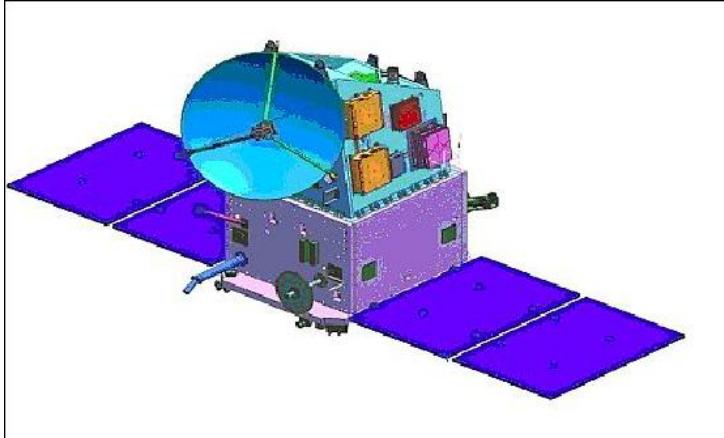


# Evaluation of Marine Surface Vectors observed by SCATSAT-1 Scatterometer

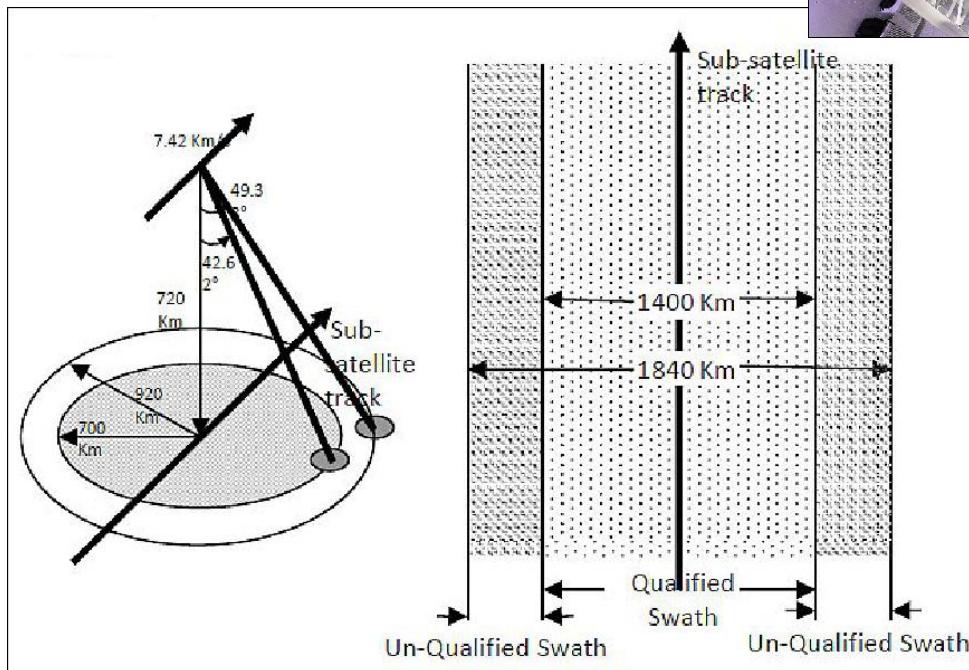
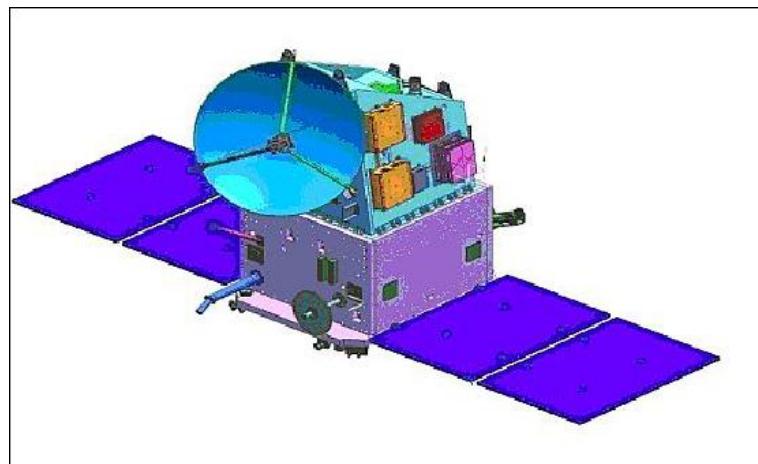


Naoto EBUCHI

Institute of Low Temperature Science, Hokkaido University

[ebuchi@lowtem.hokudai.ac.jp](mailto:ebuchi@lowtem.hokudai.ac.jp)

# SCATSAT-1 Scatterometer (OSCAT2)



Launched on 26 Sep 2016  
Ku-band (13.51 GHz)  
Scanning dual pencil beam  
VV and HH pol  
25/50 km resolution  
1840 km swath

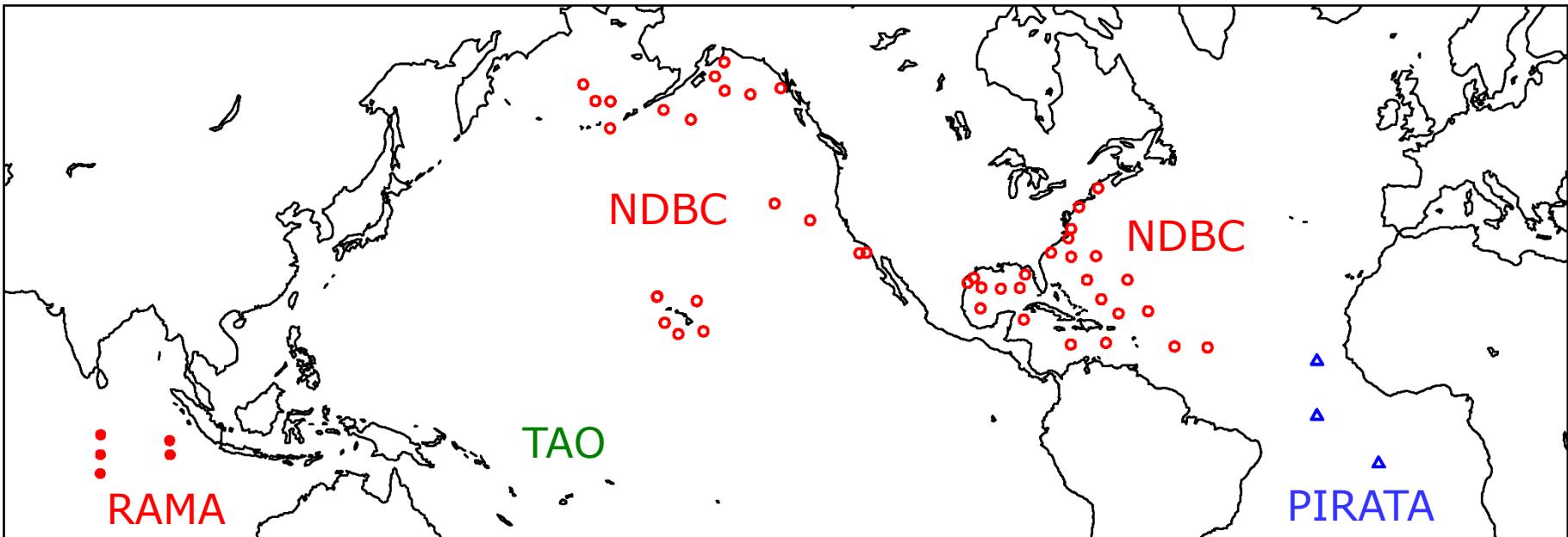
# Outline

- Comparisons with buoy data
- Assessment of statistical distributions of wind speeds and directions
  - Global wind speed histograms
  - Directional distributions relative to antenna beams

# Data

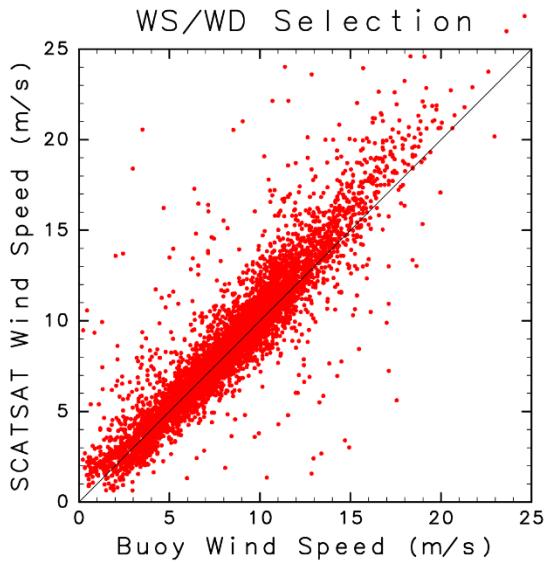
- SCATSAT-1 Wind Products,
  - Beta version (v1.0, 1.1.0, 1.1.1)
  - Level 2B, 25 km resolution
  - Downloaded from the website of NRSC/ISRO
- Data period: 11 Oct 2016 – 28 Feb 2017

# Buoy Measurements

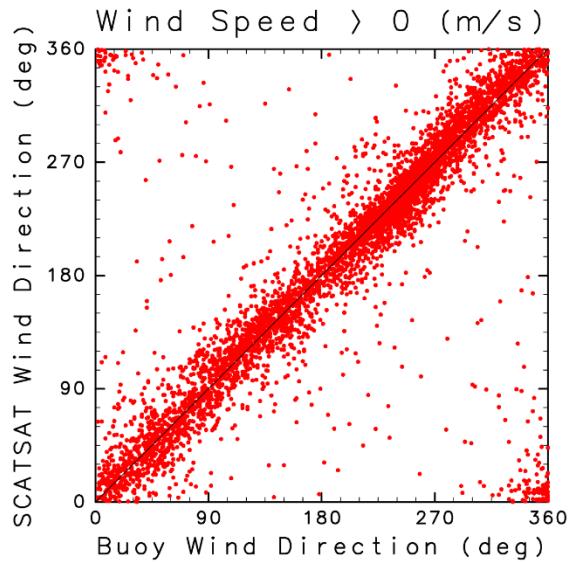


- Collocation
  - $\Delta r < 12.5 \text{ km}$ ,  $\Delta t < 5 \text{ min.}$
- Height and Stability Collections
  - Liu and Tang (1996) Code
  - 10-m height Equivalent Neutral Wind Speed

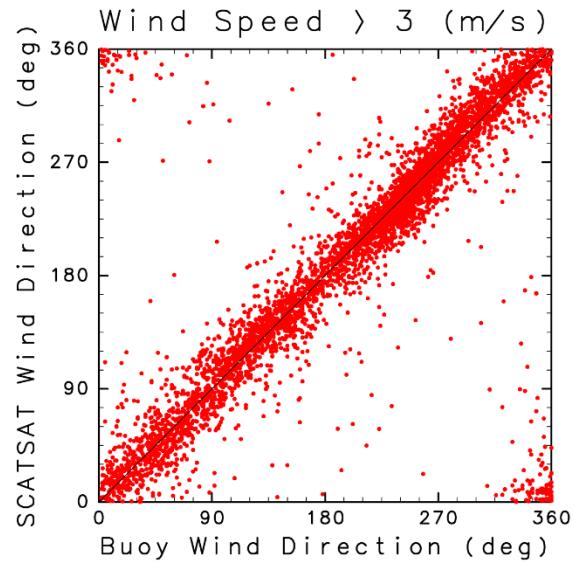
# Comparisons with Buoy Measurements



N= 5,988  
Bias= +0.37 m/s  
Rms= 1.57 m/s



N= 5,935  
Bias= +1.2 deg.  
Rms= 25.5 deg.



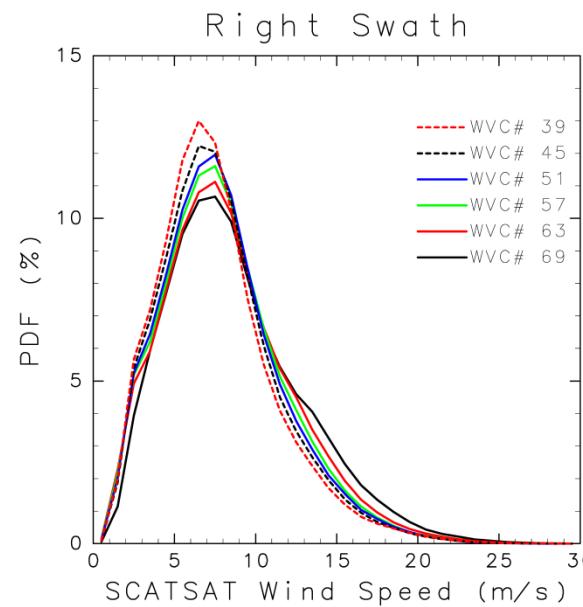
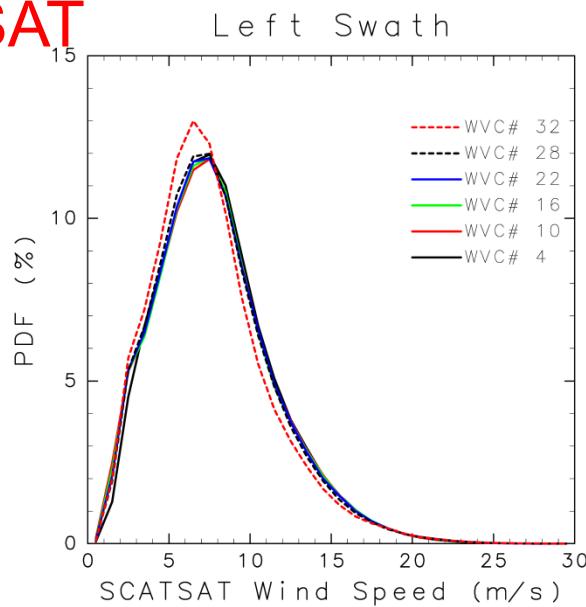
N= 5,412  
Bias= +0.7 deg.  
Rms= 20.8 deg.

# Statistics of Buoy Comparisons

	SCATSAT ISRO (beta)	OSCAT ISRO (v1.4)	NOAA	KNMI	JPL
Spatial resolution	25	25	25	50	12.5
Wind Speed (m/s)					
Number of data	5,988	3,491	3,570	2,548	19,613
Bias	0.37	0.48	-0.09	0.06	0.20
Rms difference	1.57	1.24	1.28	0.96	1.24
Correlation	0.919	0.923	0.930	0.952	0.920
Wind Direction (deg.), U > 3 m/s					
Number of data	5,412	3,117	3,205	2,413	17,243
Bias	0.7	-0.3	-1.9	2.7	-1.0
Rms difference	20.8	18.0	19.7	16.1	20.0
Correlation	0.977	0.979	0.979	0.985	0.979

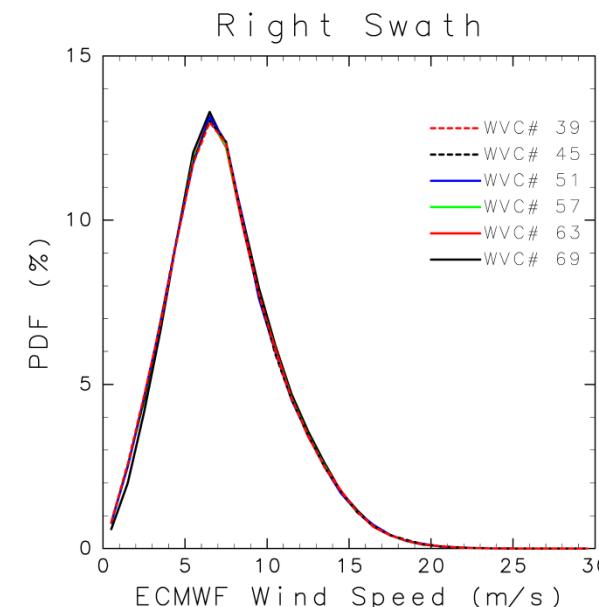
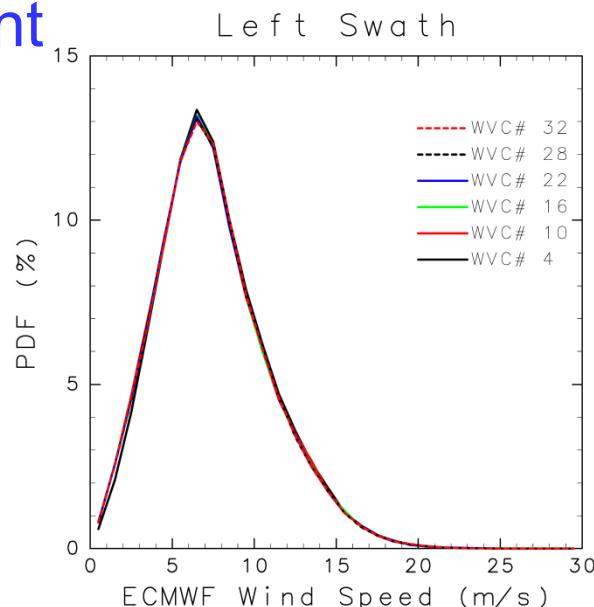
# Global Wind Speed Histograms (1)

