THE MEDIUM RESOLUTION SOIL MOISTURE DATASET: OVERVIEW OF THE SHARE ESA DUE TIGER PROJECT

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ABSTRACT

To address the needs of the hydrological community for medium resolution soil moisture dataset an approach developed at the TU WIEN for the coarse resolution ERS/METOP datasets has been transferred to medium resolution SAR data. This work was performed within the ESA Tiger Innovator project SHARE and introduces an operational soil moisture monitoring service for the region of the Southern African Development Community (SADC) and Australia. The data from the ASAR onboard ENVISAT operating in Global Mode (GM) with 1 km spatial resolution were implemented for the dataset generation that provides twice weekly measurements and captures highly variable soil moisture patterns. Several validation and application studies were summarized in this paper that demonstrated the ability of ASAR Global Mode (GM) Soil Moisture for global soil moisture monitoring. The dataset can be accessed via http://www.ipf.tuwien.ac.at/radar/share/.

Index Terms— Soil moisture, ENVISAT ASAR GM, scatterometer, hydrology, SHARE, ESA DUE TIGER, ASAR GM soil moisture

1. INTRODUCTION

Soil moisture is a key element in the global cycles of water, energy and carbon and belongs to the Essential Climate Variables as defined by the Global Climate Observing System (GCOS). Soil moisture represents a switch that controls the proportion of rainfall that percolates, runs off, or evaporates from land. Its quantitative representation can bring further improvement in hydrological monitoring and modelling.

Since the 1970's the microwave technology dominated the soil moisture retrieval. A variety of coarse resolution datasets became available from active and passive microwave systems (ERS-1/2, METOP ASCAT or AMSR-E) and the potential of these datasets for improvement in hydrological, climatological, and vegetation studies has been amply demonstrated. The importance of the soil moisture as an essential climate variable has been recently manifested by the implementation of the first near real time soil moisture dataset [1]. The dataset is provided from the ASCAT scatterometer onboard Metop and is available via EUMETCAST.

The low spatial resolution (25-50 km) reminds the main constrain of existing datasets and often discourage the hydrological community operating at local (meters or few km) scales from implying remotely sensed soil moisture datasets into hydrological models and products. To supplement this missing link, the medium (1 km) resolution soil moisture dataset has been recently developed (Figure 3) at the Vienna University of Technology in a cooperation with the University of Kwazulu Natal (South Africa) [2].

2. METHODOLOGY

The dataset is acquired using the side-looking Synthetic Aperture Radar (SAR) onboard ENVISAT taking advantage of the Doppler discrimination concept designed to acquire high resolution images. The Global Mode (GM) at 1 km spatial resolution was implemented for the product generation due to its high temporal resolution. The algorithm has been transferred from the ERS-1/2 scatterometer change detection algorithm [3] with the exception of vegetation corrections that requires repetitive, continuous coverage of the sensor.

The 1 km soil moisture dataset has been provided as part of the SHARE European Space Agency DUE TIGER innovator project and aims to provide operational soil moisture monitoring service for the SADC region. SHARE supplies soil moisture information for the African and Australian continent, at a resolution of 1 km, and makes them freely accessible to all. Monthly updates of soil moisture maps over Africa (south of 12 N) are available with approximately 2-month lag. Since 2008 similar services are available for the Australian continent.

3. DATA USERS & APPLICATION

The main aim of the SHARE ESA TIGER innovator project was to freely distributes data on operational basis among users conducting research over SADC region and Australia. The high number of data requests (~50) and subsequent user data evaluations prove its successful accomplishment. User feedback was crucial for the project and supported further improvements of the datasets.

Out of 48 data requests, 18 originated in Africa and 21 in Europe. The recently published journal papers and the representation of the SHARE project on international meetings raised the awareness on the product also by users from the USA, Australia, and variety of international organizations (Figure 1).

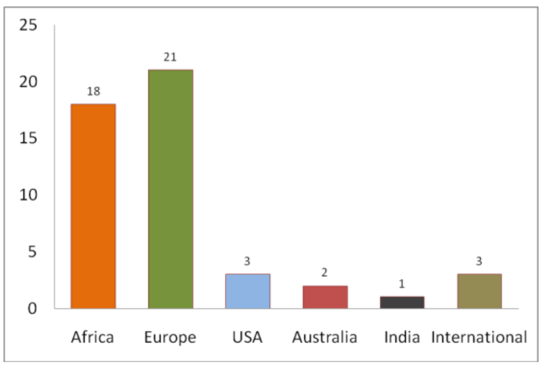

Figure 1. Origin of the ESA DUE SHARE project data users.

