Climate Working Group

1. Inter-sensor comparisons (i.e, QuikScat, RapidScat, A-Scat, Passive MW) so offsets
    a. Sigma nought: land vs. ocean, how can we use land results
    b. Satellite-Inter calibration
    c. Separating diurnal variability from other potential problems

2. Impact of GMF on climate vector winds: consistency across platforms and frequencies
    a. Fundamental differences between C-band and Ku-Band
    b. How much can choice of GMF explain C-Ku band wind differences

3. Climate application of multiple-platform vector winds.
    a. Enhancing reanalysis products
    b. Climate change: Hadley Cell
    c. Equatorial zonal winds
    d. Evaluation of CMIP5 climate models
    e. Madden-Julian Oscillation

4. Extreme winds Workshop

Outcome: Suggestion of Modest Projects involving Team Collaboration on 1-2 year time scale.

1. Inter-sensor comparisons (i.e, QuikScat, RapidScat, A-Scat, Passive MW)

so offsets

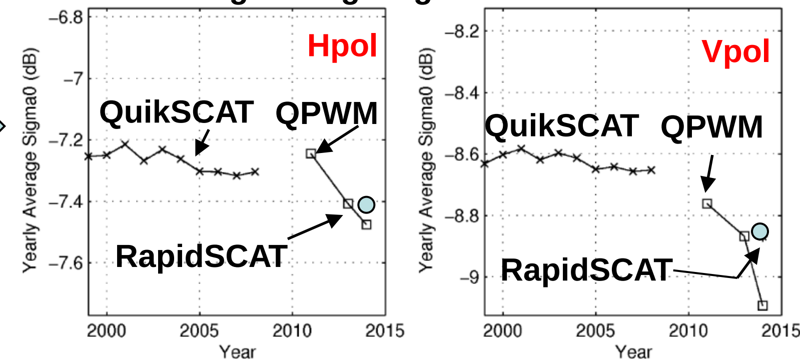
a. Sigma nought: land vs. ocean, how can we use land results
b. Satellite-Inter calibration
c. Separating diurnal variability from other potential problem

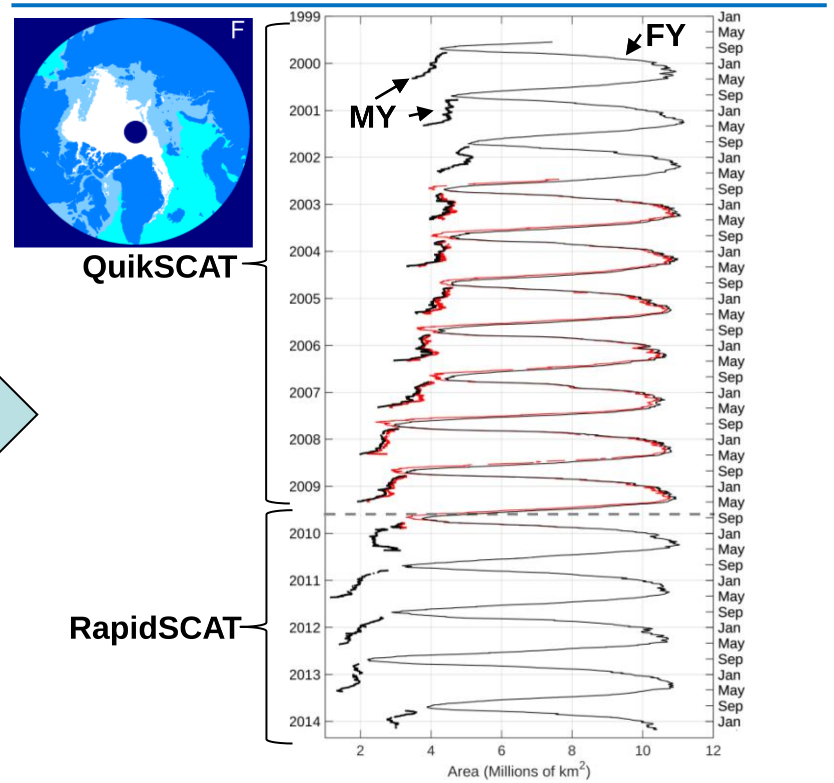
Scatterometers as Land & Ice Climate Observation Sensors (BYU)
David Long

- Long time series of Ku- and C-band surface backscatter
  - Scatterometer Climate Record Pathfinder (SCP) generating high resolution backscatter maps on consistent grids for all sensors
  - Have made significant progress in incidence angle, azimuth angle, and local time-of-day corrections to facilitate sensor cross-calibration

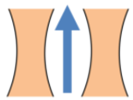
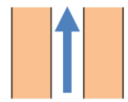
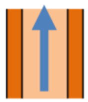
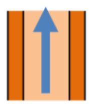
- Ku-band scatterometer measurements useful for **discriminating First-year (FY) and Multi-year (MY) ice**
  - Together QuikSCAT and OSCAT yield a 1.5 decade long time series of FY/MY sea ice maps

Year-long average sigma0s after correction





Ku-band Scatterometers

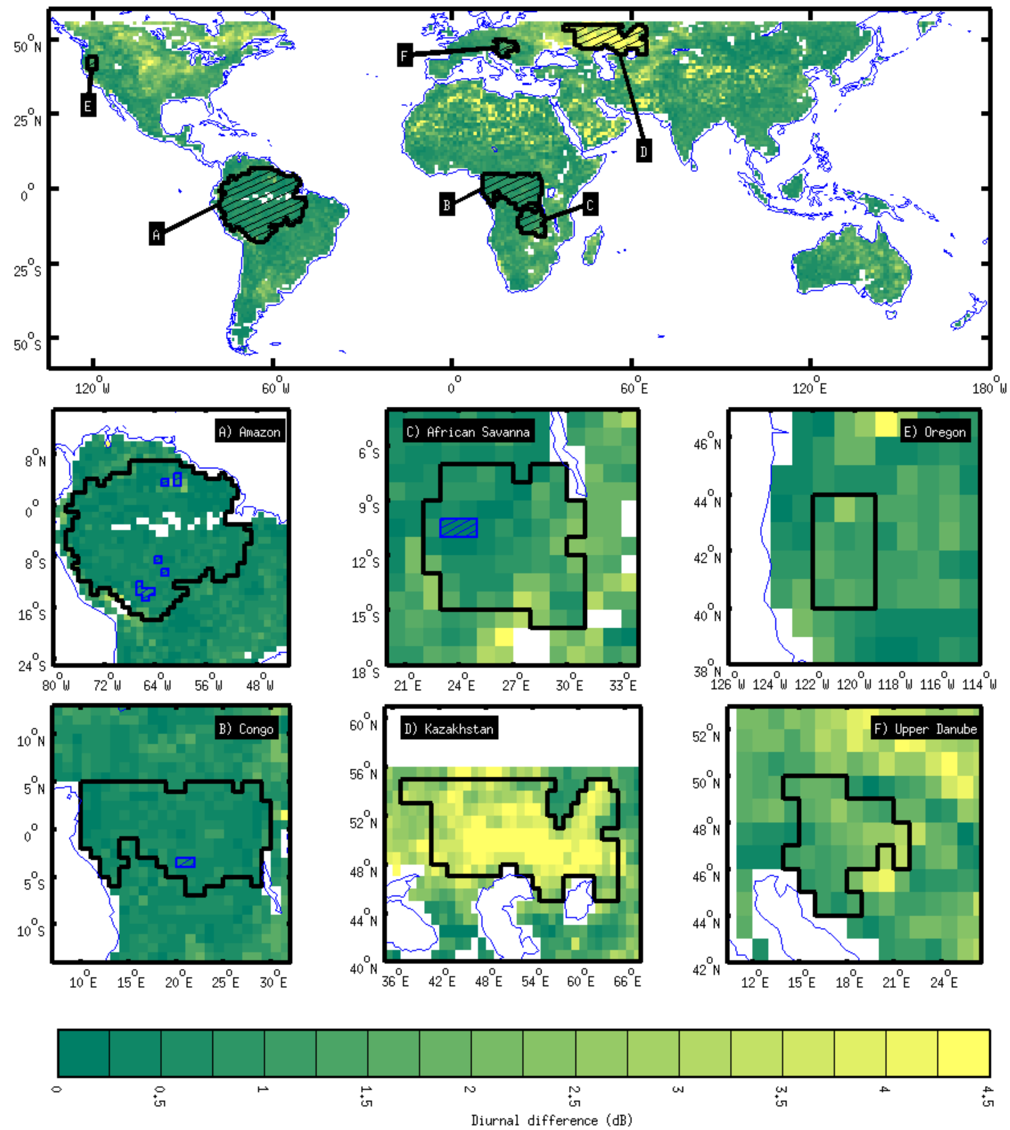
	SASS	NSCAT	SeaWinds	SeaWinds	OSCAT	HY-2A	RapidSCAT
Frequency (Ku-band)	14.6 GHz	13.995 GHz	13.6 GHz	13.6 GHz	13.6 GHz	13.256 GHz	13.6 GHz
Antenna azimuths							
Polarizations	VV and HH	VV and HH	VV-outer HH-inner	VV-outer HH-inner	VV-outer HH-inner	VV-outer HH-inner	VV-outer HH-inner
Beam resolution	Fixed Doppler	Variable Doppler	Pencil-beam	Pencil-beam	Pencil-beam	Pencil-beam	Pencil-beam
Resolution (σ^0)	Normally 50 km	25 km	Egg: 25x36 km Slice: 6x25 km	Egg: 25x36 km Slice: 6x25 km	Egg: 30x68 km Slice: 5x30 km	Outer beam 37 x 26 km Inner beam 33 x 23 km	Egg: 26x37 km Slice:8x26 km
Swath (km)	 ~750 ~750	 600 600	 1400, 1800	 1400, 1800	 1400, 1836	 1350, 1700	 900, 1100
Incidence angles	0° - 70°	12° - 60°	46° & 54.4°	46° & 54.4°	49° & 57°	41.36° & 48.44°	49° & 56°
Daily coverage	Variable	78%	92%	92%	>90%	90%	65% between 58°N and 58°S
Mission & Dates	SeaSat 6/1978-10/1978	ADEOS-I 8/1996 - 6/1997	QuikSCAT 6/1999 - 11/2009	ADEOS II 1/2002 - 10/2002	OceanSat-2 10/2009 -2/2015	8/2011 -	International Space Station 10/2014 -
Orbit type	Sun-synchronous	Sun-synchronous	Sun-synchronous	Sun-synchronous	Sun-synchronous	Sun-synchronous	Non sun-synchronous
Ascending equatorial crossing local time	6:00 AM & 12:00 PM	6:30 AM	6:00 AM	10:30 PM	12:00 AM	6:00 PM	Various
Orbit inclination	108°	98.616°	98.6°	98.62°	98.28°	99.3°	51.65°
Altitude (nominal)	805 km	803 km	800 km	802.9 km	720 km	970 km	375 – 435 km
Period	100.7 min	101 min	101 min	101 min	99.31 min	104.45 min	92.69 min

BYU D. Long and A. Paget

RapidSCAT Diurnal Observations of sigma-0 over Land (BYU)

- Past Ku-band scatterometers have measured sigma-0 at different local times-of-day (LTOD)
  - Over land sigma-0 varies with LTOD

- The ISS orbit enables RapidScat to observe the variation of sigma-0 with the diurnal cycle
  - Enables cross-calibration of the various Ku-band scatterometers



Remote Sensing Systems
www.remss.com

Bringing Consistency Among Scatterometer Winds Using Radiometer Observations

Lucrezia Ricciardulli, Frank Wentz and Thomas Meissner

Remote Sensing Systems, Santa Rosa, California

Acknowledgements

- Supported by OVWST, NASA Physical Oceanography, and RapidScat Cal/Val and Science Team.
- Thanks to JPL group (E. Rodriguez et al.)

