

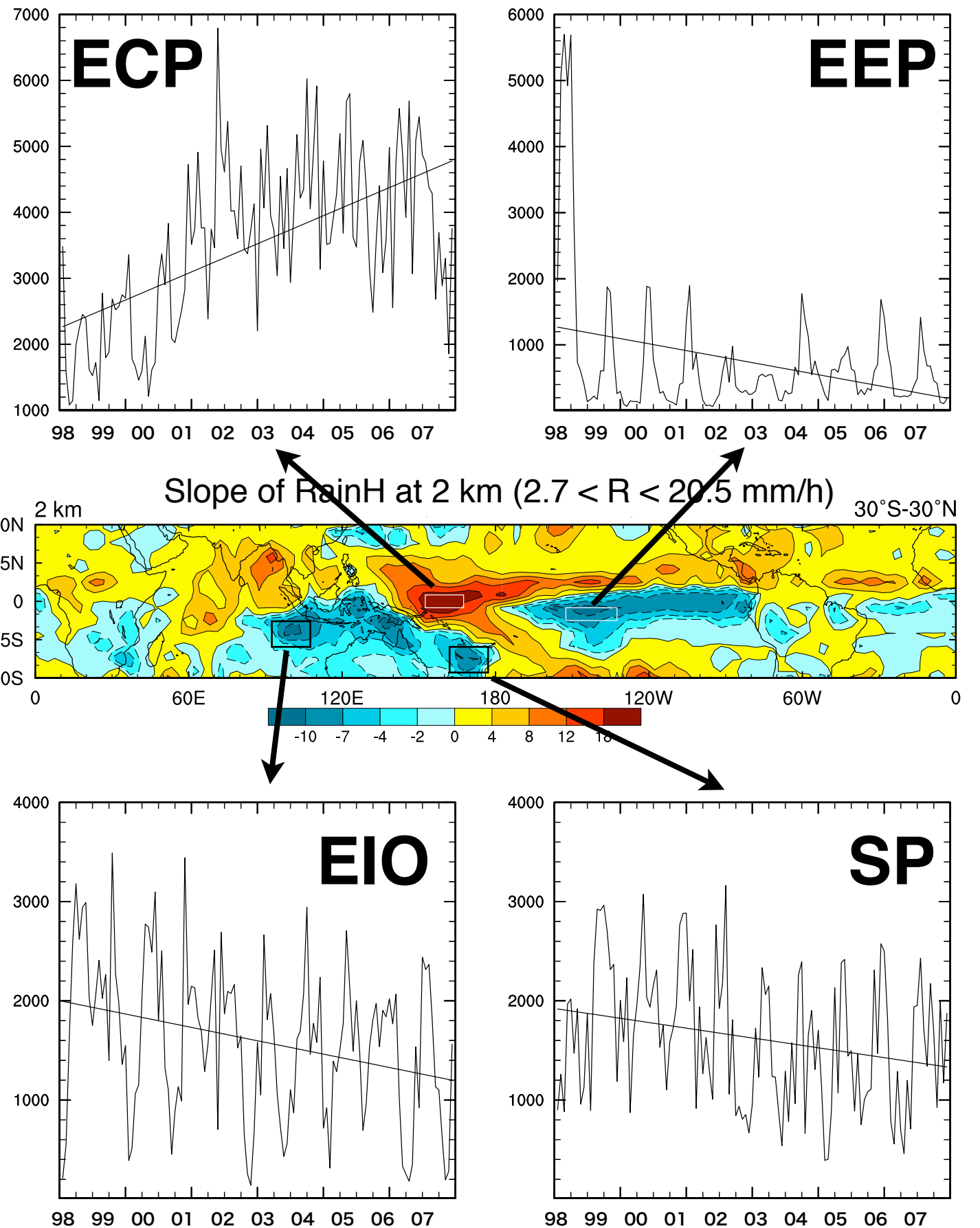
# Interannual Variation or Effect of the Boost in TRMM 3A25 Data?

Aug. 2001

- Boost
- Transition from La Niña to El Niño

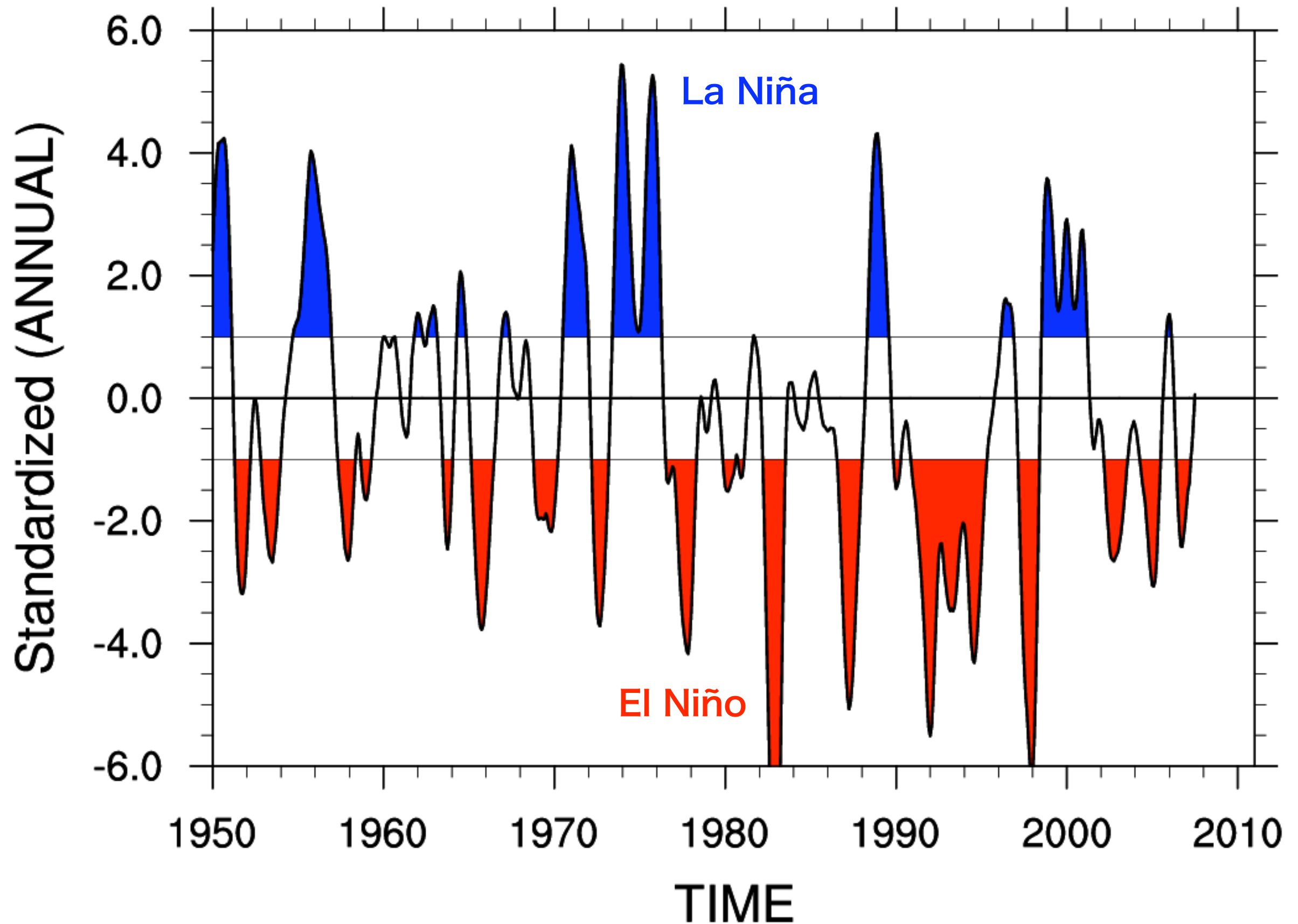
Question:

- How do these two appear in TRMM data?
- Can we separate these two in TRMM data?

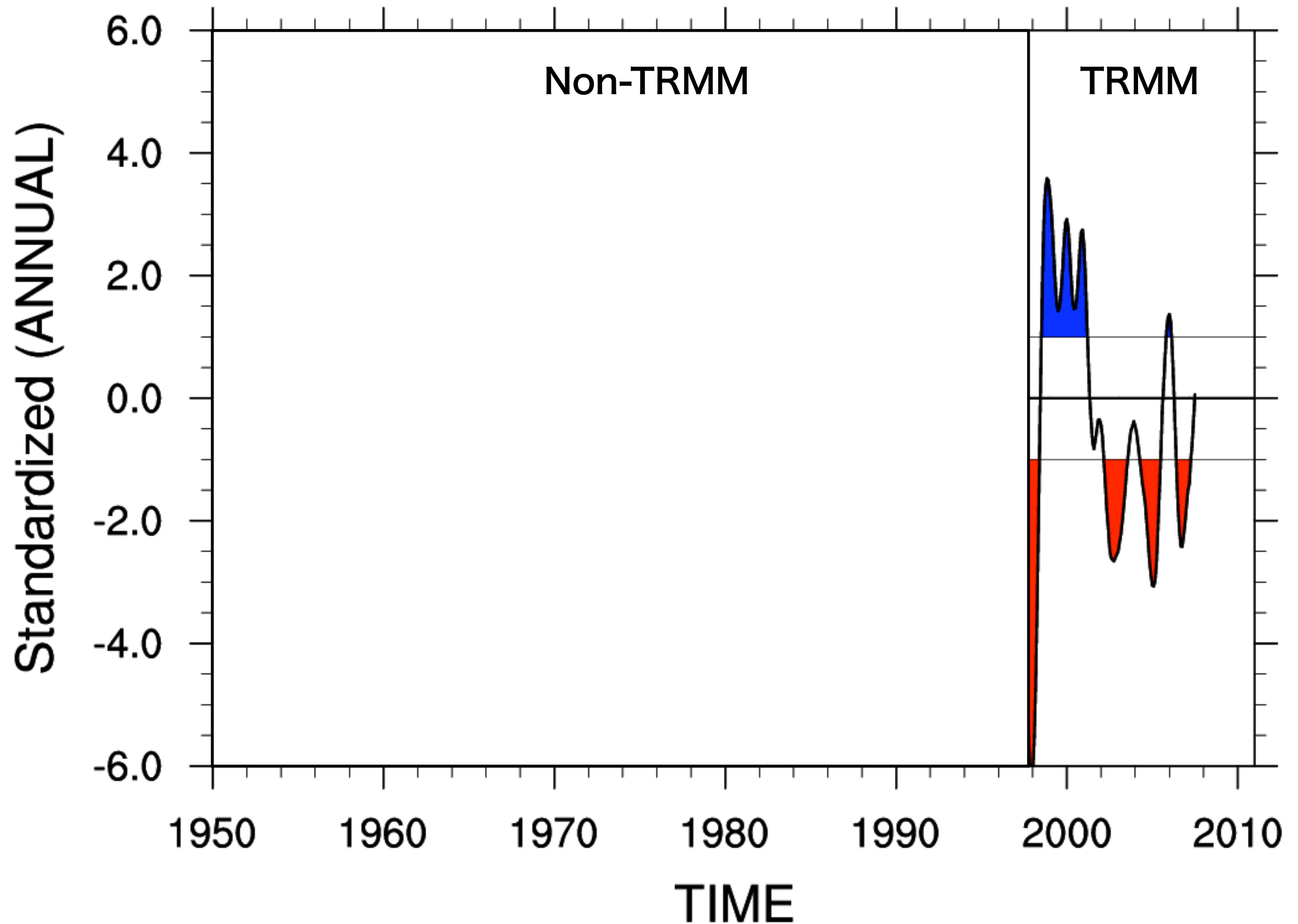


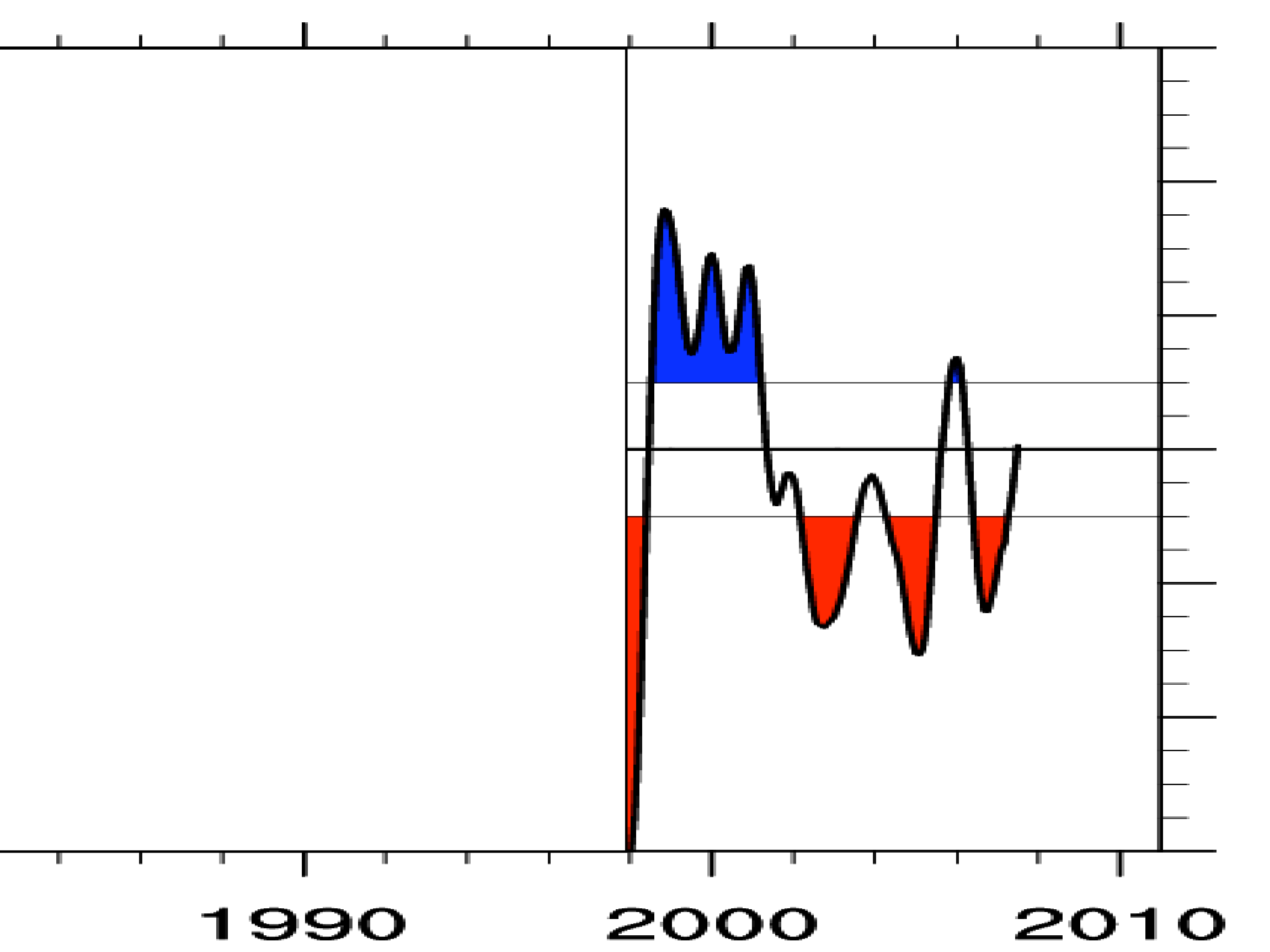
T. Nakazawa and K. Rajendran

# Southern Oscillation Indices

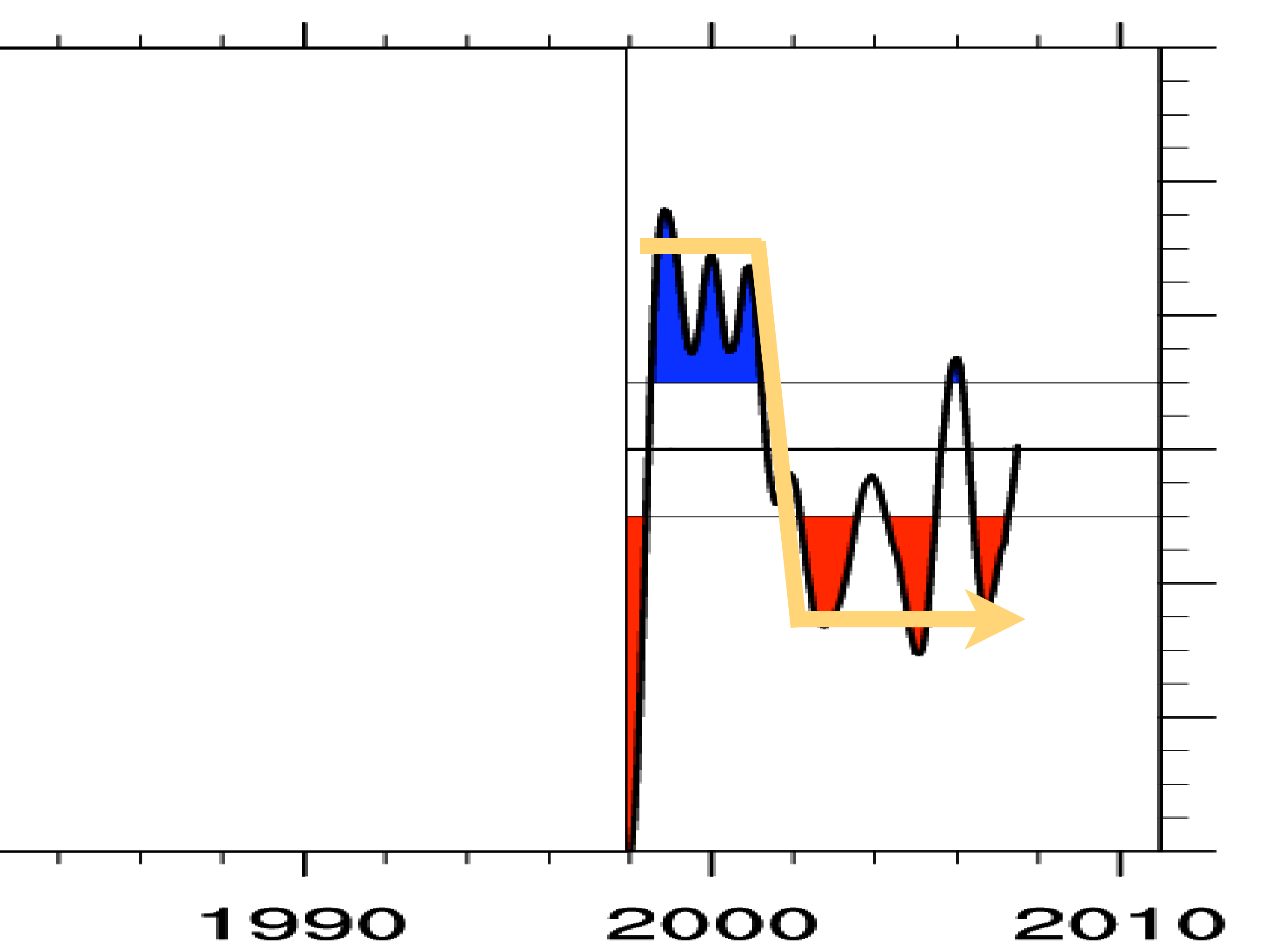


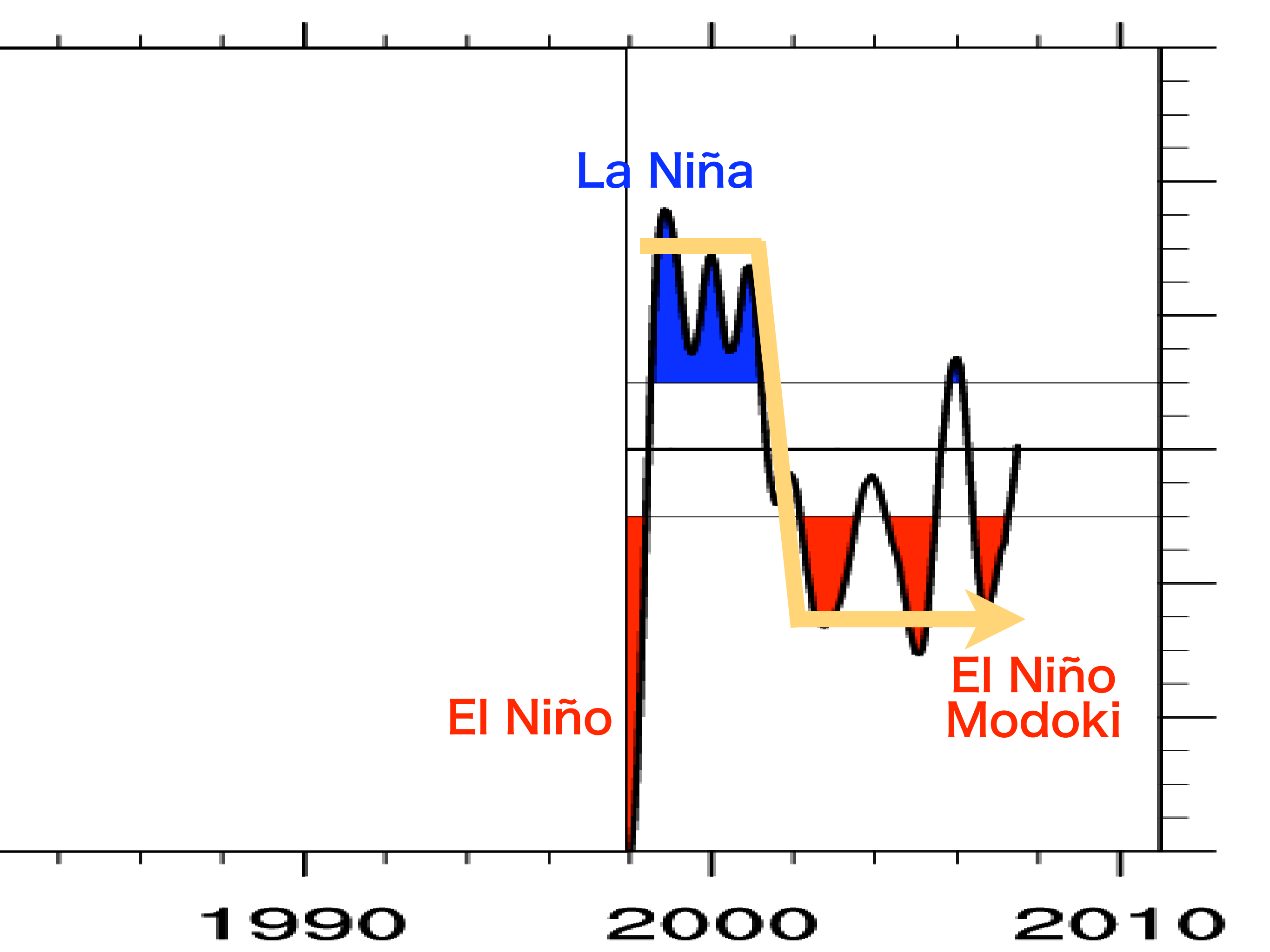
# Southern Oscillation Indices











La Niña

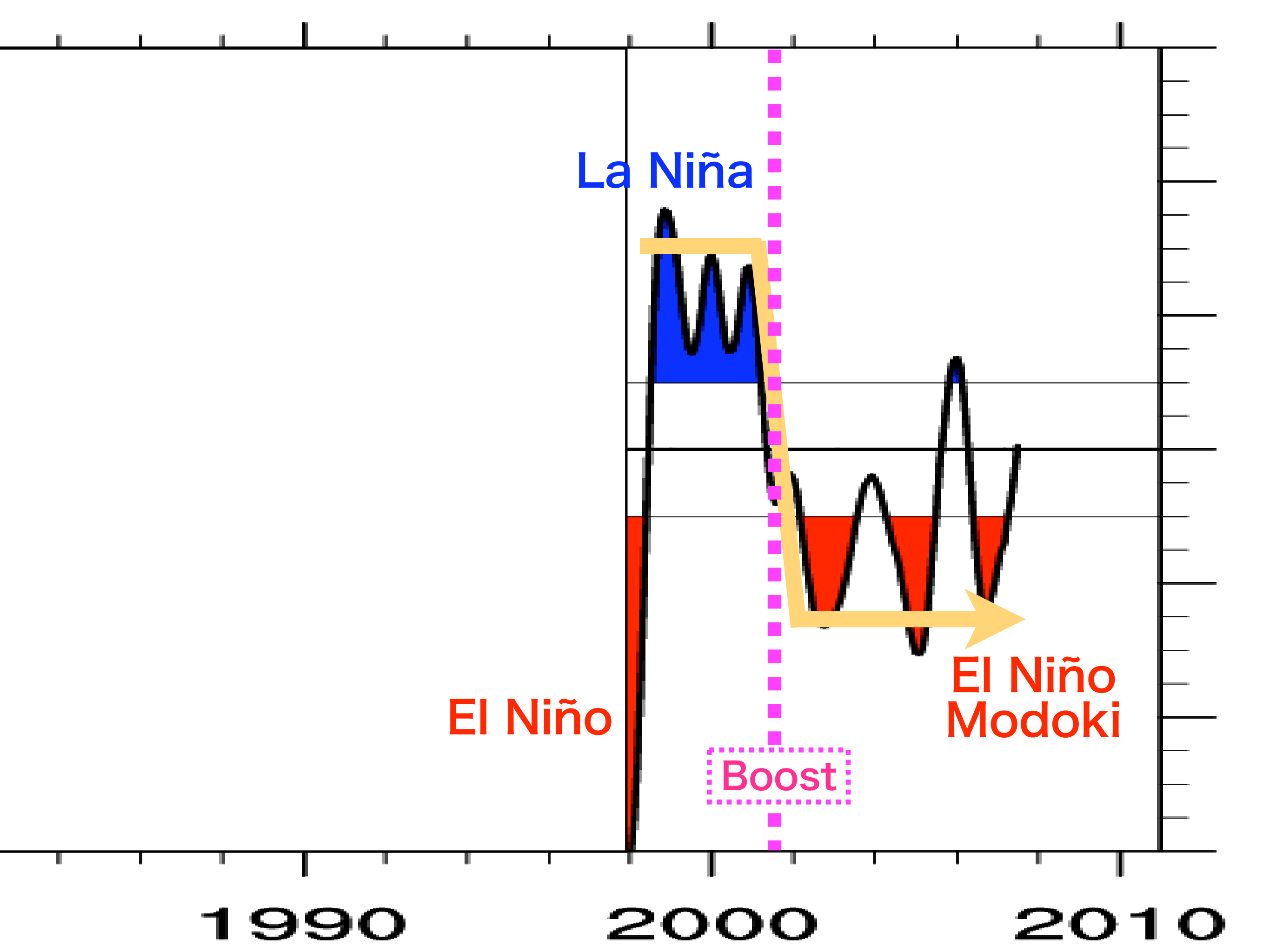
El Niño

El Niño  
Modoki

1990

2000

2010



1990

2000

2010

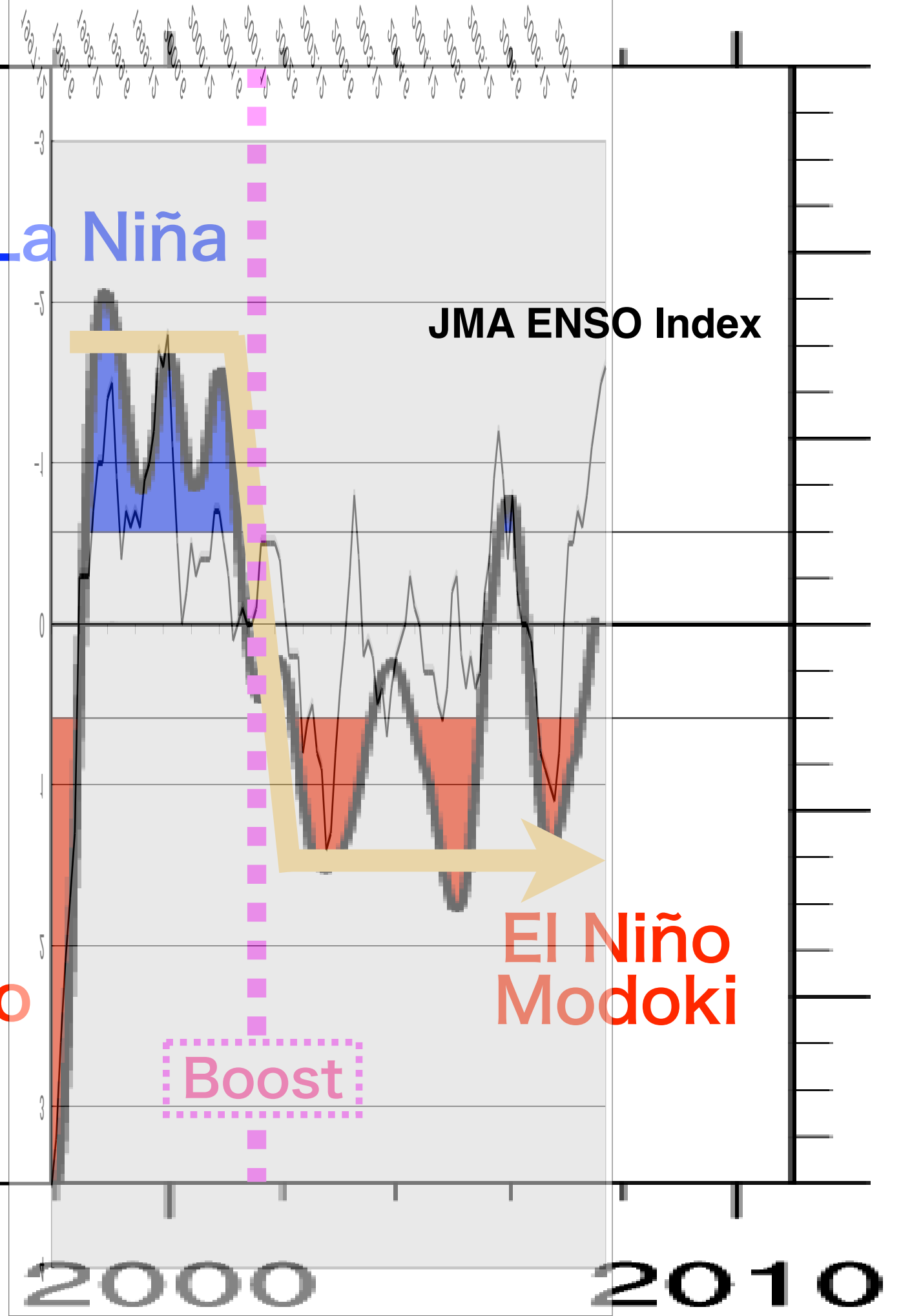
La Niña

JMA ENSO Index

El Niño

El Niño  
Modoki

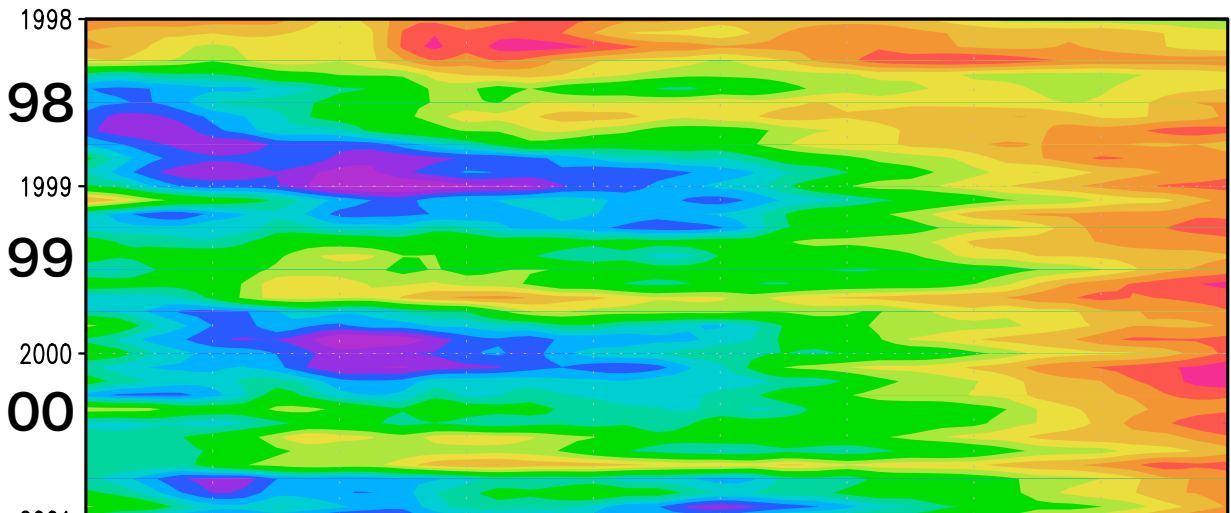
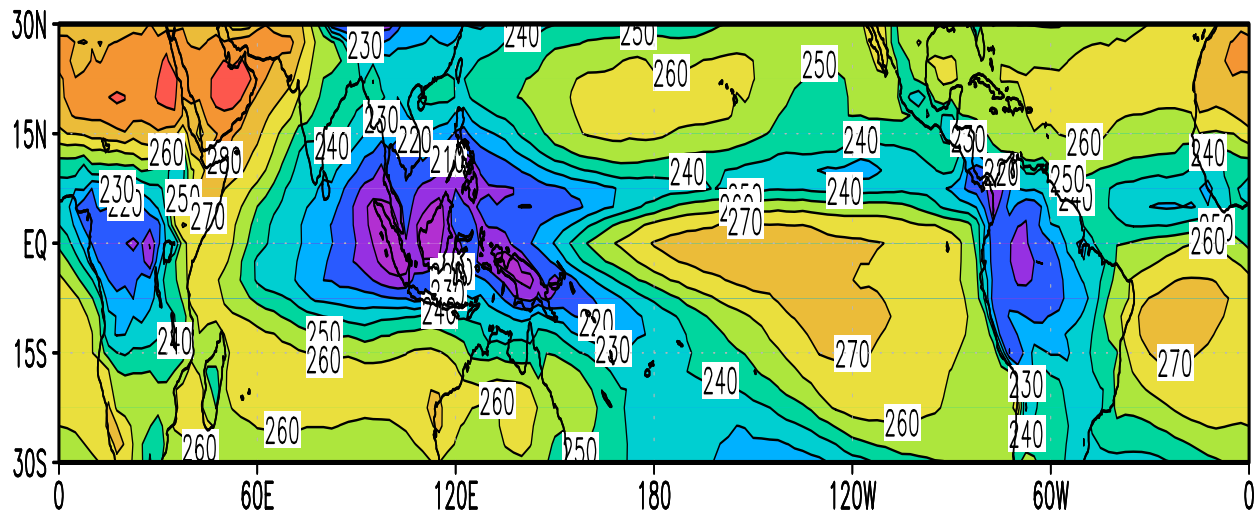
Boost



# BB

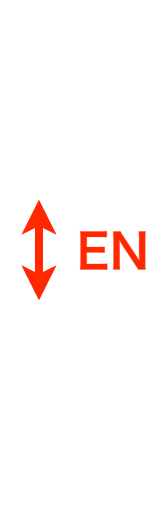
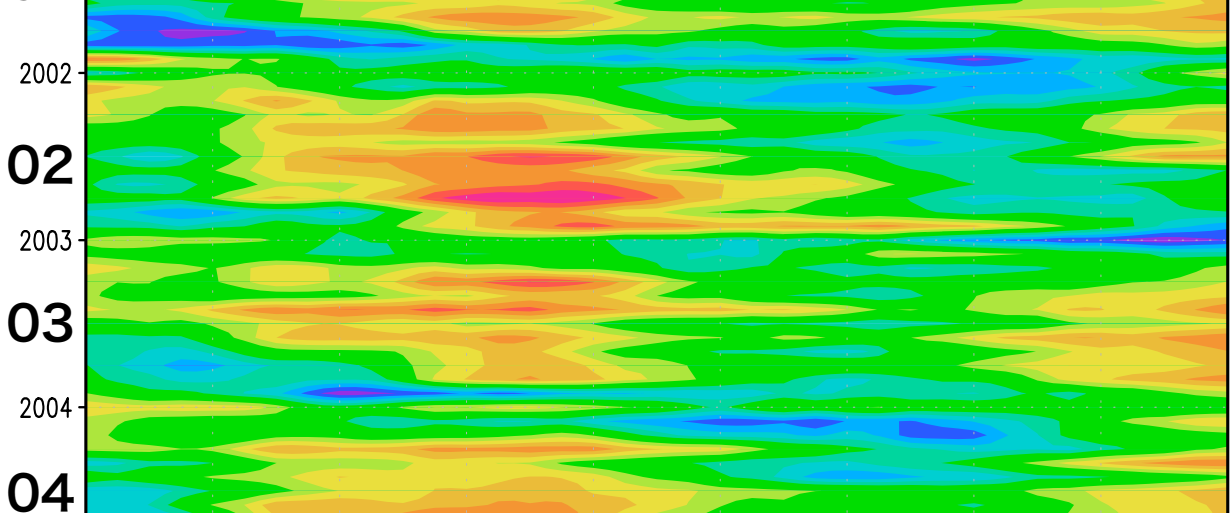
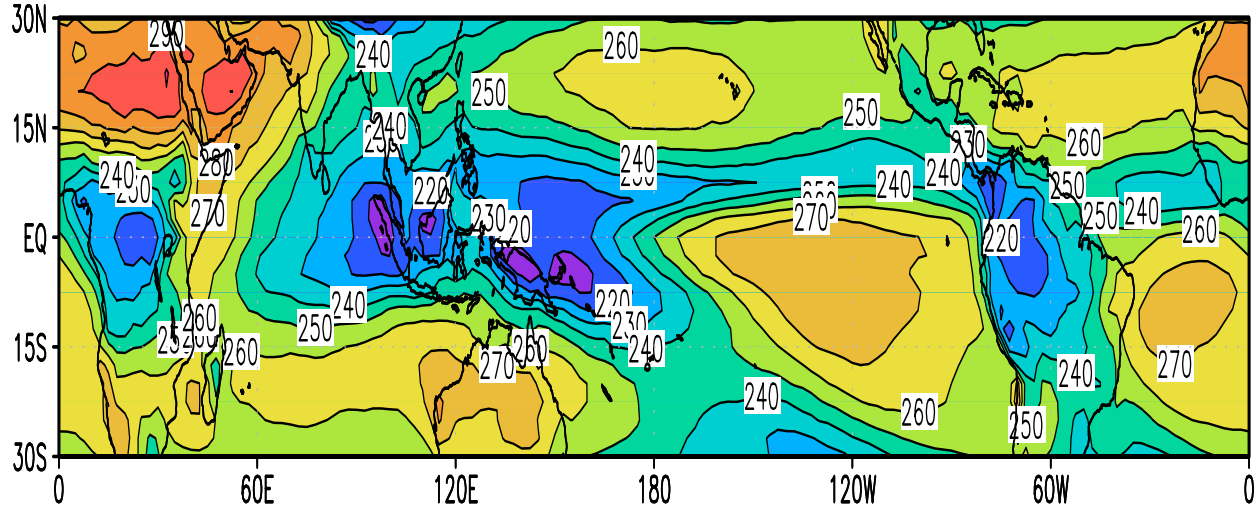
# OLR

# EQ



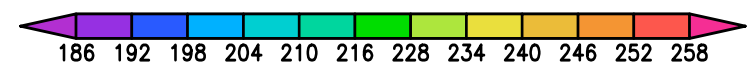
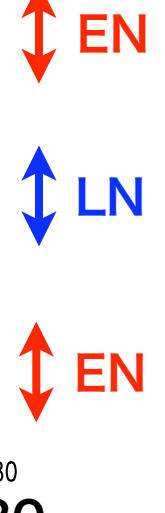
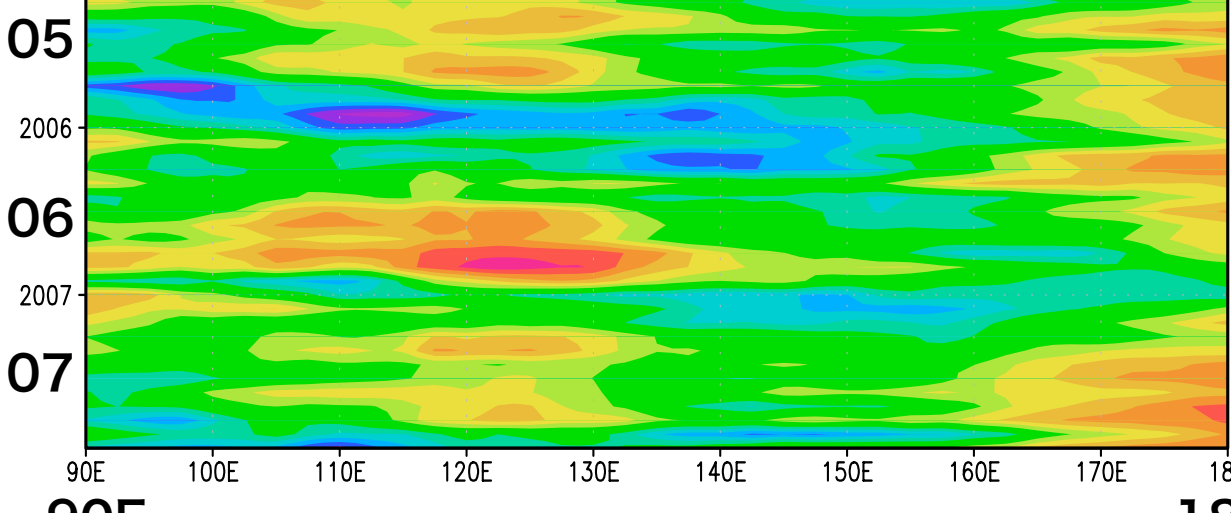
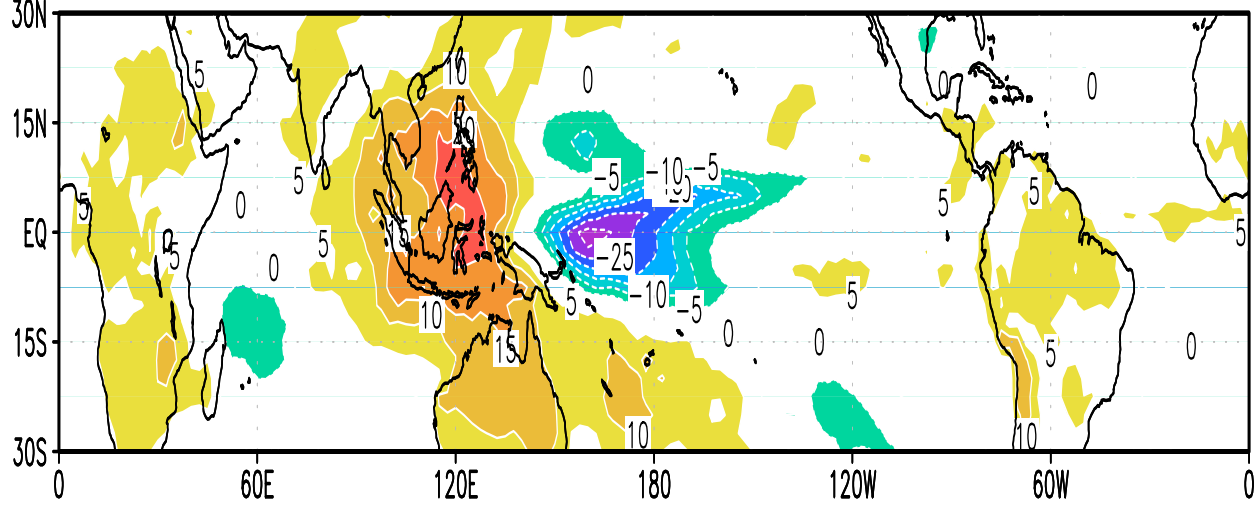
# AB

251.



# AB-BB

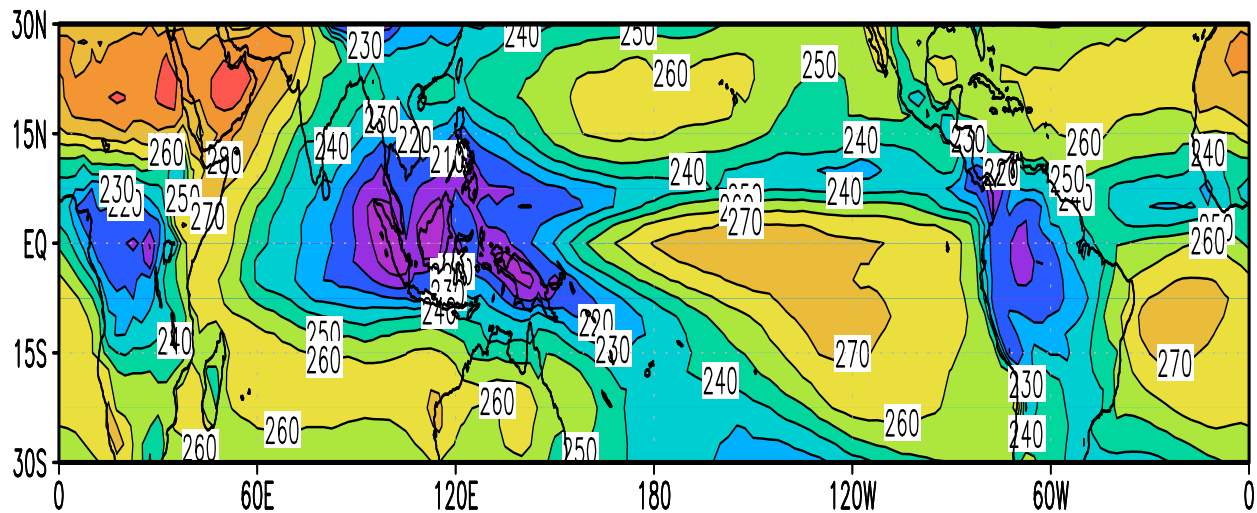
3



# BB

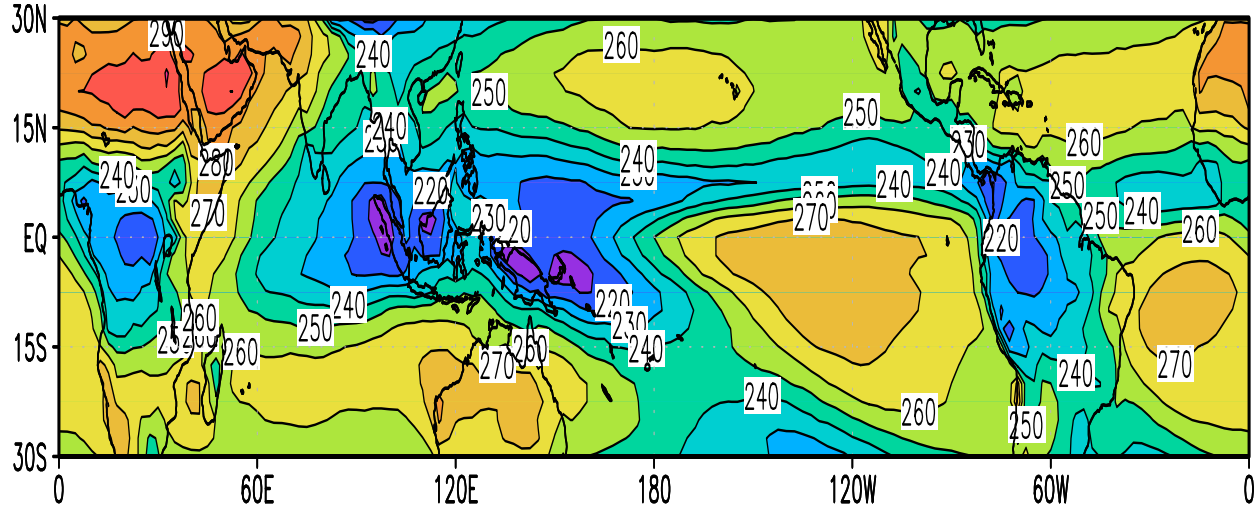
# OLR

# EQ



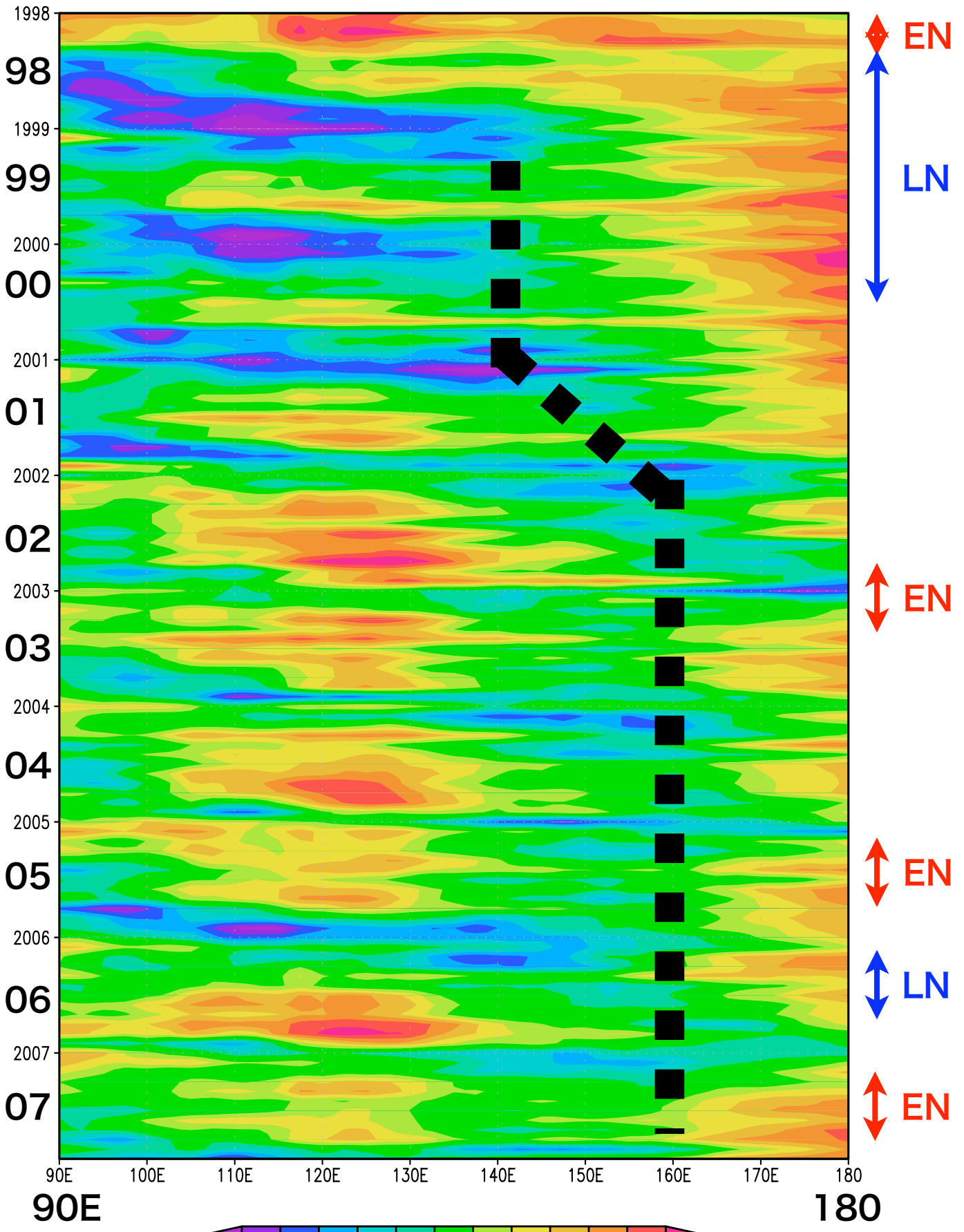
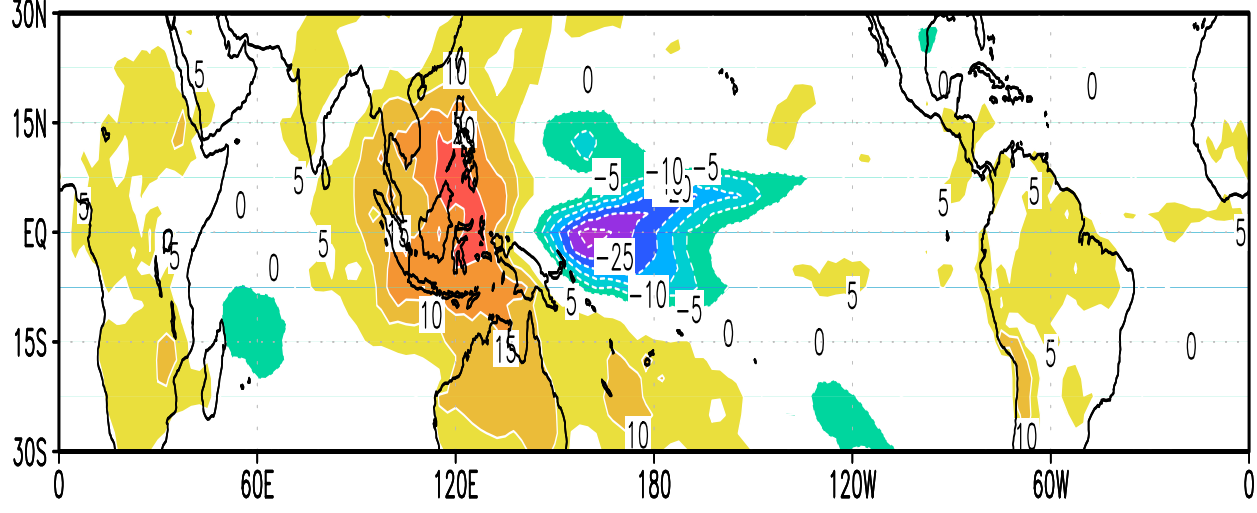
# AB

251.



