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MULTI-DECADAL VARIABILITY IN THE ARCTIC

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The meridional transport of heat through both the atmosphere and ocean is a fundamental component in maintaining the Earth's climate. Jacob Bjerknes proposed that the total energy transported by the climate system should remain approximately constant if the ocean heat storage and fluxes at the top-of-the-atmosphere were unchanging [Bjerknes, 1964]. Since heat is transported by the atmosphere and ocean, any large anomalies in the atmospheric heat transport should be balanced by opposing variations in the ocean heat transport, and vice versa; a process that has since been named Bjerknes Compensation.

Bjerknes compensation has been identified in the 600 year control run of the Bergen Climate Model by examining the anomalies of the implied meridional heat transports in both the ocean and atmosphere (Figure 1). These anomalies show strong anti-correlation ($r=-0.72$, $p \leq 0.05$), and a multi-decadal variability with a period of approximately 60-80 years. Spatial patterns associated with this multi-decadal variability highlight part of the underlying mechanism which occurs through changes in the sea-ice cover resulting in strong ocean-atmosphere fluxes and the formation of a thermal low that changes the large scale flow over the Northern Hemisphere. The anomalies in atmospheric heat transport are not only found to be well correlated to the anomalies in Arctic sea-ice, but also to the strength of the sub-polar gyre, suggesting a possible feedback of the atmosphere to the ocean on multi-decadal timescales.

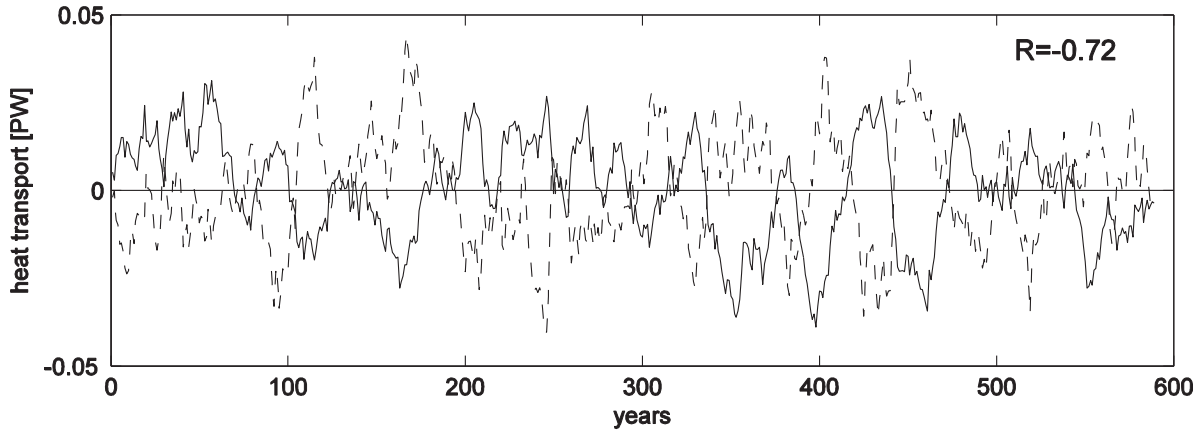

Figure 1: Meridional heat transport anomalies at 67N in the atmosphere (solid) and ocean (dashed), for the 600 year control run of the Bergen Climate Model. An 11-year running mean has been applied to highlight multi-decadal signals. The anomalies have a correlation of $r=-0.72$, $p \leq 0.05$.