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World Climate Research Programme

Grand Challenge on Regional Climate Information

Clare Goodess (WGRC) with

Francisco Doblas-Reyes (WGSIP), Lisa Goddard (CLIVAR), Bruce Hewitson (WGRC), Jan Polcher (GEWEX/WGRC) and Roberta Boscolo (WCRP)

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White Paper on WCRP Grand Challenge #1

Regional climate information:

Can we provide skilful regional climate predictions at seasonal to decadal time scales and reliable and actionable long term regional climate change projections?

Filippo Giorgi, Carolina Vera, Frederick Semazzi (JSC)

with contributions from

CLIVAR, WGRC, WGNE, WGSIP, WGCM, GEWEX

November 2012

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Frontier 1: Intraseasonal and seasonal predictability and prediction. **Identify and understand phenomena that offer some degree of intra-seasonal to inter-annual predictability, and skilfully predict these climate fluctuations and trends.**

CLIVAR lead

Frontier 2: Decadal variability, predictability and prediction. **Identify and understand phenomena that offer some degree of decadal predictability and skilfully predict these climate fluctuations and trends.**

CLIVAR lead

Frontier 3: Reliability and value of long-term regional climate change projections. **Provide reliable regional climate projections for the 21st century and beyond for use in Impact, Adaptation and Vulnerability (IAV) studies as a basis for the development of response (adaptation, mitigation) strategies to climate change**

WGRC lead

Frontier 4: Definition of usefulness: informing the risk management and decision making space. **Provide information that constitutes a solid and targeted basis for decision making concerning risk management and response options in specific sectors and contexts, also through active and two-way involvement with stakeholders.**

WGRC lead

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White Paper on WCRP Grand Challenge #1

Regional climate information: Can we provide skilful regional climate predictions at seasonal to decadal time scales and reliable and useful long-term regional climate change projections?

What are the limits and challenges to providing skilful and reliable regional climate predictions, projections and high-quality regional observations and how do we translate these to information that can be used to better inform regional decision-making?

Version 1:
Filippo Giorgi, Carolina Vera, Frederick Semazzi (JSC)
with contributions from
CLIVAR, WGRC, WGNE, WGSIP, WGCM, GEWEX
November 2012

Version 2:
Clare Goodess, ……..
with contributions from
WGRC, ……
Version 2.1: 18 June 2014

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The way forward

- Lead contact: Clare Goodess (WGRC)
- Steering group: Francisco Doblas-Reyes (WGSIP), Lisa Goddard (CLIVAR), Bruce Hewitson (WGRC), Jan Polcher (GEWEX & WGRC) supported by Roberta Boscolo (WCRP)

- Next 4-5 months:
  - Refine and prioritise the science questions
  - Develop Frontier 0 on observations
  - Identify current projects/initiatives etc which are already addressing these questions
  - Identify gaps

Frontier 4 is cross-cutting – but there are also many fundamental climate science questions which overlap between timescales, e.g., processes and predictability of local-scale versus regional scale climate variability and change

The way forward

- Produce a ‘sharpened’ version of the White Paper and a shorter document to ‘galvanise’ the community
- Involve additional individuals in the writing (WCRP projects/WGs)
- Sessions and side-events at relevant existing meetings
  - E.g., 1.5 hour break-out session, Pan-Clivar 17 July (Darmstadt in Oct?)

- Will then be in a position to engage much more widely with the various relevant communities
- And to propose a prioritised set of specific, focused and attainable initiatives and objectives for all Frontiers (and leads)
- Develop plans for and seek funding for a ‘big’ event on the Grand Challenge in 2015

Proposed Frontier 0 on high-quality regional observations to satisfy the requirements of the grand challenge

Needed by the modelling and analysis communities:

- Model initialisation
- Model validation
- Forecast quality assessment
- Forecast calibration
- ESD model calibration and validation
- Bias correction
- Process-based model evaluation and understanding
- Quantification of natural variability
- Reference/benchmark for assesing predicted/projected changes

