

HARP photolysis frequencies and convection processes in the UTLS during CONTRAST

Samuel Hall, Kirk Ullmann



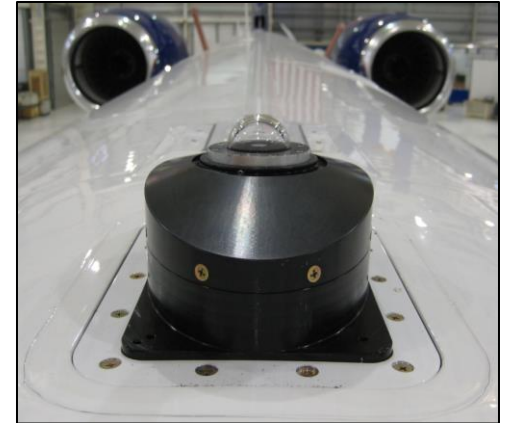
NCAR/NSF G-V



HIAPER Airborne Radiation Package (HARP)



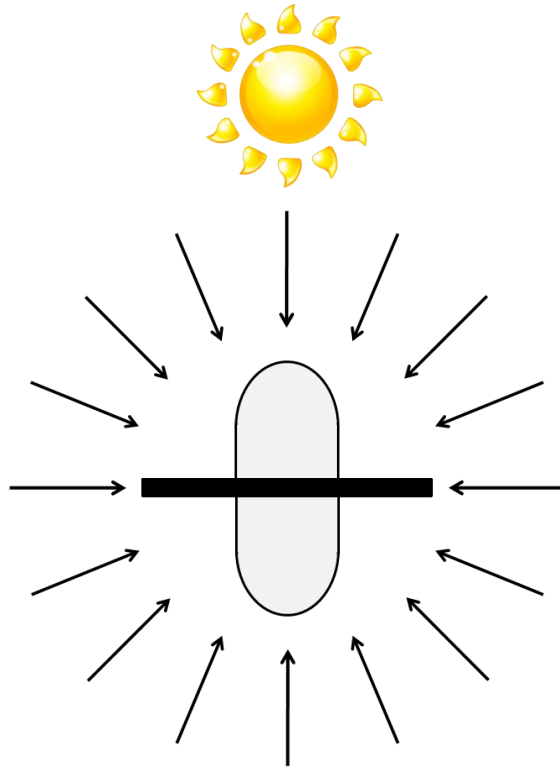
Actinic Flux



Irradiance

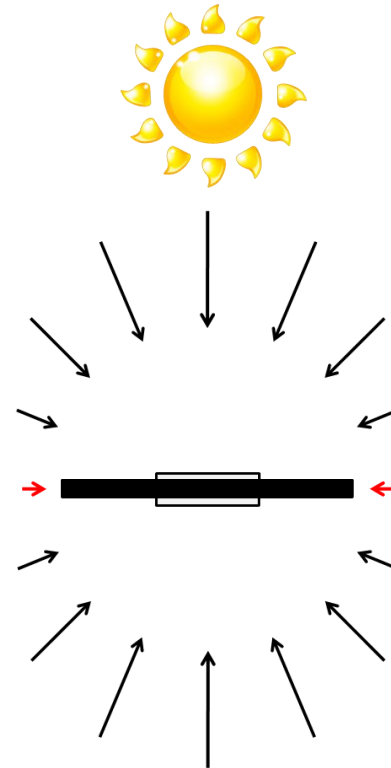


Actinic Flux



- Insensitive to aircraft orientation
- Energy Flux through a **sphere**
- Photolysis frequencies

Irradiance

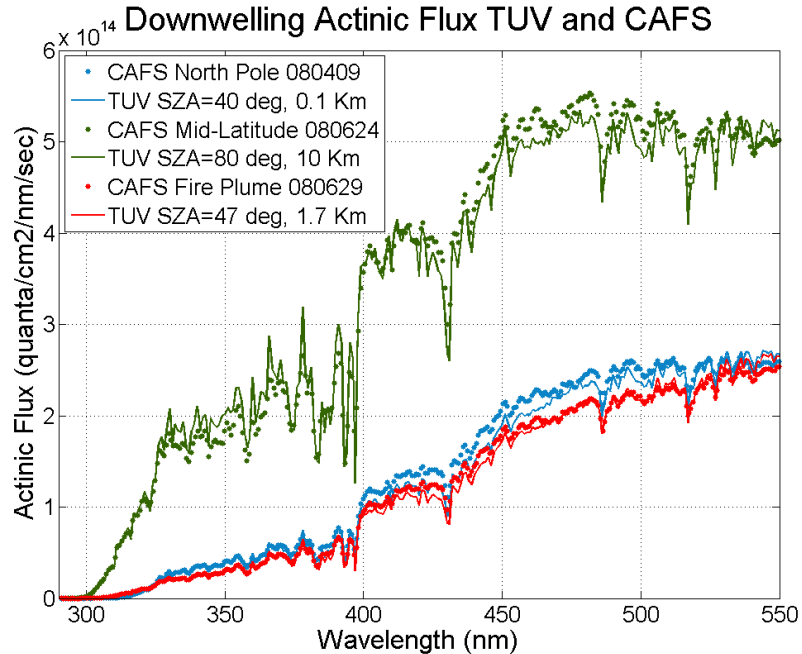


- Cosine response to aircraft orientation
- Energy Flux through a **horizontal plane**
- Transmittance, reflectance, absorptance, optical depths, net irradiance, flux divergence, albedo, etc

