



soil moisture
cci

Data Access Requirements Document (DARD)

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Prepared by

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Definitions, acronyms and abbreviations

AMI	Active Microwave Instrument
AMSR-E	Advanced Microwave Scanning Radiometer-Earth Observing System
AMSU	Advanced Microwave Sounding Unit
ASAR	Advanced Synthetic Aperture Radar
ASCAT	Advanced Scatterometer (Metop)
CCI	Climate Change Initiative
CEOP	Coordinated Energy and Water Cycle Observations Project
CMORPH	Morphing Method of the Climate Prediction Centre
CPC	Climate Prediction Centre
DARD	Data Access Requirement Document
DMSP	Defense Meteorological Satellite Program
DTED	Digital Terrain Elevation Model
EASE	Equal-Area Scalable Earth
ECV	Essential Climate Variable
ENVISAT	Environmental Satellite
EO	Earth Observation
ERA-40	ECMWF ReAnalysis 40 data set
ERS	European Remote Sensing Satellite (ESA)
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FTP	File Transfer Protocol
GIMMS	Global Inventory Modeling and Mapping Studies
GLDAS	Global Land Data Assimilation System
GLWD	Global Lakes and Wetlands Database (GSPC/University of Kassel)
GPCC	Global Precipitation Climatology Centre
GPCP	Global Precipitation Climatology Project
GRACE	Gravity Recovery And Climate Experiment
GSWP	Global Soil Wetness Project
ISMN	International Soil Moisture Network
ITRDB	International Tree-Ring Data Bank
JAXA	Dokuritsu-gyosei-hojin Uchu Koku Kenkyu Kaihatsu Kiko, (Japan Aerospace Exploration Agency)
JPL	Jet Propulsion Laboratory (nasa)
METOP	Meteorological Operational Satellite (EUMETSAT)



NASA	National Aeronautics and Space Administration
NIMA	National Imagery and Mapping Agency
NOAA	National Oceanic and Atmospheric Administration
NSIDC	National Snow and Ice Data Center (radlab)
NWS	National Weather Service (NOAA)
SAR	Synthetic Aperture Radar
SCAT	Scatterometer
SMAP	Soil Moisture Active and Passive mission
SMMR	Scanning Multichannel Microwave Radiometer
SMOS	Soil Moisture and Ocean Salinity (ESA)
SOW	Statement of Work
SSM	Surface Soil Moisture
SSM/I	Special Sensor Microwave Imager
TDR	Time Domain Reflectometry
TMI	TRMM Microwave Imager
TRMM	Tropical Rainfall Measuring Mission
TWS	Terrestrial Water Storage
USGS	United States Geological Survey
VIC	Variable Infiltration Capacity
WACMOS	Water Cycle Multimission Observation Strategy
WindSat	WindSat Radiometer



1 Executive Summary

The Data Access Requirement Document (DARD) provides the details of all datasets that are required in the generation of the ECV soil moisture product. The DARD is provided as deliverable D1.3 to the ESA CCI soil moisture project. The DARD initially focuses on level 1 products and datasets that are derived from ESA EO and third party missions and highlighting issues related to data access, data availability and data quality.

Based upon the summary of data accessibility and data availability presented in this DARD there are, compliant with the SoW [AD-2], no operational constraints to the production of the soil moisture ECV.

2 Introduction

The nature of the soil moisture essential climate variable (ECV) product, considering the requirement for the integration of different satellite sensors, and the longevity of the ECV product lead to the requirements of the access to, and integration of, a broad range of datasets from a variety of data sources. The generation of the Soil Moisture ECV relies upon a suite of datasets originating from a number of earth observation (EO) missions, from various agencies, and differing sensor systems. As shown in Figure 1, the suite of datasets cover a time span from the late 1970's to the current date and are foreseen well into the next decade.

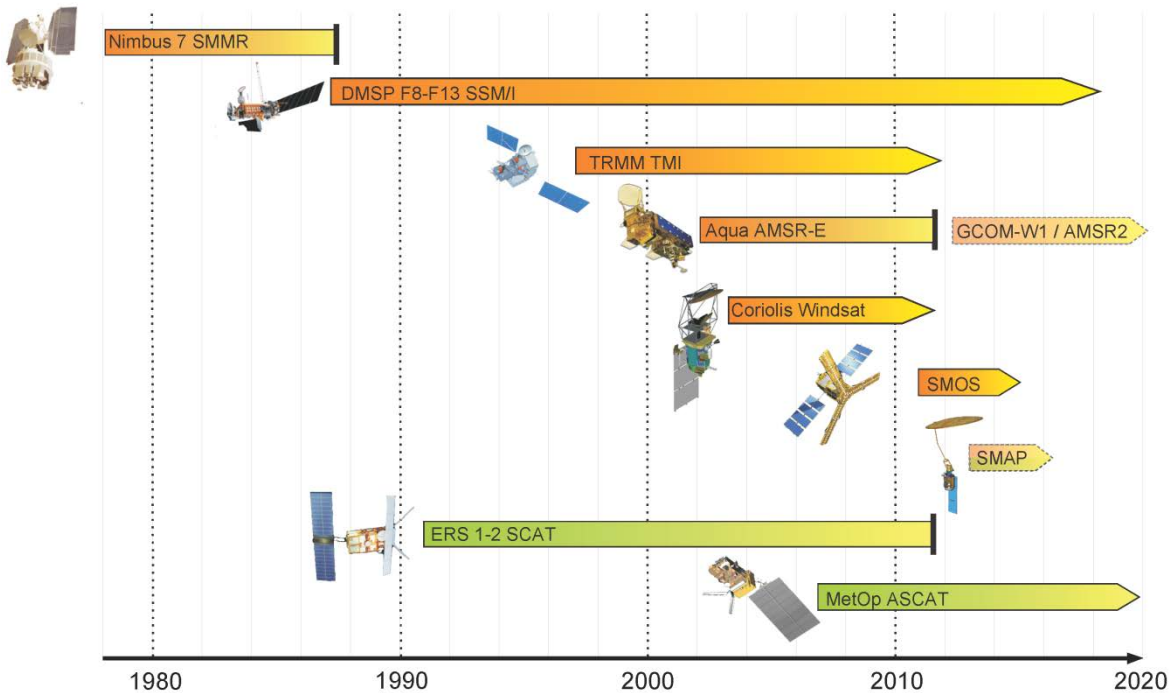


Figure 1 An overview of the Satellites and their active and passive sensors that can provide data to generate the ECV soil moisture product (figure is provided courtesy of the WACMOS project)



Supporting the EO datasets, ancillary data ranging from in-situ surface measurements of soil moisture and meteorological variables, to regional and global modelled datasets, are also required. As is seen by the example in Figure 2 for the In-Situ soil moisture measurements from the International Soil Moisture Network (ISMN) database, many of these datasets are in themselves already very comprehensive and complex.

2.1 Scope of Document

This data access requirement document (DARD) *'identifies all the data that are needed as input to perform the project, including;*

- *all required Level 1, and if necessary Level 0, products from ESA and Third Party Missions*
- *all ancillary data*
- *all in-situ observation data sources as well as higher-level products needed for product intercomparison*
- *Historical data archives, currently operational sources and sources due to become operational in next 3 years.'*
- *Historical data archives, currently operational sources and sources due to become operational in next 3 years.'* [RD-1]

With this document each data source has been categorised by its data class, and broadly aggregated into three groups being either active level 1 (earth observation) data, passive level 1 data, or ancillary datasets.

Each dataset is presented in a tabular fashion, and in accordance with the SoW, [RD-1], *'for each data source the DARD includes;*

- *information about the originating system*
- *identification of the data class (in-situ, EO, model)*
- *specification of the sensor type and key technical characteristics*
- *information about data availability & coverage (times-scale, geographic, temporal),*
- *source data product name & reference to product technical specification documents*
- *estimates of the data quantity*
- *indication of data quality and reliability*
- *description of the ordering and delivery mechanism*
- *identification of access conditions & pricing'*

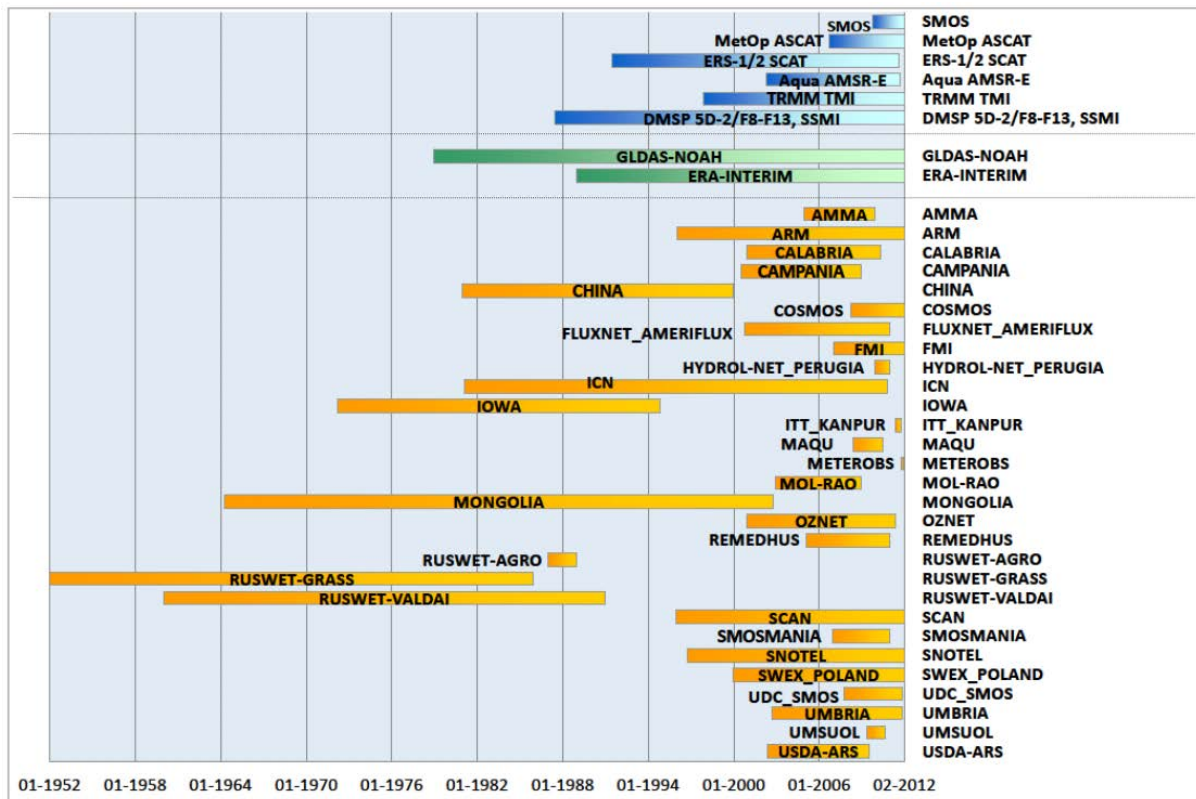


Figure 2 Temporal availability of In-situ measurements from networks within the ISMN database in comparison to availability of data from EO mission and Modeled datasets.

Each dataset section within the DARD also includes the requirements for resolving any known data access, calibration, validation and performance issues specific to the satellite ground segment processing and identifies, where possible, the potential algorithm upgrades to enable the regeneration of improved and most accurate input products required for the Soil Moisture ECV. The document clearly highlights any licensing or data access conditions for each dataset, and, where required, also notes on formal agreements with the data suppliers for delivery of the data to the project.

