

4<sup>th</sup> APCN Workshop

# A Review of Multi Model Ensemble System for Seasonal Prediction at METRI

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Climate Research Laboratory

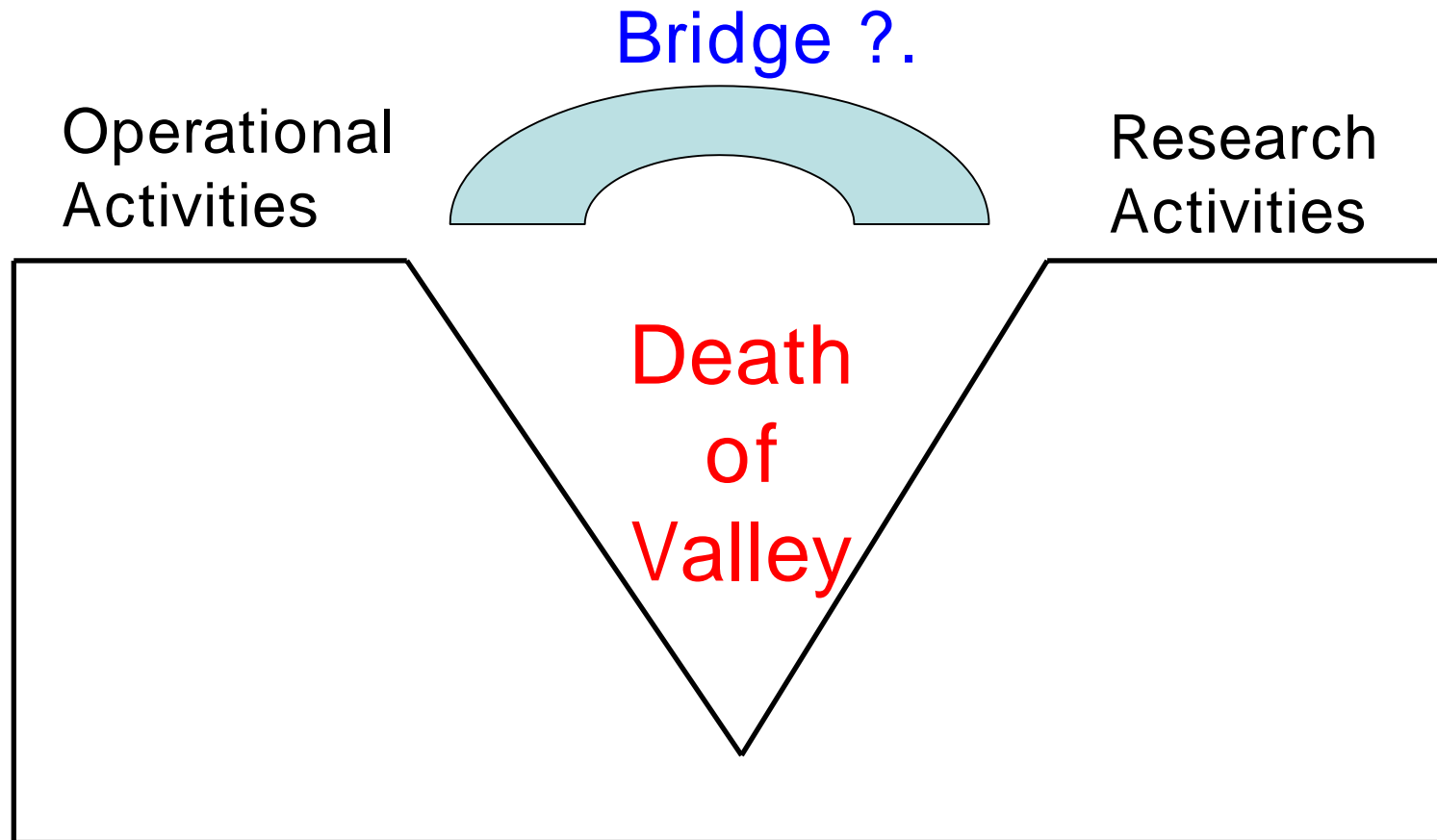
METRI / KMA / Korea

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“ Study of multimodel ensemble seasonal prediction system( )”

1. Operational Activities
2. Research Activities
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# Operational activity vs. Research activity



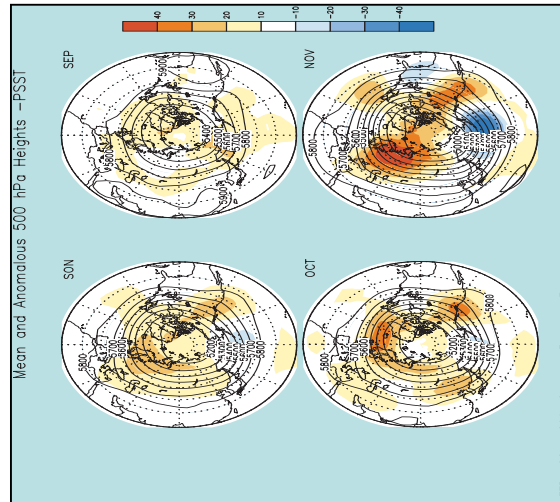
# Operational Activities (1)

## Seasonal Prediction System of METRI

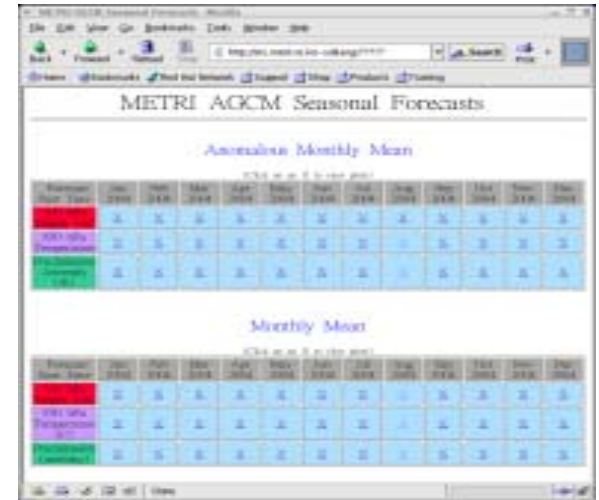
Preprocess

NCEP  
PSST  
SMIP

METRI AGCM



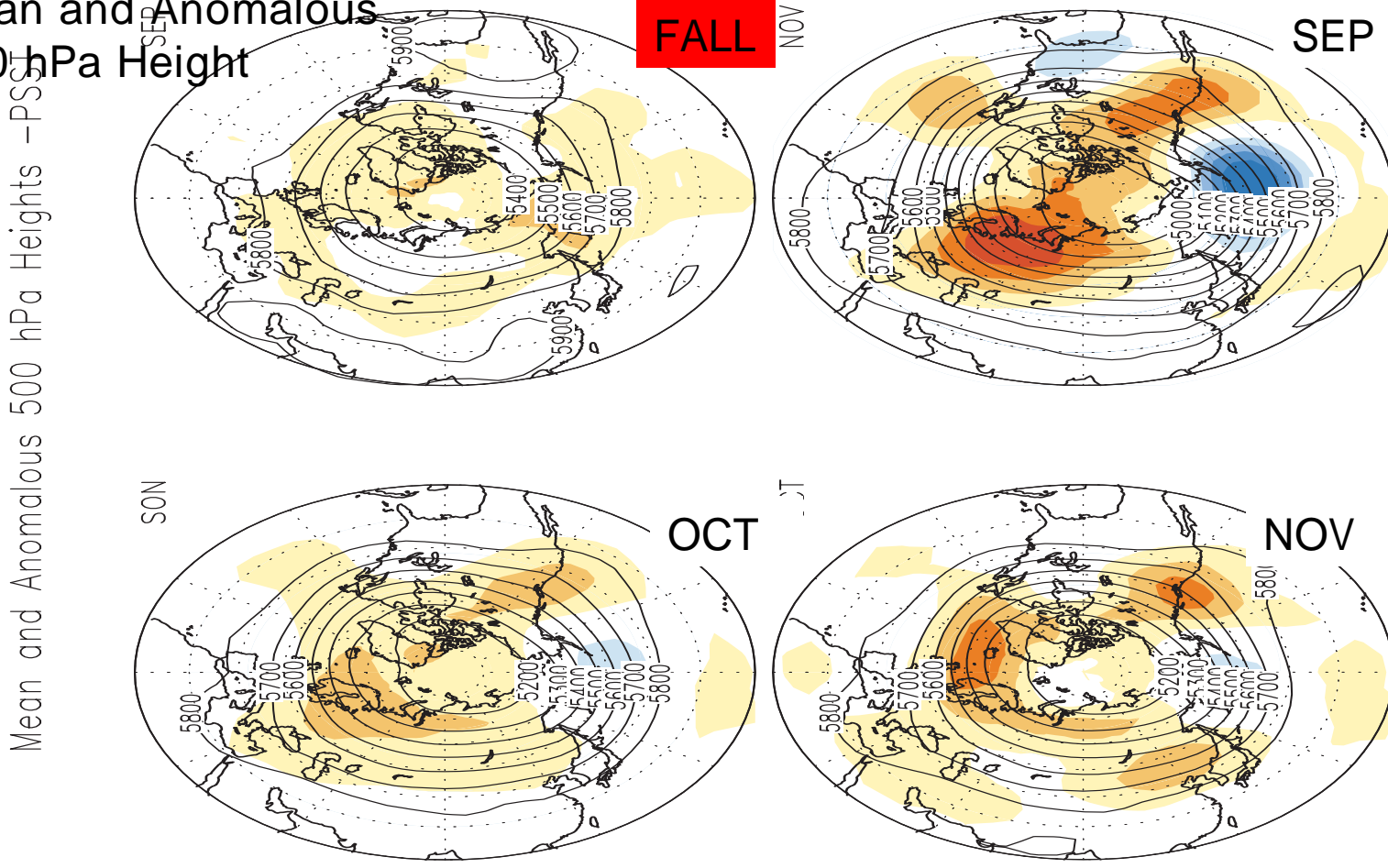
Web(Informal)



