

# Spatial Correction of the Model Outputs

**Vladimir Kryjov**

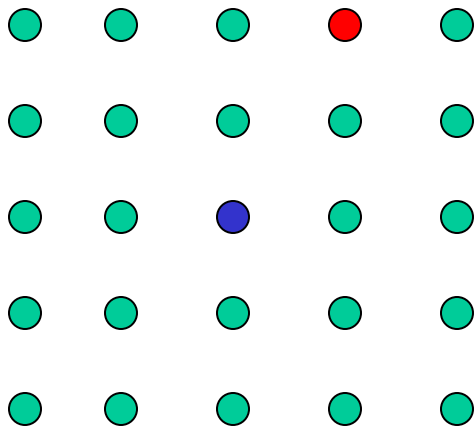


## SPATIAL CORRECTION

# - spatial correction method for deterministic forecast

Hypothesis: models predict large scale precipitation patterns correctly  
but loose skill because of mosaic spatial distribution of precipitation

Model hindcasts (X's)



Target point observations (Y)



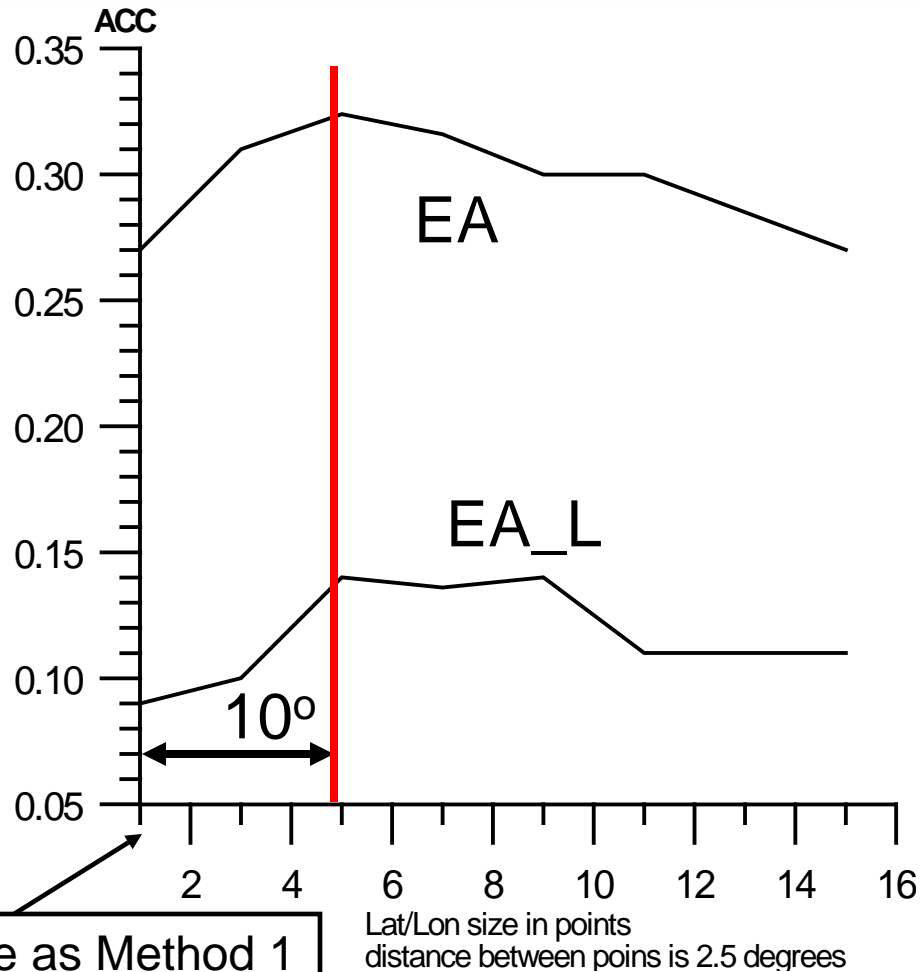
Task: To select time series XX similar to Y  
out of all X's within the window

Forecast: forecast from XX

Criteria of similarity:

1.  $\max(N_c)$ , where  $N_c$  - the number of years  $x^*y \geq 0$  (consistency between anomalies);
2. if several points meet Criterion 1 then  $\min(\text{MSE}(X, Y))$

