SST-Induced Surface Wind Response: Comparison of QuikSCAT and ASCAT depiction of the phenomenon.

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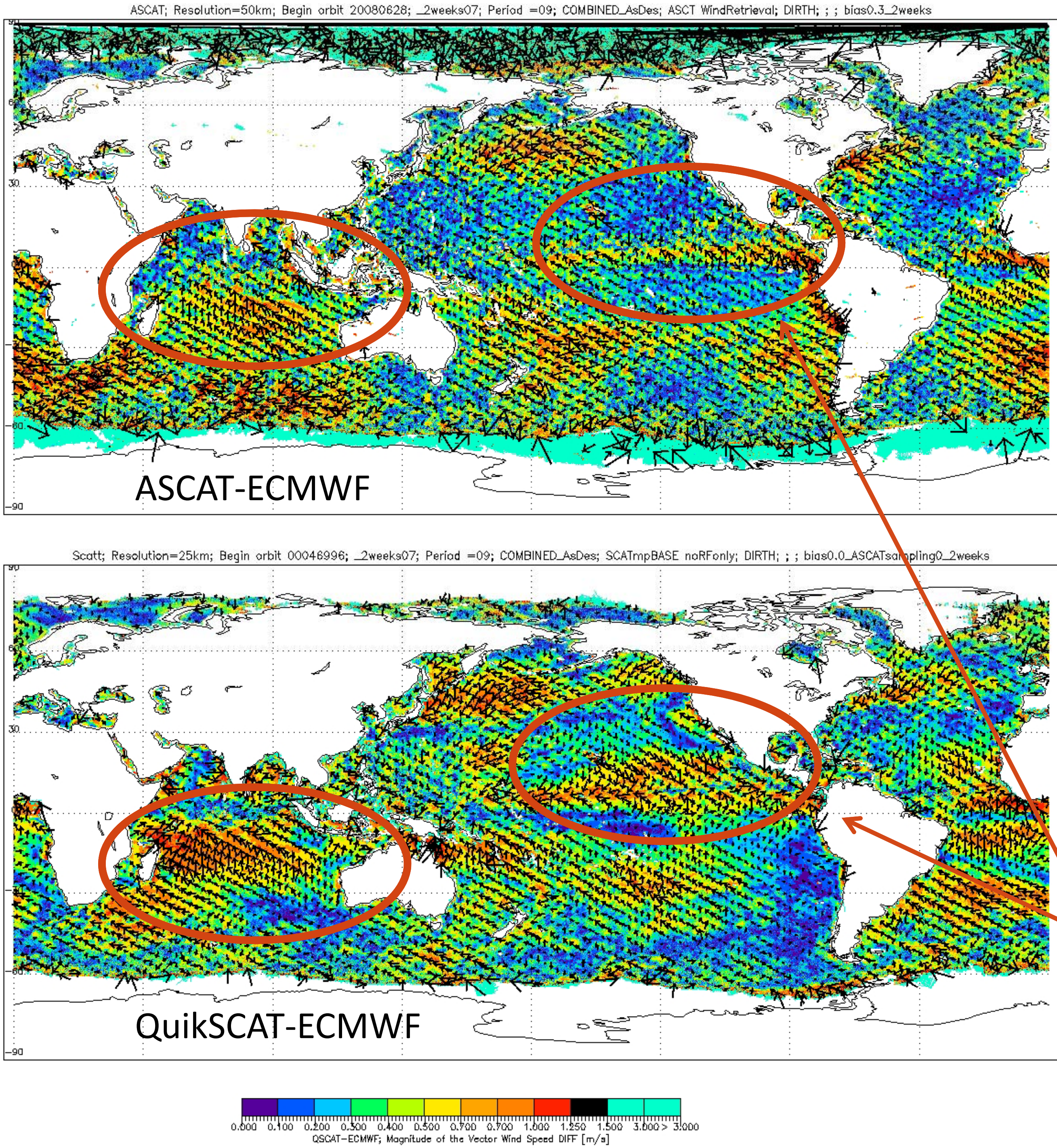
California Institute of Technology



Merging the wind estimates from ASCAT and QuikSCAT will allow extending the climate data record.

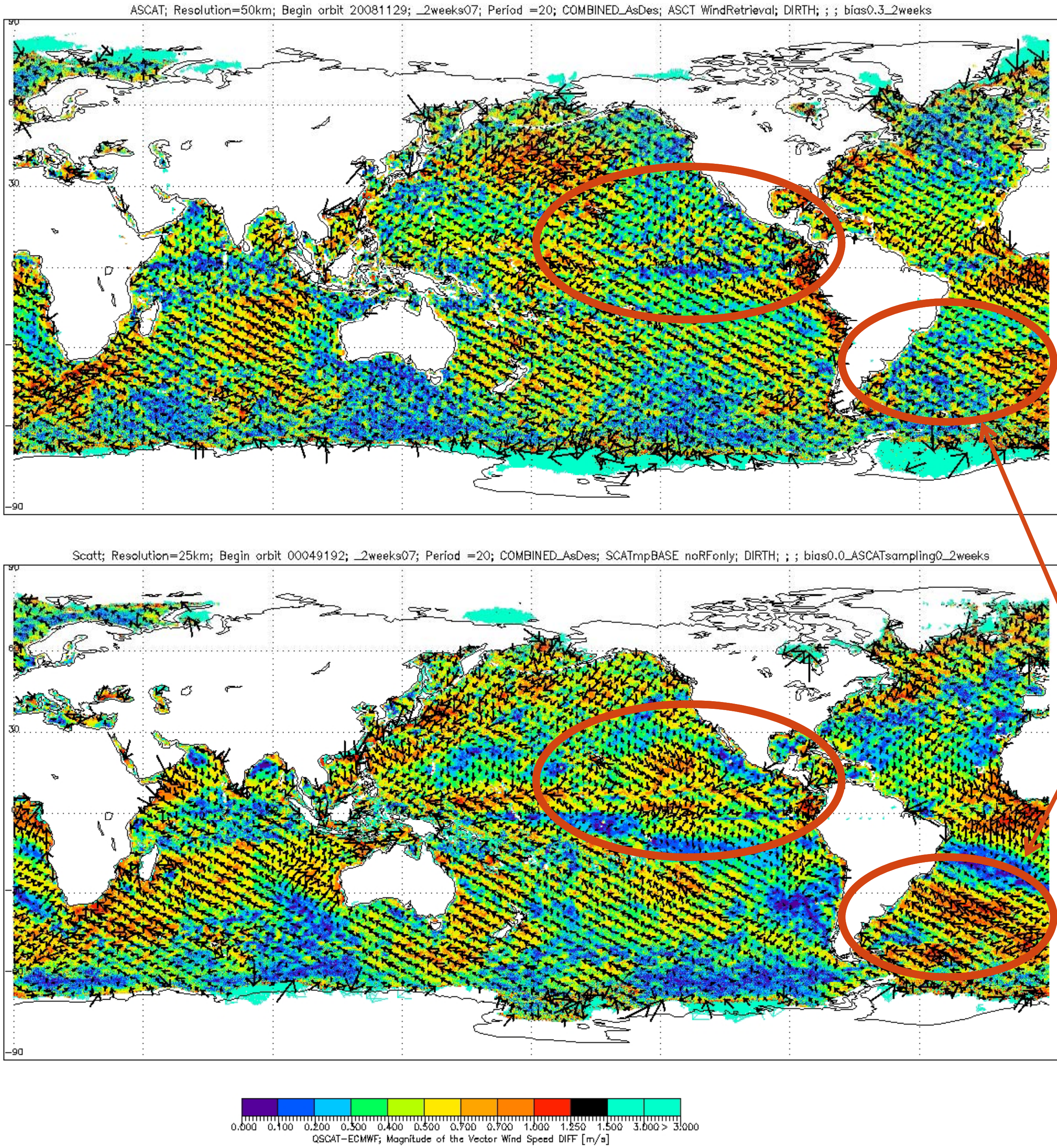
Before merging them, we have to evaluate their consistency.

Climatologies based on 3 month average:

JAS 2008

Wind calculated from L2 wind products

The overall pattern is similar, but differences exist



Climatologies based on 3 month average:

Dec. 2008-Feb. 2009

Wind calculated from L2 wind products

The overall pattern is similar, but differences exist.

Dynamical Significance of the differences

- Coupling between SST gradients and near-surface wind response - investigating the correlation between the high-frequency wind curl and divergence fields, and the cross-wind and down-wind SST gradients.

From O'NEILL, CHELTON, AND ESBENSEN, 2003

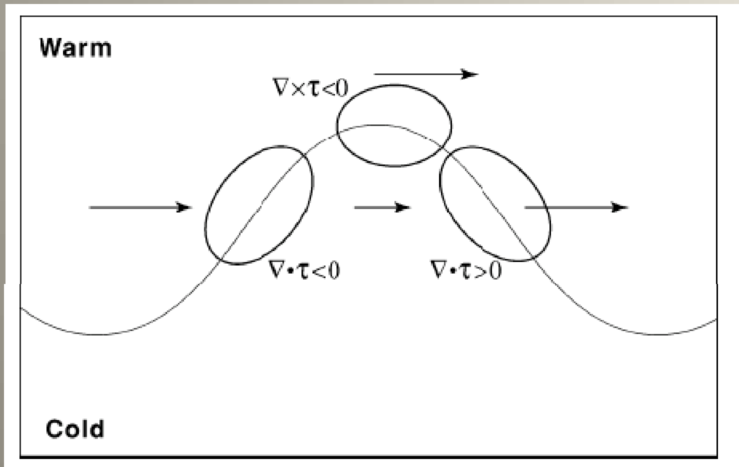


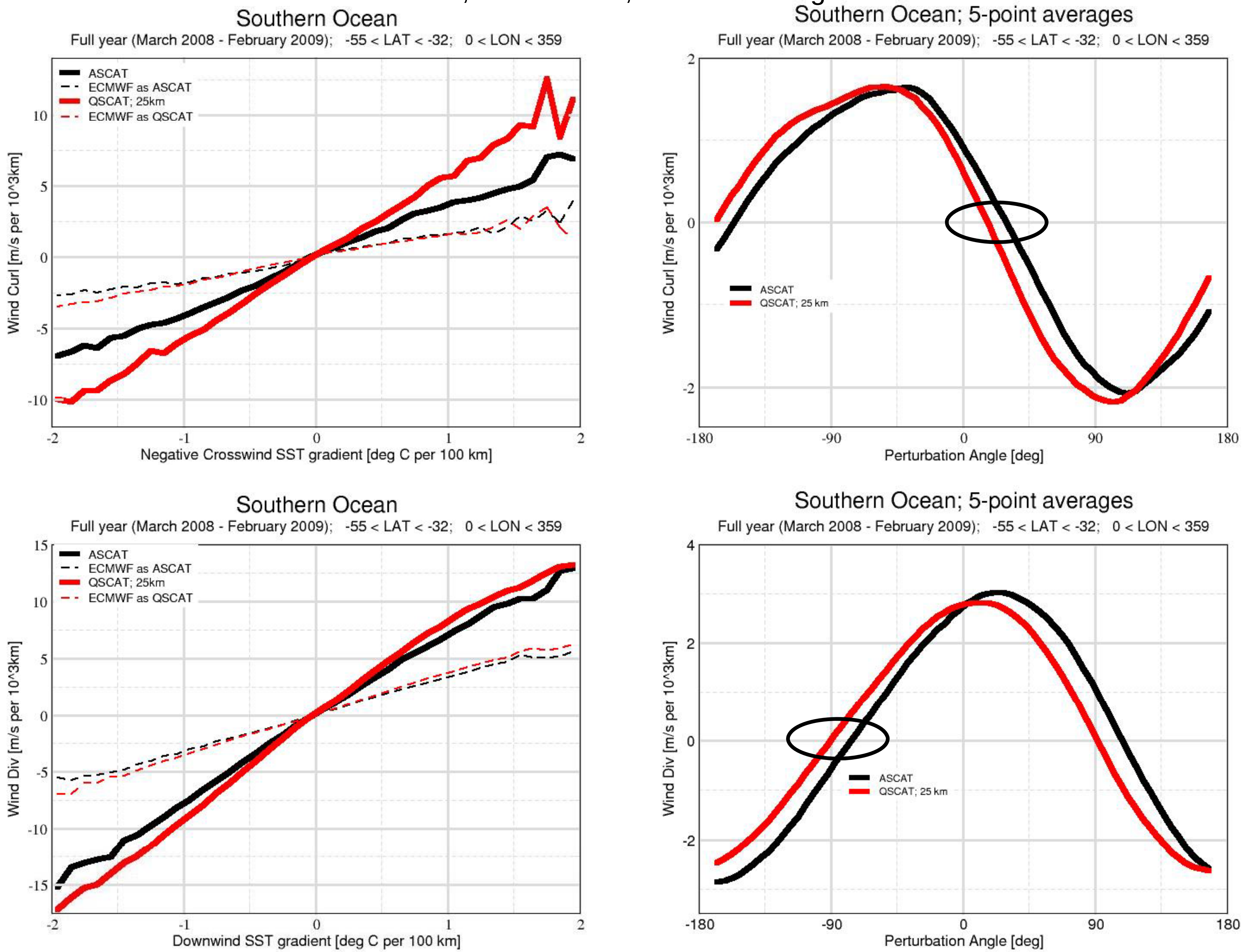
FIG. 3. Schematic of the hypothesized interaction between wind stress and SST for wind blowing obliquely across a meandering SST front. The SST front is delineated as the black sinusoidal curve, separating warm and cold water. The lengths of the arrows schematicallyrepresent the hypothesized relative magnitudes of the surface wind stress. Regions of nonzero wind stress curl and divergence are indicated.

- ASCAT/QuikSCAT comparison revisited
  - High-resolution daily SST product (OSTIA)
  - Using ASCAT bias-corrected data (+0.3m/s)
  - Computing **WIND curl/divergence**
  - from orbital instead of gridded (averaged) wind components (Chelton et al, 2007) to preserve the signals of each meteorological event and to avoid introducing artifacts from computing gradients of averaged quantities over a number of different events.

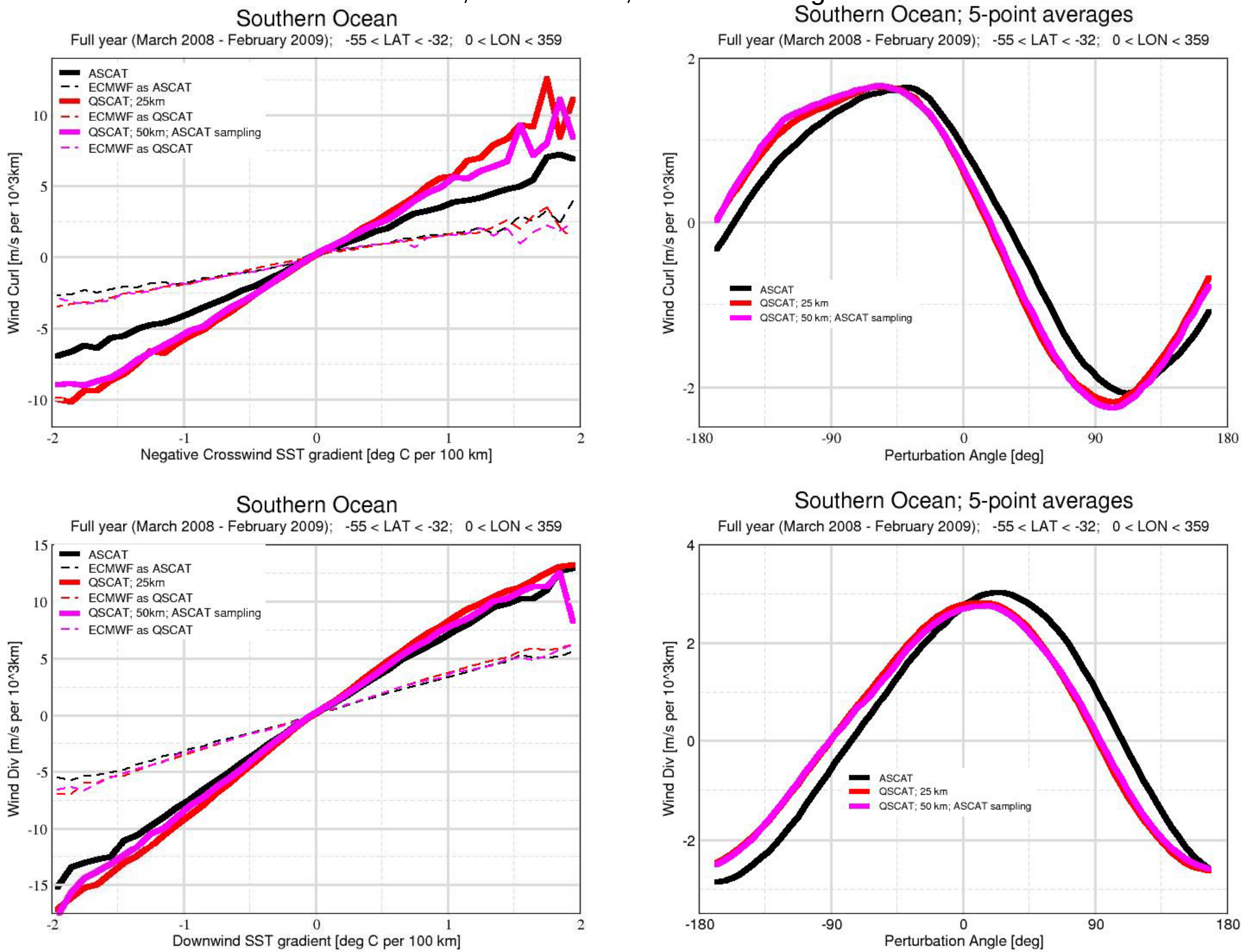
What do we look at

- Use wind and not wind stress to decrease the impact of GMF differences
- Look at
  - Impact of sampling and resolution
  - Impact of retrieved speed
    - (limit the sample to wind in the range 5-15 m/s)
  - Seasonal variability
  - Diurnal variability

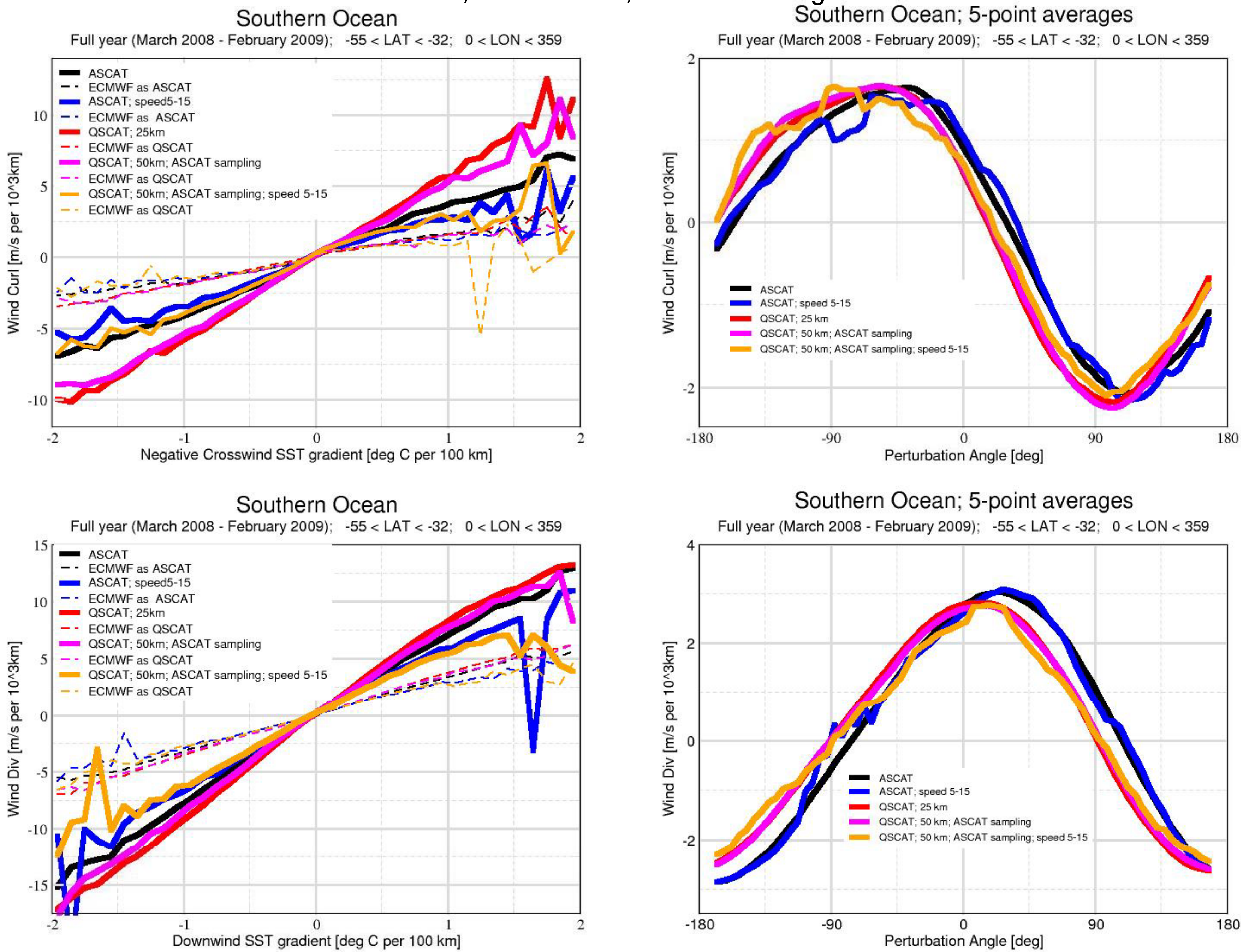
Wind; From swath; 2-week averages



Wind; From swath; 2-week averages



Wind; From swath; 2-week averages



In curvilinear natural coordinates

(e.g., Haltiner andMartin, 1957)

Perturbation vorticity	Local crosswind speed gradient	Local downwind direction gradient

$$\nabla \times U' = -\left(\frac{\partial V}{\partial n}\right)' + \left(V\frac{\partial \psi}{\partial s}\right)'$$

→ related to the **radius of curvature** of surface streamlines.

