Influence of single model ensemble on the simulated extratropical interannual variability

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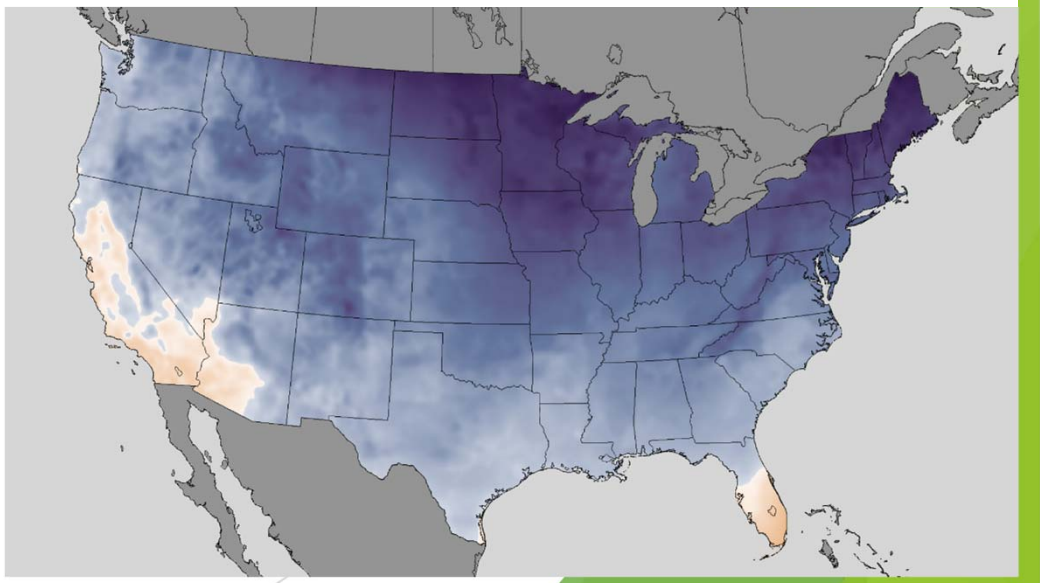
Motivation

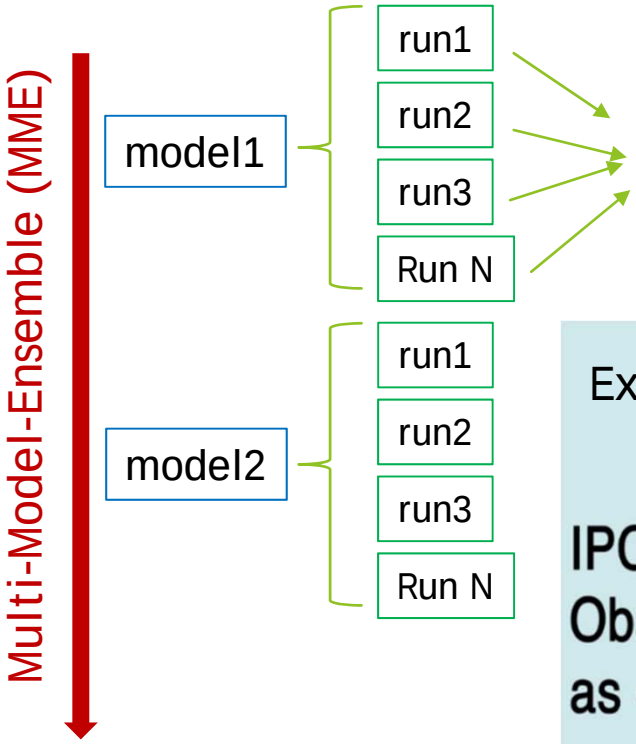
- Good ENSO simulation (目前年際變異中可被掌握得最好的現象) → Good winter Temp forecast (usually)
- Increasing extreme winter events in the extratropics in recent years
- Arctic sea ice loss or other factors?
- What is the ability of GCM to simulate the interannual variability in the extratropics ?

2014/01/02-04
Temperature (mostly <0°C)
(neutral year)



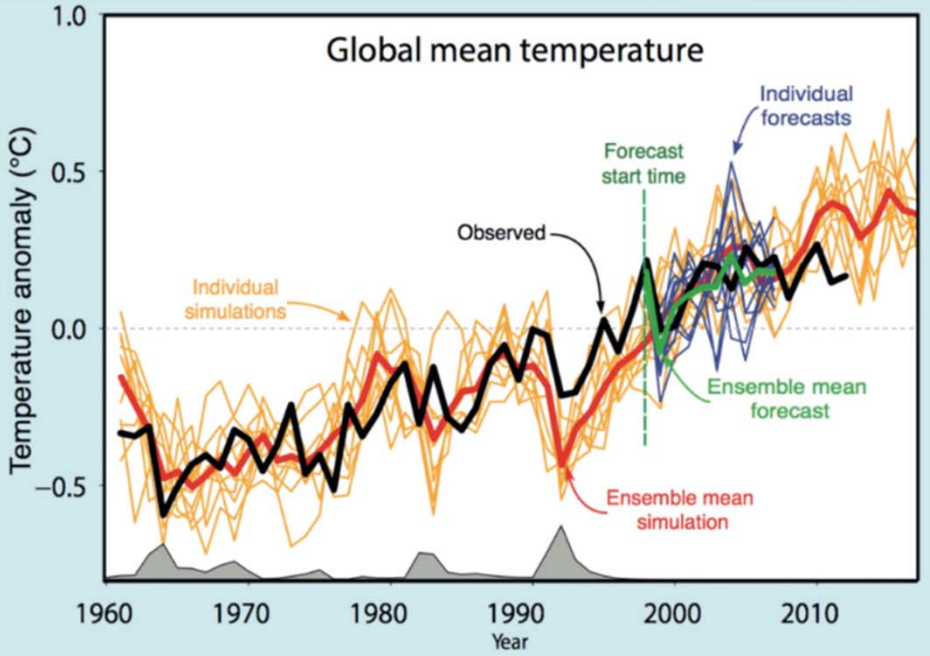
Single-model ensemble（單一模式系集平均）
Multi-model ensemble（多模式系集平均）

→ What is their effect on interannual variability ?



