The use and limitations of satellite remote sensing for the measurement of wind speed and wave height

Ian Young

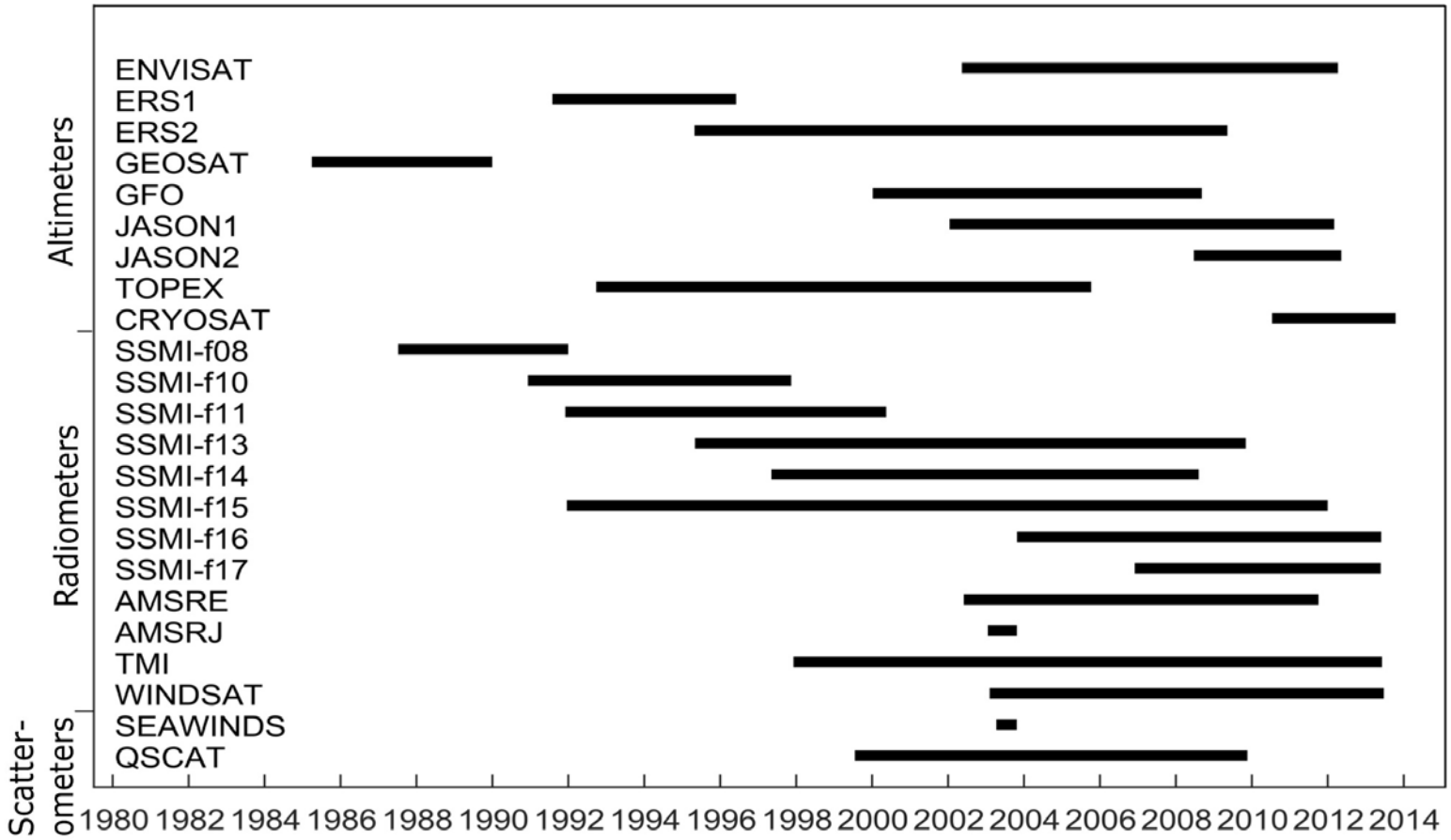
Approach

- Build a long term multi-mission satellite database
- Calibrate all instruments consistently
- Cross validate between instruments