# AB-BB

3

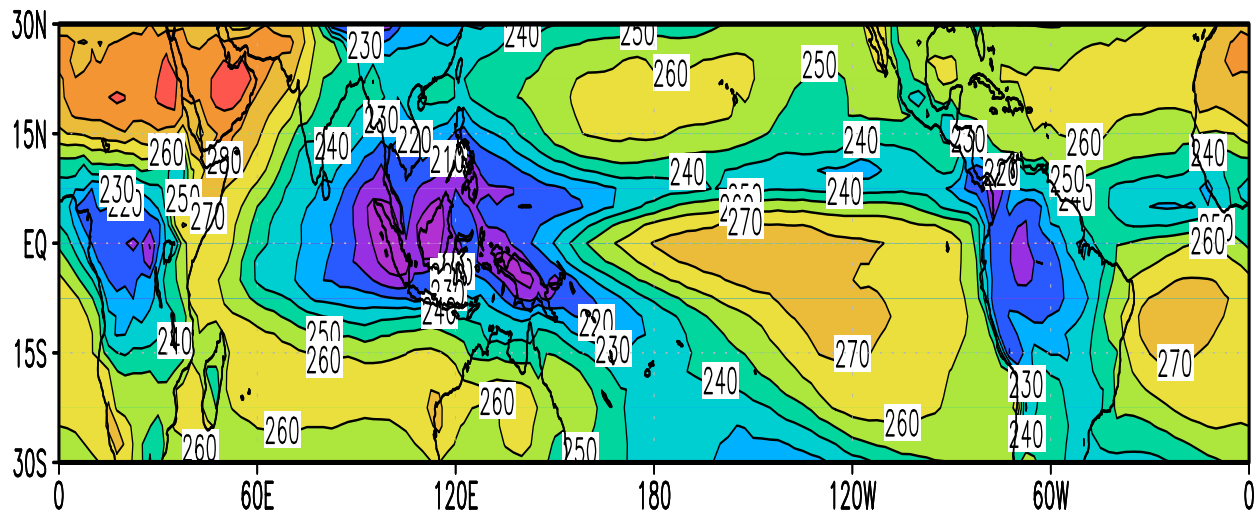




# BB

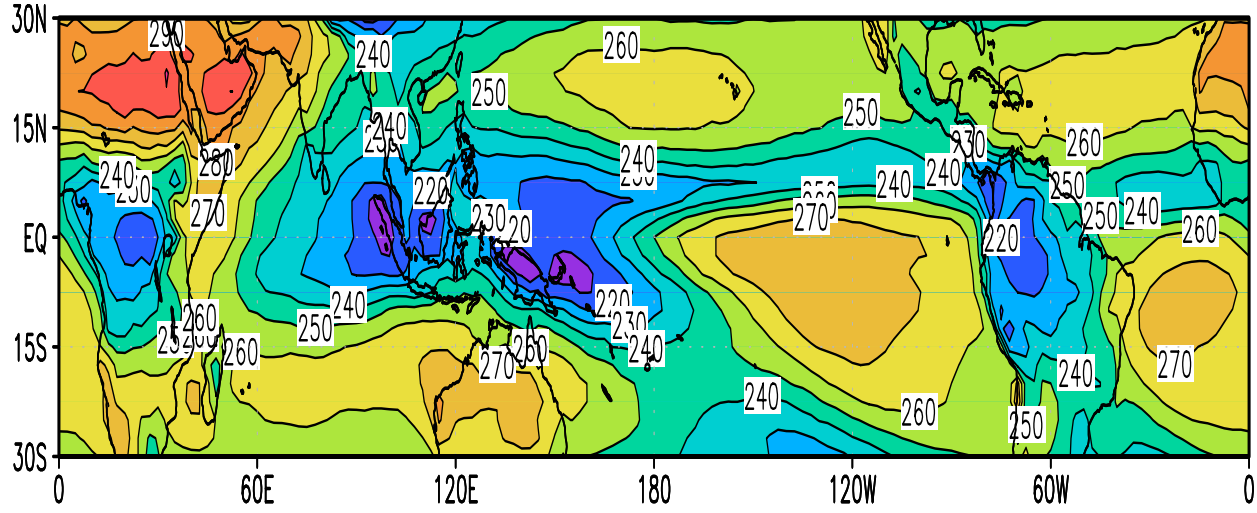
# OLR

# EQ



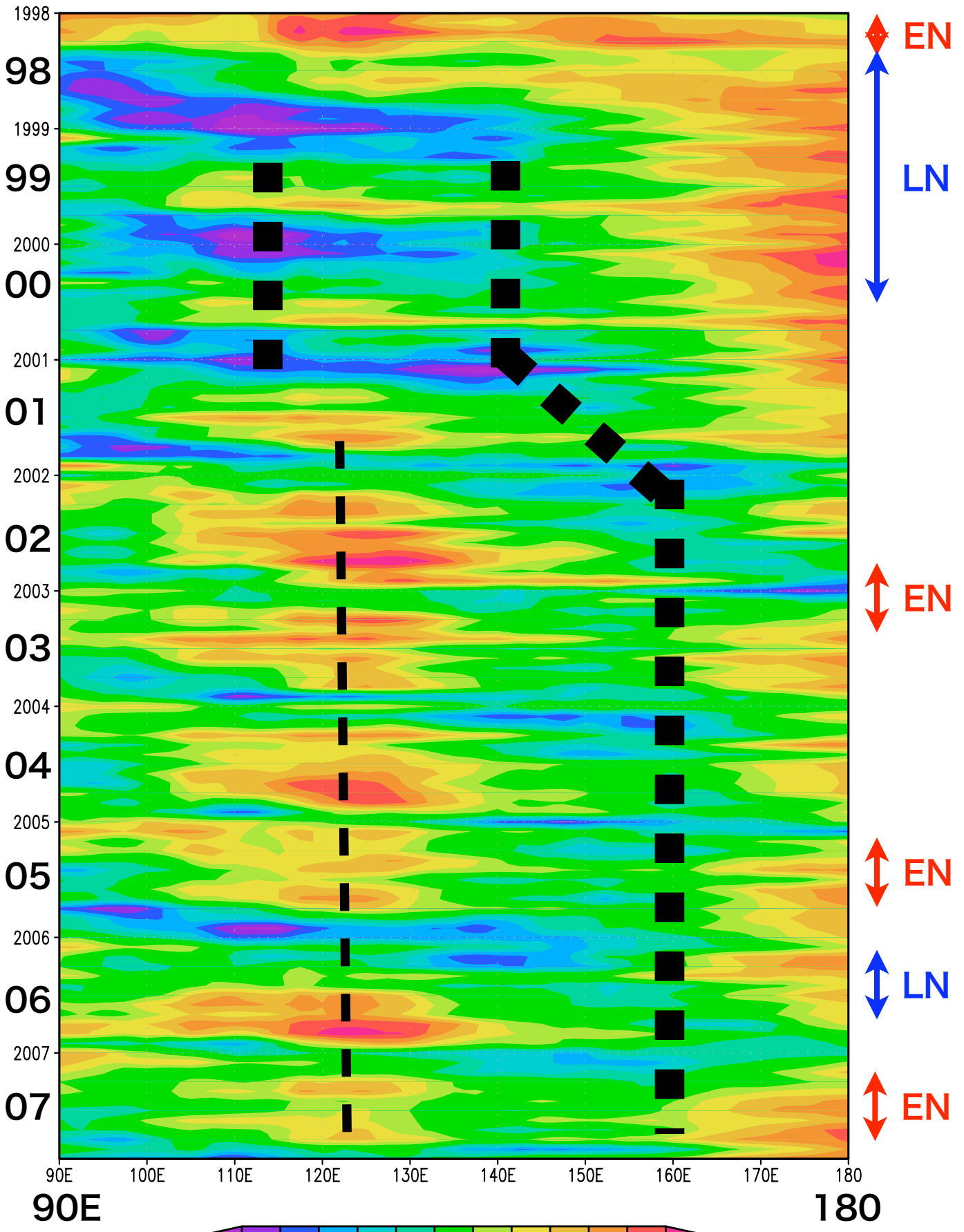
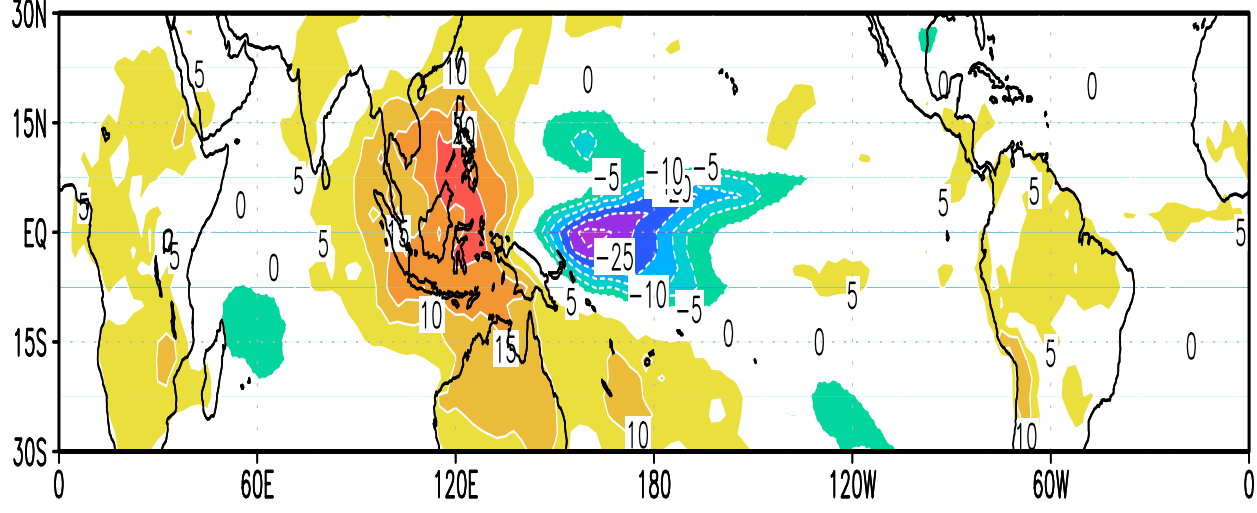
# AB

251.

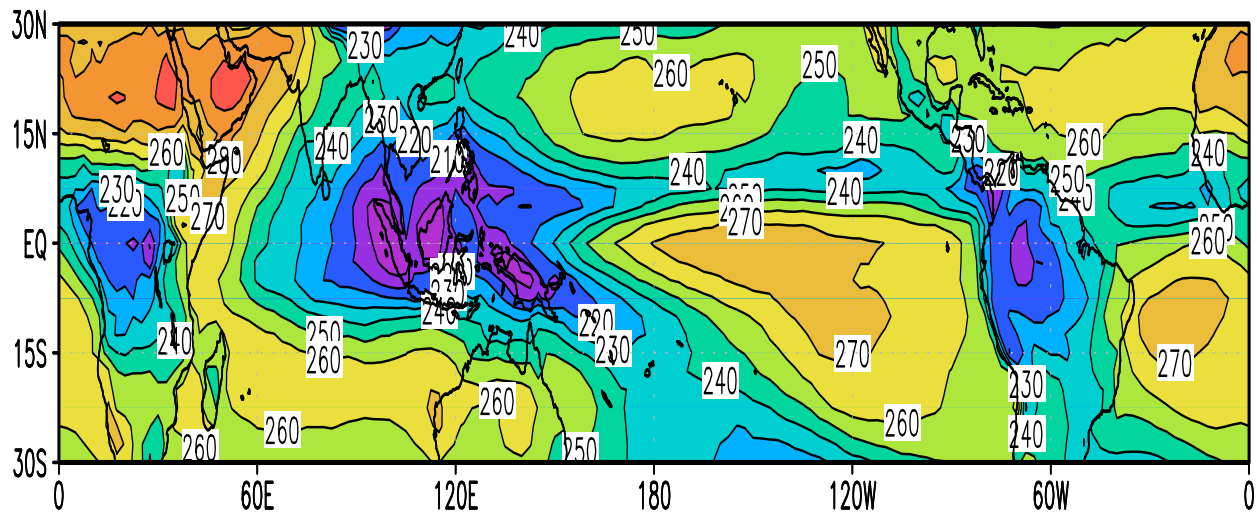


# AB-BB

3

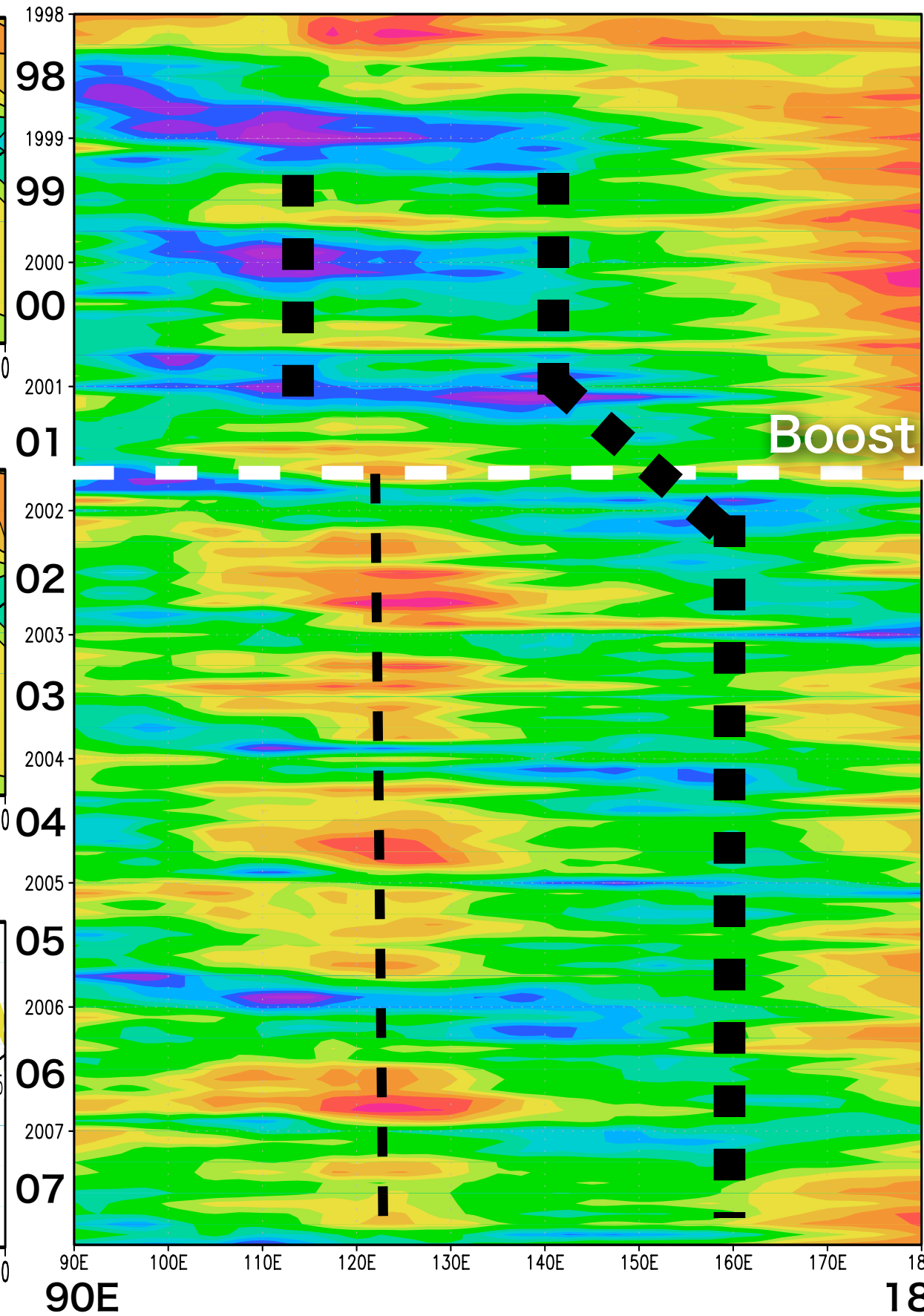


# BB



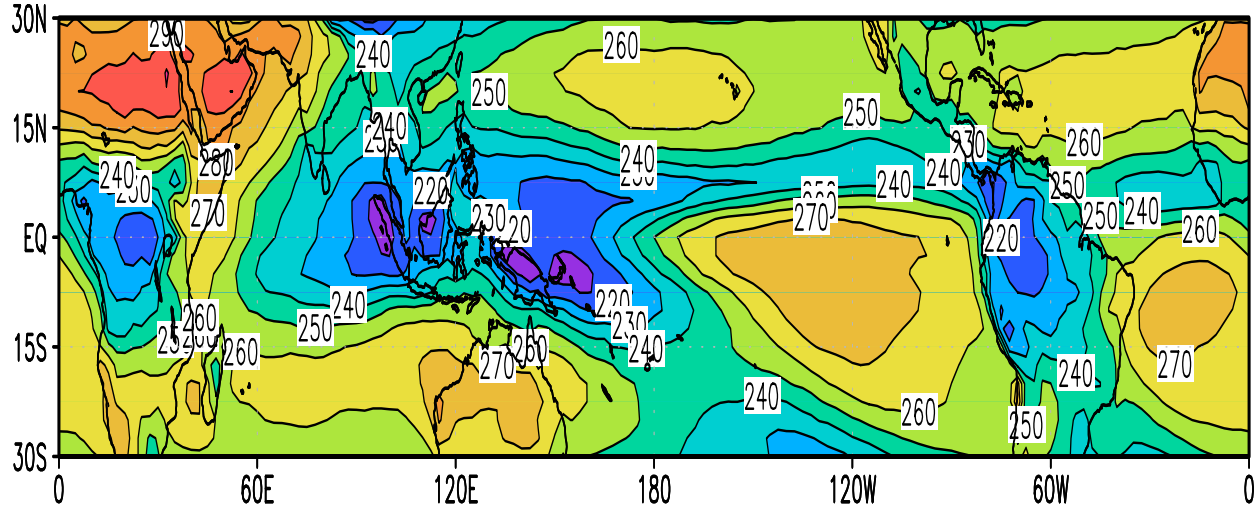
# OLR

# EQ



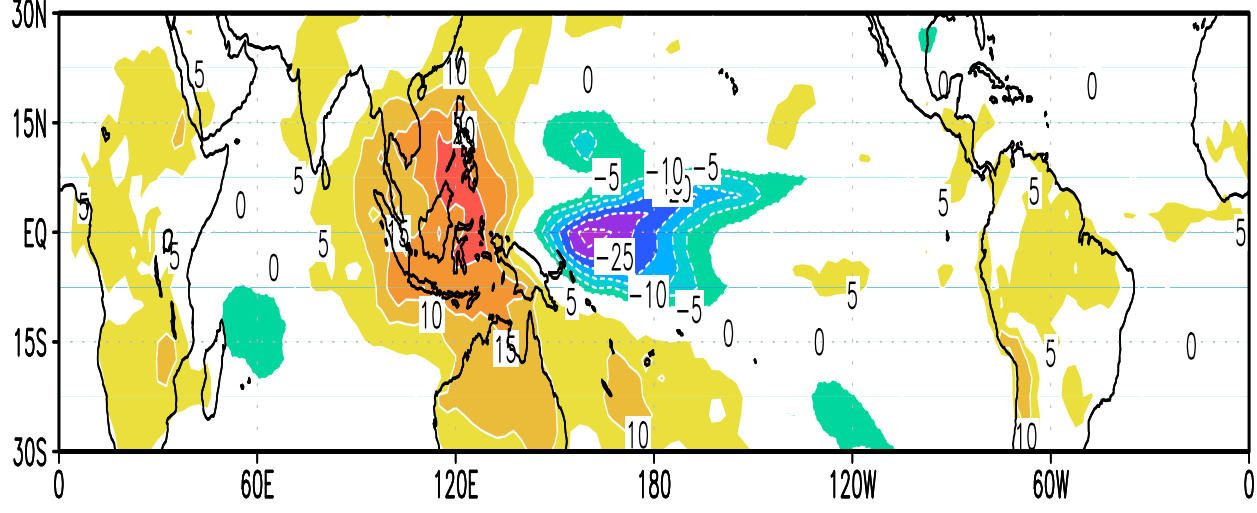
EN  
LN

# AB



251.

# AB-BB



3

EN  
LN

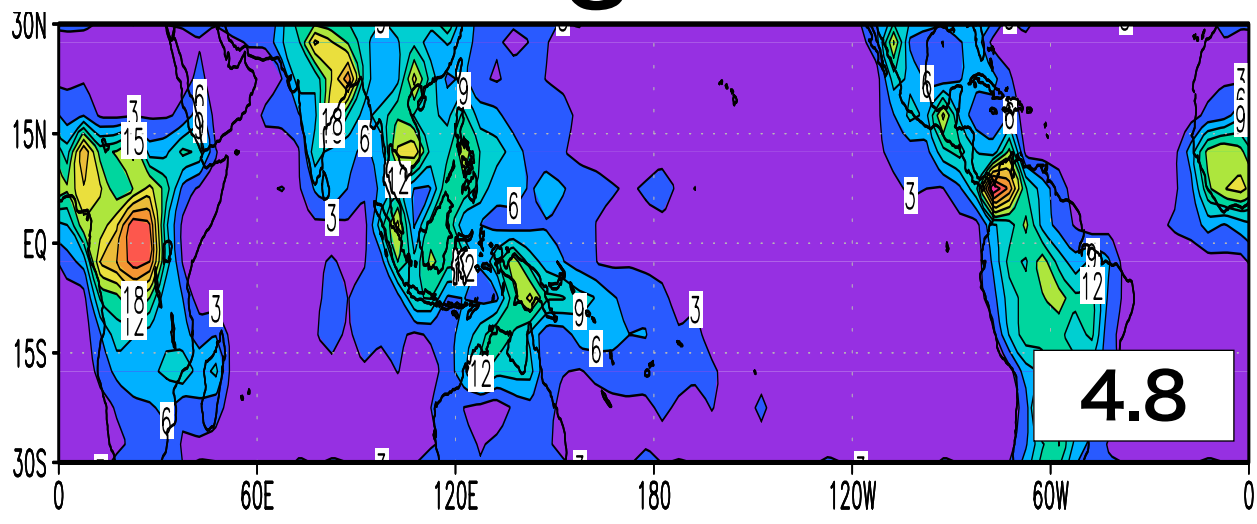
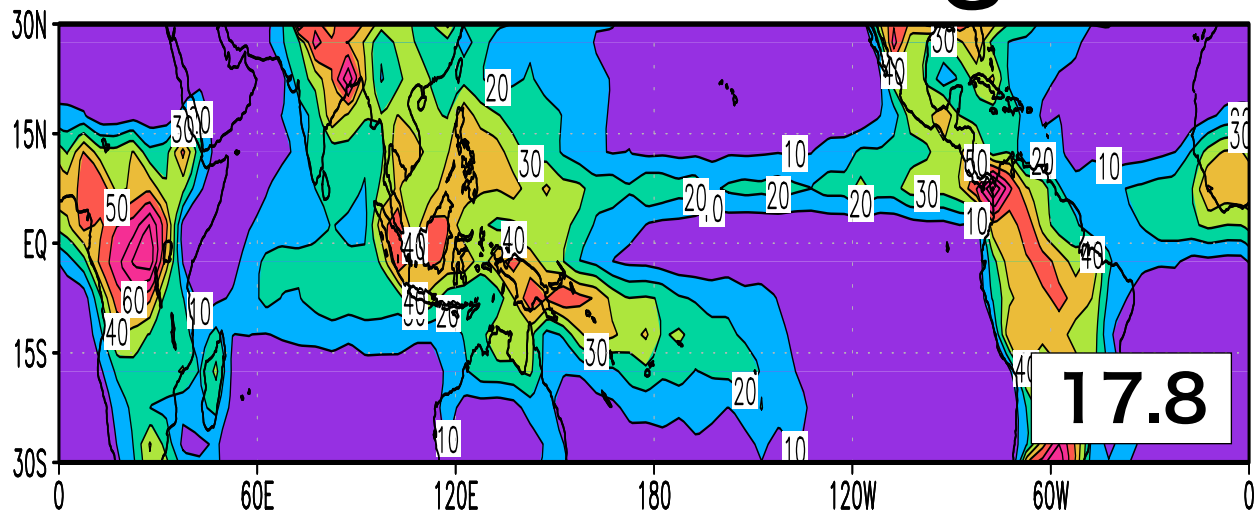
EN



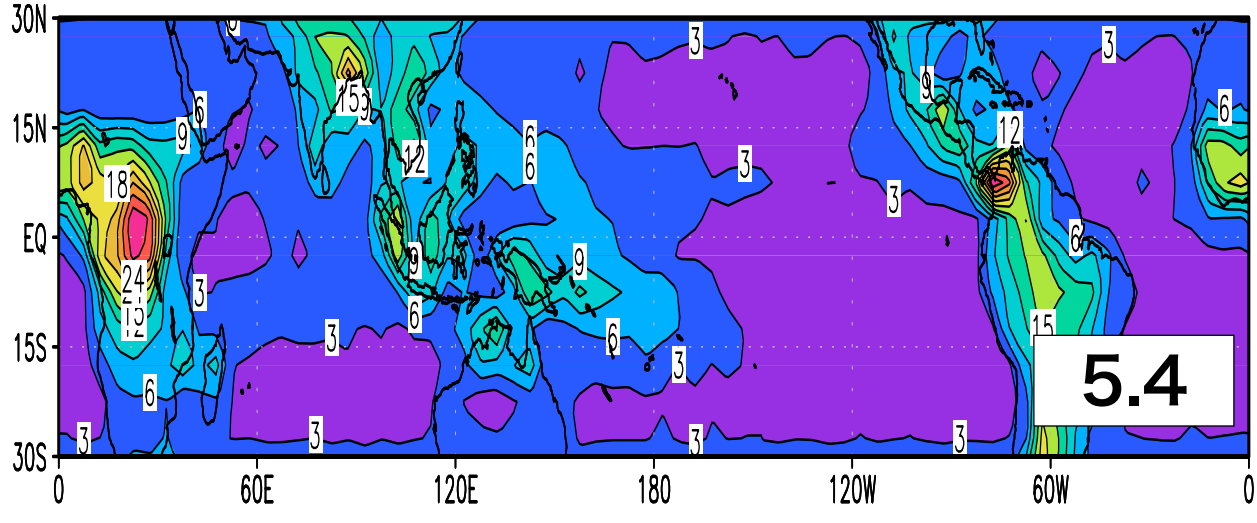
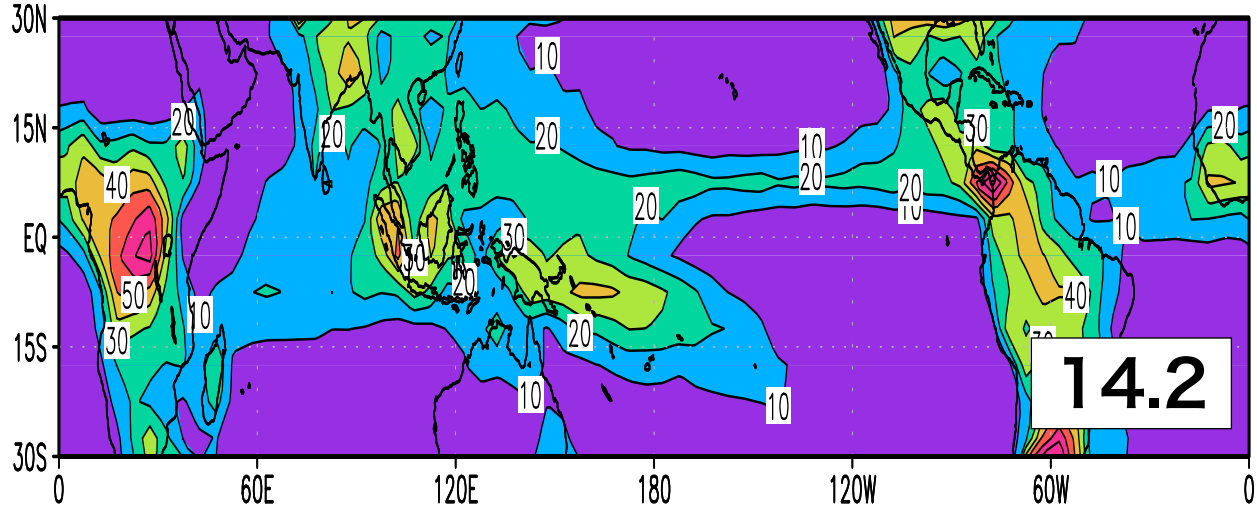
# BB Histogram of Storm Height

9-10 km

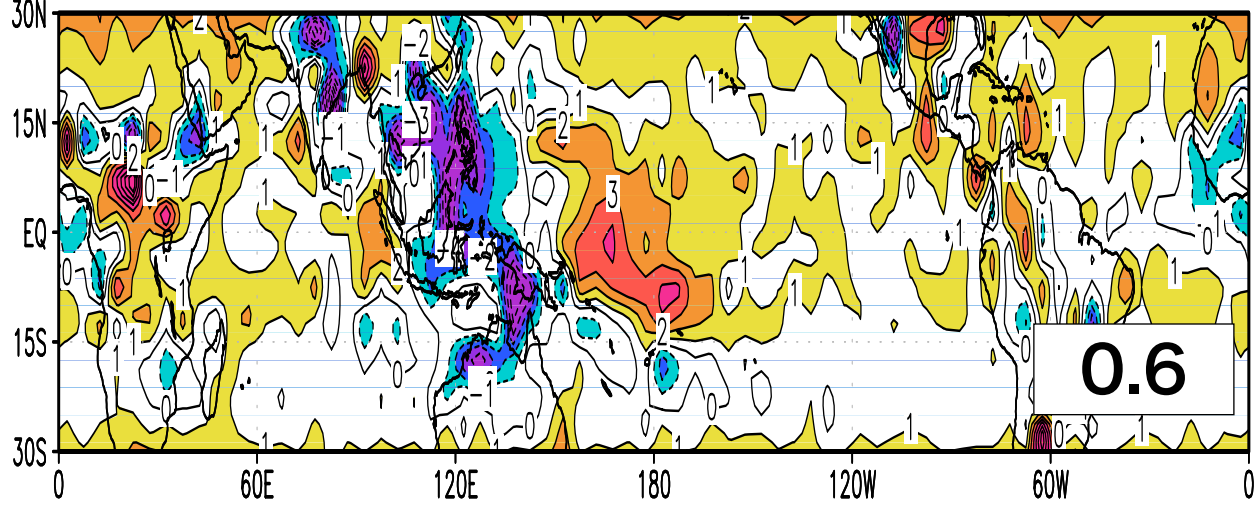
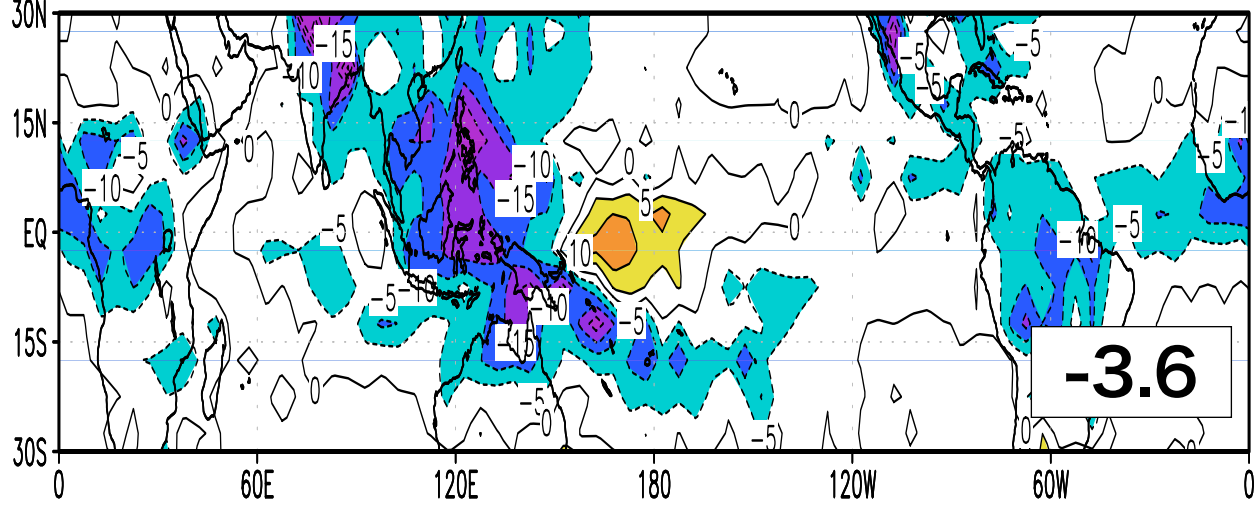
15-16 km



