Constraining a global, eddying, ocean and sea ice model with scatterometer data

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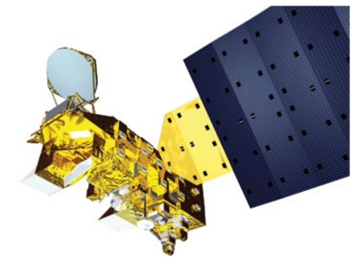
IOVWST, Utrecht, Netherlands, 13 June 2012

QuikSCAT

Jason



AMSR-E

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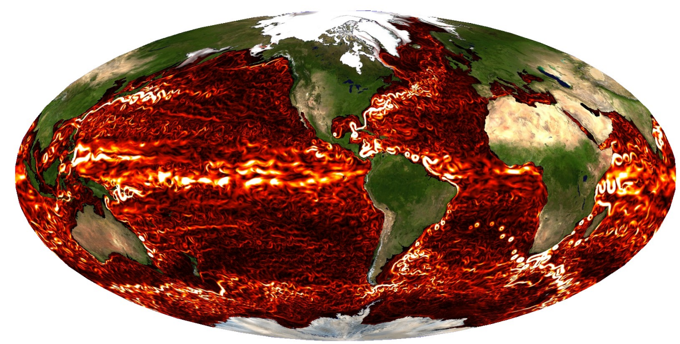
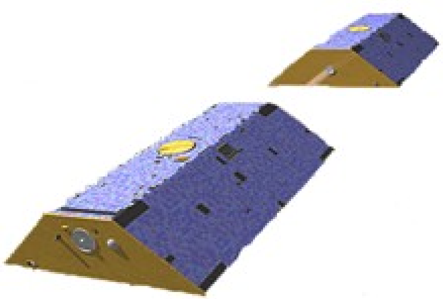
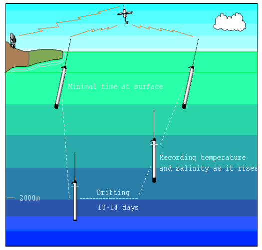




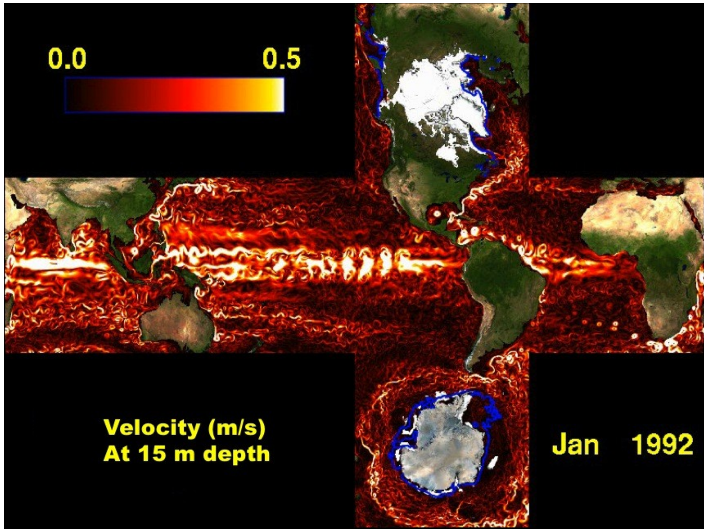
GRACE

ARGO

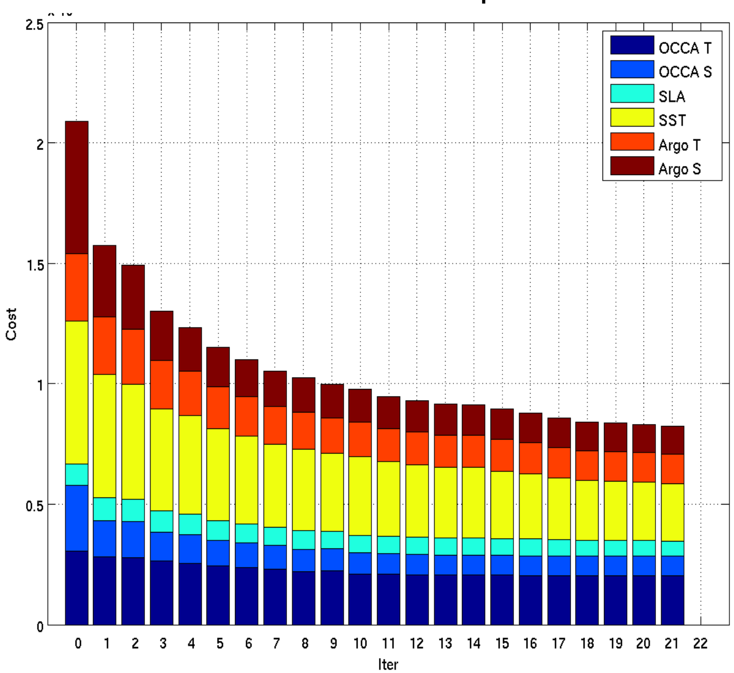


ECCO2: eddying global-ocean and sea-ice data synthesis

Cube sphere (CS510) model configuration



Cost function reduction per iteration



Full-depth ocean and sea ice configuration of MITgcm.