KMA / APCN

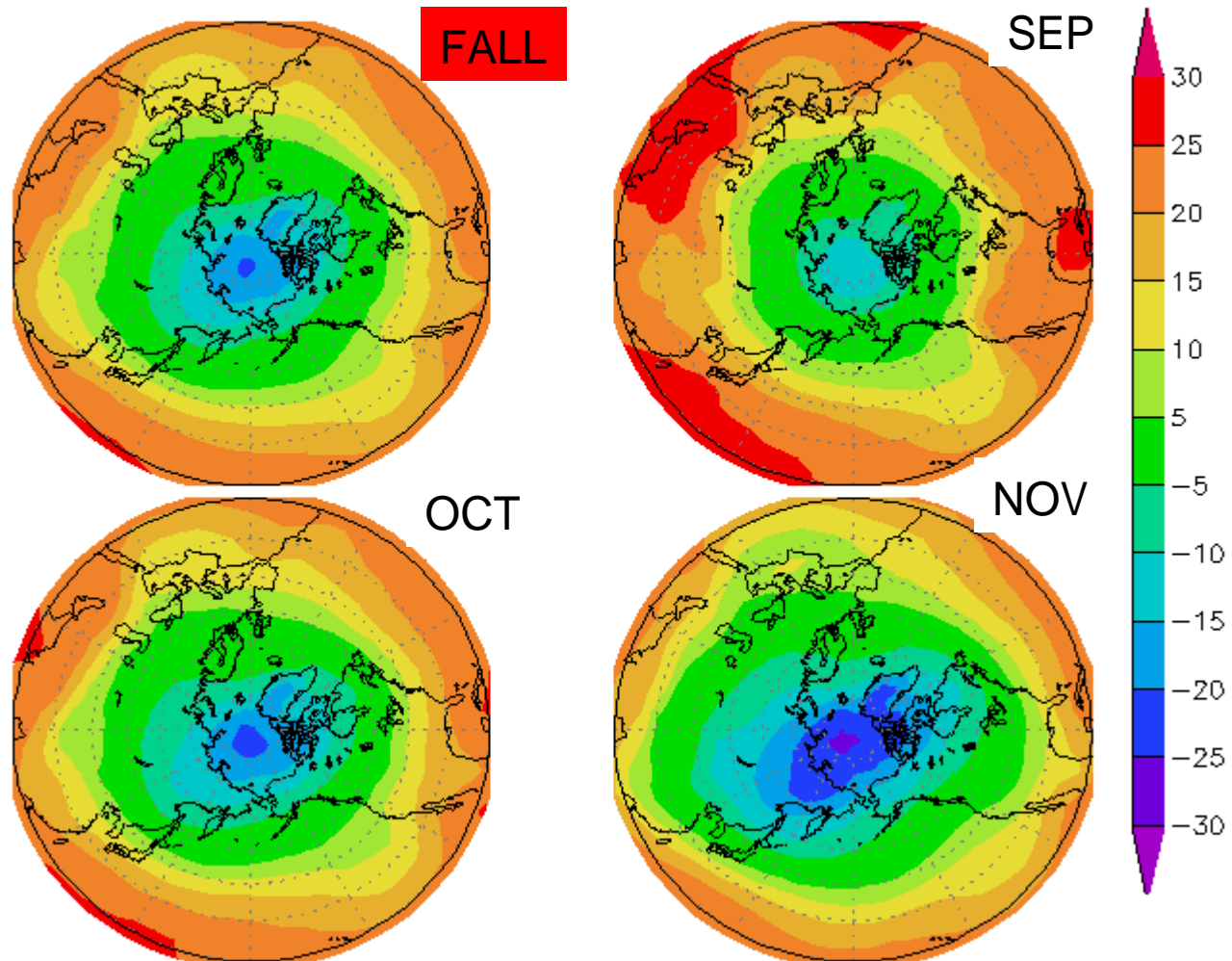
# Operational Activities (1)

Mean and Anomalous  
500 hPa Height



# Operational Activities (1)

Mean 850 hPa Temperature (PSST Case)



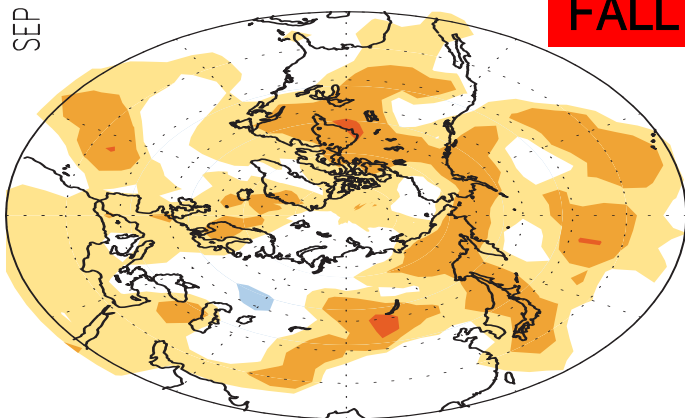
# Operational Activities (1)