Essential for understanding the impacts of climate fluctuations and change – need to focus on the scales at which weather and climate affect the environment and society

- Observing & understanding regional climate vulnerabilities.
- Observing climate variability & change & its consequences on the environment & society will define what needs to be predicted & at what scales etc

Observations

- In part a communication & awareness issue
- Need for more gridded products comparable to model resolutions
- And need for uncertainty estimates
- But also accessibility and need for guidance on how to use ‘new’ datasets
- Arguably not making most use of remote sensing, reanalysis, SOPs etc etc

For example – GEWEX RHPs

- Can help to rejuvenate, enhance and prolong the life (or even save) these in-situ networks
  - E.g., AMMA, BALTEX/BalticEarth, HyMex, SRB
- And also offer great possibilities for process-based model evaluation

SaskRB science objectives

To improve monitoring, understanding and modelling of:

- the region's variable climate, including its hydro-meteorological extremes
- key land surface systems, including Rocky Mountains, Boreal Forest and Prairies, and their response to climate variability and climate change
- effects, on water quantity/quality & aquatic ecosystems, of anthropogenic land use change
- societal controls on water management, including policy options and economic instruments

GIWS Saskatchewan River Basin Research Facility – now a World Climate Research Programme Regional Project

WGRC

- Has a major role to play in Frontier 3
  - e.g., proposed flagship pilot studies – focused studies to address key questions about the 'value' of the CORDEX approach (agenda item 5.2)

Action 13 from WGRC-2: CORDEX-Africa-Analysis (CAA) pilot project and journal paper (Giorgi, Hewitson, Zermoglio, Gutowski – next 6 months)

- An example for CORDEX analysis in other regions of the world. A position paper as a sort of guideline on the strength and weaknesses of CORDEX datasets: can the CORDEX outputs answer some of the questions that users are posing about regional climate?

This paper and other broader-CORDEX related activities reaching out to user communities and facilitated by WGRC are very relevant to Frontier 4

WGRC

Action 22 from WGRC-2: A working paper on regional climate priorities

(Landman, Mason, Gotango & Lennard)

- Skeleton document on tractable regional issues that research communities could start doing so helping gain traction. Should facilitate steering regional agendas by inputting into regional calls/strategic developments. Also needed for communicating with major agencies (e.g., NSF, Belmont, DFID, dev. banks).

WGRC can facilitate links to regional communities

- ACC2013 – Africa Climate Research for Development Agenda
- LACC2014 – CAMPANA task force
- See agenda item 6.7

