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An integral view of Extratropical Upper Troposphere / Lower Stratosphere Chemistry, Dynamics and Transport

Andrew Gettelman (1), Peter Hoor (2), Laura Pan (1), William Randel (1), Michaela Hegglin (3), and Thomas Birner (4)

(1) National Center for Atmospheric Research, Climate and Global Dynamics Division, Boulder, United States (andrew@ucar.edu), (2) Department of Atmospheric Physics, Johannes Gutenberg University Mainz, Mainz, Germany, (3) Department of Physics, University of Toronto, Toronto, ON, Canada, (4) Department of Atmospheric Sciences, Colorado State University, Fort Collins, CO, USA

The Extra-tropical Upper Troposphere and Lower Stratosphere (Ex-UTLS) is a complex region of the atmosphere that provides an extended transition between the stratosphere and the troposphere, and between the tropics and polar regions. The region contains the tropopause, a strong stability gradient and hence dynamic barrier to transport seen in tracer profiles. The Ex-UTLS couples to the troposphere chemically through constituent transport of e.g. ozone, dynamically by coupling stratospheric processes to tropospheric wave patterns, and radiatively by the presence of optically thick clouds and clear sky gradients of radiatively active gases. A picture of the Ex-UTLS is sketched that brings together several different definitions of the tropopause and many observed and simulated features of the UTLS using satellites, in-situ observations and models.

An integral view recognizes that thermal gradients and dynamic barriers are necessarily linked, and that there are radiative feedbacks that help maintain the structure of the UTLS. The Ex-UTLS structure leads to stability gradients, that govern transport pathways and thus determine tracer gradients. Different chemical gradients reflect the structure of the Ex-UTLS and the processes responsible for transport mixed with different tracer sources and sinks. The distribution and correlation of trace species in the ExUTLS chemically mirrors the dynamical transition character between the stable stratosphere and the convectively mixed (turbulent) troposphere. This perspective places disparate observations and approaches in context, and permits a deeper understanding of the role of the Ex-UTLS. The impacts of 21st century anthropogenic changes to the atmosphere due to ozone recovery and increasing greenhouse gases will be felt in the Ex-UTLS, and recent simulations of the effects of these forcings on UTLS structure and chemistry are summarized and placed in context.