## Optimal size of the window in Spatial Correction

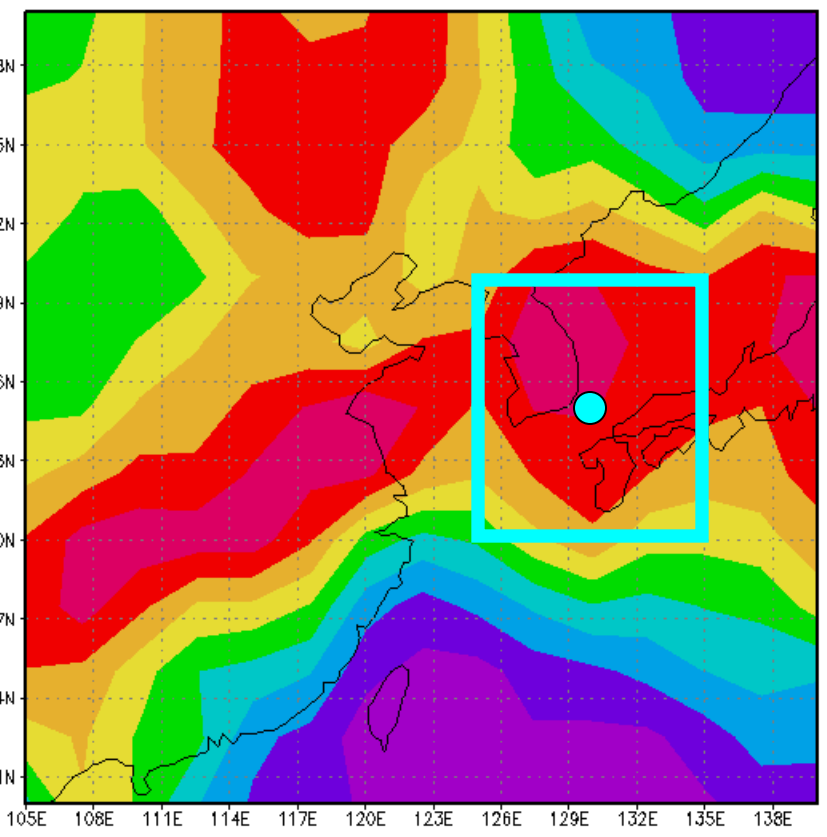


Size = 1 is the same as Method 1

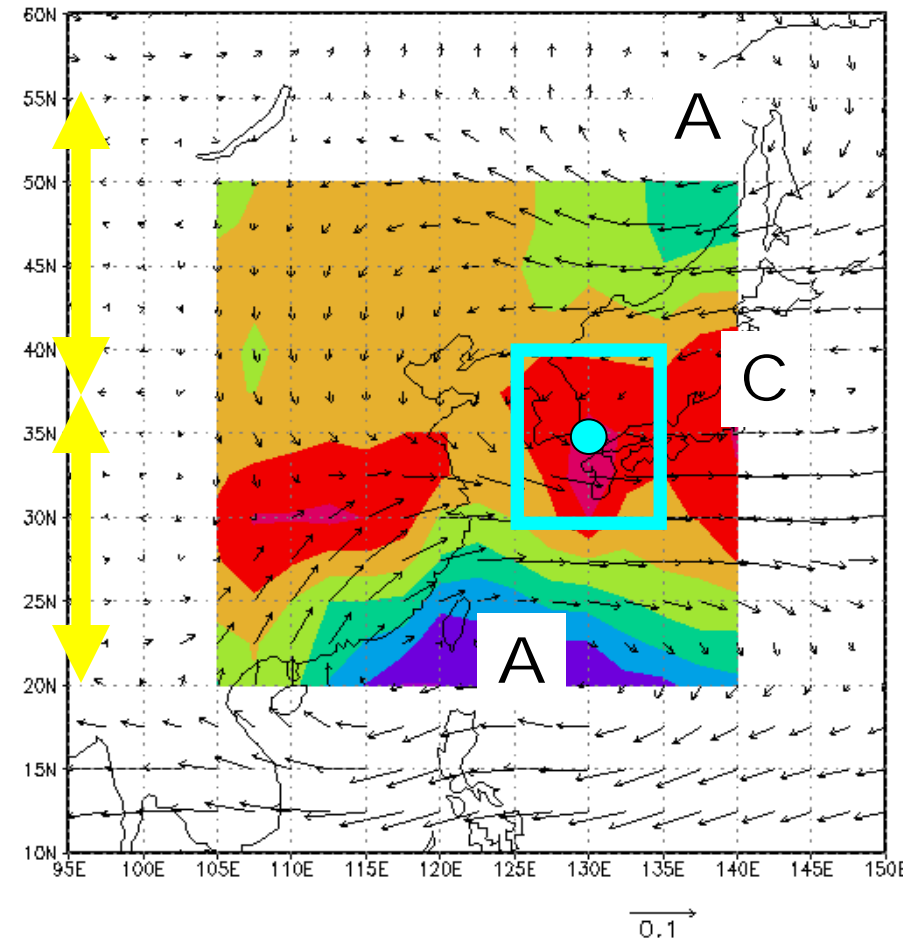
Lat/Lon size in points  
distance between points is 2.5 degrees

# - spatial correction method for deterministic forecast

EOF1 Rainfall JJA



SVD1 Rainfall : Wind850 JJA



Optimal size of the window in Spatial Correction:

5 points -  $10^\circ$  – less than 700 km from the target point

Best similar series are within the same rainy/circulation system

# MME METHODS

1. Composite with equal weights

$$\hat{y} = \frac{\sum_{i=1}^M x_i}{N}$$

2. Composite of regression corrected models

$$\hat{y} = \frac{\sum_{i=1}^M a_i x_i}{N}$$

3. Multiple regression

$$\hat{y} = \sum_{i=1}^M b_i x_i$$

4. Spatial correction,  
then composite with equal weights (Method 1)

5. Spatial correction,  
then composite of regression corrected models (Method 2)

# SKILL METRICS

Fields:  $ACC = \frac{\sum_{i=1}^N x_i y_i}{\sqrt{\sum_{i=1}^N x_i^2 \sum_{i=1}^N y_i^2}}$   $RMSE = \sqrt{\frac{\sum_{i=1}^N (x_i - y_i)^2}{N}}$

Fields and time series:

$$BSS = \left(1 - \frac{\sum_{i=1}^N (x_i - y_i)^2}{\sum_{i=1}^N y_i^2}\right) \quad HSS = (P_c - (P_e^2 + (1 - P_e)^2)) / (1 - (P_e^2 + (1 - P_e)^2))$$

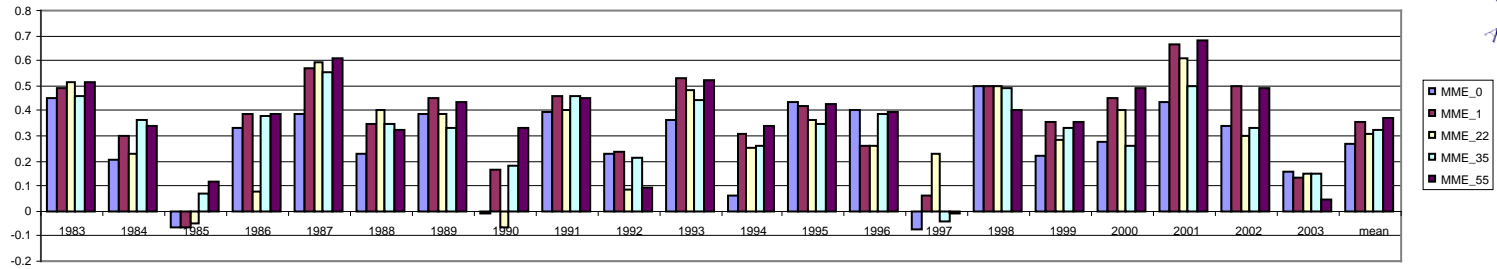
Time series:  $cor = \frac{\sum_{i=1}^N x_i y_i}{\sqrt{\sum_{i=1}^N x_i^2 \sum_{i=1}^N y_i^2}}$   $Sp.cor = 1 - \frac{6 \sum_{i=1}^N (\text{rank}(x_i) - \text{rank}(y_i))^2}{N(N^2 - 1)}$

x – model hindcast anomaly  
y – observed anomaly

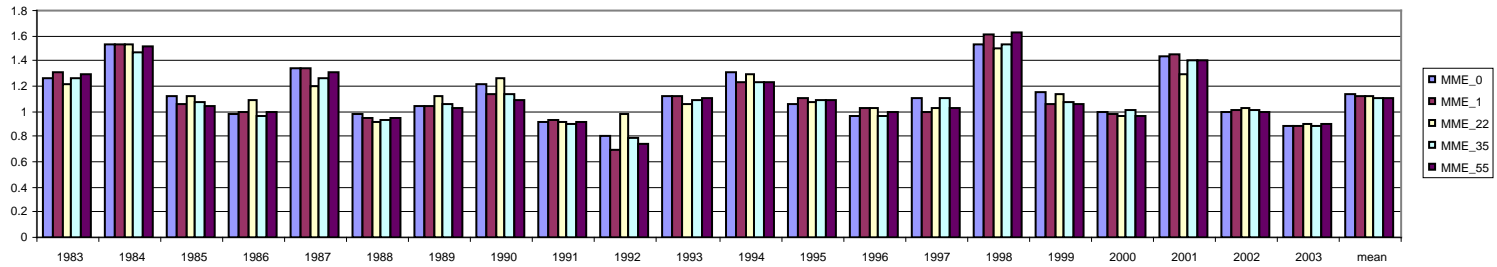
$P_c$  – probability of correct anomaly in the hindcast  
(number of points/years when  $x \cdot y \geq 0$  divided by N)

