Validation of the ESA CCI soil moisture product

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Summary

Within ESA's Climate Change Initiative (CCI; www.esa-soilmoisture-cci.org) a remotely sensed soil moisture time series was developed and is currently being validated. Similar to its forerunner ECV-SMv1 (publicly available), the time series ECV-SMv1.1 (internal release) has global coverage and is based on active and passive satellite soil moisture retrieval but is extended to the time period 1979 to 2013.

The validation of the CCI ECV-SM time series is independently conducted by project partners, who were not involved in the development of the data set. The validation is based on the comparison to soil moisture observations and soil moisture estimates using public available soil moisture data sets across different spatial scales.

Additionally to the validation, the developed ECV-SM time series is assessed for its suitability in climate research. This task includes the applicability for land-climate dynamics investigations as well as for trend analyses using e.g. NDVI, runoff and tree rings.

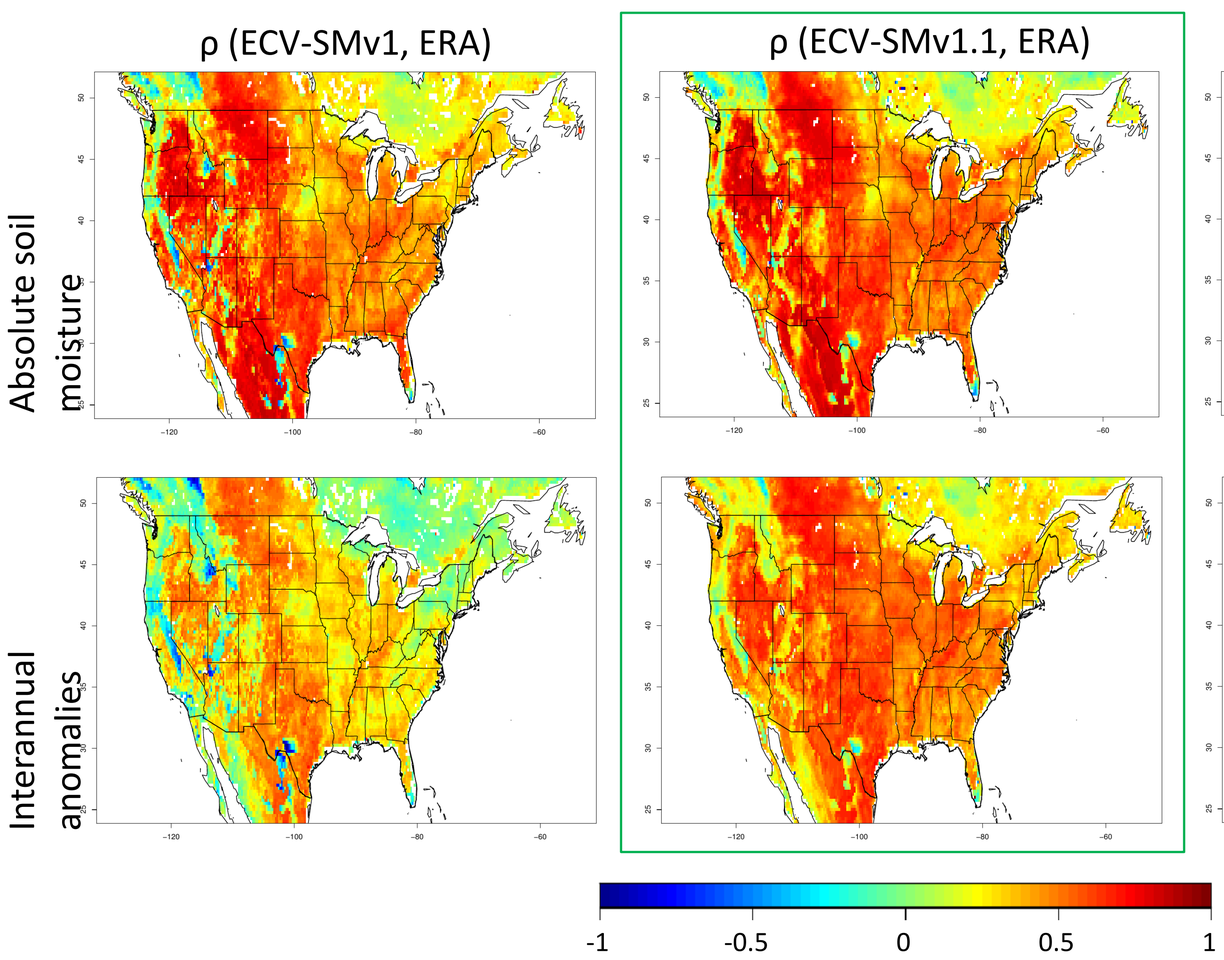
Data sets and strategy

