Combining Sub-seasonal and Seasonal Precipitation Forecasts over Indonesia

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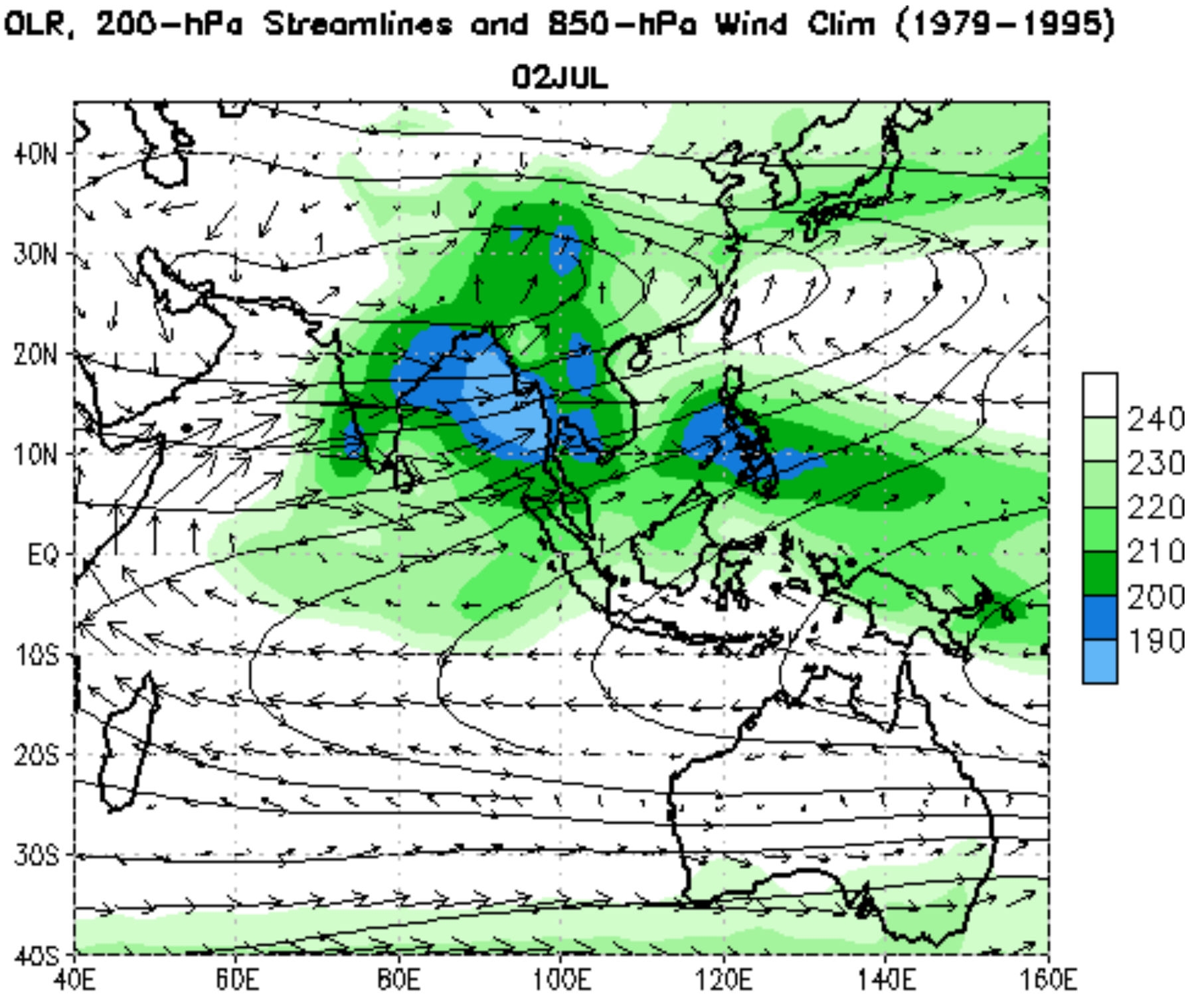
Asian-Australian Monsoons

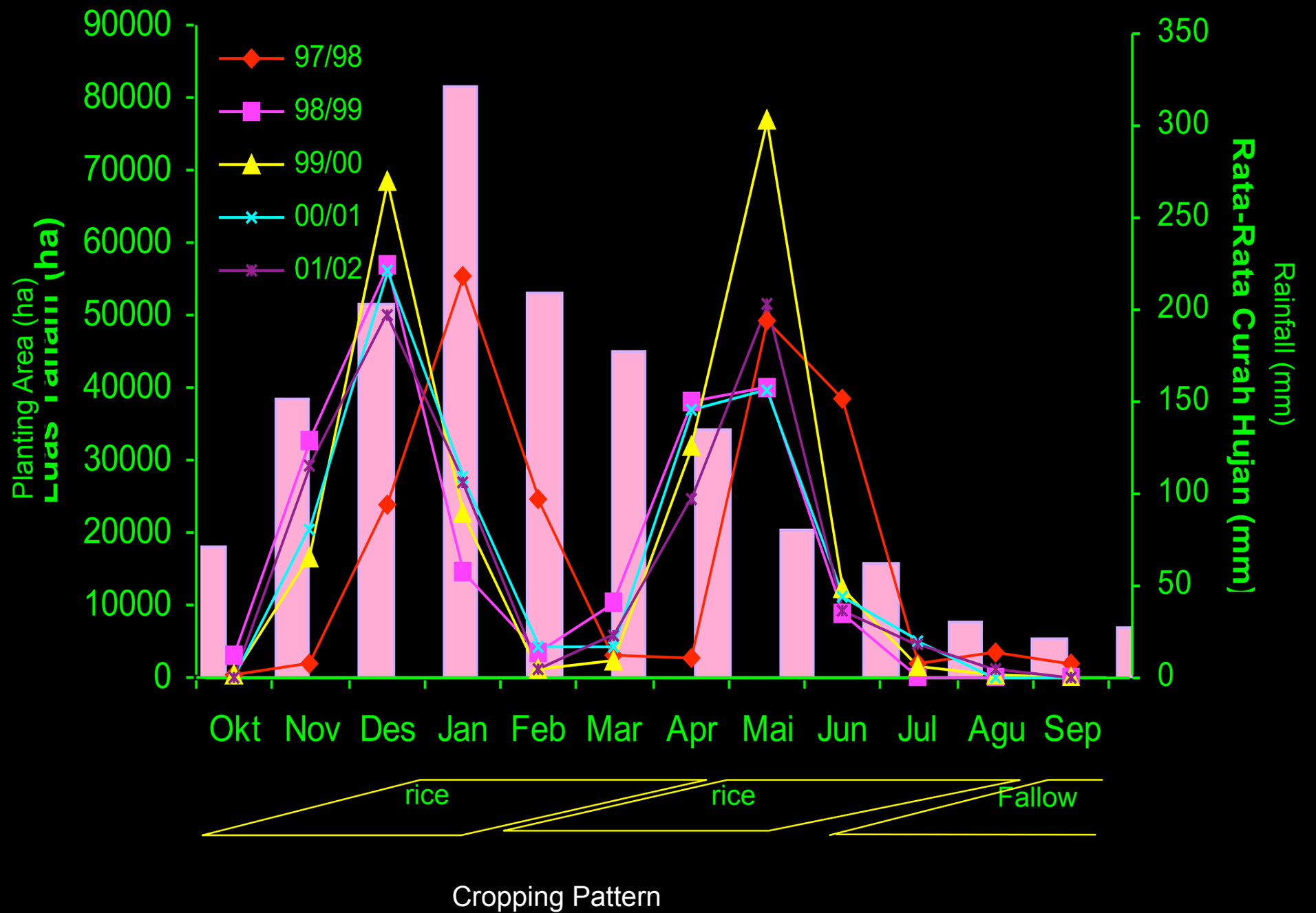


Data Sources: OLR – NESDIS/ORA, Winds – NCEP CDAS/ Reanalysis

NOAA CPC

Rice-planting area in Indramayu, Java

Source: Boer et al. (2004)



Start of planting changes from time to time, in planting season 97/98, start of planting delayed 1 month due to delay onset of rainfall, increasing drought risk for the second crop, except in La-Nina years

Seasonal predictability of monsoon onset dates over Indonesia

TABLE 1. Statistics of GSOD station onset date by subregion (N is number of stations), computed from the SAI of each region. The hindcast skill refers to the correlation between the observed and hindcast SAI with a cross-validated CCA using July SSTs as predictors. One, two, and three asterisks indicate correlation significant at the two-sided 90%, 95%, and 99% level according to a random-phase test (Janicot et al. 1996).

