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Connections Between the Madden Julian Oscillation and Extratropical Regions of the Global Ocean

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The Madden Julian Oscillation (MJO) is an important mode of atmospheric variability on intraseasonal timescales. It is most evident in observations of outgoing longwave radiation and precipitation in the tropical Indian and Pacific Ocean and the dominant periods of variability are between 30 and 90 days. There is growing evidence for an extratropical component of the MJO. For example Vecchi and Bond (2004, Geophysical Research Letters, henceforth VB2004) recently found a statistical connection between equatorially-based indices of the MJO and high-latitude surface air temperature and air pressure. This type of study points to the possibility of using the MJO to extend the range of atmospheric forecasts beyond the present limit of about 2 weeks. In this study we extend the analysis of VB2004 and search for an extratropical expression of the MJO in the global ocean. The first step is to examine the statistical relationship between the MJO and atmospheric data from a representative high-latitude station (Goose Bay, NL, Canada) using a suite of time series techniques (e.g. Hilbert transforms, conditional expectations, bandpass filtering, cross spectral analysis) that can accommodate nonlinearity, seasonality and frequency dependence. We first show that the assumption of linearity is reasonable and coherency spectra conditioned on season can recover the statistically significant relationship between the MJO and local atmospheric variability at this station found earlier by VB2004. We next search for a component of the MJO in global fields of sea surface temperature (SST) and sea level anomaly (SLA) using the above techniques. As expected, statistically significant relationships are found between the MJO and SST and SLA variability in the Indian Ocean and Western Pacific Ocean. We also identify significant, but weaker, variations in the mid- and high-latitude regions of the Atlantic and Pacific Oceans that are co-

herent with the MJO. These teleconnections are seasonally dependent (e.g. the SST covariation in the North Pacific is strongest in Summer and Fall) and occur over a subrange of MJO periods (60 to 90 days). The physical cause of the teleconnections is presently under investigation but preliminary evidence suggests an important role for (i) coastal trapped waves, generated in near equatorial regions, travelling poleward along the west coast of the Americas and Africa, and (ii) air-sea fluxes driven by the extratopical atmospheric expression of the MJO. Our next steps are to use a global ocean model (NEMO) and a global atmospheric model (GEM) to explore predictability in the ocean, and eventually the coupled atmosphere-ocean system, associated with the MJO. Hopefully this combination of statistical analysis and numerical modeling will contribute to ongoing efforts to better understand of the physics of the MJO and eventually extend forecasts of intraseasonal variability in both the ocean and atmosphere.