ASCAT-B Level 2 Soil Moisture Validation Report

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Doc.No. : EUM/OPS/DOC/12/3849
Issue : v2
Date : 20 December 2012

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Document Change Record

Issue / Revision	*Date*	*DCN. No*	*Changed Pages / Paragraphs*
V1	11 November 2012		First issue for trial dissemination
V2	11 December 2012		Update for pre-operational dissemination

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1 INTRODUCTION

1.1 Purpose and Scope

This Product Validation Report provides the results of the calibration and validation testing of the following Advanced SCATterometer (ASCAT) products in the context of the EUMETSAT Polar System (EPS) Metop-B satellite commissioning:

- ASCA_SMO_02
- ASCA_SMR_02

The Metop-B satellite has been launched from Baikonur on September 17th, 2012. The satellite commissioning including Cal/Val testing aims at verifying the capability of the satellite and ground segment to provide operational services with the required levels of availability, timeliness and quality. In particular, the main objective of Cal/Val is to ensure that the quality of the products satisfies the operational requirements.

This report is submitted to the Product Validation Review Board in order to decide on the validation status of the products. It is intended for the members of the Science and Products Validation Team (SPVT), as well as to the Metop-B commissioning management.

This issue is intended to assess the readiness to start the pre-operational dissemination to Cal/Val partners. This follows the current trial dissemination phase to Cal/Val partners and includes their feedback. These are in particular:

- Satellite Applications Facility on support to Operational Hydrology and Water Management (H-SAF), represented by the Vienna University of Technology, Institute of Photogrammetry and Remote Sensing (TU-Wien IPF)
- European Centre for Medium Range Weather Forecasting (ECMWF)
- Consiglio Nazionale delle Ricerche, Instituto di Ricerca per la Protezione Idrogeologica (CNR-IRPI)
- Météo-France
- NOAA NESDIS

1.2 Description of Validation Environment

The product validation has been performed with the following elements:

- EPS validation ground segment (GS2) running ASCAT Level 2 Soil Moisture Product Processing Facility (PPF) 3.1, configured with the parameter database based on ASCAT-A data from 2007-2008 (2.0) and backscatter bias corrections (3.1) as for ASCAT-A.
- TCE ASCAT Soil Moisture Monitoring daily reports and off-line validation tools - http://tcweb/ASCAT_Monitoring/SOMO/outputA/html/ and http://tcweb/ASCAT_Monitoring/SOMO/outputB/html/
- TCE ASCAT Level 1 Monitoring Data Processing System (DPS), daily reports and off-line validation tools - http://tcweb.eumetsat.int/~anderson/dpsdb/mon.htm

- EPS Product Quality Monitoring validation environment (EPQM VAL)

1.3 Applicable and Reference Documents

1.3.1 Applicable Documents

AD1	EPS Programme Calibration and Validation Overall Plan, EUM.EPS.SYS.PLN.02.004

1.3.2 Reference Documents

RD1	ASCAT Cal/Val schedule - DOCSLIB#220251
RD2	ASCAT-B Calibration and Validation report EUM/OPS/DOC/12/436

1.4 List of acronyms and abbreviations

ASCAT-A	Advanced SCATterometer on METOP-A (Flight Model 2)
ASCAT-B	Advanced SCATterometer on METOP-A (Flight Model 1)
ASCAT SAG	ASCAT Science Advisory Group
CAL	Calibration
Cal/Val	Calibration and Validation
CNR-IRPI	Consiglio Nazionale delle Ricerche, Instituto di Ricerca per la Protezione Idrogeologica
DPS	Data Processing System (for product quality monitoring)
ECMWF	European Centre for Medium Range Weather Forecasting
EPQM OPE/VAL	EPS Product Quality Monitoring OPErational and VALidation environments
EPS	European Polar System
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
GS1	Operational Ground Segment
GS2	Validation Ground Segment
GS3	Integration Ground Segment
H-SAF	Satellite Applications Facility on support to Hydrology and Water Management
IFS	Integrated Forecasting System
METOP	METeorological Operational Platform
PDF	Probability Density Function
PDU	Processing Data Unit
PPF	Product Processing Facility
SIOV	System In Orbit Verification
SPVT	Science and Products Validation Team
SWET	Software Engineering Task
TCE	Technical Computing Environment
TU-Wien IPF	Vienna University of Technology, Institute of Photogrammetry and Remote Sensing

2 PROTOTYPE RESULTS

There is no prototype at EUMETSAT that has been used at this stage of the validation.

3 INTERNAL EUMETSAT VALIDATION

After discussions with the H-SAF, it was agreed that no specific quantitative validation was needed on the soil moisture products to allow trial dissemination, as long as

- the cross-calibration of the ASCAT-A and –B backscatter remained within +/- 0.1 dB
- the ASCAT-B soil moisture daily reports provided values comparable to ASCAT-A

Both aspects are covered in the next two sections.

3.1 ASCAT-A and –B backscatter cross-calibration

As part of the ASCAT-B early Cal/Val process, a preliminary calibration was introduced to the Level 1B processor, in order to ensure a backscatter cross-calibration with ASCAT-A. The method and early results are provided in [RD2].

As more data has been made available, it has been confirmed that the ASCAT-A and –B cross-calibration calibration are clearly within +/- 0.1 dB for the right swath, while for the left swath, some incidence angles show a larger discrepancy , as can be seen in figure 1. Part of that discrepancy is however due to the normal variability of the rain forest month to month, as the lower panels of figure 1 show for ASCAT-A. On average though, it is clear that the cross-calibration is within +/- 0.1 dB (figure 2).

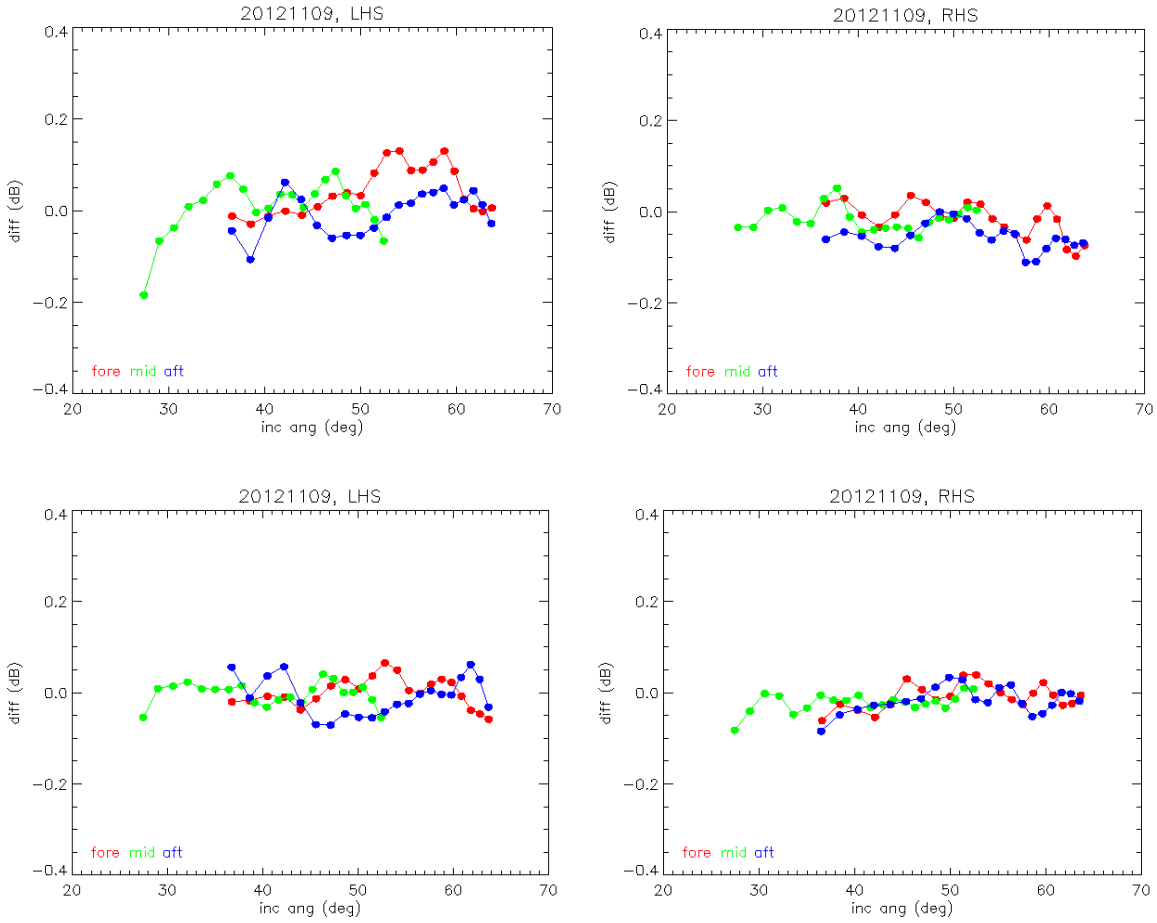

Figure 1: Gamma0 differences over the rainforest, w.r.t, a gamm0 model based on one month of ASCAT-A data, corresponding to October 2012.The panels above correspond to ASCAT-B and those below to ASCAT-A (TCE DPS).

