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Climate-Quality Intercalibration of Scatterometer Missions



A large, powerful ocean wave is shown breaking, with white spray at the crest. The water is a deep blue, and the background shows a hazy horizon under a clear sky.

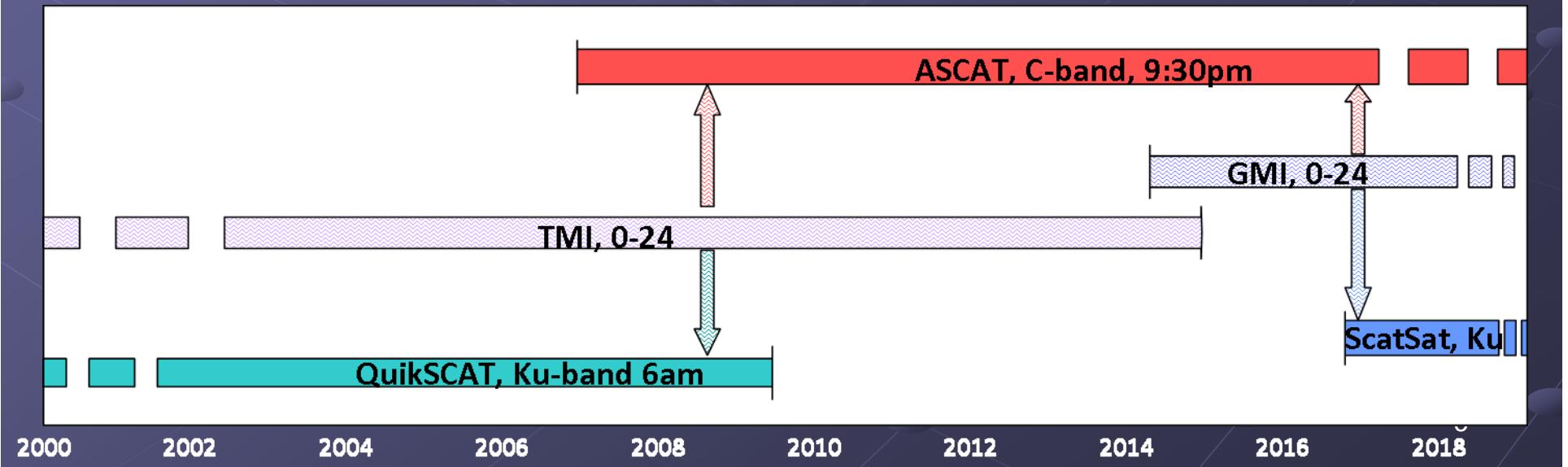
Lucrezia Ricciardulli and Frank Wentz
Remote Sensing Systems, Santa Rosa, California

Objective

- Bring consistency among all scatterometers measurements, current and past missions
- Establish a method for extending consistency to future missions
- Develop a Climate Data Record (CDR) of Ocean Vector Winds
- Accuracy level of 0.1 m/s, at global monthly scale
- X-calibration needs to account for
 - sensors observing at different time of the day
 - Potential differences in ocean response at difference sensor frequency and resolution;
 - Different Quality-Control for various datasets
 - Sensor stability issues

Cross-calibration method

- Calibrate Scatterometers to Radiometer winds (RTM V7-V8), 0-35 m/s
- In progress: Use SFMR as common calibration target for high winds
- Use non-sun-synchronous radiometers to tie wind speeds for all scatterometer missions observing at different time of the day
 - Past: TMI (tropical 40NS, 1998-2014)
 - Current and future: GMI (global 70NS, since 2014)

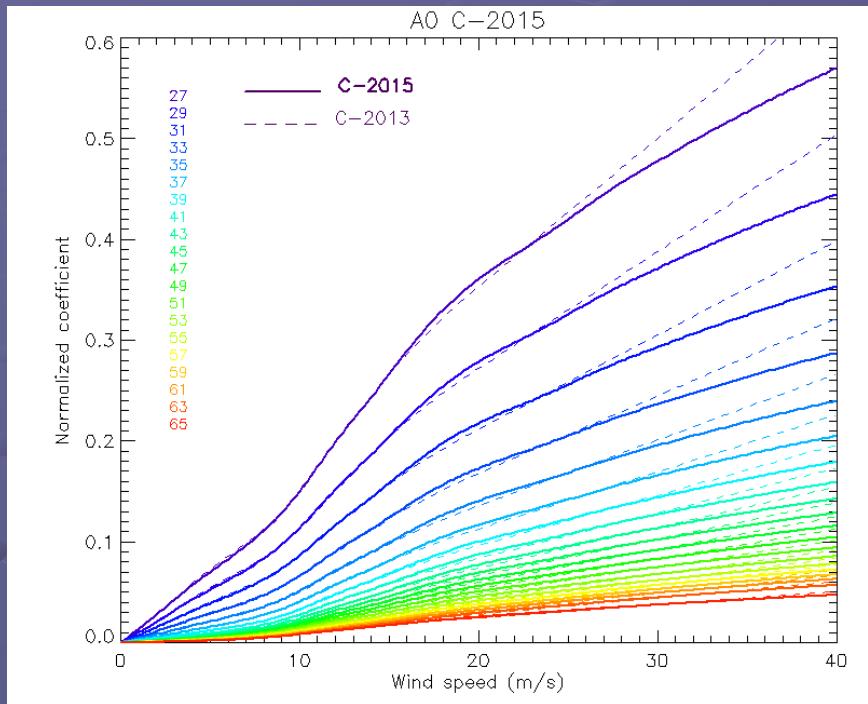


New Intercalibrated GMF: C-2015

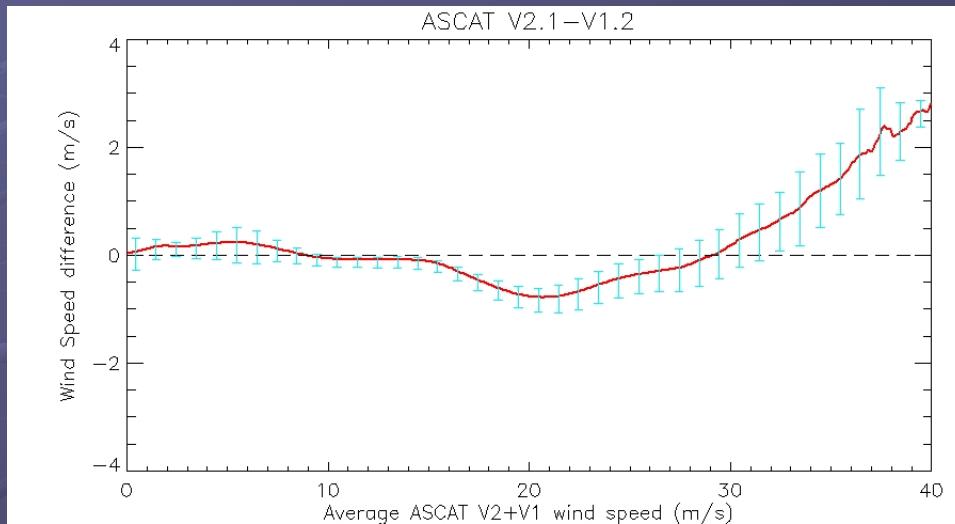
- In the past year we focused on making the Ku-band and C-band consistent at all wind speeds
- Ku-2011 (QSCAT) uses 10 GHz winds from WindSat as calibration target (Rain-free, 90 min colocations)
- C-2013 used 18 GHz winds from SSMI → stability issues, atmospheric effects, inconsistencies in PDFs vs QSCAT
- Completed the development of new C-band GMF C-2015
- C-2015 uses 10 GHz winds from TMI and GMI as calibration target (Rain-free, 2 hr colocations).
- Reprocessed and released RSS ASCAT-A V2.1 winds (April 2016) available @ www.remss.com/ascat

C-2015 versus C-2013:

Non-directional coefficient A0



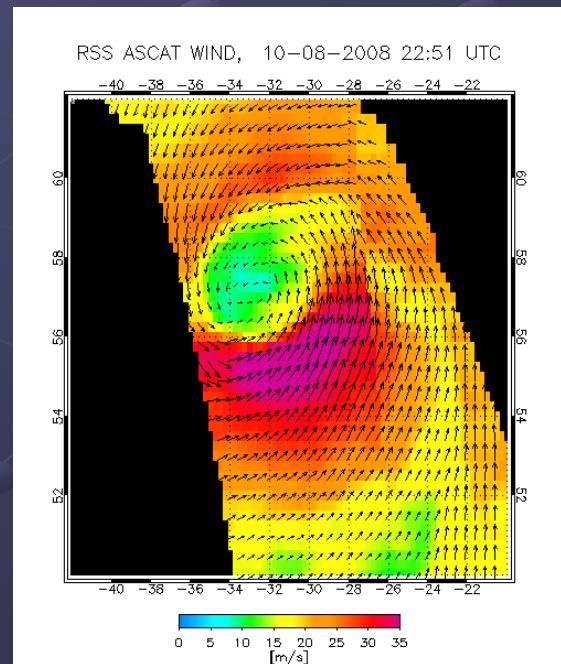
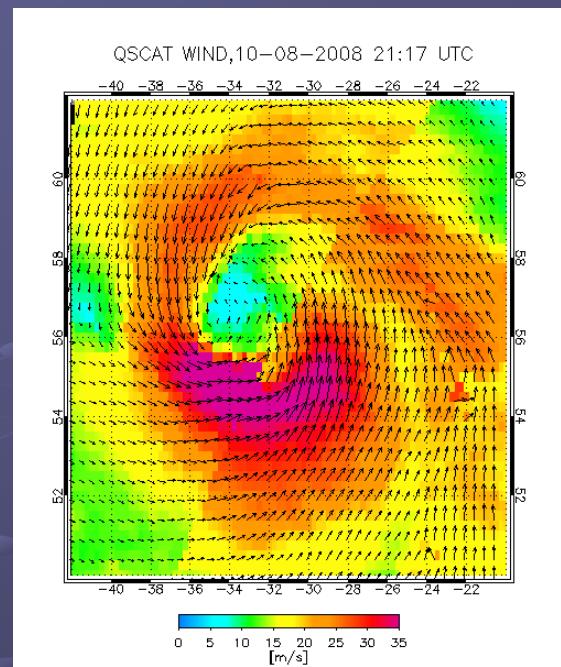
ASCAT Wind speed C2015-C2013



- Non-linear extrapolation above 30 m/s → Higher winds above 30 m/s
- Fixed a small bump around 20 m/s → consistency with QSCAT and Radiometer around 20 m/s
- Small changes at very low winds → slightly higher wind values, better PDF alignment at different WVC

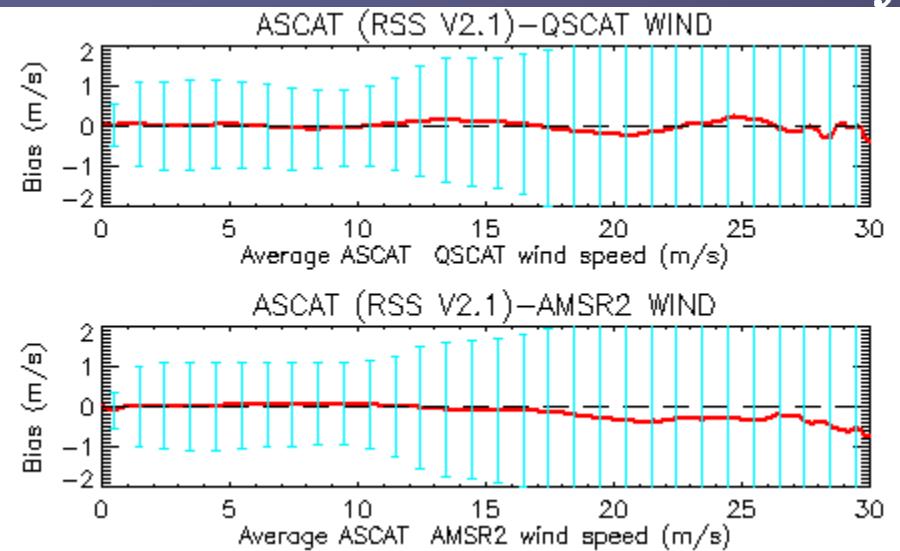
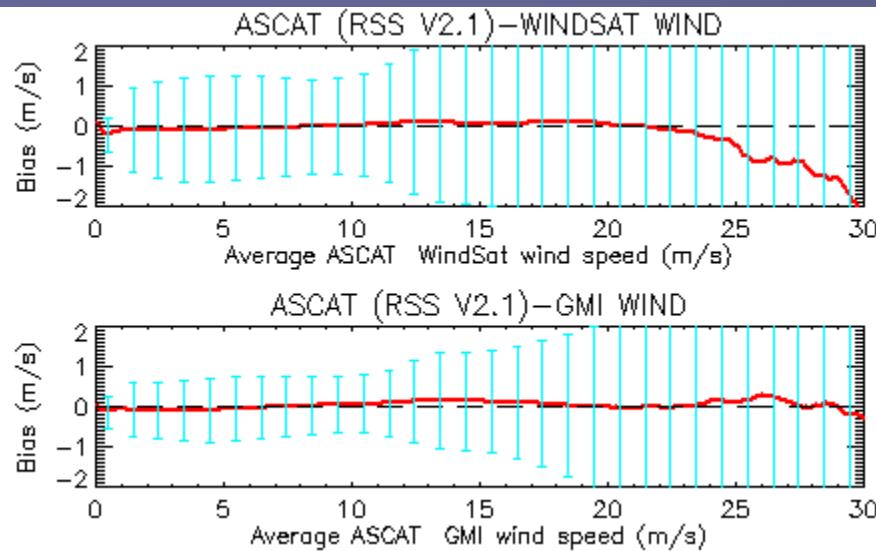
Tuning of High Winds

