Regional Climate Information Needs for Impact Modelling

Lessons Learned from

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

AgMIP
The Agricultural Model Intercomparison and Improvement Project

Delphine Deryng
Lead Author IPCC WG2 Chapter 5 Food, fibre, and other ecosystem products
Scientific Advisor at Climate Analytics www.climateanalytics.org
Contact: **delphine.deryng@climateanalytics.org**

What is ISIMIP?

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

ISIMIP offers a framework for consistently projecting the impacts of climate change across affected sectors and spatial scales.

www.isimip.org

Models participating in ISIMIP

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

Climate data

5GCM x 4RCPs
+
Historical observational

Socio-economic input

GDP, populations from SSPs
+
Historical data

Impact Models

Global
Water (13)
Agriculture (14)
Biomes (8)
Infrastructure (1)
Health/Malaria (5)
Marine ecosystems (9)
Permafrost (3)
Energy (?)
Biodiversity (?)

Regional
Forestry (3)
Water (14)

Synthesis of Impacts in terms of warming

Main goals:

Improvement of models

Cross-sectoral aggregation

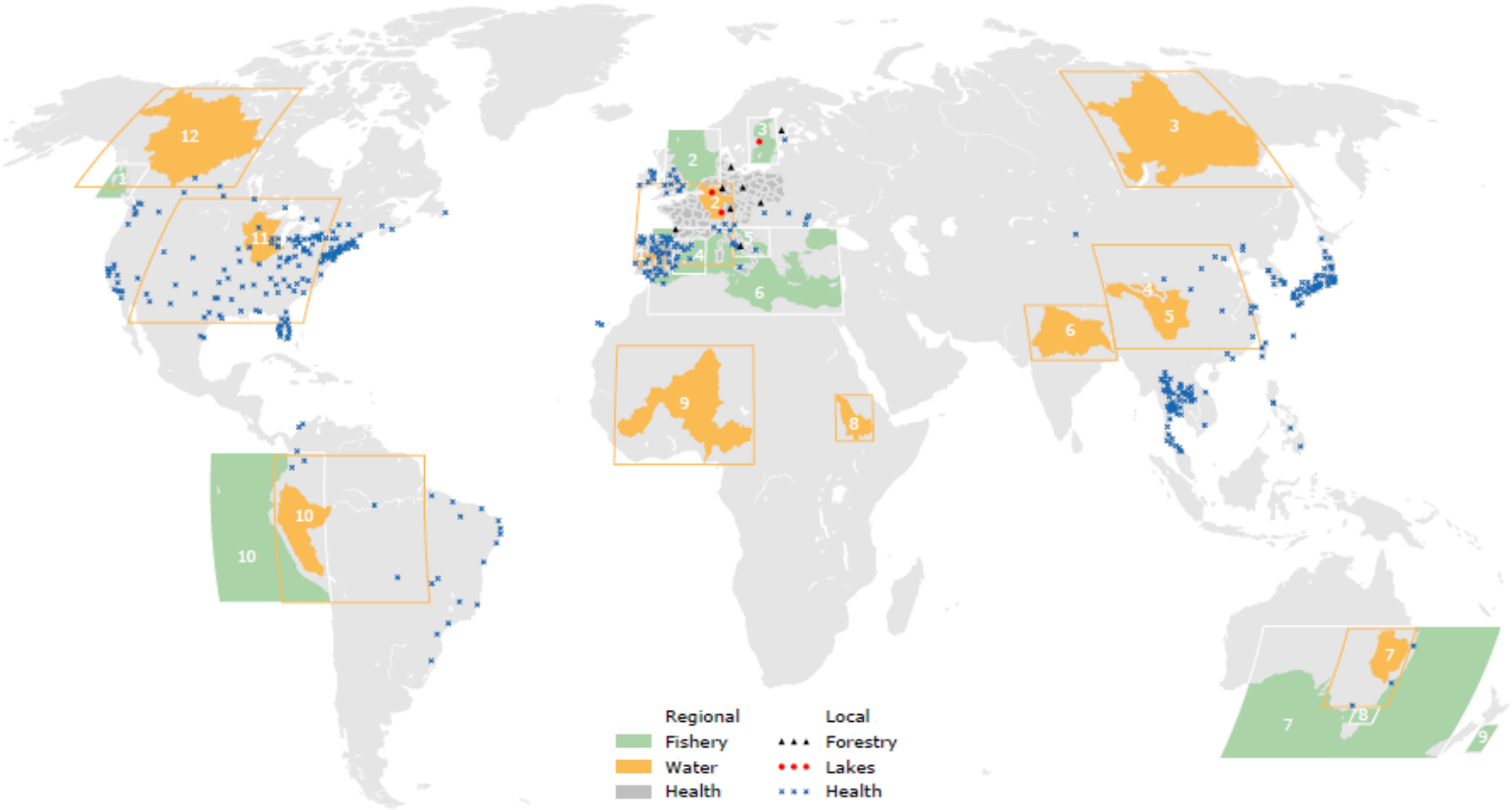
Cross-sectoral effects

ISIMIP phases

- Phase 1 – **ISIMIP Fast Track**
  - Projected impacts driven by CMIP5 climate outputs (period: 1979-2100)
  - Sectors: water, agriculture (biophysical + economics), biomes, forestry, health (vector borne diseases)
  - 5 GCMs, 4 RCPs, SSP2
  - Climate input data were corrected using WATCH
  - Global scale focus: input data 0.5º res (netcdf)
  - IPCC AR5 WGII timeline
- Phase 2a – **Historical validation**
  - More sectors: fast-track + **fisheries**, **permafrost**, **biodiversity, regional water, forests and energy**
  - Reanalysis: Princeton, WFDEI, WATCH (period: 1901-2012)
- Phase 2b – **Low-emissions impacts** (1.5ºC scenarios)
  - several new sectors, including **tropical cyclones, temperature-related mortality** and **lakes**
  - 4 GCMs, RCP 2.6 & 6.0
  - Climate input data were corrected using EWEMBI dataset
  - IPCC 1.5 SR timeline

