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Streamflow Assimilation: On the Effect of Model Biases

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While soil moisture is the single most important variable in hydrological and climate modelling, it remains difficult to accurately determine its spatial and temporal distribution through either observations or modelling. In the last two decades the use of passive microwave remote sensing to obtain this information has been brought to the forefront, but microwave emissions from the soil surface are masked by dense vegetation, meaning that the soil moisture signal cannot be remotely sensed under such conditions. Moreover, the use of models to determine the soil moisture states in such areas is prone to errors due to uncertainties in the initial conditions and forcing data. However, synthetic studies have shown that the assimilation of streamflow observations with a variational-type assimilation scheme may be used to retrieve soil moisture states in these areas. The limitation of such studies has been the assumption that model predictions are unbiased, but this is not typically the case. Streamflow predictions using the Catchment Land Surface Model for the 7000km^2 Goulburn River experimental catchment in south-eastern Australia were found to be significantly overestimated while soil moisture was well modelled. The assimilation of observed streamflow showed some improvement to the modelled streamflow and the soil moisture states. However, the potential improvement to streamflow was limited by the ability to reduce soil moisture below the wilting point, which would have resulted in degraded soil moisture estimates. Consequently, several model modifications were required to minimise the biases in predicted streamflow. The most significant modification was to allow for cracking soils under dry conditions, which effectively increased the infiltration capacity of the soil and to shut off runoff production under dry conditions.