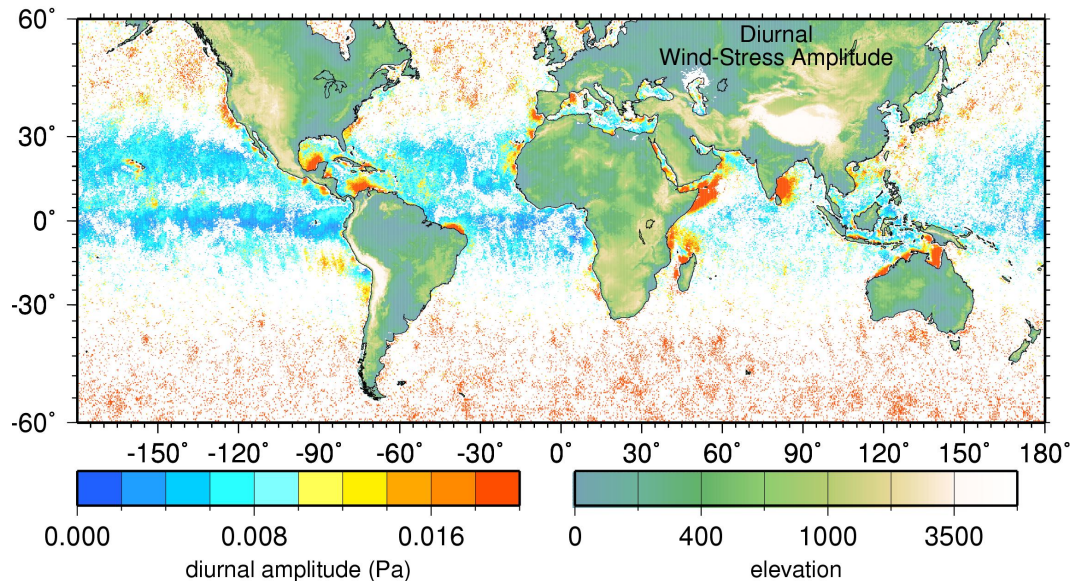


Diurnal wind variability in the tropics: Non-stationarity on seasonal to interannual timescales

Sarah Gille
Devon Northcott
Donata Giglio

Scripps Institution of
Oceanography
UCSD, La Jolla, CA
sgille@ucsd.edu



Diurnal cycle from QSCAT/ADEOS-2 tandem mission, adapted from Gille et al, GRL, 2005

Wind: Variability on different time scales

$$U(t) = \underbrace{\overline{U} + U_{yr} \cos \left(\frac{2\pi t}{365.25d} + \phi_{yr} \right) + U_{LF}(t)}_{\text{slowly varying terms}} + \underbrace{U_d \cos \left(\frac{2\pi t}{1d} + \phi_d \right)}_{\text{diurnal}} + \underbrace{U_{HF}(t)}_{\text{gusty}}$$

Slowly varying terms Time mean, annual cycle, interannual variability, all well sampled by a single scatterometer

Diurnal Diurnal (24-hour) cycles, at Nyquist frequency of a sun synchronous satellite; really need 4+ measurements per day

Gusty or high-frequency Variability on scales of minutes to hours, not well sampled by satellite

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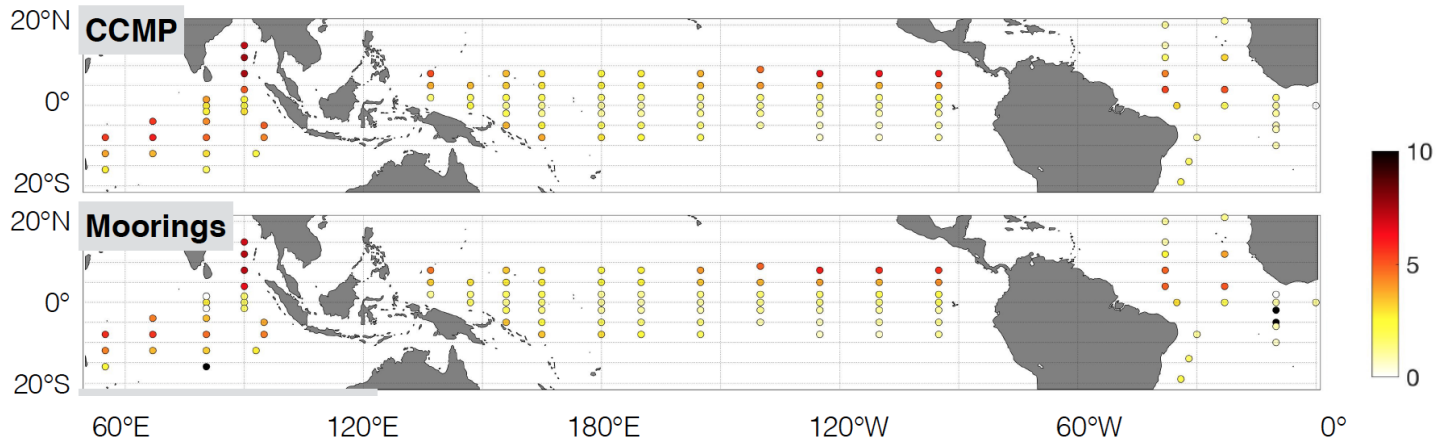
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Diurnal Diurnal (24-hour) cycles, at Nyquist frequency of a sun synchronous satellite; really need 4+ measurements per day—**This talk**

Gusty or high-frequency Variability on scales of minutes to hours, not well sampled by satellite —**Donata Giglio's talk and Magdalena Carranza's poster**