	N	25%, 50%, and 75% percentiles of the spatial average	Var [SAI]	Correlation with large-scale SAI of CMAP	Correlation with PC#1 of CMAP	Hindcast skill
Western and central Java (west of 112°E)	14	16 Oct, 28 Oct, 11 Nov	0.41	0.80***	0.83***	0.59***
Eastern Java (east of 112°E)	7	13 Nov, 21 Nov, 2 Dec	0.44	0.74***	0.72***	0.61***
Southern Sumatra (south of 1°S)	6	5 Sep, 19 Sep, 17 Oct	0.60	0.86***	0.88***	0.74***
Central Sumatra (between 1°S and 2°N)	7	15 Aug, 24 Aug, 31 Aug	0.43	0.76***	0.74***	0.51**
Northern Sumatra (north of 2°N)	6	1 Sep, 11 Sep, 15 Sep	0.23	0.46**	0.41**	0.22
Southern Kalimantan (south of 1°S)	6	17 Sep, 22 Sep, 25 Oct	0.72	0.80***	0.79***	0.84***
Central Kalimantan (north of 1°S)	5	11 Aug, 29 Aug, 12 Sep	0.48	0.70***	0.69***	0.46**
Eastern Indonesia (east of 120°E and south of 8°S)	5	30 Nov, 13 Dec, 25 Dec	0.57	0.63**	0.60**	0.49**

Moron, Robertson & Boer (2009)

Outline

- Empirical **seasonal** prediction of Maritime Continent monsoon onset date based on July Indo-Pacific SST

- Empirical **subseasonal-to-seasonal** prediction of onset based on equatorial pentad OLR

- Separation of the subseasonal component

- GCM-based sub-monthly hindcasts of Indonesian precipitation

Models and data

- Data:
  - CMAP 2.5x2.5deg precip. 1979–2009
  - CPC pentad OLR, 1979–2009
  - Station rainfall from CPC GSOD & Hamada datasets

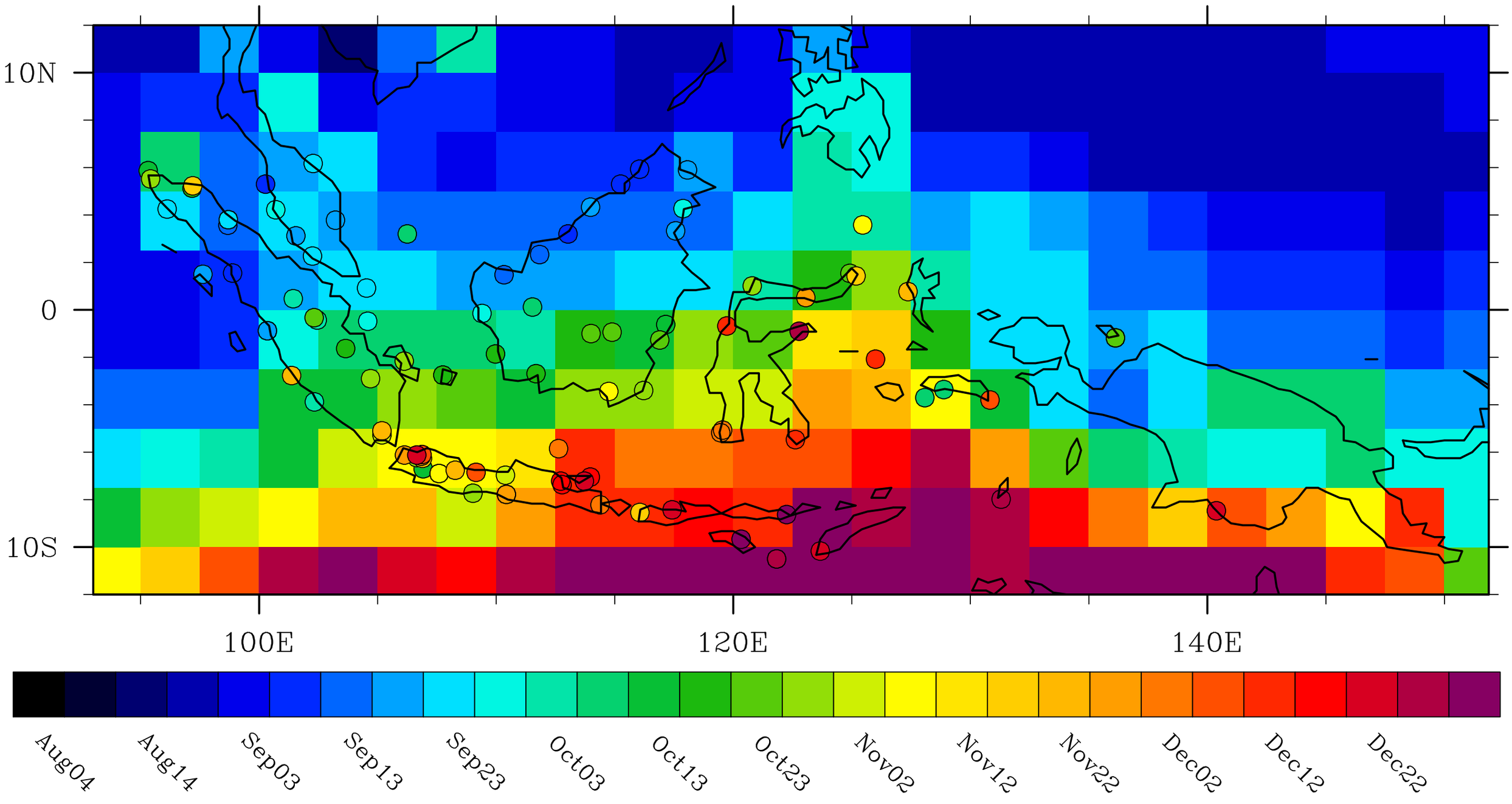
- Onset date: 20cm rainfall accumulation since Aug 1

- Empirical models:
  - Multivariate (pattern) regression using Canonical Correlation Analysis (CCA)
  - IRI's CPT Toolkit
  - Extended EOFs

