Breakout notes: High/low-latitude linkages

Notes by Yannick Peings

Gudrun Magnusdottir (*How does the atmospheric response to sea-ice decline compare to the full effect of Arctic Amplification?*): Vertical extent of Arctic warming is key to induce a cooling over Siberia. Sea ice loss is only one component of Arctic Amplification, prescribing Arctic Amplification through nudging induces deeper warming and stronger cooling over Siberia in winter. Paper published in GRL.

Yannick Peings (*Are 100 ensemble members enough to capture the remote atmospheric response to +2°C Arctic sea ice loss?*): Ocean-atmosphere coupling increases the response to Arctic sea ice loss. There is a large influence of internal variability in the results (or inconsistency in the response), especially in the regional responses, even when 100 members and more are run. Common classical tests are not sufficient to identify the truly robust (i.e., reproducible) anomalies. Need help with processing and sharing the E3SM data on ESGF. Paper in revision in Journal of Climate.

Tien-Yiao Hsu (*Understanding the role of ocean-atmosphere interactions on the response of large-scale climate to the loss of Arctic sea-ice using a hierarchy of simplified ocean models*): Arctic sea ice loss experiments using a slab ocean model induce an exaggerated ITCZ shift in the Northern Hemisphere. Develop a hierarchy of simplified ocean models to include Ekman and entrainment in SOM (Ekman Mixed-Layer Model). None of the simplified ocean models can reproduce the response of the Hadley cell, because the AMOC (ocean dynamics) is key. AMOC decreases in response to sea ice loss. AMOC has to be realistic to capture the correct response to sea ice loss. Less important for the response to Antarctic sea ice loss.

Alexandre Audette (*Opposite responses of the dry and moist eddy heat transport into the Arctic in the PAMIP experiments*): in a set of PAMIP runs, including E3SM, sea ice loss decreases the Moist Static Energy (MSE) gradient, while global SST warming increases the MSE gradient. Sea ice loss warms the equatorward branch of the energy transport circulation, SST warming drives strong poleward mass fluxes. Paper in revision in GRL.

Robert Fajber (*Latent Heating and Large Scale Transport Cause Arctic Amplification in a Model without Sea Ice*): polar amplification happens in aquaplanet models that do not have sea ice. It shows ice/albedo feedback is only one component of polar amplification. Slab-ocean runs, aquaplanet with simplified parametrized physics.Passive tracers (heat tags) allow to decompose the potential temperature field in different processes (convection, conduction, radiation , diffusion). Heat tags extend far beyond their region of origin. ⅔ of polar amplification is linked to latent heating outside the Arctic. Under CO2 doubling, heat tags from latent heating increase.

The warm air is transported to the poles to cool, and this causes Arctic Amplification. Manuscript submitted to JAS.

Theresa Morrison (*Transport of Heat Across the Greenland Continental Shelf by Winds and Eddies in High-Resolution Ocean-Sea Ice Simulations*): Ocean heat transport around Greenland. High resolution ocean runs. Heat transport is stronger over the Southeast continental shelf. Wind events influence volume transport. Eddies generated at the Denmark strait interrupt the transport of warm water across the shelf break. Ongoing experiments include freshwater flux from the Greenland ice sheet. It will be interesting to see how freshwater impacts stratification in the subpolar gyre.

Oluwayemi Garuba (*The role of oceanic and atmospheric feedbacks in the response of the Atlantic Meridional Overturning Circulation to a CO2 increase*): role of oceanic and atmospheric feedbacks in the response of AMOC to a CO2 increase. These feedbacks are key to whether the AMOC would increase or shut down. When AMOC changes, the temperature feedback stabilizes the AMOC, salinity destabilizes. What's the role of surface flux, atmospheric feedbacks ? Passive tracer decomposition to isolate the impacts of atmospheric versus advective feedbacks. Partial coupled runs to suppress atmospheric feedbacks. Atmospheric feedbacks destabilizes the AMOC, while oceanic feedbacks stabilizes it.

Wilbert Weijer (*CMIP6 Models Predict Significant 21st Century Decline of the Atlantic Meridional Overturning Circulation*): the AMOC in CMIP6 models (GRL paper). AMOC in 27 historical runs is compared with RAPID/SAMBA arrays. 18 models for future scenarios. CMIP6 multi-model mean is relatively in line with observations, but very large spread. E3SM has the weakest AMOC. No difference in the model response to different SSP scenarios until 2060 -> most of the 21st century AMOC decline is already committed. Link between Effective Climate Sensitivity (ECS) and AMOC : low ECS<-> strong AMOC, and conversely. Also a link with the AMOC trend over the historical period (low ECS <-> negative AMOC trend).

Jiaxu Zhang (*Labrador Sea freshening linked to the Beaufort Gyre freshwater release*): Labrador sea freshening linked to Beaufort Gyre freshwater release (Nature Communications paper). Since early 2000's, increase in Beaufort Gyre freshwater content. Could be transported in subpolar North Atlantic and perturb AMOC. Ocean-ice hindcast simulation with DOE HiLAT03, global model at 0.3deg resolution. Freshwater preferably flows in the North Atlantic through Davis Strait, dominated by freshwater from the Beaufort gyre. Freshening most pronounced in Labrador sea. Compared to Greenland meltwater, Beaufort Gyre flux has comparable magnitude.

Milena Veneziani (*An evaluation of the E3SM-Arctic Ocean/Sea Ice Regionally Refined Model*): evaluation of the E3SM-Arctic ocean/sea ice regionally refined model. Resolution varies from 60km to 10km in the Arctic. Forced with JRA55. Net volume, heat freshwater transports generally well represented with respect to available observations. Good exchanges through Arctic gateways, freshwater content variability, and sea ice extent/volume. Improvements needed for Arctic stratification, mean sea ice thickness and AMOC strength.

Next step will be fully coupled simulations. RRMs are advantageous in terms of cost to reproduce certain features, but some biases remain with higher resolution, and where to increase resolution is sometimes unclear.

Balu Nadiga (*Using Machine Learning to Explore Teleconnections from Lower Latitudes to the Arctic*): exploring Arctic-extratropics connections using ML-based predictive models. 6-hourly JRA55 reanalysis. Teleconnection between geopotential height, specific humidity, 850 mb temperature averaged over different regions. Arctic warming is partitioned between local and remote components (skill global, skill local, skill local with specified external forcings). Highlights the role for remote forcing of Arctic warming. Needs a lot of data, exploring techniques for performance with limited data. Area fertile for collaborations across various RGMA projects.