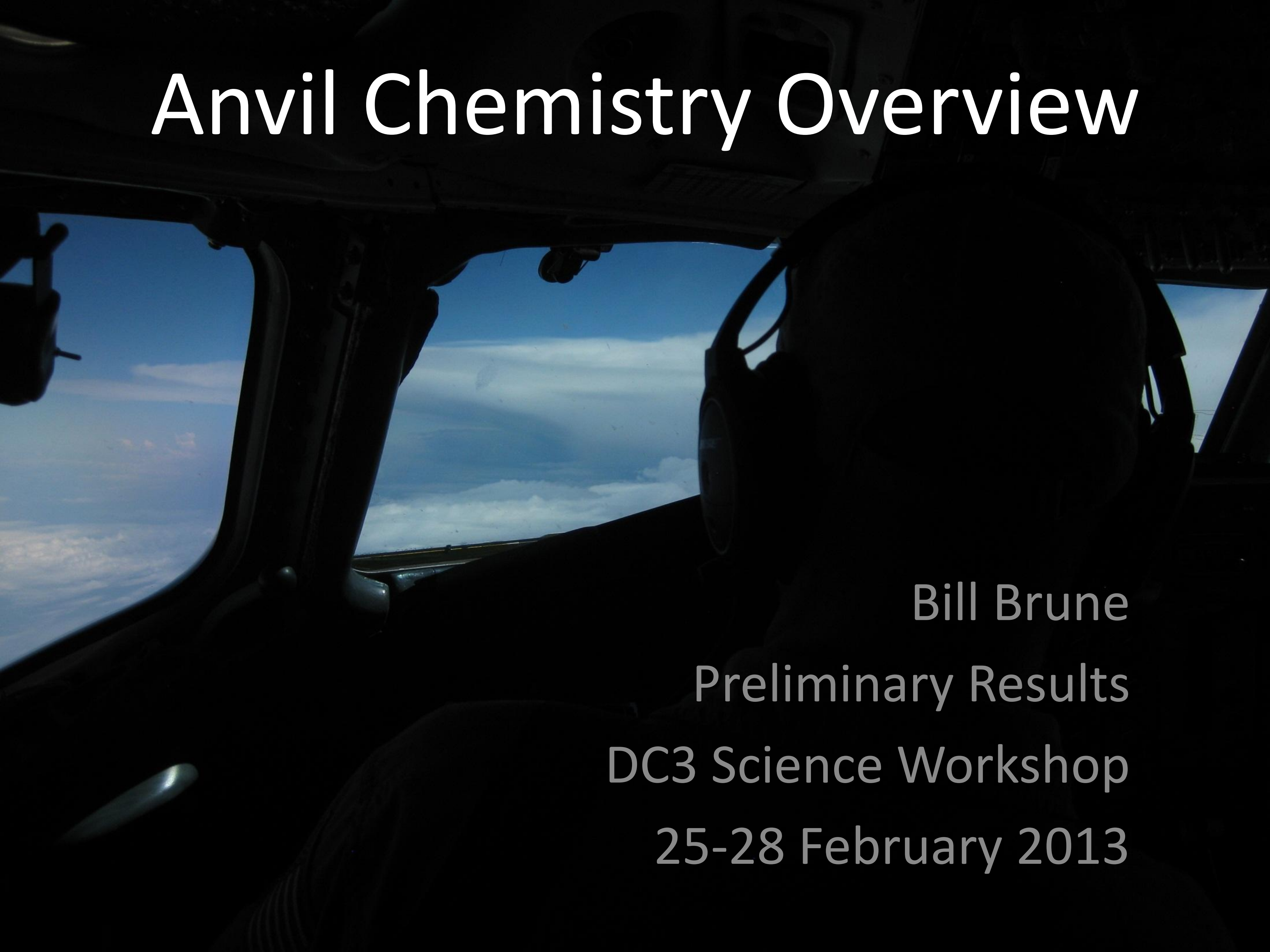
Anvil Chemistry Overview



Bill Brune

Preliminary Results

DC3 Science Workshop

25-28 February 2013

To test the anvil chemistry, we must quantify:

- when the aircraft are in the anvil;
- the anvil environment;
- the chemical composition;
- the radical chemistry, including ozone production;
- the influence of cloud particles on the chemistry.

concern:

- the influence of cloud particles on the measurements (known problems with particles)

