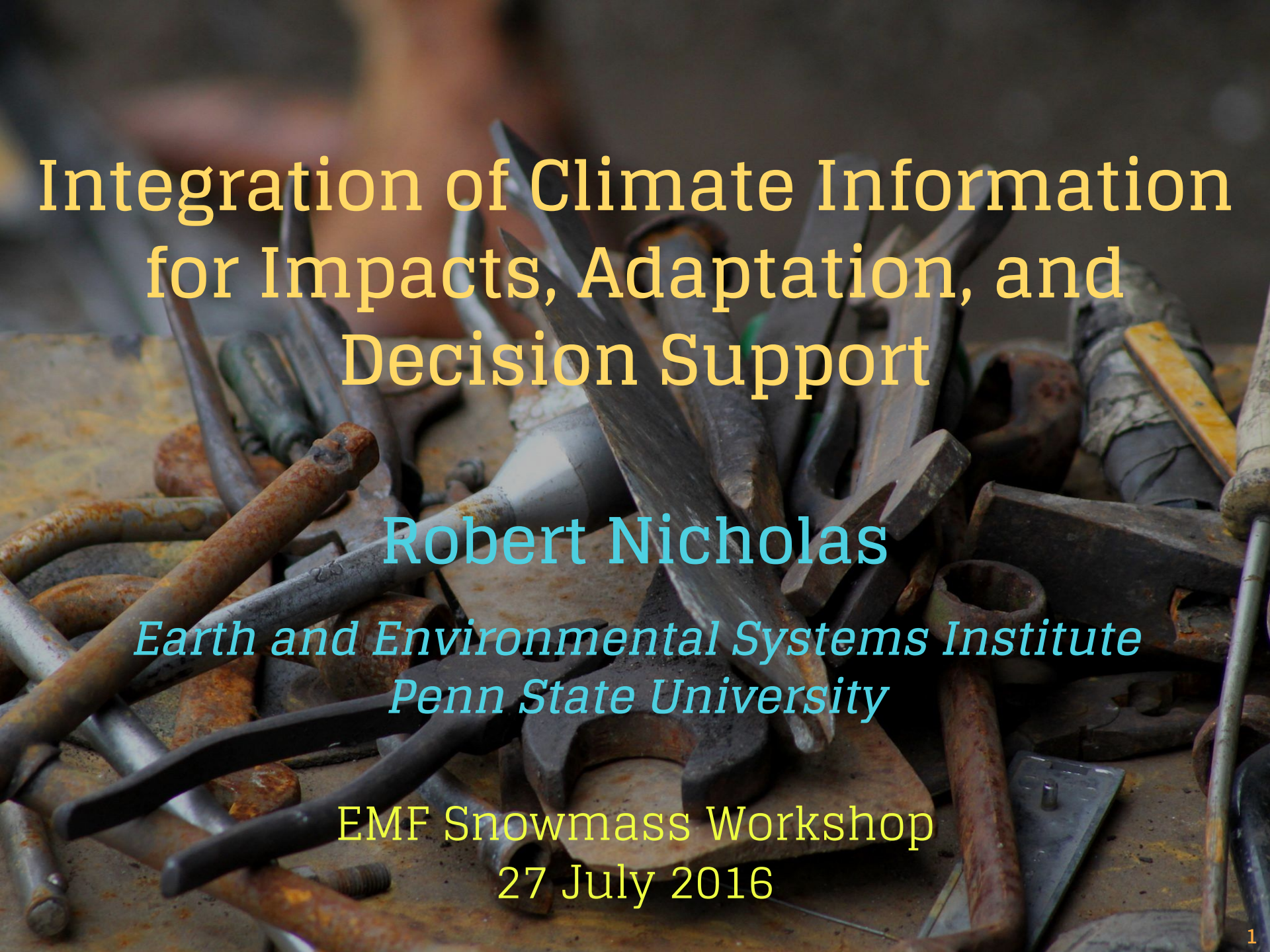

# Integration of Climate Information for Impacts, Adaptation, and Decision Support


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EMF Snowmass Workshop
27 July 2016

