The Impact of Trends in the Large Scale Atmospheric Circulation on Mediterranean Surface Turbulent Heat Fluxes

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Abstract

Interannual variations of latent heat fluxes (LHF) and sensible heat fluxes (SHF) over the Mediterranean for the boreal winter season (DJF) show positive trends during 1958-2011. Comparison of correlations between the heat fluxes and the intensity and location of the Azores High (AH), and the NAO and East Atlantic-West Russia (EAWR) teleconnections, along with analysis of composites of surface temperature, humidity and wind fields for different teleconnection states, demonstrates that variations of the AH are found to explain the heat flux changes more successfully than the NAO and the EAWR. Trends in sea level pressure and longitude of the Azores High during DJF show a strengthening, and an eastward shift. Diff Azores High pressure and longitude are shown to co-vary such that variability of the Azores High occurs along an axis defined by lower pressure and westward location at one extreme, and higher pressure and eastward location at the other extreme. The shift of the Azores High from predominance of the low/west state to the high/east state induces trends in Mediterranean Sea surface winds, temperature and moisture. These, combined with sea surface warming trends, produce trends in wintertime Mediterranean Sea sensible and latent heat fluxes.

Trends in DJF Heat Fluxes and Circulation Patterns

Correlations on monthly time scales

Effect of AH state on air-sea gradients, winds

How does AH state influence air-sea gradients?

Colder, drier conditions associated with high/east AH state

Eastward shift of anticyclonic winder flow strengthens northerly winds over Mediterranean, especially eastern basin

Adsorption of cold, dry continental air by enhanced northerly winds leads to larger air-sea T, q gradients over Mediterranean

Conclusions

Positive trends in DJF LHF and SHF over Mediterranean, with substantial spatial variability

Positive trend in Azores High slp and eastward displacement, as well as positive trend in NAO index over same period

Compared to NAO, trends in AH slp and eastward displacement best account for spatial pattern of air-sea T, q gradients and wind velocity components associated with observed trends in LHF and SHF

Trends in Mediterranean LHF and SHF best explained by the shift toward more frequent AH high/east states

Anomalous anticyclonic circulation associated with AH high/east shift causes stronger, more northerly winds over Mediterranean basin, advecting colder, drier air, producing larger air-sea T, q gradients

Datasets

Air slp and longitude indices are computed from NCEP/NCAR monthly mean slp, monthly mean NAO and EAWR indices are from the NOAA/NWS Climate Prediction Center. Monthly mean diabatic fluxes (HF and SHF) and the quantities they are derived from (air-sea surface air temperature and humidity, and SST) are from the Woods Hole Oceanographic Institution Objectively Analyzed Air-Sea Flux (OAFlux) dataset. DJF is computed using the Coupled Ocean Atmosphere Response Experiment (COARE) v2.5b algorithm. Only mean 10m and u winds are from the NCEP/NCAR reanalysis.