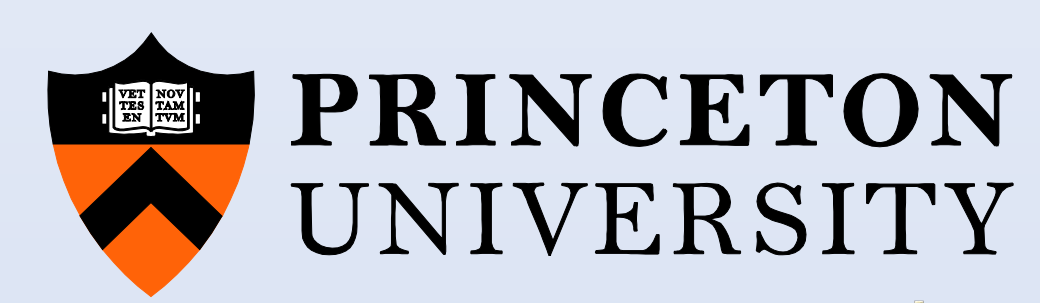


Effects of Inflow Air Quality on Ice Supersaturation in Deep Convective Outflows



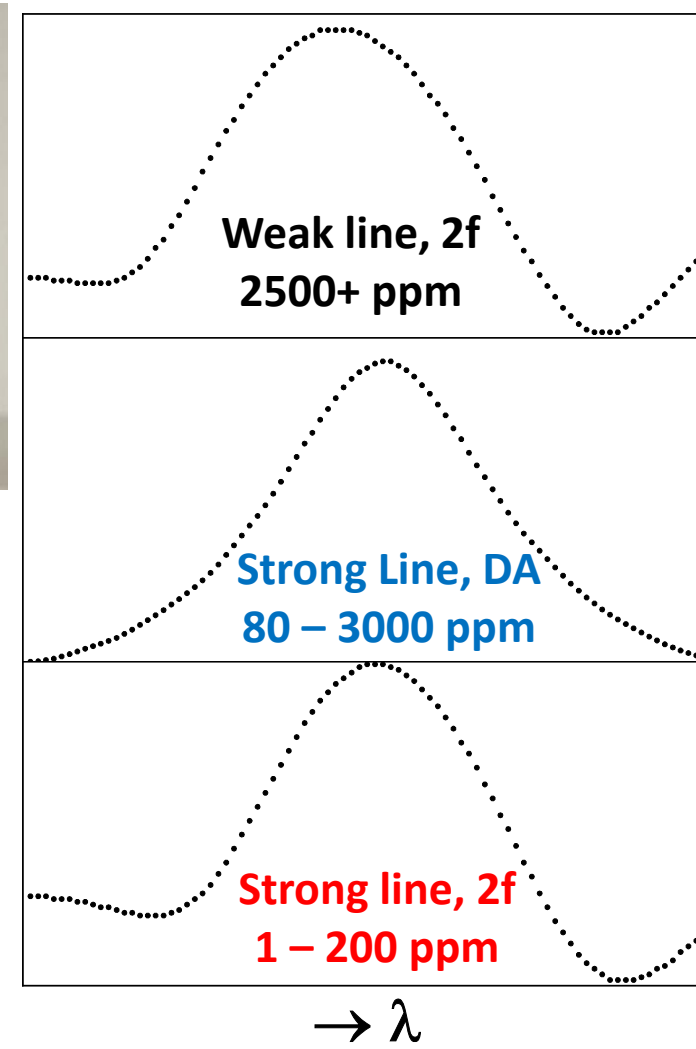
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Introduction

- Investigate how inflow air quality affects the properties of ice supersaturation regions, or ISSRs (RH > 100% & T < -40°C)
- Extent of supersaturation depends strongly on presence and composition of aerosol nuclei present in the airmass^{1,2}
- Expect enhanced aerosols/aerosol precursors in inflow to result in lower and smaller supersaturation regions

