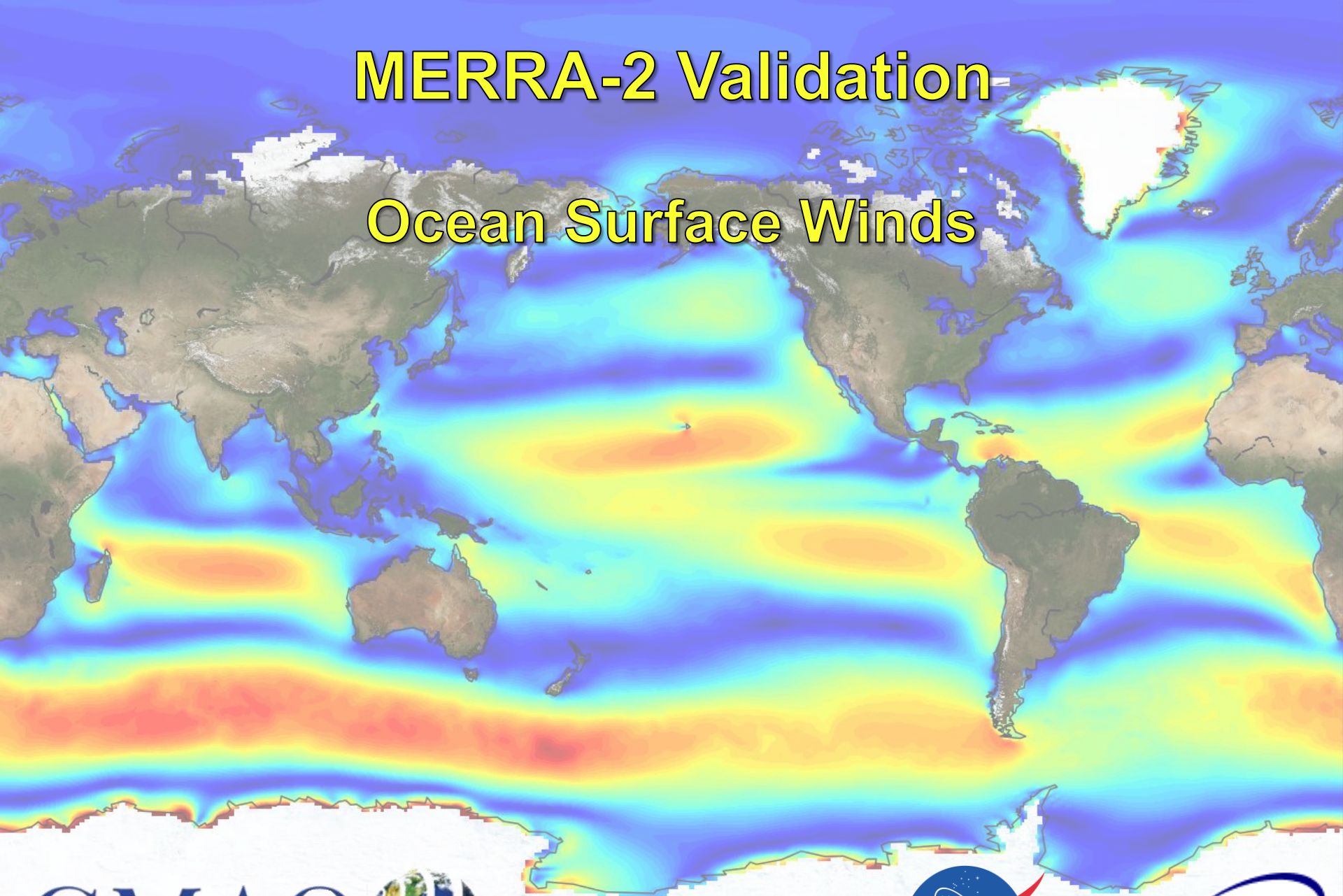


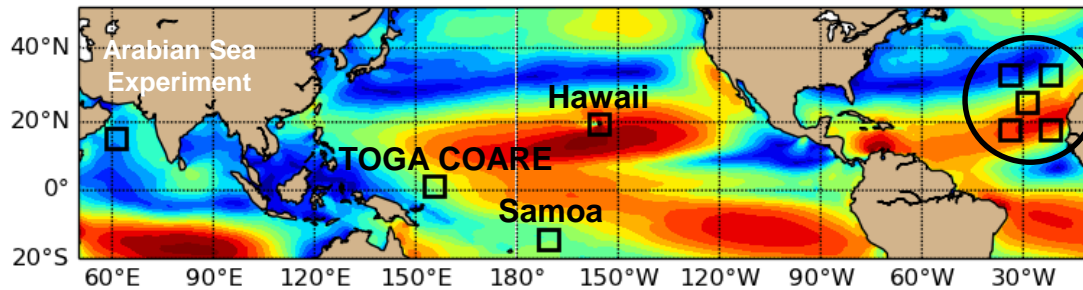
MERRA-2 Validation

Ocean Surface Winds



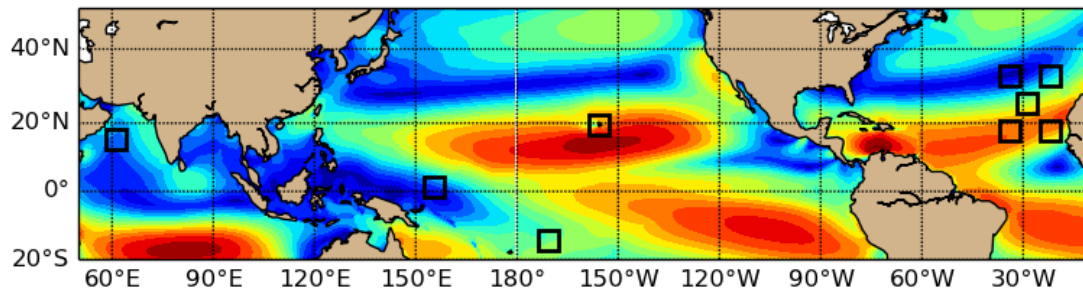
10-Meter Wind Speed (m/s): 1999-2009

MERRA-2



Subduction Experiment

MERRA



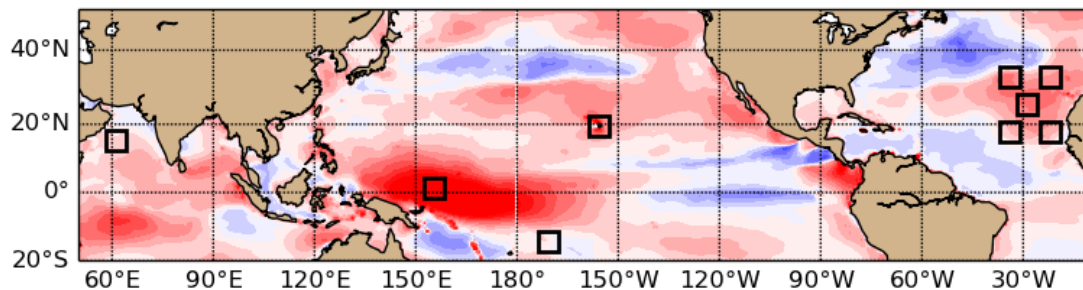
SCOW:

- The Scatterometer Climatology of Ocean Winds are from Oregon State University.
- Based on 122 months of QuikSCAT scatterometer data from 1999-2009.
- For this reason, **a climatology from 1999-2009 is used for the global wind fields.**

CCMP:

- Cross-Calibrated Multi-Platform Ocean Surface Wind Vector L2.5A Monthly Analyses.
- Based on microwave satellite data (SSM/I, SSMIS, AMSR, TMI, WindSat), QSCAT, *in-situ* obs.