Anomalous 850 hPa Temperature

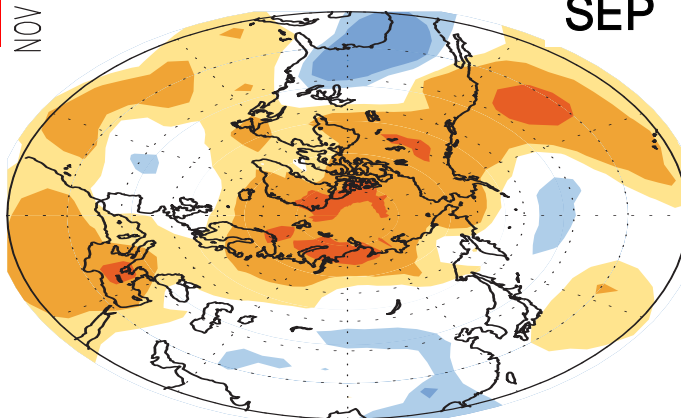
FALL

Anomalous 850 hPa Temperature - PSST

SEP

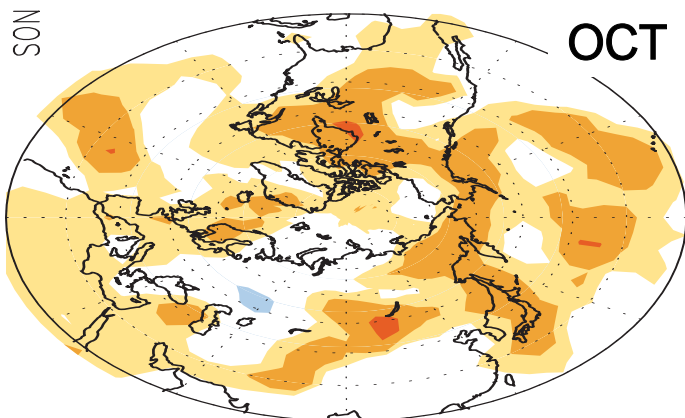


NOV



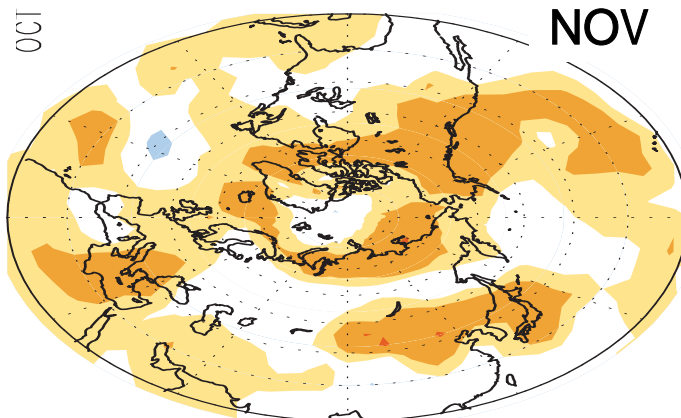
SEP

SON



OCT

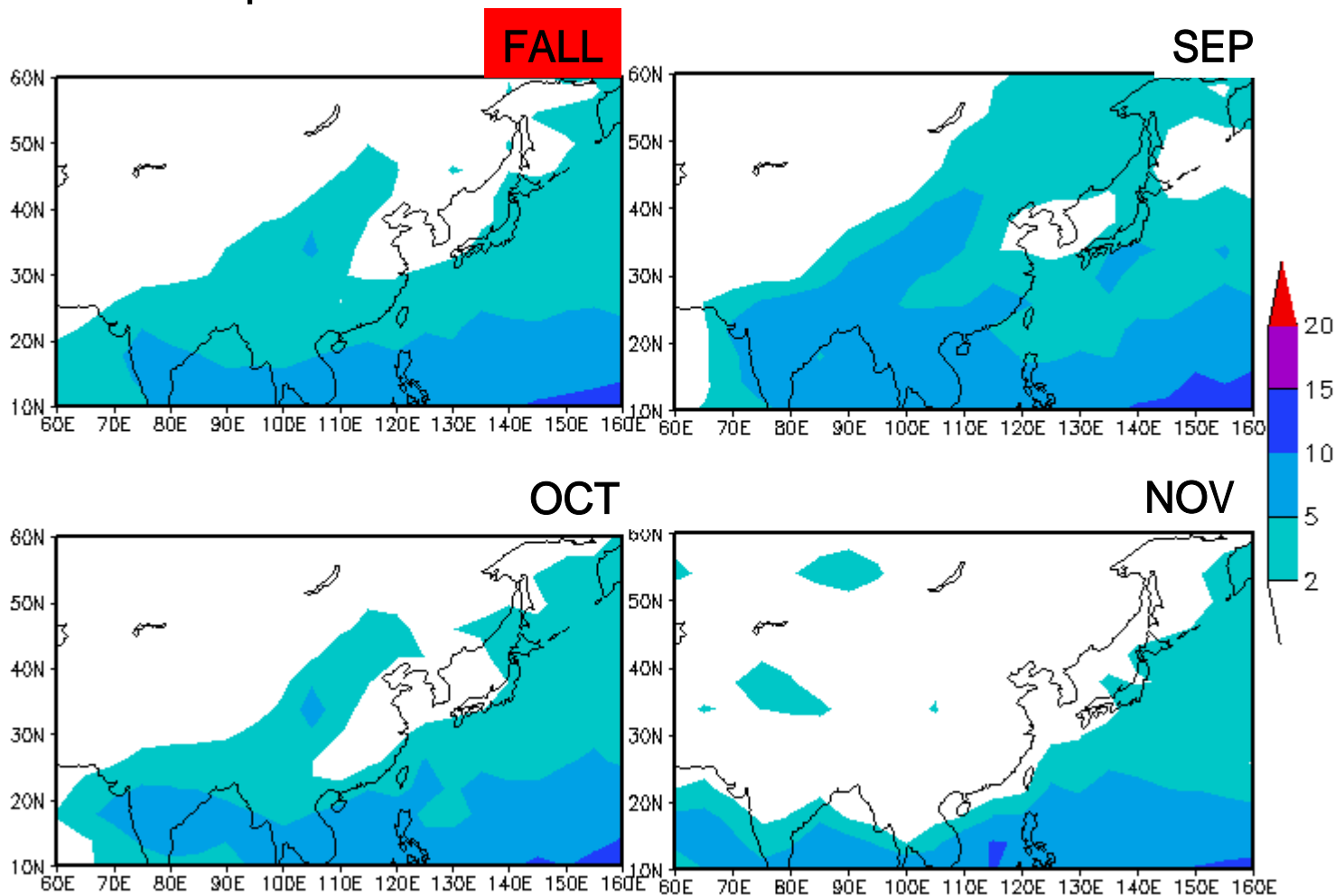
OCT



NOV

# Operational Activities (1)

## Monthly Mean Precipitation (PSST Case)



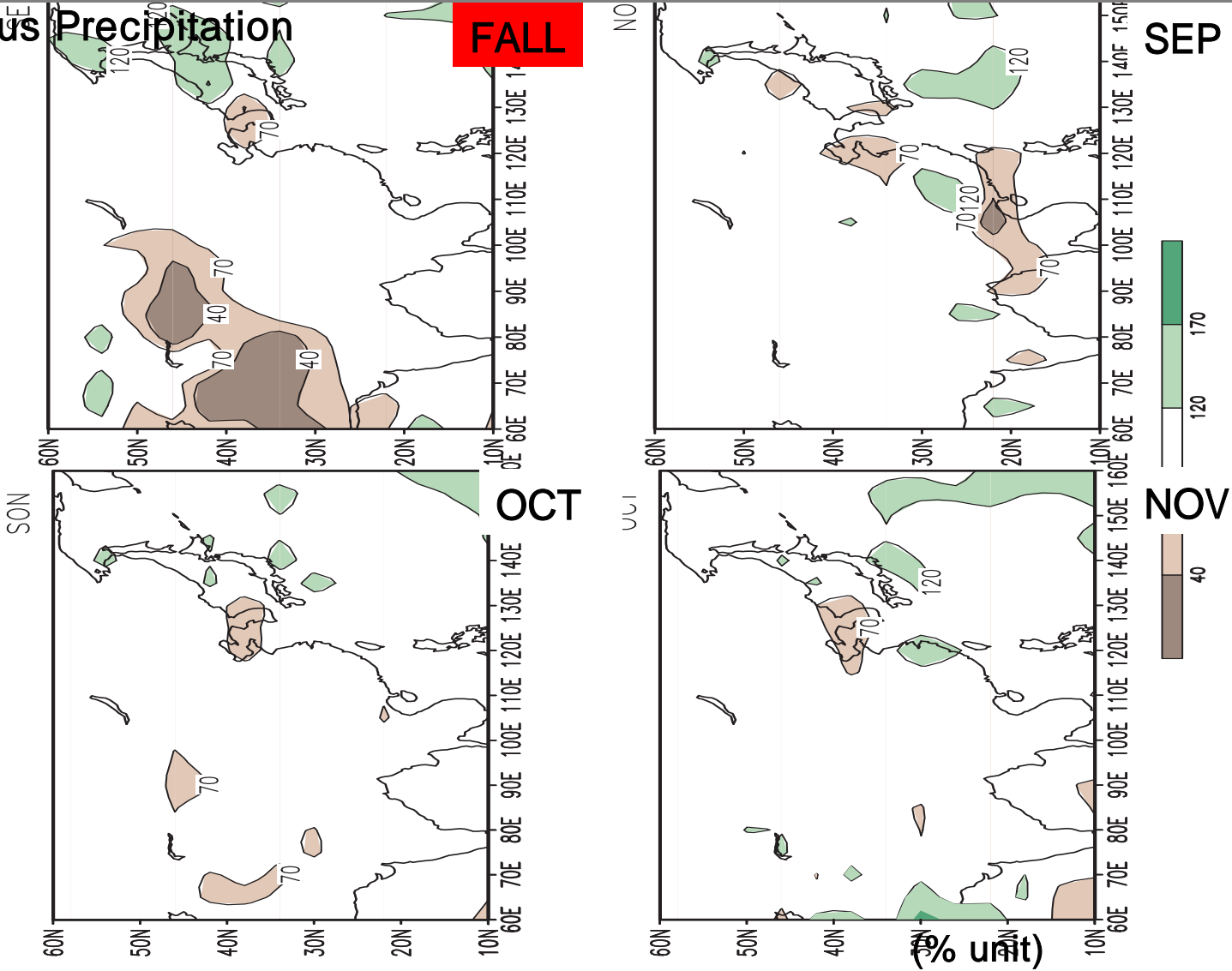
# Operational Activities (1)

Anomalous Precipitation

FALL

SEP

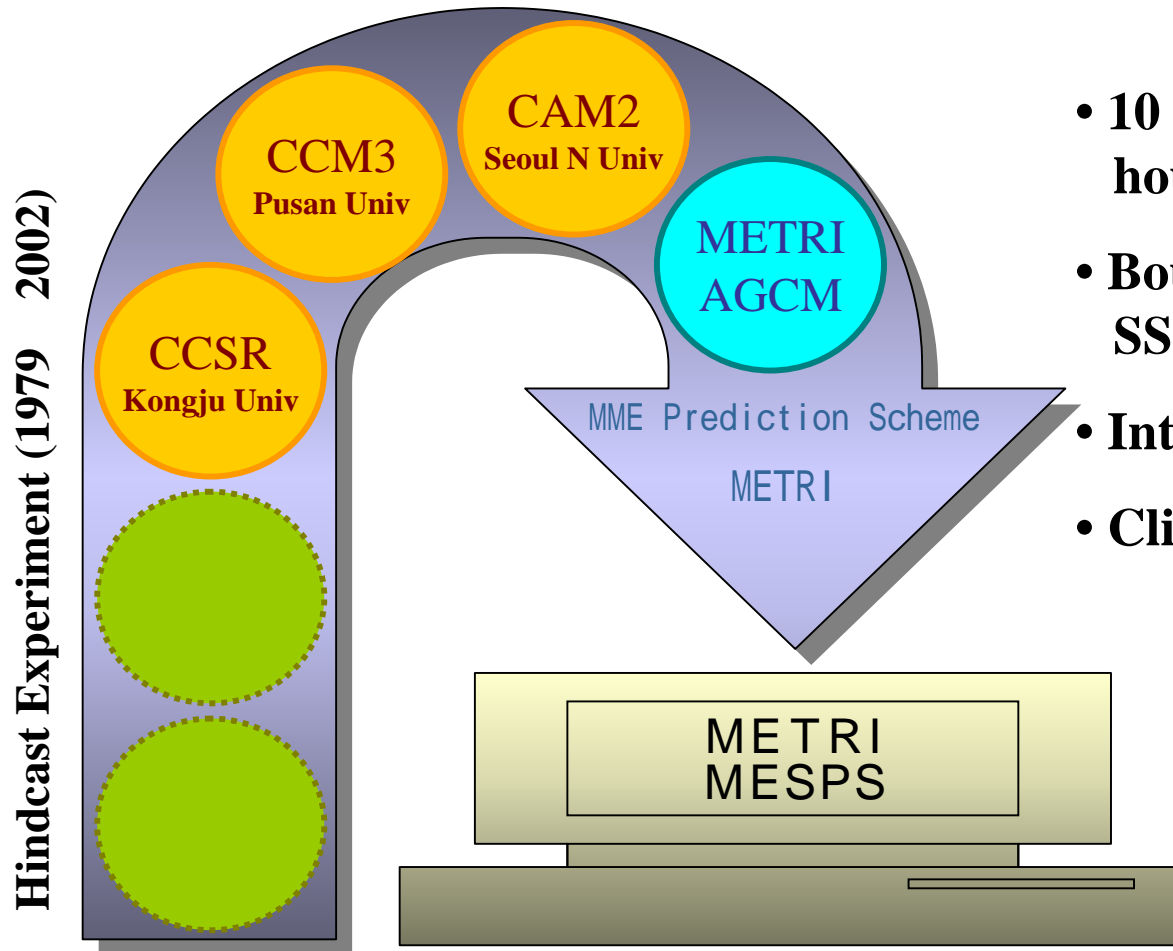
Anomalous Precipitation (%) - PSST



METRI AGCM 2004 Seasonal Ensemble Forecast

# Operational Activities (2)

## METRI Multi-Model Ensemble Prediction System



- **10 Ensemble members with -12 hourly lagged I.C**
- **Boundary condition: persisted SST anomaly**
- **Integration Period: 4 months**
- **Climatology: 24 years hindcast**

# Operational Activities (2)

- *MME\_S (Multi-Model Ensemble forecast using Simple arithmetic mean)*

**Uniform weighting**

$$MME\_S(t, m) = \bar{O}(m) + (A(t, m) - \bar{A}(m)), \quad A(t, m) = \frac{1}{N} \sum_{i=1}^N F_i(t, m)$$

- *MME\_L (Multi-Model Ensemble forecast trained by a Linear multiple regression using SVD techniques)*

**Non-uniform weighting**

$$MME\_L(t, m) = \bar{O}(m) + \sum_{i=1}^N a_i \cdot (F_i(t, m) - \bar{F}_i(m))$$

