VIIRS POLAR WINDS

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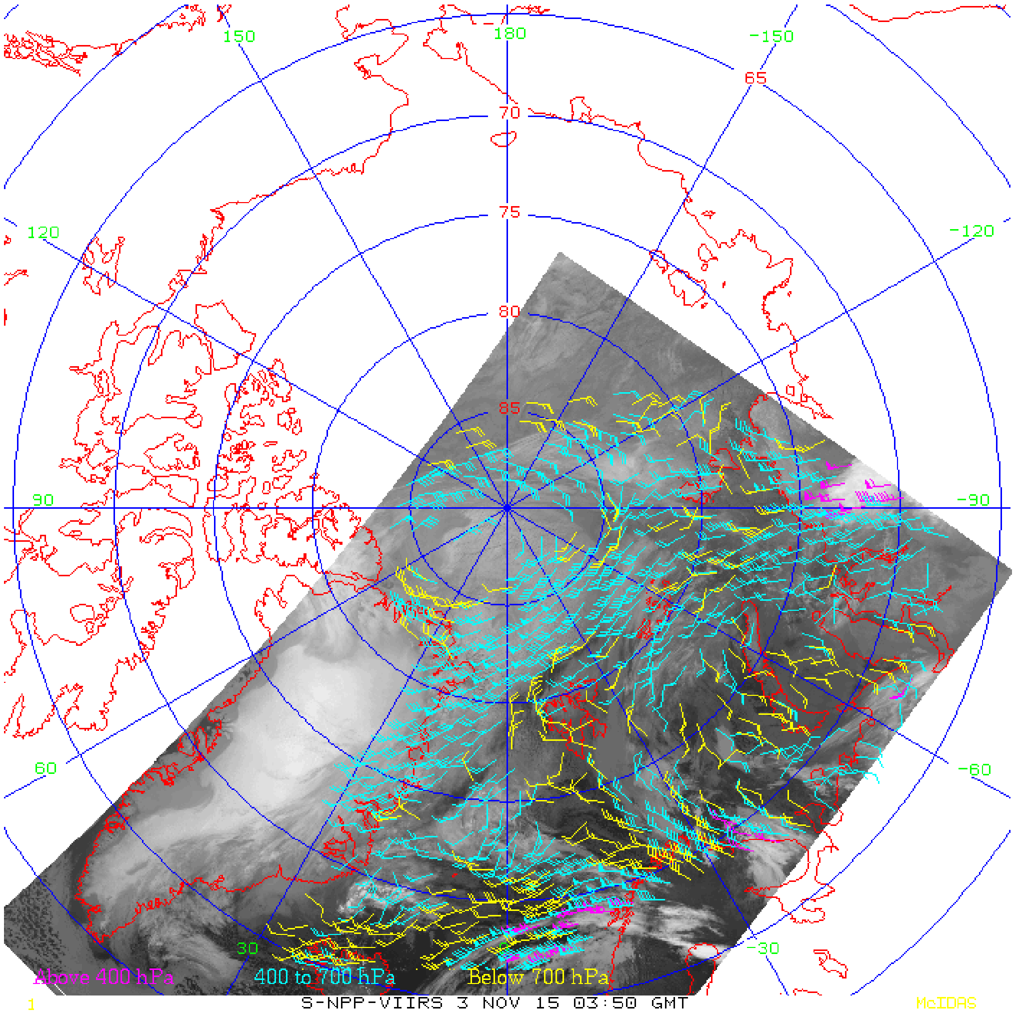
VIIRS Polar Winds Team

Name	Organization	Major Task
Jeff Key	STAR	Project management, DB winds
Jaime Daniels	STAR	Project management, algorithm development and testing
Wayne Bresky	IMSG	Algorithm development and testing
Andrew Bailey	IMSG	Algorithm development and testing
Rico Allegrino		Validation
Dave Santek	CIMSS	Algorithm and product testing
Rich Dworak	CIMSS	Algorithm and analysis
Steve Wanzong	CIMSS	Algorithm and product testing
Hongming Qi	OSPO	Operations
Walter Wolf and others	STAR, AIT	Implementation

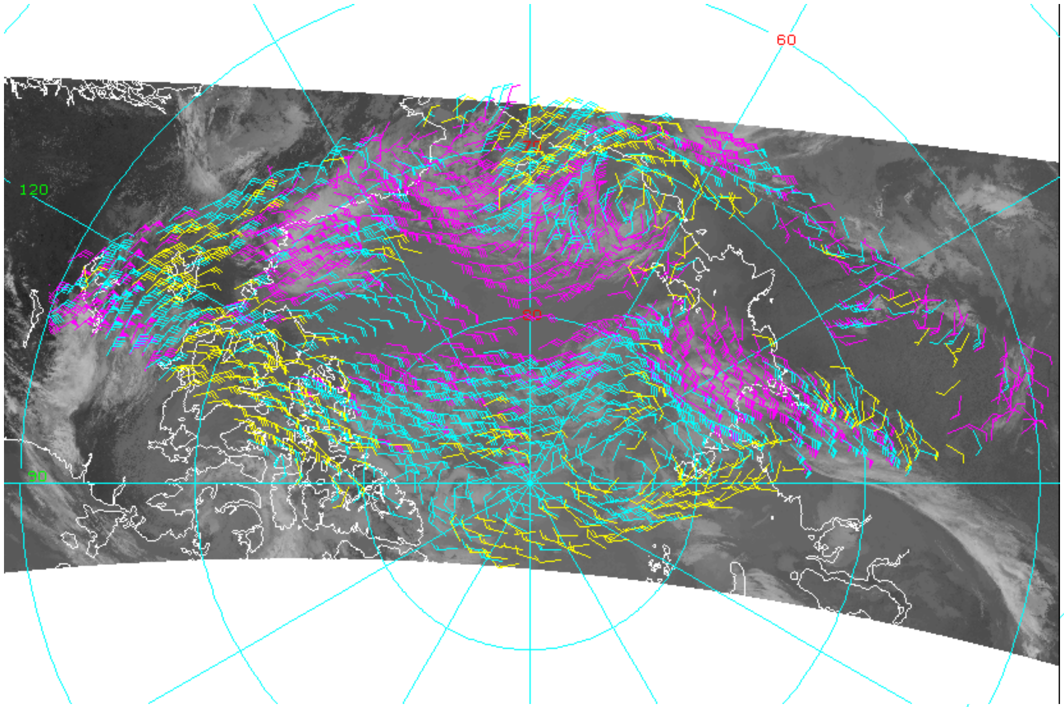
VIIRS Polar Winds (VPW) in Brief

VIIRS Polar Winds are derived by tracking clouds features in the VIIRS longwave infrared channel

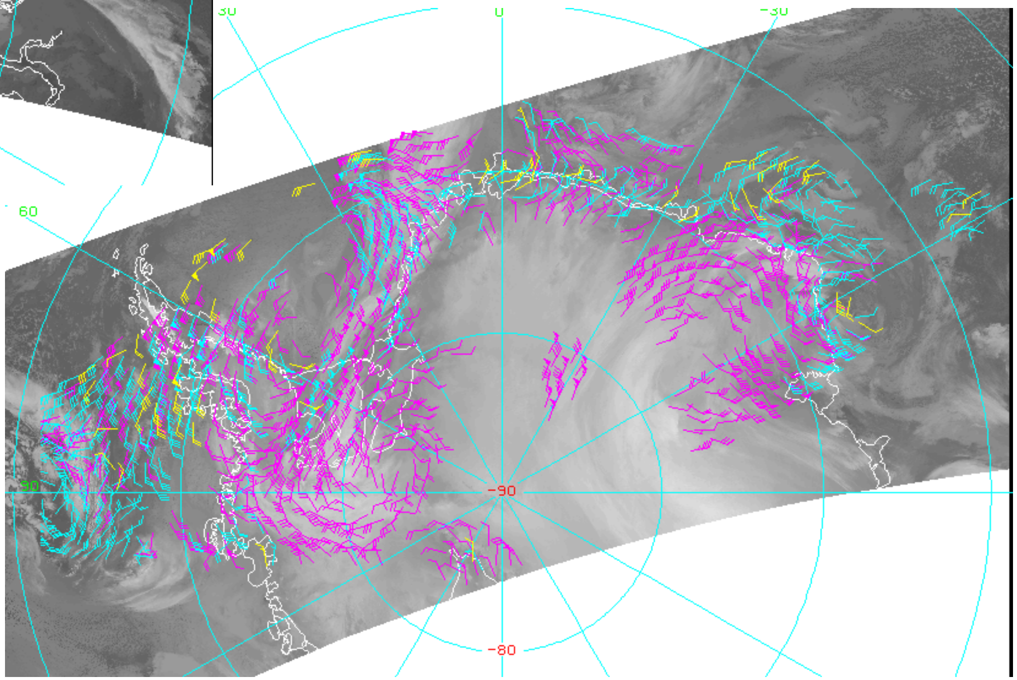
- Wind speed, direction, and height are determined throughout the troposphere, poleward of approximately 65 degrees latitude, in cloudy areas only
- Wind information is generated in both the Arctic and Antarctic regions
- The algorithm utilizes the Enterprise cloud height, phase, and (soon) mask