Perturbation divergence	Local downwind speed gradient	Local crosswind direction gradient

$$\nabla \bullet U' = +\left(\frac{\partial V}{\partial s}\right)' + \left(V\frac{\partial \psi}{\partial n}\right)'$$

→ related to the **spreading or contracting of surface streamlines in the crosswind direction**.

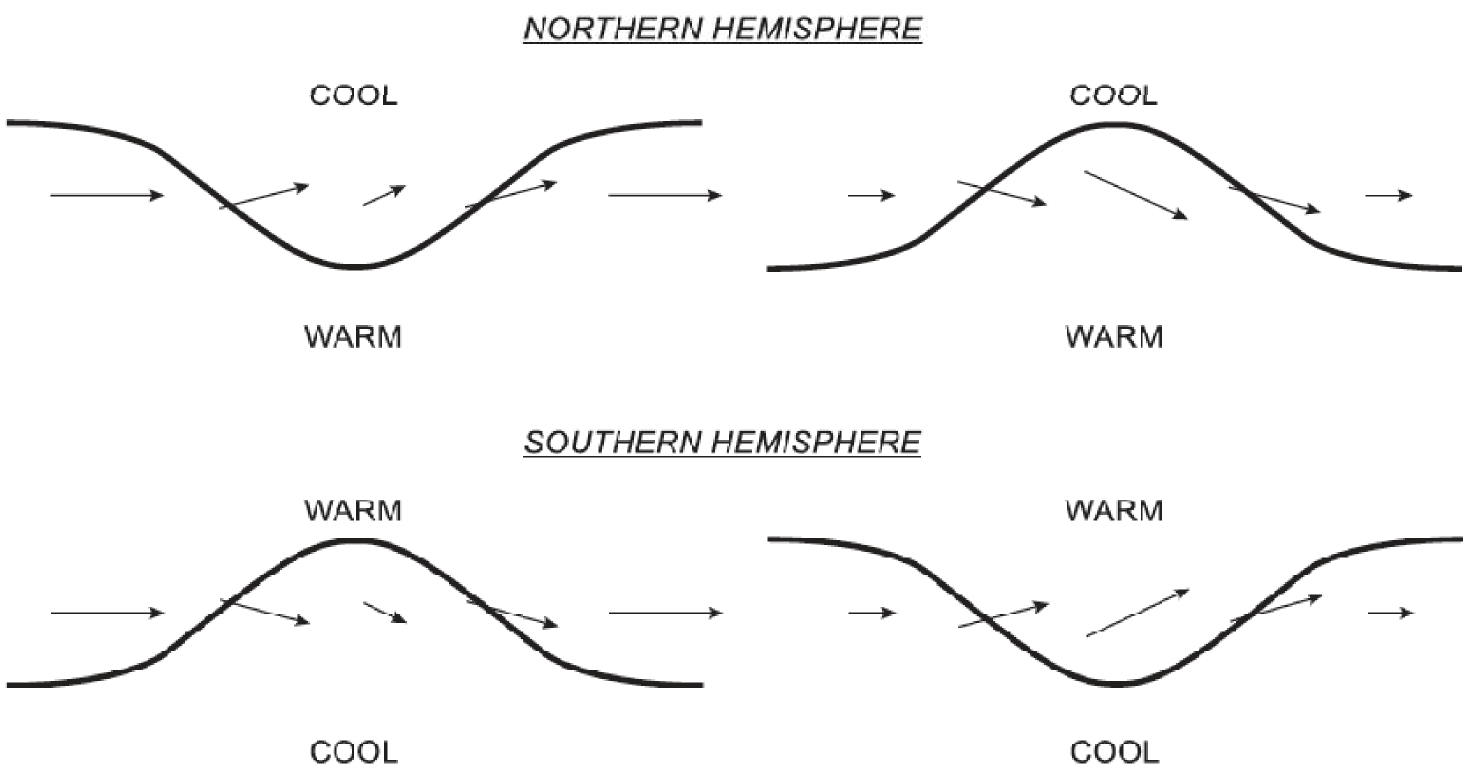
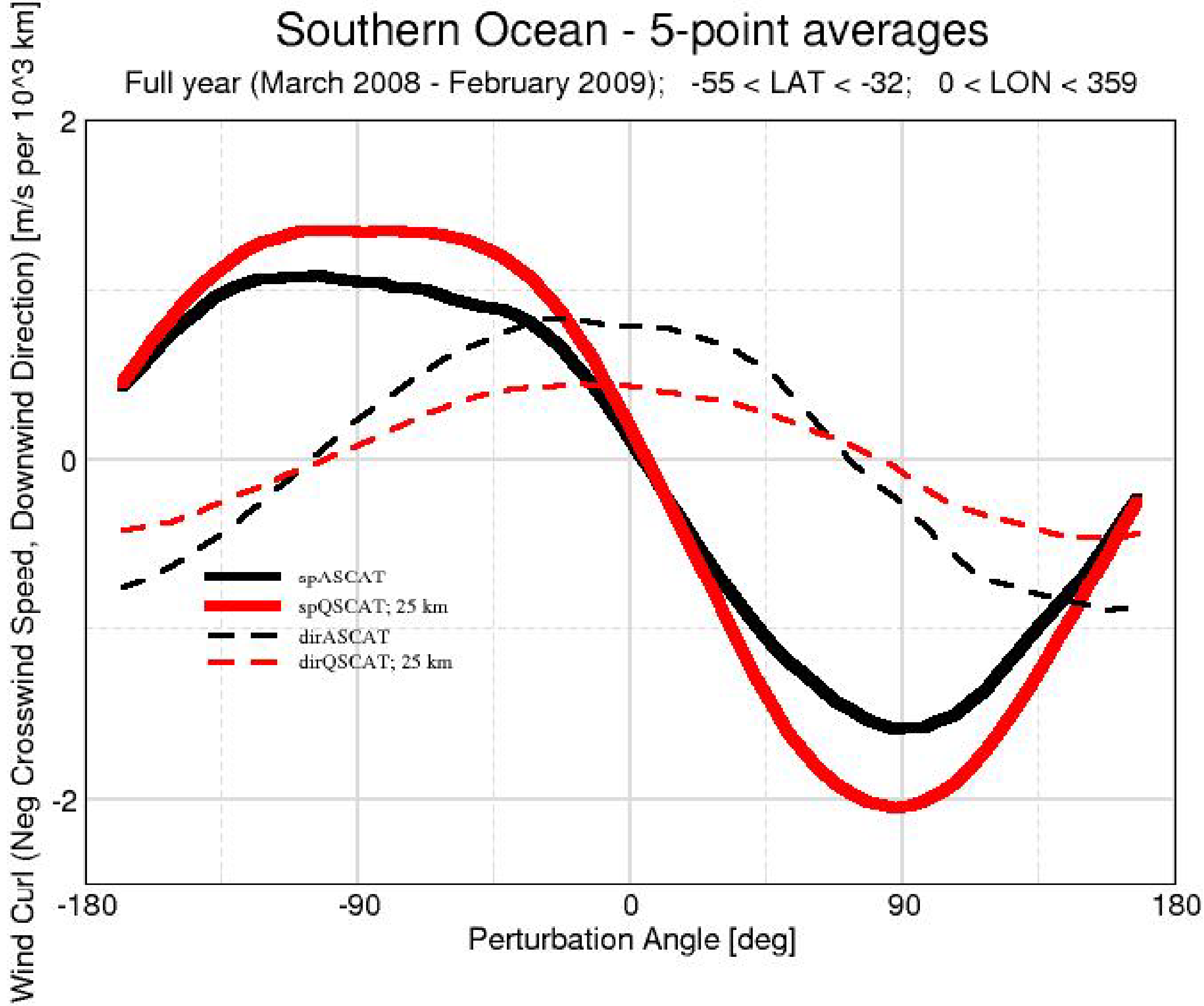
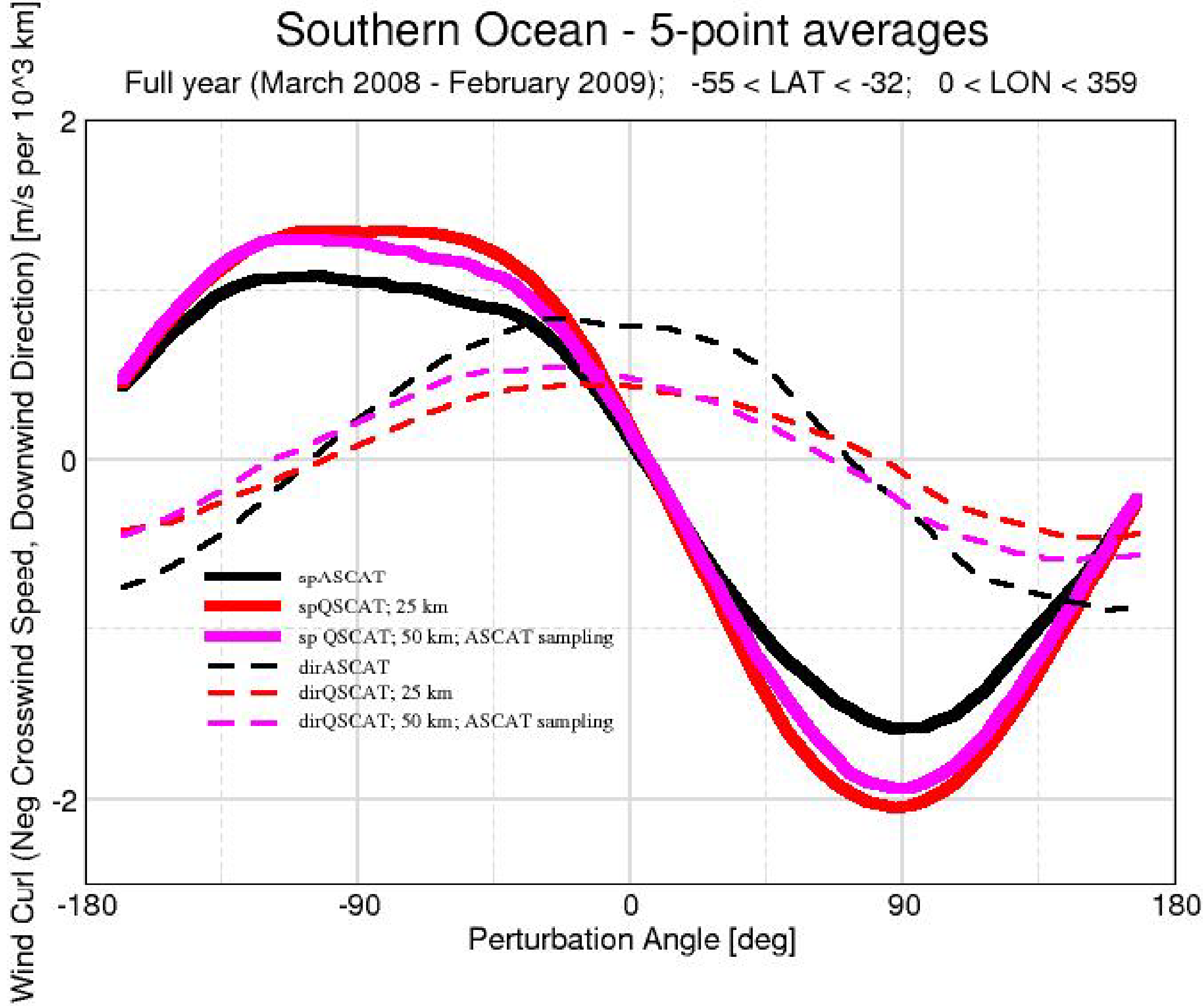


FIG. 7. Summary schematic of the vector wind response to meanders along an extratropical SST front, represented here by the solid curves, as deduced from the wind speed and direction dependencies on SST. Whereas the wind speed response to SST (as represented by the relative length of the vectors) is the same for both hemispheres, the wind direction response to SST (as represented by the relative turning of the vectors) differs in sign between the Northern and Southern Hemispheres.



Southern Ocean - 5-point averages
Full year (March 2008 - February 2009); -55 < LAT < -32; 0 < LON < 359
Wind Curl (Neg Crosswind Speed, Downwind Direction) [m/s per 10^3 km]
2
0
-2
-180
-90
0
90
180
Perturbation Angle [deg]
spASCAT
spQSCAT; 25 km
dirASCAT
dirQSCAT; 25 km


Southern Ocean - 5-point averages
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Wind Curl (Neg Crosswind Speed, Downwind Direction) [m/s per 10^3 km]
2
0
-2
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90
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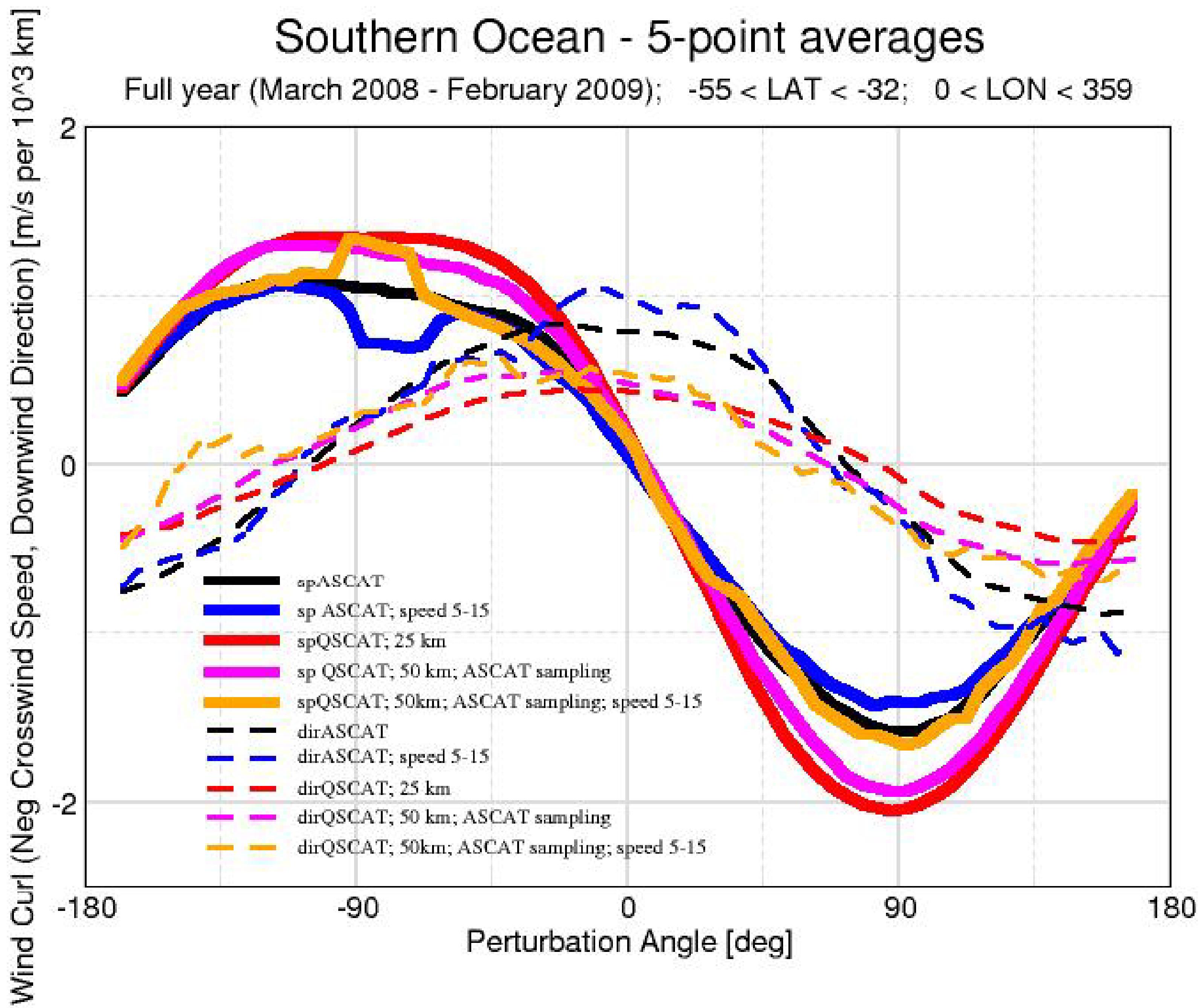
Perturbation Angle [deg]
spASCAT
spQSCAT; 25 km
sp QSCAT; 50 km; ASCAT sampling
dirASCAT
dirQSCAT; 25 km
dirQSCAT; 50 km; ASCAT sampling