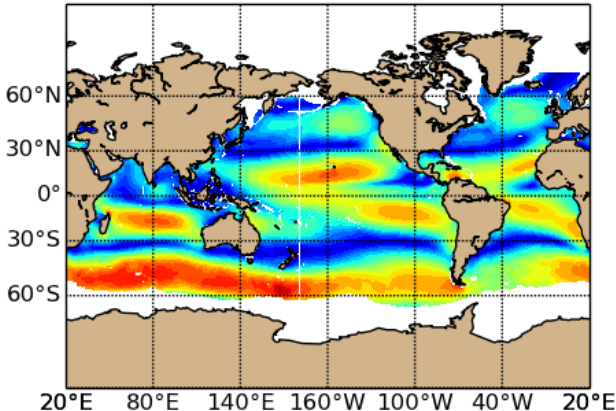
MERRA-2 - MERRA



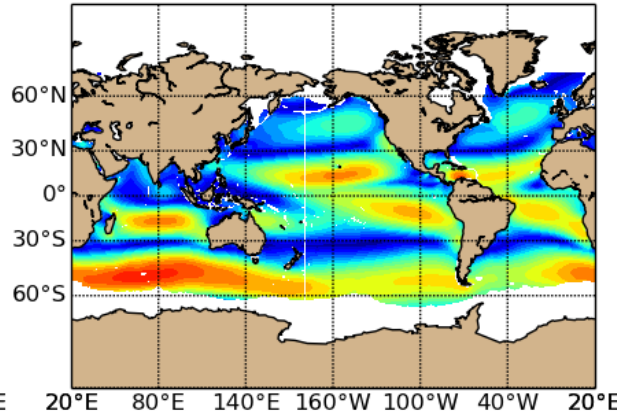
-2.0 -1.5 -1.0 -0.5 0.0 0.5 1.0 1.5 2.0

10-Meter Wind Speed (m/s): 1999-2009

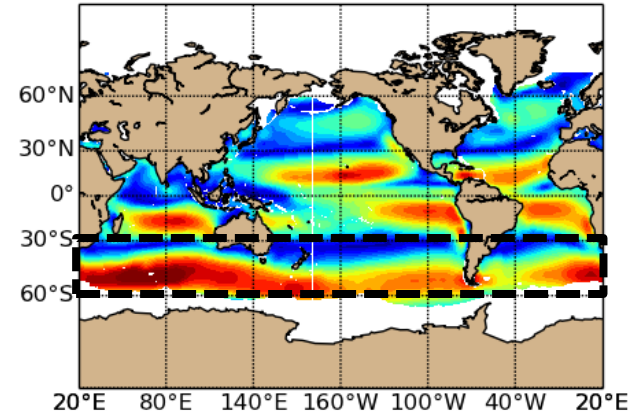
MERRA-2



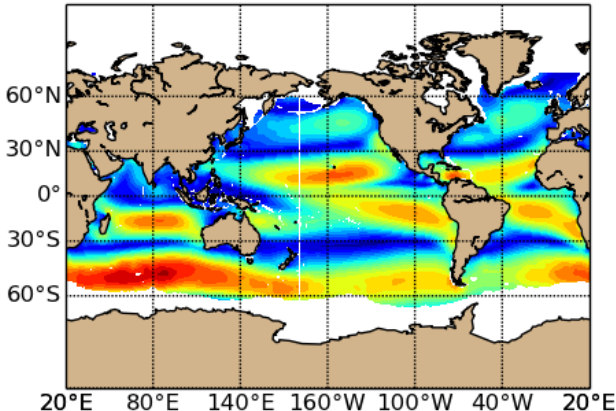
MERRA



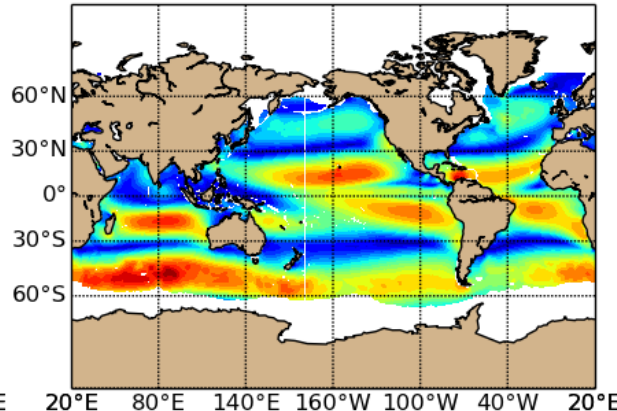
NCEP-R2



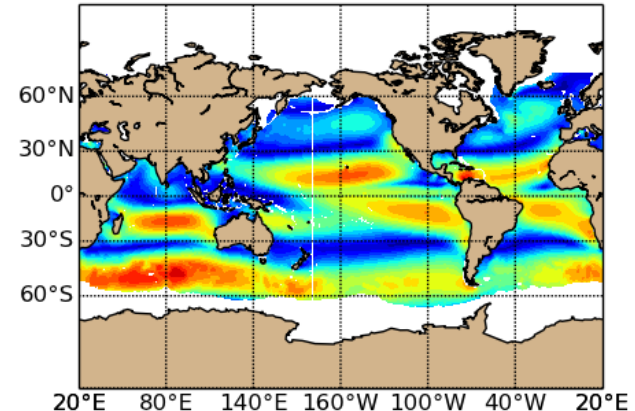
ERA-I



CCMP



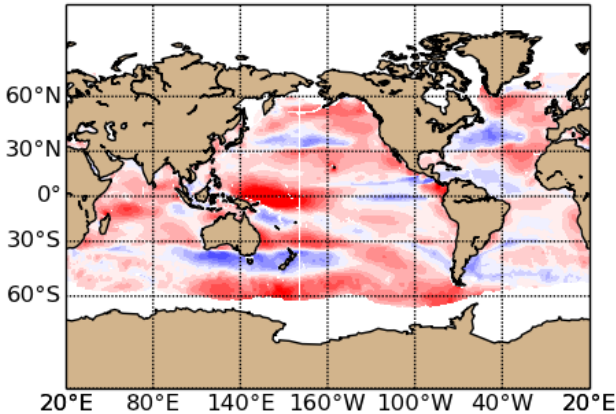
SCOW



- Patterns are similar
- **NCEP-R2**: higher intensity, especially 30S-60S
- **MERRA-2**: slightly stronger than **MERRA** in most regions

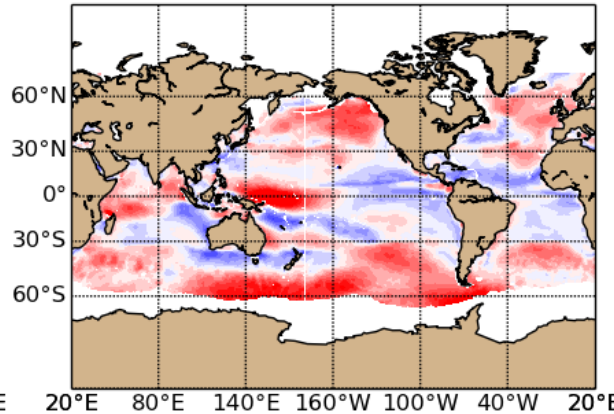
10-Meter Wind Speed Differences (m/s): 1999-2009

