

Eddies, Eddies Everywhere

Thoughts on (Ocean) Eddy-Resolving Coupled Models

WK Dewar, FSU

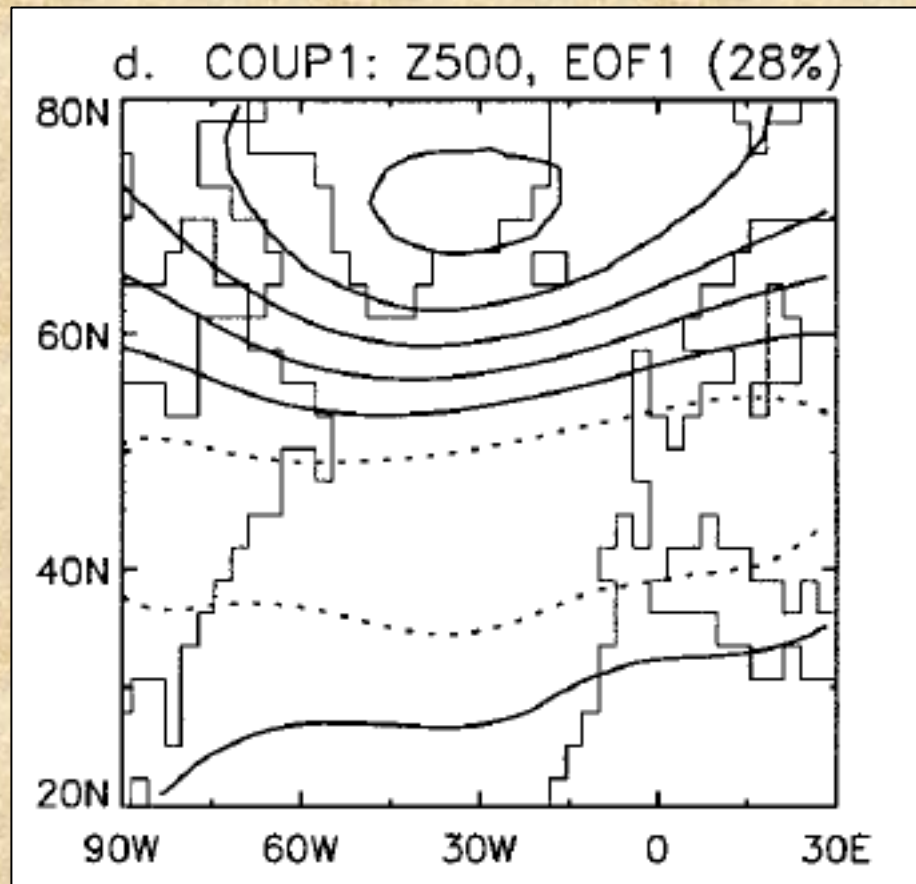
S. Kravtsov, A. Hogg, P. Berloff

M. Ghil, JC McWilliams, PD Killworth (dec), J. Blundell

WGOMD Workshop on High Resolution Ocean Climate Modeling

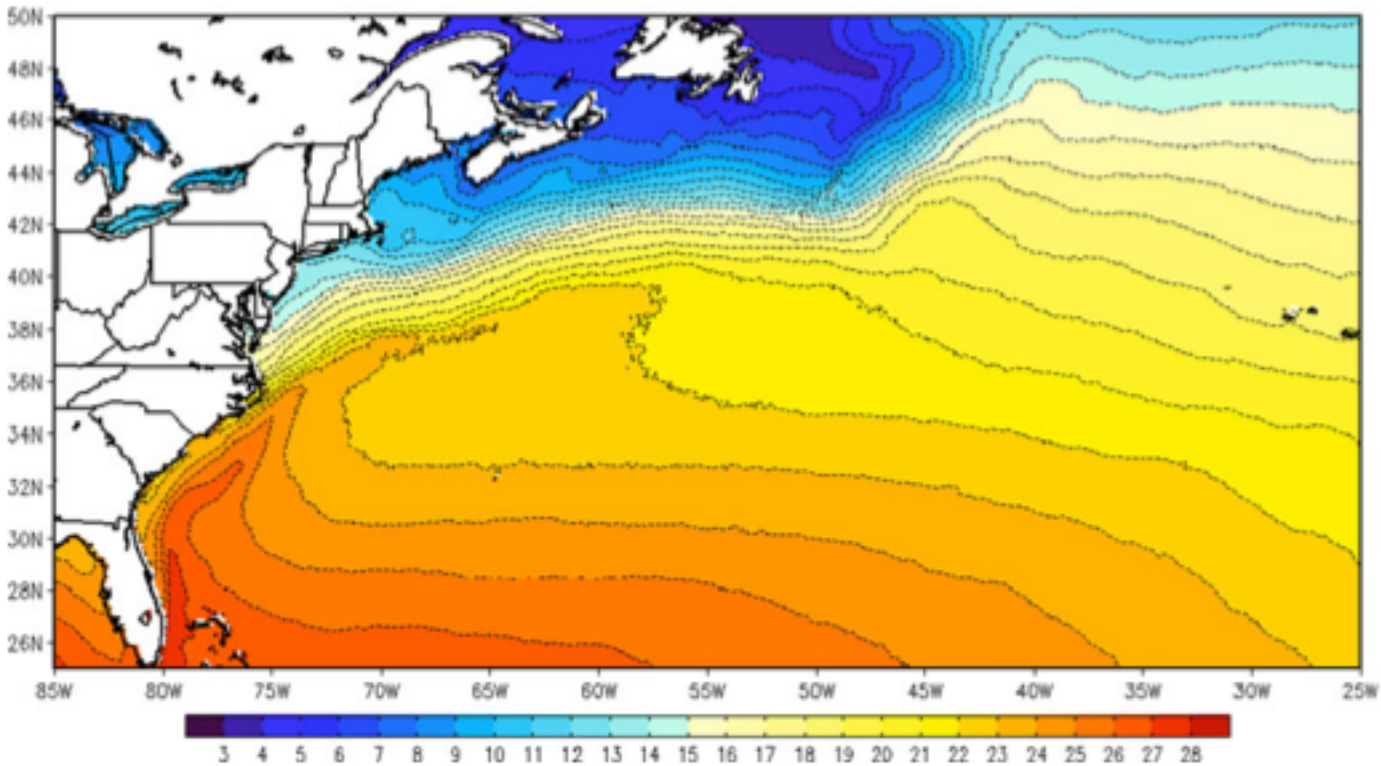
April 7, 2014

Kiel, Germany



Coupled Model Circa 1998
Atmosphere 2.8° , Ocean 1.6°
Saravanan, 1998

