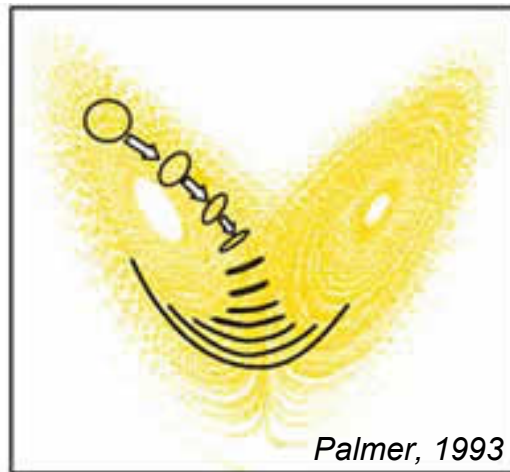


*DOE Climate Modeling PI Meeting
20 September 2011*

Initial Value Decadal Predictability of Climate Modes in Six AOGCMs

***Grant Branstator,
Haiyan Teng, Gerald Meehl,
M. Kimoto, J. Knight, M. Latif, A. Rosati***



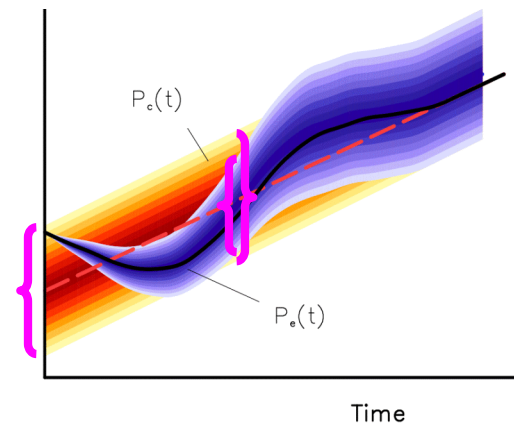
NCAR



Office of Science
U.S. Department of Energy

✓ Control Runs from

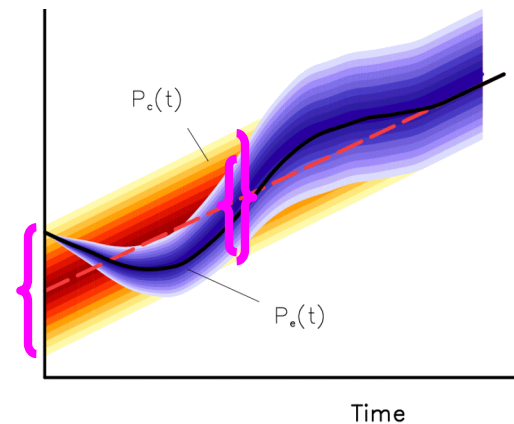
- CCSM3, NCAR700yr
- CCSM4, NCAR700yr
- KCM, University of Kiel4200yr
- CM2.1, GFDL.....2500yr
- MIROC3.2, CCSR & JAMSTEC3600yr
- HadCM3, Hadley Centre5400yr



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✓ Attractor averages

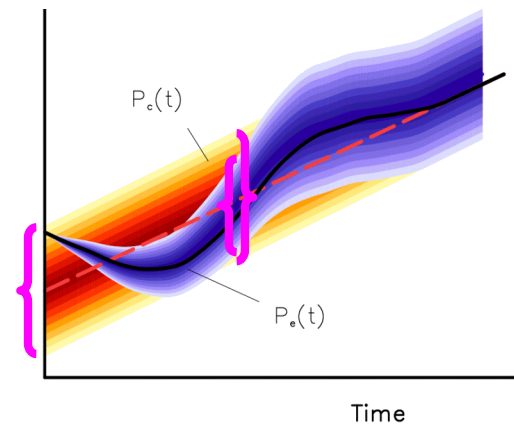


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✓ Attractor averages

✓ Relative entropy



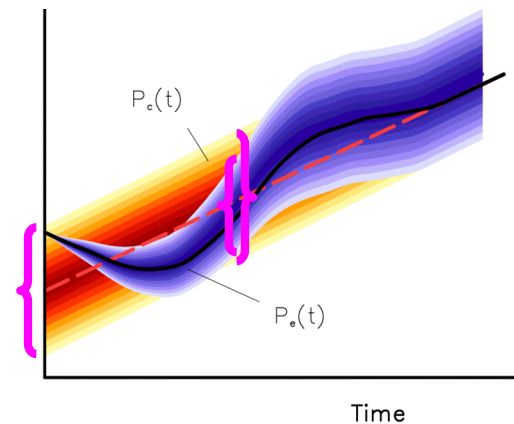
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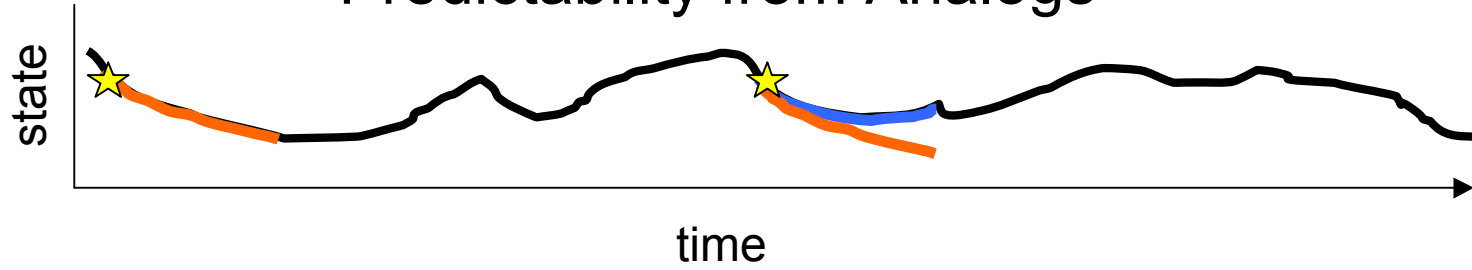
✓ Attractor averages

