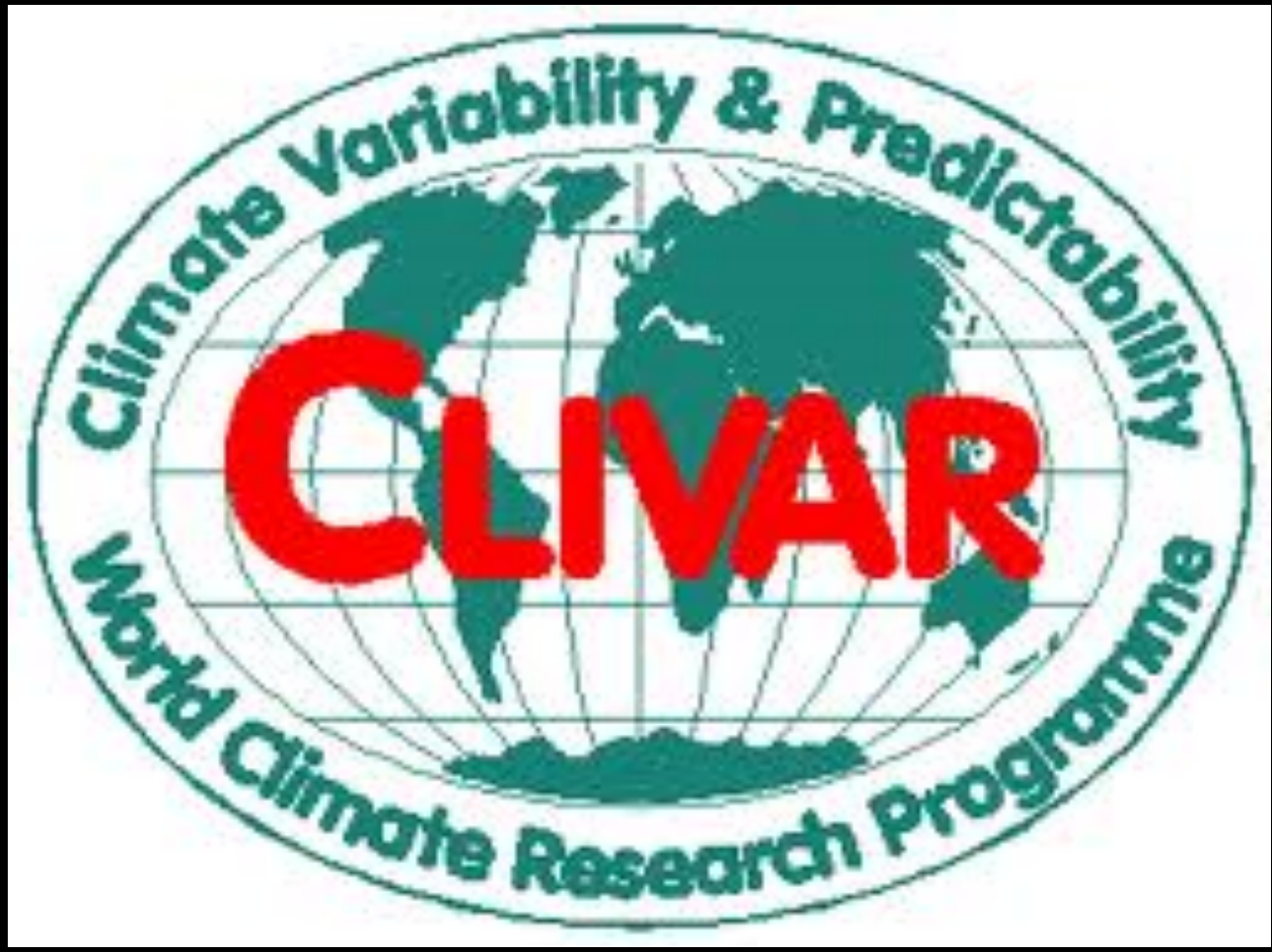
WCRP Grand Challenge:
Regional Climate Information

Plan 1


Climate Variability & Predictability
CLIVAR
World Climate Research Programme

WCRP Grand Challenge: Regional Climate Information

Can we provide skillful regional climate predictions at seasonal to decadal timescales and reliable and actionable long term regional climate change projections?

WCRP Grand Challenge: Regional Climate Information

Can we provide skillful regional climate predictions at seasonal to decadal timescales and credible and useful long term regional climate change projections?

CLIVAR Research Opportunities:

-Intraseasonal-to-interannual variability & predictability of monsoon systems

-Decadal variability & predictability

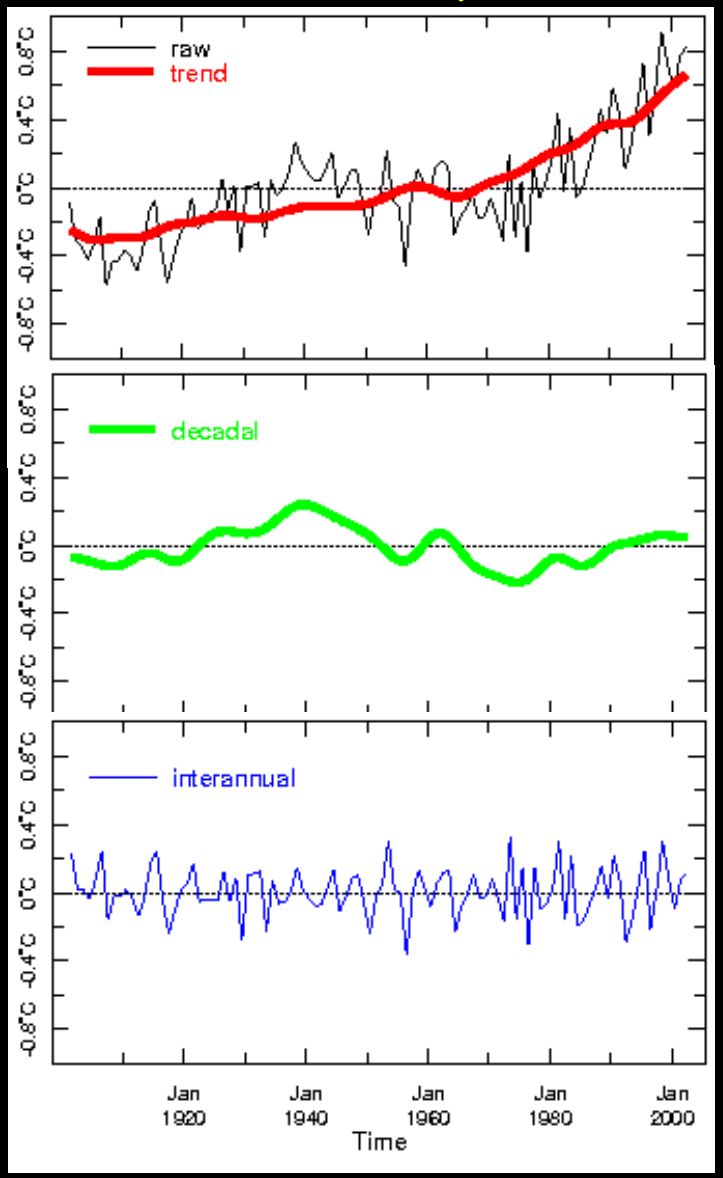
Climate Variability & Change Globally

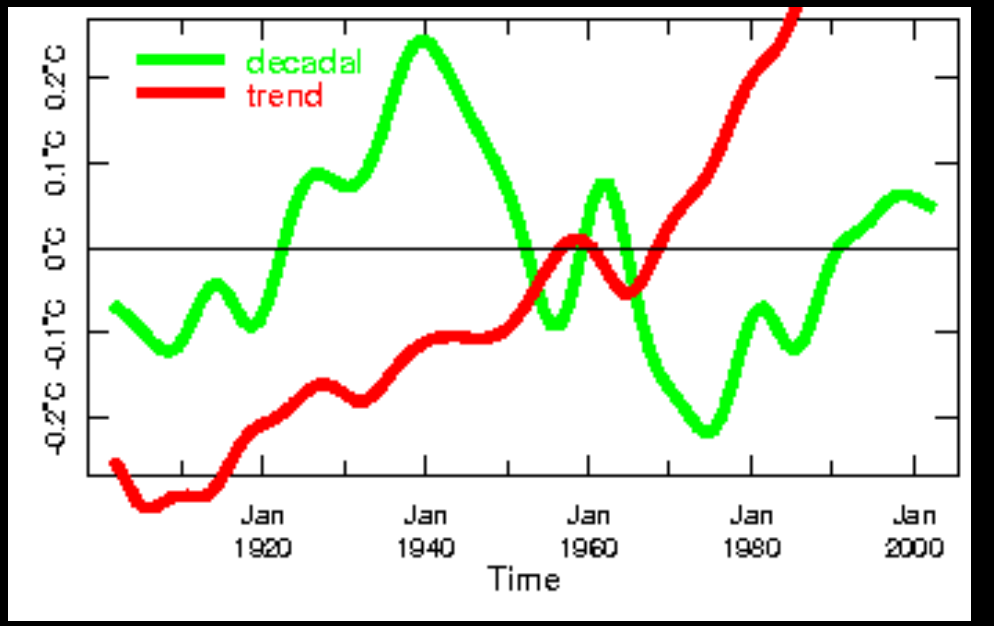
Annual Mean Temperature

65%

13%

21%





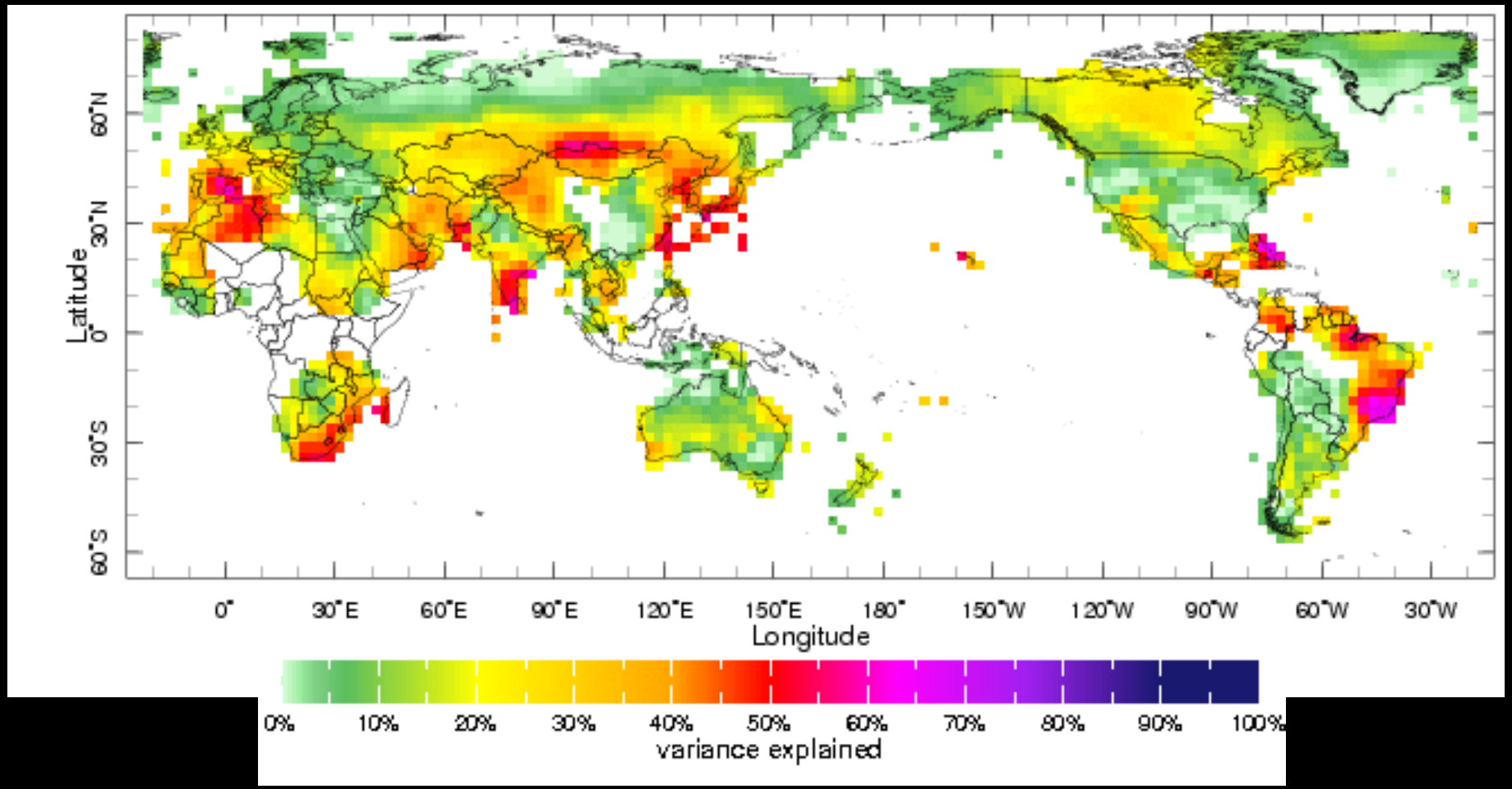
(Greene, Goddard & Cousin, 2010, *EOS*)

Time Scales Decomposition Map Room

http://iridl.ldeo.columbia.edu/maproom/Global/Time_Scales/

Temperature Trends: % of total variance

20th Century Gridded Observations -- Annual Means



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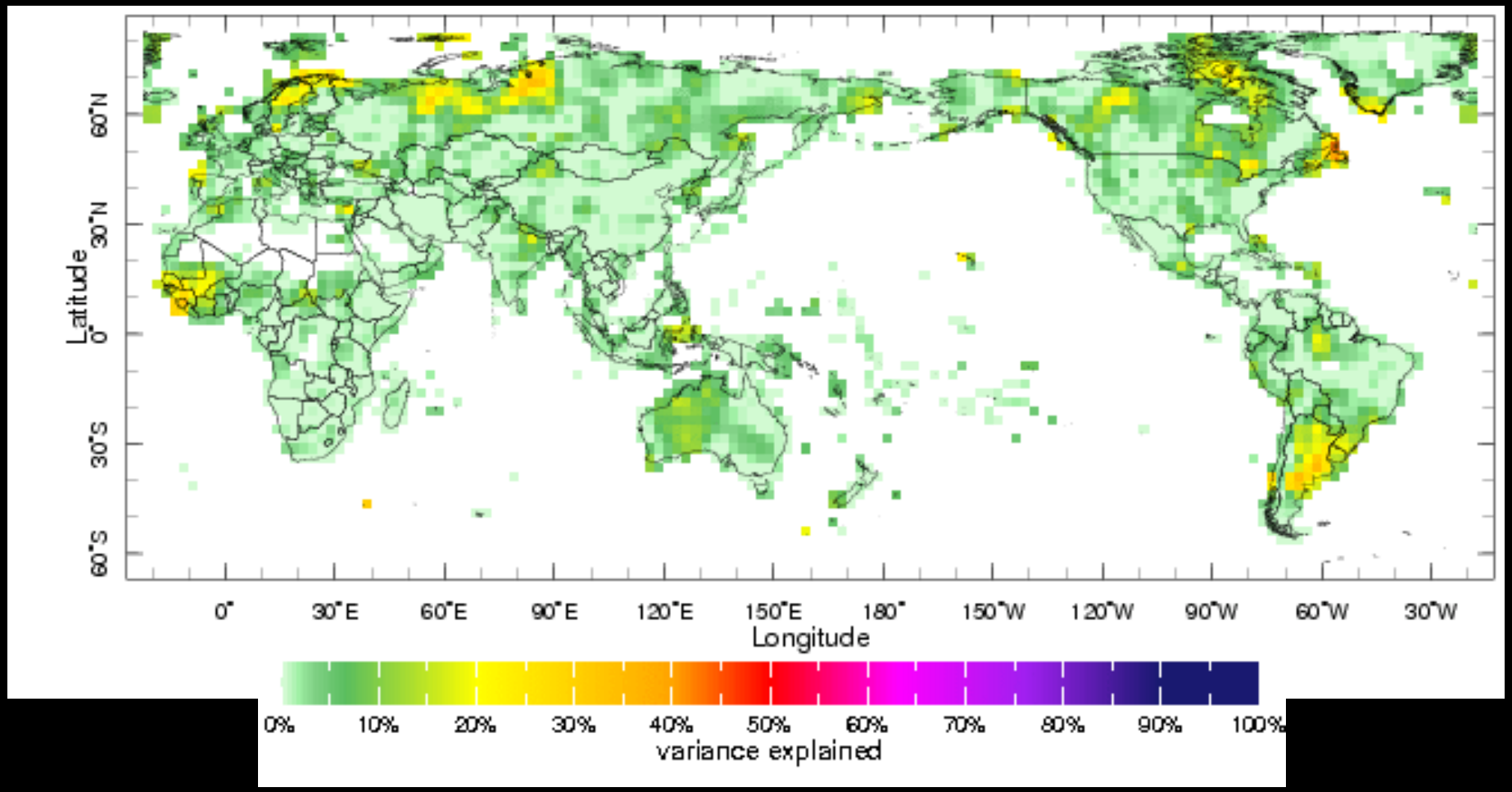
Precipitation Trends: % of total variance

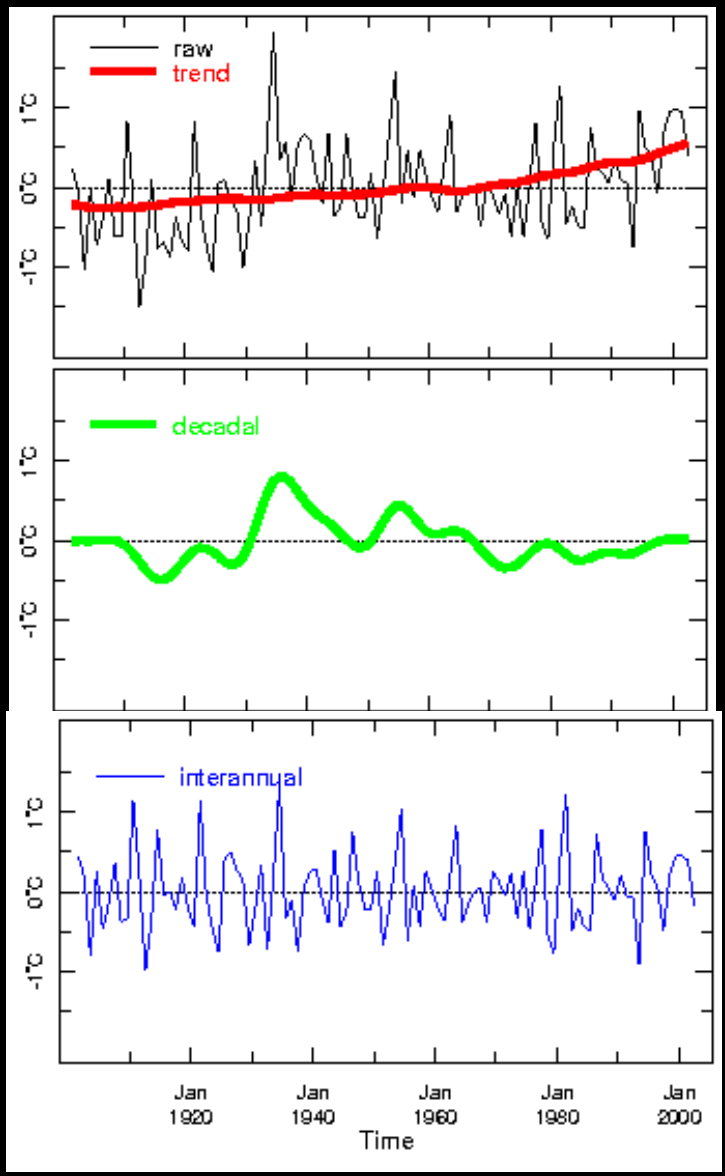
20th Century Gridded Observations -- Annual Means



