What do we gain by having an additional QuikSCAT-like scatterometer?

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A QuikSCAT-like scatterometer samples 90% of the world ocean every 24 hours.

Having an additional QuikSCAT-like scatterometer, which provide a 12-hourly coverage over 90% of the world ocean, would

3. capture some high-frequency wind associated with the diurnal cycle;
4. reduce aliasing of high-freq. (esp. diurnal) wind into low-frequency wind.

This study evaluates these two aspects and the consequence on ocean simulation using the wind data from QuikSCAT & SeaWind scatterometers during in April-October of 2003 when they were flown in tandem.

Method

Perform sensitivity experiments where an ocean model is forced by the following scatterometer wind products, respectively:

- QSdaily (QuikSCAT daily wind product)
- SWdaily (SeaWind daily wind product)
- QSSWdaily (daily product by combining QS and SW data)
- QSSW2daily (twice daily product by combining QS and SW data)

The model:

- MITOGCM, 75°S-75°N.
- 1° (x) & 0.3°-1° (y) resolution, 46 levels (10 m in upper 150 m).
- KPP & GM mixing
- No relaxation of SST & SSS

All parameters and forcing other than wind are identical among the four experiments, so differences in state are purely due to differences in wind forcing.

Outline of analysis/results

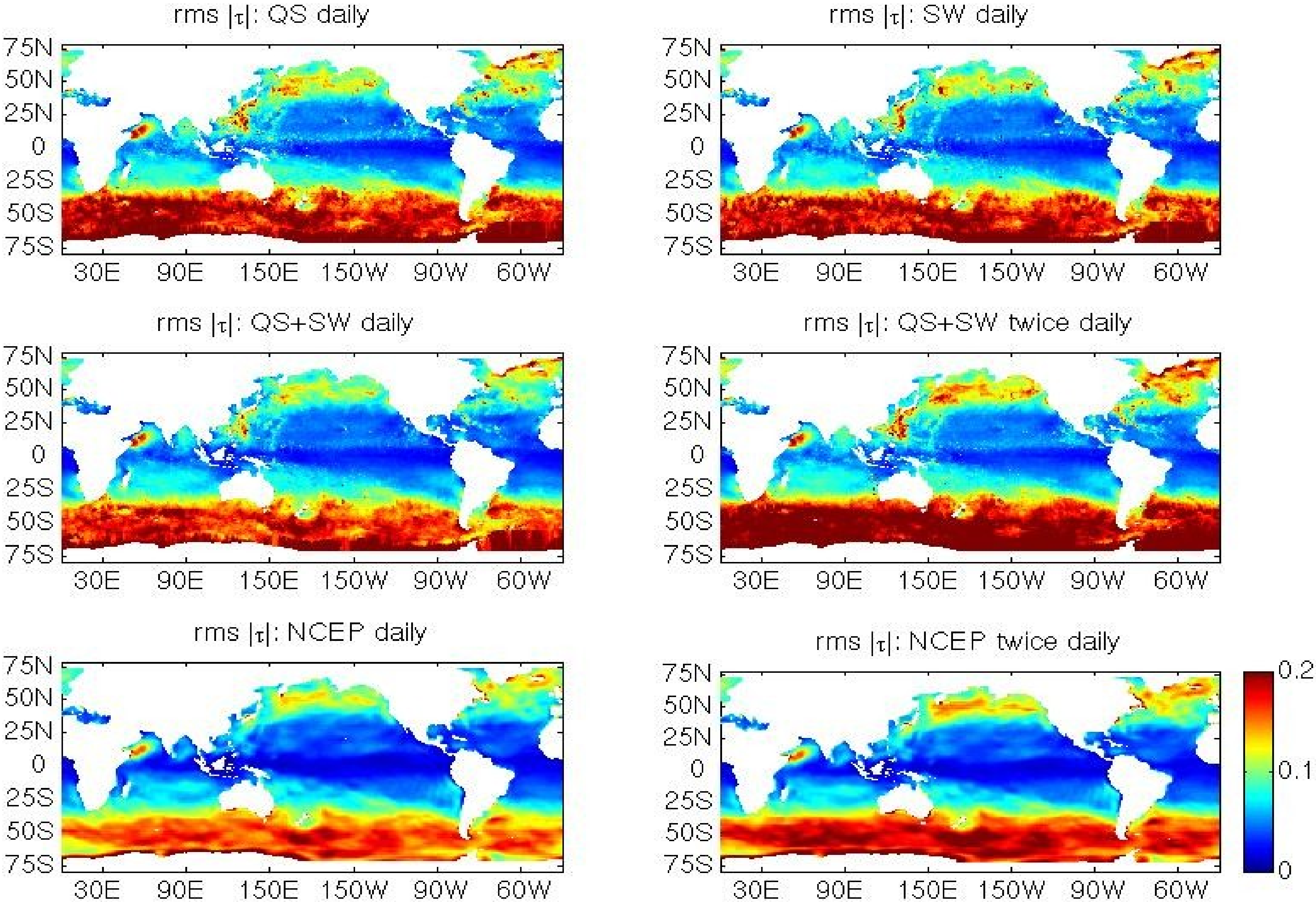
(1) Difference in r.m.s. variability of wind stress (twice daily vs. daily).

