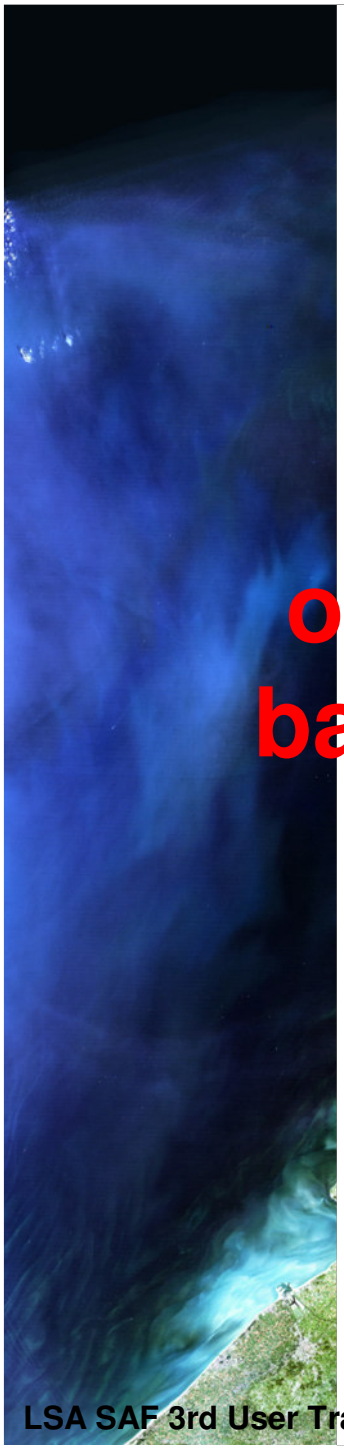


NEO

For earth observation

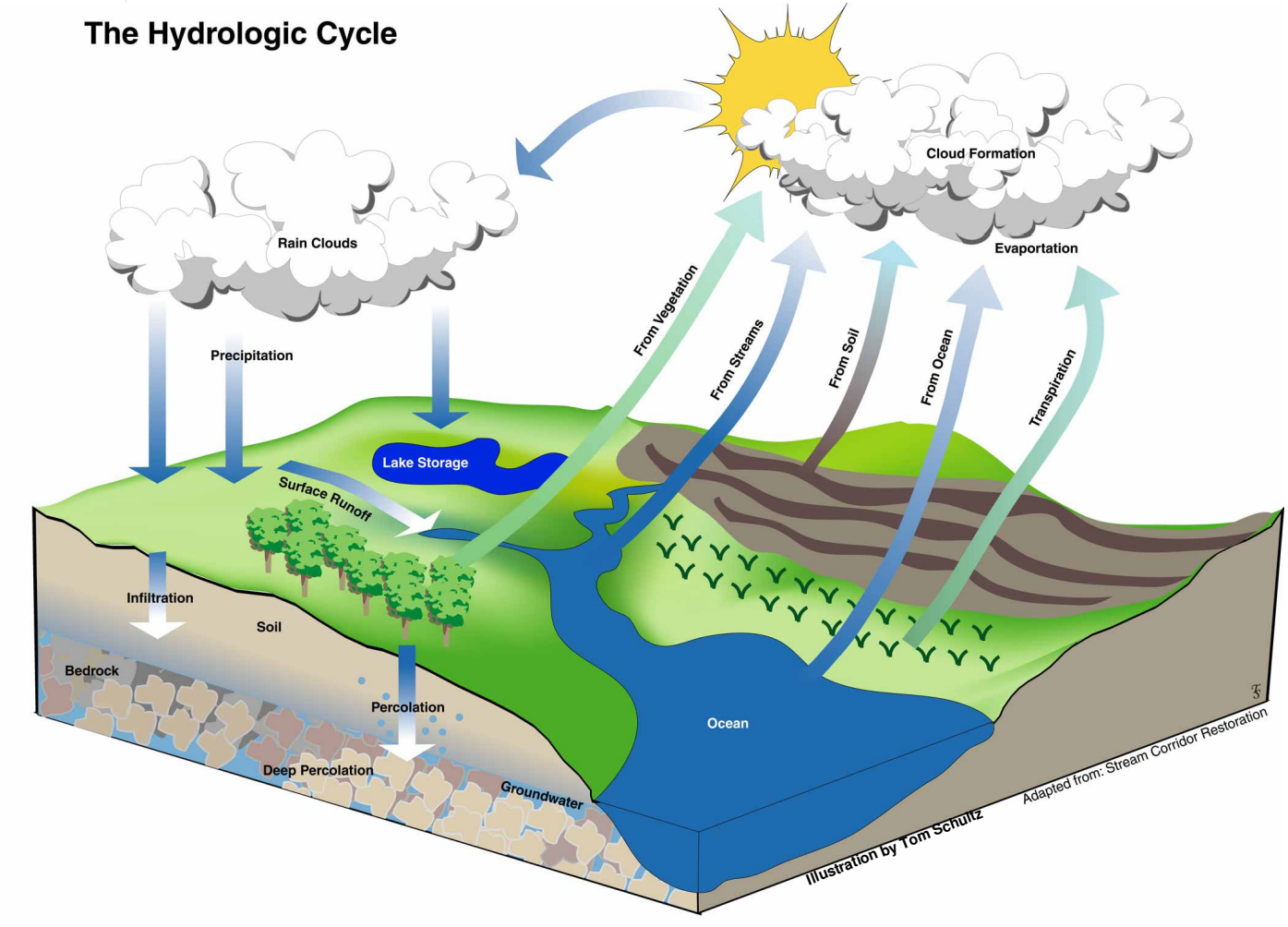
Profile soil moisture, an operational level 4 product based on the MetOp/Ascat's surface soil moisture

Remko de Lange

Presentation overview :

1. Why soil moisture?
2. EUMETSAT surface soil moisture (< 5 cm)
3. DRYMON profile soil moisture (~ 100 cm)
4. Applications
5. Conclusions