http://iridl.ldeo.columbia.edu/maproom/Global/Time_Scales/

Climate Variability & Change in Colorado

Annual Mean Temperature

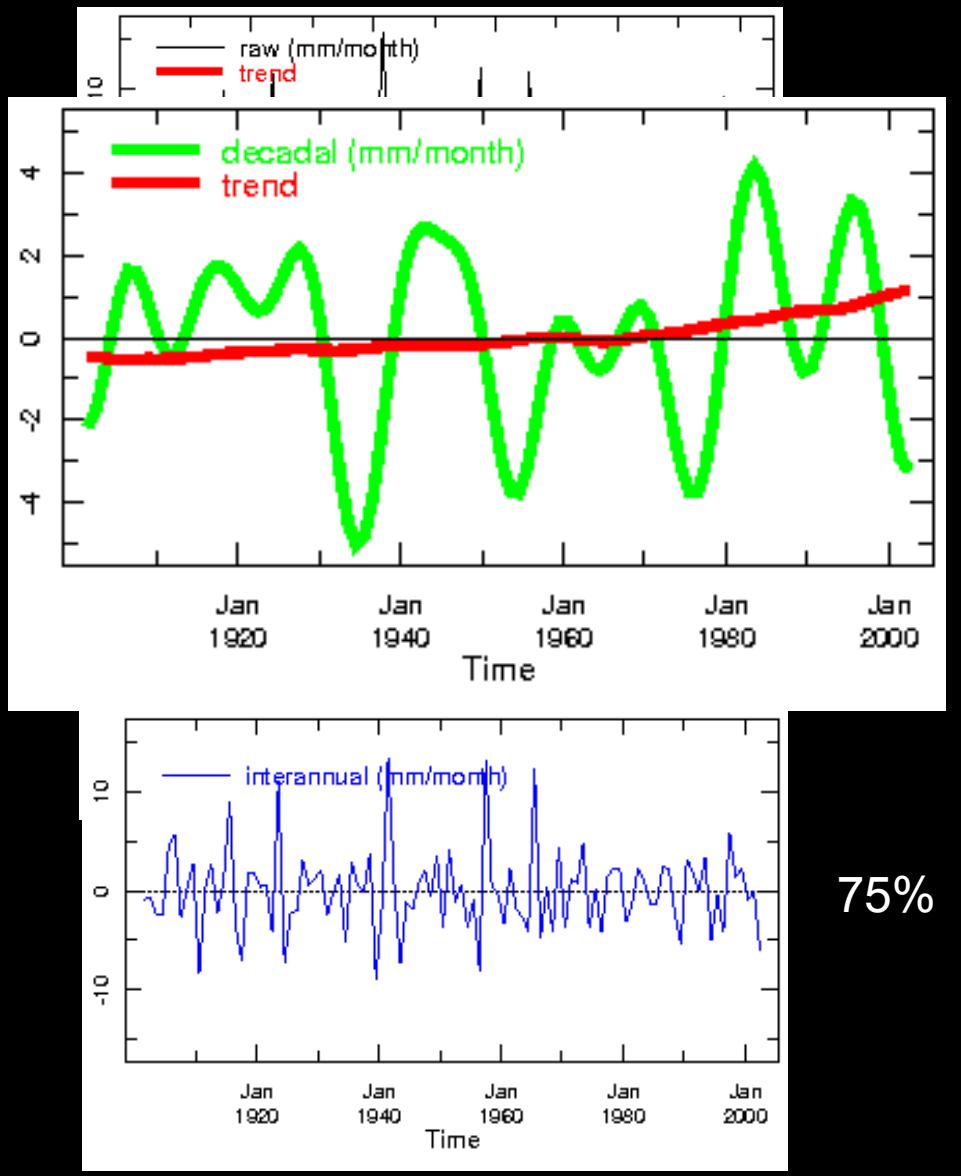


12%

21%

65%

Precipitation



75%

Grand Challenges

- be both **highly specific and highly focused identifying a specific barrier** preventing progress in a critical area of climate science
- enable the development of targeted research efforts with the likelihood of **significant progress over 5-10 years,** even if its ultimate success is uncertain
- enable the implementation of effective and measurable performance metrics
- be transformative, a Grand Challenge should bring the best minds to the table (voluntarily), building and strengthening communities of innovators that are collaborative, perhaps also extending beyond "in-house expertise"
- capture the public's imagination: teams of world-leading scientists working to solve pressing challenges
- can offer compelling storylines to capture the interest of media and the public

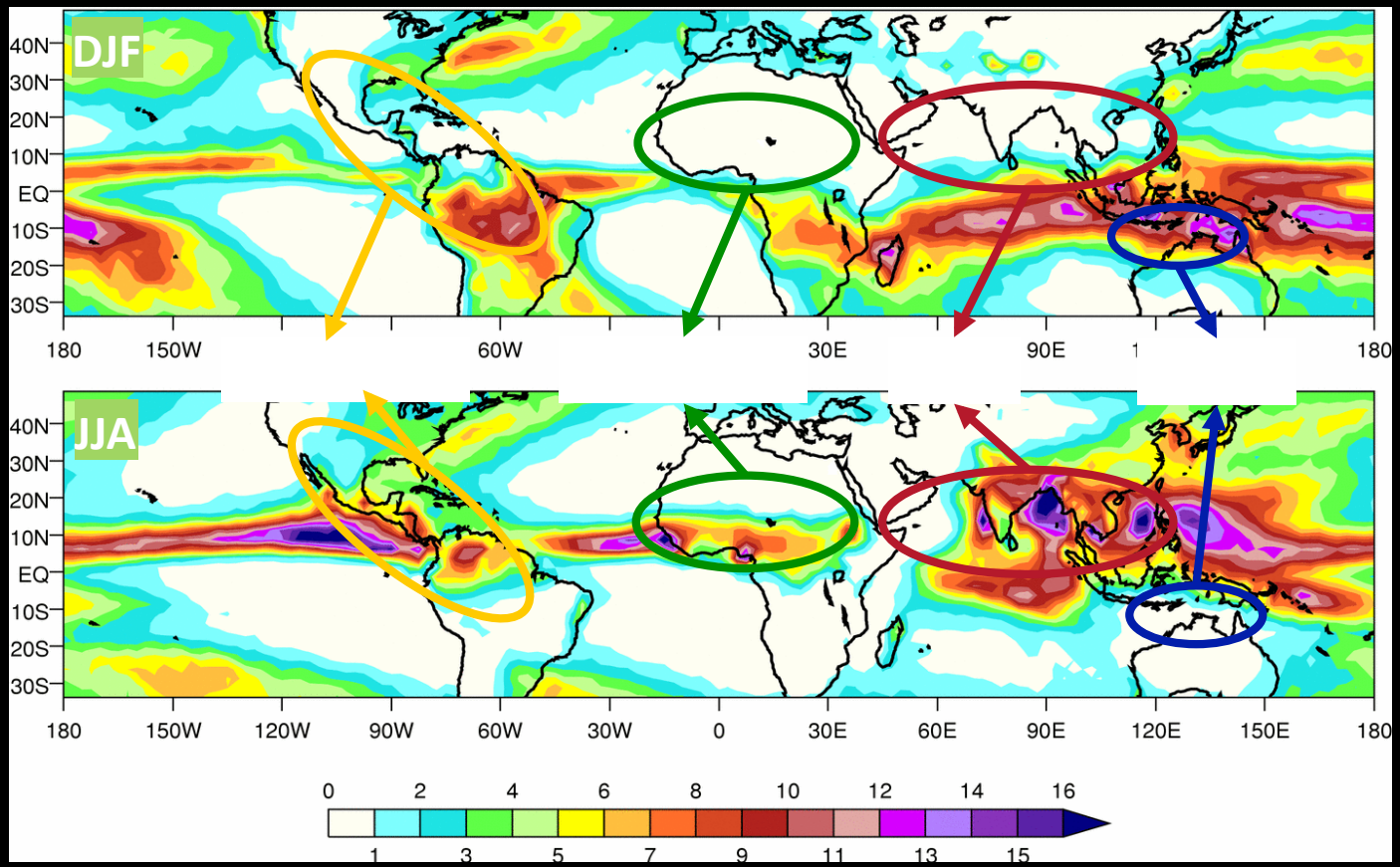
Plan 2

- Select a small number of specific research questions (preferably process-based)
- Identify what is known, and what is not
- Identify readiness – momentum of scientific community; funding opportunities; need for WCRP/CLIVAR coordination

Context: Initiative on Monsoons (?)

- Monsoon systems represent major mode of climate variability on the planet and supply the majority of rainfall to vulnerable/developing nations.

HOWEVER:
Even within this focus there are numerous specific challenges.



(Source: ISI Monsoon TT)

Intraseasonal, seasonal and interannual variability and predictability of monsoons

Key areas for progress in the next 5-10 years:

- Improved model constraint on monsoon variability and change.
- Better model representation of the key processes involved in monsoon variability.
- Improved prediction of monsoon variability and change using land surface modelling and incorporation of land surface initialisation.
- Enhanced understanding of natural climate variability and anthropogenic change on monsoon systems.

(Source: ISI Monsoon TT)

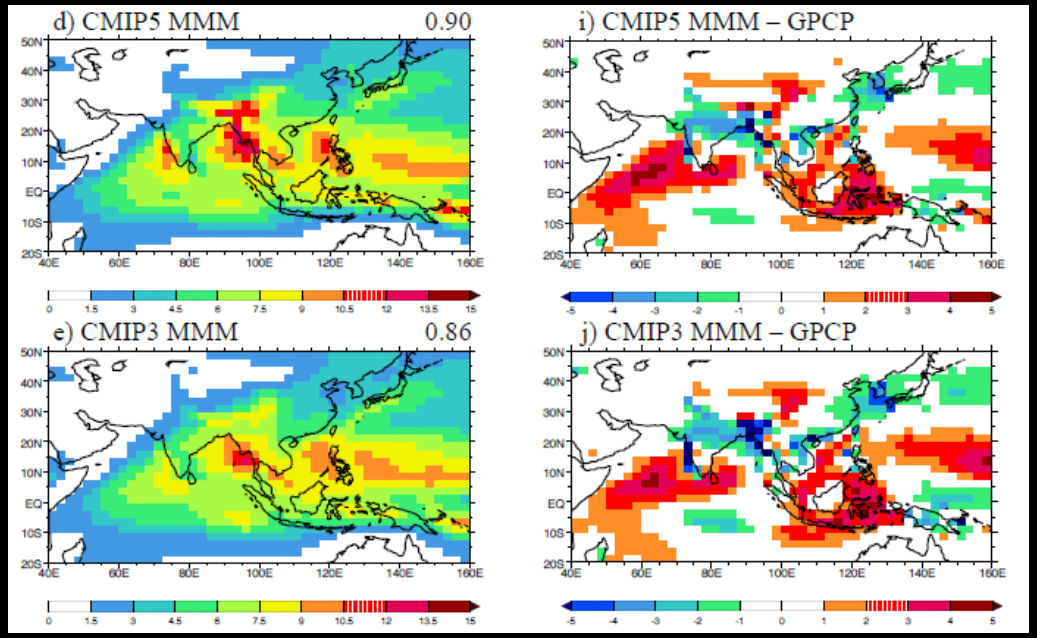
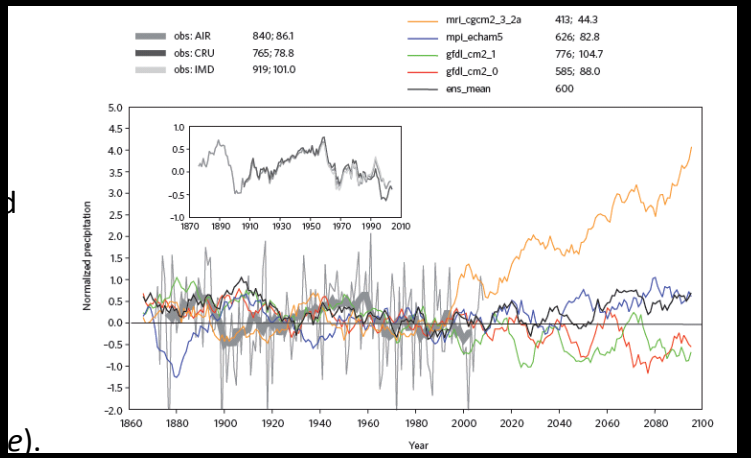


Figure shows large multi-model mean precipitation biases are present for the Asian summer monsoon in CMIP5 (from Sperber *et al.*, 2012, *Clim. Dyn.*).



e).

