中国气象科学研究院
Chinese Academy of Meteorological Sciences

Teleconnection patterns impacting on the summer consecutive extreme rainfall in Central-Eastern China

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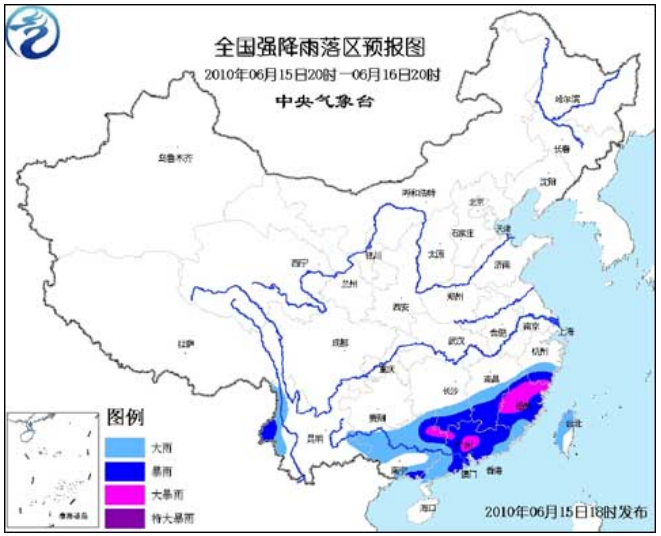
Outline

- **Motivation**
- **Data and methodology**
- **The persistent atmospheric circulation patterns of the CER**
- **Remote influences of SST variations on the CER**
- **Discussion and conclusion**

Consecutive extreme rainfall (CER) events are defined as "consecutive rainfall persisting for at least 3 days with the daily rainfall exceeding 50 mm".

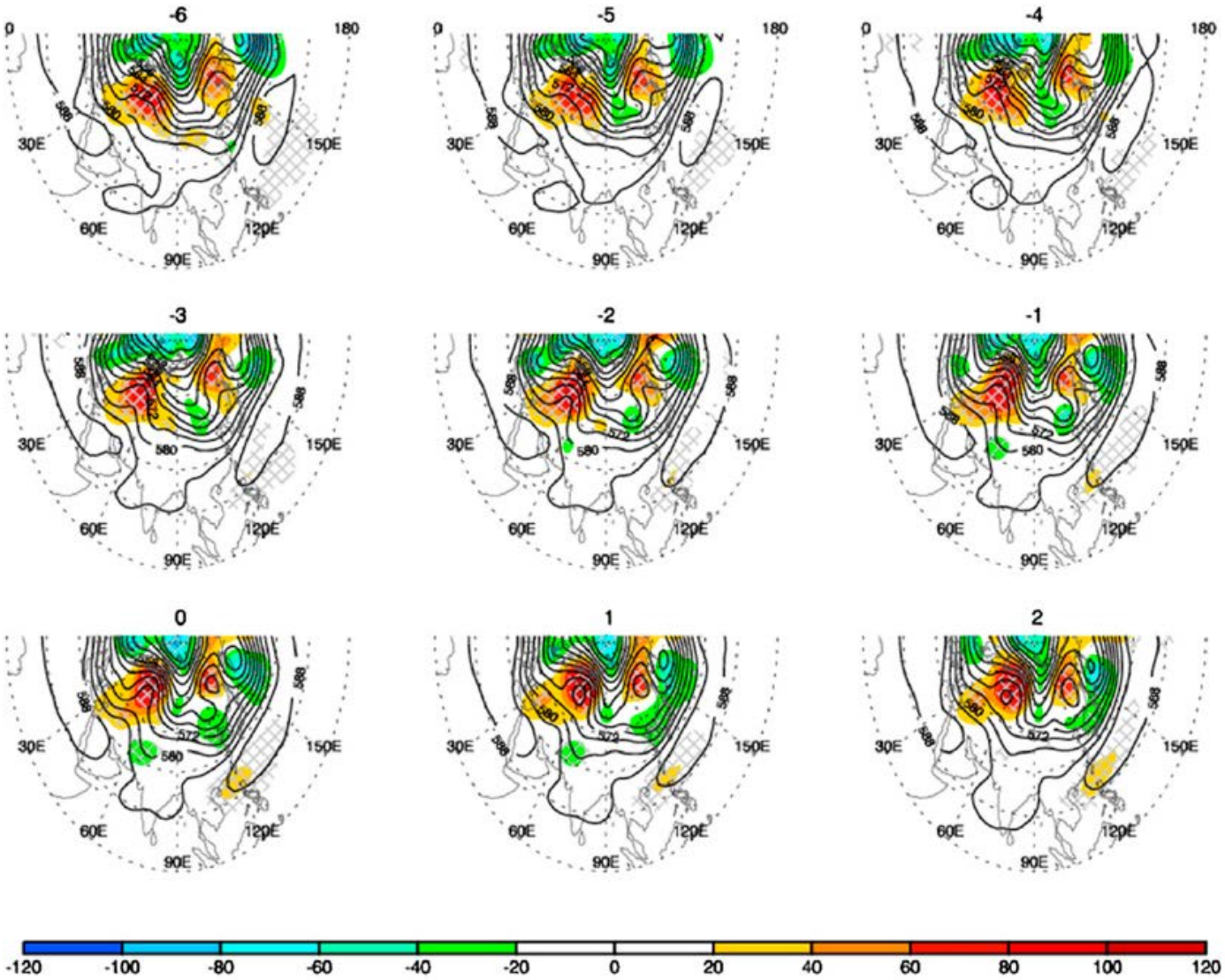
South China suffered consecutive heavy rainfall events from14 to 24 Jun, 2010



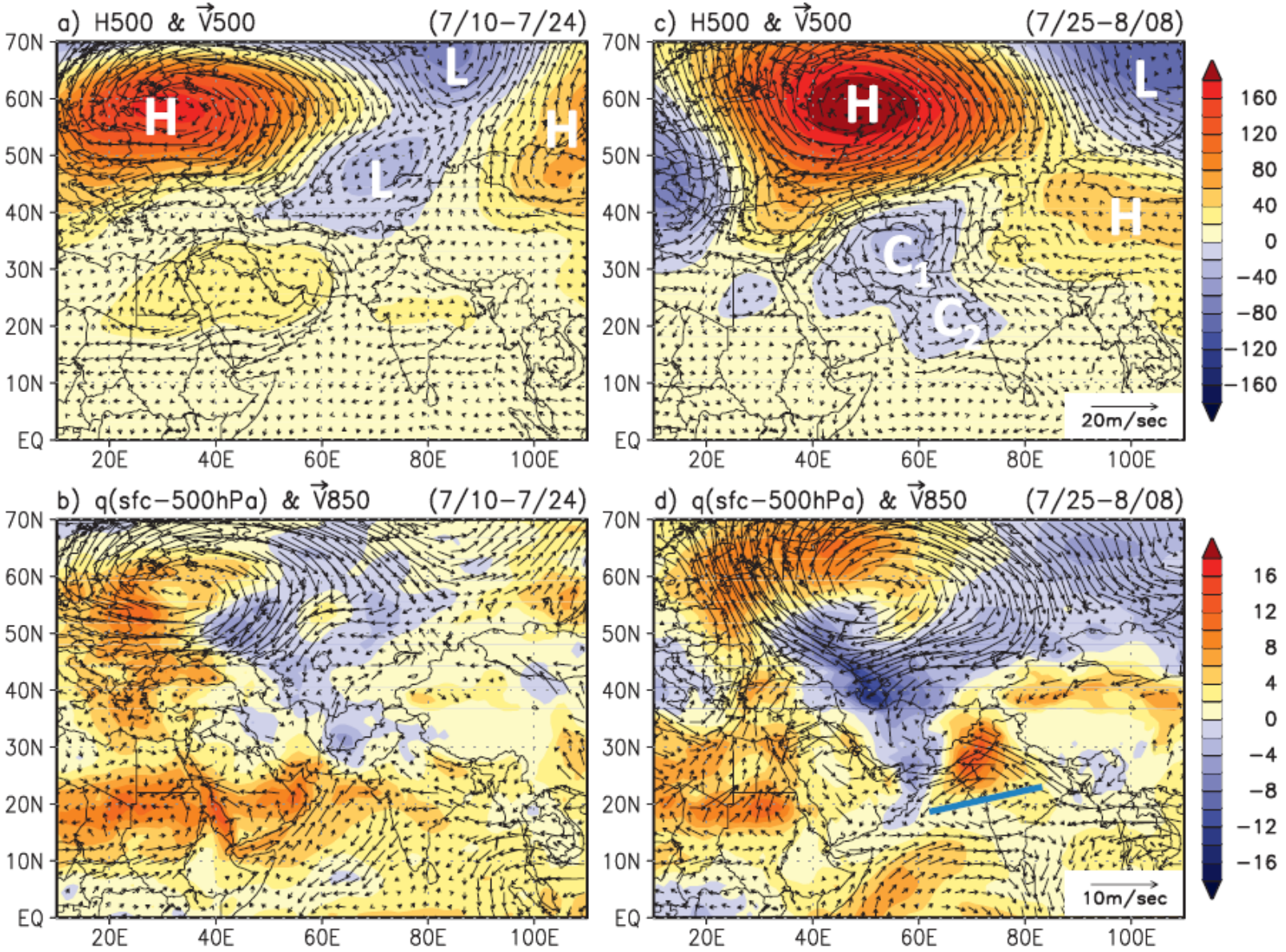
Weather forecast warned a storm was comming in South China on Jun 15, 2010

Mudflows and landslides
Jun 15 , 2010, Nanping, Fujian

Floods
Jun 15, 2010, Xining, Guangxi



Chen Y., and P. M. Zhai, 2014b: Precursor circulation features for persistent extreme precipitation in Central-Eastern China. *Wea. Forecasting*, **29**, 226–240



Lau, W. K. M., and K.-M. Kim, 2012: The 2010 Pakistan flood and Russian heat wave: teleconnection of hydrometeorological extremes. *J. Hydrometeor.*, **13**: 392– 403

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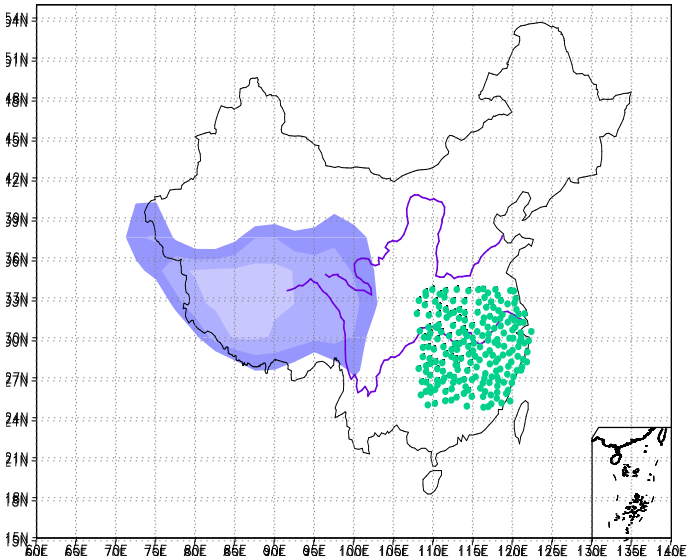
- Daily rainfall data: Observational data. Daily Surface Data for China (V3.0) archived by the National Meteorological Information Center (NMIC) of China Meteorological Administration (CMA). 1979-2010. 210 weather stations over Central-Eastern China.



