Midlatitude Ocean-Atmosphere Interaction

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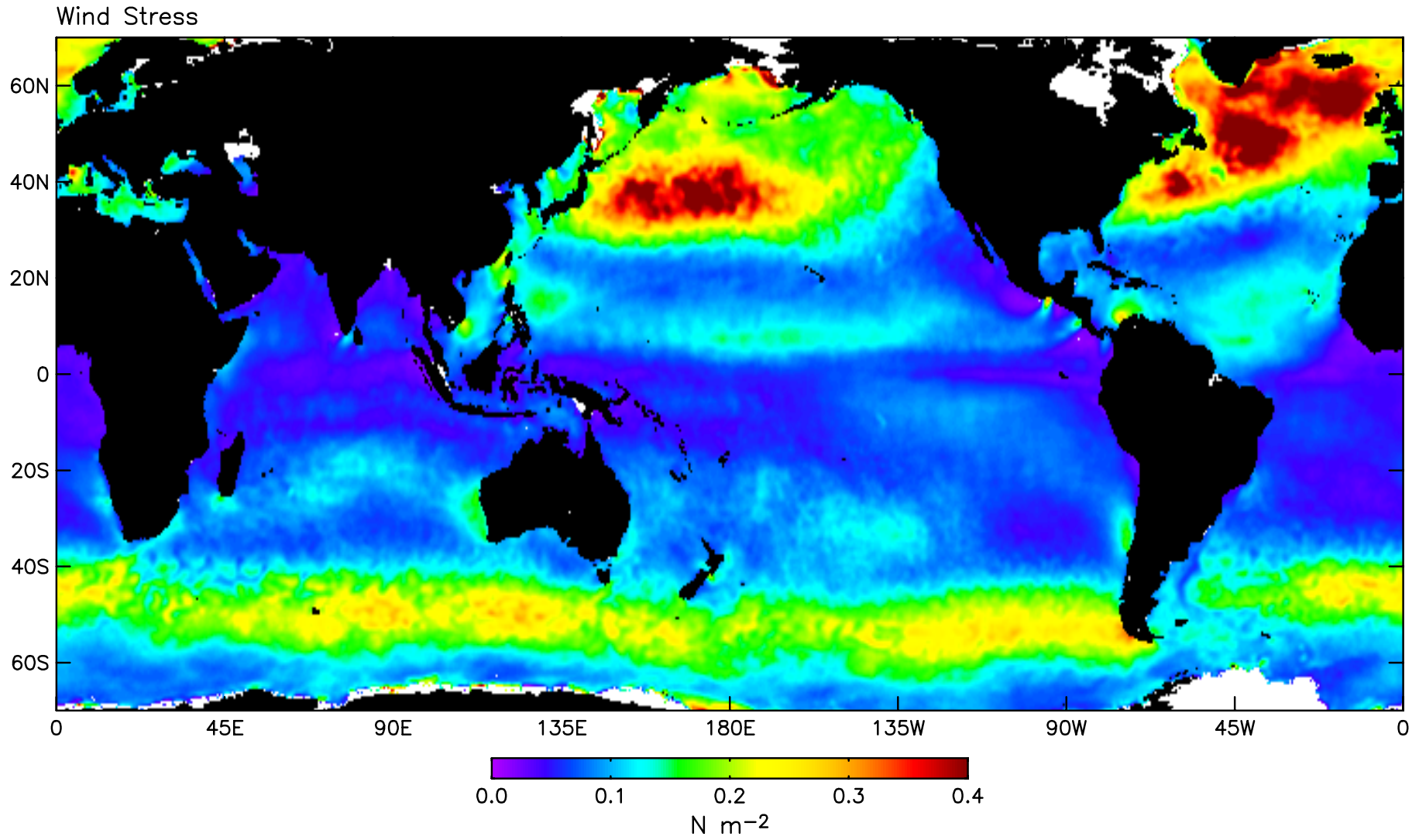
Objectives:

1) Continued analyses of QuikSCAT winds and AMSR-E SST fields, together with vertical structure inferred from the ECMWF model, to improve the understanding of SST influence on low-level winds.

2) Use QuikSCAT winds as a basis for improving the accuracies of ECMWF operational and reanalysis surface wind fields.

3) Investigate the feedback effects of SST-induced small-scale perturbations of the wind stress field on the ocean circulation.

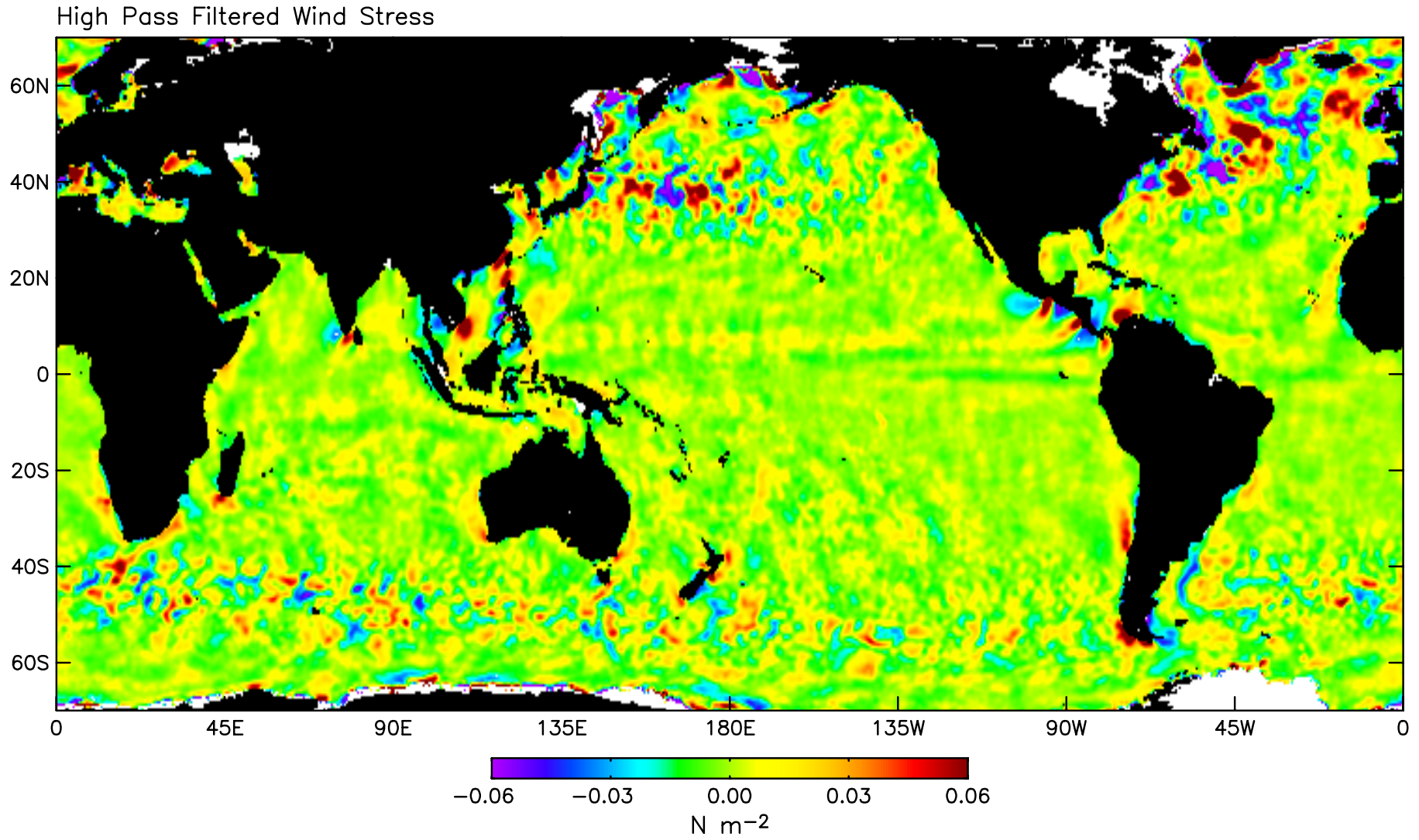
2-Month Average Wind Stress Magnitude



2-Month Average Wind Stress Magnitude

(Spatially High-Pass Filtered)

