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SUPPLEMENTARY INFORMATION

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Historical effects of CO_2 and climate trends on global crop water demand

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Supplementary Figures:

Historical Effects of CO_2 and Climate Trends on Global Crop Water Demand

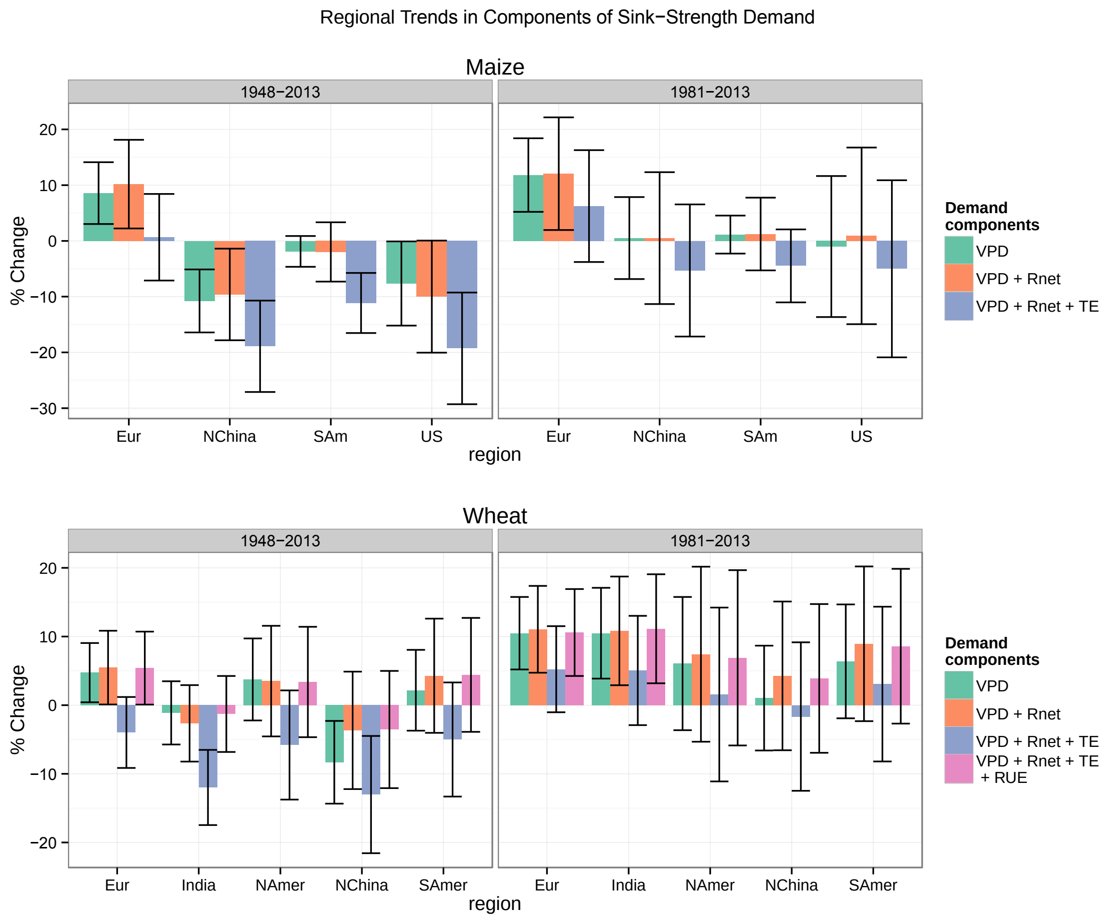

Figure S1. Equivalent to paper Fig. 2c, but for each regional aggregate rather than global aggregate. While regional variation in sign and magnitude of demand changes exists, the general pattern of RUE and TE roughly offsetting each other in wheat (a C3 crop) crop holds across regions, while the absence of an RUE effect for maize leads to a sink-strength demand that is significantly lower than atmospheric demand in all regions.

