

# Relative importance of the tropics, internal variability, and Arctic amplification on mid-latitude climate and weather

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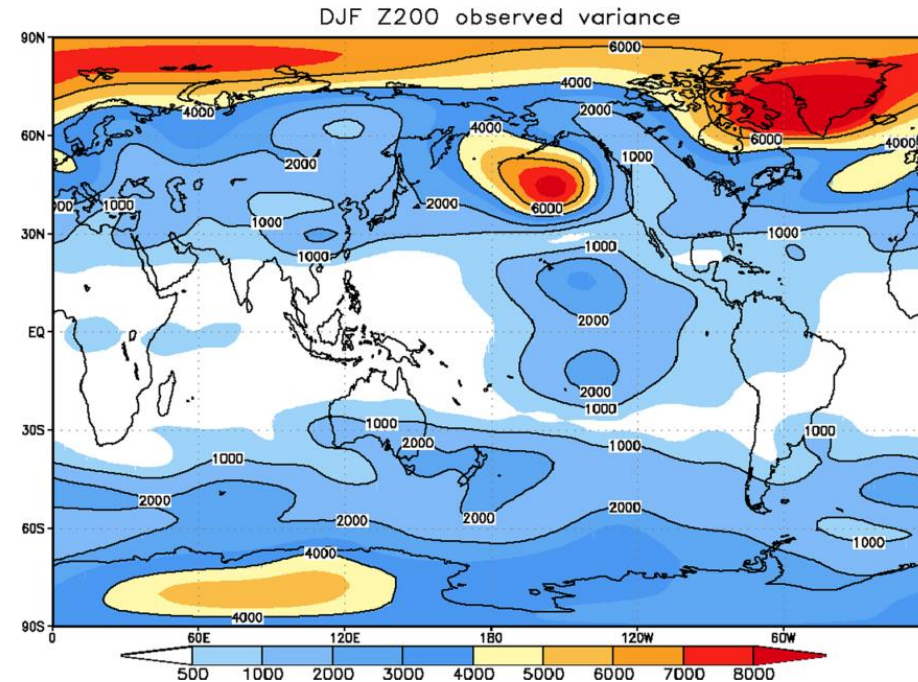
Climate Prediction Center

College Park, Maryland, USA

Mid-latitude variability = Atmospheric internal variability + External influences

### External Influences

- Tropics
- Arctic



DJF 200-mb  
Variance

Mid-latitude variability = Atmospheric internal variability + Tropics  
+ Arctic

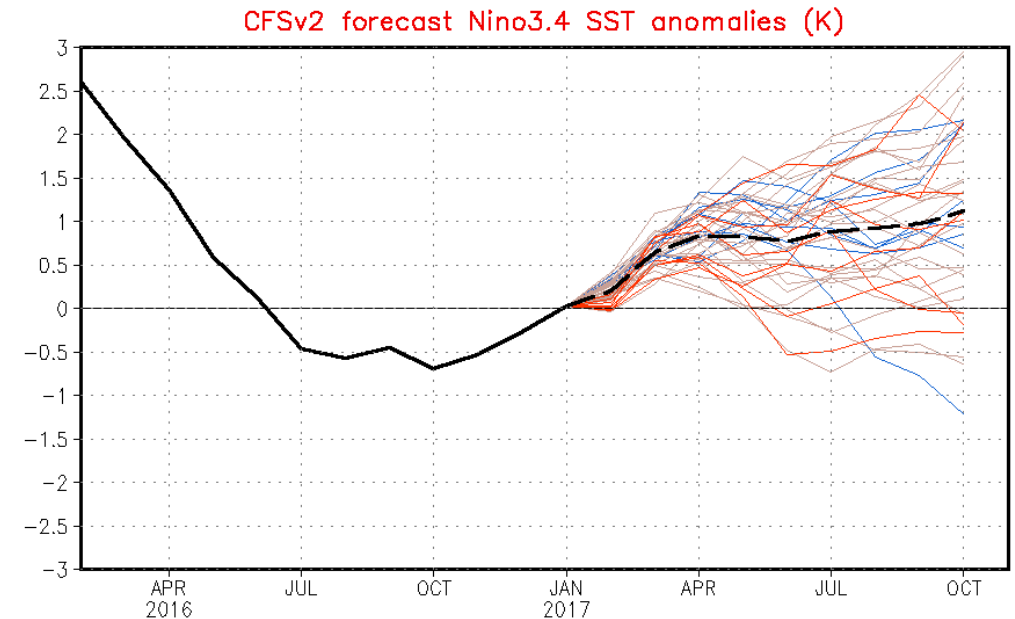
In the context of variability of North America, what is the relative role of internal variability, tropics, Arctic?

