

Supplementary Materials for

Synchronous crop failures and climate-forced production variability

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The PDF file includes:

Fig. S1. SST and crop yield anomalies during a year transitioning from El Niño to La Niña.

Fig. S2. SST, geopotential height, and crop yield anomalies associated with the NAO, TAV, and IOD.

Table S1. Crop production anomalies during a year transitioning from El Niño to La Niña.

Other Supplementary Material for this manuscript includes the following:

(available at advances.sciencemag.org/cgi/content/full/5/7/eaaw1976/DC1)

Crop yield anomalies and long-term yield trends for each statistical reporting unit from 1980 to 2010 (.zip format).

Table S1. Crop production anomalies during a year transitioning from El Niño to La Niña. ENSO-forced crop yield anomalies from SI Figure S1 ENSO-forced crop yield anomalies from SI Figure S1 converted to production anomalies using 2010 harvested area. Units are meaningful in a relative sense only, as they are millions of tonnes per one standard deviation of time expansion coefficient for mode one plus mode two. Globally, ENSO forces offsetting anomalies for wheat and soy, but not for maize. The Middle East region includes Afghanistan and Pakistan as well, but not Turkey, which is included in Europe.

Region	Soy	Wheat	Maize
Global	2.4	0.5	-43.1
United States	-10.2	5.9	-53.1
Australia	0.0	9.4	-0.1
southeast South America	14.8	2.6	8.1
India	2.8	-3.2	3.0
China	-4.3	-1.6	15.5
Eurasia	-0.3	-10.5	-5.8
Canada	-0.1	-2.0	0.4
southeast Africa	-0.1	0.1	-6.5
central and north Brazil	0.4	0.0	-2.5
west Africa	0.0	0.0	-1.7
Mexico	0.0	-0.2	0.9
East Africa	0.0	0.5	0.8