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

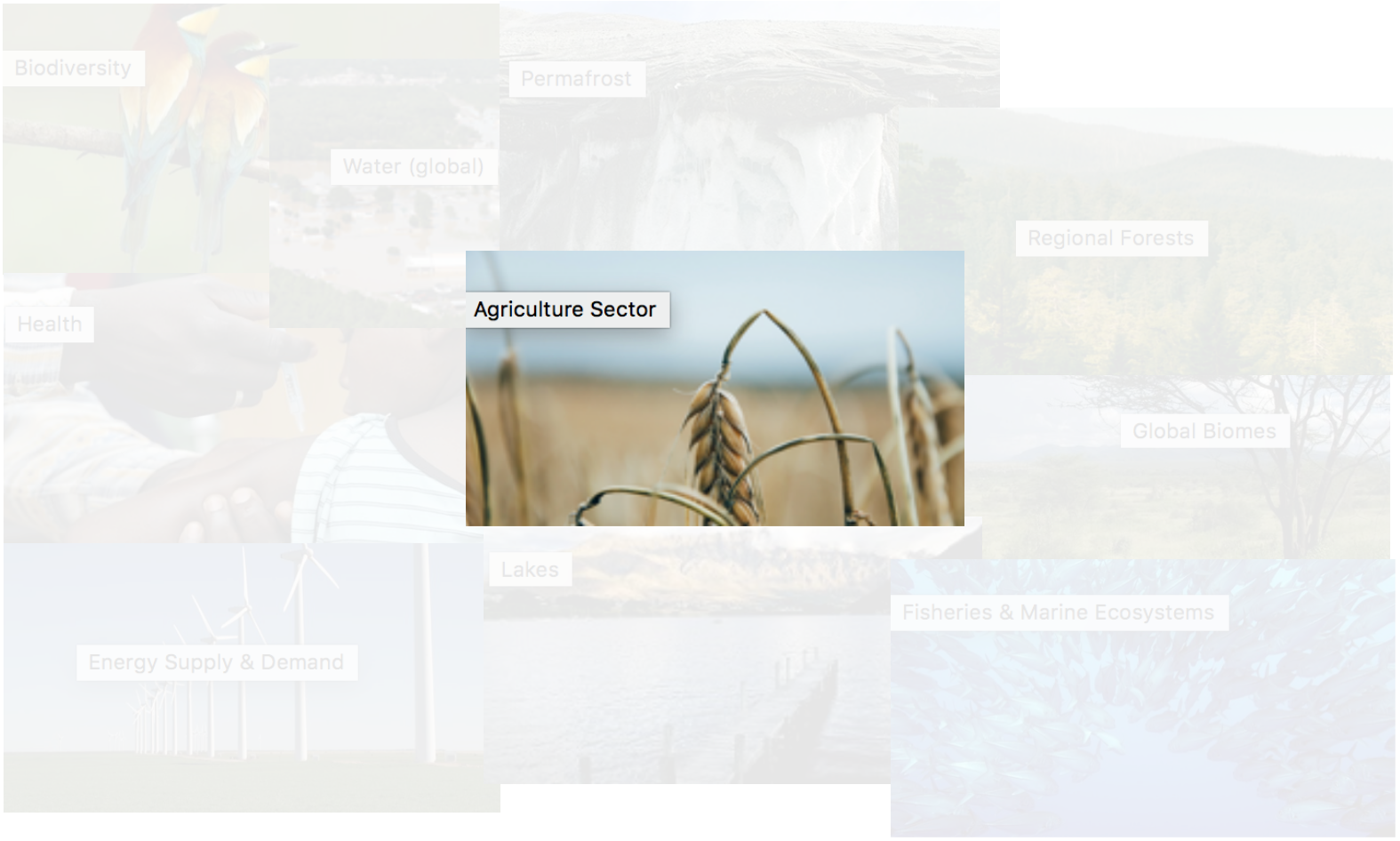
Regional focus for some sectors



AgMIP The Agricultural Model Intercomparison and Improvement Project