Southern Ocean - 5-point averages
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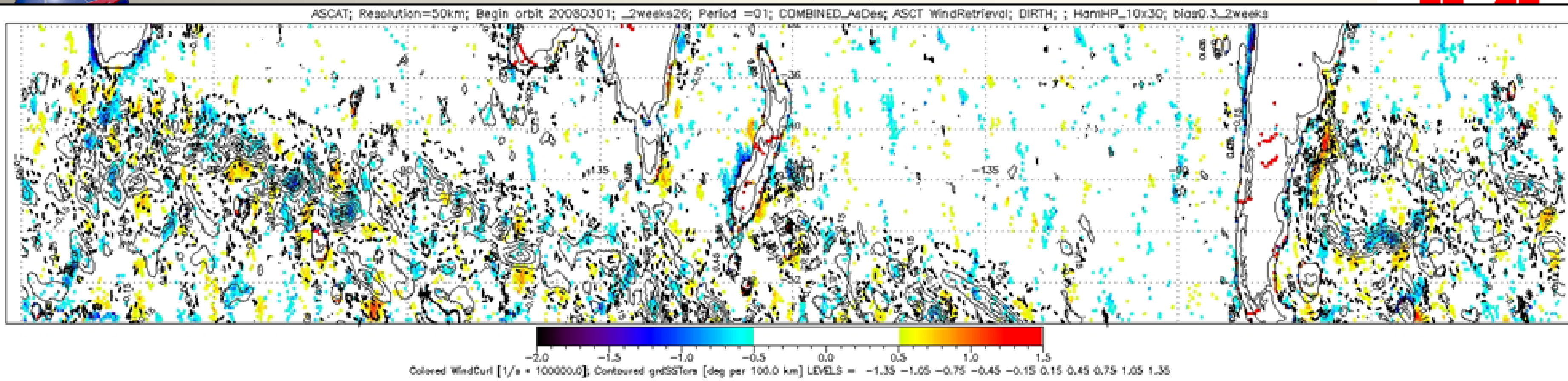
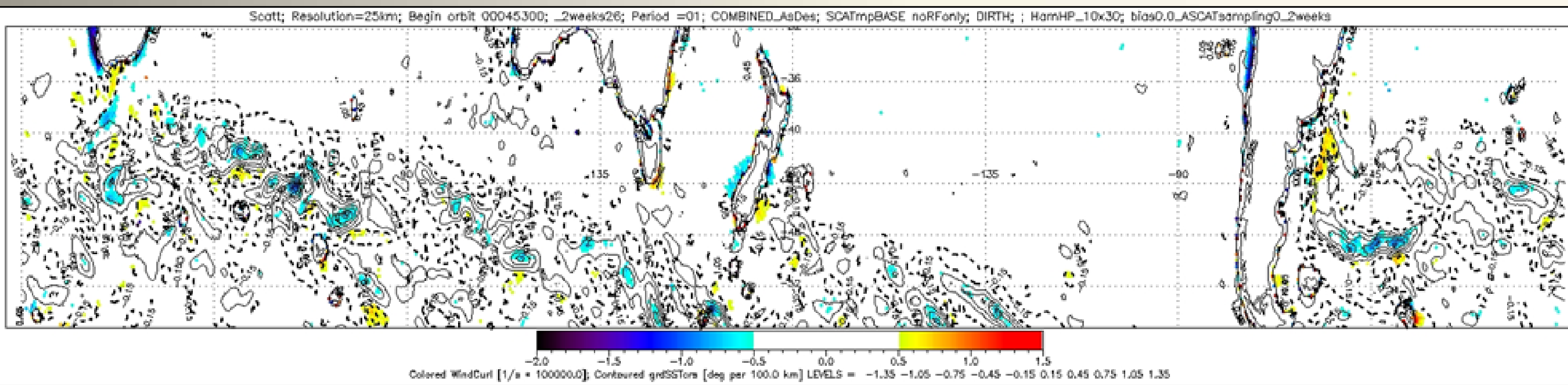
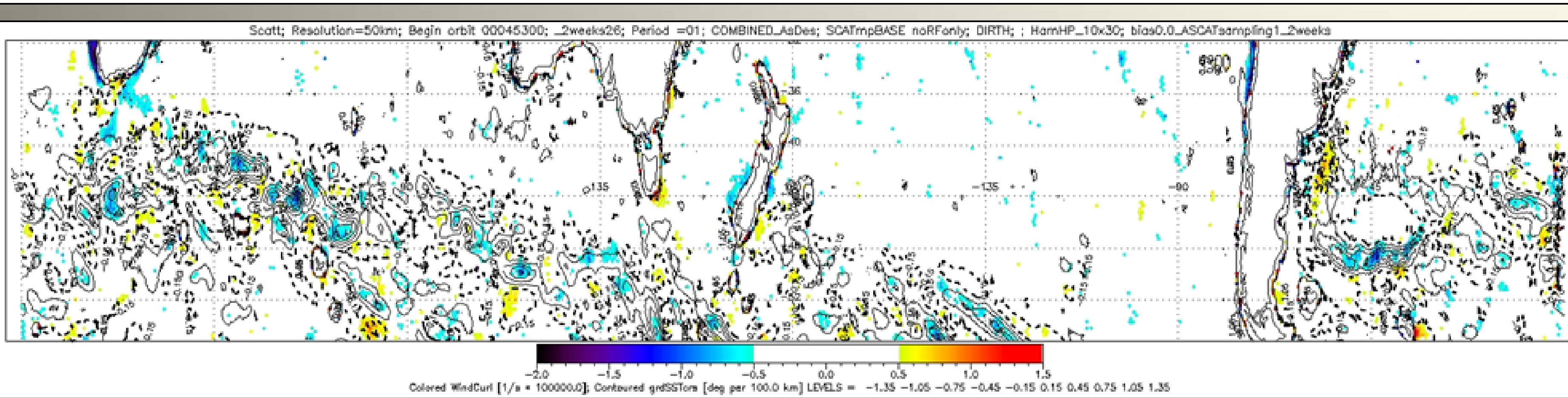
Wind Curl (Neg Crosswind Speed, Downwind Direction) [m/s per 10^3 km]
2
0
-2
-180
-90
0
90
180
Perturbation Angle [deg]
spASCAT
sp ASCAT; speed 5-15
spQSCAT; 25 km
sp QSCAT; 50 km; ASCAT sampling
spQSCAT; 50km; ASCAT sampling; speed 5-15
dirASCAT
dirASCAT; speed 5-15
dirQSCAT; 25 km
dirQSCAT; 50 km; ASCAT sampling
dirQSCAT; 50km; ASCAT sampling; speed 5-15

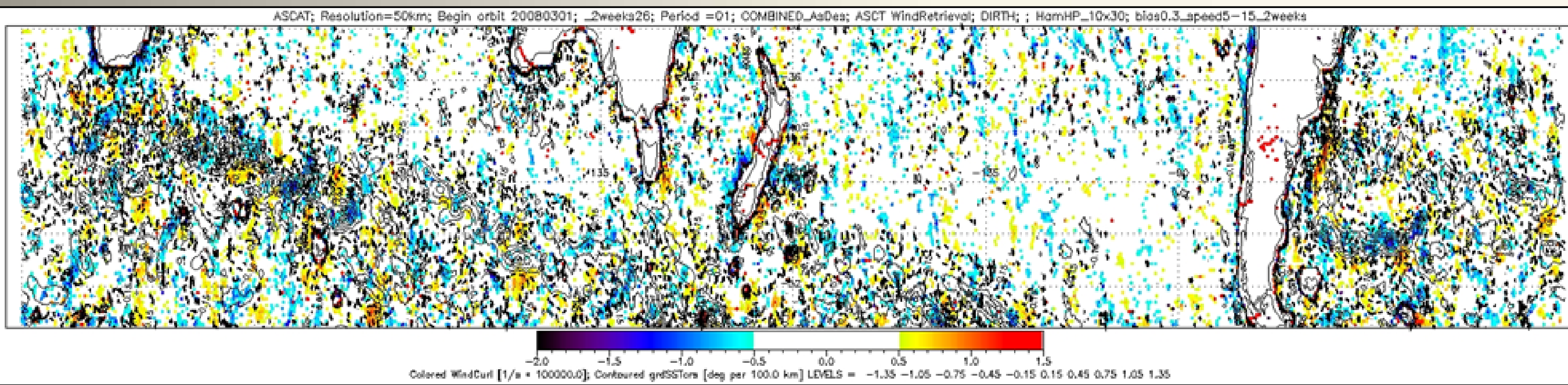
ASCAT vs QuikSCAT vs QuikSCAT with ASCAT sampling/res. - Wind Curl - 1year – 2week av

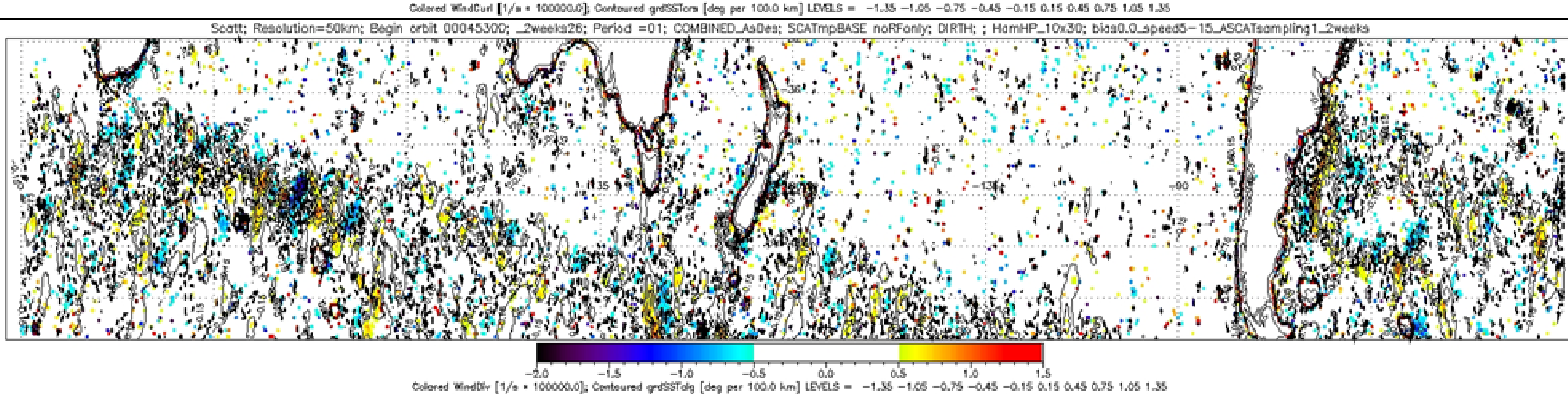




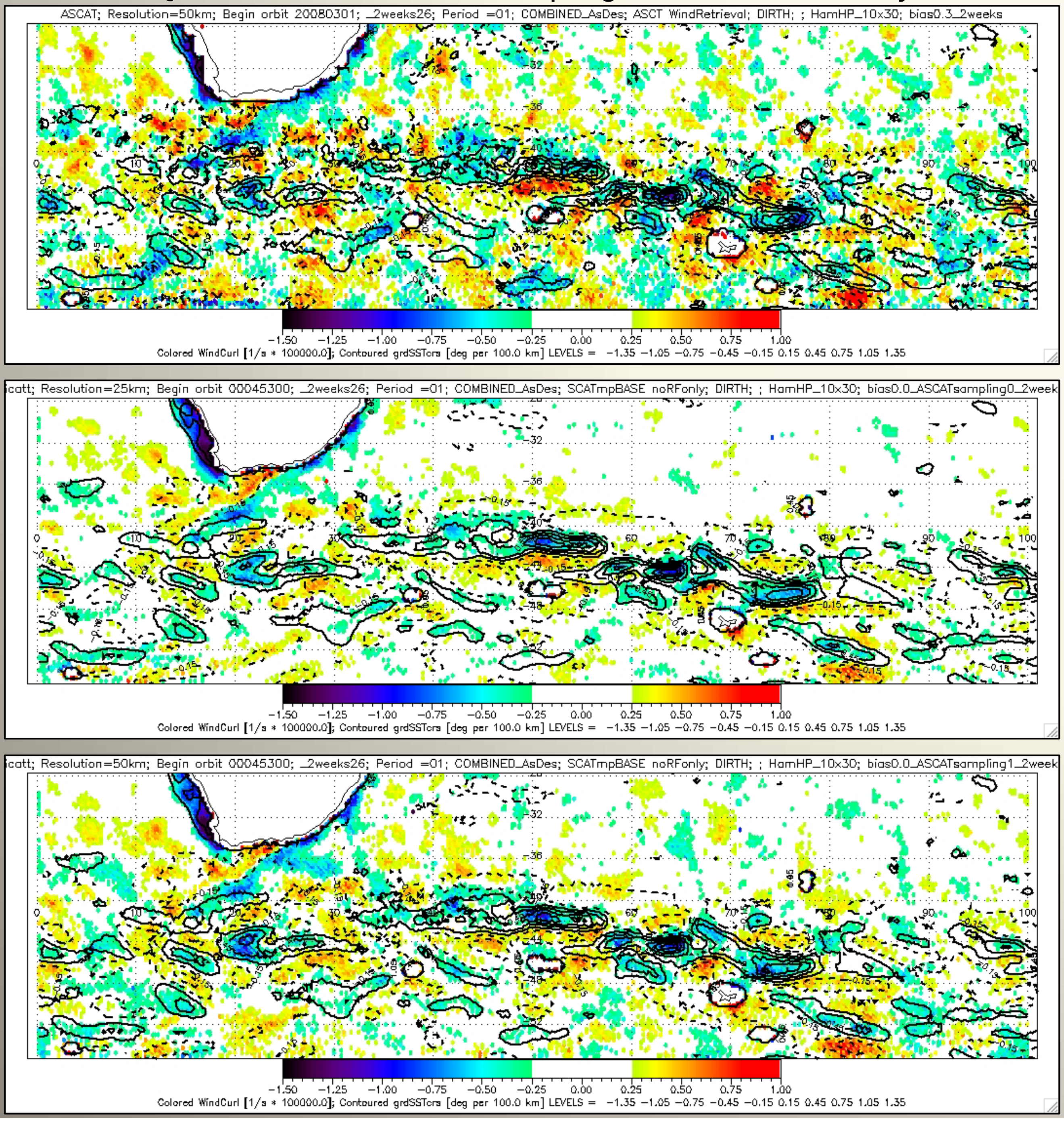


ASCAT vs QuikSCAT with ASCAT sampling/res.
Wind Curl; speed 5-15 m/s
1year – 2week av

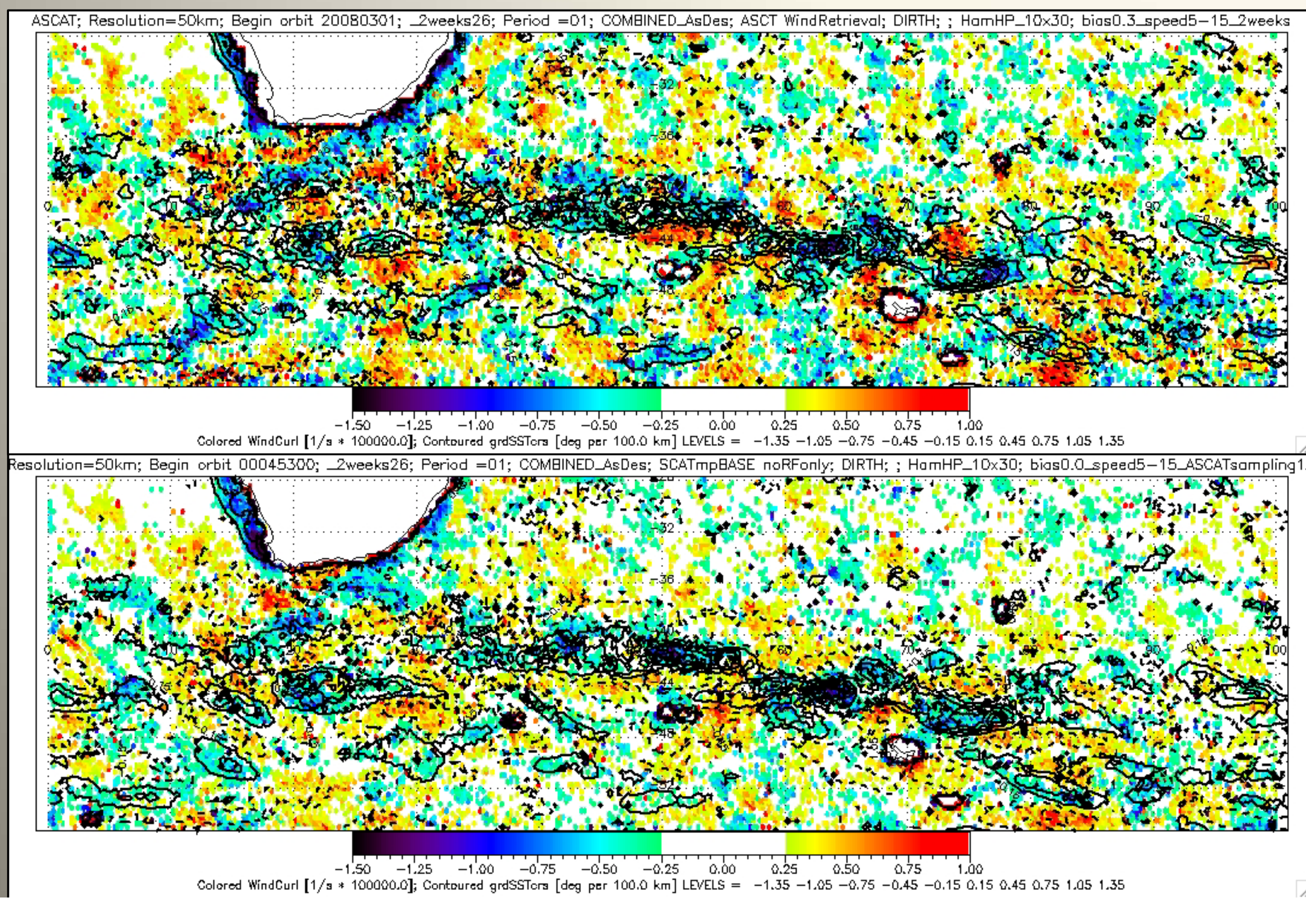




ASCAT vs QuikSCAT vs QuikSCAT with ASCAT sampling/res. - Wind Curl - 1year – 2week av

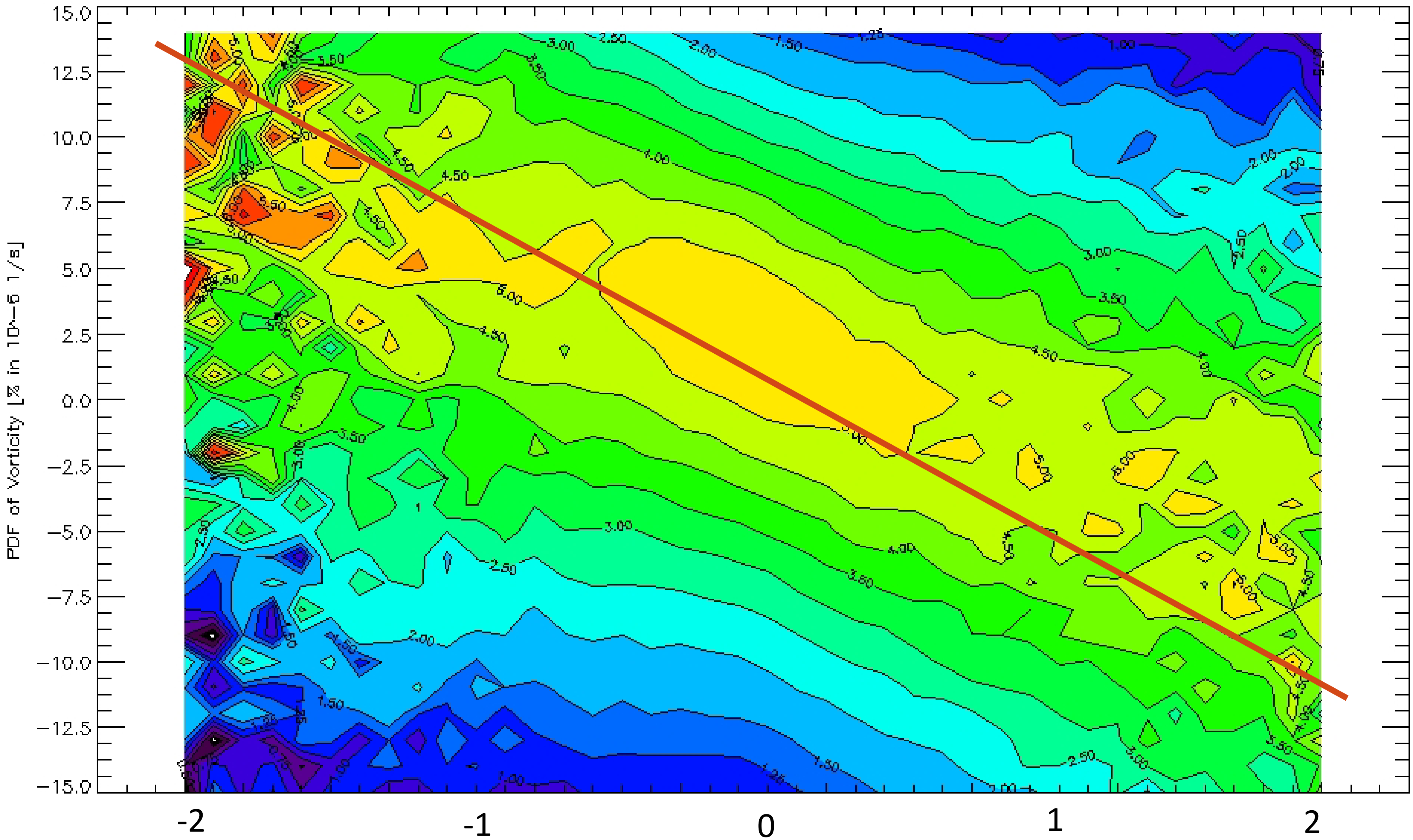


ASCAT vs QuikSCAT with ASCAT sampling/res.
Wind Curl; speed 5-15 m/s
1year – 2week av



