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AgMIP Climate Datasets and Scenarios

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NASA

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THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

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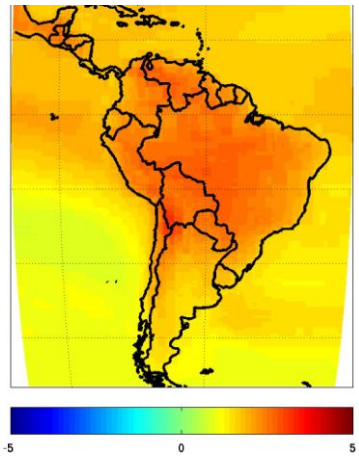
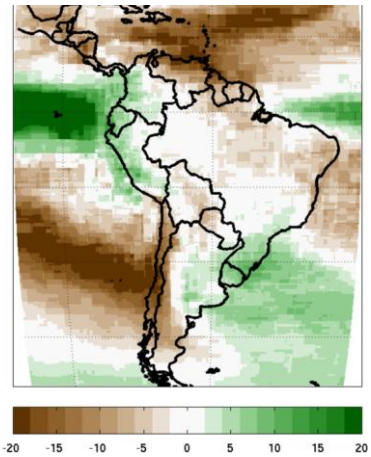
The Challenge of Climate Change

Mid-Century RCP8.5 Median Temperature Change (20 GCMs)



Mid-Century RCP8.5 Median Precipitation Change (20 GCMs)



- **Climate change has potential for substantial impacts**
- **Uncertainties from data sources, global climate models, societal emissions, and scenario generation techniques**
- **Need consistent protocols to allow comparison among studies**

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The AgMIP Climate Team

- **Constructing climate series for the current climate**
  - ***Observational datasets as proxies for gap-filling***
- **Generating probabilistic scenarios of future climates**
  - ***Incorporating mean and variability changes***
  - ***Near-term scenarios and emulated estimates***
- **Uncertainty and Agro-climatic analysis**

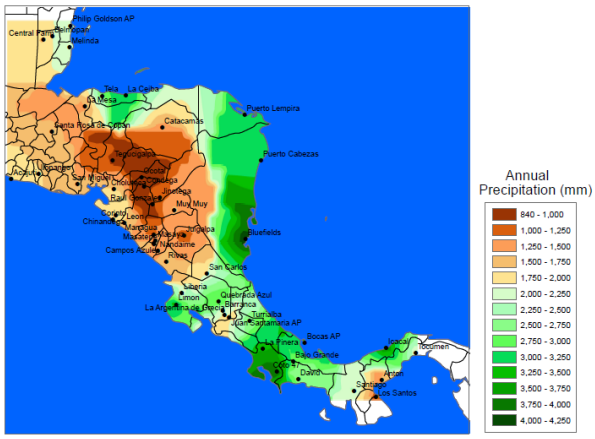
Kenya, 2011

India, 2011

Ghana, 2012

Characterizing the Current Climate

Sites identified for AgMIP activities at 2011 AgMIP workshop (in Brazil)



- **Quality-controlled station observations are the gold standard for AgMIP**
- **Data from 1980-2010 allows us to examine 30 planting years (daily data required for crop modeling)**
- **These data are used for calibration, provide helpful context for stakeholders, and help us understand current agro-climatic vulnerabilities**

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The .AgMIP Climate Format

- **Allows for easy use in IT tools developed for crop and economic models**
- **Works with translators that convert into many crop model formats**
- **Used extensively in AgMIP climate scenario generation tools**

Note: Excel template at www.agmip.org facilitates the use of this format

```
*WEATHER DATA : Ames, Iowa, USA
@ INSI      LAT     LONG  ELEV   TAV   AMP REFHT WNDHT
  USAM   42.017  -93.750   329  11.2  14.6   2.0   2.0
@DATE    YYYY  MM  DD  SRAD  TMAX  TMIN  RAIN  WIND   DEWP  VPRS  RHUM
1980001  1980   1   1   1.2   1.3  -1.5   0.0   3.1   -0.3   6.0   89
1980002  1980   1   2   4.7  -0.3  -2.6   0.0   4.9   -7.6   3.5   58
1980003  1980   1   3   1.9  -0.3  -4.8   0.0   4.3   -9.0   3.1   52
1980004  1980   1   4   3.8   0.2  -2.6   0.0   4.1   -5.2   4.2   67
1980005  1980   1   5   1.0   0.2  -3.2   1.5   3.4   -2.5   5.1   82
1980006  1980   1   6   8.5   1.9  -7.0   2.1   9.1   -0.8   5.7   82
…
…
2010364  2010  12  30   2.6   4.0   1.7   0.0   5.1    2.0   7.1   87
2010365  2010  12  31   3.4   1.3  -1.5   0.9   5.3   -2.5   5.1   76
```