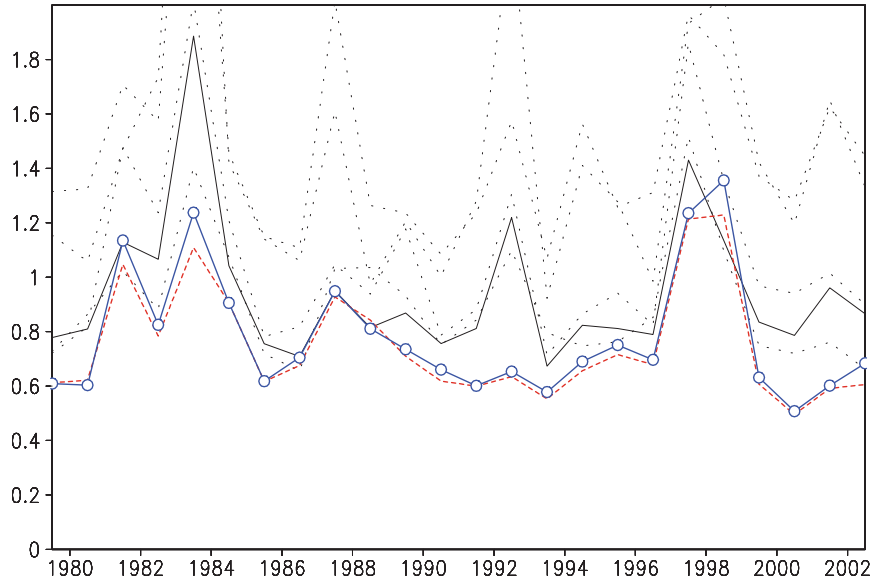
- *MME\_N (Multi-Model Ensemble forecast trained by a Nonlinear artificial neural network model)*

**Non-uniform weighting**

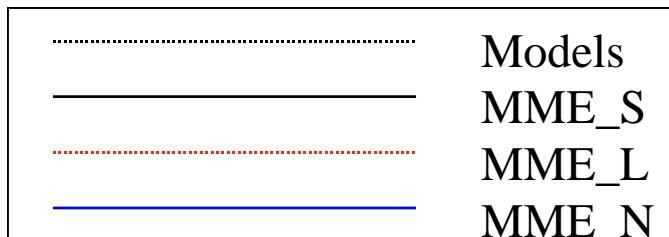
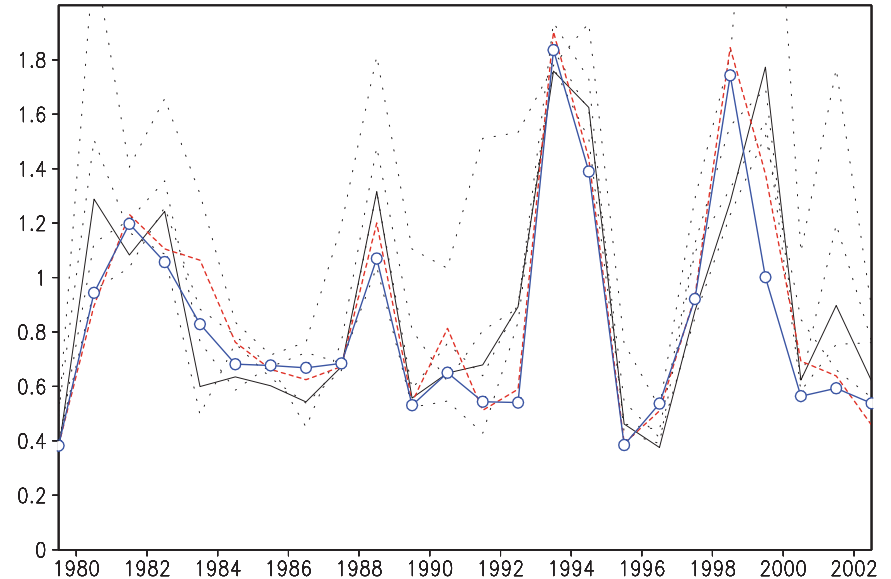
$$MME\_N(t, m) = \bar{O}(m) + \left[ \sum_{j=1}^H \tilde{w}_j \tanh \left( \sum_{i=1}^{N_{in}} w_{ij} (F_i(t, m) - \bar{F}_i(m)) + b_j \right) + \tilde{b} \right]$$

# Operational Activities (2)

MSE (precipitation) over GLOBE



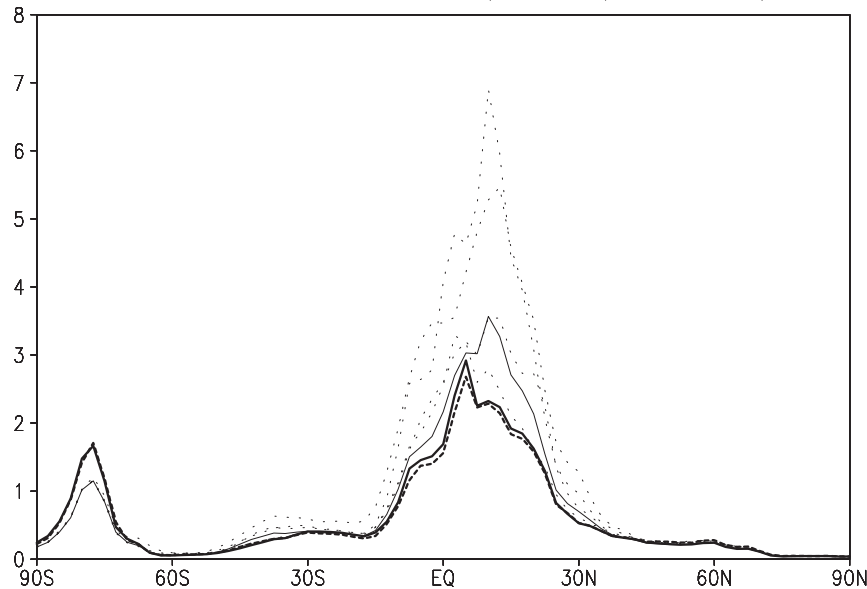
MSE (precipitation) over EASIA



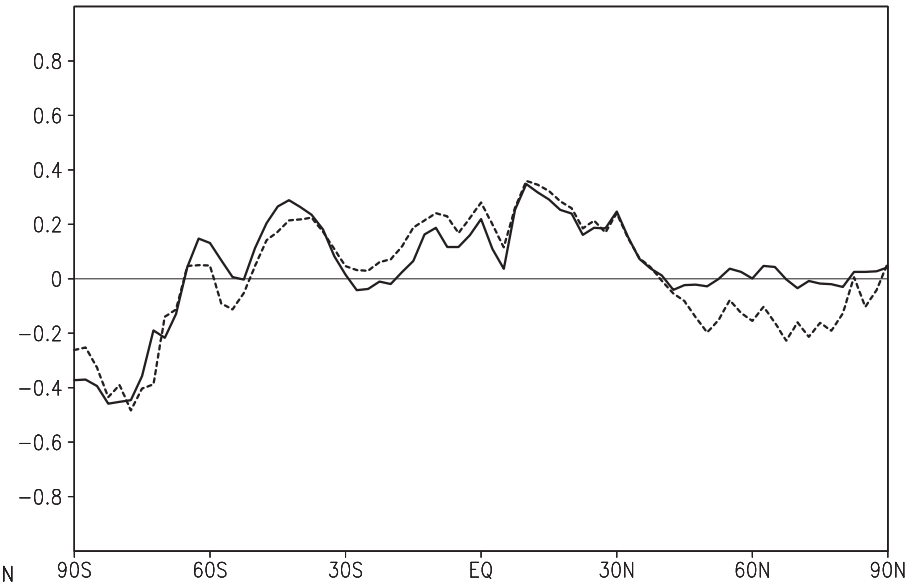
**Multi-model ensemble has  
locality !!!**

# Operational Activities (2)

Zonal mean MSE (Precipitation)



Normalized Diff. of MSE of Precip



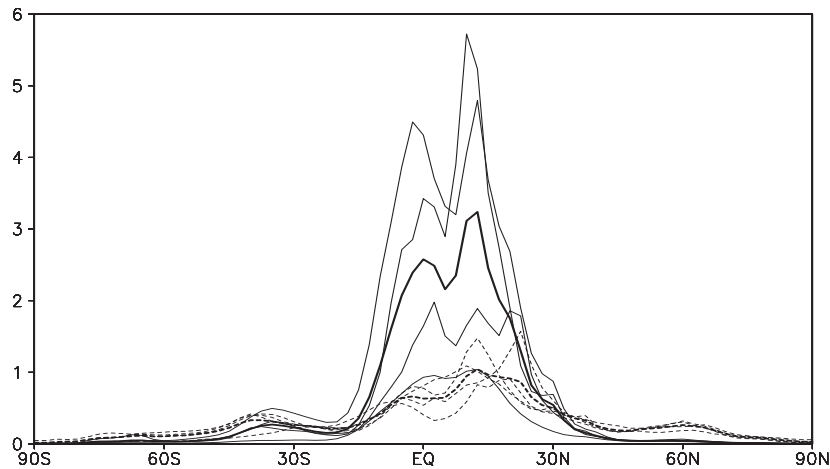
\* Normalized MSE =  $MME\_S - MME\_L$  (or  $MME\_N$ )

**MME\_L : MSE are decreased and increased at low and high latitudes, respectively.**

**MME\_N : MSE is decreased at whole region.**

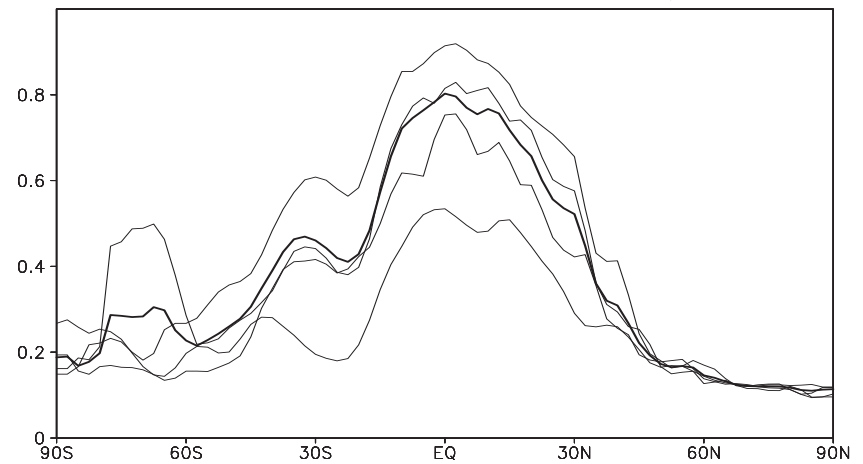
# Operational Activities (2)