- GCM hindcasts:
  - CFSv2

Mean Onset dates

VMORON Archive and CMAP-pentads



STD onset dates

days

10N

0

10S

100E

120E

4 8 12 16 20 24 28 32 36 40 44 48 52 56

Seasonal Hindcasts

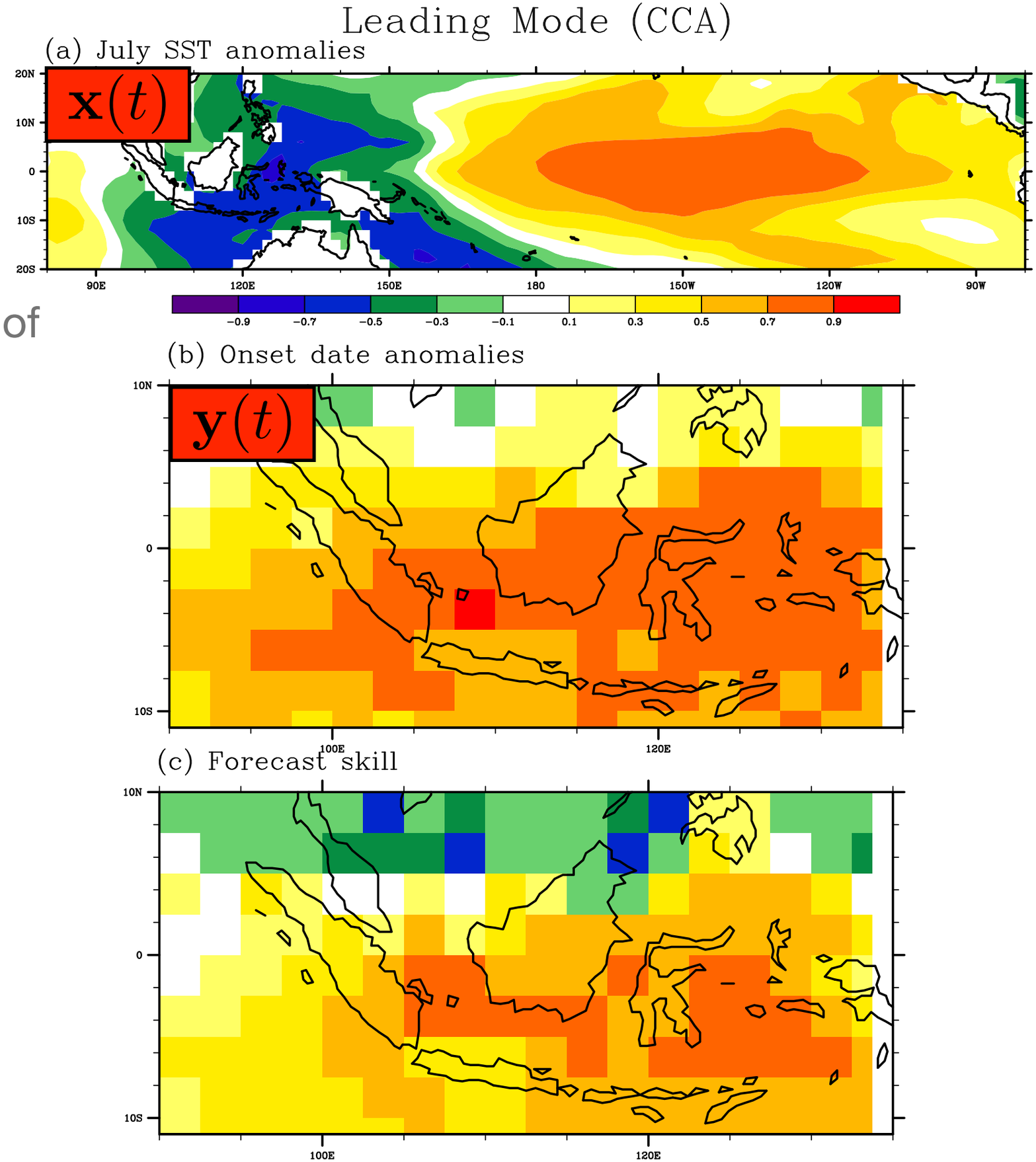
- Canonical correlation analysis of CMAP onset dates vs. July monthly SST field

