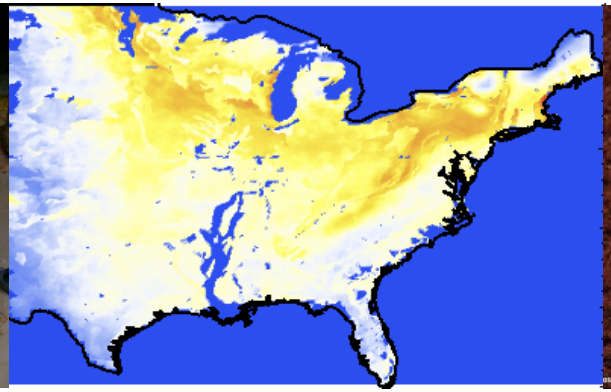
The Agricultural Model Intercomparison and Improvement Project (AgMIP)

Sonali McDermid[1]

Alex Ruane[1], **Jonathan Winter**[2]
Cynthia Rosenzweig[1], **Jim Jones**[3], **and Jerry Hatfield**[4]
[1]*NASA GISS,* [2]*Columbia University,* [3]*University of Florida,* [4]*USDA-Ames*
June 21, 2012



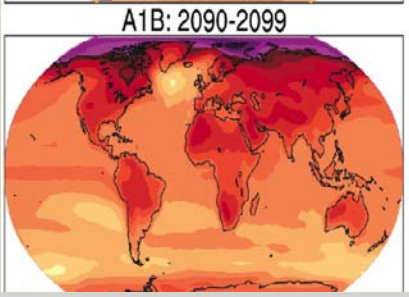



AgMIP The Agricultural Model Intercomparison and Improvement Project

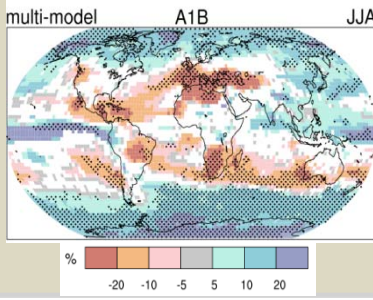
NASA

UKaid from the Department for International Development

USDA



Why AgMIP?



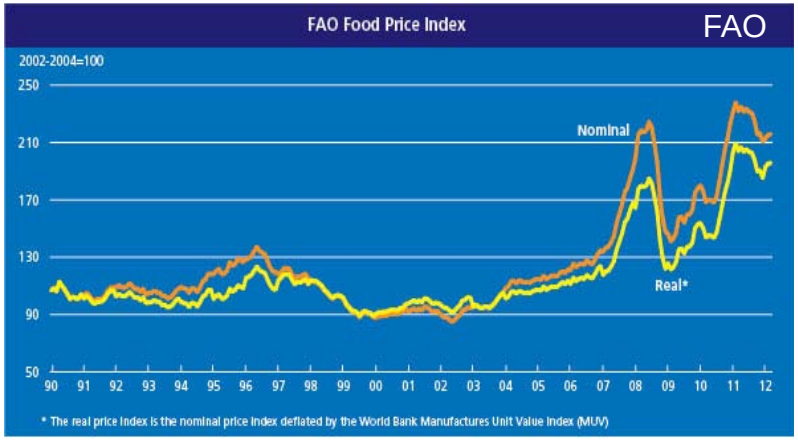
Agricultural risks growing alongside climatic changes

Climate extremes affecting major agricultural regions

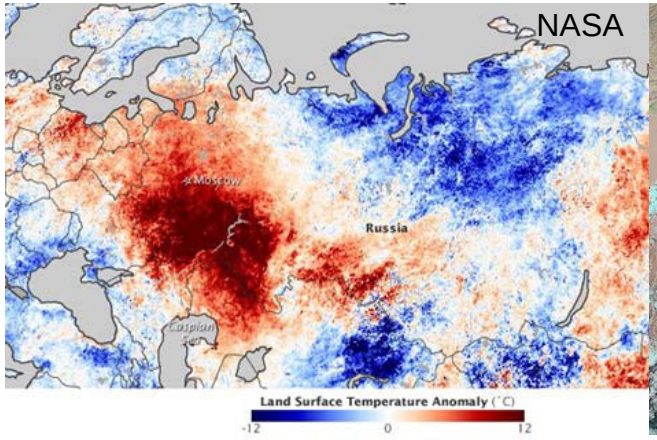
Food security is one of the most prominent climate impacts issues

Regional and world food crises driven by multiple environmental and economic stresses

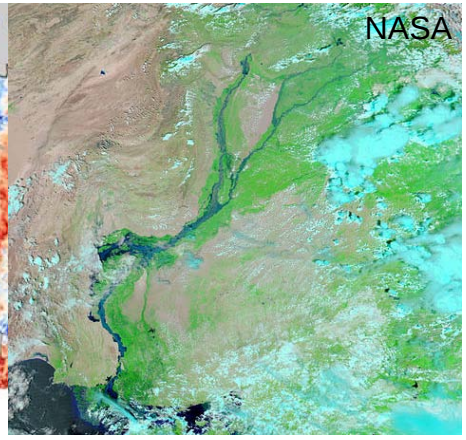
Decisionmakers demanding improved information for risk management



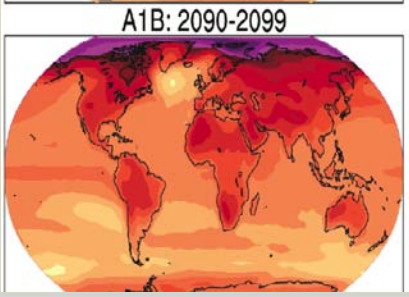
FAO Food Price Index



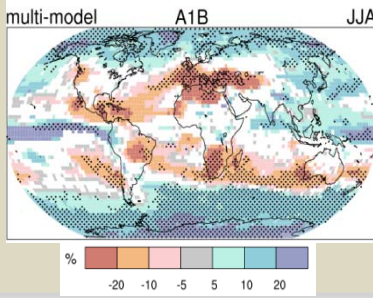
2010 Russian Heat Wave



2010 Pakistani Floods



Why AgMIP?



Consistent approach needed to enable agricultural sector analysis across relevant scales and disciplines

- Difficult to compare climate impact studies across regions and models
- Lack of a trandisciplinary community connecting climate scientists, crop modelers, economists, and IT specialists
- Lack of awareness and understanding of useful multidisciplinary datasets
- Need for improved climate assessment based on multi-model capabilities and better defined uncertainties

Long-term process needed for rigorous agricultural model testing, improvement, and assessment

- Agricultural model evaluation and assessment lagging behind climate model intercomparisons and projections
- Need to make better use of available data and methods
- Need multi-model assessments to enable uncertainty assessment and more informed risk management
- There is a need for a continuing process

  i.e., AgMIP 1 → AgMIP2 . . .