IOVWST meeting
Portland, Oregon, USA, 2015

Summary:

We described our efforts towards intercalibrating L-band, C-band, and Ku-band scatterometers using MW radiometer winds

Main results:

- Scatterometer winds are consistent within 0.1 m/s
- Consistency valid at all wind speeds
- New ASCAT GMF C2015 coming soon
- L-band winds are good → potential for SMAP
- RapidScat is very good, in line with all others
- Non-sun-synchronous TMI, GMI, RapidScat very useful to check consistency among sensors at different times of day
- Synergy Radiometers ←→ Scatterometers

OVW Climate Data Record using Radiometer winds for Cross-Calibrations

Completed (all available at www.remss.com):

- QuikSCAT (full mission 1999-2009)
- ASCAT (2007-2015)
- WindSat (polarimetric radiometer, 2003-current) OVWs (all-weather).
- Aquarius L-band winds (2011-current)
- RapidScat (processed @ JPL, with GMF consistent with QSCAT et al.)

Validation (global, regional, and daily monitoring):

- Extensive on-going cross-validation of all scatterometers/radiometers
- Global Wind Speed bias < 0.1 m/s, St. Dev < 1 m/s;
- Global Direction St Dev ~ 10 deg (7-30 m/s); higher for low wind speeds.

Work-in-progress and Future Plans

- C-band: ASCAT new GMF C-2015 coming soon, reprocess all; process ERS-1 (1991-2000) using C-2015
- Ku-band: NSCAT (1996-1997) will be reprocessed; OSCAT (?)
- L-band: SMAP ocean vector winds

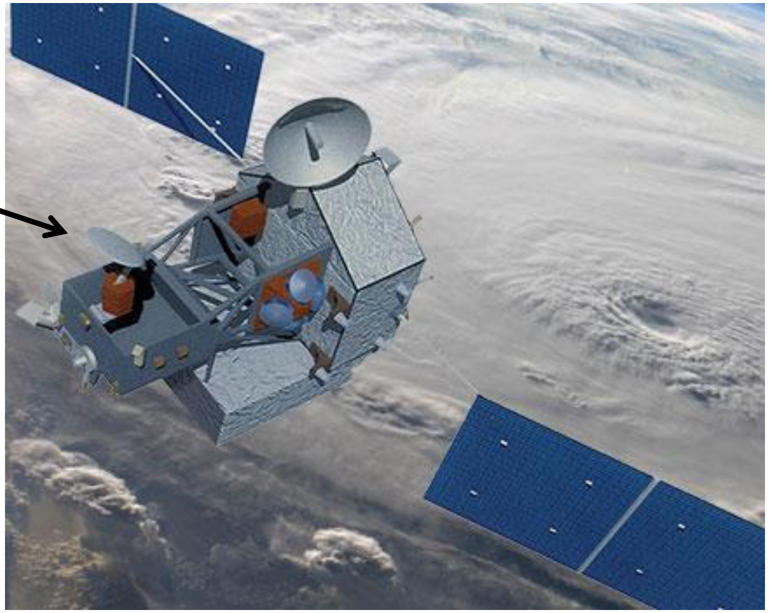
Remote Sensing Systems
www.remss.com

A 17-Year Climate Record of Diurnal Winds Derived from the TRMM Microwave Imager

Frank Wentz and Lucrezia Ricciardulli

Remote Sensing Systems

TMI



1997-2015 R.I.P.

IOVWST Annual Meeting
Portland, Oregon
May 19-21, 2015

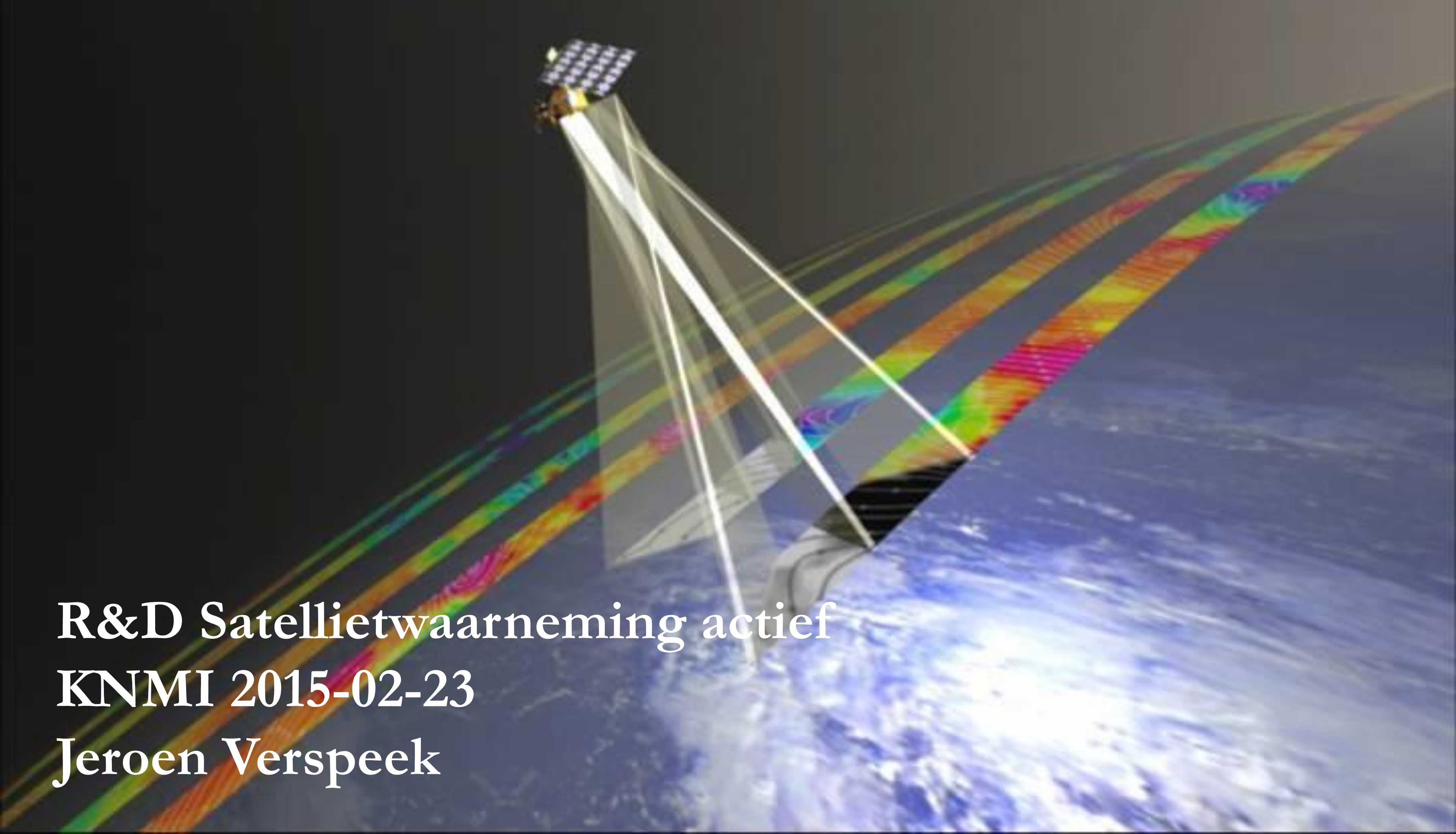
Summary and Conclusions

- RSS OVW Climate Records are tied to satellite MW radiometers wind speeds
- TMI is a very dependable and useful backbone the for satellite MW radiometers
- TMI winds are unbiased relative to buoys up to 15 m/s.
- Stability appears to be better than 0.1 m/s over 17 Years
- TMI samples the complete 24-hour diurnal cycle every 40 days
- Diurnal information on SST, Wind, Vapor, Cloud, and Rain
- TMI Directly Observes our changing climate from 1997 to 2015 at a very high precession

2. Impact of GMF on climate vector winds: consistency across platforms and frequencies

   a. **Fundamental differences between C-band and Ku-Band**
   b. **How much can choice of GMF explain C-Ku band wind differences**

