The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific and
Cultural Organization

IAEA
International Atomic Energy Agency

1968-25

Conference on Teleconnections in the Atmosphere and Oceans

17 - 20 November 2008

The dynamics of the Pacific-North America teleconnection pattern on intraseasonal and interannual time scales.

FRANZKE Christian

British Antarctic Survey
High Cross, Madingley Road
CB3 OET Cambridge
UNITED KINGDOM

The PNA Teleconnection Pattern on Intraseasonal and Interannual Time Scales

Christian Franzke

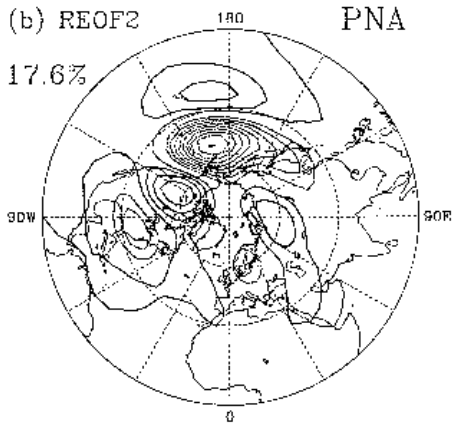
British Antarctic Survey, Cambridge, UK

Sukyoung Lee and Steven B. Feldstein, Pennsylvania State University, USA

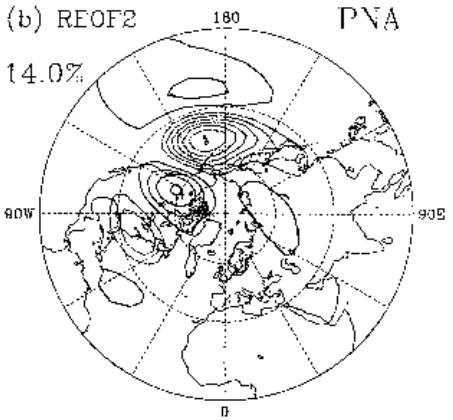
British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

PNA pattern

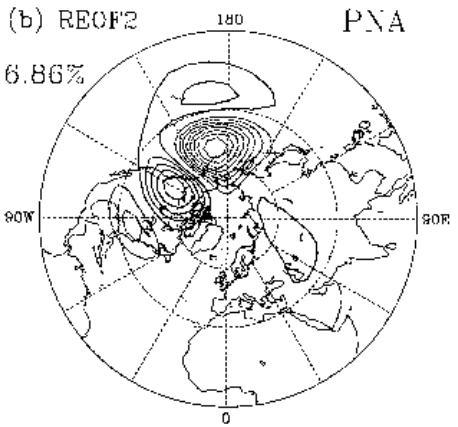
Seasonal Mean



Monthly Mean



Daily



from Feldstein 2000

Motivation

- The PNA occurs on intraseasonal and interannual time scales (Feldstein 2000).
- Intrinsic time scale of the PNA is about 10 days (Feldstein 2000, 2002) and and the PNA influences the frequency of occurence of cyclonic wave breaking (Martius et al. 2007).
- The PNA could be also externally forced by tropical convection (Trenberth et al. 1998).
- Is the PNA due to wave breaking?
- Are the physical processes leading to the PNA different on intraseasonal and interannual time scales?

Intraseasonal and Interannual Time Scales

In order to distinguish between intraseasonal fluctuations ψ' (defined as variability with periods between 10 and 90 days) and interannual fluctuations ψ^{SM} (defined as variability with periods greater then 90 days) we decompose the streamfunction ψ in the following way

$$\psi(t) = \psi^C + \psi^{SM}(t_n) + \psi'(t)$$

where ψ^C denotes the climatological mean state. The interannual variability is defined as the 92 day means over the period December through February for each winter; thus, ψ^{SM} is constant over the 92 day period for each winter but varies from winter to winter and is therefore time dependent where t_n denotes the respective winter.

