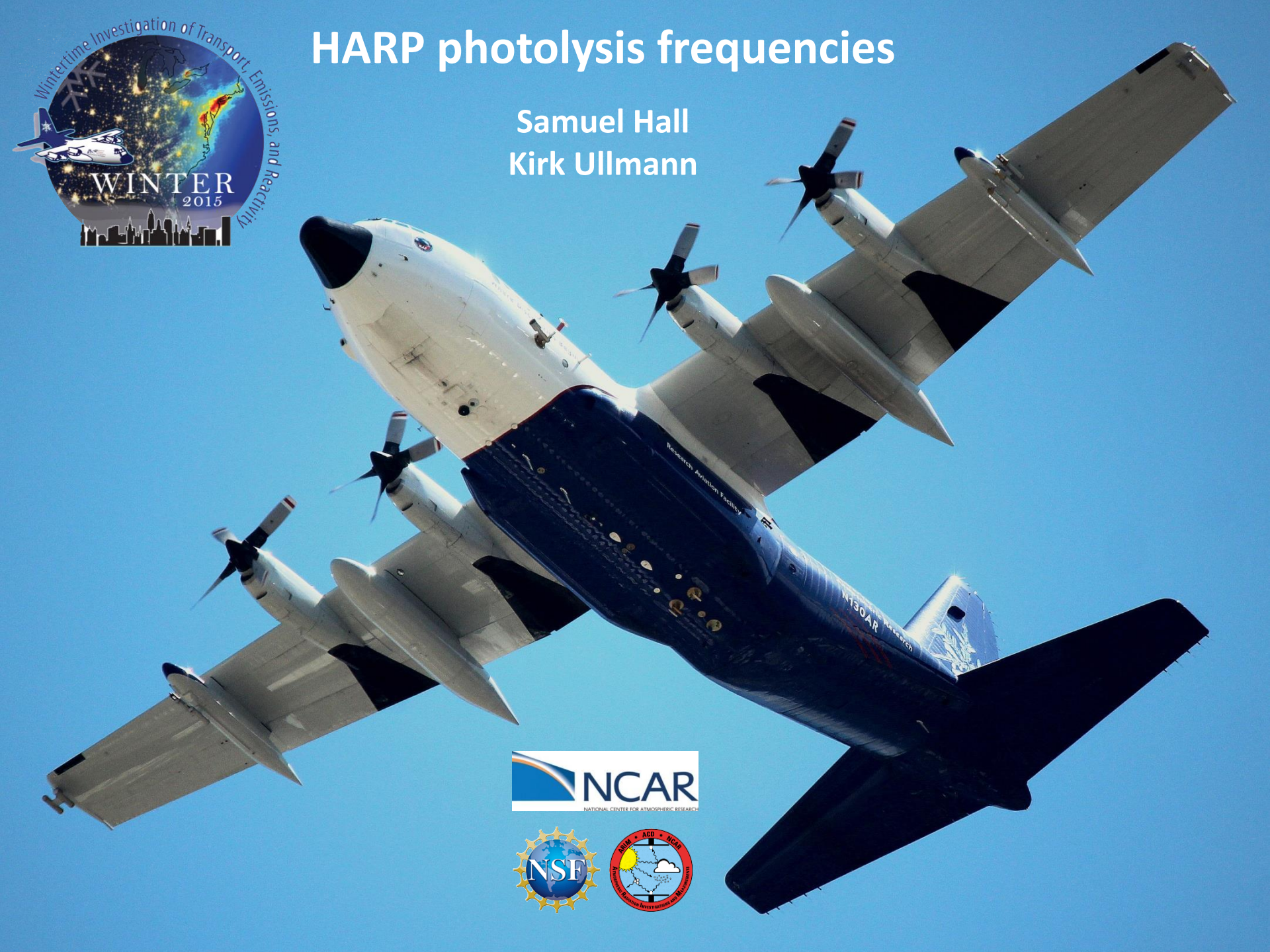
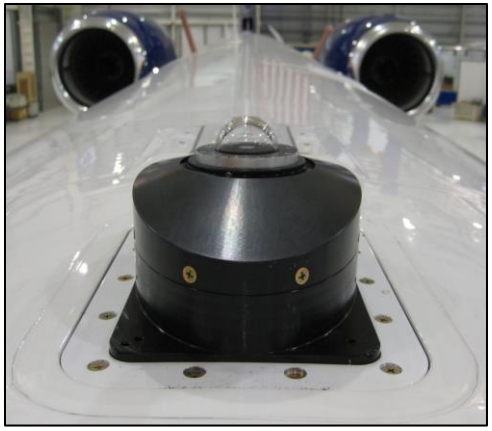
HARP photolysis frequencies