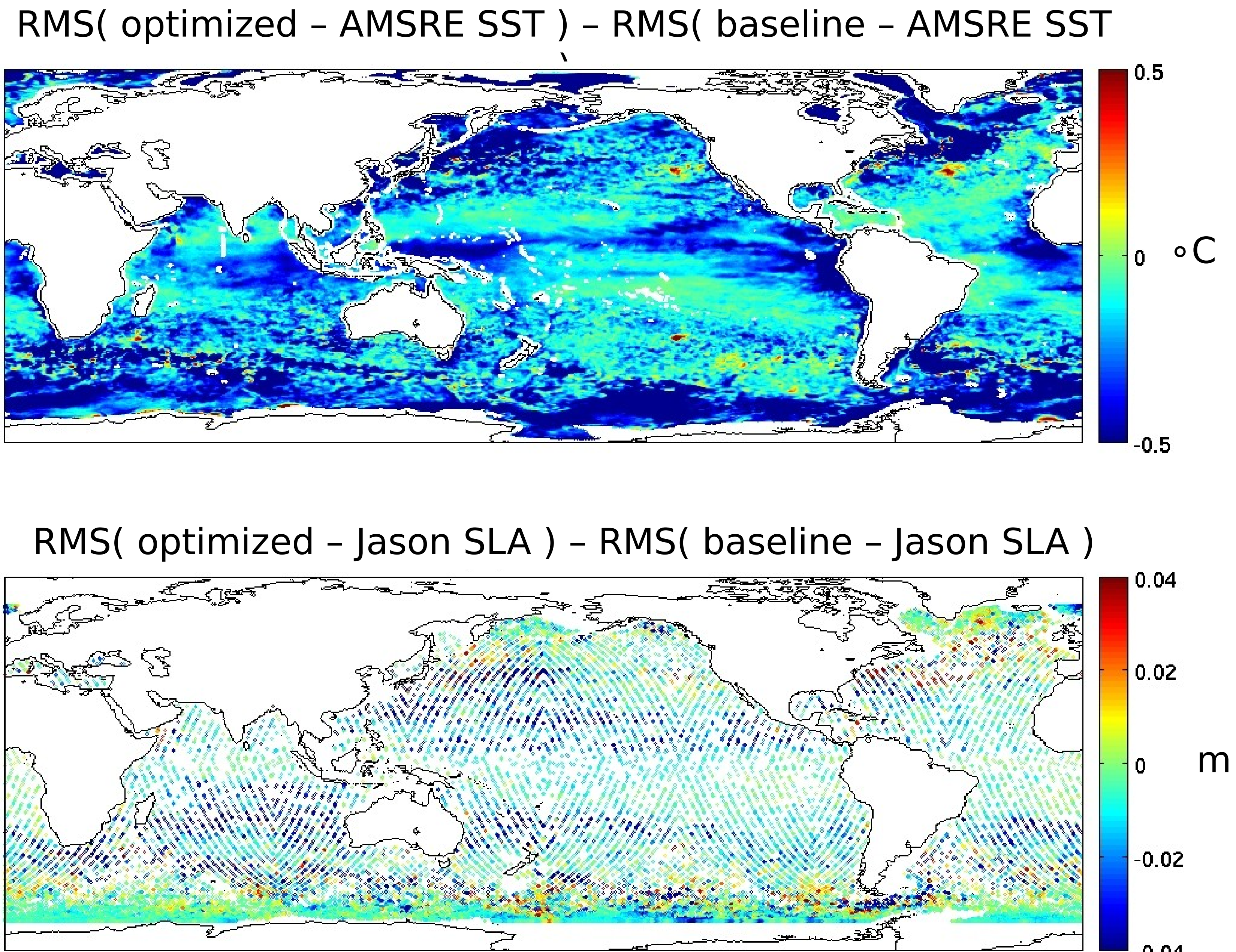
CS510 horizontal grid with 18-km horizontal spacing.

Adjoint-method-based optimization for 2004-2005.

