Toward an aircraft in situ data based chemical tracer climatology for model evaluation in the UTLS

S. Tilmes, L. L. Pan, D. E. Kinnison, A. Gettelman NCAR, USA

Abstract: The representation of chemical transport processes that couple the upper troposphere (UT) and lower stratosphere (LS) in CCMs is a key component for the models to simulate future climate scenarios. To constrain and evaluate CTMs and CCMs, we establish a climatology based on aircraft data from a set of northern hemisphere campaigns. Data are grouped into regimes that are based on the underlying transport characteristics. Diagnostics using CO, H_2O and Ozone for three regimes are presented.

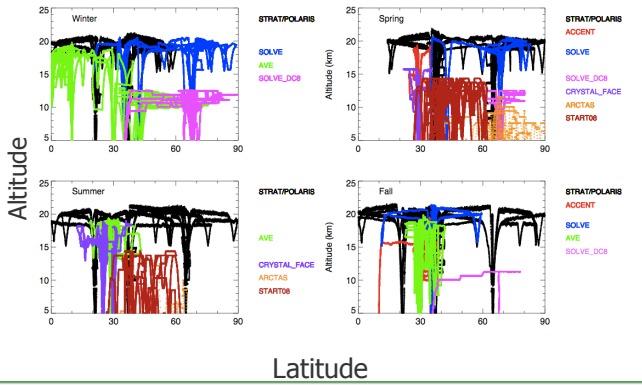
How do we use sparse aircraft observations to establish a climatology in the UTLS?

• Exchange processes and mixing between UT and LS differ with location and season [e.g., Holton 1995].
• Characteristics of different tracers depend on background transport processes.

⇒ **Sparse observations need to be grouped in a physically meaningful way to describe the characteristics of tracers in different regimes**

Altitude and Latitude location of various aircraft campaigns in the Northern Hemisphere between 1995 and 2008:

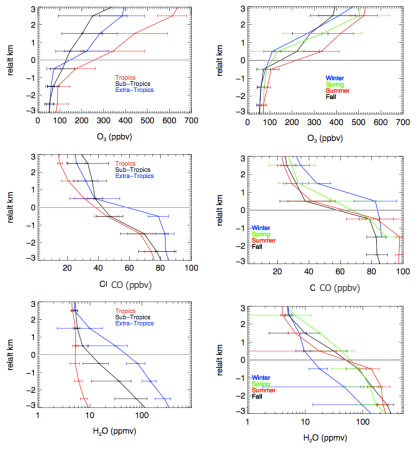
STRAT/POLARIS, ACCENT, SOLVE, CRYSTAL_FACE, ARCTAS, START08



Relative altitude with regard to the Tropopause (TP) to describe the chemical discontinuity across the TP

Different Regimes (Fall):

Different Seasons: (Extra-Tropics)

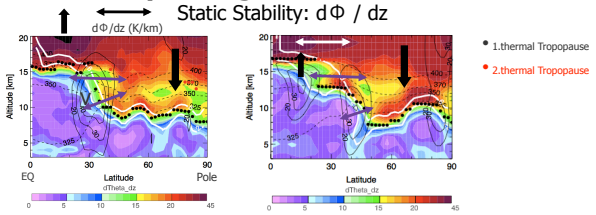


• Aircraft observations are grouped with regard to the location of the STJ and the PJ using NCEP meteorological data.

• Significant differences between different regimes and seasons for Ozone (top), CO (middle) and H_2O (bottom).

• Comparison with model results can identify shortcomings of the models.

The jet streams are important boundaries for transport regimes in the UTLS:



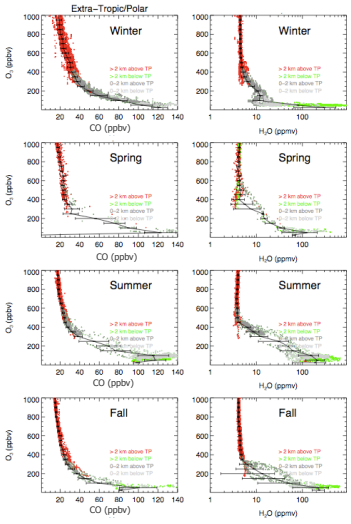
Regimes:
• Tropics: equator ward of the STJ

• Sub-Tropics: between STJ and PJ

• Extra-Tropics/Polar: pole ward of the PJ or the merged STJ / PJ

Characteristics:
• High tropopause, ascending air masses, influenced by horizontal exchange processes (Stratospheric intrusions).
• Lower tropopause, influenced by horizontal exchange processes (Tropospheric and Stratospheric Intrusions).
• Low tropopause, descending air masses, some influence by isentropic mixing processes.

Tracer-Tracer correlations to describe mixing



Extra-Tropics:
• red: 2km above the TP
• green: 2km below the TP
• gray: +/-2km around the TP

• Influence of horizontal and vertical mixing results in a deviation from the "L"-shape of O_3/CO and O_3/H_2O tracer correlations.

• Strongest mixing mixing within 2km across the TP.

• Low ozone and H_2O values above 2km of the TP (red) indicate a tropical source region of some air masses in the extra-tropics.

Acknowledgement:

We gratefully acknowledge everyone who measured, processed and provided various high quality aircraft observations. Further we acknowledge NCEP for providing meteorological analyses. The University Corporation for Atmospheric Research (UCAR) and the National Aeronautics and Space Administration (NASA) supported this work.