Geophysical Research Abstracts
Vol. 20, EGU2018-10600-1, 2018
EGU General Assembly 2018

Atmospheric circulation and variability over the Euro-Atlantic sector since 1685

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Ships' logbooks are the most important source of wind direction observations over the world's oceans and seas for the pre-instrumental period. Moreover, wind direction in the English Channel is informative about the mid-latitude atmospheric circulation over the Atlantic and plays an important role in the climate conditions of Europe.
We present four monthly indices of wind persistence, one for each cardinal direction: Northerly (NI), Easterly (EI), Southerly (SI) and Westerly (WI), based on daily observations taken aboard ships over the English Channel. These directional indices (DIs) are the longest observational record of atmospheric circulation to date, covering the 1685-2014 period. We show that the DIs constitute a powerful tool to characterize the atmospheric circulation over Europe from monthly to multidecadal time scales. Thus, they present a coherent climatic signal in terms of temperature and precipitation over most of Europe with zonal indices (WI-EI) affecting larger areas than meridional indices (NI-SI), especially during cold seasons. In fact, statistical models including all DIs are able to explain a considerable amount of climate variability, improving in most cases that accounted for by the North Atlantic Oscillation (NAO).
Moreover, the combination of DIs is able to capture the non-stationarity of the NAO. In this sense, we report multidecadal fluctuations during the last centuries between a "high-zonal" and "low-zonal" dipole of the NAO, with no discernible trend for the last 330 years. These results show the potential of DIs to study European climate variability and its responses to slowly-varying climate drivers, as well as anthropogenic and natural forcings.

This work was supported by FCT through project UID/GEO/ 50019/2013.