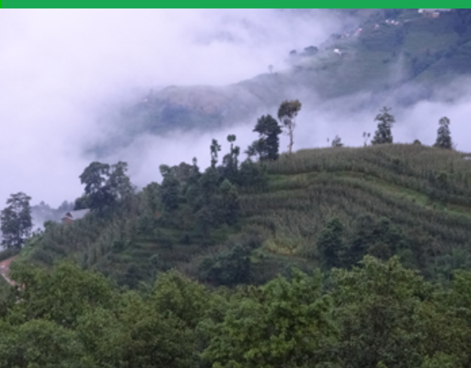
AgMIP

Weather and Climate Tools for Food Shocks Modeling

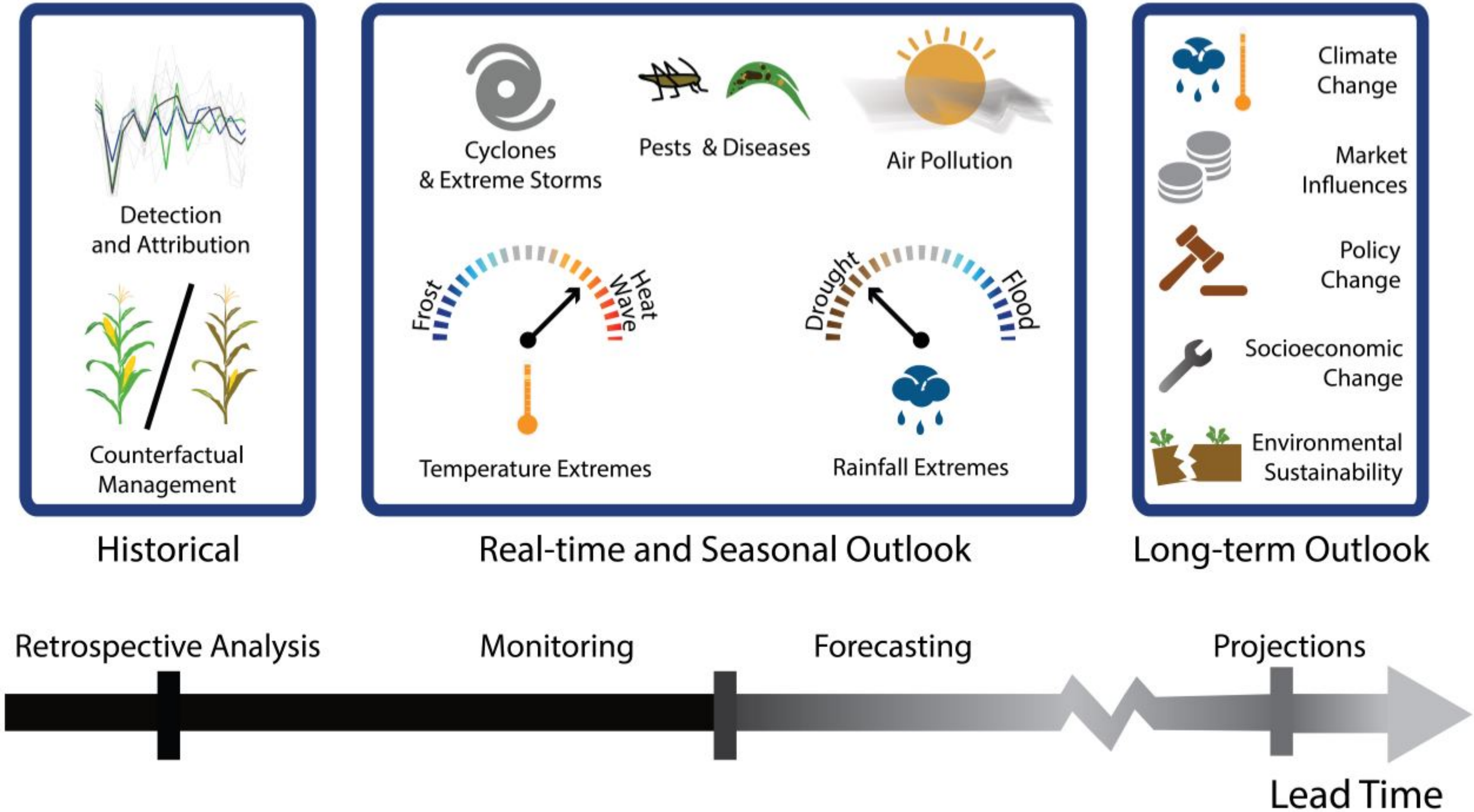



Alex Ruane, NASA Goddard Institute for Space Studies

AgMIP/AGCI Next-Generation Food Shocks Modeling Workshop

Aspen Global Change Institute
Aspen, Colorado
May 21st, 2019

Climate Resources Vary by Time Horizon

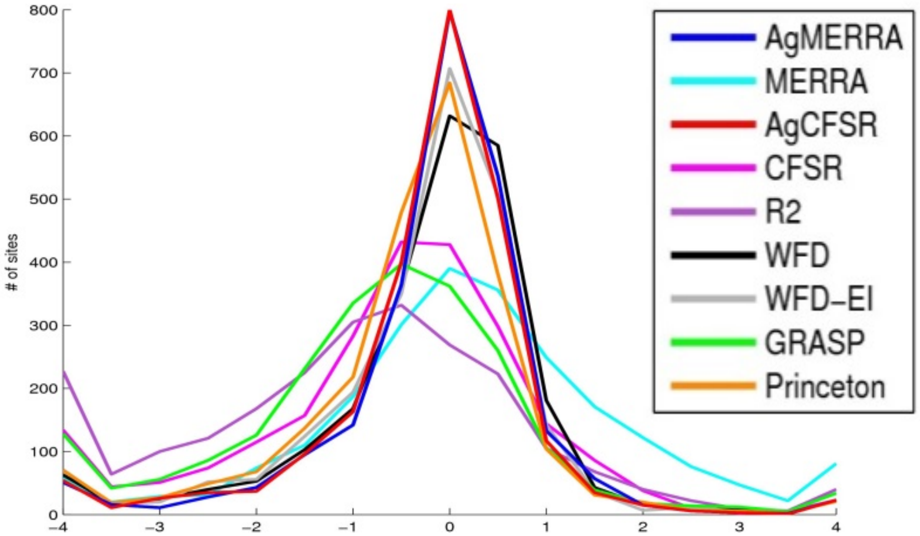


Ruane et al., in prep.

