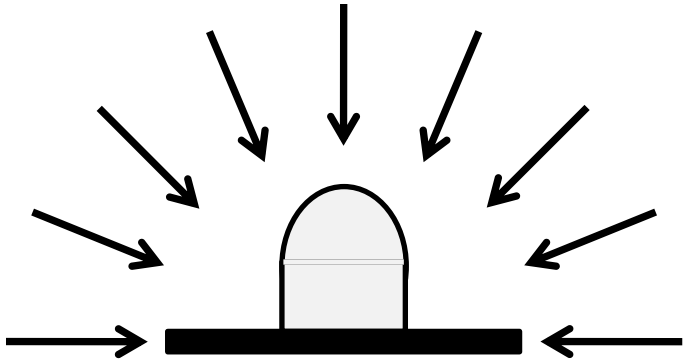
HIAPER Atmospheric Radiation Package (*HARP*)

Samuel Hall, Kirk Ullmann

Irradiance products collaboration

Sebastian Schmidt, Bruce Kindel – *University of Colorado*

Actinic flux



Frosted Dome

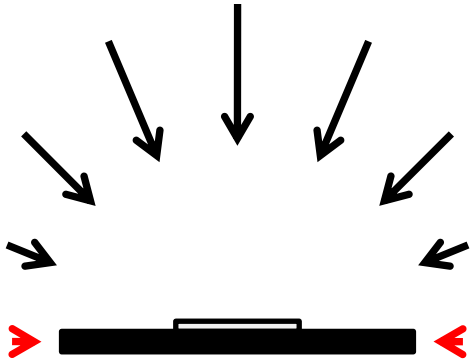
Measures Energy Flux through a sphere

Equally responsive to photons from all directions

Total Actinic Flux (sum of downwelling and upwelling) also known as spherical radiance

Photolysis: Molecules are 3-D and can absorb photons from any direction

Irradiance



Flat Plate or **Integrating Sphere**

Measures Energy Flux through a plane

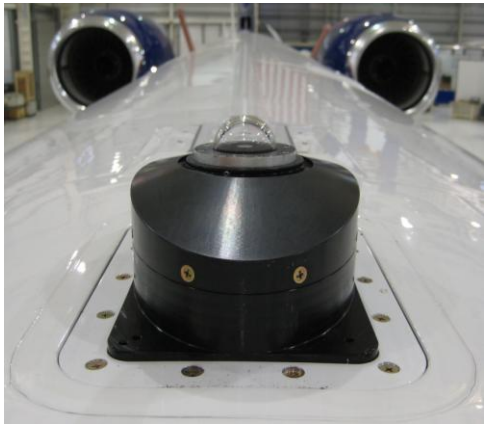
Cosine response (i.e., insensitive to photons from 90 deg)

Many uses in radiative transfer including **Net Irradiance** (difference between downwelling and upwelling)

Energy passing through a layer is sensitive to direction

NSF/NCAR HARP

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]

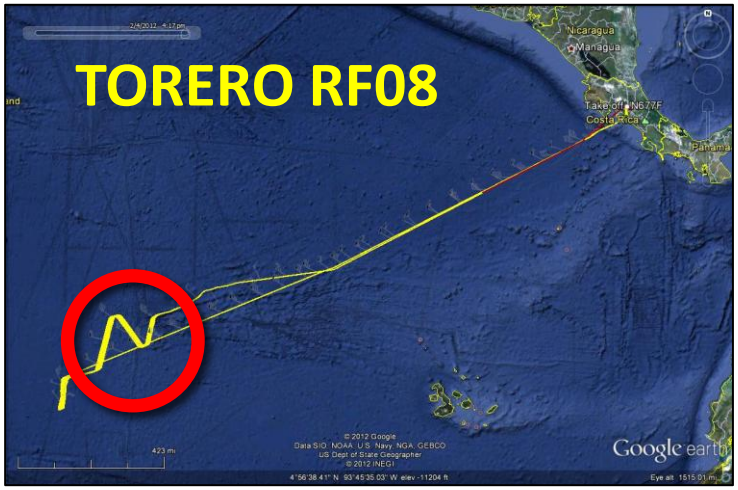
j [Cl2+hv->Cl+Cl]

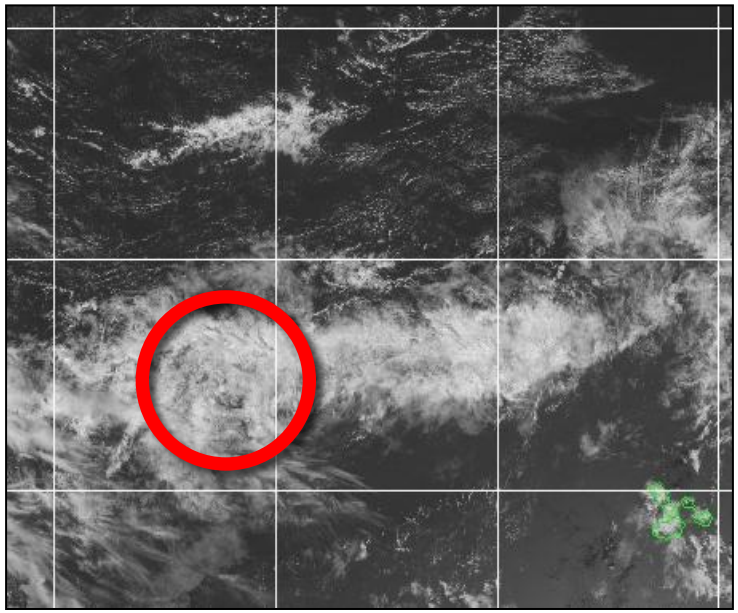
j [ClO->Cl+O]

j [ClONO2->Cl+NO3]

j [ClONO2->ClO+NO2]

Additional photolysis frequencies under construction (including Iodine compounds)



