The Regional Earth System Model RegCM-ES
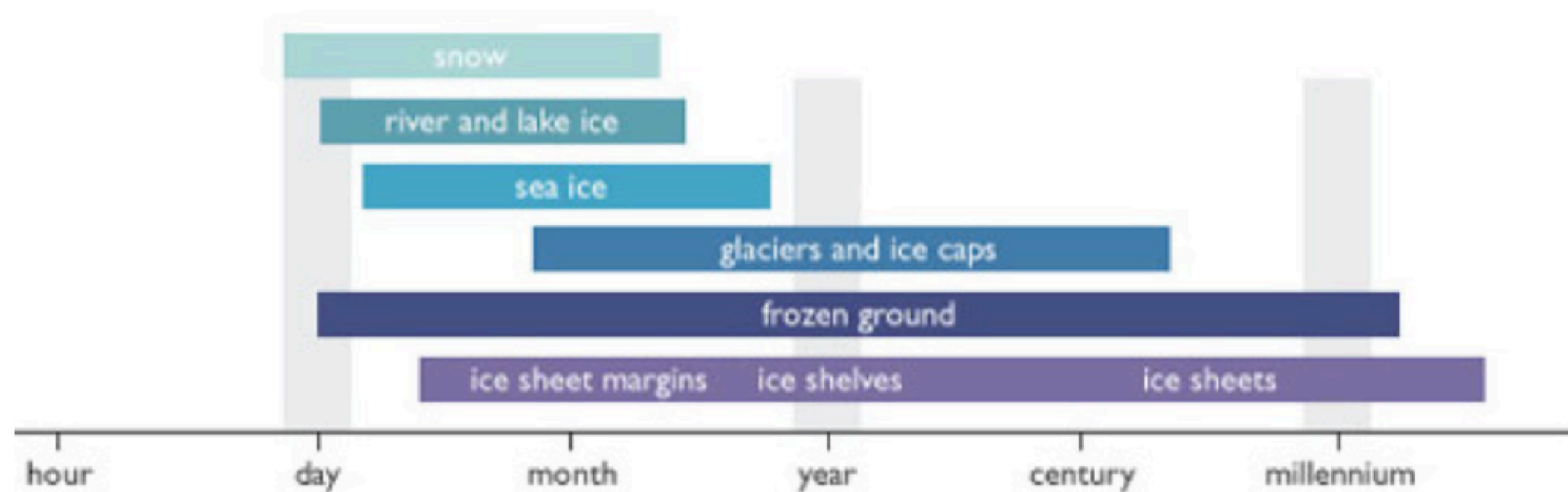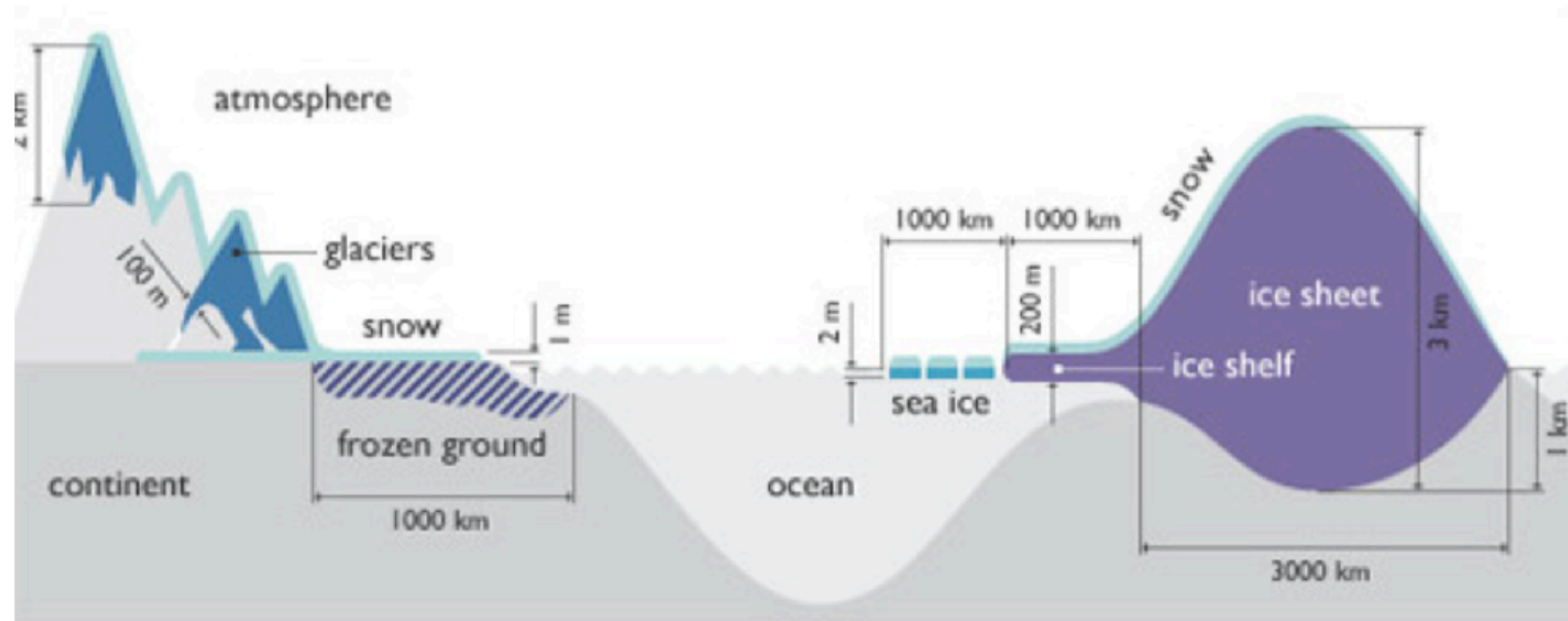
Di Sante Fabio,
Coppola Erika,
Farneti Riccardo,
Giorgi Filippo
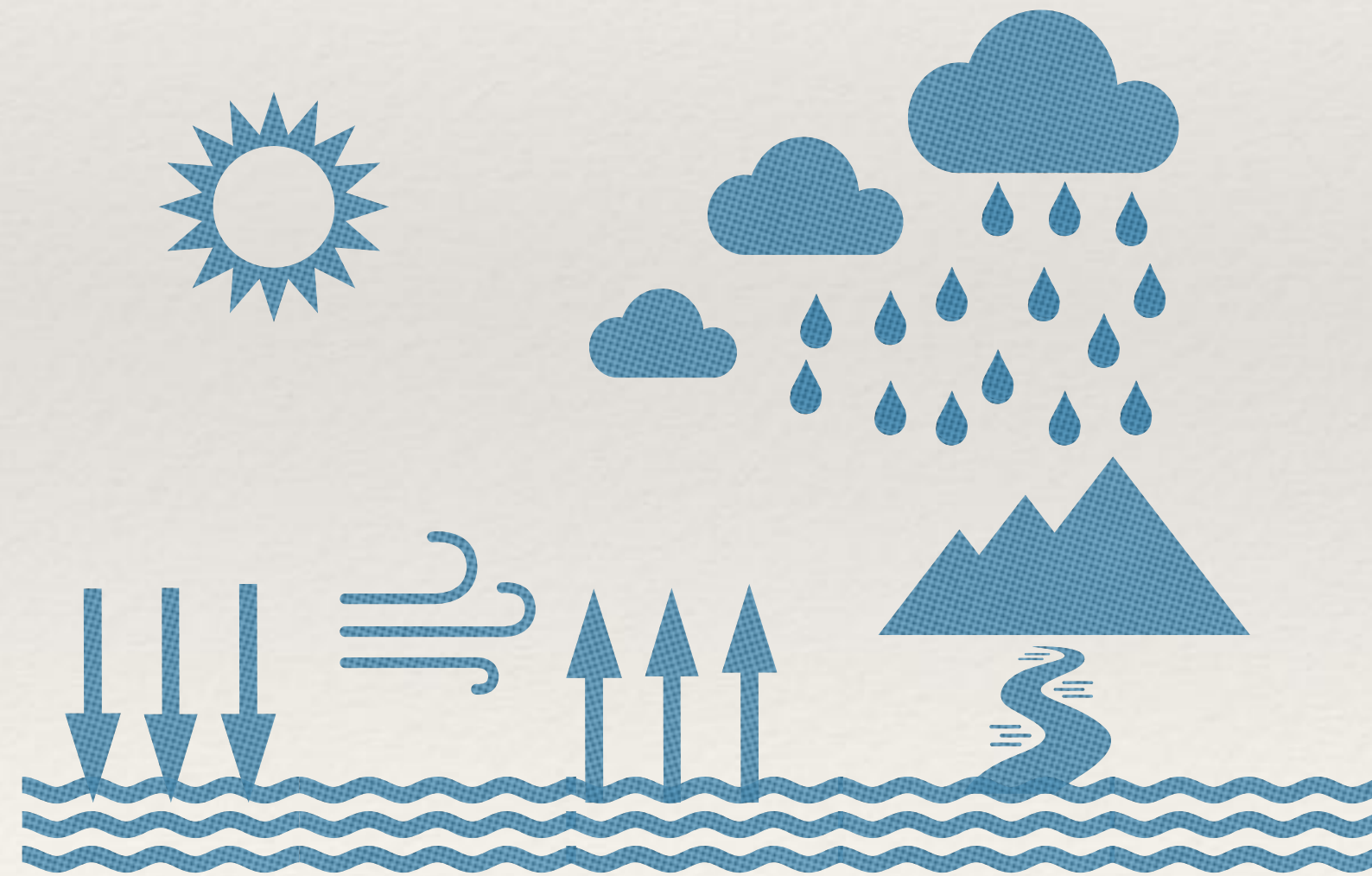
Earth System: Response time

Different spatial and temporal scales

What does it means couple model?

❖ Offline coupling -> The models run sequentially and the interactions among them are in one direction only

❖ Online coupling -> The interactions between the model are in both directions

E.g.

