Impact of Atmospheric Noise and Uncertainty in Initial Conditions on Seasonal Forecast Skill

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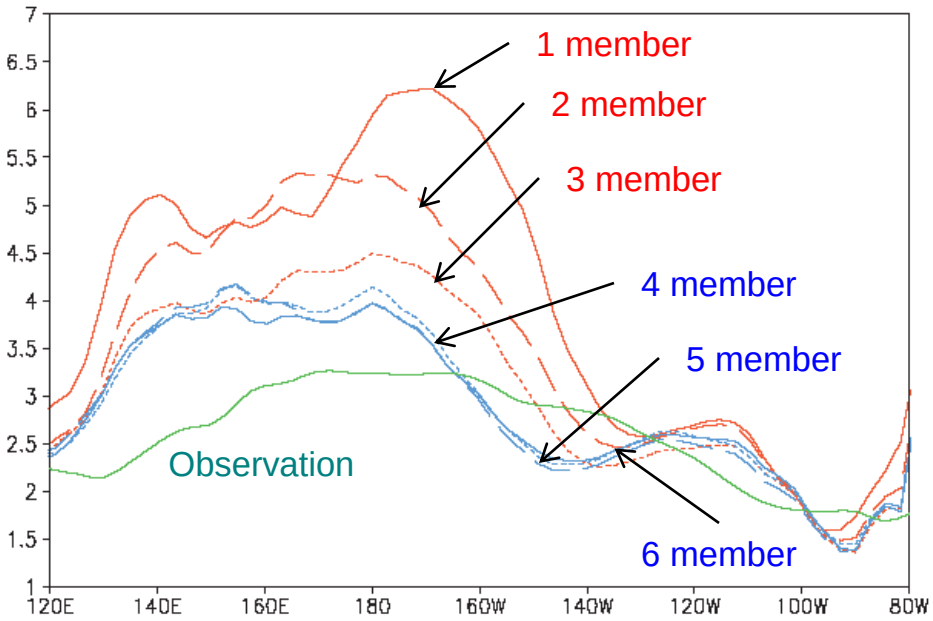
Interactive Ensemble Approach

- **Limit of ENSO predictability**
  - **Model errors**
  - **Uncertainty in Initial Conditions**
  - **Uncertainty as the System Evolves: External Stochastic Effects**

✓ **Current AGCMs are problematic in the representation of the fluxes at the air-sea interface, particularly those associated with internal dynamics.**

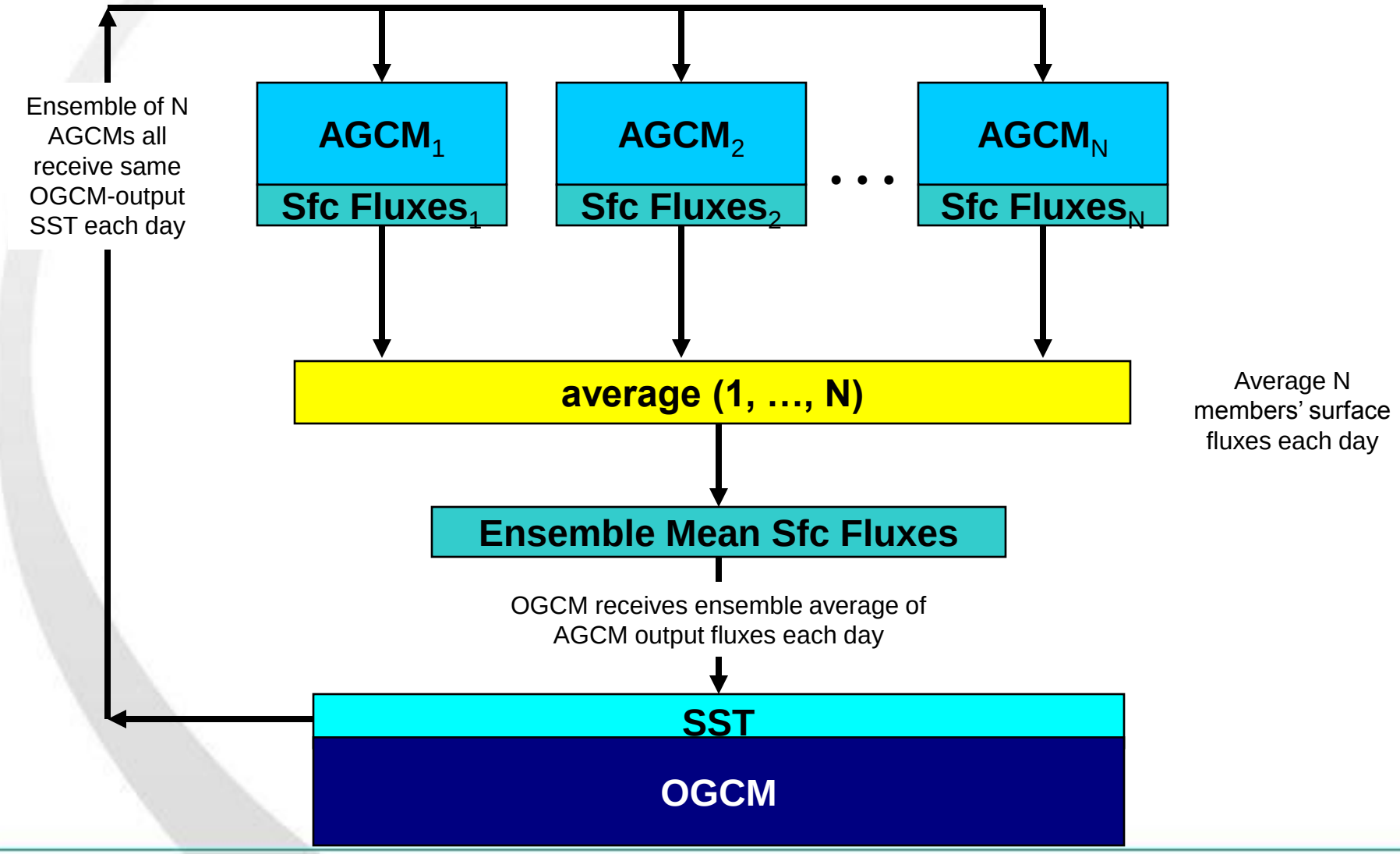
✓ **The challenge for coupled modeling is to find ways to reduce the growth of undesirable and erroneous fluctuations in the coupled system without seriously affecting the natural phenomena.**

