



# Evaluation of COWVR as a Cost-Effective Sensor for Providing Climate Data Records of Ocean Vector Winds and Other Air-Sea Variables

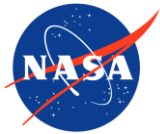
IOVWST Meeting

2024-05-29

P.I. Richard Lindsley

Co. I. Frank Wentz and Katherine Wentz

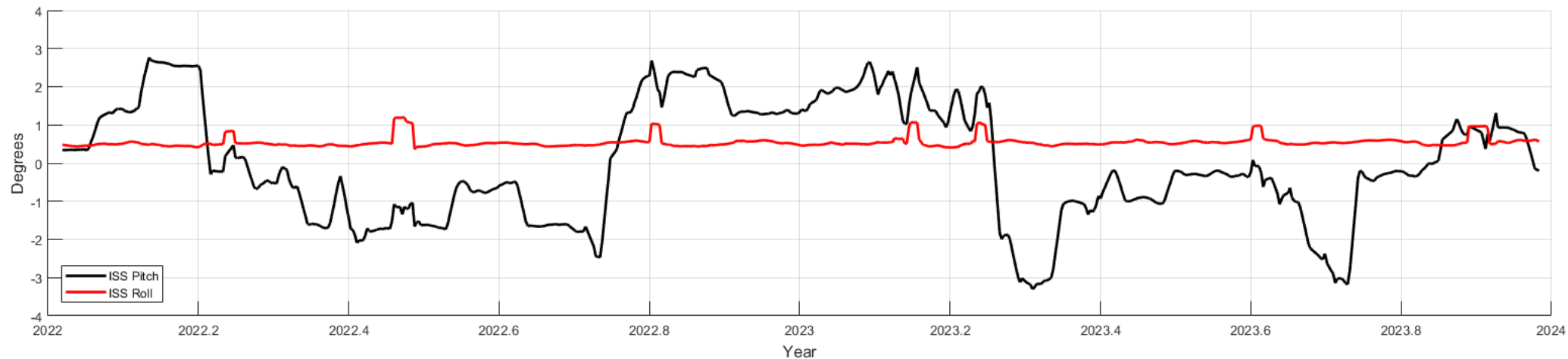
Acknowledgements: this work is supported by NASA OVVST



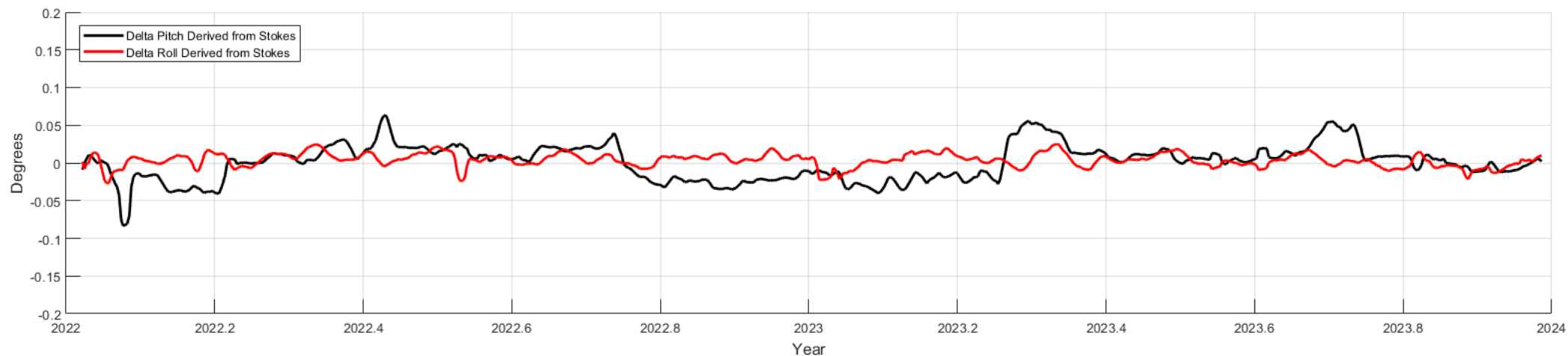
# Timeseries of COWVR Pitch and Roll Angles



As reported

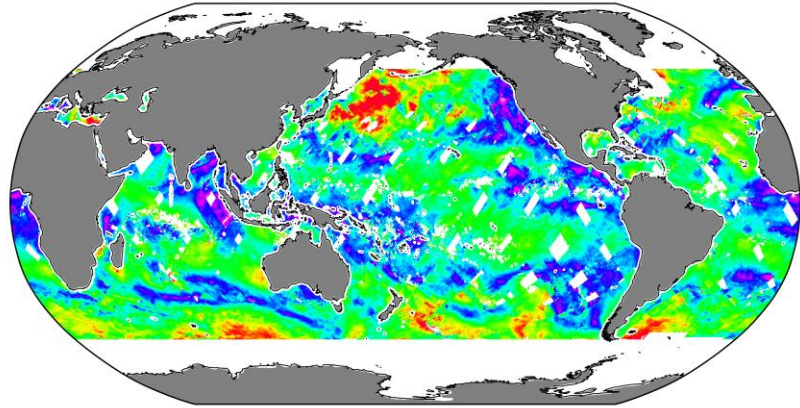


Adjustment derived from measured vs modeled 2<sup>nd</sup>/3<sup>rd</sup> Stokes TBs

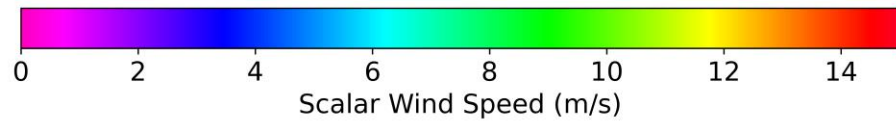
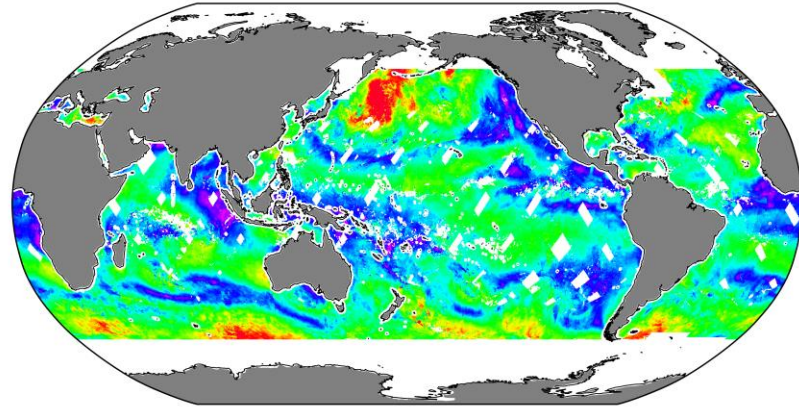




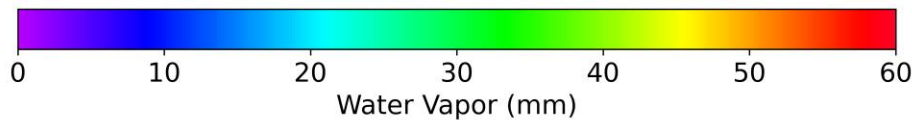
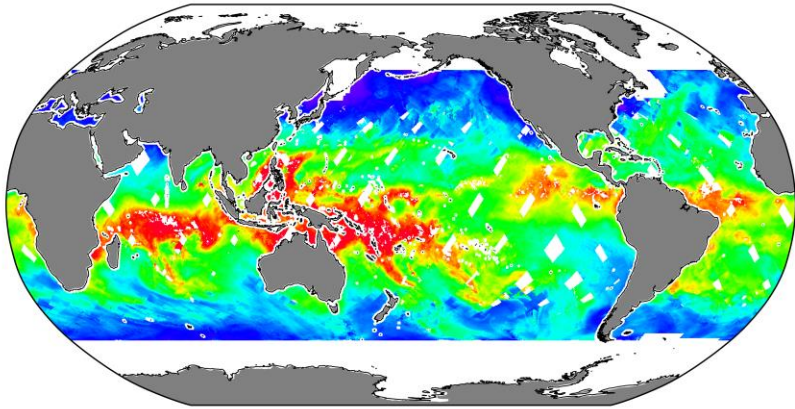
COWVR  
2022-01-25 to 2022-01-27



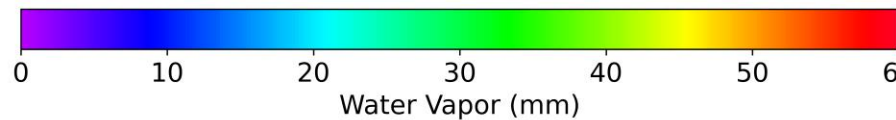
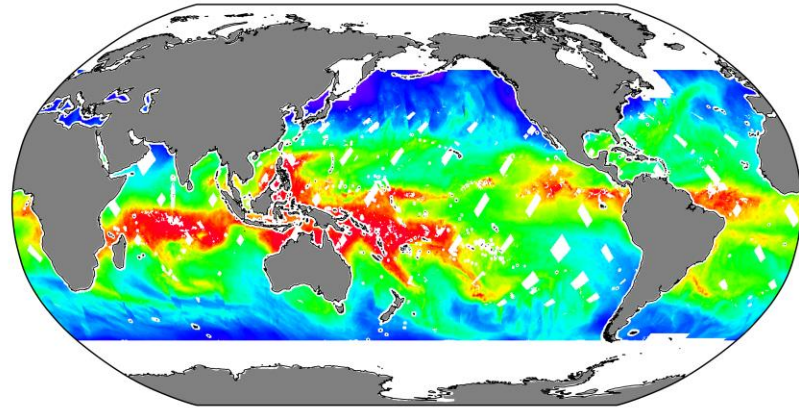
AMSR2  
2022-01-25 to 2022-01-27



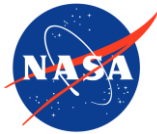
COWVR  
2022-01-25 to 2022-01-27



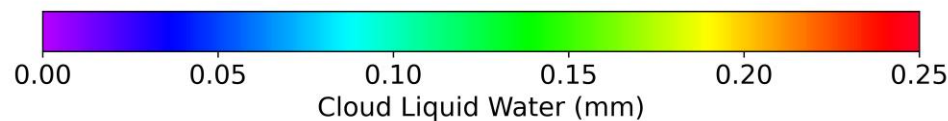
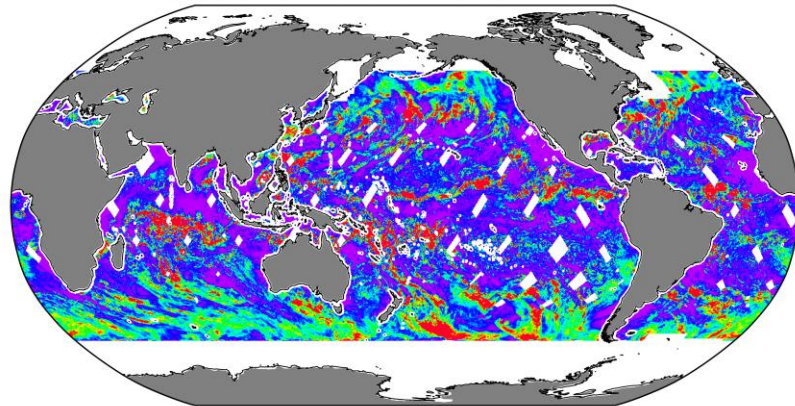
AMSR2  
2022-01-25 to 2022-01-27



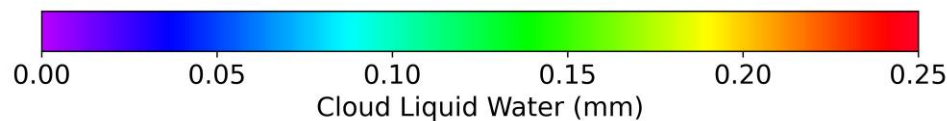
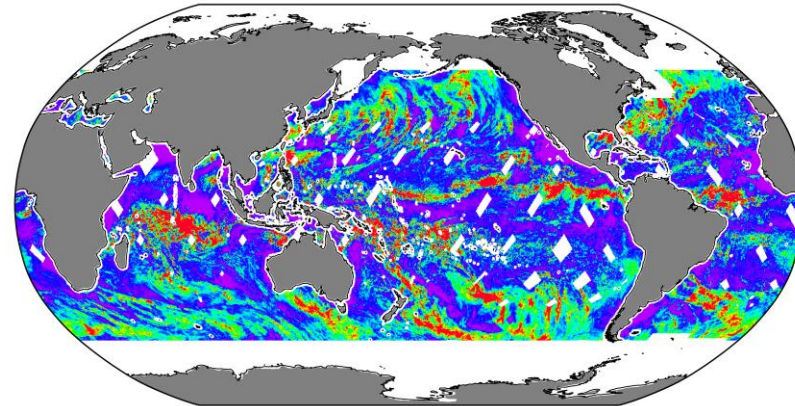