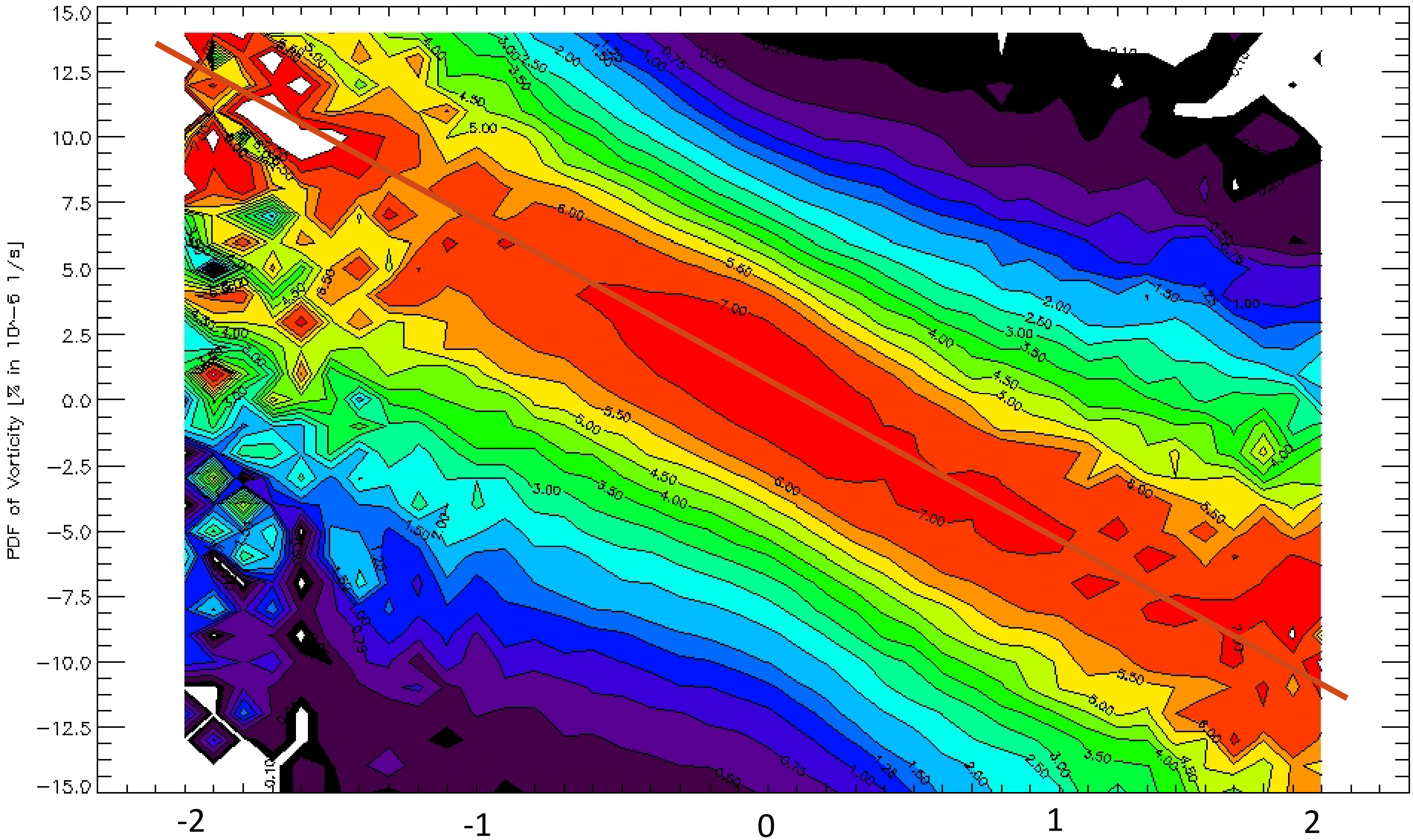
ASCAT

PDF of the vorticity perturbation as a function of the crosswind SST gradients



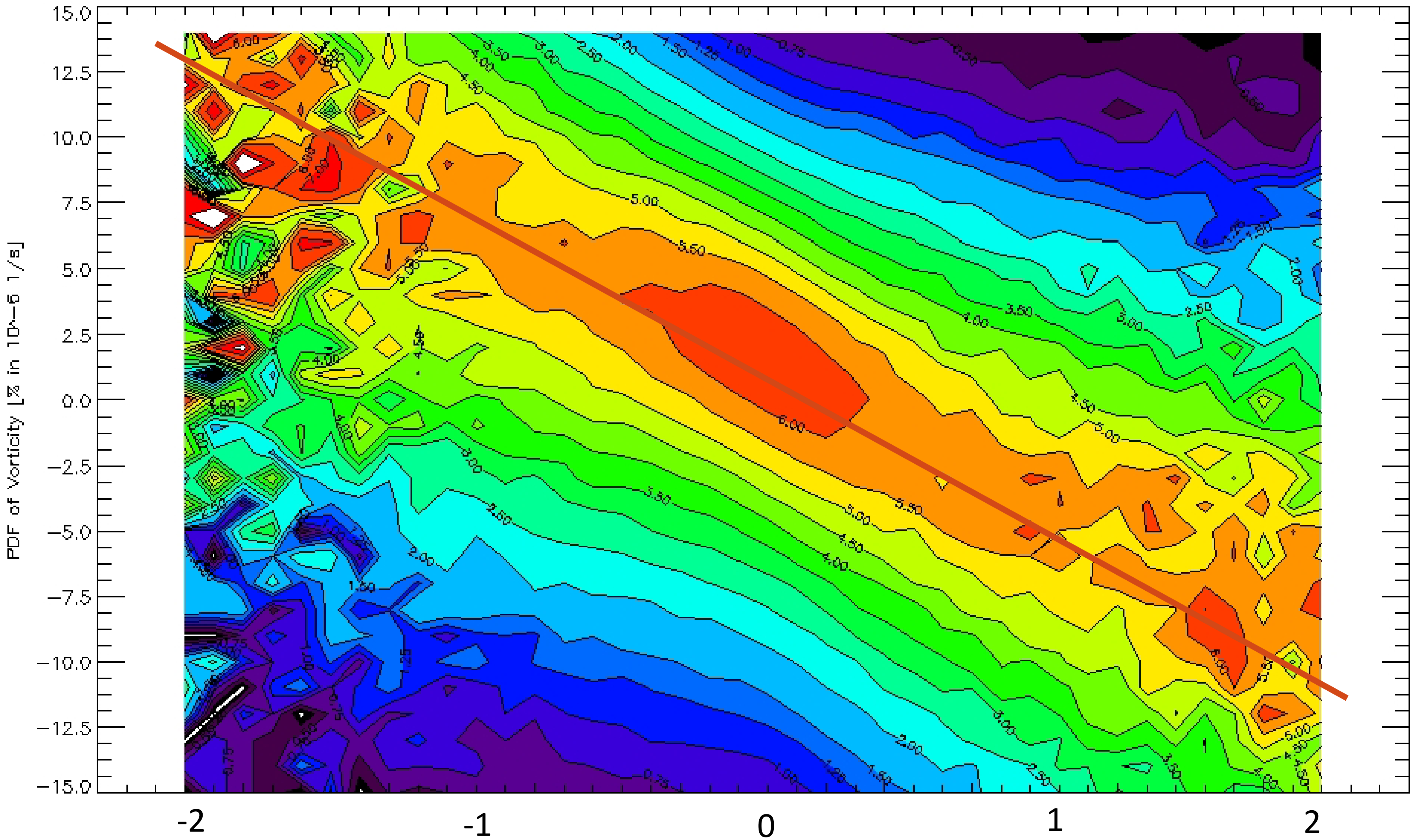
QuikSCAT; 25 km resolution

PDF of the vorticity perturbation as a function of the crosswind SST gradients



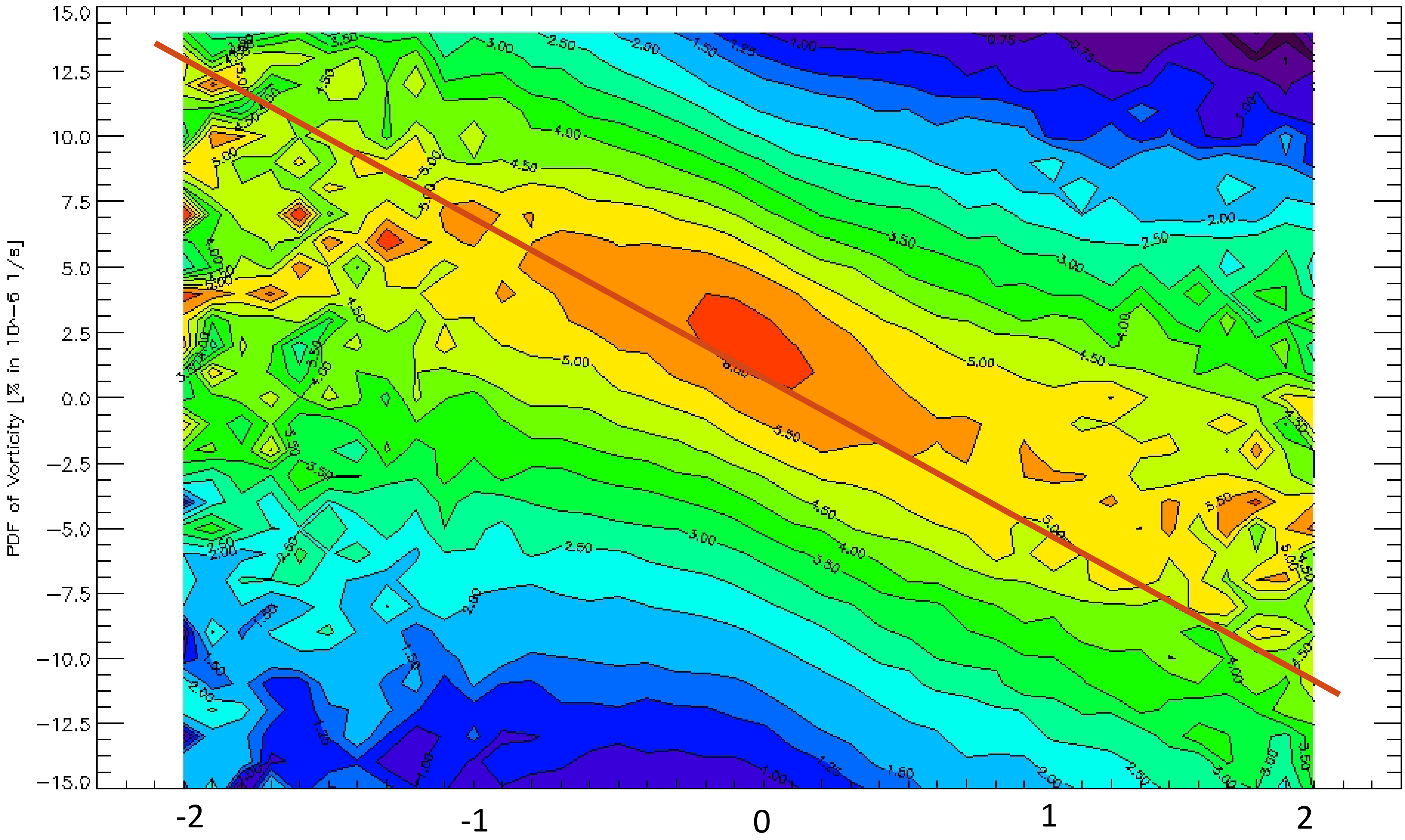
QuikSCAT; 50km; ASCAT sampling

PDF of the vorticity perturbation as a function of the crosswind SST gradients



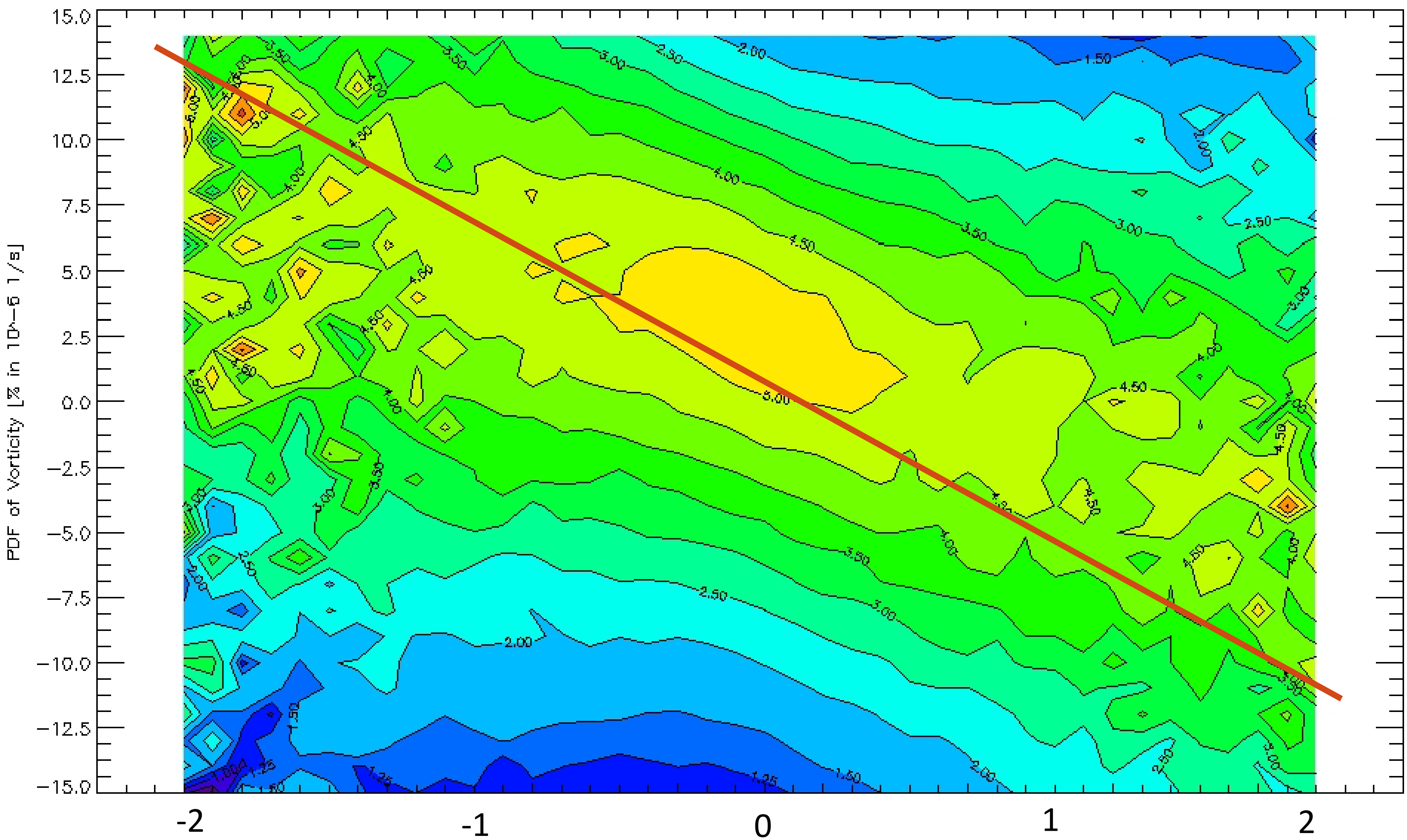
QuikSCAT; 50km; ASCAT sampling; speed 5-15 m/s