✓ Relative entropy

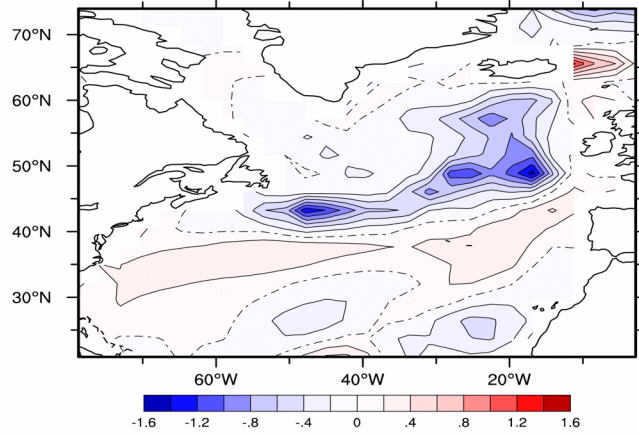
✓ Annual mean upper 300m temperature



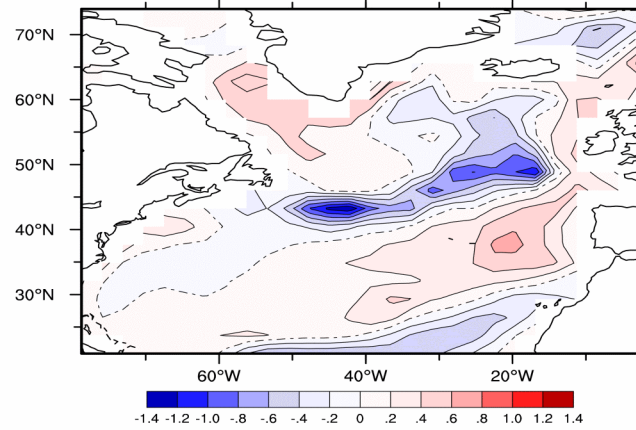
Predictability from Analogs



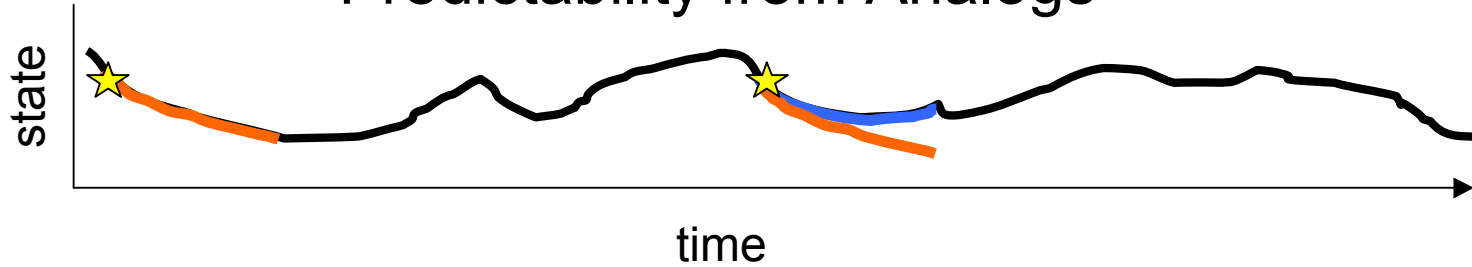
CCSM3 yr 236



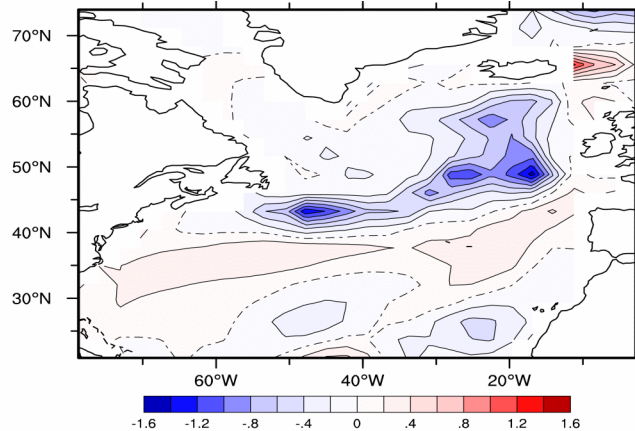
CCSM3 yr 337



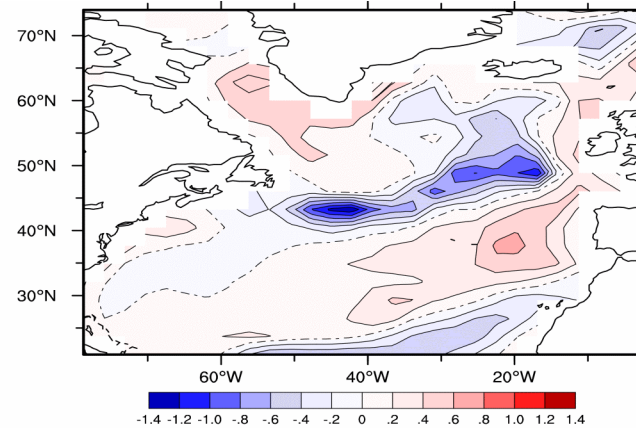