NOAA-20 VIIRS Winds Examples



Left: Arctic, 28 Jul 2018, 1942Z



Right: Antarctic, 28 Jul 2018, 2033Z

Validation Statistics

NPP VIIRS Winds vs. Radiosondes July 5-29, 2018

100_1000mb	90S – 90N	25N – 90N	25S – 25N	25S – 90S
Accuracy	5.79	5.79	0.00	0.00
Precision	3.58	3.58	0.00	0.00
Speed Bias	1.03	1.03	0.00	0.00
Speed	20.44	20.44	0.00	0.00
Sample	4668	4668	0	0

101_400mb	90S – 90N	25N – 90N	25S – 25N	25S – 90S
Accuracy	6.39	6.39	0.00	0.00
Precision	3.76	[illegible]	[illegible]	[illegible]
Speed Bias	1.33	[illegible]	[illegible]	[illegible]
Speed	23.85	2[illegible]	[illegible]	[illegible]
Sample	2085	[illegible]	[illegible]	[illegible]

401_700mb	90S – 90N	25N[illegible]	[illegible]	[illegible]
Accuracy	5.42	[illegible]	[illegible]	[illegible]
Precision	3.40	[illegible]	[illegible]	[illegible]
Speed Bias	0.81	[illegible]	[illegible]	[illegible]
Speed	18.95	1[illegible]	[illegible]	[illegible]
Sample	2071	[illegible]	[illegible]	[illegible]

701_1000mb	90S – 90N	25N[illegible]	[illegible]	[illegible]
Accuracy	4.81	[illegible]	[illegible]	[illegible]
Precision	3.13	[illegible]	[illegible]	[illegible]
Speed Bias	0.66	[illegible]	[illegible]	[illegible]
Speed	12.56	12.56	0.00	0.00
Sample	512	512	0	0

Observed
Accuracy: 5.79-5.99 m/s
Precision: 3.58-3.64 m/s

Requirements:
Accuracy: 7.5 m/s
Precision: 4.2 m/s

NPP VIIRS winds generated at OSPO

NOAA-20 VIIRS Winds vs. Radiosondes July 5-29, 2018

100_1000mb	90S – 90N	25N – 90N	25S – 25N	25S – 90S
Accuracy	5.99	5.99	0.00	0.00
Precision	3.64	3.64	0.00	0.00
Speed Bias	1.02	1.02	0.00	0.00
Speed	20.19	20.19	0.00	0.00
Sample	3860	3860	0	0

101_400mb	90S – 90N	25N – 90N	25S – 25N	25S – 90S
Accuracy	6.36	6.36	0.00	0.00
[illegible]sion	3.82	3.82	0.00	0.00
[illegible] Bias	1.23	1.23	0.00	0.00
[illegible]	23.71	23.71	0.00	0.00
[illegible]e	2073	2073	0	0

[illegible]700mb	90S – 90N	25N – 90N	25S – 25N	25S – 90S
[illegible]acy	5.79	5.79	0.00	0.00
[illegible]sion	3.47	3.47	0.00	0.00
[illegible] Bias	0.53	0.53	0.00	0.00
[illegible]	17.93	17.93	0.00	0.00
[illegible]e	1190	1190	0	0

[illegible]1000mb	90S – 90N	25N – 90N	25S – 25N	25S – 90S
[illegible]acy	5.10	5.10	0.00	0.00
[illegible]sion	3.16	3.16	0.00	0.00
Speed Bias	1.28	1.28	0.00	0.00
Speed	12.47	12.47	0.00	0.00
Sample	597	597	0	0

NOAA-20 VIIRS winds generated at STAR. Statistics include only VIIRS winds at 12Z. NOAA-20 VIIRS Winds/Raob co-location files being reprocessed for the month of July to include 00Z matchups

Users

- **13 NWP centers in 9 countries use polar winds** (MODIS, AVHRR, VIIRS); some using VIIRS winds operationally.
- U.S. Users:
  - NCEP (Dennis Keyser)
  - NRL/FNMOC (Randy Pauley)
  - GMAO/JCSDA
- Foreign Users:
  - UK Met Office (Mary Forsythe)
  - JMA (Masahiro Kazumori)
  - ECMWF (Jean-Noel Thepaut)
  - DWD (Alexandar Cress)
  - Meteo-France (Bruno Lacroix)
  - CMC (Real Sarrazin)
  - BOM (John LeMarshall)
  - EUMETSAT (Simon Elliott)
  - Russian Hydrometcenter (Mikhail Tsyrulnikov)
  - CMA (China)

User Feedback

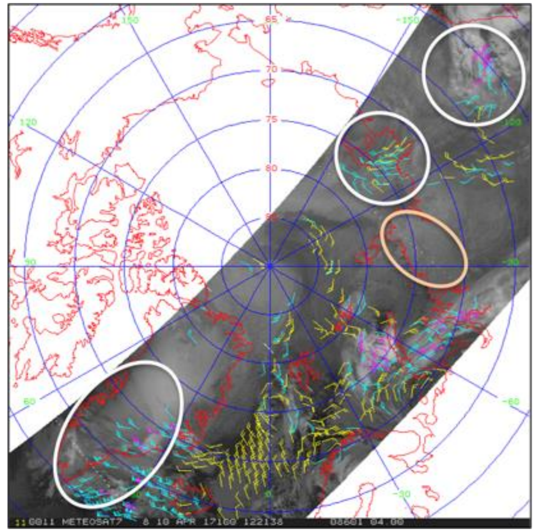
- Over the last decade, model impact studies at >10 major NWP centers have demonstrated that model *forecasts for the NH and SH extratropics are improved when the MODIS polar winds are assimilated. Forecasts can be extended 2-6 hrs, depending on the location.*
- *NWP users have reported similar results for the VIIRS Polar Winds*, as reported at the most recent International Winds Workshop (2016, Monterey) and at other venues.

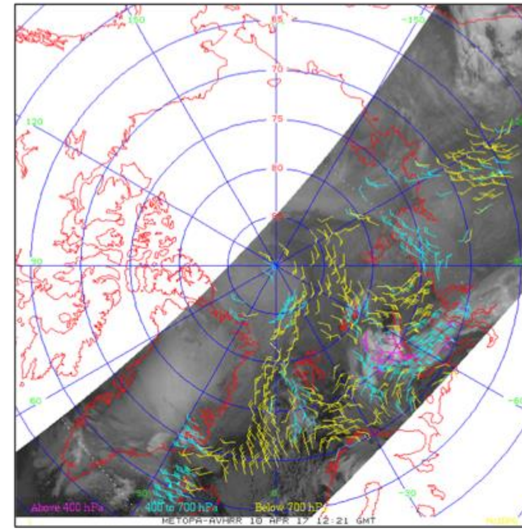
Organization	Use VPW operationally	Currently monitoring	Plan to use?
NCEP	Yes (SNPP)		Yes (early 2019 for N20)
DWD	Yes		
Navy	Yes		
ECMWF	Yes		
Met Office		Yes	Yes
CMC	Yes		
MeteoFrance		Yes	Yes

Awaiting information from the other NWP centers.

Experimental Products

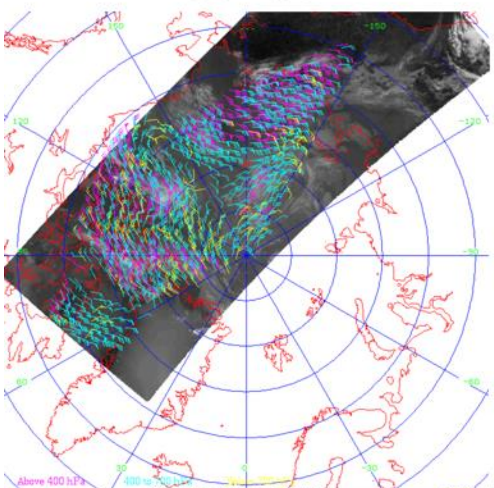
Winds from combined S-NPP and JPSS-1



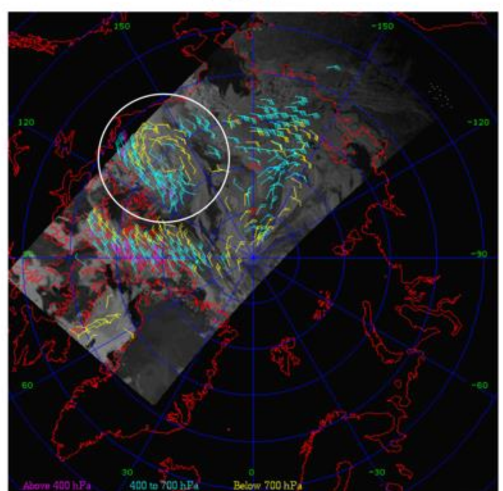


Far right: Single-satellite AVHRR winds. Right: Winds from Metop-A and –B.