PDF of the vorticity perturbation as a function of the crosswind SST gradients



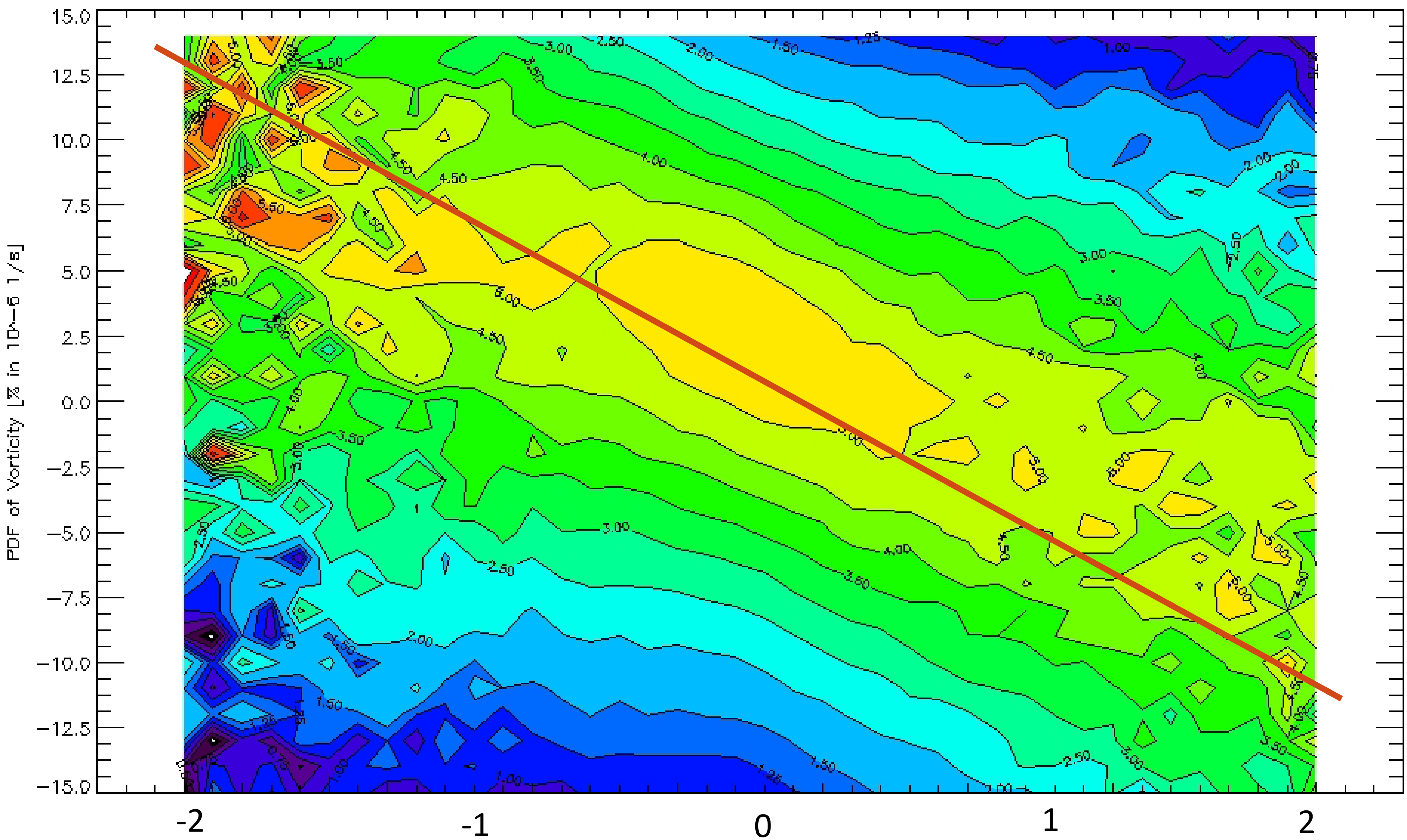
ASCAT; speed 5-15 m/s

PDF of the vorticity perturbation as a function of the crosswind SST gradients

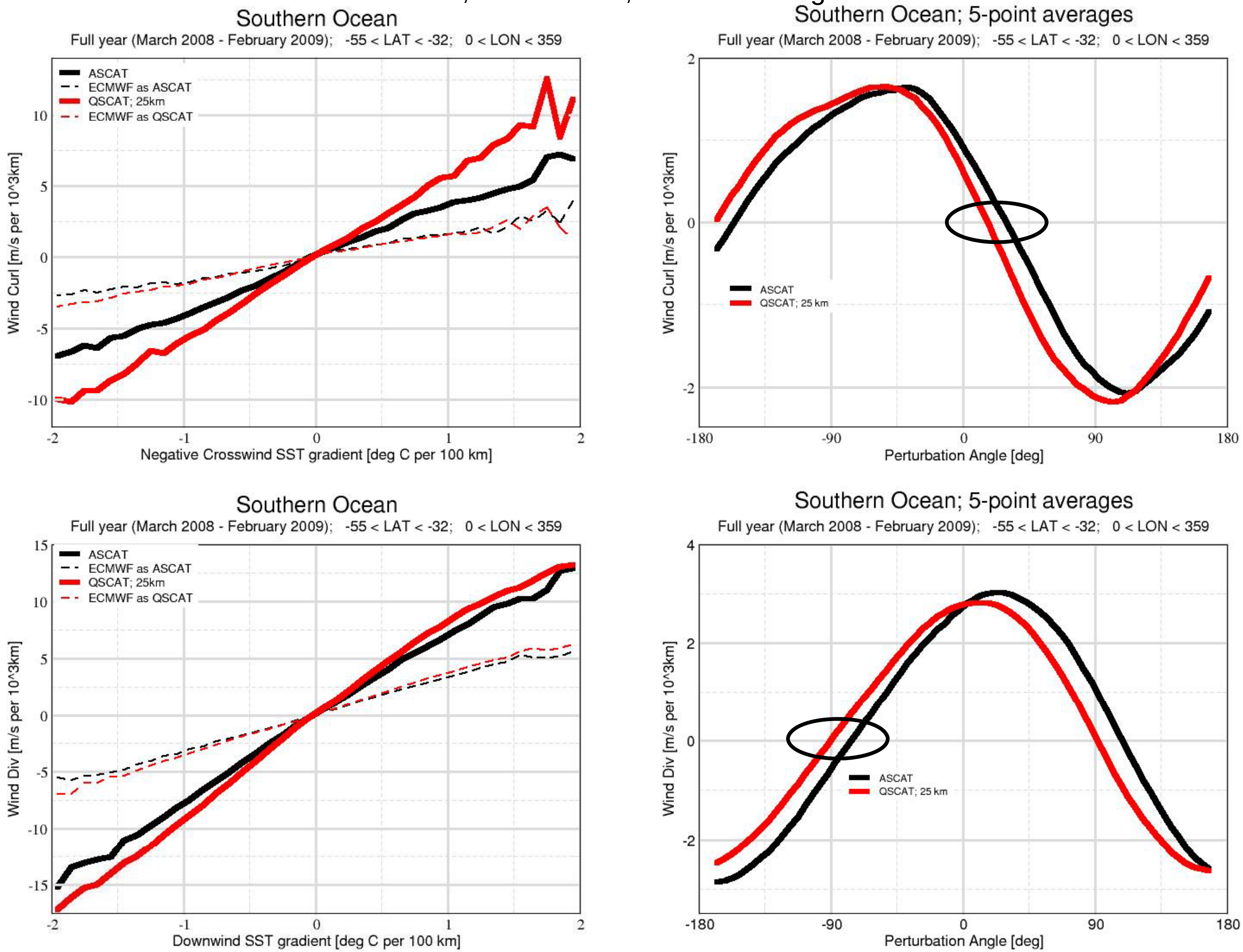


ASCAT

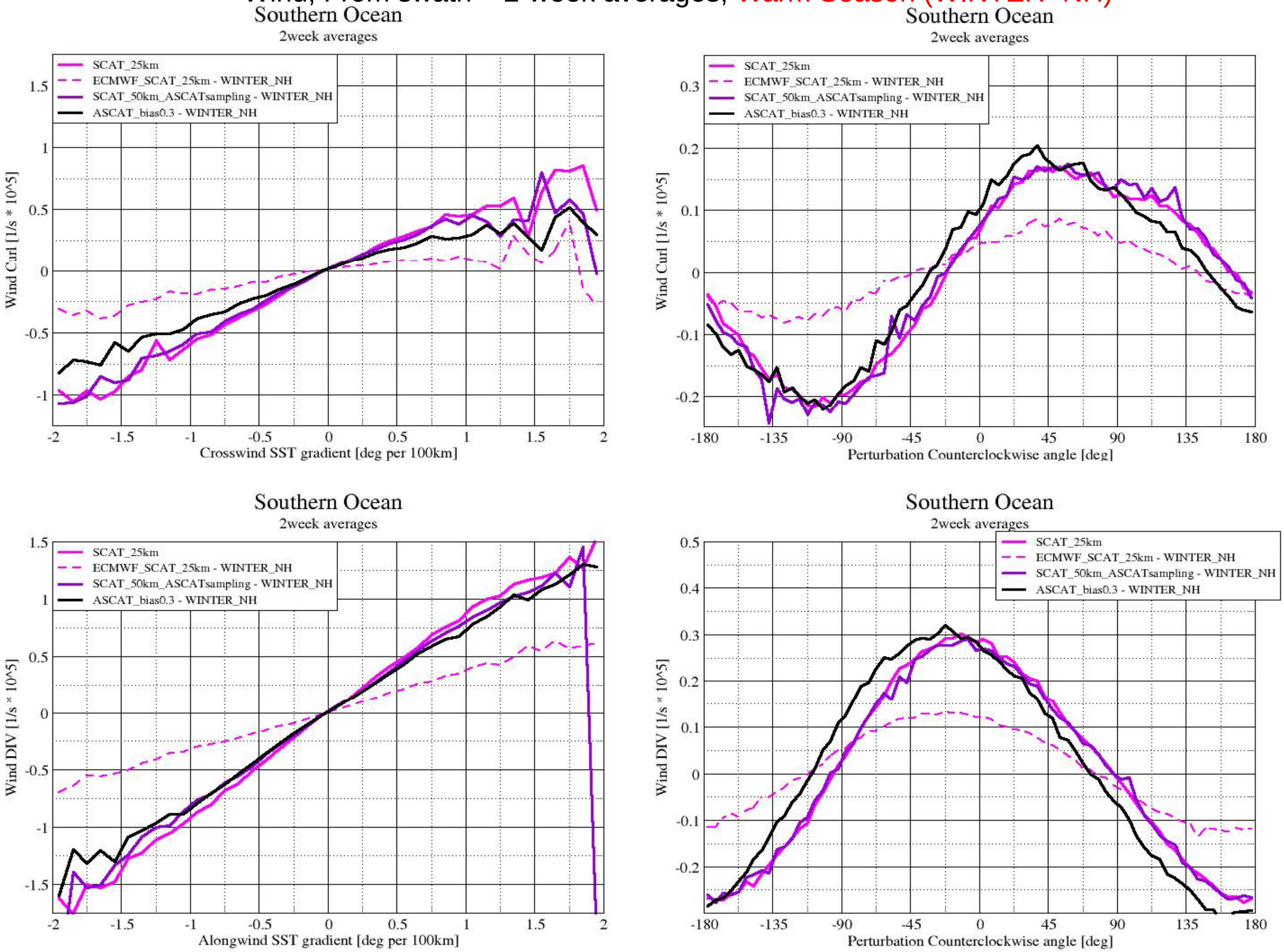
PDF of the vorticity perturbation as a function of the crosswind SST gradients



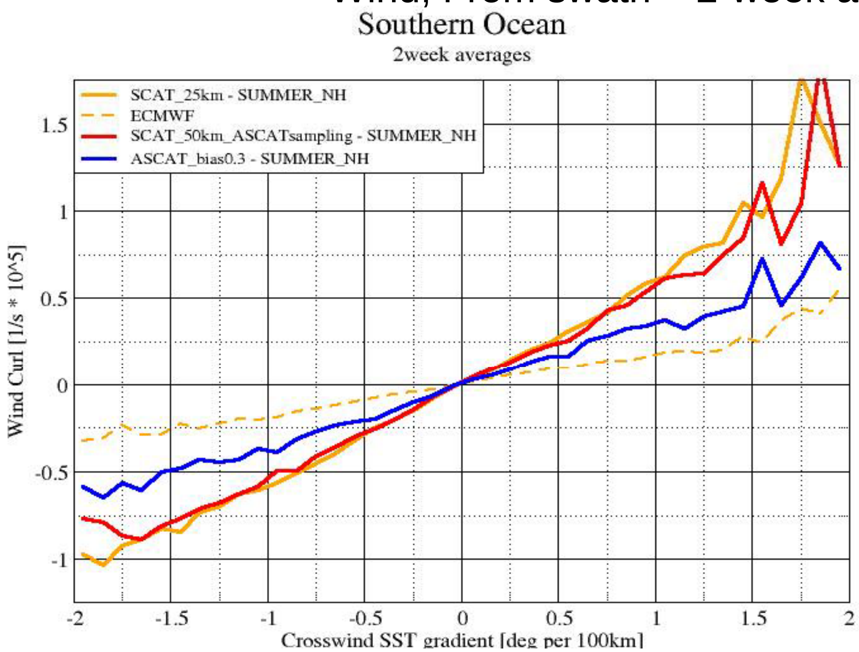
Wind; From swath; 2-week averages

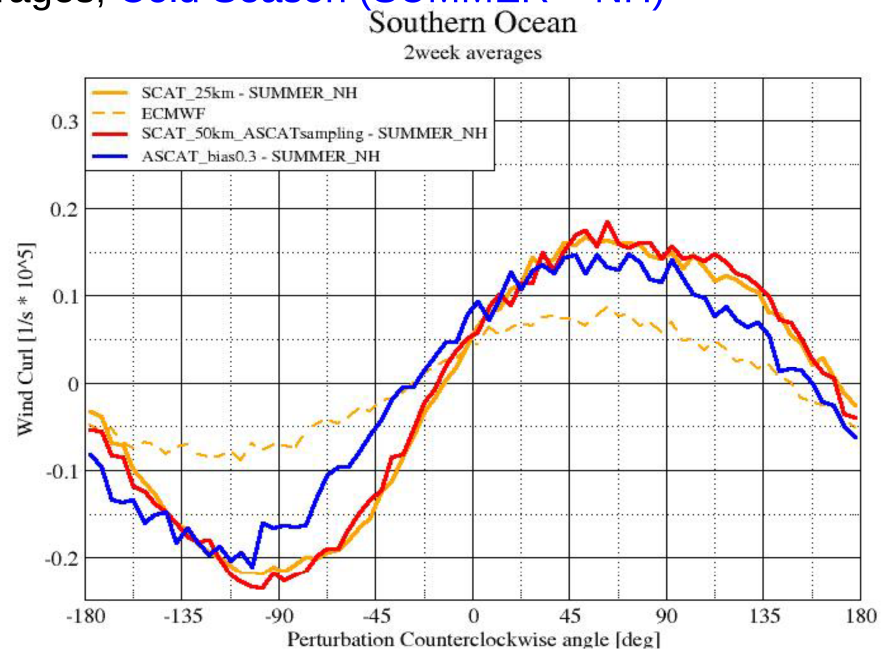


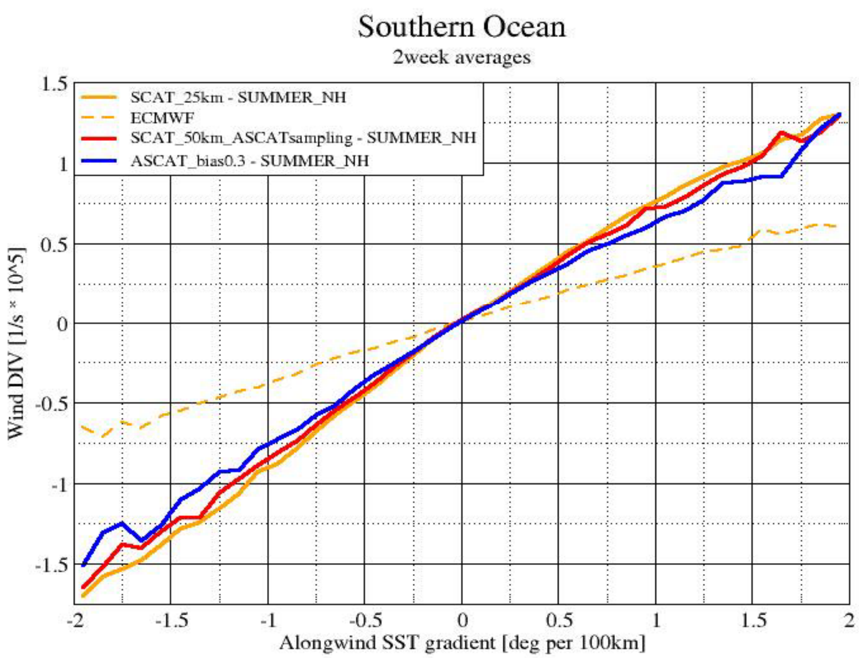
Wind; From swath – 2-week averages; Warm Season (WINTER- NH)

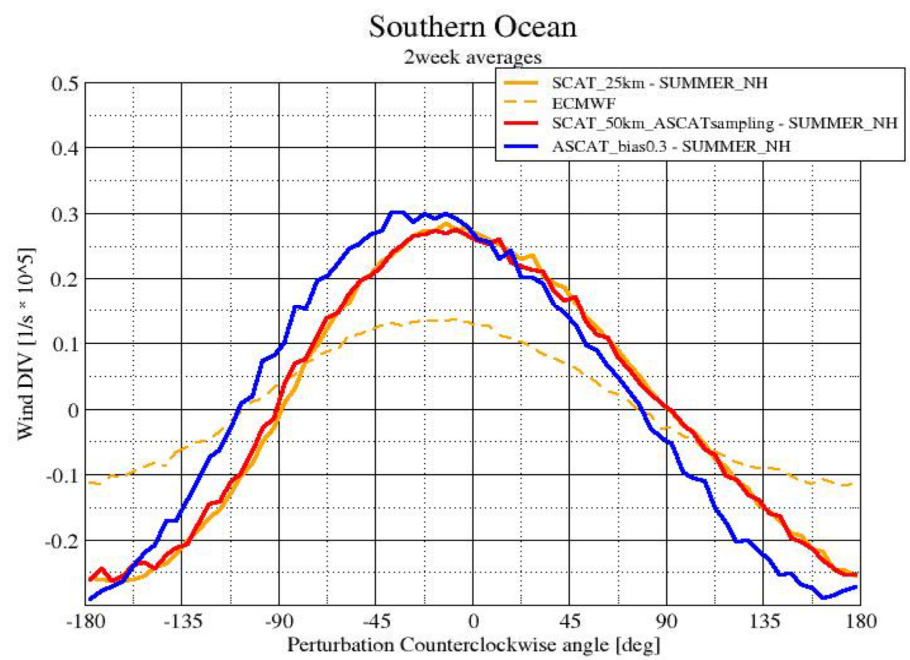


Wind; From swath – 2-week averages; Cold Season (SUMMER – NH)