Predictability from Analogs



CCSM3 yr 236



CCSM3 yr 337



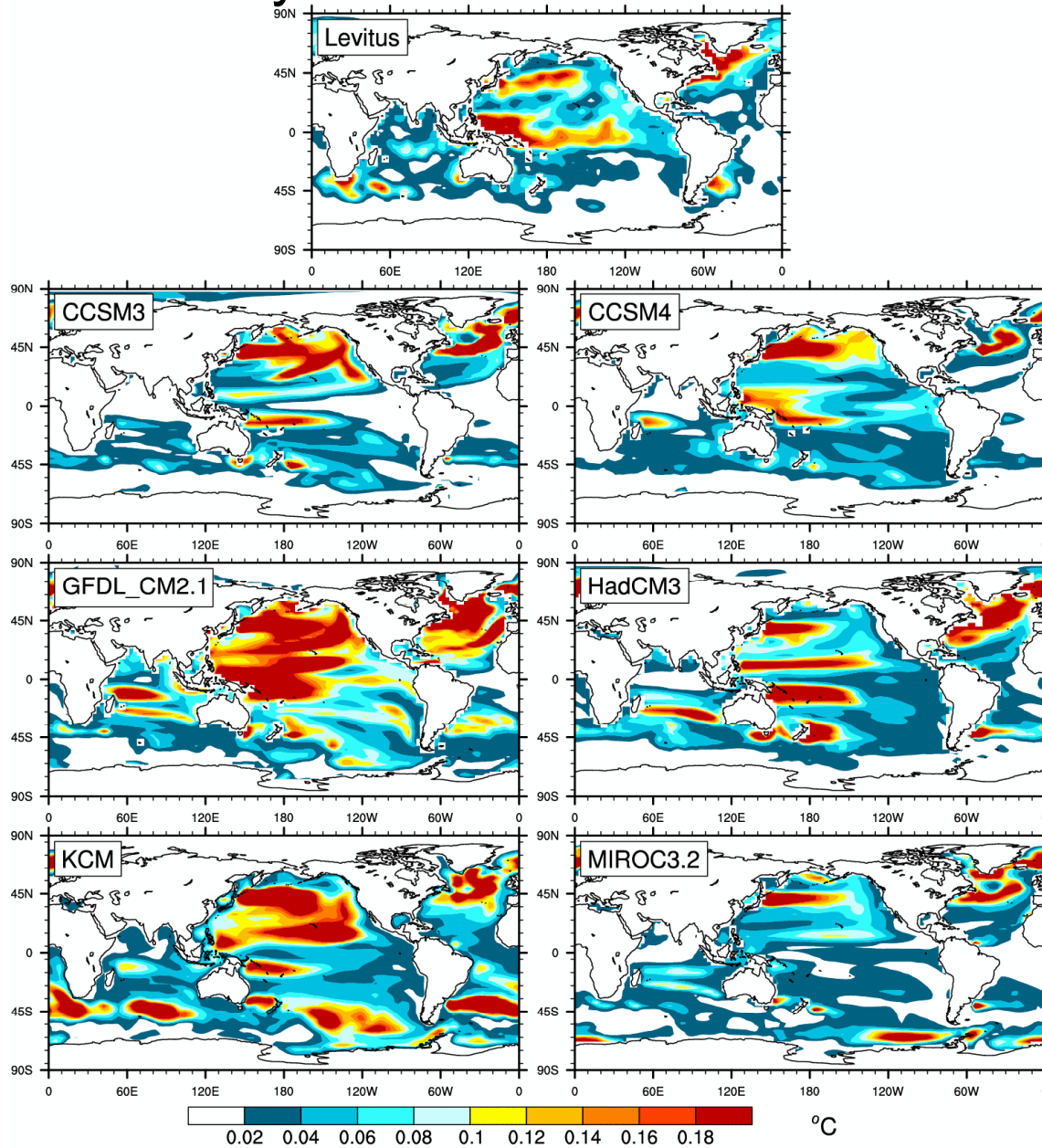
Predictability from Multivariate Linear Regression Propagators

$$x(t) = \mathbf{C}(t - t_0)\mathbf{C}^{-1}(0)x(t_0)$$

for $\mathbf{C}(\tau)$ = lag cov matrix

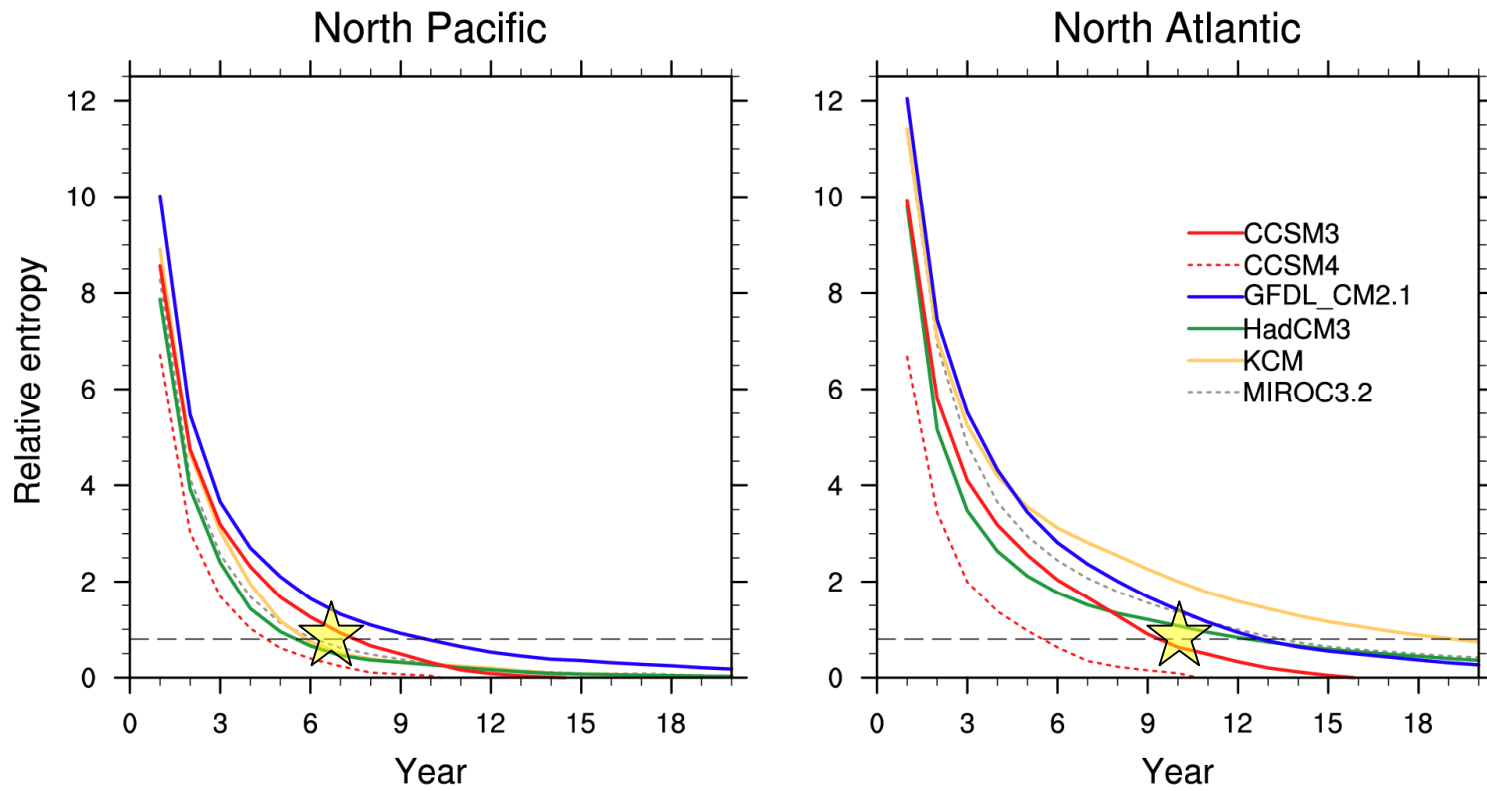
- *DelSole & Tippet (2009)*
- *Lorenz (1969)*