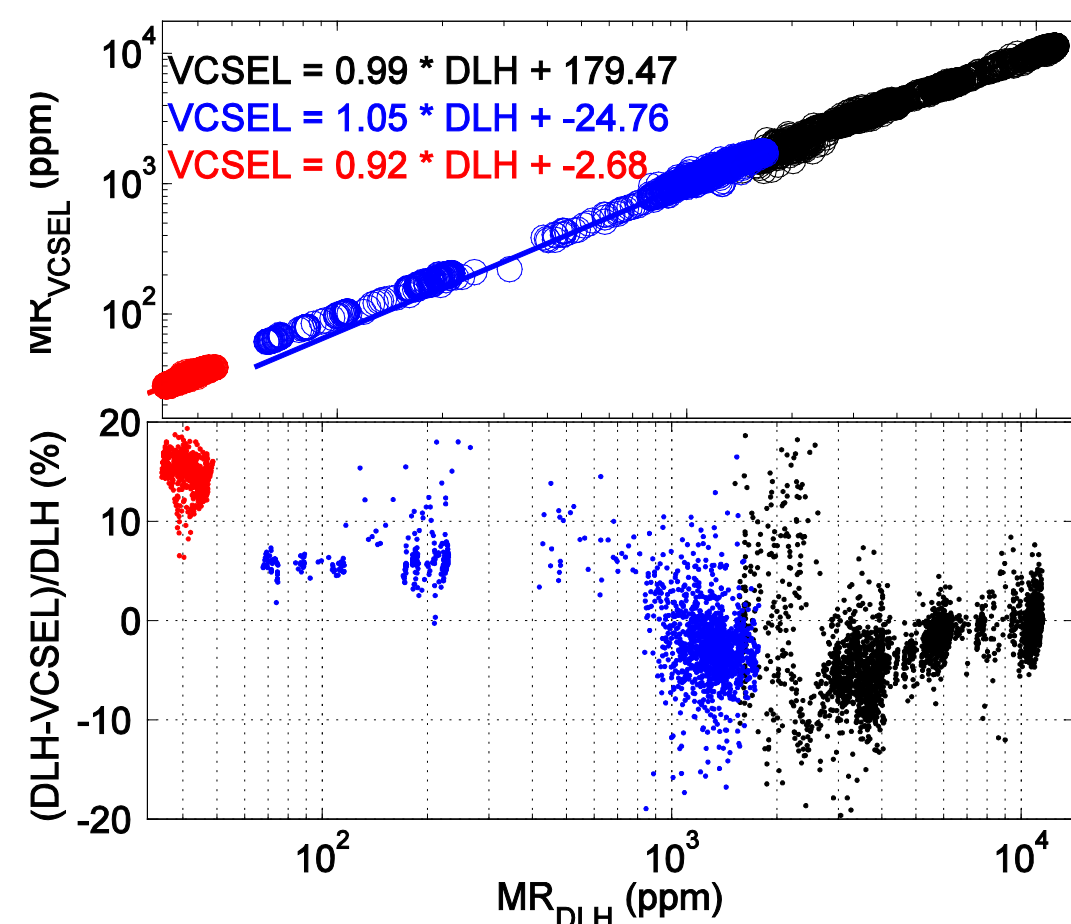
VCSEL Hygrometer



- Open path NIR absorption based spectrometer
- Uses 2 spectral features
 - Weak line (1853.38 nm)
 - Strong line (1854.03 nm)
- Measures over 5 orders of magnitude water vapor
- 25 Hz measurement -> 10 m resolution
- Precision: < 1% reading (typical)

