15.6 DIAGNOSTIC ANALYSES OF SHORT-TERM CLIMATE VARIABILITY IN NASA/GSFC GENERAL CIRCULATION MODELS

Robert X. Black*
Dennis P. Robinson
Georgia Institute of Technology
Atlanta, Georgia

1. OVERVIEW

The success of climate prediction efforts is critically dependent upon the veracity with which atmospheric general circulation models (GCMs) are able to simulate the atmospheric circulation. A minimum expectation is that GCMs employed are capable of realistically representing important aspects of the current climate. Regional climate is strongly influenced by second order atmospheric circulation features such as storm track variability and anomalous weather regimes, both of which are dynamically linked to the midlatitude jet stream and associated with prolonged abnormal surface weather. It has recently been recognized that extratropical climate is also influenced by annular modes of variability. In particular, the Northern Hemisphere Arctic Oscillation is directly linked to both storm track variations and certain anomalous weather regimes. A proper representation of the coupled behavior of anomalous weather regimes, storm tracks, and annular modes is essential for reliable climate simulations. A detailed diagnostic assessment of such short-term climate variability thus provides an important benchmark test for a climate model.

We provide an overview of a modern diagnostic approach for validating synoptic and dynamic characteristics of short-term climate variability in GCMs. Adopting this approach, we perform an exploratory study of the characteristics of anomalous weather regimes, storm tracks, and annular modes in extended integrations of NASA/GSFC GCMs. This includes an intercomparison of the representation of these natural phenomena in AMIP-type simulations of the NASA/NCAR and Aries (NSIPP) models. We diagnose their statistics, three-dimensional structure, and dynamical characteristics and contrast the results with parallel observational analyses to isolate systematic errors. Our approach combines traditional diagnostic methods (such as E-vector, deformation, and energetics analyses) with newer potential vorticity-based approaches. Specific goals include (a) determining the extent to which the models are able to replicate the observed characteristics of these phenomena and (b), in cases where a specific shortcoming is identified, performing targeted dynamical diagnoses aimed at deducing the underlying physical reasons for the systematic errors.

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* *Corresponding author address:* Robert X. Black, School of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta, GA, 30332-0340; e-mail: rob.black@eas.gatech.edu.