- We developed a database of 50+ extratropical storms (very little impact of rain), for WindSat, QSCAT, and ASCAT.
- We “tuned” the ASCAT coefficients at high winds to “statistically match” WindSat and QSCAT storm fields.
- As a consequence, ASCAT, WindSat and QSCAT are more or less consistent at high winds
- Coming soon: We plan to use SFMR to validate and tune winds > 30 m/s
- SMAP seems to match the SFMR, Could be used for additional tuning (T. Meissner’s presentation)



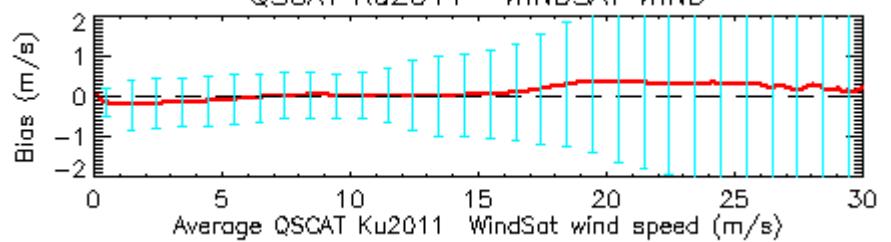
ASCAT X-Cal

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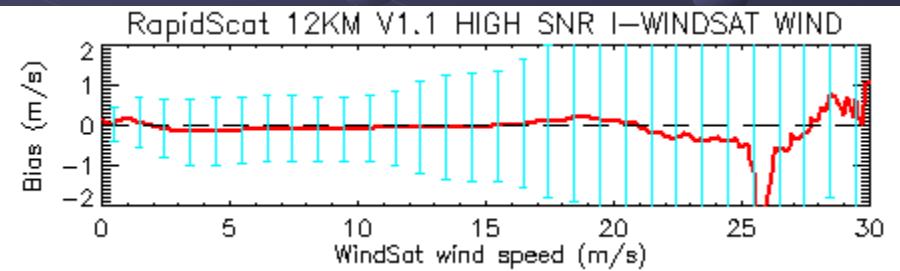
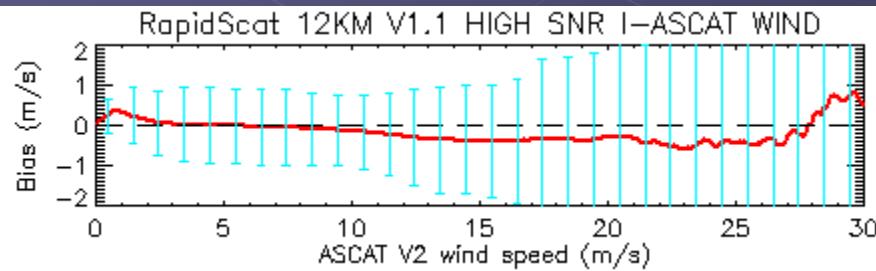


QuikSCAT X-Cal

QSCAT Ku2011 –WINDSAT WIND



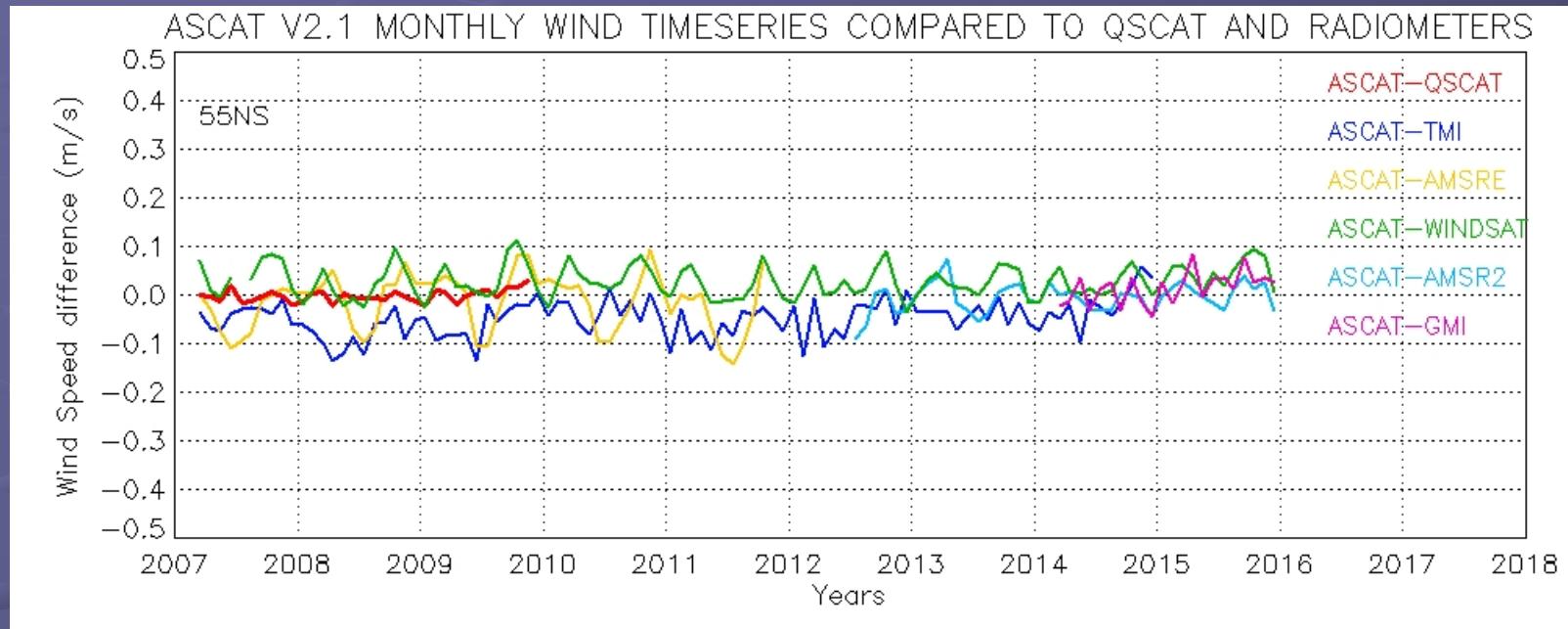
RapidScat X-Cal



	Wind Speed Bias (m/s)	St Dev (m/s)
ASCAT-QuikSCAT	0.0	1.12
ASCAT-WSAT	-0.04	1.45
ASCAT-GMI	0.0	0.90
ASCAT-TMI	-0.07	0.65
ASCAT-AMSRE	0.04	1.23
ASCAT-AMSR2	0.03	1.22
ASCAT-Buoys	-0.01	1.11
ASCAT-NCEP	0.25	1.17
ASCAT-ECMWF	0.39	1.06
ASCAT-RapidScat (High SNR I)	-0.15	1.17

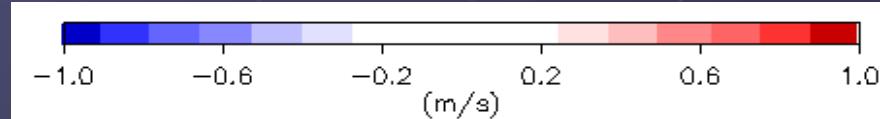
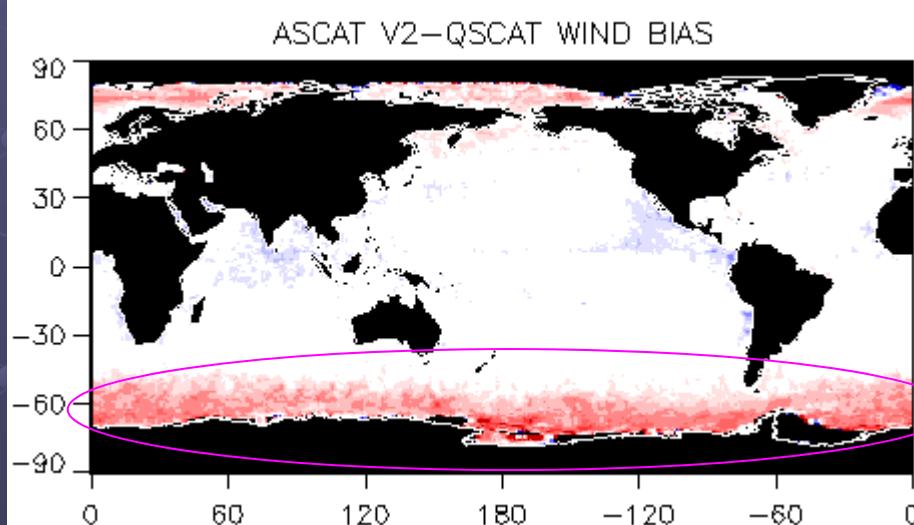
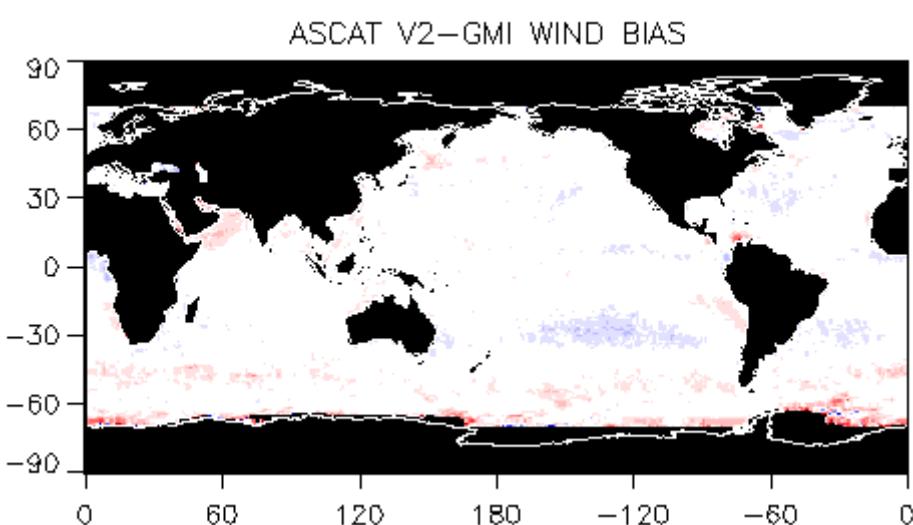
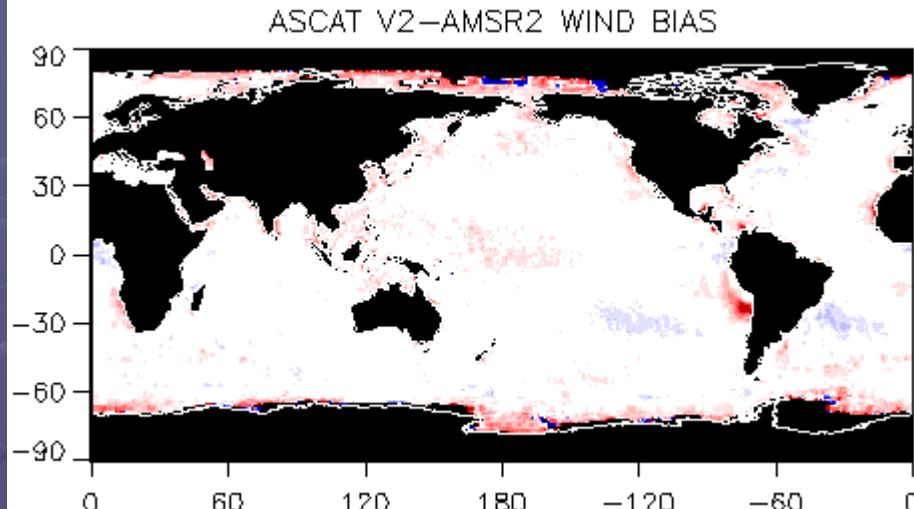
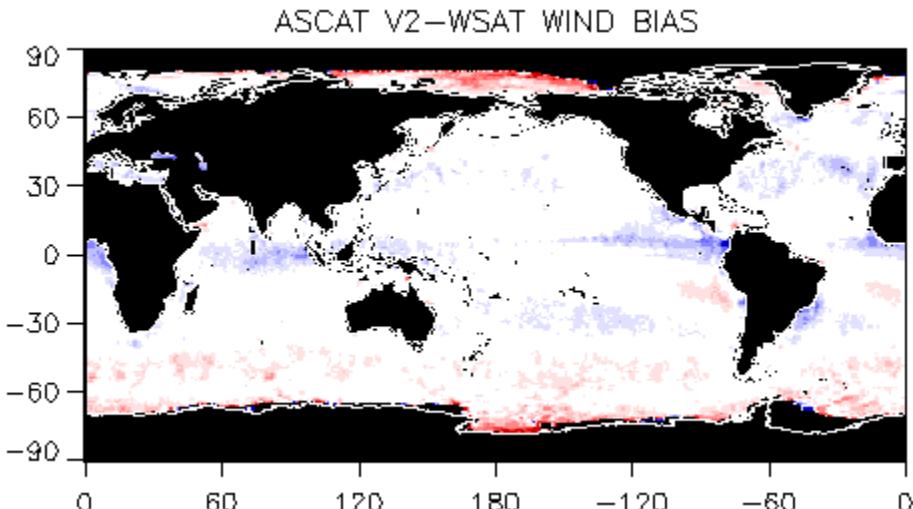
TMI,GMI,RapidScat: 90-120 min colocations; Buoys: 30 min
 All others: 4 hrs