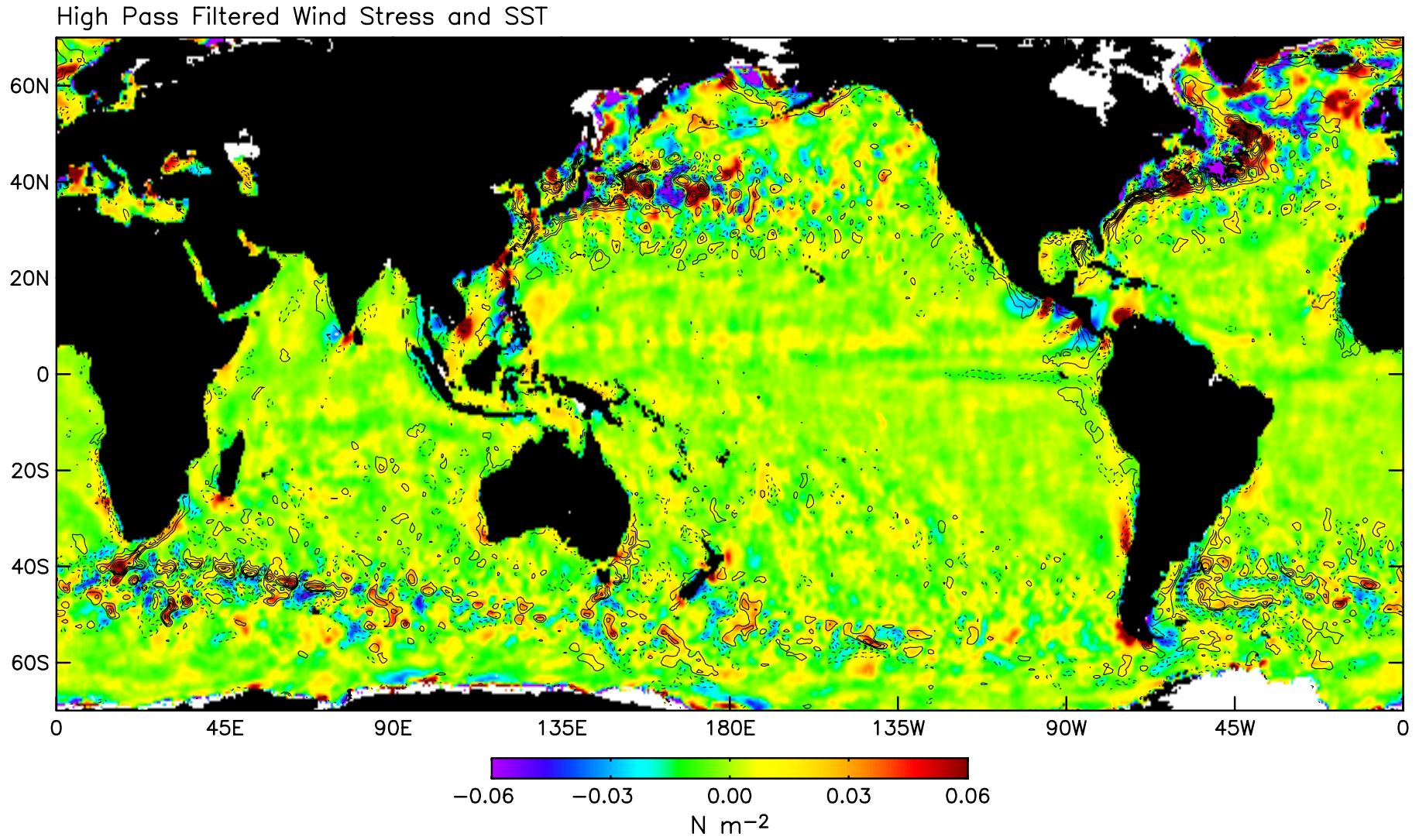
QuikSCAT, January–February 2003



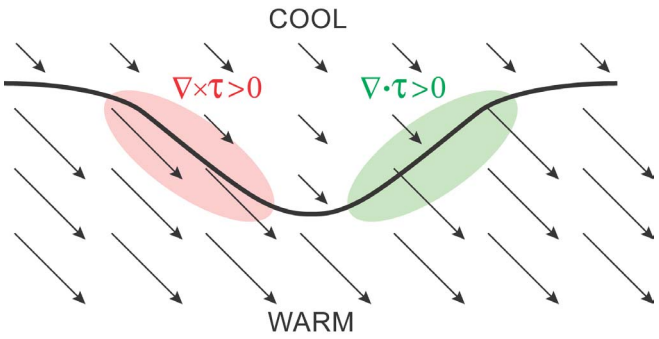
2-Month Average Wind Stress Magnitude and SST

(Spatially High-Pass Filtered)

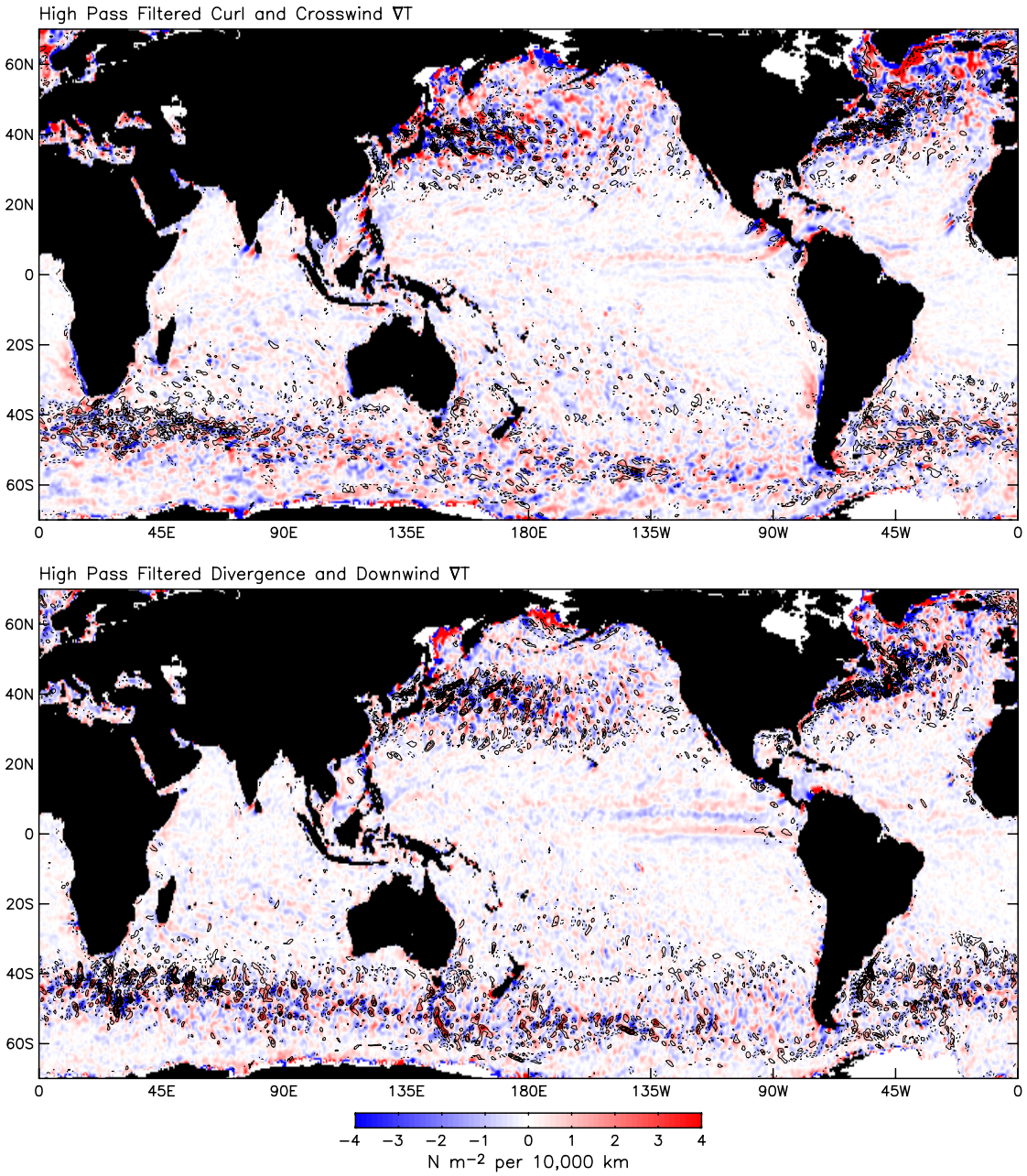
QuikSCAT, January–February 2003



Effects of SST Gradients on the Wind Stress Curl and Divergence



QuikSCAT, January–February 2003

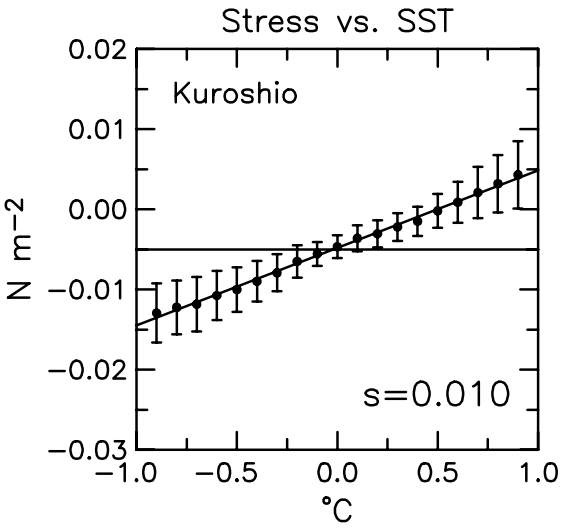


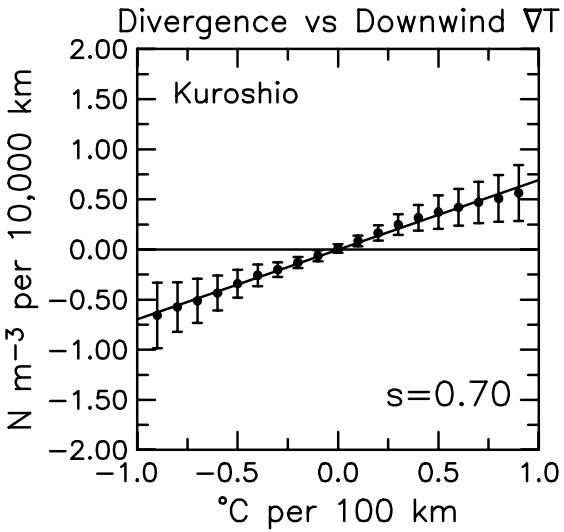
Objective 1:

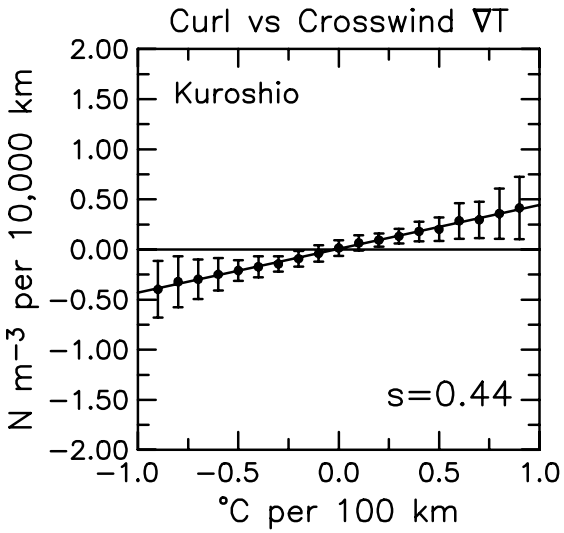
Continued analyses of QuikSCAT winds and AMSR-E SST fields, together with vertical structure inferred from the ECMWF model, to improve the understanding of SST influence on low-level winds.