Geophysical Modelling at RSS and KNMI

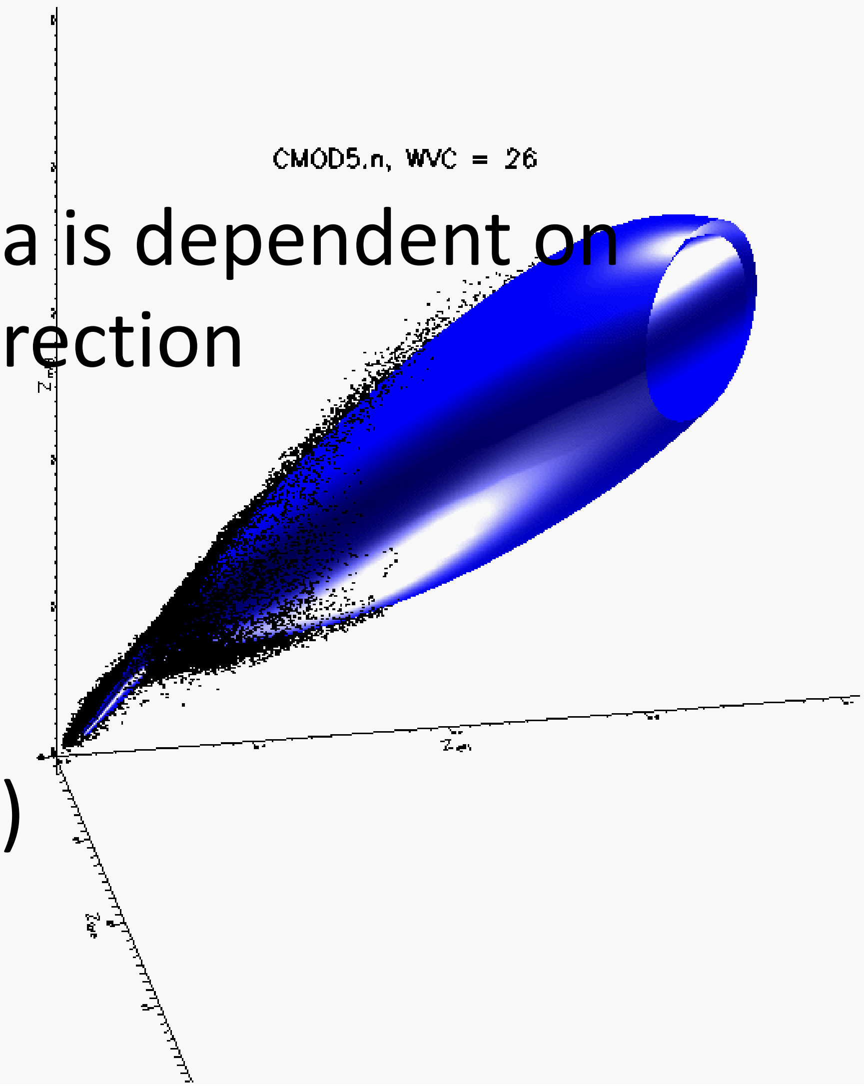


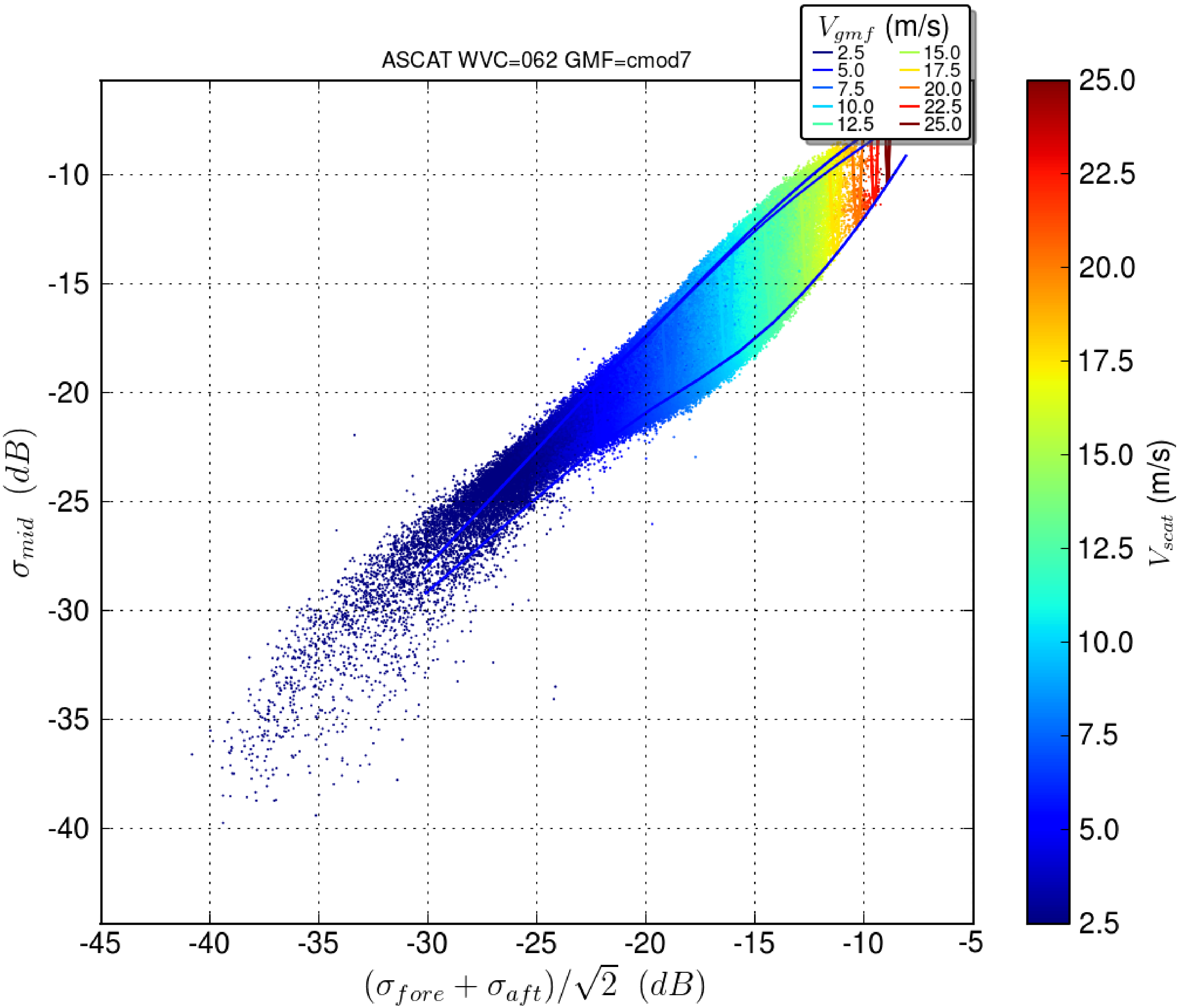
R&D Satellietwaarneming actief
KNMI 2015-02-23
Jeroen Verspeek

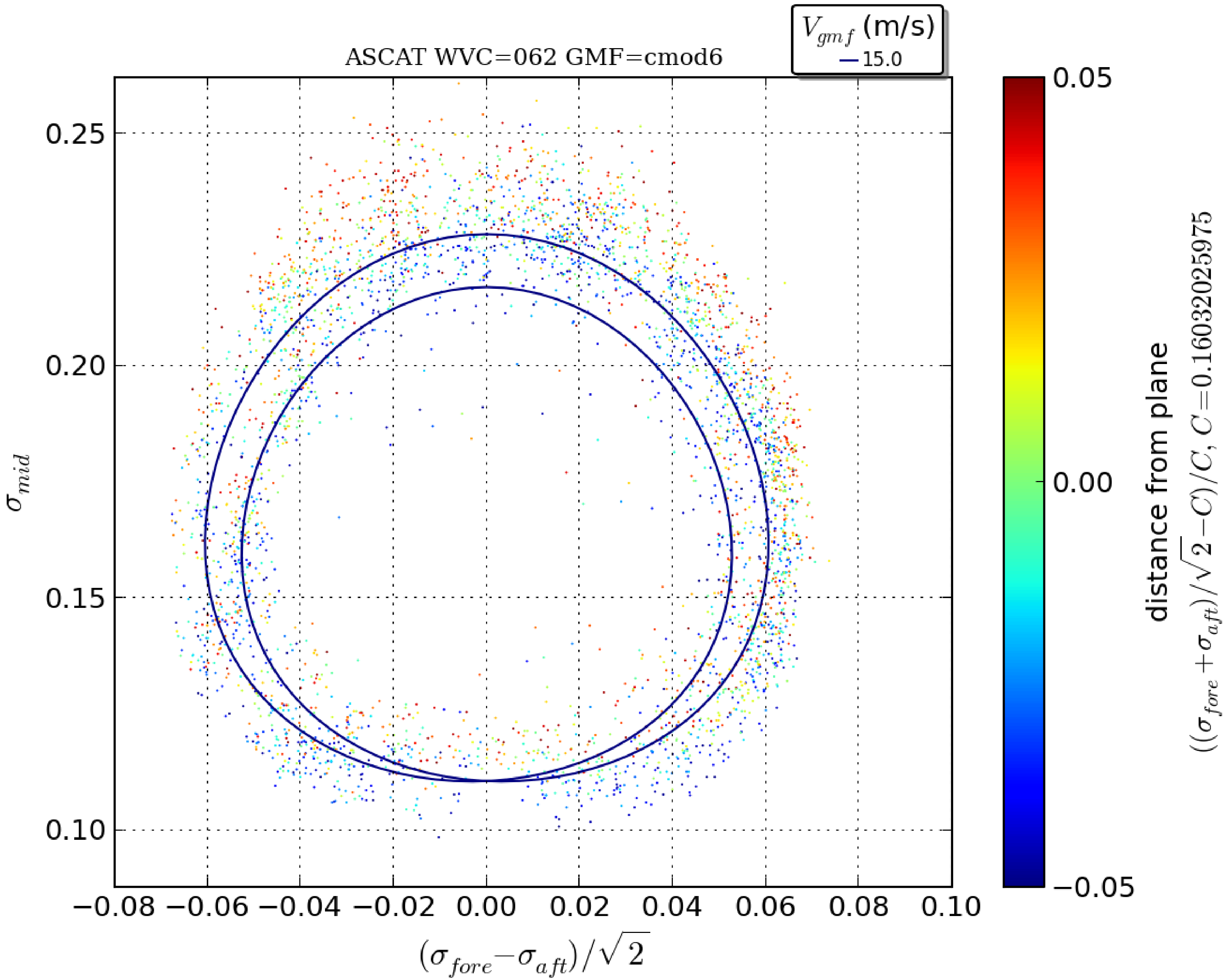
Measurement space

- Backscatter σ^0 above sea is dependent on wind speed and wind direction
- $\sigma^0 = \mathrm{GMF}(V, \theta, \phi)$
- Representation in 3D-measurement space

