VIENNA UNIVERSITY OF TECHNOLOGY

INSTITUTE OF PHOTOGRAMMETRY AND REMOTE SENSING

Global Land Surface Hydrology Monitoring using Sentinel-1: Opportunities and Challenges

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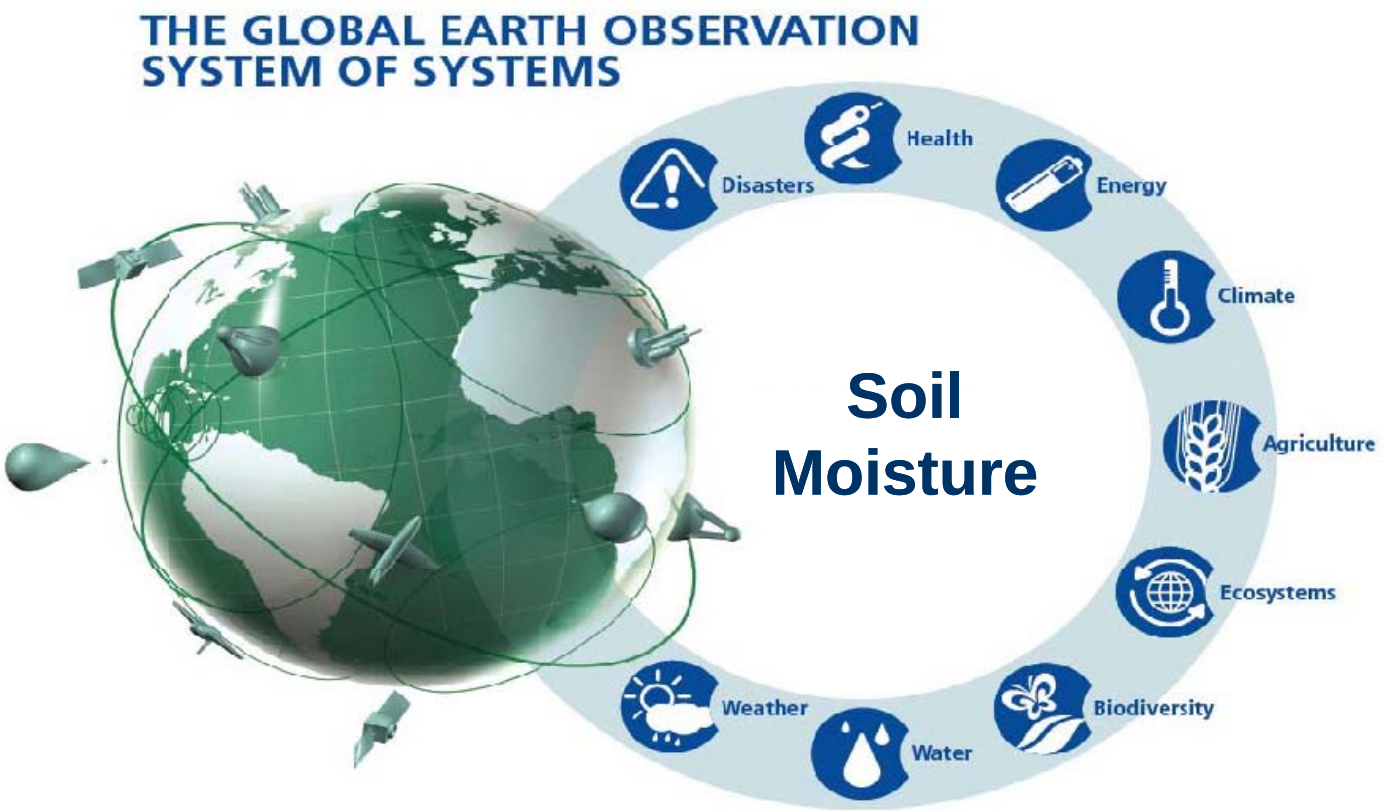
Need for Soil Moisture