1. Why soil moisture?

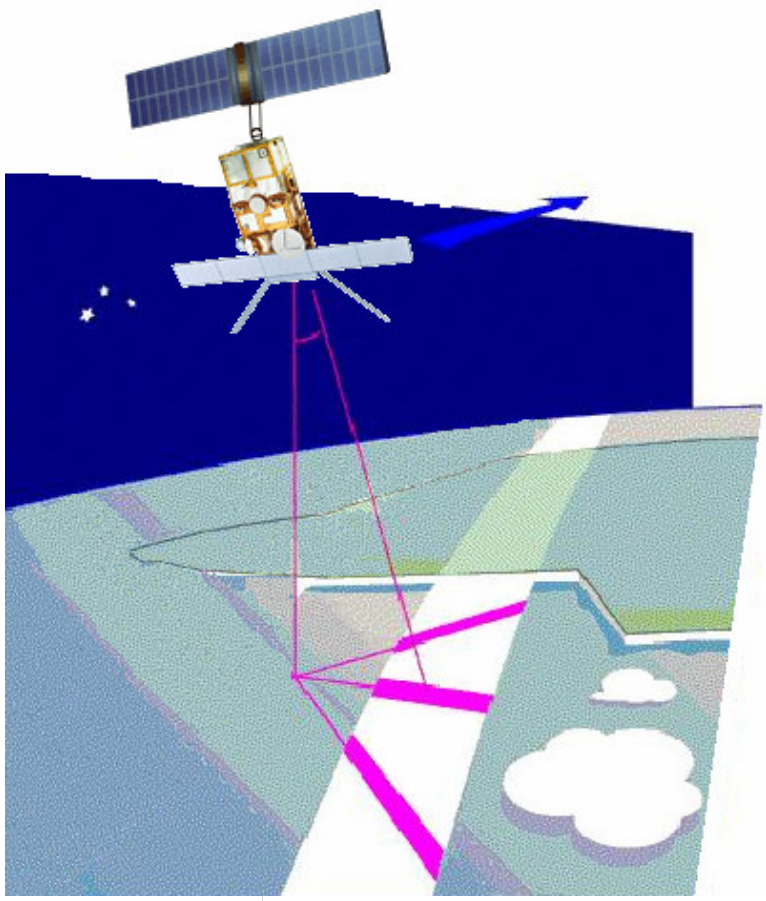


1. Why soil moisture?

Meteorological Drought → Soil water Drought → Hydrological Drought

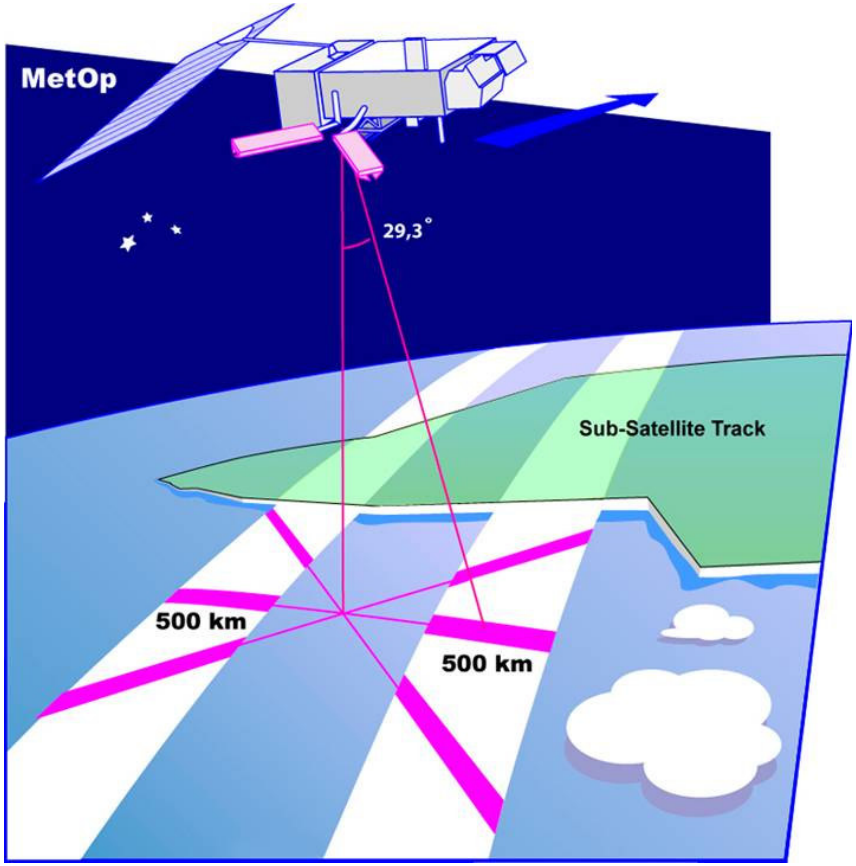
2. EUMETSAT surface soil moisture

- ERS-1: 1991 - 1996
- ERS-2: 1995 – 2007...



- Resolution 50 / (25) km
- Daily coverage: ~ 40% ...

- MetOp: 2006 - 2020



- Resolution 25 km
- Daily coverage: ~ 80%

2. EUMETSAT surface soil moisture

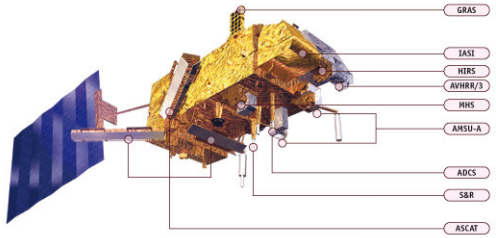
METOP/ASCAT: C-band radar
(weather & sun radiation independent)

Backscatter influenced by :

- topography (diffuse/specular scattering)
- vegetation (volume scattering)
- water (specular scattering)

Backscattering from the upper few centimeters

No soil moisture detection: rain forest, desert, snow, mountains

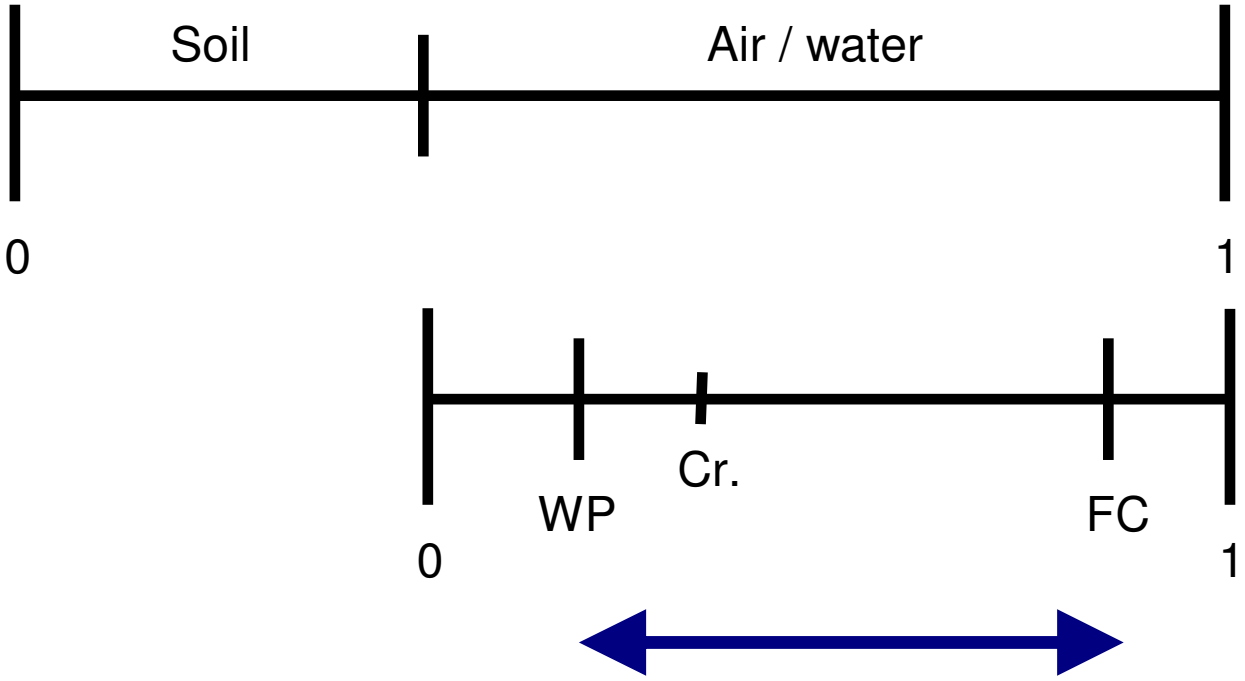


Top soil moisture from scatterometer data:

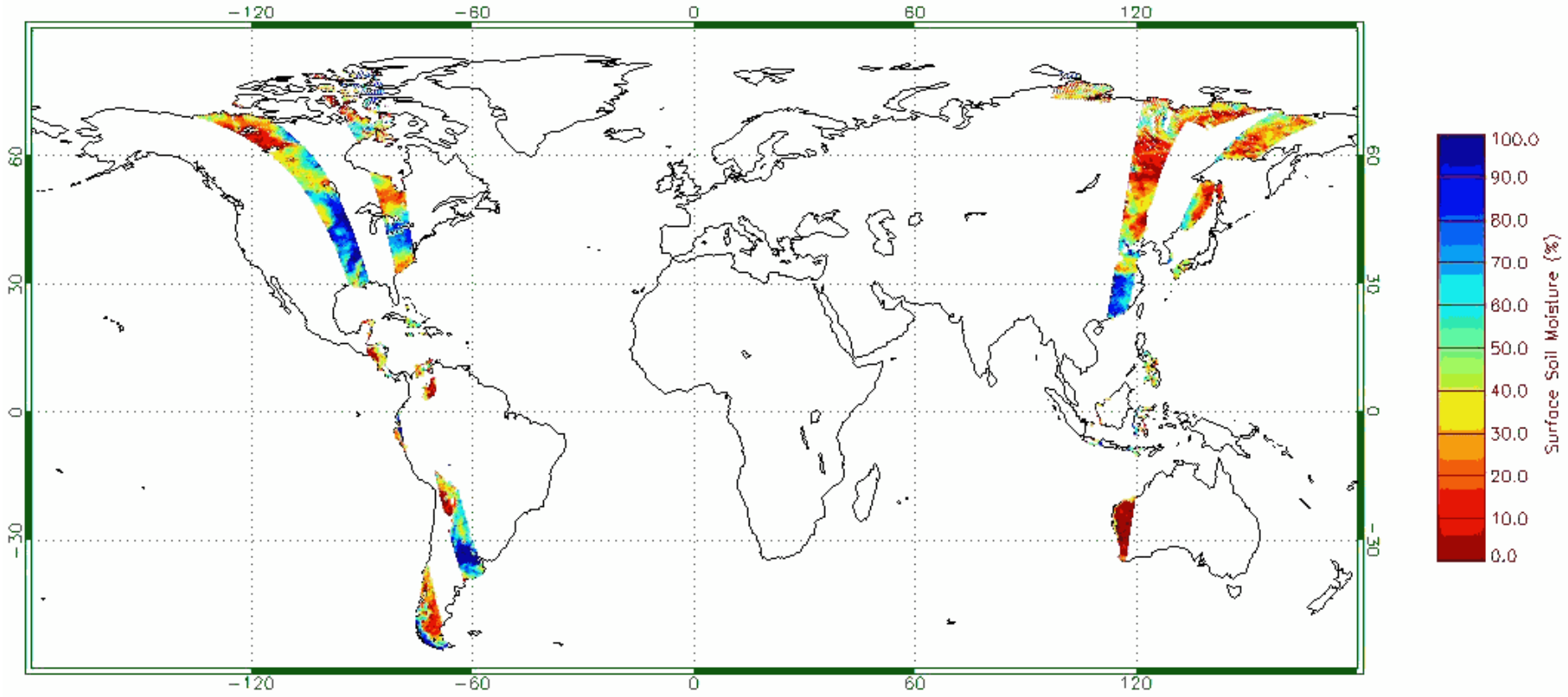
(an EUMETSAT level 2 ASCAT product)

- Methods developed by TU Wien (based on ERS data)
- Change detection of top soil moisture condition
- Corrected for:
    - annual vegetation growth cycle
    - azimuthal effect (i.e., topography)
- Indication of the soil moisture in the top soil (upper 2 cm)
- Expressed as % ranging from wet to dry top soil conditions

2. EUMETSAT surface soil moisture



2. EUMETSAT surface soil moisture



28 March 2007: 12 orbits

From surface soil moisture to profile soil moisture:

Soil Water Index: relative soil moisture, ranging from wet to dry profile:

based on a simple differential model for describing the exchange of soil moisture between surface layer **(ms)** and profile **(swi):**

$$SWI(t) = \frac{\sum_i m_s(t_i) e^{-(t-t_i)/T}}{\sum_i e^{-(t-t_i)/T}} \qquad t_i \le t$$

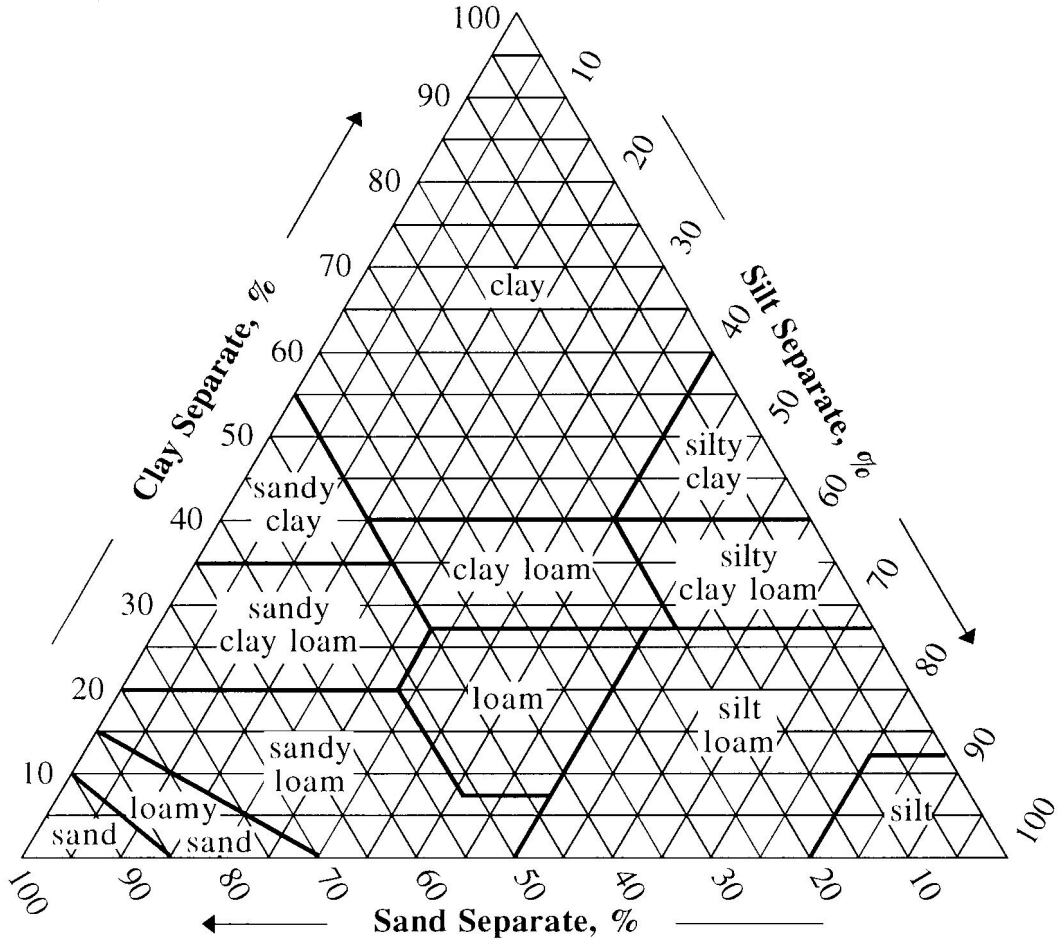
T … characteristic time (commonly: T=20 days)

Soil water index: independently validated and tested (e.g., Ceballos 2005, Pellarin 2006)

3. DRYMON profile soil moisture

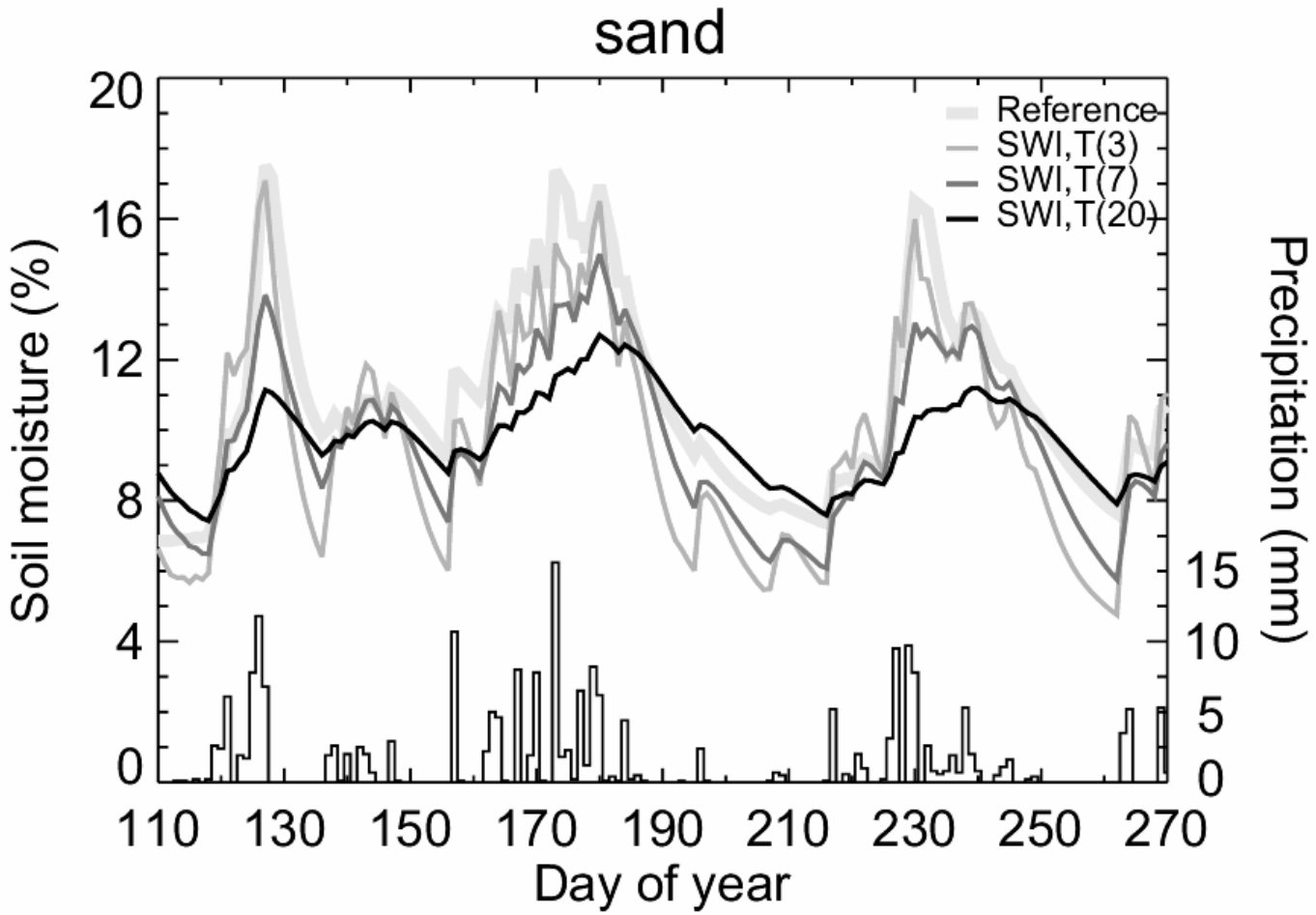
DRYMON Soil Water Index:

Geographical differentiation on soil characteristics Texture



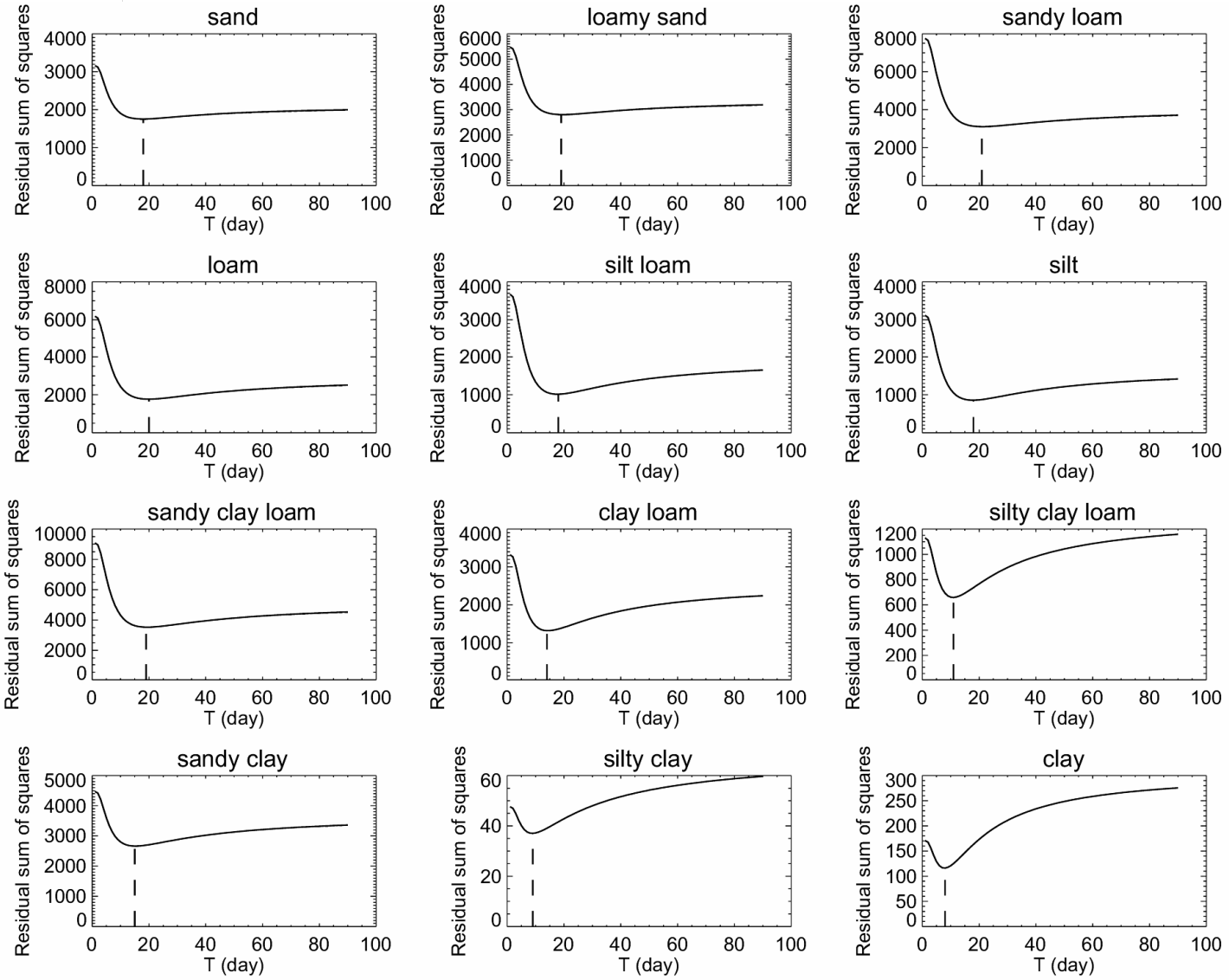
3. DRYMON profile soil moisture

Synthetic modeled soil moisture (1D Hydrus water flow model)