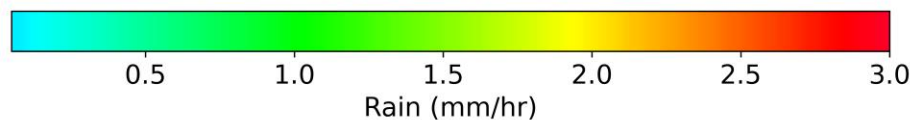
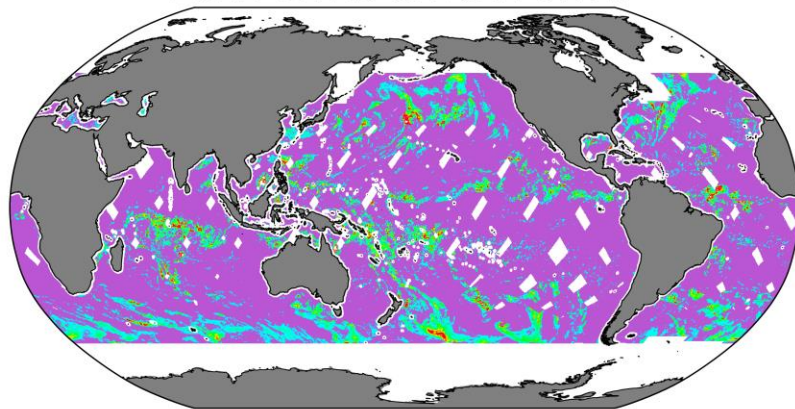
COWVR  
2022-01-25 to 2022-01-27



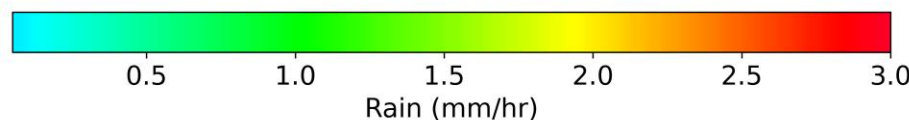
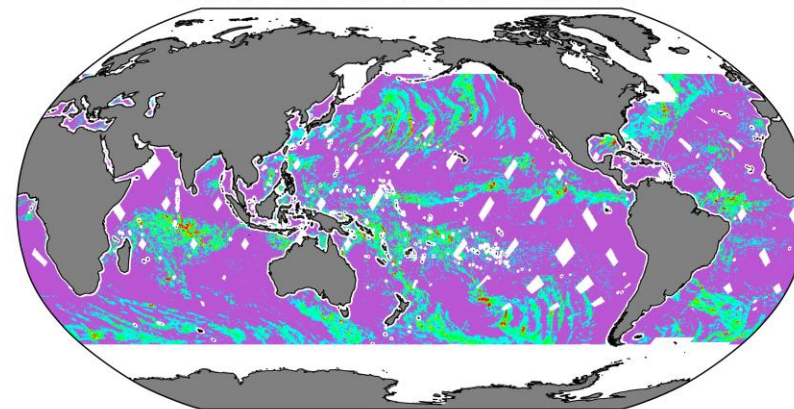
AMSR2  
2022-01-25 to 2022-01-27



COWVR  
2022-01-25 to 2022-01-27



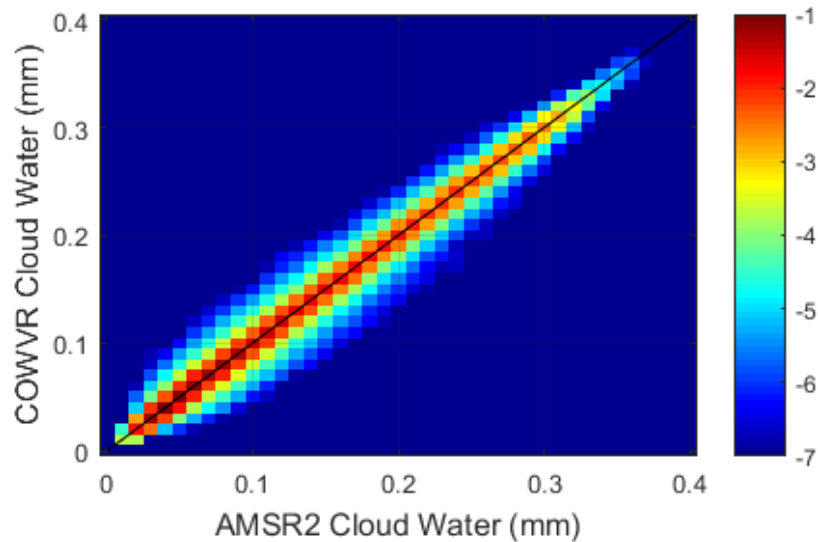
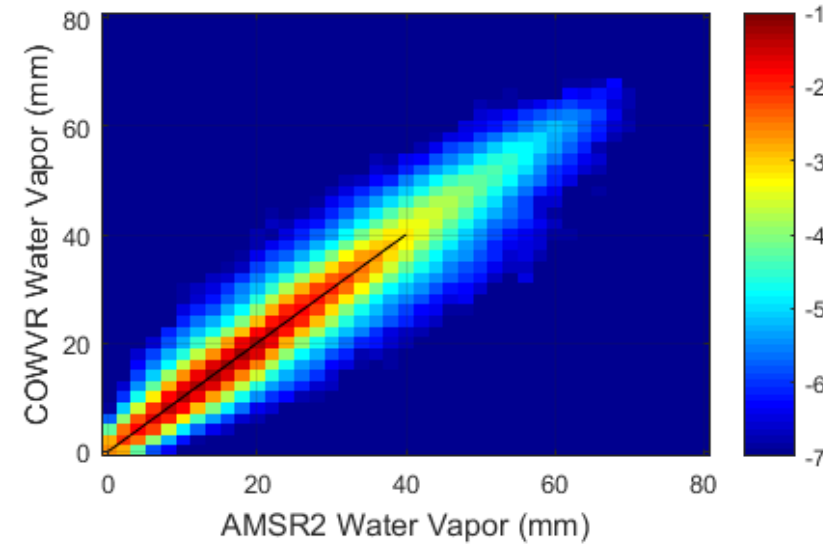
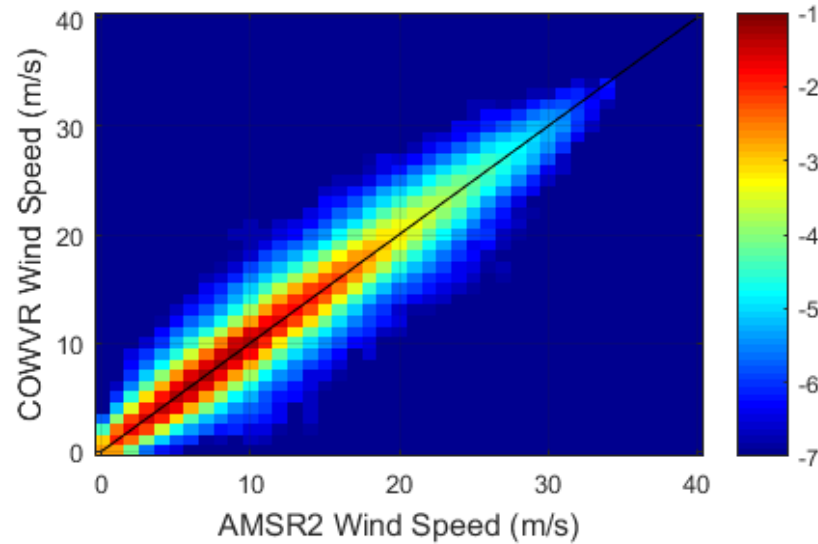
AMSR2  
2022-01-25 to 2022-01-27





# COWVR AS-ECV Comparisons

Remote Sensing Systems



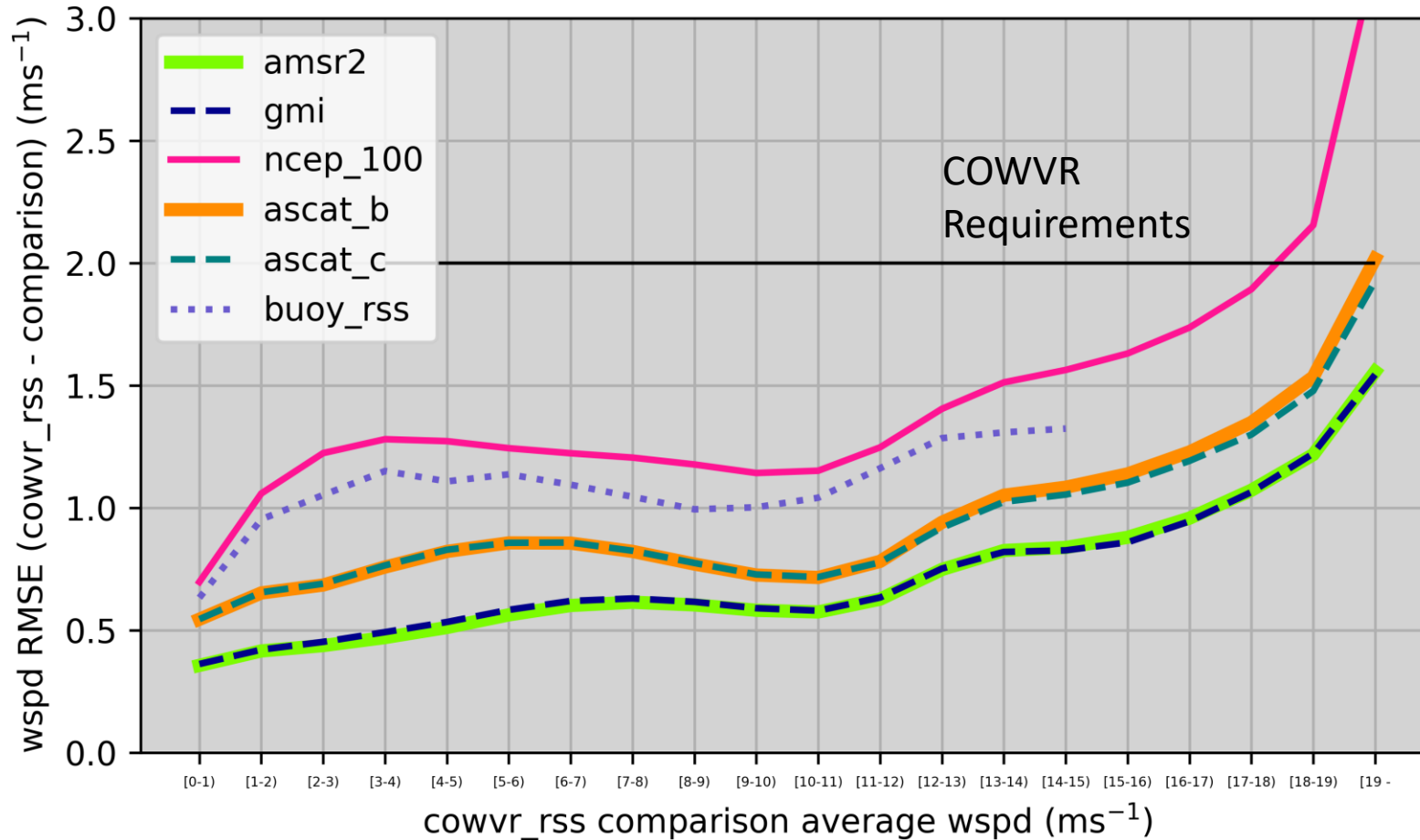
COWVR – AMSR2  
1-hour collocations for 2022 – 2023

	Mean	Std. Dev.
<b>Wind speed (m/s)</b>	-0.007	0.810
<b>Water vapor (mm)</b>	-0.034	1.018
<b>Cloud water (mm)</b>	0.001	0.020

