International Doctorate in Civil and Environmental Engineering

Innovative Use of Earth Observations into a Land Surface Model for Tracking Human Induced Changes to the Terrestrial Water Cycle

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Abstract

In recent years, human water needs have been steadily increasing, and are currently dominated by agricultural irrigation for food production world-wide. Correctly quantifying different water fluxes and storages and the effect of the human use on the terrestrial water cycle is one of the main challenges for the new generation of hydrologists. Objective of the research is to test the joint use of the Noah MP Land Surface Model (LSM) running within the NASA LIS framework, and remote sensing radar backscatter observations, integrated via data assimilation (DA), for improving the water cycle description and track the effect of the human impacts on it.

The research focuses over a study area within the Po river Valley (PRV, Italy), one of the most important agricultural areas in Italy. Particular emphasis is given to the detection and quantification of irrigation in order to identify its effect on the water cycle as one of the main human processes able to impact the water exchange between land and atmosphere. Output from the Noah MP LSM (running at 1km spatial resolution) will be optimally integrated with high resolution Sentinel-1 backscatter observations (1 km spatial resolution), which can theoretically detect both natural and anthropogenic processes and their interaction on the water cycle. It is indeed expected that the direct assimilation of level 1 microwave signal will most optimally partition the updates to soil moisture and vegetation, but extracting this information has not yet widely explored (Reichle et al. 2001; Balsamo et al. 2006, De Lannoy et al. 2013). The success (or not) of using backscatter data assimilation to correct for human driven fluxes will be investigated initially excluding

irrigated area and subsequently including an irrigation mask. An irrigation scheme (Ozdogan et al., 2010) will be additionally activated in the LSM, as part of LIS, and the performance of the scheme will be assessed comparing simulations with existing irrigation products (Brocca et al, 2018) and ground data of irrigation.

The study of optimal exploitation of Earth observations in LSMs will provide significant improvements for the management of water resources with additional economic and social benefits. An optimal characterization of the different components of the terrestrial water cycle will ensure in fact to better supply food, water and energy security to meet human needs.

References

Balsamo, G., Mahfouf, J.-F., Bélair, S., Deblonde, G. (2006) - A global root-zone soil moisture analysis using simulated L-band brightness temperature in preparation for the Hydros satellite mission. J. Hydrometeor., 7, 1126–1146.

Brocca, L., Tarpanelli, A., Filippucci, P., Dorigo, W., Zaussinger F., Gruber A., Fernandez-Pietro, D. (2018) – How much water is used for irrigation? A new approach using coarse resolution satellite soil moisture products. Int. Journ. Appl. Earth Obs. And Geoinf. 73, 752-766

De Lannoy, G.J.M., Reichle, R.H., Pauwels, V.R.N. (2013) - Global calibration of the GEOS-5 L-band microwave radiative transfer model over nonfrozen land using SMOS observations. Journal of Hydrometeorology, 14 (2013), pp. 765-785.

Ozdogan, M., Rodell,M., Beaudoing, H. K., and Toll, D. L. (2010) - Simulating the effects of irrigation over the United States in a land surface model based on satellite-derived agricultural data. J. Hydrometeorol., 11(1), 171–184.

Reichle, R. H., McLaughlin, D. B., Entekhabi, D. (2001) - Variational data assimilation of microwave radio brightness observations for land surface hydrology applications. IEEE Trans. Geosci. Remote Sens., 39, 1708–1718.