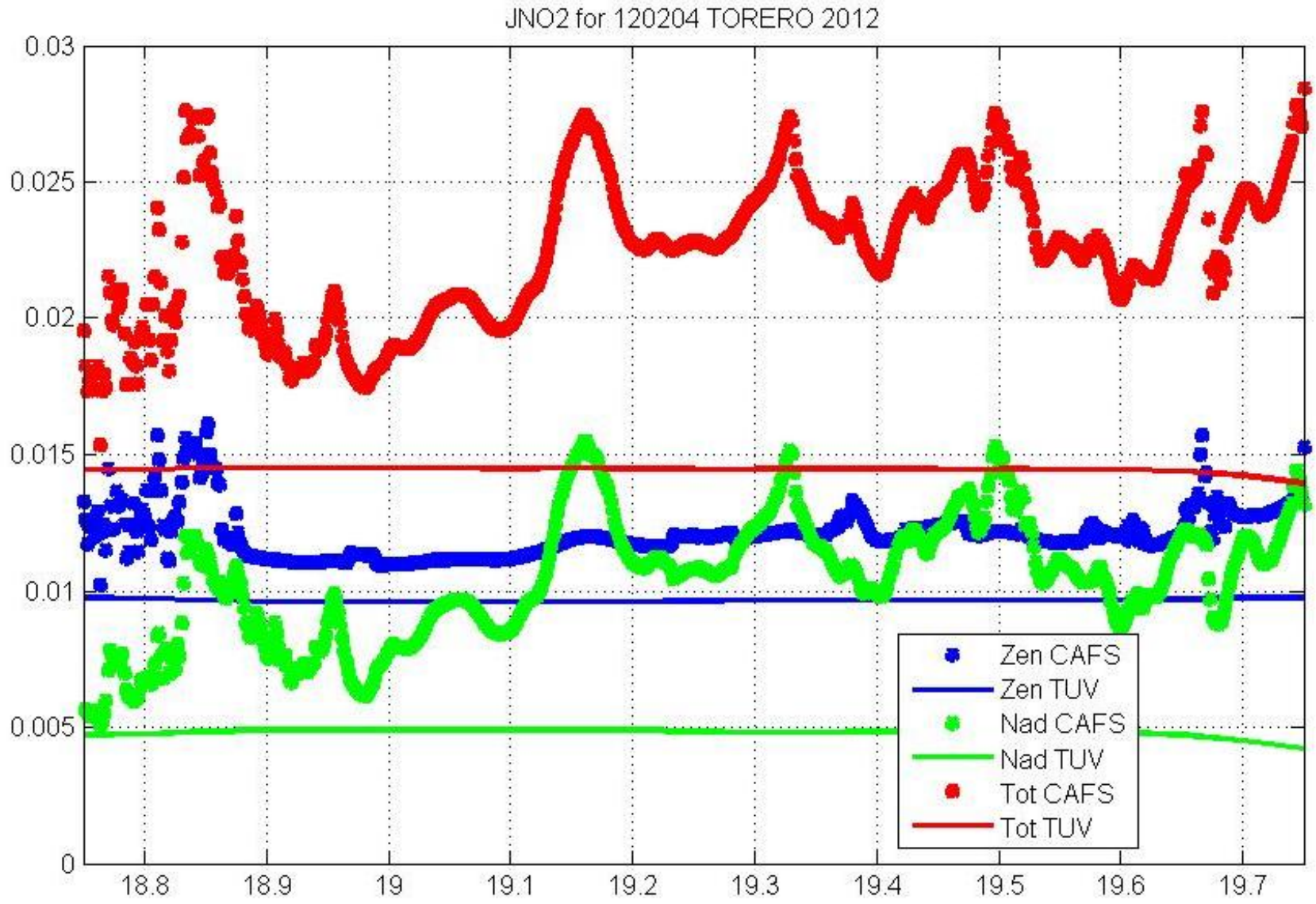


Cloud Properties

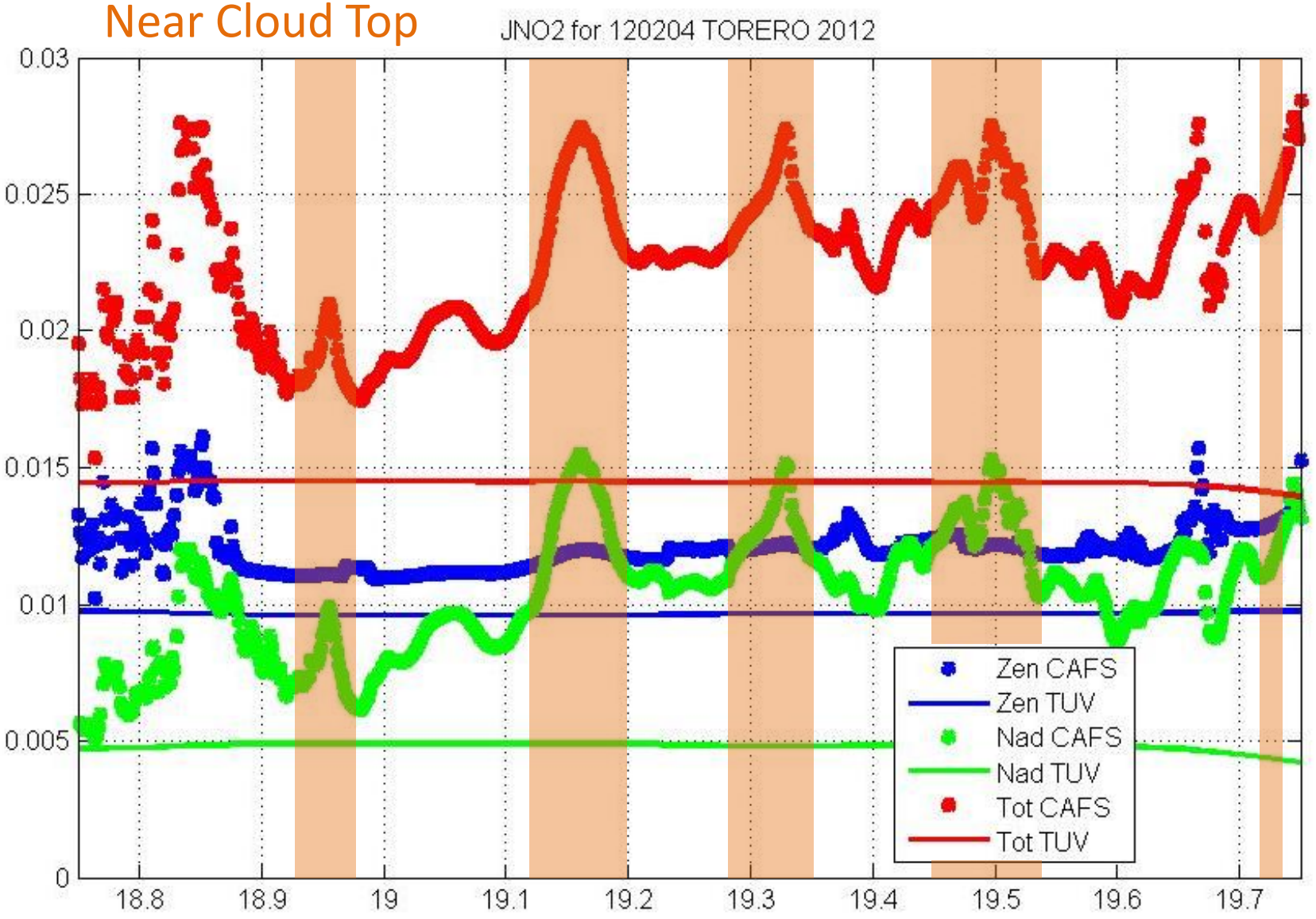
Optical thickness: 10-50 (GOES-12)