Intraseasonal and Interannual Time Scales

We assume there is one unique PNA pattern e_{PNA}. Thus we can write

$$\hat{\psi}(t) = p(t)e + \tilde{\psi}(t) \tag{1}$$

We define intrasesaonal and interannual PNA indices

$$p_I(t) = \int \mathbf{e}_{PNA}\psi'(t)\cos\theta dS \tag{2}$$

and the external index as the projection

$$p_{SM}(t_n) = \int \mathbf{e}_{PNA}(\psi^{SM}(t_n))\cos\theta dS \tag{3}$$

with

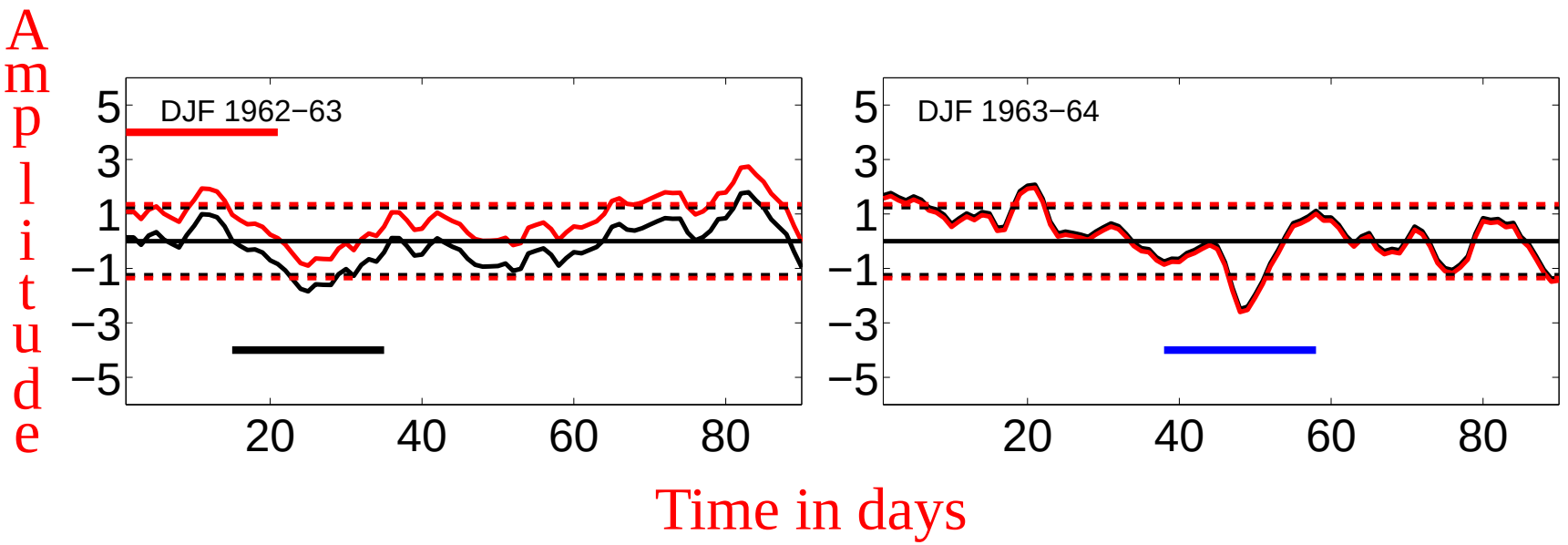
$$p(t) = p_I(t) + p_{SM}(t_n) \tag{4}$$

Classification of PNA events

In order to systematically distinguish between internal, external and mixed PNA events we use the following classification:

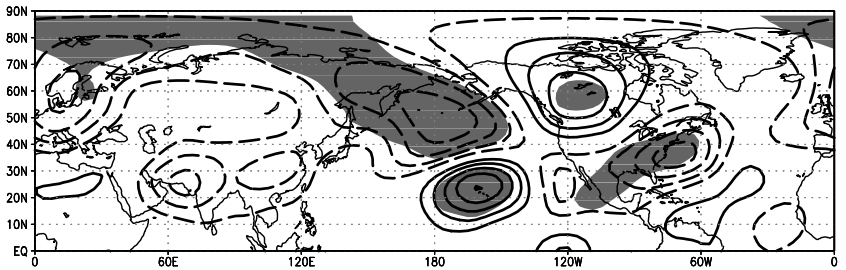
- Internal positive event: $p^I > 1.5\sigma(p^I)$ for more than 5 days and $p^I + p^{SM} < 1.5\sigma(p^I + p^{SM})$ at same time
- External positive event: $p^I + p^{SM} > 1.5\sigma(p^I + p^{SM})$ for more than 5 days and $p^I < 1.5\sigma(p^I)$ at same time
- Mixed positive event: $p^I > 1.5\sigma(p^I)$ for more than 5 days and $p^I + p^{SM} > 1.5\sigma(p^I + p^{SM})$ at same time

