Assimilation for Norway

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1. Introduction:

Soil moisture is one of the key geophysical variables for understanding the Earth's hydrological cycle. (Fig. 1). On November 2009, the ESA Earth Explorer mission SMOS (Kerr, 2010) was launched. It is a polar orbiter, and uses L-Band (~1.4 GHz) to measure soil moisture and ocean salinity.

NILU are preparing to assimilate SMOS soil moisture data (AO Project C1P.7512), and receive data for assimilation over Norway (Fig. 2).

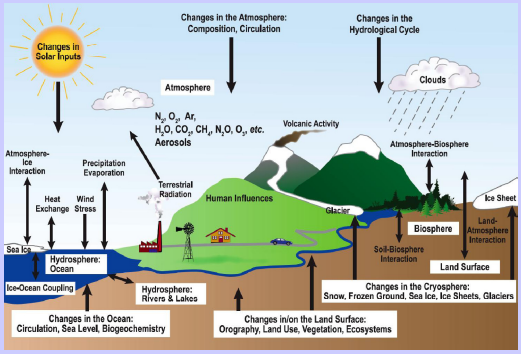

Fig.1 (left): *Global climate system (Figure from IPCC, 2007).*

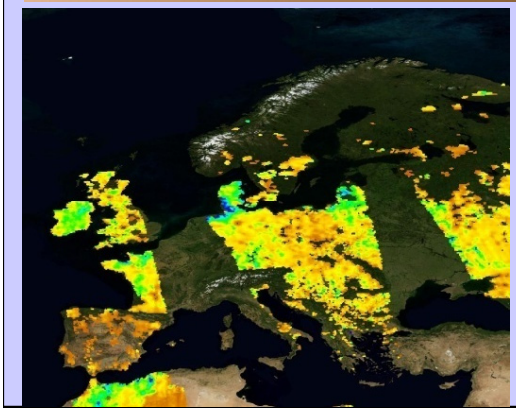

Fig. 2 (left): *SMOS soil moisture (overpasss on 24 October 2010). Blue indicates relatively wet soil; yellow/red relatively dry soil.*

2. NILU land DA system

The NILU land data assimilation (DA) system (Lahoz *et al.*, 2010a, b) is an innovative development, in collaboration with Met.no (Norwegian Meteorological Inst.) & Météo-France. It implements variants of the Ensemble Kalman Filter (EnKF). It is an off-line 1-D system based on the SURFEX land surface model (Le Moigne, 2009). Schemes include two versions of EnKF where no perturbation of observations is needed: (i) Ens. square root filter (ESRF; Sakov & Oke, 2008a); (ii) Deterministic ens. Kalman filter (DEnKF; Sakov & Oke, 2008b). NILU also uses the Extended Kalman Filter (EKF) of Mahfouf *et al.* (2009). Soil moisture from AMSR-E (*Advanced Microwave Scanning Radiometer)* is being assimilated (Fig. 3).

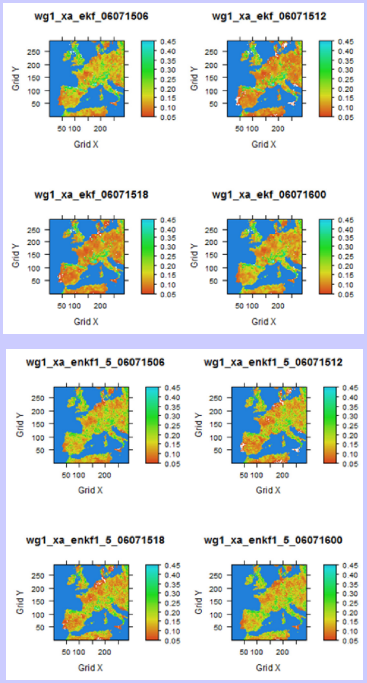

Fig. 3 (left): *Superficial volumetric water content (m^3/m^3) analysed 4 times (0600, 1200, 1800, 2400 UTC) on 15 July 2006.* ***Top, EKF, bottom, EnKF (square root; mean of 5 ensemble members)****. From a 1-month experiment involving assimilation of soil moisture information from AMSR-E (Advanced Microwave Scanning Radiometer) for July 2006. First results indicate the EnKF agrees well with the EKF.*

To assimilate SMOS soil moisture data, appropriate forcing data and boundary conditions will be provided.

3. Assimilation over Norway:

NFR (Norwegian Research Council) have funded a 3-yr PhD studentship to make more sense of SMOS soil moisture observations over Norway and Northern Areas. The recently launched SMOS satellite provides data with relatively coarse spatial resolution (~43 km footprint), a limited instantaneous field of view (~1000 km across) and relatively infrequent revisits (1-3 days).

NILU will use data DA ideas to improve spatial & temporal information provided by SMOS to be more in line with user needs, i.e., offer higher rate, higher resolution, wider area "snap shot" information. This addresses the challenge of using SMOS data to understand the hydrological cycle in Norway, a region characterized by complex orography (Fig. 4). Beneficiaries include hydrologists, NWP agencies, ESA.

The PhD student is Håvar Sollund (starting 1 Dec 2010).

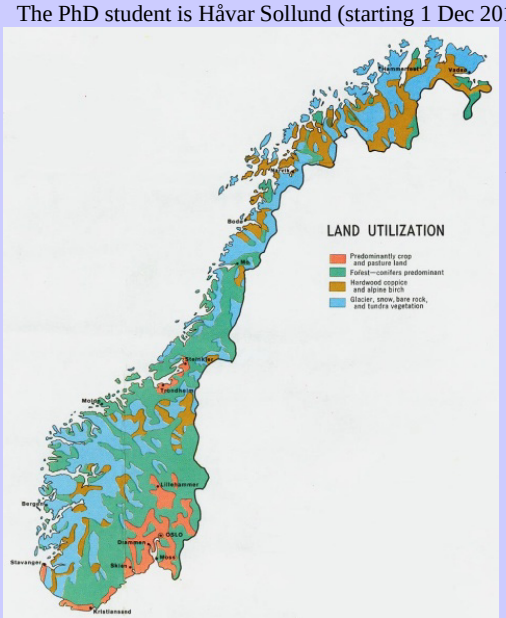

Fig. 4: *Map of Norway, identifying land use.*

4. Current plans and future perspectives:

(i) Hydrological cycle in Norway (NILU, Met.no, MF, CESBIO)

- Understand SMOS soil moisture and SURFEX model
- Test land DA system
- Produce SMOS soil moisture analyses

(ii) Hybrid EnKF/Particle Filter (PF) assimilation (NILU, NERSC)

- Assess performance of EnKF & PF schemes
- Build/test hybrid DA system;
- Apply hybrid EnKF/PF DA system to assimilate soil moisture over Europe, with a focus on Norway – advantages of combining methods

(iii) Land-use change in the Amazon (NILU, Met.no, CESBIO, U. Amazonas, Manaus)

- SMOS retrievals over the Amazon
- Soil moisture analyses
- Focus on land-use change (dry, wet, intermediate seasons)
- Use convection-resolving models to study impact on hydrological cycle (e.g. cloud cover, precipitation)

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NFR Project 202315/V30

PP/29 2010 WAL