## Internal and External Variances



\* External Variance (EV) : solide line  
Internal Variance (IV) : dashed line

## Potential Predictability

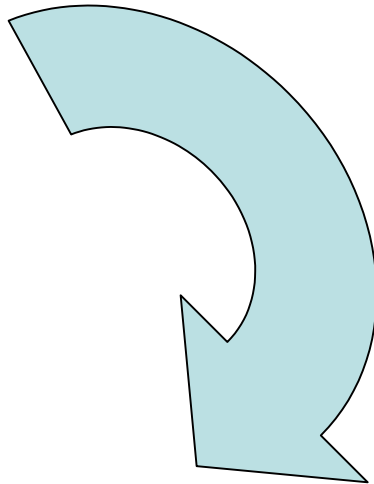
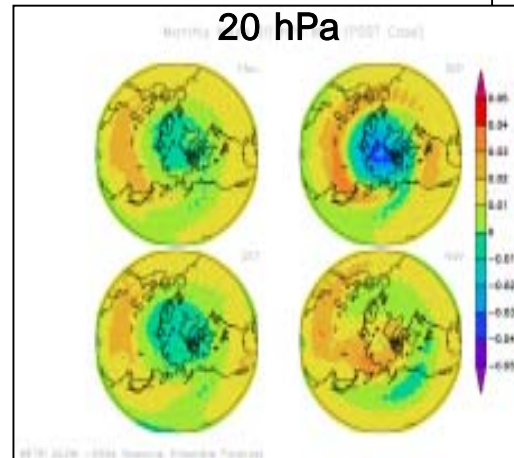
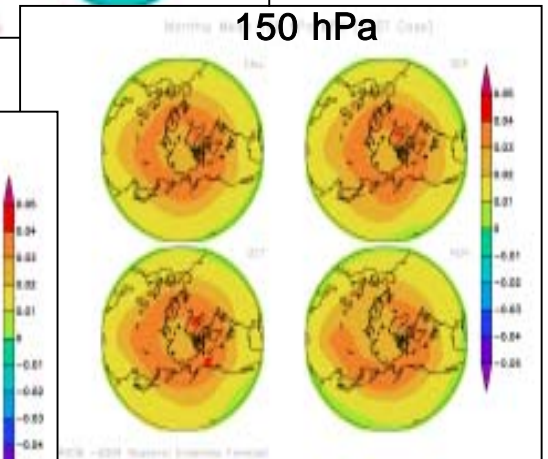
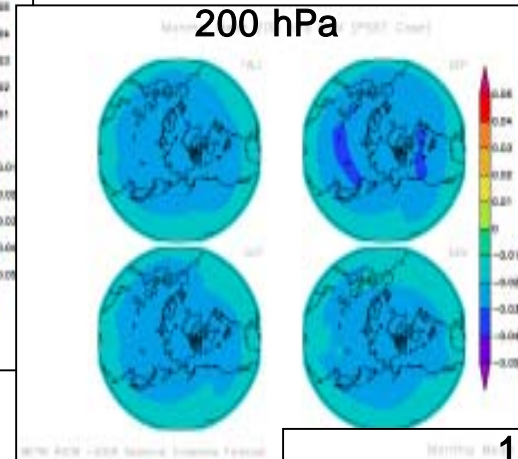
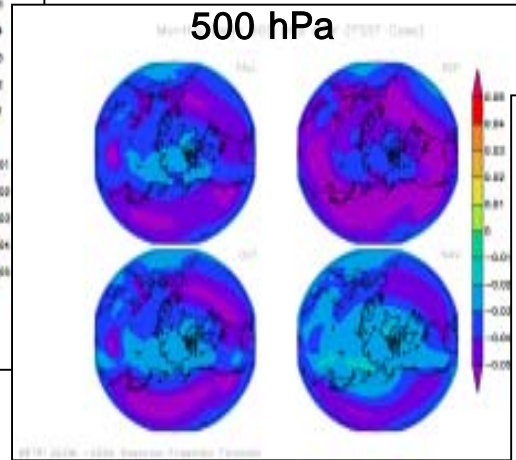
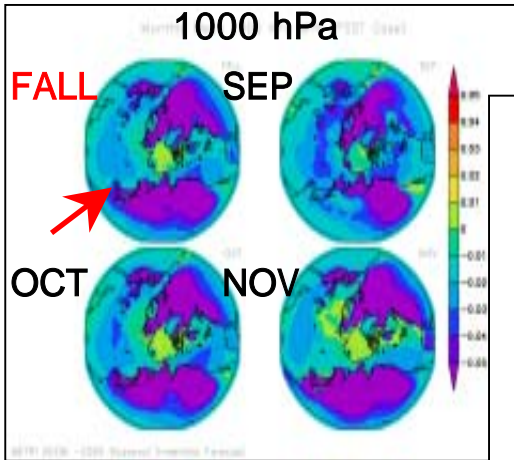


\* Potential Predictability =  $EV / TV$   
 $TV = EV + IV$

**EV : dominant at low latitude !!!**  
**IV : dominant at high latitude !!!**

# Research Activity

## Analysis of Potential Vorticity

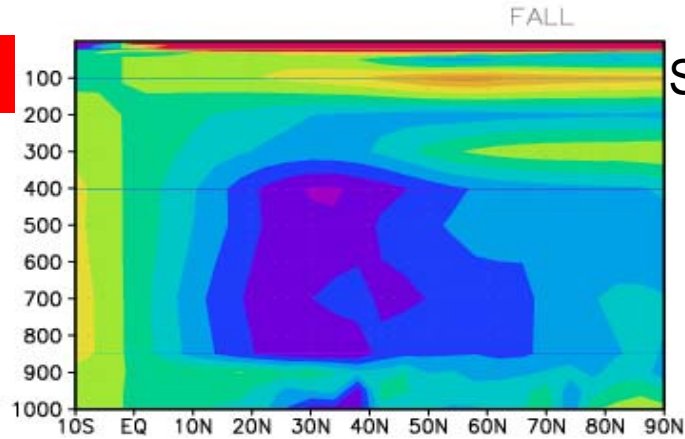


# Research Activity

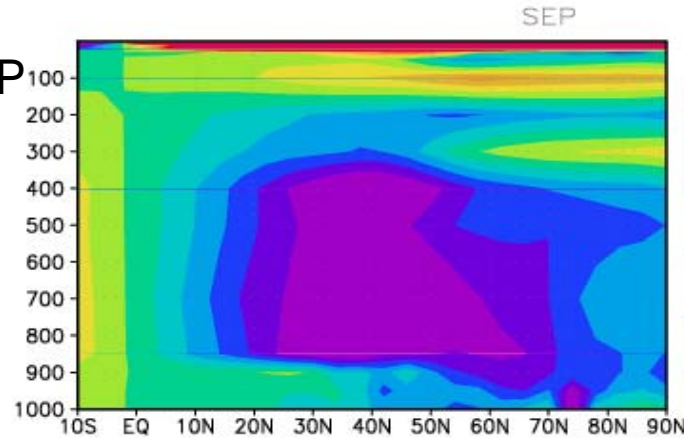
## Analysis of Potential Vorticity

Meridional Distribution of MPV (PSST Case)

FALL

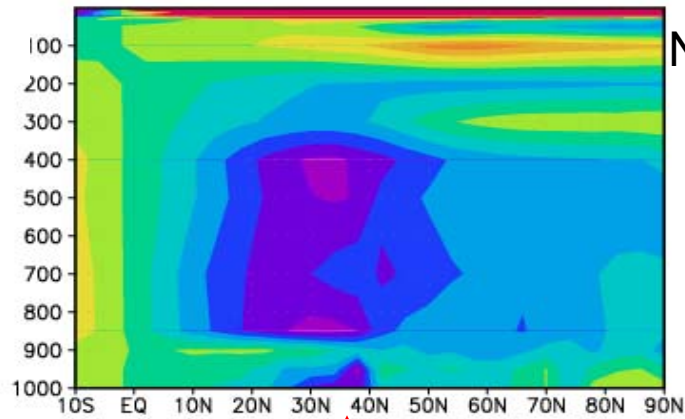


SEP

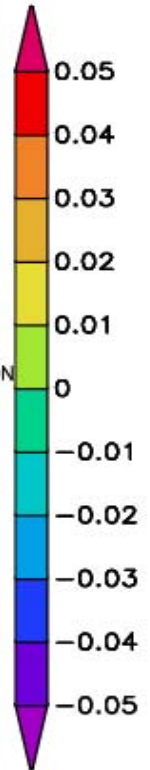
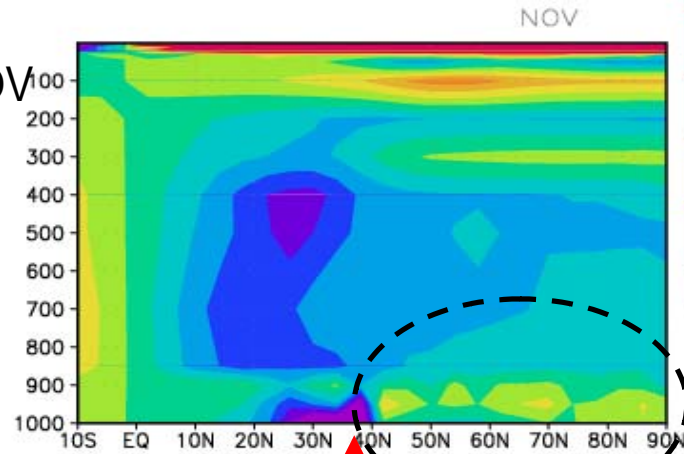