- Atmospheric circulation: ERA-interim reanalysis. 1979-2010. daily geopotential height, wind, special humidity, pressure vertical velocity, et al.
- Daily SST: NOAA Optimum Interpolation daily SST (OISST, Version 2) analysis. 1982-2010.

- Threshold for extreme rainfall: 95th percentile is used to evaluate the threshold for extreme rainfall. The absolute threshold is defined as exceeding 50 mm for daily total precipitation.

- CER events: CER events are defined according to the following criteria: (1) the JJA daily rainfall exceeds 50 mm at one or more weather stations, (2) the extreme rainfall persists for at least 3 consecutive days, and (3) the CER events end when daily rainfall is less than 50 mm d^{-1} over 2 consecutive days. (1979-2010, 210 stations, 230 events of 340 events).

Examples 50 100 80 30 45 50 70 60 10 80 50

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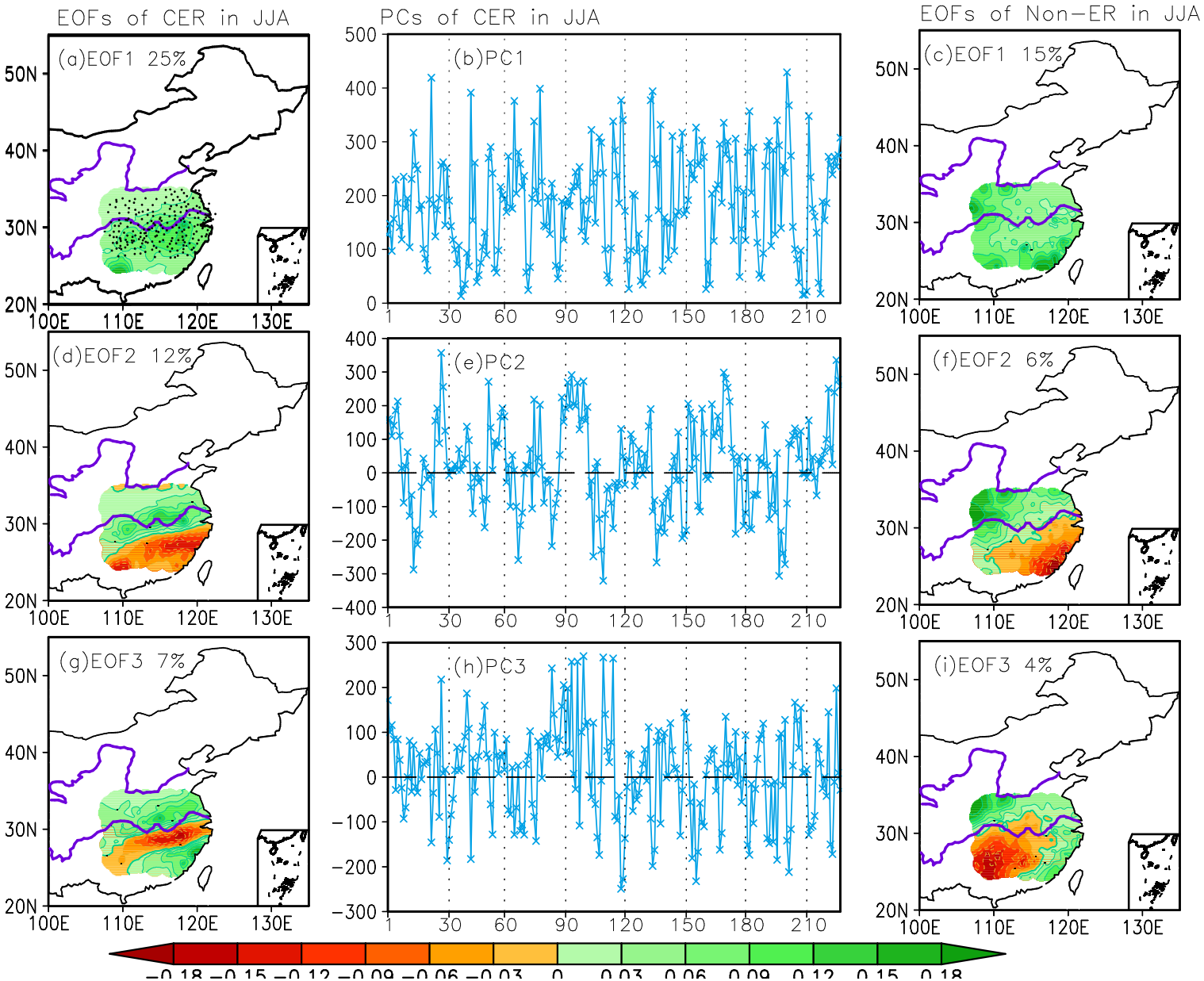
Dominant modes of the CER



r= -0.16

r= 0.55

r= 0.31

Teleconnection pattern for EOF 1

Lagged correlations between 500 mb geopotential height and PC1

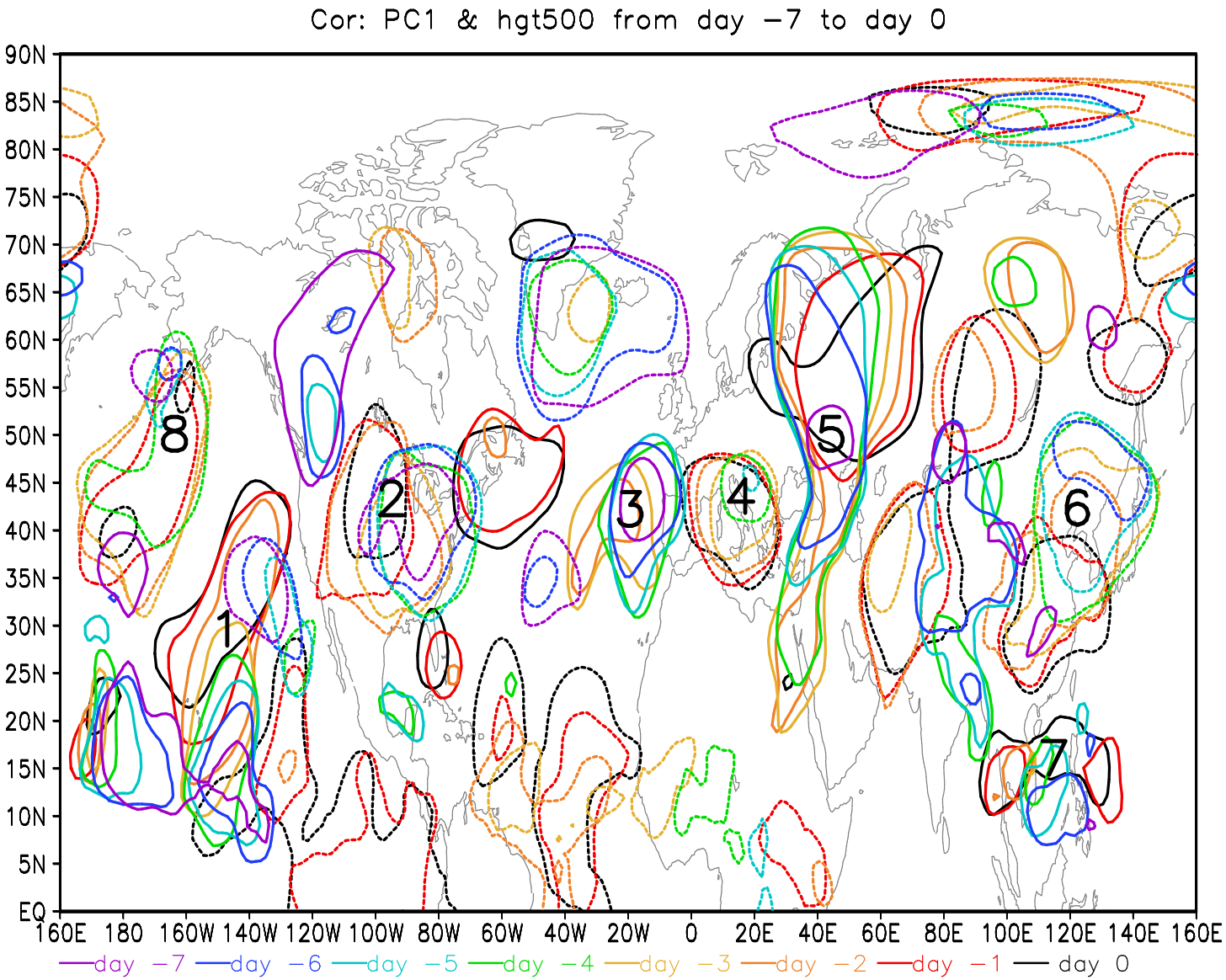
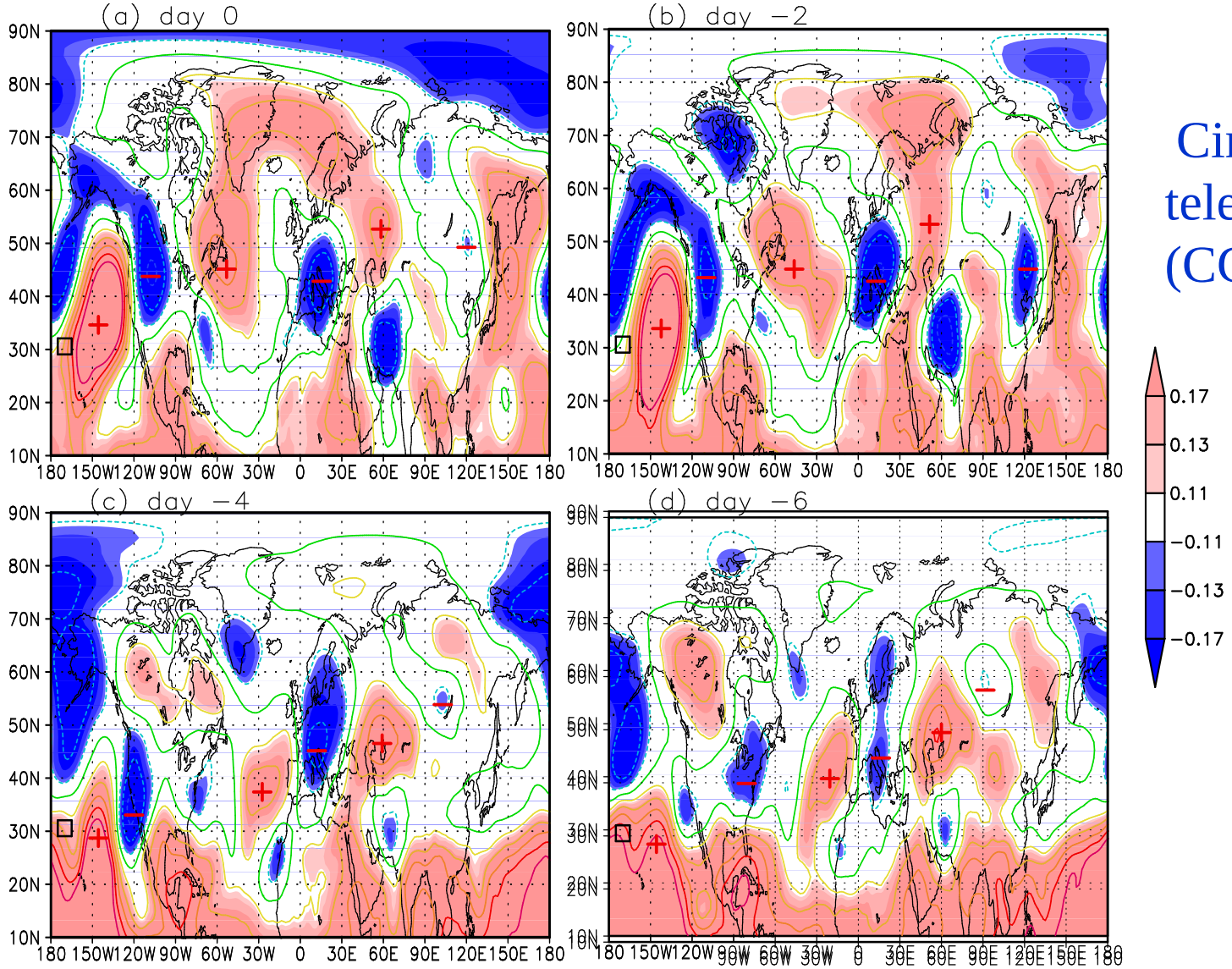