Nesting between a global and a regional model
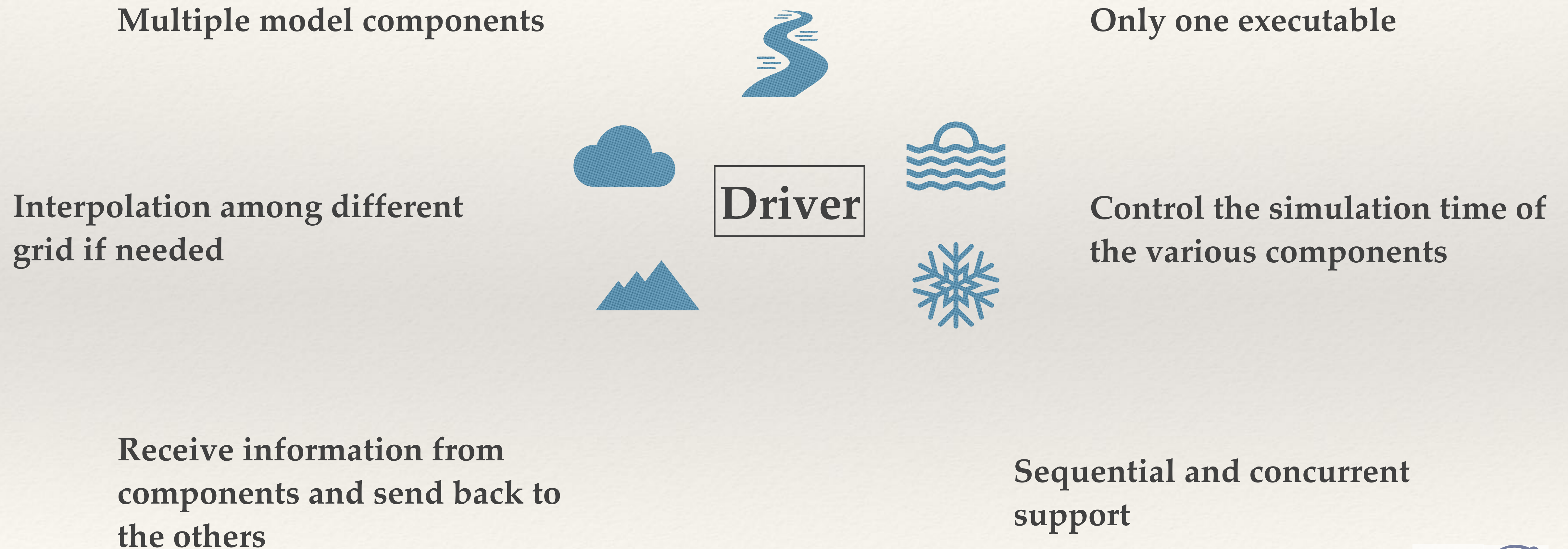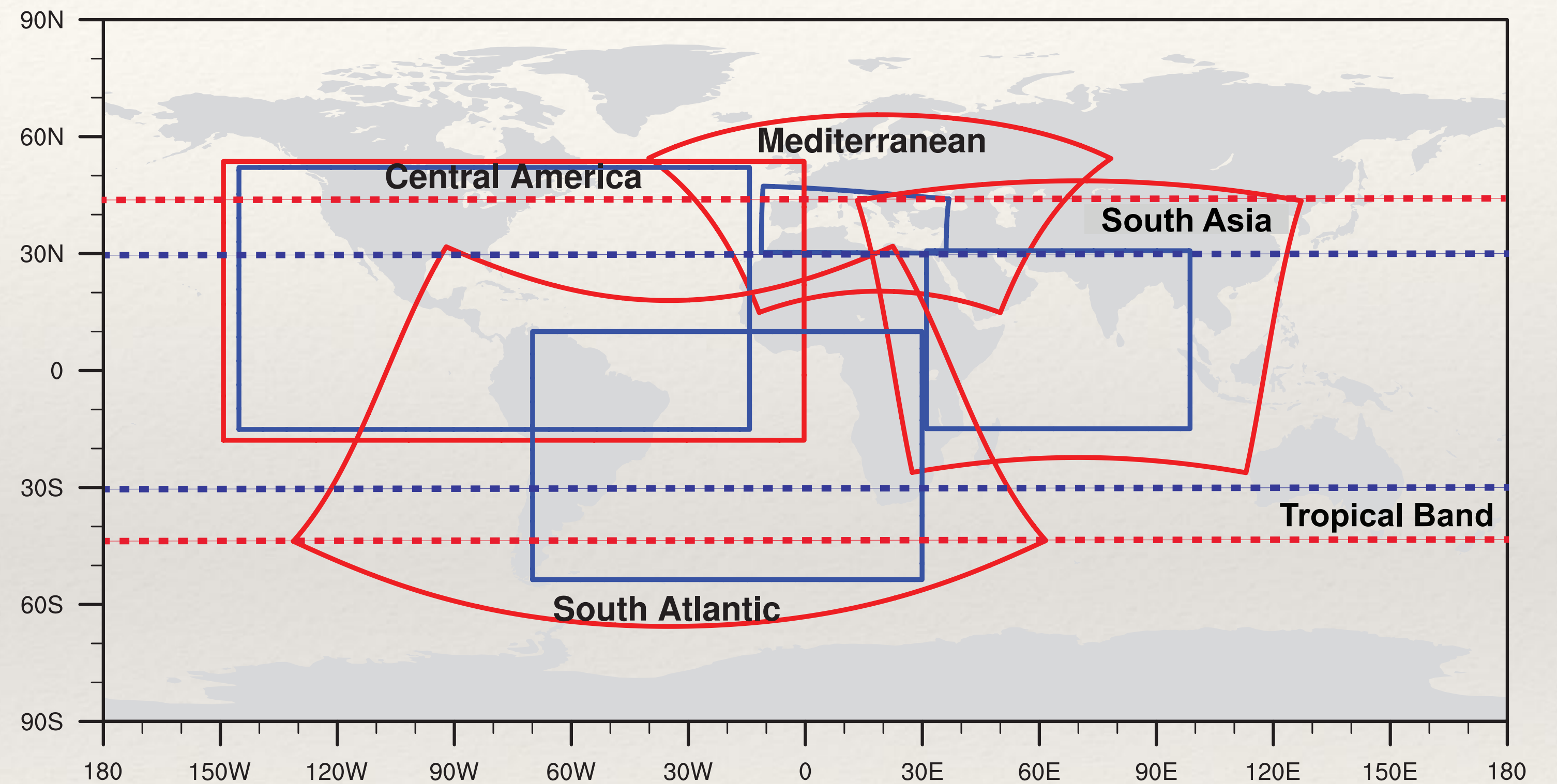
E.g.

Fully coupled Regional Earth System model

RegCM

RegCM-ES

Earth System Model: Driver approach
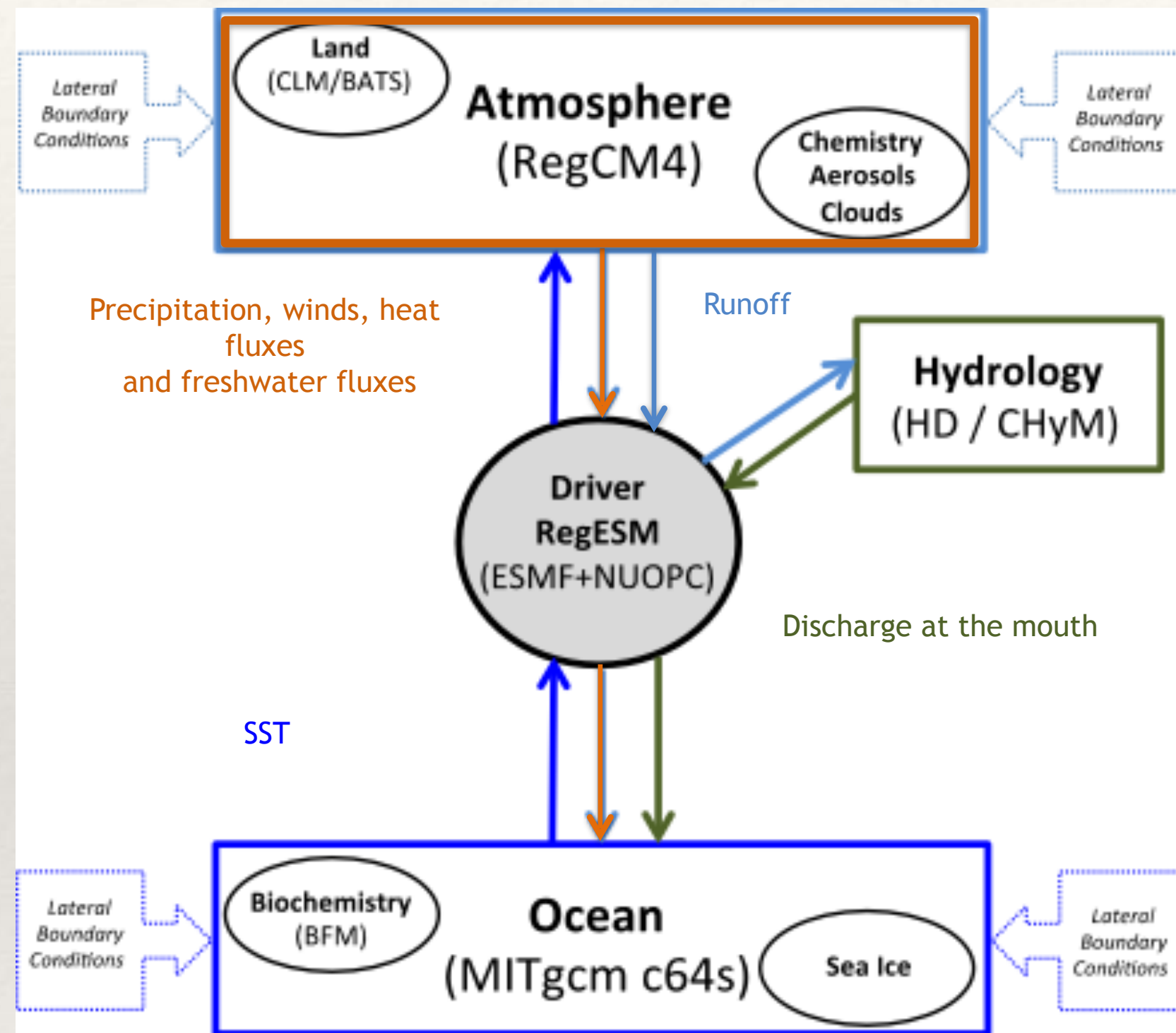
Multiple model components

Only one executable

Interpolation among different grid if needed

Driver

Control the simulation time of the various components

Receive information from components and send back to the others

**Sequential and concurrent support**

The RegCM-ES

Sitz, L. E., Di Sante, F., Farneti, R., Fuentes-Franco, R., Coppola, E., Mariotti, L., Reale, M., Sannino, G., Barreiro, M., Nogherotto, R., Giuliani, G., Graffino, G., Solidoro, C., Cossarini, C., and Giorgi, F. (2017). Description and evaluation of the eart system regional climate model (regcm-es). J. Adv. Model. Earth Syst.

First tests and simulations

Description			Atmosphere				Ocean			River
Domain	# Exp.	# Sim. Years	Spatial Resolution	Vertical Levels	Convective Scheme	ICBC	Spatial Resolution	Vertical Levels	ICBC	Model
Central America	1	1988-1997	50 Km	23	Tiedtke(lnd) Emanuel(ocn)	Era-Int	1/8°	40	MOM	HD
Mediterranean	1	1979-2015	20 Km	23	Tiedtke	Era-Int	1/12°	75	Medar/ Medatlas	HD
South Asia	1) 2) 3)	1979-2008 1979-2015 1979-2015	50 Km	18	Emanuel(lnd/ocn) Tiedtke(lnd/ocn) Tiedtke(lnd/ocn)	Era-Int	1/6°	45	MOM ORAP ORAP	HD HD CHyM
South Atlantic	1	1988-1997	50 Km	23	Tiedtke	Era-Int	1/8°	40	MOM	HD
Tropical Band	1	1979-2008	100 Km	23	Tiedtke	Era-Int	1/4°	40	SODA	HD

The South Asia experiment
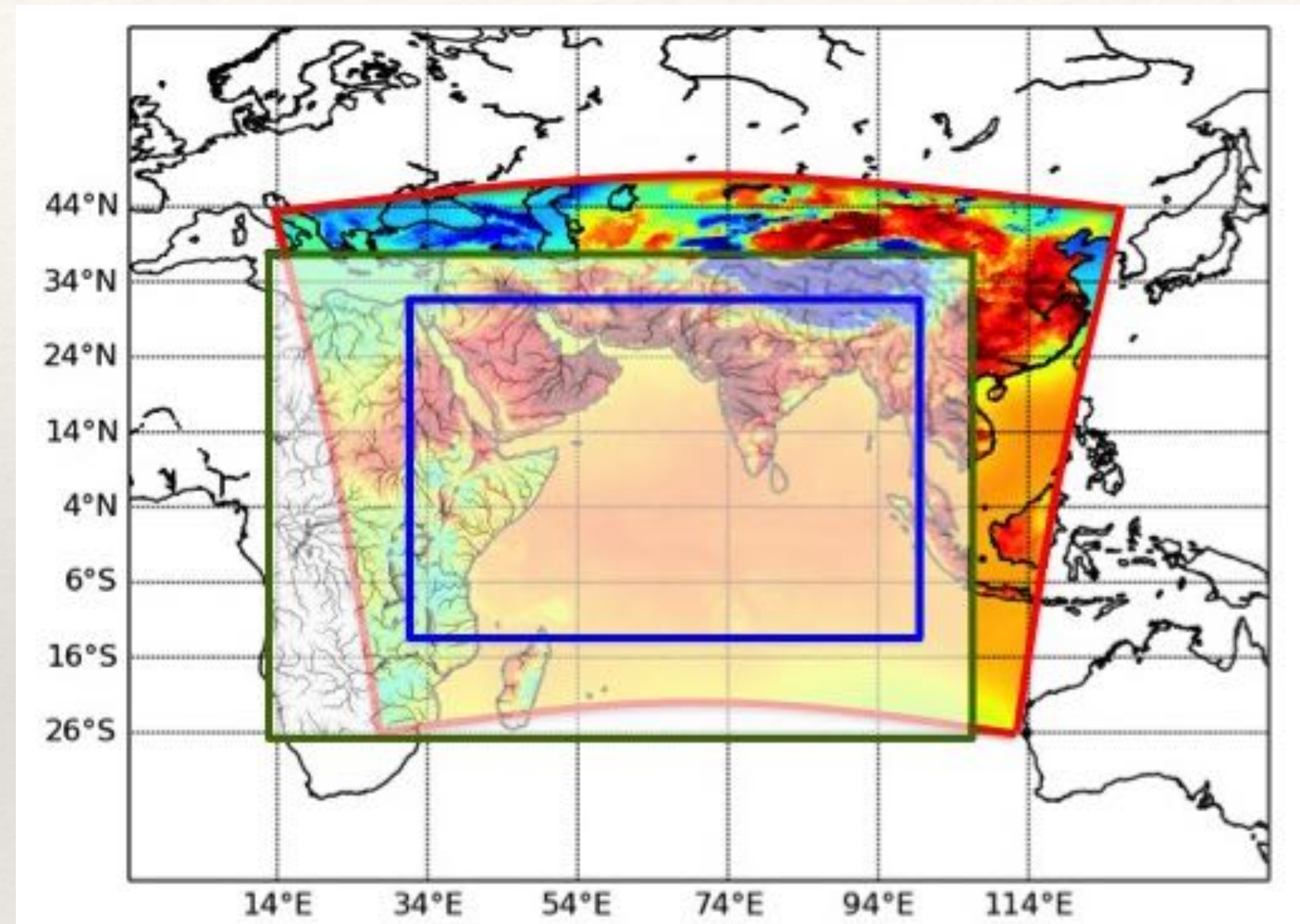
— OCN domain   — HYD domain   — ATM domain

