Diurnal wind variability from RapidScat

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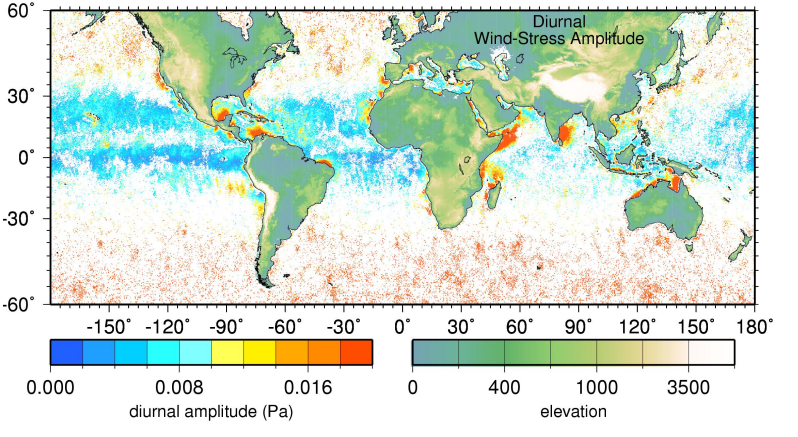
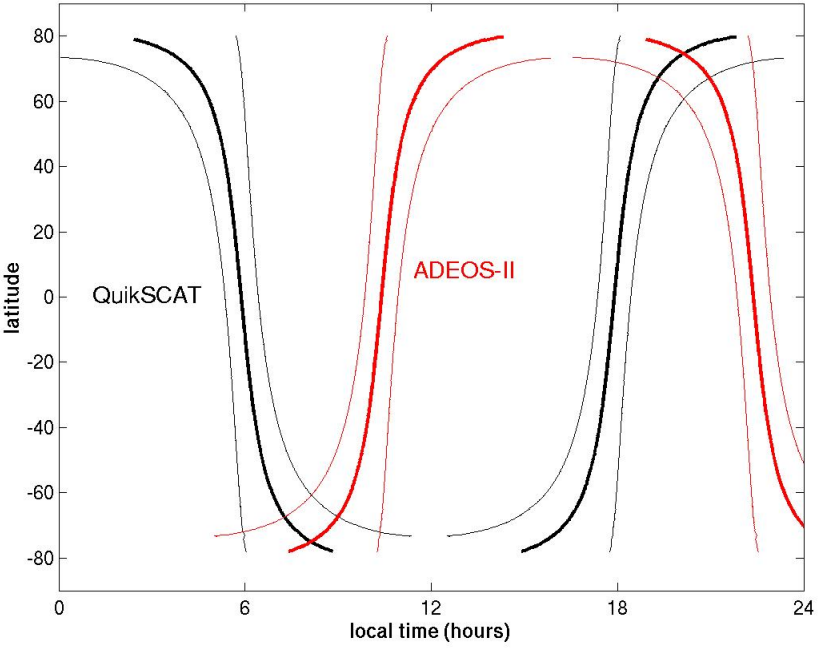


adapted from Gille et al, GRL, 2005

Outline

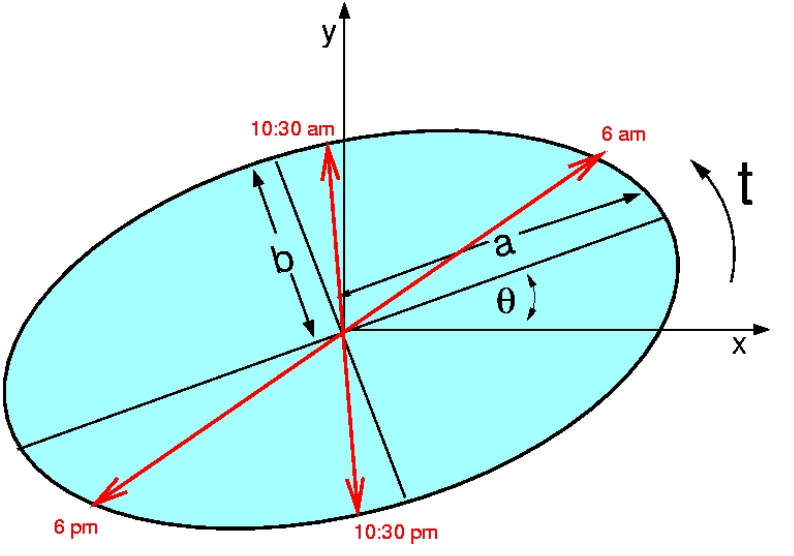
- What we expect from diurnal winds: lessons from the QuikSCAT/ADEOS-2 tandem mission
- Preliminary results from RapidScat: diurnal winds in austral summer



Projecting Winds Onto an Ellipse

Least squares fit bin-averaged winds to sinusoid:

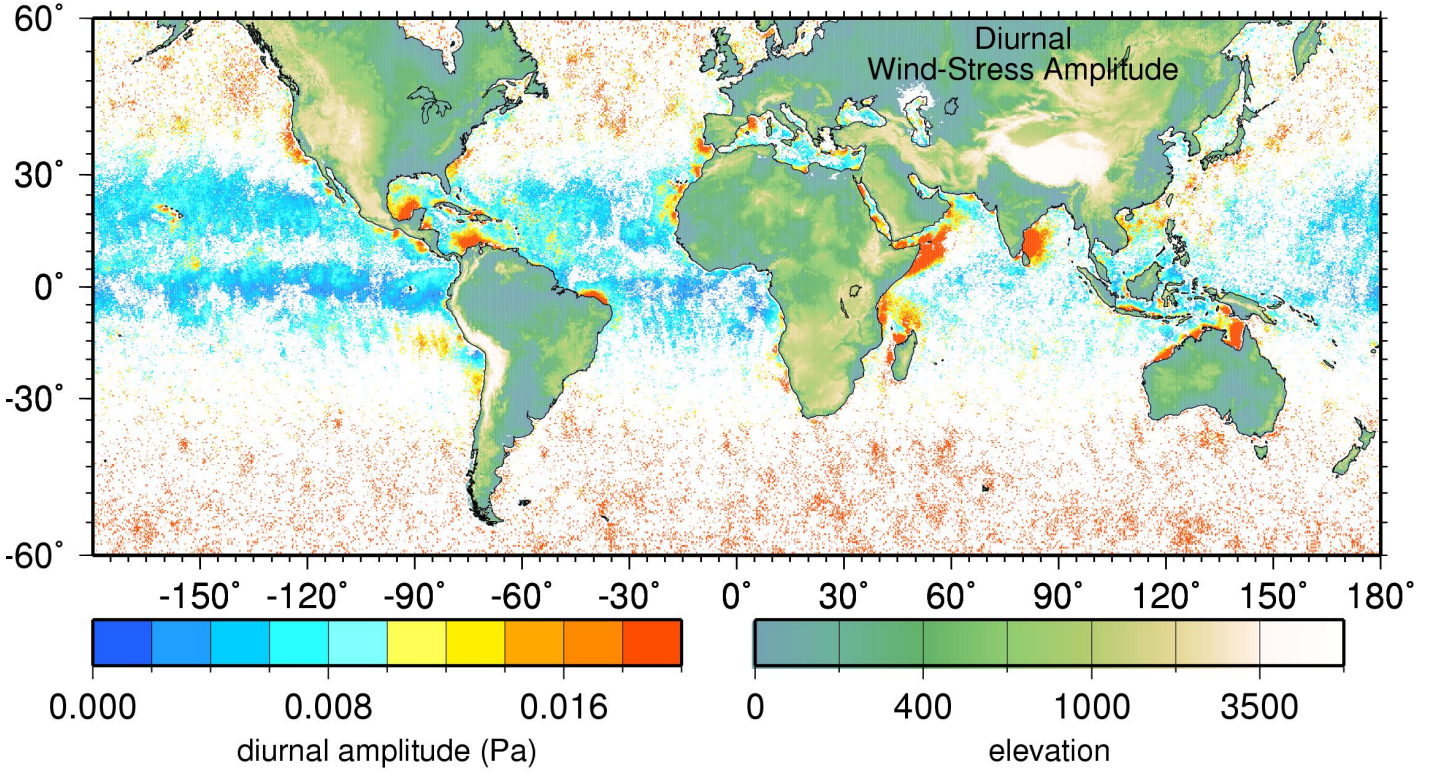
$$\begin{aligned} \tau^x &= \tau_0^x + \tau_1^x \cos\omega t + \tau_2^x \sin\omega t, \\ \tau^y &= \tau_0^y + \tau_1^y \cos\omega t + \tau_2^y \sin\omega t, \end{aligned}$$