Samuel Hall
Kirk Ullmann



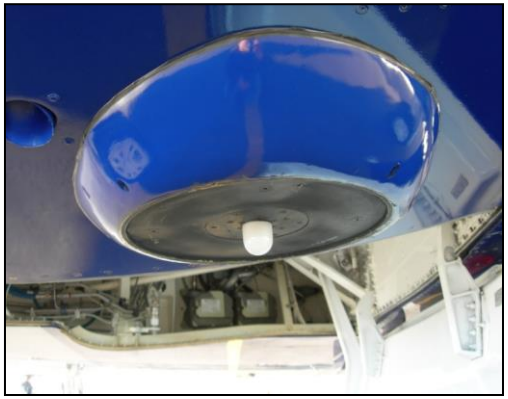
NCAR/NSF **G-V**

HIAPER Airborne Radiation Package (**HARP**)



Actinic Flux

Irradiance



HARP Zenith
(downwelling)

HARP Nadir
(upwelling)

HARP Actinic Flux Spectroradiometers

Measurement

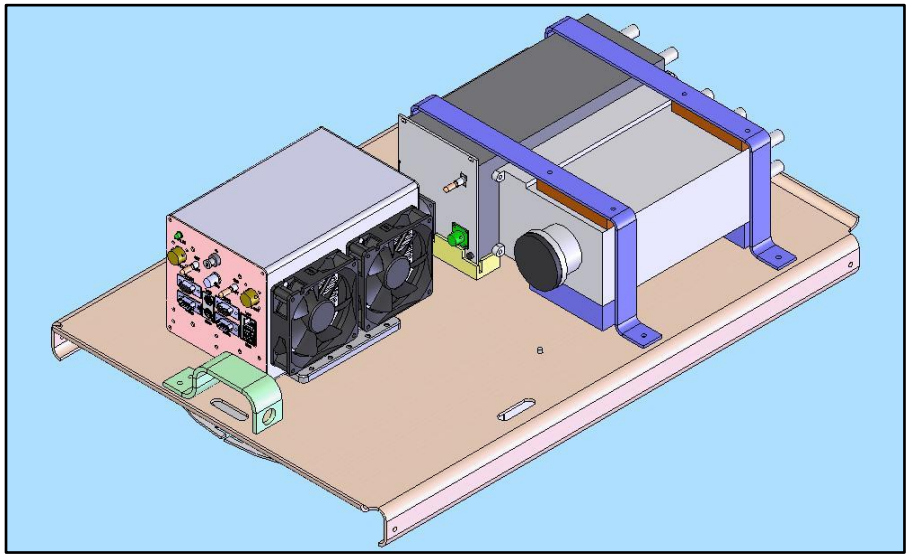
CCD detection of spectrally resolved up and downwelling actinic flux

Calibrations

- NIST traceable absolute spectral sensitivity (primary lab, secondary field)
- Wavelength assignment (Hg and solar)
- Angular, azimuthal and effective plane
- Stray light characterization
- Radiative transfer model comparisons
- Chemical actinometer comparisons

