1. Data / Model available

The SMOS satellite, to be launch in 2008, will be the first instrument to provide global fields of L-band brightness temperature. SMOS brightness temperatures will be used at the European Centre for Medium-Range Weather Forecasts (ECMWF) to analyse soil moisture through the Surface Data Assimilation System (SDAS) and ocean salinity. The observations are expected to improve the accuracy of initial conditions of the Numerical Weather Prediction (NWP) model and subsequently the quality of the medium range forecast. In turn, NWP products are of great importance for space agencies in order to derive the Level2 soil moisture and ocean salinity products.

In this context, the Community Microwave Emission Model (CMEM) has been developed by the European Centre for Medium-Range Weather Forecasts (ECMWF) as the forward operator for low frequency passive microwave brightness temperatures (from 1GHz to 20 GHz) of the surface (Drusch et al., 2007; Holmes et al., 2007).
CMEM results from the merging between the two land surface microwave emission models MEB (Microwave Emission of the Biosphere, Wigneron et al., 2007) and LSMEM (Land Surface Microwave Emission Model, Drusch et al., 2001). It is a highly modular microwave emission model that allows considering different parameterisations of the soil dielectric constant as well as different soil approaches (either coherent of incoherent) and different effective temperature, roughness, vegetation and atmospheric contribution opacity models.

Firstly, the model was calibrated using ERA-40 data and SKYLAB observations. Secondly, an error propagation study was performed by Holmes et al. 2007, on errors introduced trough (1) the parameterization of radiative transfer, (2) auxiliary geophysical quantities for the radiative transfer model, (3) imperfection in NWP model.

In a next step, CMEM convergence with the L-MEB model and the ESA / SMOS retrieval algorithm is being studied based on the Surface Monitoring Of the Soil Reservoir EXperiment (SMOSREX) data set (de Rosnay et al., 2006). SMOSREX provides a continuous 2003-2007 complete ground and remotely sensed data set. Soil moisture and temperature profiles, meteorological variables and multi-spectral measurements, including high accuracy L-Band, have been continuously monitored at a sub-hour time step ranging from 2 min to 30 min. Vegetation characteristics have also been monitored on a monthly basis. Background errors on ECMWF simulated L-band brightness temperatures are under investigation over SMOSREX and an error propagation study is performed for different incidence angles and different modular configurations. Forcing CMEM with observed data and input from the operational NWP model allows estimating qualitative and quantitative features in background errors according to the approach that will be used for the future SMOS data assimilation system.

The modular structure allows modifications and updates for future applications at higher frequencies. To test CMEM for higher frequencies, data sets from several sensors are either already available at ECMWF or will become available in the near future. For all of them, brightness temperatures are provided at both horizontal and vertical polarizations.
Surface emissivities can also be computed ‘backwards’ through the Integrated Forecast System using the observed brightness temperatures, atmospheric model fields and modelled surface temperatures. However, this has not been done operationally and the emissivity maps are not available through MARS.

- TMI (TRMM -Tropical Rainfall Measuring Mission- Microwave Imager):
  - Space agency: NASA
  - Frequency: X-band (10.7 GHz), Ka-band (19.35 GHz)
  - Quantity: brightness temperatures, dual-polarization
  - Period: 1997-present
  - Incidence angle: 52.8°

- Resolution: 50 km, 1 day

- AMSR-E (Advanced Microwave Scanning Radiometer on Earth Observing System):
  - Space Agency: NASA
  - Frequency: C-band (6.9 GHz), X-band (10.7 GHz) and Ka-band (18.7 GHz)
  - Quantity: brightness temperatures, dual-polarization
  - Period: 2002-present
  - Incidence angle: 55°
  - Resolution: 50 km, 1 day

- SMMR (Scanning Multichannel Microwave Radiometer):
  - Space agency: NASA
  - Frequency: C-band (6.6 GHz), X-band (10.7 GHz) and Ka-band (18 GHz)
  - Quantity: brightness temperatures, dual-polarization
  - Period: 1978-1987
  - Incidence angle: 50.3°
  - Resolution: 100km, 3 days

- SSM/I (Special Sensor Microwave / Imager):
  - Space agency: NASA
  - Frequency: 19 GHz
  - Quantity: brightness temperatures, dual-polarization
  - Period: 1987-present
  - Incidence angle: 50.3°
  - Resolution: 70 km, variable

- SMOS (Soil Moisture and Ocean Salinity):
  - Space agency: ESA
  - Frequency: L-band (1.4 GHz)
  - Quantity: brightness temperatures, dual-polarization
  - Period: to be launched in 2008
  - Incidence angles: from 0° to 55°
  - Resolution: 40 km, 3 days

2. Developer (institution and developer 's name)

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Collaboration: Jean-Pierre Wigneron (INRA/EPHYSE, Bordeaux, France), Jean-Christophe Calvet (CNRM-Météo-France, Toulouse, France), Fatima Karbou (Météo-France), P. Bauer (ECMWF), Gianpaolo Balsamo (ECMWF)

3. Scientific documentation (e.g. link to paper)

de Rosnay, P. and 20 co-authors, 2006: SMOSREX: A long term field campaign experiment for soil moisture and land surface processes remote sensing, *Rem. Sens. Env*., **102**, 377-389

Drusch, M., Holmes, T., and G. Balsamo 2007: Comparing ERA-40 based L-band brightness temperatures with Skylab observations: A calibration / validation study using the Community Microwave Emission Model, *submitted to J. Hydromet.*

Drusch, M., E.F. Wood, and T. Jackson, 2001: Vegetative and atmospheric corrections for the soil moisture retrieval from passive microwave remote sensing data: Results from the Southern Great Plains Hydrology Experiment 1997, *J. Hydromet*., **2**, 181-192

Holmes, T., M. Drusch, J.-P. Wigneron, and G. Balsamo, 2007: A global simulation of microwave emission: Error structures based on output from ECMWF's operational Integrated Forecast System, *submitted to IEEE TGARS.*

Wigneron, J.-P., Y. Kerr, P. Waldteufel, K. Saleh, M. Escorihuela, P. Richaume, P. Ferrazzoli, P. de Rosnay, R. Gurney, J.-C. Calvet, M. Guglielmetti, B. Hornbuckle, C. M¨atzler, T. Pellarin, and M. Schwank, 2007 : L-band Microwave Emission of the Biosphere (L-MEB) model: Description and calibration against experimental data sets over crop elds. Remote Sensing of Environment, vol 107, pp. 639-655

4. How to access information (either direct link or instructions)

Contact link: Patricia.Rosnay@ecmwf.int or Matthias.Drusch@ecmwf.int

5. Format Information

CMEM model is coded in Fortran, following ECMWF / Météo-France coding standards.
Input and Output data are currently in grib format. Ascii and netcdf input/output format will be included as well. A portable version will be available end of 2007.

6. **Date information last updated and by whom**

7. **Date last checked and by whom and date for next check and by whom**

8. **Confirmed users of this data source**

NWP centres: ECMWF, Météo-France