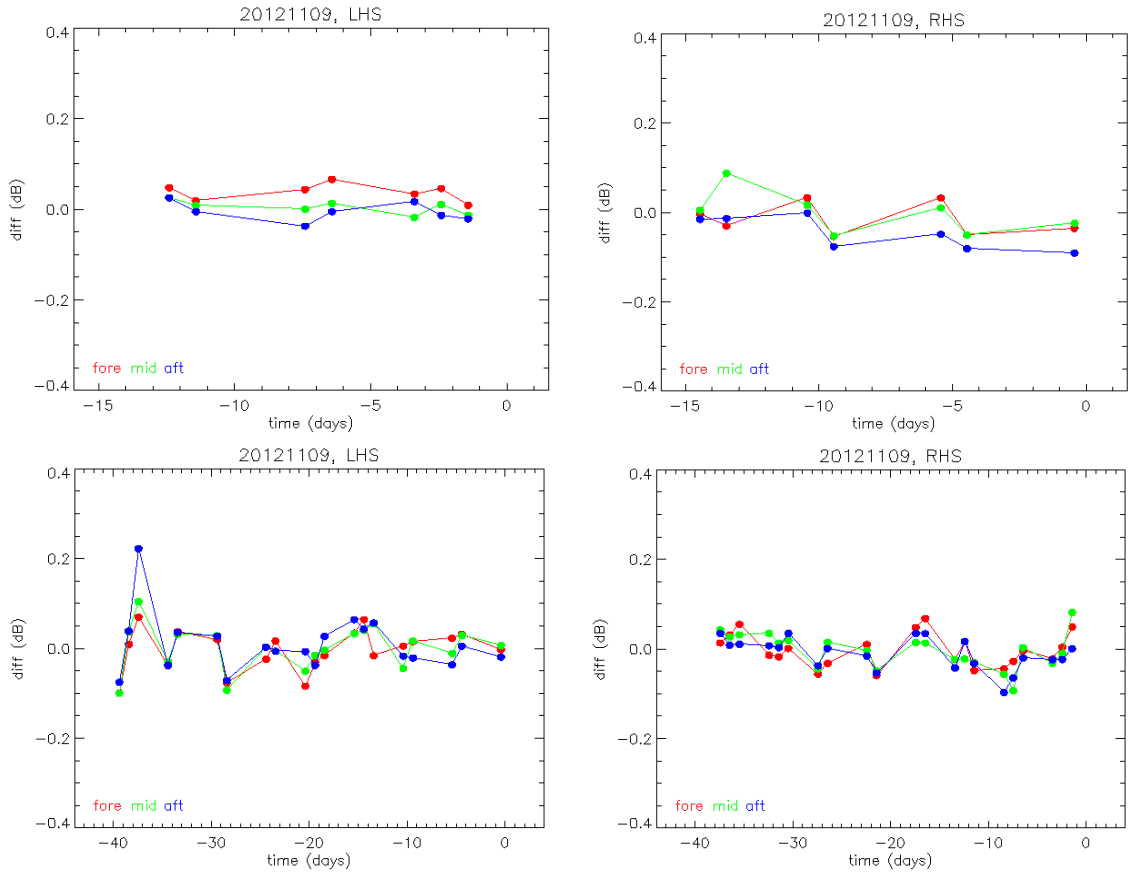

Figure 2: Time series of average (for the full incidence angle range) gamma0 differences over the rainforest, w.r.t, a gamm0 model based on one month of ASCAT-A data, corresponding to October 2012.The panels above correspond to ASCAT-B and those below to ASCAT-, where a longer time series has been used (TCE DPS).

3.2 ASCAT-B Soil Moisture daily reports

ASCAT-A and ASCAT-B monitoring reports run on the TCE from the TCE off-line environment rolling archive (/tcc1/fbf/tcdras/store/gs2/). The ingestion of the data in the EPQM soil moisture parameter database was moreover also confirmed. Although no reports have been yet generated from the EPQM database, it is intended to provide a longer term analysis from it, prior to the start of operational dissemination.

The TCE reports offer daily maps of all parameters contained in the product, namely soil moisture index, sigma0_40, sigma0_40 slope, dry and wet backscatter references and their estimated errors, as well as all processing and advisory flags. They provide also a time series of daily statistics.

Examining the reports for ASCAT-A and ASCAT-B, there are no distinguishable differences in the maps, nor in the time series, beyond those expected due to the slightly different coverage due to the 50 min orbit phasing. This allows us to conclude that the soil moisture products are good enough for the cal/val partners to start their evaluation. This is shown in figures 3, 4, 5, 6, 7, 8. Figure 9 shows a map of merged ASCAT-A and ASCAT-B soil

moisture, which confirms that it is really hard to tell which is which. It is in fact based on Figure 9 that the H-SAF recommended the start of trial dissemination for Cal/Val partners.

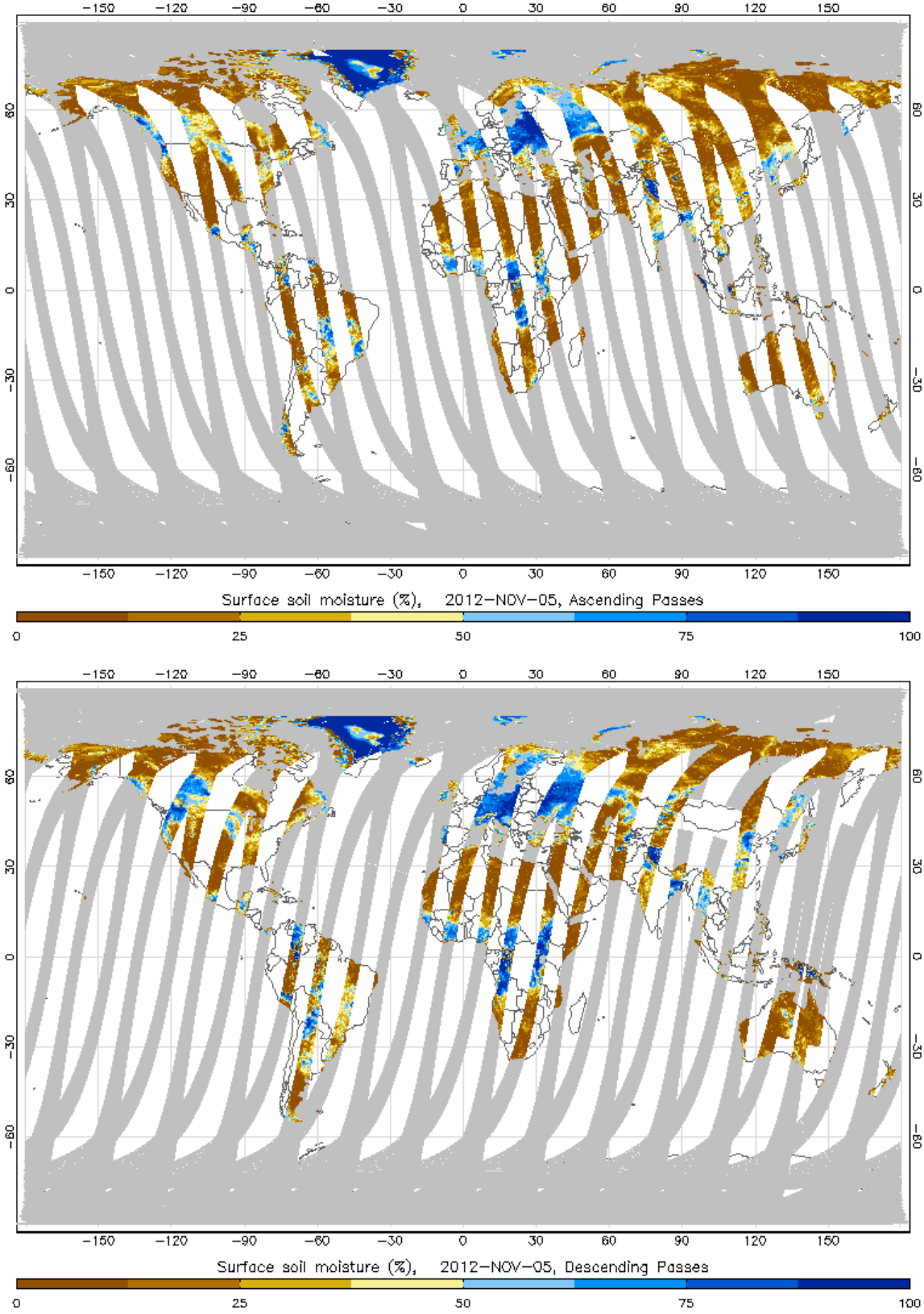

Figure 3a: Soil moisture map corresponding to 05.11 for ASCAT-A (soil moisture daily monitoring reports).