$$\mathbf{y}(t) = \mathbf{A}.\mathbf{x}(t) + \mathbf{C}$$

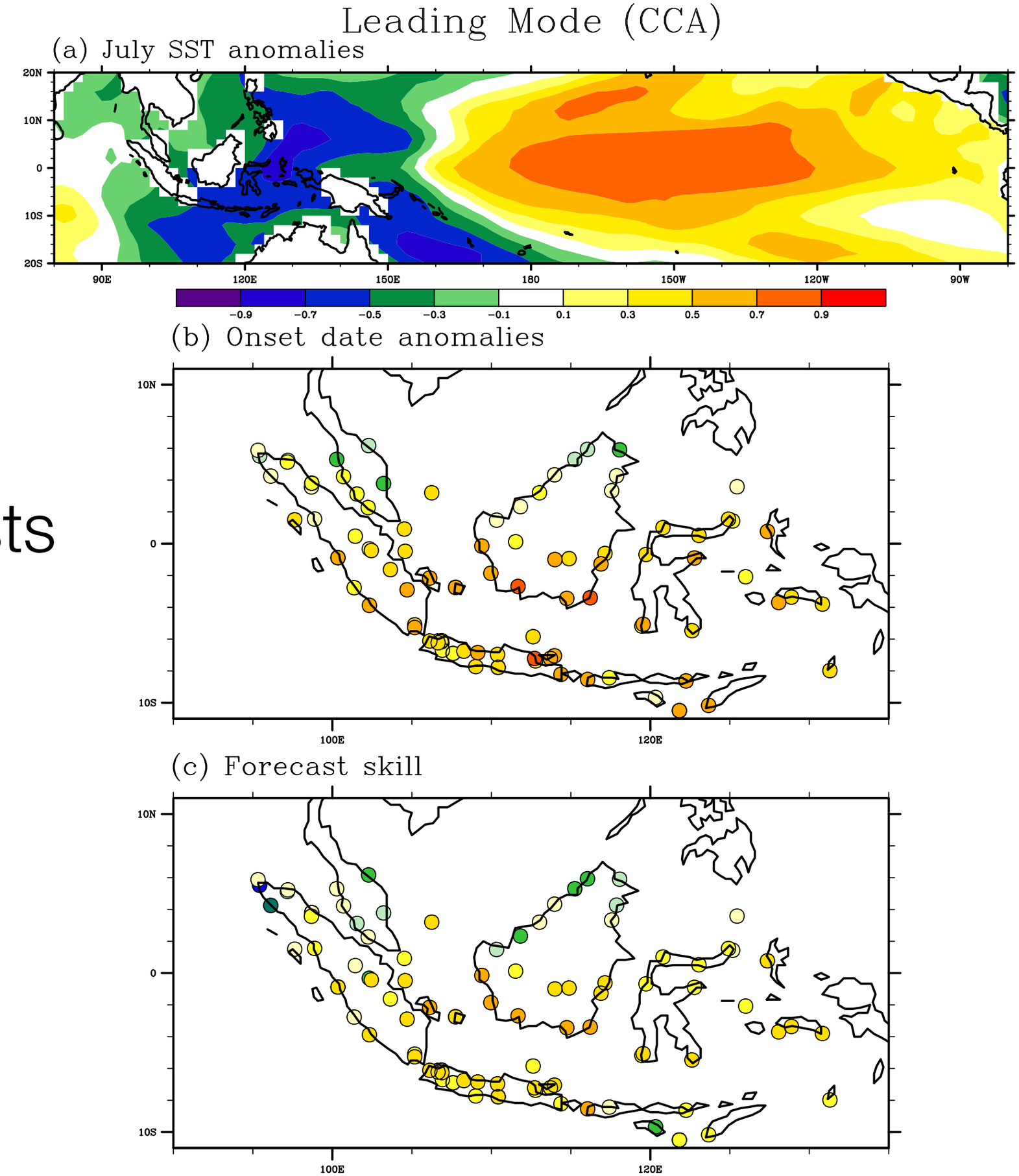
t : $1979, 1980, \ldots, 2009.$

- Cross-validated anomaly correlation skill

$$r(\hat{y}(t), y(t))$$



Seasonal Hindcasts with station data



Subseasonal-to-seasonal hindcasts

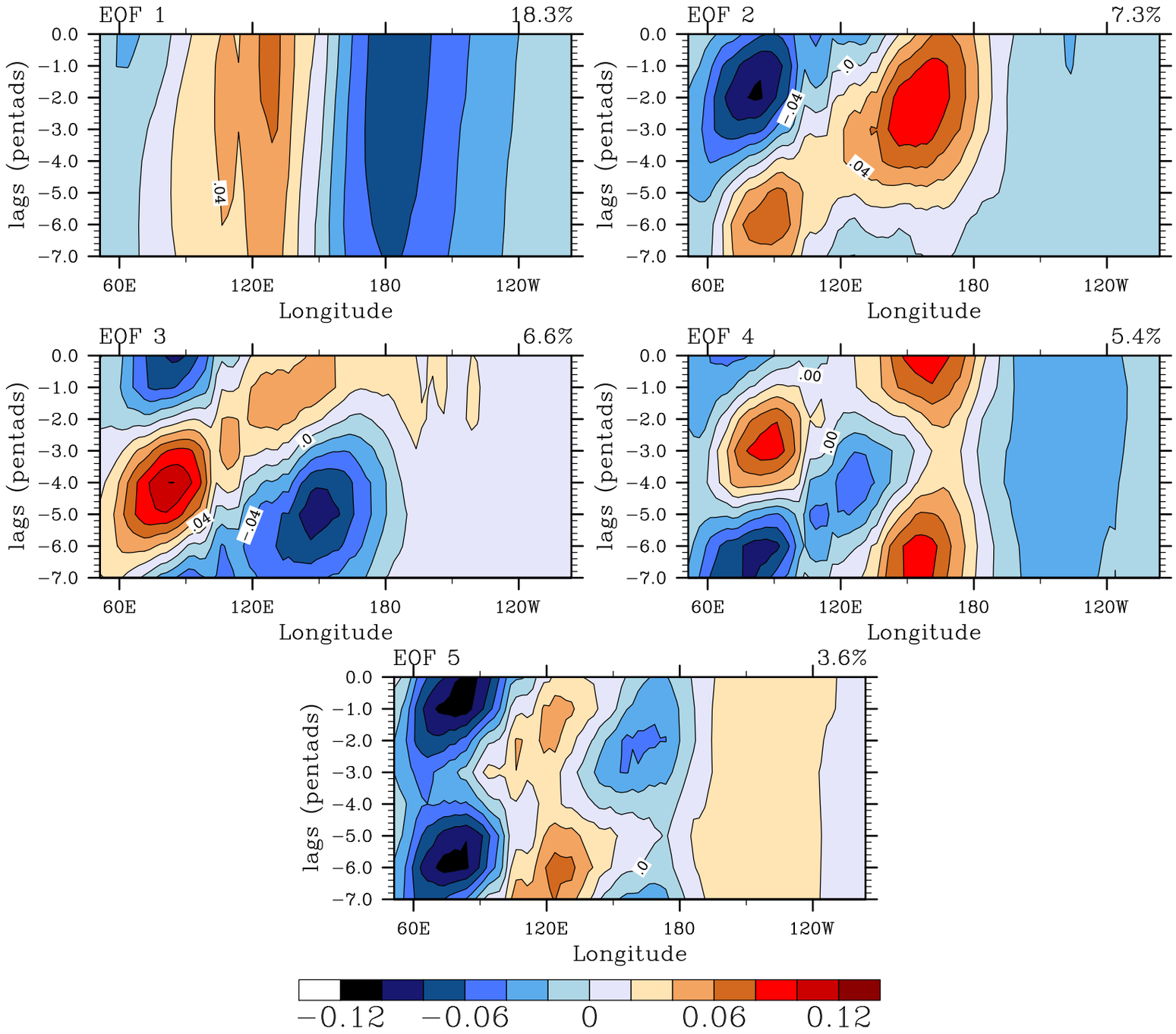
- CCA of onset dates vs OLR at 8 previous pentads before start date
- Start dates at each pentad, beginning Jul 15–19
- CCA uses PCs of 5 extended EOFs of latitude-averaged OLR [10S-10N] vs PCs of onset date (4 modes), for the Aug–Dec season, with seasonal cycle subtracted

$$\mathbf{y}(t) = \mathbf{A}.\mathbf{x}(t) + \mathbf{C} \qquad t : 1979, 1980, \ldots, 2009.$$

