

Introduction

A more complete wind stress formulation takes into account the ocean surface currents while the conventional wind stress popularly used in the ocean circulation models is only a function of 10-m winds. A pair of 2-year (2004-2005) non-data assimilative HYbrid Coordinate Ocean Model (HYCOM) simulations that only differ in the wind stress formulation will be analyzed to study the global wind work difference. The hypothesis is that both wind work on geostrophic and ageostrophic currents will be reduced, but wind work on ageostrophic currents is reduced more than wind work on geostrophic currents when ocean surface currents are included in the wind stress formulation.

Approach

We selected a 2 year timespan between 2004-2005 to begin the extraction of NetCDF files from the HPC. I generated MATLAB programs to calculate the averages from the hourly HYCOM NetCDF output (wind stress and surface currents). I also applied geostrophic balance to calculate the geostrophic currents from Sea Surface Height (SSH). Then using this data, I calculated the wind work on the geostrophic and ageostrophic currents.

Terminology

$$\text{Wind work: } W = \overline{\tau_x u_o} + \overline{\tau_y v_o}$$

$$\text{Mean Components: } W_m = (\overline{\tau_x} \overline{u_o}) + (\overline{\tau_y} \overline{v_o})$$

$$\text{Eddy Components: } W_e = \overline{\tau_x' u_o'} + \overline{\tau_y' v_o'}$$

$$\text{Geostrophy: } u_g = -\frac{g}{f} \frac{\partial(SSH)}{\partial y} \quad v_g = \frac{g}{f} \frac{\partial(SSH)}{\partial x}$$

$$\text{Ageostrophy: } u_{ag} = u_o - u_g \quad v_{ag} = v_o - v_g$$

$$\text{Time Series: } A(t) = \overline{A(t)} + A'(t)$$

Experiment 615 vs 616

The only difference between experiment 615 and 616 is that experiment 615 includes the effect of ocean surface currents in the wind stress formulation, whereas experiment 616 does not.

$$615: \tau_n = \rho_a C_d |V_{10} - V_o| (V_{10} - V_o)$$

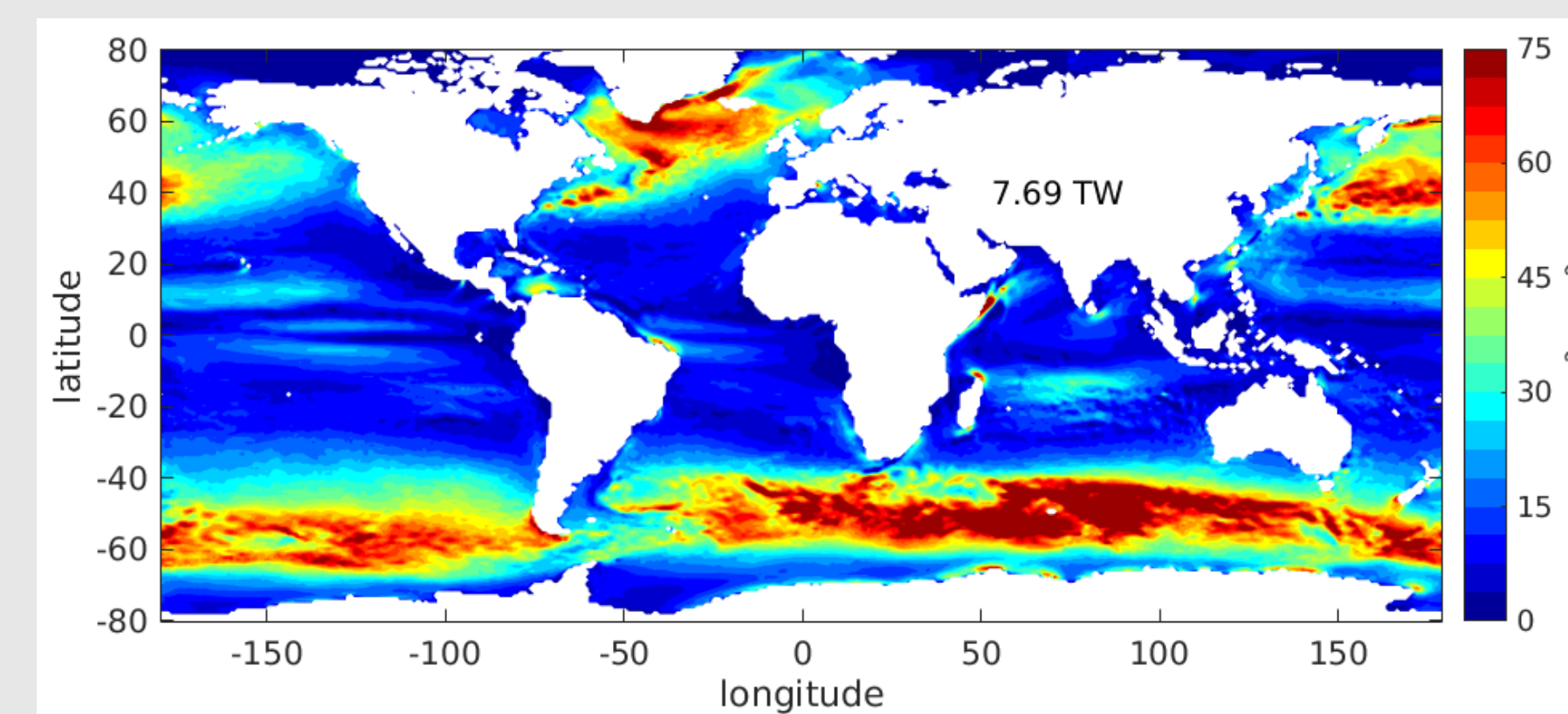
$$616: \tau_c = \rho_a C_d |V_{10}| V_{10}$$