## AB

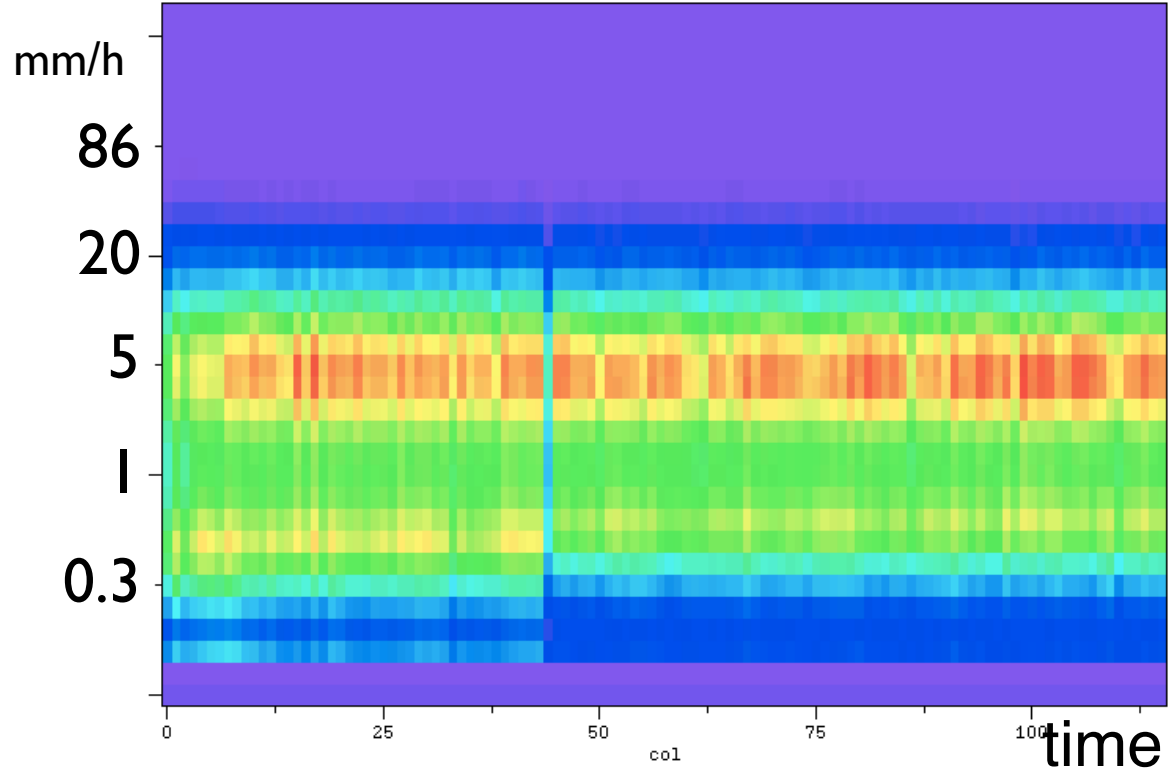


## AB-BB

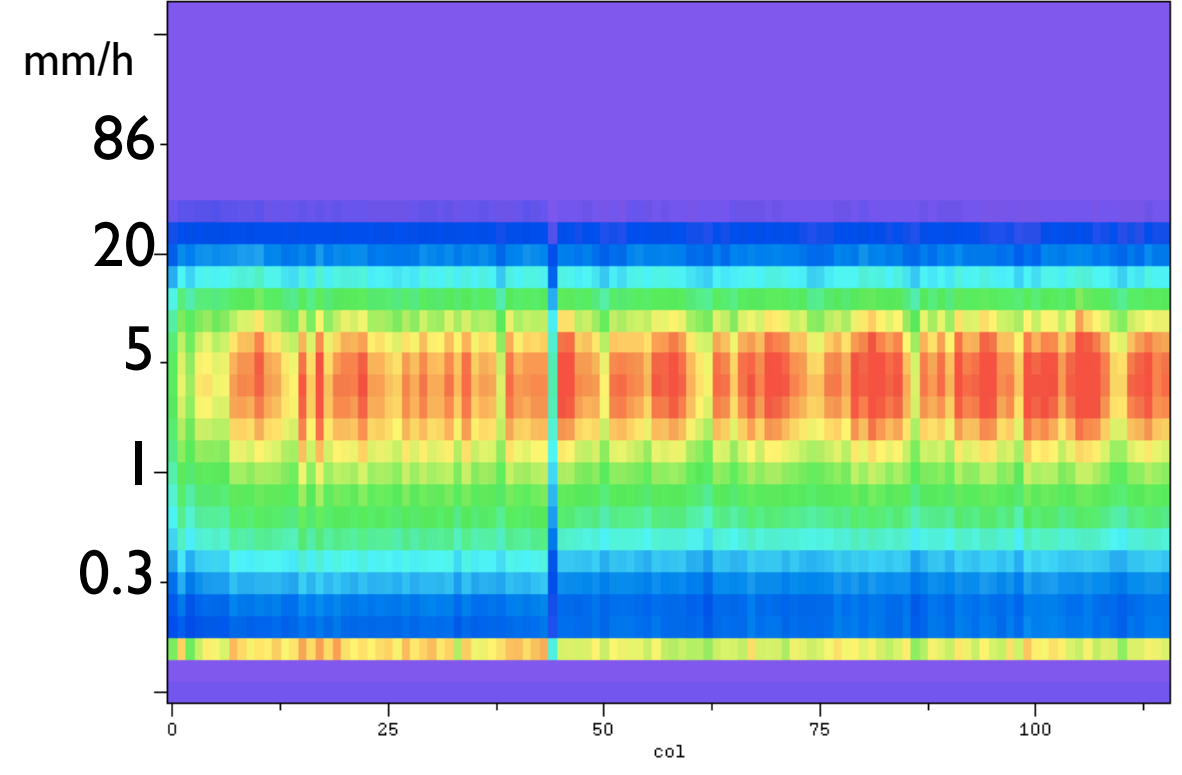


# ConvRainH (Histogram of ConvR)

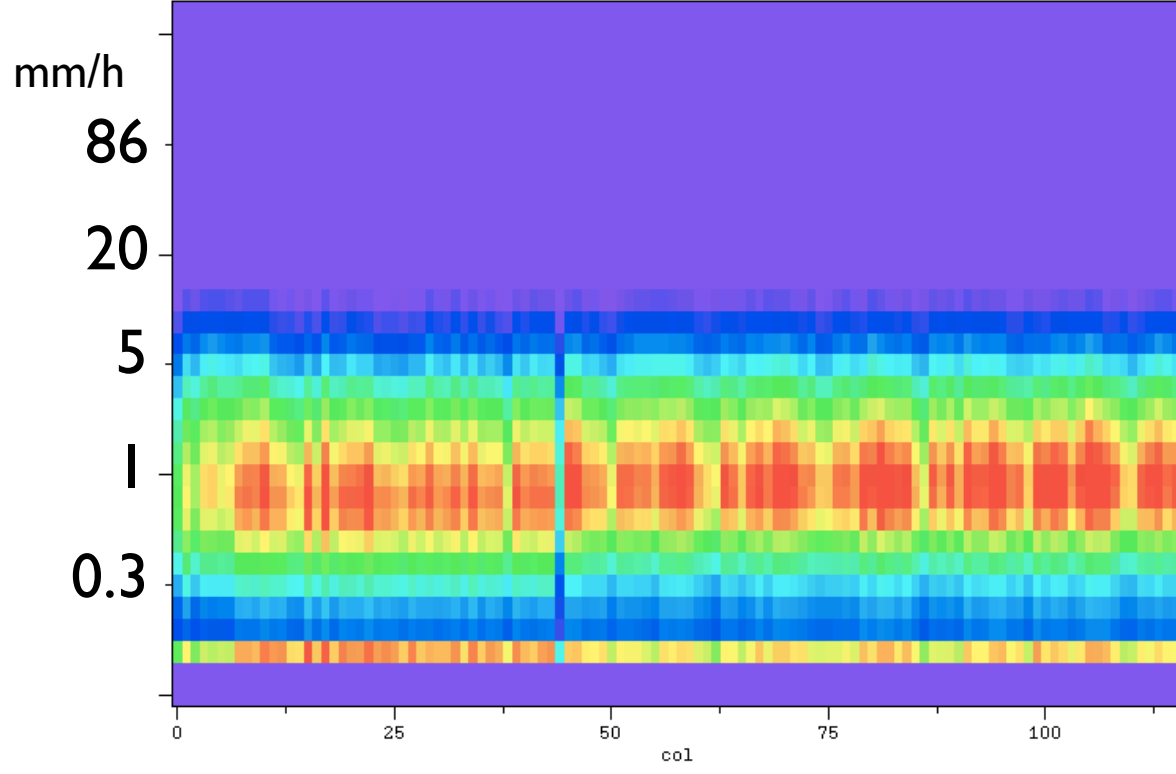
2 km



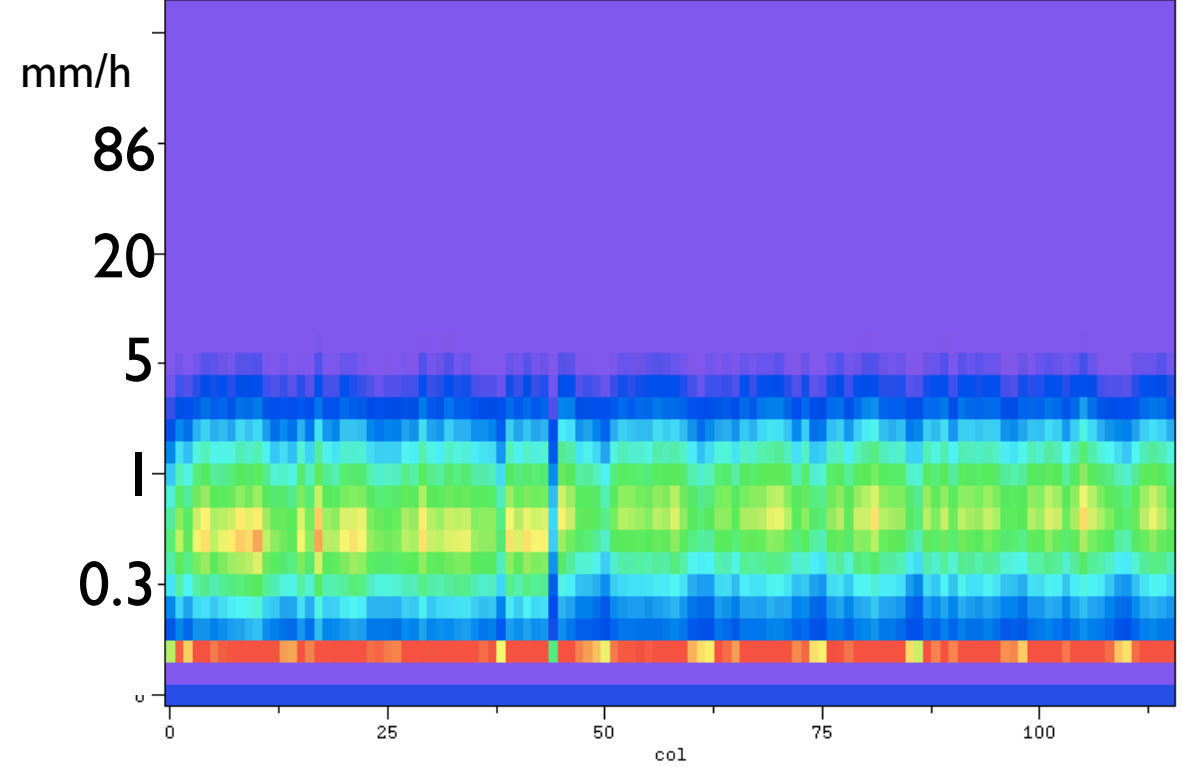
4 km



6 km

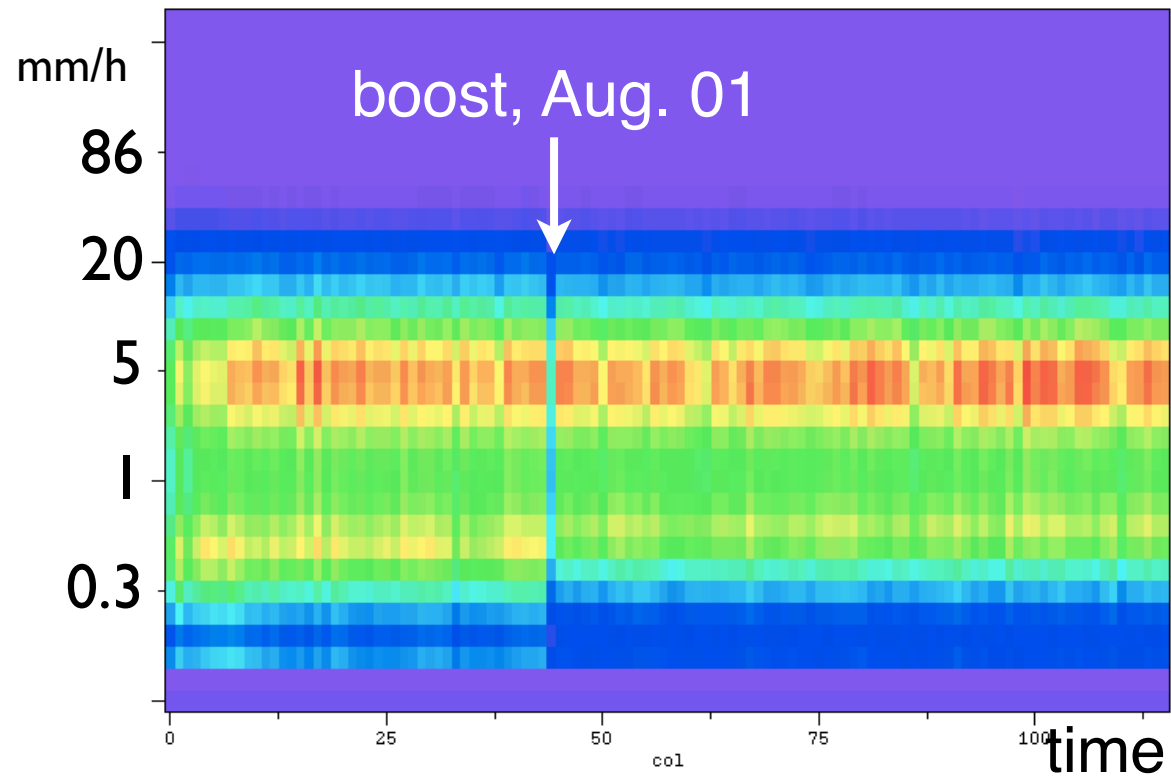


10 km

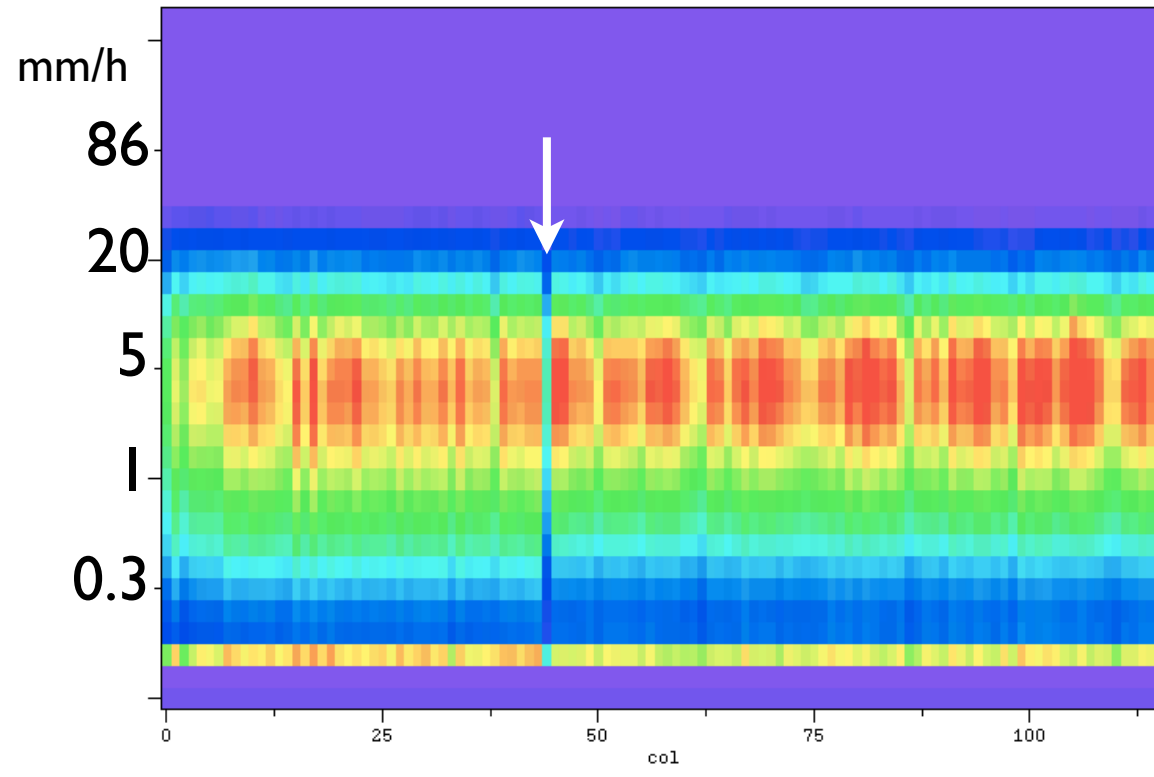


# ConvRainH (Histogram of ConvR)

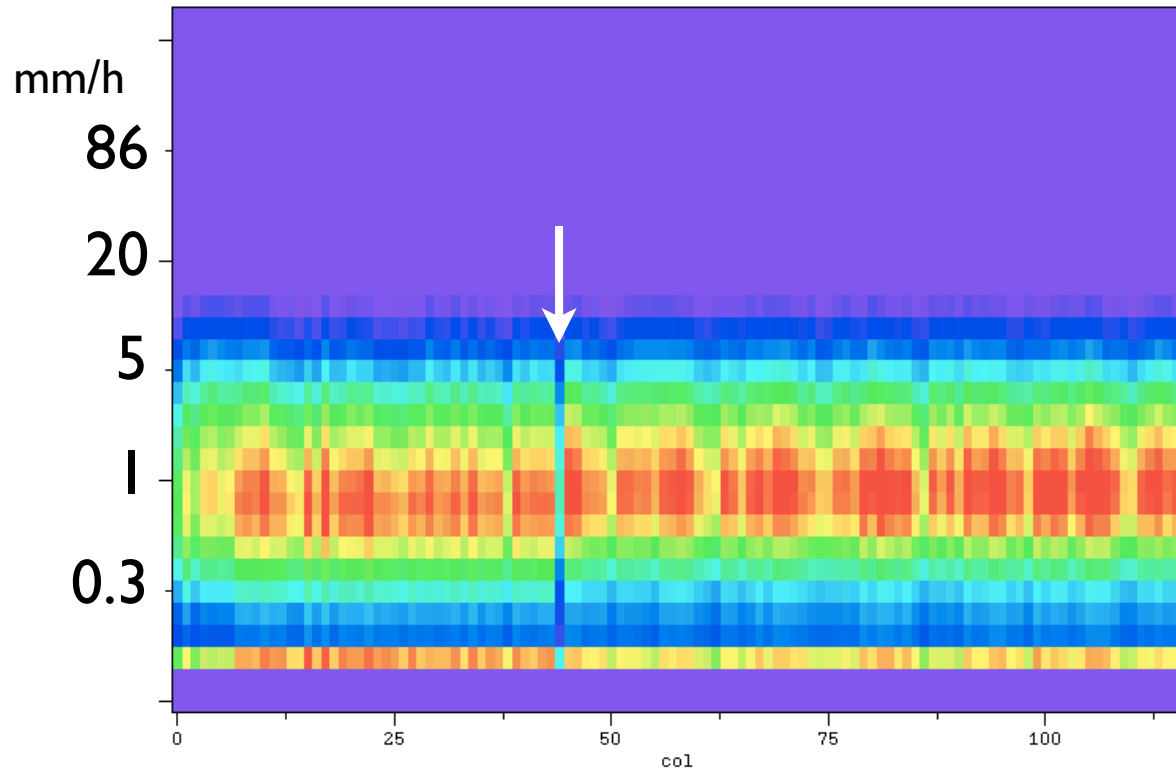
2 km



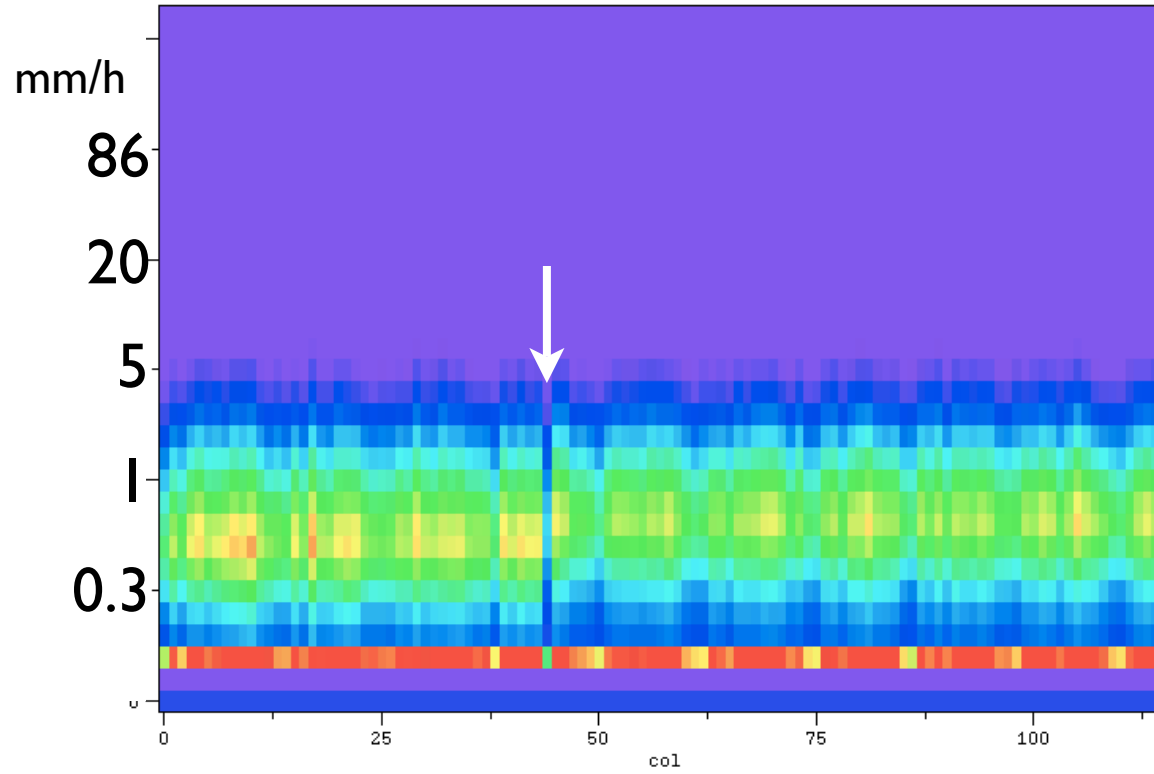
4 km



6 km

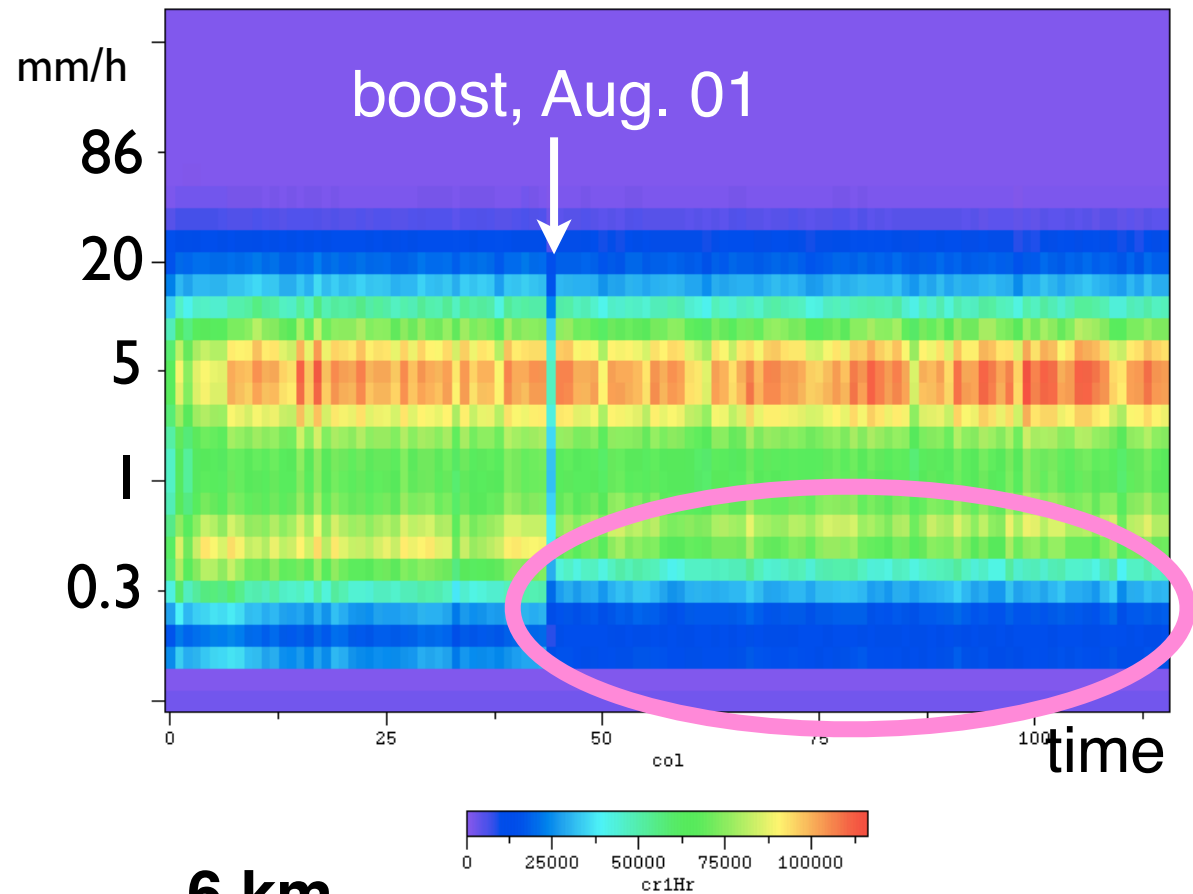


10 km

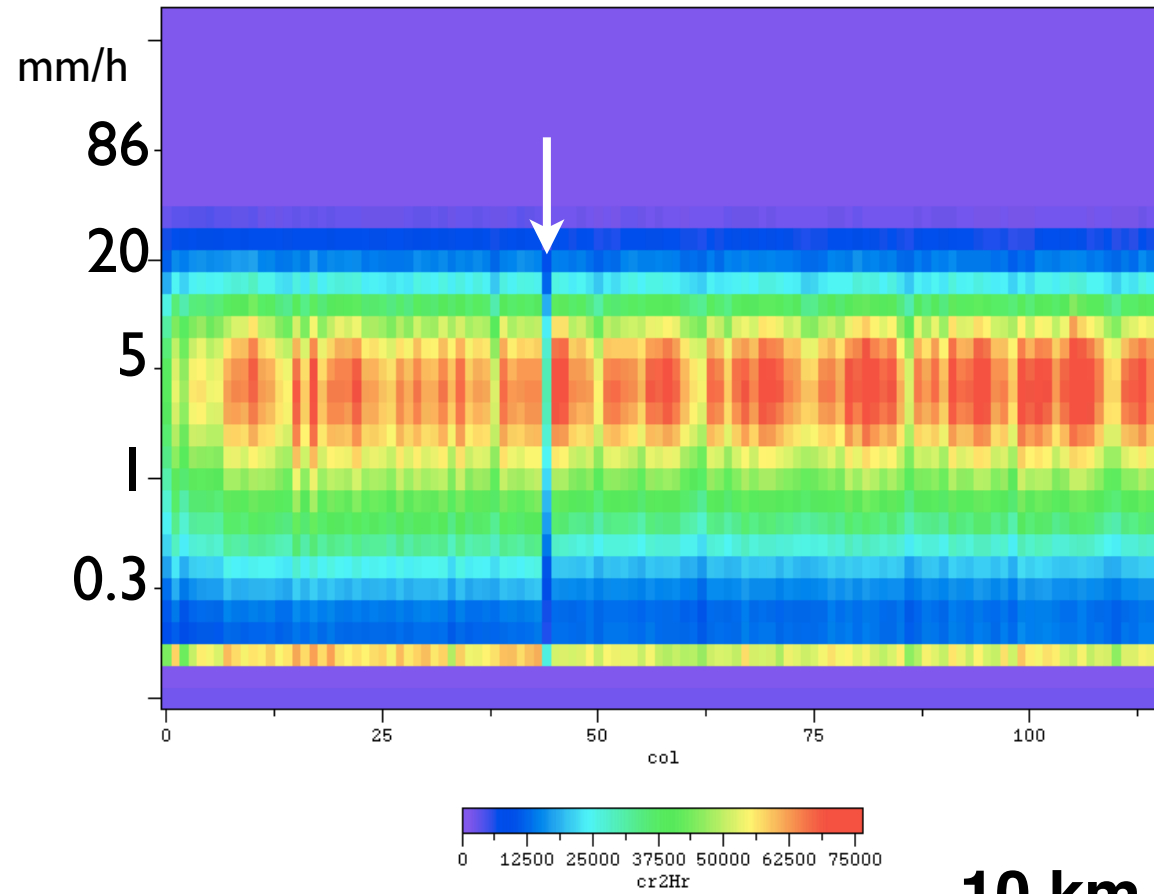


# ConvRainH (Histogram of ConvR)

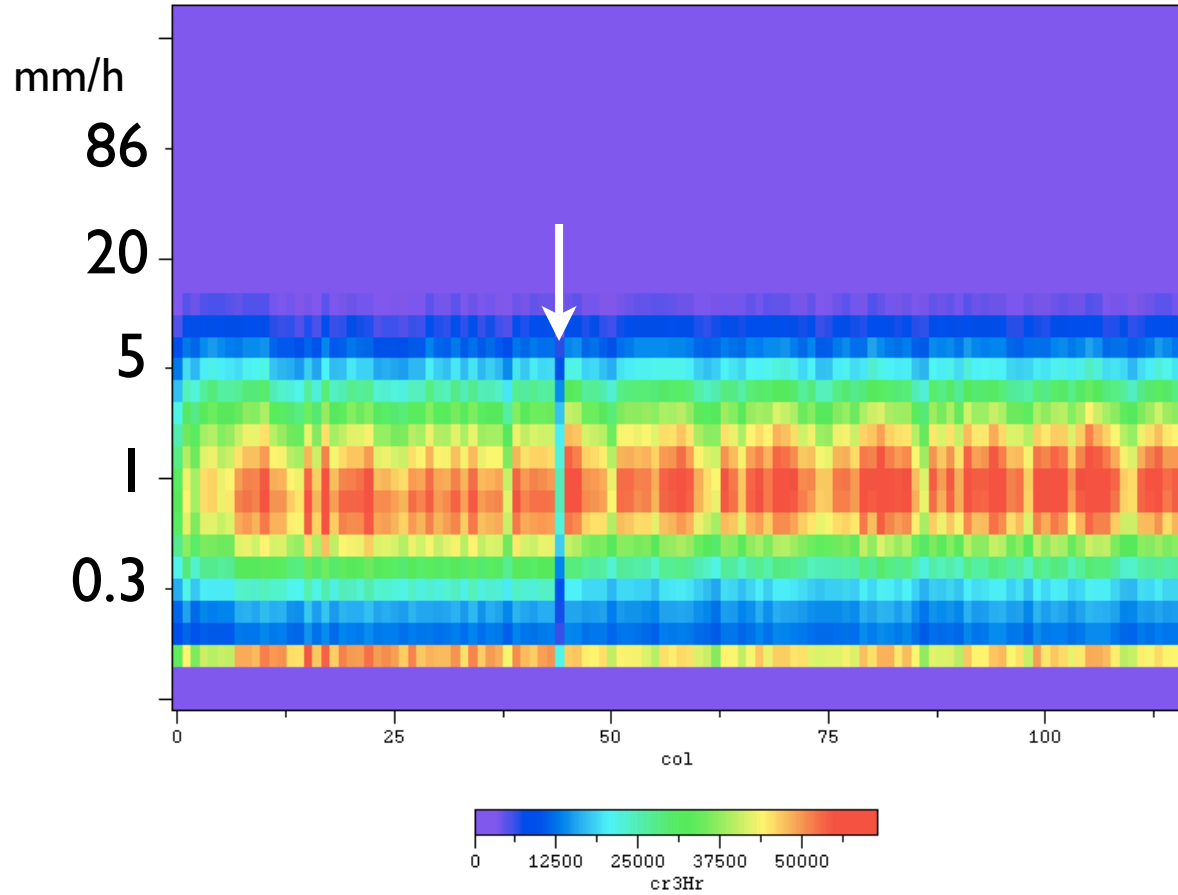
2 km



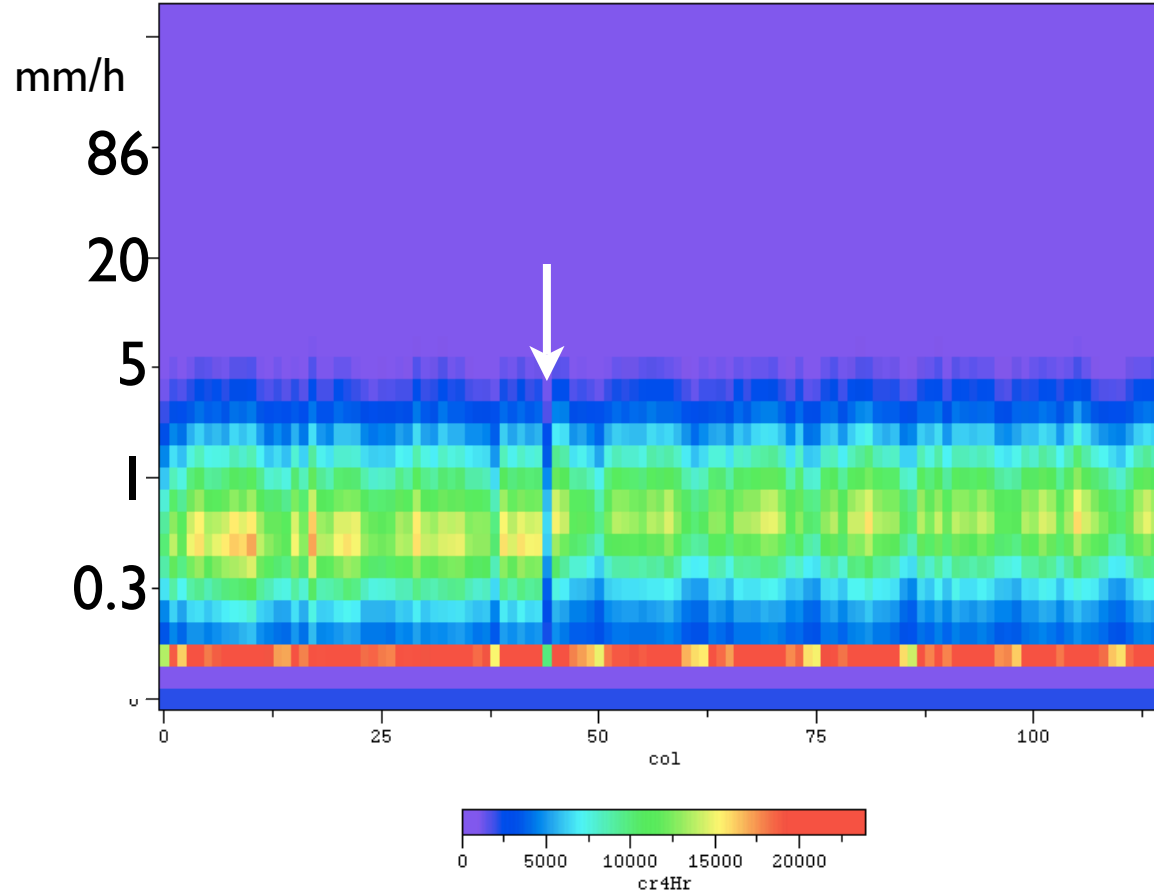
4 km



6 km

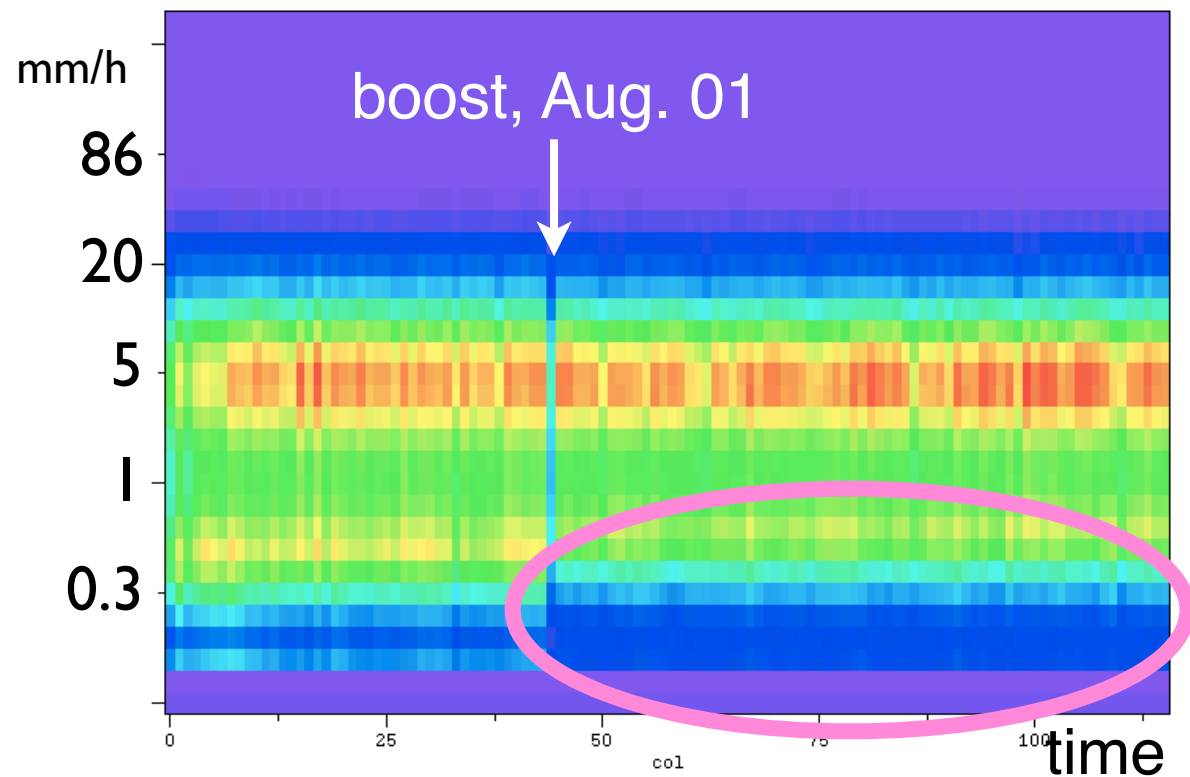


10 km

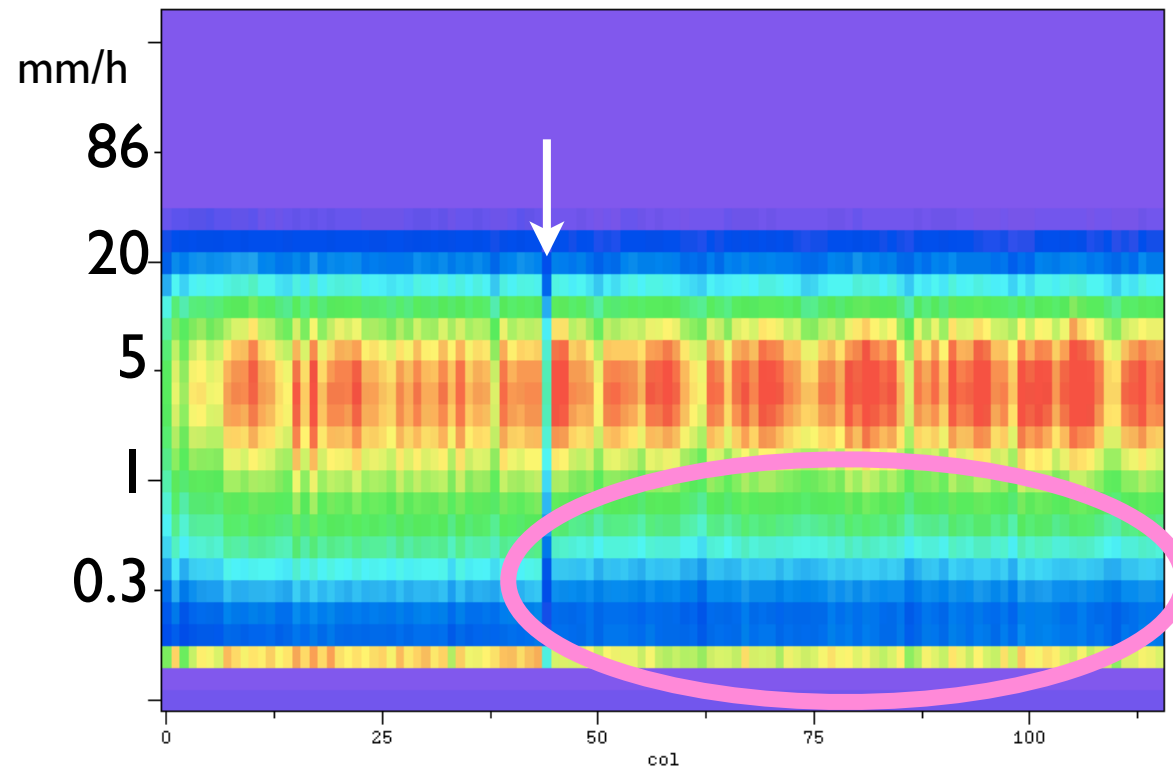


# ConvRainH (Histogram of ConvR)

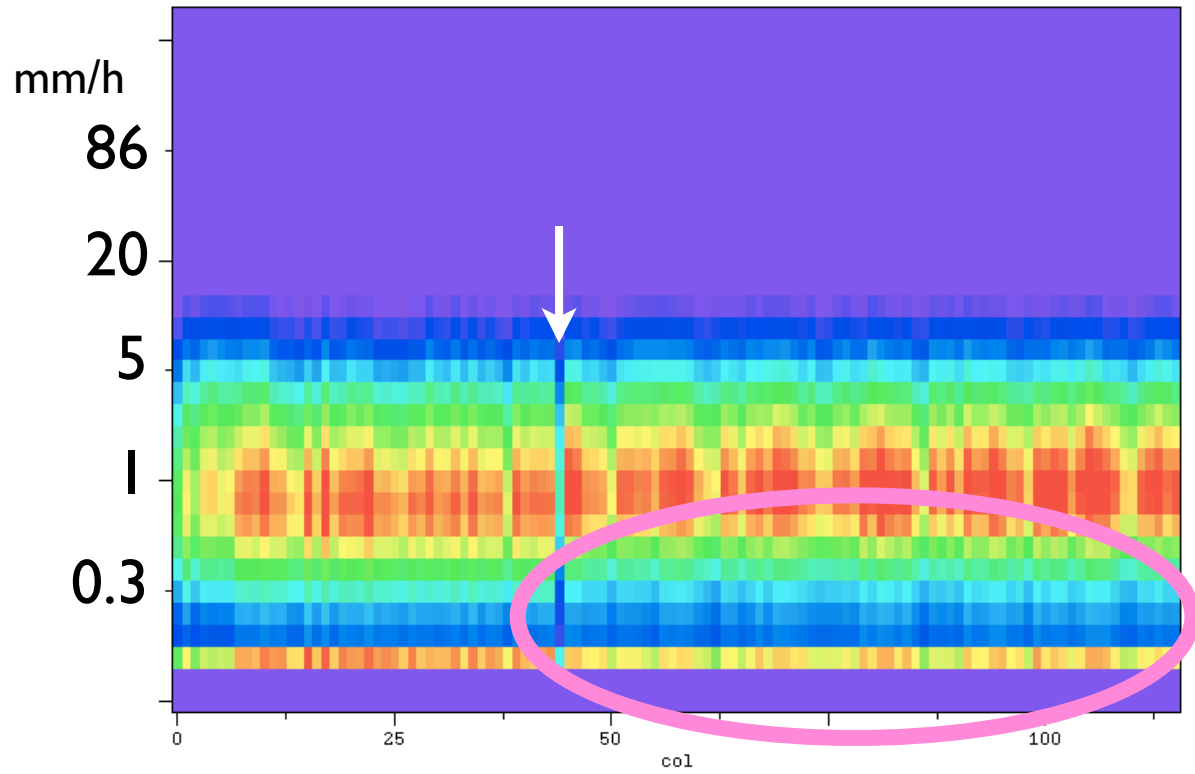
2 km



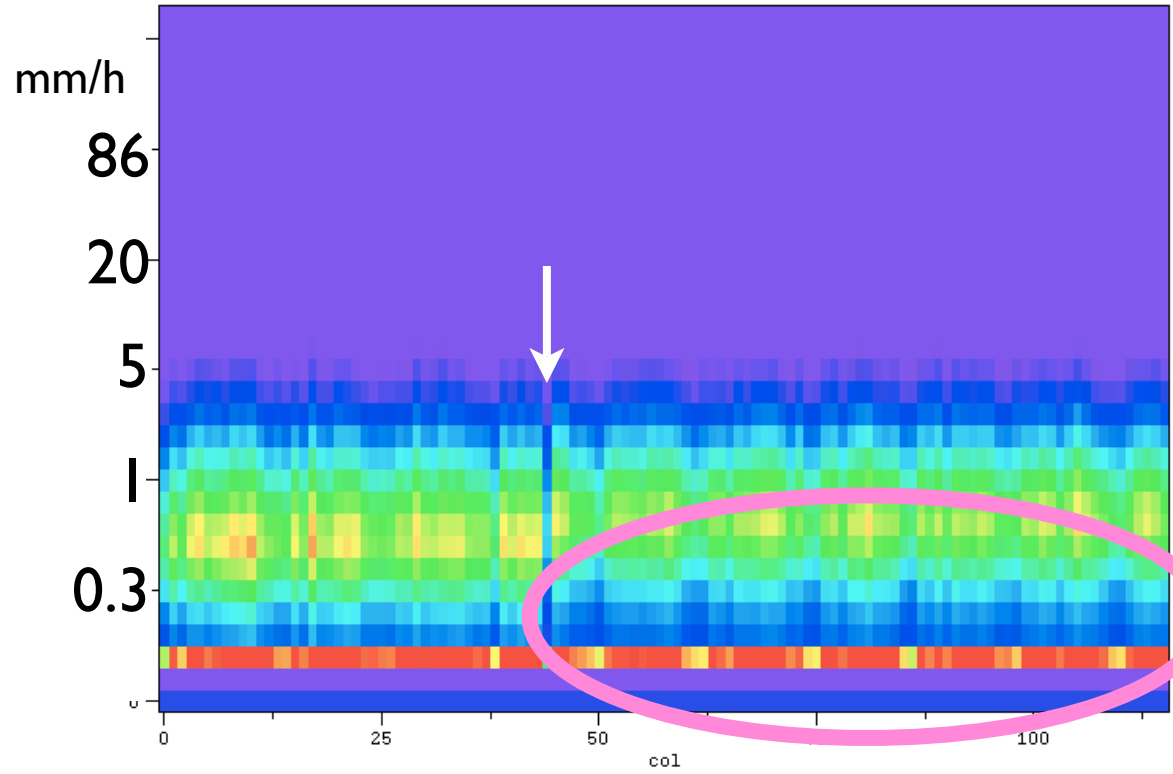
4 km



6 km

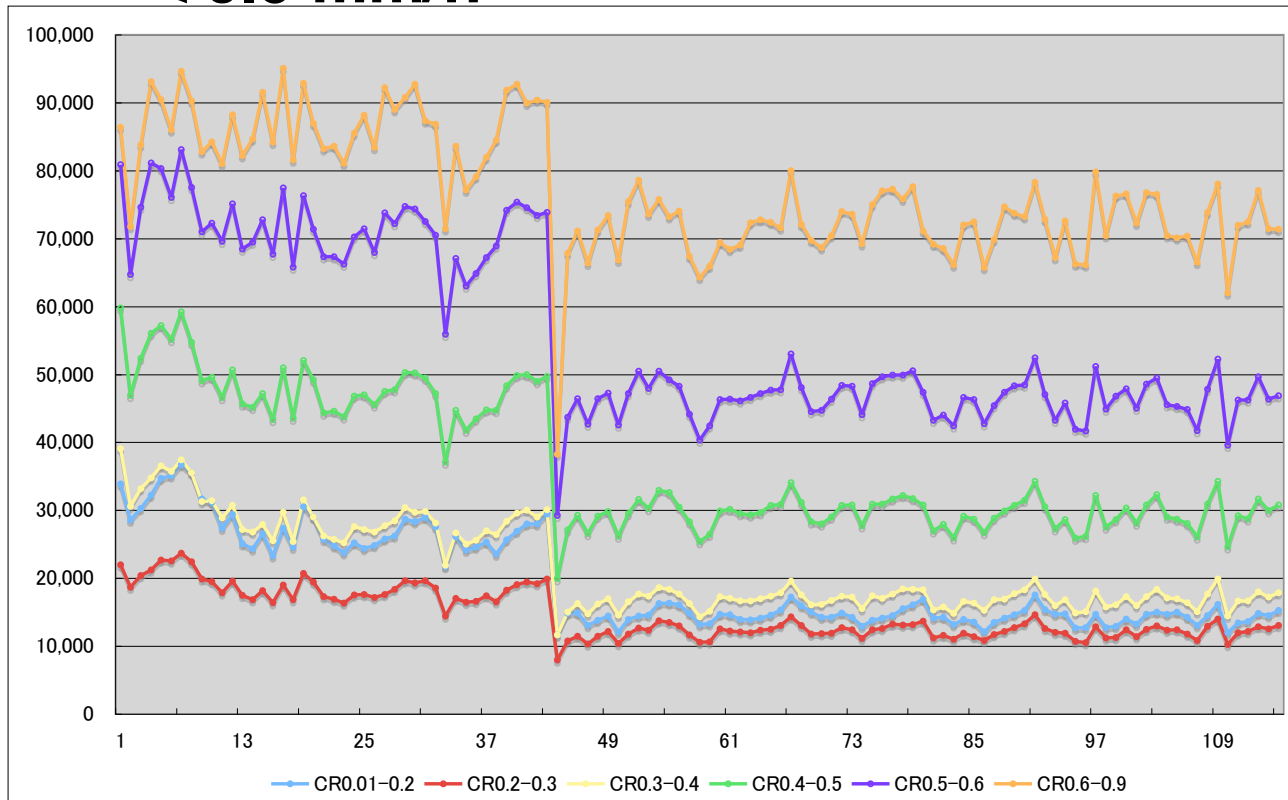


10 km

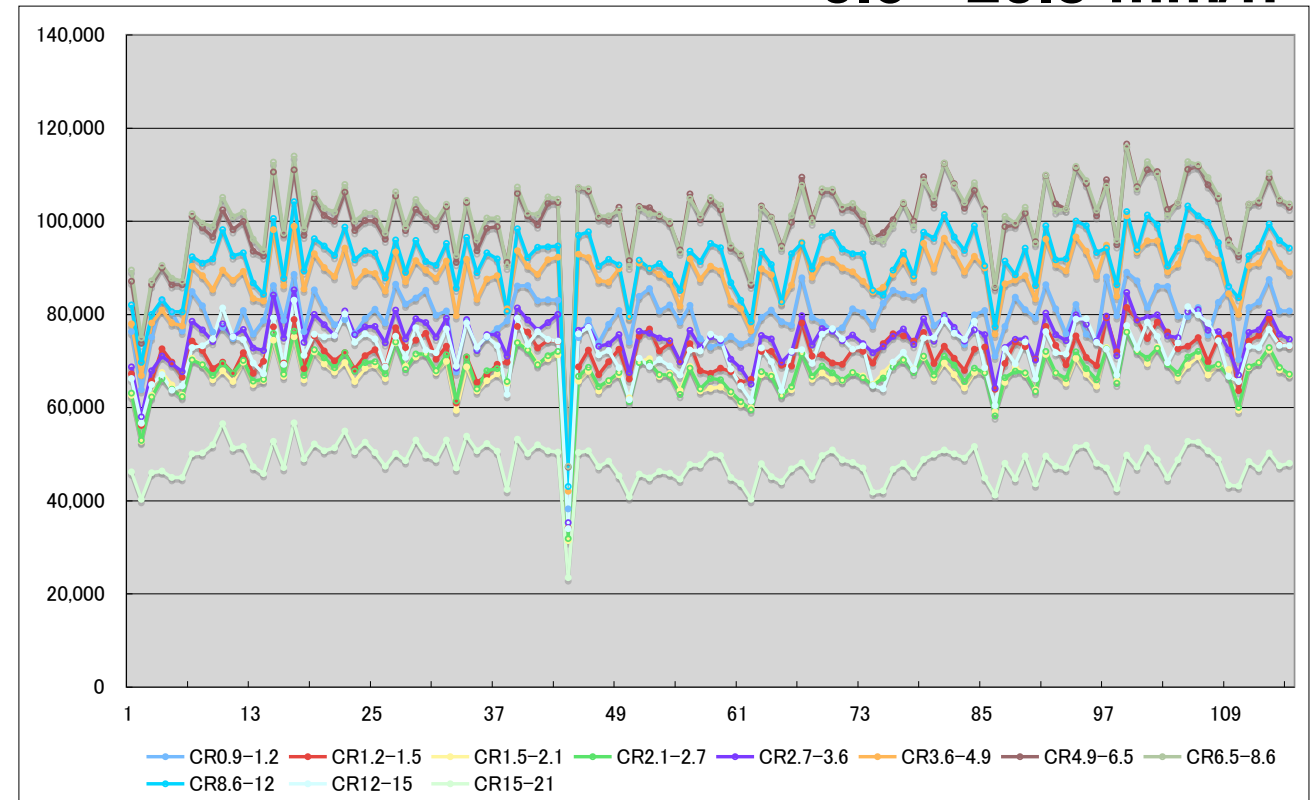


# Histogram of Cond. ConvRainrate at 2 km

< 0.9 mm/h



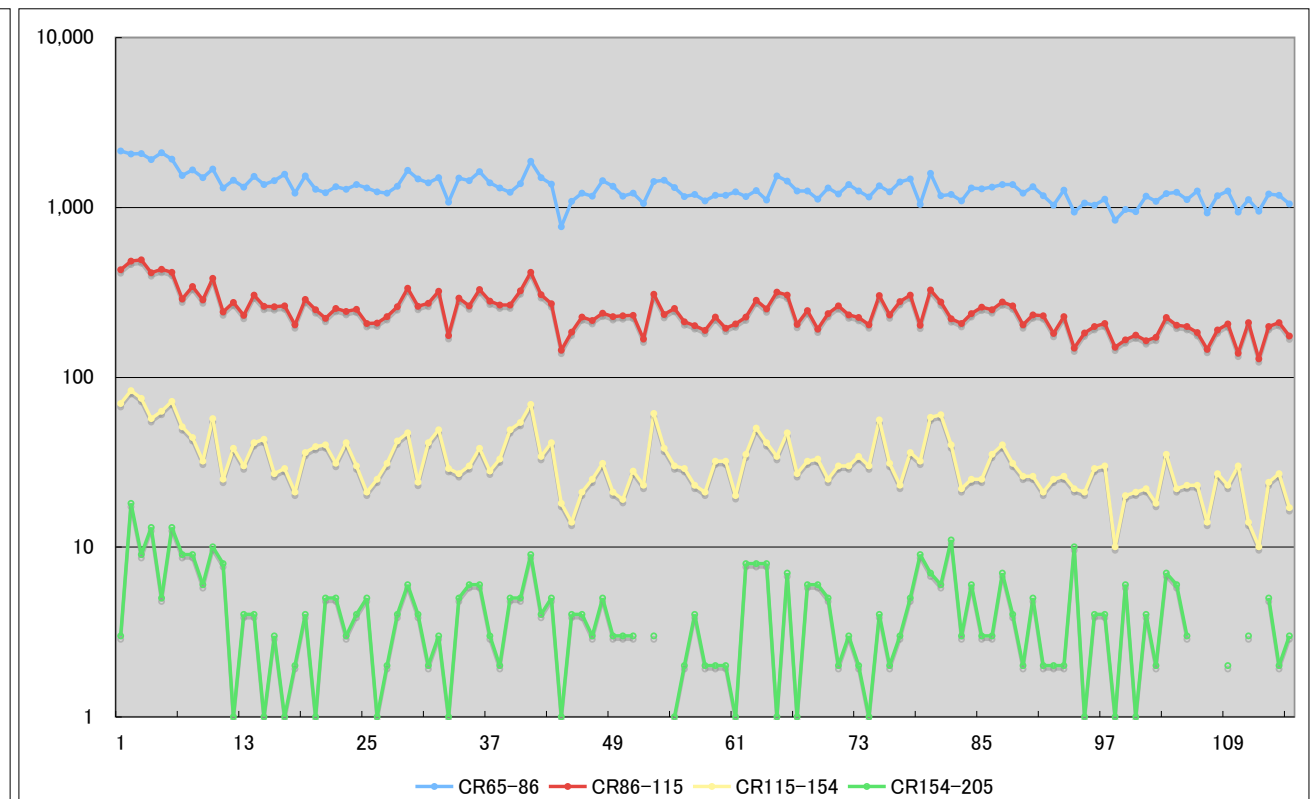
0.9 - 20.5 mm/h



20.5 - 64.8 mm/h



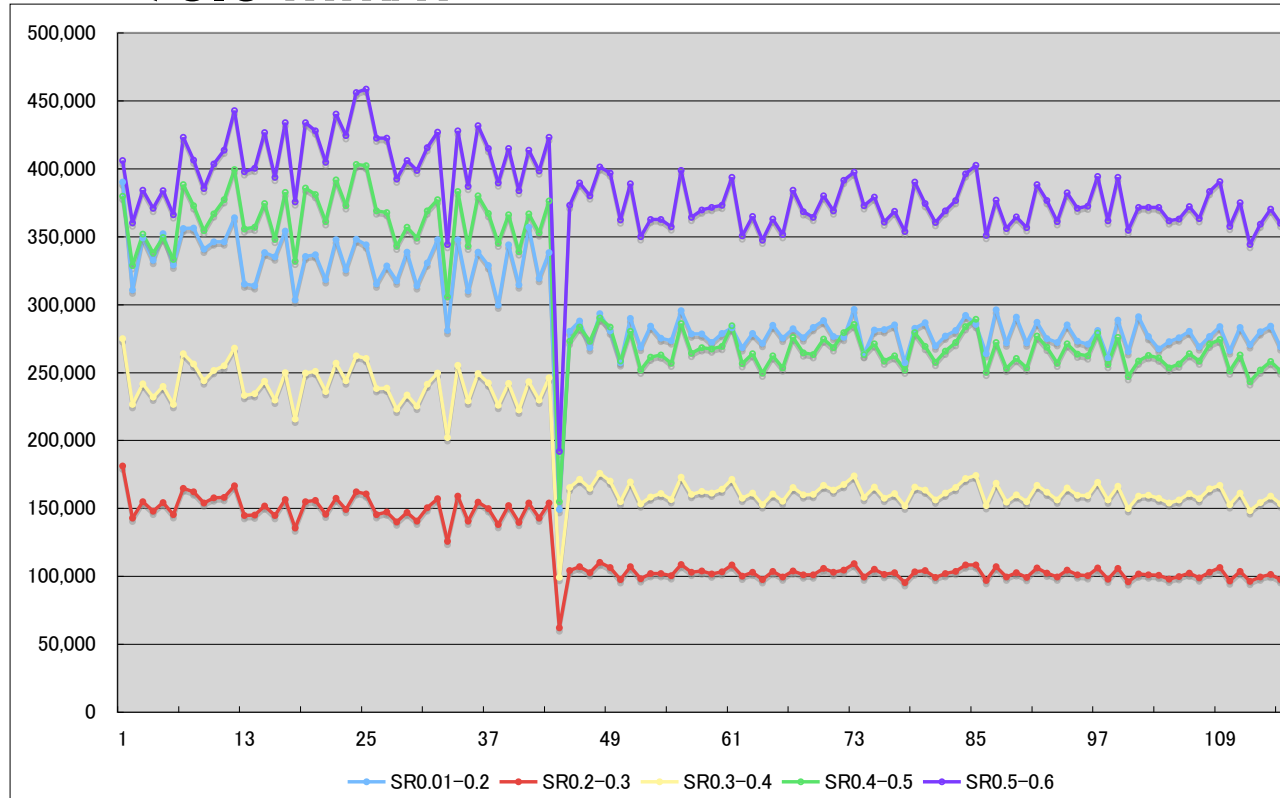
64.8 - 205 mm/h



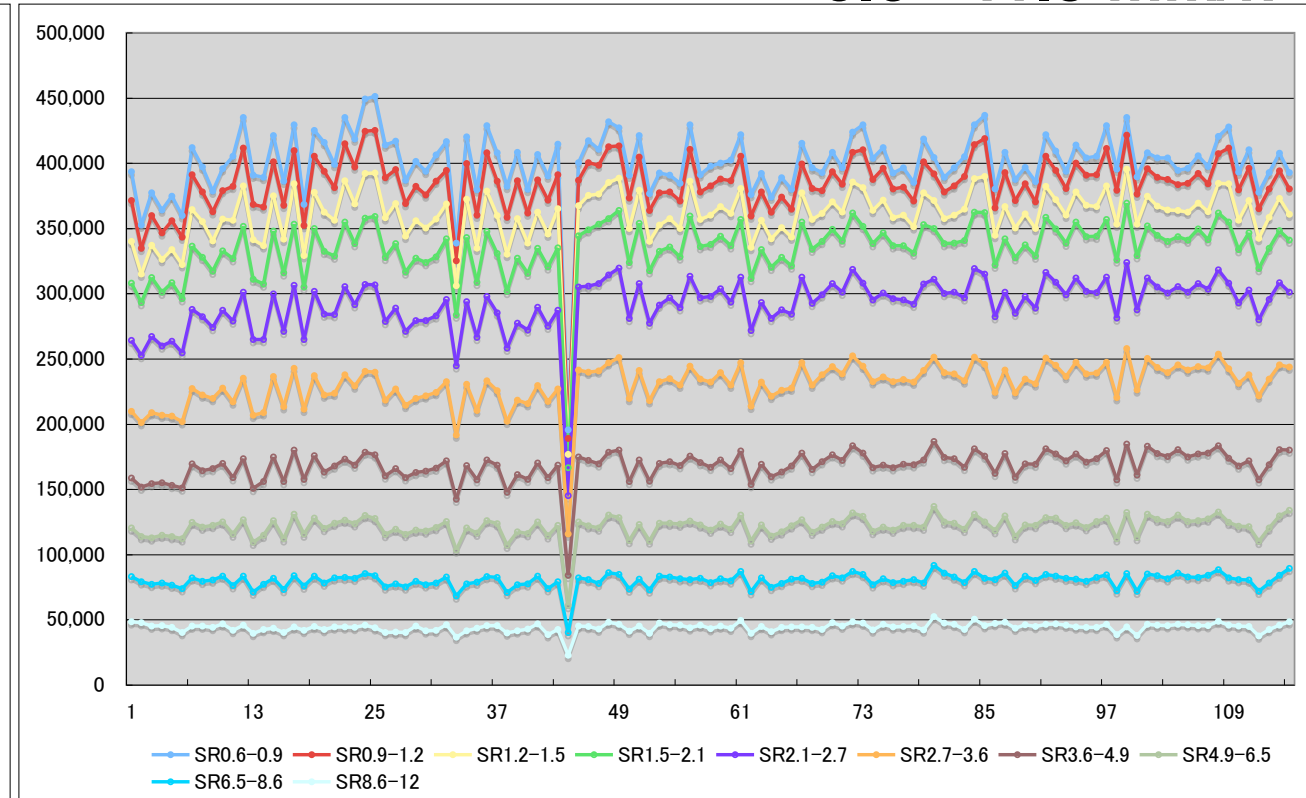


# Histogram of Cond. StratRainrate at 2 km

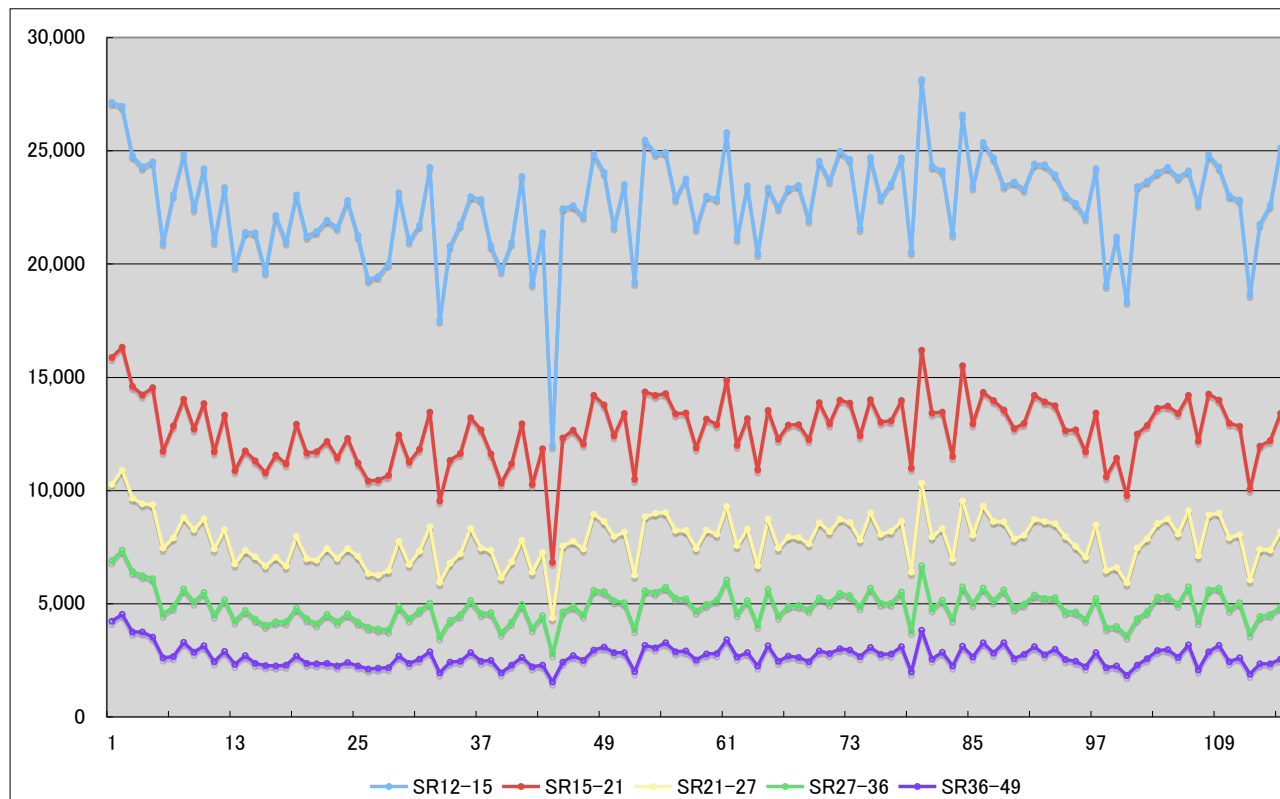