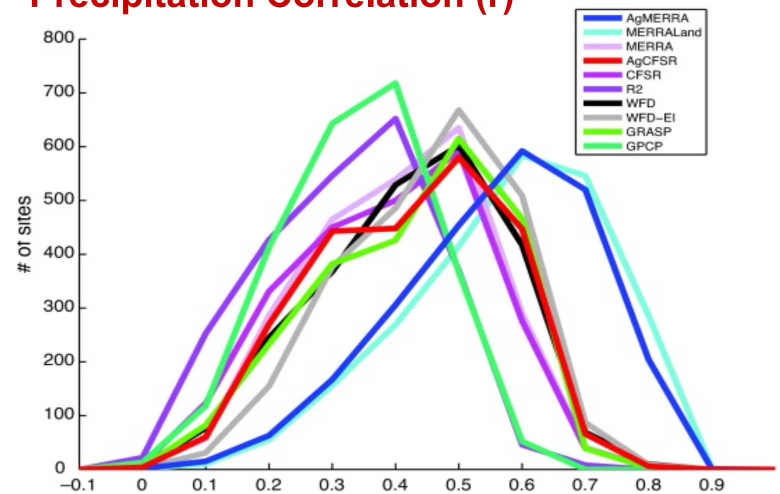
AgMERRA: Historical Climate Dataset for Agricultural Model Applications

Ruane et al., 2013

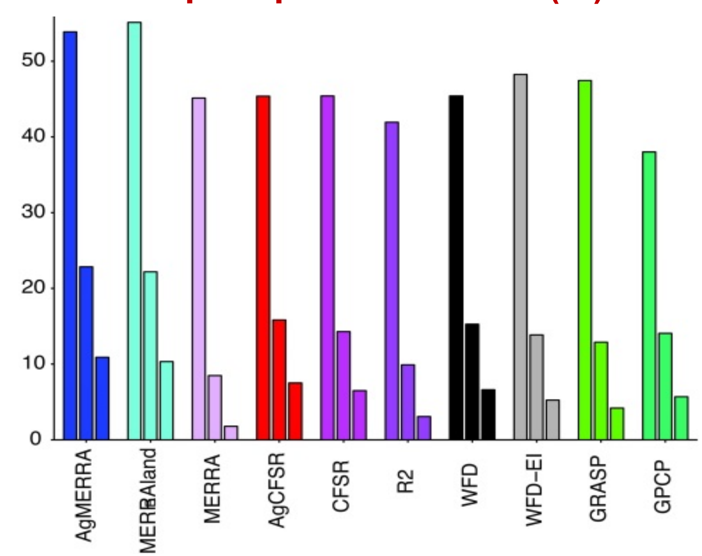
Avg of Tmax and Tmin Biases (°C)



Precipitation Correlation (r)



Threat score for 1, 25, and 50mm precipitation events (%)



AgMERRA features:

- Improved solar radiation (NASA/GEWEX SRB)
- Improved precipitation variability (MERRA-land)
- Fine spatial patterns of rainfall from satellites
- An adjustment to diurnal temperature range
- Relative humidity at Tmax

AgMERRA better captures rainfall distribution and actual sequence of extreme events

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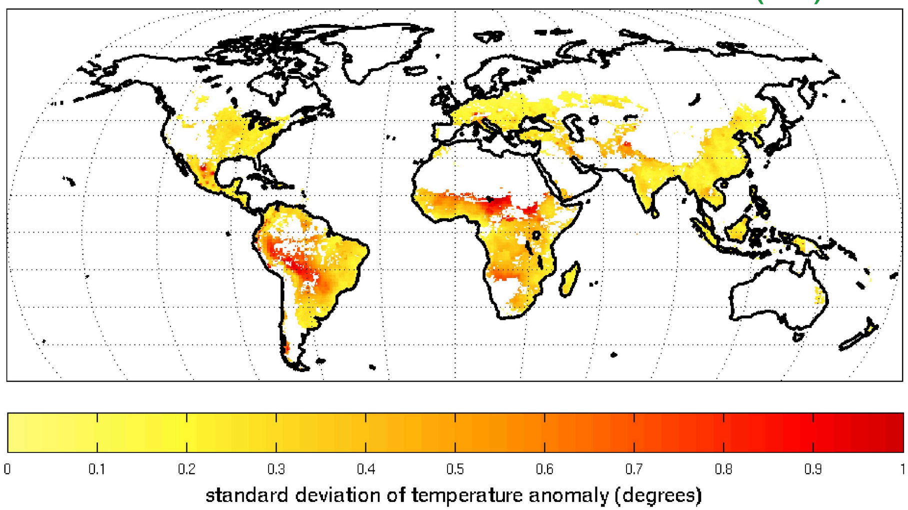
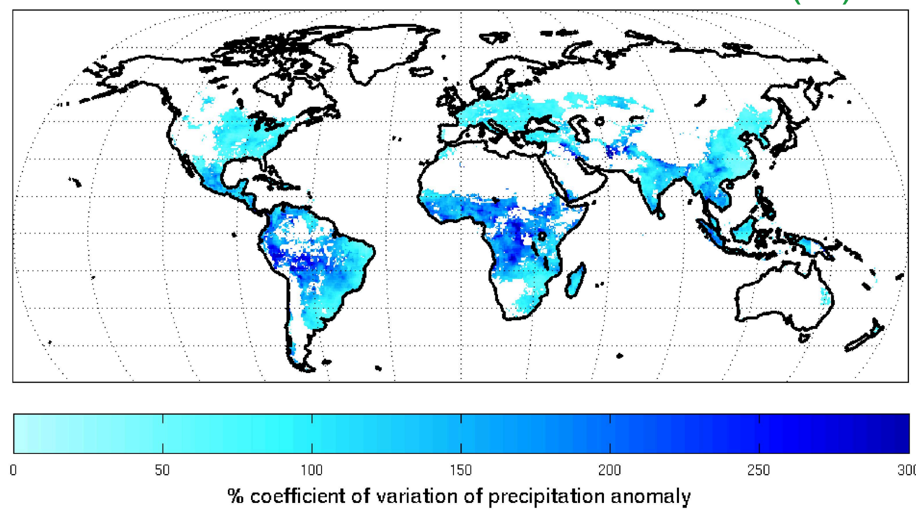
Uncertainty in Agro-climatic Simulation

Access to high quality weather data is major limitation

Standard deviation of seasonal T' (ºC)



Coefficient of variation for seasonal P' (%)



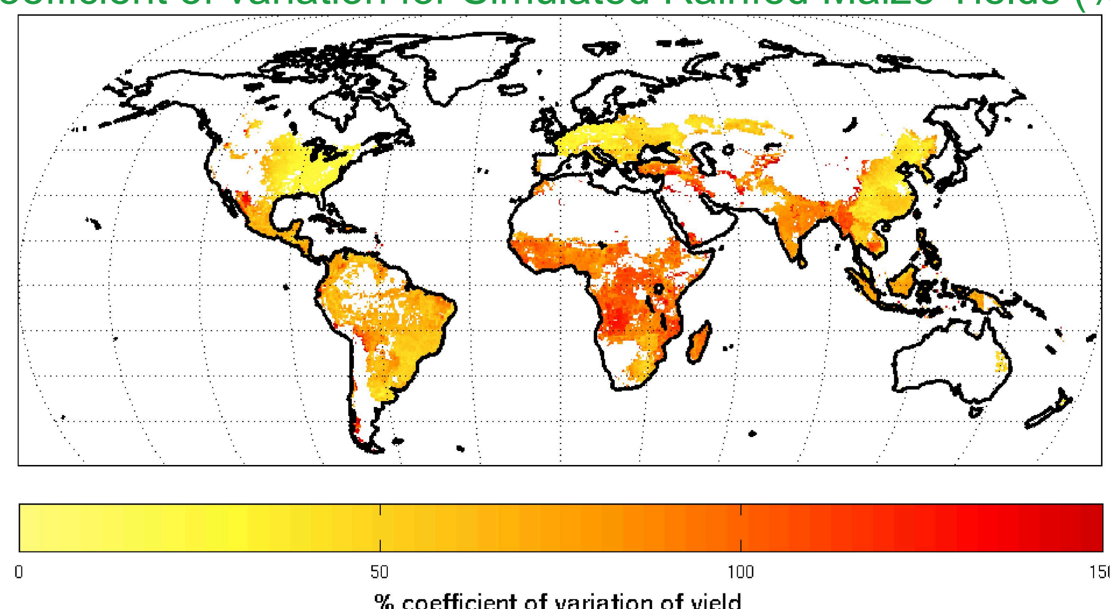
Coefficient of variation for Simulated Rainfed Maize Yields (%)

Rain-fed Maize Season

1980-2010

9 Climate forcing datasets

12 Crop models



Ruane et al., in preparation

Outputs from AgMIP GGCMI Phase 1

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Models enable use of Latest Probabilistic Weather & Climate Forecasting

- **Climate information continues to improve**
  - most notably in regions with poor in situ coverage and for extreme events.