QuikSCAT/ADEOS-2 tandem mission features:

- 2 equivalent scatterometers
- 1800-km wide swaths
- 6 months data: April to October 2003

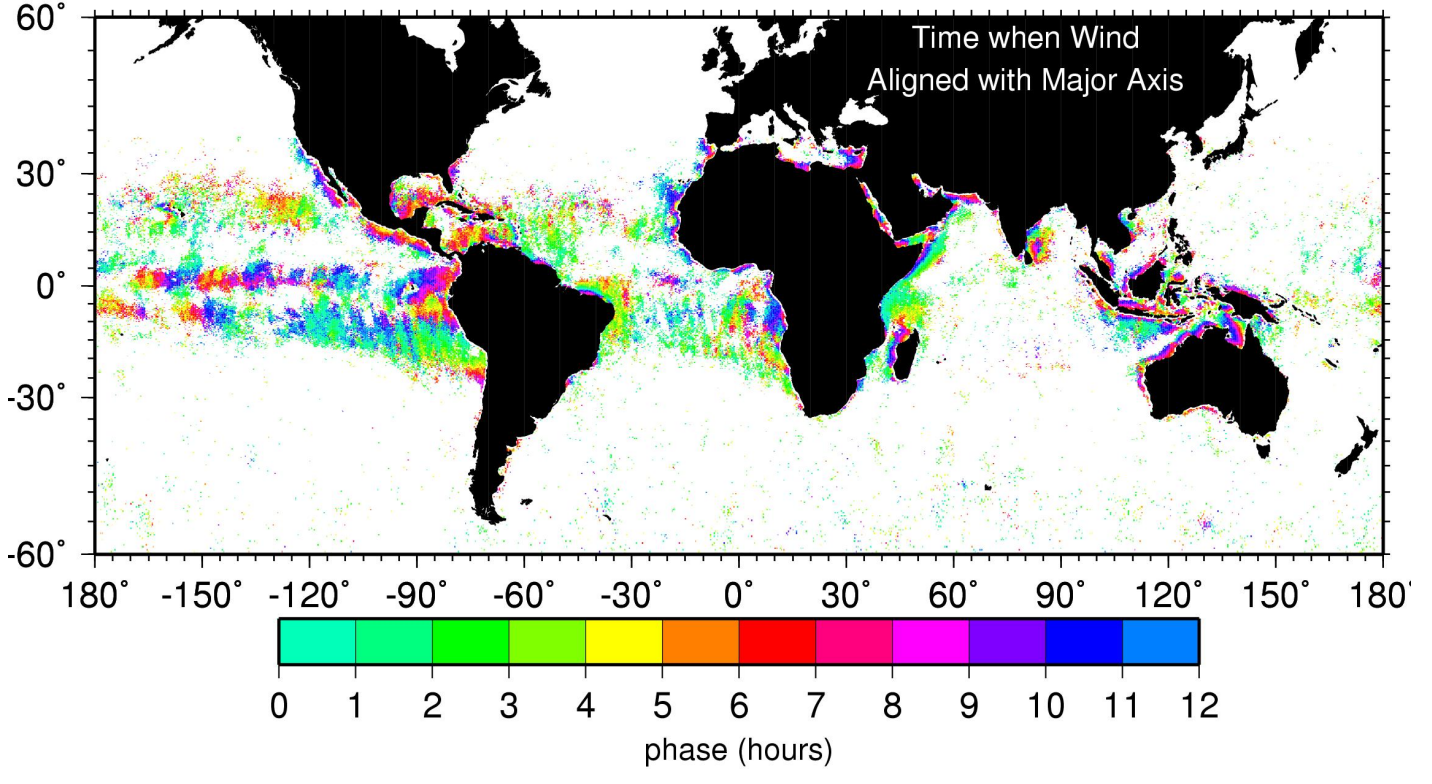
Global diurnal cycles span the tropics



Diurnal winds pronounced in summer.

