Plenary Session 2
Future planning: WCRP Implementation Plan

CORDEX Contributions to the Strategic Plan

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WCRP Strategic Plan Scientific Objectives

1. Fundamental understanding of the climate system, including variability and change as part of a coupled system, with emphases on dynamics and cycles

Possible research opportunities for CORDEX

- Investigate further the dynamics and cycles of the climate system at very fine scales

- Promote interdisciplinary approaches across Earth system components and their coupling to make the next leap in our understanding of regional climate.
  - Flagship Pilot Studies
  - Foster Earth System research in CORDEX

WCRP Strategic Plan Scientific Objectives

2. Prediction of the near-term evolution of the climate system and associated uncertainties with emphases on extremes and simulation capabilities

Possible research opportunities for CORDEX

- Explore downscaling potential of prediction on sub-seasonal, seasonal and decadal timescales.

WCRP Strategic Plan Scientific Objectives

3. Long-term response of the climate, quantifying the responses, feedbacks, and uncertainties intrinsic to the changing climate system with advanced simulation capabilities

Possible research opportunities for CORDEX

- Quantify long-term responses to coupled natural and human-induced forcings in RESMs

- Expand CMIP-CORDEX synergies;

- Enlarge simulation ensembles to include multiple sources of climate uncertainty across all regions.

WCRP Strategic Plan Scientific Objectives

4. **Bridging climate science and society, supporting innovation in the generation of decision-relevant information and knowledge about the evolving Earth system**

Possible research opportunities for CORDEX

- Pursue capacity building
- Promote development of useful regional climate information
- Promote user-inspired regional climate research

Critical infrastructures to support the Objectives

- Develop hierarchies of simulation tools

- Foster sustained observations and reference data sets

- Support open access principles

- Engage high end computing and data management

  – Exascale computing and Earth system hardware emulators;

  – Machine learning to distill information from simulations

  – CORDEX data on the Earth System Grid Federation;

  – Innovative approaches to data dissemination

Further challenges for CORDEX

- **Improving the reliability of the data provided for impact studies**
  - Improving our understanding of the climate change signal at the local/regional scale.

- **Improving the quality of the climate information involving more complex models, higher resolution and a multi-dimensional approach**

Further challenges for CORDEX

- **Coordinating**
  - **Smaller domains with finer resolution**
  - **Increasing resolution in GCMs & RCMs**

Smaller domains with finer resolution

Challenge

Coordinated simulations at convective permitting resolution (less than 4 km) in a ***multi-dimensional*** approach including different driving GCMs; RCPs, SSPs, RCMs and ESDs)

Questions

⇒ How can a common setup be defined to assure model ensembles for smaller *convection permitting resolution* domains?

⇒ How do we assure reliability with few simulations in some *convection permitting resolution domains?*

⇒ What are the common scientific challenges?

Suggestions

- CORDEX scientific challenges tackled in a community approach
  - Telescoping nested approach; coordination with HiResMIP
- Choice of domains
  - Scientifically interesting phenomena; Availability of high quality data; Relevance to other WCRP initiatives

Increasing complexity

Challenge

ESRCMs integrating various two-way coupled procesess. Additionally, is is envisioned to address the feedback of adaptation strategies on regional climates, e.g. LULCC (reforestation, BECCS, urban, etc).

Questions

⇒ Can we find a compromise resolution for ESRCMs so they can still produce coupled simulations over the standard CORDEX domains or should we aim at sub-domains ?

⇒ How may the regional climate change signal be modulated under future scenarios including changing GHG concentrations (RCPs) and LULCC (SSPs)?

Suggestions

- Regional CORDEX communities should discuss the possible compromises and see if it is still possible to produce simulations over the standard CORDEX domains or should be focused on specific regions.
    - CORDEX-MIP on ESRCMs exploring the regional response including a variety of coupled components to the RCMs.
- Preliminary exercises including the emerging RCP-SSP framework
- A protocol for developing a modelling strategy should be defined.

Increasing resolution

Challenge

GCMs are using resolutions of 25-50 km in HighResMIP for CMIP6, reaching the RCM scale. Some tests are done with global models at 1-km resolution for a few months. RCMs should then be nested in high resolution GCMs to allow for building a multi-dimensional matrix to include a wide range of uncertainty sources.

Questions

⇒ What resolution are GCMs expected to use in the next 5-10 years?

⇒ What are the RCMs aiming at?

⇒ How can we foster interaction between the modelling groups, learning from each other?

Suggestions

- Further development work is needed to improve model performance at high resolutions (higher than 4 km).
  - Looking further ahead, at ~100m resolution the PBL parameterization may be no longer required. A similar fundamental change in model behavior can occur.
- Overall, it is envisioned that RCMs will lead the simulations over several domains around the world at convective permitting scales, while GCMs will increase resolution but still serve as drivers of the convective permitting RCMs.

Exascale computing

Challenge

A new generation of high-performance computers are being established, using GPUs, specialized processors, etc. Models have to be adapted to this new development. These changes will also require new evaluation tools.

Questions

⇒ Are the RCMs ready for the new generation of high-performance computers?

⇒ How can the models be adapted?

⇒ How can this adaptation be done in a flexible, generic, hardware independent way?

Suggestions

- CORDEX can foster the exchange of information about technical aspects concerning the transformation of models to the new generation of high performance computers.

Data and Infrastructure

Challenge

Strong need for external funding to support the maintenance and growth of the storage capacity. Publication of simulations on the ESGF by all domains needs to be ensured, as this will greatly facilitate scientific analysis and exploitation by end-users (climate services, VIA, NAPs, etc).

Questions

⇒ Will the ESGF remain the home of the standard CORDEX projection data?

⇒ Where will data from FPSs be stored and how will access be made open?

⇒ What new tools are needed to analyse the data as it continues to expand in size?

Suggestions

• CORDEX should foster the creation of tools to simplify data access and facilitate data analysis. It is also suggested to provide documentation on how to access and use the data and to provide a guidance on the CORDEX web page.