

SMOS Sea Ice Thickness ReadMe-first Technical Note (RM-TN)

Document Version

Version	Date	Description	Author
1.0	01/11/2018	Draft of the ReadMe-first Technical Note	Xiangshan Tian-Kunze (AWI)

Applicable Documents

Abbreviation	Name	Description
ATBD	AWI_ESA_SMOS_ATBD_v1.0	Algorithm Theoretical Basis Document
PDD	AWI_ESA_SMOS_PDD_v1.0	Product Description Document
SMP	AWI_ESA_SMOS_SMP_v1.0	Service Migration Plan

Read-me-first note for the release of SMOS Sea Ice Thickness	
Processor version	320
Release date by ESA	*add date*
Author(s)	Xiangshan Tian-Kunze
Further information	<p>A detailed description of the processing algorithm can be found in the Algorithm Theoretical Basis Document (ATBD):</p> <p>*add link*</p> <p>Information about the data product can be found in the Product description document (PDD):</p> <p>*add link*</p> <p>Information on how to access the SMOS ice thickness data can be found here.</p>
How to cite the data	<p>1. Please cite:</p> <p>Tian-Kunze, X., Kaleschke, L., Maaß, N., Mäkynen, M., Serra, N., Drusch, M., and Krumpen, T.: SMOS-derived thin sea ice thickness: algorithm baseline, product specifications and initial verification, The Cryosphere, 8, 997–1018, doi:10.5194/ tc-8-997-2014, URL http://www.the-cryosphere.net/8/997/2014/, 2014.</p> <p>Kaleschke, L. et al. (2016), SMOS sea ice product: Operational application and validation in the Barents Sea marginal ice zone, Remote Sensing of Environment, Volume 180, July 2016, Pages 264-273, ISSN 0034-4257, http://dx.doi.org/10.1016/j.rse.2016.03.009.</p> <p>2. Include the following phrase into the acknowledgment:</p> <p>"The production of SMOS sea ice thickness data was funded by the ESA project SMOS & CryoSat-2 Sea Ice Data Product Processing and Dissemination Service, and data from DATE to DATE were obtained from AWI."</p>
Contact for helpline	For all issues related to data access, please contact ESA's HelpDesk at eohelp@esa.int
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1. Introduction

The read-me-first note provides information about improvements with regard to the previous releases, data caveats, and instruction about how to use auxiliary data and uncertainties contained in the product.

The product version v3.2 is available since October 2018, and is now continuously generated within the ESA project **SMOS & CryoSat-2 Sea Ice Data Product Processing and Dissemination Service**. The product is only available for the Northern Hemisphere from October to April. Release of Southern Hemisphere ice thickness is planned for 2019. The SMOS ice thickness data from October 2010 to April 2018 will be reprocessed using Algorithm v3.2 and v620 L1C TB within the winter season of 2018/19. The data set acquired during the SMOS mission commissioning phase (from January 2010 to 31 May 2010) has been acquired during periods when the MIRAS instrument underwent several tests and was operated in different modes causing drifts not fully compensated by the on-ground calibration processing. For that reason, this data set is only available upon request and should not be used for long term data exploitation. The SMOS data users are recommended to use this new data set, which supersedes the previous one generated by the algorithm baseline version v2.1 and v3.1, and to read this note carefully to ensure optimal exploitation of the version 3.2 dataset.

2. Main Improvements in the current Data Set

The major improvements introduced in the current operational version 3.2 of Level 3 sea ice thickness processor compared with previous versions are the following:

1. Improved brightness temperature data filtering: instead of the 300 K threshold method used in the previous algorithms (Algorithm I, II and II*), we implement flagging-based data filtering in the v3.1 and v3.2 data (Kaleschke et al., 2017).
2. Parameterization of look-up table for the correction of plane layer ice thickness to heterogeneous layer ice thickness with polynomial functions: An analysis of the v2.1 SMOS ice thickness data retrieved with Algorithm II* has shown gaps in the histogram of the data, caused by the coarse-resolved look-up table. To avoid this inconsistency, we parameterized the look-up table with a polynomial fit function (degree = 3) for each ice temperature and ice salinity. The polynomial fit function avoid the gaps in the

histograms of ice thickness data, therefore, will replace the look-up table for the ice thickness correction in v3.1 and v3.2 data (Tietsche et al., 2018).