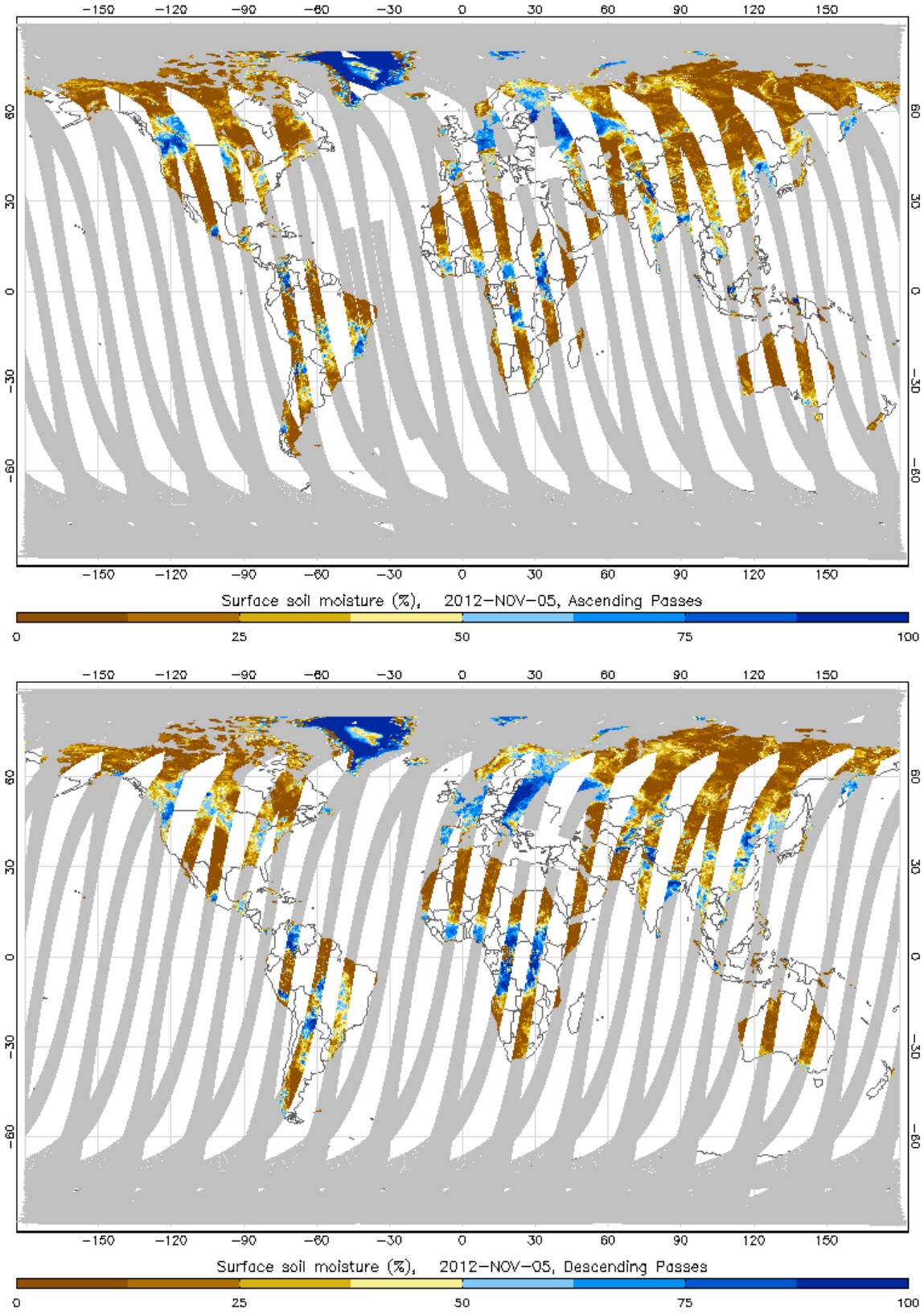

Figure 3b: Soil moisture map corresponding to 05.11 for ASCAT-B (soil moisture daily monitoring reports).

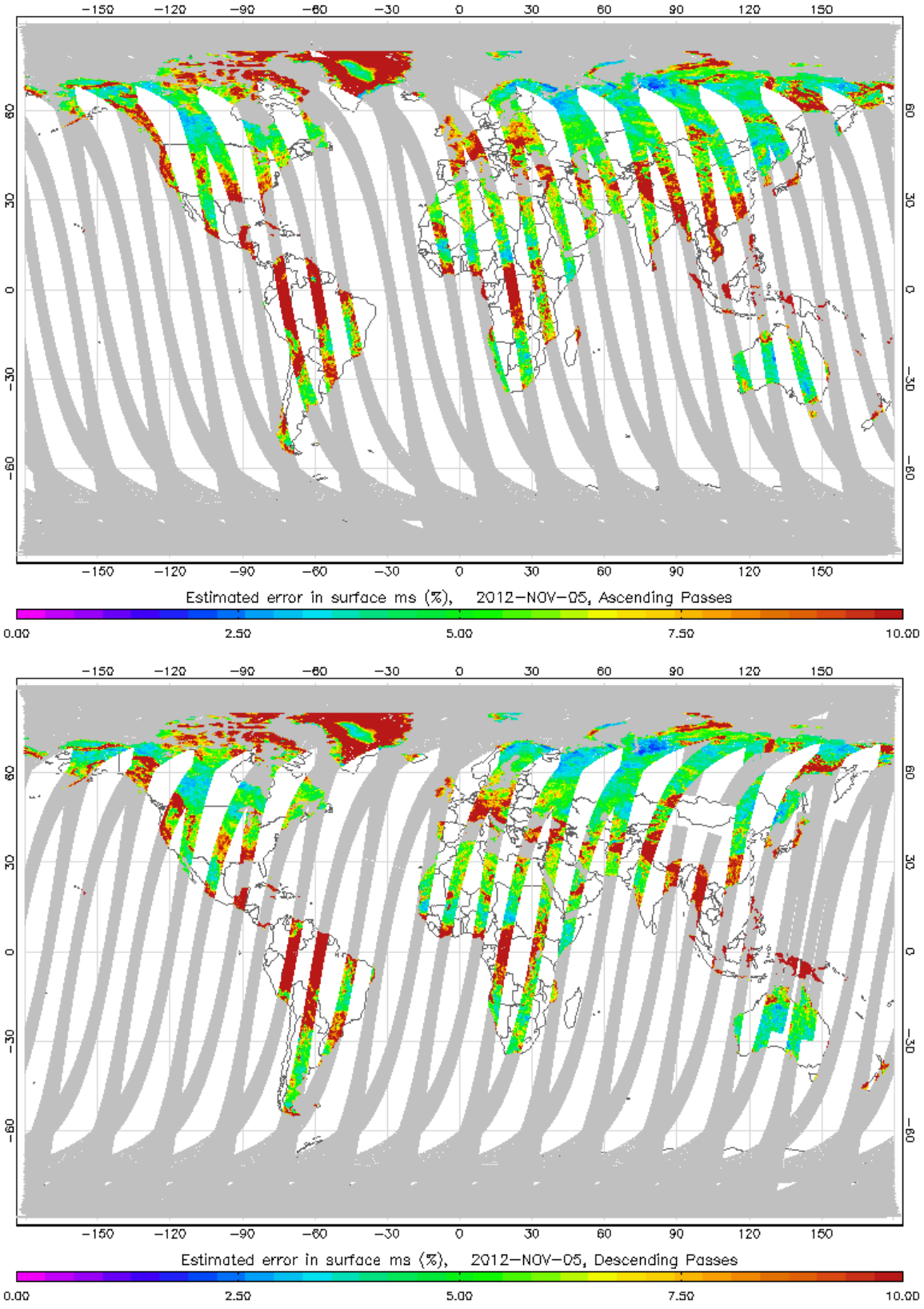

Figure 4a: Soil moisture error map corresponding to 05.11 for ASCAT-A (soil moisture daily monitoring reports).