Example:

IPCC AR5 Observations as of 2014



Box 11.1, Figure 1 | The evolution of observation-based global mean temperature *T* (the black line) as the difference from the 1986–2005 average together with an ensemble of externally forced simulations to 2005 and projections based on the RCP4.5 scenario thereafter (the yellow lines). The model-based estimate of the externally forced component T_f (the red line) is the average over the ensemble of simulations. To the extent that the red line correctly estimates the forced component, the difference between the black and red lines is the internally generated component T_i for global mean temperature. An ensemble of forecasts of global annual mean temperature, initialized in 1998, is plotted as thin purple lines and their average, the ensemble mean forecast, as the thick green line. The grey areas along the axis indicate the presence of external forcing associated with volcanoes.

Model Simulations

Climate simulations

EU Seasonal Forecast

NCEP

Projects	Models			
CMIP5(20)	BCC-CSM1.1	CCSM4	CESM1-FASTCHEM	CESM1-WACCM
	CNRM-CM5	CanESM2	CSIRO-Mk3-6-0	FGOALS-g2
	FGOALS-s2	GFDL-ESM2G	GFDL-CM3	GISS-E2-H
	GISS-E2-R	HadGEM2-ES	HadGEM2-CC	MPI-ESM-LR
	MIROC5	MIROC4	MRI-CGCM3	NorESM1-M
DEMETER(7)	CERFACS	ECMWF	INGV	LODYC
	MeteoFrance	MPI	UK	
ENSEMBLES(6)	ARPEGEClimate4.6	DePreSys_HadCM3	ECHAM5_OPA8.2	ECHAM5_T63L31
	HadGEM2	IFS31R1_HOPE-E		
CFS V2 (1)				

CMIP 5 (different starting time from piControl)

EU (9 different initial conditions, SSTA, wind stress)
NCEP (8 different initial times)

Observation: ERA40

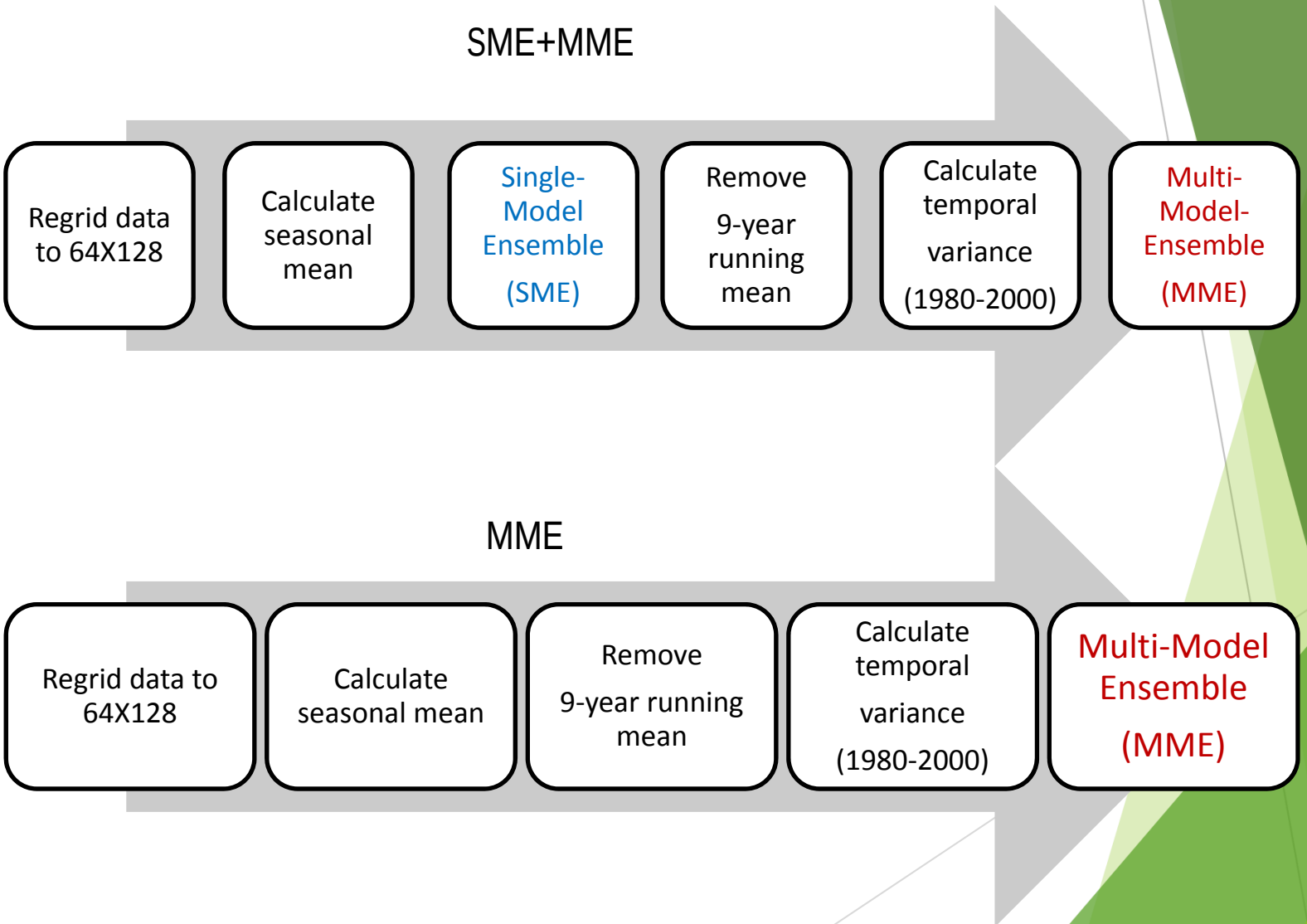
Two approaches

- **Seasonal forecast**
  - GCM
  - Sensitive to initial conditions
  - Predict ENSO well

  →Good interannual variability? (extratropics DJF T2m)