# How can we more effectively couple / integrate IAMs, ESMs, and IAV analyses?

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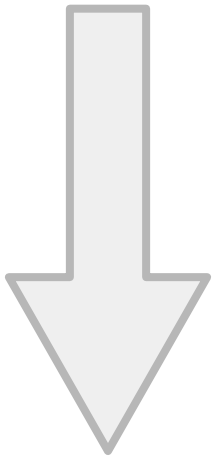
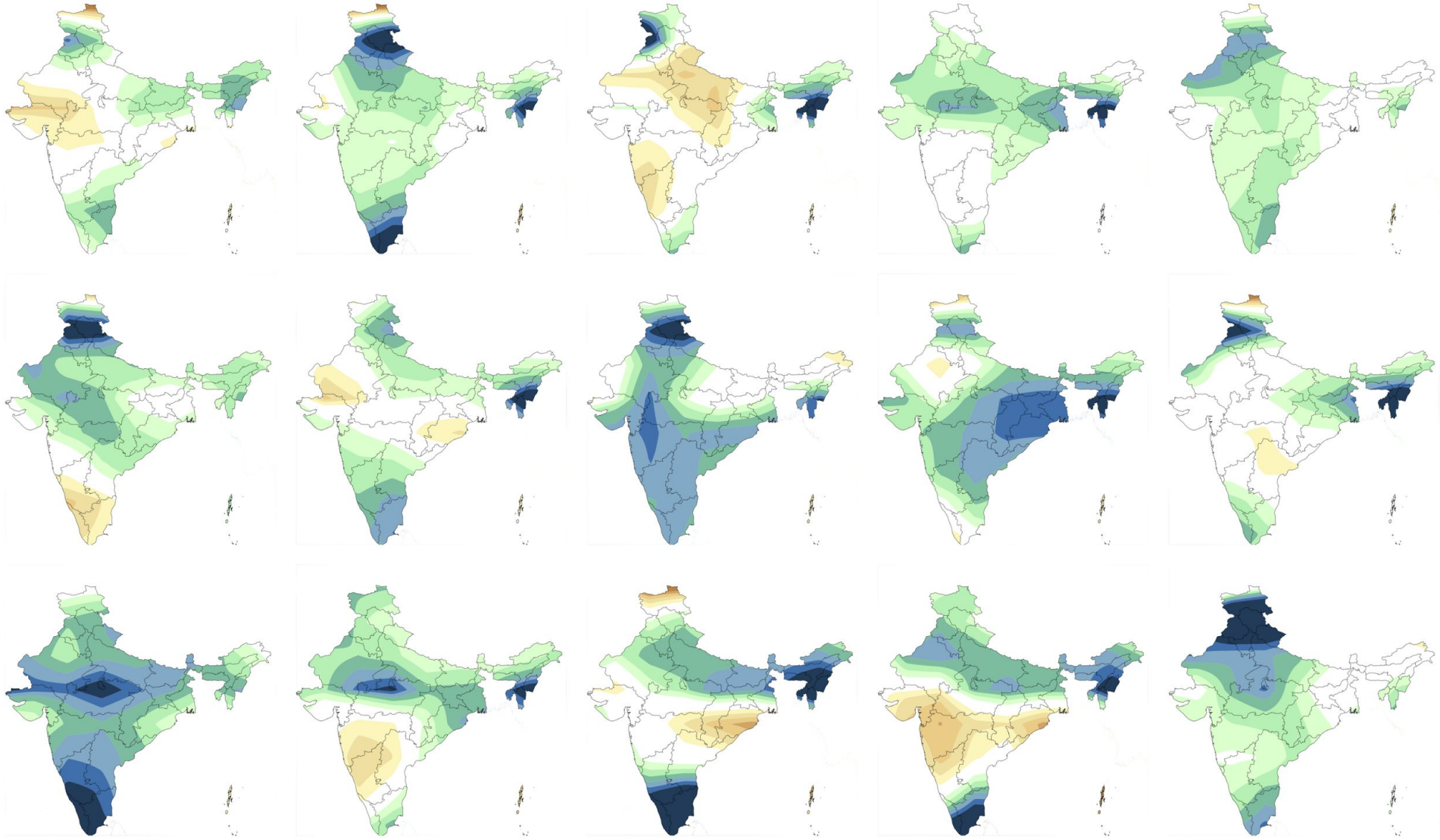