Climatology of the ISM

Precipitation

JF   MAM

JJAS   OND

Winds (850hPa)

JF   MAM

JJAS   OND
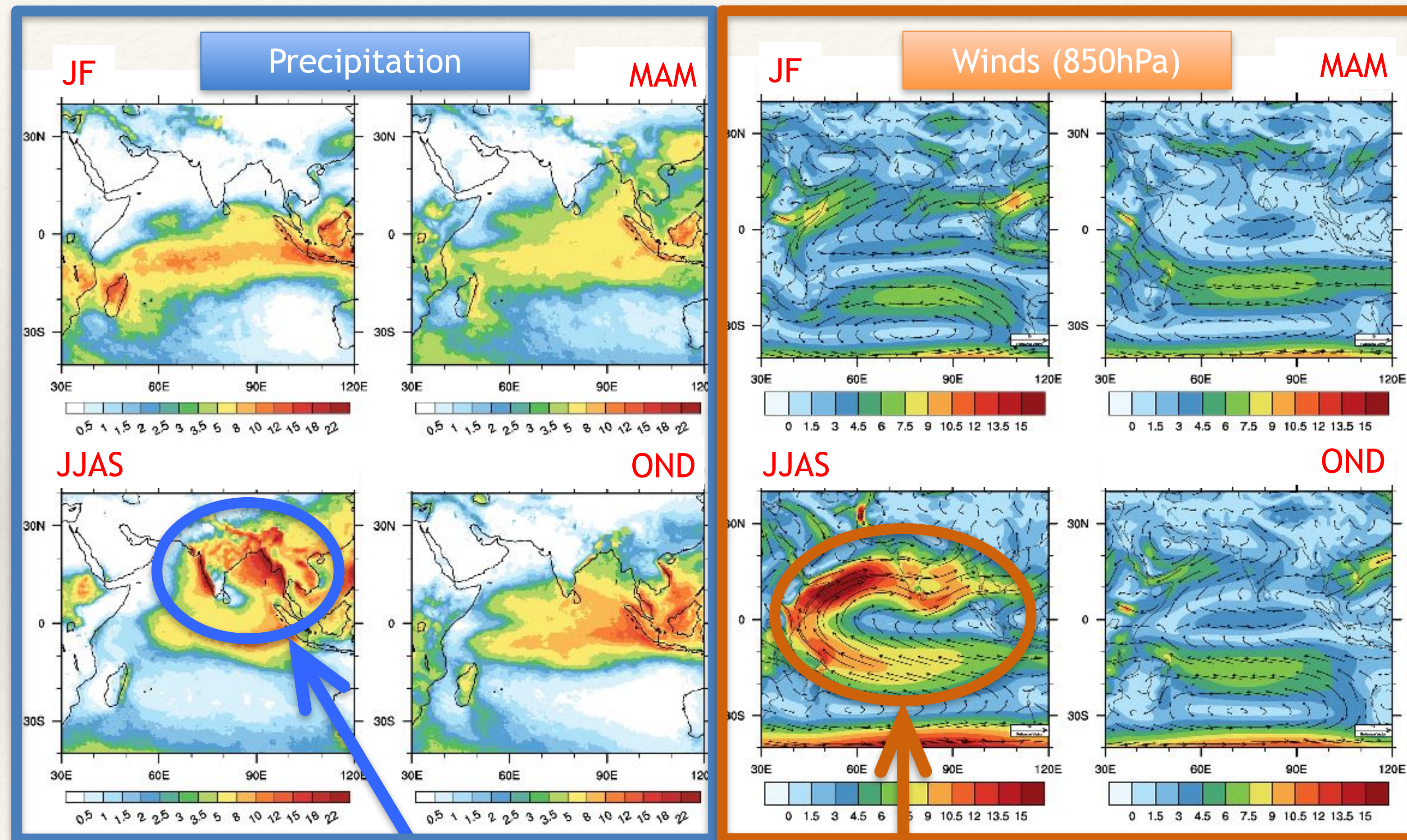
Large Increase in precipitation and runoff

Low Level Jet

Intraseasonal oscillations of the ISM
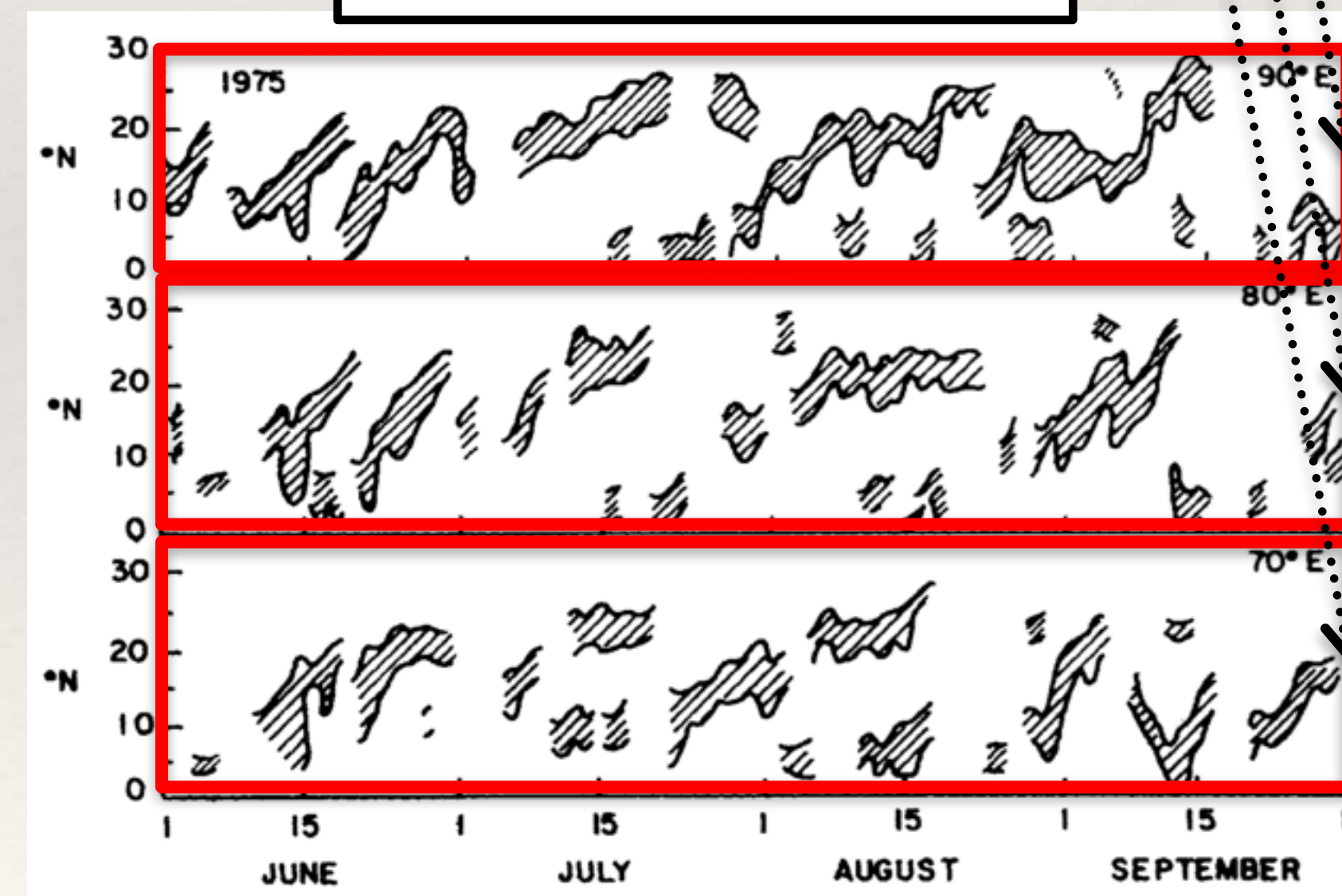

Rainfall

1994

2013

2014
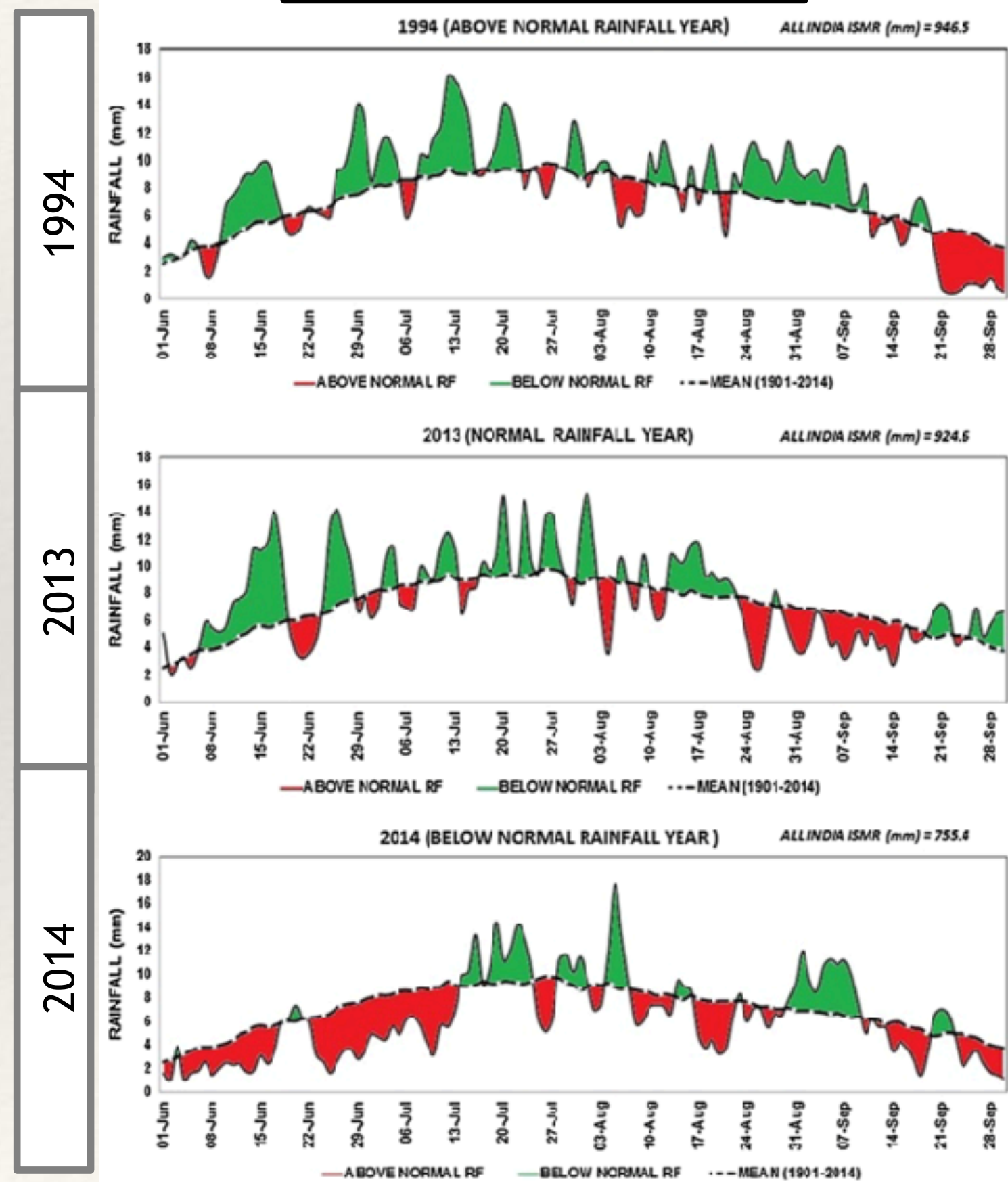
Composite of break/active
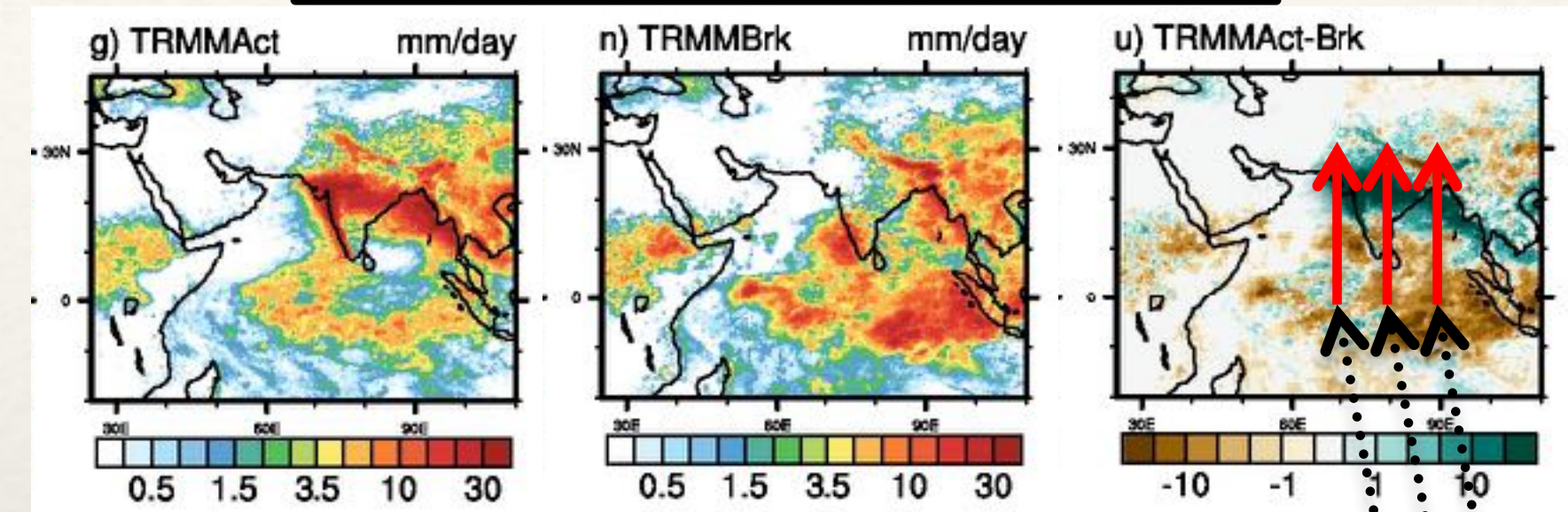
Maximum cloud zone