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Distillation

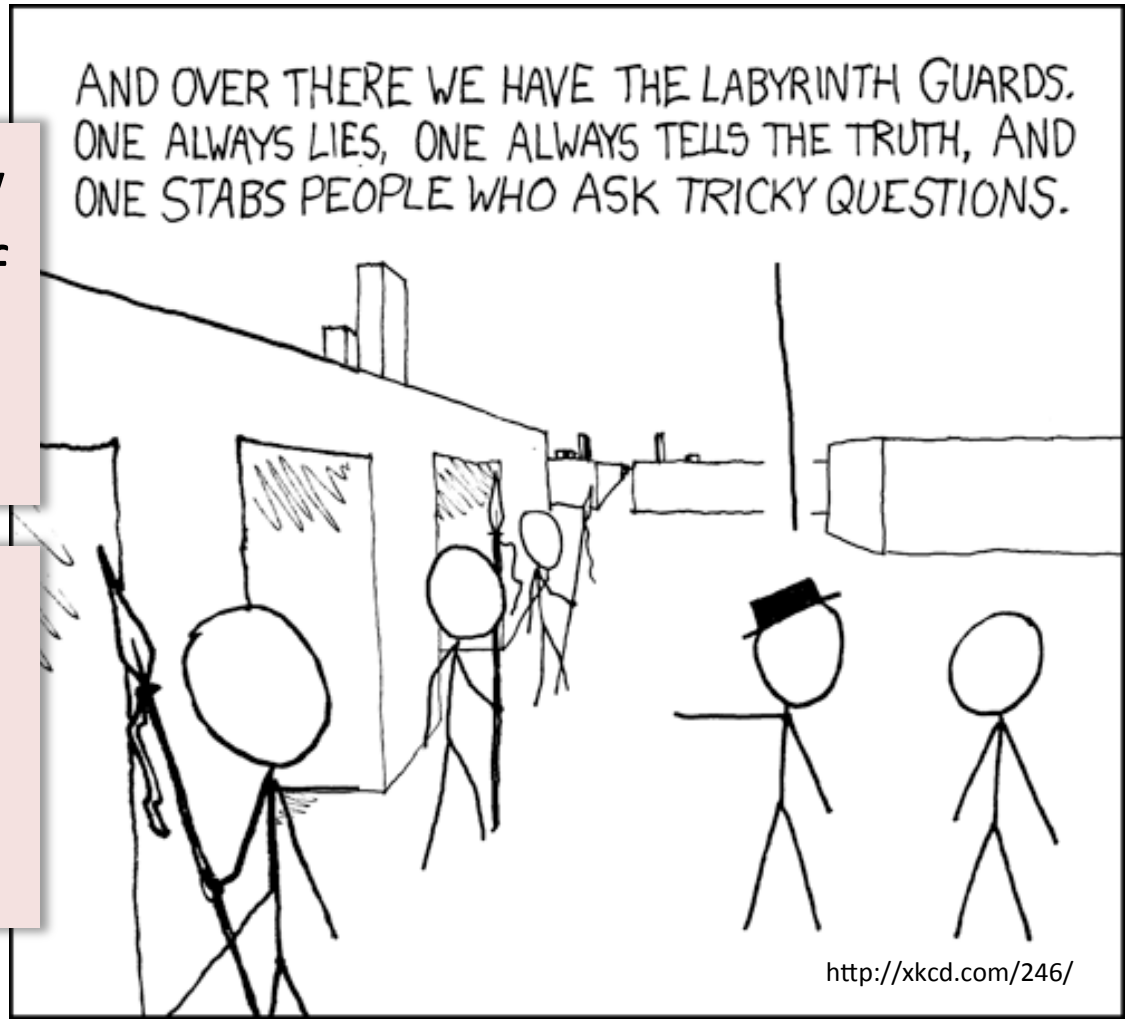
Some of the Frontier 3 scientific questions: How to extract regional forced signals from the underlying natural variability? What are the reasons for inter-model differences? How do model systematic errors affect regional climate projections? How to best assemble the information from ensembles of model projections? How to better understand and characterize the uncertainty in regional climate projections?

Frontier 4 scientific questions: How to characterize the range of stakeholders and IAV applications for which targeted information is required? In each instance, how to best post-process climate data to provide such targeted information for IAV applications within the context of risk management? How to use information from model ensembles? What indices of extremes are needed for IAV applications? How to convey credibility and uncertainty to users of the climate information? How to assess the value of the information in relation to its quality? What are the most promising methods for assessing value? How to contextualize the climate information within climate and non-climate thresholds of relevance for IAV applications? How to best engage the stakeholder community in a fruitful dialogue with the climate science community in order to maximize the usefulness of climate information? How to ensure a sustainable infrastructure for dialogue, feedback and delivery of useful information?