$P_e$  – climatological probability of correct anomaly

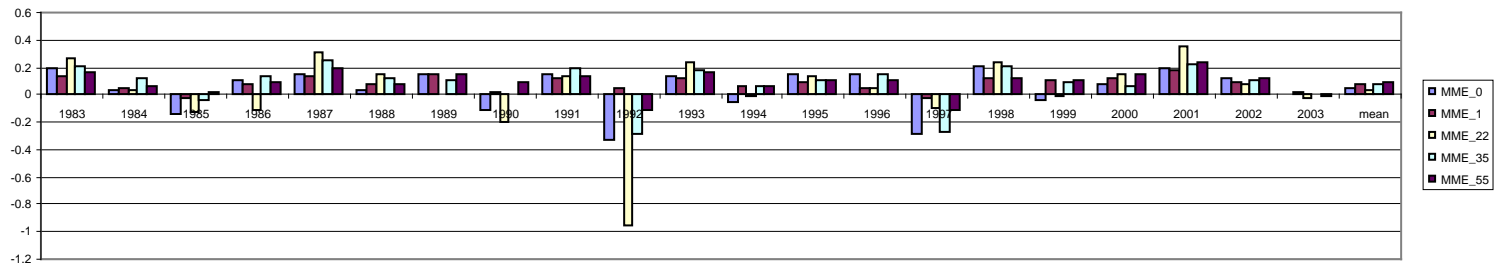
EA\_ACC



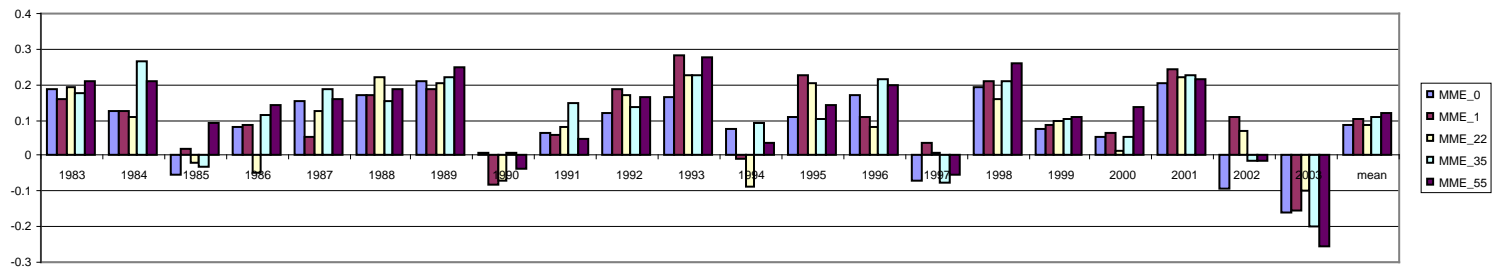
EA\_RMSE



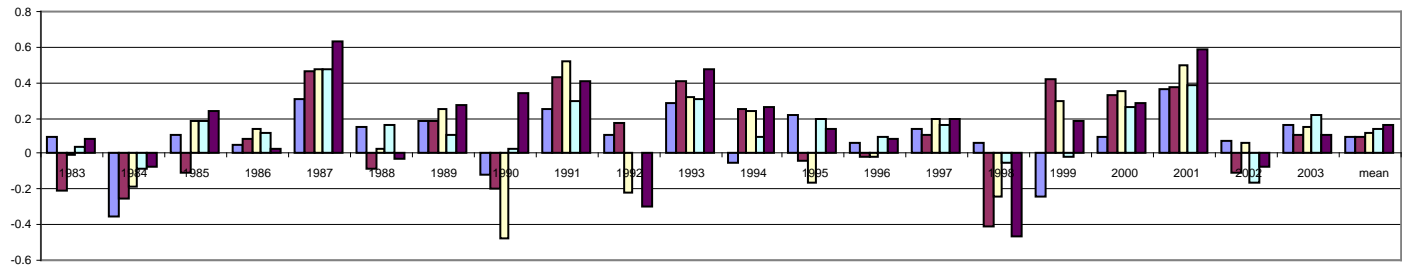
EA\_BSS



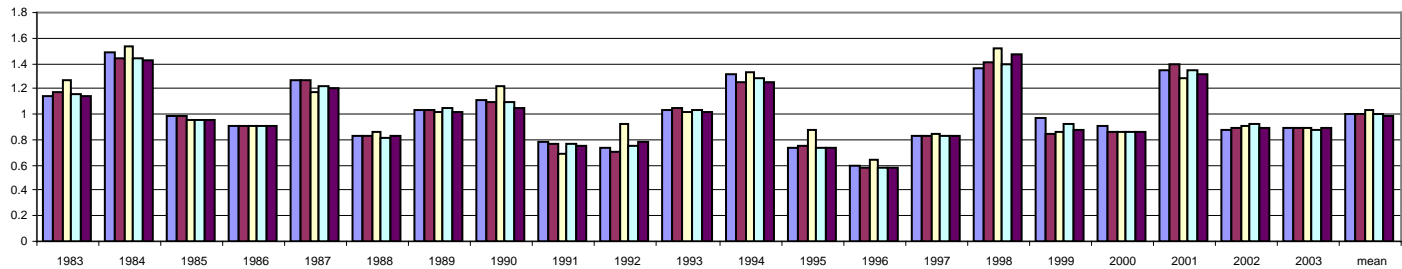
EA\_HSS



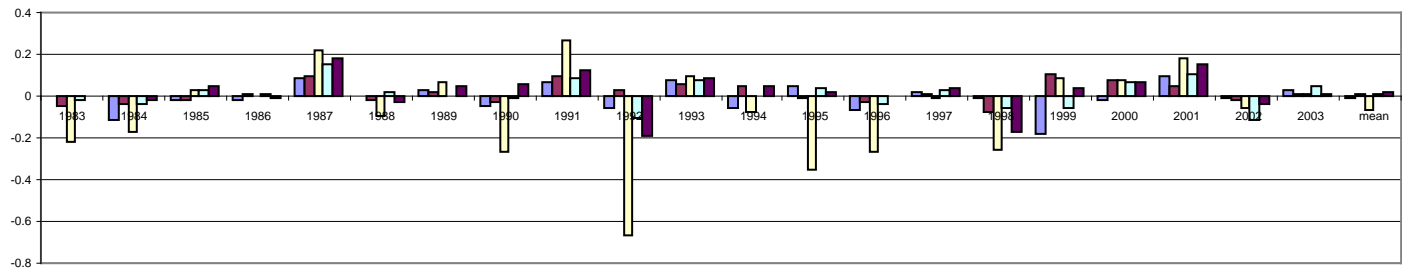
EA\_ACC\_L



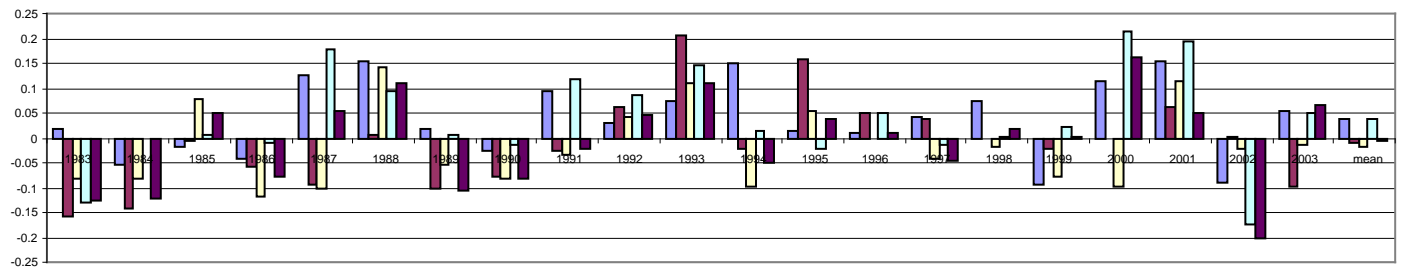
EA\_RMSE\_L



EA\_BSS\_L

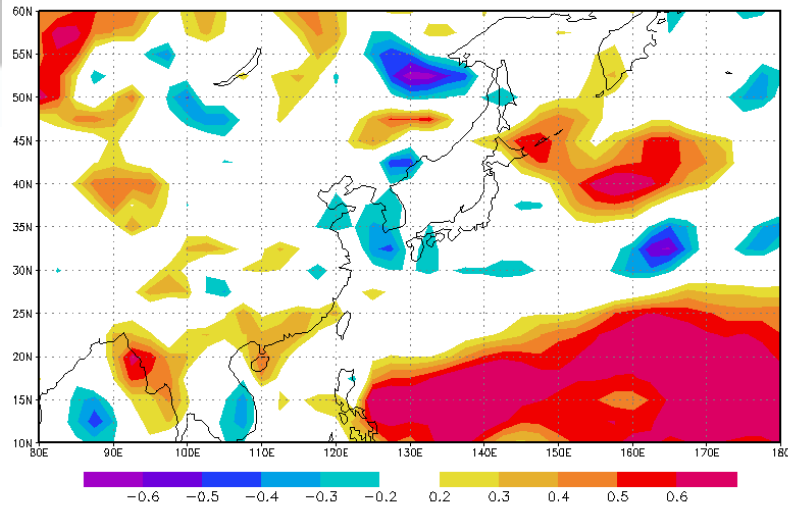


