Observed extratropical circulation response to Fast and Slow MJO episodes

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Motivation

The objective of this study is **to distinguish the remote Northern Hemisphere responses to episodes of slow MJO propagation from those of fast MJO episodes** during boreal winter.The questions addressed are:

1. What significant differences are seen in composite response of the extratropical circulation height and streamfunction fields as function of MJO episode between fast and slow episodes?
2. Are there significant differences in the evolution of wave-activity flux between fast and slow episodes?
3. Do the established relationships between the MJO and Euro-Atlantic (EA) weather regimes depend on the speed of evolution of the MJO heating?
4. Do differences in the associated storm tracks between fast and slow episodes play a role in the propagation of eddies?

Data and Methods

Data ERA-Interim reanalysis, NOAA OLR data for 32-year period 1980/81-2011/12 (32 winters) from 16October-17March.

The three types of categories identified are:
Slow: OLR minimum takes > 20 days to propagate into the west Pacific (8 episodes).
Fast: OLR minimum takes <= 10 days to propagate into the west Pacific (26 episodes).
IOnP: OLR minimum did not propagate into the west Pacific (17 episodes).

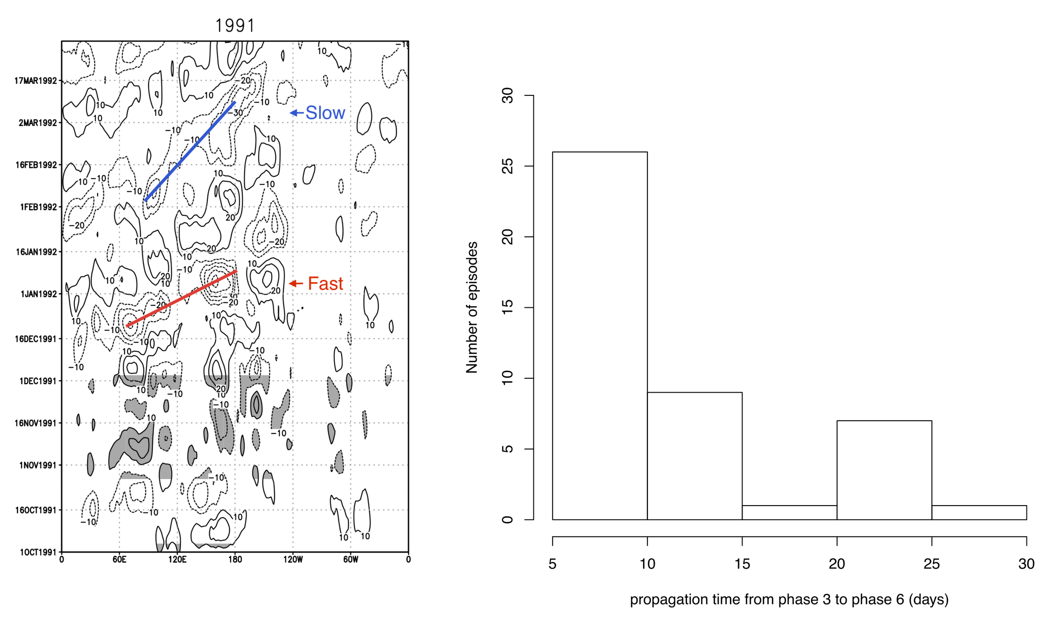

Figure 1: (Left) Observed 20-100 days band-pass filtered OLR averaged from 15S-15N as a function of time.The contour interval is 10Wm^{-2}. Periods when the MJO indices < 1.0 are shaded; (Right) Histogram of propagation time from phases 3 to 6.

Table for dates of each Slow episode

Start Date	End Date	Event
1-Nov-84	21-Jan-85	Weak La Niña
23-Dec-86	4-Mar-87	Moderate El Niño
20-Jan-92	16-Mar-92	Non-ENSO
22-Nov-93	7-Jan-94	Moderate El Niño
30-Jan-98	17-Mar-98	Strong El Niño
24-Oct-01	7-Jan-02	Non-ENSO
8-Jan-02	8-Mar-02	Non-ENSO
20-Dec-09	20-Dec-09	Moderate El Niño

Reference

Yadav, P. and D.M. Straus, 2017: Circulation Response to Fast and Slow MJO Episodes. *Mon. Wea. Rev.*, 145, 1577–1596