MERRA-2 - MERRA



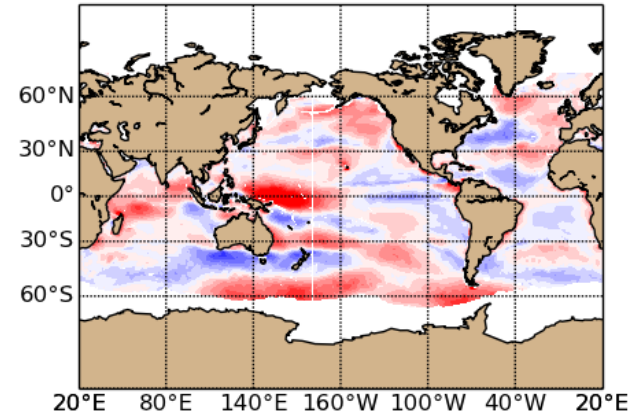
diff=0.288, rms=0.630, corr=0.965

MERRA-2 - SCOW



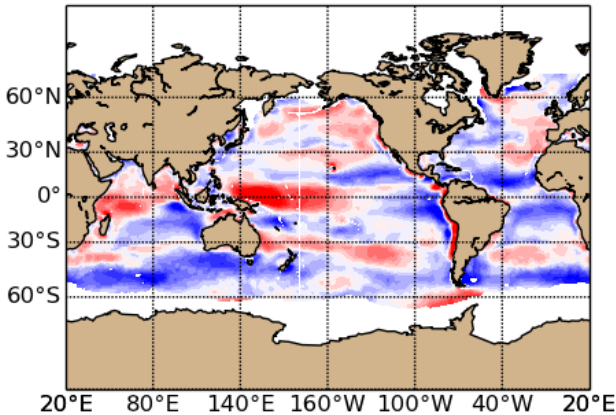
diff=0.201, rms=0.706, corr=0.950

MERRA-2 - ERA-I



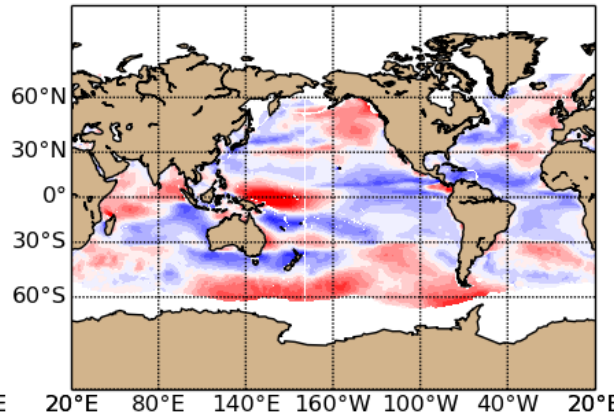
diff=0.114, rms=0.566, corr=0.967

MERRA-2 - NCEP-R2



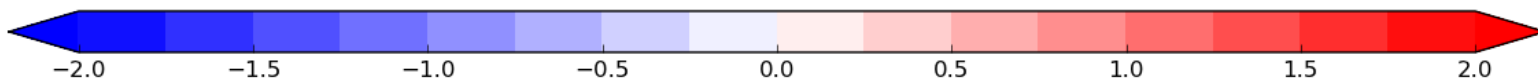
diff=-0.23, rms=0.814, corr=0.950

MERRA-2 - CCMP

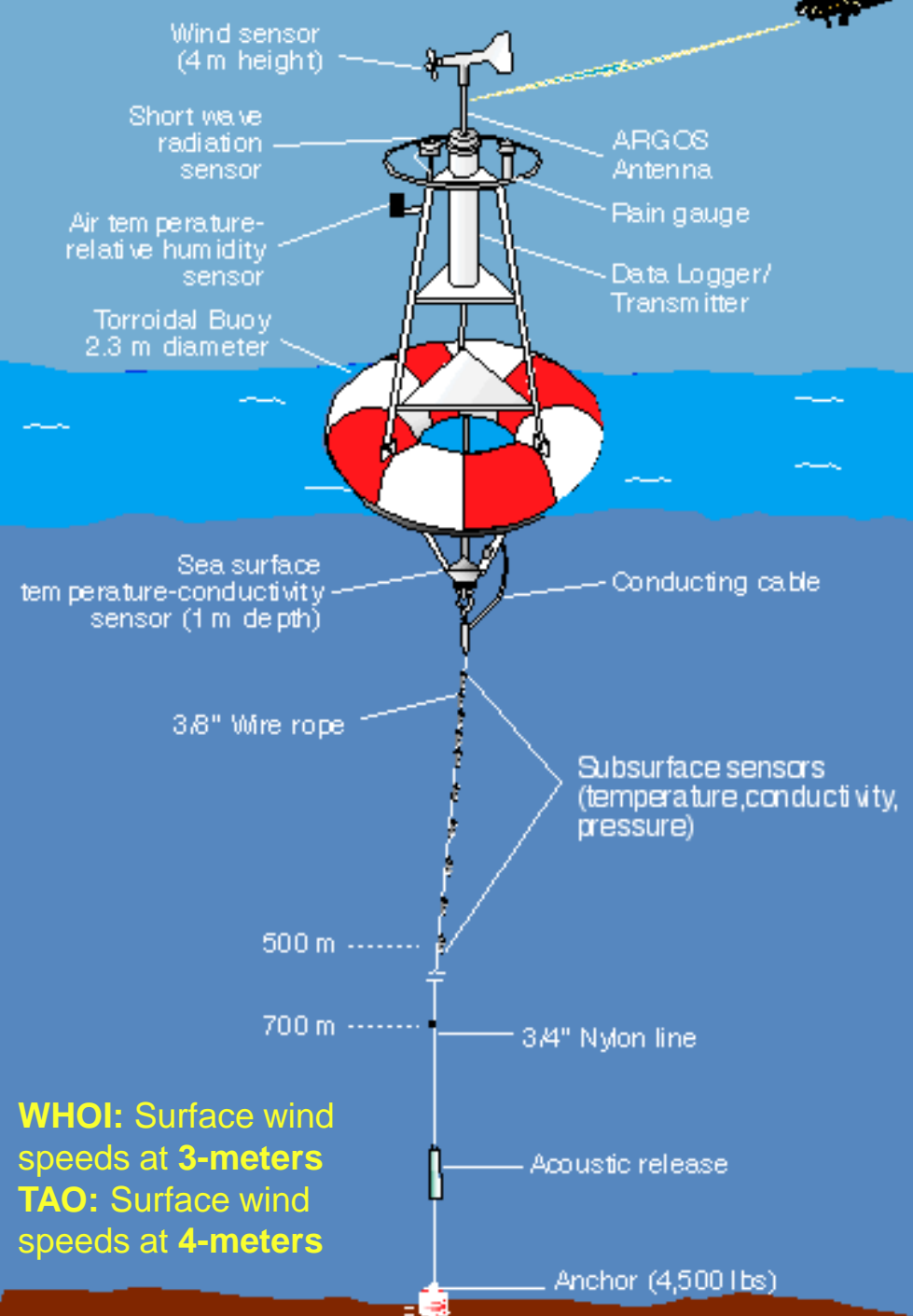


diff=-0.05, rms=0.630, corr=0.958

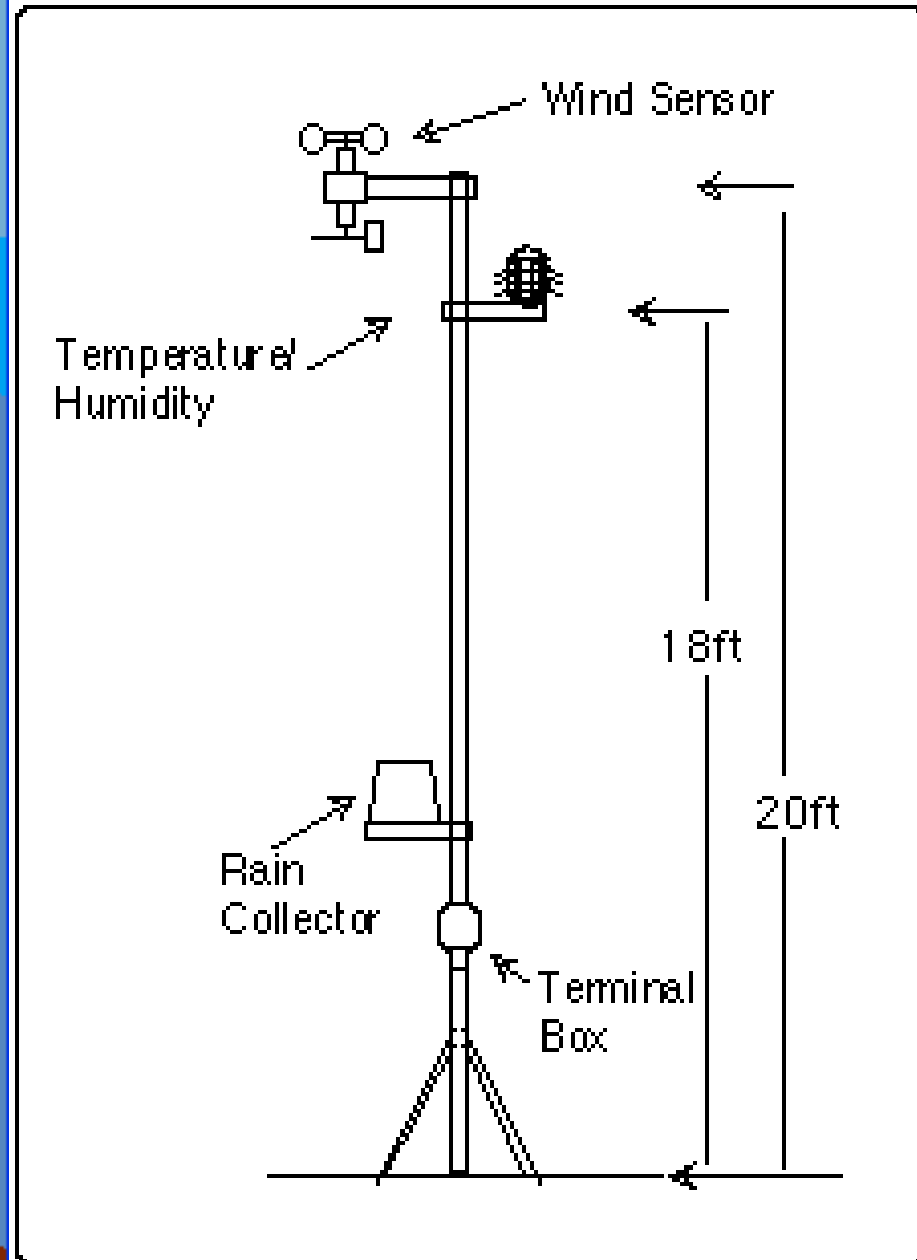
	Mean Bias	RMS
CCMP-MERRA-2	0.056	0.630
CCMP-MERRA	0.345	0.538
CCMP-SCOW	0.258	0.332
CCMP-ERA-I	0.170	0.376
CCMP-NCEP-R2	-0.177	0.657



- **MERRA-2** compares best with **CCMP** with a mean diff of **0.05 m/s**
- **MERRA-2** winds are generally stronger (more red) than **MERRA**, **SCOW**, & **ERA-I** in most regions

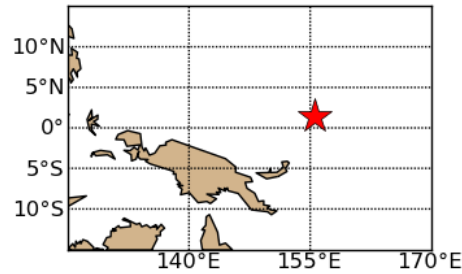


ESRL: 10-meter wind speeds



WHOI Mooring, TOGA COARE (1992-1993)