adapted from Gille et al, GRL, 2005

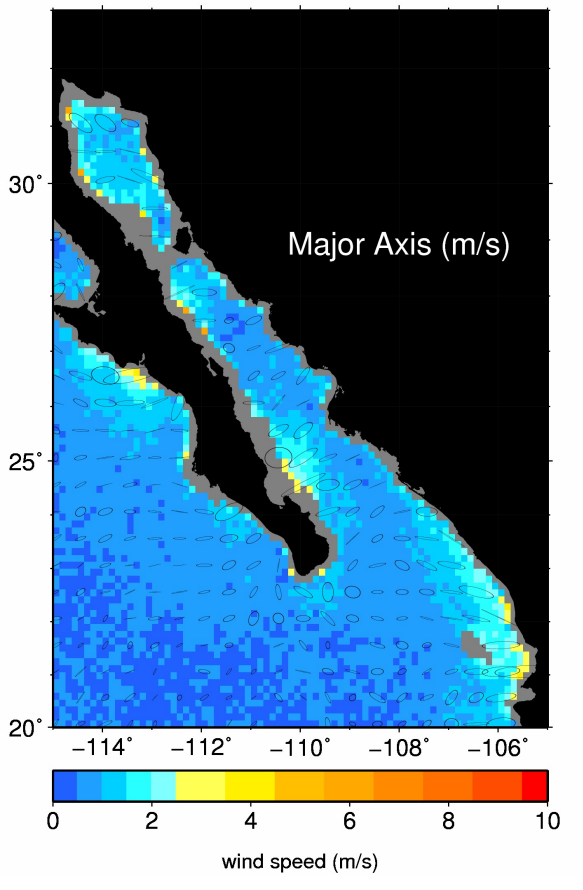
Global Diurnal Phase for Wind Stress

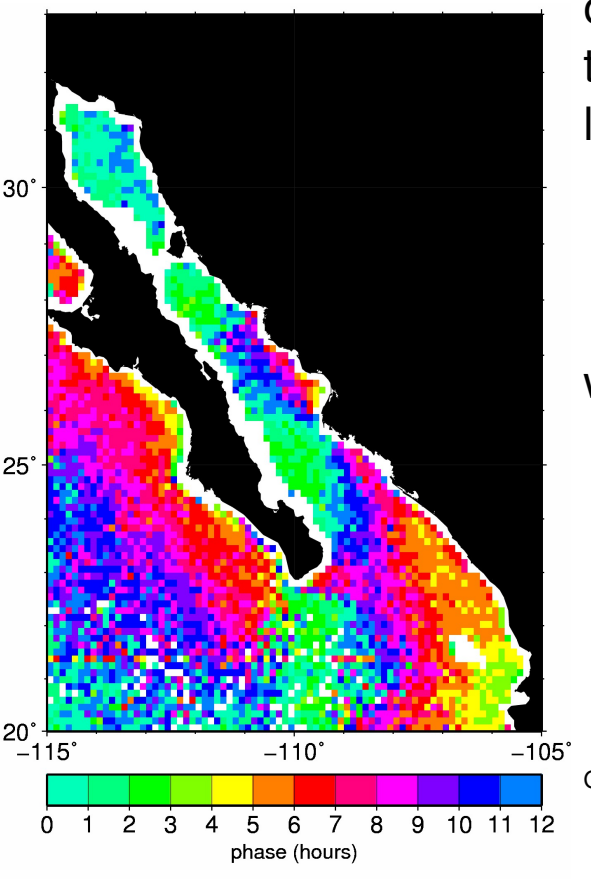


Signals propagate offshore.

adapted from Gille et al, GRL, 2005

Baja California Example: Diurnal Wind Ellipse





offshore propagation (9 ± 4 m s^{-1}) like gravity current:

$$U = \kappa\sqrt{g'd} = 8 \text{ m s}^{-1},$$

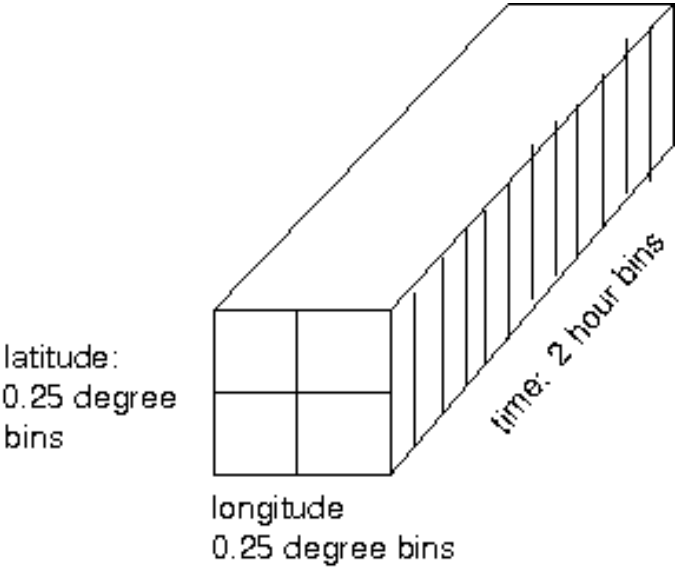
with

$$\kappa = 0.62,$$
$$T = 300 \text{ K},$$
$$\Delta T = 5 \text{ K},$$
$$d = 1000 \text{ m}.$$

Gille et al, GRL, 2005

Open questions: What the QuikSCAT/ADEOS-2 data don't answer

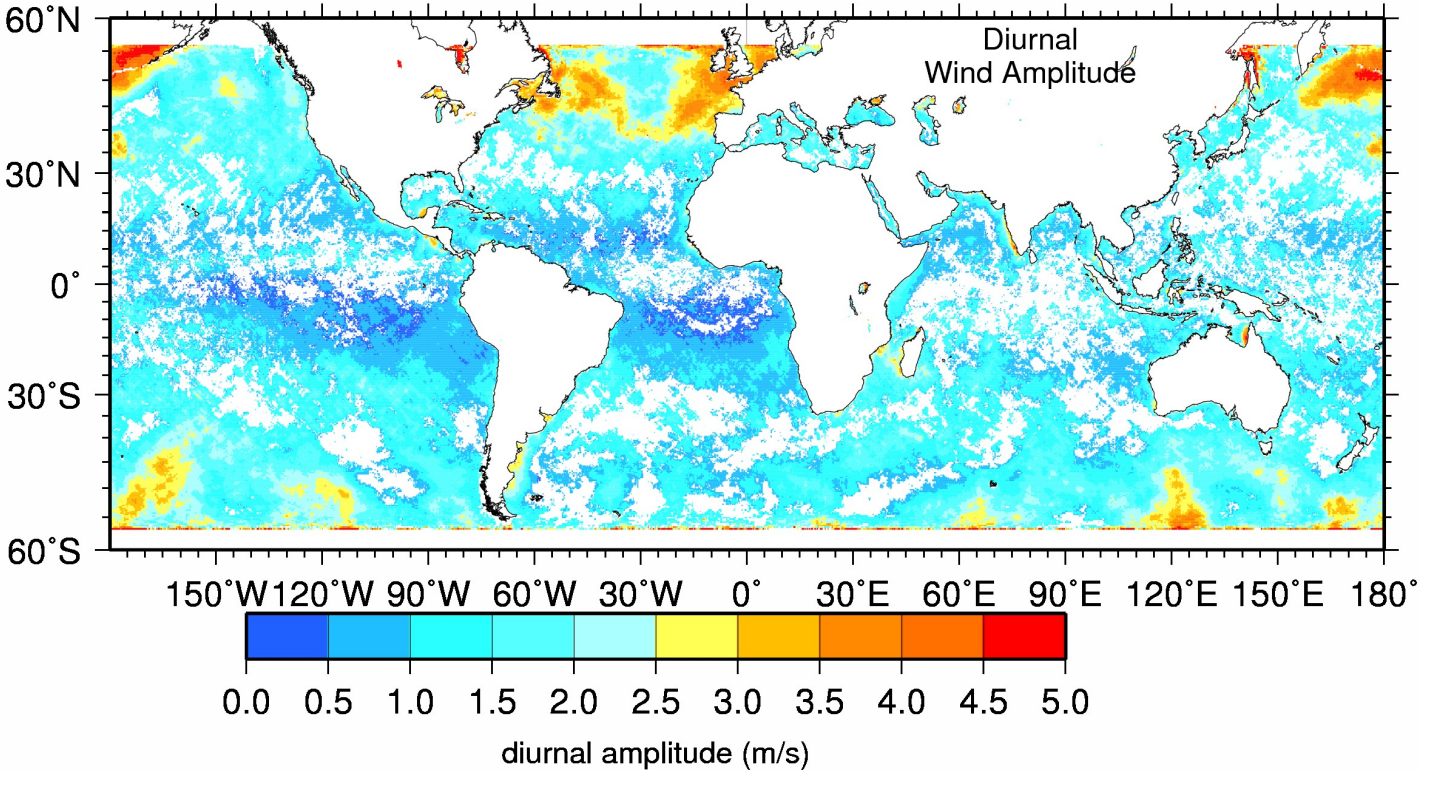
- What happens in Southern Hemisphere summer?
- Are diurnal winds strictly sinusoidal?
- How does one year differ from another?