< 0.6 mm/h



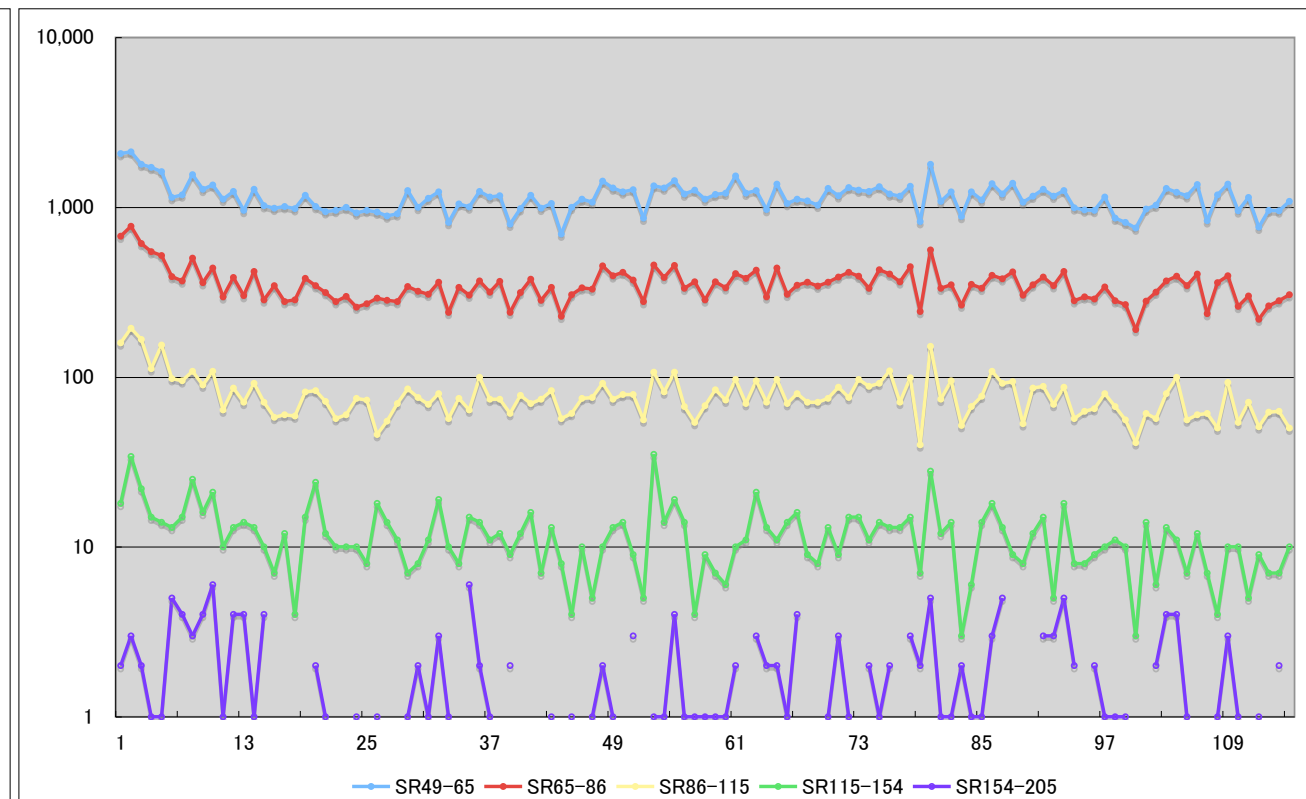
0.6 - 11.5 mm/h



11.5 - 48.6 mm/h



48.6 - 205 mm/h

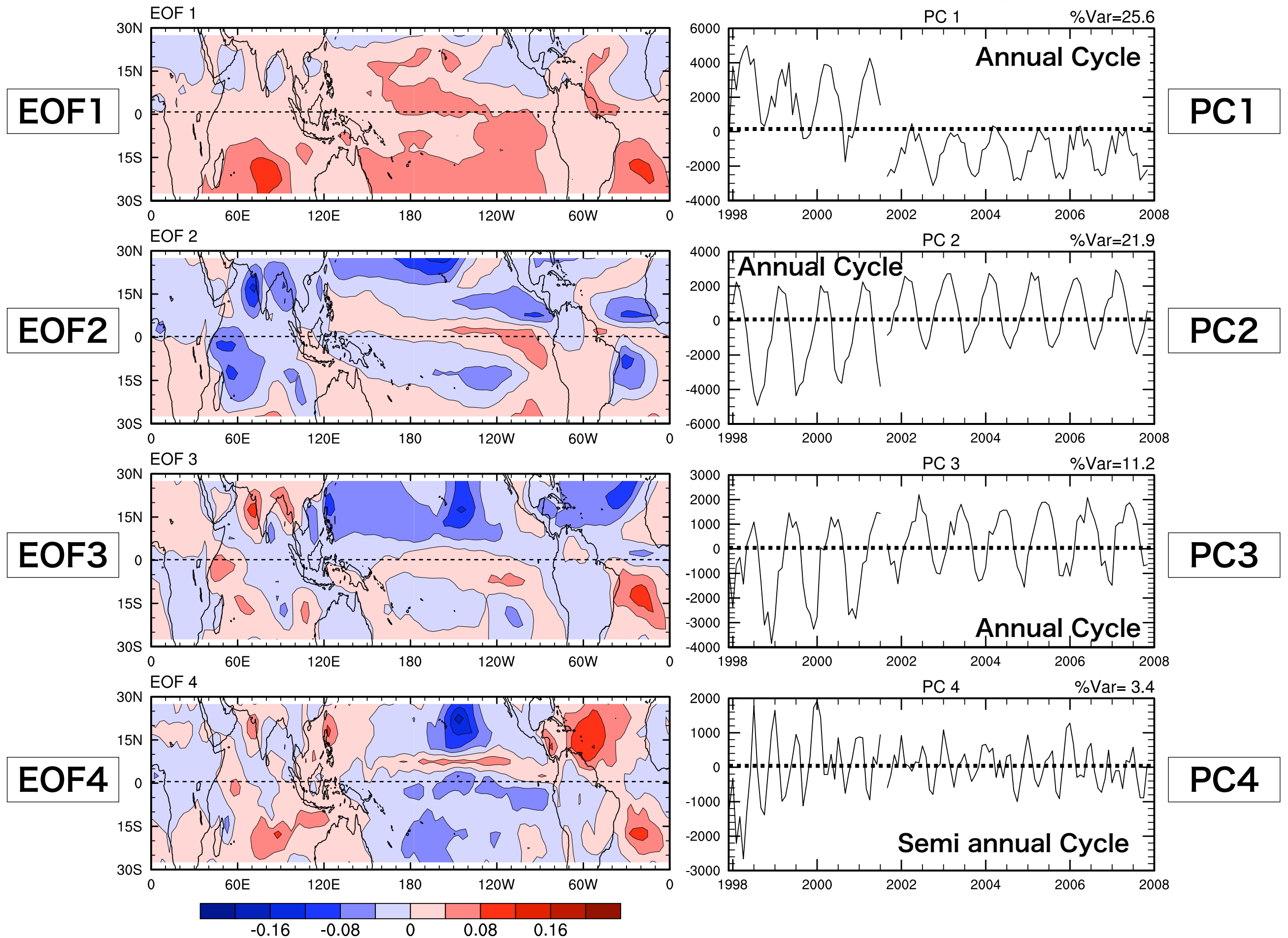


# EOF Analysis

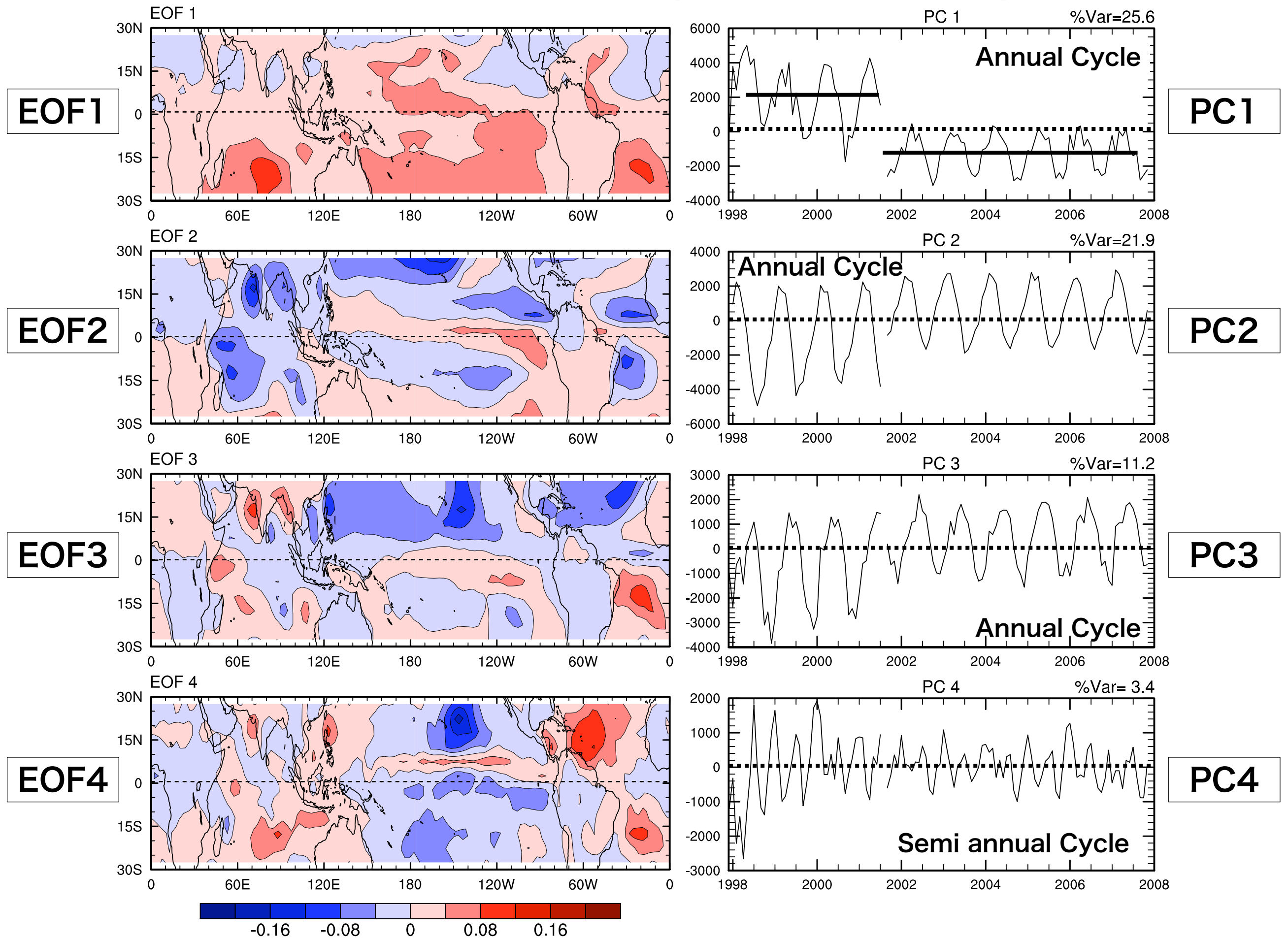
- to identify the dominant pattern in PR 3A25 and SST Data for 10 years from 1998 to 2007
- unconditional Rain, convR and stratR
- RainH, convRH and stratRH of 5 classes (light to heavy) at 2 km
- SST



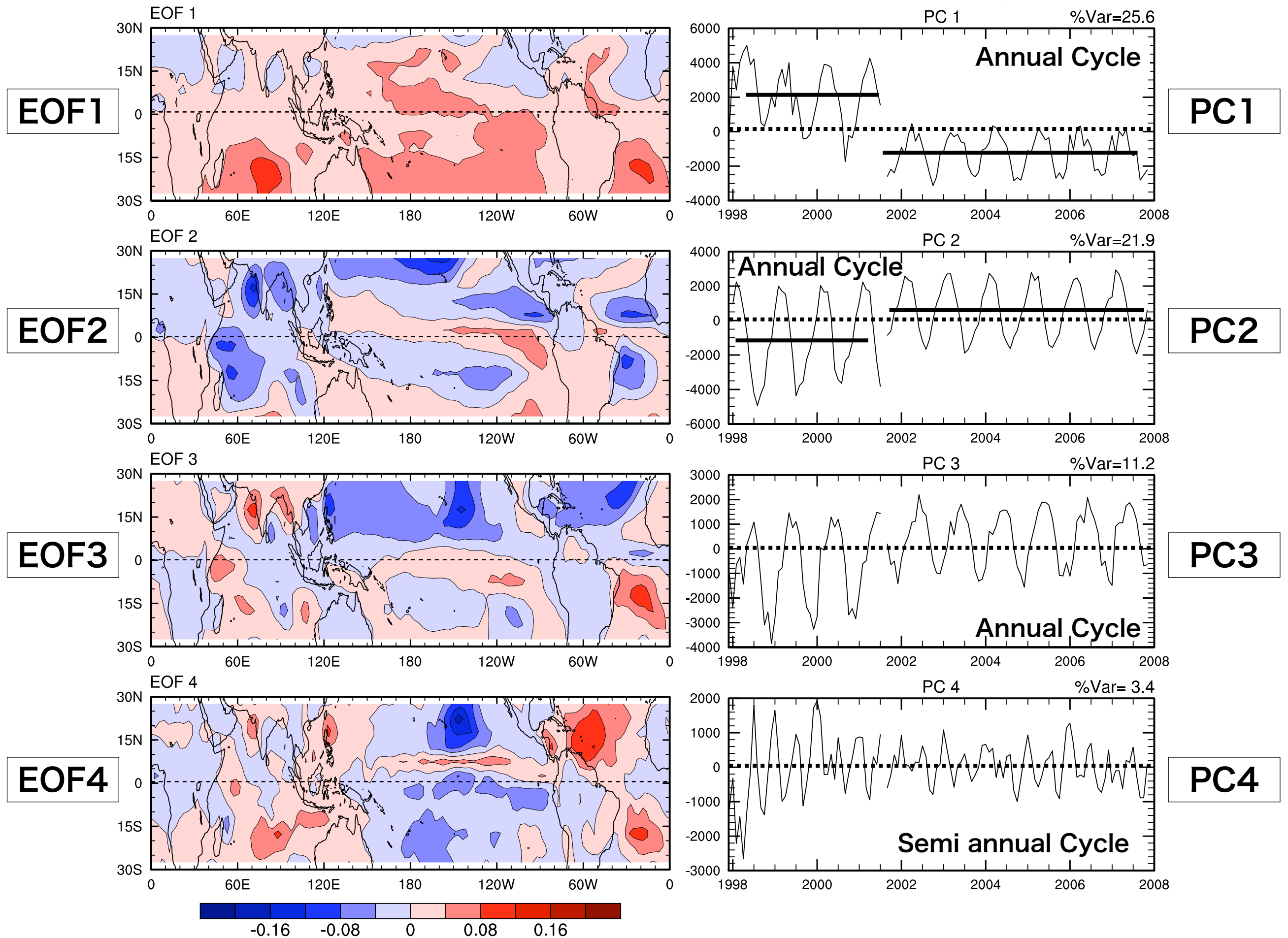
# ConvR at 2 km ( $R < 0.86$ mm/h)



# ConvR at 2 km ( $R < 0.86$ mm/h)

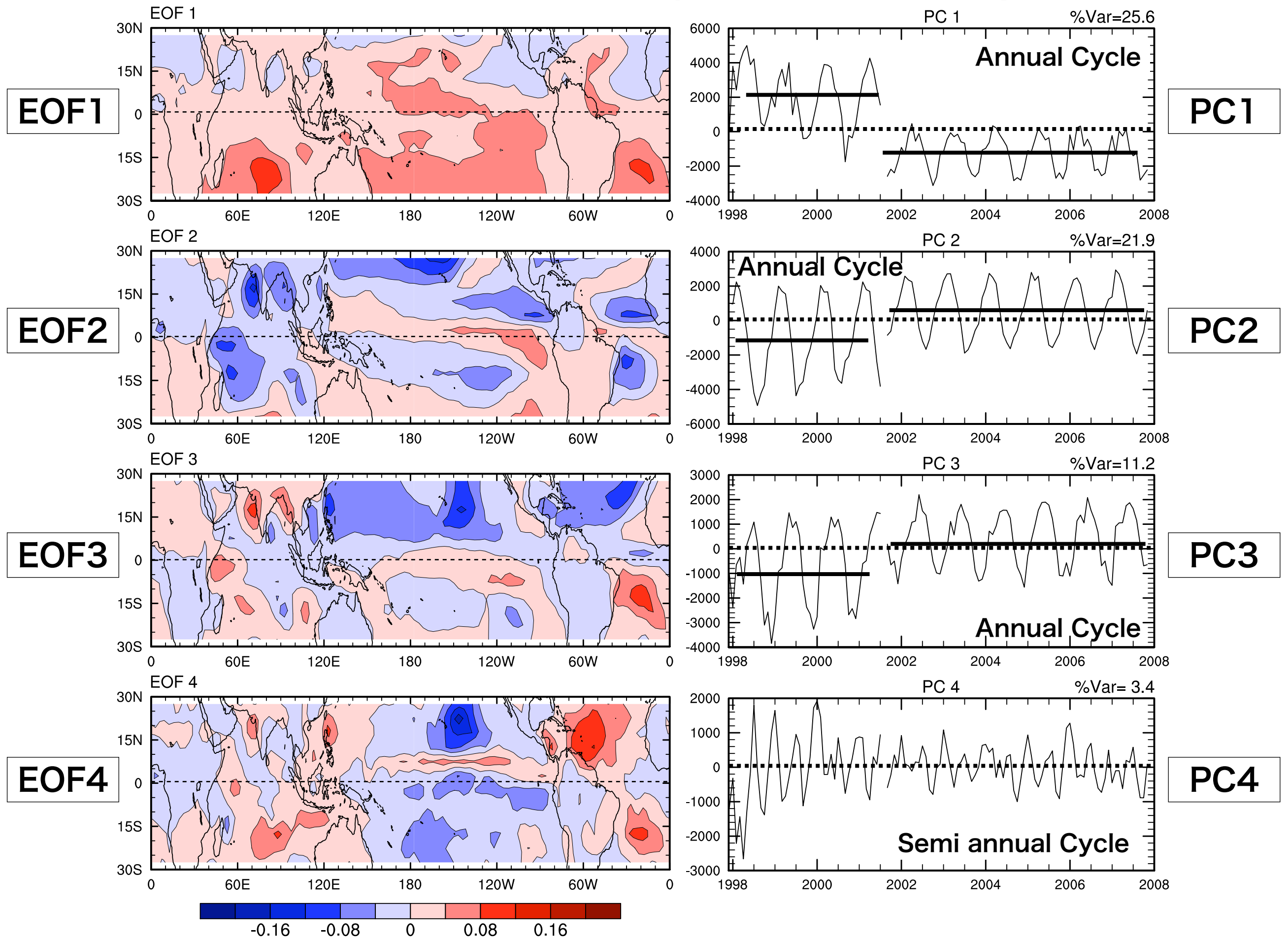


# ConvR at 2 km ( $R < 0.86$ mm/h)

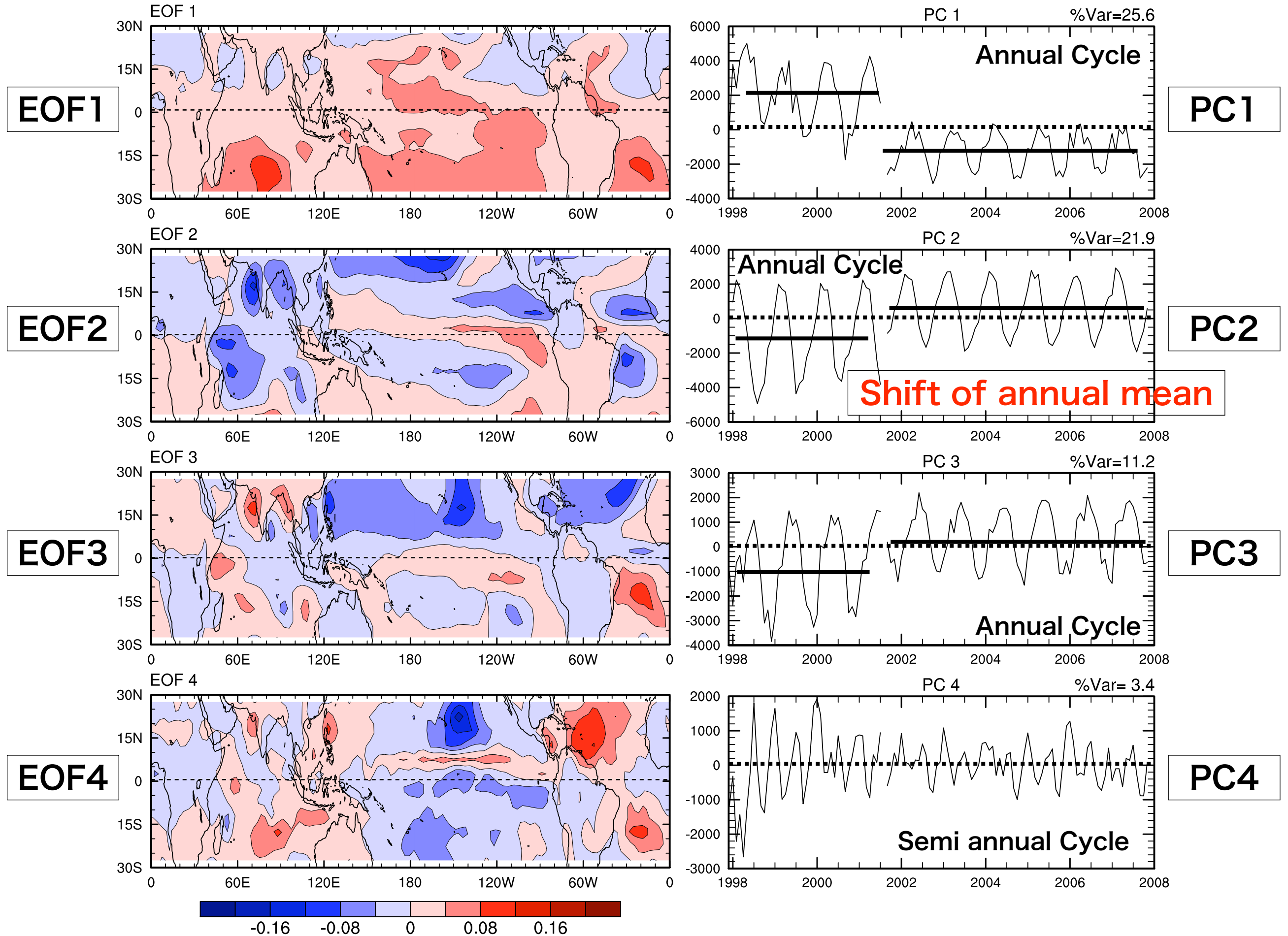




# ConvR at 2 km ( $R < 0.86$ mm/h)



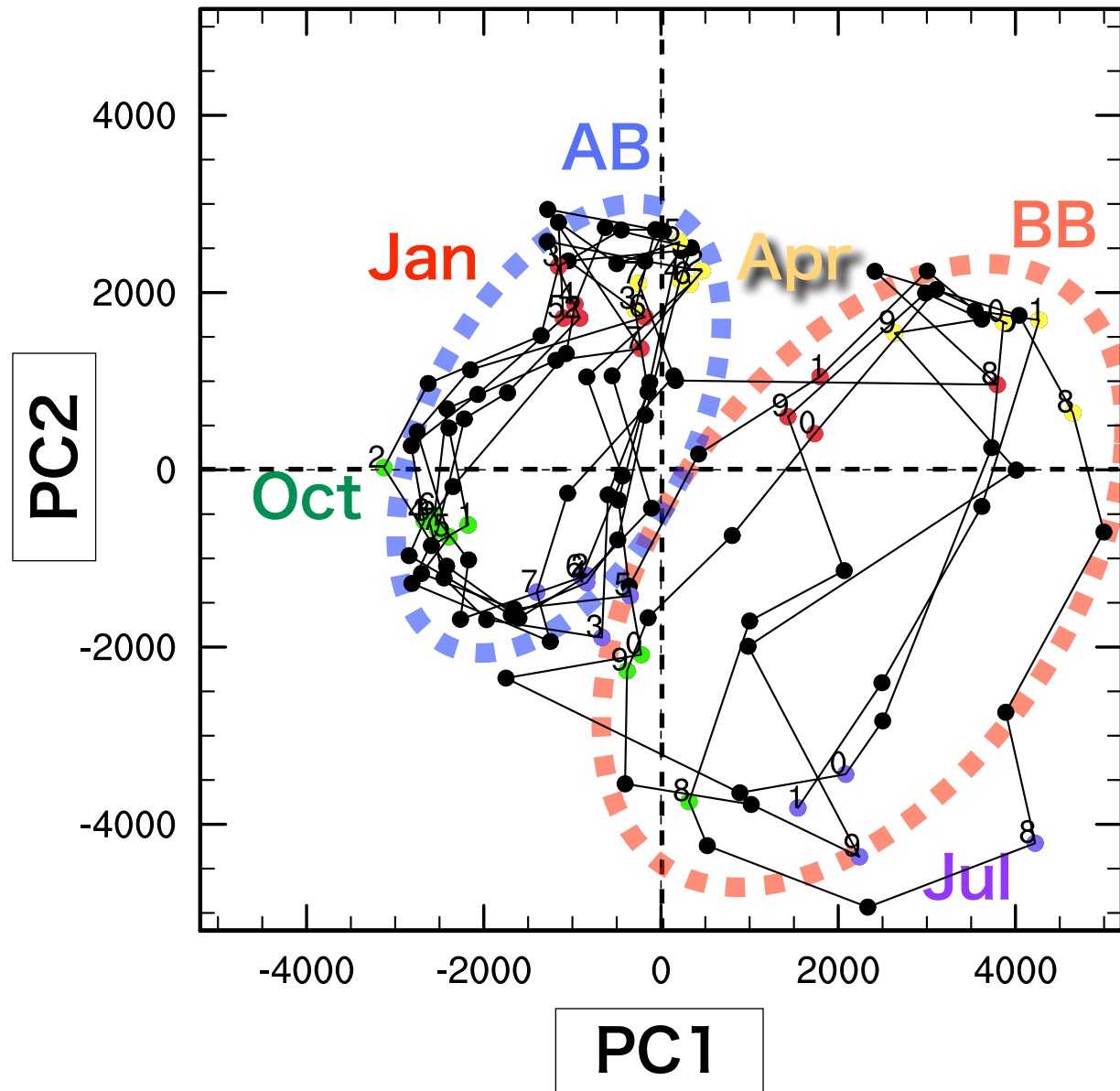
# ConvR at 2 km ( $R < 0.86$ mm/h)



# ConvR at 2 km ( $R < 0.86$ mm/h)

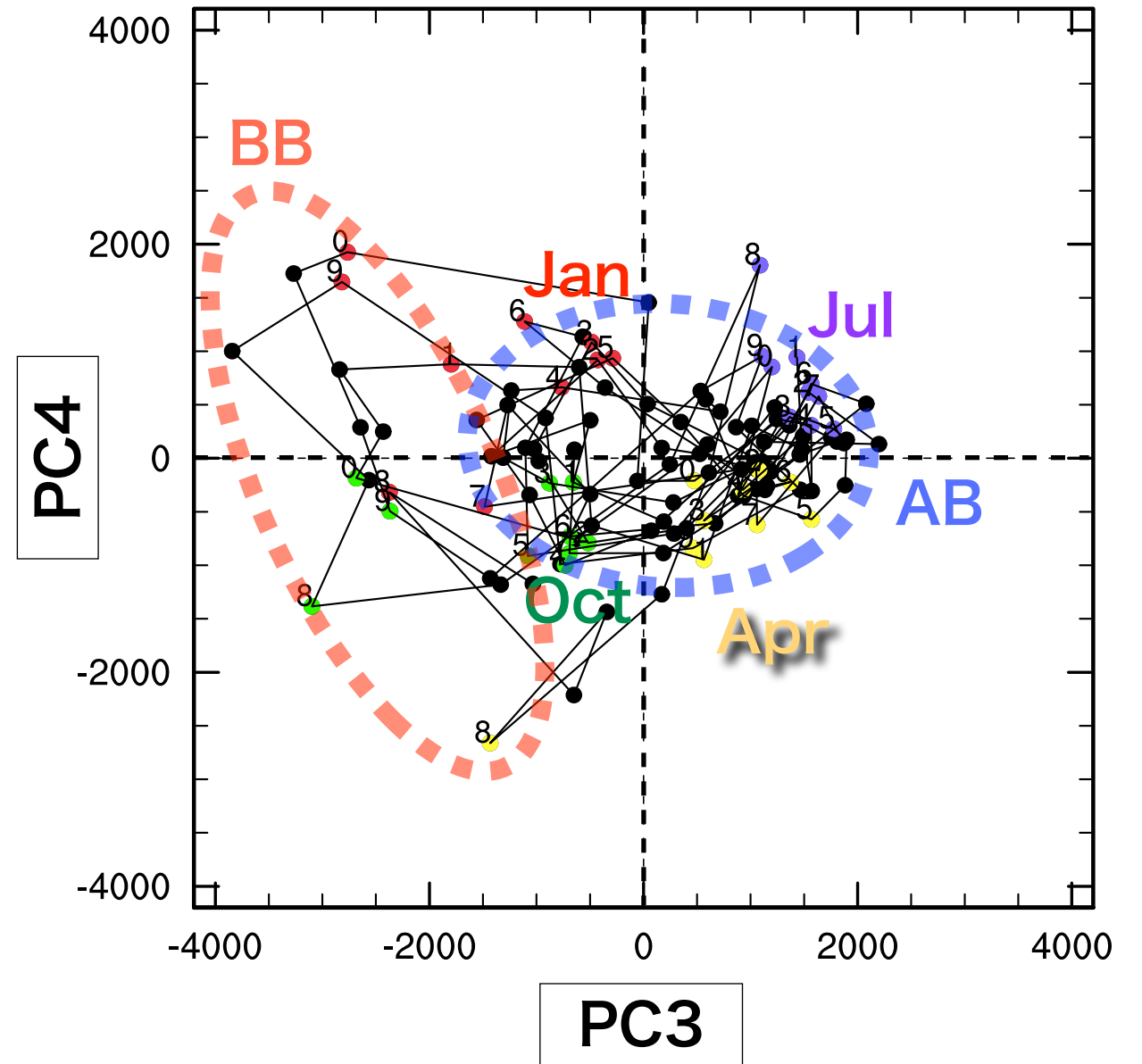
(PC1, PC2)

2km convRainH ( $R < 0.86$  mm/h)



(PC3, PC4)

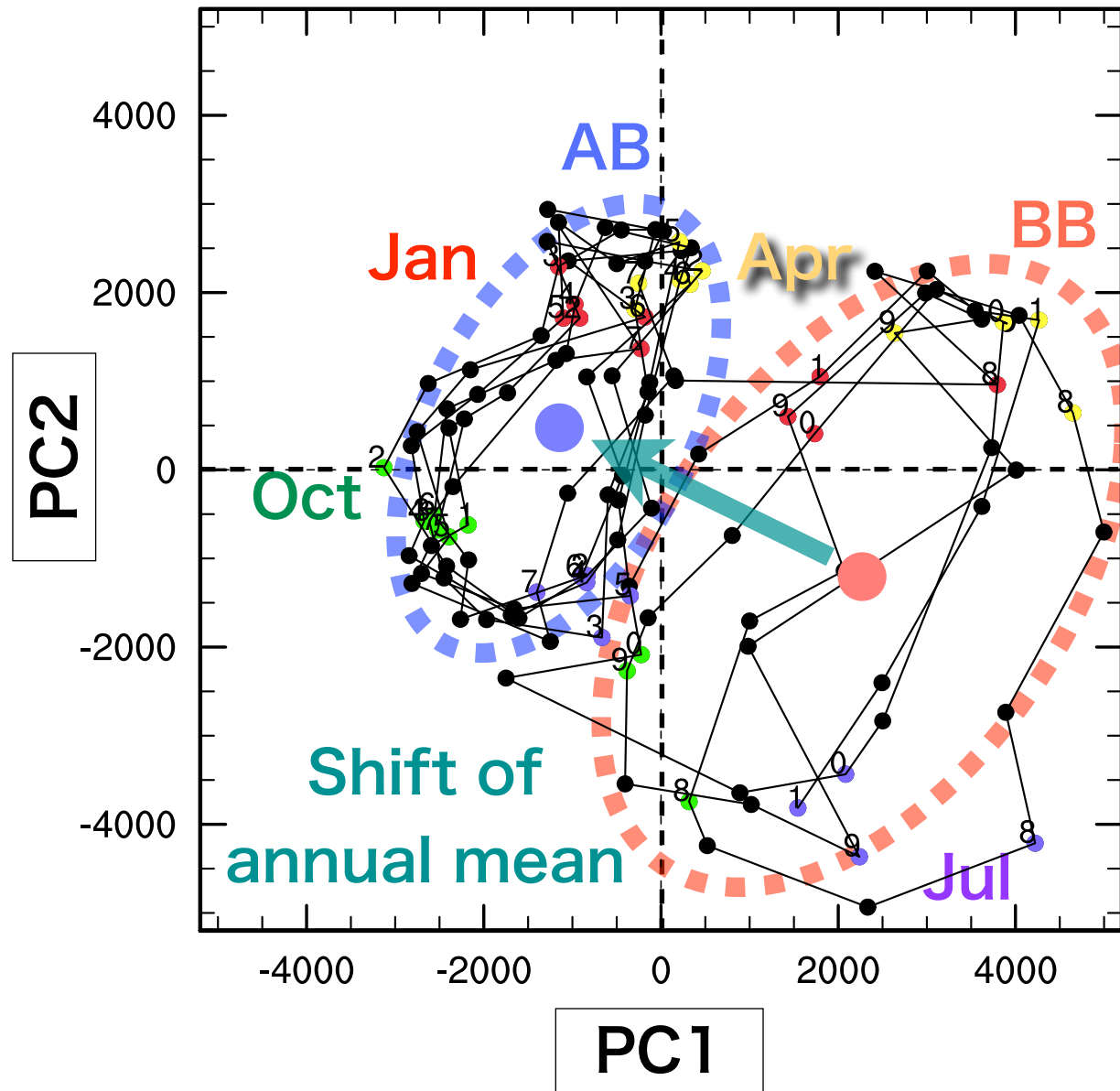
2km convRainH ( $R < 0.86$  mm/h)



# ConvR at 2 km ( $R < 0.86$ mm/h)

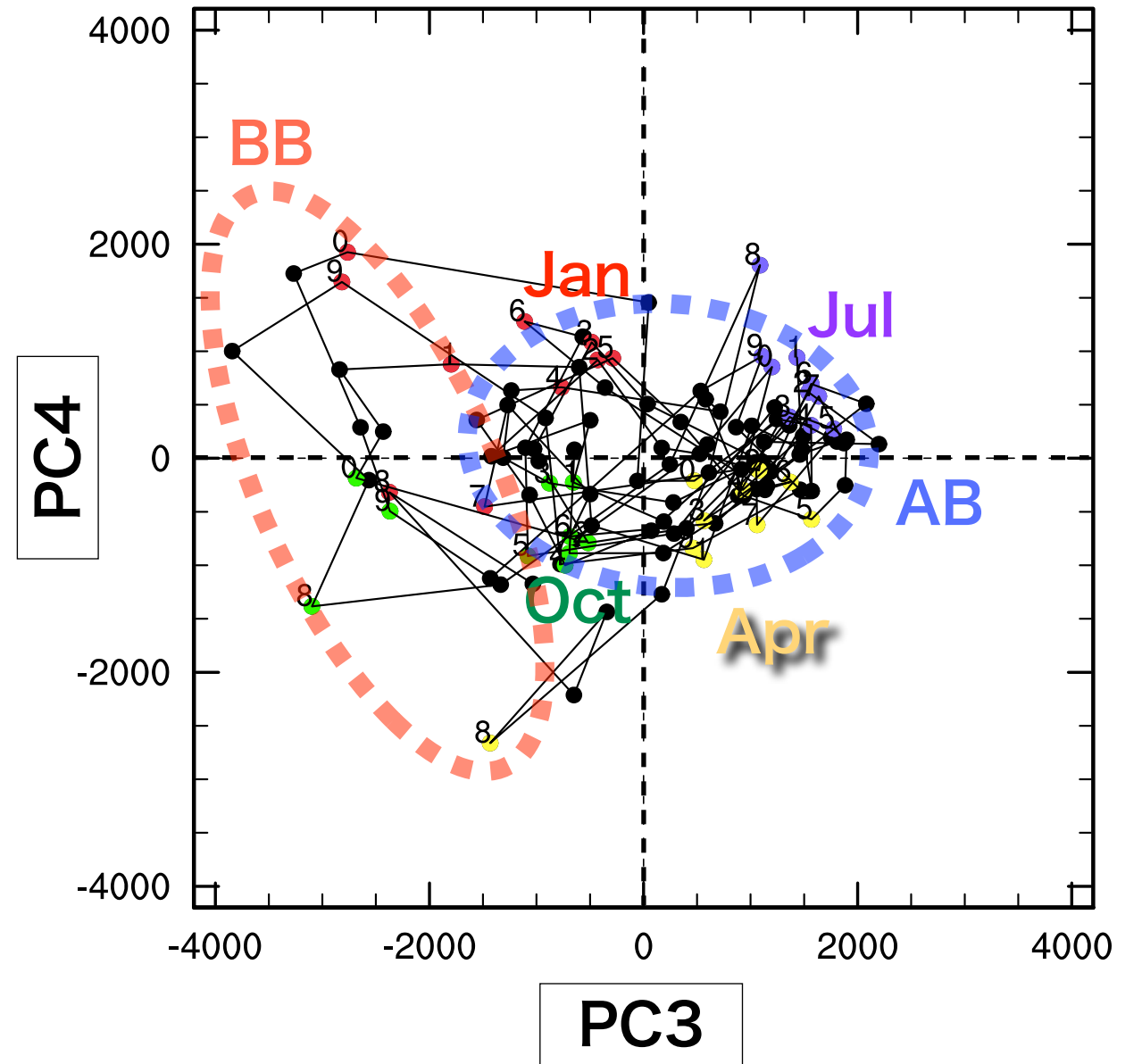
(PC1, PC2)

2km convRainH ( $R < 0.86$  mm/h)



(PC3, PC4)

2km convRainH ( $R < 0.86$  mm/h)

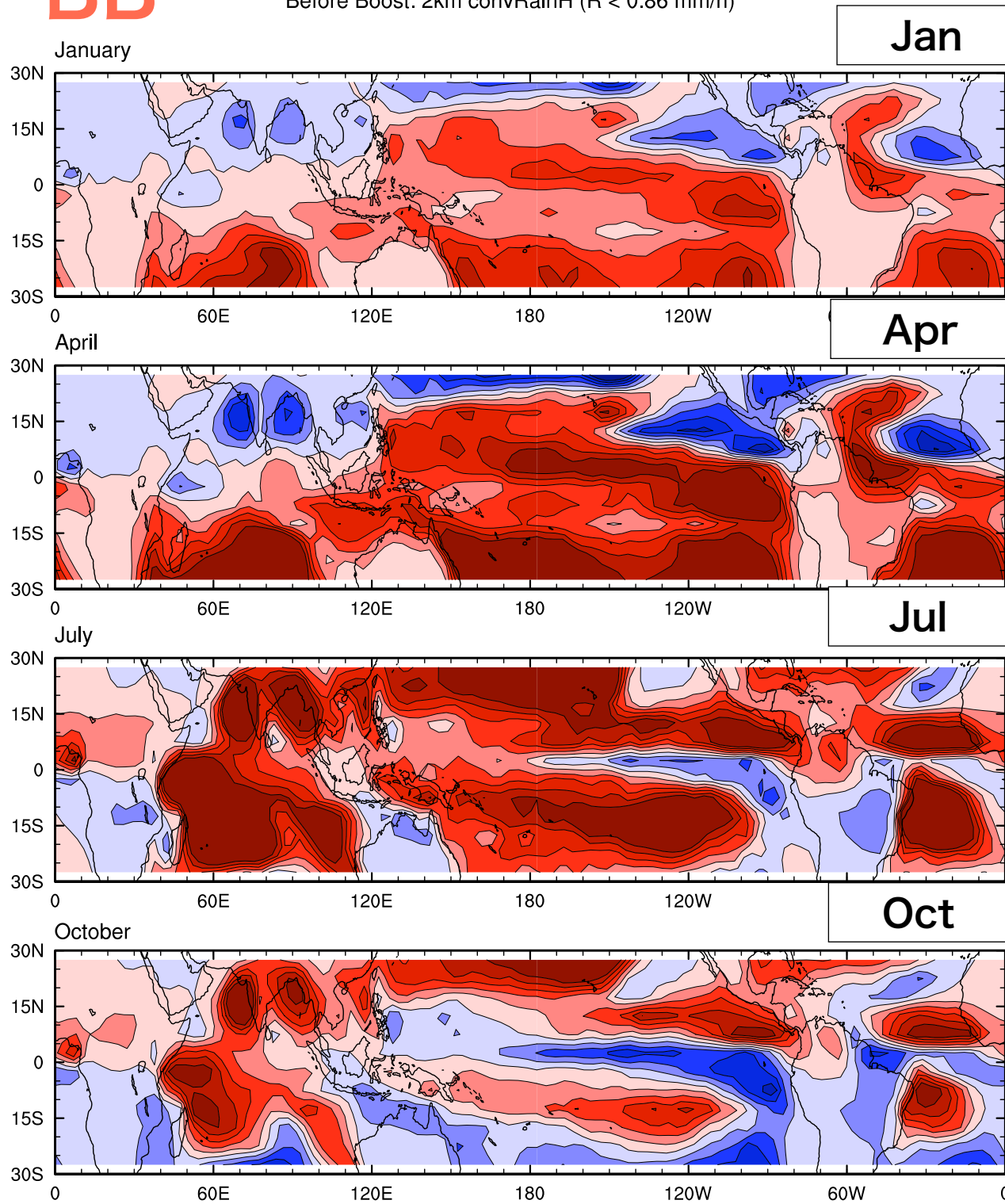




# Decrease of occurrence of convR ( $R < 0.86$ mm/h)

**BB**

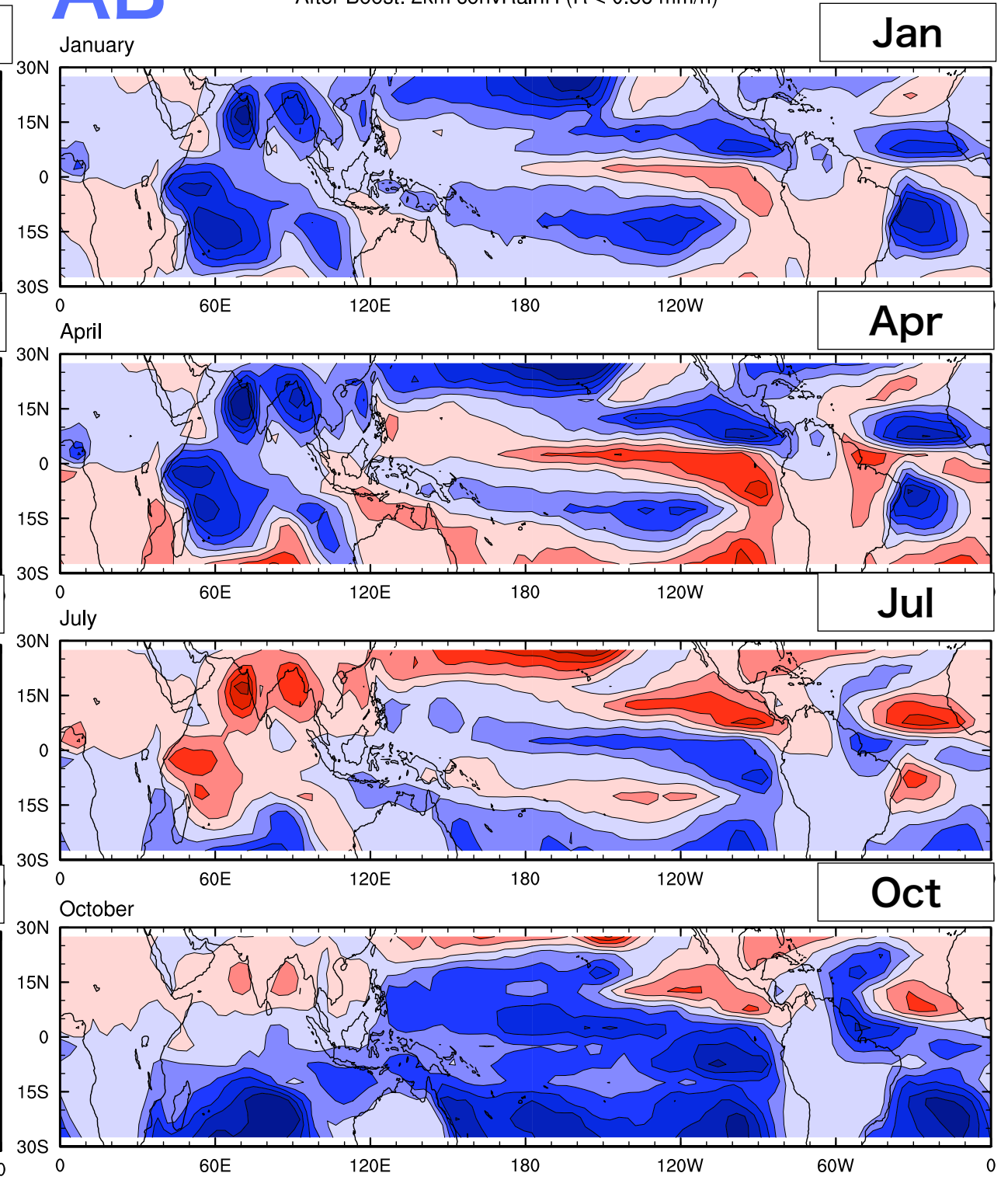
Before Boost: 2km convRainH ( $R < 0.86$  mm/h)