(2) Difference in time-mean (Apr.-Oct.) difference in wind stress (twice daily vs. daily).

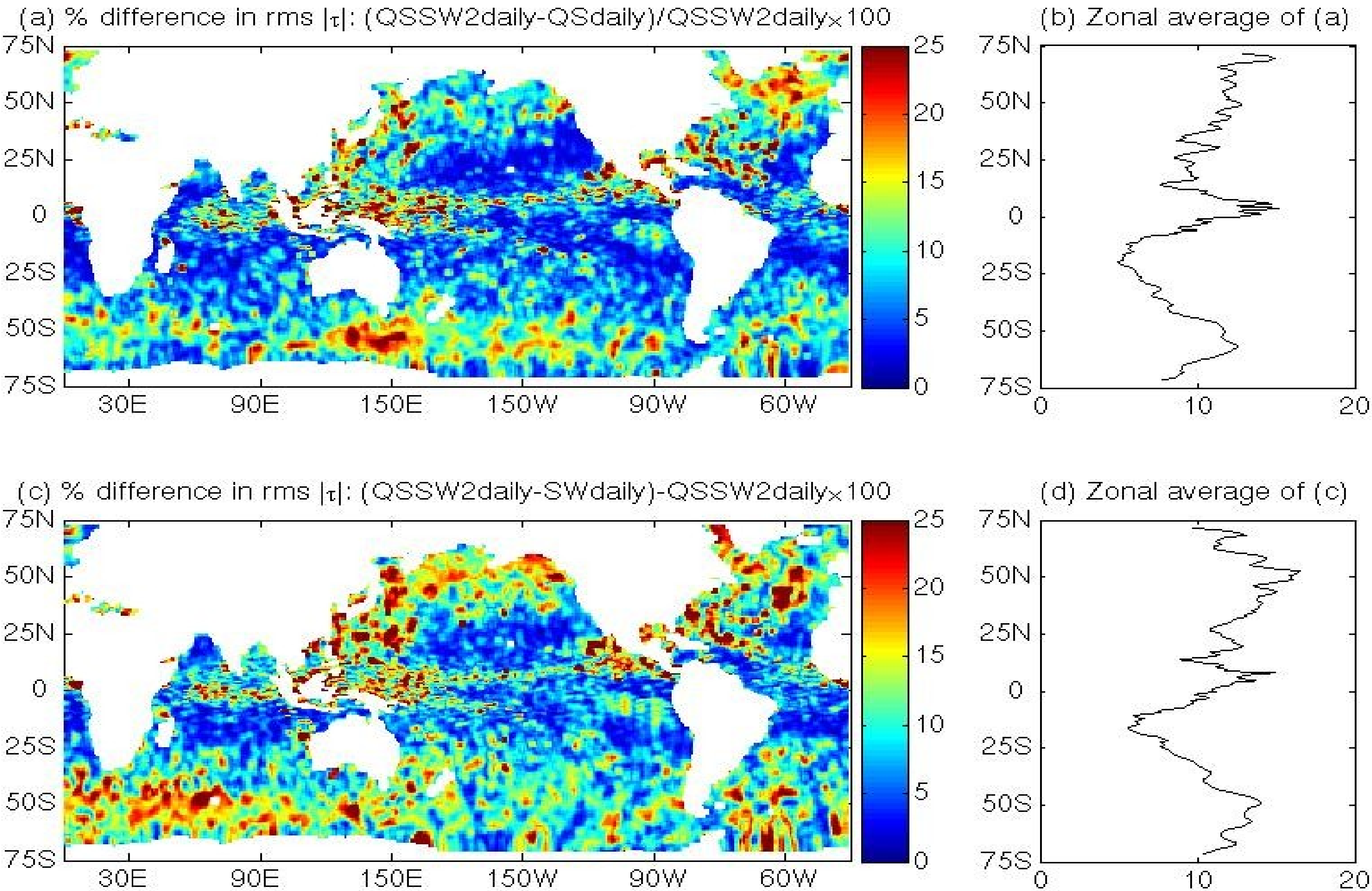
(3) Impact of (1) on upper-ocean T & S structure and associated processes.

(4) Impact of (2) on upper-ocean structure and associated processes.