EA\_HSS\_L

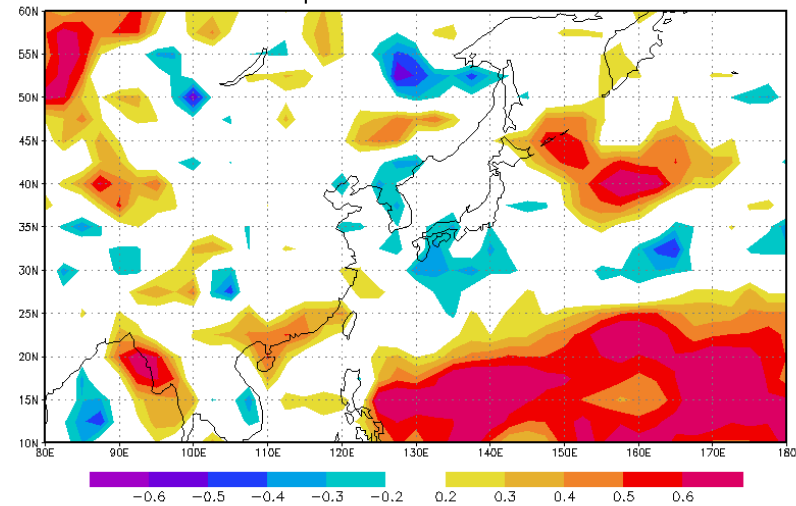


# COMPOSITE (Method 1)

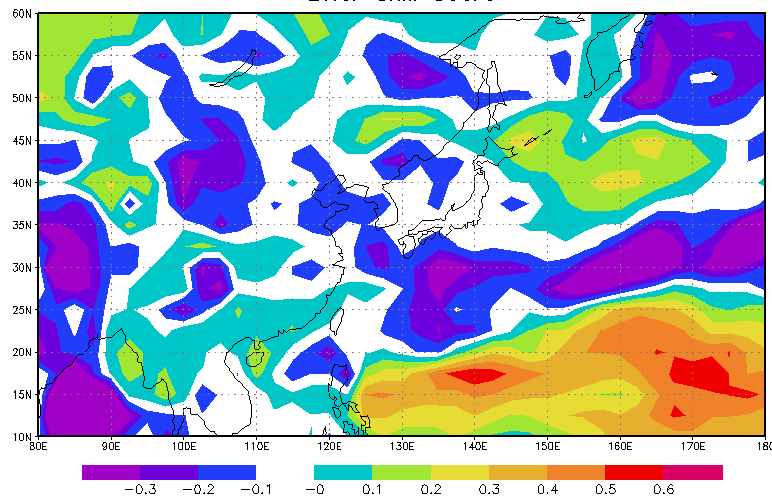
### Correlation



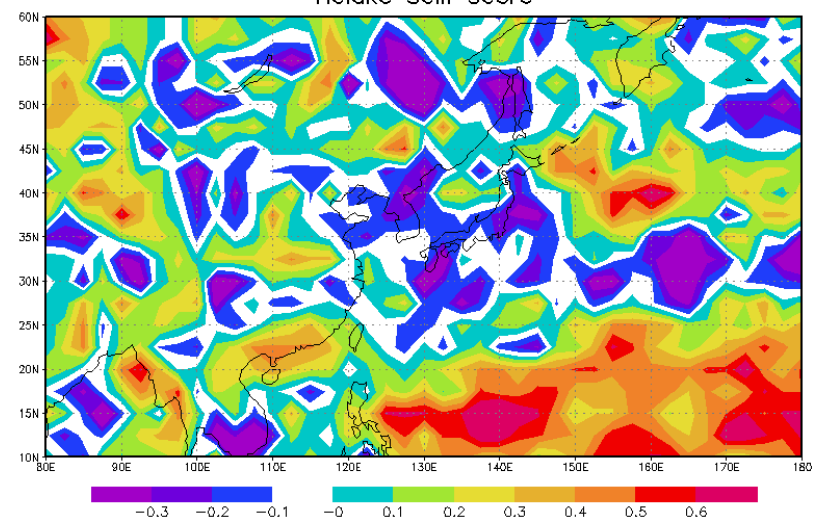
### Spearman Correlation



### Brier Skill Score

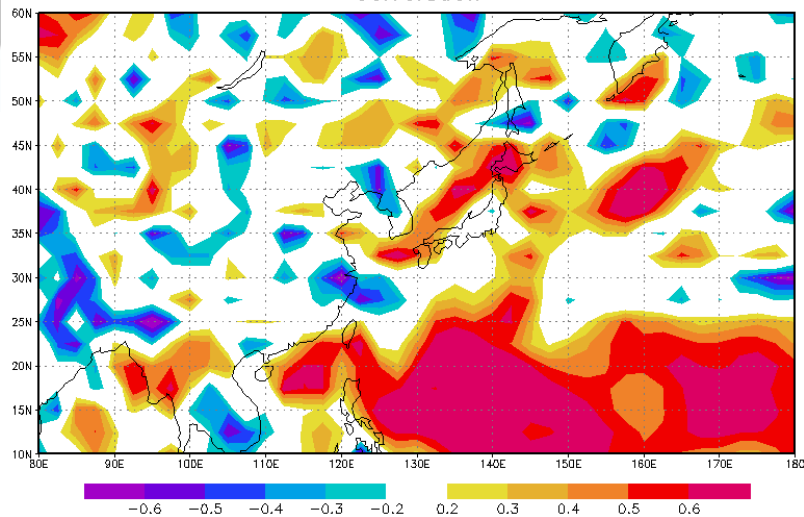


### Heidke Skill Score

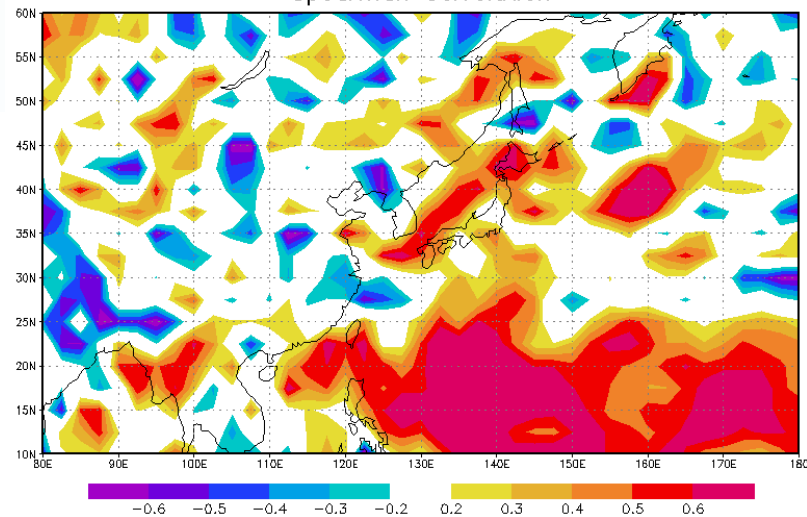


# COMPOSITE of CORRECTED MODELS (Method 2)

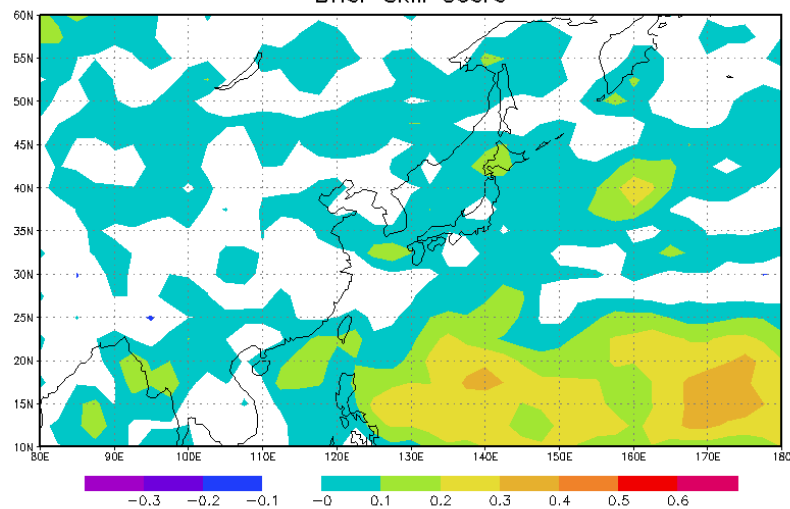
