Readme file for ERS-2 Scatterometer Soil Moisture Products

Field:	Contents:
Title	Readme file for ERS-2 Scatterometer Soil Moisture Products
Reference	ESA-EOPG-EBA-TN-2, issue 1.0 Date: 7 June 2019
Affected data sets	This readme file applies to the following products: • ERS.SSM.H and ERS.SSM.N (soil moisture orbit product high and nominal resolution) • ERS.SSM.H.TS and ERS.SSM.N.TS (soil moisture time series high and nominal resolution) generated by the WAter Retrieval Package (WARP) v. 5.5 in the framework of the SCIRoCCo project.
Product specification references	Product Specification: SCI-MAN-16-0048-v02, Issue v02, 06/11/2016 - Product User Manual Orbit Product SCI-MAN-16-0047-v02, Issue v02, 06/11/2016 - Product User Manual Time-series Product

Summary

1. ERS-2 Wind Scatterometer Mission Overview

The European Remote-sensing Satellite (ERS)-2 was launched in July 1995 as the follow-on mission to ERS-1 and was concluded with the deorbiting of the satellite on July 2011.

Scatterometers send microwave pulses under an incidence angle θ to the Earth's surface, and measure the power scattered back, allowing estimation of the normalised radar cross section (σ_o) of the Earth's surface. Over Ocean, the radar cross-section σ0 mainly depends on the sea roughness, which in turn depends on wind speed and direction (it increases when the wind speed increases). Multiple, collocated, nearly simultaneous σ_o measurements acquired from three directions

(i.e. one looking perpendicular to the satellite ground track, one looking forward and one looking backwards at 45° azimuth projection angle with respect to the ground track) can be used to solve simultaneously the minimization of a cost function to retrieve the wind speed and direction. The most widely adopted forward models, used in the cost function, relating σ_o to the wind speed are empirical and are periodically updated and improved based on real satellite measurements.

The ERS-2 Active Microwave Instrument (AMI) operated in wind scatterometer mode has a spatial resolution of about 25 – 50 Km depending on the incidence angle over a swath of about 500 km. The acquisition repeat cycle is 3 days at the equator. Table 1 lists the operating characteristics of the Wind Scatterometer.

Table 1: Operating Characteristics of ERS-2 AMI in Wind Scatterometer mode

Time Period	21 April 1995 – 5 July 2011
Frequency	5.3 GHz (C band)
Antenna Azimuth Orientations	Three fixed
Polarizations	V Only
Beam Resolution	Range Gate
Resolution	25/50 km
Number of pulses per 50 km	256
Swath width	500 km
Incidence Angle	18 – 59o
Orbit	Sun-synchronous 780 km altitude 98.52° inclination

During the 16 years of operations, the ERS-2 mission underwent a number of failures (platform and AMI) and consequent changes of both the acquisition plan and the ground segment configuration. A brief summary of the main events of the ERS-2 mission is presented in the Table 2 below:

Table 2: Main Events of ERS-2 mission [Crapolicchio et al., 2012]

Period	**Event**
1995, Apr.	ERS-2 is launched on April 21, 1995.
1995, Nov.	The first Scatterometer measurement is achieved by setting the antenna circulator system into an intermediate position to avoid arcing in the AMI transmitter. In this new configuration the transmitted power is reduced by a factor of 3 dB if compared with ERS-1.
1996, Aug.	Due to an anomaly in the internal calibration unit, the calibration sub-system is switched from side A (nominal) to side B (redundant).
2000, Jan	Three of the six gyroscope fail, the operation mode is changed from Nominal to Mono-Gyro Mode. In Mono-Gyro configuration the accuracy of the satellite attitude was degraded in particular for the yaw angle.
2001, Jan.	Other two gyroscopes fail, leading to the so-called Zero-Gyro Mode; the single operating gyroscope is only used for important orbital manoeuvres.

