Soil Moisture “re-processing” activities

Presentation to

SCIRoCCO project team
ESA

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Outline

- Introduction to WARP and WARP NRT
  - Different processing approaches
  - SM product differences
  - Software evolution
- Current available ERS ESCAT SM products
  - Who are the users of the different products?
- Proposed “re-processing” plan
- Achievements since PM#1
- Outlook

WARP vs. WARP NRT

WAter Retrieval Package (WARP)
Near Real Time (NRT)

- Processing of L1 data archives
- Time-series based processing on a discrete global grid (DGG)
- Outputs
  - SM model parameter
  - SM time-series on DGG

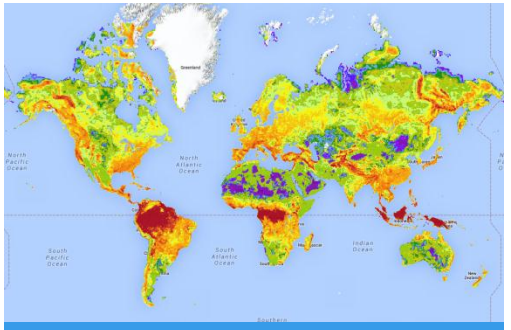
- Operational processing of L1 data
- Orbit based processing on swath grid
- Outputs
  - SM in orbit (swath grid)

WARP processing approach

Level 1 orbit product

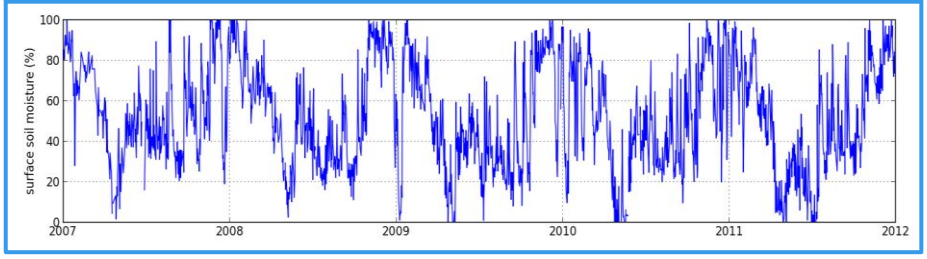
Resampling to DGG

5.5 WARP



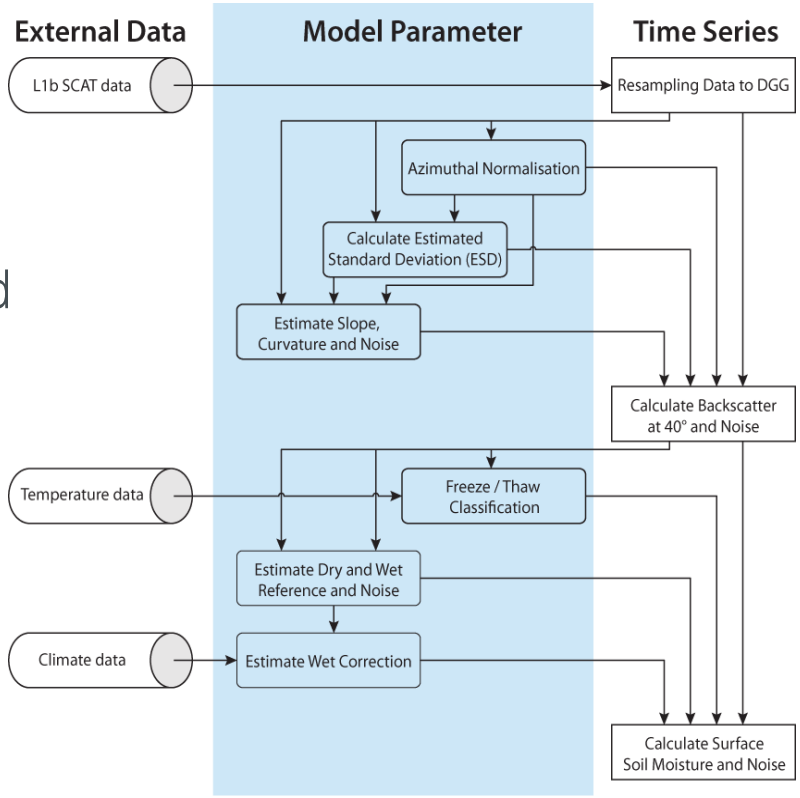
Model Parameter estimation

Soil moisture time-series



WARP processing steps

- Model Calibration
  - Estimation of Model Parameter
  - Time consuming task
- All operations are performed in the time-domain
- 9 processing steps required to retrieve SM