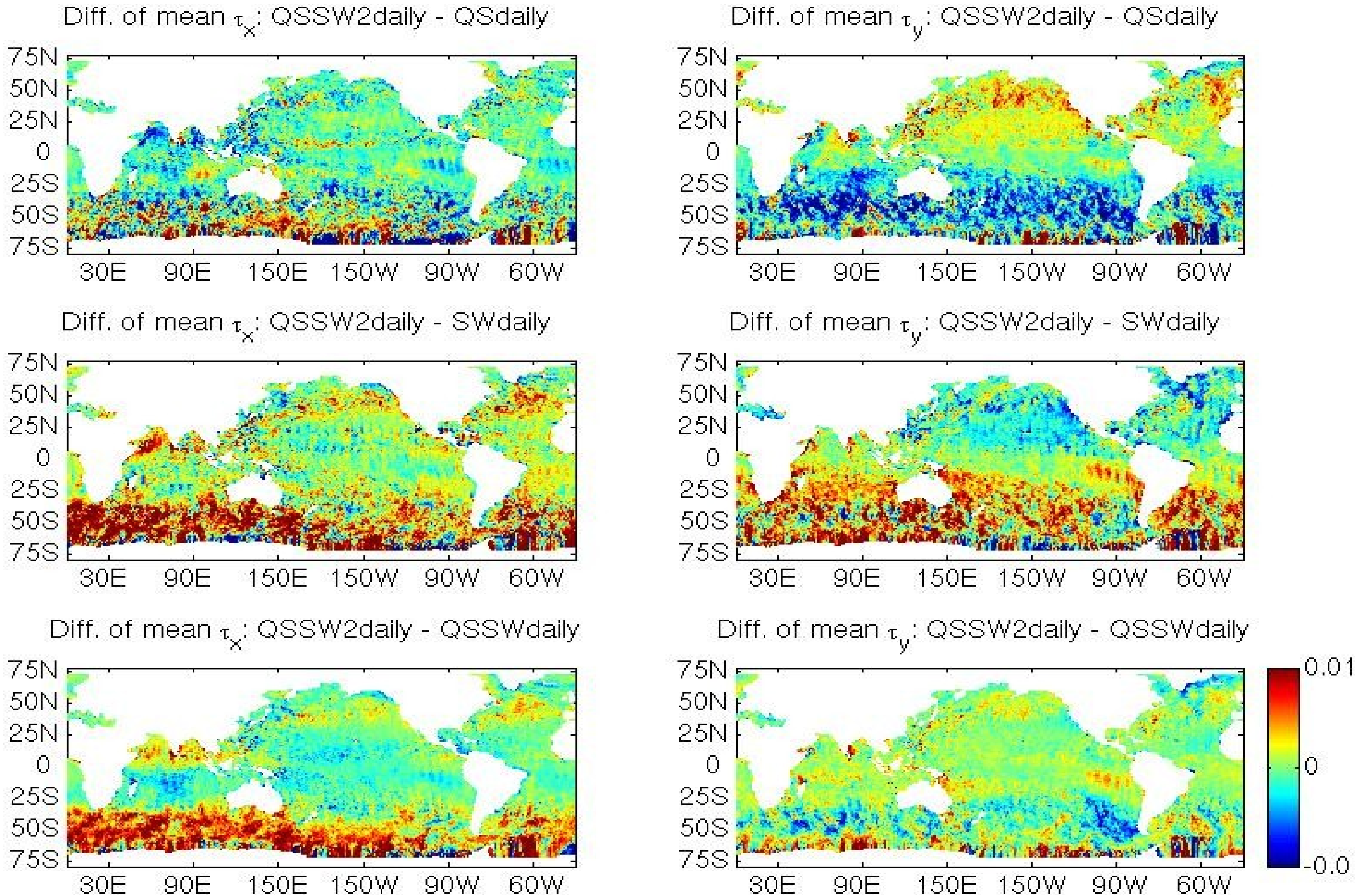
r.m.s. variability of wind stress: QS+SW twice daily wind give larger variability, especially at mid- to high-latitudes



