Robust Spatial and Seasonal Changes to the Coupled Arctic Energy Budget in a Large Ensemble

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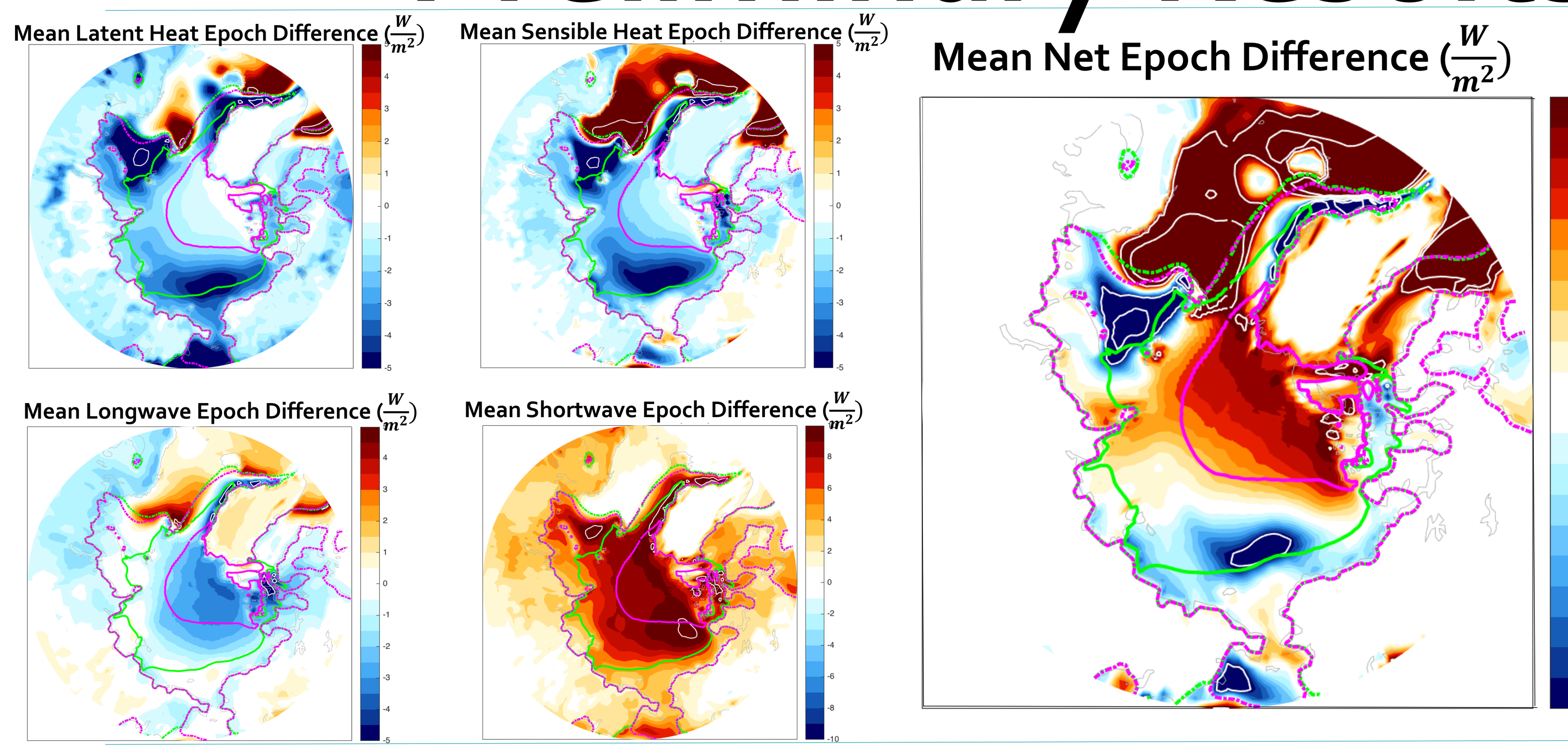
Preliminary Conclusions