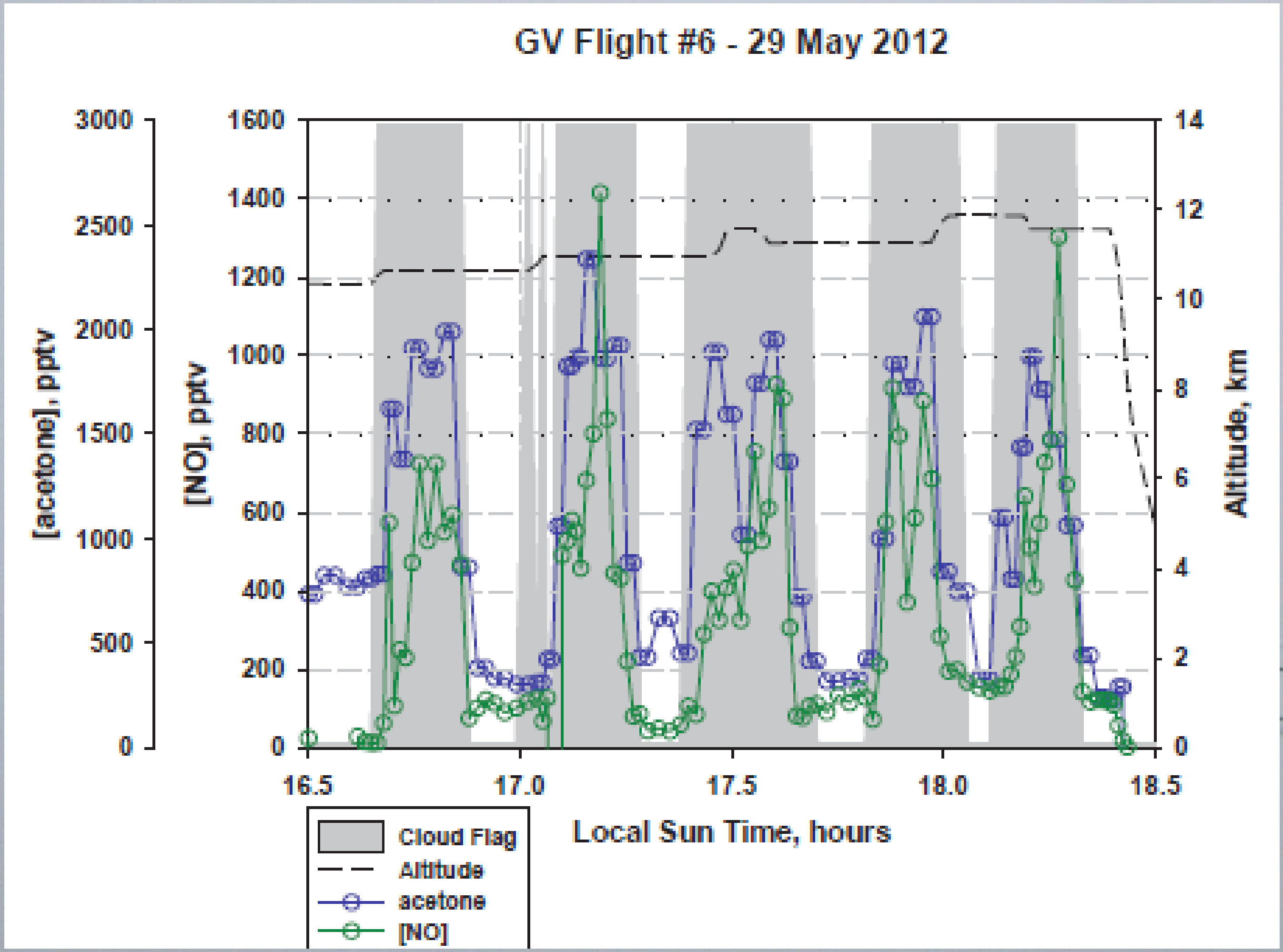
The aircraft are in the anvil when the

- aircraft forward camera video looks gray;
- cloud probe particle count is “high”;
- ice water content is “high”;
- ATHOS background scattering signal is “high” (DC8);
- extinction in long-path water vapor measurement is “high” (DC8).

- GV, DC8 in anvil ~30% of time above 6 km.

need to get together, cross-check all methods, produce a unified “soft-edged” cloud flag.