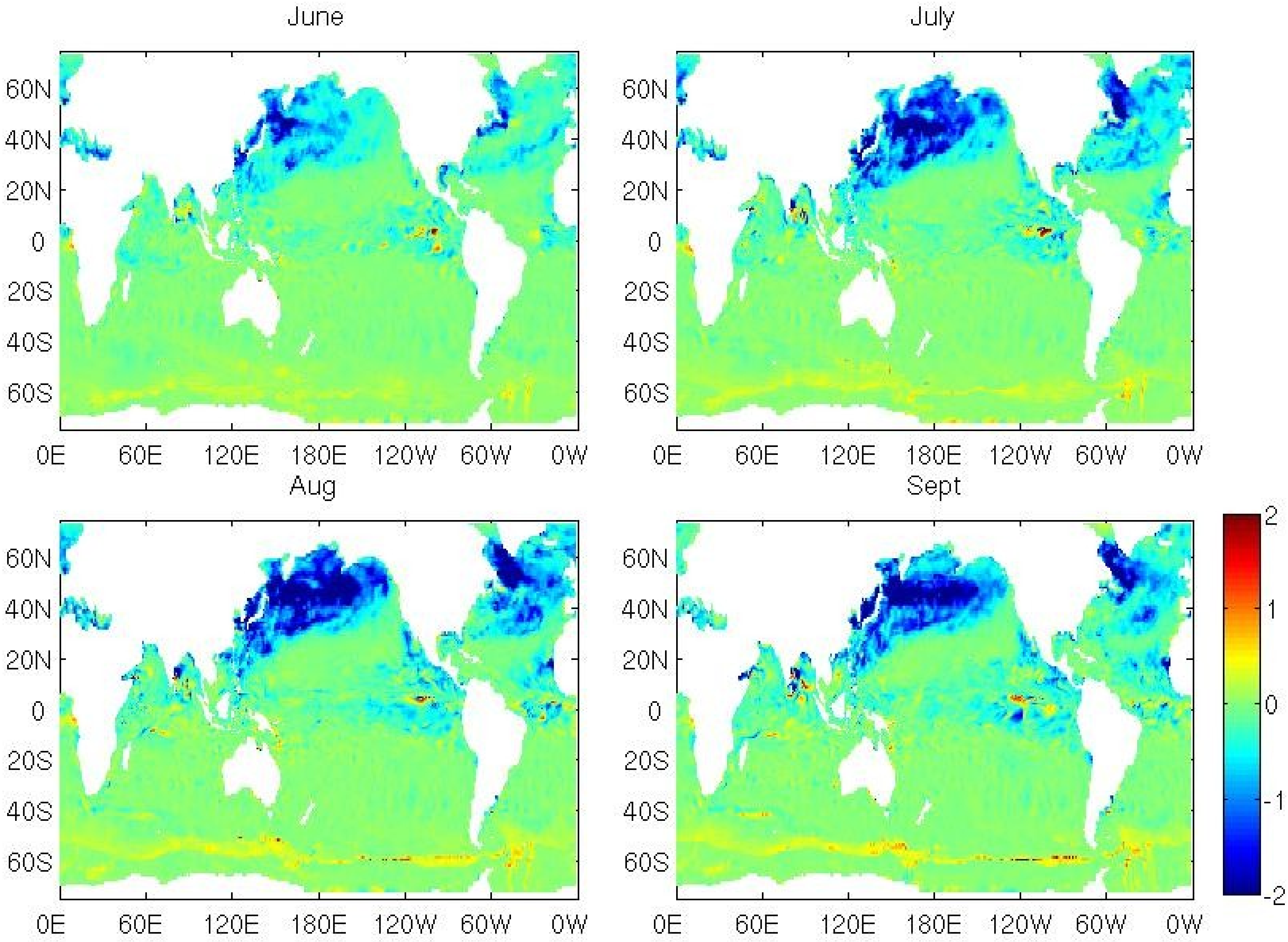
Percentage difference of enhanced r.m.s. variability of wind stress



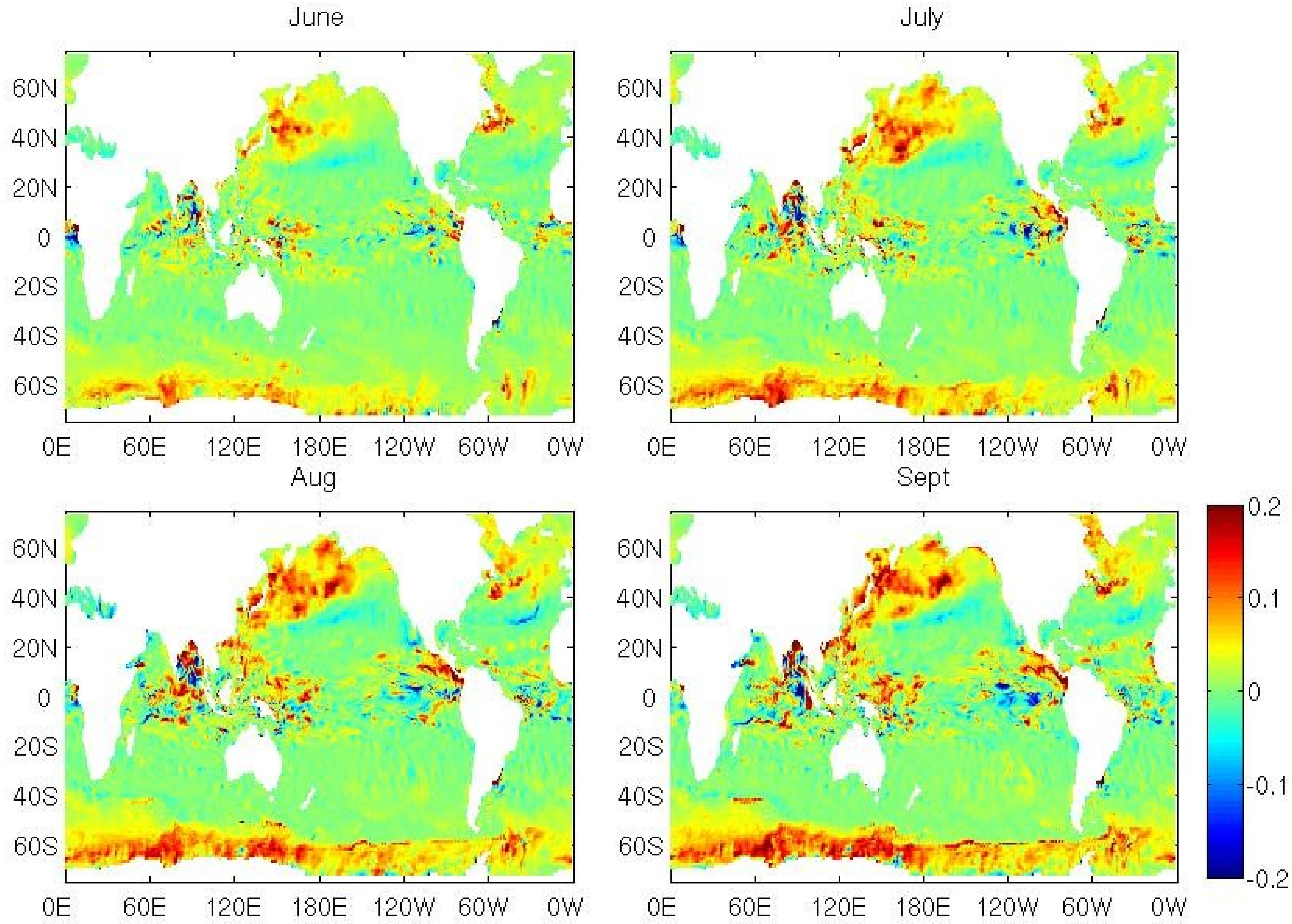
Apr.-Oct. mean differences in zonal (left) & meridional (right) wind stress: showing aliasing of high-freq. wind to low freq. wind