Table 1 Correlation coefficients between the indices of geopotential height related to PC1[a]

[a] Values in bold exceed the 0.05 significance level.

	index1	index2	index3	index4	index5	index6	index7	index8
index1	1.	**-0.22**	**0.28**	**-0.26**	**0.17**	0.01	**0.19**	**-0.25**
index2	**-0.22**	1.	**0.16**	0.07	-0.10	0.09	-0.06	0.06
index3	**0.28**	0.16	1.	-0.01	**0.21**	0.03	0.06	**-0.18**
index4	**-0.26**	0.07	-0.01	1.	-0.09	0.05	0.03	**0.29**
index5	**0.17**	-0.10	**0.21**	-0.09	1.	**-0.15**	**0.20**	0.12
index6	0.01	0.09	0.03	0.05	**-0.15**	1.	**-0.15**	**0.25**
index7	**0.19**	-0.06	0.06	0.03	**0.20**	**-0.15**	1.	-0.07
index8	**-0.25**	0.06	**-0.18**	**0.29**	0.12	**0.25**	-0.07	1.

One-point correlation map between the base point (box) and 500 mb geopotential height anomalies



Circumglobal teleconnection (CGT) pattern

Teleconnection pattern for EOF 2

Lagged correlations of 500 hPa geopotential height with PC2

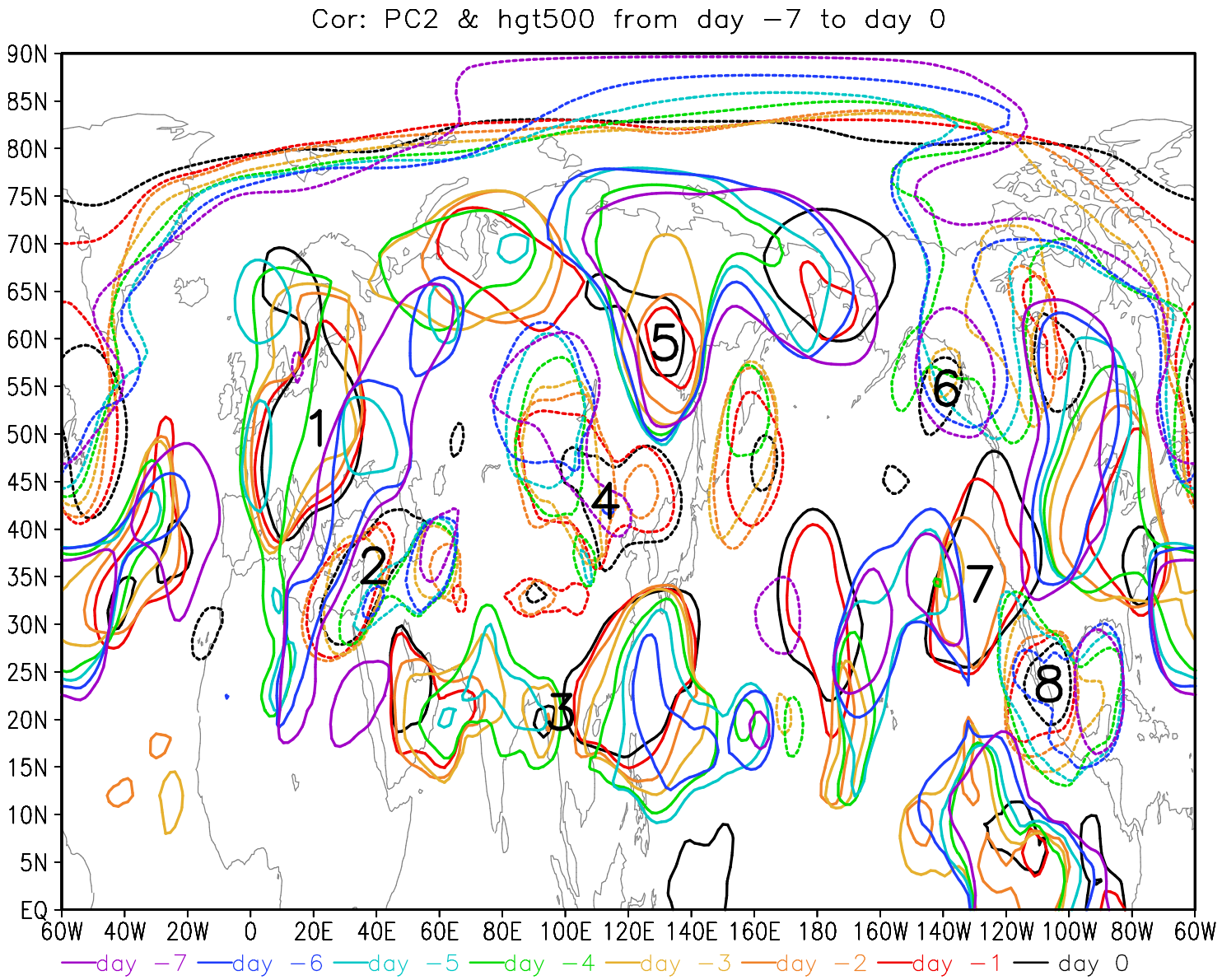
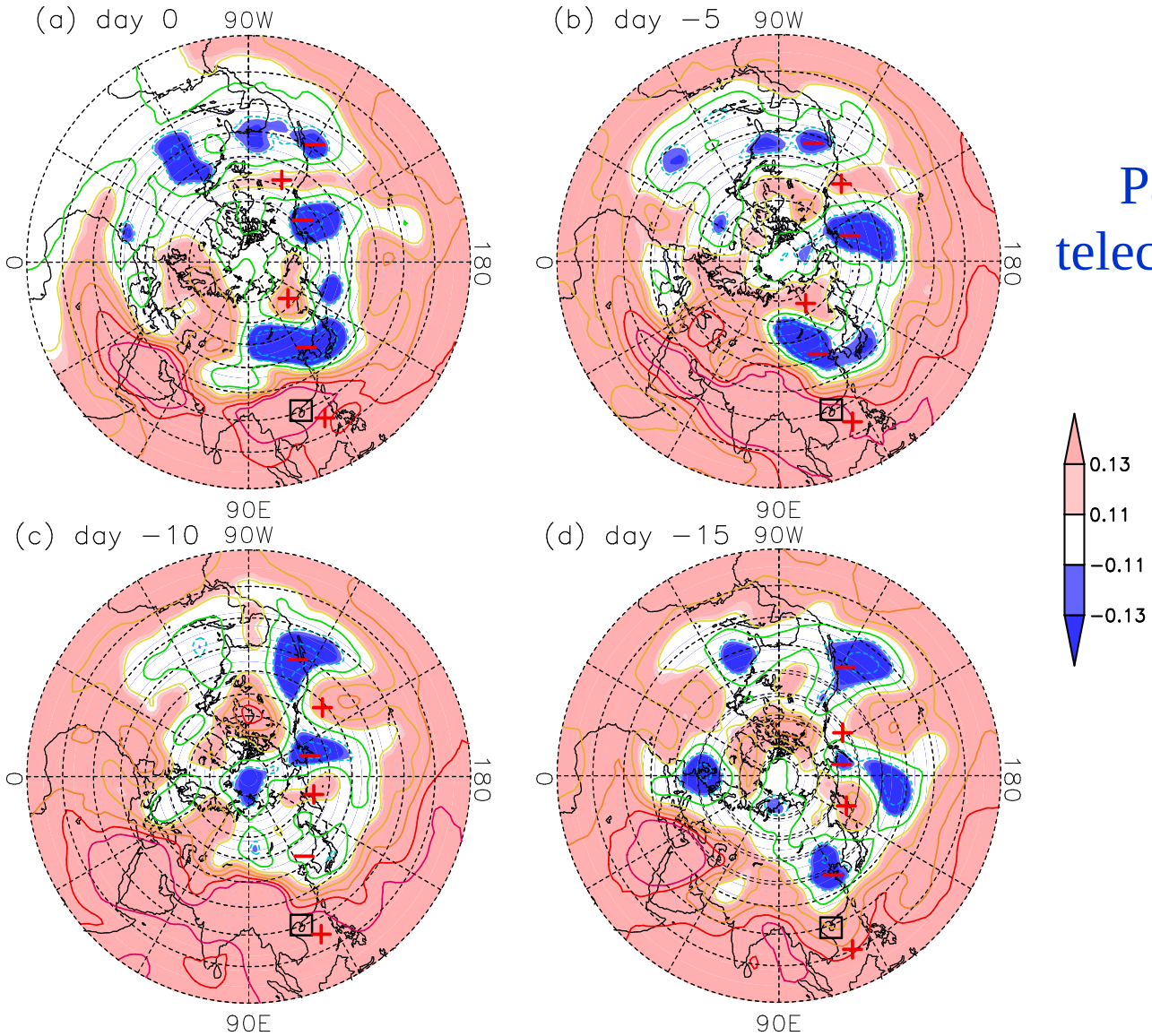


Table 2 Correlation coefficients between the indices of geopotential height related to PC2[a]

[a] Values in bold exceed the 0.05 significance level.

	index1	index2	***index3***	index4	index5	index6	index7	index8
index1	1.	-0.04	**0.24**	-0.12	**0.15**	-0.06	-0.05	**0.14**
index2	-0.04	1.	**0.16**	0.04	0.07	**0.20**	0. 10	0.06
index3	**0.24**	**0.16**	1.	**-0.33**	**0.17**	**-0.14**	-0.11	-0.11
index4	-0.12	0.04	**-0.33**	1.	**-0.26**	0.06	0.11	0.08
index5	**0.15**	0.07	**0.17**	**-0.26**	1.	0.05	-0.01	**0.18**
index6	-0.06	**0.20**	**-0.14**	0.06	0.05	1.	**0.35**	-0.01
index7	-0.05	0.10	-0.11	0.11	-0.01	**0.35**	1.	**0.17**
index8	**0.14**	0.06	-0.11	0.08	**0.18**	-0.01	**0.17**	1.