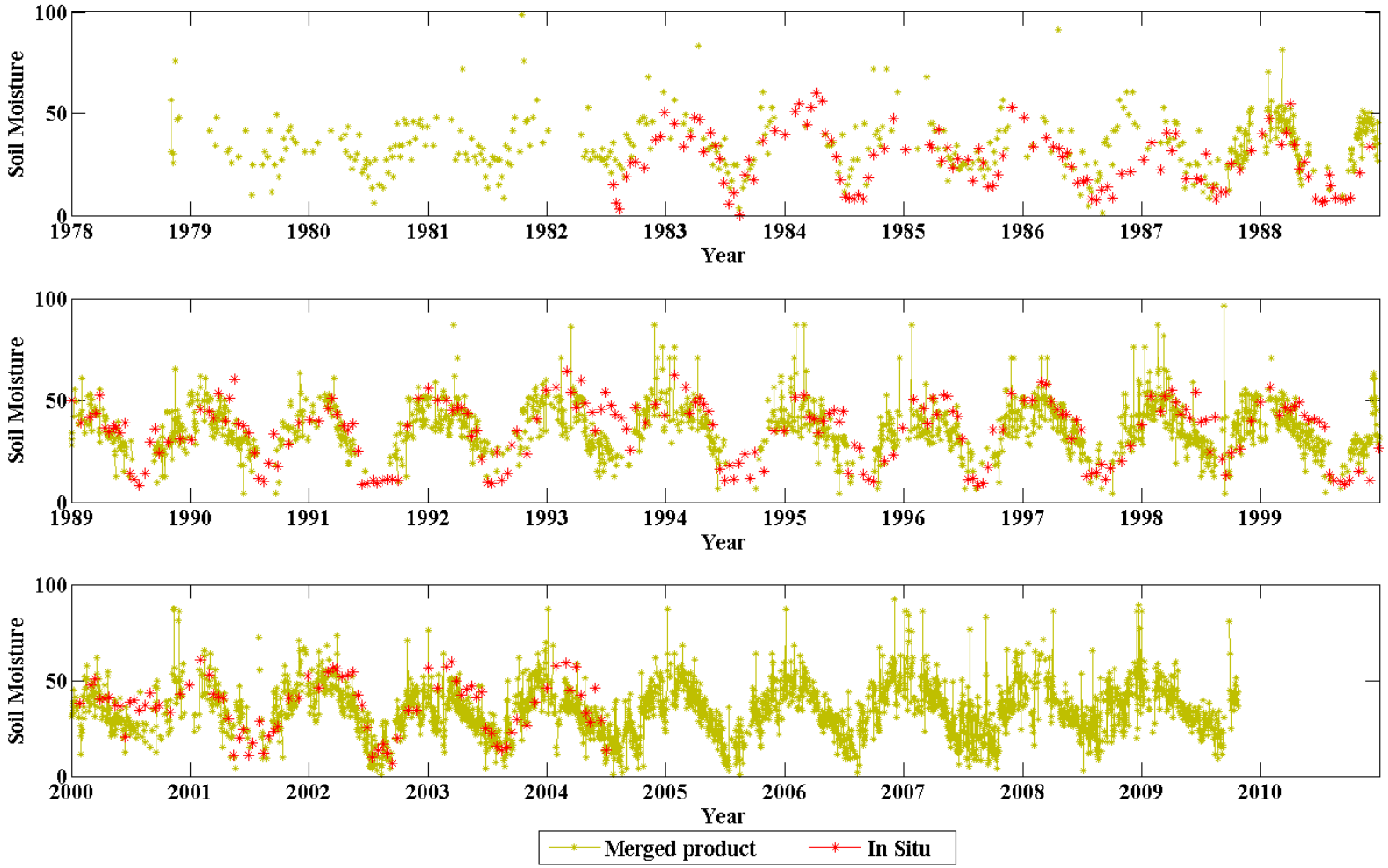
- Soil moisture is needed by all GEO Social Benefit Areas and was ranked the second top priority parameter (behind precipitation) in a year 2010 GEO report on „Critical Earth Observation Priorities“