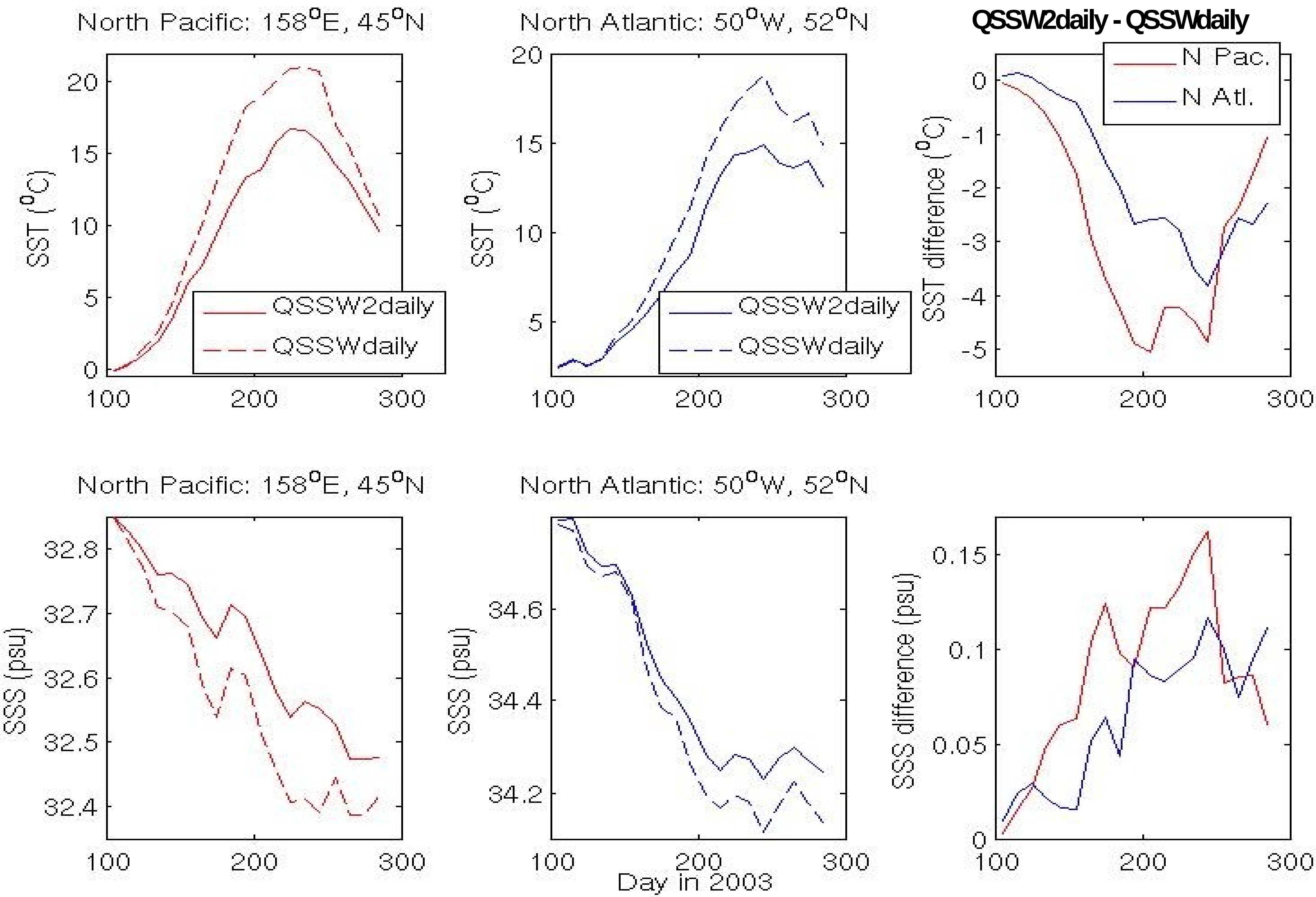
SST difference resulting from twice daily & daily winds: QSSW2daily–QSSWdaily twice daily wind results in colder SST in mid- to high-latitude N. Pac. & Atl.



