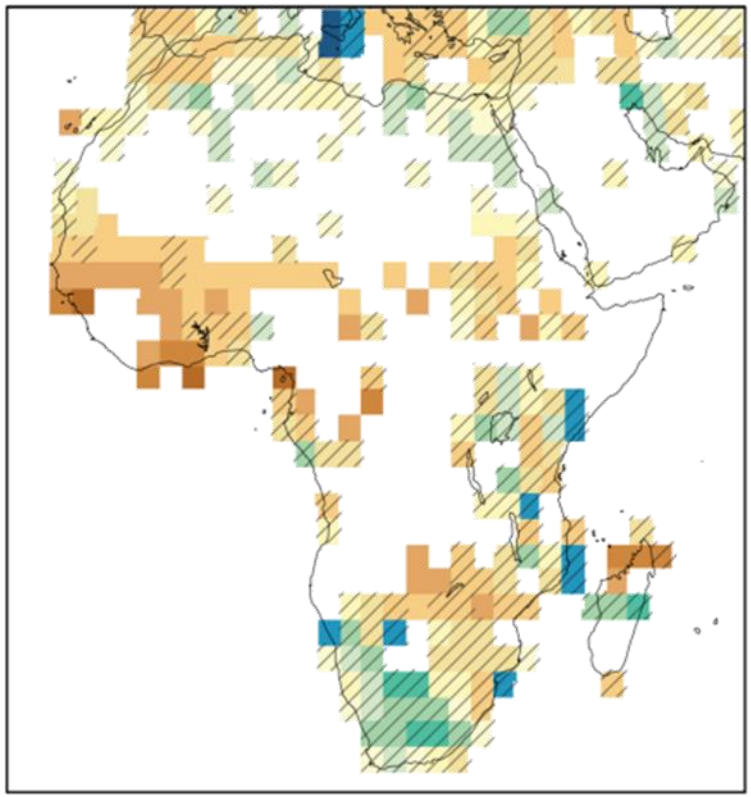
Overview on observational needs for ~~different~~ regions

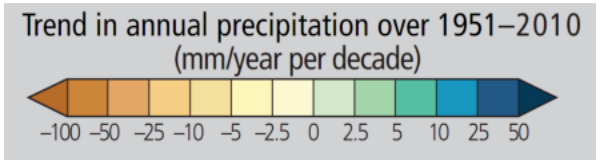
Building on GFCS priority areas water, agriculture and food security, disaster risk reduction, and health)

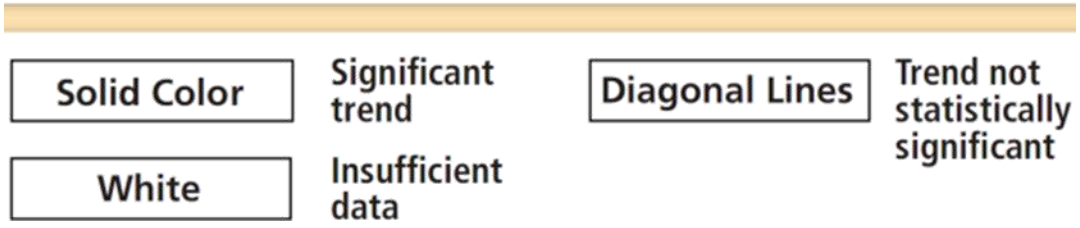


Bruce Hewitson, Coordinating Lead Author, IPCC WG II AR5 Chapter 21

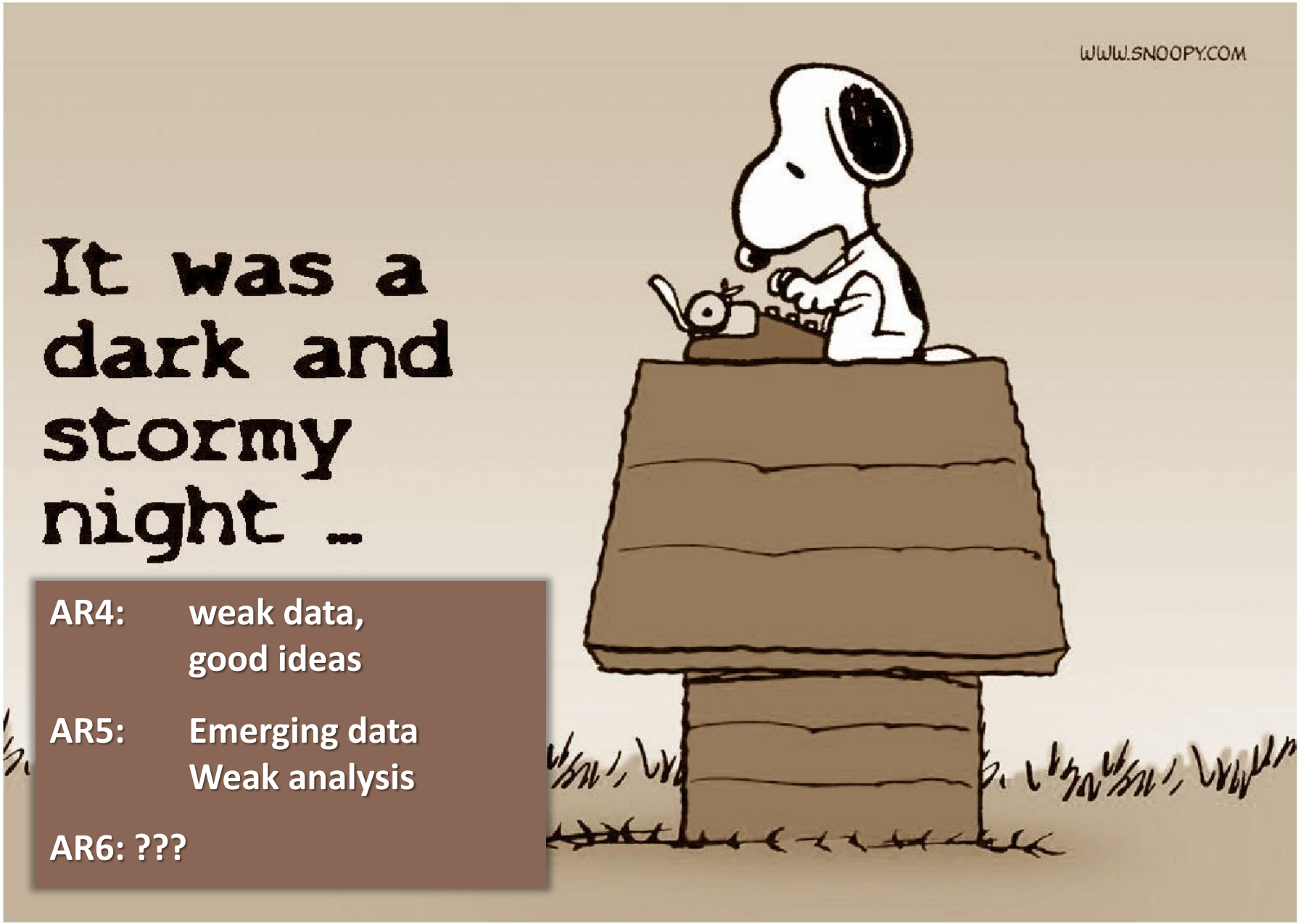
Using perspectives from the TGICA, WCRP WGRC, and from living and working in a developing nation!

