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Understanding Hydrometeorology using Global Models and Surface Observations

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Models are a powerful tool for understanding the coupling of physical processes. We have developed a new methodology for understanding the coupling and feedbacks between physical processes in models, so that different models can be compared with each other and with data. We illustrate this first using model data from ERA-40 for the Madeira River, a south-western basin of the Amazon, which has a large seasonal cycle with a dry season in the austral winter. Daily-mean land-surface fluxes and state variables can be used to map the transitions of the surface 'climate' of a model; and to quantify the links between the soil moisture, the mean cloud-base and cloud field, the short-wave and long-wave radiation fields at the surface, the vertical motion field, the atmospheric precipitable water and the surface precipitation. Several important surface processes are strongly influenced by soil moisture: relative humidity which gives the mixed sub-cloud layer depth, low cloud cover and the surface net long-wave flux. Surface evaporation is controlled as much by the feedback of the cloud field on the surface radiation budget as by soil moisture. Above the surface the cloud field and precipitation is coupled to the large-scale dynamics, specifically the mid-tropospheric omega field. We then use long time-series of daily mean data from the three BERMS flux sites in central Saskatchewan to explore biases in ERA-40 on the grid-point scale, and to study the relationships between surface variables and fluxes and cloud cover in the observed and model data sets. On the seasonal timescale the biases in ERA-40 of temperature and humidity are small, but the model has a high bias of evaporative fraction in the warm season, and except in mid-summer a low bias of reflective cloud, which gives a high bias in the surface downward net shortwave flux. The internal relationships between near-surface relative humidity, linked to the mean lifting condensation level, cloud cover and the surface radiation fluxes are however very similar in model and data.