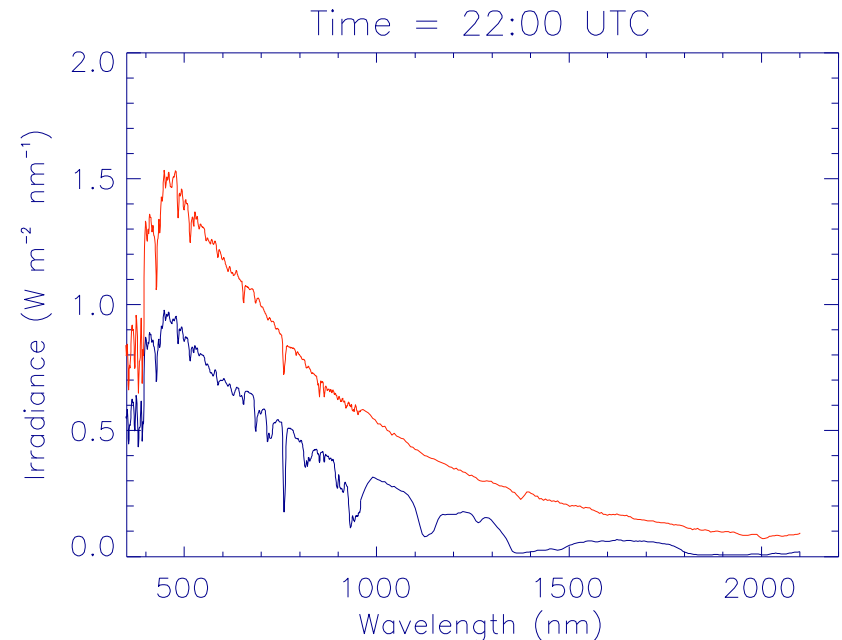
Spectral Specifications

| Measurement | Optical Design | Spectral Description | Wavelengths (nm) | Pixels | Sampling (nm) | FWHM (nm) |
|-------------------|--------------------|----------------------|------------------|--------|---------------|-------------------------------|
| Actinic Flux | Concentric Domes | UV-VIS | 280-680 | 512 | 0.8 | 1.7 @ 297 nm, 2.4 @ 400 nm |
| Irradiance Si | Integrating Sphere | VIS-NIR | 260-1090 | 1024 | 0.8 | 3 |
| Irradiance InGaAs | Integrating Sphere | NIR | 903-2217 | 256 | 5 | 16 |

Actinic Flux



Irradiance



Calculated photolysis frequencies from actinic flux

j [O₃->O₂+O(1D)]

j [NO₂->NO+O(3P)]

j [H₂O₂->2OH]

j [HNO₂->OH+NO]

j [HNO₃->OH+NO₂]

j [CH₂O->H+HCO]

j [CH₂O->H₂+CO]

j [CH₃CHO->CH₃+HCO]

j [CH₃CHO->CH₄+CO]

j [C₂H₅CHO->C₂H₅+HCO]

j [CHOCHO->products]

j [CHOCHO->HCO+HCO]

j [CH₃COCHO->products]

j [CH₃COCH₃-

>CH₃CO+CH₃]

j [CH₃OOH->CH₃O+OH]

j [CH₃ONO₂->CH₃O+NO₂]

j [PAN->products]

j [CH₃COCH₂CH₃->

Products]

j [CH₃CH₂CH₂CHO->

C₃H₇+HCO]

j [CH₃CH₂CH₂CHO->

C₂H₄+CH₂CHOH]

j [HO₂NO₂-->HO₂+NO₂]

j [HO₂NO₂-->OH+NO₃]

j [CH₃CH₂ONO₂->

Products]

j [Br₂->Br+Br]

j [BrO->Br+O]

j [Br₂O->products]

j [BrNO₃->Br+NO₃]

j [BrNO₃->BrO+NO₂]

j [BrCl->Br+Cl]

j [HOBr->HO+Br]

j [BrONO₂->Br+NO₃]

j [BrONO₂->BrO+NO₂]

j [Cl₂+hν->Cl+Cl]

j [ClO->Cl+O]

j [ClONO₂->Cl+NO₃]

j [ClONO₂->ClO+NO₂]

j [CHBr₃->Products]