T0-300 5yr Low-Pass Standard Deviation



Basin Total Relative Entropy

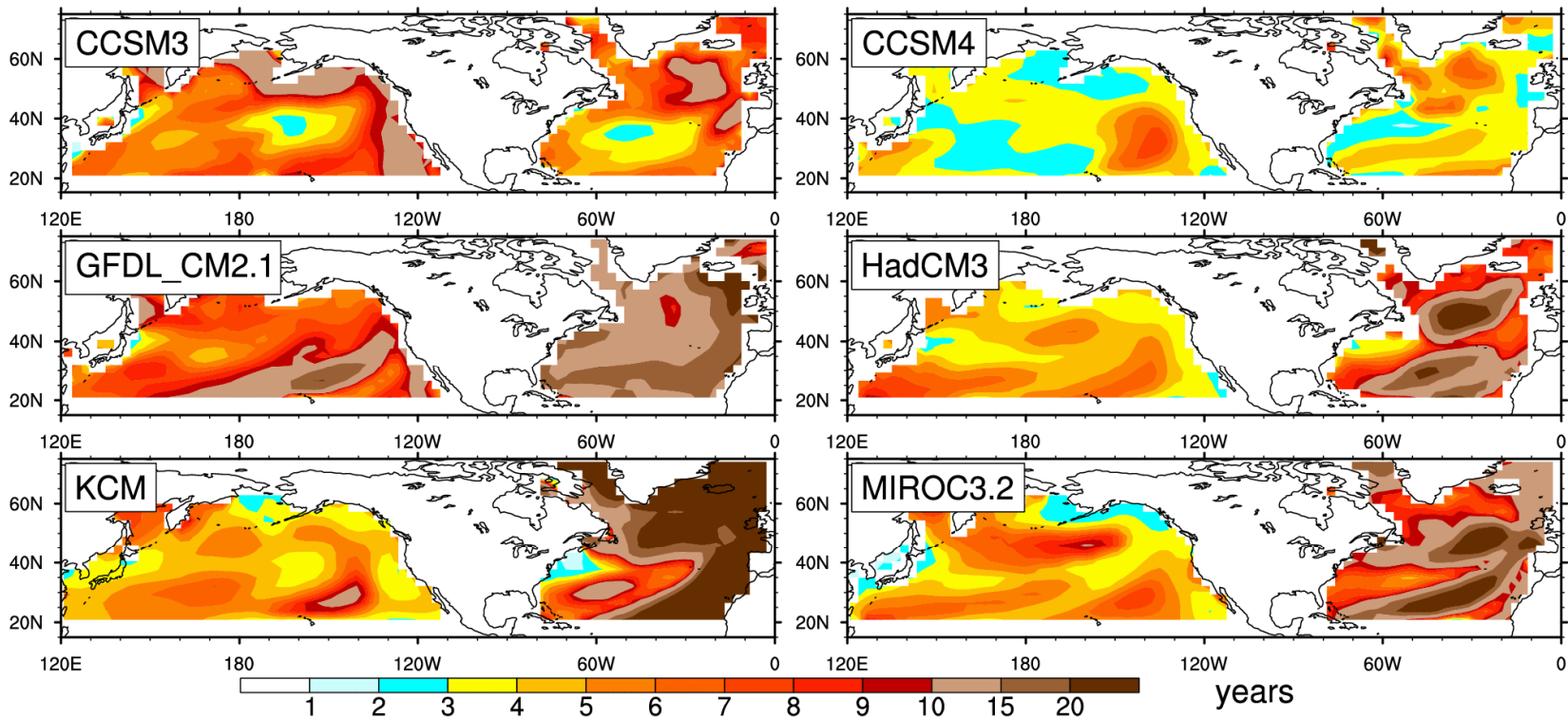
multivariate regression method



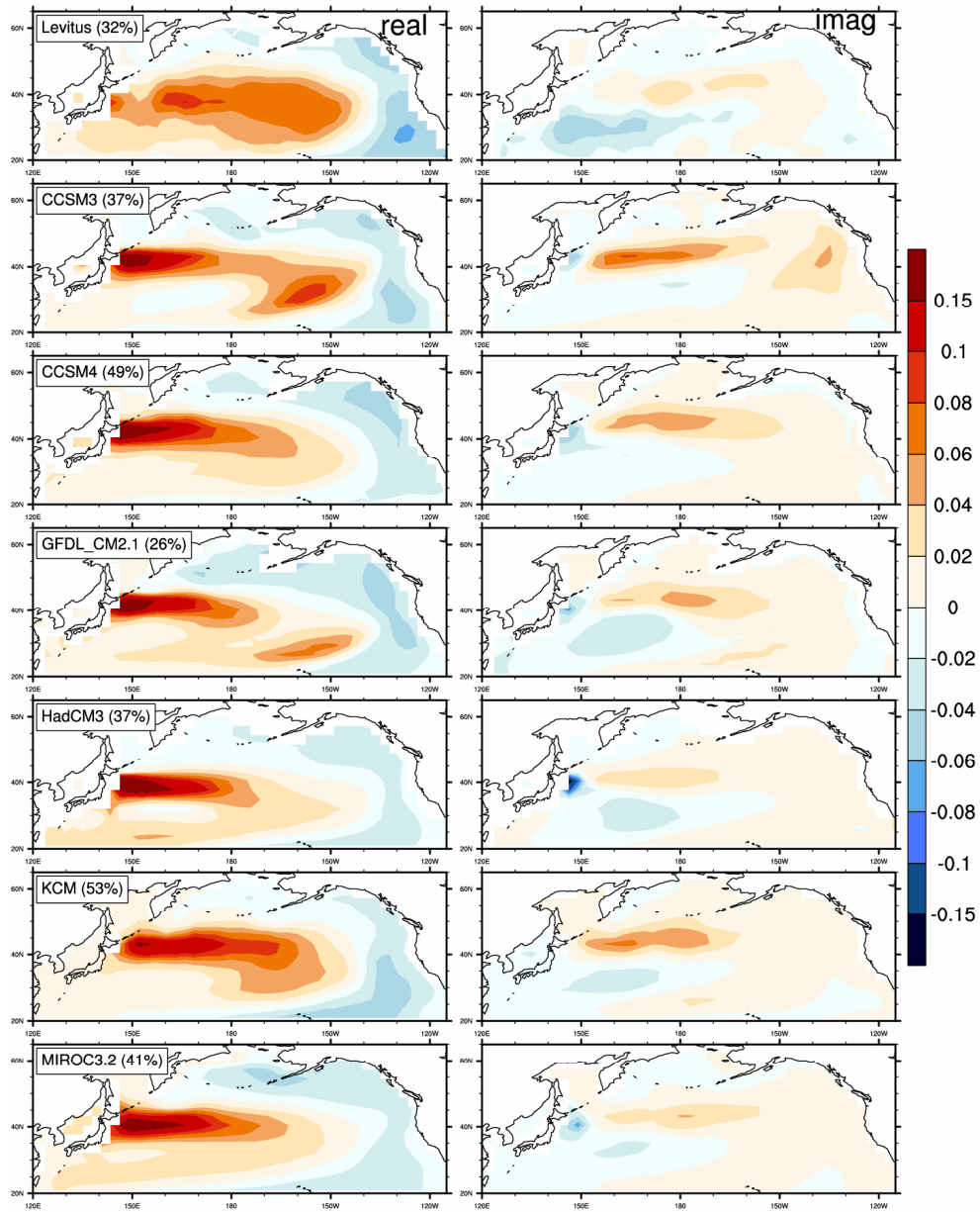