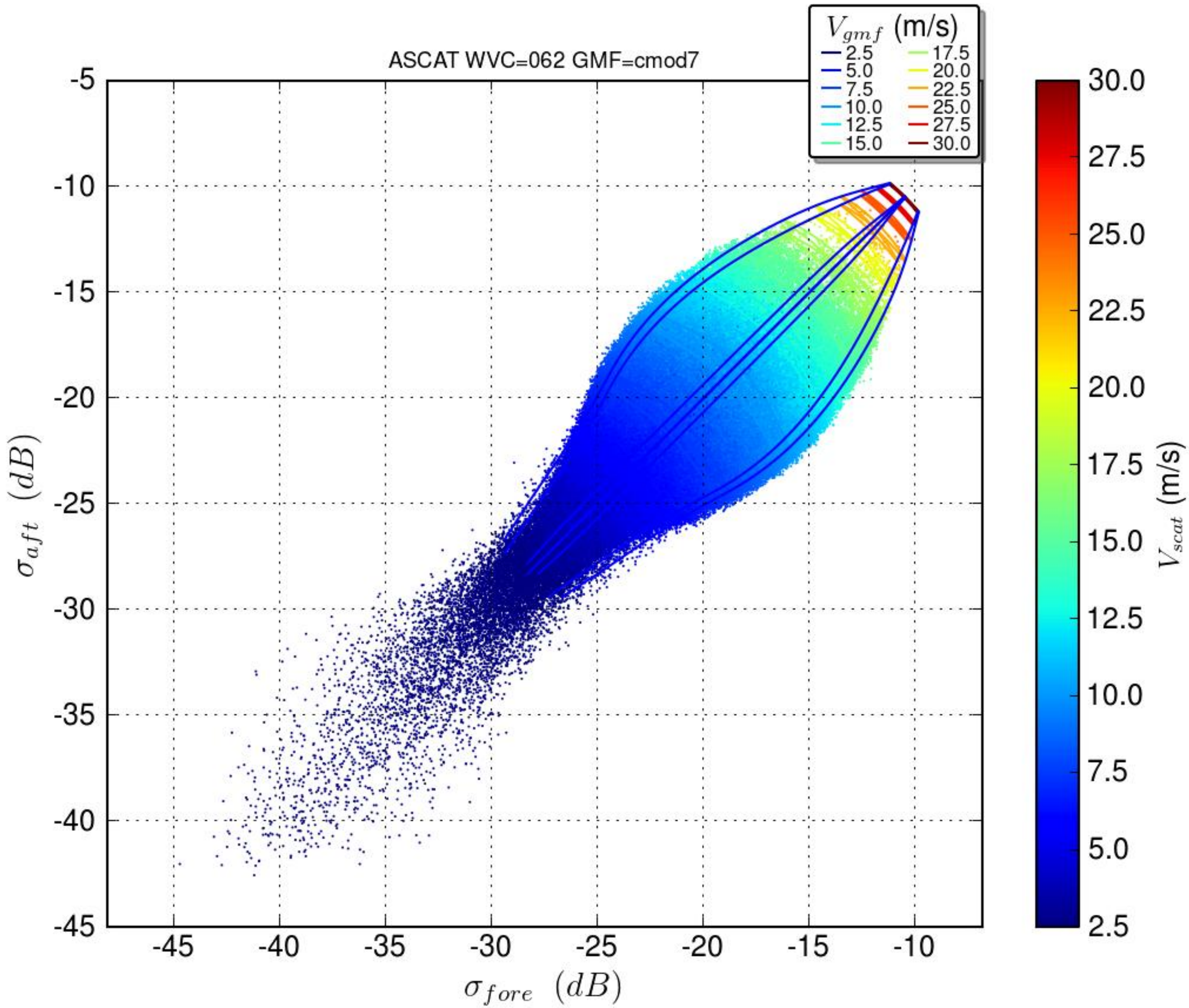
$(x, y, z)=(\sigma^0_{\mathrm{fore}}, \sigma^0_{\mathrm{aft}}, \sigma^0_{\mathrm{mid}})$




ASCAT WVC=062 GMF=cmod7
V_{gmf} (m/s)
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
σ_{mid} (dB)
$(\sigma_{fore} + \sigma_{aft})/\sqrt{2}$ (dB)
V_{scat} (m/s)
-10
-15
-20
-25
-30
-35
-40
-45
-5
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5



ASCAT WVC=062 GMF=cmod6
V_{gmf} (m/s)
15.0
0.25
0.20
0.15
0.10
−0.08 −0.06 −0.04 −0.02 0.00 0.02 0.04 0.06 0.08 0.10
σ_{mid}
$(\sigma_{fore} - \sigma_{aft})/\sqrt{2}$
0.05
0.00
−0.05
distance from plane
$((\sigma_{fore} + \sigma_{aft})/\sqrt{2} - C)/C$, $C = 0.16032025975$


ASCAT WVC=062 GMF=cmod7
V_{gmf} (m/s)
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
27.5
30.0
σ_{aft} (dB)
σ_{fore} (dB)
V_{scat} (m/s)
-5
-10
-15
-20
-25
-30
-35
-40
-45
-45
-40
-35
-30
-25
-20
-15
-10
30.0
27.5
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5

Conclusions

- C2013 provided by RSS and CMOD6 by KNMI
- C2013 is strongly biased for winds > 15 m/s with respect to ECMWF and buoy winds → need consolidation of extremes
- C2013 shows improved winds for V < 5 m/s
- CMOD7 uses CMOD6 for V >= 7 m/s and mix of CMOD6 and C2013 for V < 7 m/s
- Interpolation between C2013 and CMOD6 works well
- Wind statistics of CMOD7 are best
- Interpolation function is being tuned

Ernesto Tand Ads talks Suggests some fundamental differece between Ku and C-band.

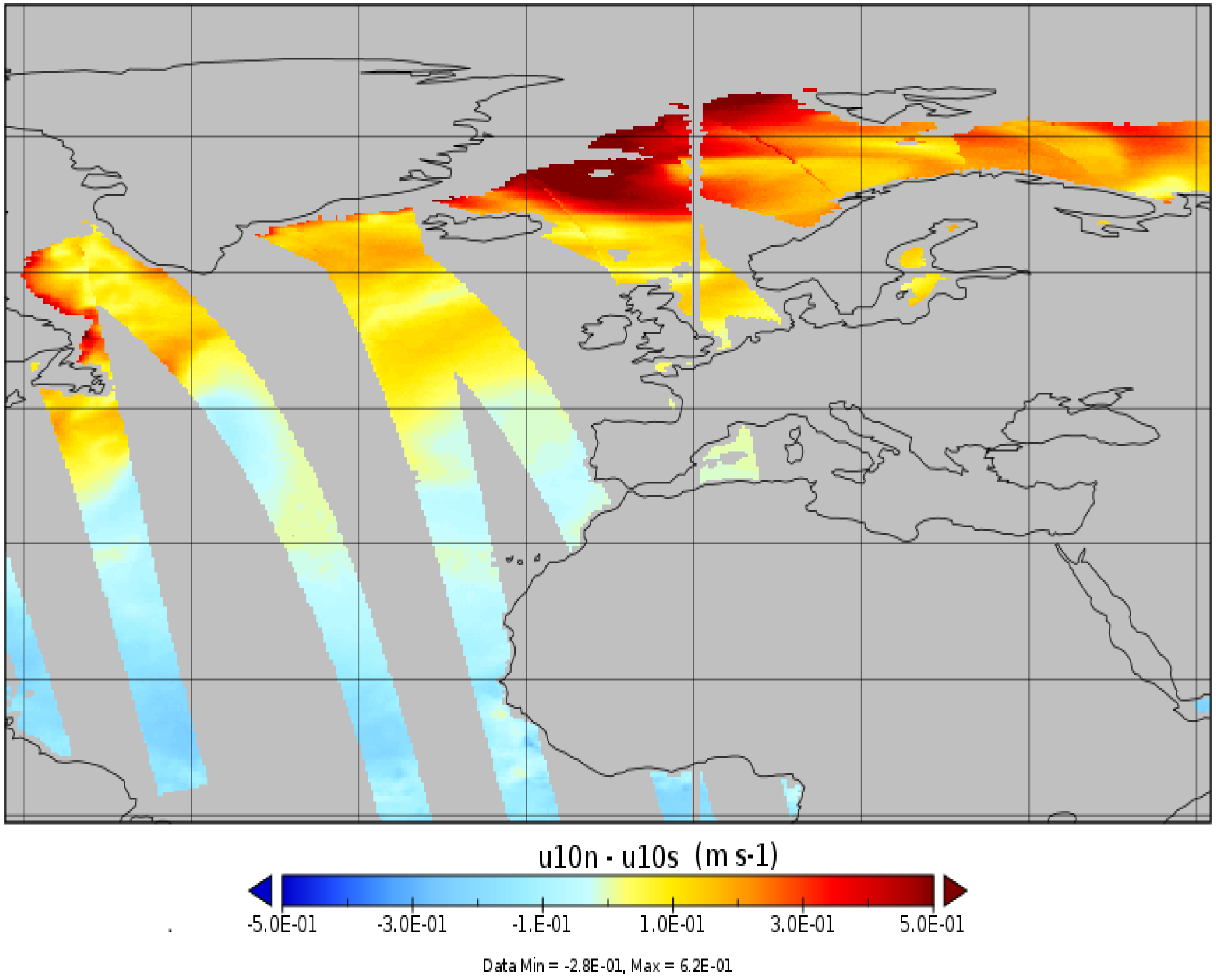
Latitude Plots of Ku minus C-band winds difference.

Stress-equivalent Winds, U10S

Equivalent neutral winds, $\boldsymbol{u}_{10\mathrm{N}}$, depend only on $\boldsymbol{u}_{*}$, surface roughness and the presence of ocean currents and were used for backscatter geophysical model functions (GMFs)