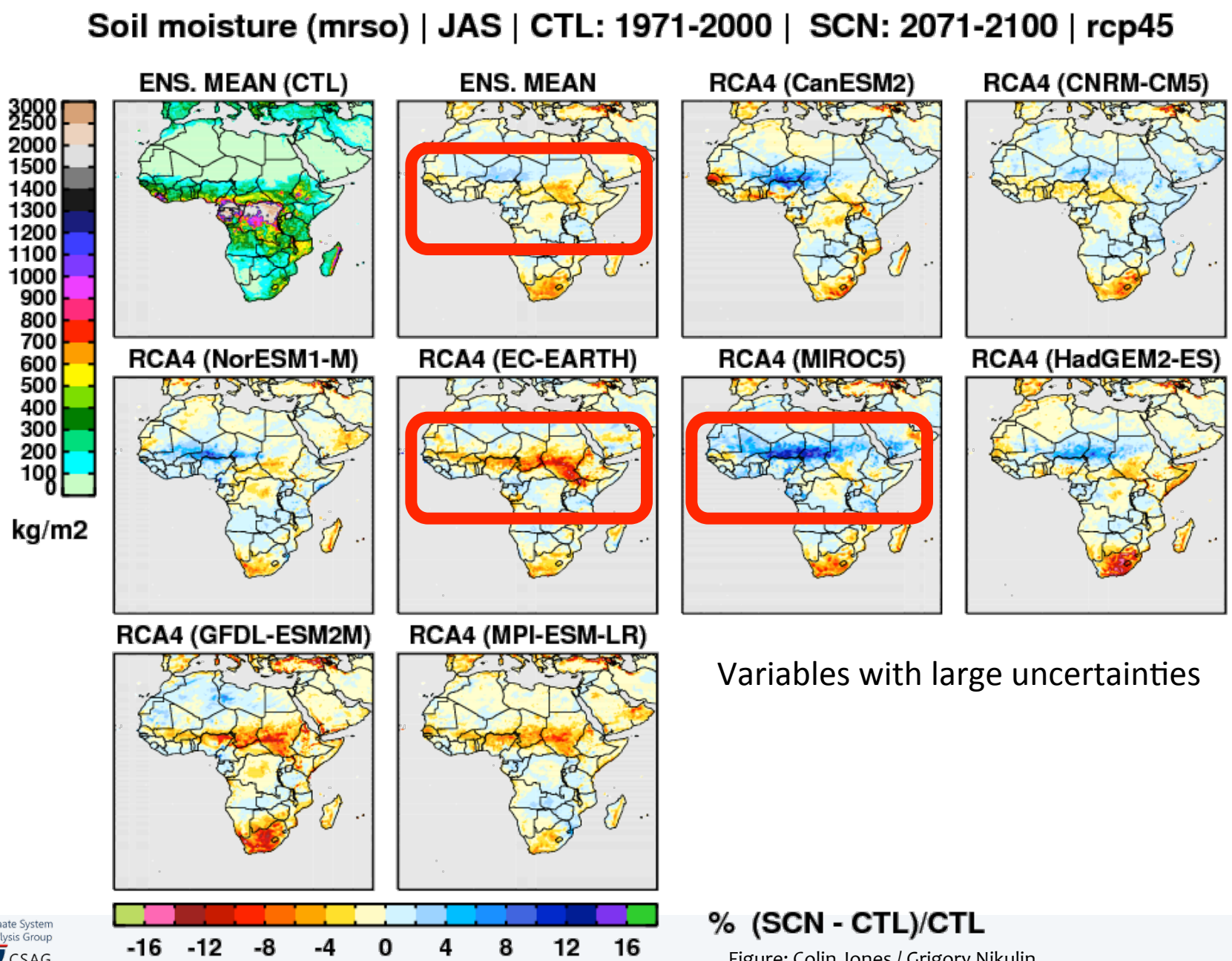
If an informed user did your data evaluation …

How much do you know about the ingredients of your information product?

Do you deal with or communicate the fact that other products contradict yours?



