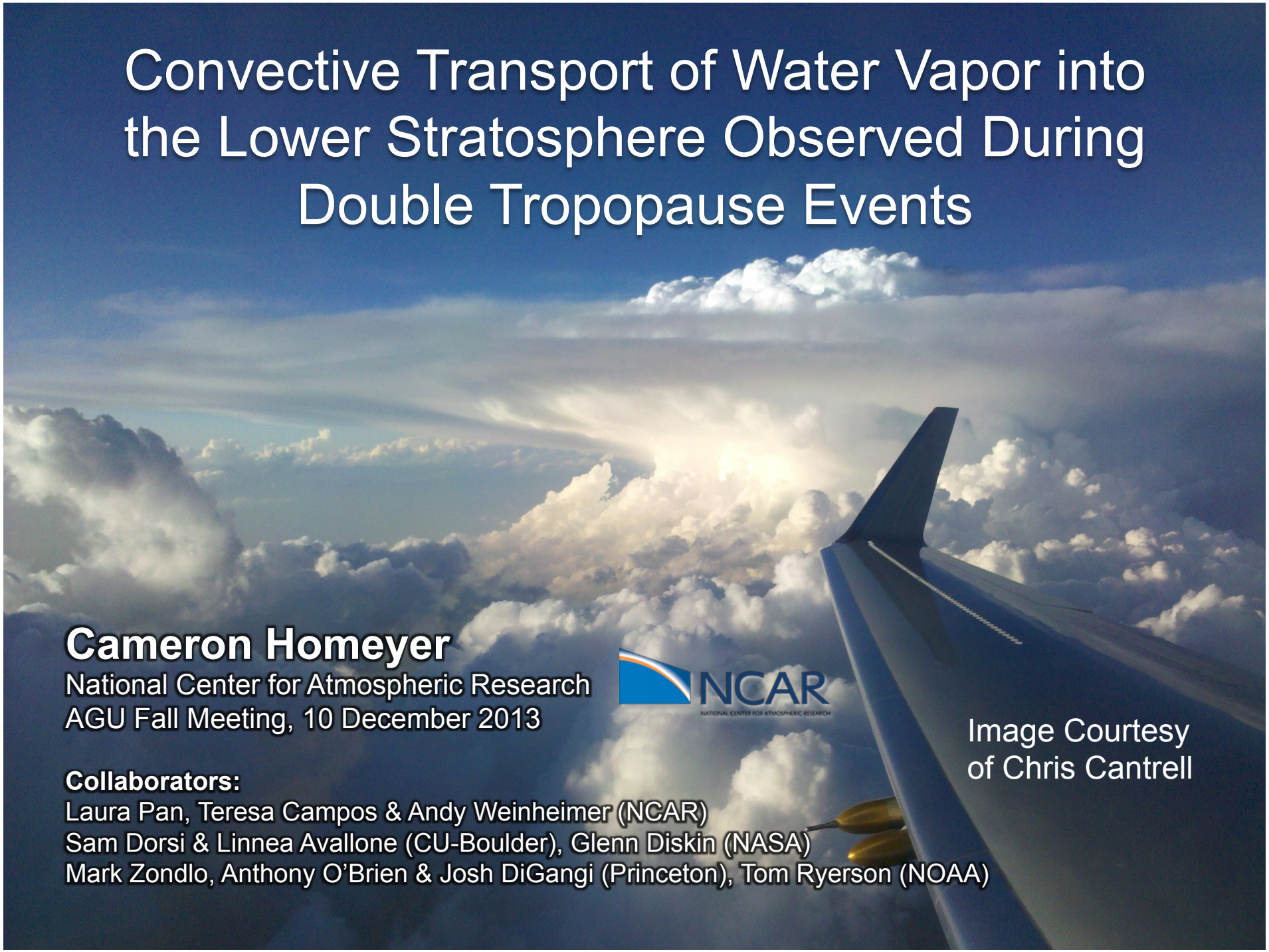
Convective Transport of Water Vapor into the Lower Stratosphere Observed During Double Tropopause Events