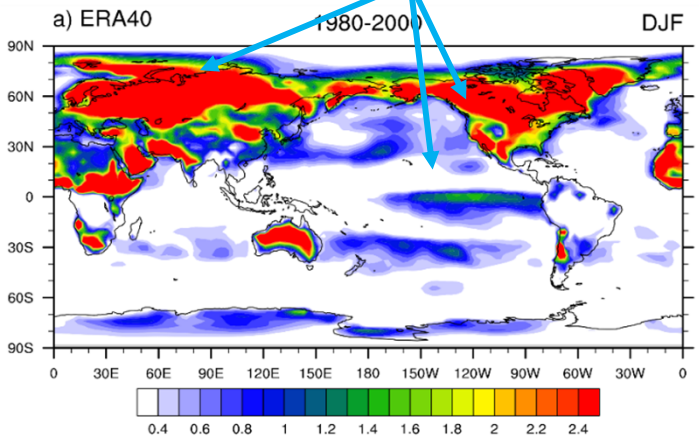
- **Climate simulation**
  - GCM
  - Avoid effects from initial conditions
  - Good interannual variability (statistically)

Data processing



Interannual Variability of DJF T2M

Large variance



SME + MME

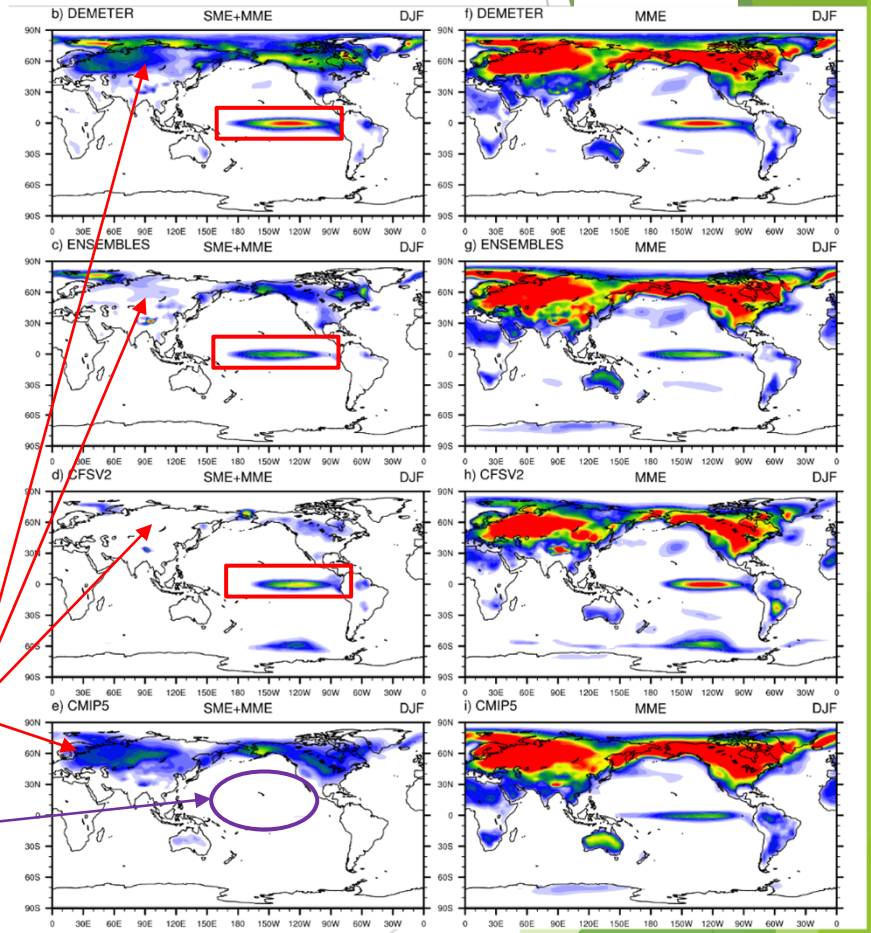
MME

DEMETER

ENSEMBLES

CFSV2

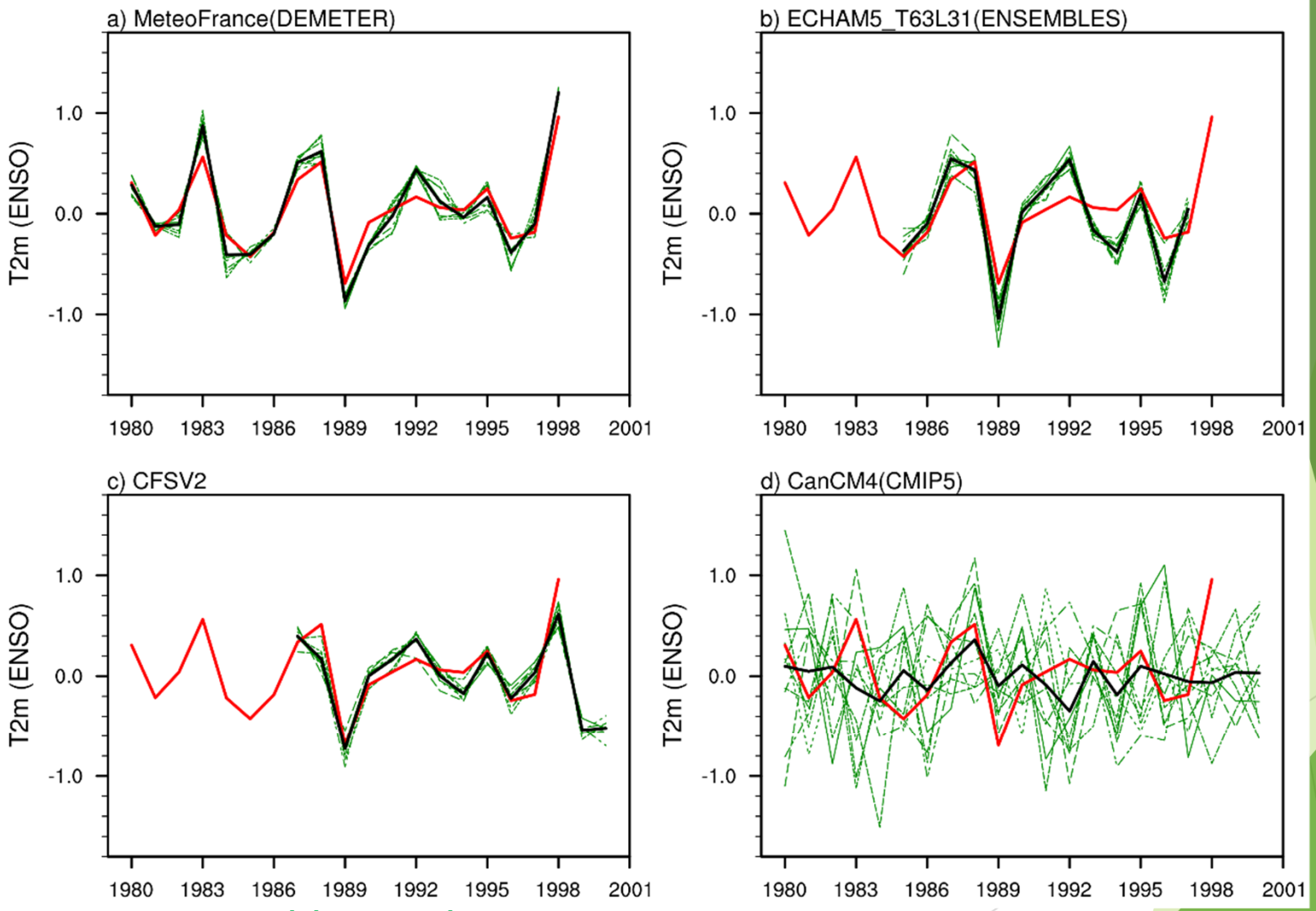
CMIP5



Strong impact from SME process

ENSO signal is gone

Cancelation effect in SME step
DJF T2m over tropical Pacific (ENSO)



