High-Latitude Processes and Feedbacks Breakout

Discussion Slides

High-Latitude Processes and Feedbacks Breakout

- Please use Slack: High-Latitudes for discussions
- Charge: Provide input for White Paper
  - Identify knowledge gaps in High-Latitude Processes and Feedbacks
  - Identify short-term (3-5 yr) and long-term (10 yr) goals
- We will break out in two groups
  - High/low-latitude linkages (Gudrun)
  - High-latitude processes (Wieslaw)
- Please rename yourself:
  - 1_Name: if you want to stay in High/low-latitude linkages
  - 2_Name: if you want to go to High-latitude processes
- We will reconvene after break
  - Report outs from the two sub-breakouts
  - Discuss knowledge gaps, research goals

White Paper

- Started as part of 2018 PI Meeting
  - Gudrun, Hailong, Wilbert were responsible for High-Latitudes section
- Section was largely based on 2017 High-Latitudes White Paper
  - By Wieslaw, Wilbert, and Phil Rasch
  - Result from 2016 PI meeting
- We have the chance to update the document
  - Inform the direction of High-Latitudes research in RGMA

Current Structure

- Introduction and Grand Challenge
- Description of Challenges and Current Research in RGMA
- Gaps in Current Research
- Future Directions
  - Short-term Research Goals (3-5 yr)
  - Long-term Research Goals (10 yr)

Grand Challenge Question

What are the roles of regional processes and feedbacks, atmospheric and oceanic coupling to lower latitudes, in shaping the high-latitude Earth system, its variability and trends and what are the consequences of high-latitude climate change for the regional and global carbon cycle and sea level rise?

Short-Term Research Goals (3-5 yr) (1/2)

- **High/low-latitude linkages**
  - What is the role of decadal to multidecadal climate patterns such as the IPV and AMV in forcing polar amplification? What is the role of remote SST warming compared to local feedback processes in polar amplification?
  - Investigate the climate response to changes in meridional ocean heat fluxes and ocean heat uptake, using fully-coupled models.
  - Study the influence of sea-ice loss on mid-latitude weather and climate, using machine learning and system identification techniques, and water tagging methods.
- **Regional Ocean/sea ice/atmosphere processes and feedbacks**
  - Study the influence of sea-ice loss on local heat and moisture fluxes, and subsequent impacts on clouds and precipitation.
  - Evaluate new or improved parameterizations of momentum and radiation transfer within and between atmosphere and ocean in presence/absence of sea-ice and melt ponds.
  - Explore the role of mesoscale processes (e.g. sea-ice deformations, mesoscale ocean eddies) in high-latitude climate processes and feedbacks, by using high-resolution regional and global models.

Short-Term Research Goals (3-5 yr) (2/2)

- **Terrestrial hydrology, ice sheets, coastal impacts**
  - Study the spatio-temporal characteristics of Arctic deltas, using satellite observations and numerical modeling.
  - Investigate freshwater (river runoff and glacier meltwater) pathways from coast to the shelf and to the deep ocean in order to estimate time scales and influence of freshwater spreading on thermohaline processes in the ocean, using high-resolution coupled ocean-ice models.
- **Ecosystems, BGC**
  - Study the impact of glacial and fluvial inputs of freshwater and nutrients on high-latitude marine ecosystems, and the consequences for marine aerosol emissions and clouds in a fully-coupled climate system model.
  - Investigate changes in marine ecosystem productivity on seasonal to multidecadal time scales.
  - Study the effects of expected changes in precipitation on biogeochemical cycles and interactions with climate.
  - Analyze the roles of high-latitude vegetation changes on surface energy budgets, carbon dynamics and greenhouse gas emissions, and interactions with regional and global atmospheric responses.
  - Study the environmental controls on the surface organic layer in the boreal Arctic system, its spatial heterogeneity, and its role in regulating active-layer thickness and permafrost dynamics.
- **Ice sheets**
  - Explore ice-sheet/climate interactions using climate models with partly and fully interactive ice sheets.
  - Project sea level rise from the Greenland Ice Sheet, as part of the ISMIP6 project.

Long Term Research Goals (10 yr) (1/2)

- **Ocean/sea ice/atmosphere processes, interactions, and feedbacks**
  - Quantify process interactions and feedbacks between cryosphere, ocean, land and atmosphere, and identify the distinctive feedbacks operating in the Arctic and Antarctic;
- **Ecosystem processes and feedbacks**
  - Explore terrestrial and marine ecosystems responses to HLES change, and potential feedbacks on other components of the climate system
  - Quantify regional carbon sinks and sources in the high-latitude regions and their potential changes in a warmer planet.
  - Enhance understanding of high-latitude terrestrial and marine ecosystems and their impact on the carbon cycle.
- **High-Latitude response to external forcing**
  - Quantify high-latitude climate responses to exogenous (external) factors, e.g., aerosols, in the presence of natural variability.
  - Mid- and low-latitude atmosphere-ocean effects on the high-latitude climate systems.

Long Term Research Goals (10 yr) (2/2)

- **Lower-latitude impacts of high-latitude change**
  - High-latitude effects on mid-latitude weather and climate; specifically, how do polar changes in sea ice cover affect the local and remote atmospheric circulation?
  - Do polar changes impact the frequency, intensity and duration of extreme weather events in midlatitudes?
  - What is the role of the stratosphere and forcing of anomalous planetary waves in communicating the response to midlatitudes?
  - High-latitude effects on the ocean's wind-driven and meridional overturning circulation, and their implications for global climate (e.g. shifts in ITCZ precipitation).
- **Ice sheet processes and feedbacks**
  - Use ice sheet models partly or fully coupled to other Earth system components to:
  - Better understand the dynamics of ice sheets, glaciers, and ice shelves, and their response to external drivers;
  - Improve prediction of land ice mass loss and its impact on global sea level rise.