Stability of the Wind Timeseries



Intercalibration at global monthly scale within 0.1 m/s

Regional X-Cal, ASCAT V2.1

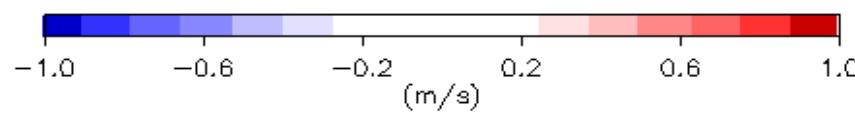
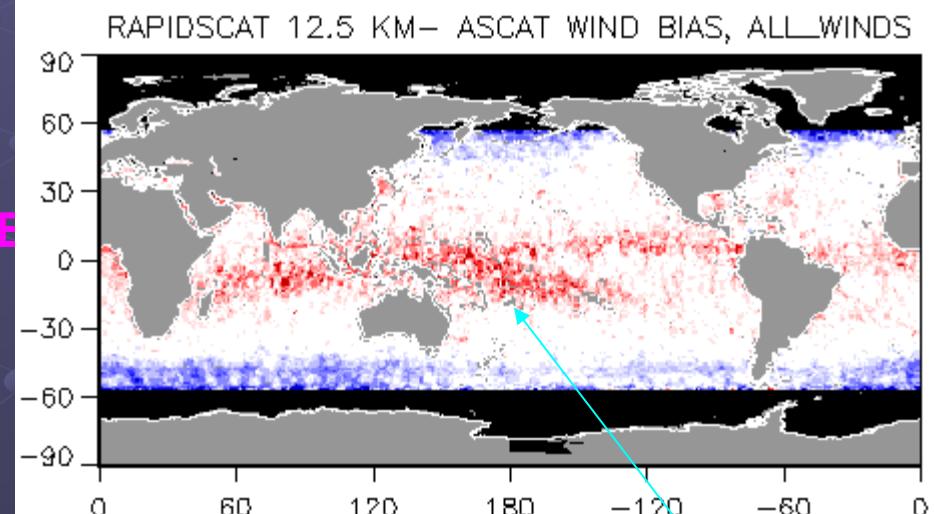
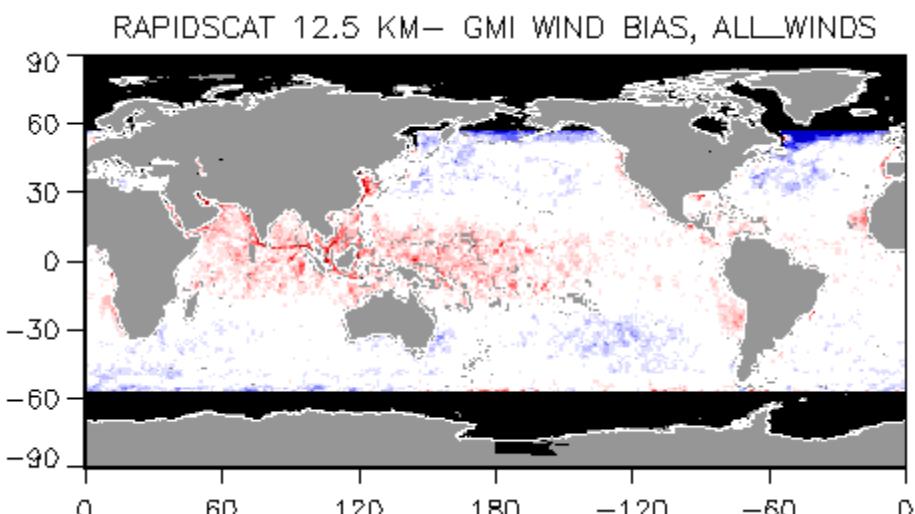
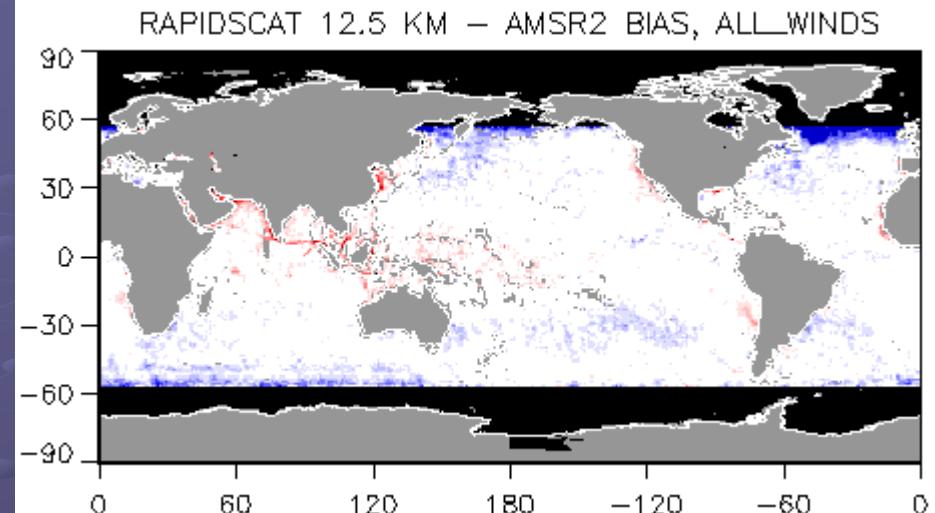
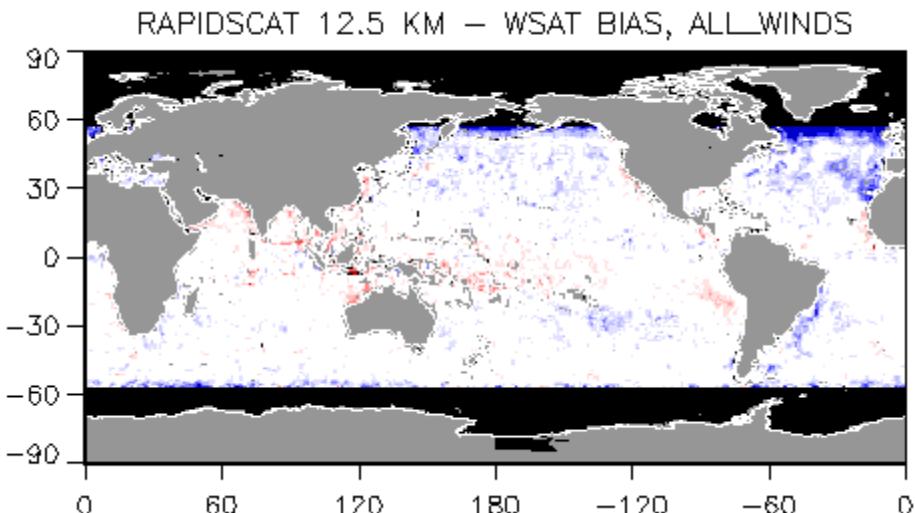


More about this later...

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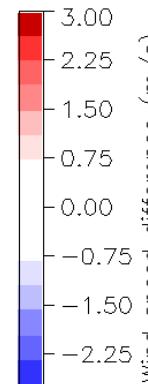
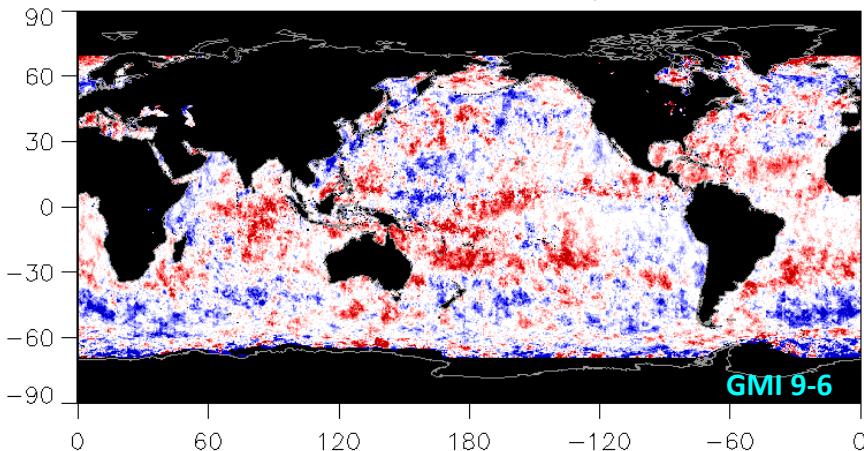


Regional X-Cal, RapidScat (High SNR)



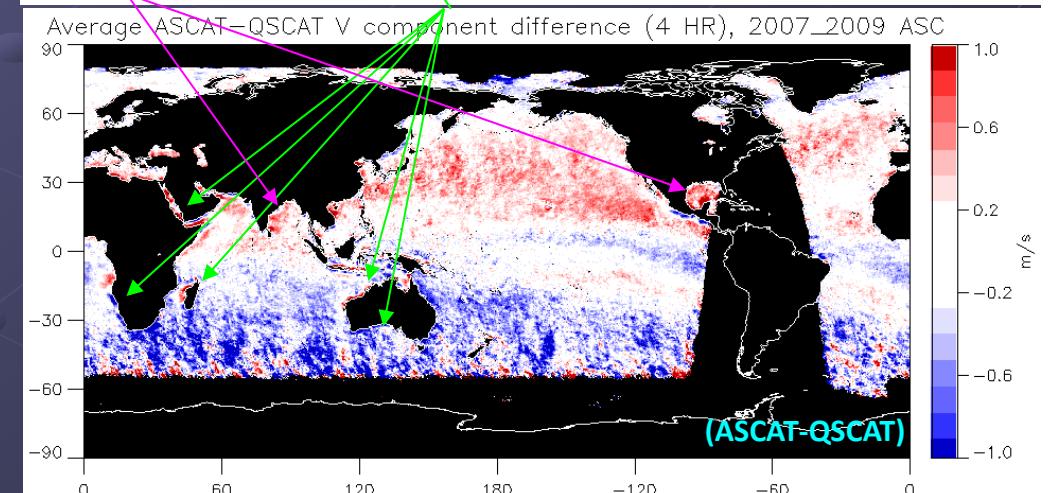
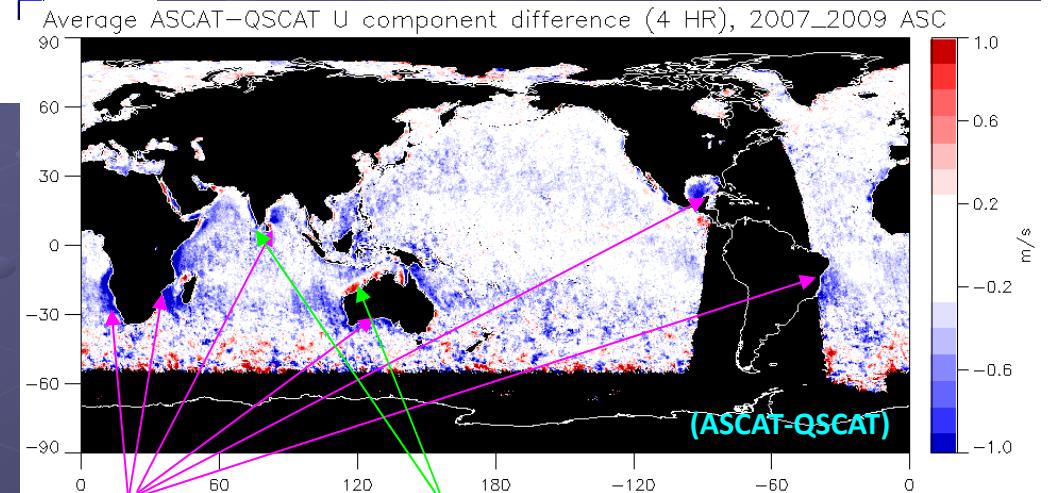
Residual rain
11