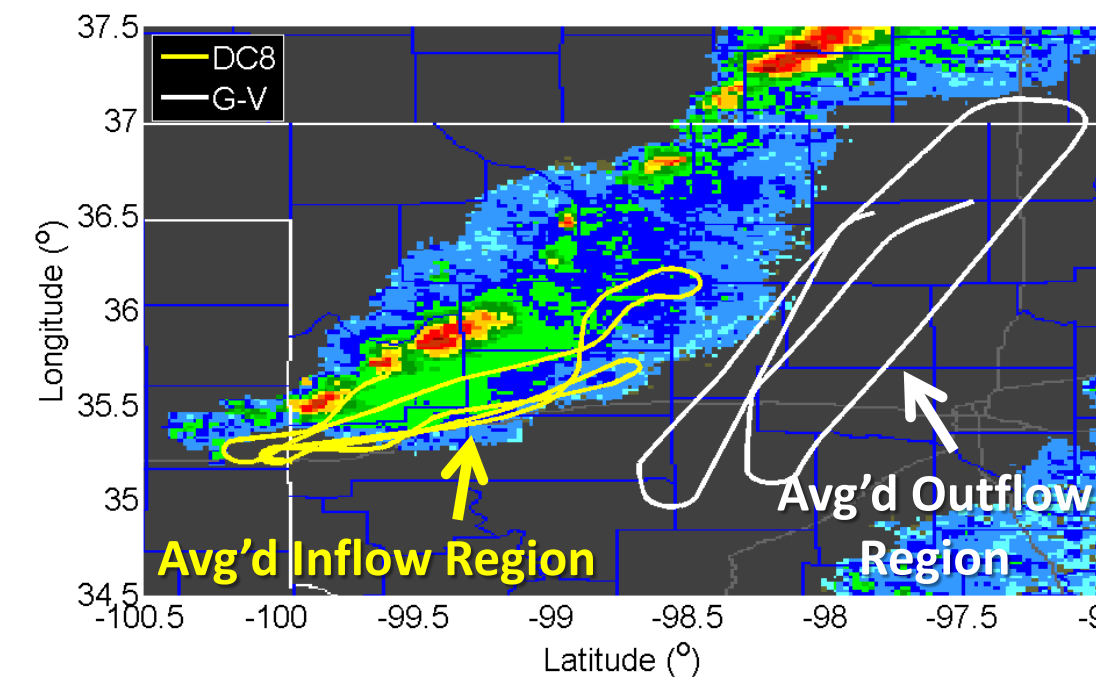
NASA DLH Intercomparison

- Wingtip-wingtip comp during G-V RF07, RF08, and RF15 of VCSEL with diode laser hygrometer (DLH: Glenn Diskin, NASA)
- Compared within instrument uncertainties ($\pm 5\%$ DLH, $\pm 5\%$ VCSEL) above 50 ppm
- Lower concentrations exhibited an offset of typically 15%



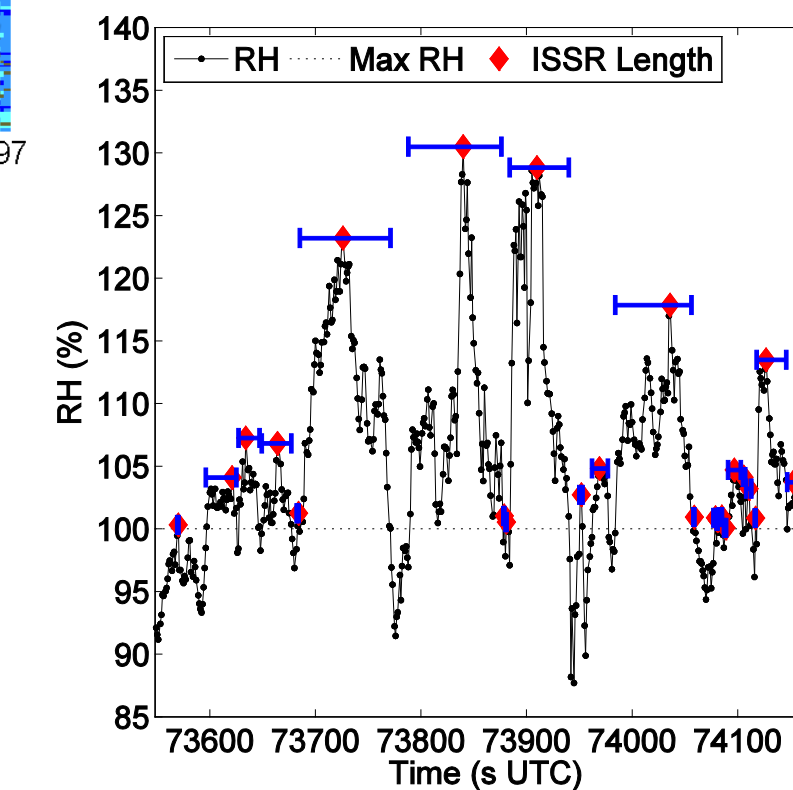
Note: DLH data is preliminary field submission