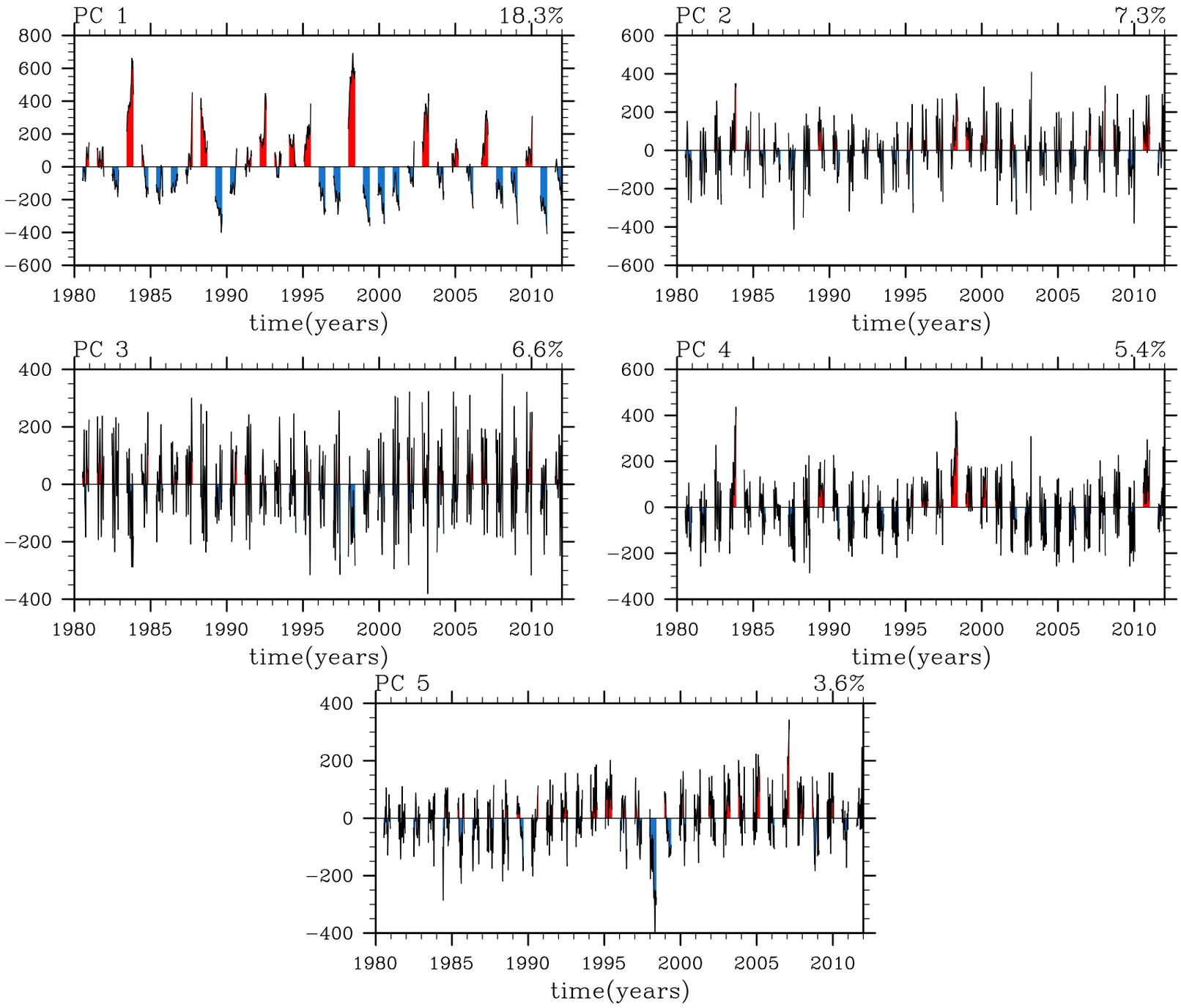
Onset dates

PCs of lagged OLR

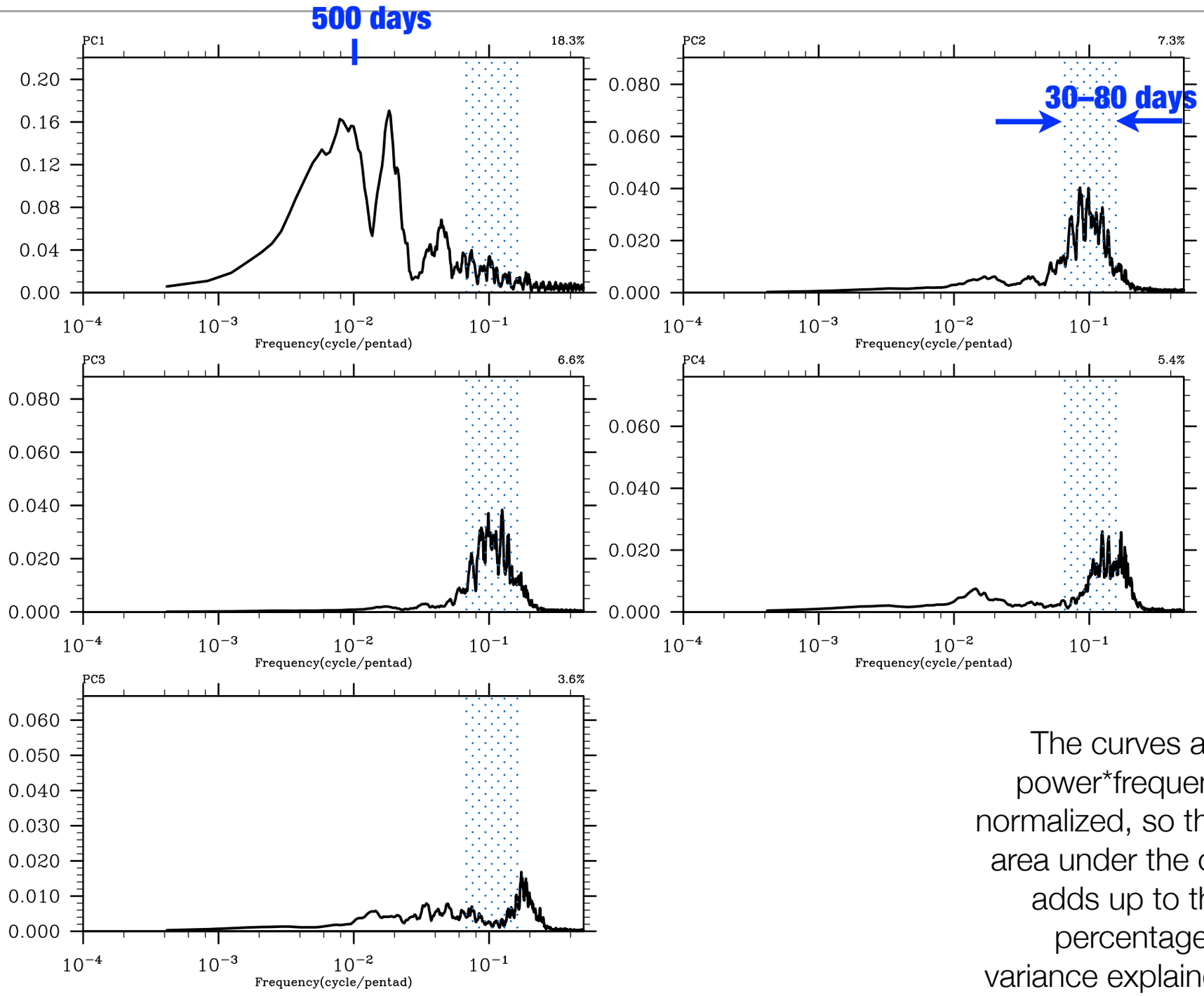
Extended EOFs of Zonally-averaged OLR [10S-10N, Aug–Dec]



Timeseries of OLR Extended EOFs

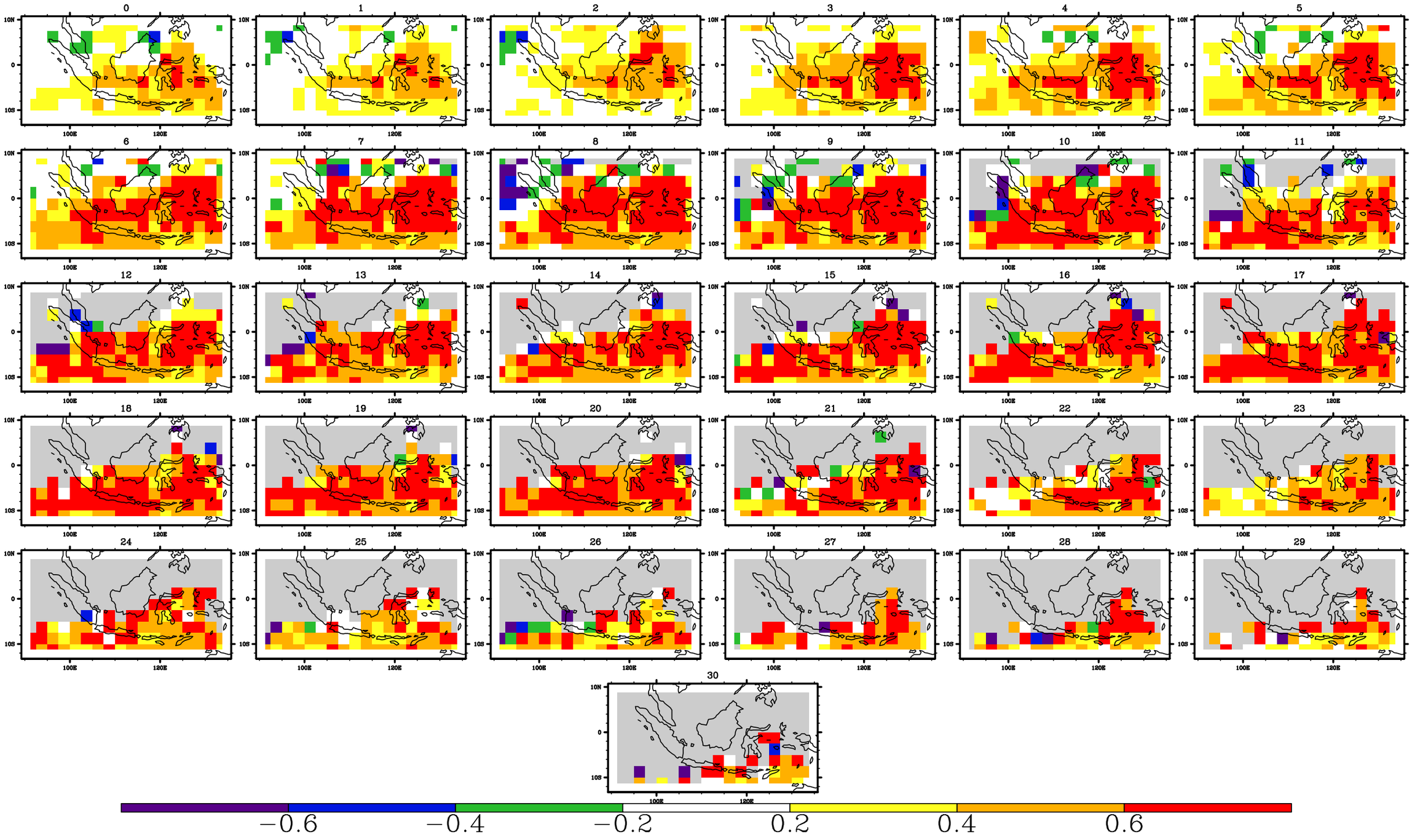


Power Spectra of PC Timeseries



The curves are power*frequency normalized, so that the area under the curve adds up to the percentage variance explained by each mode.