Cameron Homeyer
National Center for Atmospheric Research
AGU Fall Meeting, 10 December 2013

Image Courtesy of Chris Cantrell

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Outline

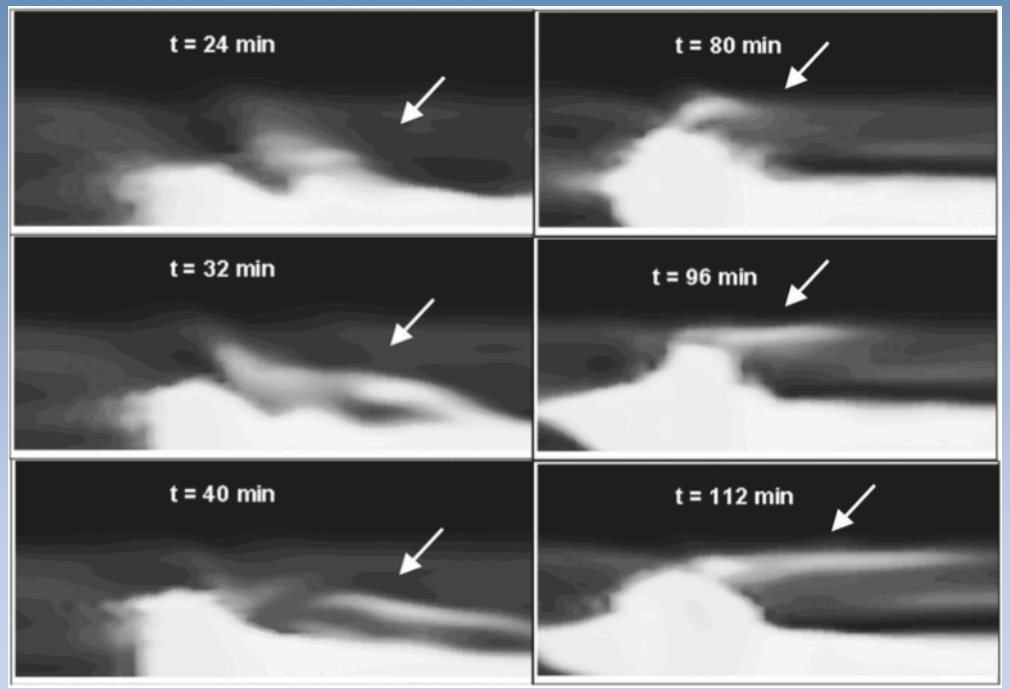
- Observations from the Deep Convective Clouds and Chemistry (DC3) experiment
  - May-June 2012
  - NSF-NCAR Gulfstream V (GV) & NASA DC-8
  - Primary goal was to characterize effect of midlatitude convection on UT composition and chemistry
- Water vapor injection into LS
  - May 19-20 (GV)
  - May 30-31 (GV & DC-8)

Motivation

- Well known: stratosphere-troposphere exchange modifies UTLS chemistry, radiation budget, and climate
- Potential impacts of STE from extratropical convection:
  - TST: Increase in stratospheric water vapor
    - Inorganic chlorine activation and ozone destruction? (*Anderson et al, 2012,* ***Science***)
  - STT: Increase in tropospheric ozone
- Problems?
  - Convection and associated transport not resolved in global climate models
  - Apart from the identification of overshooting extratropical convection, little is known about the characteristic depth and frequency, large-scale environments conducive to overshooting, and mechanisms responsible for transport

Transport Mechanisms

"Jumping Cirrus"