10 EOFs

Year of Nominal Predictability Limit

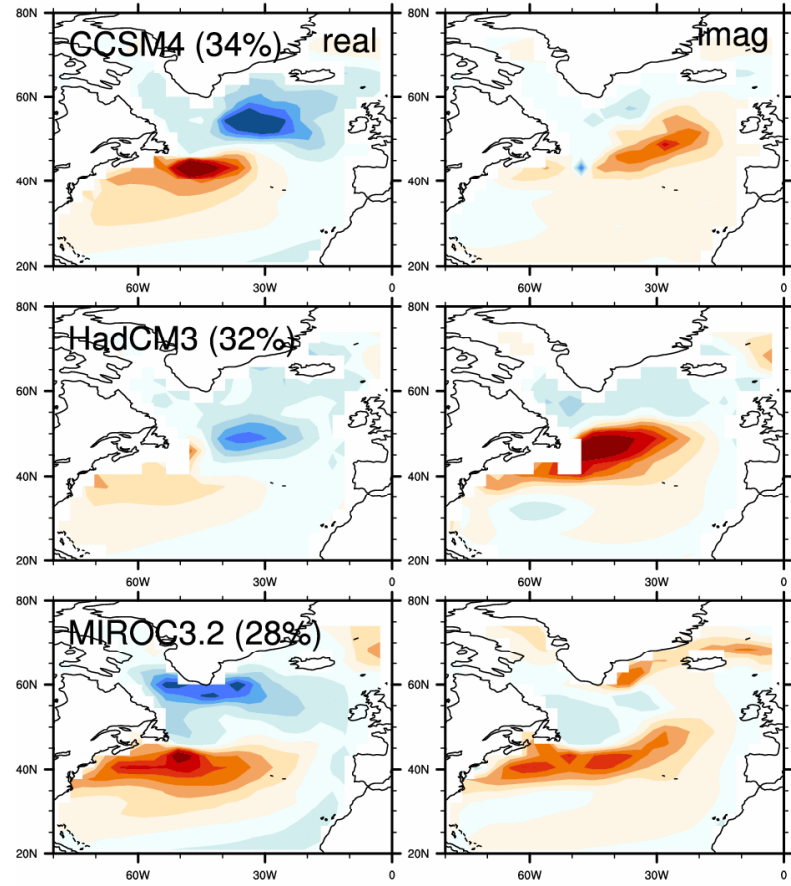
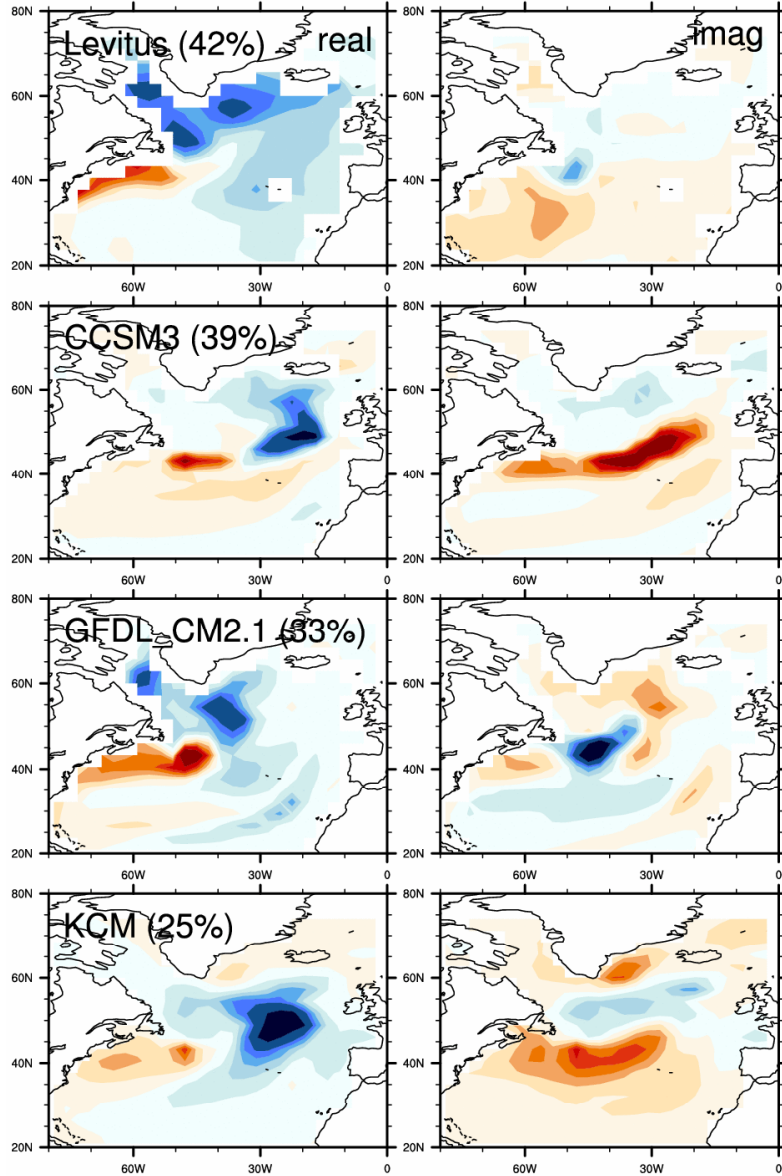
multivariate regression method



