Maintenance and Development of the JAXA GCOM-W1 AMSR2 Snow Depth and Snow Water Equivalent Algorithm

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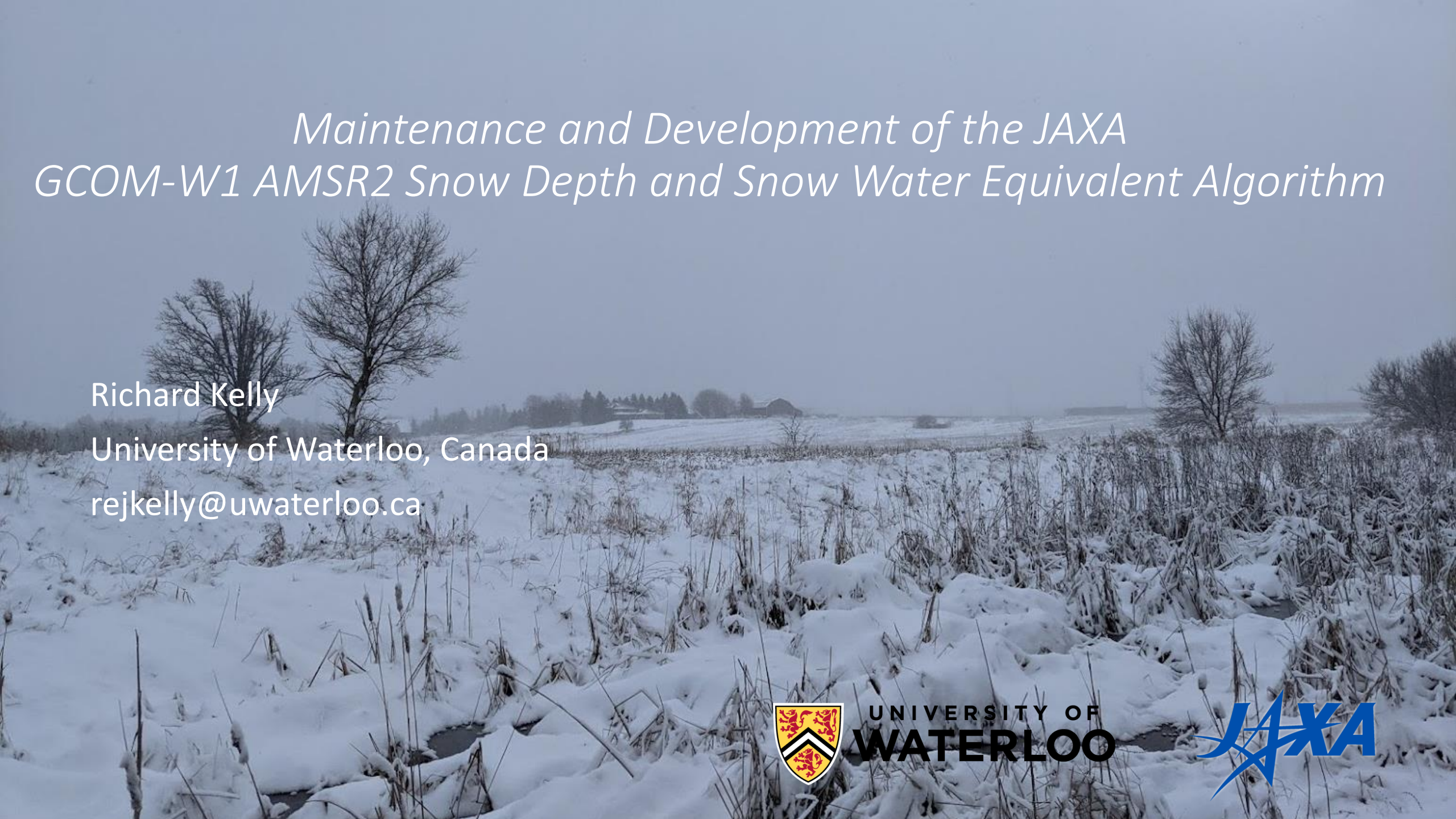

Objective:

to <u>implement</u> a satellite-based microwave snow algorithm (SMSA)

- Improve Algorithm Retrieval Capabilities for AMSR2 Snow Depth estimates
- Develop long-term record of depth estimates (intercompare with others)

Outline:

The satellite-based microwave snow algorithm (SMSA)

- SMSA summary
- SMSA v3.0
- SMSA v3.1 (bias correct)
- Summary and ongoing activities

