International Doctorate in Civil and Environmental Engineering

High resolution remote sensing for flood prediction

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Abstract

Monitoring the water cycle is fundamental to prevent and mitigate the effects of hydroclimatic hazards. The meteorological and hydrological monitoring stations spread in the world can provide data of the main components of the hydrological cycle like rainfall, discharge and soil moisture with high temporal resolution, but those stations have limited spatial representativeness and their number is declining (Kidd et al., 2011). Recent earth observations derived from remote sensing (i.e. radar, radar altimeters, and radiometers) are currently the only valuable alternative to ground-based networks as they have demonstrated their potential in the estimation of rainfall, soil moisture and discharge at relevant spatial and temporal scales globally. Nevertheless, the major limitation of satellite observations is the inherent "technological" compromise between temporal and spatial coverage. It is of primary importance to obtain data with high temporal and spatial resolution, in order to enhance the prediction capability of hydrological models thanks to the possibility of monitoring the variation of rainfall, soil moisture and discharge with high spatial and temporal details.
The new launched Sentinel Missions of the European Earth Observation program Copernicus, have opened new possibilities to overcome these issues, since each mission is composed by two satellites that share the same orbit 180° apart, obtaining high spatial resolution and halved revisit time.
The main objective of this PhD program is the exploitation of Sentinel high-resolution data for estimating soil moisture, rainfall and discharge, and their use in hydrological modelling for improving flood prediction and forecasting.

For estimating the needed hydrological variables (soil moisture, rainfall and discharge) from Sentinel observations, algorithms and techniques developed by the Hydrology group of the Research Institute for Geo-Hydrological Protection of National Research Council, that will support the candidate, will be implemented. Rainfall will be estimated from Sentinel-1 soil moisture data by

applying the recently developed SM2RAIN algorithm (Brocca et al., 2014), based on the inversion of the soil water balance equation that has been already successfully applied worldwide. Discharge can be obtained from Sentinel-2 multispectral data, by using the approach proposed by Tarpanelli et al. (2017) that is capable to obtain discharge data by comparing the difference in near-infrared band surface reflectance between land and water. All the techniques mentioned before has been applied to previous satellite sensors characterized by lower spatial resolution. Therefore, the first challenge of the PhD program will be their implementation to high-resolution observations from Sentinel missions.

References

Brocca L., Ciabatta L., Massari C., Moramarco T., Hahn S., Hasenauer S., Kidd R., Dorigo W., Wagner W., Levizzani V. – "Soil as a natural rain gauge: Estimating global rainfall from satellite soil moisture data". J. Geophys. Res. Atmos. vol. 119, pp. 5128–5141, 2014. doi: 10.1002/2014JD021489

Kidd C., Becker A., Huffman G. J., Muller C. L., Joe P., Skofronick-Jackson G., Kirschbaum D. – "So, how much of the earth's surface is covered by rain gauges?". American Meteorological Society vol. 98 pp. 69-78, 2017. doi:10.1175/bams-d-14-00283.1

Tarpanelli A., Brocca L., Lacava T., Melone F., Moramarco T., Faruolo M., Pergola N., Tramutoli V. – "Toward the estimation of river discharge variations using MODIS data in ungauged basins," Remote Sens. Environ. vol. 136, pp. 47–55, 2013. doi:10.1016/j.rse.2013.04.010