Water Availability Grand Challenge for North America Workshop

Christopher L. Castro
Associate Professor
Department of Hydrology and Atmospheric Sciences
University of Arizona

Water-related limitations in process-understanding, modeling, monitoring

Process understanding

- **Impact of atmospheric aerosols on precipitation**, in terms of first-order (radiative) and second order (cloud-drop nucleation) effects. How these both impact convective precipitation is especially not well known.
- **Dynamic processes that lead to extreme precipitation, drought** on a variety of spatiotemporal scales (e.g. atmospheric rivers, teleconnection patterns, synoptic transients)

Monitoring

- Generally speaking, **higher spatiotemporal resolution observed information to better characterize weather and climate extremes**. **A particular problem in complex terrain** because alpine water sheds important source of snowpack and mountains are convective initiation point. A great lack of information on this outside of the United States (e.g. Mexico, Central America)
- How can **emerging observing systems** help to better characterize precipitation and the water cycle in such places? (e.g. GPS water vapor measurements, lightning)

Modeling

- **Meso-γ scale (less than 5km), to explicitly resolve convective processes and orographically-forced precipitation (i.e. snowfall)**. Need to ascertain the value of such modeling added in terms of physical process metrics (e.g. organized convection) and statistical characterization of precipitation extremes, against existing, more statistical downscaling-type approaches.
- **Conclusively demonstrating the value added of of meso-γ multi-model ensemble modeling approaches in climate forecasts and projections,** for example, in the area sub-seasonal to seasonal forecasting is urgently needed but will require a coordinated community effort (e.g. like MRED, NARCCAP).
- Hydrologic and land surface modeling approaches (e.g. WRF-Hydro, NOAH-MP) that can **have more explicit treatments horizontal transports of water, dynamic vegetation, groundwater, and anthropogenic components (urbanization, irrigation)**. Impacts of two-way interaction at convective permitting scales is unknown.
- **Two-way coupling to dynamic ocean models** may be important for more accurate climatological representation of precipitation, especially in the IntraAmericas seas region (Mexico, Caribbean, Central America).
- **Bin-microphysical parameterization coupled to interactive chemistry** (e.g. WRF-CHEM) investigate the aerosol-precipitation question.

Key objectives, tasks, resultant benefits

Key objectives, tasks

- **Form coordinated teams of groups** to investigate modeling, observational challenges in a way that emphasizes multi-model ensemble modeling, so as to address questions of both statistical and physical confidence. Should address challenges of resourcing to produce and analyze very large amounts of data (computation + labor).
- Can we collectively **identify the most urgent research gaps** in our processed-based physical understanding?
- Ascertain from stakeholder agencies what their **most critical resource needs** are.
- **Engage with relevant federal agencies** to develop white paper(s) and/or highly visible articles that may inform new research initiatives.
- Identify what new observations needed and/or how existing ones can be better used.

Resultant benefits

- More physically confident forecasts and projections of the hydroclimate.
- Better characterization and projection of hydroclimate extremes.
- Produce information at a spatial scale more relevant to decision making and impacts assessment.