Method

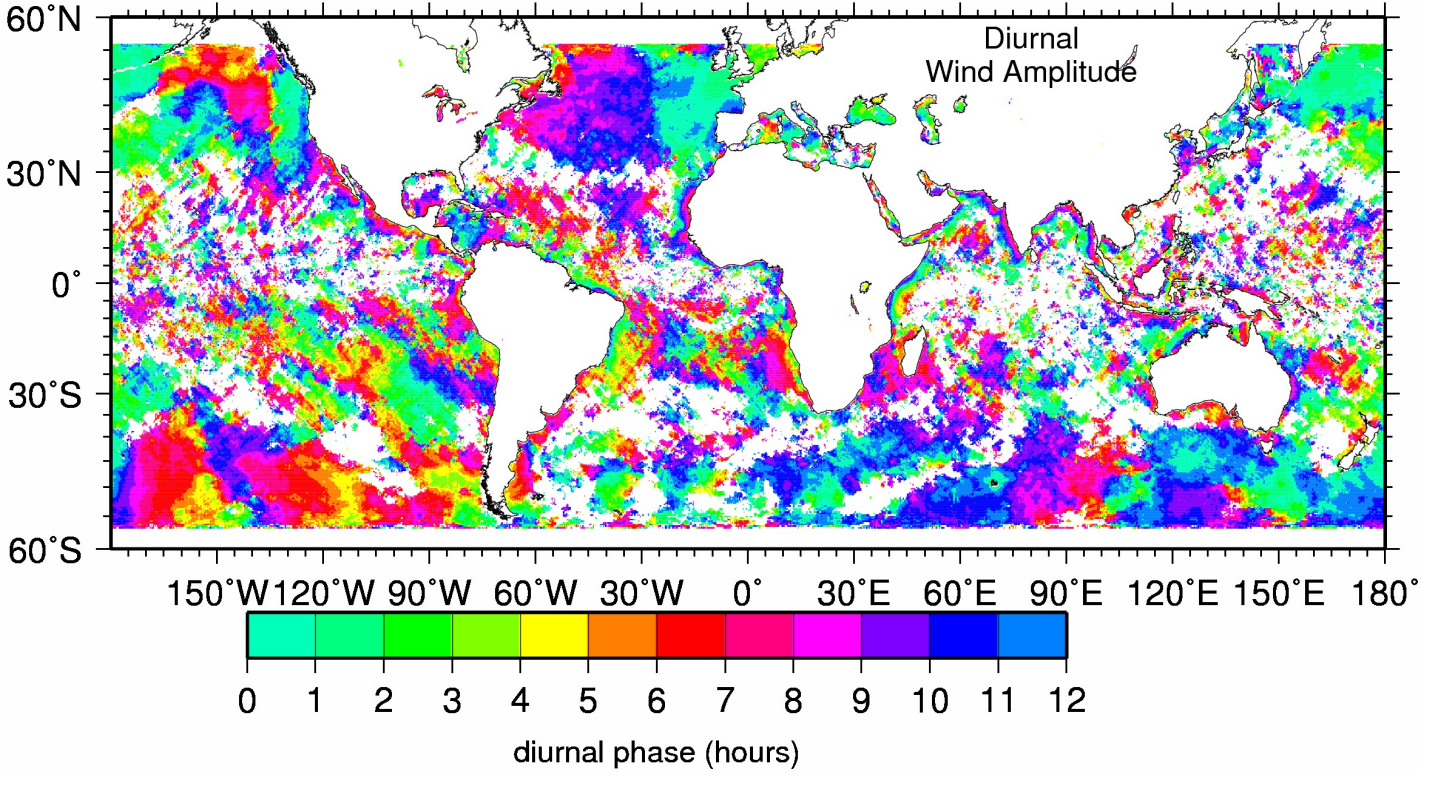
1. Bin average available RapidScat data for zonal and meridional wind components.
2. Sinusoidal fit for diurnal and semi-diurnal frequencies.
3. Diurnal amplitude and phase are non-linear: need Monte Carlo calculation to infer statistical uncertainty

Diurnal patterns from RapidScat



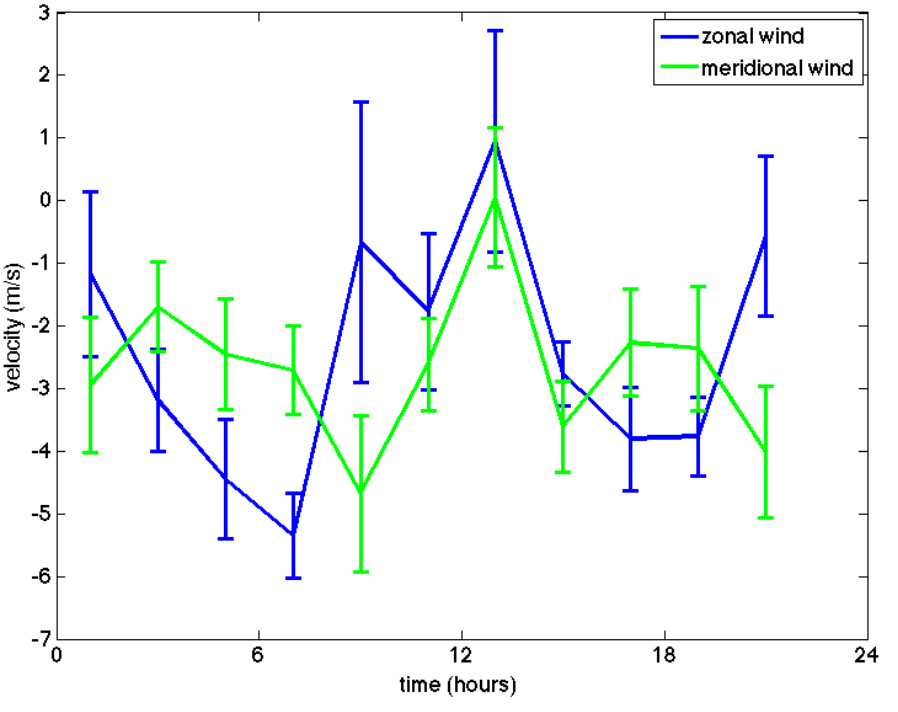
- Large diurnal signals in Southern Hemisphere (summer).
- Large signals at high latitudes