Outline

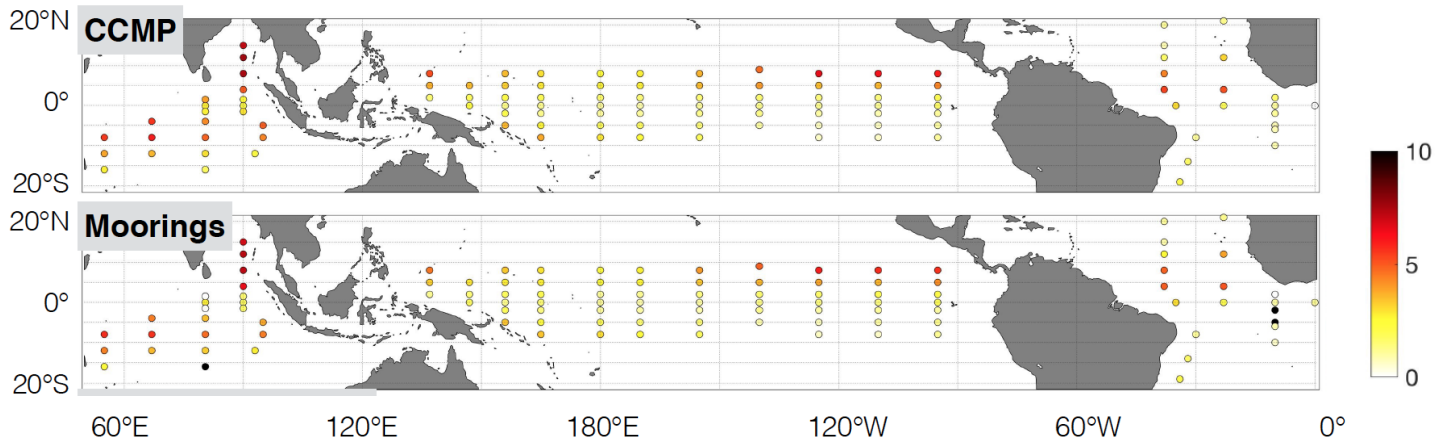
- What do the tropical moorings tell us about diurnal winds?
- Evaluate prospects for identifying diurnal cycles with a RapidScat-like sampling pattern.



RAMA (Indian), TAO (Pacific), and PIRATA (Atlantic) mooring locations with annual wind amplitude (m/s)

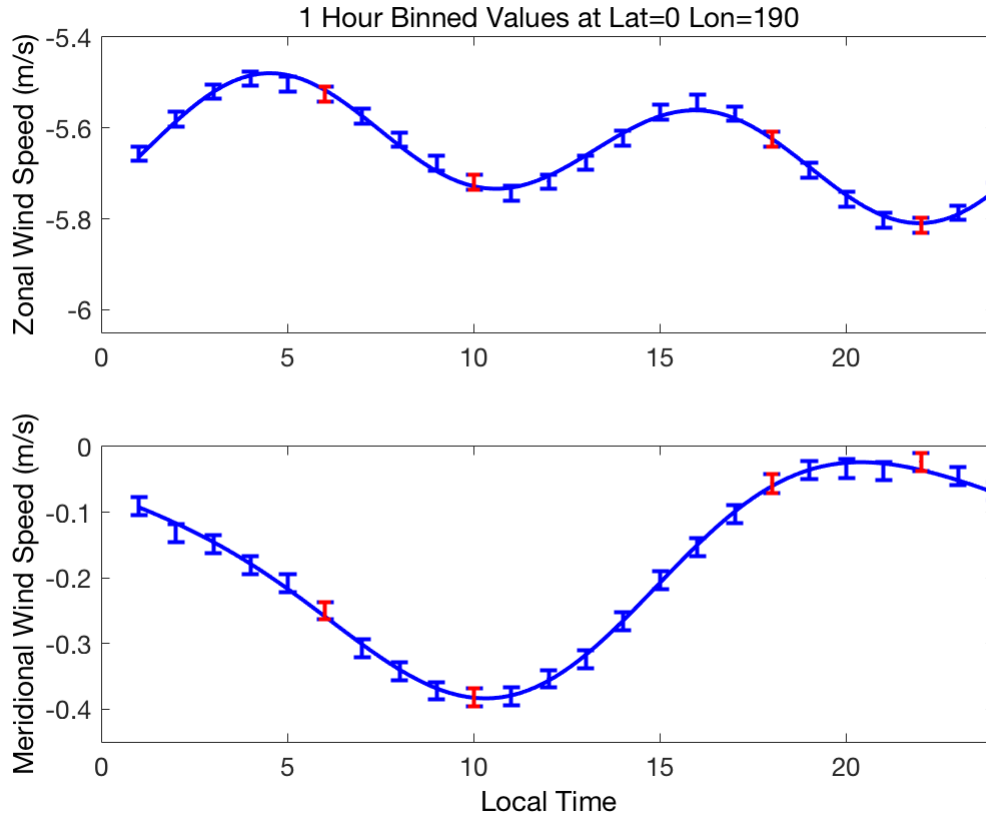
Outline

- What do the tropical moorings tell us about diurnal winds? **Diurnal winds are non stationary, and semi-diurnal signal can be significant.**
- Evaluate prospects for identifying diurnal cycles with a RapidScat-like sampling pattern. **Annual cycle aliases into diurnal over short time periods, but effect diminishes with 2 years of data.**



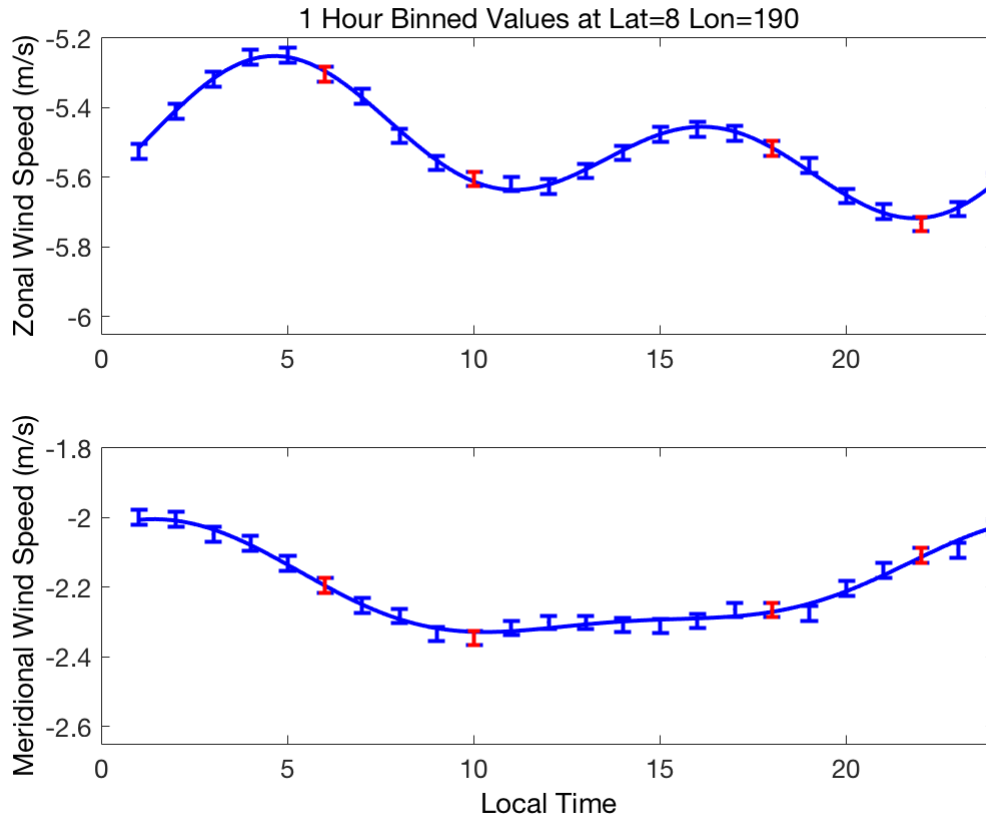
RAMA (Indian), TAO (Pacific), and PIRATA (Atlantic) mooring locations with annual wind amplitude (m/s)