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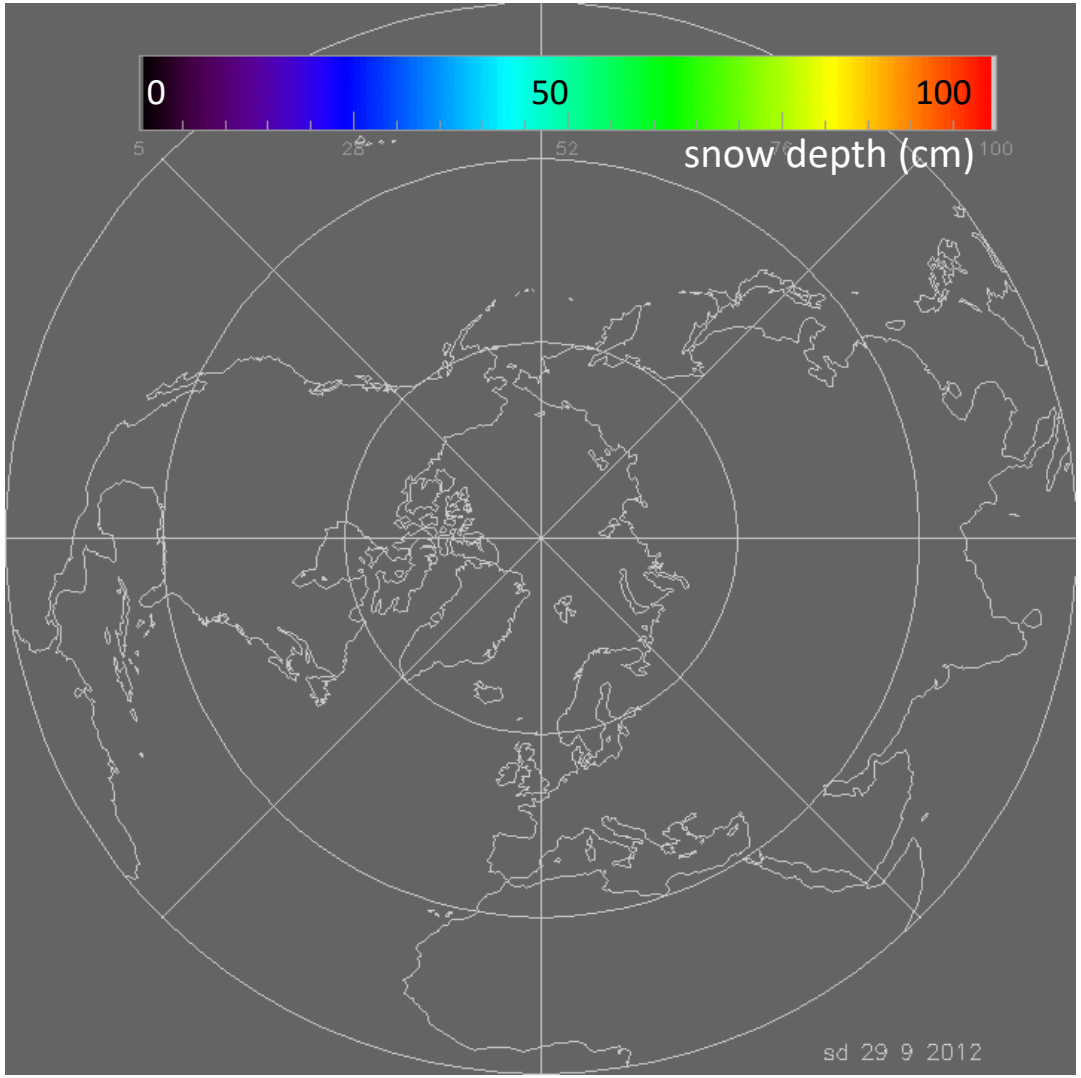
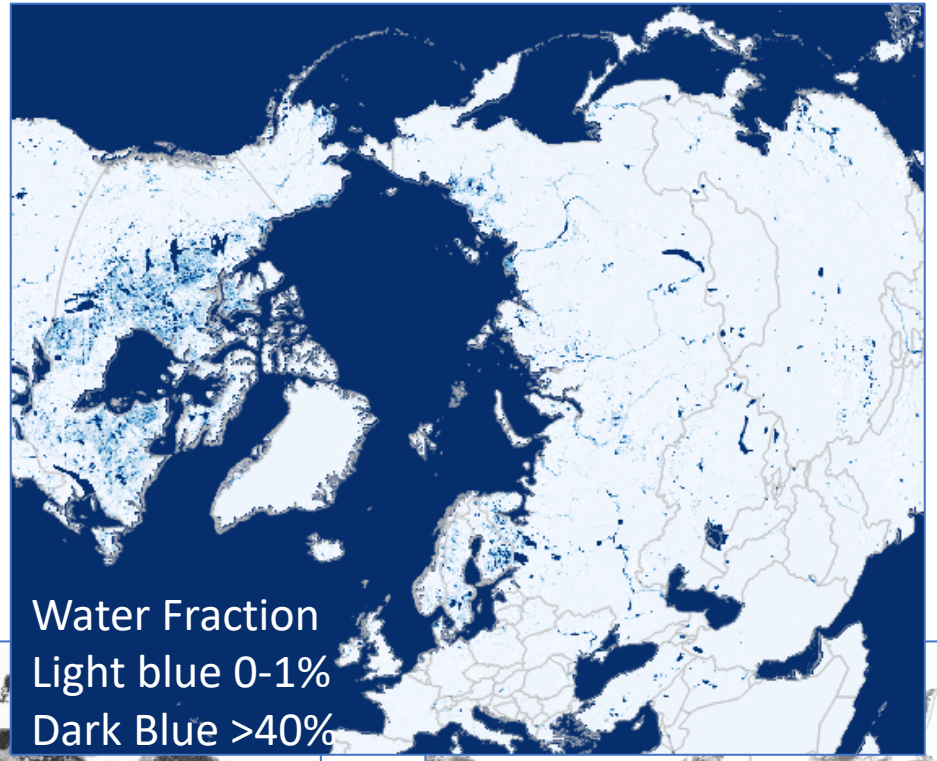
SMSA: approach

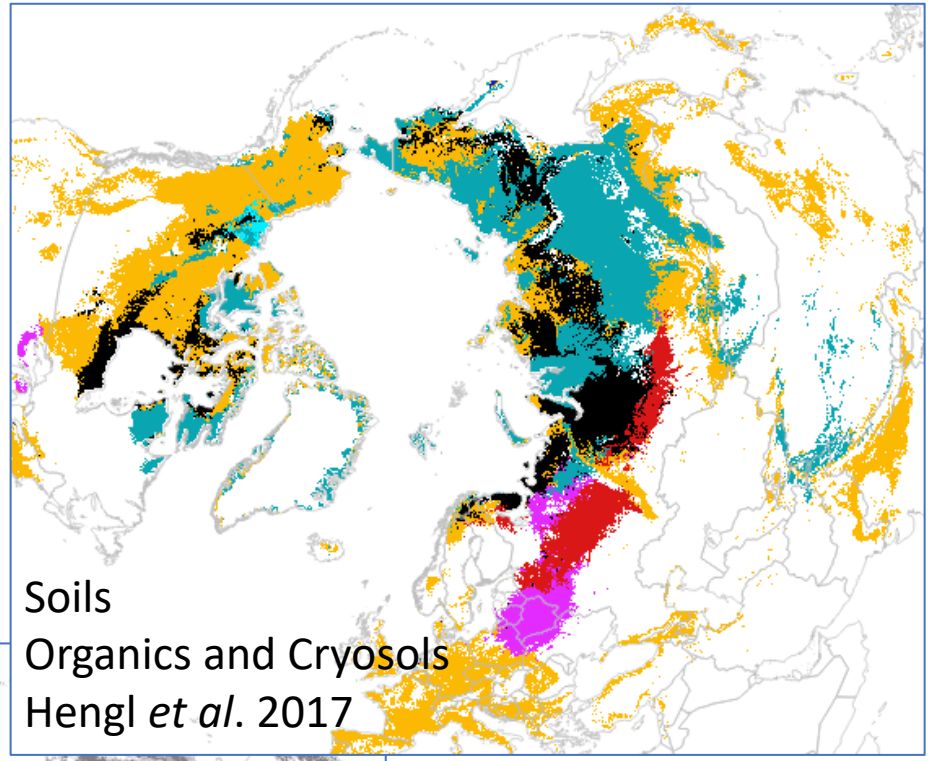
- Snow detection: AMSR2 Tb obs. coupled with auxiliary data. Snow typing: shallow/moderate/wet.
- Snow depth retrieval: single layer DMRT model LUT. AMSR2 Tb parameterization of *d0*, ρ, T_{phys}. Cost function minimizes $(Tb18\text{-}Tb36)_{est}$ and $(Tb18\text{-}Tb36)_{obs}$. (H or V pol depending on snow detection)
- Temporal inertia: gaussian weighted Tb data incorporated.
- Bias correction from unresolved forest attenuation
- SWE estimated as a bi-product of DMRT and ρ
- Algorithm grid 12.5 EASE2 ➔ L2 Product granule (lat/lon) ➔ L3 PSG NH product