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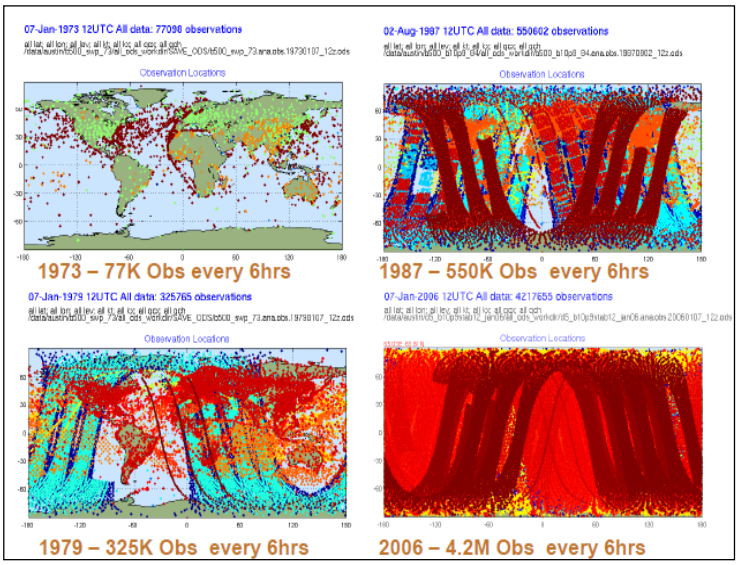
Using AgMERRA and AgCFSR to fill in gaps



AgCFSR = Similar dataset based upon NCEP Climate Forecast System Reanalysis

- **Begins with NASA MERRA reanalysis and data assimilation**
- **MERRA relies on model physics for more complex variables (sunshine, rainfall)**
- **AgMERRA corrects to a gridded temperature and precipitation set and covers 1980-2010**
- **AgMERRA uses:**
  - **improved solar radiation**
  - **spatial patterns of rainfall from satellites**
  - **an adjustment to diurnal temperature range**
- **Tools developed to easily create .AgMIP-formatted time series**
- **Bias correction still necessary in most situations**

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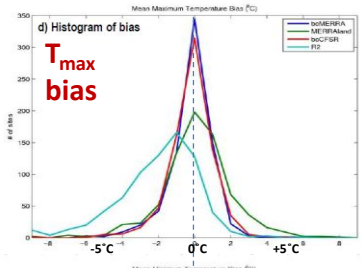
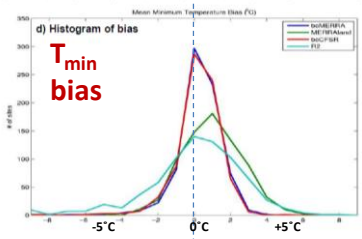
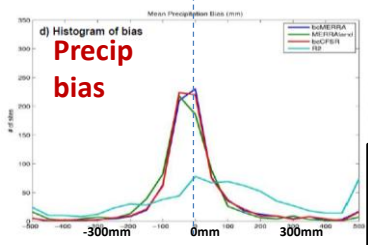
Evaluation of AgMERRA and AgCFSR (750+ sites)

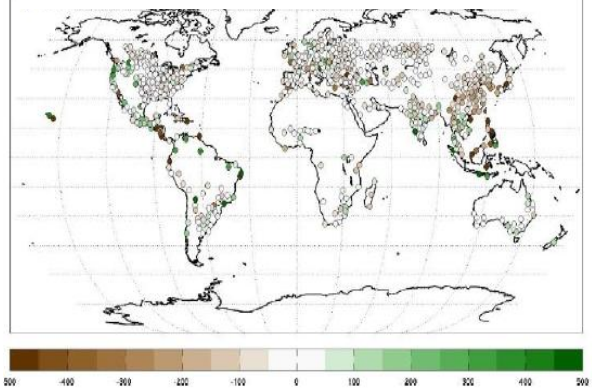






AgMERRA
MERRA
AgCFSR
NCEP/NCAR Reanalysis-2

AgMERRA Precipitation bias (mm/year)