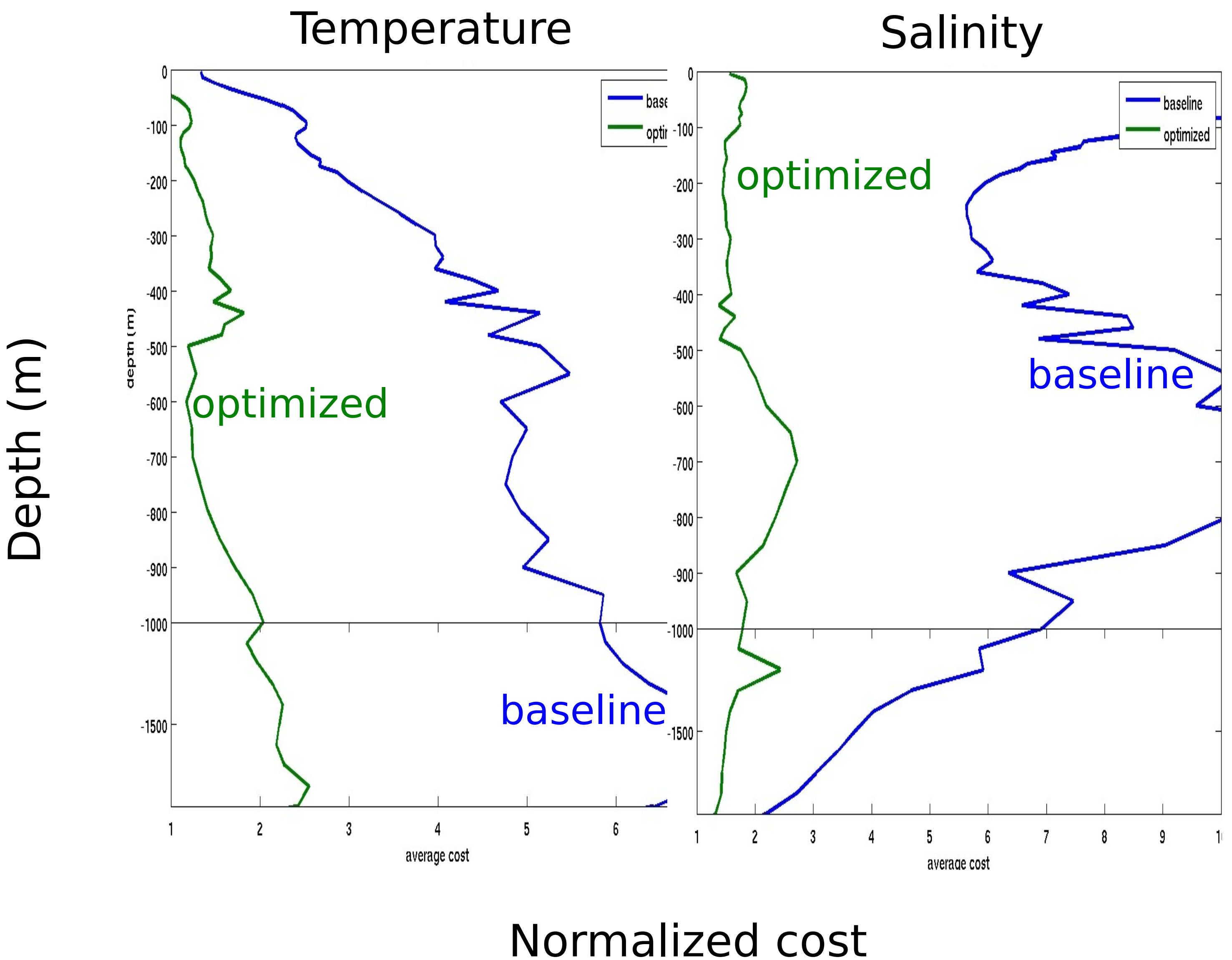
Data constraints currently include Jason and Envisat SSH, AMSR-E SST, and Argo T/S profiles.

Control variables are initial and surface atmospheric boundary conditions.

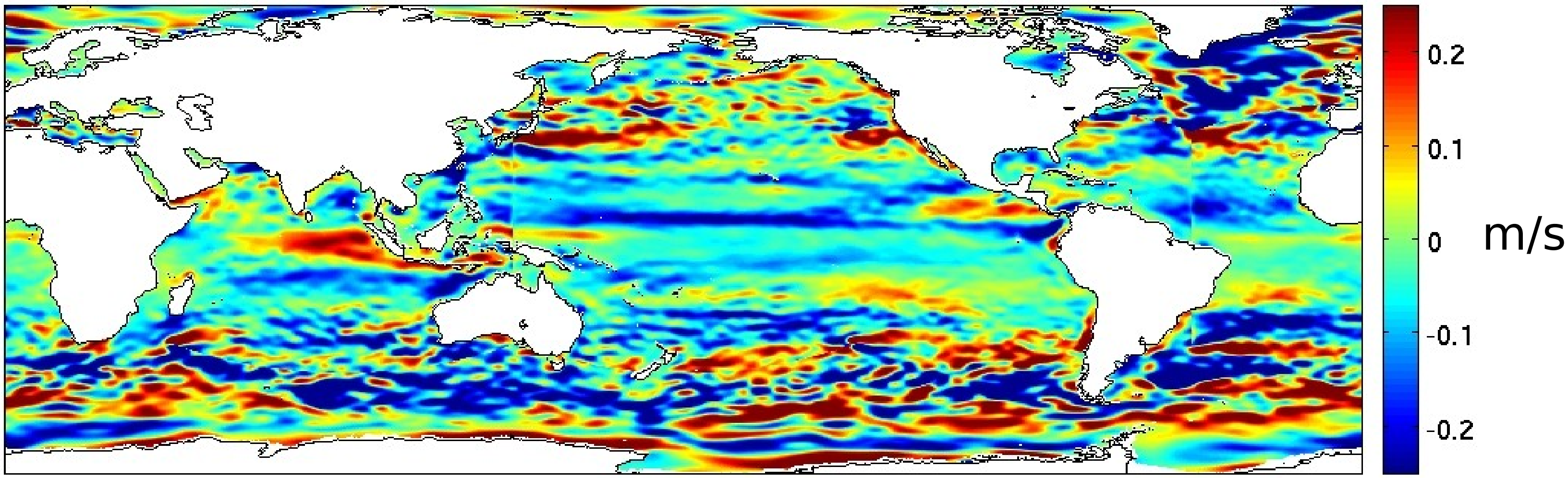
A QuikSCAT-constrained solution has also been computed.