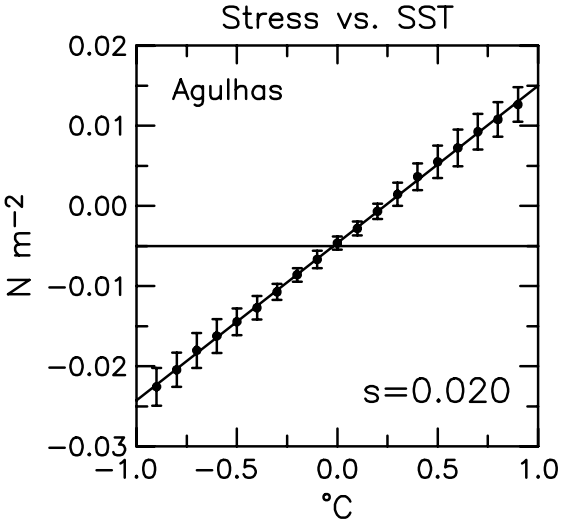
- *Why does the coupling between SST and winds vary geographically?*
- *Why is the coupling stronger in winter than in summer?*
- *What is the mechanism for generation of small-scale structures in the wind stress field in regions of weak SST gradients?*
- . . .

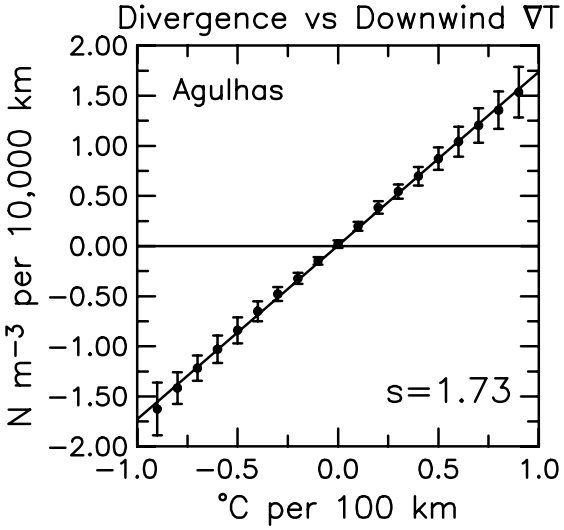
QuikSCAT and AMSR, September 2002 - August 2004