- Investigate
  - Climatology
  - Trends
  - Extremes

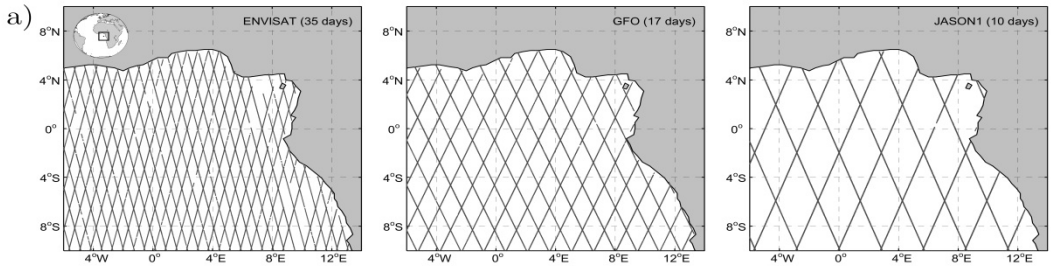
Period of data coverage

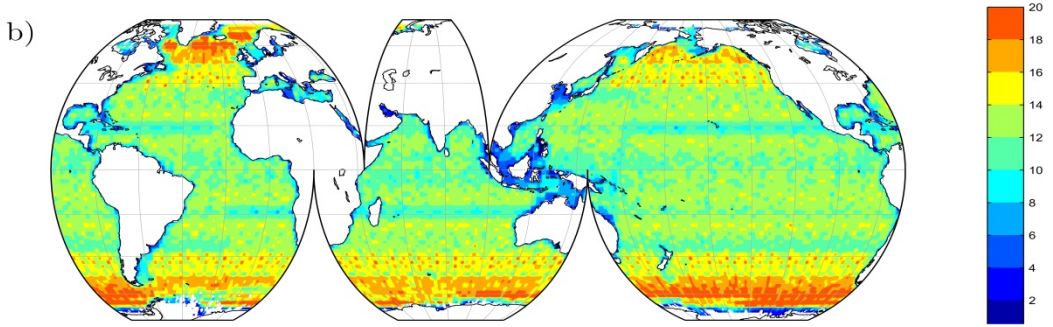
Combined dataset of 30 years duration

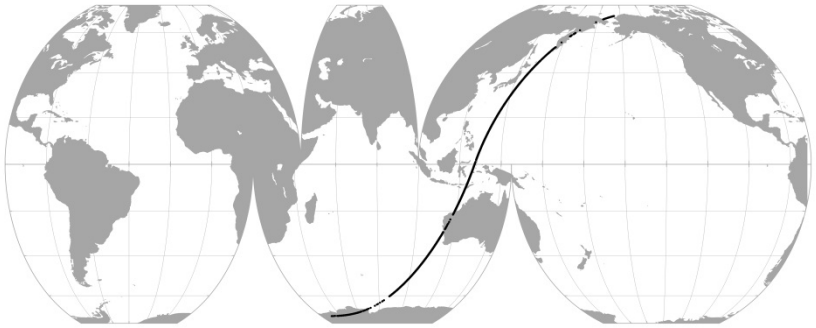


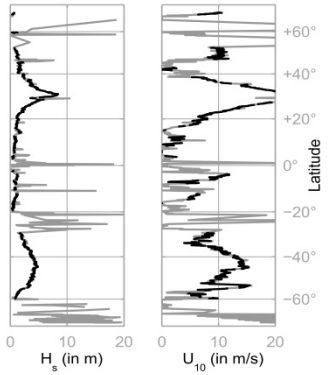
Satellite data coverage

Satellite Data Coverage - Altimeter



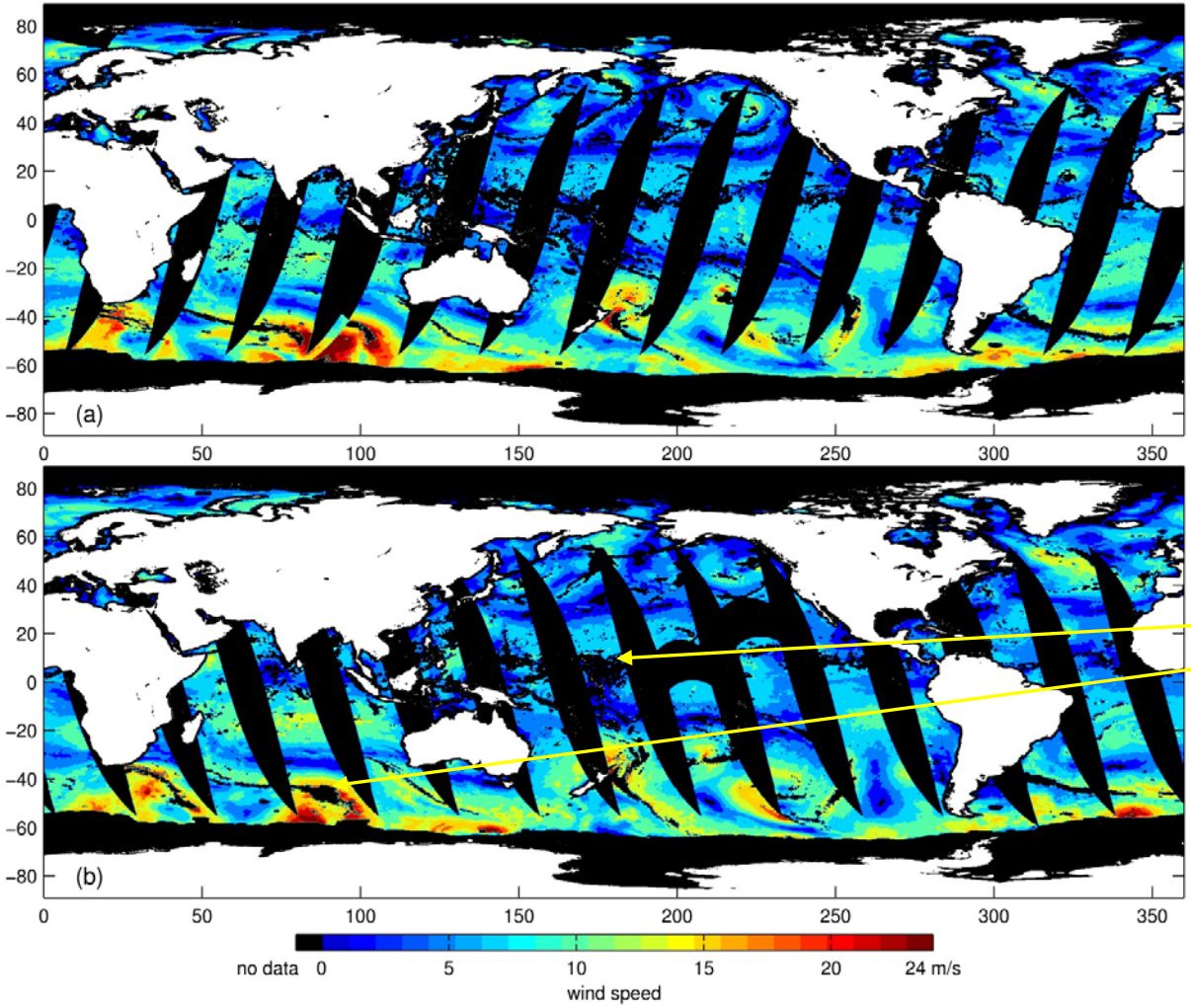






Satellite data coverage

Satellite Data Coverage – Radiometer/Scatterometer

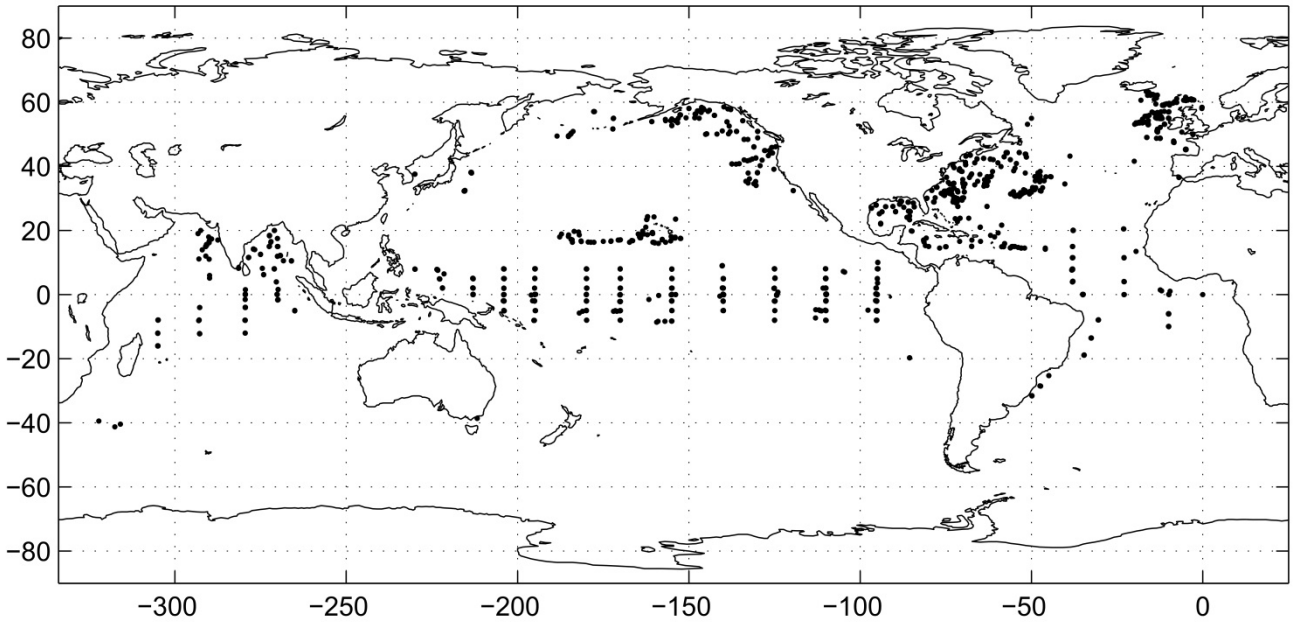


Data “holes” under rain

Insitu calibration buoys

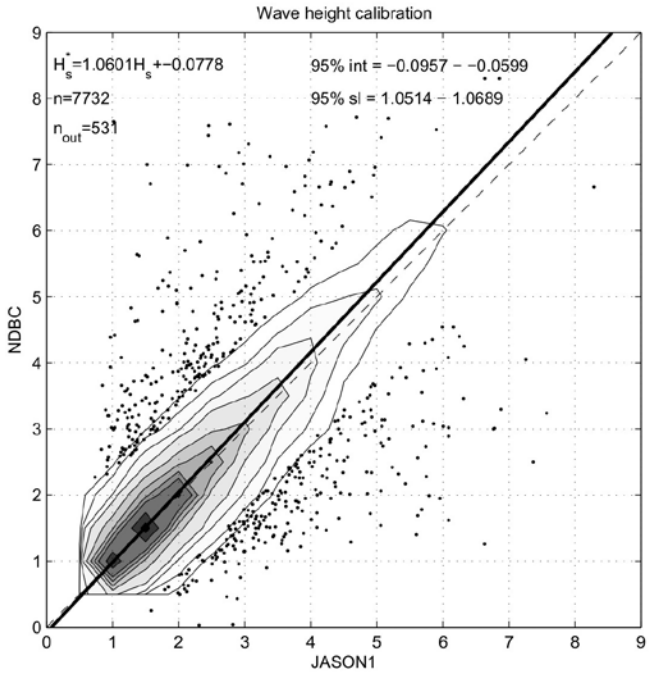
Two data sets

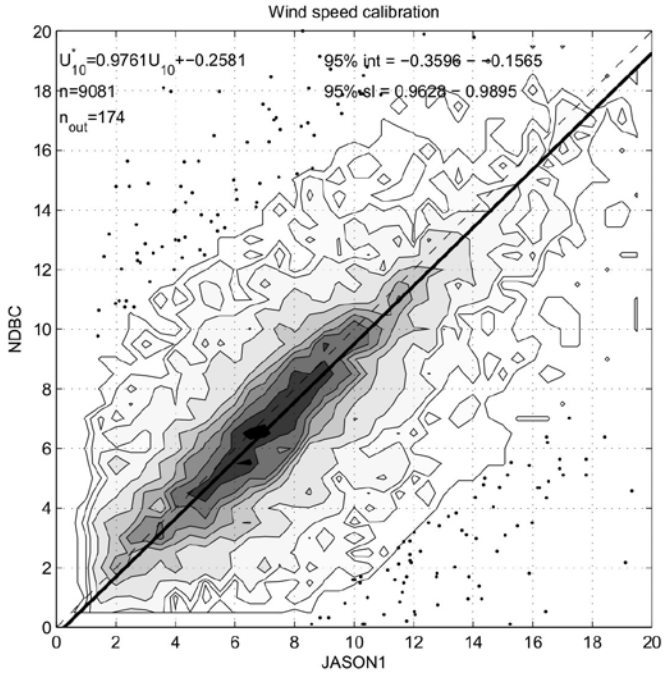
- NDBC
- ECMWF composite data



Altimeter calibration (and radiometer)

Matchups – 50km and 30 mins.