3. Including ice thickness uncertainty caused by the lognormal thickness distribution function: In v3.1 and v3.2 data, besides the uncertainty factors which were considered in v2.1 data, we also consider the uncertainty caused by the thickness distribution function. The uncertainty caused by this function can be estimated using the standard deviation of logsigma, which is assumed as constant in the lognormal thickness distribution function (Kaleschke et al., 2017).
4. Difference between v3.1 and v3.2: A critical bug is found in the interpolation command "surface.c" in the GMT version 4.5.14, which is used to interpolate JRA55 surface temperature into 12.5 km grid for the retrieval algorithm v3.1. In the data set v3.2, an up-to-date version GMT4.5.15 is used for the interpolation.

Besides these Level 3 algorithm modifications, improvements made at L1 processing also impact the now operational version 3.2 of the sea ice thickness products. For further details on the new L1C (v620) data sets, see the L1 data version 620 read-me-first note available here: <https://earth.esa.int/web/guest/-/data-processors-7632>.

An analysis has been performed of several reference datasets of the sea ice thickness products generated using previous versions and current version. The analysis has been carried out to assess both i) the impact of Level 1C changes in L3 sea ice thickness products, ii) the Level 3 changes themselves, by comparing the new output products to the old ones and to the validation data.

Version change from 505 to 620 in L1C data has caused considerable difference in the daily averaged brightness temperature. On average, brightness temperature in v620 data is about 3 K higher than that in v505. The changes in L1C have impact on the sea ice thickness retrieval. As can be seen in Fig. 1, sea ice thickness retrieved with v620 L1C data is slightly thicker than that retrieved with v505 L1C data, although the retrieval algorithm is the same.

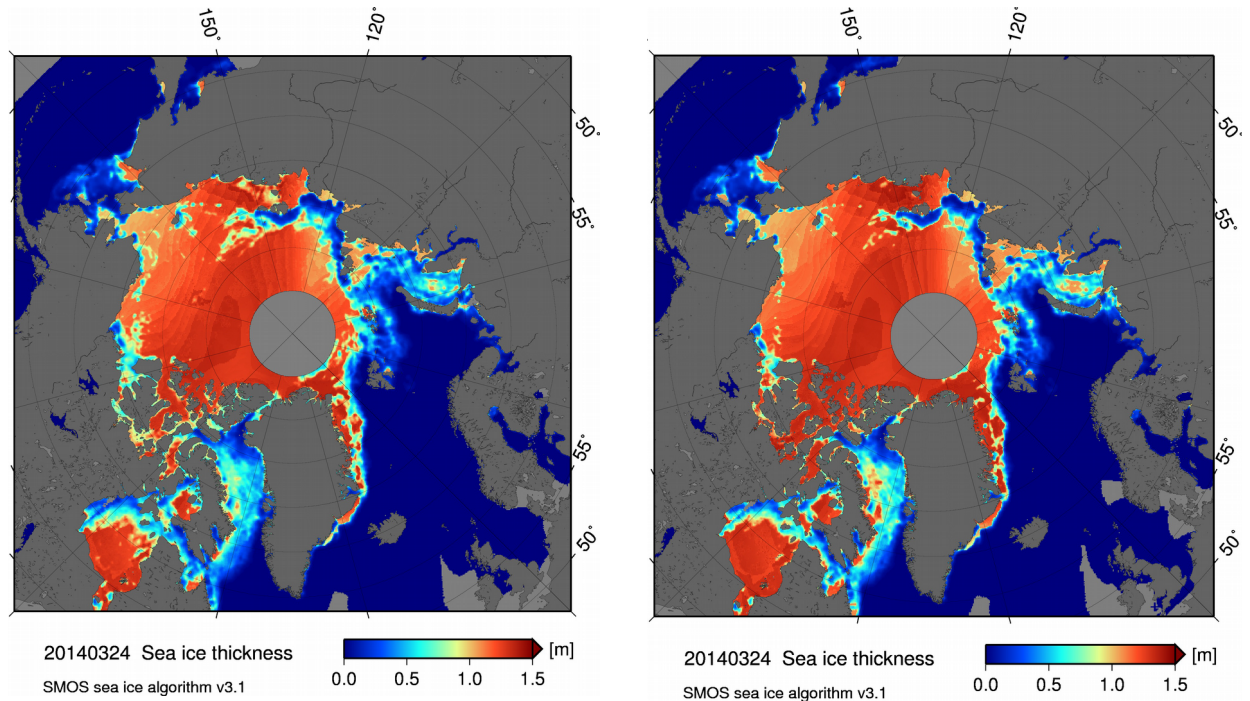


Fig. 1. Sea ice thickness retrieved with algorithm 3.1 on 24 March, 2014 using v505 L1C data (left) and v620 L1C data (right).