Cloud Top Height: 10-11 Km

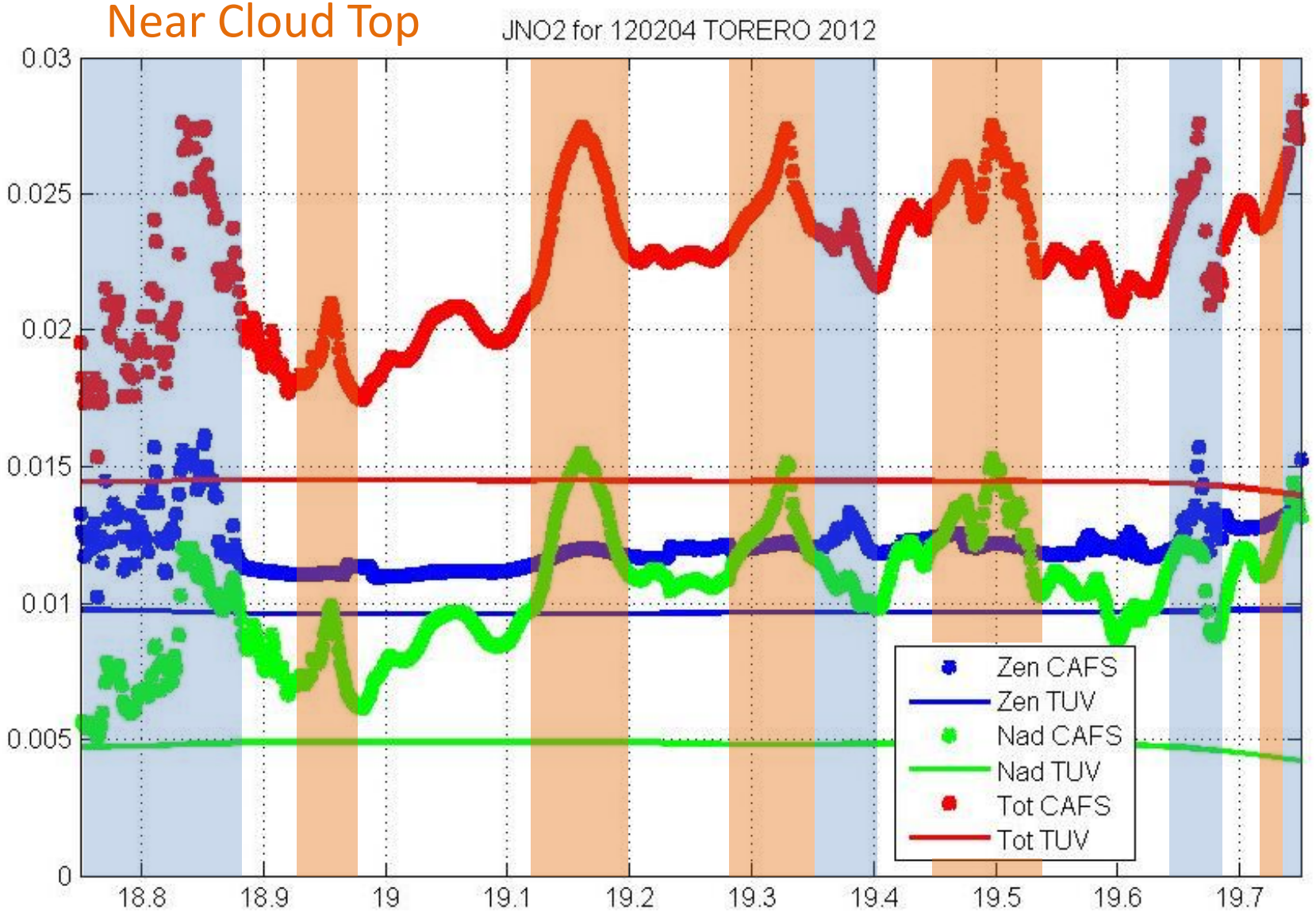
SZA: 19-22 deg

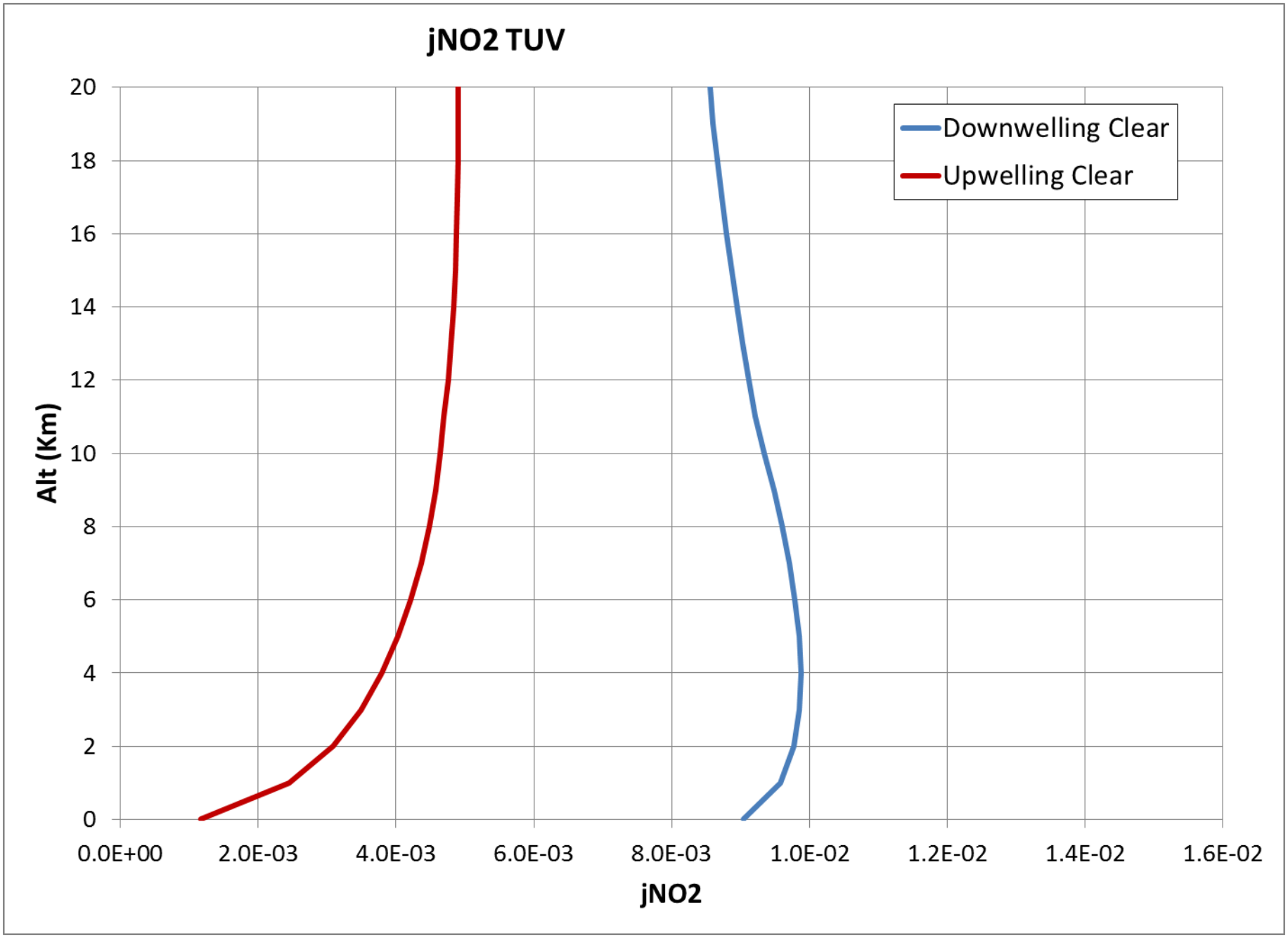

JNO2 for 120204 TORERO 2012
0.03
0.025
0.02
0.015
0.01
0.005
0
18.8
18.9
19
19.1
19.2
19.3
19.4
19.5
19.6
19.7
Zen CAFS
Zen TUV
Nad CAFS
Nad TUV
Tot CAFS
Tot TUV