Buoy Winds: Diurnal and Semi-diurnal (0° N, 190° E)



- Diurnal cycle in meridional component; semi-diurnal in zonal component
- Strong semi-diurnal: time of maximum sensitive to noise

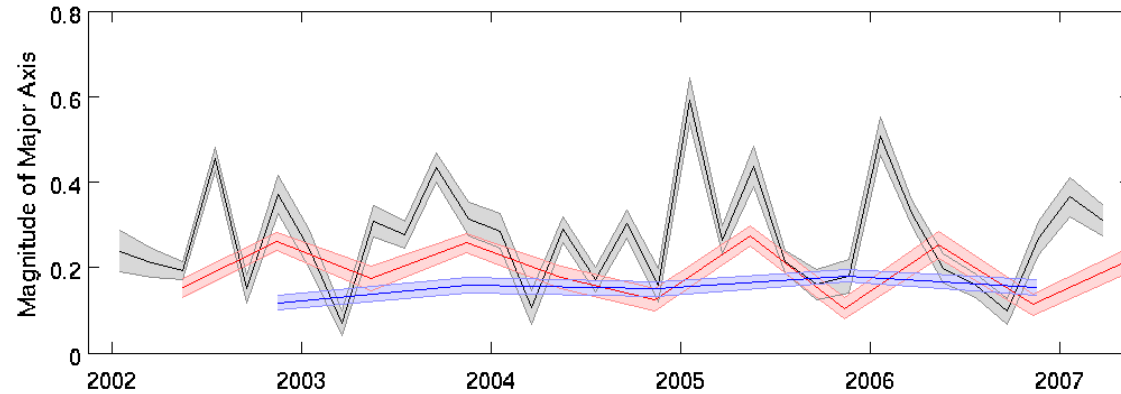
Buoy Winds: Diurnal and Semi-diurnal (8°N , 190°E)



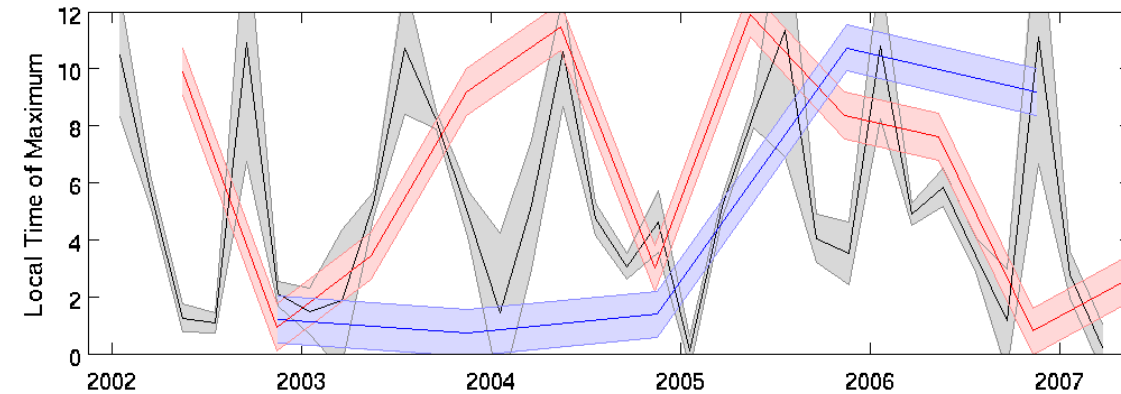
- Diurnal cycle in meridional component; semi-diurnal in zonal component
- Details don't change as we move off Equator

Buoy Winds: Non-Stationarity of Diurnal Winds

Major Axis & Phasing w/ Various Bin Lengths at Lat=8 Lon=190

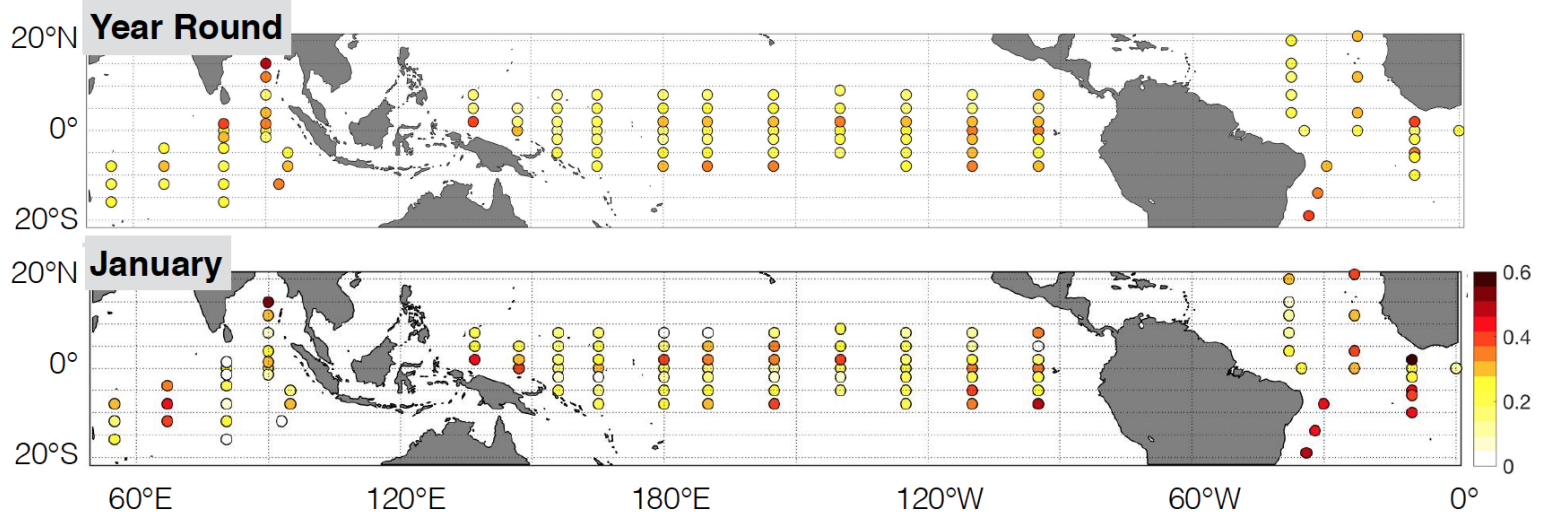


Amplitude (m/s)
Black: 2-month averages
Red: 6-month averages
Blue: 12-month averages