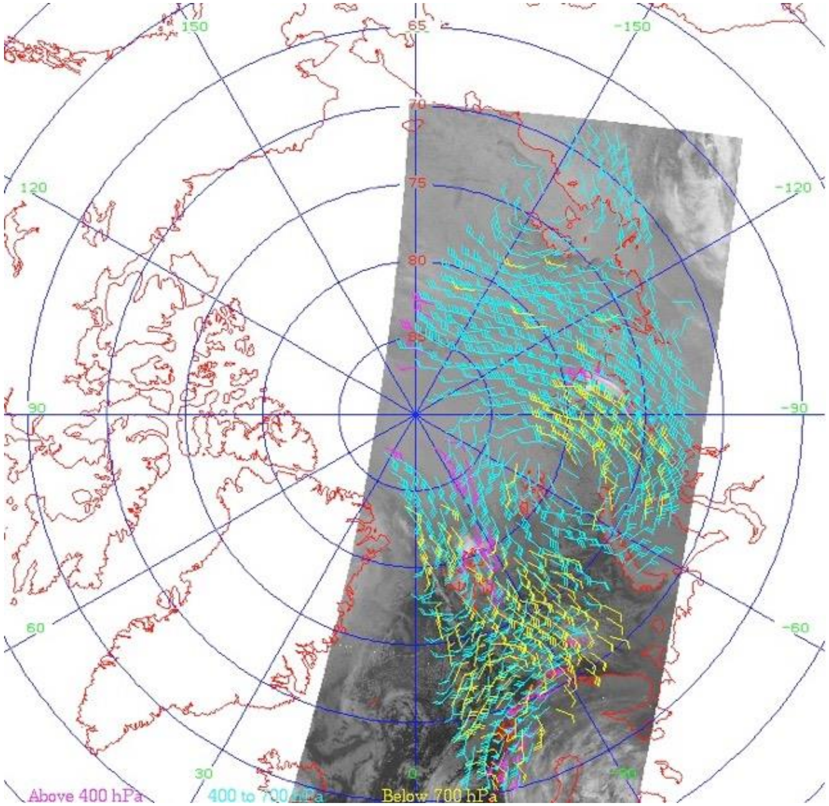
WV + IR



SWIR



Polar winds with the SWIR band


150
65
-150
70
75
120
-120
80
90
-90
60
-60
30
0
Above 400 hPa
Below 700 hPa

Thank you!

AMV Performance Metrics

AMVs (QI>60) are matched and compared against RAOBS or GFS model analysis winds. Metrics:

$$Accuracy = \frac{1}{N}\sum_{i=1}^{N}(VD_i)$$

$$Precision = \sqrt{\frac{1}{N}\sum_{i=1}^{N}((VD_i) - (MVD))^2}$$

where:

$$(VD)_i = \sqrt{(U_i - U_r)^2 + (V_i - V_r)^2}$$

U_i and V_i ---> AMV
U_r and V_r ---> “Truth”

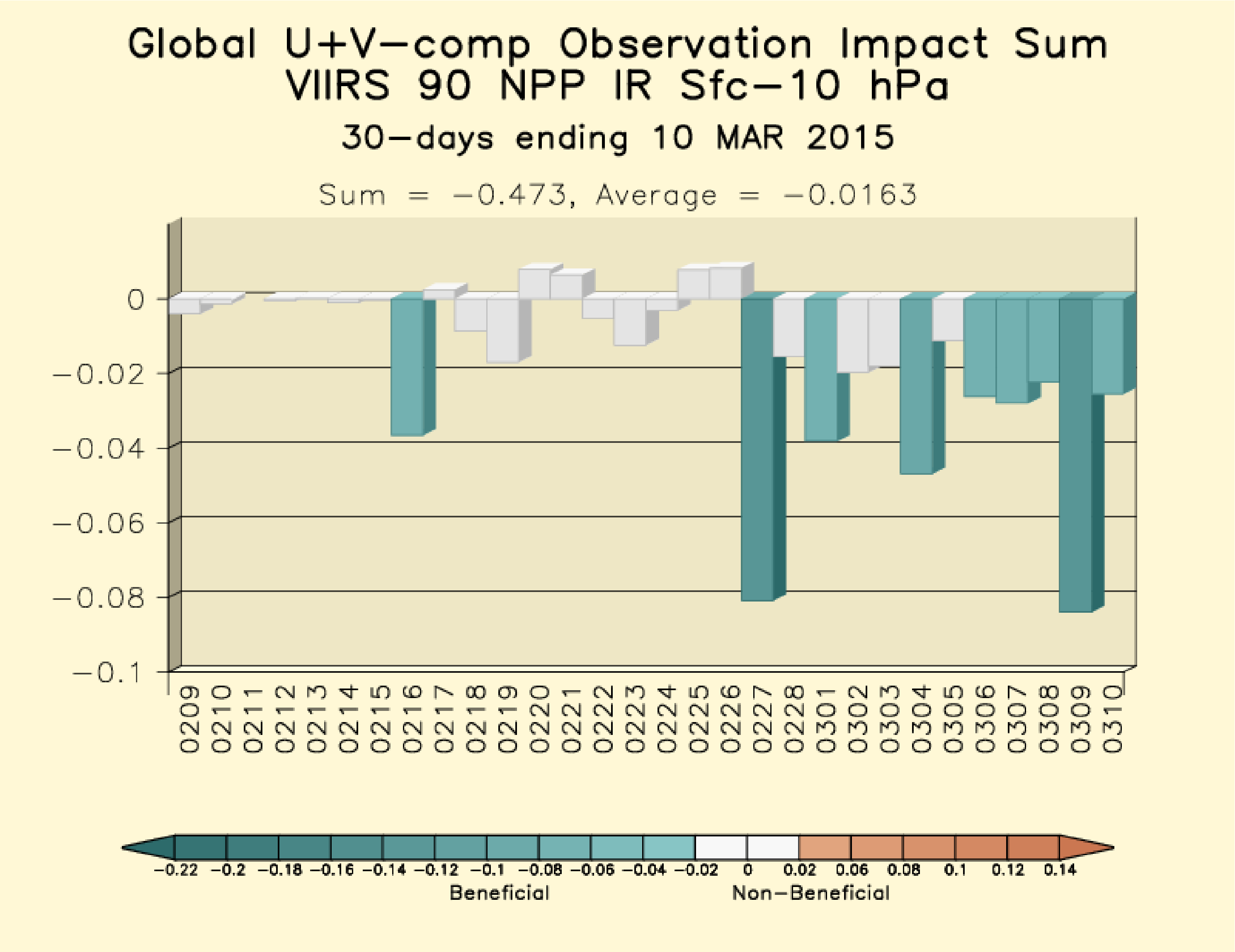
Status

Error Budget, S-NPP and NOAA-20:

Attribute Analyzed	L1RD Threshold	Analysis/Validation Result	Meets spec?
Accuracy	7.5 m/s	5.7-7.0 m/s	Y
Precision	4.2 m/s	2.7-3.8 m/s	Y
Horizontal cell size	10 km	19 km (inherent to the algorithm)	N; Change the requirement as it is an error
Mapping uncertainty	0.4 km nadir; 1.5 km EOS	0.57 km	Y

- **The S-NPP VIIRS Polar Winds product has been operational since May 2014.**
- **NOAA-20 VIIRS Winds Validated Maturity review scheduled for October 2018**
- VPW is also generated at direct broadcast sites and delivered to NWP centers.

Users, cont.



Courtesy of Naval Research Lab

NOAA AMSR2 SNOW AND ICE PRODUCTS

(abridged version)

Jeff Key

NOAA/NESDIS

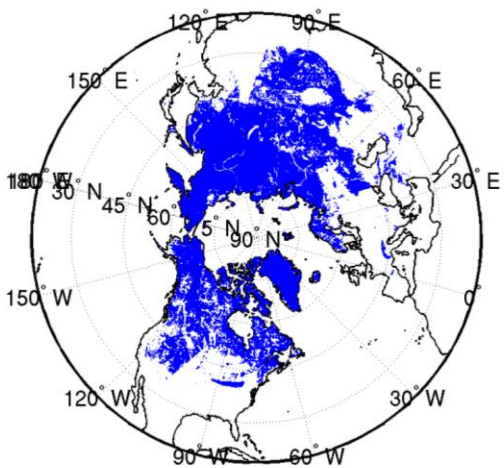
Madison, Wisconsin USA

Team Members

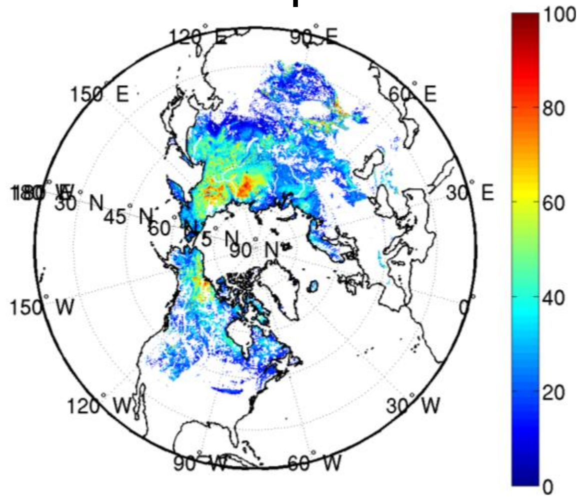
EDR	Name	Organization
Lead; Snow, ice	Jeff Key	NESDIS/STAR
Wisconsin:		
Snow products	~~Yong-Keun Lee~~	CIMSS (now CICS)
Maryland:		
Snow	Cezar Kongoli	CICS
Colorado:		
Sea ice	Walt Meier	NSIDC (formerly NASA GSFC)
Sea ice	Scott Stewart	CU Contractor
Sea ice	Florence Fetterer	NSIDC