Approach



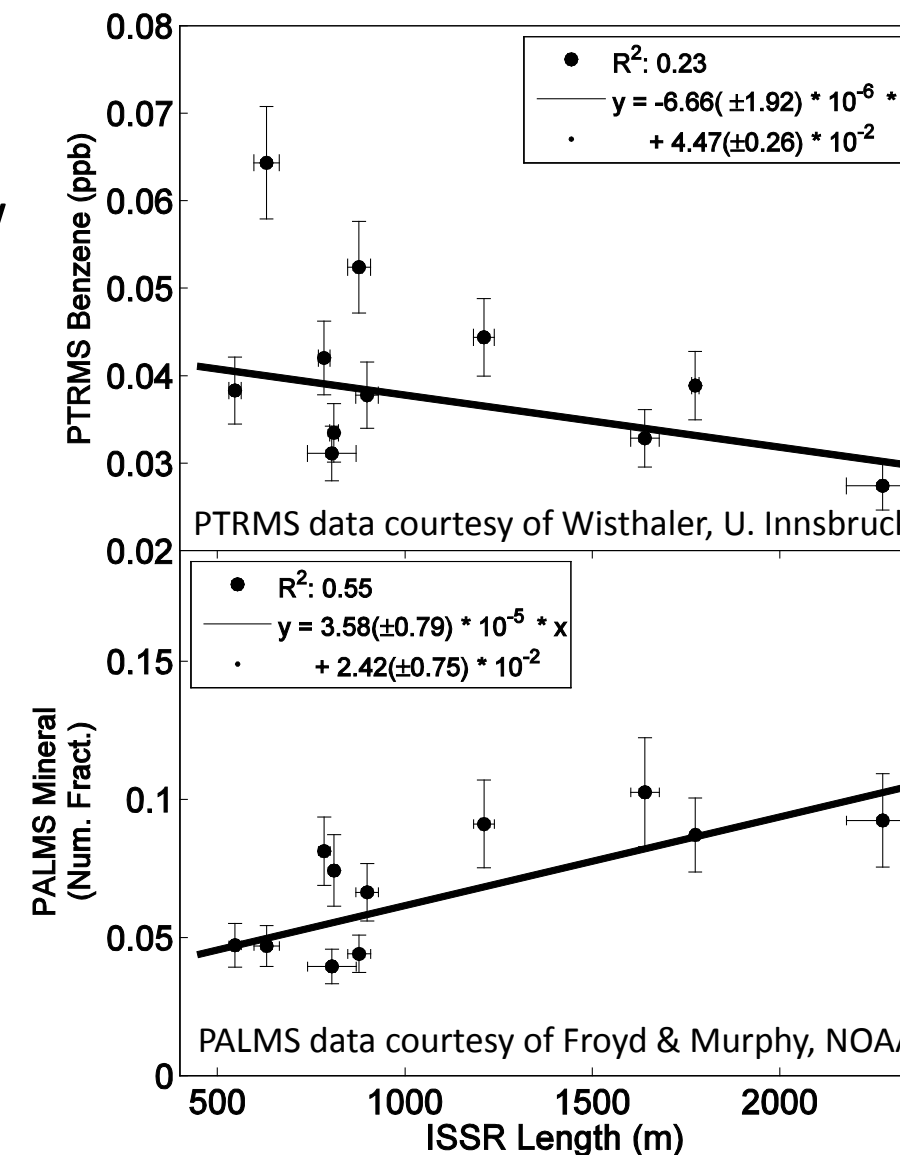
- Ice supersaturation region (ISSR) defined as contiguous region where RH > 100%
- ISSR length is defined as length along flight track determined by time extent of ISSR and aircraft true air speed

- Inflow and outflow regions determined by flight tracks and PI reports
- Species are averaged over regions for each storm



ISSR Length

- Increased benzene in inflow show slight correlation with reduction in ISSR size
- Direct benzene relationship unclear, perhaps an indicator of effect of anthropogenic pollution
- Higher fractions of mineral-based aerosols in inflow correlate with increase in ISSR size
- Mineral correlation implies inhibited nucleation



