High Latitude Breakout Session Summary Report

The High Latitude topical breakout session was organized around 3 strawman Grand Challenges. Each discussion block started with a series of 2-minute flash talks that were selected from the submitted abstracts. The session was well attended, and the participants were very engaged in the discussion.

Grand Challenge 1

The first part of the session focused on "Identifying a hierarchy of high-latitude multiscale and non-linear interactions critical to polar warming, and to the occurrence of extreme and threshold events in the Arctic and Antarctic" (Grand Challenge 1).

It was noted that identifying these interactions is important, but that understanding and predicting them may even be more challenging and critical.

The sparsity of observations was mentioned time and time again as a barrier to making progress. Processes with minimal observations that were mentioned were under-ice algae blooms and primary production in general, the ocean, waves in the marginal ice zone, riverine fluxes, and as a general feature, fluxes between Earth system components, instead of just state variables. Also, the availability and accessibility of existing observations was mentioned as a barrier, as was the sparsity of observations from the Siberian side.

In fact, with rapidly disappearing Arctic summer sea ice, we may only have ~20 years left to collect observations before tipping points begin to cascade. It was emphasized that more opportunities for observationalists and modelers to meet and discuss mutual needs would be beneficial. Models might help inform where observations might be most impactful. NGEE-Arctic is a good example of a project that integrates modeling and observational elements. Also, more interaction and joint funding opportunities with NOAA and NASA would be beneficial. Would a MODEX approach across several agencies work? IARPC may be a good platform for initiating such discussions. The Arctic Observing Initiative (https://arctic.noaa.gov/research/united-states-arctic-observing-network/??) is standing up panels for specific sets of observations to benefit everyone from locals to climate modelers.

The importance of natural variability was mentioned as a source of extreme events, and as potentially interacting with tipping elements, making the system more vulnerable. As an example, teleconnections from the tropics play an important role in extreme events at high latitudes, and may help detsbailize Antarctic ice sheets.

We also spent some time discussing the definition of a tipping point, regime shifts, and how to detect them. As an example, we know that there is nonlinear behavior in sea ice cover, and some studies claim that this may lead to irreversible change; however we can reverse this effect in our models. So it may be better to define threshold on a case-by-case basis. Time scales might be useful in the definition, as well as (ir)reversability. Testing if a climate switch is reversible needs a large number of simulations, and we must consider longer range of timescales and structural/parameteric choices to have confidence in rare event simulation.

Permafrost degradation was discussed as a critical process, with global impacts through methane and CO2 release (a potential tipping element), as well as regional impacts on infrastructure. But this is poorly represented in ESMs (including E3SM). Other critical processes that were discussed were Interactions of mesoscale eddies and Antarctic shelf front in a changing climate, under-ice algae bloom, which will disappear in an ice-free Arctic,

Grand Challenge 2

The second part of the session focused on “combining demonstrated critical processes in an Earth system model to simulate polar warming with global feedbacks on decadal to centennial timescales in a computationally feasible manner” (Grand Challenge 2).

This segment started with a discussion of the scope of the Grand Challenge, and there were many challenges to the current formulation that will be addressed when developing the white paper. How to determine whether a process is critical? What does computationally feasible mean (single ‘hero’ run, ensemble) and is that a moving target? What is the specific science question that is addressed? Should we explicitly call out ‘impacts’?

Some critical processes that were discussed were planetary albedo, ice sheets and sea level rise, permafrost methane sinks and ocean sink feedbacks, and thermohaline circulation and deep water formation.

The discussion then emphasized that the DOE has exceptional strengths in this area, including its variable resolution model capabilities that can resolve clouds and ocean eddies; the explicit coupling with ice sheets; tides and solid-Earth interactions; marine and sea ice bgc, including the benthos; dust, DMS and clouds.

Challenges are to explicitly include human feedbacks into Earth system models, hence removing the need for emission scenarios, but this is still in its infancy. Other challenges are to reduce the long spin-up time of several model components, including the ocean firn, and ice sheet dynamics. Machine learning techniques may be helpful here, as well as reduced-order models.

It was recommended that the GC should at least include some metrics of success for simulating polar warming. Comparison of historical simulations with the observed record would be a good way to demonstrate both the importance of ‘critical processes’, as well as their successful representation in the Earth System Models (ESMs). Improvements could be demonstrated with the use of various benchmarking packages developed by the RGMA program, and this record of improvements would help build confidence in future projections.

Grand Challenge 3

The final section of this session focused on “identifying societal impacts of high-latitude Earth system change that are relevant to different groups of stakeholders, and how to make this information actionable to stakeholders” (Grand Challenge 3).

The discussion started examining the question which stakeholders are we talking about? Different stakeholders have different needs. Should this GC be limited to humans in the Arctic, or globally? Arctic change has implications for people worldwide, including sea level rise from melting ice sheets, pathogens being released from permafrost, and the pollution and economic impacts of changes in shipping patterns.

While DOE interests and capabilities in high-latitude science are well established, the participants expressed an interest to learn more about the Arctic interests of other agencies, including defense and intelligence, as well their support for Arctic research. It was suggested that a workshop could be helpful to expose such interests and provide opportunities for cross-agency collaborations.

The discussion turned towards what certainty do stakeholders need to take action. It was pointed out that people are capable of making decisions with uncertainty –they do that all the time; so the challenge is for us to understand the decision making process of stakeholders, and to deliver information that is most relevant, in the most effective way. This information should convey the uncertainty in the information and moderate stakeholders’ expectations of what is scientifically possible to simulate.

The discussion also touched briefly on geo-engineering, and the fact that studies are necessary to investigate the wanted and unwanted consequences of proposed approaches.

The session concluded with the perspective that high-latitude communities are dominantly rural. A focus on the human dimension of high-latitude change provides an opportunity to understand rural interests, and as such is complementary to many other focus areas that emphasize urban interests.