PNA events

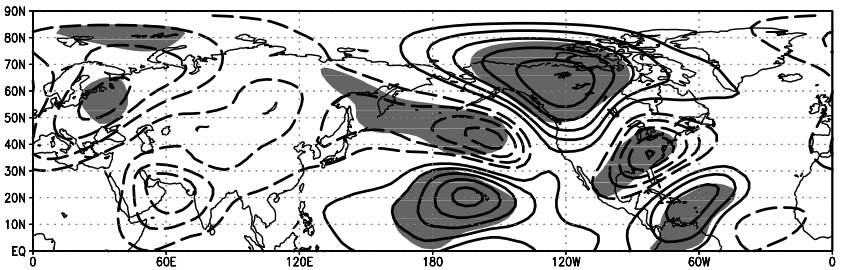

Amplitude
DJF 1962−63
DJF 1963−64
5
3
1
−1
−3
−5
20
40
60
80
Time in days

Positive PNA Phase Composites

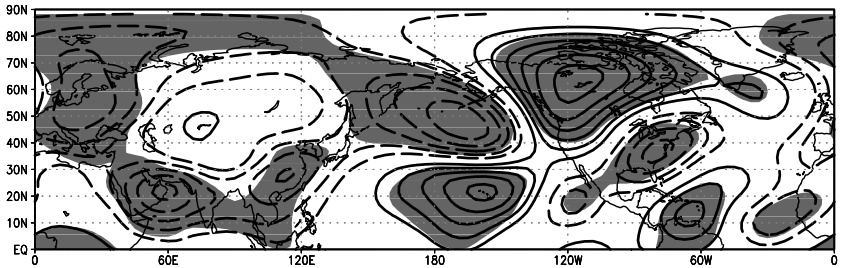
Internal PNA Composite



External PNA Composite

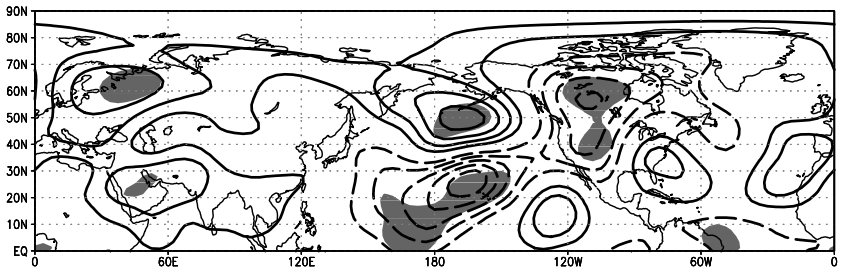


Mixed PNA Composite

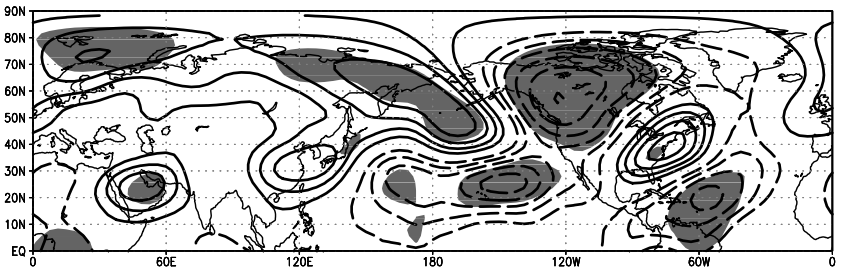


Negative PNA Phase Composites

