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Long-term variability of mid-latitude atmosphere: impact of interannual and decadal climate modes

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One of the topical problems in studying climate of the mid-latitudes is the identification of the long-term atmospheric variability mechanisms. In this report we analyze a response of the atmosphere to leading interannual and decadal climate modes extracted from the global sea surface temperatures (SST). The analysis is a two-step procedure.

First, an optimal linear dynamical mode decomposition [1,2] is applied to the global time series of monthly SST anomalies (SST deviations from the long-term monthly means) on the time interval from 1960 to 2014. The decomposition procedure includes two external forcings as prescribed variables: (i) the global CO_2 abundance in the atmosphere, and (ii) a smoothed time series of the sunspot numbers characterizing the solar activity. It is shown that the decomposition separates efficiently time scales contained in the SST field: the one part of the obtained components describes mainly the decadal variability, and the other - interannual. The obtained decadal components of the mode contribute largely to the Pacific Decadal Oscillation (PDO) pattern; also, it yields synchronous structures in the north and tropical parts of the Atlantic, indicating the existence of long-distance PDO teleconnections. The interannual components correspond to the El Nino – South Oscillation (ENSO) dynamics: they clearly explain the ENSO-related tropical indices as well as a structure of ENSO teleconnections in the extra-tropics and in the Indian and Atlantic oceans.

Next, we study an impact of the obtained climate mode on the atmosphere, in particular, in mid-latitudes. To this end, we use the lagged regression of different atmospheric fields (geopotential heights on various levels through the troposphere, surface temperature, etc.) on the components of the obtained dynamic mode. The detected response of the large-scale atmosphere circulation patterns to different ENSO-related components as well as to decadal climate variability is demonstrated, and implications in long-term forecast of mid-latitude weather patterns are discussed.

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