GMI 9AMPM–6AMPM WIND SPEED, 2014–2016



Diurnal Effects 9 PM/AM-6 PM/AM

- GMI: No significant diurnal effect on wind speed between 9 (ASCAT) and 6 (QSCAT) in S Ocean
- Significant **diurnal** signal in U for selected regions
- Some **diurnal** effects in V
- Some regions of **sea breeze** emerge (at low winds)

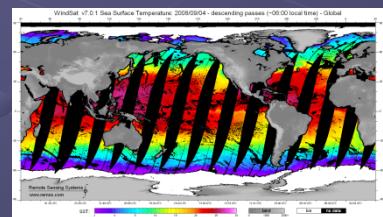


Unresolved Issue:

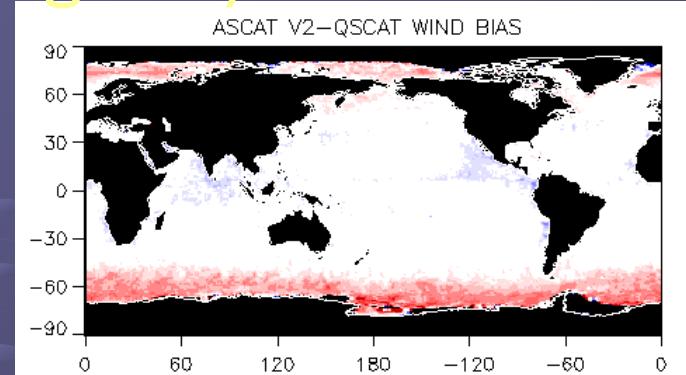
ASCAT-QSCAT S Ocean bias (in progress)

Facts:

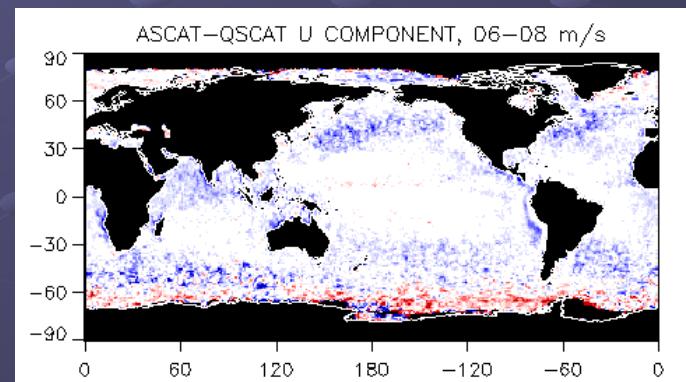
- The bias is in the V component, not U
- The bias is mostly at winds 6-12 m/s
- Diurnal effects are not an issue
(compared to GMI 9-6; And ASCAT-QSCAT 1 hr colocations in S Ocean)
- In daily difference plots, bias is not uniform, but spotty.
- Rain impact has been minimized by very conservative rain flags
- SST effect or else?



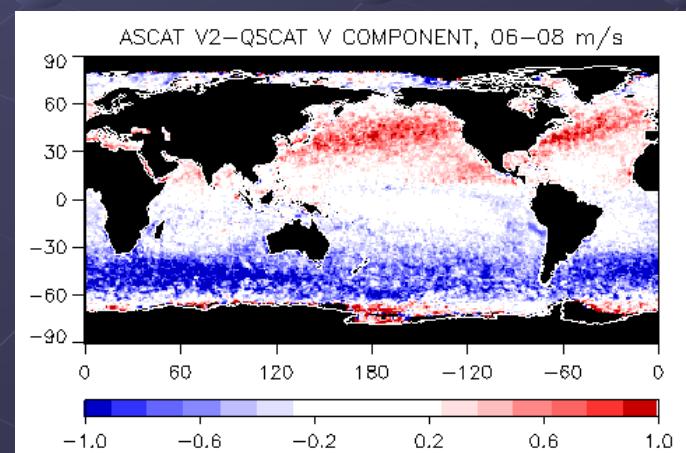
W



U



V

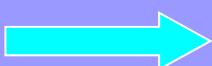


WORST CASE SCENARIO:

V for winds 6-8 m/s

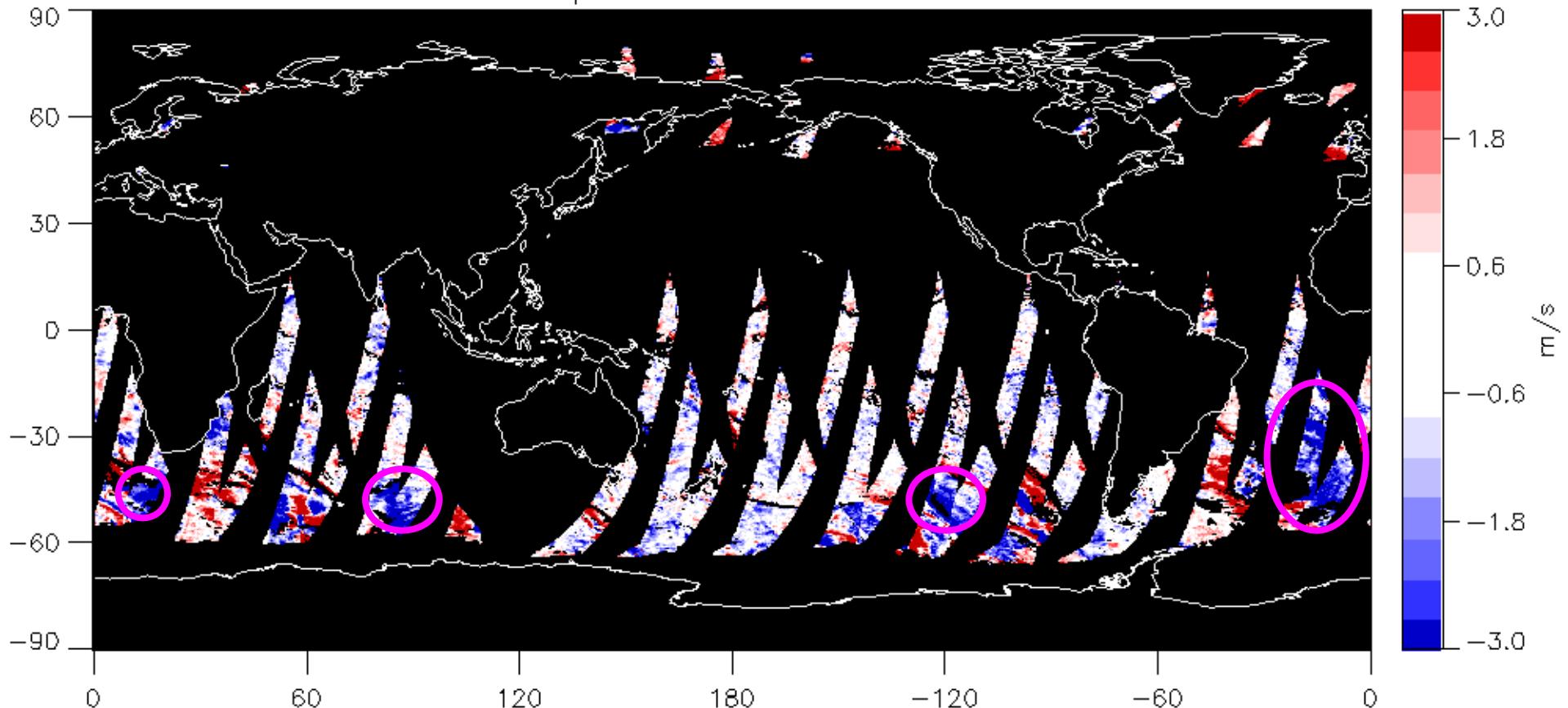
Most prominent in STORM TRACK regions

Rapidly varying rotational flow?

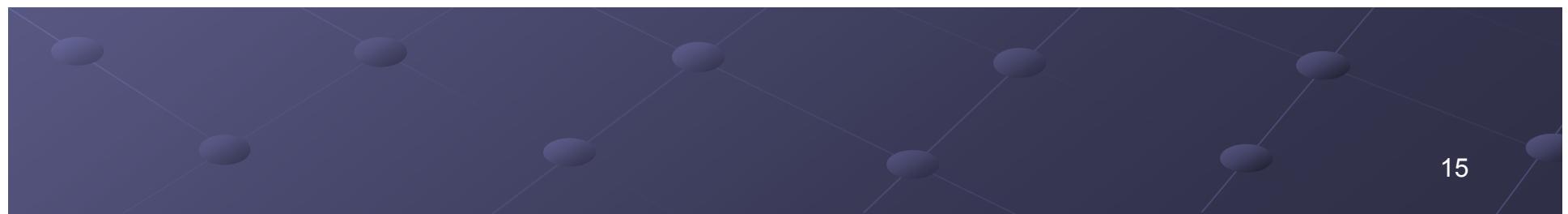
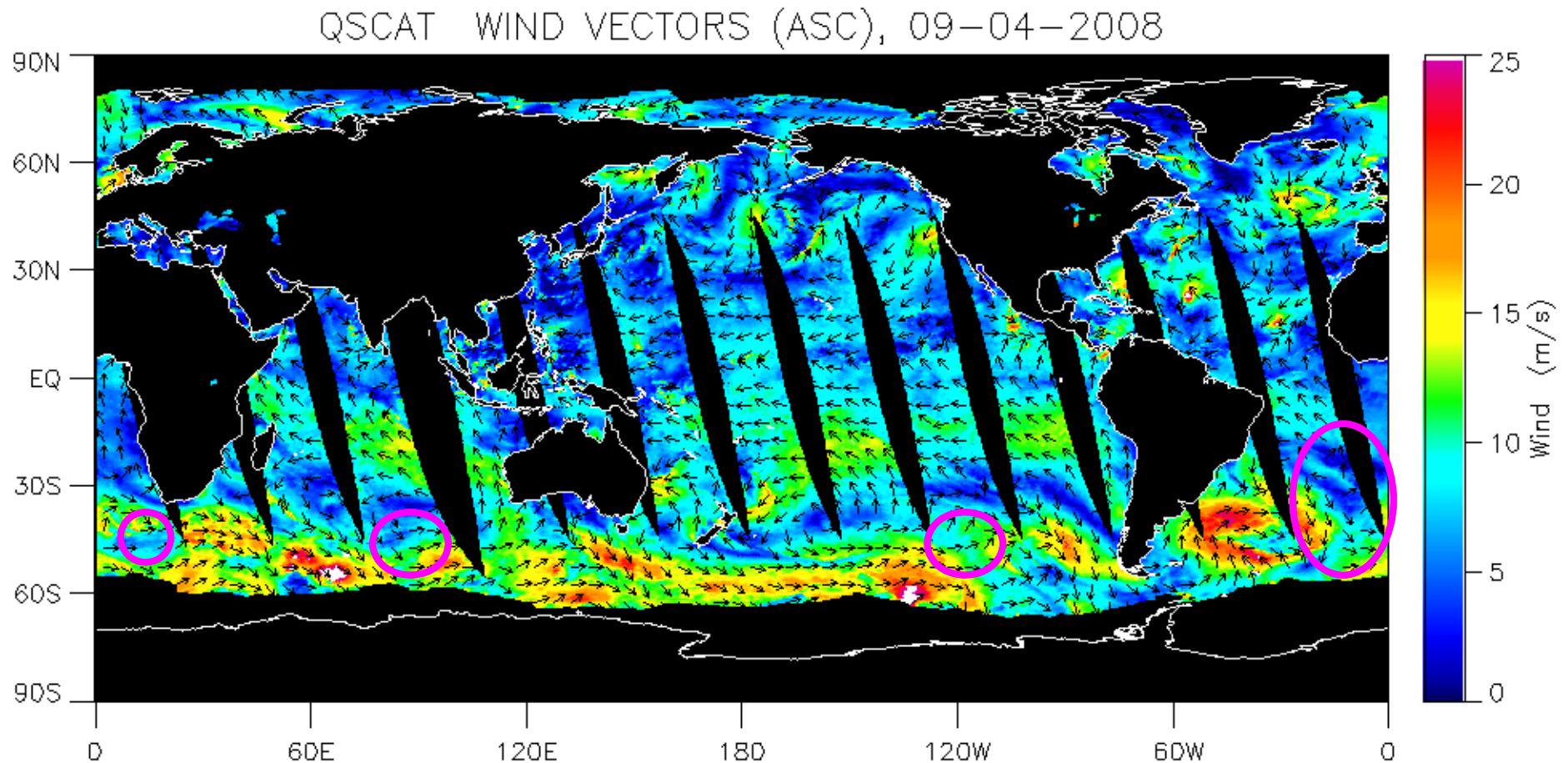