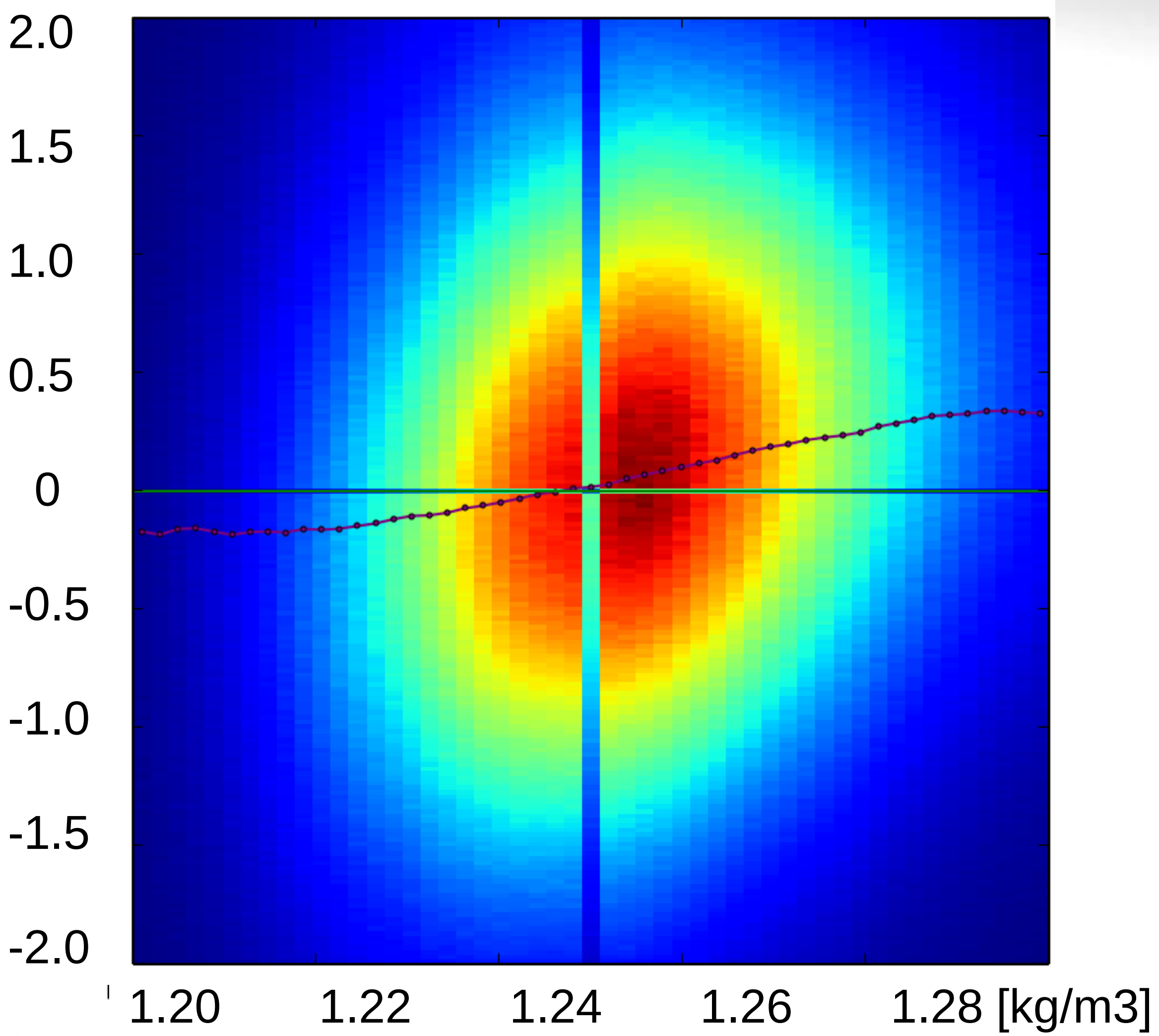
Stress-equivalent wind, $\boldsymbol{u}_{10\mathrm{S}} = \sqrt{\rho_{air}} \cdot \boldsymbol{u}_{10\mathrm{N}} / \sqrt{\rho_{ref}}$ is a better input for backscatter GMFs

Implemented in MyO FO v5 and under evaluation in the IOVWST



ASCAT U10S minus ECMWF U10N

- 2012
- Above 45 latitude
- Clear correlation of ASCAT U10N with air mass density
- Not in tropics!



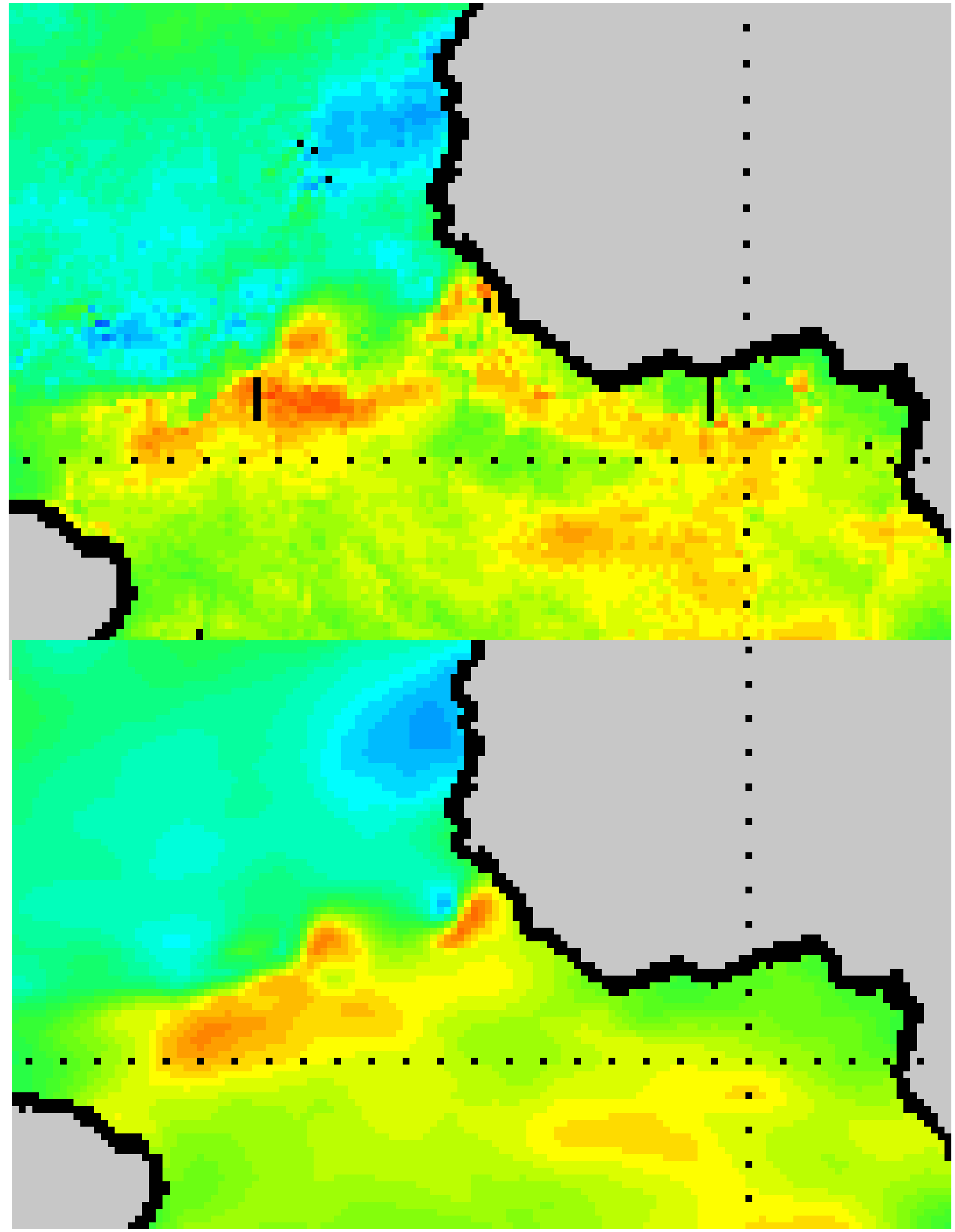
3. Climate application of multiple-platform vector winds.

- **a. Enhancing reanalysis products**
- **b. Climate change: Hadley Cell**
- **c. Equatorial zonal winds**
- **d. Evaluation of CMIP5 climate models**
- **e. Madden-Julian**

ERA* Details

- ERA*(top) shows a clear meridional wind effect south of the African coast and another effect south of the equator
- Moist convection?
- Needs further spatial and temporal analysis
- Test implications for curl and divergence

Ana trindade



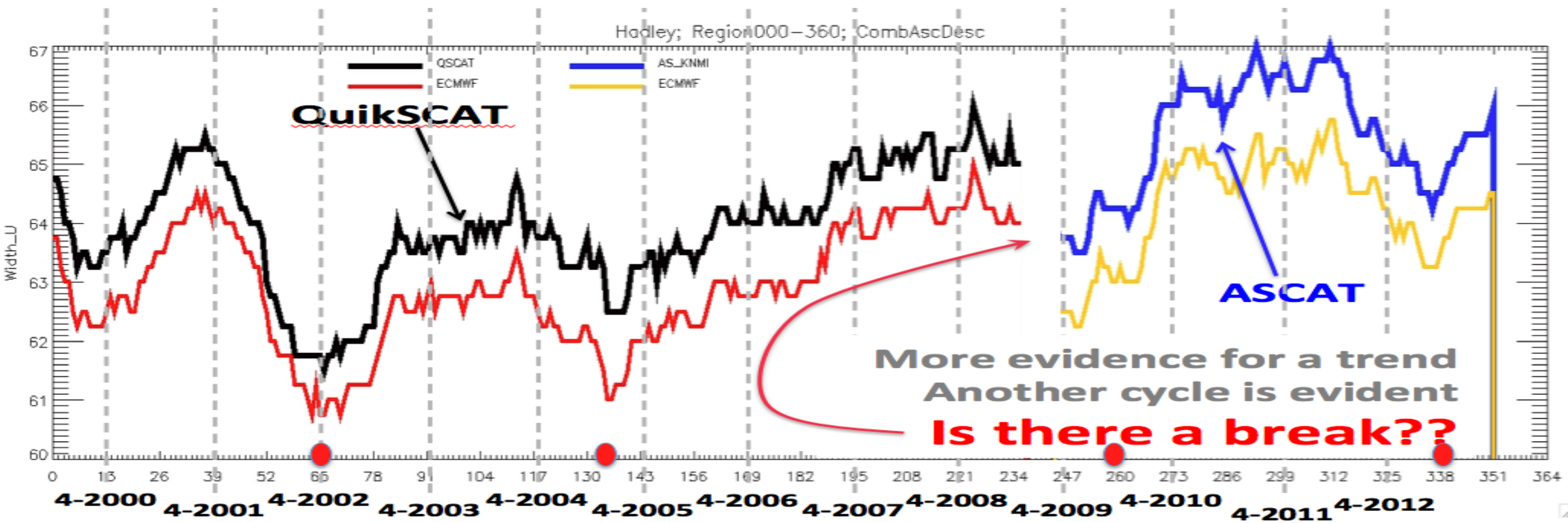
From tandem missions to RapidScat – uncovering the diurnal signal in the large-scale circulations. Implications for the climate record of the ocean surface winds.