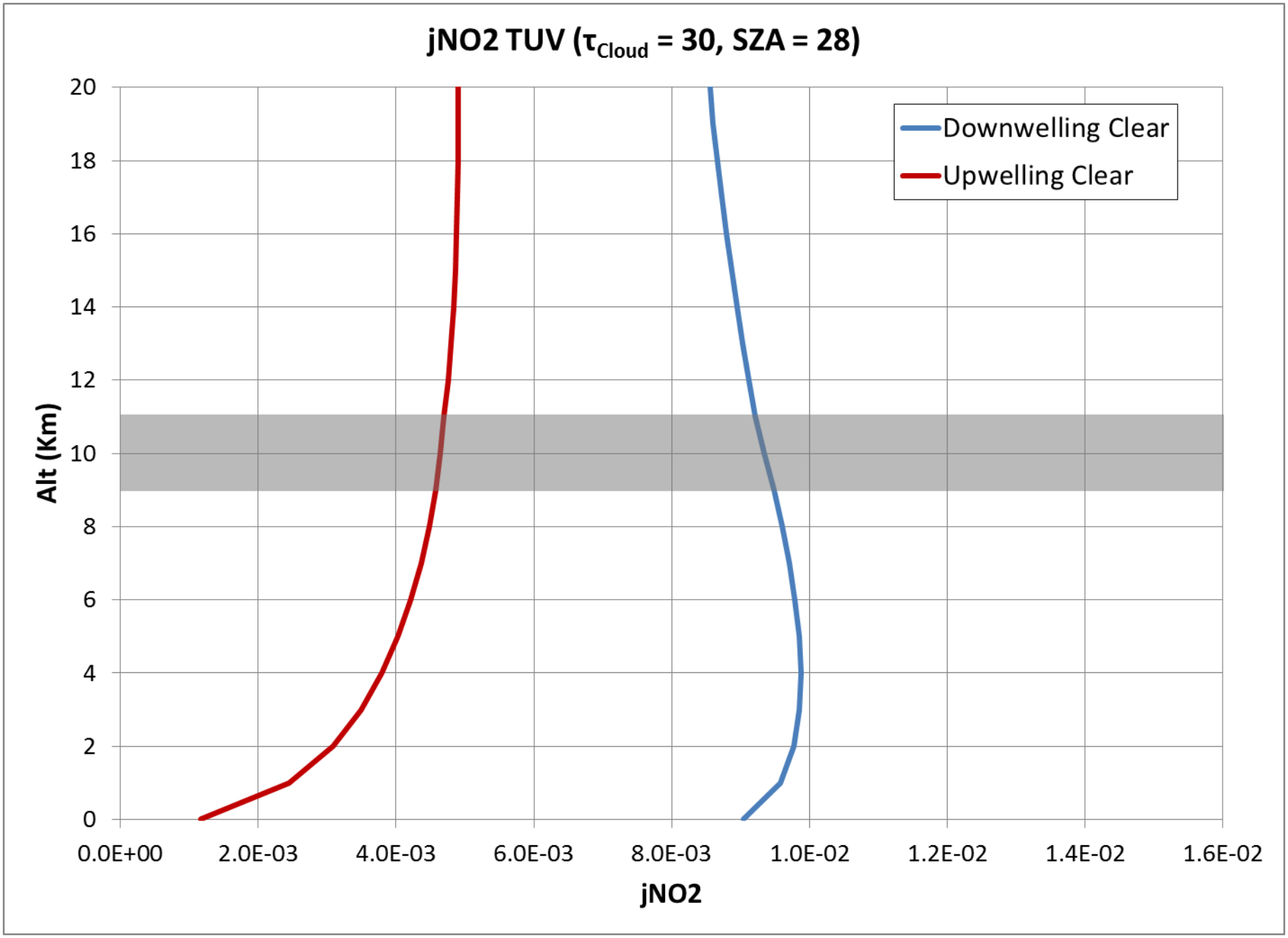
Near Cloud Top

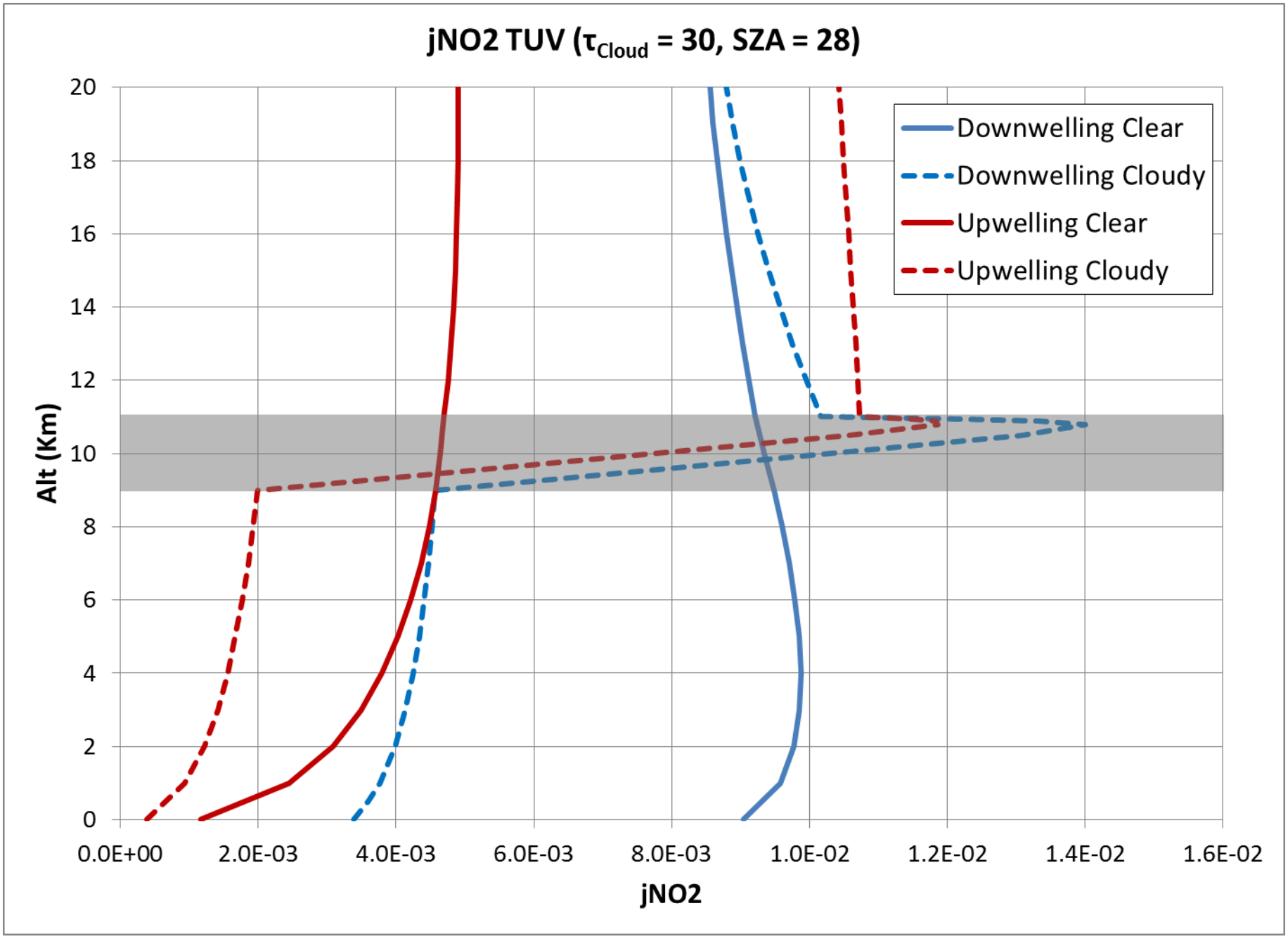


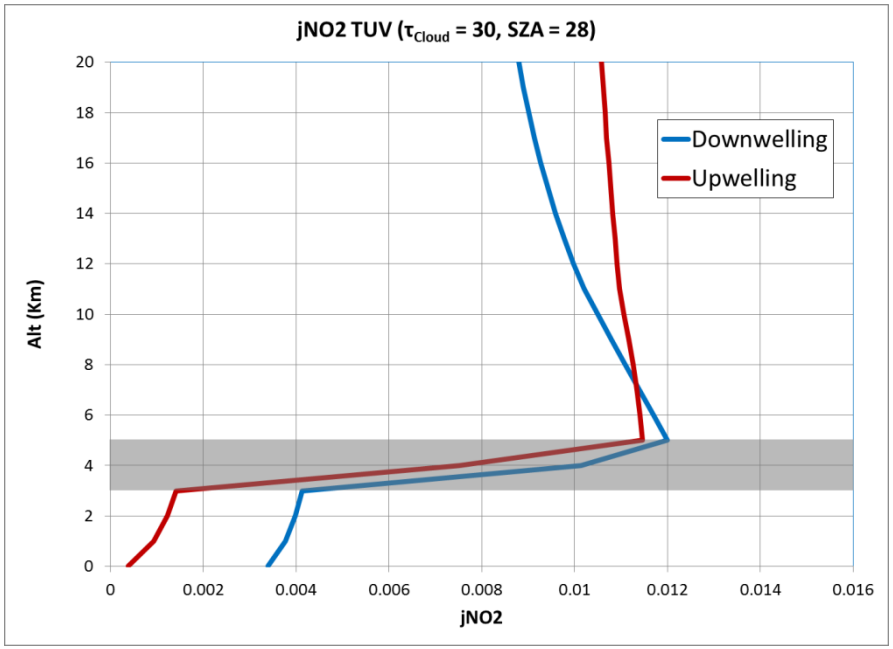
In-Cloud
Near Cloud Top

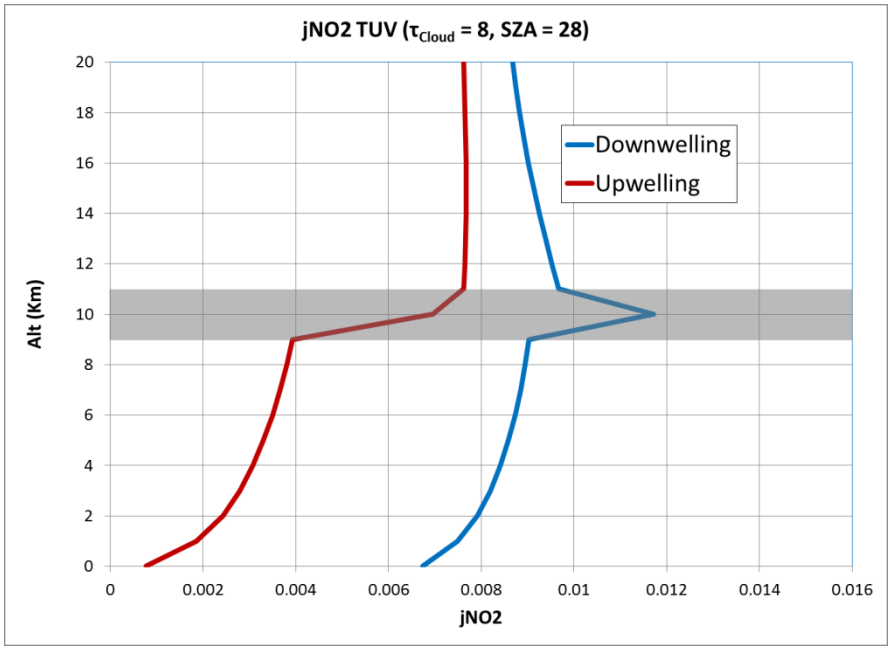


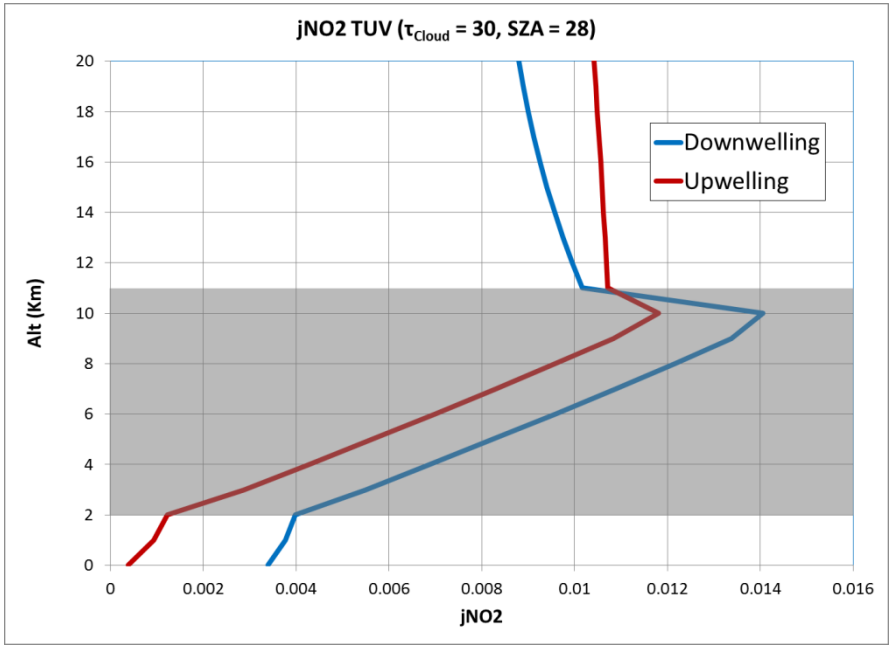

jNO2 TUV
Downwelling Clear
Upwelling Clear
Alt (Km)
0
2
4
6
8
10
12
14
16
18
20
0.0E+00
2.0E-03
4.0E-03
6.0E-03
8.0E-03
1.0E-02
1.2E-02
1.4E-02
1.6E-02
jNO2