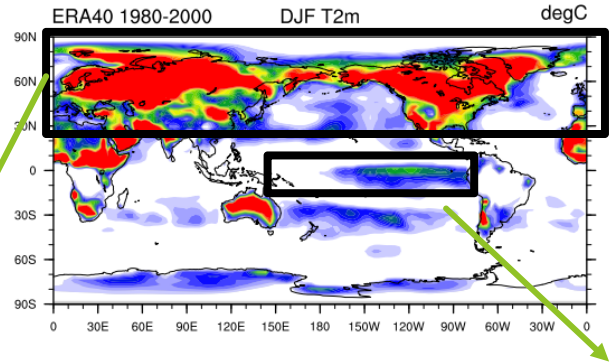
Ensemble members

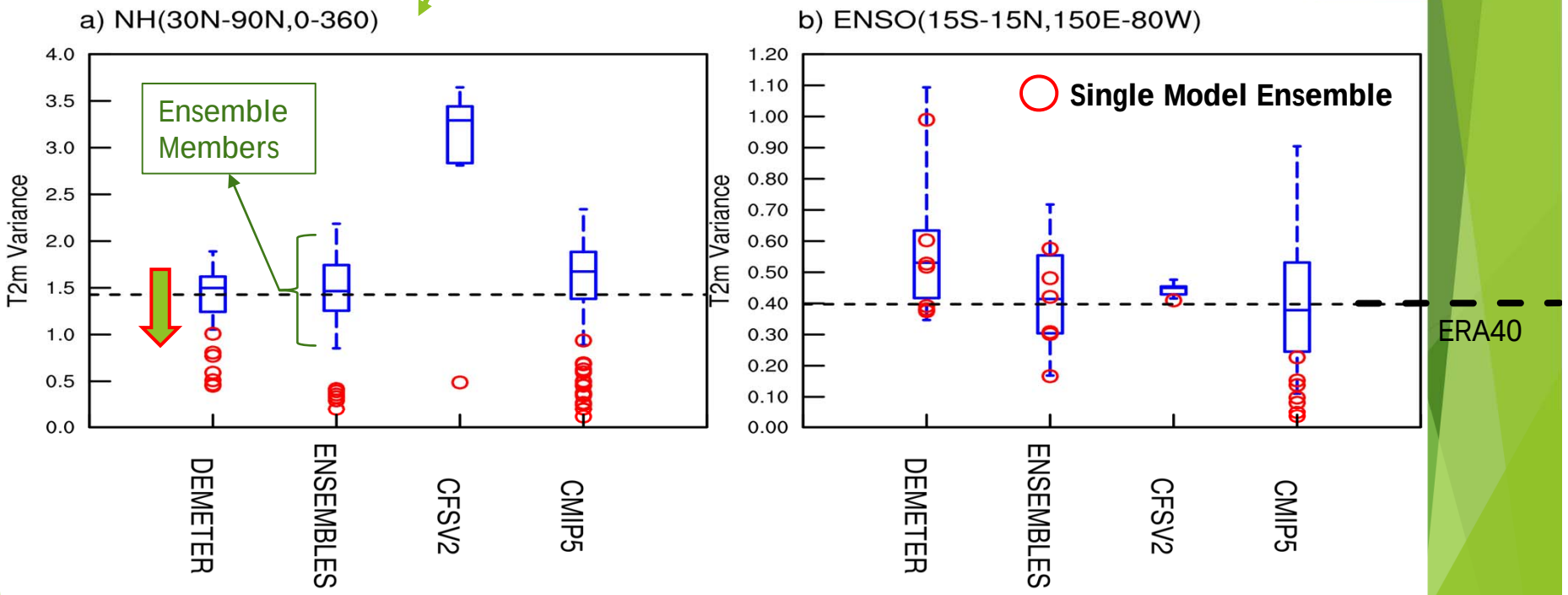
SME

ERA40

Strong cancelation effect
in CMIP type simulations

SME Impact on interannual variability DJF T2m





Extratropical variance
Significantly drops after SME

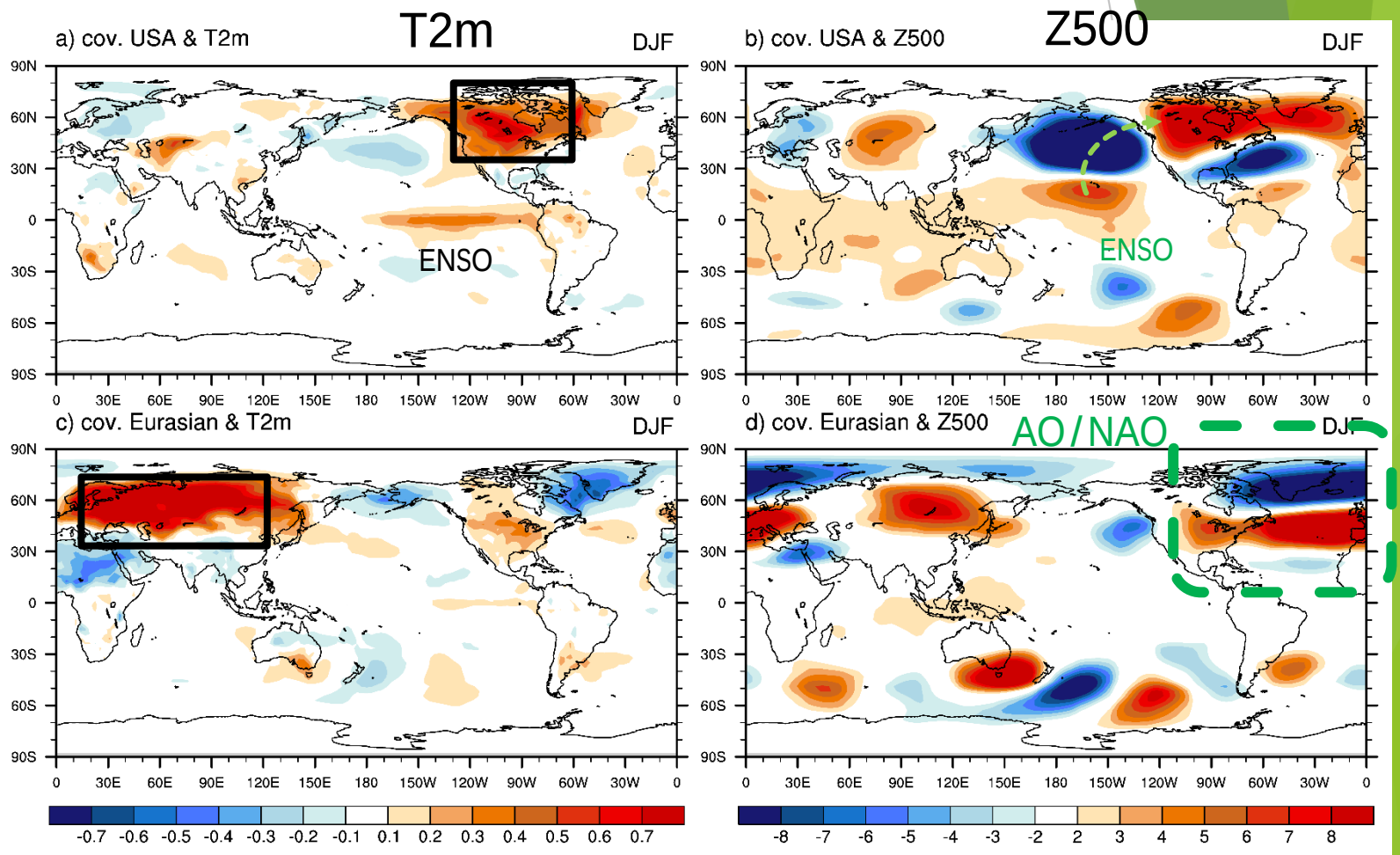
Tropical variance is less effected

Covariance maps (ERA 40)

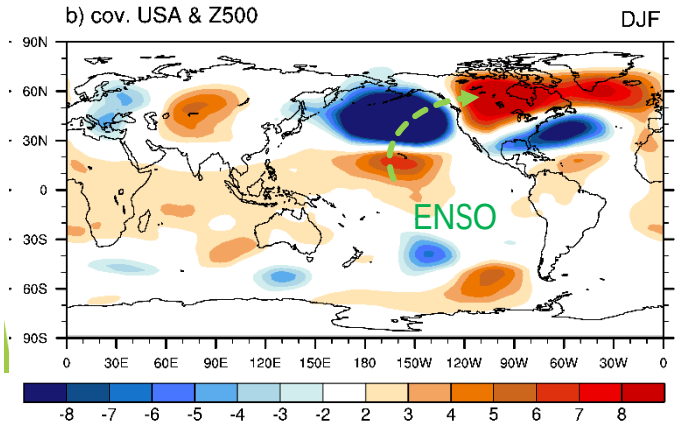
Regional T2m vs. all grids T2m (or Z500)