RMS(optimized – AMSRE SST) – RMS(baseline – AMSRE SST)
0.5
0
-0.5
∘C
RMS(optimized – Jason SLA) – RMS(baseline – Jason SLA)
0.04
0.02
0
-0.02
-0.04
m

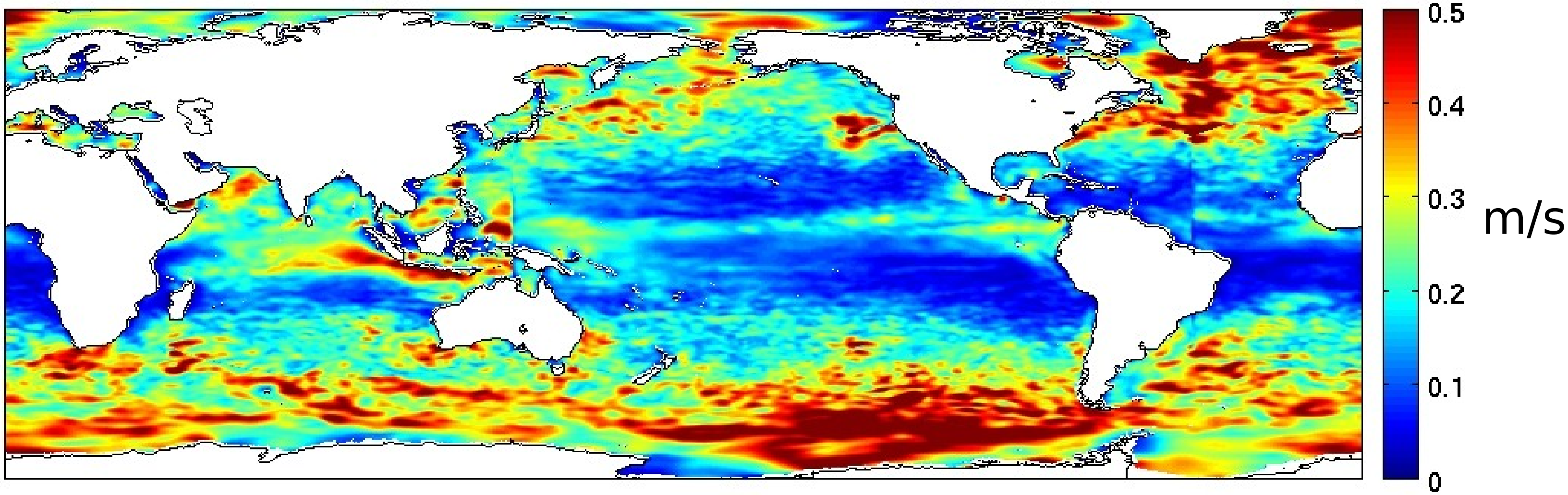
Cost function reduction relative to Argo data



Time-mean of zonal wind adjustment



Standard deviation of zonal wind adjustment

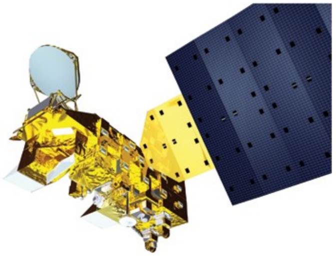


Is optimized solution consistent with QuikSCAT wind stress retrievals?