Svetla Hristova-Veleva, Ernesto Rodriguez, Ziad Haddad, Bryan Stiles, F. Joseph Turk

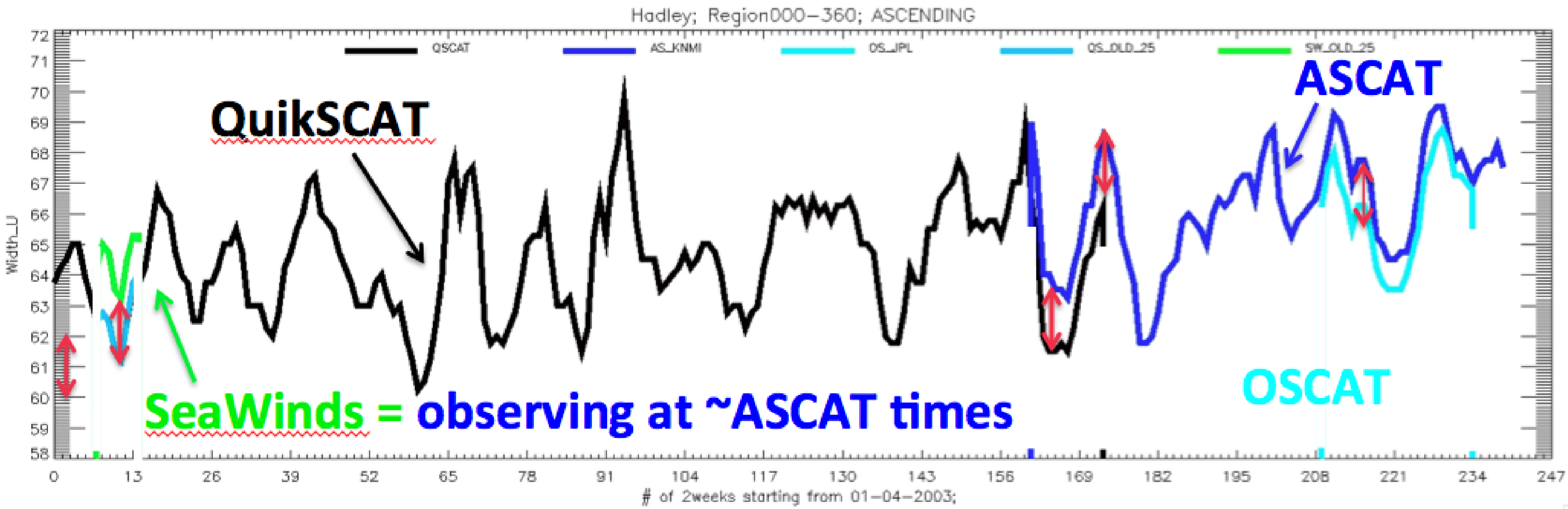
We used scatterometer surface winds to determine the extent of the Hadley cell.

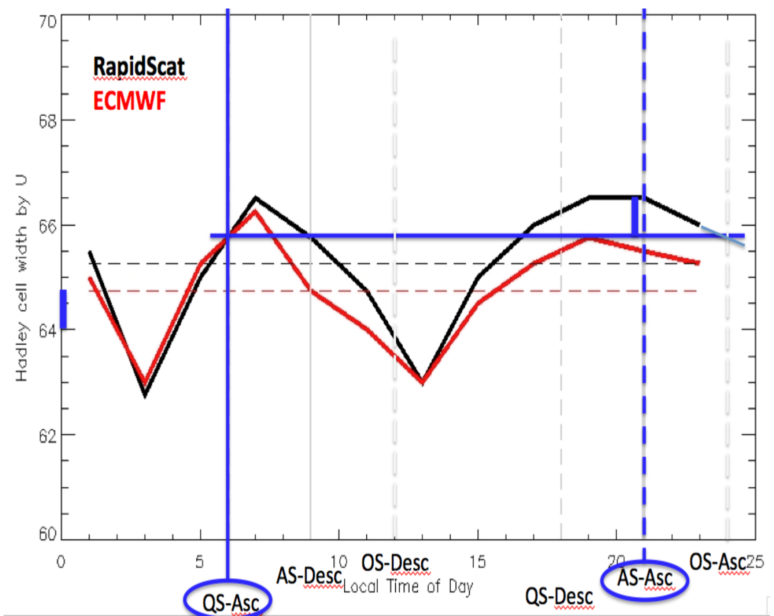
Last year we presented analysis of the trends in the Hadley Cell width using observations from QuikSCAT, and ASCAT

We found Breaks in the Hadley width (determined from the zonal wind U) when using different satellites !!



Suspecting that the diurnal variability might be a significant contributor, we performed similar analysis during periods of tandem missions



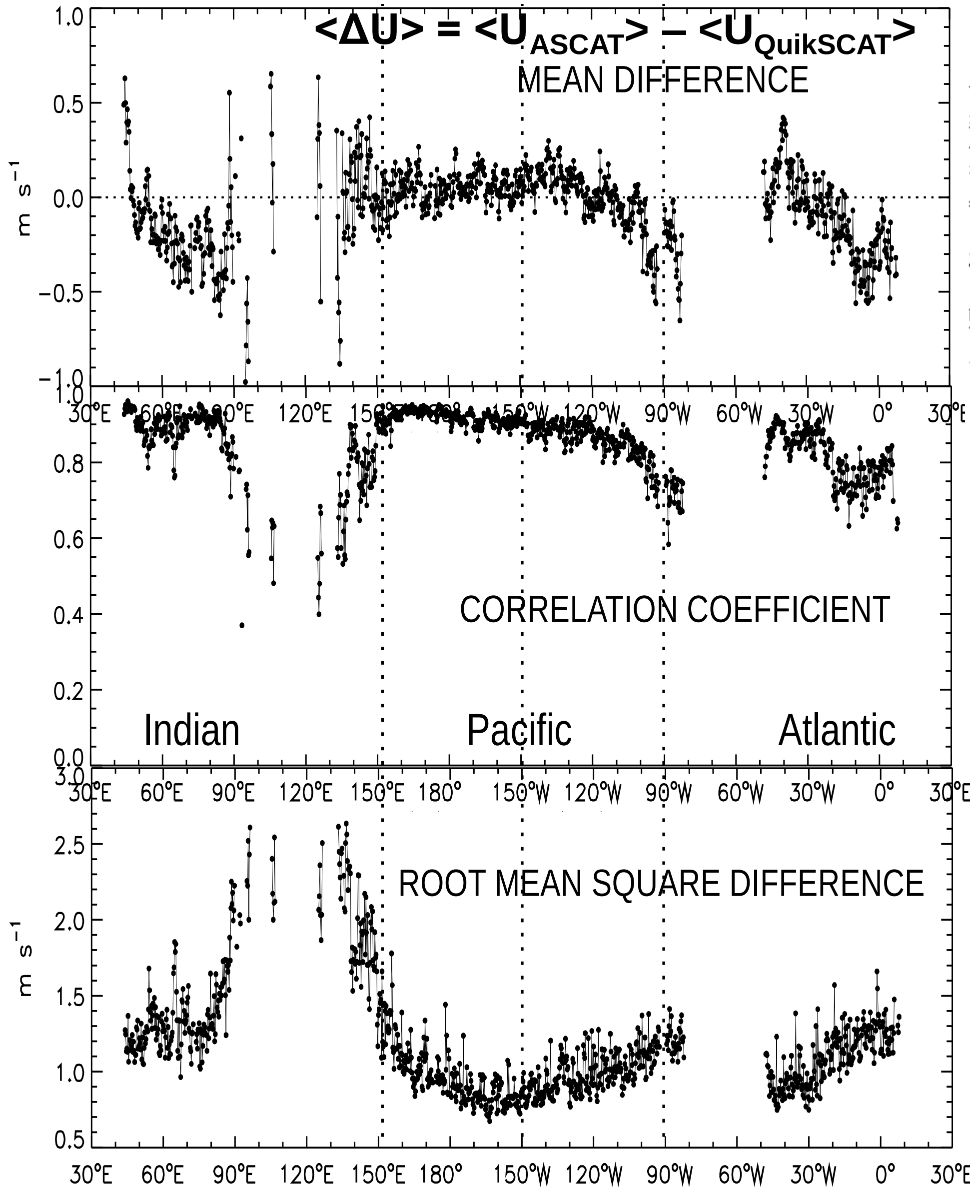


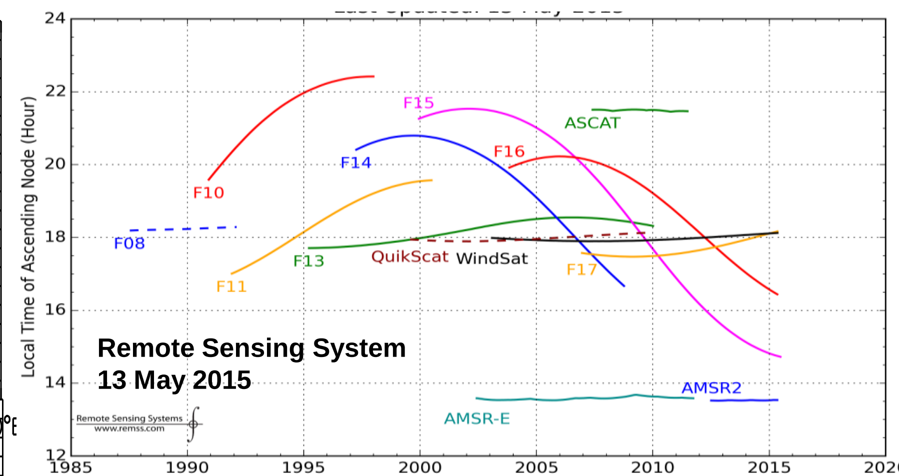
We used RapidScat observations to study the diurnal signal in the width of the Hadley cell.
Our analysis show that:

- **There is a significant variability in the Hadley Cell width with a clear semidiurnal signal**
- **RapidScat observations provide strong evidence that the Hadley cell is wider during the ASCAT observing times than it is during the QuikScat observing times**
- **This explains previously found discrepancies between Qs and AS observations and supports our earlier findings**

ASCAT & QuikSCAT Zonal Wind Intercomparison
1 June 2007 – 31 October 2009

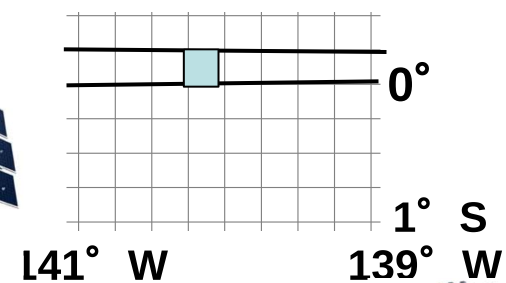
David Halpern with Lucrezia Ricciardulli