Atmospheric Low-Frequency Variability and Its Relationship to Mid-Latitude SST Variability
Mid-Latitude Coupling is Weak



Coupled Model Circa 2012

Atmosphere nominal 0.5°

Ocean 0.1°

Kirtman et al., 2012

Impact of ocean model resolution on CCSM climate simulations

Mid-Latitude Coupling Significant

Some History:

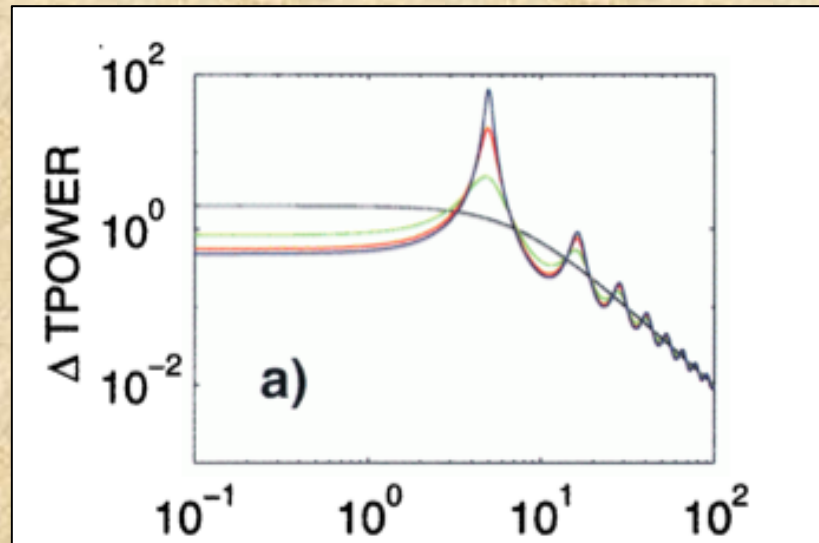
Starting roughly in the mid-90's, mid-latitude
coupling grew in interest

(counterpoint to 1977 Hasselmann...)