SCATSAT



60°S – 60°N  
Bin size = 1 m/s

ERA-int



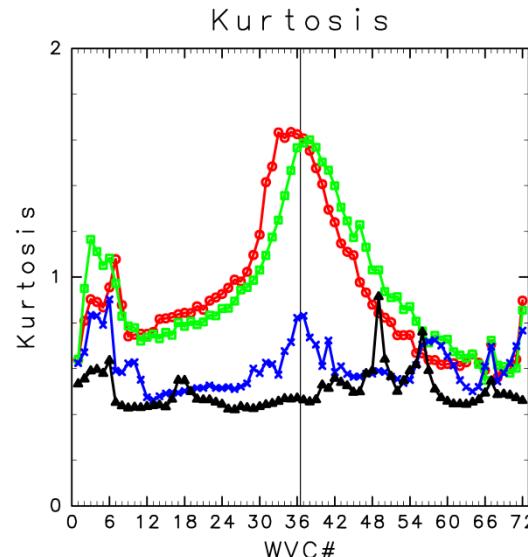
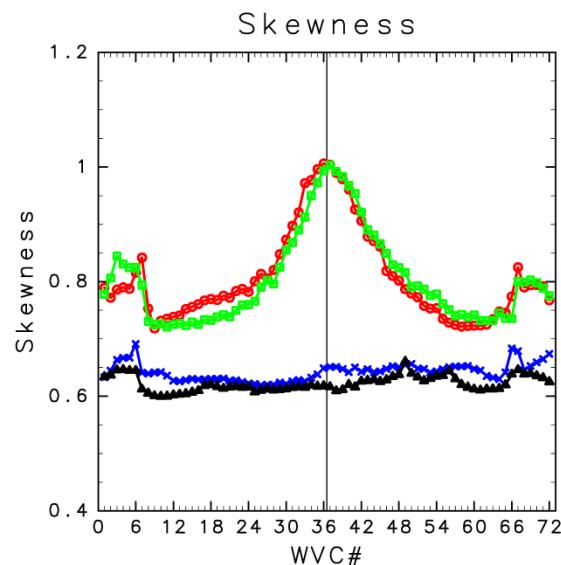
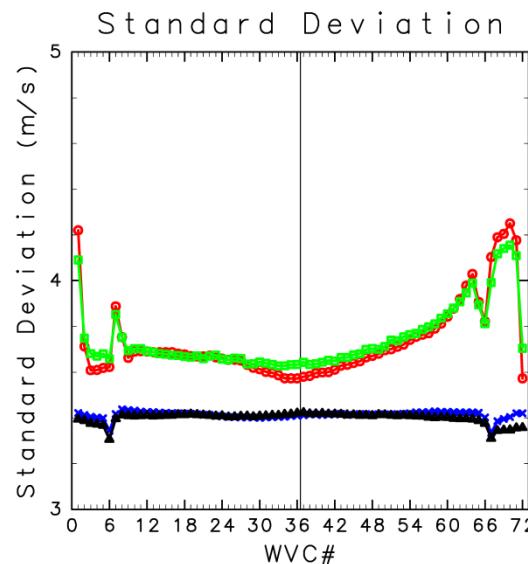
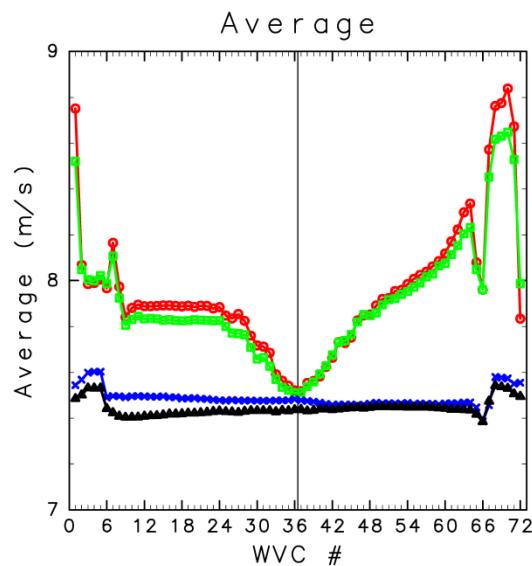
Collocated with  
SCATSAT WVCs

# Global Wind Speed Histograms (2)

SCAT/Asc  
SCAT/Dsc

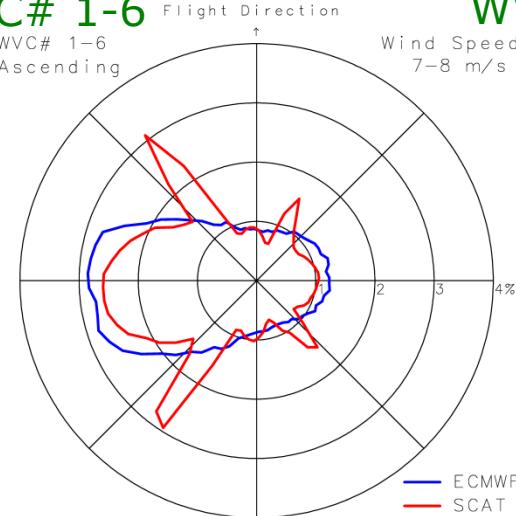
ERA/Asc  
ERA/Dsc

60°S – 60°N  
Bin size = 1 m/s

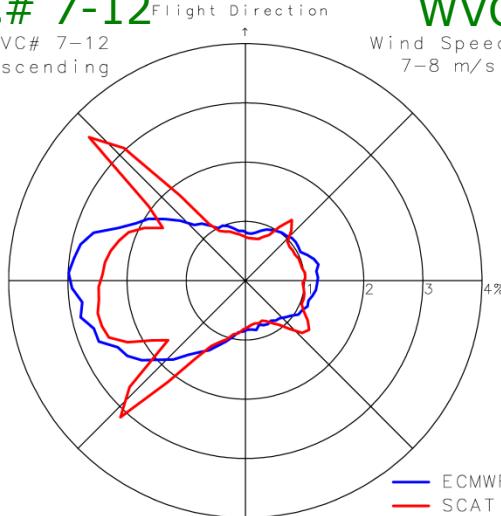


# Wind Direction Histograms

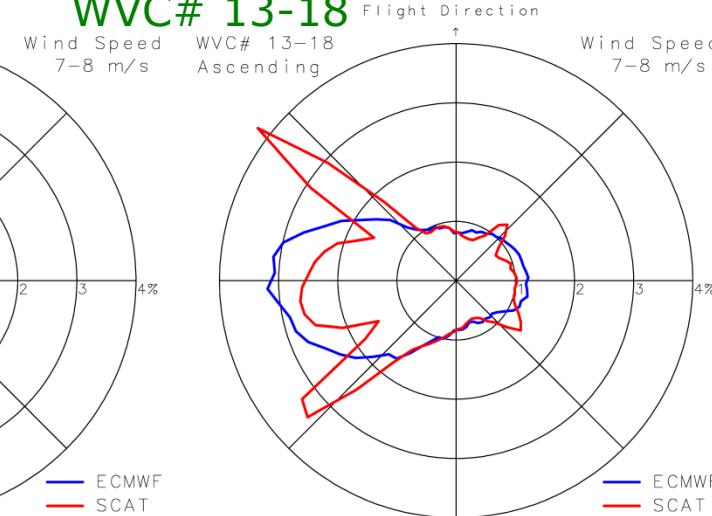
**WVC# 1-6** Flight Direction



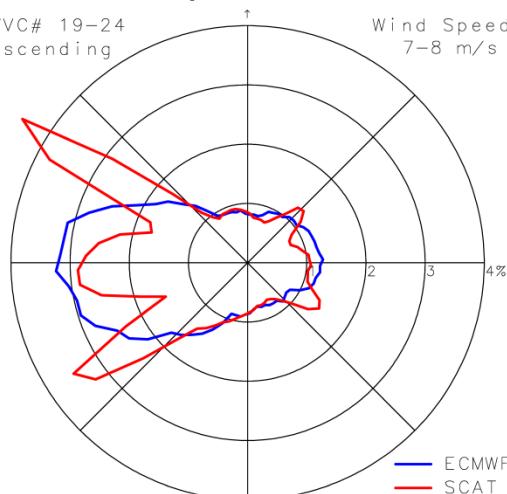
**WVC# 7-12** Flight Direction



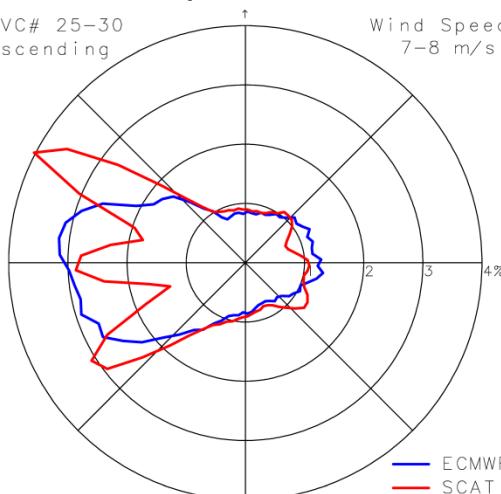
**WVC# 13-18** Flight Direction



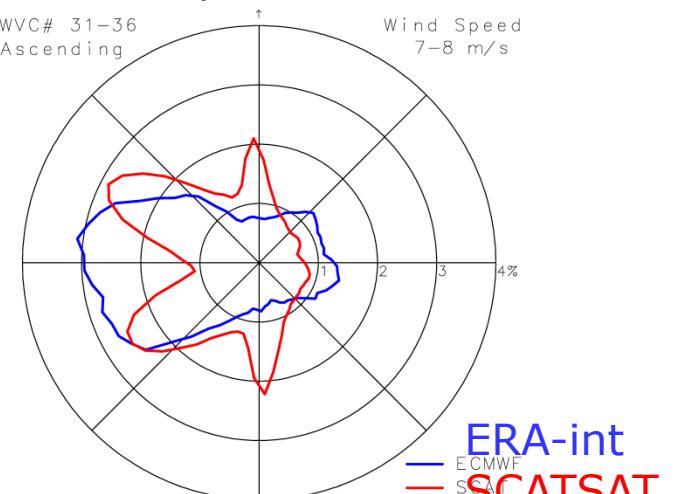
**WVC# 19-24** Flight Direction



**WVC# 25-30** Flight Direction



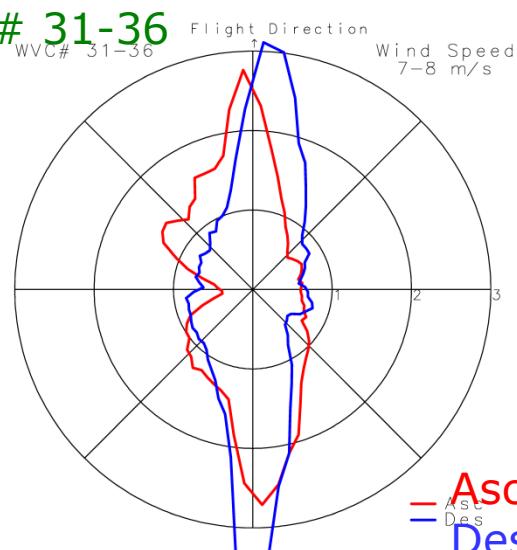
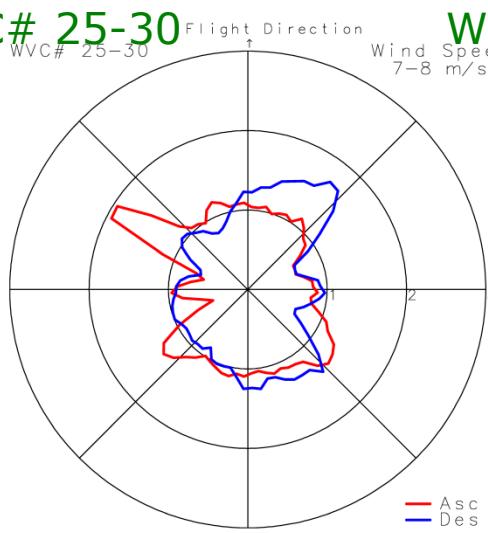
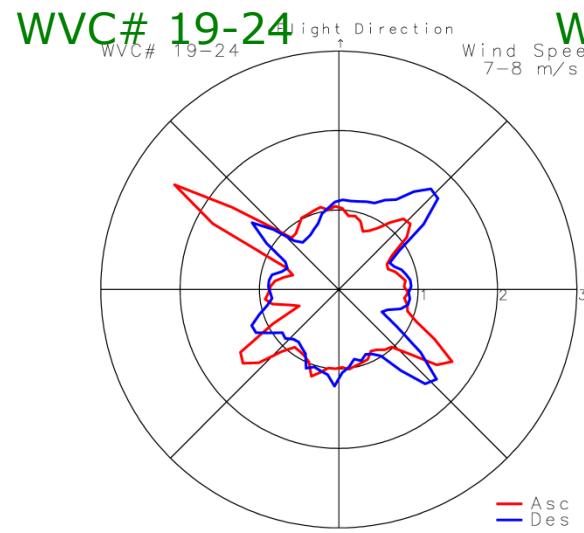
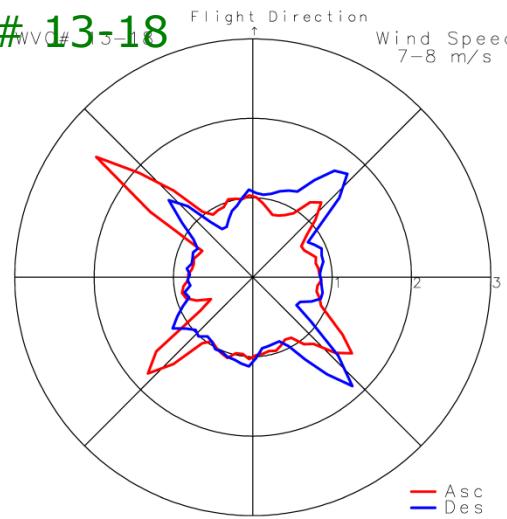
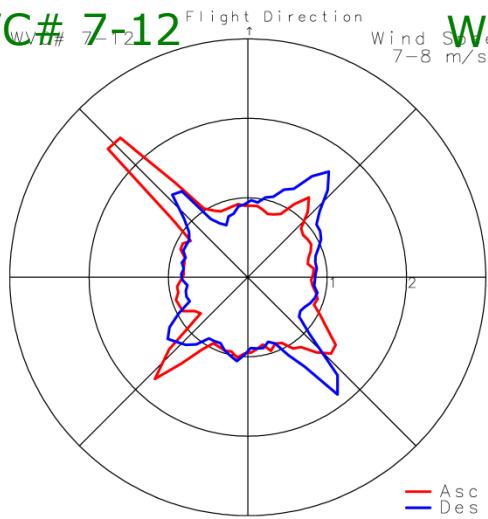
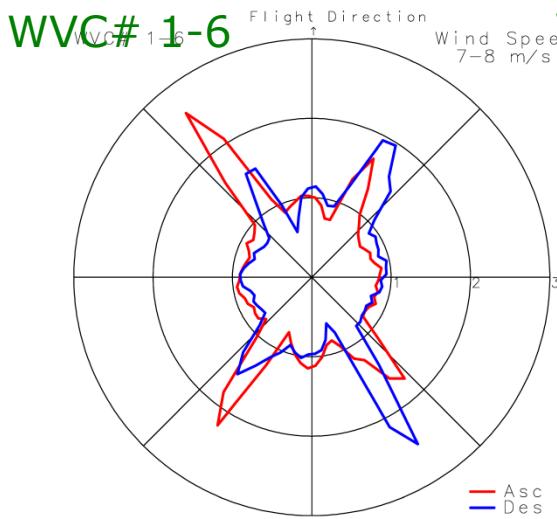
**WVC# 31-36** Flight Direction



Left Swath, Wind Speed Range: 7-9 m/s, Ascending Paths

ERA-int  
ECMWF  
SCATSAT

# Normalized Wind Direction Histograms



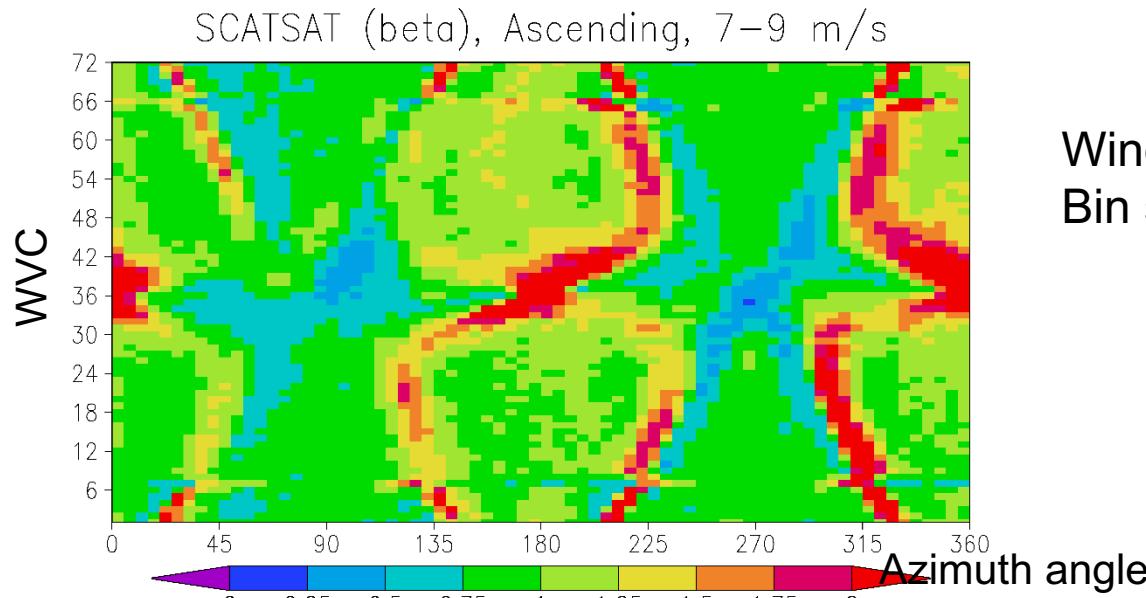
— Ascending  
— Descending

$\text{PDF}_{\text{SCAT}}/\text{PDF}_{\text{ERA}}$

Left Swath, Wind Speed Range: 7-9 m/s

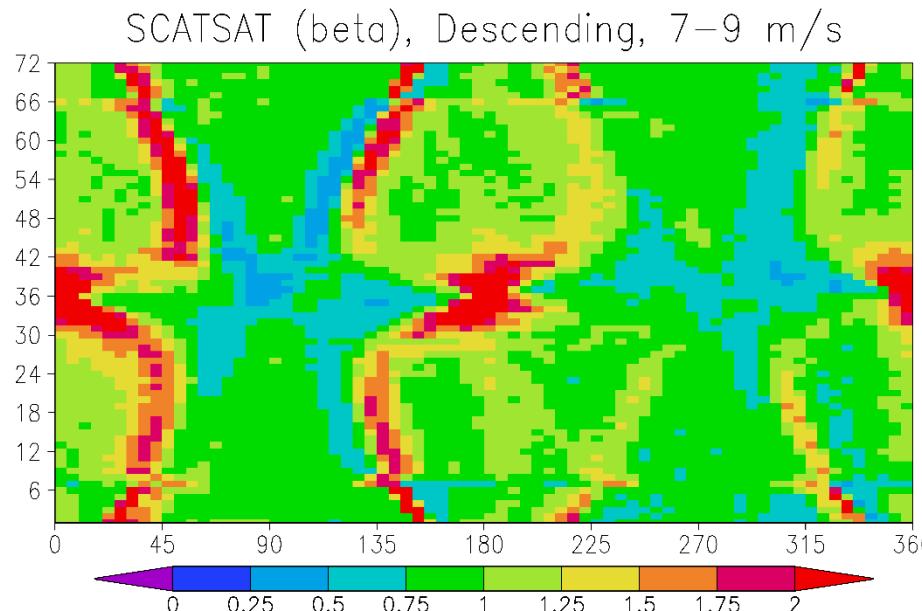
# Normalized Histograms of Wind Direction

Ascending



Wind speed = 7–9 m/s  
Bin size = 5 deg.

