The 20–30 Day Rossby-Haurwitz Wave

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OBJECTIVE

- To investigate the variability and effects of Rossby-Haurtwitz (RH) wave on intraseasonal.

MOTIVATION

- Variations in atmospheric AM (AAM) with respect to the Earth's axis of rotation is often associated with particular types of atmospheric circulation patterns (Peioxoto and Oort 1992).
- The 5-day RH wave generates the highest amplitude variability in AAM and was first discovered by Eliassen and Machenhauer (1965).

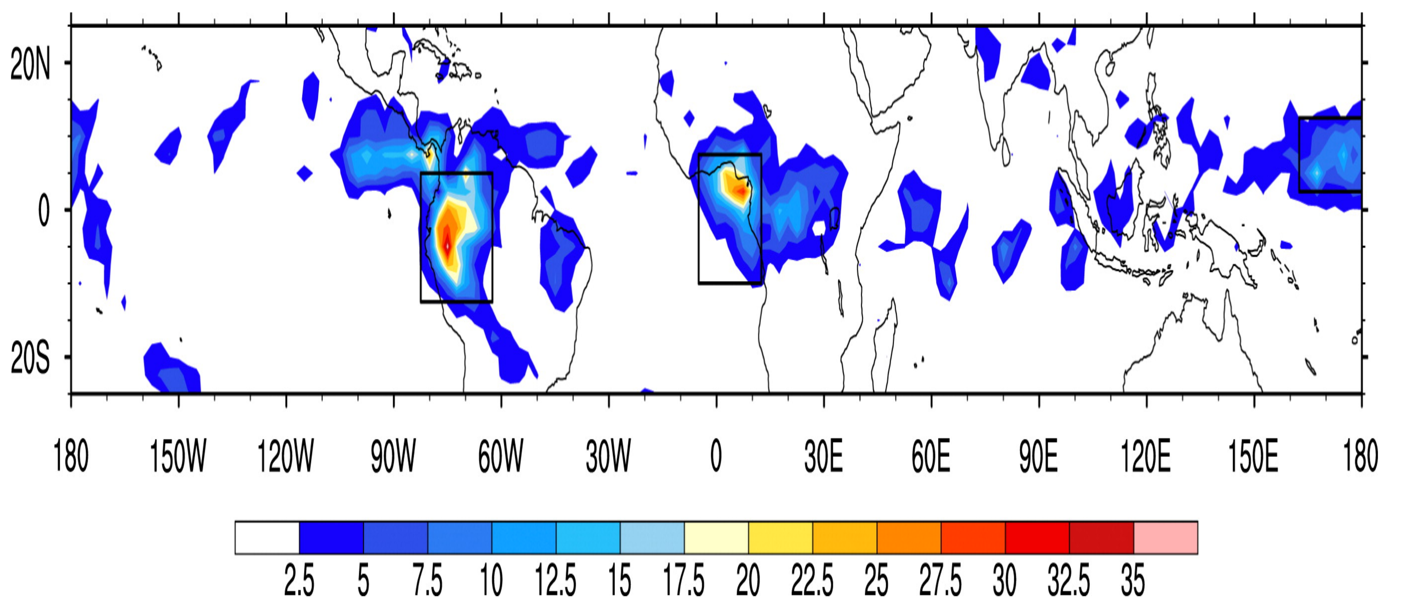


Fig.1. Variance of outgoing longwave radiation signal over lags from −2 to 2 days [(W m^{-2})^2] regressed against bandpass-filtered 850-hPa zonal wind time series. King et al 2015

- King et al. 2015 (Fig.1) discovered that the 5-day waves produce a high variance in precipitation and outgoing longwave radiation (OLR) in tropical mountain ranges due to orographic forcing.