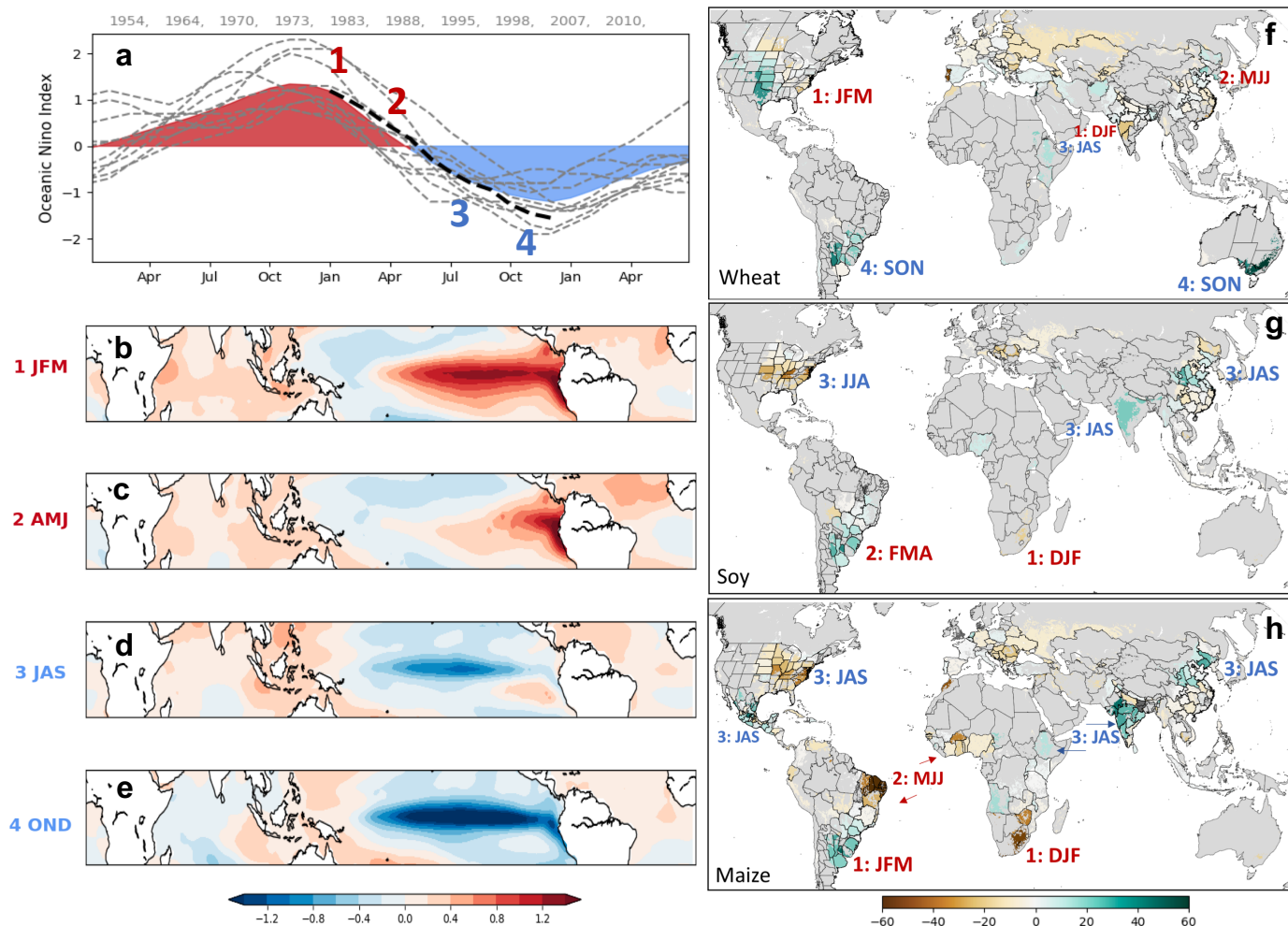


Fig. S1. SST and crop yield anomalies during a year transitioning from El Niño to La Niña. Results of the MCA analysis for ENSO. Typical SST anomalies °C during an El Niño to La Niña life cycle in the Niño 3.4 region in observations (grey dotted lines, shading up to ensemble mean) and as represented by the ENSO modes in the MCA analysis (black dotted line) in **a** .Spatial SST modes 1+2 (°C) averaged into seasons in **b-e**, also indicated on **a** . Panels **f-h** show the corresponding crop yield modes (anomalies in percent of expected yield) for wheat, soy, and maize, respectively. The numbers in all panels refer to seasons: (1) mature El Niño, boreal winter, (2) decaying El Niño, boreal spring, (3) developing La Niña, boreal summer, and (4) mature La Niña, boreal fall. The number coloring refers to the ENSO state during that season. The seasons next to yield anomalies correspond to the timing of ENSO teleconnections, which are often, but not always, around flowering. The first two SST and crop yield modes are each scaled to one half standard deviation before being added to match the evolution of an average event (see panel **a**).

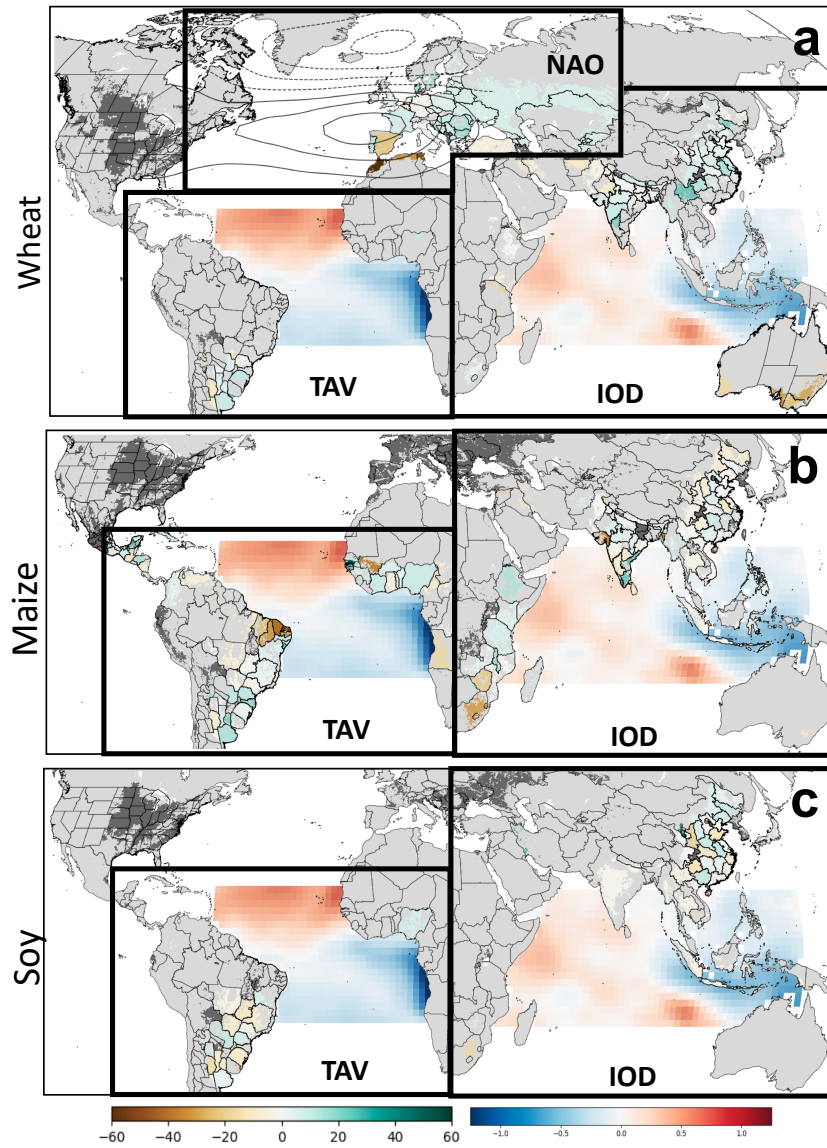


Fig. S2. SST, geopotential height, and crop yield anomalies associated with the NAO, TAV, and IOD. Results of the MCA analysis for the IOD, TAV and NAO. Right panels: spatial pattern of NAO, TAV and IOD-forced crop yield and geopotential height (contours, NAO only) or sea surface temperature anomalies (colors, TAV and IOD only). Climate modes have been averaged into seasonal means, and are repeated in each panel for each crop. Bounding boxes indicate approximate domains used for each analysis (see methods for details).