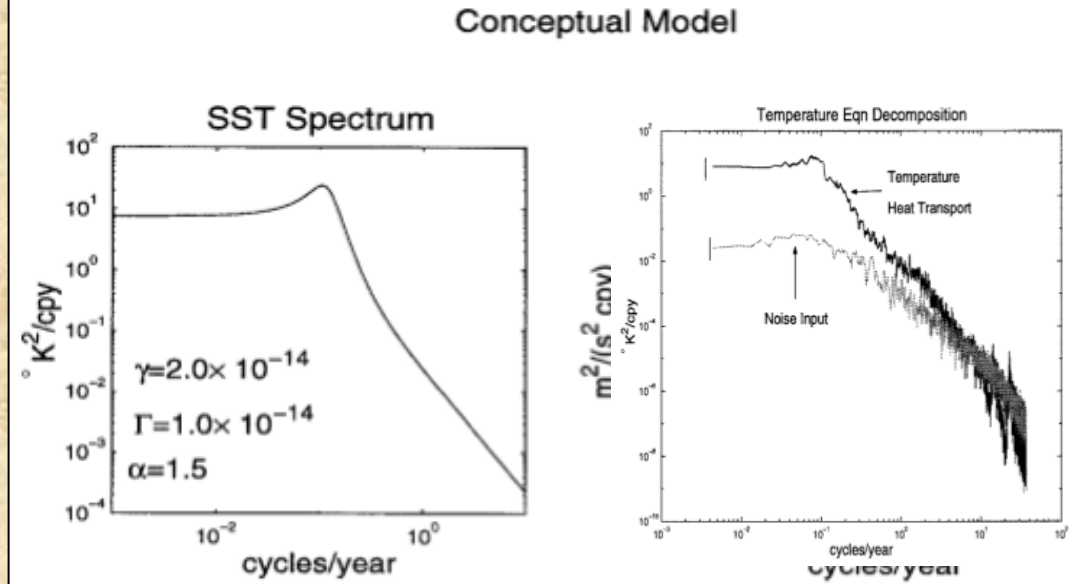
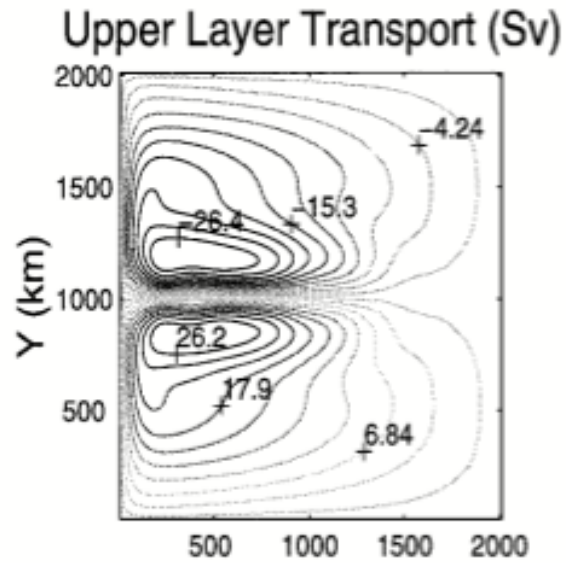
Rodman et al, Mehta et al., Bretherton and
Battisti, Jin, Neelin,(apologies)