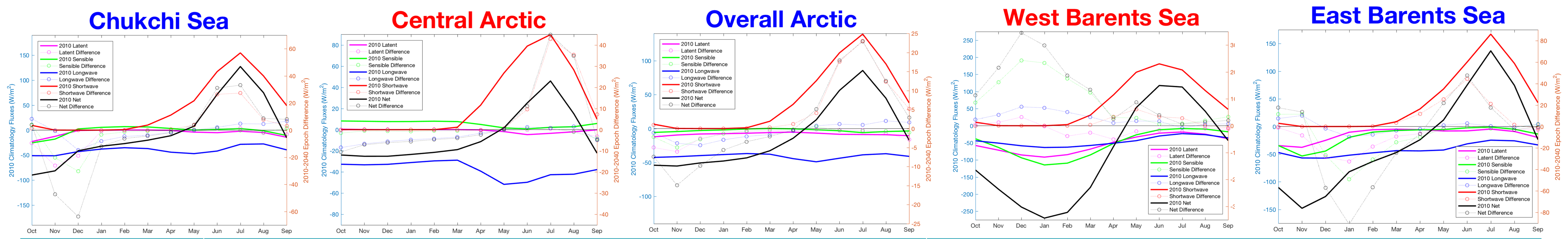
- A seasonal and spatial perspective is essential to understand the energy balance of the Arctic.
- A one-dimensional energy balance of the Arctic can document and identify locations/seasons where a fully three-dimensional perspective is necessary.

Preliminary Results



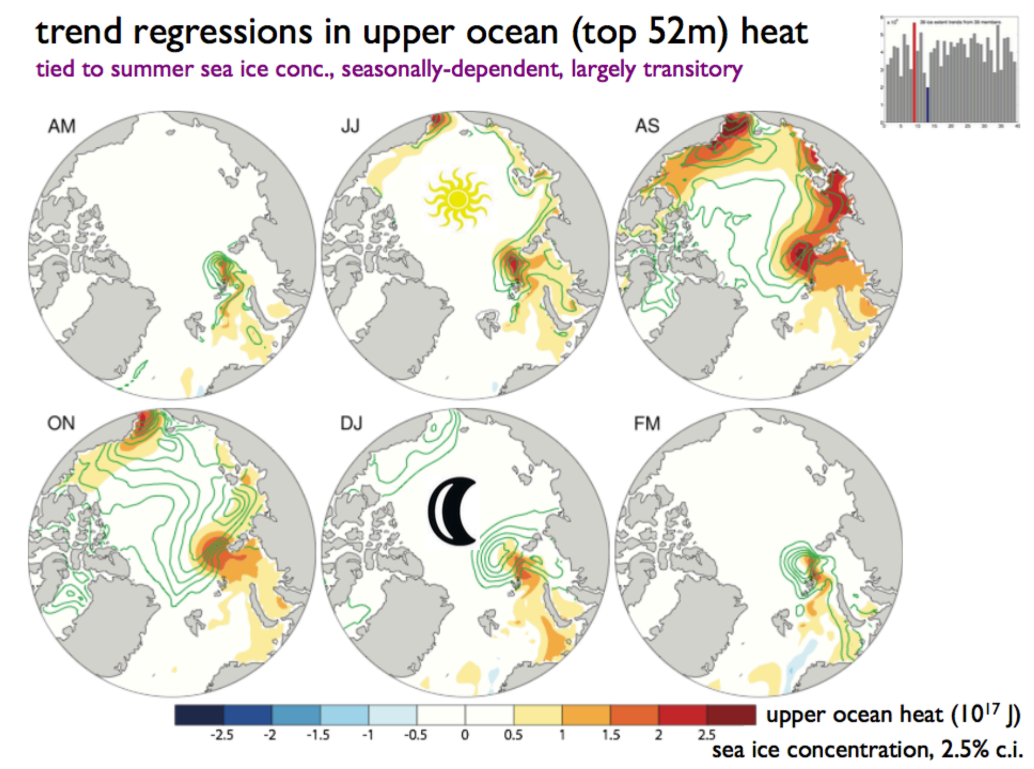
The 2010-2040 epoch differences for the radiative forcings. Positive (negative) is treated as energy entering (leaving) the surface.

