Improving remotely sensed soil moisture by combining alternate products from AMSR2

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1. Introduction

- Soil moisture is an important variable in hydrological systems
- Direct applications of remotely sensed soil moisture have been limited due to the coarse spatial resolution and uncertainties resulting from a number of complex factors that affect the radiative transfer model
- Two soil moisture products from AMSR2 observations, retrieved by the JAXA and LPRM algorithms are assessed
- As the errors in the two products are complementary, a combinatorial approach is presented here for improving the quality of soil moisture datasets

2. Data

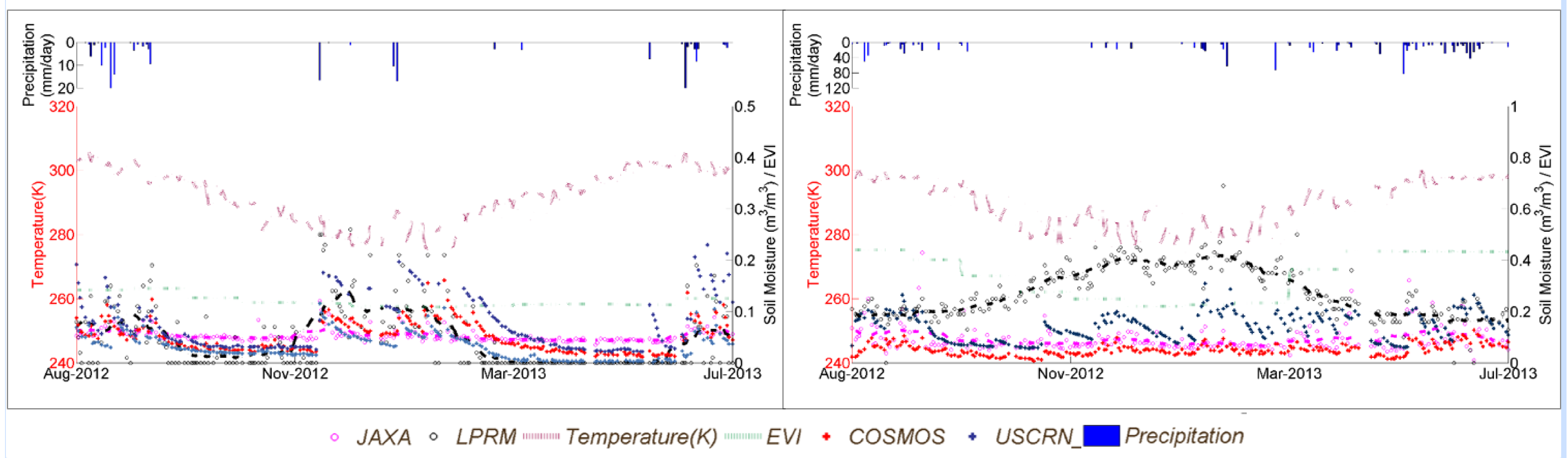

Figure 1. Example time series of AMSR2 soil moisture retrievals, soil temperature, EVI, precipitation and ground soil moisture measurements for two COSMOS stations where correlation coefficients of seasonal cycle between the two AMSR2 products are highest (left) and lowest (right)

- Study period: 01/08/2012 - 31/07/2013
- Remotely sensed soil moisture: AMSR2 - JAXA and LPRM
- Ground soil moisture: observations from 47 COSMOS stations and 17 USCRN stations
- Ancillary data: MODIS EVI, 1km DEM (GLOBE), soil temperature (ERA-Interim) and TRMM precipitation

