Aerosol Optical Depths from Airborne Sunphotometry in INTEX-B/MILAGRO

as a Validation Tool for the Ozone Monitoring Instrument (OMI) on Aura

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[4]NASA Goddard, Greenbelt, MD
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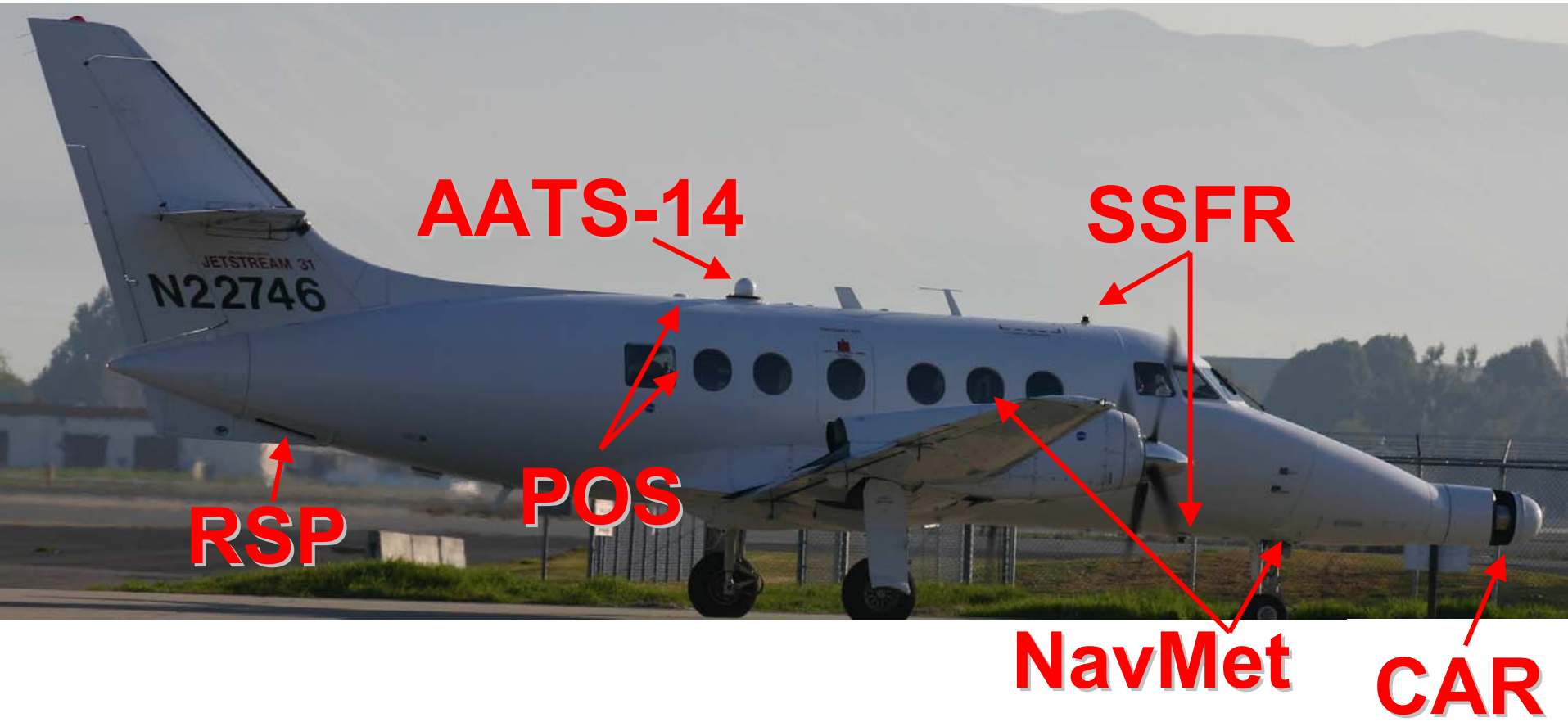
[6]U. Hawaii, HI

Aura Validation & Science Team Meeting
Boulder, CO
Sep 2006

J31 in INTEX-B/MILAGRO: Instrument Locations



14-channel Ames Airborne Tracking Sunphotometer (AATS-14)

Measures: Solar direct-beam transmission, T, at 14 wavelengths, λ=353-2139 nm

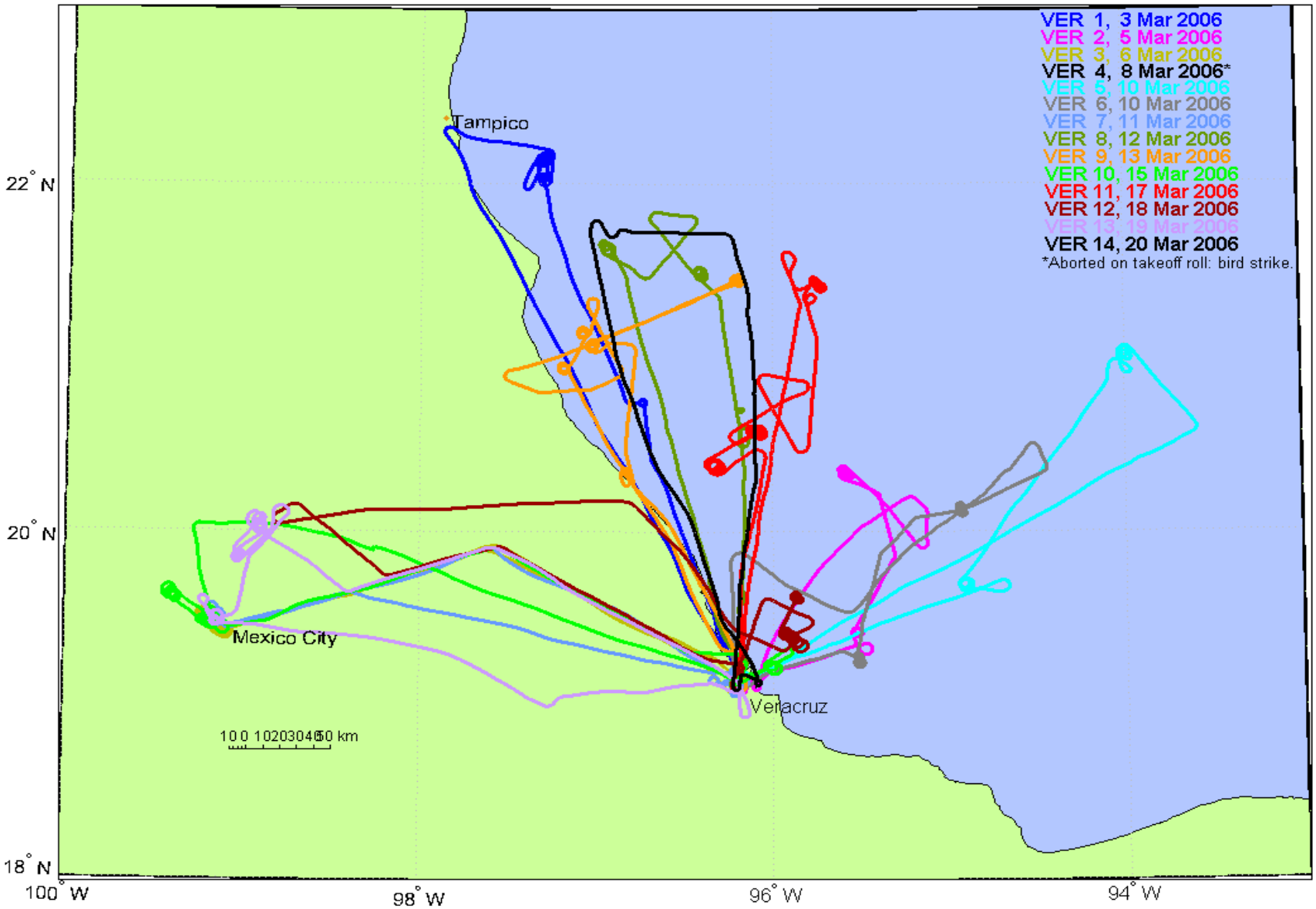
Data products

- Aerosol optical depth (AOD) at 13 λ, 353-2139 nm
- Water vapor column content [using T(940 nm)]
- Aerosol extinction, 340-2139 nm
- Water vapor density

} When A/C flies vertical profiles

INTEX-B/MILAGRO

J31 made 13 science flights out of Veracruz to Mexico City and over Gulf of Mexico



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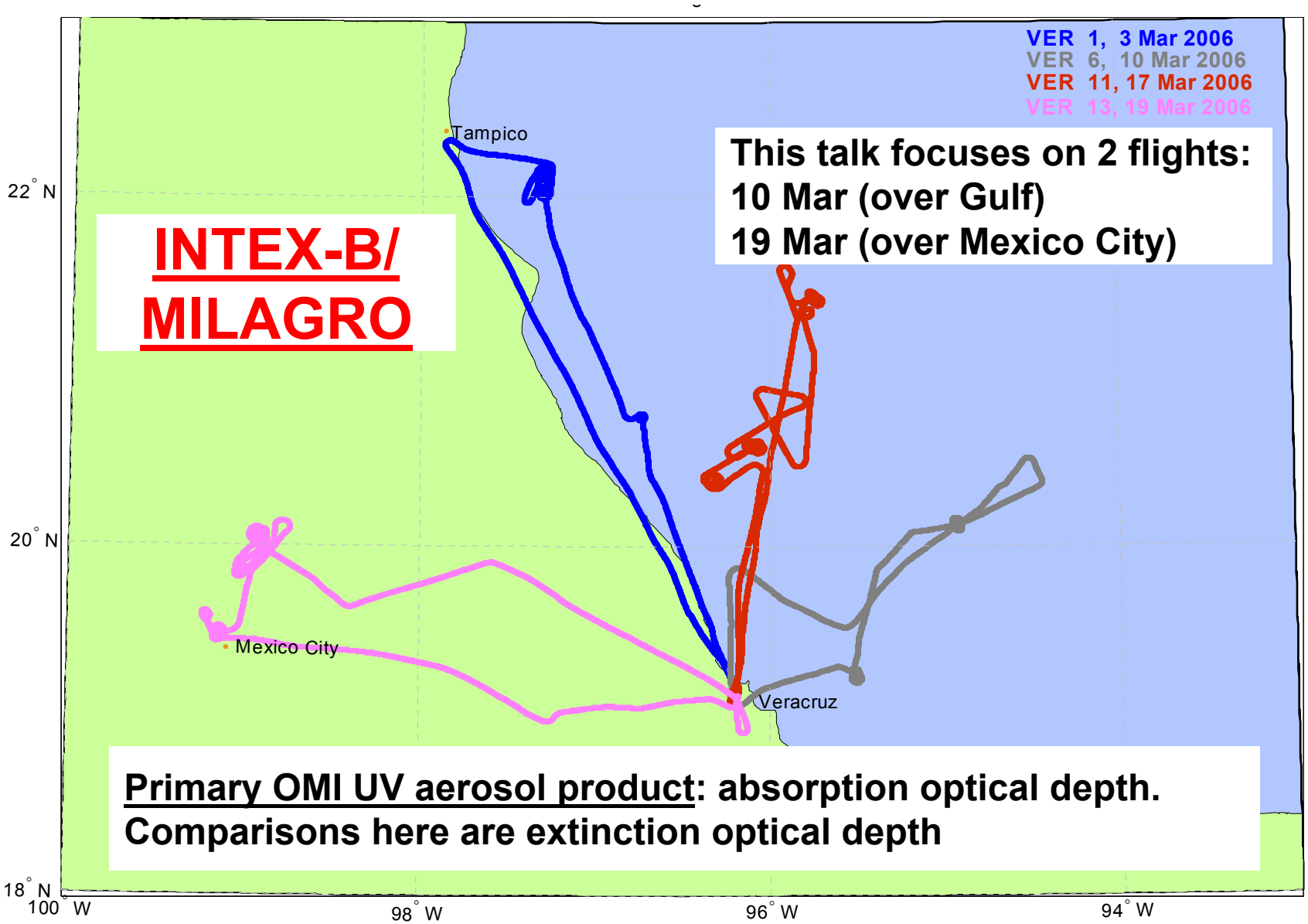
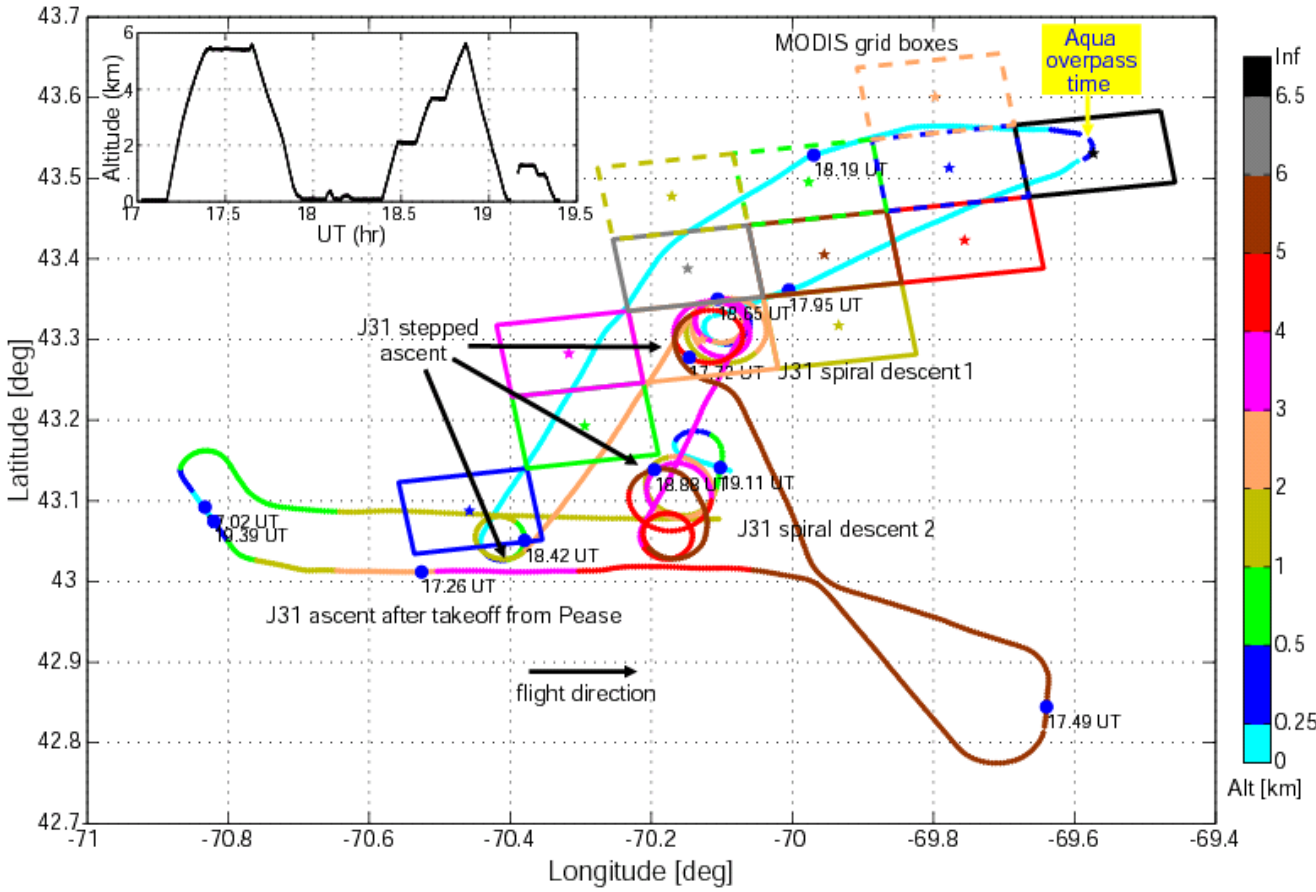
4 J31 flights have AOD data coincident or near-coincident with OMI-UV AOD data