2.2 Document Overview

The DARD is presented in the following manner. After an overview of all EO derived products in section 4, sections 5 and 6 present all level 1 EO products required from passive and active systems. (Noting that future sensors are also briefly considered, but datasets from altimeters and thermal sensors are not yet included). Section 7 provides an overview of all ancillary datasets starting with validation datasets, include EO derived datasets, In-situ measurements, regional model simulation, global model simulations and diagnosed datasets, before noting ancillary datasets that support soil moisture retrieval from EO data, and further on to additional datasets.



Section 8 provides a summary note of outstanding issues for particular datasets that might impact the project, before section 9 presents brief conclusion on the DARD. Annex: A provides an overview of all datasets described within the DARD.

2.3 Targeted audience

This document targets mainly

- remote sensing experts interested in the data requirements related to setting up a production system for, and providing validation of, essential climate variables, with a particular focus on soil moisture products derived from active and passive microwave data sets.

3 Documents

3.1 Applicable documents

The documents outlined here detail the scope and focus for the work that is reported in this document.

[AD-1] Phase 1 of the ESA Climate Change Initiative Soil- Moisture- cci. ESRIN Contract No: 4000104814/11/I-NB

[AD-2] ESA Climate Change Initiative Phase 1, Statement of Work for Soil Moisture and Ice Sheets, European Space Agency, EOEP-STRI-EOPS-SW-11-0001.

[AD-3] Technical Proposal (Part 3) in response to ESA Climate Change Initiative Phase 1 ESRIN/AO/1-6782/11/I-NB, Vienna University of Technology.

3.2 Reference documents

A complete list of reference documents is provided in section 10 Reference Documents. The section provides a list of references documents upon which this document is either based, or are required to be referenced by the reader in order to obtain the full information intended by the authors. Where relevant some parts of these reference document may have been included in this document in a verbatim fashion. These sections are noted by the use of pairs of single quotation marks " (inverted comma's), with the *verbatim text being detailed in italic font* and full attribution to the appropriate referral document.



3.3 Bibliography

A complete bibliographic list, detailing scientific text or publications that support arguments or statements made within the current document is provided in section 11



4 Overview of required Earth Observation products

An overview of the Earth Observation level 1, level 2 and level 3 datasets, or products, required to support the ECV soil moisture generation are provided in Table 1. ESA and third party missions are identified along with data licensing constraints. A fuller overview of all datasets required for the ECV soil moisture project are provided in Annex: A.

Principle Purpose	Agency Producer	Satellite	Sensor	Period	Products	Data Licensing
ECV production	ESA	ERS-1, ERS -2	AMI-WS	05-08-1991 to 17-01-2001, 13-08-2003 to 28-01-2010	L1B - Nominal	Freely Available
ECV production	ESA	ERS -2	AMI-WS	20-05-1997 to 17-02-2003	L1B-High Resolution	Available with ESA consent
ECV production	ESA	ERS -2	AMI-WS	17-02-2003 to 07-2011	L1B -High Resolution	
ECV production (Future)	ESA	SMOS		Nov 2009 to current (Feb 2012) and continuing	L1C	Freely Available
ECV production (Future)	ESA	SMOS		Nov 2009 to current (Feb 2012) and continuing	L2	TBC
ECV Validation	ESA	ENVISAT	ASAR	Dec 2004 to current (Feb 2012) and continuing	L1B	Freely Available for Non Commercial
ECV Validation	ESA	ENVISAT	ASAR	Dec 2004 to current (Feb 2012) and continuing	L1B	Freely Available for Non Commercial
ECV production	EUMETSAT	METOP-A	ASCAT	01-01-2007 to current (Feb 2012) and continuing	L1B	Freely Available
ECV production (Future)	JAXA	GCOM W	AMSR 2	Launch in 2012		Freely Available
ECV production	NASA	NIMBUS 7	SMMR	Oct-1978 to Aug 1987	L1B	Freely Available
ECV production (Future)	NASA	SMAP		Post 2014		TBC
ECV production (Future)	NASA	Aquaris		June 2011 to current (Feb 2012) and continuing	L2	Freely Available
ECV Validation RR Passive	NASA	GRACE		Apr-2002 to current (Feb 2012) and continuing	L2	Freely Available



ECV production	NASA, JAXA	TRMM	TMI	Nov-1997 to current (Feb 2012) and continuing	L1B	Freely Available
ECV production	NASA, JAXA	Coriolis	Windsat	Jan 2003 to current (Feb 2012) and continuing	L1	Freely Available
ECV production	Naval Research Laboratory	AQUA	AMSR	June 2002 - Oct 2011	L2A	Freely Available
ECV production	NOAA	DMSP	SSM/I	Jun 1987 to current (Feb 2012) and continuing	L1	Freely Available
ECV Validation /RR Passive	NOAA/GLCF	NOAA	AVHRR	July 1981 to Dec 2006	L3	Freely Available
ECV Validation (Additional)	NSIDC	DMSP	SSM/I	04-05-1995 to current (Feb 2012) and continuing	L2	Freely Available

Table 1 EO Products required for the ECV soil moisture generation



5 Access requirements for active level 1 data

5.1 ERS SCAT Nominal

Originating System	Active Microwave Instrument (AMI) Wind Scatterometer (WS) onboard ERS-1 and ERS-2
Data class	Earth Observation data
Sensor Type and key technical characteristics	<ul style="list-style-type: none"> • Scatterometer with 3 fan-beam antennae • Frequency 5.3 GHz \pm 52kHz (C-Band) • Polarization: linear vertical (VV) • Inc. angles: 18 – 47 (mid), 25 – 59 (fore/aft) • Spatial resolution: \geq 45 km • Swath width: \geq 500 km • Swath stand-off: 200 km to right of sub-sat. Track
Data Availability and Coverage	<p>IFREMER 1991/08/05 – 2001/01/17, 180°W 82°S – 180°E 82°N</p> <p>ESA Rolling Archive 2003/08/13 – 2010/01/28, 180°W 82°S – 180°E 82°N</p>
Source Data Name and Product Technical Specifications	<p>IFREMER ERS.WSC.WNF (IFREMER product WNF Format)</p> <p>Technical Specification:</p> <ul style="list-style-type: none"> • Spatial Resolution: 50x50 km • Spatial Sampling: 25x25 km • C2-MUT-W-01-IF <p>ESA Rolling Archive ERS.WSC.UWI (fast delivery product BUFR Format)</p> <p>Technical Specification:</p> <ul style="list-style-type: none"> • Spatial Resolution: 50x50 km • Spatial Sampling: 25x25 km • http://earth.esa.int/pub/ESA_DOC/scatt_work98_product.pdf[RD-3]

Data Quantity	~32 GB
Data Quality and Reliability	Instrument specification <ul style="list-style-type: none"> • Radiometric stability: 0.46 dB • Localisation accuracy: 5 km Validation reports <ul style="list-style-type: none"> • http://earth.eo.esa.int/pcs/ers/scatt/reports/pcs_cyclic/ [RD-4]
Ordering and delivery mechanism	IFREMER Ordering via CERSAT webpage http://cersat.ifremer.fr , currently no information about delivery mechanism. (CD) ESA Rolling Archive Ordering via ESA Earthnet Online http://earth.esa.int Delivery is possible via <ul style="list-style-type: none"> • FTP
Access conditions and pricing	Freely accessible
Issues	Due to the loss of gyroscopes onboard of ERS-2 in January 2001, data from 2001/01/17 to 2003/08/13 is lost.

5.2 ERS SCAT High Resolution

Originating System	Active Microwave Instrument (AMI) Wind Scatterometer (WS) onboard ERS-1 and ERS-2
Data class	Earth Observation data
Sensor Type and key technical characteristics	<ul style="list-style-type: none"> • Scatterometer with 3 fan-beam antennae • Frequency 5.3 GHz \pm 52kHz (C-Band) • Polarization: linear vertical (VV) • Inc. angles: 18 – 47 (mid), 25 – 59 (fore/aft) • Spatial resolution: \geq 45 km



	<ul style="list-style-type: none"> • Swath width: ≥ 500 km • Swath stand-off: 200 km to right of sub-sat. track
Data Availability and Coverage	1997/05/20 – 2003/02/17, 180°W 82°S – 180°E 82°N
Source Data Name and Product Technical Specifications	ERS.ASPS20.H Technical Specification: <ul style="list-style-type: none"> • Spatial Resolution: 25x25 km • Spatial Sampling: 12.5x12.5 km • ERSE-GSEV-EOPG-RS-06-0002
Data Quantity	333 GB
Data Quality and Reliability	Instrument specification <ul style="list-style-type: none"> • Radiometric stability: 0.46 dB • Localisation accuracy: 5 km Validation reports <ul style="list-style-type: none"> • http://earth.eo.esa.int/pcs/ers/scatt/reports/pcs_cyclic/ [RD-4]
Ordering and delivery mechanism	Ordering via ESA Earthnet Online http://earth.esa.int Delivery is possible via <ul style="list-style-type: none"> • FTP
Access conditions and pricing	Freely accessible
Issues	The data is currently used by IPF TUWien for the ESCAT Project. Article b.7 of the project contract notes that data shall not be copied transferred or otherwise made available to third parties without prior written consent of ESA. Access for CCI SM needs to be clarified. To guarantee a long term time series of soil moisture from active level 1 data with a consistent spatial resolution of 25x25 km a reprocessing of the entire ERS-1 and ERS-2 AMI WS is preferred.



5.3 ASCAT

Originating System	Advanced Scatterometer (ASCAT) onboard METOP-A
Data class	Earth observation
Sensor Type and key technical characteristics	<ul style="list-style-type: none"> • Scatterometer with 6 fan-beam antennae • 5.255 GHz (C-band), λ 5.70 cm (VV Polarization) • Inc. angles: 25 – 53.5 (mid), 33.7-64.5 (fore/aft) • Spatial sampling: 25x25 / 12.5x12.5 km • Spatial resolution: 50x50 / 37x25 km
Data Availability and Coverage	<p>2007/01/01 – cont., 180°W 90°S – 180°E 90°N</p> <p>A summary of data gaps can be found in</p> <ul style="list-style-type: none"> • EUM/OPS/DOC/09/2481 [RD-5] • EUM/OPS/REP/09/3033 [RD-6]
Source Data Name and Product Technical Specifications	<p>ASCAT Level 1B</p> <p>Technical Specification</p> <ul style="list-style-type: none"> • EUM/OPS/DOC/10/1296 [RD-10] • EUM/OPS/SYS/SPE/990009 [RD-8] • EPS/MIS/SPE/97233 [RD-7]
Data Quantity	~120 GB/year for L1b backscatter 25 km resolution
Data Quality and Reliability	<p>Instrument specification</p> <ul style="list-style-type: none"> • Radiometric stability: 0.46 dB • Localisation accuracy: 4.46x4.46 km <p>Validation reports</p> <ul style="list-style-type: none"> • EUM/MET/REP/08/0525 [RD-11] • EUM/OPS/REP/11/2465 [RD-12]
Ordering and delivery mechanism	<p>Ordering via EUMETSAT Data Centre</p> <p>http://archive.eumetsat.int/umarf/</p> <p>Delivery is possible via</p> <ul style="list-style-type: none"> • FTP over Internet



	<ul style="list-style-type: none">• EUMETCast• Direct Dissemination
Access conditions and pricing	Freely accessible
Issues	A small calibration change in the instrument, observed in September 2009, is compensated for with new antenna gain patterns updated on 18 AUG 2011. (EUM/OPS/REP/11/2465 [RD-12])