Direct Overshoot Mixing

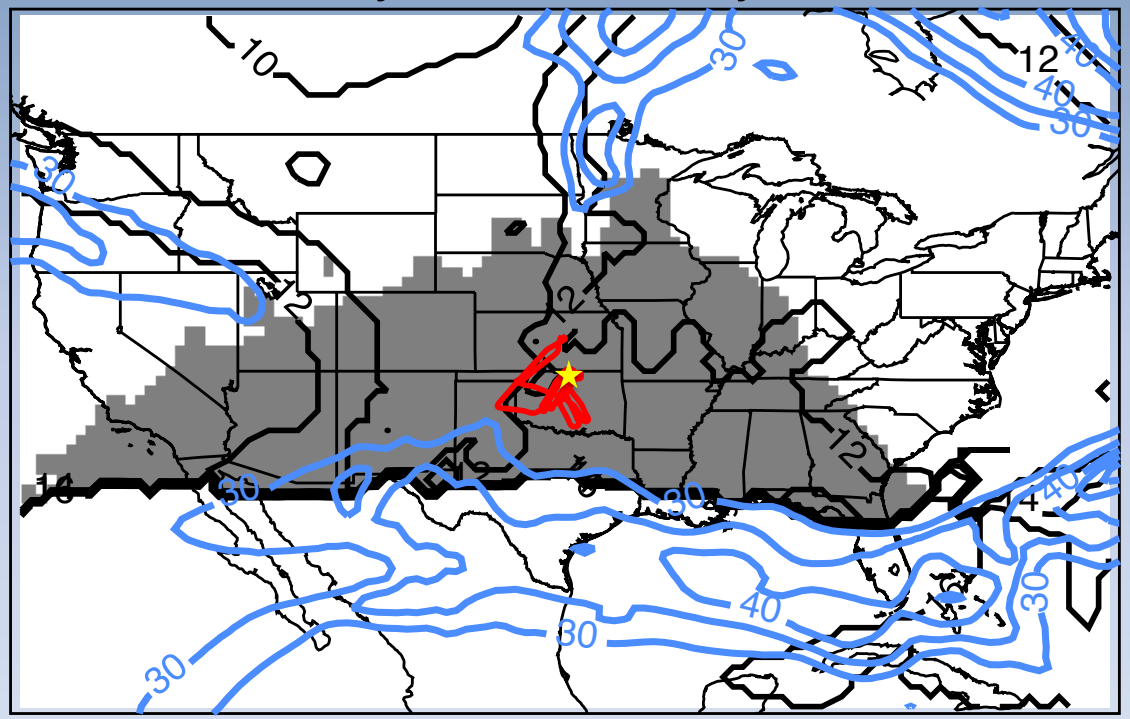
Wang, 2003, J. Geophys. Res.