Photolysis impact of convection

Strong Enhancement

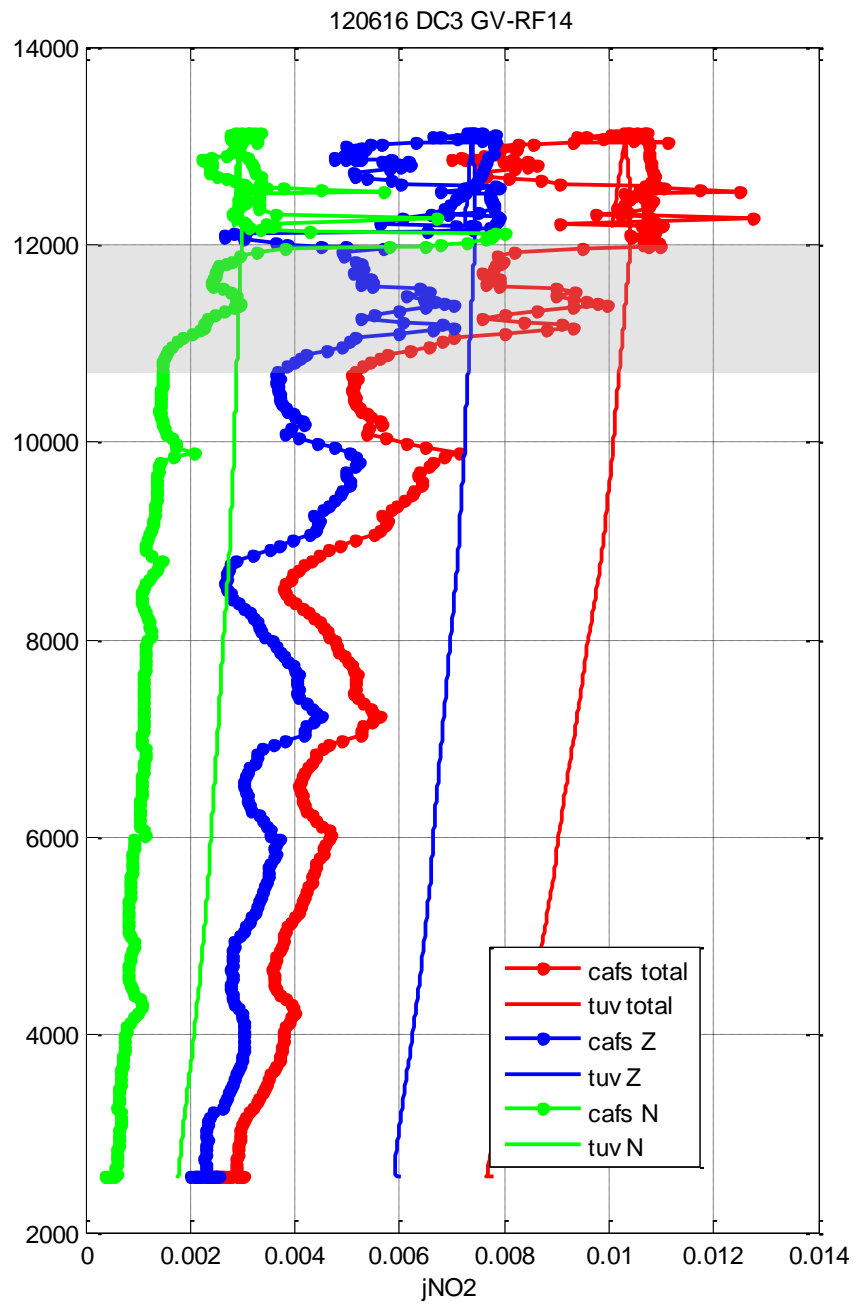
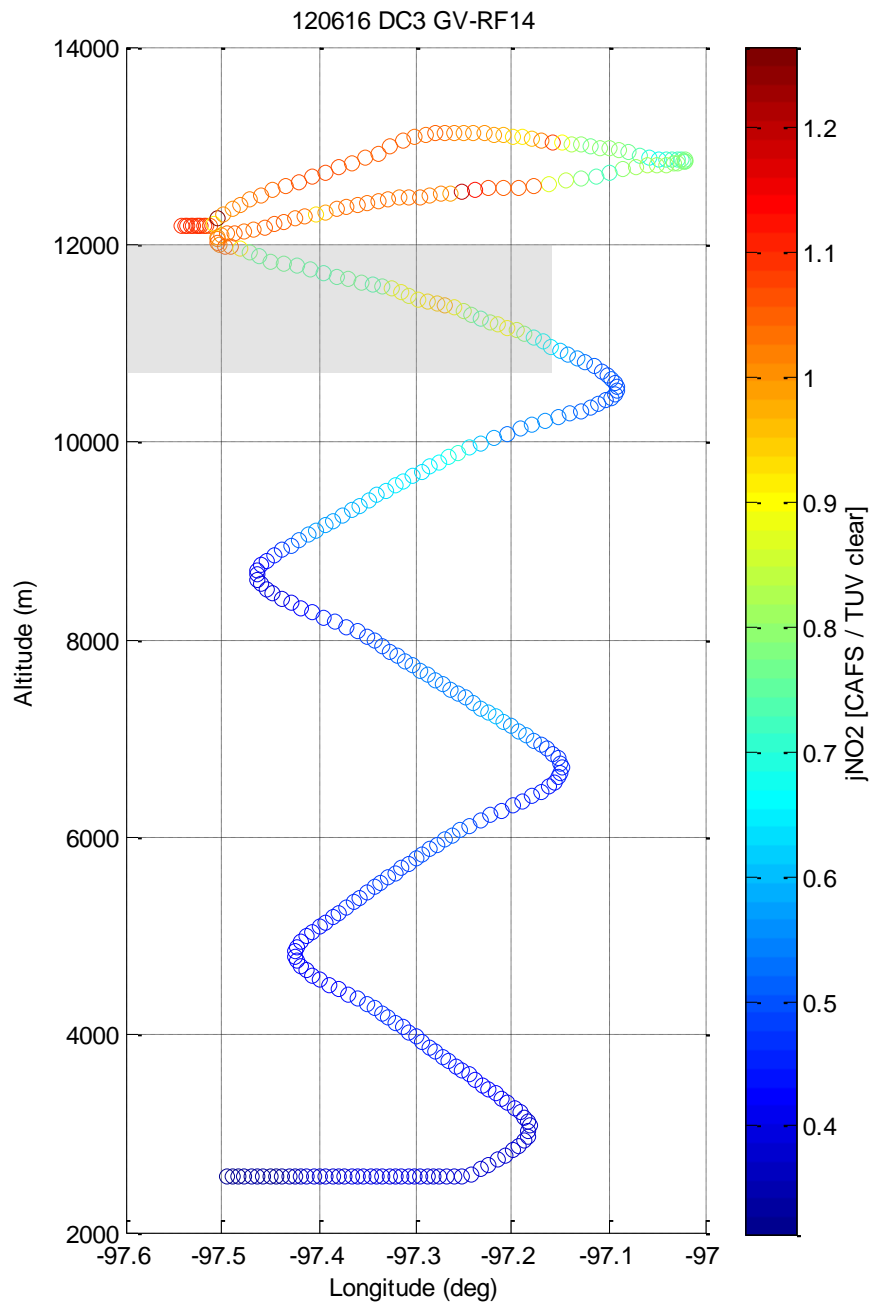