Pai et al. [2016]
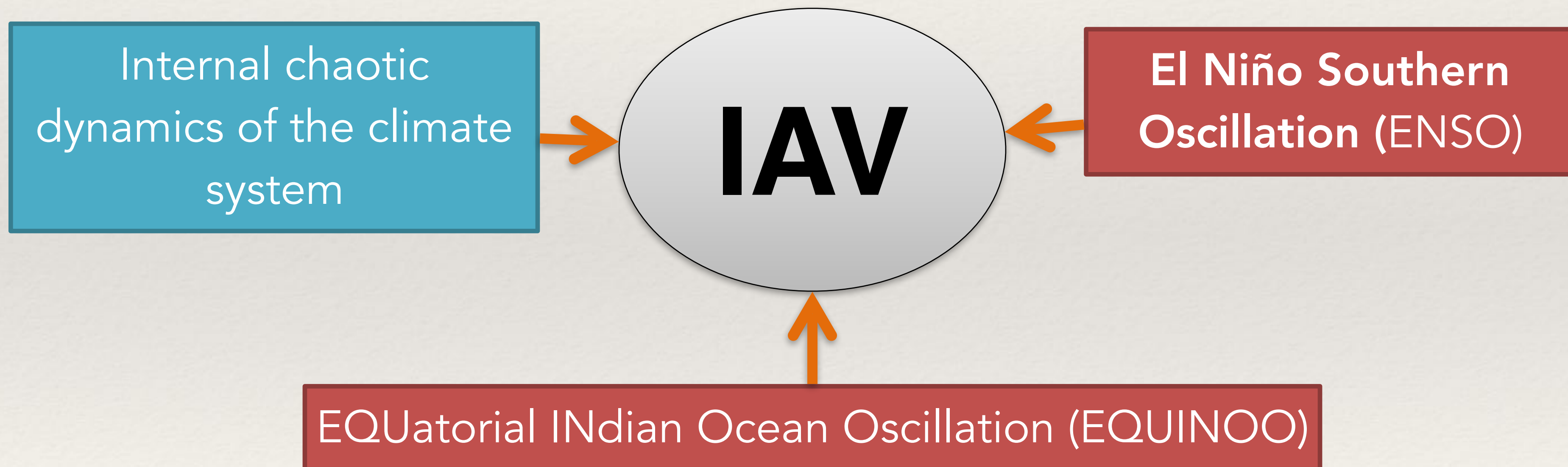
Goswami [1994]

Interannual variability of the Indian Summer Monsoon

The Indian summer monsoon is characterized by large year-to-year variations in the total amount of rainfall over the Indian continent.

Internal chaotic dynamics of the climate system

IAV

El Niño Southern Oscillation (ENSO)

EQUatorial INdian Ocean Oscillation (EQUINOO)

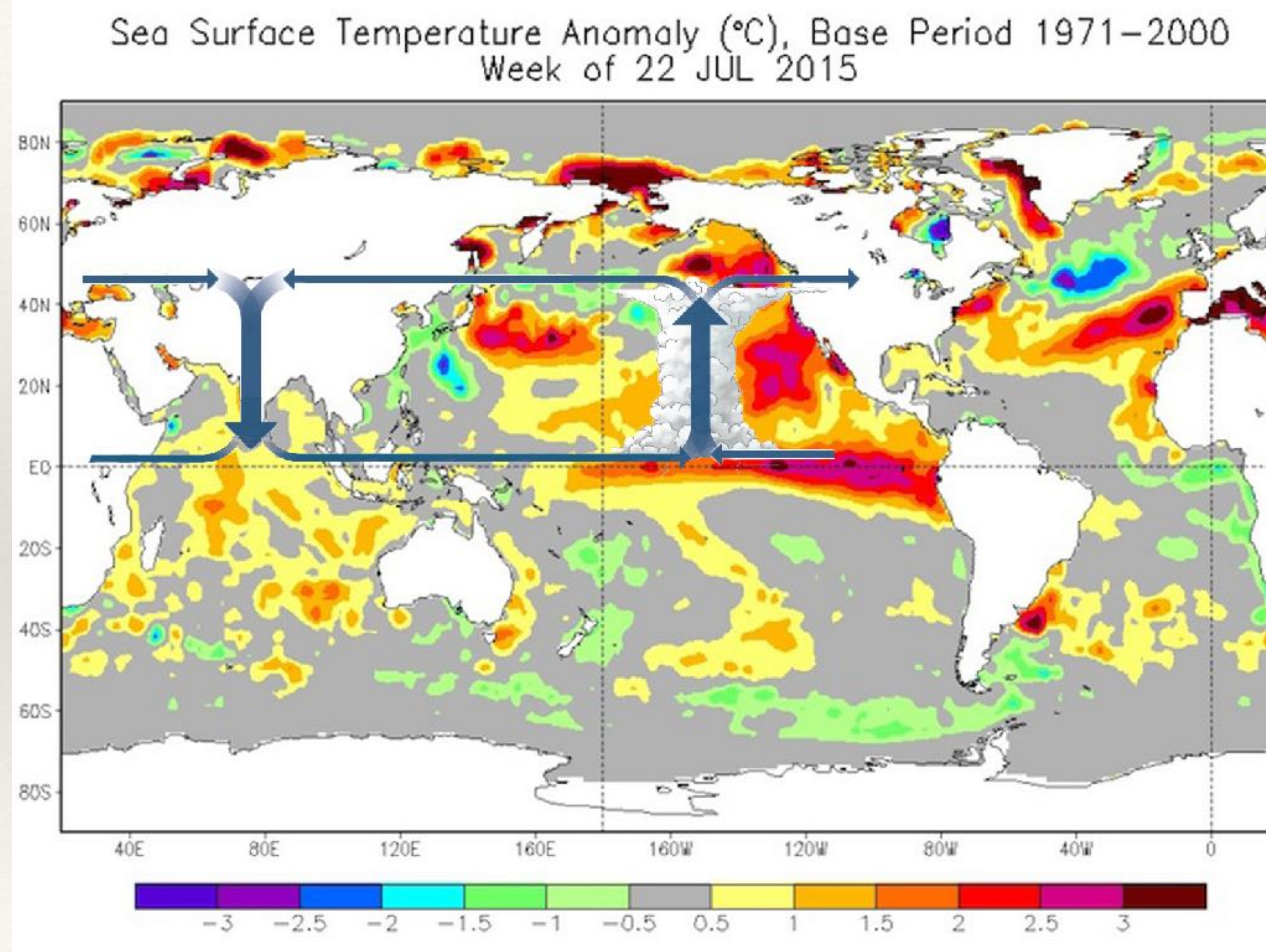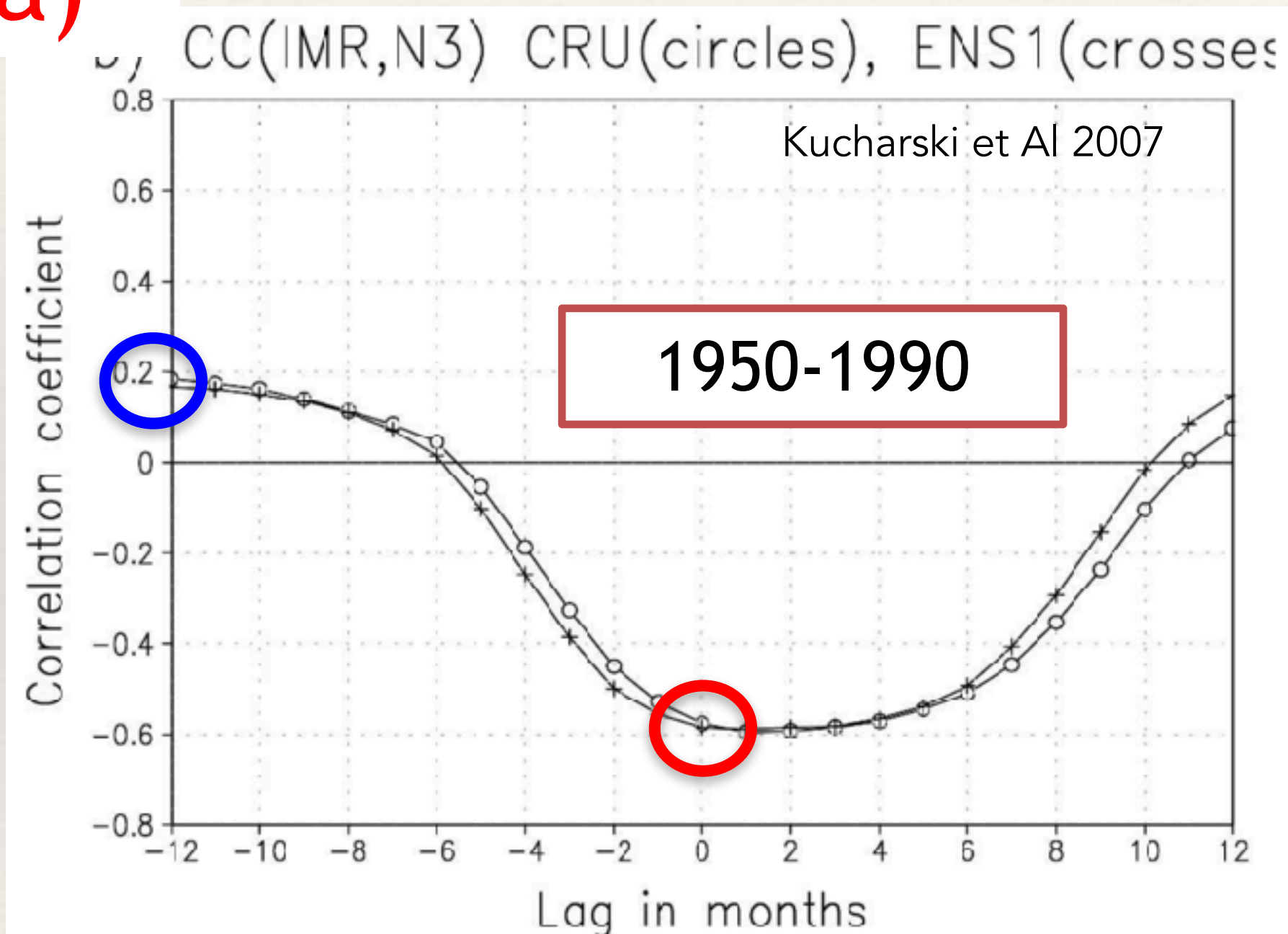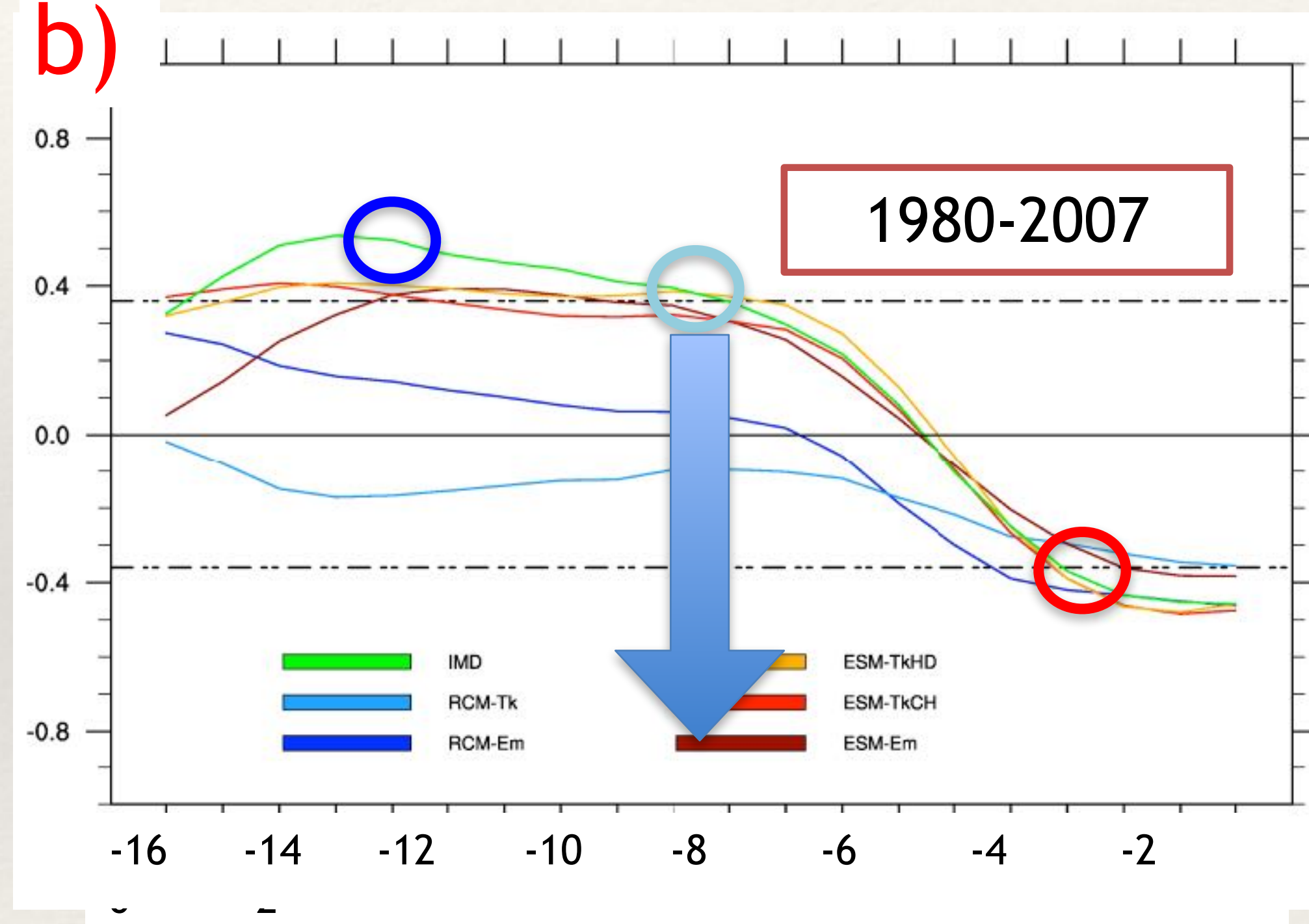# Results: ENSO forcing on ISM (direct effect during JJAS)