What is AgMIP?

www.agmip.org



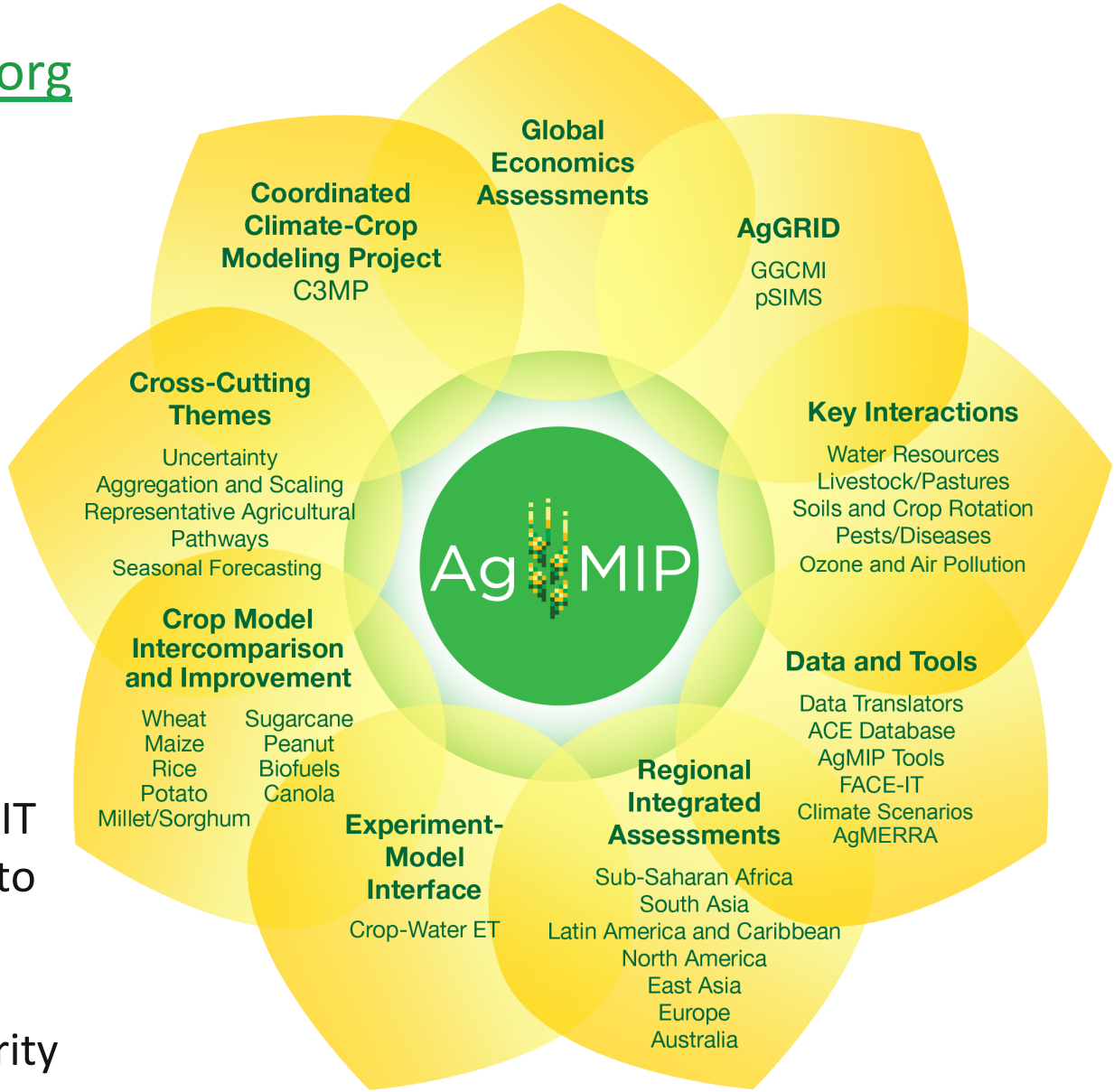
AgMIP The Agricultural Model Intercomparison and Improvement Project

What is AgMIP?