3. DRYMON profile soil moisture

Optimized characteristic timelength (T) for each texture class

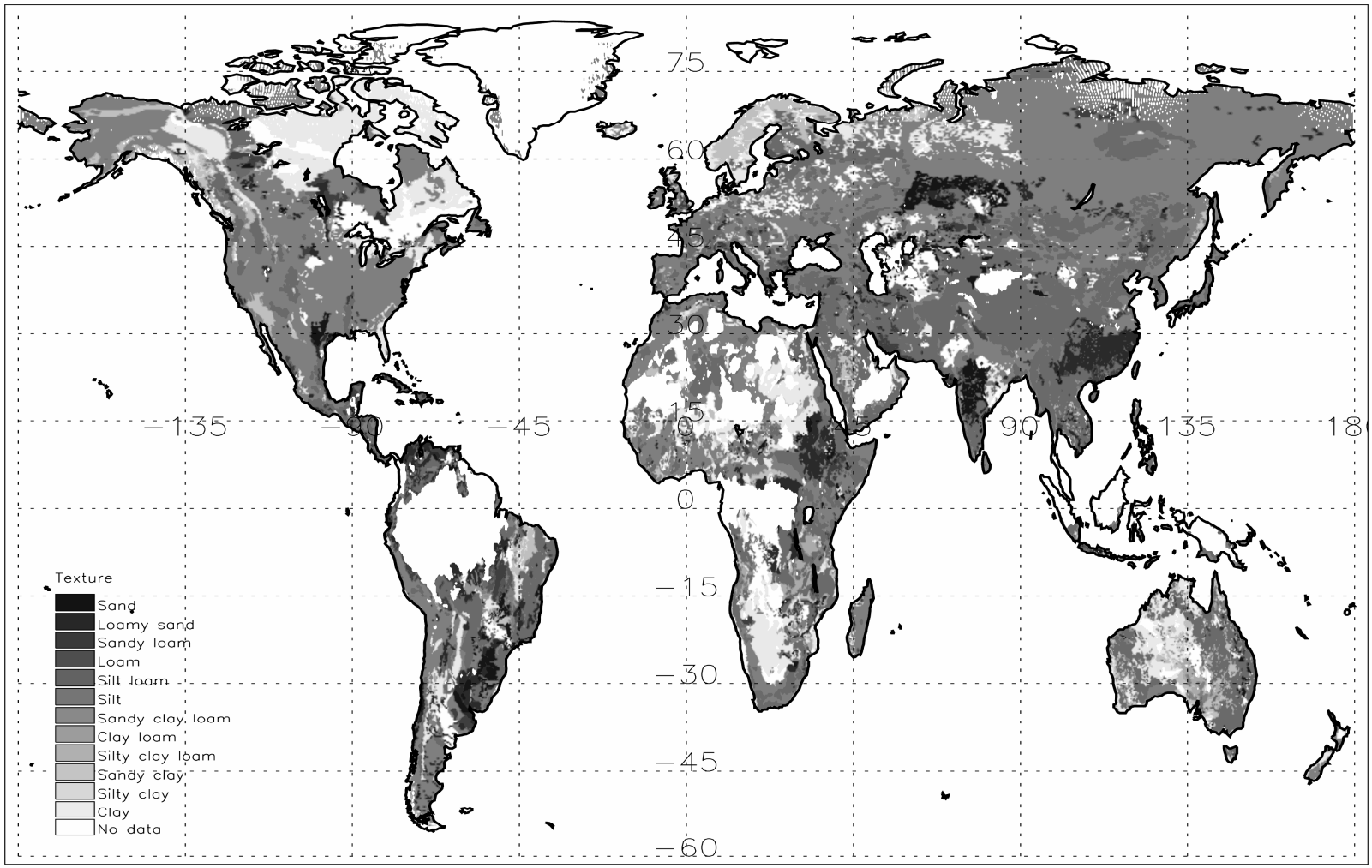


3. DRYMON profile soil moisture

Optimized characteristic timelength (T) for each texture class

Sampling interval (day)	Sand	Loamy sand	Sandy loam	Loam	Silt loam	Silt	Sandy clay loam	Clay loam	Silty clay loam	Sandy clay	Silty clay	Clay
1	7	9	11	11	9	10	10	7	5	9	2	2
2	8	10	12	11	10	10	11	8	6	9	3	3
3	9	11	13	13	11	11	12	9	7	10	4	4
4	10	12	14	13	12	12	13	9	7	11	4	4
5	13	14	16	15	13	13	15	11	8	13	5	5
6	14	15	17	16	14	14	16	11	9	14	6	6
7	15	16	18	17	15	15	17	12	10	14	7	6
8	15	17	18	17	15	16	17	13	10	14	7	7
9	17	18	20	19	17	17	18	13	10	15	8	7
10	18	19	21	20	18	18	19	14	11	15	9	8

3. DRYMON profile soil moisture



FAO soil map

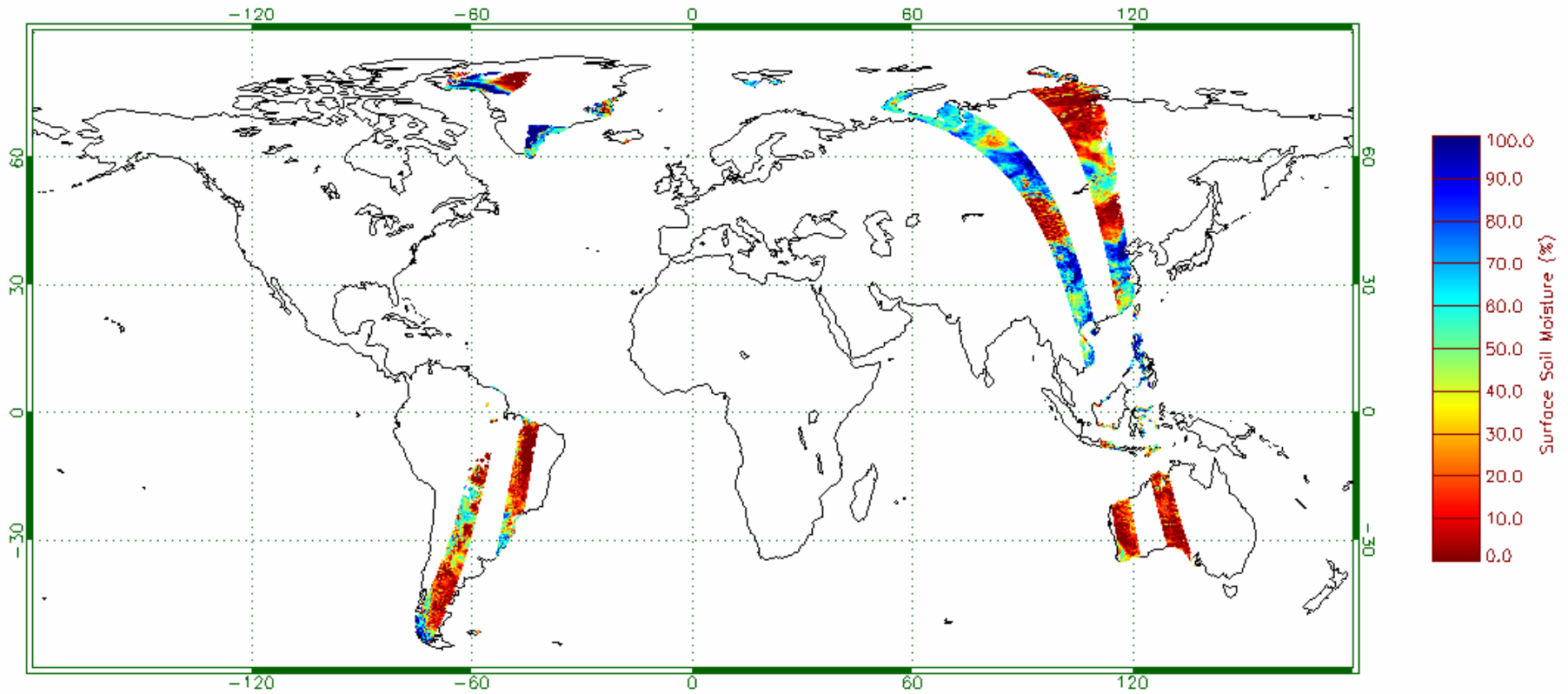
3. DRYMON profile soil moisture

Optimized characteristic timelength (T) applied to ASCAT:

- select surface soil moisture data
- transformation from orbits to fixed grid (level 3)
- spatial differentiation by characteristic timelength
- calculate DRYMON profile soil moisture