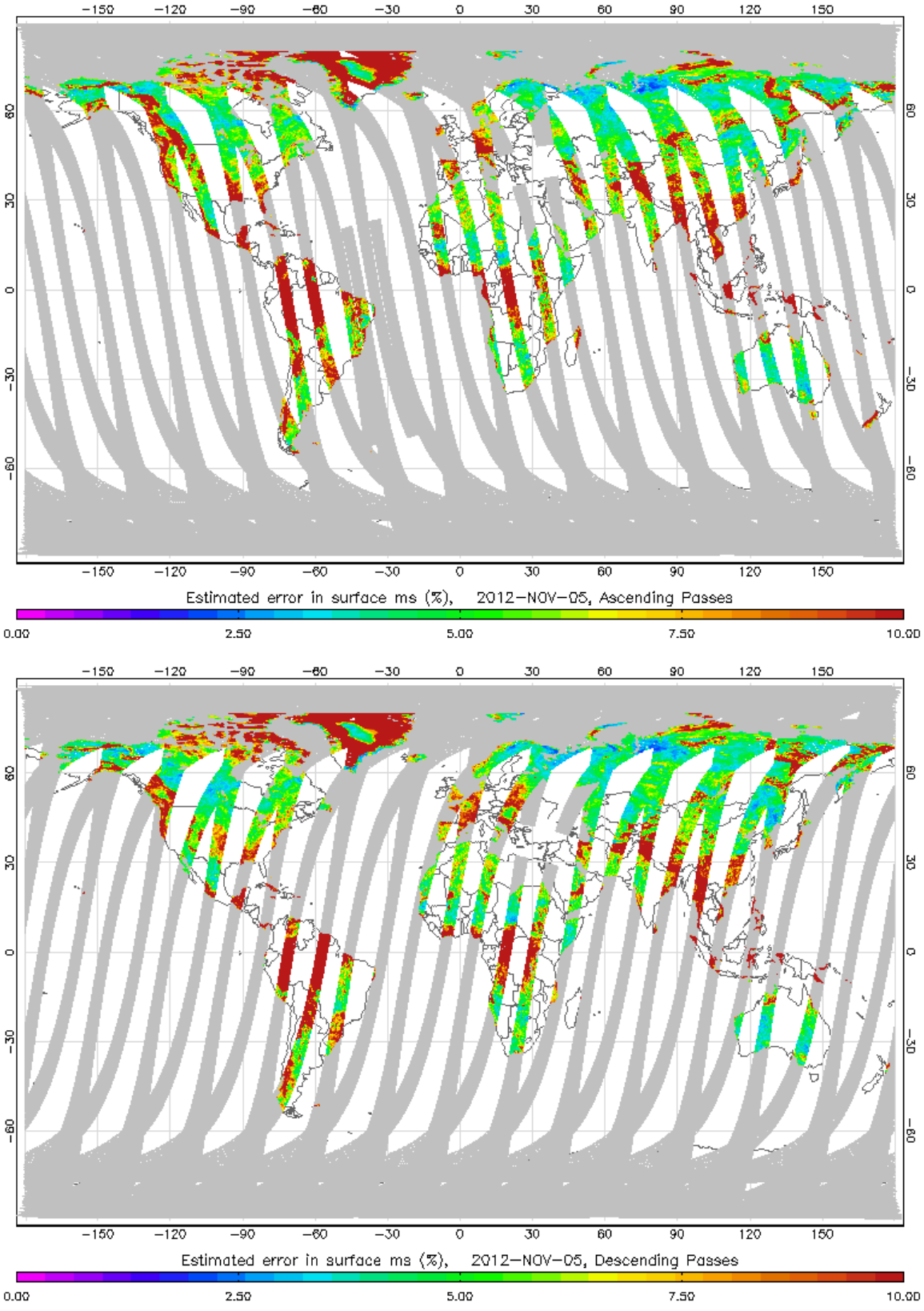

Figure 4b: Soil moisture error map corresponding to 05.11 for ASCAT-B (soil moisture daily monitoring reports).

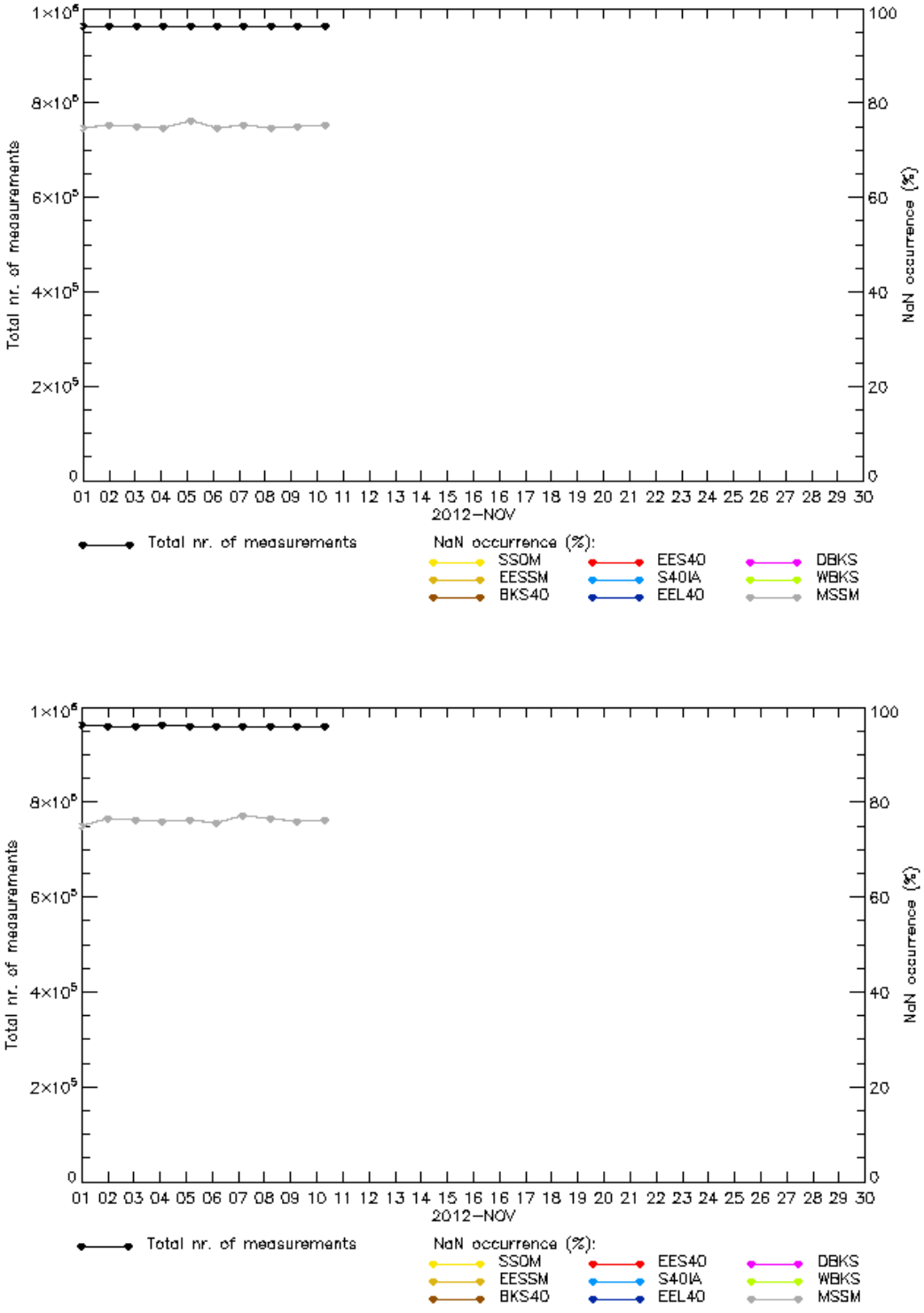

Figure 5: November 2012 time series of daily total number of measurements, as well as non-valid values of soil moisture, soil moisture error, sigma0_40, sigma0_40 error, sigma0_40 slope, sigma0_40 slope error, dry and wet backscatter references and long term mean surface soil moisture. ASCAT-A above and ASCAT-B below.

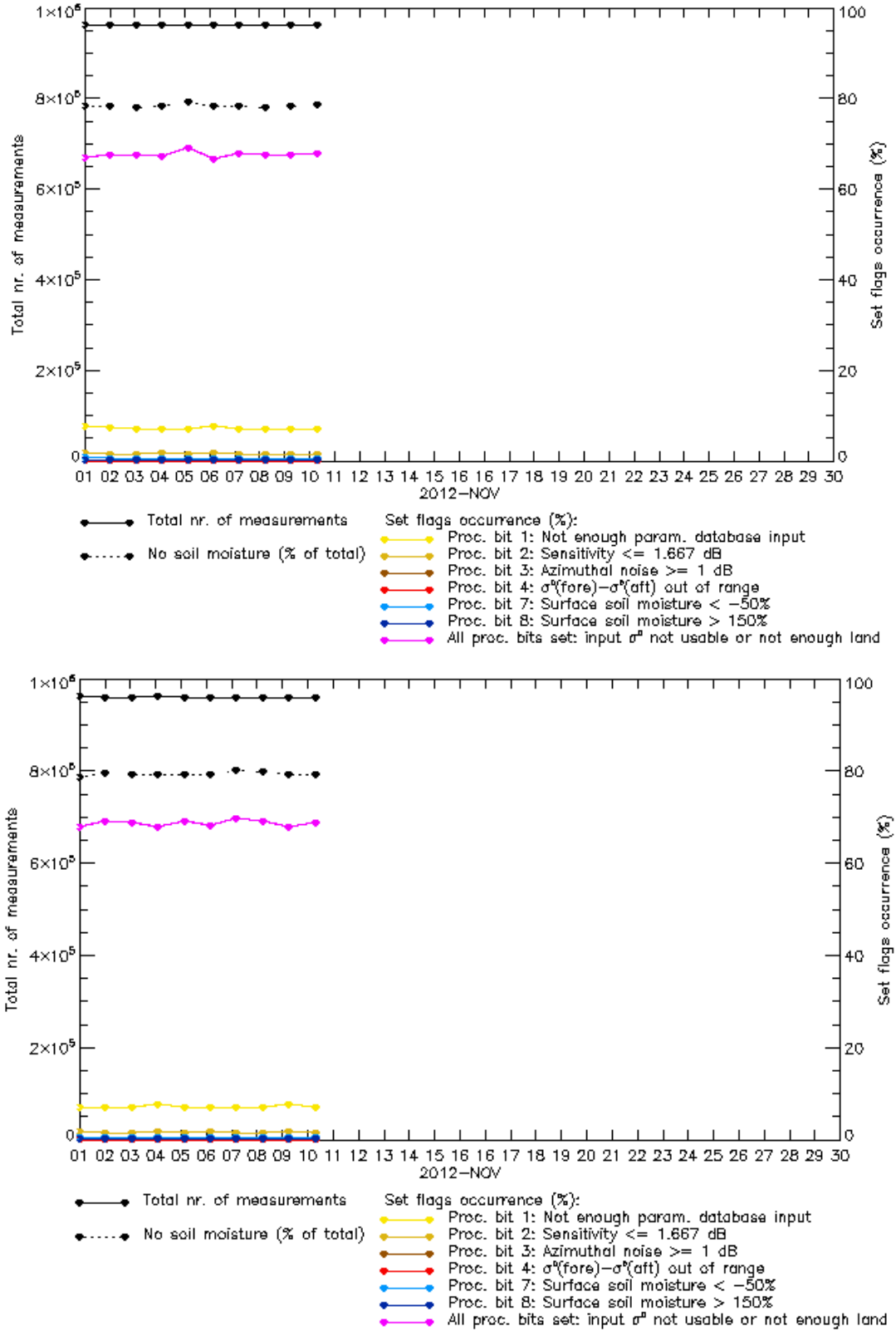

Figure 6: November 2012 time series of daily total number of measurements, non-valid values of soil moisture, and % occurrence of all processing flags. ASCAT-A above and ASCAT-B below.