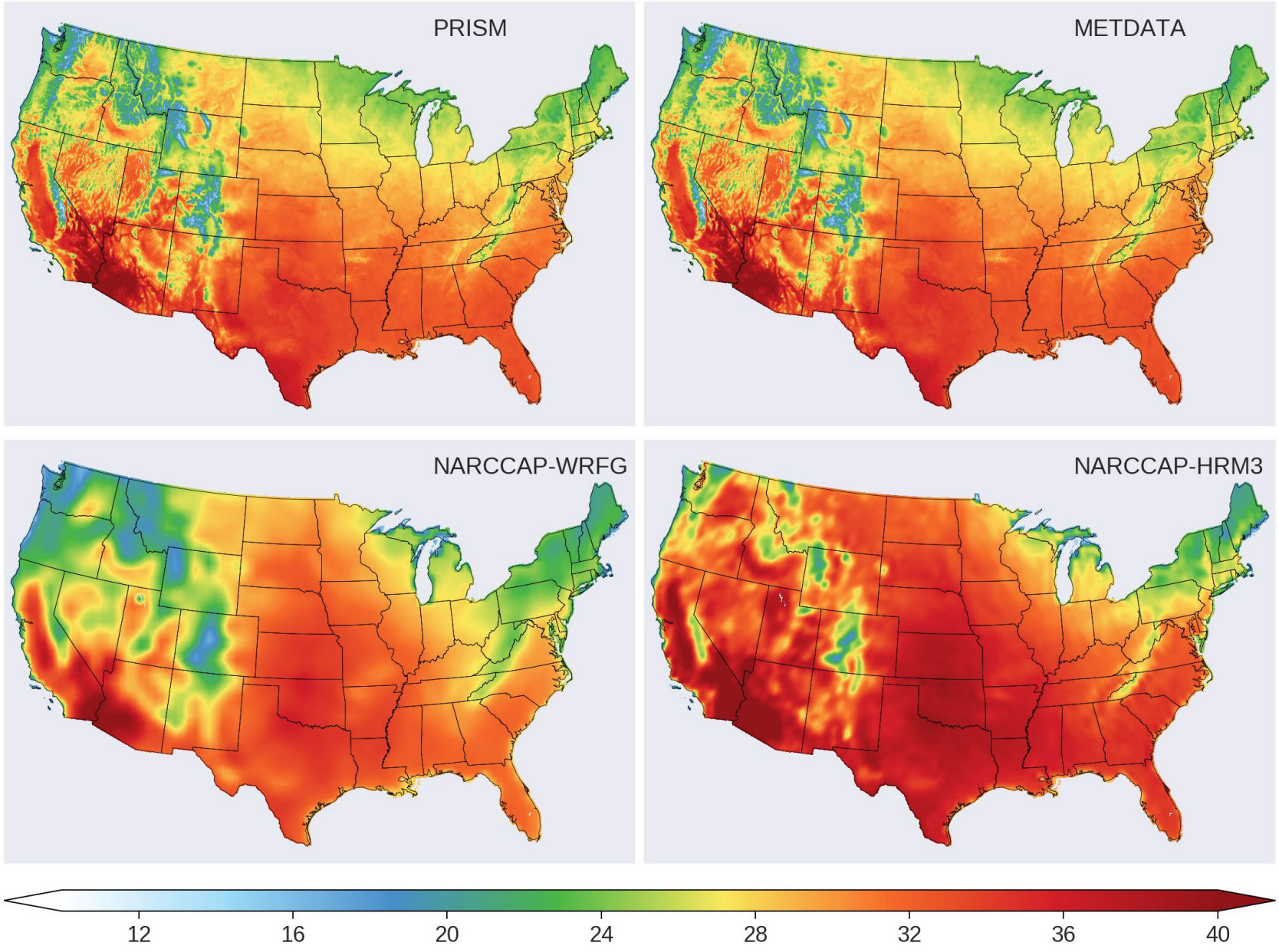
**How can we more effectively integrate climate information into IAMs, IAV analyses, and decision-support applications?**