The 2004-2005 Global Sum of Mean and Eddy Wind Work Components (TW)

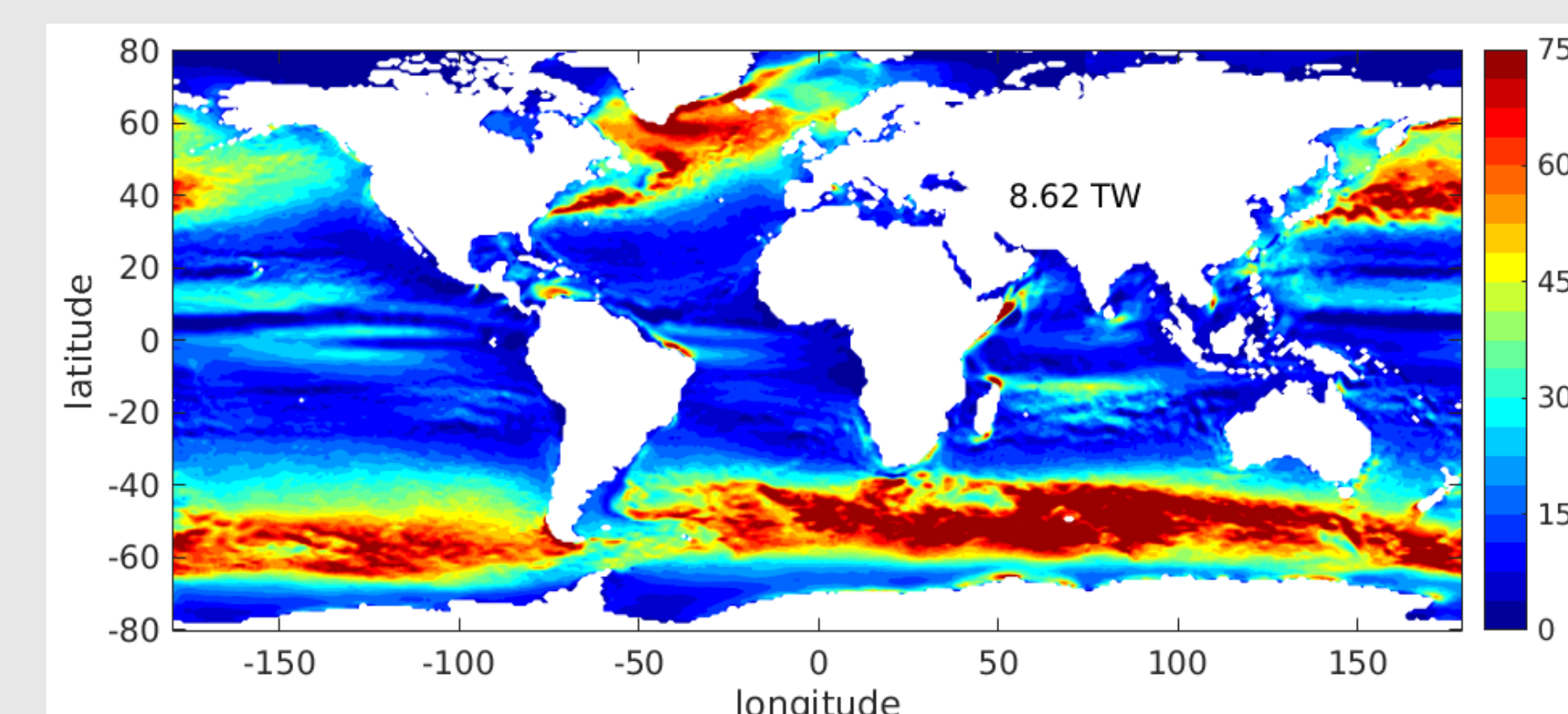
Experiment:	615		616	
Component:	Mean	Eddy	Mean	Eddy
Total	2.35	5.33	2.62	5.99
Geostrophic	0.62	-0.26	0.70	-0.18
Ageostrophic	1.62	5.51	1.75	6.08