500-hPa Height Response

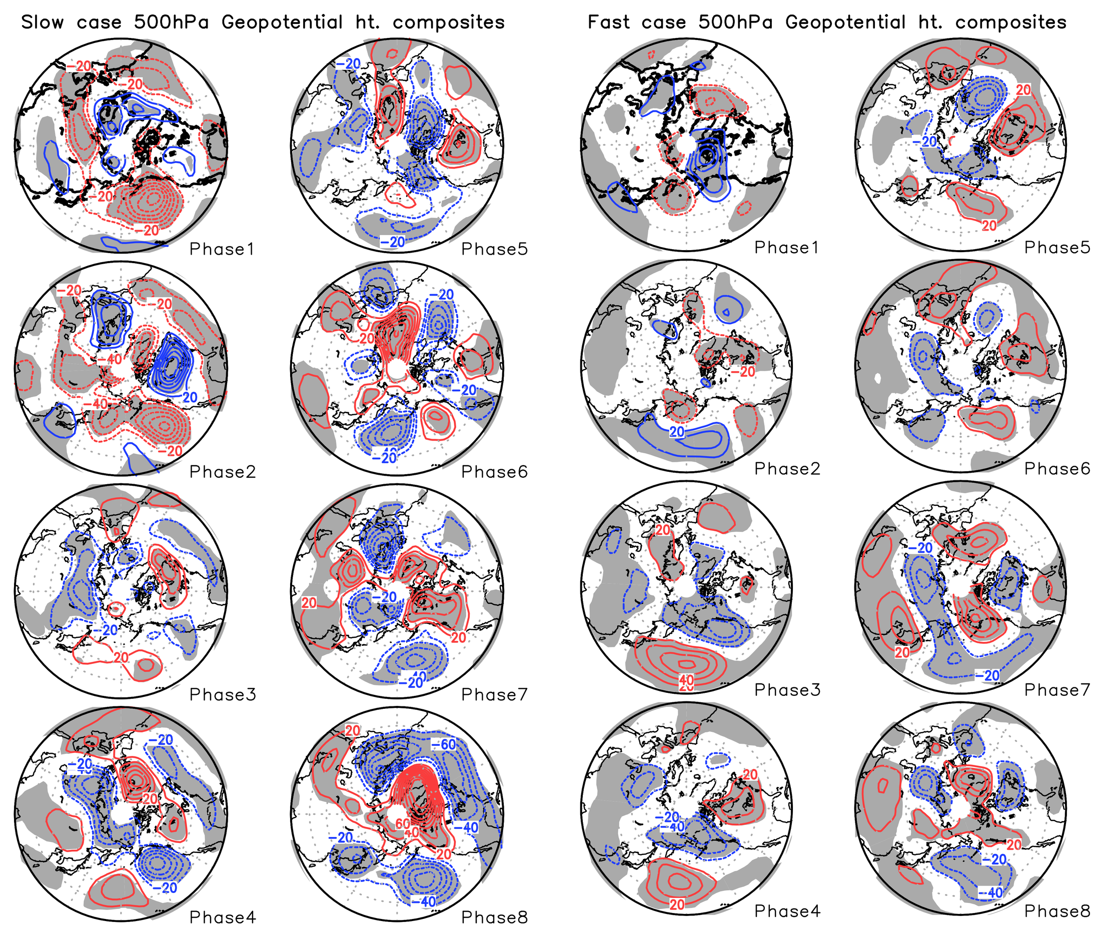

Figure 2: Composite anomalies of daily 500-hPa height (m) for fast and Slow MJO episodes for eight phases Of MJO with normalized amplitude exceeding 1.0. Shaded regions show areas with statistical confidence at or above 90% based on bootstrap resampling. The domain is north of 20N.