Cross-validated Forecast skill at different dates



Anomaly Correlation of
Cross-validated forecast at every pentad from Jul-15/19 (lag = 0)

Seasonal Hindcasts

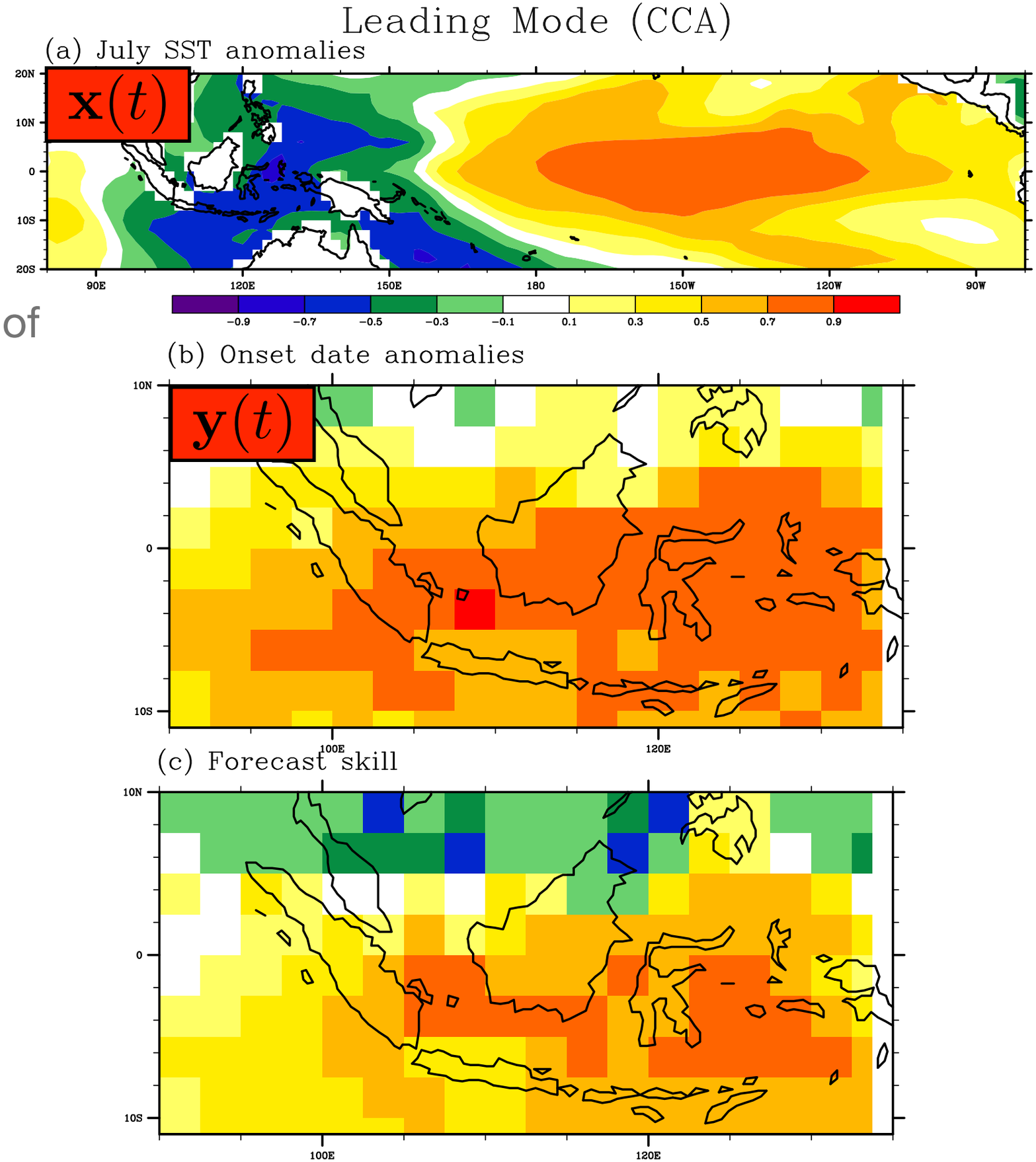
- Canonical correlation analysis of CMAP onset dates vs. July monthly SST field

