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Use of remotely-sensed thermal and microwave data to constrain regional estimates of surface water and energy balance

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The ability to accurately map the fluxes and stores of water in the landscape is an essential part of water resources assessment, with implications for water management and forecasting of future water availability. Land surface models (LSMs) provide estimates of soil moisture and evaporative fluxes for the continent, but model constraints are limited to data from a small number of scattered in-situ monitoring sites (e.g., gauged catchments and flux towers).

Other potential data sources to constrain LSMs are the indirect measurements from remote sensing systems. Satellite-based remote sensing data have the advantage of continental spatial coverage and sub-daily observation frequency. However, with the exception of some spectral radiance-based image products, LSM outputs rarely match what is measured by the satellite sensor. Therefore, if these data are to be of use, it is necessary to either develop retrieval schemes that derive as accurately as possible from the satellite observations the land surface variables that correspond to model output, or develop appropriate observational models that relate the LSM states/variables to the remotely-sensed observations.

This paper describes three aspects of the use of satellite-based thermal and microwave observations to constrain regional estimates of surface energy and water balance components of a LSM being developed as part of an alliance between the Australian Bureau of Meteorology and CSIRO. Firstly, we examine geostationary imagery as a constraint on surface energy fluxes by assessing the accuracy of land surface temperature (LST) retrievals from the MTSAT-1R satellite and test long-held assumptions regarding diurnal variability in the partitioning of latent and sensible heat fluxes. Secondly, we explore time series of near-surface soil moisture content (SMC) retrievals from passive microwave brightness temperature observations, from a range of polar-orbiting platforms, as constraints for modelled near-surface SMC. The usefulness of remotely-sensed LST and SMC estimates in constraining estimates from the LSM is assessed against the networks of flux tower observations, in-situ soil moisture monitoring and stream flow measurements around Australia. Thirdly, we demonstrate the complementarity of these two data sets by identifying the set of environmental conditions affecting their relative performance as observational constraints.