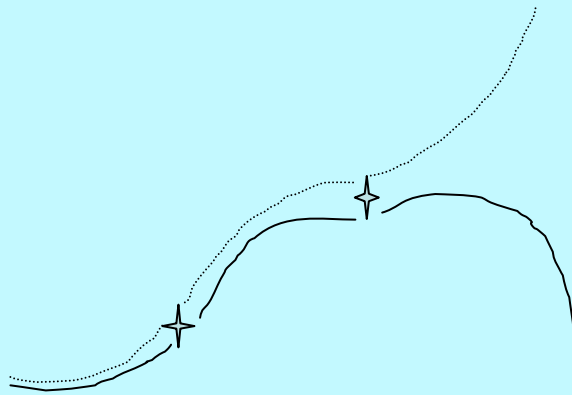


An anomalous ensemble-mean
approach for
seasonal prediction?

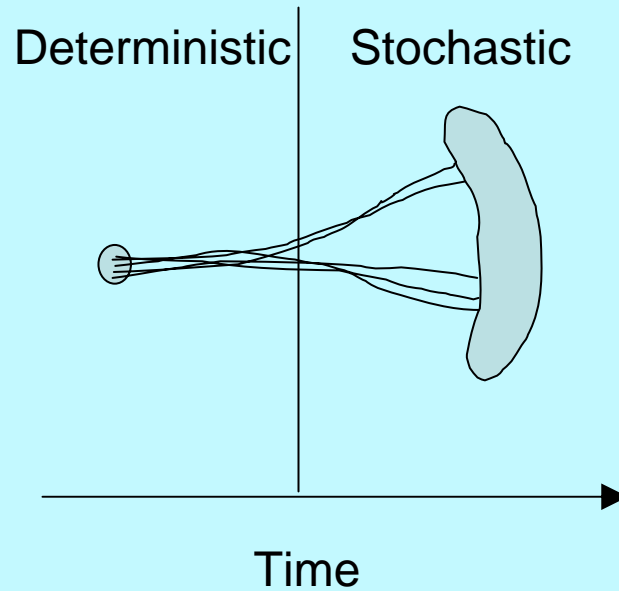
F.-F. Jin
Department of Meteorology
Florida State University

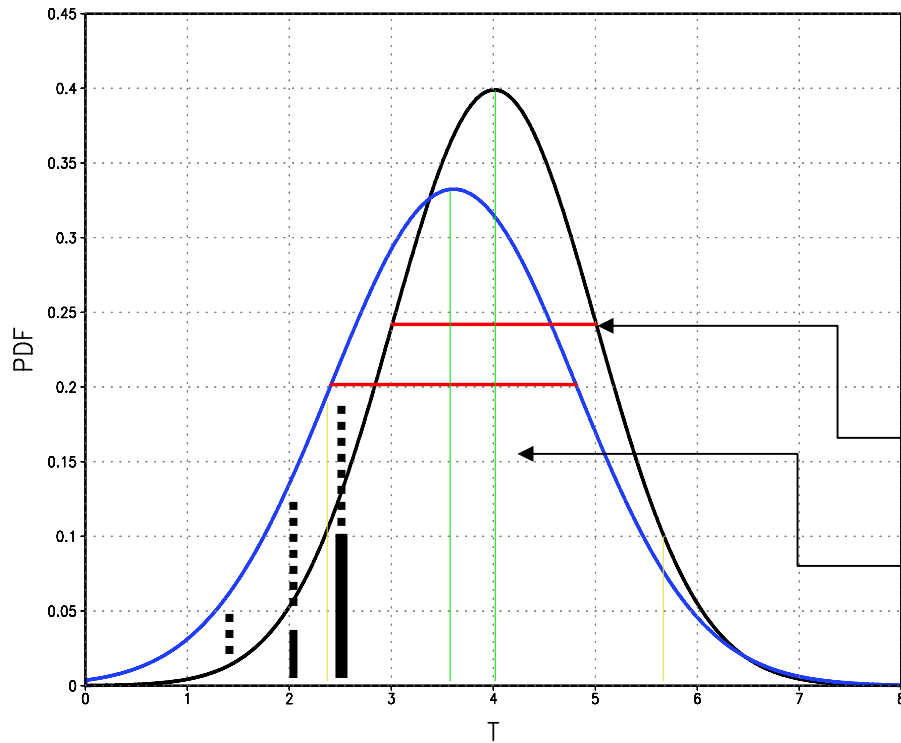
Finite limit of predictability for NWP (Lorenz, 1963)