Building an integrated framework across scales, disciplines, and models

www.agmip.org

AgMIP is an international community of 1000+ climate scientists, agronomists, economists, and IT experts working to **improve** assessments of future food security



AgMIP The Agricultural Model Intercomparison and Improvement Project

Involved in ISIMIP

- GGCMI: global gridded crop modelling intercomparison initiative (contribute to the agriculture sector of ISIMIP)
  - Phase 0: ISIMIP fast-track
  - Phase 1: model evaluation (against historical data)
    - ISIMIP 2a
  - Phase 2: sensitivity analysis to assess crop-carbon/ temperature/water/nitrogen interactions
  - Phase 3: model improvement + implementation & evaluation of adaptation measures

Impact models
Climate information needs

Two tracks

- Model calibration & validation
- Attribution

Historical Climate

- Impact projections
- Adaptation

Future Climate

Impact models
Climate information needs

- Ag model/impact model needs good historical forcing dataset
- Attributes:
  - high resolution (temporal, spatial)
  - Continuous and consistent
  - All necessary variables (surface)
  - reduce biases
- Projections that capture key drivers of sector impacts (eg water deficit, droughts)
- Bias-adjustment
  - ISIMIP approach: trend-preserving

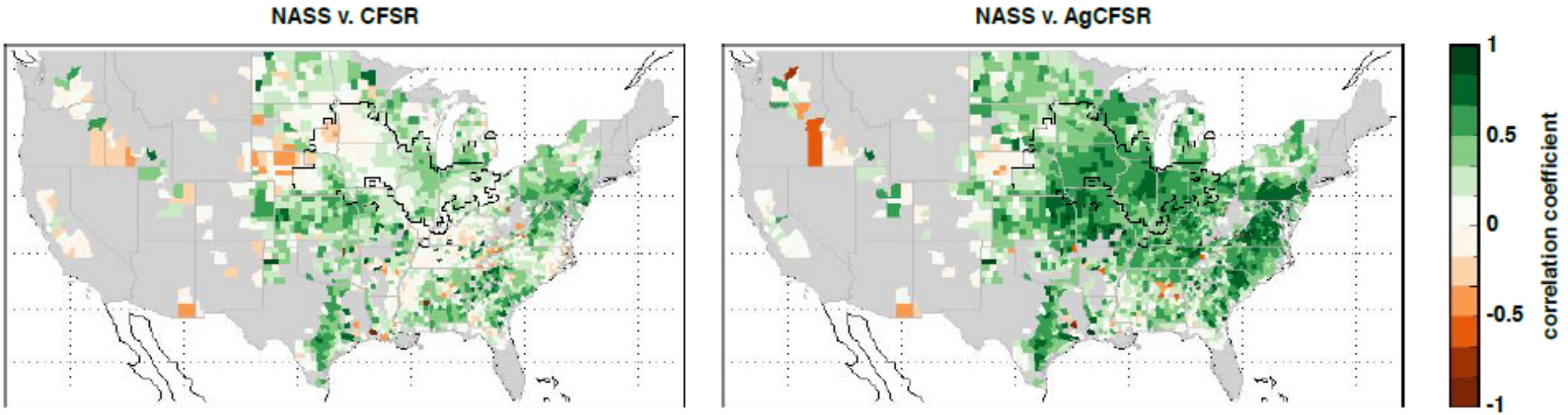
Provided climate variables in daily resolution

Variable name	Short name
Near-surface relative humidity	hurs
Near-surface specific humidity	huss
Precipitation	pr
Snowfall flux	prsn
Surface pressure	ps
Sea-level pressure	psl
Surface downwelling longwave radiation	rlds
Surface downwelling shortwave radiation	rsds
Near-surface wind speed	sfcWind
Near-surface air temperature	tas
Daily maximum near-surface air temperature	tasmax
Daily minimum near-surface air temperature	tasmin