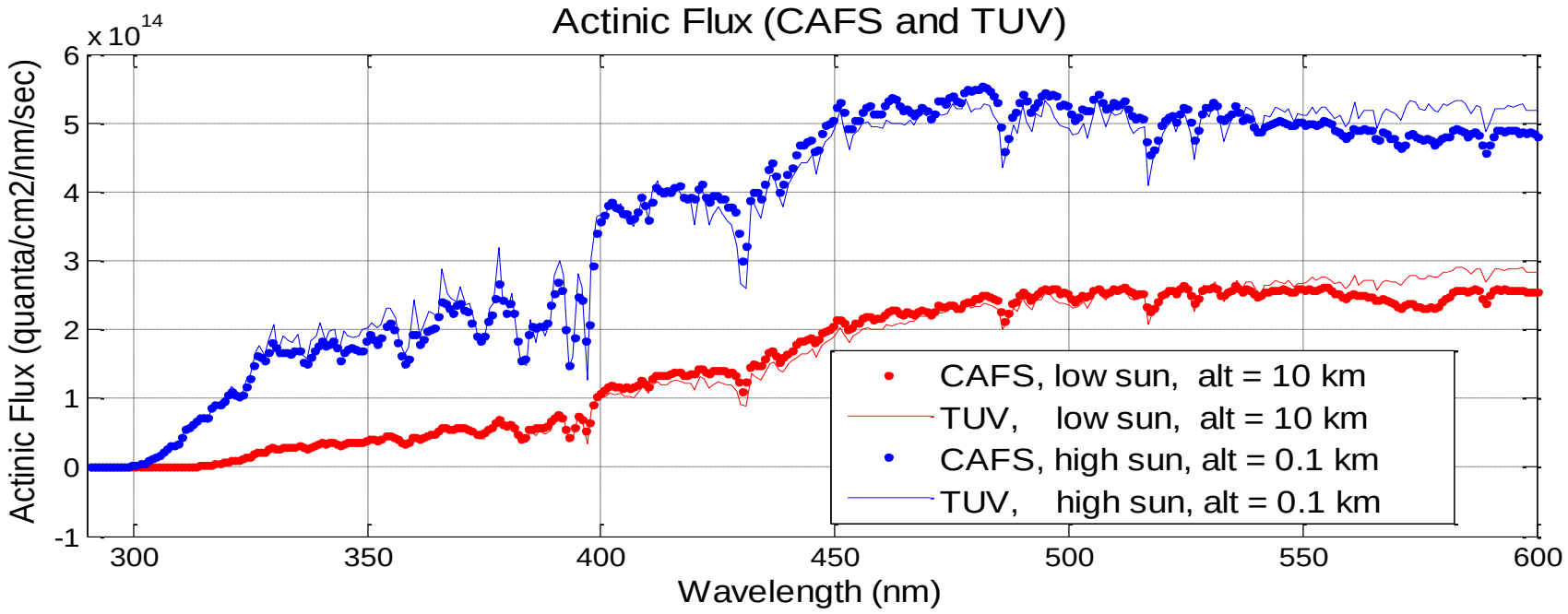
Products

Photolysis frequencies calculated from cross-sections and quantum yields

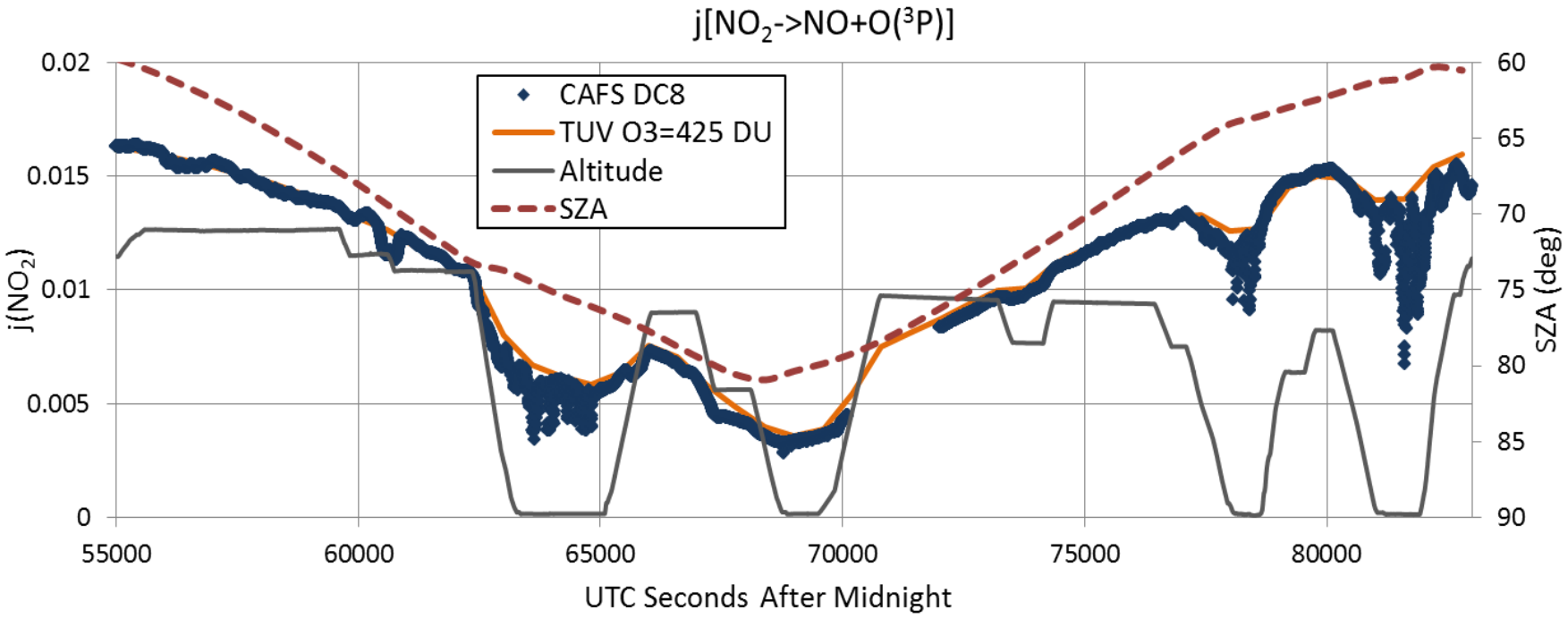


Wavelengths	280-680 nm (unfiltered)
Resolution	~1.8 nm FWHM at 297 nm
Precision	1-2% wavelength dependent
Spectral Accuracy	5% (UV-B), 3% (UV-A/VIS) limited by NIST standards
Detection Limits	~0.04 mW/m2/nm at 300 nm
Data Rate	3-6 seconds