➔ **"Interactive ensemble"**



COLA AGCM 850 mb zonal wind standard deviation along the equator as a function of ensemble size

Interactive Ensemble Approach



Interactive Ensemble Approach

❑ Procedure

: The difference resides in the coupling procedures between the AGCM and OGCM

→ The AGCM ensemble mean fluxes are used to drive the ocean model, while all atmospheric ensemble members experience the same SST produced by the OGCM

❑ Advantage of Interactive Ensemble

−The AGCM has unrealistic internal dynamics noise, and that an ensemble average of multiple atmospheric states forced by the same SST will reduce the internal atmospheric noise, thereby enhancing the relative strength of the SST forced signal.

−The end result of such a simulation could be quite different from averaging the end results of several coupled model simulations.

: As the ensemble forecasts offers a solution to improve the error forecasts due to uncertainty in initial conditions, the interactive ensemble coupling strategy offers a solution to improve the error forecasts due to model errors which translate into poor simulation of the atmospheric internal dynamics.

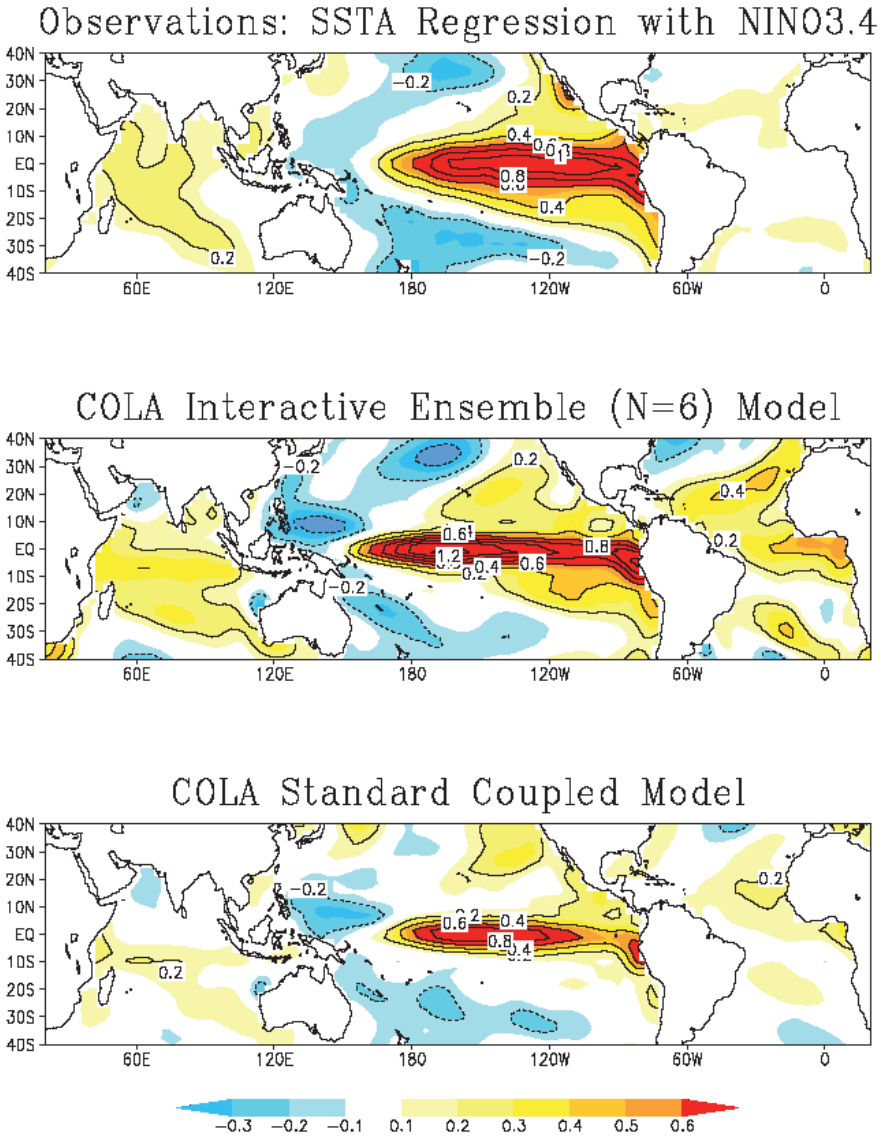
Example of Interactive Ensemble

Interactive ensemble coupled model: (COLA CGCM)

- produces realistic ENSO events that are irregular.
- improves the simulation of the global teleconnection associated with ENSO and ENSO-monsoon relationship.

(Kirtman and Shukla, 2002)

NINO34 Regression on Equatorial Pacific SSTA



Model and Dataset

Retrospective Forecast

- CCSM 3.0: CAM3 T85L26 + POP 1.4 gx1v3 L40
- Initial condition case of **January** are analyzed.
- As observational counterparts, OISST and CMAP rainfall are used.

		CCSM 3.0	CCSM 3.0 Interactive
Initialization	**Atm**	Random conditions from CCSM long run via AMIP (No observation)	Random conditions from CCSM IE long run via AMIP (No observation)
	Ocean	GFDL MOM3 ODA (Rosati and Harrison, 2002)	GFDL MOM3 ODA (Rosati and Harrison, 2002)
Member		6	**6** (36 atmospheric realizations)
Lead month		12	12
Period		1981-1998	1981-2000

CCSMIE - Reduce Noise Version (interactive ensemble) of CCSM

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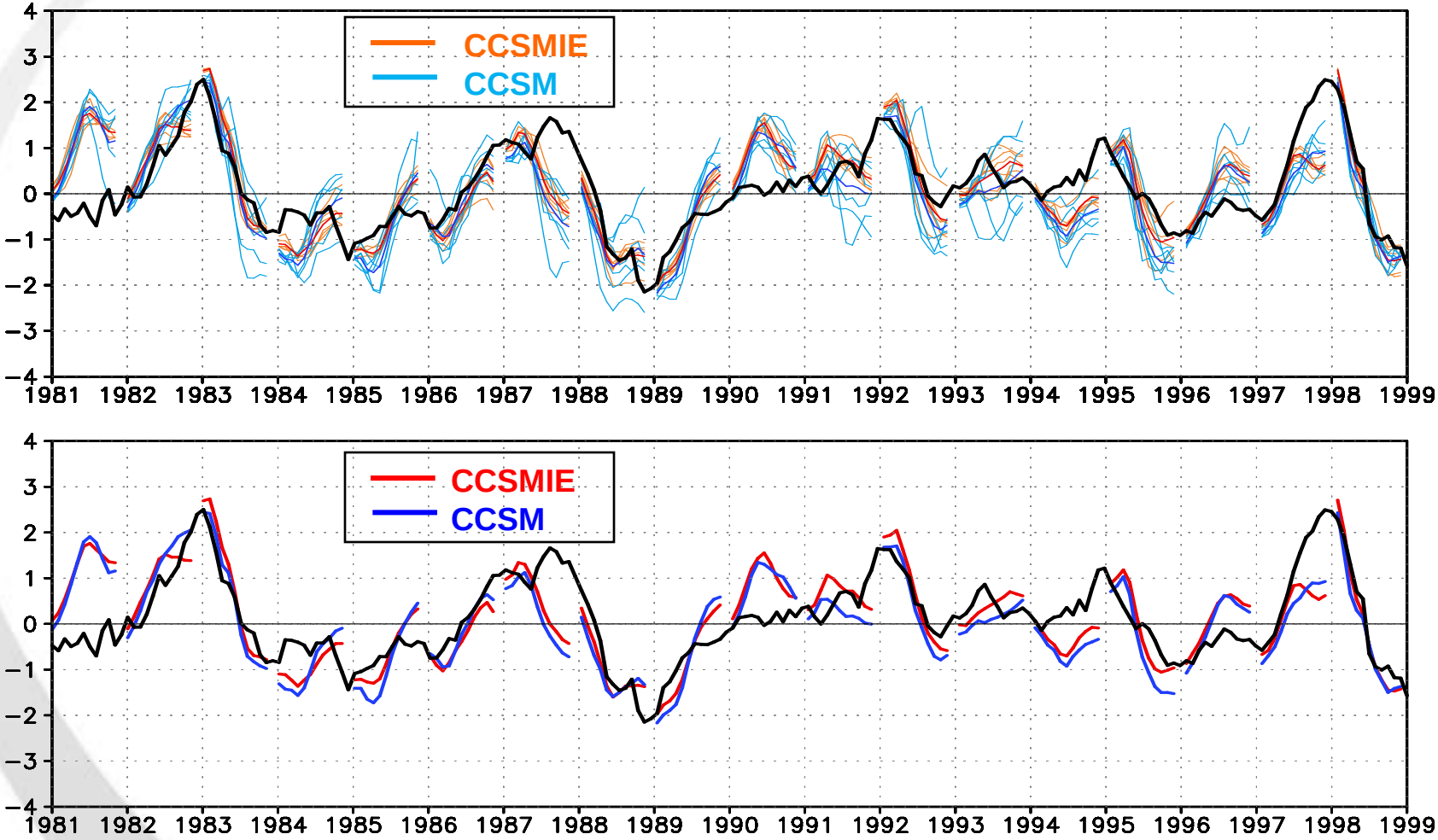
NINO3.4 SST Anomalies