### Correlation



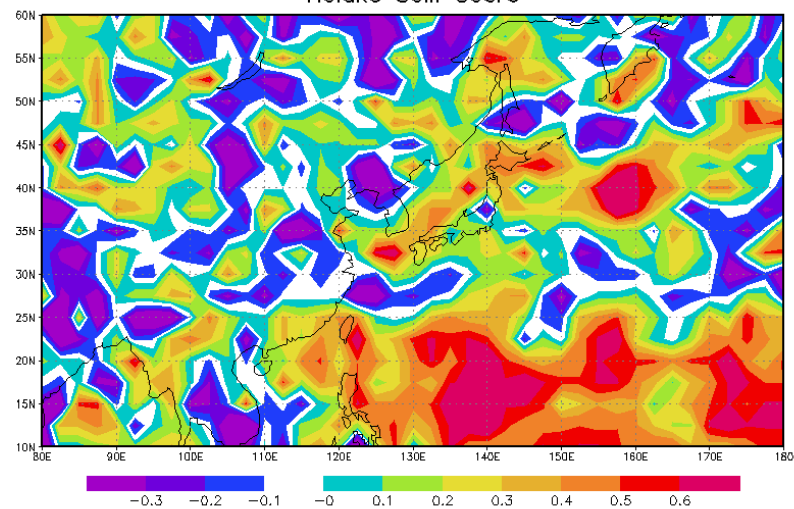
### Spearman Correlation



### Brier Skill Score

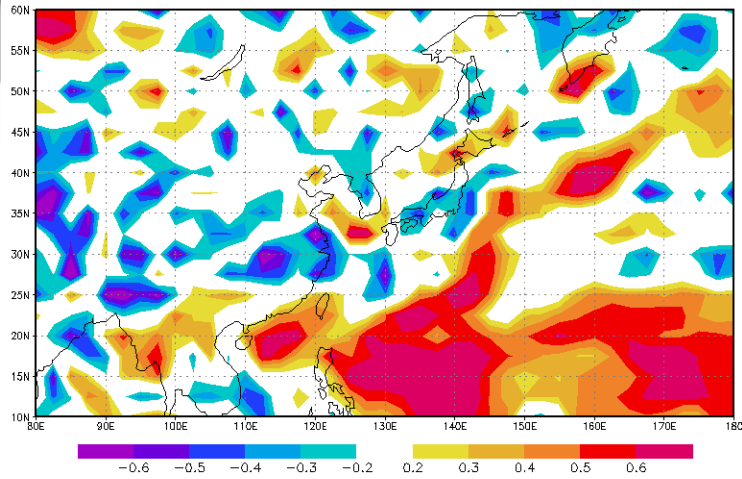


### Heidke Skill Score

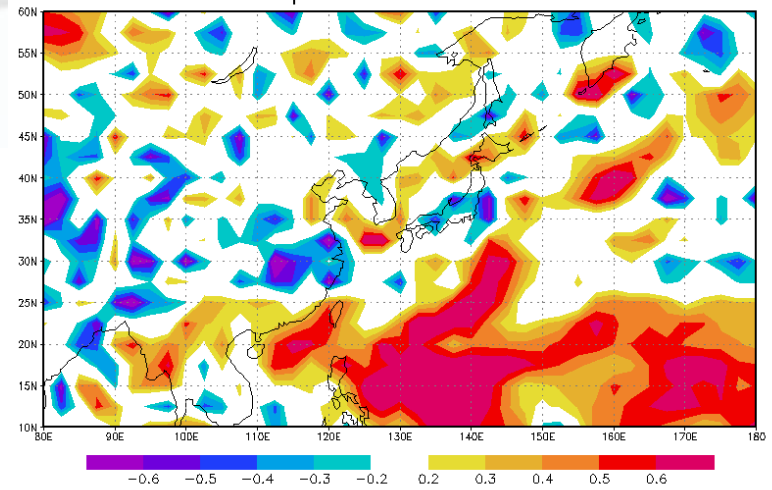


# SUPERENSEMBLE 2 SVD MODES (Method 3)

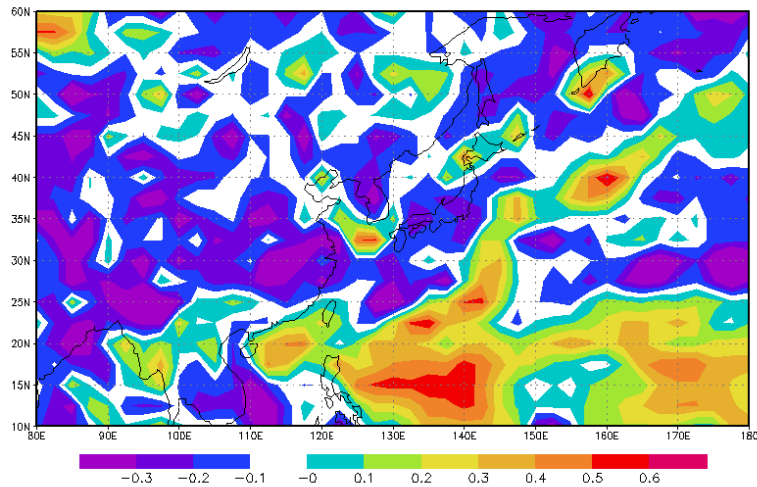
### Correlation



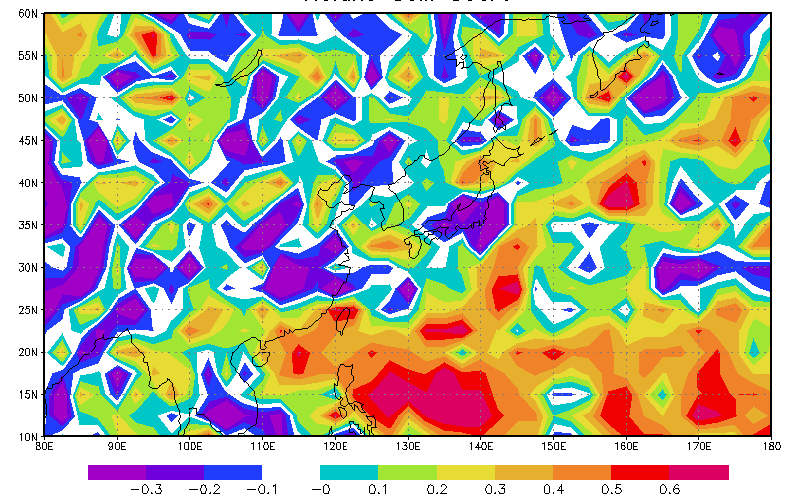