Descending

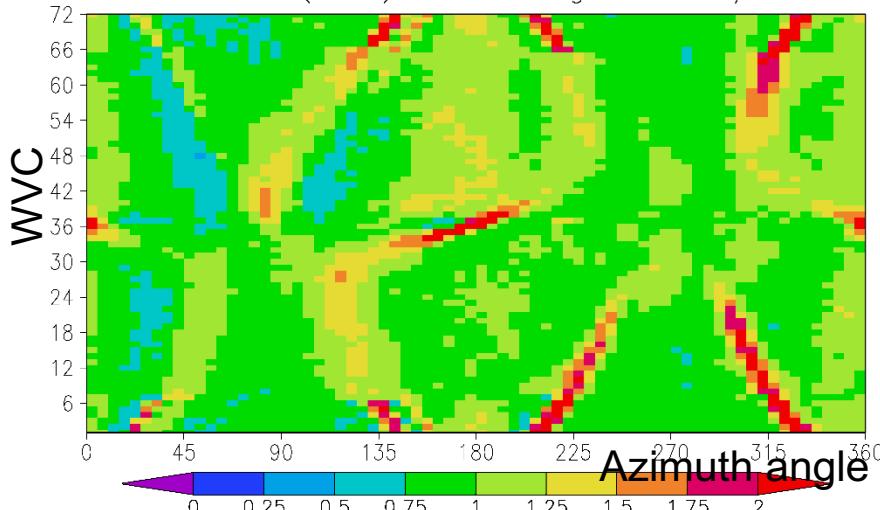


**OSCAT**

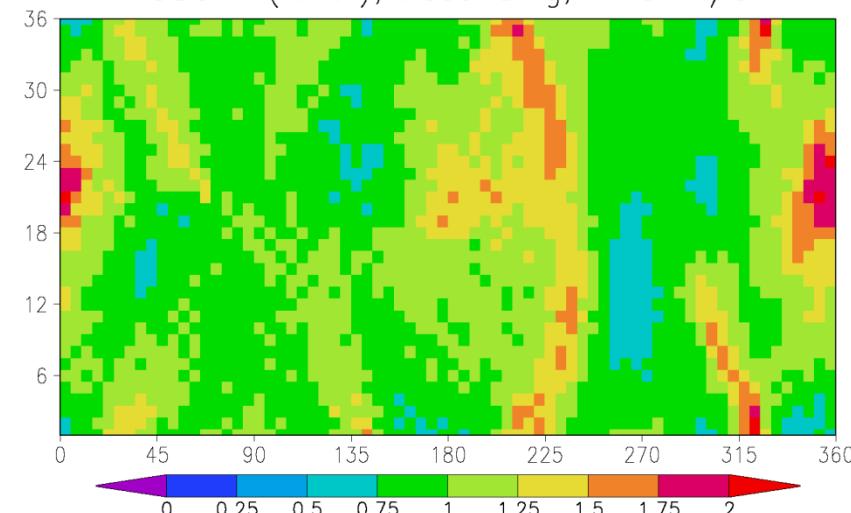
# Normalized Histograms of Wind Direction

**ISRO v1.4**

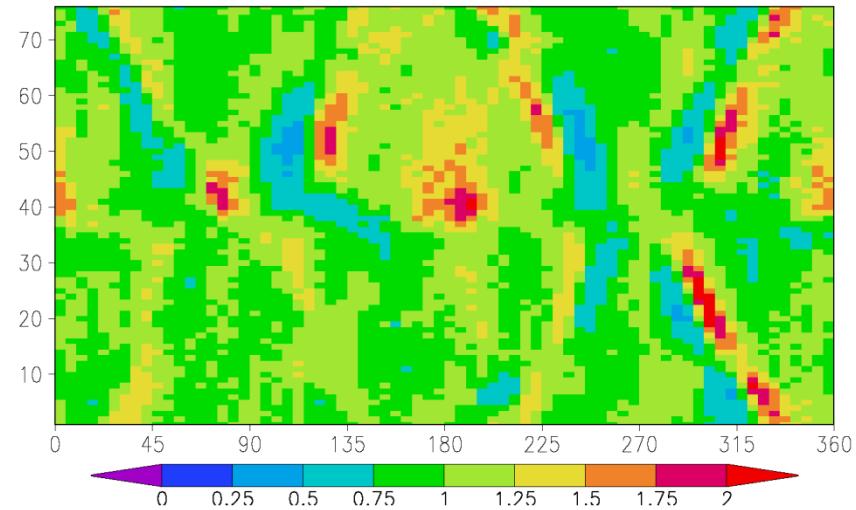
OSCAT (v1.4), Ascending, 7–9 m/s

**KNMI**

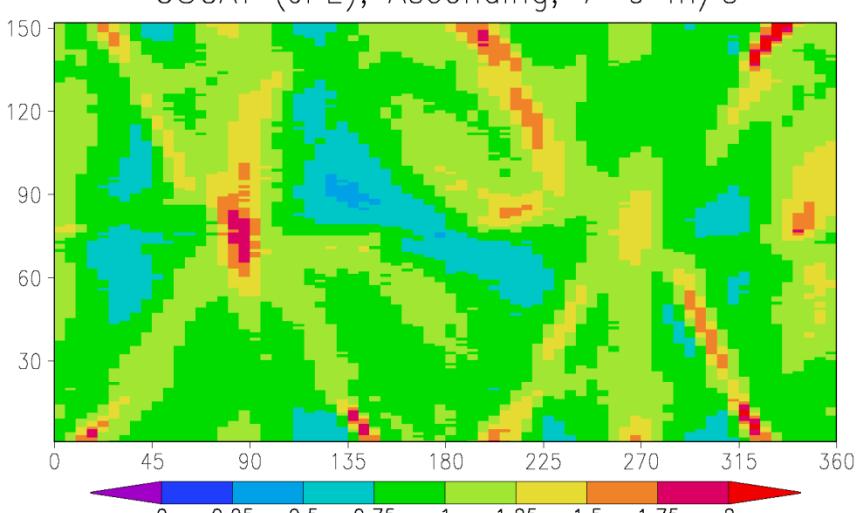
OSCAT (KNMI), Ascending, 7–9 m/s

**NOAA**

OSCAT (NOAA), Ascending, 7–9 m/s

**JPL**

OSCAT (JPL), Ascending, 7–9 m/s



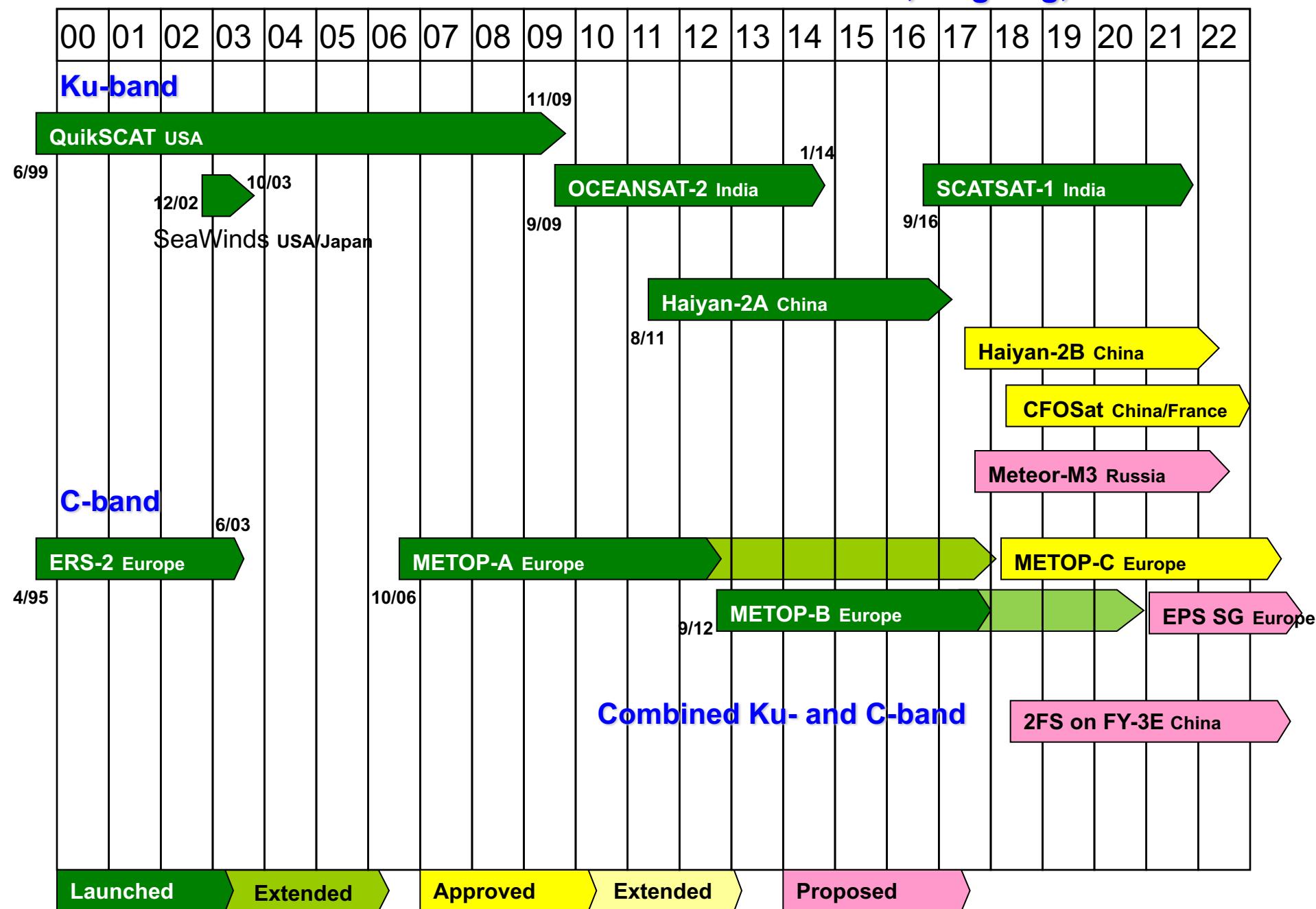
Ascending paths, Wind speed = 7–9 m/s, Bin size = 5 deg.

# Summary

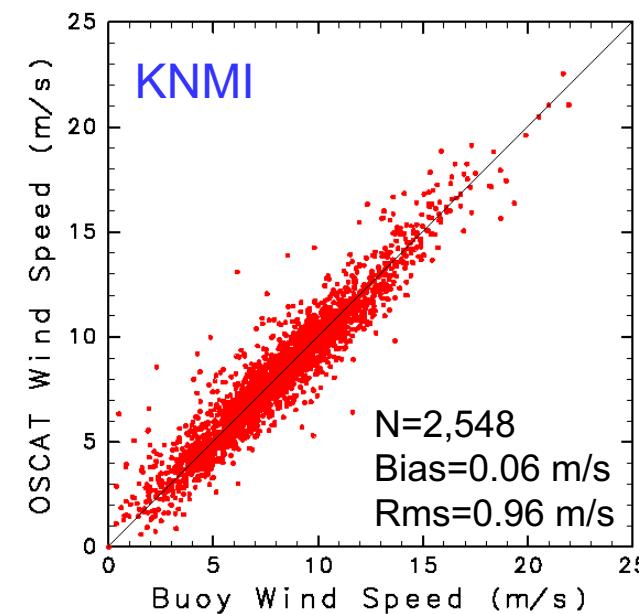
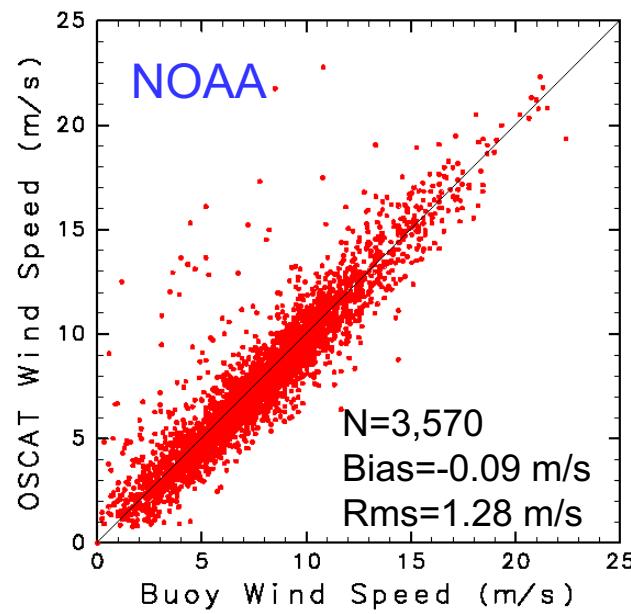
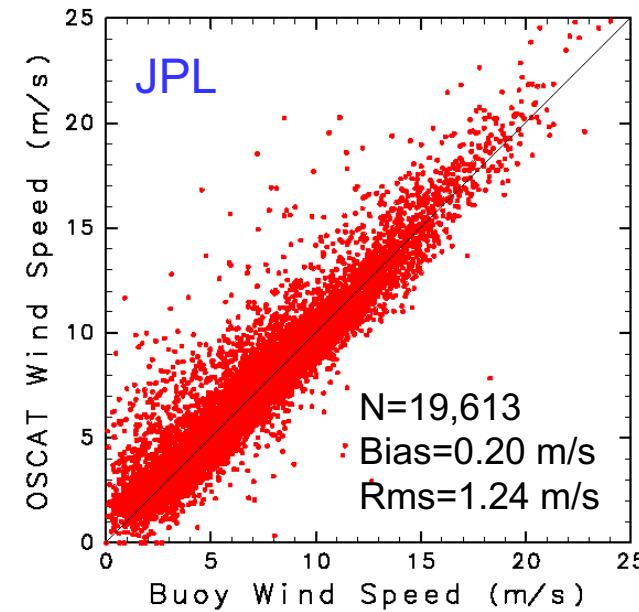
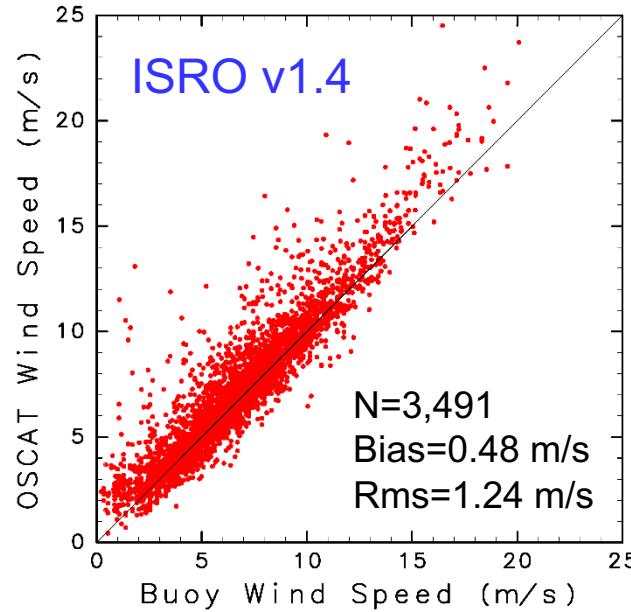
- Wind speeds and directions in the ISRO SCATSAT Wind Products (beta version) agree well with buoy observations with rms differences of 1.6 m/s and 20 deg., respectively.
- Global wind speed histograms exhibit consistent feature over the cross-track WVC location.
- Wind directions show significant directivity relative to the antenna beams.
- These features are very similar to those of the ISRO OSCAT wind products (v1.4/v1.3).
- We may expect further improvements of the data quality by ISRO or other data providers (JPL, NOAA/NESDIS, KNMI...). ISRO has started distribution and reprocess of a new version (v1.1.2) on 24 April 2017.



