Read-me for Data Users

MEMORANDUM FOR: The Record
FROM: Jeff Key (NOAA) and Yong-Keun Lee (CIMSS)
SUBJECT: GCOM-W1 AMSR2 snow products Validated maturity status and public release
DATE: 05/10/2017

Validated maturity status declaration for Snow Cover and Snow Depth; Provisional maturity status declaration for Snow Water Equivalent
Maturity Review Date: **04/20/2017**
Effective Date: **04/20/2017**
Operational System: **NDE 1.0.10**

The JPSS Algorithm Maturity Readiness Review Board approved the release of the AMSR2 snow products to the public with a Validated maturity level quality for Snow Cover and Snow Depth products, and a Provisional maturity level quality for Snow Water Equivalent as of 04/20/2017 (effective date), based on JPSS Validation Maturity Review held on 04/20/2016.

1. Validated maturity means:
   - Product performance has been demonstrated over a large and wide range of representative conditions (i.e., global, seasonal).
   - Comprehensive documentation of product performance exists that includes all known product anomalies and their recommended remediation strategies for a full range of retrieval conditions and severity level.
   - Product analyses are sufficient for full qualitative and quantitative determination of product fitness-for-purpose.
   - Product is ready for operational use based on documented validation findings and user feedback.
   - Product validation, quality assurance, and algorithm stewardship continue through the lifetime of the instrument.

   Provisional maturity means:
   - Product performance has been demonstrated through analysis of a large, but still limited (i.e., not necessarily globally or seasonally representative) number of independent measurements obtained from selected locations, time periods, or field campaign efforts.
   - Product analyses are sufficient for qualitative, and limited quantitative, determination of product fitness-for-purpose.
   - Documentation of product performance, testing involving product fixes, identified product performance anomalies, including recommended remediation strategies, exists.
   - Product is recommended for potential operational use (user decision) and in scientific publications after consulting product status documents.

2. Algorithm Description:
   Snow cover, snow depth, and snow water equivalent (SWE) are generated sequentially. The overall algorithm starts with snow detection using brightness temperature decision tree approach, considering land surface type and snow cover climatology. Once an AMSR2 pixel is determined to have snow cover, snow depth is calculated based on an empirical relationship between snow depth and brightness temperature spectral gradients that employs dynamical coefficients. SWE is calculated by multiplying the snow depth by an assumed snow density for various snow classes.

   Additional information is available in the algorithm theoretical basis document (ATBD) and validation maturity review briefing, which can be accessed at:
   http://www.star.nesdis.noaa.gov/jpss/Docs.php

   List of Products and quality flags:

EDR Output	Description	Dynamic Range
Latitude	Latitude of Observation Points for Low Resolution Channels	-90.0 to 90.0°
Longitude	Longitude of Observation Points for Low Resolution Channels	-180.0 to 180.0°
Snow_Cover	0: N/A 1: water 2: land without snow 3: land with wet snow possible 4: land with dry snow	[0, 1, 2, 3, 4]
Snow_Depth	Snow Depth	0 to 100 cm
SWE	Snow Water Equivalent	0 to 500kg/m^2
Snow_Climatology_Index	0: N/A (water) 1: no snow in climatology 2: snow in climatology but may be wet according to Tb36 (V&H) 3: snow in climatology	[0, 1, 2, 3]
Snow_Depth_Index	0: no snow depth retrieval 1: no snow depth retrieval (maybe over glacier or permanent snow area) 2: land with snow, but sd or SWE exceed the limit 3: valid sd and SWE retrieval	[0, 1, 2, 3]
Scattering_Surface_Index	0: N/A (water or etc.) 1: precipitation possible	[0, 1, 2, …, 9]

	2: cold desert possible 3: rain + cold desert possible 4: frozen ground possible 5: rain + frozen ground possible 6: cold desert + frozen ground possible 7: rain + cold desert + frozen ground possible 8: glacier possible 9: valid snow cover	

Product requirements/Exclusions (L1RDS):

GCOM Snow Cover/Depth	
EDR Attribute	Threshold
Applicable conditions	Delivered under "all weather" conditions
Sensing depth	0 – 60 cm
Horizontal cell size	10 km
Mapping uncertainty, 3 sigma	5 km
Snow depth ranges	5 – 60 cm
Measurement uncertainty	
-- Clear	
-- Cloudy	80% probability of correct snow/no snow classification; Snow Depth: 20 cm
Refresh	At least 90% coverage of the globe about every 20 hours (monthly average)

Note: Uncertainty requirements do not apply to (1) mountainous areas (2) melting snow condition.

GCOM Snow Water Equivalent	
EDR Attribute	Threshold
Applicable conditions	Delivered under "all weather“ conditions
Horizontal cell size	10 km
Mapping uncertainty, 3 sigma	5 km
Measurement range	10 – 200 mm
Measurement uncertainty	
-- Shallow to moderate snow packs (10 – 100 mm)	20 mm or 50%
-- High snow accumulation (above 100 mm)	70%
Refresh	At least 90% coverage of the globe about every 20 hours (monthly average)

Note: Uncertainty requirements do not apply to (1) mountainous areas (2) melting snow condition. Relaxed accuracy requirement should be specified for densely forested areas.

Product evaluation/validation:
The following validation results were obtained for Snow Cover:

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

The validation results for Snow Depth, by snow classification type, are:

	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

The validation results for Snow Water Equivalent are:

Month	Bias (cm)	Prec. (cm)	Uncertainty (RMSE, cm)	Mean1 (cm)	Mean2 (cm)	% Error	# pixels
11/2016	-4.9	8.8	10.1	29.4	45.4	22.2	92846
12/2016	-3.5	7.1	7.9	29.6	36.4	21.7	1124420
01/2017	-5.2	9.6	11.0	45.5	53.9	20.4	1681461
02/2017	-6.6	14.1	15.6	68.8	75.2	20.7	1334818
03/2017	-10.9	17.8	20.8	75.9	103.3	20.1	975439

where Bias = AMSR2 - SNODAS (the Snow Data Assimilation System), Prec is the Precision (standard deviation of differences), Mean1 is the mean of AMSR2 SWE, Mean 2 is the mean of SNOWDAS SWE, and % Error is RMSE/Mean2.

Product availability/reliability:
EDR data were produced since 09/30/2016.

Algorithm performance dependence:
None

Known errors/issues/limitations
The most significant limitation is wet snow. Wet snow degrades the detectability of snow, so if it is present the snow product will not indicate snow. The difference in snow cover for ascending and descending portions of orbits can be significant because the ascending portion will be on the warmer side of the earth. The wet snow quality flag is therefore important.

3. Changes since last maturity stage

None. This is the first maturity stage evaluation.

4. Review board recommendations – as stated above.

5. Path Forward/Future Plan

The main focus over the next several months will be further validation of the snow water equivalent product and minor improvements to snow detection/cover.

6. Additional Items to note: None

Points of Contact:

Name: Yong-Keun Lee, Cooperative Institute for Meteorological Satellite Studies (CIMSS)
Email: yklee@ssec.wisc.edu

Name: Jeff Key, NOAA
Email: Jeff.Key@noaa.gov