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"Water for the Food Baskets of the World" Grand Challenge Report

1. Highlights for JSC

This Grand Challenge made some significant progress in July 2017 thanks to a visit of Jan Polcher to Roy Rasumssen's lab. This allowed us to refine the planning and structure of the Grand Challenge.

One of the outcome of that visit was to propose to divide the Grand Challenge (GC) into two complementary research activities which will need to be supported and encouraged in order to help WCRP bring answers to stakeholders and help society adapt to climate change. The first activity is to enhance observations of the interactions between the water cycle, its management for agricultural production and climate. The objective is to better monitor the processes at play in these complex interactions. This is typically a regional activity because of the strong difference in socio-economic structures which govern water usage and management but relies heavily on the knowledge of the global climate available from WCRP. This observational and process based approach builds on the GEWEX Hydroclimate Panel and its current and future Regional Hydroclimate Programs (RHP).

The second activity will be more novel and aims at building within WCRP the capacity to model and predict the interactions between the human management of water resources and the processes in the lower atmosphere and coastal ocean. The objective is to ensure that in the future, the models use by the WCRP community can predict a credible evolution of a managed water cycle under climate change. This activity will build on the tradition of process oriented model inter-comparison exercises which have generated model innovations in the past.

Observations:

The current generation of RHPs have directly taken into account in their design the interactions between the water cycle and socio-economic structures and processes in place for the management of the resources. Below the current RHPs are briefly presented and in particular how they take into account anthropogenic influences on the continental branch of the water cycle. Through their detailed observation and analyses of the water cycle processes, they contribute directly to the objectives of this Grand Challenge.

The following current and developing RHPs fit very well these objectives :

- HyMex : irrigation is a major challenge and will be the object of a dedicated field campaign in 2020 : LIAISE
- Global Water Futures (CCRN follow-on) : Land management and its impact of cold processes : snow melt and runoff generation.
- BalticEarth : agriculture's impact on nutrients flow to the ocean.
- PannEx : water management's impact on ground water.
- A U.S. centric RHP: water and water management in the western U.S.

- ANDEX: High mountains change under climate change and its effects on water resources, agriculture and infrastructure.

Modelling :

The last 50 years have seen the industrialization of agronomy and thus large scale human modifications to the partitioning of energy at the surface by favoring evaporation and the related gross primary production of the biosphere. To what extent has this change of the surface interacted with the climate ? Has it changed the structure of the atmosphere close to the surface ? Has it modified the response of the surface to extreme weather events ?
The aim is to analyze these processes by running, over the period of agronomy industrialization some of the large food baskets of the world, using Convection-Permitting regional climate models (CP-RCM) coupled to land surface models (LSM) which include the evolution of agricultural and water management practices. This should provide a more realistic re-construction of the climate of the last century while enabling us to dissect the impacts of the changes that humans have made to their environment.

In the food baskets of the world, the standard procedure for analyzing climate change consequences is by downscaling global simulations to drive impact models. This is probably limiting our understanding as it neglects the strong interactions between human land & water management and climate variability and change. Thus, this proposed activity of the Grand Challenge will help us better understand how climate change will impact the food baskets of the world and which methodologies are best suited to predict the future agronomic potential of these regions. It will increase our confidence in the predicted water resources in these areas that are critical to our societies in a warmer climate.

Expected outcome :

We would call this GC a success if more than one of these possible outcomes occur:

- Land surface models include water management at least at the level of complexity equivalent to what is found in today's global hydrological models.
- We better understand the impact of irrigation on the atmosphere and the continental water cycle.
- Weather forecast models would consider it important to include irrigation and water management to improve their forecasts.
- The community moves to a vision of the continental water cycle which goes from the bed rock to the atmosphere, linking it with the oceans and including water management.
- The "water for food baskets" is used as an "umbrella theme" to support new WCRP based research activities.

Other activities :

In an effort to obtain support for the Regional Hydroclimate Projects we presented GEWEX and the GC to regional development banks and the World Bank. These institutions have to see GEWEX and WCRP as honest brokers for their needs in climate and water cycle information and should involve the RHP communities when they need advice on climate change and its interaction with natural resources.

2. Early success and/or planned activities in 2018/2019

3. Partners for GC implementation (within and outside WCRP community)

The following collaborations will be needed for this GC :

- GHP/GEWEX : Key partner for the process studies within this GC
- CORDEX : Could be a partner for the modelling project within this GC.
- CLIVAR : Interactions with the coastal oceans.
- Engage the hydrological community and in particular the Commission for Hydrology of WMO the the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSHI).
- iLEAPS and FutureEarth

4.Overall GC timeline (include any milestones)

In the coming 12 month two actions are planned :

- Encourage RHPs to clearly identify the on-going and planned actions which will contribute to better understanding the human control of the water cycle.
- Identify a region over which the first CP-RCM simulations could be done to study the interactions of climate fluctuations and water management.
- Develop an science and implementation plan for ANDEX

The outcome of these two actions will allow to judge the readiness of the community and allow us to envisage more ambitious activities.

5. Issues and challenges

The challenge for this GC will be to engage the community and ensure that groups are willing to invest in model development and observational campaigns to make water management part of their expertise.