6 Access requirements for passive level 1 data

6.1 NIMBUS 7 SMMR (NASA)

Originating System	Scanning Multichannel Microwave Radiometer on board Nimbus 7
Data class	Earth observation
Sensor Type and key technical characteristics	<ul style="list-style-type: none"> • Microwave Radiometer, 5 frequencies data in swath format (level 1b) • 6.6, 10.7, 18 and 37 GHz in both horizontal and vertical polarization, 21 GHz in vertical polarization • Inc. angle: 50.3 degrees • Spatial sampling: 25x25 km • Spatial resolution: 148x95 km (6.6 GHz), 91x59 km (10.7 GHz), 55x41 km (18 GHz), 46x30 km (21 GHz), 27x18 km (37 GHz) • Temporal resolution, ~6 days, sunsynchronous observation with (daytime (12 hr) and night time (24 hr) equator crossings. • Data Citation: Njoku 1996 [RD-13]
Data Availability and Coverage	<p>October 1978- August 1987, 180°W 90°S – 180°E 90°N</p> <p>A summary of the data can be found on</p> <ul style="list-style-type: none"> • http://nsidc.org/data/nsidc-0036.html • Fu et al., 1988 [RD-14]
Source Data Name and Product Technical Specifications	<p>SMMR Level 1b</p> <p>Technical Specification</p> <ul style="list-style-type: none"> • Njoku, 1996 [RD-13] • http://nsidc.org/data/nsidc-0036.html • Fu et al., 1988 [RD-14]
Data Quantity	Total volume is 70 GB (compressed)
Data Quality and Reliability	<p>Instrument specification:</p> <ul style="list-style-type: none"> • Radiometric sensitivity: 0.7 K (6.6 GHz), 0.8 K (10.7 GHz), 0.9 K (18 GHz), 1 K (21 GHz), 1.4 K (37 GHz) <p>Validation reports</p>

	<ul style="list-style-type: none"> • Njoku et al., 1995 [RD-15] • Gloerissen et al., 1984 [RD-16]
Ordering and delivery mechanism	Ordering via NSIDC Data Centre http://nsidc.org Delivery is possible via <ul style="list-style-type: none"> • FTP over Internet
Access conditions and pricing	Freely accessible
Issues	In 1986 There is a high frequency of bad antenna counts, especially during and for some time after the Special Operations Period (April – October 1986). Interpolating radiometric samples within scans and between adjacent scans tends to smear the effect of these "bad" antenna counts, which are most noticeable in browse image maps of 6.6 GHz horizontal polarization data.

6.2 DMSP SSM/I (NESDIS NOAA)

Originating System	the Special Sensor Microwave Imager (SSM/I) of the Defense Meteorological Satellite Program (DMSP)
Data class	Earth observation
Sensor Type and key technical characteristics	<ul style="list-style-type: none"> • Version 6 20+ year intercalibrated microwave Radiometer observations from 6 different satellites (F8, F10, F11, F13, F14, F15) • 19.4, 37 and 85.5 GHz in both horizontal and vertical polarization, 22.3 GHz in vertical polarization • Inc. angle: ~53 degrees • Spatial sampling: 25x25 km • Spatial resolution: 69x43 km (19.4 GHz), 50x40 km (22.2 GHz), 28x25 km (37 GHz), 15x13 km (85.5 GHz) • Temporal resolution, ~daily, sunsynchronous observation with various observation time depending on satellite platform • the ascending equator crossings for the different satellites are

	<p>F8 6h15, F10 19h42, F11 17h00, F13 17h42, F14 20h21, F15 21h31</p> <ul style="list-style-type: none"> • Data Citation: Wentz 2007 [RD-17]
Data Availability and Coverage	<p>F08 (Jun 87 – Aug 1991), F10 (Dec 1990 – Nov 1997), F11 (Nov 1991 – Dec 2000), F13 (Mar 1995 – Now), F14 (May 1997 – Aug 2008), F15 (Dec 1999, Now), 180°W 90°S – 180°E 90°N</p> <p>A summary of the data can be found on</p> <ul style="list-style-type: none"> • Wentz 1993 [RD-18]
Source Data Name and Product Technical Specifications	<p>Version 6 20+ years SSMI brightness temperatures</p> <p>Technical Specification</p> <ul style="list-style-type: none"> • Wentz 1991 [RD-19] • Wentz 1993 [RD-18] • Wentz et al. ,2007 [RD-17]
Data Quantity	100 GB/year
Data Quality and Reliability	<p>Instrument specification:</p> <ul style="list-style-type: none"> • Radiometric sensitivity (noise): 0.4 K (19.4 GHz), 0.7 K (22.2 GHz), 0.4 K (37 GHz), 0.7 K (85.5 GHz) <p>Validation reports</p> <ul style="list-style-type: none"> • Hillburn and Shie 2011 [RD-20]
Ordering and delivery mechanism	<p>Ordering via SSMI Data Centre</p> <p>http://www.ssmi.com/ssmi/ssmi_brightness_temperatures.html</p> <p>Delivery is possible via</p> <ul style="list-style-type: none"> • Order Hard disk
Access conditions and pricing	Freely accessible
Issues	The data used here is based on a series of different satellites

6.3 TRMM-TMI (NASA/JAXA)

Originating System	Tropical Rainfall Measurement Mission Microwave Imager (TRMM-TMI)
Data class	Earth observation
Sensor Type and key technical characteristics	<ul style="list-style-type: none"> • 5 frequency Radiometer • 10.7, 19.4, 37, and 85.5 GHz in both horizontal and vertical polarization. 21.3 GHz in vertical polarization • Inc. angle: 53.4 degrees • Spatial sampling: 25x25 km • Spatial resolution: 63.2x36.8 km (10.7 GHz), 30.4x18.4 km (19.4 GHz), 27x18.4 km (21.3 GHz), 16x9.2 km (37 GHz), 7.2x4.6km (85.5 GHz) • Temporal resolution, ~3 hourly; a non-sun-synchronous orbit to measure with large daily variation quantitatively. The inclination angle of the orbit is 35 degrees, and the satellite orbits the Earth every 90 minutes, 16 times per day • Variable observation times • Data Citation: [RD-21]
Data Availability and Coverage	November 1997 – Now, 180°W 38°S – 180°E 38°N A summary of the data can be found on <ul style="list-style-type: none"> • http://pps.gsfc.nasa.gov/tsdis/Documents/ICSVol3.pdf [RD-21]
Source Data Name and Product Technical Specifications	Level 1 b calibrated brightness temperatures TRMM TMI Technical Specification <ul style="list-style-type: none"> • TRMM Data Users Handbook [RD-22] • http://pps.gsfc.nasa.gov/tsdis/Documents/ICSVol3.pdf [RD-21]
Data Quantity	10 GB per year
Data Quality and	Instrument specification:



Reliability	<ul style="list-style-type: none"> Radiometric sensitivity (noise): about 1 K for all frequencies <p>Validation reports</p> <ul style="list-style-type: none"> Validation completed by the TRMM validation Office: http://trmm-fc.gsfc.nasa.gov/trmm_gv/index.html
Ordering and delivery mechanism	<p>Ordering via NASA GES DISC Data Centre http://mirador.gsfc.nasa.gov</p> <p>Delivery is possible via</p> <ul style="list-style-type: none"> ftp
Access conditions and pricing	Freely accessible
Issues	The satellite observations slightly changed after a boost in August 2001 and there is a pre-boost dataset (before 7-8-2001) and a post boost dataset (after 24-8-2001)

6.4 AQUA AMSR-E (NASA JAXA)

Originating System	The Advanced Microwave Scanning Radiometer onboard the AQUA satellite
Data class	Earth observation
Sensor Type and key technical characteristics	<ul style="list-style-type: none"> Multi frequency Scanning Radiometer 6.9, 10.7, 18.7, 23.8, 36.5 and 89 GHz in both horizontal and vertical polarization. Inc. angle: ~55 degrees Spatial sampling: 10x10 km Spatial resolution: 75x43 km (6.9 GHz), 51x29 km (10.7 GHz), 26x16 km (18.7 and 23.8 GHz), 14x8 (36.5 GHz), 6x4 km (89 GHz) Temporal resolution, ~daily, sunsynchronous observations the ascending equator crossings at 13:30 hr Data Citation: Ashcroft, Peter and Frank Wentz. 2000. [RD-23]
Data Availability	June 2002- October 2011, 180°W 89.24°S – 180°E 89.24°N

and Coverage	A summary of the data can be found on <ul style="list-style-type: none"> • Ascroft and Wentz, 2000 [RD-23]
Source Data Name and Product Technical Specifications	AMSR-E/Aqua L2A Global Swath Spatially-Resampled Brightness Temperatures Technical Specification <ul style="list-style-type: none"> • Ascroft and Wentz, 2000 [RD-23]
Data Quantity	1 TB per year
Data Quality and Reliability	Instrument specification: <ul style="list-style-type: none"> • Radiometric sensitivity (noise): 0.3 K (6.9 GHz), 0.6 K (10.7, 18.7, 23.8, and 36.5 GHz), 1.1 K (89 GHz) Validation reports <ul style="list-style-type: none"> • Bennartz and Michelson 2004 [RD-24]
Ordering and delivery mechanism	Ordering via NASA GES DISC or NSIDC data center e.g. http://mirador.gsfc.nasa.gov Delivery is possible via <ul style="list-style-type: none"> • ftp
Access conditions and pricing	Freely accessible
Issues	Versions older than V07 had significant geolocation problems (a few km off).

6.5 Coriolis WindSat (Naval Research Laboratory)

Originating System	Windsat Radiometer onboard the Coriolis satellite
Data class	Earth observation
Sensor Type and key technical characteristics	<ul style="list-style-type: none"> • Multi frequency Scanning Radiometer • 6.8, 10.7, 18.7, 23.8, and 37 GHz in both horizontal and vertical polarization. • Inc. angle varies: 53.5 degrees for 6.8 GHz, 49.9 degrees for 10.7 GHz, 55.3 degrees for 18.7 GHz and 53.0 degrees for 23.8

	<p>and 37.0 GHz</p> <ul style="list-style-type: none"> • Spatial sampling: 25x25 km • Spatial resolution: 60x40 km (6.9 GHz), 25x38 km (10.7 GHz), 26x16 km (18.7 and 23.8 GHz), 8x13 km (37 GHz) • Temporal resolution, ~daily, sunsynchronous observations • the ascending equator crossings at 18:00 hr • Data Citation: Gaiser et al., 2004 [RD-26]
Data Availability and Coverage	<p>January 2003- present, 180°W 90°S – 180°E 90°N</p> <p>A summary of the data can be found on</p> <ul style="list-style-type: none"> • Gaiser et al., 2004 [RD-26] and WindSat Data Products Users' Manual [RD-25]
Source Data Name and Product Technical Specifications	<p>Windsat Brightness Temperatures</p> <p>Technical Specification</p> <ul style="list-style-type: none"> • WindSat Data Products Users' Manual [RD-25]
Data Quantity	~1 TB per year
Data Quality and Reliability	<p>Instrument specification:</p> <ul style="list-style-type: none"> • Radiometric sensitivity (noise): 0.75 K for all frequencies • Validation reports • Gaiser et al., 2004 [RD-26] • Parinussa et al., 2012 [RD-27]
Ordering and delivery mechanism	<p>Ordering via Naval Research laboratory</p> <p>Delivery is possible via</p> <ul style="list-style-type: none"> • Hard disk
Access conditions and pricing	Freely accessible
Issues	Data is not yet available through an ftp service and is only available on an hard disk