The soil moisture parameter has been implemented in variety of applied studies ranging from crop yield estimates, runoff prediction [4] to climate variability studies..A number of comparison and validation studies with in-situ [2, 5] modelled [6] and remote sensing datasets [7] has also been performed. These are described in detail in the next section.

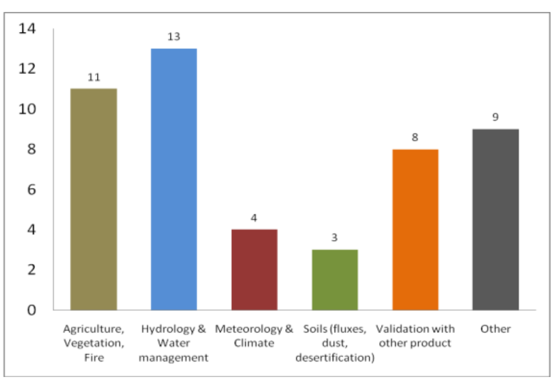

Figure 2. Applications of the ASAR GM soil moisture product by data users.

4. VALIDATION RESULTS

4.1. In-situ data

The soil moisture validation with in-situ data is difficult due to the low radiometric resolution of the ASAR GM, and the differences in the spatial and temporal scale of the remotely sensed products and in-situ measurements. Moreover, the remotely sensed soil moisture represents only upper few cm of soil while majority of in-situ networks represents soil moisture at >10cm.

A comparison of the ASAR GM SM dataset and in-situ soil moisture networks has been performed over Oklahoma MESONET network in the USA [2] and Goulburn catchment soil moisture network in south-eastern Australia [5]. The yielded average correlation coefficients were 0.75 for the Goulburn catchment and 0.6 for the MESONET network in-situ stations. The temporal trends in both in-situ station networks were captured well by the ASAR GM illustrating the potential of the ASAR GM soil moisture for global soil monitoring. In addition, a positive wet bias was found between ASAR GM and in-situ stations that may be due to the depth difference of soil moisture measured by in-situ (>10cm) and remote sensing data (<3cm).

4.2. Modelled data

An estimate of the soil moisture from a physically-based hydrological model (TOPKAPI) was compared to ASAR GM SM over Liebensbergvlei catchment in South Africa [6]. Results showed a good correspondence between the modelled and remotely sensed soil moisture, particularly with respect to the soil moisture dynamic, illustrated over two selected seasons of 8 months, yielding regression R^2 coefficients lying between 0.68 and 0.92.Vischel concludes that such a close similarity between these two different, independent approaches is promising for remote sensing in general as well as for the hydrological models to assimilate the remotely sensed soil moisture.

	cropl and	**rangeland**	**forest**	**Barren/sparsely veg.**
Mean R	0.91	0.74	0.65	0.53
Mean bias [%]	3.3	14.8	-3.6	23.3

Table 1. Mean statistics values comparing ASCAT SM and ASAR GM SM (averaged over ASCAT pixel) over different land cover types. (adapted from Sabel, 2008 [7])

4.3. Other remote sensing data

Despite the large differences in spatial and radiometric resolution of the ASAR GM and ASCAT soil moisture datasets the spatial agreement for the ASCAT and ASAR GM soil moisture products have been demonstrated over southeastern Australia and Oklahoma [7, 2].

Sabel [7] demonstrates a high average correlation with the ASCAT soil moisture product and discusses the role of land cover on the performance. The ASAR GM product performs best in areas with less dense vegetation, such as agricultural lands and crop lands. In areas with a dense vegetation canopy or deserts, the uncertainties in the extracted soil moisture values are large. Results are demonstrated in Table 1. The comparison of the ERS soil moisture and the ASAR over Oklahoma revealed a mean correlation coefficient of 0.54 [2].