Time of maximum diurnal wind



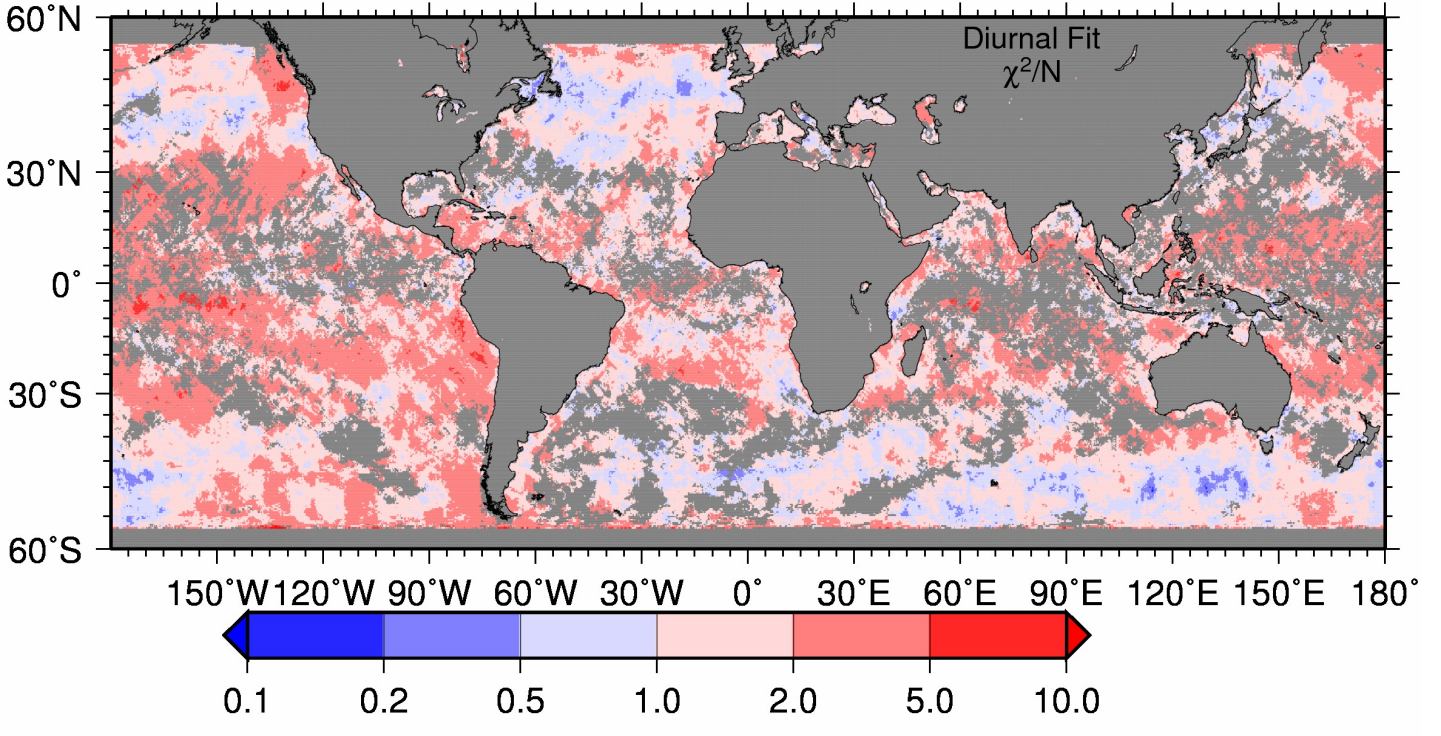
- Signals appear to propagate offshore.
- Much diurnal variability appears spurious, indicating need for better uncertainty estimation and/or more months of RapidScat.

Does a diurnal fit make sense?