6.6 SMOS (ESA)

Originating System	Soil Moisture and Ocean Salinity Mission
Data class	Earth observation
Sensor Type and key technical characteristics	<ul style="list-style-type: none"> • Passive Microwave 2D interferometer • L-band (21 cm, 1.4 GHz) • Level 1 C multi-angular brightness temperatures • Full polarization • Spatial resolution 35 km at centre of field of view • Angular range 0-55 degrees • 3 day revisit at Equator (sunsynchronous, 6 AM ascending) • Data Citation: Kerr et al., 2001
Data Availability and Coverage	November 2009-Now, 180°W 90°S – 180°E 90°N
Source Data Name and Product Technical Specifications	SMOS Level 1c Technical Specification <ul style="list-style-type: none"> • Algorithm Theoretical Basis Document (ATBD) for the SMOS Level 2 Soil Moisture Processor [RD-28] • SMOS L1 Processor L1c Data Processing Model [RD-29]
Data Quantity	~5 Tb per year
Data Quality and Reliability	Instrument specification: <ul style="list-style-type: none"> • Radiometric sensitivity: 0.8 – 2.2 K
Ordering and delivery mechanism	Ordering via ESA Delivery is possible via <ul style="list-style-type: none"> • FTP over Internet
Access conditions and pricing	Freely accessible
Issues	Data is continuously reprocessed

6.7 NASA (SMAP)

Originating System	Soil Moisture Active Passive
Data class	Earth observation
Sensor Type and key technical characteristics	<ul style="list-style-type: none"> • L-band Radar (SAR) (1.26 GHz) • Polarization (VV,HH, HV) • Incidence angle 40 degrees • 1-2 km spatial resolution • L-band Microwave radiometer (1.4 GHz) • Polarization: H, V, 3rd and 4th Skokes • Incidence angle 40 degrees • 40 km spatial resolution • Relative accuracy: 1.3 K • Temporal resolution, ~daily, sunsynchronous observations (ascending 6 am)
Data Availability and Coverage	Anticipated launch 2014
Source Data Name and Product Technical Specifications	N/A
Data Quantity	N/A
Data Quality and Reliability	N/A
Ordering and delivery mechanism	N/A
Access conditions and pricing	N/A
Issues	Satellite is not launched

6.8 GCOM W AMSR-2 (JAXA)

Originating System	The second Advanced Microwave Scanning Radiometer onboard the GCOM W satellite
Data class	Earth observation
Sensor Type and key technical characteristics	<ul style="list-style-type: none"> • Multi frequency Scanning Radiometer • 6.9/7.3, 10.7, 18.7, 23.8, 36.5 and 89 GHz in both horizontal and vertical polarization. • Inc. angle: ~55 degrees • Spatial sampling: 10x10 km • Spatial resolution: 62x43 km (6.9 GHz/7.3 GHz), 42x24 km (10.7 GHz), 22x14 km (18.7 GHz), 26x15 km (23.8 GHz), 12x7 (36.5 GHz), 5x3 km (89 GHz) • Temporal resolution, ~daily, sunsynchronous observations • the ascending equator crossings at 13:30 hr
Data Availability and Coverage	Launch 2012, 180°W 89.24°S – 180°E 89.24°N
Source Data Name and Product Technical Specifications	N/A
Data Quantity	~1 TB per year
Data Quality and Reliability	Instrument specification: <ul style="list-style-type: none"> • Radiometric sensitivity (noise): ~0.1 K
Ordering and delivery mechanism	Ordering via JAXA or NASA GES DISC Delivery is possible via <ul style="list-style-type: none"> • ftp
Access conditions and pricing	Freely accessible
Issues	Satellite is not yet Launched

**6.9 Aquarius (NASA)**

Originating System	Aquarius
Data class	Earth observation
Sensor Type and key technical characteristics	<ul style="list-style-type: none"> • L band radiometer (1.4 Ghz) and L band (1.26 GHz) Scatterometer • polarimetric Radiometer (TH, TV, U (T+45°, T-45°)) • polarimetric (co-pol and cross-pol) Scatterometer • three beams • inner beam 28.7 degrees, middle beam 37.8 degrees and outer beam 45.6 degrees • Spatial resolution radiometer: 98 km (inner beam), 126 km (middle beam), 164.1 km (outer beam) • Spatial resolution scatterometer: 74.3 km (inner beam), 94.9 km (middle beam), 127.6 km (outer beam) • Temporal resolution, 7 days, sunsynchronous observations • the ascending equator crossings at 18:00 hr • http://aquarius.nasa.gov/index.html
Data Availability and Coverage	June 2011- present, 180°W 90°S – 180°E 90°N
Source Data Name and Product Technical Specifications	<p>Level 2 data</p> <p>Technical Specification</p> <ul style="list-style-type: none"> • AQUARIUS User Guide, Revision [1.0], August 11, 2011 [RD-30]
Data Quantity	~100 GB per year
Data Quality and Reliability	<p>Instrument specification:</p> <ul style="list-style-type: none"> • Radiometric sensitivity (noise): 0.06 K for the L band radiometer and between 0.04-0.1 dB for the Radar
Ordering and delivery mechanism	<p>Ordering via NASA GES DISC portal</p> <p>Delivery is possible via</p> <ul style="list-style-type: none"> • ftp (http://podaac.jpl.nasa.gov/AquariusDataAccess)



Access conditions and pricing	Freely accessible
Issues	Data is not yet free available (reprocessing)

7 Access requirements for ancillary data

7.1 Validation data

7.1.1 Earth Observation Datasets

7.1.1.1 ASAR

Originating System	Advanced Synthetic Aperture Radar (ASAR) onboard the ENVISAT satellite
Data class	Earth observation
Sensor Type and key technical characteristics	<ul style="list-style-type: none"> • Synthetic Aperture Radar (SAR) at 5.333 GHz (C-band) • ScanSAR capability with 7 subswaths – up to 405 km combined swath width • Five mutually exclusive modes of operation. Of interest here are the Global Monitoring (GM) mode and Wide Swath (WS) mode.
Data Availability and Coverage	<p>Wide swath:</p> <ul style="list-style-type: none"> • 2007/05/06 – cont.: nearly global coverage over land (VV and HH), good coverage over polar areas in HH polarisation. • Temporal sampling highly dependent on location and latitude (approx. sampling frequency 1 week – 1 year) • Acquisition planning: ASAR Background Regional Mission (BRM)¹. <p>Global Monitoring:</p> <ul style="list-style-type: none"> • 2004/12/10 – cont.; nearly global coverage over land, complete coverage (land and oceans) south of latitude 55°S and north of latitude 65°N. • Temporal sampling dependent on location and latitude (approx. sampling frequency 4-30 days) • Acquisition planning: ASAR Background Mission (BM).

¹ https://earth.esa.int/web/guest/data-access/content?p_r_p_564233524_assetIdentifier=asar-background-regional-mission-brm-4045#_101_INSTANCE_3Bha_matmp

Source Data Name and Product Technical Specifications	<p>Wide Swath:</p> <ul style="list-style-type: none"> ASAR Wide Swath mode Level 1b (ASA_WSM_1P) Polarisation: either HH or VV Incidence angles: 17°-42° Spatial resolution: 150 m Radiometric resolution: >11.5 Equivalent Number of Looks (ENL) <p>Global Monitoring:</p> <ul style="list-style-type: none"> ASAR Global Monitoring mode Level 1b (ASA_GM1_1P) Polarisation: HH Incidence angles: 17°-42° Spatial resolution: 1 km Radiometric resolution: 7-9 Equivalent Number of Looks (ENL) [RD-31]
Data Quantity	<p>Global Monitoring: 2 TB, ~200.000 datasets</p> <p>Wide Swath: 24 TB, ~200.000 datasets</p>
Data Quality and Reliability	<p>Both modes: between December 2004 (start of I.P.F. archive) and February 2012 there were 9 interruption longer than 1 day. The longest interruption was 5 days.</p> <p>ASAR Public Performance Reports: http://earth.eo.esa.int/pcs/envisat/asar/public_reports/</p> <p>Instrument Availability Interruptions: http://envisat.esa.int/instruments/availability/</p>
Ordering and delivery mechanism	<p>Automatic daily downloads to I.P.F. servers from ESA's Rolling Archives (FTP).</p>
Access conditions and pricing	<p>Access:</p> <ul style="list-style-type: none"> December 2004 – May 2007: through ESA agreement "AfriScan" (Tiger AO 2934). May 2007 – cont.: open access <p>Free of charge for non-commercial applications.</p>

Issues	Azimuthal striping artefacts along subswaths in some regions stemming from Antenna Pattern Correction in Level 1b processor.
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7.1.1.2 Gravity Recovery and Climate Experiment (GRACE) total water storage

Originating System	GRACE total water storage is based on gravity anomaly measurements from the GRACE satellite
Data class	Earth Observation
Sensor Type and key technical characteristics	More information on the GRACE monthly mass grids is provided by: <ul style="list-style-type: none"> • JPL.- GRACE MONTHLY MASS GRIDS – LAND [RD-32]; • Grace Product Specification Document [RD-33]
Data Availability and Coverage	2002-present monthly, Global
Source Data Name and Product Technical Specifications	The Technical Specifications of the GRACE Gravity Model is provided by the University of Texas [RD-34]
Data Quantity	~10 GB
Data Quality and Reliability	GRACE quality is related to the location and varies on average between 10 and 40 mm. Wahr et al., 2006 [RD-35]
Ordering and delivery mechanism	NASA GRACE Tellus FTP ftp://podaac-ftp.jpl.nasa.gov/allData/tellus/L3/land_mass/
Access conditions and pricing	Free available
Issues	Users need to be aware that the monthly grids have higher errors when the orbit is near exact repeat. Such months include July to December 2004. Another source of increasing error is lack of data in a particular month Since December 2010 the batteries on GRACE are failing causing limited coverage.

7.1.1.3 Global Precipitation Climatology Project (GPCP)

Originating System	The dataset product is produced by work being carried out by the Physical Sciences Division (PSD) of the NOAA Earth System Research Laboratory as part of the Global Precipitation Climatology Project (GPCP). It forms part of an international project of the WMO/WCRP/GEWEX designed to provide improved long-record estimates of precipitation over the globe. For further information see the GPCP home page is located at http://precip.gsfc.nasa.gov/
Data class	Comparison dataset to facilitate the AMSR-E Round-robin Exercise.
Sensor Type and key technical characteristics	<p>The dataset combines observations and satellite precipitation data into 2.5°x2.5° spatial resolution global grids. The Version 2 Data Set contains data from several contributing centers:</p> <ol style="list-style-type: none"> I. GPCP Polar Satellite Precipitation Data Centre - Emission (SSM/I emission estimates), II. F17 SSMIS: calibrating microwave data source to replace the F13 SSM/I (note this sensor failed in September 2009). III. GPCP Polar Satellite Precipitation Data Centre - Scattering (SSM/I scattering estimates), IV. GPCP Geostationary Satellite Precipitation Data Centre (GPI and OPI estimates and rain gauge analyses), V. NASA/GSFC Satellite Applications Office (TOVS estimates), and VI. GPCP Global Precipitation Climatology Centre (rain gauge analyses).
Data Availability and Coverage	<p>Temporal Coverage:</p> <p>Monthly values from January 1979 through to December 2010 [last reviewed 13th March, 2012]</p> <p>Spatial Coverage:</p> <p>2.5 degree latitude x 2.5 degree longitude global grid (144x72)</p> <p>88.75N - 88.75S, 1.25E - 358.75E</p>
Source Data Name and Product Technical Specifications	The <i>GPCP Version 2.2 Combined Precipitation Data Set</i> consists of monthly precipitation means derived from satellite and gauge measurements. Two final products are provided with the dataset:

	<ul style="list-style-type: none"> I. the combined satellite-gauge (SG) precipitation estimate II. the combined satellite-gauge precipitation error estimate <p>The unformatted binary files with ASCII headers are distributed by FTP download over the internet.</p> <p>File names take the form: “<i>gpcp_v2.2_esg.YYYY</i>”</p> <p>Dataset Format and Size: Unformatted binary files with ASCII headers are provided for both precipitation estimates and error estimates. Monthly estimates are available within each year file. Both precipitation estimate files and error estimate files for each year have a file-size of approximately 0.5MB.</p> <p>Note: Missing Data is flagged with a value of -99999.</p>
Data Quantity	<p>Each annual pair of files (Precipitation estimates + error estimates) occupies almost 1.0 MB. For the time-period in question (2007 to 2011) an estimated 5.0 MB of free disk space will be required.</p>
Data Quality and Reliability	<p>Quality and Confidence Estimates are provided with the data in the form of random error estimations, and bias error estimations. A detailed description on the error estimates given, and the algorithms used to derive them are available in Huffman & Bolvin (2011). It is worth noting that a comparison between Versions 2.1 and 2.2 of the datasets is also currently being developed.</p> <p>It is also worth noting that the GPCP Version 2.2 Data Set is currently considered a “provisional data set” because the GPCP Merge Development Centre (GMDC) has made temporary adjustments to the input datasets at several points to enable release of the entire dataset while the input dataset issues are resolved. Further details are provided in the “issues” section of this dataset description, and in Huffman & Bolvin (2011).</p> <p>For further information on data quality and reliability, see Adler et al. (2003), and Huffman & Bolvin, (2011).</p>
Ordering and delivery mechanism	<p>The archive and distribution sites for the GPCP Version 2.2 Combined Precipitation Data Set are:</p> <p>The World Data Center A Home Page http://lwf.ncdc.noaa.gov/oa/wmo/wdcamet-ncdc.html</p> <p>Contact: Mr. D. Smith - david.p.smith@noaa.gov</p>



	<p>The two final products are provided for download from the site along with Version 2.2 documentation and Version 2.2 Intermediate files.</p> <p>the combined satellite-gauge (SG) precipitation estimate</p> <p>Download at: http://ftp.ncdc.noaa.gov/pub/data/gpcp/gpcp-v2.2/psg</p> <p>the combined satellite-gauge precipitation error estimate</p> <p>Download at: http://ftp.ncdc.noaa.gov/pub/data/gpcp/gpcp-v2.2/esg</p>
<p>Access conditions and pricing</p>	<p>Data are freely available.</p> <p>The GPCP combined precipitation data were developed and computed by the NASA/Goddard Space Flight Center's Laboratory for Atmospheres as a contribution to the GEWEX Global Precipitation Climatology Project. In the event of using GPCP Precipitation data products from PSD, it is requested that the PSD be acknowledged. This may be done by including text such as <i>"GPCP Precipitation data provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their Web site at http://www.esrl.noaa.gov/psd/"</i> in any documents or publications using these data.</p> <p>PSD would also appreciate receiving a copy of the relevant publications to justify maintaining the GPCP dataset freely available online.</p>
<p>Issues</p>	<p>Some single-source data sets extend beyond the periods for which they're used in Version 2 in their original archival locations. The latter two are only posted for months in which they contribute to the final product.</p> <p>Since no single satellite data source spans the entire data record, the product draws upon many different sources covering different times within the entire data record. The periods of differing data coverage are:</p> <p>January 1979 – December 1985</p> <p>January 1986 – June 1987 (and December 1987)</p> <p>July 1987 – April 2005 (excluding December 1987)</p> <p>May 2005 – December 2008</p> <p>January 2009 – present.</p> <p>The GPCP Version 2.2 Data Set is currently considered a "provisional data set" because the GPCP Merge Development Centre (GMDC) has</p>



	<p>made temporary adjustments to the input datasets at several points to enable release of the entire dataset while the input dataset issues are resolved. This includes the months of GPCP Version 2.2 data involving F17 (January 2009 – present), NOAA F08 SSMI PR2 estimates (June 1990 – December 1991), and partially sampled months of F08 (July 1987, January 1988, and December 1991). The “provisional” label indicates that the developers believe the data for these months to be useful, but that users should exercise caution in cross-checking unexpected features. This is particularly the case for coasts, near-coastal ocean regions, islands, and small peninsulas, which are less likely to have the gauge coverage necessary to control possible biases in the provisional estimates. For further information see Huffman & Bolvin (2011)</p> <p>The dataset for 2011 has not yet been made available online.</p>
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7.1.1.4 NOAA CPC Morphing Technique ("CMORPH")

Originating System	The NOAA National Weather Service (“CMORPH” Global Precipitation Dataset)
Data class	Earth Observation.
Sensor Type and key technical characteristics	<p>Precipitation estimates derived from the passive microwaves aboard low orbiter satellite microwave observations exclusively (DMSP 13, 14 & 15 (SSM/I), the NOAA-15, 16, 17 & 18 (AMSU-B), and AMSR-E and TMI aboard NASA's Aqua and TRMM spacecraft) are integrated into a Global Precipitation Analysis using the CPC MORPHing technique.</p> <p>The technique is not a precipitation estimation algorithm but a means by which estimates from existing microwave rainfall algorithms can be combined. Therefore, this method is extremely flexible such that any precipitation estimates from any microwave satellite source can be incorporated.</p> <p>Detailed information can be found in Joyce et al., (2004), and through consulting the NOAA NWS CMORPH homepage (http://www.cpc.ncep.noaa.gov/products/janowiak/cmorph_description.html)</p>
Data Availability	Data is available with global coverage, and spanning the time period

and Coverage	from December 2002 to present at 3-hourly intervals.
Source Data Name and Product Technical Specifications	The “CMORPH” Global Precipitation Dataset is available as 3-hourly estimates, with a spatial resolution of 0.25°x0.25°, extending from 2002 to present.
Data Quantity	Approximately 3MB for each global data package (compressed) covering a 3-hourly interval. Approximately 45 MB uncompressed
Data Quality and Reliability	The CMORPH estimates have been validated using high quality rain gauge data over the United States and Australia and radar data over the United States. This indicated that CMORPH estimates perform better than mere composites of precipitation analyses and sometimes performs better than radar.
Ordering and delivery mechanism	The entire CMORPH record (December 2002 - present) for 3-hourly, 1/4 degree lat/long resolutions can be found at http://www.cpc.ncep.noaa.gov/products/janowiak/cmorph_description.html where one can link to an ftp-download site.
Access conditions and pricing	The data is freely available. Users must acknowledge the data providers, and product developers (NOAA National Weather Service, Joyce et al. 2004)
Issues	When precipitation forms and dissipates over a region between overpasses by a sensor contributing precipitation estimates, it will not be detected (Joyce et al., 2004).

7.1.2 *In-situ data sets*

7.1.2.1 *In-situ soil moisture ISMN*

Originating System	In situ soil moisture measurements provided mainly from Universities and regional and national organizations. Depending on the sites, there are different original data sets generated in 1952 (oldest) or to present.
Data class	Ground-based <i>in-situ</i> measurements data
Sensor Type and key technical	The sensor types most commonly used has changed over the time period of the ISMN:

characteristics	<ul style="list-style-type: none"> • TDR (Time Domain Reflectometry) • ML2x-Theta Probe (Impedance dielectric sensor) • Hydra Probe Analogue/Digital (Coaxial Impedance dielectric sensor: measurements of soil moisture, soil electrical conductivity and soil temperature) • EnviroSCAN (Capacitance sensor: measure soil moisture at different depths with the same profile probe) • Cosmic-ray Probe (Cosmic rays collide with soil and generate a big amount of fast neutrons, from which those escaped back into the air are counted by a detector. The observed count rate is related to water content because of hydrogen is the most effective element to absorb fast neutrons)
Data Availability and Coverage	<p>Some of the networks began their measurements in 1952, and nowadays there are around 20 networks providing data, five of which are now providing data in near real time. See Figure 2.</p> <p>The coverage varies from Alaska and Finland in northern hemisphere to Africa, Brazil and even Antarctica in southern hemisphere.</p>
Source Data Name and Product Technical Specifications	<p>The source is open due to the networks data sets are provided from different countries worldwide operated by different universities and national and regional organizations.</p> <p>Depending on the site and also the sensor used, the data set provided will be with different number of variables measured. All measure soil moisture and in addition some of them measure also soil temperature, snow water equivalent, snow depth, precipitation and/or air temperature.</p> <p>The original data sets received are in ASCII (.txt, .dat), but also in EXCEL (.xls) formats. The ISMN output format is in ASCII (.txt).</p>
Data Quantity	<p>The temporal resolution of the data sets is very diverse depending on the site: 20 min, 30 min, hourly, 6-hourly, 12-hourly, daily and weekly.</p> <ul style="list-style-type: none"> • Database volume: 28 networks, 835 stations, 16155 data sets. <p>57822 MB data volume of 1(+2) TB total capacity</p> <p>Download of all data sets takes ~ 8 hours. Multiple concurrent downloads significantly increase time per data set.</p>
Data Quality and	<p>Each site is responsible of the quality of its data. Nevertheless, after</p>



Reliability	processing the original data a Quality Control is performed with a data flagging system. See Dorigo, W.A., et al. (2011) [RD-36] for more information.
Ordering and delivery mechanism	Via Internet providing a compressed (.zip) file. http://www.ipf.tuwien.ac.at/insitu/index.php/download-instructions.html
Access conditions and pricing	Free with previous registration and for scientific use only. Neither onward distribution nor commercial use is permitted.
Issues	The CEOP standard output format will be discontinued in the near future switching to one of the other two available formats: 1) Variables stored in separate files (CEOP formatted) 2) Variables stored in separate files (Header+values)

7.1.2.2 In-situ temperature data (CPC ds512.0)

Originating System	About 8900 in situ stations that measure various meteorological parameters, most important for freeze/thaw validation is daily maximum and minimum air temperature.
Data class	Ground based in-situ measurements
Sensor Type and key technical characteristics	8900 stations distributed globally, sensor types are not known. Temporal resolution: daily
Data Availability and Coverage	Temporal coverage from 1979-01-01 to 2011-04-30 (ongoing updates). Periods of record can vary widely among the stations.
Source Data Name and Product Technical Specifications	CPC Global Summary of Day/Month Observations (ds512.0) Variable of interest: 24h maximum and minimum air temperature (RMAX,RMIN). Full details of all parameters available are provided by CPC. [RD-37]
Data Quantity	13.21 GBytes (Entire dataset) including all other parameters
Data Quality and Reliability	CPC extracts surface synoptic weather observations from the Global Telecommunications System (GTS) and performs limited automated validation of the parameters.[RD-38] Reliability:

	Lists where for each month more than 20 days had a observation of this dataset. [RD-39]
Ordering and delivery mechanism	Data are available after registration over Internet http://dss.ucar.edu/cgi-bin/dataaccess?dsnum=512.0
Access conditions and pricing	Freely accessible
Issues	If the maximum or minimum temperatures are not reported, they are estimated from reported air temperatures in the regular synoptic reports when sufficient data exist. [RD-40]

7.1.2.3 In-situ soil moisture (Regional)

Originating System	FMI Soil moisture network measurements
Data class	Soil moisture
Sensor Type and key technical characteristics	FMI Soil moisture stations in Northern Finland
Data Availability and Coverage	Point measurements in Northern Finland, covering typical forest areas, wetland areas and open areas.
Source Data Name and Product Technical Specifications	FMI Northern Finland Soil moisture network Variable: soil moisture profile, variable depths Variable: soil temperature profile, variable depths
Data Quantity	Recorded in 10 minutes interval (averaged over 10 minutes), ~100 MB/year
Data Quality and Reliability	
Ordering and delivery mechanism	Data partially available via Internet http://litdb.fmi.fi/database/ New experimental stations: data available upon request from FMI
Access conditions and pricing	Freely accessible
Issues	Data quality to be further confirmed