- **AgMERRA and AgCFSR compared against 750+ high-quality weather stations in agricultural regions**
- **Reanalysis maximum temperatures tend to be too cool; minimum temperatures tend to be too warm**
- **Reanalysis precipitation can have large biases**
- **AgMERRA and AgCFSR reduce these biases substantially**
- **WorldClim dataset can be used to provide further spatial information**

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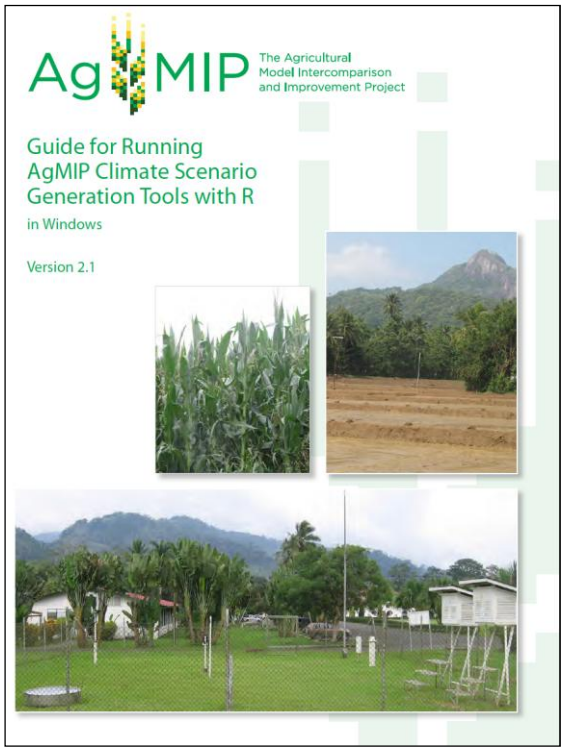
The AgMIP Guide for Running Climate Scenario Generation with R



Available at:
http://www.agmip.org/climate-team/

- **Contains links to datasets, including processed versions of WorldClim (for some regions) and the CMIP5 GCMs**
- **Provides links to download R processing language (free) and climate scenario generation scripts**
- **Contains detailed descriptions of how the scripts can be set up and executed for AgMIP**
- **Designed for AgMIP studies in Sub-Saharan Africa and South Asia**
- **Updated regularly**

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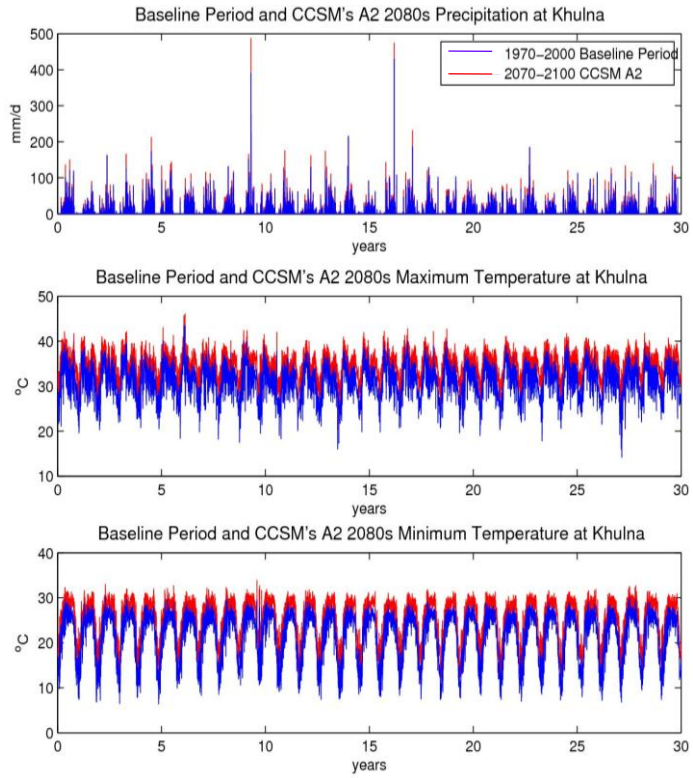
Mean-change-only ("Delta") Scenarios



Most widely-used approach for climate impacts research

- **Adjust historical climate observations according to climate changes projected by Global Climate Models**
- **Add temperature changes by month**
- **Multiply precipitation changes by month**
- **Does not change variability within a month (e.g., number of rainy days) or between years (e.g., El Niño)**