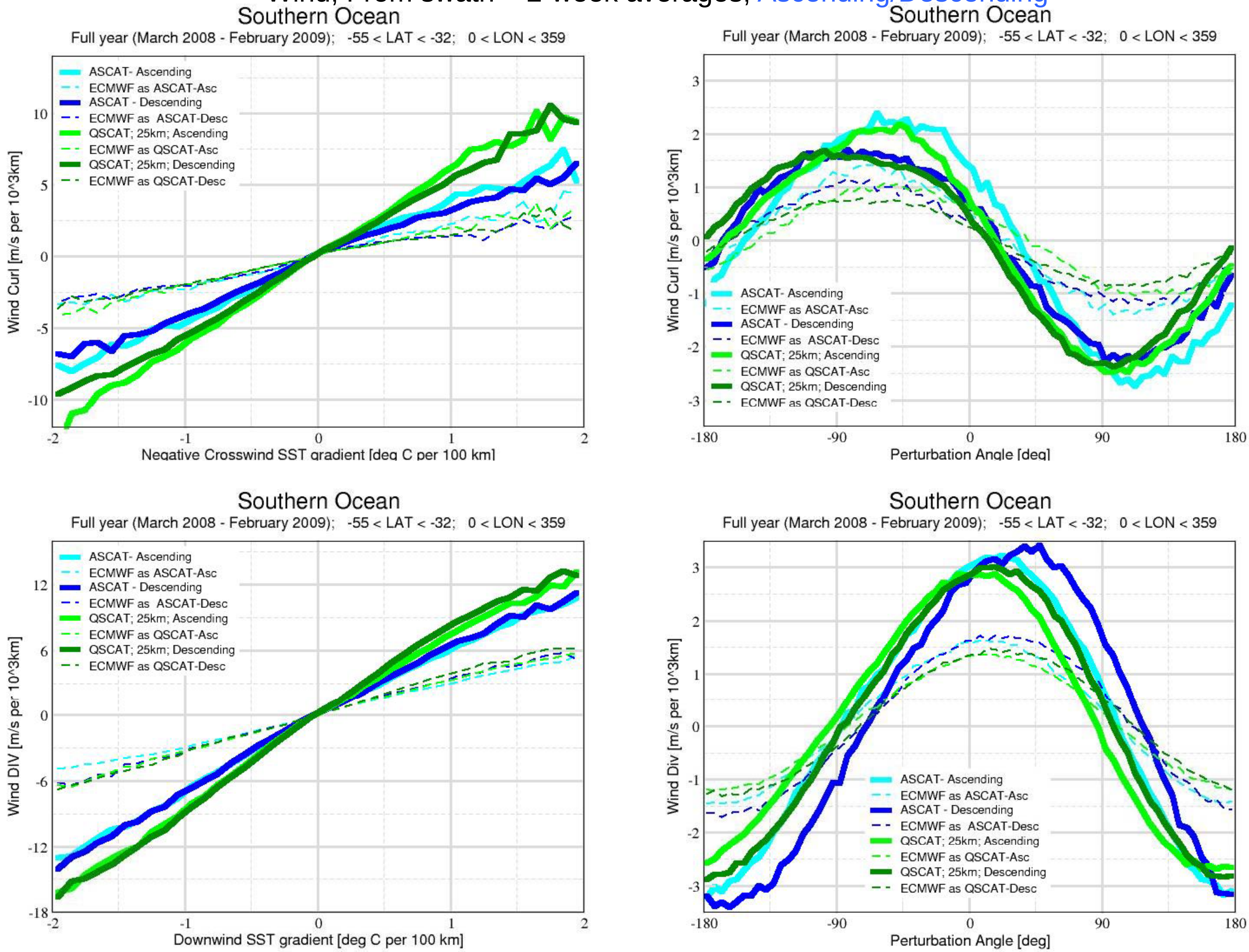


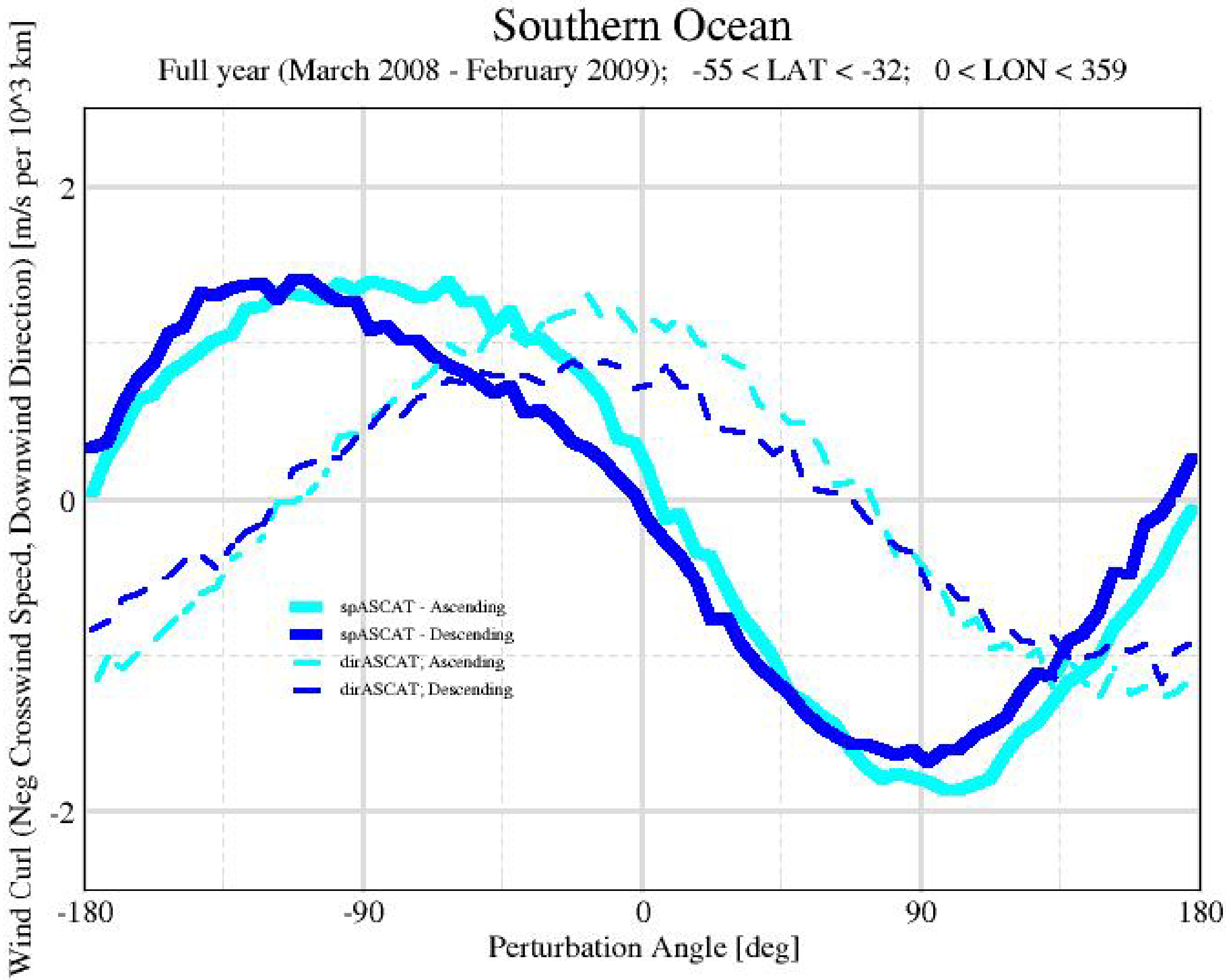




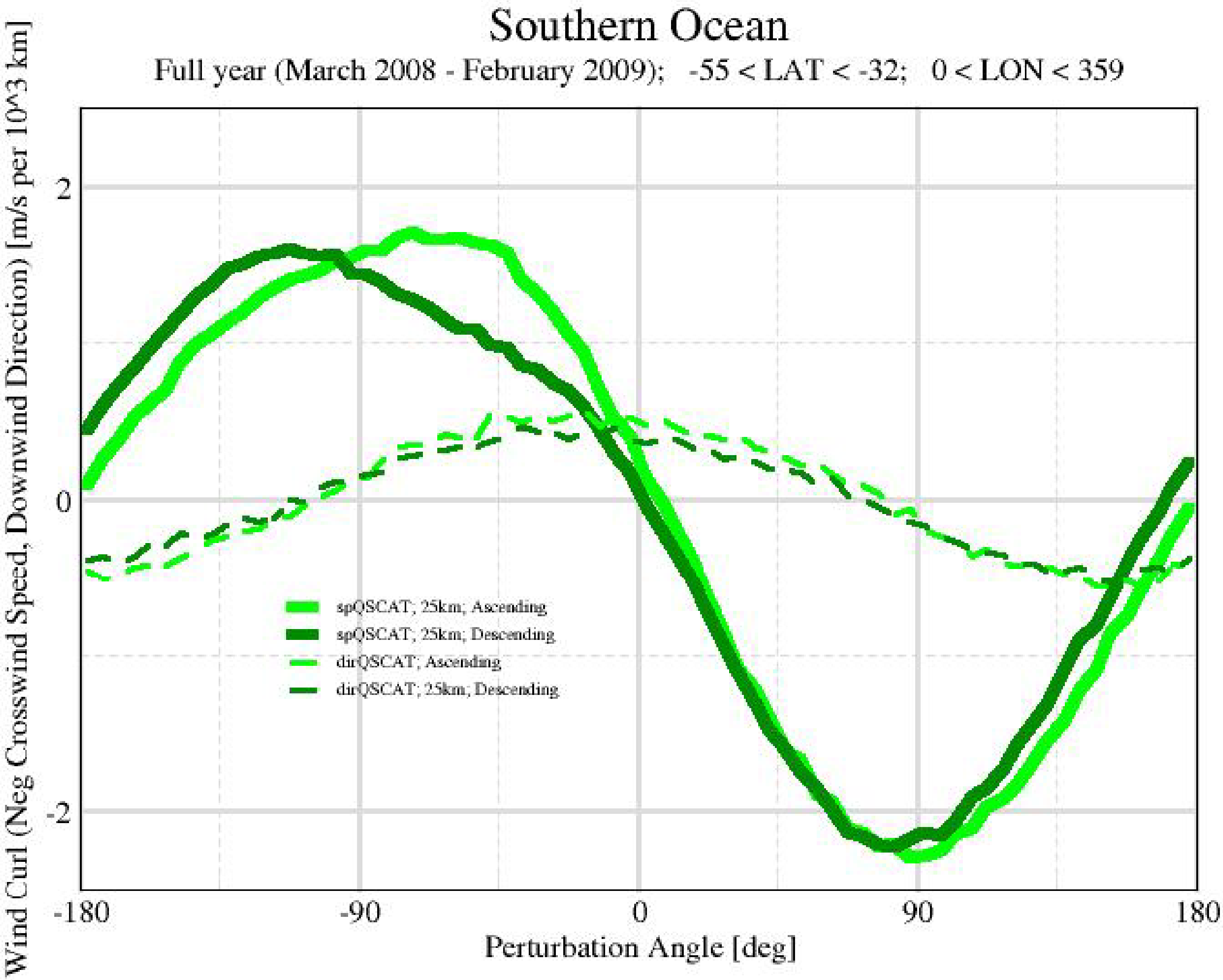


Wind; From swath – 2-week averages; Ascending/Descending

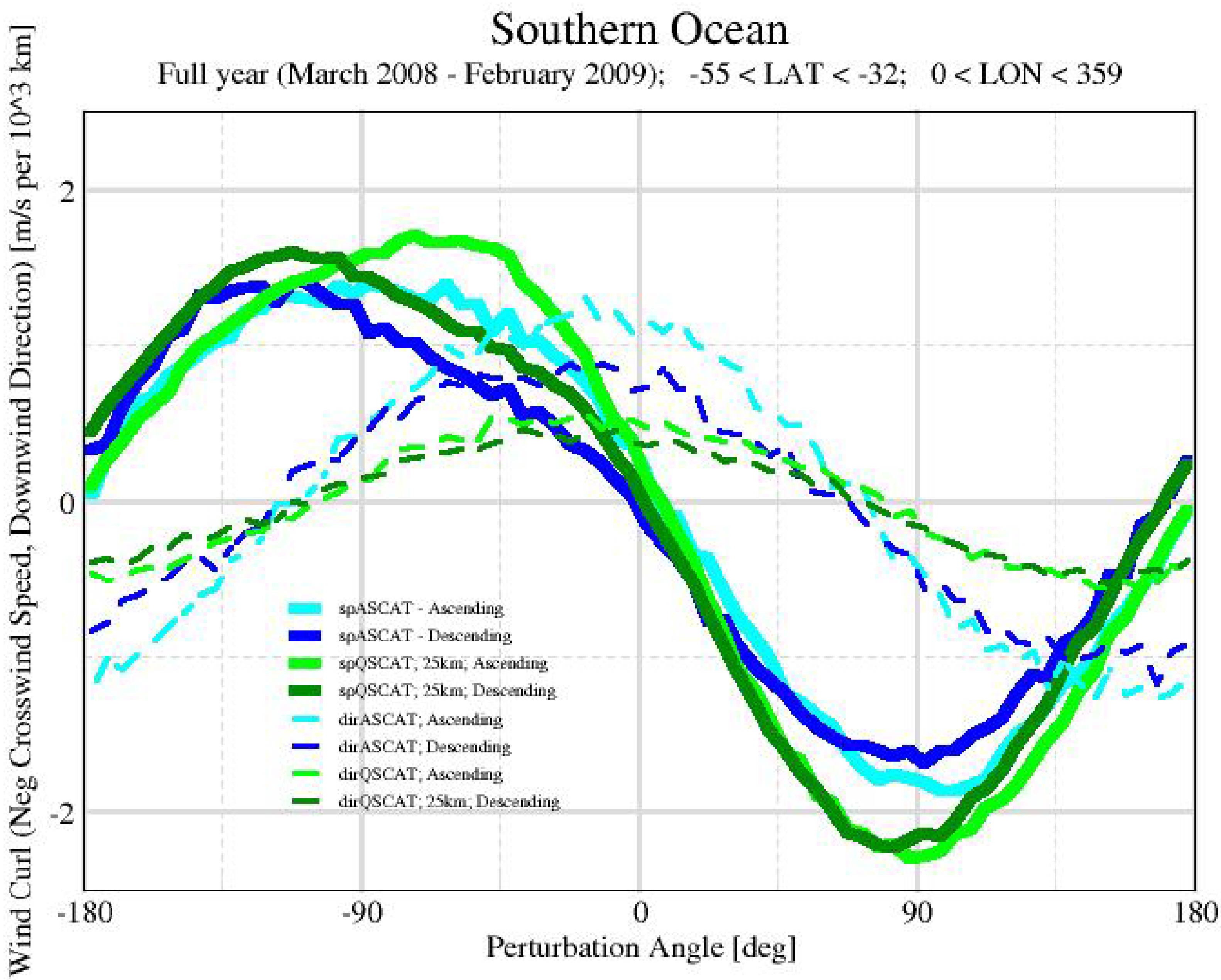




Southern Ocean
Full year (March 2008 - February 2009); -55 < LAT < -32; 0 < LON < 359
Wind Curl (Neg Crosswind Speed, Downwind Direction) [m/s per 10^3 km]
2
0
-2
-180
-90
0
90
180
Perturbation Angle [deg]
spASCAT - Ascending
spASCAT - Descending
dirASCAT; Ascending
dirASCAT; Descending



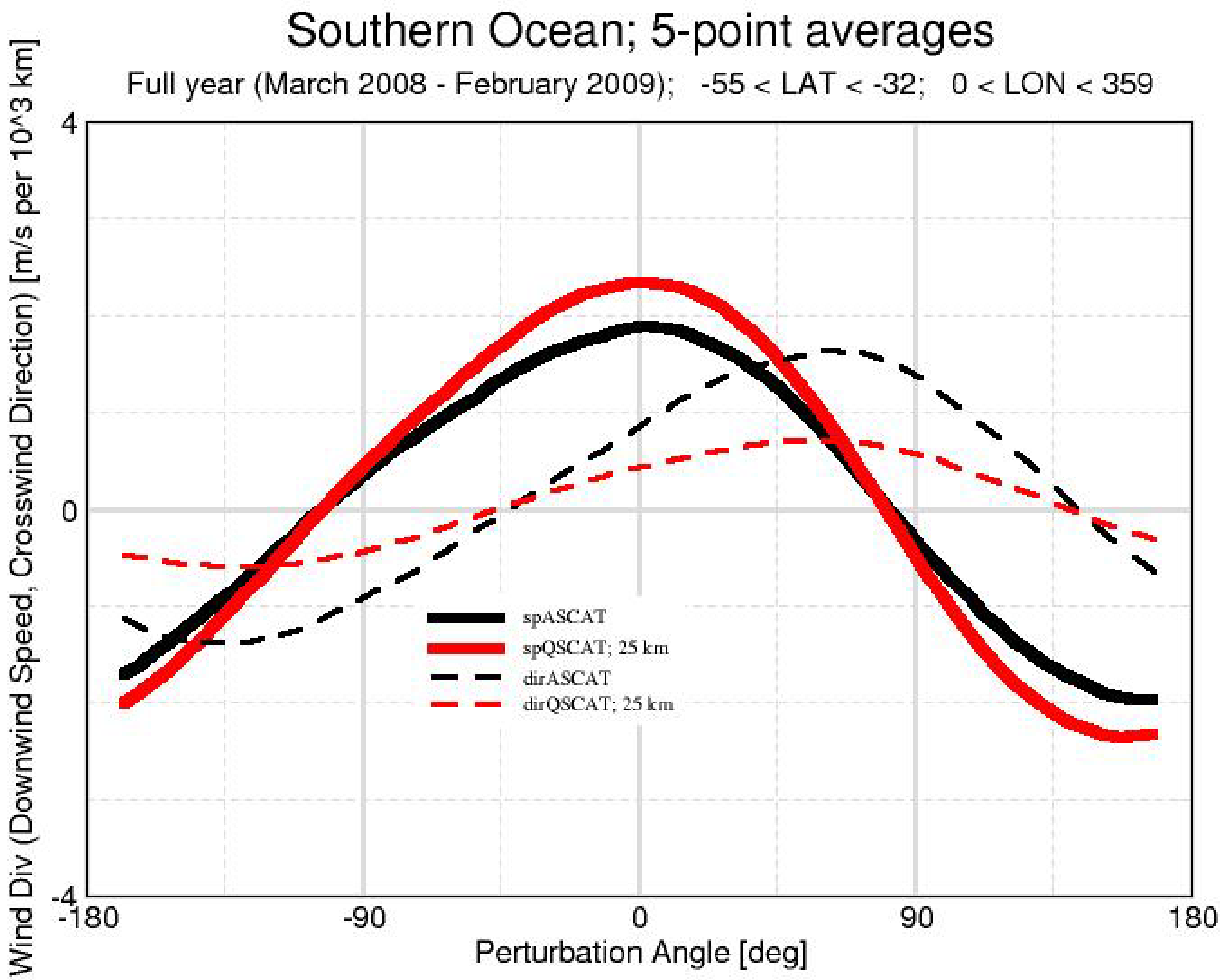
Southern Ocean
Full year (March 2008 - February 2009); -55 < LAT < -32; 0 < LON < 359
Wind Curl (Neg Crosswind Speed, Downwind Direction) [m/s per 10^3 km]
2
0
-2
-180
-90
0
90
180
Perturbation Angle [deg]
spQSCAT; 25km; Ascending
spQSCAT; 25km; Descending
dirQSCAT; Ascending
dirQSCAT; 25km; Descending

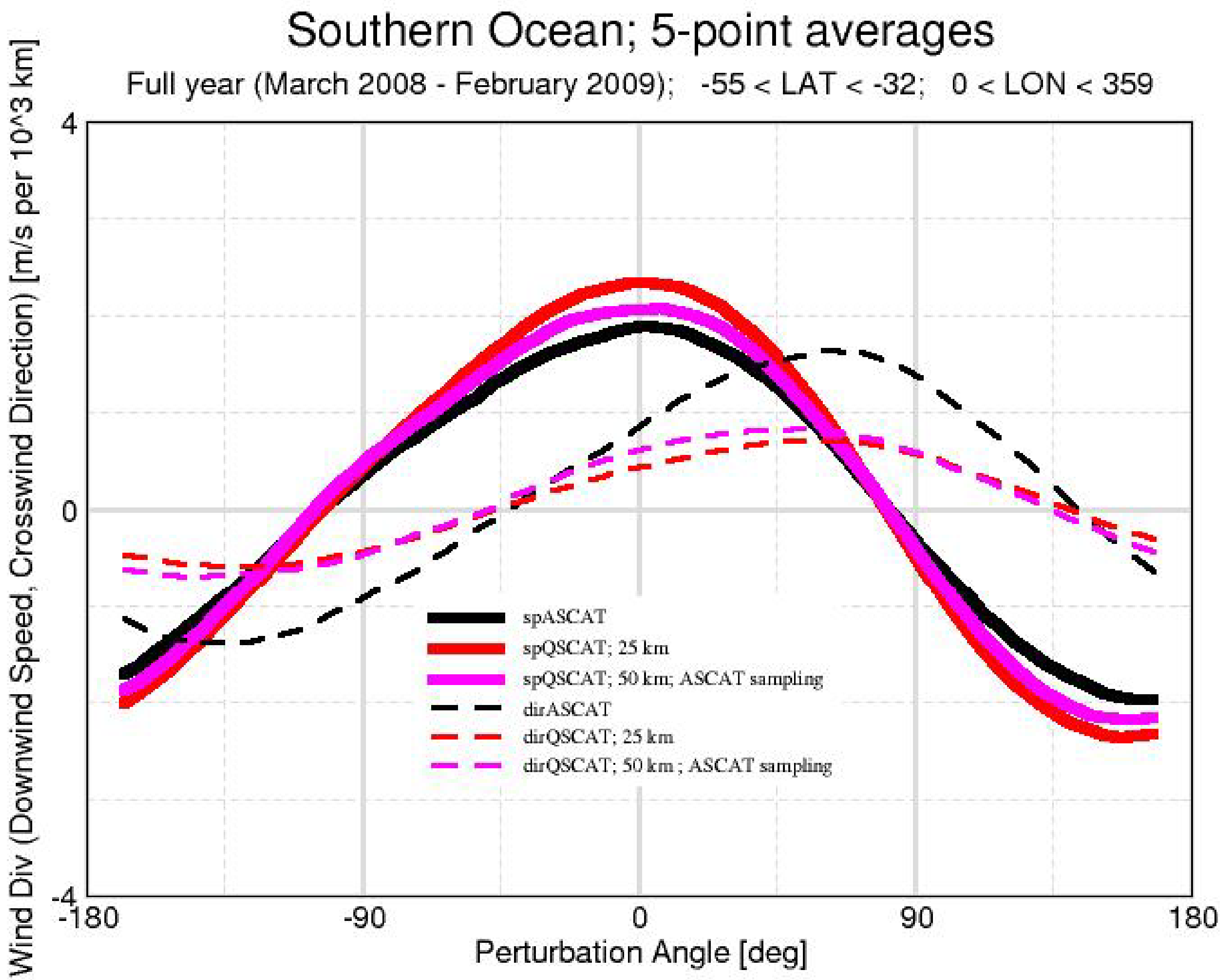

Southern Ocean
Full year (March 2008 - February 2009); -55 < LAT < -32; 0 < LON < 359
Wind Curl (Neg Crosswind Speed, Downwind Direction) [m/s per 10^3 km]
2
0
-2
-180
-90
0
90
180
Perturbation Angle [deg]
spASCAT - Ascending
spASCAT - Descending
spQSCAT; 25km; Ascending
spQSCAT; 25km; Descending
dirASCAT; Ascending
dirASCAT; Descending
dirQSCAT; Ascending
dirQSCAT; 25km; Descending

Summary

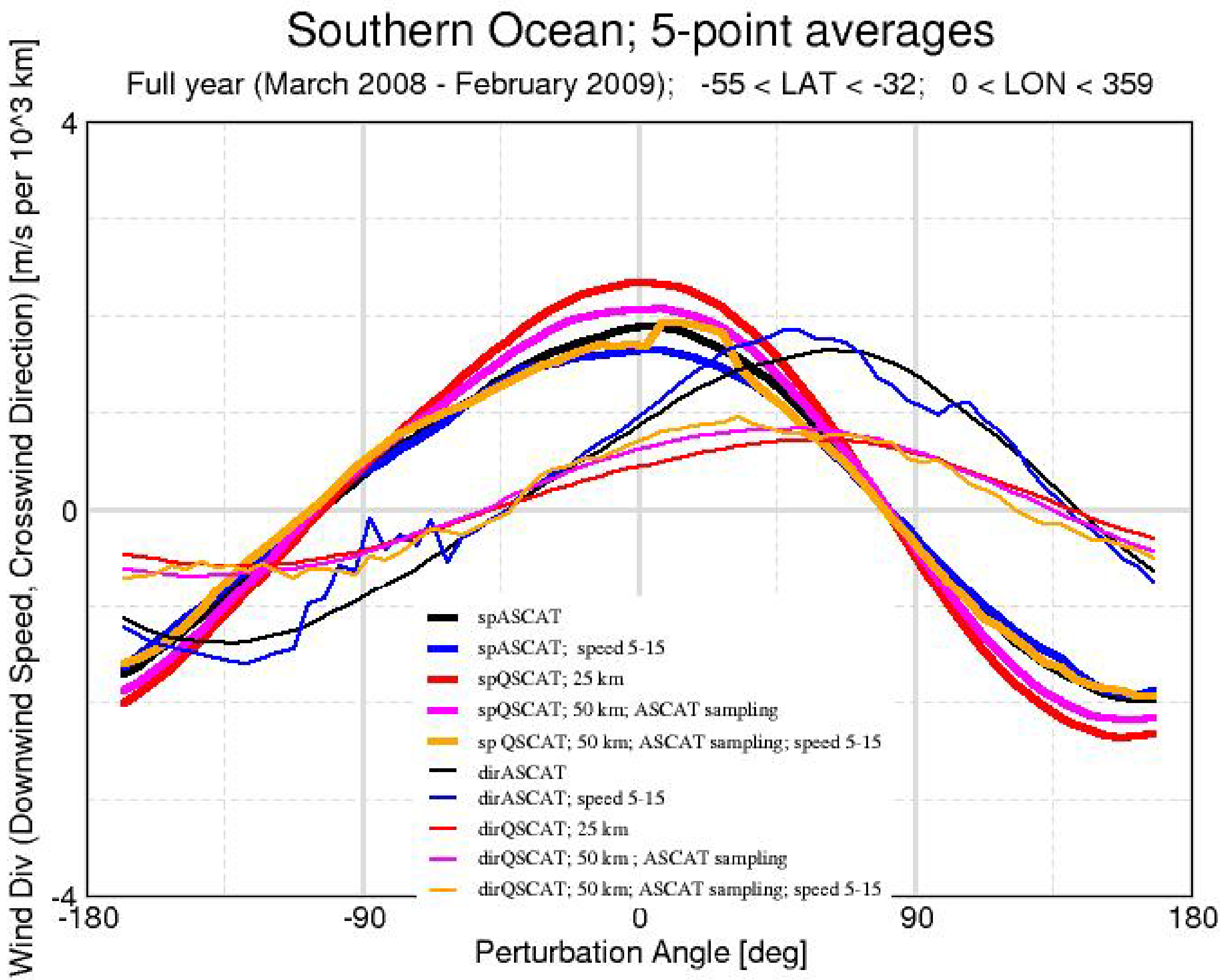
- ASCAT and QuikSCAT wind estimates differ from the ECMWF winds in a similar way
- However, ASCAT and QuikSCAT departures from ECMWF also differ
- In terms of the wind coupling with SST gradients, the differences in departure:
  - Have geographical, seasonal and diurnal variability
  - cannot be explained by the different instrument resolution and sampling
  - GMF difference does not seems to be the source either
  - ASCAT wind curl perturbations are associated with:
    - weaker crosswind speed gradients than QuikSCAT
    - Stronger downwind direction gradients
  - The ASCAT coupling between wind curl perturbations and cross-wind SST gradients is noisier than the QuikSCAT coupling
  - This is consistent with the stronger ASCAT directional response since the directional response is generally noisier

Backup


Southern Ocean; 5-point averages
Full year (March 2008 - February 2009); -55 < LAT < -32; 0 < LON < 359
Wind Div (Downwind Speed, Crosswind Direction) [m/s per 10^3 km]
4
0
-4
-180
-90
0
90
180
Perturbation Angle [deg]
spASCAT
spQSCAT; 25 km
dirASCAT
dirQSCAT; 25 km