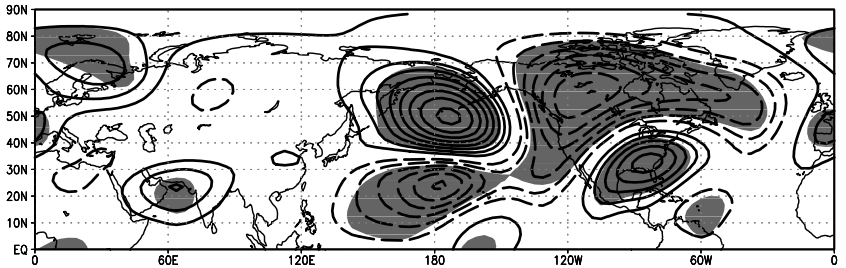
Internal PNA Composite



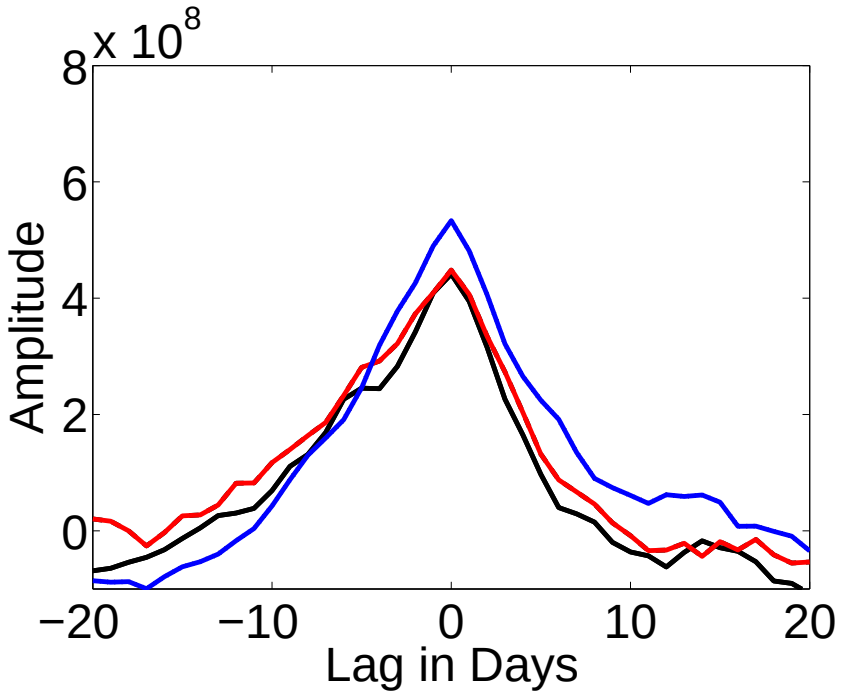
External PNA Composite

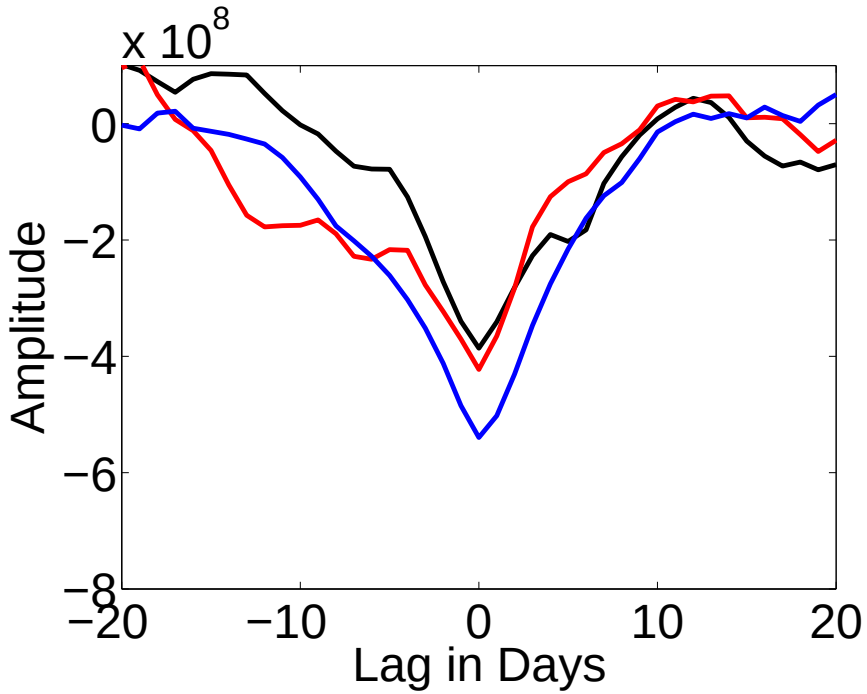


Mixed PNA Composite



PNA Time Scales

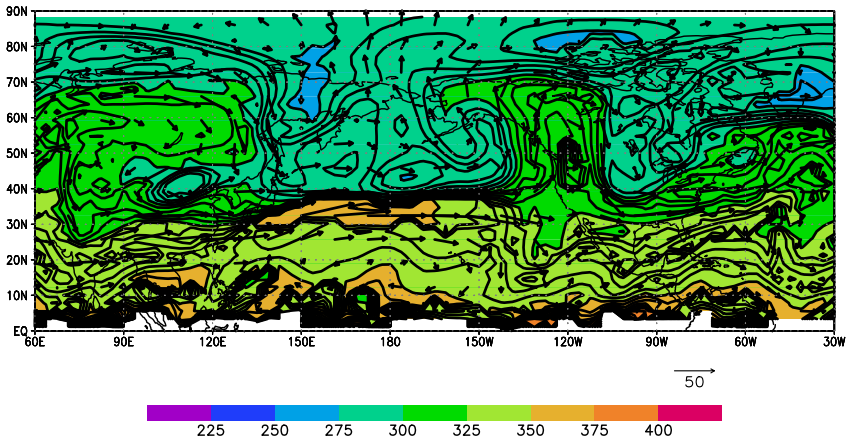




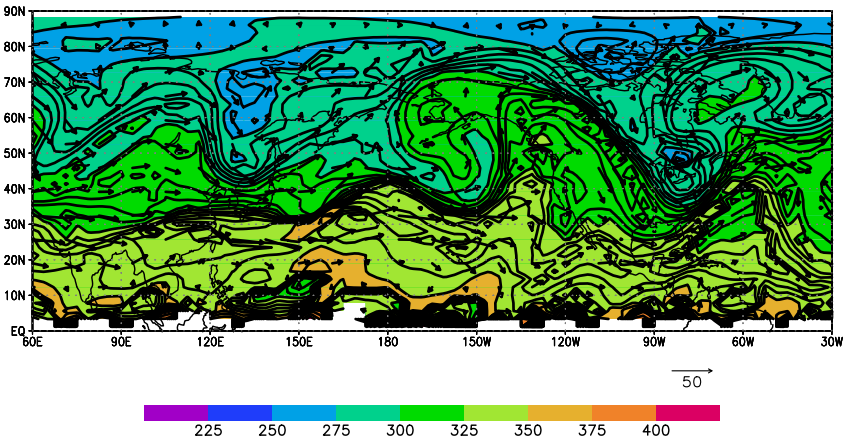
Composites of PNA indices: Black line: Internal PNA; Red line: External PNA; Blue line: Mixed PNA.