One-point correlation map between the base point (box) and 500 hPa geopotential height anomalies



Pacific-Japan teleconnection (PJ) pattern

Teleconnection pattern for EOF 3

Lagged correlations of 500 hPa geopotential height with PC3

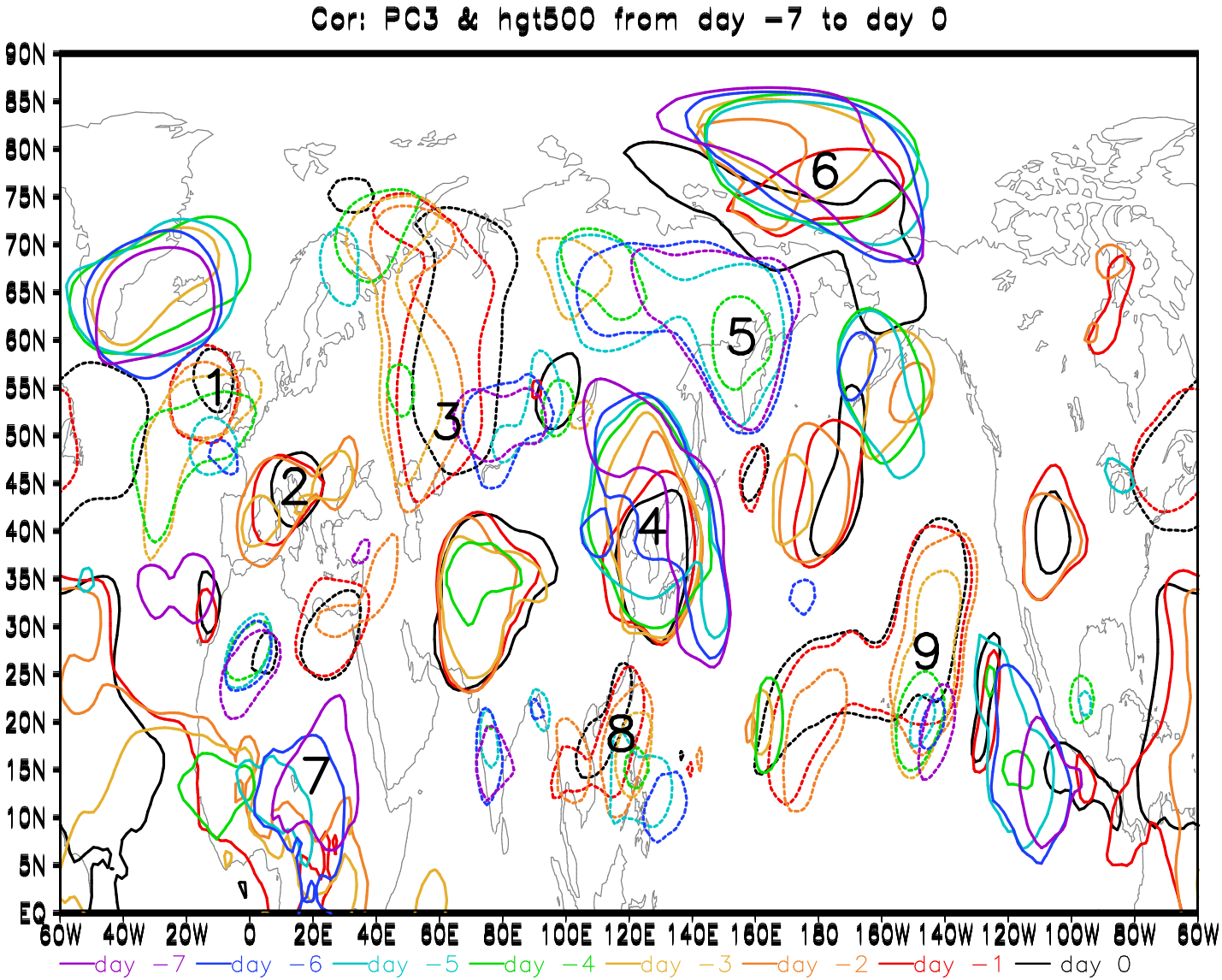
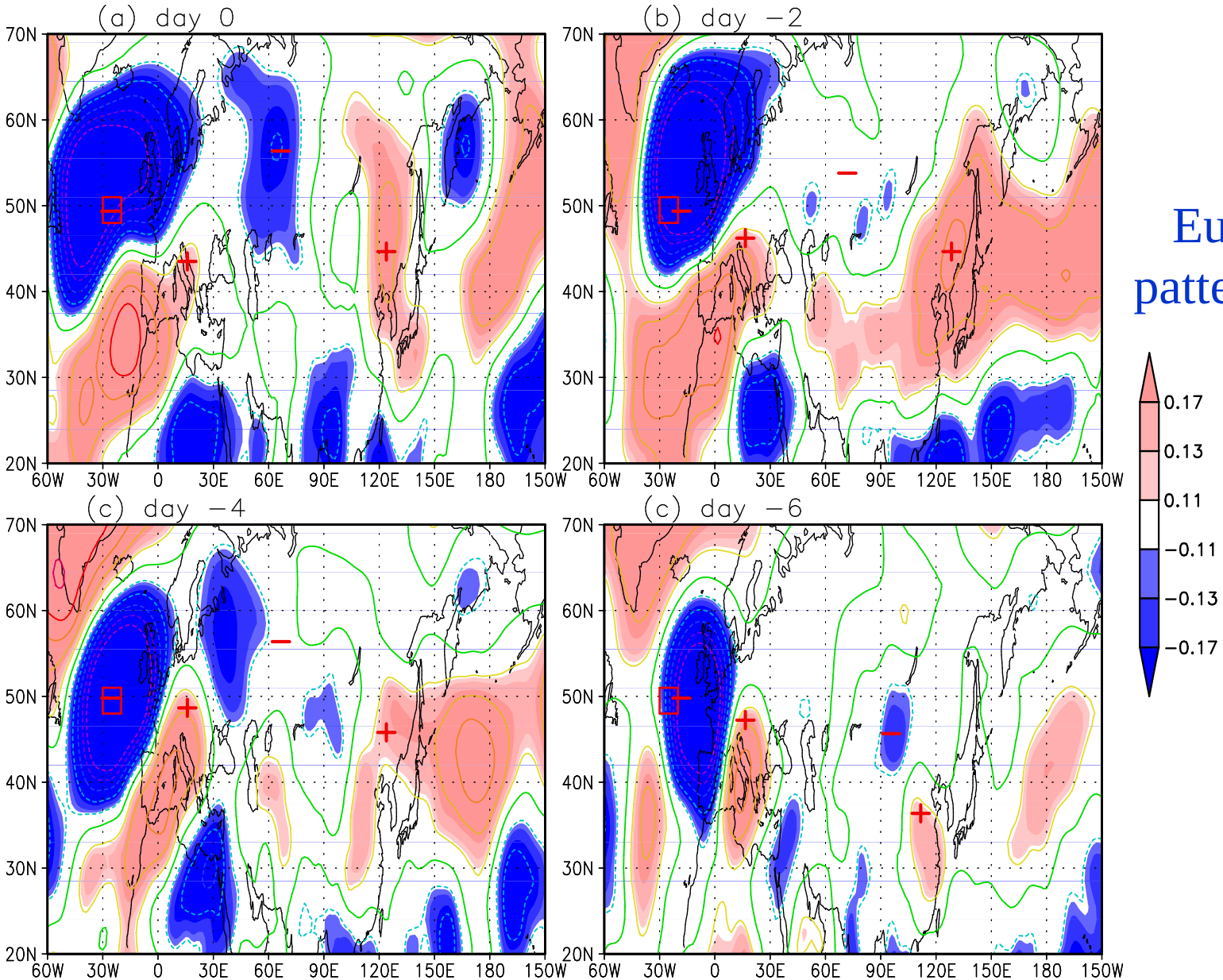


Table 3 Correlation coefficients between the indices of geopotential height related to PC3[a]

[a] Values in bold exceed the 0.05 significance level.

	index1	index2	index3	index4	index5	index6	index7	index8	index9
index1	1.	**-0.20**	**0.15**	**-0.18**	0.01	**-0.29**	**-0.13**	**0.15**	**0.28**
index2	**-0.20**	1.	-0.04	**0.25**	0.03	0.12	**0.23**	0.04	**-0.33**
index3	**0.15**	-0.04	1.	**-0.18**	**0.15**	-0.10	0.04	**0.30**	**0.17**
index4	**-0.18**	**0.25**	**-0.18**	1.	**0.25**	-0.05	0.10	**-0.26**	-0.03
index5	0.01	0.03	**0.15**	**0.25**	1.	**-0.17**	**0.16**	0.02	**0.24**
index6	**-0.29**	0.12	-0.10	-0.05	**-0.17**	1.	0.04	**-0.14**	**-0.23**
index7	**-0.13**	**0.23**	0.04	0.10	**0.16**	0.04	1.	0.08	0.00
index8	**0.15**	0.04	**0.30**	**-0.26**	0.02	**-0.14**	-0.08	1.	**0.24**
index9	**0.28**	**-0.33**	**0.17**	-0.03	**0.24**	**-0.23**	0.00	**0.24**	1.

One-point correlation map between the base point (box) and 500 hPa geopotential height anomalies



Eurasian pattern (EU)