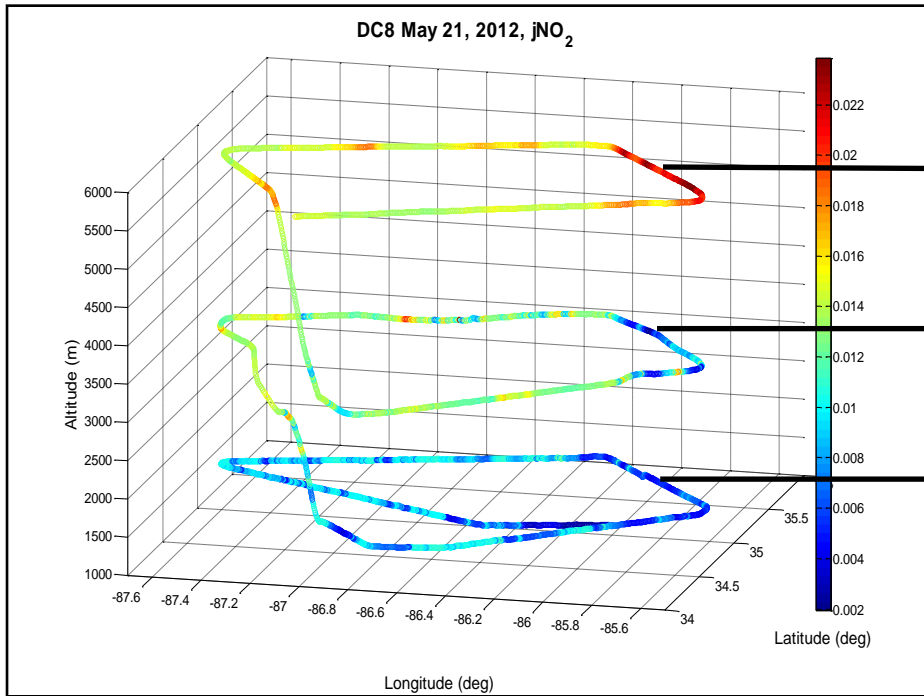
Some enhancement

Partial shading

Strong Shading



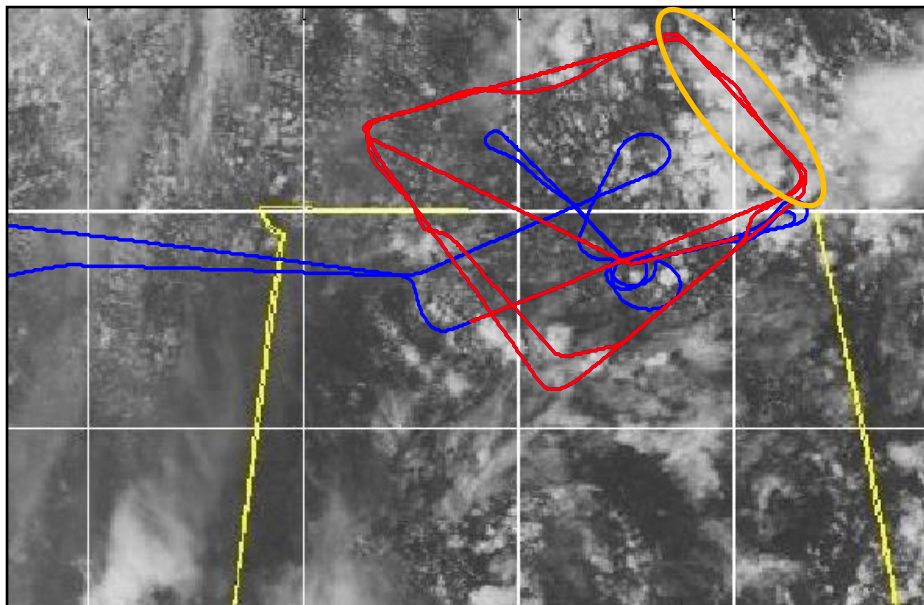
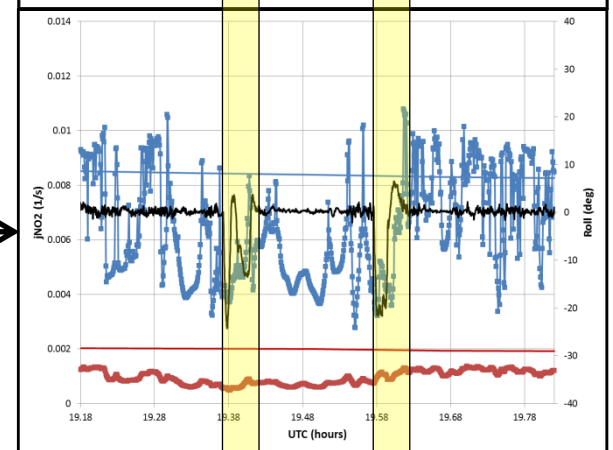
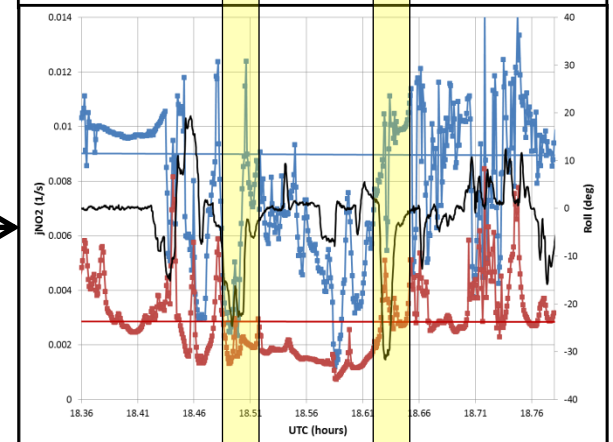
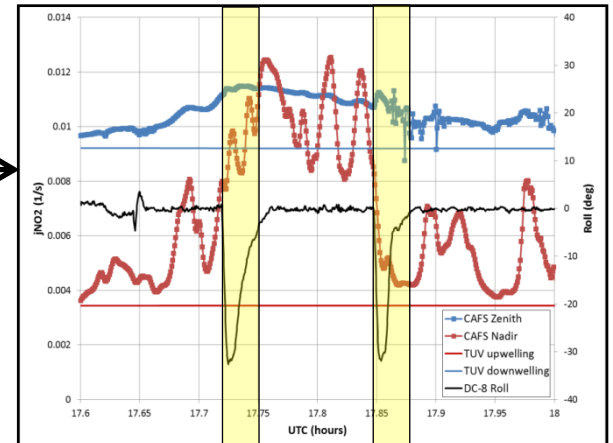