Year

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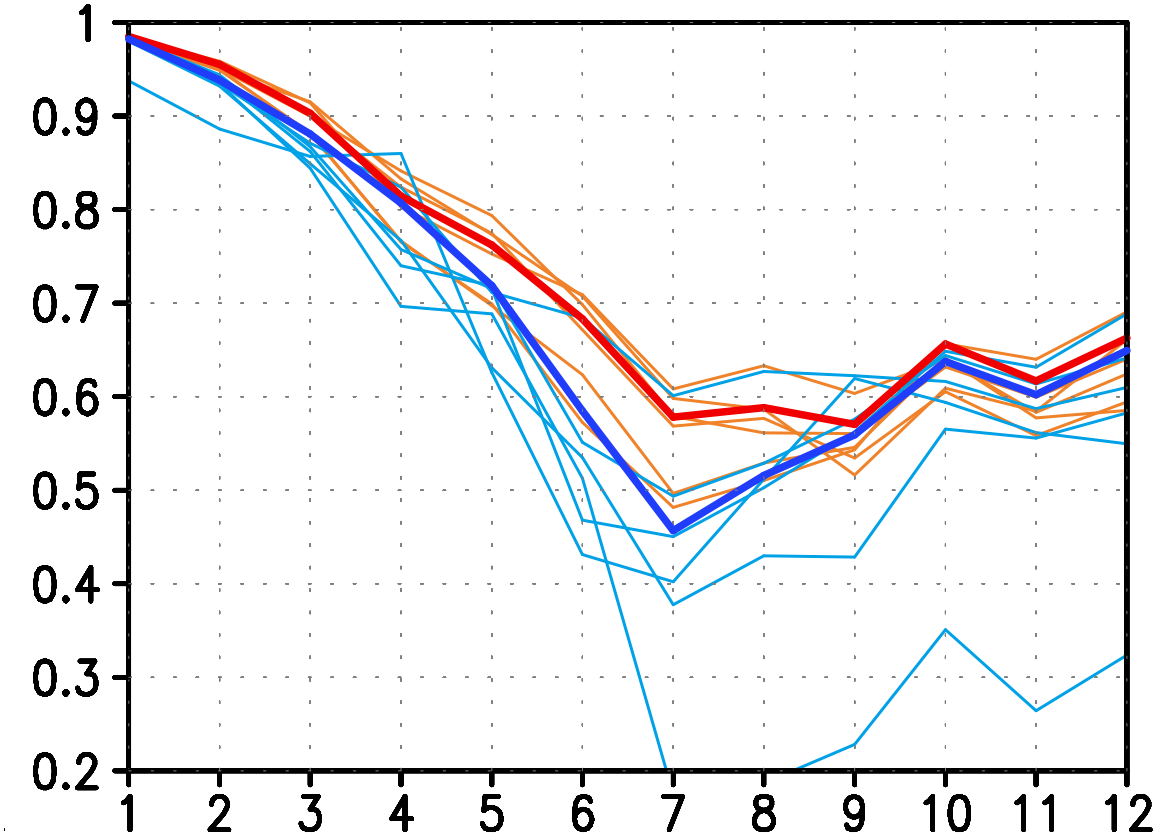
