Examining wheat yield sensitivity to temperature and precipitation changes for a large ensemble of crop models using impact response surfaces

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Impact response surfaces (IRSs) depict the response of an impact variable to changes in two explanatory variables as a plotted surface. Here, IRSs of spring and winter wheat yields were constructed from a 25-member ensemble of process-based crop simulation models. Twenty-one models were calibrated by different groups using a common set of calibration data, with calibrations applied independently to the same models in three cases. The sensitivity of modelled yield to changes in temperature and precipitation was tested by systematically modifying values of 1981-2010 baseline weather data to span the range of

changes projected for the late 21st century at three locations in Europe: Finland (northern, mainly temperature-limited), Spain (southern, mainly precipitation-limited) and Germany (central, high current suitability). Only a baseline CO_2 level was considered and simplified assumptions made about soils and management with an aim to distinguish differences in model response attributable to climate.

The patterns of responses depicted in the IRS plots can be used to compare model behaviour under a range of climates, evaluate model robustness, locate thresholds, and identify possible model deficiencies while searching for their causes. Preliminary results indicate that while simulated absolute yield levels vary considerably between models, inter-annual relative yield variability for baseline conditions is remarkably consistent across models, especially for spring wheat. Results are sensitive to calibration method, as the same models calibrated by different groups exhibited contrasting behaviour. Further work will examine other responses (e.g. CO_2 and adaptation options) and combine IRSs with probabilistic climate to evaluate risks of yield shortfall.