

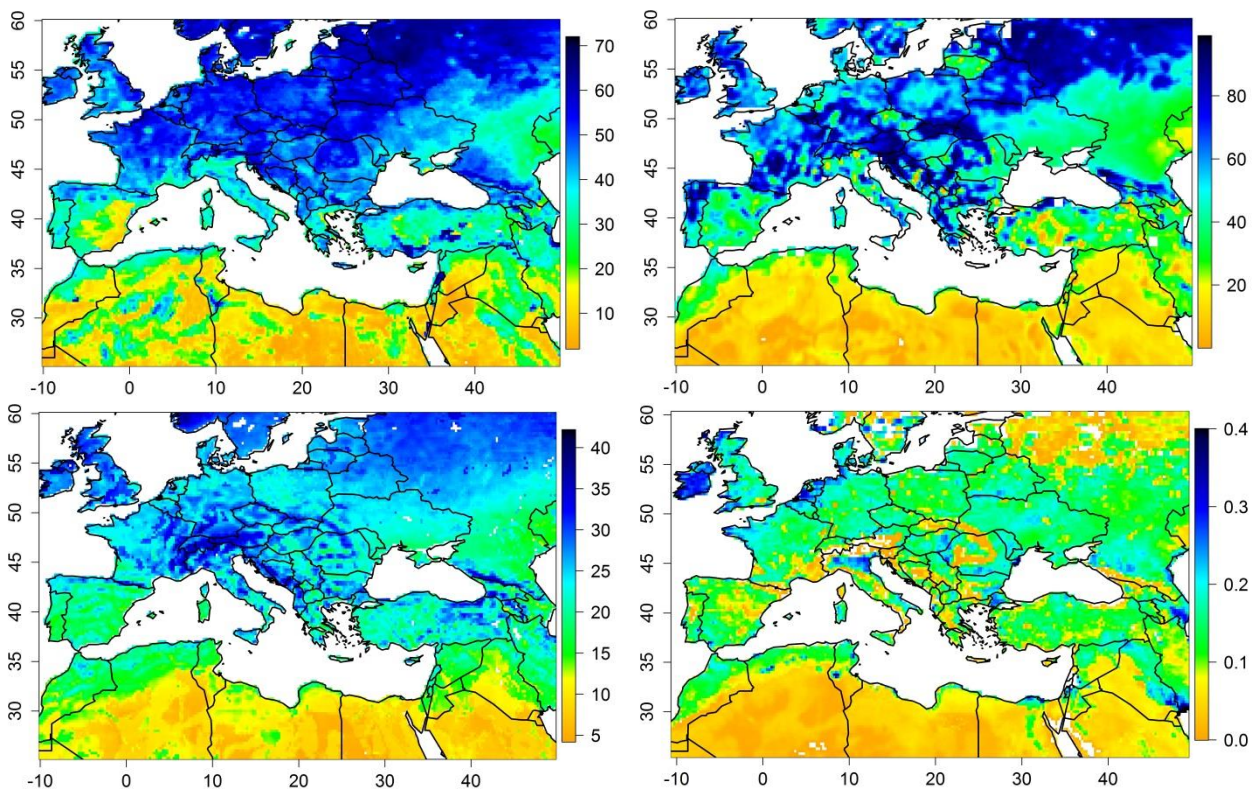
## SOILMOISTURE

### IMPROVED VEGETATION STATUS PREDICTION VIA OPTIMAL MERGED SOIL MOISTURE OBSERVATIONS

Research objectives of project SOILMOISTURE are:

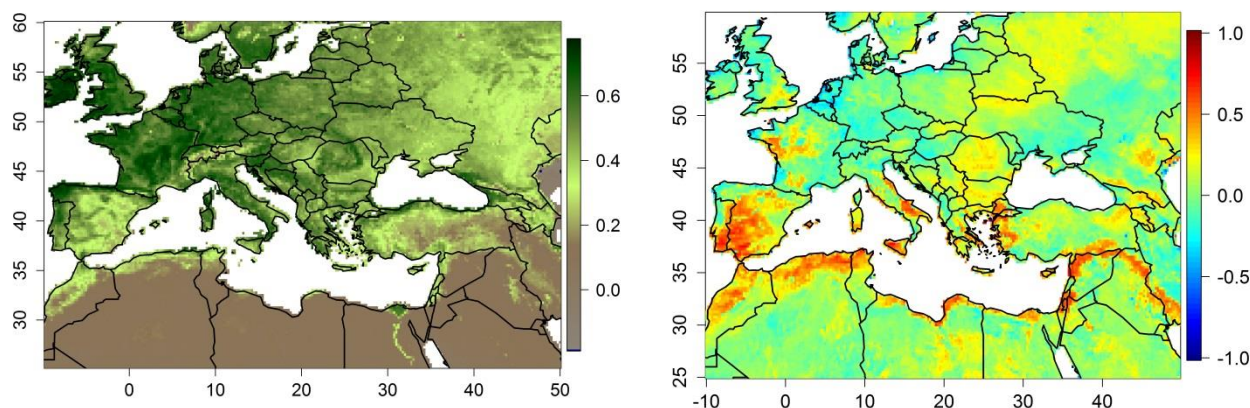
- *Obtaining individual uncertainty estimates of each soil moisture datasets over Europe and northern Africa;*
- *Obtaining improved soil moisture and its uncertainty estimates;*
- *Evaluation of the predictability of vegetation conditions using merged soil moisture estimates and the predictive skill differences between least squares and data assimilation;*
- *Form a basis for an operational system that merges soil moisture datasets;*