Goal: Compare Aerosol Optical Depth (AOD) from AATS Measurements and OMI Retrievals

Background Example:

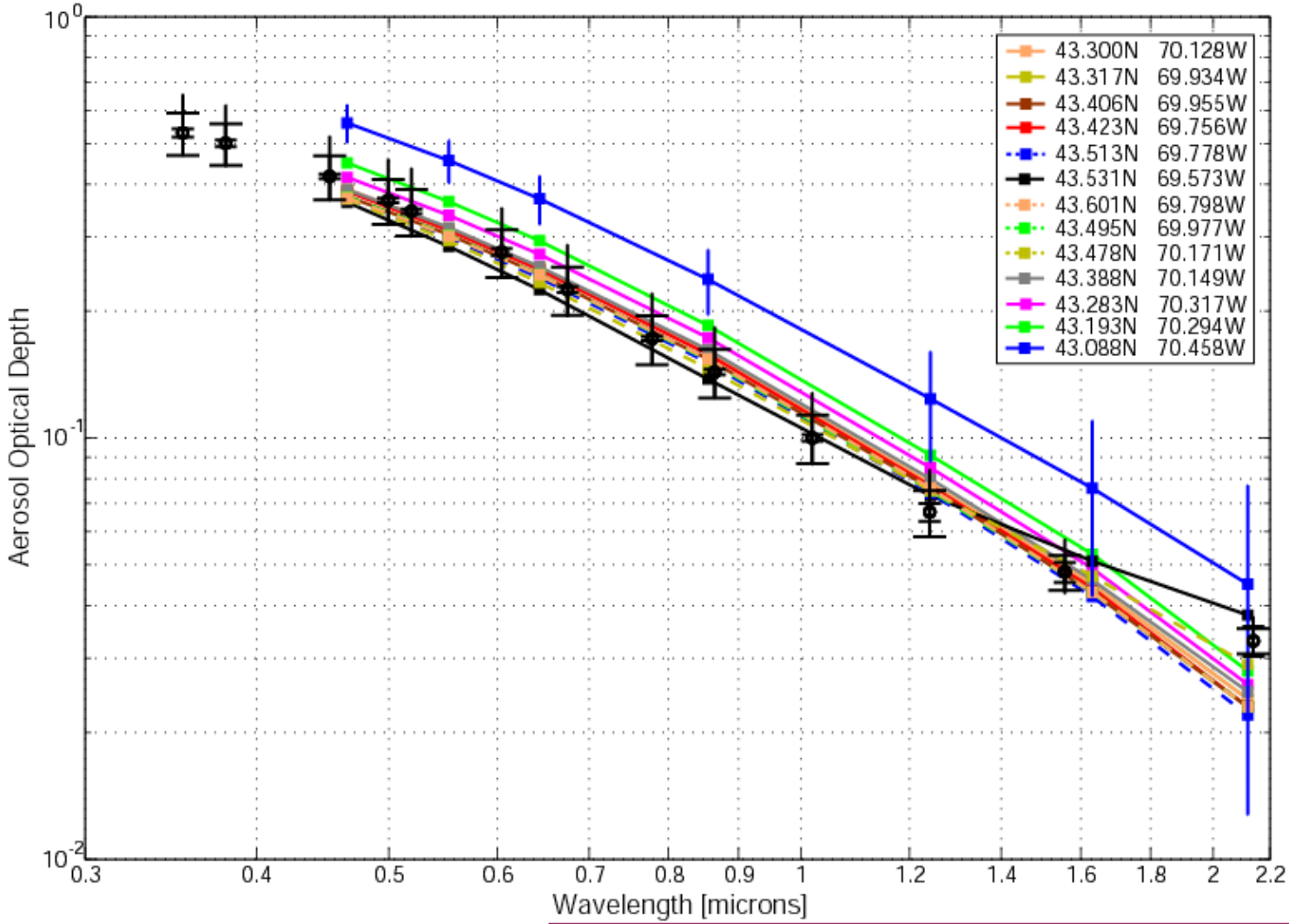
MODIS-Aqua AOD Cells, with J31 flight track from INTEX-A superimposed



Russell et al., *JGR*, in review, 2006

Background Example:

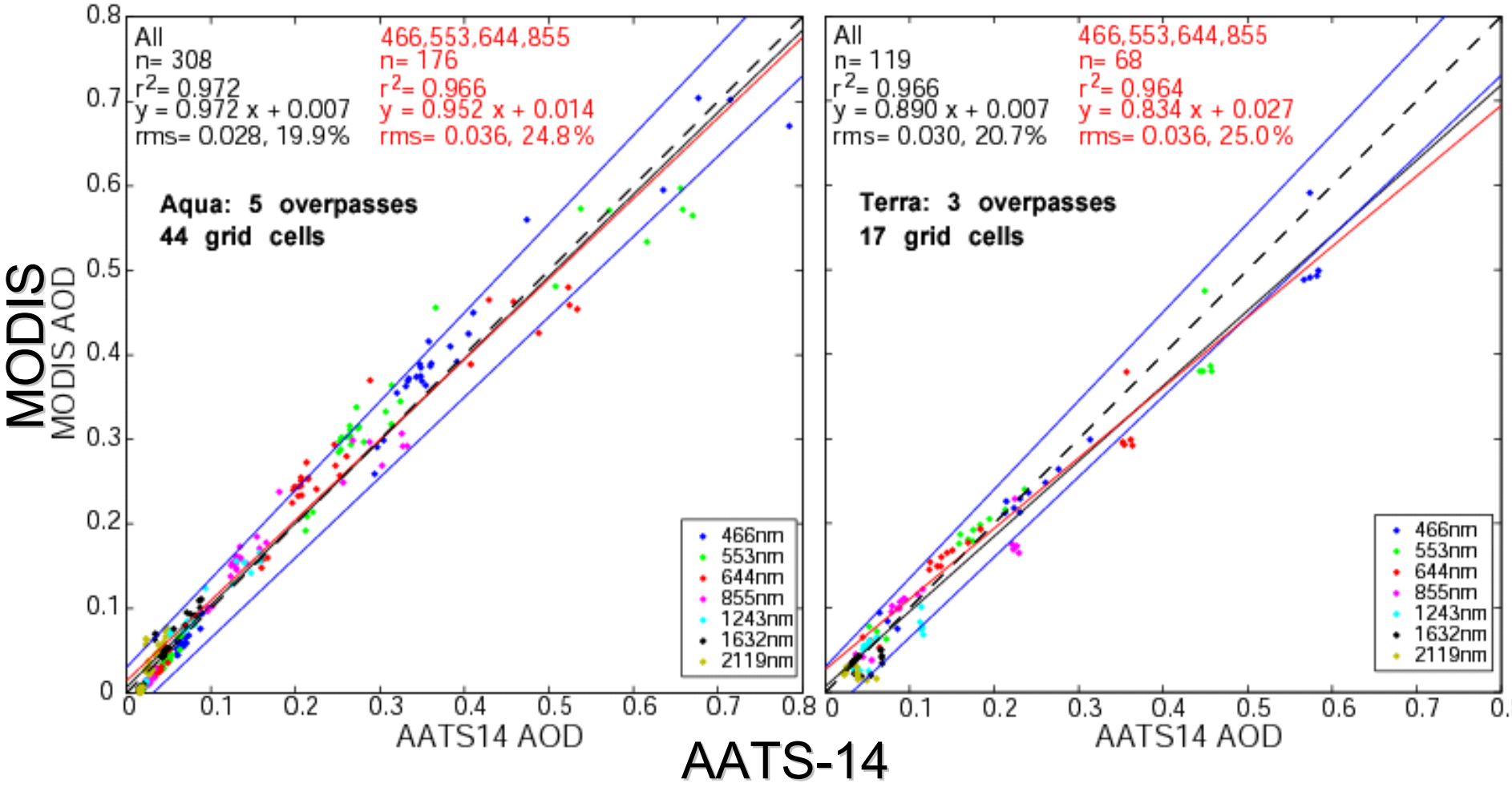
Comparison of Aerosol Optical Depth (AOD) from MODIS-Aqua and AATS-14 in INTEX-A



Russell et al., *JGR*, in review, 2006

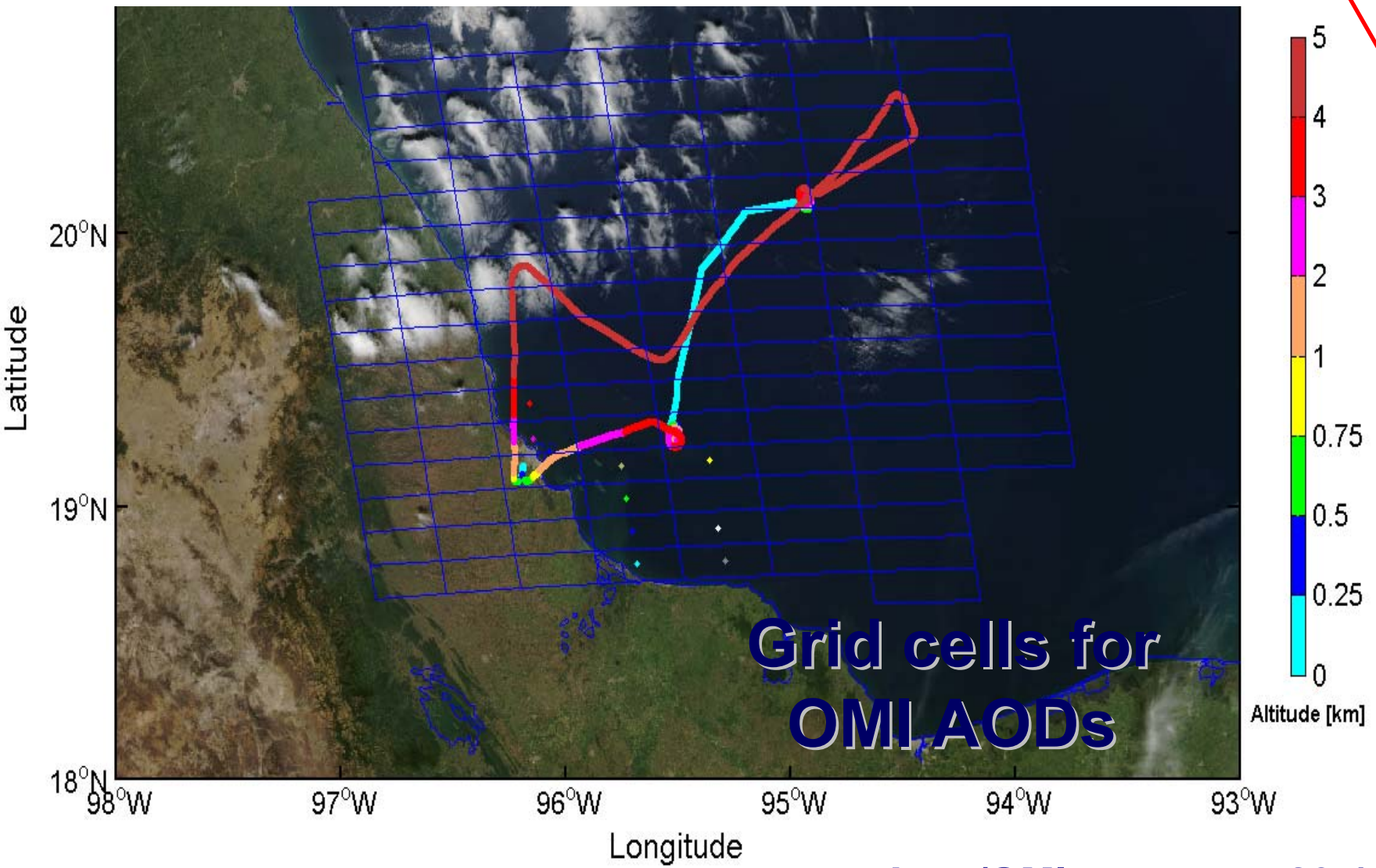
Background Example:

Comparisons of Aerosol Optical Depth (AOD) from MODIS-Terra &-Alpha with AATS-14 in INTEX-A



Russell et al., *JGR*, in review, 2006

INTEX-B: 10 Mar 2006 J31 flight track on MODIS-Aqua true-color image, ~19:57 UT

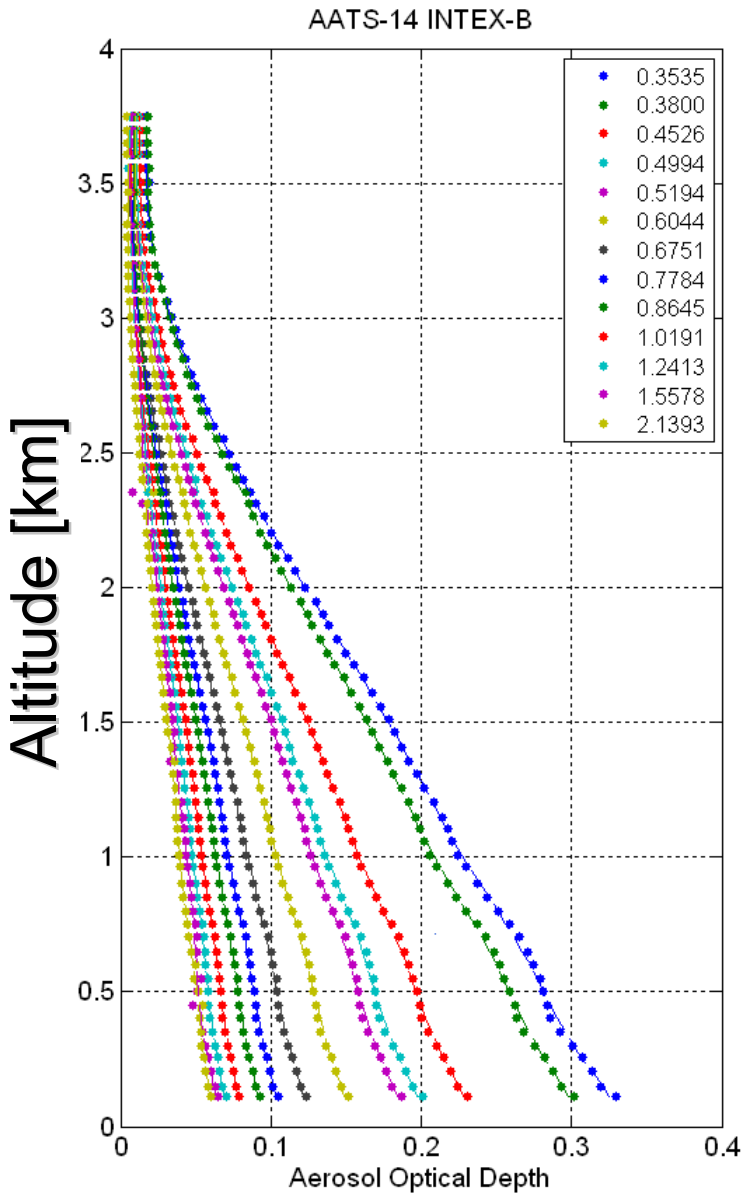


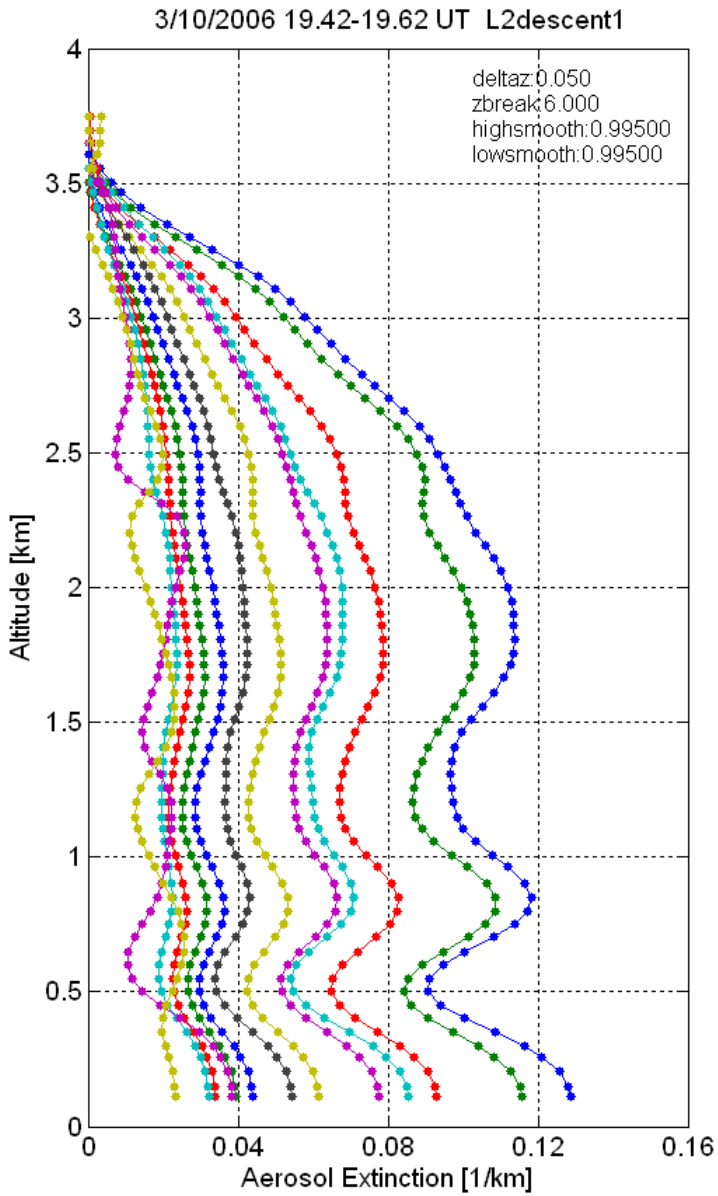
A-Train, ~15 minutes

Aura/OMI overpass: 20:13 UT

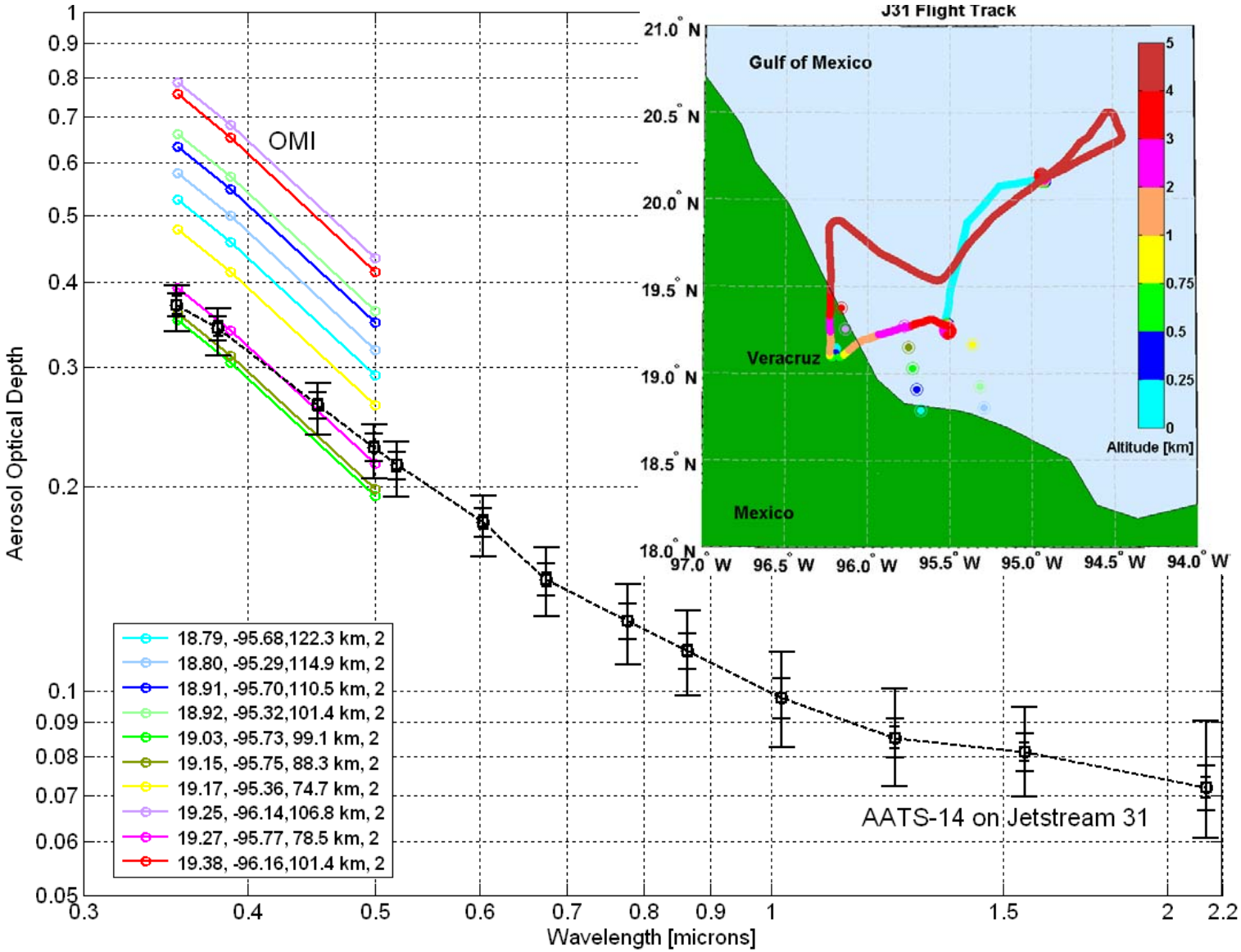
Livingston/Russell, Aura ST, Boulder, Sep 2006