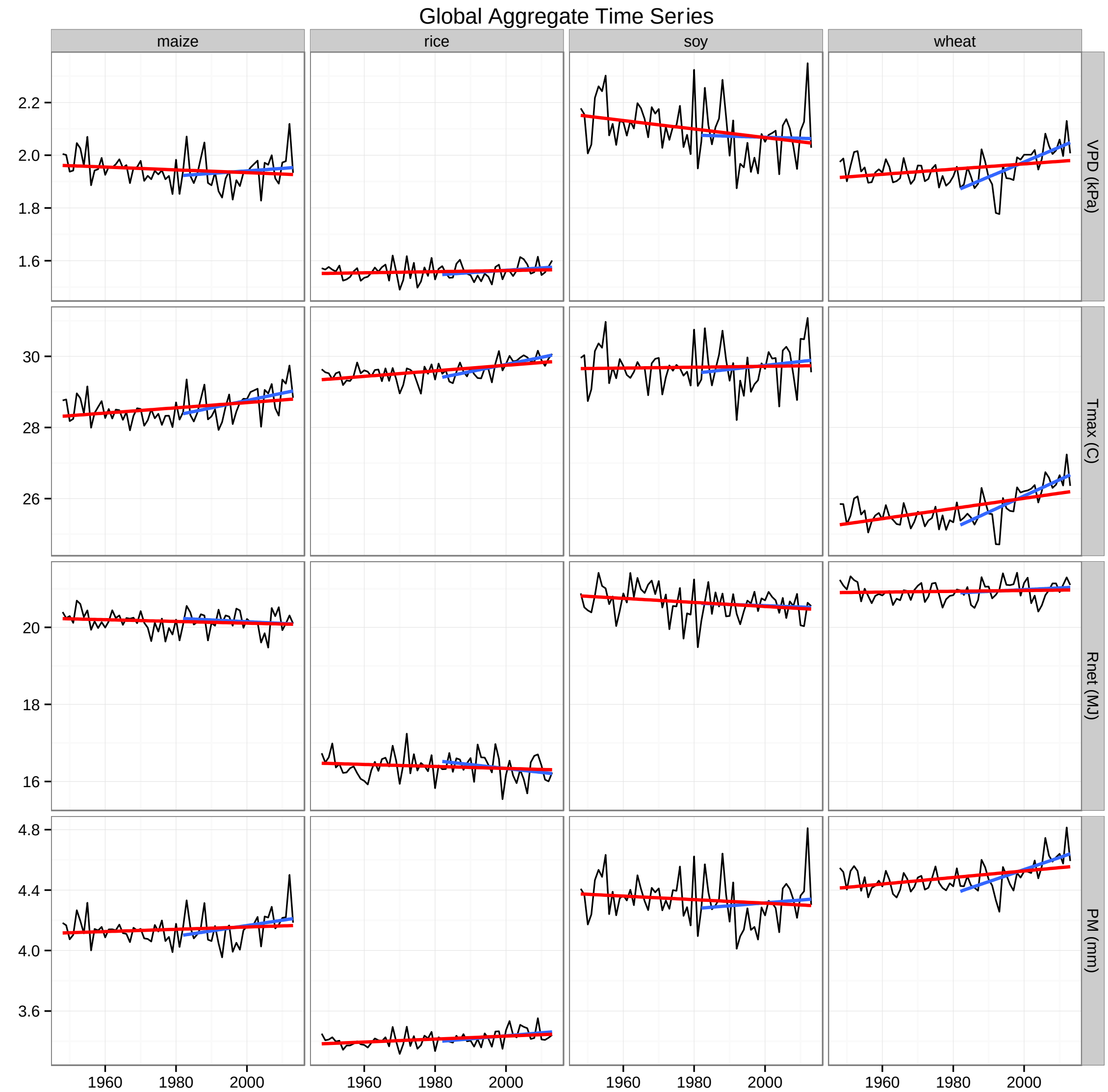

Figure S2. Time series of key meteorological variables, aggregated by crop area over all grid cells. Long-term trends in these variables (red lines), and hence also in crop water demand, owe mostly to the much sharper increases in the post-1980 period (blue lines).