### Spearman Correlation



### Brier Skill Score

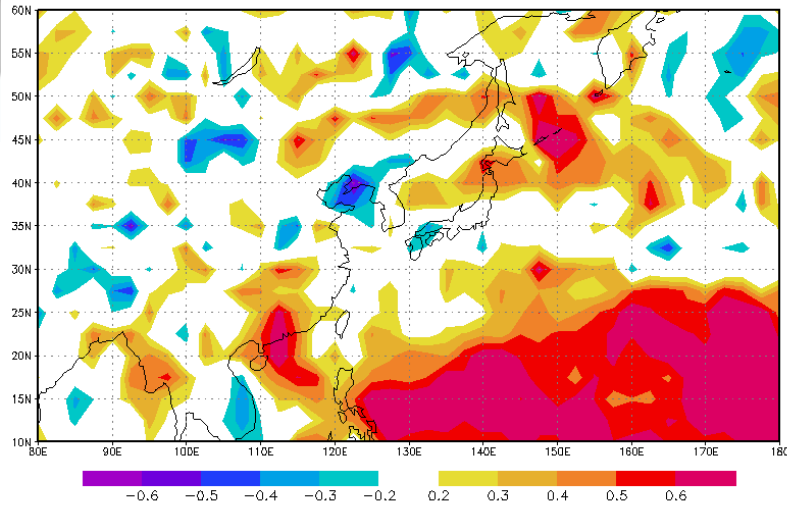


### Heidke Skill Score

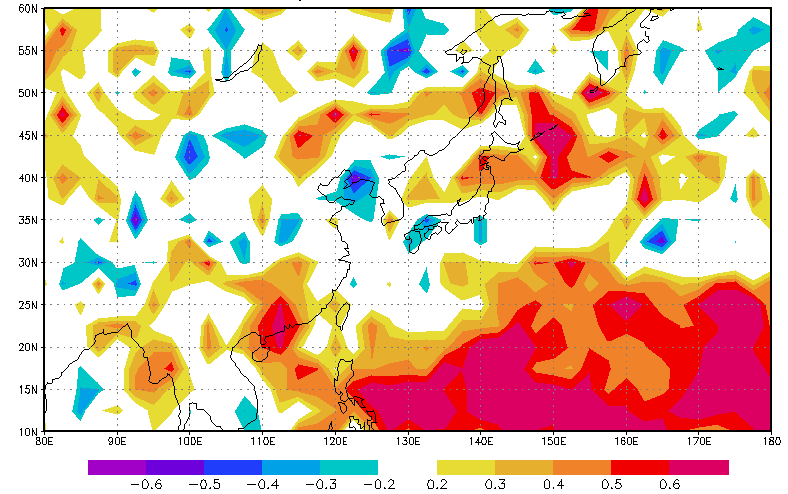


# COMPOSITE of SPATIALLY CORRECTED MODELS (Method 4)

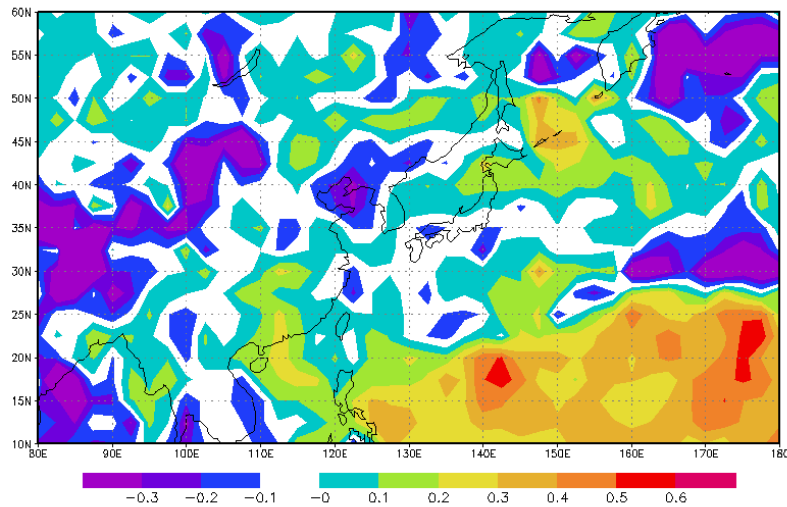
Correlation



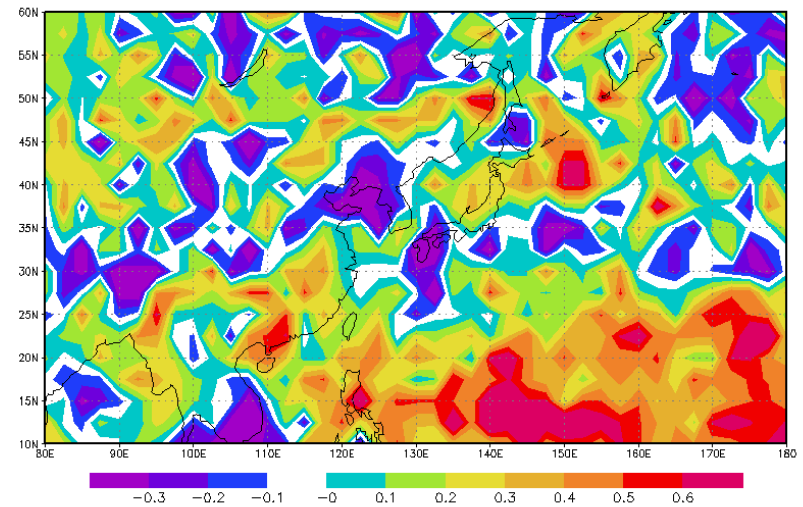
Spearman Correlation



Brier Skill Score

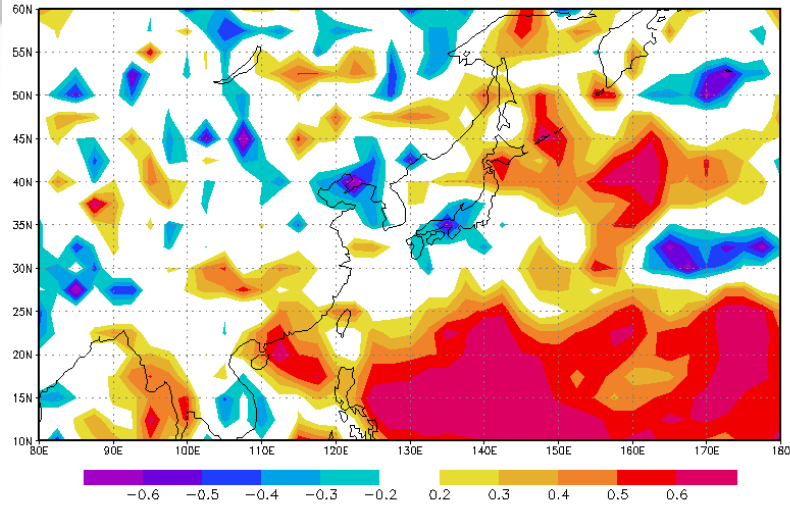


Heidke Skill Score

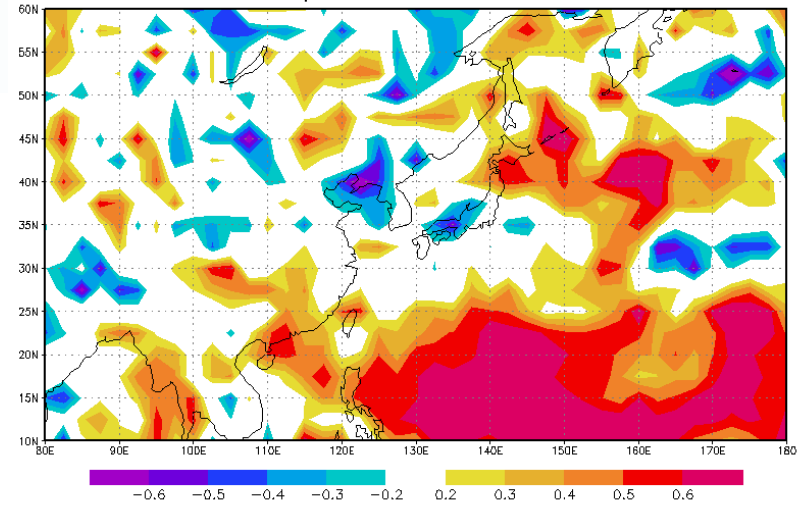