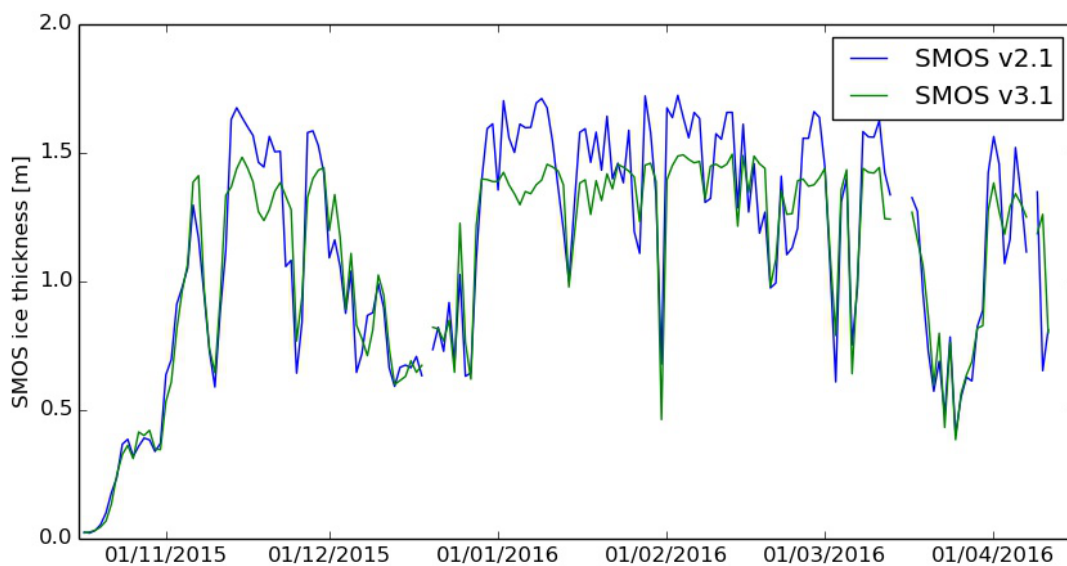


Fig. 2 Comparison of v2.1 and v3.1 sea ice thickness data at (74.5 N, 127.0 E), both level 3 sea ice thickness data are based on v620 L1C data.

Fig. 2 shows the comparison of v2.1 and v3.1 sea ice thickness data in the Laptev Sea for the winter season of 2015/16. Both data are based on v620 L1C data, therefore the underlying brightness temperature measurements are the same. The v3.1 sea ice thickness data have minor difference to the v2.1 data where thin ice dominates. However, over thicker

ice (thicker than 1 m), v3.1 shows less variability from one day to another and lower ice thickness. This is caused partly by the surface air temperature fields, which are averaged over three previous days in v3.1 (in v2.1 we use only one previous day average), and partly caused by the lower logsigma, which is 0.6 in v3.1 compared to 0.7 in v2.1.

The transfer of GMT version from 4.5.14 (sea ice retrieval v3.1) to 4.5.15 (sea ice retrieval v3.2) causes up to 1 K difference in the interpolated surface temperature, which is boundary condition in the sea ice retrieval (Fig. 3). Accordingly, the retrieved ice thicknesses show spatial differences of up to several centimeters compared to the v3.1 (Fig. 4). The differences in the resulting mean ice thickness between both versions are however negligible.