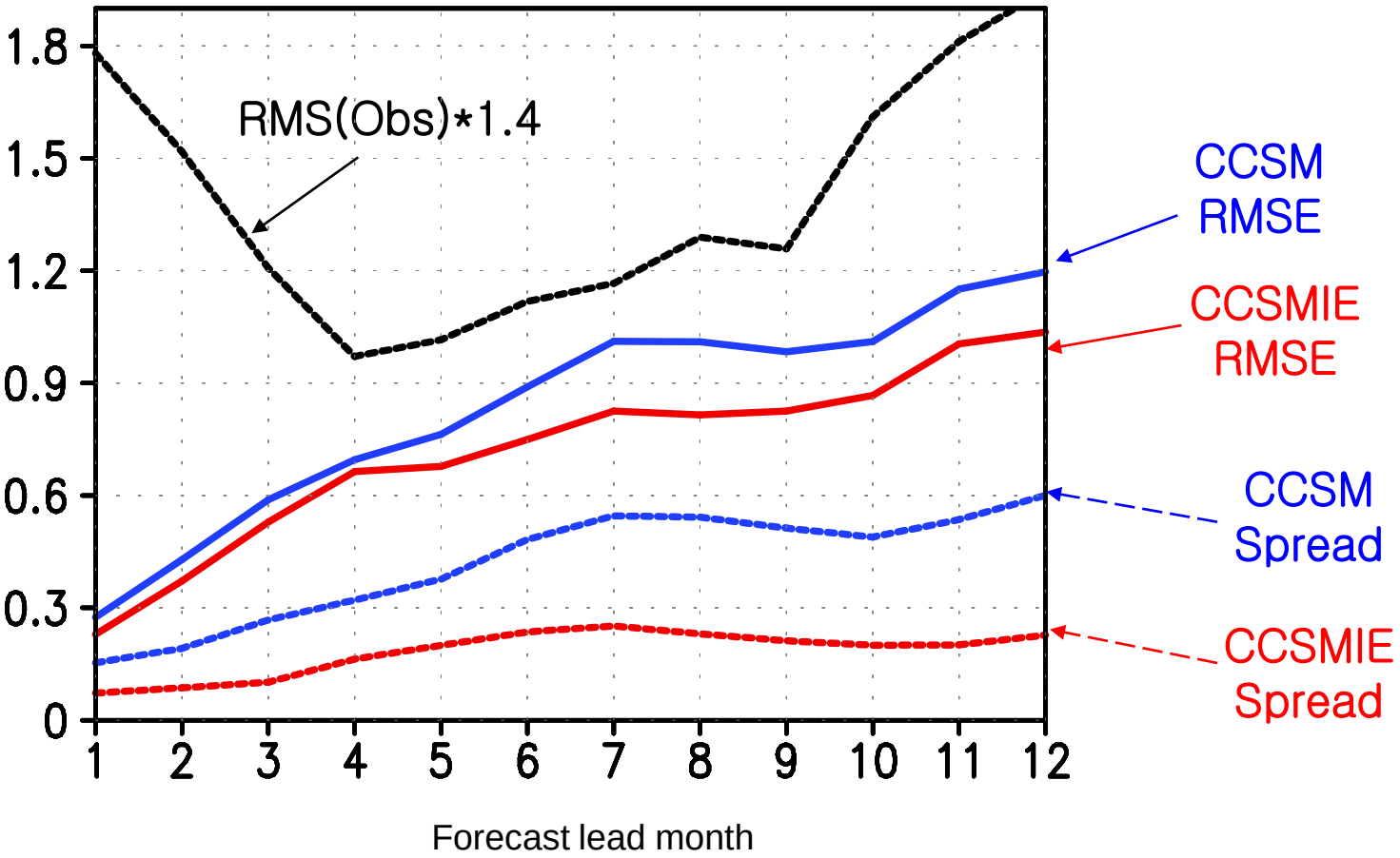
Forecast Skill of NINO3.4