Image credit: NOAA National Centers for Environmental Information

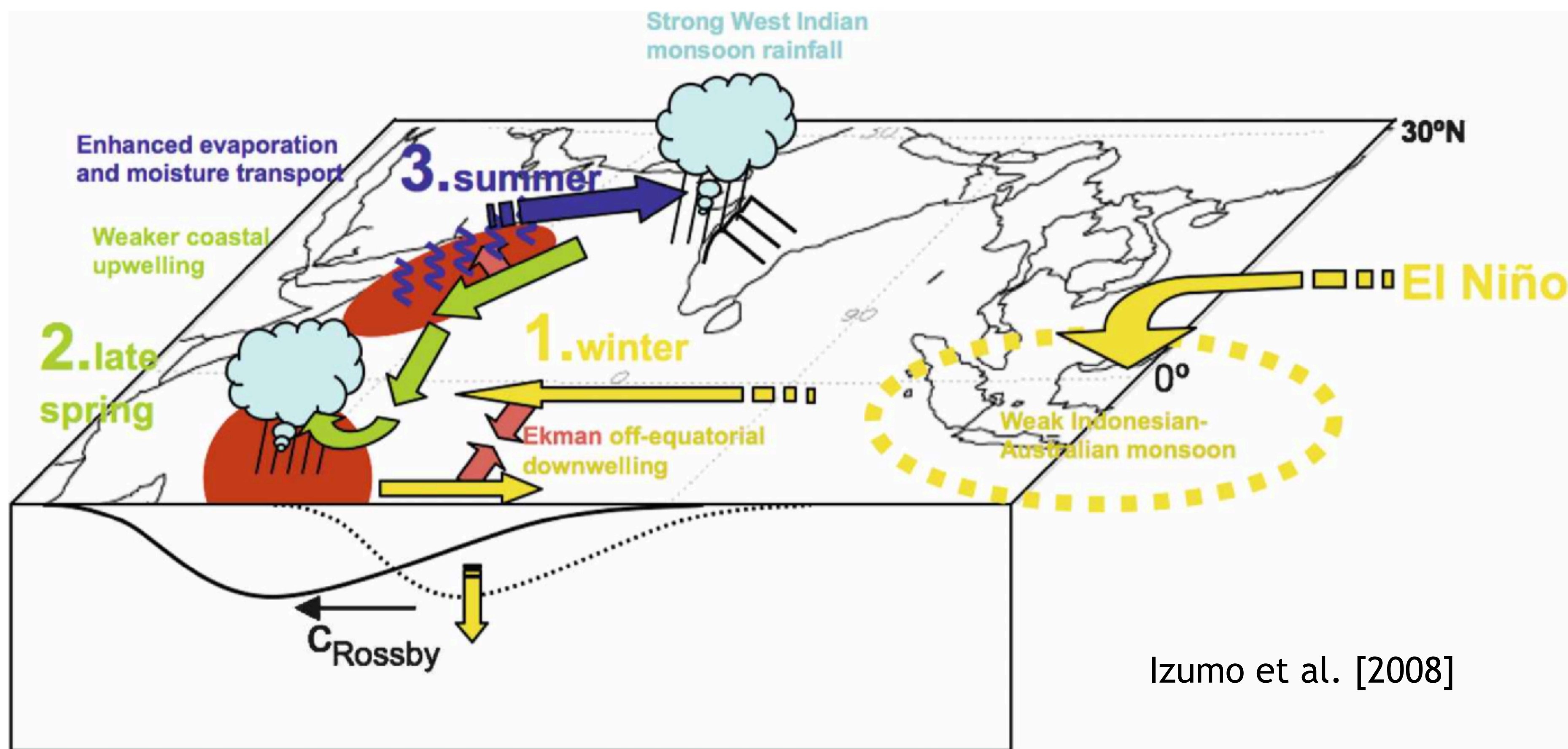# Results: ENSO forcing on ISM (delayed effect)

a)

CC(IMR,N3) CRU(circles), ENS1(crosses)

Kucharski et Al 2007

1950-1990

b)

1980-2007

IMD ESM-TkHD
RCM-Tk ESM-TkCH
RCM-Em ESM-Em

Izumo et al. [2008]

Results: ENSO forcing on ISM (delayed effect from JJAS)

Results: ENSO forcing on ISM (delayed effect from JJAS)

Regressed maps (OBS) of Niño3.4 (JJAS)