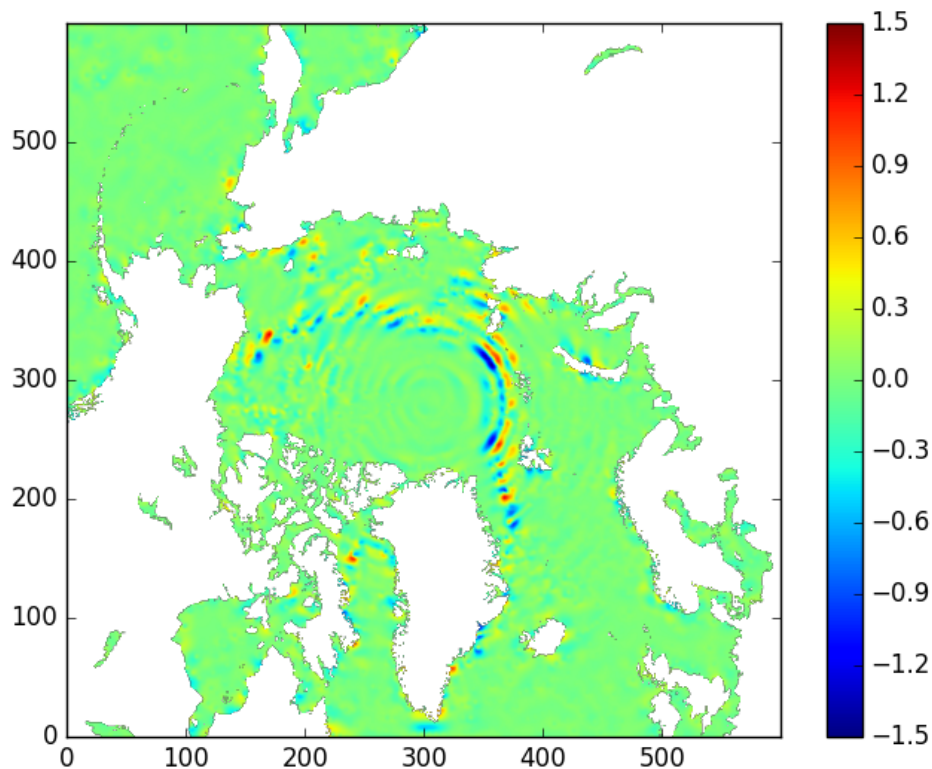


Fig. 3. Interpolated JRA55 surface temperature difference (unit: K) between v3.2 and v3.1.
Time: 2018102712

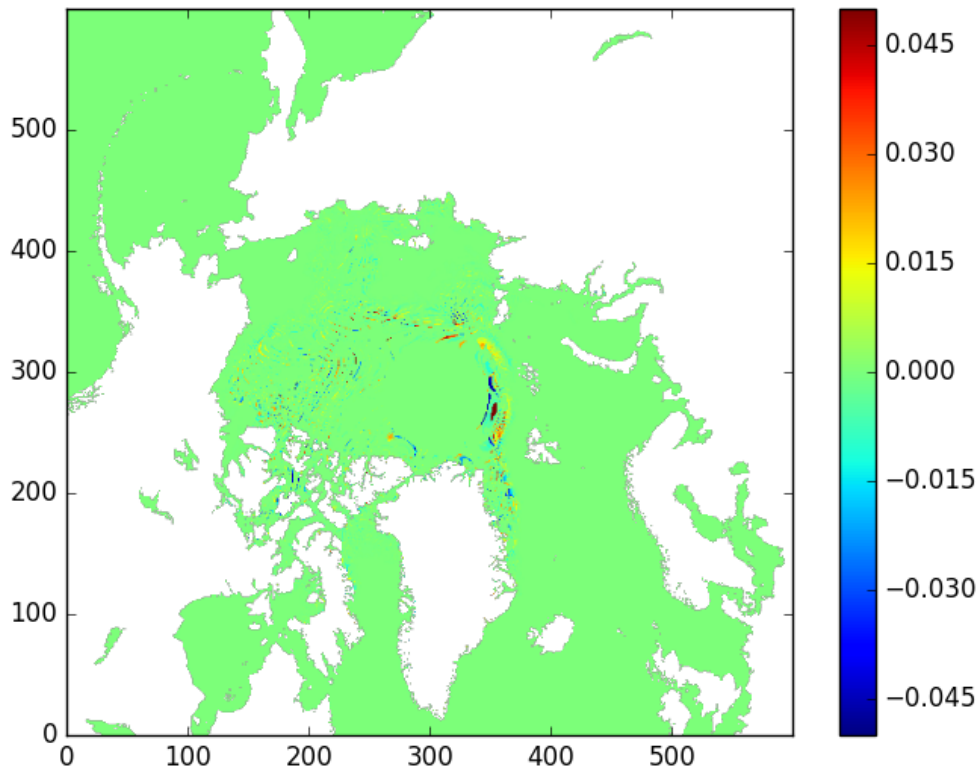


Fig. 4. Difference (unit: m) in the retrieved ice thicknesses between v3.2 and v3.1. Date: 20181028