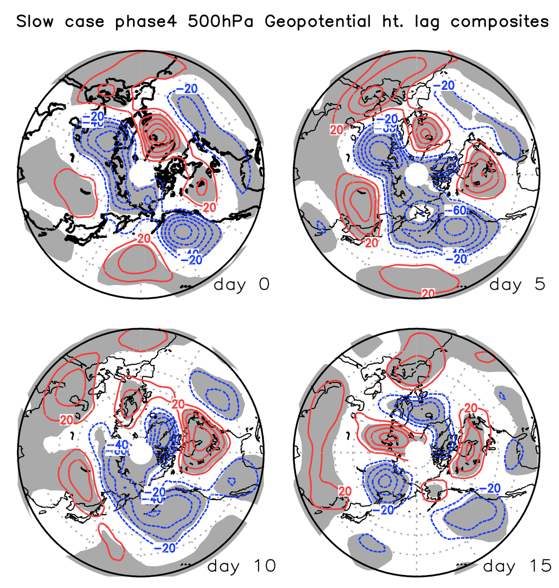

Figure 3: Lag composite anomalies of daily 500-hPa height (m) for slow MJO episodes (with normalized amplitude exceeding 1.0) for periods when the MJO is in phase 4 at (top left) lag 0, (top right) lag +5 days, (bottom left) lag +10 days, and (bottom right) lag +15 days. Shaded regions show areas with statistical confidence at or above 90% based on bootstrap resampling. The domain is north of 20N.

The development of the NAO+ like response is seen following phase 4. *In contrast to fast MJO episodes, the lagged composites do not reproduce the composites at later MJO phases in a regular way.*

Relationship with Stormtracks

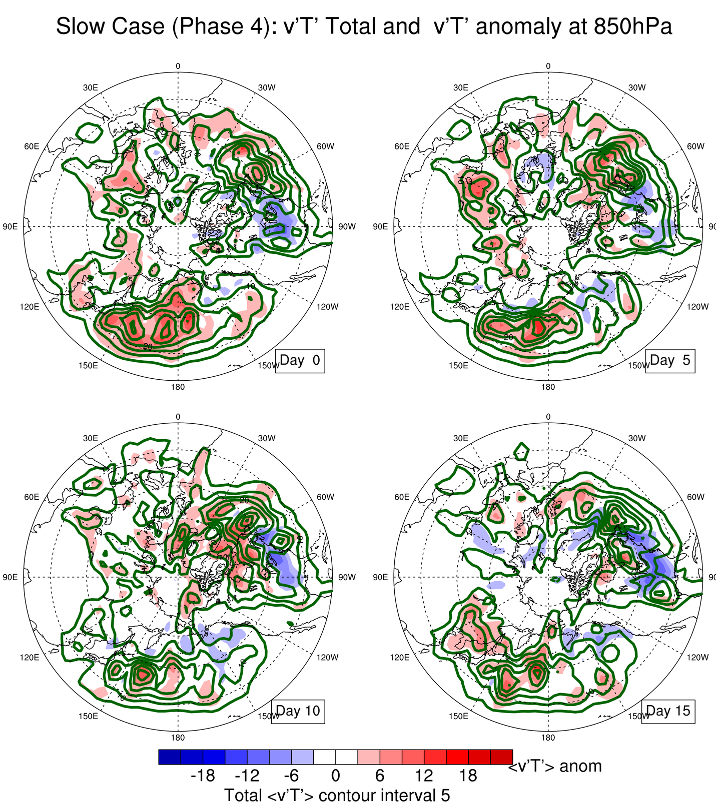

Figure 4: Slow episode composites of covariance between high-pass meridional wind and temperature at 850-hPa for MJO phase 4 at lags 0, +5, +10, and +15 days (covariance lag MJO). Contours show total (interval of 5ms^{-1}K), shading shows anomalies.

Acknowledgements

This material is based upon research supported by, or in part by, the U. S. Office of Naval Research under award number N00014-12-1-0449

Weather Regime Response

To study the lagged relationships between the eight phases of the MJO and the four North Atlantic circulation regimes, the anomalous occurrence of a given regime is computed as a function of MJO phase and lag, with regimes lagging the MJO phases.

