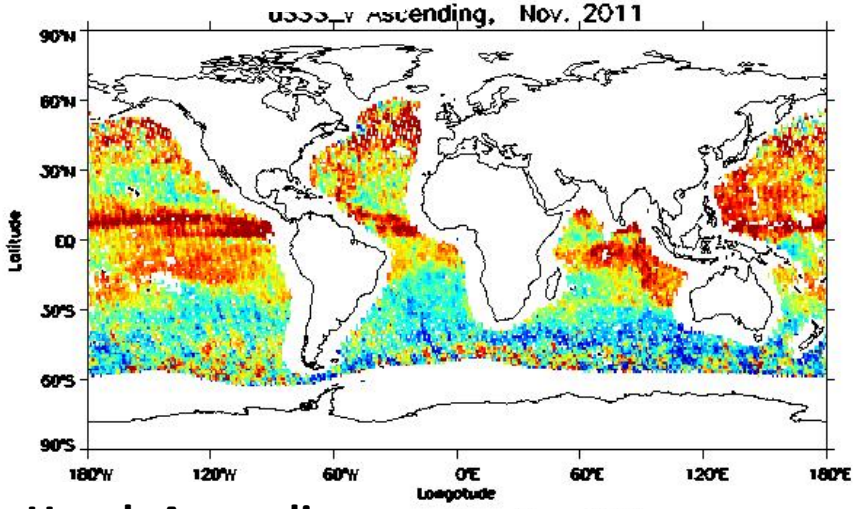
H-pol, Descending



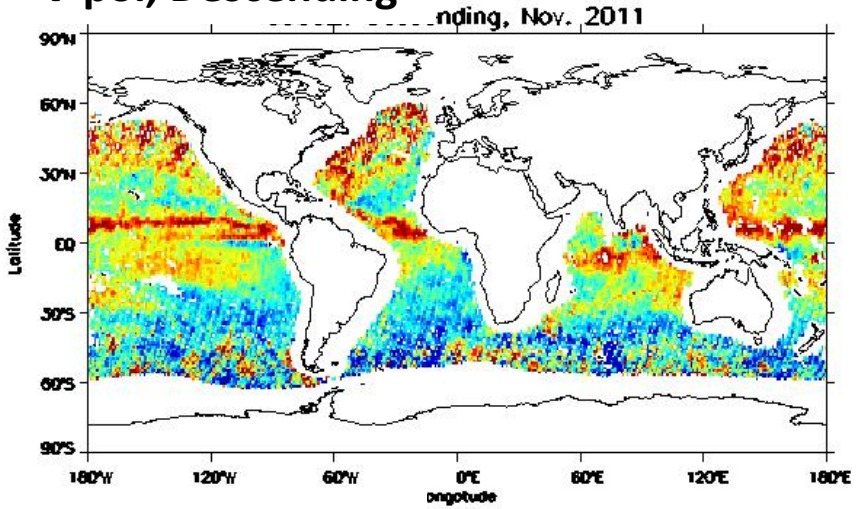
$$dSSS = dTB(anc_SSS)/(dTB(anc_SSS) - dTB(anc_SSS - 1))$$