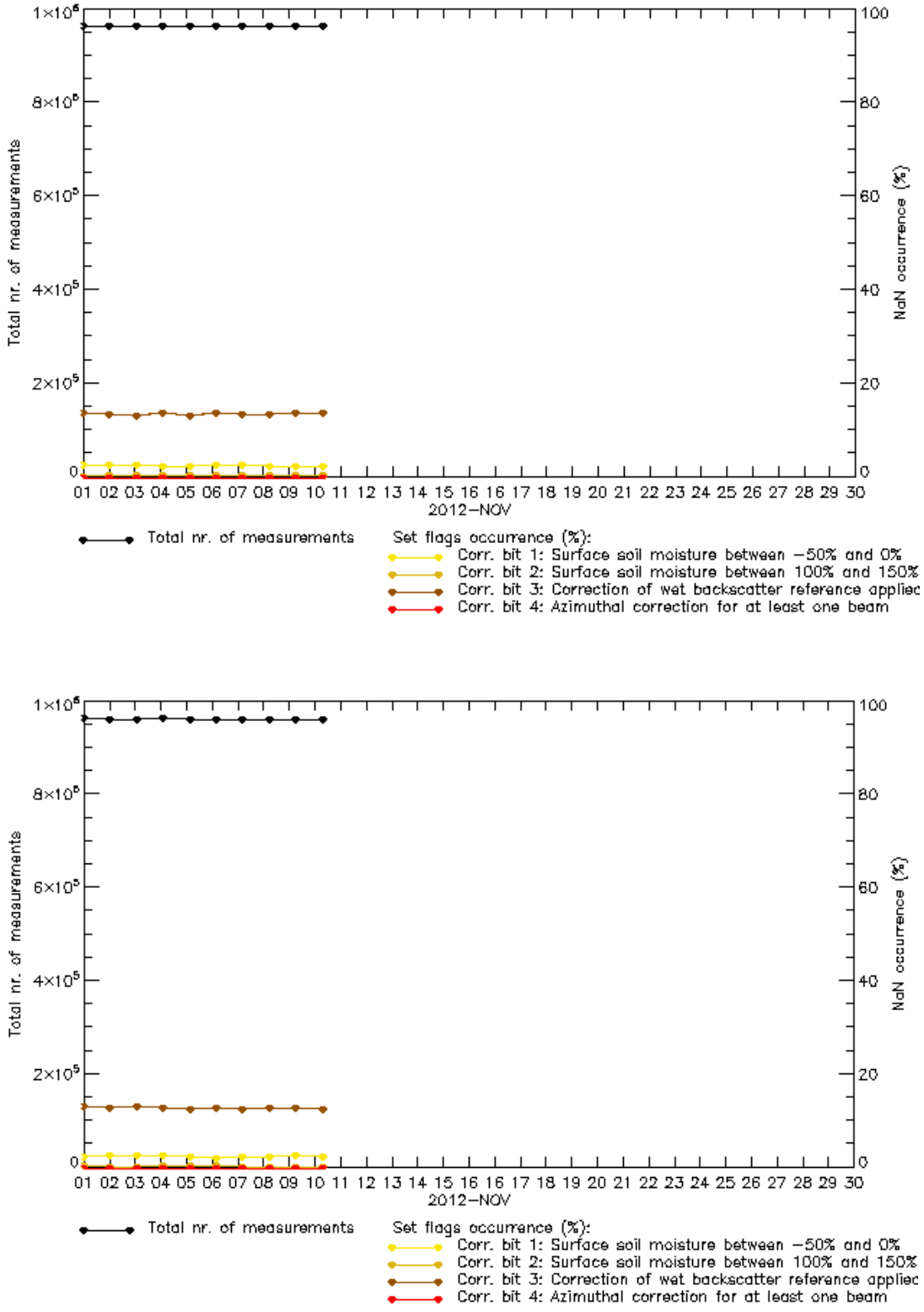

Figure 7: November 2012 time series of daily total number of measurements and % occurrence of all correction flags. ASCAT-A above and ASCAT-B below.

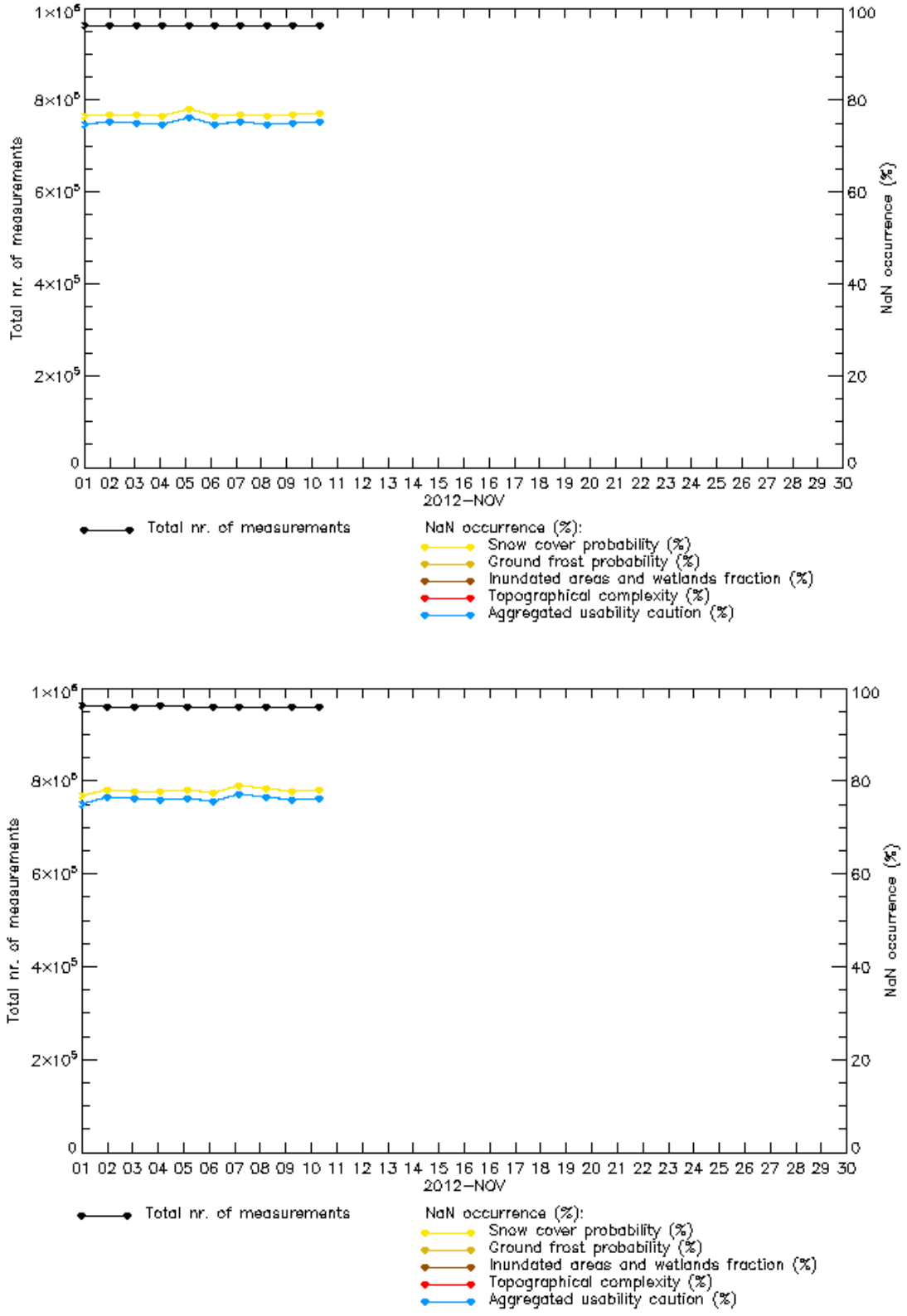

Figure 8: November 2012 time series of daily total number of measurements and % occurrence of all advisory flags. ASCAT-A above and ASCAT-B below.