A nice early process model
Czaja and Marshall

$$h_t - ch_x = -w_e$$



An elaboration of the Jin, Neelin, Czaja, Marshall.....
wave models



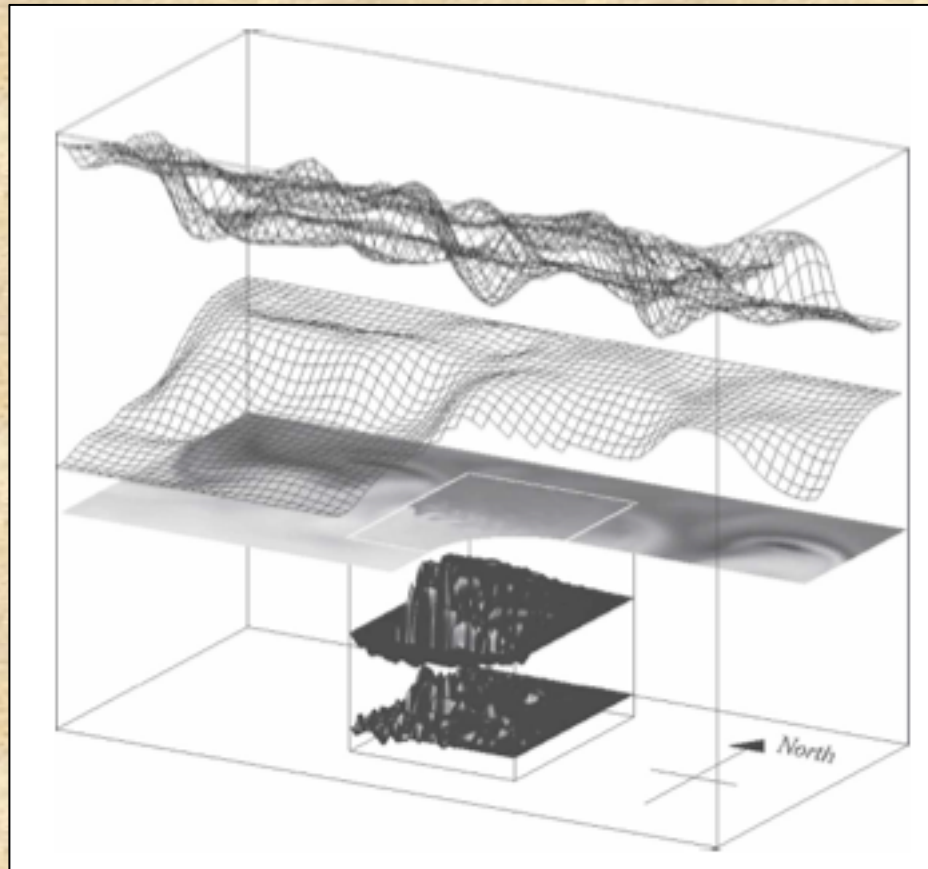
Dewar, 2001
Ocean in control
Eddies of indirect importance

But Also Funding!