**What are the barriers to effectively integrating climate information?**

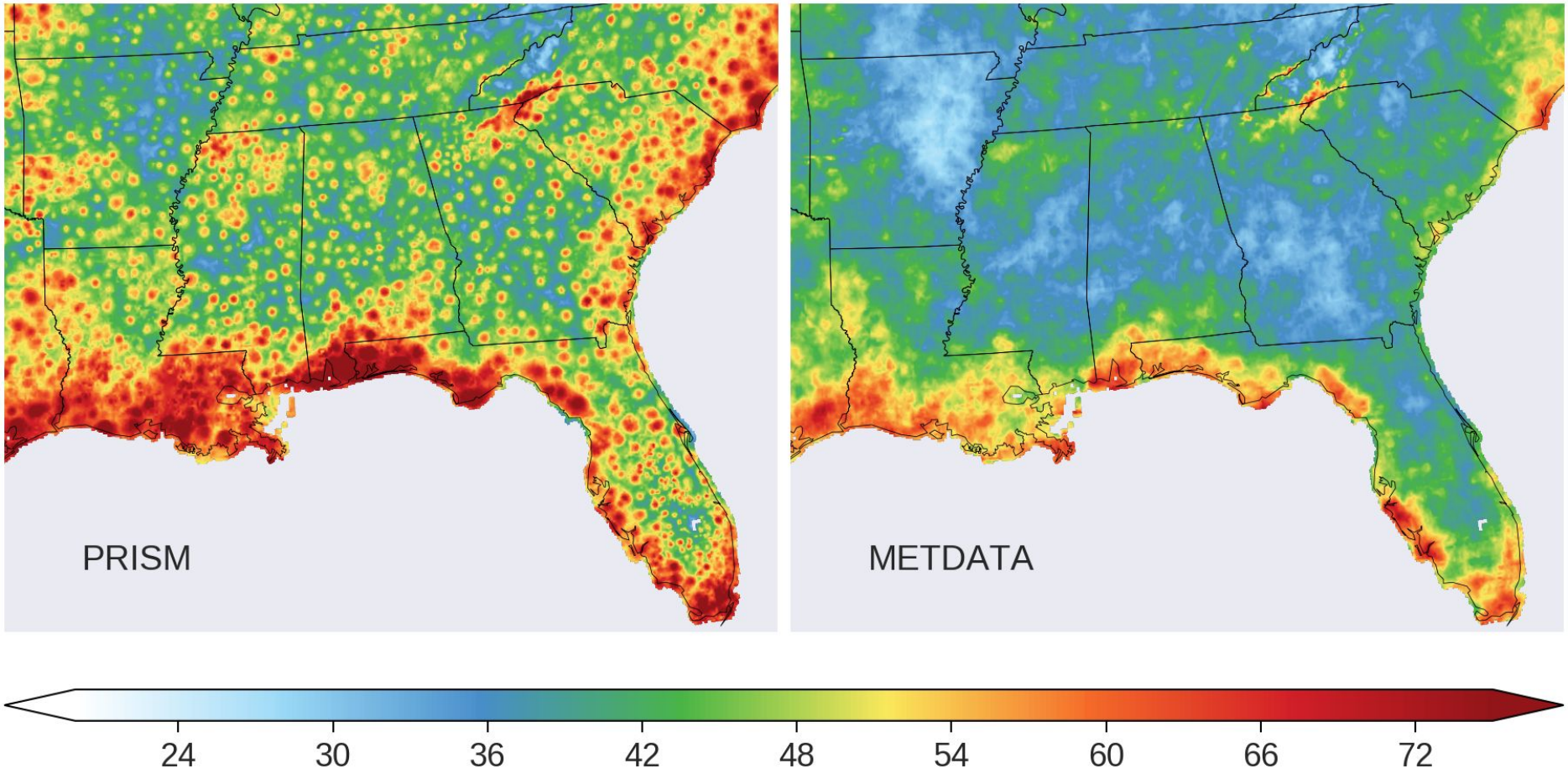



# Monsoon Total Precipitation, 2011-2060 Trend

PIAMDDI-CESM Large Ensemble, Sriver et al. (*GRL*, 2015)