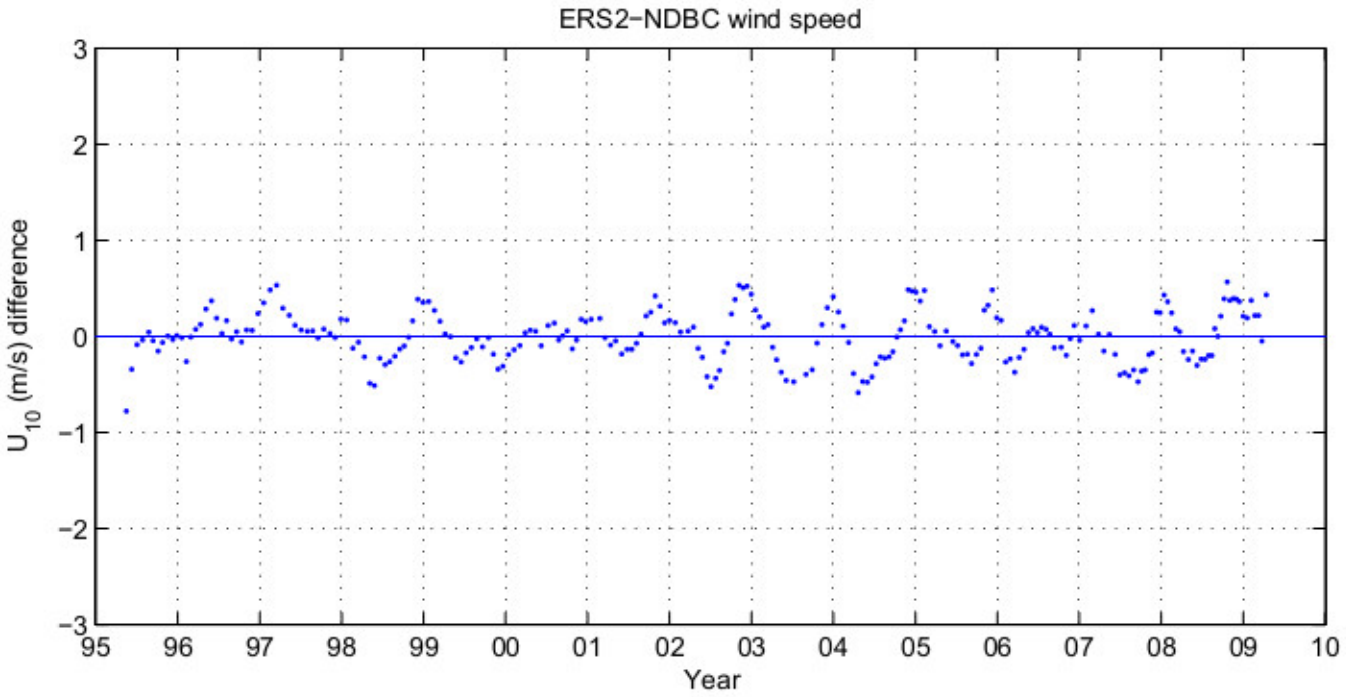




Greater scatter for wind speed

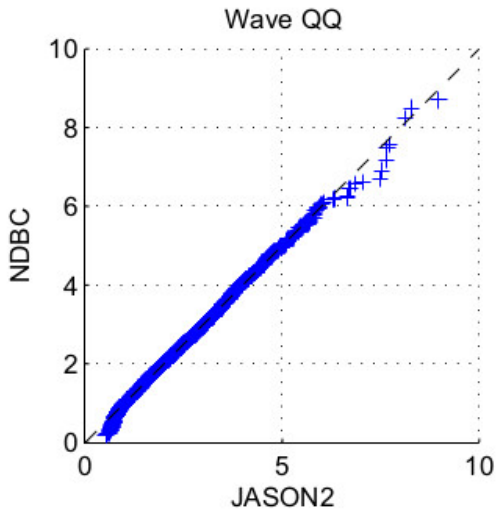
Altimeter long term stability

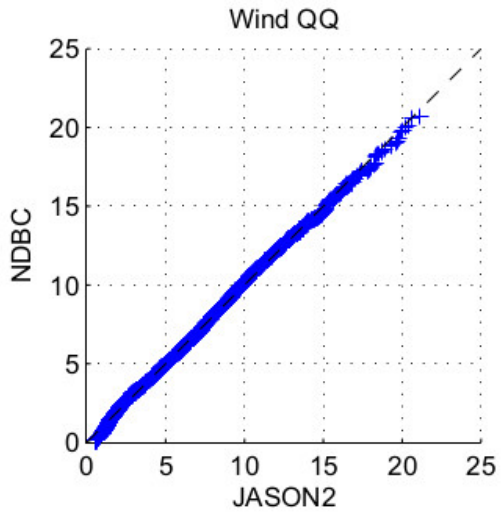
Discontinuities removed



Buoy – altimeter PDF comparisons

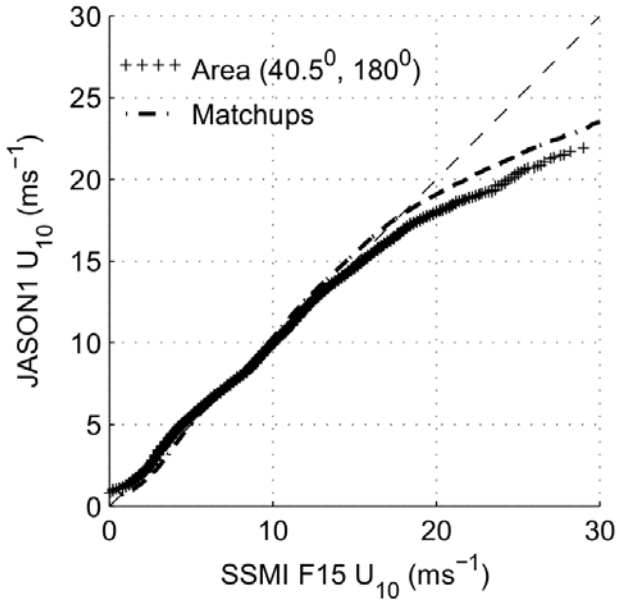
- Altimeter wind speed and wave height both reproduce PDF of buoy data