$$\mathbf{y}(t) = \mathbf{A}.\mathbf{x}(t) + \mathbf{C}$$

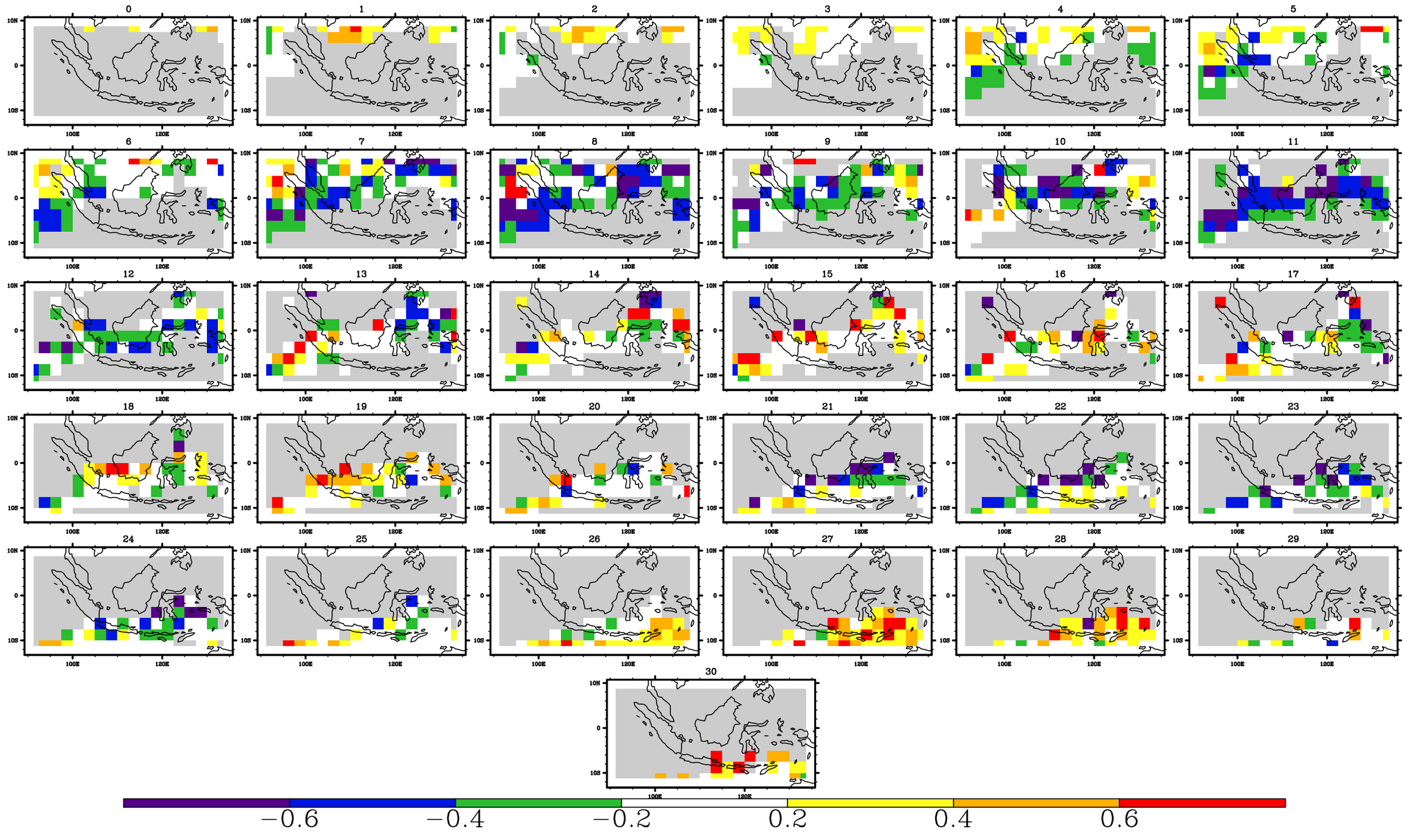
t : $1979, 1980, \ldots, 2009.$

- Cross-validated anomaly correlation skill

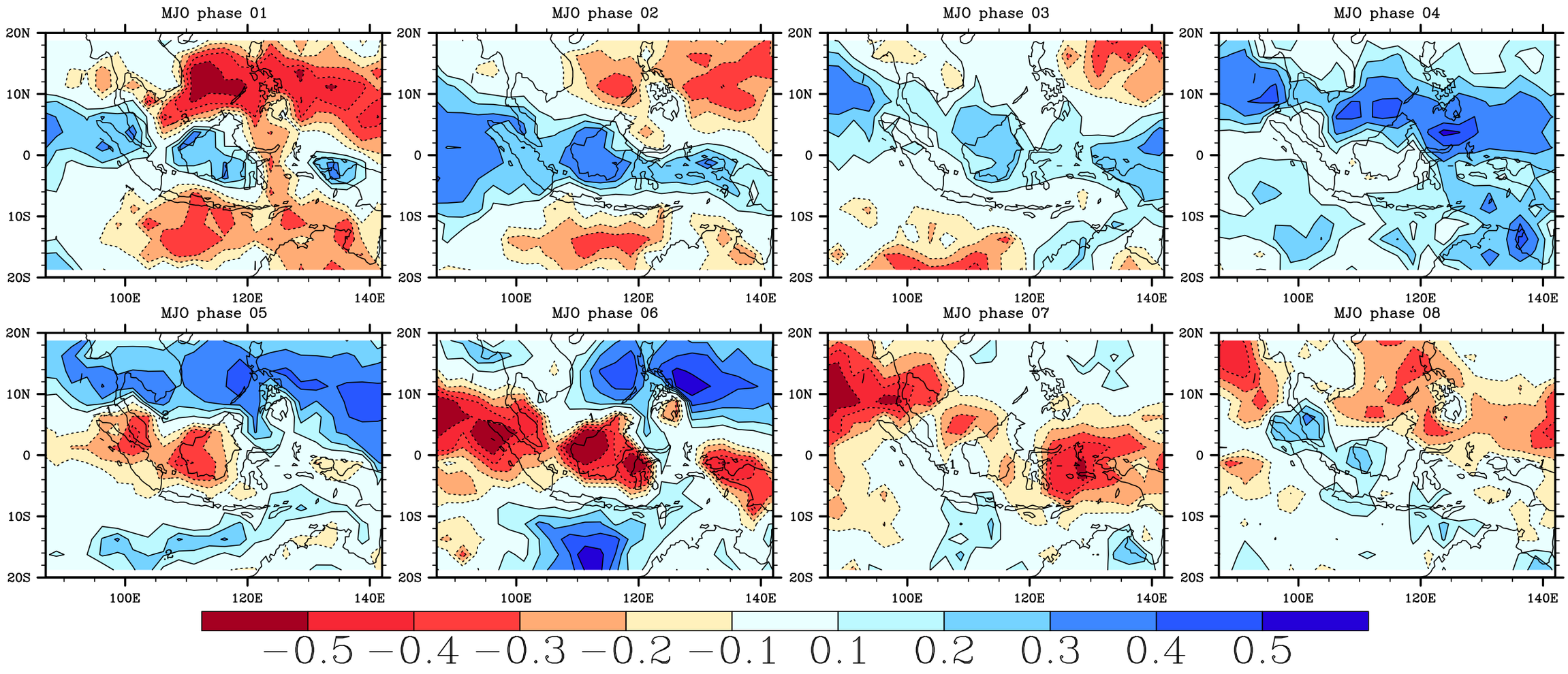
$$r(\hat{y}(t), y(t))$$



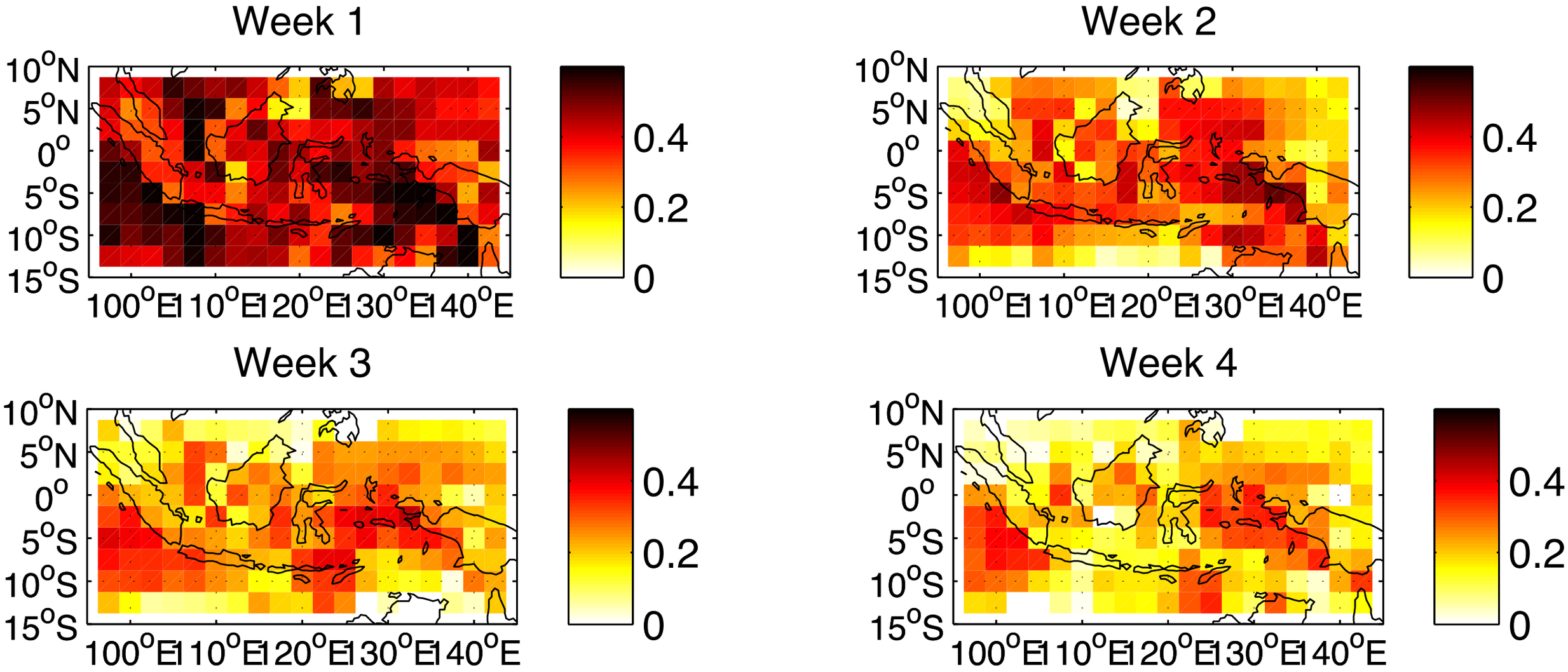
Model skill excluding interannual variability (EEOF 1)



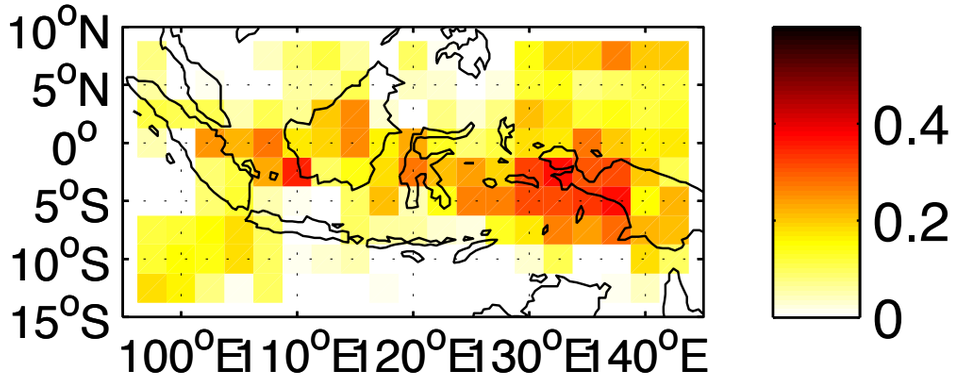
MJO impact on rainfall, based on RMM phases