GMI comparisons look nearly the same  
Note color bar scale is logarithmic

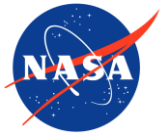


# Wind Speed Comparison



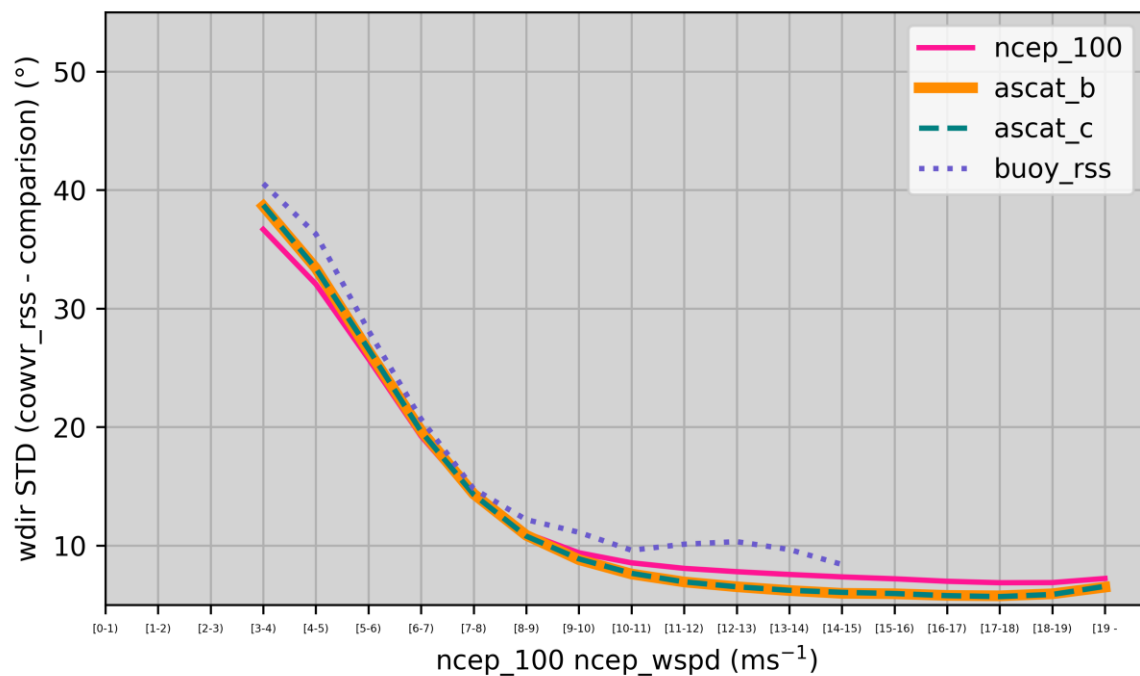
COWVR V901 Collocations for 2022-01-08 – 2023-12-26  
1 hour maximum time difference

Excluded: rain, RFI, severe sun glint, single-look retrievals  
For buoys only: excluded winds > 15 m/s

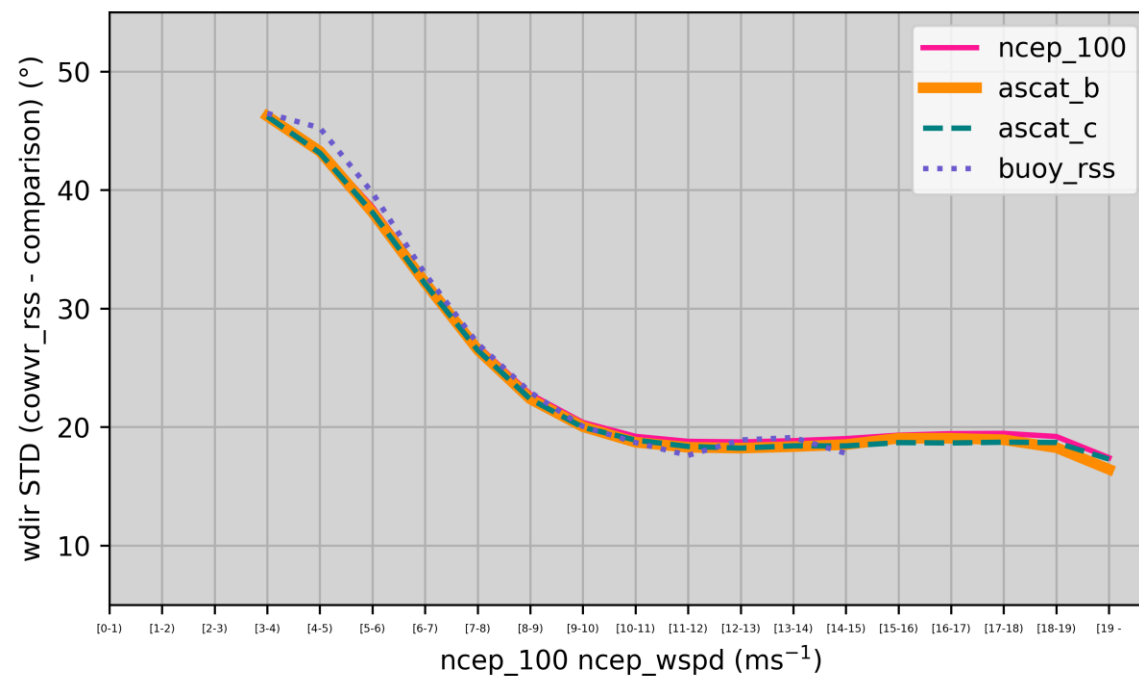


# Wind Direction Comparison

## Two Looks



## One Look

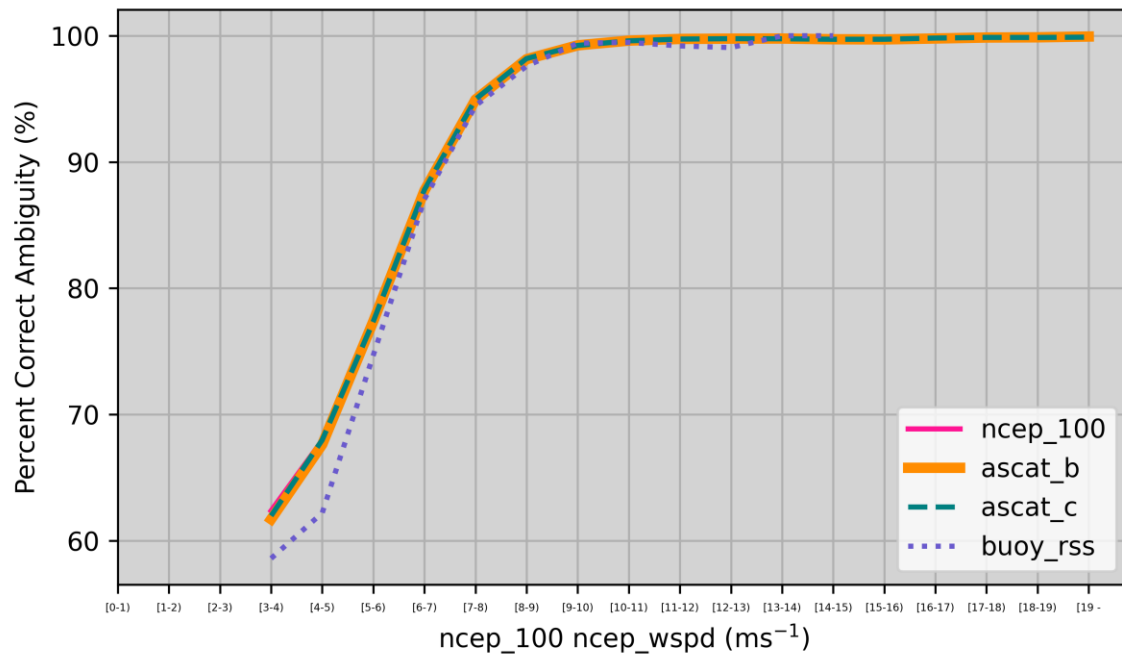


First-rank (lowest chi-squared value) ambiguity shown, direction errors > 90° excluded