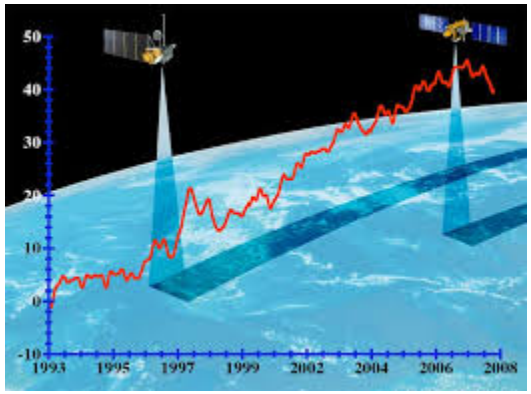




Altimeter – Radiometer comparison

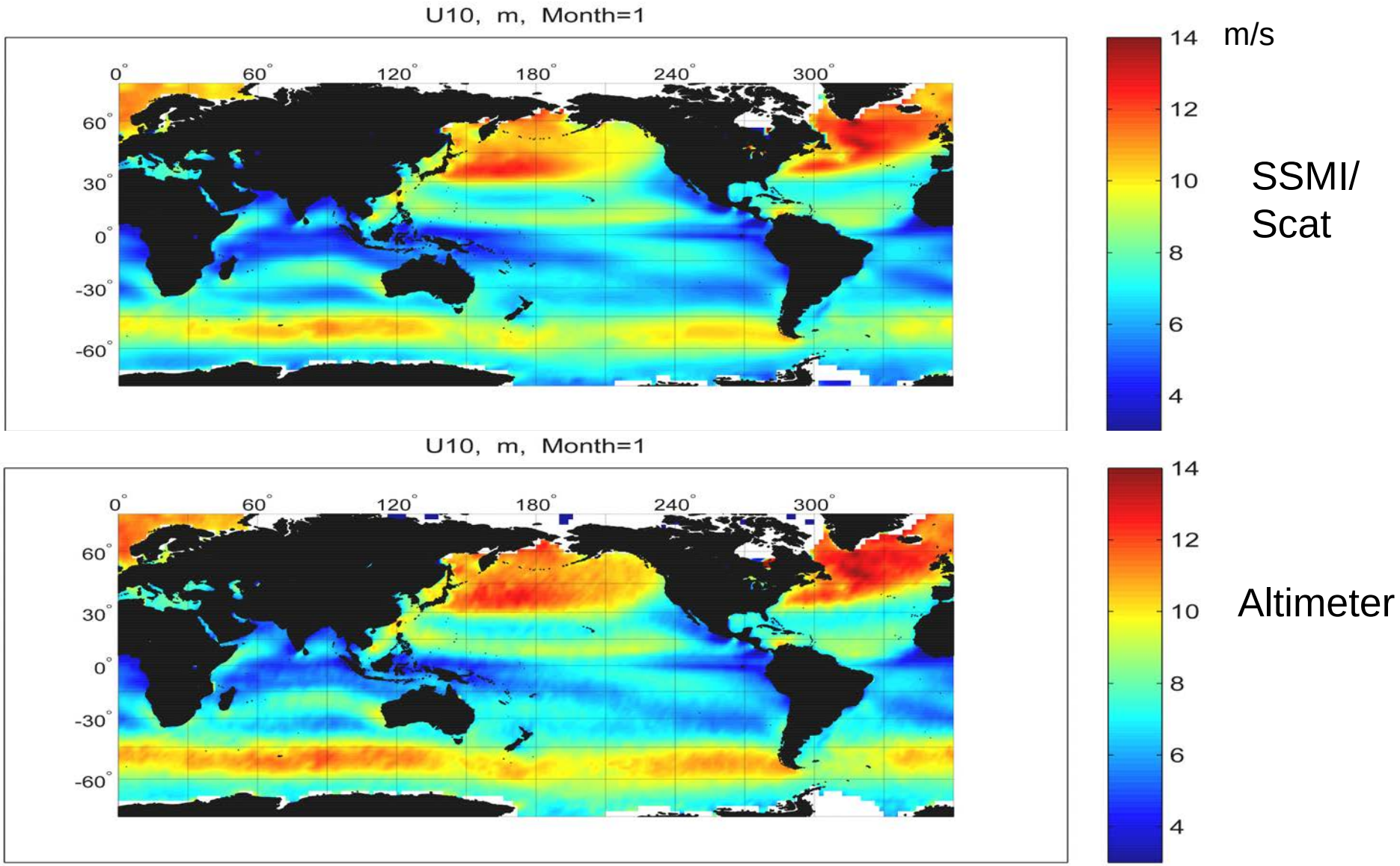
- Radiometer measures higher than altimeter at high wind speeds
- Altimeter undersampling perhaps not as bad as one may think



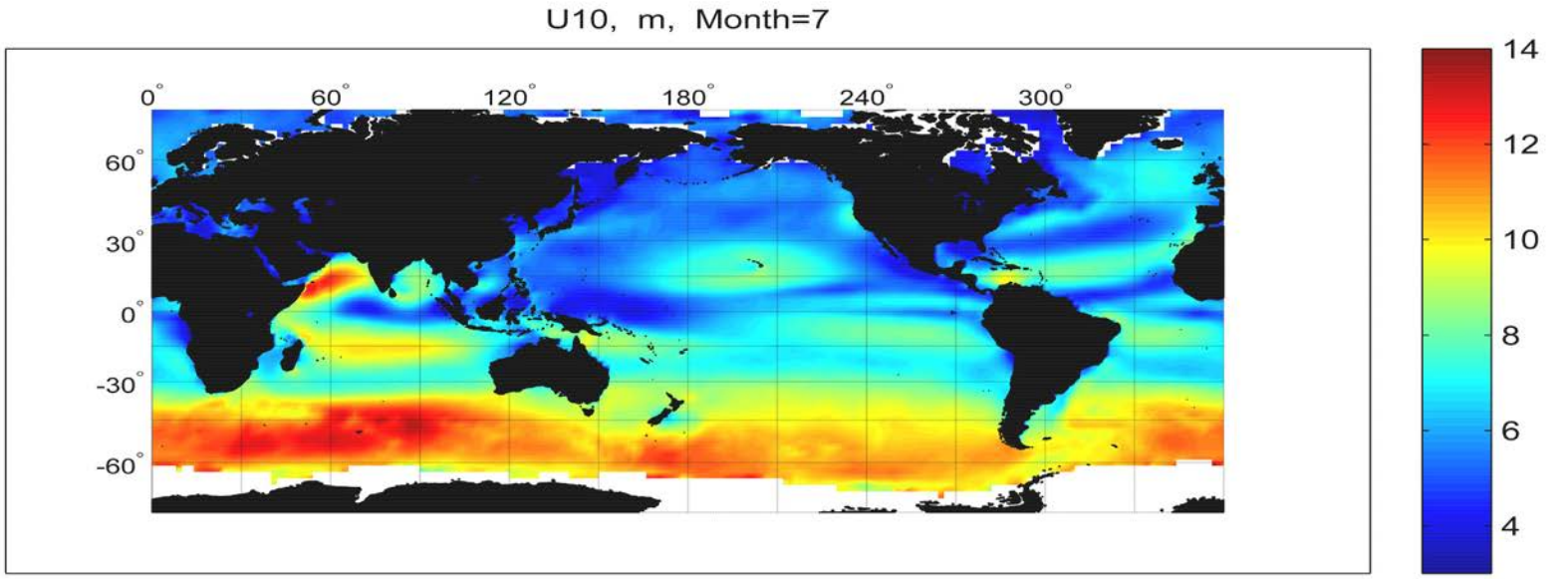


Young et al (2017) JTech

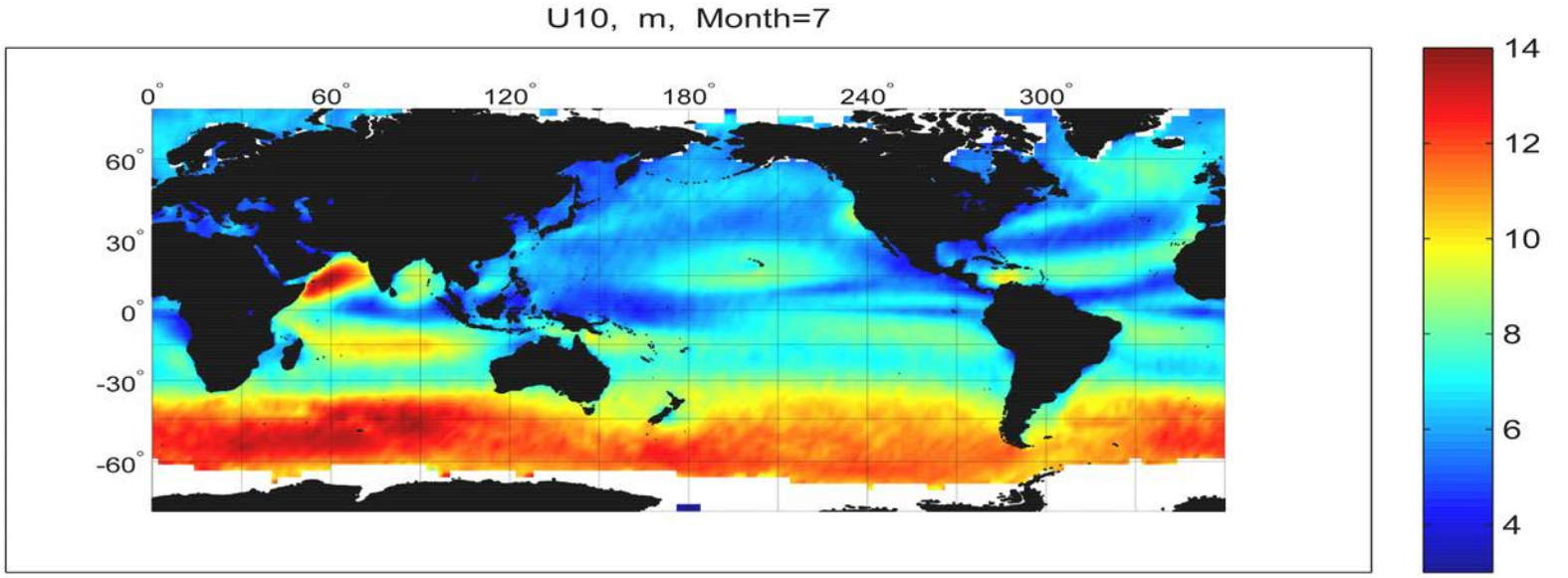
Global climatology – January U_{10} Monthly means