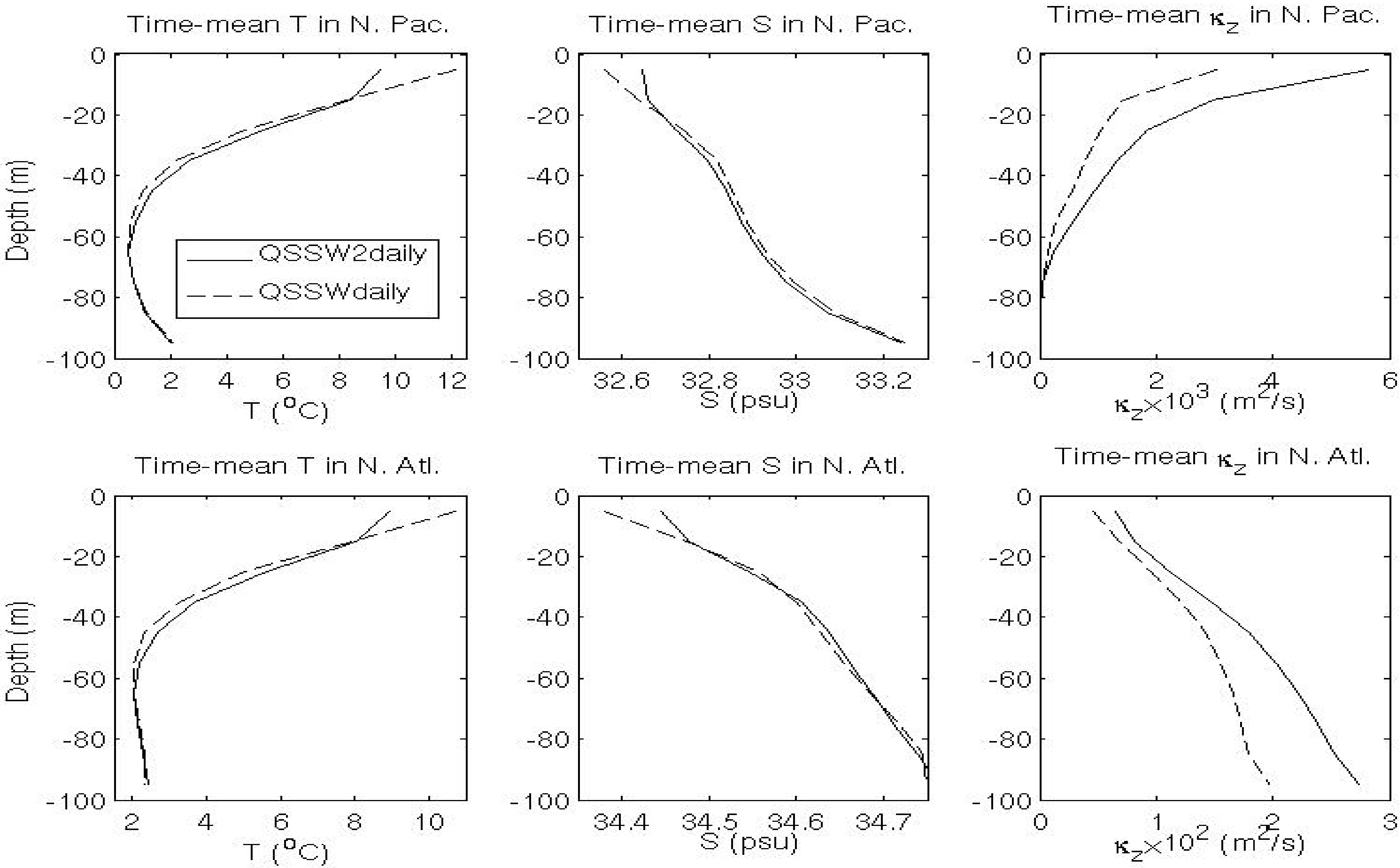
SSS difference resulting from twice daily & daily winds: QSSW2daily–QSSWdaily twice daily wind results in higher SSS in mid- to high-latitude Pac. & Atl.