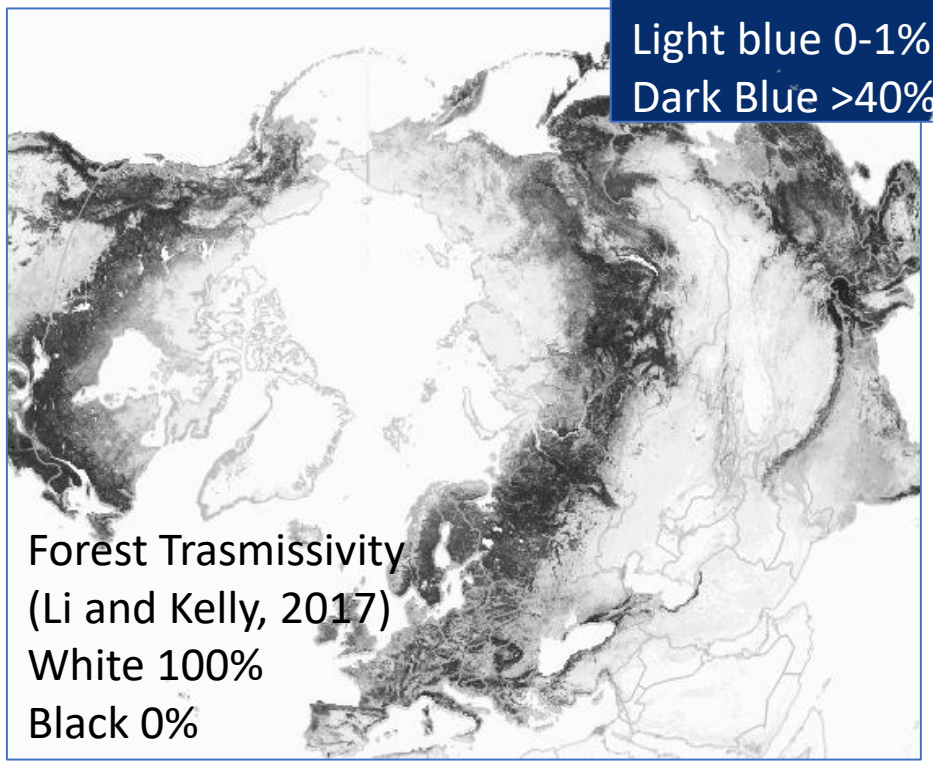
Internal EASE2.0 grid SD memory 2012-13

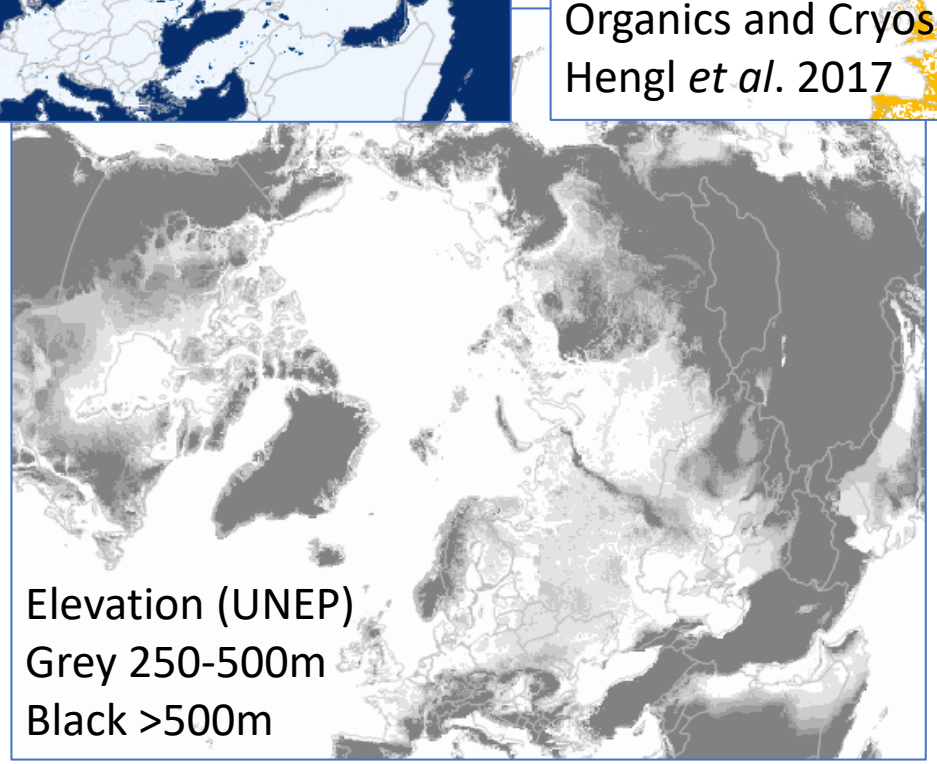


SMSA:
auxiliary data



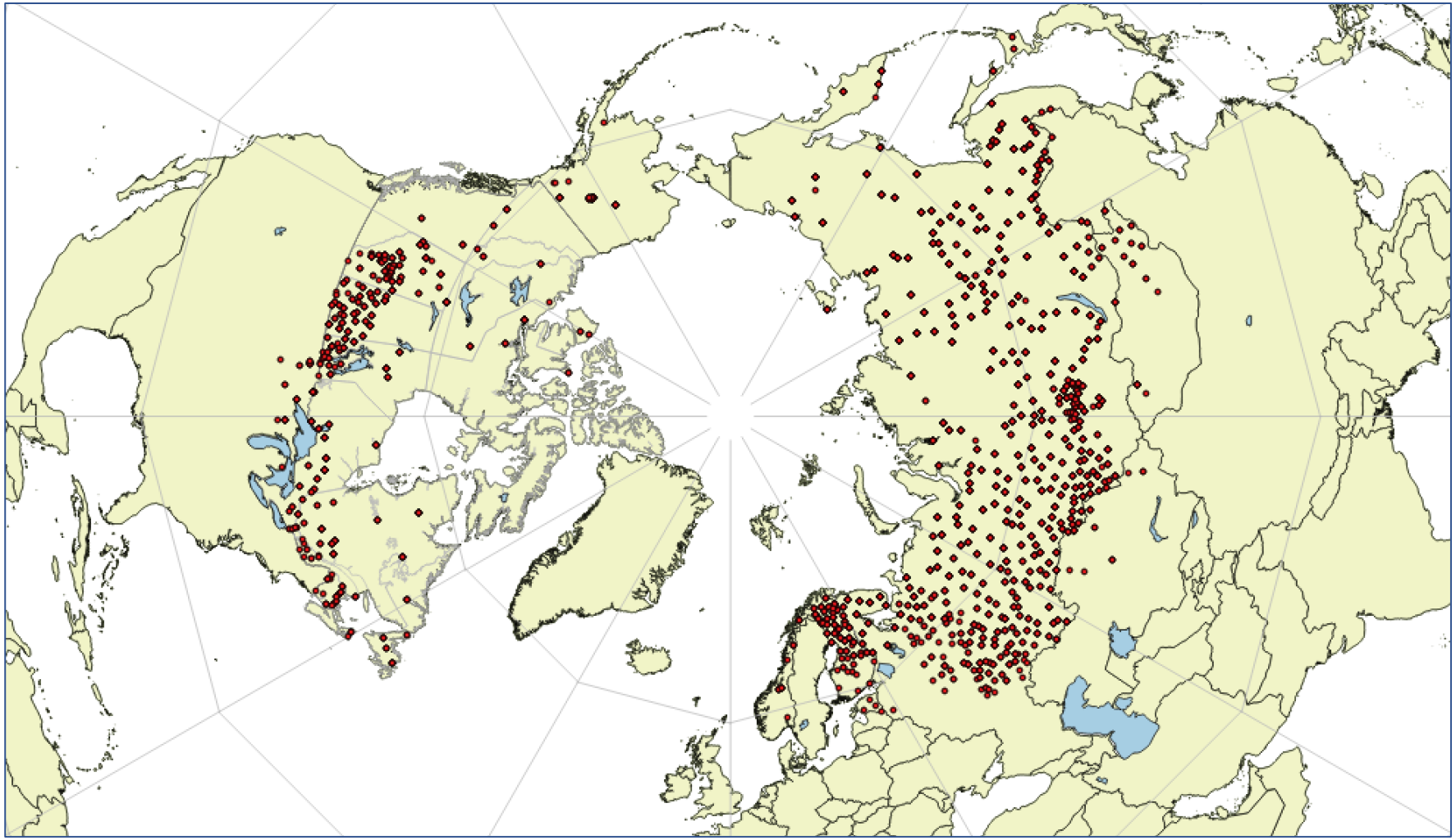


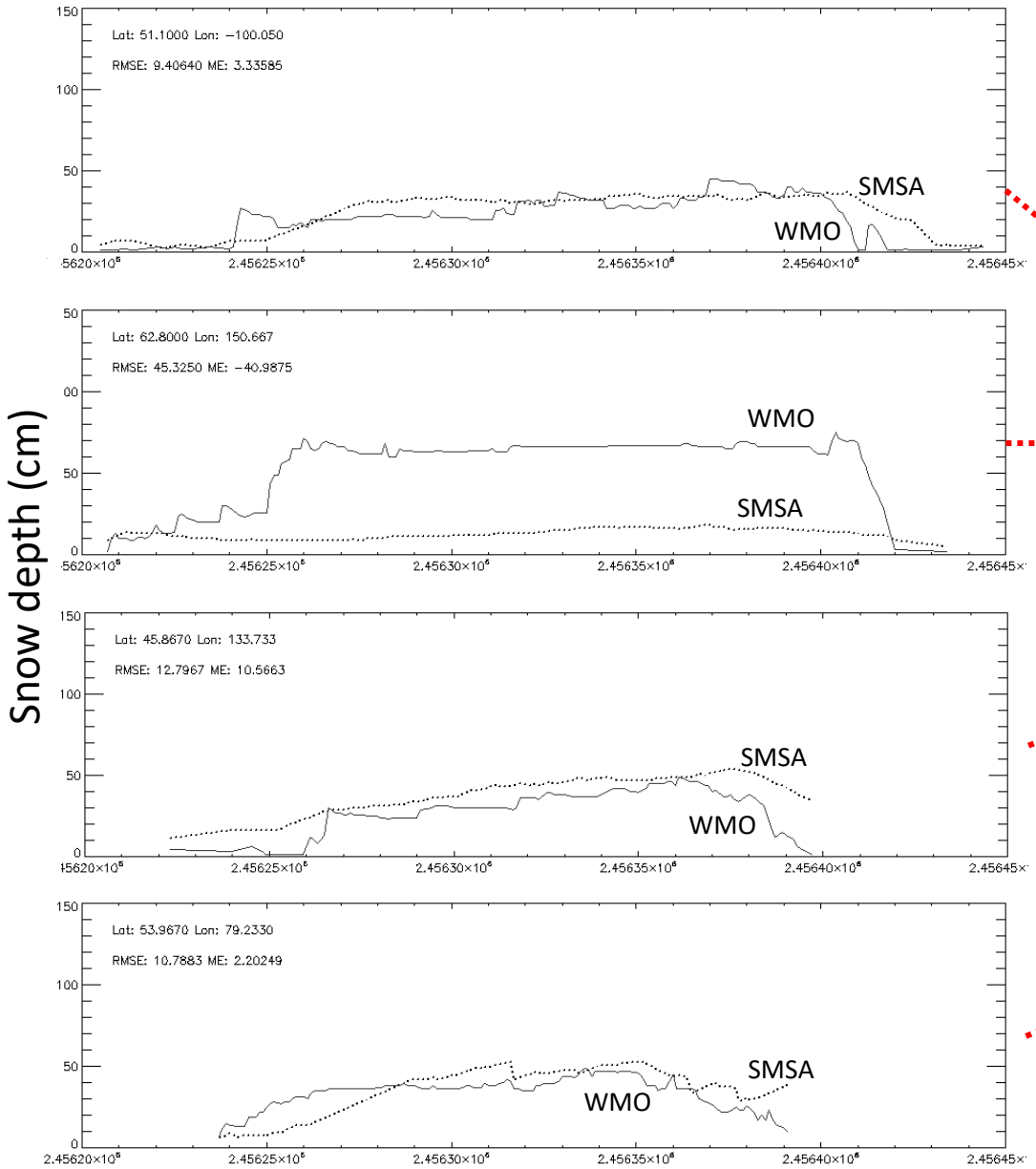


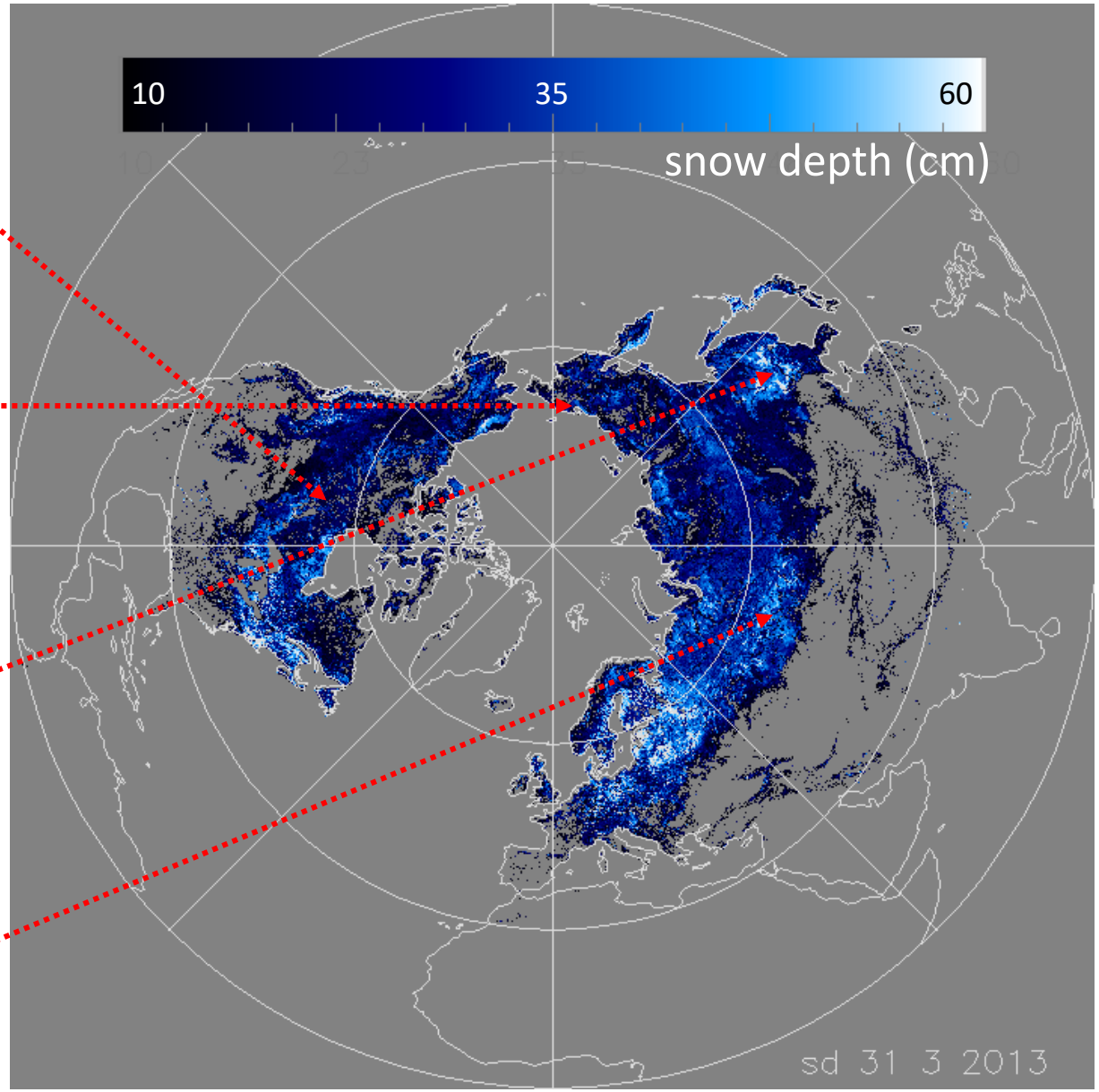


SMSA: Uncertainty Estimation

- WMO GSOD snow depth – *in situ* point locations.
- >100 snow days (SD>0) per season
- <100cm observed depth
- RMSE, MBE estimates
- Average number of stations per year: 545 (range: 373-649)




Lat: 51.1000 Lon: −100.050