Global climatology – July U_{10} Monthly means

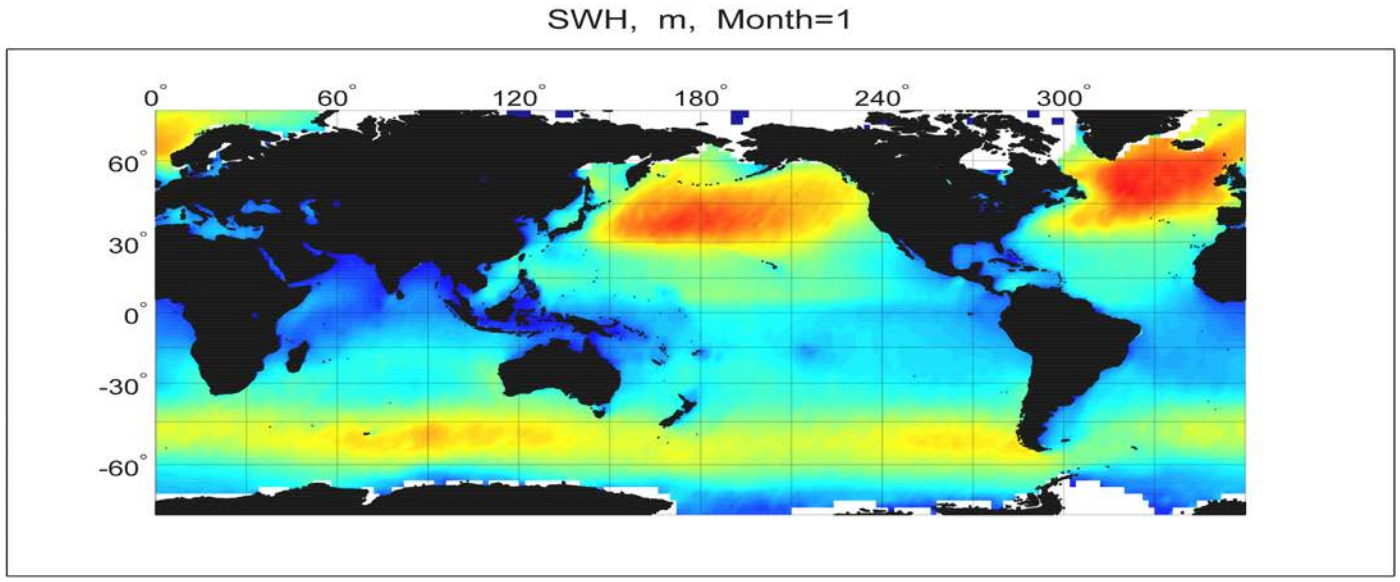


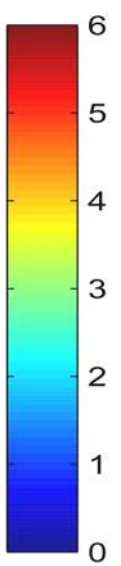
SSMI/ Scat



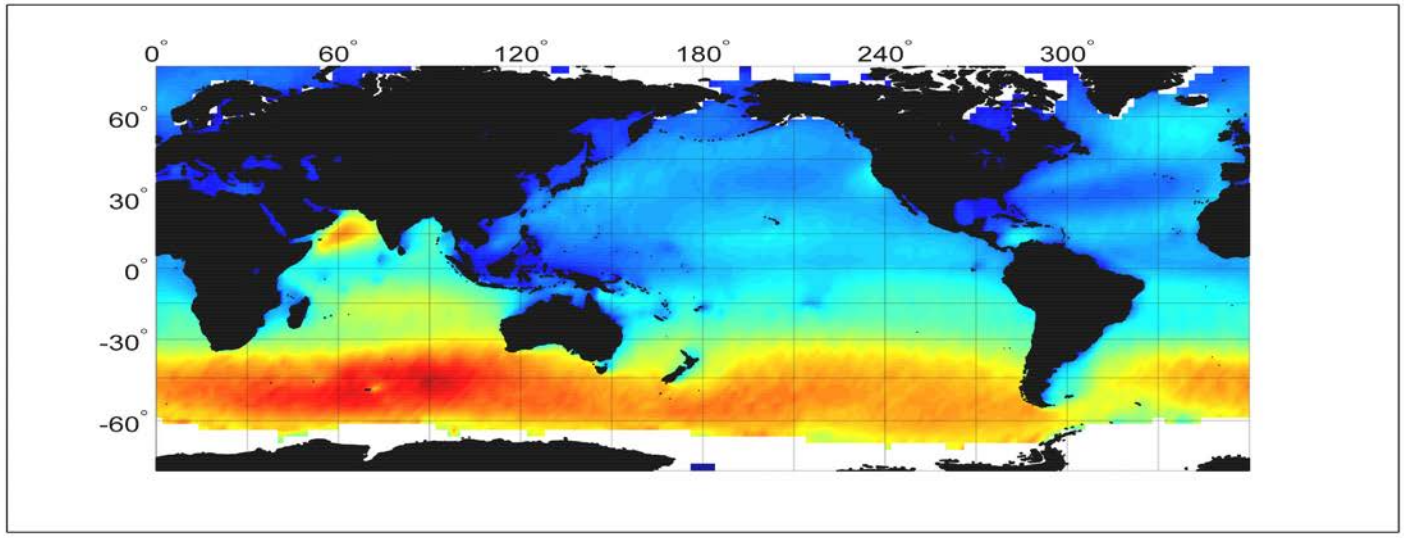
Altimeter

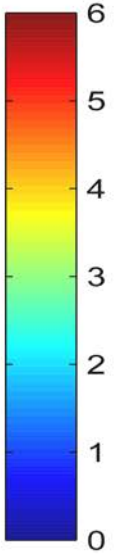
Global climatology – Hs Mean monthly - altimeter