Fujita, 1982, J. Meteorol. Soc. Japan

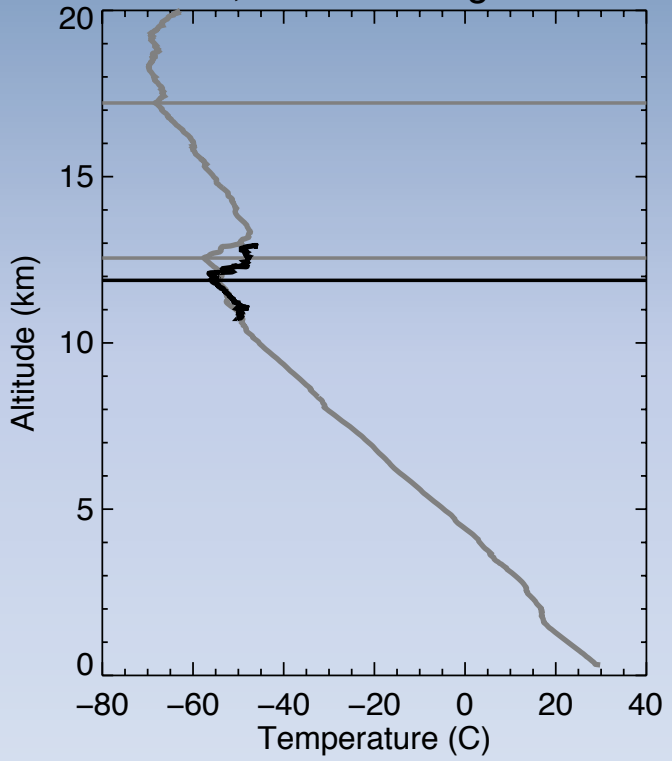
19-20 May 2012

Flight Track & Large-Scale Environment

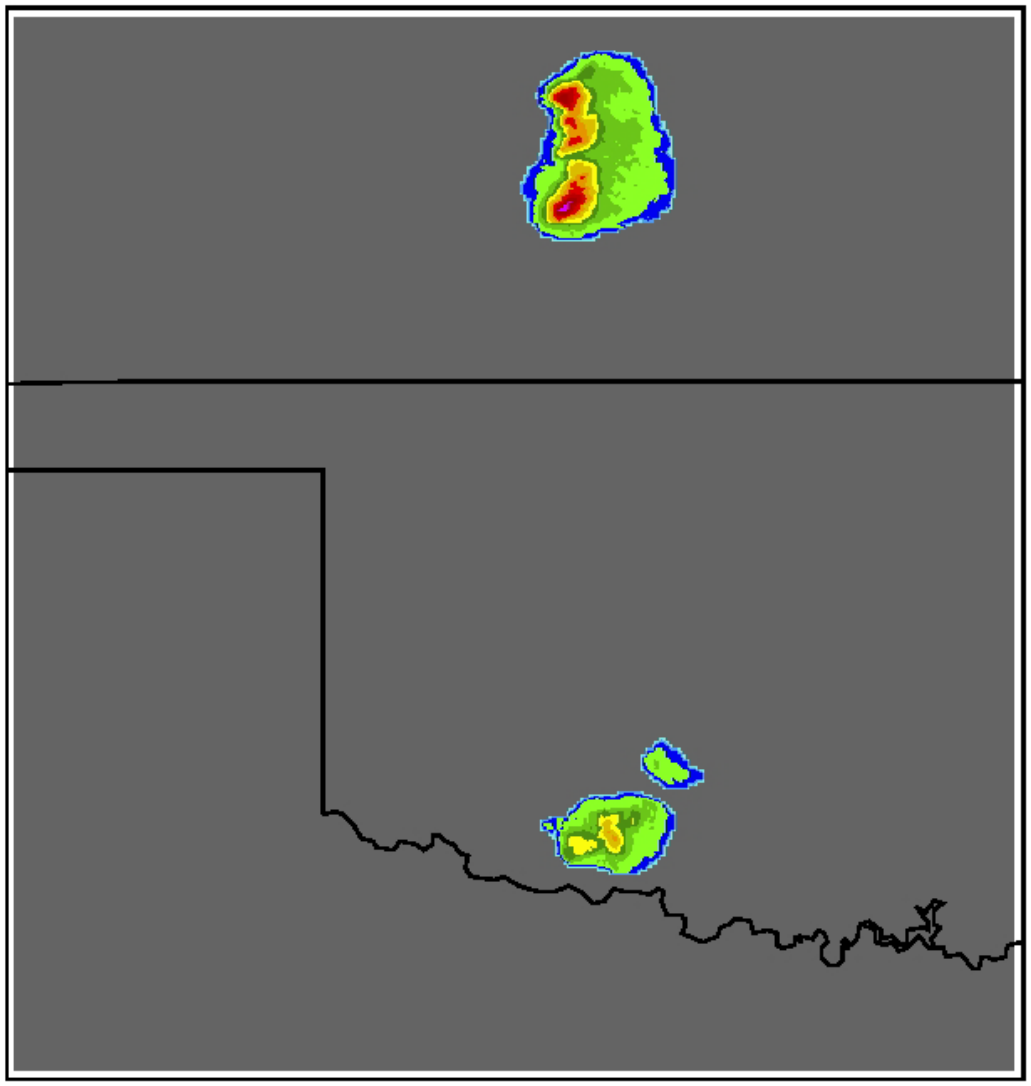
NCEP-GFS Analysis valid 20 May 2012 at 00 UTC

