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A global integration technique to describe the Mediterranean water cycle using satellite data

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The Mediterranean region has been identified as one of the main climate change hotspots by the Intergovernmental Panel on Climate Change (IPCC): its sensitivity to global change is high and its evolution remains uncertain. The region experiences many interactions and feedbacks at the oceanic, atmospheric, and hydrological level, while facing high anthropogenic activities. Analysing the water cycle over the Mediterranean region and the causes of its inter-annual variability are of major importance to environmental and socio-economic aspects. The monitoring of the Mediterranean WC represents one of the key challenges for the climate community.

This study is an effort for a better understanding and quantification of the hydrological cycle and related processes in the Mediterranean region, by using satellite EO. An increasing number of satellite missions can be used to monitor the Mediterranean region. However, using Earth Observations (EO) to study the water cycle is still a challenge, at the regional as at the global scale. Indeed, EO data suffer from numerous systematic and/or random errors and they are often not coherent with each other. Several integration techniques are currently being investigated to optimise the use of EO data to study the water cycle (Pan et al. 2012; Aires et al. 2014) at the basin (Shefield et al. 2009; Munier et al. 2016) or the global (Rodel et al. 2015; Munier et al. 2017) scales.
Our method does not only focus on the terrestrial hydrological processes; the full water cycle is examined by including its atmospheric and oceanic components too. The analysis is conducted at the monthly scale, and at the basin (i.e. entire drainage area of the Mediterranean and Black seas) or sub-basin (i.e. drainage area of a particular coastal region) scales. The best way to use the multiplicity of datasets will be investigated given the criteria of minimising the water cycle budget residual.

The integration approach allows obtaining a long-term dataset describing the full water cycle over the Mediterranean region, using only observations and no model. The closure of the water cycle is largely improved: the RMS of the WC budget residuals goes down to 3.55 mm/month over land and 5.27 mm/month in the atmosphere (i.e. an improvement of respectively 78% and 80% compared to the best direct satellite datasets). Evaluation is performed for precipitation and evapotranspiration, in addition to better close the water cycle budget, optimised datasets are also closer to in situ measurements. The spatial, multi-EO based component databases describing the terrestrial, oceanic and atmospheric water cycles over the Mediterranean are now proposed to the scientific community. This study is funded by the WACMOS-MED project of the European Space Agency (http://wacmosmed.estellus.fr/)