

WCRP Grand Challenges

GC concept (discussed at the JSC in October 2011) :

Identify critical areas of climate science where specific barriers are preventing progress and where targeted research efforts are likely to demonstrate significant progress over the next 5-10 years.

WCRP Grand Challenges :

1. Provision of Skilful Future Climate Information on Regional Scales (IS to seasonal to interannual prediction, decadal prediction, long-term regional climate information and polar climate predictability (CLIVAR, WGRC, SPARC)
2. Regional Sea-Level Rise (CLIVAR)
3. Cryosphere in a Changing Climate (CLIC)
4. Clouds and Climate Sensitivity (JSC 2012 -> WGCM)
5. Changes in Water Availability (GEWEX)
6. Prediction and Attribution of Extreme Events (GEWEX)

GC White Papers :

- Why is this a grand challenge ?
- Why is this area prime for progress ?
- Initiatives

White Paper on WCRP Grand Challenge #4

Clouds and Climate Sensitivity:

**Or how the interactions between clouds, greenhouse gases and aerosols
affect temperature and precipitation in a changing climate**

Sandrine Bony and Bjorn Stevens (WGCM)

with contributions from

Steve Klein (GASS), Kevin Trenberth (GEWEX)

Mark Webb (CFMIP), Masa Kageyama and Pascale Braconnot (PMIP)

Christian Jakob (WGNE), Teruyuki Nakajima, Hong Liao and Graciela B. Raga (JSC)

Sept 10, 2012

The Grand Challenge :

- Barrier 1 : Inability to constrain the effects of clouds on climate sensitivity estimates
- Barrier 2 : Lack of understanding of regional circulation and precipitation changes, especially over land
- Barrier 3 : Unreliable representation of the coupling between cloud processes and large-scale dynamics

Opportunities for rapid progress :

- **CMIP5 and other MIPs** (CFMIP, PMIP, Transpose AMIP, GeoMIP, AeroCom..)
- **Qualitatively new types of models** (LES/CRMs over large domains, super-parameterizations)
- **A golden age of Earth observations**
- **Lessons from experience** (physical understanding gained through a spectrum of approaches, often through highly idealized frameworks)
- **An interconnected research community**

Initiatives :

We propose to develop targeted research efforts around 5 initiatives.

I1 : Climate and Hydrological Sensitivity

Aim : design critical tests for climate models, whose application will help assess the most likely estimates of climate and hydrological sensitivity.

Focus : intensify on-going efforts to identify causes of inter-model differences in climate and hydrological sensitivity.

I2 : Leveraging the Past Record

Aim : targeting the exploitation of observations of the recent past, or proxies for changes over the more distant past, to improve understanding and assessment of climate sensitivity and precipitation projections

Focus : analysis of multi-decadal records of satellite and in-situ observations, improvement of paleo-climates reconstructions and syntheses, comparisons of past and future climate changes, facilitation of interactions between modelling and observations communities.

Initiatives :

I3 : Coupling Clouds to Circulations

Aim : tackle the parameterization problem through a better understanding the interaction between cloud/convective processes and large-scale dynamics,

Focus : interaction between diabatic heating and large-scale dynamics, dependence of cloud statistics on resolution, lessons from cloud-resolving modelling over large domains, analysis of new observations.

I4 : Changing Patterns

Aim : better anticipate how the large-scale atmospheric circulation will respond to anthropogenic forcing.

Focus : interactions cloud experts / large-scale dynamicists, CMIP5 analysis, understanding of the role of clouds and aerosols in circulation, understanding of local vs large-scale or remotely forced changes in driving regional changes, impact of model biases.

I5 : Reliable Models

Aim : improve models and understand how errors or shortcomings impact projections and predictions

Focus : identification and reduction of errors in the representation of cloud and radiative processes, assessment of how model errors or shortcomings (physics, resolution) translate into climate errors, including climate projections and predictions.

Strategy of coordination and integration :

- **GC led by WGCM, in close collaboration with GEWEX/GASS and WGNE.**
- **GC Joint Steering Committee to strengthen the coordination and integration** of the different initiatives, including representatives of the key groups involved and incorporating key expertise (climate, paleo, observations, processes, CRM, NWP..) First goal will be to associate each initiative with a clear goal and a person to lead it.
- **Many of the initiatives leverage on-going or planned WCRP projects.** Will make sure that workshops associated with these activities address the GC's goals.
- **Interaction with WMAC and WDAC**
- **First step will be to organize small-scale workshops to sharpen each initiative,** and then present the GC to the community through an article in high profile journals.

Feedback and Ideas Welcome !

- **WGCM will be involved in several GC, and will be responsible for one of them**
- **Great opportunity for WGCM :**
 - to highlight and integrate WGCM activities (CMIP, PMIP, CFMIP, OAGCM devt)
 - to strengthen or build new connections with partners (e.g. GASS, WGNE, WGSIP, AEROCOM..)
- **Make suggestions regarding :**
 - science (initiatives)
 - how to leverage on-going activities or projects
 - strategy of coordination