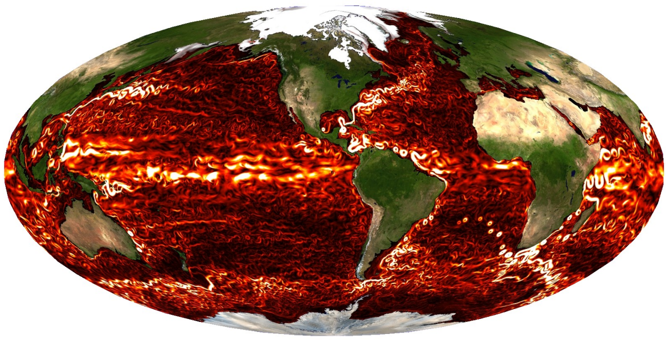
QuikSCAT

$$\stackrel{?}{=}$$

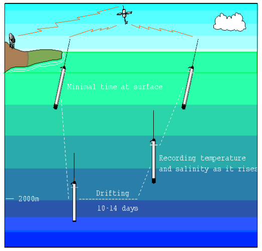
Jason



AMSR-E

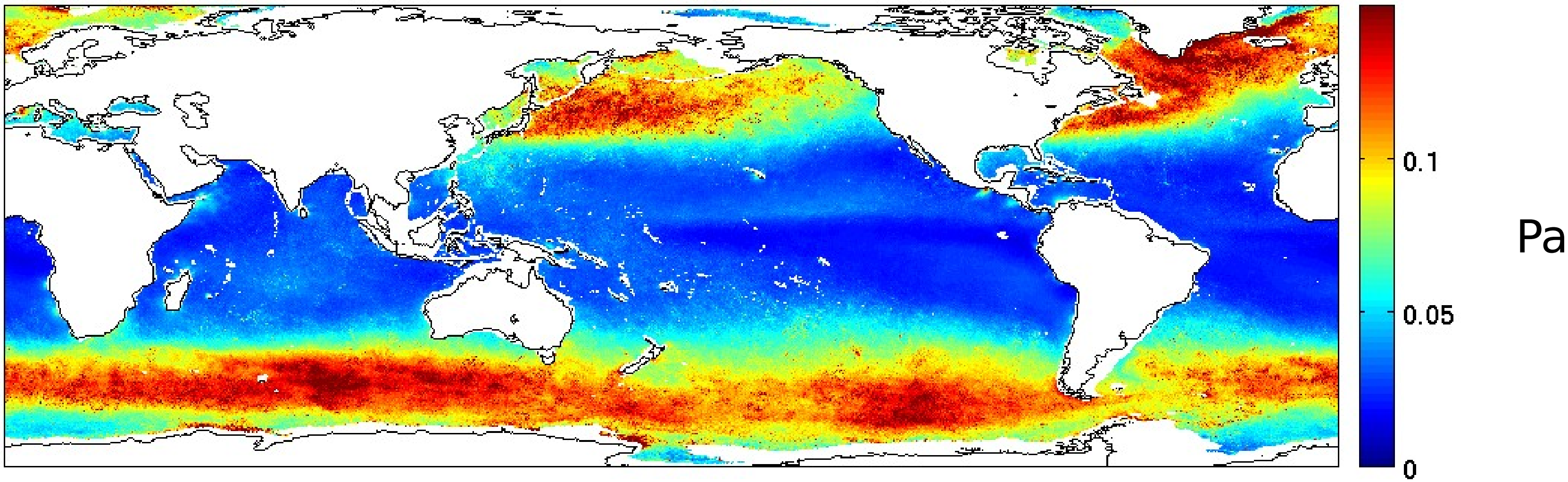


ARGO

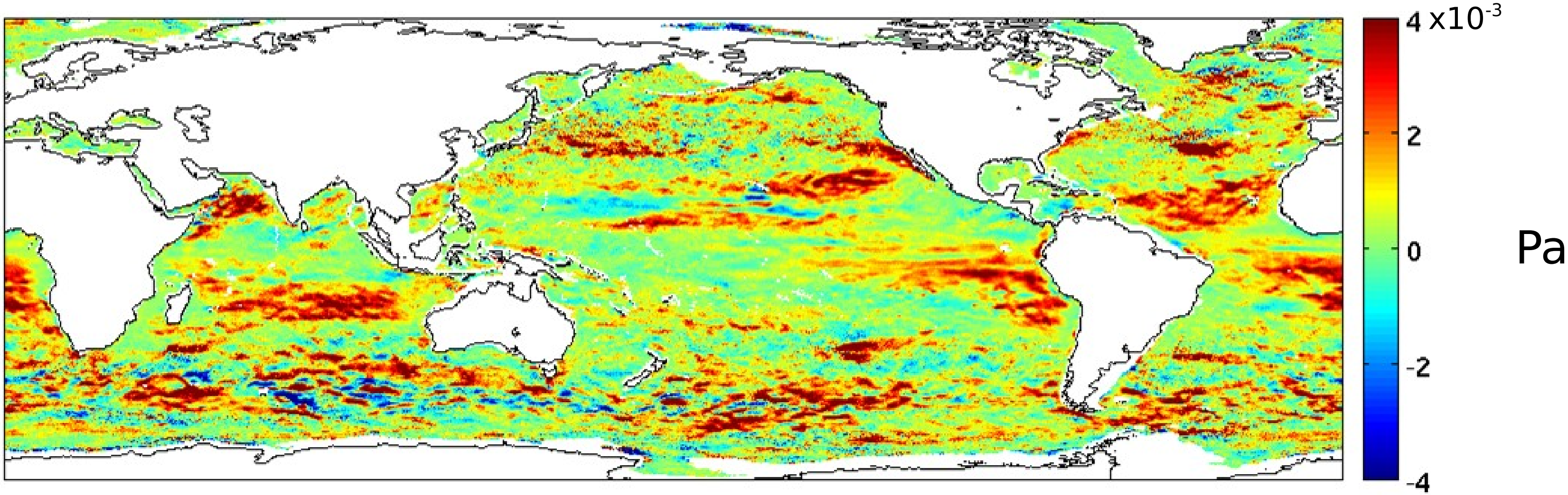


Jason/Argo/AMSRE-constrained solution is further away from QuikSCAT wind stress retrievals than the baseline simulation.

RMS(baseline – QSCAT τ_x)

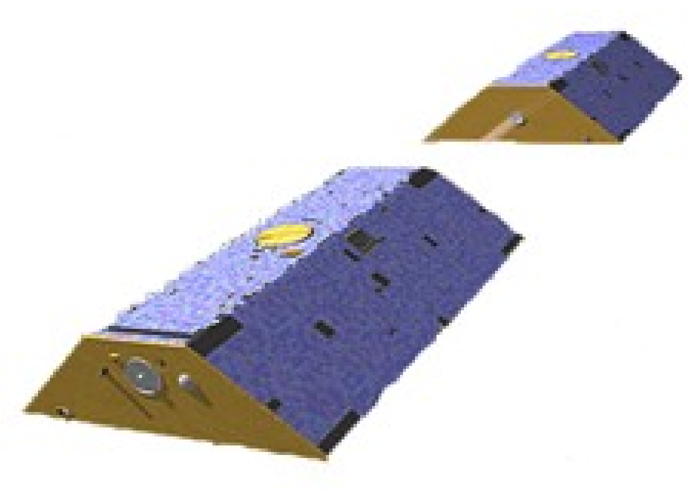


RMS(optimized – QSCAT τ_x) – RMS(baseline – QSCAT τ_x)



(positive values mean that optimized solution is further away from QuikSCAT)

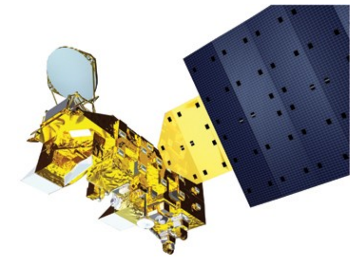
Is optimized solution consistent with GRACE gravity data?