AR5 WG2: Fig 21.2





Overview on observational needs for ~~different~~ regions



Bruce Hewitson, Coordinating Lead Author, IPCC WG II AR5 Chapter 21

IPCC AR5
(WGI, 2013; WGII & III, 2014)

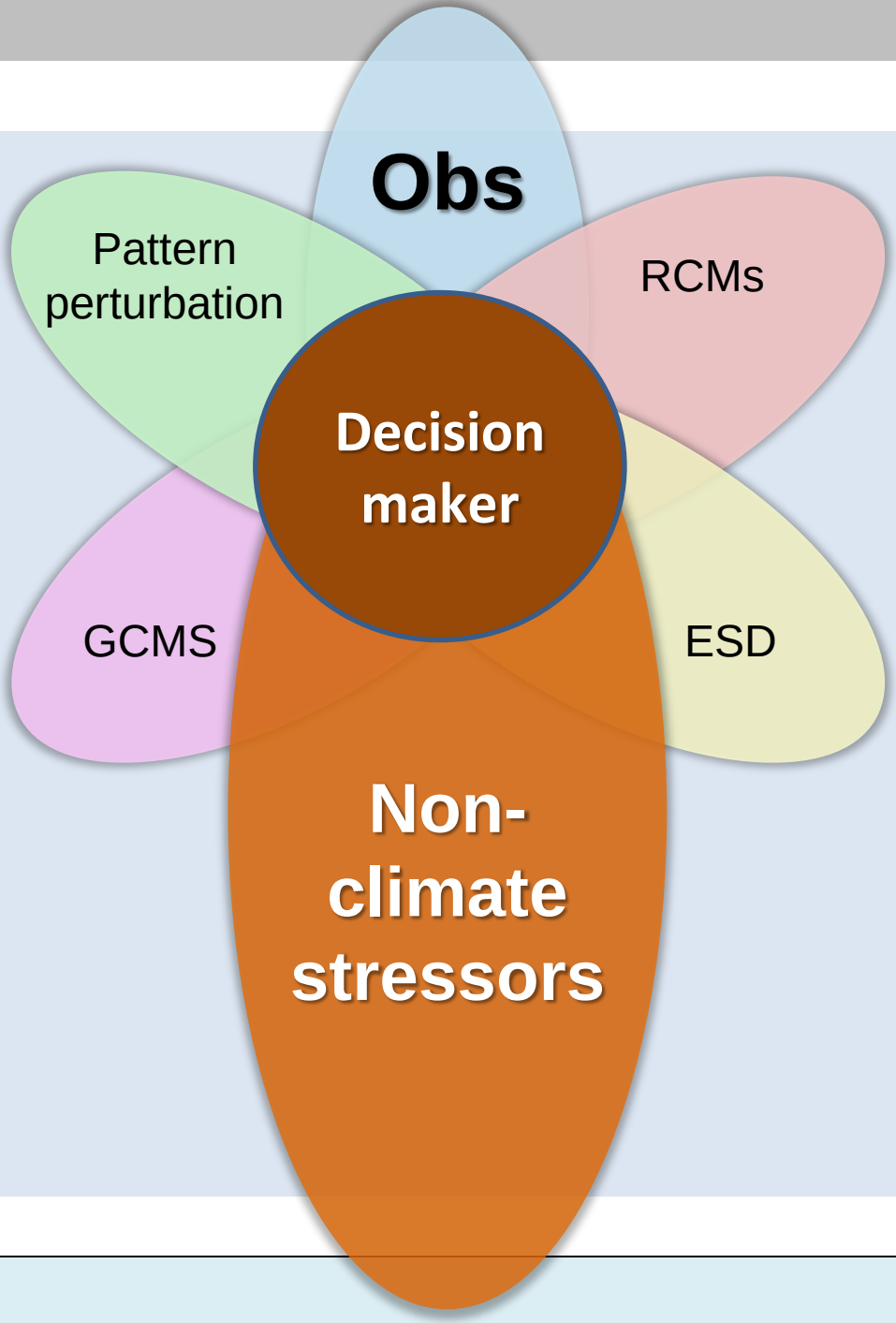
From “it’s real” to “here is the information you need to make good decisions for your stakeholders”

[Chris Field, WGII co-chair)

Did we meet the target?

The decision maker's dilemma: How do they:

- Assess skill
- Understand confidence
- Consider uncertainty
- Accommodate scale dependency
- Reconcile contradictions
- Find trust amidst competing climate services



WCRP World Climate Research Programme

WMO IOC ICSU

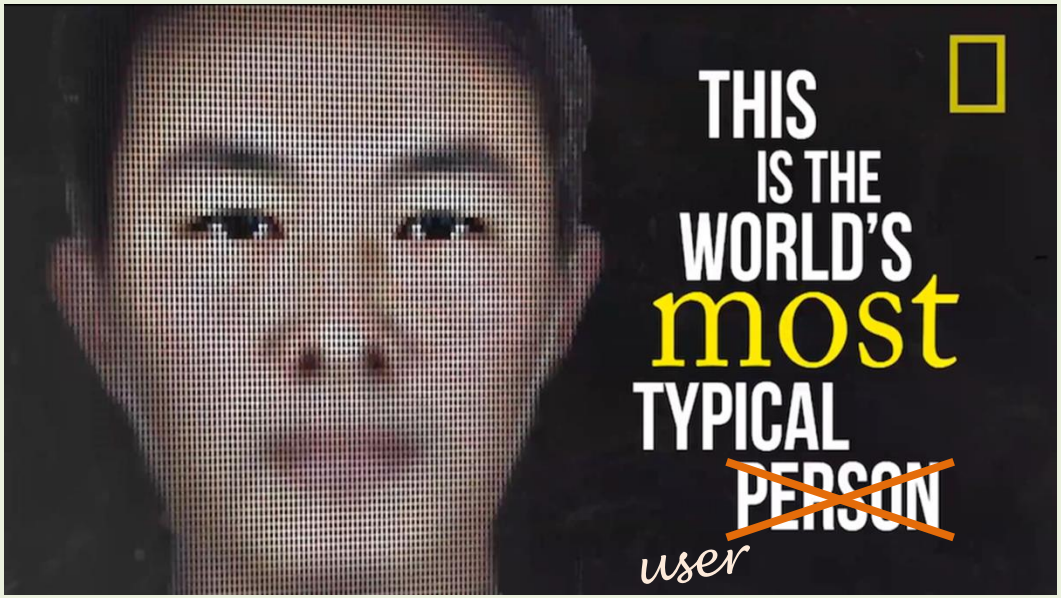
Considering Connection with IAV/Users:

“Users” are mostly place-based: meaning that evaluation by means of large scale averages and/or “reasonable looking” large spatial patterns and/or … … … are of limited value.

“Users” information needs are often attribute based: that is, the issues are often dependent on *characteristics* of a variable’s change, such as rain day frequency, seasonal onset, dry spell duration, and threshold exceedences.

“Users” vulnerabilities are often compound in nature: interactions of multiple climate variables in space and time drive the impacts

“Users” mostly operate in a near to medium term decision space alongside non-climate stressors: climate may/may not be important.