Nov., 2011

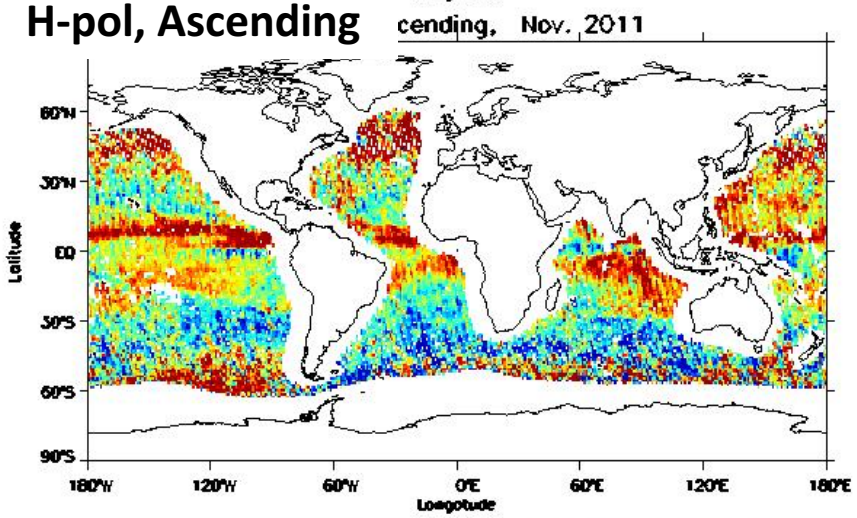
V-pol, Ascending



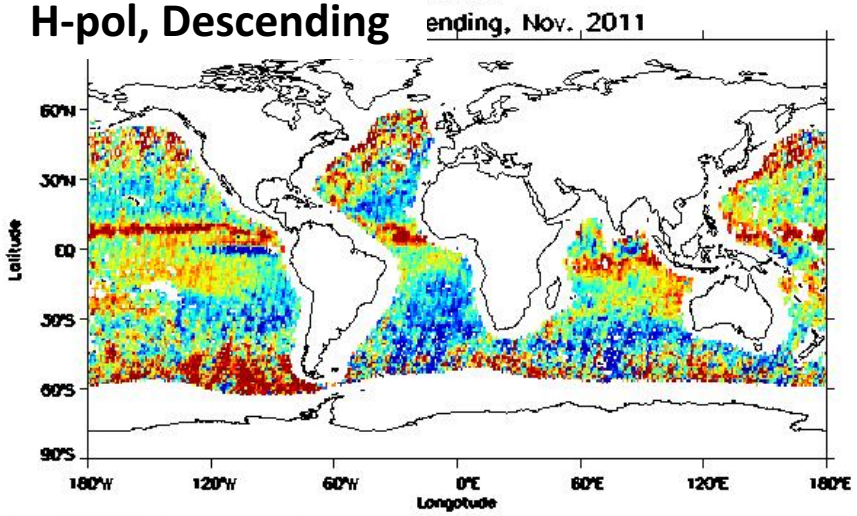
V-pol, Descending

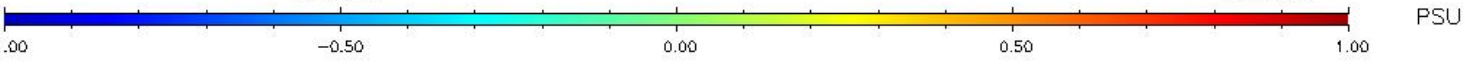


H-pol, Ascending



H-pol, Descending

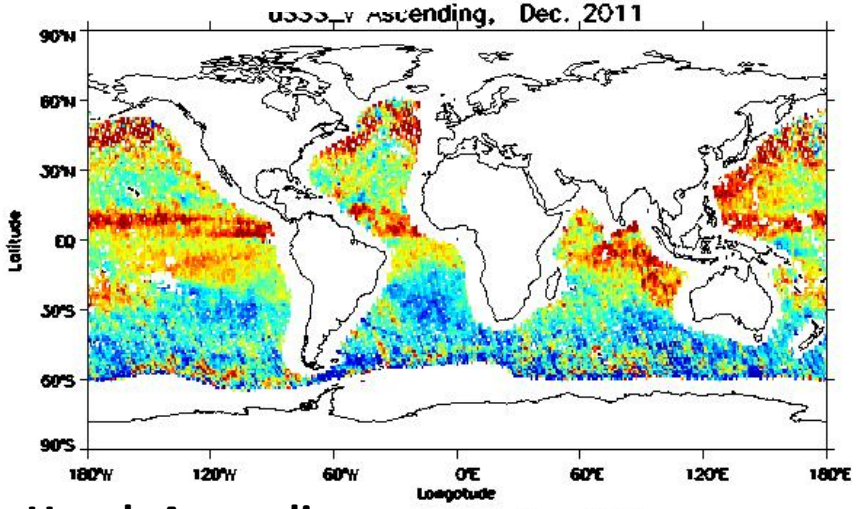




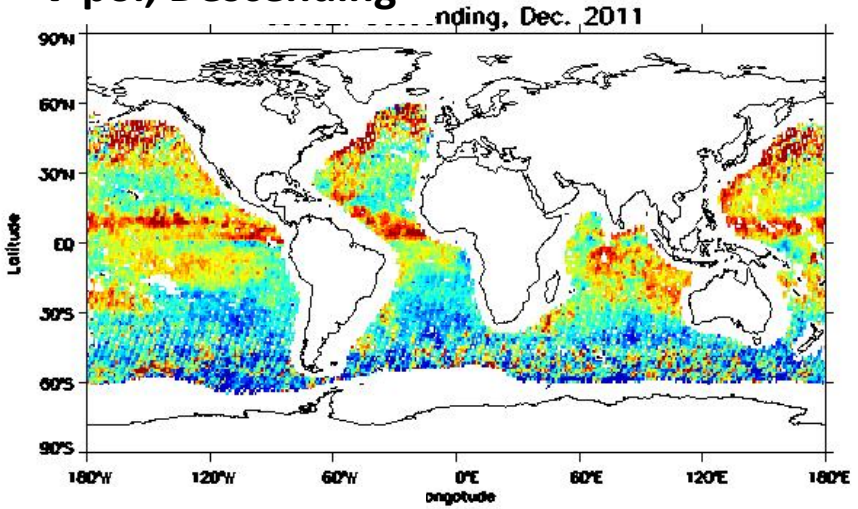
$$dSSS = dTB(anc_SSS)/(dTB(anc_SSS) - dTB(anc_SSS - 1))$$