January





July

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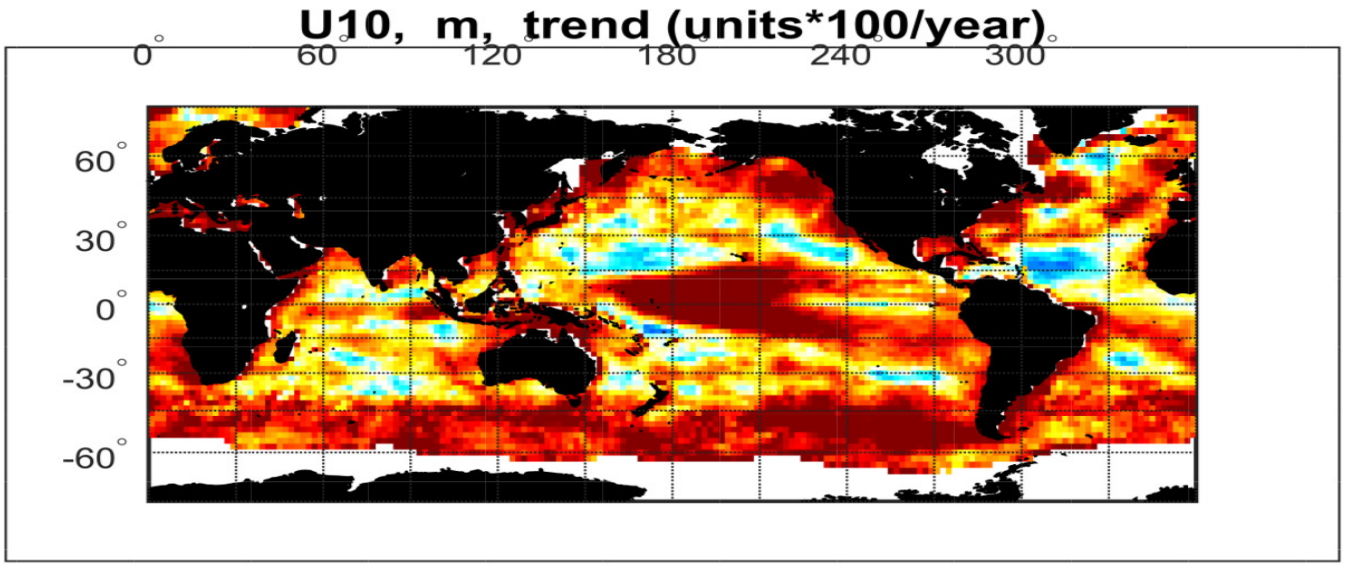
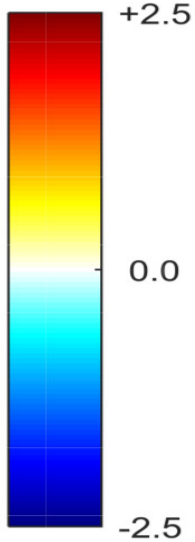
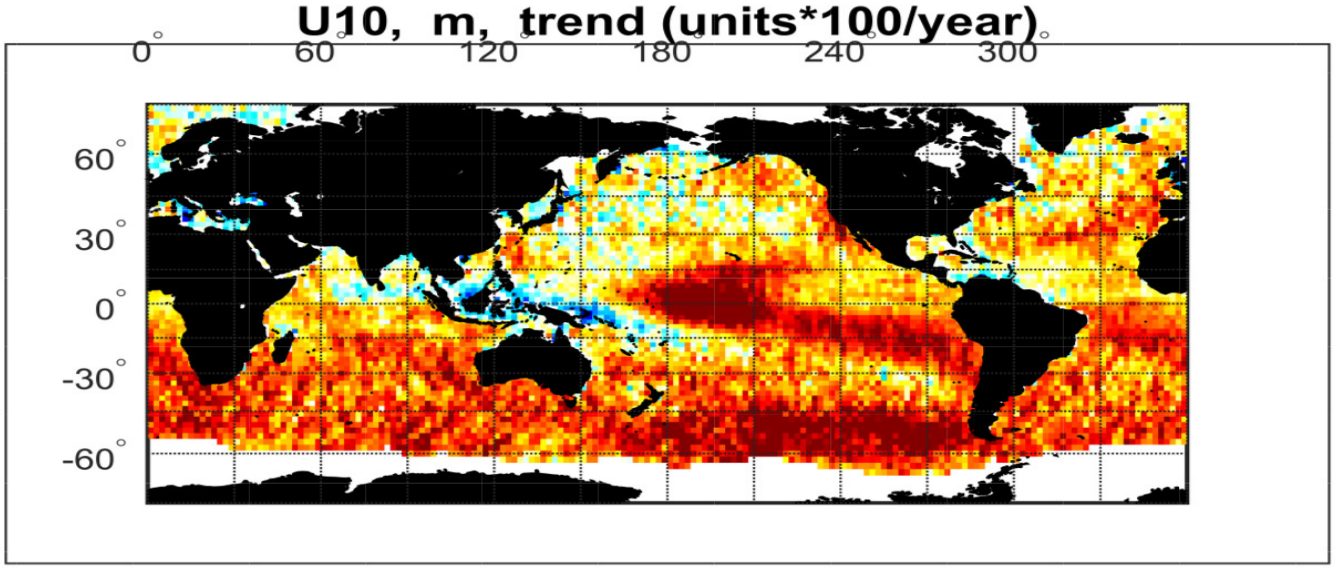
Mean monthly U_{10} trends