AMSR2 Snow and Ice Products

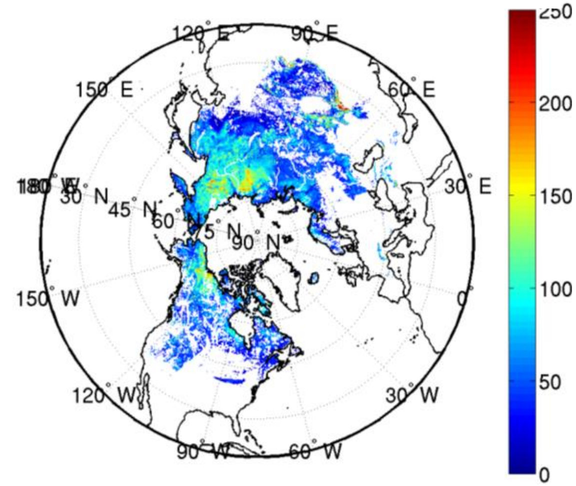
Snow Cover



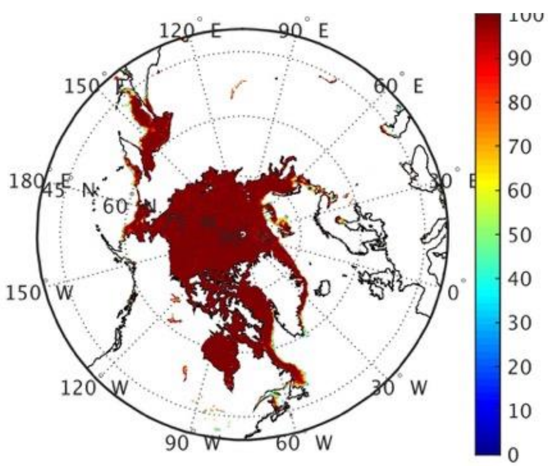
Snow Depth



Snow Water Equivalent

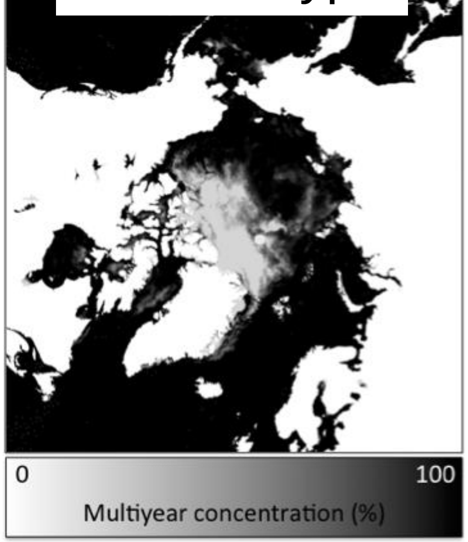


Sea Ice Concentration



Status: Operational, nominal, products meet requirements

Sea Ice Type



Product Performance – AMSR2

Product	L1RDS APU Thresholds	Performance	Meets Spec?
Snow cover (binary)	80% correct typing	72-97%	Y
Snow depth	20 cm uncertainty	15-22 cm	Y (marginal)
SWE	50-70% uncertainty (shallow to thick snowpacks)	~20-22%	Y
Ice concentration	10% uncertainty	3.9% NH; 4.4% SH	Y
Ice type	70% correct typing	80-90%, Arctic winter	Y

Future Plans

Snow:

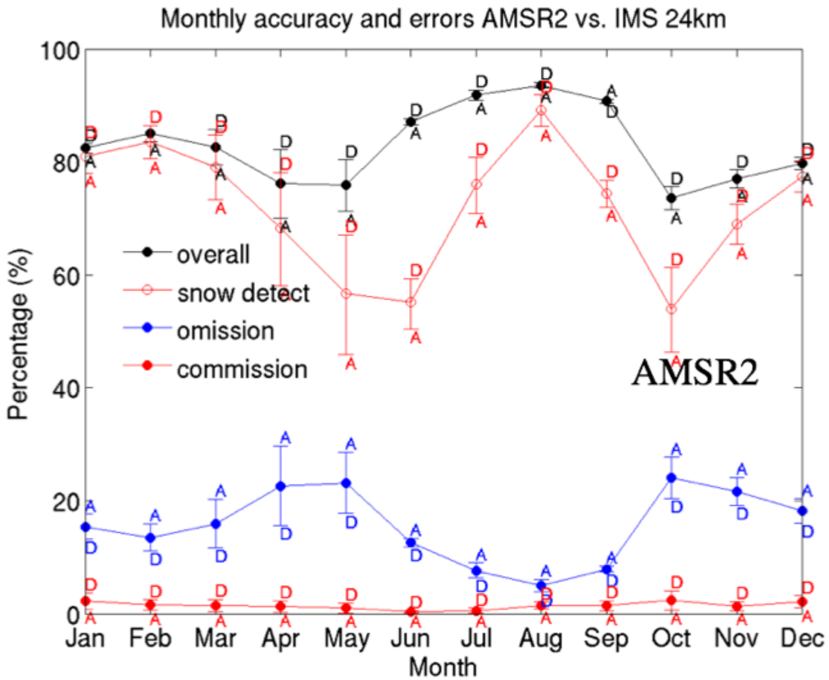
- Regional assessment of biases in AMSR2 snow products and adjustment of algorithm parameters to improve retrievals;
- Explore and develop a data assimilation-based AMSR2 SWE product similar to ESA's GlobSnow.

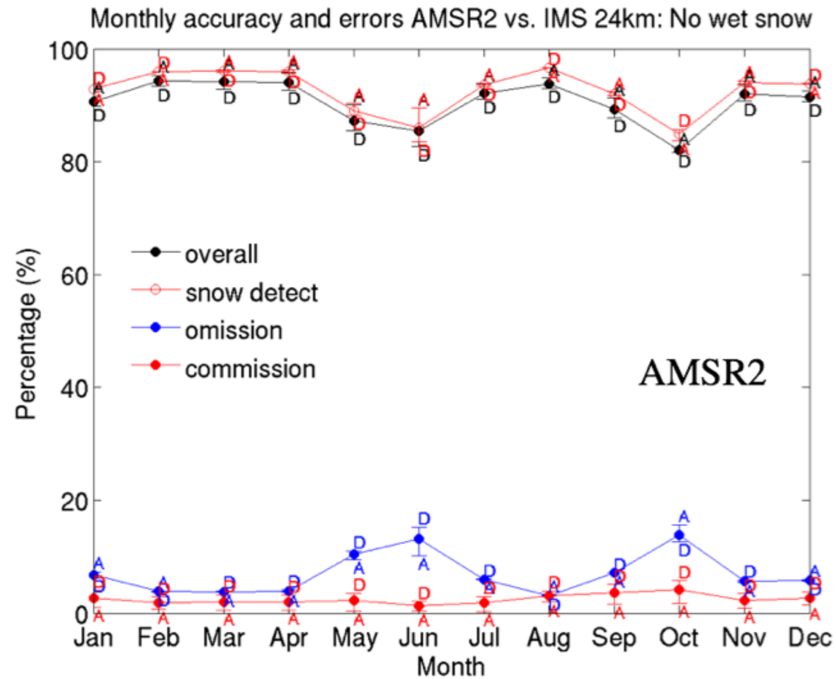
Sea ice:

- Further development and validation of ice type and publication of ice type methodology.