3. Caveats

The assumption of 100% ice concentration in the retrieval leads to an underestimation of ice thickness for the grid cells with ice concentration less than 100%. Strong underestimation exists for the thick ice due to the saturation of SMOS brightness temperature with thickness. The maximum retrievable ice thickness is limited, it depends on sea ice salinity and temperature. Accordingly the maximum retrievable ice thickness varies with region and season. Therefore, the sea ice thickness should always be combined with its uncertainty and/or with the saturation ratio (ratio between retrieved and maximum retrievable sea ice thickness). Data with an uncertainty > 1 m or with a saturation ratio near 100% should not be used.

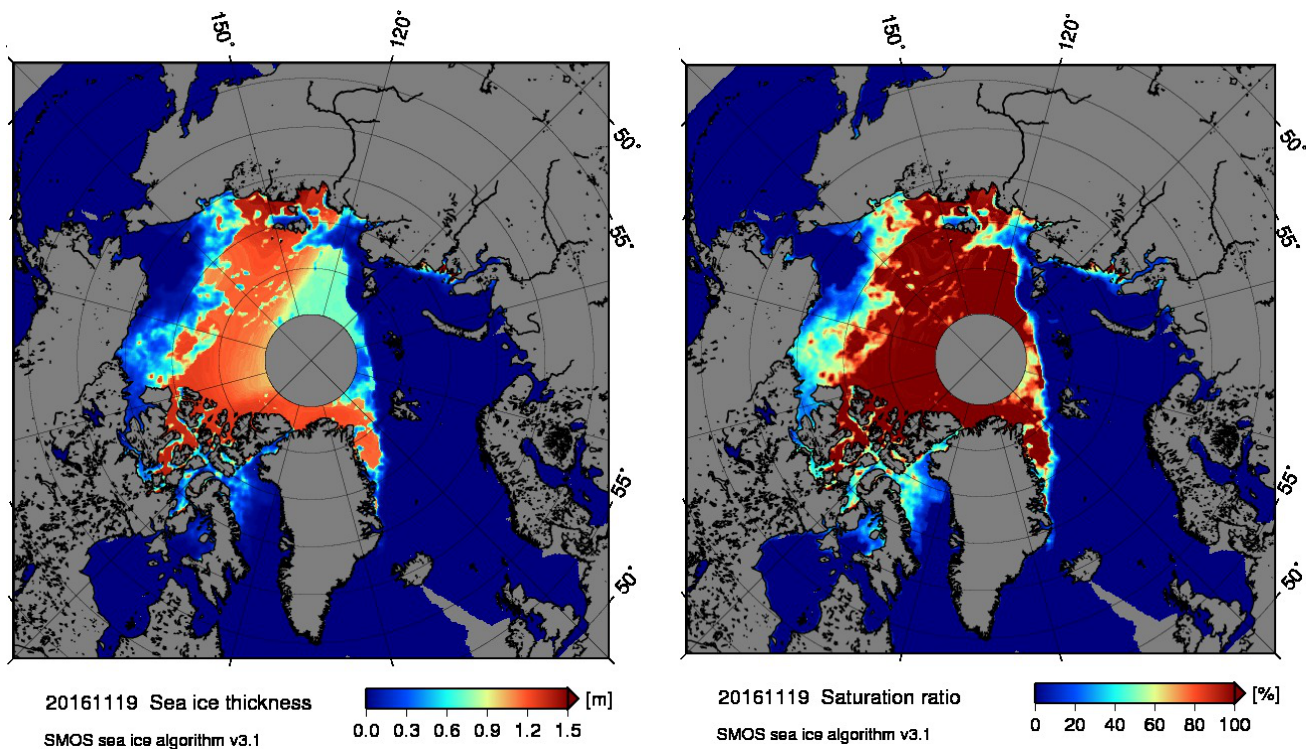


Fig. 5. An example of sea ice thickness and saturation ratio maps under warm conditions: large region of lower-biased ice thickness can be observed in the east part of Arctic ocean. In this region the saturation ratio is also near 100%, which means that the ice thickness data should not be used.

References

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