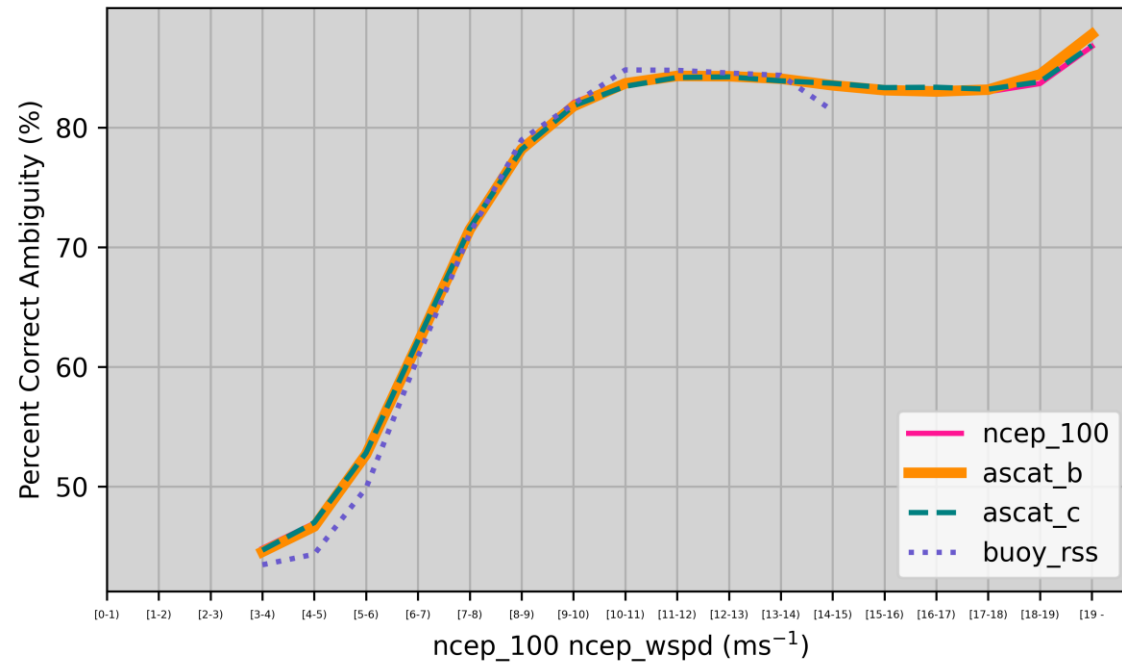


# Ambiguity Skill

## Two Looks



## One Look

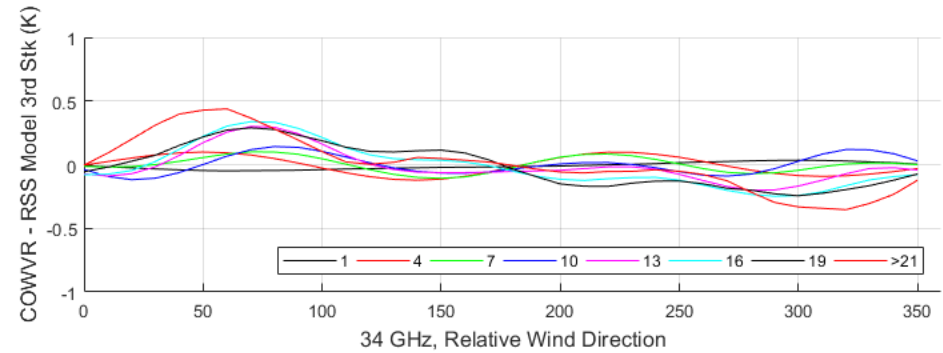
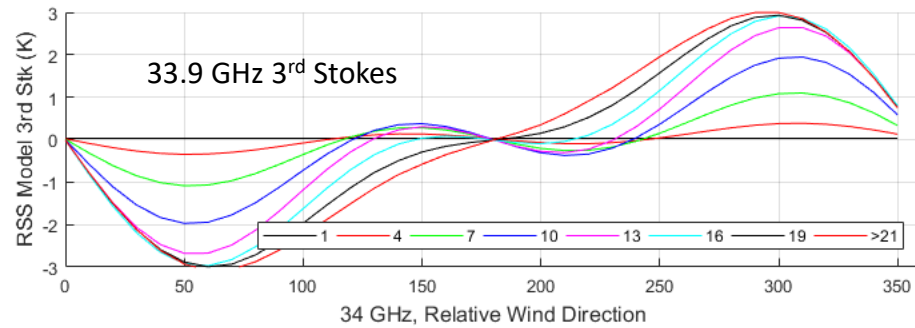
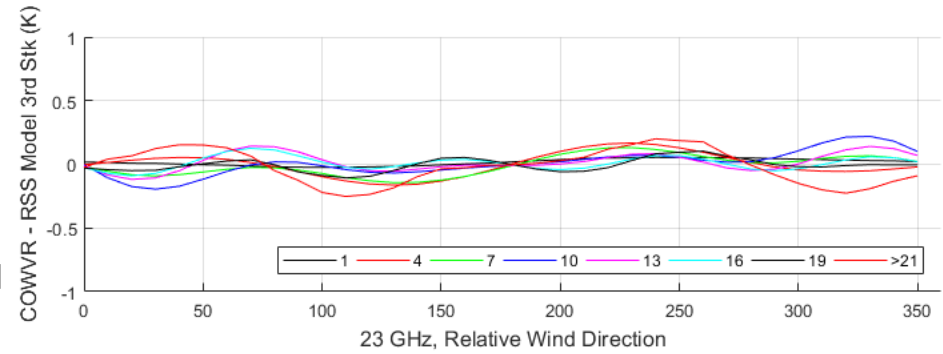
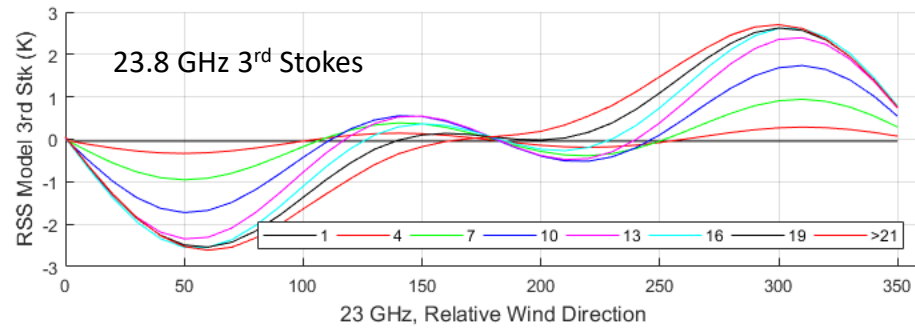
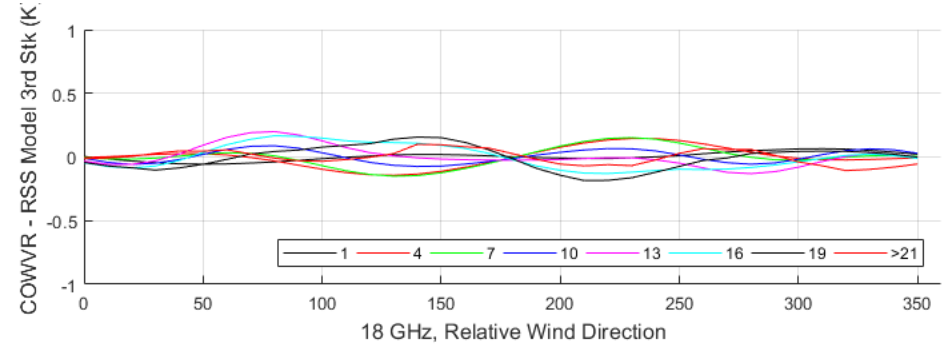
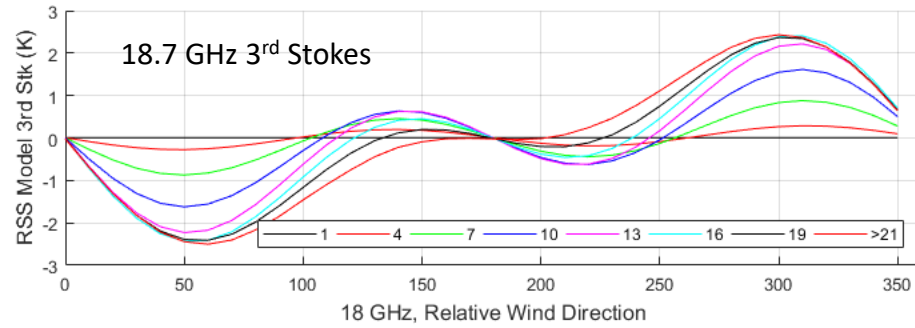






# Polarimetric GMF Derived from WindSat Works Well for COWVR

No changes required (at least for now)



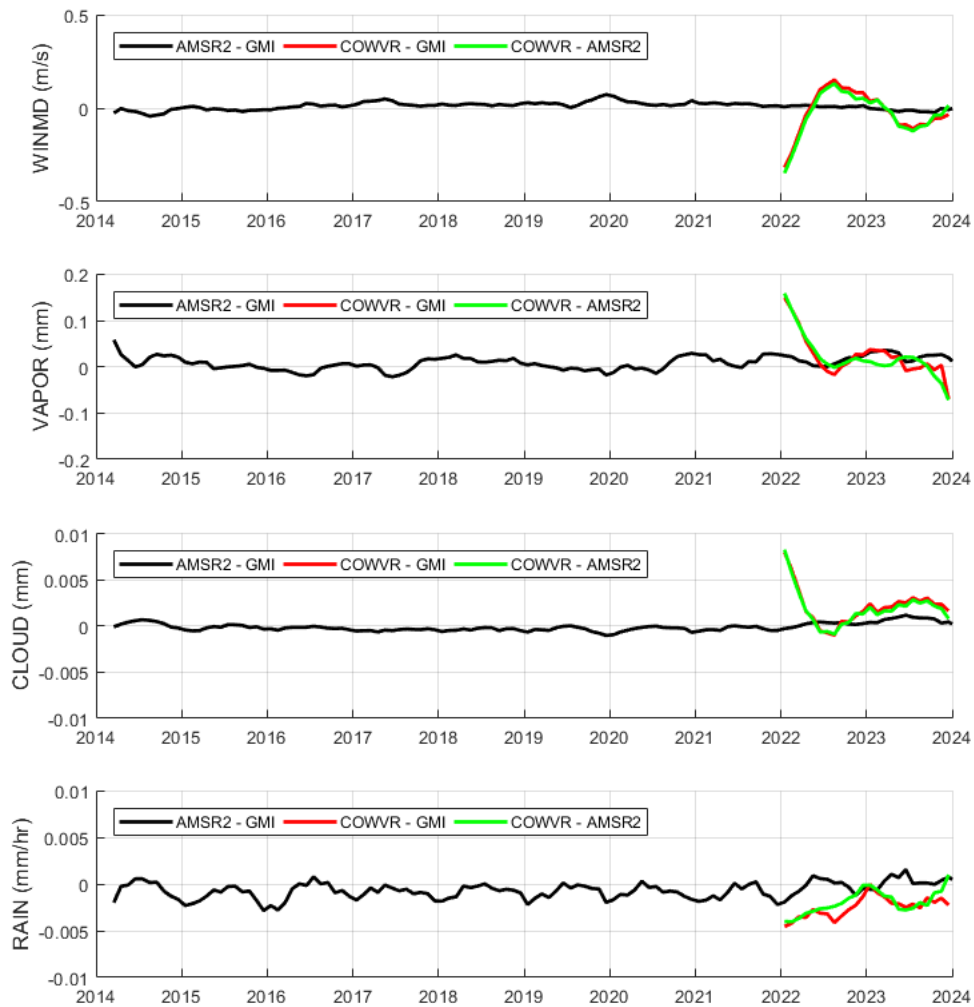
Colors are different wind speed bins (m/s)