7.1.2.4 Frost tube measurements

Originating System	SYKE (Finnish Environment Institute) Frost tube network observations
Data class	Seasonal soil frost depth
Sensor Type and key technical characteristics	SYKE Frost tubes About 40 locations in Finland
Data Availability and Coverage	Point measurements, in each location typically one tube in forest one in wetland and one in open area.
Source Data Name and Product Technical Specifications	SYKE frost tube network: Variable: Soil frost depth and state Variable: Snowpack thickness
Data Quantity	Recorded manually usually three times per month. ~10 MB in ASCII format
Data Quality and Reliability	
Ordering and delivery mechanism	Data available via Internet http://www.p2.ymparisto.fi/scripts/palvelut.asp , service requires free registration, only available in Finnish
Access conditions and pricing	Freely accessible
Issues	

7.1.3 Regional model simulation

7.1.3.1 Variable Infiltration Capacity

Originating System	Variable Infiltration Capacity (VIC) Macroscale Hydrologic Model [RD-41]
Data class	Land Surface / Hydrological Model Data
Sensor Type and key	The Variable Infiltration Capacity model (VIC) developed by the

technical characteristics	<p>University of Washington, represents surface and subsurface hydrological processes through spatially distributed grid cells. The variable infiltration curve scales the maximum infiltration by a non-linear function of the fractional grid cell area to enable runoff calculations for sub grid-scales. The land surface of the grid cell is partitioned into different land cover classes and its subsurface is specified by using average soil characteristics for a number of vertical soil layers. Within each grid cell, the infiltration, evapotranspiration, vertical moisture drainage, surface runoff and baseflow as well as soil moisture, frost depth, thawing depth and soil temperatures at varying depths are computed for each land cover class. A separate routing model is used to transport lateral moisture fluxes to sub-basin outlets.</p>
Data Availability and Coverage	<p>Test area in Northern Finland</p> <p>Relevant Model Output to the Project Include:</p> <p>Grid Cell; Precipitation, Evaporation, Runoff, Baseflow, Relative humidity, Air temperature, Near surface wind speed, Fractional area of snow cover</p> <p>Sub-grid scale; canopy interception of liquid water, moisture content of each soil layer, evaporation from canopy storage, transpiration from the vegetation, evaporation from bare soil, sublimation from canopy interception, sublimation from ground snow pack, surface temperature, depth of the freezing front, depth of the thawing front, total soil moisture in each layer, fraction of total soil moisture in each layer, snow water equivalent in snow pack, depth of snow pack , snow interception storage in canopy</p> <p>Albedo of surface cover for each snow band</p>
Source Data Name and Product Technical Specifications	<p>Information on output data for Variable Infiltration Capacity (VIC) Macroscale Hydrologic Model [RD-42]</p>
Data Quantity	<p>~1 GB for test region in Northern Finland</p>
Data Quality and Reliability	<p>For further information please see Gao, H. Et al (2010)</p>
Ordering and	<p>-</p>



delivery mechanism	
Access conditions and pricing	Free – Open Source Code
Issues	Requires calibration and stream flow observation, soil frost tube observations and soil moisture observations for validation

7.1.4 Global model simulations and diagnosed datasets

7.1.4.1 Global Precipitation Climatology Centre

Originating System	Global Precipitation Climatology Centre
Data class	Data Reanalysis Product
Sensor Type and key technical characteristics	Conventional (rain) gauge-measurements are taken at climate monitoring stations around the globe. These station measurements are then used to compile the monthly gridded product. Data coverage per month varies from less than 10,000 to more than 45,000 gauge stations.
Data Availability and Coverage	Data is available covering the period 1901 to 2007 with near-global coverage (Antarctica and Greenland are not included due to a lack of station precipitation data).
Source Data Name and Product Technical Specifications	The GPCC Full Data Reanalysis Product is based on all available global gauge stations, near real-time and non real-time, held in the GPCC database supplying data for the individual month. This has been interpolated into a global gridded dataset of monthly precipitation sums for data from 1901 to 2007. These data are available in a spatial resolution of 0.5°x0.5°. The dataset is updated at irregular time intervals subsequent to significant data base improvements.
Data Quantity	Each download package covers a ten year period (decade) (e.g. 2001 to 2010) with a download file size of approximately 55 MB, and requiring approximately 1GB of free disc space.
Data Quality and Reliability	Prior to gridding, all available station-data are subjected to a multi-stage quality control of observed values as well as of station-meta data. Only station time series with a minimum of 90% data availability during the analysed period (1901 - 2007) are used for

	<p>interpolation by Ordinary Kriging (Krige, 1962) into the full data reanalysis product.</p> <p>Detailed quality information is available in Rudolf & Schneider (2005), [RD-43]</p>
Ordering and delivery mechanism	<p>The 50 year dataset (1901 - 2007) is downloadable from http://gpcc.dwd.de.</p>
Access conditions and pricing	<p>The gridded GPCC analysis products such as the VASClimO dataset, are freely available. All users are requested to refer to the GPCC and this http://gpcc.dwd.de website.</p>
Issues	<p>Antarctica and Greenland are not included because of a lack of precipitation station data.</p> <p>Users of the gauge-based gridded GPCC precipitation totals are recommended to take into account the station database (number of stations per grid) used for each GPCC analyses and to apply the correction factors for systematic gauge measuring errors.</p>

7.1.4.2 Global Land Data Assimilation System (GLDAS)

Originating System	<p>The forcing data set combines multiple data sets for the period of January 1, 1979 to present. (see [RD-44] for details)</p>
Data class	<p>Water and energy budget components, forcing data</p>
Sensor Type and key technical characteristics	<p>Spatial resolution: 0.25° and 1.0°</p> <p>Temporal resolution: 3-hourly or monthly</p>
Data Availability and Coverage	<p>1979/01/01 – cont. for 1.0° data</p> <p>2000/02/24 – cont. for 0.25° data</p> <p>180°W 60°S – 180°E 90°N</p>
Source Data Name and Product Technical Specifications	<p>Global Land Data Assimilation System:</p> <p>Variable: soil moisture (0-0.1, 0.1-0.4, 0.4-1.0, 1.0-2.0 m)</p> <p>Variable: surface temperature</p> <p>Variable: soil temperature (0-0.1, 0.1-0.4, 0.4-1.0, 1.0-2.0 m)</p> <p>A fuller description of GLDAS is given in Rodell, M. et al., (2004) [RD-</p>

	45]
Data Quantity	3-hourly data ~2.6 GB/year 1°x1° ~42 GB/year 0.25°x0.25° Monthly data ~9.6 MB/year 1°x1° ~153 MB/year 0.25°x0.25°
Data Quality and Reliability	Please see Rodell, M. et al.,(2004). The Global Land Data Assimilation System. [RD-45]
Ordering and delivery mechanism	Data are available via FTP over Internet ftp://hydro1.sci.gsfc.nasa.gov/data/s4pa/GLDAS_V1/
Access conditions and pricing	Freely accessible
Issues	<p>Dec 1, 2009. An input parameter error for the 3-hourly products for CLM, Mosaic and Noah models covering August 1-13, 2009 was corrected and republished in October, 2009. Users of these products delivered in September, 2009 are recommended to download the republished data.</p> <p>Dec 1, 2009. Due to uncertain data quality in the rainfall, pressure and humidity forcing data during mid 1995-1997, the soil moisture and other fields during this period are highly uncertain.</p>

7.1.4.3 Terrestrial water storage (TWS) changes

Originating System	Basin-scale water-balance estimates of TWS changes for large river basins derived from atmospheric reanalysis fields and observed runoff data
Data class	Diagnosed dataset
Sensor Type and key technical characteristics	Water-balance TWS changes calculated from convergence of vertically integrated water vapour flux, change in column storage of water vapour and river runoff
Data Availability and Coverage	River basin scale Maximum temporal coverage 1989-2008 (1979-2010 possible if

	updated), shorter for basins where river runoff in-situ data availability limited
Source Data Name and Product Technical Specifications	Basin-scale water-balance dataset
Data Quantity	5-20 kB per basin (total ~700 kB)
Data Quality and Reliability	Please see Mueller, B. et al., 2011. [RD-46].
Ordering and delivery mechanism	Data will be made available over Internet. Currently contact: brigitte.mueller@env.ethz.ch
Access conditions and pricing	On request/ freely accessible
Issues	

7.1.4.4 LandFlux-EVAL merged data set

Originating System	Combination of multiple datasets for the period 1989-1995, see LandFlux project web page [RD-47]
Data class	Land evapotranspiration
Sensor Type and key technical characteristics	Spatial resolution: 1° Temporal resolution: Monthly
Data Availability and Coverage	1989-1995, Global (without poles and deserts)
Source Data Name and Product Technical Specifications	LandFlux-EVAL dataset Combination of 7 diagnostic evapotranspiration datasets and evapotranspiration from 19 land-surface models and 5 atmospheric reanalyses
Data Quantity	Less than 1 MB per month
Data Quality and Reliability	Please see Mueller, B. et al., 2011,[RD-48] or Jimenez, C. et al.,2011, [RD-49]

Ordering and delivery mechanism	On request
Access conditions and pricing	On request
Issues	Will become available in July 2012

7.1.4.5 Global Soil Wetness Project (GSWP)

Originating System	Multi-model land surface analysis from several land-surface models, driven with a common forcing dataset
Data class	Land-surface models
Sensor Type and key technical characteristics	Forcing based on the ISLSCP-II regrided NCEP/DOE reanalysis, bias corrected with observed precipitation.
Data Availability and Coverage	1986-1995, Global
Source Data Name and Product Technical Specifications	Please see Global Soil Wetness Project GSWP [RD-50]
Data Quantity	Depends upon number of variables that are required from the dataset (50 to 100GB)
Data Quality and Reliability	Please see Dirmeyer, P. et al., 2006. [RD-51].
Ordering and delivery mechanism	DVD available from Center of Ocean-Land-Atmosphere Studies (COLA), see www.iges.org/gswp
Access conditions and pricing	Freely available
Issues	

7.1.4.6 WATCH-GWSP Model Intercomparison Project.WATERMIP

Originating System	Multi-model land surface analysis from several land-surface models,
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	driven with a common forcing dataset
Data class	Land-surface models
Sensor Type and key technical characteristics	WATCH forcing data. Naturalised runs and runs with interventions.
Data Availability and Coverage	1985-1999, Global
Source Data Name and Product Technical Specifications	Water Model Intercomparison Project
Data Quantity	~145 MB per variable
Data Quality and Reliability	Please see Gudmundsson, L. et al., 2011.[RD-52].
Ordering and delivery mechanism	FTP via Internet: www.eu-watch.org
Access conditions and pricing	Only for WATCH project partners
Issues	

7.2 Data for soil moisture retrieval

7.2.1 Global model simulation

7.2.1.1 ERA-Interim

Originating System	ERA-Interim uses mostly the sets of observations acquired for ERA-40, supplemented by data for later years from ECMWF's operational archive.
Data class	Gridded analyses, modelled data
Sensor Type and key technical characteristics	3-hourly surface parameters, describing weather as well as ocean-wave and land-surface conditions, and 6-hourly upper-air parameters covering the troposphere and stratosphere, as well as vertical integrals of atmospheric fluxes, monthly averages for many of the

	parameters, and other derived fields. [RD-53]
Data Availability and Coverage	1979 – cont., 180°W 90°S – 180°E 90°N
Source Data Name and Product Technical Specifications	ERA Interim Please see Dee, D.P. et al., 2011.[RD-54]
Data Quantity	Depends upon number of variables that are required from the dataset
Data Quality and Reliability	Please see Dee, D.P. et al., 2011.[RD-54]
Ordering and delivery mechanism	FTP via Internet http://data-portal.ecmwf.int/data/d/interim_full_daily
Access conditions and pricing	Free for research users. See ECWMF for Terms and conditions for commercial usage.
Issues	

7.3 Additional datasets

7.3.1 *Surface Soil Moisture (SSM) Advisory flags*

The following section describes datasets that are used to generate the advisory flags provided as additional information to the Surface Soil Moisture products derived from the active EO sensors. The advisory flags are not provided as part of the SSM datasets but only as datasets to support interpretation and analysis of the SSM products.