3. DRYMON profile soil moisture

Select surface soil moisture data

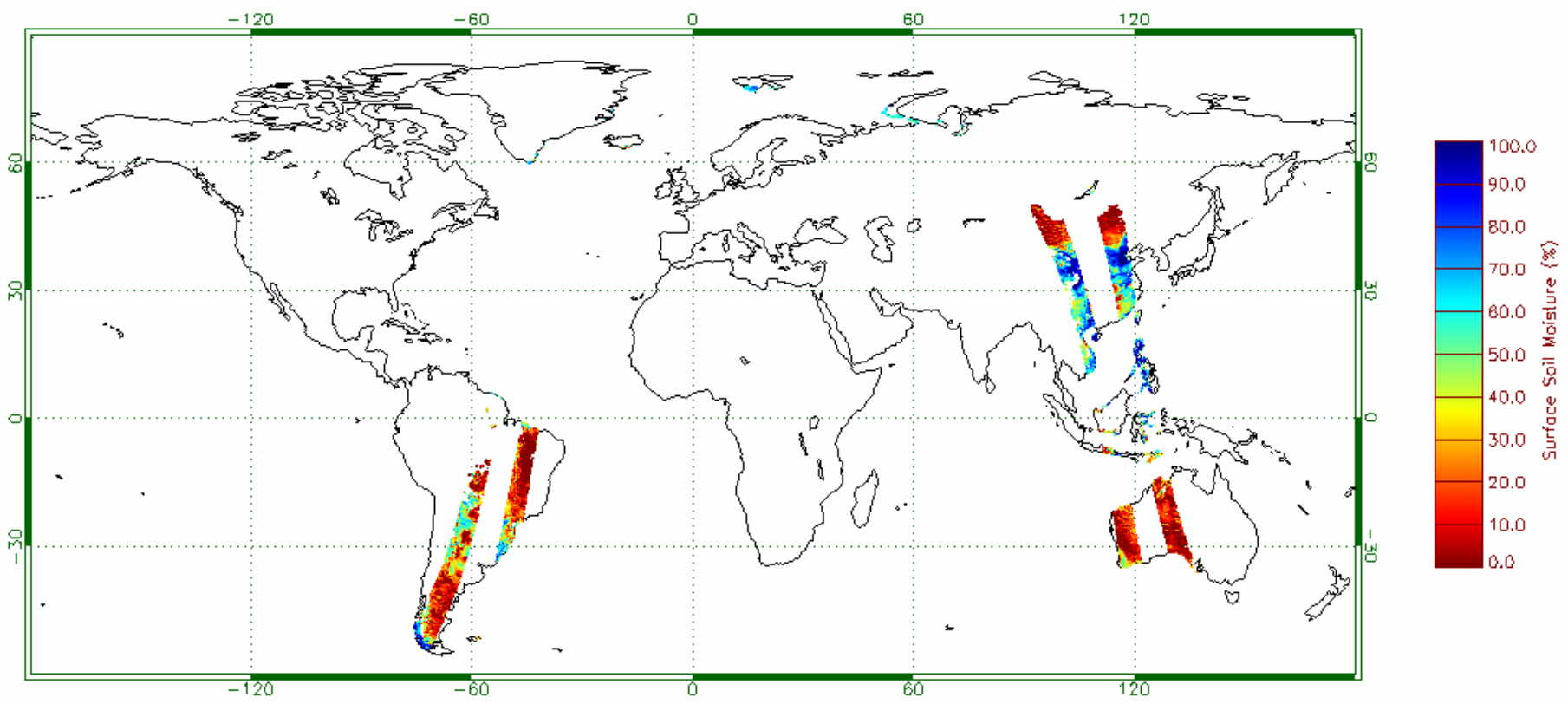


30 September 2007, 12:30

Filtering: wet lands, complex topography, frozen land

3. DRYMON profile soil moisture

Transformation from orbits to fixed grid (level 3)

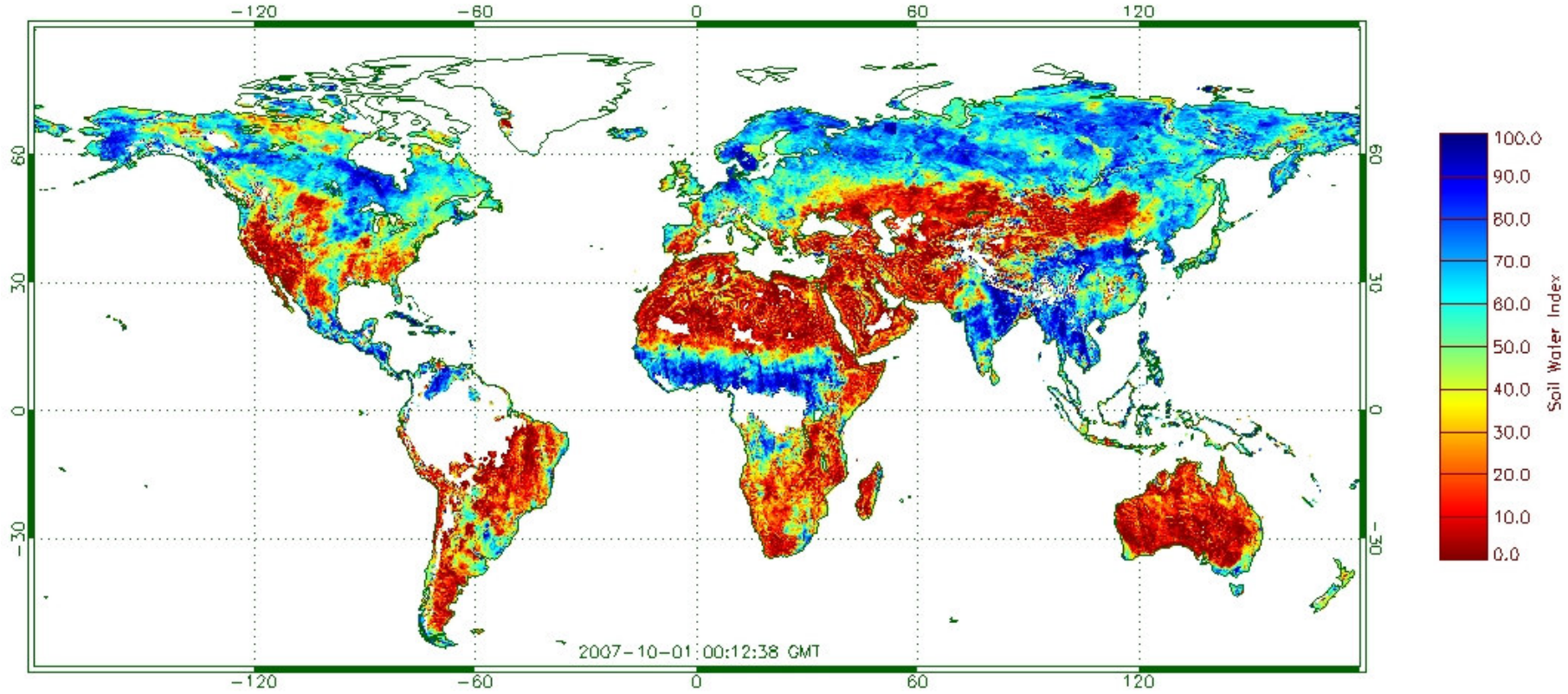


30 September 2007, 12:30

Fixed grid: 12.5 km resolution

3. DRYMON profile soil moisture

DRYMON profile soil moisture (level 4)



1 October 2007, 00:12

Fixed grid: 12.5 km resolution
Differentiated on soil characteristics
Adapted for snow conditions

Water management

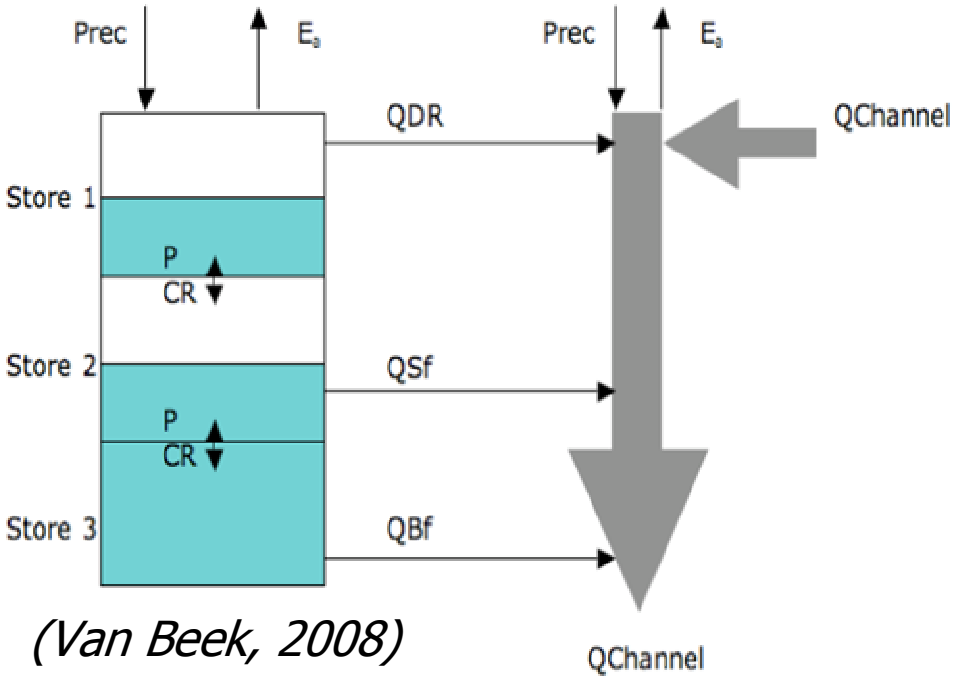
• Soil moisture information assimilated with hydrological models (i.e., West Africa)