J31/AATS Profiles Show Altitudes of Extinction Layers



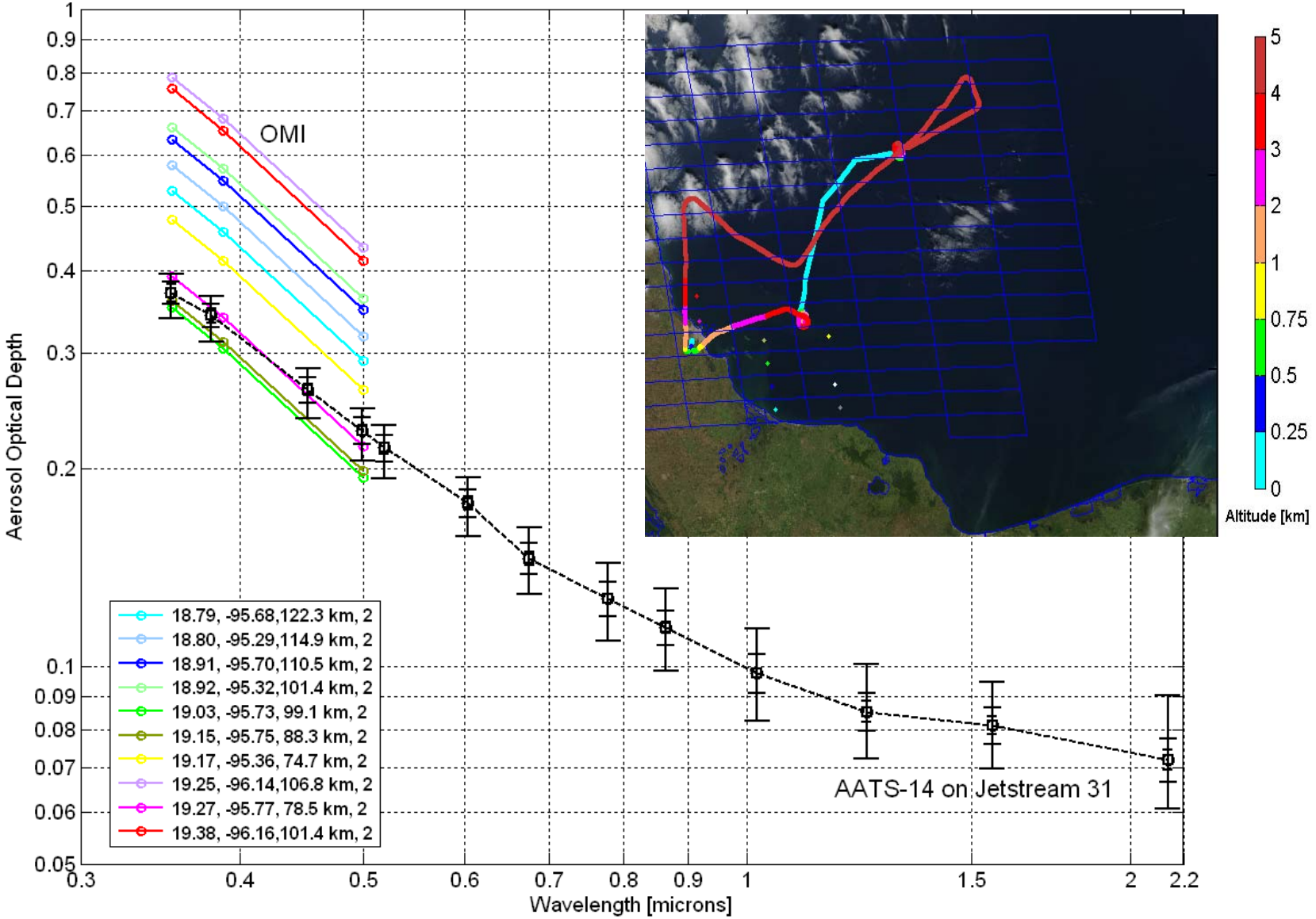


Comparison of AOD spectra from AATS & OMI
10 Mar 2006



Livingston/Russell, Aura ST, Boulder, Sep 2006

Comparison of AOD spectra from AATS & OMI
10 Mar 2006



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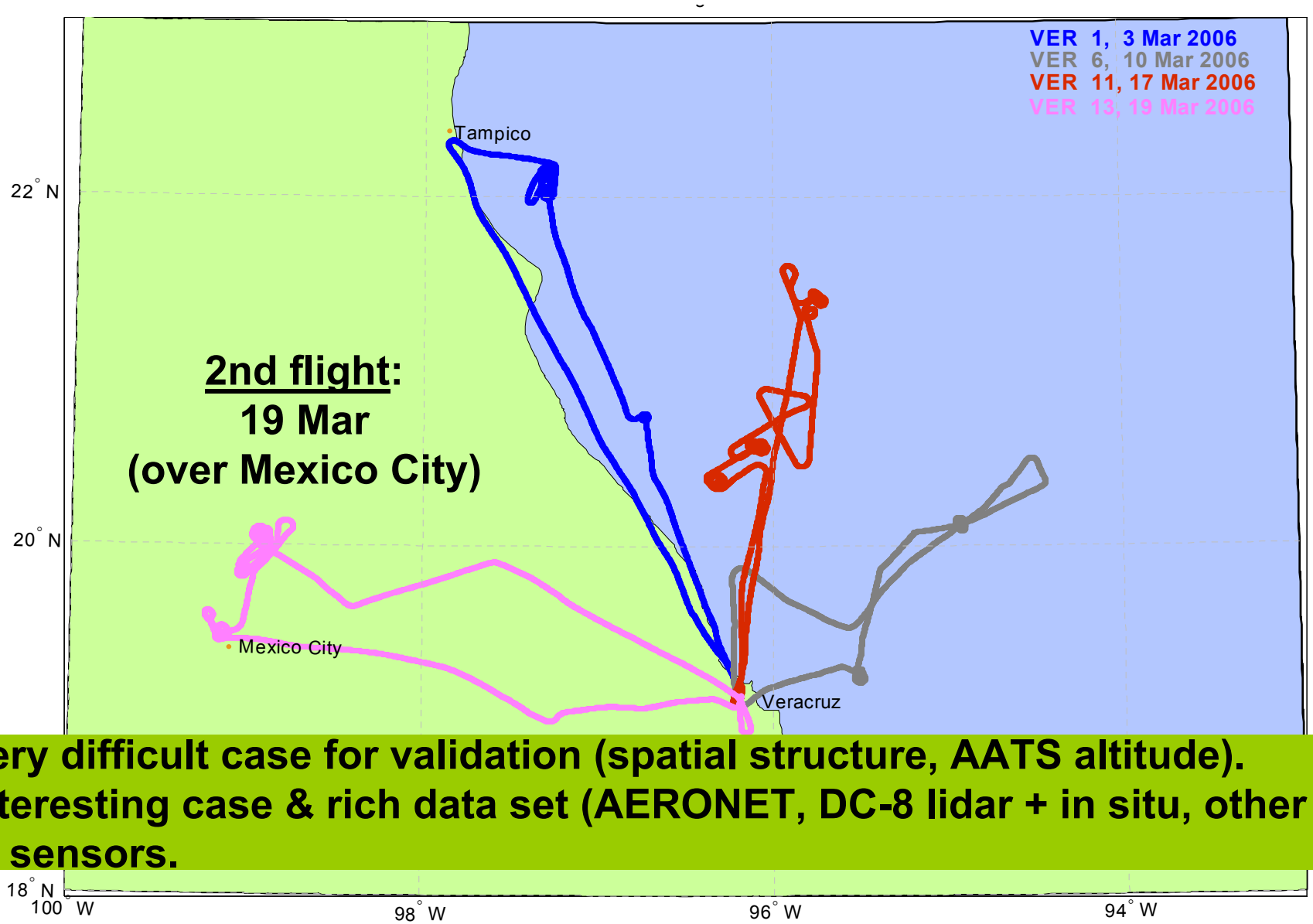
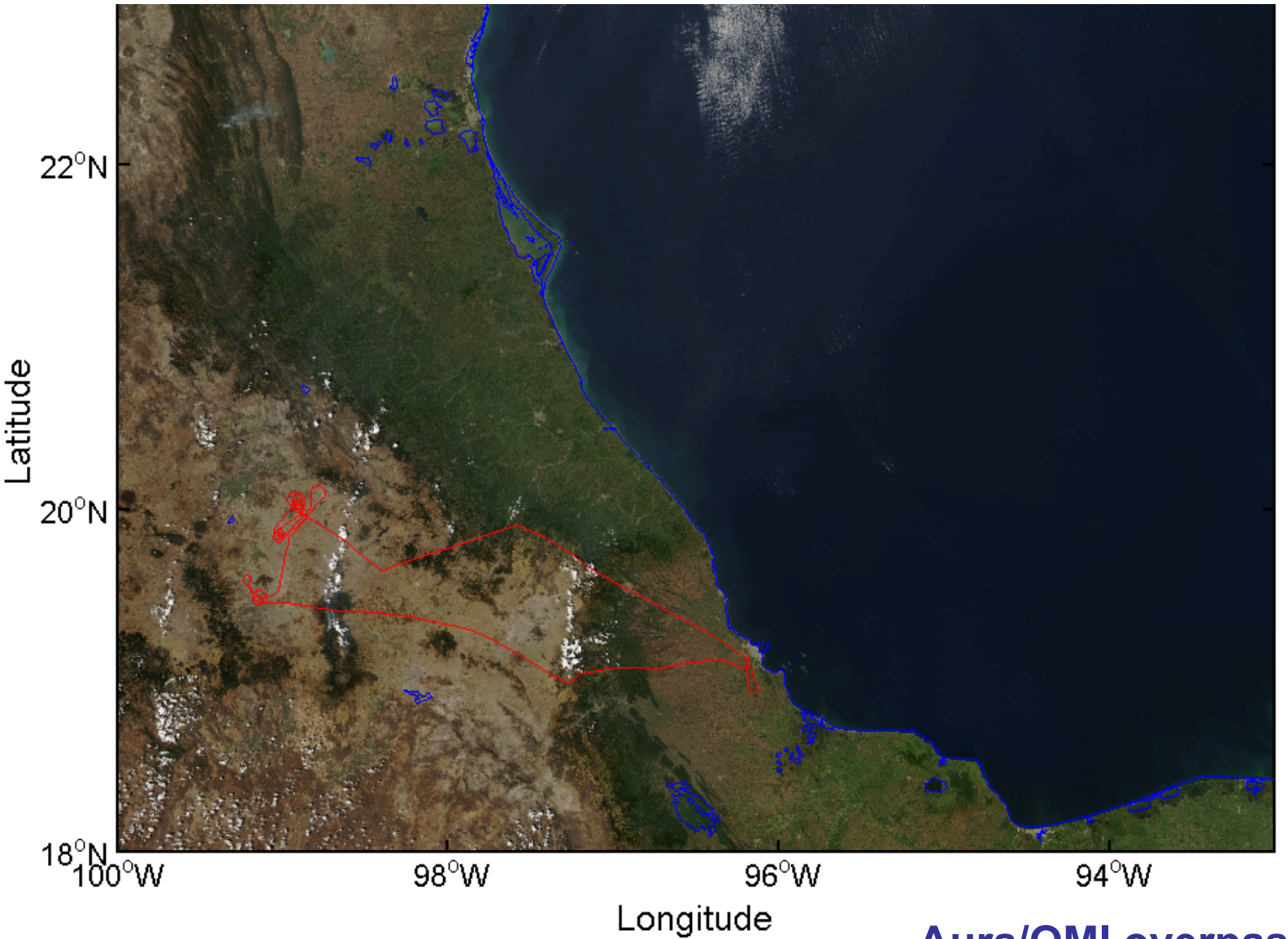


- **Very difficult case for validation (spatial structure, AATS altitude).**
- **Interesting case & rich data set (AERONET, DC-8 lidar + in situ, other J31 sensors.**

