Land evapotranspiration in reanalyses: Comparisons to observations-based datasets, land-surface models and IPCC AR4 simulations

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Evapotranspiration (ET) is an important variable of the hydrological cycle, influencing climate in various ways. Several global ET datasets have recently been derived with diverse techniques. However, a validation of these datasets is difficult, because ET cannot be directly measured on a large scale. The LandFlux-EVAL project, which originates from the LandFlux initiative of the GEWEX Radiation Panel, aims at evaluating and comparing different existing land ET products. We focus on observations-based data, land-surface model output and atmospheric and land reanalyses (ERA-Interim, MERRA, MERRA-Land, NCEP/NCAR and JRA25). Additionally, an evaluation of simulations from global climate models that were conducted for the 4th Assessment Report of the IPCC (IPCC AR4) is presented. Preliminary results with analyses of IPCC AR5 simulations will also be discussed.

The diagnostic datasets specifically derive ET from observations or observations-based estimates while all other datasets provide ET estimates as a byproduct. The diagnostic datasets, land surface models (LSMs) and reanalyses are also referred to as 'reference datasets'. The analyzed time period is 1989-1995 for all datasets and multi-year means, and 1989-2005 for the assessment of annual and inter-annual variability of a subset of the datasets.

In global average, ET from reanalyses is roughly 4% higher than that from diagnostic datasets and 16% higher than that from LSMs. The NCEP/NCAR reanalysis, followed by MERRA, displays the largest multi-year mean ET values in global average, and the former also in several river basins that have been chosen for analysis. The within-category spread between global ET values from different datasets is similar for all categories, i.e. for diagnostic datasets, LSMs, reanalyses and IPCC AR4 model output. Even though the studied datasets are mostly based on different measurements and models, they also show similarities regarding their spatial patterns and reveal few regions with significant differences. Reanalyses display significantly higher ET values than the reference datasets in northern regions, East Asia and Central Africa, while IPCC AR4 simulations show higher ET values as well as higher inter-model spread than the other dataset groups in semi-arid regions.

In order to study cross-relationships between the analyzed datasets, a hierarchical cluster analysis of multi-year mean ET was performed. In the resulting cluster tree, the datasets are sorted in a way that the degree of association between two datasets being next to each other in subbranches of the tree is maximal. LSMs driven with the same forcing data are situated in the same branch of the tree, except for one model. This indicates that these datasets are similar to each other. Reanalysis datasets, which assimilate different observations, are separated from each other. These findings point at a critical role of forcing data for the resulting ET patterns.

An analysis considering both ET and precipitation from the different datasets reveals that not only ET, but also precipitation is high in the reanalyses compared to the other analyzed datasets. We further present an analysis of seasonal cycles and short term trends in ET for different climate regions. Preliminary results have shown a positive trend in ET from 1989 to 1997, followed by a decline in trend (1998-2005), both globally and in Southern hemisphere arid regions in nearly all the considered datasets. The global ET trend decline amounts to $12.5 km^3/year^2$. In more humid climate regions, such as the tropics, the considered ET and precipitation datasets do not agree in the trend changes.

The main constraint for the validation of ET products is the lack of large-scale in-situ validation data. This presentation provides a comparison of ET from reanalyses, diagnostic datasets, LSMs and output from IPCC AR4 global climate models. Even though land-surface variables are not assimilated in atmospheric reanalyses, the resulting 'uncertainty' (inter-quartile range between datasets) in ET in this category does not differ substantially from the uncertainties in other dataset categories.

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