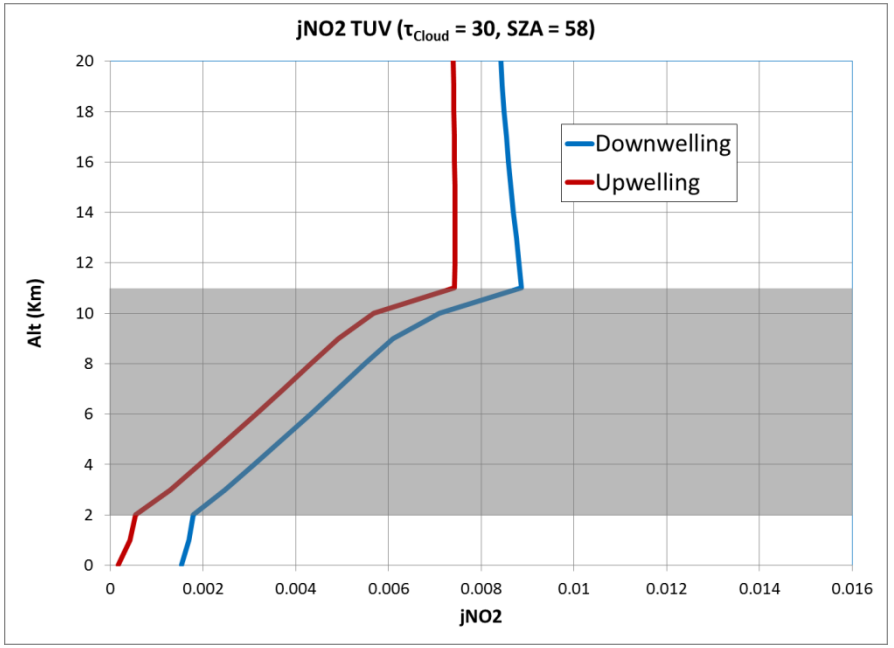

jNO2 TUV (τCloud = 30, SZA = 28)
Downwelling Clear
Upwelling Clear
Alt (Km)
0
2
4
6
8
10
12
14
16
18
20
0.0E+00
2.0E-03
4.0E-03
6.0E-03
8.0E-03
1.0E-02
1.2E-02
1.4E-02
1.6E-02
jNO2

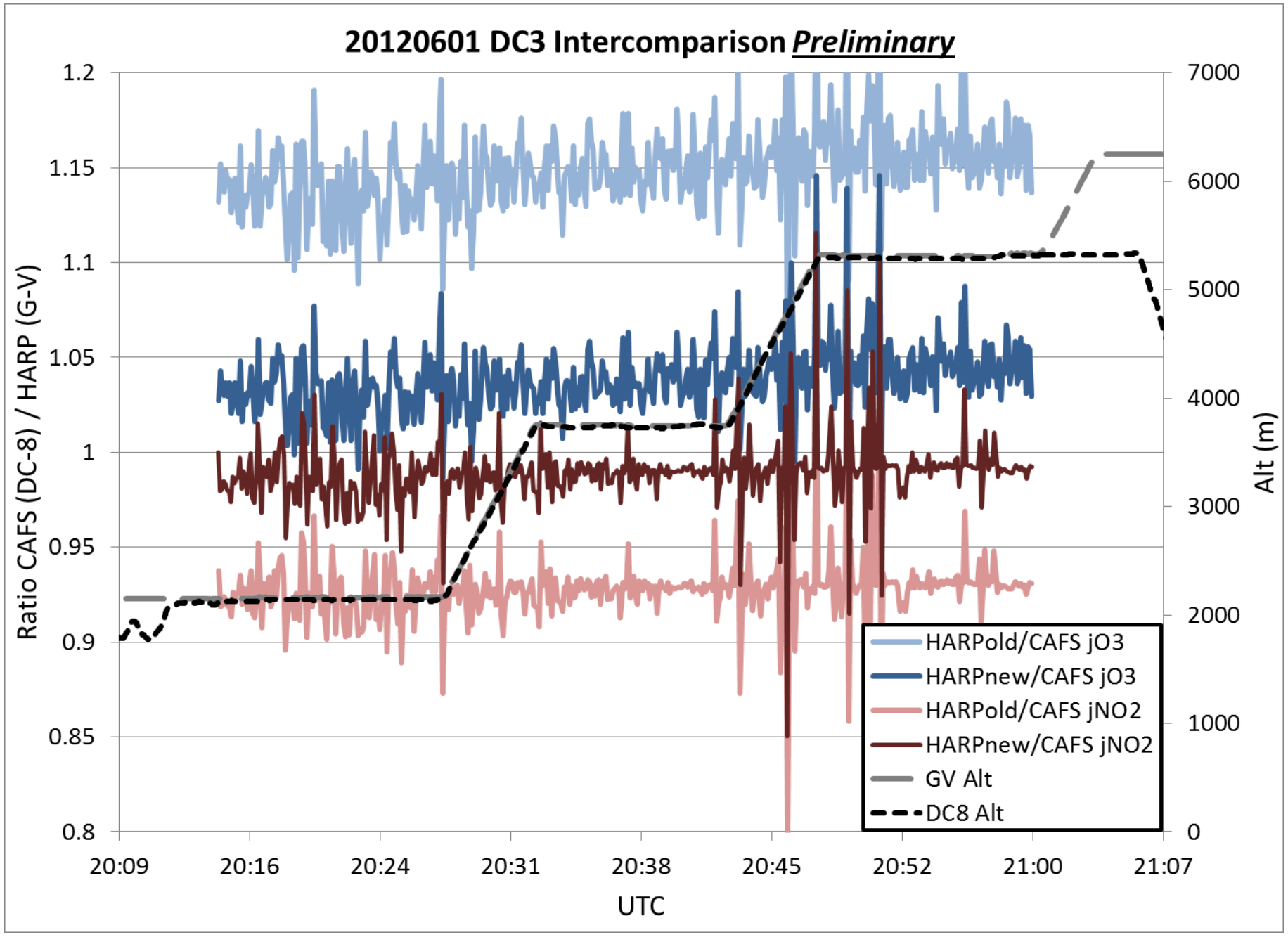

jNO2 TUV (τCloud = 30, SZA = 28)
Alt (Km)
jNO2
Downwelling Clear
Downwelling Cloudy
Upwelling Clear
Upwelling Cloudy
0
2
4
6
8
10
12
14
16
18
20
0.0E+00
2.0E-03
4.0E-03
6.0E-03
8.0E-03
1.0E-02
1.2E-02
1.4E-02
1.6E-02


jNO2 TUV (τCloud = 30, SZA = 28)
Alt (Km)
jNO2
Downwelling
Upwelling
0
2
4
6
8
10
12
14
16
18
20
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016

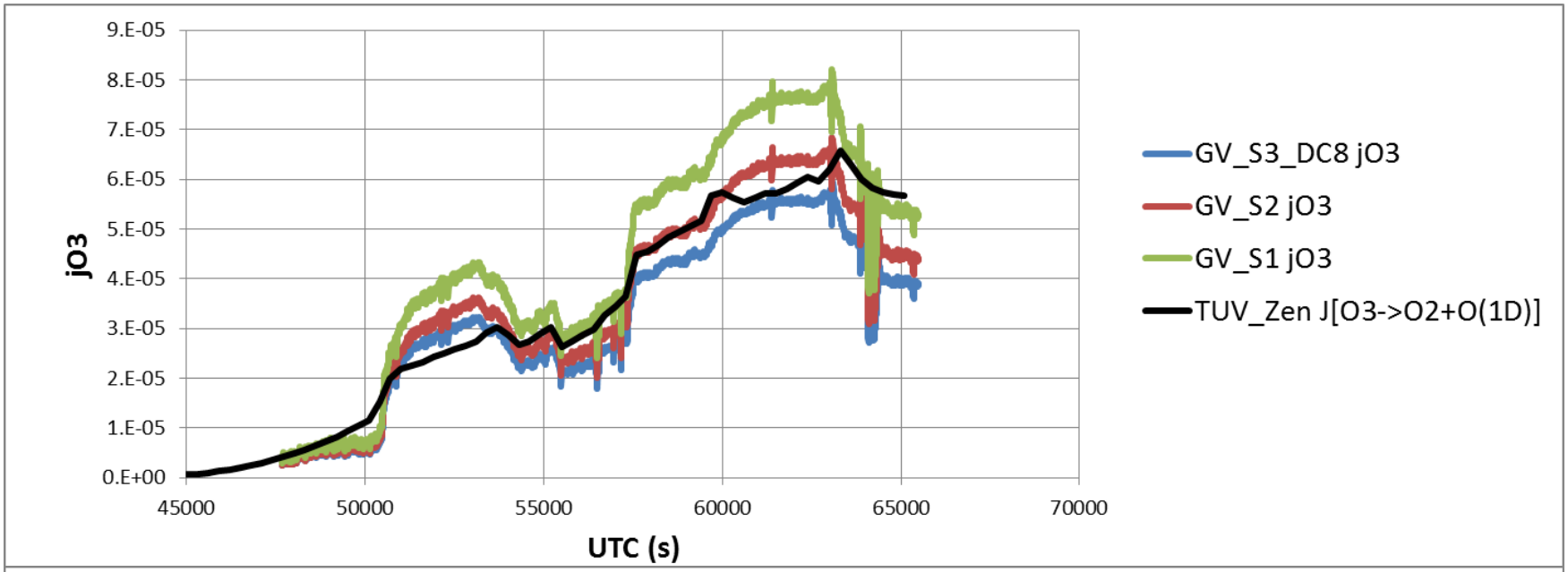

jNO2 TUV (τCloud = 8, SZA = 28)
Alt (Km)
jNO2
Downwelling
Upwelling
0
2
4
6
8
10
12
14
16
18
20
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016

