



# Unique Role of Airborne Research in Atmospheric Chemistry-Coupled to Dynamics

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# Main points of my remarks

## Science:

- Airborne research is uniquely important in identifying the two-way interactions between ***Weather*** ↔ ***Atmospheric Chemistry*** ↔ ***Climate***.

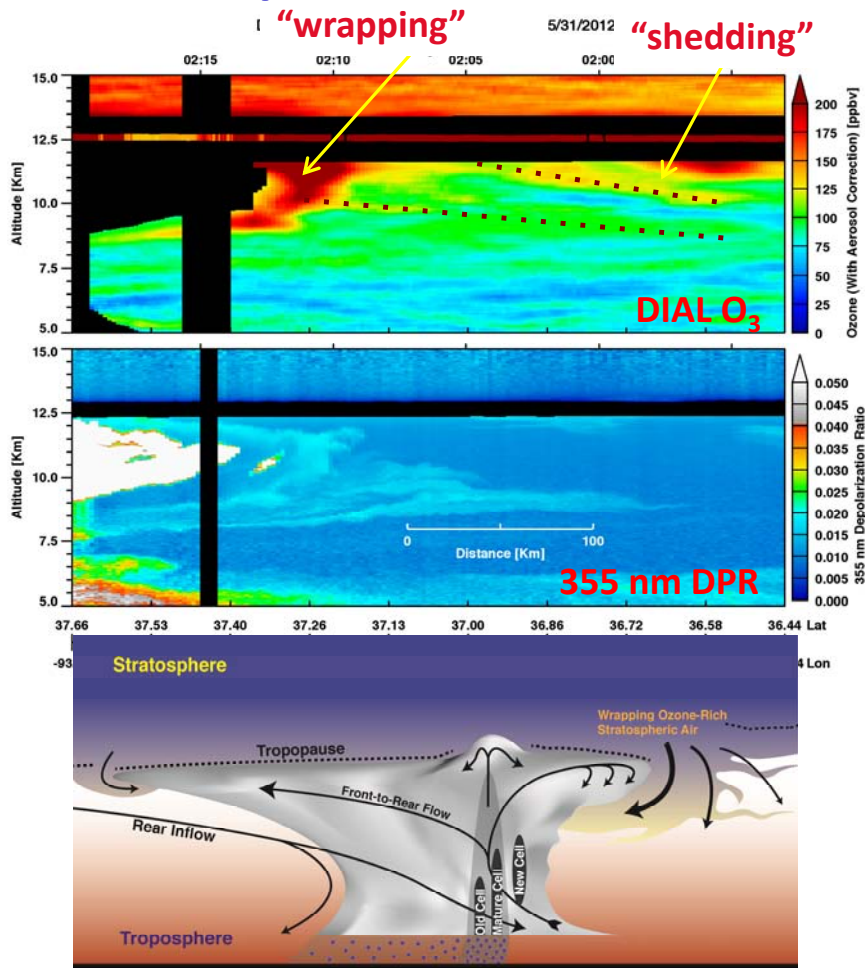
## Role in integrated research strategy (satellite/**airborne**/surface/modeling):

- Airborne measurement capability is a critical component in the strategy: new process identification and discovery, satellite validation, and model diagnostics

## Role of a heavy-lifting research aircraft:

- “DC-8-like” large payload capability is essential for targeted campaigns and new discoveries

# Unique role of airborne observations in new process identification

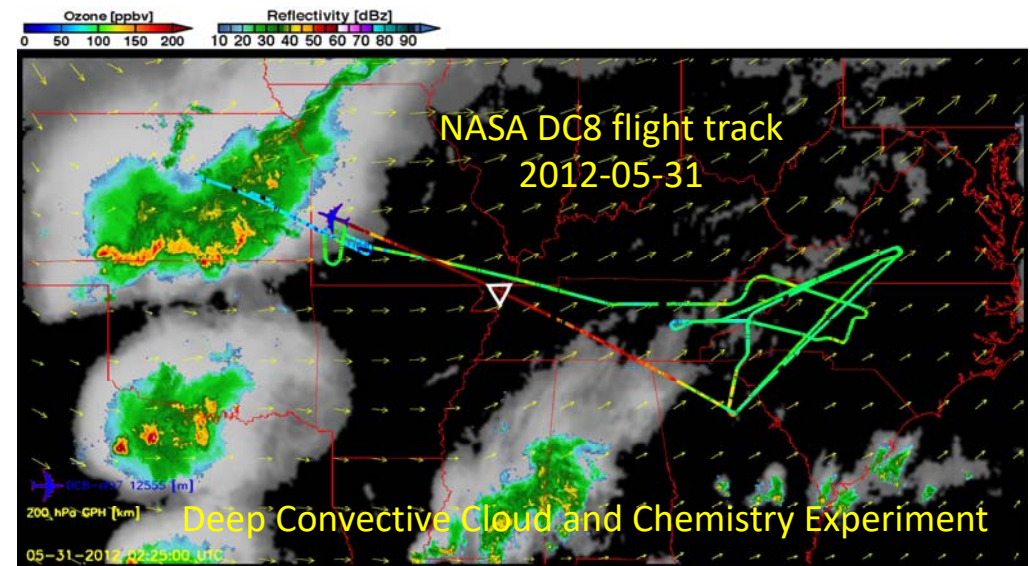


Adapted from Houze et al., 1989

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## Thunderstorms and Tropospheric Ozone:

- Unambiguous process identification
- A missing transport mechanism in global models
- A competing interpretation of UT ozone enhancement in summer (Lightning NO<sub>x</sub> is no longer the only mechanism for ozone enhancement around storms)
- Add new understanding to the storm dynamics



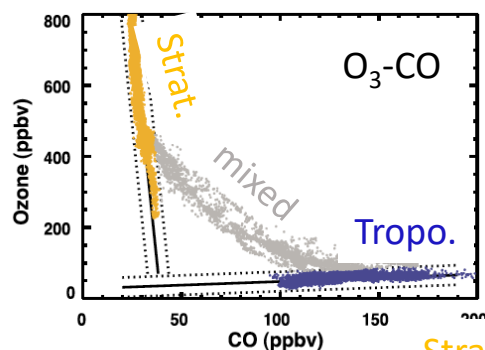
Pan et al., 2014 GRL

Workshop on the future use of NASA airborne Platforms

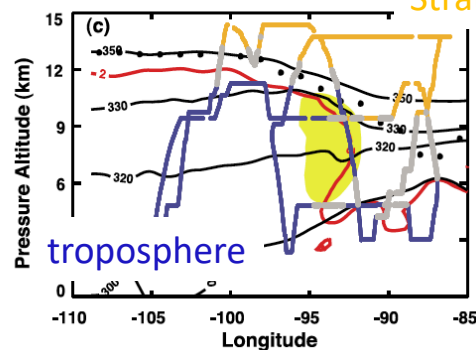
# Airborne trace gas measurements as process diagnostic

## – Examples of using trace gases relationship

START08 Experiment, NCAR Gulfstream V



Compact relationship between  $O_3$  and CO is commonly used to identify  $O_3$  sources

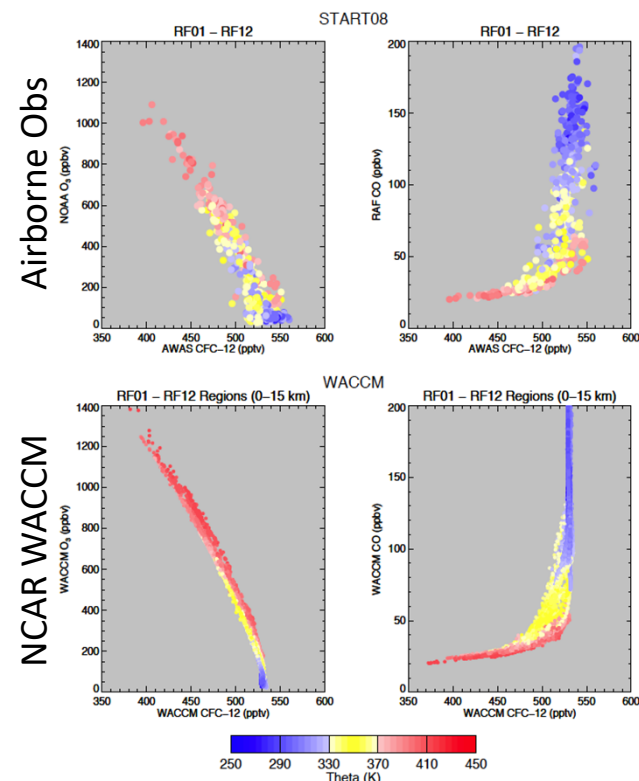


Tracer-tracer relationship is also a powerful diagnostic for global models

Konopka and Pan, 2012 GRL

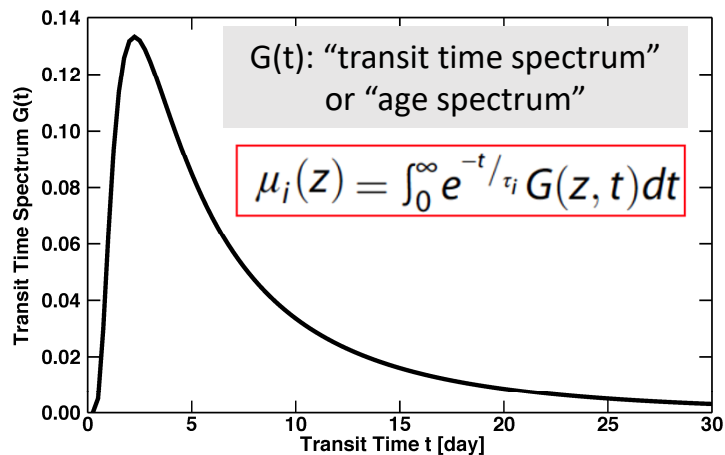
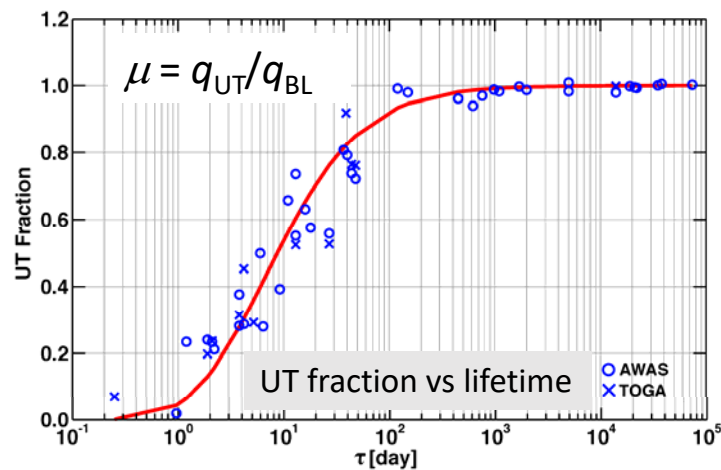
CFC12 vs  $O_3$