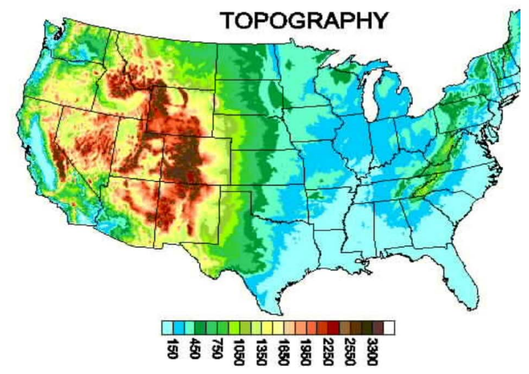
The surface soil moisture (SSM) of the ECV-SMv1.1 is compared

- To soil moisture measurements and soil moisture estimates:
  - In-situ: ISMN (Dorigo et al., 2011), NASMD (www.soilmoisture.tamu.edu/), SwissSMEX (Mittelbach et al. 2011, Mittelbach and Seneviratne 2012)
  - Land surface model (LSM) estimates: ERA Interim/Land
  - Remote sensing: forerunner ECV-SM product (ECV-SMv1)
- Using unscaled and scaled, i.e. applying cdf-matching using in-situ as reference, values of absolute soil moisture (absSSM) as well as its resulting interannual anomalies (iaaSSM), i.e. removing mean seasonal cycle from the (un-)scaled absSSM
- At the point- and global scale
  - Focus on temporal correlation (Spearman)
  - Include Taylor diagram to assess also variability and ubRMSD
  - Interannual variability on yearly and seasonal basis
- Assess average product performance for geographical regions (continents), Köppen-Geiger classes, soil texture and measurement depths for whole year and seasons

Performance of daily ECV-SMv1.1

Global-scale: Correlation ρ for unscaled daily SSM over North America for April-September 2003-2010