Extra Slides

Snow Cover Validation

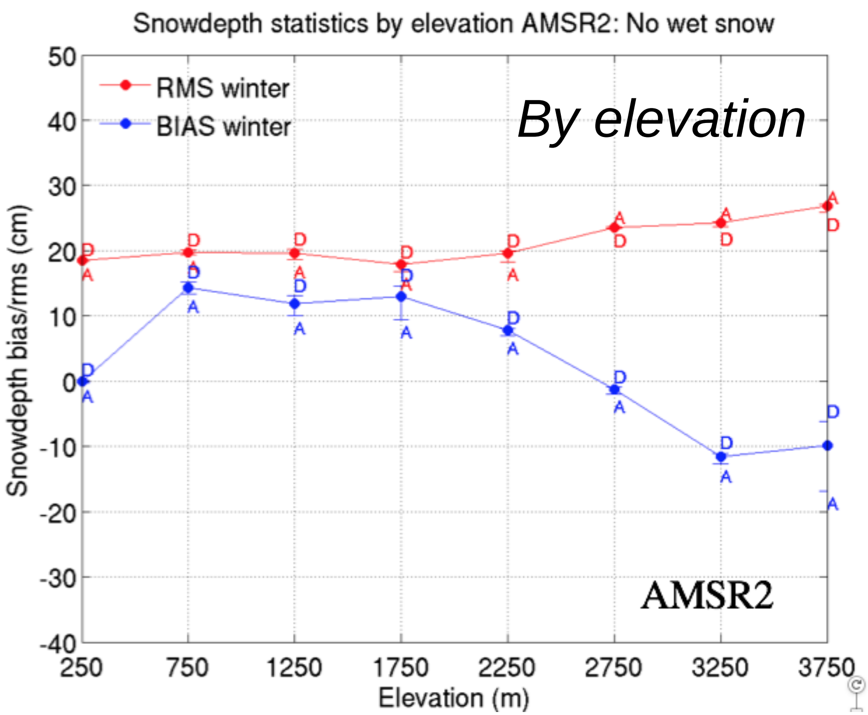


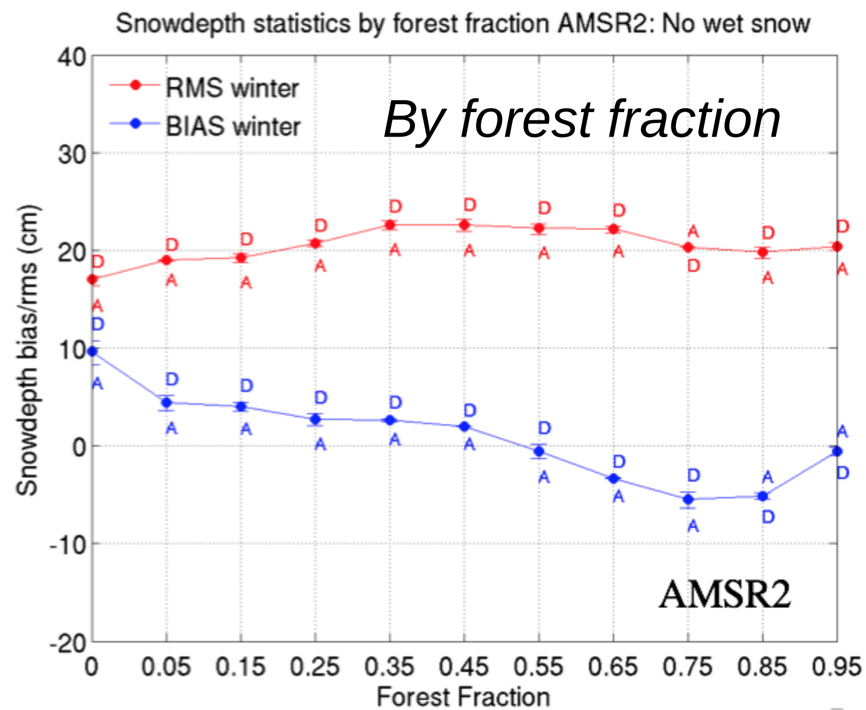


If wet snow is not included, detection accuracy is higher.

	Tundra	Taiga	Maritime	Ephemeral	Prairie	Alpine
Overall Accuracy	94.6%	97.4%	80.9%	71.7%	74.0%	86.9%

Snow Depth Validation





	Tundra	Taiga	Maritime	Ephemeral	Prairie	Alpine
RMSE (cm)	18.77	20.96	19.37	14.95	18.93	21.97
Bias (cm)	4.51	3.77	-5.34	6.05	2.75	-4.45
Mean (cm) of in-situ obs	25.10	19.18	20.20	8.40	18.49	25.14

Snow Water Equivalent Validation

SWE comparison between AMSR2 retrievals and **GHCN**

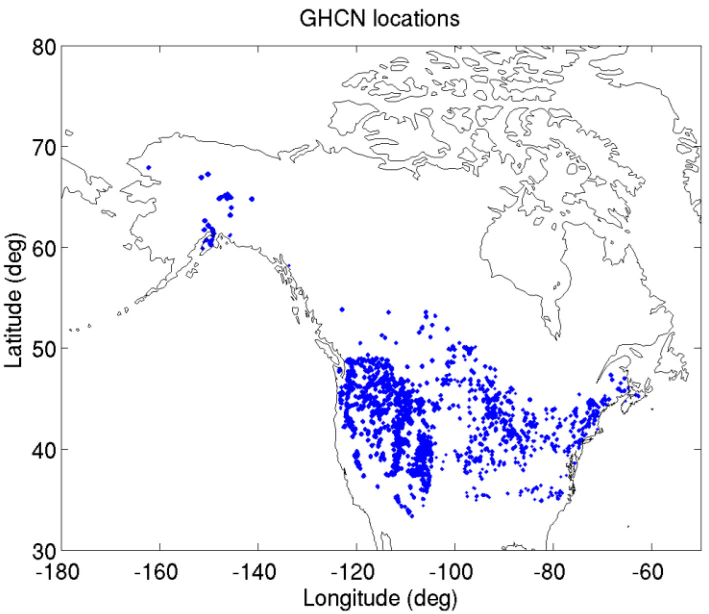
When 10 < AMSR2 SWE < 100 and 10 < GHCN SWE < 100 and the location altitude < 3000m:

bias	std	rmse	mean1	mean2	number of pixels
-7.97	30.77	31.79	46.54	54.52	45033

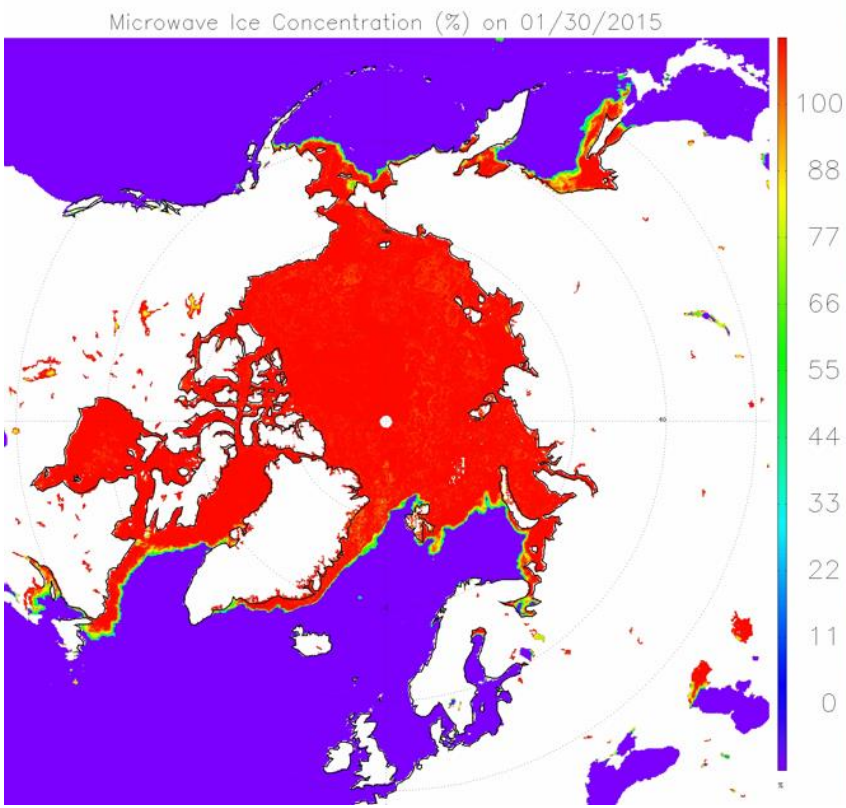
When 100 < AMSR2 SWE and 100 < GHCN SWE and the location altitude < 3000m:

bias	std	rmse	mean1	mean2	number of pixels
-29.91	50.91	59.05	115.56	145.47	657

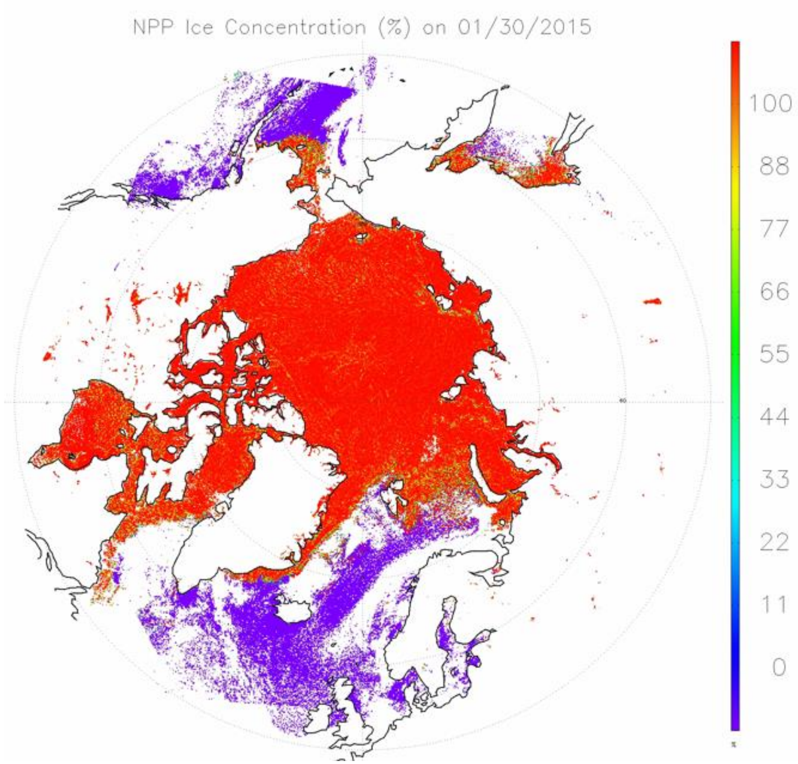
mean1: average of AMSR2 SWE
mean2: average of GHCN SWE
bias: mean of AMSR2 SWE - GHCN SWE
GHCN: Global Historical Climatology Network



Validation



Comparison of AMSR2 (left) and VIIRS (below) sea ice concentration over the Arctic on 31 January 2015.