- **Crop models can be run for retrospective analyses and forecast mode**

1980 … 2016 -6 months -60 days -15 days **Present** +15 days +60 days +6 months

Retrospective Climate Analyses

Examples: NCEP/NCAR Reanalysis, MERRA-2, ERA-Interim, CFSR

Climate Forcing Datasets for Agriculture

Examples: AgMERRA, WFD-EI, DayMet, CHIRPS, IMERG

Archived by Climate-System Historical Forecast Project (CHFP)

Seasonal Forecasts

Archived by Subseasonal to Seasonal Project (S2S)

Sub-seasonal Forecasts

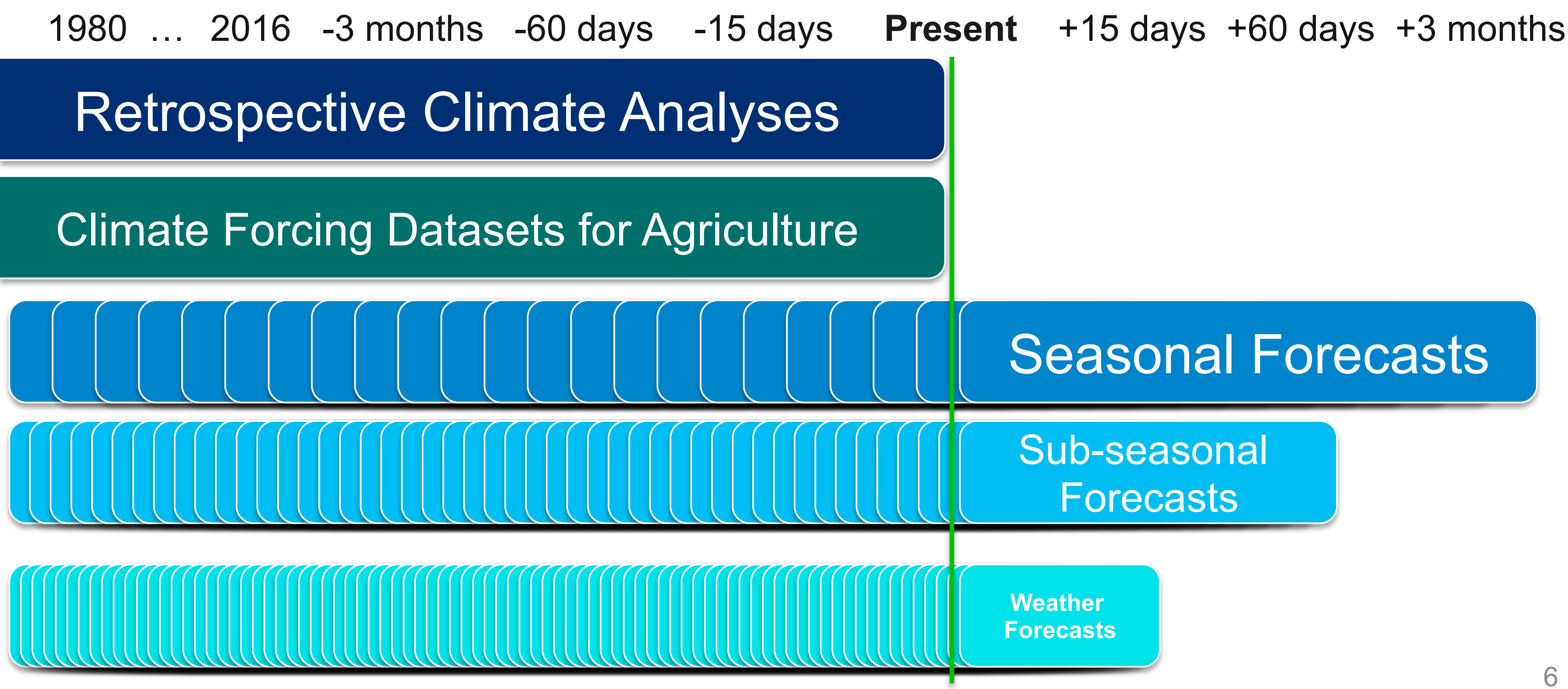
Archived by THORPEX Interactive Grand Global Ensemble (TIGGE)

Weather Forecasts

Models enable use of Latest Probabilistic Weather & Climate Forecasting

- **Climate information continues to improve**
  - ➢ most notably in regions with poor in situ coverage and for extreme events.

- **Crop models can be run for retrospective analyses and forecast mode and in hindcast mode to enable probabilistic decision-support**



Example of Forecast Horizon Use (Early-season Perspective)