Deterministic vs stochastic



Sensitivity to initial conditions
in chaotic system





GrADS: COLA/IGES

2004-10-13-15:40

Weather T'
Variability:

Measures
For Climate:

$$\bar{T}, \overline{T'^2}$$

What we want predict:

$$\Delta\bar{T}, \Delta\overline{T'^2}$$

Ensemble forecasting for climate variability predicts the totality of the ensemble means by a limited numbers of the realizations:

$$\overline{T}, \overline{T'^2} .$$

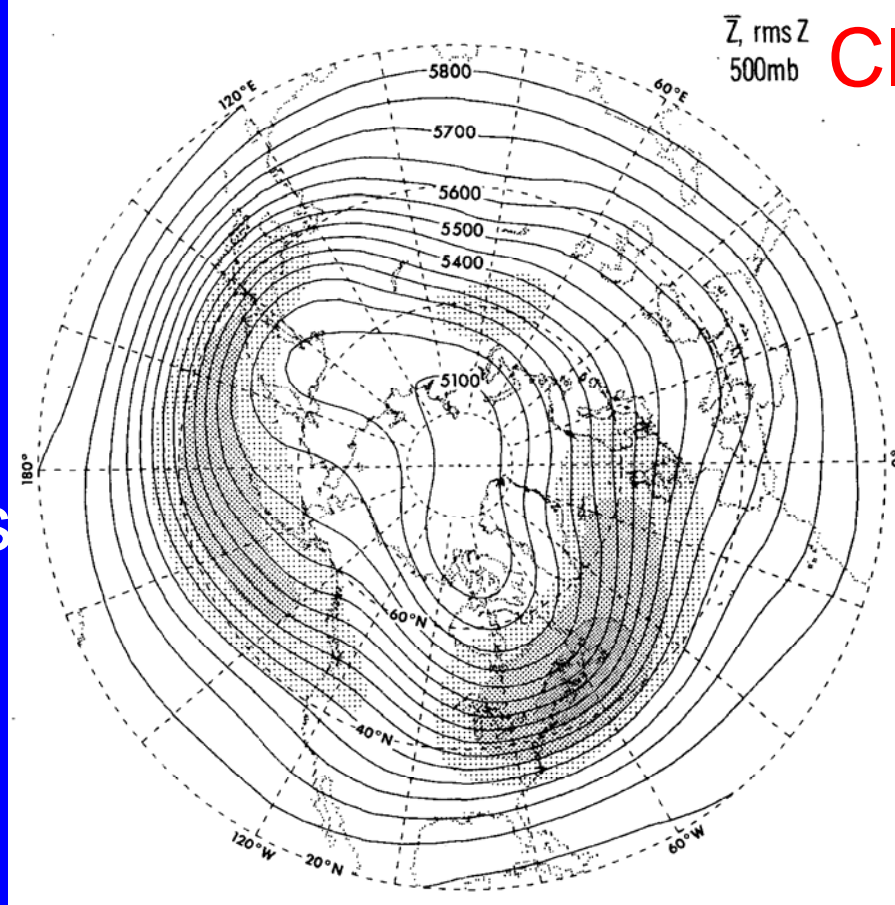
In fact, the prediction is aimed for the small anomalies in these quantities.

Can we model the anomalous fields:

$$\Delta\overline{T}, \Delta\overline{T'^2}$$

directly?