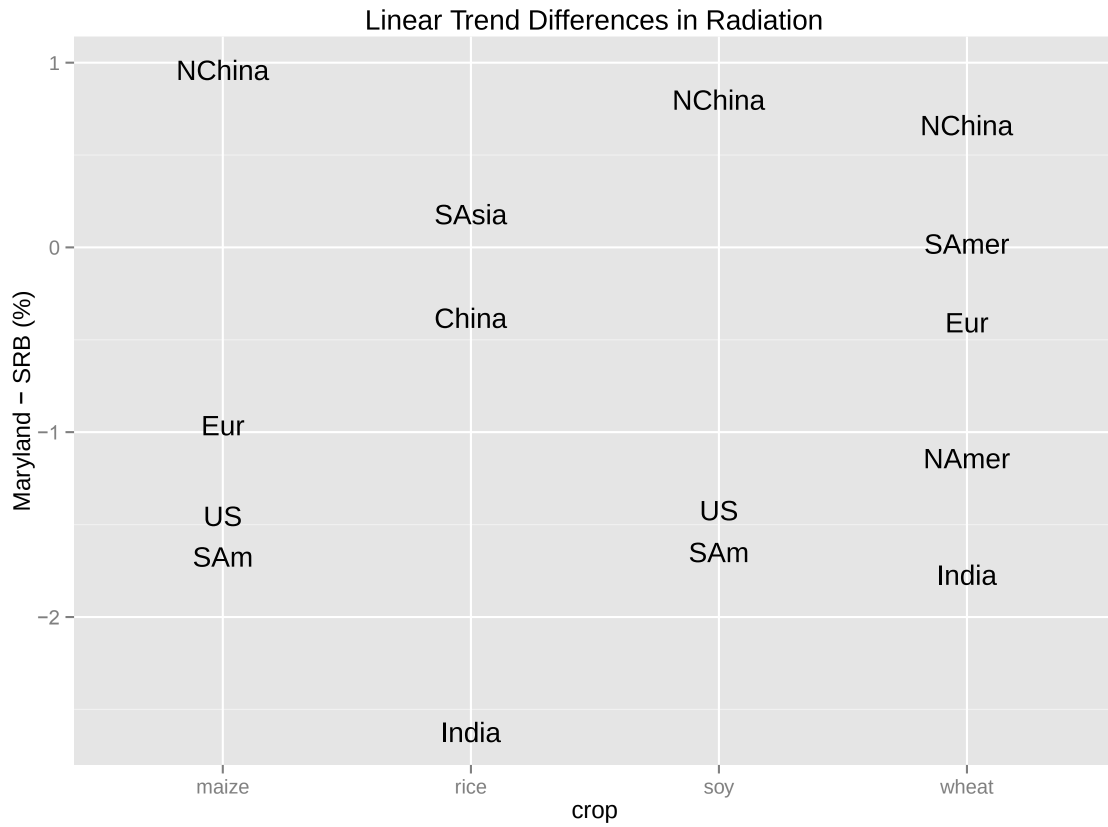

Figure S3. Difference in the percent changes over 1981-2013 between the Maryland and SRB radiation datasets. Before this period, the two datasets differ negligibly. For most crops and regions, radiation trends agree within 1 to 2%, indicating that uncertainty in radiation trends is likely not a major source of uncertainty in demand trends.