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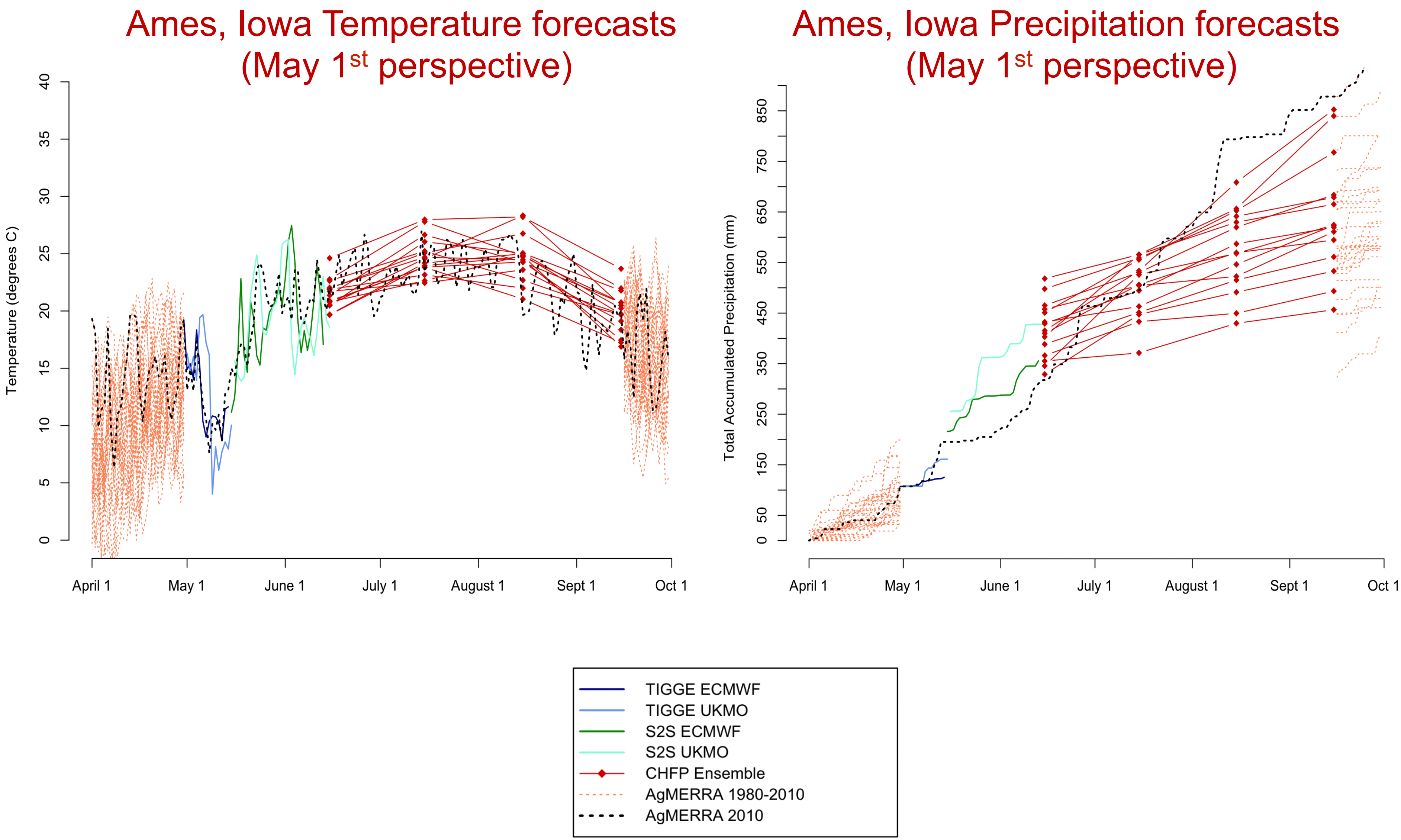

Example of Forecast Horizon Use (Iterative Perspective)

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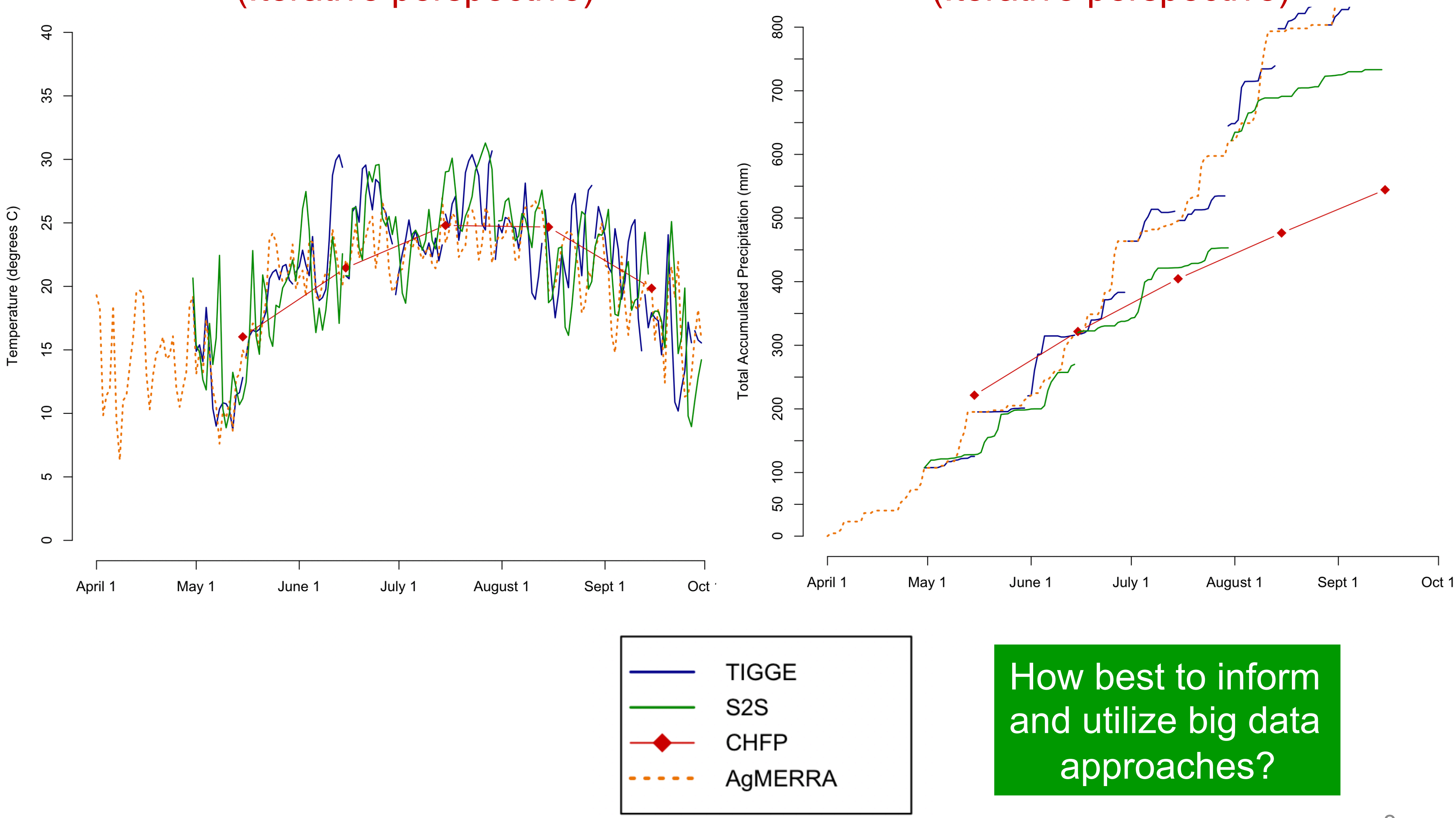
Ames, Iowa Temperature forecasts (Iterative perspective)

Ames, Iowa Precipitation forecasts (Iterative perspective)



How best to inform and utilize big data approaches?

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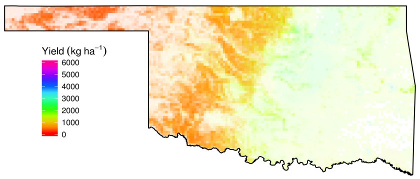
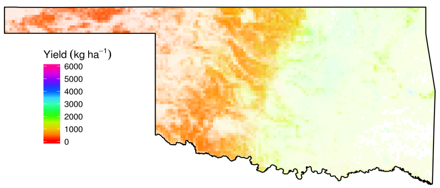
Analysis of different climate and soil datasets