Source: National Geographic

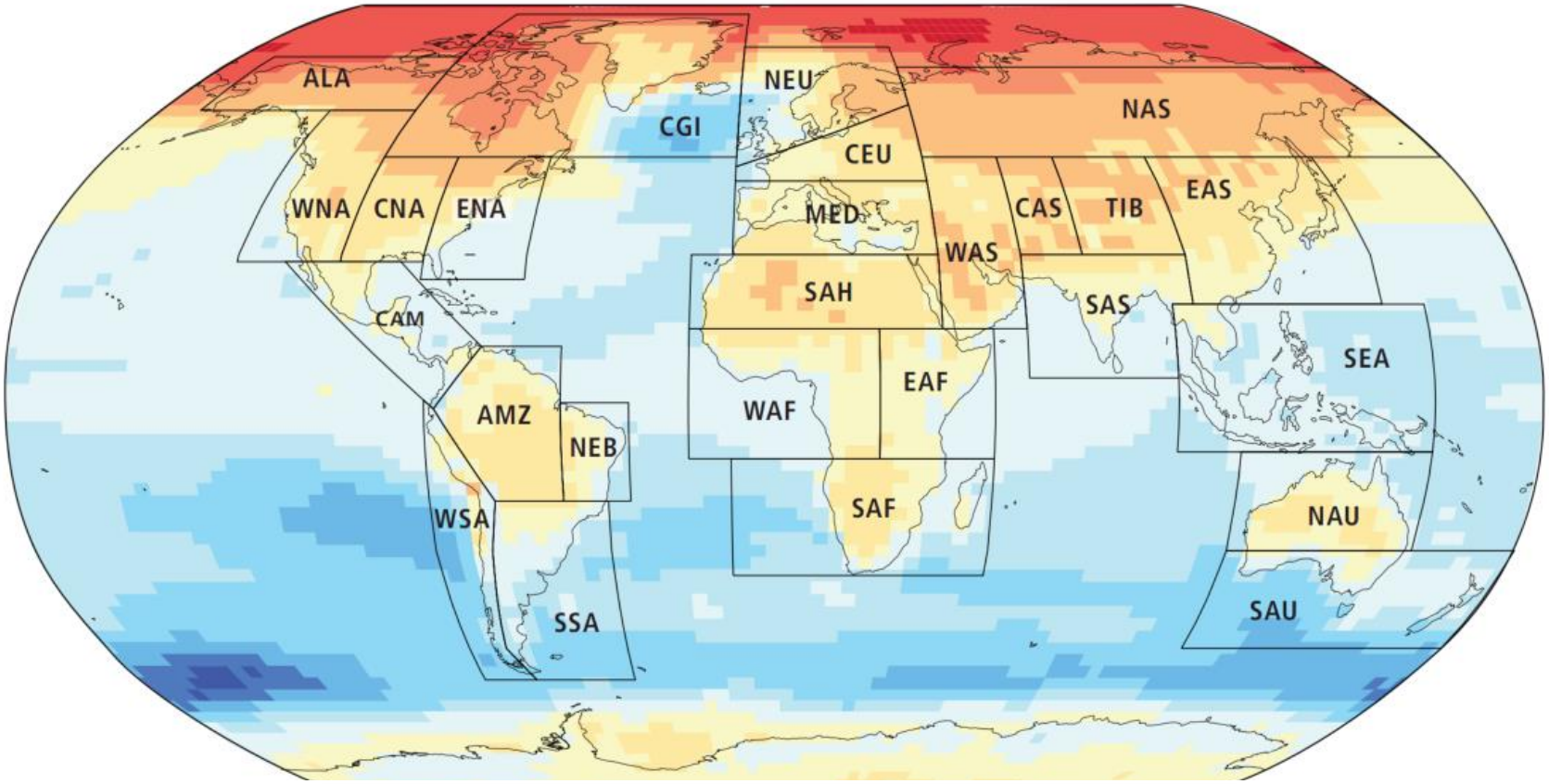
Mostly, we are serving "average" information for an "average" user which is then often over-interpreted as "Truth"

Exec Summary messages from Ch 21 relevant to obs:

- A good **understanding of decision-making contexts** is essential *[how is this arrived at?]*
- The available information is limited by the **lack of comprehensive observations and analyses** of regional climate *[not much to be done on absence of obs but a lot on the analysis of obs]*
- There is **substantial regional variation in observations** and projections of climate change impacts *[need ways to improve consistency]*

These encompass a deep array of issues for regional information in observational data

1. What is "REGIONAL"? This is different to "resolution", has widely different usage, and often with an unarticulated use-case in mind



AR5 WG2: Fig 21.4

Some of the many scales of activities already in place

Table 21-1: Dimensions of the institutions and actors involved in climate change decision-making … extended from Mickwitz (2009).

Coherent policies and decision-making

Multi-level organisation and governance

Level: \ Domain:	Economy	Energy	Food/fibre	Technology	Environment	…
Global	IMF/WB WTO MDGs NGOs	IEA NGOs	FAO WTO CLOS (fisheries) NGOs	WIPO NGOs	UNFCCC CBD Montreal Protocol NGOs	
Trans-national	MFIs/MDBs BFIs OECD/EU CLOS (transport)	OPEC Electric grid operators Oil/gas distributor	AFTA COMESA MERCOSUR EU CAP/CFP	Multi-nationals R&D EU Innovation Union	CLRTAP MRC LVBC EU Directives	
National	Ministry/Gov. Dept./Agency Banks Taxation	Ministry/Gov. Dept./Agency Energy provider Energy regulator	Ministry/Gov. Dept./Agency Tariffs, Quotas, Regulations	Ministry/Gov. Dept./Agency Education/R&D/ Innovation	Ministry/Gov. Dept./Agency Environmental law	
Sub-national	State/Province/ County/City Taxation	State/Province/ County/City Public/private energy provider	State/Province/ County/City Extension service Land use planning	State/Province/ County/City Incentives, Science parks	State/Province/ County/City Protected areas Regional offices	
Local	Micro-finance, Co-operative, Employer, Voter, Consumer	Renewables Producer, Voter, Consumer	Farmer, Forester, Fisher, Landowner, Voter, Consumer	Entrepreneur, Invester, Voter, Consumer	Environmentalist, Landowner, Voter, Consumer	

2. The question of climate services

a) Presupposes a purpose which is often ill-defined

b) Traditionally follows a supply chain paradigm: which entails a measure of unintentional arrogance that assumes “I know what you need”

c) Or is needs driven: science does what its asked!

d) Sometimes is “user-informed”: science responds to an understanding of the information needs, and engages in necessary foundations

e) With a growing commercialization: take a science data product, adapt it (usually using approach (a)), and sells it on with little or no accountability

"Marketplace" examples: an implicit mentality of competition?