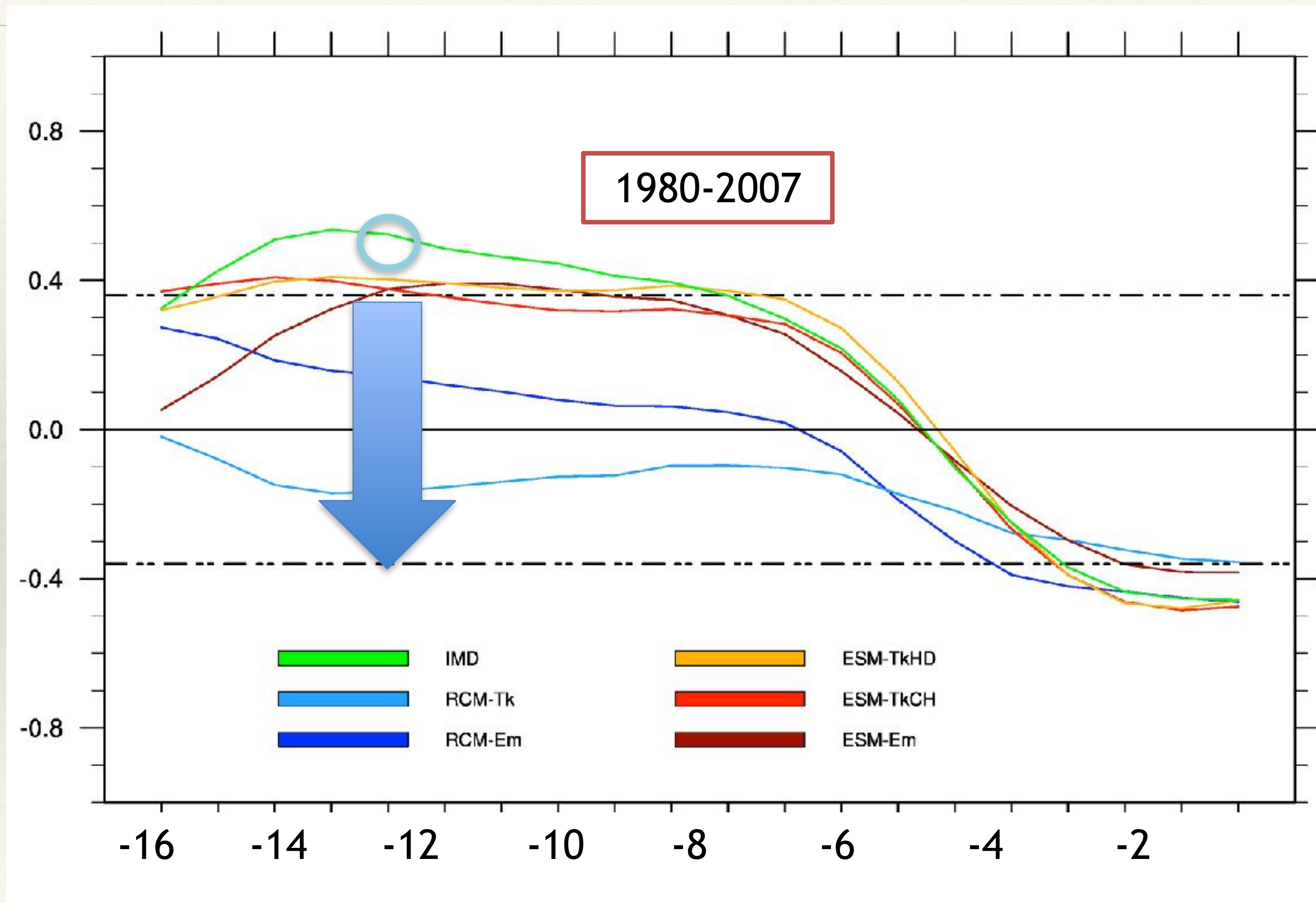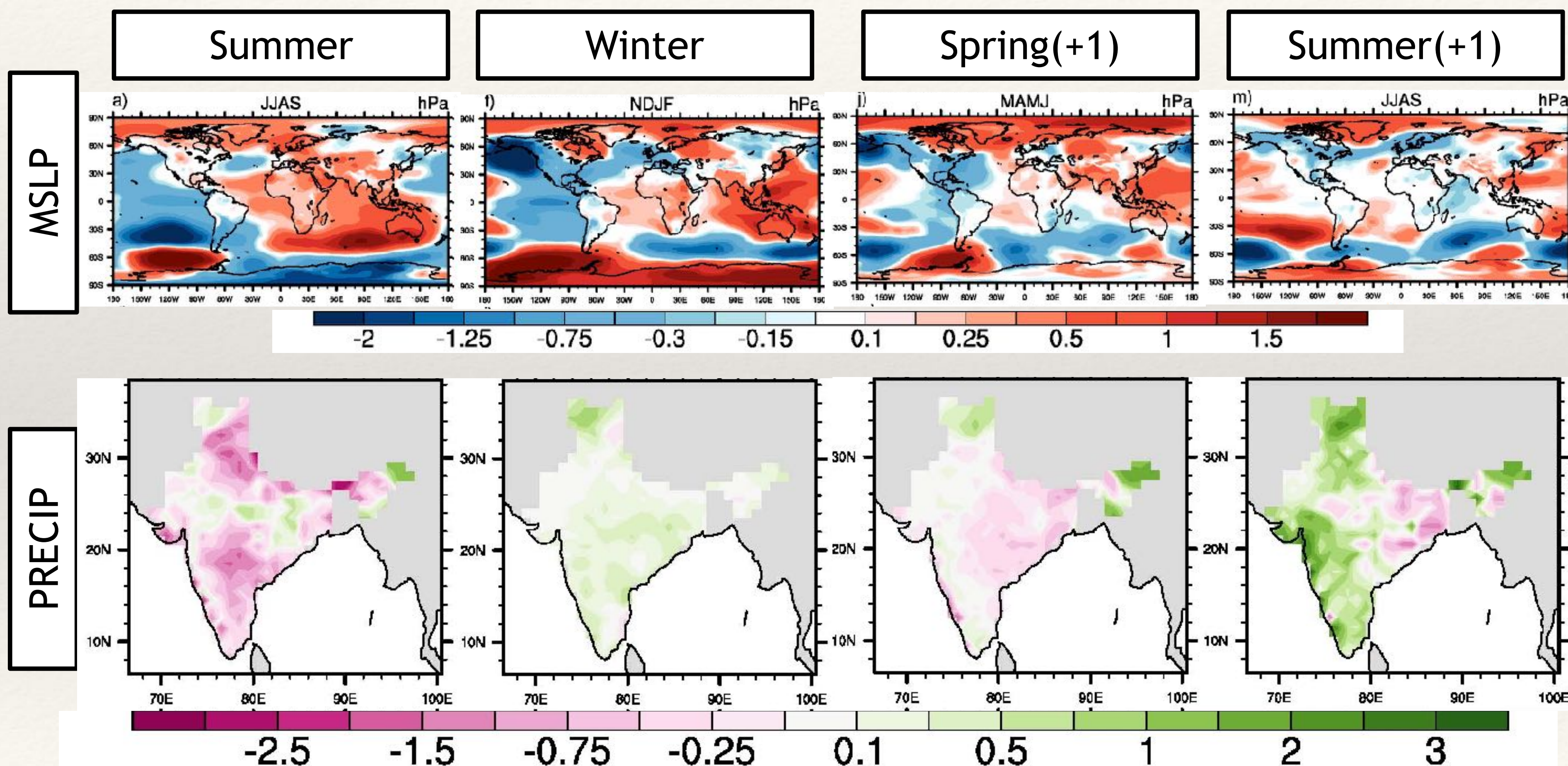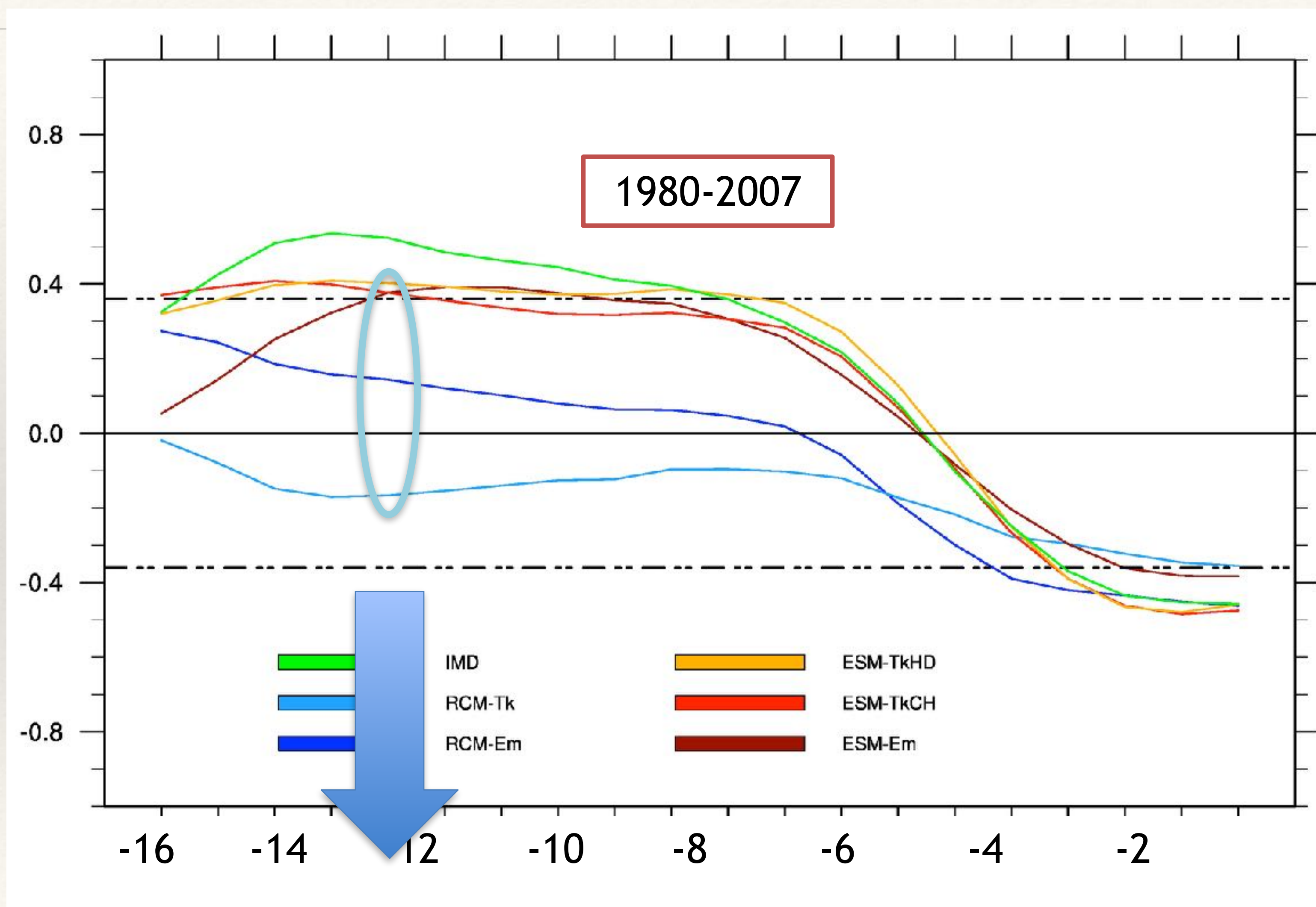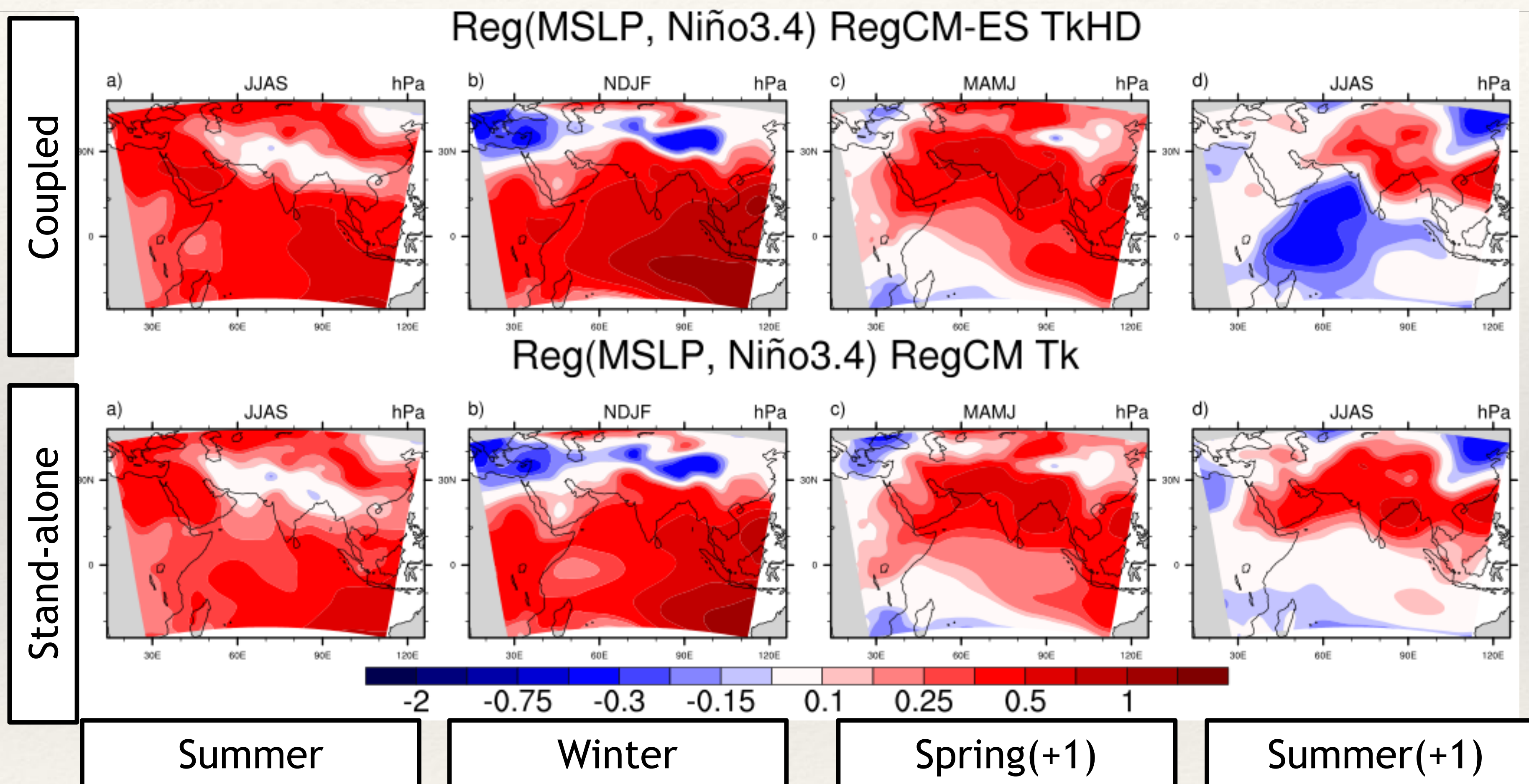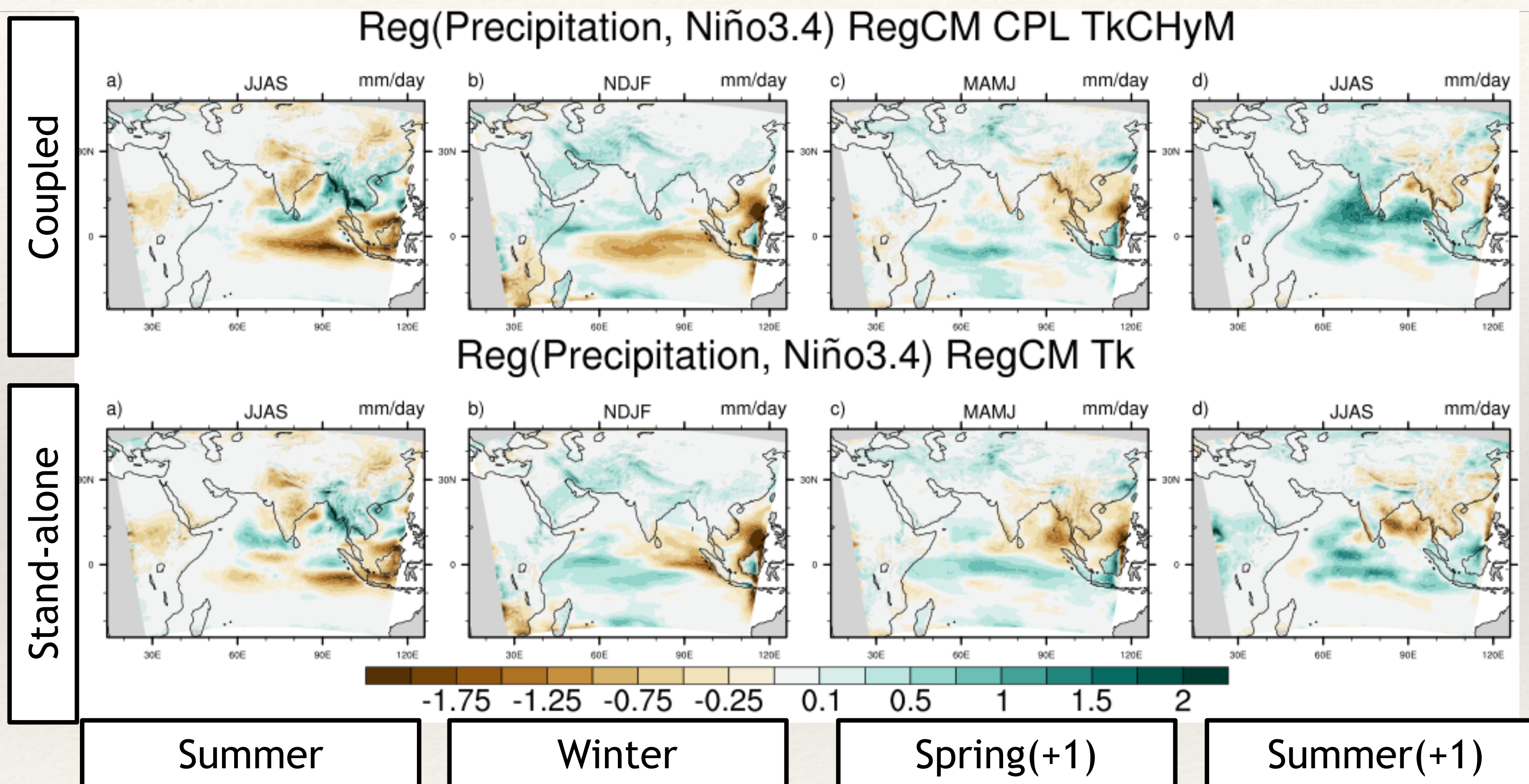# Results: ENSO forcing on ISM (delayed effect from JJAS)