CFC12 vs CO



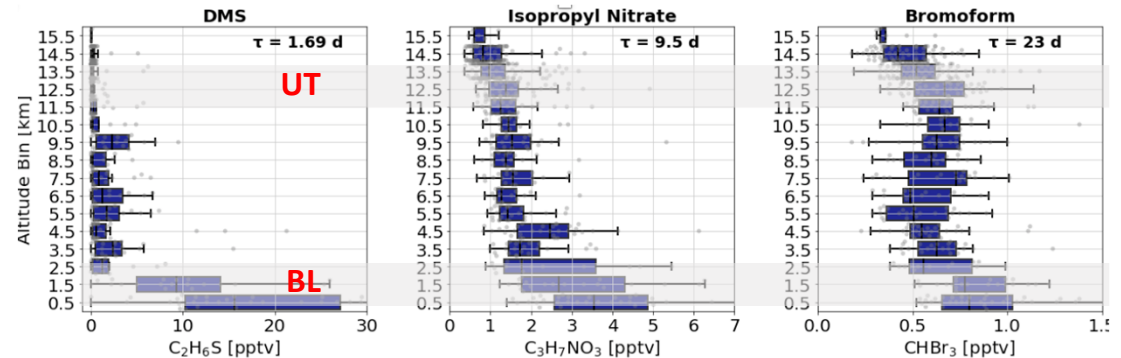
Potential Temperature

# Airborne in situ VOCs inform time scales of convection and convective transport



Luo, Pan, et al., 2018 *GRL*

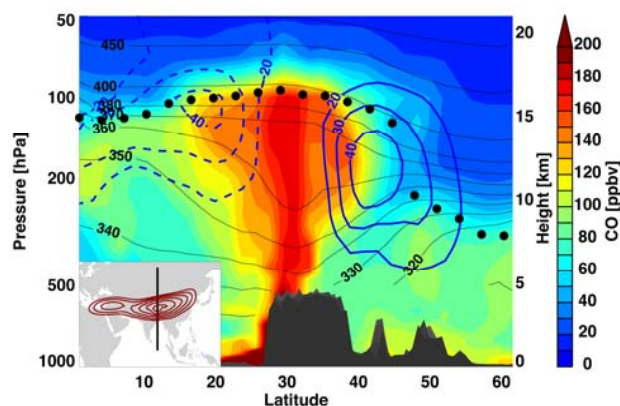
## CONvective Transport of Active Species in the Tropics (CONTRAST) Jan-Feb 2014, Western Pacific, NCAR Gulfstream V



Chelpon et al., to be submitted

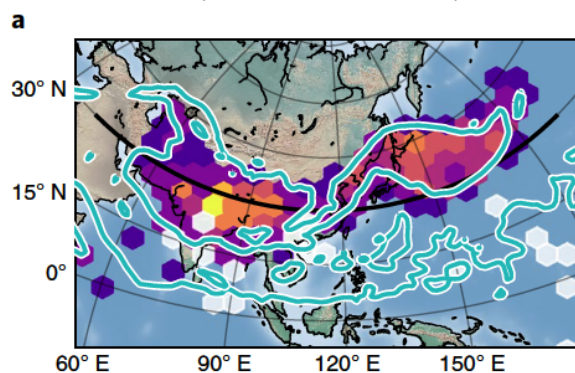
- Large number of chemical species with lifetimes ranging from a few hours to a few decades
- Wealth of information for dynamics in chemical in situ measurements
- Enable diagnostic that informs regional transport characteristics and model parameterization of convection

# Chemical and Climate Impacts of Asian Summer Monsoon



CO from WACCM model

(Pan et al., 2016 JGR)



Ammonium Nitrate aerosol at 380 K

(Höpfner et al., 2019, Nature Geoscience)

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- A **prime** example of *weather – climate* interaction with a *chemistry* link
  - Regional source that has global impacts
  - Complex chemical sources and processing involving gas phase and aerosols
  - Only airborne studies can address the process level questions, optimally multi-aircraft campaigns
- A “DC-8-like” long-duration and heavy-lifting research aircraft is essential for dissecting this complex system
  - Need full range measurements of chemical species
  - Need aerosol size distribution and composition
  - Need in situ and remote sensing to map out the vertical range of the impact