3. How are they different?

3.1 Correlation coefficients

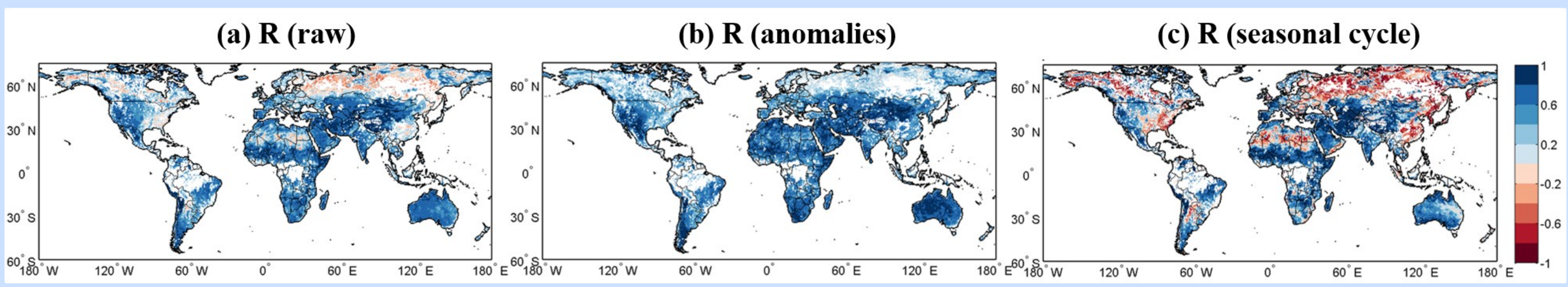

Fig. 2. Spatial distribution of Pearson correlation coefficients for (a) raw, (b) anomaly and (c) seasonal cycle between daily JAXA and LPRM soil moisture products for the period August 2012 through July 2013. The soil moisture products are from the descending overpasses of 10.7 GHz (X-band), and the regions with dense forests are masked out. The raw soil moisture is decomposed into anomaly and seasonal cycle by taking a 31-day moving average over the study period.

- **Raw (Fig. 2a):** The two products are moderately positively correlated, but low or negative correlations are observed over many regions, e.g. western Canada, Russia, southeast USA, southeast China, central South America and northern Africa
- **Anomaly (Fig. 2b):** The soil moisture anomalies of the two products are highly positively correlated, which means that both products have similar responses to rainfall events
- **Seasonal cycle (Fig. 2c):** Negative correlation coefficients are notable over the above-mentioned regions

References

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Sharma, A., & Mehrotra, R. (2014). An information theoretic alternative to model a natural system using observational information alone. *Water Resources Research, 50*(1), 650-660. doi: 10.1002/2013WR013845