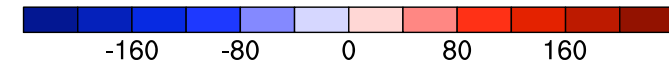
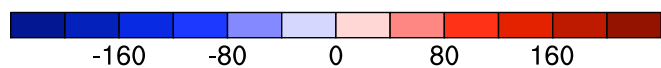
More in Apr. in **BB**

**AB**

After Boost: 2km convRainH ( $R < 0.86$  mm/h)

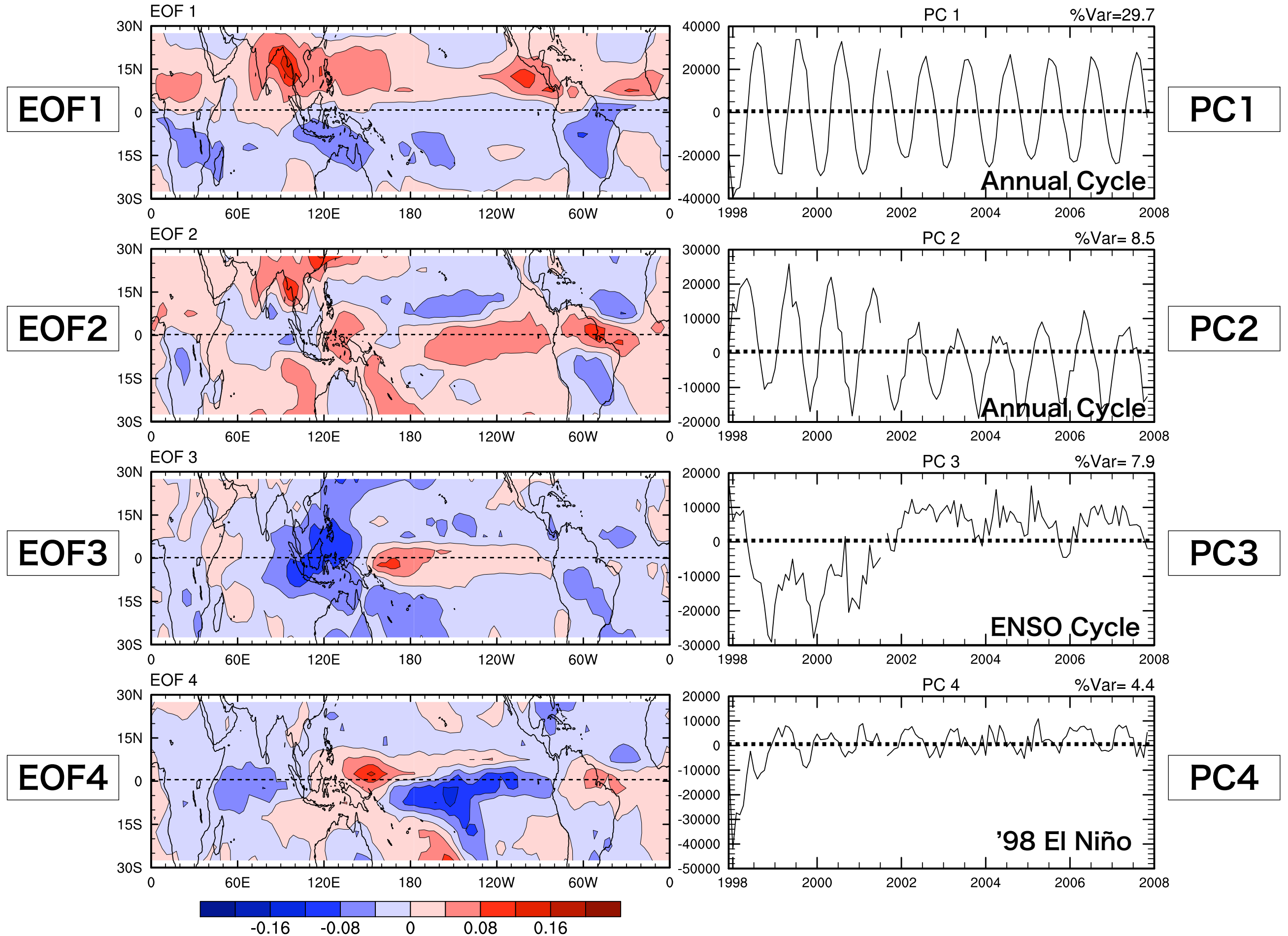


Less in Oct. in **AB**

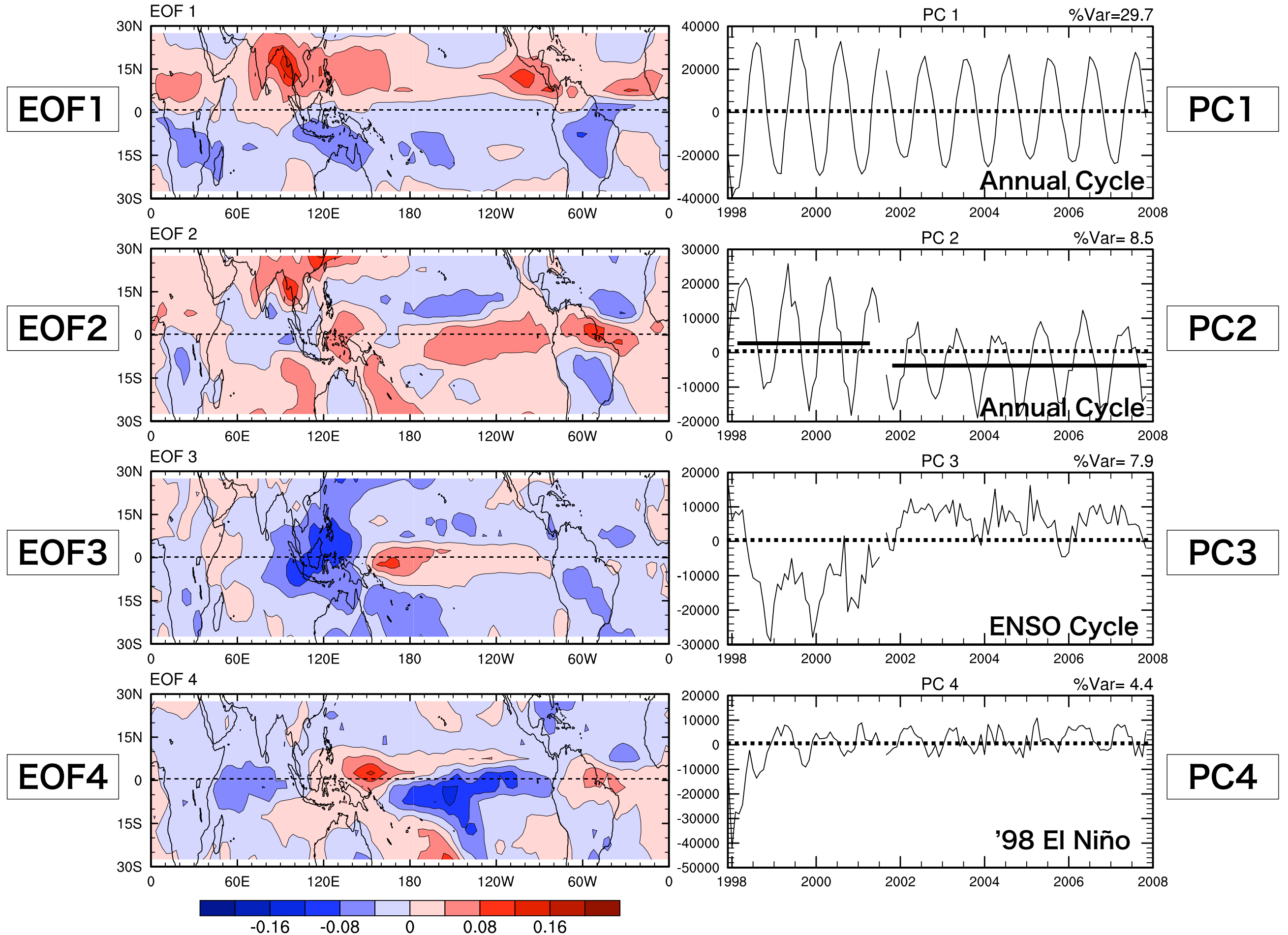




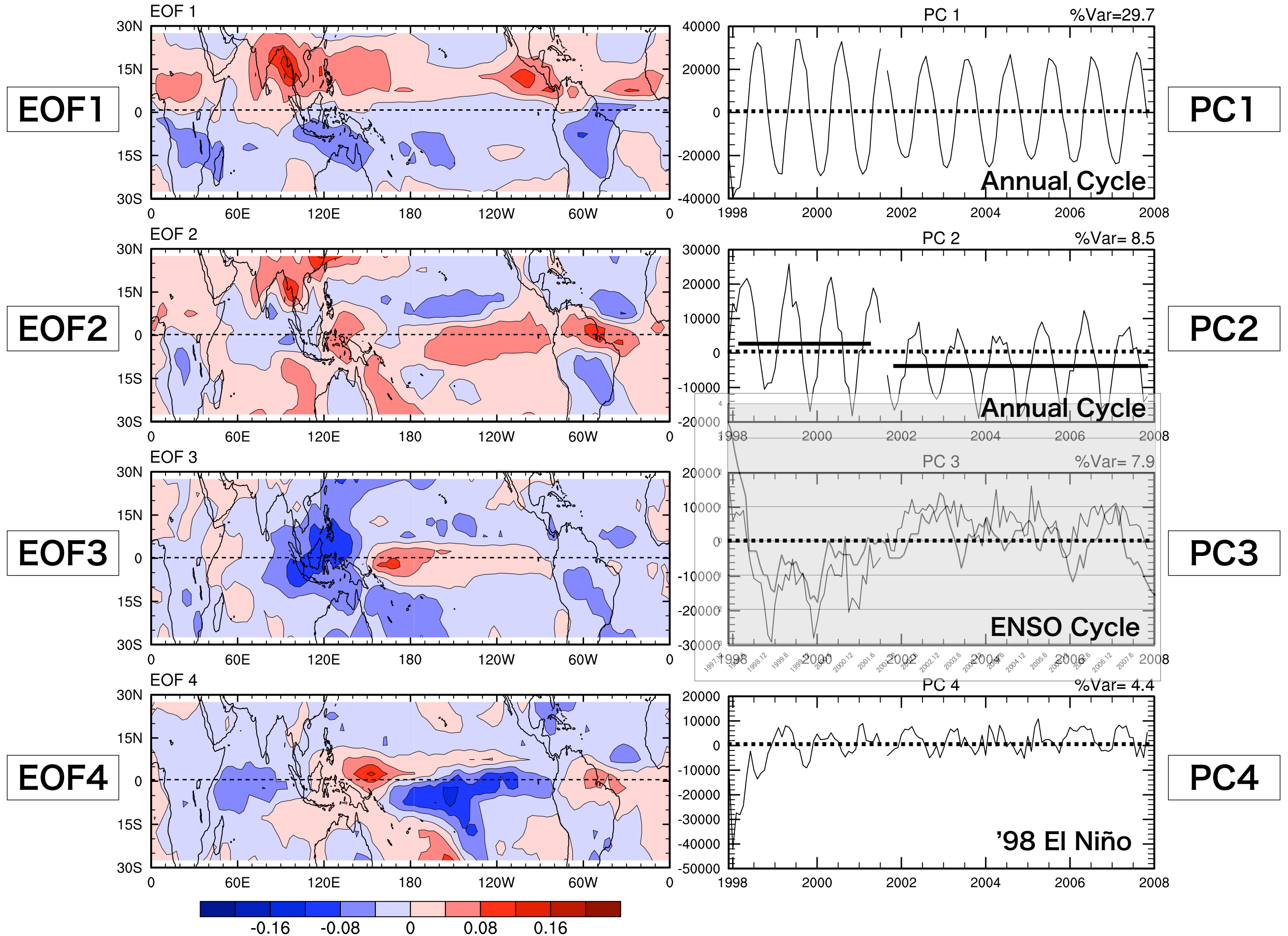
# Rain at 2 km ( $R < 0.65$ mm/h)



# Rain at 2 km ( $R < 0.65$ mm/h)

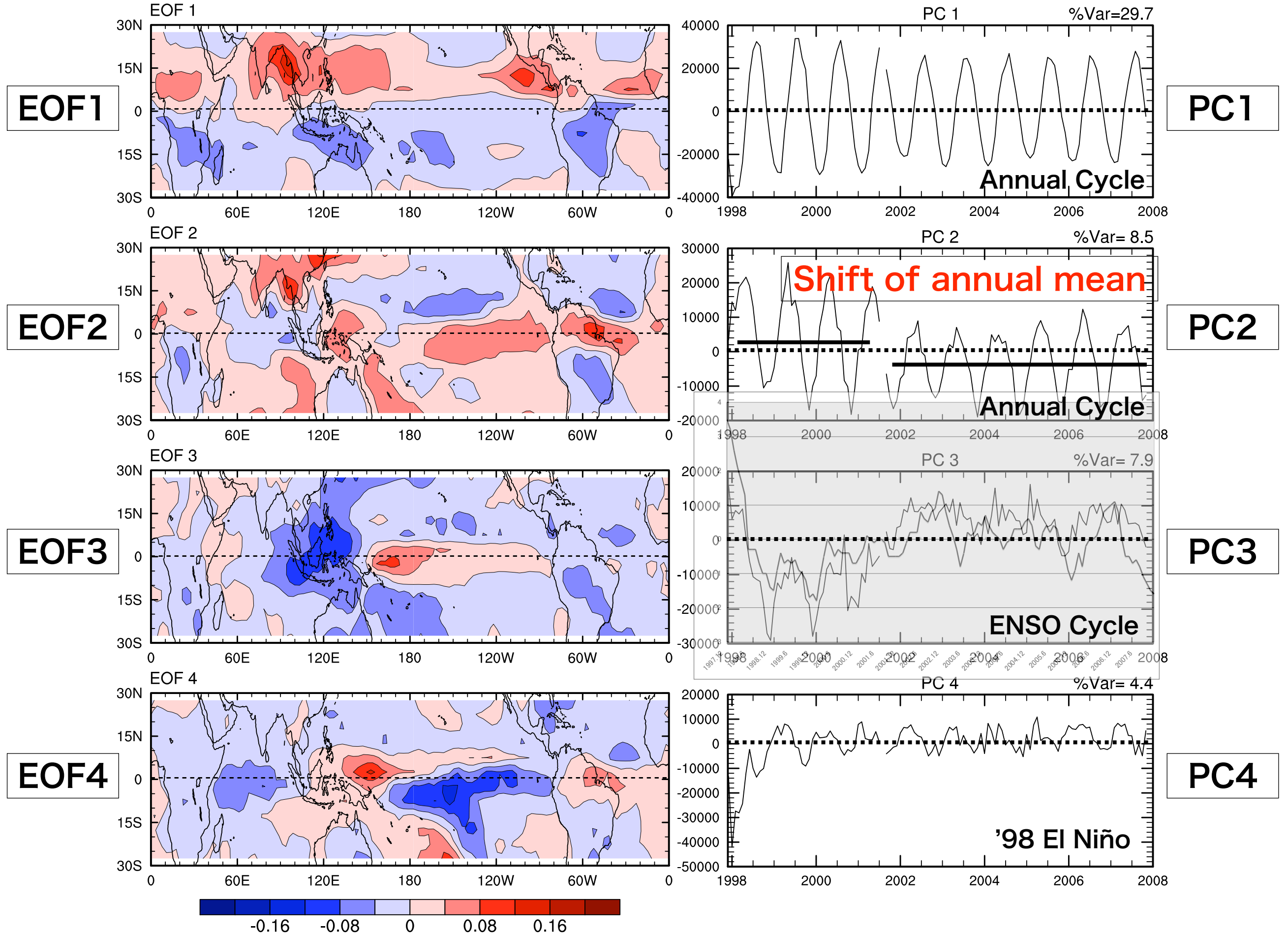


# Rain at 2 km ( $R < 0.65$ mm/h)

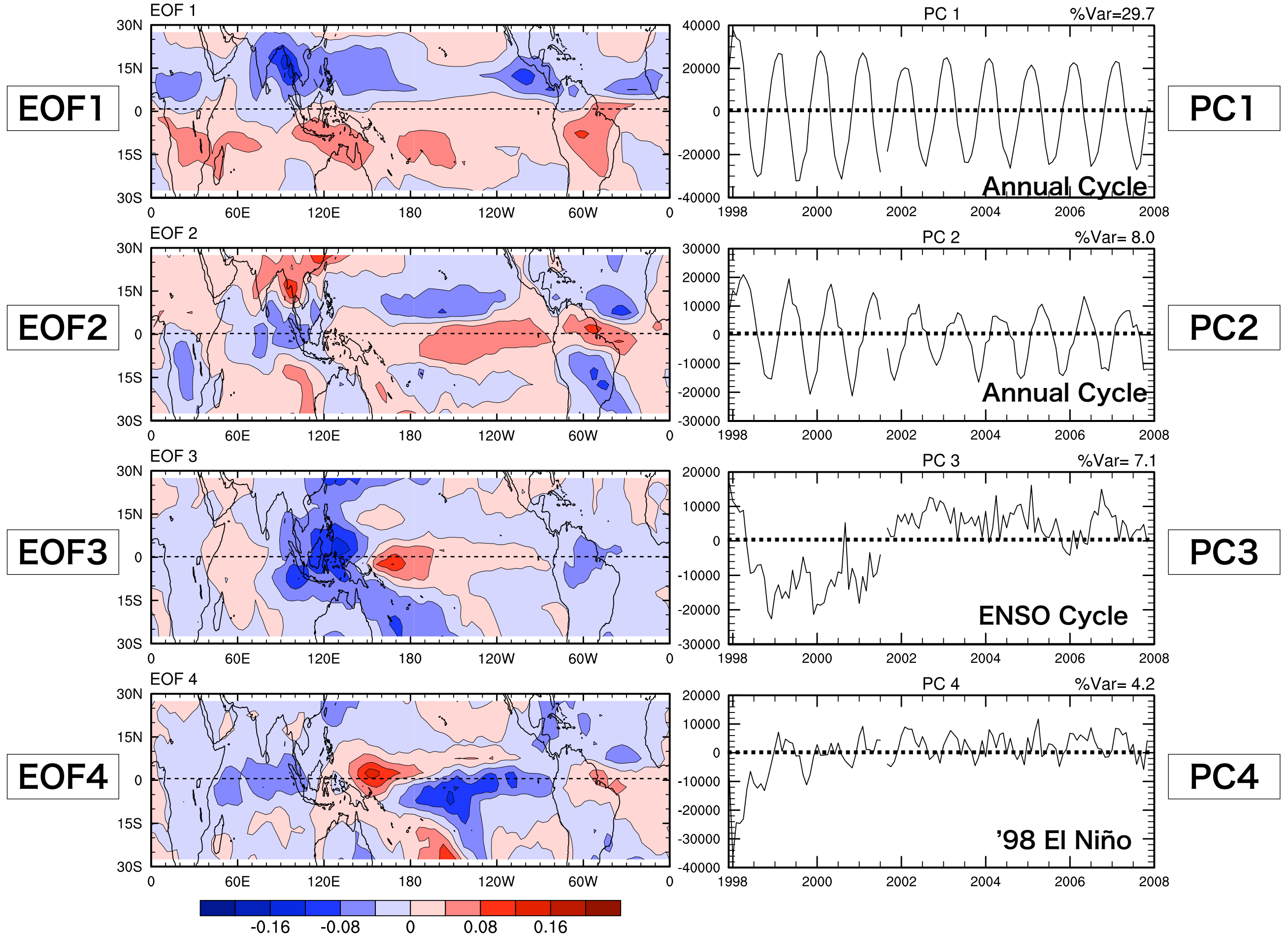




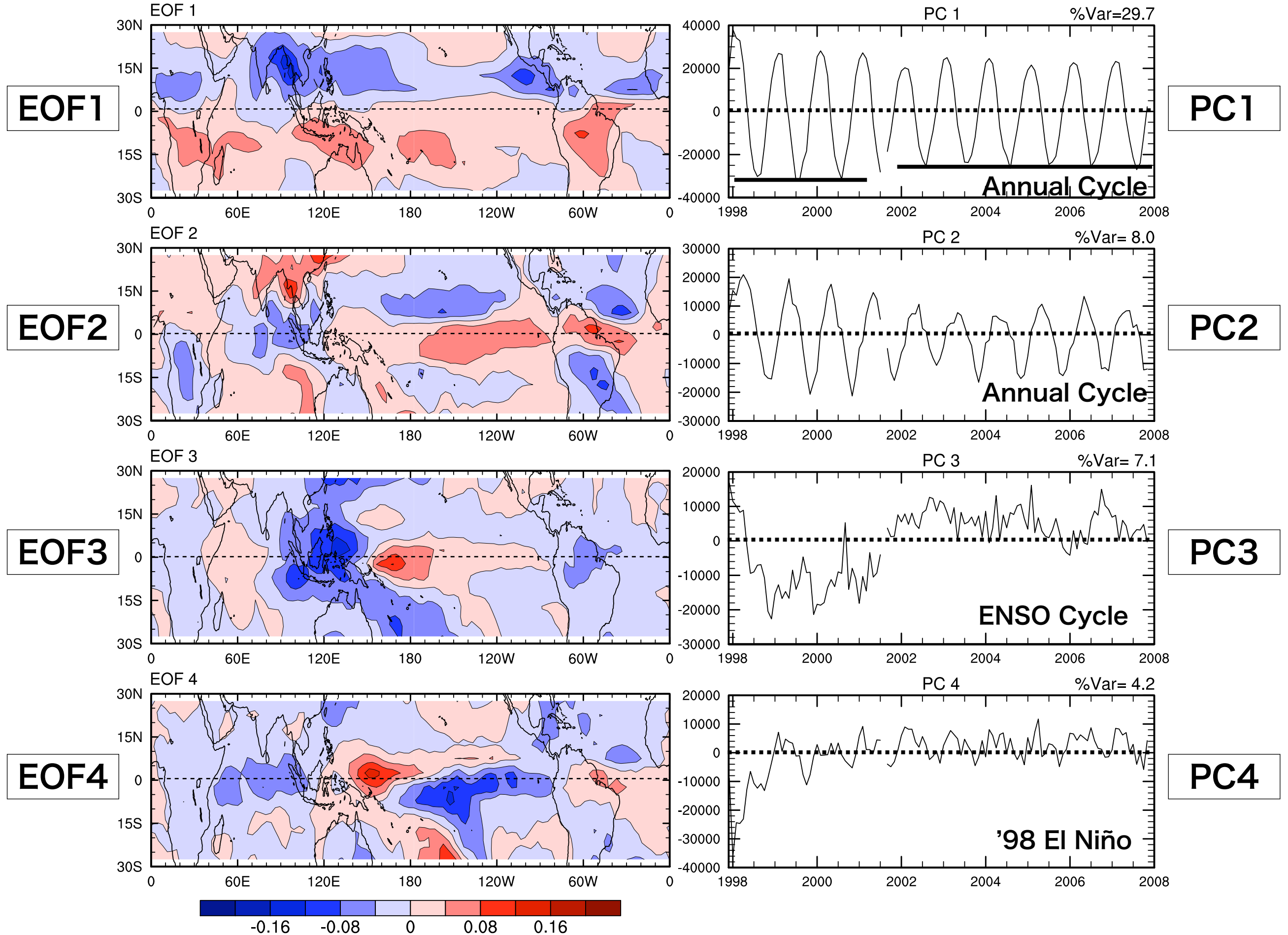
# Rain at 2 km ( $R < 0.65$ mm/h)



# stratR at 2 km ( $R < 0.65$ mm/h)

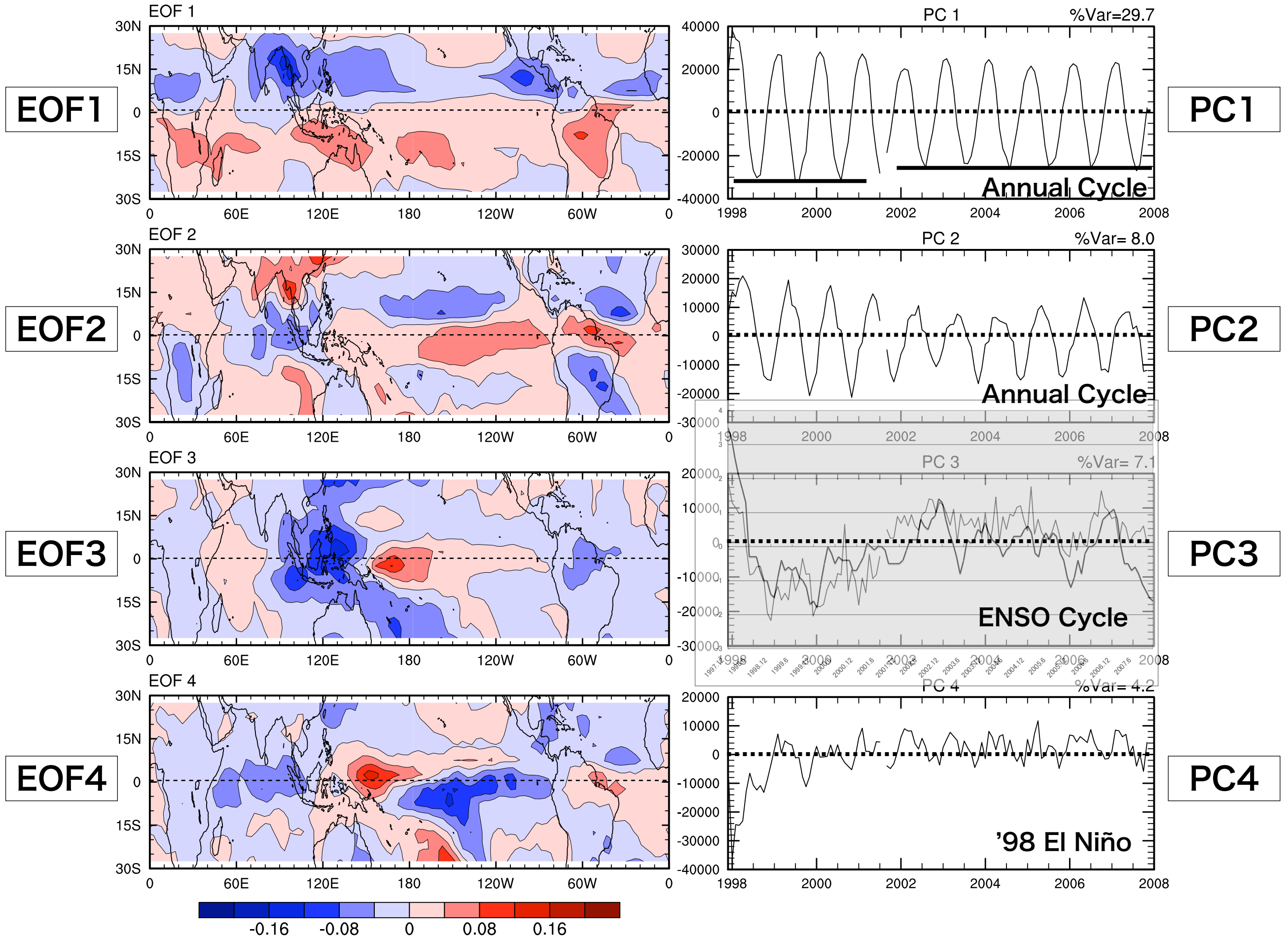


# stratR at 2 km ( $R < 0.65$ mm/h)

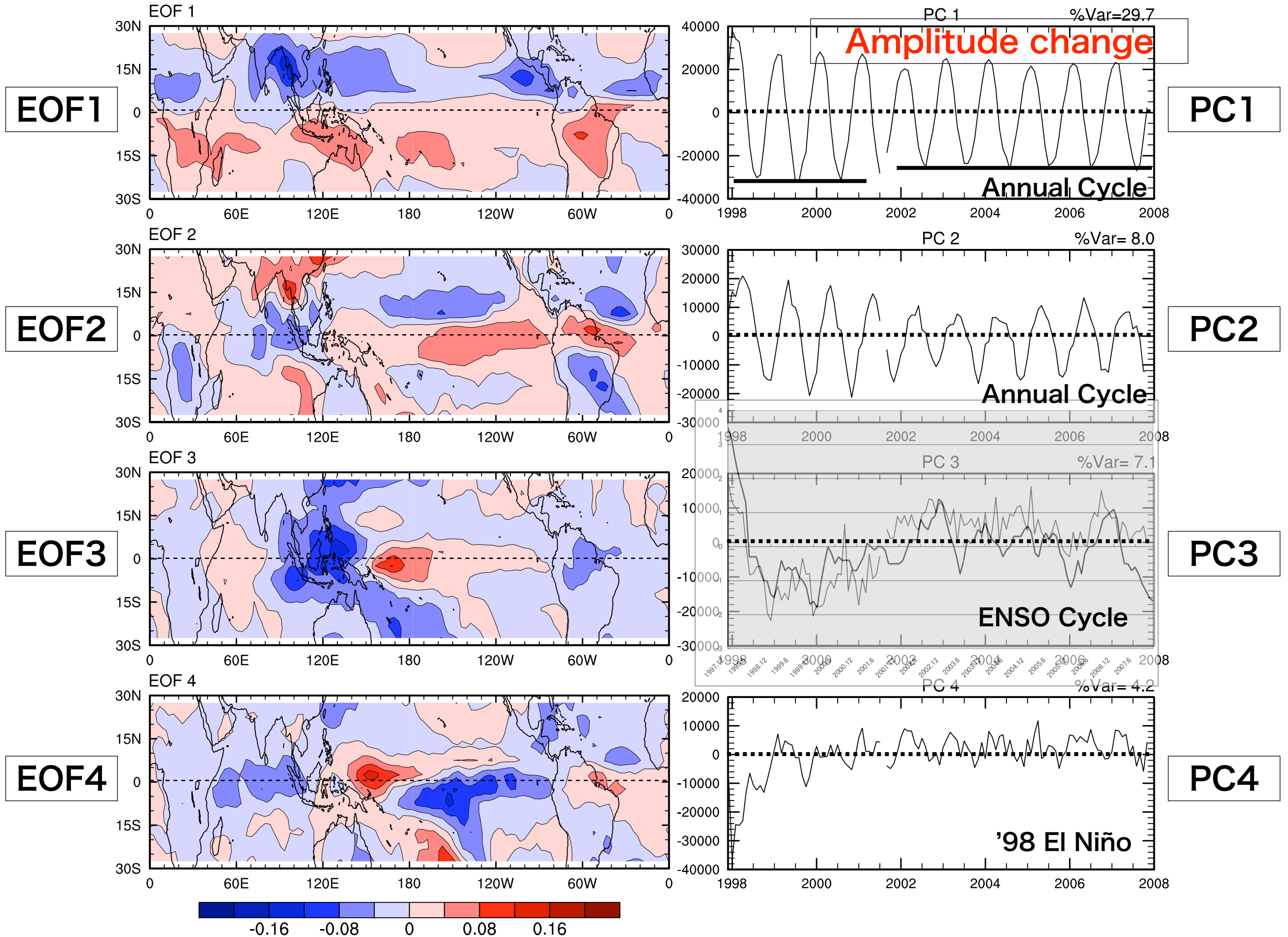




# stratR at 2 km ( $R < 0.65$ mm/h)

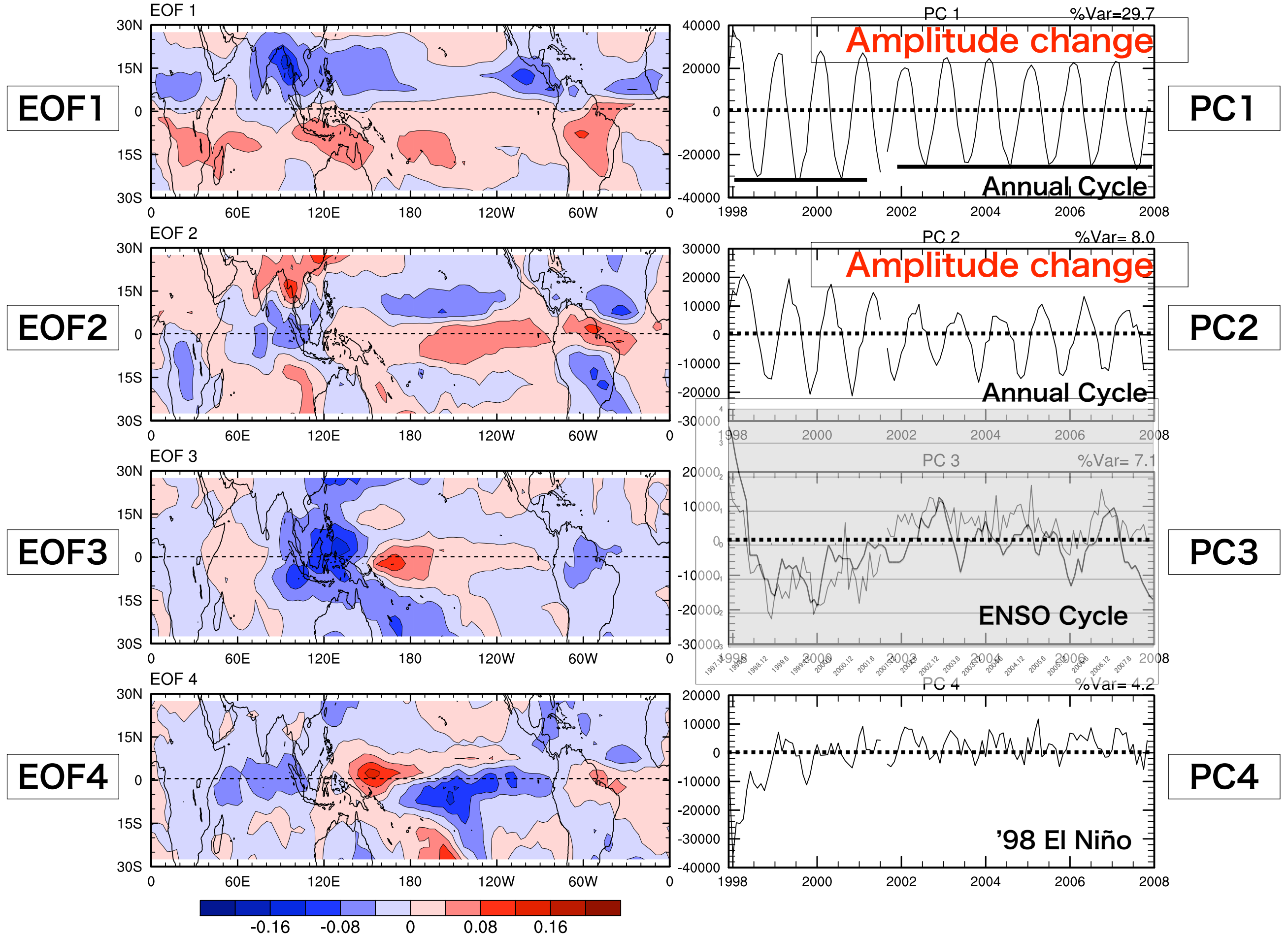


# stratR at 2 km ( $R < 0.65$ mm/h)





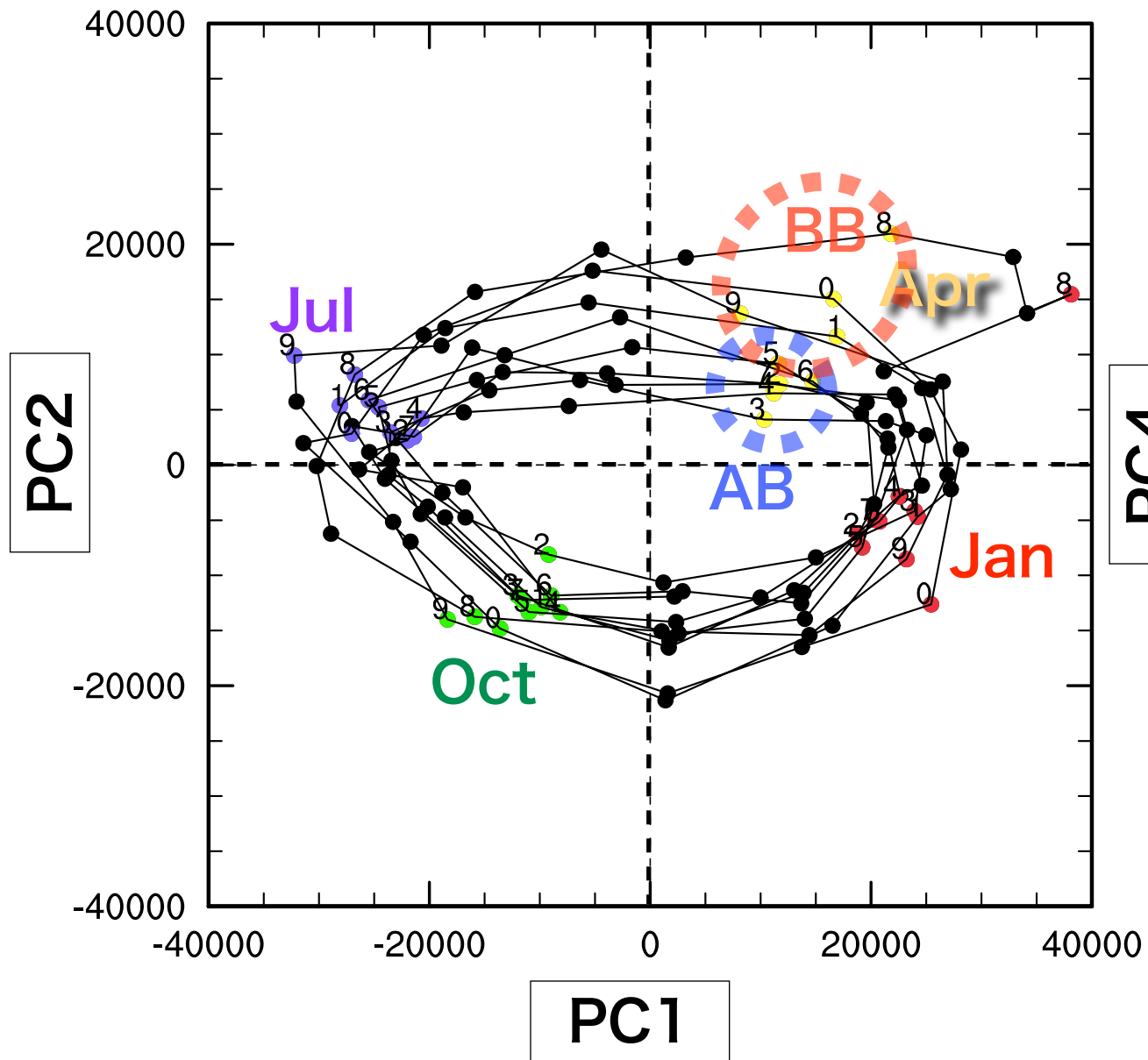
# stratR at 2 km ( $R < 0.65$ mm/h)



# stratR at 2 km ( $R < 0.65$ mm/h)

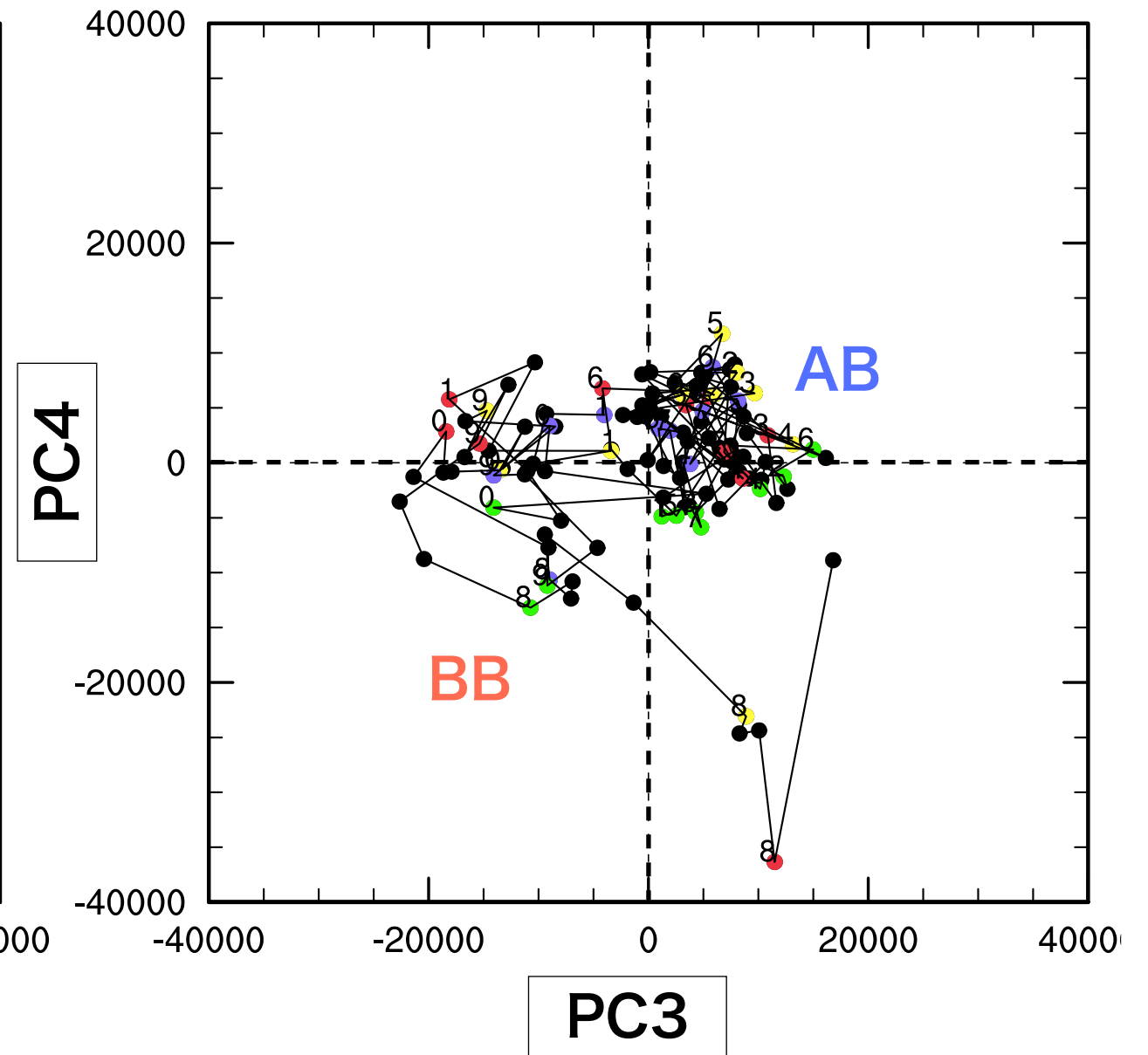
(PC1, PC2)

2km stratRainH ( $R < 0.65$  mm/h)



(PC3, PC4)

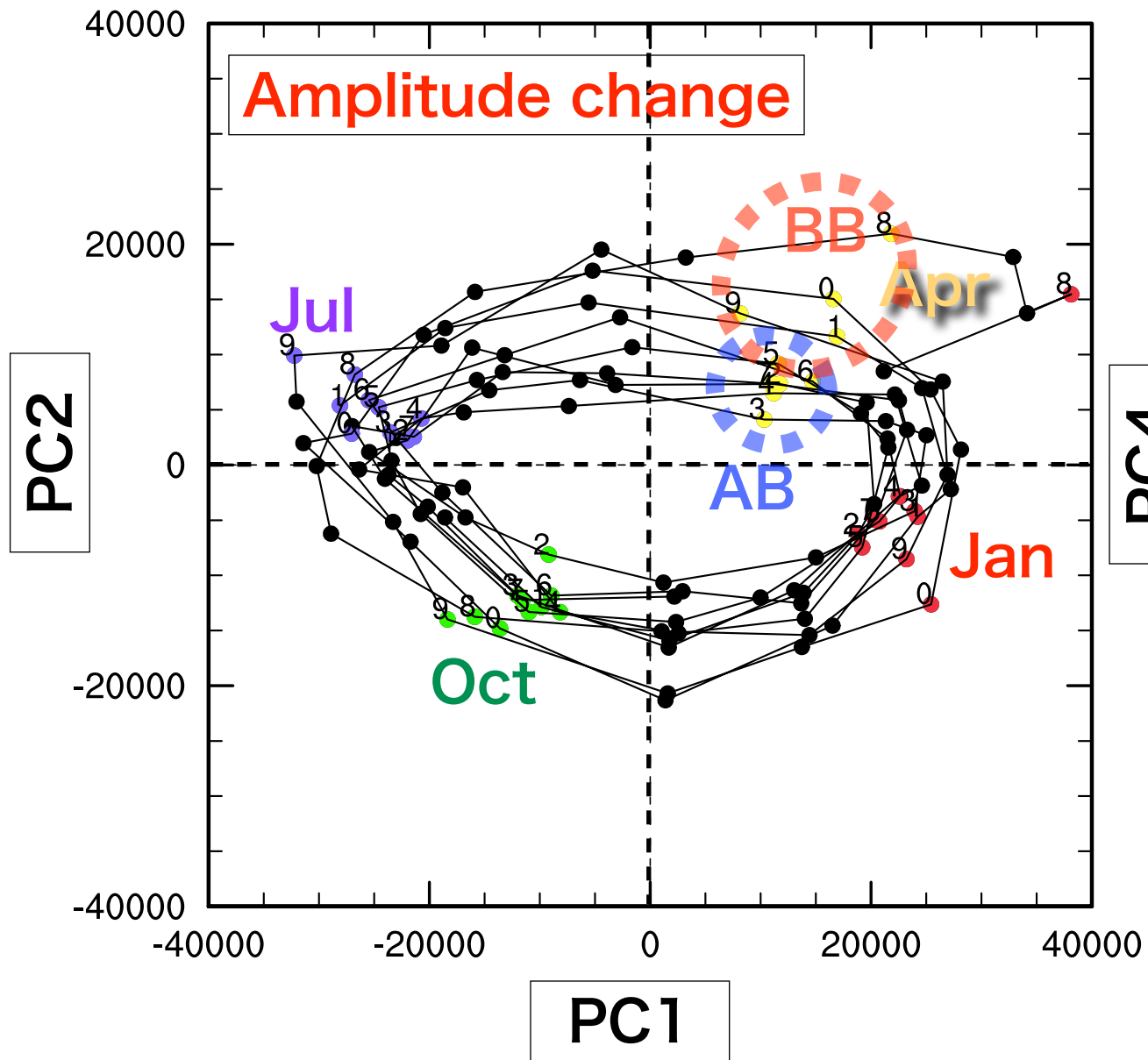
2km stratRainH ( $R < 0.65$  mm/h)



# stratR at 2 km ( $R < 0.65$ mm/h)

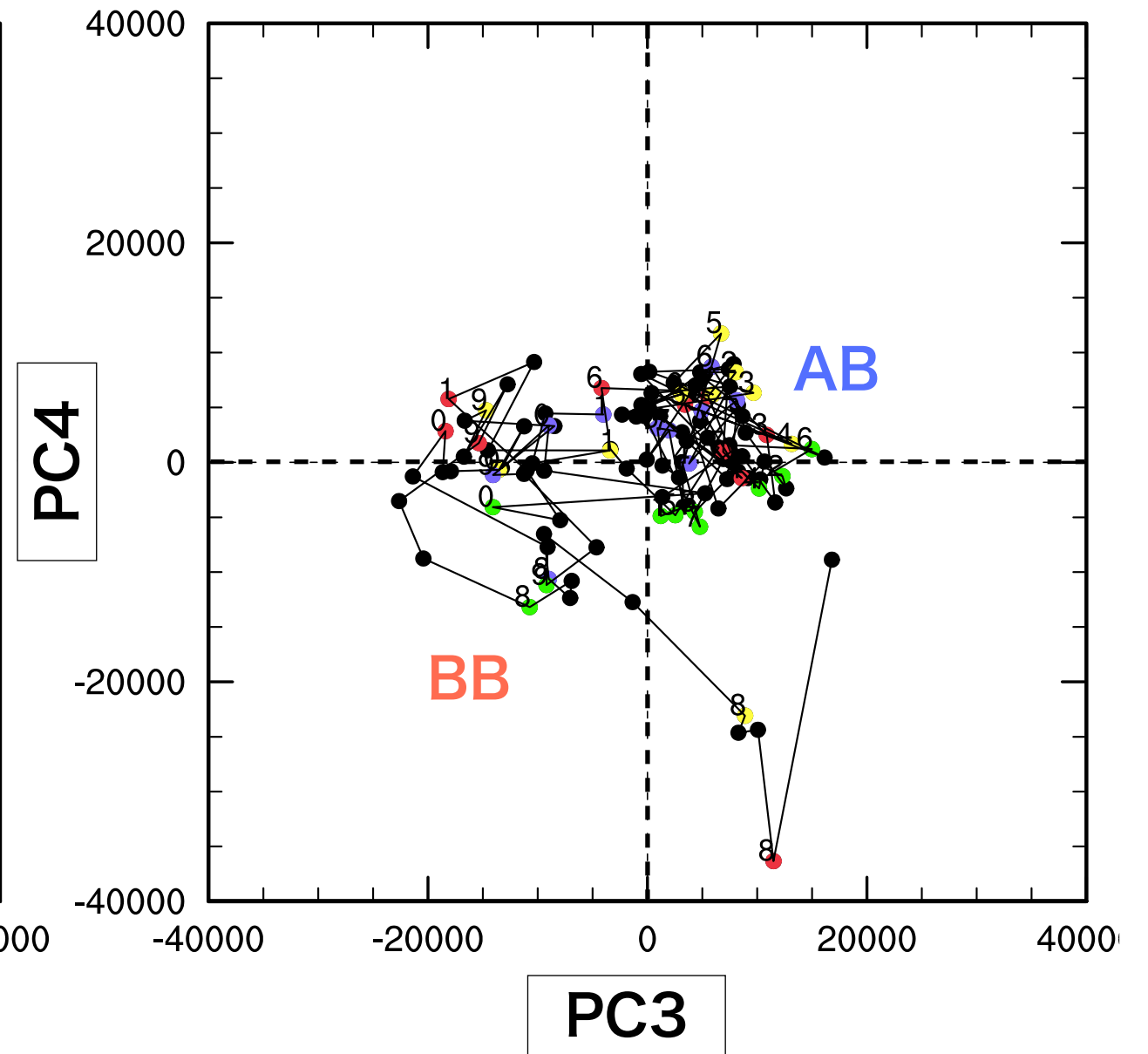
(PC1, PC2)