	Scatterometer operational data is degraded and are not disseminated to the users. More details can be found in the list of events affecting ERS-2 Scatterometer mission at https://earth.esa.int/web/sppa/mission-performance/esa-missions/ers-2/scatterometer/mission-highlights.
2001, Jun.	To test a way to compensate for the gyroscopes failure, ERS-2 AMI starts operating only in Wind-Wave acquisition mode.
2003, May	Nominal Wind Scatterometer acquisition mode is resumed.
2003, Aug.	ERS Scatterometer Attitude Corrected Algorithm (ESACA) is included in the processing chain to compensate for the switching off of the gyroscopes.
2010, Sep.	Due to an irrecoverable transponder failure, the calibration acquisition mode is removed from the orbital planning and substituted by nominal acquisition.
2011, Feb.	ERS-2 is lowered by a series of orbit manoeuvres. As a consequence of that, the repeat cycle changes from 35 to the 3 day.
2011, Jul.	ERS-2 is decommissioned.

2. ERS-2 Scatterometer Soil Moisture products

The ERS-2 Scatterometer Soil Moisture products have been generated in the framework of the SCIRoCCo project. Surface soil moisture records are derived from the backscatter coefficient measured by the scatterometer (AMI) on-board the European Remote Sensing (ERS) satellites using the TU Wien soil moisture retrieval algorithm Naeimi et al. [2009]; Wagner et al. [1999].
A detailed description of the TU Wien soil moisture retrieval algorithm together with a description of the derivation of the model parameters can be found in the Product User Manual.

3. ERS-2 Scatterometer Soil Moisture data set availability

ERS-2 AMI Scatterometer data set has been reprocessed covering the period from 26 March 1996 to 4th July 2011 (end of mission). These data have been processed by the WARP software in order to produce the Soil Moisture products.

The size of the available data is: 308 GB and 2.69 GB for High Resolution (for orbital and time series modes respectively), 75.9 GB and 2.26 GB for Low Resolution (for orbital and time series modes respectively).

The soil moisture data set is available together with the other ERS-1/2 Scatterometer data through ESA Fast Registration.

3.1 ERS-2 Scatterometer Soil Moisture data set caveat

Please find below a list of caveats, which might affect the intended data usage.

- Scatterometer Soil Moisture products are NOT available for:

- **Cycle 1-9:** the initial period of the ERS-2 mission from 15th May 1995 to 25th March 1996 was not reprocessed due to the limited availability of the AMI in Wind Scatterometer mode.
- **Cycle 69 to Cycle 74:** data set has been reprocessed but is not available to the users due to degraded calibration performances in the Aft beam antenna measurements.

4 References

- R. Crapolicchio, G. De Chiara, A. Elyouncha, P. Lecomte, X. Neyt, A. Paciucci, and M. Talone, 2012: ERS-2 Scatterometer: Mission Performances and Current Reprocessing Achievements. *IEEE Trans. Geoscience and Remote Sensing*, vol. 50, n. 7, pp 2427-2448. doi: 10.1109/TGRS.2011.2179808.
- V. Naeimi, K. Scipal, Z. Bartalis, S. Hasenauer, and W. Wagner. An Improved Soil Moisture Retrieval Algorithm for ERS and METOP Scatterometer Observations. *IEEE Trans. on Geoscience and Remote Sensing*, 47:1999–2013, July 2009. ISSN 0196-2892, 1558-0644. doi: 10.1109/TGRS.2008.2011617.
- W. Wagner, J. Noll, M. Borgeaud, and H. Rott. Monitoring soil moisture over the Canadian Prairies with the ERS scatterometer. *IEEE Trans. on Geoscience and Remote Sensing*, 37(1):206-216, Jan. 1999. ISSN 01962892. doi: 10.1109/36.739155.

5 Acronyms and Abbreviations

ATBD	Algorithm Theoretical Baseline Document
ASPS	Advanced Scatterometer Processing System
ERS	European Remote-sensing Satellite
ESA	European Space Agency
ESACA	ERS Scatterometer Attitude Corrected Algorithm
SCIRoCCo	SCatterometer InstRument Competence Centre
PUM	Product User Manual

WWW References	• **Mission Operations Overview:** ○ ERS-2 • **Processors documentation** can be found here • **ERS-2 Telemetry data** can be found here (with AMI Operational modes, and Antenna Temperature)
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