Dec., 2011

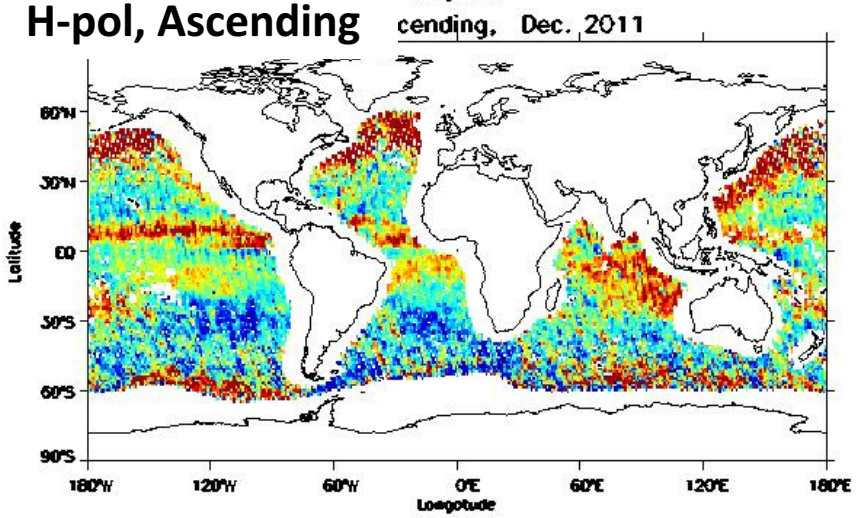
V-pol, Ascending



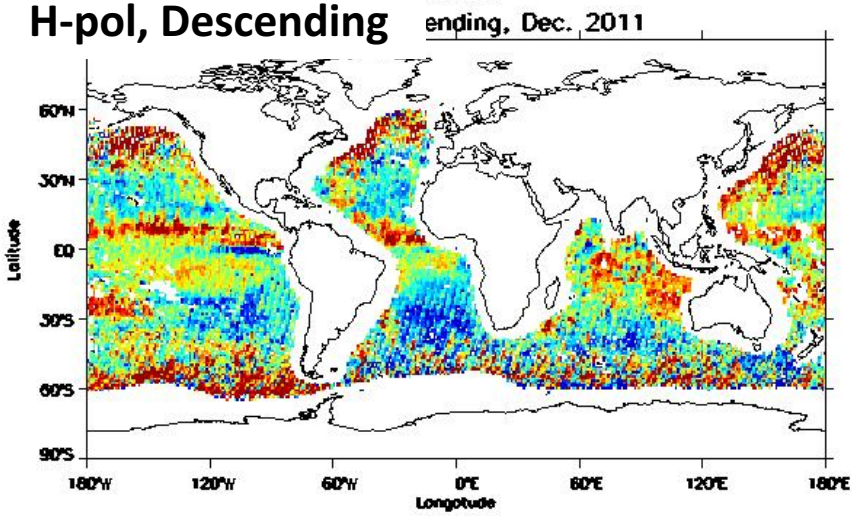
V-pol, Descending



H-pol, Ascending



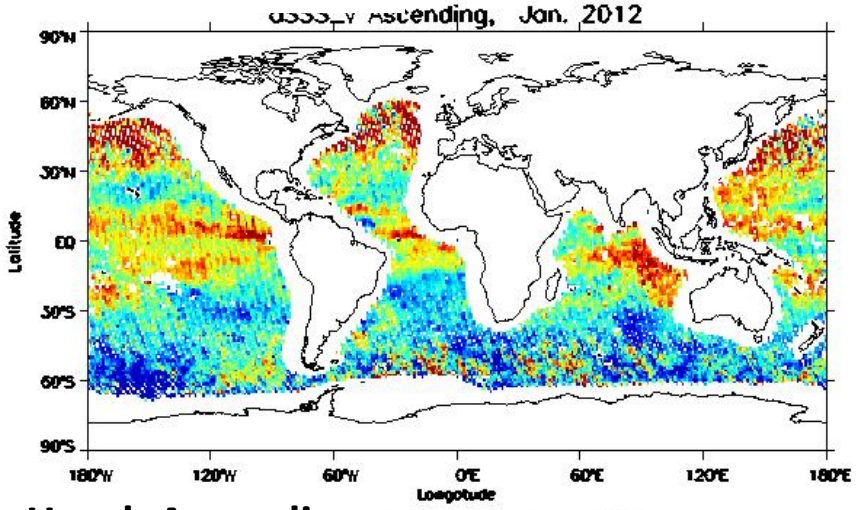
H-pol, Descending



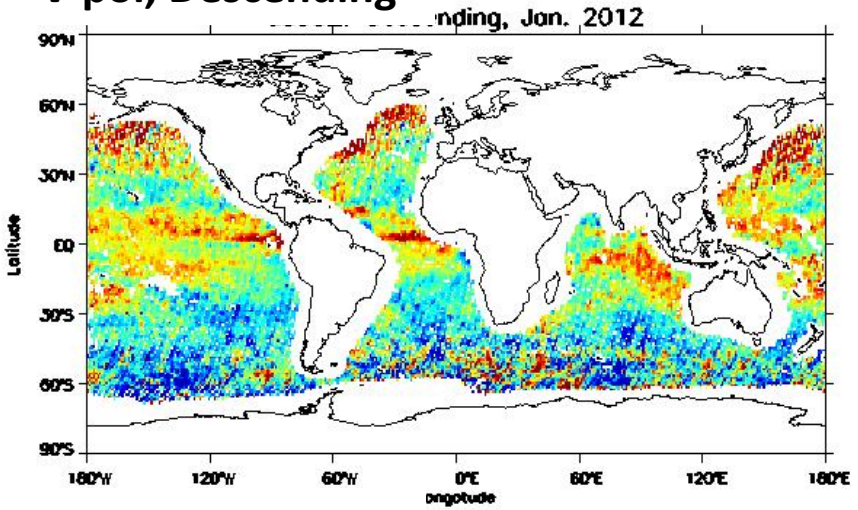
$$dSSS = dTB(anc_SSS)/(dTB(anc_SSS) - dTB(anc_SSS - 1))$$

