Estimating Surface Heat Fluxes from Remote Sensing, Process Models and Regional Climate Simulations

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Introduction
Accurate estimation of surface heat fluxes is of considerable interest to meteorological, climatological and agricultural investigations. While characterising surface fluxes is critical in describing the partitioning of water and energy across Earth’s terrestrial surfaces, accurately monitoring the spatial variation, particularly at daily and sub-daily temporal scales, is notoriously difficult. To robustly evaluate the performance of different techniques for estimating latent heat flux requires the development of a common forcing dataset. Here, output from multi-annual simulations of the Weather Research and Forecasting (WRF) model developed over Australia’s Murray Darling Basin (MDB) are used as the principal forcing data with which to drive a number of common flux estimation approaches to examine the variation and consistency within a variety of estimation approaches.

Model Descriptions and Forcing Data
Land and atmospheric forcing data were derived from Weather Research and Forecasting (WRF) model. Simulations of a coupled WRF-NOAH model over the MDB from the period covering 1985-2010 have been carried out at a 3 hourly time step with 10 km resolution (Evans and McCabe, 2010). Initial boundary conditions were derived from the NCEP/NCAR reanalysis. These forcing were then applied to the following algorithms to assess ET:

- **Surface Energy Balance System (SEBS):** Estimation of sensible heat flux using Monin-Obukhov Similarity Theory (MOST) with scaling based on Su (2002);
- **Penman-Monteith (PM):** based on PM equations as described in Brutsaert (2005) with estimation of surface resistance as employed in NOAH LSM (Chen, 2007);
- **Modified Priestly-Taylor (PT):** Based on Fisher et al (2008) approach and using vegetation indices derived from global monthly MODIS NDVI;
- **Advection-Aridity (AA):** based on the concept of Bouchet (1963) but using formulation in Brutsaert (2005), relying solely on meteorological parameters. Roughness parameter derivations are based on the methodology by Massman (1997) and Su et al (2001) with vegetation height derived from NOAH look-up tables.

Comparisons against selected Global Land Data Assimilation System (GLDAS) land surface model output for the MDB are also provided to evaluate operational systems against the Regional Climate Model (RCM) WRF output at point and regional scales.

Multiple ET Algorithm Intercomparison with Common Forcing
To examine the degree of variability in different approaches for surface heat flux estimation, algorithms were driven with common WRF forcing. Although input requirements for some techniques are not common to all models, all forcing was derived from the WRF simulations.

Discussion and Future Work
There is considerable variability between different estimation techniques across the MDB domain. Understanding the cause of these discrepancies is an ongoing effort. Identifying the most appropriate approach is a challenging task, particularly as there is a paucity of in-situ measurements to assess retrievals against. Remote sensing data offer one approach to address issues of consistency, but currently lack the capacity to quantitatively assess the different techniques available for flux prediction.


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