Daily ASCAT-QSCAT V (9-6am)

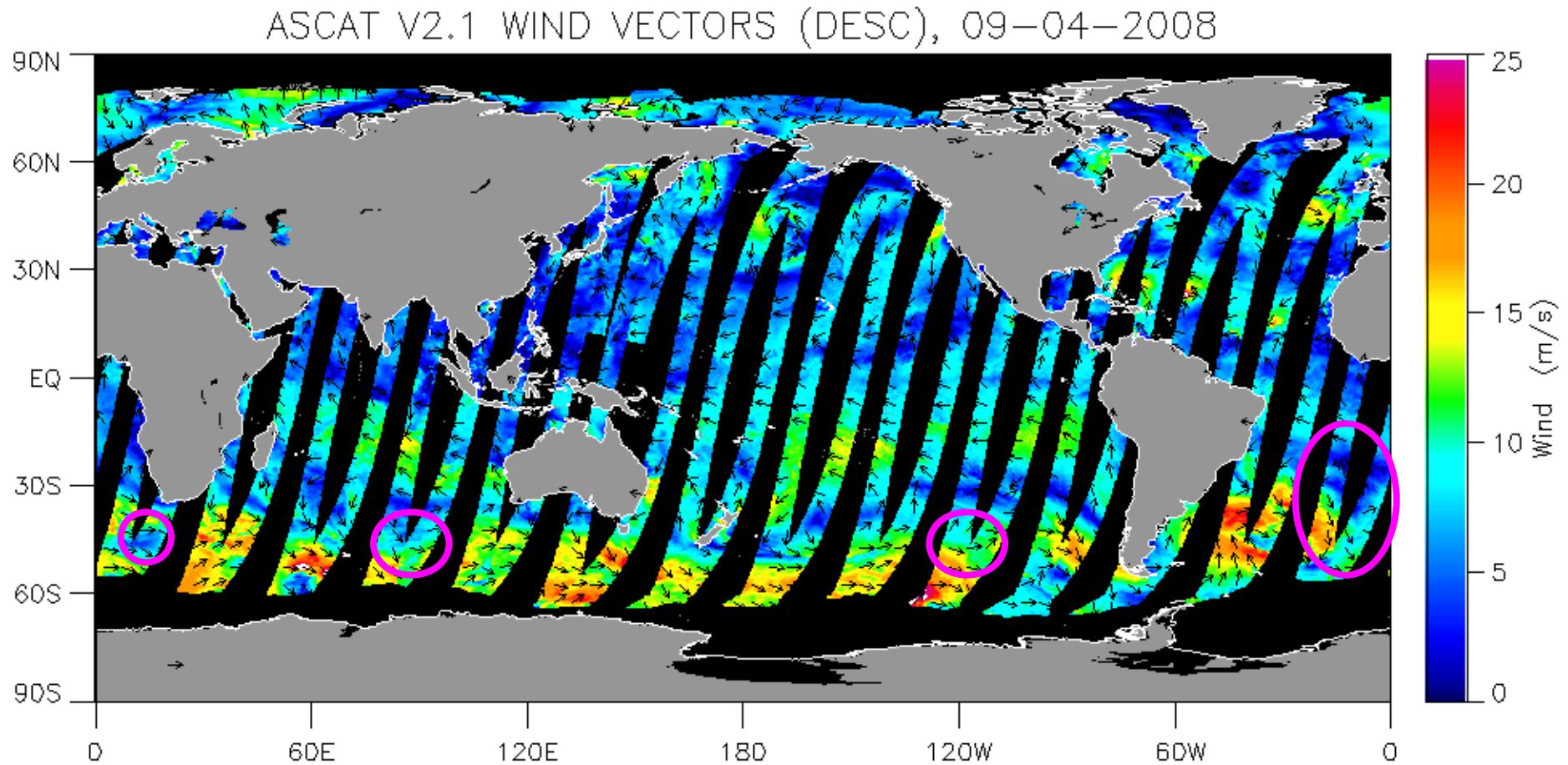
ASCAT–QSCAT V component difference 09–04–2008 DESC



Daily QSCAT Wind Vectors (6am)



Daily ASCAT Wind Vectors (9:30am)



The bias seem to be in regions where the storm is moving in, sharp gradients



Future plans:

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How do we extend the X-Cal forward

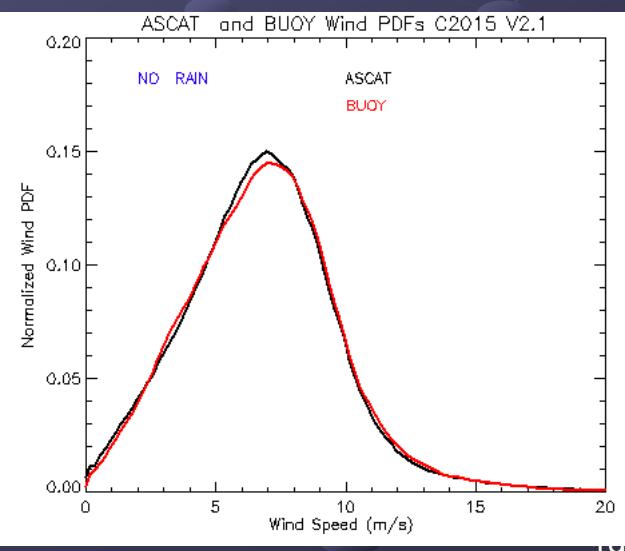
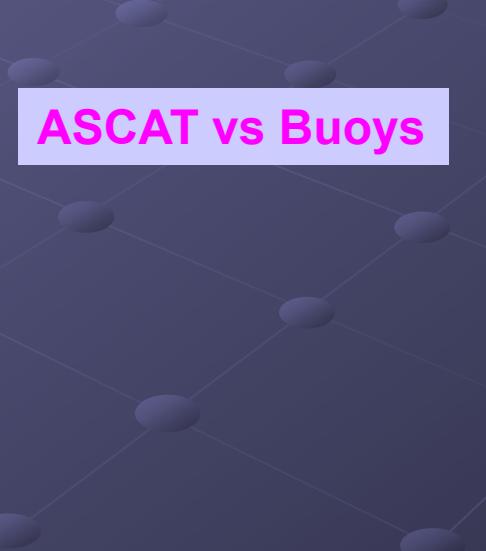
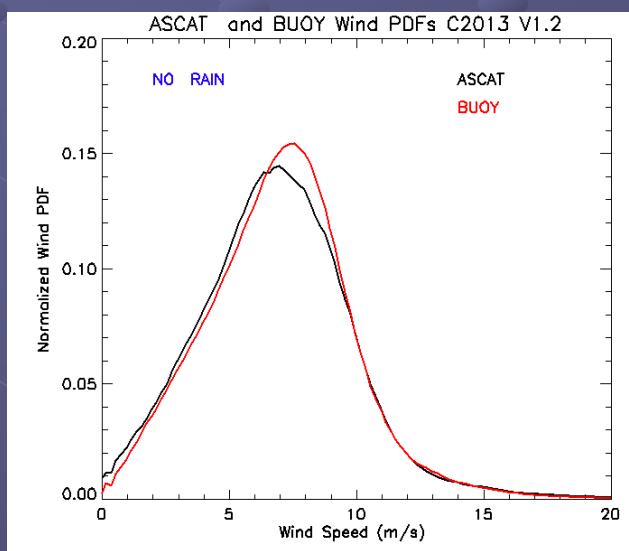
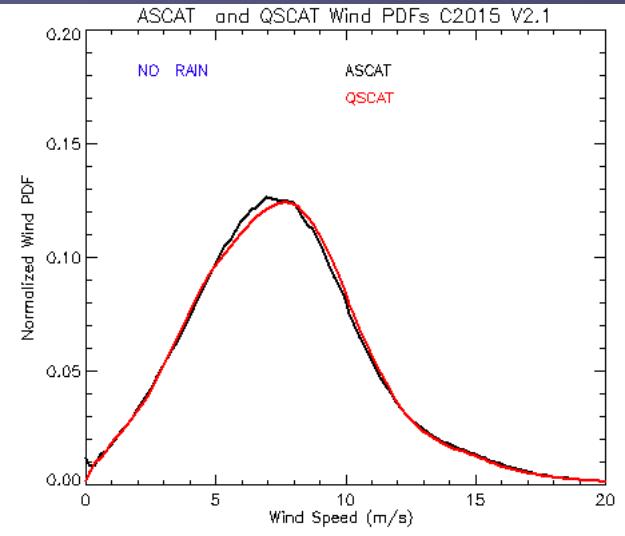
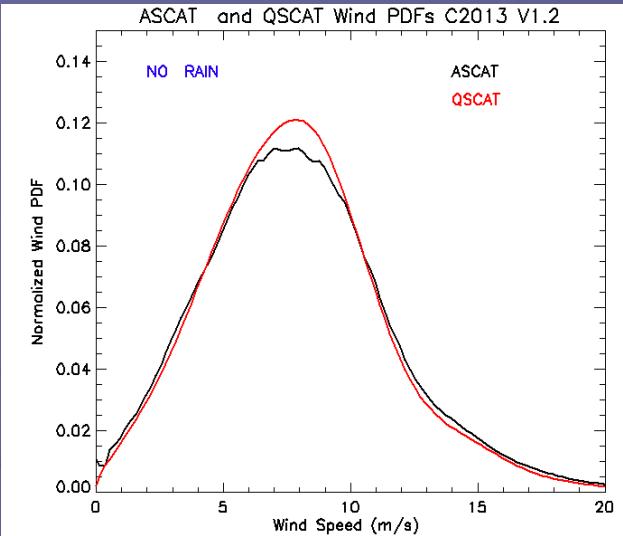
- Use non-sun-synchronous wind speed observations from stable sensor (GMI)
- RapidScat might not be stable enough for direct X-Cal of future sensors
- Use RapidScat indirectly to verify diurnal cycle of wind speed, and estimate diurnal cycle of components
- Use land C-band and Ku-band calibration as additional verification of stability of sensors (David Long, JPL group, KNMI, ...)
- In the very near future, we can still use non-spinning QuikSCAT for sigma0 calibration
- Use all these methods for calibration of Indian ScatSat

