

THE TROPOPAUSE AND THE THERMAL STRATIFICATION IN THE EXTRATROPICS OF A DRY ATMOSPHERE

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ABSTRACT

A dynamical constraint on the extratropical tropopause height and thermal stratification is derived by considerations of entropy fluxes, or isentropic mass fluxes, and their different magnitudes in the troposphere and stratosphere. The dynamical constraint is based on a relation between isentropic mass fluxes and eddy fluxes of potential vorticity and surface potential temperature and on diffusive eddy flux closures. It takes baroclinic eddy fluxes as central for determining the extratropical tropopause height and thermal stratification and relates the tropopause potential temperature approximately linearly to the surface potential temperature and its gradient.

Simulations with an idealized GCM point to the possibility of an extratropical climate in which baroclinic eddy fluxes maintain a statically stable thermal stratification and, in interaction with large-scale diabatic processes, lead to the formation of a sharp tropopause. The simulations show that the extratropical tropopause height and thermal stratification are set locally by extratropical processes and do not depend on tropical processes and that, across a wide range of atmospheric circulations, the dynamical constraint describes the relation between tropopause and surface potential temperatures well. An analysis of observational data shows that the dynamical constraint, derived for an idealized dry atmosphere, can account for interannual variations of the tropopause height and thermal stratification in the extratropics of the Earth atmosphere.

The dynamical constraint implies that if baroclinic eddies determine the tropopause height and thermal stratification, an atmosphere organizes itself into a state in which nonlinear interactions among eddies are inhibited. The inhibition of nonlinear eddy-eddy interactions offers an ex-

planation for the historic successes of linear and weakly nonlinear models of large-scale extratropical dynamics.

REFERENCES

- Schneider, T., 2003: The tropopause and the mean thermal stratification in the extratropics of a dry atmosphere. *J. Atmos. Sci.*, submitted. [Preprint available at www.gps.caltech.edu/~tapio/.]

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