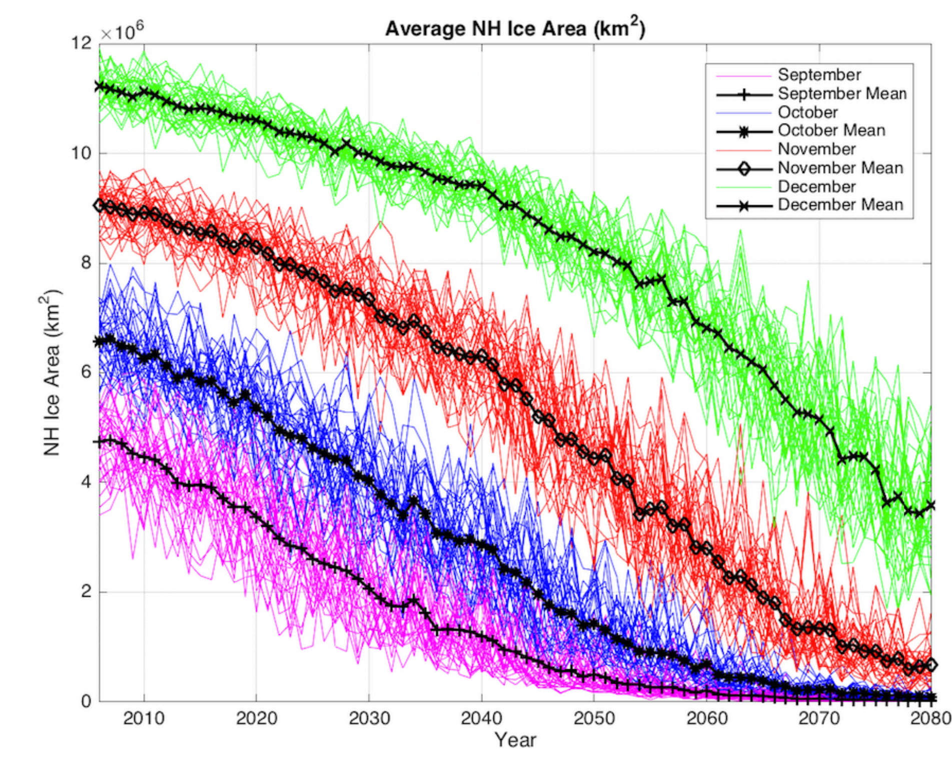
- Dotted green = sea ice maximum in 2010
- Solid green = sea ice minimum in 2010
- Dotted pink = sea ice maximum in 2040
- Solid pink = sea ice minimum in 2040



Region	Fluxes for Climatology	Alterations in Fluxes
Chukchi Sea	Longwave emission is the strongest cooling factor and is fairly stable throughout the year. Sensible and latent heat also contribute to release of energy during the winter but are negligible throughout the rest of the year.	Sensible & latent heat are projected to ramp up energy loss as the Chukchi Sea becomes ice-free in the summer during the 2010-2040 time period. Massive amount of energy loss during winter by 2040.
Central Arctic	Shortwave and longwave dominant in this region. Longwave emission actually enhances during same time period of increased shortwave absorption during the summer. Minor role of sensible intake during winter months, latent release during summer.	Incredibly large increase in the amount of shortwave absorption during the summer as sea ice in the area is lost. More gradual longwave emission during winter months. Slight decrease in sensible intake, minor increase in latent emission.
Overall Arctic	Longwave emission is dominant, but sensible and latent release also play a role in cooling the Arctic as a whole.	Loss of sea ice leads to more shortwave absorption. Latent and sensible heat become larger contributors in cooling. Longwave emission also increases during winter, but actually decreases slightly during the summer.
West Barents Sea	Latent and sensible dominant winter cooling with longwave also playing a large role.	The amount of energy lost due to sensible heat greatly decreases, while the amount of outgoing longwave and latent heat also slightly declines.
East Barents Sea	Longwave dominants but sensible and latent also play important roles in cooling throughout the year.	Sensible heat and latent heat release greatly increase by 2040. Little to no variation in longwave emission.

Background & Motivation





Loss of sea ice will lead to alterations in the high-latitude energy budget and its component fluxes. This study has two primary goals:

1). Determine how well we understand the one-dimensional energy budget over the central Arctic and how it will be altered due to climate change.

2). Determine whether, as a whole, the coupled ocean-atmosphere-sea ice in the Arctic is mostly isolated or strongly influenced by advection.

Data & Methods

A thirty-three member ensemble of the fully-coupled Community Earth System Model-Community Atmosphere Model, version 5 was used to evaluate the seasonal cycle of long-term epoch differences in various radiative, thermodynamic, and advective processes. Epoch differencing between 2038-2042 – 2008-2012 was used to explore the interval of most rapid change in the coupled Arctic system.

References

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