2km stratRainH ( $R < 0.65$  mm/h)

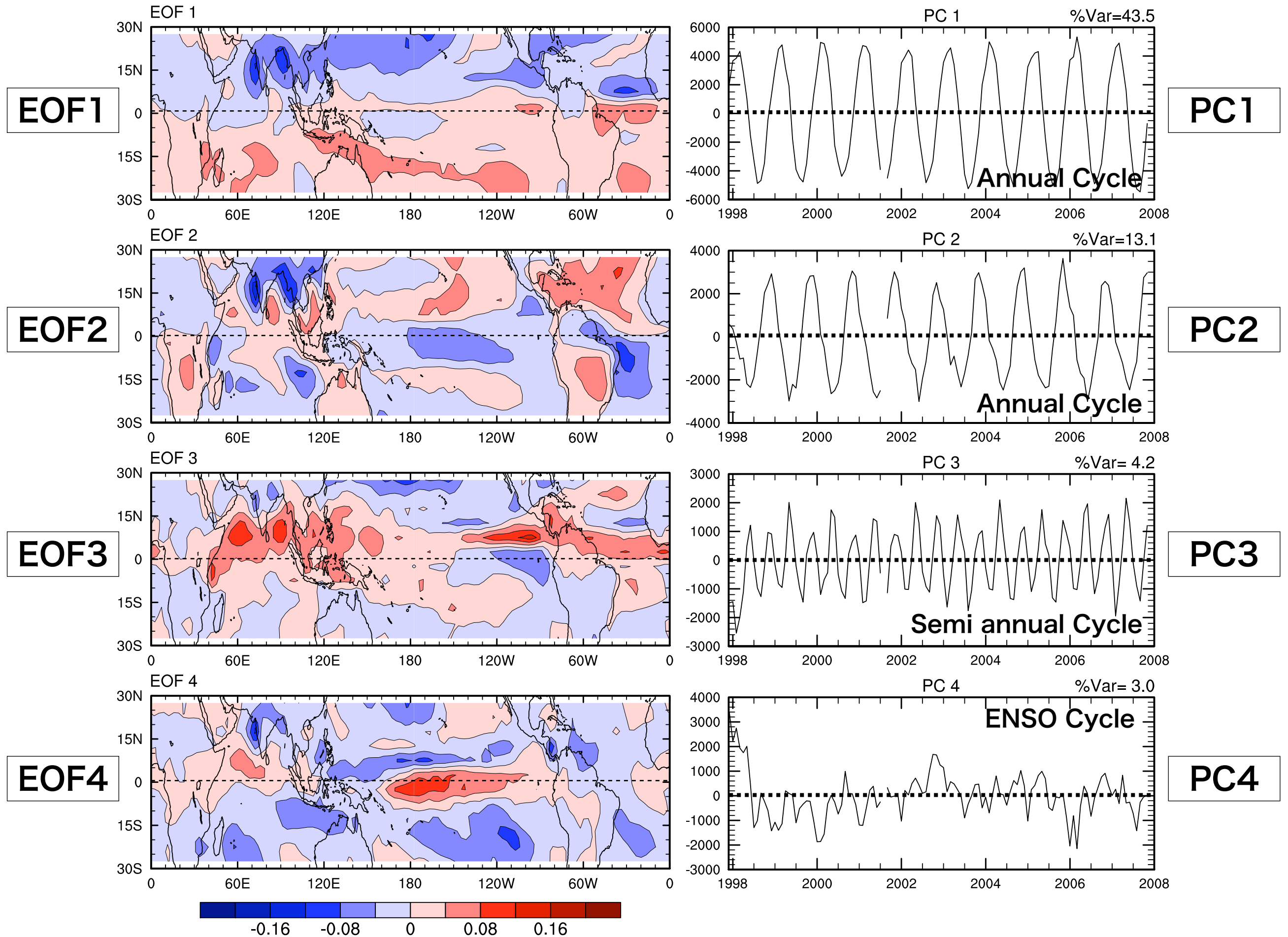


(PC3, PC4)

2km stratRainH ( $R < 0.65$  mm/h)



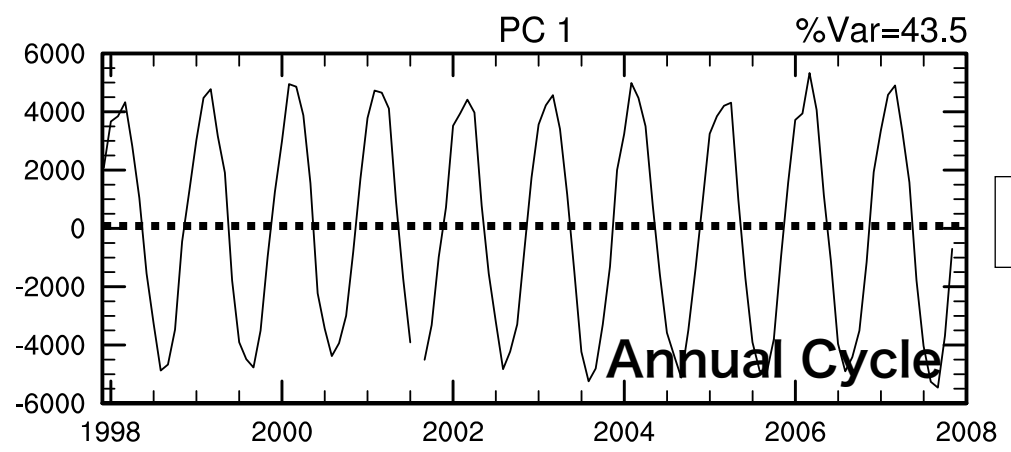
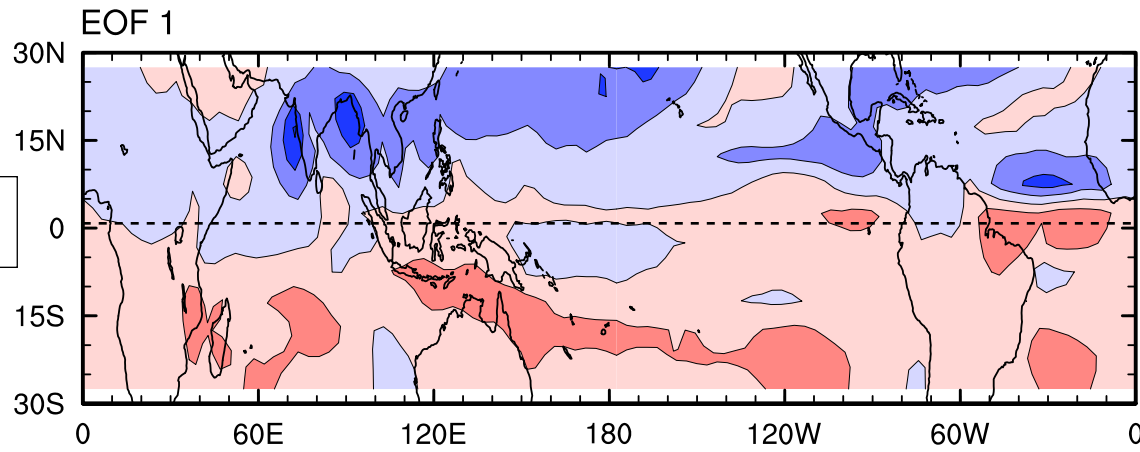
# ConvR at 2 km ( $0.86 < R < 2.7$ mm/h)





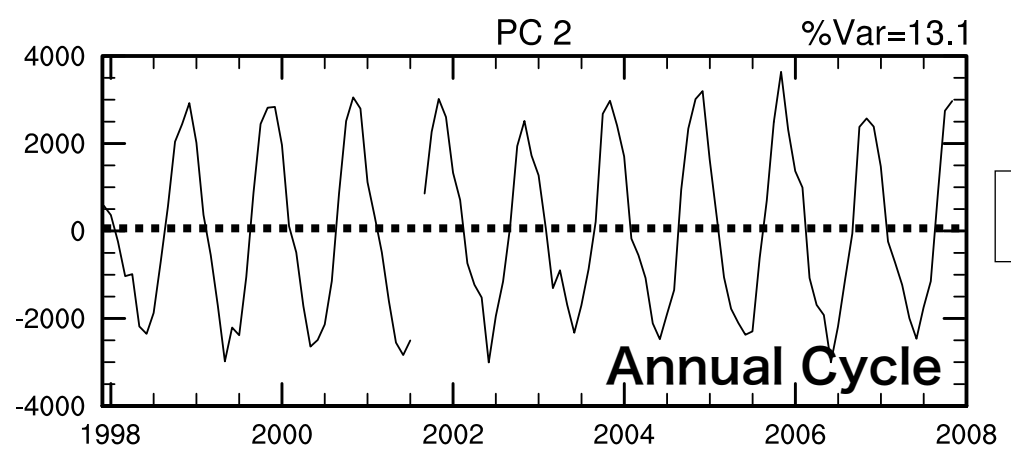
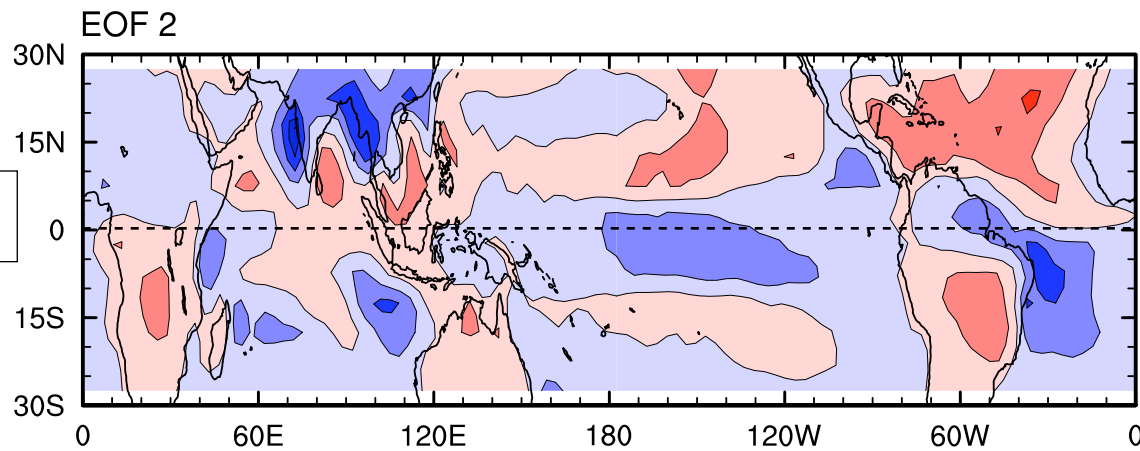
# ConvR at 2 km ( $0.86 < R < 2.7$ mm/h)

EOF1



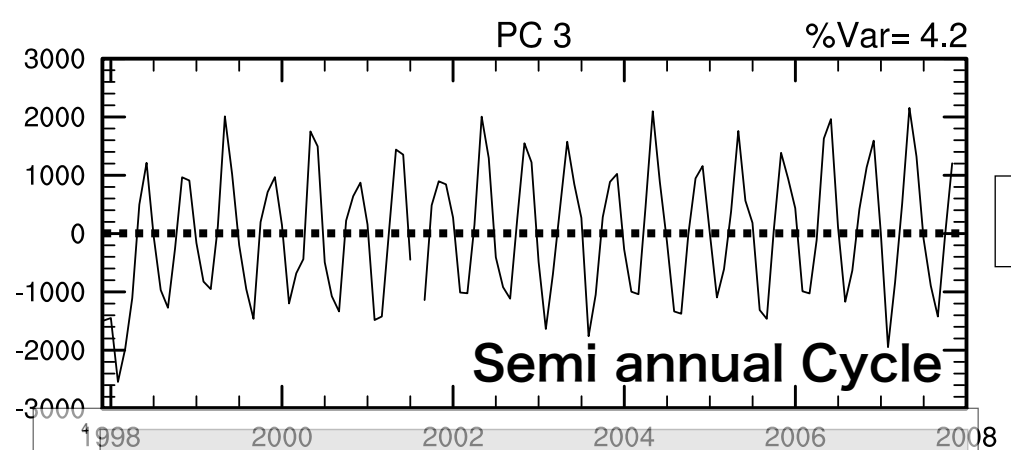
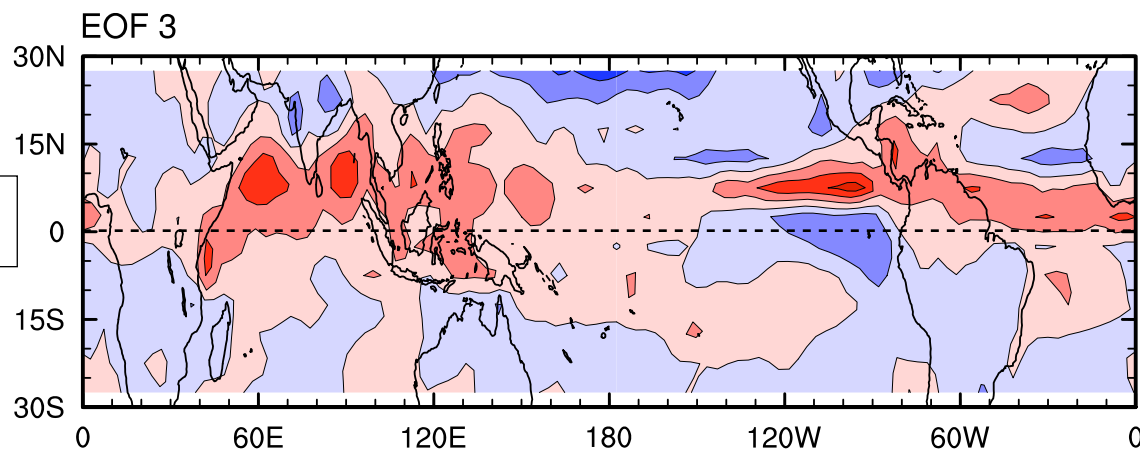
PC1

EOF2



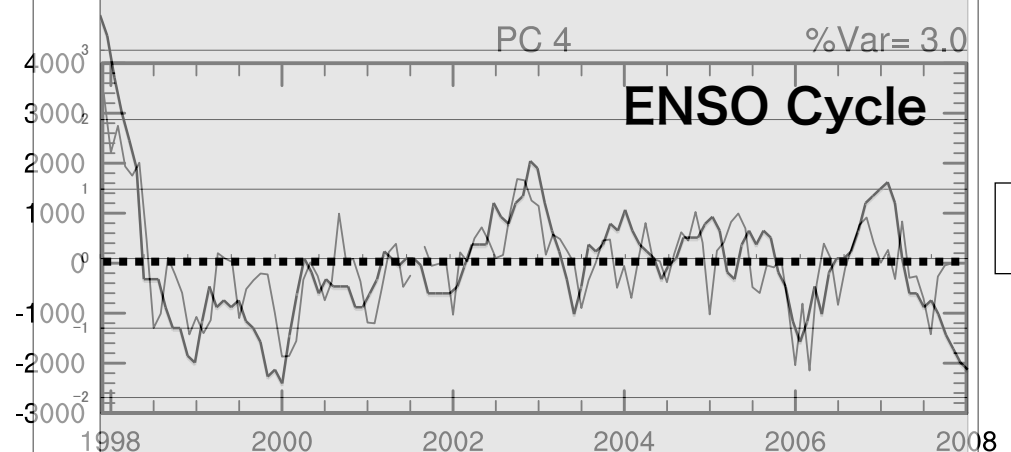
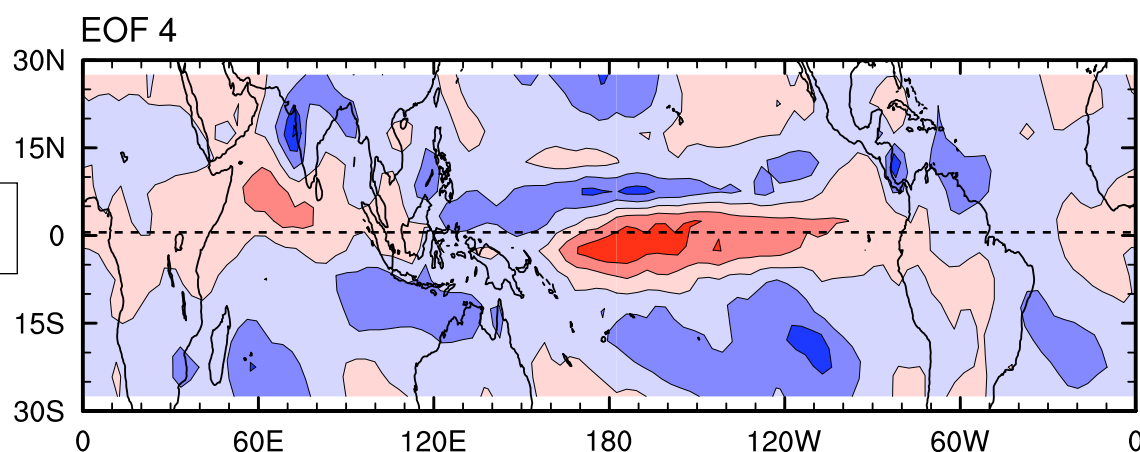
PC2

EOF3

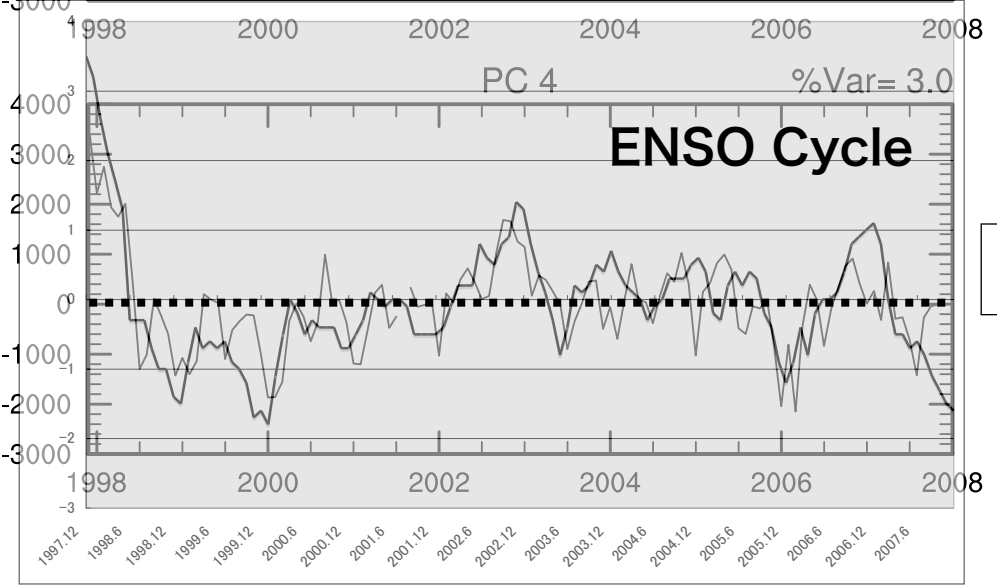
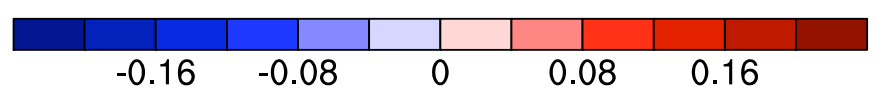


PC3

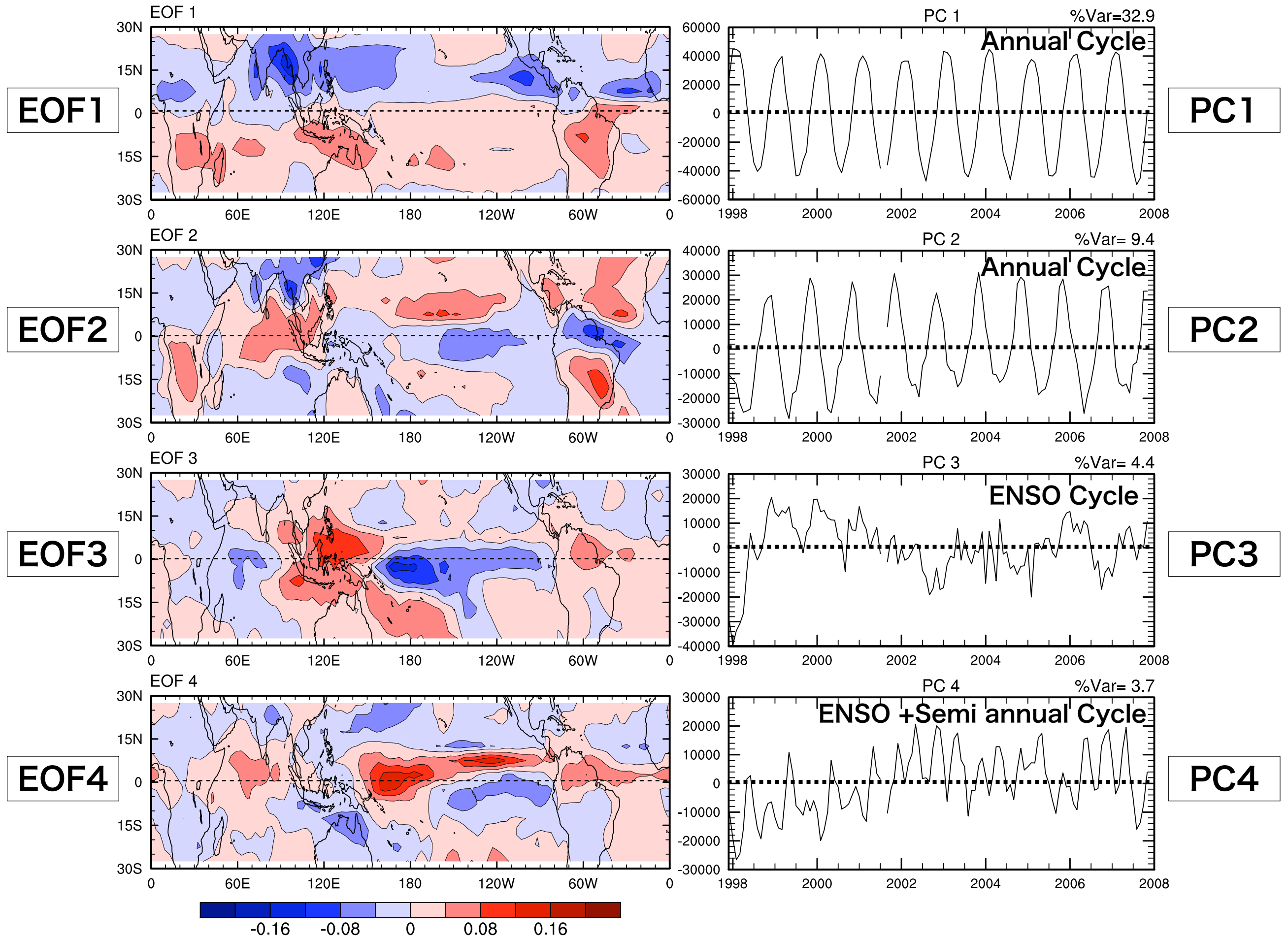
EOF4



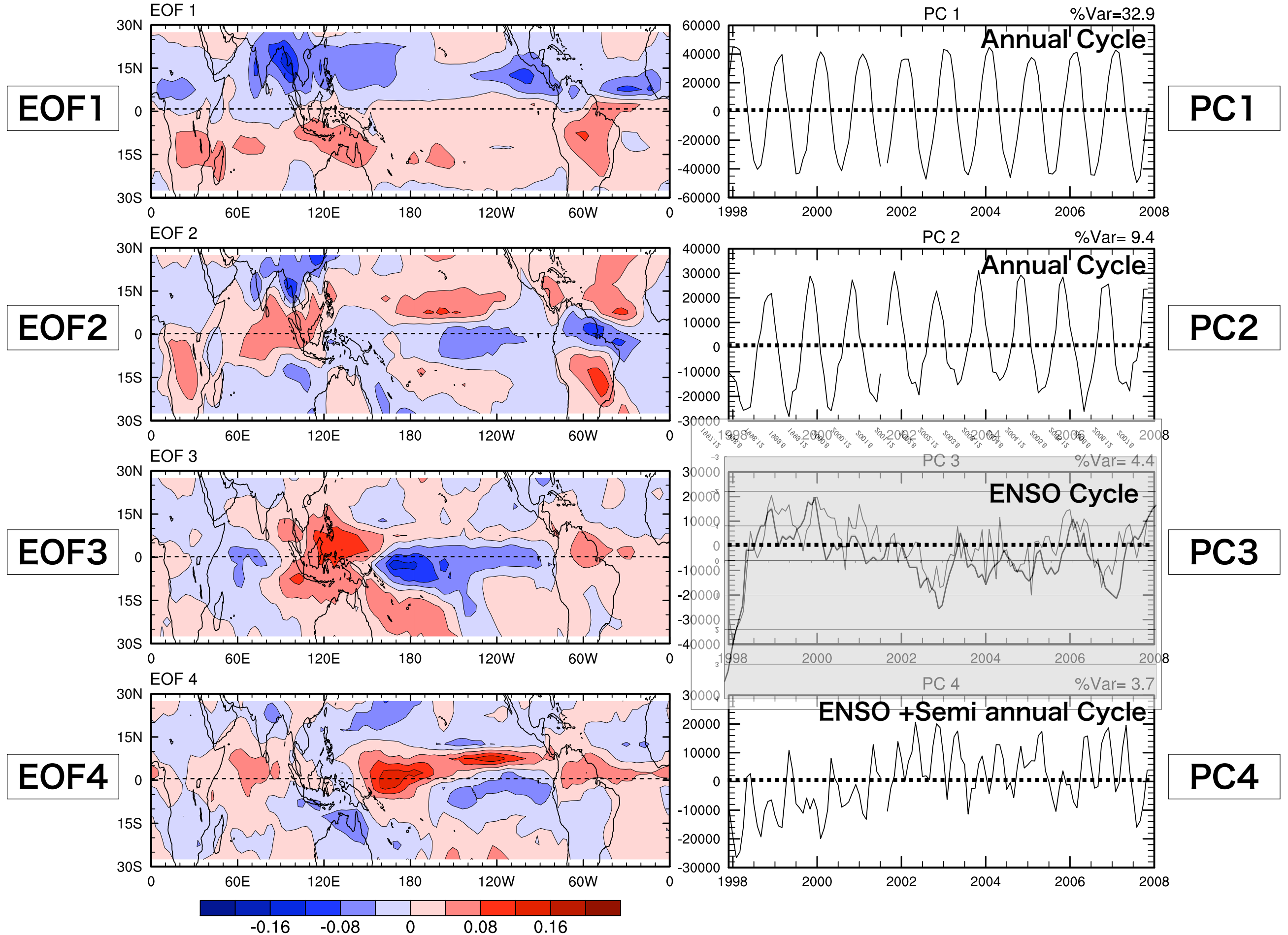
PC4



# Rain at 2 km ( $0.65 < R < 2.7$ mm/h)



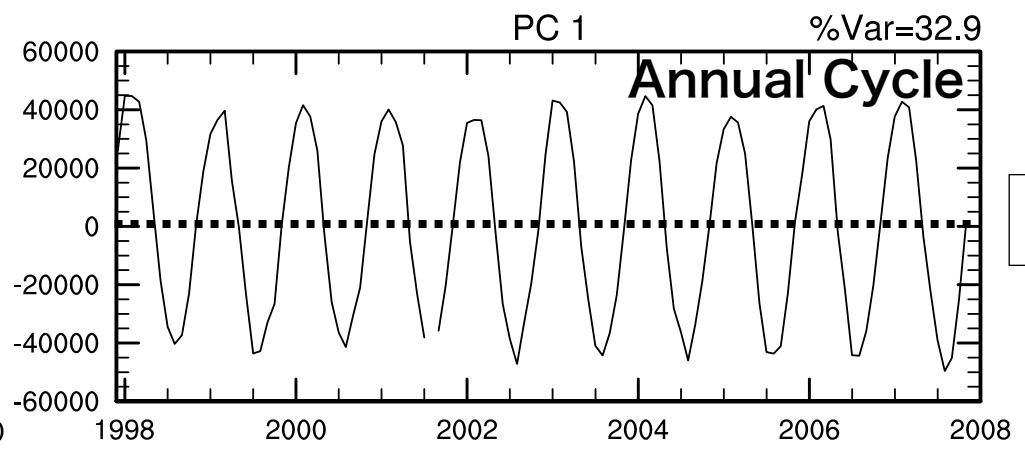
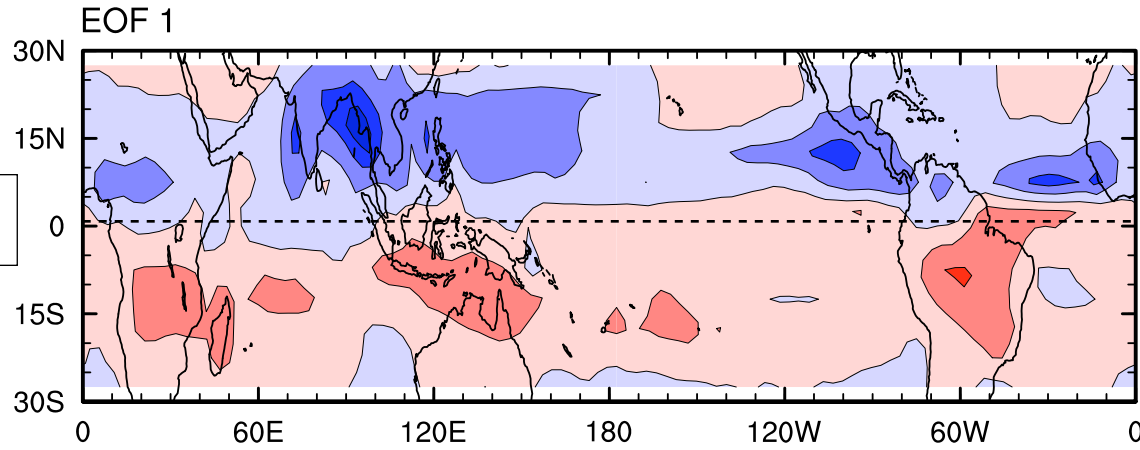
# Rain at 2 km ( $0.65 < R < 2.7$ mm/h)





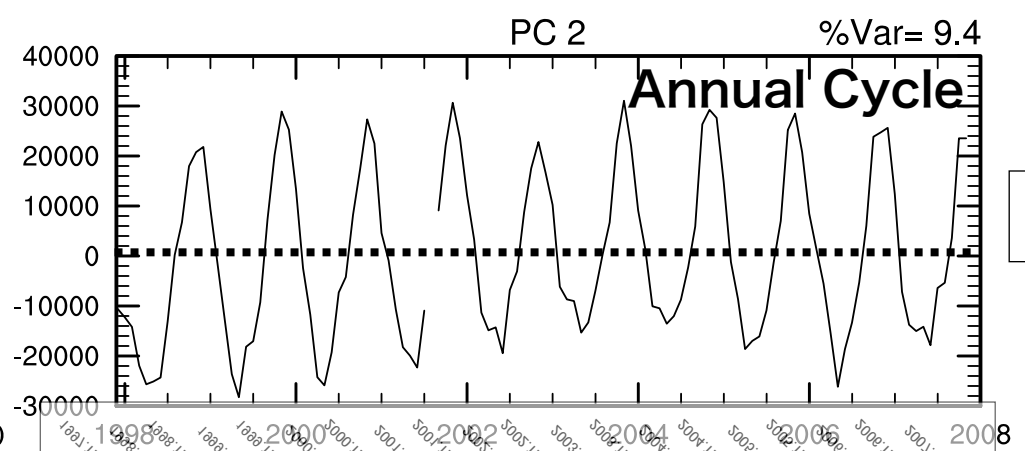
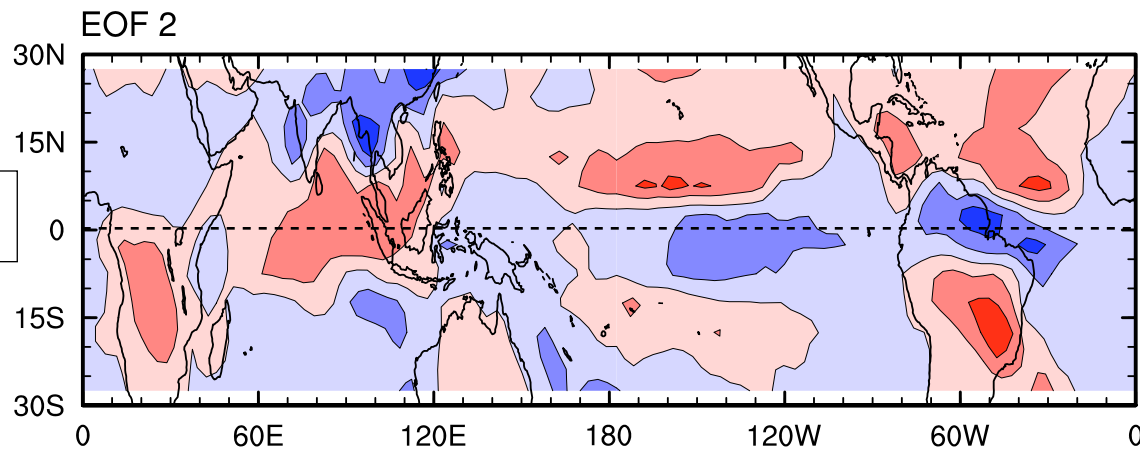
# Rain at 2 km ( $0.65 < R < 2.7$ mm/h)

EOF1



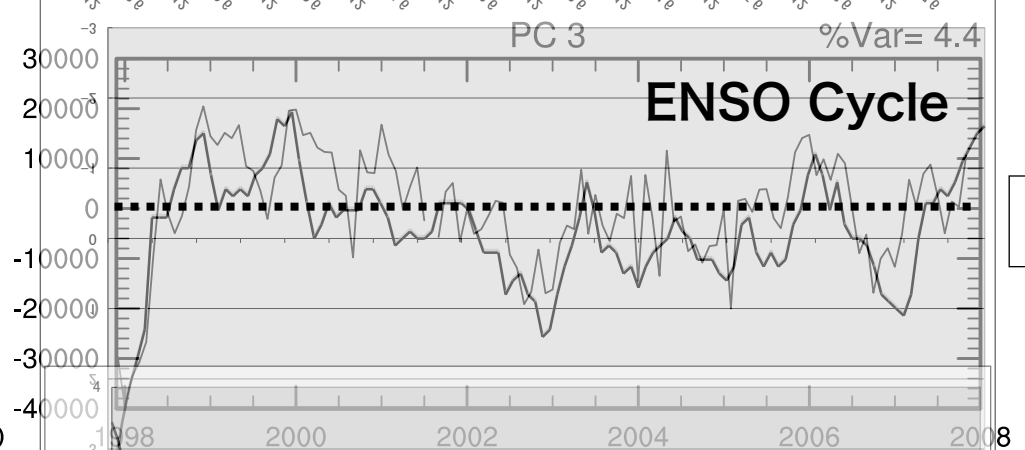
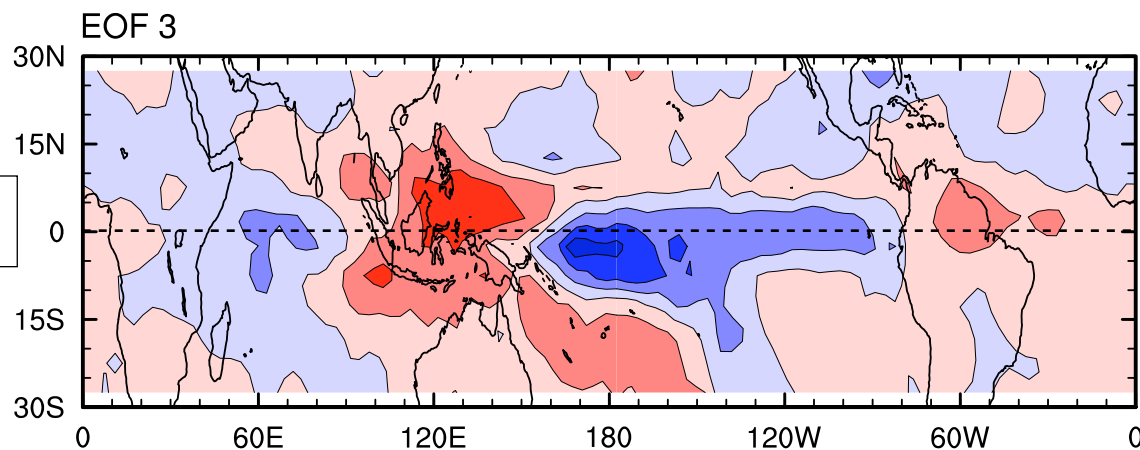
PC1

EOF2



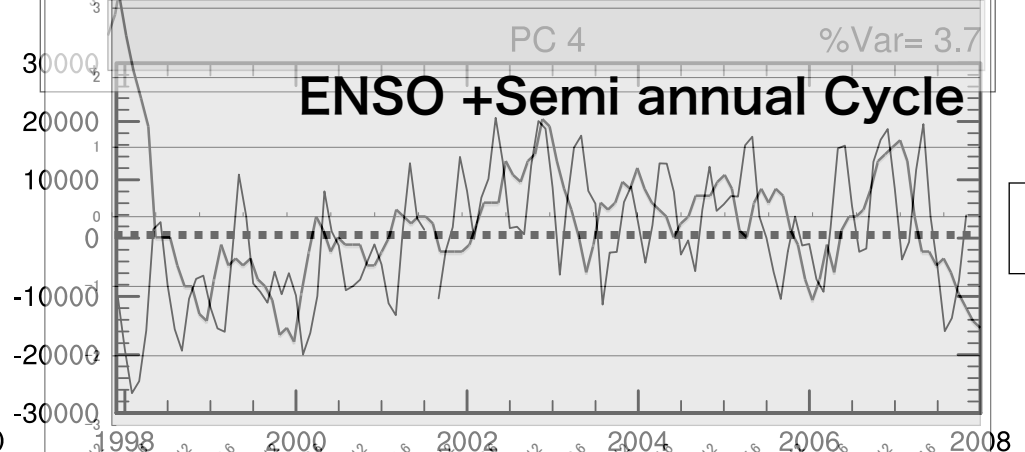
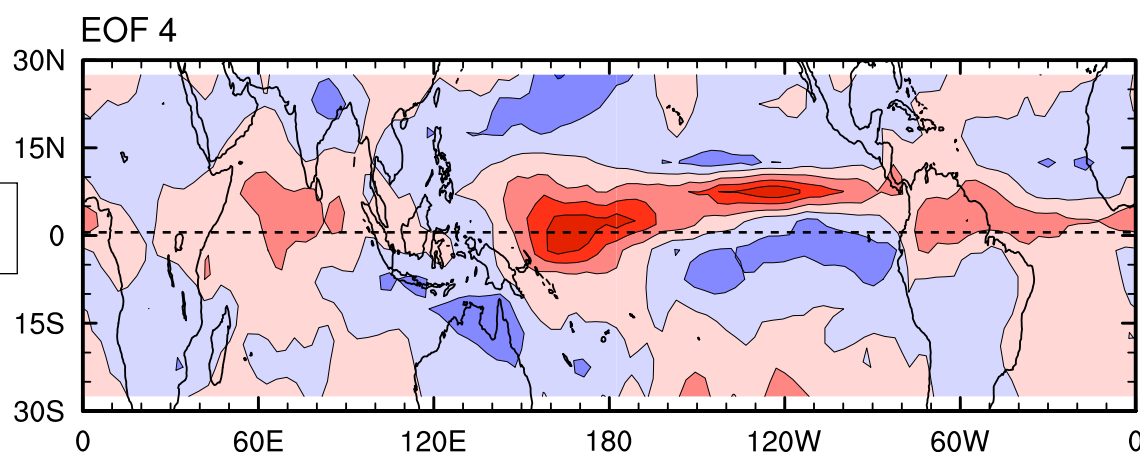
PC2

EOF3

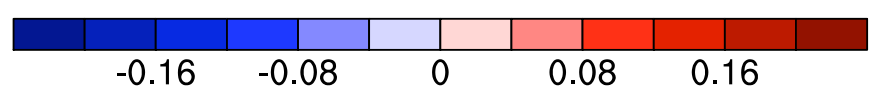


PC3

EOF4



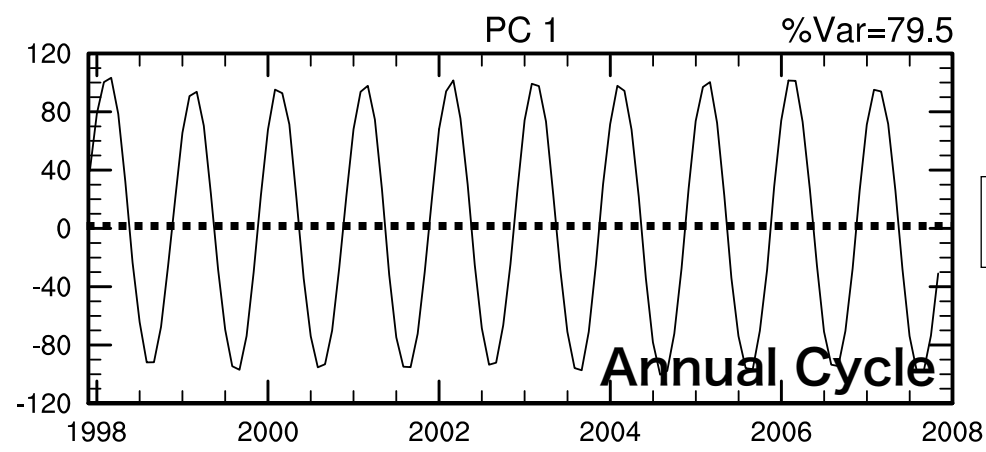
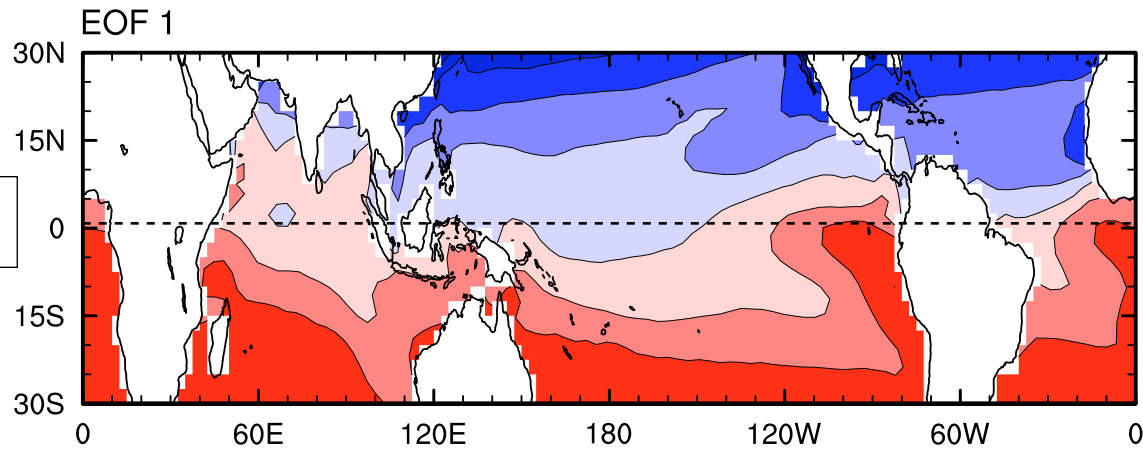
PC4





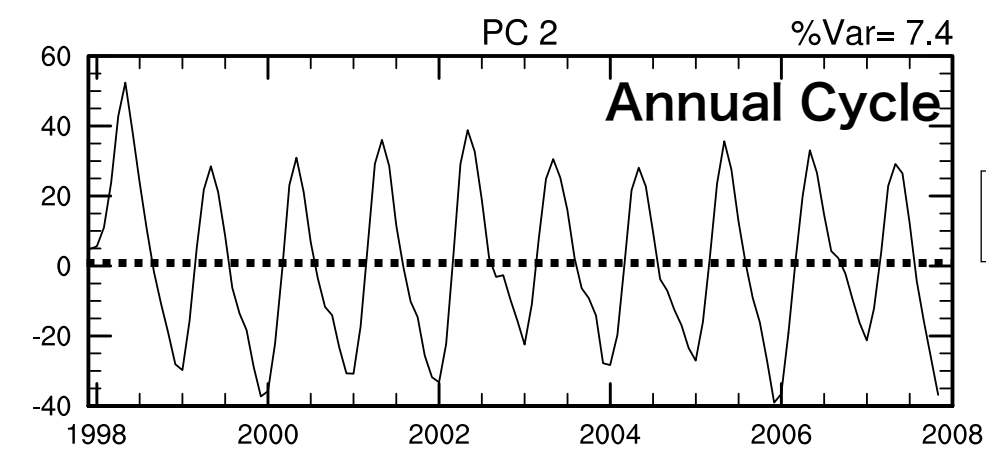
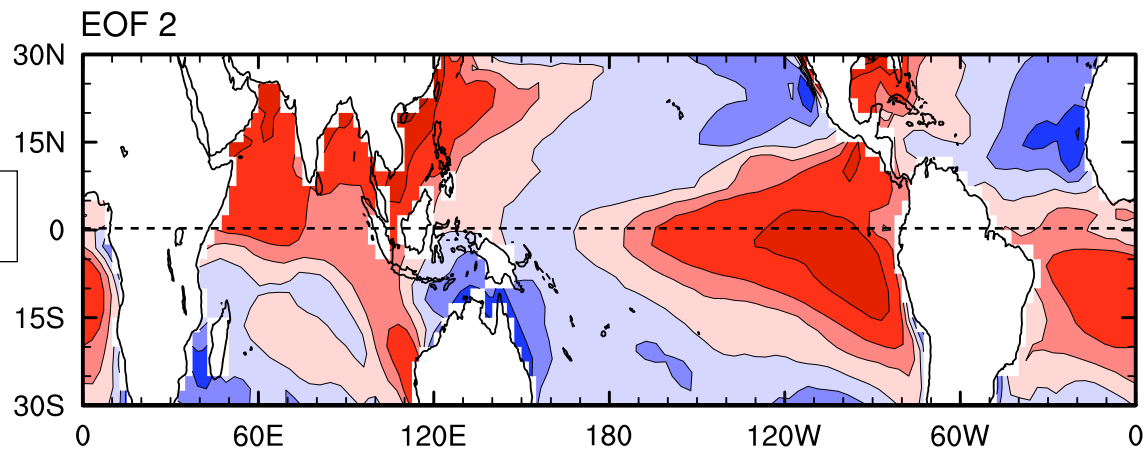
# SST

EOF1



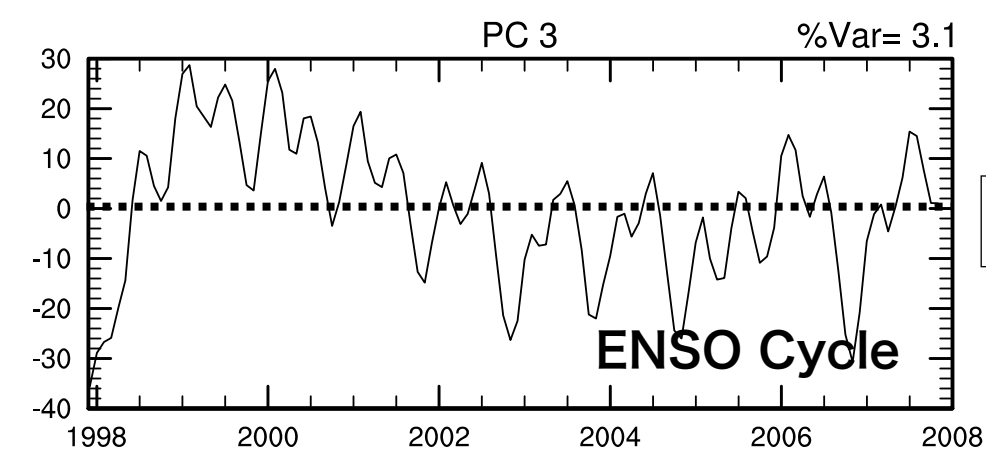
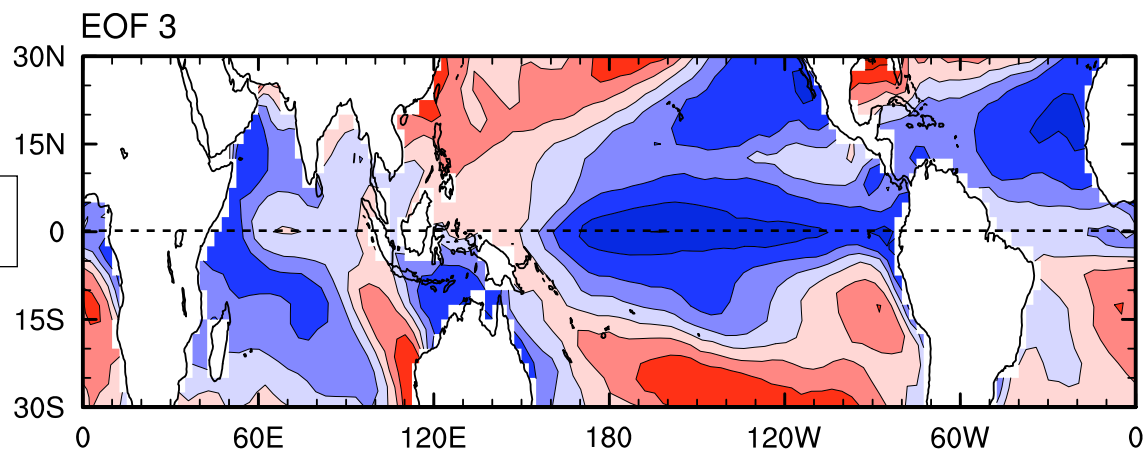
PC1