North America

North Eurasia



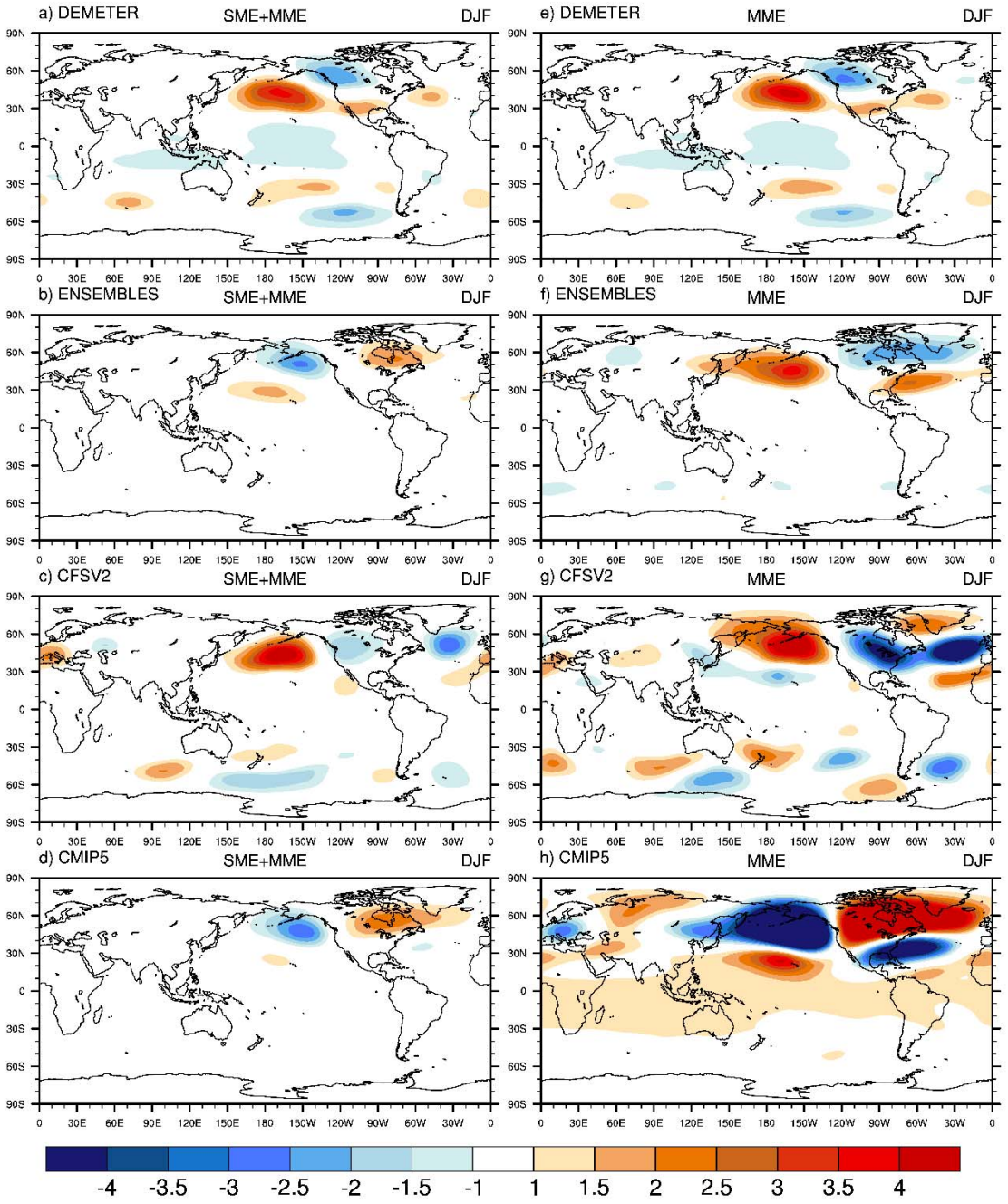
North America T2m vs. Z500



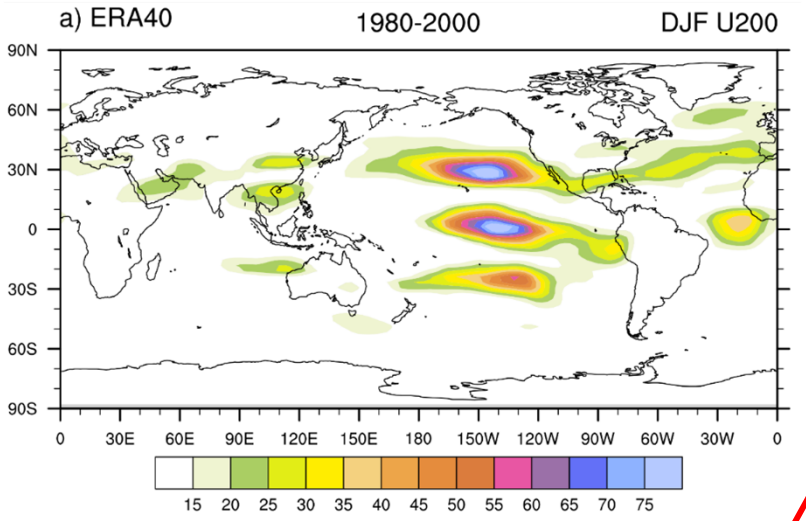
1. The atmospheric waves forced by ENSO disperse in extratropics