Morphology of positive PNA (Theta on 2PVU)

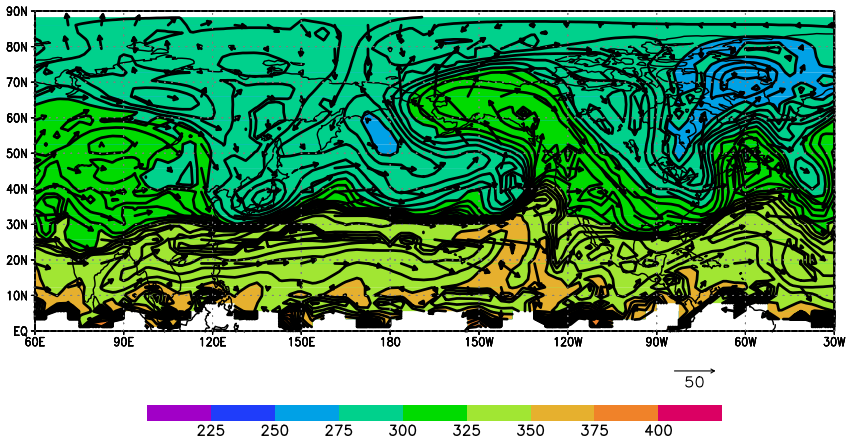
Internal PNA Event (DJF 1990/91)



External PNA Event (DJF 1962/63)



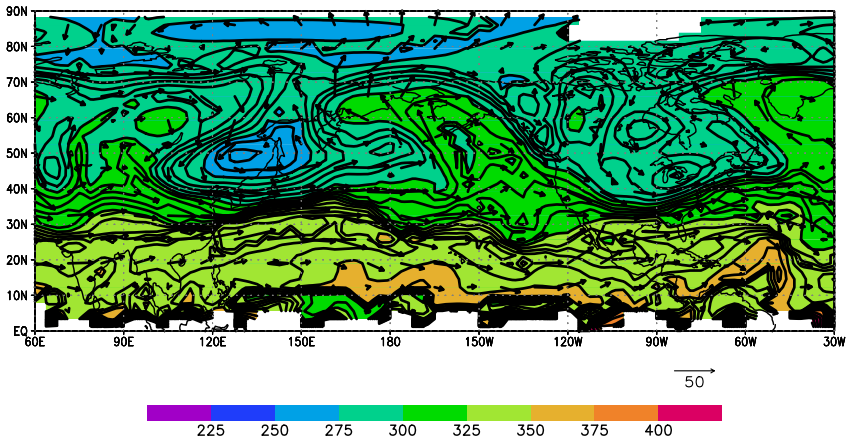
Mixed PNA Event (DJF 1994/95)



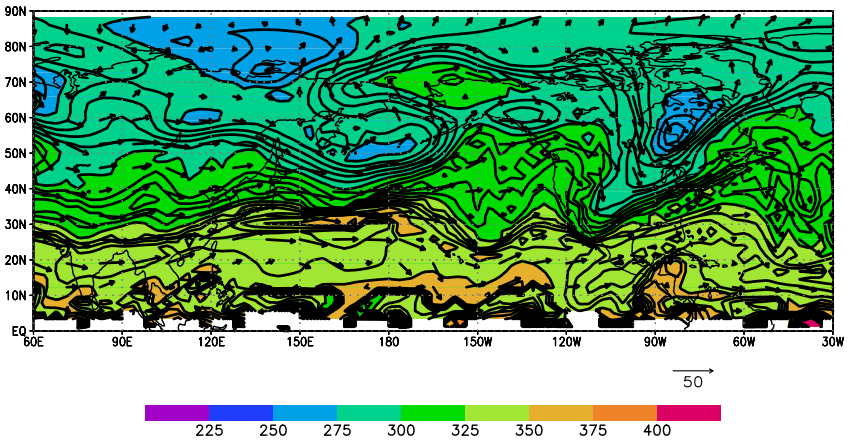
British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Morphology of negative PNA (Theta on 2 PVU)