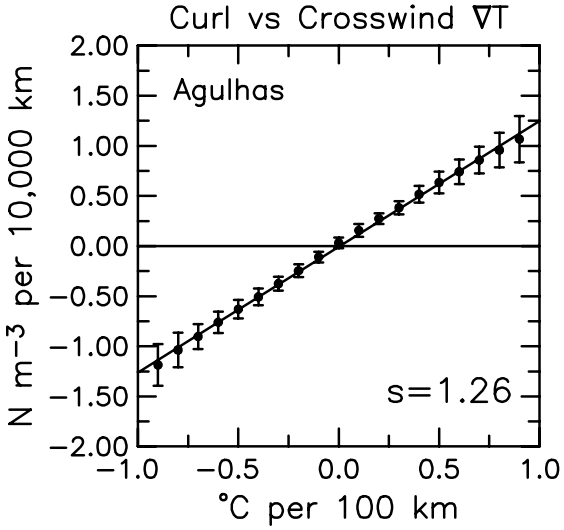




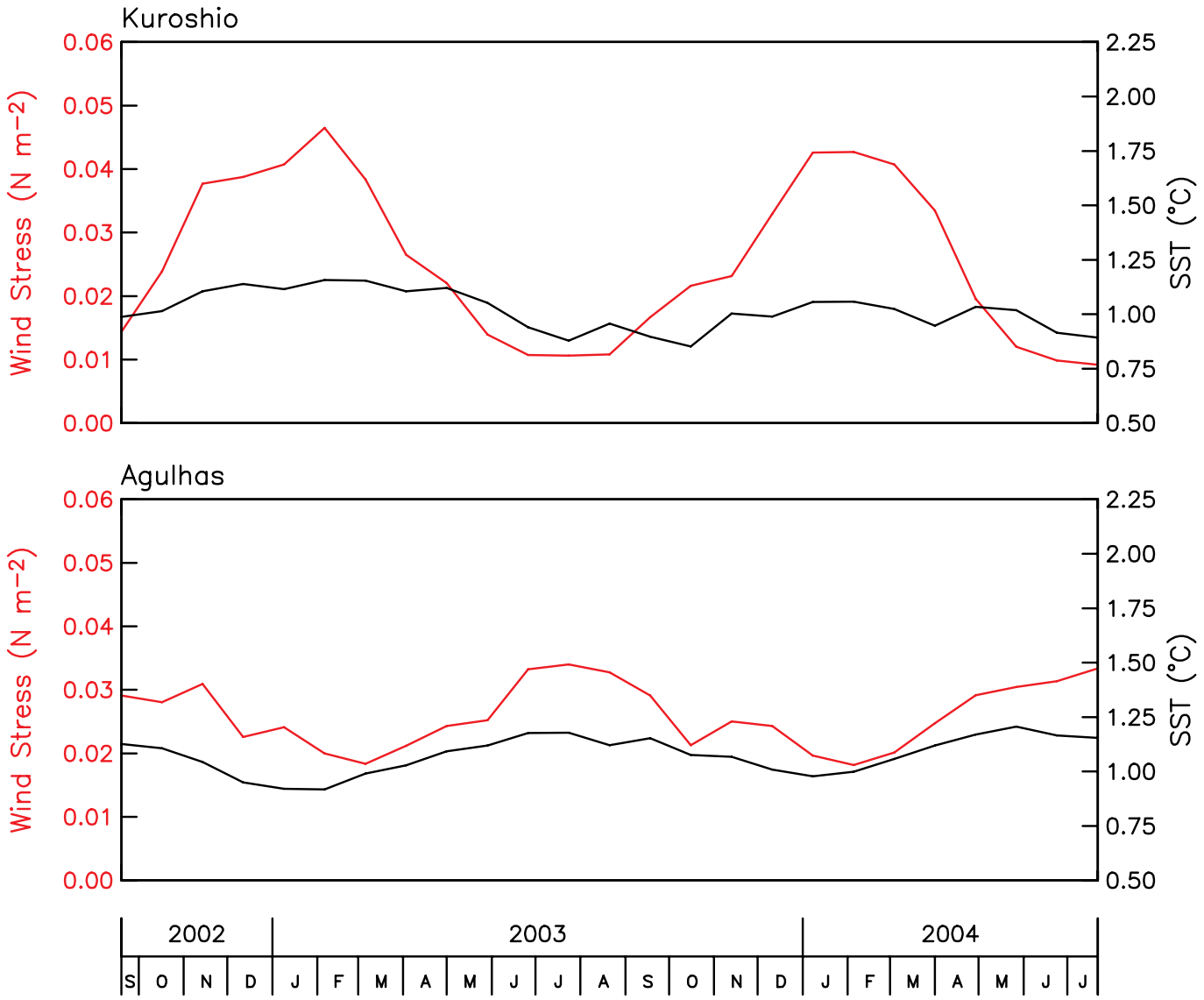


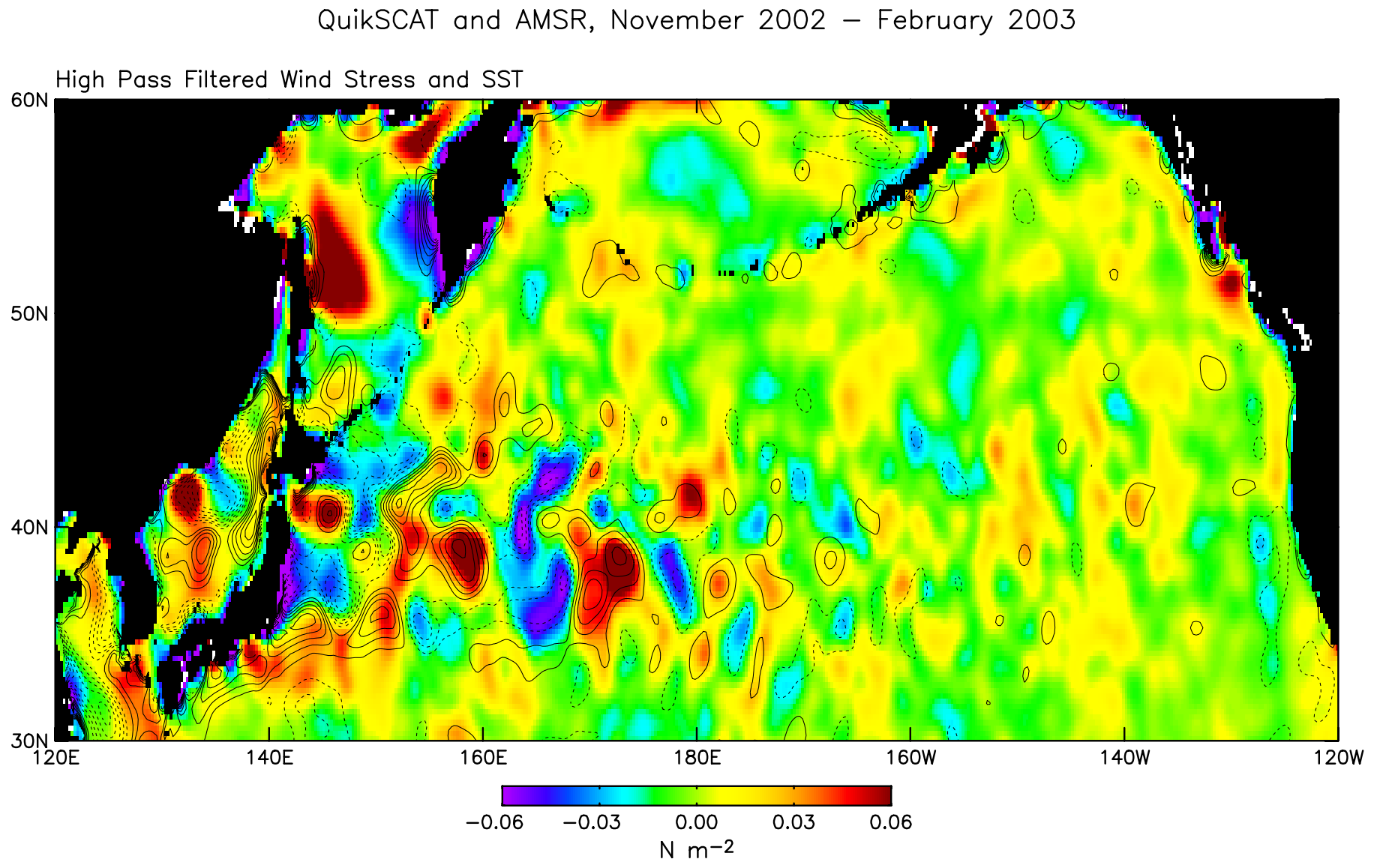






Standard Deviations of Small-Scale Variability of the Wind Stress Magnitude and SST Fields




QuikSCAT and AMSR, November 2002 – February 2003
High Pass Filtered Wind Stress and SST
60N
50N
40N
30N
120E
140E
160E
180E
160W
140W
120W
−0.06
−0.03
0.00
0.03
0.06
N m−2

Objective 2:

Use QuikSCAT winds as a basis for improving the accuracies of ECMWF operational and reanalysis surface wind fields.

Motivation: Accurate ECMWF Reanalysis wind stress fields are needed for ocean circulation modeling.

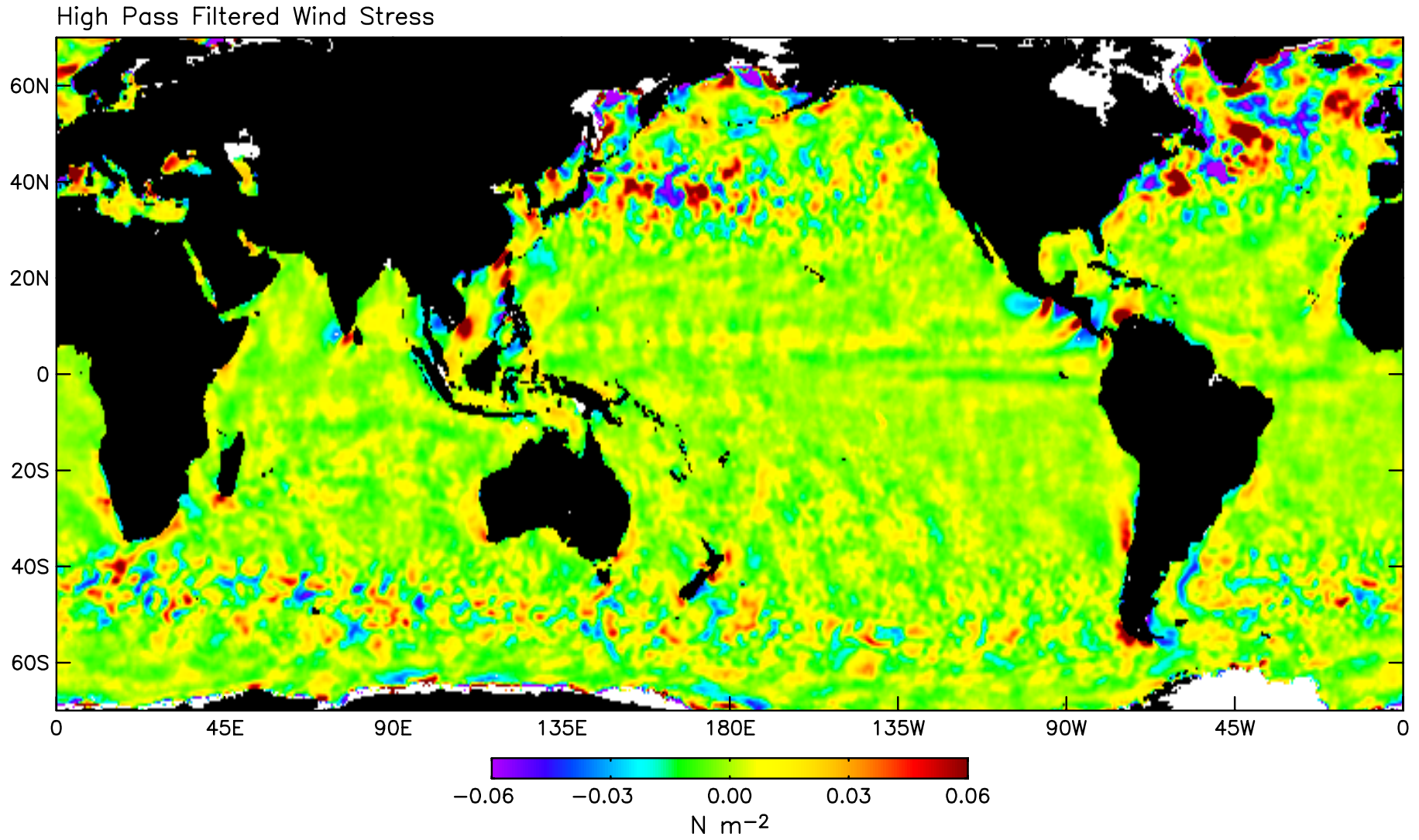
- *Use QuikSCAT winds and AMSR-E SST fields to:*
  - *improve the resolution and accuracy of the surface SST boundary condition of the ECMWF model.*
  - *improve the parameterization of boundary layer mixing in the ECMWF model.*

This work is being done collaboratively with Anton Beljaars and Hans Hersbach at ECMWF.

2-Month Average Wind Stress Magnitude

(Spatially High-Pass Filtered)

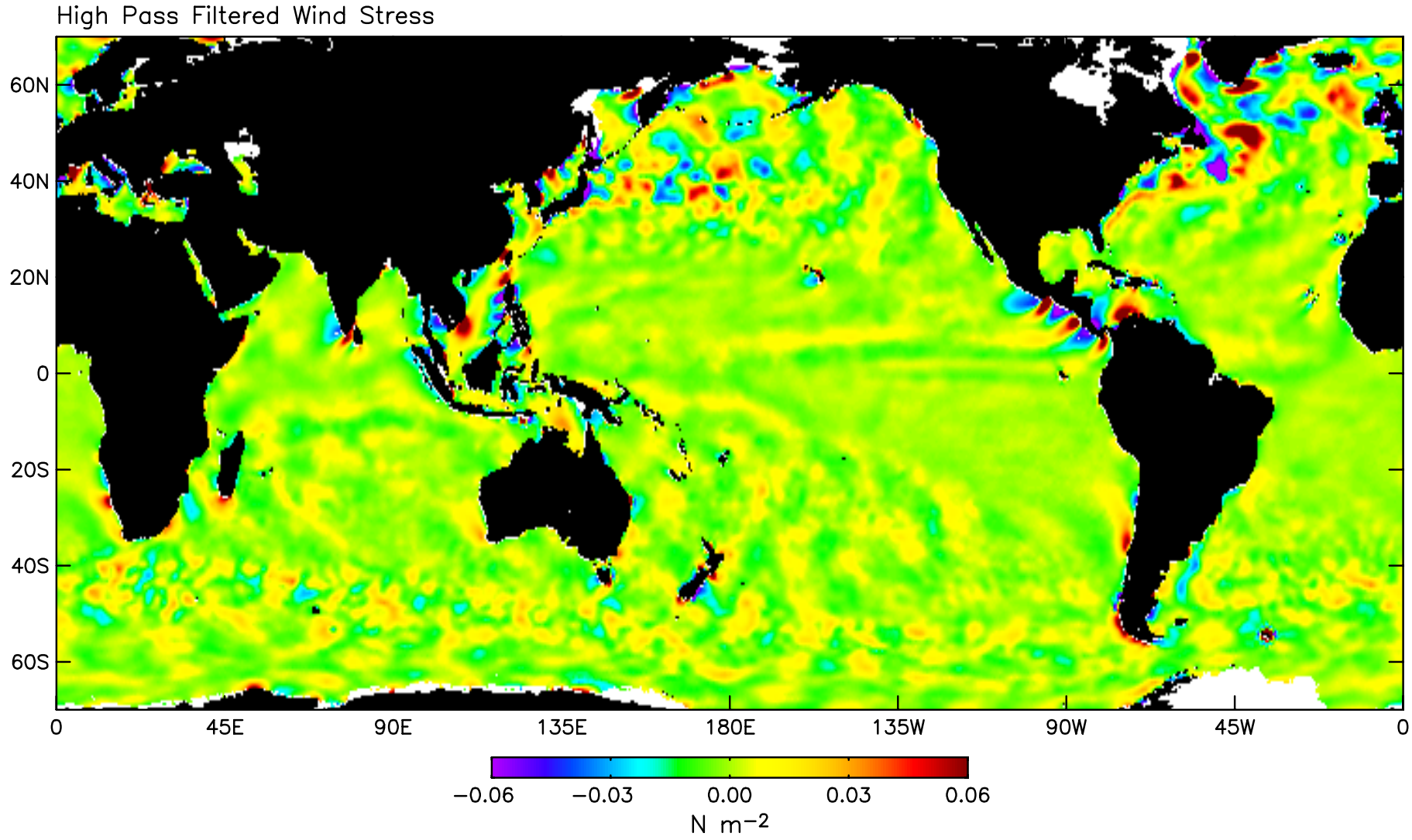
QuikSCAT, January–February 2003



2-Month Average Wind Stress Magnitude

(Spatially High-Pass Filtered)