RSS Model

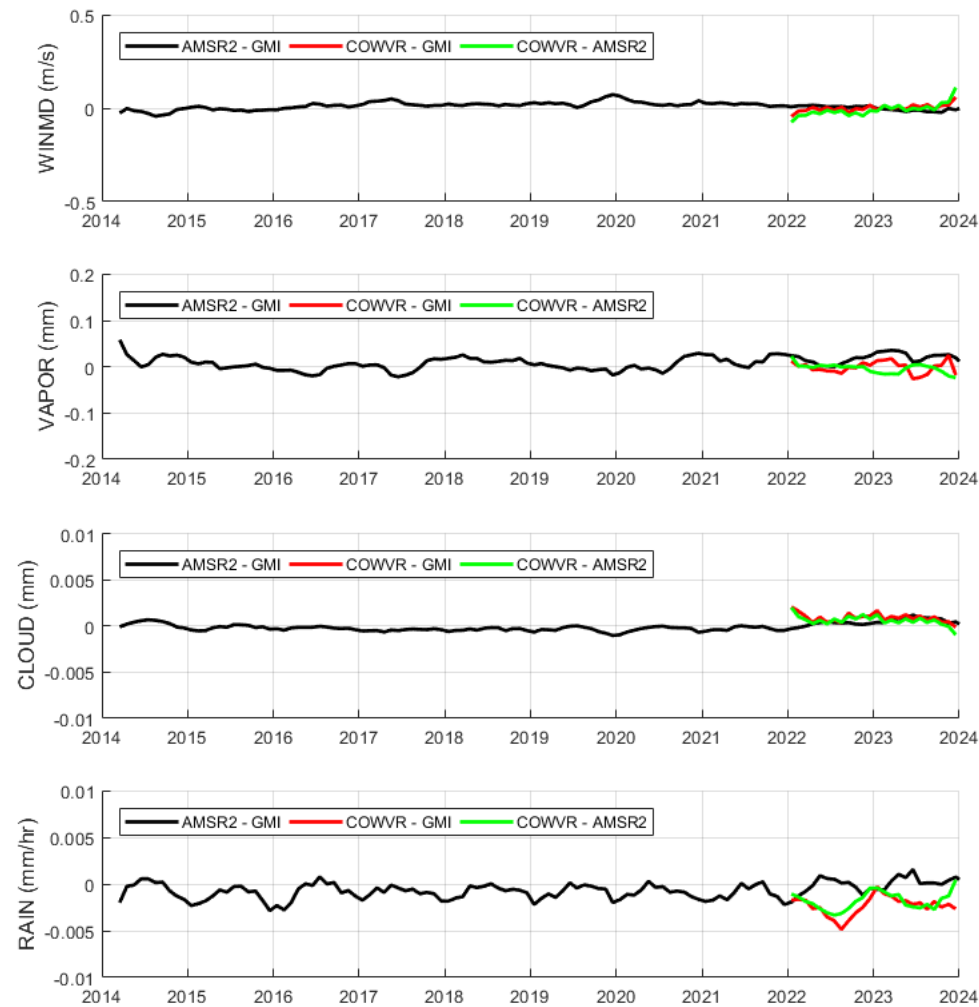
COWVR Measurements Minus RSS Model



# Timeseries of COWVR, AMSR2, GMI AS-ECV Differences



No Time Correction

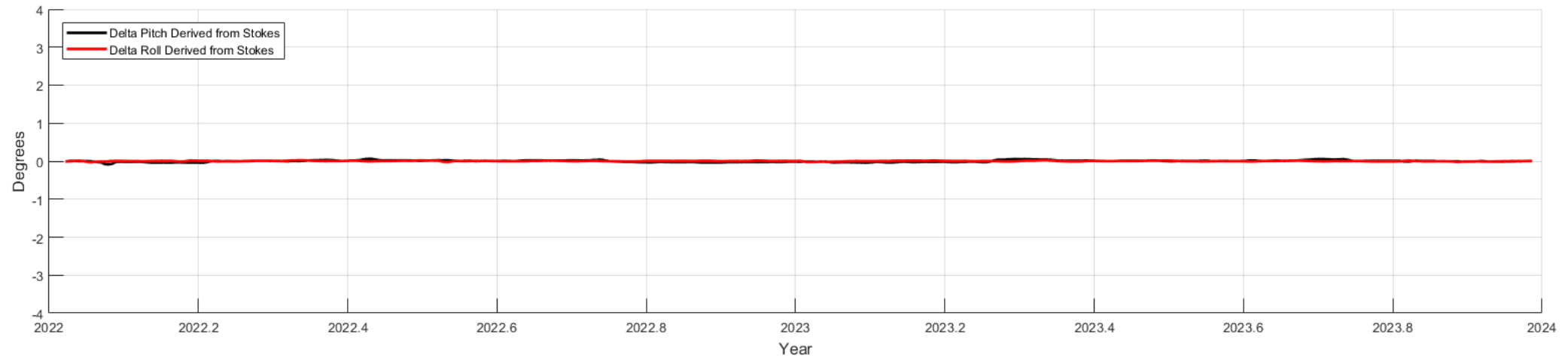
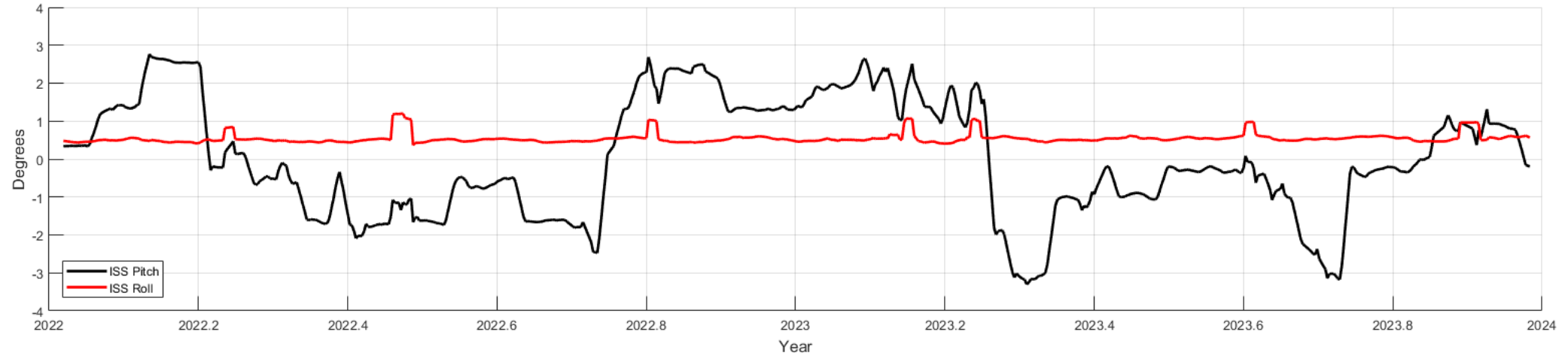


Drift in  $T_B$  Removed with 60-day Running Average

# Appendix: extra slides

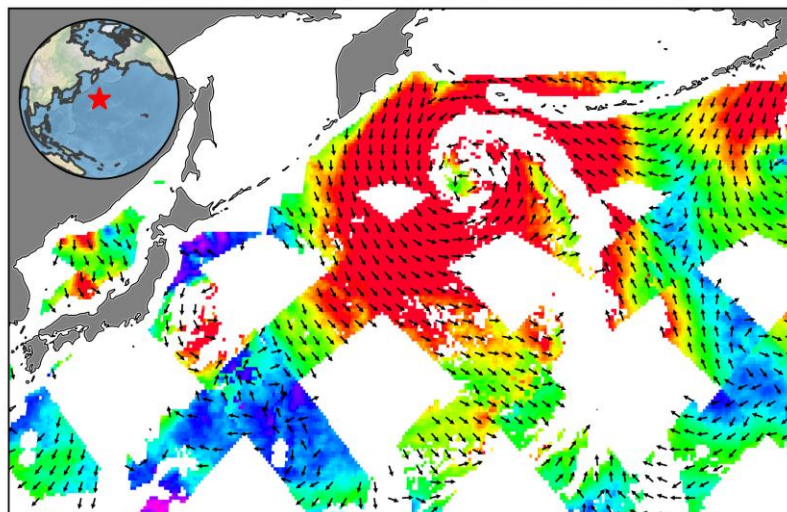


Same as a previous slide but y-axis scale on top and bottom frames are the same.  
This shows how small the delta pitch and delta roll adjustments are.

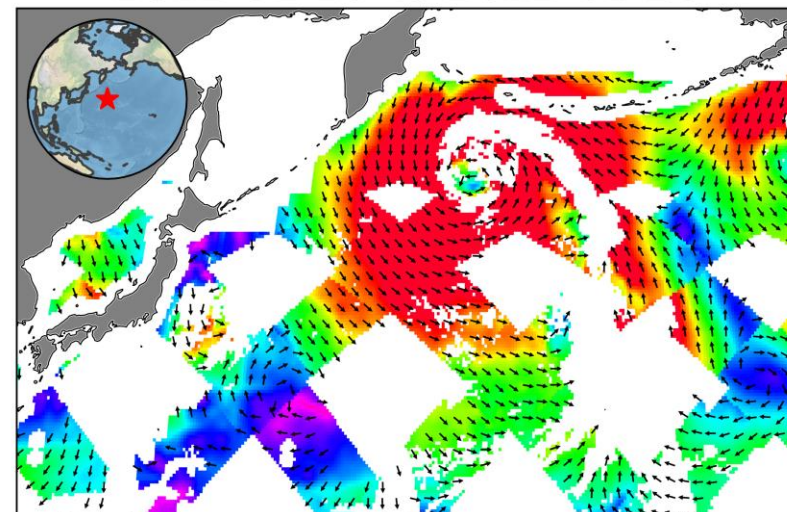




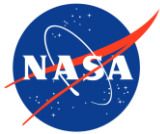
COWVR  
2022-01-26 to 2022-01-26



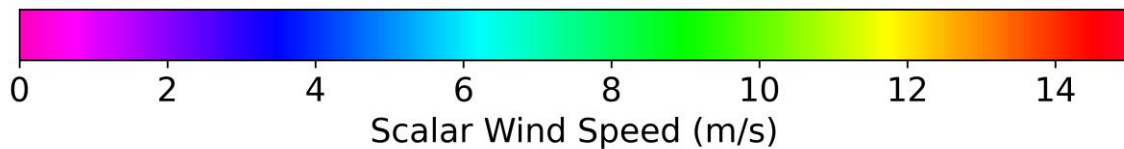
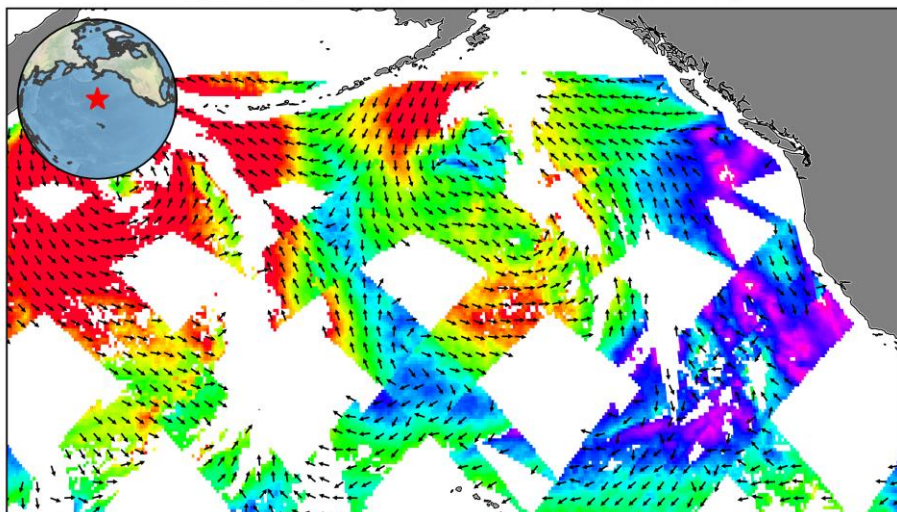
NCEP  
2022-01-26 to 2022-01-26



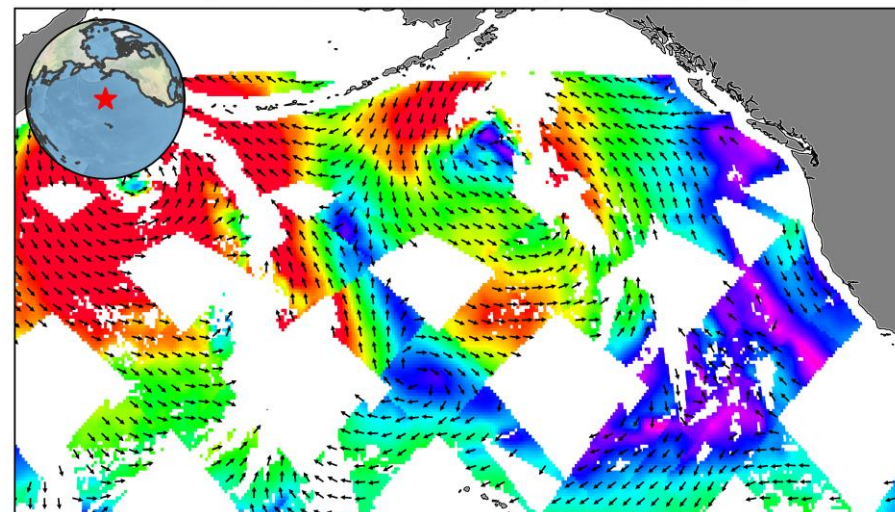




COWVR  
2022-01-26 to 2022-01-26



NCEP  
2022-01-26 to 2022-01-26



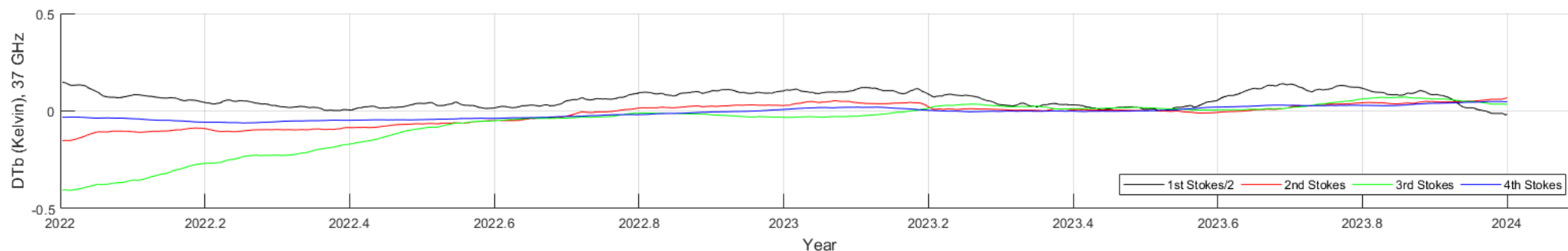
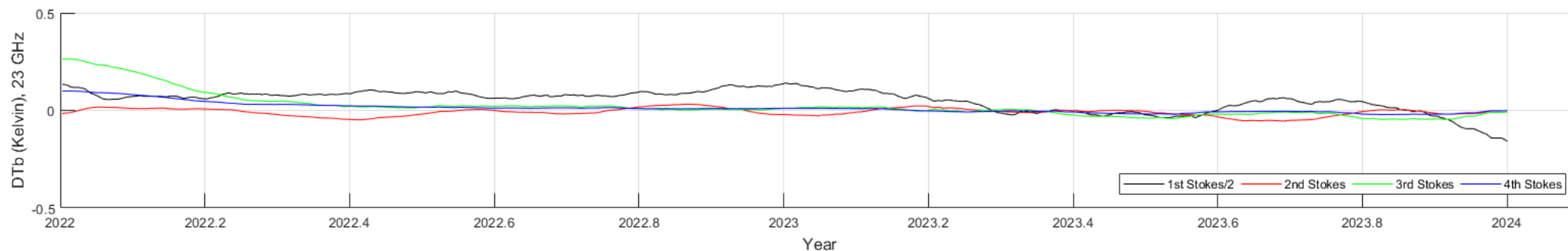
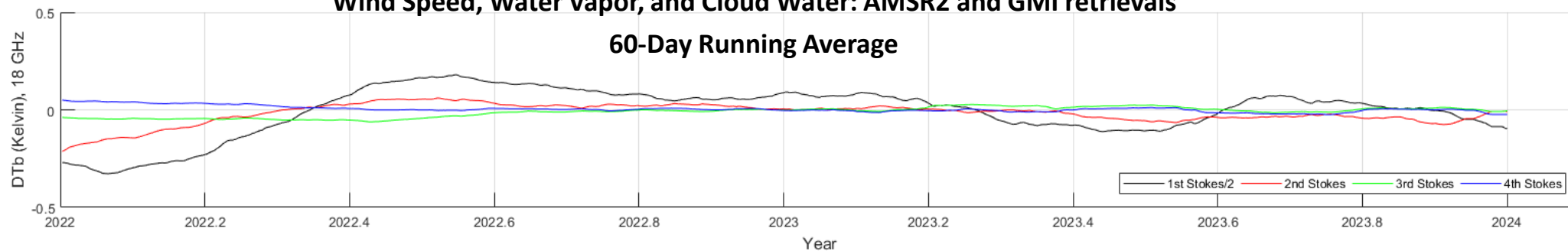