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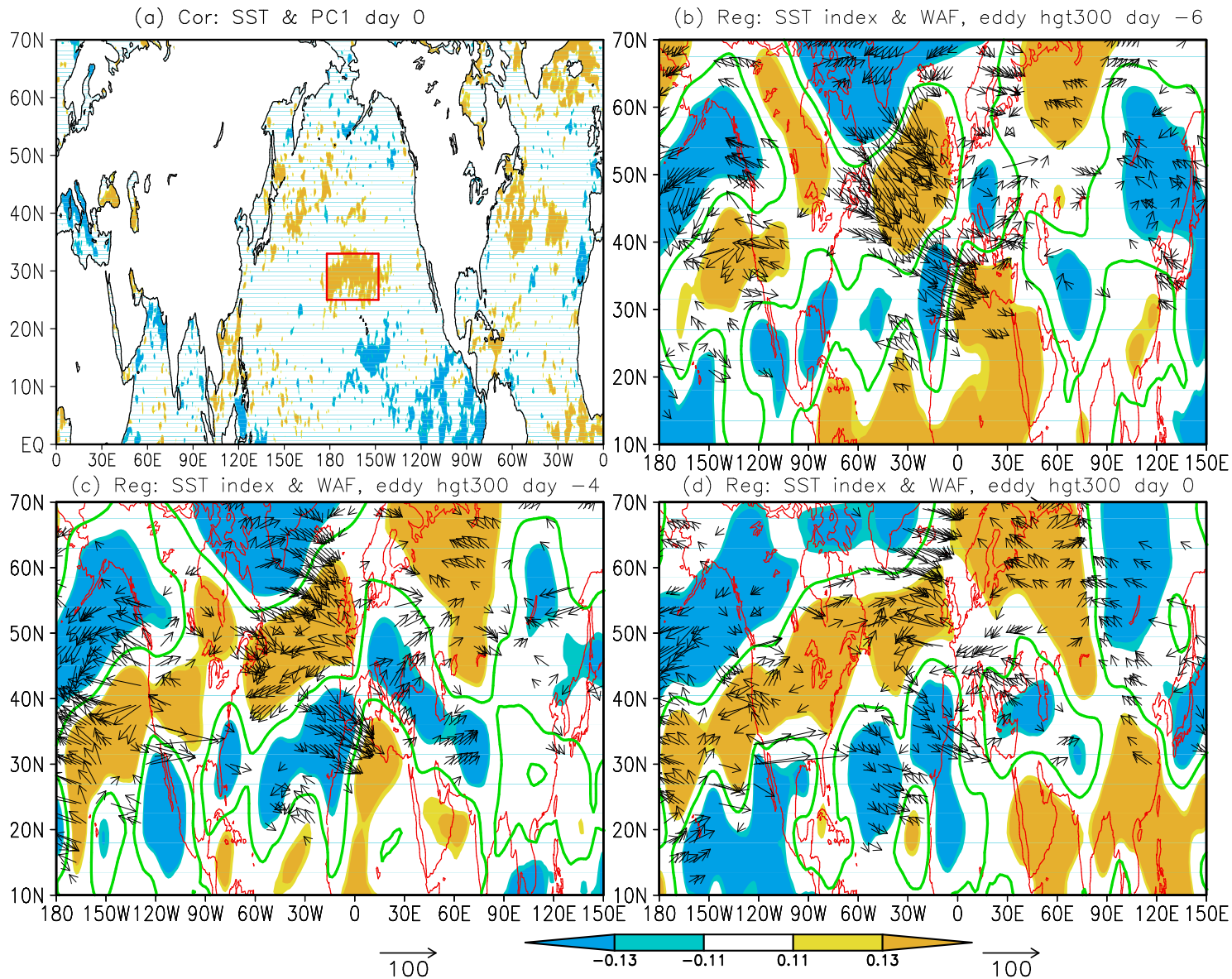
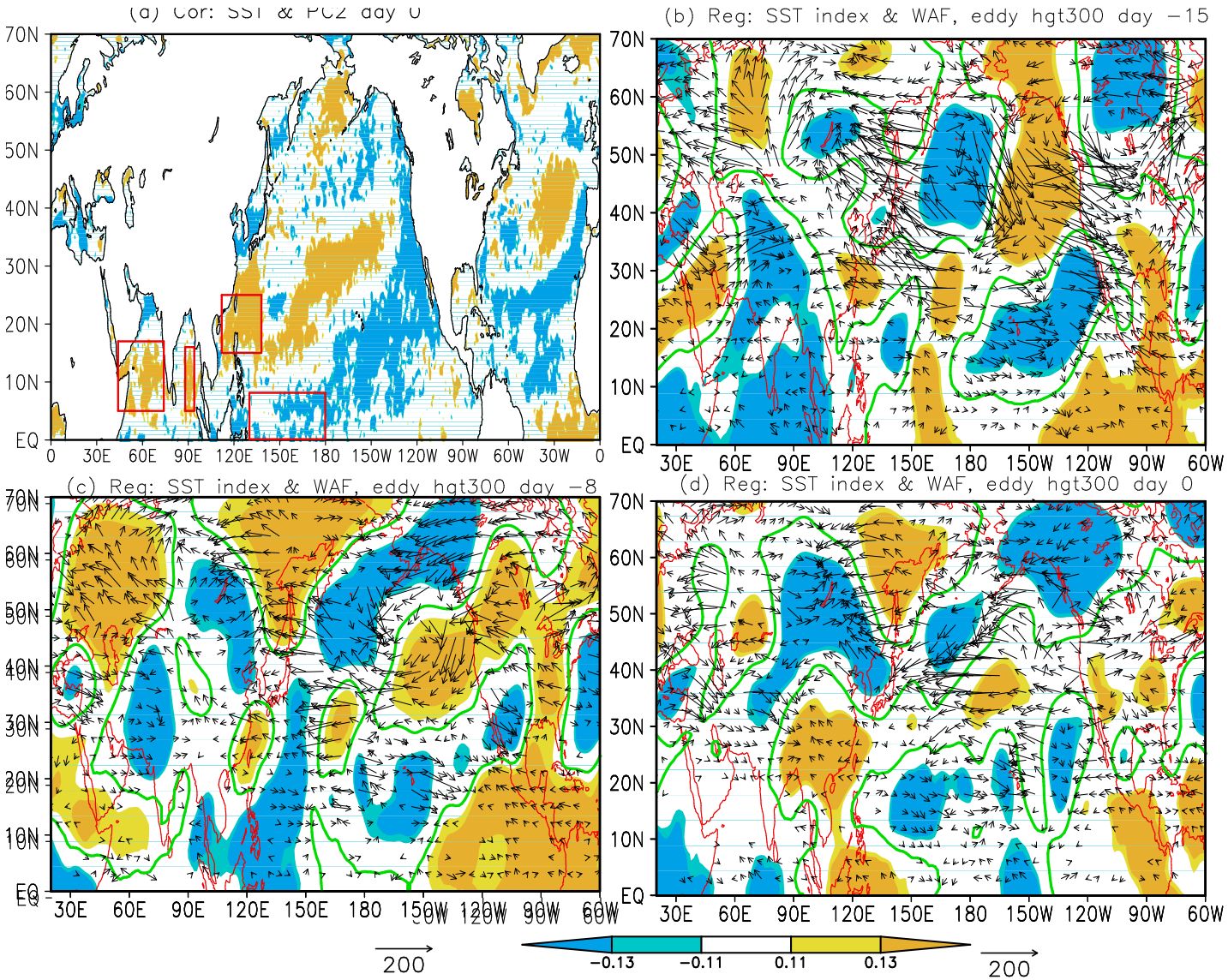
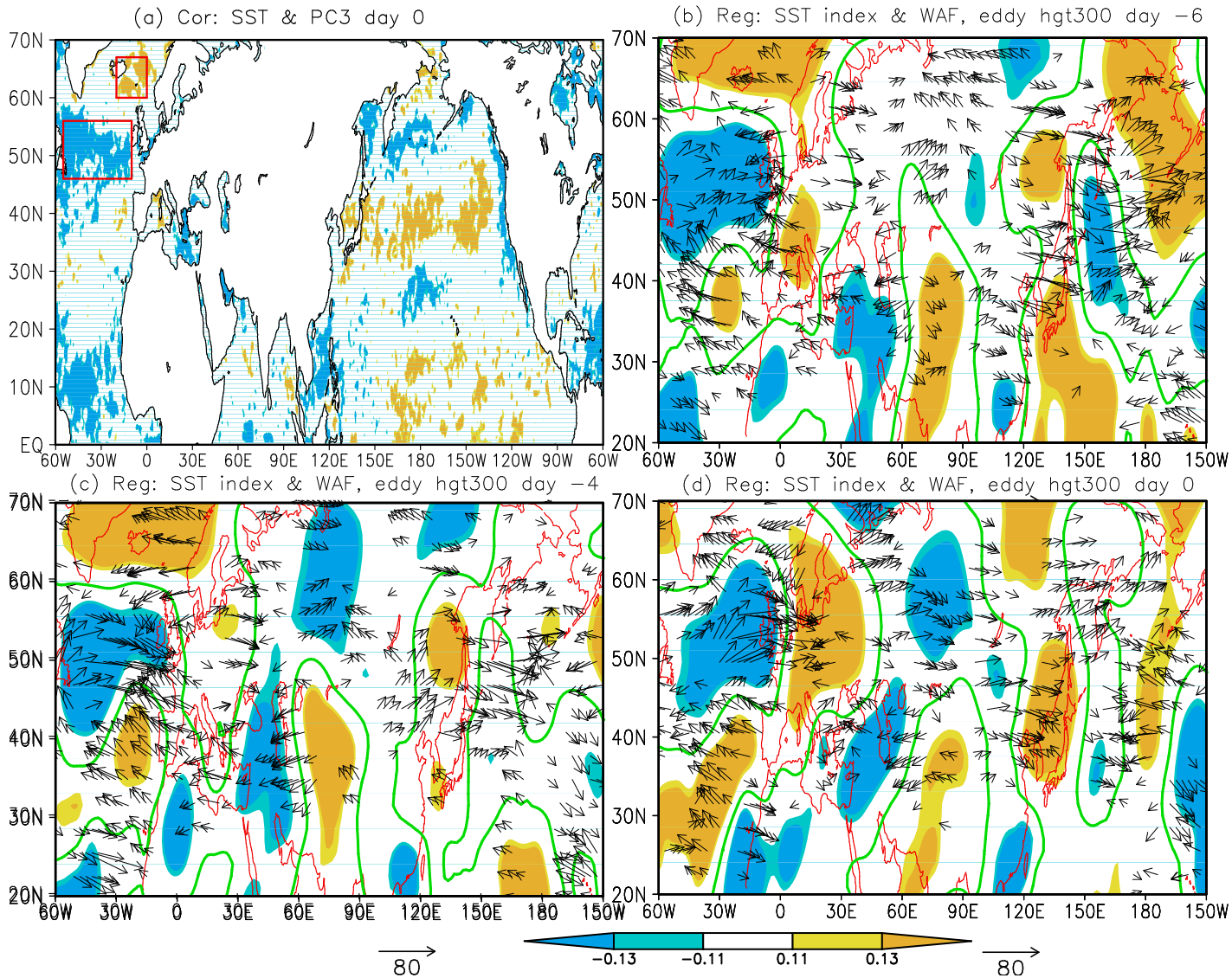
Map of the correlation between SSTs and PC1 at day 0 (a). The lagged regression coefficients of wave-activity flux (arrows, in m^2 s^{-2}) and lagged correlation coefficients of eddy geopotential height (shaded areas) on SST indices.



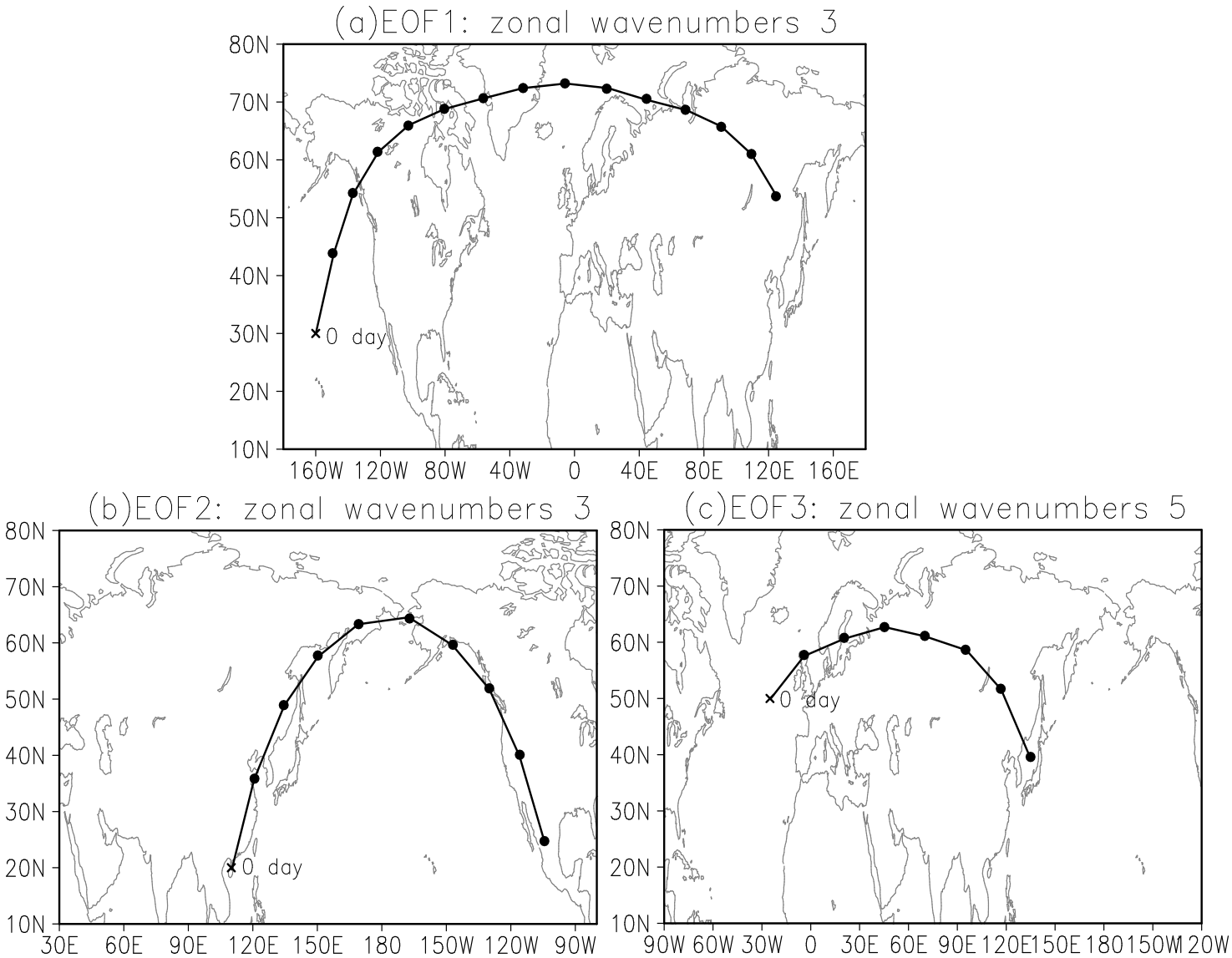
Map of the correlation between SSTs and PC2 at day 0 (a). The lagged regression coefficients of wave-activity flux (arrows, in $m^2 s^{-2}$) and lagged correlation coefficients of eddy geopotential height (shaded areas) on SST indices.