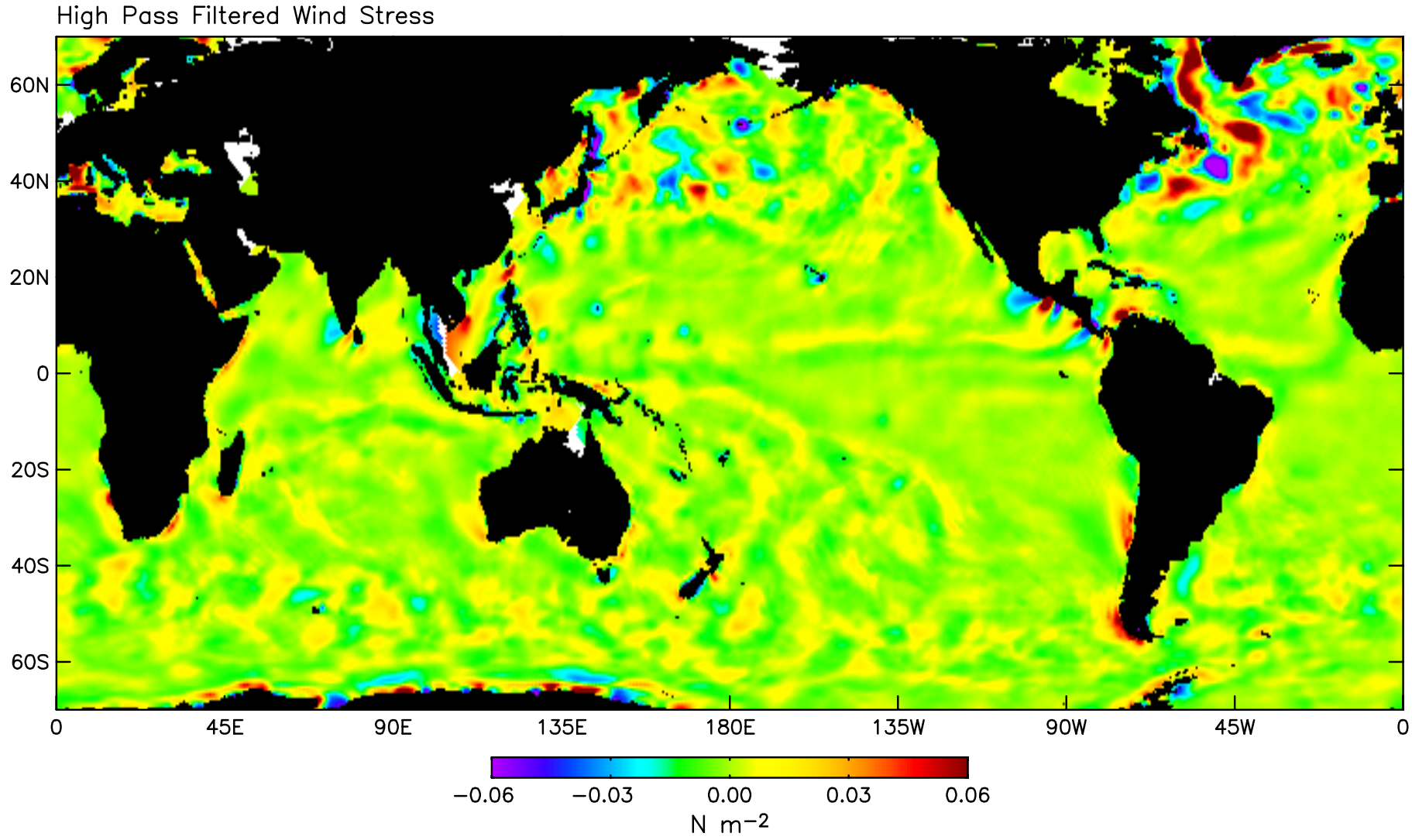
ECMWF, January–February 2003



2-Month Average Wind Stress Magnitude

(Spatially High-Pass Filtered)

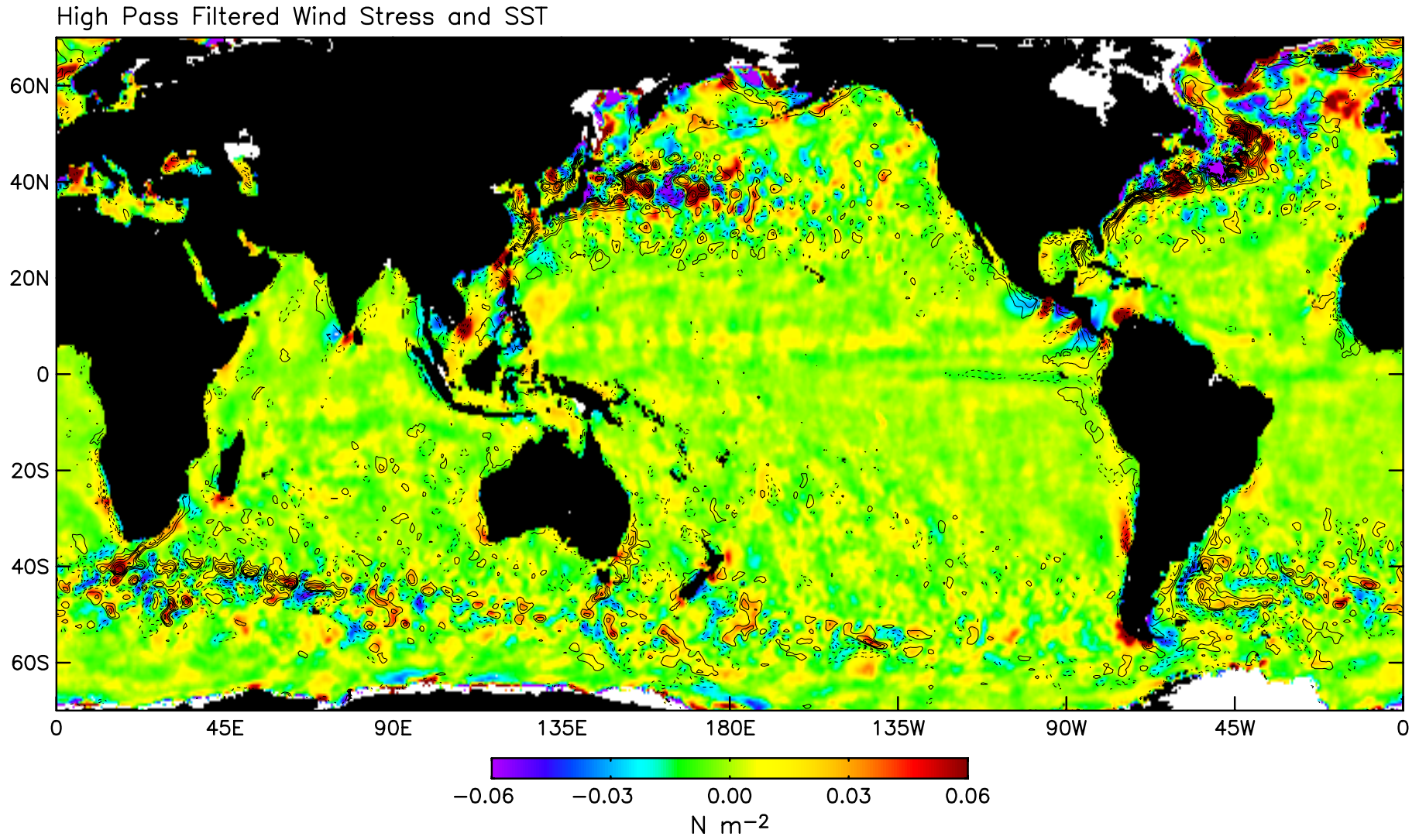
NCEP, January–February 2003



2-Month Average Wind Stress Magnitude

(Spatially High-Pass Filtered)