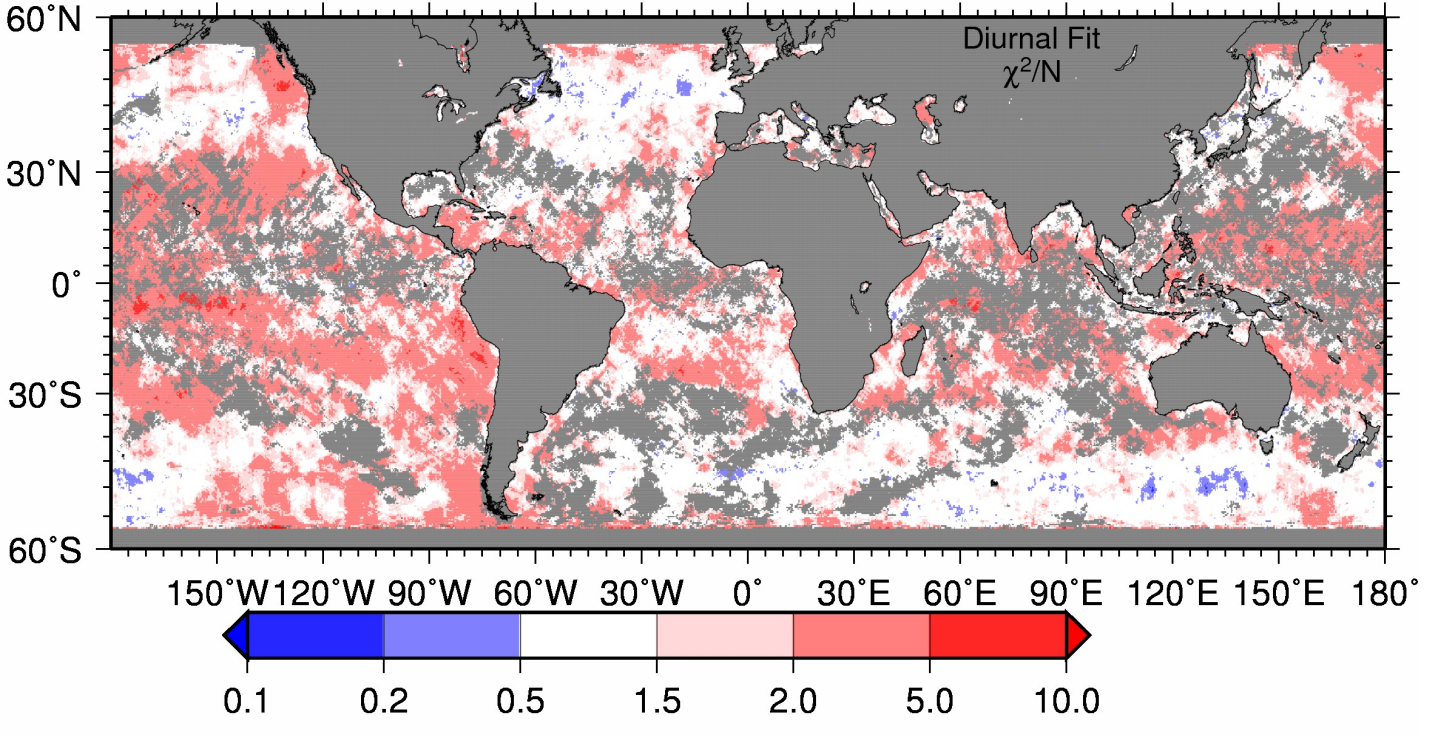
Central tropical Pacific: 10°S, 160°W

Assessing goodness of fit: reduced χ^2



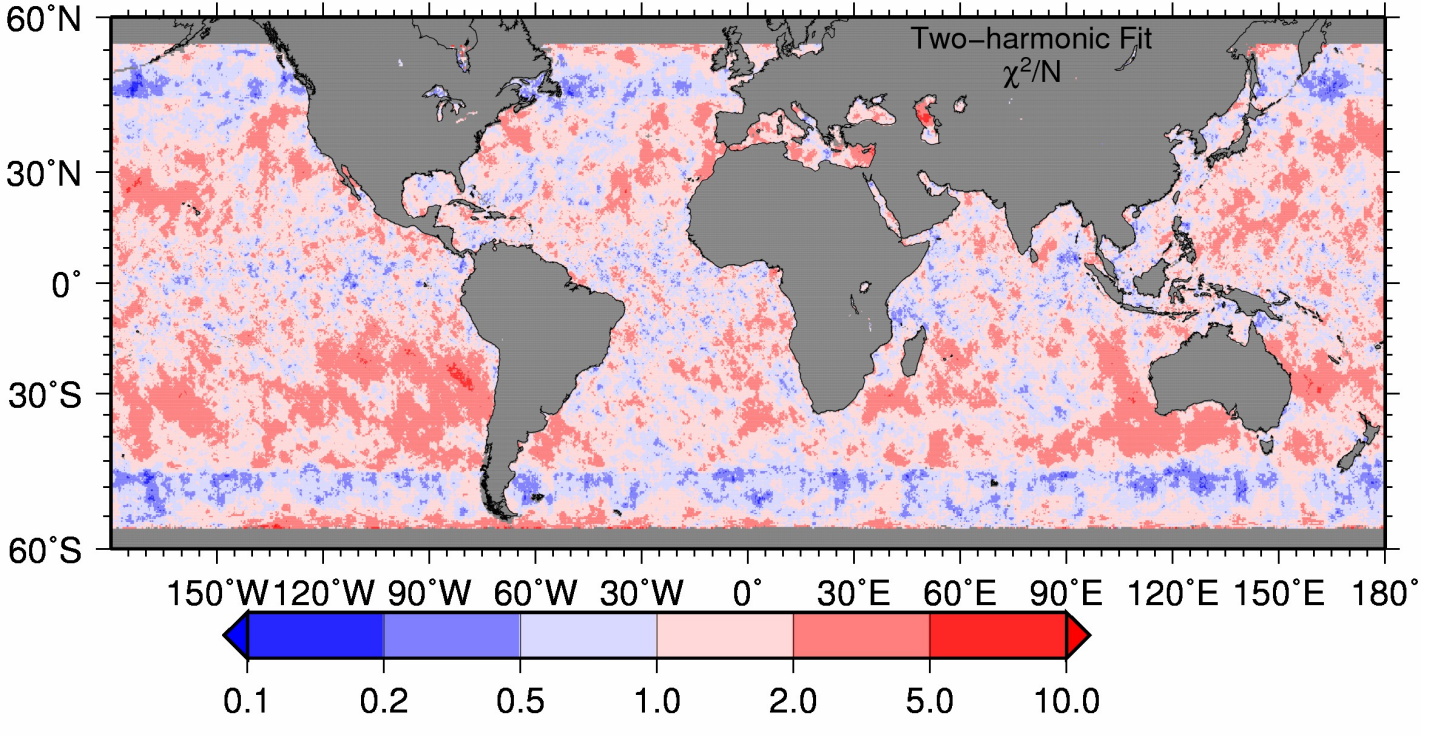
- χ^2/N (where N is degrees of freedom after fitting) should be about 1. Values greater than 1 indicate a poor model function and large misfit; values much less than 1 imply over fitting relative to data uncertainties.