Winter Wheat Yield using DSSAT

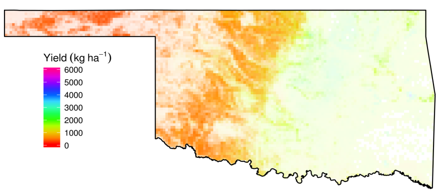
Soilgrids - CHIRPS



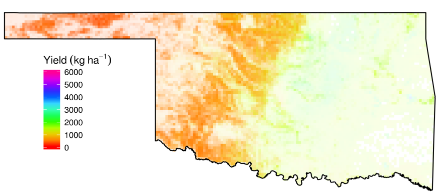
Soilgrids - NOAA Stage IV QPE



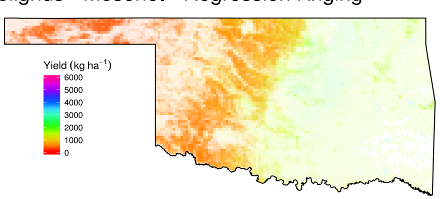
Soilgrids - Mesonet - Nearest Neighbor



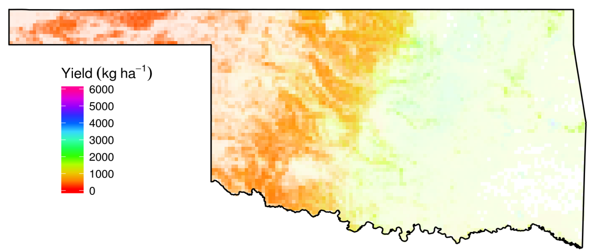
Soilgrids - Mesonet - Inverse Distance Weighting



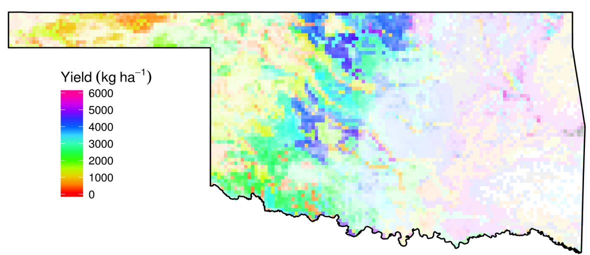
Soilgrids - Mesonet - Regression Kriging



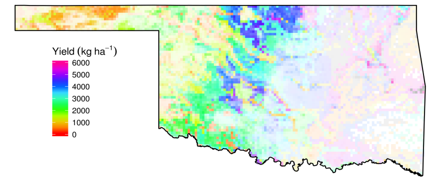
Soilgrids



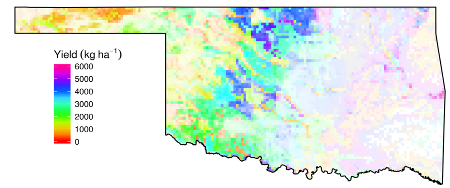
STATSGO2



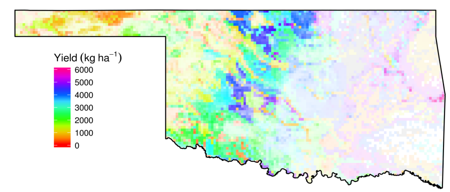
STATSGO2 - CHIRPS



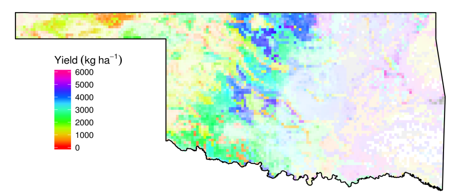
STATSGO2 - NOAA Stage IV QPE



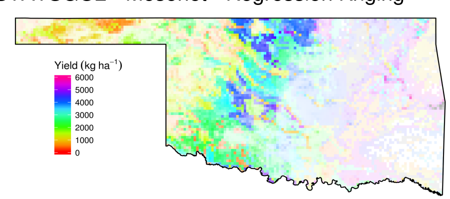
STATSGO2 - Mesonet - Nearest Neighbor



STATSGO2 - Mesonet - Inverse Distance Weightin



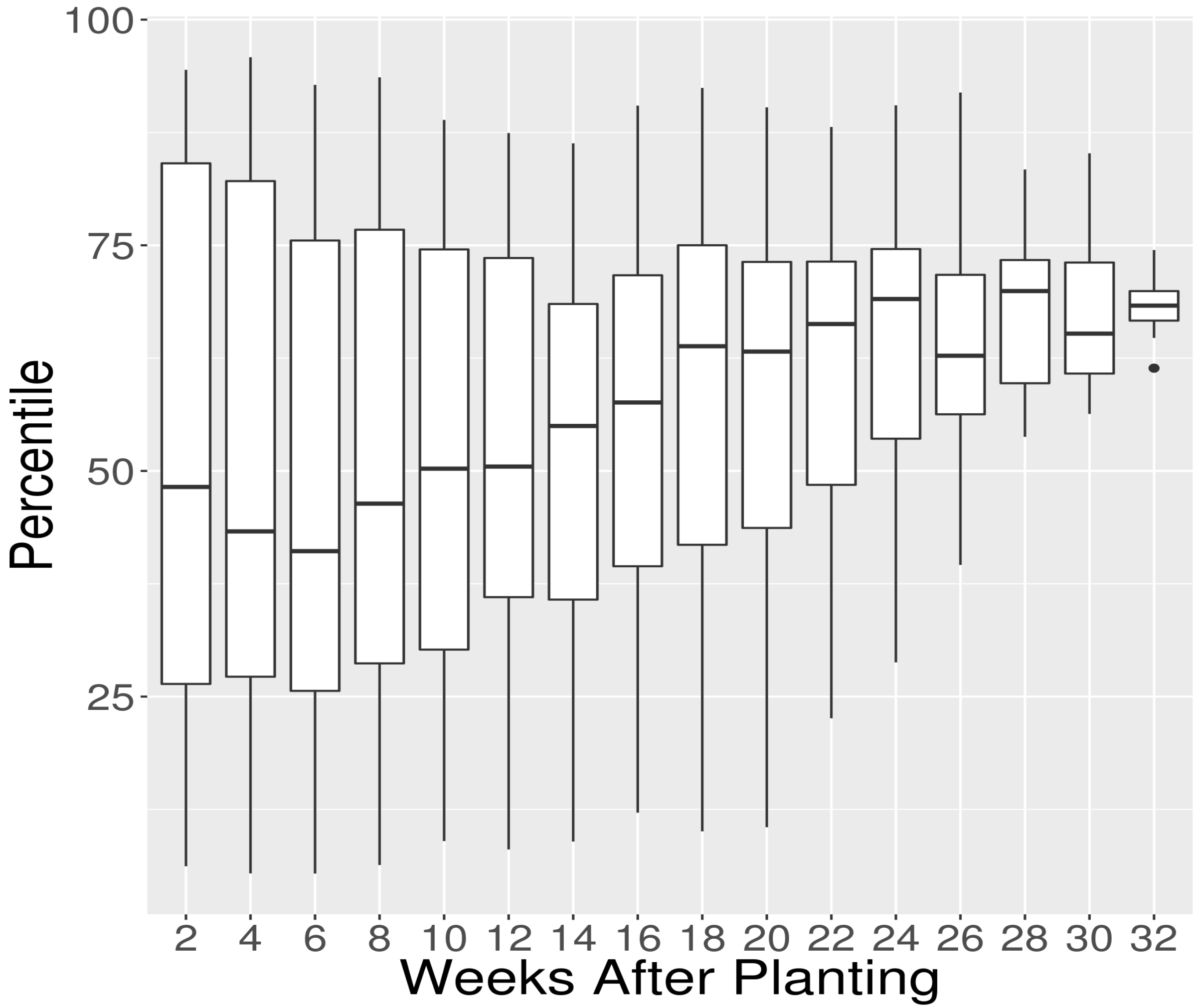
STATSGO2 - Mesonet - Regression Kriging



Alderman, Ruane, et al. (in preparation)