Southern Ocean; 5-point averages
Full year (March 2008 - February 2009); -55 < LAT < -32; 0 < LON < 359
Wind Div (Downwind Speed, Crosswind Direction) [m/s per 10^3 km]
4
0
-4
-180
-90
0
90
180
Perturbation Angle [deg]
spASCAT
spQSCAT; 25 km
spQSCAT; 50 km; ASCAT sampling
dirASCAT
dirQSCAT; 25 km
dirQSCAT; 50 km ; ASCAT sampling



Southern Ocean; 5-point averages
Full year (March 2008 - February 2009); -55 < LAT < -32; 0 < LON < 359
Wind Div (Downwind Speed, Crosswind Direction) [m/s per 10^3 km]
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Perturbation Angle [deg]
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spASCAT; speed 5-15
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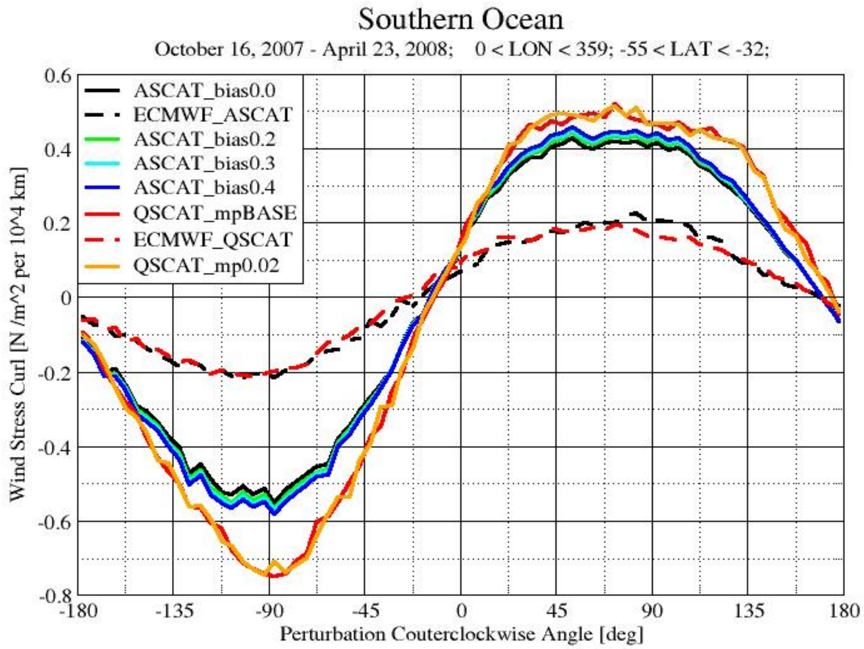
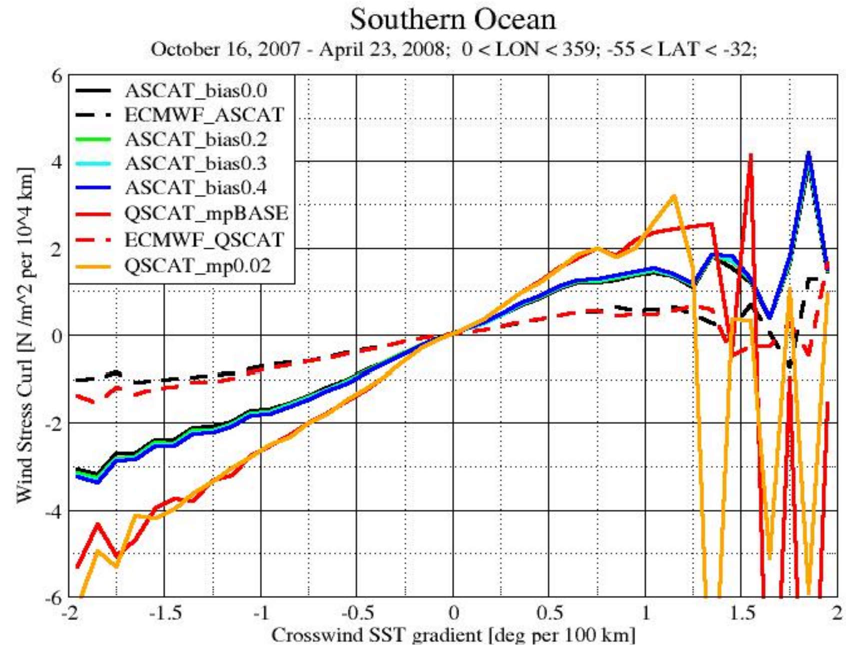
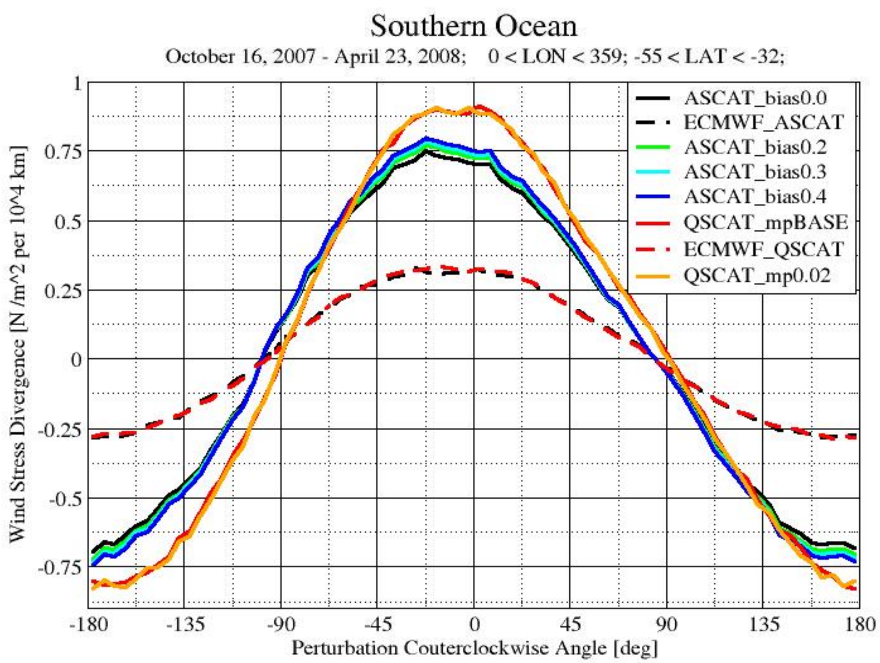
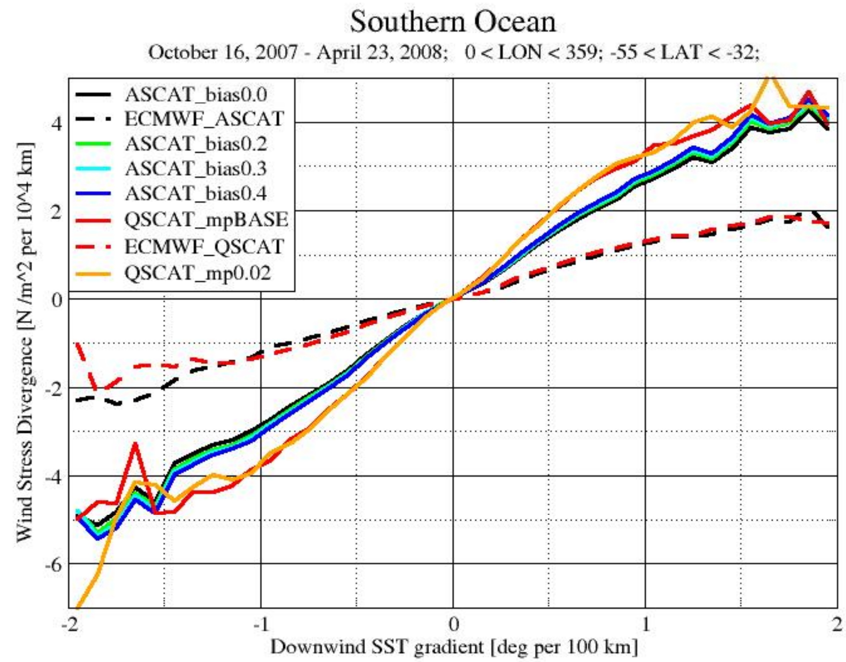
dirASCAT
dirASCAT; speed 5-15
dirQSCAT; 25 km
dirQSCAT; 50 km ; ASCAT sampling
dirQSCAT; 50 km; ASCAT sampling; speed 5-15

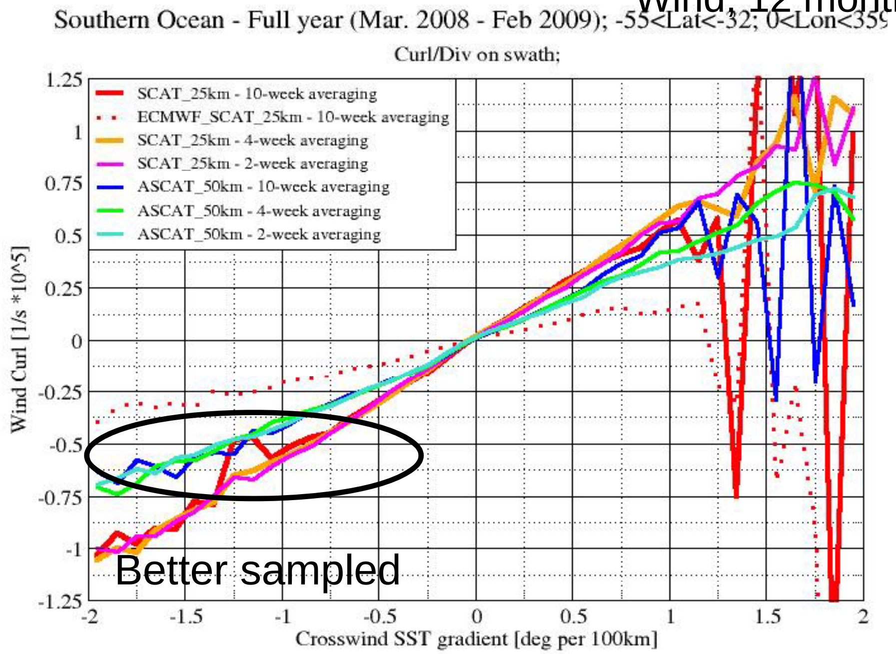

Southern Ocean
October 16, 2007 - April 23, 2008; 0 < LON < 359; -55 < LAT < -32;
ASCAT_bias0.0
ECMWF_ASCAT
ASCAT_bias0.2
ASCAT_bias0.3
ASCAT_bias0.4
QSCAT_mpBASE
ECMWF_QSCAT
QSCAT_mp0.02
Wind Stress Curl [N /m^2 per 10^4 km]
Perturbation Couterclockwise Angle [deg]

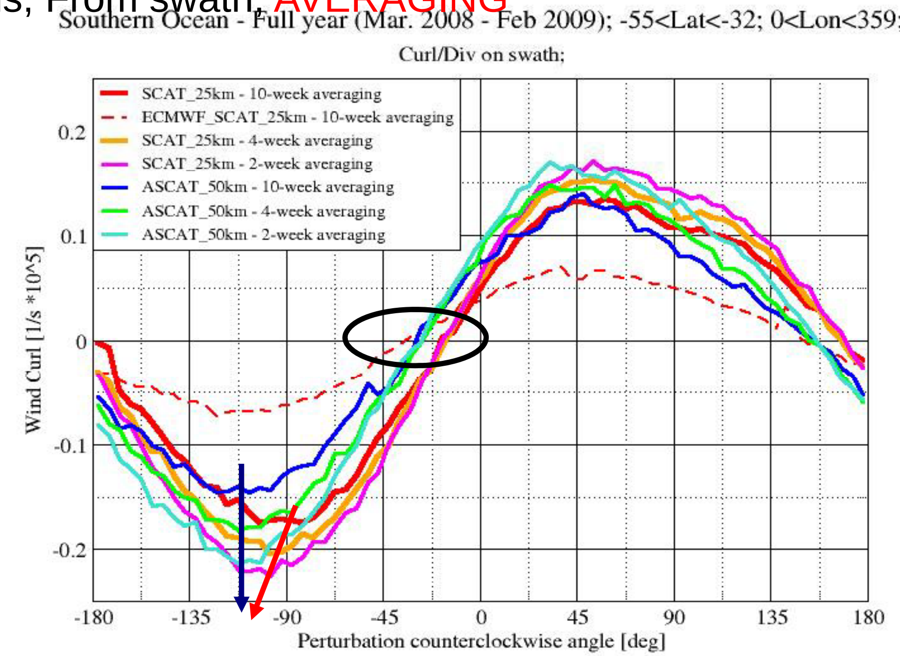

Southern Ocean
October 16, 2007 - April 23, 2008; 0 < LON < 359; -55 < LAT < -32;
ASCAT_bias0.0
ECMWF_ASCAT
ASCAT_bias0.2
ASCAT_bias0.3
ASCAT_bias0.4
QSCAT_mpBASE
ECMWF_QSCAT
QSCAT_mp0.02
Wind Stress Curl [N /m^2 per 10^4 km]
Crosswind SST gradient [deg per 100 km]

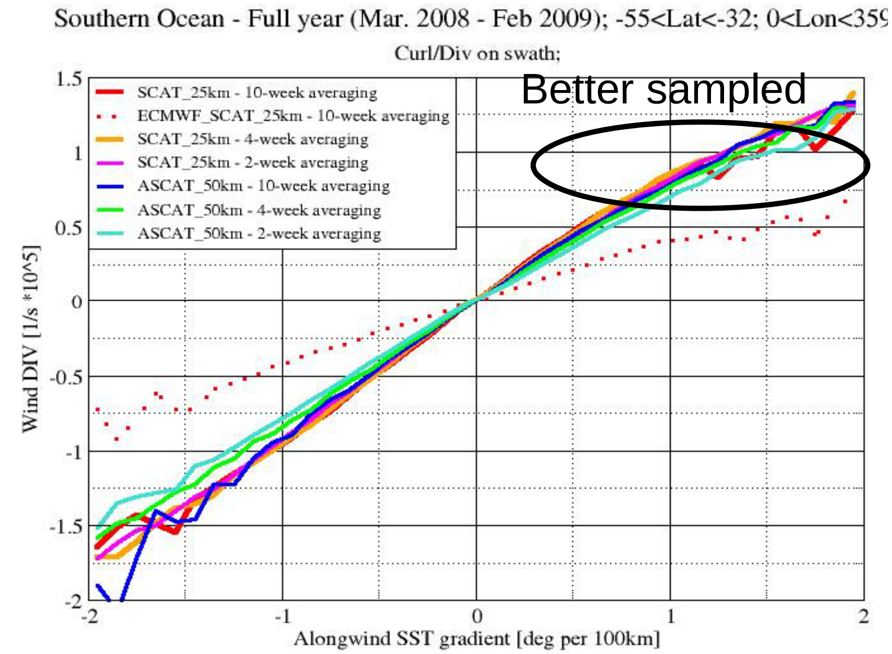

Southern Ocean
October 16, 2007 - April 23, 2008; 0 < LON < 359; -55 < LAT < -32;
ASCAT_bias0.0
ECMWF_ASCAT
ASCAT_bias0.2
ASCAT_bias0.3
ASCAT_bias0.4
QSCAT_mpBASE
ECMWF_QSCAT
QSCAT_mp0.02
Wind Stress Divergence [N /m^2 per 10^4 km]
Perturbation Couterclockwise Angle [deg]

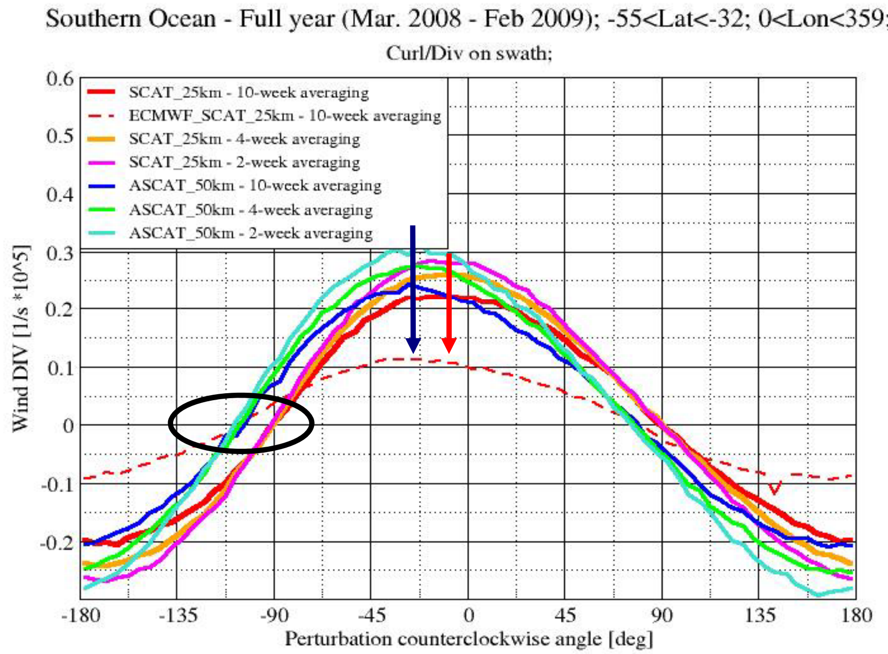

Southern Ocean
October 16, 2007 - April 23, 2008; 0 < LON < 359; -55 < LAT < -32;
ASCAT_bias0.0
ECMWF_ASCAT
ASCAT_bias0.2
ASCAT_bias0.3
ASCAT_bias0.4
QSCAT_mpBASE
ECMWF_QSCAT
QSCAT_mp0.02
Wind Stress Divergence [N /m^2 per 10^4 km]
Downwind SST gradient [deg per 100 km]