19 Mar 2006 J31 flight track on MODIS-Aqua true-color image, ~19:52 UT



A-Train, ~15 minutes

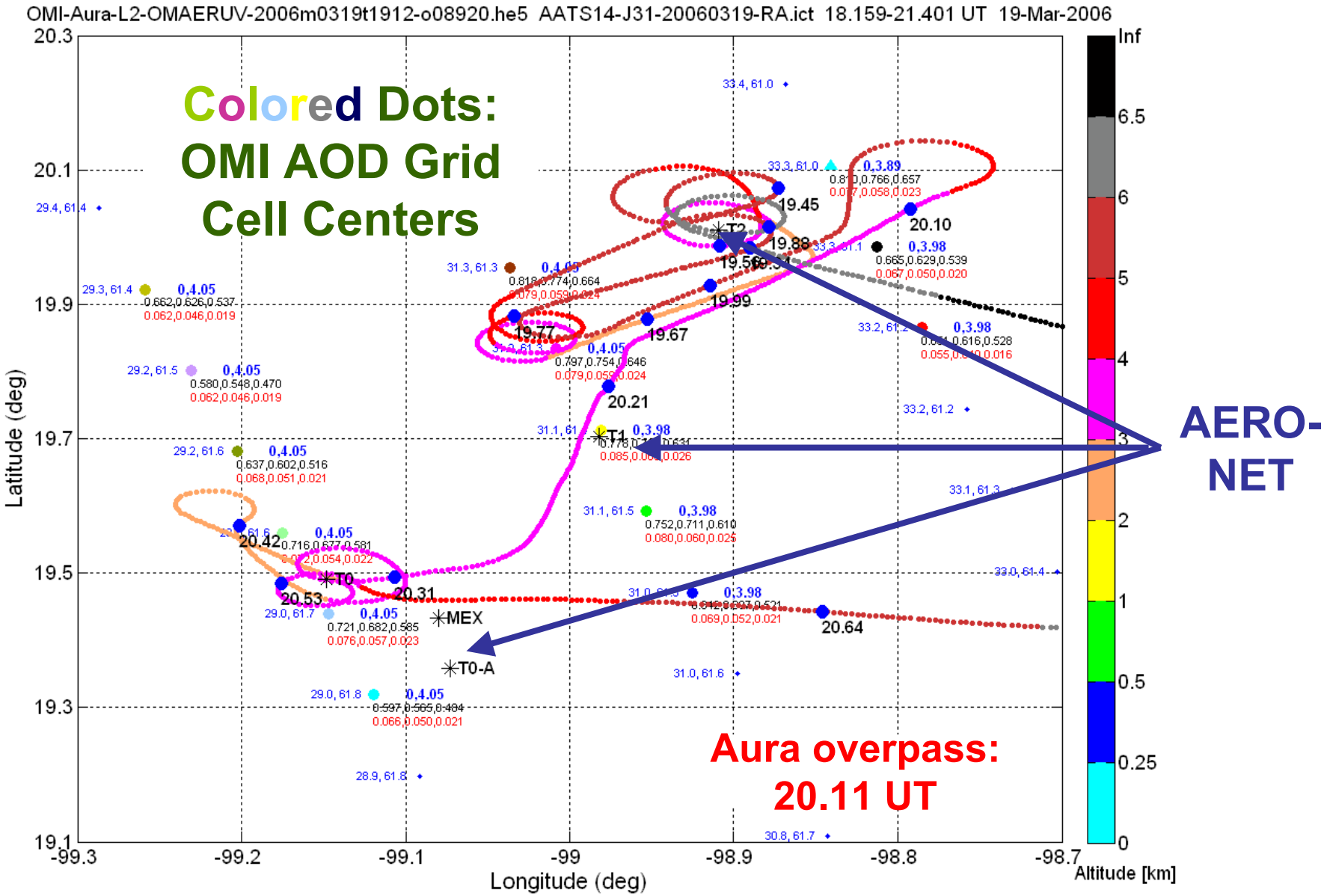
Aura/OMI overpass: 20:07 UT

Livingston/Russell, Aura ST, Boulder, Sep 2006

Photo from DC-8 over Mexico City, 19 Mar 2006

Courtesy of Cam McNaughton

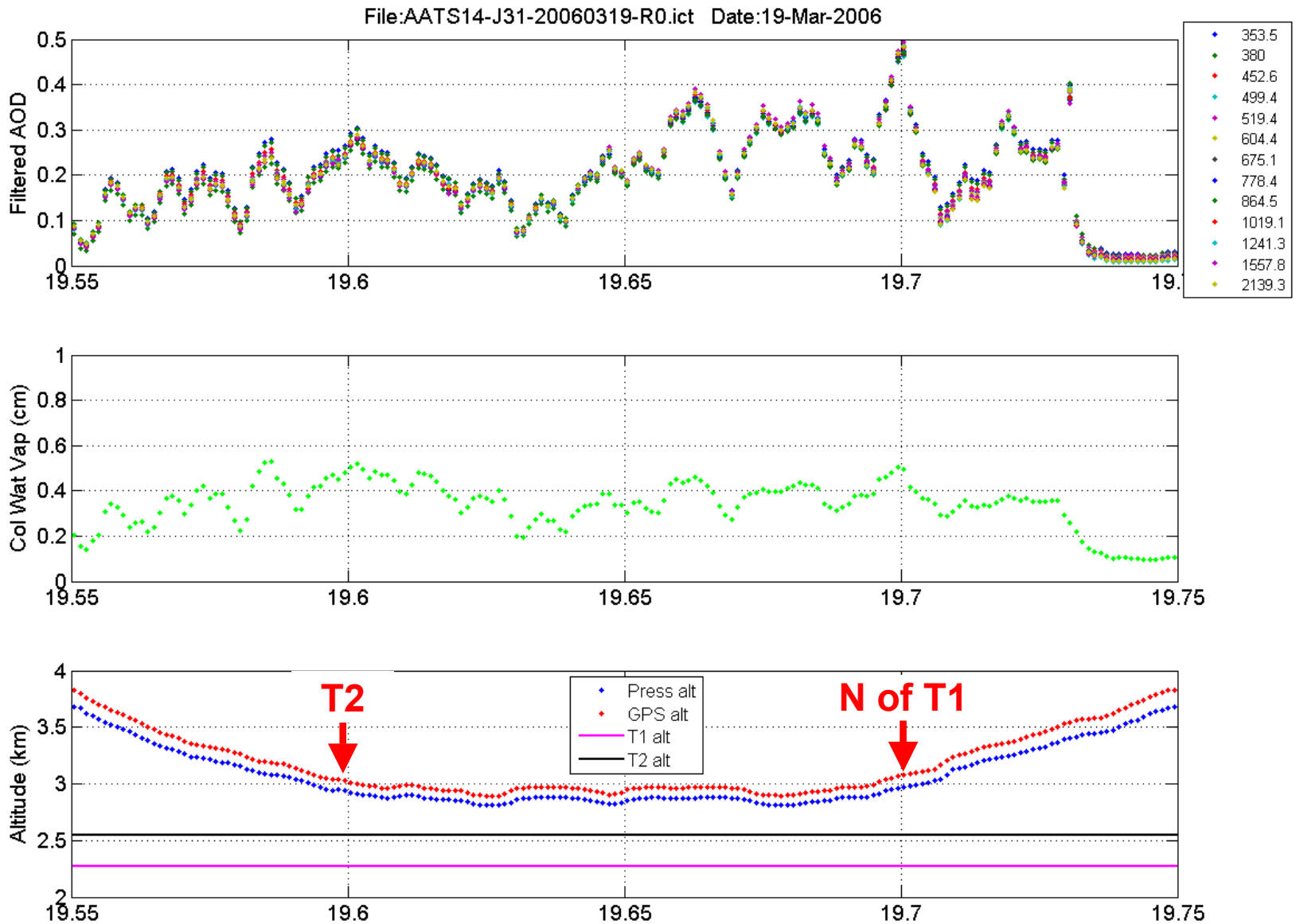
J31 Flight Track, 19 Mar 2006, Mexico City & Downwind



Livingston/Russell, Aura ST, Boulder, Sep 2006

glint angle, satellite elev viewing angle printed in blue to left of each OMI location

NNE of Mexico City



"Visibility poor. Eyes burning in cockpit."

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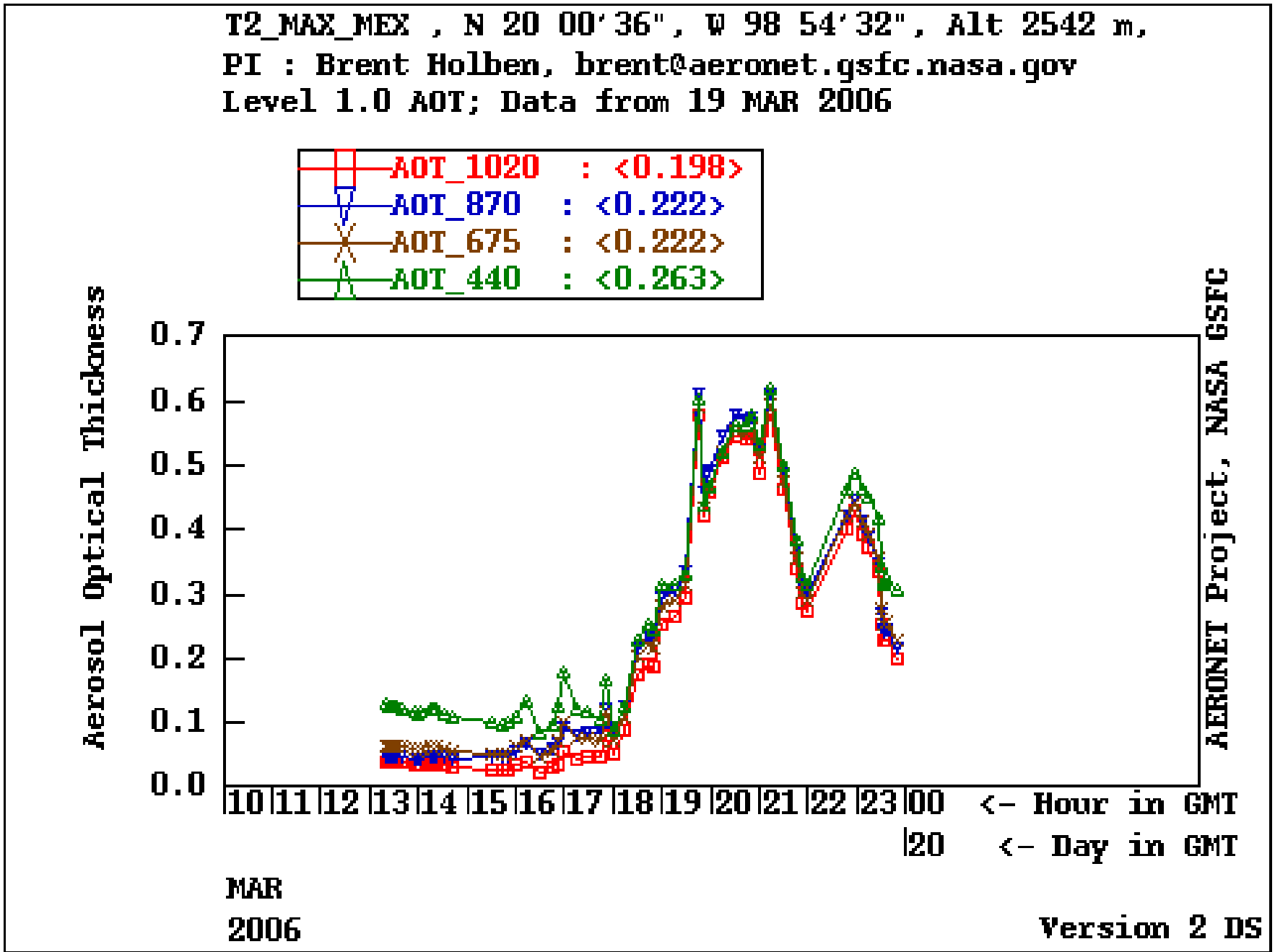
AERONET T2



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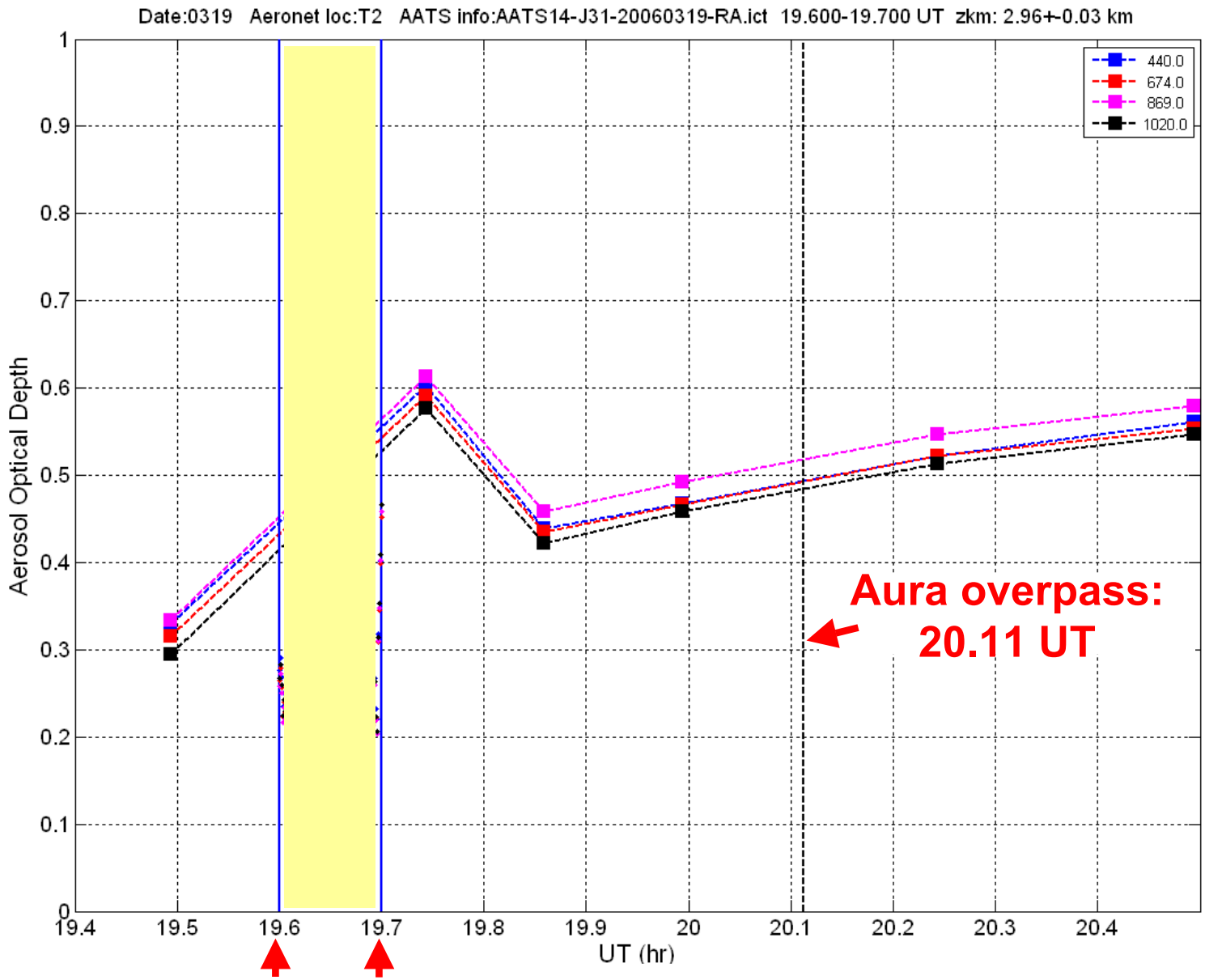
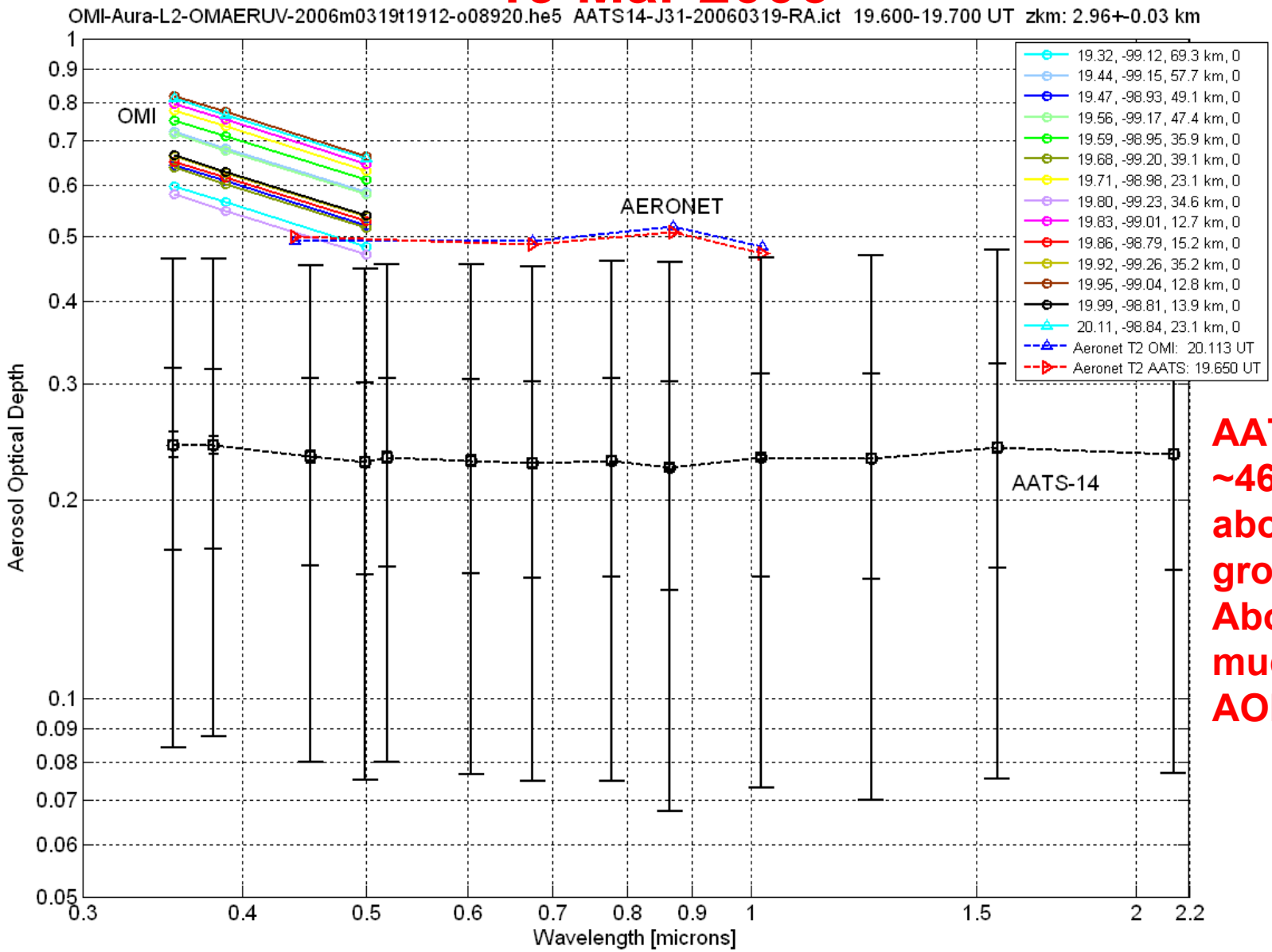
AERONET AOD at T2, 19 Mar 2006