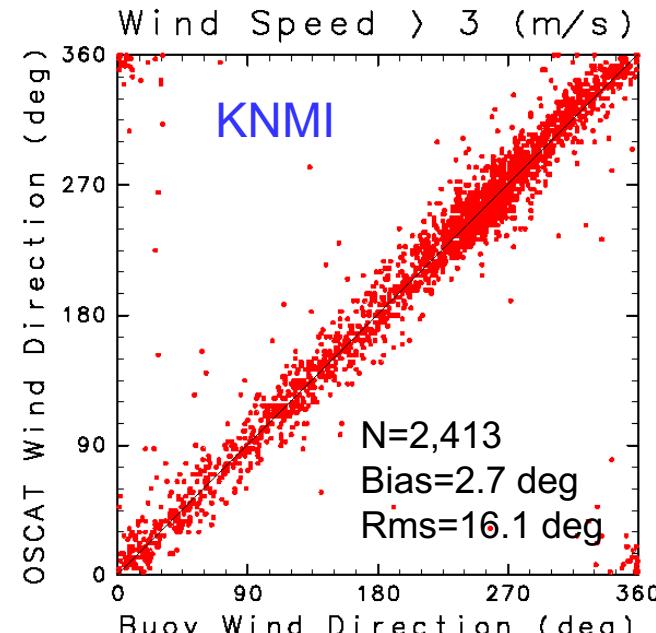
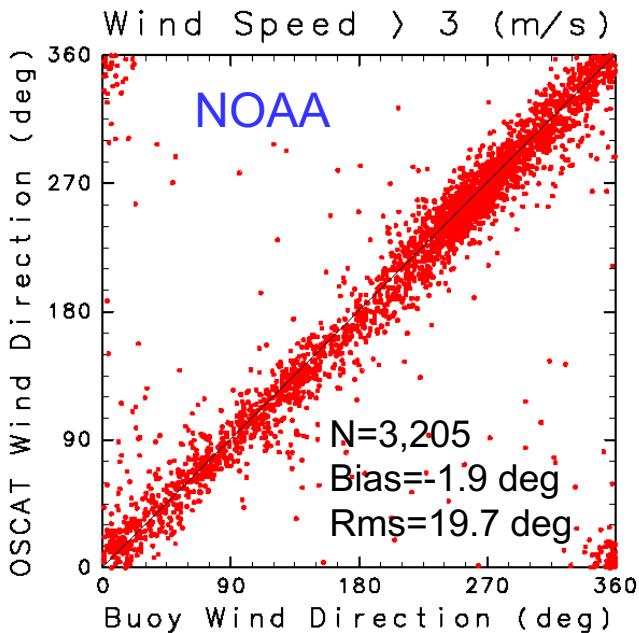
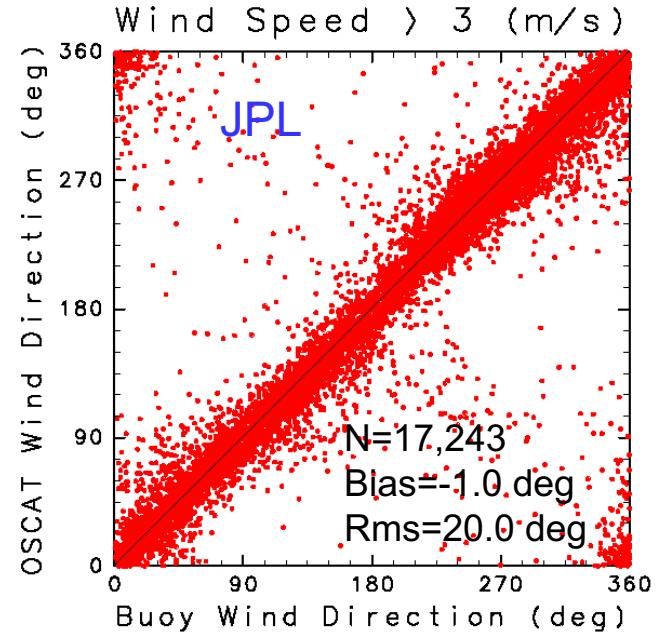
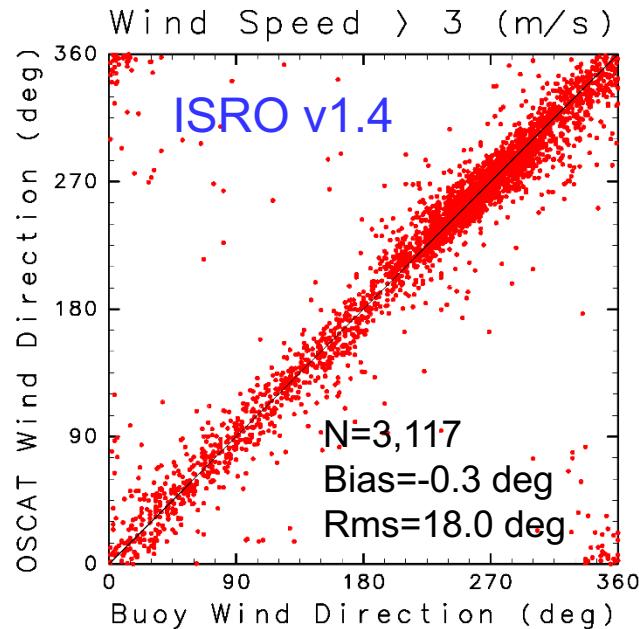
# Global Scatterometer Missions: The Previous Decade, Ongoing, the Future



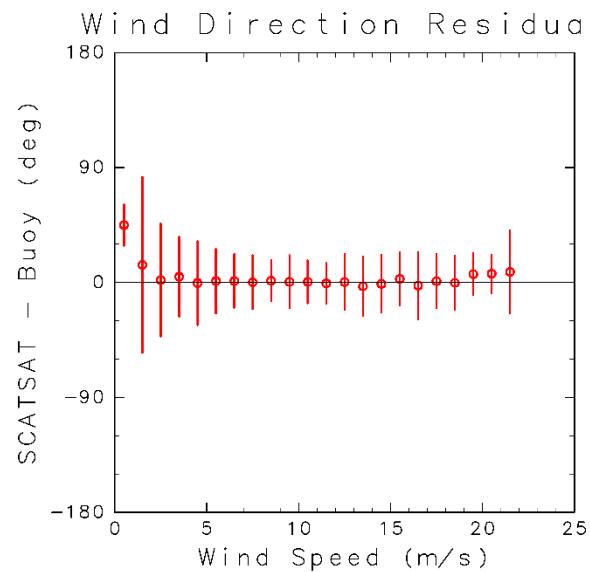
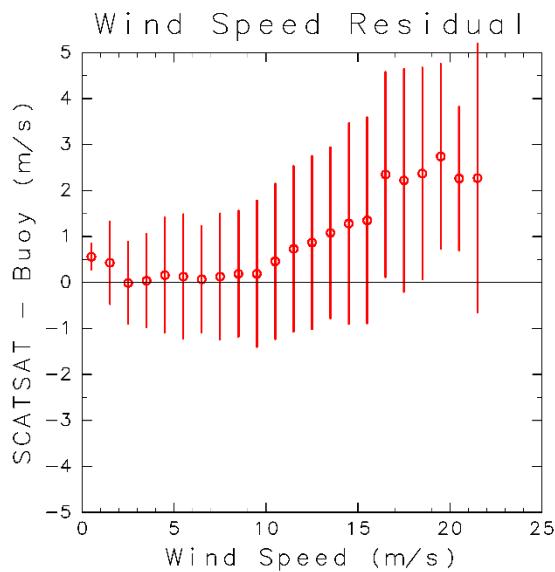
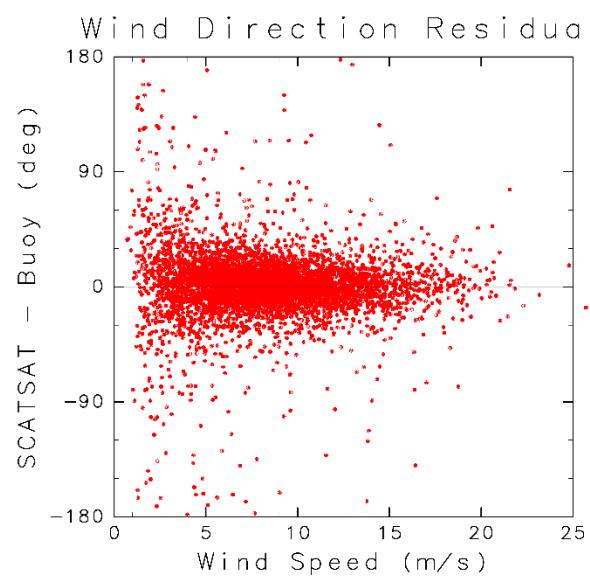
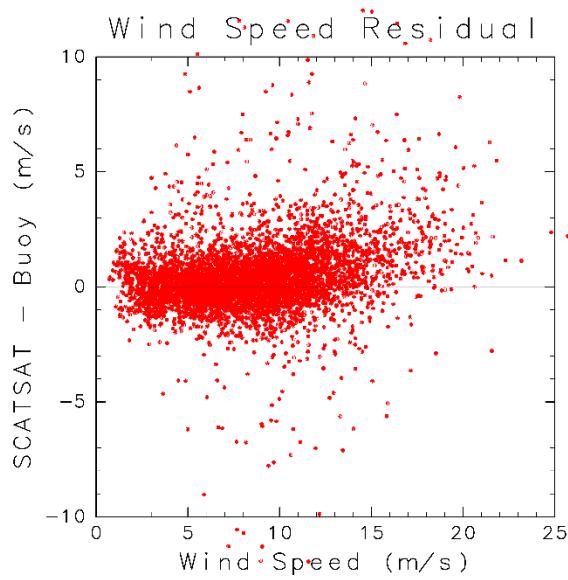
# Comparisons of Wind Speed



# Comparisons of Wind Direction

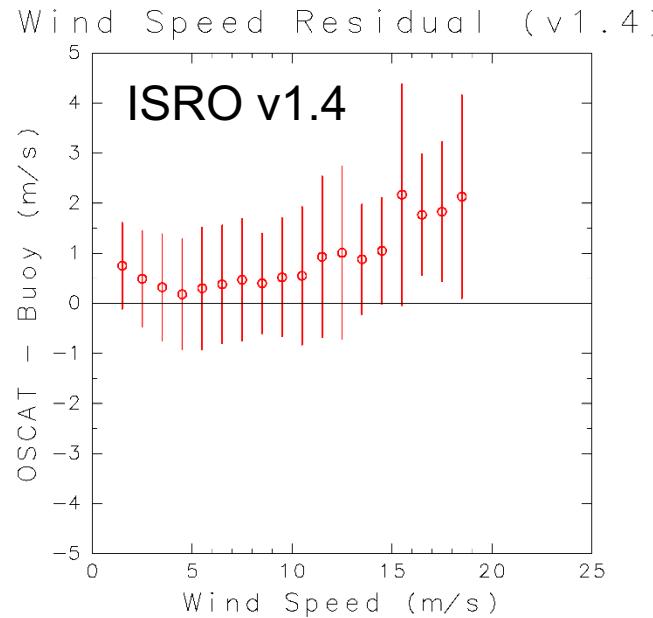
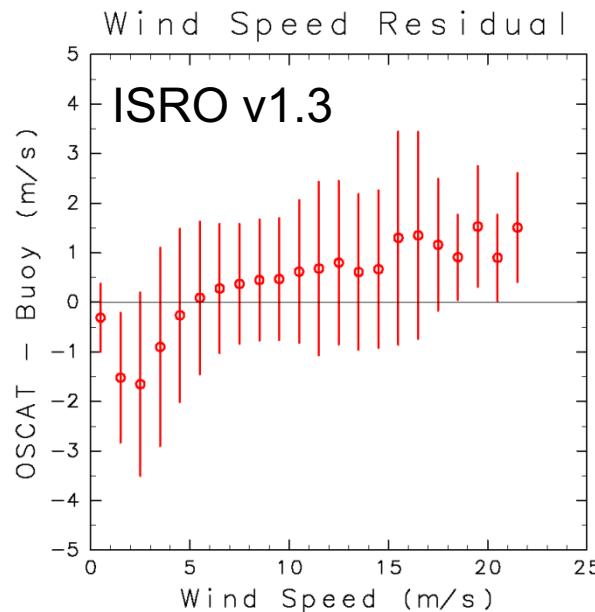


# Comparisons with Buoy Measurements (2)

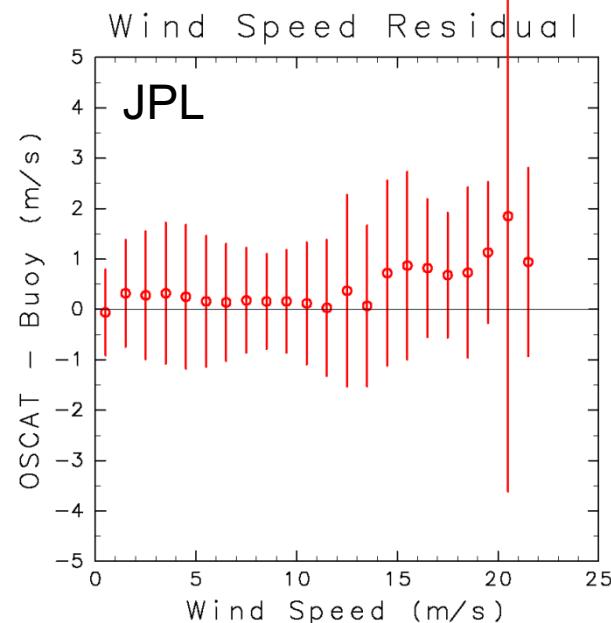
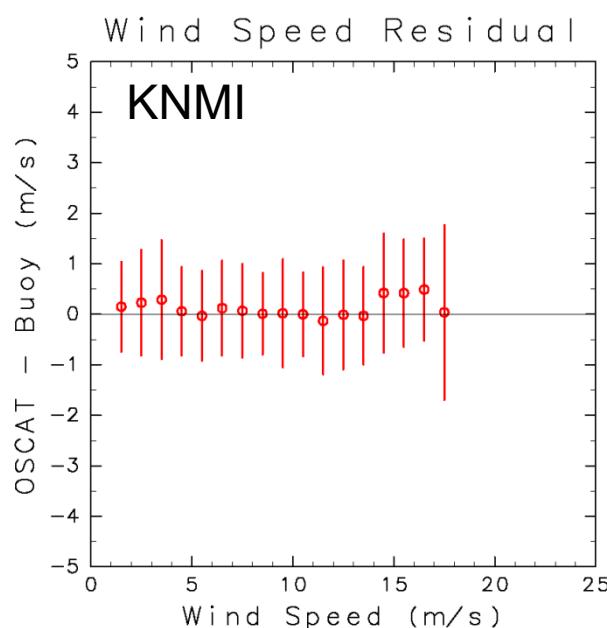
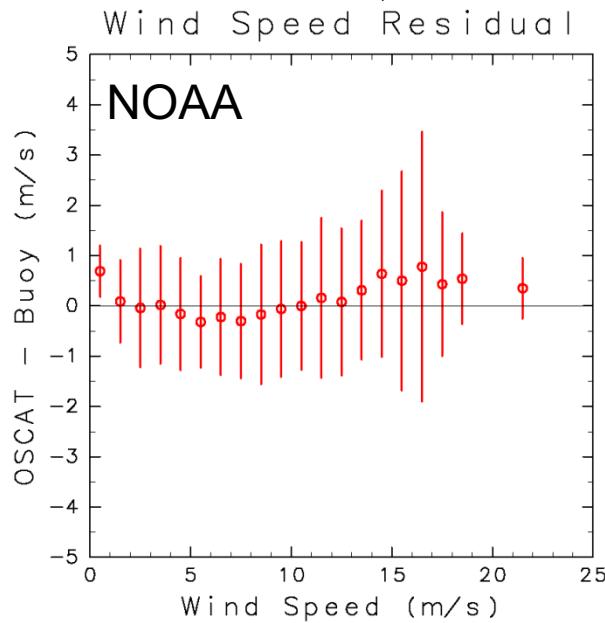


Binning wind speed  
 $= (U_{buoy} + U_{scat})/2$

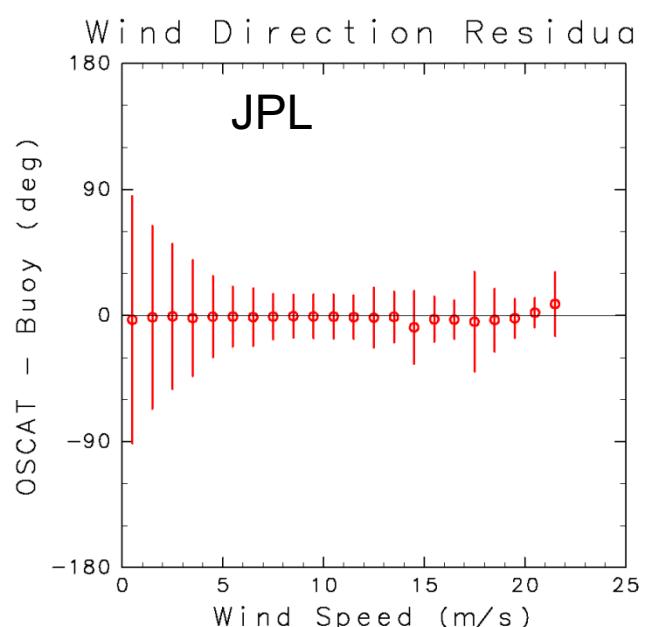
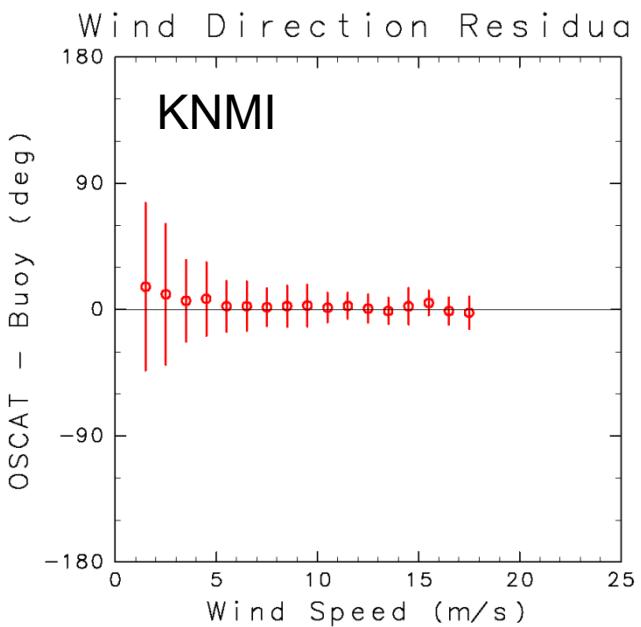
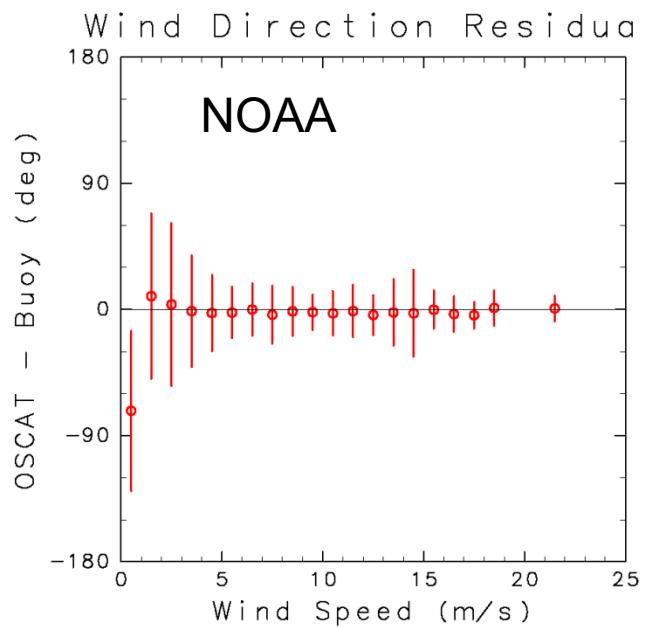
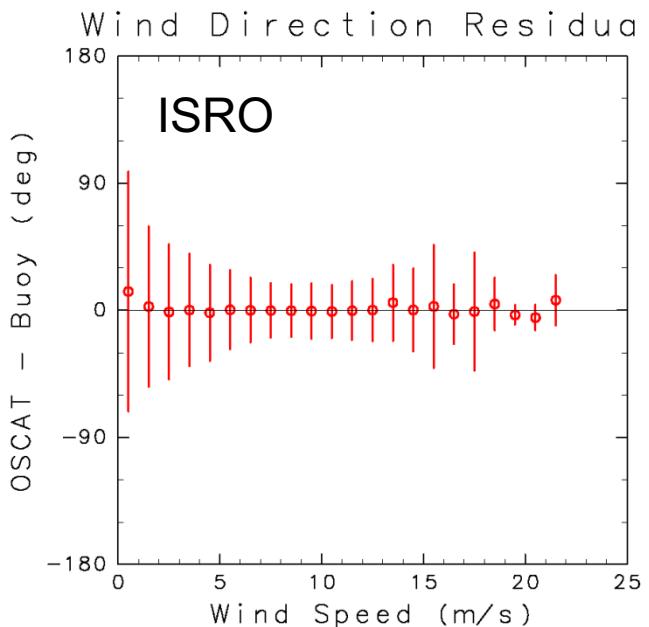
# Comparisons of Wind Speed (2)