EOF2



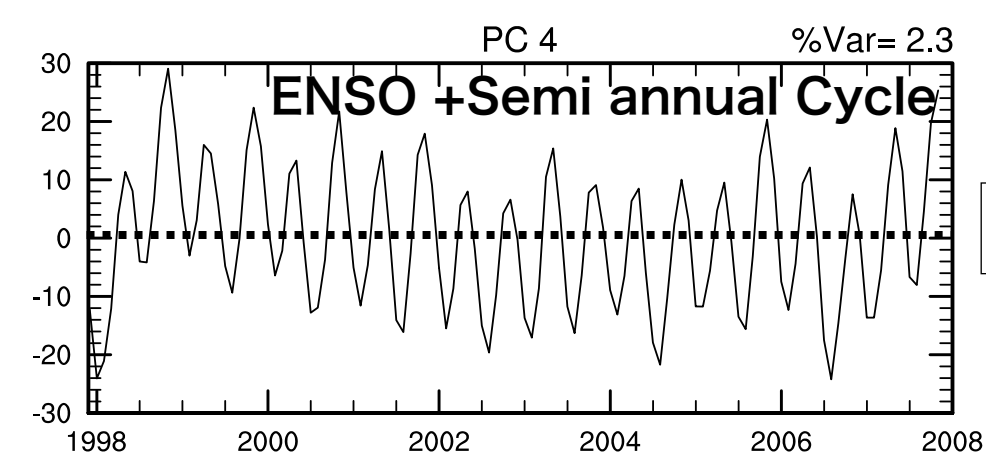
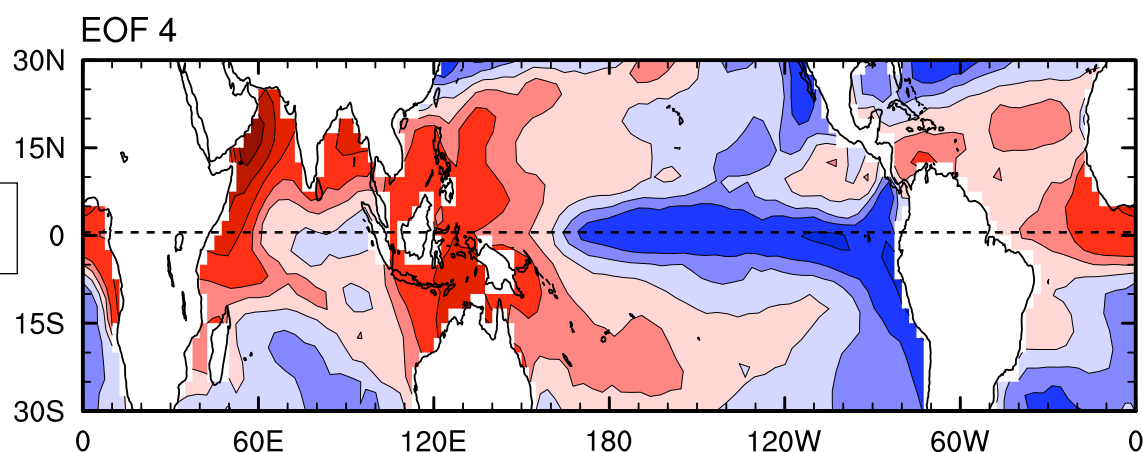
PC2

EOF3

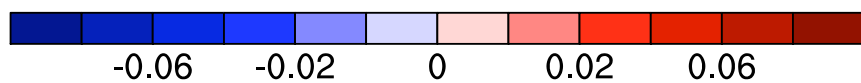


PC3

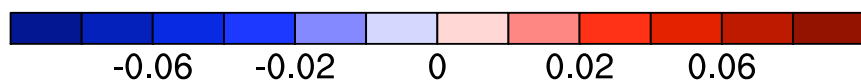
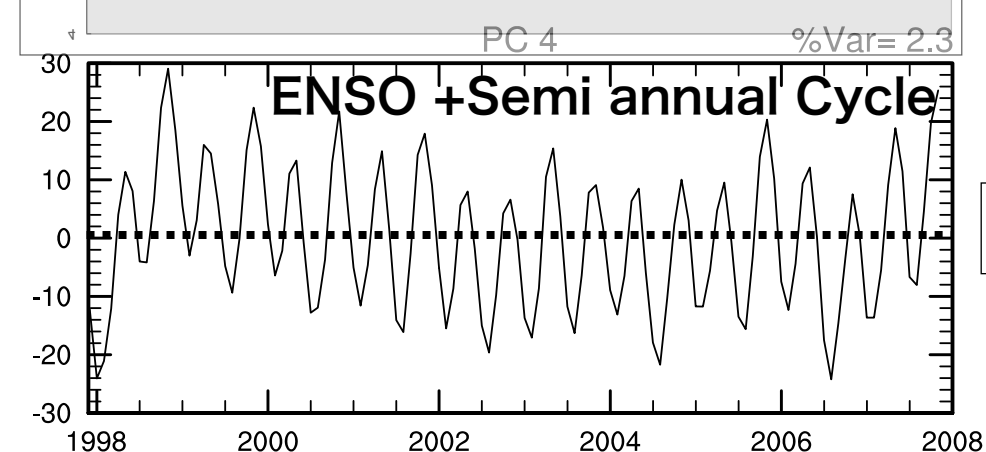
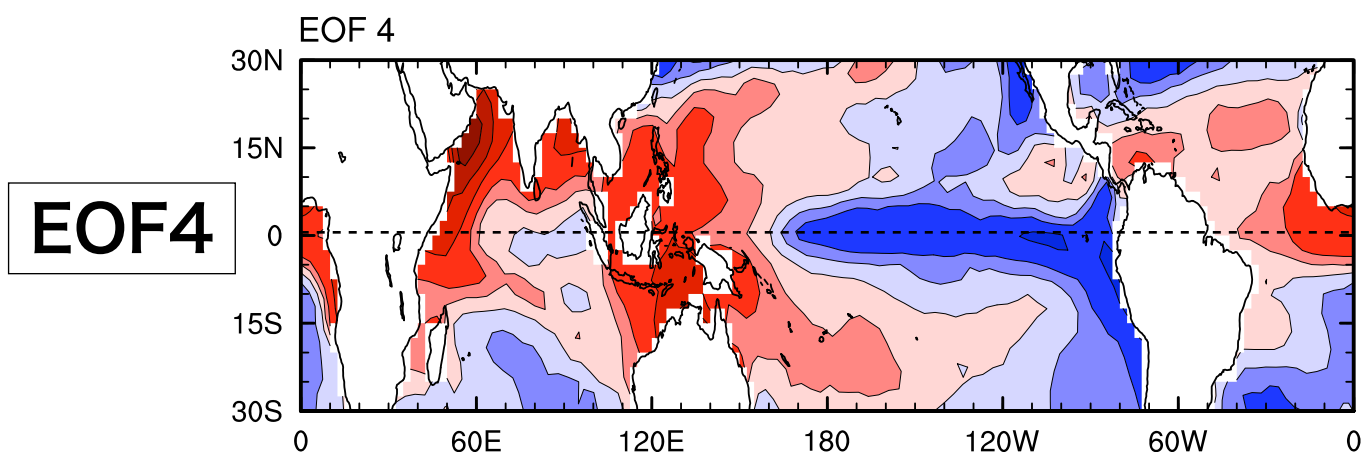
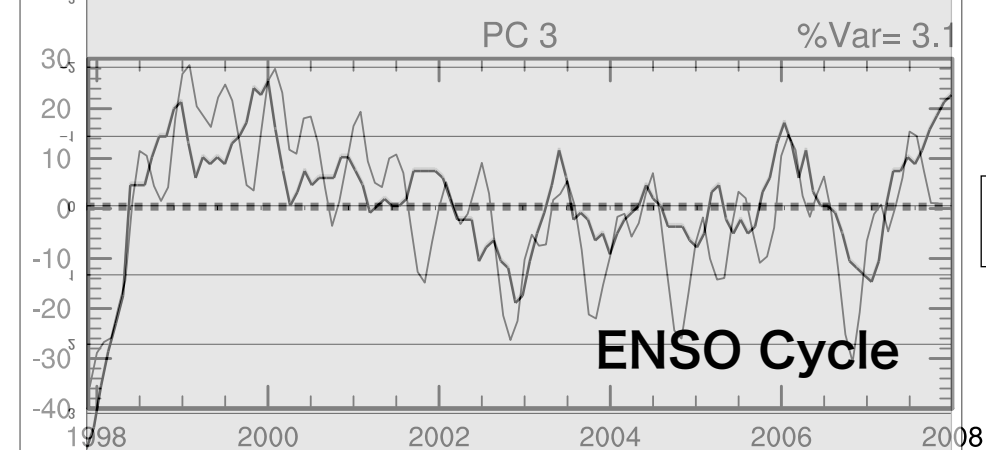
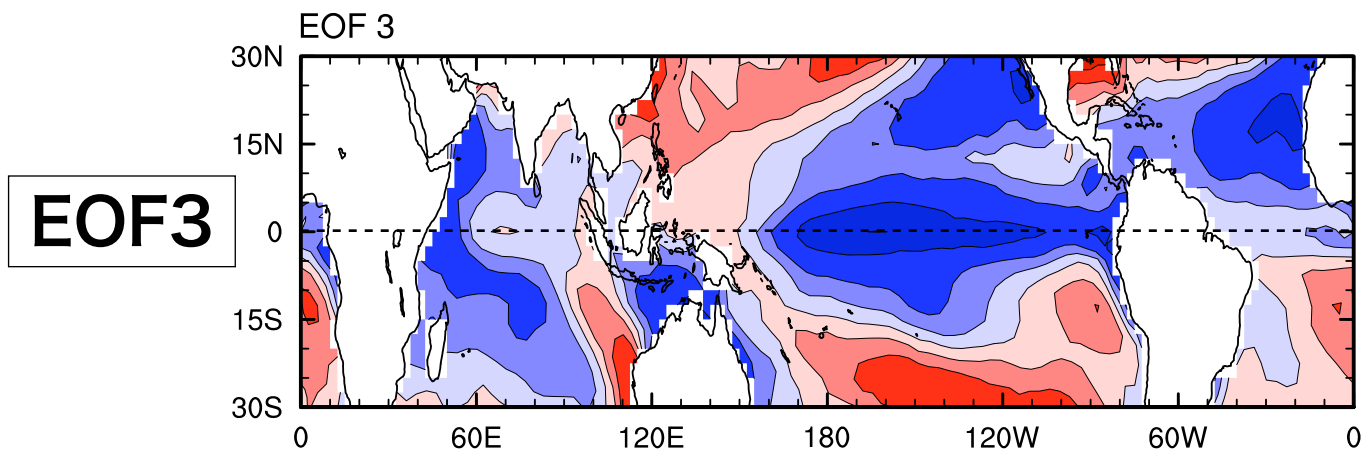
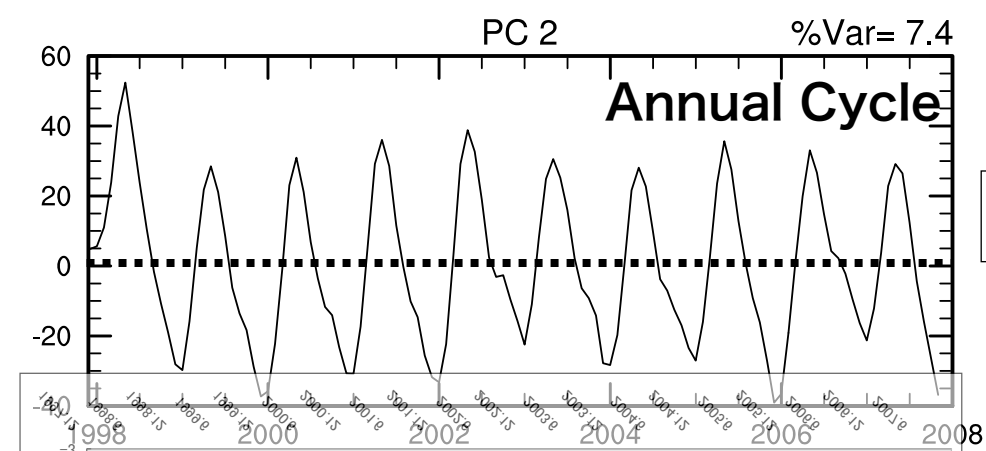
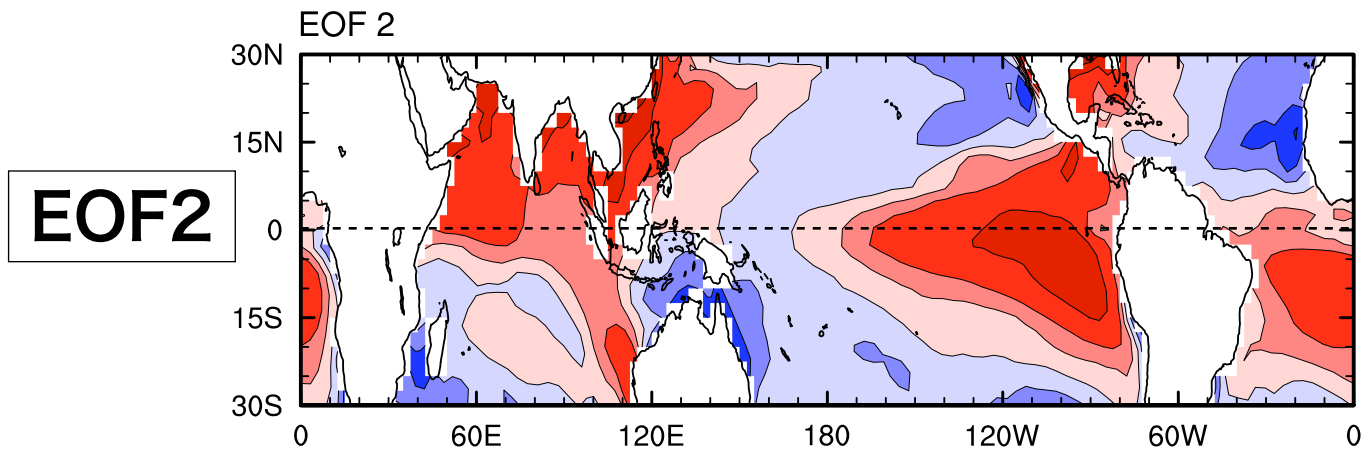
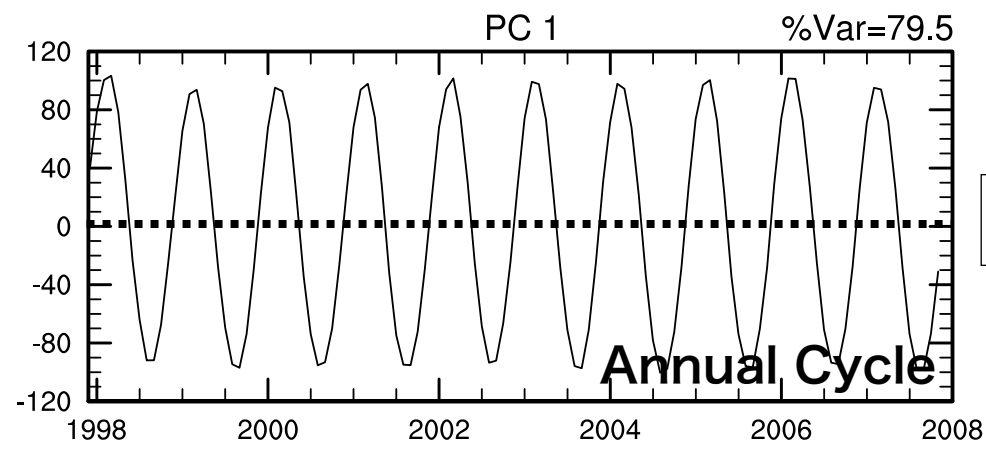
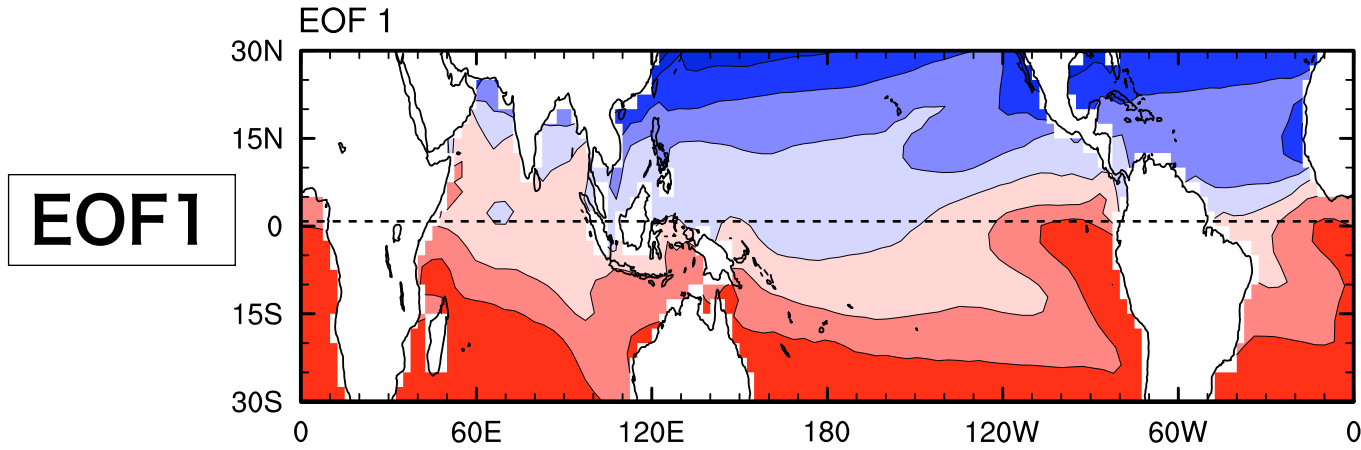
EOF4



PC4

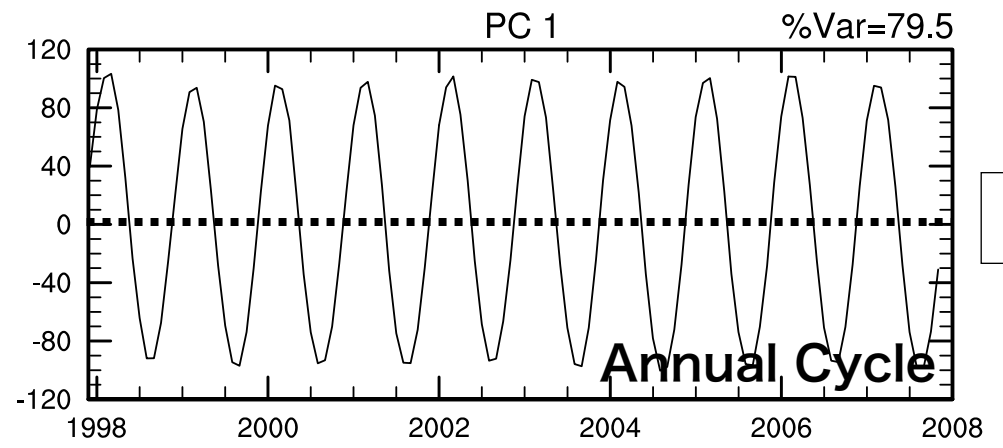
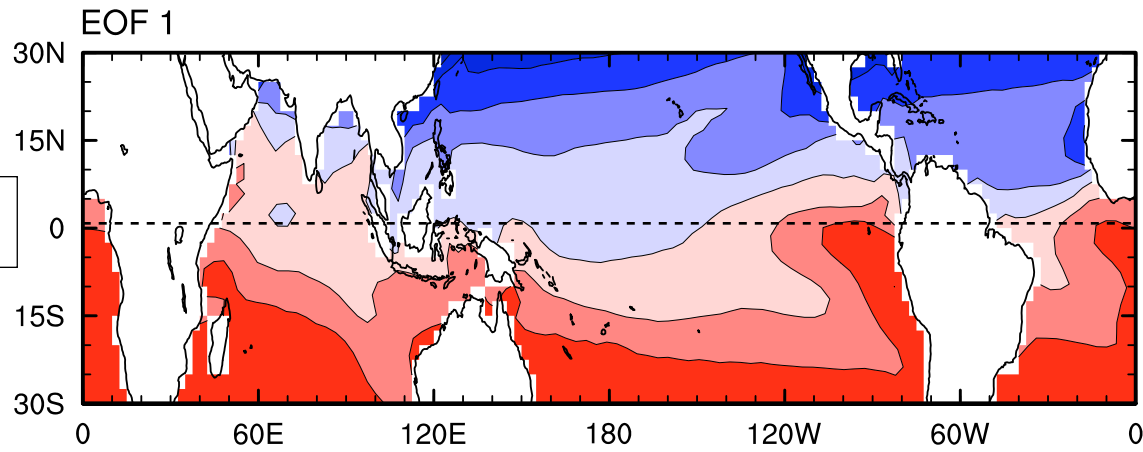


# SST



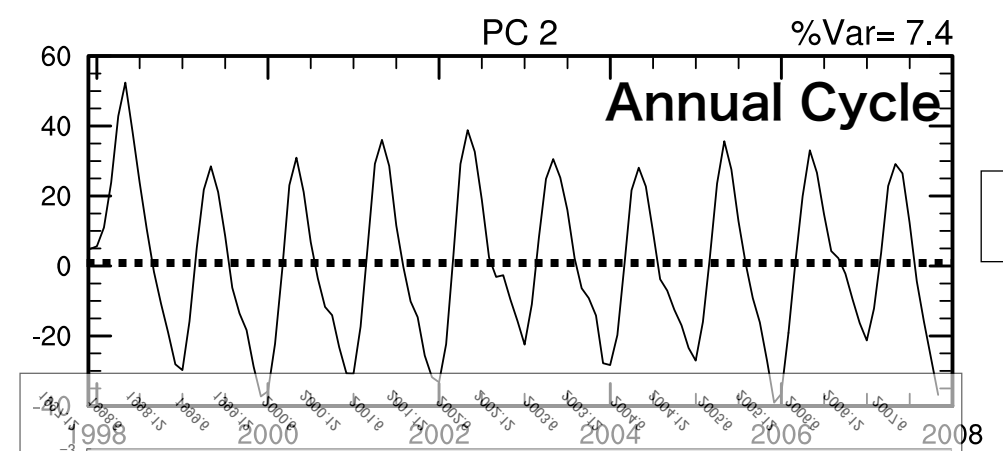
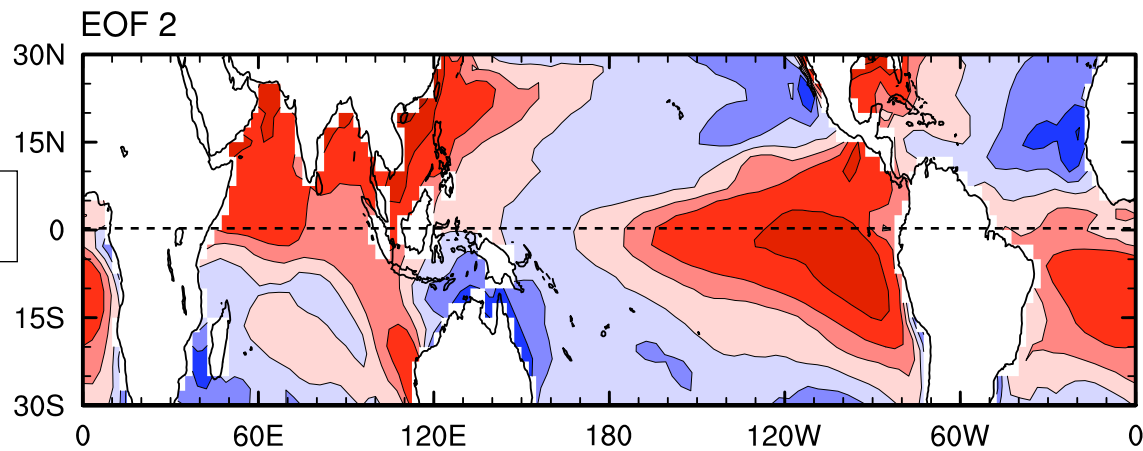
# SST

EOF1



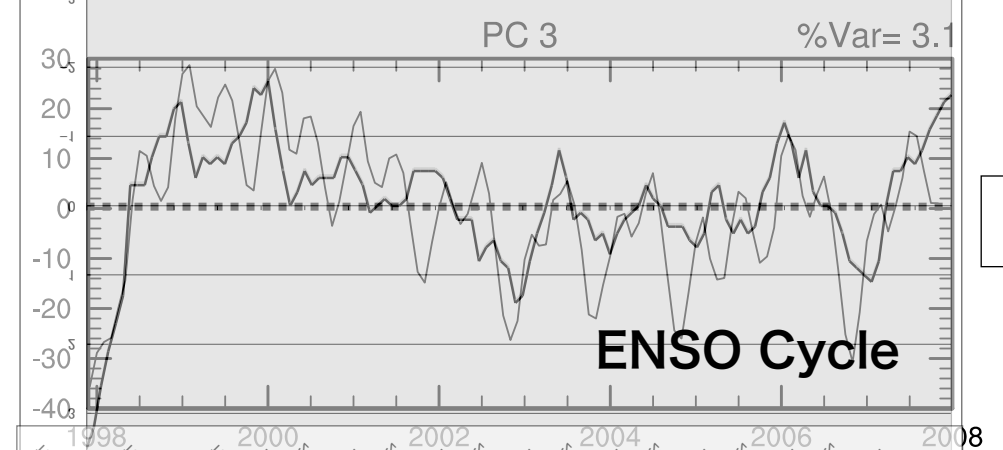
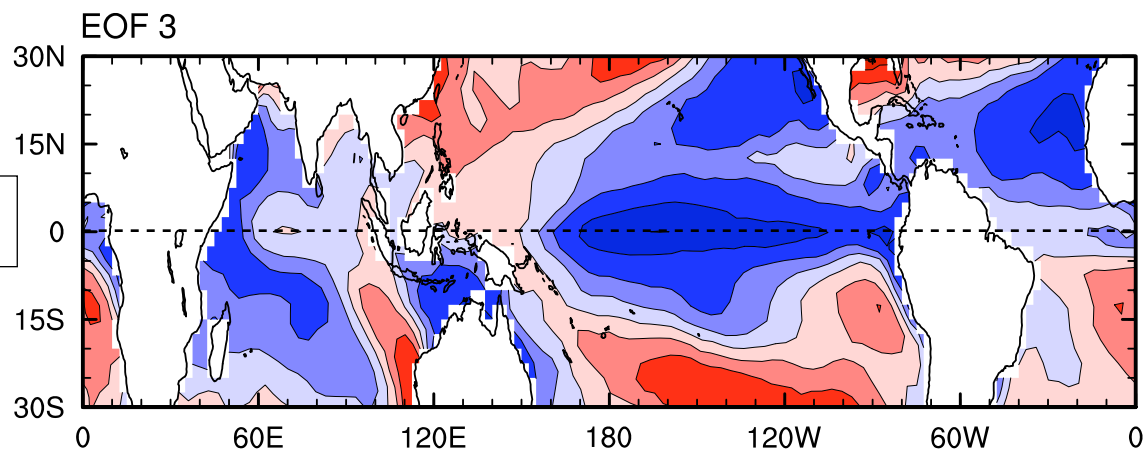
PC1

EOF2



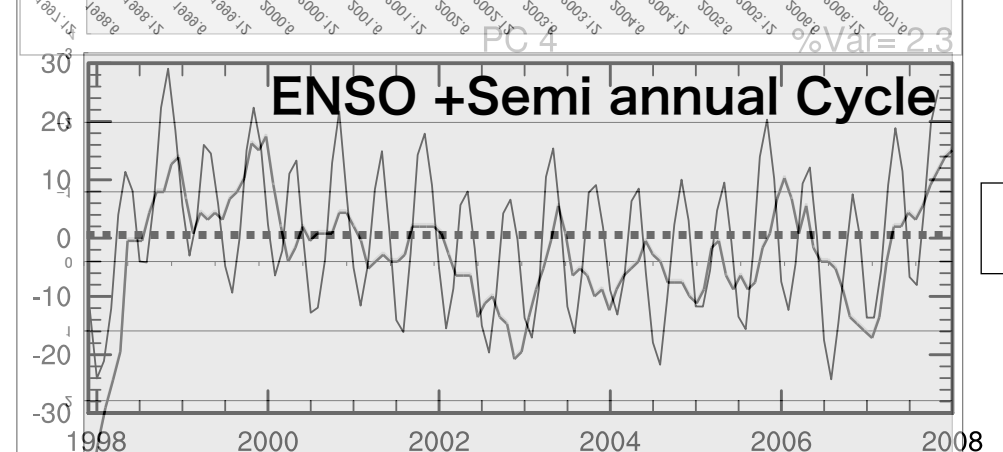
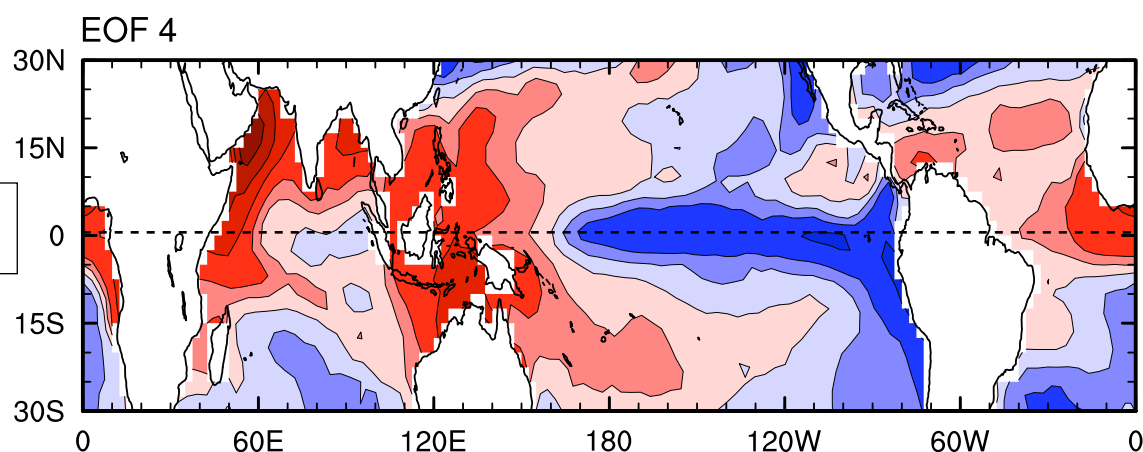
PC2

EOF3

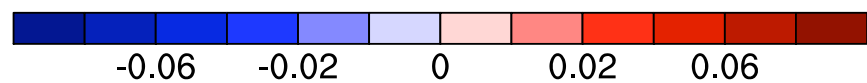


PC3

EOF4

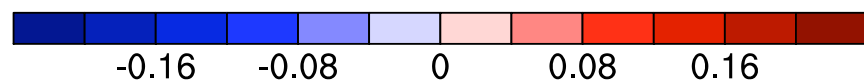
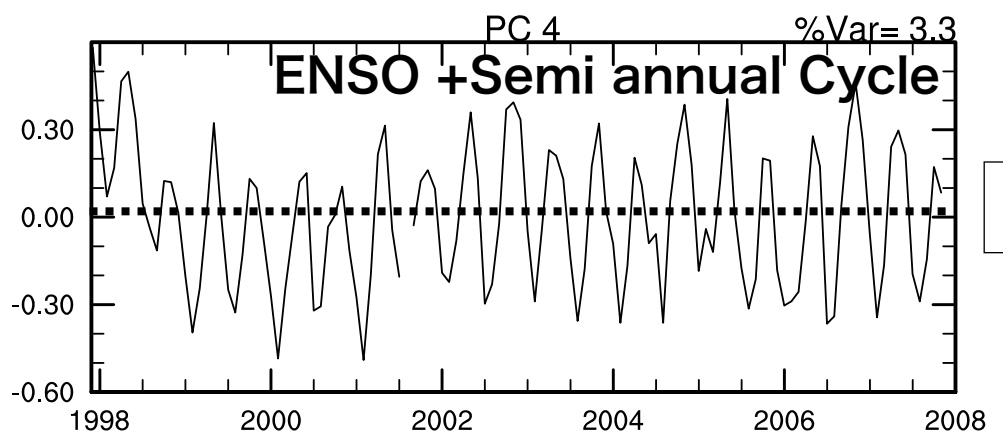
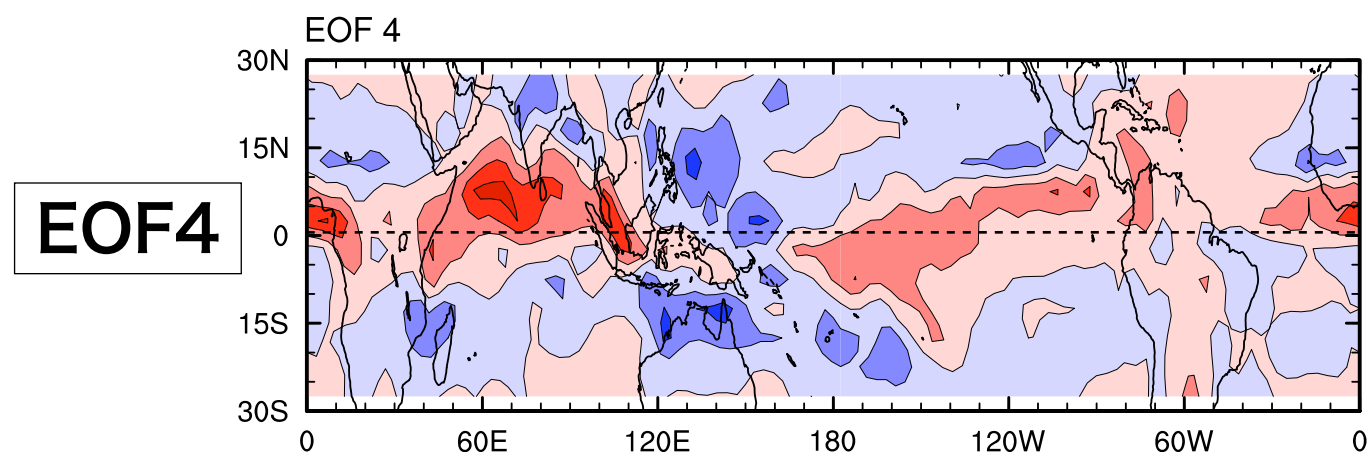
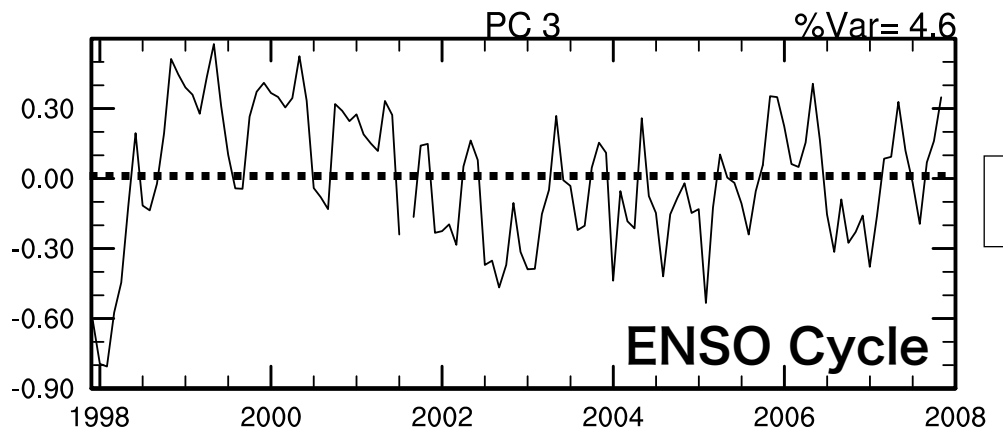
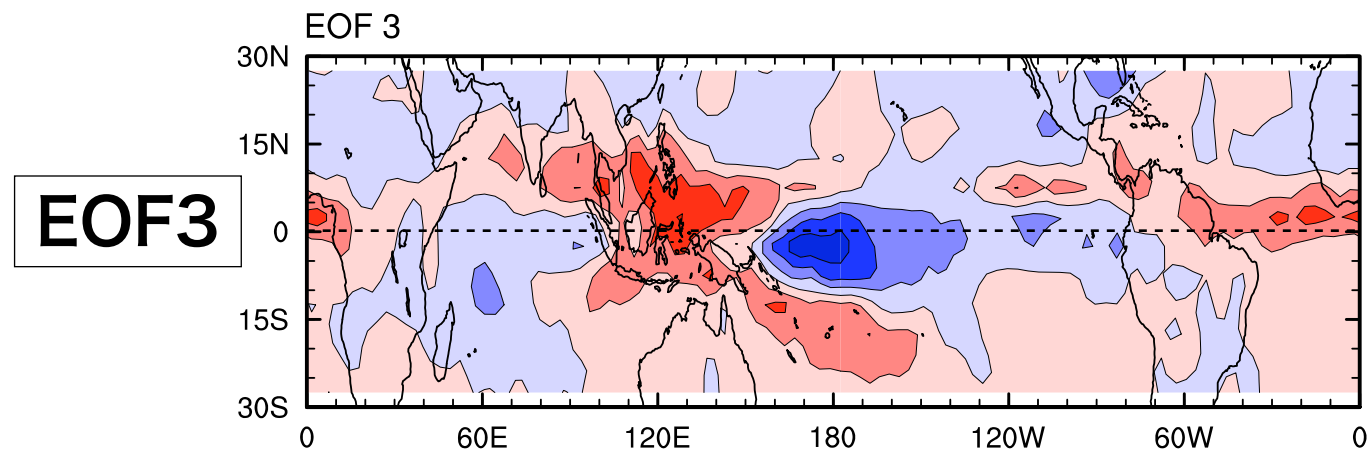
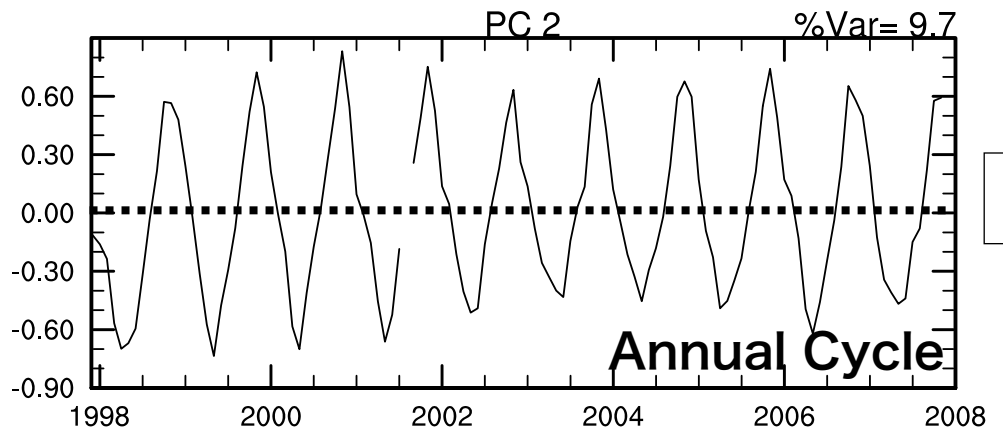
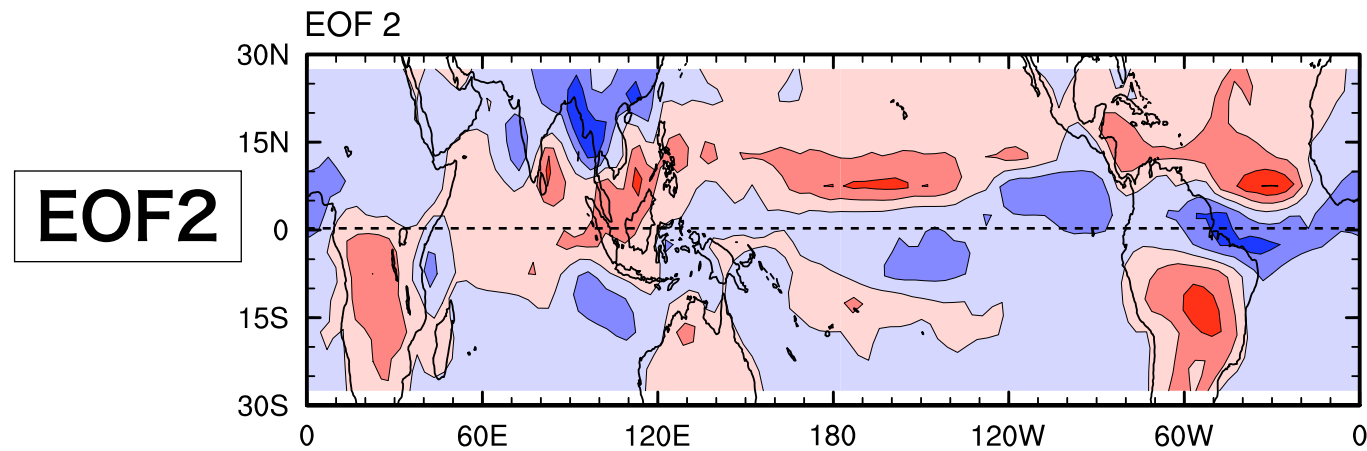
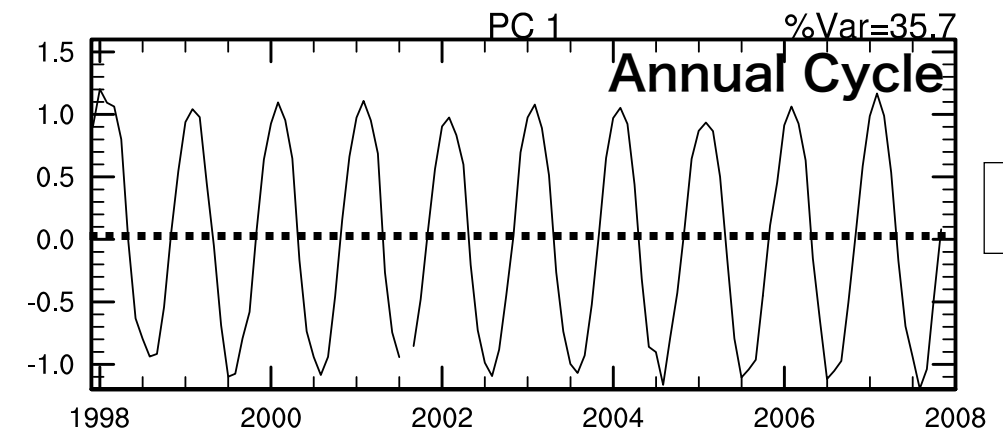
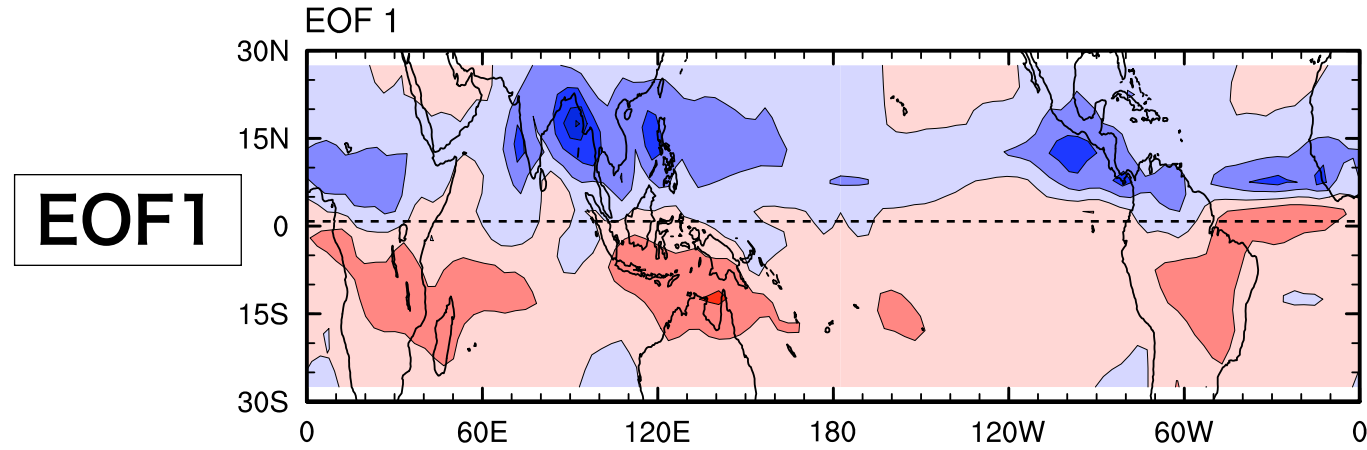


PC4



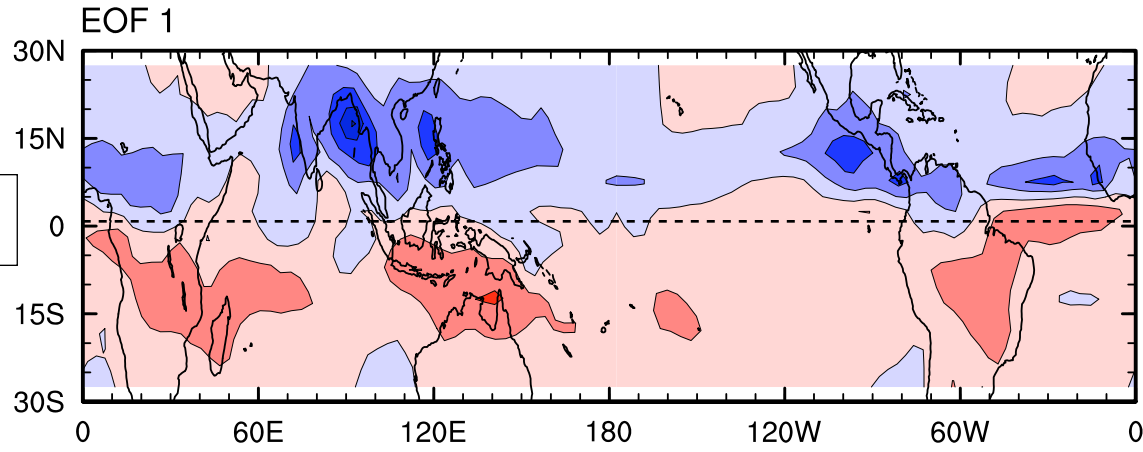


# ConvRuncon at 2 km

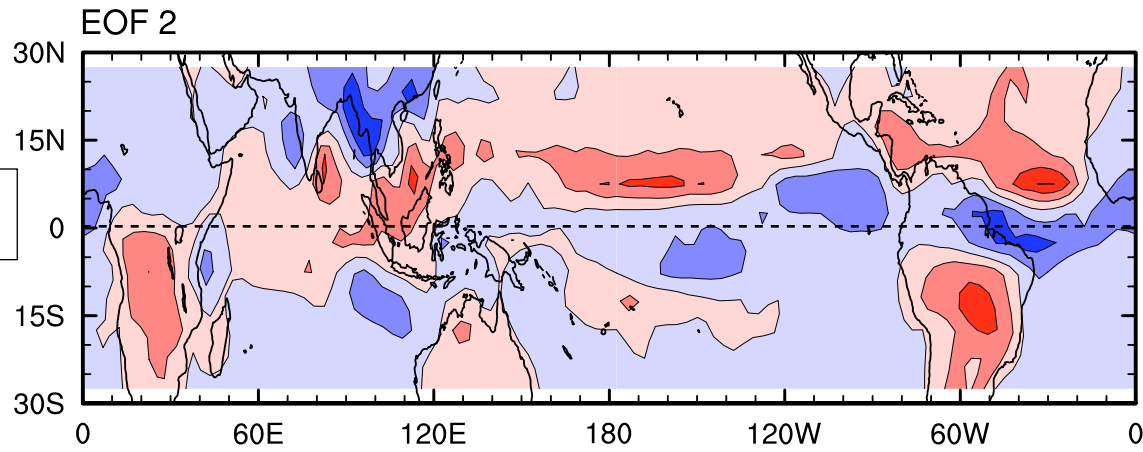


# ConvRuncon at 2 km

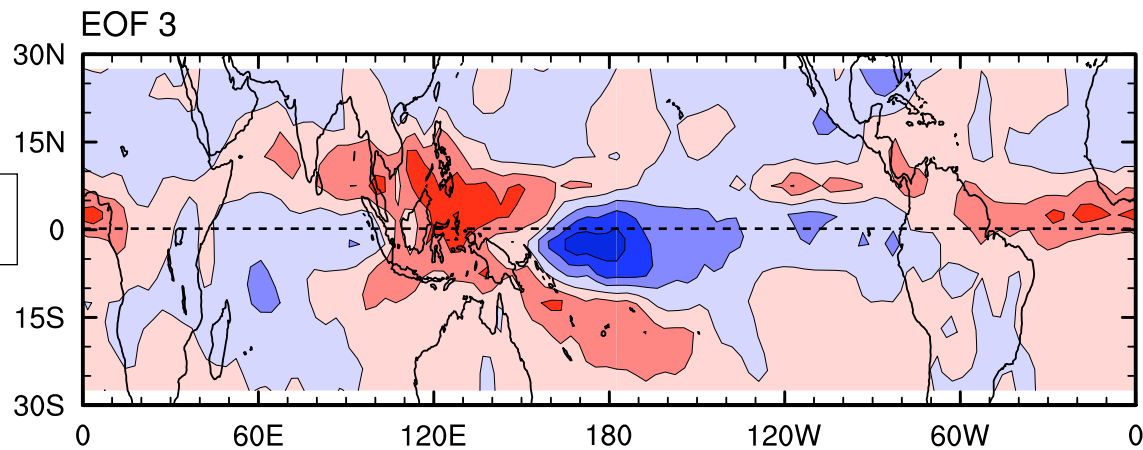
EOF1



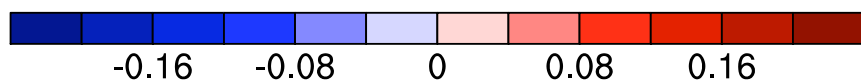
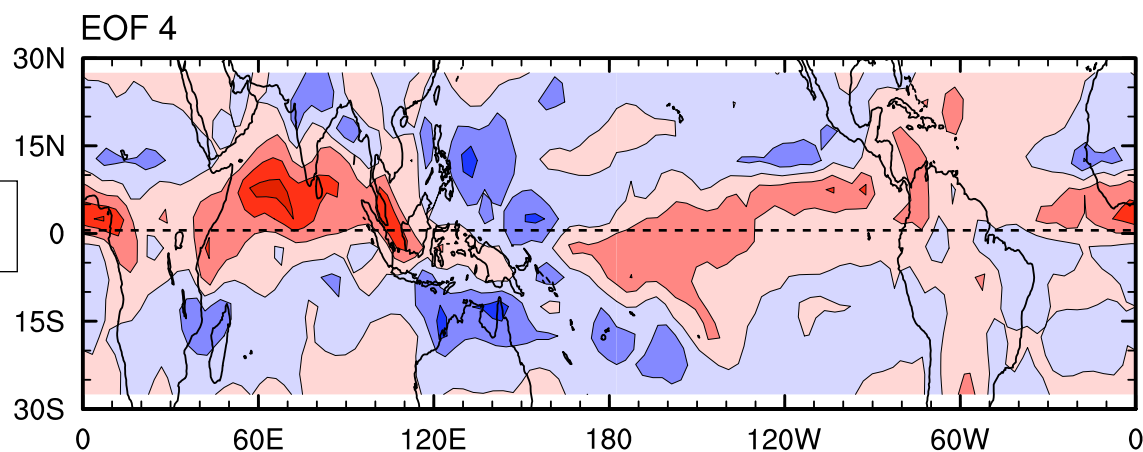
EOF2



