M.S. Defense Announcement
Charlotte Connolly
Monday, November 14, 2022, at 11:00 a.m. MT

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Defense
CIRA Commons or Teams

Post Defense Meeting
ATS Main Conference Room (209 ATS)

Committee:
Elizabeth Barnes (Adviser)
David Randall
Charles Anderson (Computer Science)

Using Neural Networks to Learn the Forced Response of the Jet-Stream to Tropospheric Temperature Tendencies

Two distinct features of anthropogenic climate change, warming in the tropical upper troposphere and warming at the Arctic surface, have competing effects on the midlatitude jet-stream's latitudinal position, often referred to as a "tug-of-war". Many previous studies have investigated the strength of the jet response to these thermal forcings, as well as many others, and have shown that the jet response is sensitive to model type, season, initial atmospheric conditions, and the shape and magnitude of the forcing. Here, we explore the potential for training a convolutional neural network (CNN) on internal variability alone to examine possible nonlinear jet responses to a variety of thermal forcings. Our approach thus makes use of the fluctuation-dissipation theorem, which relates the internal variability of a system to its forced response. We train a CNN on data from a long control run of the CESM dry dynamical core, thereby providing it with ample data to learn relationships between the temperature forcing and the jet movement over the coming days. Then, we use the CNN to explore the jet response to a wide range of tropospheric temperature tendencies. Despite being trained on the jet-stream response to internal variability alone, we show that the trained CNN is able to skillfully predict the nonlinear response of the jet-stream to sustained external forcing. The trained CNN provides a quick method for exploring the jet-stream sensitivity to a wide range of tropospheric temperature tendencies and, considering that this method can likely be applied to any model with a long control run, could lend itself useful for early stage experiment design.

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