OCT

OCT

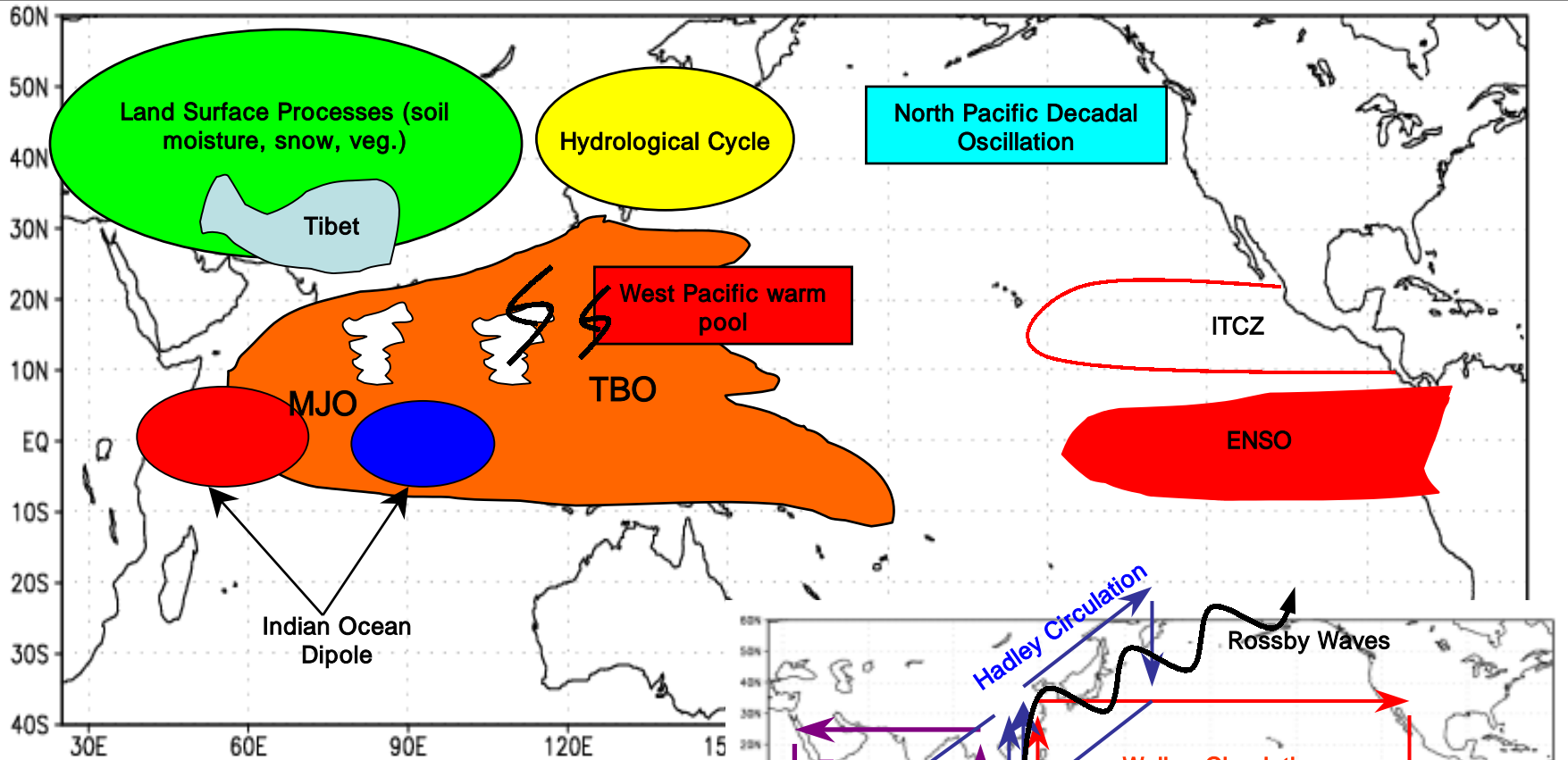


NOV

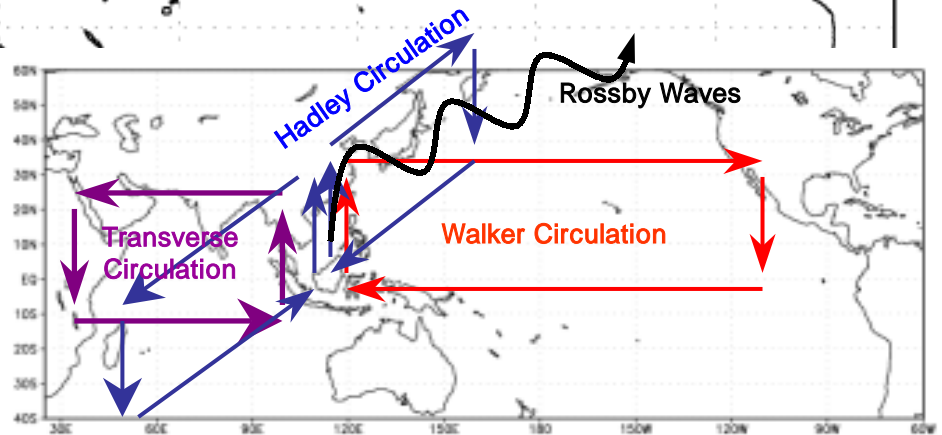


METRI AGCM -2004 Seasonal Ensemble Forecast

# Future Plan (1)



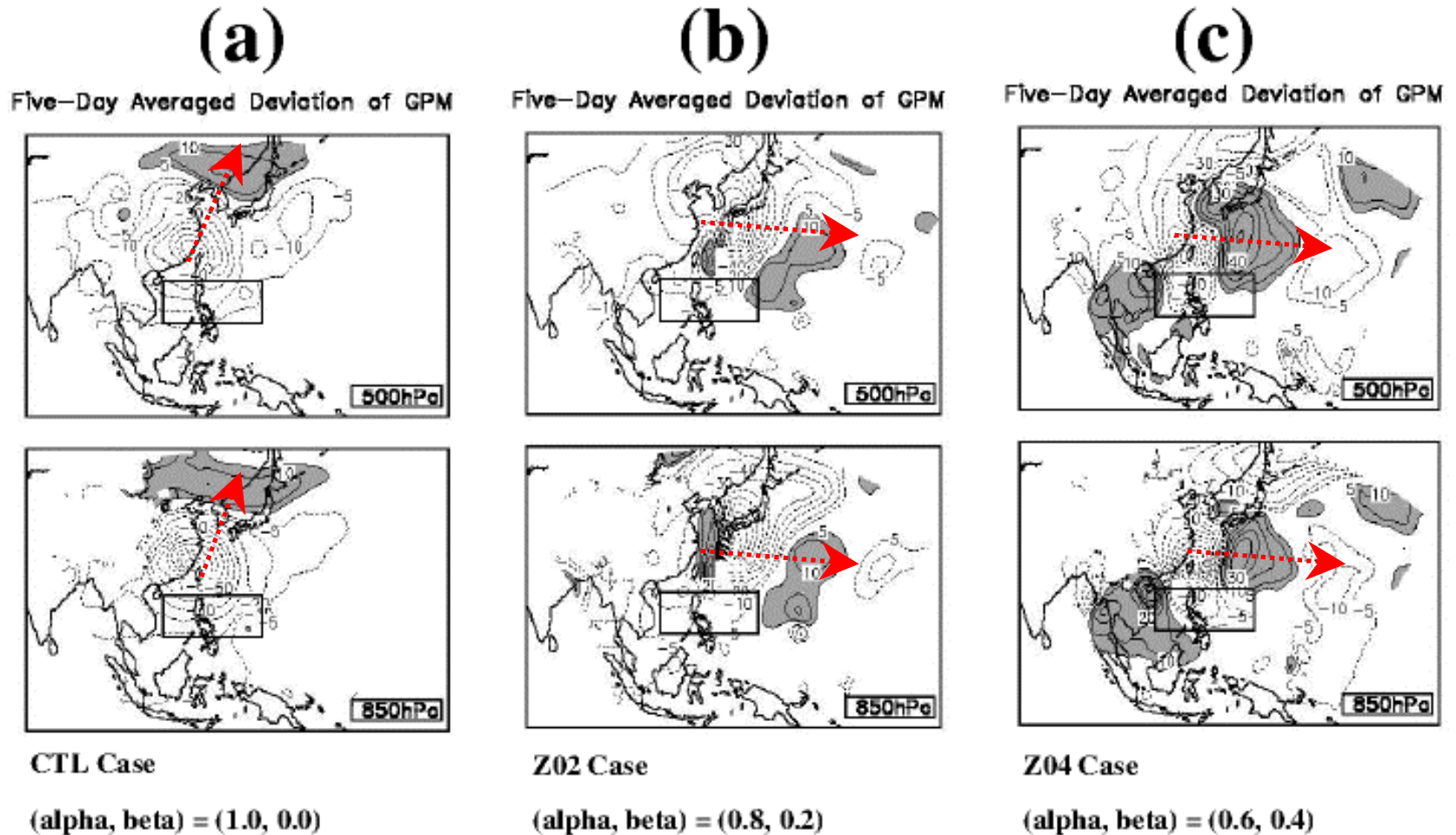
A summary of processes being studied to understand the source of variability on the regional climate of East Asia.



The influence of the tropical SST forcing on global circulation.

# Future Plan (1)

## Directional Transition of Rossby Wave Propagation (NCAR MM5)



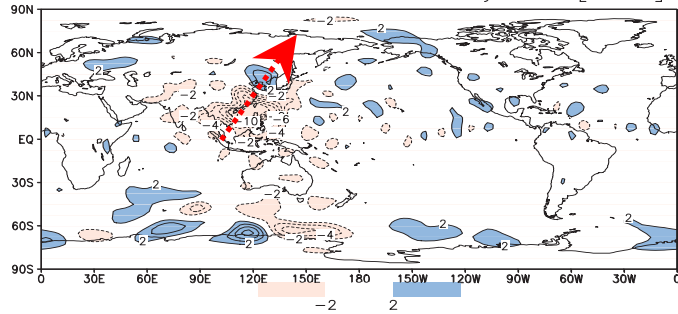
$$\text{Initial Condition} = \alpha * \text{NCEP} + \beta * Z$$

# Future Plan (1)

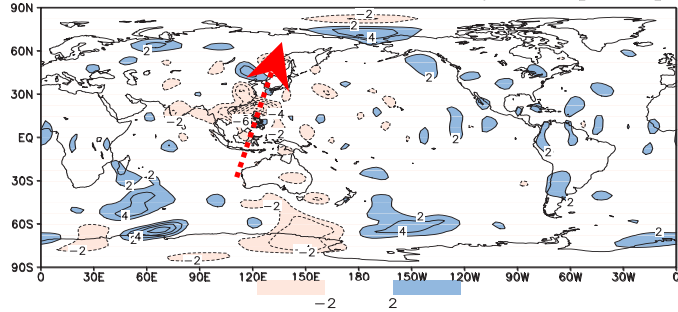
## Directional Transition of Rossby Wave Propagation (NCEP **GSM**)

### CTL Case

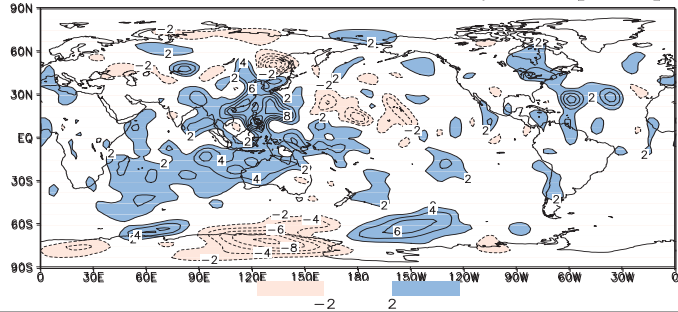
Deviation of 850Z 16–21 July 96 [CNTL]



