MECHANISMS MODULATING TELECONNECTION PATTERNS IN THE EASTERN MEDITERRANEAN

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Abstract

Major atmospheric modes of variability can have a significant effect on oceanic variability. Environmental data that characterize the climatic and oceanic conditions that dominate the Eastern Mediterranean were analysed using the Barnett-Preisendorfer Canonical Correlation Analysis, to describe the mechanisms linking large-scale atmospheric phenomena to regional climatic and oceanic variation.

Keywords : Eastern Mediterranean, Air-sea Interactions.

Atmospheric, meteorological and oceanic data analyses suggest a strong correlation between climatic and/or oceanic variability and the oscillations of the prevailing global atmospheric patterns. Connections at a distance, or teleconnections, can occur by the direct transfer of mass through changes in regular circulations or by propagating waves initiated by a variety of mechanisms.

Recent research efforts are oriented towards the identification of physical mechanisms that characterize observed teleconnection phenomena and could provide the basis for explaining them. The proposed mechanisms either describe teleconnections as an internal oscillation of the coupled ocean-atmosphere system [1] or suggest that they are modulated as propagating Rossby-waves [2] and/or by solar activity [3]. The aim of the present study is the description of teleconnection phenomena observed in the Eastern Mediterranean and of their underlying mechanisms.

Data sets of environmental variables available for the Eastern Mediterranean (atmospheric pressure, precipitation, wind speed and direction, sea surface temperature, salinity, sea level height, chlorophyll concentration and parity) were organized in a GIS database. Indices of atmospheric oscillatory patterns were either generated from atmospheric data or derived from the literature. Barnett-Preisendorfer Canonical Correlation Analysis (CCA) was used: CCA was applied on a number of Principal Components (PC), derived from Empirical Orthogonal Function (EOF) analysis. The EOF method decomposes spatiotemporal data into modes ranked by their temporal variance and was therefore applied on each variable in order to reduce the dimensions of the data, and identify physically interpretable dominant spatial and temporal variability patterns. The EOF analysis is in essence a type of filter that throws away much of the small-scale noise. CCA is a statistical method for finding spatially coherent patterns in different data fields that have the largest possible temporal correlation. CCA yields two sets of weights that give the combinations of the corresponding sets of patterns with the maximum temporal correlation. In order to determine possible relationships between the atmospheric indices and the observed oceanic variability, the amplitude functions corresponding to the most relevant PCs were selected and cross-correlation analysis was applied. Pre-processing includes decomposition of the time series in order to remove seasonality and thus avoid artificial cross correlations.

The surface pressure field in the Eastern Mediterranean is influenced by the oceanic Azores High, the Siberian winter anticyclone, and the northwestern extension of the South Asian summer thermal low. The main atmospheric pattern identified in the Mediterranean is the Mediterranean Oscillation. The Mediterranean Oscillation has been suggested to be related to recent variability and trends of the Mediterranean precipitation [4], to air temperature [5], cyclogenesis [6], sea surface temperature [7], sea level height, salinity [8] and surface wind [9]. Altimetry and sea surface temperature have been linked to the Southern Oscillation and the North Atlantic Oscillation indices, while atmospheric regimes related to the North Atlantic Oscillation seem to play a regulatory role in the oceanic circulation regime, influencing eddy and deep water formation. We present results on the spatiotemporal links between the various environmental variables and on the proposed teleconnection mechanisms in a region that is influenced by a large number of modes of atmospheric variability.

References

1 - Goswami, B.N., M.S., Madhusoodanan, C.P., Neema and D. Sengupta. 2006. A physical mechanism for North Atlantic SST influence on the Indian summer monsoon. *Geophys. Res. Lett*., 33,L02706, doi:10.1029/2005GL024803.

2 - Saji N.H., Ambrizzi T. and Ferraz S.E.T.,2005. Indian Ocean Dipole mode events and austral surface air temperature anomalies. *Dynam. Atmos. Oceans*, 39: 87-101.

3 - Kirov B. and Georgieva K., 2002. Long-term variations and interrelations of ENSO, NAO and solar activity. *Phys. Chem. Earth*, 27: 441-448.

4 - Dunkeloh A. and Jacobeit J., 2003. Circulation Dynamics of Mediterranean precipitation variability 1948-98. *Int. J. Climatol.*, 23: 1843-1866.

5 - Maheras P., Xaplaki E., Davies T., Martin-Vide J., Bariendos M. and Alcoforado M.J., 1999. Warm and cold monthly anomalies across the Mediterranean basin and their relationship with circulation: 1860-1990. *Int. J. Climatol*., 19: 1697-1715.

6 - Suselj K. and Bergant K., 2006. Mediterranean Oscillation Index. *Geophys. Res. Abstracts*, 8: 02145.

7 - Lolis C.J., Bartzokas A. and Katsoulis B.D., 2002. Spatial and temporal 850 hPA air temperature and sea surface temperature covariances in the Mediterranean region and their connection to atmospheric circulation. *Int. J. Climatol.*, 22: 663-676.

8 - Morovic M., Grbec B. and Zore-Armanda M., 2003. Mediterranean Oscillation index and its relationship to interannula salinity fluctuations in the Adriatic Sea. *Geophys. Res. Abstracts*, 5: 04469.

9 - Reddaway J.M. and Bigg G.R., 1996. Climatic change over the Mediterranean and links to more general atmospheric circulation. *Int. J. Climatol*., 16: 651-661.