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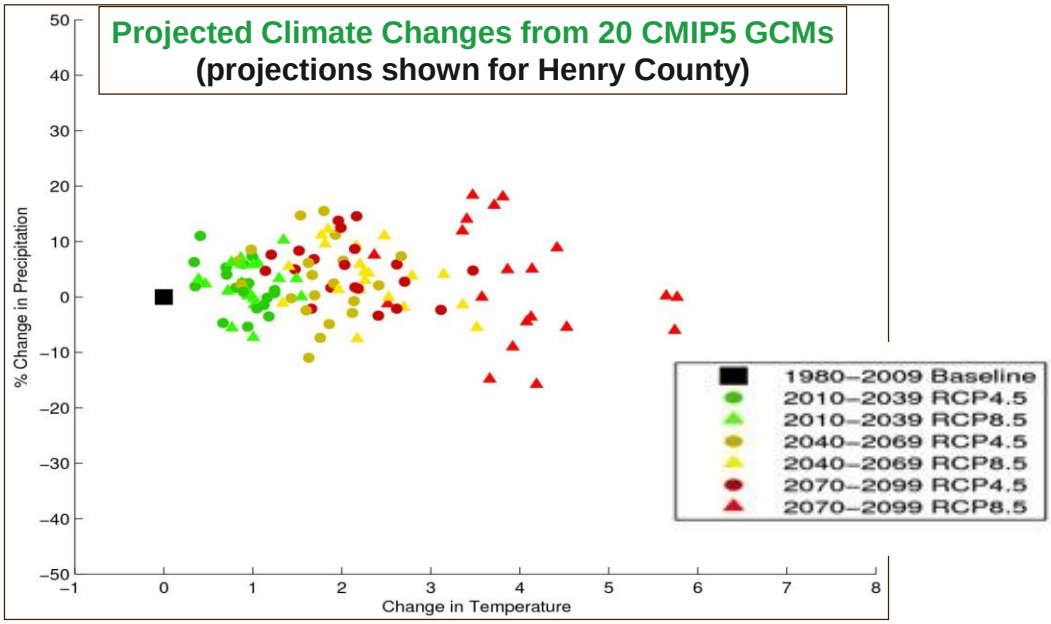
Distribution of Climate Change Projections

%Change in Precipitation [-50% to 50%]



Change in Temperature [-1˚C to +8˚C]

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Full Ensemble of Scenarios

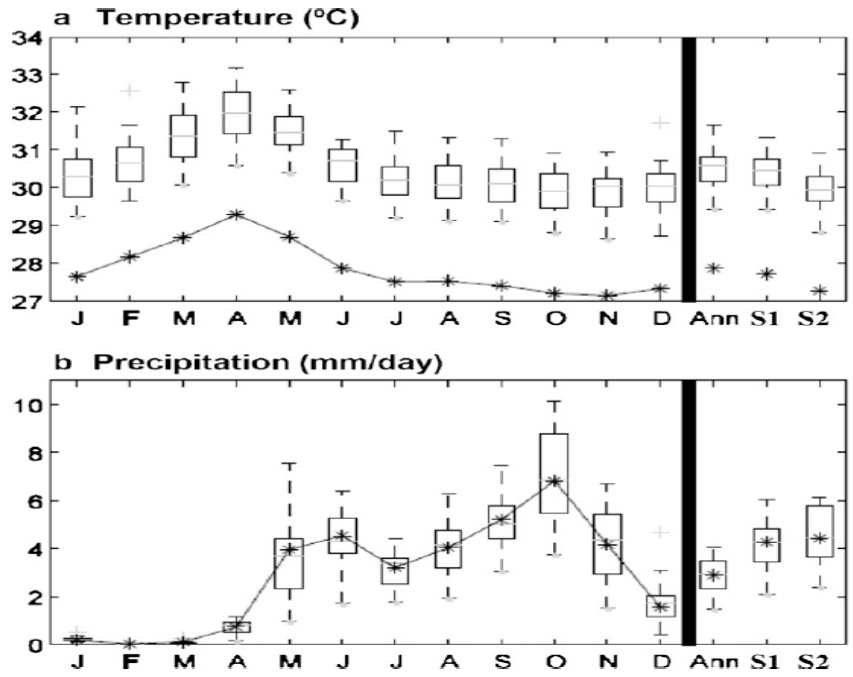

Fig. 2. Baseline (black line and stars) and A2 End-of-Century projected range (across 16 GCMs) of monthly, annual, and seasonal a) temperature and b) precipitation for Los Santos, Panama. S1:primera coa: May–August; S2: segunda coa: September–December.