Historical Climate Products

AgMERRA (Ruane et al., 2015b): Agricultural modeling version of NASA MERRA Reanalysis with common bias adjustments (from gauges and satellites)
- global, 0.25º x 0.25º, 1980-2010 daily record
- commonly used for gridded studies and to fill in gaps in developing country datasets

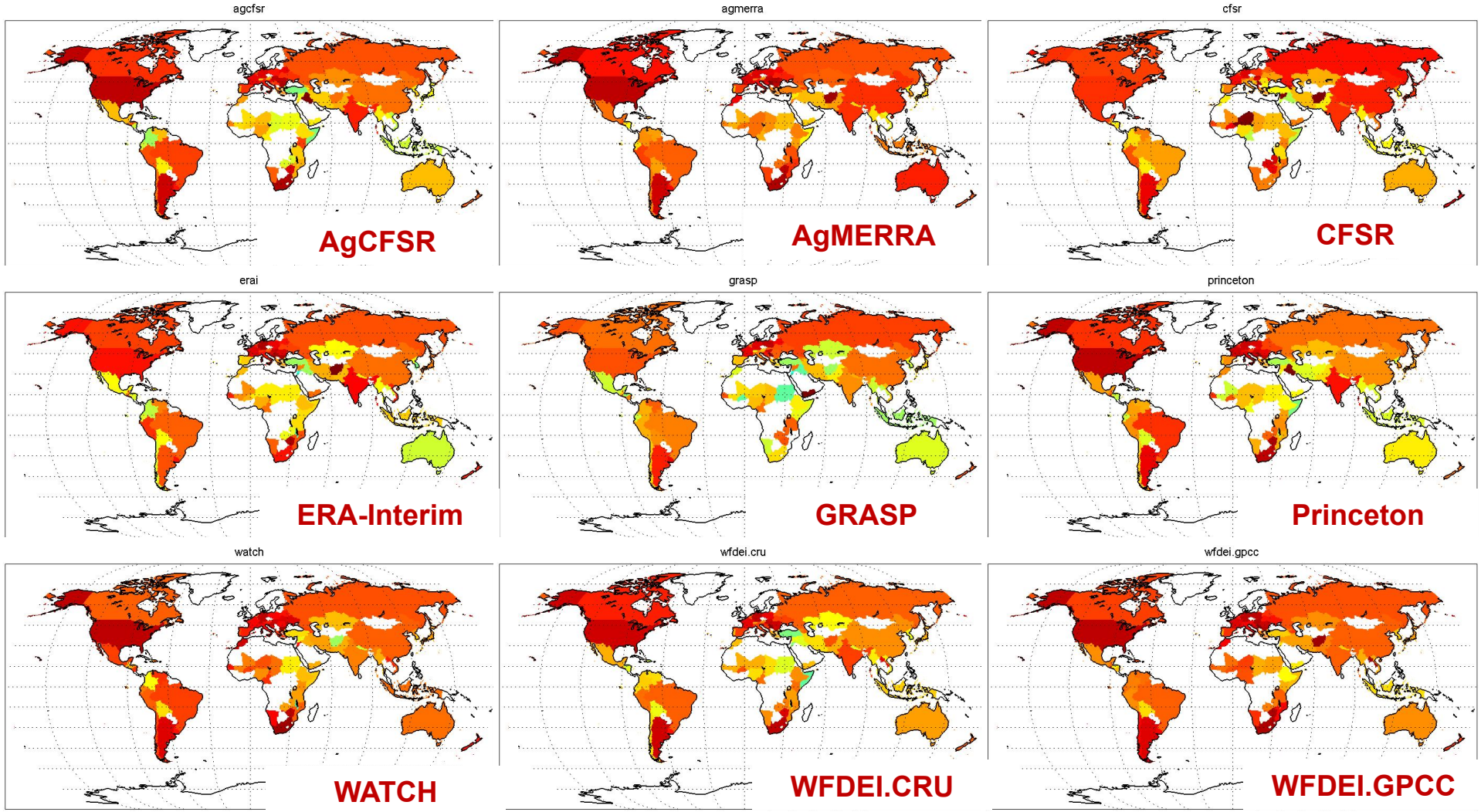
AgCFSR: Same approach using NCAR CFSR Reanalysis as basis



Above: 1980-2010 Correlations between National Agricultural Statistics Service (NASS) County-level production and that simulated by pDSSAT using CFSR (left) and AgCFSR (right) climate data (from Glotter et al., 2016). Note dramatic improvement in correlations over major agricultural regions including the US Corn Belt (outlined in black).