Equatorial Crossing Times of Ascending Orbits
QuikSCAT Ascending ECT = 06:00
ASCAT Descending ECT = 09:30

http://www.remss.com/support/crossing-times



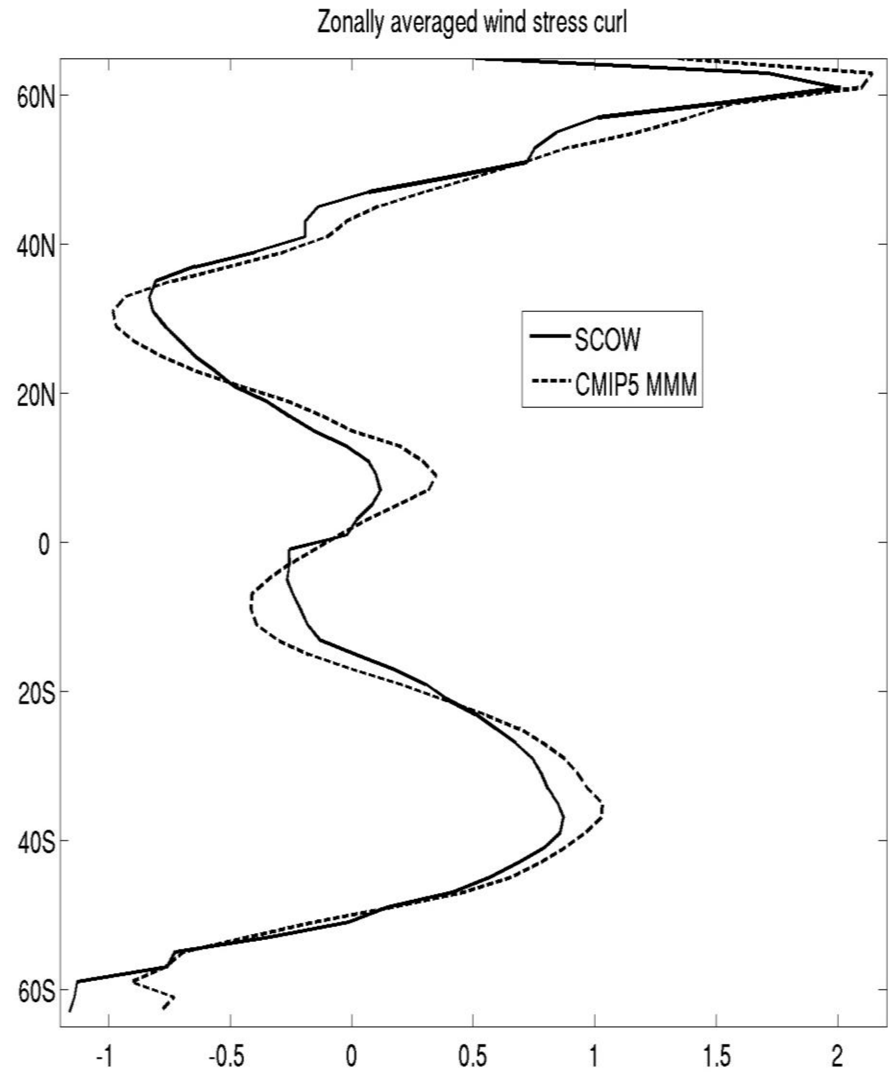
SeaWinds on QuikSCAT

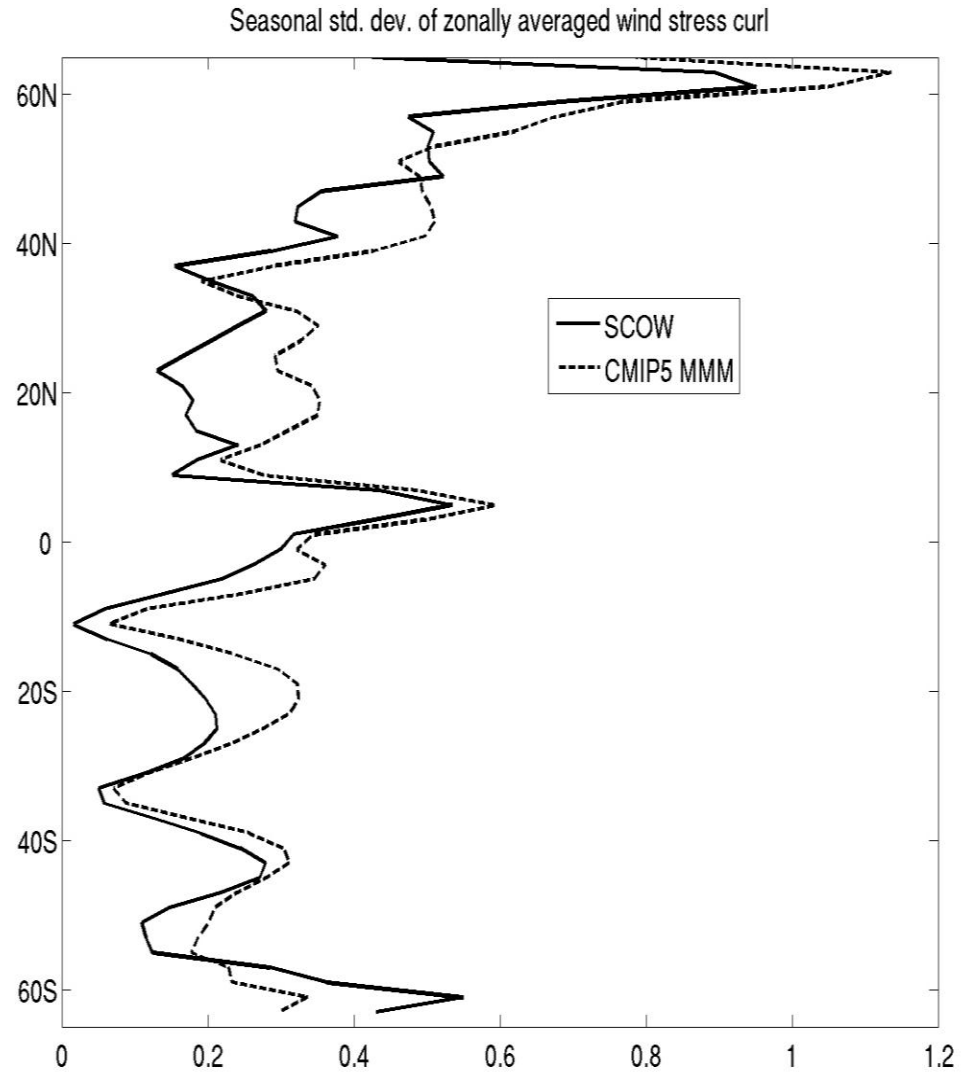
ASCAT on MetOp-A

Evaluation of CMIP5 wind stress curl & divergence using QuikSCAT data

Tong Lee, JPL

CMIP5 models overestimate time-mean wind stress curl in tropical, subtropical, subpolar gyres and the seasonal variations



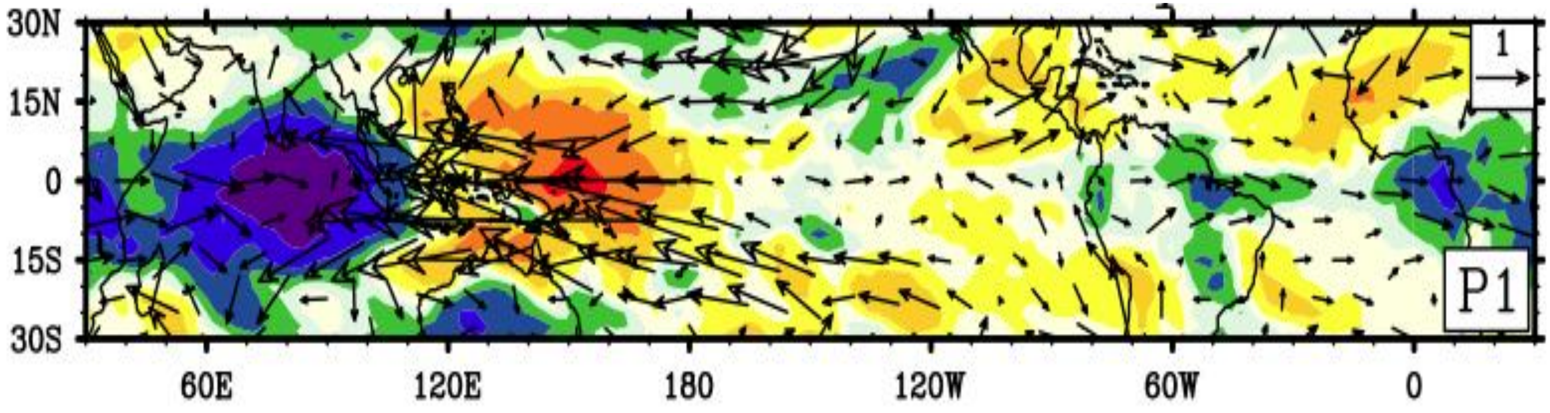


The role of ocean dynamical processes in determining intraseasonal SST Variability in the tropical Indian Ocean: with implication on MJO initiation

Yuanlong Li & Weiqing Han

Background

The Madden-Julian Oscillation (MJO): Many initiate in the Indian Ocean & propagate, impact weather and climate



Existing studies:

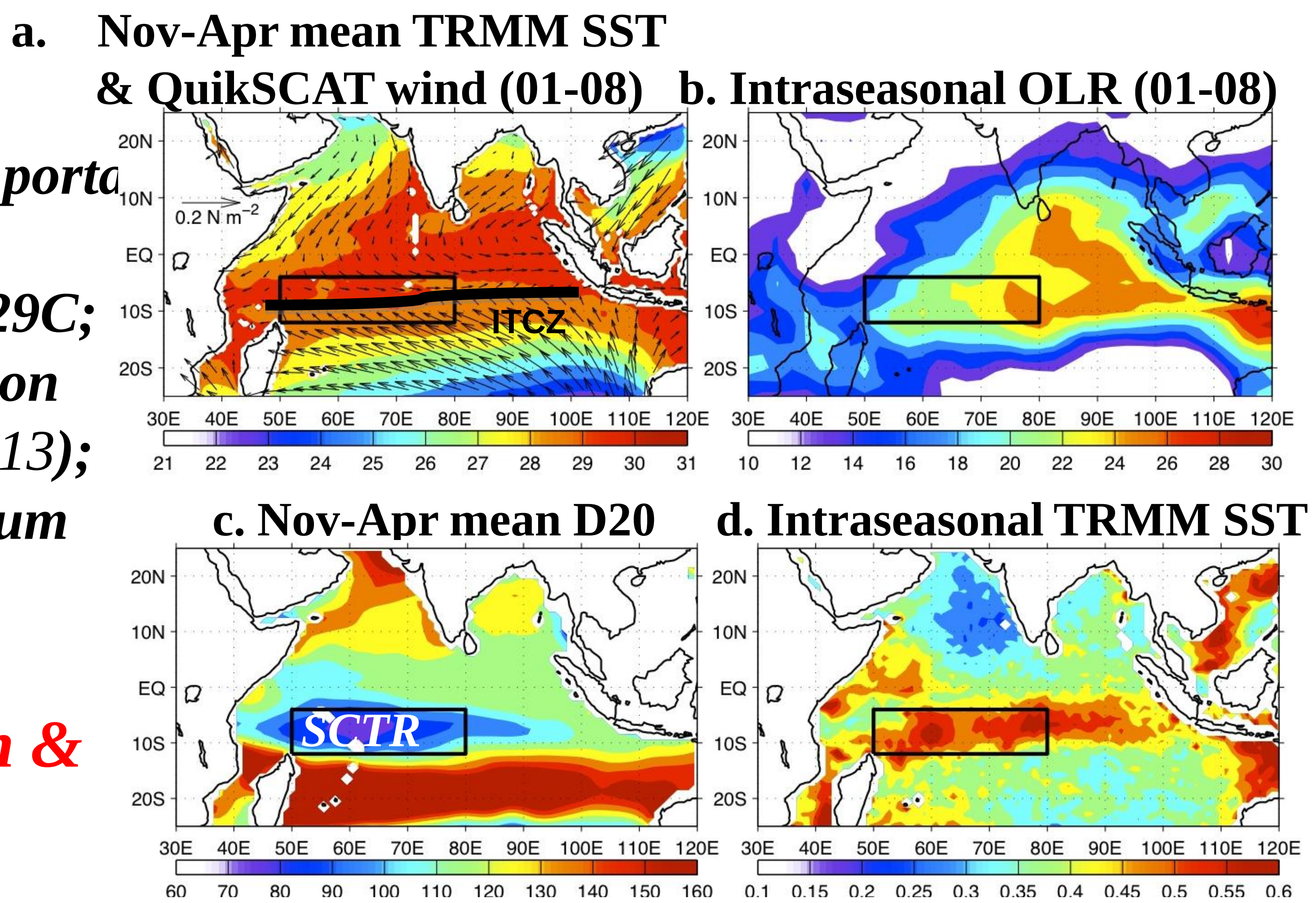
•The MJO – atmos. internal variability; Air-sea coupling over Indian Ocean – improve MJO amplitude, propagation & forecast.

Issues: Air-sea coupling processes are not well understood.

Existing studies: Diverged views on processes for MJO to cause sea surface temperature (SST) variability; how the SSTA affects the wintertime (Nov-Apr) MJO initiation – remains largely unknown.

Goal:

Re-examine the processes controlling wintertime (Nov-Apr) SSTA in Seychelles-Chagos thermocline ridge (SCTR) region of the Indian Ocean *(using recently available, high-quality satellite obs and improved ocean model).*

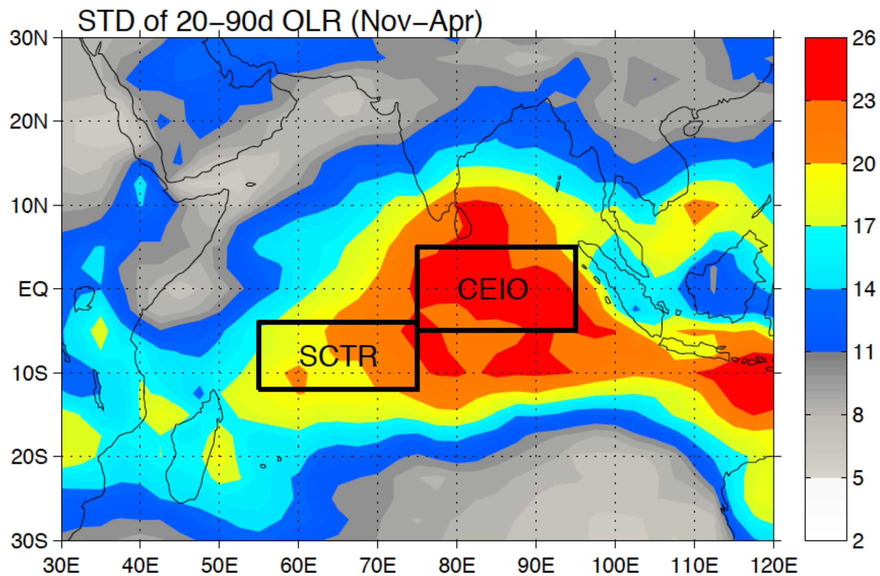


Why is SCTR Importa

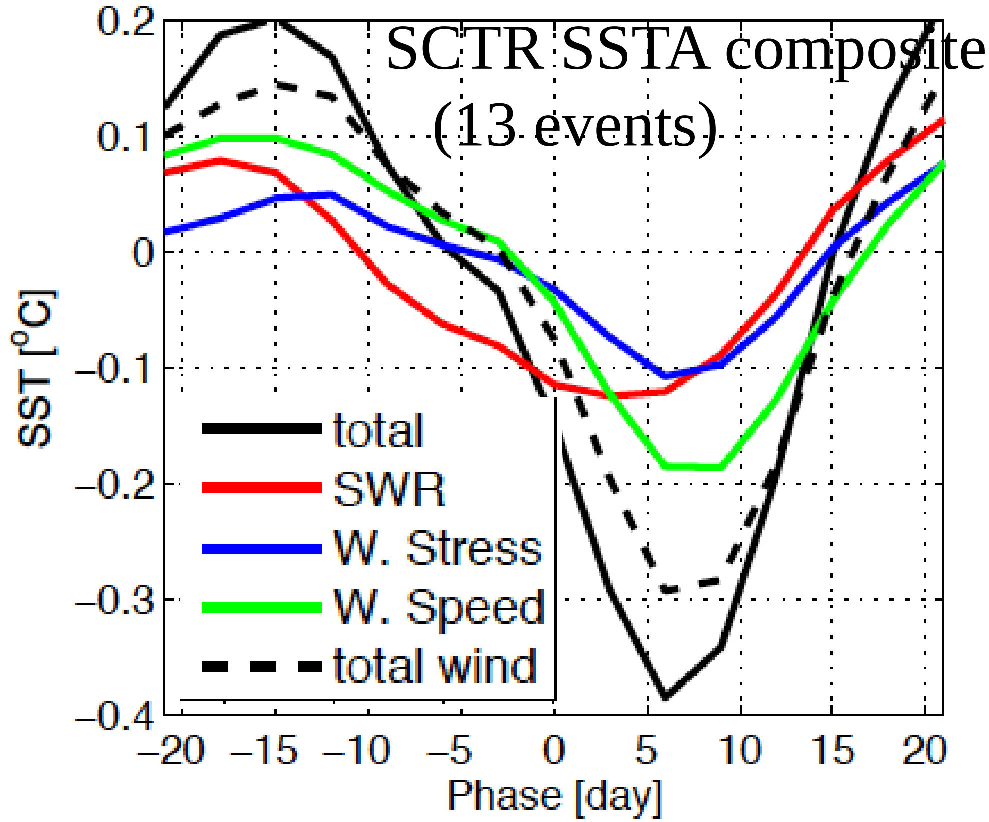
(1) Mean SST>29C;
(2) MJOs initiation *(Zhao et al. 2013)**;***
(3) SSTA maximum

Important: MJO initiation & prediction!

OGCM results: Processes: SCTR MJO SSTA



2001-11: 29 events: 13 begun in SCTR and amplify in CEIO

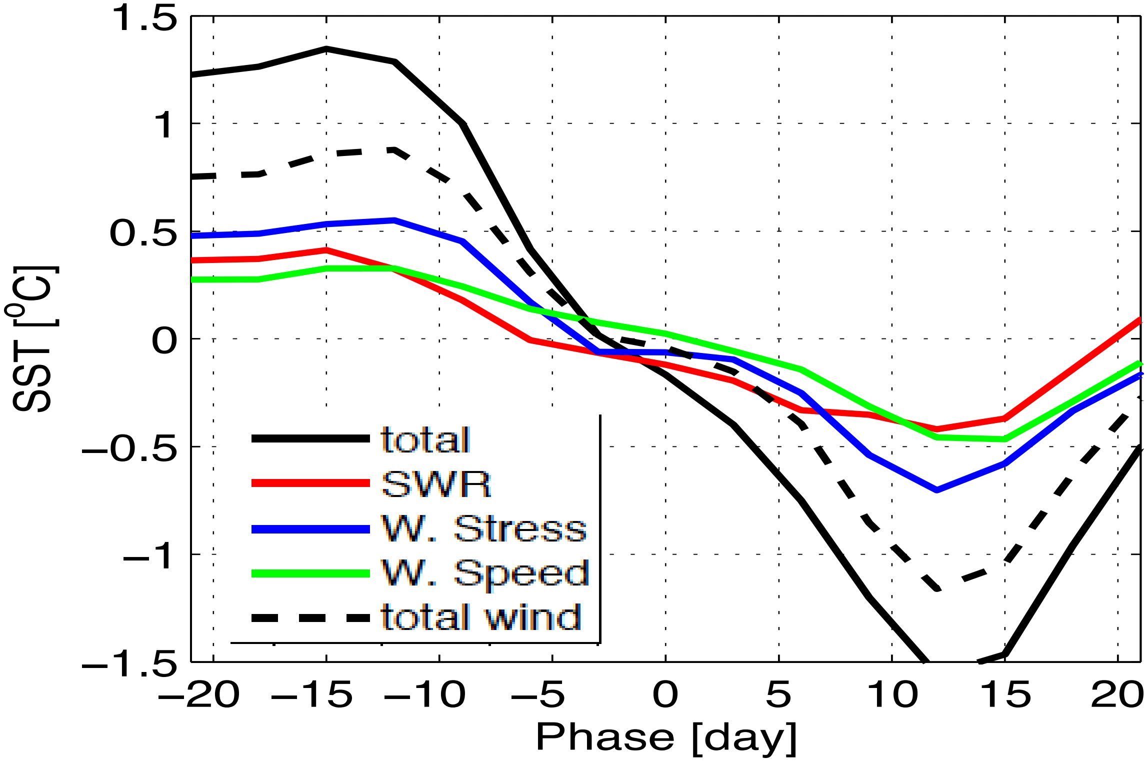


In the composite:

Wind: deterministic role; Shortwave radiation (SWR) also significant;

Ocean dynamics (w. stress) contributes to ~25-30%

February 2008 strong SCTR MJO



For a strong MJO event, oceanic processes (entrainment, upwelling & advection) play the most important role!

– ***Implies possible importance of Indian Ocean processes in initiating LARGE SCTR MJO!***