AgMIP Objectives

- **Incorporate state-of-the-art climate products as well as crop and agricultural trade model improvements in coordinated regional and global assessments of future climate impacts**
- **Include multiple models, scenarios, locations, crops and participants to explore uncertainty and impact of data and methodological choices**
- **Collaborate with regional experts in agronomy, economics, and climate to build strong basis for applied simulations addressing key climate-related questions**
- **Improve scientific and adaptive capacity for major agricultural regions in the developing and developed world**
- **Develop framework to identify and prioritize adaptation strategies**
- **Link to key on-going efforts**
  - **CCAFS, Global Futures, MOSAICC, Yield Gap Analysis, SERVIR**
  - **National Research Programs, National Adaptation Plans, IPCC, ISI-MIP**




AgMIP Two-Track Science Approach

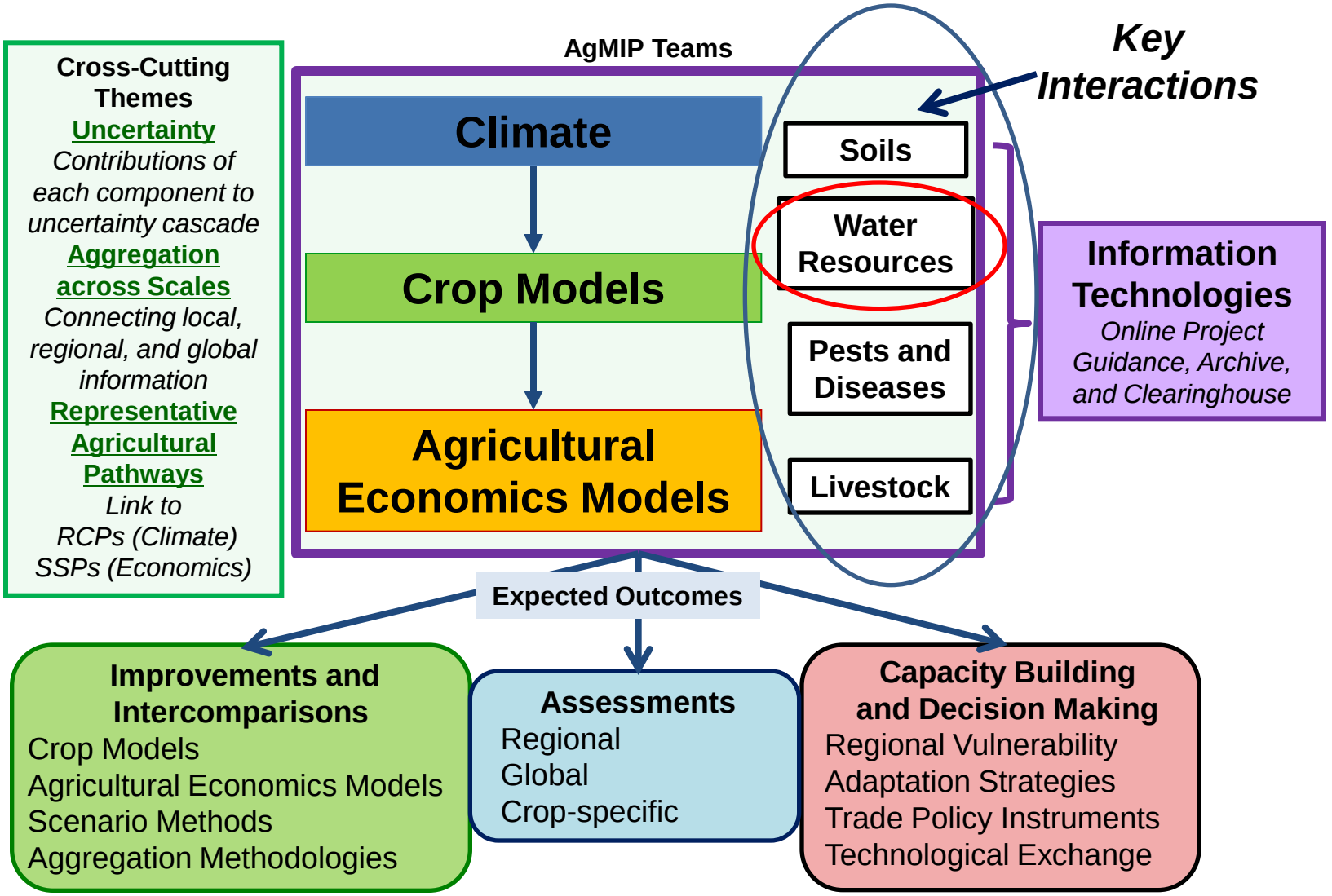
Driven by Data at Sentinel Sites

Track 1: Model Improvement and Intercomparison

Track 2: Climate Change Multi-Model Assessment

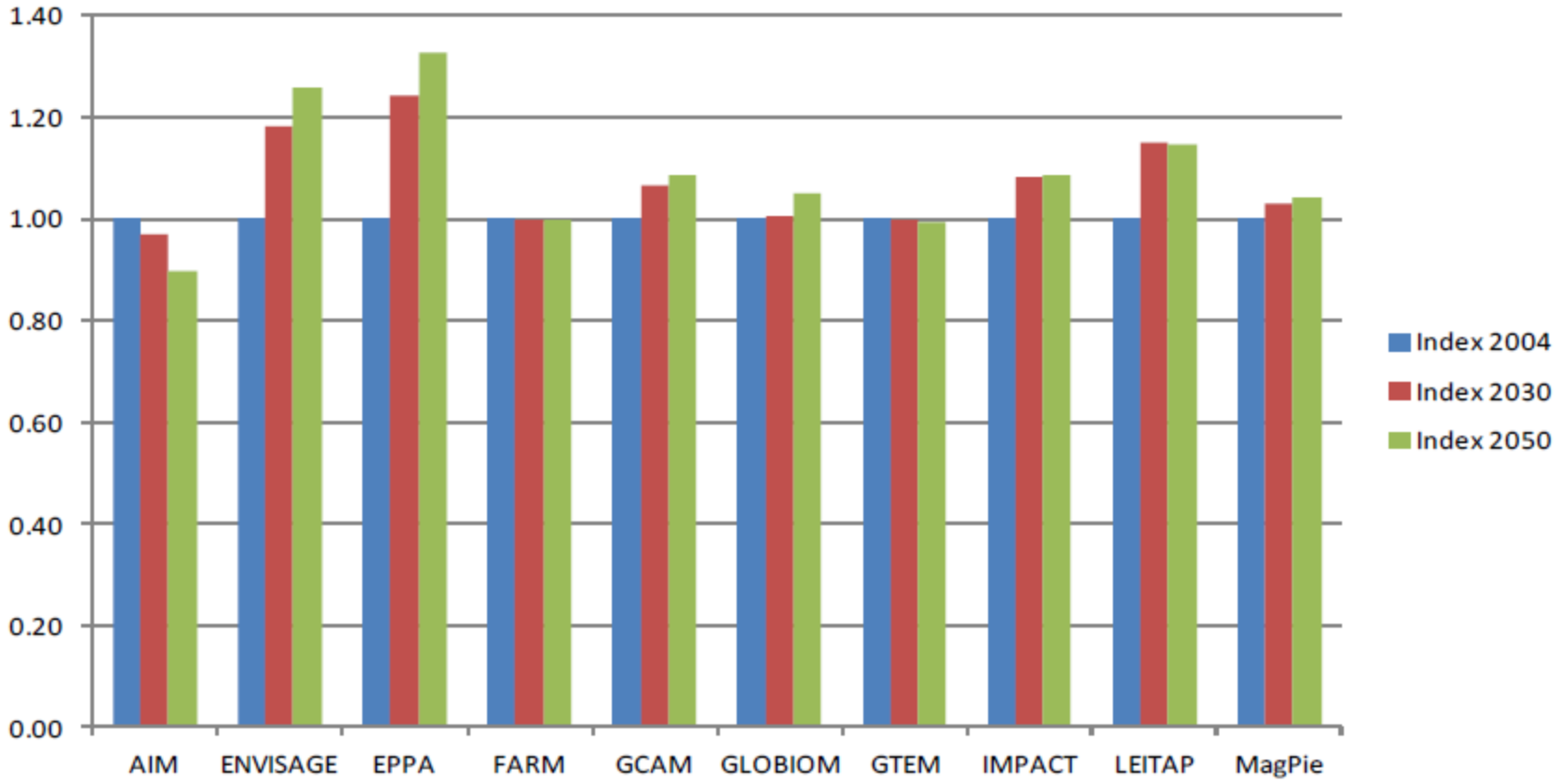
Cross-Cutting Themes: Uncertainty, Aggregation Across Scales, Representative Agricultural Pathways