RMSE: 9.40640 ME: 3.33585
SMSA
WMO
Lat: 62.8000 Lon: 150.667
RMSE: 45.3250 ME: −40.9875
WMO
SMSA
Lat: 45.8670 Lon: 133.733
RMSE: 12.7967 ME: 10.5663
SMSA
WMO
Lat: 53.9670 Lon: 79.2330
RMSE: 10.7883 ME: 2.20249
SMSA
WMO
Snow depth (cm)
1 Oct. 2012 – 31 May 2013


10
35
60
snow depth (cm)
sd 31 3 2013

Outline:

The satellite-based microwave snow algorithm (SMSA)

- SMSA summary
- SMSA v3.0
- SMSA v3.1 (bias correct)
- Summary and ongoing activities

UW: *in house* Validation

Source: WMO GSOD daily snow depth, >500 stations per year, >100 consecutive snow days.

SMSA (v3.0) vs v2 algorithm

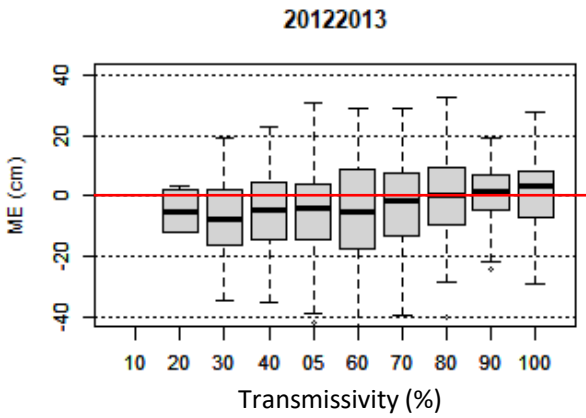
	SMSA (v3.0)			Current (v2)		
Year	**RMSE**	**MAE**	**ME**	**RMSE**	**MAE**	**ME**
2012-13	16.9	14.3	-3.4	20.4	16.8	-3.5
2013-14	18.9	16.2	-4.9	23.2	19.7	-5.0
2014-15	19.5	16.9	-4.1	23.9	20.1	-2.5
2015-16	18.0	15.3	-3.2	22.8	19.3	-3.7
2016-17	19.0	16.1	-4.7	23.9	20.2	-8.0
2017-18	19.6	17.0	-4.4	24.8	21.0	-4.5
2018-19	18.6	15.8	-4.7	23.5	19.3	-4.2
Average	**18.6**	**16.0**	**-4.7**	**23.2**	**19.5**	**-4.5**

