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Monitoring evapotranspiration from remote sensing data for groundwater resources evaluation

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Evapotranspiration (ET) is a fundamental variable of the hydrological cycle which plays a major role on surface water balance and surface energy balance. When regional information is required, e.g. for monitoring ground water resources, estimation of ET often relies on estimation from meteorological data through potential evapotranspiration formulas. At regional scale remote sensing provides spatially distributed information for mapping and monitoring ET, but this information is still rarely used for ground water assessment. Indeed, remote sensing estimation of ET suffers several drawbacks. In particular, remote sensing information by itself cannot provide a continuous monitoring of ET because of the presence of clouds and the revisit period of the sensor. Another difficulty originates in the lack of exhaustive evaluation of remote sensed ET since accurate ground measurements are scarce and representative of a limited number of homogeneous areas. This has also for consequence that a large number of methodologies to derive ET were developed with no real possibility of a consistent evaluation.
We have developed the EVASPA (EVapotranspiration Assessment from SPAce) tool to monitor ET on a daily basis, together with an evaluation of the associated uncertainties, from remote sensing data in the thermal and the solar domains. This tool combines the estimation of ET from various models and various sources of data, including MODIS sensors, LANDSAT-borne sensors and meteorological information. EVASPA was applied to estimate evapotranspiration over several areas in the South of France to help in monitoring the water budget of different hydrosystems: superficial aquifer in the Rhône river delta (Camargue), karstic aquifer of the Fontaine de Vaucluse spring system and alluvial aquifer in Limagne with increasing water withdrawing for irrigation.
The method was first evaluated against flux tower measurements (RMSE between 0.5 and 1 mm/day depending on the ecosystems). When integrated over watershed, ET retrievals were also compared to indirect estimates of evapotranspiration from either water balance and stream flow monitoring or other modelling approaches for time period of more than a decade (these include remote sensing operational products such as MOD16 or analysis of atmospheric-hydrological modeling such as the operational Safran-Isba-Modcou application). The results highlight the potential use of the retrieved ET for calibrating ground water models (e.g. for estimating aquifer parameters…) or evaluating model inputs (e.g. determination of effective rainfall, identification of irrigated areas…). We also evaluated the impact of the uncertainties in the estimation of ET in the monitoring of ground water. We showed that the main sources of ET uncertainty were related to the uncertainties in incident radiations and surface temperature together with the diversity of ET models. When forced in ground water models, the uncertainties in ET had an impact almost equivalent to the impact of uncertainties in rain inputs.