Pacific and Atlantic Storm tracks



\bar{Z} , rms Z
500mb **Climate means:**

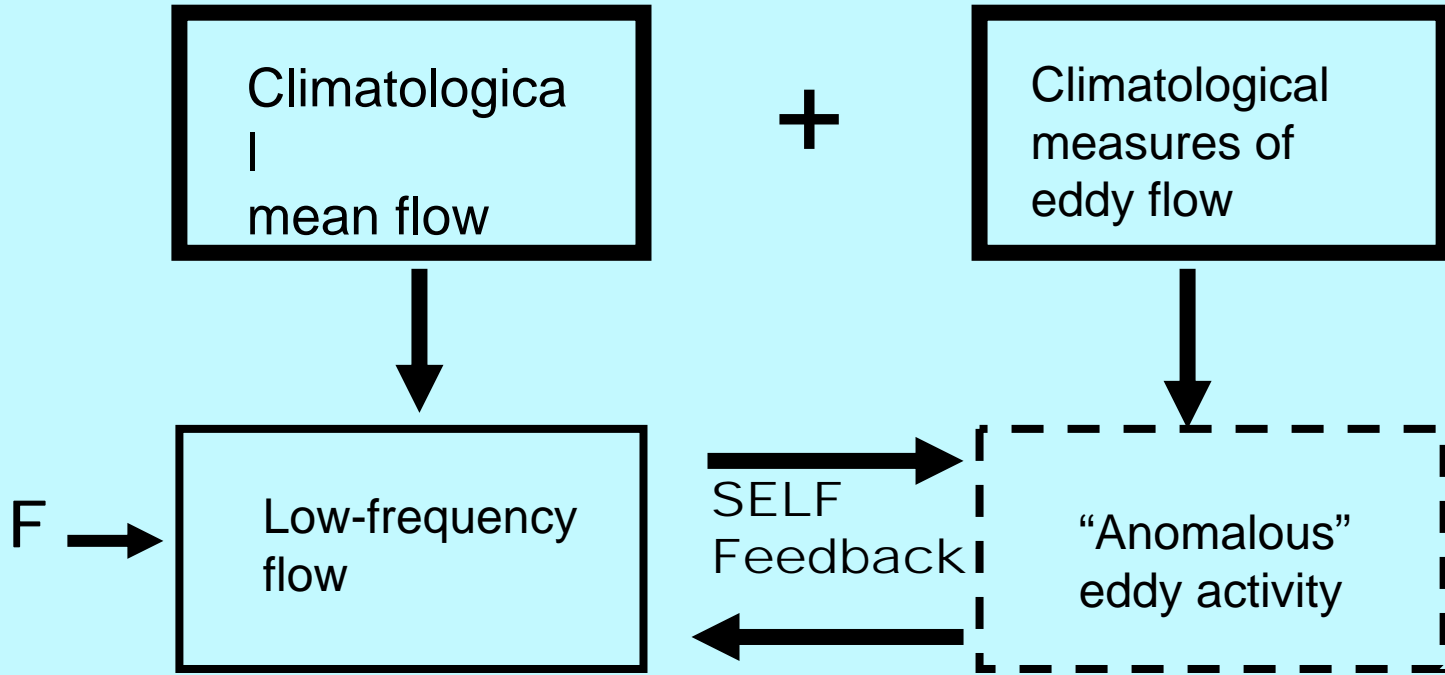
$$\bar{\psi}^c, \overline{\psi^2}^c$$

QuickTime?and a
TIFF (LZW) decompressor
are needed to see this picture.

$$\xi_j(t)$$

The Basic ideas of the new approach

- (i) The climatological parts of the first and second moments of PDF can be prescribed by the observed history of the atmospheric circulation.**
- (ii) Only the relative small anomalies in the first and second moments of PDF are to be predicted through dynamic models.**



Taking the barotropic model as an example:

$$\frac{\partial}{\partial t} \Delta \bar{\psi}^a + L \bar{\psi}^a = \bar{Q}^a - \nabla \cdot (\bar{V}' \zeta'^a)$$

$$\nabla \cdot (\bar{V}' \zeta'^a) = \sum_{n=1}^{N_c} \sigma_n^2 (J(\hat{\psi}_n, \Delta \hat{E}_n) + J(\hat{E}_n, \Delta \hat{\psi}_n)) + cc$$

$$\frac{\partial}{\partial t} \Delta \hat{\psi}_n + L \hat{\psi}_n + (\tau_n^{-1} + i\omega_n) \Delta \hat{\psi}_n =$$

$$-J(\hat{E}_n, \Delta \bar{\psi}^a) - J(\bar{\psi}^a, \Delta \hat{E}_n)$$

$$n=1, N_c$$

2N is the number of second order anomalous moments in 2N-dimension PDF space

Uniqueness of the new system:

With a GCM framework, the anomaly first (ensemble mean) and a number of second moments will be governed by a coupled set of linearized GCMs.

It has an unbiased description of dynamic interaction between the stochastic synoptic eddy flow and slowly varying flow of climate variability.