WARP algorithmic evolution

- WARP 5.0 (IDL, new implementation)
  - New definition of the **Discrete Global Grid (DGG)**
  - Spatial resampling using “Hamming-Window”
  - Initial implementation of **error modelling**
  - Experimental use of **MetOp ASCAT EPS data**
  - New/improved **Slope/Curvature** estimation
- WARP 5.1 (IDL)
  - Improvements related to error modelling
  - First tests between **ESCAT and ASCAT**

WARP algorithmic evolution

- WARP 5.2 (IDL)
  - Improved resampling (lookup-table, buffer handling with bugs removed)
  - Code entirely adopted to **ASCAT**
- WARP 5.3 (IDL)
  - Implementation of **freeze/thaw (F/T) thresholds** estimation
  - Calculation of **Surface State Flag (SSF)**
  - Improvements in **Dry- and Wet- Reference** calculation
  - Output of global binaries (WARP NRT)

WARP algorithmic evolution

- WARP 5.4 (IDL)
  - Generic I/O routines fully implemented (data-structure)
  - New cell-structure (partitioning) for DGG
  - New resampling step with different methods (Hamming Window, Inverse Distance Weighting, Lanzcos filtering)
  - ESCAT processing capability re-introduced partly
    - F/T thresholds and SSF missing
- WARP 5.5 (IDL, **latest version**)
  - Revisions/Changes in SSF processing
  - Capabilities of parallel processing
  - Sensor **intra- and inter-calibration** of ESCAT and ASCAT

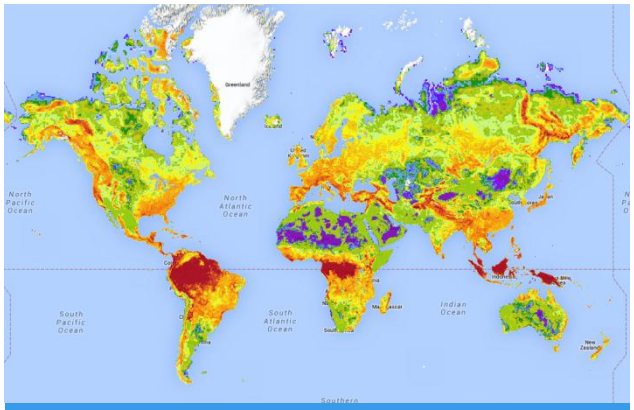
WARP algorithmic evolution

- WARP 6.0 (Python, planned version)
  - **Daily Slope/Curvature** estimation (ASCAT and ESCAT)
  - Improved Dry- Wet-Reference estimation (**Cross-over angle optimisation**)
  - Improved Wet-Correction
  - **NetCDF IO** instead of GenericIO
  - Revision of sensor intra- and inter-calibration
  - **Noise estimate** based on Kp-value
  - Complete **ESCAT and ASCAT** processing capability

WARP NRT processing approach

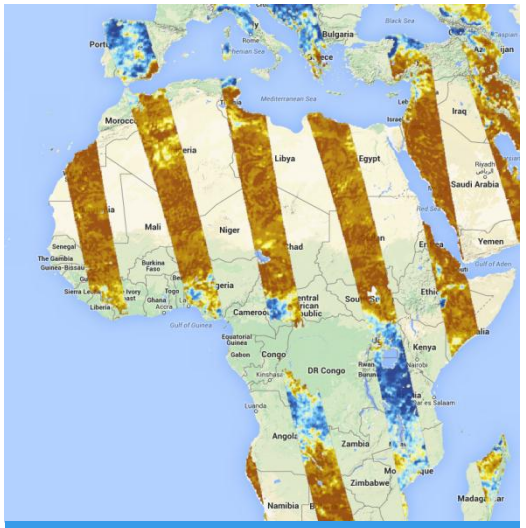
standalone and simplified implementation of TU-Wien SM model