Soil Moisture Monitoring using Radars

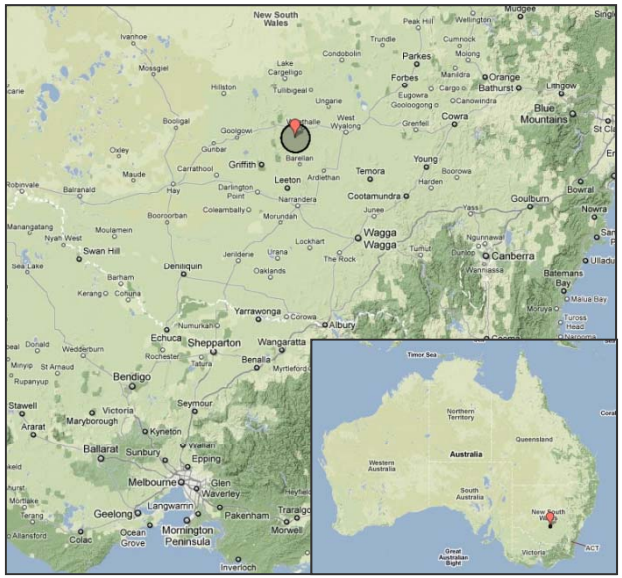
- Scatterometers (25-50 km)
  - Near-real-time METOP ASCAT surface soil moisture product fully operational since 2008
  - Positive impact of ERS SCAT and ASCAT data has already been demonstrated in some application areas
    - NWP, hydrology, epidemiology, …
  - Convergence with passive sensors (AMSR-E, SMOS, …)
- SAR (10-100 m)
  - Most intensively investigated radar mode but progress limited due to the difficulties of modelling roughness and vegetation at this scale
- ScanSAR (0.1-1 km)
  - ENVISAT ASAR Wide Swath and Global Monitoring modes have serves as test bed for pre-operational demonstration
  - Validation and application developments are advancing well, but problems due to limited coverage and high noise