The Choice of Historical Climate Product Matters in GGCMI ensemble

AgMIP The Agricultural Model Intercomparison and Improvement Project



Crop Model: **highest of 7**
Detrending tech: **highest**

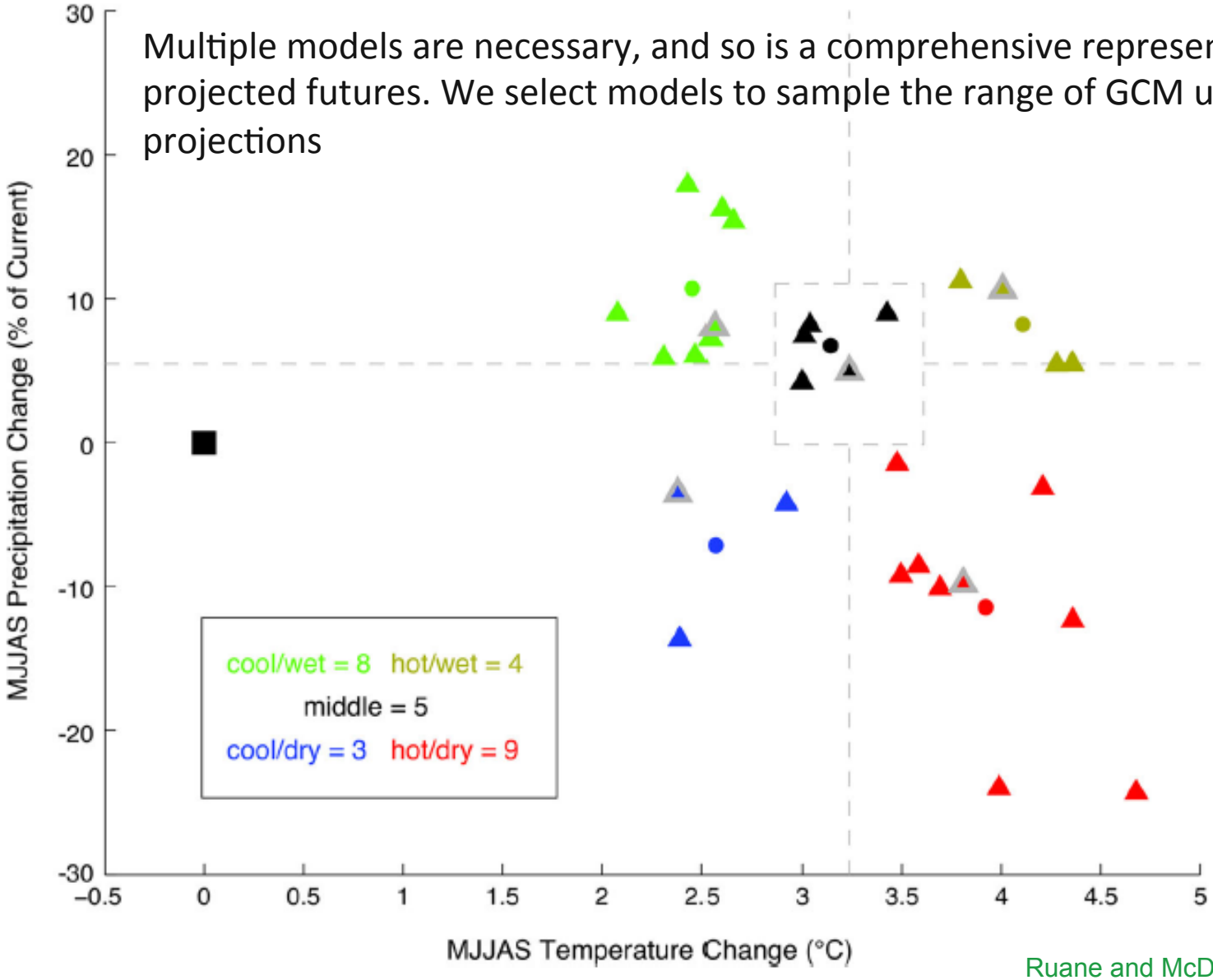
Scenario: default
Time range: 1980-2009

-1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8 1

Correlation with FAO Production

Climate Projections
Selecting a Representative GCM Subset

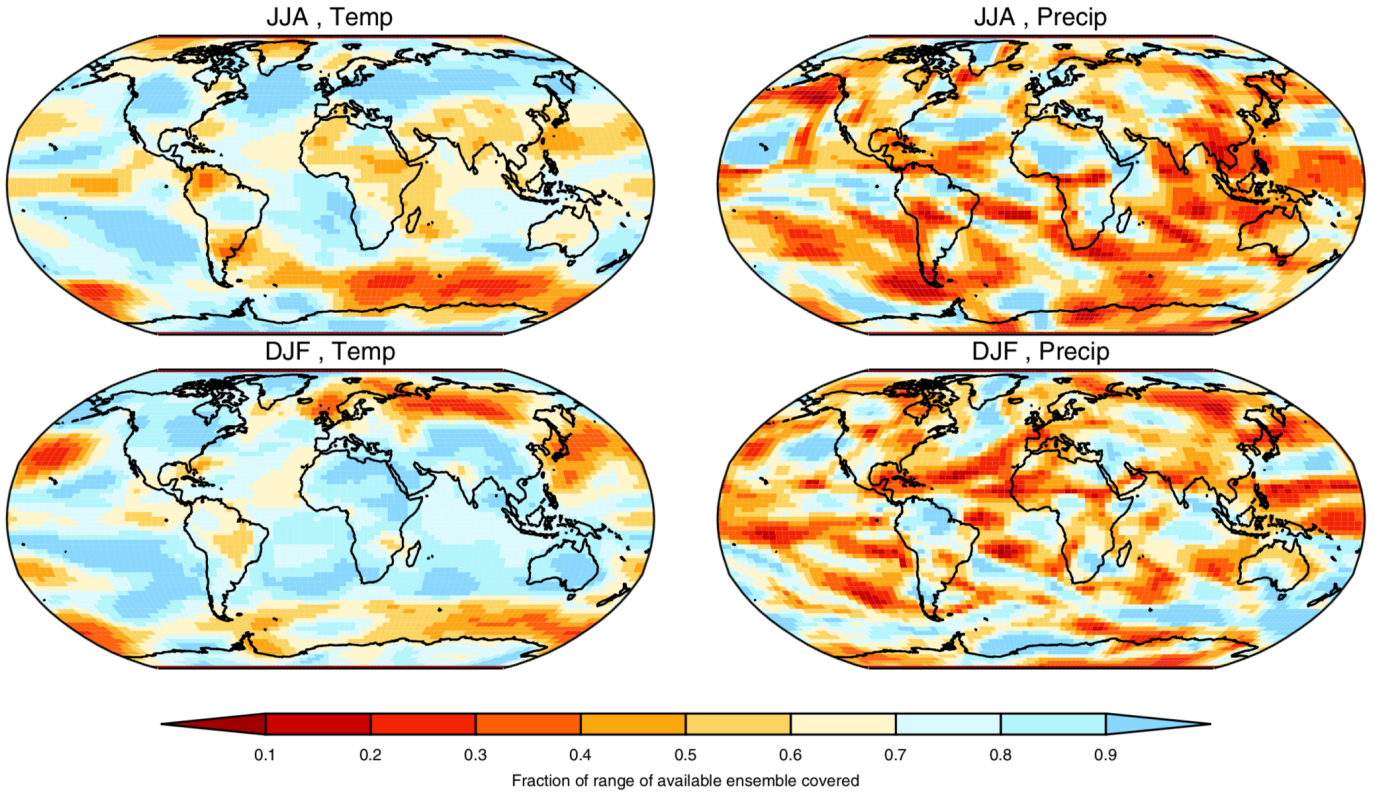
Multiple models are necessary, and so is a comprehensive representation of projected futures. We select models to sample the range of GCM uncertainty in projections



Ruane and McDermid, 2017

Climate Projections
Selecting a Representative GCM Subset

How well do the 5 GCMs in ISIMIP represent the range of the full CMIP5 ensemble?



Fractional Range Coverage: fraction of the range of projections in either variable that is spanned by any subset compared with the 'full' ensemble of 36 models

McSweeney & Jones, Climate Service (2016)