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3.2 Field measurements

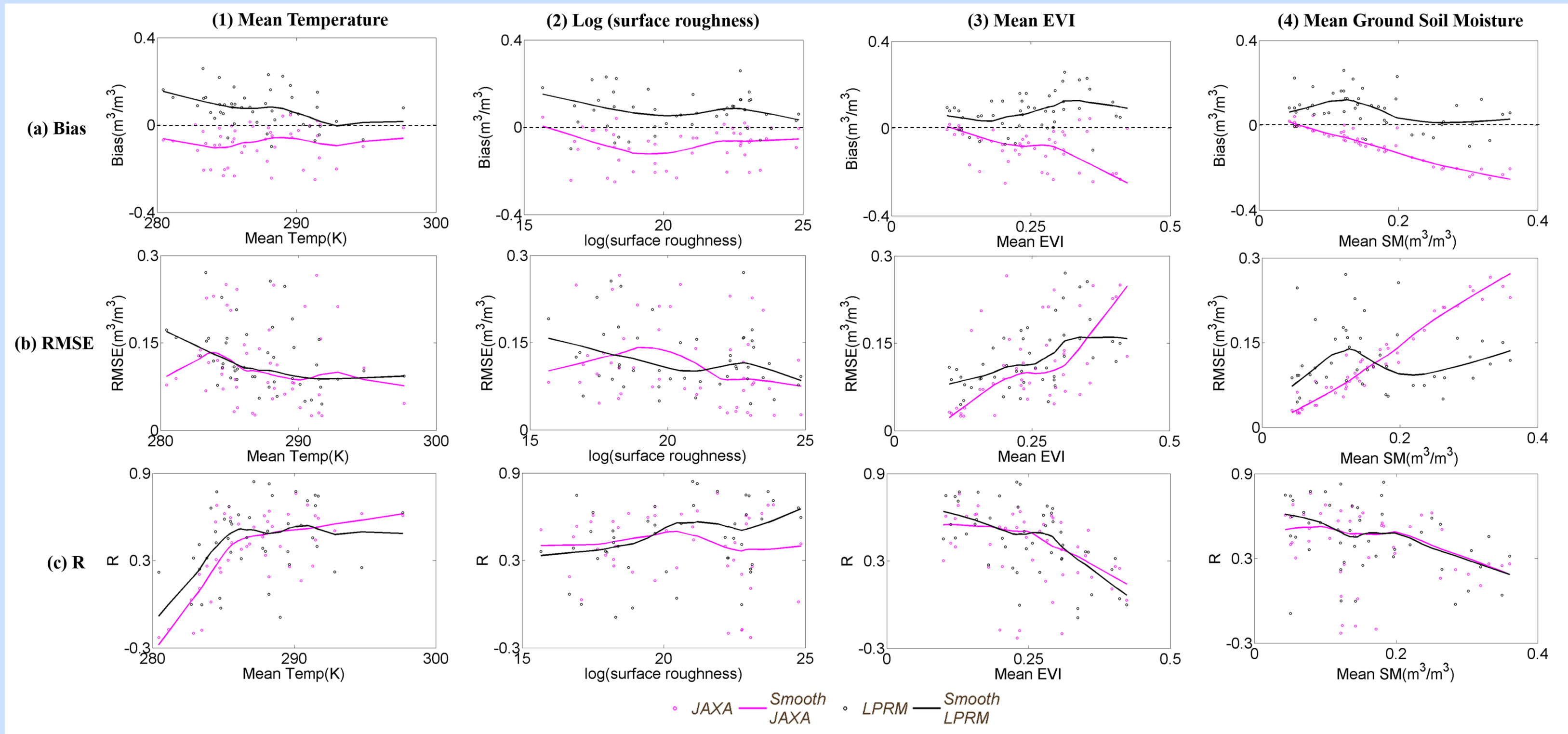

Figure 3. Scatterplots of (y-axis) bias, RMSE and correlation coefficients (R) between AMSR2-based raw soil moisture and field measurements from 47 COSMOS stations against (x-axis) mean temperature, coarse scale surface roughness (log (h)), mean EVI and mean ground soil moisture. A robust local regression method is used for smoothing data.

- JAXA algorithm generally underestimates soil moisture, whereas LPRM algorithm tends to overestimate
- Correlation coefficients (R) of both products decrease when mean temperature decreases below approximately 290K
- LPRM correlations increase as surface becomes rougher whilst JAXA correlations decreases
- Performance of JAXA is affected in areas with dense vegetation (mean EVI > 0.30)
- Distributions of bias and RMSE of LPRM are relatively insensitive to variation of mean ground soil moisture; JAXA performs better in dry condition for bias and RMSE while LPRM performs better in such conditions for R

4. Combination strategy

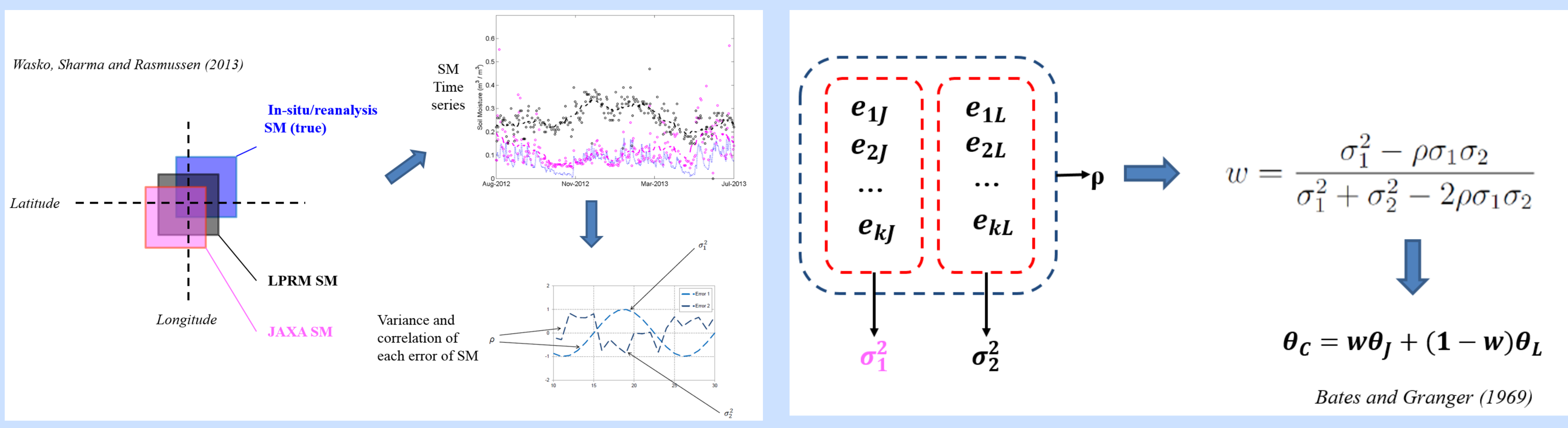

Figure 4. Schematic concept for combining the two AMSR2 soil moisture products (JAXA and LPRM). External soil moisture products (e.g. in situ, re-analyses) are assumed to be the true values, (a) variances σ_1^2 and σ_2^2, error correlation ρ and (b) a weighting factor w minimizing the variance of linear combination can be calculated

- A combinatorial approach is proposed for improving quality of soil moisture dataset
- The approach is a linear combination technique which applies a spatio-temporal weighting factor *w*, calculated based on error statistics of each of the products
- The weighting factor *w* can be regarded as a function of variables (latitude, longitude, vegetation, temperature, roughness) which can be modeled with the assumed true values of soil moisture
- The model is based on significant predictors identified by Partial Informational Correlation (PIC) and Partial Weight (PW) (Sharma and Mehrotra, 2014), and will be tested as a combination tool for the remotely sensed soil moisture products

5. Conclusion

We assessed two AMSR2 soil moisture products retrieved by the JAXA and LPRM algorithms at the global scale. The products generally agree, particularly in anomalies. The two products show complementary characteristics under various temperature, roughness, vegetation and ground mean soil moisture. A linear combination approach is presented for improving the quality of soil moisture dataset by PIC and PW.