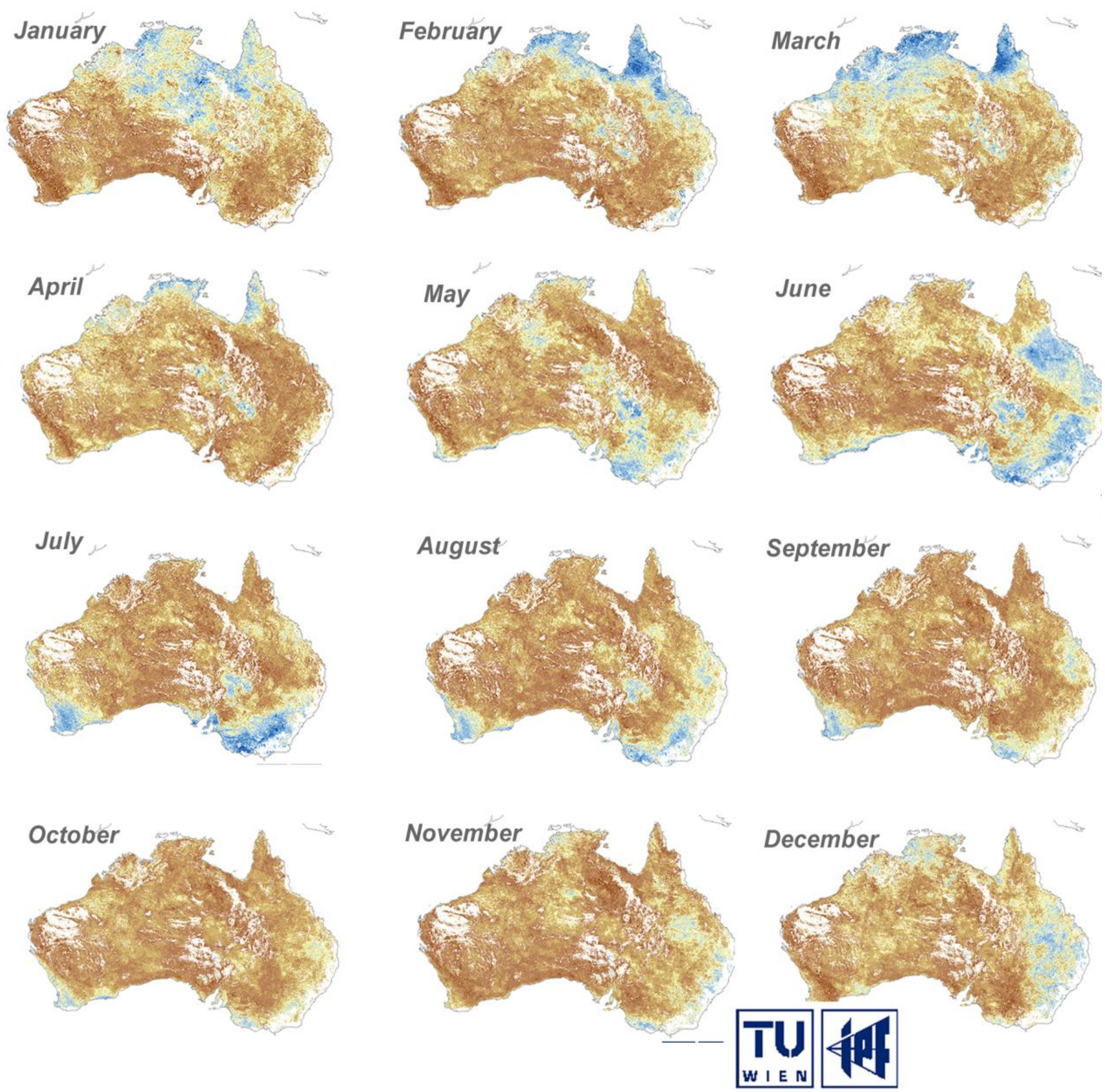

Figure 3. Yearly dynamics over Australia captured by the monthly mean ASAR GM SM product, 2007.

5. CONCLUSION AND DISCUSSION

The high correlation results have been revealed from the validation analyses of the ASAR GM SM product with other remote sensing datasets, modelled data as well as in-situ stations. This demonstrated the ability of ASAR GM SM for global soil moisture monitoring. The main aim of the SHARE ESA TIGER Innovator project was to freely distributes data on operational basis. The high number of data requests (~50) and subsequent user data evaluations prove its successful accomplishment.

Further research is, however, required to understand the errors caused by neglecting seasonal vegetation effects in the retrieval and to develop data assimilation techniques for the effective use of these data in hydrological and meteorological applications. The ASAR GM soil moisture data can be obtained from the SHARE project website: http://www.ipf.tuwien.ac.at/radar/share/.

9. REFERENCES

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