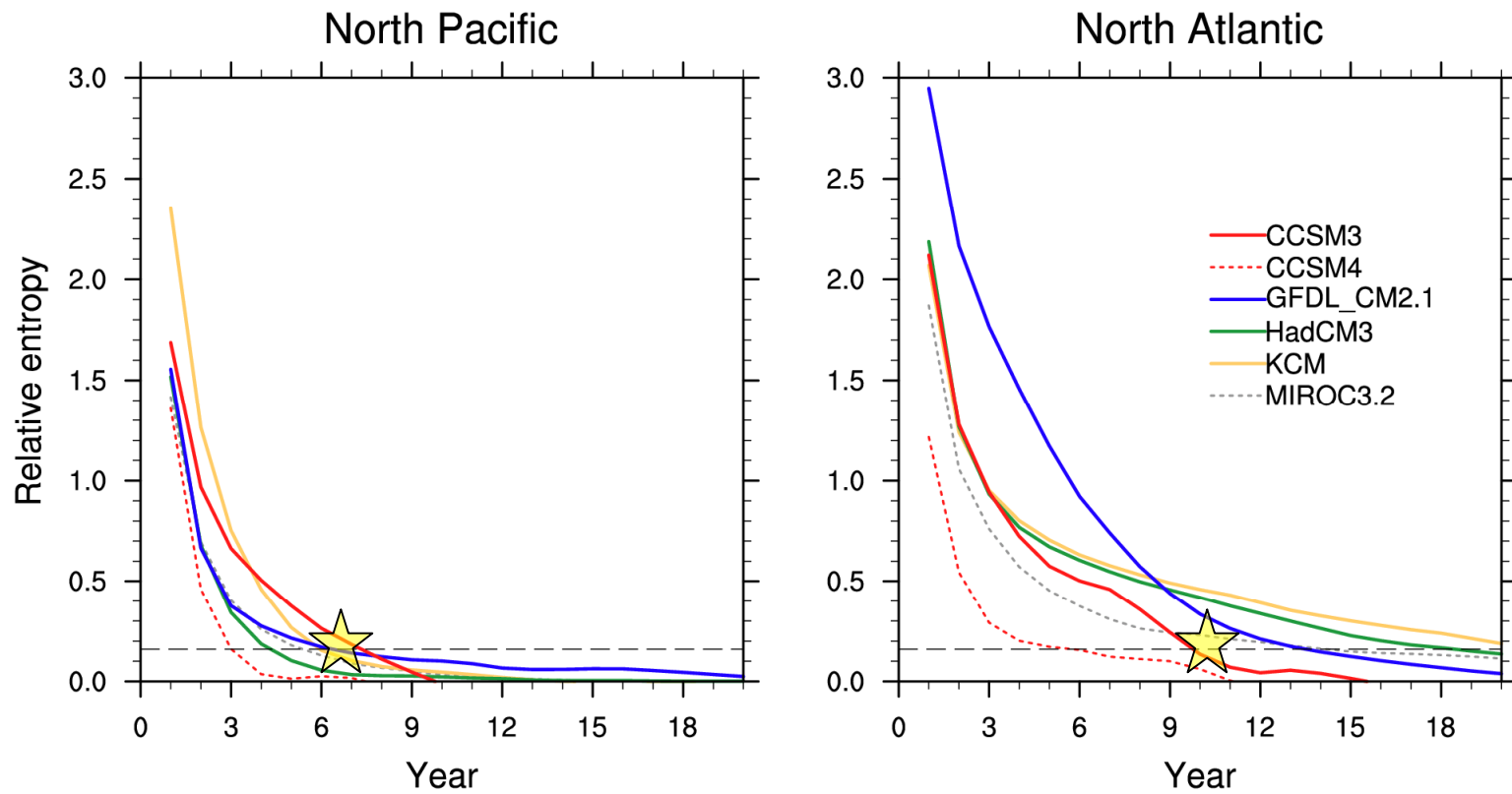
North Pacific CEOF1



North Atlantic CEOF1



Relative Entropy for CEOF1



Summary

1. *For both basins and modes, T0-300 initial value predictability limit is roughly a **decade***
2. *There are substantial **model-to-model** and **region-to-region** variations in predictability*

Ergo

** An essential component of any decadal prediction effort is quantification of the predictability of the