# Timeseries of COWVR $T_B$ Minus RTM

SST and Wind Direction: NCEP

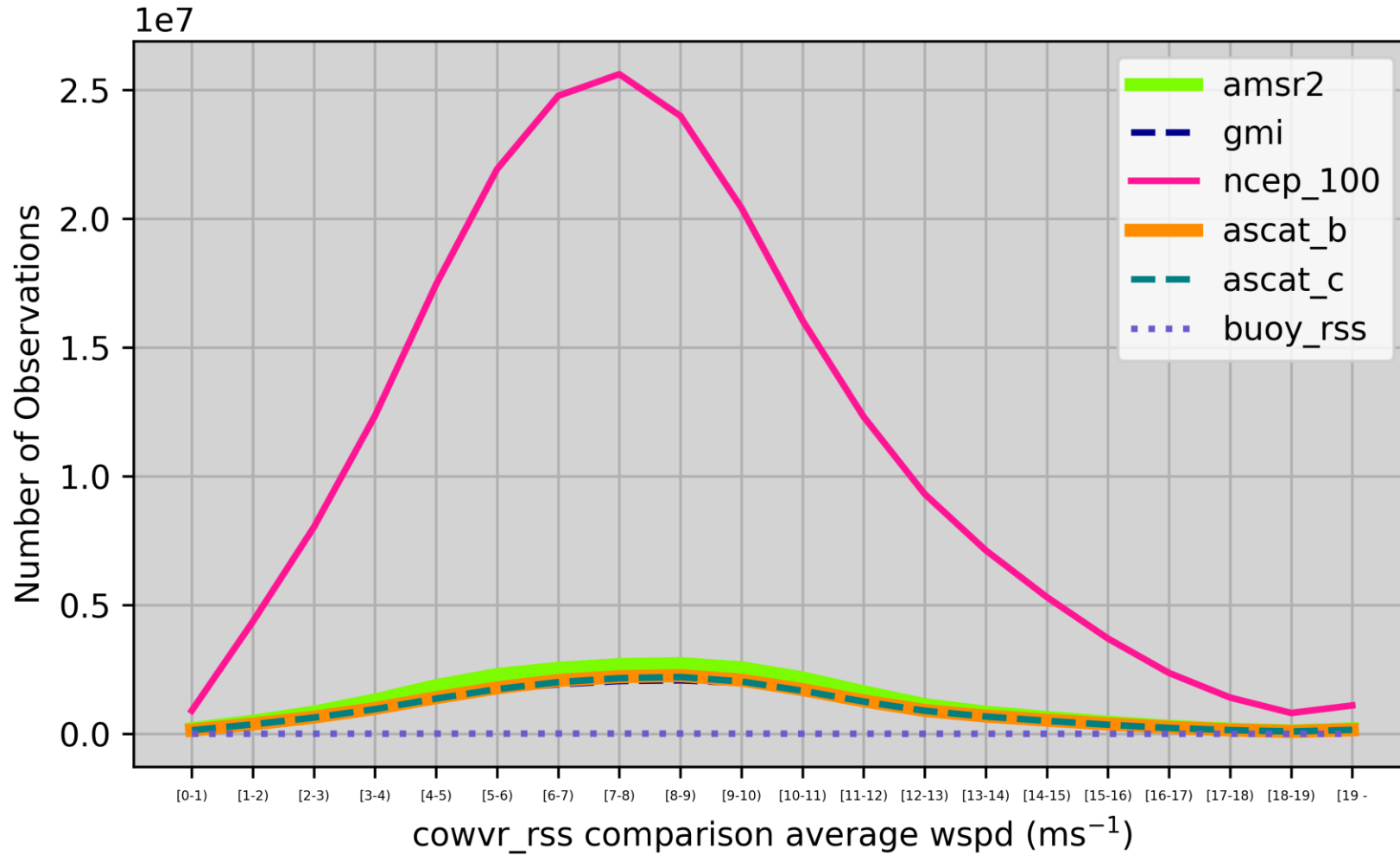
Wind Speed, Water Vapor, and Cloud Water: AMSR2 and GMI retrievals

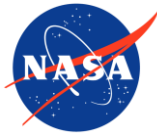
60-Day Running Average





### Wind Speed Comparison: Number of collocations





## Wind Speed Comparison



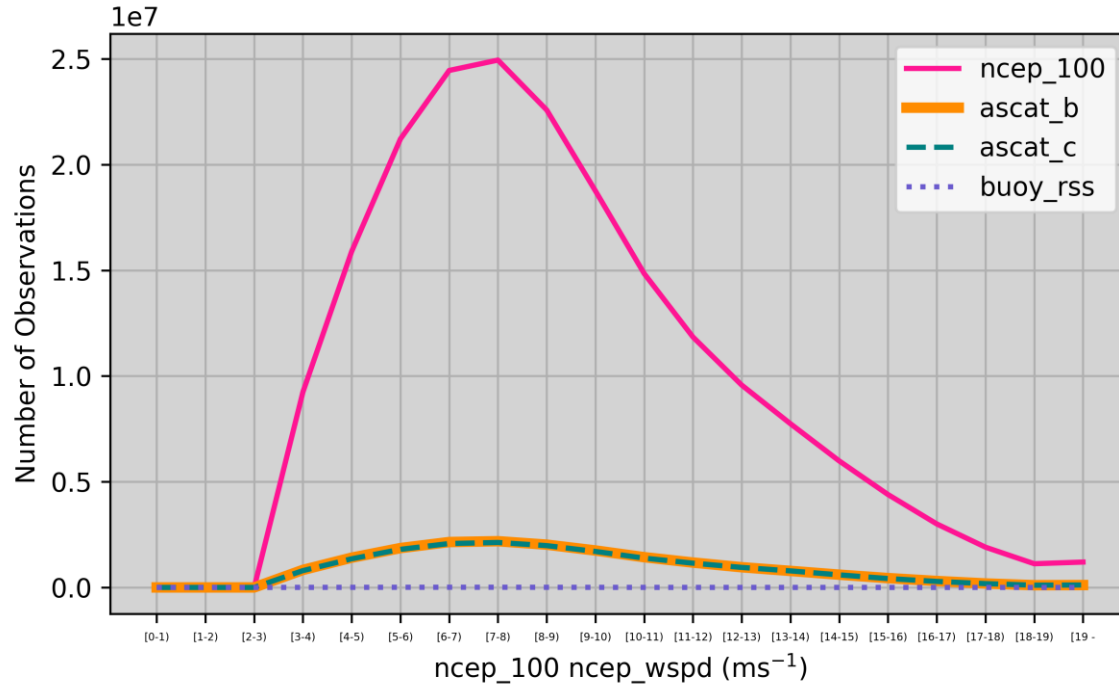
AMSR2 RMSE	0.36	0.42	0.44	0.47	0.51	0.56	0.60	0.61	0.60	0.58	0.57	0.63	0.75	0.83	0.84	0.88	0.96	1.07	1.22	1.56
GMI RMSE	0.36	0.42	0.45	0.49	0.53	0.58	0.62	0.63	0.62	0.59	0.58	0.63	0.75	0.82	0.83	0.86	0.95	1.06	1.22	1.54
NCEP 1-deg RMSE	0.70	1.06	1.22	1.28	1.27	1.24	1.22	1.21	1.18	1.14	1.15	1.25	1.40	1.51	1.56	1.63	1.74	1.89	2.15	3.24
ASCAT-B RMSE	0.54	0.65	0.68	0.76	0.82	0.86	0.86	0.82	0.77	0.73	0.72	0.78	0.94	1.05	1.08	1.14	1.23	1.35	1.53	2.02
ASCAT-C RMSE	0.55	0.65	0.69	0.77	0.83	0.86	0.86	0.82	0.77	0.73	0.72	0.78	0.92	1.02	1.05	1.10	1.19	1.30	1.48	1.93
Buoy RSS RMSE	0.63	0.95	1.05	1.15	1.11	1.14	1.09	1.05	0.99	1.00	1.04	1.16	1.28	1.31	1.32					

Each column corresponds to a wind speed bin in the previous figures  
Units are in m/s