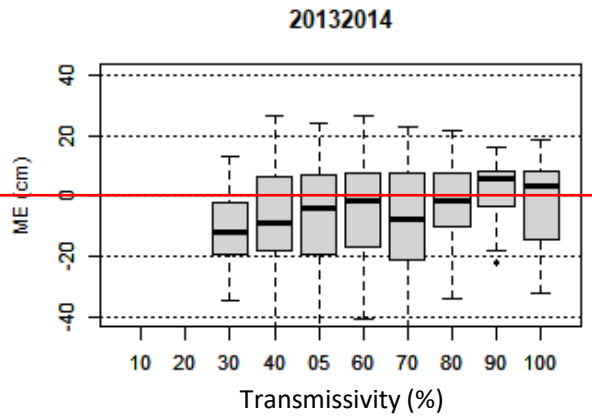
RMSE Root Mean Square Error. **ME** Mean Bias Error. **MAE** Mean Absolute Error.

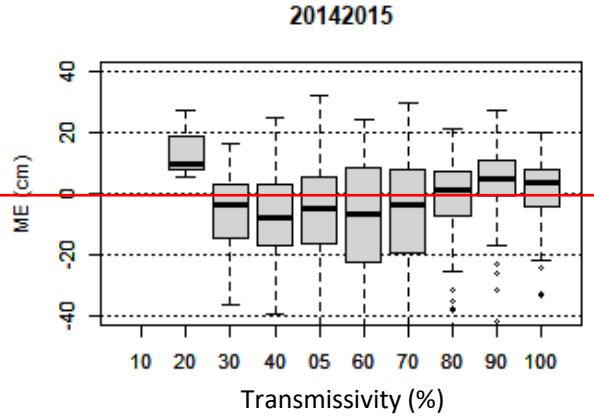
Summary

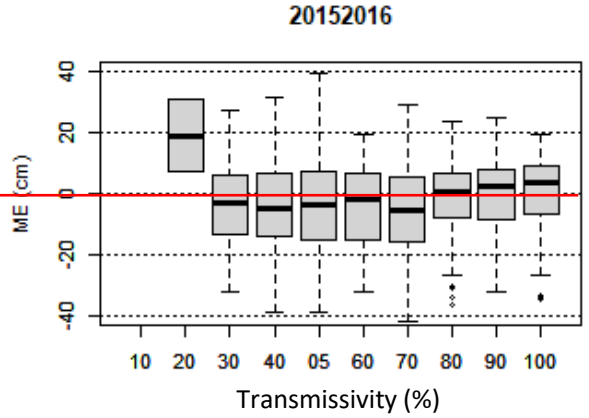
- v3.0 performs better than v2 (current) method
- v3.0 average bias (cm): -4.7 (GSv3: +5.4)
- v3.0 RMSE (cm): 18.6 (GSv3: 20.8)
- v3.0 RMSE < 20 cm (JAXA requirement)

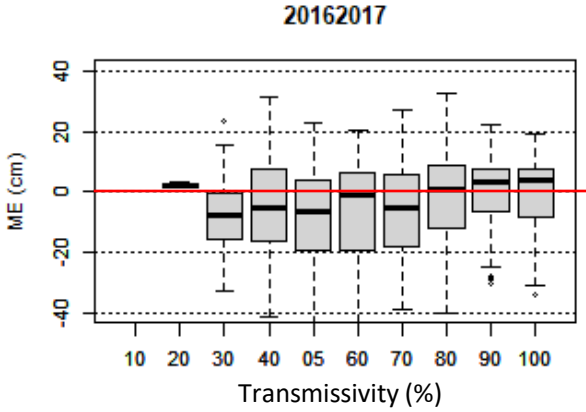
v3.0 Mean Error (bias, cm) vs Forest Transmissivity (%)

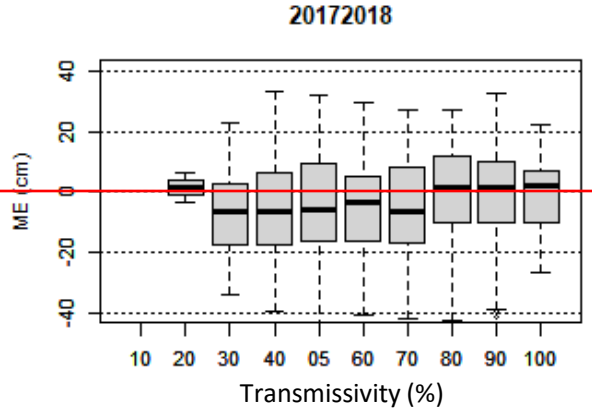


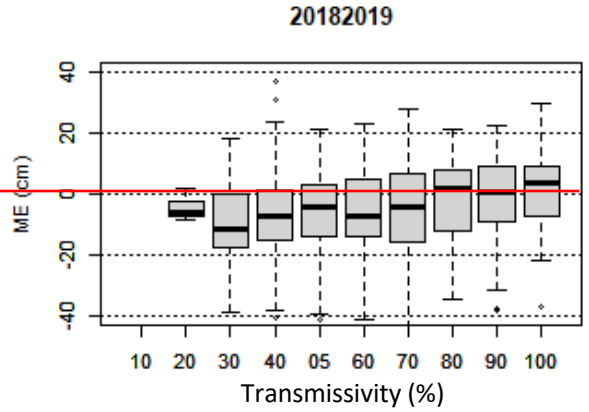












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Source: WMO GSOD daily snow depth, >500 stations per year, >100 consecutive snow days.

SMSA (v3.1) vs SMSA (v3.0) algorithm

	SMSA (v3.0)			SMSA (v3.1)		
Year	**RMSE**	**MAE**	**ME**	**RMSE**	**MAE**	**ME**
2012-13	16.9	14.3	-3.4	16.8	14.4	-0.4
2013-14	18.9	16.2	-4.9	18.5	15.9	-2.1
2014-15	19.5	16.9	-4.1	19.3	16.8	-1.0
2015-16	18.0	15.3	-3.2	18.1	15.6	0.0
2016-17	19.0	16.1	-4.7	19.0	16.3	-1.6
2017-18	19.6	17.0	-4.4	19.6	17.1	-1.2
2018-19	18.6	15.8	-4.7	18.2	15.8	-1.6
Average	**18.6**	**16.0**	**-4.7**	**18.5**	**16.0**	**-1.1**

RMSE Root Mean Square Error.