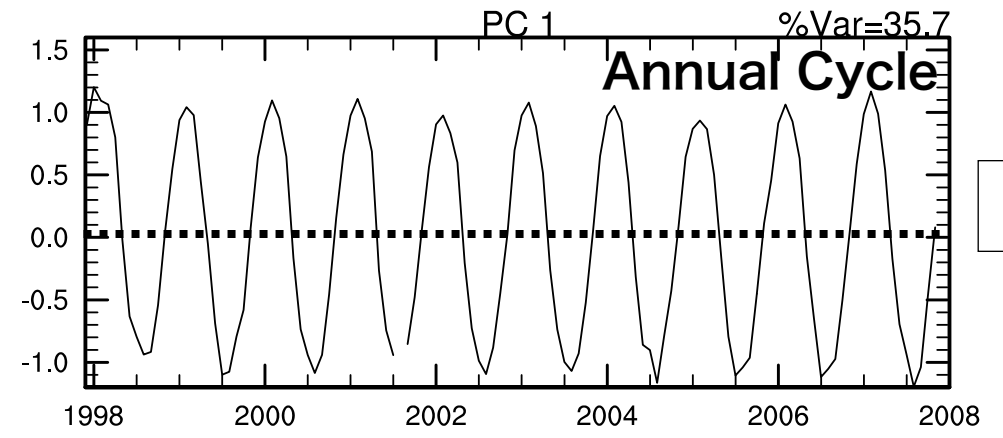
EOF3



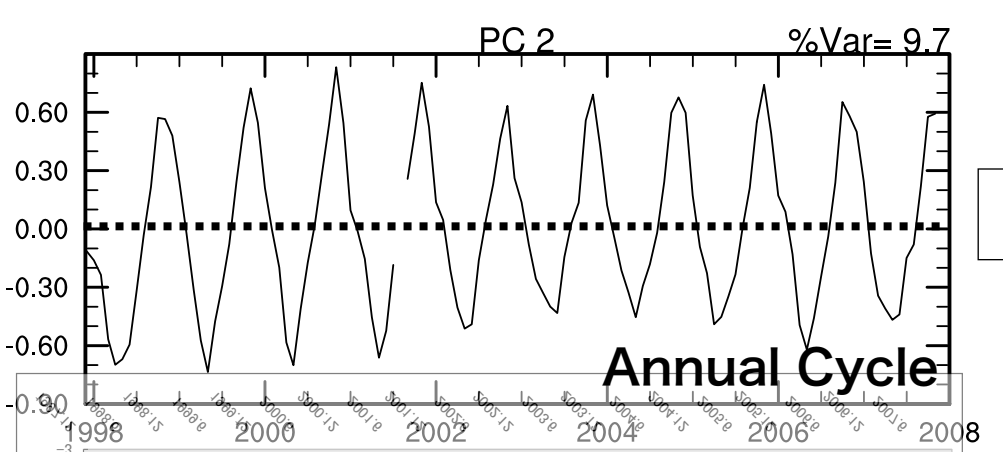
EOF4



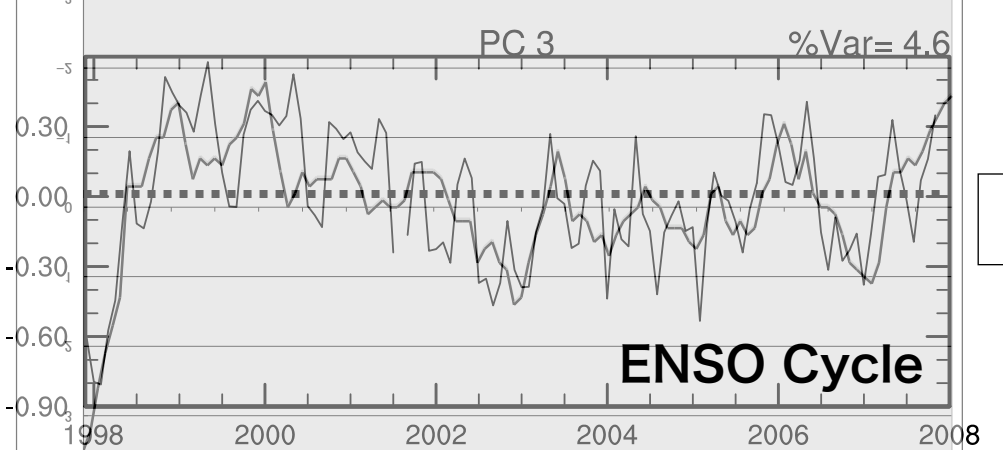
PC1



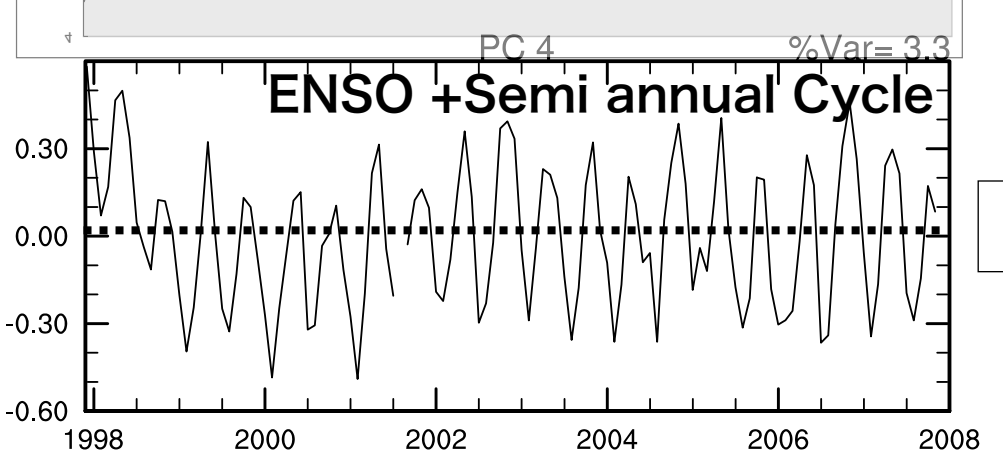
PC2



PC3



PC4

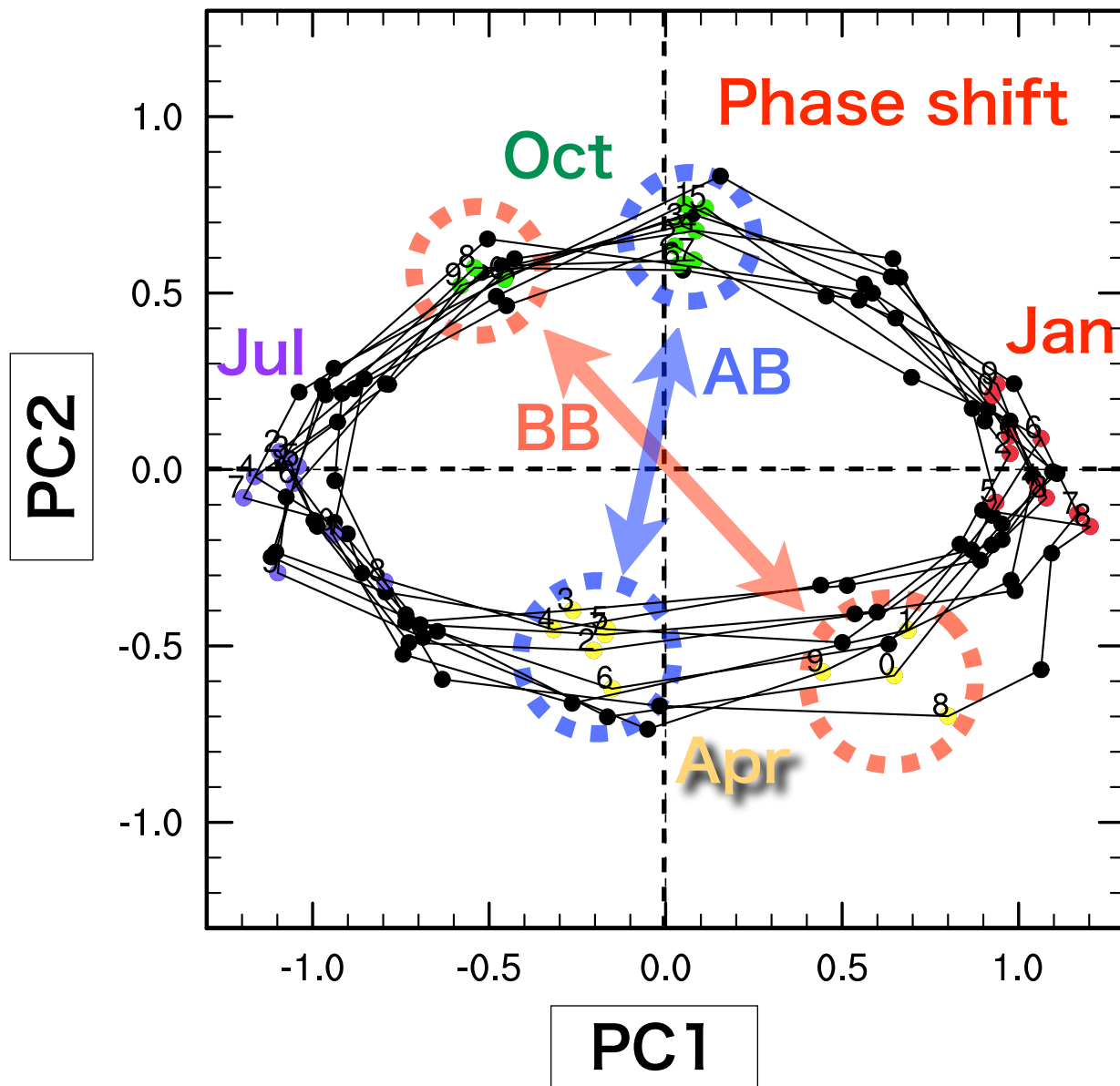




# ConvRuncon at 2 km

(PC1, PC2)

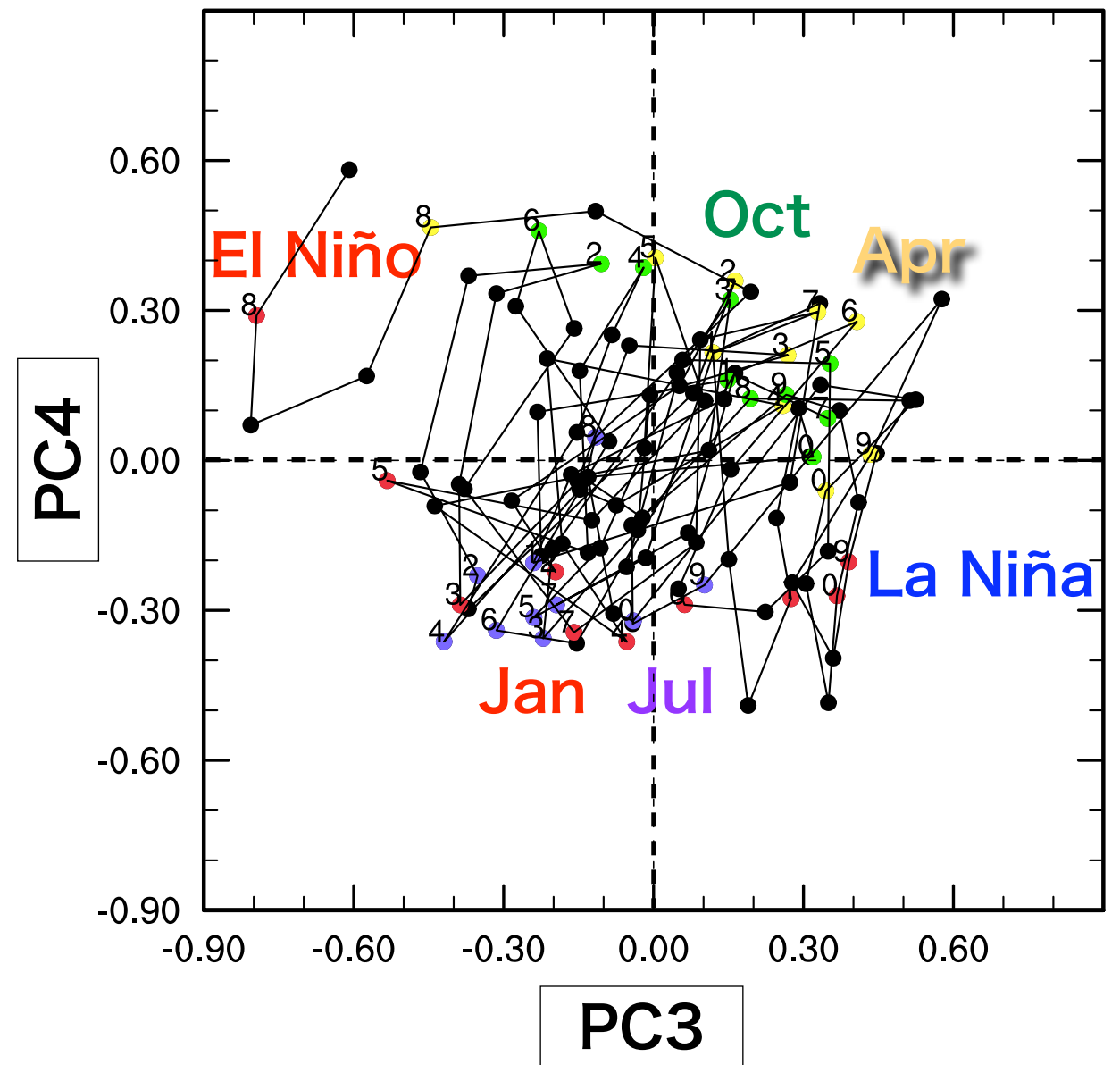
convRain<sub>uncond</sub> (2km)



**AB:** Annual cycle delays  
by one month from **BB**

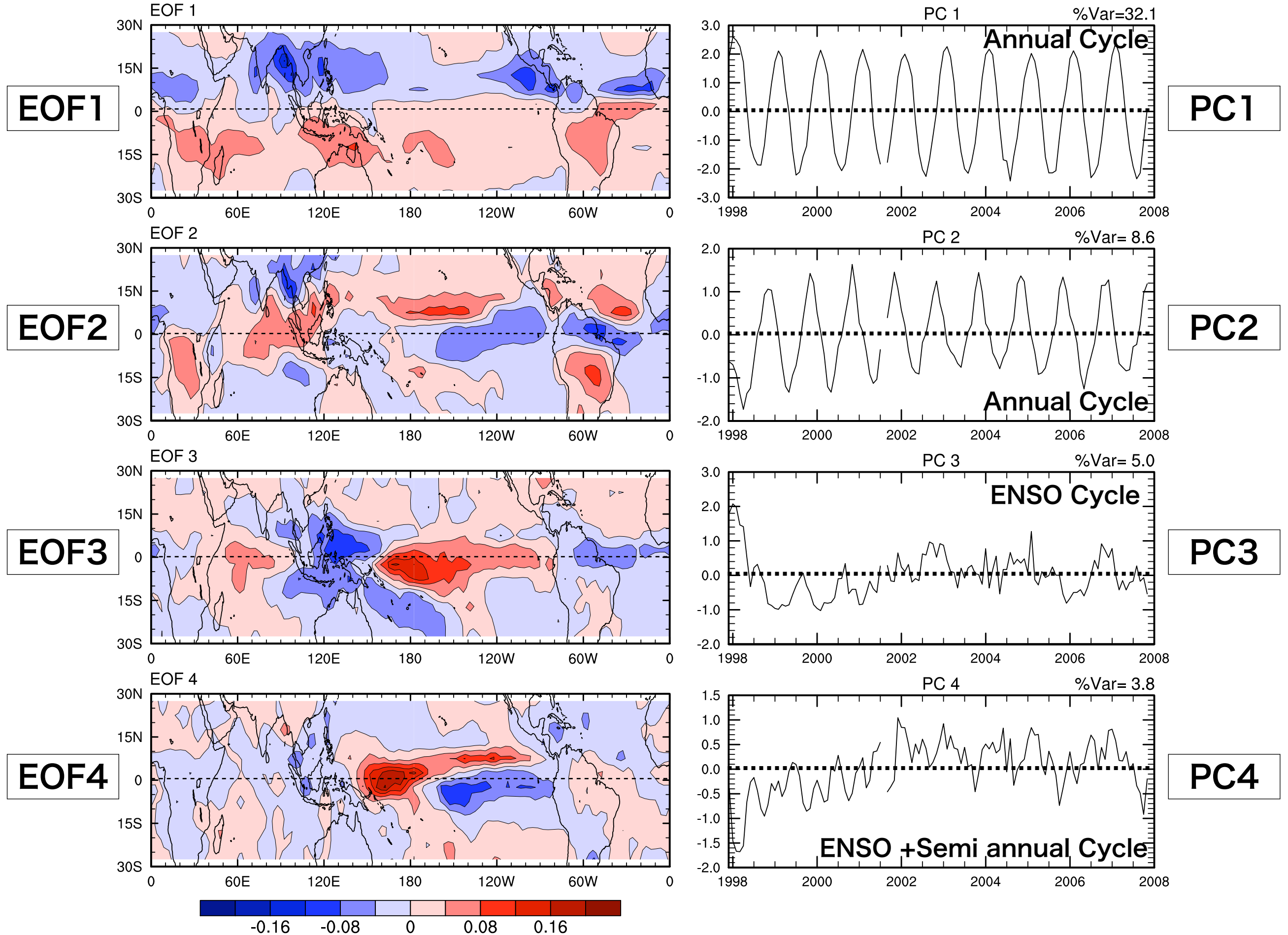
(PC3, PC4)

convRain<sub>uncond</sub> (2km)

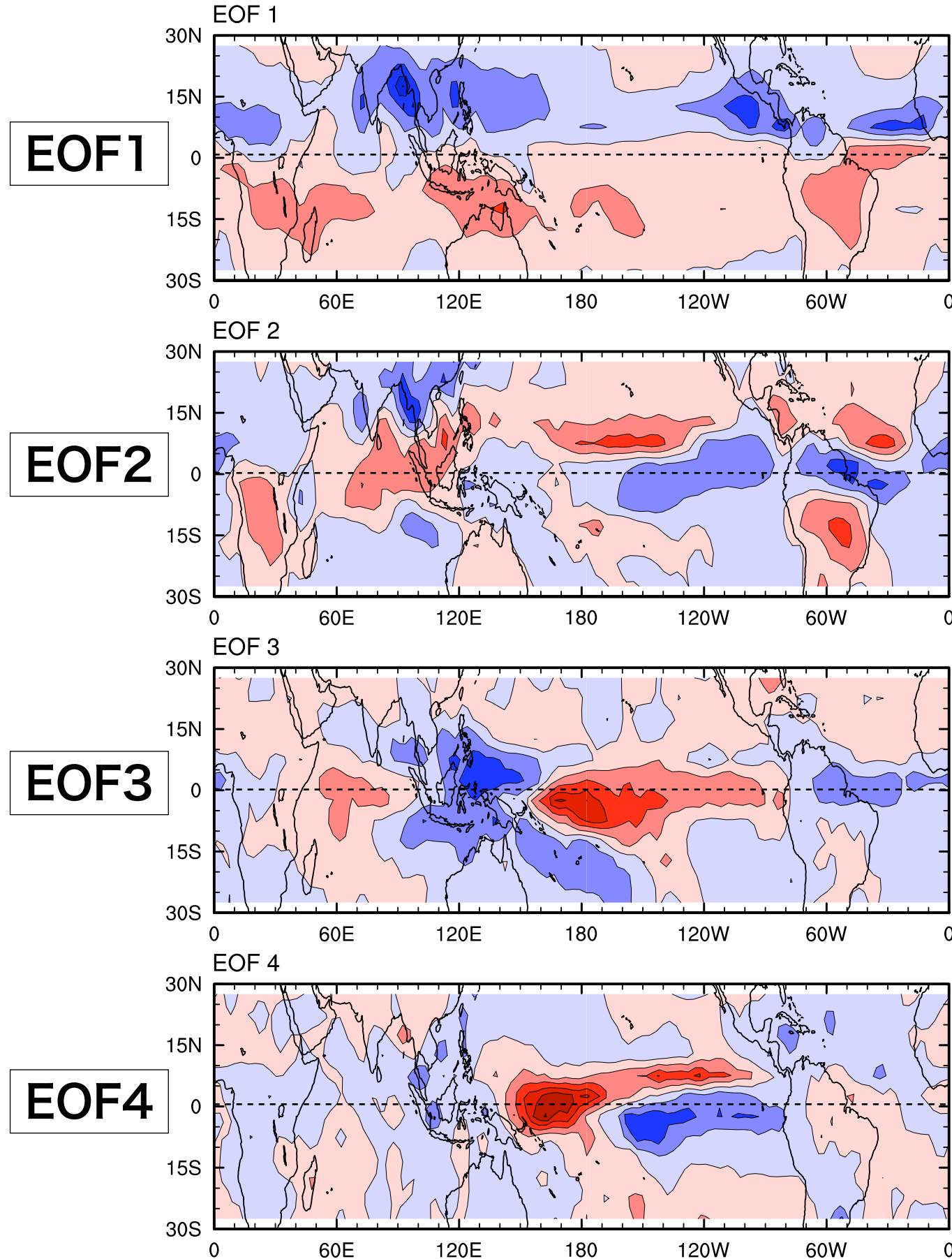


**Semi annual cycle**  
**is evident**

# Runcon at 2 km



# Runcon at 2 km

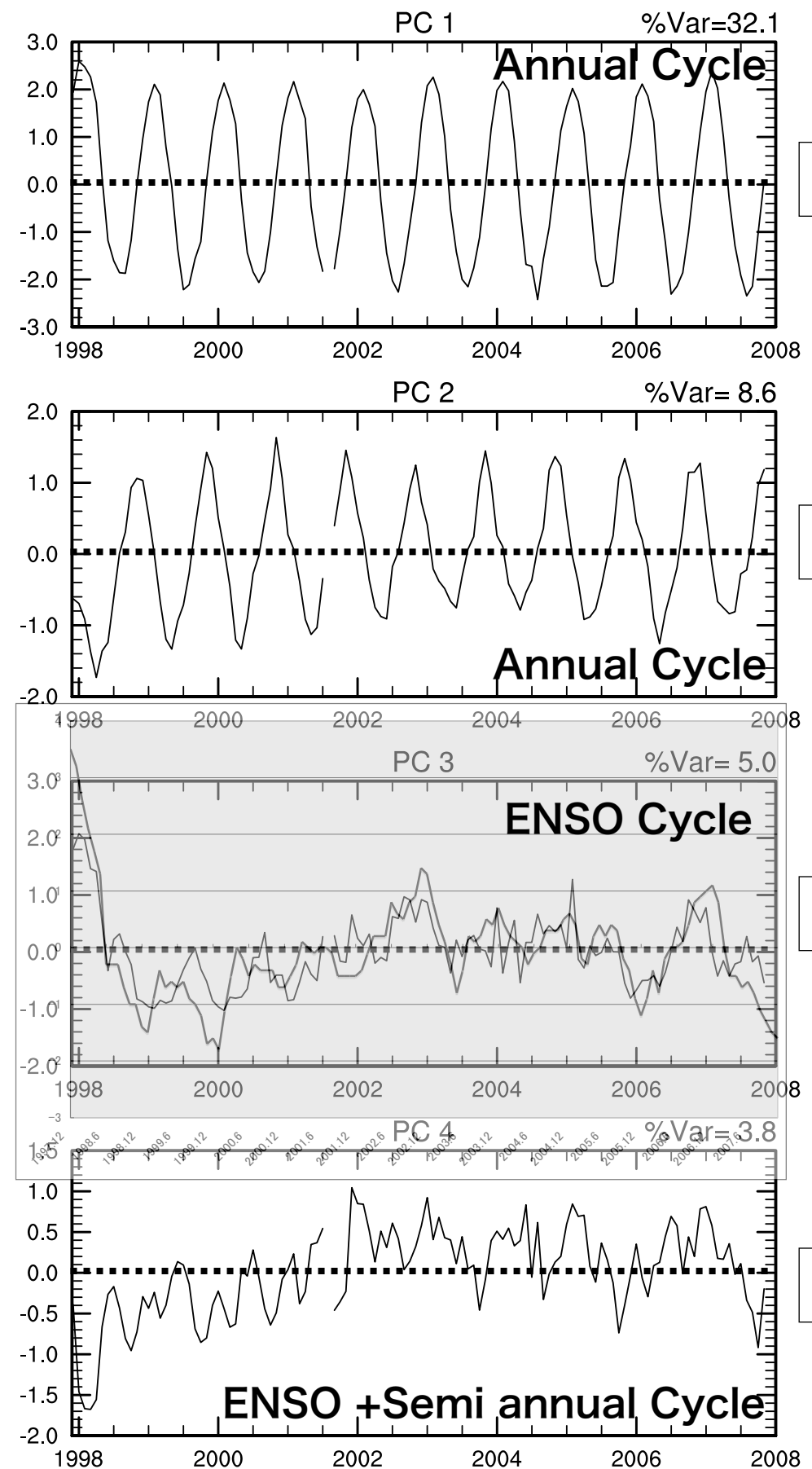


EOF1

EOF2

EOF3

EOF4



PC1

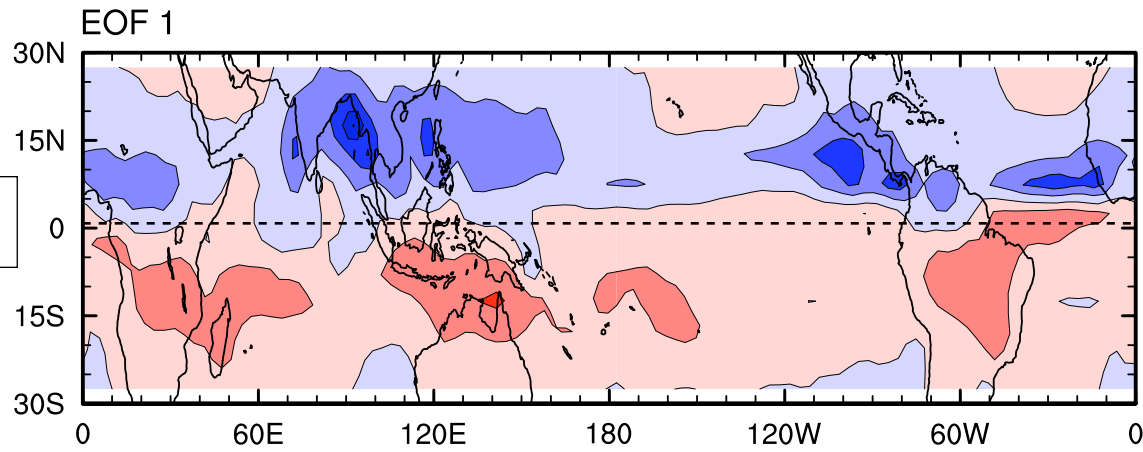
PC2

PC3

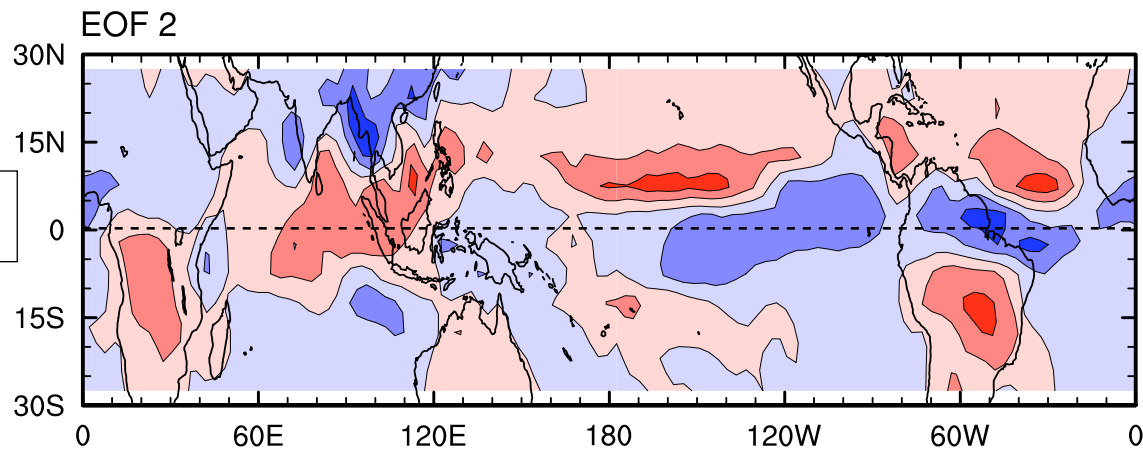
PC4

# Runcon at 2 km

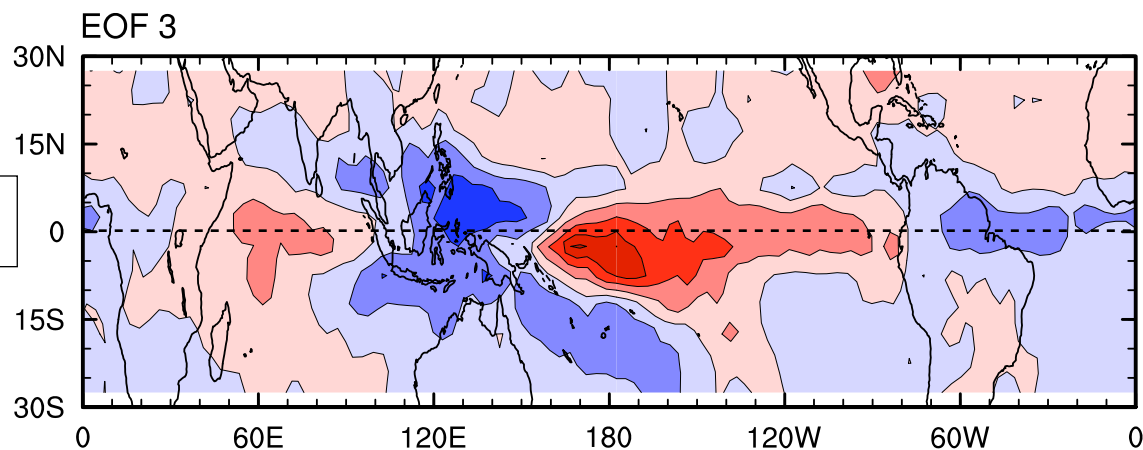
EOF1



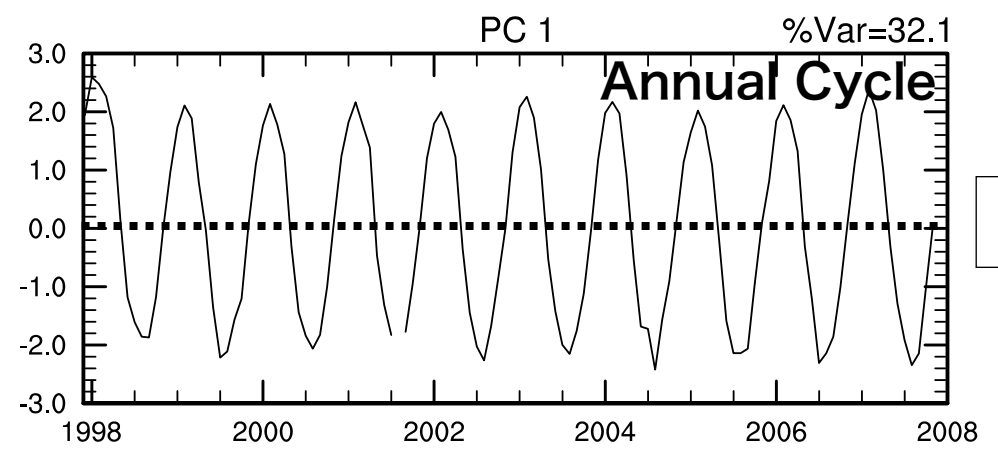
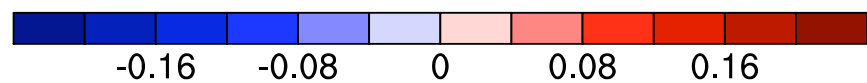
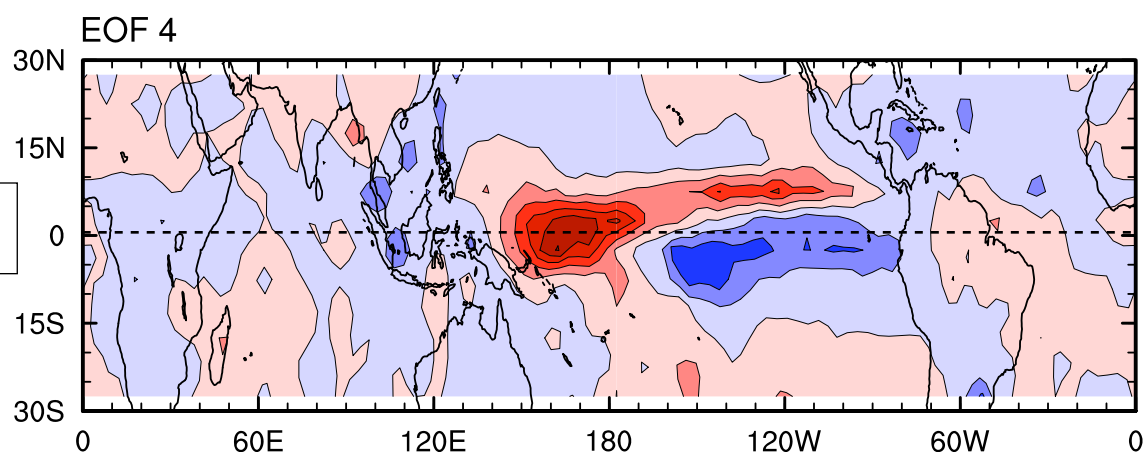
EOF2



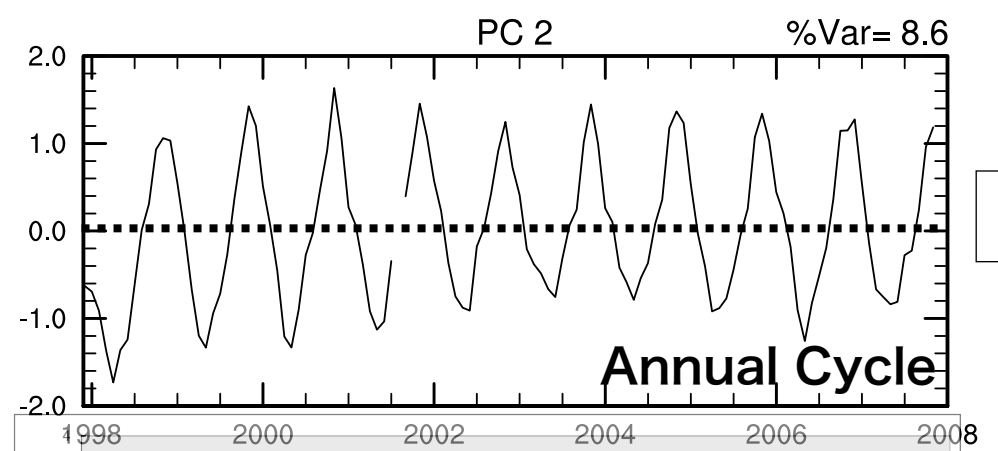
EOF3



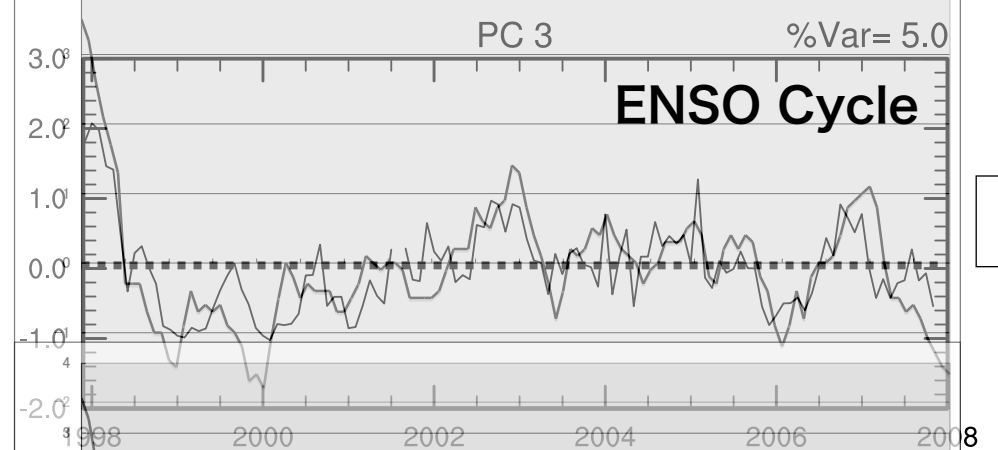
EOF4



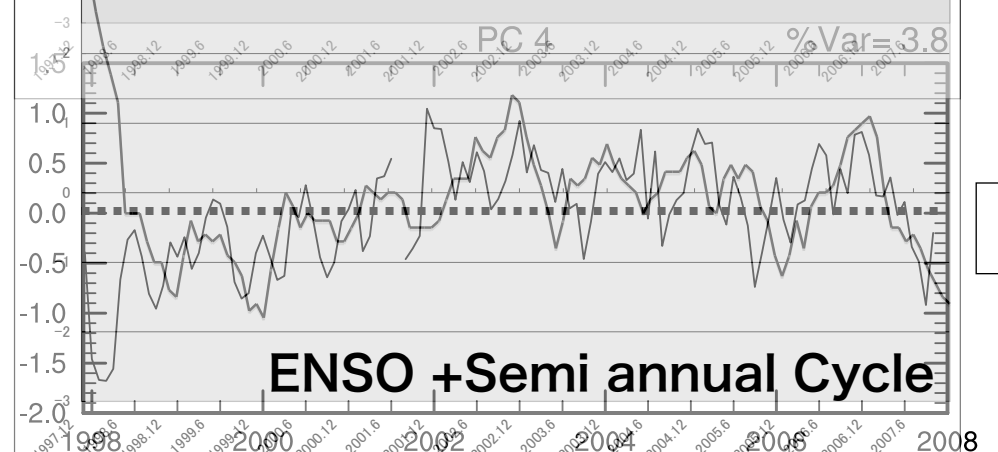
PC1



PC2



PC3



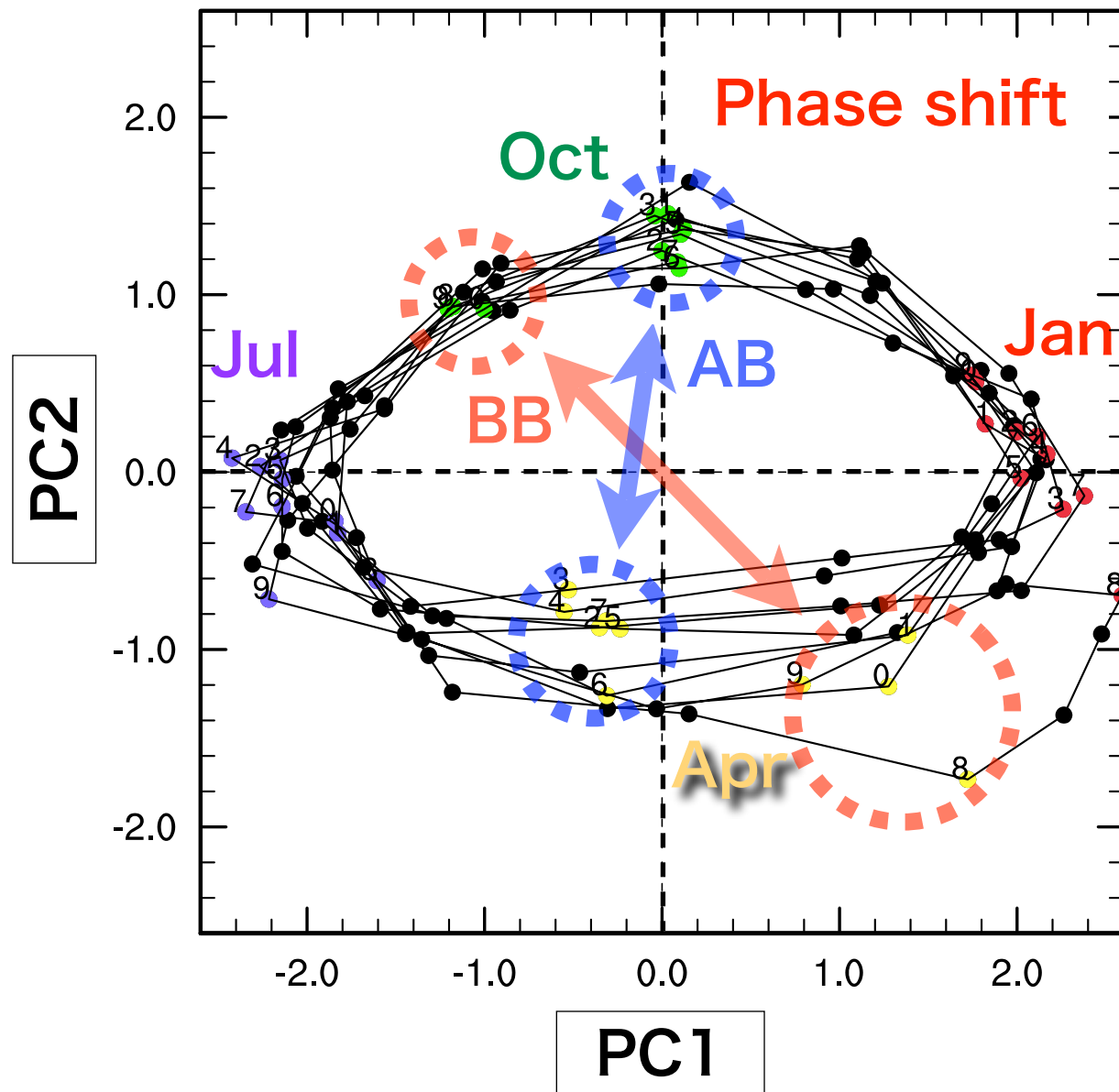
PC4



# Runcon at 2 km

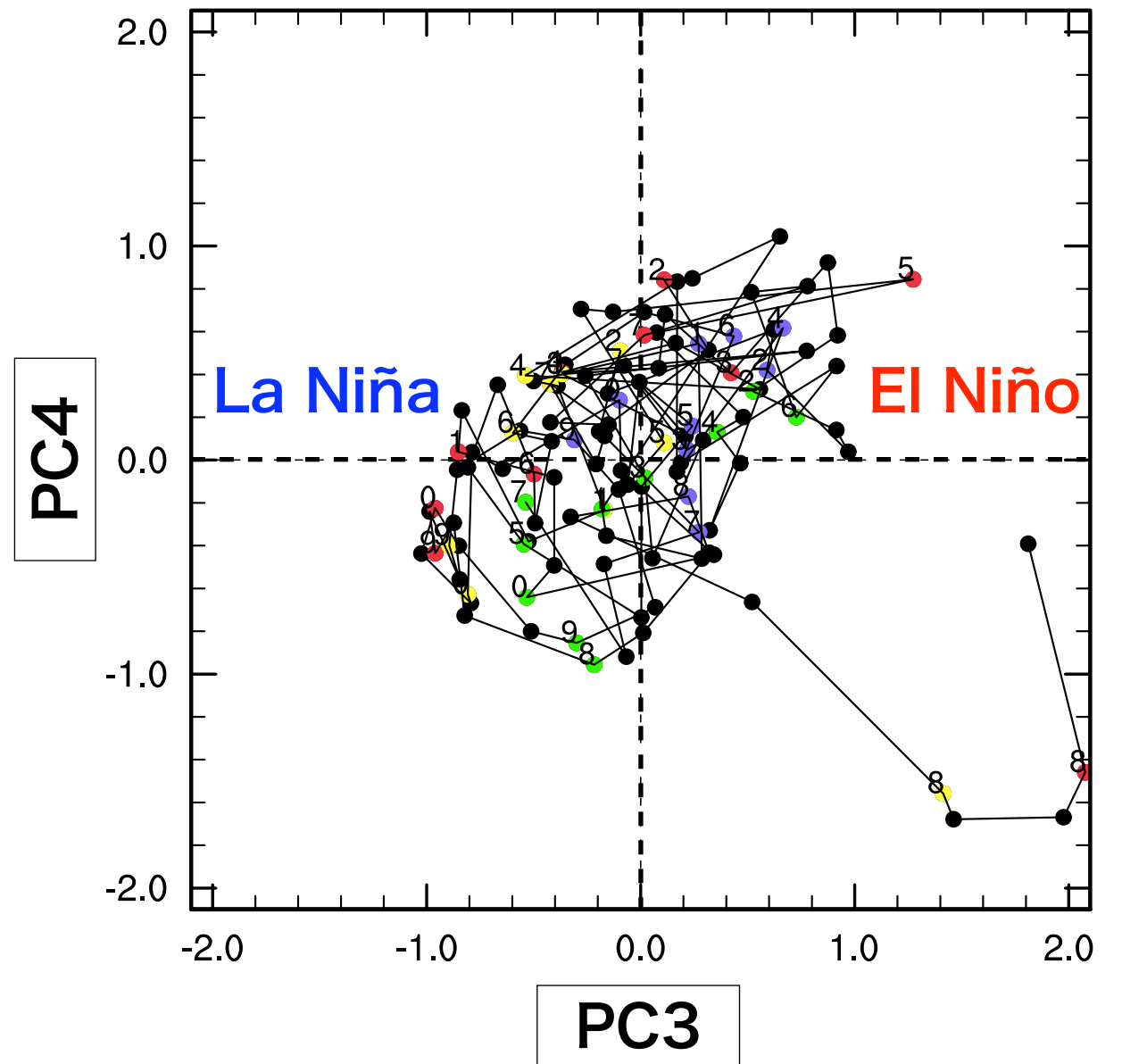
(PC1, PC2)

Rain<sub>uncond</sub> (2km)



(PC3, PC4)

Rain<sub>uncond</sub> (2km)



# Summary

## - How do these two appear in TRMM data?

By applying EOF analysis to rainrate histogram data of the PR 3A25, several basic modes have been identified.

- Annual Cycle
- Interannual variations (ENSO Cycle, 2 modes)
- higher frequency variations (semi-annual etc.)
- Boot Impact (only in the light rainrates)

## - Can we separate these two in TRMM data?

- Yes.

But, there are several behaviors in these variations.

- \* shift of annual mean in interannual variation
- \* amplitude change of annual cycle
- \* phase shift in annual cycle

# On-Going Work

- **Rain Profile, related with Boost or ENSO?**
  - using sub-satellite PR 2A25 data
- **Rain Characteristics/Probability?**
  - using 31-bin histogram of R/convR/stratR in 3A25
  - using 3J68(?) data with 31-bin histogram information in 2A25
- **Latent Heating Data Analysis**
  - using SLH Data
- **Combined EOF for PR and TMI Data**