Wind; 12 months; From swath; AVERAGING

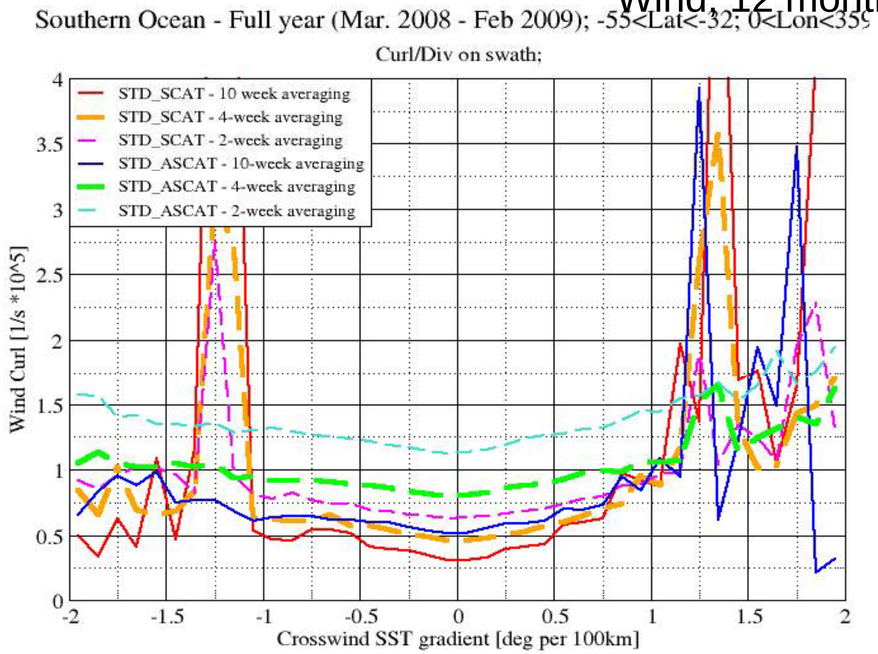


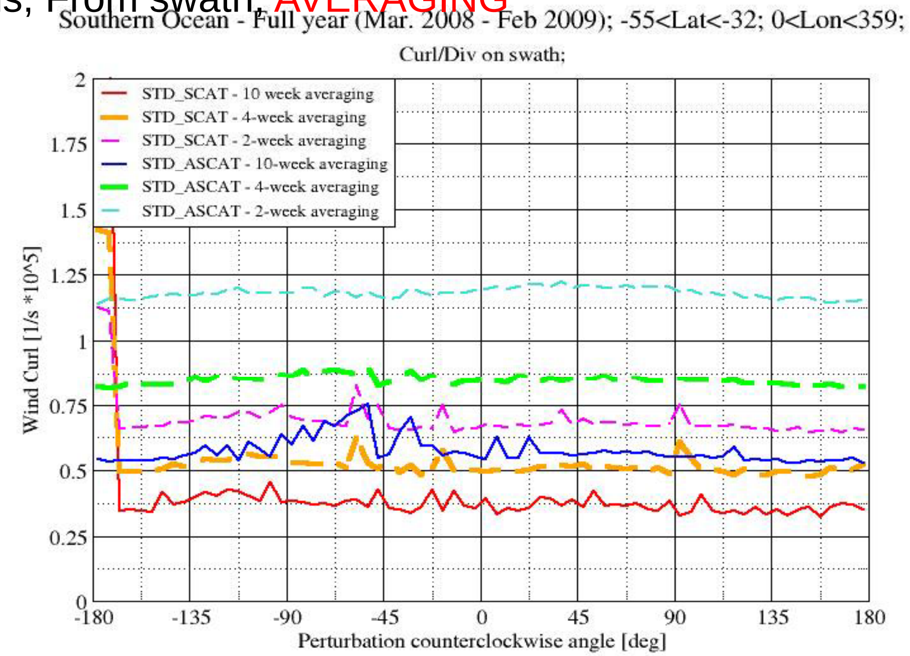


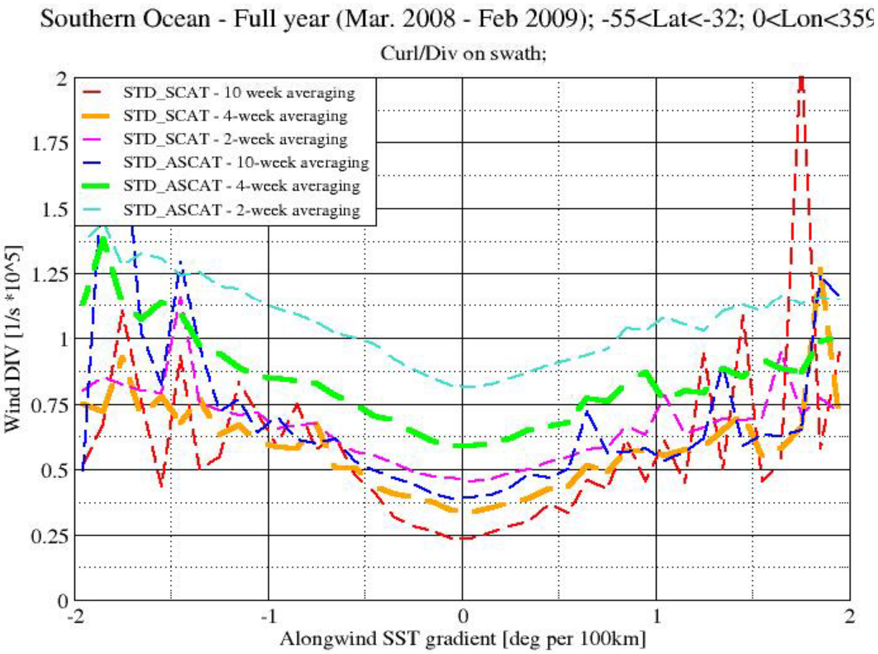


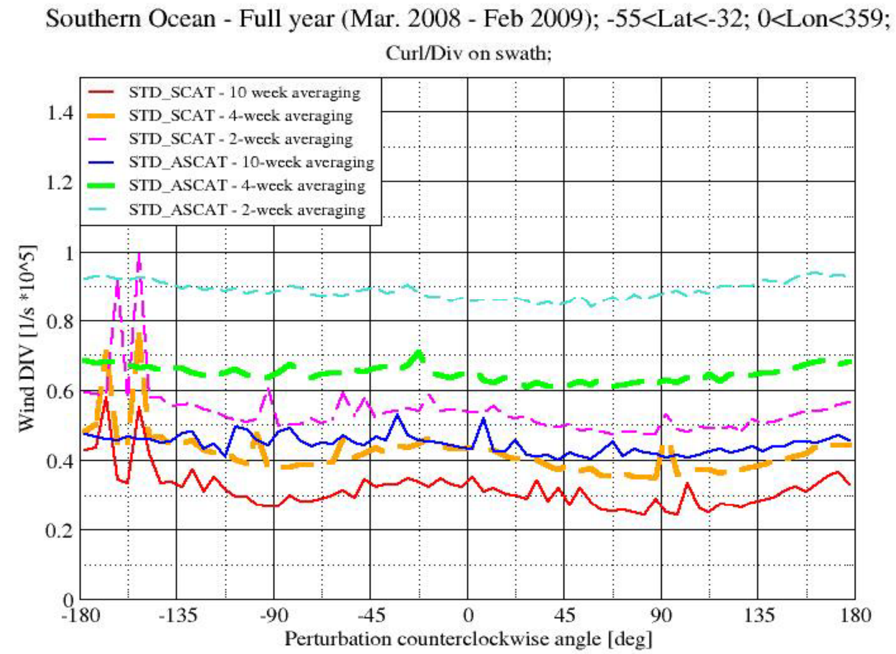


Wind; 12 months; From swath; AVERAGING

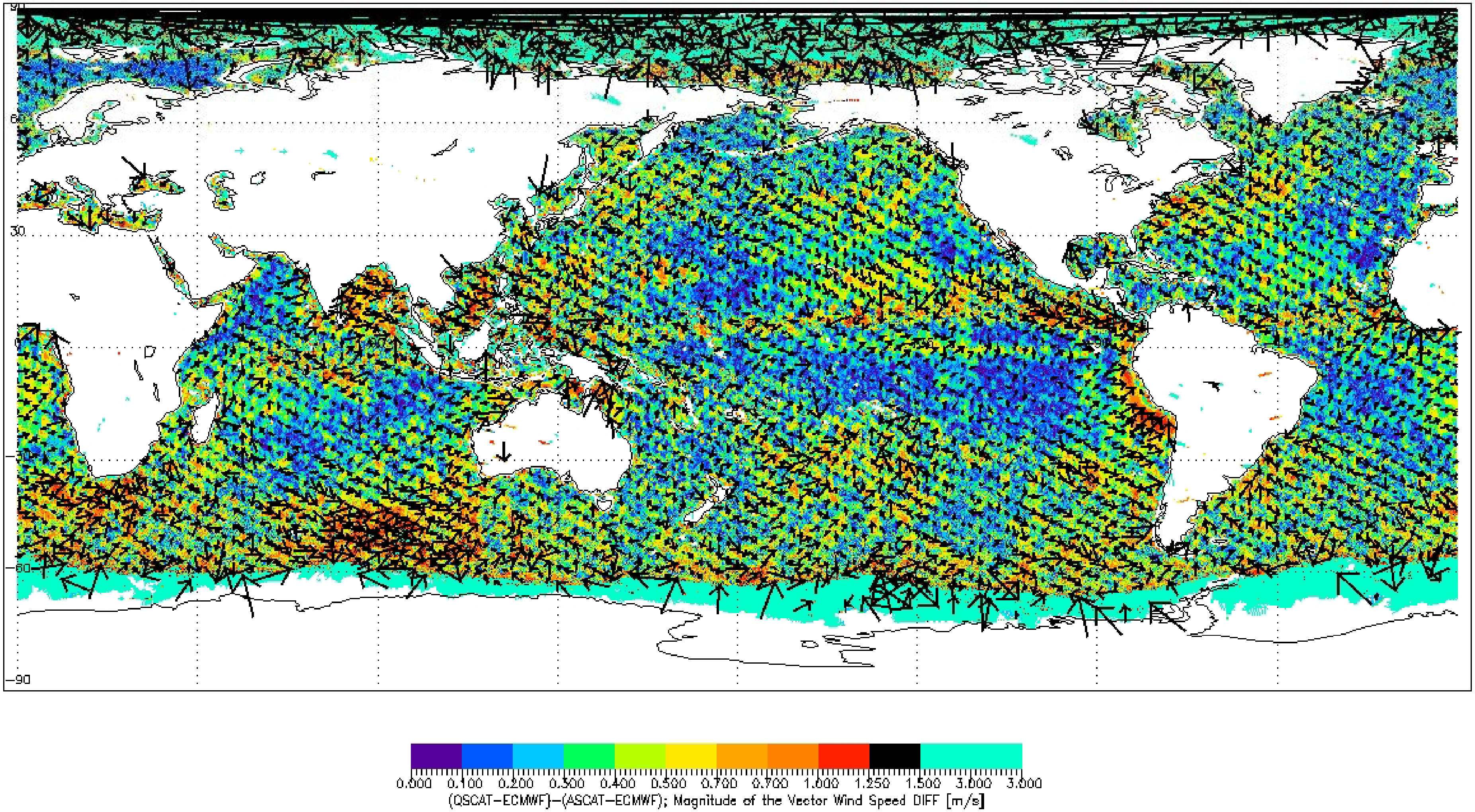




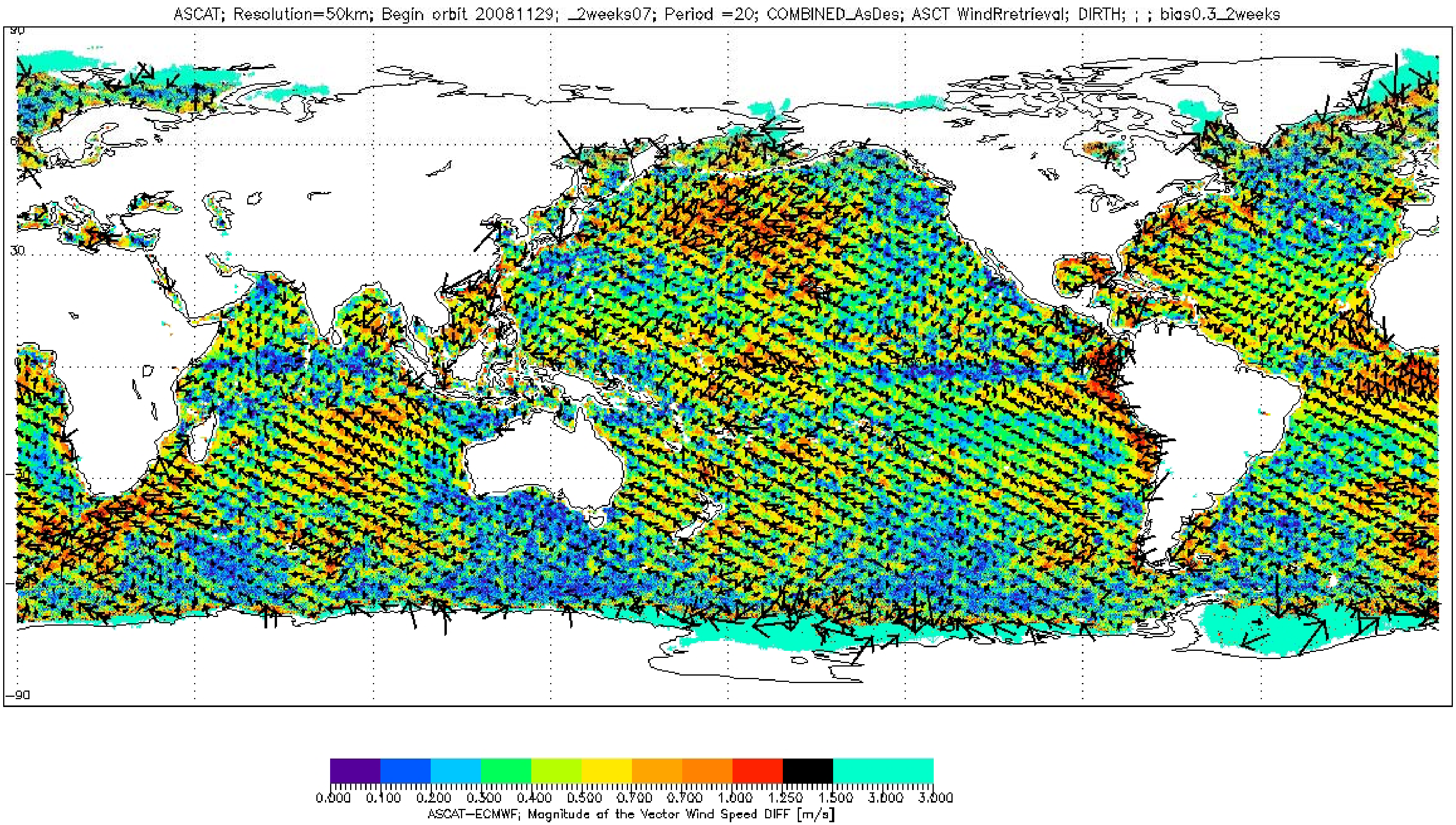




Summer


30
−60
−90
0.000 0.100 0.200 0.300 0.400 0.500 0.700 0.700 1.000 1.250 1.500 3.000 3.000
(QSCAT−ECMWF)−(ASCAT−ECMWF); Magnitude of the Vector Wind Speed DIFF [m/s]

Winter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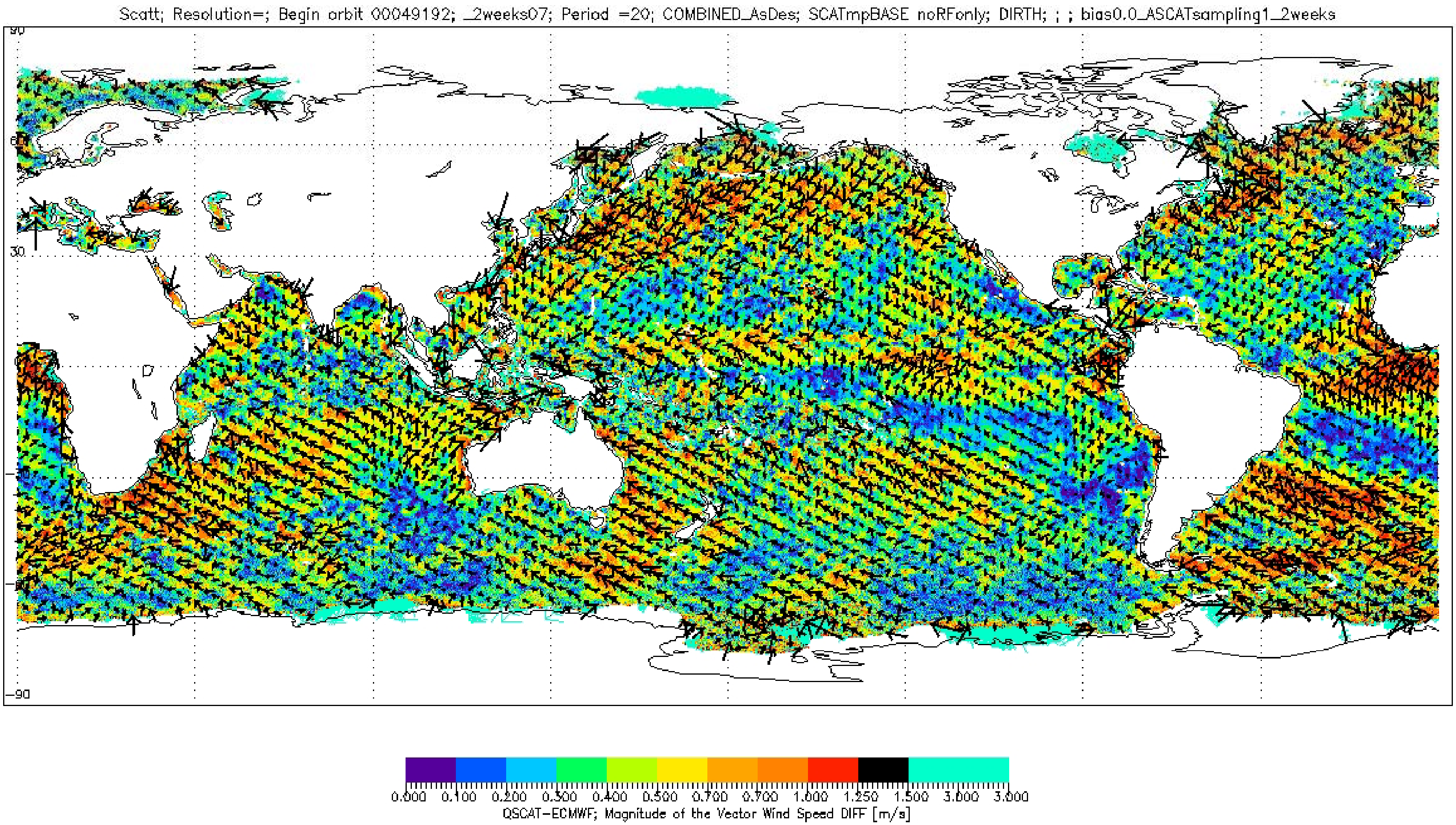
90
30
-90
0.000 0.100 0.200 0.300 0.400 0.500 0.700 0.700 1.000 1.250 1.500 3.000 3.000
ASCAT-ECMWF; Magnitude of the Vector Wind Speed DIFF [m/s]

Winter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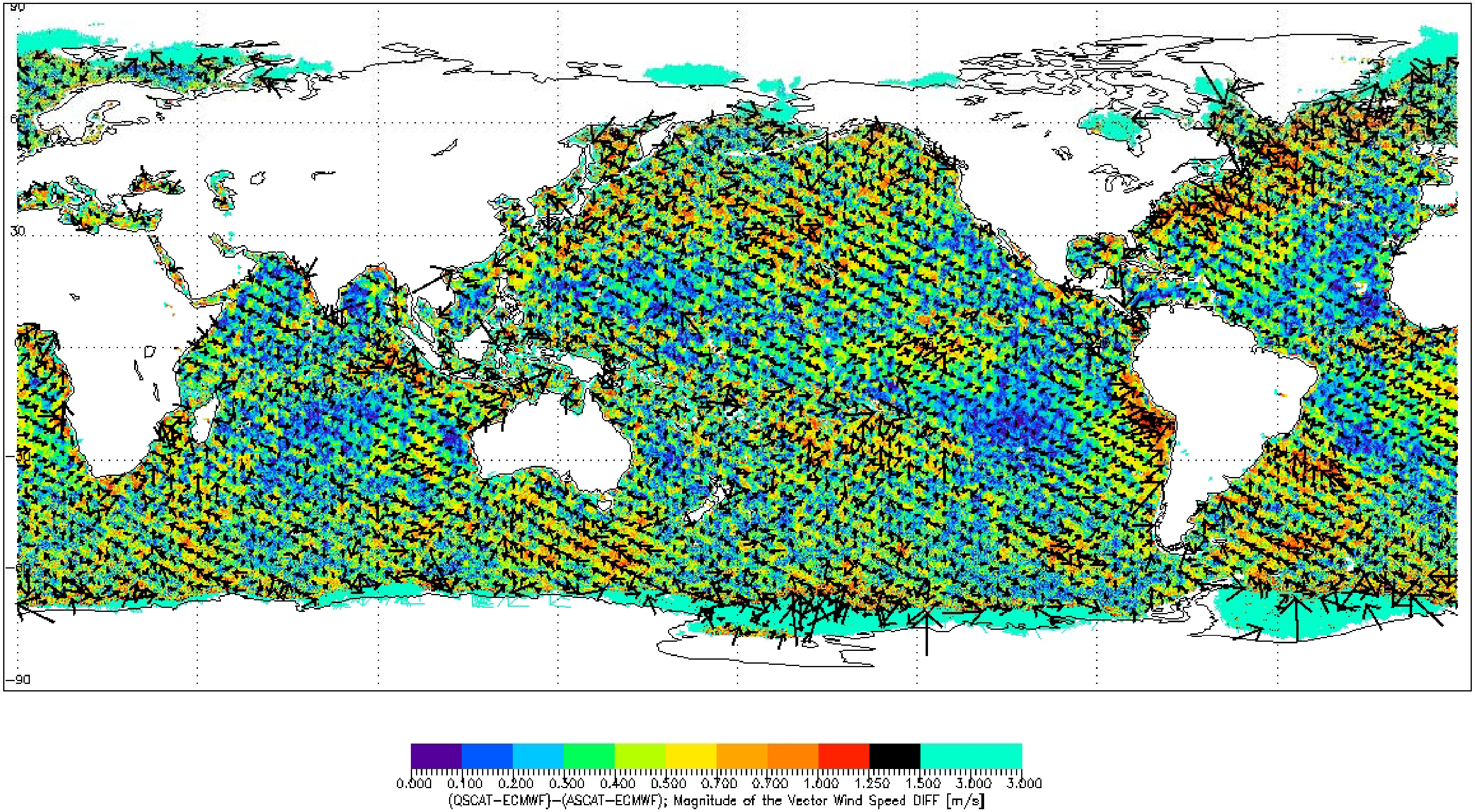
60
30
-90
0.000 0.100 0.200 0.300 0.400 0.500 0.700 0.700 1.000 1.250 1.500 3.000 3.000
QSCAT-ECMWF; Magnitude of the Vector Wind Speed DIFF [m/s]

Winter



90
30
-90
0.000 0.100 0.200 0.300 0.400 0.500 0.700 0.700 1.000 1.250 1.500 3.000 3.000
(QSCAT-ECMWF)-(ASCAT-ECMWF); Magnitude of the Vector Wind Speed DIFF [m/s]