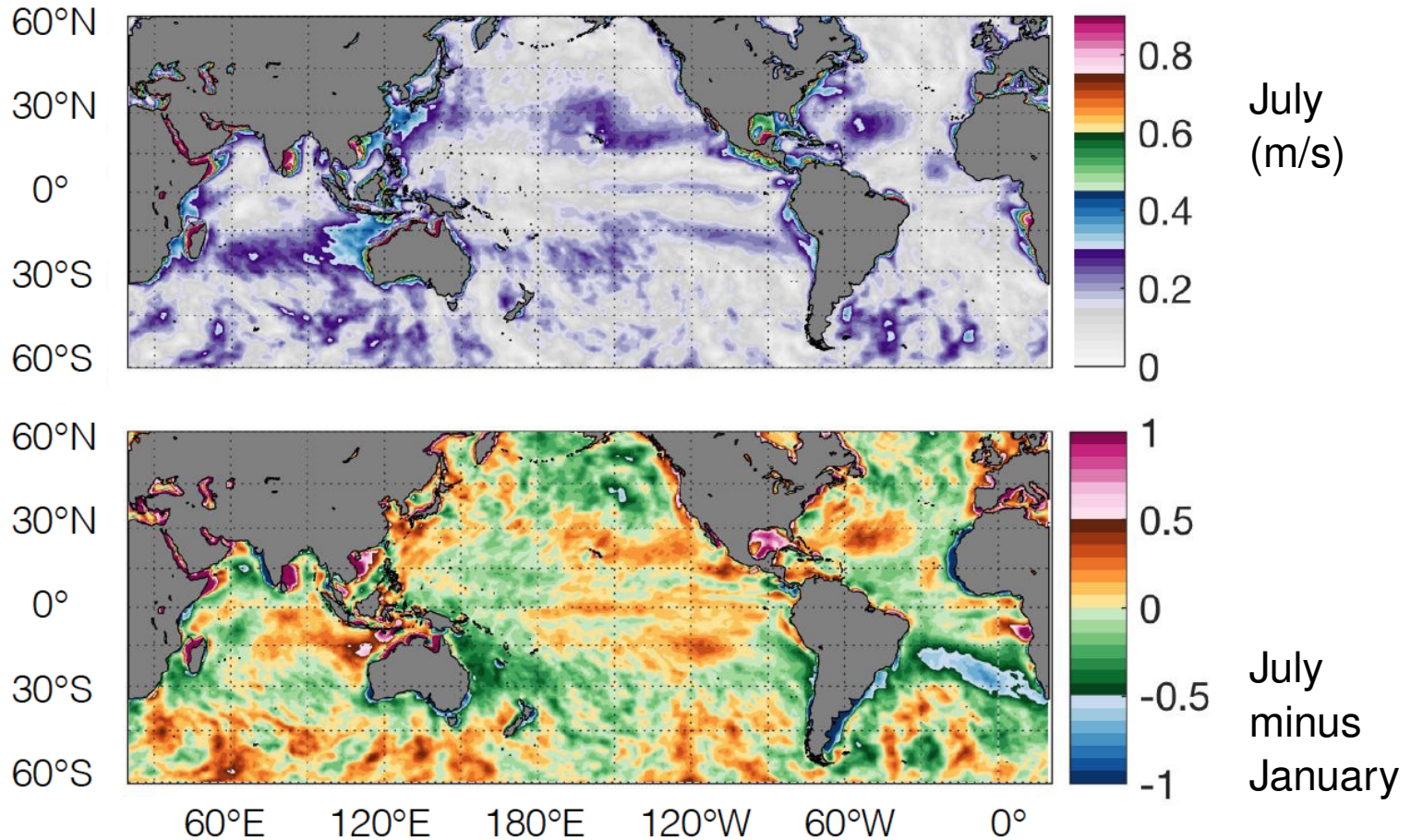
Phase

Buoys: Climatological Diurnal Cycle

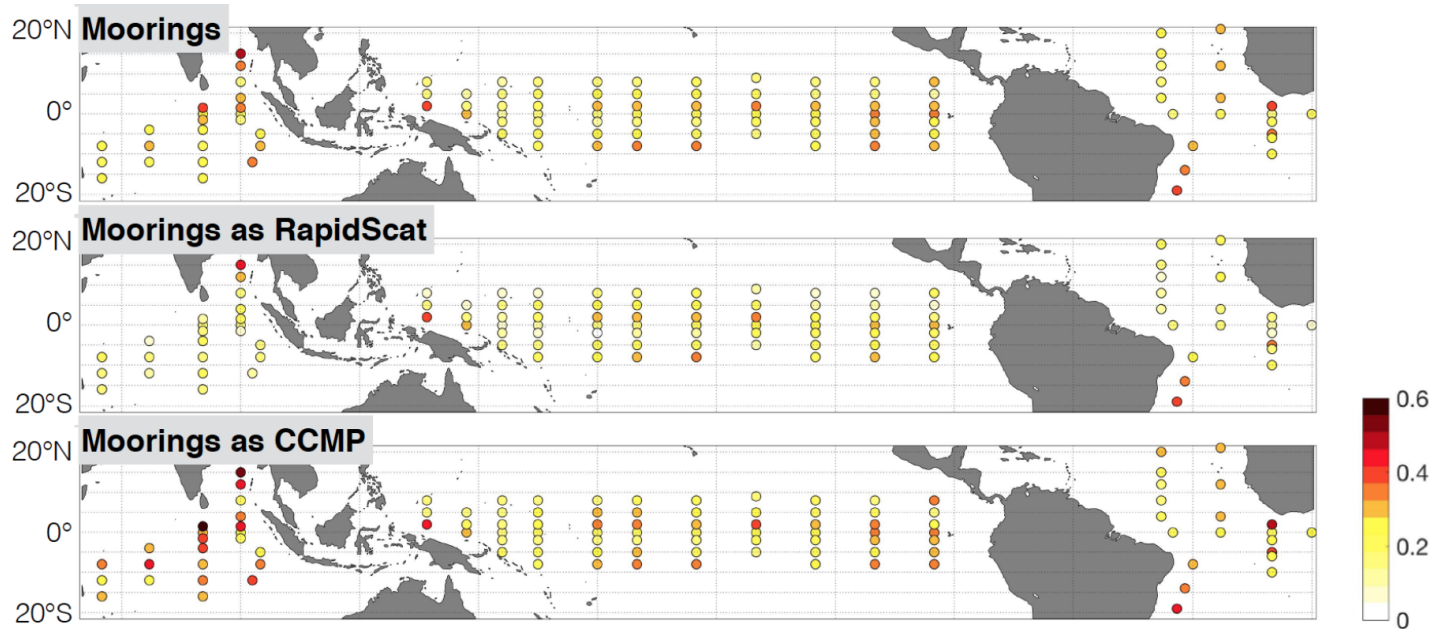


- Buoy diurnal cycles (in m/s) small but detectable
- January averages differ from year round averages