Extra slides

C-2013

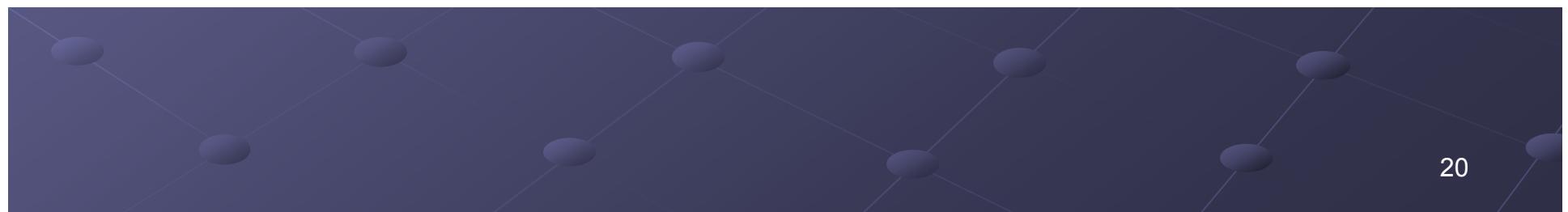
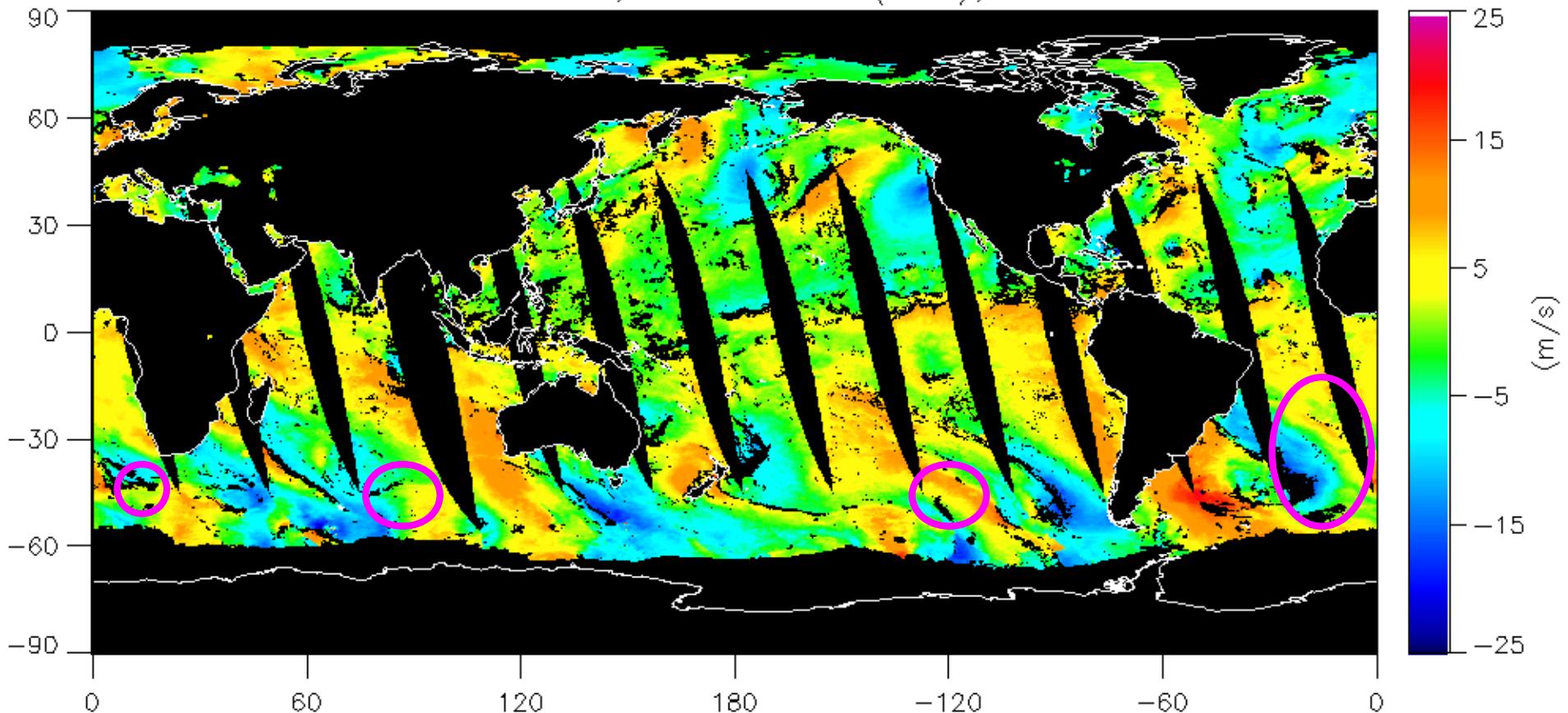


C-2015



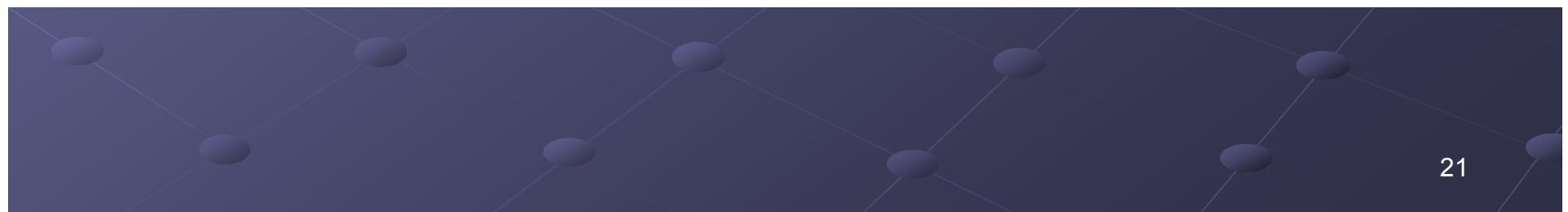
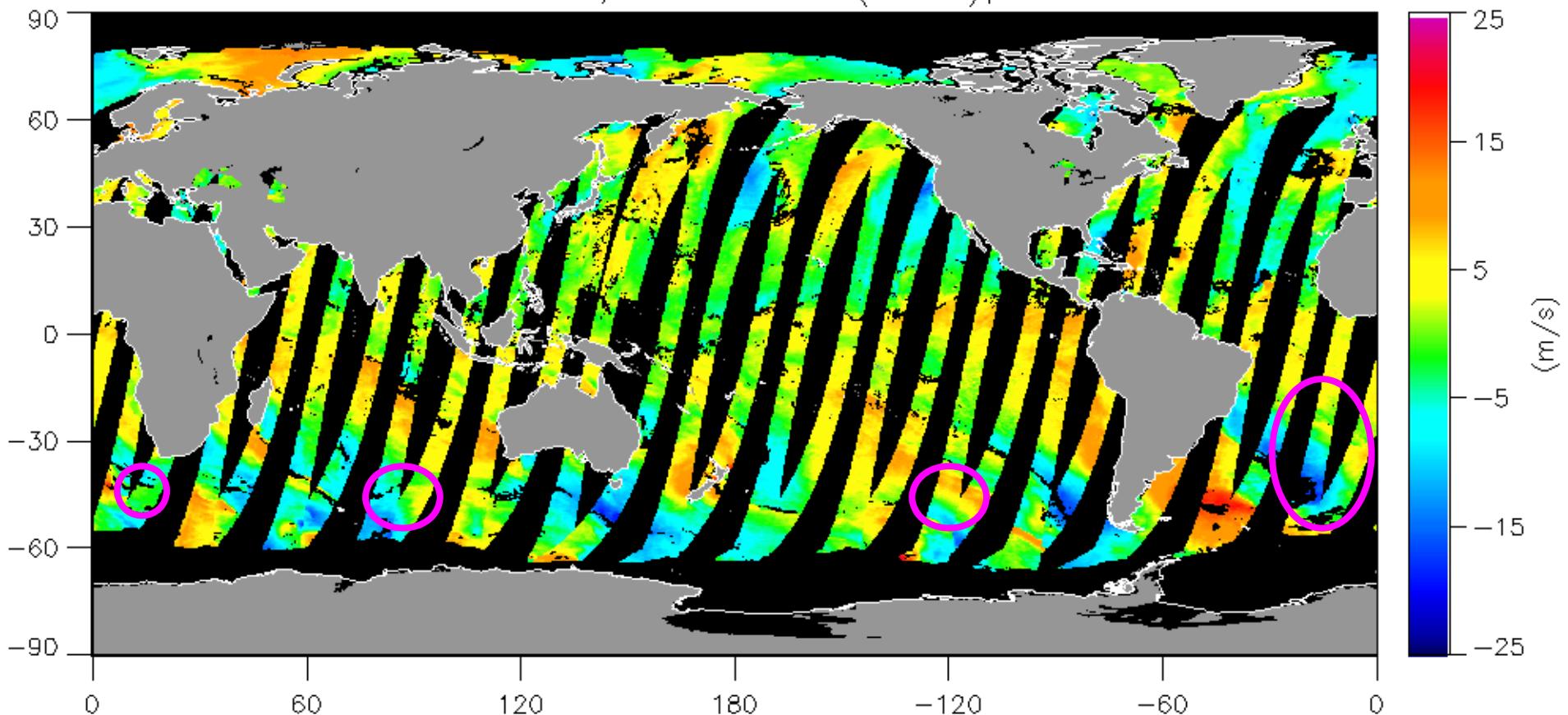
Daily QSCAT V (6am)

QSCAT V WIND SPEED, RAIN-FREE (ASC), 09-04-2008



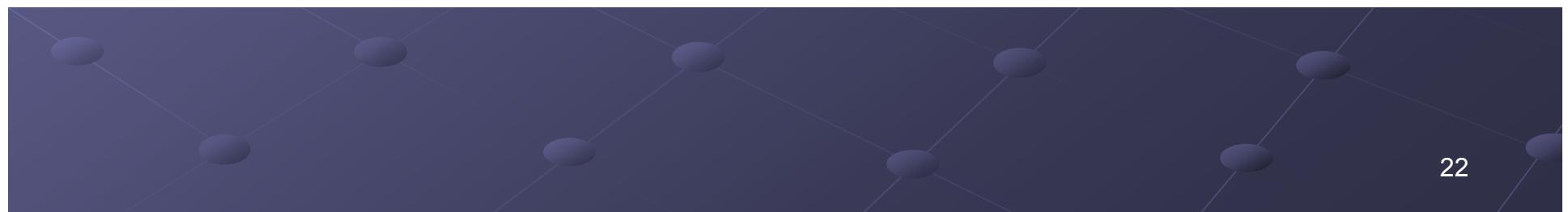
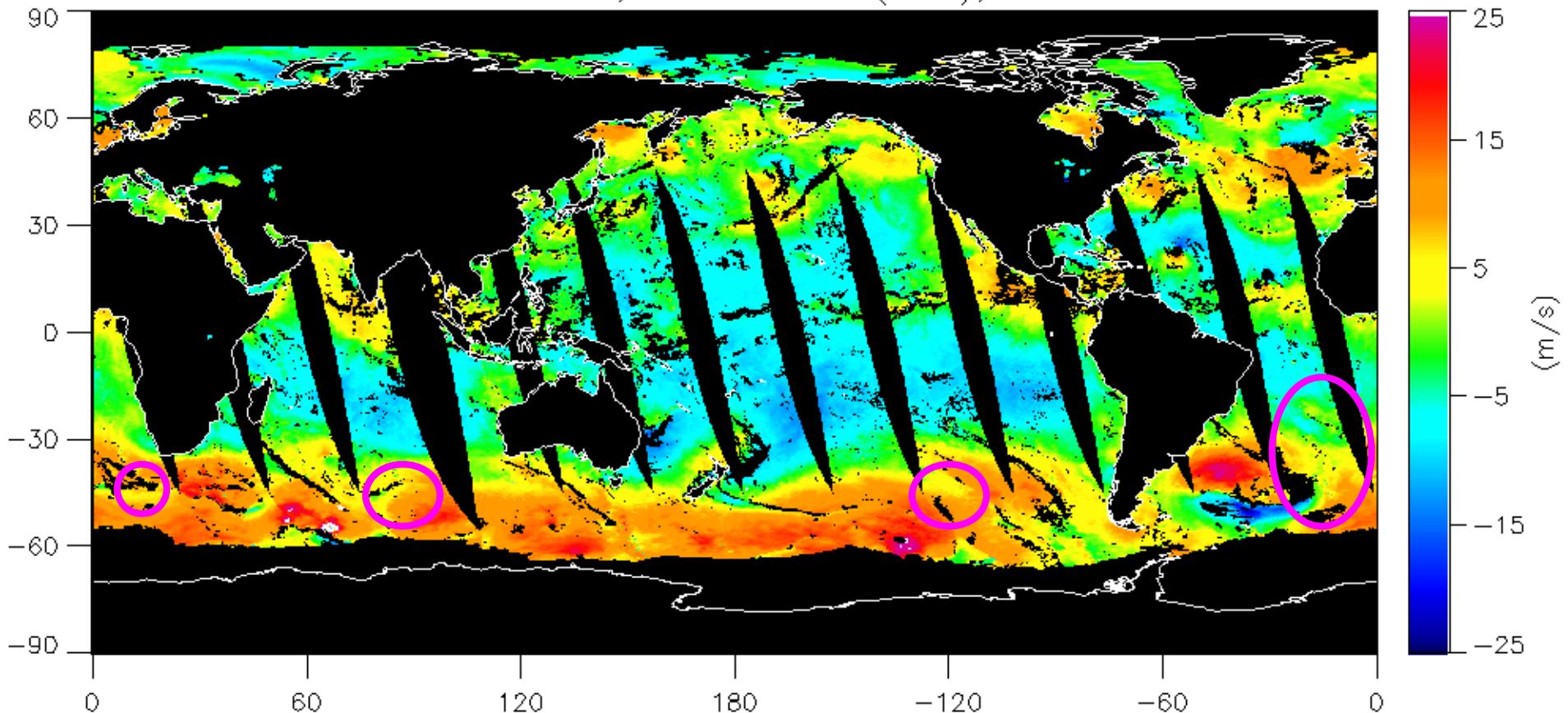
Daily ASCAT V (9:30am)