forecast model*

- *Current numerical models cannot be used to assess nature's initial value decadal predictability*
- *Focusing on modes may not substantially enhance predictability*

Summary

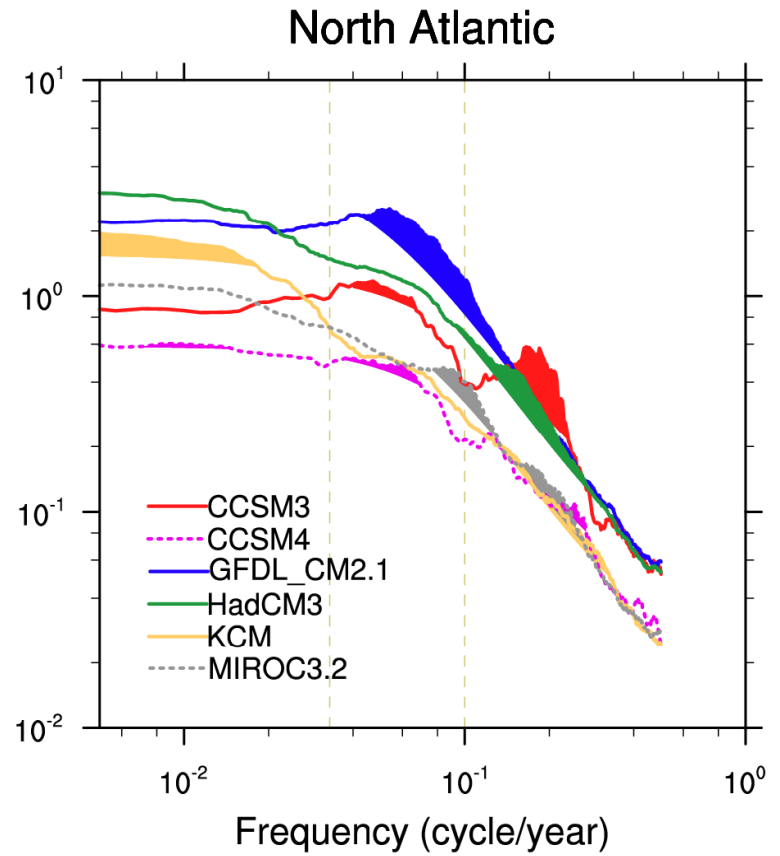
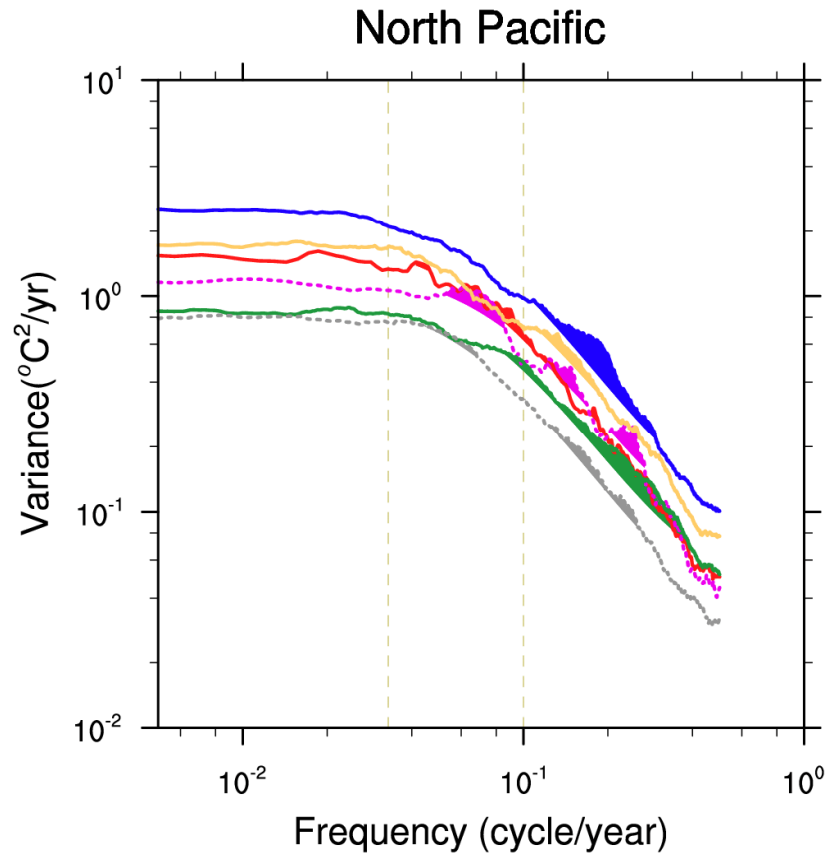
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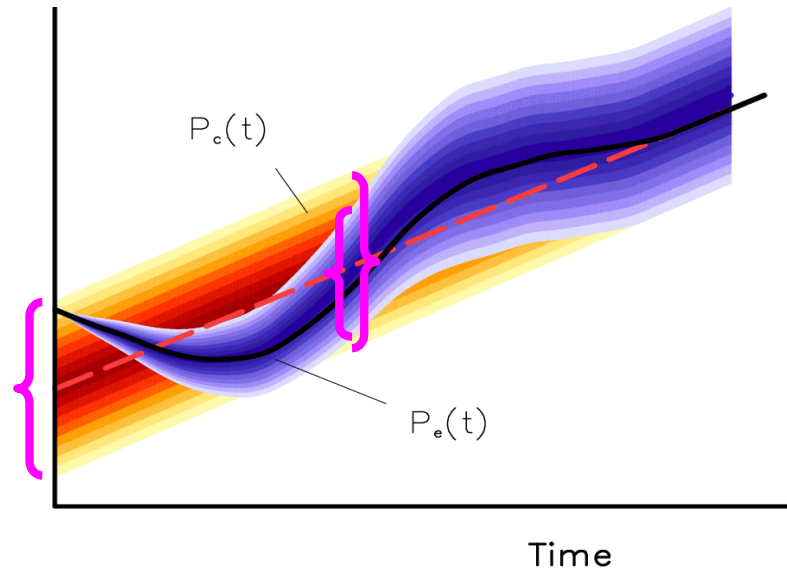
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Average Spectrum