AgMIP Teams, Linkages, and Outcomes



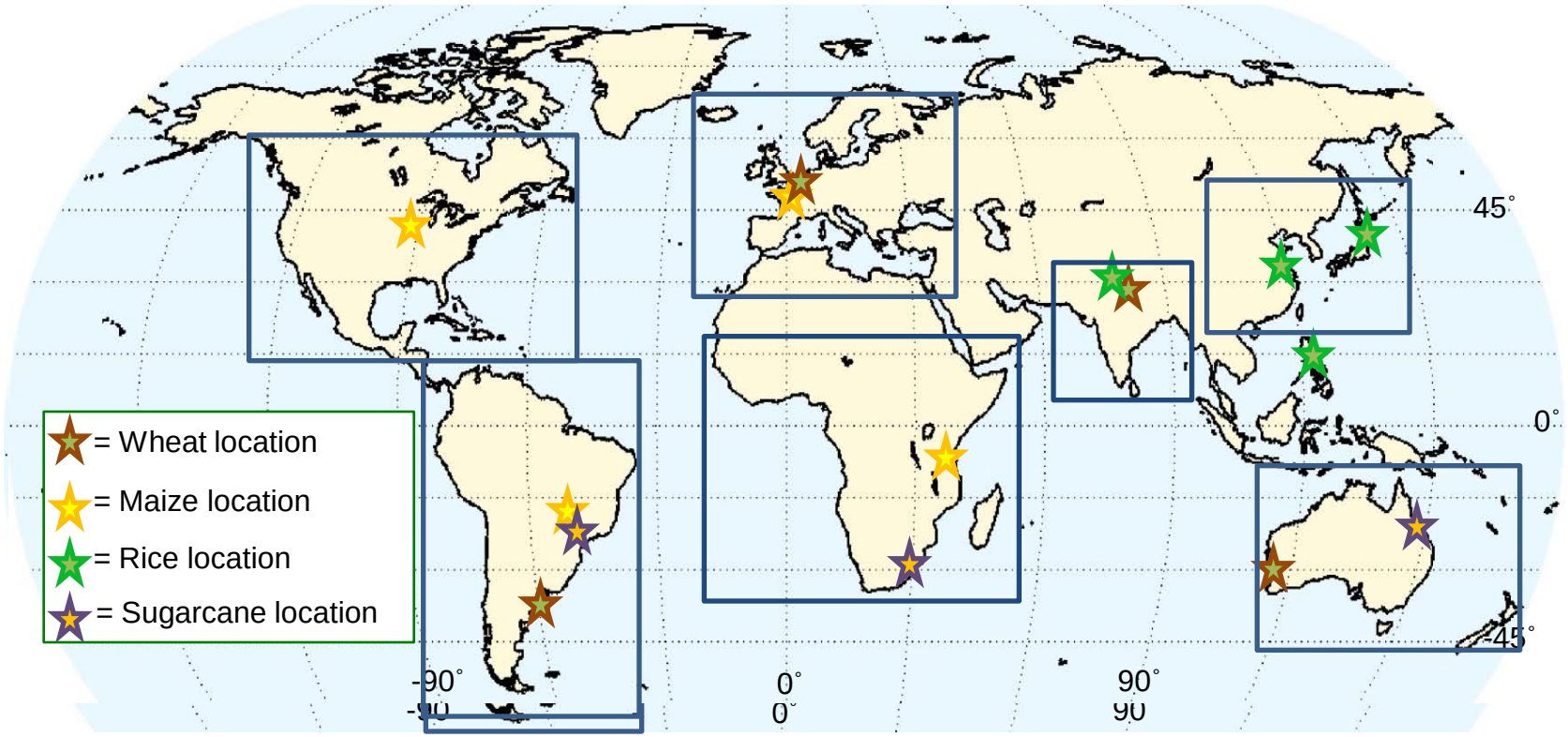
AgMIP and Model Intercomparison

World agricultural land, perfect mitigation scenario



Must understand why models show discrepancies, particularly when needed for decision-making!

AgMIP Regions – A Global Initiative

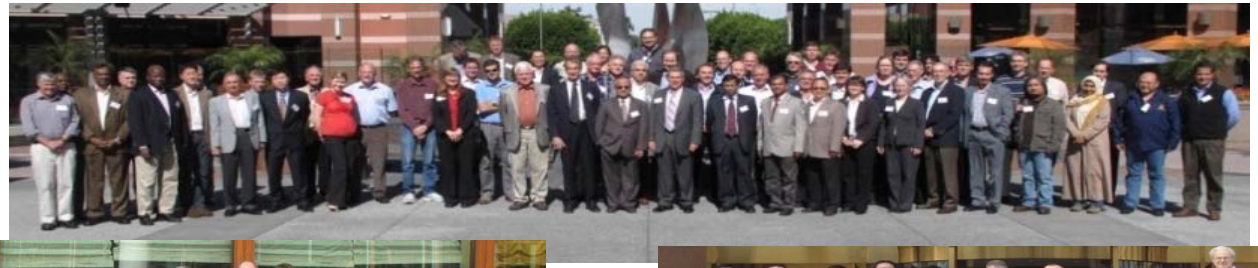


Benefits include:

- **Improved capacity for climate, crop, and economic modeling to identify and prioritize adaptation strategies**
- **Consistent protocols, scenarios, and data access**
- **Improved regional assessments of climate impacts**
- **Facilitated transdisciplinary collaboration and active partnerships**
- **Contributions to National Adaptation Plans**

AgMIP International Workshops

~450+ members of AgMIP list-serv



1st Global

Wheat

Rice

2nd Global

South America

Sub-Saharan Africa

South Asia

AgMIP Teams

AgMIP Protocols Available at www.agmip.org

AgMIP Teams: Climate Team

Agro-Climatic Analysis

Baseline Analysis and Intercomparison

First Phase

- Local station observations
- Geospatial weather generator from local observations

Second Phase

- Alternative weather generators
- Gridded observational products from local obs
- Satellite-based observational products

Climate Sensitivity Scenarios

First Phase

- Mean T, P, [CO_2]
- Impacts response surfaces

Second Phase

- Temperature variability
- Temperature extremes
- Rainfall variability
- Rainfall extremes

Scenarios for Each Future Climate Period

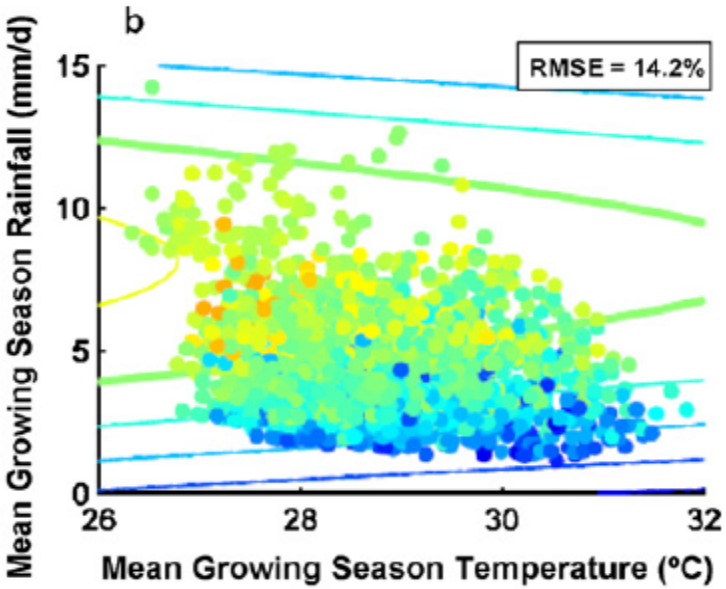
First Phase

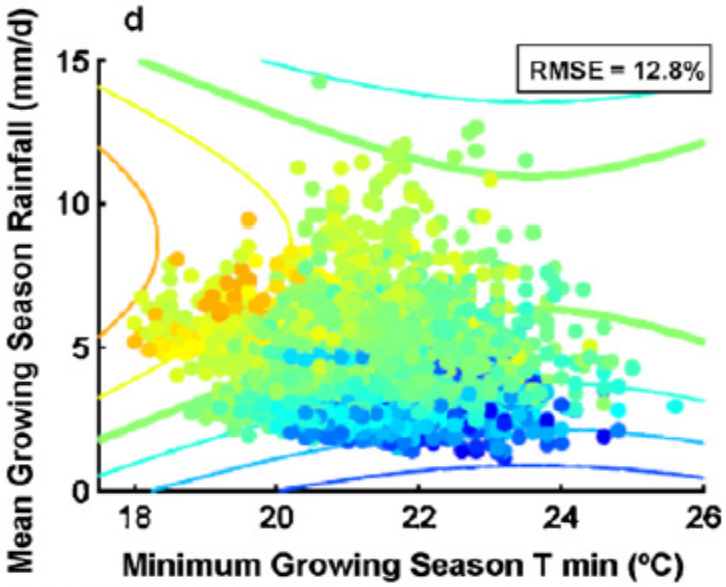
- Enhanced GCM delta method
- Geospatial weather generator from GCMs

Second Phase

- Alternative weather generators
- RCM-based mean and variability changes

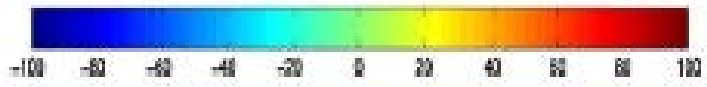
Climate Sensitivity Scenarios Impacts Response Surfaces





Crop model simulations can help identify critical sensitivities to address with adaptation

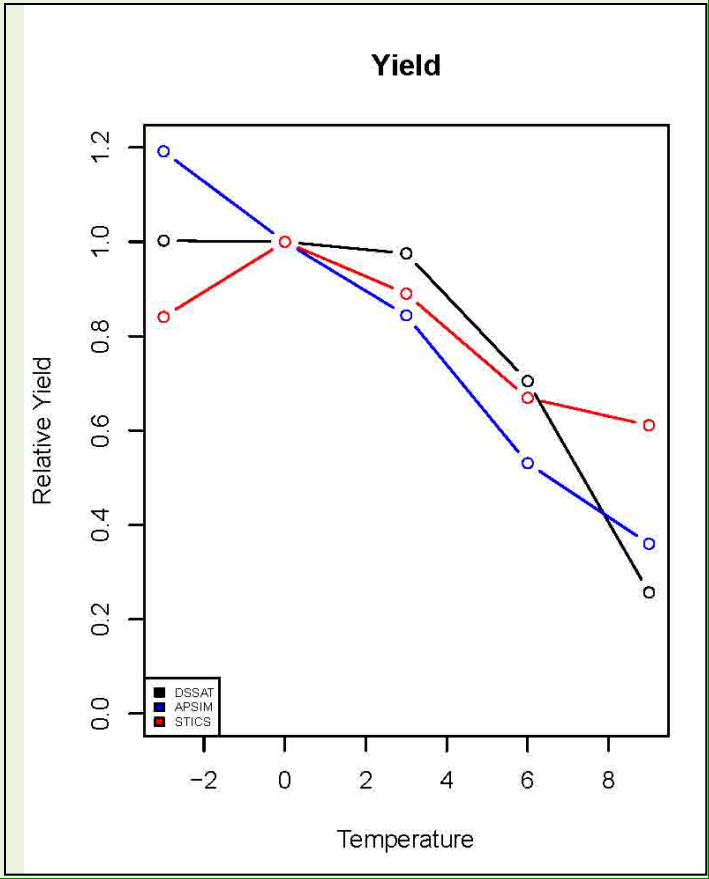
- Crop model simulations in Los Santos respond particularly to:
  - growing season rainfall
  - minimum temperatures in December (correlated with end-of-season drought)
- Sensitivity of agriculture can be compared to uncertainty of climate projections



Yield (% of baseline mean)