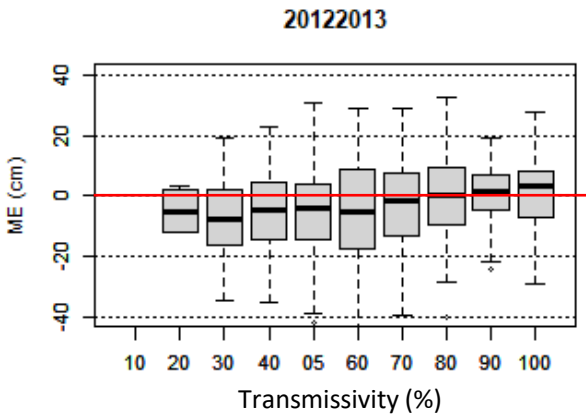
ME Mean Bias Error.

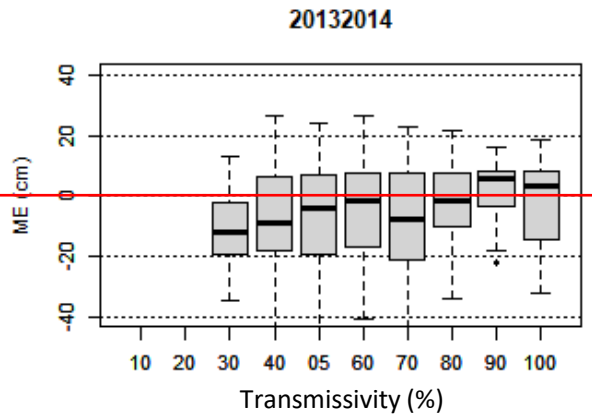
MAE Mean Absolute Error.

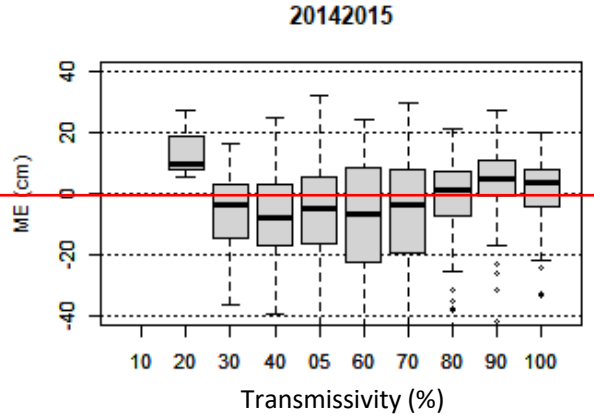
Summary

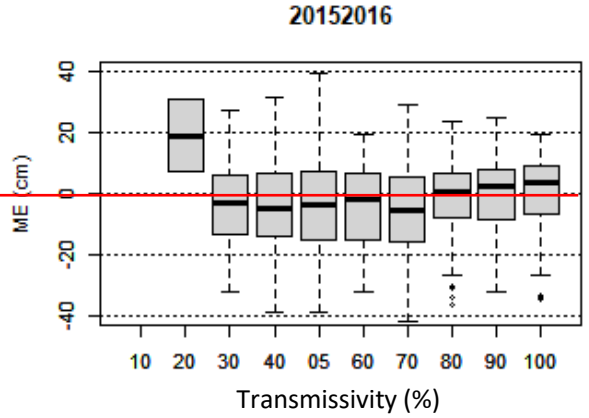
- v3.1 RMSE & MAE slightly better than v3.0
- v3.1 average bias (cm): -1.1 (v3.0 -4.7)

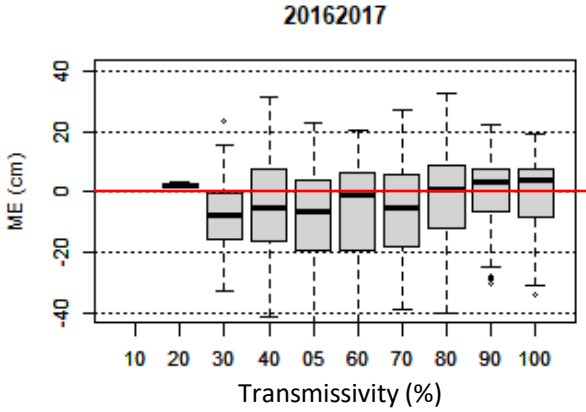
v3.0 Mean Error (bias, cm) vs Forest Transmissivity (%)