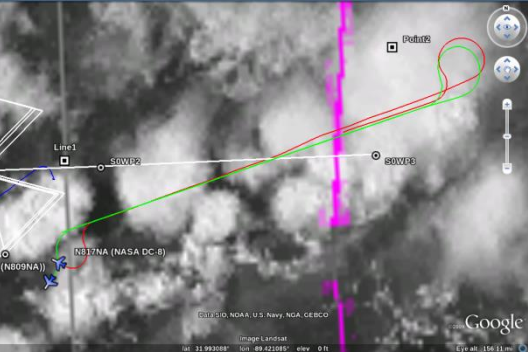


Above

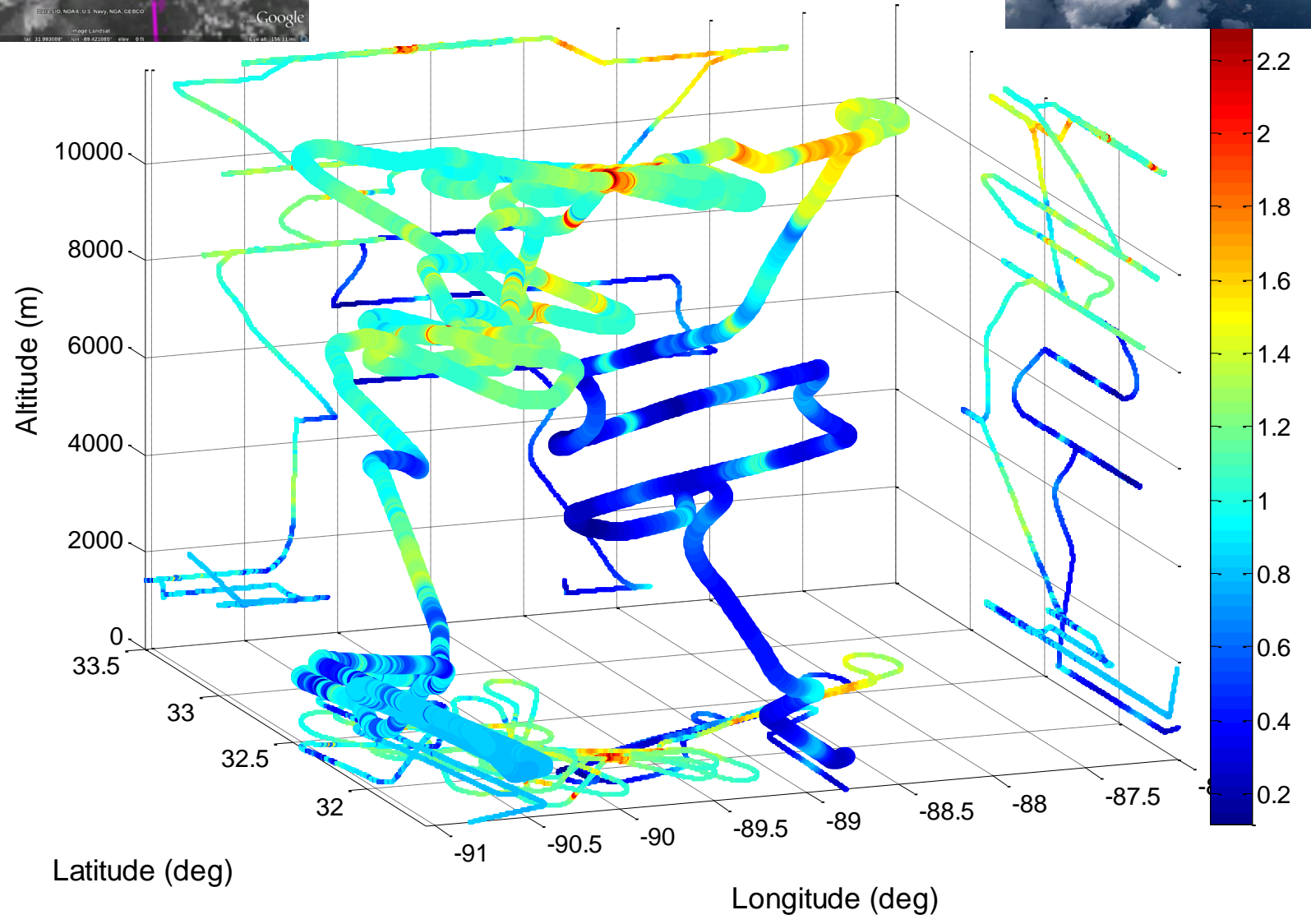
Through

Below

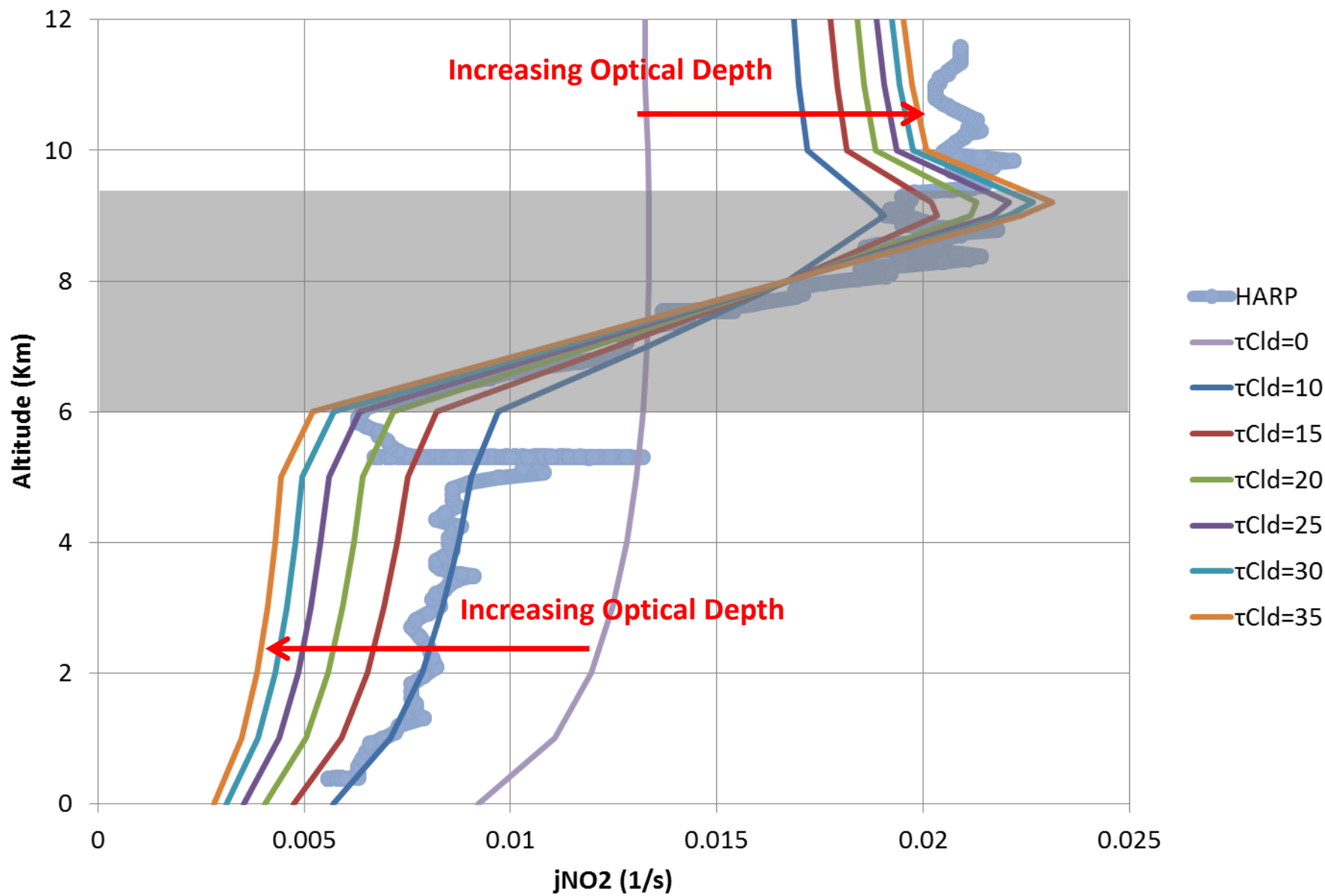


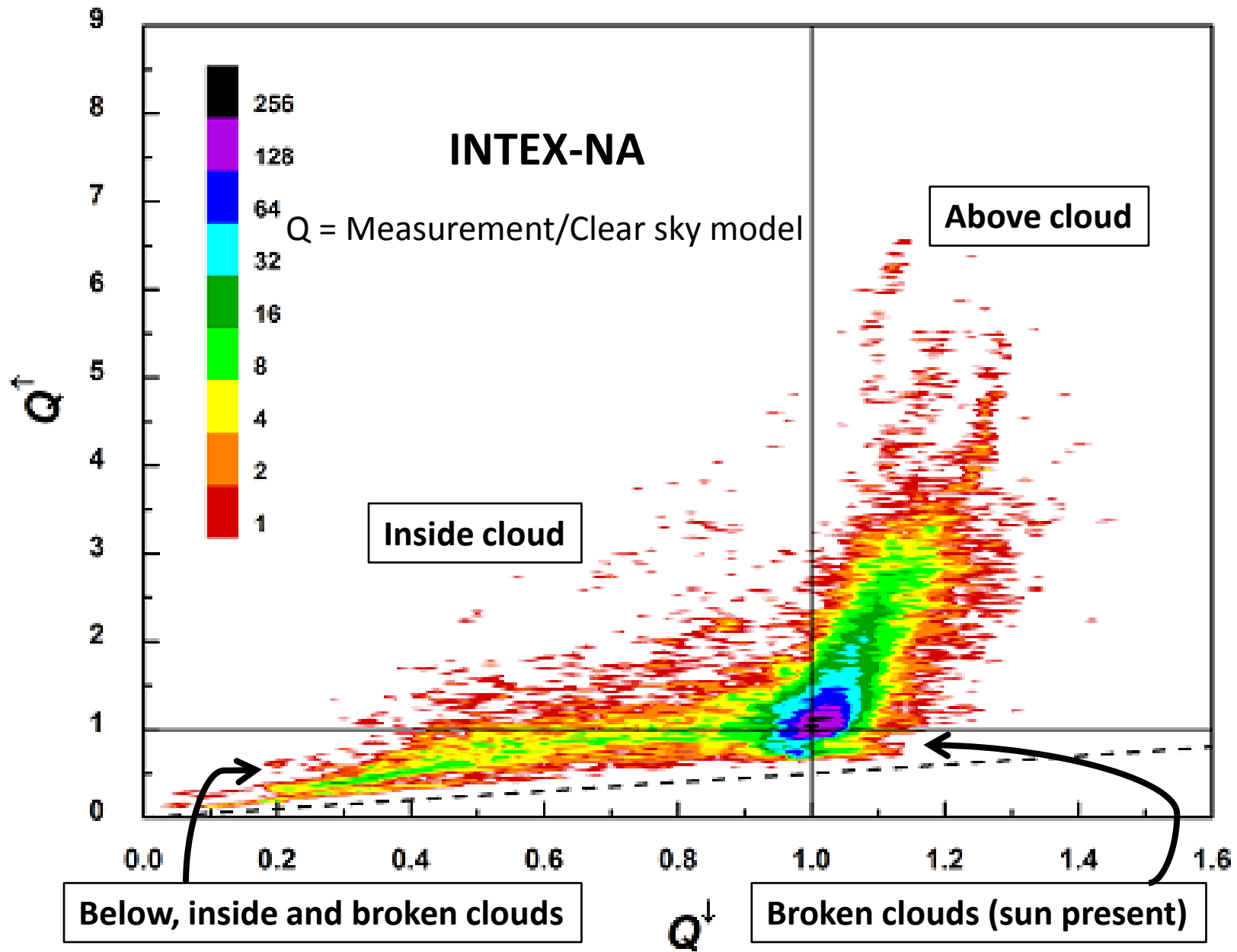


jNO2 ratio (CAFS/TUV) 20130902 DC-8 RF12

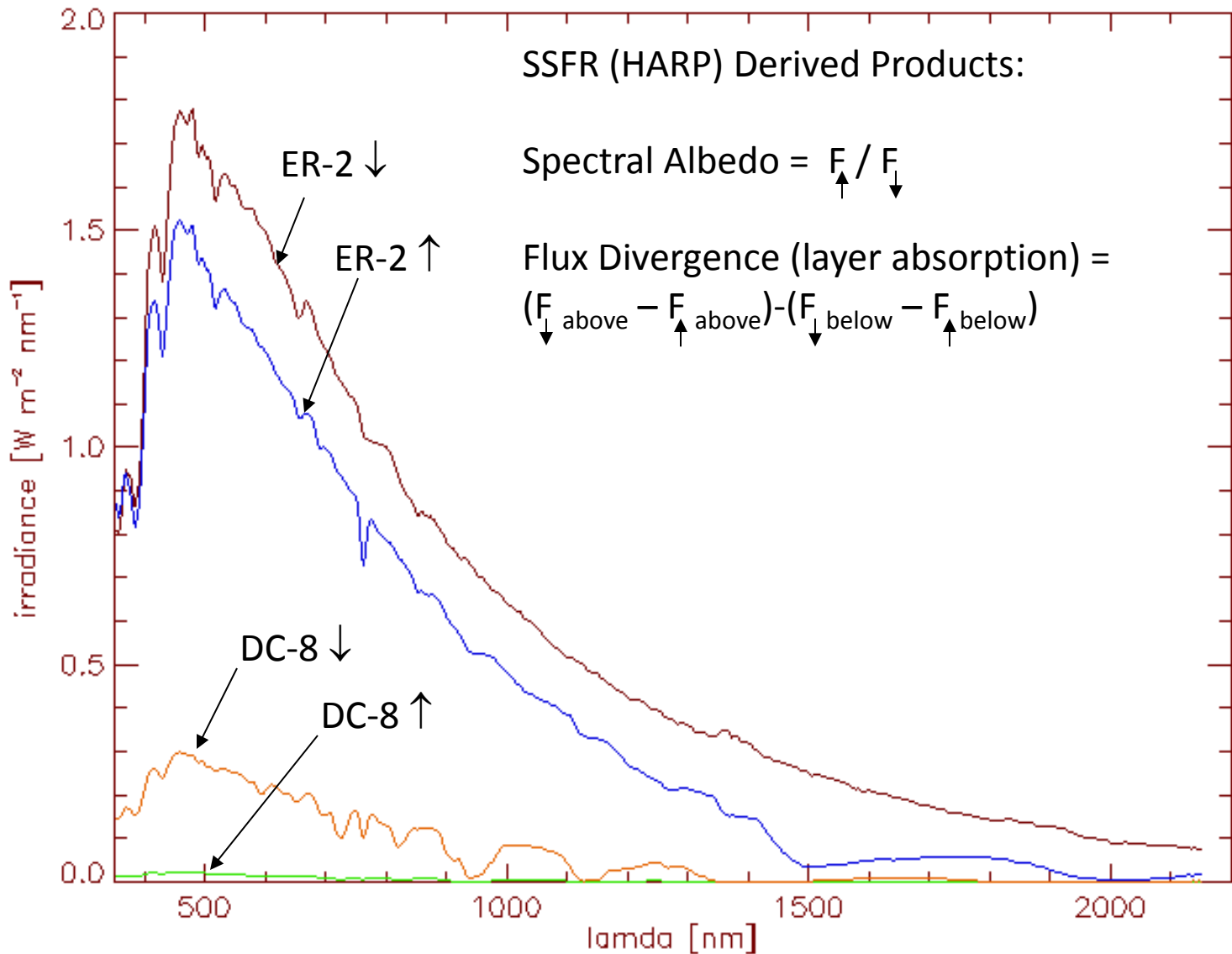


20120511 DC3 jNO2