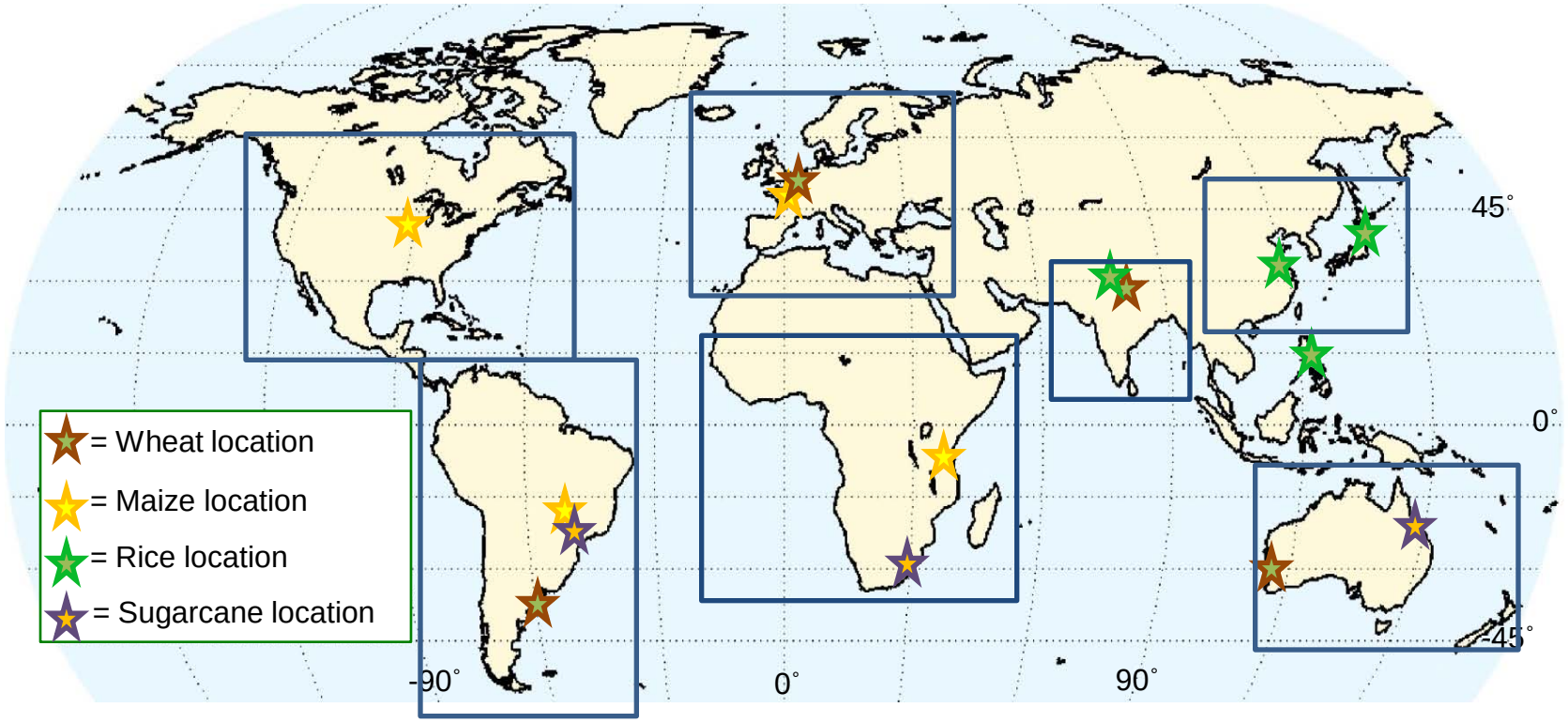
AgMIP Teams: Crop Modeling Team

- Collect Agronomic Data for Sentinel Sites
- Crop-Specific Pilots
  - Wheat, maize, rice, and sugarcane underway
- CO_2/Temperature/Water Workshop
  - Crop modelers and FACE experimentalists
  - US National Climate Assessment
- Regional Intercomparisons and Sensitivity Tests
  - Obregon, Mexico (Rosenzweig et al., 2012)
  - S. America, Africa, S. Asia Workshops
  - Maize, rice, wheat, sugarcane, groundnut



Crop Modeling Protocols, including Sentinel Sites Categories, available at www.agmip.org

AgMIP Crop Model Intercomparison Pilot Studies



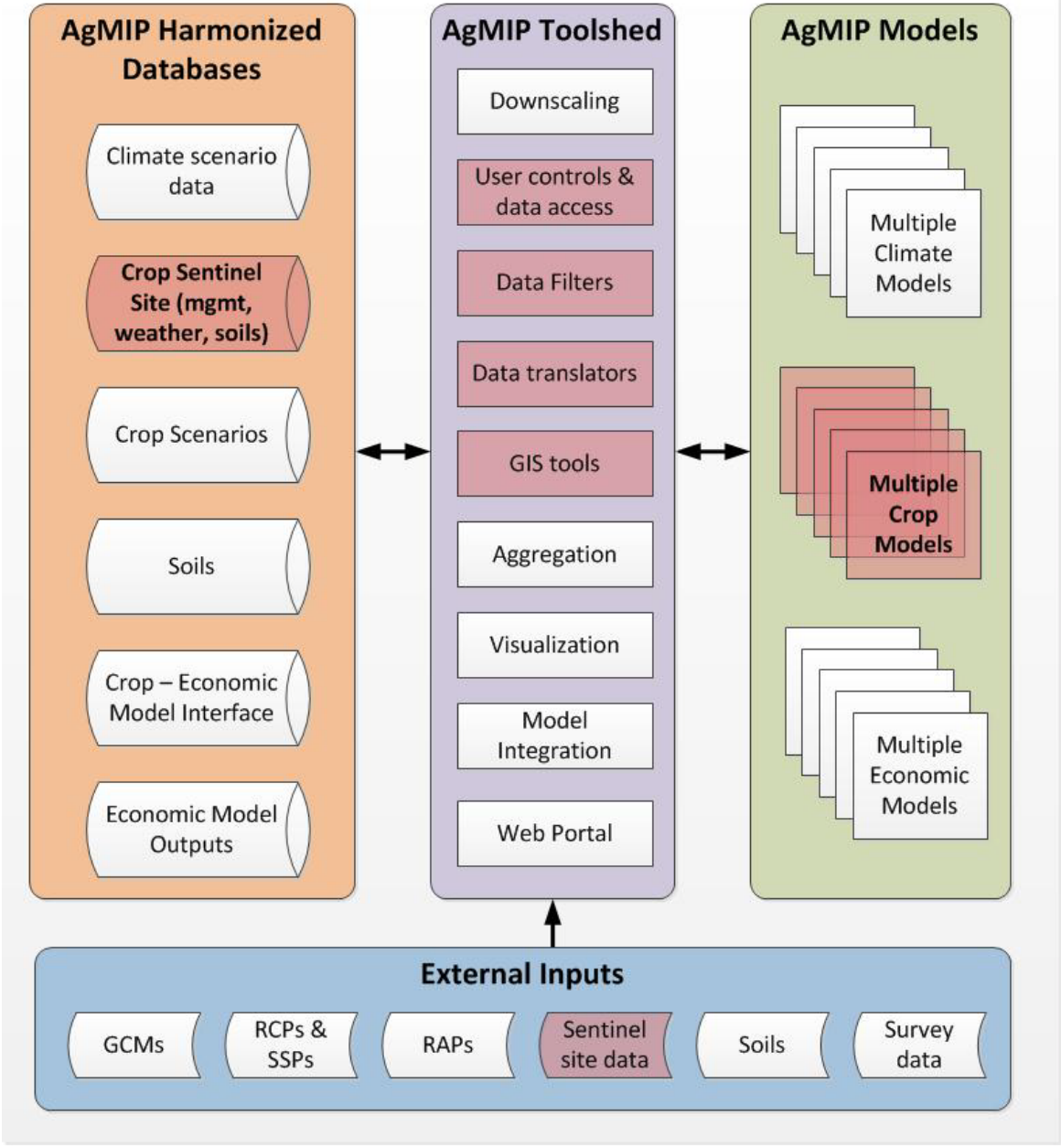
- Wheat (27 models), Maize (~20), and Rice Model (~15) Pilots underway
- Pilots under development for sugarcane, millet/sorghum, soybean, groundnut, potato, and livestock