	Ranking		
	#1	#2	#3
Internal	5	1	0
Tropics	1	4	1
Arctic	0	1	5

Thanks to those who responded!

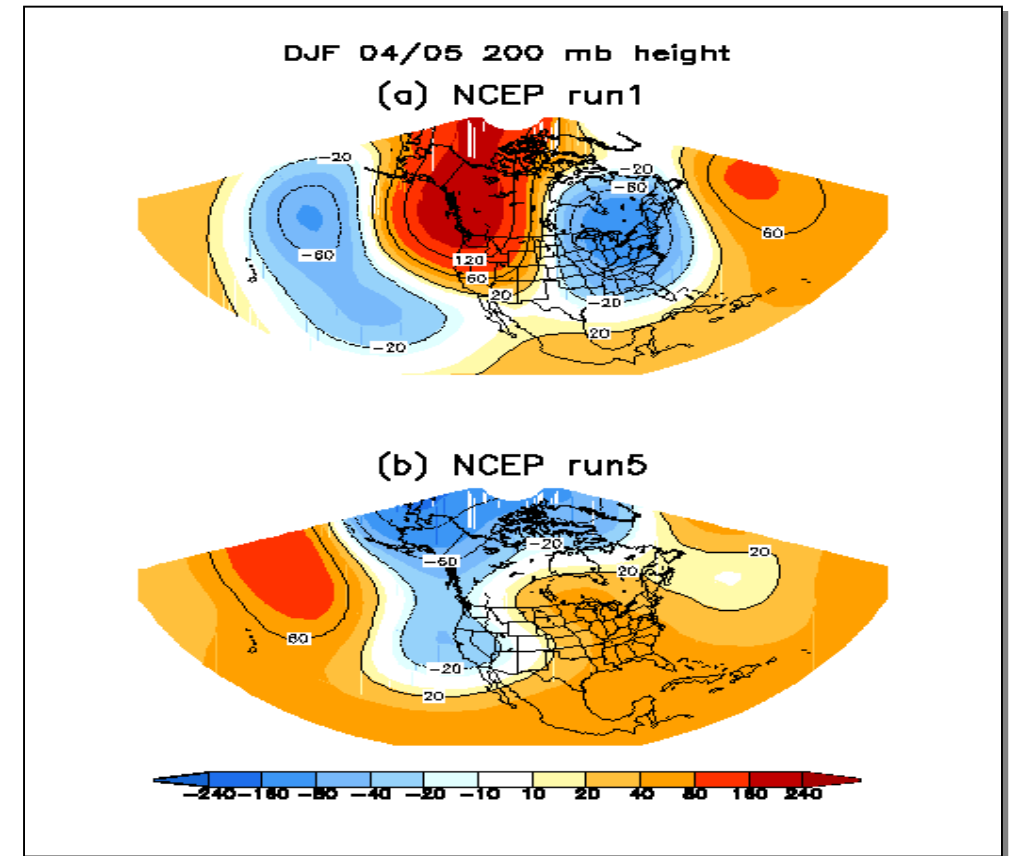
# Internal Variability

- Source
  - Non-linear growth of small perturbation
  - Responsible for divergence in an ensemble of forecasts
  - Limits our ability to predict on all time-scales
- Has a large contribution!