Map of the correlation between SSTs and PC3 at day 0 (a). The lagged regression coefficients of wave-activity flux (arrows, in m^2 s^{-2}) and lagged correlation coefficients of eddy geopotential height (shaded areas) on SST indices.



Ray paths of the dominant CER modes for (a) EOF1, (b) EOF2, and (c) EOF3. Black circles represent daily intervals.



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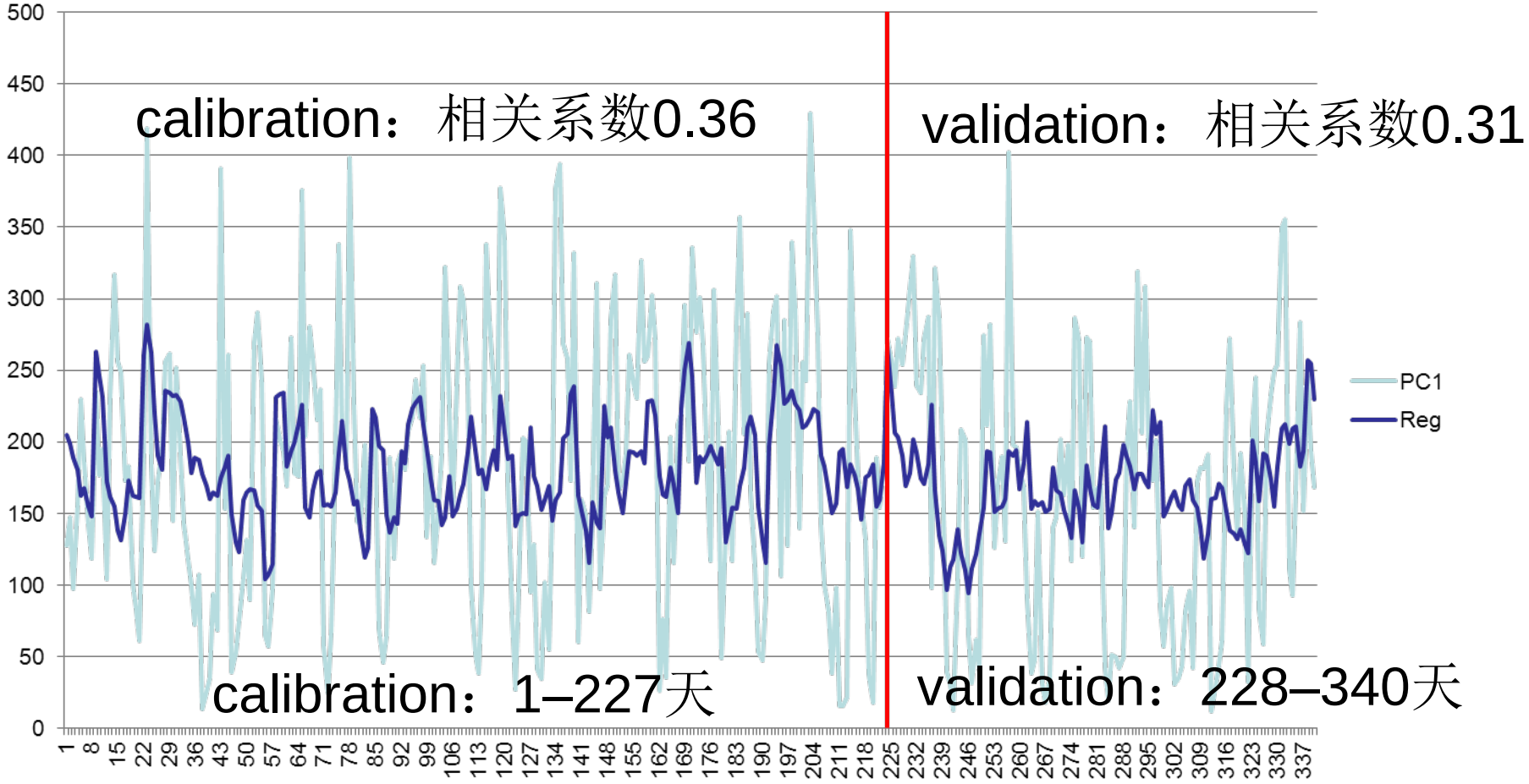
Discussion and conclusion

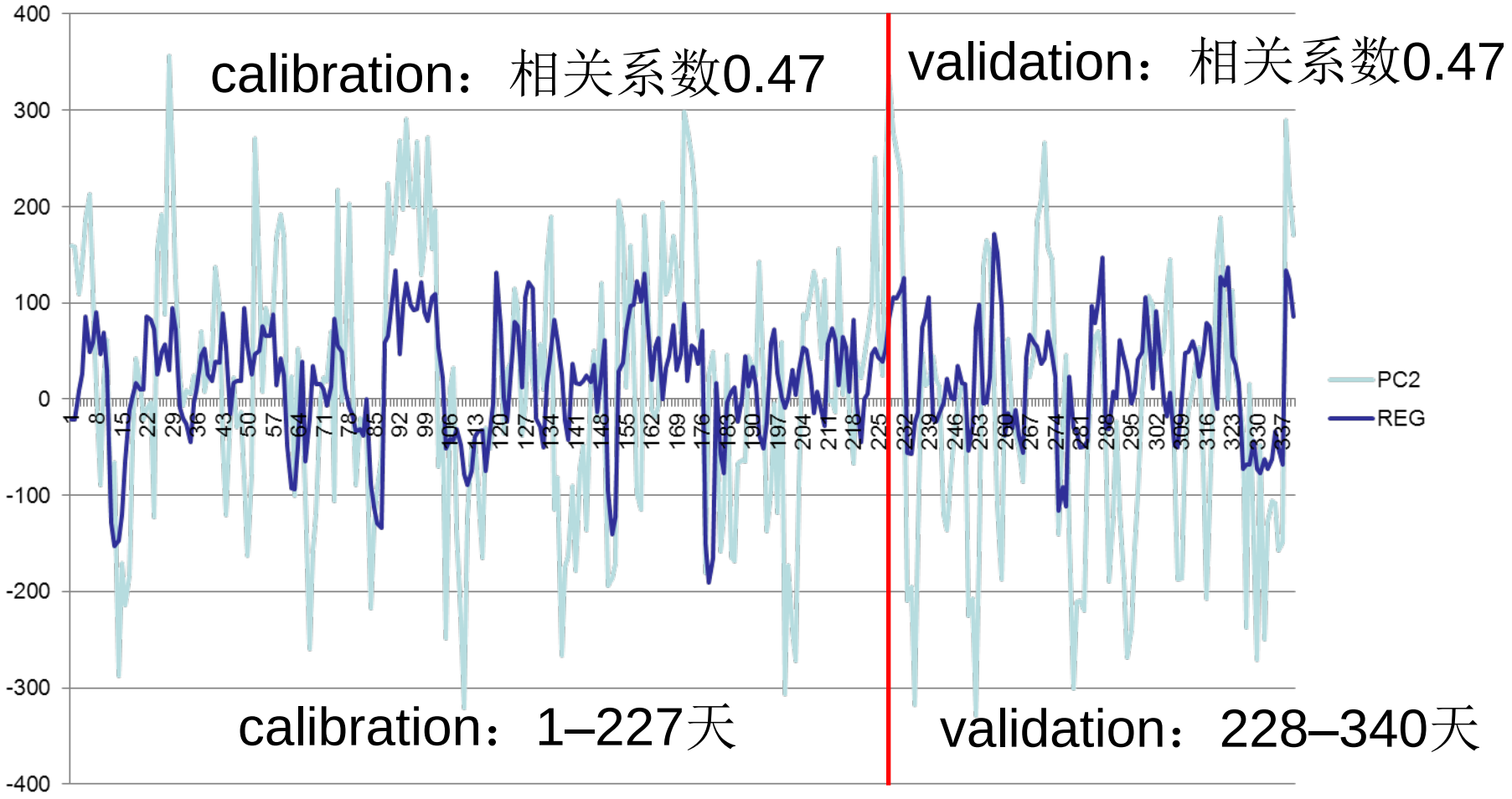
- The dominant modes of the CER were determined based on EOF analysis. Together, the three leading EOFs explain 44% of the total CER variance.
- The circulation patterns related to the first CER mode manifest a barotropic circumglobal teleconnection (CGT) pattern 6 days before the CER events occur in the study area. The second CER mode is associated with a negative Pacific-Japan (PJ) teleconnection pattern, which persists for 15 days until the onset of CER events. For the third CER mode, a negative Eurasian pattern (EU) is identified 6 days prior to CER event onset.
- SST variations in the subtropical North Pacific, the tropical western North Pacific-South China Sea, and the northeastern Atlantic can trigger eastward/northward-propagating Rossby waves associated with teleconnection patterns.

Thanks for your attention !