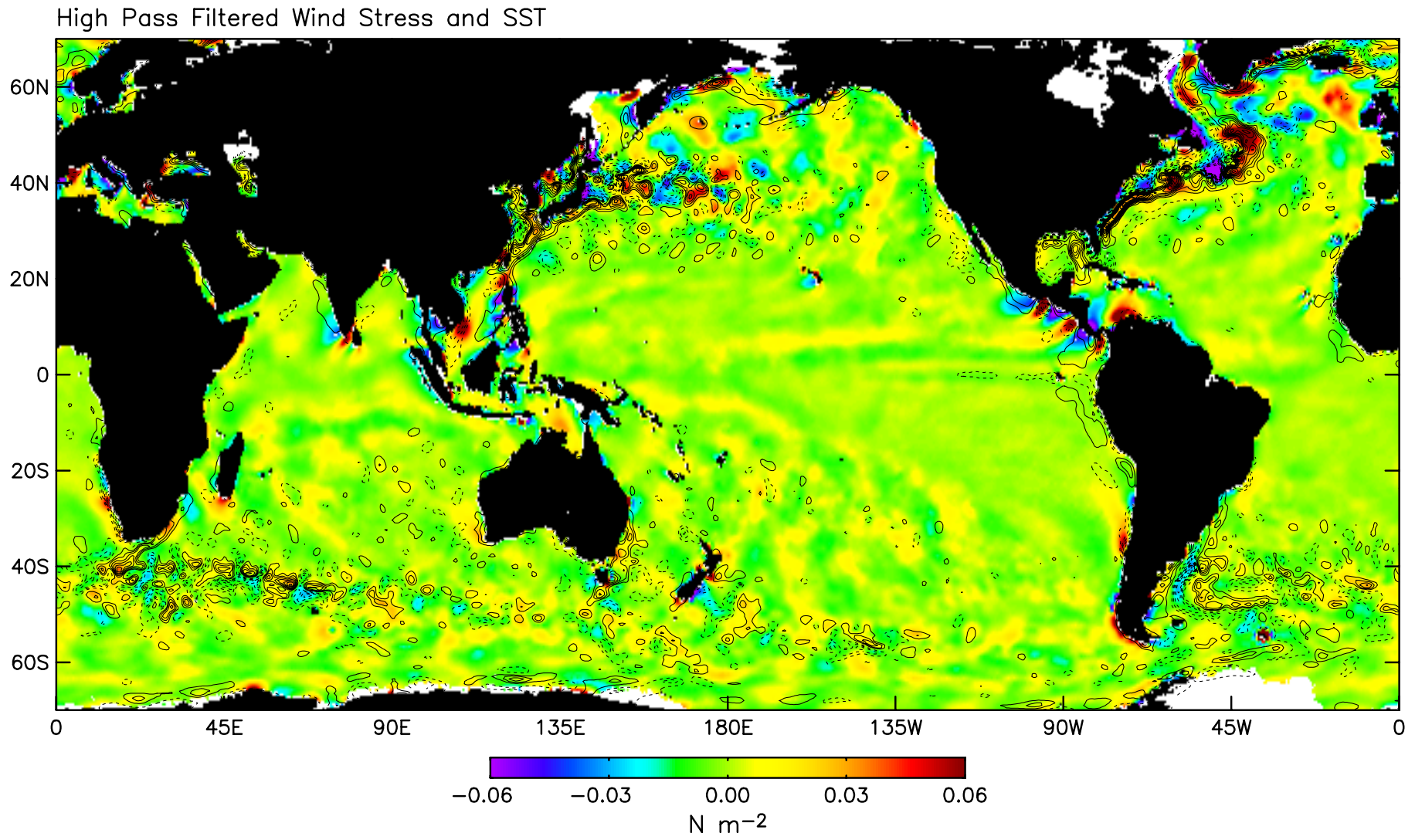
QuikSCAT, January–February 2003



2-Month Average Wind Stress Magnitude

(Spatially High-Pass Filtered)

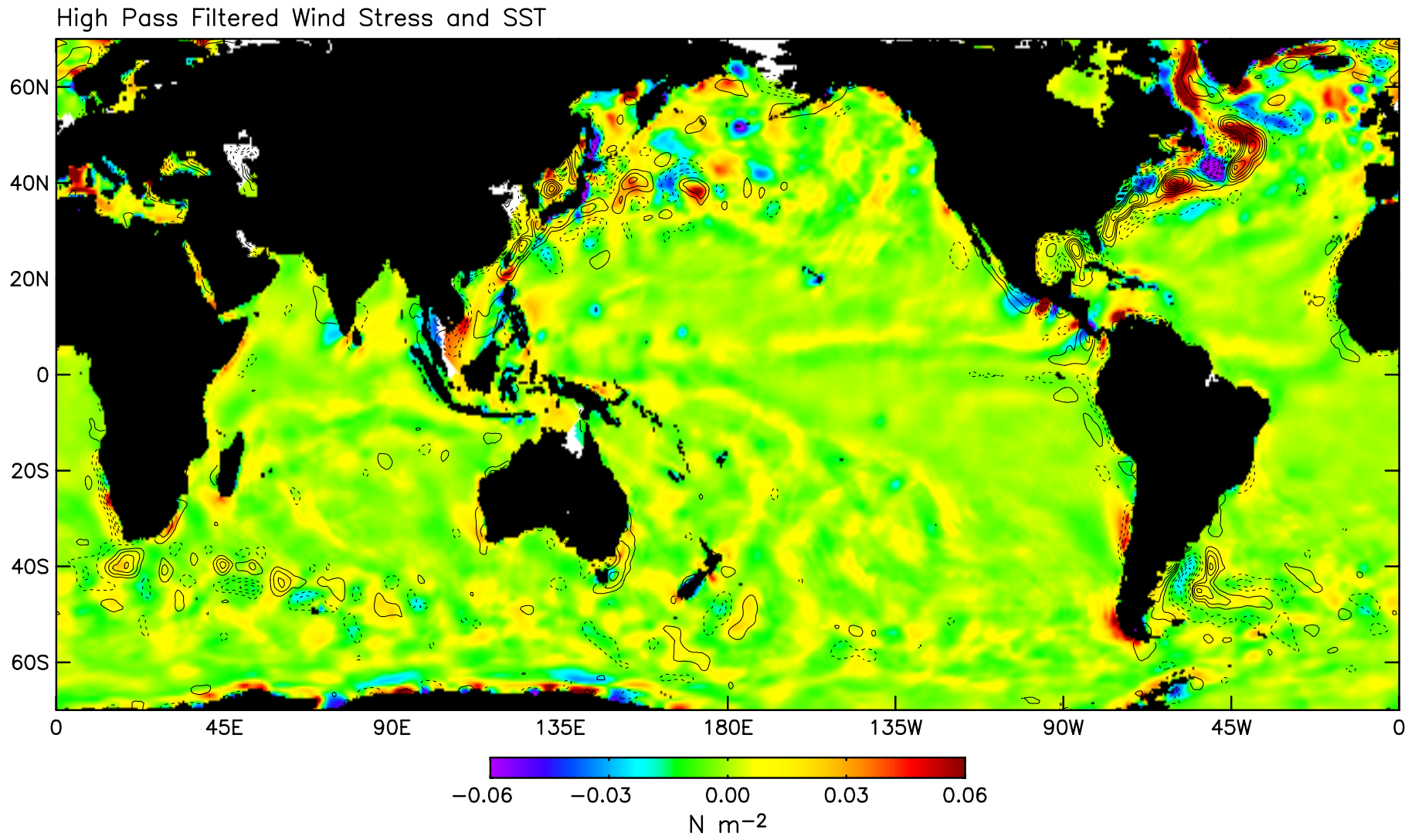
ECMWF, January–February 2003



2-Month Average Wind Stress Magnitude

(Spatially High-Pass Filtered)

NCEP, January–February 2003



Result:

Improving the resolution and accuracy of SST improves the accuracy of surface winds in NWP models.

Result:

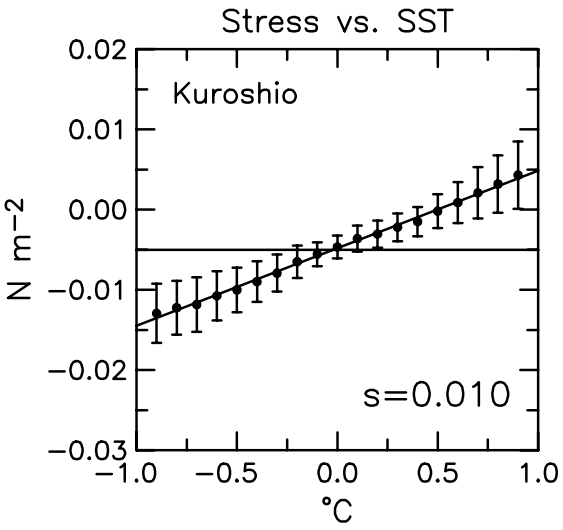
Improving the resolution and accuracy of SST improves the accuracy of surface winds in NWP models.

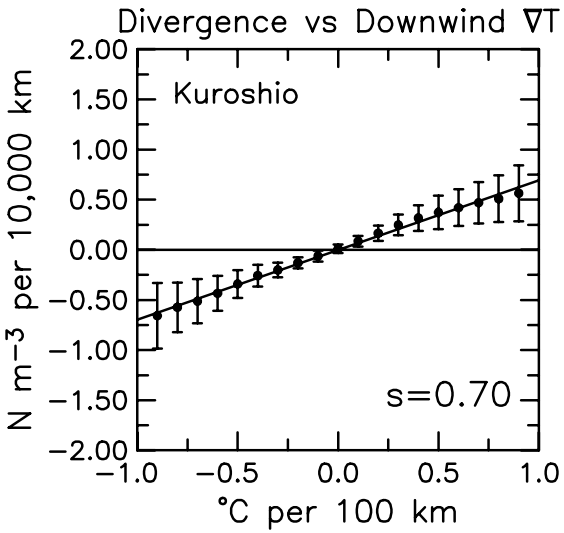
Question:

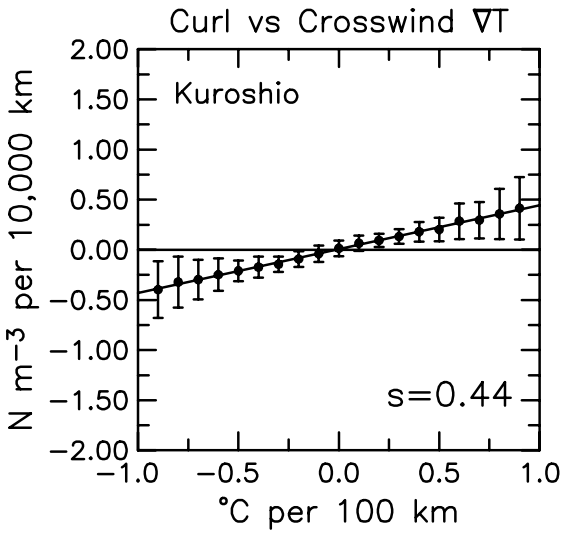
How well would the observed air-sea interaction be represented in the models if the SST boundary condition were “perfect” ?