Level 1 orbit product



WARP Model Parameter

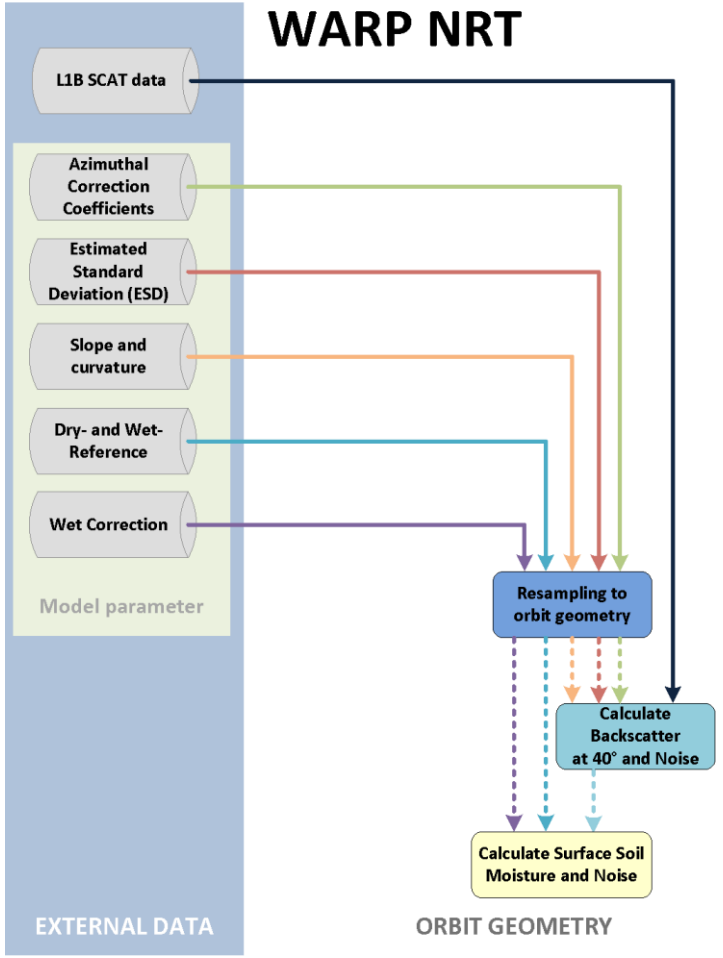
3.0 NRT WARP



Soil moisture in orbit (swath)

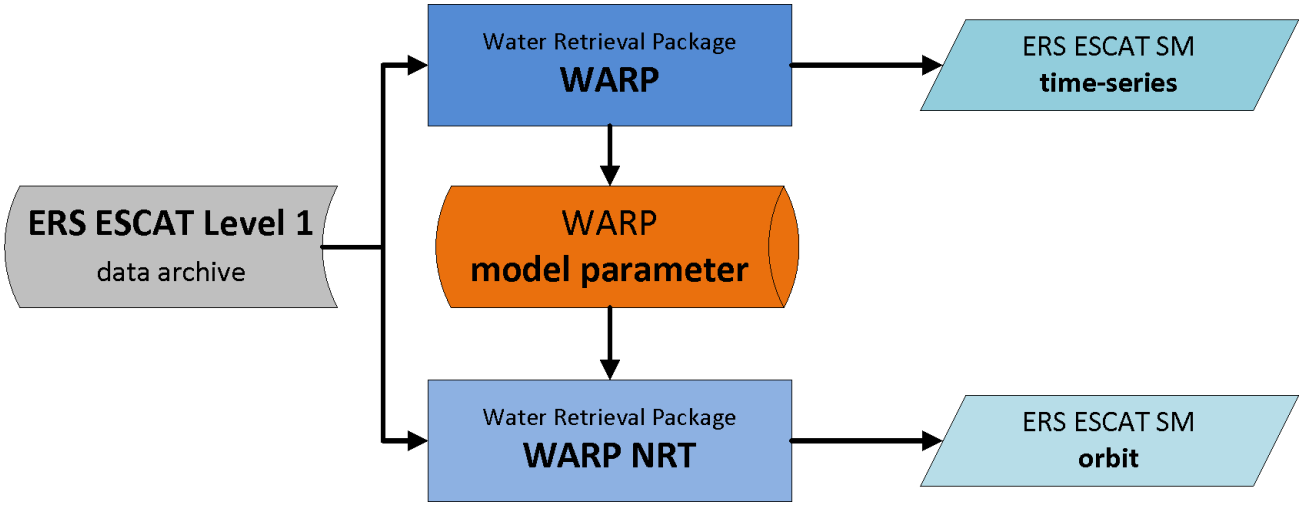
WARP NRT processing steps

- NRT processing take full advantage of pre-computed model parameters
- Model parameters are resampled to orbit (swath grid)
  - Fast computation of SM



From WARP to WARP NRT

- WARP and WARP NRT are individual software packages
  - Dependency because of required “model parameter”
  - Model parameter are related to the utilised WARP version



WARP NRT algorithmic evolution

- WARP NRT 1.0 and 1.1 (IDL and C++)
  - Initial implementation
  - **ERS-2 UWI data** handling
  - First tests with MetOp ASCAT EPS data
  - **WARP 4.0** model parameters
- WARP NRT 2.0 (C++, latest ASCAT version)
  - **Operational SM processor** @ EUMETSAT
  - Adaptions to **WARP 5** processing steps and model parameters
- WARP NRT 2.4 (IDL, latest ESCAT version)
  - IDL implementation of version 2.0
  - Adaptions to **WARP 5.4**
  - **ERS-2 ASPS_H** data handling