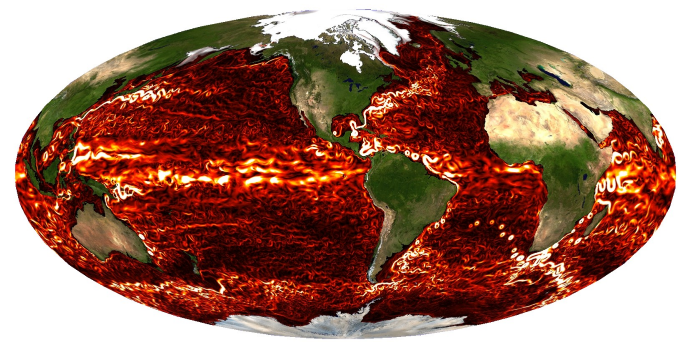
GRACE

$\stackrel{?}{=}$

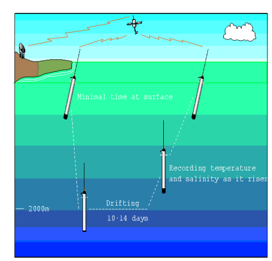
Jason



AMSR-E

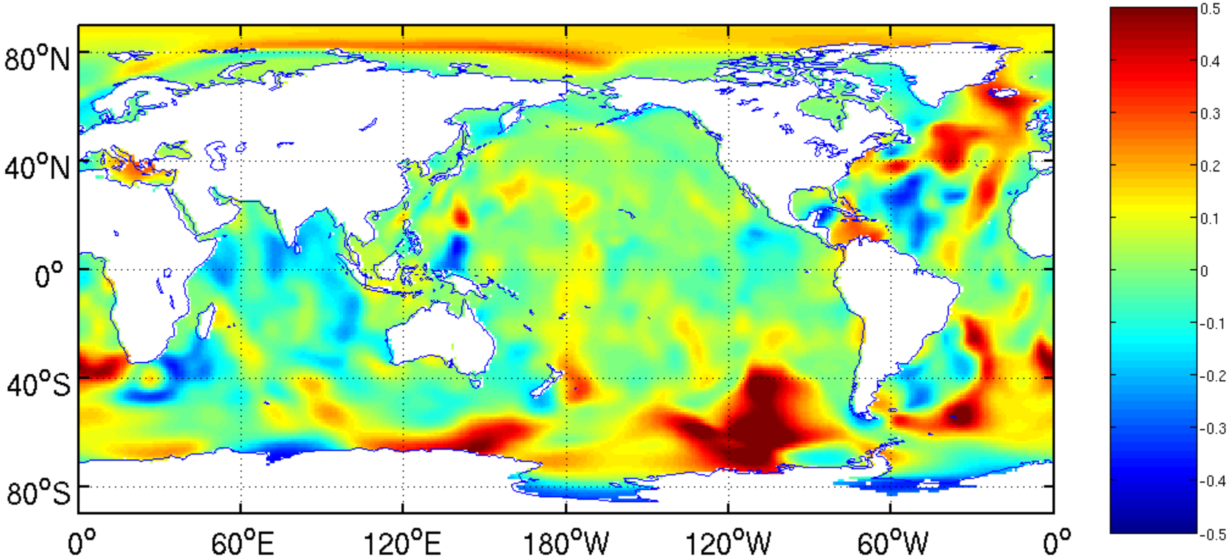


ARGO



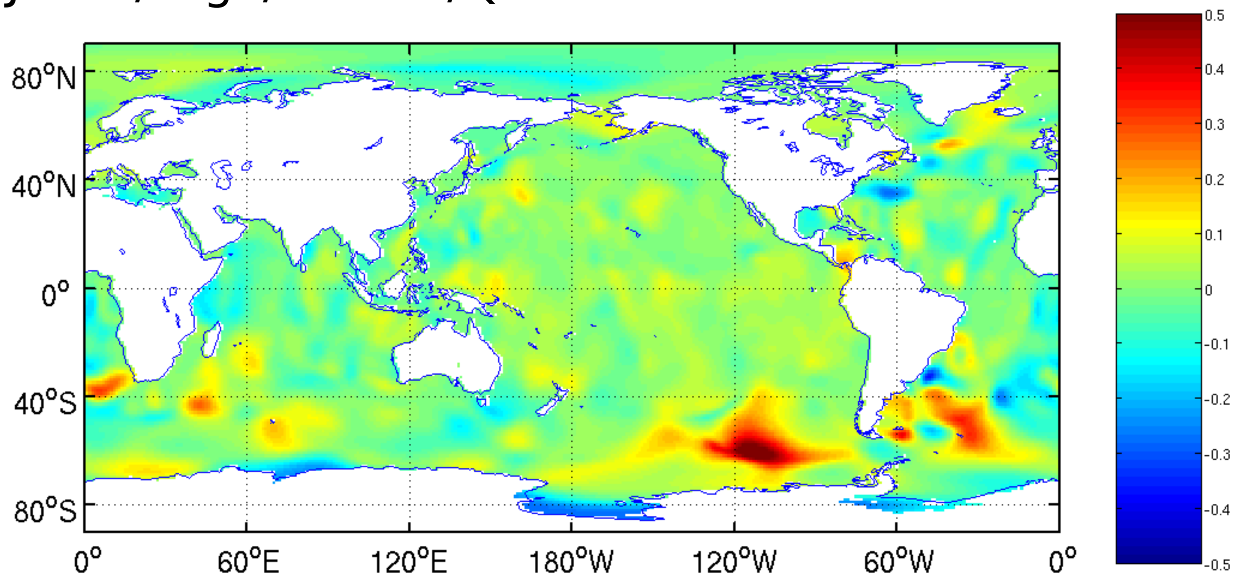
Fractional increase in explained variance of GRACE data

Jason/Argo/AMSRE-constrained solution



Jason/Argo/AMSRE-constrained solution explains 20% more GRACE variance than baseline simulation, …

Jason/Argo/AMSRE/QuikSCAT-constrained solution



but addition of QuikSCAT level-2 wind stress data constraints degrades explained variance relative to GRACE.