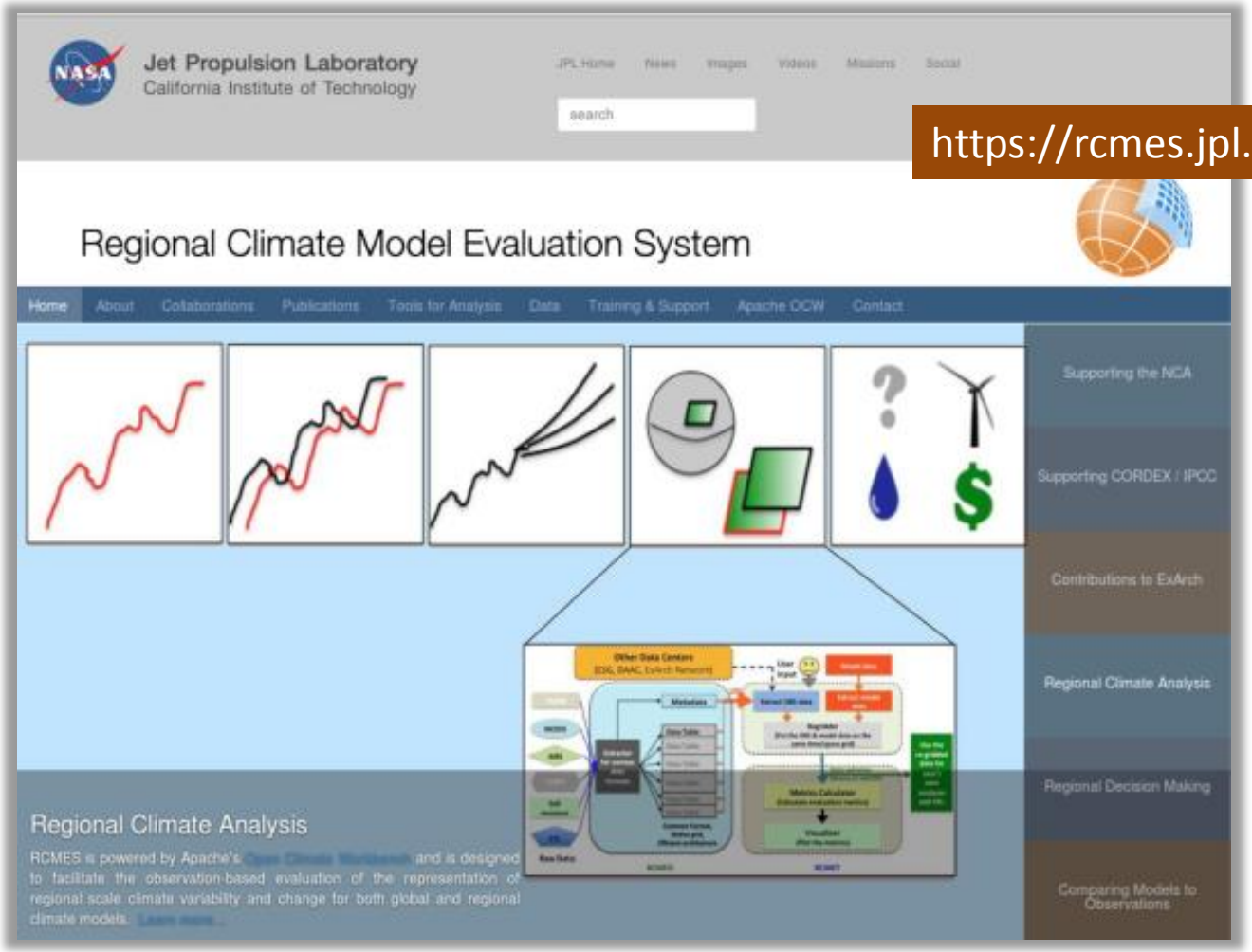
It's like having a meteorological station every 9km, *[this company]* interpolates data collected from global meteorological stations and orbiting satellites, providing accurate data in detailed 9km grids.

The data available here are climate projections from GCMs that were statistically downscaled *[with obs]* and calibrated … The spatial resolution is 30 arc seconds (~1 km2).

The availability of these data … represent a huge step in bridging the gap between climate science and on-the-ground decision making. Common Questions answered by the data on the portal [include] … *How much uncertainty [using obs] surrounds the future projections and changes?*

3. The need for developing equivalencies

- Translating obs into model equivalencies
- Adapting obs for impact model input



4. Enhanced baselines with quantified uncertainty

For (among others):

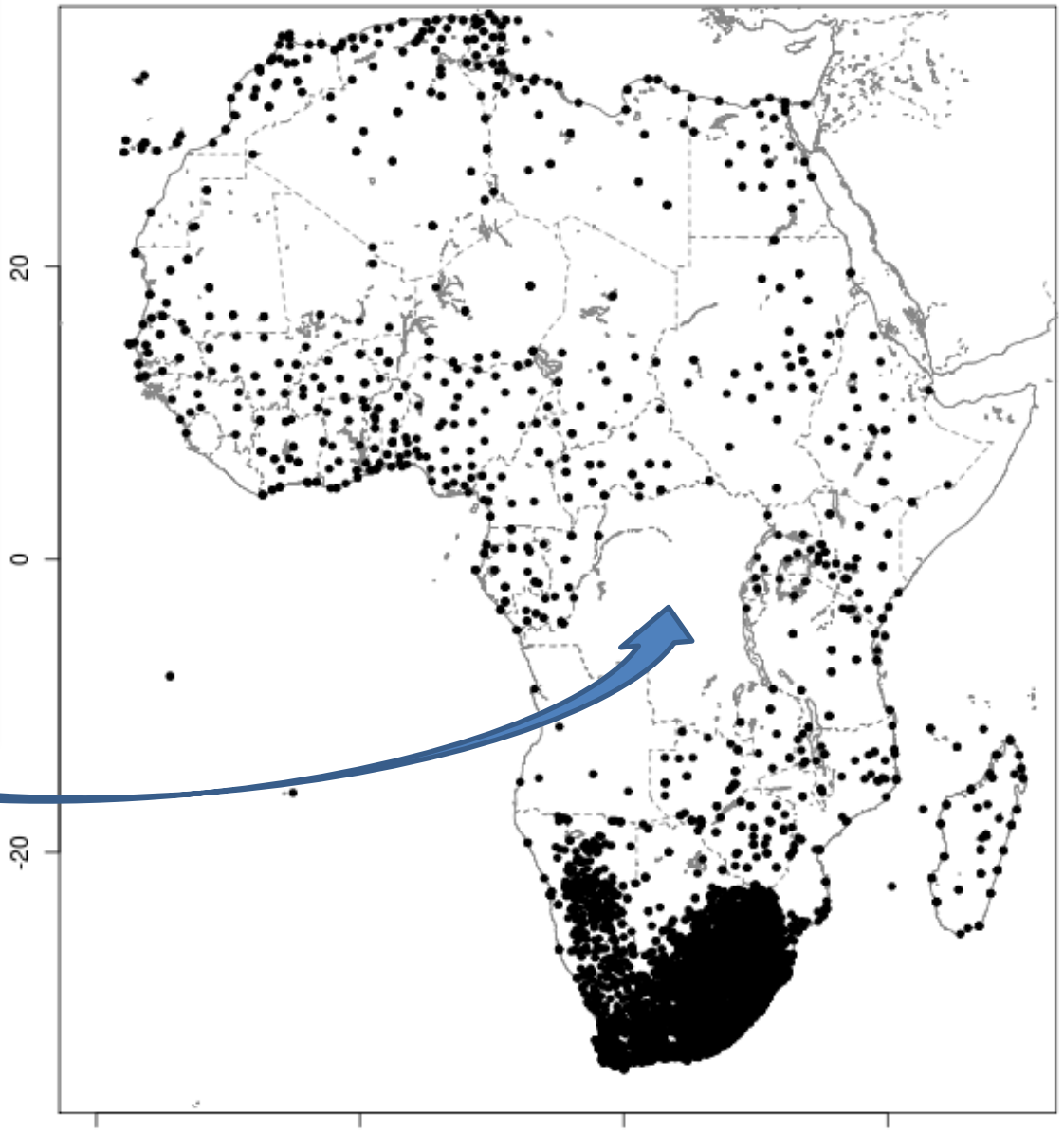
- Evaluating models
- Constraining & training statistical downscaling
- Understanding past changes
- Assessing future departures from the “normal”