Mean JJA Daily Maximum Temperature (°C), 1981-2004




99.5th Percentile JJA Daily Precipitation (mm), 1981-2004

# barriers to integration of climate information

identifying, obtaining, and preparing appropriate climate information

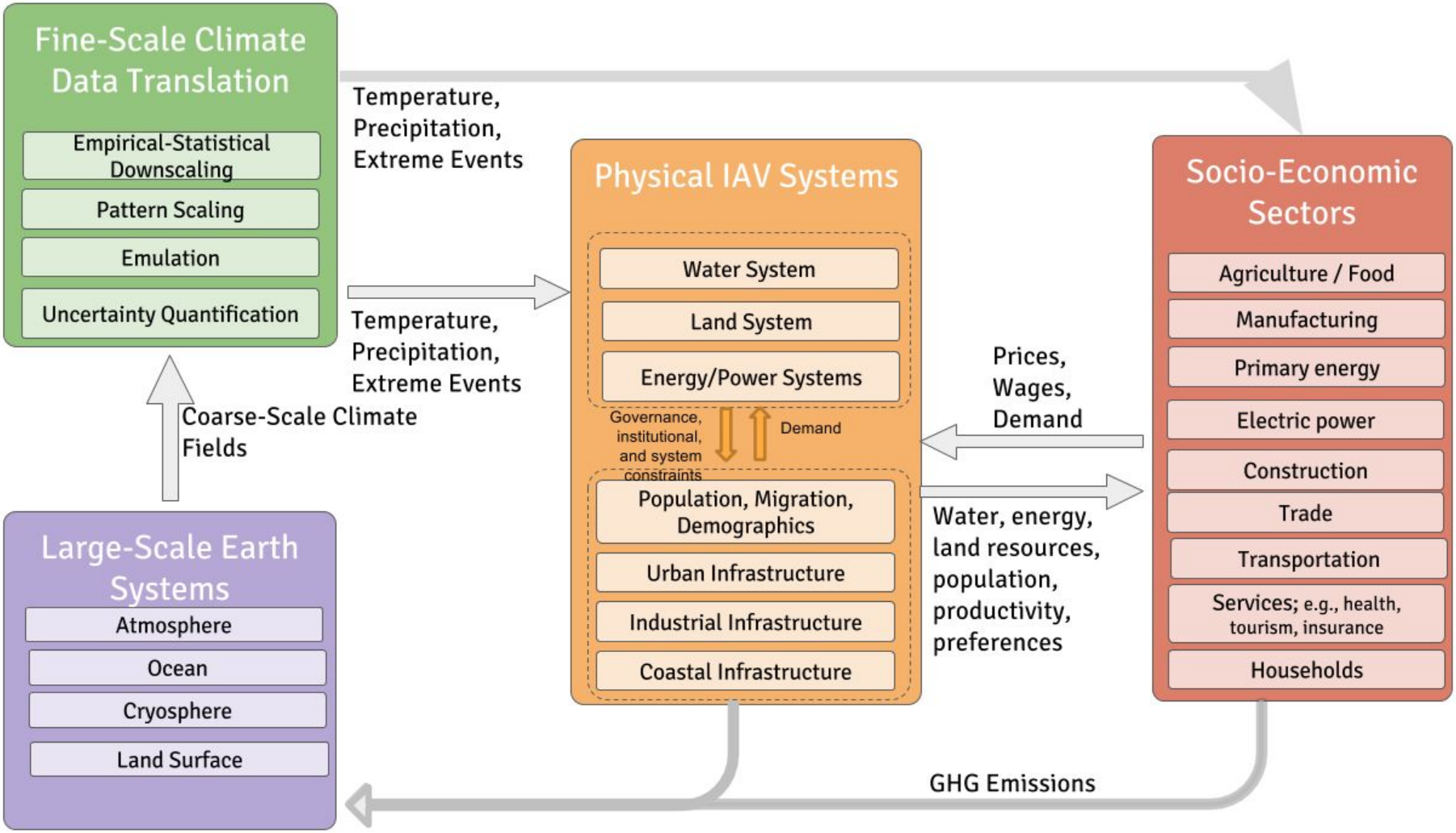
- data volume
- differences in software, tools, file formats, and approaches to spatial information across disciplines
- quality control
- mismatches in spatial and temporal resolution

communicating, understanding, and accounting for bias and uncertainty (structural, parametric, forcing/scenario, and natural variability)

capturing the relevant characteristics of weather and climate

- understanding model sensitivity and response
- extreme events, tails of the distribution