THEORETICAL BACKGROUND

An RH wave is considered a free oscillation and is one for which there is no thermal or gravitational forcing (Haurwitz 1937). By assuming a non-divergent wave such as an RH wave and that we can relate streamfunction to vorticity as $\nabla^2\psi = \zeta$, one can derive a time tendency vorticity equation for such oscillation as follows: $\frac{\partial \zeta}{\partial t} = -\beta \mathrm{v}$

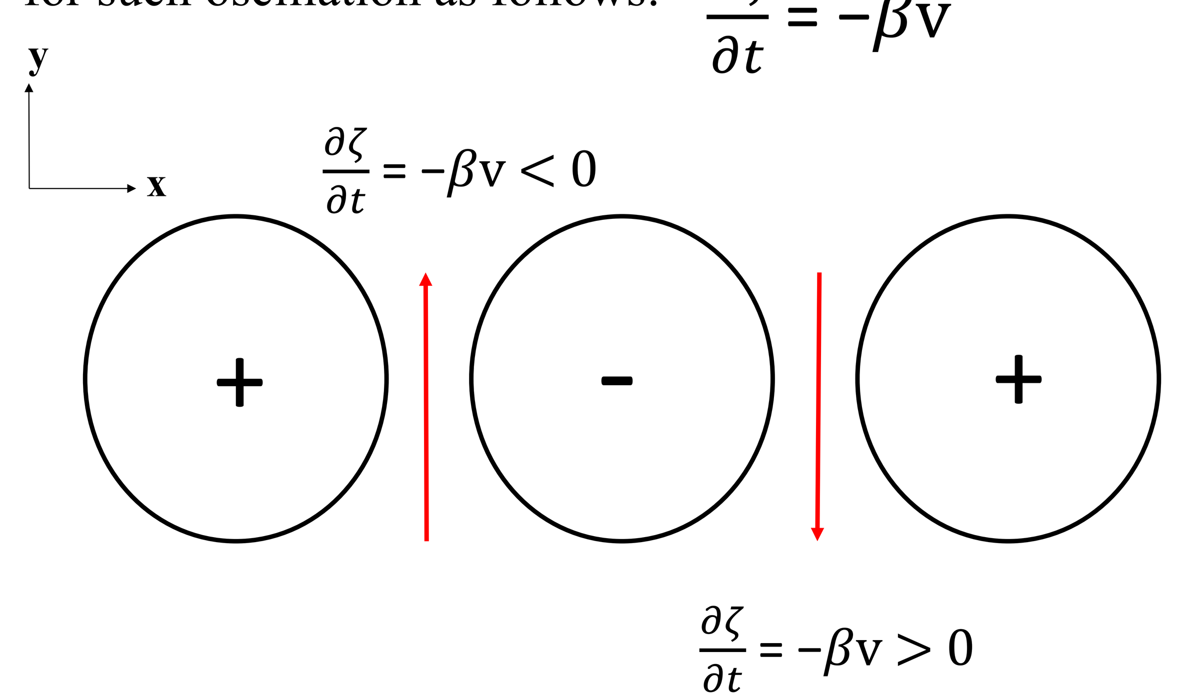


Fig.2. Schematic view of chain of vortices along a latitude circle, illustrating the westward propagation of Rossby waves.

DATA

NCEP-NCAR reanalysis dataset from 1985–2010 was used (Kalnay et al. 1996). Daily average geopotential height, air temperatures, zonal and meridional winds at all levels were obtained.

METHODS

- To compute the vertically integrated relative AAM the following formula is used:

$$M_r = -\frac{1}{g}\int_{p_{top}}^{p_0} urcos(\varphi)dp$$

- To diagnose the source of variability in the AM field, a space–time spectral method similar to that of Hendon and Wheeler (2004) was utilized.
- An EOF analysis is conducted to track and monitor the 20–30 day wave. The AM data are space-time bandpass filtered following Wheeler and Kiladis (1999).
- An 8-phase index was created using Hendon and Wheeler (2004) RMM index method.
- Composites of normalized geopotential height for each phase were created.