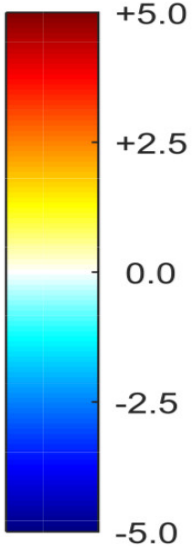




cm/s/yr

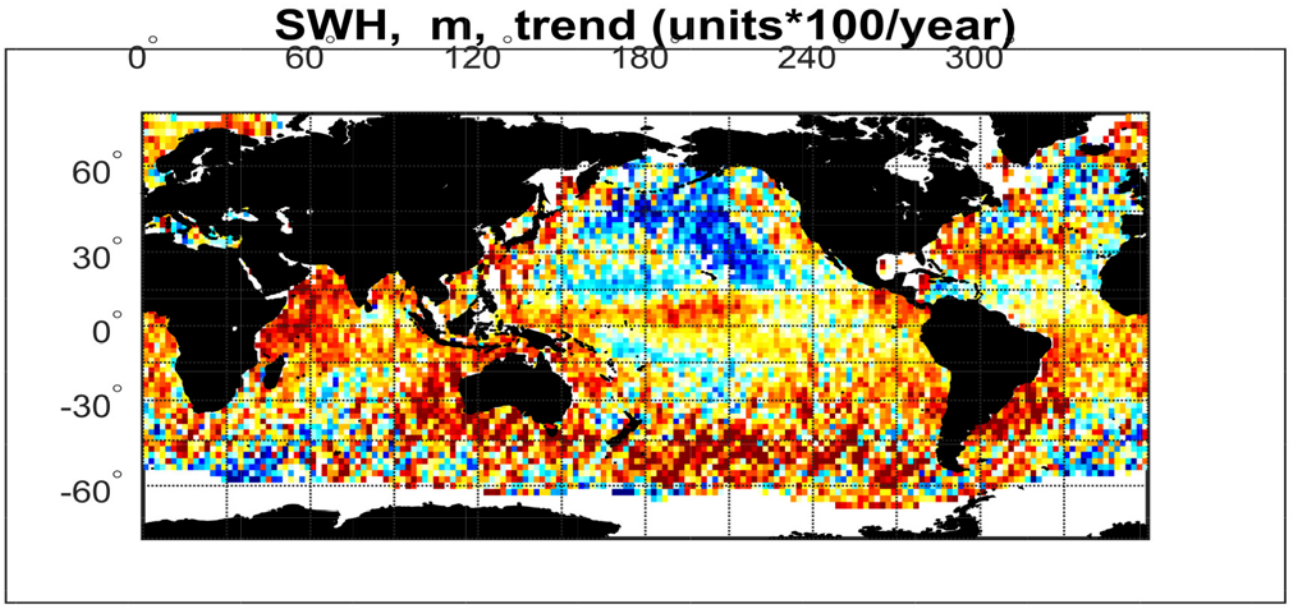
SSMI/
Scat

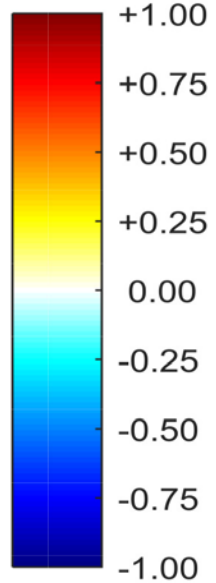




Altimeters

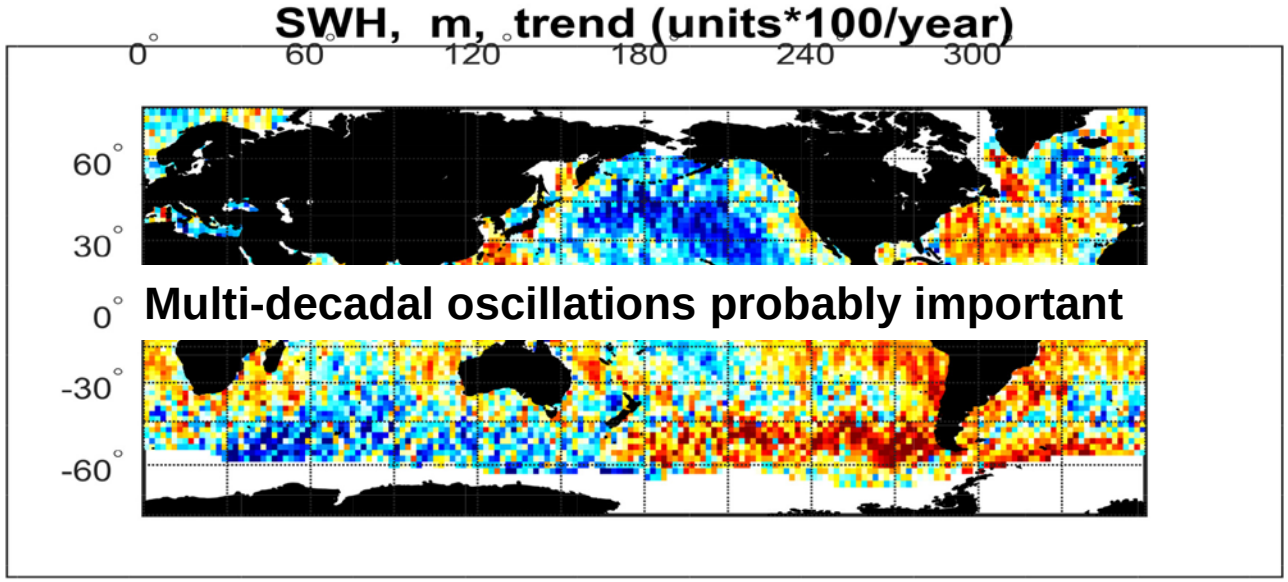
Mean monthly H_s trends - altimeter



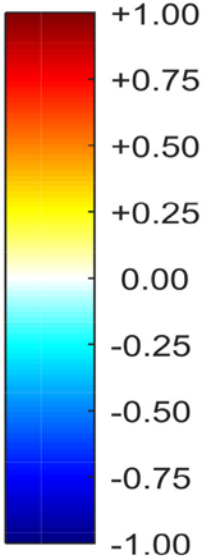


cm/yr

1985 - 2008



Multi-decadal oscillations probably important



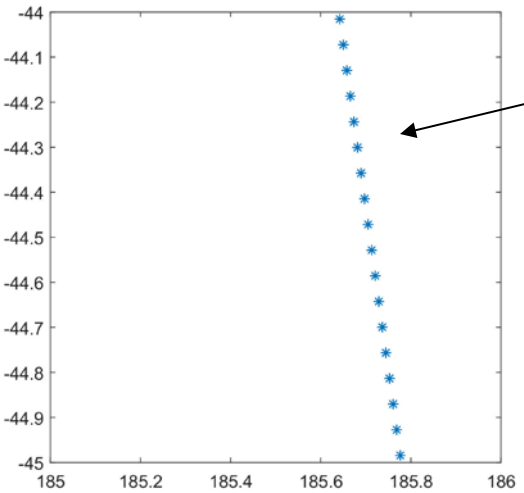
cm/yr

1985 - 2013

Extreme value analysis

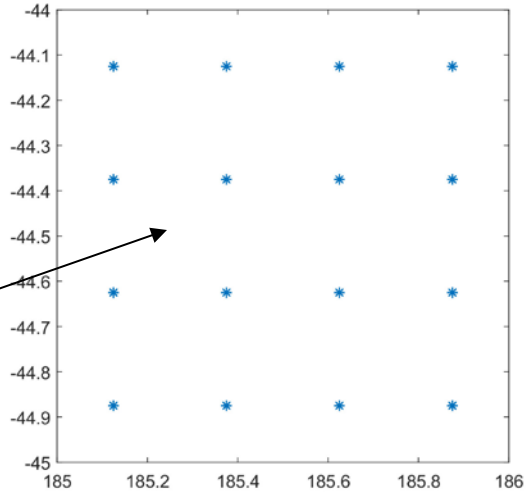
- Bin data (altimeter and radiometer) into 2 degree bins
- Combine all calibrated instruments (30 years)
- Consider maximum value of each pass (independence)

- Analyse data using:
  - Peak over threshold and Generalized Pareto distribution
  - Initial Distribution Method (full pdf) and Gumbel distribution