# COMPOSITE of SPATIALLY CORRECTED, then REGRESSION CORRECTED MODELS (Method 5)

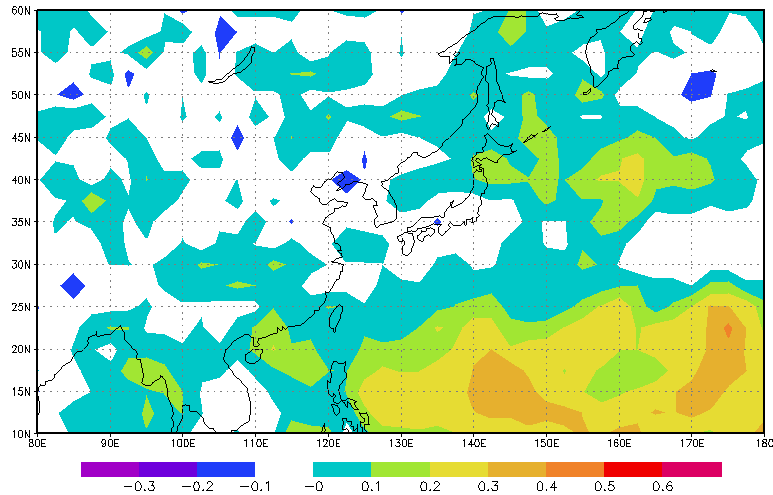
Correlation



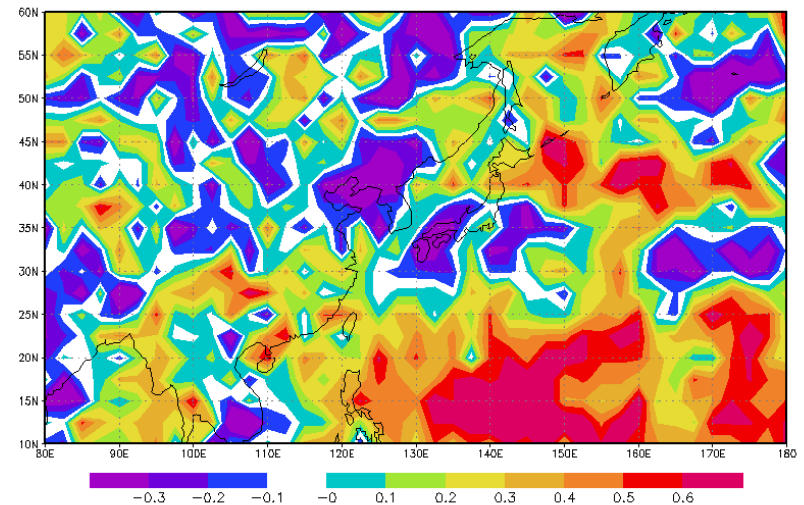
Spearman Correlation



Brier Skill Score

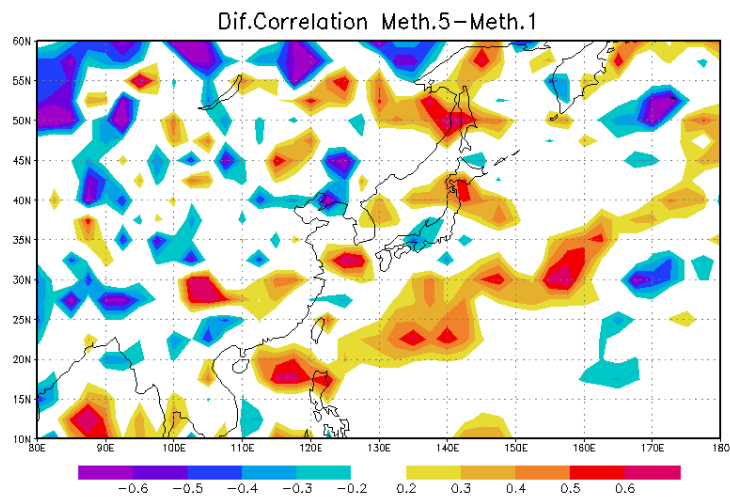
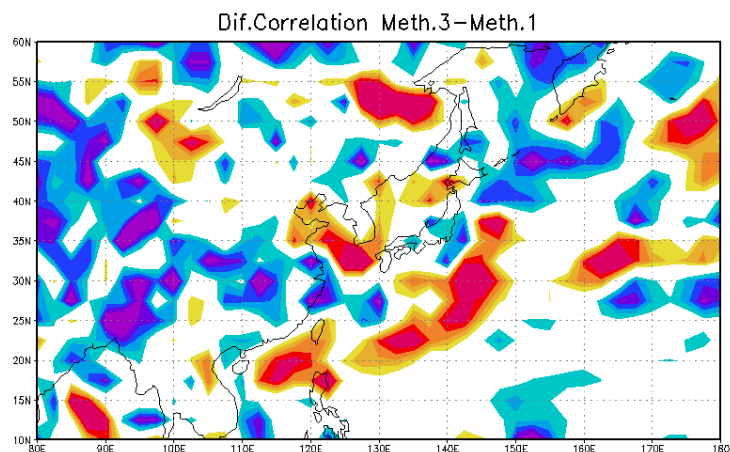
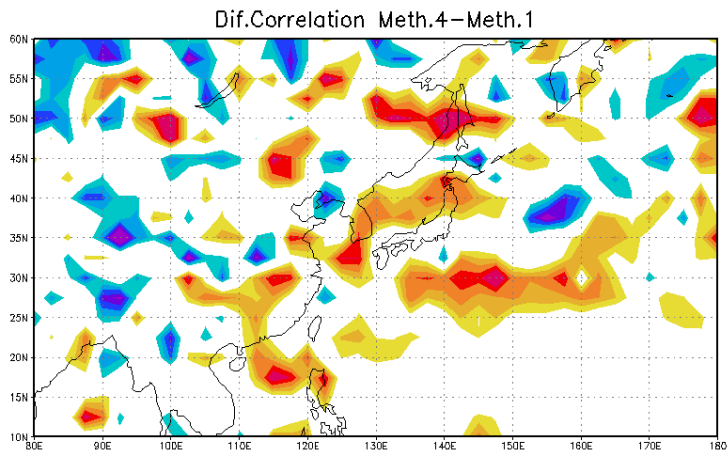
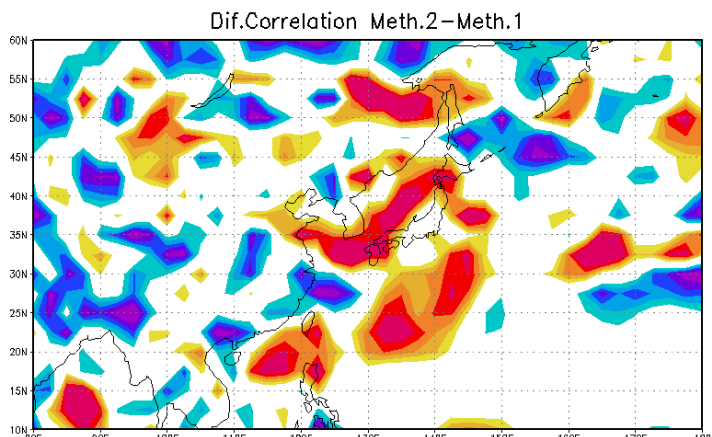
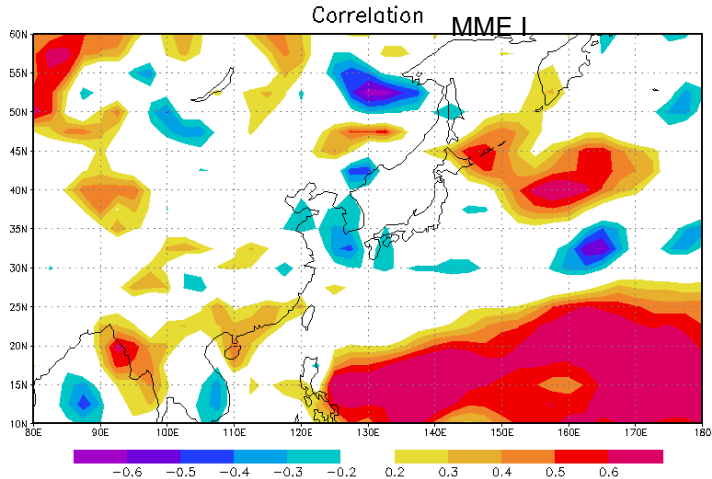