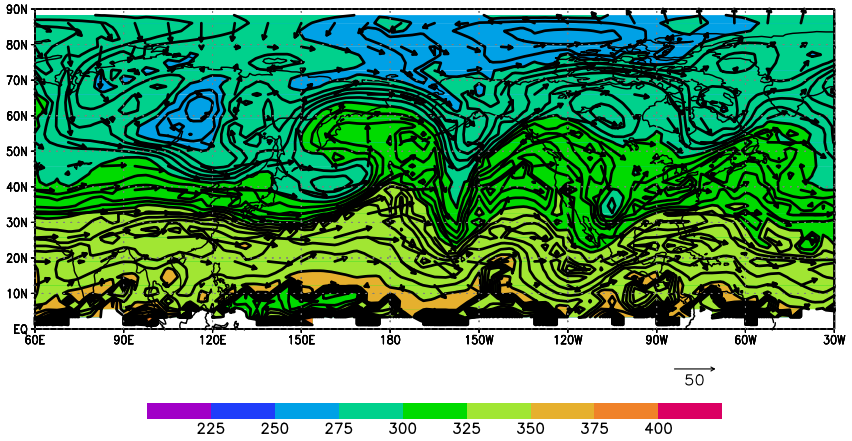
Internal PNA Event (DJF 1980/81)



External PNA Event (DJF 1948/49)



Mixed PNA Event (DJF 1958/59)