# Estimating Internal Variability

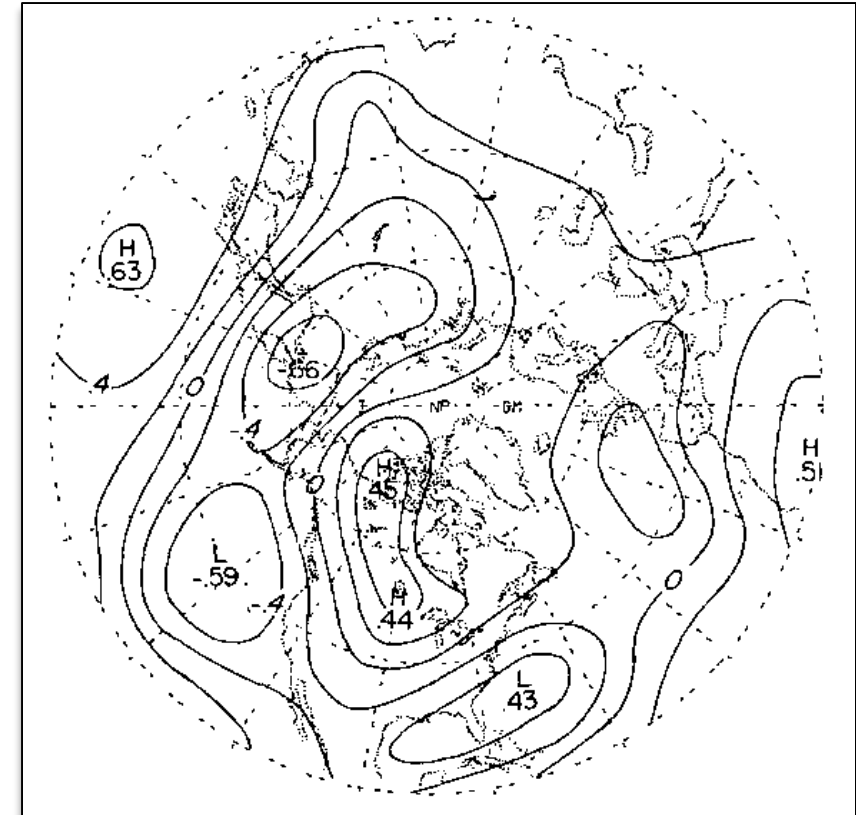
- AGCM simulations with repeated seasonal cycle of boundary forcings
- Ensemble of AGCM simulations with time varying boundary forcings; Departure from ensemble mean



Large differences in  
seasonal means for same  
boundary forcings

# Role of tropics

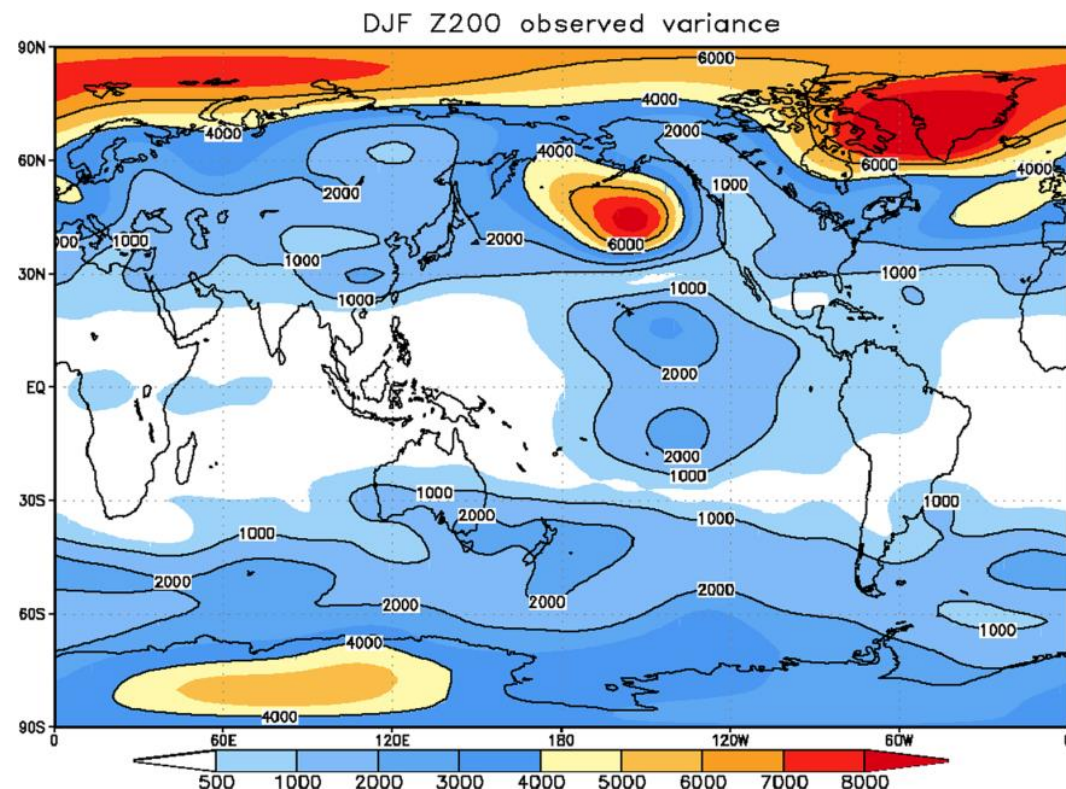
- SST Variability associated with El Niño – Southern Oscillation (ENSO)
- Has a long history (Horel and Wallace 1981)
- Is the basis for operational seasonal predictions