Heidke Skill Score

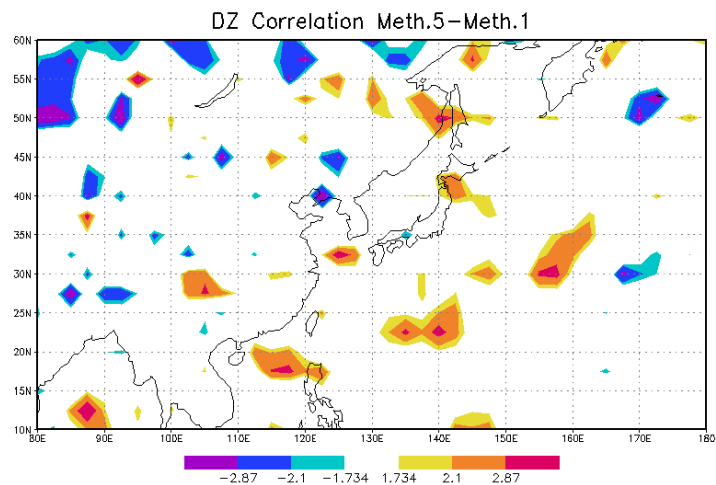
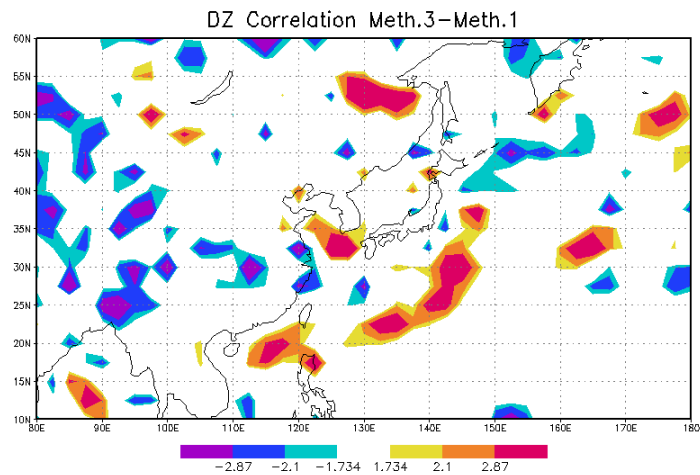
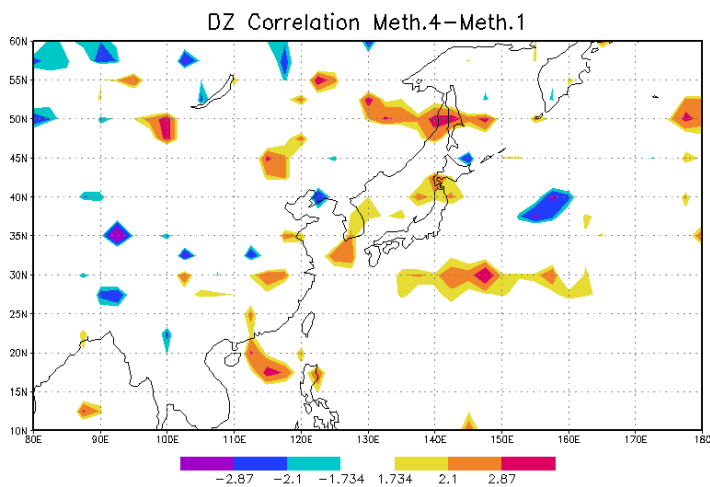
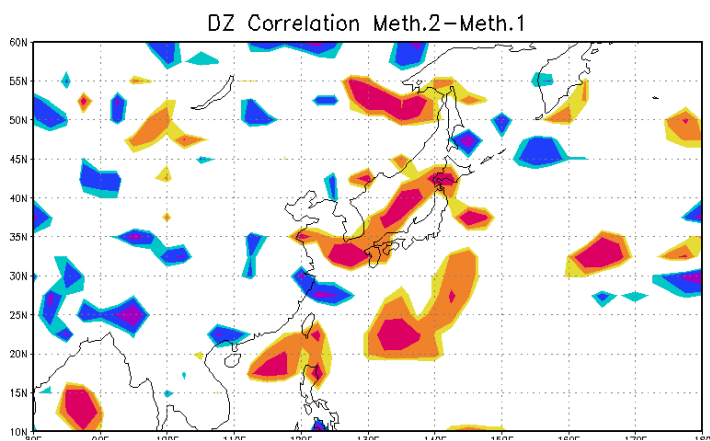
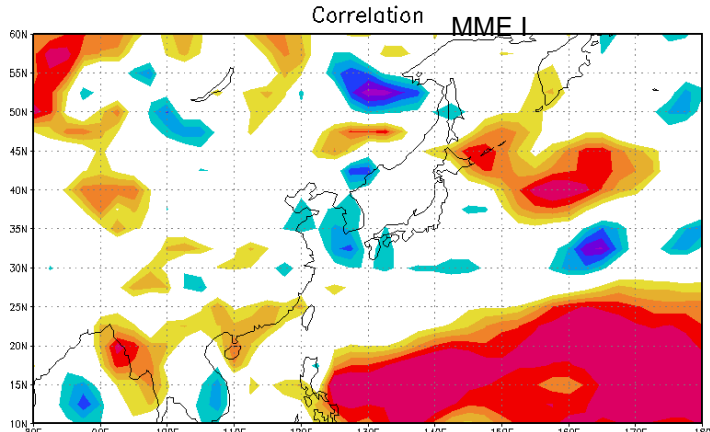


# DIFFERENCE in CORRELATIONS

Improvement and deterioration as against MME 1  
(qualitative assessment)



Areas of  
Statistically significant (10%, 5%, 1%)  
**DIFFERENCE** in CORRELATIONS  
as against MME I  
 $|t^*=(z_i-z_1)/\sigma_z| > \text{criterion}$



## ALL MODELS Vs. TOP MODELS

# Skill of the MMEs with different model sets.

A whole model set (11 models; blue)

Five top models (METRI, NCEP, JMA, IRI, GCPC; red)

	Method 1	Method 2	Method 3	Method 4	Method 5
ACC EA	0.27	0.36	0.31	0.32	0.37
	0.30	0.32	0.23*	0.33	0.36
RMSE EA	1.13	1.11	1.13	1.11	1.10
	1.14	1.11	1.16	1.11	1.10
ACC EA_Land	0.09	0.09	0.11	0.14	0.16
	0.09	0.07	-0.09*	0.12	0.15
RMSE EA_Land	1.01	1.00	1.02	1.00	0.99
	1.02	1.00	1.07	1.01	0.99
*0.28 and +0.08 if M nonzero = 5					