(positive values mean that optimized solution is closer to GRACE)

Why is QuikSCAT data inconsistent with model?

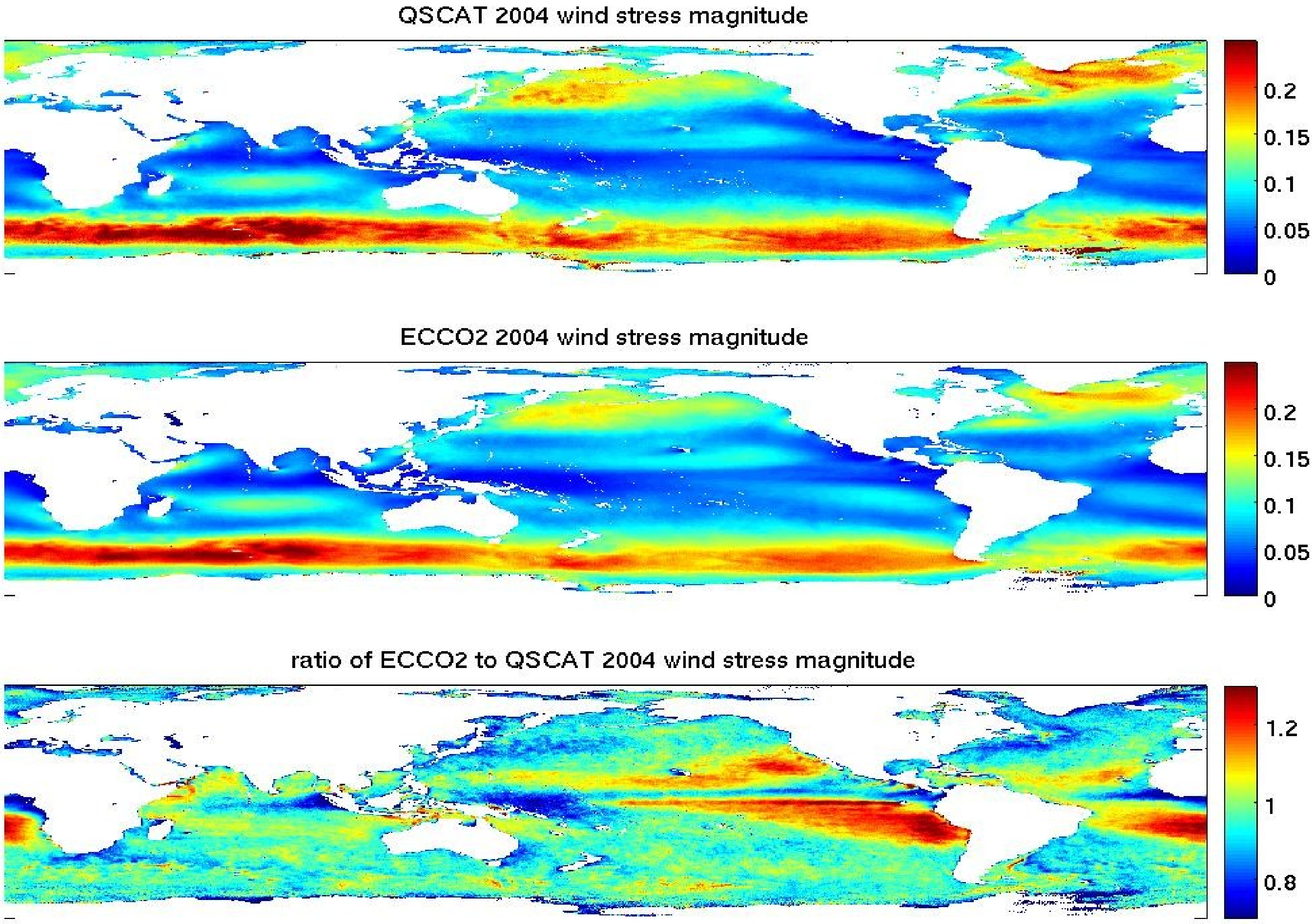
Problem with model physics, e.g., wrong stratification requires wrong wind stress curl for given change in temperature.
(Possible, ... but keep in mind that optimized solution has much improved stratification relative to Argo and that it explains 20% more GRACE variance.)

Bias in QuikSCAT retrievals, e.g., because of air density, direction, surface currents, wave action, or in dealing with extreme winds.