But:

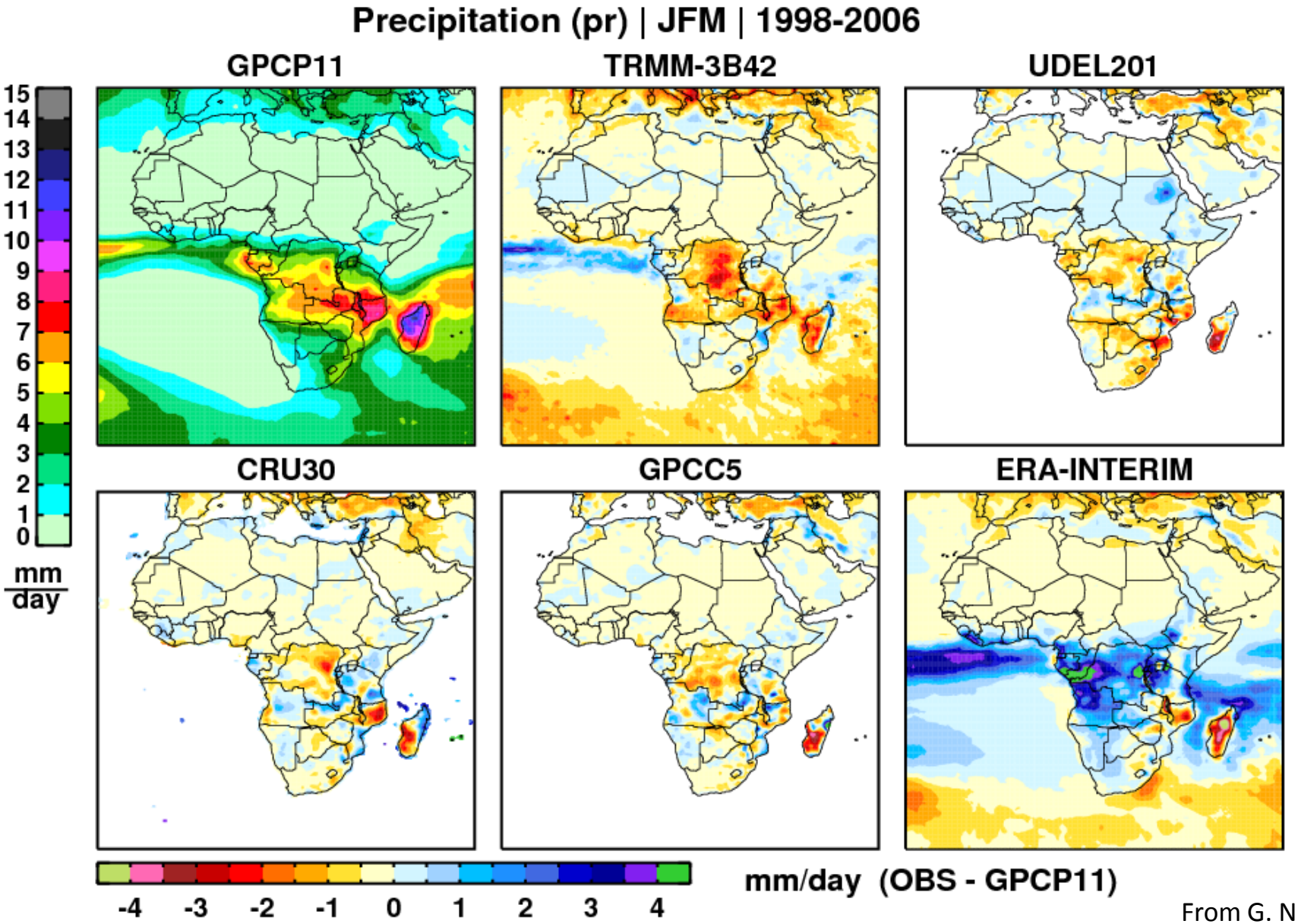
- Obs data are spatially and temporally mixed in resolution, variable, and history: heterogeneous
- Data sets not in agreement, even contradictory
- Resolution is often incompatible with application

A probabilistic history?

(I want to evaluate my model over there …)