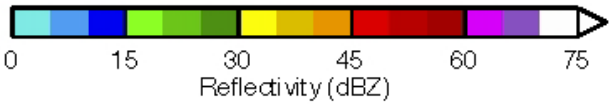


Lamont, OK Sounding



NEXRAD Composite Reflectivity valid 20120519T2100Z





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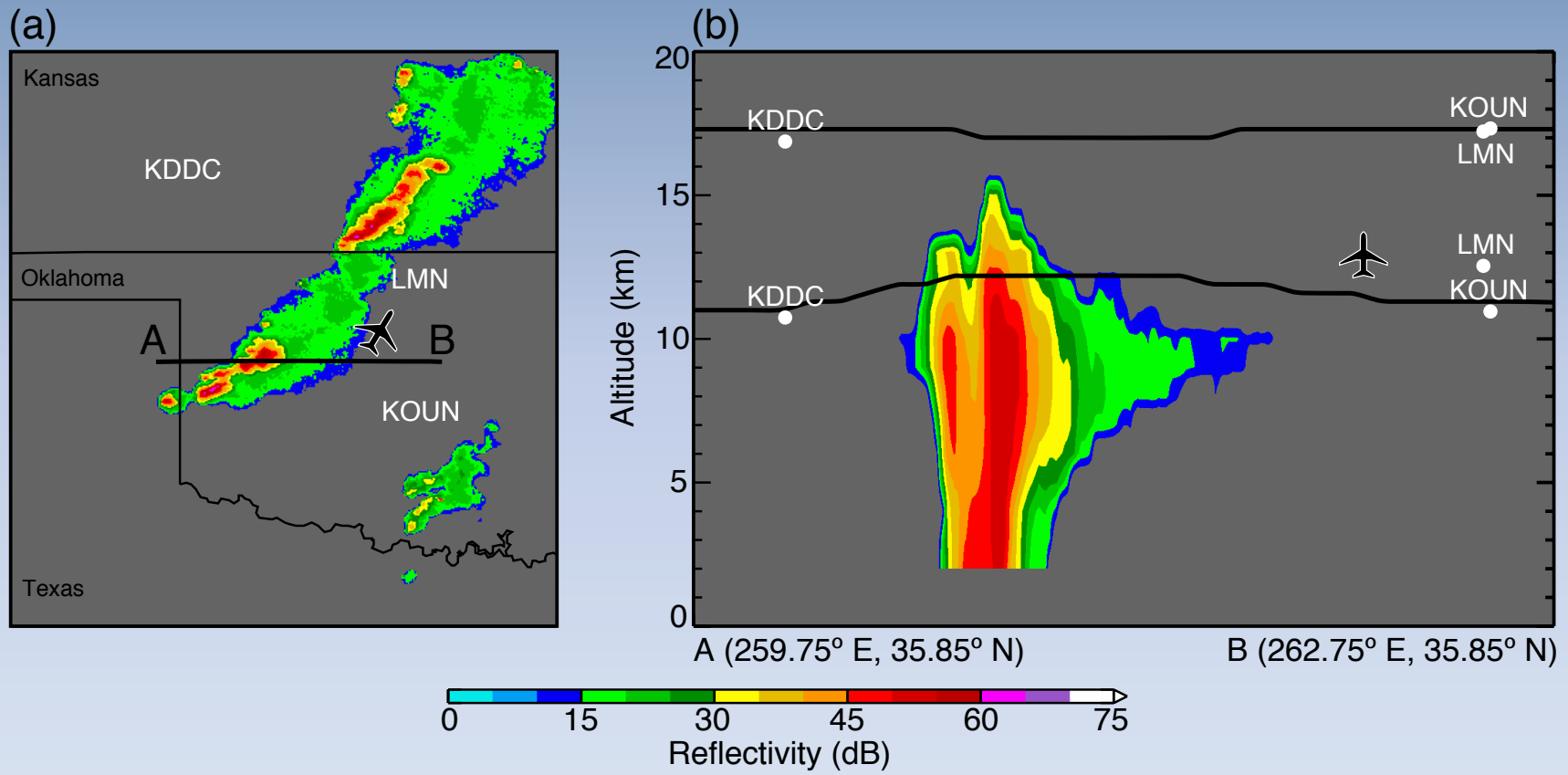
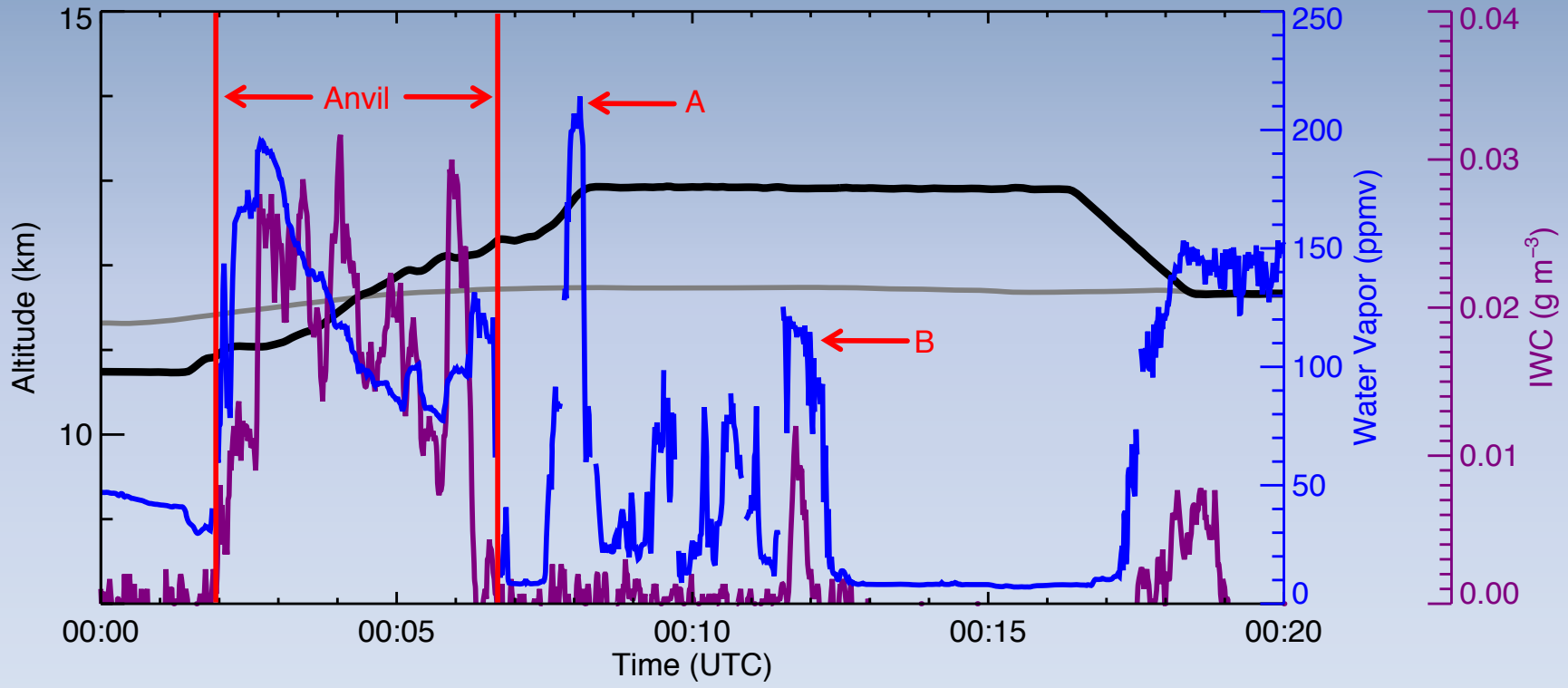
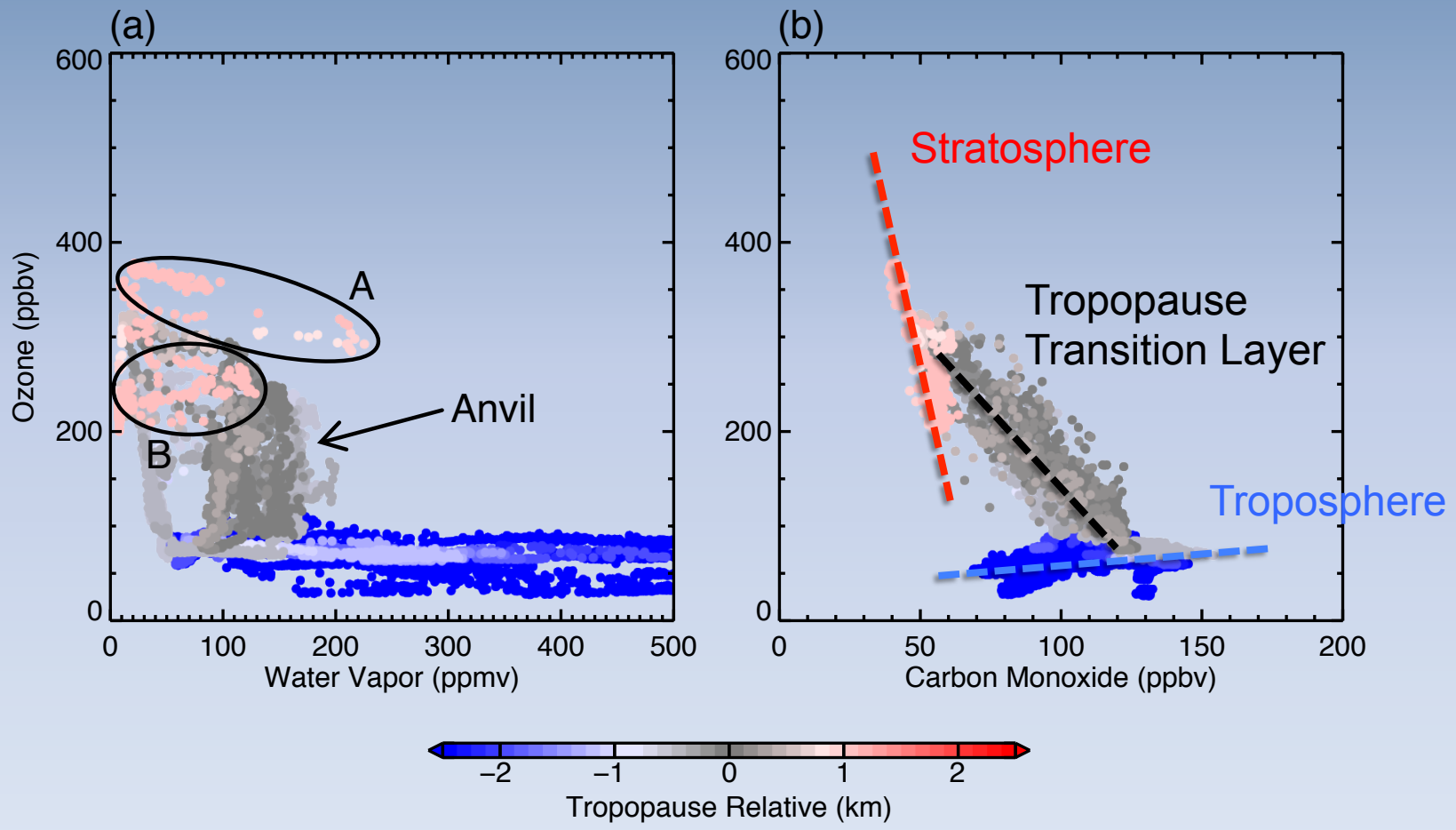
Radar Cross-section



In situ Measurements



Tracer-tracer Relationships



Conclusions

- Observed water vapor mixing ratios up to 200 ppmv above LS background levels (5-10 ppmv) at altitudes 1-2 km above the tropopause
  - Limited by aircraft ceilings; visual evidence of transport deeper into the LS
- All cases of injection during DC3 are observed during double tropopause events from poleward Rossby wavebreaking
  - Unique stability background may facilitate deep overshooting
  - Largely devoid of inorganic chlorine

Transport Illustration