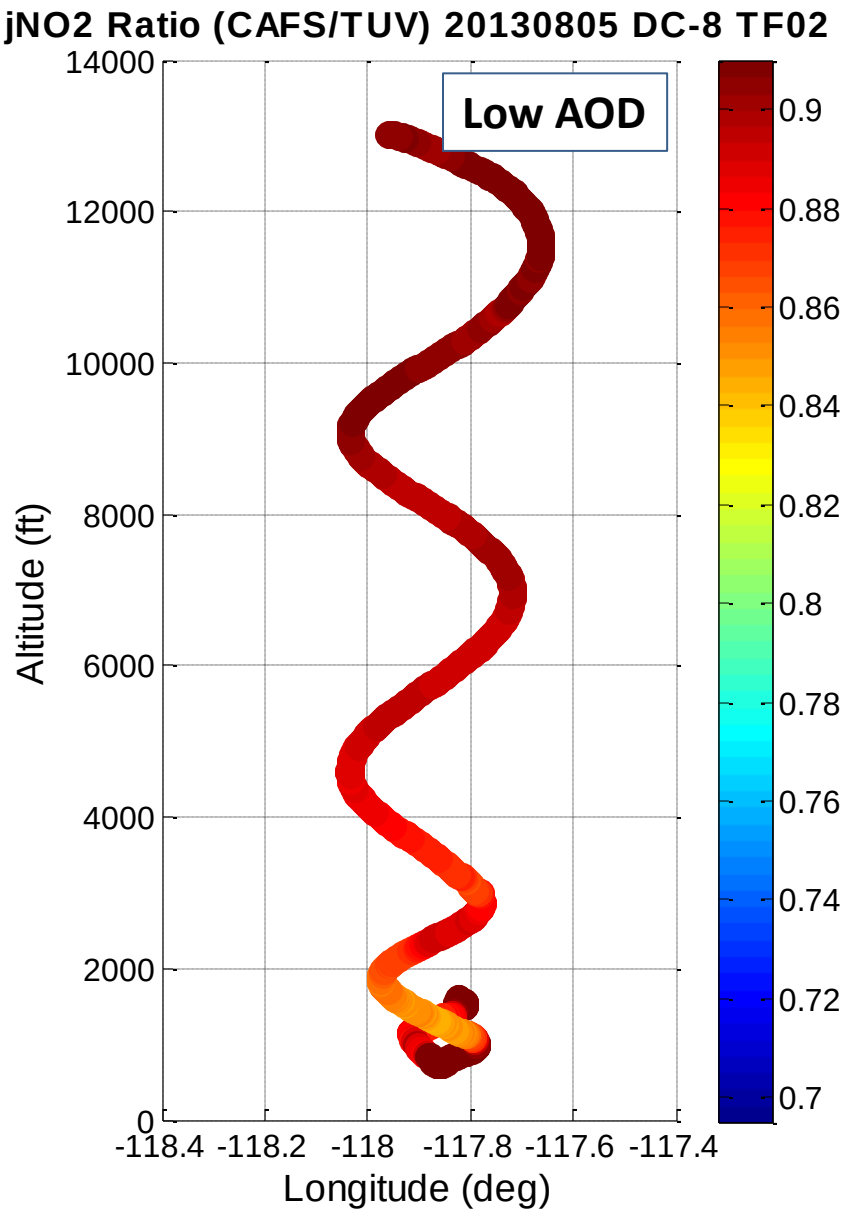
MEASUREMENT

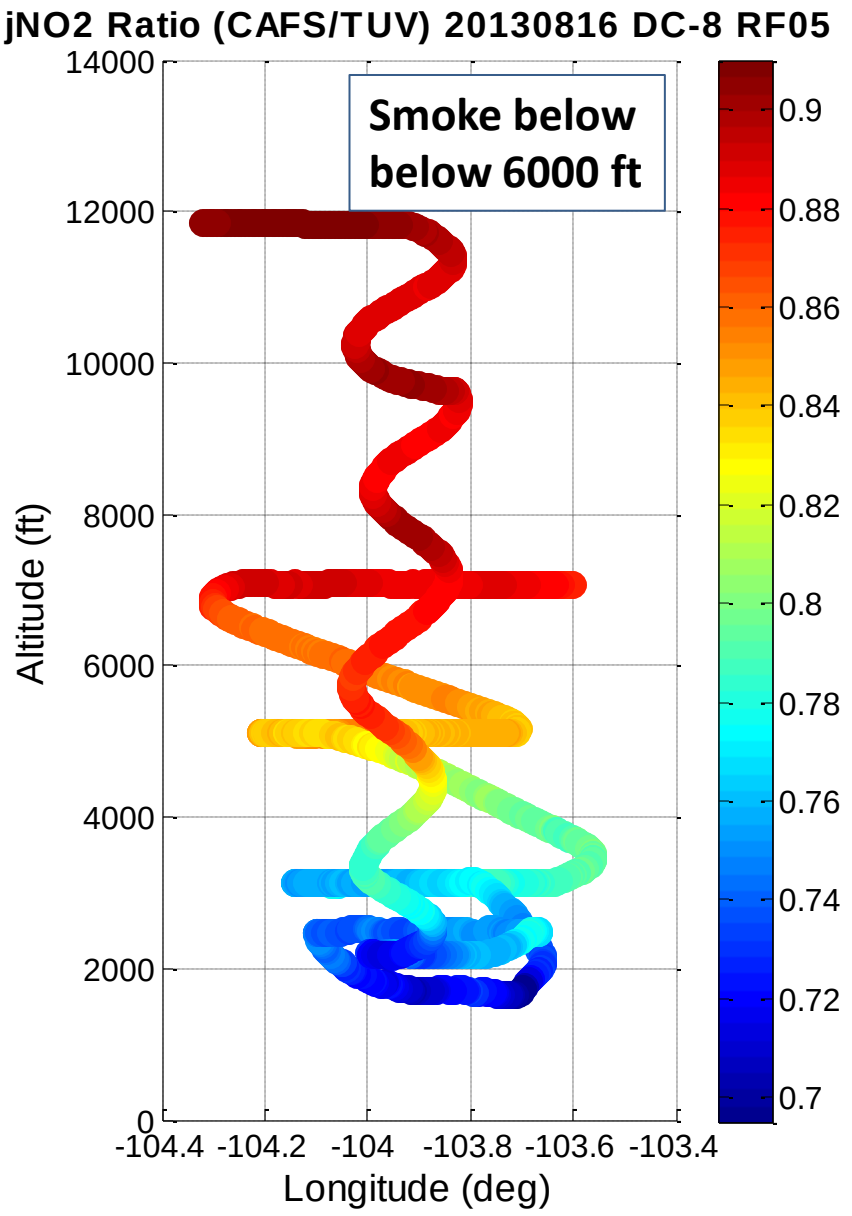


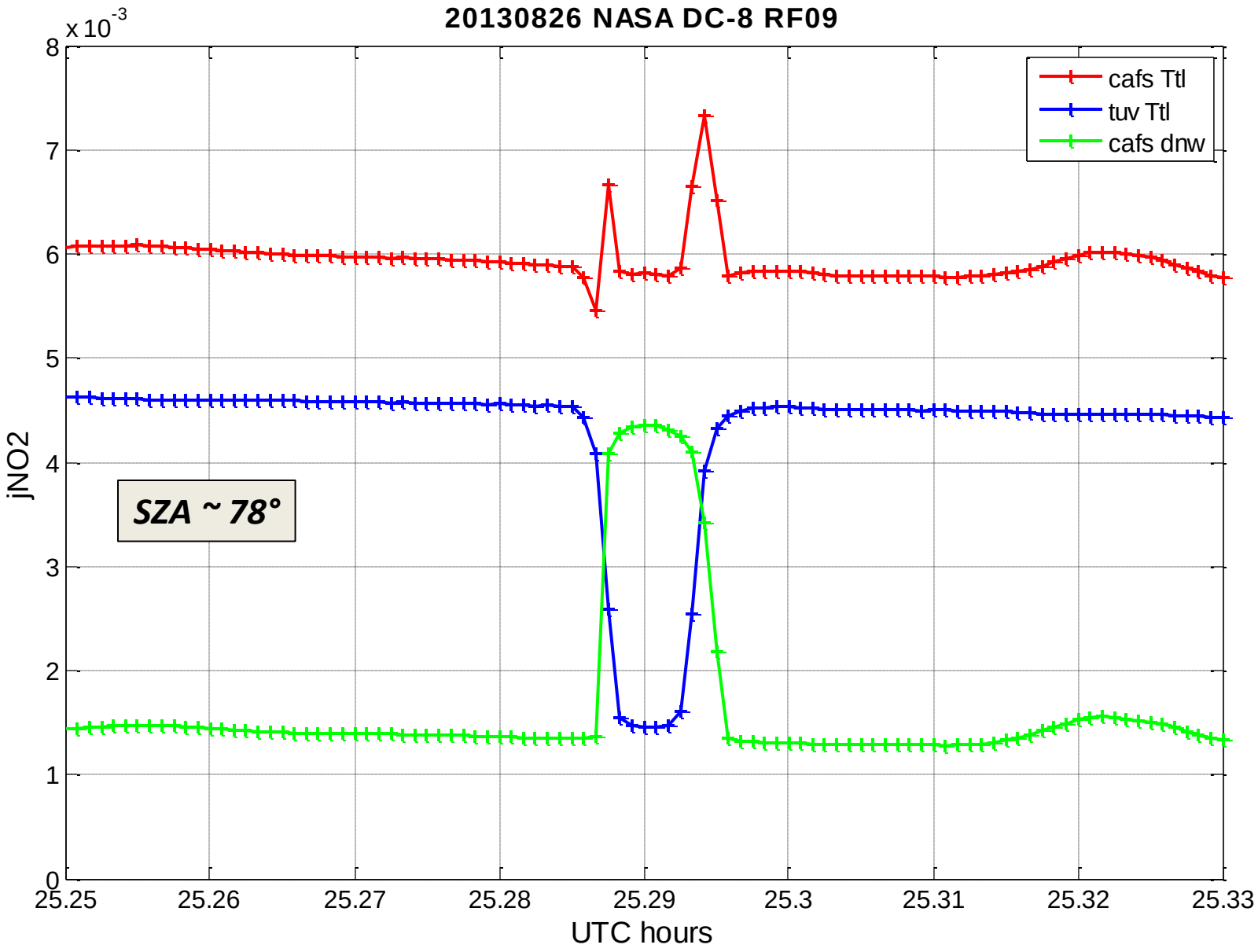
PRODUCT



Aerosol Profile






20130826 NASA DC-8 RF09
x 10^-3
8
7
6
5
4
3
2
1
0
jNO2
cafs Ttl
tuv Ttl
cafs dnw
SZA ~ 78°
25.25
25.26
25.27
25.28
25.29
25.3
25.31
25.32
25.33
UTC hours

Photolysis frequencies calculated from HARP actinic flux

j [$O_3 \rightarrow O_2 + O(^1D)$]

j [$NO_2 \rightarrow NO + O(^3P)$]

j [$H_2O_2 \rightarrow 2OH$]

j [$HNO_2 \rightarrow OH + NO$]

j [$HNO_3 \rightarrow OH + NO_2$]

j [$CH_2O \rightarrow H + HCO$]

j [$CH_2O \rightarrow H_2 + CO$]

j [$CH_3CHO \rightarrow CH_3 + HCO$]