WARP NRT algorithmic evolution

- WARP 3.0 (Python, planned version)
  - **Processor encapsulated** from input data
    - Common interface for European scatterometer data (**ESCAT and ASCAT**)
  - **Adaptations** to **WARP 6.0** processing steps and model parameters
    - Noise estimate based on Kp-value
    - Integration of F/T threshold model parameters
    - Estimate of SSF, …
  - Sensor intra- and inter-calibration capabilities
  - Improved Processing Flags
  - Revised Advisory Flags
  - Standardised **NetCDF** Level 2 soil moisture product output

ERS soil moisture product releases

- 4 different products available
  - Time-series vs. Orbit products
  - Different processor versions (model parameters)
  - Various input data (formats) with different spatial resolutions
    - Temporal coverage (data gaps)
    - Data consistency

"re-processing" demanded

Product Name	Processor	Input data	Temporal Coverage	Spatial Coverage
ERS-1/2 ESCAT Soil Moisture Time-Series	WARP 5.0	ERS-1/2 WNF, UWI 50 km	1991-08-05 to 2007-05-31, data gap between 2001-01 and 2003-08	Global coverage until 2001, from 2003 onwards regional coverage
ERS-2 ESCAT ASPS_H Soil Moisture Time-Series	WARP 5.4	ERS-2 ASPS_H	1997-05-20 to 2003-02-17	Global coverage
ERS-2 ESCAT ASPS_H Soil Moisture	WARP NRT 2.4	ERS-2 ASPS_H	1997-05-20 to 2003-02-17	Global coverage
ERS-1/2 ESCAT Soil Moisture Time-Series	WARP 5.5	ERS-1/2 WNF, UWI 50 km	1991-08-05 to 2007-05-31, data gap between 2001-01 and 2003-08	Global coverage until 2001, from 2003 onwards regional coverage

Products in use

- Who are (will be) the users of the different products?
  - **Orbit product** (operational product, close as possible to L1 measurements)
    - Meteorological Offices
      - ECMWF
      - Met Office (UK)
      - Météo France
      - ZAMG (Austria)
      - …
  - **Time-series product** (research product)
    - Universities
    - Other research institutions
      - Climate change research

ESA CCI SM project requires consistent ERS-1/2 ESCAT SM

Contribution from SCIRoCCo

“Re-processing” activities

- Re-processing activity plan outlined in a Technical Note
- Proposed activities were split in two phases
  - **Phase 1:**
    - **“Completion of ERS-2 ESCAT ASPS data archive”**
    - Extend ERS-2 ESCAT **ASPS_H** SM orbit product
    - Creation of ERS-2 ESCAT **ASPS_N** SM orbit product (**WARP 5.4 and WARP NRT 2.4**)
  - **Phase 2:**
    - **“Generation of the most complete and consistent ERS-1/2 ESCAT products”**
      - ASPS_H and ASPS_N
    - Incorporating all achieved SM-model improvements
    - Set of model parameters based on ERS-1/2

Phase 1 (revision request)

- Products generated within Phase 1
  - Products become **obsolete** after a few month
  - Improved products will be released in Phase 2
- **Request for revision of "Phase 1"**
  - Neglect product generation within Phase1
  - Use freed resources for
    - proper implementation / documentation of WARP NRT 3.0
      - Implementation tests
      - Output verification (WARP NRT 2.4 vs. 3.0)
      - Product validation (QC)
    - Concentrate on algorithmic improvements demanded in Phase 2

Achievements since PM#1

- Transition from IDL to Python
  - **ASPS reader** implemented in Python
  - **NetCDF** reader/writer for orbit data
  - **WARP** processor ported to Python
    - Python vs IDL processor (WARP 5.5)
      - First implementation tests of proc. steps were successful
      - Output verification indicates insignificant differences
  - **WARP NRT** processor ported to Python (package)
    - Processor encapsulated from input data
    - Resampling different to IDL version (Kd-tree) [pyresample]
    - Interface to run processor with ESCAT and ASCAT data (70%)

Outlook

- Phase 1 “re-processing” products required ?
  - If yes, delivery of data (ASPS_H/N) end of August 2015?
- Phase 2 outlook (timeframe end of 2015)
  - WARP NRT 3.0
    - Implementation tests
    - Output verification (WARP NRT 2.4 vs. 3.0)
    - Adaptations of NetCDF writer (identical format for ESCAT and ASCAT)
  - WARP NRT 3.0 improvements
    - Surface State Flag from F/T-thresholds
    - Improved error characterisation using Kp-value
  - First validation study

Questions or Comments