AgMIP Teams: Economics Team

Regional Modeling	Global Modeling
Identify focus regions & models, spatial resolution, inter-model linkages	Identify and document models, linkages with crop & other models, key drivers
Downscale global RAPs to regional scales	Standardize scenario variables, create RAPs consistent with RCPs & SSPs
Collaborate with climate and crop teams to improve crop-economic model linkages	Collaborate with climate and crop teams to improve crop-economic model linkages
Develop methods and standards for uncertainty assessment and regional model intercomparisons, cross-scale comparisons with global models	Develop methods and standards for uncertainty assessment and global model intercomparisons
Downscale global model outputs and implement regional model analyses with RAPs and AgMIP datasets, develop adaptation and mitigation strategies.	Implement global models with RAPs and AgMIP datasets, develop adaptation and mitigation strategies.

10 Global Economic Models participating in AgMIP Intercomparison ISI-MIP; Preliminary results presented at Planet Under Pressure

AgMIP Teams: Information Technologies



Harmonized data Archives

Data translators
Workflow tools

Advanced online analysis tools

AgMIP Cross-Cutting Themes

AgMIP Cross-Cutting Themes

Representative Agricultural Pathways

John Antle, Oregon State University

Aggregation and Scaling

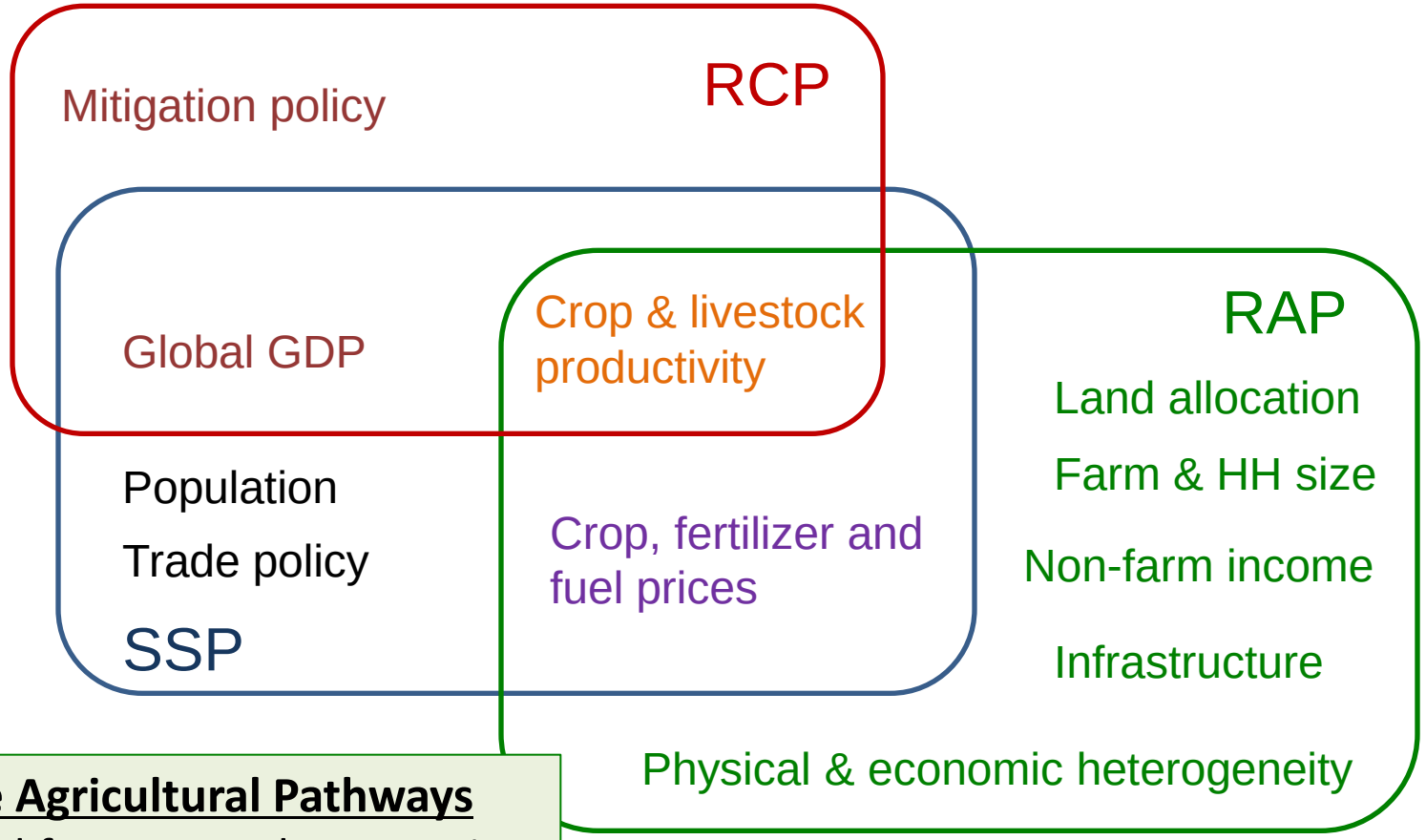
Frank Ewert, University of Bonn

Uncertainty

Daniel Wallach (INRA)

Mike Rivington (James Hutton Institute, Scotland)

Representative Agricultural Pathways: RCPs, SSPs, and RAPs



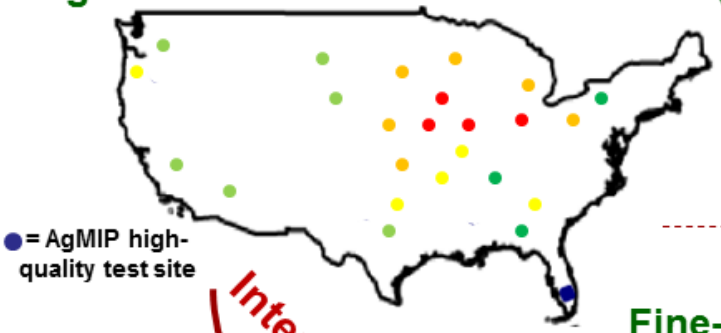
Representative Agricultural Pathways

- RAPs needed for crop and economic modeling scenarios
- Similar scenarios may be useful for other impacts sectors