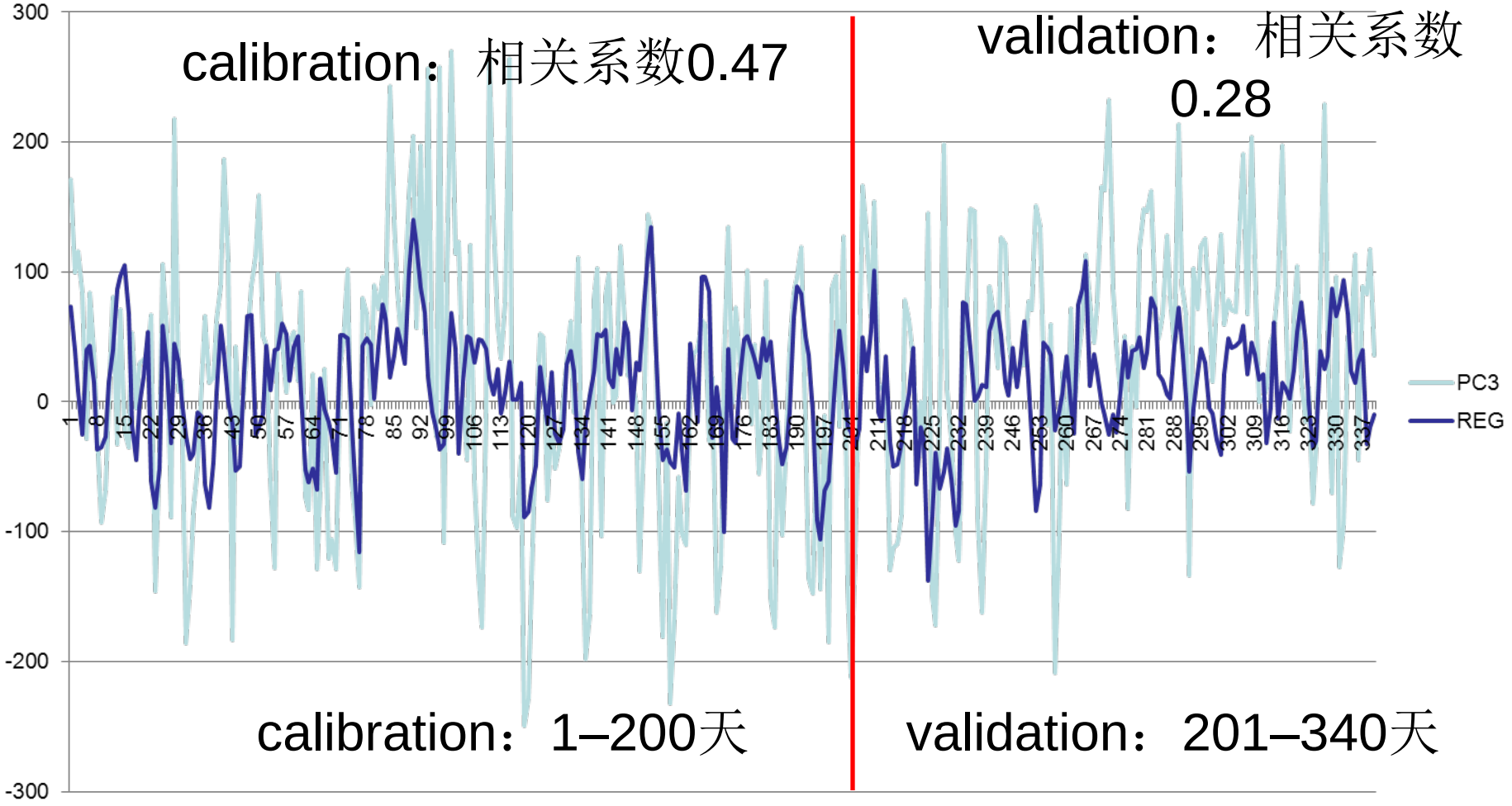
提前6天 预报PC1（样本数340天）



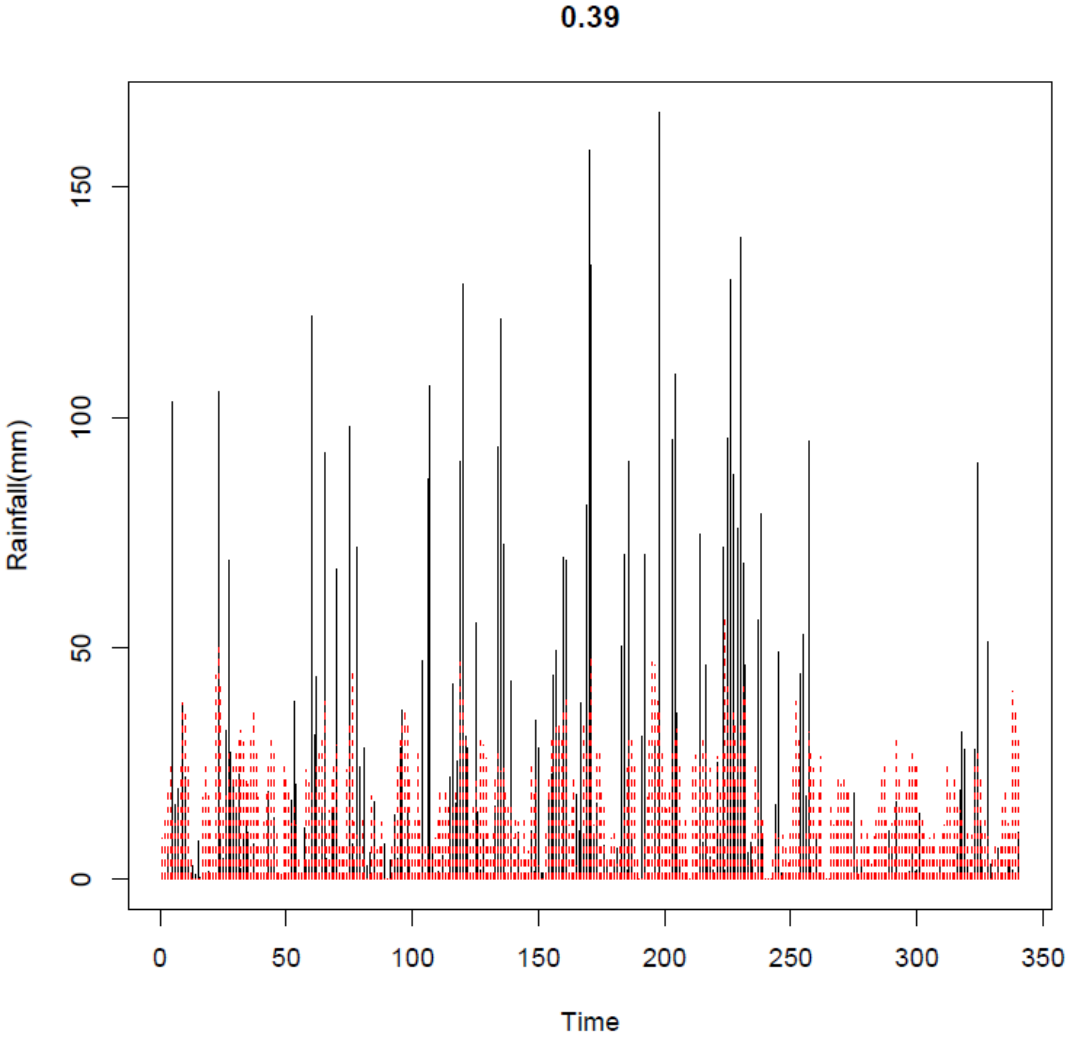
提前6天 预报PC2


calibration：相关系数0.47
validation：相关系数0.47
calibration：1–227天
validation：228–340天
PC2
REG
400
300
200
100
0
-100
-200
-300
-400

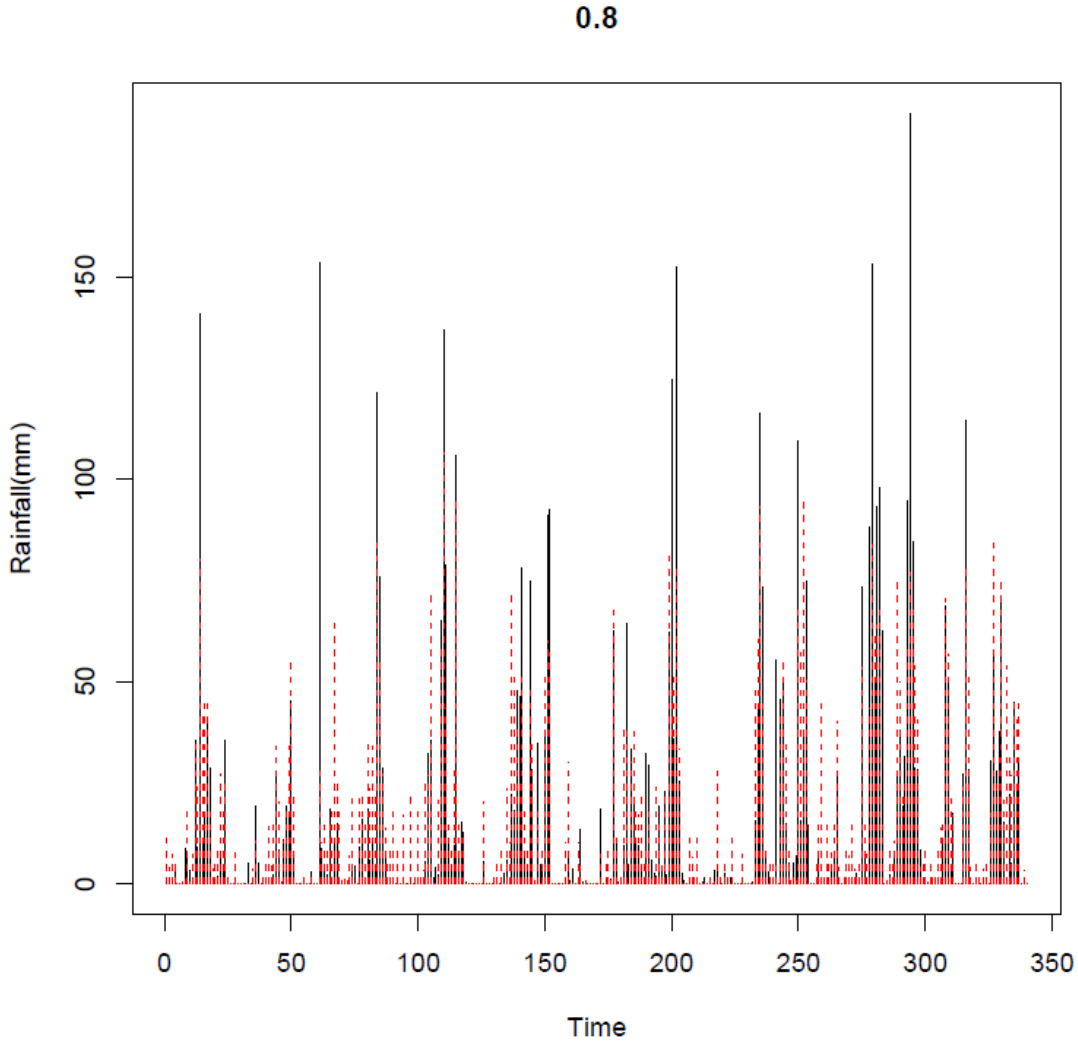
提前6天 预报PC3


calibration：相关系数0.47
validation：相关系数0.28
calibration：1–200天
validation：201–340天
PC3
REG
300
200
100
0
-100
-200
-300