Lead time skill improvement

Medford, Oklahoma, hindcast for 1997 winter wheat

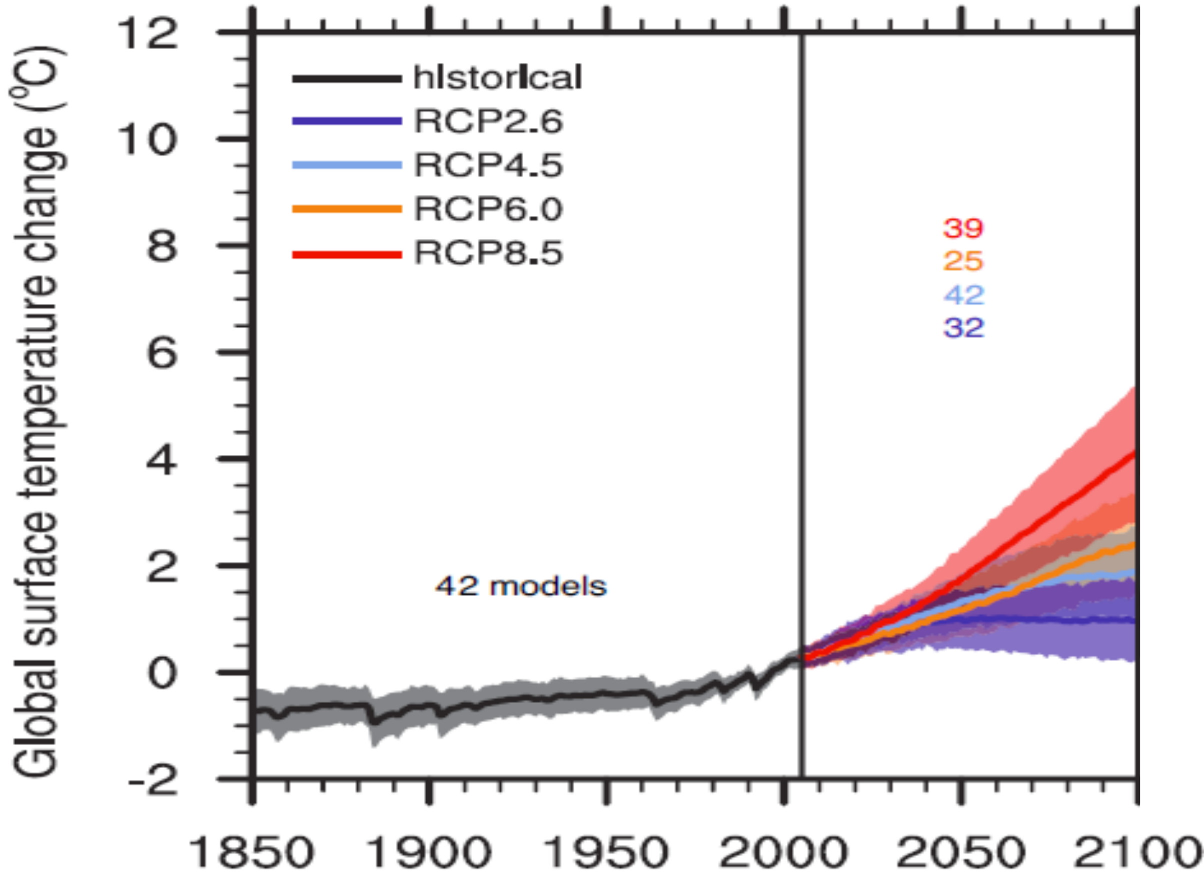


Alderman, Ruane, et al. (in preparation)

Projections of Global Mean Temperature Change

- Scenarios of the future depend upon:
  - new technologies
  - technology sharing
  - population
  - volcanoes
  - emissions controls

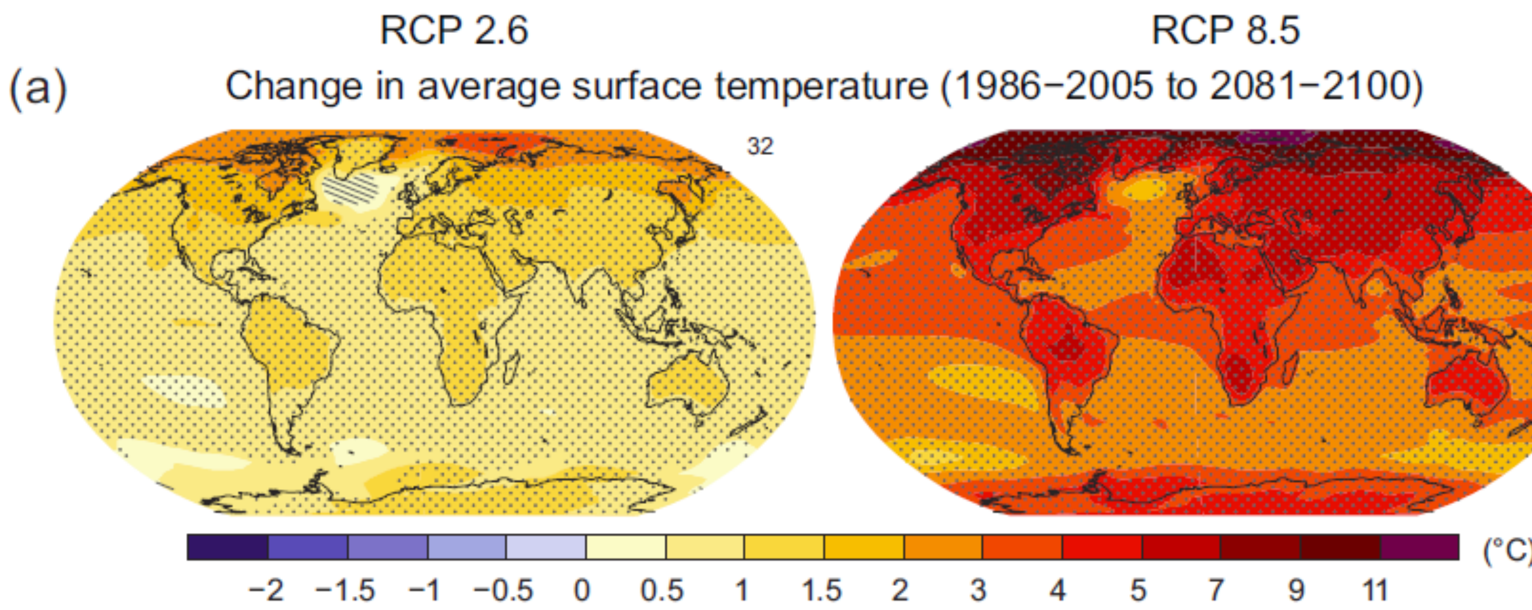
- Range of projected avera[g]e temperature increase due more to the path we take than model disagreement