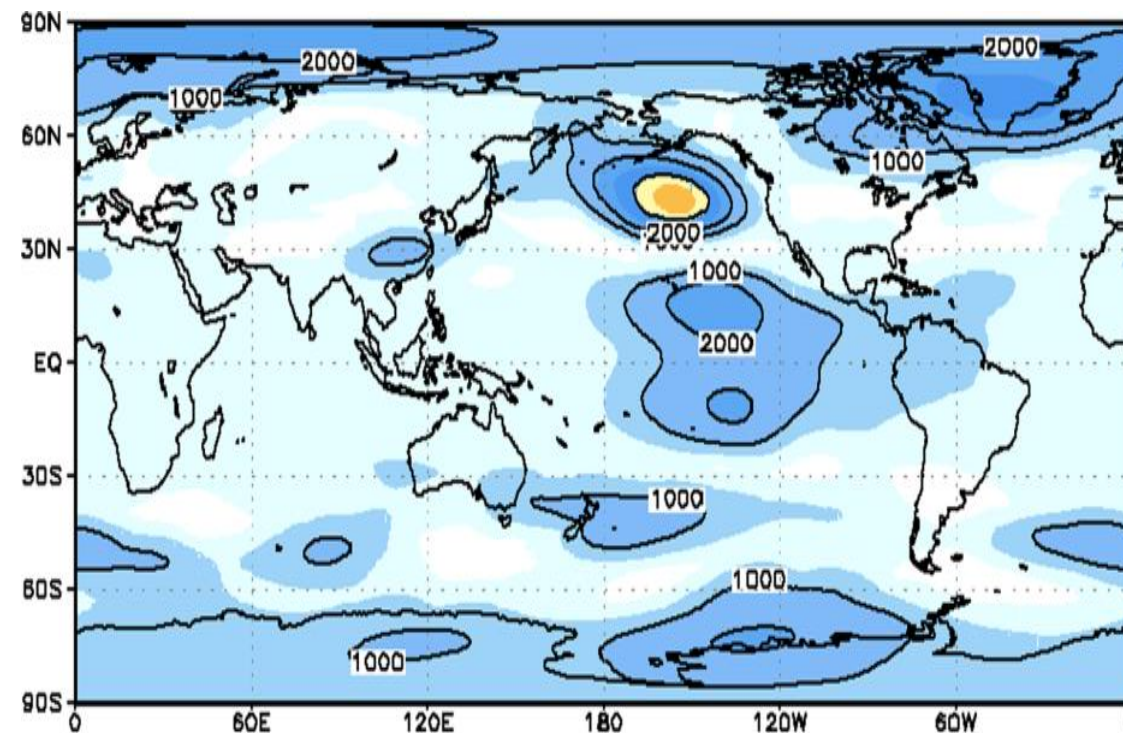
DJF Z700 Correlation with SST index



# ENSO Contribution to mid-latitude variability



DJF 200-mb  
Variance

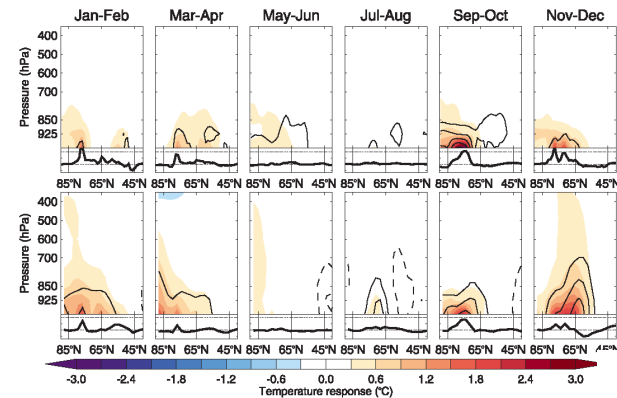
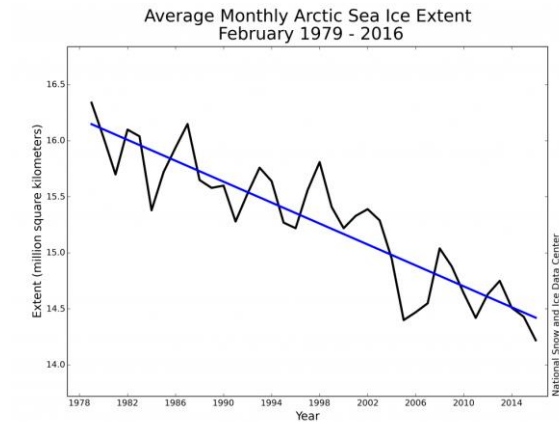


An estimate of ENSO  
related variance

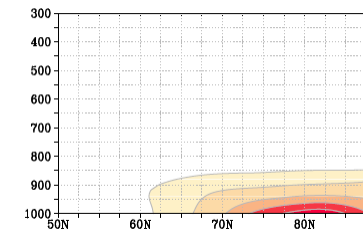
...ENSO has a small influence on  
internal variability!

# Influence of Arctic

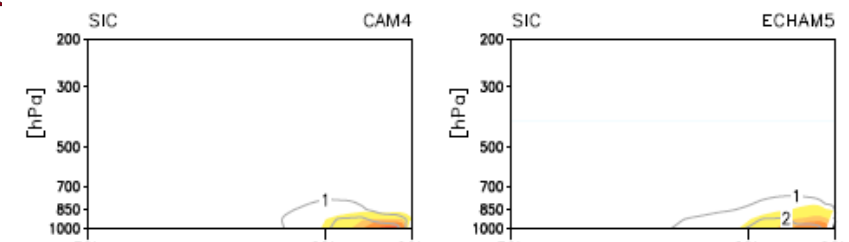
- Sea Ice decline
- Well documented influence on Arctic temperature, particularly in lower troposphere (this influence is similar to the influence of ENSO on the seasonal mean state)
- Arctic Amplification!