Merged Active-Passive Soil Moisture Time Series



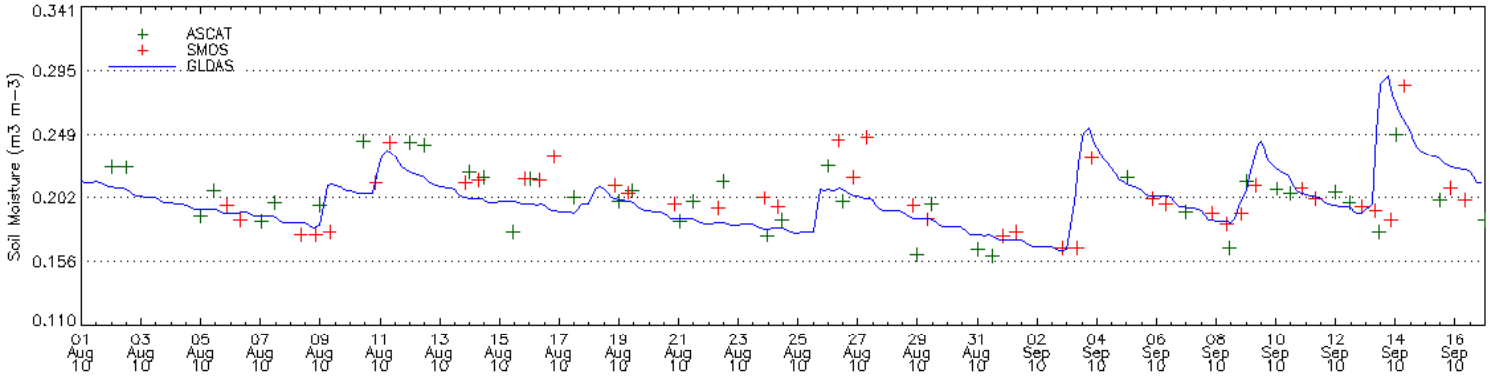
Illinois Climate Record

SMOS & ASCAT Timeseries

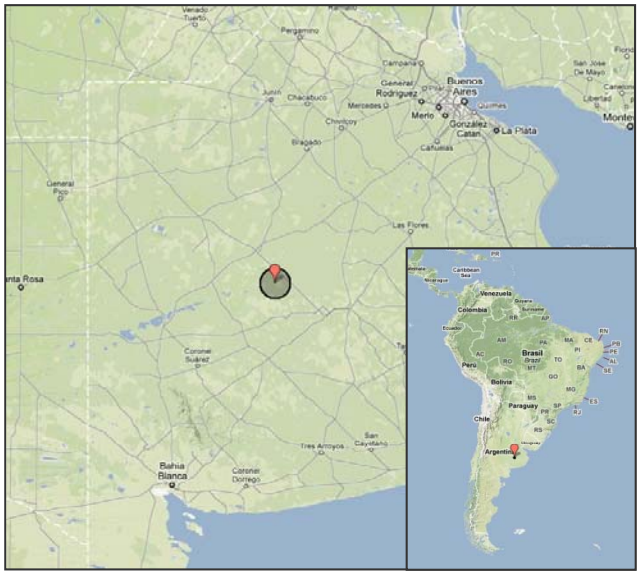


Southwest Australia
Latitude: -33.9897 °
Longitude: 146.516 °
GPI: 1821007

	ASCAT/ GLDAS	SMOS/ GLDAS	ASCAT/ SMOS
R (Pearson)	0.43	0.46	0.33
R (Spearman)	0.62	0.50	0.37
RMSE (m^3 m^-3)	0.024	0.025	0.045

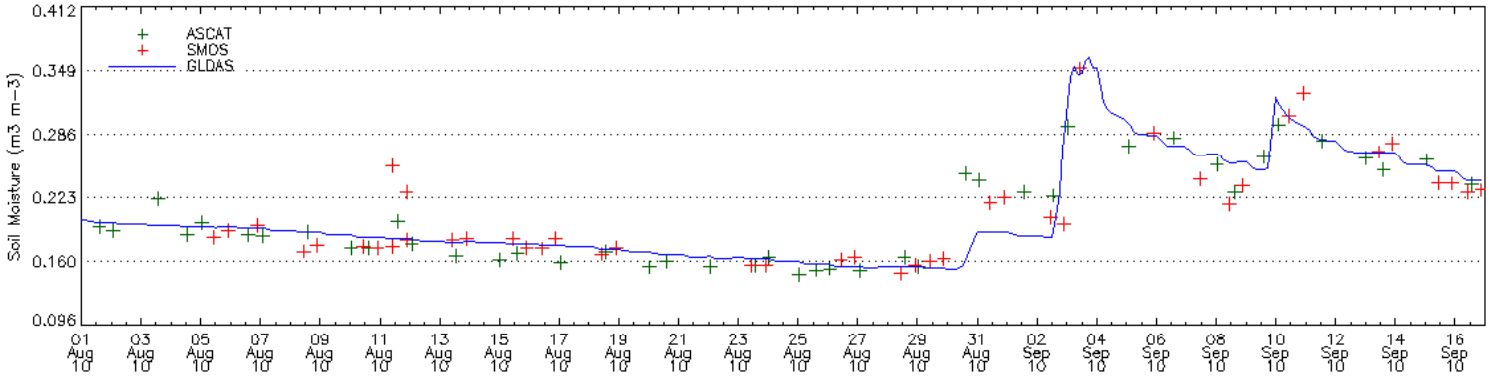


SMOS & ASCAT Time Series



Argentina
Latitude: -36.581 °
Longitude: -60.895 °
GPI: 1939010

	ASCAT/ GLDAS	SMOS/ GLDAS	ASCAT/ SMOS
R (Pearson)	0.90	0.90	0.82
R (Spearman)	0.88	0.89	0.87
RMSE (m^3 m^-3)	0.020	0.020	0.078