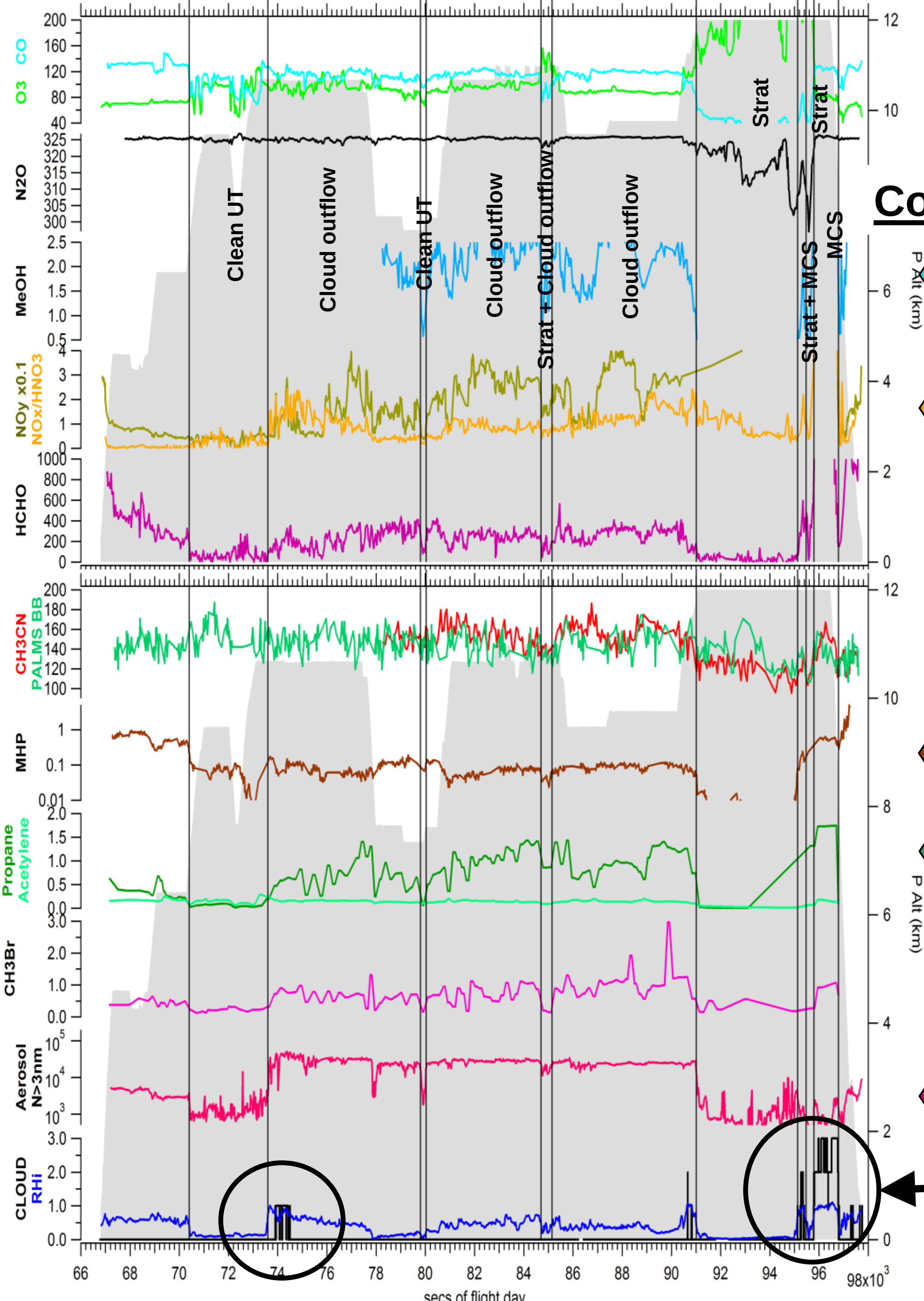
Cloud flag: correlation with trace chemicals



GV data put together by Chris Cantrell

Identify Aged Outflow

May 30 Downwind flight – DC8



Consistent Indicators

- Methanol
- NOx / HNO3
- CH3OOH
- Alkanes
- Ultrafine particle concentration (outside cloud)

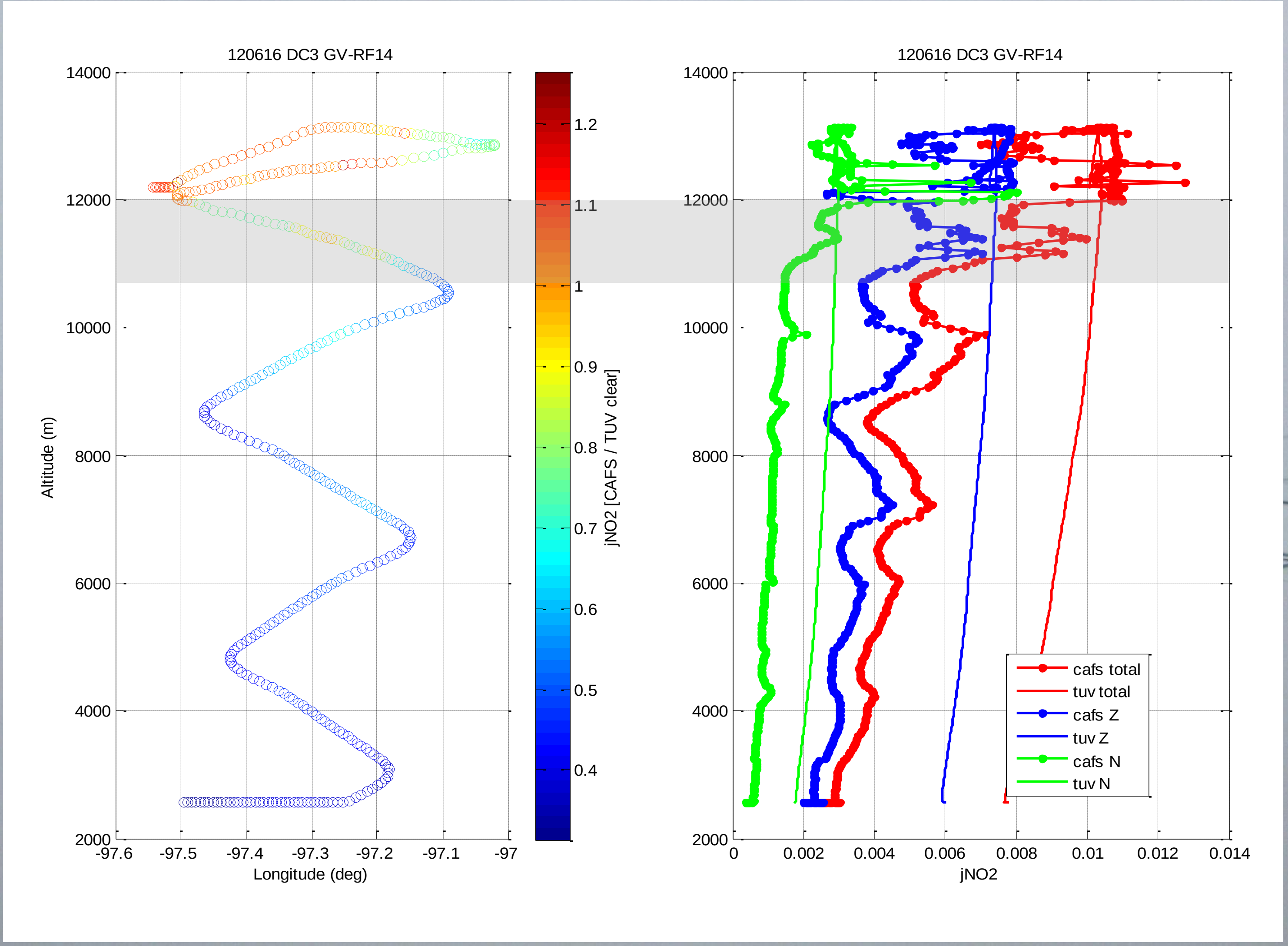
Not recommended for aged outflow: O_3, CO, HCHO, Aromatics, RH