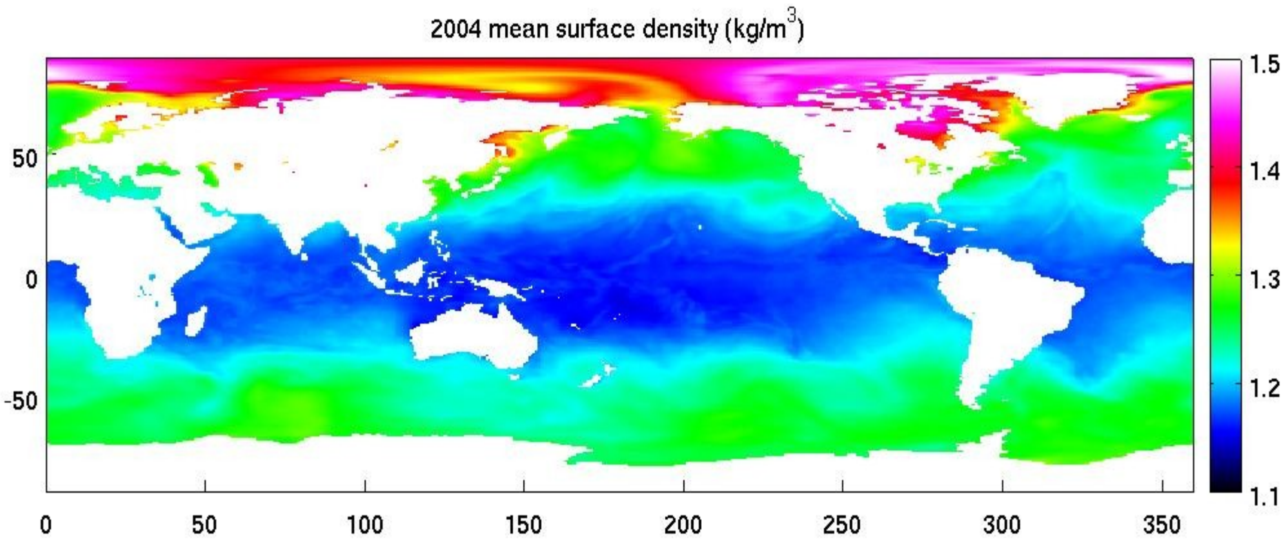
Sampling considerations, e.g., aliasing due to diurnal cycle variability or to extreme strong or weak wind events.

Other suggestions?

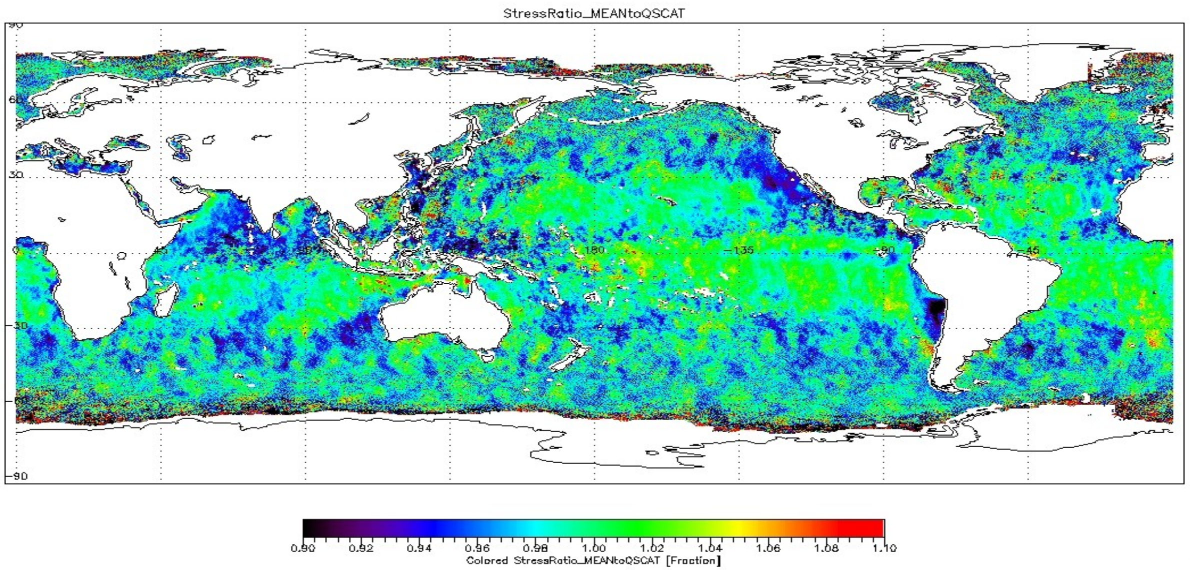
On the annual mean, ECCO2 wind stress magnitude is 10-20% larger than QSCAT wind stress based on Bourassa (2006) drag coefficient.



Looking for causes of QuikSCAT/ECCO2 inconsistencies



Surface air density



Ratio of mean wind stress to QuikSCAT wind stress

$\dfrac{\text{QuikSCAT + SeaWINDS}}{\text{2*QuikSCAT}}$

(S. Hristova-Veleva)

Summary and concluding remarks

- A global, eddying ocean and sea ice simulation has been constrained by altimeter, GHRSST, and in situ data using the adjoint method.
- The optimized solution, however, is **NOT** closer to QSCAT wind stress retrievals obtained using the Bourassa (2006) or Large and Pond (1981) drag coefficients.
- The optimized solution explains ~20% more GRACE variance than baseline simulation, …
- but the addition of QuikSCAT level-2 wind stress data constraints degrades the explained variance.

- Is primary cause of discrepancy a problem with ocean model or a problem with the QuikSCAT wind stress retrievals?

- Evaluate wind stress retrievals from other missions, e.g., ASCAT.
- Explore impact of near-surface diurnal cycle, air density, atmospheric stability, and sea-state dependent surface flux parameterizations.
- Evaluate model solution vs improved GRACE retrievals and other independent observations and data products, e.g., earth rotation and OAFlux.
- **Repeat analysis with improved QSCAT wind stress retrievals.**

- Ocean state estimation provides a rigorous test of consistency of observations and models and can motivate improvements in retrieval algorithms and model parameterizations.