7.3.1.1 *SSM/I-SSMIS EASE-Grid Daily Global Ice Concentration and Snow Extent*

Originating System	Special Sensor Microwave Imager (SSM/I) and Special Sensor Microwave Imager/Sounder (SSMIS)
Data class	Earth observation
Sensor Type and key technical characteristics	The SSM/I is a seven-channel, four-frequency, orthogonally polarized, passive microwave radiometric system that measures atmospheric, ocean and terrain microwave brightness temperatures at 19.35, 22.2,

	37.0, and 85.5 GHz.
Data Availability and Coverage	1995/05/04 – cont., 180°W 90°S – 180°E 90°N
Source Data Name and Product Technical Specifications	SSM/I-SSMIS EASE-Grid Daily Global Ice Concentration and Snow Extent [RD-55]
Data Quantity	~800 MB/year
Data Quality and Reliability	See also [RD-55]
Ordering and delivery mechanism	Data are available via FTP over Internet http://nsidc.org/forms/nise.html
Access conditions and pricing	Freely accessible
Issues	

7.3.1.2 ERA-40

Originating System	ERA-40 is a re-analysis of meteorological observations produced by the European Centre for Medium-Range Weather Forecasts (ECMWF) in collaboration with many institutions. The observations used in ERA-40 were accumulated from many sources.
Data class	Gridded analyses, modelled data
Sensor Type and key technical characteristics	Spatial resolution: 0.5°/2.5° Temporal coverage: Daily (6 hourly) More information can be found in: Uppala, S.M. et al., 2005. [RD-56]
Data Availability and Coverage	SEP 1957 – AUG 2002, 180°W 90°S – 180°E 90°N
Source Data Name and Product Technical Specifications	ERA-40 Project Report Series[RD-57] Uppala, S.M. et al., 2005.[RD-56]
Data Quantity	~800 MB/year

Data Quality and Reliability	ERA 40 Performance [RD-58]
Ordering and delivery mechanism	Detailed information of how to order data can be obtained from the ECMWF Data Services. http://www.ecmwf.int/products/data/index.html
Access conditions and pricing	On request
Issues	

7.3.1.3 Global lakes and wetlands database (GLWD)

Originating System	See Table 1 in Lehner, B. & Döll, P., 2004. [RD-59]
Data class	GIS database
Sensor Type and key technical characteristics	<p>Organisation in three levels:</p> <p>Level 1 comprises the shoreline polygons of the 3067 largest lakes (surface area 50 km²) and 654 largest reservoirs (storage capacity 0.5 km³) worldwide, and offers extensive attribute data.</p> <p>Level 2 contains the shoreline polygons of approx. 250,000 smaller lakes, reservoirs and rivers (surface area 0.1 km²), excluding all water bodies of level 1</p> <p>Level 3 represents lakes, reservoirs, rivers, and different wetland types in the form of a global raster map at 30-second resolution, including all water bodies of levels 1 and 2.</p>
Data Availability and Coverage	Global (except Antarctica)
Source Data Name and Product Technical Specifications	GLWD http://www.worldwildlife.org/science/data/WWFBinaryitem8606.pdf
Data Quantity	~50 MB
Data Quality and Reliability	More information is provided in Lehner, B. & Döll, P., 2004. [RD-59].
Ordering and	Download from FTP



delivery mechanism	https://secure.worldwildlife.org/science/data/item1877.html
Access conditions and pricing	GLWD is available for non-commercial scientific, conservation, and educational purposes.
Issues	

7.3.1.4 GTOPO30

Originating System	GTOPO30 is based on data derived from 8 sources of elevation information, including vector and raster data sets (for details see [RD-60])
Data class	GIS database
Sensor Type and key technical characteristics	Digital Terrain Elevation Data (DTED) is a raster topographic data base with a horizontal grid spacing of 3-arc seconds (approximately 90 meters) produced by the National Imagery and Mapping Agency (NIMA) (formerly the Defense Mapping Agency).
Data Availability and Coverage	Global
Source Data Name and Product Technical Specifications	Please see [RD-60]
Data Quantity	~3 GB
Data Quality and Reliability	±650 m (Vertical) Details are provided in [RD-60]
Ordering and delivery mechanism	USGS FTP ftp://edcftp.cr.usgs.gov/data/gtopo30/
Access conditions and pricing	Free
Issues	

7.4 Vegetation data sets

7.4.1 NDVI

Originating System	A global, harmonised normalized difference vegetation index (NDVI) time series is available with the GIMMS (Global Inventory Modeling and Mapping Studies) data set [RD-61].
Data class	Earth observation
Sensor Type and key technical characteristics	Sensor: Advanced Very High Resolution Radiometer (AVHRR) instrument onboard the NOAA satellite series 7, 9, 11, 14, 16 and 17 Spatial resolution: 8 km × 8 km Temporal resolution: 15 days
Data Availability and Coverage	July 1981- December 2006 Global
Source Data Name and Product Technical Specifications	GIMMS (Global Inventory Modeling and Mapping Studies): Variable: Normalized Difference Vegetation Index (NDVI) Tucker, C.J., et al (2004), [RD-62]
Data Quantity	15 daily data ~20 MB/ global (unzipped) ~ 3,3 MB/global (zipped) Yearly ~90 MB/global (zipped, including flags for each date) Full archive (1981 – 2006) ~2,3 GB/global
Data Quality and Reliability	Tucker, C.J., et al (2004), [RD-62], Pinzon, J., et al., (2005), [RD-64], Tucker, C.J.,et al (2005), [RD-65].
Ordering and delivery mechanism	Data are available via FTP over Internet ftp://ftp.glc.f.umd.edu/glc/GIMMS/
Access conditions and pricing	Freely accessible
Issues	To date this dataset is only available for download until 2006.



	<p>However, a continuation of the time series at least until December 2011 is planned according to information from the producer and should be available by the time of the validation activities carried out in the soil moisture CCI [RD-66] If this is not the case alternatively the NDVI time series can be extended with SPOT VEGETATION based NDVI [RD-67] that is available until present for different continents. Another alternative is FEWS NET NDVI that originates from the NASA GIMMS group and is available until end of 2010 for the African continent [RD-68]. As these datasets are available at continental scale they would have to be merged to cover the globe. However, NDVI is a standard, freely available EO dataset that will be continued and produced at global scale.</p>
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7.4.2 Tree ring data bank

Originating System	International tree ring data bank (ITRDB)
Data class	In situ observation
Sensor Type and key technical characteristics	Please see International Tree-Ring Data Bank, NOAA Paleoclimatology Program, [RD-69]
Data Availability and Coverage	More than 6,000 data sets, including 2804 raw measurement files and 3275 tree-ring chronologies.
Source Data Name and Product Technical Specifications	For information on International Tree-Ring Data Bank, NOAA Paleoclimatology Program please see [RD-70] and [RD-69]
Data Quantity	~1 GB
Data Quality and Reliability	Tree-ring data submitted to the must meet certain requirements before assimilation into the holdings. First, each tree-ring chronology must have been developed from at least 10 trees. Second, the minimum length of the final chronology should be at least 100 years. Third, the ITRDB requests contributions of the original tree-ring measurements used to develop the final master chronologies. We make this request to ensure that original measurements are available in the future should new methods and techniques be developed.



	<p>Fourth, it is expected that the series have undergone intense scrutiny by the principal investigator to ensure all individual series are correctly crossdated, and that errors during measurement have been minimized. Finally, all necessary documentation must be delivered to the ITRDB (for example, all site data or information on publications that used the data) to ensure as much information is archived as possible. Under special circumstances, these requirements can be waived when samples are too few and scarce (as, for example, with archaeological tree-ring material), or when the data were developed for extremely detailed analyses (as, for example, in stem growth analyses).</p>
Ordering and delivery mechanism	<p>ftp portal http://www.ncdc.noaa.gov/paleo/treering.html</p>
Access conditions and pricing	<p>Free available</p>
Issues	<p>The available tree ring data is not equally distributed over the globe</p>



8 Discussion

Issues noted within the dataset description are briefly summarised in the following section.

8.1 Data Accessibility (Licensing):

Of the 38 datasets that are described in the DARD, (See **Error! Reference source not found.** in Annex: A) 27 are freely available without constraint for scientific research. Of the 9 other datasets 2 datasets (SMOS, SMAP) relate to systems, or datasets, that are not yet operationally available or fully considered, whilst information on two further datasets (CMORPH, GPCP) are not yet completed.

Three further datasets (ERA-40, Terrestrial water storage (TWS) changes, LandFlux-EVAL merged data set) require a request to be made to obtain data, which can be made by the project, and a further dataset (WATCH-GWSP) is available only to FP7 EU Watch project partners. MPI Meteorology, VUA, and Met Office Hadley Centre are partners within the Watch project, and data access will be pursued with these partners

The final outstanding dataset, ERS-2 SCAT high resolution, (ERS.ASPS20.H) requires ESA permission to be used within the project. TU Wien will follow up directly with ESA to seek appropriate permission.

8.2 Data Availability:

19 of the datasets are currently available within project partners. The availability of a further 11 datasets require confirmation (TMI, WindSat, AMSR-E, SSM/I, SMMR, GLDAS, CMORPH, SSM/I-SSMIS EASE-Grid Daily Global Ice Concentration and Snow Extent, GPCP, ERA-40, Tree Ring databank), but are likely to be already held by project partners.

Of the outstanding 6 datasets 5 relate to future missions, or missions only with quasi operational data provision, (SMOS L1B, SMOS L2, AMSR-2, SMAP, Aquarius), whilst the final dataset (ERS SCAT high resolution) requires a further reprocessing effort by ESA to complete.

8.3 Data Type and structure:

In order to facilitate access to the datasets further information should be included with the DARD relating to the data type and data structure of the datasets. This will be addressed along with any further revisions required by ESA to this draft document.



9 Conclusion

The data access requirements document (DARD) provides descriptions of all datasets required for the successful generation and validation of the Soil Moisture essential climate variable within ESA CCI project.

Based upon the summary of data accessibility and data availability presented in this DARD there are, compliant with the SoW [AD-2], no operational constraints to the production of the soil moisture ECV.



10 Reference Documents

The following section provides a list of references documents upon which this document is either based, or is required to be referenced by the reader in order to obtain the full information intended by the authors. Where relevant some parts of these reference document may have been included in this document in a verbatim fashion. These sections are noted by the use of pairs of single quotation marks " (inverted comma's), with the *verbatim text being detailed in italic font* and full attribution to the appropriate referral document.