Assessing goodness of fit: reduced χ^2



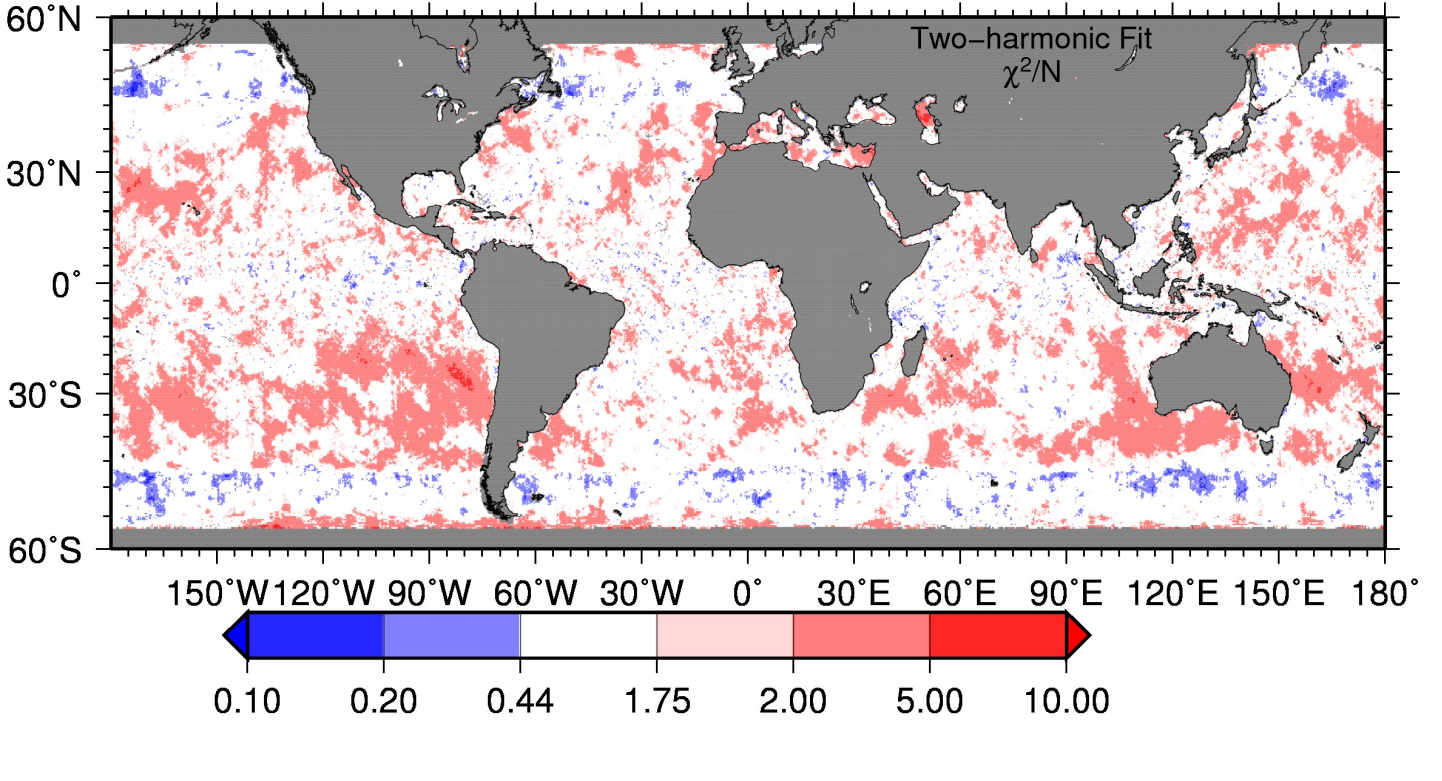
- χ^2/N (where N is degrees of freedom after fitting) should be about 1.
- Values between 0.05 and 0.95 probabilities whited out.

Assessing goodness of fit: reduced χ^2



- Fit to semi-diurnal and diurnal cycles appears more successful.

Assessing goodness of fit: reduced χ^2



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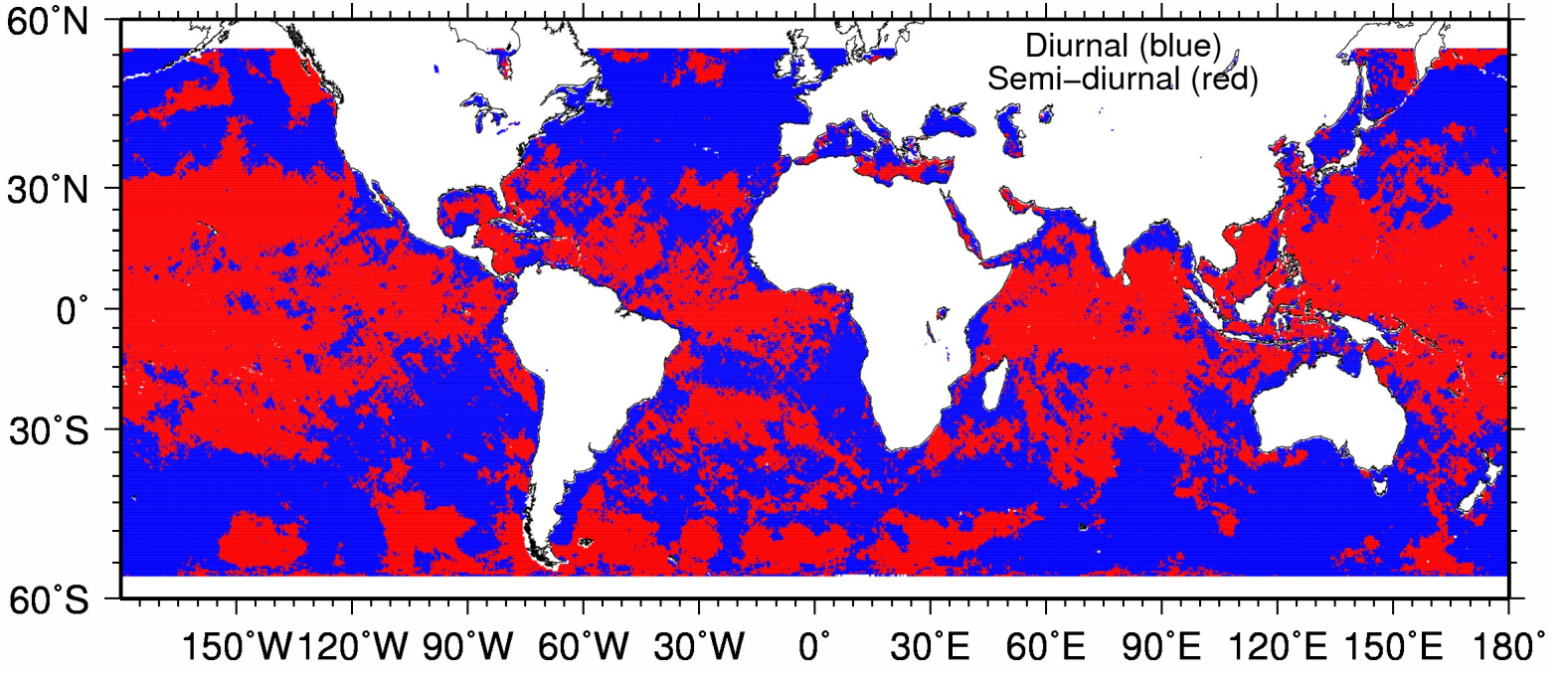
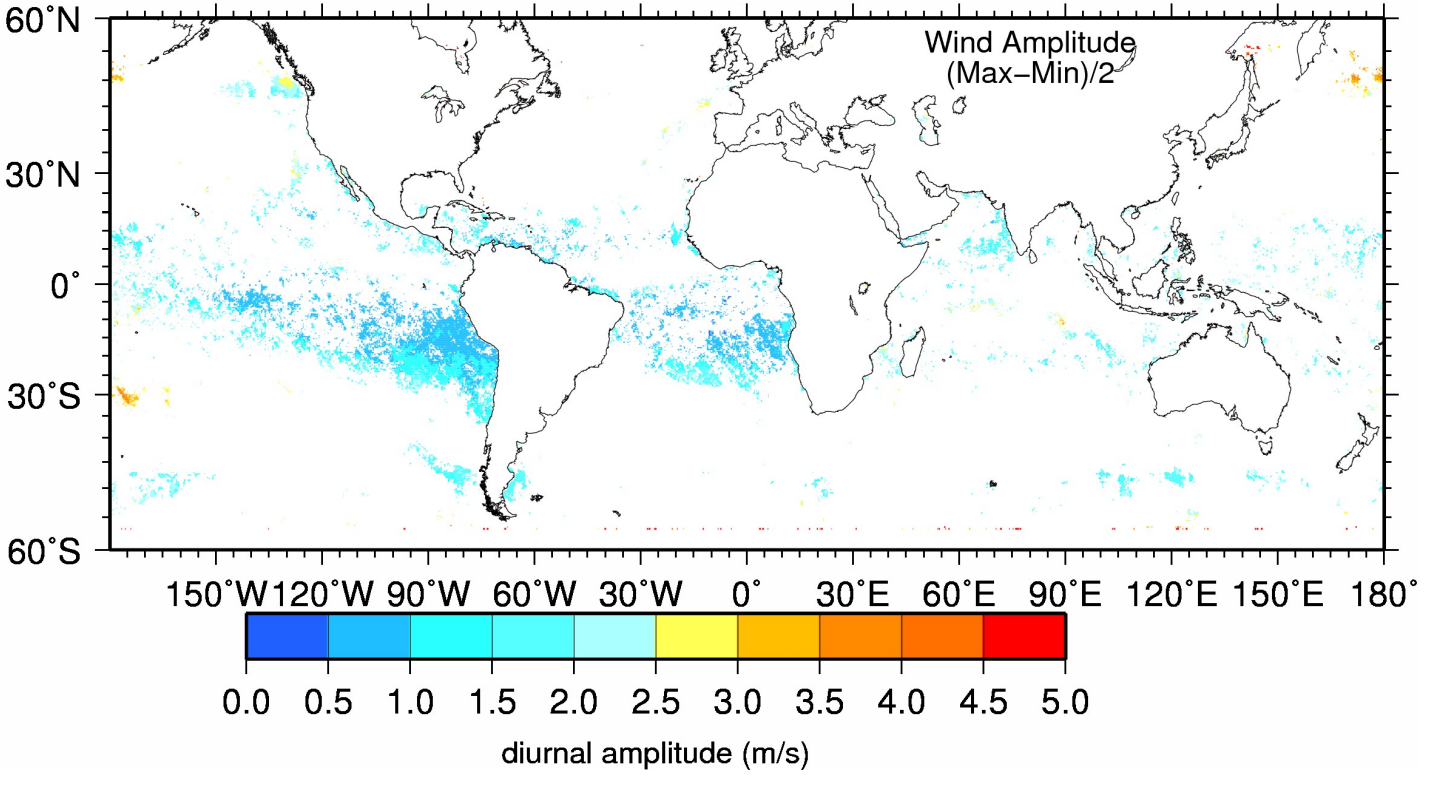
Is the semi-diurnal or diurnal amplitude bigger?