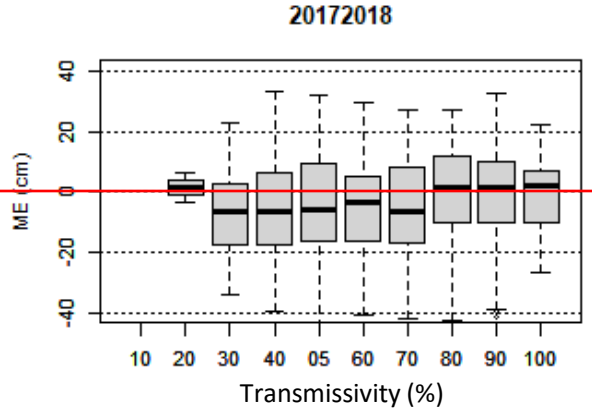


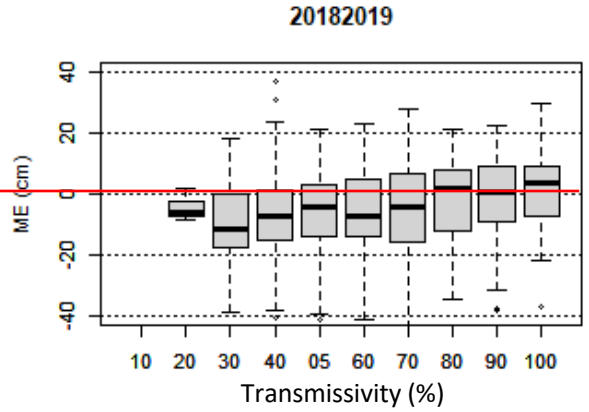




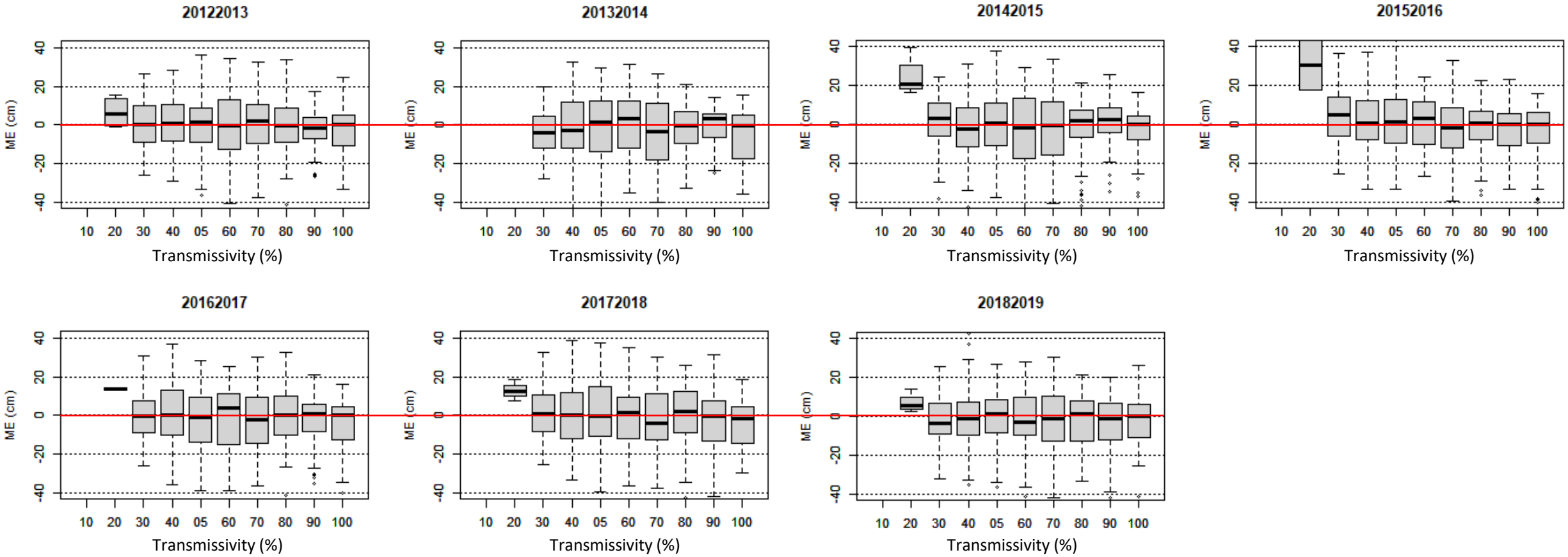






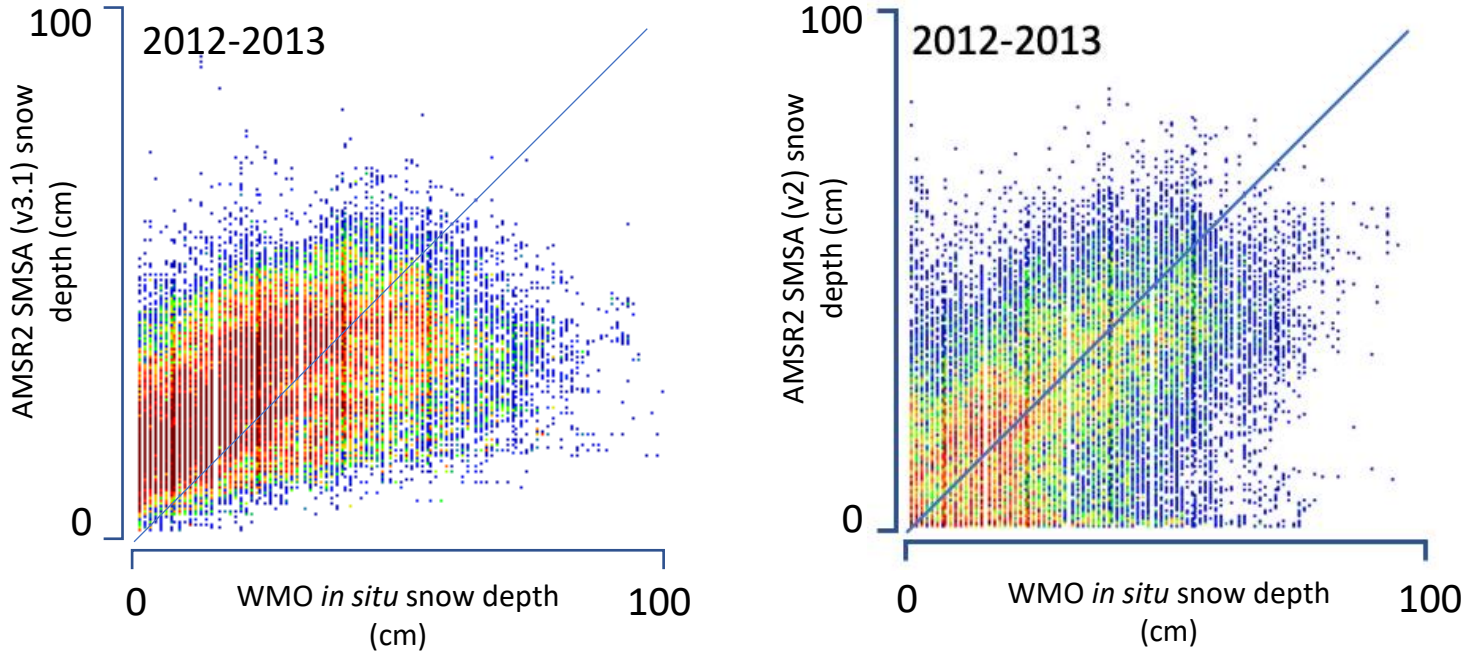


v3.1 Mean Error (bias, cm) vs Forest Transmissivity (%)



“False positives” issue

- Detection algorithm under scrutiny. Possible WMO biases in SD data (airports, human settlements) and in low forest transmissivity areas.
- Testing snow detection algorithm – scope for updated approach.



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Conclusions & ongoing work

SMSA status (v3.0 and v3.1)

- Both v3.0 and v3.1 achieve AMSR2 target MAE (<20 cm)
  - v3.0: MAE(ME) ➔ 16.0(-4.6) cm.
  - v3.1: MAE(ME) ➔ 16.0(-1.1) cm
- Ongoing assessment of seasonal station-wise errors in v3.0 and v3.1
  - geographically regionalized processes (e.g. taiga) caused by issues in underlying soil state
  - False positives an issue in v3.0 and more in v3.1. Spatial majority filtering and improvement of snow detection probable solution.
  - V3.0 fewer false positives (larger negative bias). Release for AMSR3.
- Creating a snow depth record to cover full AMSR2 and AMSR-E record

THANK YOU!

UNIVERSITY OF WATERLOO

JAXA