Deviation of 500Z 16–21 July 96 [CNTL]

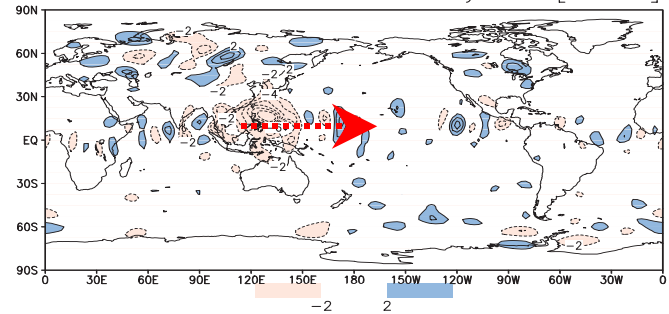


Deviation of 200Z 16–21 July 96 [CNTL]

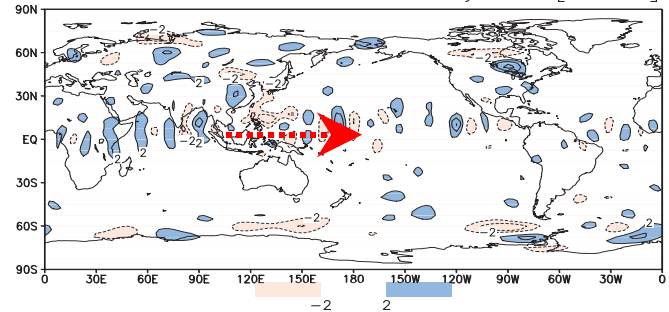


### Zonal Mean Case

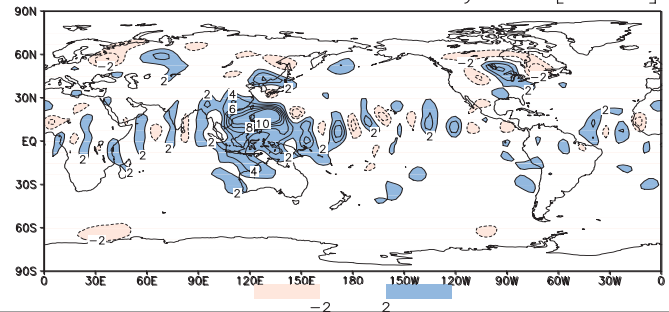
Deviation of 850Z 16–21 July 96 [WAVE1]



Deviation of 500Z 16–21 July 96 [WAVE1]

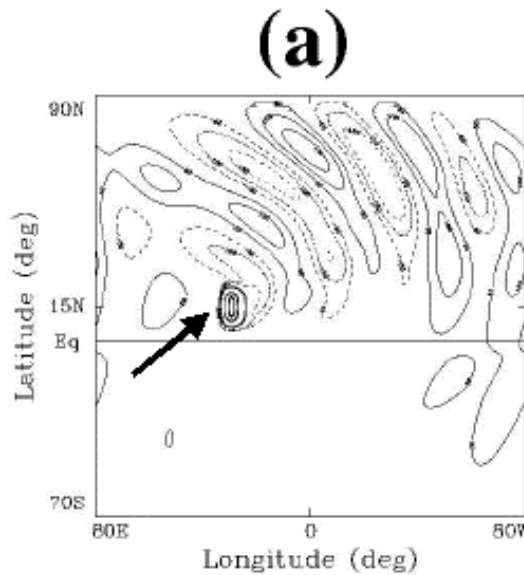


Deviation of 200Z 16–21 July 96 [WAVE1]



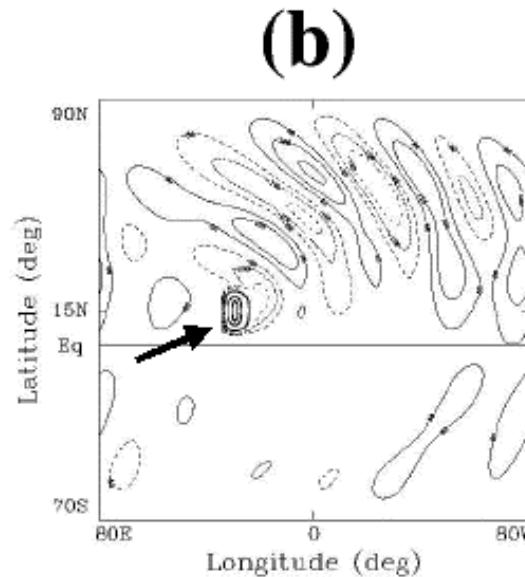
# Future Plan (1)

## Directional Transition of Rossby Wave Propagation (**SWM**)



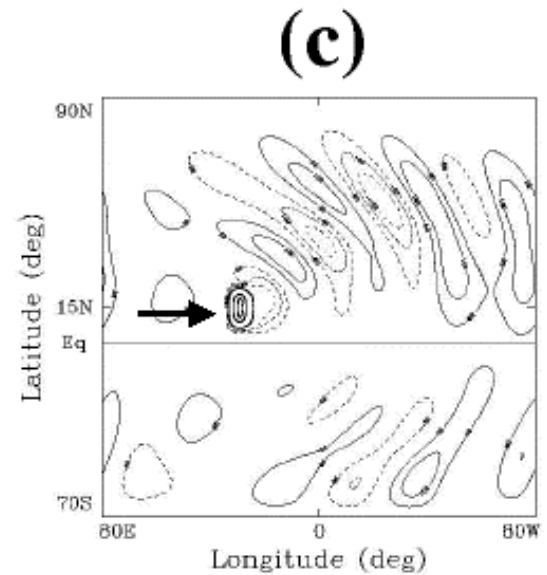
**CTL Case**

$(u_0, v_0) = (6 \text{ m/s}, 2.0 \text{ m/s})$



**V10 Case**

$(u_0, v_0) = (6 \text{ m/s}, 1.0 \text{ m/s})$



**V00 Case**

$(u_0, v_0) = (6 \text{ m/s}, 0.0 \text{ m/s})$

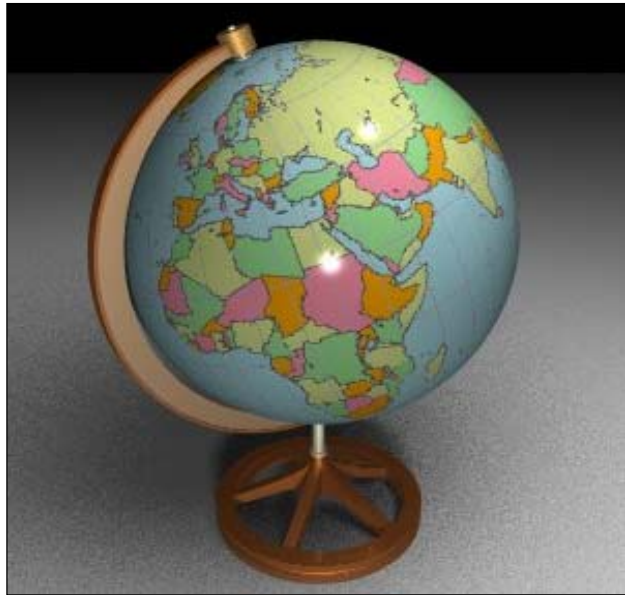
Initial Condition =  $\text{Sqrt}(u_0^{**2} + v_0^{**2})$

## Future Plan (2)

### **Why do we need to develop next generation climate model ?**

- O enhanced computational resources (MPI, OpenMP)
- O “pole problem” and “Gibbs phenomena” on GCM
- O Current GCM failed to predict the phenomena of cloud resolving scale
- O Atmospheric motion is multi scale phenomena

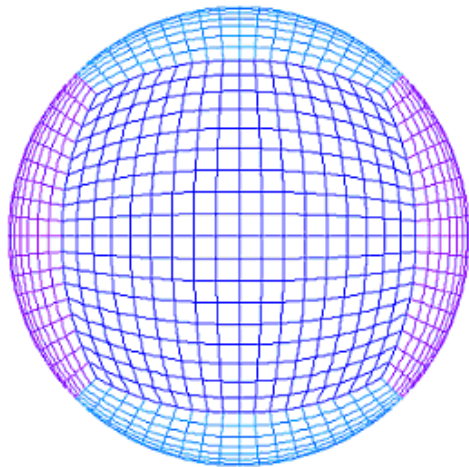
# Future Plan (2)



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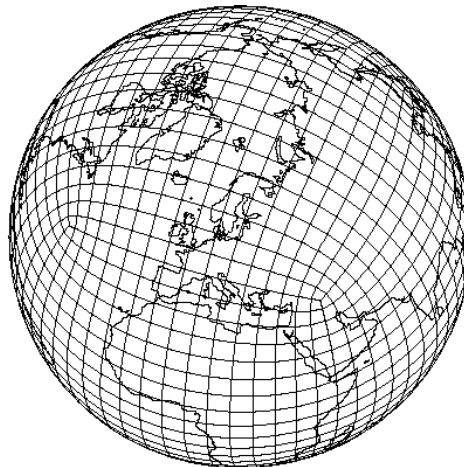
\*\* New Dynamic Core for Next Generation Climate Model (Cubic Grid)