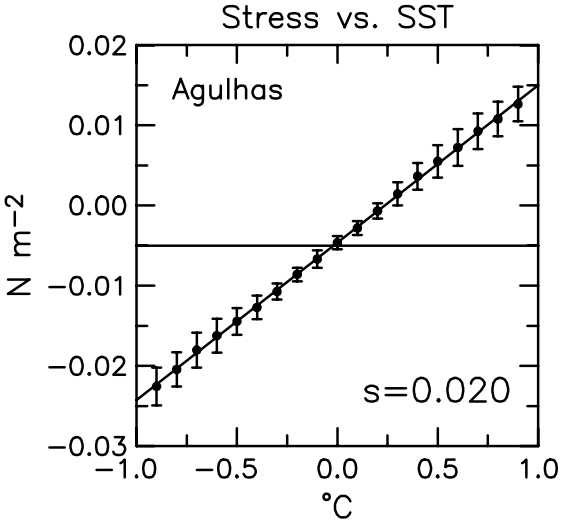
In other words, how well does the coupling coefficient between wind stress and SST in the models compare with the coupling coefficient inferred from QuikSCAT and AMSR data?

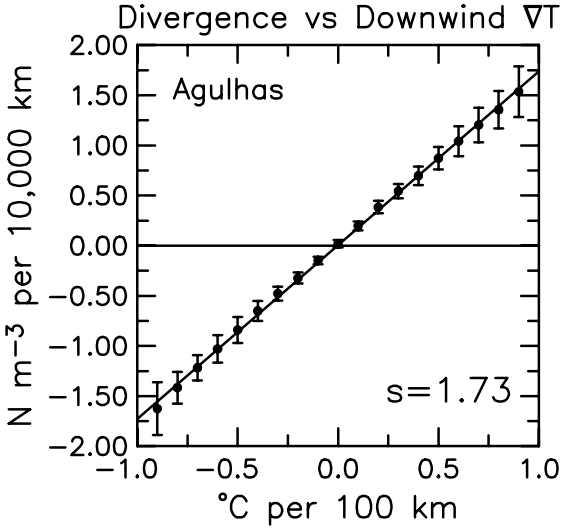
QuikSCAT and AMSR, September 2002 - August 2004

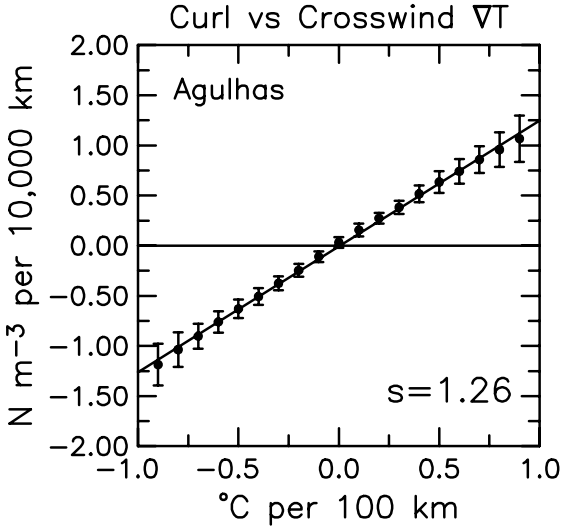




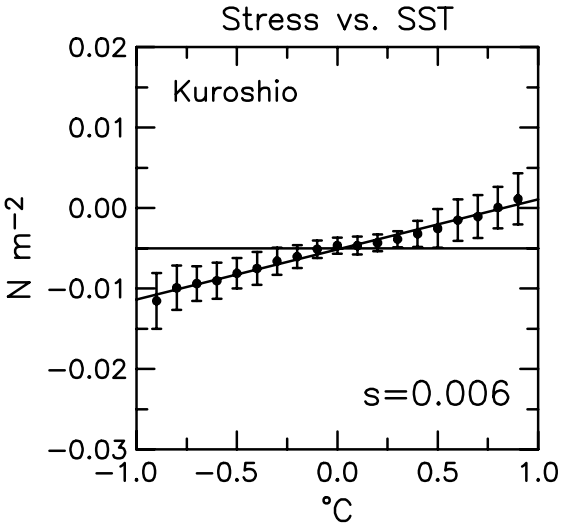


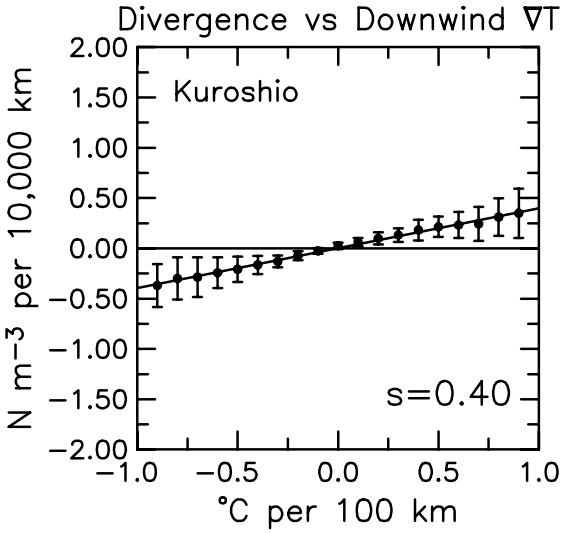


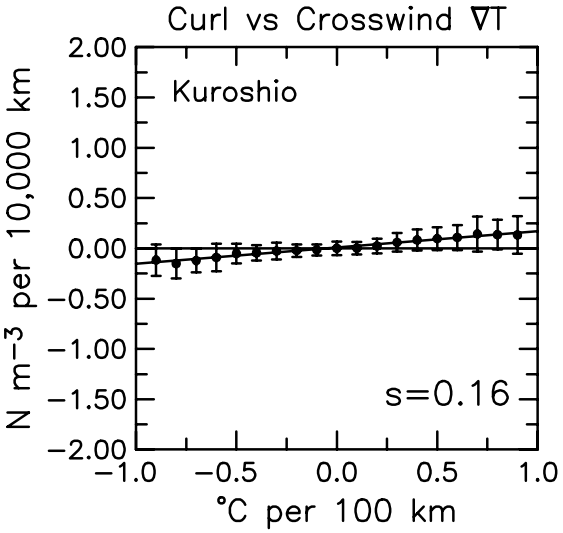


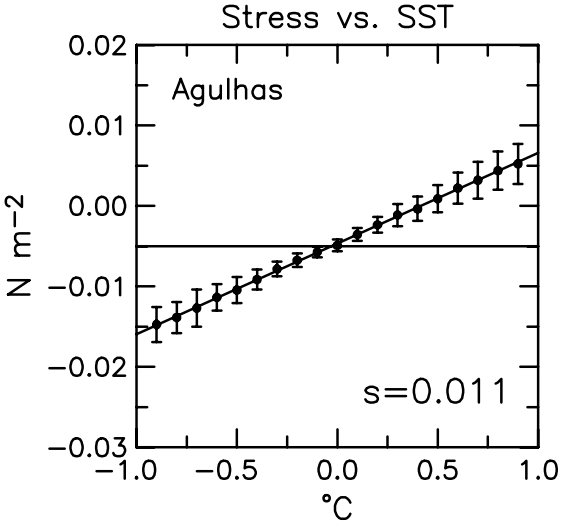


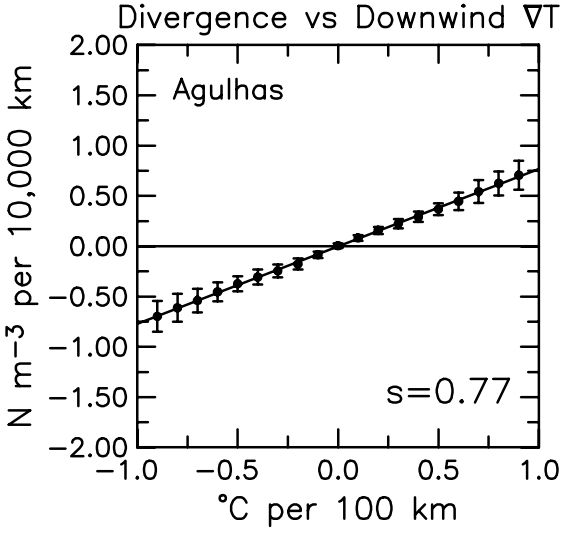
ECMWF and RTG, September 2002 - August 2004

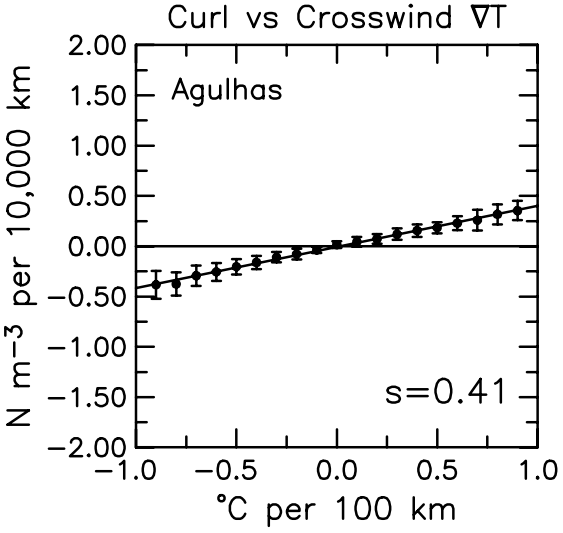












Objective 3:

Investigate the feedback effects of SST-induced small-scale perturbations of the wind stress field on the ocean circulation.

- *Conduct a hierarchy of ocean circulation modeling studies to determine whether the SST-induced small-scale variability in the wind stress field significantly influences the ocean circulation.*

Approach:

Force the Princeton MOM-2 model with low- and high-resolution wind stress fields.