IPCC, 2013

Earth's climate is warming and changing

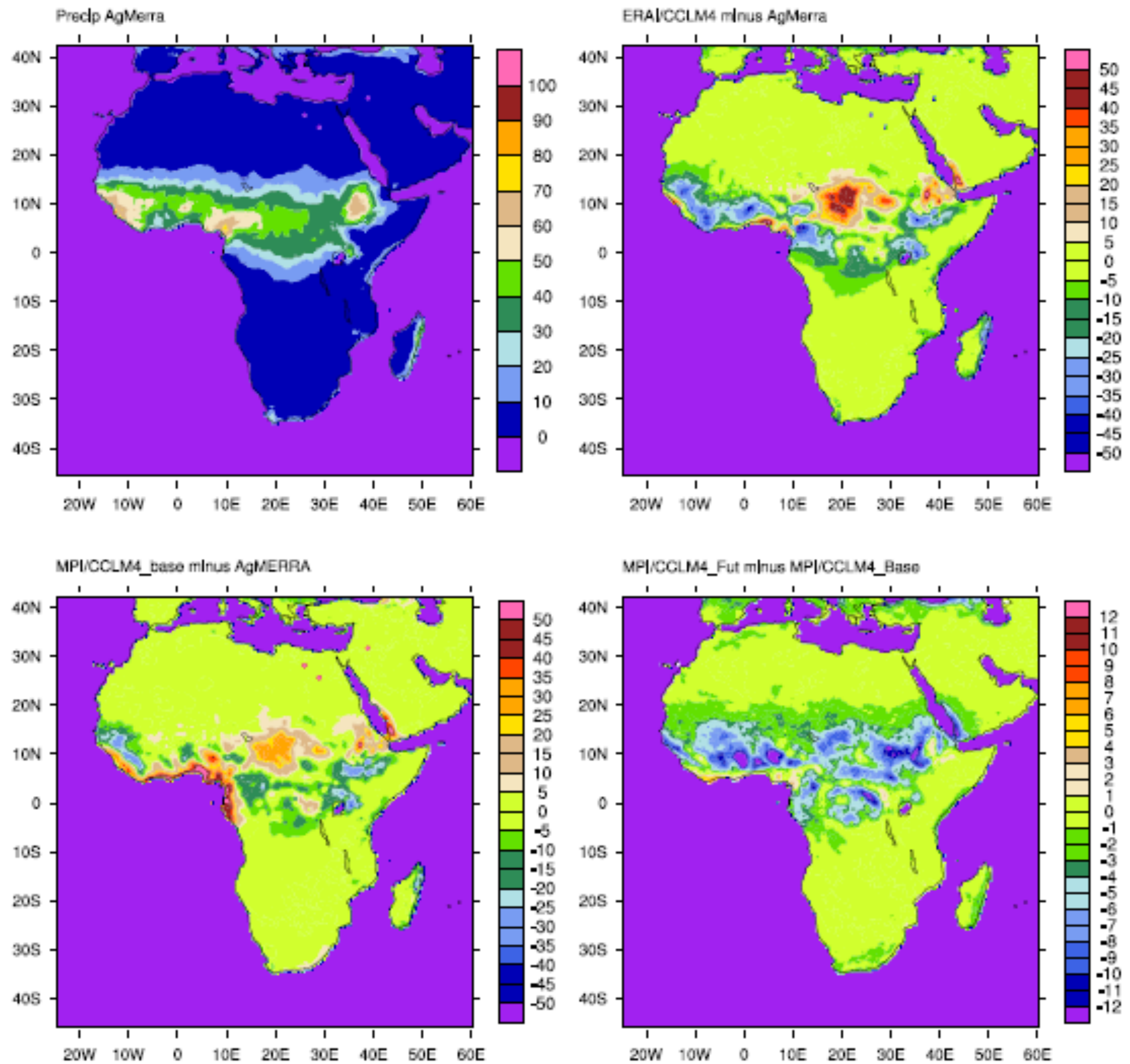
We can identify patterns



IPCC, 2013

Dynamical Downscaling CORDEX+

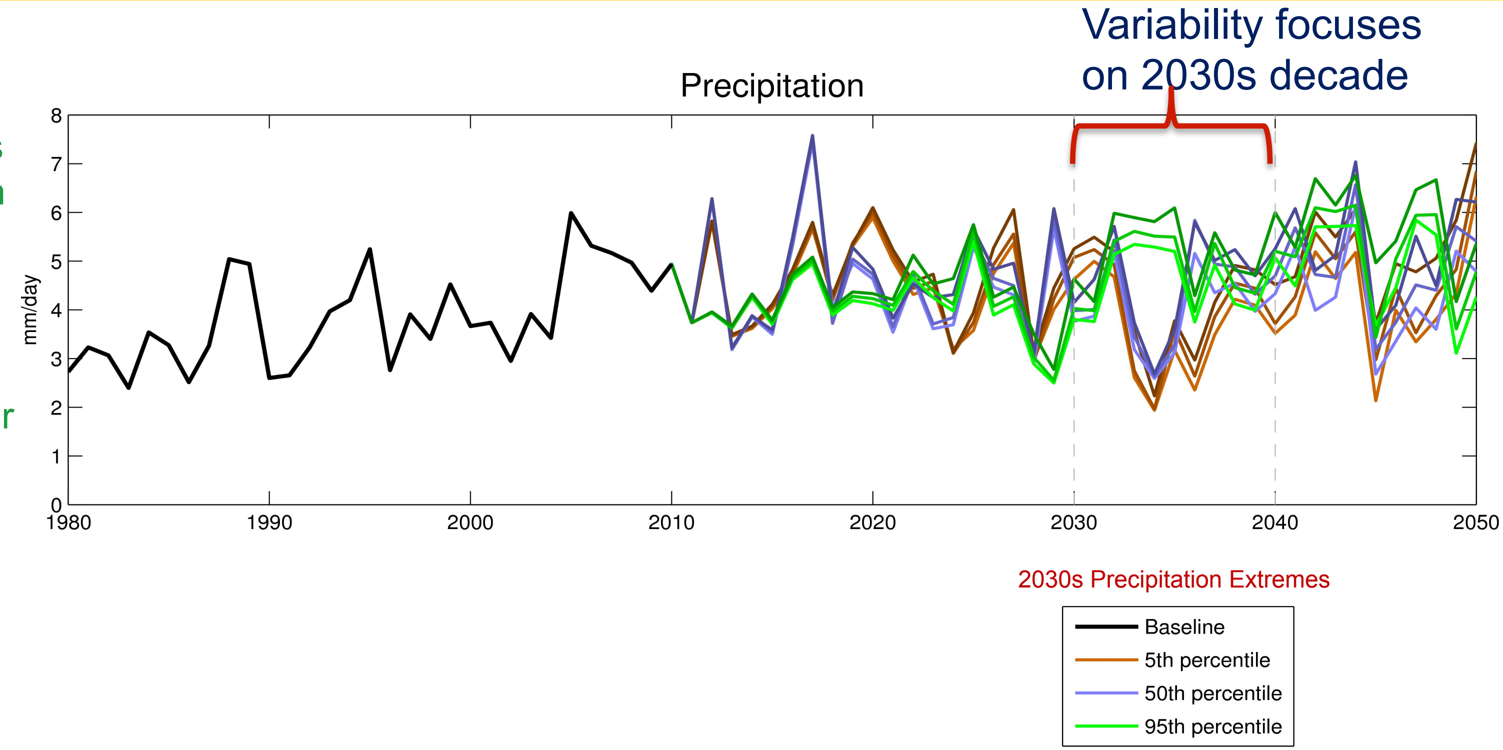
Seasonal Precip 5mm Rainy Day 30yrs June-Sep (1976-2005)