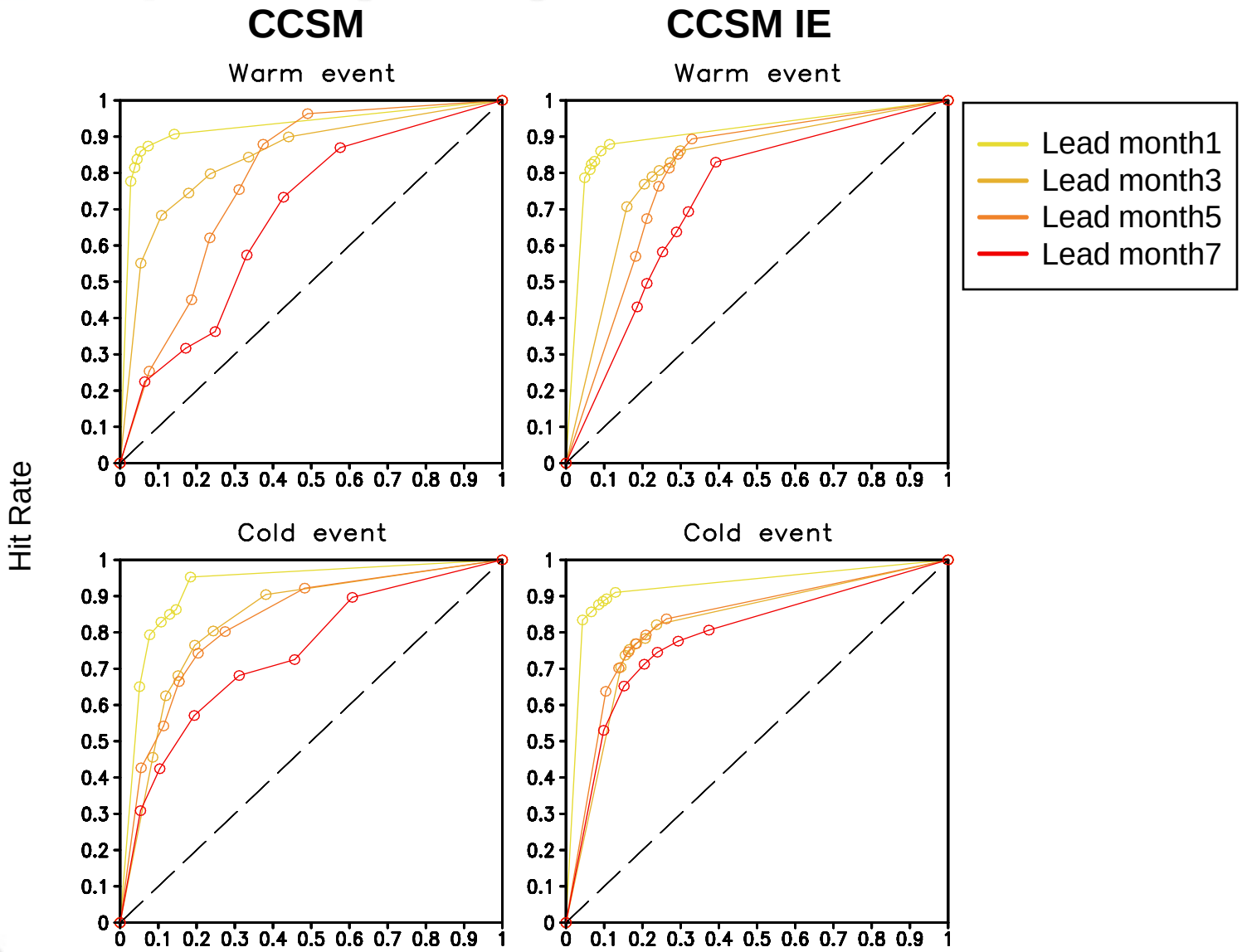
Anomaly Correlation Coefficient



RMS Error of NINO3.4

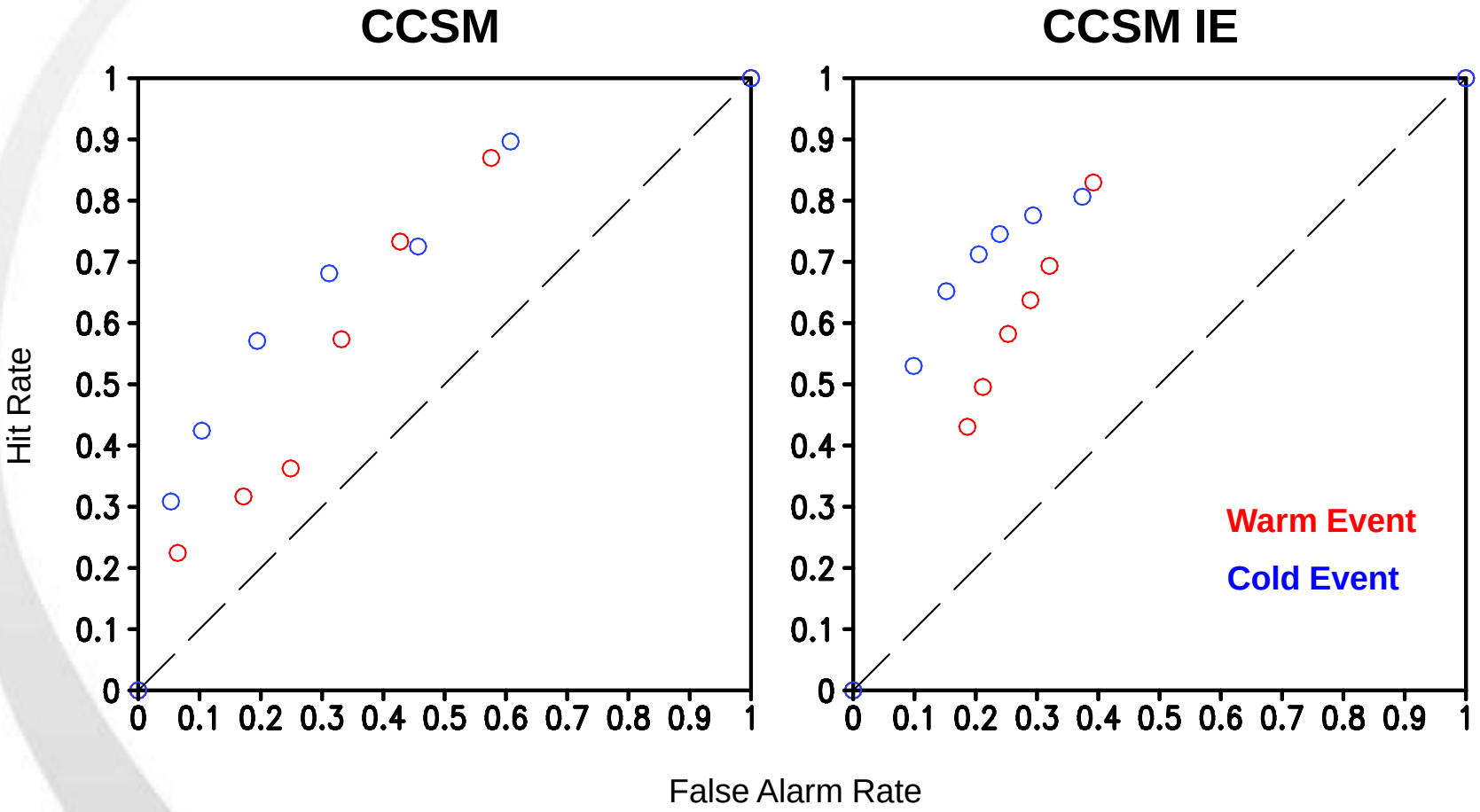