NSF

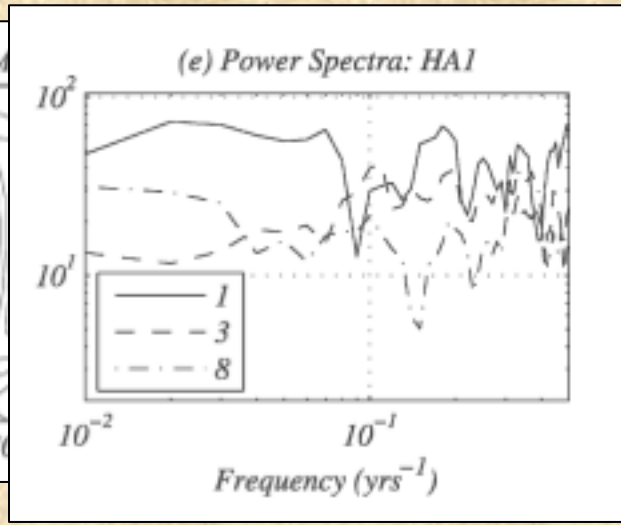
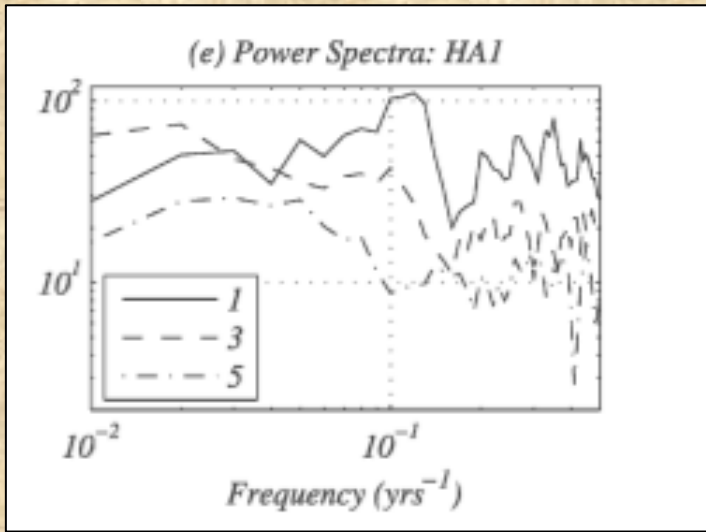
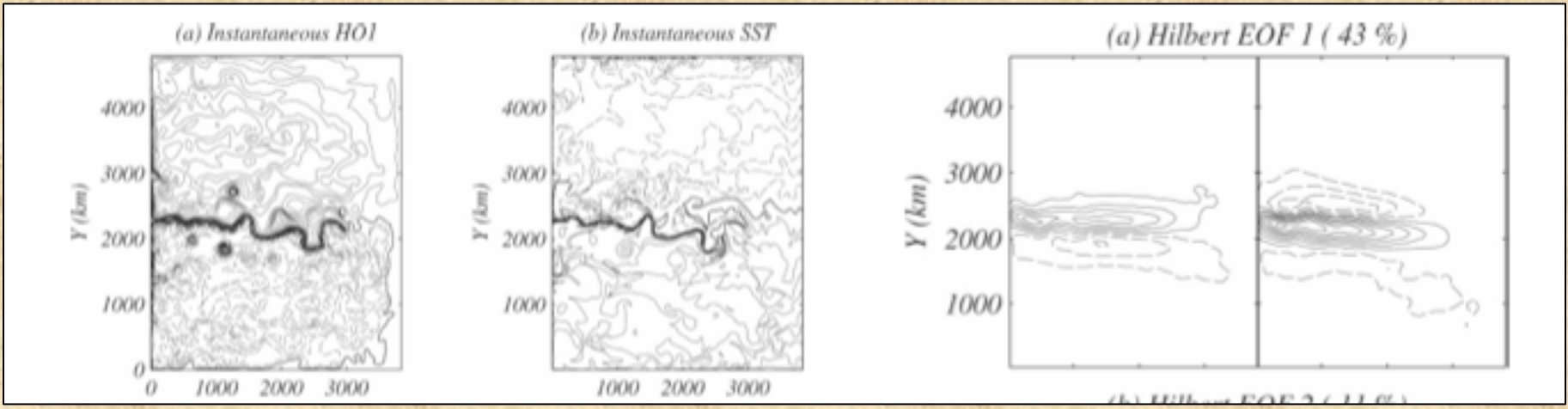
NERC