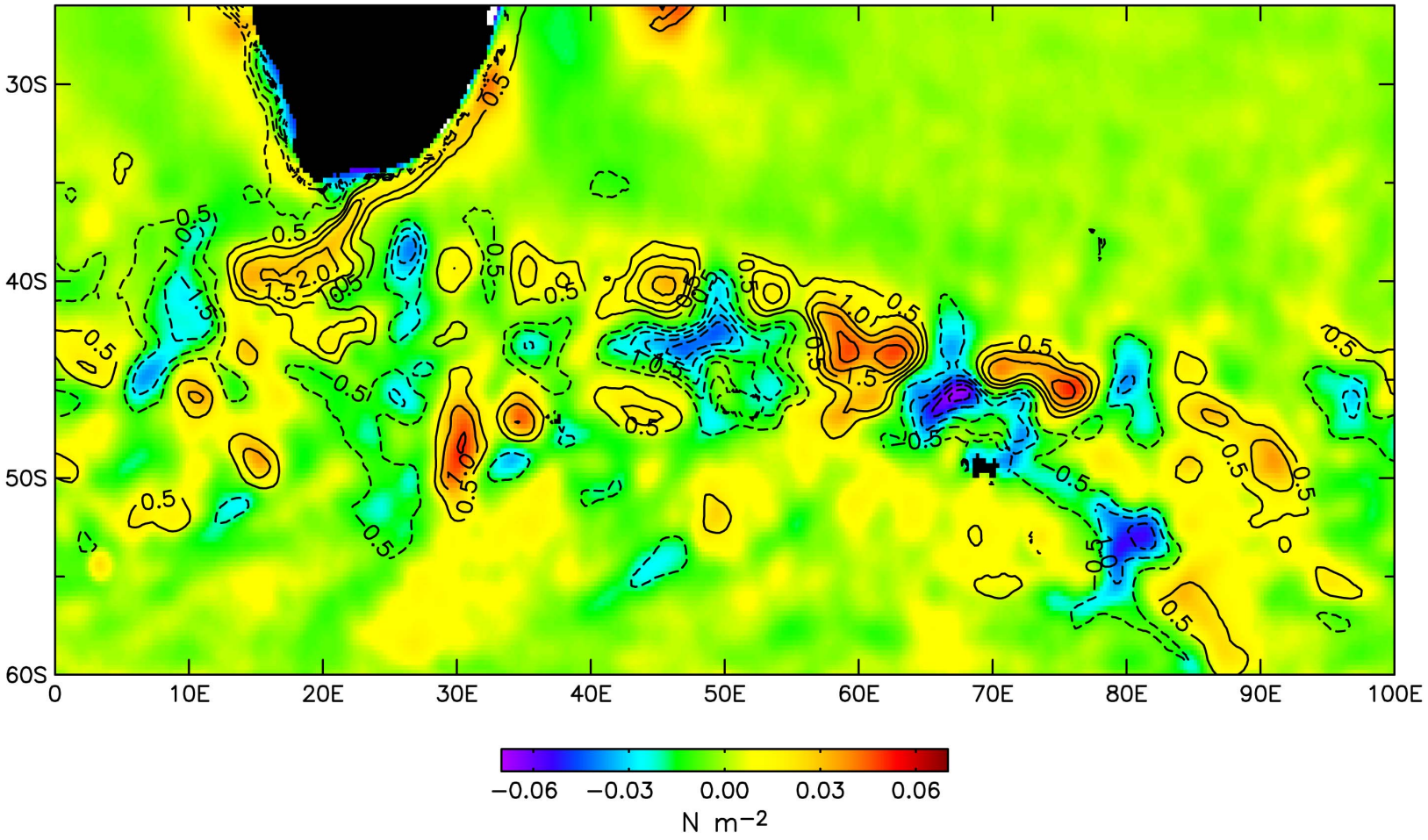
- *steady forcing*
- *seasonal cycle forcing*
- *weekly forcing*

This work is being done collaboratively with Prof. Ricardo Matano at Oregon State University

South Indian Ocean Region

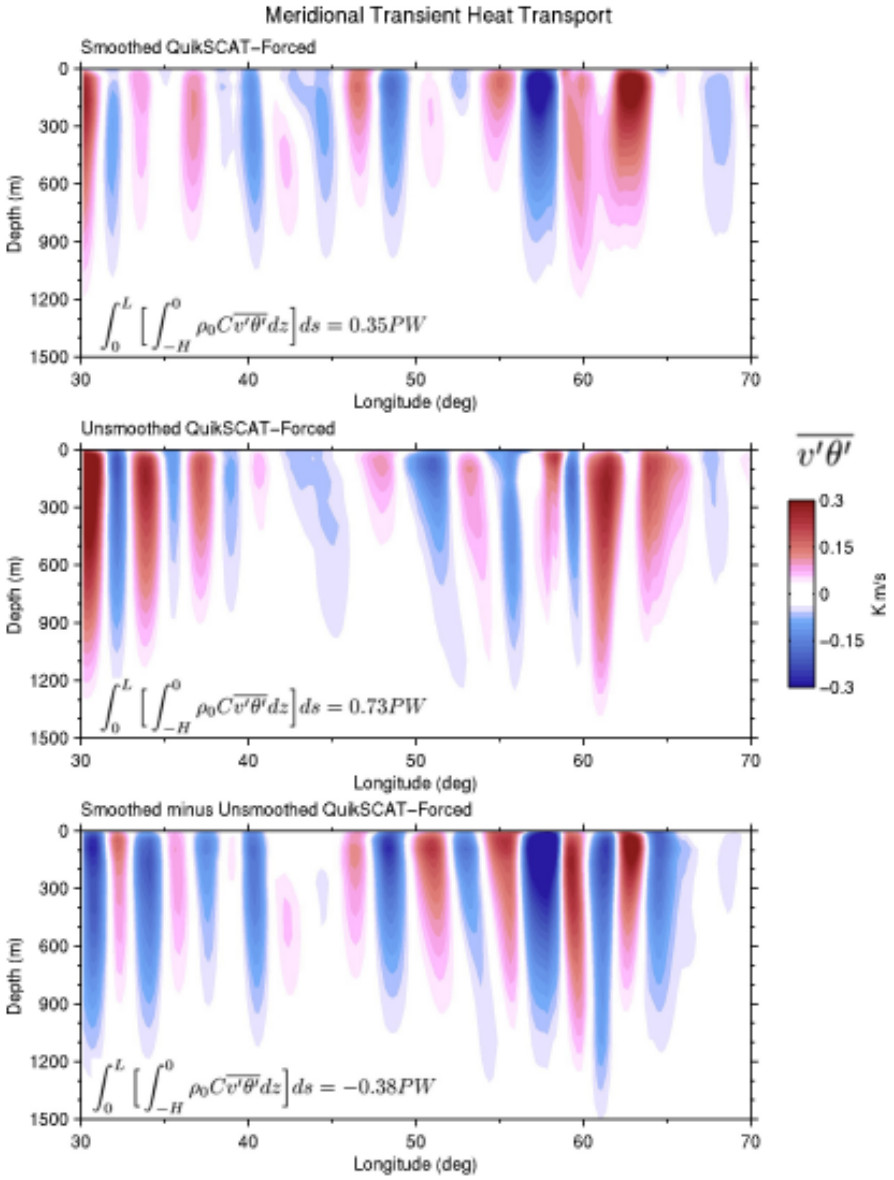
Filtered 2-Year Average QuikSCAT Wind Stress Magnitude and AMSR Sea Surface Temperature Contours

August 2002 - July 2004



Meridional Eddy Heat Transport in the South Indian Ocean

(O'Neill et al., 2006)

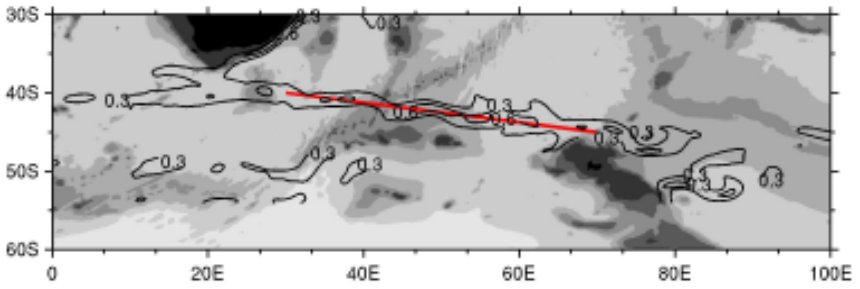


The MOM2 model was forced with 4-year average QuikSCAT winds in two ways:

- *Raw 25-km QuikSCAT wind stress*
- *QuikSCAT wind stress spatially smoothed to retain only the large scales that are resolved by the NCEP global forecast model.*

Result:

The meridional heat transport is twice as strong in the model forced by the unsmoothed QuikSCAT wind stress field.



Future Work

1) Continue empirical analyses of the SST influence on the marine atmospheric boundary layer (MABL):
   - *How are the geographical and temporal (winter vs. summer) variations of the coupling coefficients between wind and SST related to the background structure of the MABL (e.g., the mean stability profile, the thickness of the MABL, etc.)?*
   - *Why is the wind stress divergence response to downwind SST gradients stronger than the wind stress curl response to crosswind SST gradients?*
   - . . .

2) Analyze the output of test runs of the ECMWF model to assess the impact of modifications of the boundary layer parameterizations.
   - *Work to be done with Anton Beljaars and Hans Hersbach at ECMWF.*

3) Continue hierarchy of ocean model simulations of the Antarctic Circumpolar Current forced by QuikSCAT wind stress fields.
   - *Work to be done with Ricardo Matano at Oregon State University.*