Azuero Peninsula, Panama (from Ruane et al., 2013)

- **Black line and stars represent current temperature (top) + rainfall (bottom)**
- **Box-and-whiskers represent spread of GCM scenarios for each month**
- **Annual and seasonal metrics also shown**

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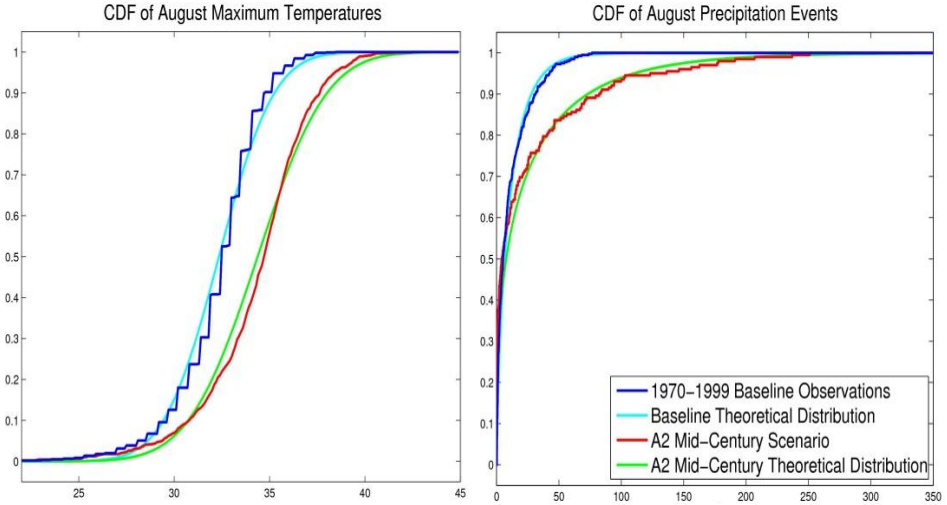
Mean-and-Variability Change Scenarios



- **R scripts are available to simultaneously adjust mean and variability (frequency of rainy days, standard deviation of minimum and maximum temperature, distribution of rainfall amounts)**
- **Variability shifts from GCMs are less trustworthy than mean shifts, so RCM projections of variability changes may be incorporated if there are enough RCM simulations to understand uncertainty**

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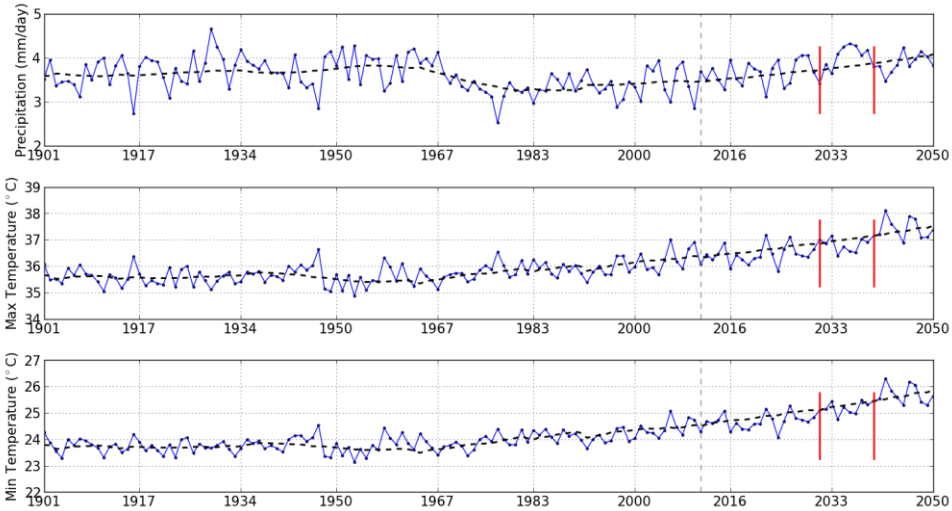
Probabilistic Near-term Climate Scenarios



- **Developing probabilistic decadal scenarios with continuity across space and variables**
- **Allows examination of 95% wettest or driest decade according to vector-auto-regressive model based on historical observations and GCM projections**

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From Arthur Greene and James Chryssanthacopolous

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Questions or Suggestions?

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For protocols, Climate Scenarios Guidebook, up-to-date events and news, and to join AgMIP listserve:
www.agmip.org