TOGA COaRE: Trp. Pac. Warm Pool



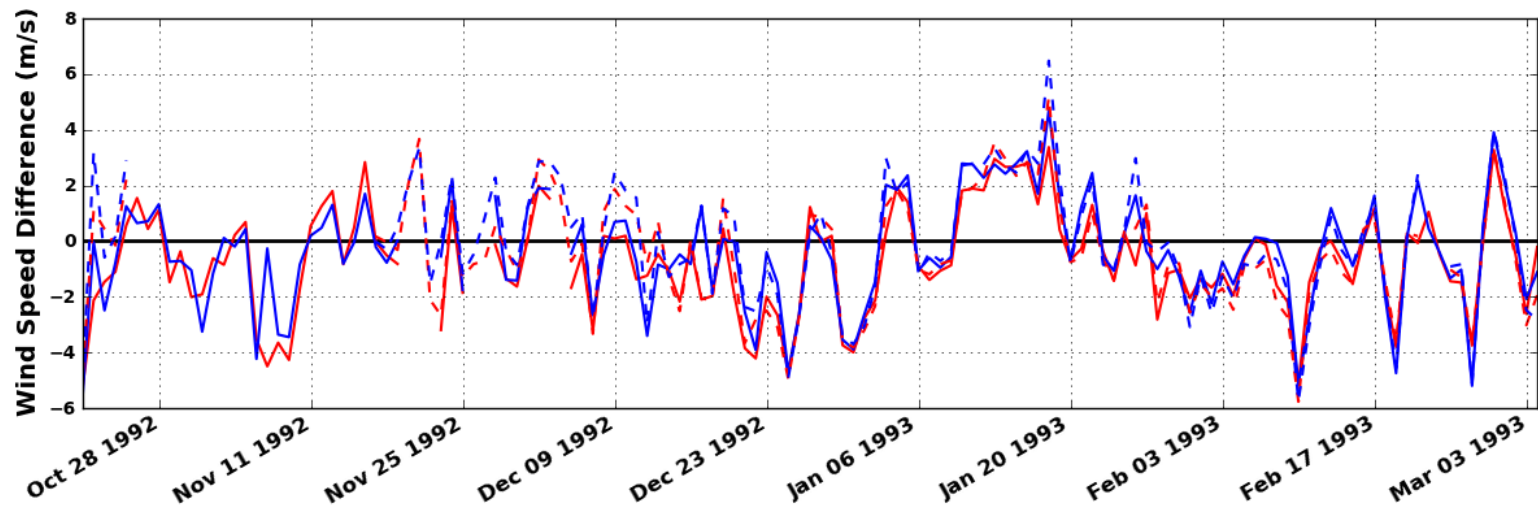
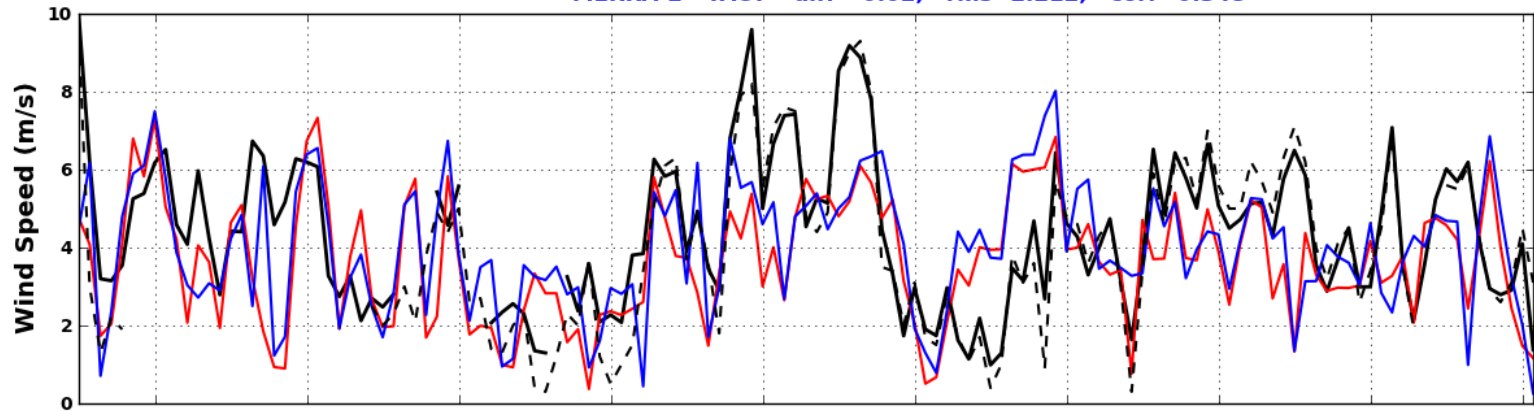
— MERRA — MERRA-2 — WHOI - - TAO

MERRA - WHOI: diff=-0.72, rms=1.975, corr=0.453

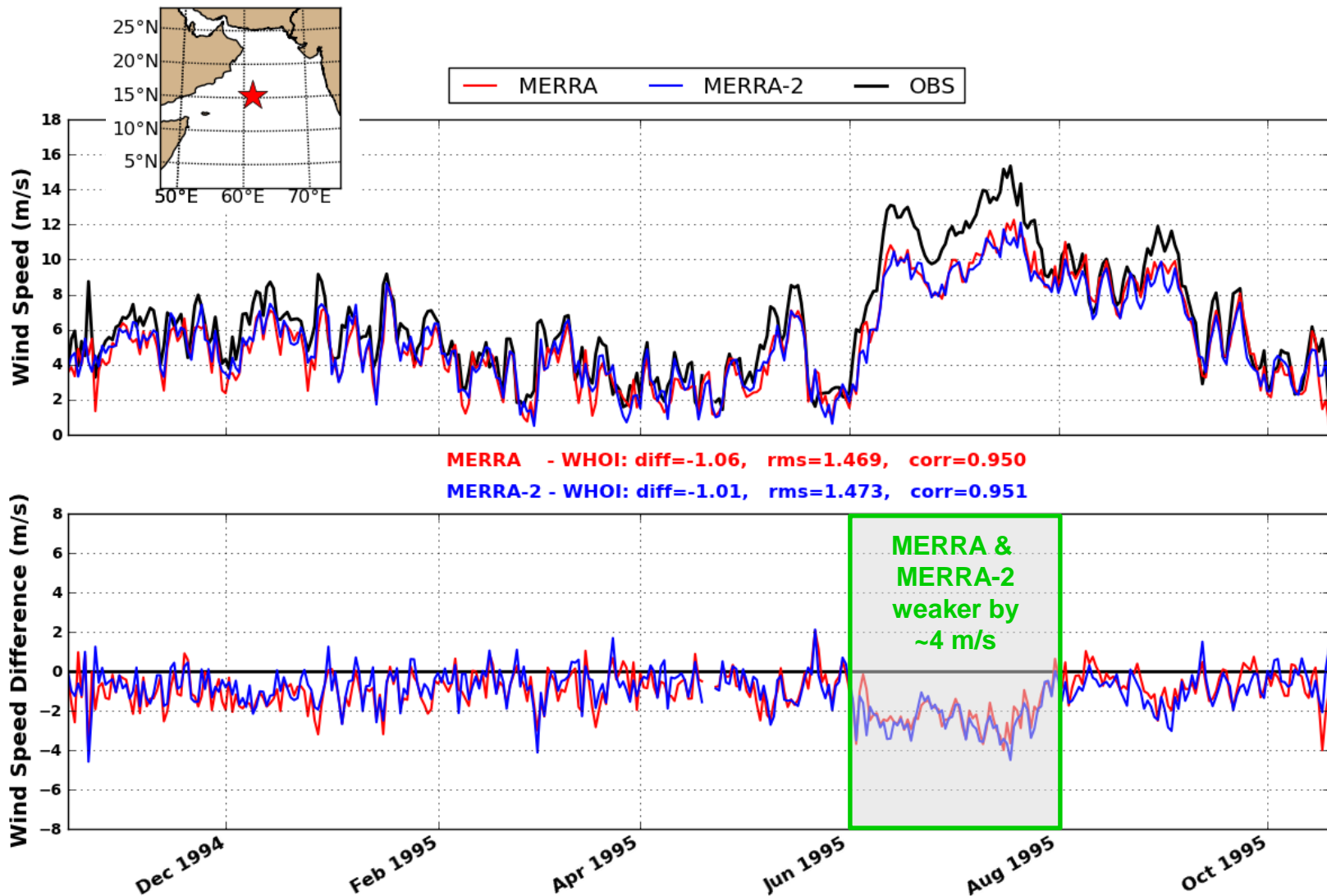
MERRA-2 - WHOI: diff=-0.37, rms=1.968, corr=0.419