2004-2005 Results

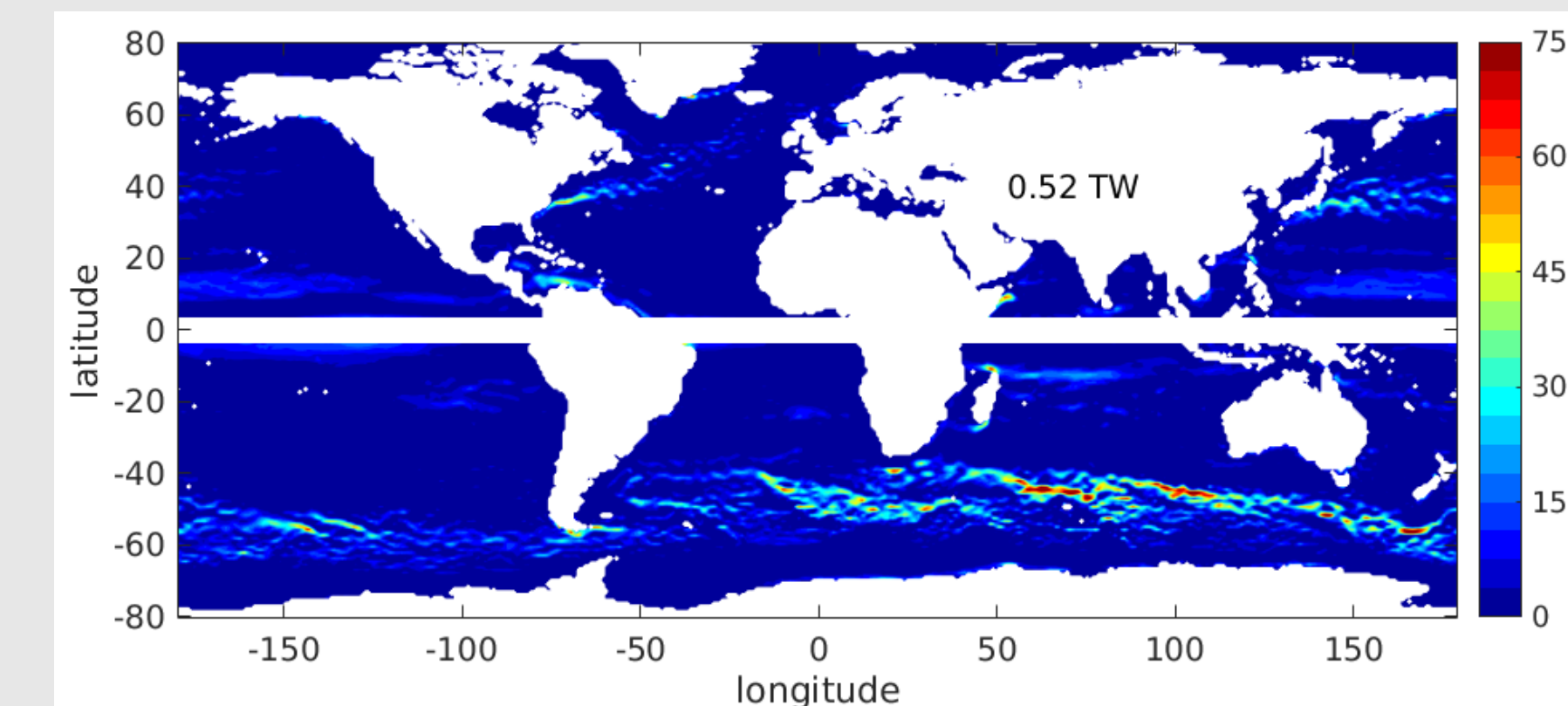