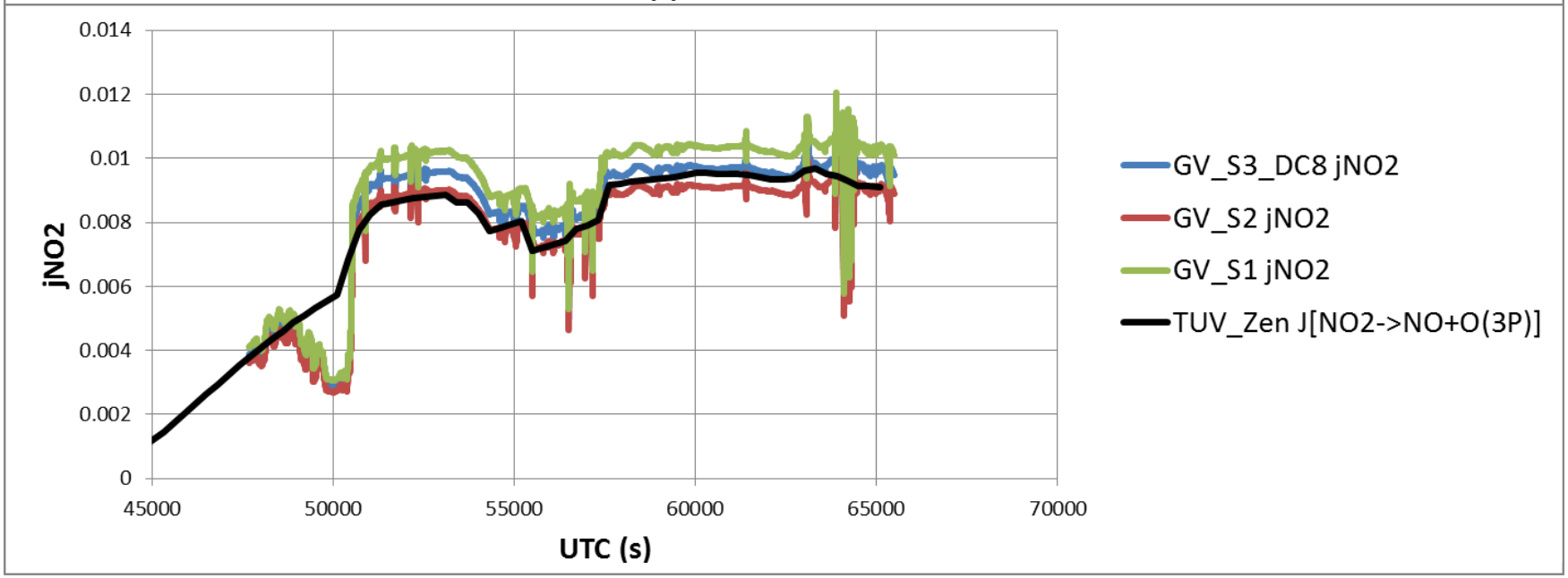

jNO2 TUV (τCloud = 30, SZA = 28)
Alt (Km)
jNO2
Downwelling
Upwelling
0
2
4
6
8
10
12
14
16
18
20
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016


jNO2 TUV (τCloud = 30, SZA = 58)
Alt (Km)
jNO2
Downwelling
Upwelling
0
2
4
6
8
10
12
14
16
18
20
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016

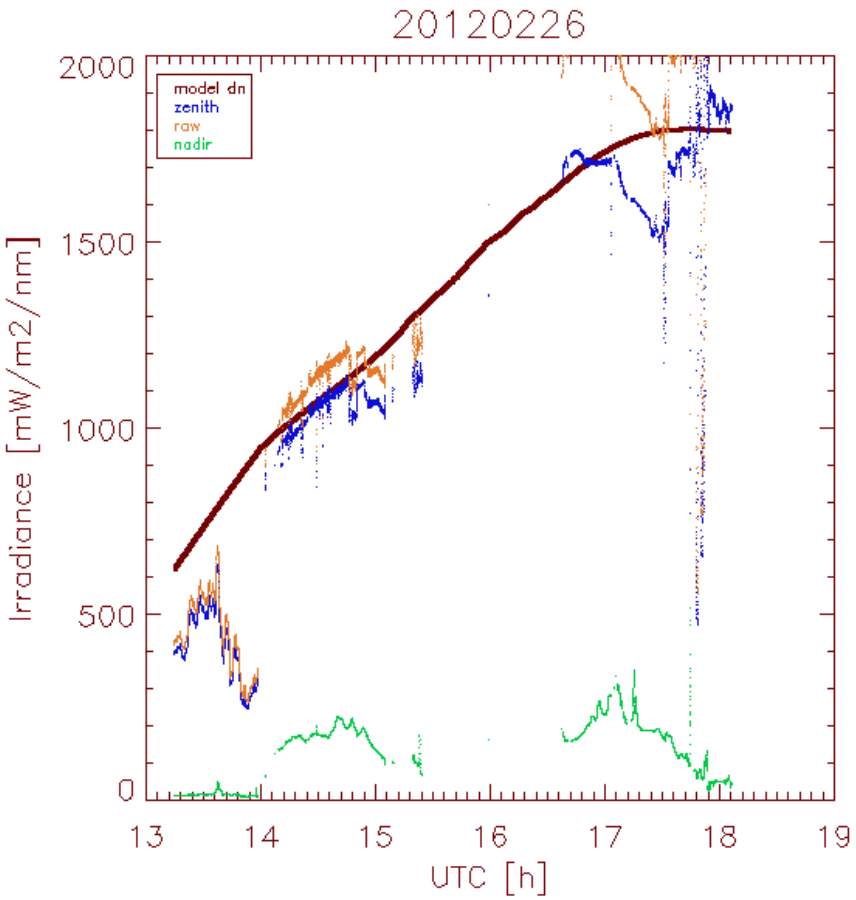

20120601 DC3 Intercomparison Preliminary
Ratio CAFS (DC-8) / HARP (G-V)
Alt (m)
UTC
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
7000
6000
5000
4000
3000
2000
1000
0
20:09
20:16
20:24
20:31
20:38
20:45
20:52
21:00
21:07
HARPold/CAFS jO3
HARPnew/CAFS jO3
HARPold/CAFS jNO2
HARPnew/CAFS jNO2
GV Alt
DC8 Alt