# components of an integrated IAV system within an integrated assessment framework



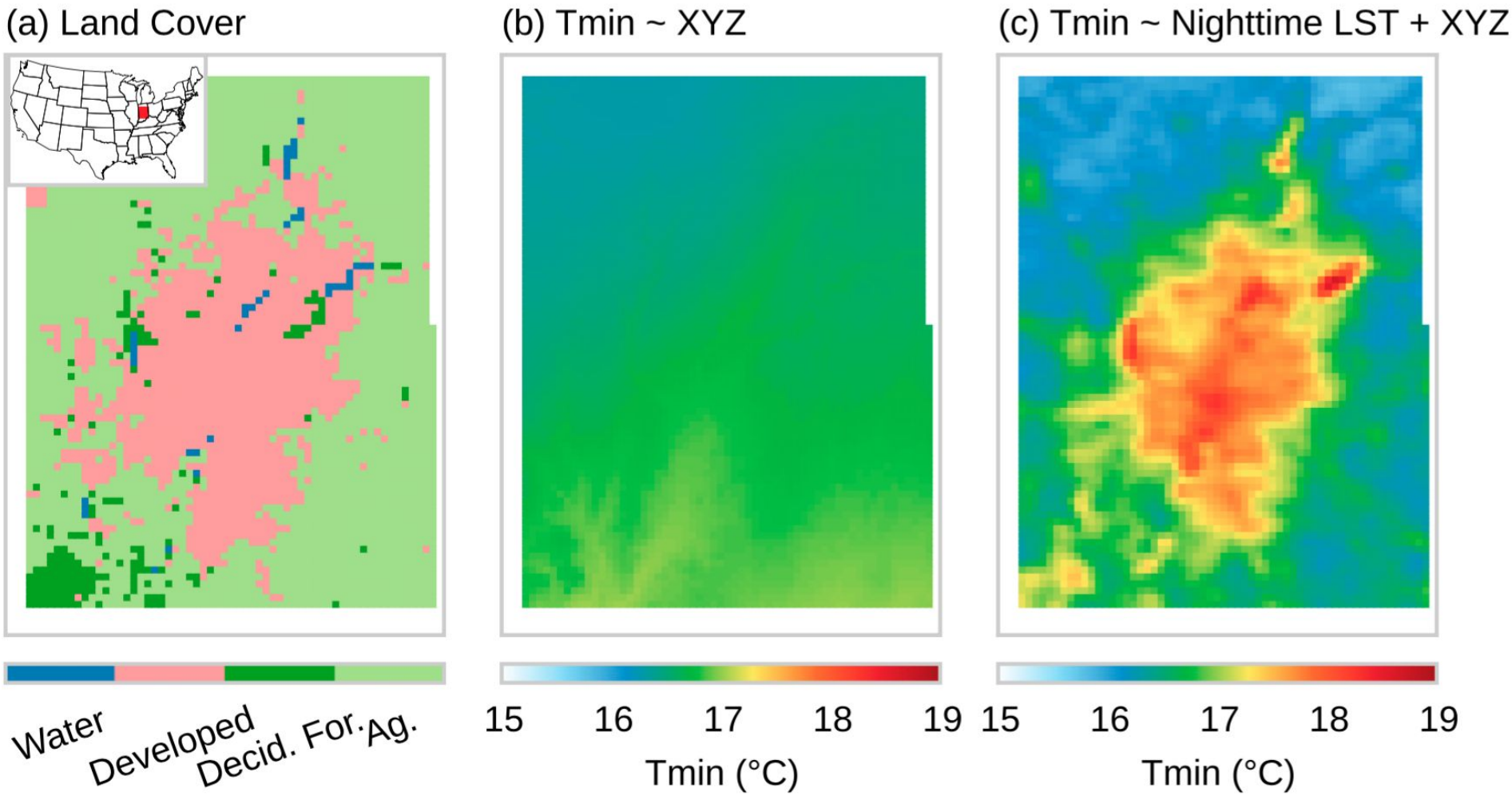
# vision for a climate information toolchain

- Develop a collection of simple, single-task, interoperable tools for the development, manipulation, analysis, and exchange of climate information with IAMs and IAV sectoral models.
- Borrows heavily from elements of the UNIX philosophy: expect tools to be combined to perform complex, unanticipated tasks.
- Design around strong standards ⇒ implementation independence
- User and use-case driven
- Why?
  - acknowledges diversity in workflows and modeling environments
  - assumes unanticipated research directions/activities/outcomes
  - allows us to  borrow from and build upon existing open source tools
  - easily extensible
  - encourages synergies between projects