Cloud Indicator also available

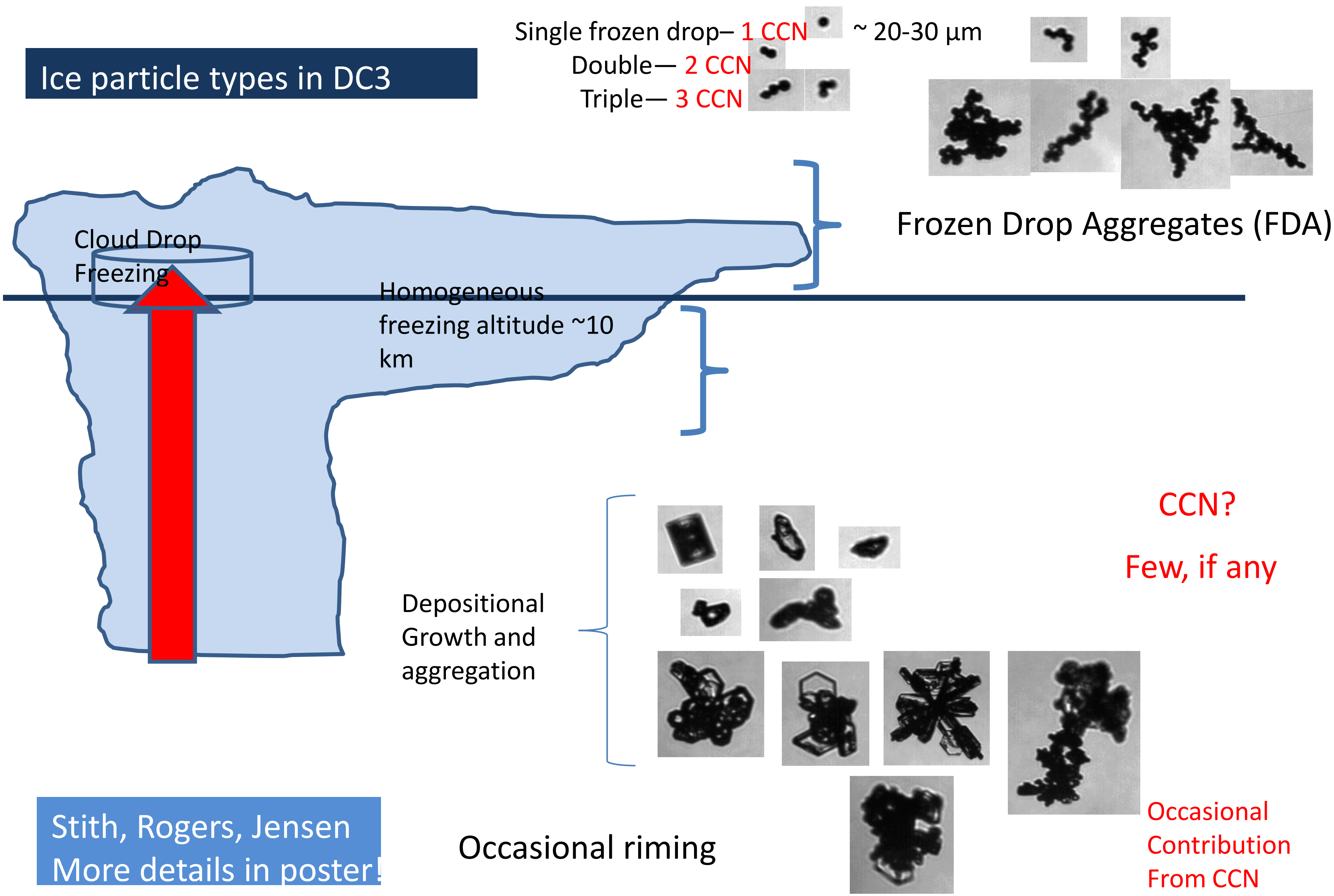
Karl Froyd

Anvil environment: photolysis frequencies (from Sam Hall)