Some tests

Math test:

super-rotational flow

$$u_0 = 15 \text{ms}^{-1}$$

Stochastic
super-rotational
flow

$$u_0(1 + 0.5\xi(t))$$

QuickTime?and a
TIFF (LZW) decompressor
are needed to see this picture.

Numerical
Ensemble
Simulation

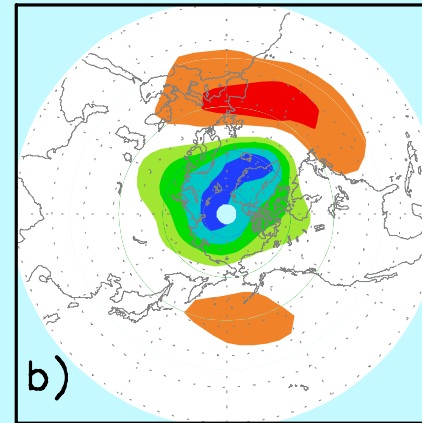
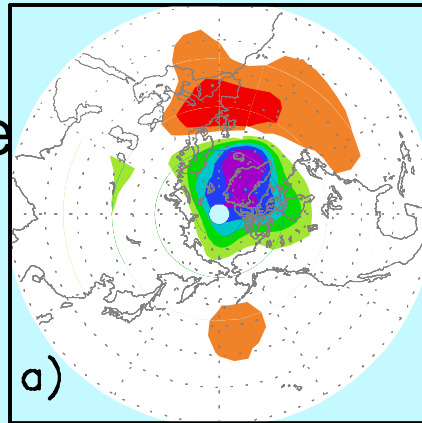
Analytical
closure

Robby wave propagations

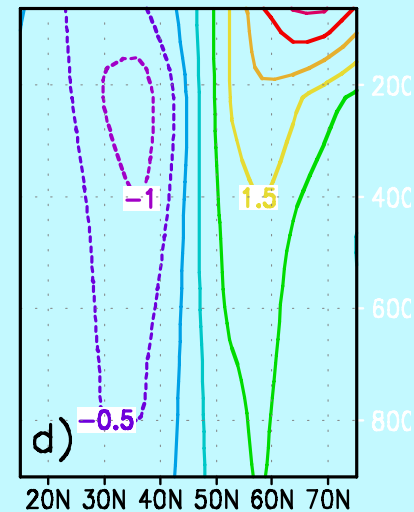
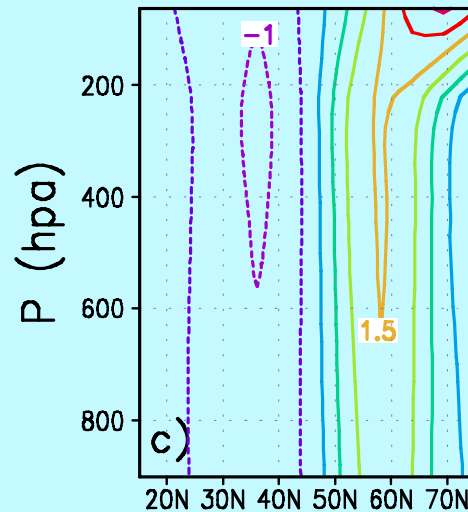
Observed AO