Uncertainty in gridded products



From G. Nikulin

Observations for Research, Modelling, and Assessment

→ **DERIVED ATTRIBUTES CAN COMPOUND UNCERTAINTY**

e.g. timing of West African monsoon onset and demise

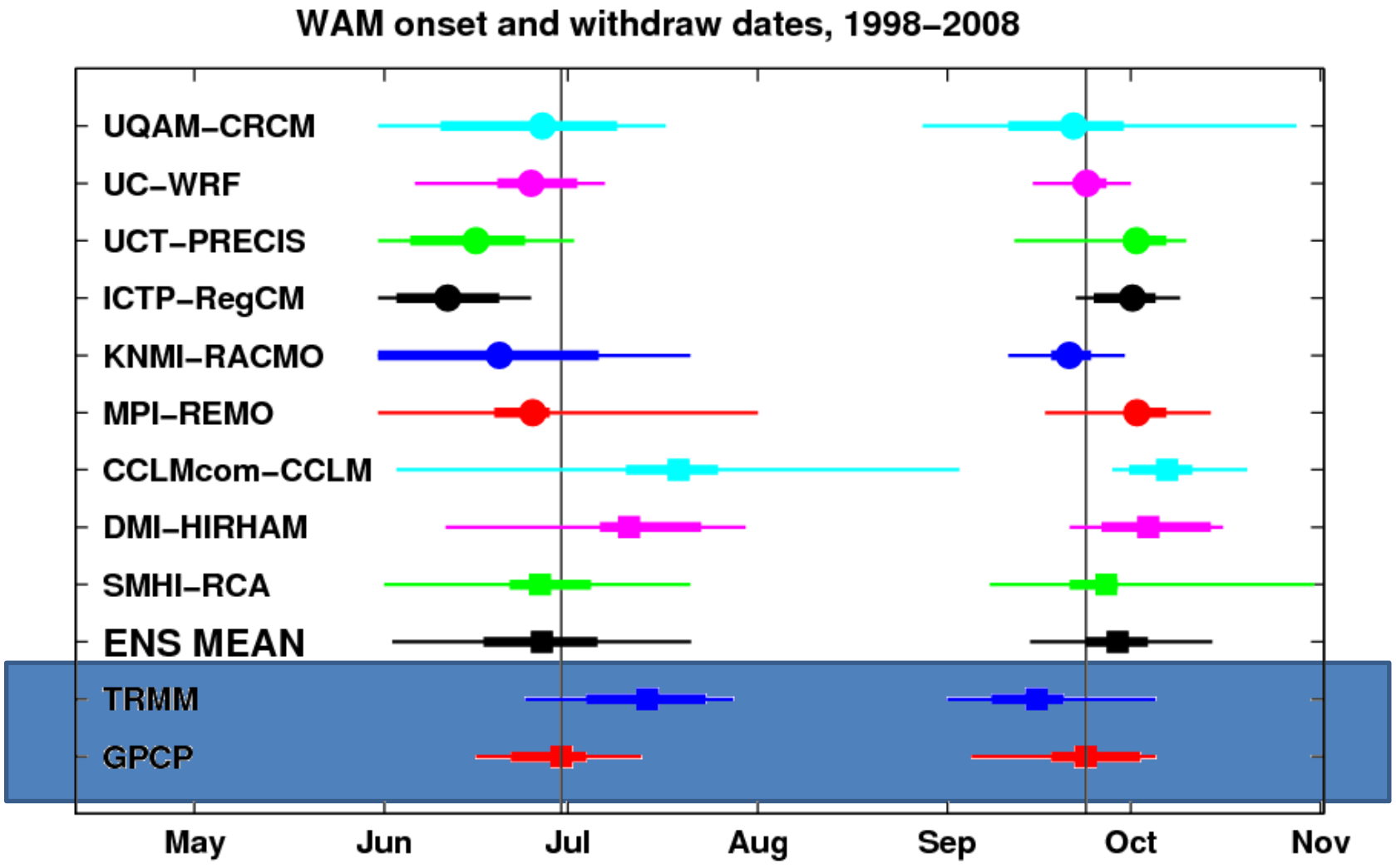
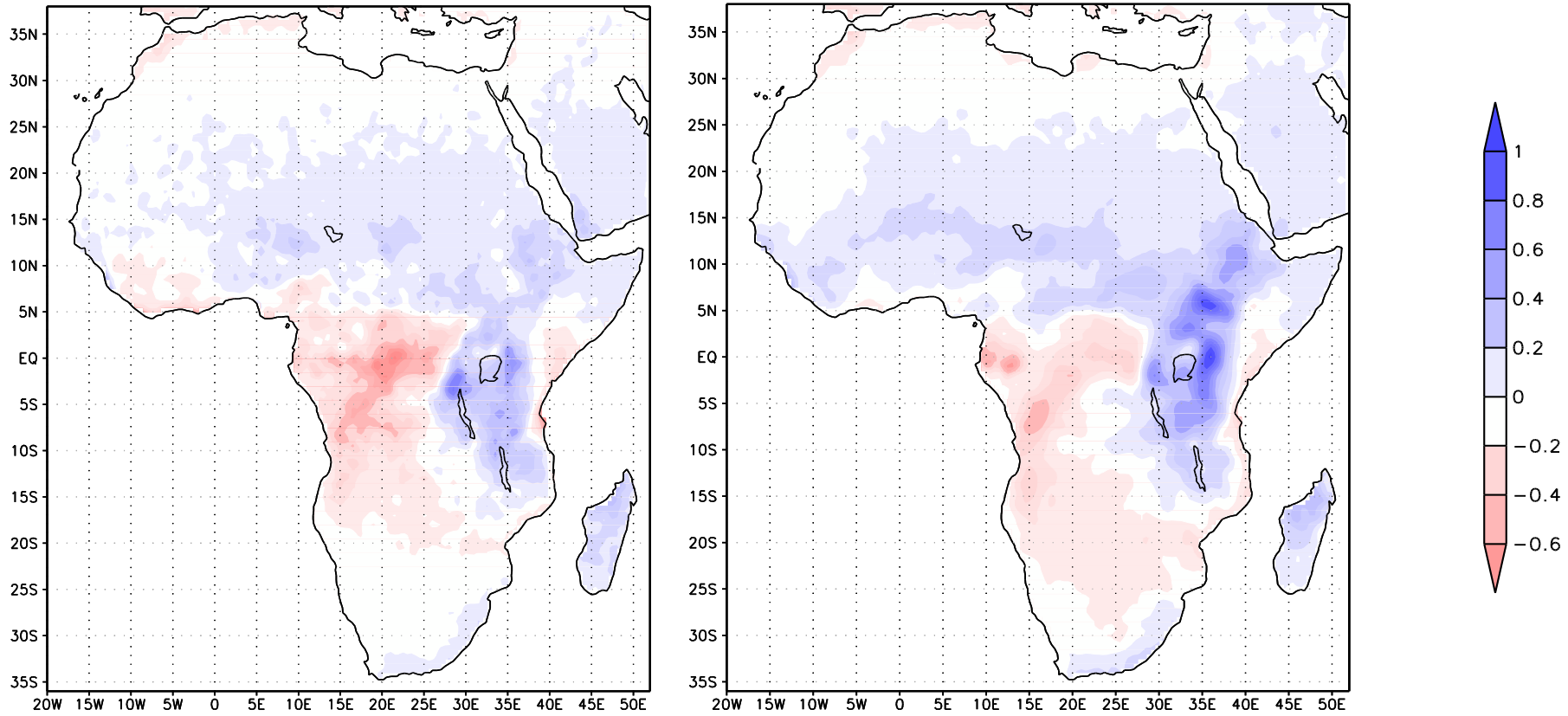


Figure: Colin Jones

Even simple pre-method choices make a difference: e.g. the choice of which observational data set for use in ESD