Climate Projections
Selecting a Representative GCM Subset

AgMIP The Agricultural Model Intercomparison and Improvement Project

Geophysical Research Letters

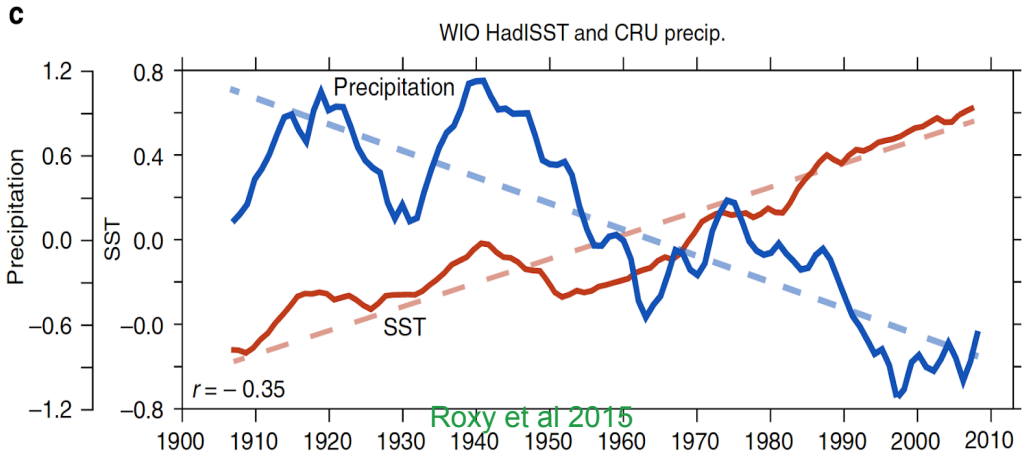
RESEARCH LETTER
10.1002/2014GL061573

Key Points:
- CMIP5 models fail to simulate post-1950

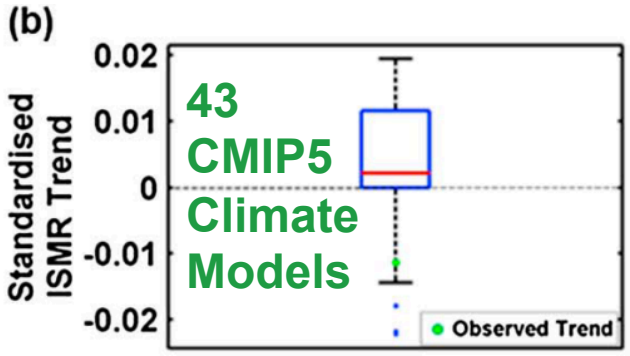
Failure of CMIP5 climate models in simulating post-1950 decreasing trend of Indian monsoon

Anamitra Saha[1], Subimal Ghosh[1,2], A. S. Sahana[1], and E. P. Rao[1]

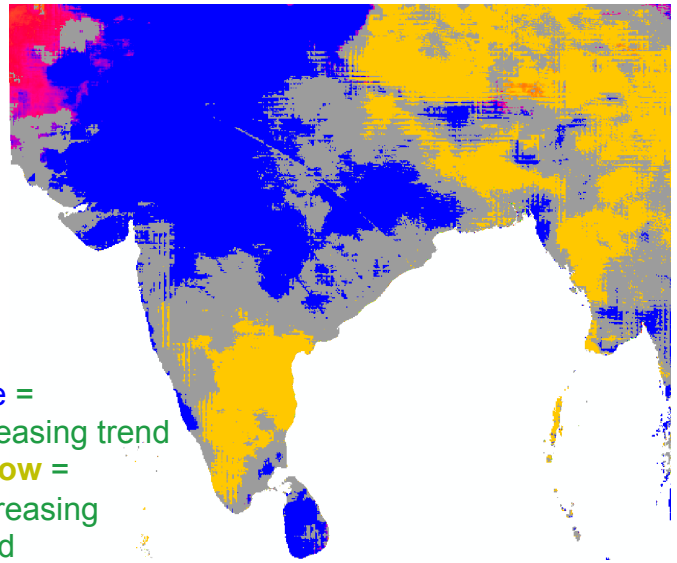
Observed ISMR Trend



Roxy et al 2015



Observed ISMR Trends since 2000



Blue = increasing trend
Yellow = decreasing trend

Mondal and McDermid, in prep

Lessons learned

- Information on **regional skill** (monsoon, …etc.)
- AgMIP and ISIMIP have primarily used bias-correction, not so much **downscaling** (combination data availability and demonstrated added value)
- Improve **bias-correction** method
- Eager to use improved tools (e.g. dynamical and empirical downscaling) to enhance our understanding of **extreme events and variation across space**

Thank You!

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

AgMIP
The Agricultural Model Intercomparison and Improvement Project

ISIMIP Lead:
Katja Frieler, PIK (Katja Frieler katja.frieler@pik-potsdam.de)

AgMIP Climate Team Leads:
Sonali McDermid, NYU (sps246@nyu.edu) & **Alex Ruane**, NASA GISS (alexander.c.ruane@nasa.gov)

Delphine Deryng, delphine.deryng@climateanalytics.org