ASCAT V WIND SPEED, RAIN-FREE (DESC), 09-04-2008

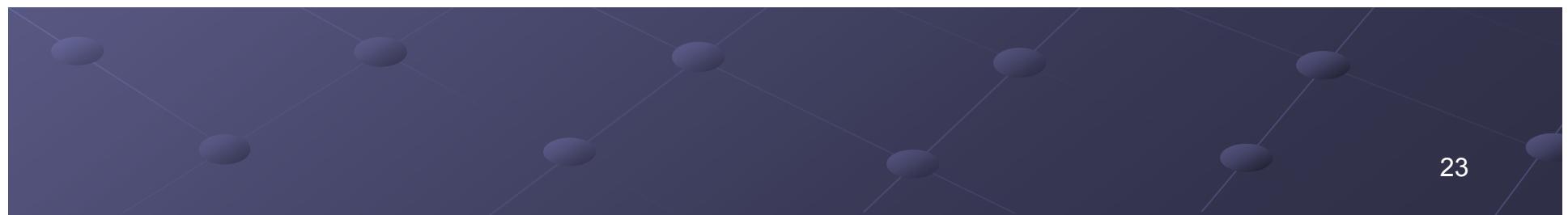
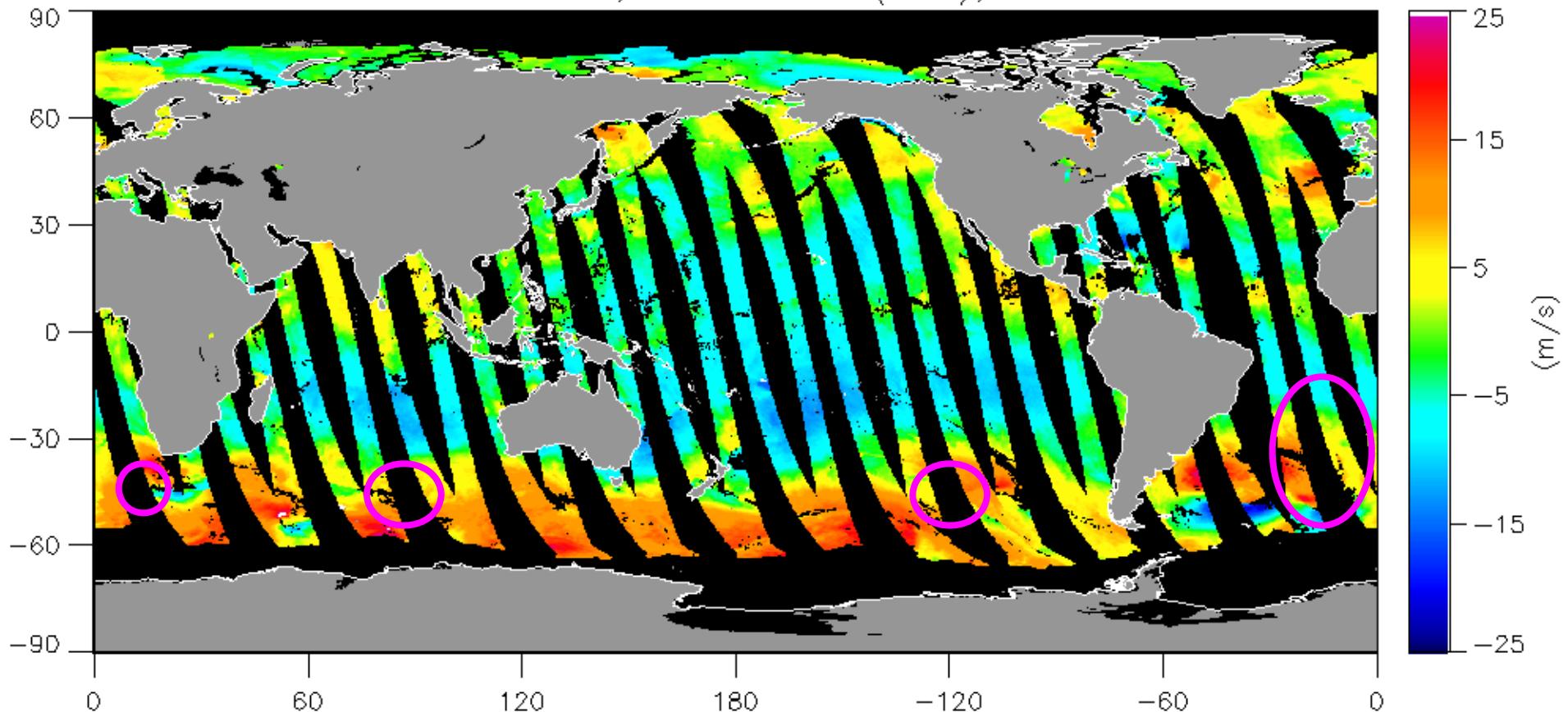


Daily QSCAT U (6am)

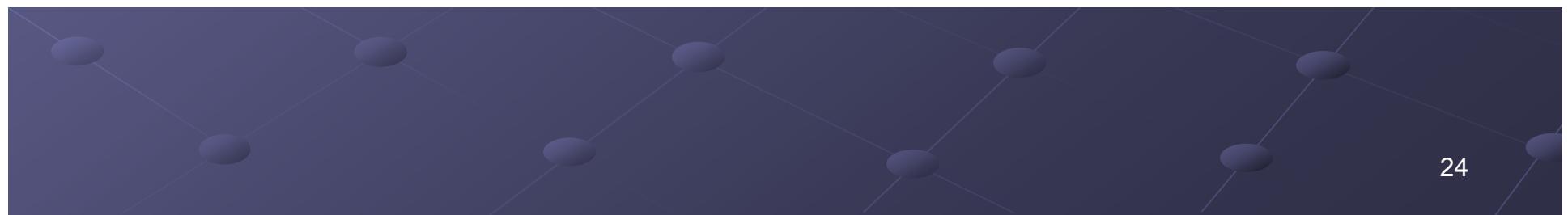
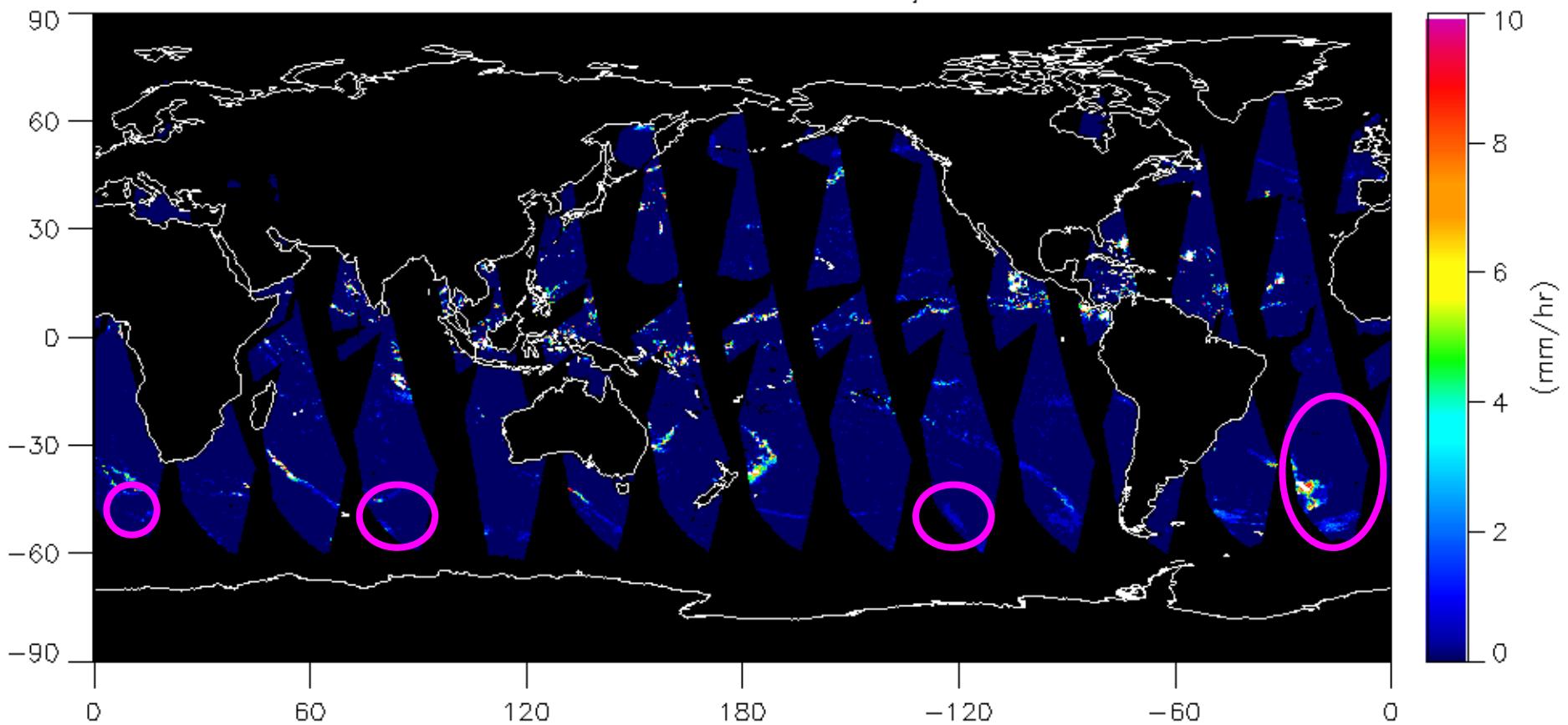
QSCAT U WIND SPEED, RAIN-FREE (ASC), 09-04-2008