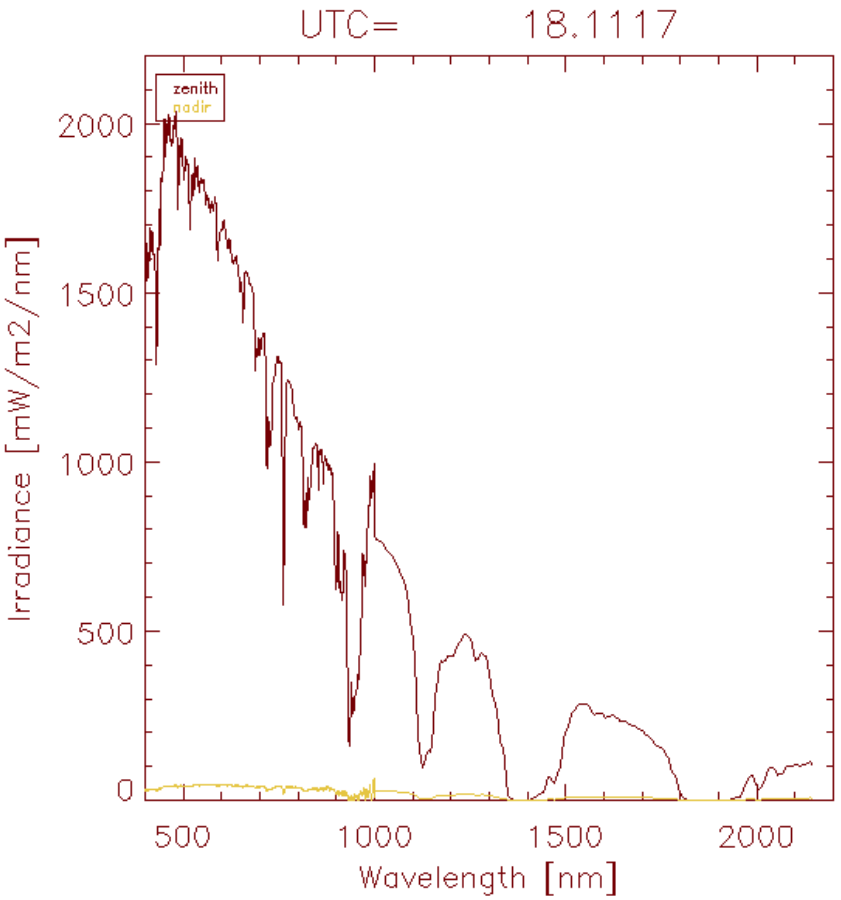
20120226

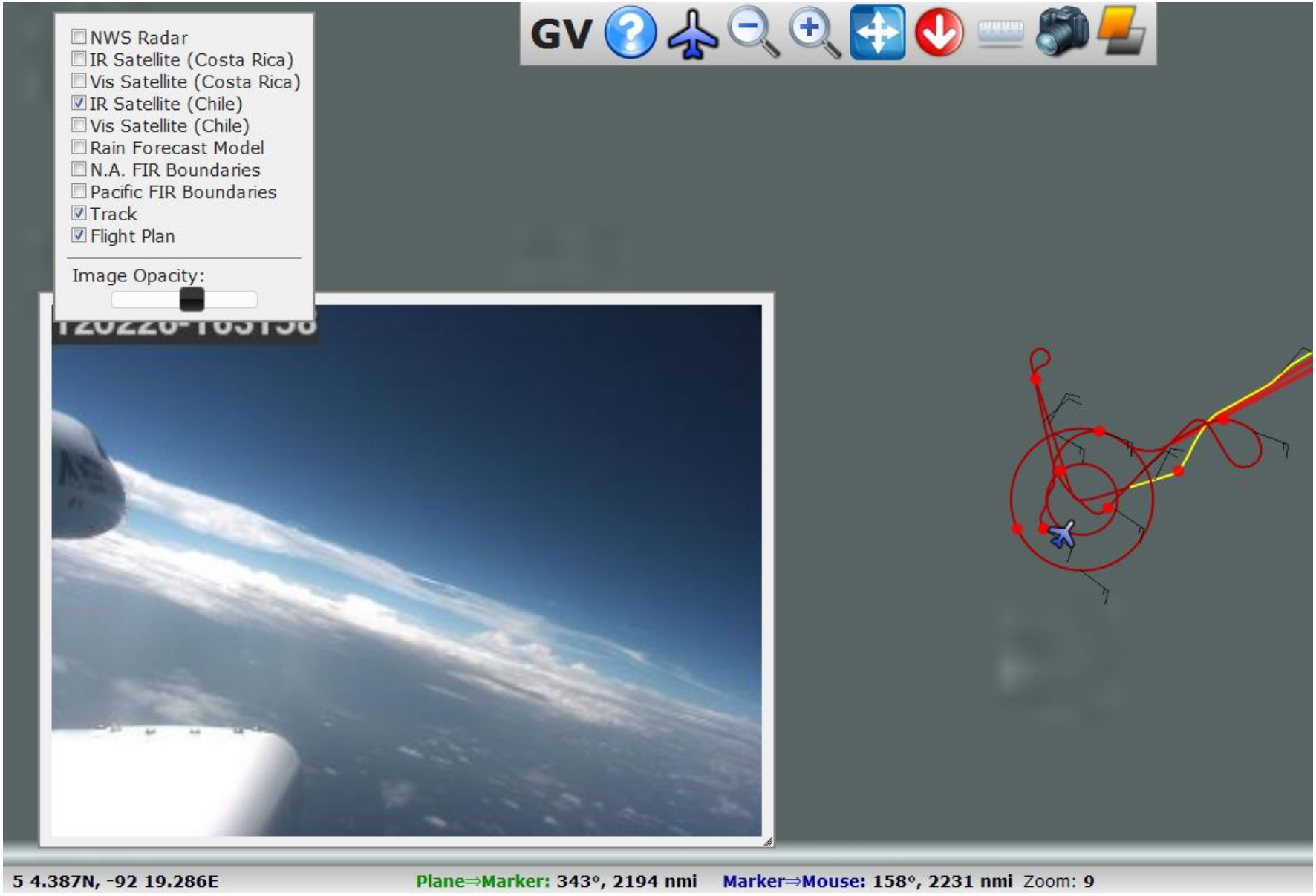

9.E-05
8.E-05
7.E-05
6.E-05
5.E-05
4.E-05
3.E-05
2.E-05
1.E-05
0.E+00
jO3
45000
50000
55000
60000
65000
70000
UTC (s)
GV_S3_DC8 jO3
GV_S2 jO3
GV_S1 jO3
TUV_Zen J[O3->O2+O(1D)]


0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
jNO2
45000
50000
55000
60000
65000
70000
UTC (s)
GV_S3_DC8 jNO2
GV_S2 jNO2
GV_S1 jNO2
TUV_Zen J[NO2->NO+O(3P)]

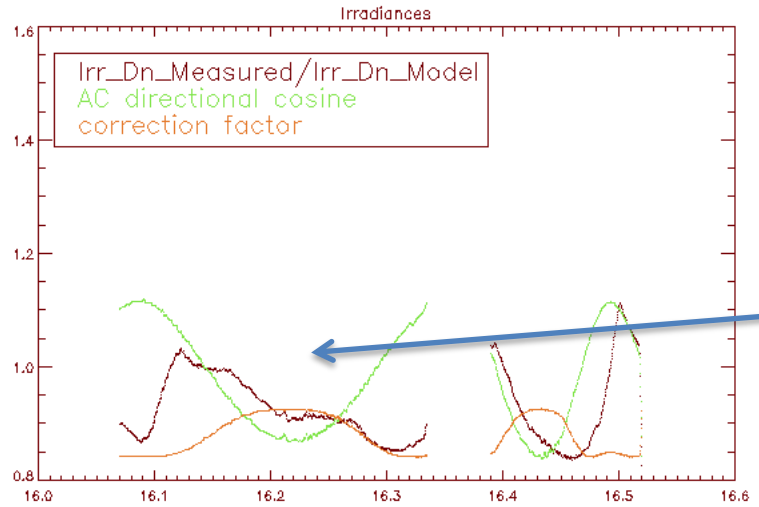
Sebastian Schmidt, 5/15/2012
Remote sensing flight 2/26

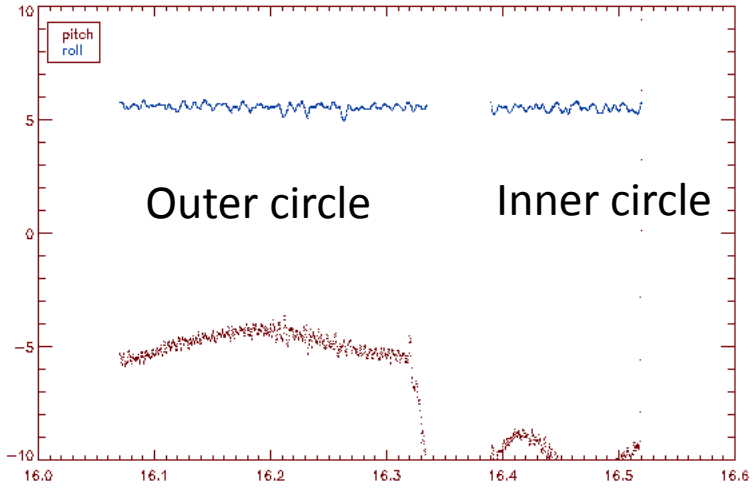





GV
NWS Radar
IR Satellite (Costa Rica)
Vis Satellite (Costa Rica)
IR Satellite (Chile)
Vis Satellite (Chile)
Rain Forecast Model
N.A. FIR Boundaries
Pacific FIR Boundaries
Track
Flight Plan
Image Opacity:
5 4.387N, -92 19.286E
Plane⇒Marker: 343°, 2194 nmi
Marker⇒Mouse: 158°, 2231 nmi
Zoom: 9

Circle maneuver 2/26 for HARP

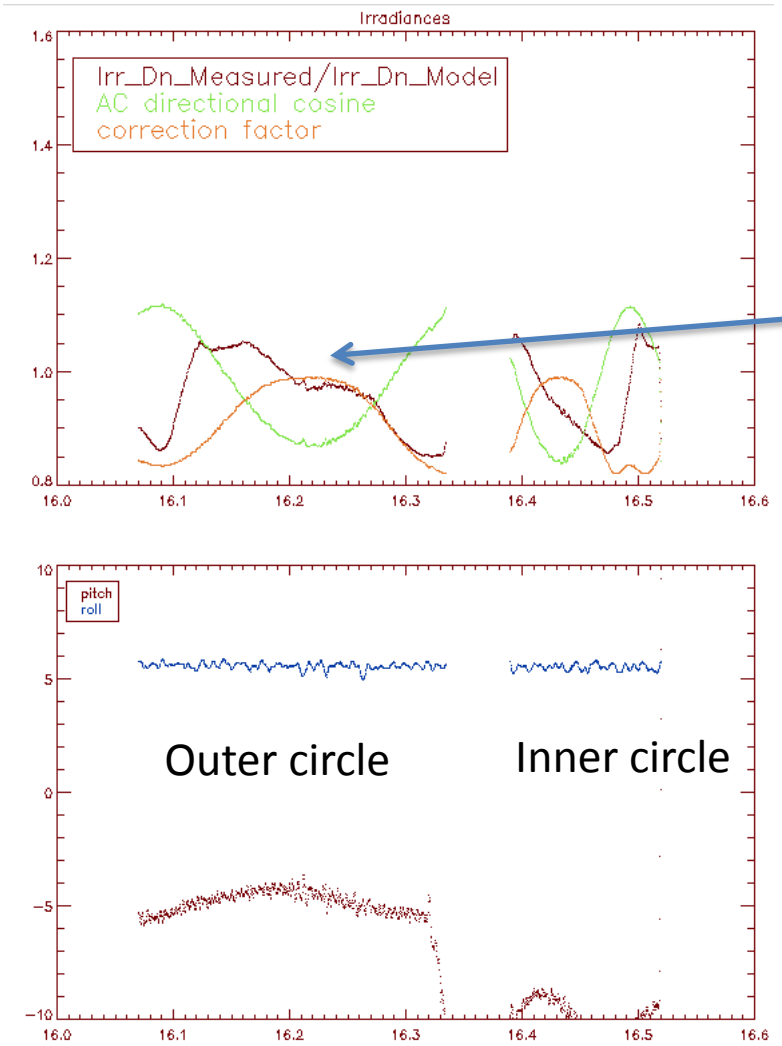




We can probably use the second half of this circle (outer) which is unaffected by the neighboring cloud!