With Kravtsov, Berloff, McWilliams, Ghil, Killworth, Hogg and Blundell



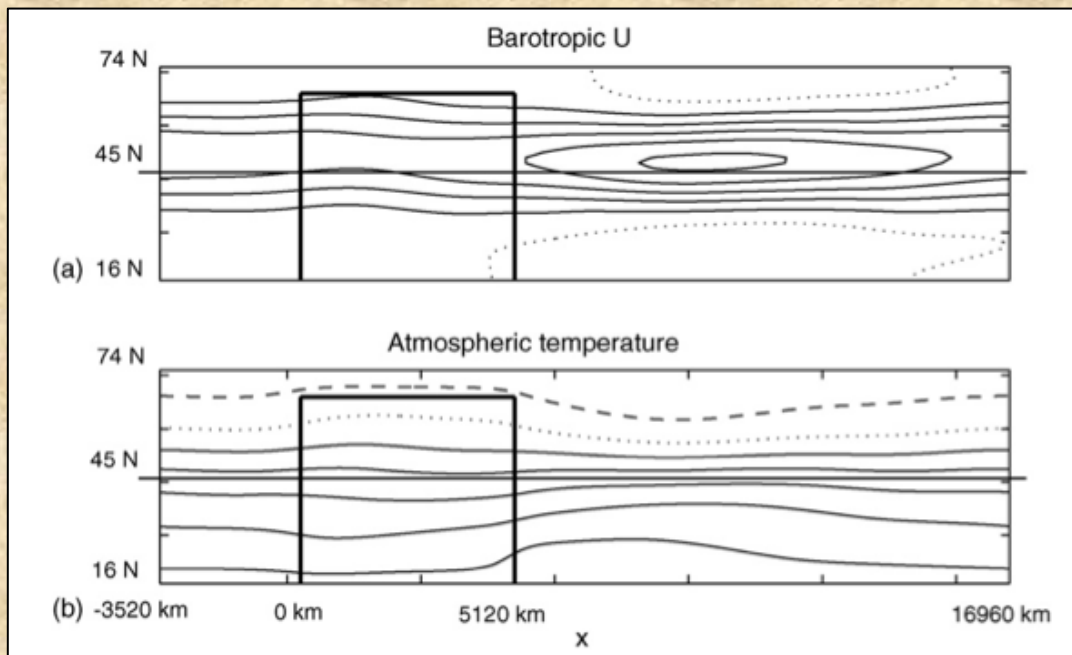
Q-GCM

An early tool to study high-resolution climate modeling



Coupled

Uncoupled



Kravtsov, et al., 2007

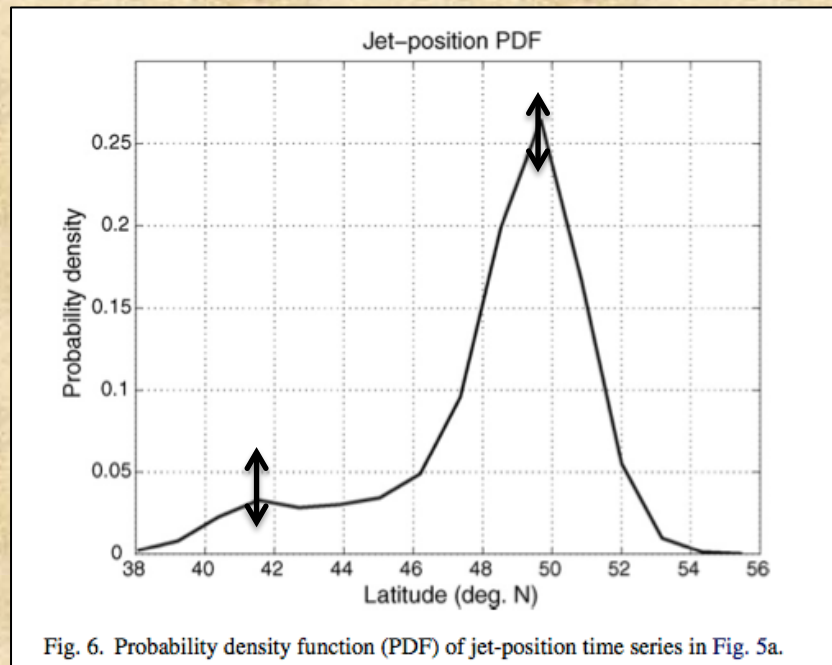
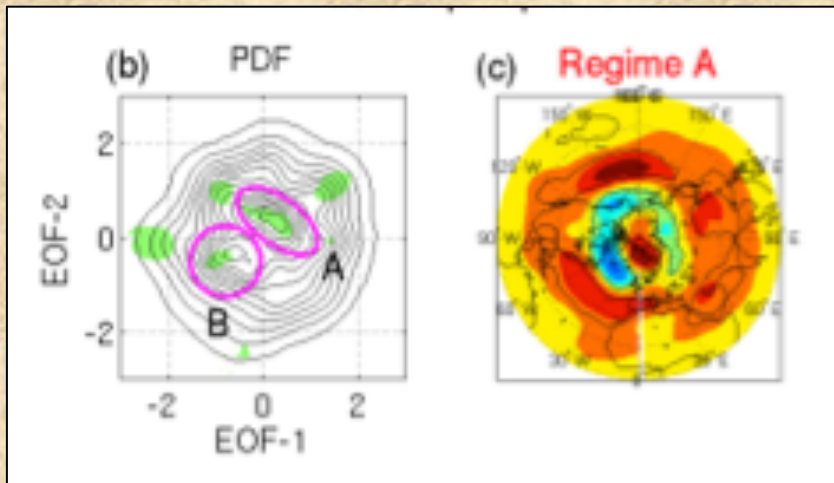
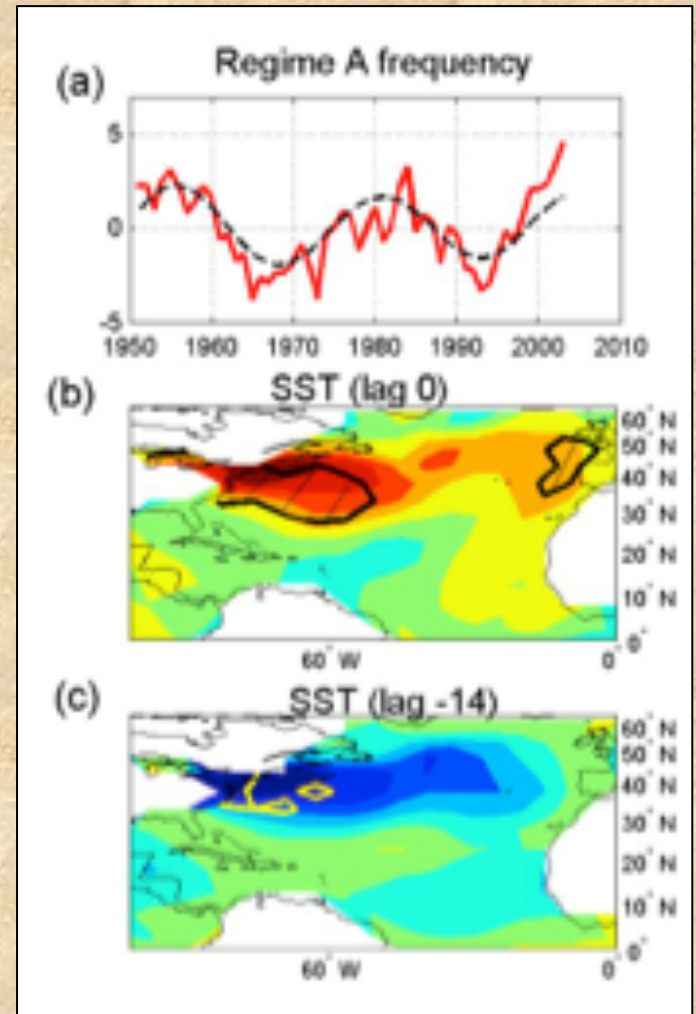