Acknowledgements

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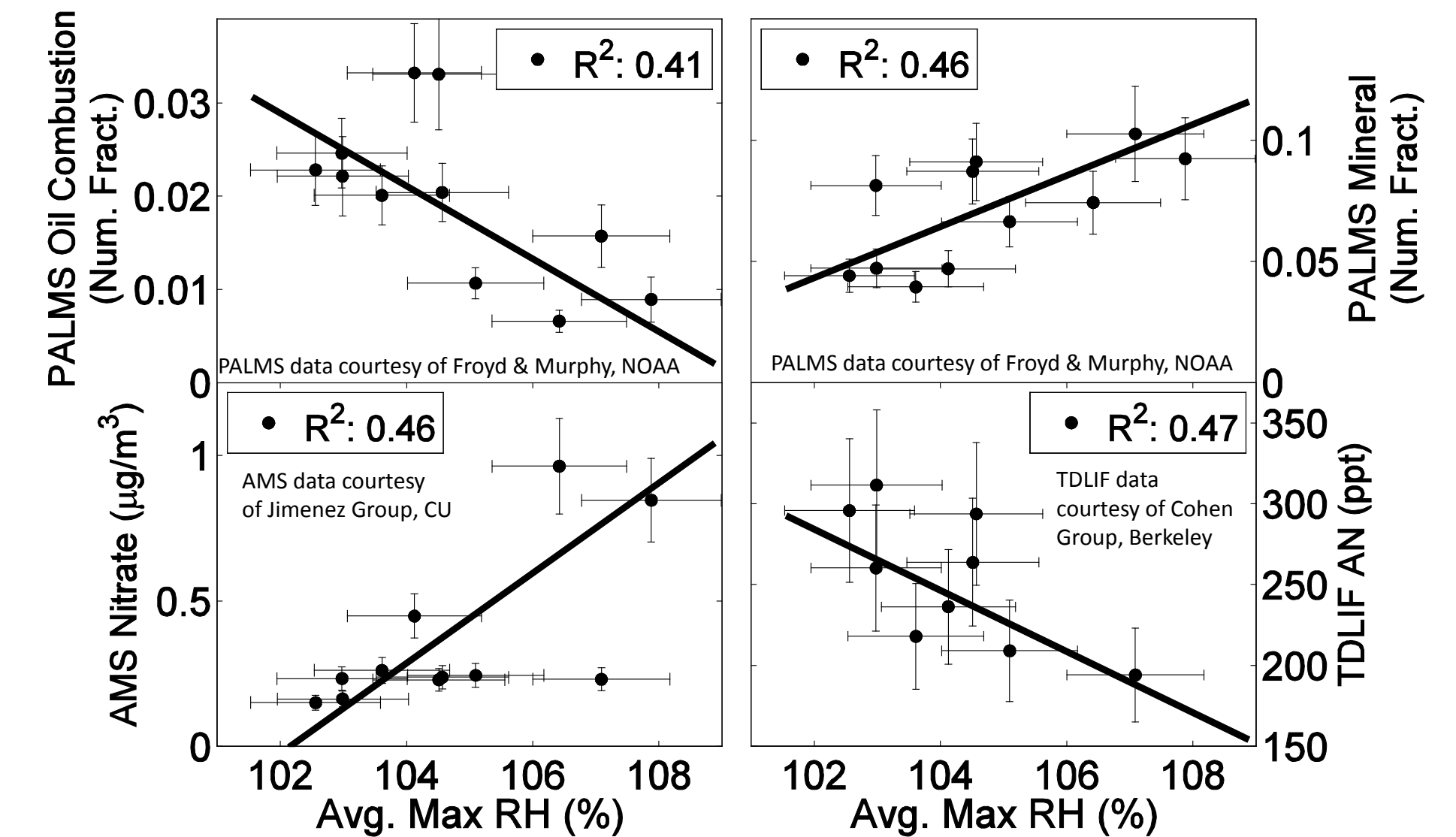
Data:

NASA - G. Diskin
CU - P. Campuzano-Jost, J. Jimenez, et al.
NOAA - K. Froyd & D. Murphy
U. Innsbruck - A. Wisthaler
UC Berkeley - P. Wooldridge & R. Cohen

References

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- Jensen, E.J., et al., Ice nucleation processes in upper tropospheric wave-clouds observed during SUCCESS. *Geophysical Research Letters*, 25 (1998).
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ISSR Maximum RH



- Oil combustion aerosols correlate with lower supersaturation, implies enhanced nucleation possibly due to higher aerosol concentrations of incompletely combusted OVOCs
- Mineral aerosols correlate with higher supersaturation, implies inhibited nucleation, possibly due to lower fraction of other nuclei and/or hydrophobic coatings
- Nitrate aerosols correlate with higher supersaturation, implies inhibited nucleation, possibly due high conc. of nitric acid: hypothesized to inhibit ice crystal growth³
- Gaseous alkyl nitrates correlate with lower supersaturation, implies enhanced nucleation, may be precursor to aerosol formation in outflow

Summary

- Evidence found that inflow air quality can affect upper troposphere water vapor distribution
- Enhanced alkyl nitrate in inflow correlated with lower supersaturation, potentially due to secondary aerosol formation
- Enhanced mineral aerosol presence in inflow counter-intuitively correlated with increased size and intensity of ISSRs
- Further work will include examining other contributing factors, such as uplift speeds and ice particle size/concentration