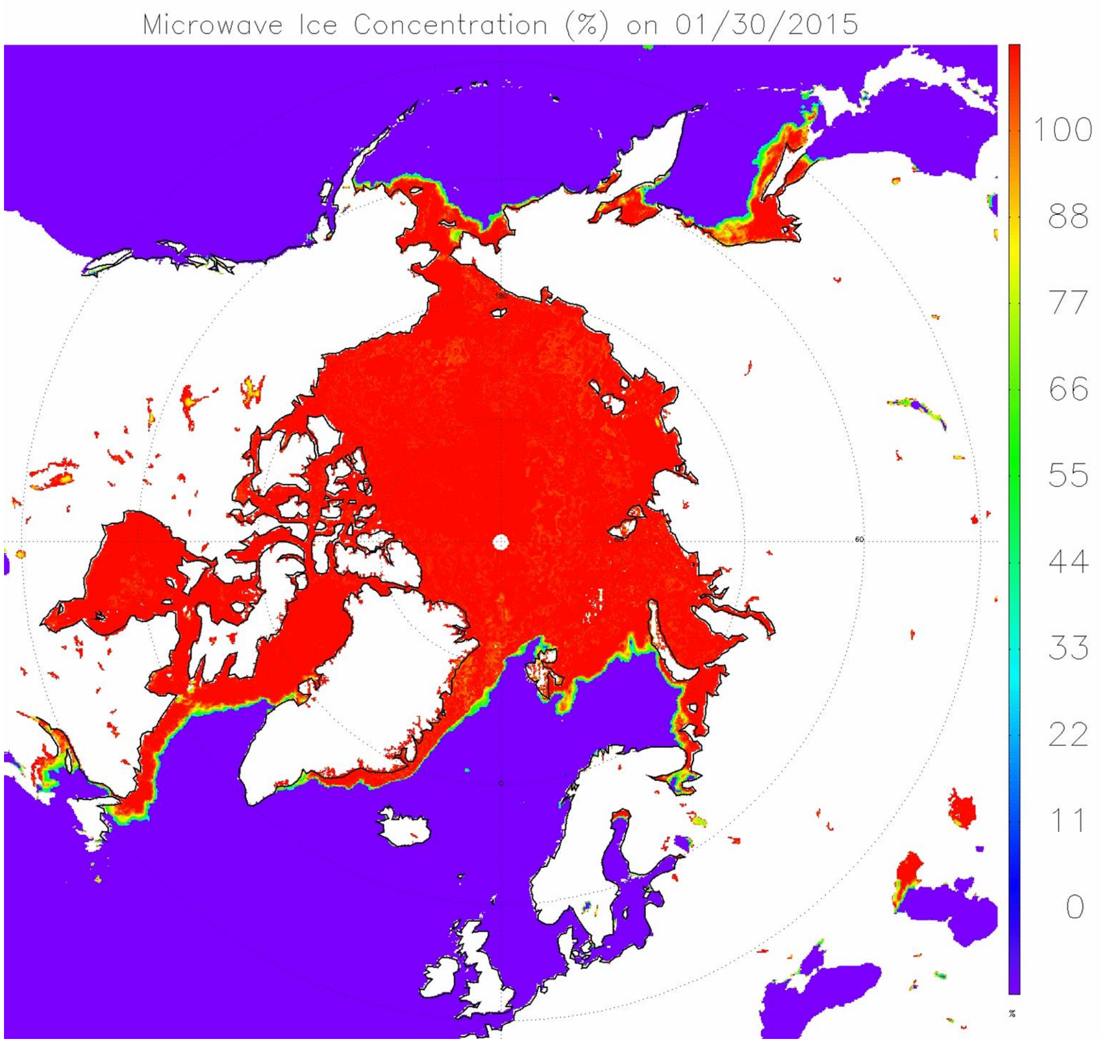


Additional information on validation is in the notes section of this slide

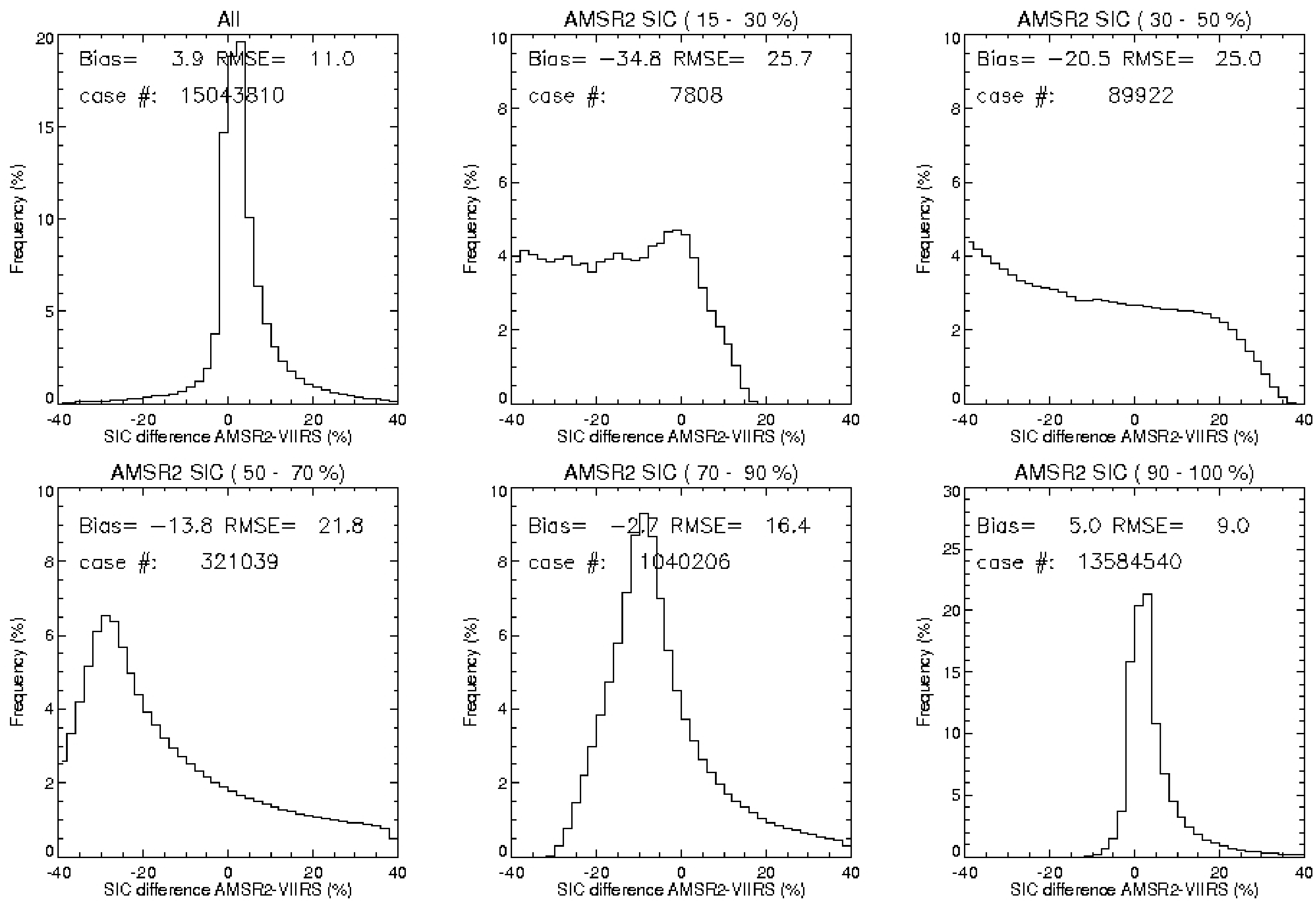
Sea Ice Concentration Validation

Comparison of AMSR2 and VIIRS sea ice concentration over the Arctic on 31 January 2015.