Binning wind speed  
 $= (U_{buoy} + U_{scat})/2$



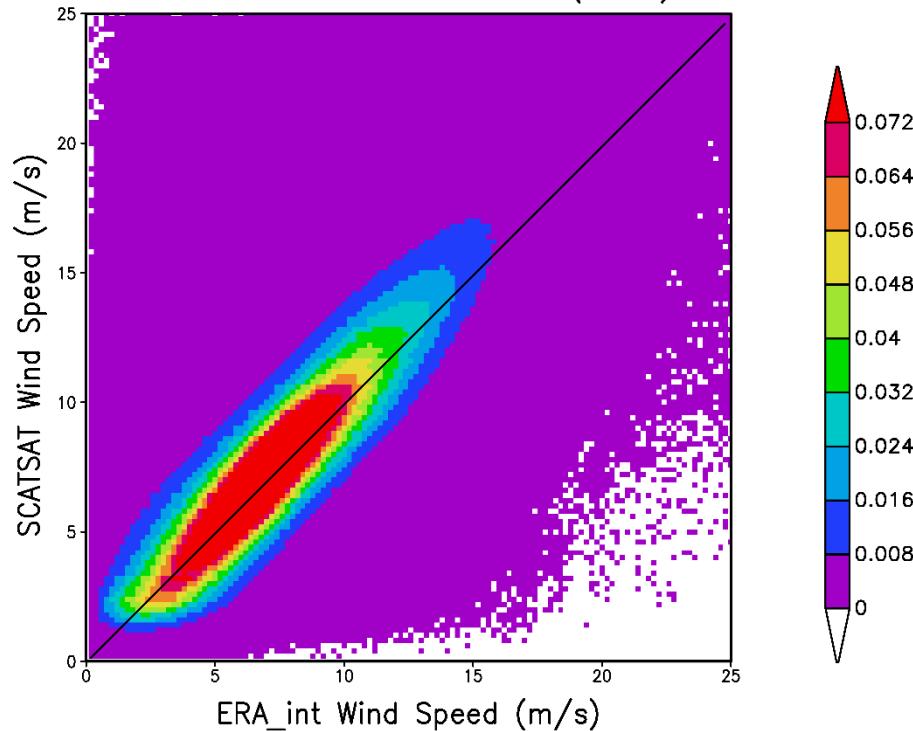
# Comparisons of Wind Direction (2)



# Comparisons with ERA Interim (1)

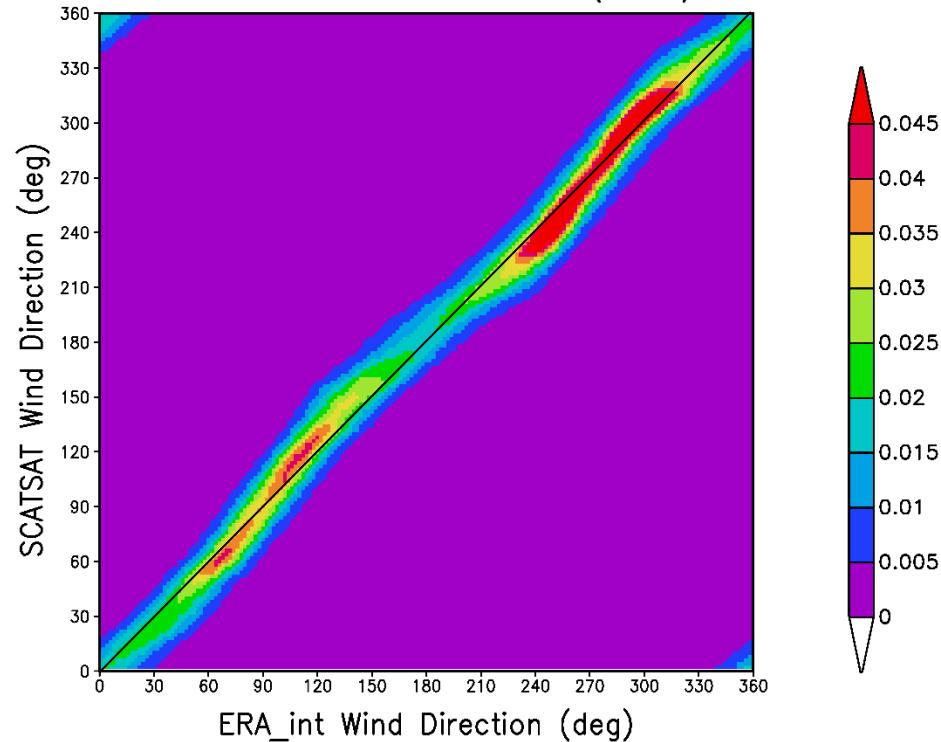
Wind Speed

Oct 2016 – Jan 2017 (beta)



Wind Direction (U> 3 m/s)

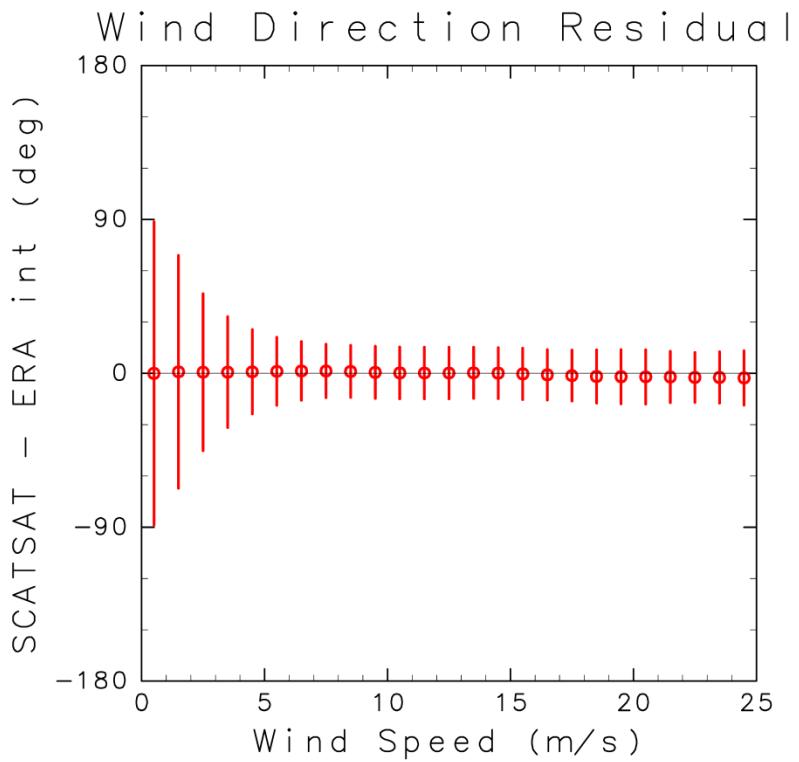
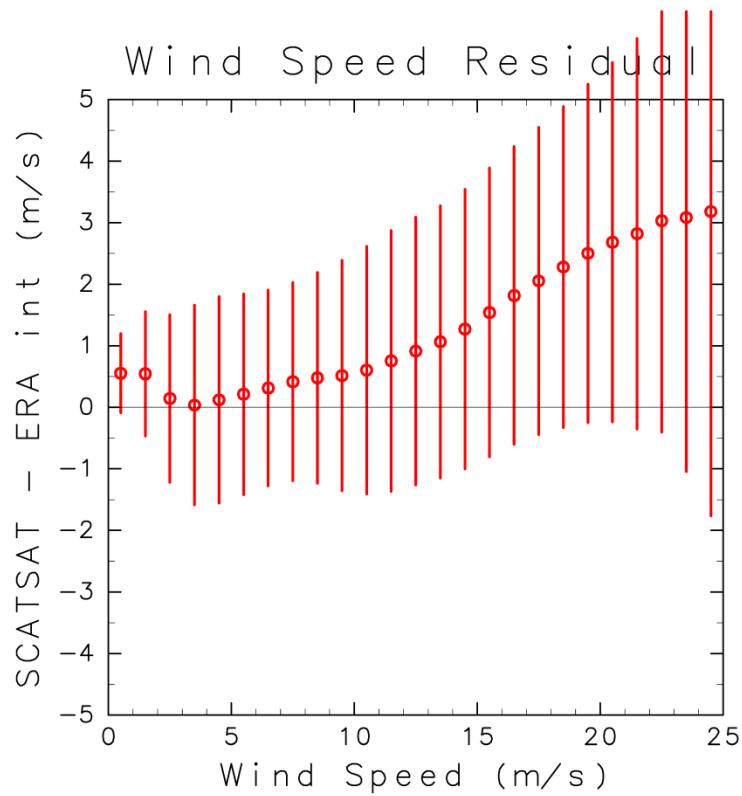
Oct 2016 – Jan 2017 (beta)



Bin size = 0.2 m/s

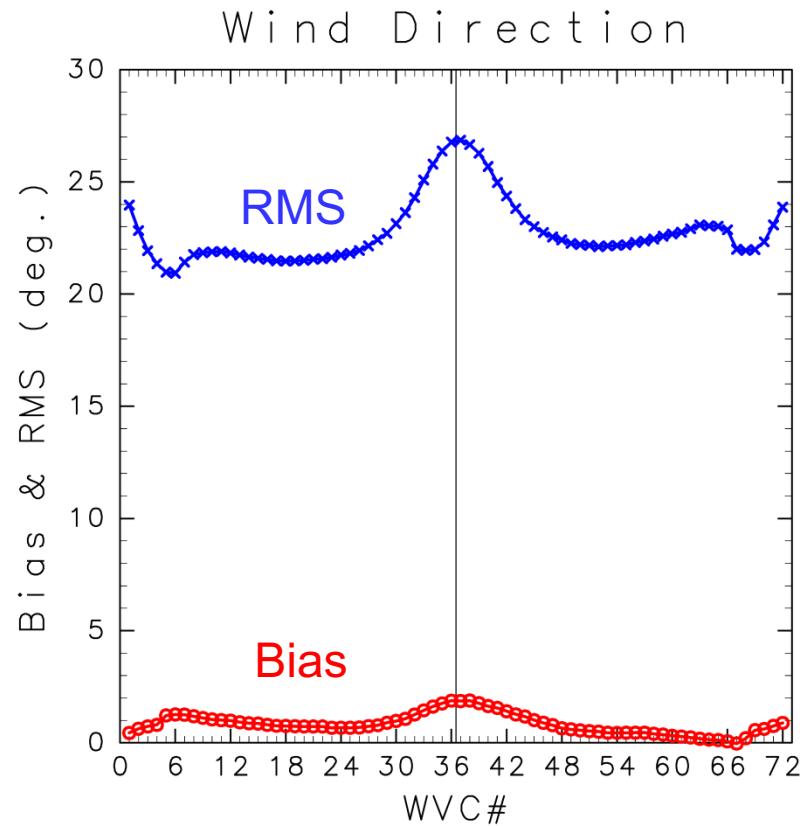
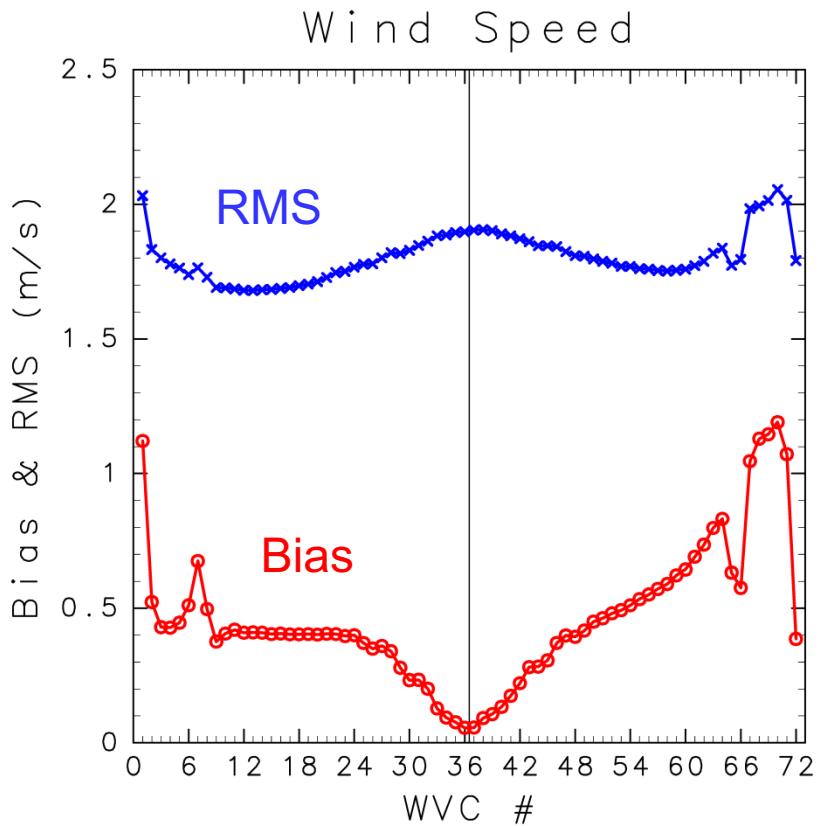
Bin size = 5 deg.

# Comparisons with ERA Interim (2)



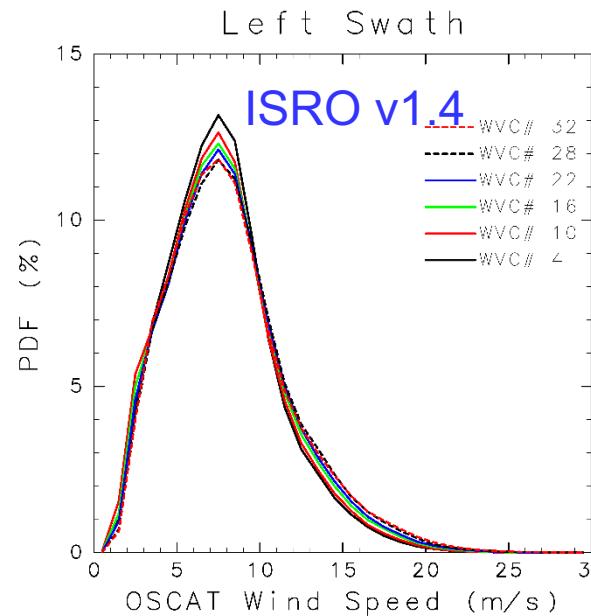
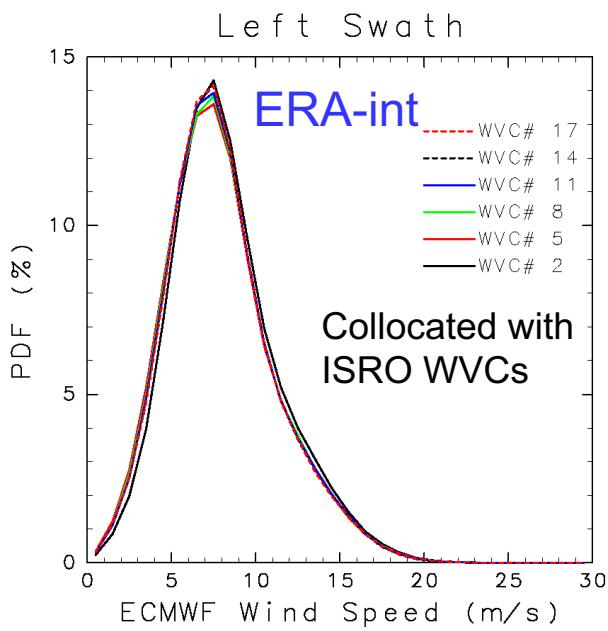
Binning wind speed =  $(U_{ERA} + U_{scat})/2$