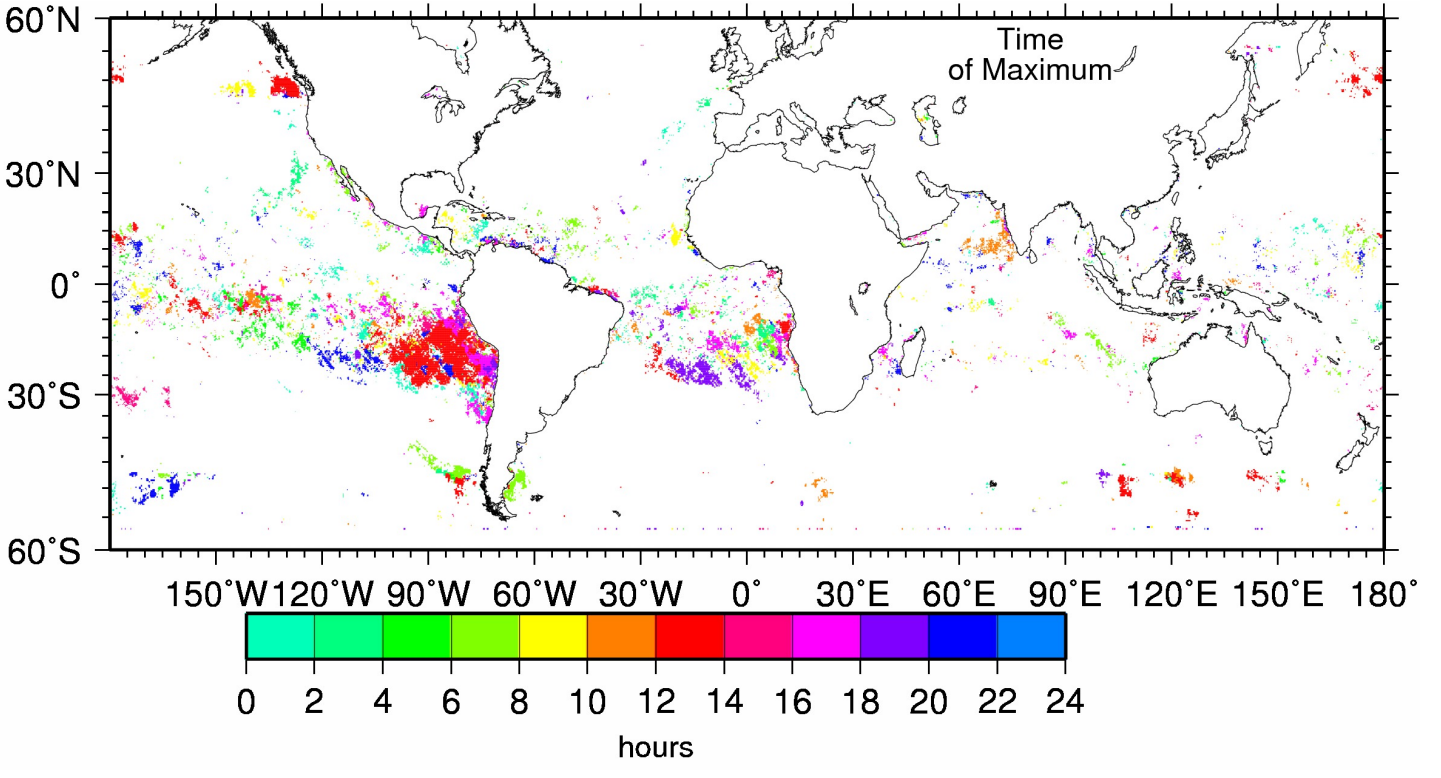
- Semi-diurnal (red) bigger in tropics
- Diurnal (blue) bigger at high latitudes in open ocean.

Diurnal patterns from RapidScat: empirical approach



- Statistically significant differences between maximum and minimum primarily in tropics in summer hemisphere.

Diurnal patterns from RapidScat: time of maximum



- Maxima in afternoon (sometimes).
- Propagation?

Summary

- RapidScat record is short for inferring diurnal cycle.
- Stronger diurnal variability in summer than winter.
- Better fits when semi-diurnal component included.