Early CORDEX results for Africa



Variables with large uncertainties

Figure: Colin Jones / Grigory Nikulin

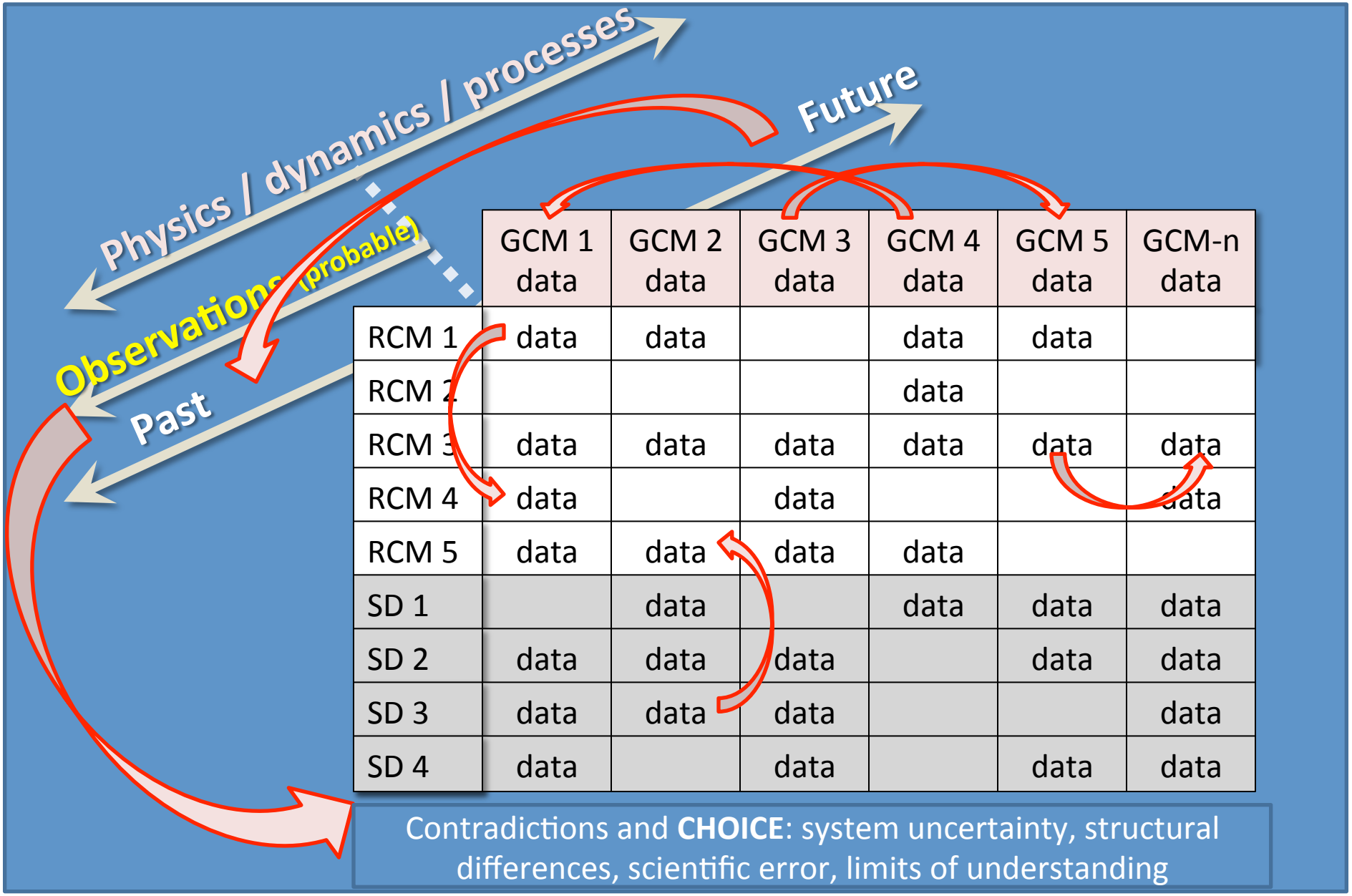
Some aspects of the *"user's point of view"*

"Users" are mostly place-based: meaning that evaluation by means of large scale averages and/or "reasonable looking" large spatial patterns and/or Taylor diagrams 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 with non-climate stressors: climate may or may not be important.