Gnomonic Cube



**Sadourny (1972)**

Conformal Mapping



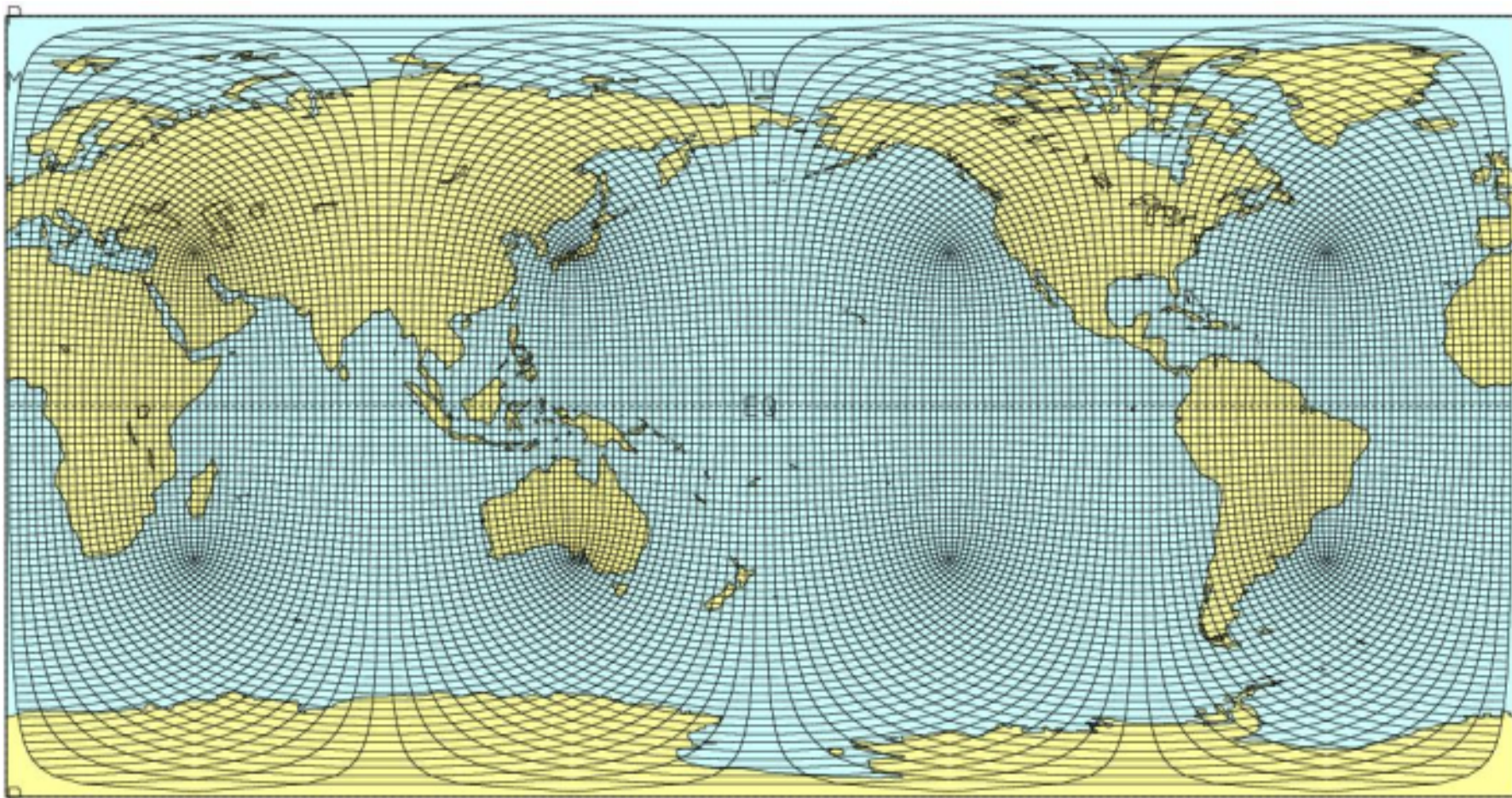
**Rancic and Purser (1996)**

Homogeneous Mapping



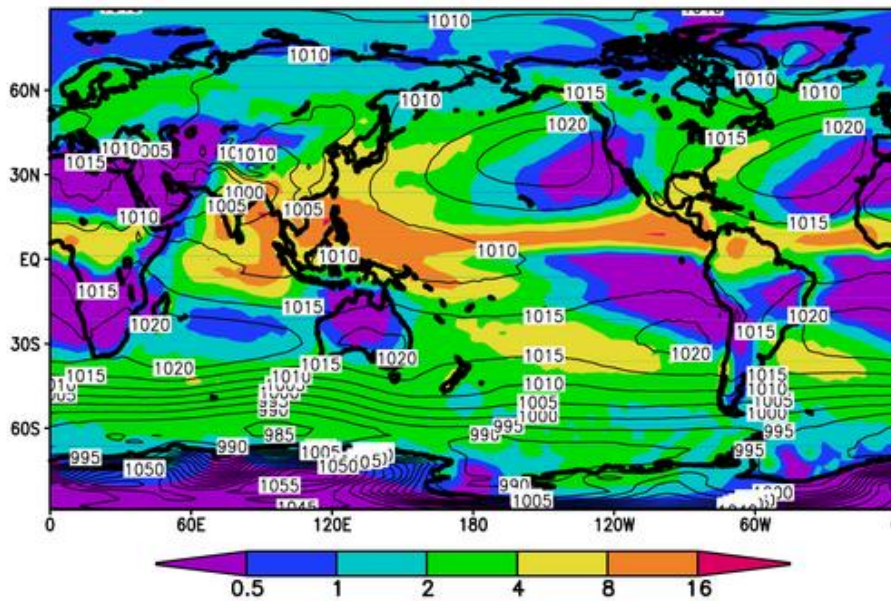
**Purser and Rancic (1998)**

# Future Plan (2)

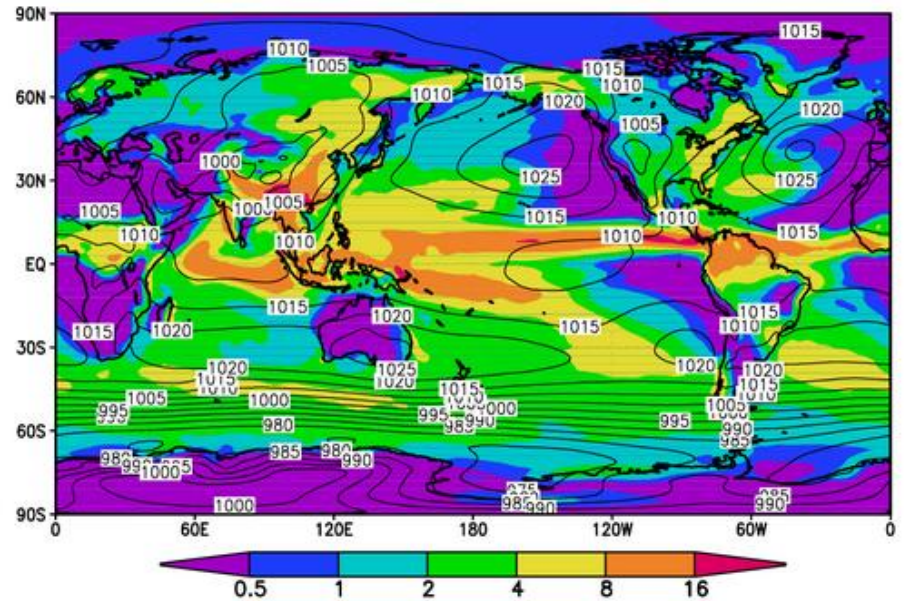


# Future Plan (2)

CMAP 1979-95 JJA

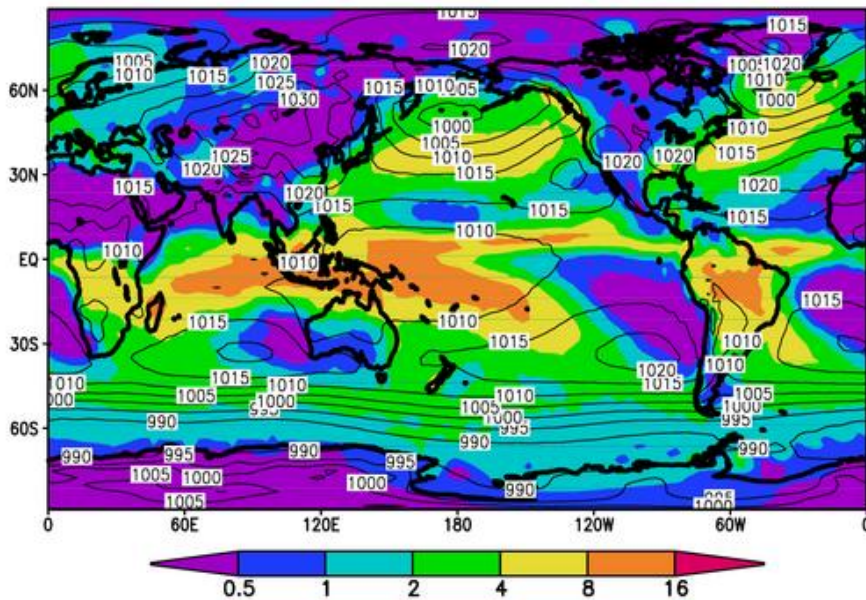


C-CAM 1979-95 JJA

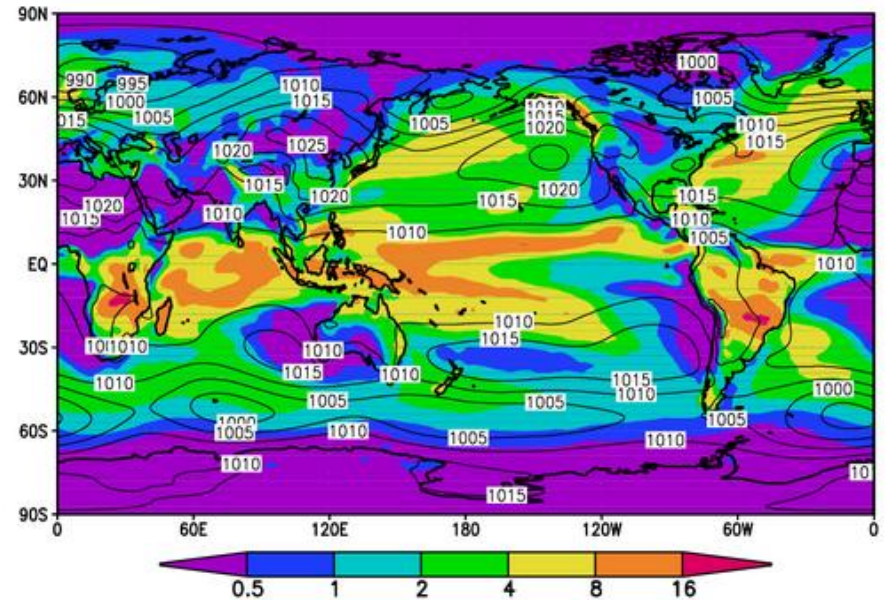


# Future Plan (2)

CMAP 1979-95 DJF



C-CAM 1979-95 DJF



# Conclusion