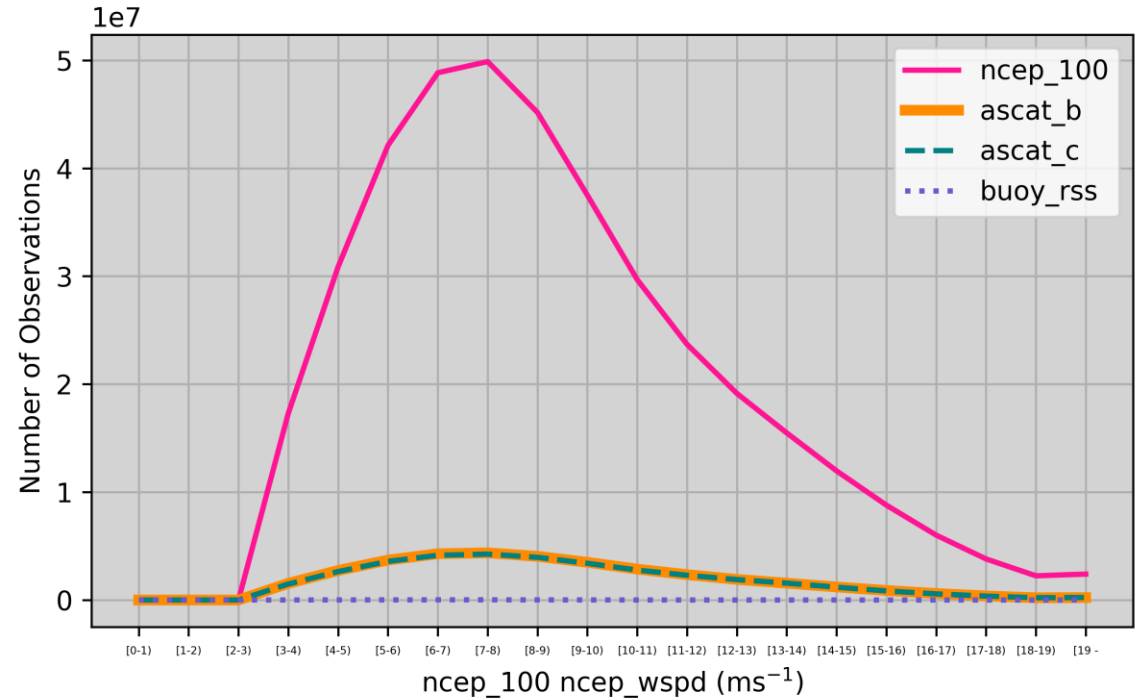


# Wind Direction Comparison: Number of collocations

## Two Looks

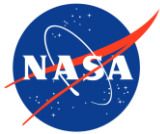


## One Look



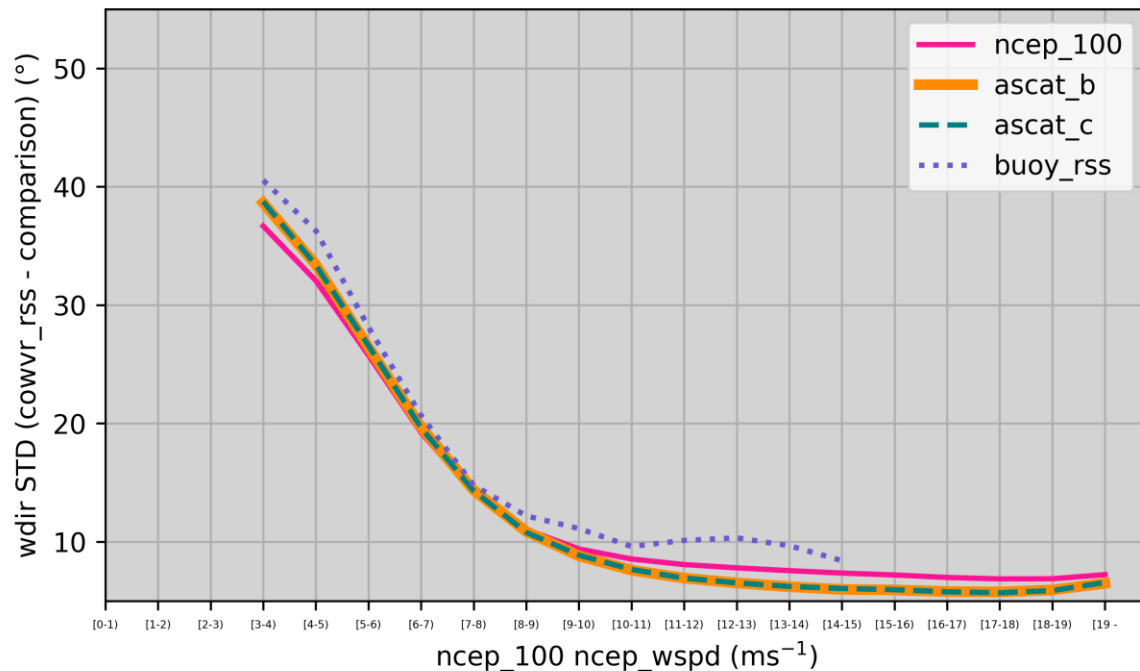
Wind speeds < 3 m/s omitted



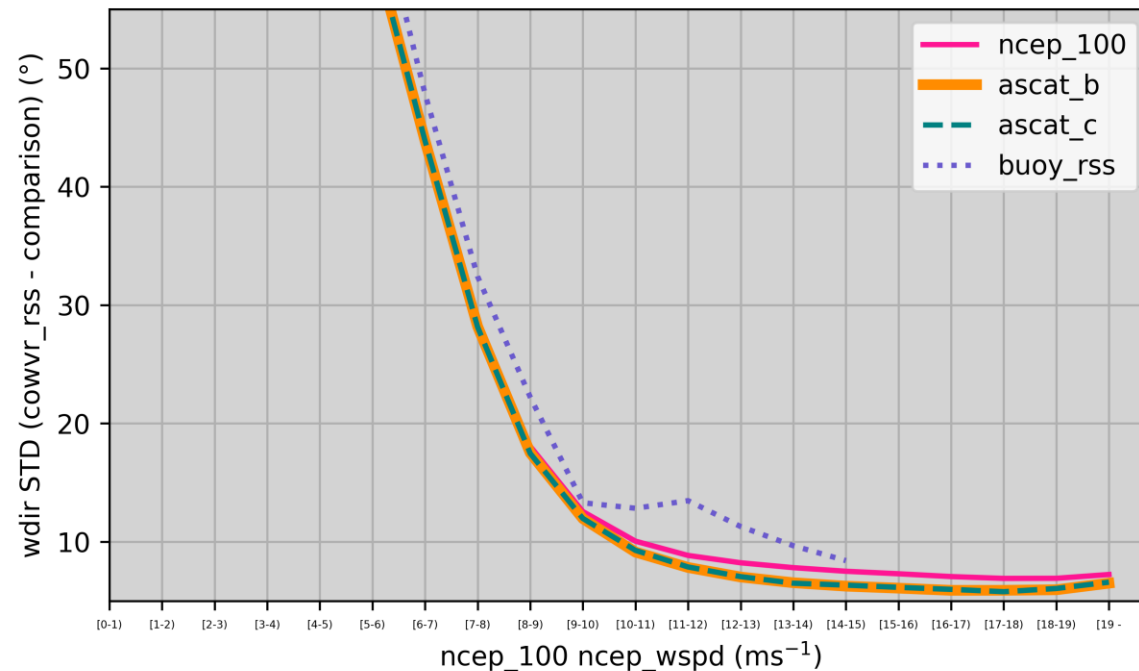


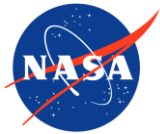
# Wind Direction Comparison Two Looks

Ambiguity: first-rank (lowest sum-of-squares error)  
(only within  $\leq 90^\circ$ )



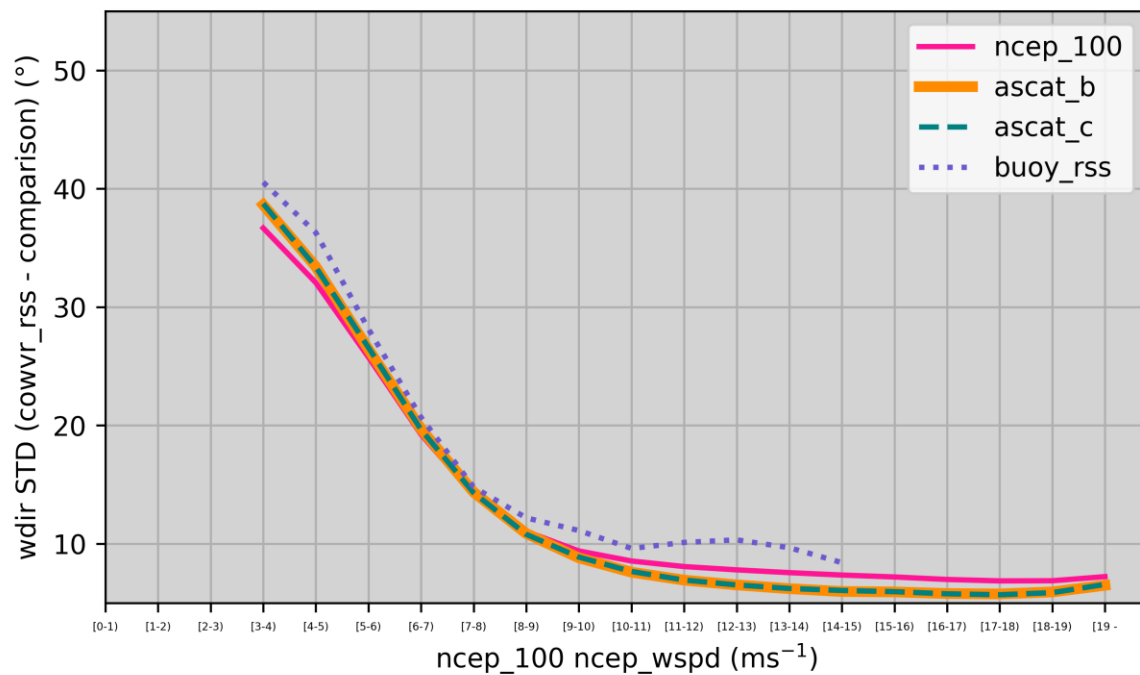
Ambiguity: first-rank (lowest sum-of-squares error)  
(no exclusions)



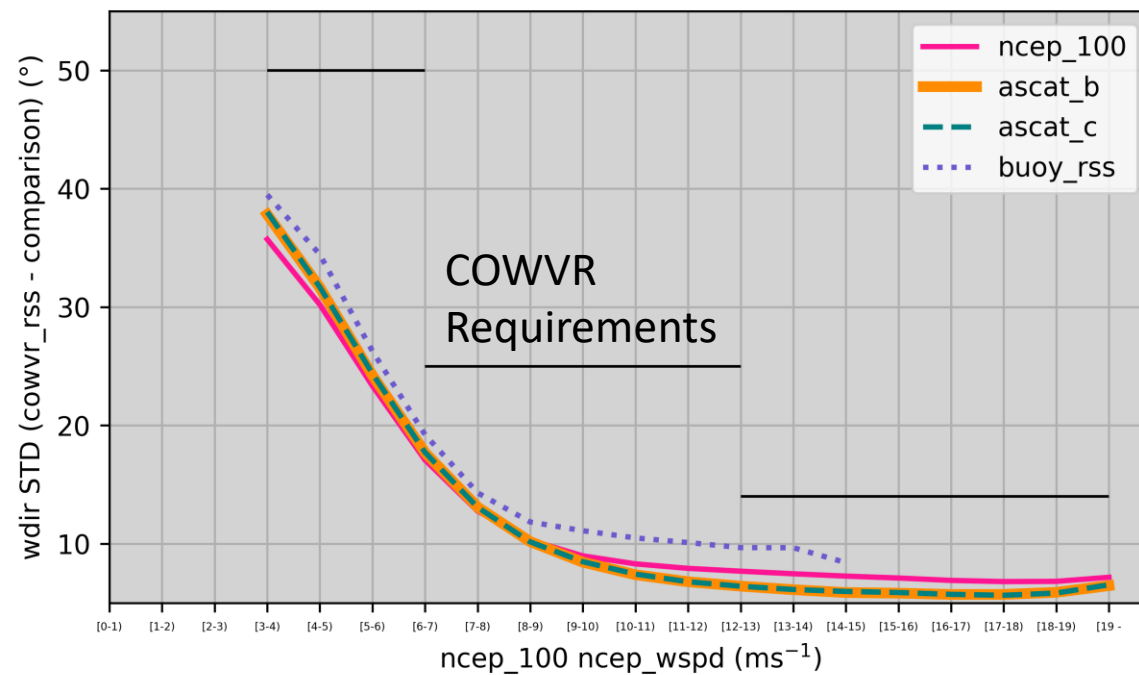


# Wind Direction Comparison Two Looks

Ambiguity: first-rank (lowest sum-of-squares error)  
(only within  $\leq 90^\circ$ )



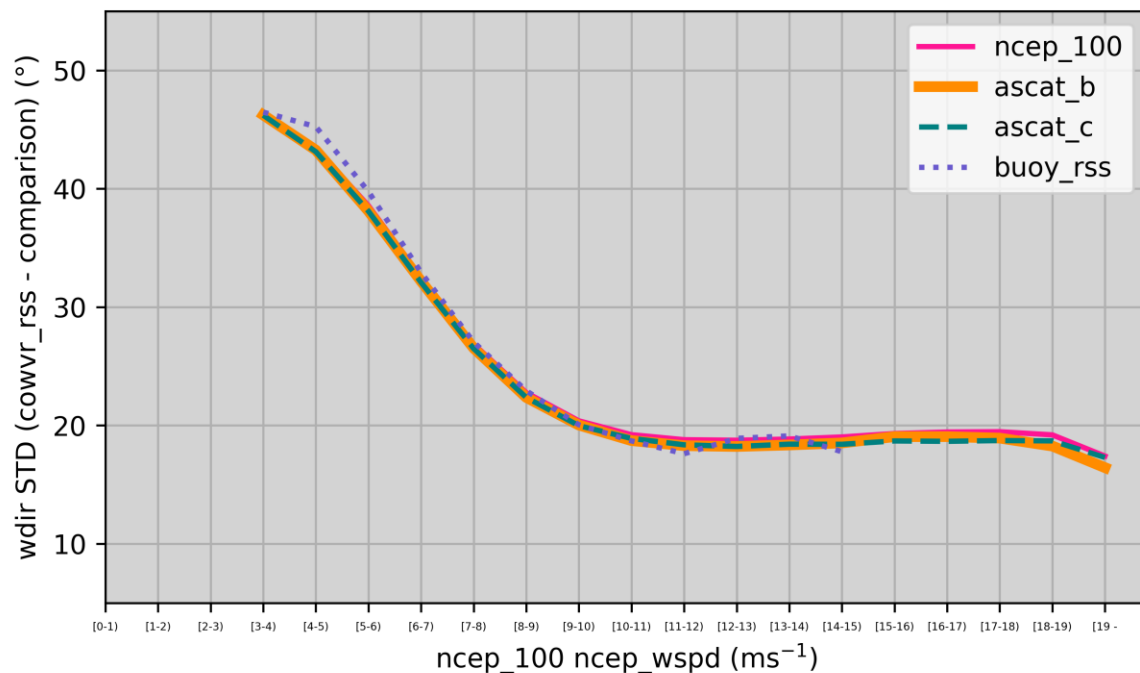
Ambiguity: closest to comparison



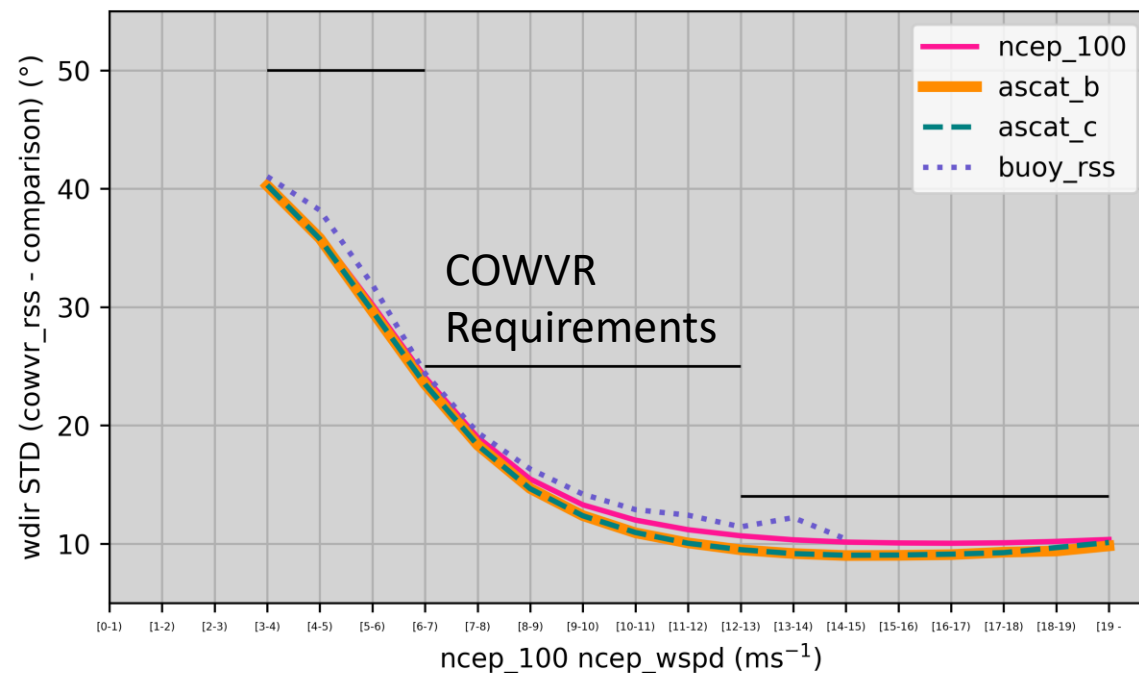


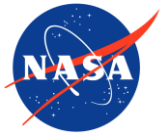
# Wind Direction Comparison One Look

Ambiguity: first-rank (lowest sum-of-squares error)  
(only within  $\leq 90^\circ$ )