Time series of SST & SSS in the N. Pac. & Atl. resulting from twice daily & daily winds, and their differences

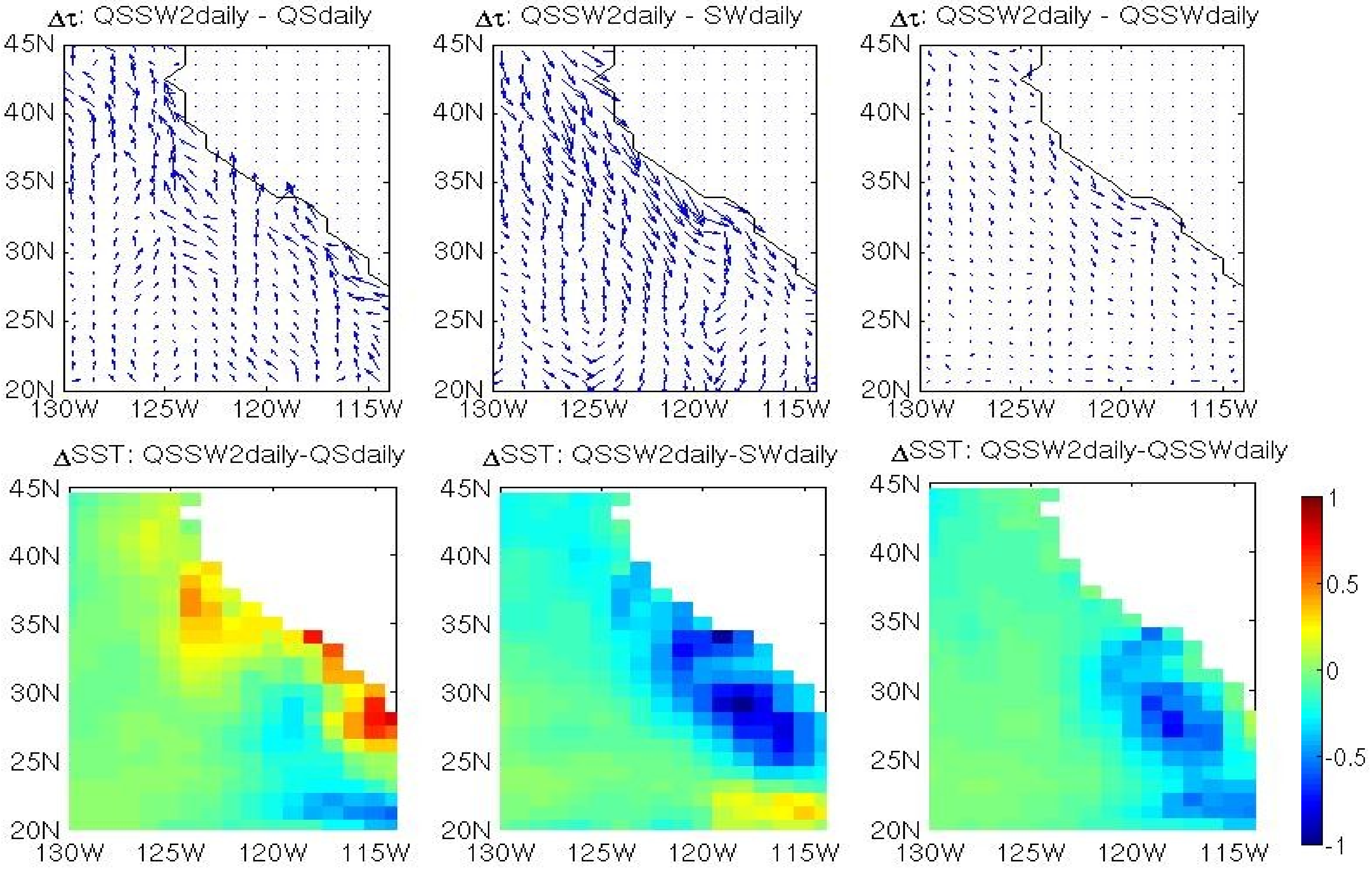


Apr.-Oct. mean vertical profiles of SST, SSS, and vertical mixing coefficient resulting from twice daily & daily winds