Results: ENSO forcing on ISM (delayed effect from JJAS)

Results: ENSO forcing on ISM (delayed effect from JJAS)

Reg(Precipitation, Niño3.4) RegCM CPL TkCHyM

Reg(Precipitation, Niño3.4) RegCM Tk

Coupled

Stand-alone

Summer   Winter   Spring(+1)   Summer(+1)

Results: interannual variability
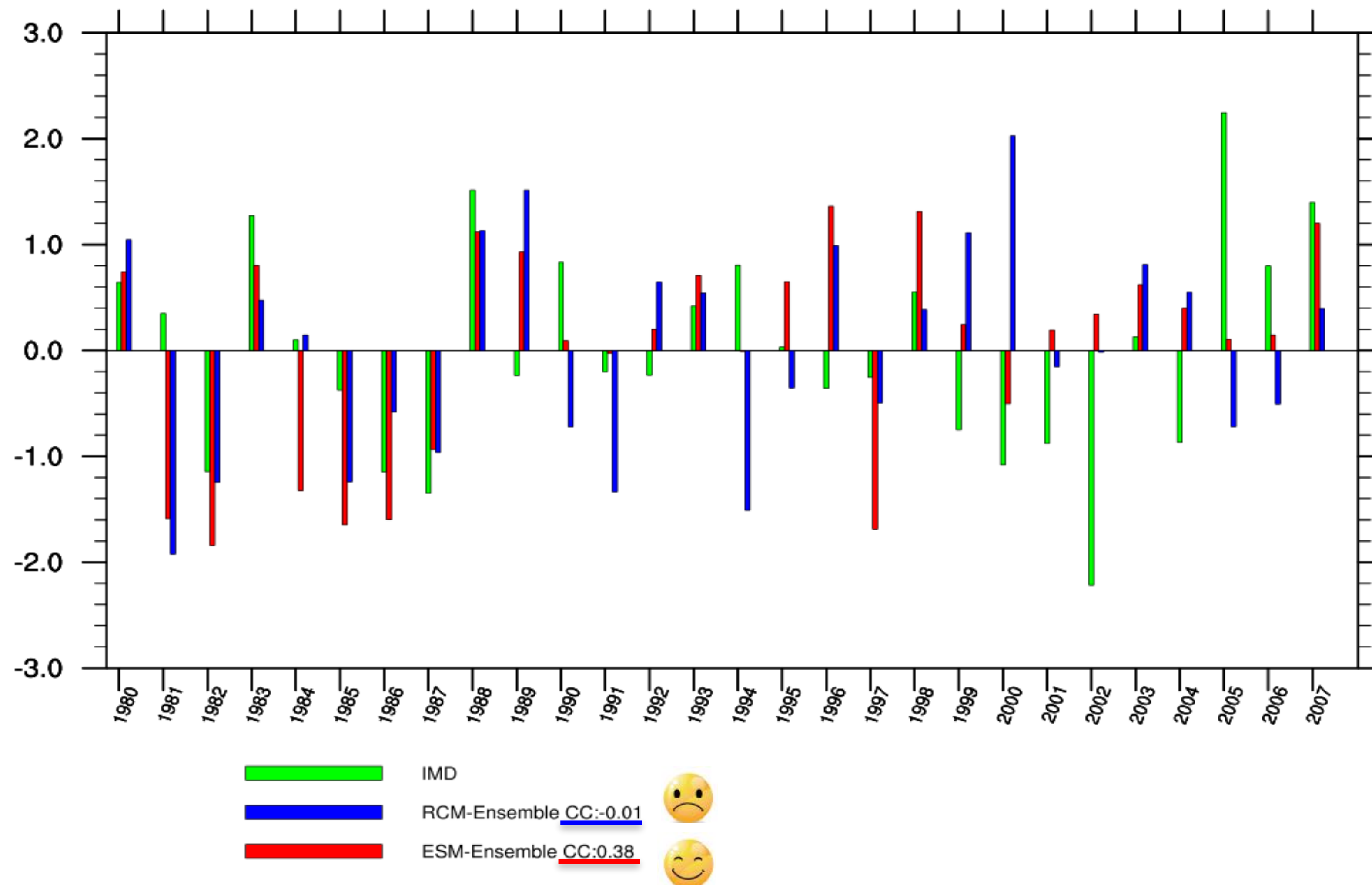
Our analysis confirm what found in the previous studies, namely the necessity of using a coupled system to simulate the Indian Summer Monsoon variability