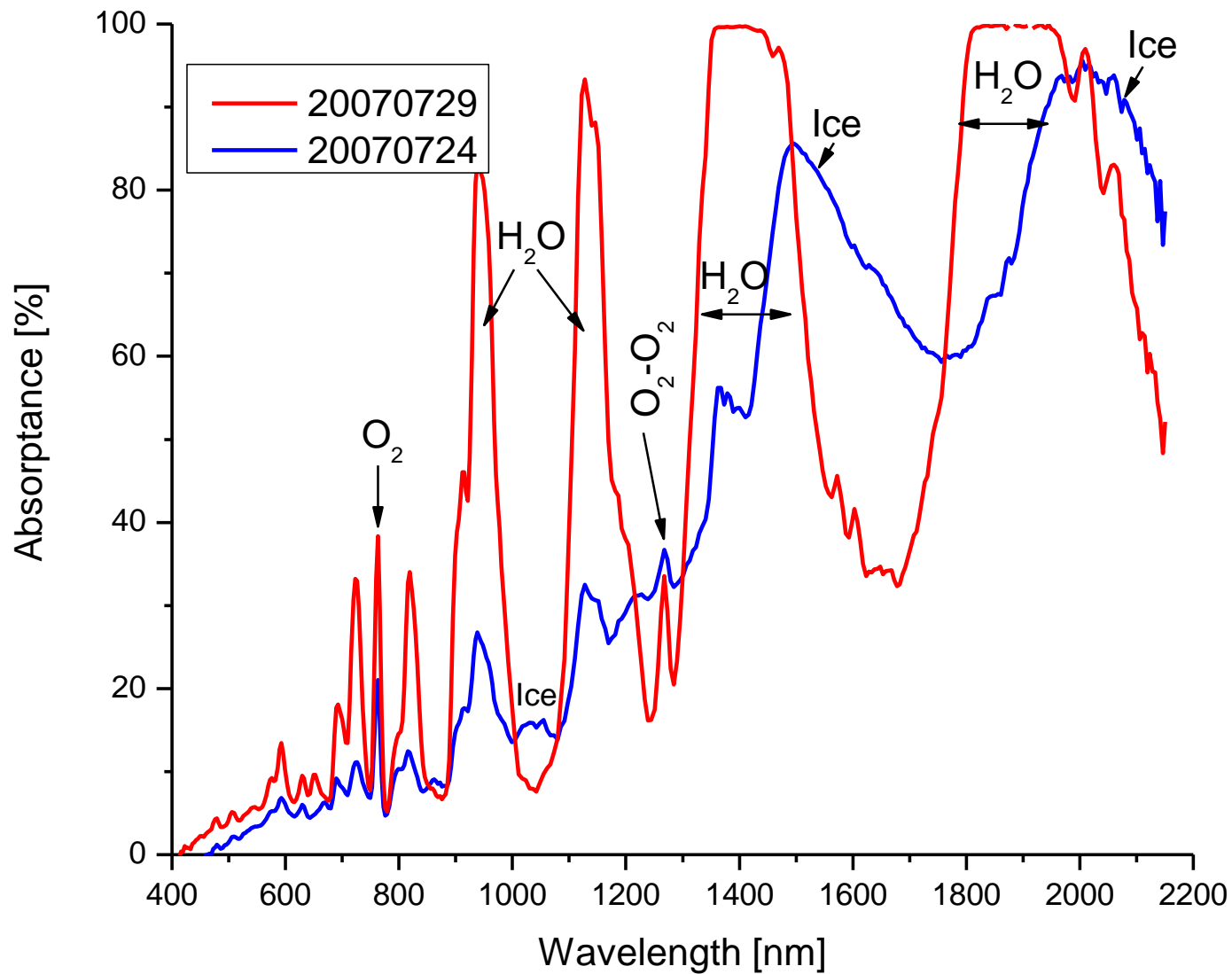


20070724 – DC-8 & ER-2 spectra



Water Cloud vs. Ice Cloud Absorption

TC4



Summary

- Measure spectrally resolved actinic flux density and calculate photolysis frequencies (280-680 nm)
- Chemical evolution (ozone, halogens, NO_x, HO_x, VOCs, etc) in the convectively perturbed UT/LS