Jan., 2012

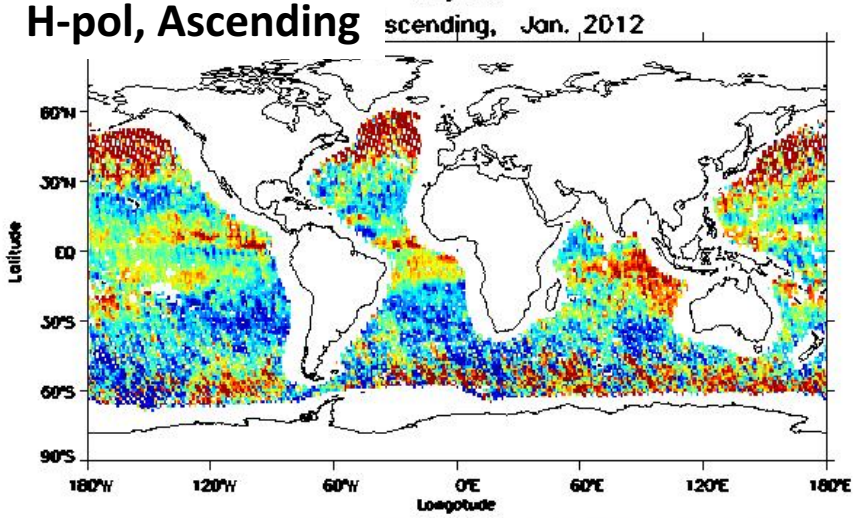
V-pol, Ascending



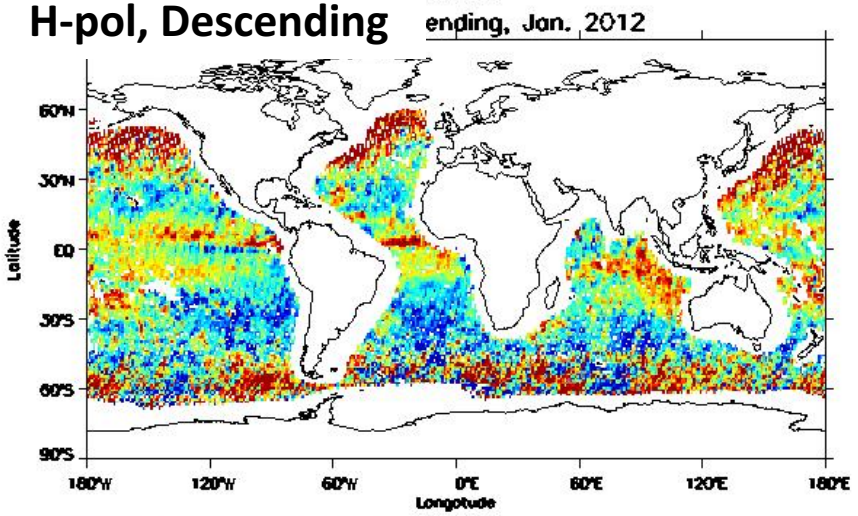
V-pol, Descending



H-pol, Ascending



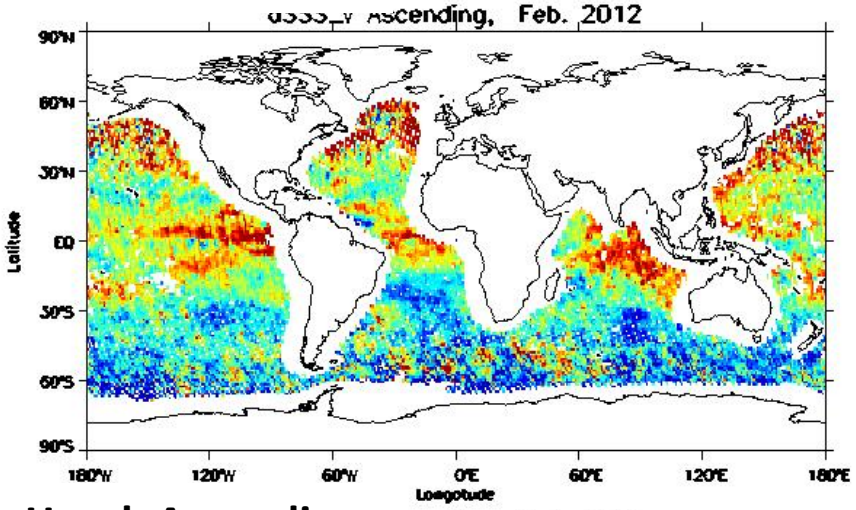
H-pol, Descending



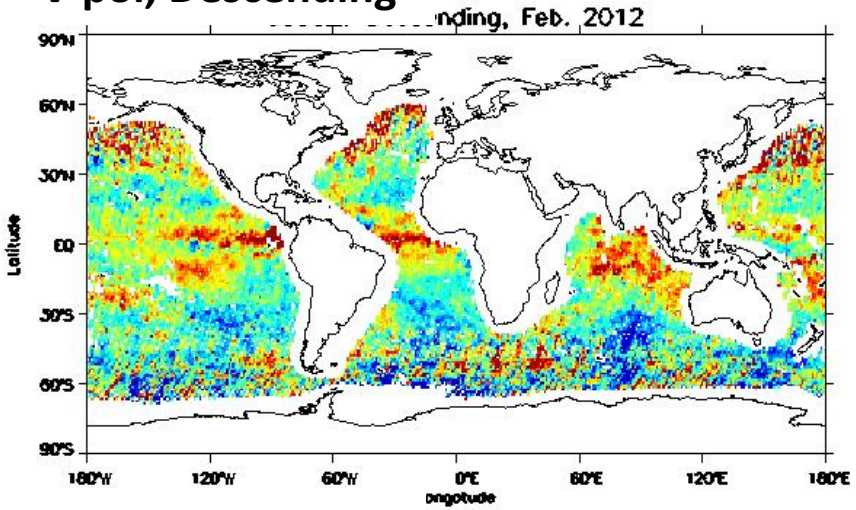
$$dSSS = dTB(anc_SSS)/(dTB(anc_SSS) - dTB(anc_SSS - 1))$$