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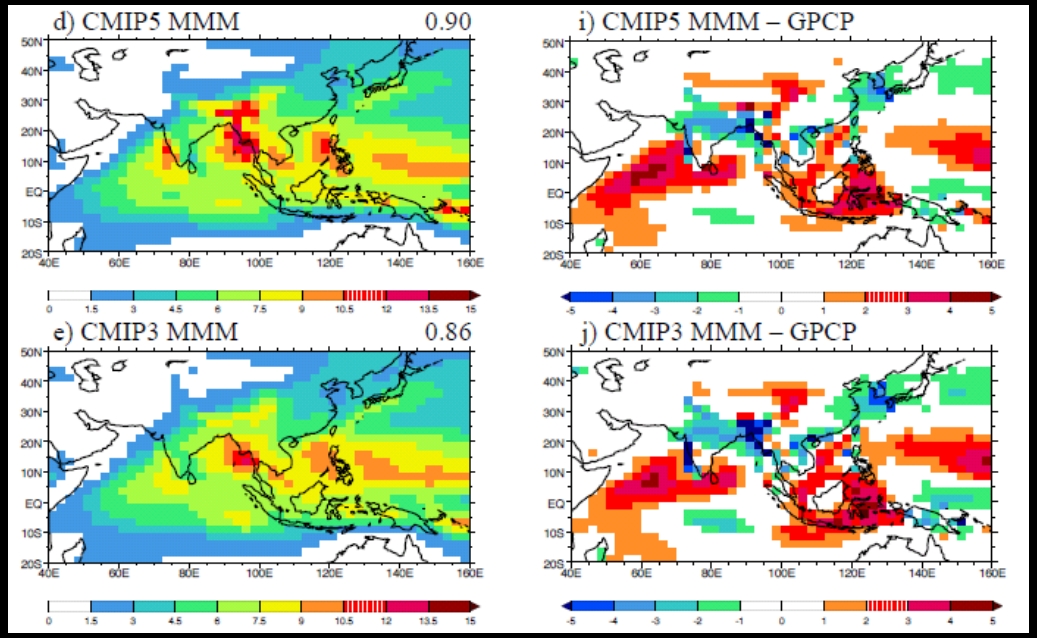

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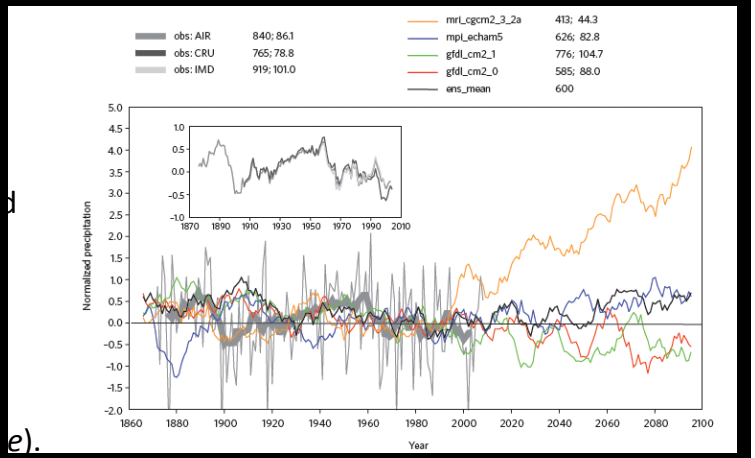


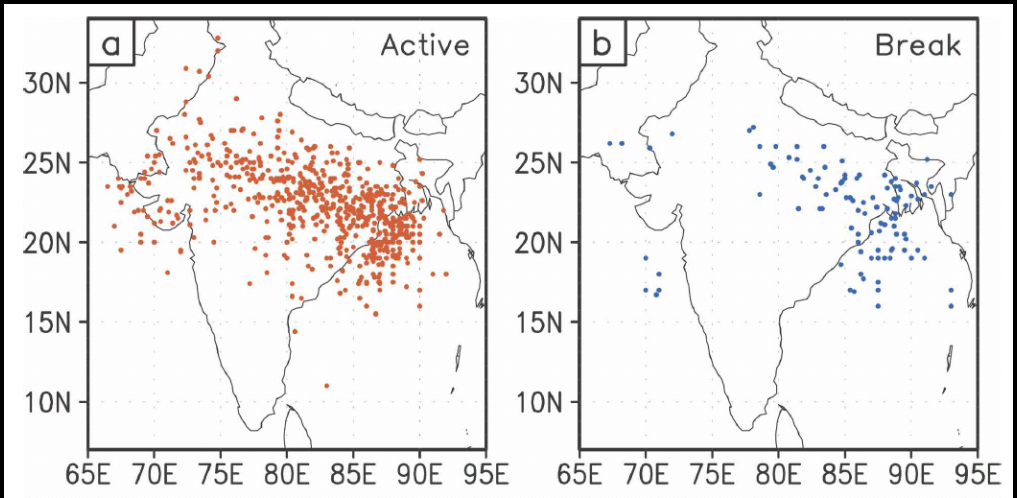
e).

Key scientific questions: processes

- Can we make links between different modes of variability? (e.g., does ENSO affect the statistics of monsoon intraseasonal variability?)

Cascade of predictability:

- Decadal variability (or mean state error) → ENSO teleconnections → intraseasonal and synoptic behaviour?



In other words, using scale-interactions to understand predictability (GC1, Frontier 1).

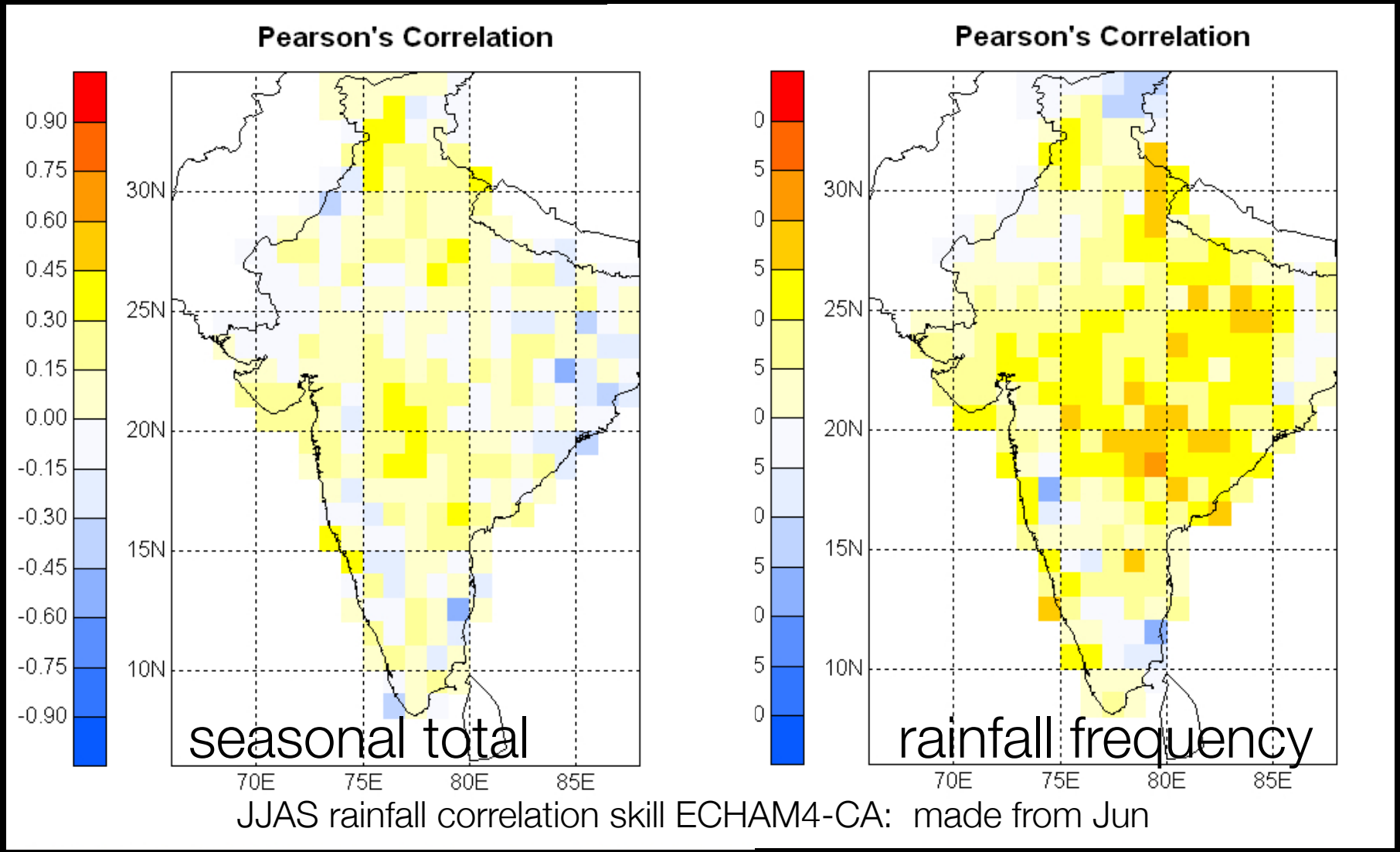
From Krishnamurthy & Shukla (2007, J. Clim.)

(Source: ISI Monsoon TT)

Weather Within Climate

Skill of statistical downscaling seasonal rainfall statistics:

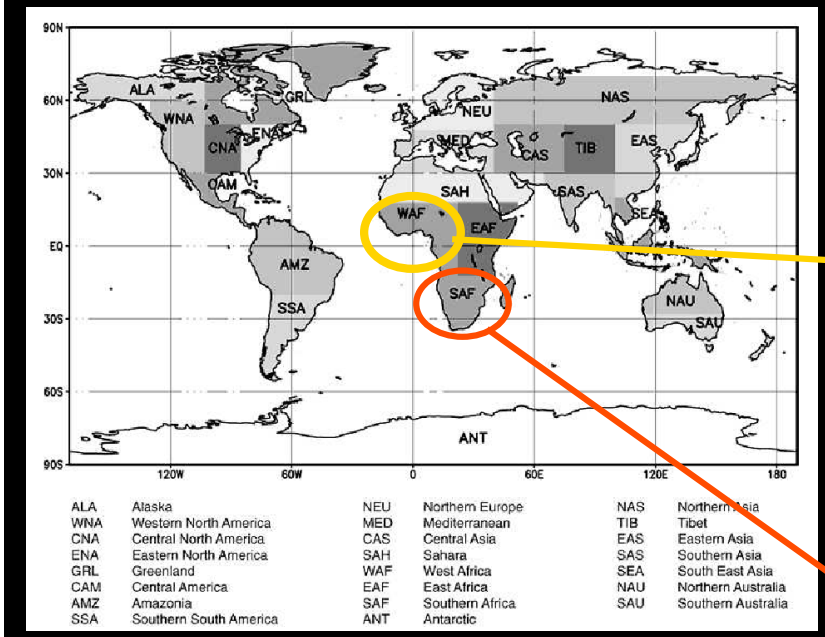
Indian monsoon rainfall



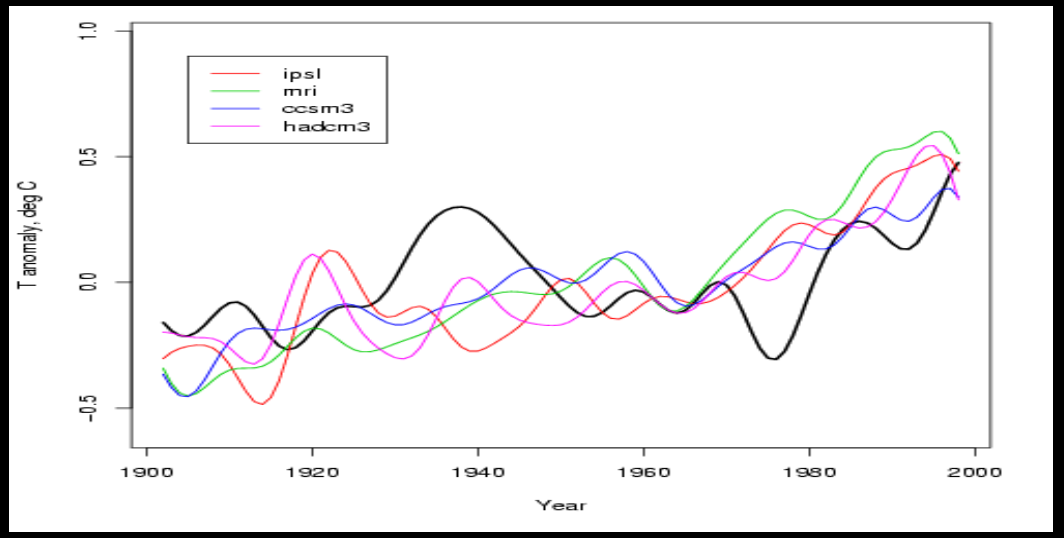
JJAS rainfall correlation skill ECHAM4-CA: made from Jun

(Source: Andy Robertson)

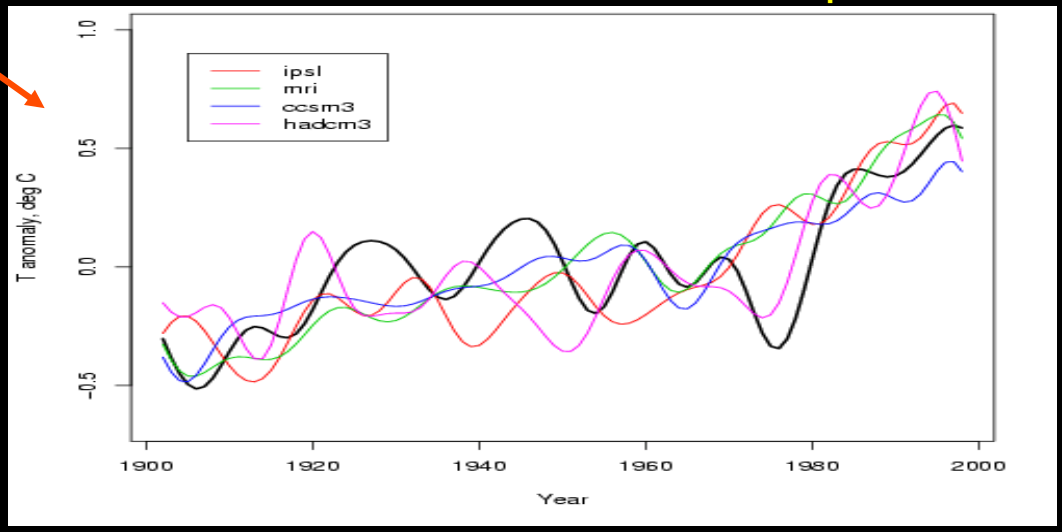
Regional Scale Decadal Predictions?



Western Africa : Annual-Mean Temperature

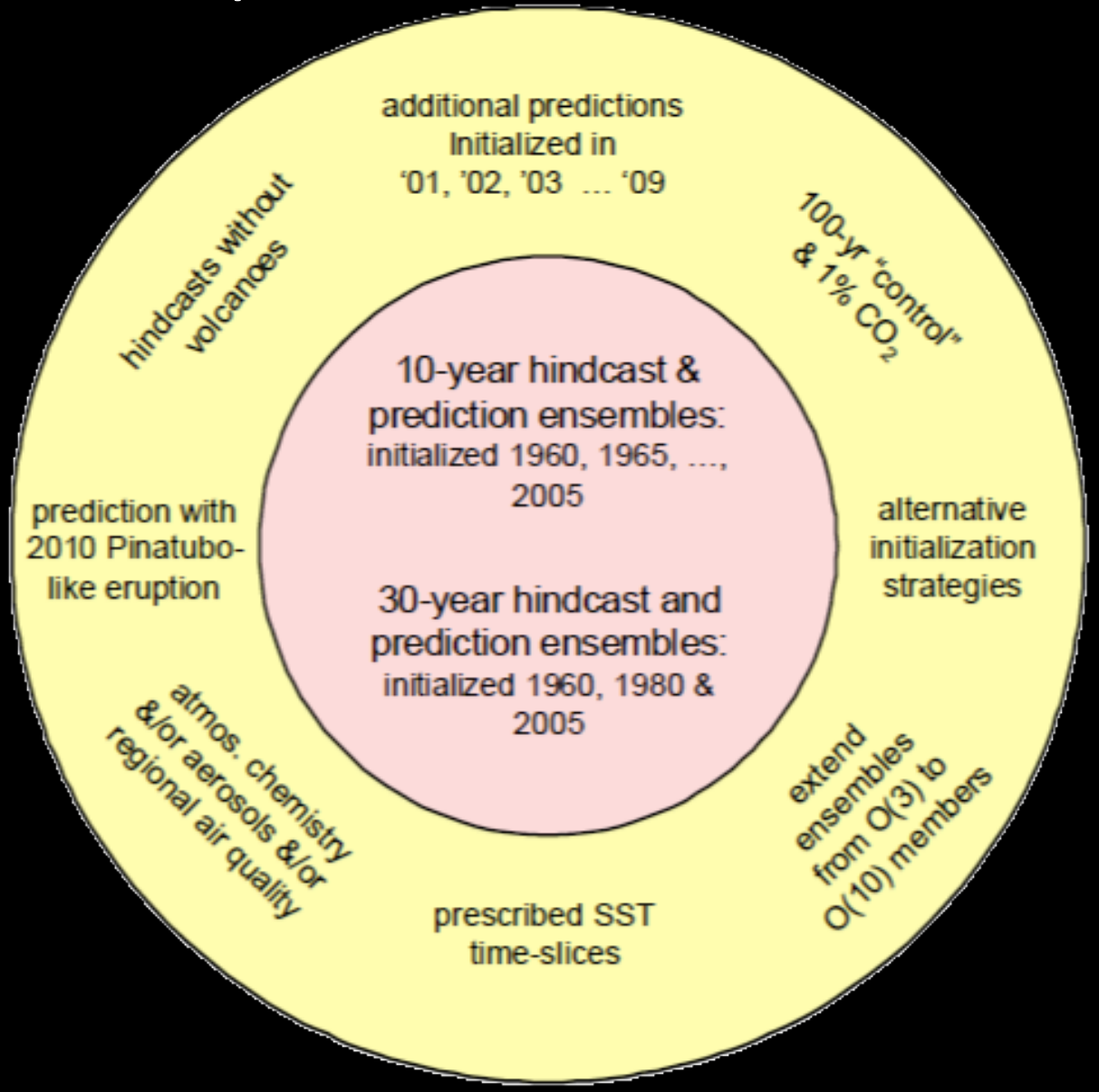


Southern Africa : Annual-Mean Temperature



Climate Change **Projections cannot** deliver predictions of decadal variability

CMIP5 Experimental Prediction Design



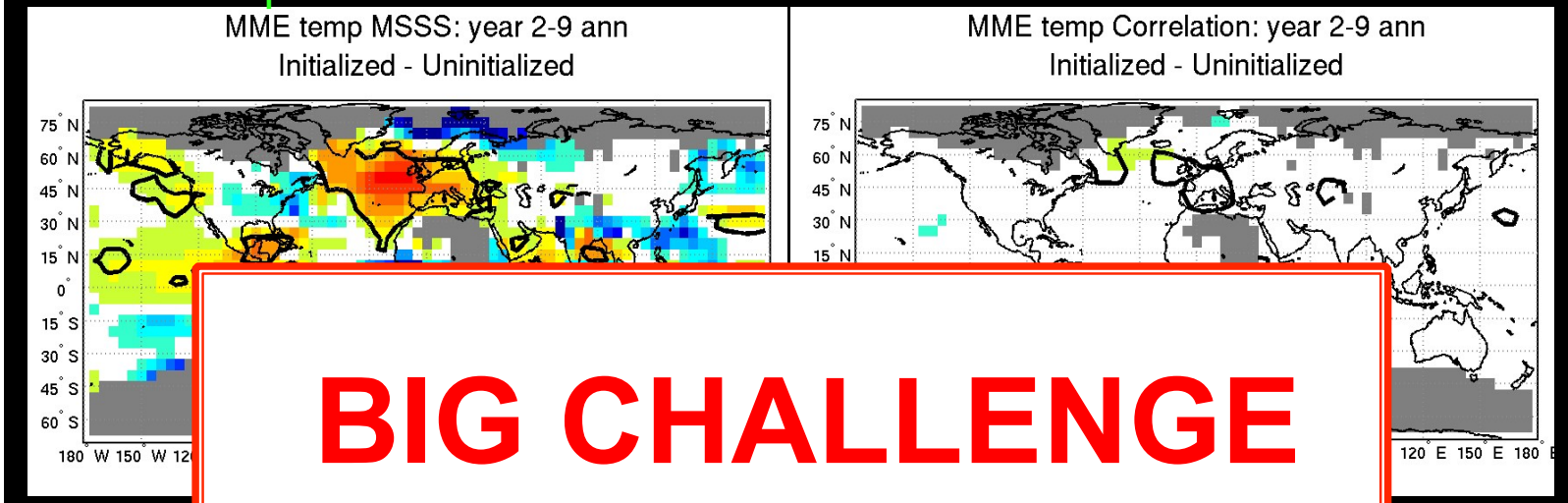
http://www.clivar.org/organization/wgcm/references/Taylor_CMIP5.pdf

Decadal Predictions: *Skill still to be demonstrated*

Multi-model Ensemble (12 models: Equal Weighting)