Fig. 6. Probability density function (PDF) of jet-position time series in Fig. 5a.

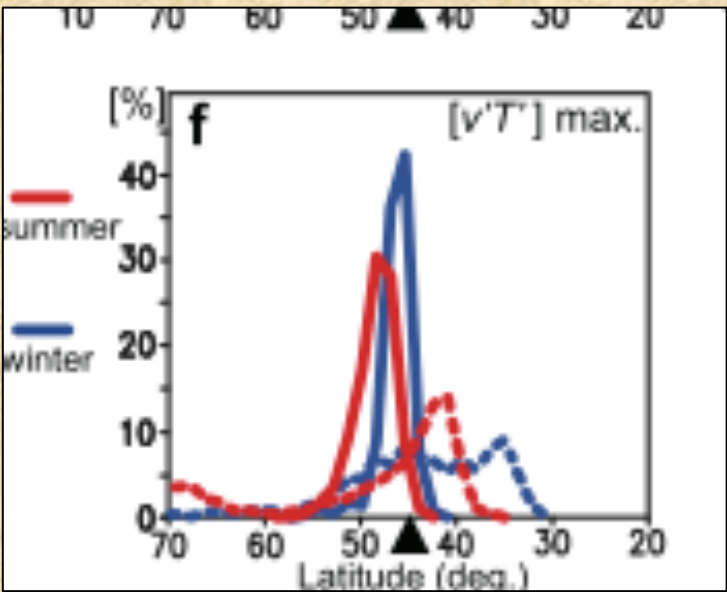
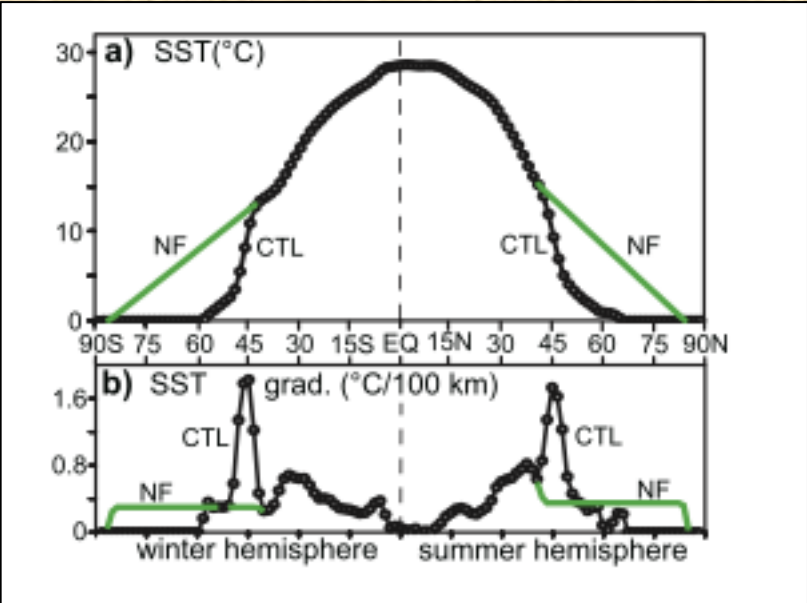
Some Observational Evidence?