# a flexible toolchain for climate information

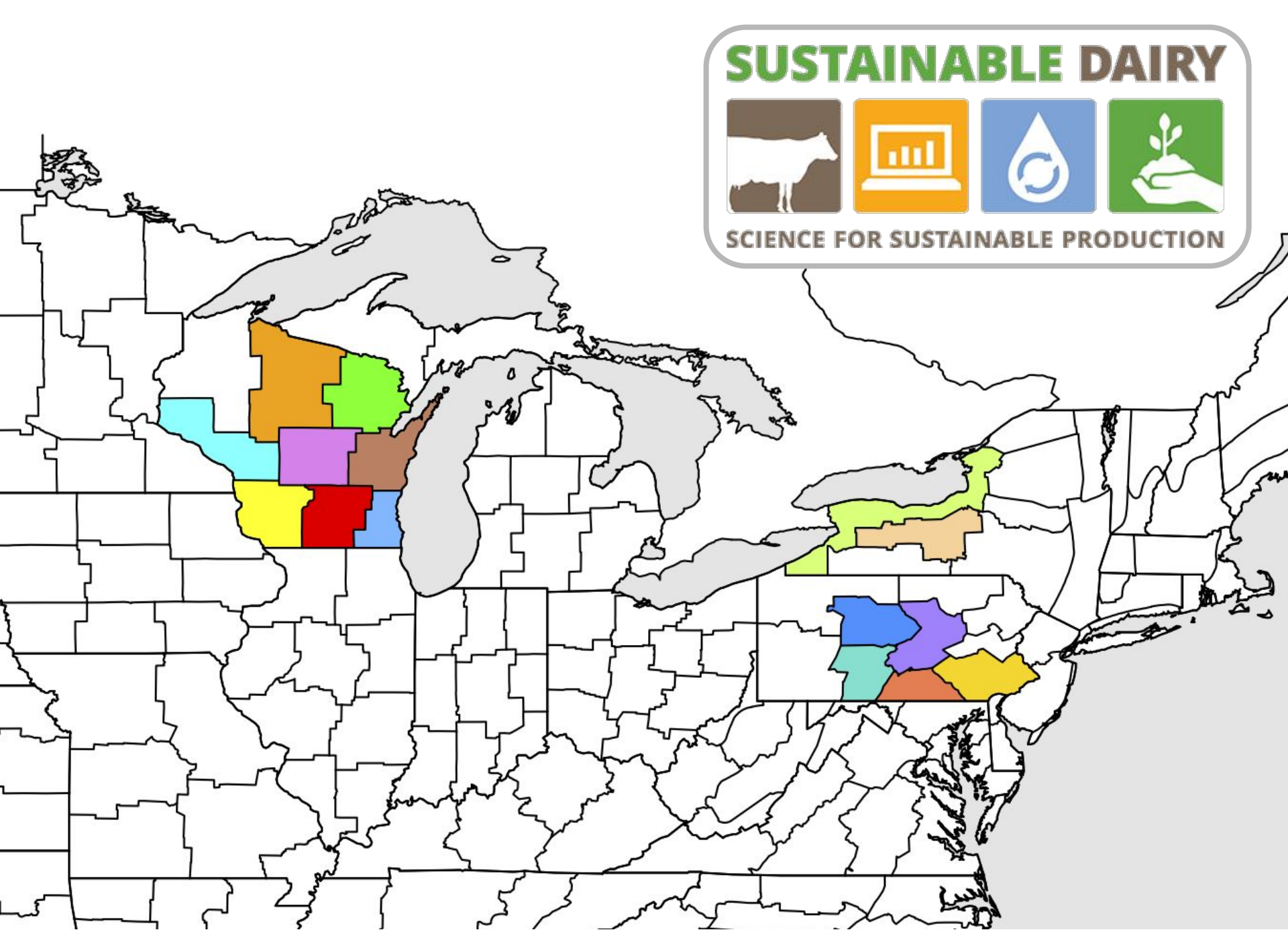
- curated data libraries (station and gridded observations, reanalyses, GCM ensembles, regional model ensembles, scenarios)
- statistical and mechanistic emulators, simple models
- pattern-scaling, empirical/statistical downscaling, and bias-correction routines
- statistical weather/climate realization generators
- spatial/temporal interpolators and aggregators
- format converters/filters
- standardized test / diagnostics suite (e.g. extreme events)
- standards for units, metadata, file format, and intertool data exchange
- exhaustive documentation