Feb., 2012

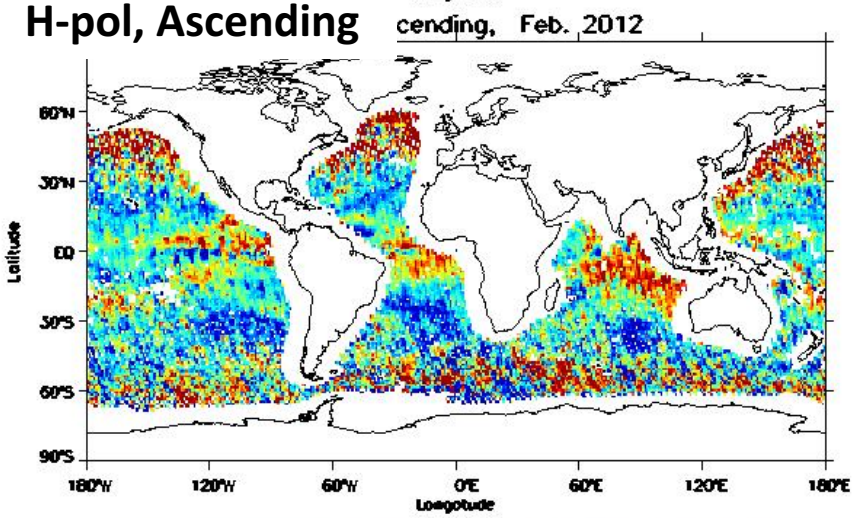
V-pol, Ascending



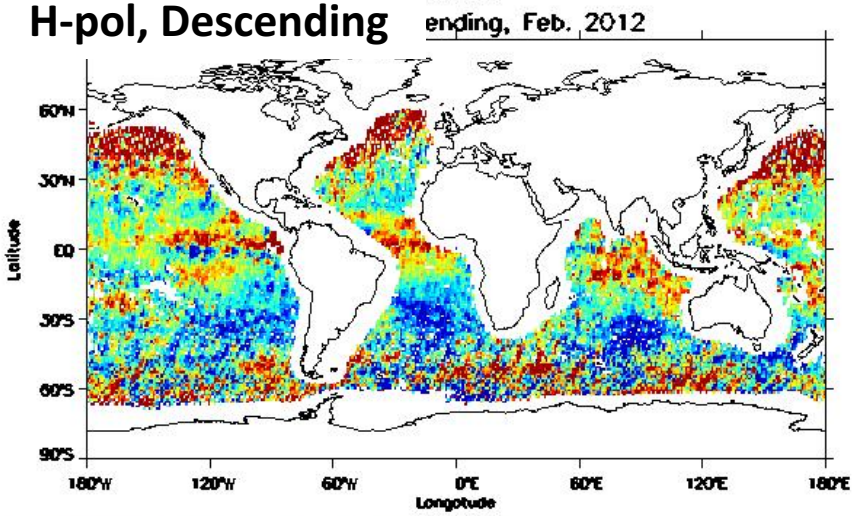
V-pol, Descending

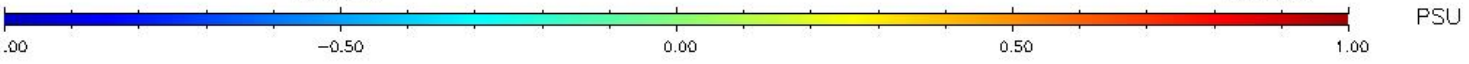


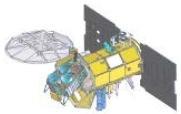
H-pol, Ascending



H-pol, Descending



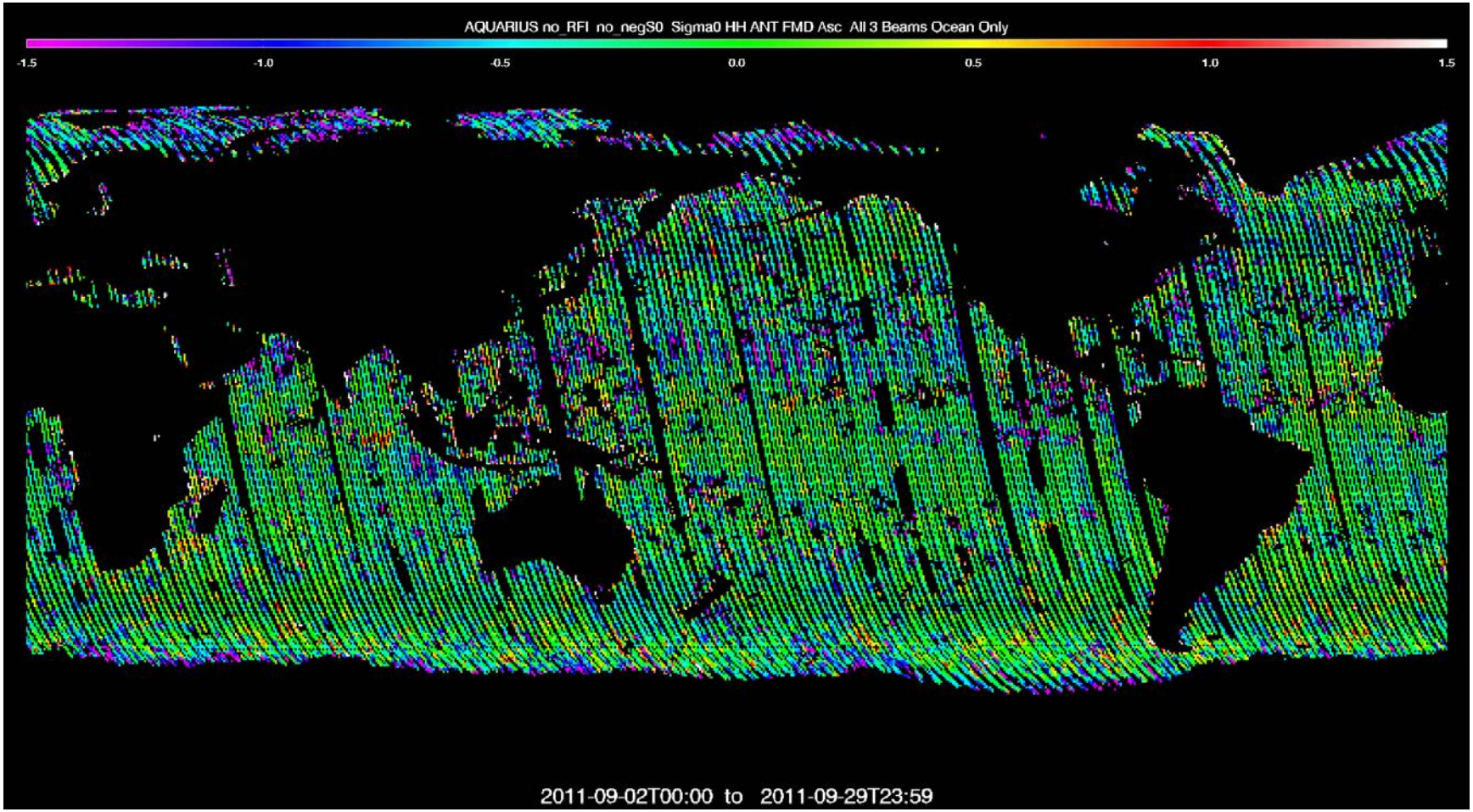




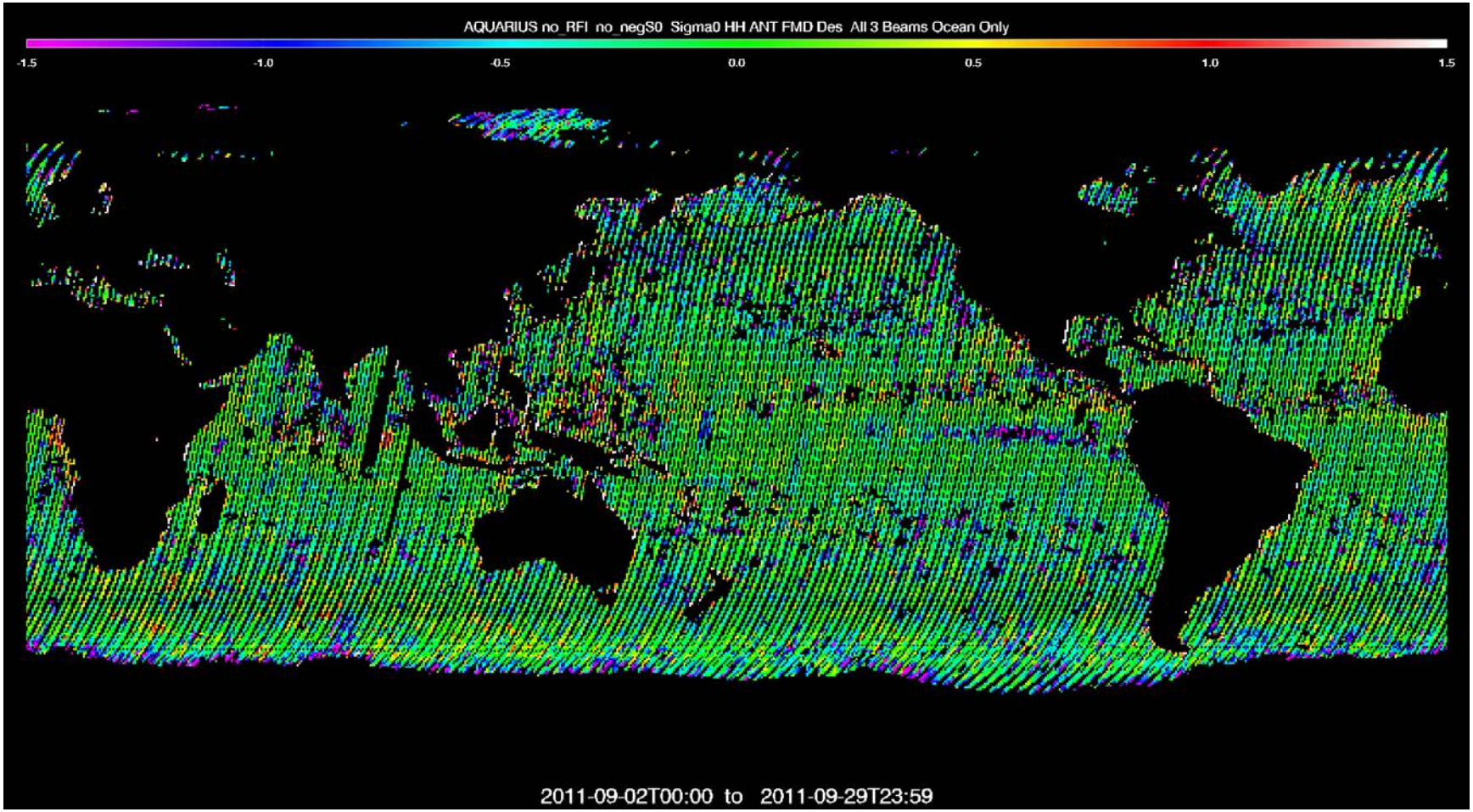
Summary

- The spatial pattern of observed positive dTB seems to correlate with the rain in the tropics; negtive dTB in subtropical southern oceans
- dTB for ascending is higher than descending in most region for Sep. and Oct., the asymmetry starts to decrease in Nov., almost disappear later
- Temporal variation of dTBV and dTBH seems support the the hypotheses that the positive dTB caused by fresher water surface associated with rain in the tropics (not for beam-3)
- Sensitivity test shows consistent positive dTB in rain area, and decreasing of ascending/descending asymmetry over time