Near-term and tail-end risk scenarios

Diourbel, Senegal probabilistic projections to 2050s factor in mean changes and internal variability

(work done in collaboration with Arthur Greene and James Chryssanthacopoulos)



Tools available to generate 1000s of climatological years in order to examine risk of extreme events:

- **Weather generators**
- **Climate emulators**
- **Large-ensemble ESM simulations**

Shifting Risk with Climate Change

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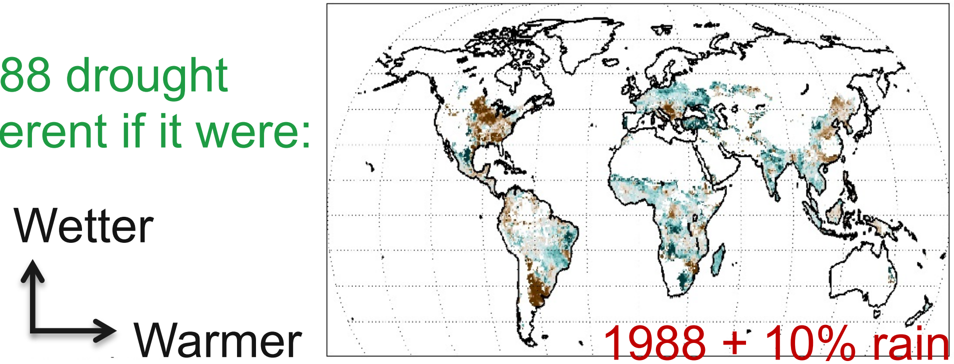
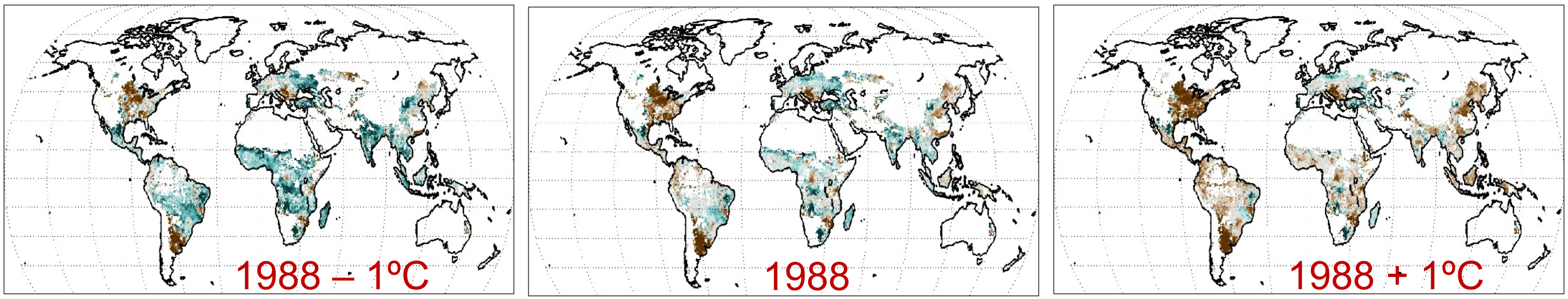
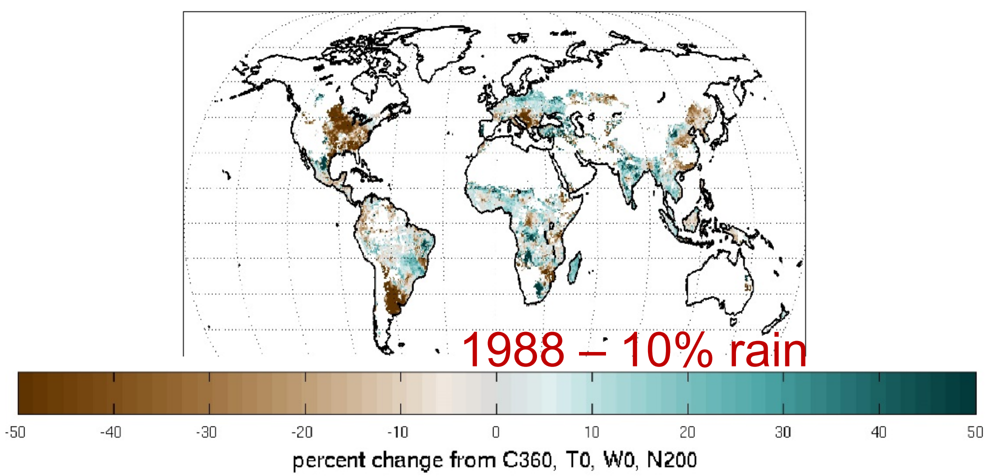
How would 1988 drought have been different if it were:







Ruane et al., in preparation

Additional Weather/Climate Products for Food Shock Analysis

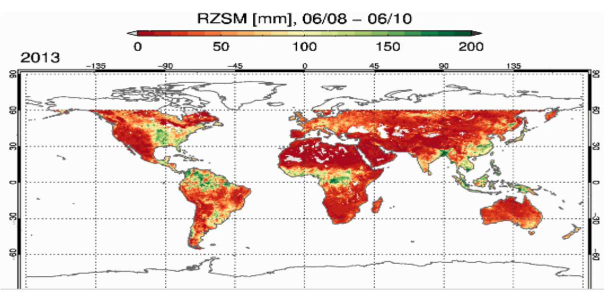
Additional Weather/Climate Products

- **Direct climate-based crop yield estimators**

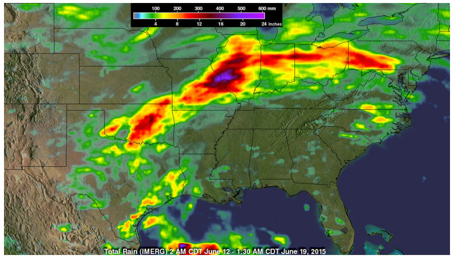
- **Large number of climate indices:**
  - **Drought and heat wave indices**
    - **Hot/dry for plants**
    - **Hot/humid for humans and livestock**

  - **Be careful to distinguish between:**
    - **Meteorological drought (precipitation deficit)**
    - **Agricultural drought (soil moisture deficit)**
    - **Hydrologic drought (water resources deficit)**

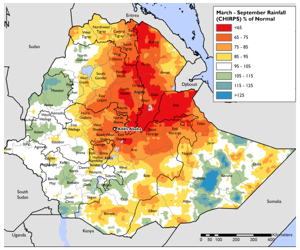
- **Inland flooding planning can utilize hydrologic models**
  - New advances in convection-permitting atmospheric models
- **Coastal flooding planning can utilize tropical storm and surge models**
  - Dramatic improvement in recent decades

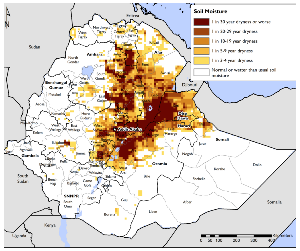


Soil Moisture anomalies from SMAP/SMOS



IMERG Precipitation


CHIRPS Precipitation anomalies


FLDAS soil water anomalies