2. Signal improved without SME, but still underestimate

SME + MME **MME**



Interannual variability of DJF U200

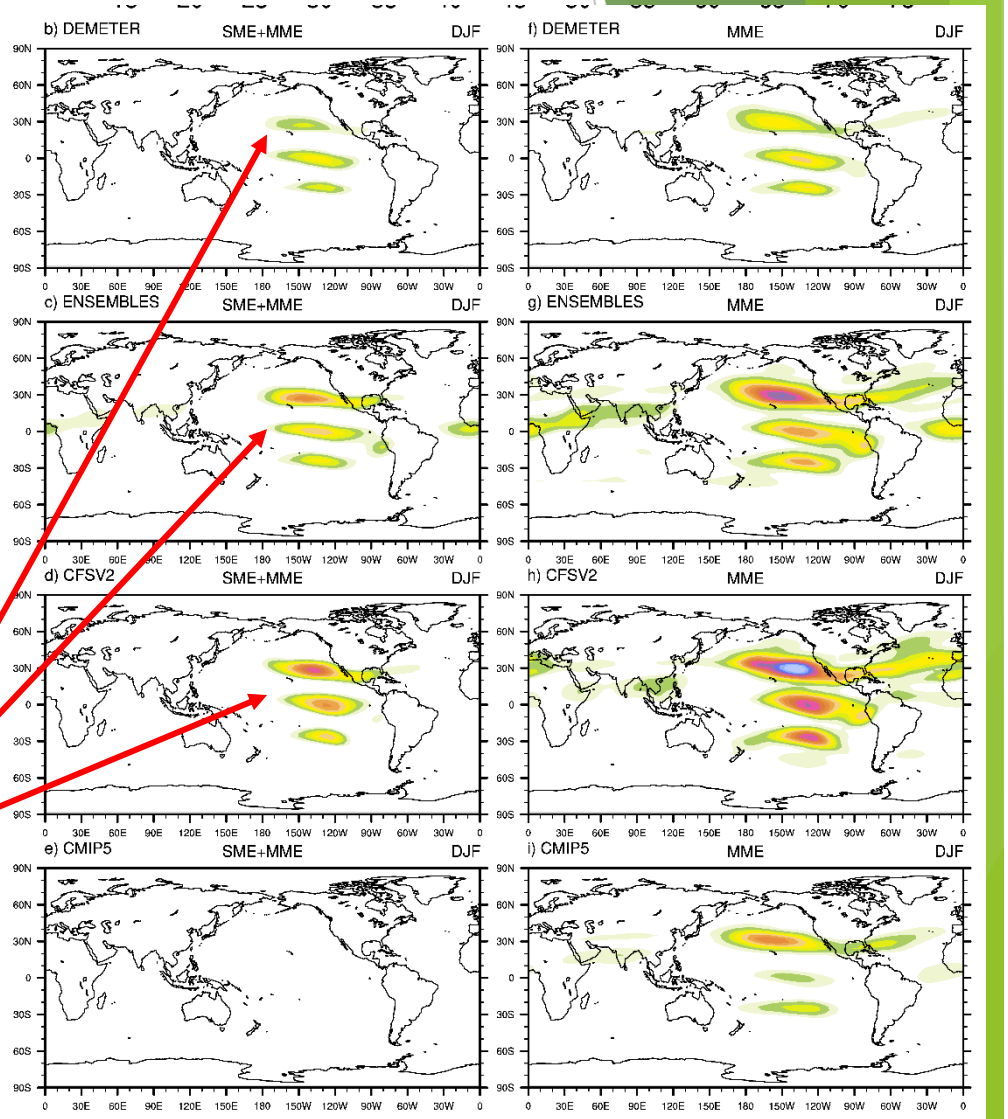


Strong impact from SME
Even the ENSO signal is strong

The atmospheric waves forced by ENSO propagate poleward and are dispersed.