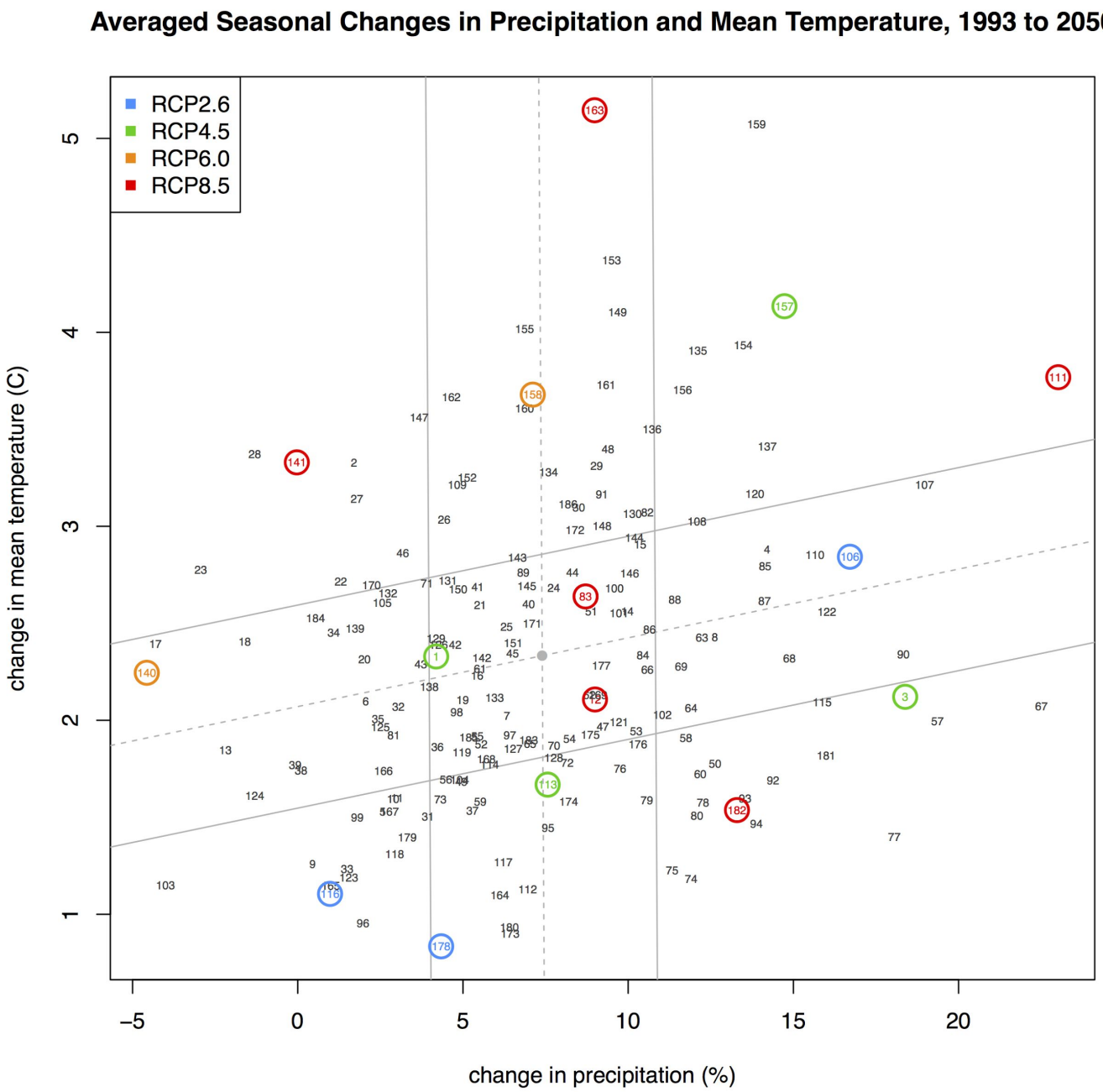
# improved observational data products




TopoWx August Climatological Daily Minimum Temperature over Indianapolis

Oyler et al. (*JAMC*, 2015)


SUSTAINABLE DAIRY
SCIENCE FOR SUSTAINABLE PRODUCTION




# Dairy CAP Climate Scenarios

Downscaled, Bias-Corrected Daily Climate Realizations for 15 Regions

- Tmin, Tmax
- precipitation
- relative humidity
- solar radiation
- wind speed

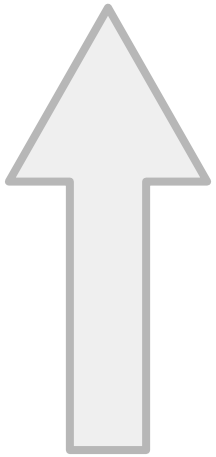
Includes corresponding translation tools

# how do we begin?

1. Start small ⇒ single coordinated collection of projects
2. Build for portability but make data, tools, and modeling capacity available in the same place ⇒ shared computational environment
3. Focus on collecting input from users and stakeholders (surveys, interviews, workshops)
4. Prototype on specific projects but design for generality
5. Develop clear, open standards
6. Borrow (and share) liberally

**dedicated facilitators are an essential element of this approach**

# How can this approach advance coupling / integration of IAMs, ESMs, and IAV analyses?



How can we more effectively integrate climate information into IAMs, IAV analyses, and decision-support applications?

# rob.nicholas@psu.edu

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slide 6: Nicholas et al. (2016, in prep)

slide 7: courtesy Jared Oyler

slide 8: courtesy Jared Oyler

slide 10:

slide 13: Oyler et al. (2015), http://dx.doi.org/10.1175/JAMC-D-15-0276.1

slide 14: Nicholas and Forest (2016, in prep)

slide 15: Nicholas and Forest (2016, in prep)