In this reporting period, soil moisture and NDVI datasets are acquired and their initial assessments are made. In this study daily ASCAT, NOAH, LPRM (AMSR2) and SMOS soil moisture datasets are used and compared against MODIS NDVI values between 2010 and 2015. All datasets are acquired at/averaged to 0.25 degree spatial resolution. NOAH hydrological model soil moisture values are taken from GLDAS simulations (Rodell et al., 2004) part of the mission of NASA's Earth Science Division and archived and distributed by NASA GES DISC. Two passive microwave-based soil moisture products are used in this study: dataset using LPRM algorithm and utilizing AMSR-2 observations (Parinussa et al., 2015) obtained from NASA GES DISC and SMOS datasets (Kerr et al., 2001, 2012) obtained from CATDS. Lastly, active microwave-based ASCAT soil wetness values (Wagner et al., 1999) obtained from EUMETSAT Network of Satellite Application Facilities H-SAF program are also used. ASCAT values globally provided as point data are gridded to 0.25 degree resolution products using nearest neighborhood method by averaging all relevant observations in any given particular day. MODIS MOD13C1 NDVI values are obtained from NASA's Land Processes Distributed Active Archive Center (LP DAAC) located at the USGS Earth Resources Observation and Science (EROS) Center. All daily soil moisture datasets are averaged to weekly to investigate the relation between products while 16-daily averages are calculated to match the temporal resolution of native NDVI product where 0.05 degree spatial resolution native NDVI product is also averaged to 0.25 degrees to match the spatial resolution of soil moisture products.



Average soil moisture values (%) of ASCAT, LPRM, NOAH, and SMOS (upper left, upper right, lower left, and lower right, respectively) between 2010 and 2015.

## SOILMOISTURE



Average NDVI (left) and SM-NDVI correlations (right) between 2010 and 2015.

Using a model product (NOAH), an active (ASCAT) and two passive (LPRM2 and SMOS) microwave observation based products, all error cross correlations between 4 products (total 6 error cross-correlation information) cannot be resolved simultaneously. Instead only some (between passive microwave products) can be retrieved while the remaining (i.e., between passive, active, and model products) are assumed to be not cross-correlated. Here, the extended collocation analysis presented by Gruber et al. (2016) is implemented to find the error cross correlation and variance information. However, this analysis implementation did not converge to reasonable error cross-correlation estimates, instead they appeared very unrealistic. There could be several different reasons for these unrealistic error variance estimates: the length of the time series is not sufficient enough to obtain accurate error variance estimates as extended collocation analysis (similar to TCA) require long time series to reduce sampling errors (Zwieback et al., 2012), and/or despite the assumption that certain error cross correlations are zero (e.g., between model, active, and passive datasets) these products do have correlated errors (i.e., due to impact of seasonality over errors) similar to the example given by Yilmaz and Crow (2014).

The ultimate goal of this study is to objectively merge soil moisture datasets to obtain improved vegetation status prediction ability, where the uncertainty estimates of the products are utilized to obtain relative weights of the products. Initially, the uncertainty estimates of products were foreseen to be obtained via quadruple collocation (i.e. extended collocation) analysis where the error cross correlation information will be an added value. Here, the weights must be proportional to the accuracy of datasets; this is why the uncertainty estimates are sought for. Given reasonable error cross correlation estimates could not be obtained from the performed collocation analysis, the weights that will be used to merge datasets will not be obtained using collocation analysis. Here, alternatively, the uncertainty estimates of products are obtained using cross-correlation information directly. High cross correlations between products support this choice where the products that have lower cross-correlation with other products are assigned higher uncertainty estimates while the higher cross-correlations are associated with lower uncertainty.

Obtained uncertainty estimates will be used to calculate weights for soil moisture products, while these weights will be used to merge soil moisture products in a least squares fashion. Parallel to the originally proposed work, it is hoped that the merged estimate will improve NDVI cross-correlations and the predictions. These improved NDVI predictions in return help increase the lead time of skillful vegetation status predictions.

The web page of this project is <http://blog.metu.edu.tr/tuyilmaz/soilmoisture/>

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