Development of pan-European daily high-resolution soil moisture reanalysis dataset using parallel data assimilation system

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Introduction

• Soil moisture (SM) is an important driver for water and energy exchange at the land surface. A correct prediction of soil moisture (e.g., with hydrological or earth system models) plays a crucial role in water management, food production, flood forecasting, or climate projections.

• The land surface data assimilation system TSMP-PDAF consisting of the Terrestrial System Modeling Platform (Shrestha et al., 2014) and the Parallel Data Assimilation Framework (Nerger & Hiller, 2013, Kurtz et al., 2016) was used to generate SM reanalysis dataset.

• Satellite-derived soil moisture data are assimilated into the land surface model using an ensemble Kalman filter data assimilation scheme, producing a 3 km daily soil moisture reanalysis dataset.

• Surface soil moisture validation with in-situ observations

Surface soil moisture validation with in-situ observations

• Surface soil moisture data between 2000–2015 at 112 ISMN stations for top 5 cm soil layer were collected and compared with the top two CLM soil layers (about 3 cm).

• CLM-DA is in good agreement with observations over half of the stations.

Comparison of daily time series of volumetric water content [m^3/m^3] from CLM-DA and in-situ observations for REMEDHUS and SMDOSMANIA networks. The average of the in-situ observations of all stations within ISMN network was first calculated and then compared with the averaged soil moisture of all grids within the same ISMN network.

Acknowledgements

The authors gratefully acknowledge the financial support by the German Federal Ministry of Education and Research (BMBF) through the framework project "Development of an international high-resolution soil moisture reanalysis dataset for Europe" (within the framework of the project "CLM-DA"); the National Centre for High Performance Computing (NIC) of the Jülich Supercomputing Centre (JSC) under the project "HPSC-ABC/J (Germany)"); and the ESSMRA project (H2020 Marie Curie European Research Council grant agreement No 824158) under the Horizon2020 Framework of the European Union.

TSMP-PDAF modeling setup

Data assimilation

• Domain extent and resolution: EU-CORDEX at 0.027° × 0.027° (~3km)

• ESA CCI satellite-based surface soil moisture products (2000–2015) at 0.25° resolution.

• For data assimilation 1000 grid cells were randomly selected (black points).

• Soil moisture updates were set to 1 day.

Model Validation:

• In-situ soil moisture from ISMN (red points)

• ESA CCI and existing SM reanalysis products (GLDAS, ERA5 and GLEAM) over PRUDENCE regions

Regional scale validation

• ESSMRA followed the seasonal variations fairly well, indicating that the timing and magnitude of SM at monthly and annual scales is reasonably accurate.

• In the dryer regions such as IP and MD, the soil moisture estimates by ESSMRA is lower than the other products particularly in summer.

Summer soil moisture variability

The summer SM anomaly (relative to 2000–2015) from CLM-DA for the dry, wet and normal years (2003, 2007, 2011) has better match with ESA CCI, while CLM-OM shows much stronger negative anomaly.

Summary

• Comparison of CLM-DA simulated soil moisture with ISMN network shows a good agreement with observations over half of the stations.

• Assimilating daily satellite SM improved the RMSE of CLM 3.5 near-surface soil moisture simulations up to 45% relative to open-loop simulations over PRUDENCE regions.

• CLM-DA simulated soil moisture anomalies are consistent with other reanalysis products.

• In future fully coupled TSMP assimilation of other RS SM products (e.g. SMAP) and joint assimilation of SM and GRACE data will be explored.

References


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The authors gratefully acknowledge the financial support by the German Federal Ministry of Education and Research (BMBF) through the framework project “Development of an international high-resolution soil moisture reanalysis dataset for Europe” (within the framework of the project “CLM-DA”); the National Centre for High Performance Computing (NIC) of the Jülich Supercomputing Centre (JSC) under the project “HPSC-ABC/J (Germany)” and the ESSMRA project (H2020 Marie Curie European Research Council grant agreement No 824158) under the Horizon2020 Framework of the European Union.

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