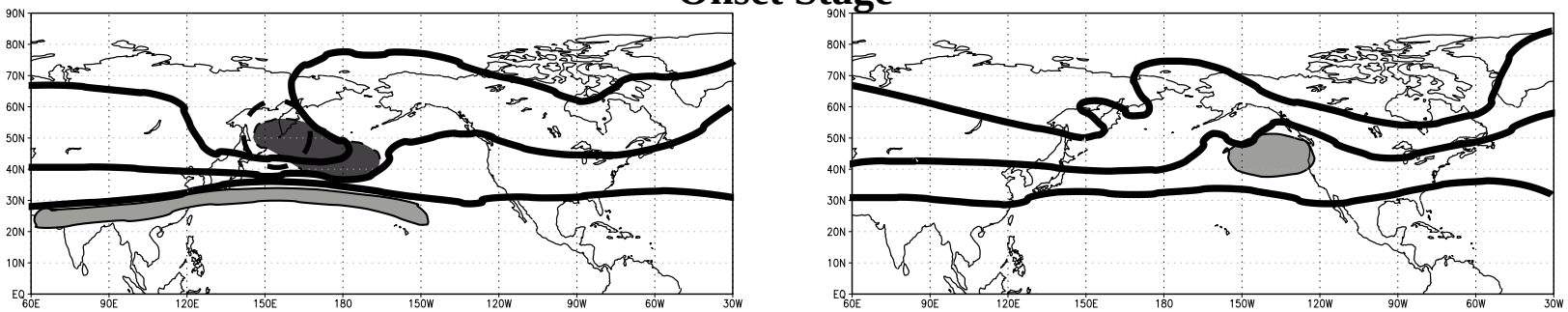


Schematic evolution of the PNA

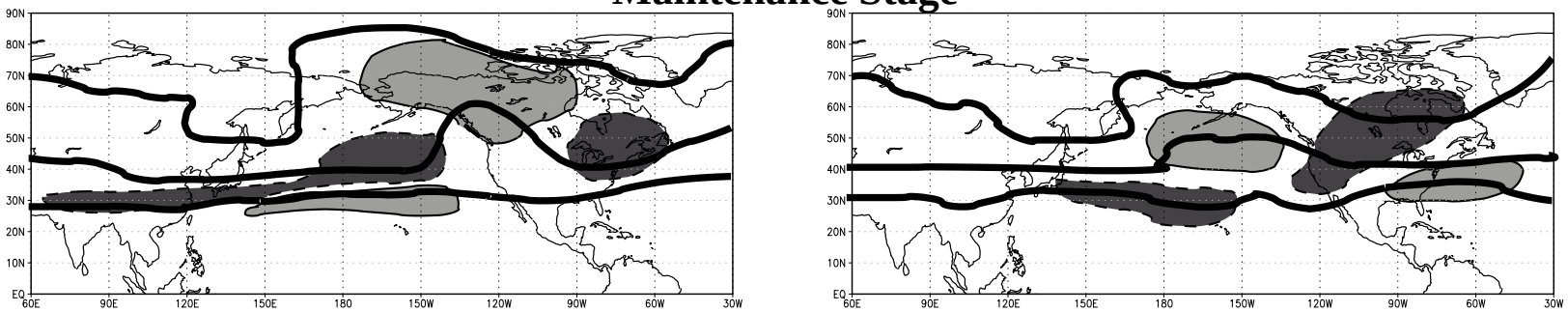
a) Positive Phase

b) Negative Phase

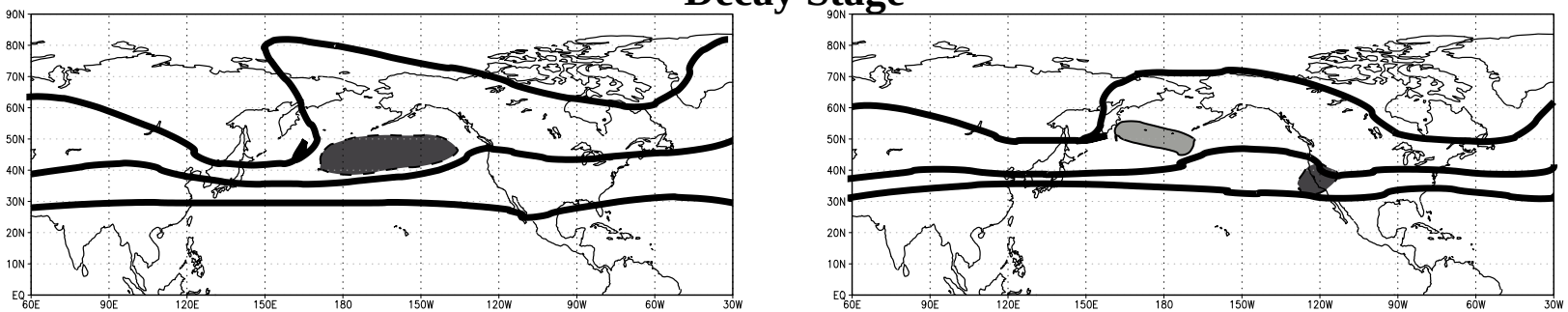
Onset Stage



Maintenance Stage



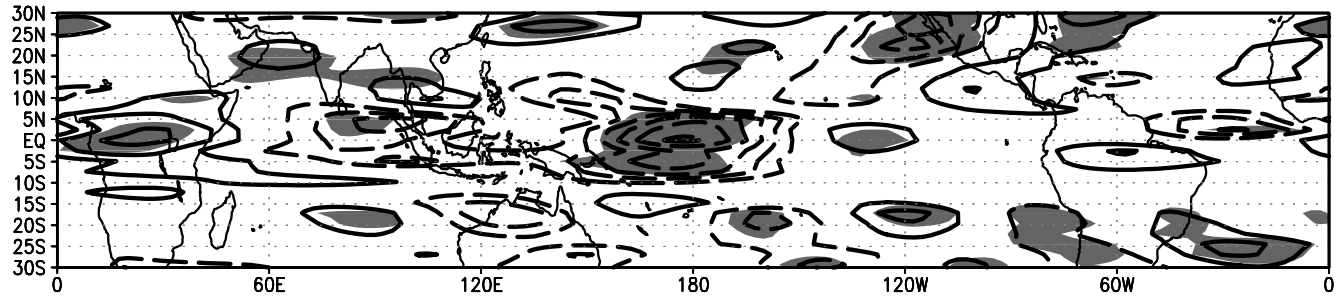
Decay Stage



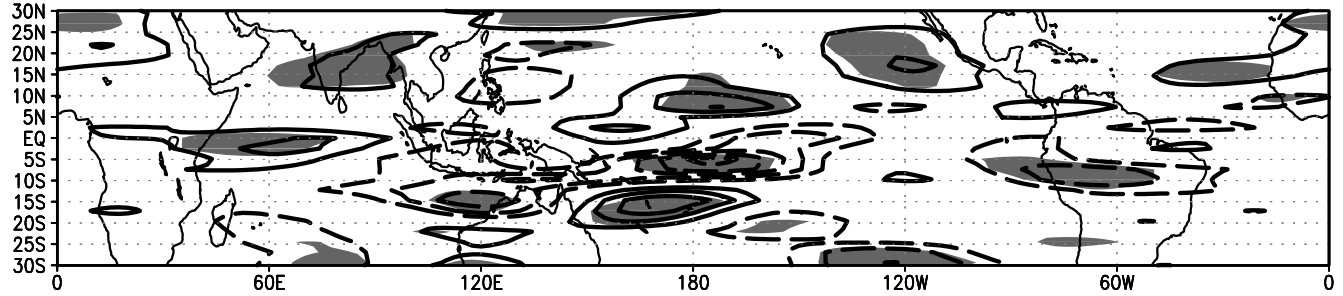
British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