- [RD-1] ESA Climate Change Initiative Phase 1, Statement of Work for Soil Moisture and Ice Sheets, European Space Agency, EOEP-STRI-EOPS-SW-11-0001.
- [RD-2] Technical Proposal (Part 3) in response to ESA Climate Change Initiative Phase 1 ESRIN/AO/1-6782/11/I-NB, Vienna University of Technology.
- [RD-3] Lecomte P., "ERS Wind product specifications", In Emerging Scatterometer Applications - from research to Operations: Proc, ESA/EUMETSAT Workshop, ESTEC, Noordwijk (NL), 5-7 October 1998 (November 1998), Guyenne T.D.(ED.) ESA SP-424 PP. 304 pgs http://earth.esa.int/pub/ESA_DOC/scatt_work98_product.pdf
- [RD-4] ESA, Earth Observation, Product Control Service, PCF cyclic performance reports: http://earth.eo.esa.int/pcs/ers/scatt/reports/pcs_cyclic/
- [RD-5] EUM/OPS/DOC/09/2481 ASCAT Level 1 Reprocessing Phase 1 — Dataset Description
- [RD-6] EUM/OPS/REP/09/3033 ASCAT Reprocessing Phase 1 — Validation Report
- [RD-7] EPS/MIS/SPE/97233 ASCAT Level 1 Product Format Specification
- [RD-8] EUM/EPS/SYS/SPE/990009 ASCAT Level 1 Product Generation Function Specification
- [RD-9] EUM/EPS/SYS/PLN/01/011 ASCAT Calibration and Validation Plan
- [RD-10] EUM/OPS/DOC/10/1296 ASCAT Factsheet
- [RD-11] EUM/MET/REP/08/0525 Metop-A ASCAT Commissioning Quality Report
- [RD-12] EUM/OPS/REP/11/2465 ASCAT 7.4.3 — Product Validation Report
- [RD-13] Njoku, E. 1996. *Nimbus-7 SMMR Pathfinder brightness temperatures*. Boulder, CO: National Snow and Ice Data Center
- [RD-14] Fu, C. C., D. Han, S. T. Kim, and P. Gloersen. 1988. *User's guide for the Nimbus-7 Scanning Multichannel Microwave Radiometer (SMMR) CELL-ALL tape*. NASA Reference Publication #1210, National Aeronautics and Space Administration, Washington, D.C.



- [RD-15] Njoku, E. G., B. Rague, And K. Flemming (1995): Nimbus-7 Scanning Multichannel Microwave Radiometer (SMMR): Brightness Temperature Data (SMMR Level 1B Pathfinder). JPL Publication xx, Jet Propulsion Laboratory, Pasadena, CA. 'User's Guide for the Scanning Multichannel Microwave Radiometer Instrument First Year Antenna Temperature Data Set', Systems & Applied Sciences Corporation, August 1982, NASA Contract NAS5-27393. 'Nimbus-7 SMMR Pathfinder Brightness Temperatures', NSIDC Dataset Guide Documentation.
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Annex: A. ECV SM DARD Table

Principle Purpose	Datasets described in DARD	Agency Producer	Satellite	Sensor	Period	Products	Data Licensing	CCI SM Contact	Issues
ECV Validation (Additional)	Global lakes and wetlands database (GLWD)	CESR	N/A	N/A	N/A	GIS database	Available for non-commercial scientific	TUW	
ECV Validation (Additional)	ERA-40	ECMWF	N/A	N/A	Sept 1957 to Aug 2002	Model Simulations	On request	TUW	
ECV Validation/RR Active	ERA-Interim	ECMWF	N/A	N/A	1979 to current (Feb 2012) and continuing		Free for research users	TUW	
ECV production	ERS SCAT (nominal resolution)	ESA	ERS-1, ERS-2	AMI-WS	05-08-1991 to 17-01-2001, 13-08-2003 to 28-01-2010	L1B - Nominal	Freely Available	TUW	Due to the loss of gyroscopes onboard of ERS-2 in January 2001, data from 2001/01/17 to 2003/08/13 is lost.
ECV production	ERS SCAT (high resolution)	ESA	ERS-2	AMI-WS	20-05-1997 to 17-02-2003	L1B-High Resolution	Available with ESA consent	TUW	Only part of the ERS-1 and ERS-2 archive is processed to nominal resolution
ECV production	ERS SCAT (high resolution)	ESA	ERS-2	AMI-WS	17-02-2003 to 07-2011	L1B-High Resolution		TUW	Complete processing of remaining ERS-2 archive is required

ECV production (Future)	SMOS	ESA	SMOS		Nov 2009 to current (Feb 2012) and continuing	L1C	Freely Available	VUA	Data is not continuously reprocessed
ECV production (Future)	SMOS	ESA	SMOS		Nov 2009 to current (Feb 2012) and continuing	L2	tbc	TUW	
ECV Validation	ASAR-IM	ESA	ENVISAT	ASAR	Dec 2004 to current (Feb 2012) and continuing	L1B	Freely Available for Non Commercial	TUW	Azimuthal striping artefacts along subswaths in some regions stemming from Antenna Pattern Correction in Level 1b processor.
ECV Validation	ASAR-GM	ESA	ENVISAT	ASAR	Dec 2004 to current (Feb 2012) and continuing	L1B	Freely Available for Non Commercial	TUW	Azimuthal striping artefacts along subswaths in some regions stemming from Antenna Pattern Correction in Level 1b processor.
ECV Validation	Terrestrial water storage (TWS) changes	ETH Zürich	N/A	N/A	1989 to 2010	Diagnosed Data	On request/ freely accessible	ETH Zürich	Data not available currently (Feb 2012) on-line, only via personal e-mail
ECV Validation	LandFlux-EVAL merged data set	ETH Zürich	N/A	N/A	1989 to 1995	Diagnosed Data	On request	ETH Zürich	Will become available July 2012
ECV production	ASCAT	EUMETSAT	METOP-A	ASCAT	01-01-2007 to current (Feb 2012) and continuing	L1B	Freely Available	TUW	new antenna gain patterns updated on 18 AUG 2011

ECV Validation (In Situ)	In-situ soil moisture (Regional)	FMI	N/A	N/A	2000-2008	In-Situ Soil Moisture Measurements	Freely Available	FMI	Data quality to be further confirmed
ECV Validation (In Situ)	Frost tube measurements	FMI	N/A	N/A		In-Situ Soil Frost Depth	Freely Available	FMI	
ECV Validation (Regional Model)	Variable Infiltration Capacity	FMI	N/A	N/A	1980-1993	Model Simulations	Freely Available	FMI	Requires calibration and stream flow observation, soil frost tube observations and soil moisture observations for validation
ECV Validation (In Situ)	Tree ring data bank	ITRDB	N/A	N/A			Freely Available	VUA	The available tree ring data is not equally distributed over the globe
ECV production (Future)	AMSR-2	JAXA	GCOM W	AMSR 2	Launch in 2012		Freely Available	VUA	Satellite is not launched
ECV production	NIMBUS 7 SMMR	NASA	NIMBUS 7	SMMR	Oct-1978 to Aug 1987	L1B	Freely Available	VUA	April to Oct 1986, high frequency of bad antenna counts, esp notable in 6.6 Ghz polarisation data
ECV production (Future)	SMAP	NASA	SMAP		Post 2014		tbc	VUA	Satellite is not launched
ECV production (Future)	Aquarius	NASA	Aquaris		June 2011 to current (Feb 2012) and continuing	L2	Freely Available	VUA	Data is not yet free available (reprocessing)

ECV Validation/RR Passive	Gravity Recovery and Climate Experiment (GRACE) total water storage	NASA	GRACE		Apr-2002 to current (Feb 2012) and continuing	L2	Freely Available	ETH Zürich	Users need to be aware that the monthly grids have higher errors when the orbit is near exact repeat. Such months include July to December 2004. Another source of increasing error is lack of data in a particular month. Since December 2010 the batteries on GRACE are failing causing limited coverage.
ECV Validation/RR Passive	Global Land Data Assimilation System	NASA	N/A	N/A	01-01-1979 to current (Feb 2012) and continuing	Model Simulations	Freely Available	TUW	Dec 1, 2009. Due to uncertain data quality in the rainfall, pressure and humidity forcing data during mid 1995-1997, the soil moisture and other fields during this period are highly uncertain.
ECV production	TRMM-TMI	NASA/JAXA	TRMM	TMI	Nov-1997 to current (Feb 2012) and continuing	L1B	Freely Available	VUA	Slight inconsistency in data resulting in two datasets (pre and post boost)
ECV production	Coriolis WindSat	NASA/JAXA	Coriolis	Windsat	Jan 2003 to current (Feb 2012) and continuing	L1	Freely Available	VUA	Data only available on hard drive
ECV production	AQUA AMSR-E	Naval Research Laboratory	AQUA	AMSR	June 2002 - Oct 2011	L2A	Freely Available	VUA	Versions older than V07 had significant geolocation problems

ECV Validation (In Situ)	In-situ temperature data (CPC ds512.0)	NCAR	N/A	N/A	01-01-1979 to 03-04-2011 (on going updates)	In-Situ Meterological Measurements	Freely Available for Non Commerical	TUW	If the maximum or minimum temperatures are not reported, they are estimated from reported air temperatures in the regular synoptic reports when sufficient data exist.
ECV production	DMSP SSM/I	NOAA	DMSP	SSM/I	Jun 1987 to current (Feb 2012) and continuing	L1	Freely Available	VUA	The data used here is based on a series of different satellites
ECV Validation/RR Passive	NOAA CPC Morphing Technique (CMORPH)	NOAA	DMSP 13 to 15, NOAA-15 to 18, Aqua and TRMM	SSM/I, AMSU-B, AMSR-E	2002 to current (Feb 2012) and continuing	L3	Freely Available		When precipitation forms and dissipates over a region between overpasses by a sensor contributing precipitation estimates, it will not be detected
ECV Validataion/RR Passive	NDVI	NOAA/GLCF	NOAA	AVHRR	July 1981 to Dec 2006	L3	Freely Available	GeoVille	To date this dataset is only available for download until 2006. However, a continuation of the time series at least until December 2011 is planned according to information from the producer and should be available by the time of the validation activities carried out in the soil moisture CCI
ECV Validation (Additional)	SSM/I-SSMIS EASE-Grid Daily Global Ice Concentration and Snow Extent	NSIDC	DMSP	SSM/I	04-05-1995 to current (Feb 2012)	L2	Freely Available	TUW	

					and continuing				
ECV Validation/RR Active	In-situ soil moisture ISMN	TU Wien	N/A	Various	1952 to current (Feb 2012) and continuing	In-Situ Soil Moisture Measurements	Freely Available - Scientific and non distribution	TUW	The CEOP standard output format will be discontinued in the near future
ECV Validation (Additional)	GTOPO30	USGS	N/A	N/A		GIS database	Freely Available	TUW	
ECV Validation	WATCH-GWSP Model Intercomparison Project.WATERMIP	WATERMIP	N/A	N/A	1985 to 1999	Land Surface Models	Available ONLY to WATCH project partners	ETH Zürich	Only for WATCH project partners (via VUA?)
ECV Validation/RR Passive	Global Precipitation Climatology Project (GPCP)	WCRP	N/A	N/A	1901 to 2007 (tbc)	Data Reanalysis Product	Freely Available	tbc	Antarctica and Greenland are not included because of a lack of precipitation station data. Take into account number of stations per grid
ECV Validation	Global Soil Wetness Project (GSWP)	WCRP	N/A	N/A	1986 to 1995	Diagnosed Data	Freely Available	ETH Zürich	

Table 2 Data Required for ECV soil moisture generation and validation. Data from ESA mission are noted in Blue, Data from third party missions are noted in grey, whilst ancillary data in noted in light green.