Screen et al. 2013



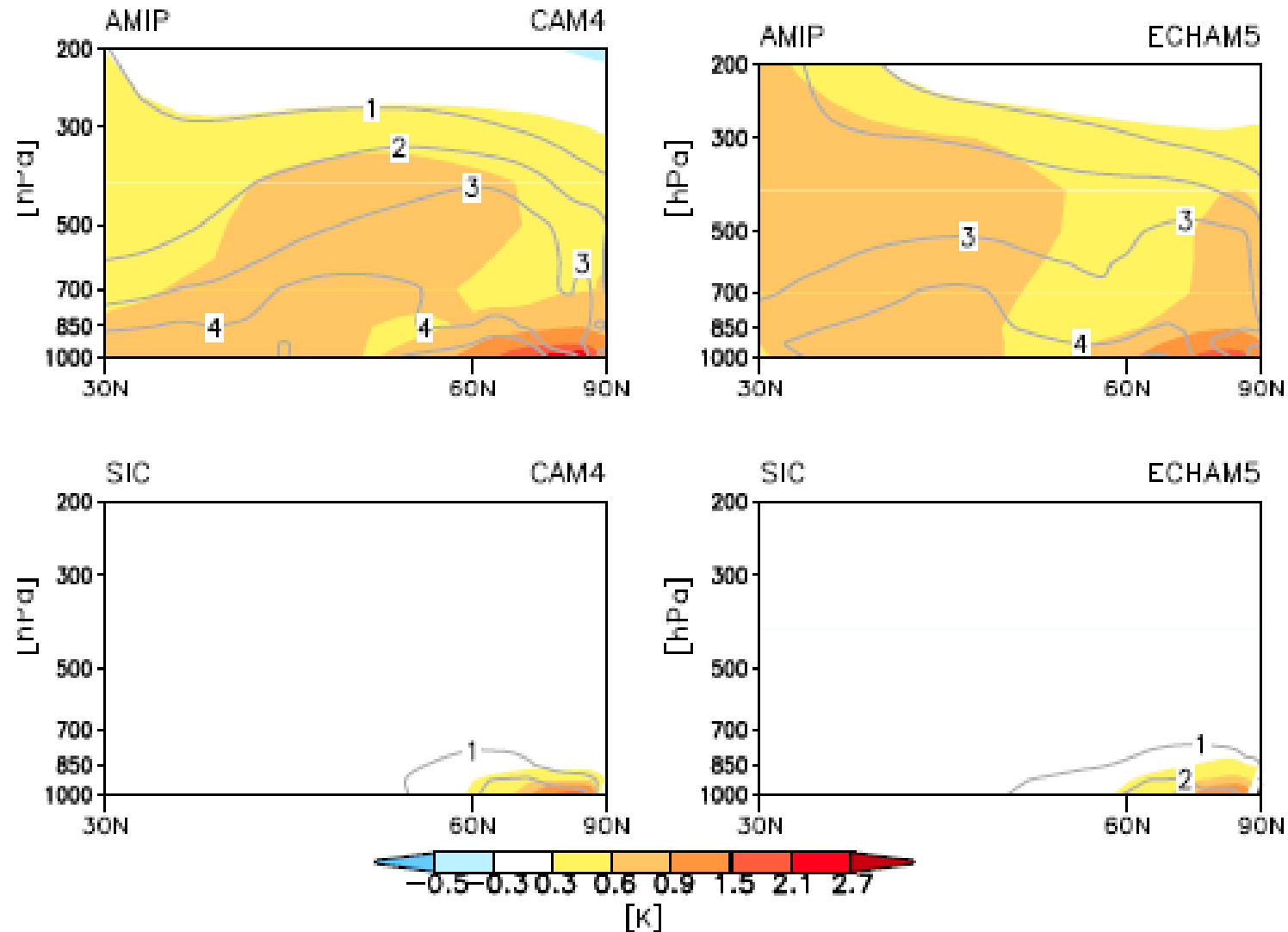
Kumar et al. 2010



Perlitz et al. 2015



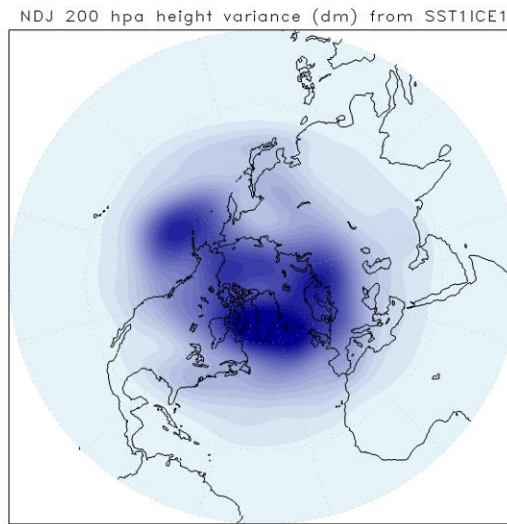
# Tropics vs. Arctic



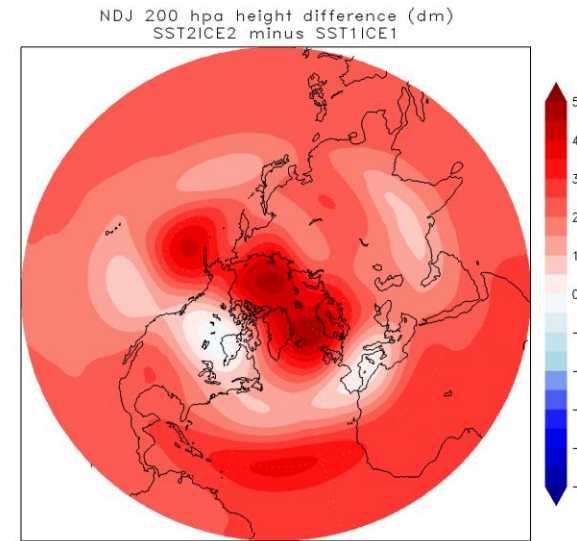
Perlwitz et al.  
2015

# Tropics vs. Arctic

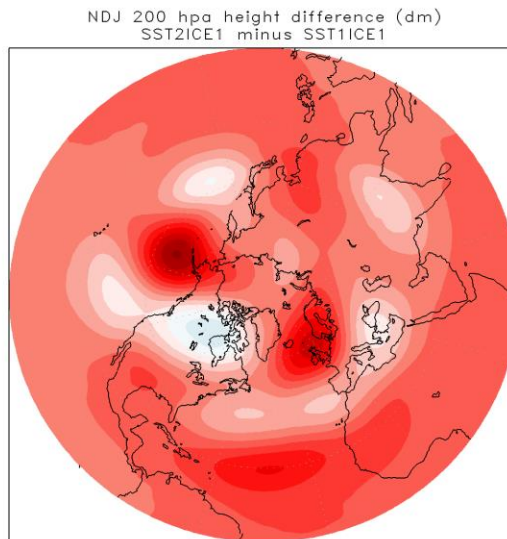
NDJ 200-mb  
Total  
variability



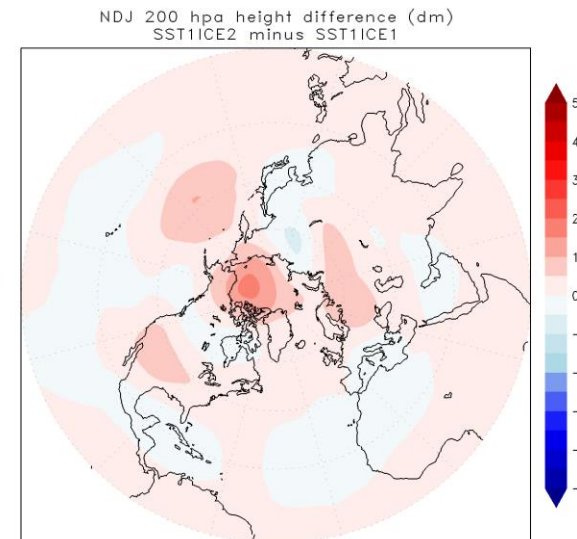
Contribution  
of SST



Contribution  
of SST & Sea  
ICE



Contribution  
of Sea Ice



See Tom Collow

# Influence of Arctic

- Decline in Sea Ice → Contributes to Arctic Amplification → What is the influence on the mid-latitude variability!
- Has been a hard question to answer.
- The very reason it is a hard question to answer may imply that the influence is small.

the coming decades. The climate dynamics literature concerning Arctic-mid-latitude linkages is currently inconclusive, which may help explain the media portrayal of a polarized view among scientists<sup>81</sup>. Furthermore, the severe winter of 2013–2014 across eastern

Cohen et al. 2014

# Resolving the question of the “relative importance of the tropics, internal variability, and Arctic amplification on mid-latitude climate and weather”

- Model simulations to increase the sample and multiple models to build confidence in results!
- NCAR Large Ensembles (LENS) Project (Key et al. 2015)
- Co-ordinate a set of GCM simulations with controlled boundary forcings
  - Control run
  - SST changes
  - Sea Ice changes
- These simulation can provide a first order assessment of relative influence of internal variability, ENSO, and changes in Arctic