Probability Skill (ROC) of NINO3.4 SSTA



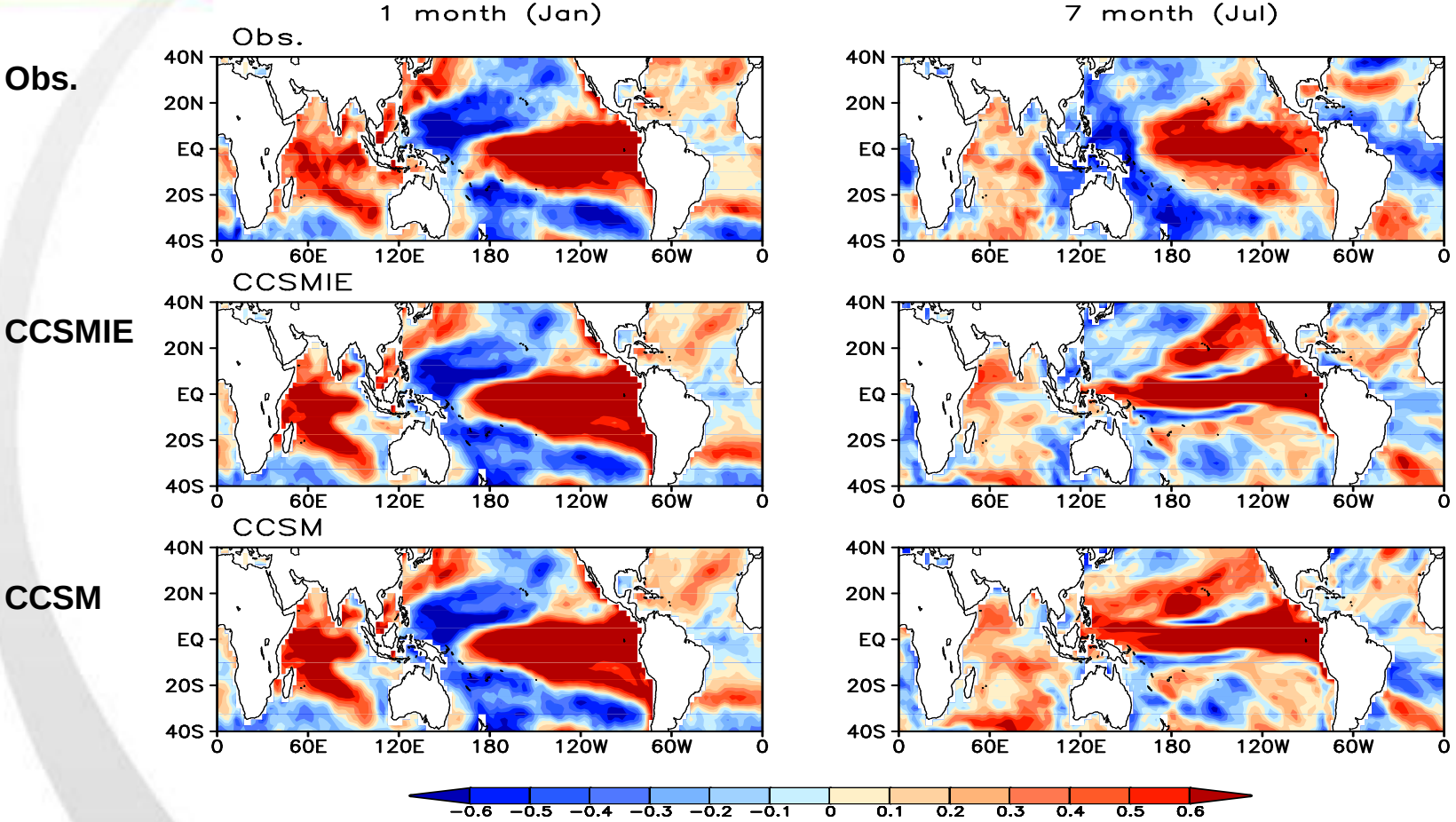
Probability Skill of NINO3.4 SST Anomalies