Antle, 2011; Arnell and Kram, 2011

Aggregation to Decision-Relevant Spatial Scales

AgMIP Network of Simulated Yields (A_j)



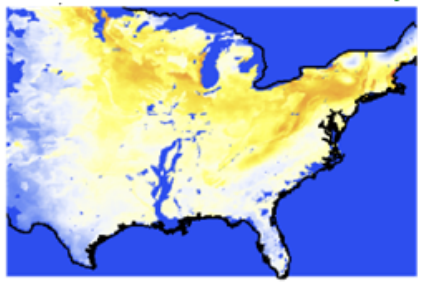
Crop Model Yields ***(from model j)***

- Network of yields simulated by a given crop model or ensemble of crop model results

Interpolation

Direct Regional Regression

Fine-scale Production Estimates (B_{jk})



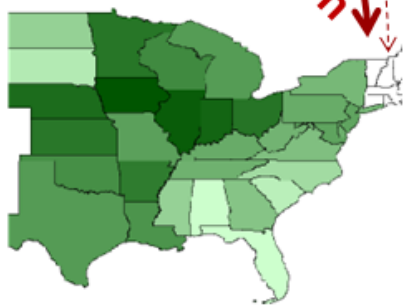
Interpolated production estimates ***(from crop model j and interpolation method k)***

- Require high-resolution yield proxies from satellites, models, and/or gridded environmental datasets
- Require high-resolution land-cover and land-use database

Aggregation

Aggregated Production ***(from crop model j and interpolation method k)***

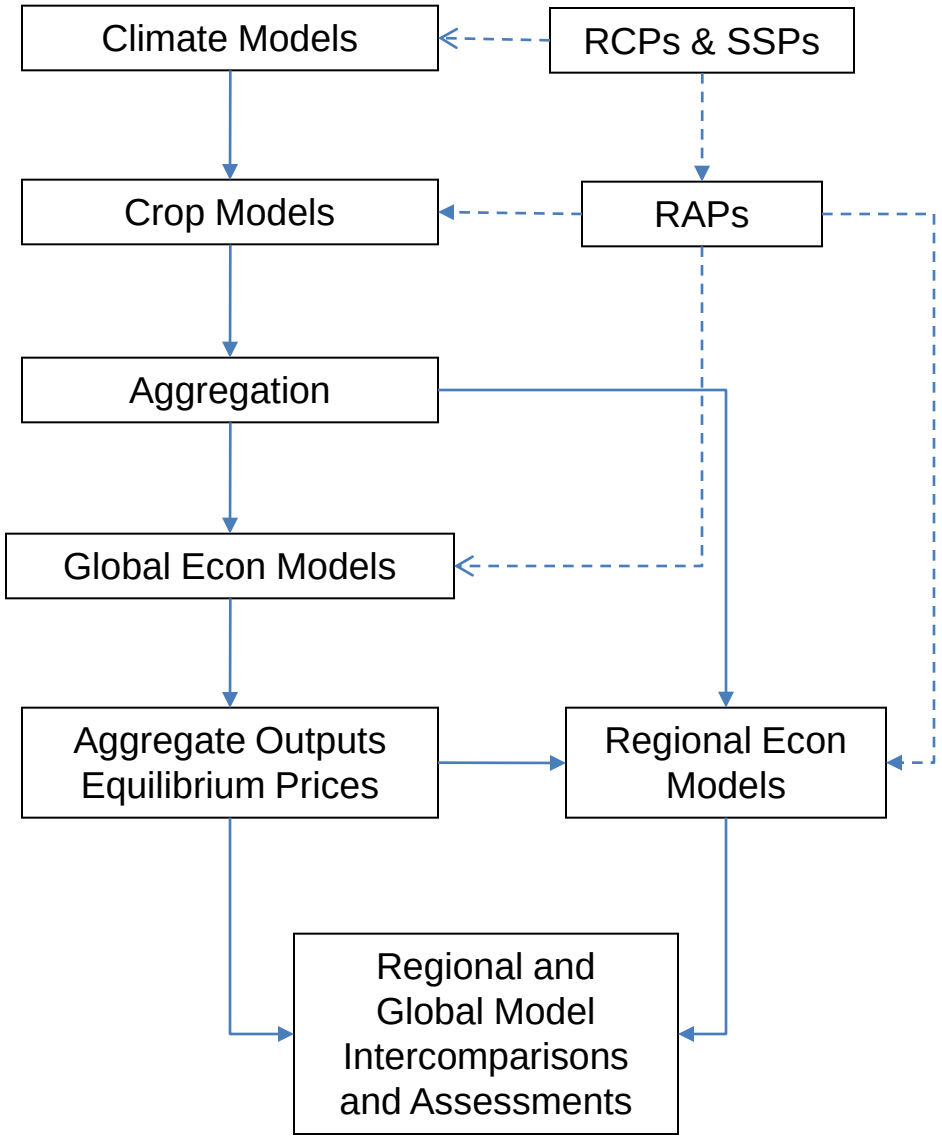
- To decision-relevant economic, political, or environmental regions
- Production skill at larger scale better than skill from fine scale estimates



Production at Decision-Relevant Scale (C_{jk})