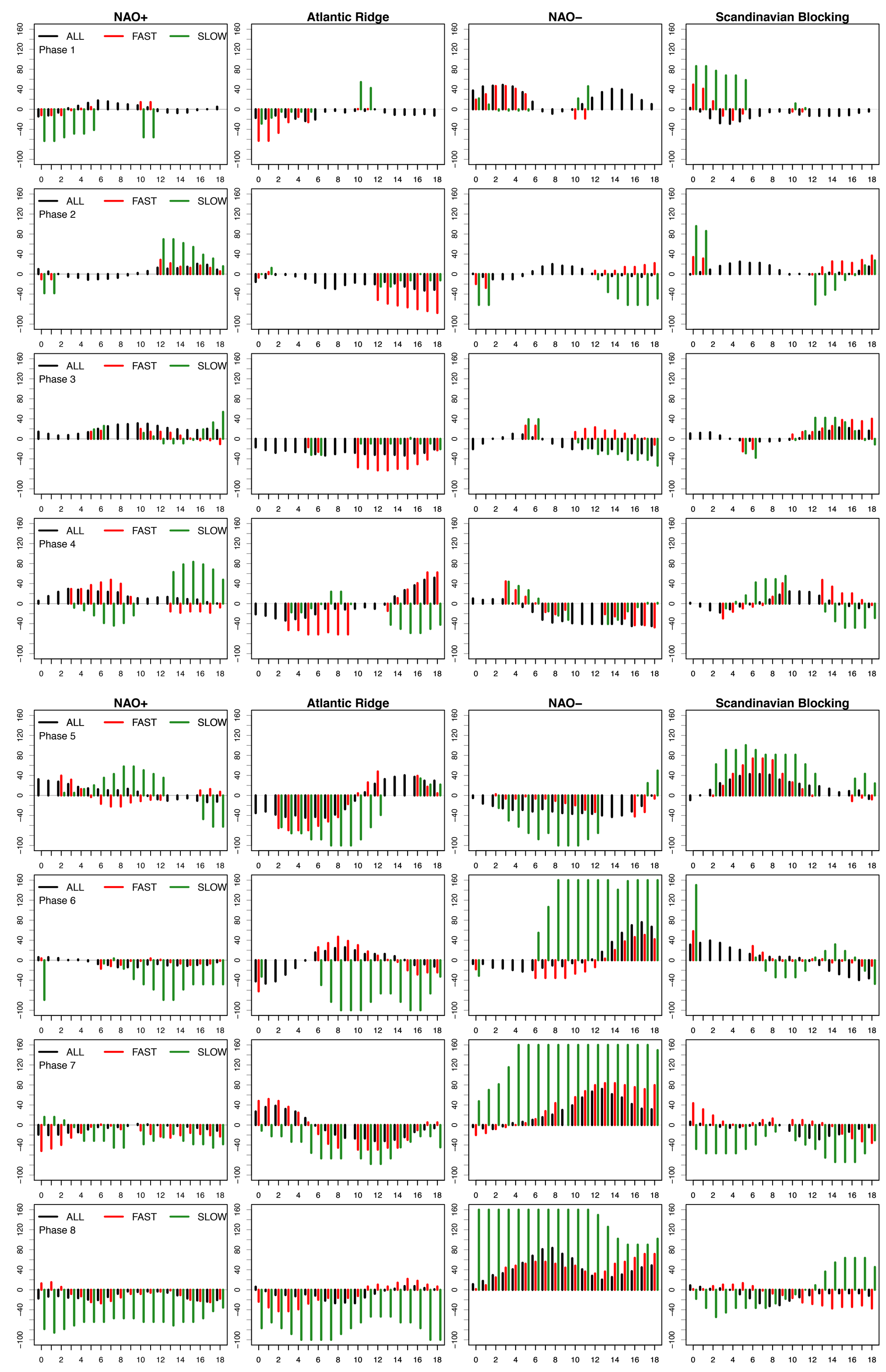

Figure 5: Anomalous percentage occurrence of each of four Euro-Atlantic regimes as a function of lag in days for MJO phases 1–8 (with regimes lagging MJO phases). Fast episodes are shown in red bars, slow are shown in green, and all episodes are shown in black. Results that are not significant at the 90% level using a chi-squared test are not shown

Conclusions

1. A signature of the NAO+ regime is seen associated with phases 4 and 5 for Fast episodes.
2. The modest increase in NAO+ frequency for all strong episodes (total category) for phase 3 after about 10 days agrees with previous work, but the strong increases in frequency of occurrence of the NAO+ regime seen in the slow episodes after phases 4–5 are new.
3. The slow episode changes for NAO- in phase 6 are much larger than seen previously for all episodes, indicating that this response is dominated by slow MJO episodes.
4. For the slow episodes, the baroclinic source (following MJO phase 3) is coincident with enhanced storm-track activity suggests that the storm tracks play an important role in enhancing the NAO response.