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Title: *Data Analysis for the Arctic Oscillation using the AOI equation*

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Data Analysis for the Arctic Oscillation using the AOI equation

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In this study we have derived a dynamical equation that governs the time change of the Arctic Oscillation Index (AOI). The equation is called AOI equation, which is based on the 3D spectral primitive equation on a sphere with the basis of 3D normal mode functions. The AOI equation is applied to the NCEP/NCAR reanalysis for 1950 to 2011 to investigate the time change of the AOI in the framework of linear process, nonlinear process, and external forcing effect. According to the result, it is found that the decadal scale AO is amplified resonantly by the linear process to reveal the structure of the most unstable barotropic instability for a zonally varying basic state. Since the eigenmode is a standing mode with zero frequency and a fixed geographical pattern, there are only two directions to grow: one is AO positive and the other is AO negative directions. The nonlinear process and external forcing appear to damp the amplified AO. The result implies that the decadal change of the AO is explained as an internal variation of the atmospheric dynamical eigenmode.