MERRA - TAO: diff=-0.44, rms=2.069, corr=0.436

MERRA-2 - TAO: diff=-0.02, rms=2.212, corr=0.348



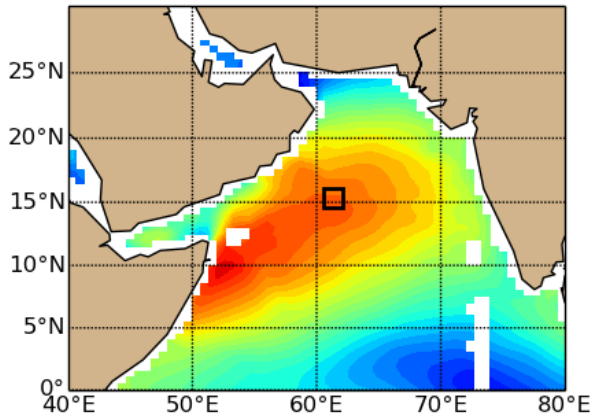
WHOI Mooring, Arabian Sea (1994-1995)



- MERRA-2 and MERRA are slightly weaker than observations by ~1 m/s
- Both correlate highly with OBS around 0.95
- Not capturing the stronger winds of the Southwest Monsoon (Jun-Aug 1995)

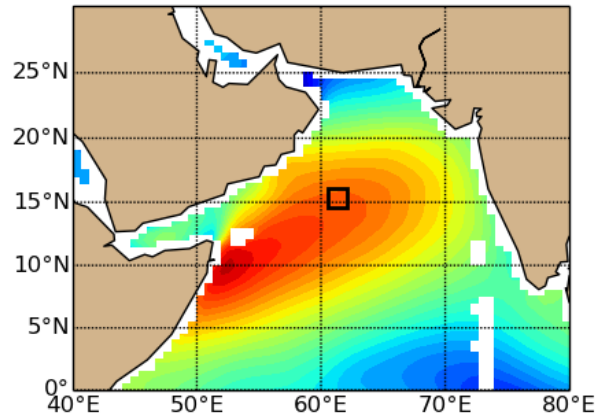
10-Meter Wind Speed: July 1995: Peak of Summer Monsoon

MERRA-2



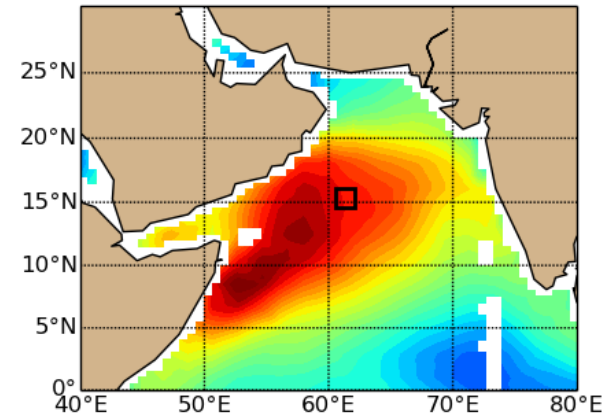
min=0.038, max=13.7, mean=5.1, std=0.38

MERRA



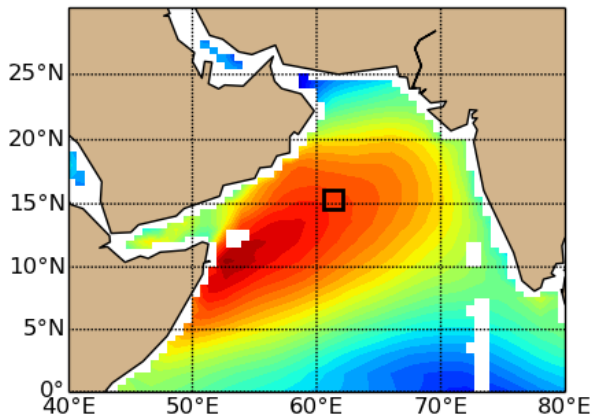
min=0.017, max=14.1, mean=5.0, std=0.41

NCEP-R2



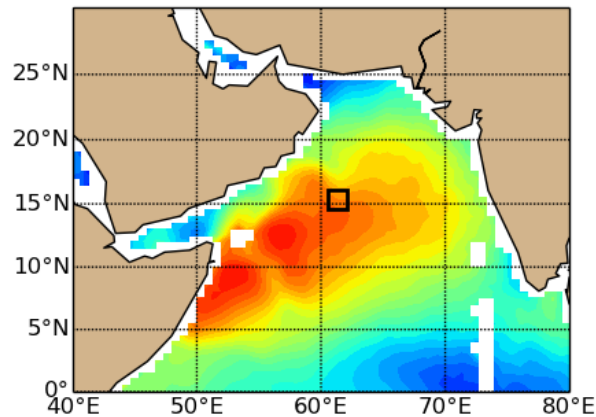
min=0.190, max=15.4, mean=5.6, std=0.49

ERA-I



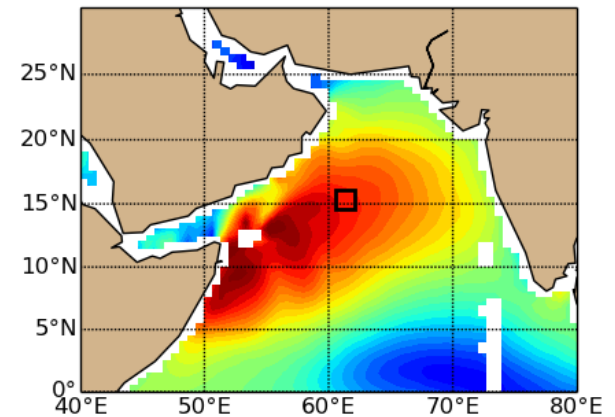
min=0.032, max=14.6, mean=5.2, std=0.43

CCMP

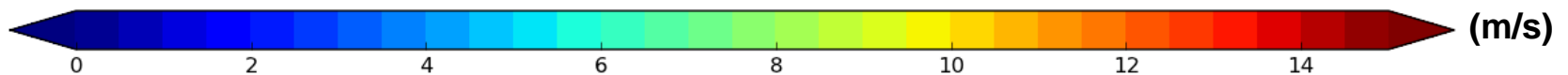


min=0.083, max=13.4, mean=5.5, std=0.40

SCOW



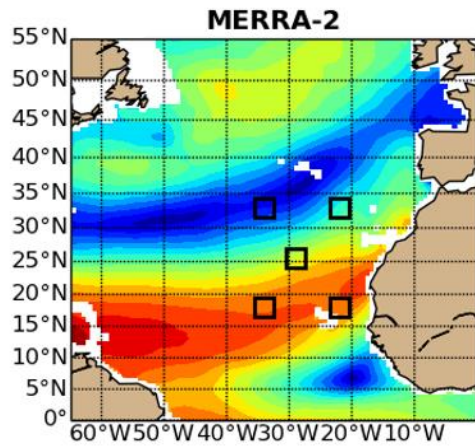
min=0.022, max=16.0, mean=4.8, std=0.30



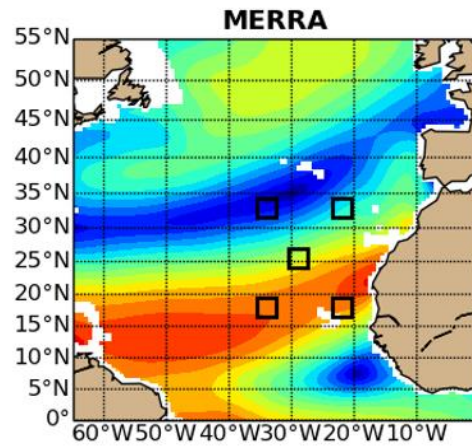
- MERRA-2, MERRA, and CCMP underestimate the winds
- Why are MERRA-2 winds weak?