#1 SVD mode
of PE model $L + L_f$

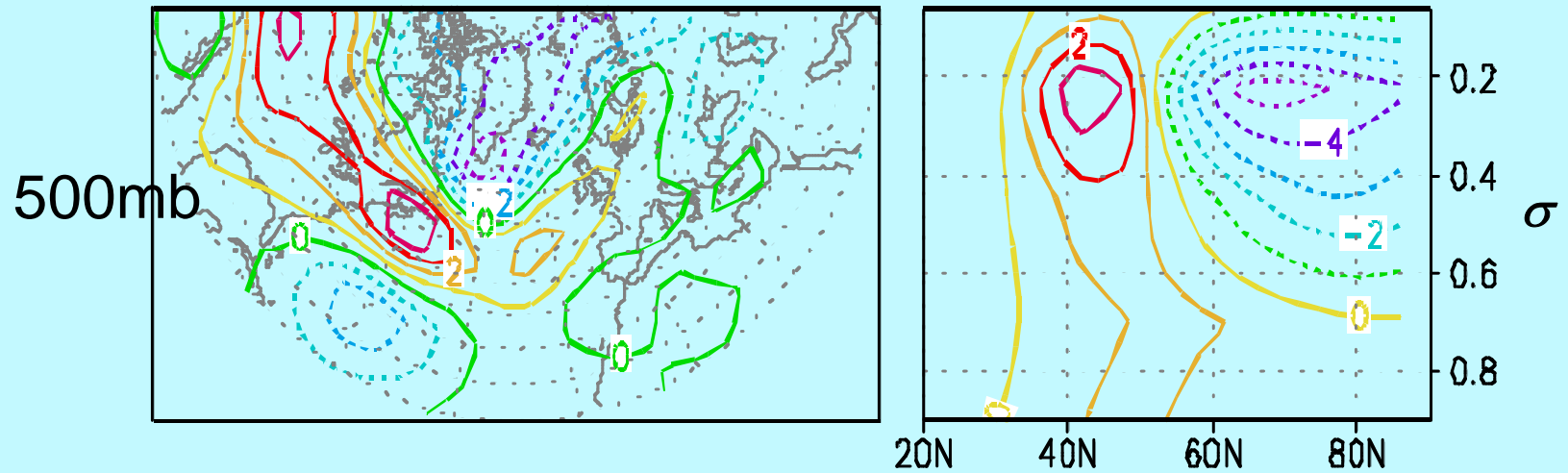
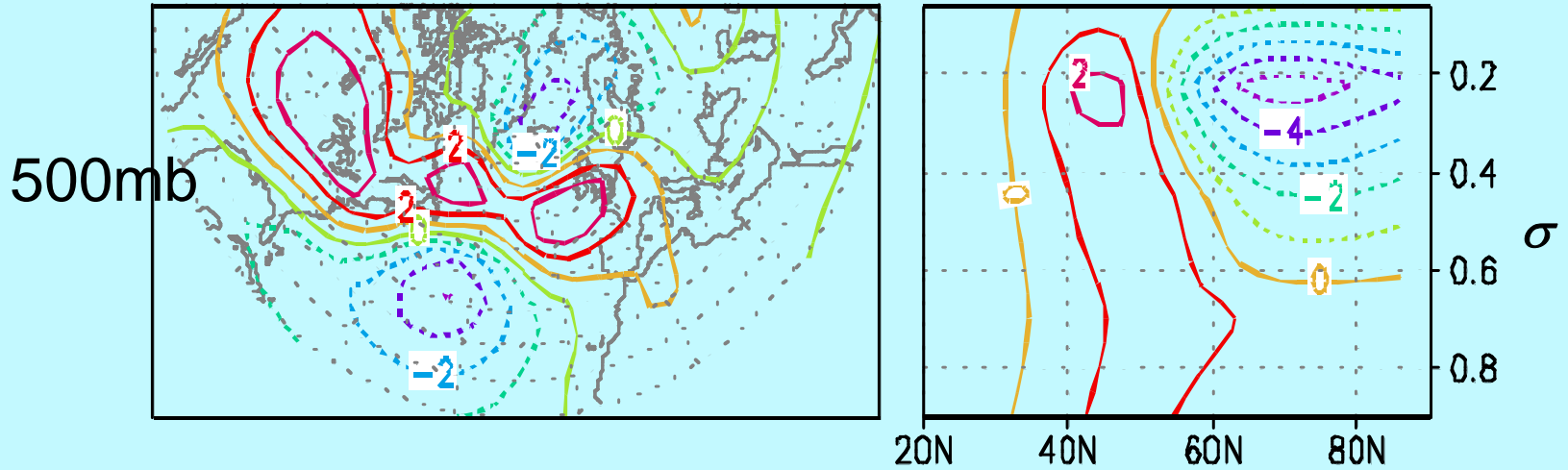
Surface Pressure



Zonal mean
zonal winds



Observed eddy forcing related to NAO



Theoretic eddy forcing related to NAO

by the new system based on a linear 5-layer-T21 PE model

Possible applications for seasonal predication?

Assessing the impact of the systematic errors in the climatological means of the circulation and storm track activity on the seasonal forecasts.

Summary:

- **A new framework for the anomalous first and second moments of the PDF is formulated for modeling and understanding the low-frequency variability. This framework may have some applications as a stochastic-dynamic approach for the ensemble seasonal prediction.**