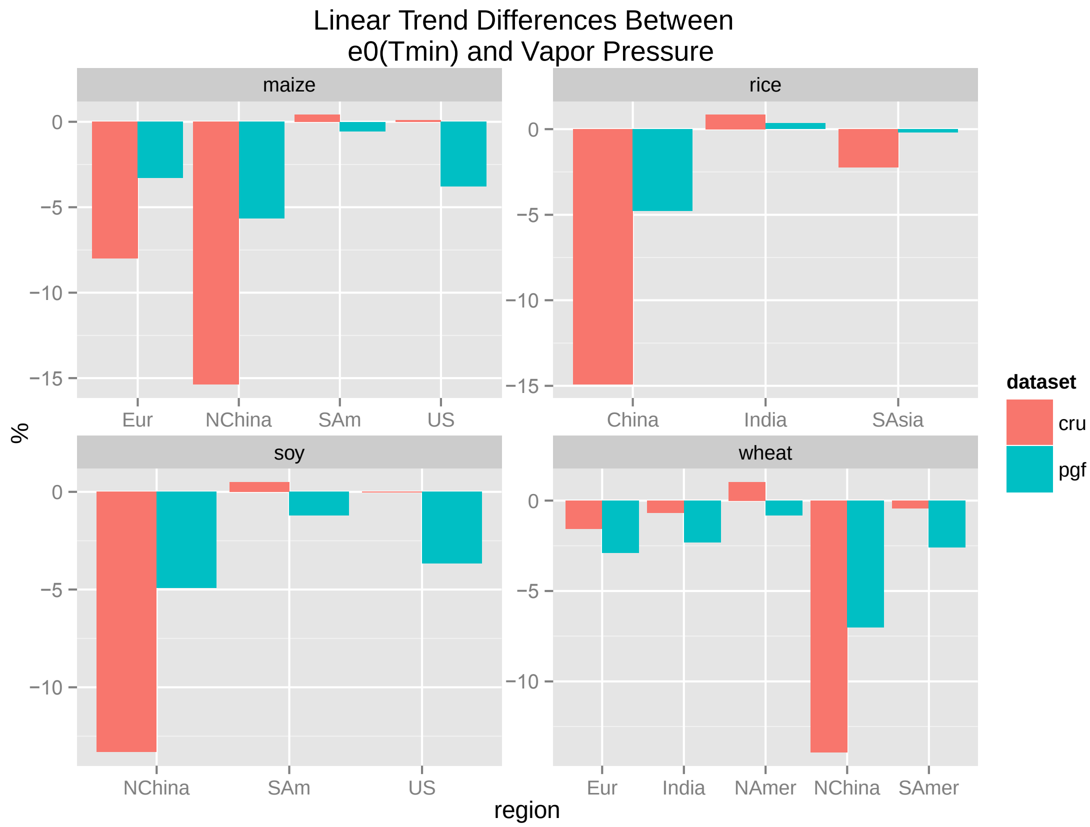

Figure S4. Percent differences between a VPD formulation assuming saturation at Tmin, and one instead using surface vapor pressure as taken from each gridded dataset. In all crops, China is the obvious outlier in which choice of VPD formulation makes a significant difference. This difference is especially great when using CRU data, which have relatively poor coverage over China and indicate much larger humidity increases than the PGF data.

