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A new global method of satellite dataset merging and quality characterisation constrained by the terrestrial water budget

Filipe Aires (1,2), Simon Munier (3), Victor Pellet (1,2)
(1) LERMA/Observatoire de Paris, France, (2) Estellus, Paris, (3) CNRM/Météo-France, France

During the last decades, satellite observations have increasingly been used to study the global water cycle. Although their value is now appreciated by the hydrology community, they are still limited by their uncertainties and their inability to close the water budget.

We show that it is possible to optimally integrate several datasets for each component of the terrestrial water cycle to close the budget at the basin scale by using only satellite observations, without any model assimilation (Aires et al. 2014; Munier et al. 2015). When considering enough basins and associated river discharges to constrain a closed domain such as the Mediterranean region, it is possible to develop a dedicated integration technique that closes simultaneously the terrestrial, oceanic and atmospheric water cycle budgets (Pellet et al. 2018). The budget closure constraint can be imposed simultaneously at multiple temporal and spatial scales.
Once a reference dataset is obtained to describe the water cycle in a hydrologically coherent way, it is possible to design an independent and simple calibration of each satellite dataset to reduce the overall budget residual. In order to extend this calibration procedure to the global scale, spatial interpolation/extrapolation techniques need to be used. We propose here to first classify pixels into surface types characterised by their NDVI and net precipitation values, and then use this surface classification to extrapolate worldwide the calibration of the satellite data. We show that this global calibration transforms the original datasets towards a consensus that is hydrologically more coherent, with a budget residual reduced by 26% (Munier et al. 2018). The calibrated datasets are compared to ground-based observations, showing an improvement for more than 65% of the sites tested. Furthermore, inconsistencies among the various satellite datasets can be used as a proxy for satellite observation uncertainties.

The quality of our calibration procedure is constrained by the availability of discharge measurements, and could therefore be improved in the future, as discharge measurement networks become more extensive. This approach opens new perspectives to generate long-term datasets at global scale based purely on all available satellites observations, which describe all the terrestrial water components useful for climate purposes.