POWER SPECTRA

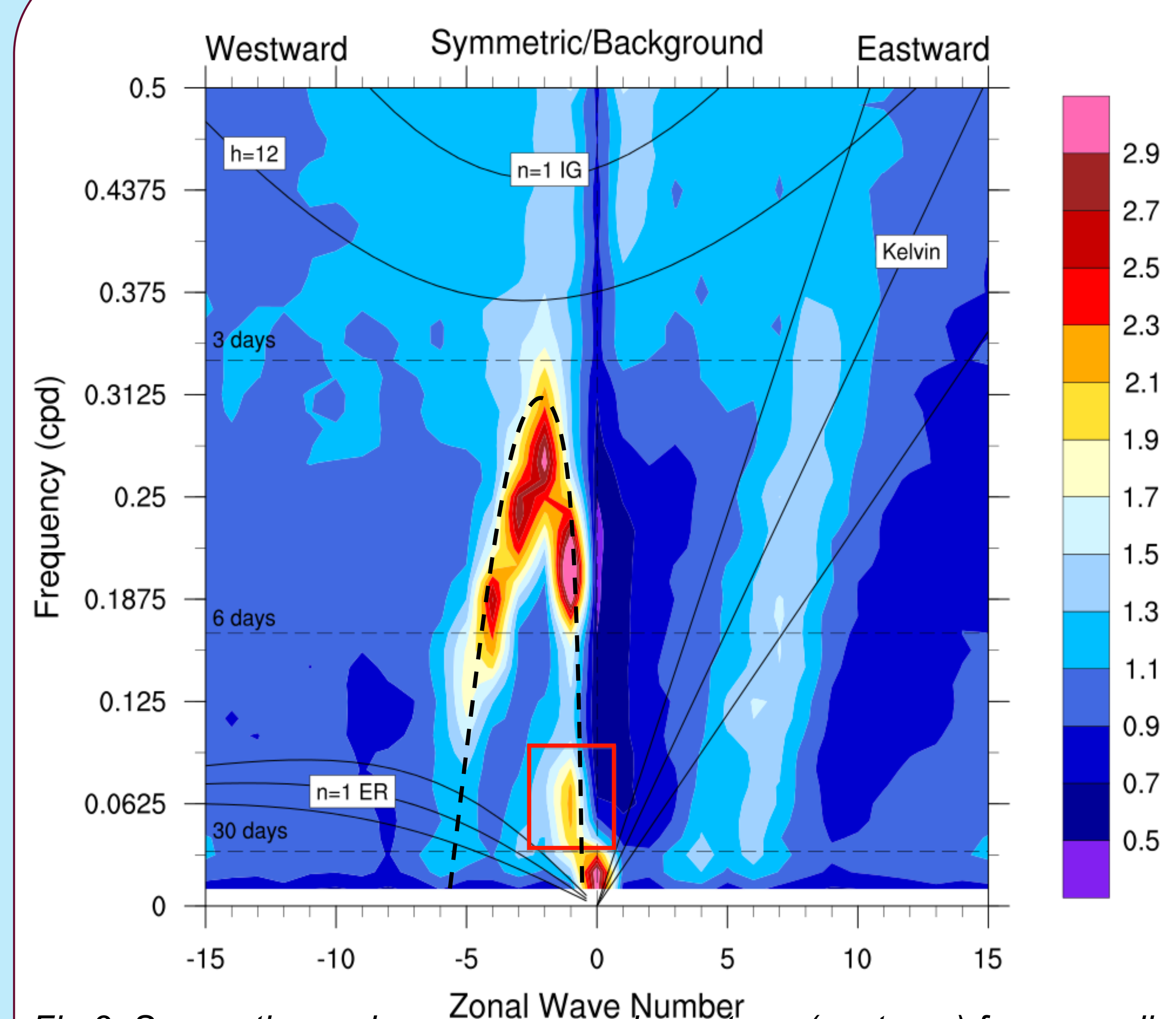


Fig 3. Space–time coherence-squared spectrum (contours) for anomalies in the latitude range 15° N–15° S symmetric about the equator in AAM . Black dotted line is dispersion curve for RH waves. Solid dispersion curves are those for Kelvin, equatorial Rossby (ER), symmetric inertio–gravity (IG).

- **Highest power** is collocated with **the RH dispersion line**, this study focuses on the intraseasonal scale of this wave 20–30 day (red box)