OLR Composite for positive PNA

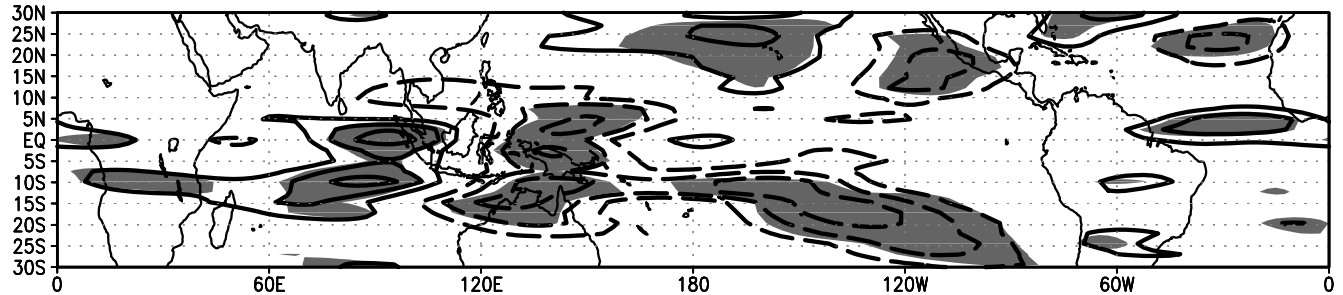
Internal



External



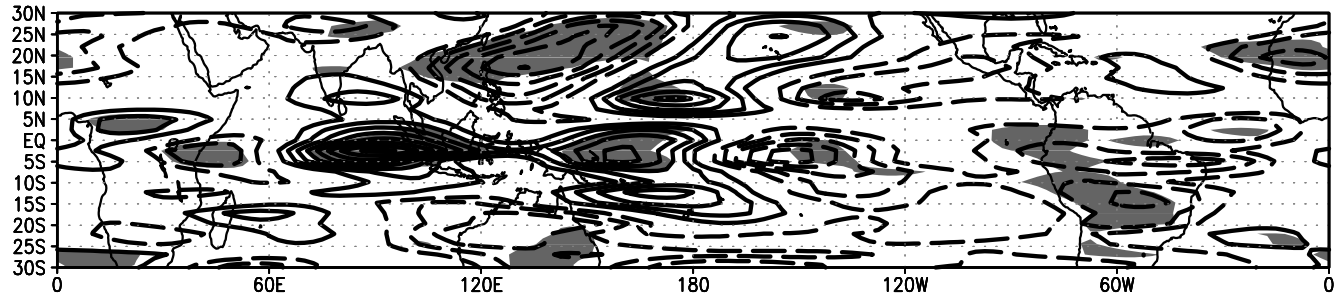
Mixed



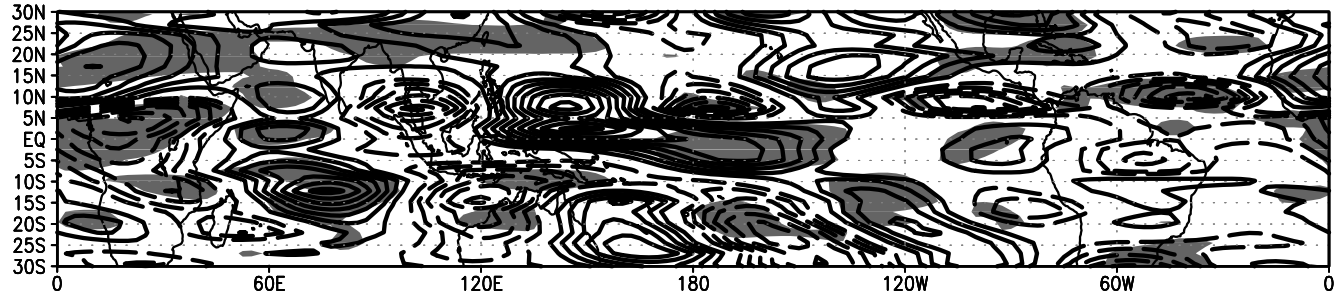
The shading indicates anomalies which are statistically significant above the 90% confidence level for a two-sided student's t-test.

OLR Composite for negative PNA

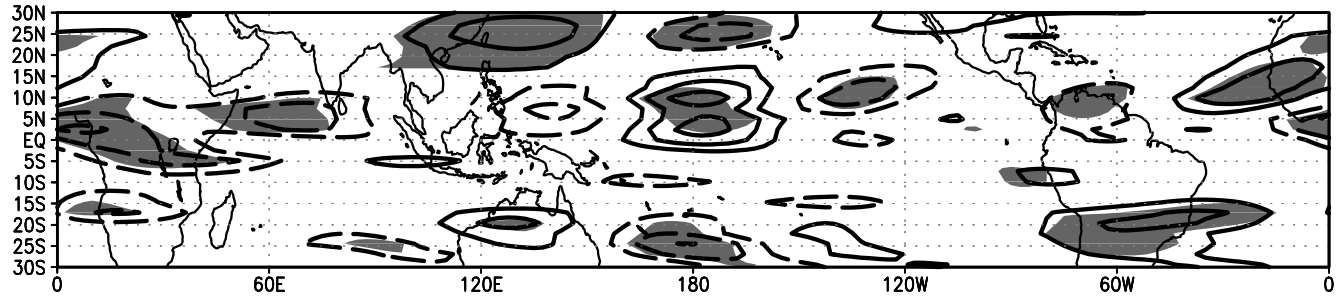
Internal



External



Mixed



The shading indicates anomalies which are statistically significant above the 90% confidence level for a two-sided student's t-test.

Summary

- We decomposed PNA into internal, external and mixed events
- Internal, external and mixed PNA events occur on the same intrinsic time scale of about 10 days
- Both positive and negative PNA phases are due to cyclonic wave breaking
- Both PNA phases are associated with OLR anomalies