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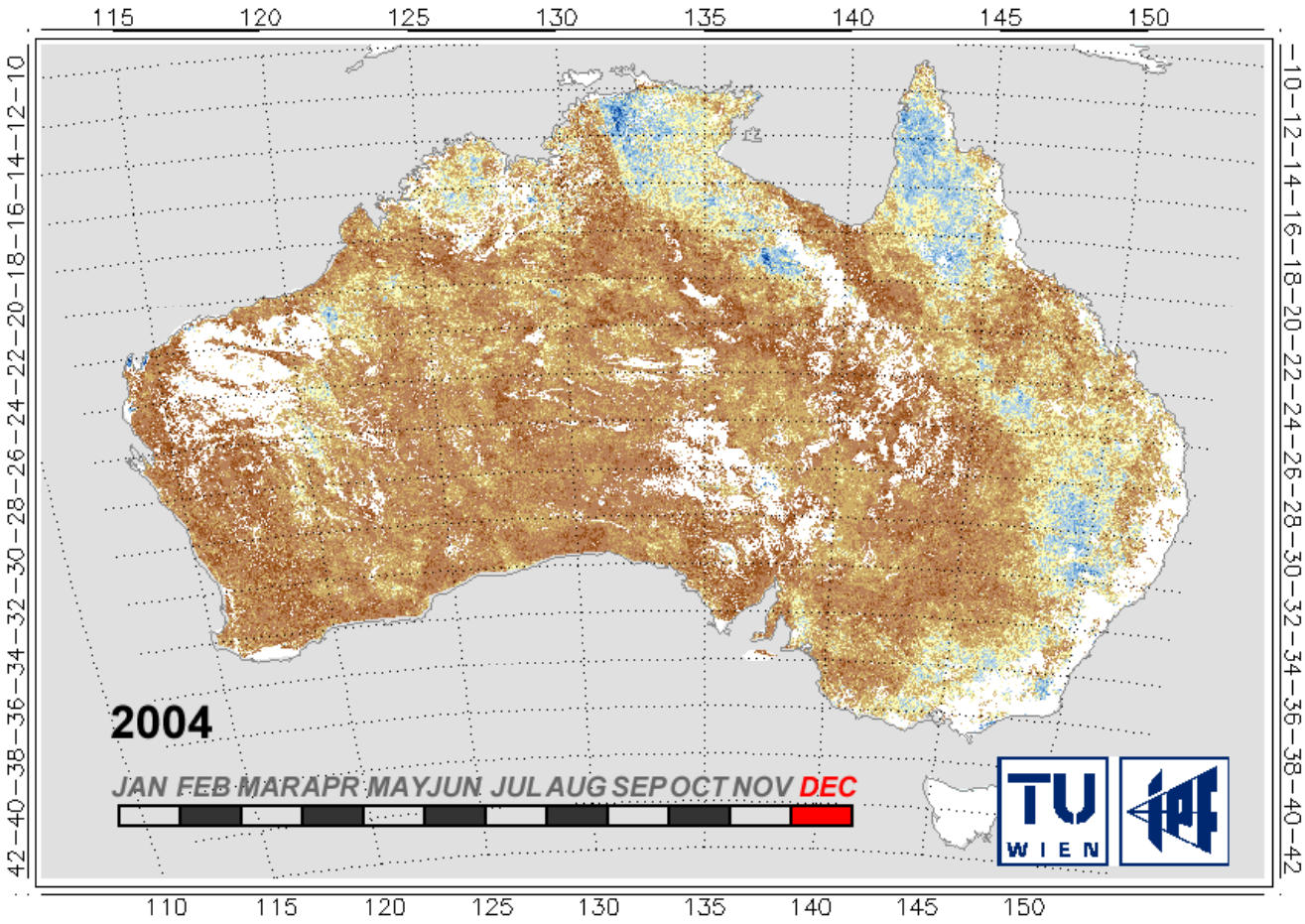