WHOI Moorings, Subduction Experiment (1991-1993)

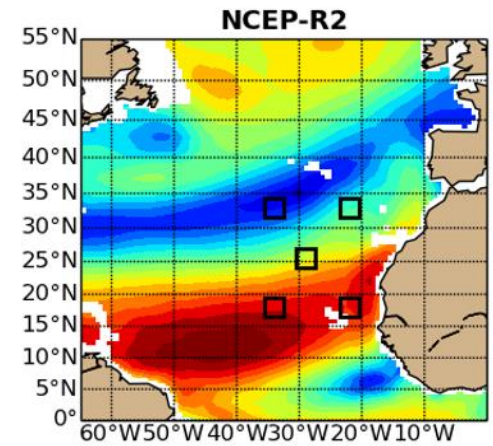
10-Meter Wind Speed: 1991-1993



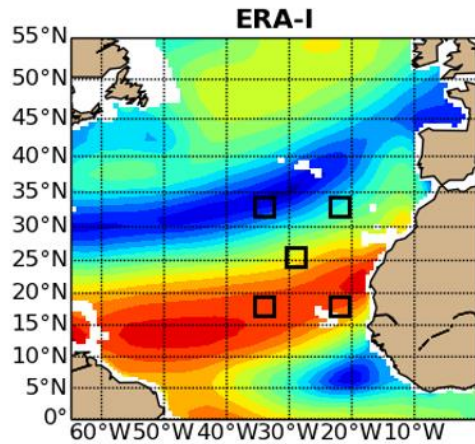
min=0.024, max=10.3, mean=4.1, std=0.30



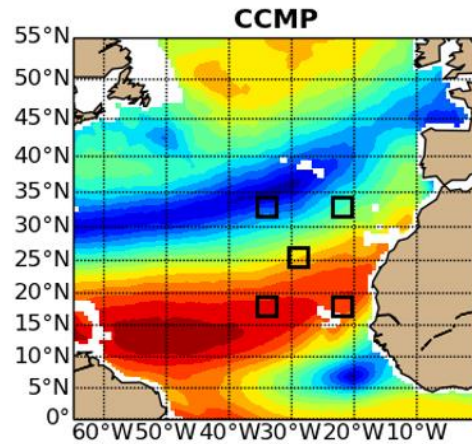
min=0.009, max=8.89, mean=4.1, std=0.40



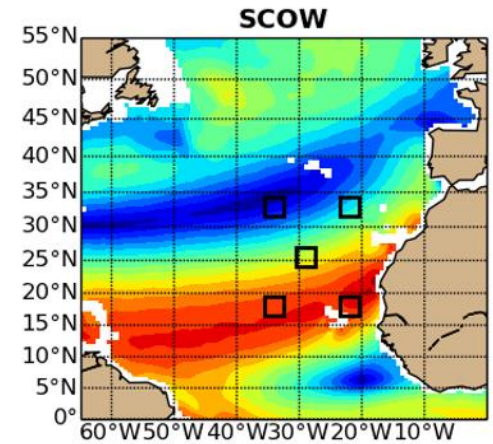
min=0.032, max=10.4, mean=4.6, std=0.49



min=0.037, max=9.54, mean=4.2, std=0.41



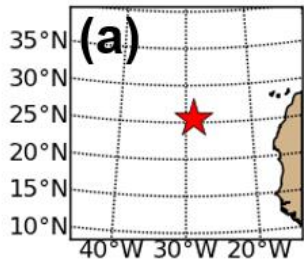
min=0.040, max=9.73, mean=4.5, std=0.37



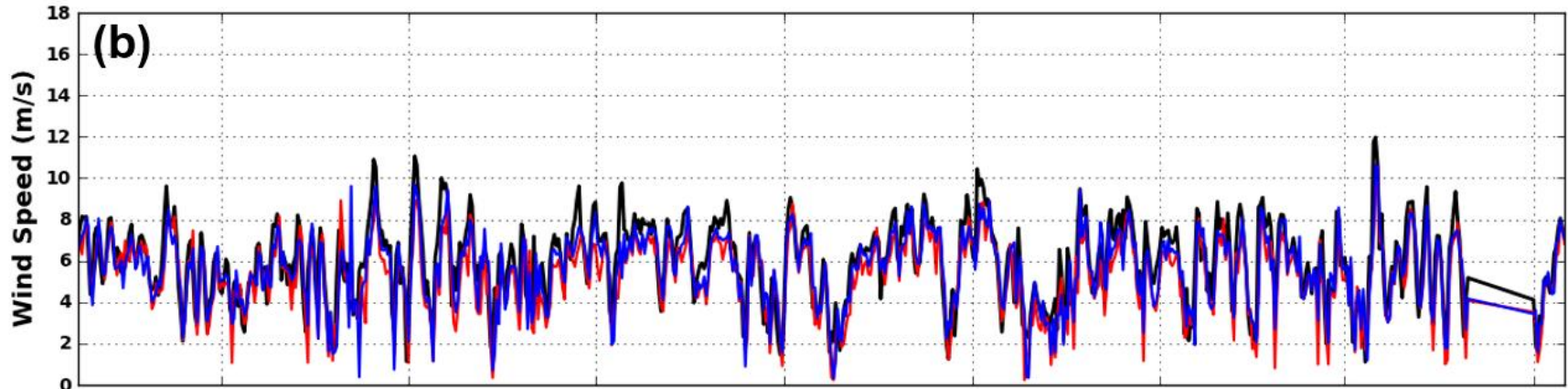
min=0.040, max=9.35, mean=4.2, std=0.28



WHOI Mooring, North Atlantic (1991-1993)