(animation)

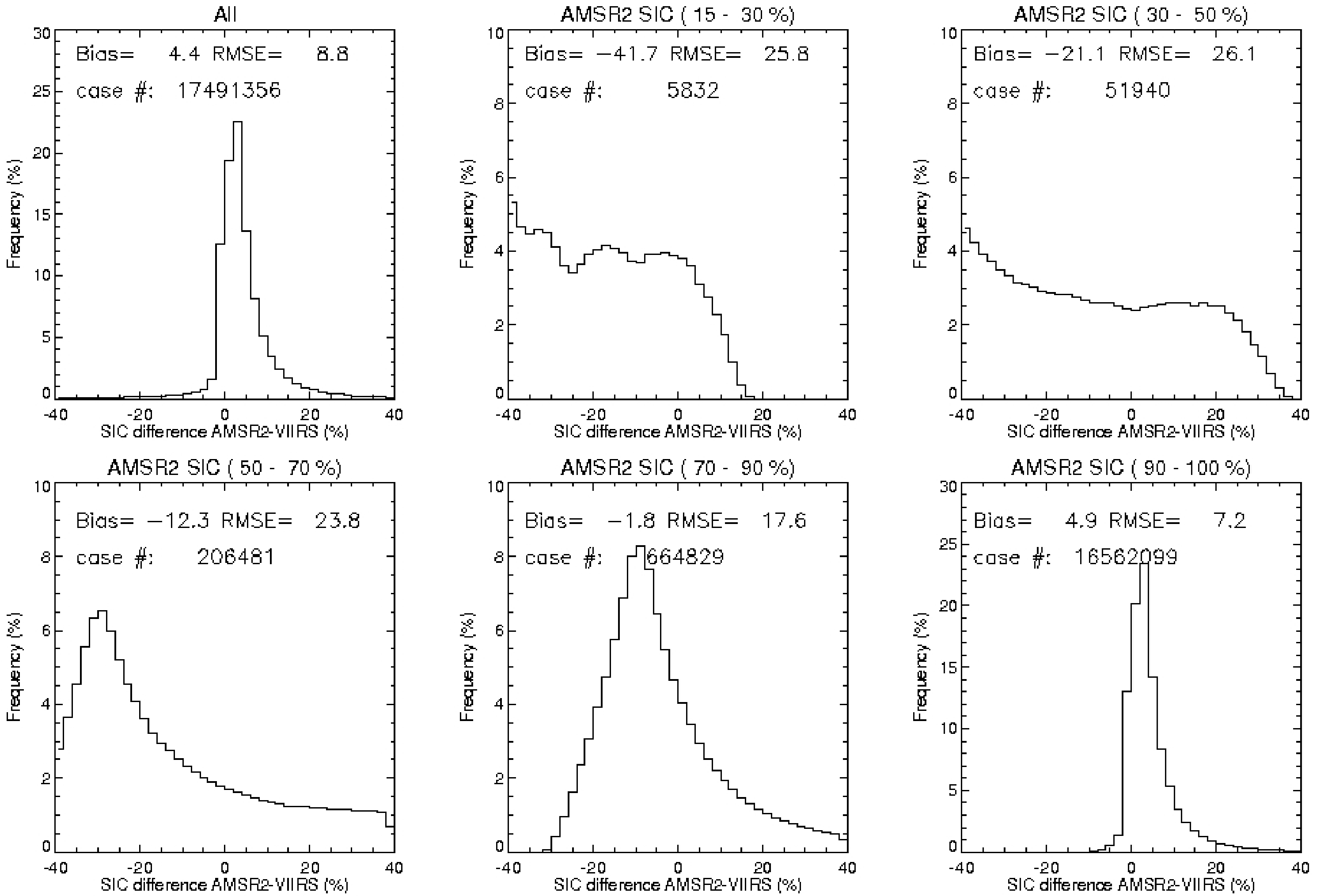


Sea Ice Concentration Validation



Comparison of AMSR2 minus VIIRS ice concentrations for different AMSR2 ice concentration ranges/bins in the Arctic. Note that the y-axis range is different for "All", "90-100%", and the other plots. Data are from January to October 2016.

Sea Ice Concentration Validation



Same as previous slide except for the Antarctic.

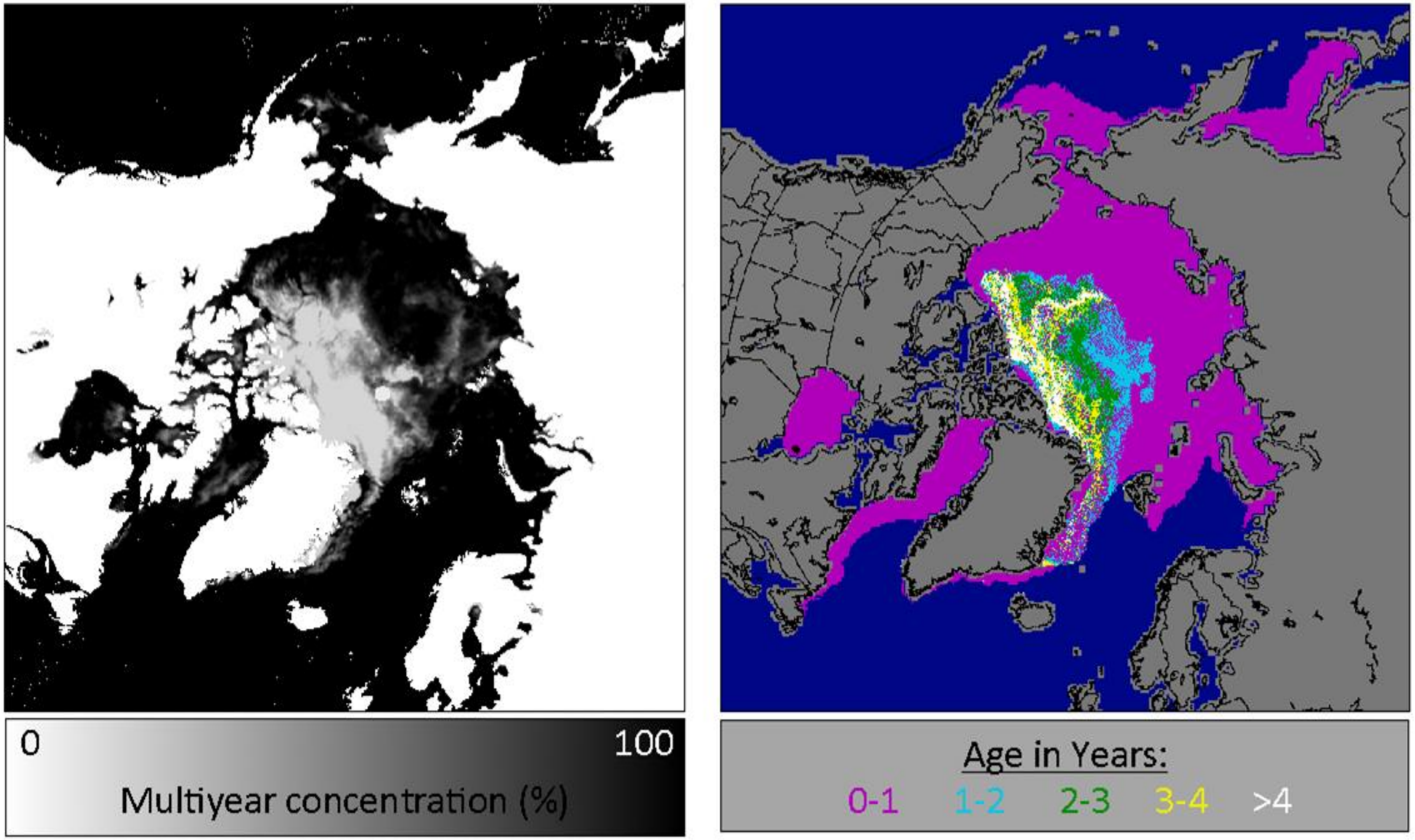
Sea Ice Concentration Validation

Statistical results of the comparison in sea ice concentration between AMSR2 and VIIRS.

Maximum (red) and minimum (blue) values in each column are highlighted.

