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Changes in yields and their variability at different levels of global warming

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An assessment of climate change impacts at different levels of global warming is crucial to inform the political discussion about mitigation targets as well as for the inclusion of climate change impacts in Integrated Assessment Models (IAMs) that generally only provide global mean temperature change as an indicator of climate change. While there is a well-established framework for the scalability of regional temperature and precipitation changes with global mean temperature change we provide an assessment of the extent to which impacts such as crop yield changes can also be described in terms of global mean temperature changes without accounting for the specific underlying emissions scenario. Based on multi-crop-model simulations of the four major cereal crops (maize, rice, soy, and wheat) on a 0.5 x 0.5 degree global grid generated within ISI-MIP, we show the average spatial patterns of projected crop yield changes at one half degree warming steps. We find that emissions scenario dependence is a minor component of the overall variance of projected yield changes at different levels of global warming. Furthermore, scenario dependence can be reduced by accounting for the direct effects of CO_2 fertilization in each global climate model (GCM)/impact model combination through an inclusion of the global atmospheric CO_2 concentration as a second predictor. The choice of GCM output used to force the crop model simulations accounts for a slightly larger portion of the total yield variance, but the greatest contributor to variance in both global and regional crop yields and at all levels of warming, is the inter-crop-model spread. The unique multi impact model ensemble available with ISI-MIP data also indicates that the overall variability of crop yields is projected to increase in conjunction with increasing global mean temperature. This result is consistent throughout the ensemble of impact models and across many world regions. Such a hike in yield volatility could have significant policy implications by affecting food prices and supplies.