Group 1 – Basic Science Questions on Mechanisms

1) Internal vs. External
   - Definition depends on our point of view
   - External: Aerosols, GHG, Volcanic, solar cycle, initial conditions
   - Internal: Natural variability on all time scales, known modes of "low frequency" variability (NAO/AO, PDO, MJO, …)
   - Example: Mid-latitude weather prediction (e.g. Cold air outbreaks). What are external forcings?

     Answer: Sea ice loss, or changes in snow.
   - E.g. Extremes -> forcing may change

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2) What is the starting point questions

A. What caused the loss of sea ice? GHC?

- Ice-Albedo feedback (details…)
- Atmospheric moisture (heat) transport from lower latitudes.
- Ocean heat transport, and advection of sea ice out of the central basin (and new ice forming behind). Ocean upwelling and double diffusion can also bring warm Atlantic water heat up.

B. What is the response to this loss?

- Meridional temperature gradient changes global circulation, through changes in the strength and position of jet streams, and might change the waviness (define).
- Heat loss from ocean to atmosphere through cracks in ice.
- Sea ice loss is geographically removed from areas of the jets.
- Heating of the Arctic creates Rossby waves which propagate vertically and presumably equatorward.
- Low level heat source (in the Arctic) should propagate a signal up into the stratosphere, and eventually down to mid-latitudes.

If we start with the mid-latitude anomalies, we can use Fluctuation Dissipation analysis (Branstanter) may help us find forcing and response.

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Null Hypothesis: Warming of the Arctic does not affect mid-latitude weather.

3) Increasing Sample Size

- Paleodata from early – mid-Holocene show Arctic warming, but stable tropics. Data from temperature, and precip from ice/lake/ocean cores.
- Focus on weather scale, i.e. studying short time scales gives is much more data (e.g. Feldstein, 2000).
- Look at the warming of the 1940s, which gives us another period of study. Use the 20th Century Reanalyses, and Walsh et al. 2017.