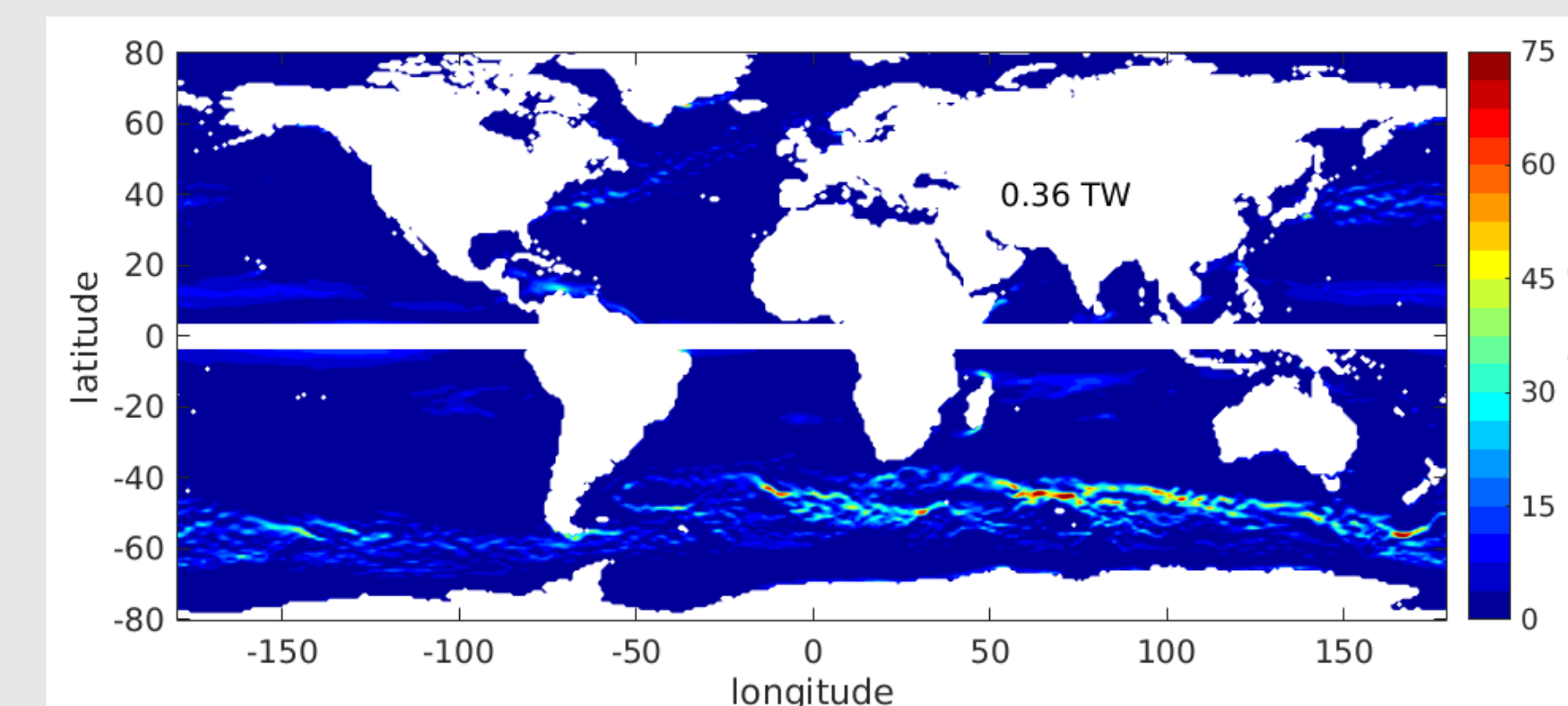
615:



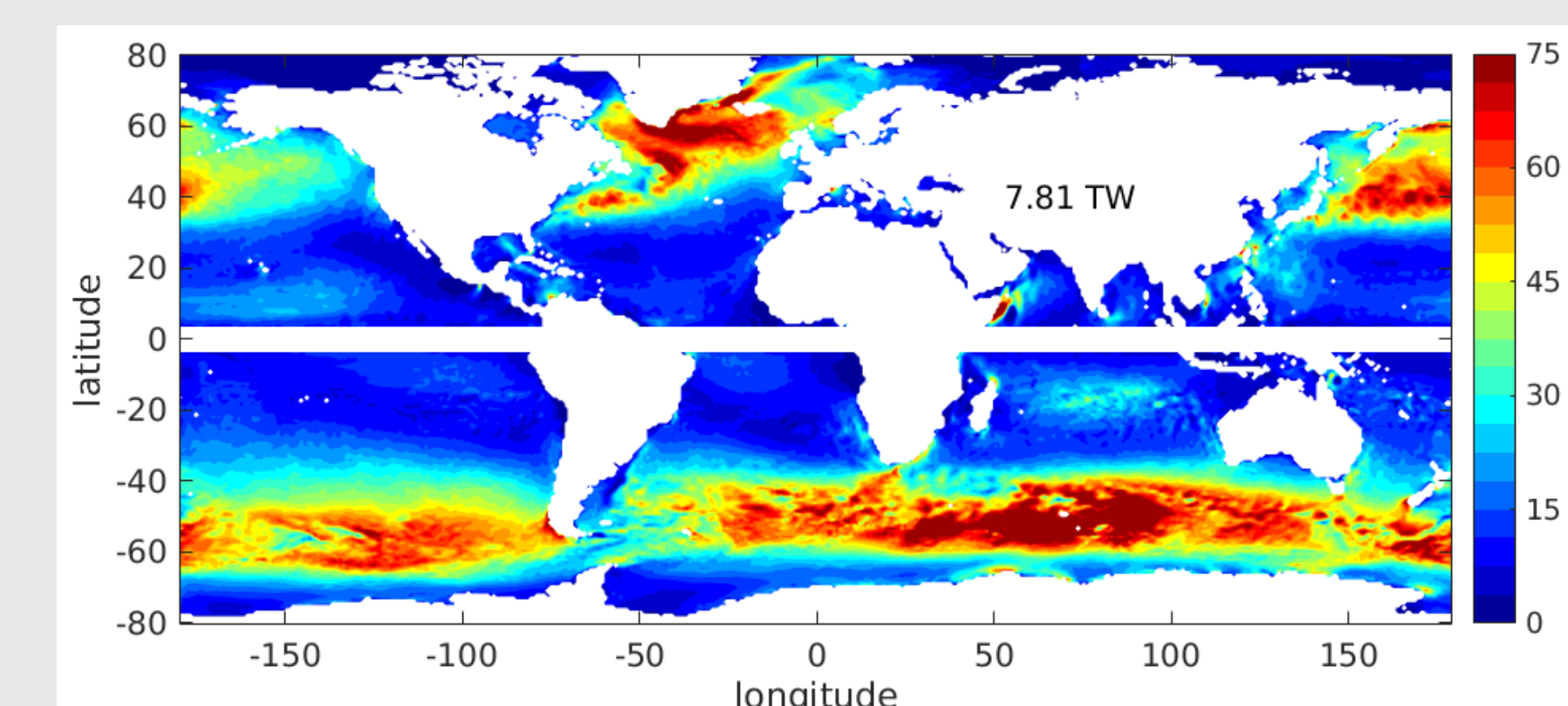
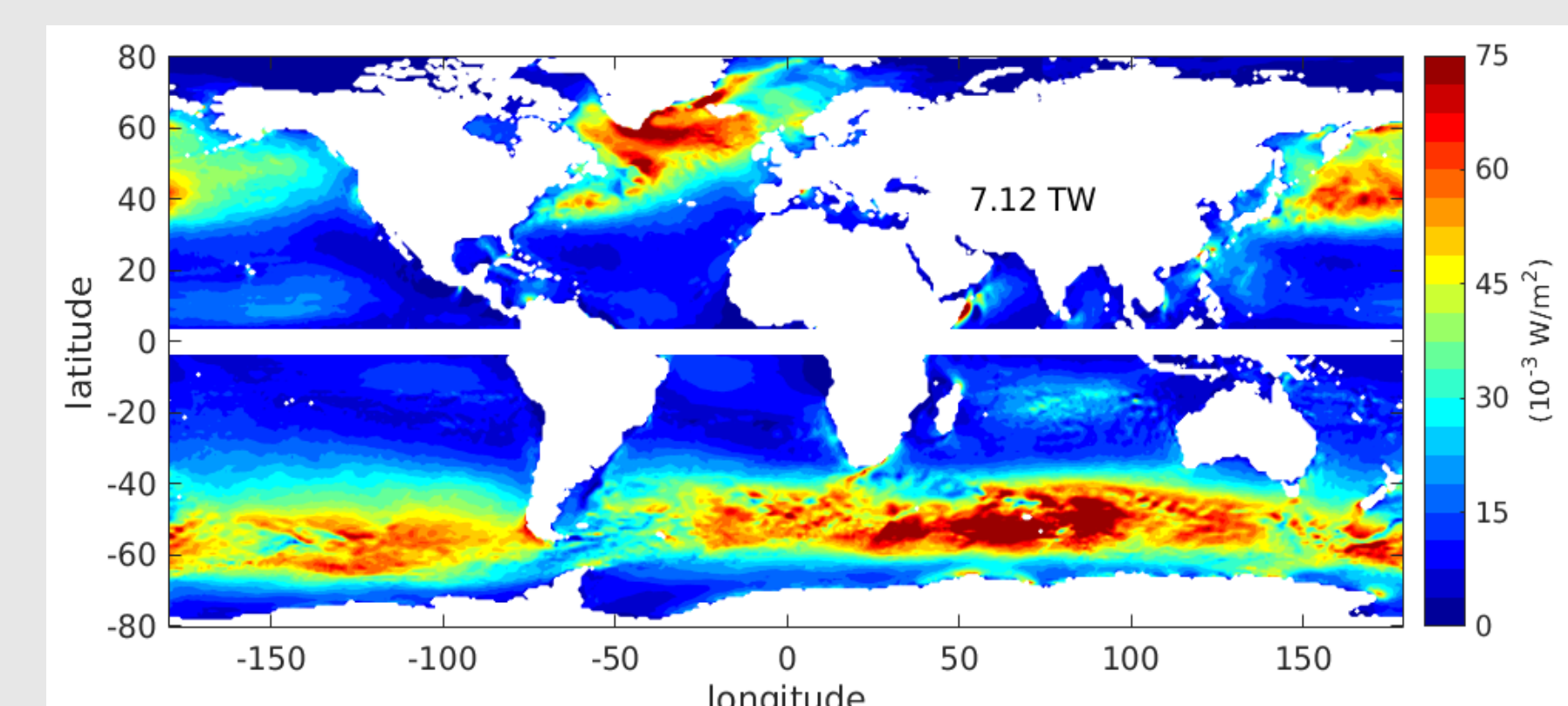
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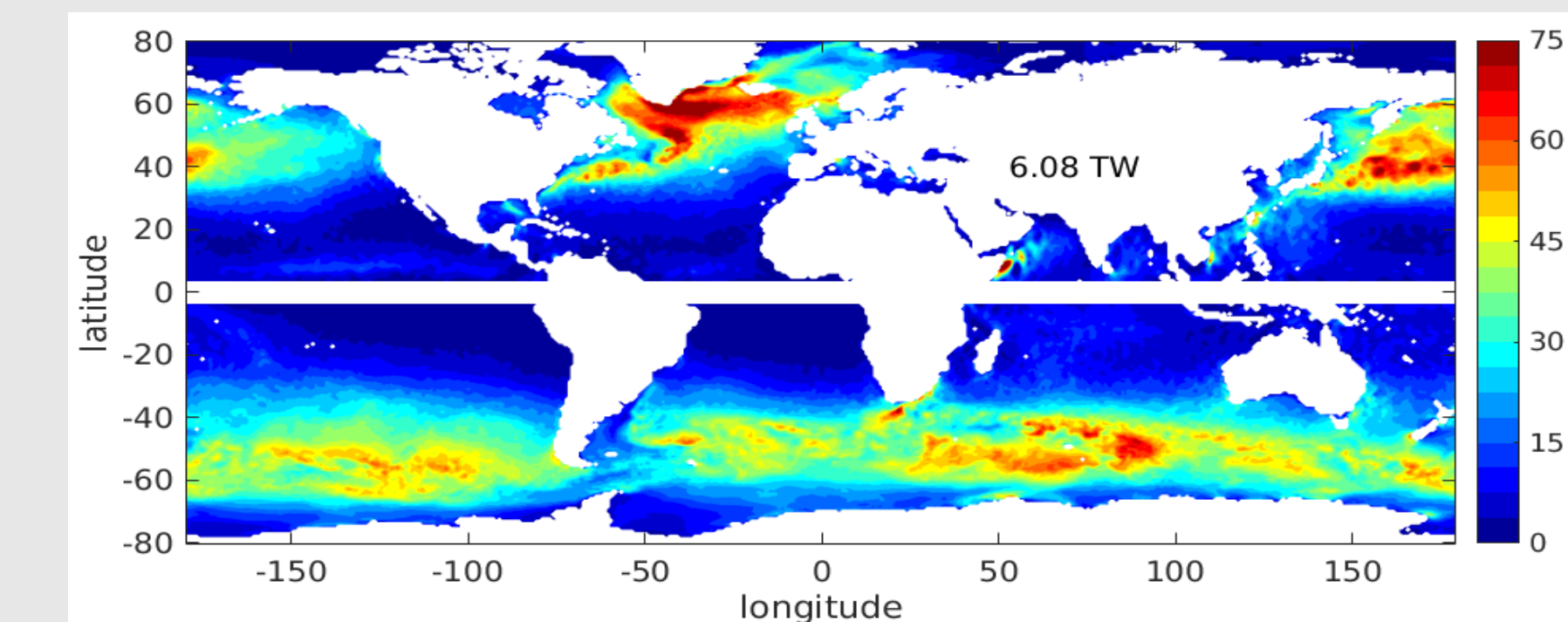
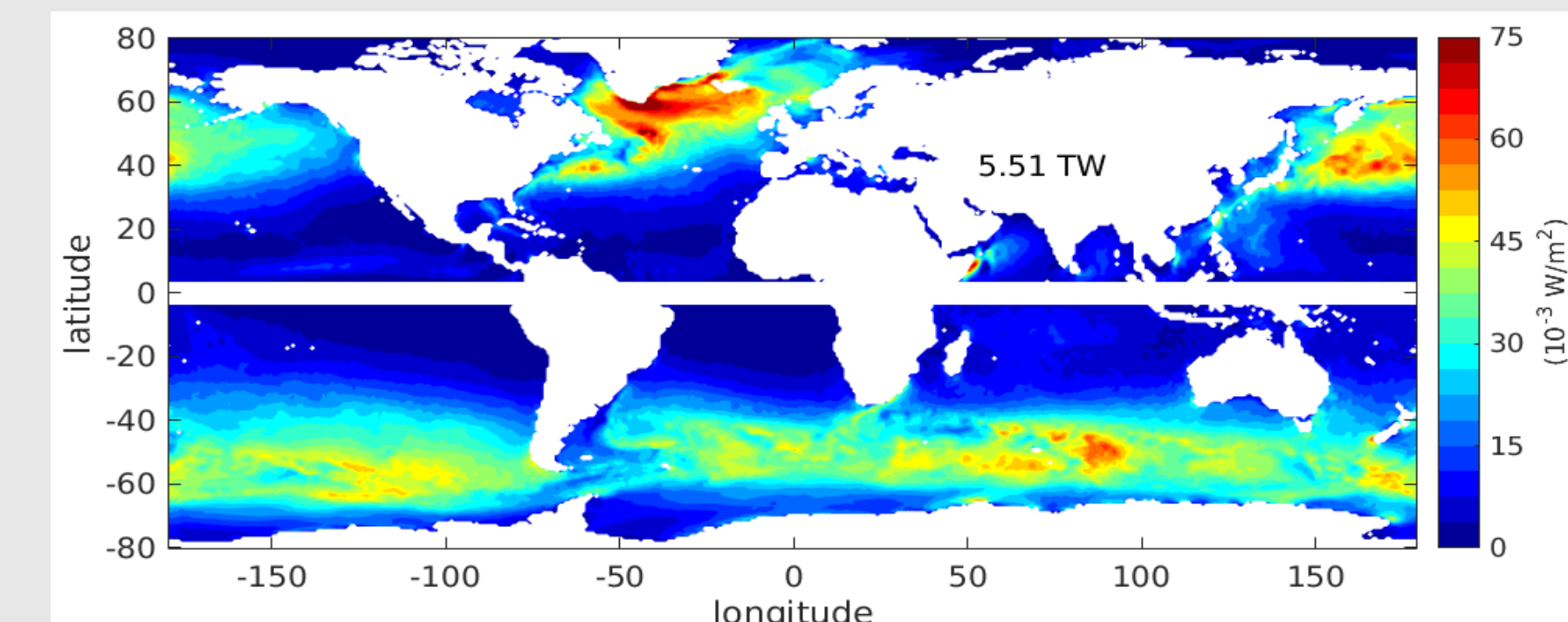
Total Wind Work



Geostrophic Wind Work



Ageostrophic Wind Work



Eddy Component of the Ageostrophic Wind Work

Conclusions

- There is less wind work (geostrophic, ageostrophic, and total) into the global ocean when the sea surface currents are included in the wind stress formulation.
- The wind work on the ageostrophic currents dominates the total wind work.
- The eddy component of the wind work on ageostrophic currents is much larger than the mean component.

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References

Yu, Z., E. J. Metzger, and Y. Fan, 2017. The impact of ocean surface currents on Sverdrup transport in the midlatitude north Pacific via the wind stress formulation. *J. Phys. Oceanogr.*, 47, DOI:10.1175/JPO-D-16-0155.1.
 Yu, Z., Y. Fan, E. J. Metzger, and O. M. Smedstad, 2018. The wind work input into the global ocean revealed by a 17-year global Hybrid Coordinate ocean model reanalysis. *Ocean Model.* *accepted.*