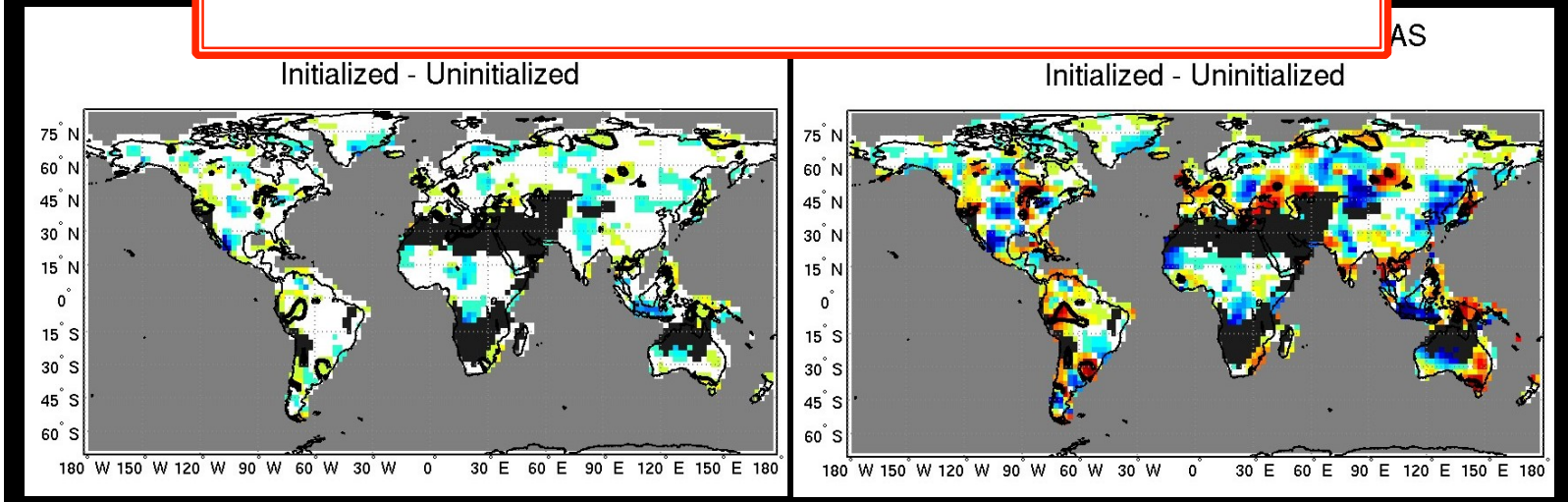
Mean Squared Skill Score

Correlation



Annual T

BIG CHALLENGE



Jul-Aug-Sep P

(*based on Goddard et al. 2013, Climate Dynamics; See also http://clivar-dpwg.iri.columbia.edu)*

Stratosphere-Troposphere coupling, Decadal Climate Prediction and the WCRP "Regional Climate Information" Grand Challenge

Manzini, Matthes, Reichler, Arblaster and Scaife

Why Stratosphere-Troposphere coupling?

- **Long simulations with climate models have shown that there is power in decadal variations in the stratosphere (e.g., Butchart et al. 2000, Schimanke et al. 2011, Manzini et al. 2012)**

- **Stratospheric decadal variations are important for surface climate, in particular for the North Atlantic sector (e.g., Scaife et al. 2005, Matthes et al. 2006, Ineson et al. 2011, Reichler et al. 2012)**

- **The stratosphere can provide atmospheric memory for the turbulent troposphere on seasonal to interannual timescales. It can also act as a conduit for teleconnections and variability.**

Stratosphere-Troposphere coupling, Decadal Climate Prediction and the WCRP "Regional Climate Information" Grand Challenge

What are the sources of decadal stratospheric variability?

- External: solar variability, volcanoes, ozone.
- Internal: QBO, feedbacks between ocean-surface conditions and stratospheric dynamics.

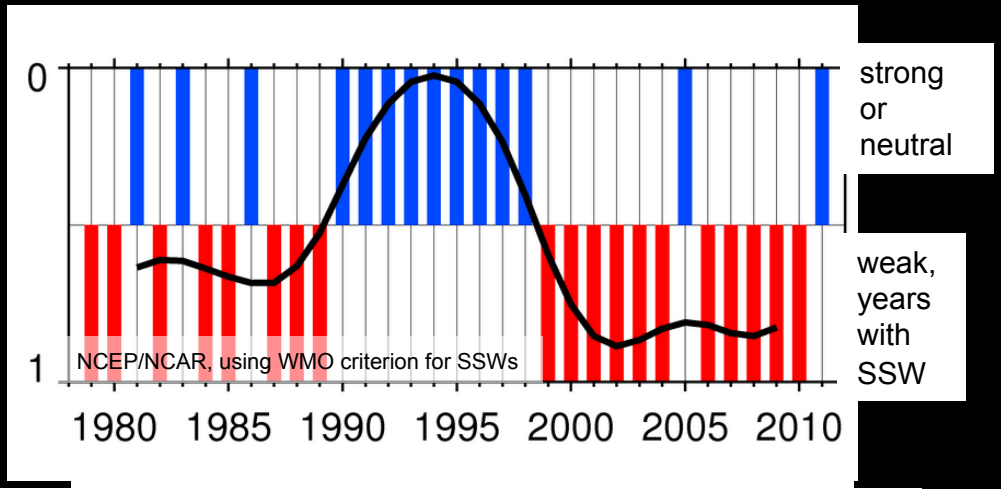
- What are the connections and relative role of the different sources?
- Is there a role for the atmospheric state inclusive of the stratosphere in decadal prediction?
- Do decadal prediction models include a well resolved stratosphere?

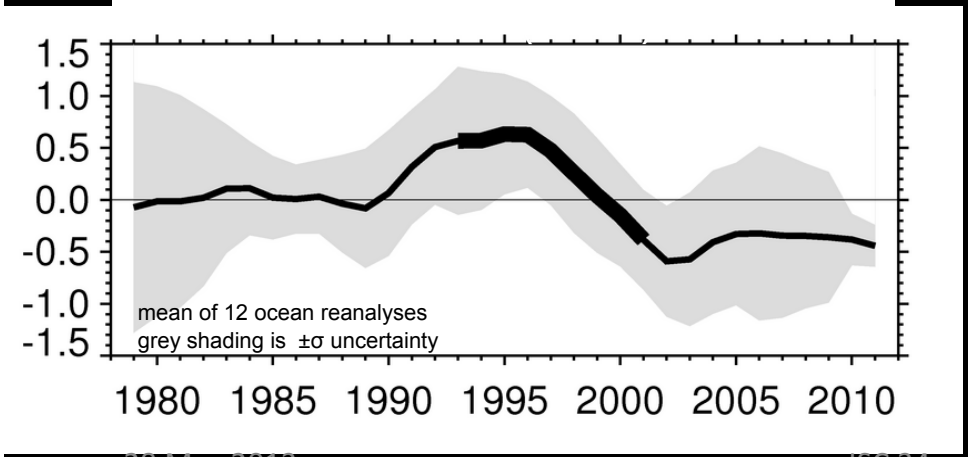
Implications:

- Improving the stratosphere in models for decadal prediction could improve regional climate information as is being done in seasonal prediction

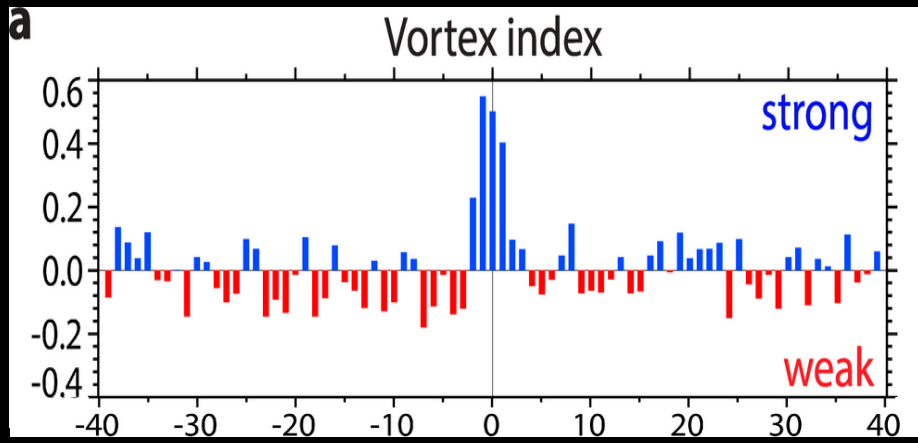
Stratosphere-Troposphere coupling, Decadal Climate Prediction and the WCRP "Regional Climate Information" Grand Challenge

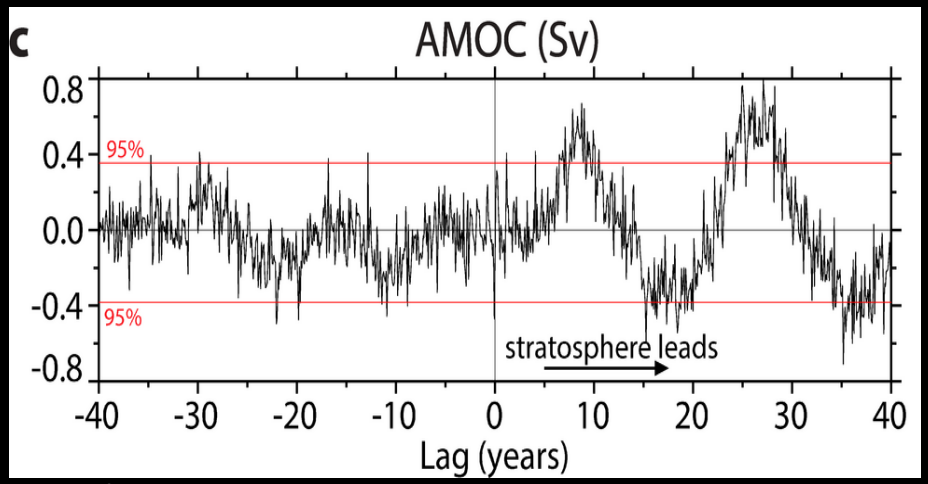
REANALYSIS





GFDL CM2.1





Reichler et al. 2012

SPARC Contribution to Stratosphere-Troposphere coupling, Decadal Climate Prediction and the WCRP "Regional Climate Information" Grand Challenge

SPARC-DynVar activity (Manzini)

http://www.sparcdynvar.org

- AMOC and PDO Research Topic & Group (Reichler): Understand all aspects of the stratospheric connection to low-frequency ocean variability and the implications of such a connection for the decadal to long-term climate prediction problem

SPARC-SOLARIS/HEPPA activity (Matthes, Funke)

http://sparcsolaris.geomar.de/

- Coordinated analysis of the CMIP5 simulations with respect to the representation of solar climate signals, investigation of the stratospheric "top-down" and air-sea "bottom-up" mechanisms
- Coordinated analysis of future solar signals (new Grand Minimum)
- Coordinated analysis of uncertainty in spectral solar irradiance data set

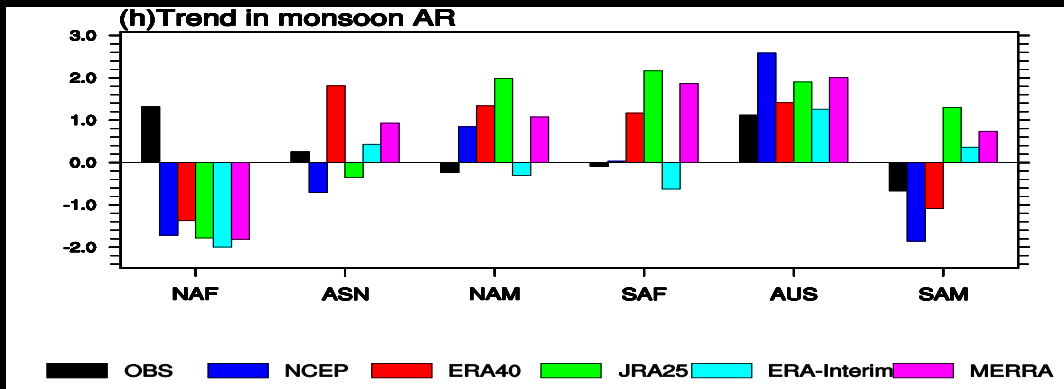
Community-wide Issues

- Quality of observations and analyses

Key scientific questions: characterizing & observing

- Can we reconcile differences between analysis products and observational datasets to provide a more consistent framework for monsoon analysis?
- What are the priority observations not currently in existence or unavailable?