J31/AATS: T2 N of T1 ~460 m above T2, ~780 m above T1

Comparison of OMI, AATS, & AERONET AOD at T2, 19 Mar 2006



AATS ~460 m above ground; Above much of AOD

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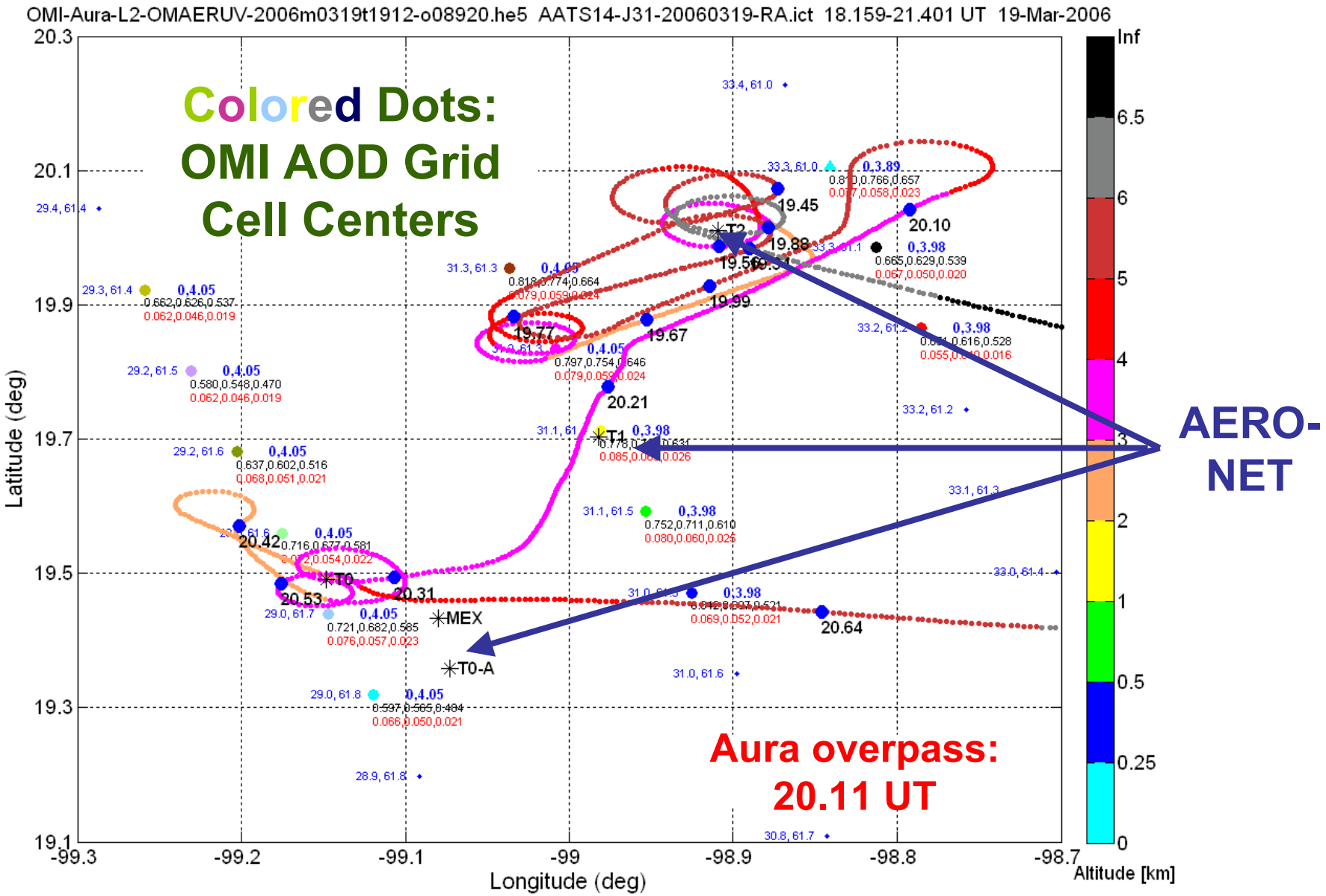
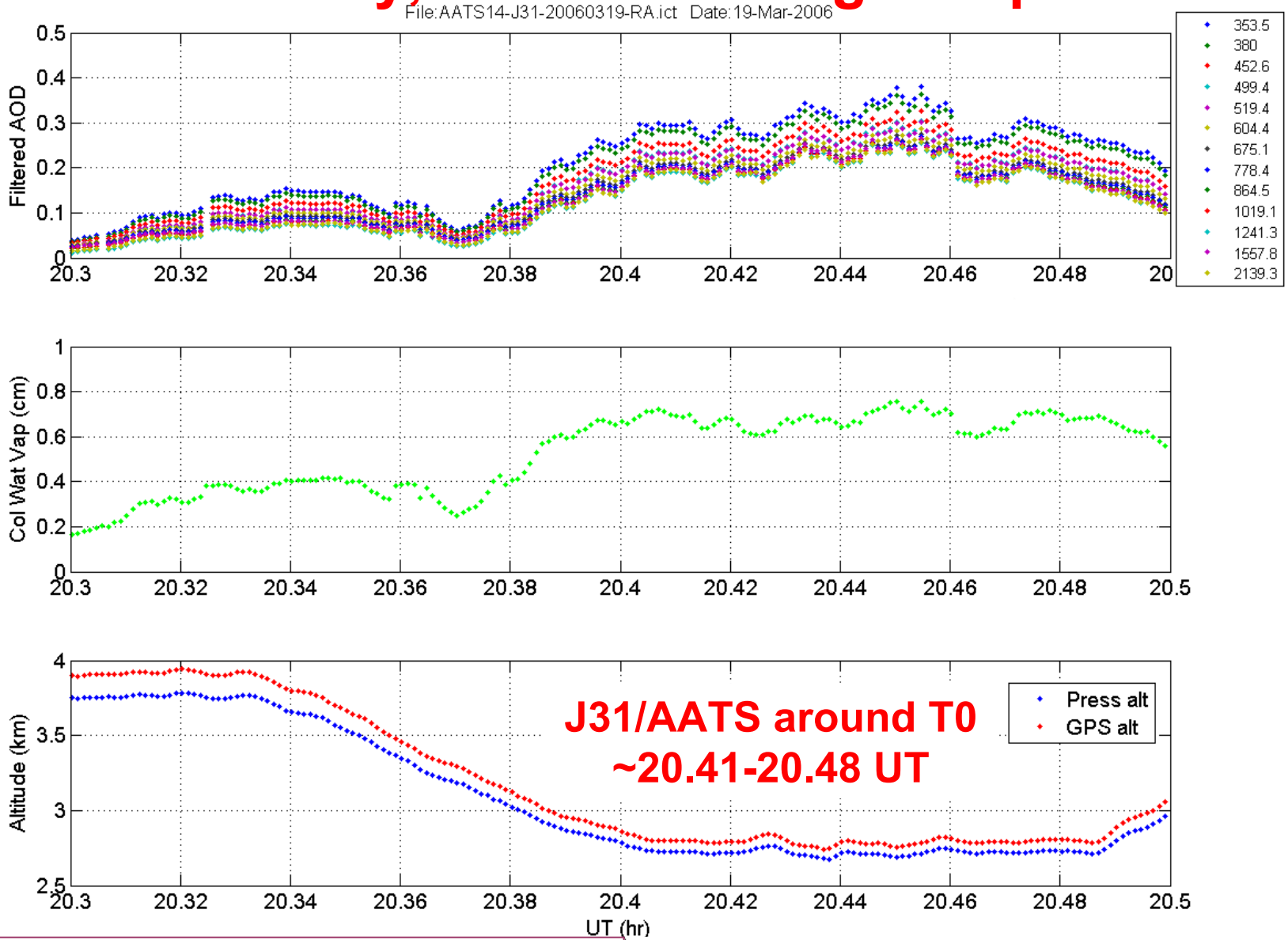
J31 Flight Track, 19 Mar 2006, Mexico City & Downwind



Livingston/Russell, Aura ST, Boulder, Sep 2006

glint angle, satellite elev viewing angle printed in blue to left of each OMI location

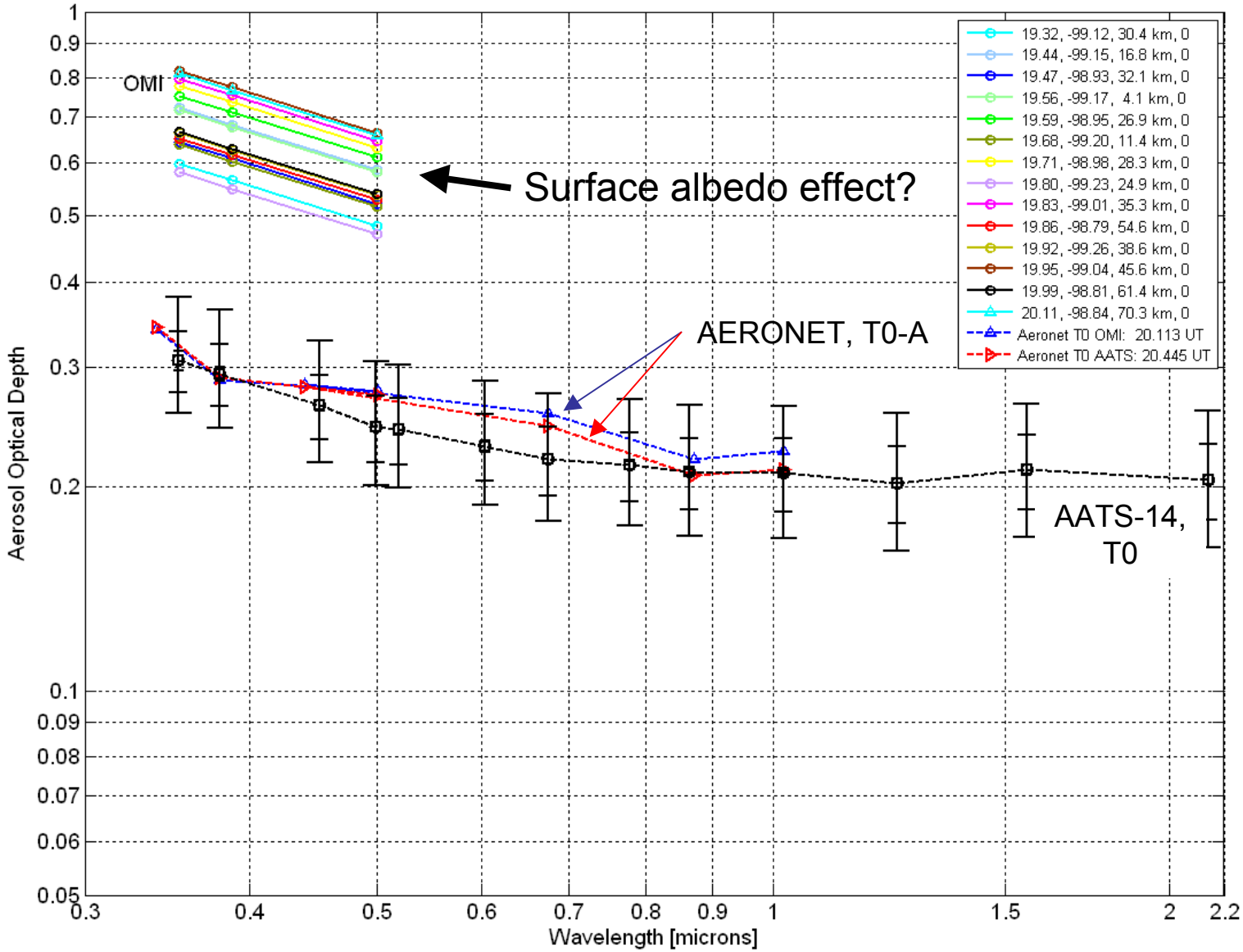
AATS AOD at T0, 19 Mar 2006: Less spatial variability, more wavelength dependence



"Much clearer as we approach T0."