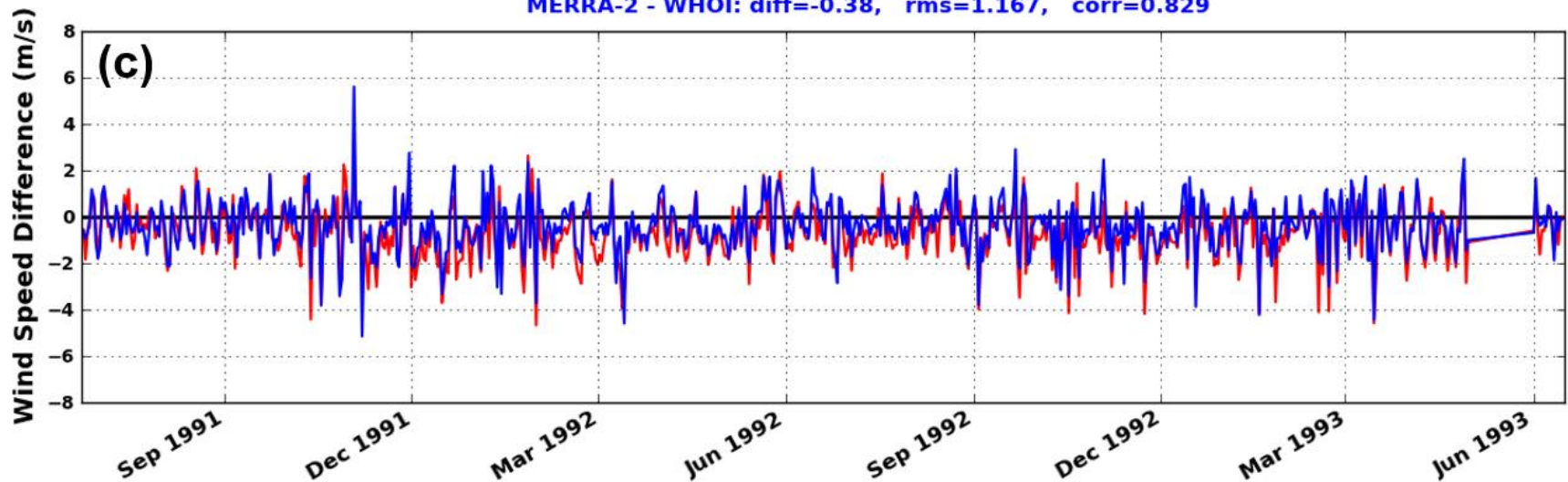


Subduction-Central: Subtropical North Atlantic

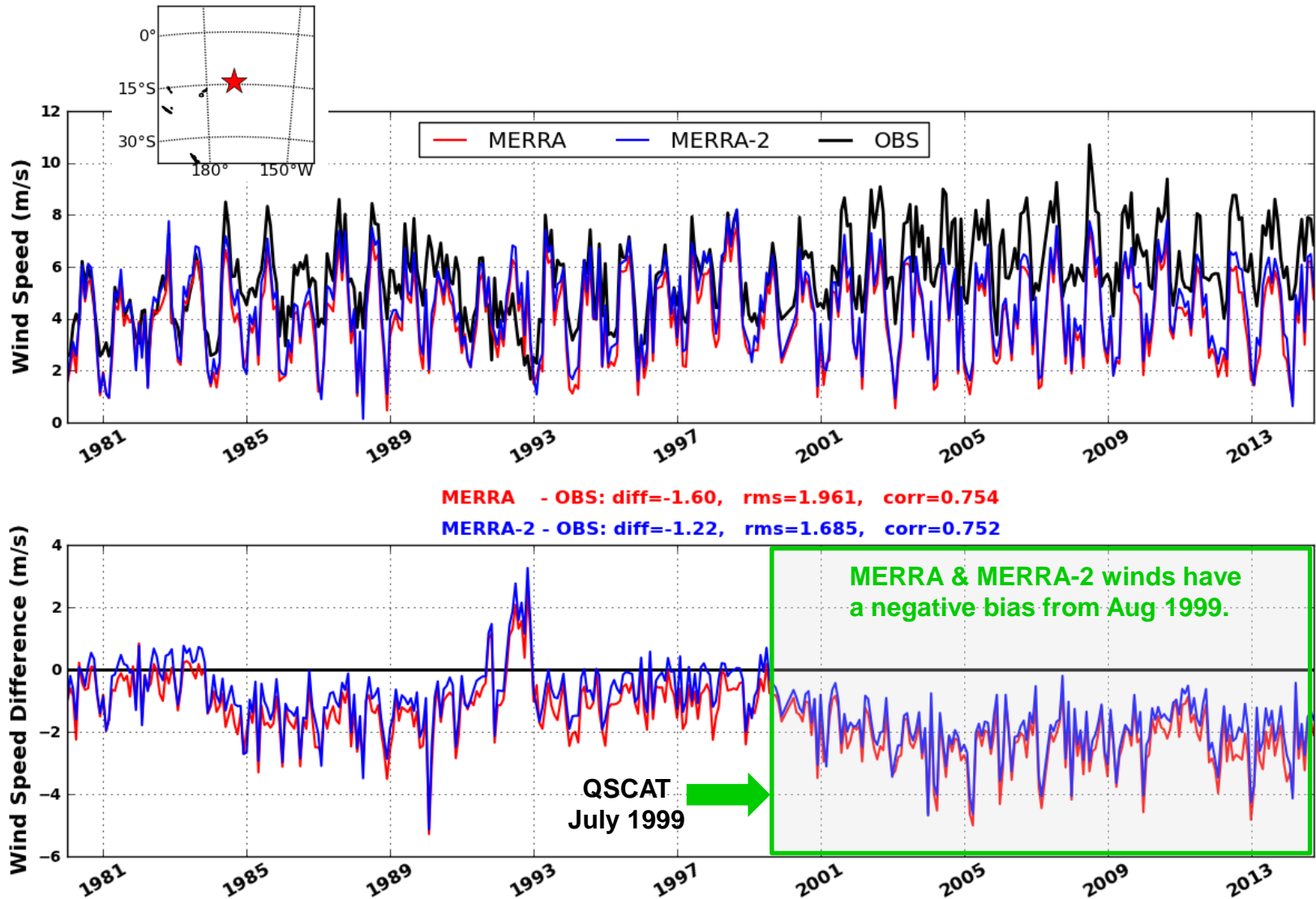


MERRA - WHOI: diff=-0.68, rms=1.318, corr=0.822

MERRA-2 - WHOI: diff=-0.38, rms=1.167, corr=0.829



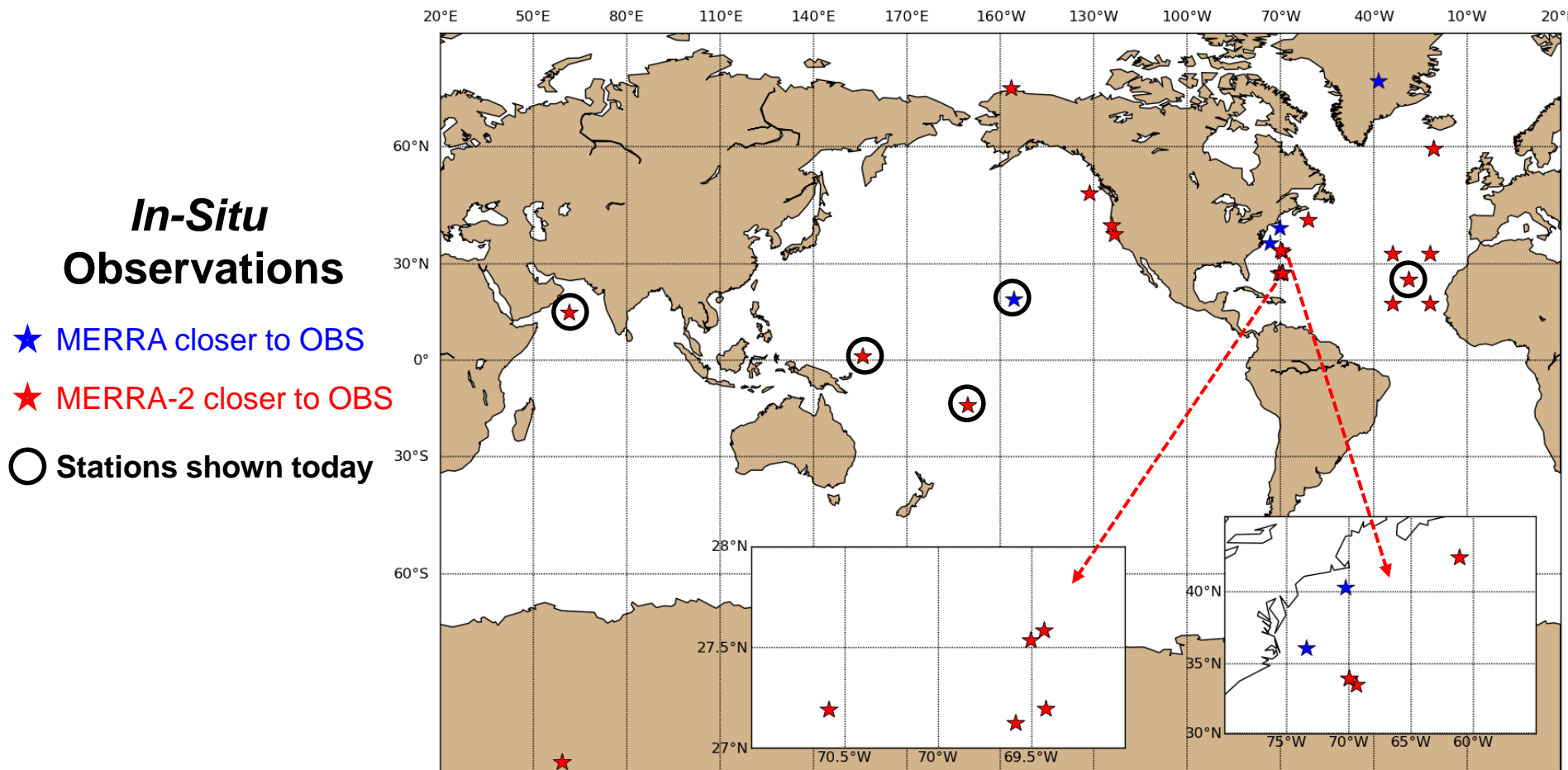
Tutuila, Samoa ESRL Station (1981-2013)



- MERRA-2 and MERRA are weaker than observations by up to 5 m/s, except Apr-Dec 1992
- MERRA-2 is closer to obs than MERRA

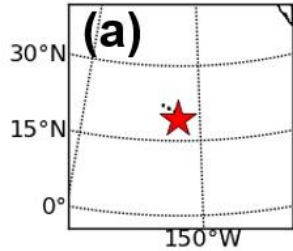
Conclusions

- **Global wind speed fields (1999-2009 climatology)**
 - Patterns are similar for all six products
 - **MERRA-2** compares best with CCMP
 - **MERRA-2** is stronger than MERRA, SCOW, and ERA-I in most regions
 - **MERRA-2** is weaker than NCEP-R2 and CCMP



