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Abstract: WAVES is a daily time-step one-dimensional vegetation, water and energy transfer model that has been used extensively across Australia (and globally) to simulate ecohydrological processes. In particular it has been used extensively for assessing future recharge under climate change. A literature review suggests parameter values from the user manual are most commonly used in research. This suggests that further investigation into the stability and equifinality of the parameters might be warranted, specifically since the model is used for scenario studies. This study made use of an extensive sapflow and soil moisture data set for 7 tree vegetation sites in the Cotter catchment in the ACT in Australia. Uncalibrated, and including best measured and guessed parameters the WAVES model simulations deviated considerably from the observed data. Calibration was augmented with satellite evaporation (ET) and leaf area index (LAI) timeseries. To limit overparameterisation, sensitivity analysis identified 6 vegetation and 6 soil parameters for calibration using different combinations of calibration data and using the Shuffled Complex Evolution optimisation algorithm. The results highlight parameter equifinality and instability despite the wealth of calibration data. There were significant differences between sites and calibration datasets in terms of parameter identification. Model calibration based on state variables (MODIS LAI and soil moisture) in general performed far worse than model calibration based on flux variables (sapflow and MODIS ET), but in both cases parameter values varied widely. Overall this suggests that a high level of caution is warranted for using a detailed vegetation model such as WAVES without clear measured parameter values. That is, this information cannot be obtained through calibration as the interactions between the parameters prevent the model from finding a solution. In addition, detailed models such as WAVES are best used for system behaviour exploration and hypothesis testing rather than for scenario development and predictions.

***Keywords**:* ecohydrology, model, uncertainty, equifinality