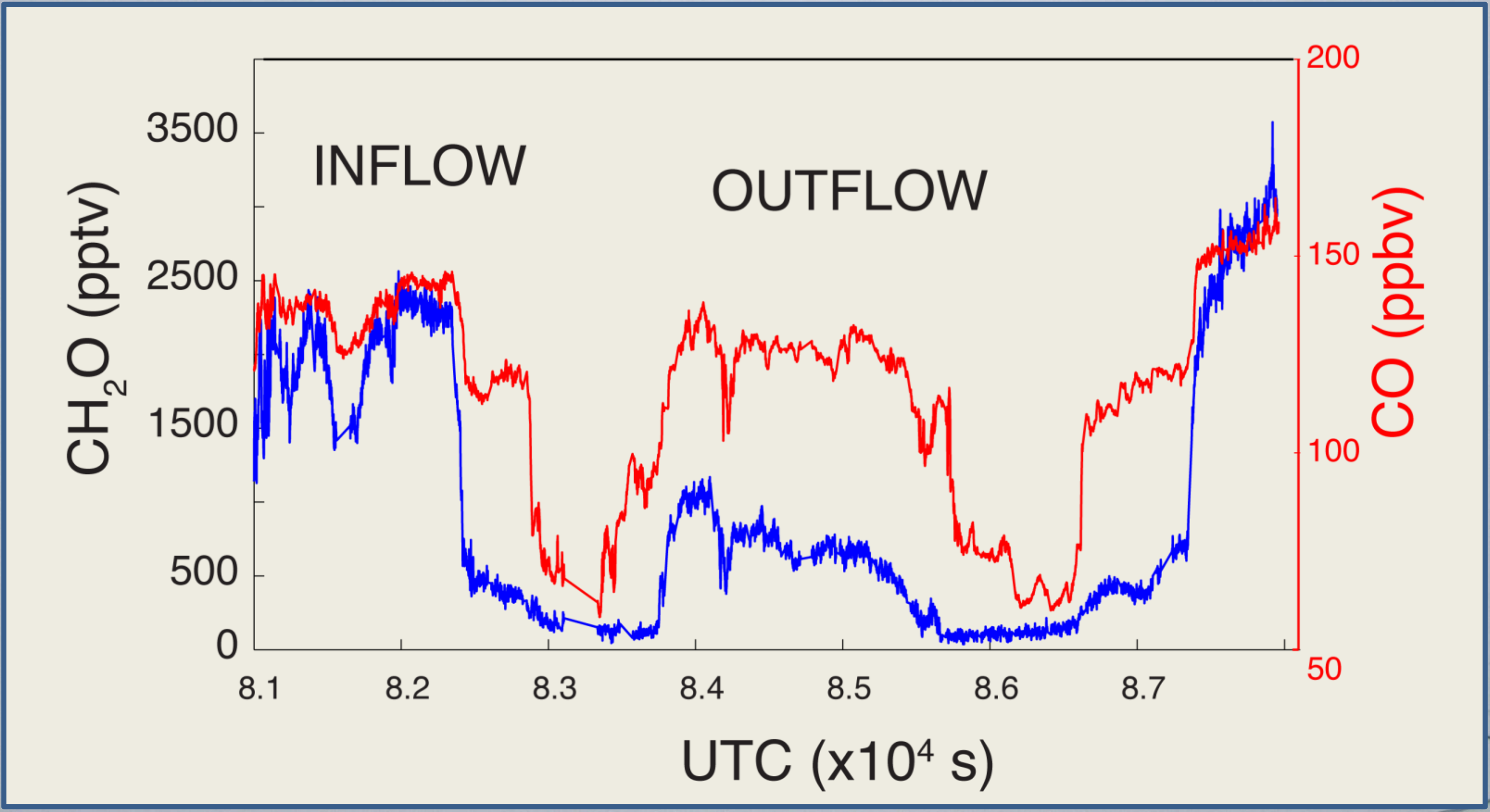
measured JNO_2 elevated above cloud, highly variable in cloud, decreased below cloud



Anvil environment: ice particle characteristics/microphysics



Chemical composition: e.g., Formaldehyde (HCHO)