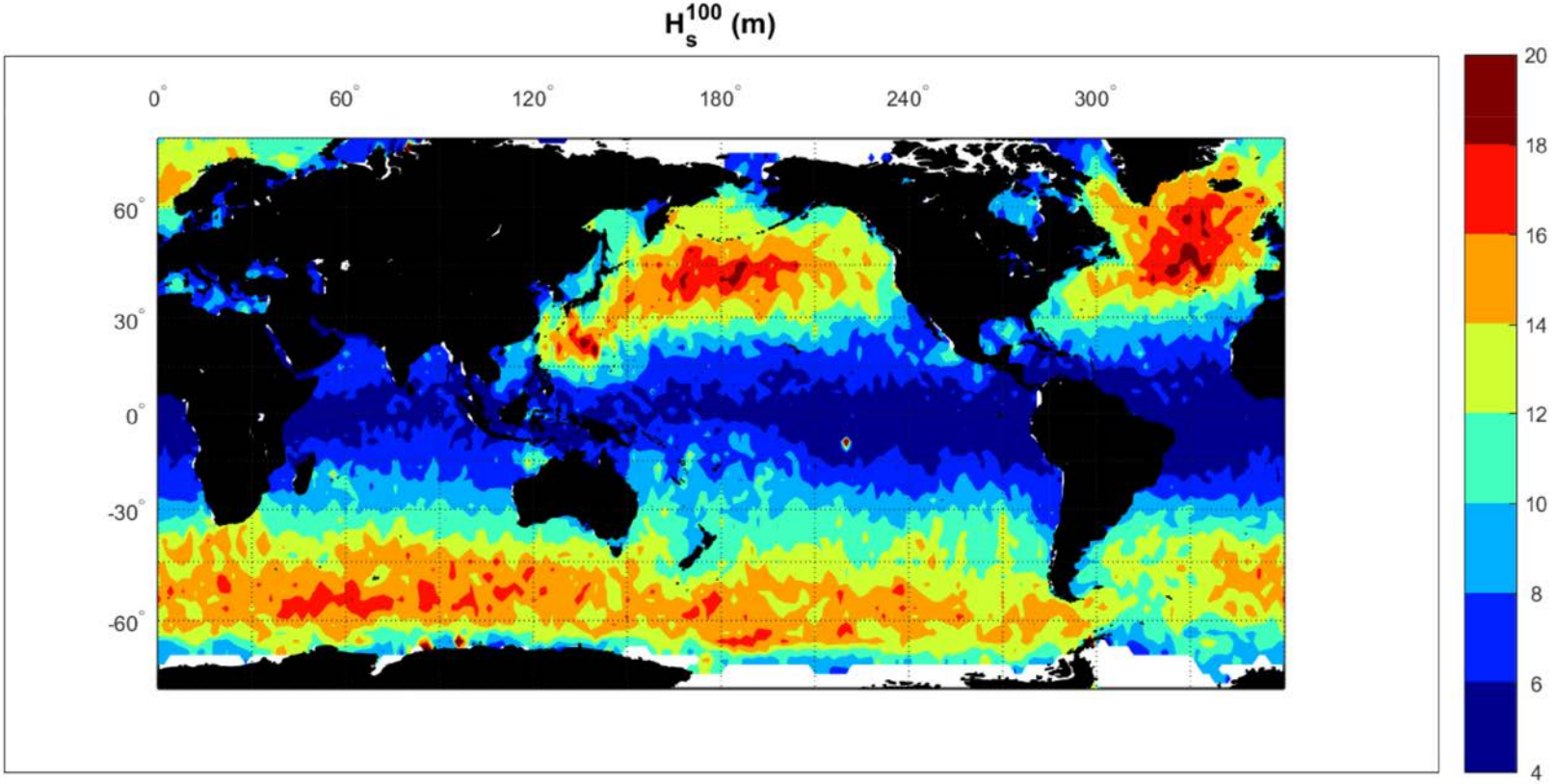


Altimeter
1 per 8 days

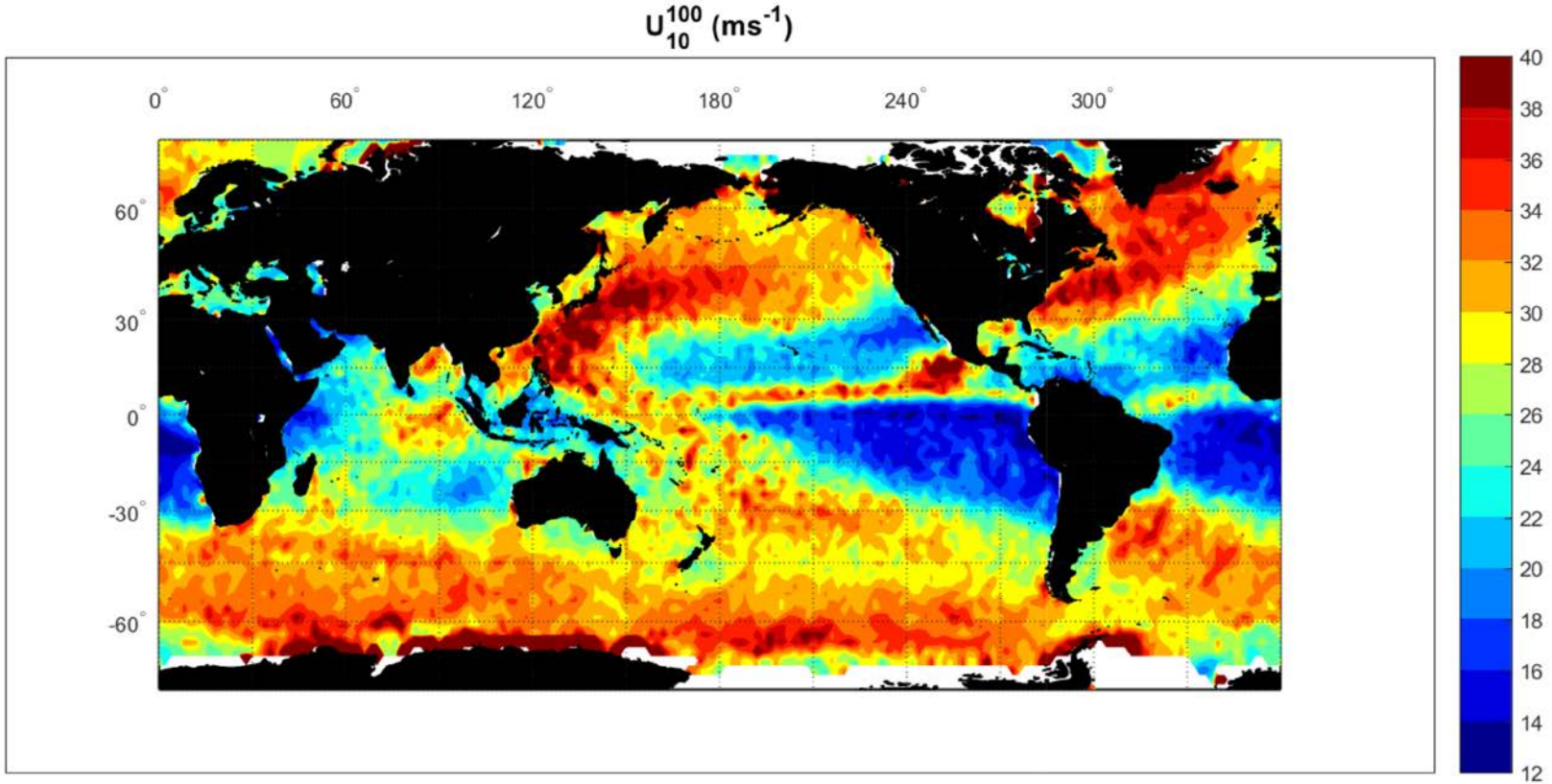
Radiometer
2 per day



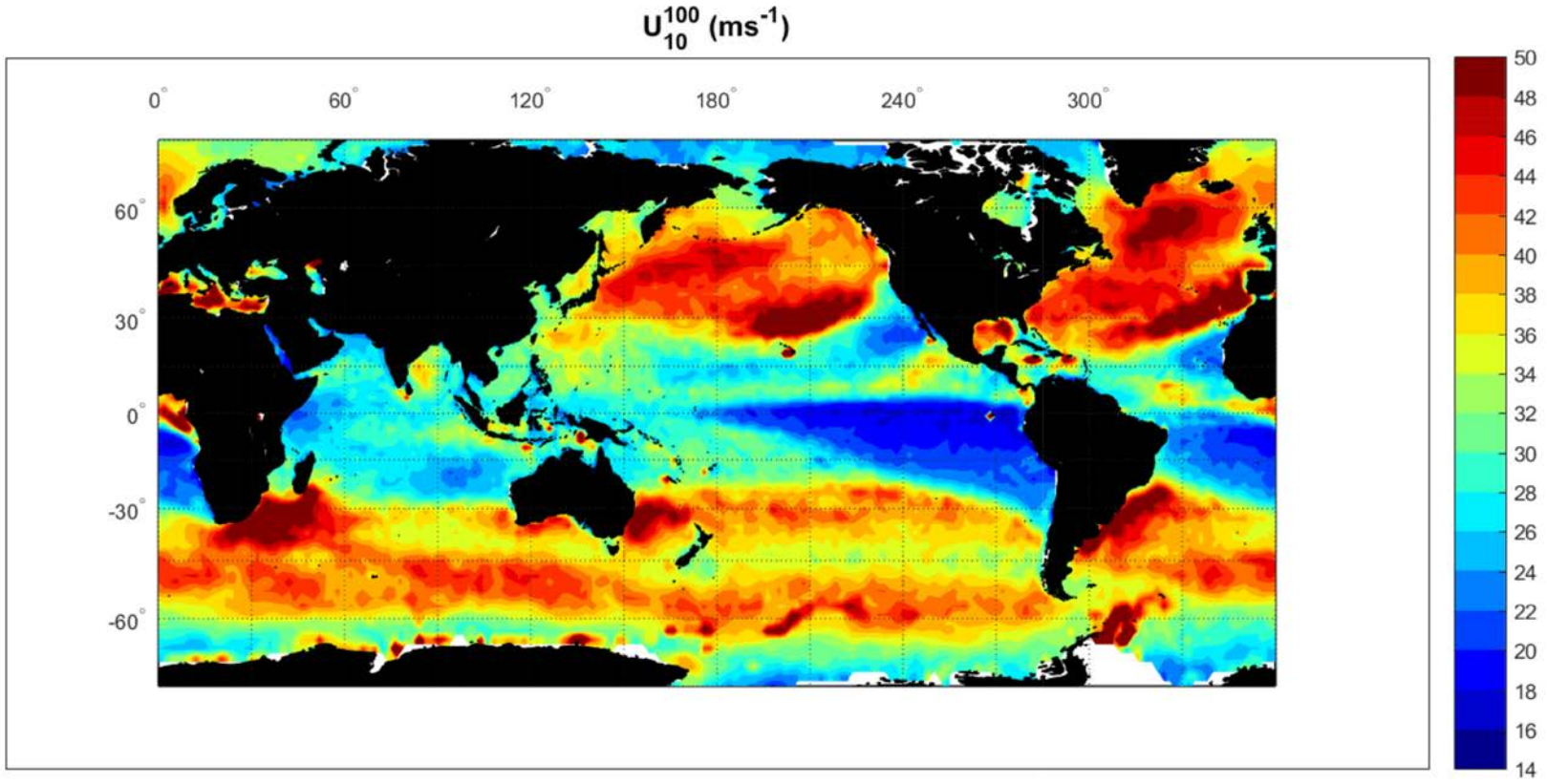
Altimeter – H_s - PoT (GPD)



Altimeter – U_{10} – PoT (GPD)



Radiometer – U_{10} – PoT (GPD)



Summary

- Database complete and fully validated
- Issues around ground truth – what is correct at high wind speed and wave height? – buoy, satellite, neither
- Positive trends confirmed between instruments but differences in magnitude for wind speed
- First apparently stable PoT estimates from satellites
- Altimeter undersampling does not appear significant
- Radiometer fair-weather bias and high wind speed performance an issue

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