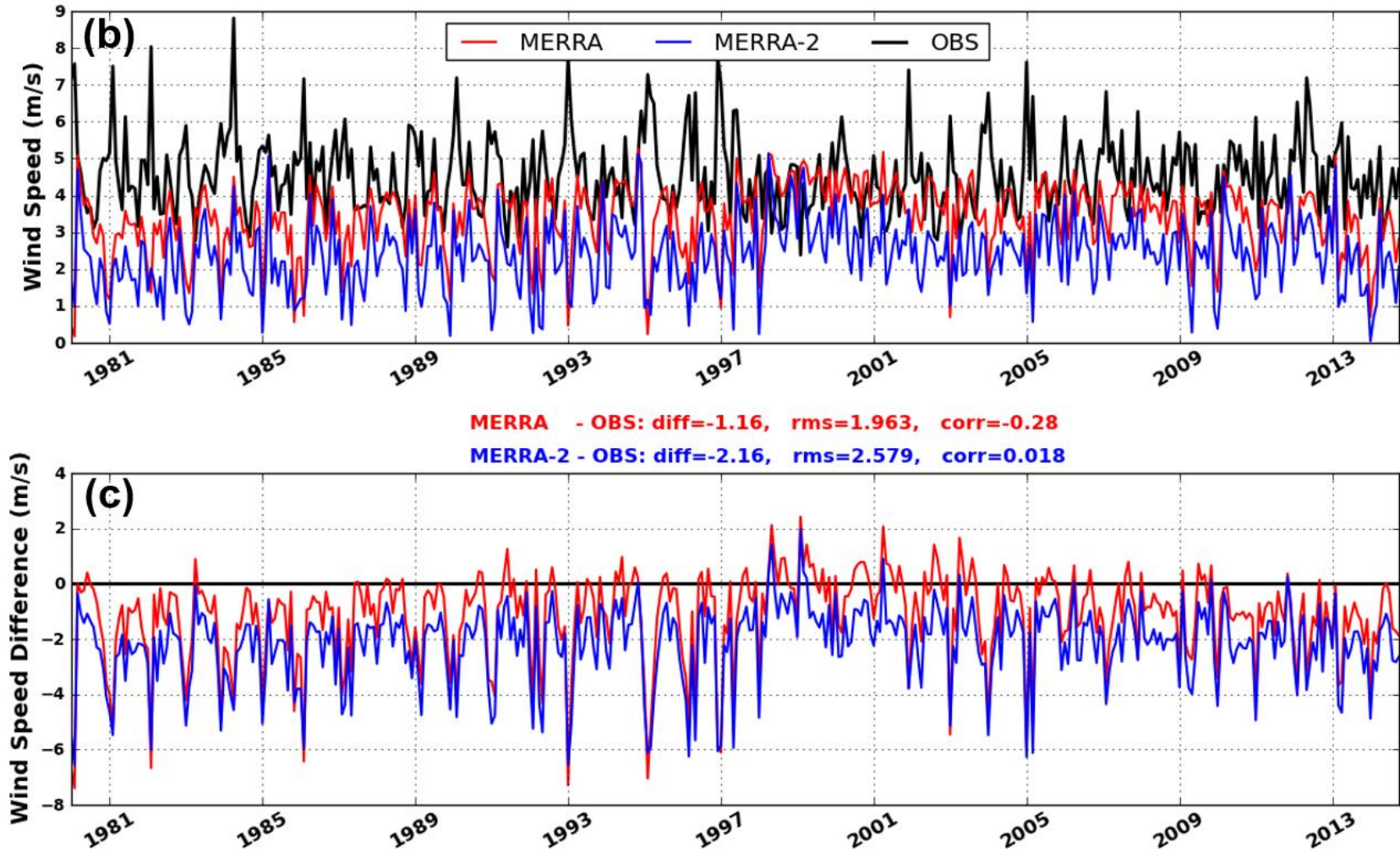
Backup

Mauna Loa, Hawaii: ESRL Station (1981-2013)



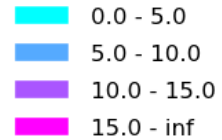
Mauna Loa, Hawaii

OBS (elevation=3397 m)
MERRA/MERRA-2 (elevation=1145 m)

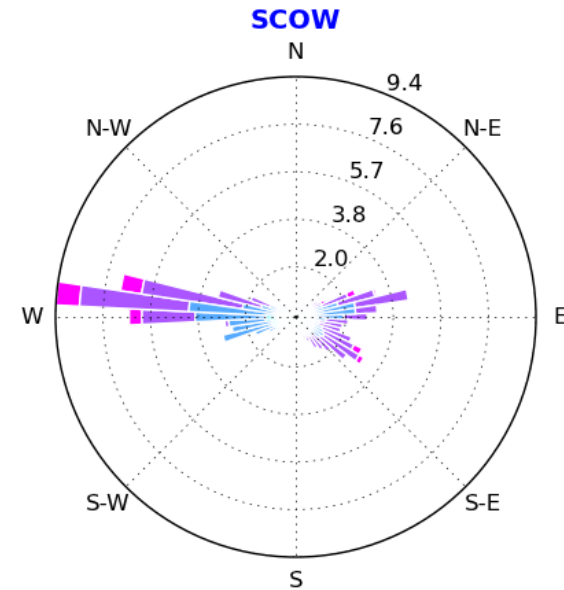
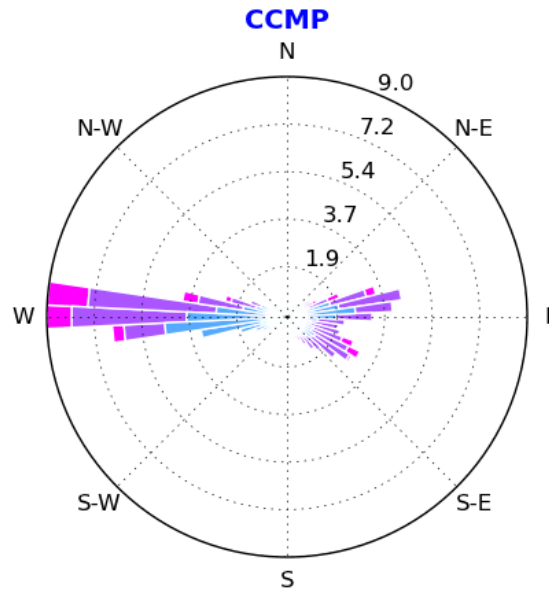
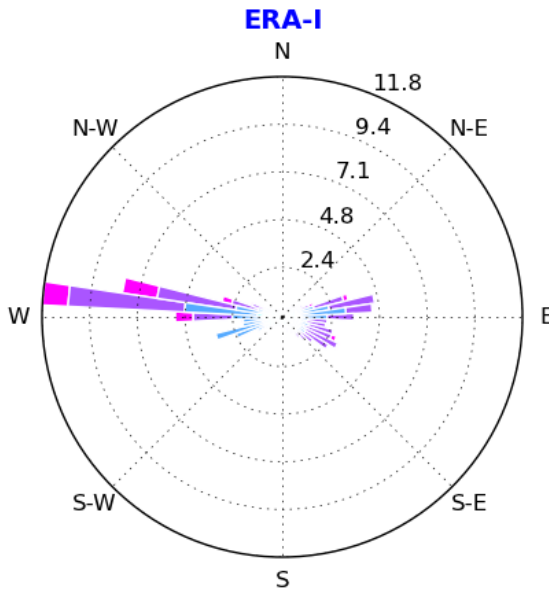
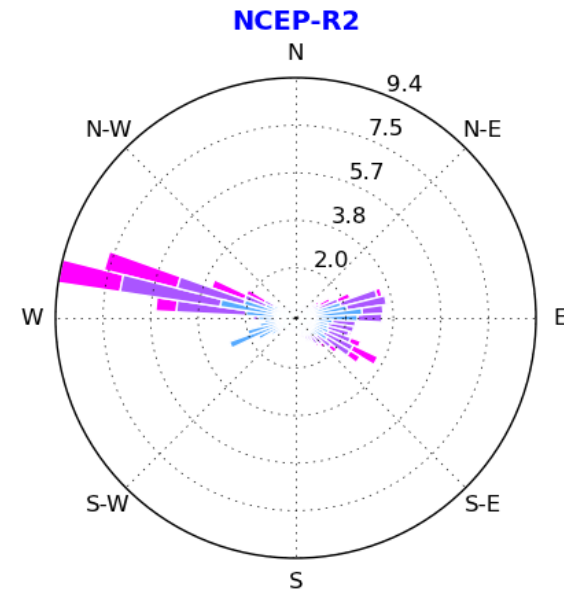
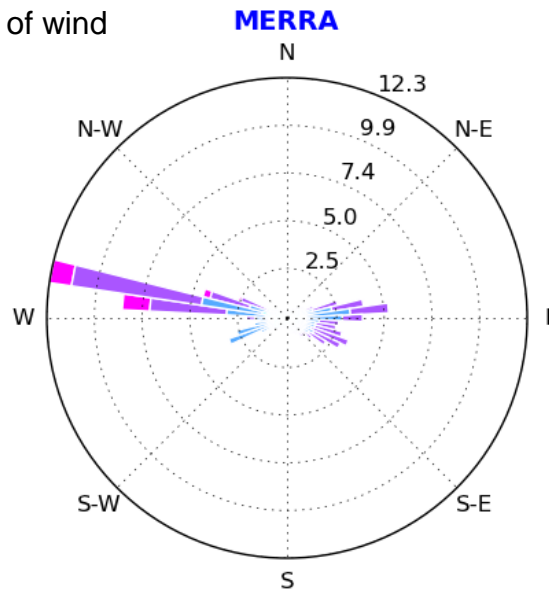
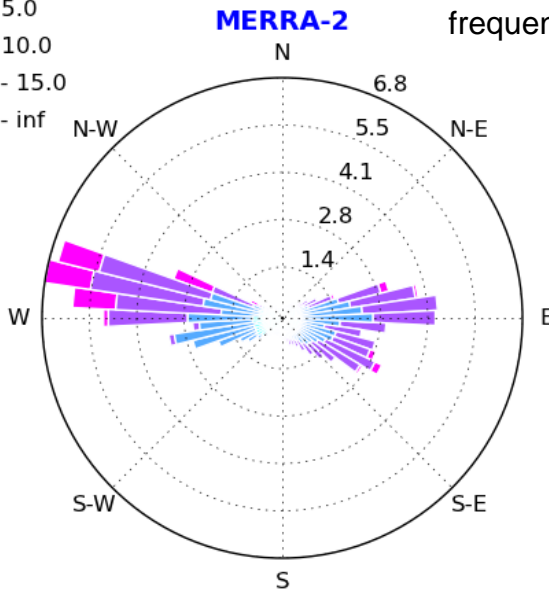


10-Meter Wind Rose: 1999-2009

Speed (knots)



Radial Band frequency of wind



Pre-dominant winds are the Westerlies (30-60), then NE Trades (0-30N), and SE Trades (0-30S).