Climate System Analysis Group CSAG
Bruce Hewitson, University of Cape Town
www.csag.uct.ac.za

WCRP WGRC Expert Meeting

"Assessment, analysis & integration of climate data information conflicts" or "The information distillation dilemma"
29-31 October 2014, Santander, Spain

- Agenda development – Hewitson, Goodess, Gutowski
- Organisation committee – 3 + Landman, Mason, Giorgi, Boscolo (and local)
- About 20 funded and 15 self-funded participants
- Invitations gone out to CLIC, CLIVAR, GEWEX, WGSIP, WGCM
- Currently identifying other individuals and groups (FE, GFCS, GCOS, PROVIA)

Anticipated outcomes:

- initiate writing of a position paper
- frame a research guidance paper
- foster future collaboration & communication between relevant communities
- establish a community of practice for addressing the distillation challenge

Workshop themes

- Review current activities, assess barriers & limitations that constrain robustness of regional info - & which particularly inhibit IAV activities
- Explore understanding of contradictions between models, observations, GCMs, RCMs & ESD – the sources & reasons
- Prioritize research frontiers which offer greatest investment return (benefit to IAV community)
- Assess emerging approaches to method-independent user-relevant metrics of skill, & options to advance these activities
- Outline possible research agenda to explicitly address contradictions & uncertainty inherent in disparity of multi-model, multi-method, multi-scale simulation & observational data sets
- Identify potential approaches to best advance development of robust regional information on climate change & variability – that are scale relevant and geographically transferrable

Regional climate grand challenge

How can WGSIP contribute to provide skilful regional climate predictions at seasonal to decadal time scales and actionable climate information?

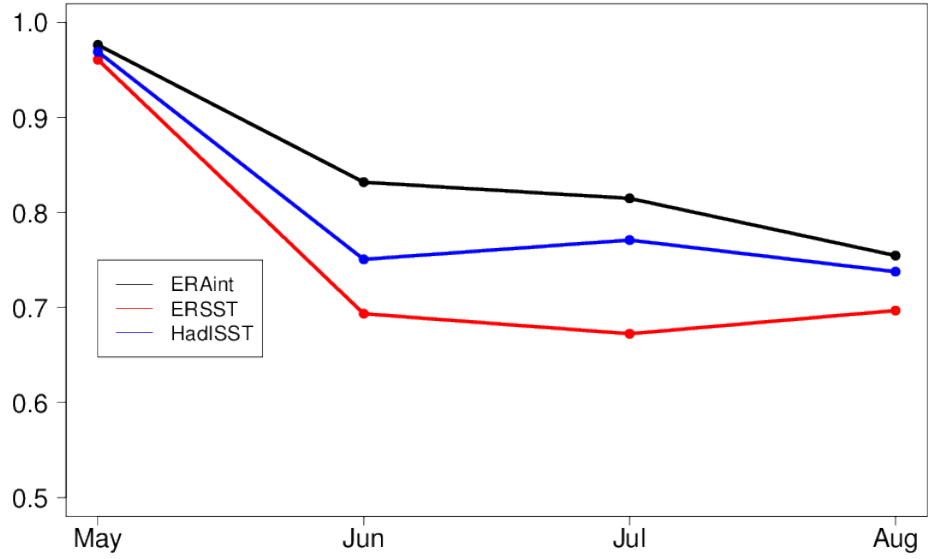
WGSIP is involved in four scientific frontiers:

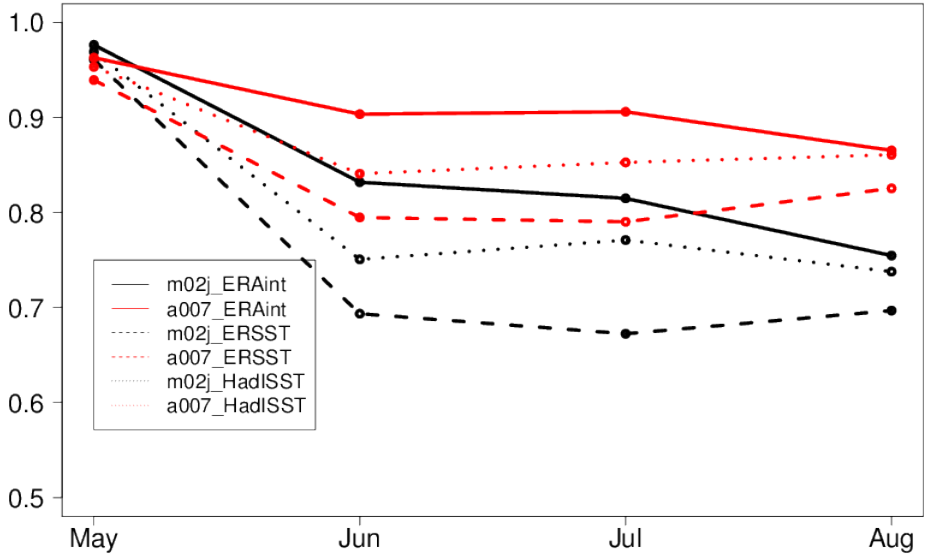
- **Frontier 0: Observations.**
- **Frontier 1: Intraseasonal and seasonal predictability and prediction.**
- **Frontier 2: Decadal variability, predictability and prediction.**
- **Frontier 4: Definition of usefulness: informing the risk management and decision making space.**

Regional climate grand challenge

Frontier 0: Observations. Climate prediction requires global observational datasets at high resolution (25 km) for initialisation, model validation, and forecast quality assessment. Observational datasets are also needed for forecast calibration, although they are more specific to the user requirement. All datasets should come along with observational estimates.

Correlation of Niño3.4 SST from four-month EC-Earth3 hindcasts. May start dates over 1993-2009 using ERA-Interim and ten-member ensembles. (Left) Impact of the uncertainty in the reference dataset. (Right) Impact of the ocean reanalysis used as initial conditions: m02j GLORYS, a007 ORAS4.





Regional climate grand challenge

Frontier 1: Intraseasonal and seasonal predictability and prediction. WGSIP and S2S are the two initiatives trying to develop coordinated sub-seasonal to seasonal climate prediction systems and process-based analyses using both dynamical and statistical methods.

Data archive planned for S2S. An archive already exists for the Climate Historical Forecast Project (CHFP) on **http://chfps.cima.fcen.uba.ar**

	Time-range	Resolution	Ens. Size	Frequency	Hcsts	Hcst length	Hcst Freq	Hcst Size
ECMWF	d 0-32	T639/319L62	51	2/week	On the fly	Past 18y	weekly	5
UKMO	d 0-60	N96L85	4	daily	On the fly	1989-2003	4/month	3
NCEP	d 0-60	T126L64	16	daily	Fix	1999-2010	Once a day	4
EC (exp)	d 0-35	0.6x0.6 L40	21	weekly	On the fly	Past 18y	weekly	4
CAWCR	d 0-120	T47L17	33	2/week	Fix	1989-2010	3/month	33
JMA	d 0-34	T159L60	50	weekly	Fix	1979-2010	3/month	5
KMA	d 0-30	T106L21	20	3/month	Fix	1979-2010	3/month	20
CMA	d 0-45	T63L16	40	6/month	Fix	1982-now	monthly	48
CPTEC	d 0-30	T126L28	1	daily	No	-	-	-
Met-Fr	d 0-60	T127L31	51	monthly	Fix	1981-2005	monthly	11
SAWS	d 0-60	T42L19	6	monthly	Fix	1981-2001	monthly	6
HMCR	d 0-60	1.1x1.4 L28	10	weekly	Fix	1979-2003	monthly	10

Regional climate grand challenge

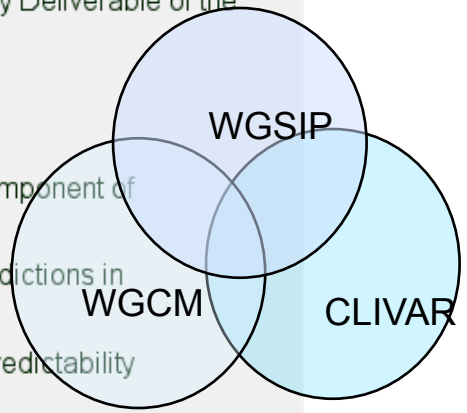
Frontier 2: Decadal variability, predictability and prediction. The Decadal Climate Prediction Panel (DCPP) promotes coordinated decadal prediction experimental set ups and informal near-real time exchange of multi-model forecasts. It also organises the decadal MIP.