EOF ANALYSIS

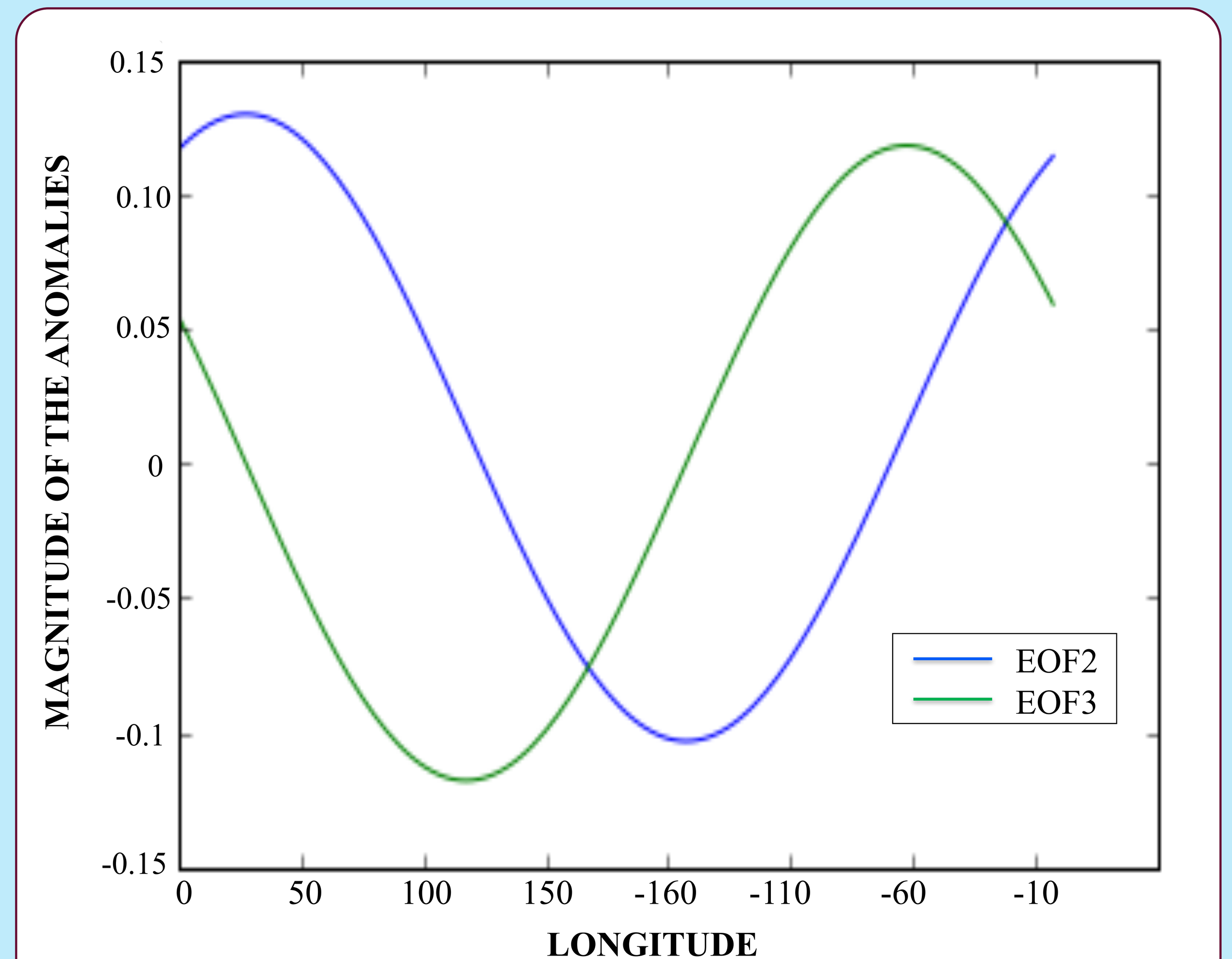
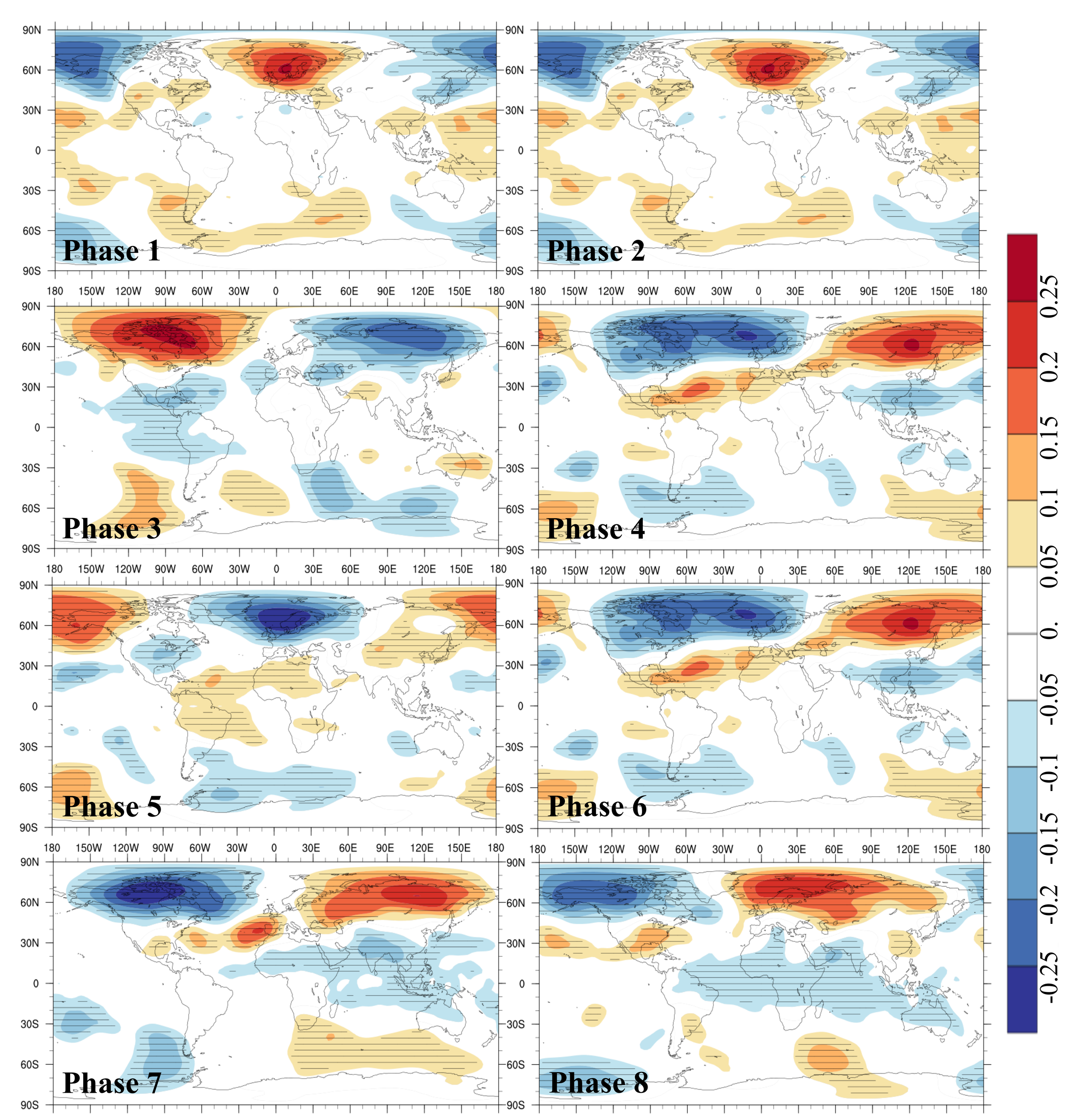


Fig 4. Spatial structures of EOFs 2 and 3 of the normalized Atmospheric Angular Momentum. The variance explained by the respective EOFs is 19.8% and 21.2%

- These two EOF's are in **quadrature** with each other indicating a **westward moving pattern with a period of 20 days.**

COMPOSITE



- In the left is a composite of standardized anomaly of **geopotential height** for all phases (σ, shaded). Hatch areas are statistically significant to the 95%.
- **Strongest anomalies** are confined to the **Northern Hemisphere.**
- Phase 1 shows a wavenumber one pattern in the height field, with **ridge anomalies** confined to northern Europe, across most of the Continental United States, and the tropical western Pacific Ocean. **Trough anomalies** are confined to northwestern Asia and northern Pacific.
- In subsequent phases, **the anomalies move westward**, which is consistent with the **westward propagation of the RH wave.**

RESEARCH QUESTIONS

- What are the dynamics that govern the geopotential height anomalies?
- How does the structure of this wave vary during different seasons?
- What governs the structure of the OLR anomalies (not shown) produced by this wave?
- What are the effects of other AM waves on the general circulation?

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