~480 m above T0, ~510 m above ground

Comparison of OMI, AATS, & AERONET AOD at T0 & T0-A, 19 Mar 2006



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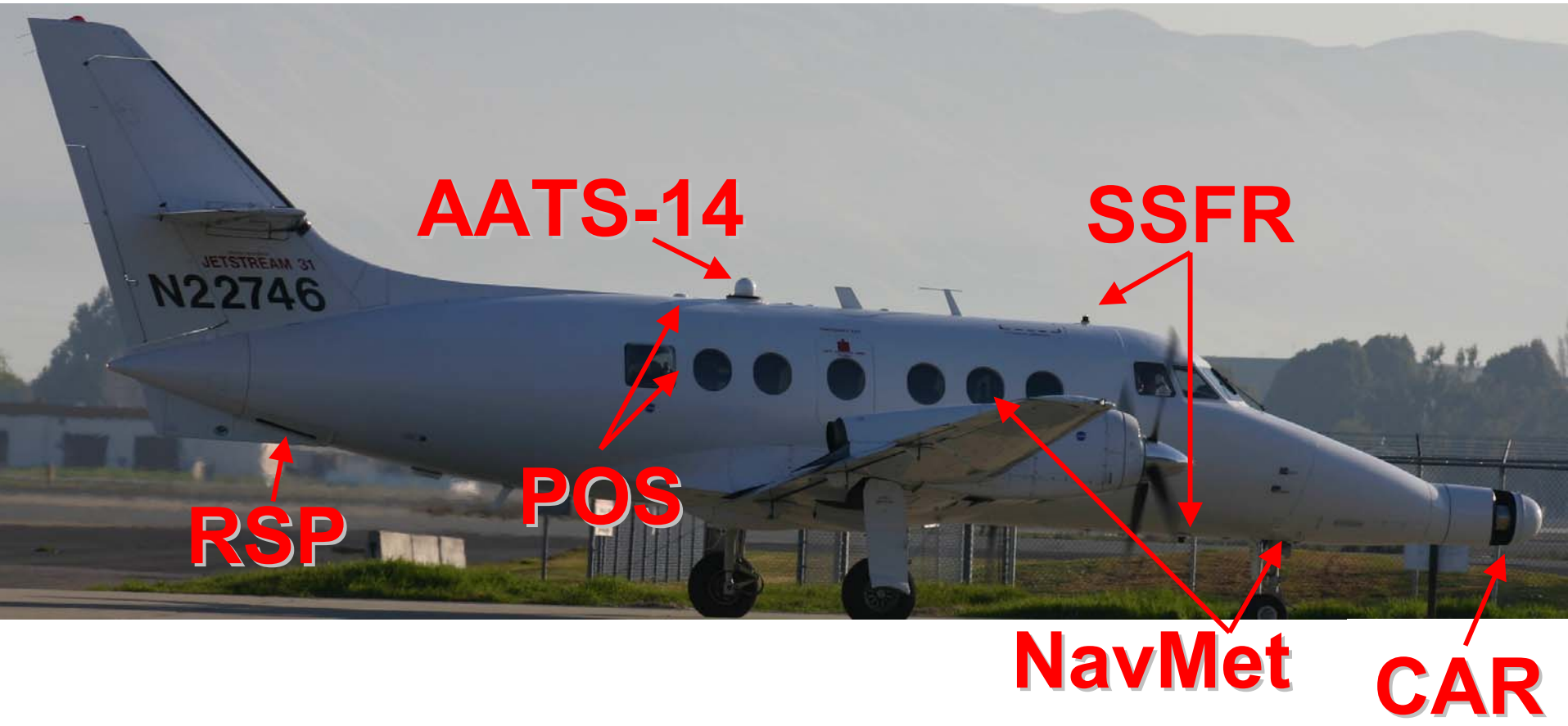
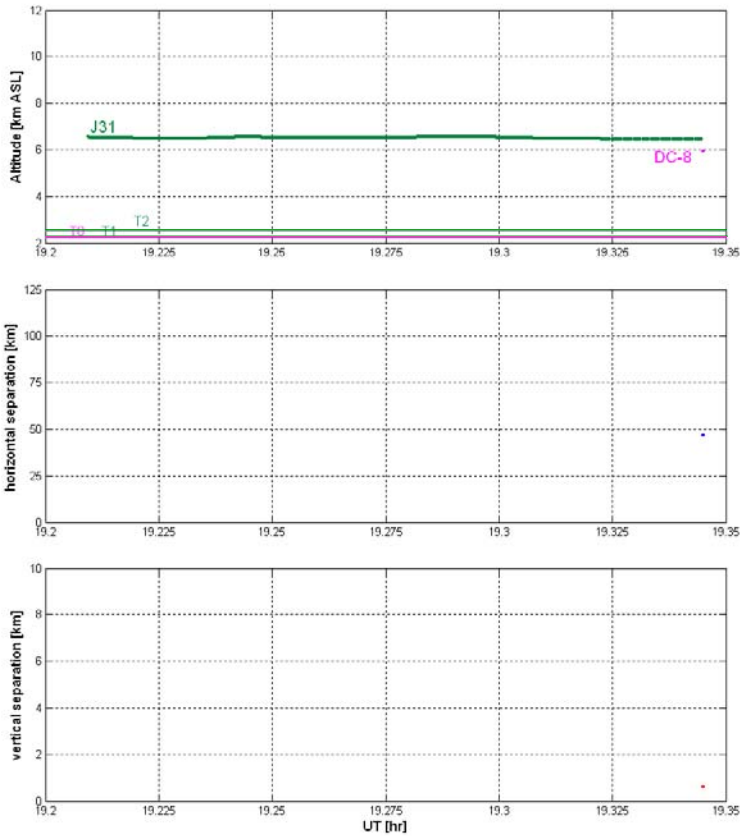
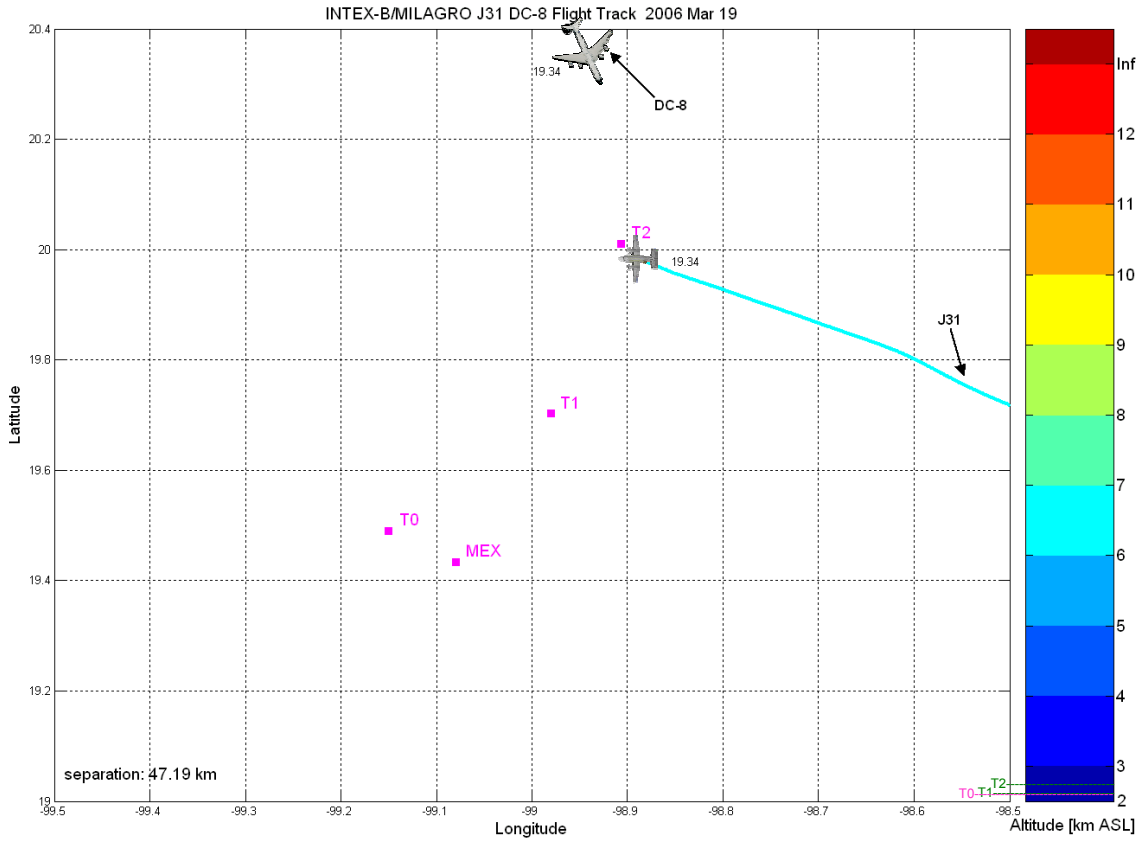
Other J31 instruments measure surface albedo (SSFR) and BRDF (RSP & CAR)



Coordination of DC-8 and J31 Flights, 19 Mar 2006, INTEX-B/MILAGRO





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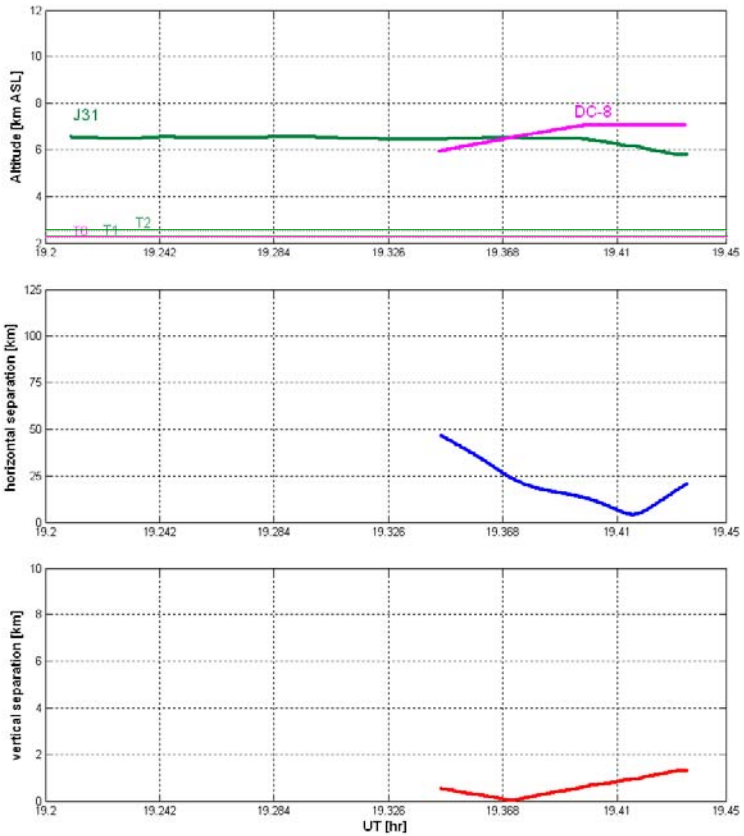