Description of the DCPP. The DCPP is managed by WGSIP, WGCM and CLIVAR.

The term "decadal prediction" encompasses predictions on annual, multi-annual to decadal timescales. The possibility of making skilful forecasts on these timescales, and the ability to do so, is investigated by means of predictability studies and retrospective predictions (hindcasts) made using the current generation of climate models as well as by means of statistical approaches. Skilful decadal prediction of relevant climate parameters is a Key Deliverable of the WCRP's Grand Challenge of providing Regional Climate Information.

The DCPP envisions four components:

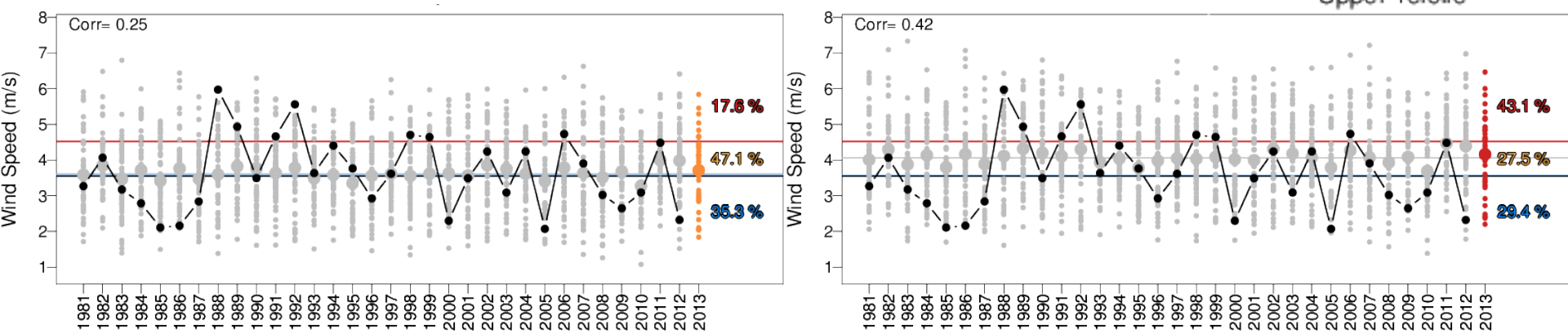
- ***Hindcasts***: the design and organization of a coordinated decadal prediction (hindcast) component of CMIP6 in conjunction with the seasonal prediction and climate modelling communities
- ***Forecasts***: the ongoing production of experimental quasi-operational decadal climate predictions in support of multi-model annual to decadal forecasting and the application of the forecasts
- ***Predictability and mechanisms***: the organization and coordination of decadal climate predictability studies including the study of the mechanisms that determine predictability
- ***Case studies***: the organization and coordination of case studies to investigate the ability to predict particular climate shifts and variations that have occurred and to identify the processes determining these behaviours



Regional climate grand challenge

Frontier 4: Definition of usefulness: informing the risk management and decision making space. Climate prediction institutions are working with a range of impact scientists, the industry and decision makers to provide actionable information. Climate predictions are considered as a tool for near-term climate adaptation. Bias correction, calibration and combination are key stages.

Bias correction and calibration have different effects. ECMWF System4 seasonal predictions of 10-metre wind speed over the North Sea for DJF starting in November. Bias corrected (simple scaling, left) and ensemble calibration (right). One-year-out cross-validation applied.



Need to develop links with other Grand Challenges

WCRP Organization