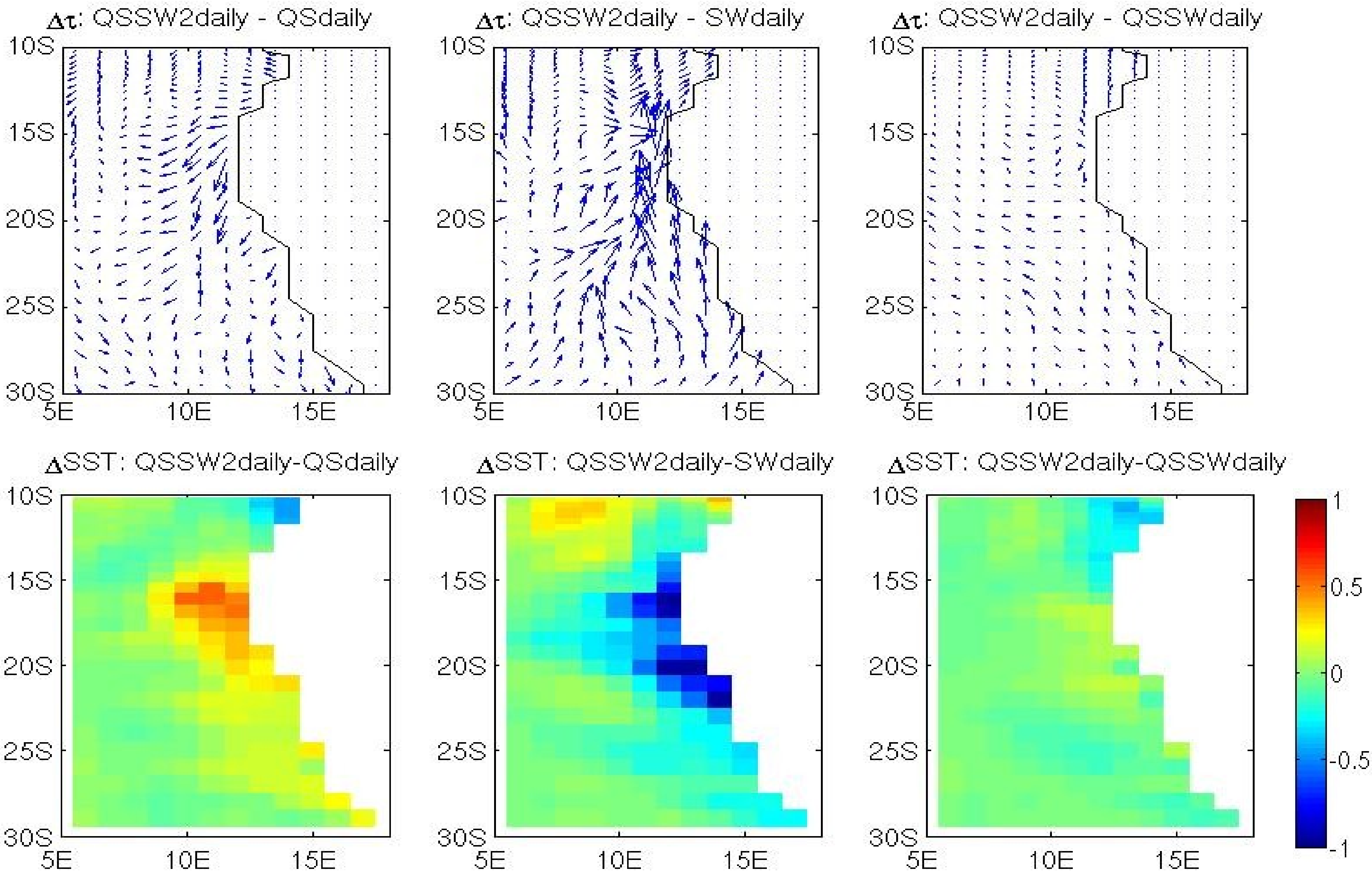


Enhanced vertical mixing by twice daily wind bring up colder-saltier subsurface waters

Apr.-Oct. mean difference in wind stress (upper) and SST (lower) near the eastern boundary of the N. Pac. (upwelling zone): showing effect of potential aliasing of time-mean winds (along-shore wind and sea breeze)



Apr.-Oct. mean difference in wind stress (upper) and SST (lower) near the eastern boundary of the S. Atl. (upwelling zone): showing effect of potential aliasing of time-mean winds (along-shore wind and sea breeze)



Implications to ocean modeling and data assimilation

Differences in simulated SST (SSS) from observations are often "fixed" by artificial surface heat (freshwater) flux by relaxing to SST (SSS) data. This creates incorrect balance of near-surface properties because the error sources are improper vertical mixing and horizontal/vertical advection, not surface buoyancy fluxes. For control data assimilation, such SST (SSS) errors should be attributed to errors in the wind rather than that in buoyancy forcings.

Summary

- The scatterometer tandem mission data during Apr.-Oct. of 2003 are used with an ocean model to assess the impact of (not) having an additional QuikSCAT-like scatterometer.
- Two scatterometers result in about 10-15% stronger r.m.s. variability of wind stress than one scatterometer, which significantly enhanced vertical mixing (of momentum, heat, salt, and other properties).
- Two scatterometers also better resolve diurnal winds (esp. in coastal upwelling regions) and reduce the effect of aliasing into low frequencies.
- These differences in wind forcing significantly impact SST and SSS in mid- to high-latitude open oceans (due to difference in vertical diffusion) and in eastern-boundary upwelling regions (due to difference in advection as well as diffusion).
- Important implications to ocean modeling and data assimilation in terms of attribution of error source.
- Implications to biogeochemistry.