CCMP: Climatological Diurnal Cycle



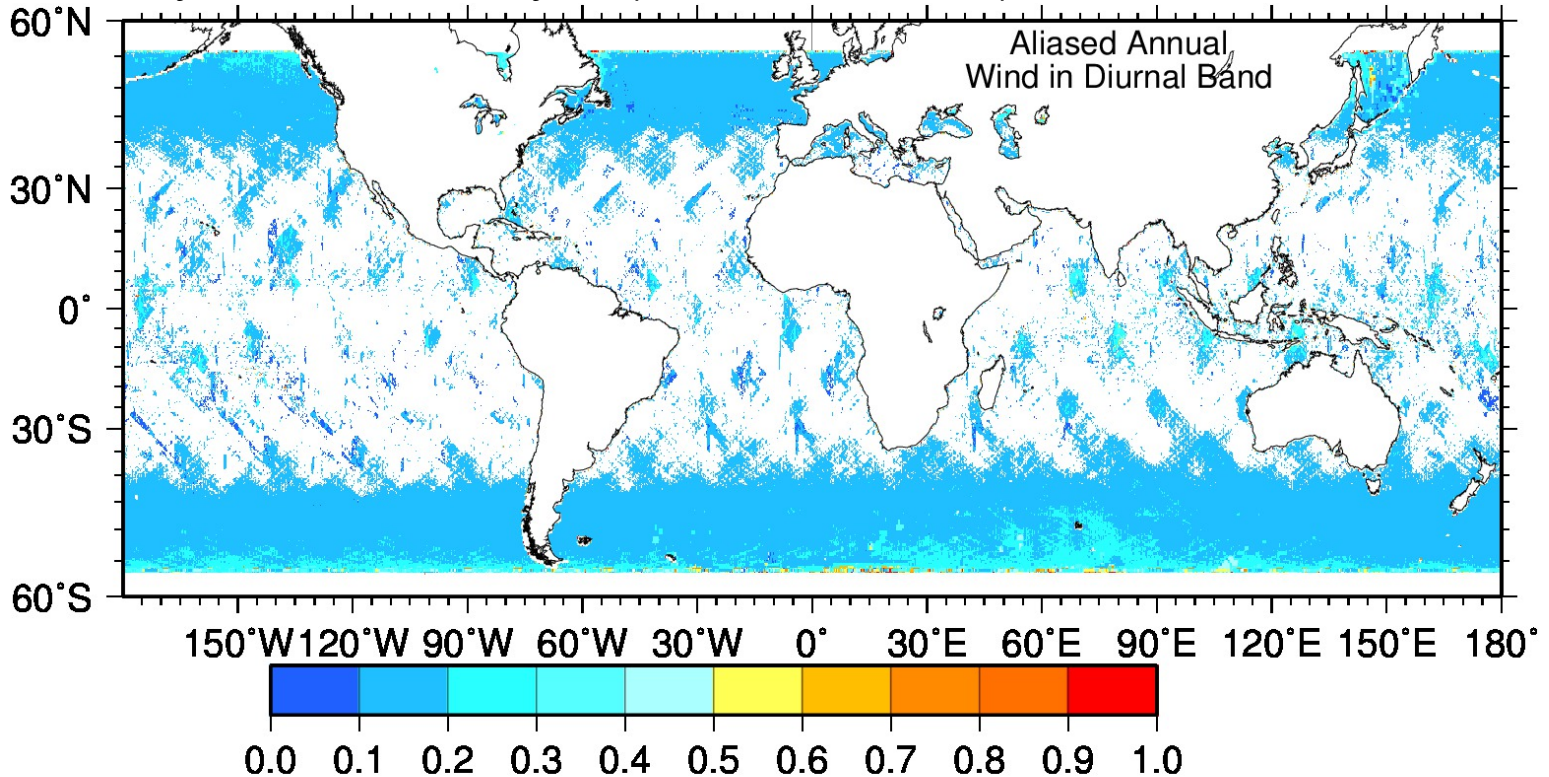
Buoys: 2000-2015 Diurnal Cycle (year round)



- Mooring record, sampled like RapidScat, produces similar diurnal cycle, implying that full RapidScat record sampled diurnal cycle effectively.
- CCMP sampling suggests greater discrepancies.

Can we capture diurnal cycle from RapidScat?