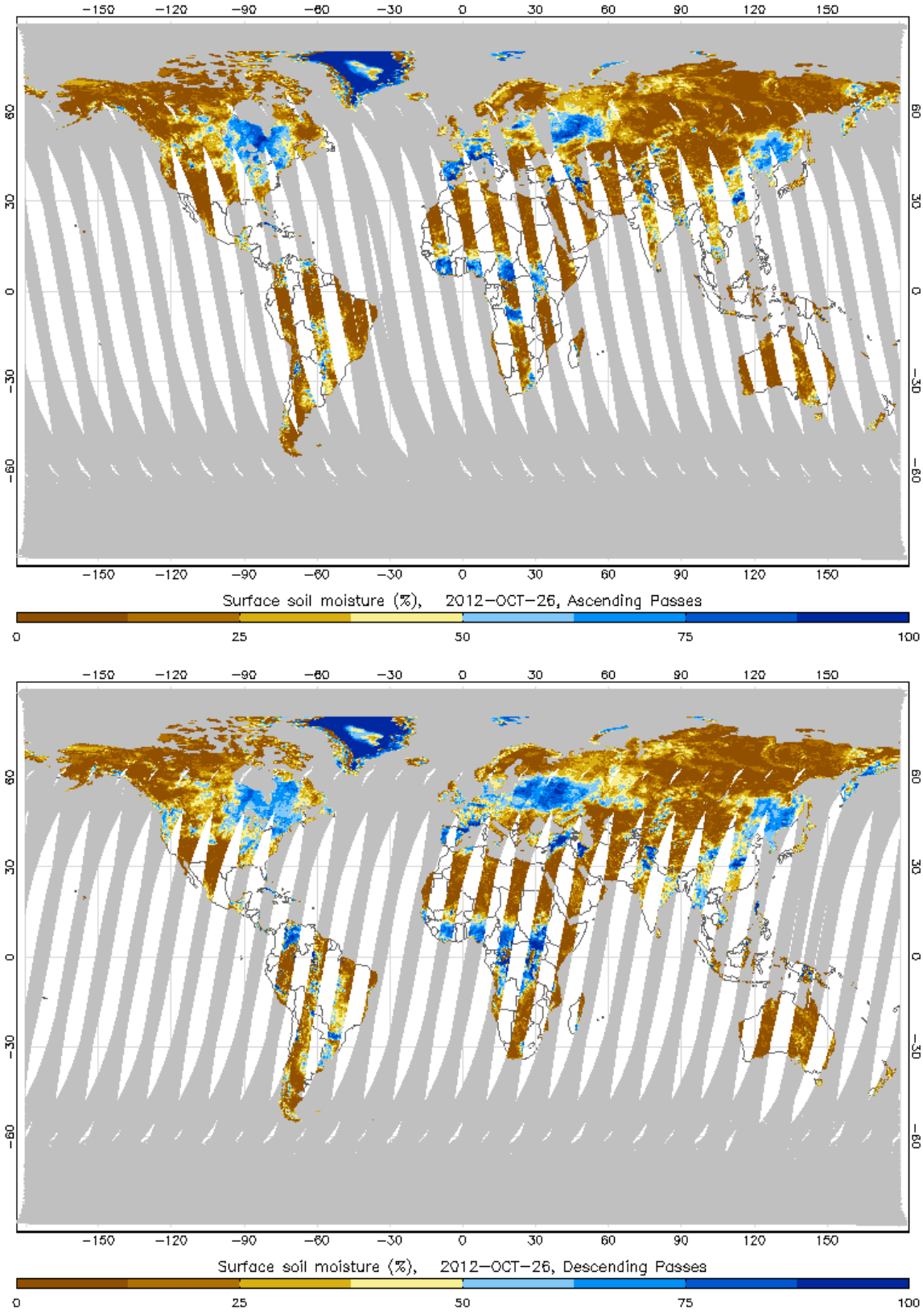

Figure 9: Soil moisture map corresponding to 26.10 for ASCAT-B and ASCAT-B.

4 EXTERNAL PARTNER VALIDATION

Feedback has been received by the H-SAF, ECMWF and CNR-IRPI, confirming the good quality of the ASCAT-B soil moisture products.

4.1 H-SAF

The H-SAF has sent feedback both on backscatter and soil moisture. The feedback on backscatter has been included in the ASCAT-B Calibration and Validation Report [RD2]. They have further looked into the soil moisture global statistics. Figure 10 provides an example for a day of global coverage for ASCAT-A and -B soil moisture, showing a good comparison. Figure 11 shows global distribution of soil moisture values from both instruments, showing again a very good comparison. Equivalent figures for other days look very similar (not shown).

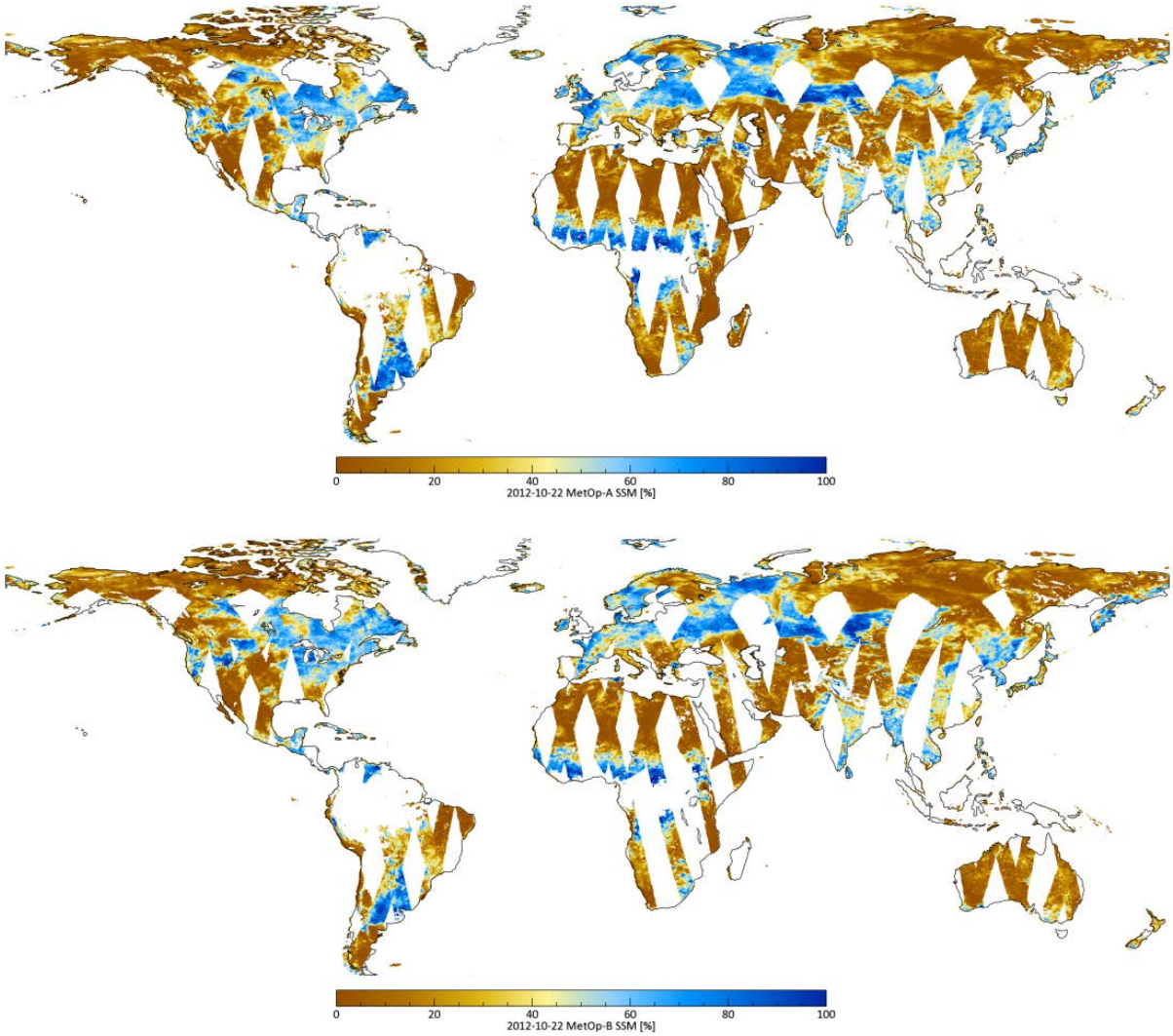

Figure 10: Soil moisture map corresponding to 22.10 for ASCAT-A (above) and ASCAT-B (below). Courtesy of H-SAF TU-Wien.