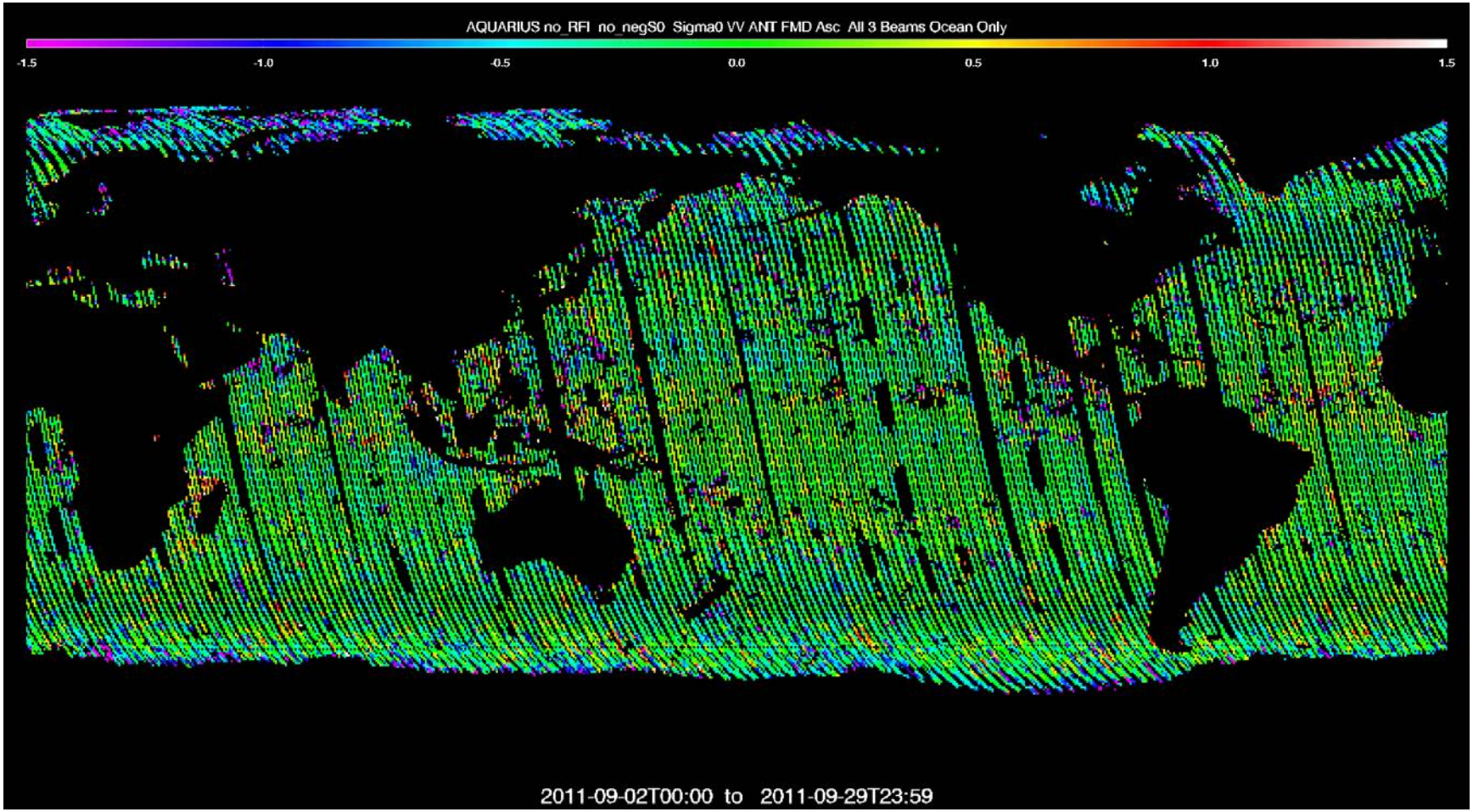
September H Asc



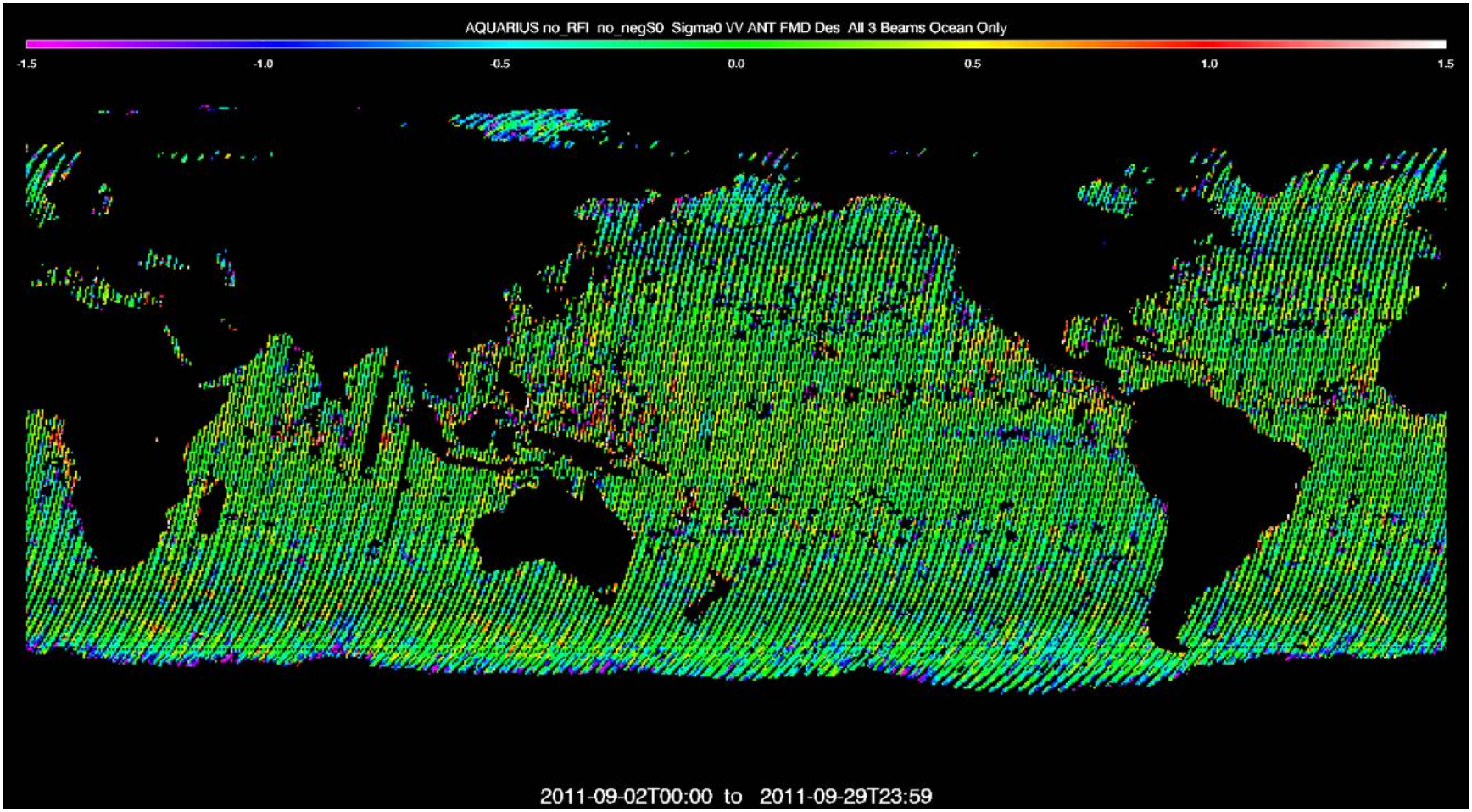
September H Des