Tianjun Zhou (2013, pers. comm.): diversity in reanalysis datasets

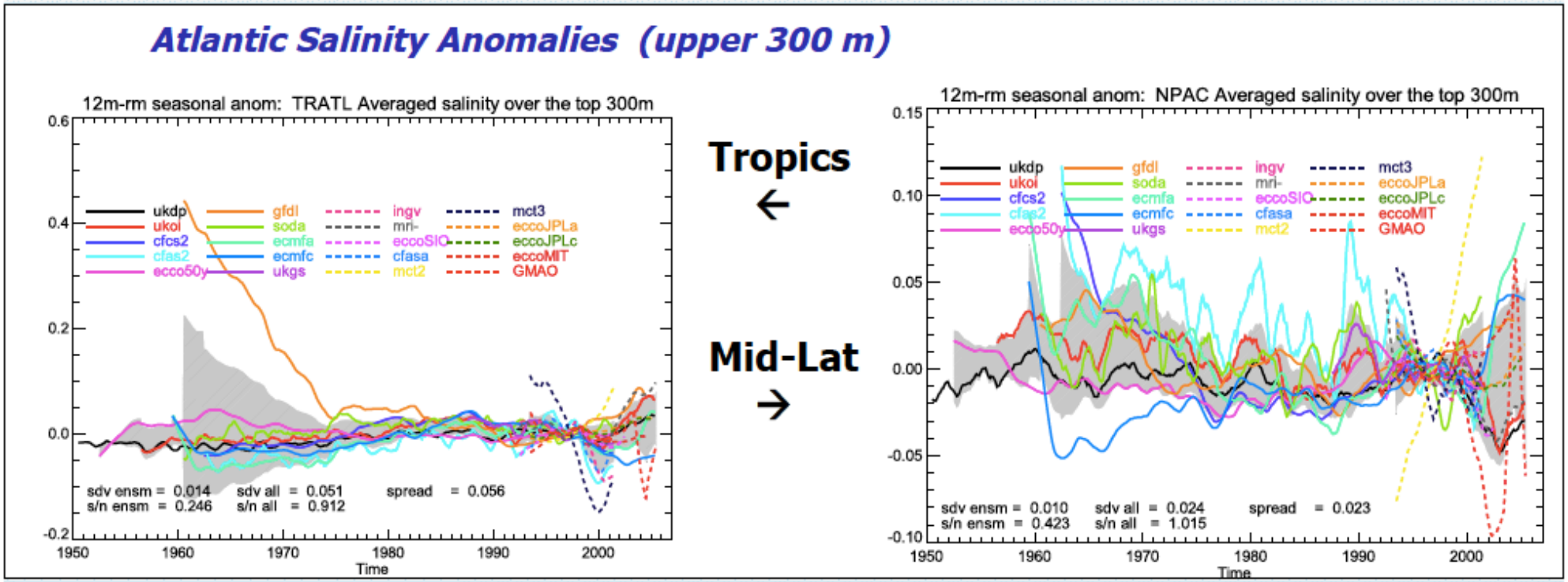


Annual range trends over 1979-2001 in observational & reanalyses: North African; (b) Asian; (c) North American; (d) South African; (e) Australian; and (f) South American.

Decadal Prediction Challenges

Observations & Initialization

- Significant differences exist among various analysis products
- Large inherent uncertainty in driving of the AMOC
  - uncertainty among products may be as large as the signal



Community-wide Issues

- Quality of observations and analyses
- Data sharing of models and observations
  - Infrastructure to enable that

Community-wide Issues

- Quality of observations and analyses
- Data sharing of models and observations
  - Infrastructure to enable that
- Clear communication to broader research community
  - Infrastructure to enable that

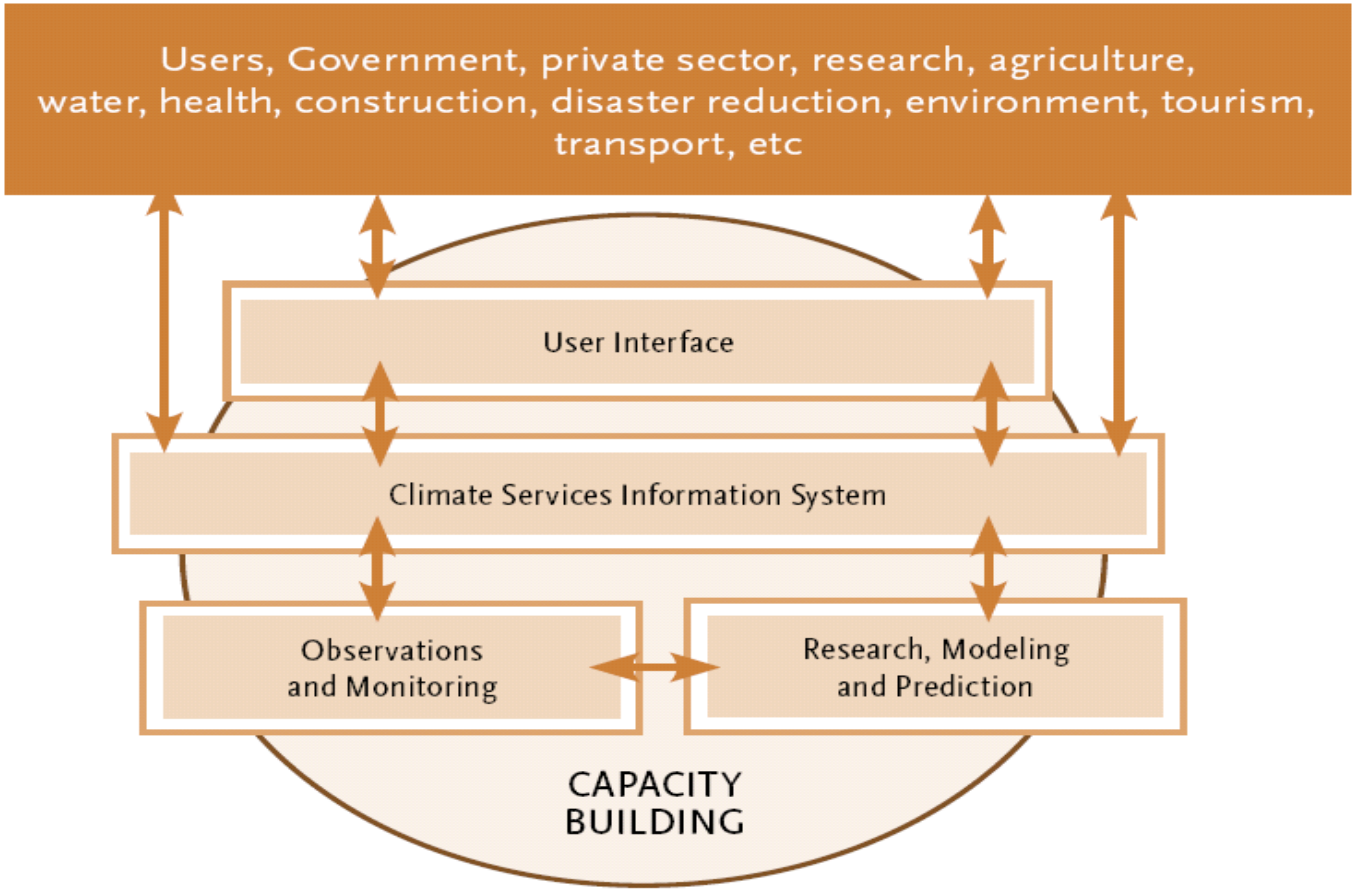
How do WCRP WGs and panels deliver actionable climate information for decision makers in support of GFCS & FutureEarth?

How do WCRP WGs and panels deliver "action-oriented" climate information for decision makers in support of GFCS & FutureEarth?

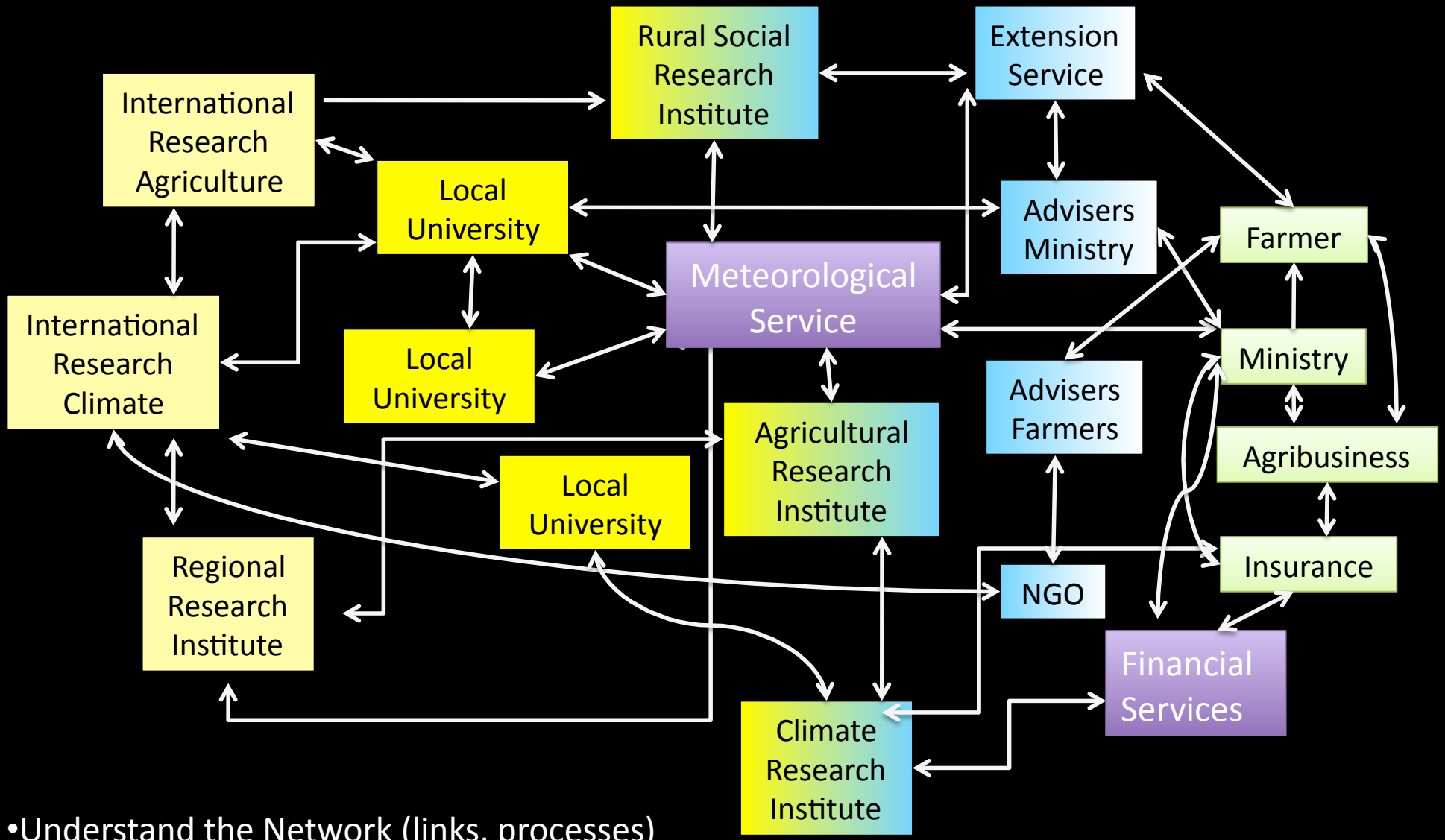
They don't.