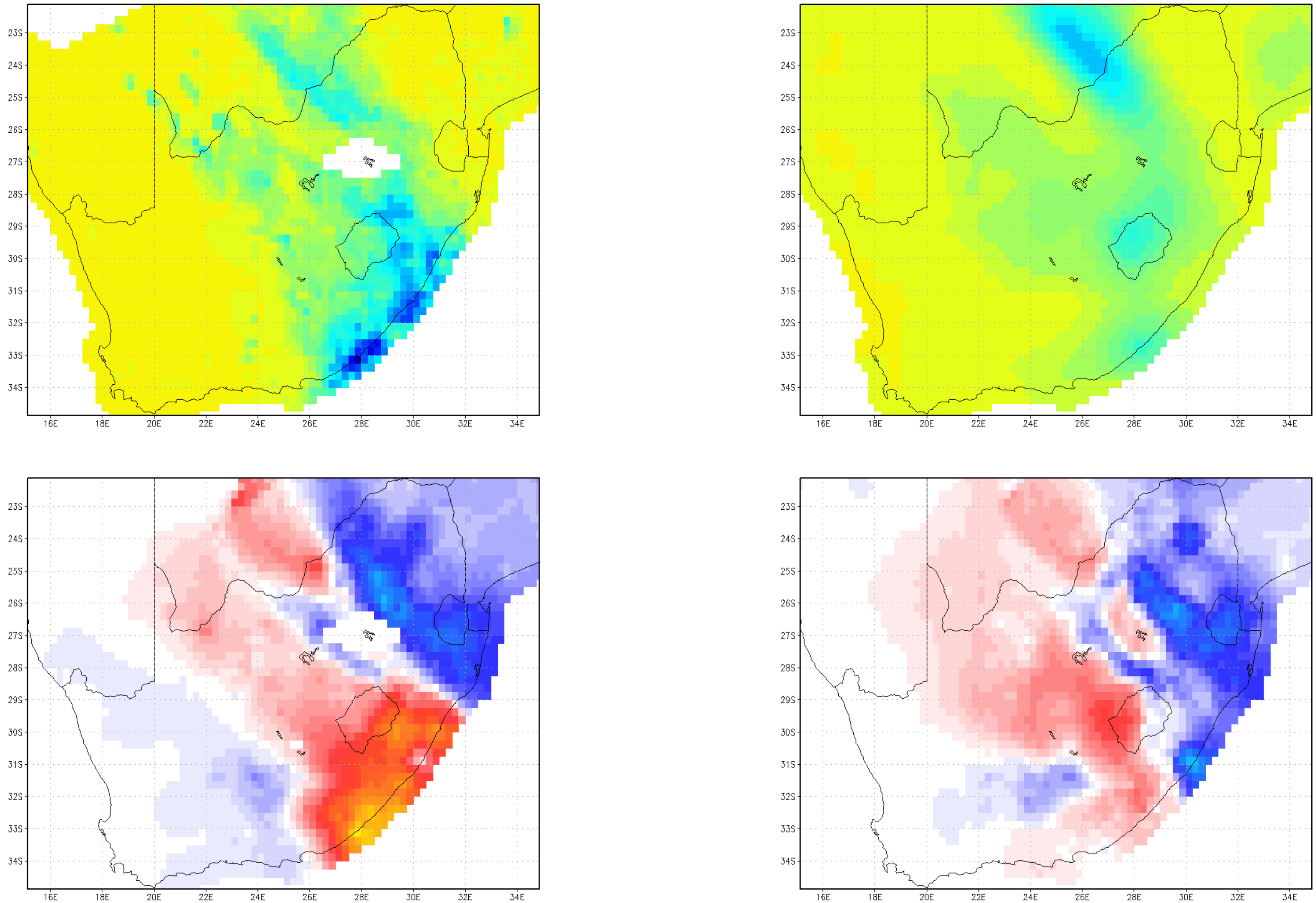
Projected change anomaly (mm/day) *(Figure 4 from Hewitson et al, 2013, Climatic Change.)*

5. Reanalysis data is increasingly being used as obs:

- Who defines the application constraints
- How is this communicated in user's language?
- This ties to climate services, and ethics

Single day rainfall total (summer)

TRMM ERA-Interim



Difference w.r.t. stations

Climate System Analysis Group
CSAG
University of Cape Town

6. Weak "consistent" analysis of incomplete observations to help transparent communication

e.g.

- Attributes (e.g. raindrop intensity at puddle scale with surface wind over the northern Sahel)
- Linking atmospheric processes to surface measurements to enhance confidence in signals
- Disaggregating natural variability from structural, physics, parameterization errors (e.g. hiatus studies such as Marotzke & Forster (2015))
- Explaining data differences and contradictions
- Integrating disparate data (stations, satellite, interpolated, etc) into relevant information.

7. Leveraging AR4 / AR5 for AR6

i.e. User-informed analysis for regionally contextualized information built on process understanding

Executive Summary

Increasingly reliable regional climate change projections are now available for many regions of the world due to advances in modelling and understanding of the physical processes of the climate system. A number of important themes have emerged:

- Warming over many land areas is greater than global annual mean warming due to less water availability for evaporative cooling and a smaller thermal inertia as compared to the oceans.
- Warming generally increases the spatial variability of precipitation, contributing to a reduction of rainfall in the subtropics and an increase at higher latitudes and in parts of the regions and th Circula
- The po with th precipi reducti subtro in prec adjace
- There in inc conver monso tropica

Atmosp the primar of possibl aspects of improvement in model resolution, the simulation of processes of importance for regional change and the expanding set of available simulations. Advances have been made in developing probabilistic information at regional scales from the AOGCM simulations, but these methods remain in the exploratory phase. There has been less development extending this to downscaled regional information. However, downscaling methods have matured since the Third Assessment Report (TAR; IPCC, 2001) and have been more widely applied, although only in some regions (e.g. large-scale coordination of multi-model downscaling of climate change simulations been achieved.

Regional climate change projections presented here are assessed drawing on information from four potential sources: AOGCM simulations; downscaling of AOGCM-simulated data using techniques to enhance regional detail; physical understanding of the processes governing regional responses; and recent historical climate change.

Previous chapters describe observed climate change on regional scales (Chapter 3) and compare global model simulations with these changes (Chapter 9). Comparisons of model simulations of temperature change with observations can be used to help constrain future regional temperature projections. Regional assessments of precipitation change rely primarily on convergence in both global and downscaling models along with physical insights. Where there is near unanimity among models with good supporting physical arguments, as is more typical for middle and higher latitudes, these factors encourage stronger statements as to the likelihood of a regional climate change. In some circumstances, physical insights alone clearly indicate the direction of future change.

The summary likelihood statements on projected regional climate are as follows:

sources of information. The most notable improvements in confidence relate to the regional statements concerning heat waves, heavy precipitation and droughts. Despite these advances, specific analyses of models are not available for some regions, which is reflected in the robust statements on extremes. In particular, projections concerning extreme events in the tropics remain uncertain. The difficulty in projecting the distribution of tropical cyclones adds to this uncertainty. Changes in extra-tropical cyclones are dependent on details of regional atmospheric circulation response, some of which remain uncertain.