j [$C_2H_5CHO \rightarrow C_2H_5 + HCO$]

j [$CHOCHO \rightarrow H_2 + 2CO$]

j [$CHOCHO \rightarrow CH2O + CO$]

j [$CHOCHO \rightarrow HCO + HCO$]

j [$CH_3COCHO \rightarrow CH_3CO + HCO$]

j [$CH_3COCH_3 \rightarrow CH_3CO + CH_3$]

j [$CH_3OOH \rightarrow CH_3O + OH$]

j [$N_2O_5 \rightarrow NO_3 + NO_2$]

j [$CH_3ONO_2 \rightarrow CH_3O + NO_2$]

j [$HO_2NO_2 \rightarrow HO_2 + NO_2$]

j [$HO_2NO_2 \rightarrow OH + NO_3$]

j [$CH_3CO(OONO_2) \rightarrow CH_3CO(OO) + NO_2$]

j [$CH_3CO(OONO_2) \rightarrow CH_3CO(O) + NO_3$]

j [$CH_3COCH_2CH_3 \rightarrow CH_3CO + CH_2CH_3$]

j [$CH_3CH_2CH_2CHO \rightarrow C_3H_7 + HCO$]

j [$CH_3CH_2CH_2CHO \rightarrow C_2H_4 + CH_2CHOH$]

j [$CH_3CH_2ONO_2 \rightarrow CH_3CH_2O + NO_2$]

j [$Br_2 \rightarrow Br + Br$]

j [$BrO \rightarrow Br + O$]

j [$Br_2O \rightarrow products$]

j [$HOBr \rightarrow HO + Br$]

j [$BrONO_2 \rightarrow Br + NO_3$]

j [$BrONO_2 \rightarrow BrO + NO_2$]

j [$BrCl \rightarrow Br + Cl$]

j [$Cl_2 \rightarrow Cl + Cl$]

j [$ClO \rightarrow Cl + O(^3P)$]

j [$ClONO_2 \rightarrow Cl + NO_3$]

j [$ClONO_2 \rightarrow ClO + NO_2$]

Recent Additions

j [$ClNO_2 \rightarrow Cl + NO_2$]

j [$ClONO \rightarrow Cl + NO_2$]

j [$BrNO \rightarrow Br + NO$]

j [$BrONO \rightarrow Br + NO_2$]