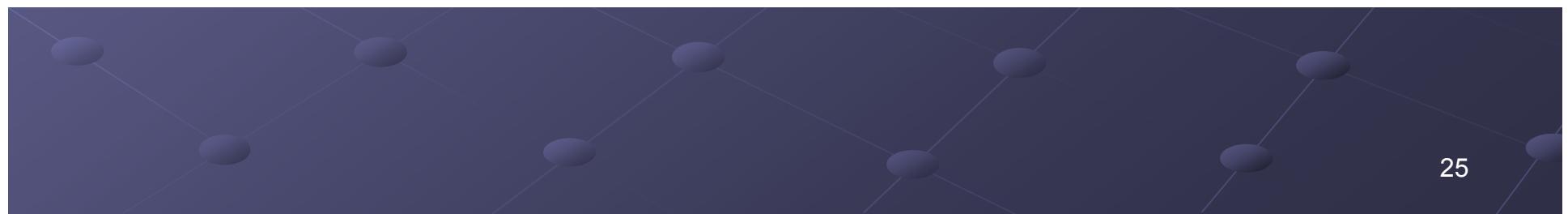
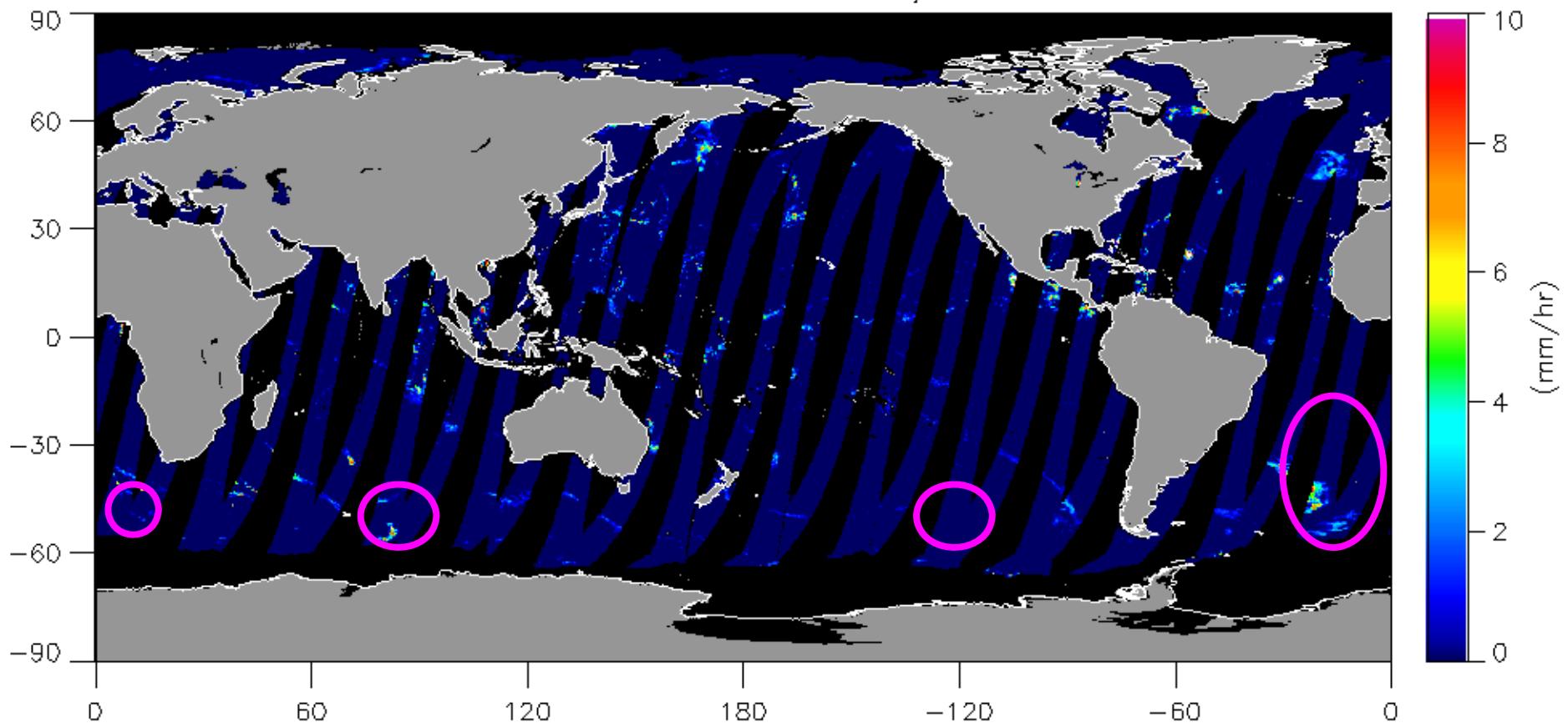
ASCAT U WIND SPEED, RAIN-FREE (ASC), 09-04-2008



RADIOMETER RAIN accumulation , 09-04-2008

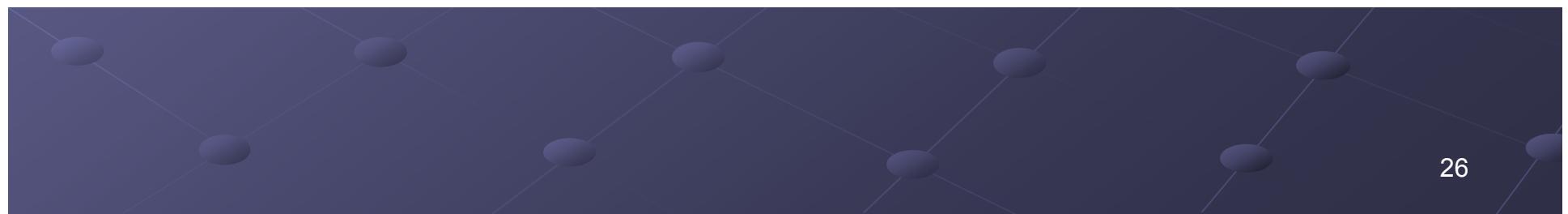
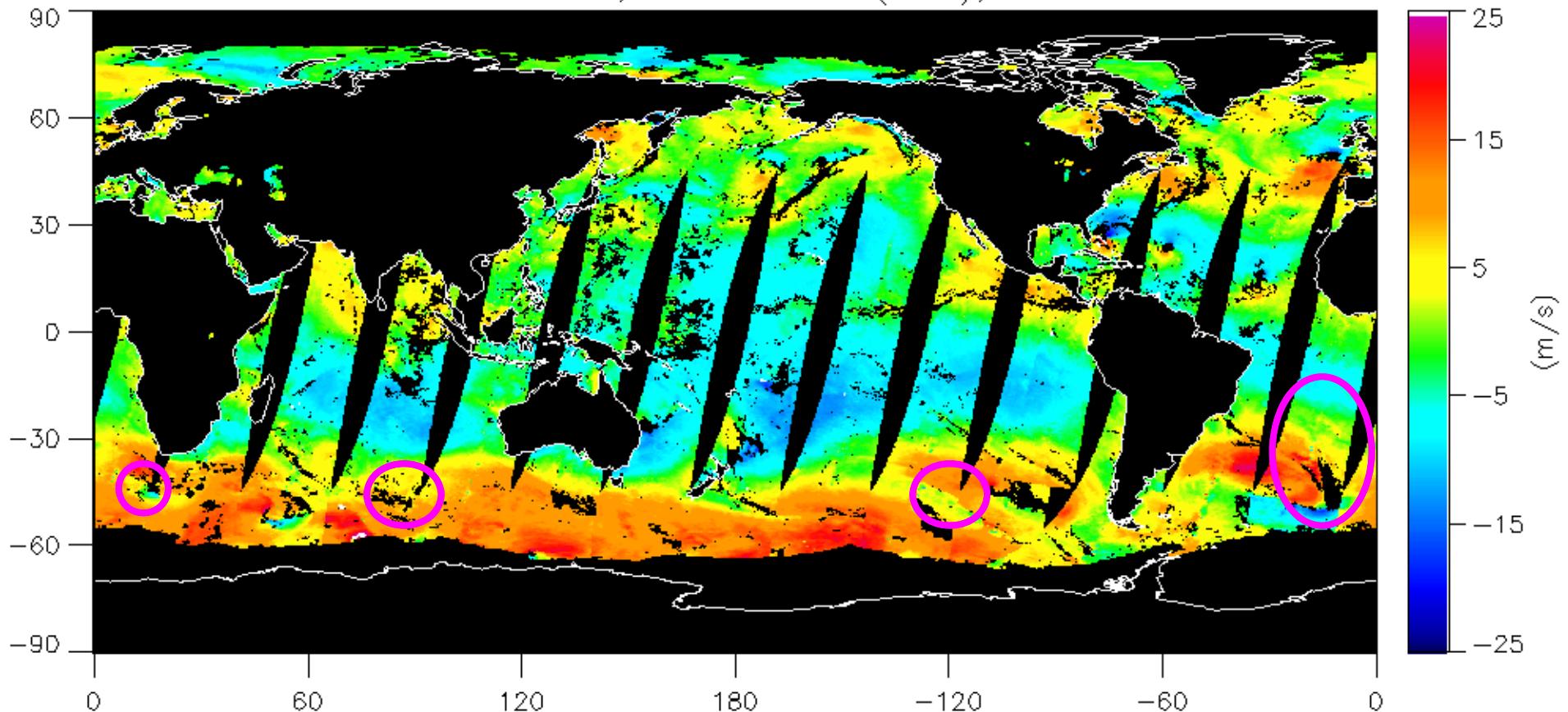


RADIOMETER RAIN accumulation , 09-04-2008

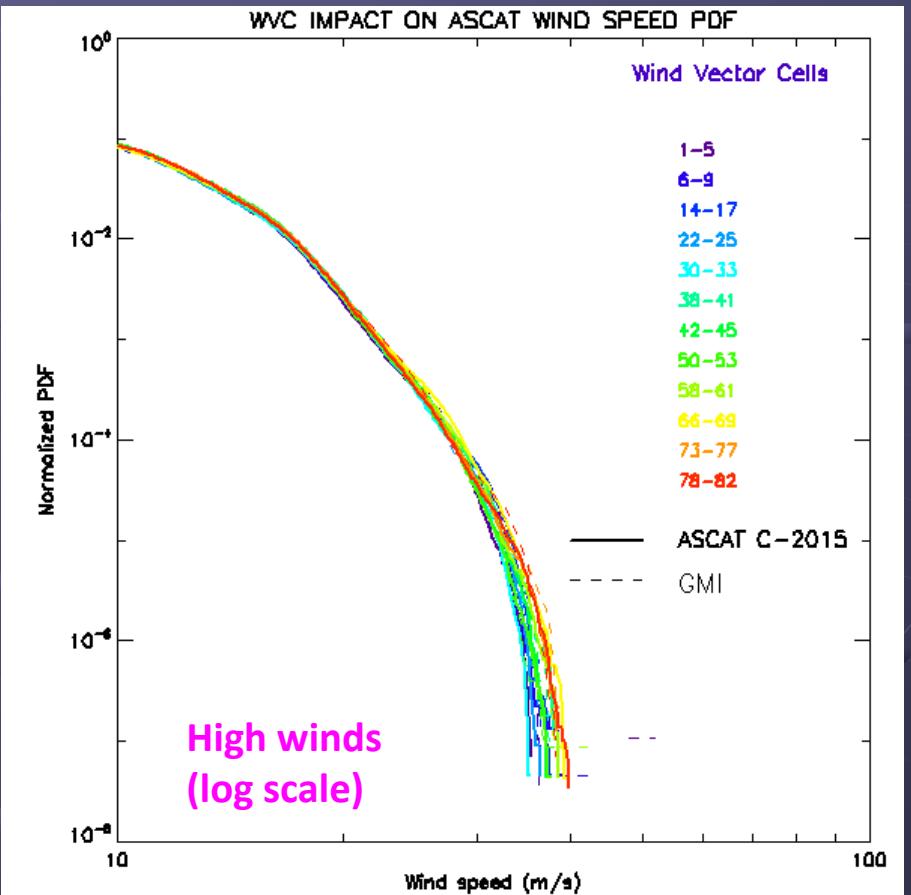
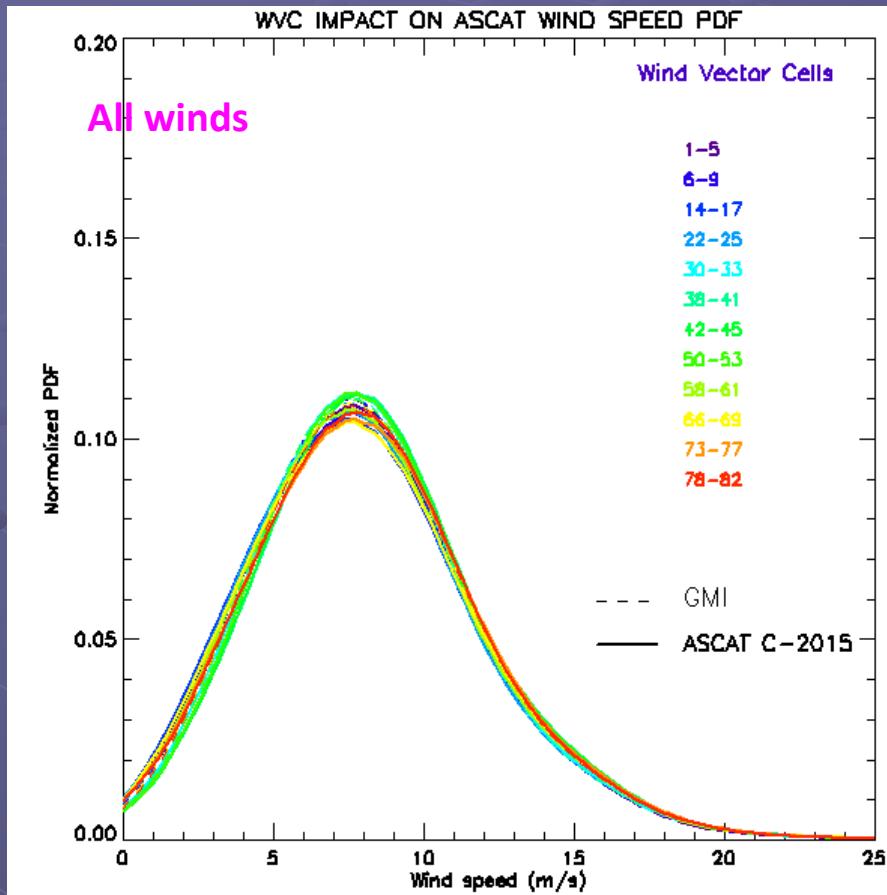


Daily QSCAT U (6pm)

QSCAT U WIND SPEED, RAIN-FREE (ASC), 09-04-2008



C-2015 alignment of PDFs vs colocated GMI



↑
20 m/s 40 m/s