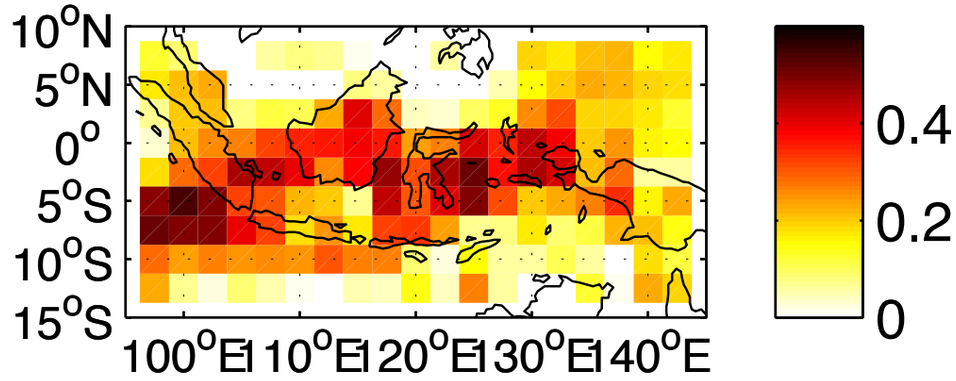


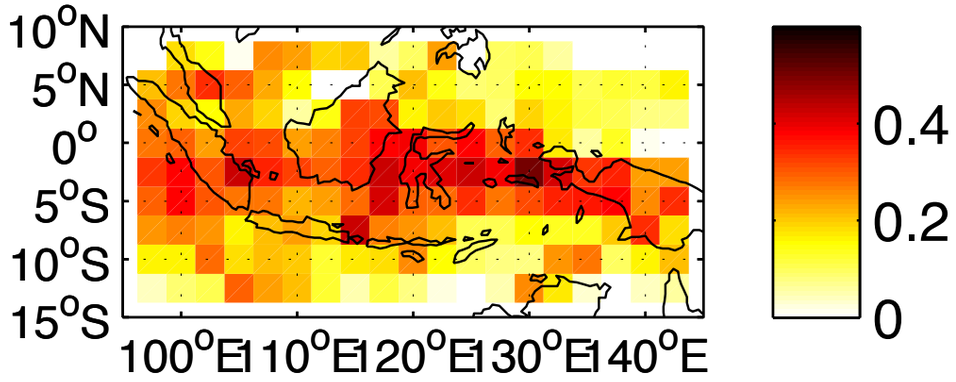
CFSv2 Sub-monthly skill: May–Nov 1982–2009
Anomaly correlation with CMAP

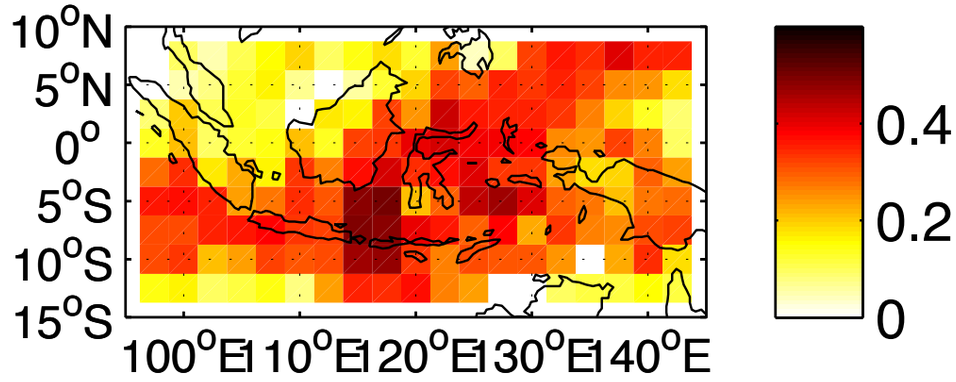


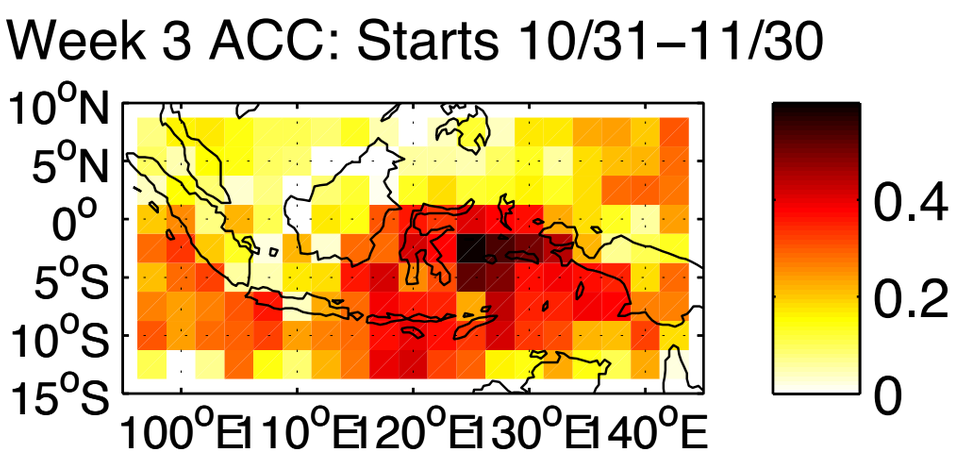
20 starts every 10 days, May 21–Nov 27
4-member average





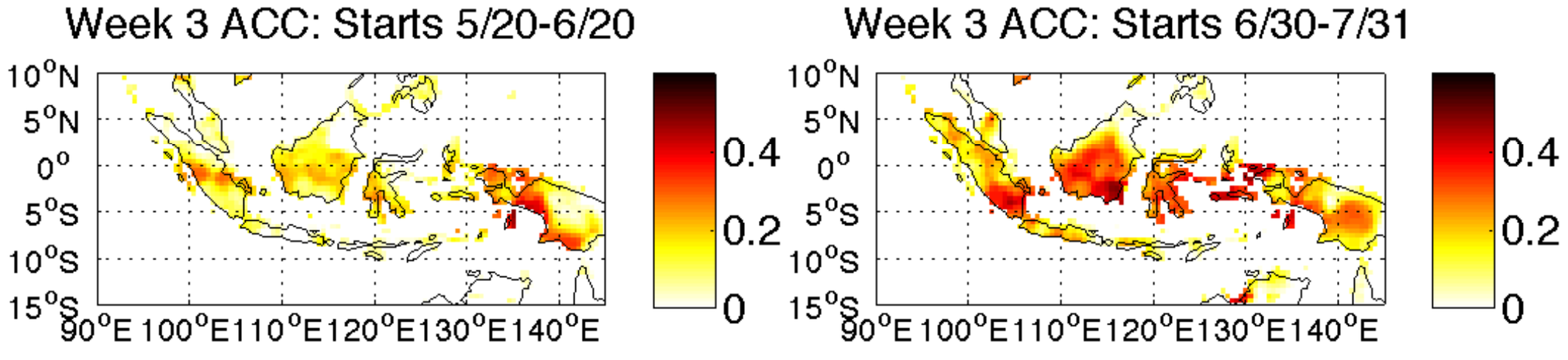






Seasonality of Week 3 Hindcasts Anomaly Correlation with CMAP

Seasonality of Week 3 ACC skill in JMA model



Anomaly Correlation with CPC Unified

Conclusions

- High seasonal hindcast skill of monsoon onset date over Indonesia

- Subseasonal OLR observations have the potential to augment the seasonal skill as the monsoon migrates southward, associated with the MJO, although sub-seasonal skill is only found over eastern Java during Nov-Dec (i.e. close to onset date there)

- Sub-monthly GCM hindcasts exhibit seasonally-varying skill up to 3–4 weeks ahead in some areas