ROC at lead month 7

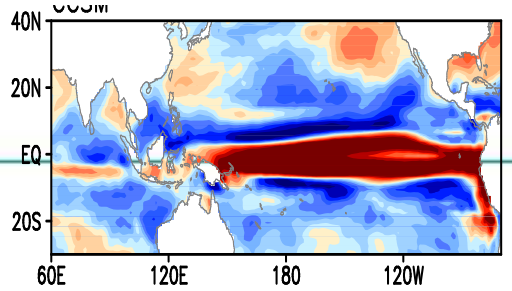


Global Response Associated with ENSO

NINO34 Regression on SST Anomalies



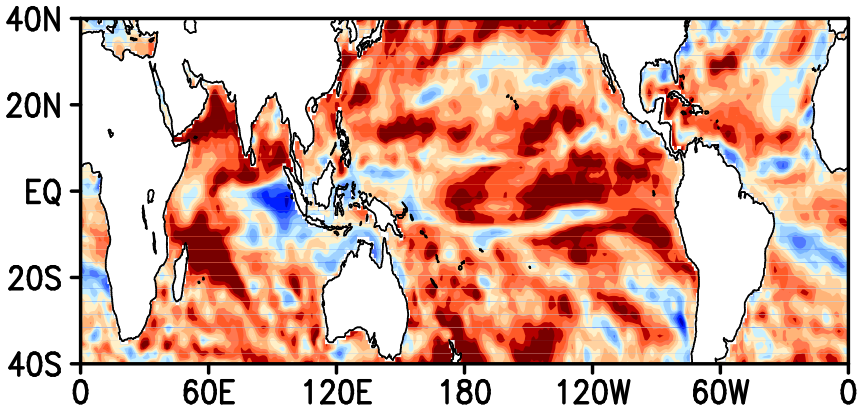
CCSM long run



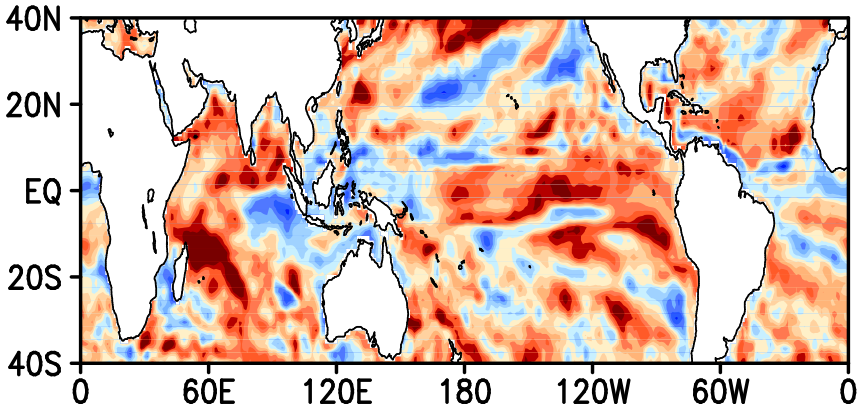
Forecast Skill of SST

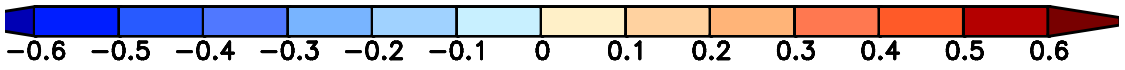
Temporal correlation at lead month 7 (July)

CCSMIE



CCSM





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Summary

- In this study, the retrospective forecast of CCSM3 interactive ensemble has conducted to improve the error forecasts due to model errors which translate into poor simulation of the atmospheric internal dynamics noise.
- The CCSMIE reduces the noise at the air-sea interface but allows realization of multiple atmospheric states that are equally likely to result from a single ocean state.
- In RMS error growth, the deterministic forecast skill of CCSMIE is improved but the amount is modest comparing to the amount of reduced spread. An initial condition error or a model error that leads to the RMS error growth can be considered to fill the gap.
- The SST ensemble forecasts produced by the system with reduced noise has a reduced spread within the ensemble members, but the probabilistic skill is not reduced by the lack of spread in both warm and cold SST probabilistic skill in CCSMIE.

THANK YOU!

ANY QUESTIONS?