The brown line should be near 1 after all corrections are applied properly.

Circle maneuver 2/26 for HARP

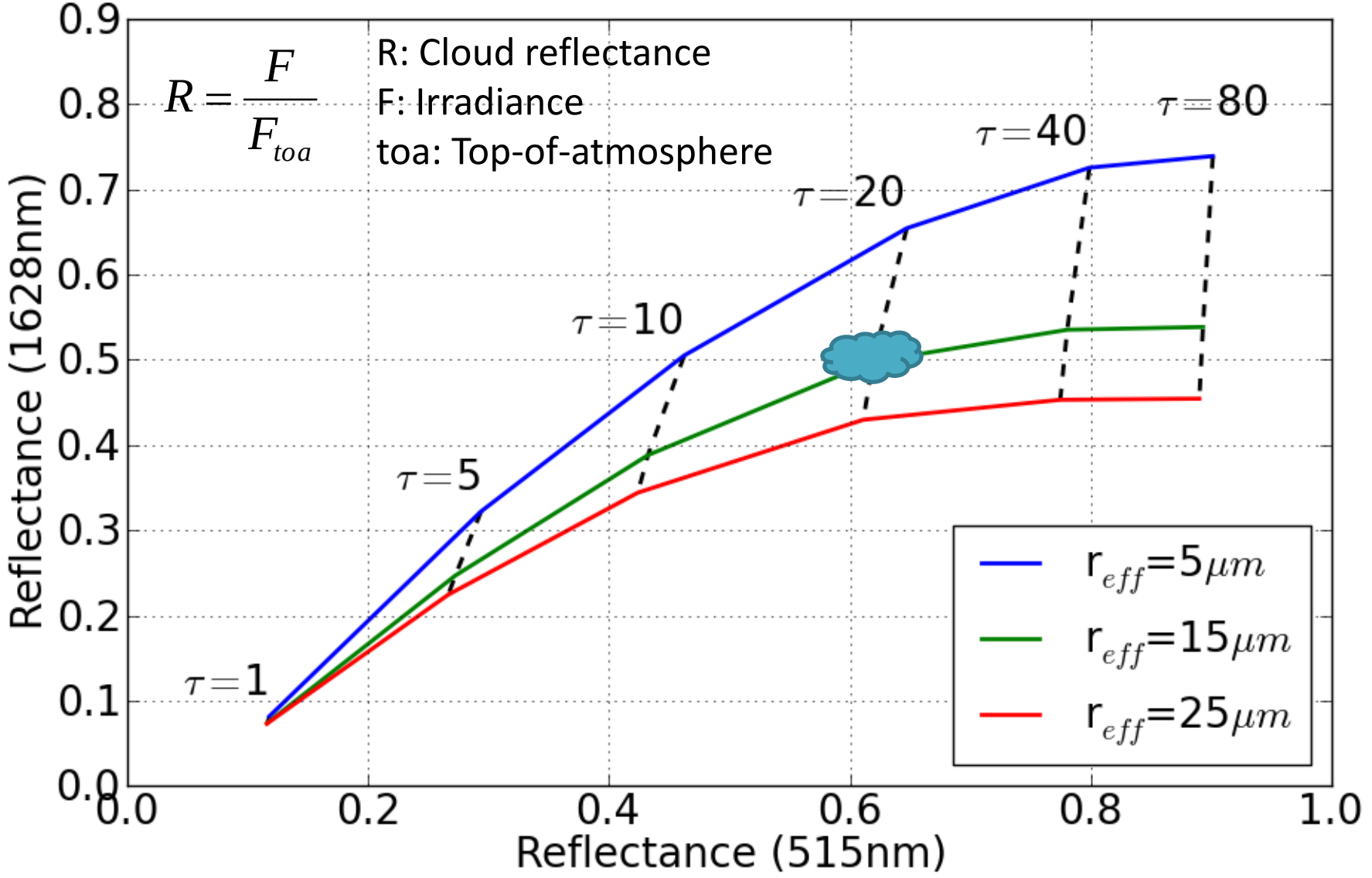


We can probably use the second half of this circle (outer) which is unaffected by the neighboring cloud!

The brown line should be near 1 after all corrections are applied properly.

Cloud Reflectance Retrievals

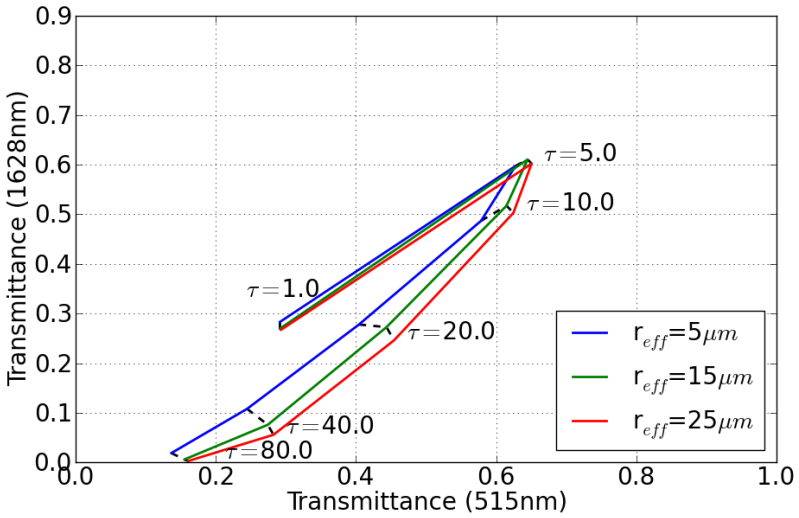
This will still work for TORERO (but need to modify to work with reflected irradiance).

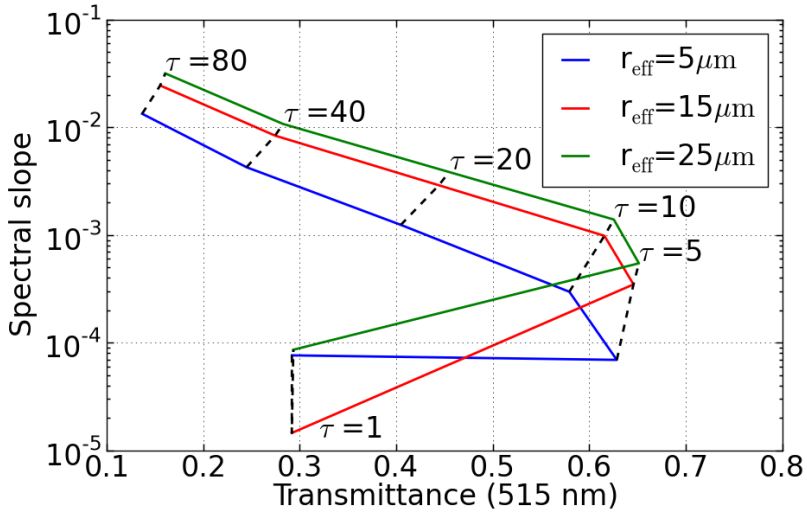


Cloud Transmittance Retrievals

With spectral slopes, get independence from radiometric calibration and rely on spectral information. So far, have implemented *transmittance-slope* technique. This will not work for TORERO, need *slope-slope* method.

Question: How sensitive is it to *thin* clouds?





McBride et al., 2011

Summary (irradiance)

• No (or very minimal) data for ferry flight or RF01-RF04 due to failure of stabilized platform. Near complete coverage for remaining flights on fixed platform

• Circles + Sam's/Kirk's cosine response measurements improved HARP data analysis.

• Can still use HARP data for cloud retrievals, by relying on spectral techniques (and absolute techniques for tau>5). Need to see how this works for thin clouds (use information content analysis).

• Cannot derive aerosol products. Must rely on other data for atmospheric correction and ocean color products.