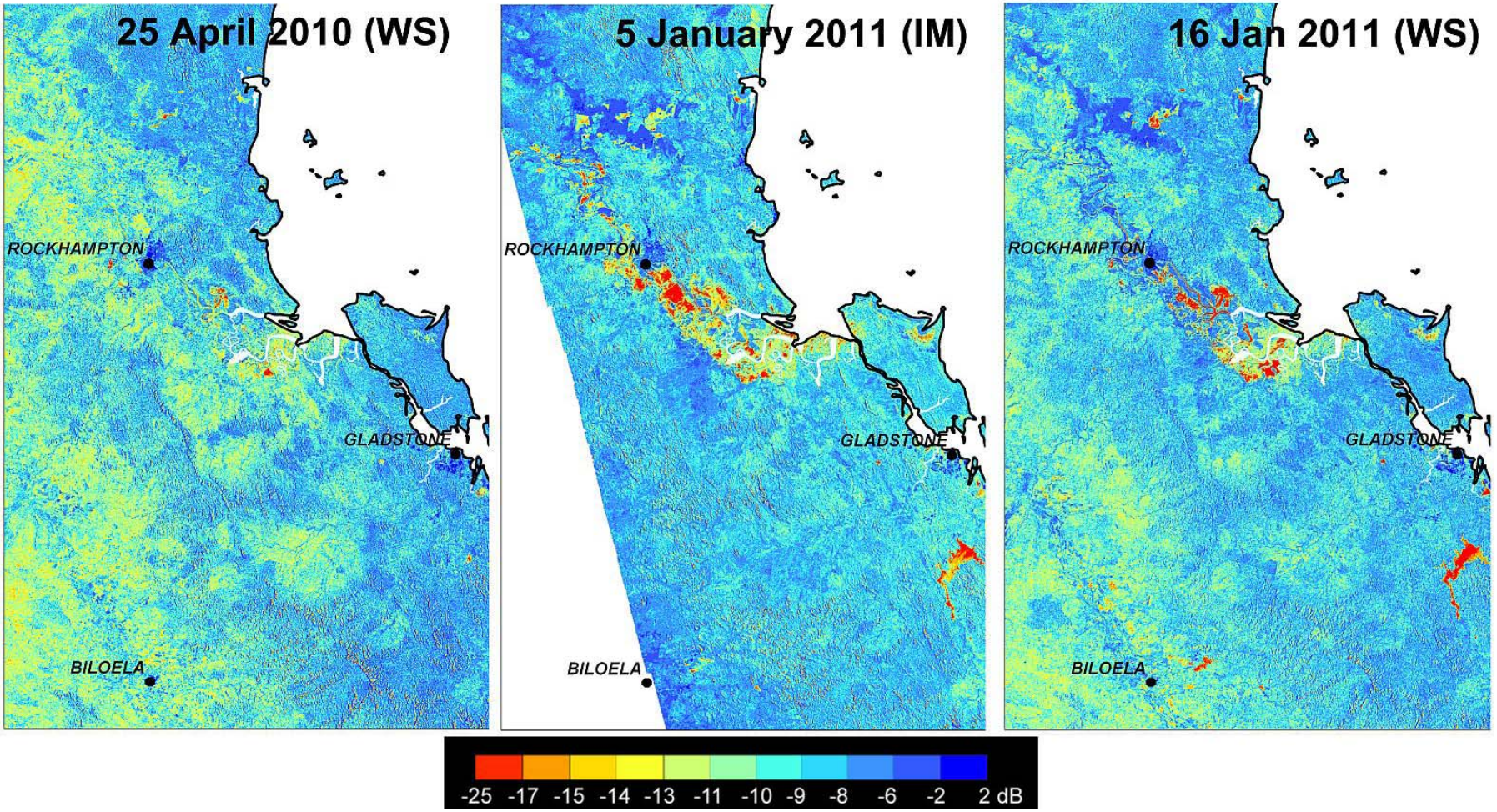
ENVISAT ASAR Soil Moisture