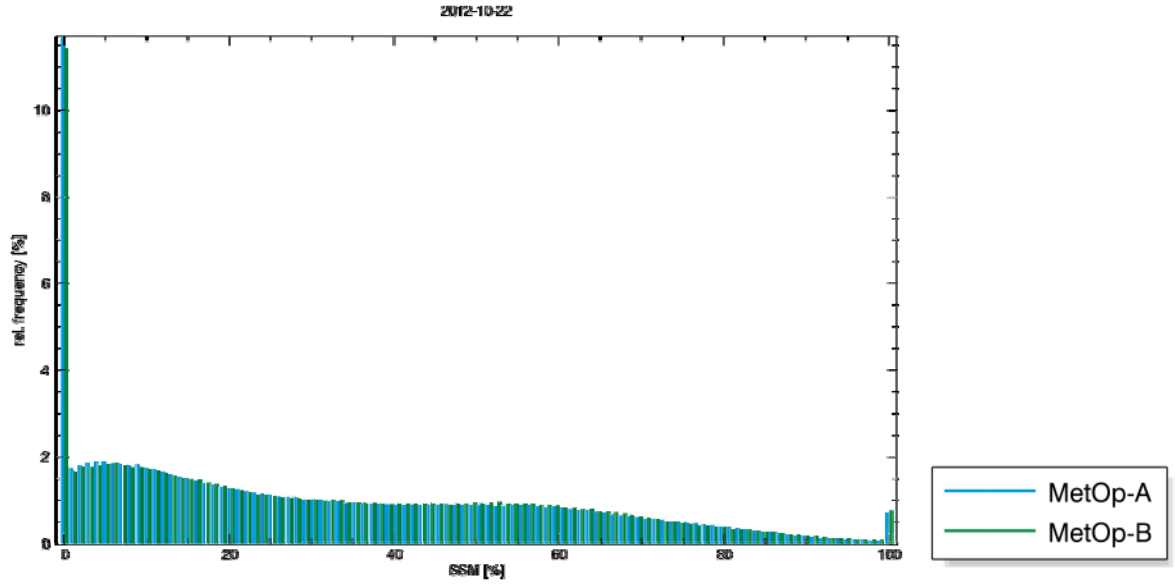

Figure 11: Soil moisture normalised Probability Density Function corresponding to 22.10 for ASCAT-A (blue) and ASCAT-B (green). Courtesy of H-SAF TU-Wien.

4.2 ECMWF

ECMWF started archiving ASCAT-B soil moisture data for analysis on 23.11. The Probability Density Function (PDF) from 23-24.11 shows consistent distributions between ASCAT-A and -B and derives global statistics almost identical, as shown in Table 1

	Nb	Mean (%)	Std (%)
ASCAT-A	471592	31.6	27.3
ASCAT-B	468076	31.5	27.4

Table 1:Global statistics of soil moisture index from ASCAT-A and -B corresponding to 23-24.11. Courtesy of ECMWF.

Furthermore, departures of soil moisture index from model first guess show equivalent geographical distribution (Figure 12, 13) and statistics (Table 2).

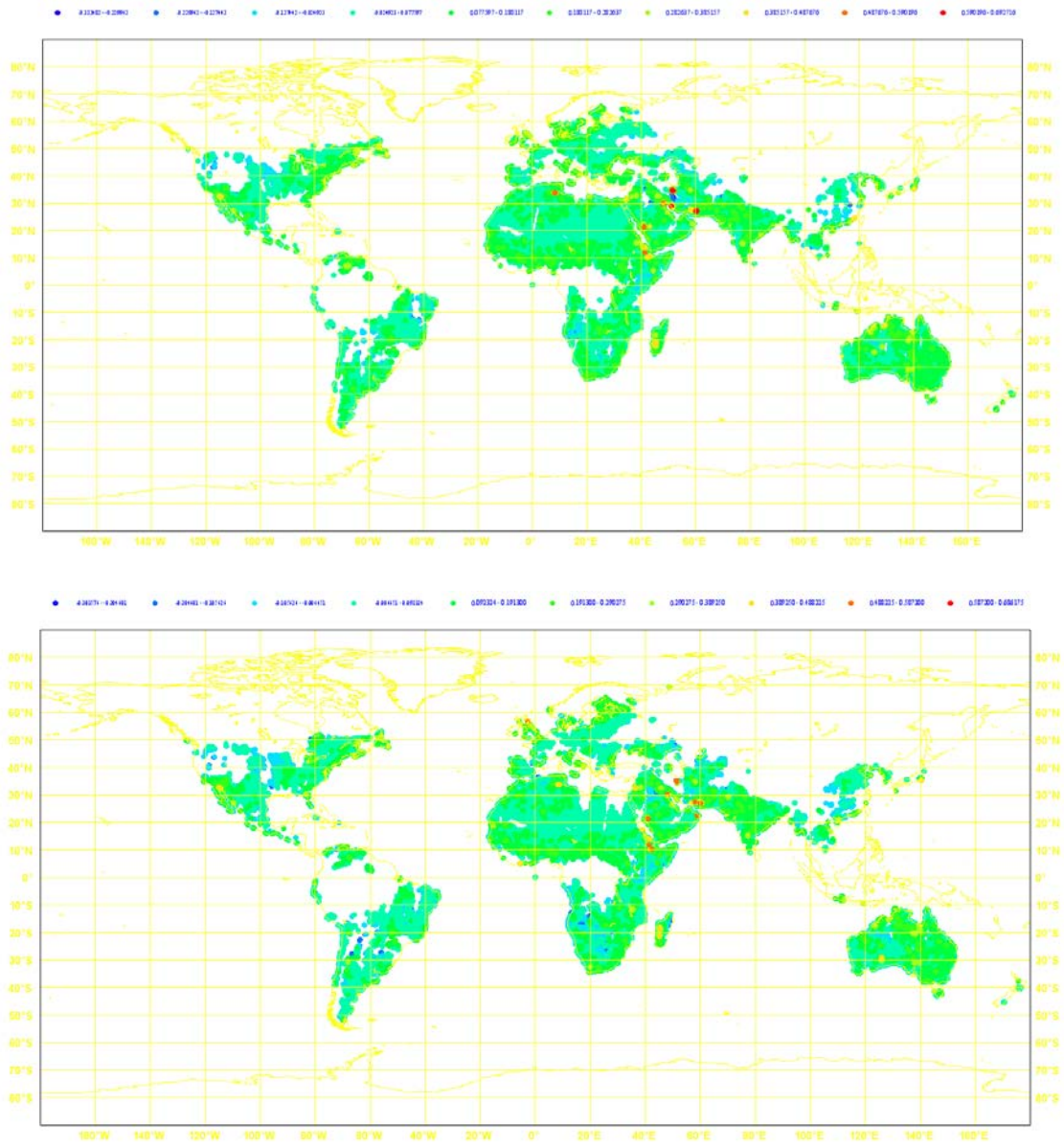

Figure 12:Global distribution of soil moisture index departures from model first guess ($m^3 * m^{-3}$) for ASCAT-A (above) and -B (below) corresponding to 23-24.11. Courtesy of ECMWF.

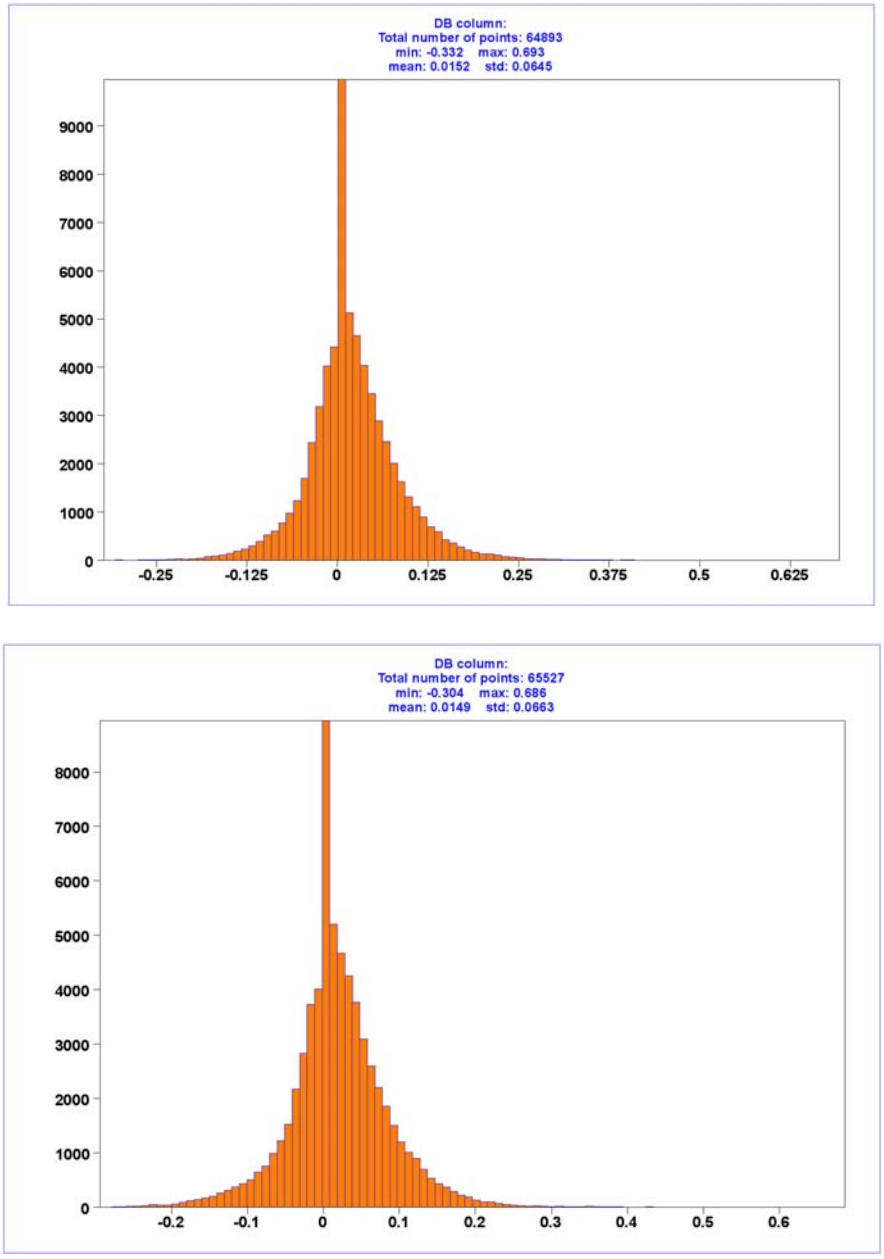

Figure 12: Histograms of soil moisture index departures from model first guess ($m^3 * m^{-3}$) for ASCAT-A (above) and -B (below) corresponding to 23-24.11. Courtesy of ECMWF.

