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The role of model selection in representing evapotranspiration processes in climate impact assessments

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Projected changes to near-surface atmospheric temperature, wind, humidity and solar radiation are expected to lead to changes in evaporative demand – and thus changes to the catchment water balance – in many catchments worldwide. To quantify likely implications on runoff, a modelling chain is commonly used in which the meteorological variables are first converted to potential evapotranspiration (PET), followed by the conversion of PET to runoff using one or more rainfall-runoff models. The role of the PET model and rainfall-runoff model selection on changes to the catchment water balance is assessed using a sensitivity analysis applied to data from five climatologically different catchments in Australia. Changes to temperature have the strongest influence on both evapotranspiration and runoff for all models and catchments, whereas the relative role of the remaining variables depends on both the catchment location and the PET and rainfall-runoff model choice. Importantly, sensitivity experiments show that 1) distributions of climate variables differ for dry/wet conditions; 2) seasonal distribution of changes to PET differs for driving variables. These findings suggest possible interactions between PET model selection and the way that evapotranspiration processes are represented within rainfall-runoff model. For a constant percentage change to PET, this effect can lead to five-fold difference in runoff changes depending on which meteorological variable is being perturbed.