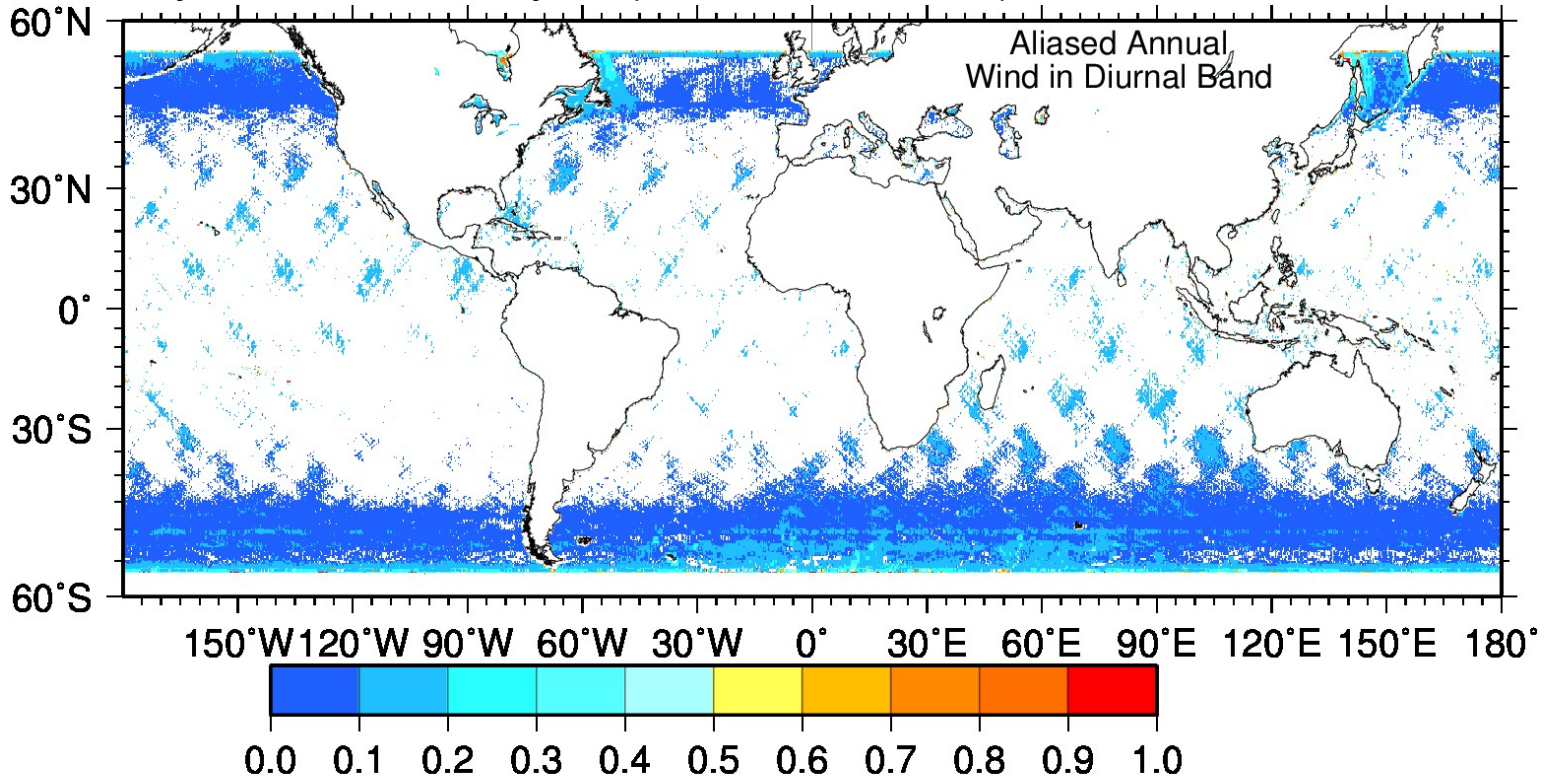
Challenge: RapidScat orbit clusters at certain times. Short records can alias annual cycle into diurnal cycle (and vice versa)



Aliasing of annual cycle into diurnal with 6 months of RapidScat data.

Can we capture diurnal cycle from RapidScat?

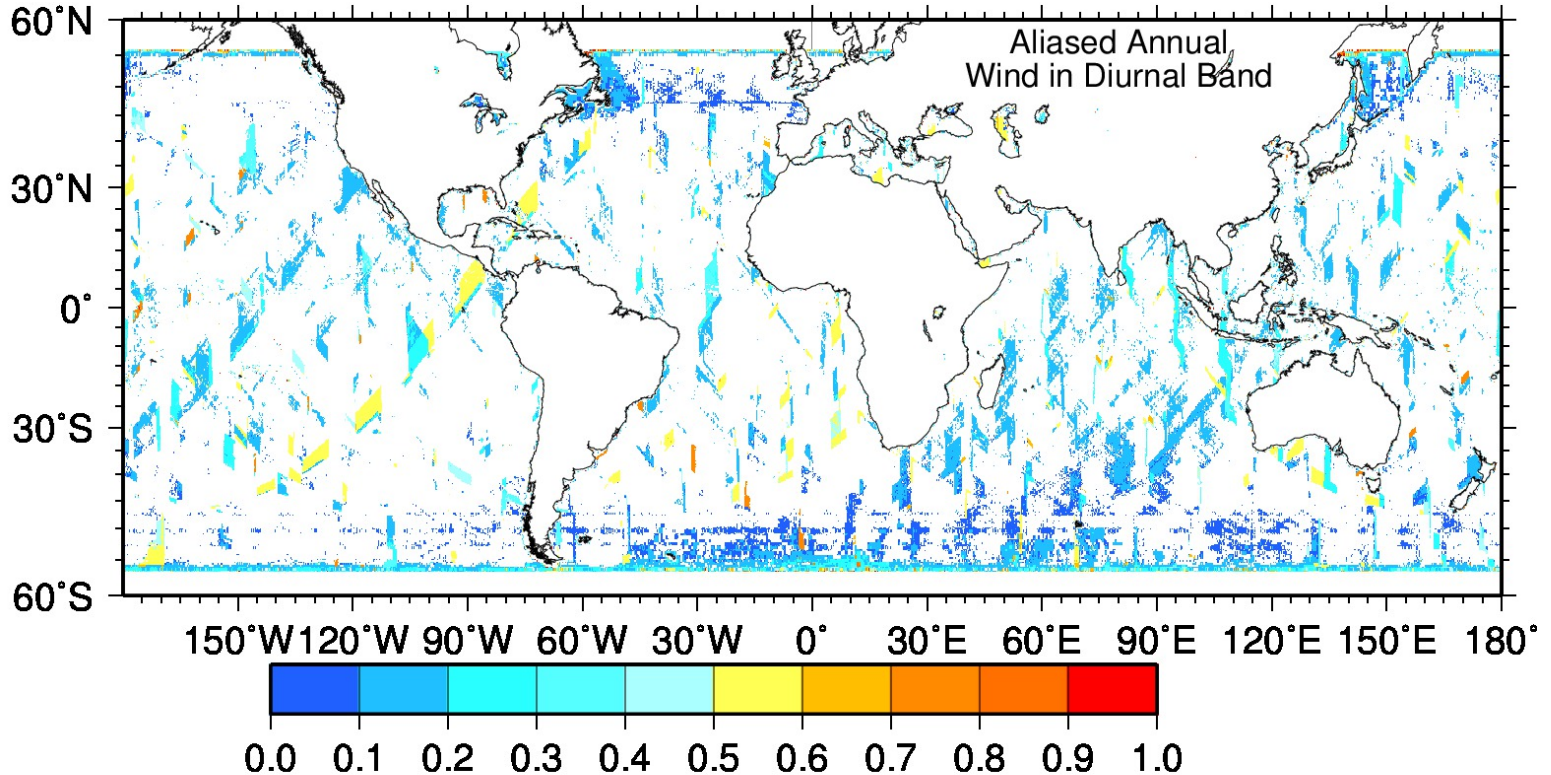
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Aliasing of annual cycle into diurnal with one year of data.