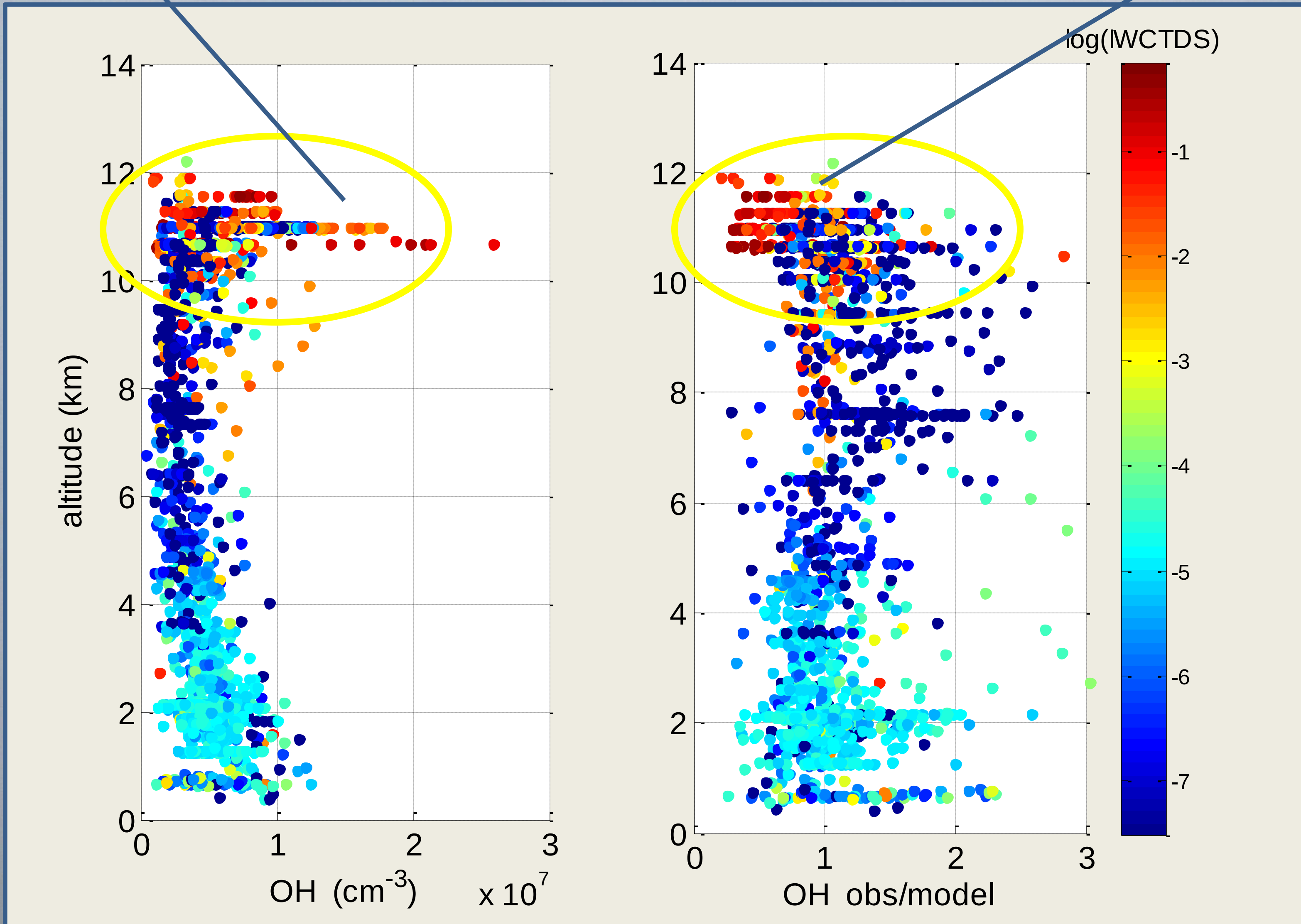
from Tom Hanisco, Heather Arkinson

- CH_2O is a major source of HO_2 and OH
- strategy: constrain model to some chemicals, model to compare to measured chemicals of interest
- can examine many facets of anvil chemistry