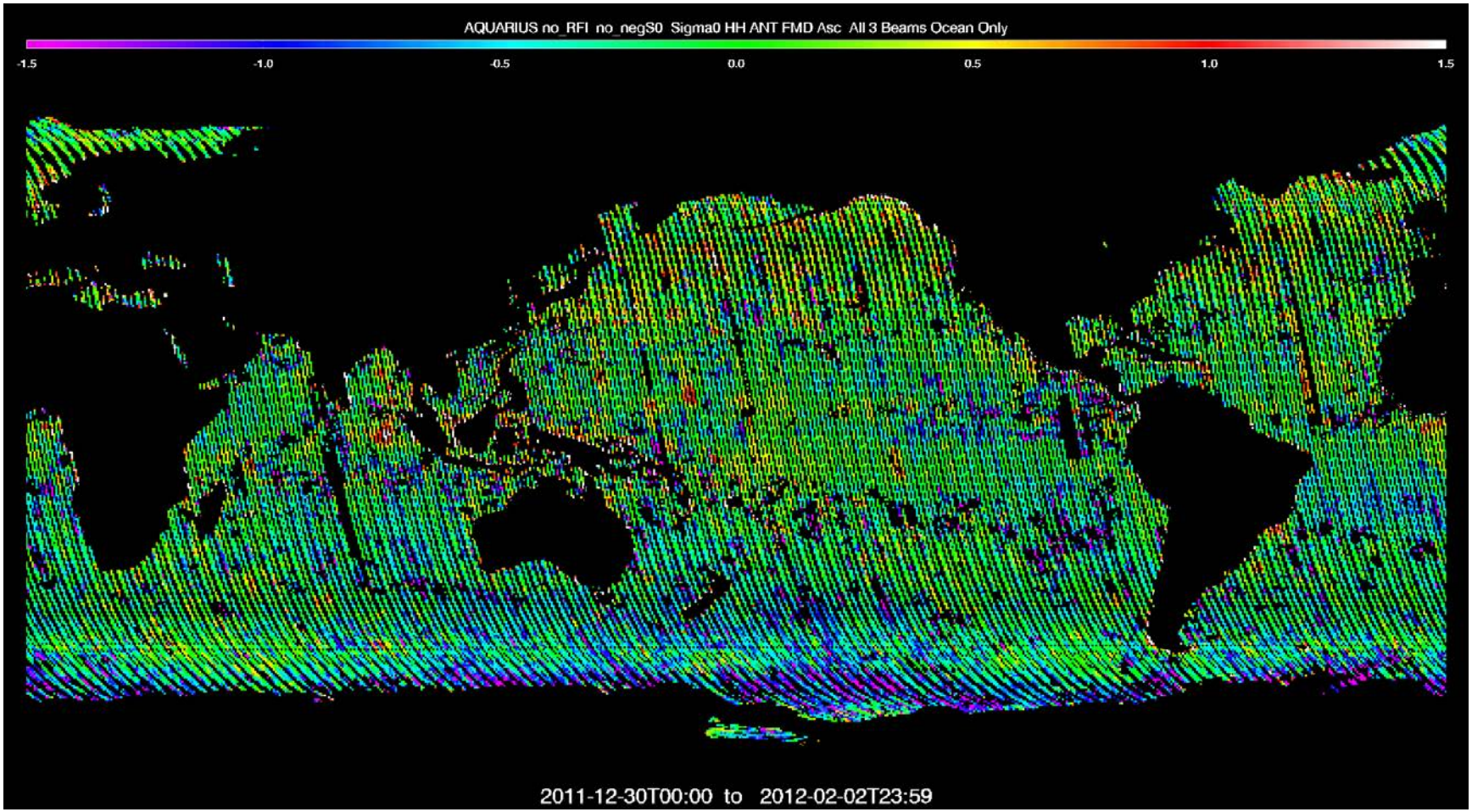
September V Asc



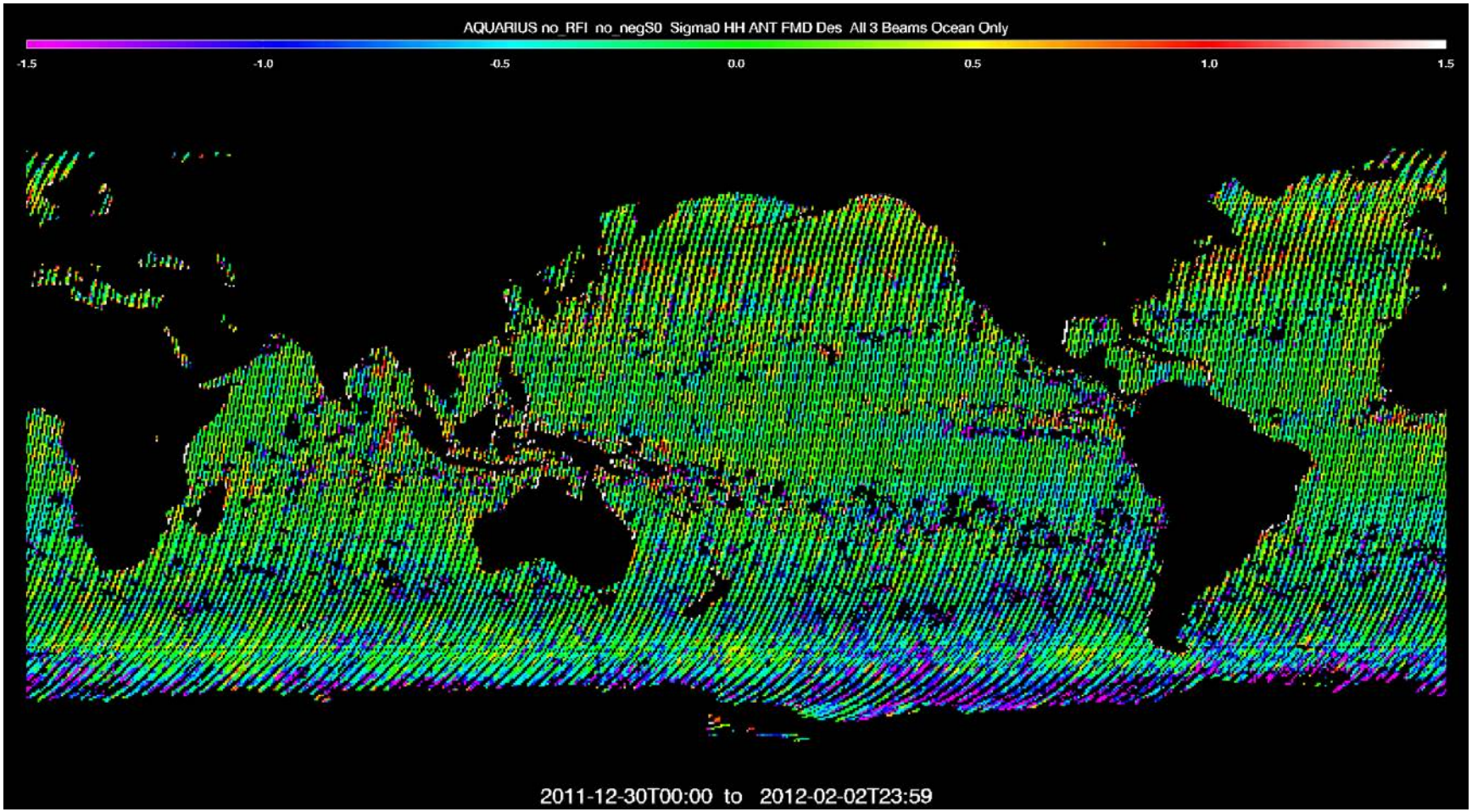
September V Des



