Session: C36 Poster: Th60B

The impact of climate change on the spatial and temporal structure of the Annular modes

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The annular modes are the dominant natural modes of variability in the extratropics of both hemispheres, characterizing shifts of the jet stream and storm tracks on intraseasonal time scales. Coupled climate models predict that the extratropical jets and associated storm tracks will expand poleward in response to anthropogenic forcing. We explore how the spatial and temporal structure of internal variability responds to changes in the climatological jet in the CMIP5 data set, and compare the results with assessments of the CMIP3 coupled models and Chemistry-Climate Models from the CCMVal2, which include a better representation of stratospheric processes. The latter set of models is included in the study because the annular modes also characterize coupling between the stratosphere and troposphere, and so could reflect changes in the vertical coupling of the atmosphere. The intraseasonal properties of the annular mode in the CMIP3 and CCMVal2 models appear to change very little over the course of the 21st century, provided one properly accounts for climate trends in defining the intraseasonal variability. Confidence in these prediction, however, is dampened by the fact that there were substantial and systematic biases in the statistics of the models' annular modes in their 20th century simulations, as compared with observations. The ability of climate models to capture the temporal structure of internal variability has often been overlooked. Evidence from a wide spectrum of comprehensive and idealized GCMs has suggested a connection between the climatological position of the jet stream and the time scales of natural variability. Detection of such relationships in previous multimodel climate records has been hampered by scarcity of data (the annular mode time scales are extremely slow to converge) and the biases in previous generation models. We explore whether the CMIP5 data set provides sufficient detail to test whether wave mean flow interactions change in response to anthropogenic forcing.