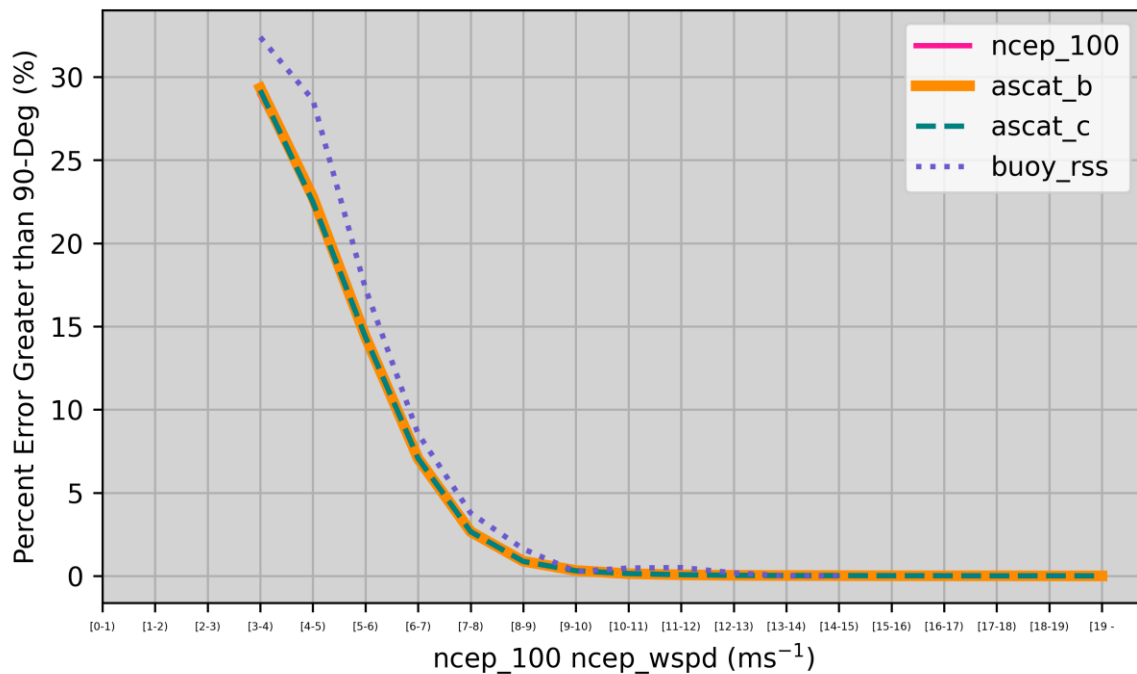
Ambiguity: closest to comparison



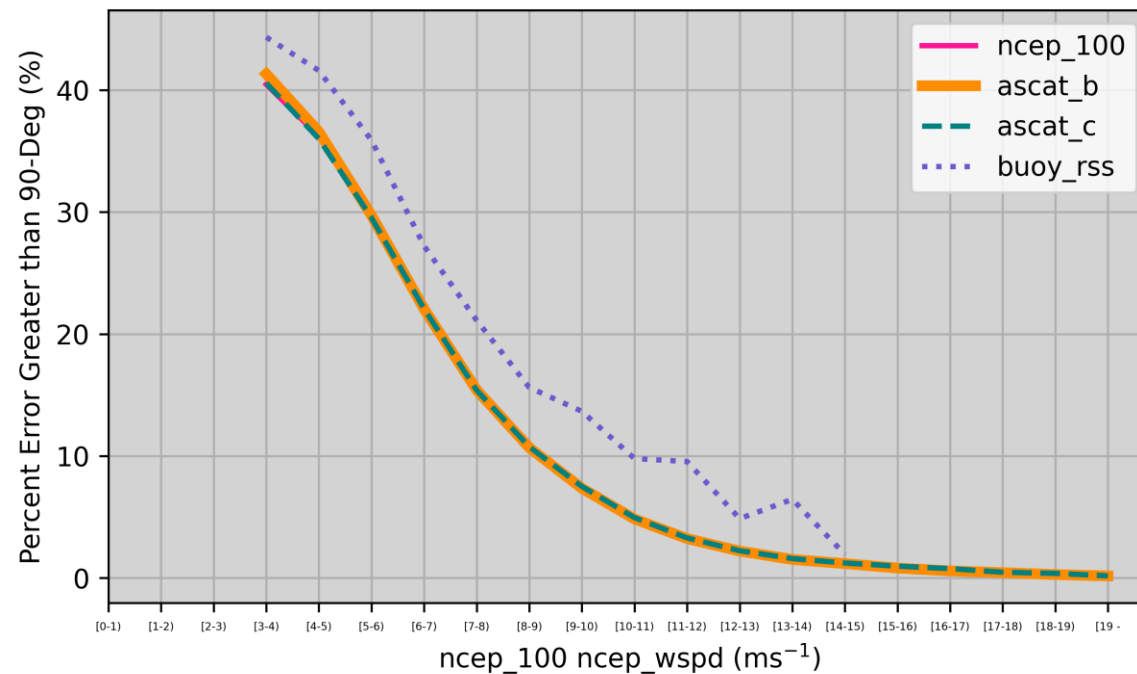


# Wind Direction Comparison: Percentage > 90° error for first-rank ambiguity

## Two Looks

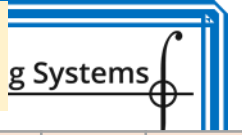


## One Look





Wind Direction Comparison: Each column corresponds to a wind speed bin in the previous figures; units are in degrees



NCEP 1-deg: Closest to NCEP 1-deg STD	35.73	30.21	23.34	17.08	12.76	10.30	8.98	8.30	7.93	7.69	7.47	7.27	7.11	6.91	6.81	6.83	7.17
NCEP 1-deg: Lowest SOS ( $\leq 90$ deg err) STD	36.68	32.06	25.76	19.24	14.15	11.05	9.40	8.55	8.08	7.80	7.56	7.36	7.20	6.99	6.87	6.88	7.23
NCEP 1-deg: Lowest SOS STD	83.19	74.70	61.40	44.59	44.59	18.06	12.56	10.05	8.85	8.23	7.82	7.51	7.30	7.06	6.91	6.92	7.24
NCEP 1-deg: 1-Look Closest to NCEP 1-deg STD	40.38	36.08	30.21	24.08	19.00	15.47	13.29	12.00	11.19	10.68	10.34	10.14	10.07	10.05	10.09	10.20	10.37
NCEP 1-deg: 1-Look Lowest SOS ( $\leq 90$ deg err) STD	46.41	43.44	38.57	32.52	26.88	22.77	20.39	19.22	18.79	18.75	18.85	19.03	19.31	19.44	19.47	19.20	17.41
NCEP 1-deg: Skill	62.37	67.95	77.09	87.48	94.83	98.10	99.21	99.58	99.72	99.75	99.74	99.71	99.71	99.75	99.81	99.86	99.89
ASCAT-B: Closest to ASCAT-B STD	37.83	31.65	24.23	17.71	13.10	10.18	8.45	7.39	6.80	6.42	6.12	5.88	5.83	5.72	5.73	5.90	6.47
ASCAT-B: Lowest SOS ( $\leq 90$ deg err) STD	38.64	33.41	26.44	19.71	14.36	10.87	8.81	7.6	6.93	6.53	6.21	5.97	5.94	5.80	5.76	5.93	6.49
ASCAT-B: Lowest SOS STD	83.31	74.63	60.75	43.88	28.19	17.51	11.96	9.13	7.83	7.02	6.54	6.25	6.08	5.90	5.90	5.95	6.51
ASCAT-B: 1-Look Closest to ASCAT-B STD	40.26	35.81	29.63	23.48	18.35	14.67	12.38	10.93	10.07	9.49	9.18	9.01	9.02	9.09	9.29	9.39	9.83
ASCAT-B: 1-Look Lowest SOS ( $\leq 90$ deg err) STD	46.23	43.26	38.12	32.19	26.53	22.37	20.03	18.72	18.29	18.22	18.35	18.52	19.05	19.06	18.93	18.26	16.44
ASCAT-B: Skill	61.7	67.62	77.38	87.73	94.94	98.14	99.24	99.61	99.75	99.77	99.78	99.72	99.71	99.78	99.86	99.88	99.94
ASCAT-C: Closest to ASCAT-B STD	38.03	31.69	24.38	17.72	13.08	10.16	8.49	7.44	6.80	6.41	6.14	5.98	5.88	5.73	5.65	5.84	6.54
ASCAT-C: Lowest SOS ( $\leq 90$ deg err) STD	38.74	33.38	26.59	19.64	14.31	10.80	8.88	7.66	6.94	6.53	6.23	6.06	5.96	5.78	5.70	5.88	6.57
ASCAT-C: Lowest SOS STD	83.01	74.15	60.68	43.87	28.14	17.46	11.97	9.28	7.87	7.06	6.50	6.34	6.15	5.98	5.78	6.06	6.59
ASCAT-C: 1-Look Closest to ASCAT-B STD	40.30	35.76	29.67	23.48	18.33	14.65	12.37	10.96	10.05	9.50	9.17	9.03	9.05	9.13	9.25	9.68	10.11
ASCAT-C: 1-Look Lowest SOS ( $\leq 90$ deg err) STD	46.21	43.13	38.10	32.09	26.49	22.36	19.98	18.90	18.36	18.22	18.42	18.41	18.69	18.66	18.72	18.70	17.29
ASCAT-C: Skill	61.97	67.97	77.37	87.80	94.97	98.20	99.23	99.60	99.74	99.77	99.76	99.72	99.72	99.82	99.87	99.86	99.89
Buoy RSS: Closest to Buoy RSS STD	39.49	34.44	26.28	19.22	14.31	11.84	11.11	10.50	10.11	9.68	9.67	8.41					
Buoy RSS: Lowest SOS ( $\leq 90$ deg err) STD	40.55	36.29	28.15	20.68	14.79	12.19	11.12	9.61	10.12	10.33	9.67	8.41					
Buoy RSS: Lowest SOS STD	87.09	82.82	65.74	47.85	32.41	22.22	13.30	12.83	13.48	11.29	9.67	8.41					
Buoy RSS: 1-Look Closest to Buoy RSS STD	41.03	38.19	31.89	24.40	19.40	16.32	14.19	12.89	12.42	11.43	12.21	10.40					
Buoy RSS: 1-Look Lowest SOS ( $\leq 90$ deg err) STD	46.47	45.24	39.76	32.93	27.05	22.93	20.06	18.69	17.61	18.91	19.12	17.78					
Buoy RSS: Skill	58.59	62.2	74.69	87.05	94.46	97.60	99.41	99.47	99.20	99.06	100.	100.					