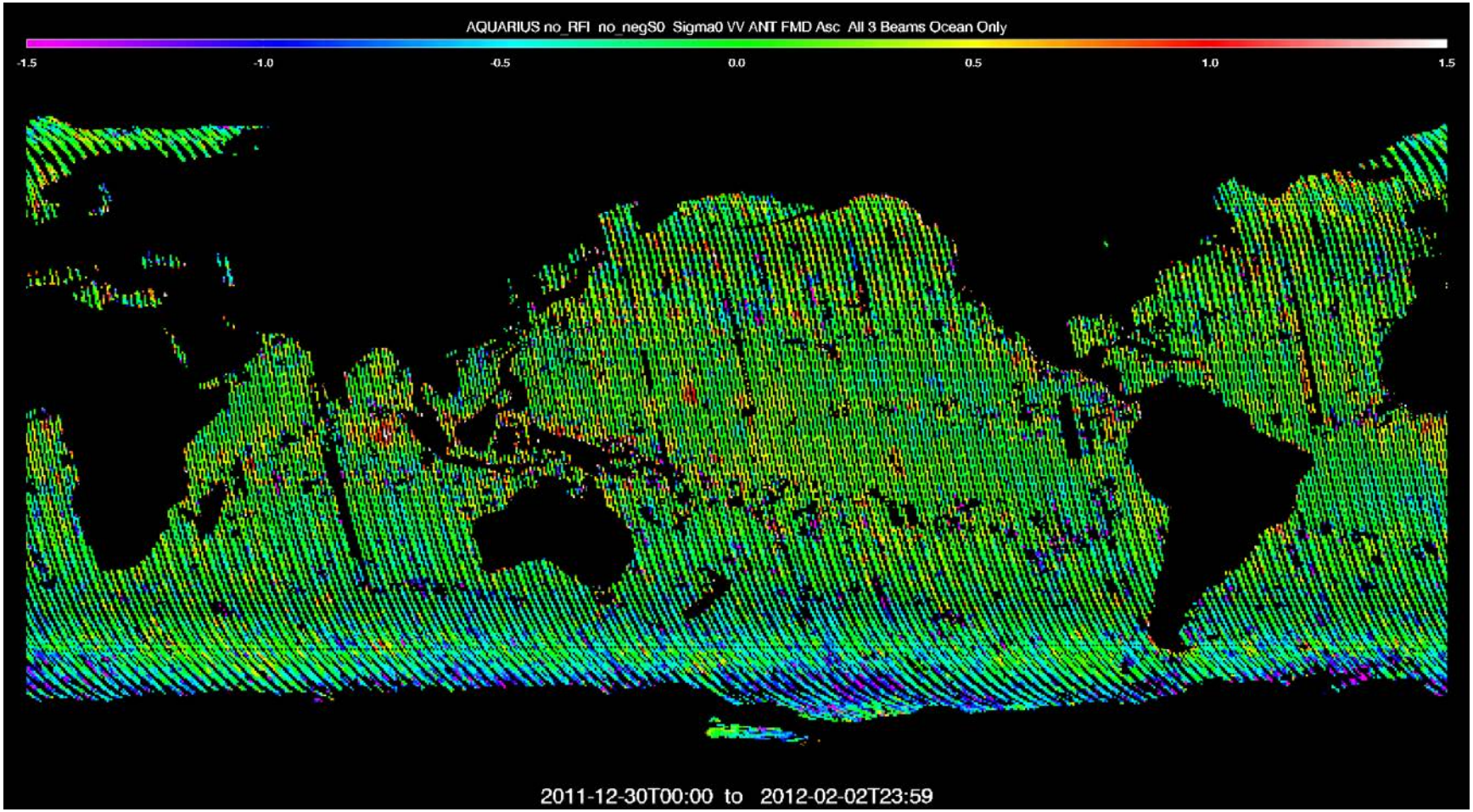
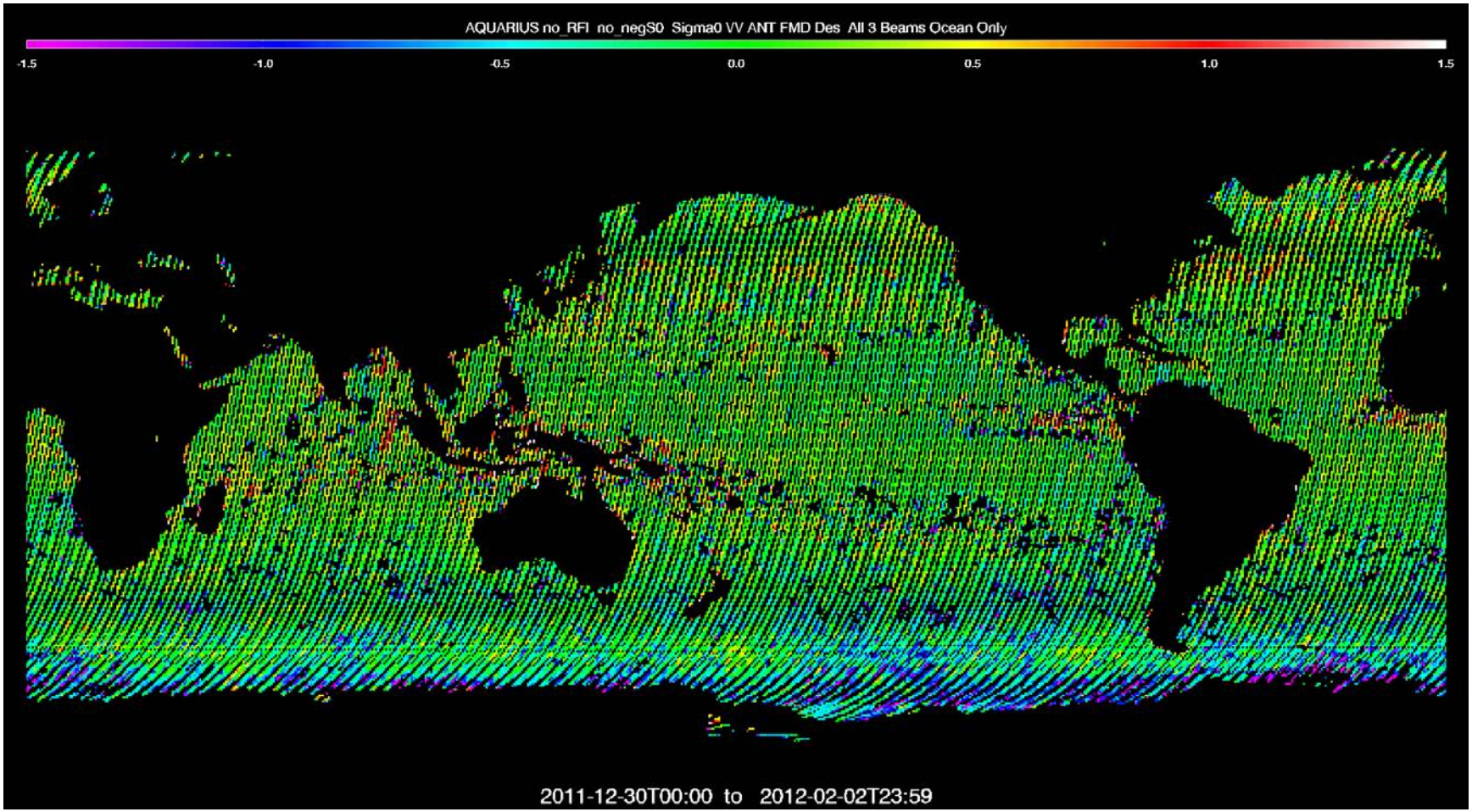
January H Asc



January H Des



January V Asc



January V Des