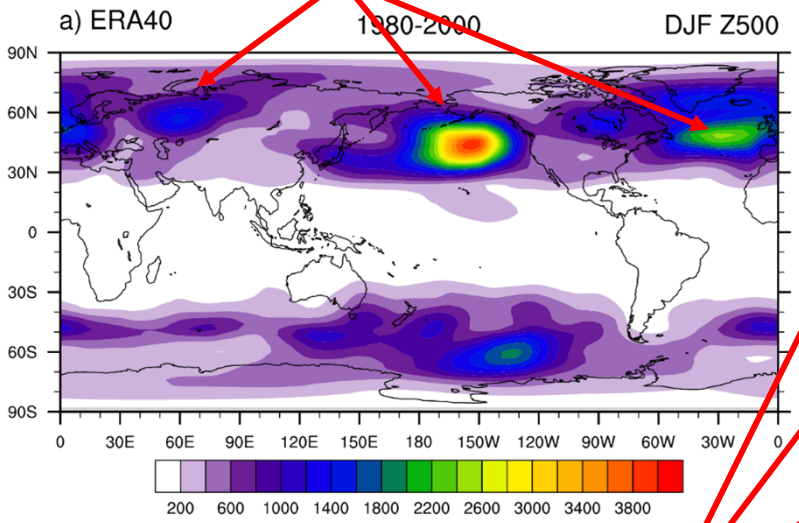
SME + MME

MME



Interannual variability of DJF Z500

Large variance

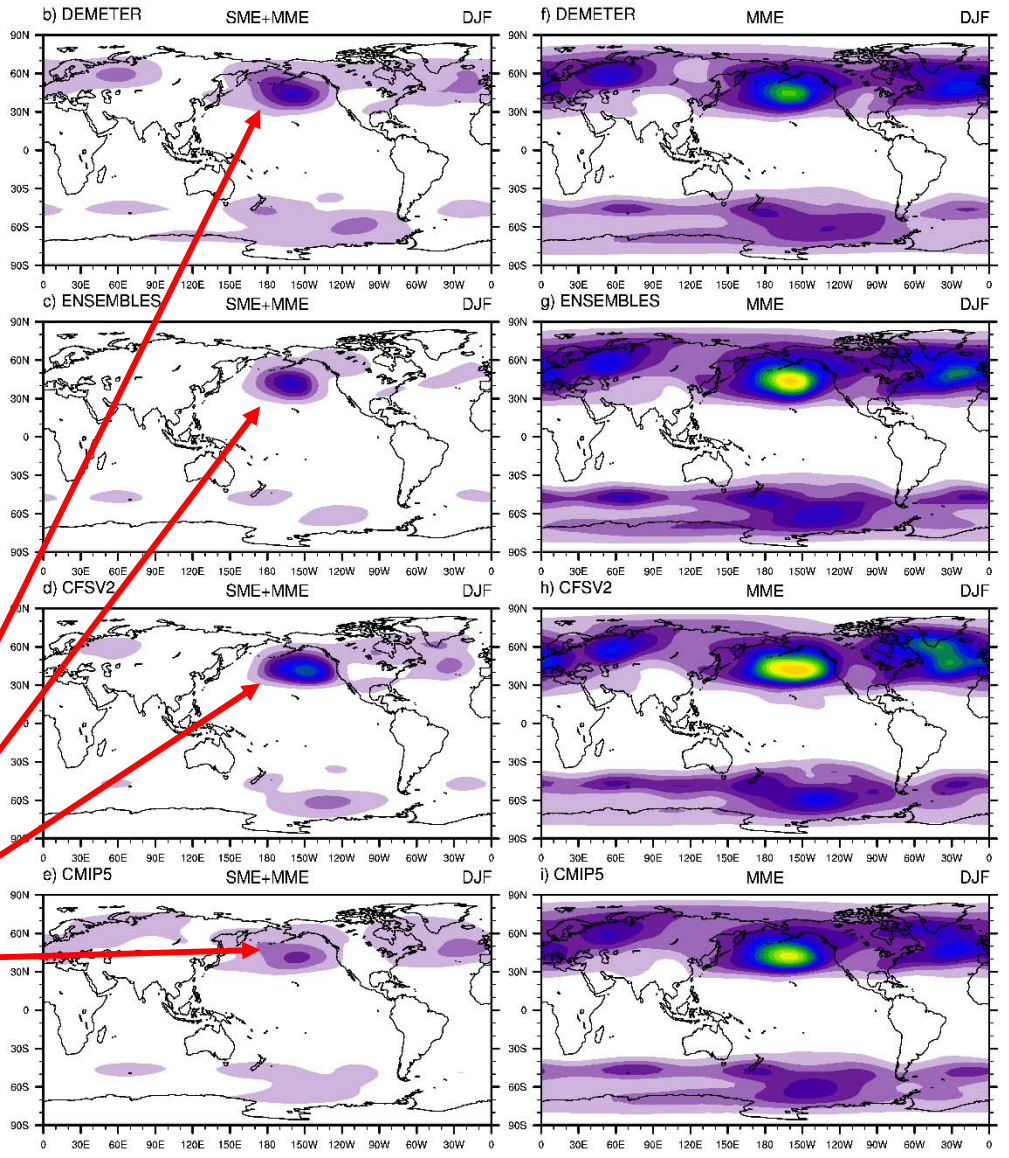


Strong impact from SME

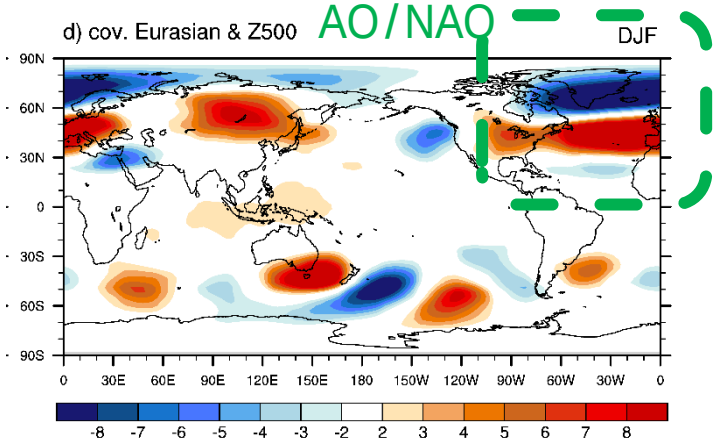
Signal improved without SME, but still underestimate

SME + MME

MME



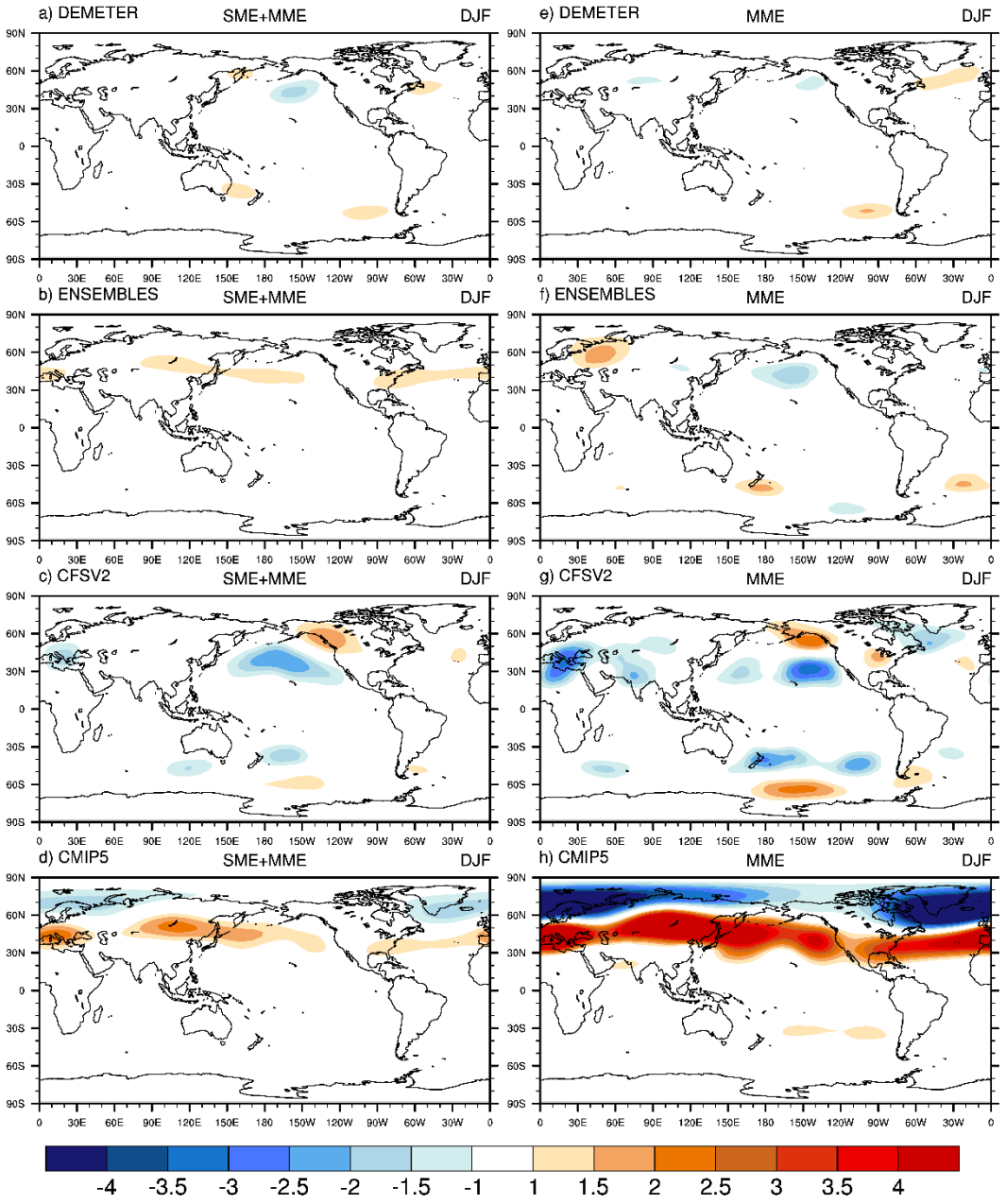
North Eurasia T2m vs. Z500



- Atmospheric internal waves (AO/NAO) are random signals, and difficult to simulate.

→poor simulations for N. Eurasia T2m

SME + MME **MME**



Concluding remarks

- Strong cancelation effect caused by SME on random signals
  - ENSO in CMIP5, Extratropical T2m in N.H.
  - Need to avoid SME for analyzing variances.
- North America DJF T2m is influenced by ENSO forcing through atmospheric (Rossby-like) waves which disperse in the extratropics.
  - Need better simulations for Rossby-like waves (mid-latitude atmospheric dynamics)
- North Eurasia DJF T2m is influenced by atmospheric internal modes (AO/NAO) which are random in nature and hard to simulate.
  - Need to consider processes from Arctic.

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