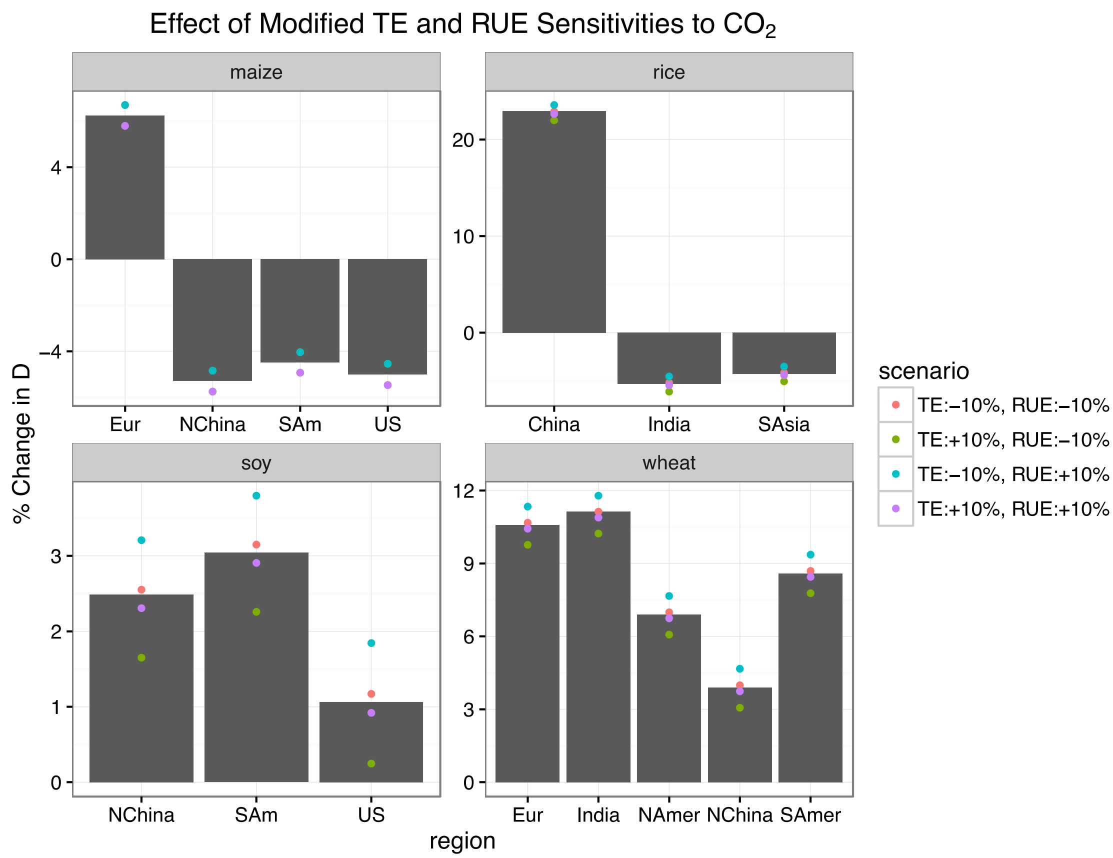

Figure S5. The sink strength model scales constant, crop-specific values by CO_2-varying coefficients f_c and f_{c_TE} to obtain combined, CO2-dependent values of RUE and TE, respectively. A consideration for our study, therefore, is the sensitivity of our results to f_c and f_{c_TE}. To examine this, we vary f_c and f_{c_TE} by 10% in both positive and negative directions, and recompute the percent changes in water demand (D) over the 1981-2013 time period. The bar heights in this figure represent D at the nominal f_c and f_{c_TE} values, and are therefore equivalent to the corresponding values in Figure 3 in the main text. The colored dots represent the values of D at increased(decreased) values of f_c and f_{c_Te}. The change in D with changes in sensitivity to CO_2 is small for most crops and regions, such that the main conclusions regarding which crops and regions have seen the largest demand increases do not appreciably change under reasonable perturbations to CO_2 sensitivity.

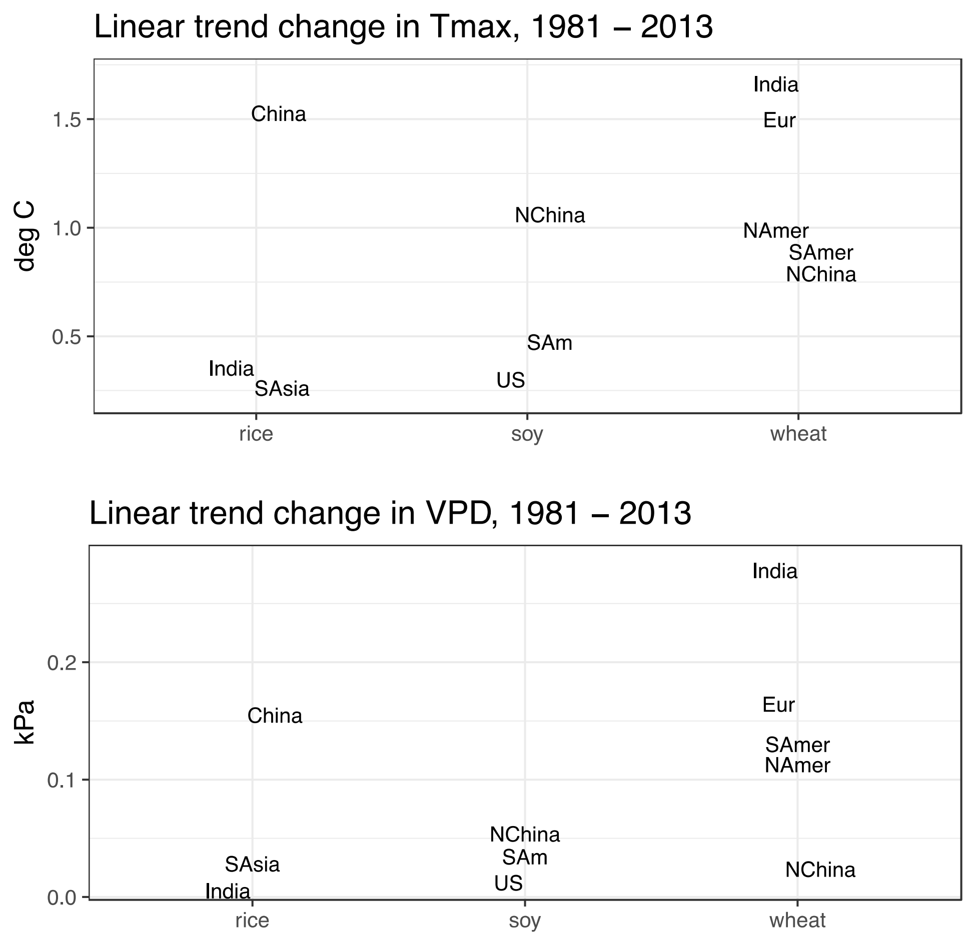

Figure S6: Here we explicitly provide the regional changes in VPD and Tmax over 1981-2013 that contribute to the global trendlines seen in Figure S2. We focus on the C3 crops to demonstrate that it is largely differing weather trends, rather than differing RUE and TE responses, that drive the global aggregate demand change values. For example, changes in wheat are largely driven by Tmax and VPD changes in India and Europe, which account for almost half of the global wheat area used in this study, and thus have a heavy influence on the global aggregate.