Crop growth / crop yield forecasts

• Soil moisture information assimilated with crop growth models (i.e., Europe)

PCR-GLOBWB Model

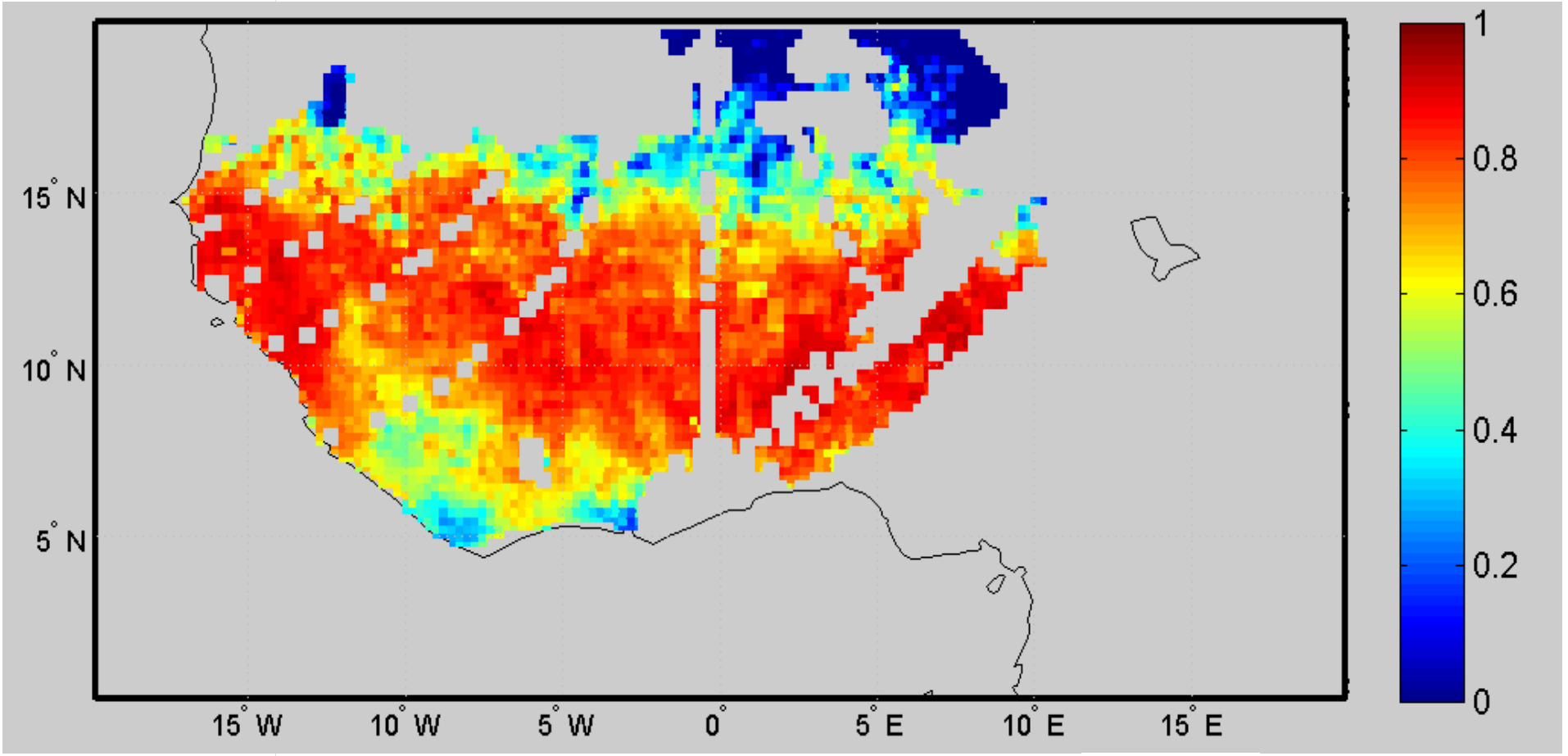
- Conceptual global hydrological model based on HBV *(Van Beek, 2008)*
- Not calibrated
- Forced with:
  - Precipitation (TRMM, NASA)
  - Actual evaporation (EARS, *De Weird et al. ,2006)*
- Size soil stores:
  - Store 1 ~ 20 cm
  - Store 2 ~ 100 cm



(Van Beek, 2008)