Uncertainty

AgMIP Global Assessment Flow Chart



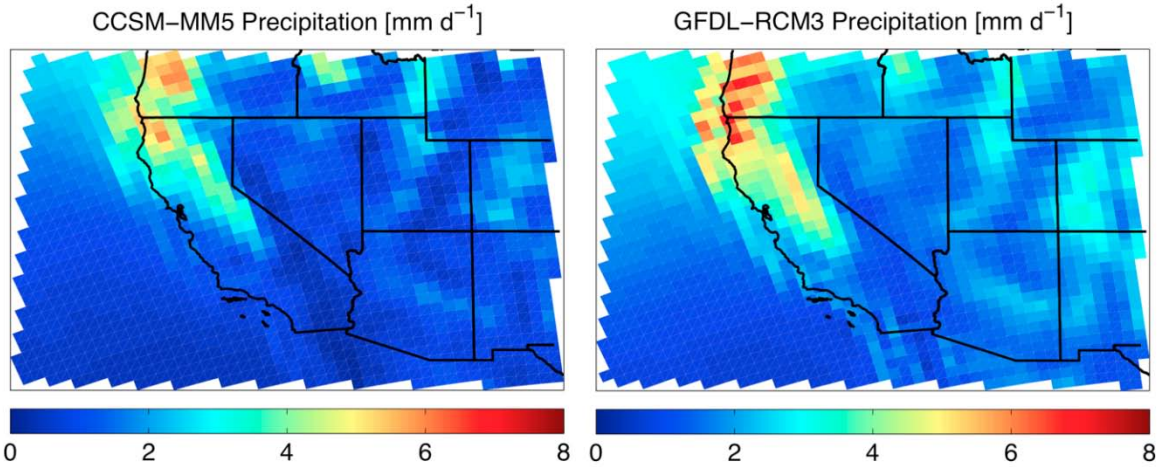
Potential Sources

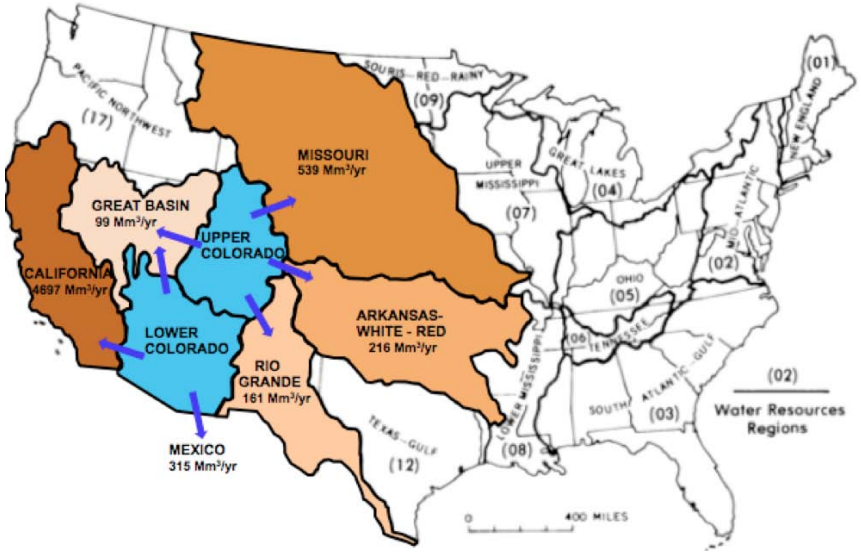
- Data collection and analysis
- Scenarios
- Model ensembles
- Unresolved processes
- Model interactions
- Methodological choices

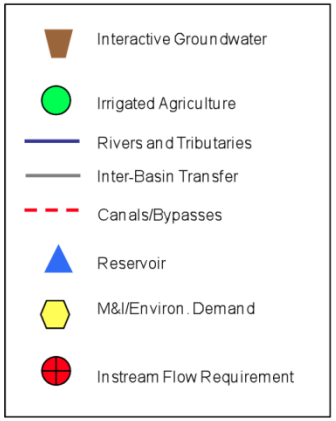
AgMIP Pilot for Agricultural Water Resources

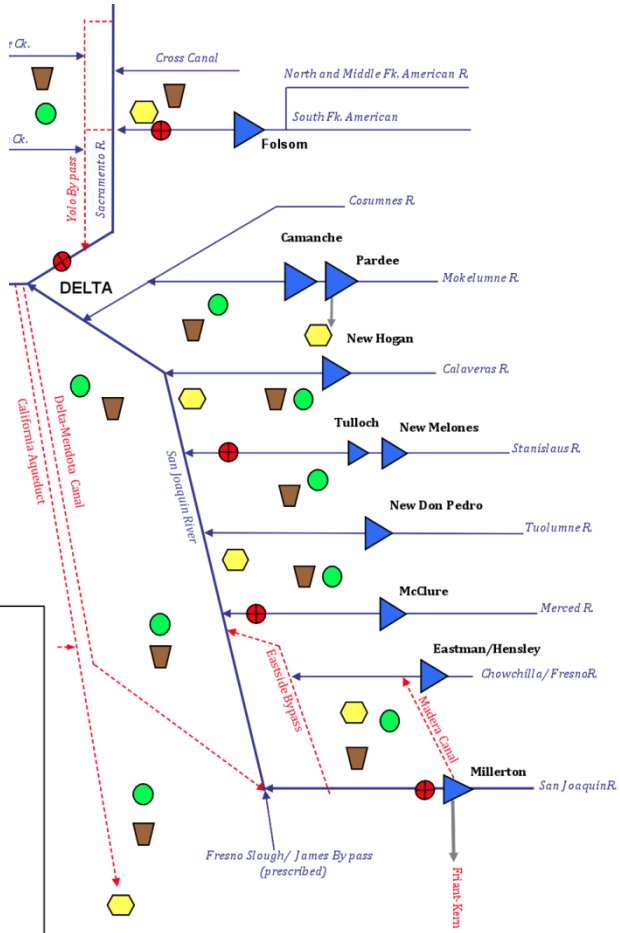
- Estimate future water demand for key agricultural areas throughout the continental United States using results from AgMIP and hydrologic models.
- Simulate the distribution of future available water among sectors.
- Identify water stressed/ food insecure areas.
- Construct and test strategies using the framework.

AgMIP Water Resources Pilot Assessment Methodology









AgMIP Research Horizons

Potential Interaction with the SDWG

Where AgMIP Your Needs Help

Understand Current/Future Water Availability – Water is partly uncontrolled

How do the different types of models compare? Do land surface models produce responses (ET, etc.) similar to crop models?

Analyze models' output distribution and extremes, interannual and intraseasonal variability

AgMIP Research Horizons

Potential Interaction with the SDWG

Where AgMIP Can Help You

Model Intercomparisons Can Help Develop/Inform Your Models Too!

AgMIP-style Frameworks (Climate-Crop-Econ; RAPs) can help link cutting-edge important process models, fostering more trans-disciplinary assessments

Accessibility to Models' Output and Scenario Responses – AgMIP and collaborators want to provide best information on potential agricultural "shocks"

Next Steps and Upcoming Events

RFP Process for Sub-Saharan Africa and South Asia for AgMIP teams – 31 proposals received; 9 team projects recommended

AgMIP leading agricultural sector in ISI-MIP

Coordinated Climate-Crop Model Pilot (C3MP)

Regional and Global Workshops

Completed:

- Global Workshops just prior to ASA annual meeting in US: Long Beach, October 2010; San Antonio, October 2011
- Europe Wheat Pilot: Amsterdam, April 2011
- South America: Campinas, August 2011
- Rice Pilot: Beijing, August 2011
- Sub-Saharan Africa: Kenya, January 2012
- South Asia: Hyderabad, February 2012
- Global Economic Model Intercomparison: Kenya, Paris

Upcoming:

- Global Economic Model Intercomparison: DC 2012
- CO_2, Temperature, and Water (CTW) Workshop: TBD 2012
- North America: Ames, IA, September 4-7 2012
- Third Annual Global Workshop: Rome, October 2012
- East Asia: In development, 2012
- World Crop FACE Workshop: Tsukuba, 2012

AgMIP The Agricultural Model Intercomparison and Improvement Project

For Protocols, Up-to-Date events and News, visit

www.agmip.org

Contacts

Cynthia Rosenzweig, Alex Ruane, and Carolyn Mutter

crosenzweig@giss.nasa.gov

Alexander.C.Ruane@nasa.gov

czm2001@columbia.edu