Flood in Queensland, Australia, January 2011



ENVISAT Advanced Synthetic Aperture (ASAR) Wide Swath mode (150 m) (ESA SHARE Project)

Potential of Sentinel-1

- With two satellites and a fixed acquisition scenario (IWS mode in HH or VV polarisation over land) Sentinel-1 can overcome all shortcomings of ENVISAT ASAR mode!
  - Europe coverage within 4-6 days
  - Global coverage within 12 days

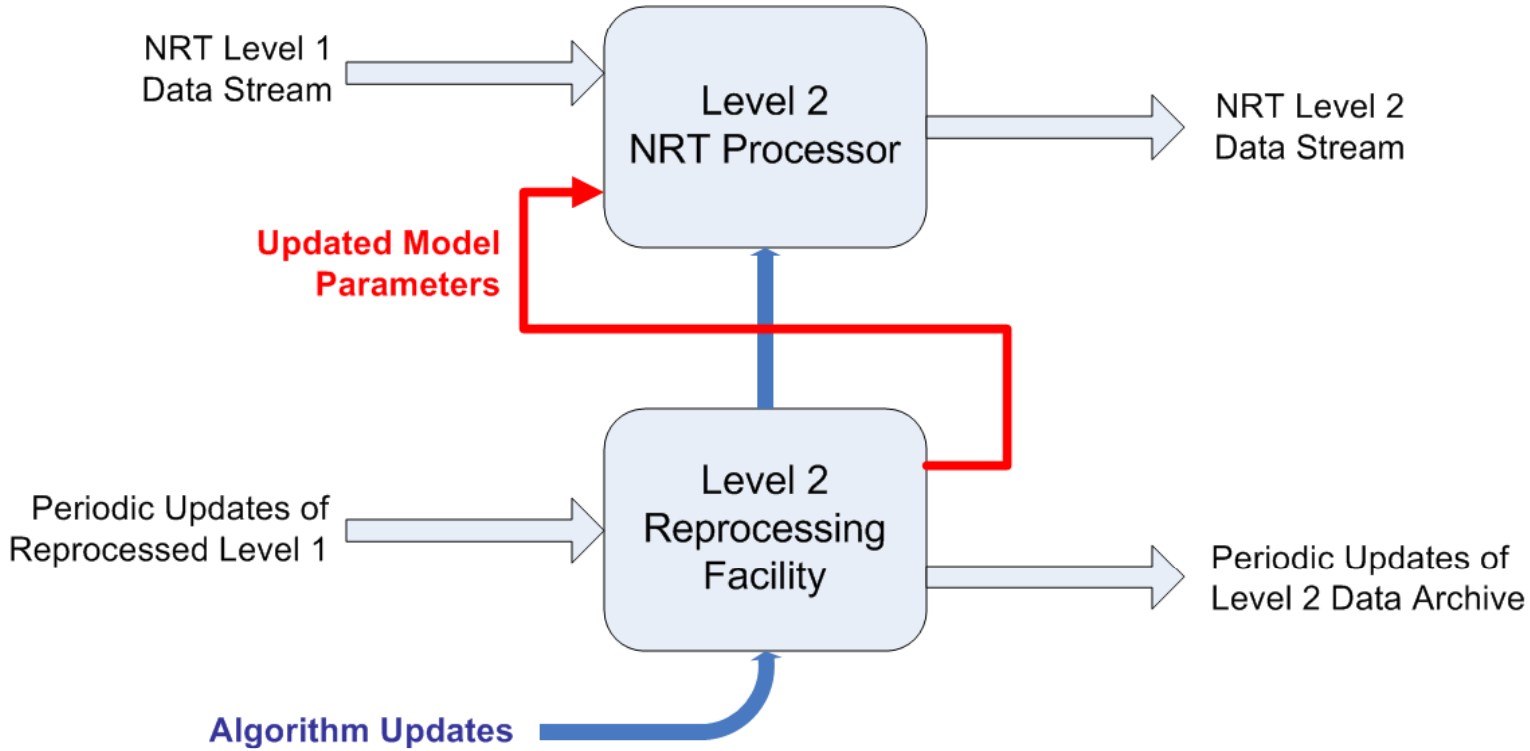
True Monitoring Concept!

- Fully-automatic near-real-time land hydrology service
  - Soil moisture at 1 km
  - Freeze/thaw at 1km
  - Water bodies at 20-50 m

- Why soil moisture at 1 km?
  - Validity of change detection algorithm
  - Keep data volume within limits

Implementation

- Some models are better than others, but essentially “all models are wrong” → Need for Level 2 model calibration strategy & close coupling between processor and reprocessing facility



Good Reasons for Getting Prepared

- The potential of Sentinel-1 to be used for global land hydrology monitoring is significant
  - Only NASA‘s Soil Moisture Active Passive (SMAP) mission offers a comparable spatio-temporal coverage
- But the Sentinel-1 data volume is unprecedented
  - Level 0 + Level 1
    - ~1 Terabyte each day
    - ~8 Petabyte for complete mission
  - For each Level 2/3 product the comparable data volume must be expected
  - For complete service several tens of Petabyte are needed
    - Reprocessing needs to be done on a regular basis with sufficient speed
- No processing facility exists yet in Europe to cope with this data volume and processing requirements
  - Does Moore’s law still hold considering energy demand and costs?