	Nb	**Mean** *($m^3 * m^{-3}$)*	**Std** *($m^3 * m^{-3}$)*
ASCAT-A	64893	0.0152	0.0645
ASCAT-B	65527	0.0149	0.0663

Table 2:Global statistics of soil moisture index departure from model first guess ($m^3 * m^{-3}$) for ASCAT-A and -B corresponding to 23-24.11. Courtesy of ECMWF.

Additionally, ASCAT-B Soil moisture index was included into the passive monitoring through an operational change on the Integrated Forecast System (IFS) cycle 38r1 on 06.12. Since then, monitoring is offered by ECMWF under the links below for both ASCAT-A and ASCAT-B and examples of some of the monitoring plots are shown in Figure 13, confirming the very good agreement between the data from the two instruments.

http://www.ecmwf.int/products/forecasts/d/charts/monitoring/satellite/slmoist/metopb/
http://www.ecmwf.int/products/forecasts/d/charts/monitoring/satellite/slmoist/metopa/

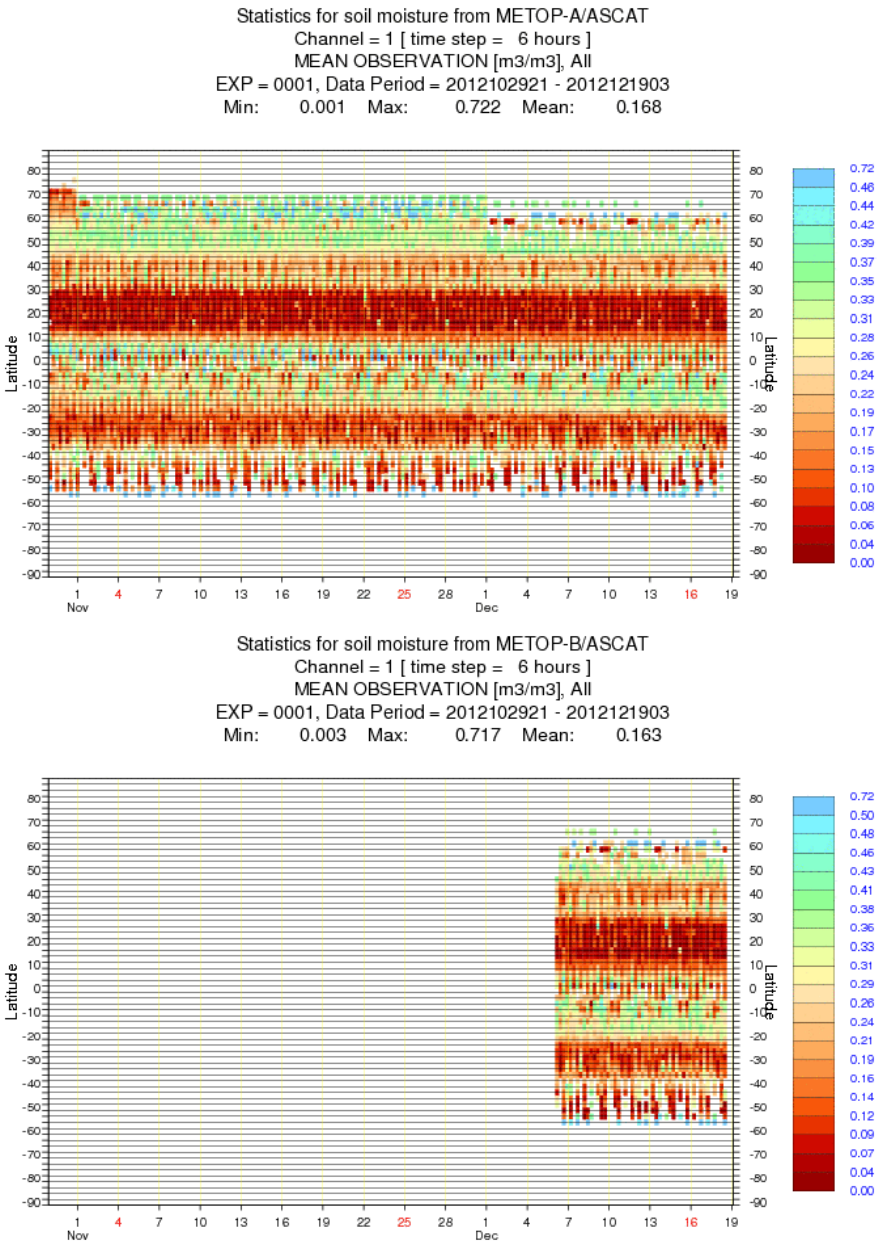

Figure 13: Hovmoeller zonal mean fields for ASCAT-A (above) and ASCAT-B (below) soil moisture observations ($m^3 * m^{-3}$). Courtesy of ECMWF.

4.3 CNR-IRPI

Our colleagues at CNR-IRPI have further provided comparisons with in-situ soil moisture stations, confirming the good agreement between instruments and also with respect to the in-situ data (Figure 14).

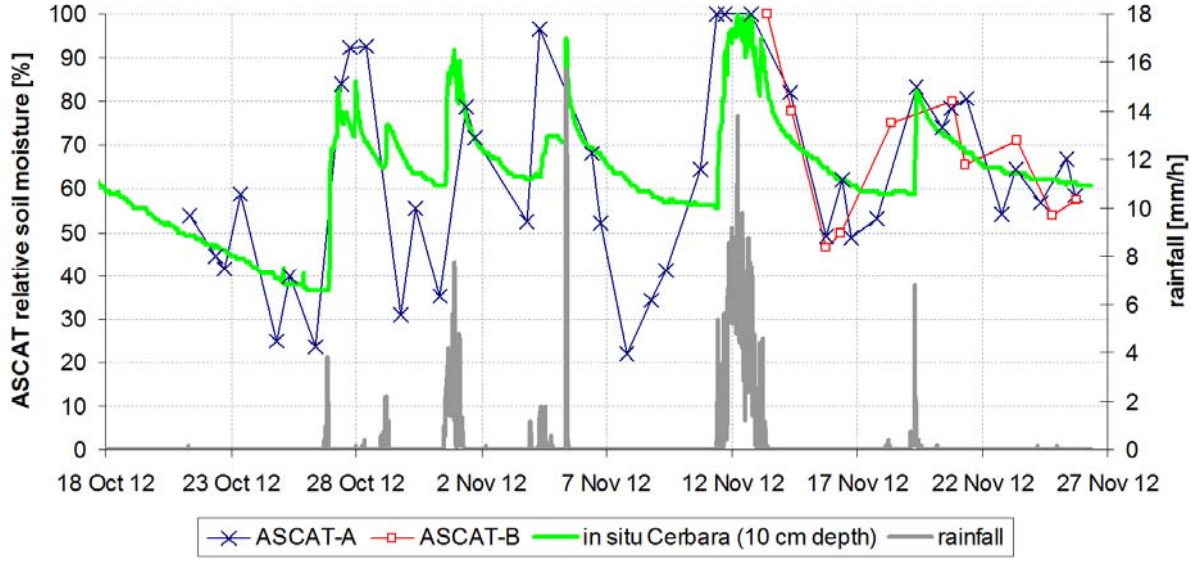

Figure 14: ASCAT-A and -B soil moisture vs. in-situ observations for the Italian station Cerbara, collocated as well with rainfall measurements. Courtesy of Luca Brocca at CNR-IRPI.

5 CONCLUSIONS

5.1 Product Validation Summary

During this first phase of Cal/Val, we have verified that the ASCAT-B backscatter calibration is within +/- 0.1 dB with respect to that of ASCAT-A.

The ASCAT-B soil moisture reports running in the TCE also show that the ASCAT-A and –B soil moisture products are very comparable, not only with respect to the soil moisture values, but also with respect to the error estimations and other processing and advisory flags.

Feedback from Cal/Val partners show that the global statistics and geographical characteristics of soil moisture products are almost identical and in good agreement with ground observations.

5.2 Product Validation Issues

None

5.3 Actions for Product Rollout

None

5.3.1 Time Schedule

Start of pre-operational dissemination, including GTS: 13.11

5.3.2 User Notification

Already sent.

5.3.3 Verification

None.

5.3.4 Document Update

None necessary for the trial dissemination. Product guide updates will be prepared for the start of operational dissemination.

5.3.5 Web Update

None.

6 RECOMMENDATION

We recommend that the pre-operational dissemination to all users is started for ASCAT-B Level 2 soil moisture products.

Note that with the start of open dissemination to all users of both the soil moisture and the wind products, the multi-parameter product generated at the OSI SAF is complete and ready for use. It is proposed to encourage the OSI SAF to start with pre-operational dissemination of the multi-parameter product on EUMETCast and the GTS as soon as the wind products are ready for that phase.