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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 0ET 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
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 the PNA influences the frequency of occurrence 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 $\psi'$ (defined as variability with periods between 10 and 90 days) and interannual fluctuations $\psi^{SM}$ (defined as variability with periods greater than 90 days) we decompose the streamfunction $\psi$ in the following way

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

where $\psi^C$ 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, $\psi^{SM}$ 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

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

We define intraseasonal and interannual PNA indices

$$p_I(t) = \int e_{PNA} \psi'(t) \cos \theta dS \quad (2)$$

and the external index as the projection

$$p_{SM}(t_n) = \int e_{PNA}(\psi^{SM}(t_n)) \cos \theta dS \quad (3)$$

with

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

Time in days

DJF 1962–63

DJF 1963–64

-5
-3
-1
1
3
5

20 40 60 80

20 40 60 80
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
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)
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

Onset Stage

Maintenance Stage

Decay Stage

b) Negative Phase
OLR Composite for positive PNA

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