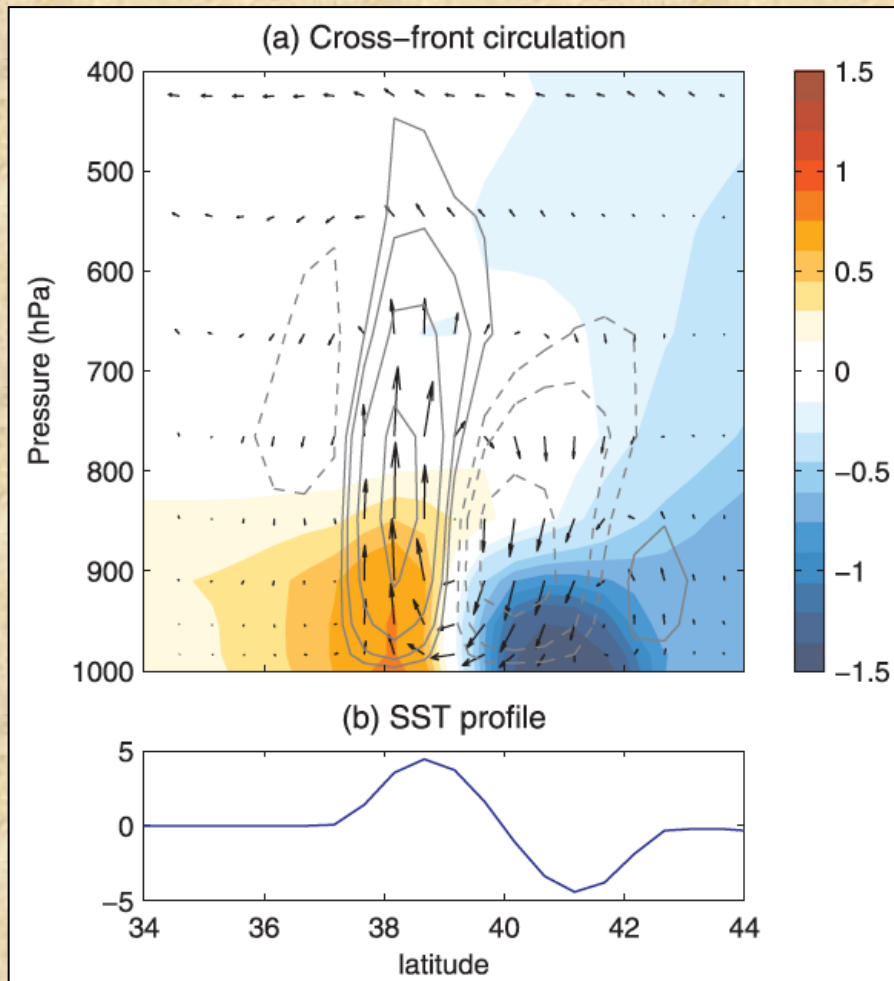
Based on the 1948-2003
NCEP-NCAR reanalysis



More Recent Studies –
Nakamura – 2008
Atmosphere only



Ghil, Deremble, Simmonet, Feliks



Summary:

Process modeling and theory are useful tools in coupled climate modeling

Q-GCM indicates two different mode types dependent on eddies

- 'Hogg' mode – Ocean 'drives' the atmosphere
(~Dewar 2001)
- 'Kravtsov' mode – Coupled mode requiring nonlinear atmosphere

Both involve 'clocking' an atmospheric mode (or modes)

Key ingredient -eddy-mean flow

Front controls storm track and sharpness results in deep penetration of both dry and moist effects (Nakamura, Ghil, collaborators)