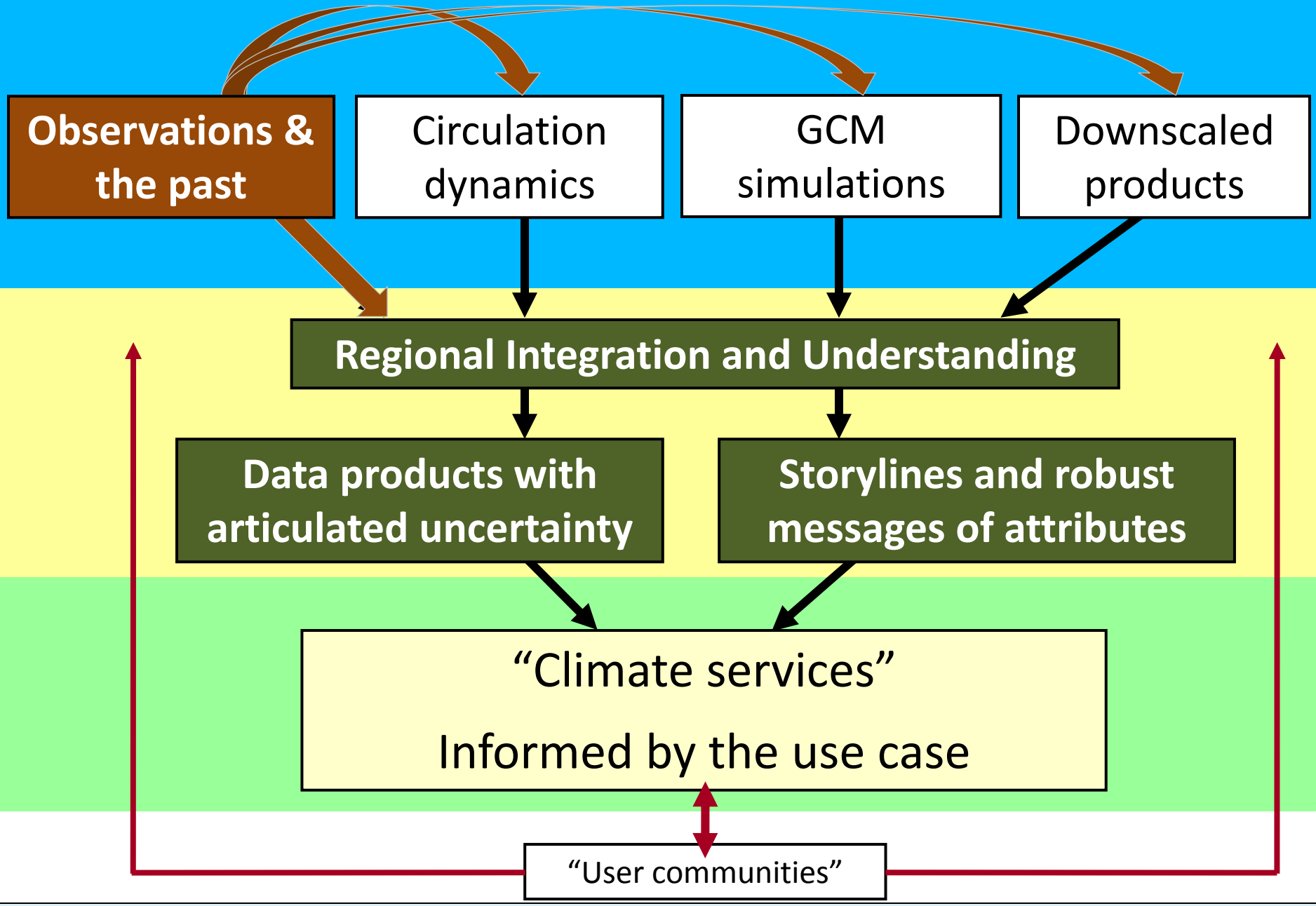
The following summarises the robust findings of the projected regional change over the 21st century. Supporting narratives are provided in Sections 11.2 to 11.9. These changes are assessed as *likely* to *very likely* taking into account the uncertainties in climate sensitivity and emission trajectories (in the Special Report on Emission Scenarios (SRES) B1/A1B/B2 scenario range) discussed in earlier chapters.

Regional climate change projections presented here are assessed drawing on information from four potential sources: AOGCM simulations; downscaling of AOGCM-simulated data using techniques to enhance regional detail; physical understanding of the processes governing regional responses; and recent historical climate change.

AR4 presented an approach to develop decision-centric information

AR5 strengthened the process analysis, but lost some of the integration

Observations are fundamental



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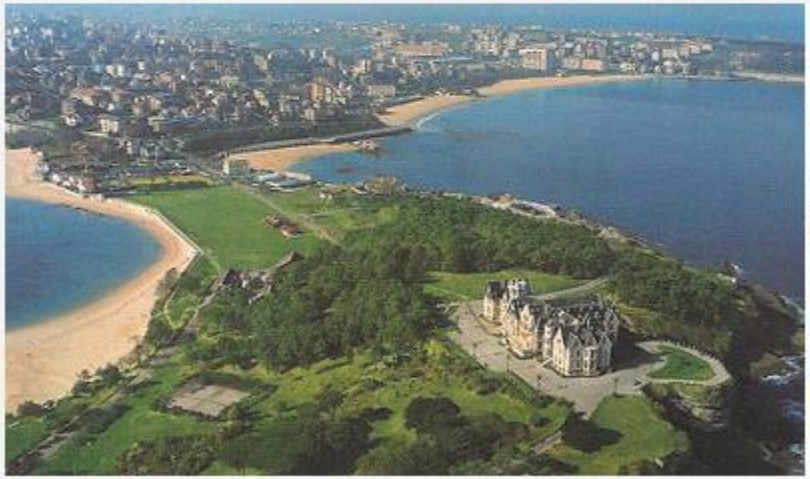
WCRP WGRC Expert Meeting on Climate Information Distillation

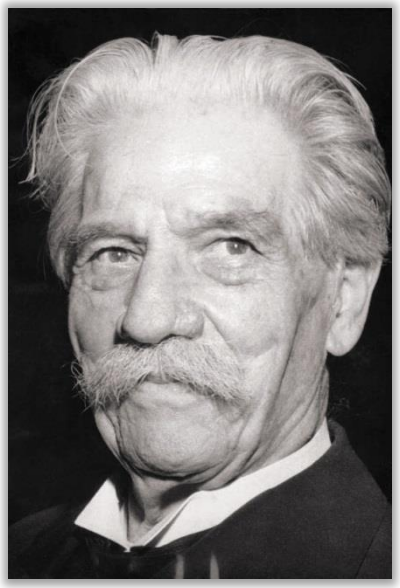
A WGRC Workshop on the Assessment, Analysis and Integration of Climate Information Conflicts

29-31 October 2014, Santander SPAIN



Arguably the leading complication for users of climate information for policy and adaptation is the spread of messages arising from data of historical change, GCM projections, downscaled projections from RCMs and statistical downscaling, and from other related spatial disaggregation methods. These contrasting data sets offer widely differing, and often times fundamentally contradictory indications of the magnitude and direction of past and future regional climate change.

8. Examples!



"Example is not the main thing in influencing others. It is the only thing."
Albert Schweitzer – a German who came to Africa. Nobel prize winner, philosopher, musician, physician

AR5 WG2: Table 21.8

Research need: Case studies and underlying theory of these features of societies, and documentation of the effectiveness of actions taken, are needed in conjunction with methods development

9. Many other nuances

- Language and terminology
- Contrast of priorities and capacity between developed nation and developing nations
- Authorities that steer effort and investment
- Cross-culture perceptions
- Ethics and values

Etc.

10. Relevant statements from table AR5 WG2 21.6: Knowledge gaps and research needs

a) There is not a strong understanding of how to integrate … uncertainty is weakly characterized and quantifying how much of an observed or simulated climate change is due to internal variability or external forcing is difficult in many situations

b) The attributes of regional climate change through which impacts are manifest, such as the intensity, persistence, distribution, recurrence, and frequency of weather events, is poorly understood. The information conveyed to the adaptation community is dominated by aggregates in time and space … which hide the important attributes underlying these aggregated changes.

c) The historical record for many regions, especially those regions most vulnerable to climate change, is poor … The research need is to integrate the multiplicity of historical data as represented by the raw observations into processed gridded products

Question: **What are the priority inadequacies** and/or gaps in our observational data (in terms of location, temporal scales, and variables), **which if addressed, would bring the greatest advance in value** for research on regional climate projections and for the adaptation and decision making communities?

Challenge: Recognizing that the heterogeneity of observational data (different temporal and spatial scales, gaps in time and space, uncertain error, difficult accessibility, missing metadata, contradictions between data sets of the same variable, etc.): **can we integrate across this diversity [of data]** to construct common information products that are open access, represent a derived best estimate, are spatially continuous, quality controlled, with quantified uncertainty, and most importantly are aligned to the scale and attribute needs of priority user communities (e.g. downscaling, modelers, IAV, and decision makers).