# Comparisons with ERA Interim (3)

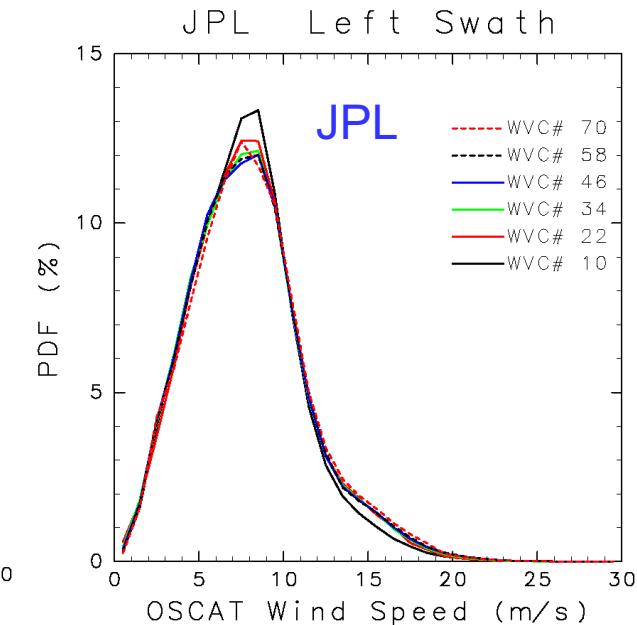
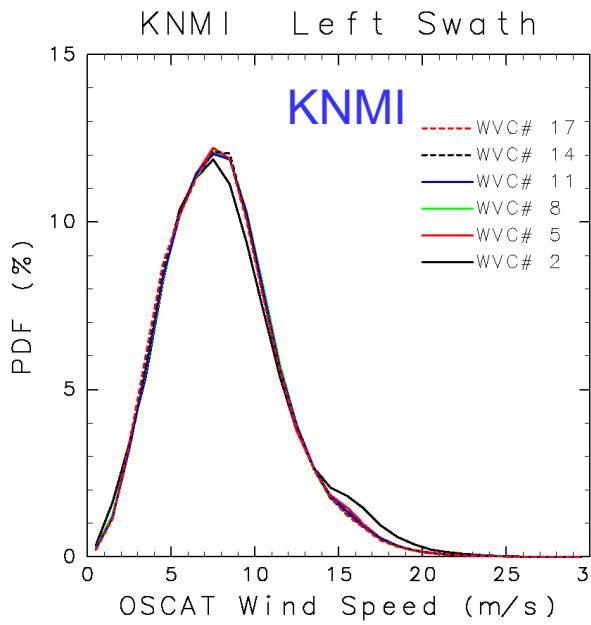
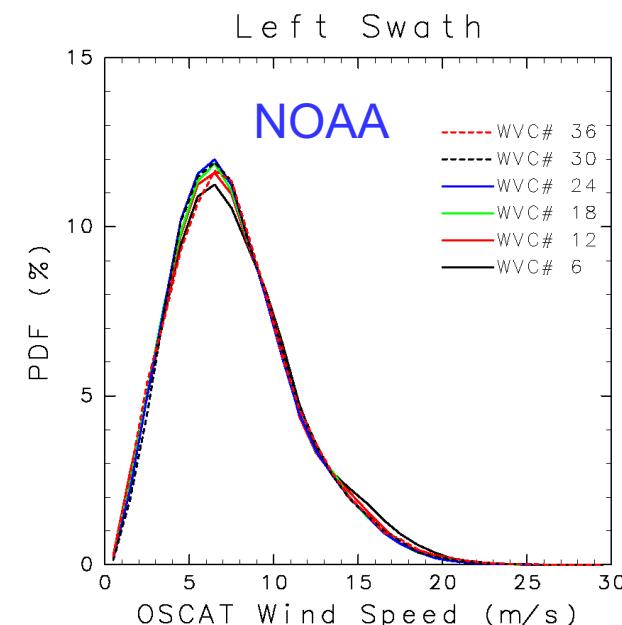


**OSCAT**

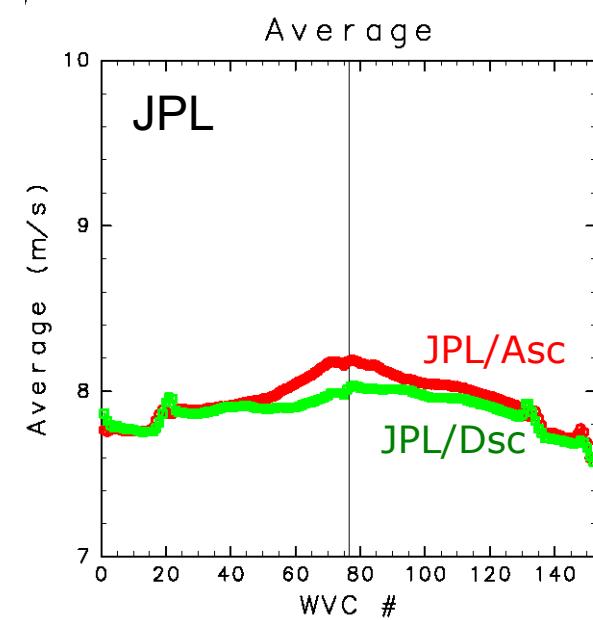
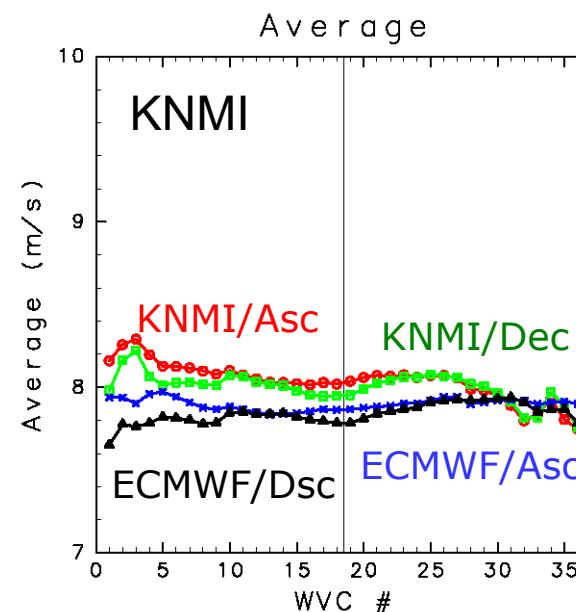
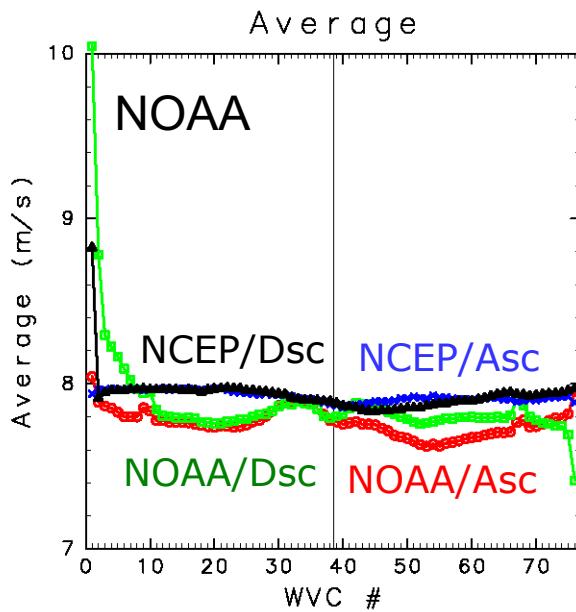
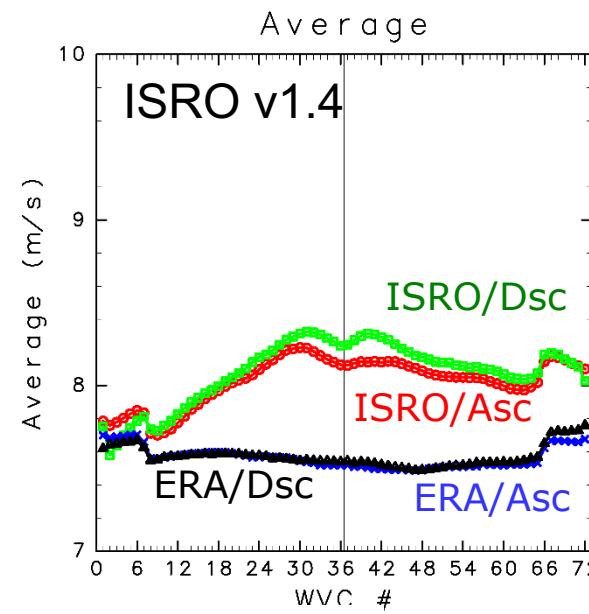
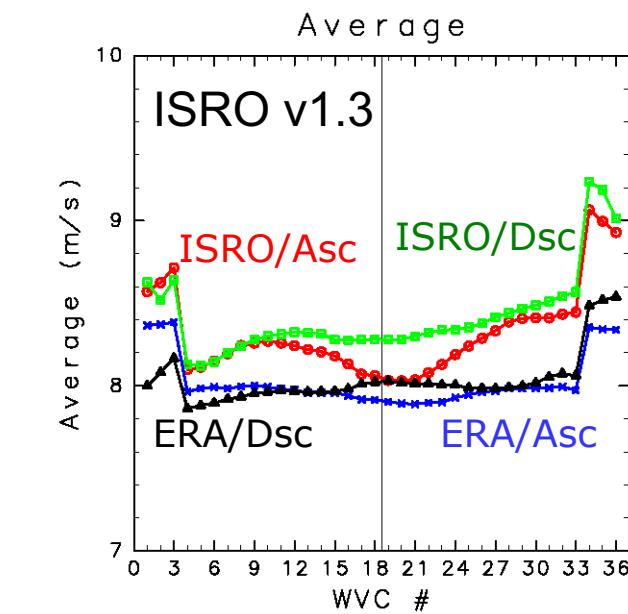
# Global Wind Speed Histograms



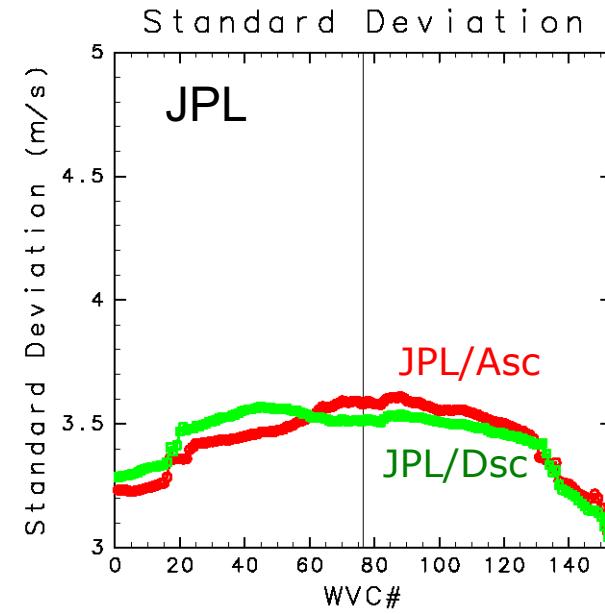
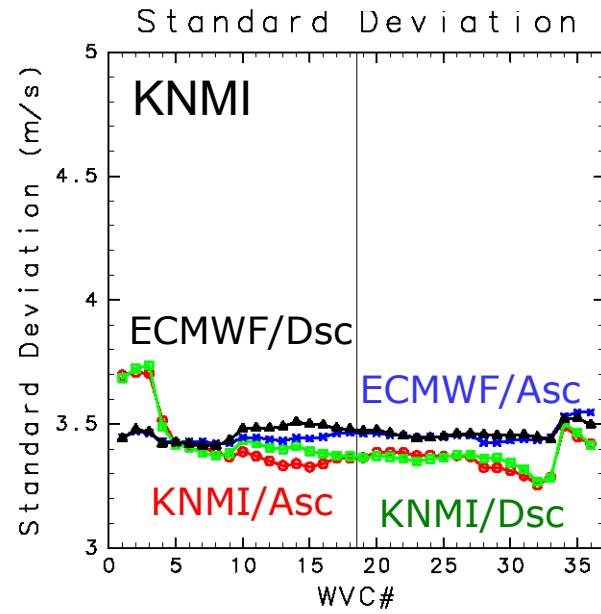
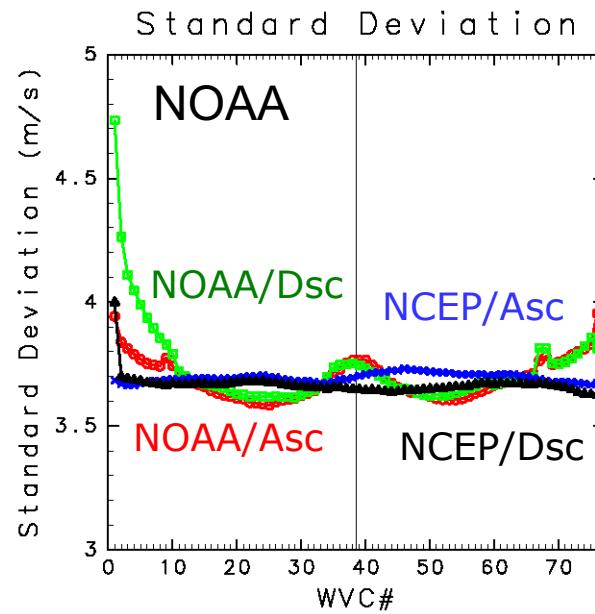
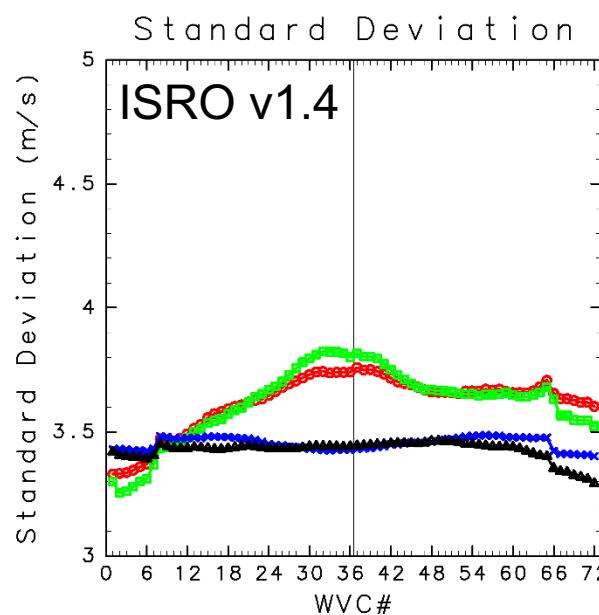
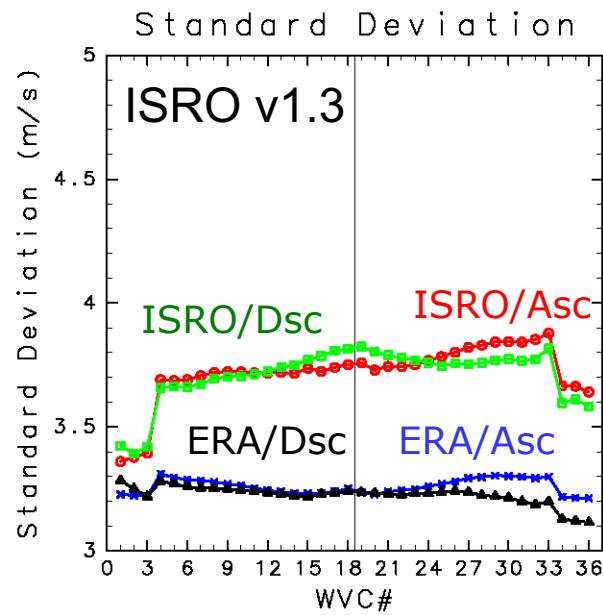
60°S – 60°N  
Bin size = 1 m/s



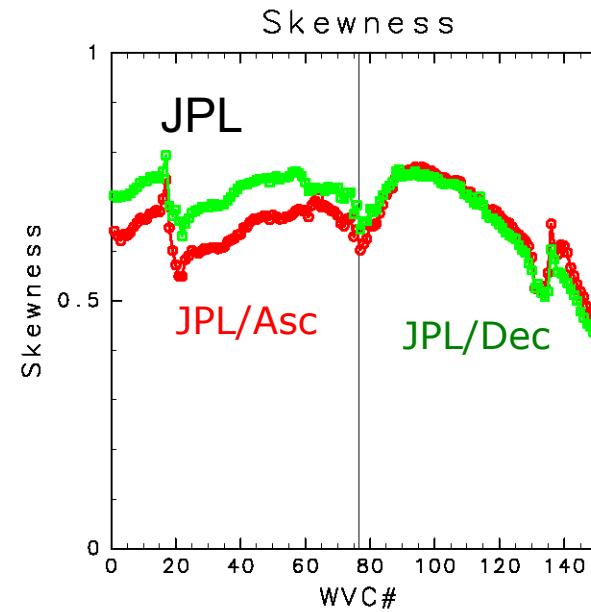
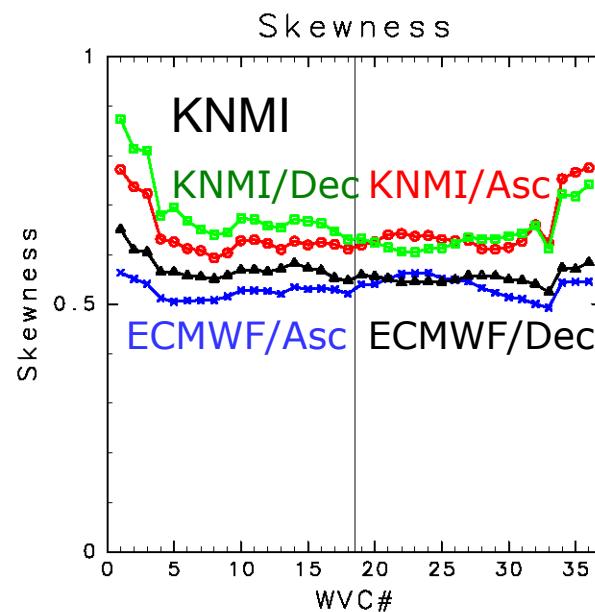
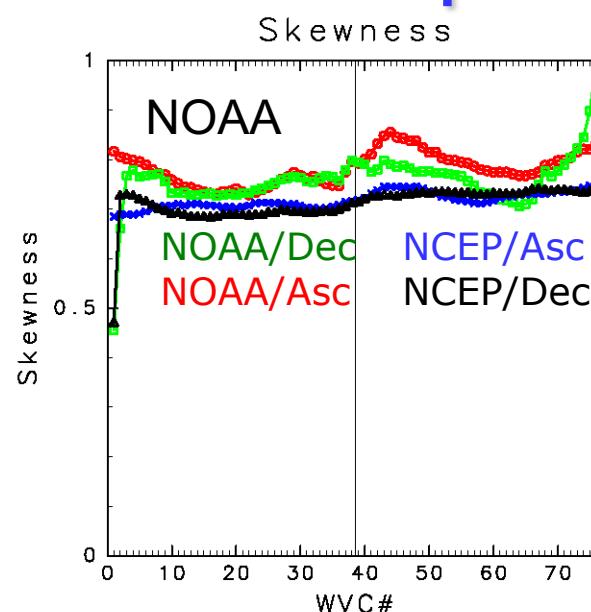
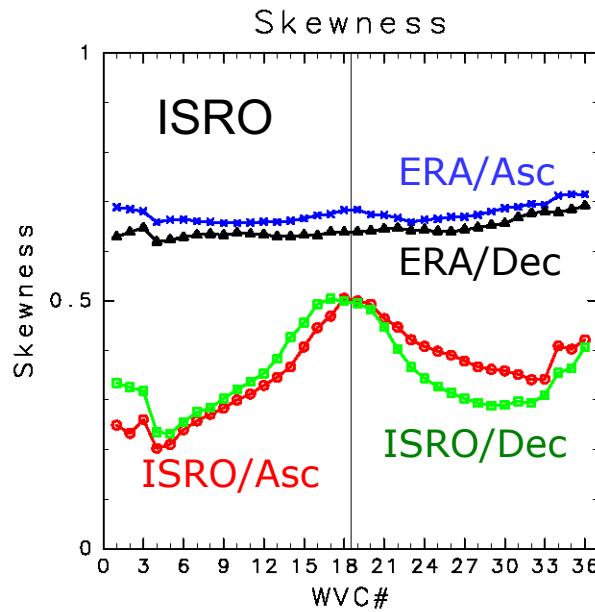
# Global Mean Wind Speed