They deliver scientific understanding, climate-quality observations, models that represent relevant climate processes, and make all this accessible by the broader scientific and decision-maker community.

GFCS


Users, Government, private sector, research, agriculture, water, health, construction, disaster reduction, environment, tourism, transport, etc
User Interface
Climate Services Information System
Observations and Monitoring
Research, Modeling and Prediction
CAPACITY BUILDING

(Very) Simplified Information Network for Agriculture



- Understand the Network (links, processes)
- Define priorities
- Target "users" (problems/demands/goals)
- Strengthen links, communication

(Courtesy: Walter Baethgen)

Climate Services Partnership

- Informal, interdisciplinary partnership (+200 members) working to improve development and provision of climate services worldwide in support of GFCS
- Created 2011 at first International Conference on Climate Services (ICCS 1), in NY
- Engaged in a range of collaborative activities on evaluation, guidance, training, etc.
- Looking forward to ICCS 3, December 4-6 in Jamaica

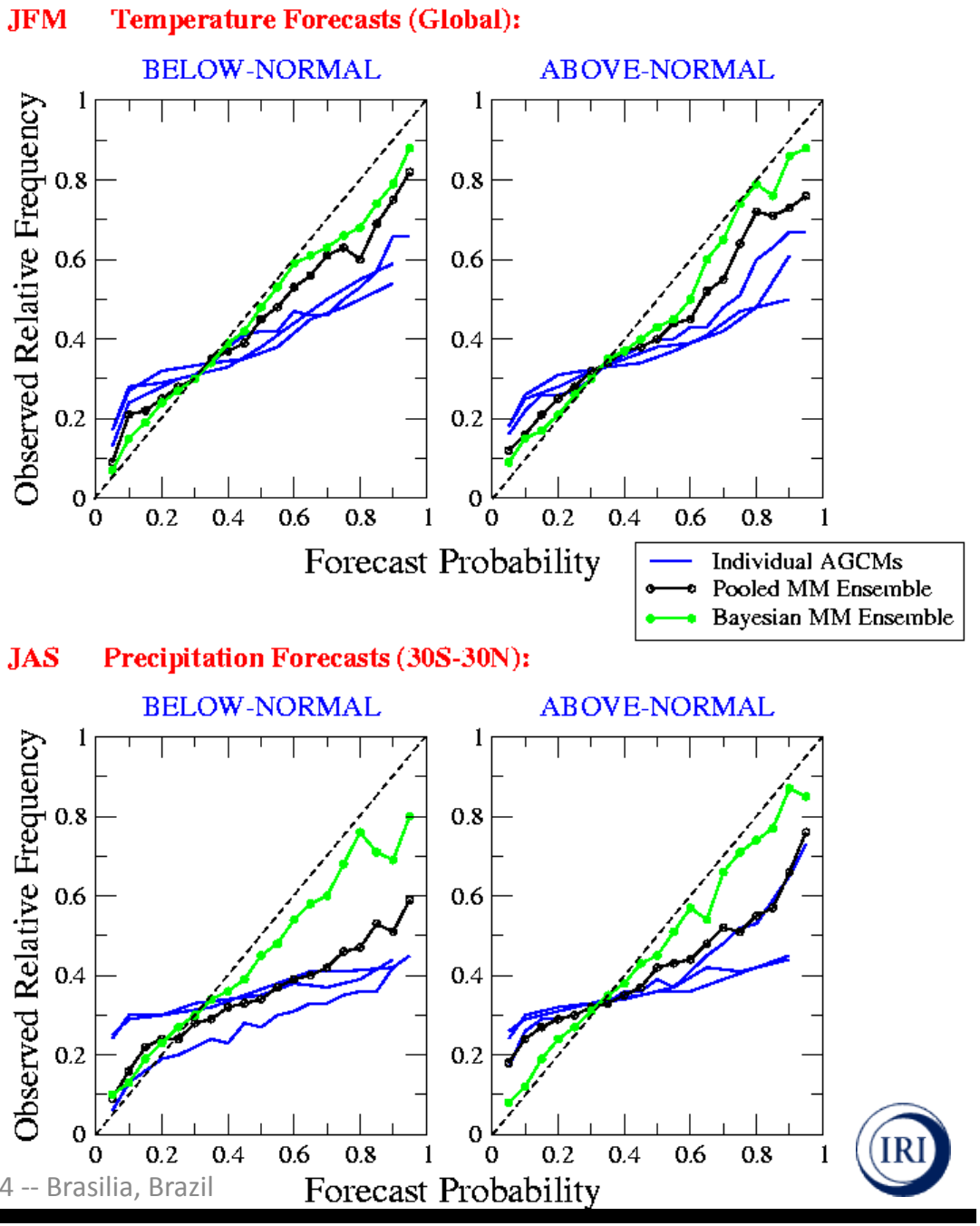
CSP case studies

- More than 30 case studies from a range of partners, in 10 sectors, from regions around the world – 16 African
- Case study template developed jointly with the WMO – GFCS
- Case study analysis revealed information on good practice in climate service provision
- Unique dissemination methods: CSAG, ACMAD, RC
- Lessons learned, the collection of useful information on climate services themselves

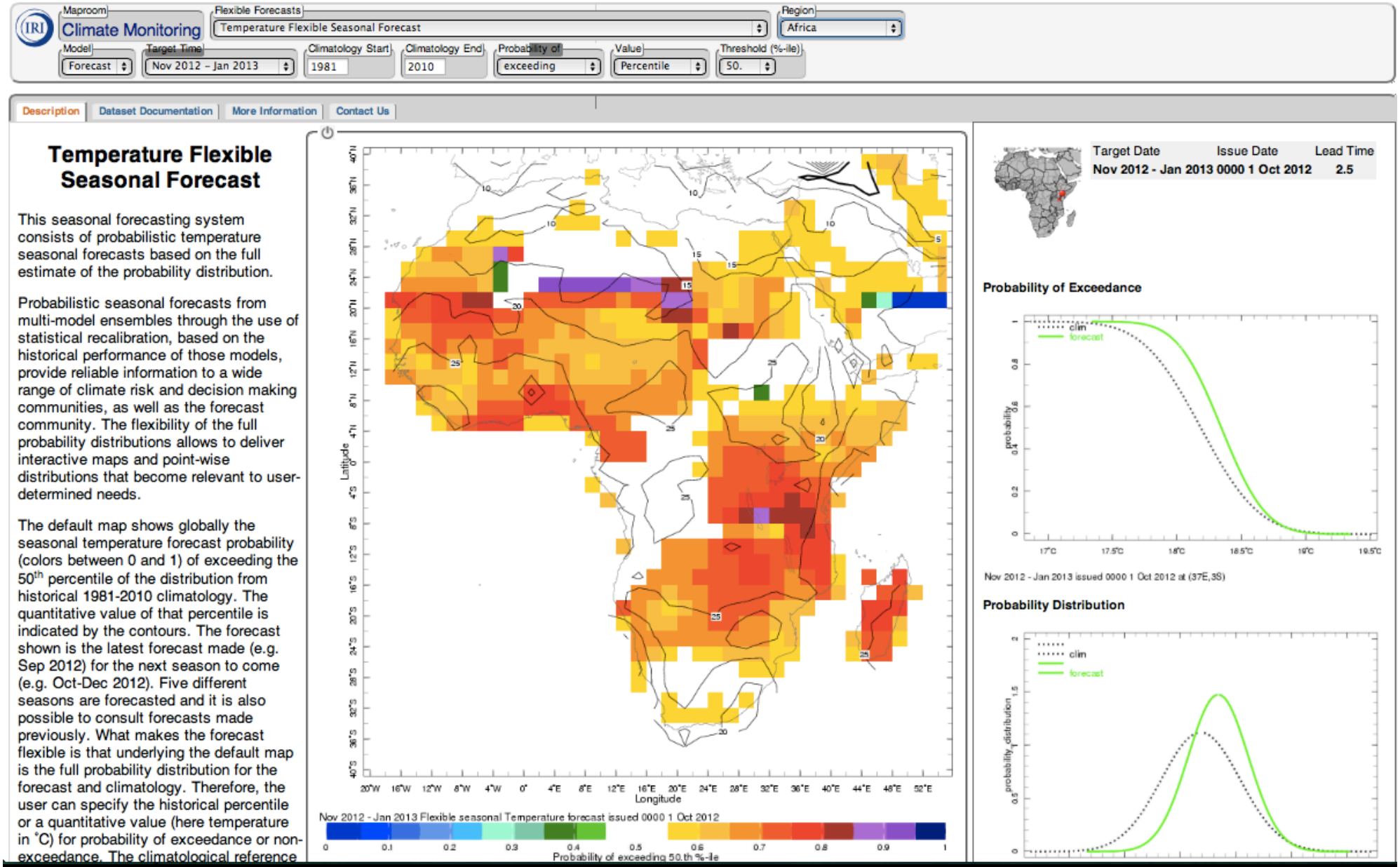
A Major Goal of Probabilistic Forecasts

Reliability!

Forecasts should "mean what they say".



FORECASTING THE FULL PDF



(Cousin et al. *in prep*)

"Actionable"

- Business world:

  "Can be acted on" → good

- Legal (policy) world:

  "Can be sued" → bad