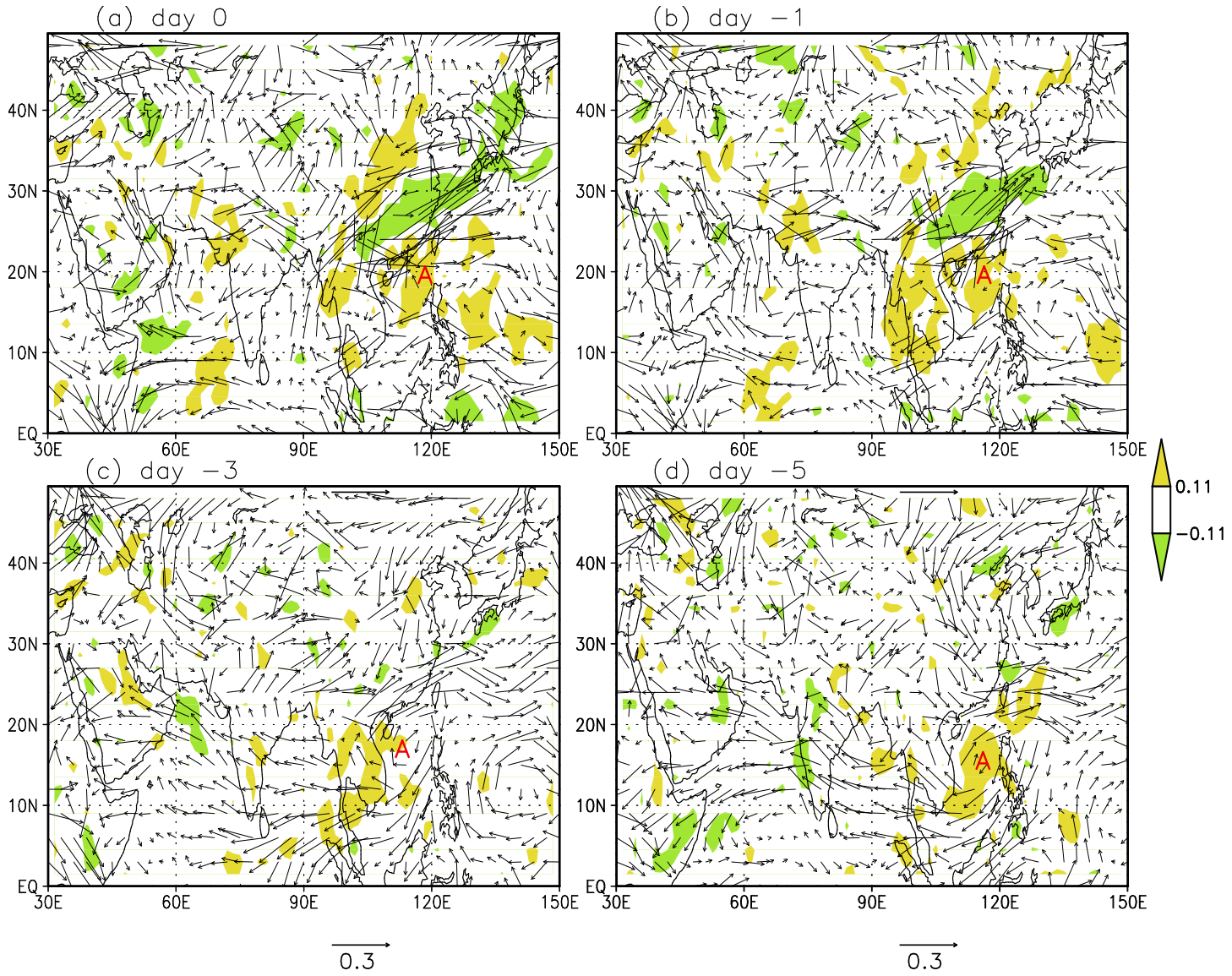
采用提前6天预报的PC1–PC3建立多元回归方程，拟合210个测站CEPEs事件发生时6-8月逐日降水量，将其与观测的逐日降水量比较，发现相关系数大于0.3的测站有36个，大于0.2的测站有143个。



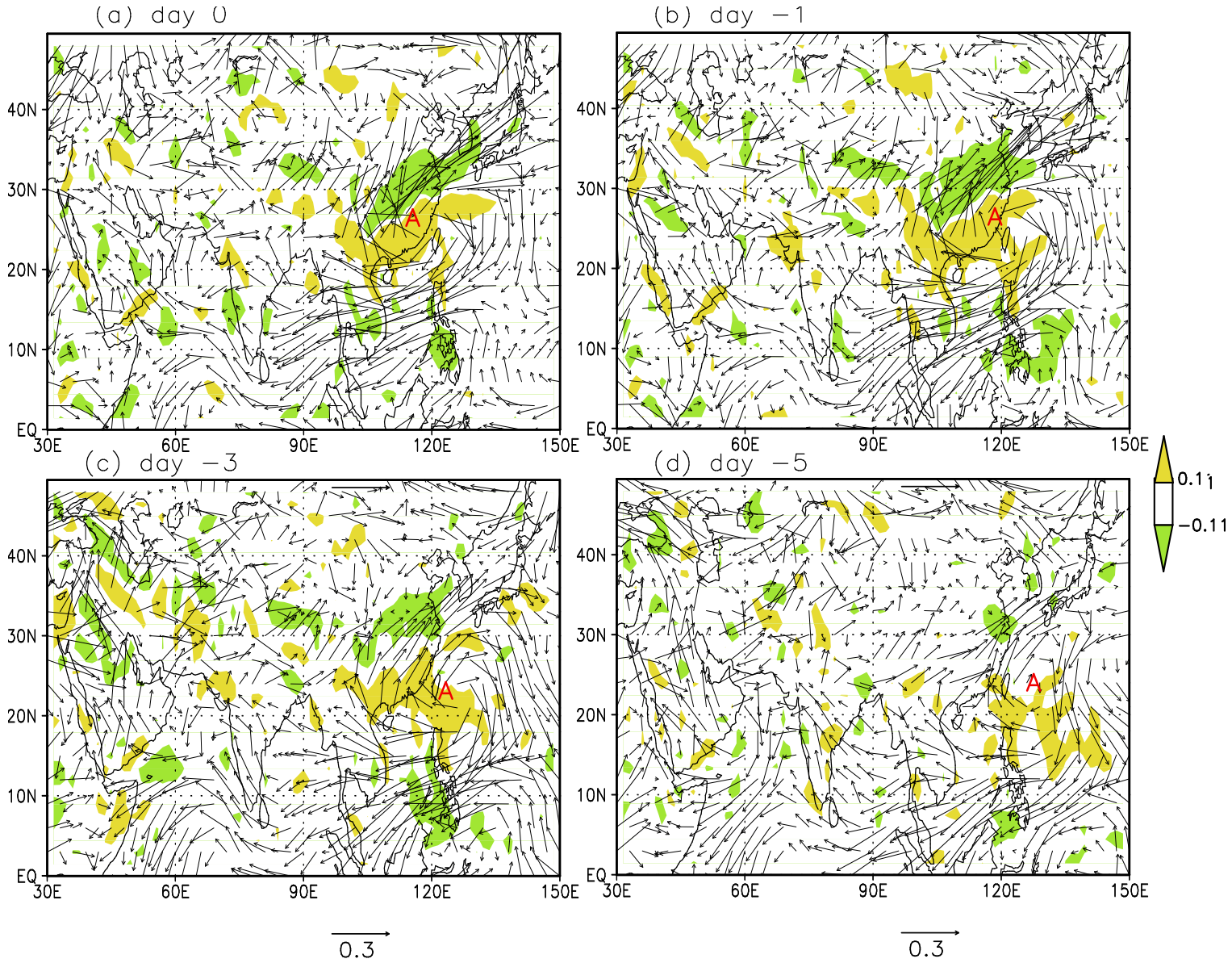
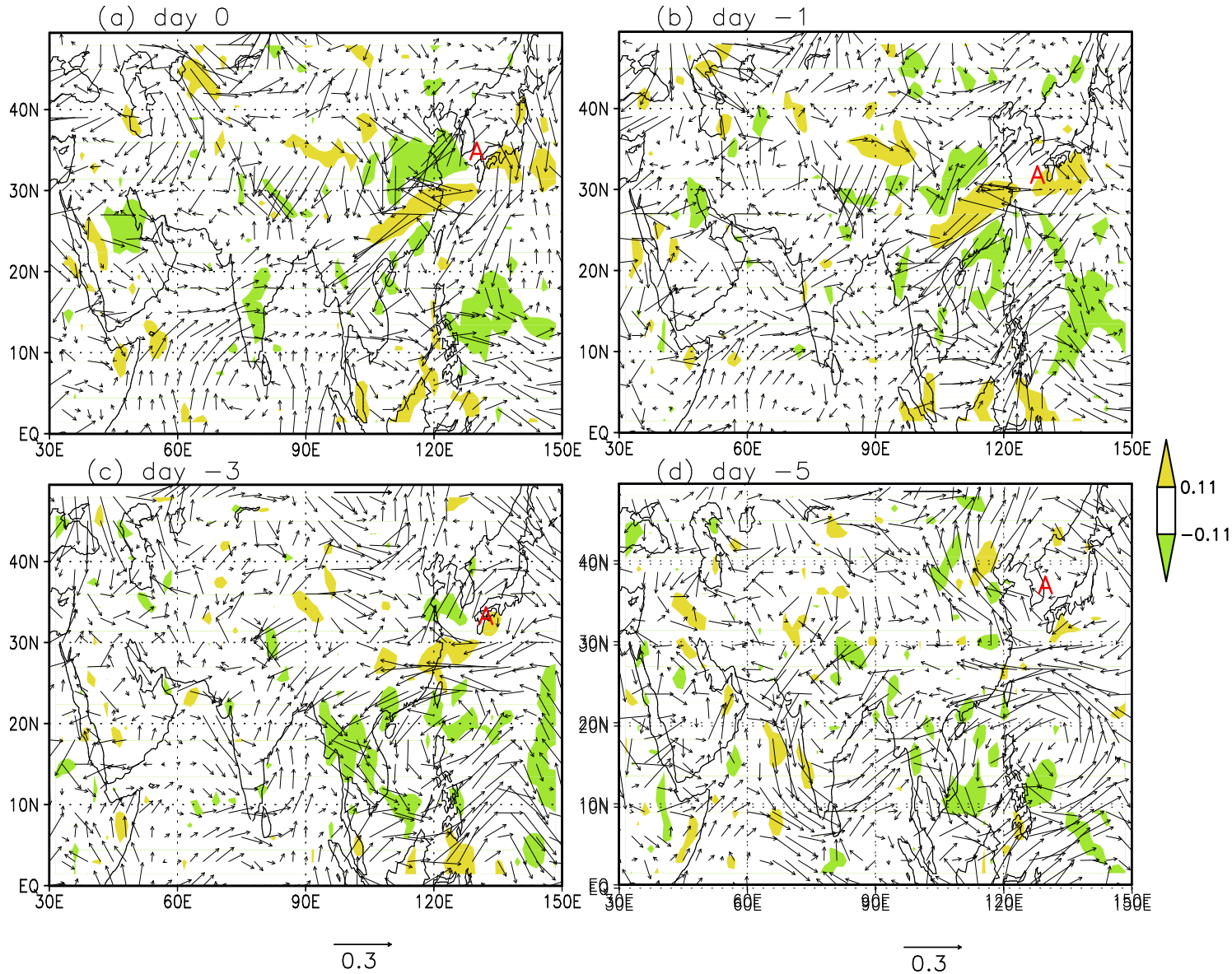
根据CEPEs事件的PC1–PC3建立多元回归方程，拟合210个测站CEPEs事件的逐日降水量，将其与观测的逐日降水量求相关，发现相关系数大于0.5的测站108个，大于0.4的测站153个。



Lagged correlation between PC1 and wind at 850 hPa (vectors), vertically integrated moisture flux divergences(shading)



Lagged correlation between PC2 and wind at 850 hPa (vectors), vertically integrated moisture flux divergences(shading)



Lagged correlation between PC3 and wind at 850 hPa (vectors), vertically integrated moisture flux divergences(shading)