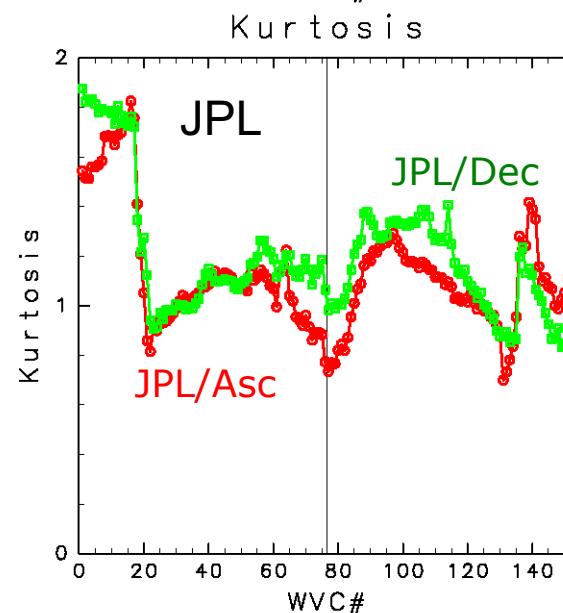
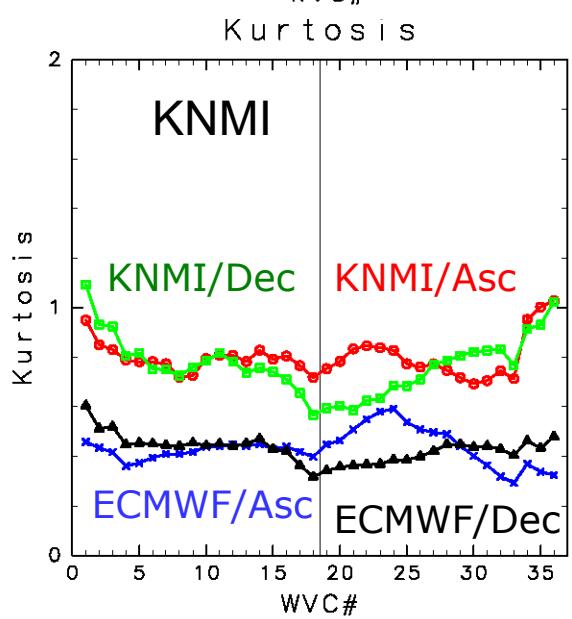
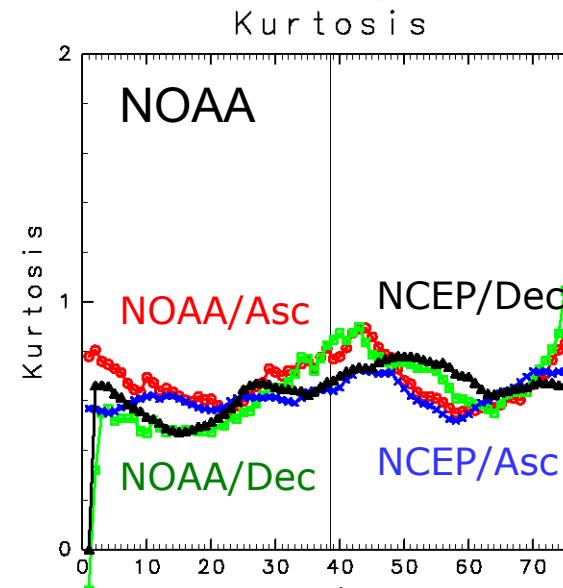
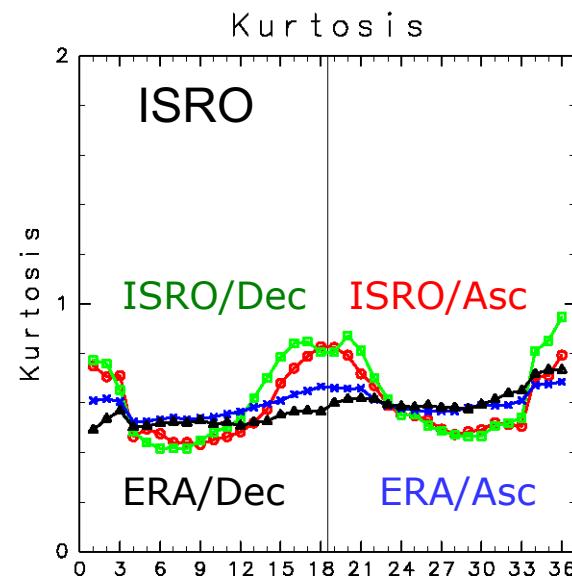
# Standard Deviation of Wind Speed



# Skewness of Wind Speed

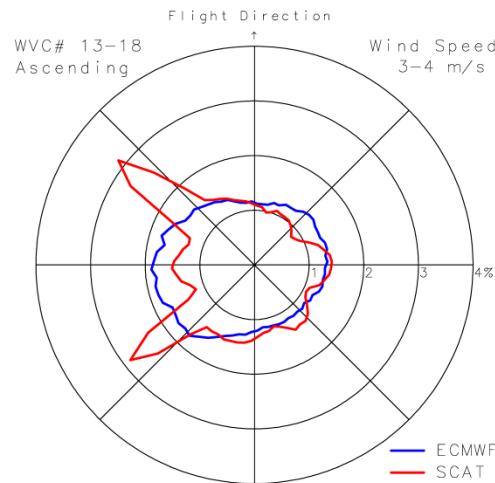


# Kurtosis of Wind Speed

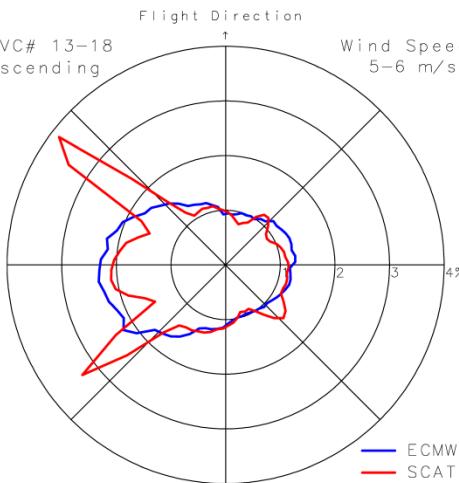


# Wind Speed Dependence of Wind Direction Histograms (Mid Cells)

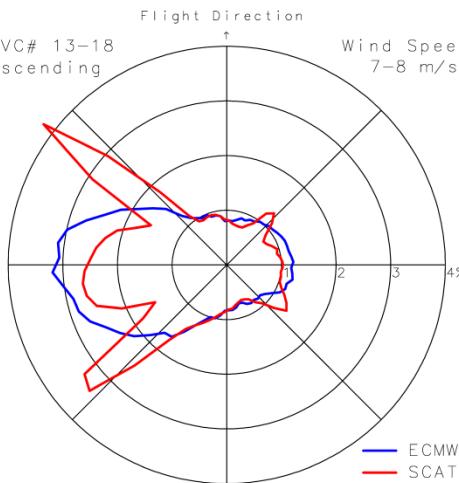
3-5 m/s



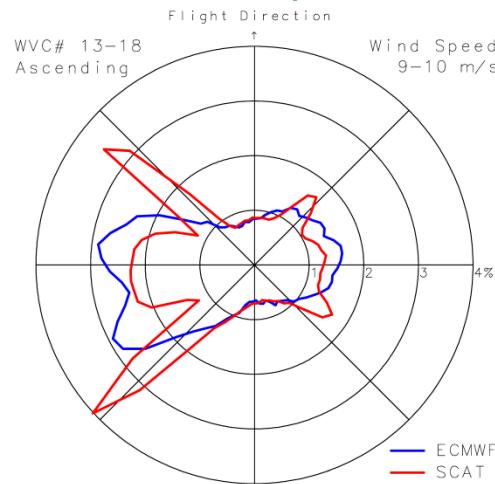
5-7 m/s



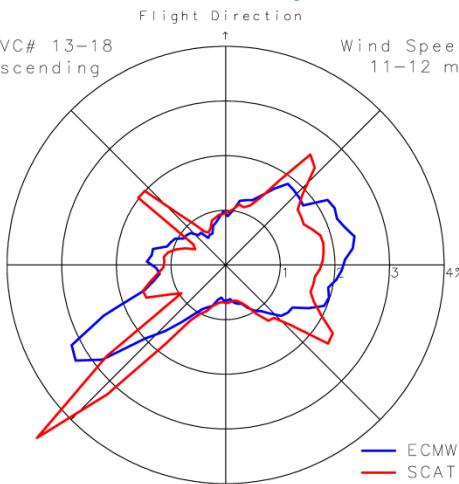
7-9 m/s



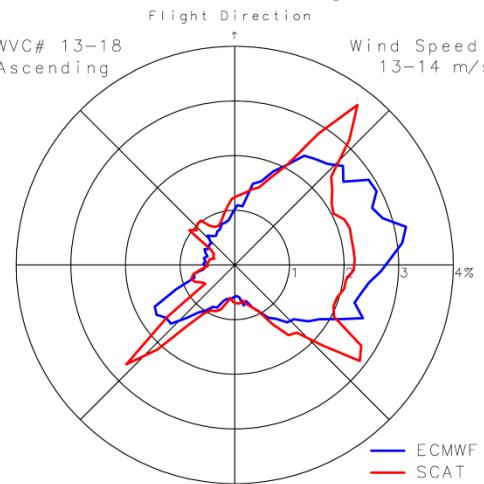
9-11 m/s



11-13 m/s



13-15 m/s



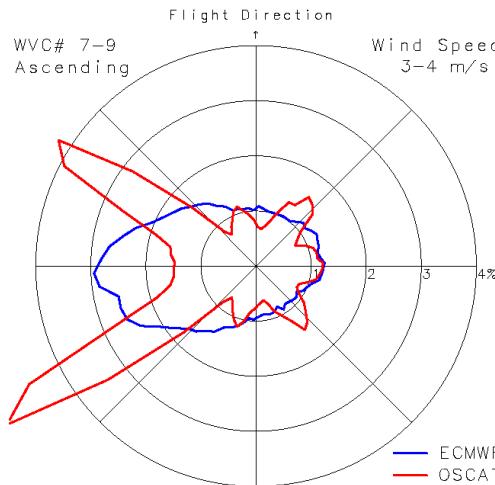
ERA-int  
SCATSAT

WVC#: 13-18 (Left Mid Swath)

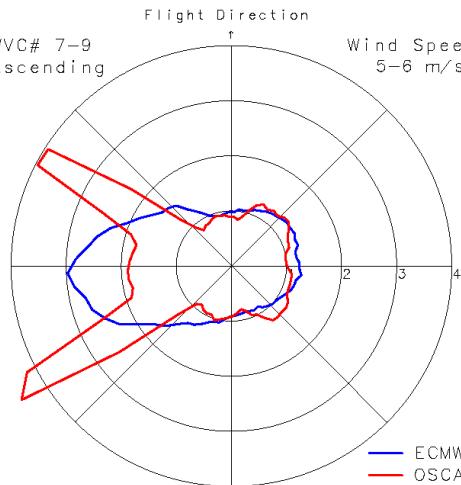
# Wind Speed Dependence of Wind Direction Histograms (Mid Cells, ISRO v1.3)

OSCAT

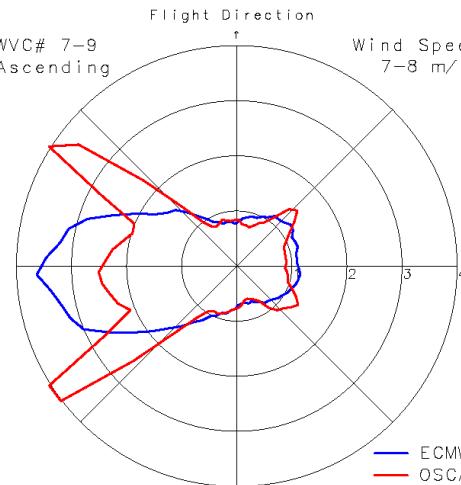
3-5 m/s



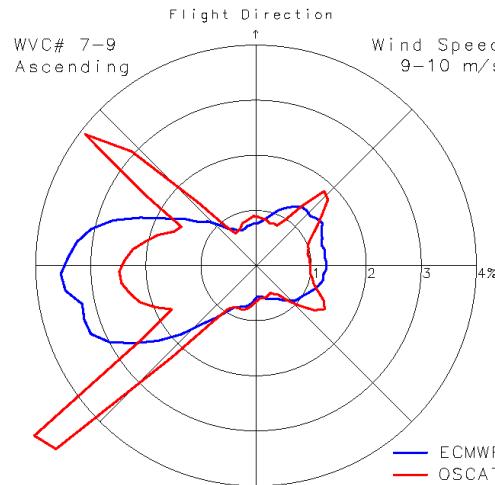
5-7 m/s



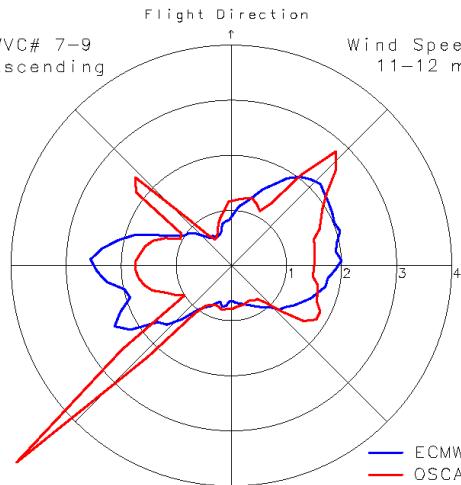
7-9 m/s



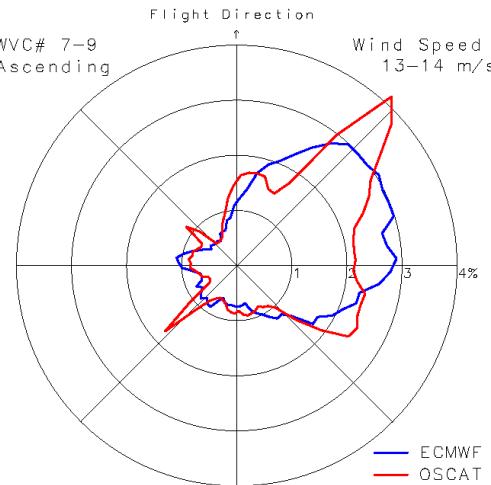
9-11 m/s



11-13 m/s



13-15 m/s

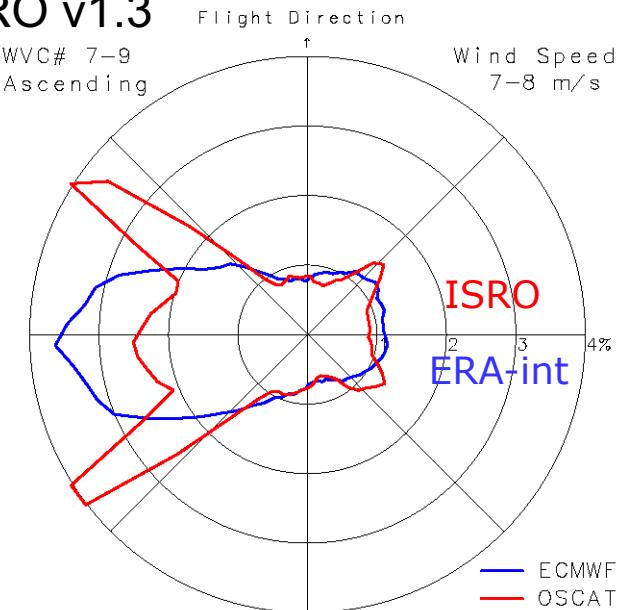
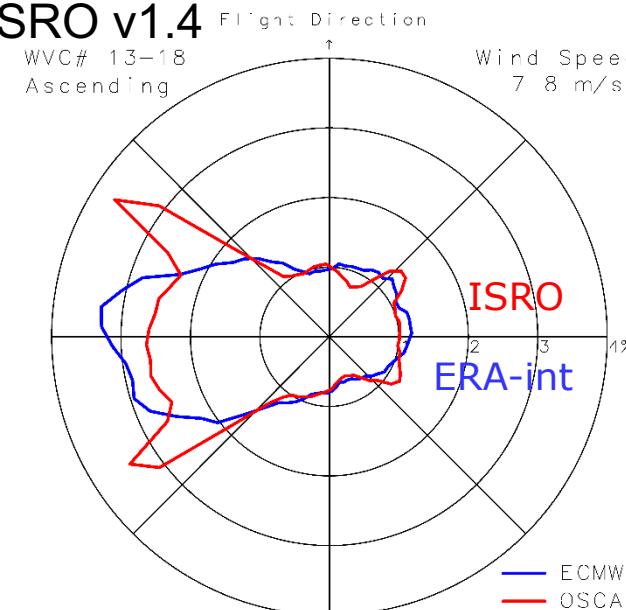


