SIMPLE MODELS FOR THE HEAT FLUX FROM THE ATLANTIC MERIDIONAL OVERTURNING CIRCULATION (AMOC) TO THE ATMOSPHERE

Mona Behl1,2, Doron Nof2,3, Steve Van Gorder2

1. The Texas Sea Grant College Program, Texas A&M University, College Station TX.
2. Department of Earth, Ocean and Atmospheric Science, The Florida State University, Tallahassee, FL.
3. Geophysical Fluid Dynamics Institute, The Florida State University, Tallahassee, FL.

Introduction
It has been suggested that a slow down of the AMOC would cause the northern hemisphere to cool by a few degrees. We use a sequence of simple analytical models to show that, due to the non-linearity of the system, the simplified heat flux from the modeled AMOC to the atmosphere above is so robust that even changes of as much as 50% in the present AMOC transport are not enough to significantly change the temperature of the outgoing warmed atmosphere. Our most realistic model involves a warm ocean losing heat to an otherwise motionless and colder atmosphere. As a result, the compressible atmosphere convects and the generated airflow ultimately penetrates horizontally into the surrounding air. The behavior of the system is attributable to four key aspects of the underlying physical processes: Convective atmospheric transport increases by warming the atmosphere, the fact that ocean is warmer than the atmosphere, the observation that the surface heat flux is usually proportional to the temperature difference between the ocean and the atmosphere, the fact that the specific heat capacity of water is much larger than that of the air. Taken together, these properties of the system lead to the existence of a dynamical “saturation” state, a modeled regime where even significant changes in the AMOC transport have almost no effect on the ocean-atmosphere heat flux and the resulting outgoing atmospheric temperature.

Four conceptual models

Results

Discussion and Summary

Non-linear dependence of atmospheric mass transport on the transport of water
The dependence of atmospheric transport on the large specific heat capacity ratio of water to air (~4)

The fact that ocean is warmer (by 10-20 degrees) than the air
The observation that the heat-flux is usually proportional to the temperature difference between the ocean and the air

References

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