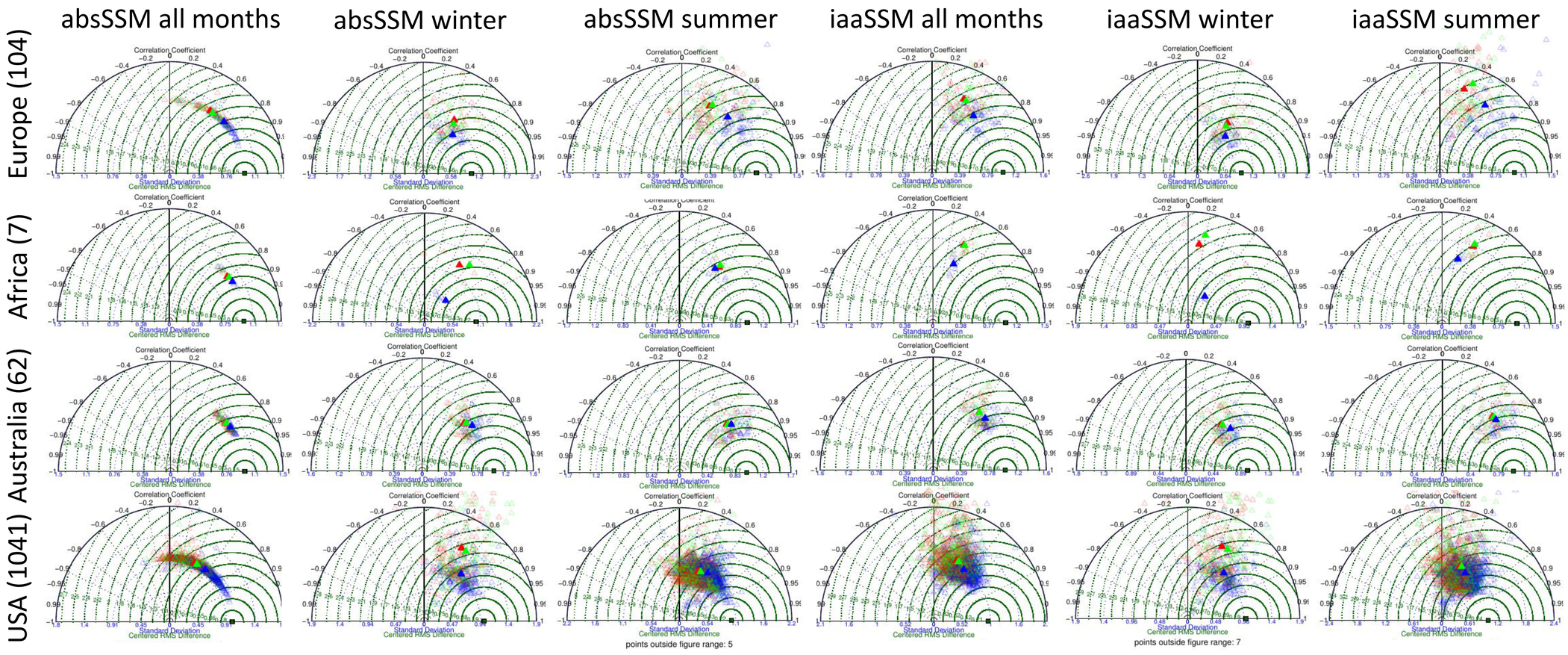




Correlation ρ between the ESA CCI remotely sensed soil moisture (forerunner: ECV-SMv1; new version: ECV-SMv1.1) and the LSM estimates ERA Interim/Land for absSSM (upper panels) and iaaSSM (lower panels). With respect to ERA:

- *Spatial patterns of ρ between ERA and both ECV-SM versions are comparable*
- *Lowest ρ for areas with complex terrain*
- *Higher ρ for absSSM than for iaaSSM*
- *Improvement in ρ for iaaSSM in ECV-SMv1.1*

Point-scale: Average performance for geographical regions for scaled daily SSM for 2003-2010 using in-situ as reference



ECV-SMv1 ECV-SMv1.1 ERA

- *ECV-SMv1.1 slightly better than forerunner*
- *ERA mostly better than remote sens. products*
- *ρ ranges between 0.2-0.8*
- *absSSM better than iaaSM*
- *Lowest average perf. mostly in summer*
- *Best performing region and most similar results between 3 products in Australia: highest ρ and only small differences between abs and iaa for all seasons*

References

Dorigo et al. 2011: The International Soil Moisture Network: A data hosting facility for global in situ soil moisture measurements. HESS, 15(5), 1675-1698.

Mittelbach et al. 2011: Soil moisture monitoring for climate research: Evaluation of a low-cost sensor in the framework of the Swiss Soil Moisture Experiment (SwissSMEX) campaign. JGR, 116, D05111.

Mittelbach, H. and S.I. Seneviratne 2012: A new perspective on the spatio-temporal variability of soil moisture: Temporal dynamics versus time invariant contributions. HESS, 16, 2169-2179. .