Historical ENSO monsoon correlation

Based on IITM
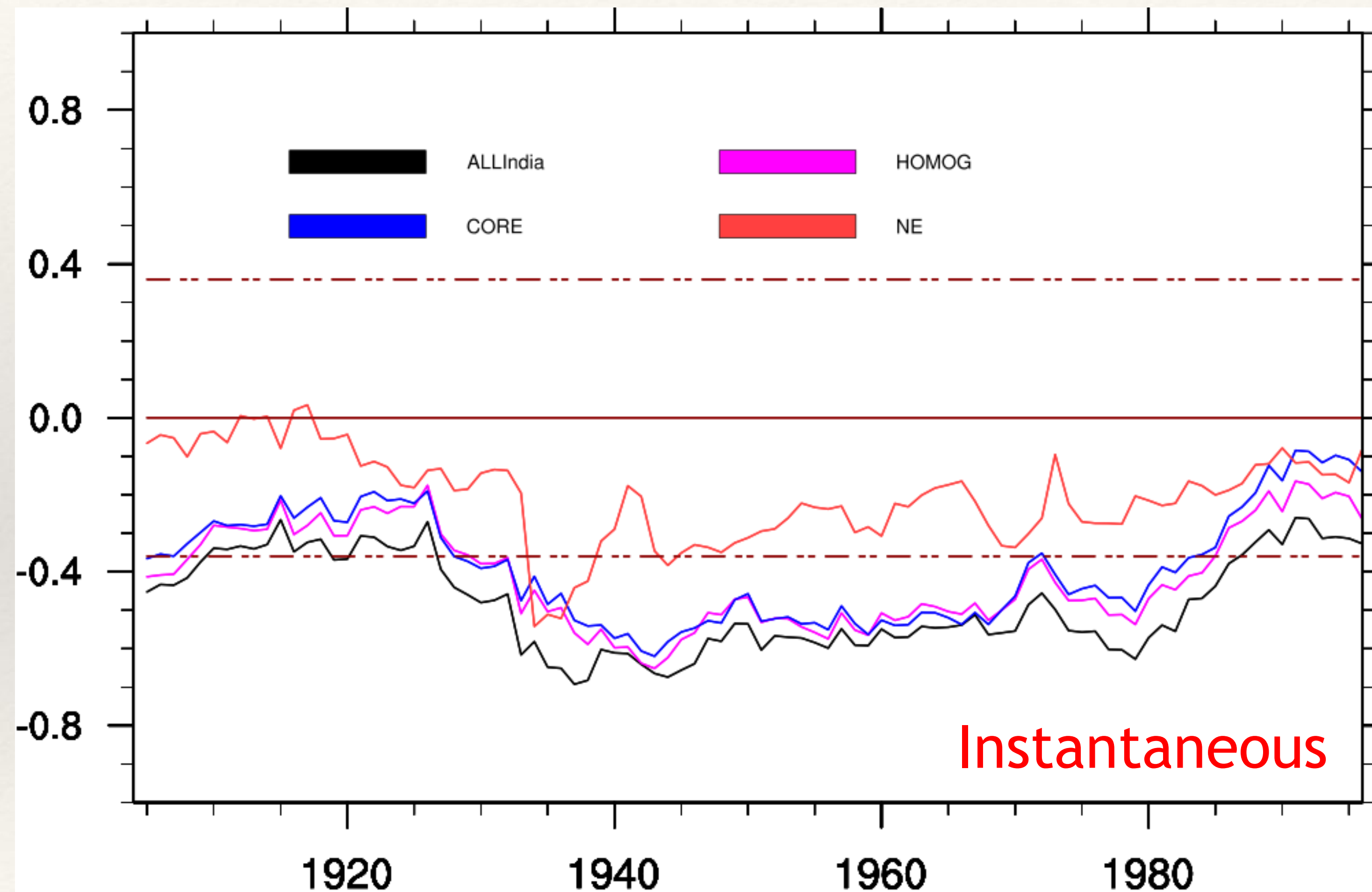Homogeneous

Historical ENSO monsoon correlation

Based on IITM
Homogeneous
monsoon rainfall
dataset
(http://
www.tropmet.res
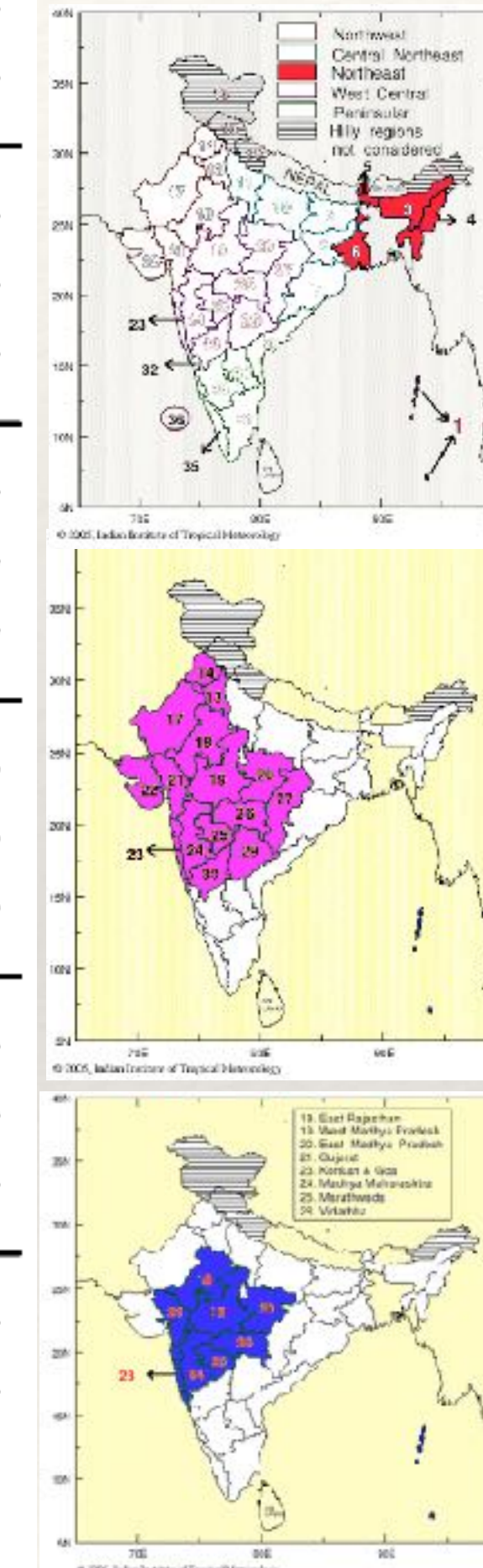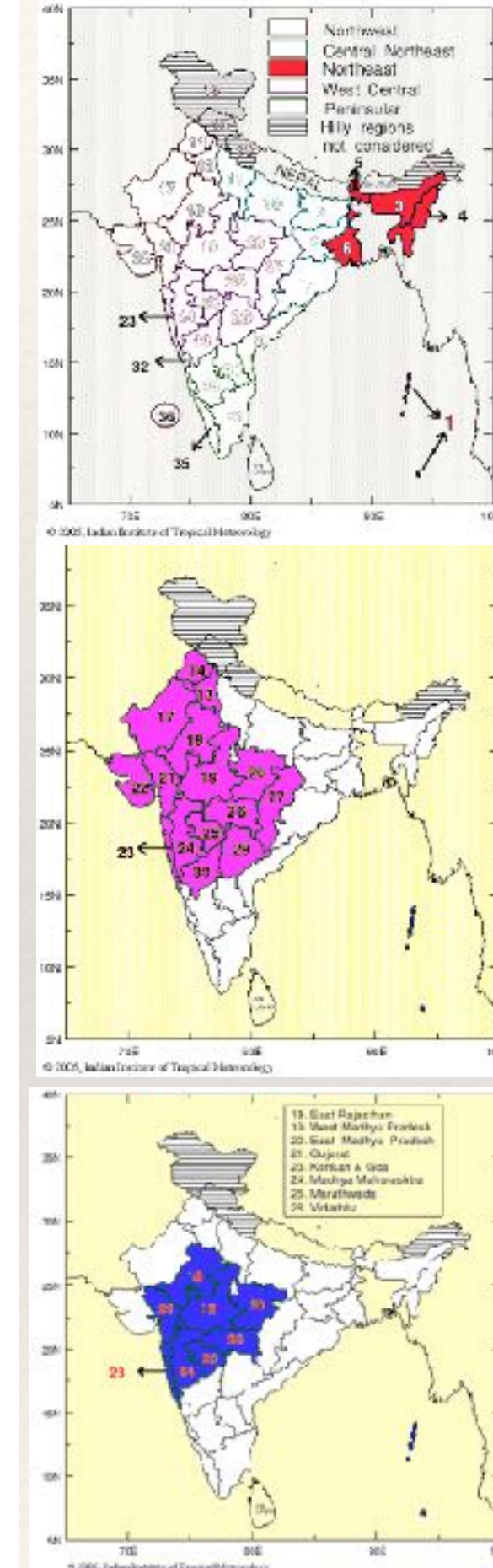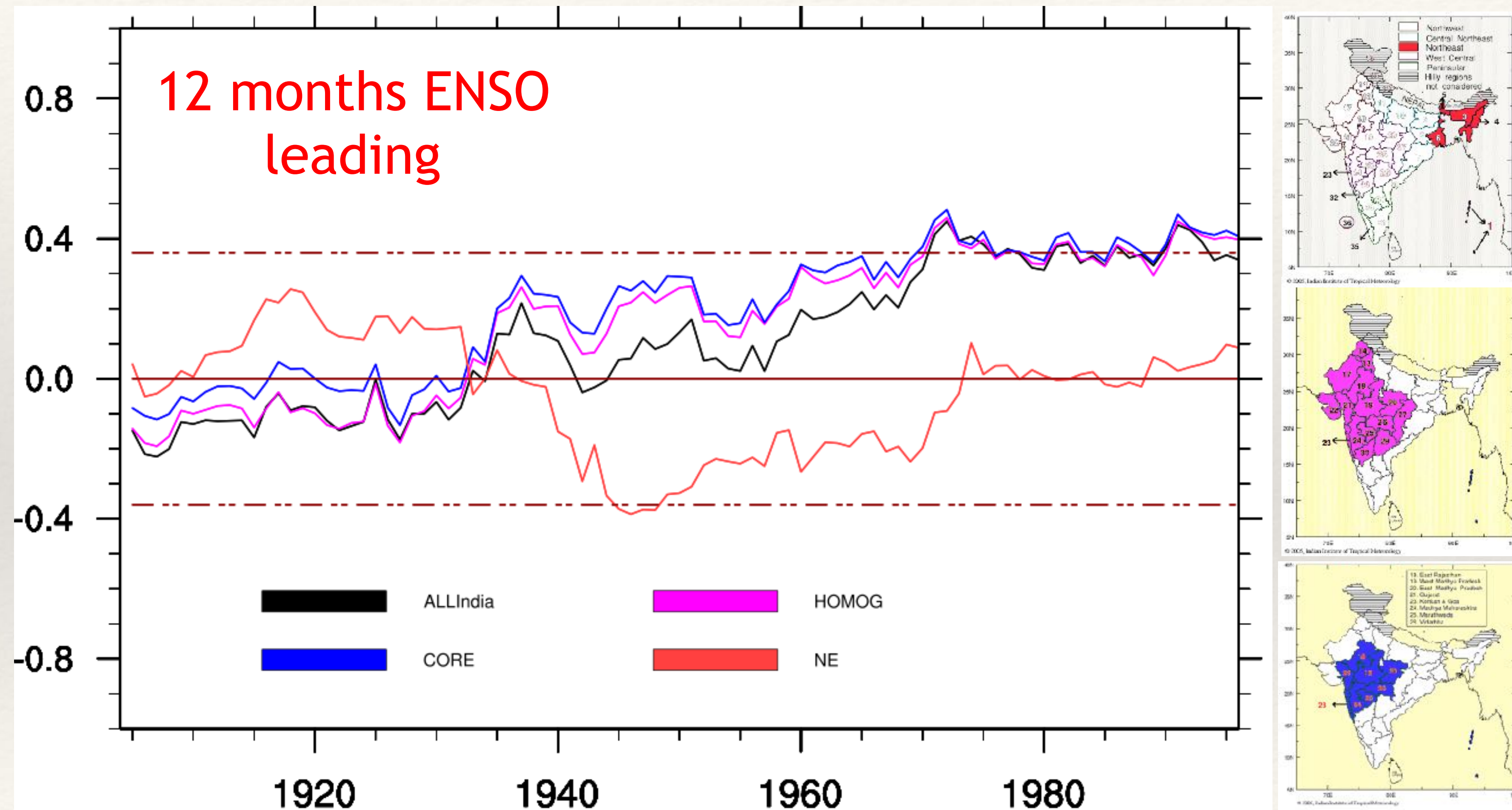.in/)

Summary and conclusions

- Our analysis confirm what found in the previous studies, namely the necessity of using a coupled system to simulate the Indian Summer Monsoon variability

- RegCM-ES allows to study the complex coupled phenomena that are related to the large scale forcing (ENSO) on the ISMR. The understanding of these phenomena may leads to an increase of predictability of the monsoon with a very high impact on socio-economic aspects of the region

- The nature of the increased predictability of the monsoon intensity during the last decades is not fully understood and further studies are needed

What's next?
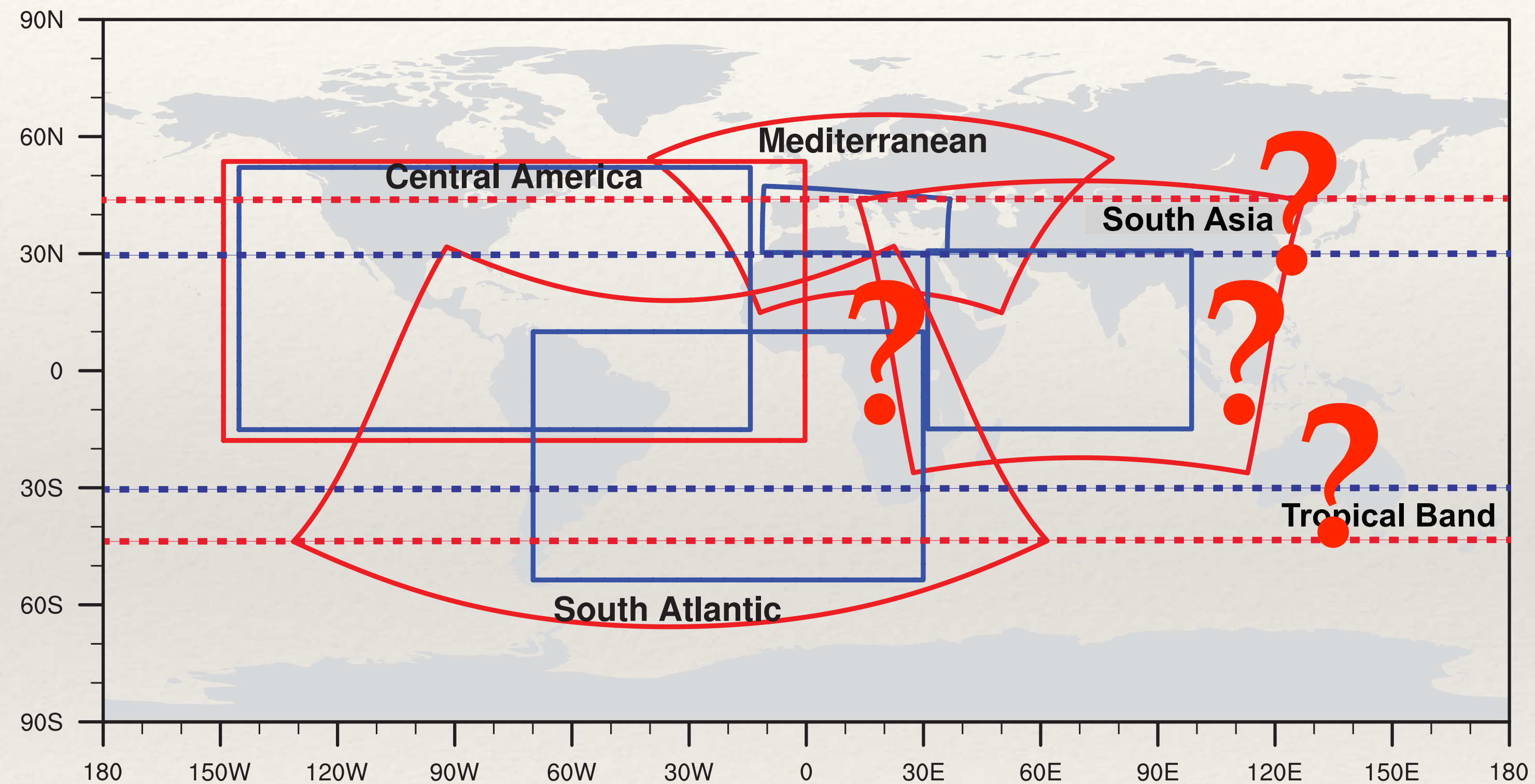
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- Xie, S.-P., Hu, K., Hafner, J., Tokinaga, H., Du, Y., Huang, G., and Sampe, T. (2009). Indian ocean capacitor effect on indo–western pacific climate during the summer following el niño. Journal of Climate, 22(3):730–747.