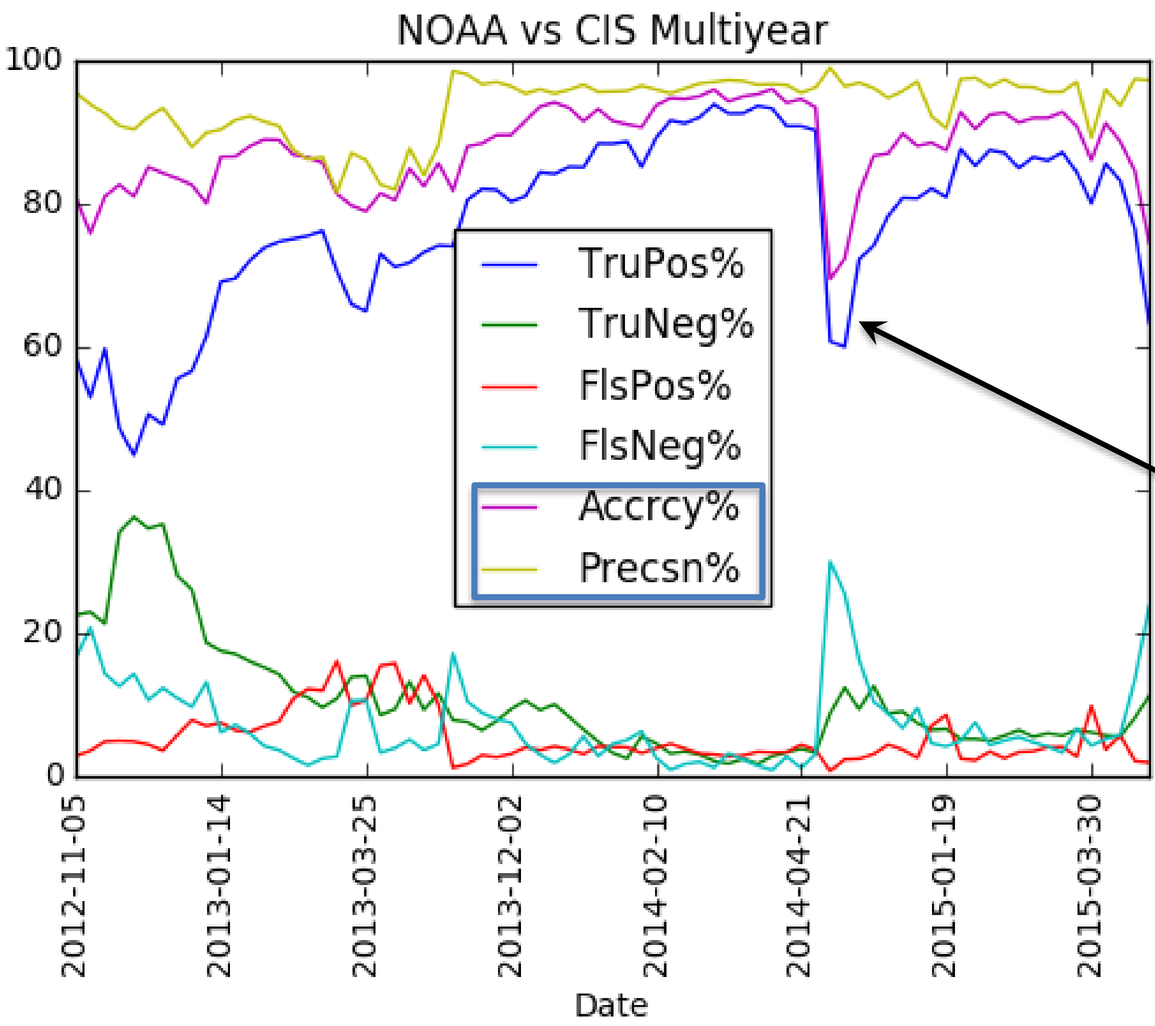
	Arctic			Antarctic		
	Accu	Prec	Cases	Accu	Prec	Cases
01/30	1.61	***8.76***	123747	0.50	21.45	22776
01/31	1.62	9.10	***124514***	1.53	***22.03***	***19556***
02/27	2.05	9.91	122376	1.04	20.19	20101
02/28	2.03	9.35	120343	***0.21***	20.88	22256
03/30	2.45	10.01	122108	1.52	14.90	48343
03/31	2.12	9.39	118841	2.48	15.24	43737
04/30	3.02	11.98	88959	1.85	12.64	79228
04/31	3.01	11.87	79756	2.24	12.62	82094
05/30	3.20	11.46	65418	2.19	13.03	99093
05/31	***3.22***	11.92	70990	1.80	12.97	104142
06/30	2.19	14.05	56864	1.55	***11.08***	121964
06/31	1.89	14.41	55580	1.56	11.78	123805
07/30	1.89	18.33	35577	2.43	12.62	***142350***
07/31	2.53	18.20	38069	2.58	12.34	138524
08/30	***0.25***	***18.48***	28727	2.79	11.87	133027
08/31	0.61	17.19	***27315***	***2.95***	12.71	142208

Multiyear Ice Validation



Initial comparison with independent ice age fields (Lagrangian tracking of ice parcels) indicates good agreement in terms of spatial distribution of multi-year ice cover.

Ice Type Validation: Ice Charts

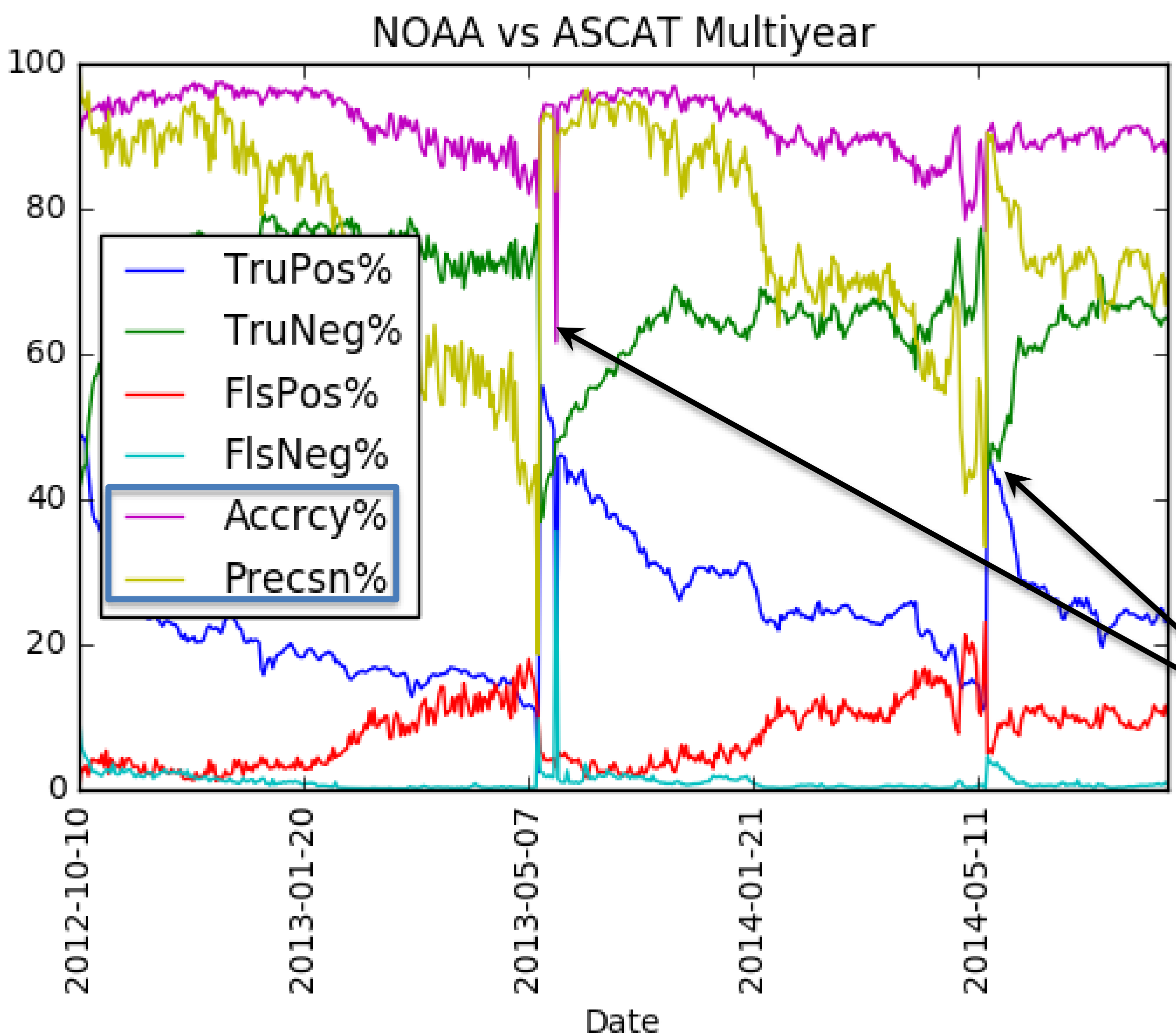


Comparison of NOAA vs. Canadian Ice Service (CIS) charts in high Arctic

Performance drops in May (melt onset)

NOTE: Summer months are not included in plot.

Ice Type Validation: ASCAT



Comparison of NOAA vs. ASCAT scatterometer

Lower performance expected from ASCAT as well

Performance drops in May

NOTE: Summer months are not included in plot.

Ice Type Validation: OSI-SAF

Confusion Matrix results, 2012-2015

- Average over all 3.5 years (Oct. 2012 – Dec. 2015)
- Mid-October through mid-April each year

	OSISAF MYI	OSISAF no-MYI
NOAA MYI	28.1%	2.1%
NOAA no-MYI	4.8%	65.1%

Accuracy: 93.2 ± 2.3%
Precision: 84.5 ± 8.5%

NOAA agrees with OSISAF (i.e., "correct" retrieval)