- Case studies for cloud optical depths
- Measurement-model ratios demonstrate bimodal cloud behavior. Do global/regional models show the same tendency?

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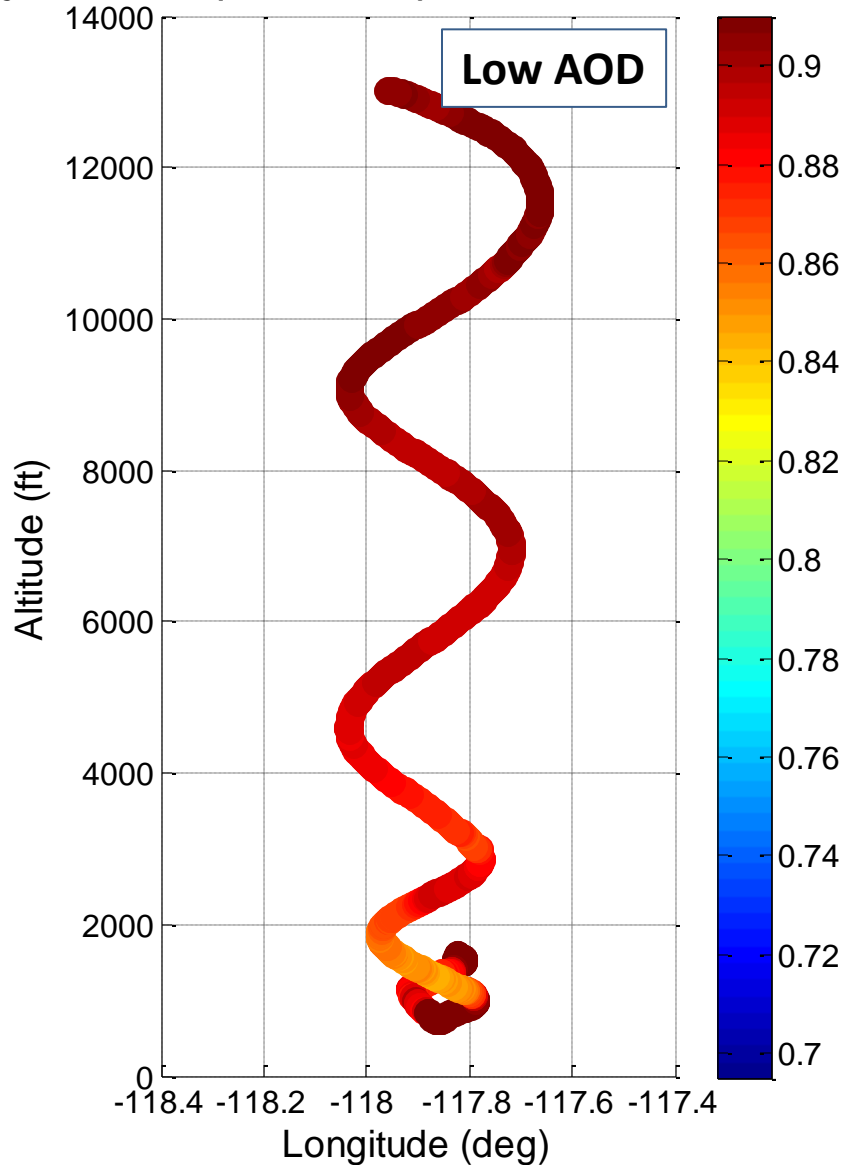
Irradiance

- Measure spectrally resolved irradiance (350-2200 nm)
- Collaboration with Peter Pilewskie (CU) for irradiance products
- Strong synergy potential with ATTREX for layer products
- Fixed irradiance measurements require level legs for accurate calculations

Extra Slides

Smoke Profile

jNO2 Ratio (CAFS/TUV) 20130805 DC-8 TF02



jNO2 Ratio (CAFS/TUV) 20130816 DC-8 RF05