ERA-int  
ISRO

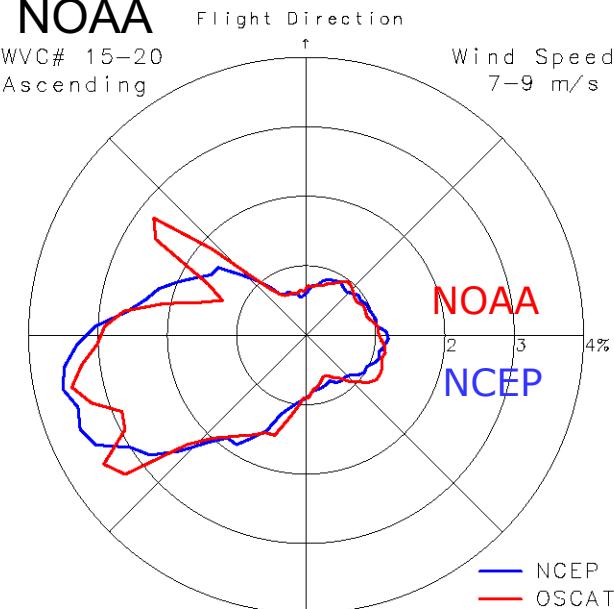
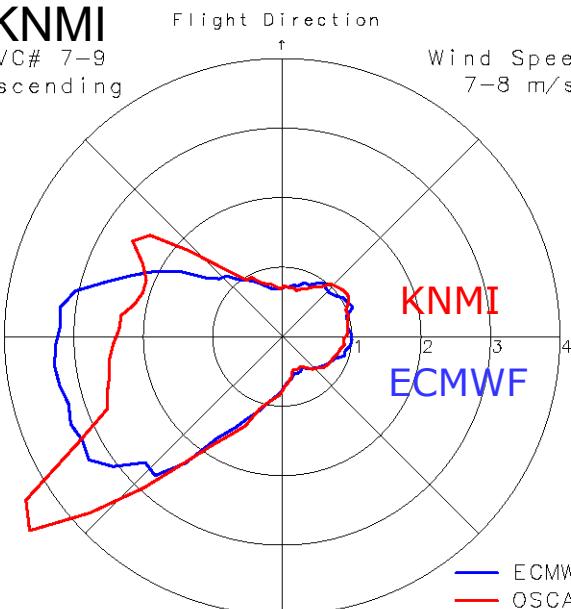
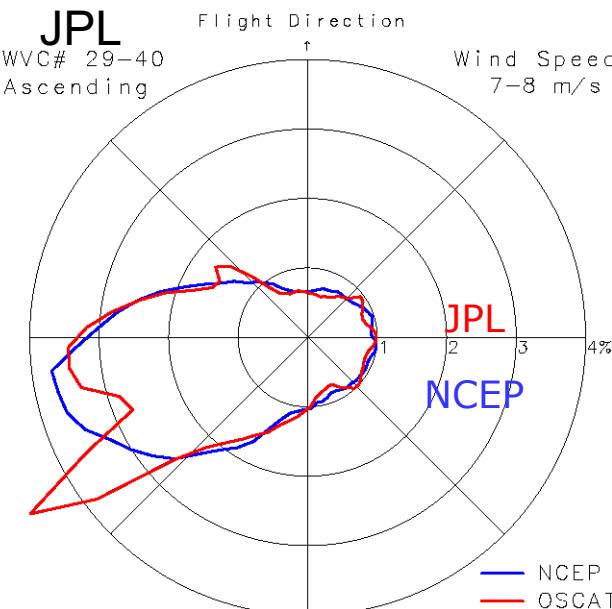
WVC#: 7-9 (Left Mid Swath)

**OSCAT**

# Histograms of Wind Direction

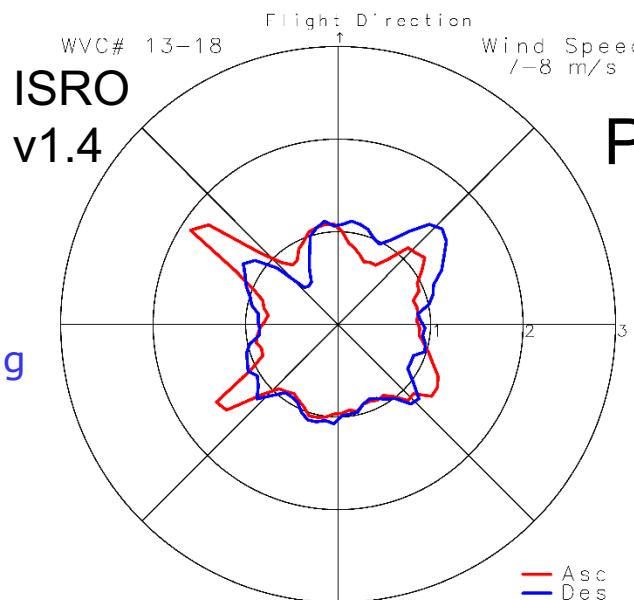
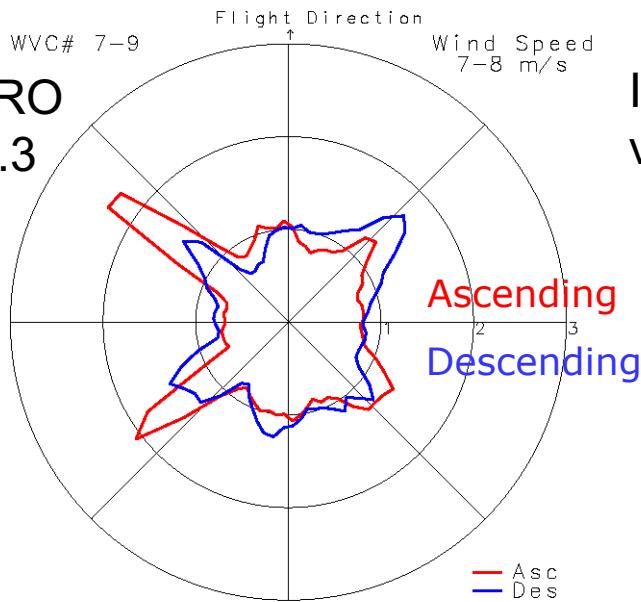
**ISRO v1.3****ISRO v1.4**

Ascending paths  
Left swath  
Mid cell  
Wind speed  
= 7–9 m/s  
Bin size = 5 deg.

**NOAA****KNMI****JPL**

# Normalized Histograms of Wind Direction

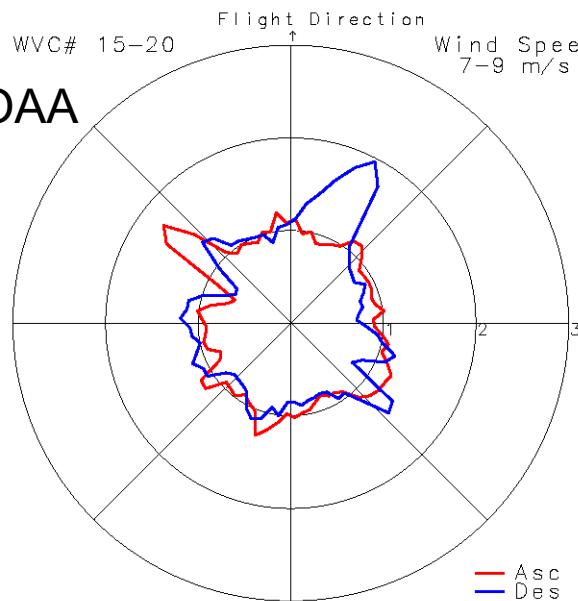
ISRO  
v1.3



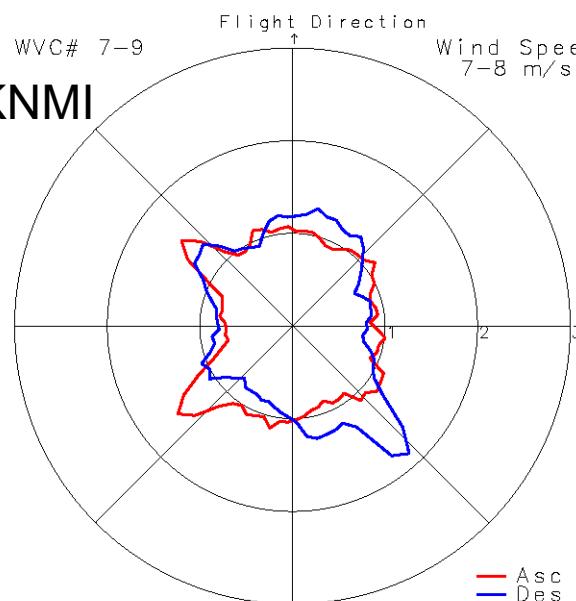
$\text{PDF}_{\text{OSCAT}}/\text{PDF}_{\text{NWP}}$

Left swath  
Mid cell  
Wind speed  
= 7-9 m/s  
Bin size = 5 deg.

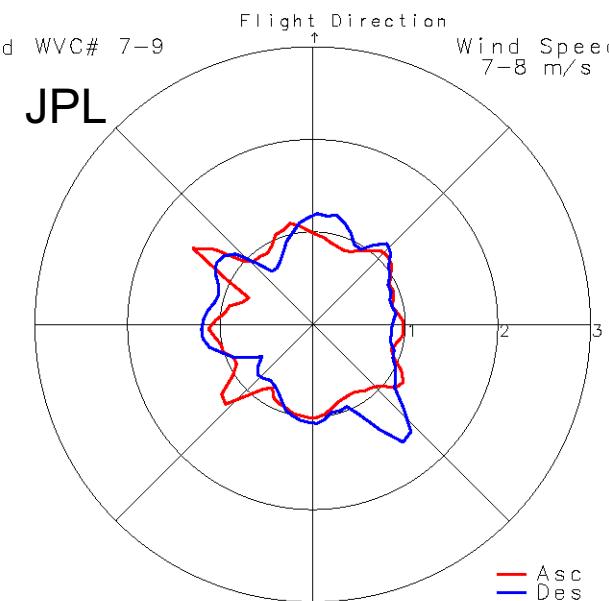
NOAA



KNMI



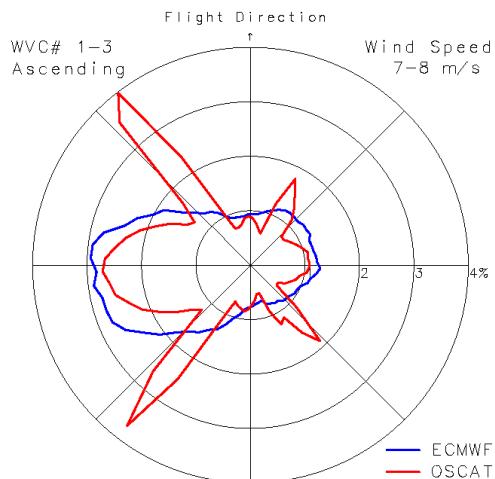
JPL



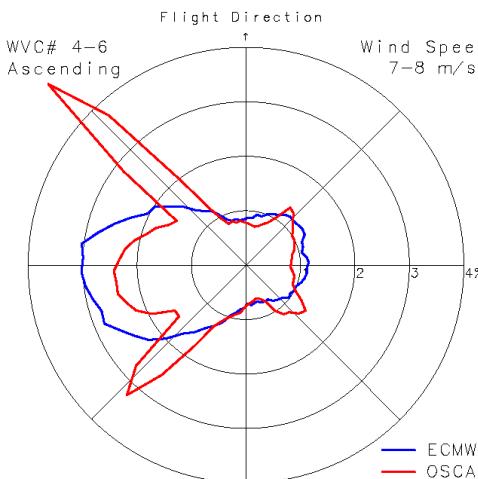
**OSCAT**

# OSCAT Wind Direction Histograms

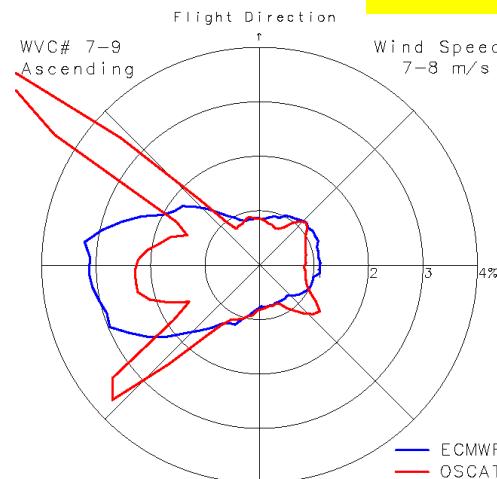
WVC# 1-3



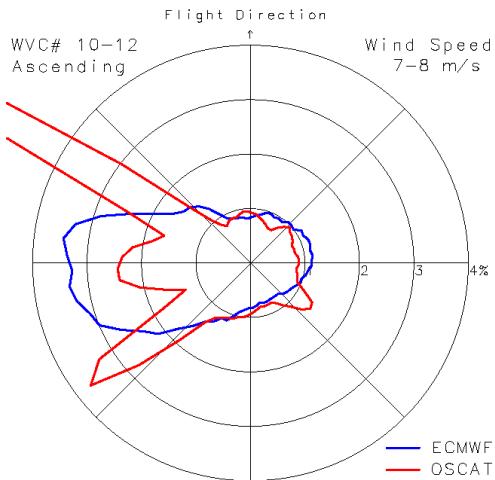
WVC# 4-6



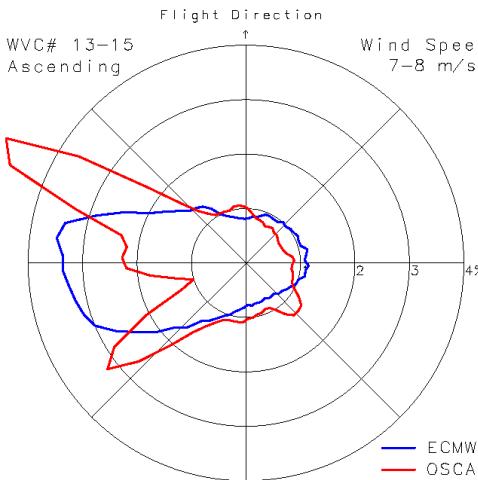
WVC# 7-9

**Old Version**

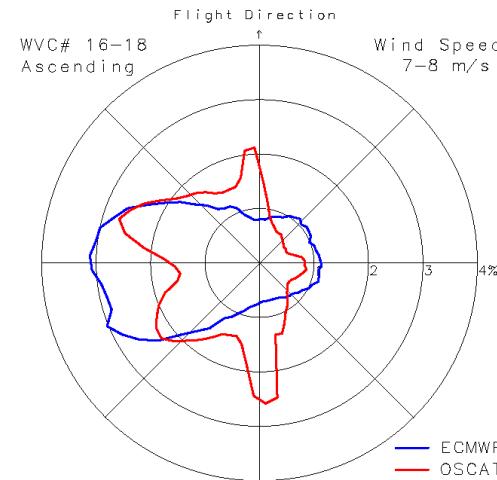
WVC# 10-12



WVC# 13-15

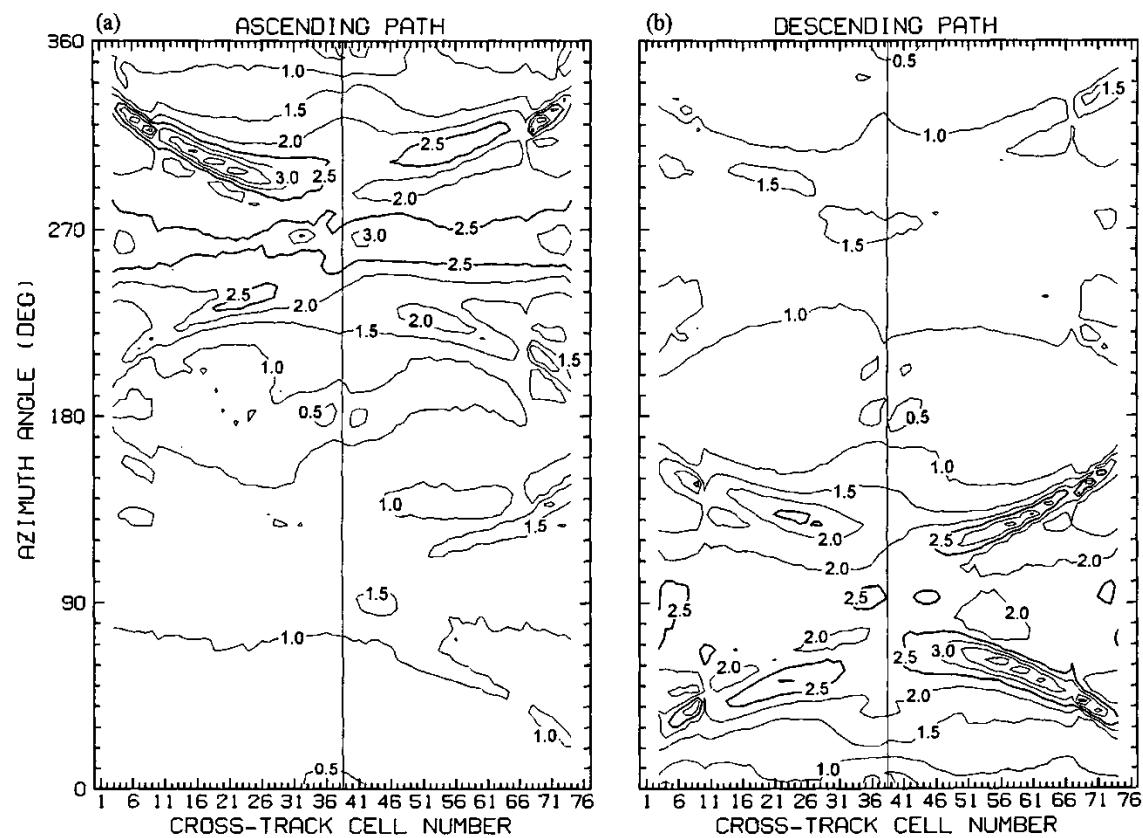
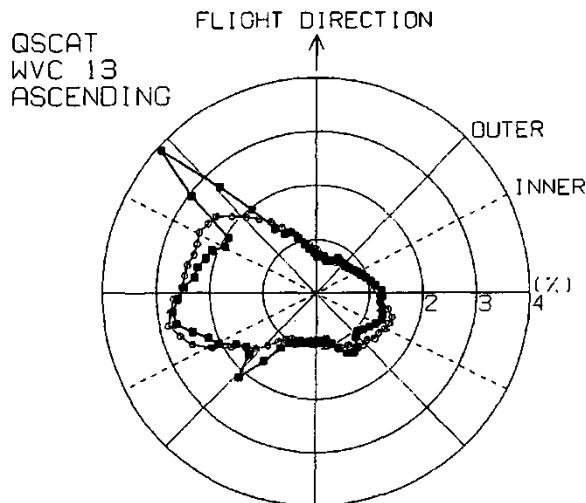


WVC# 16-18

**ECMWF  
OSCAT**

Left Swath, Wind Speed Range: 7-9 m/s, Ascending Paths

# Histograms of QSCAT Wind Directions



(Ebuchi, Proc. IGARSS 2000, 2000)