Radical chemistry: comparing observations to model

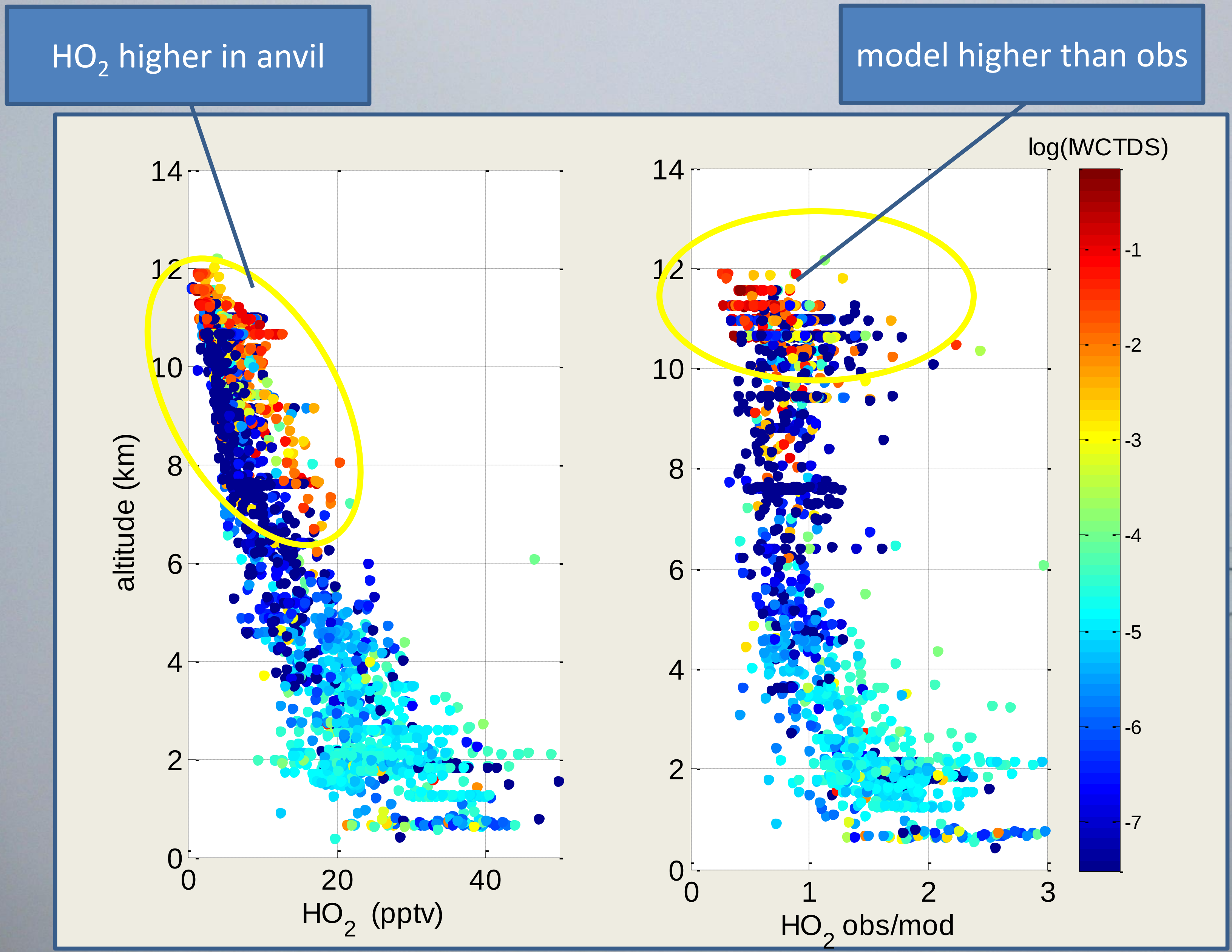
OH high in anvil

model OH even higher



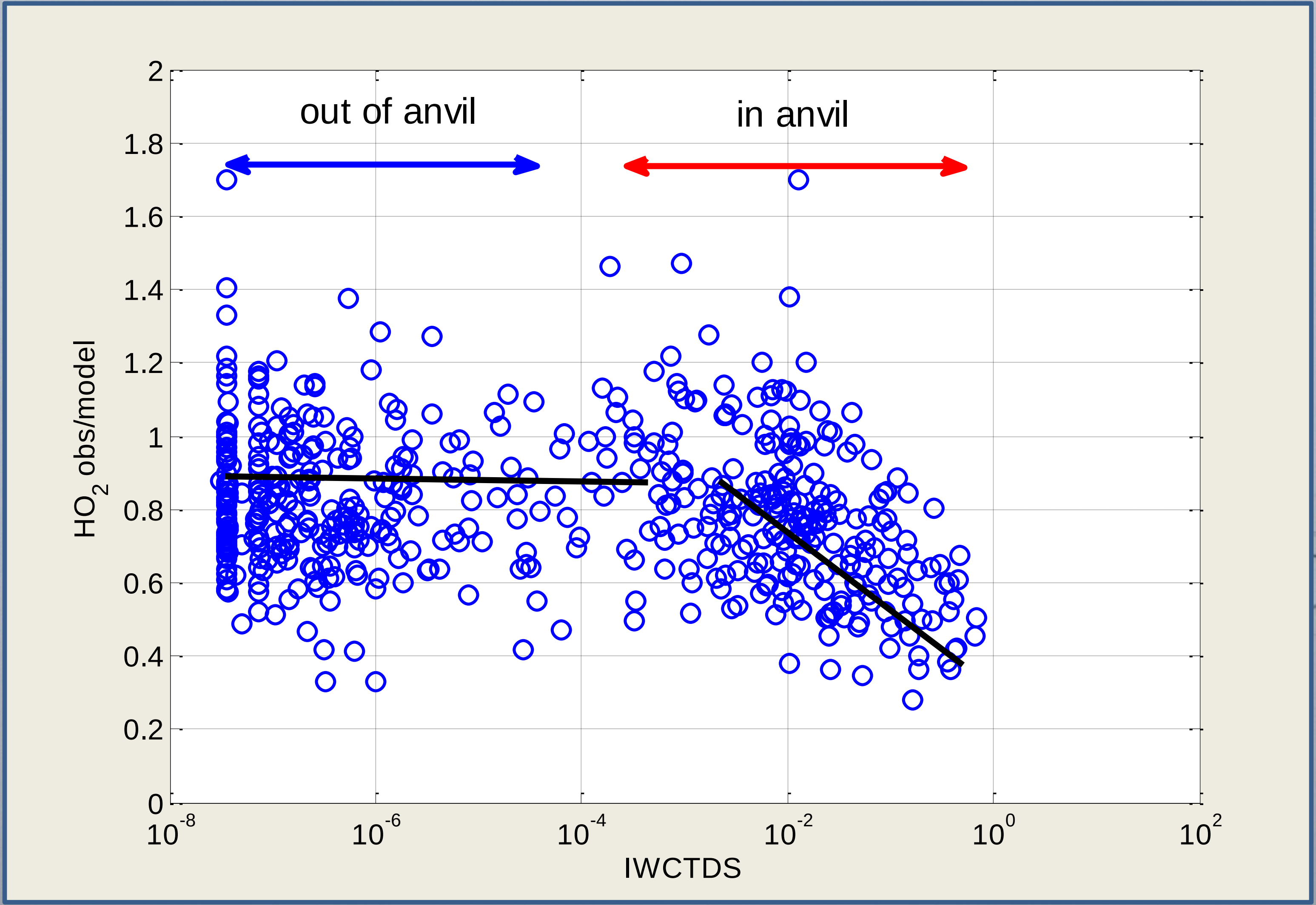
from Xinrong Ren, Li Zhang

Radical chemistry: comparing observations to model

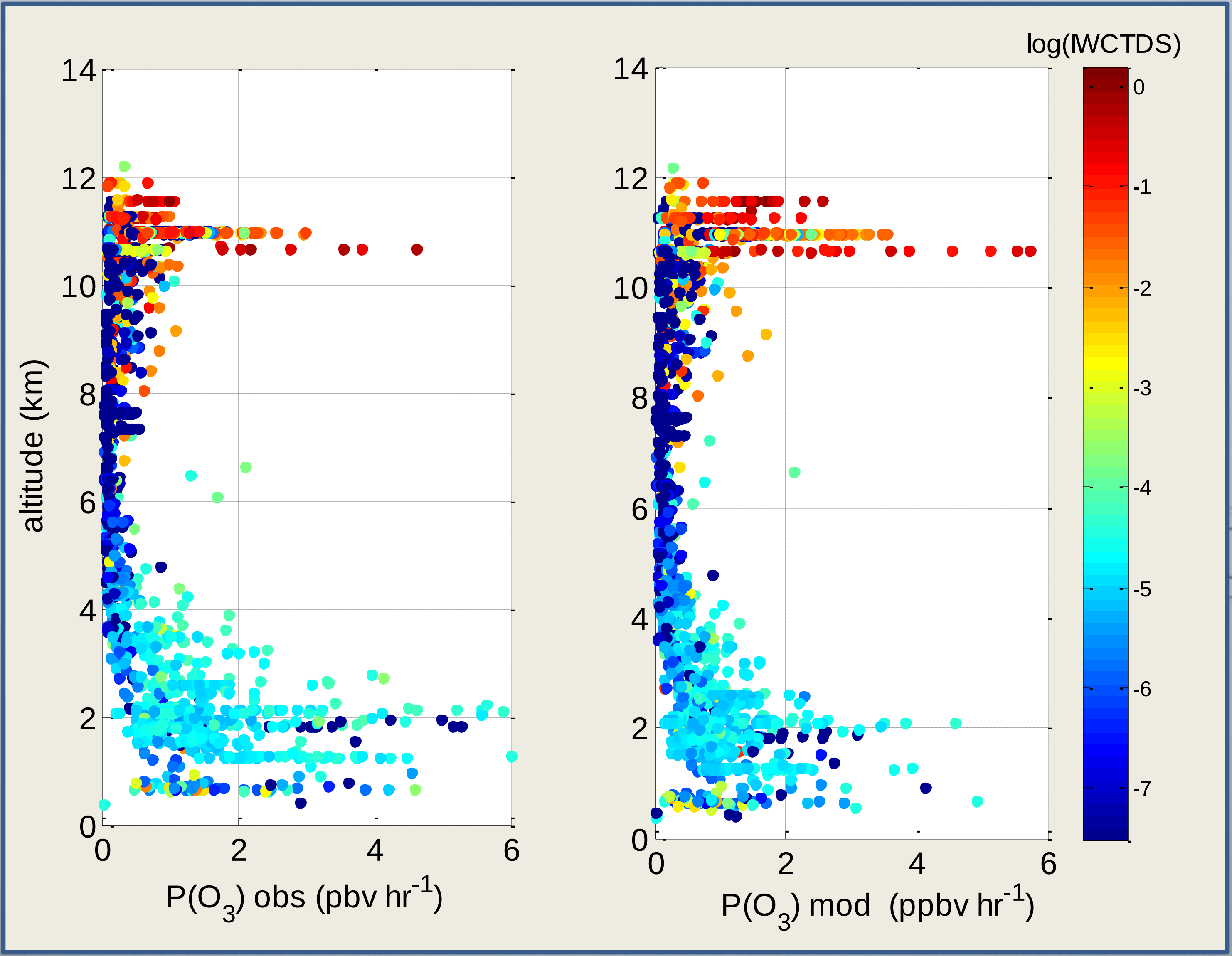


from Xinrong Ren, Li Zhang

Particle influence: HO_2 obs/mod versus IWC



Radical chemistry: calculated ozone production typically a few ppbv per hour …



Anvil chemistry - summary

preliminary findings:

- very active oxidation chemistry!
- HO_x radicals moderately well understood?

to do:

- test other parts of chemical mechanism, such as nitrogen species, peroxides, acids
- examine chemistry as a function of time in the anvil (Lagrangian box model?)
- include ice particle chemistry in model

to worry about:

- influence of cloud particles on measurements