Initial Value Predictability



Relative Entropy

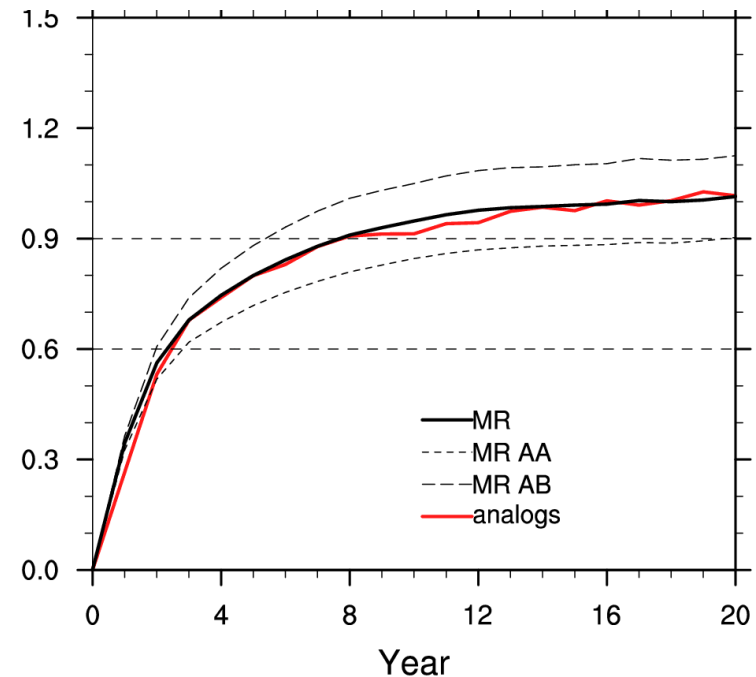
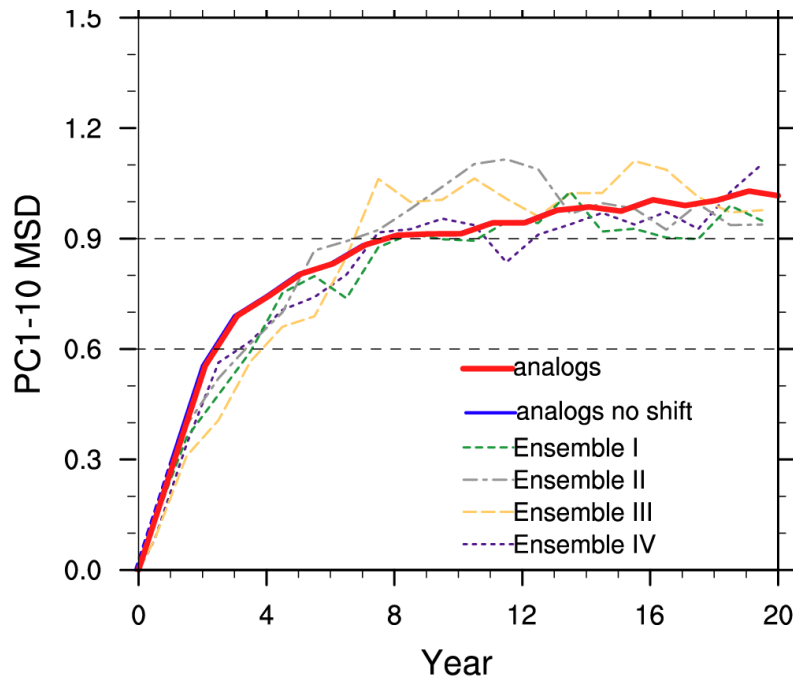
$$R = \int_s P_e(s) \ln \left[\frac{P_e(s)}{P_c(s)} \right] ds = \frac{1}{2} \left[\underbrace{\ln \left(\frac{\sigma_c^2}{\sigma_e^2} \right)}_{\text{dispersion}} + \underbrace{tr \frac{\sigma_e^2}{\sigma_c^2} + (\mu^e - \mu^c)^T \sigma_c^{-2} (\mu^e - \mu^c)}_{\text{signal}} - n \right]$$

Predictability from Ensembles, Analogs & Regression

Attractor averages

CCSM3

North Pacific



$$x(t) = \mathbf{C}(t - t_0)\mathbf{C}^{-1}(0)x(t_0)$$

for $\mathbf{C}(\tau)$ = lag cov matrix

- DelSole & Tippet (2009)
- Lorenz (1969)

Mean Square Difference

analog method