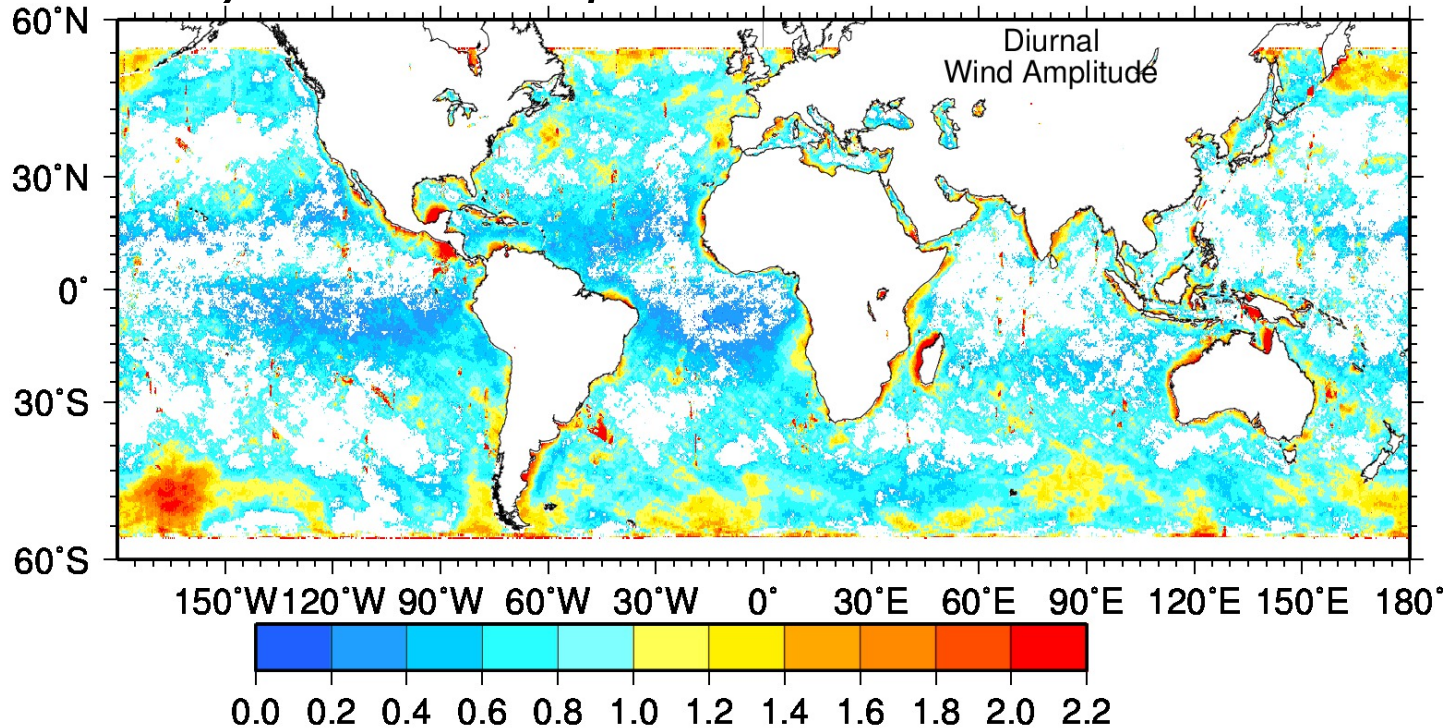
Can we capture diurnal cycle from RapidScat?

Challenge: RapidScat orbit clusters at certain times. Short records can alias annual cycle into diurnal cycle (and vice versa)



Aliasing of annual cycle into diurnal with two years of data.

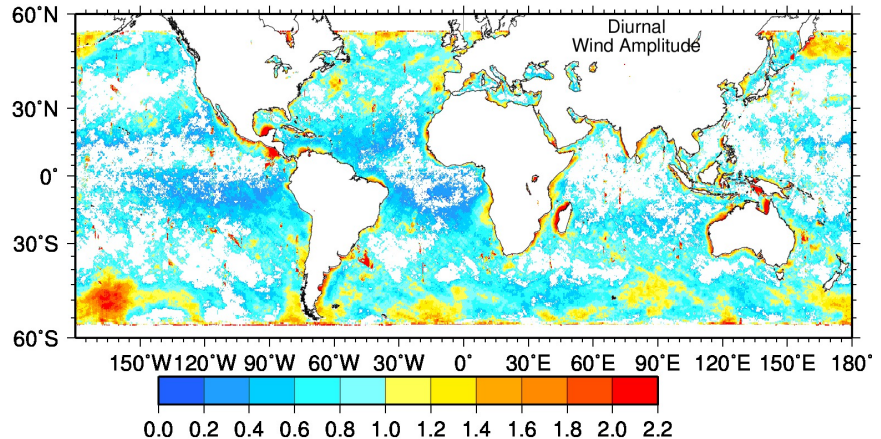
Diurnal cycle from RapidScat



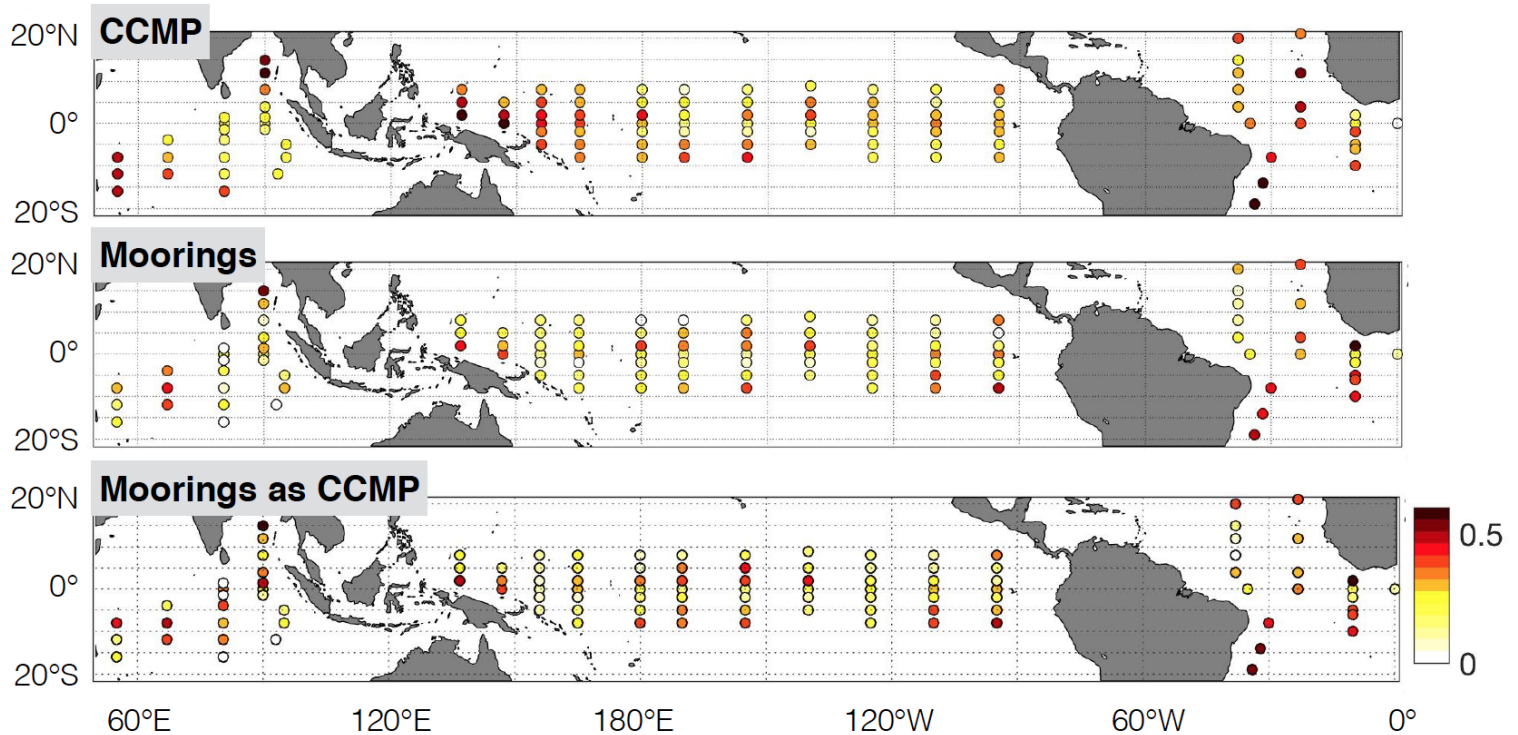
- Diurnal cycle inferred from full RapidScat record.
- Strong signals on coast, consistent with sea breeze signals
- Little detectable diurnal signal in tropics
- Large-amplitude signals at high latitudes unlikely to be robust diurnal signals; could be aliased annual or semi-annual cycle