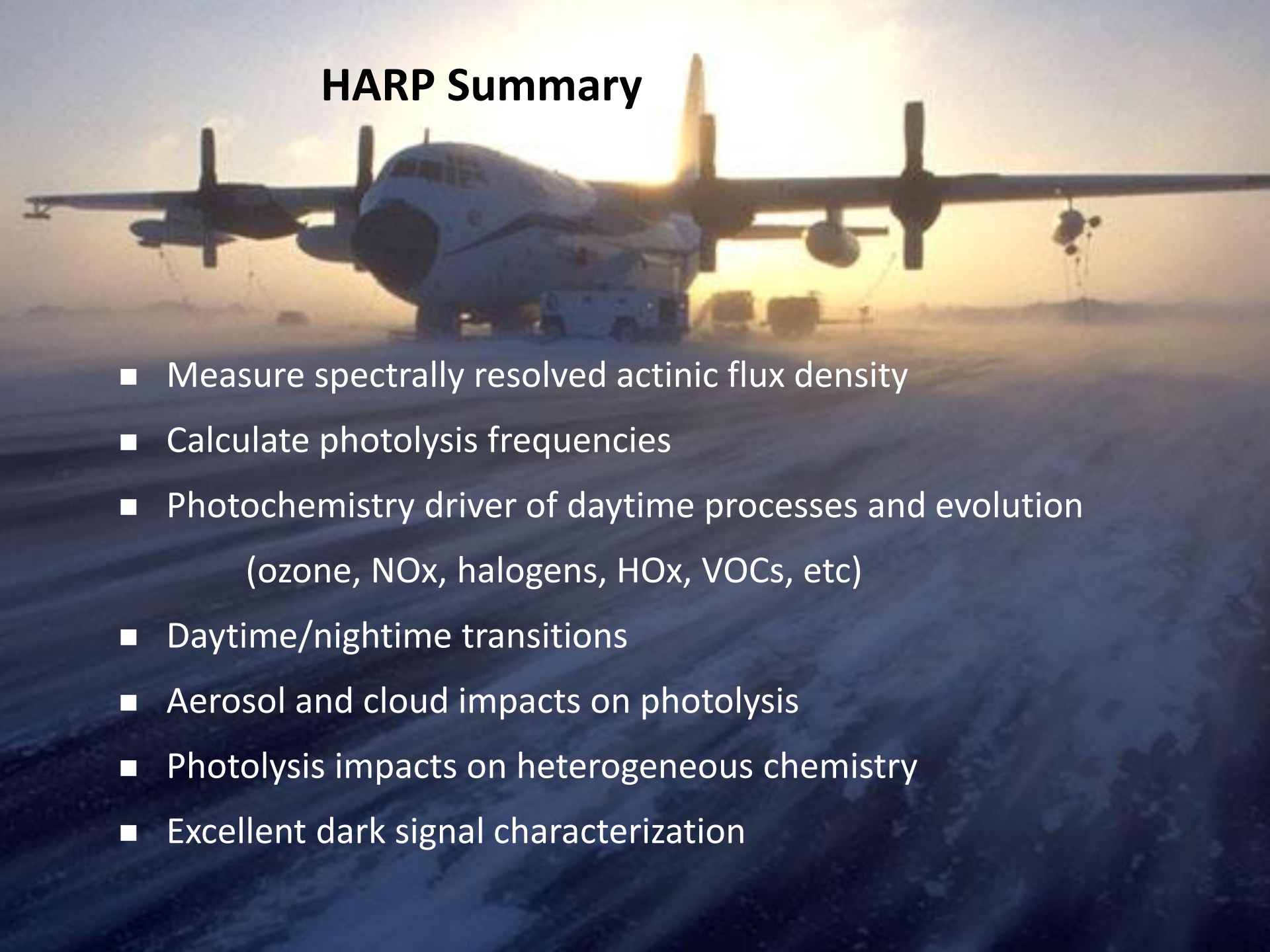
j [$BrONO \rightarrow BrO + NO$]

j [$BrNO_2 \rightarrow Br + NO_2$]

j [$CHBr_3 \rightarrow Products$]

j [$CH_2=C(CH_3)CHO \rightarrow Products$]

j [$CH_3COCH=CH_2 \rightarrow Products$]



HARP Summary

- Measure spectrally resolved actinic flux density
- Calculate photolysis frequencies
- Photochemistry driver of daytime processes and evolution

  (ozone, NOx, halogens, HOx, VOCs, etc)
- Daytime/nightime transitions
- Aerosol and cloud impacts on photolysis
- Photolysis impacts on heterogeneous chemistry
- Excellent dark signal characterization