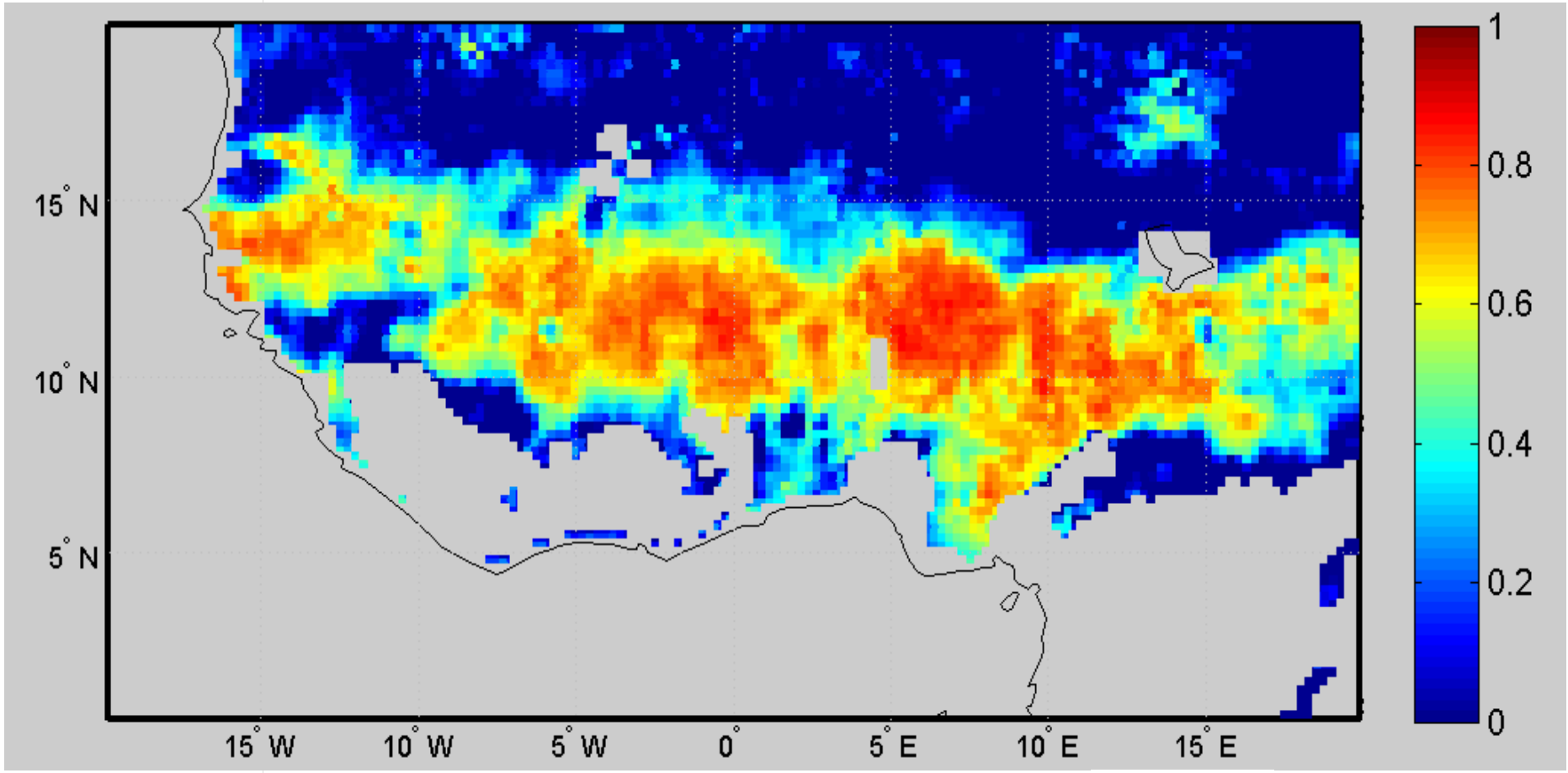
M. Rutten
N. Van de Giesen

Correlation model and ERS



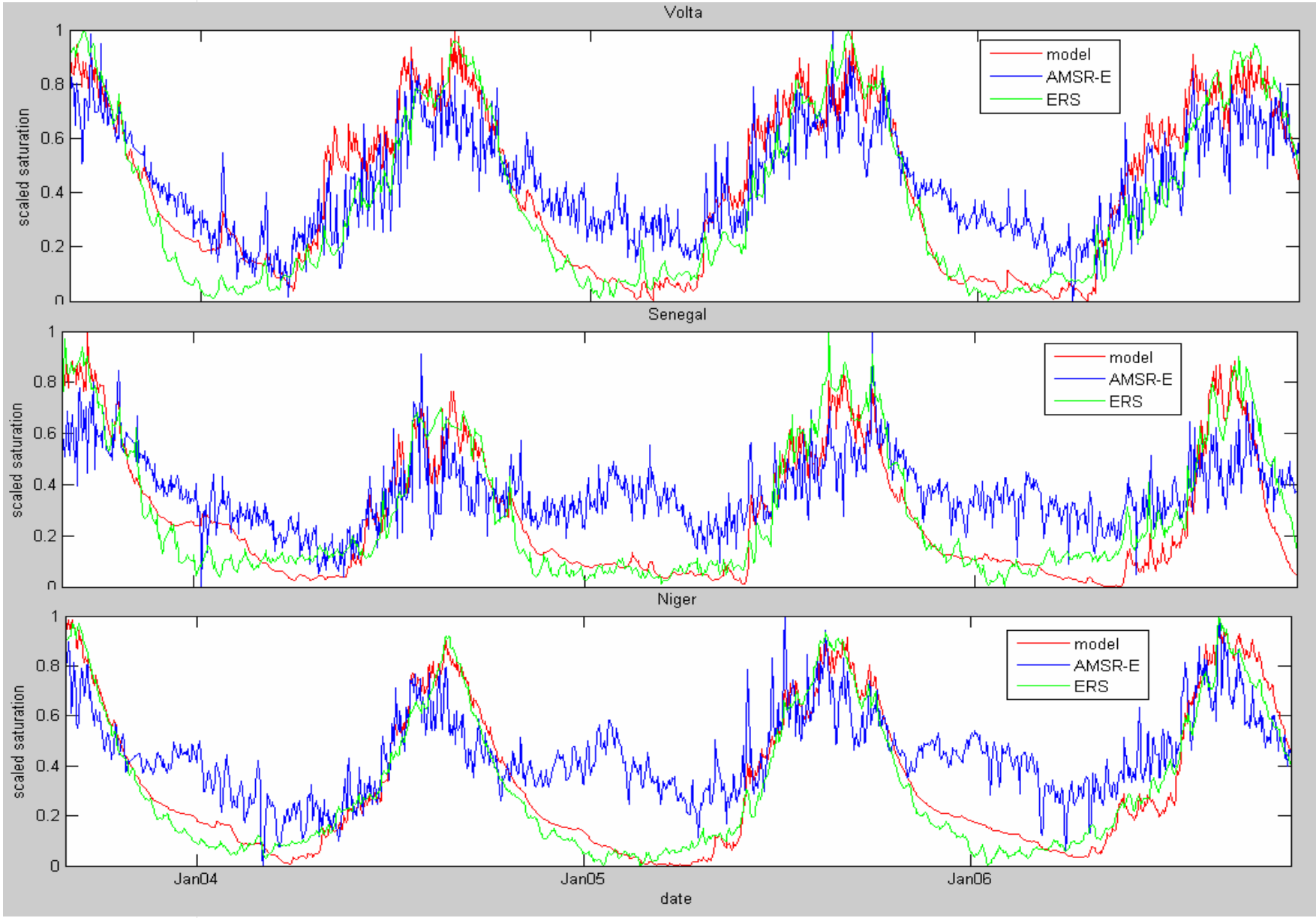
TU Delft Technische Universiteit Delft
M. Rutten
N. Van de Giesen

Correlation model and AMSR-E



TU Delft Technische Universiteit Delft
M. Rutten
N. Van de Giesen

Results averaged per basin



Conclusions

- ASCAT also good for land-applications
- Soil moisture products guaranteed for coming 15 years, with MetOp
- (Multi) daily soil moisture products:
  - Daily profile soil moisture, fixed grid (level 4)
  - Daily anomalous profile soil moisture, fixed grid (level 4)
  - Daily profile soil moisture error, fixed grid (level 4)
  - Surface soil moisture, fixed grid (level 3)
- Many possible fields that can benefit from direct soil moisture observations:
  - crop yield forecast & early warnings
  - water management
  - meteorology, weather forecasting
  - ..

Thank you !

Contact details:

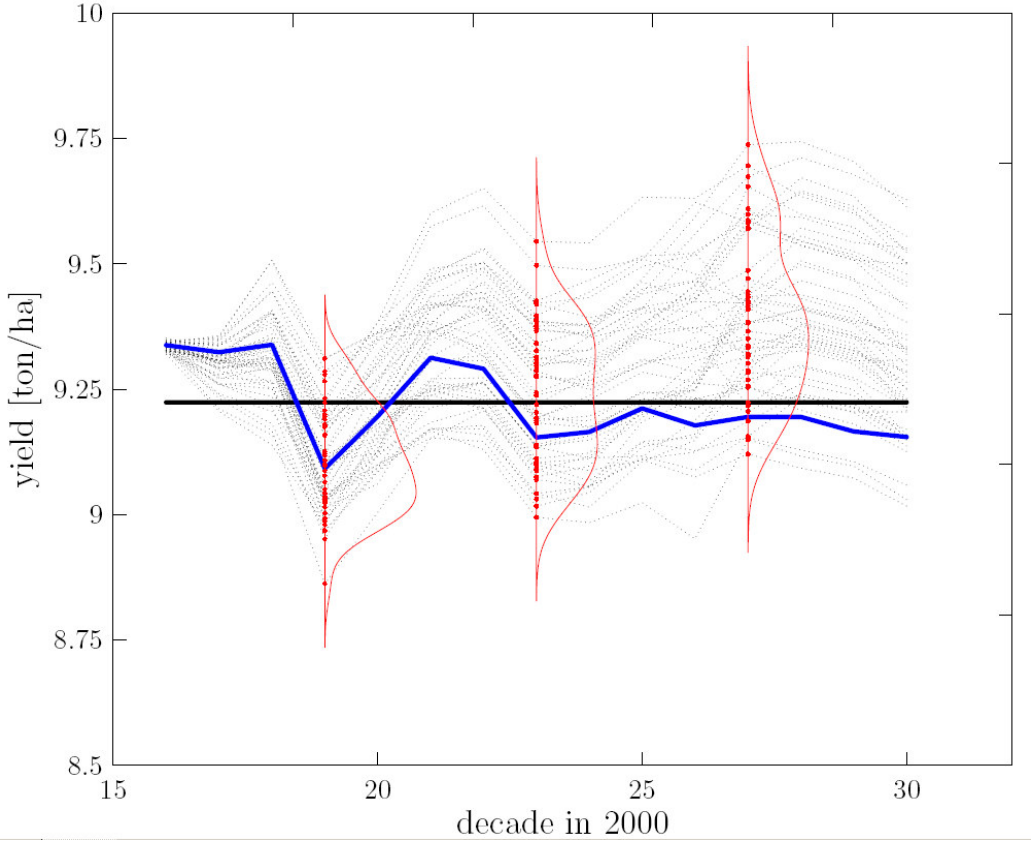
Remko de Lange

Tel: +31 (0)33 463 74 33
Email: remko.delange@neo.nl
Web: www.neo.nl / www.drymon.biz

4. Applications

Soil moisture information assimilated with crop growth models

A yield forecast through the season for grain maize for a region in South-France. The black line shows the EUROSTAT reported yield and the blue line the CGMS yield forecast. The ensemble of dotted lines shows the magnitude of the influence of uncertainty in precipitation on the CGMS yield forecast.



A. de Wit, Alterra