Summary

- Buoy data and CCMP winds indicate that diurnal cycle is non-stationary with seasonal amplitude changes and inter-annual variability.
- Semi-diurnal winds significant; further complicate sampling issues
- RapidScat's orbit can alias annual cycle into diurnal, particularly for short time periods
- But after 2 years, RapidScat's orbit OK for inferring time-mean diurnal cycle.
- Results support community recommendation for 3 scatterometers with well-timed orbits.

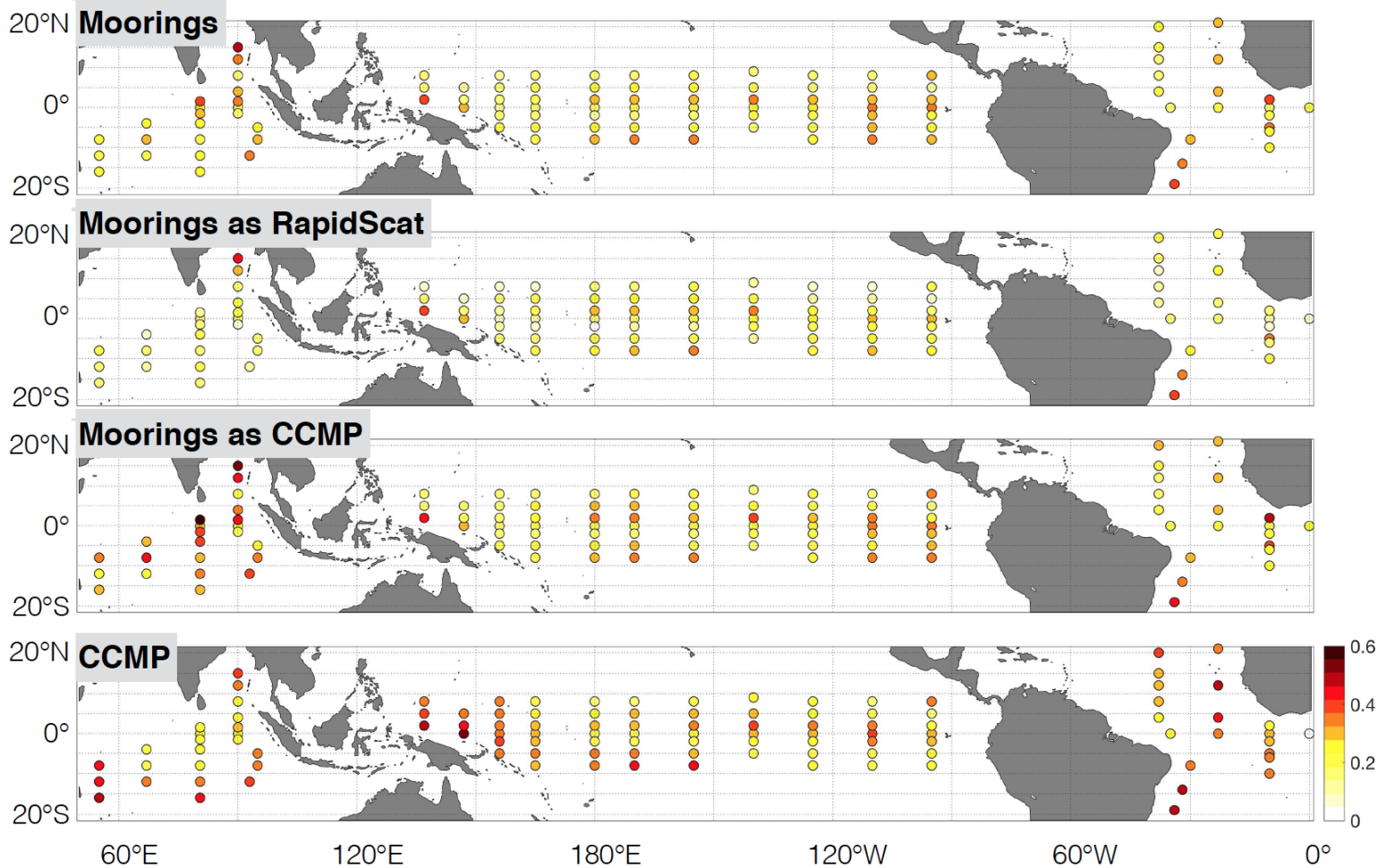


Buoy Sites: Climatological January Diurnal Cycle



- CCMP implies stronger diurnal cycles than moorings
- Amplitude (m/s) differences associated with CCMP sampling (middle vs bottom) and CCMP vs moorings (top vs bottom)

Buoy Sites: 2000-2015 Diurnal Cycle (year round)



Full RapidScat record sampling good for diurnal cycle.