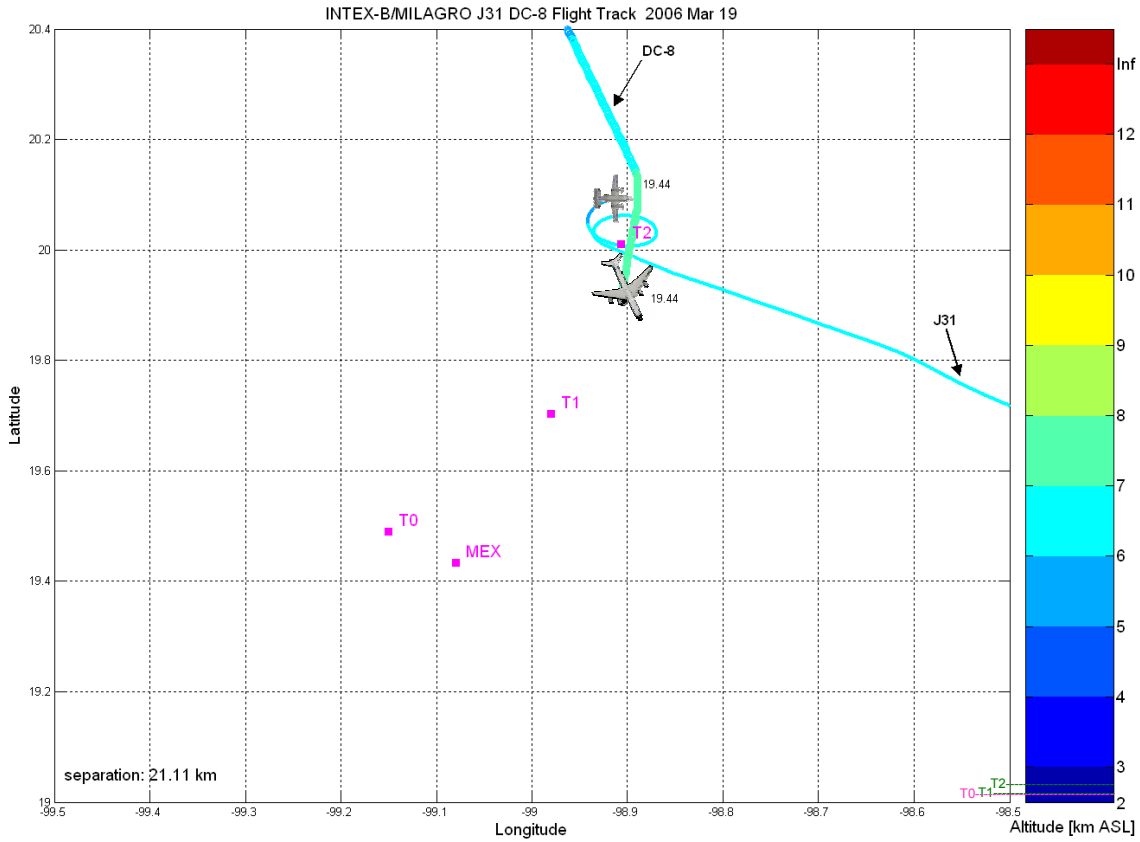

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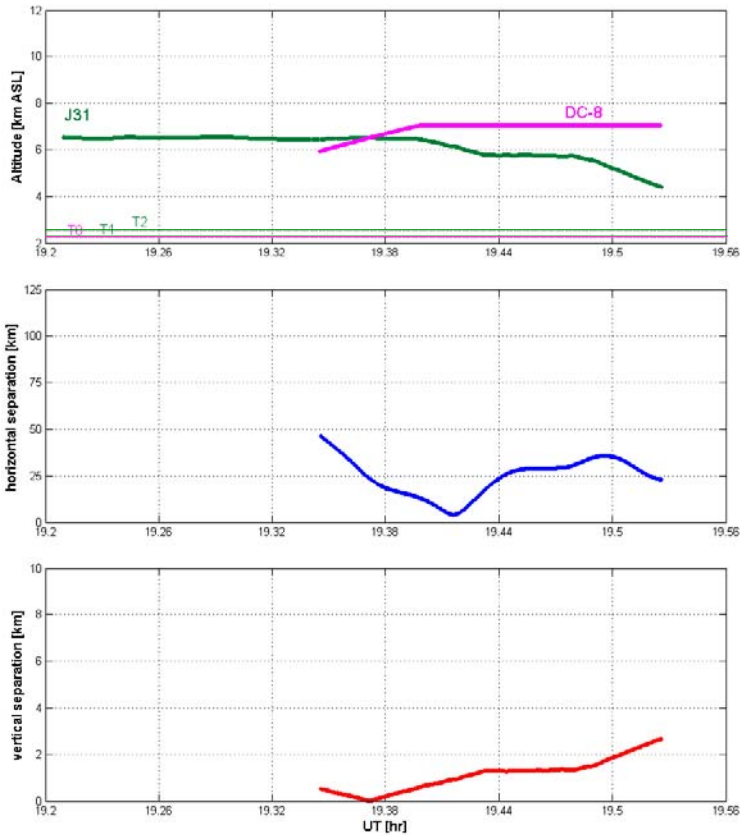

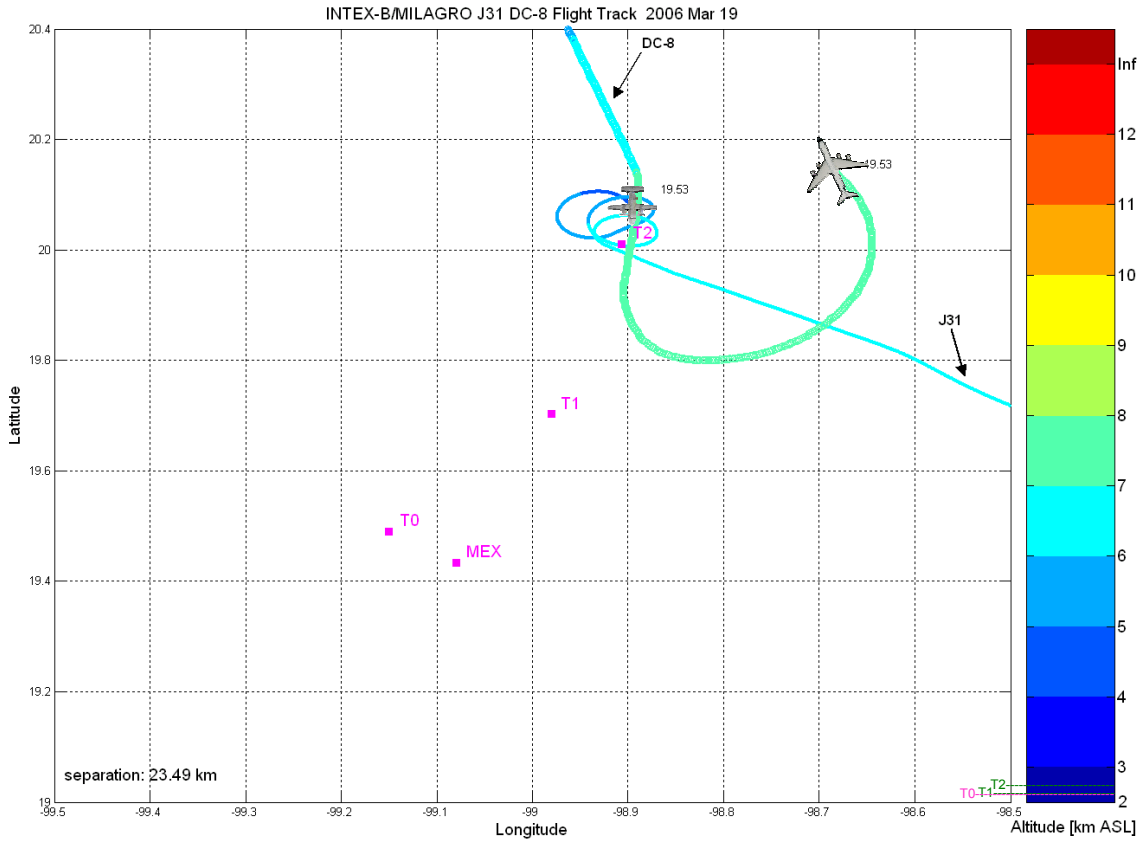

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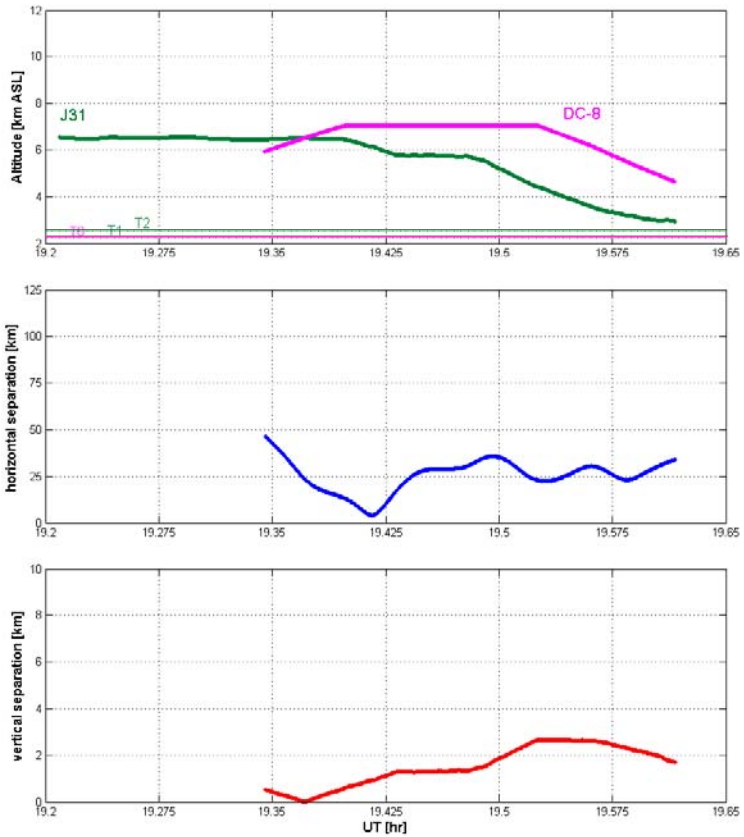

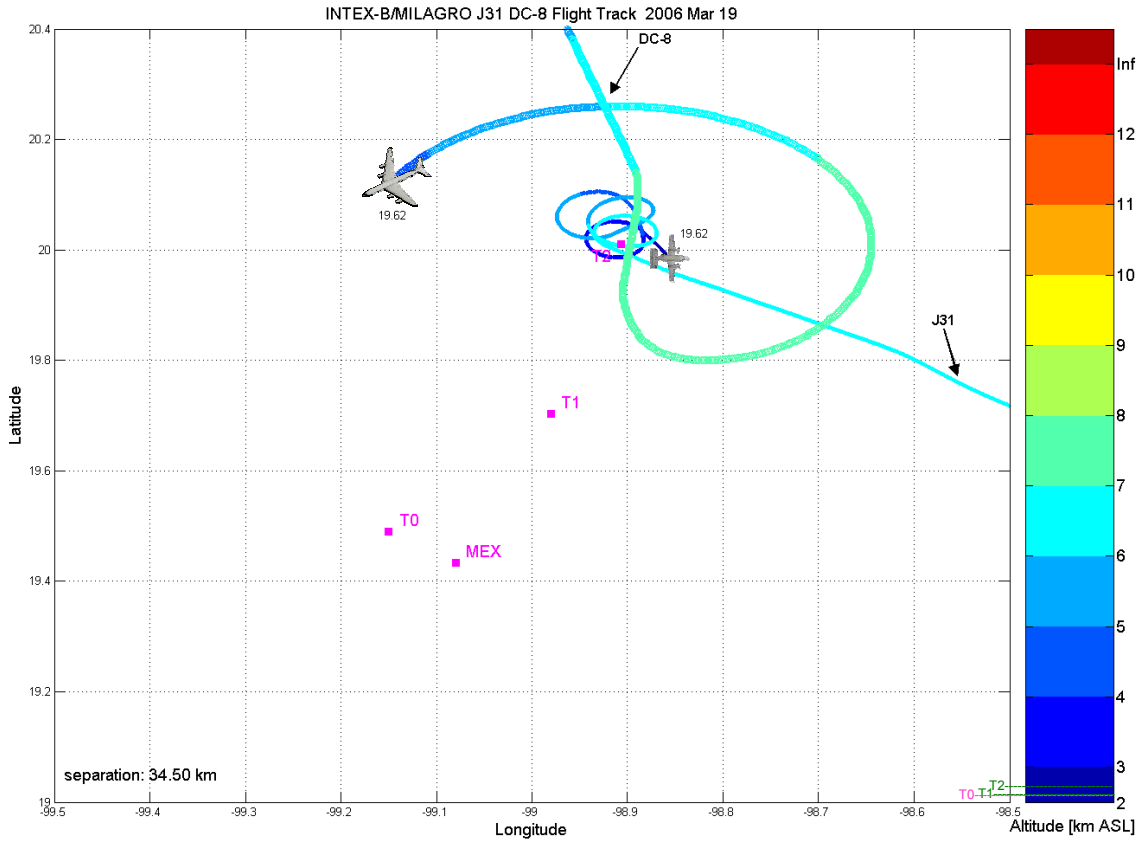

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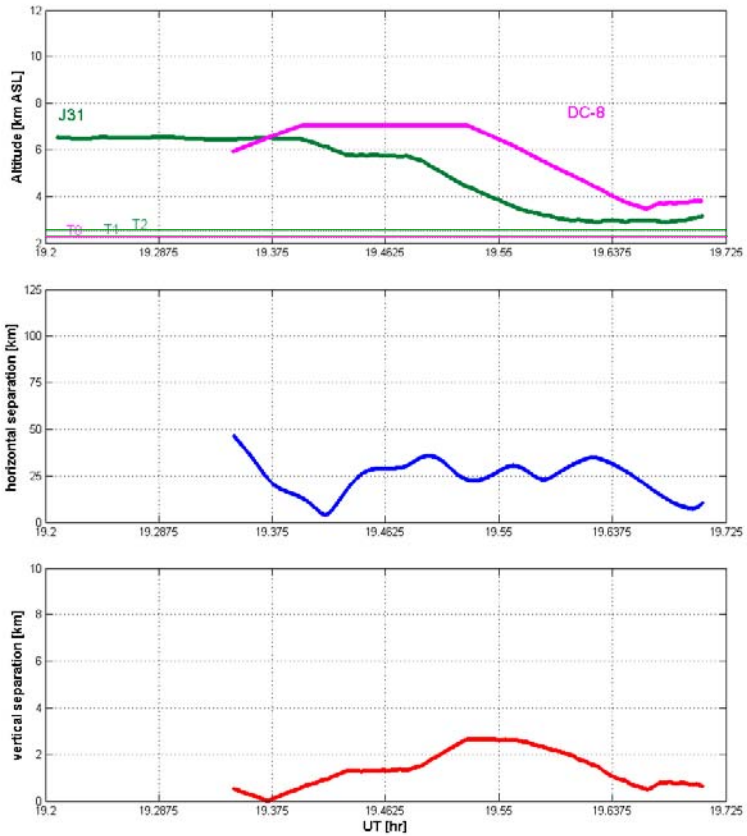

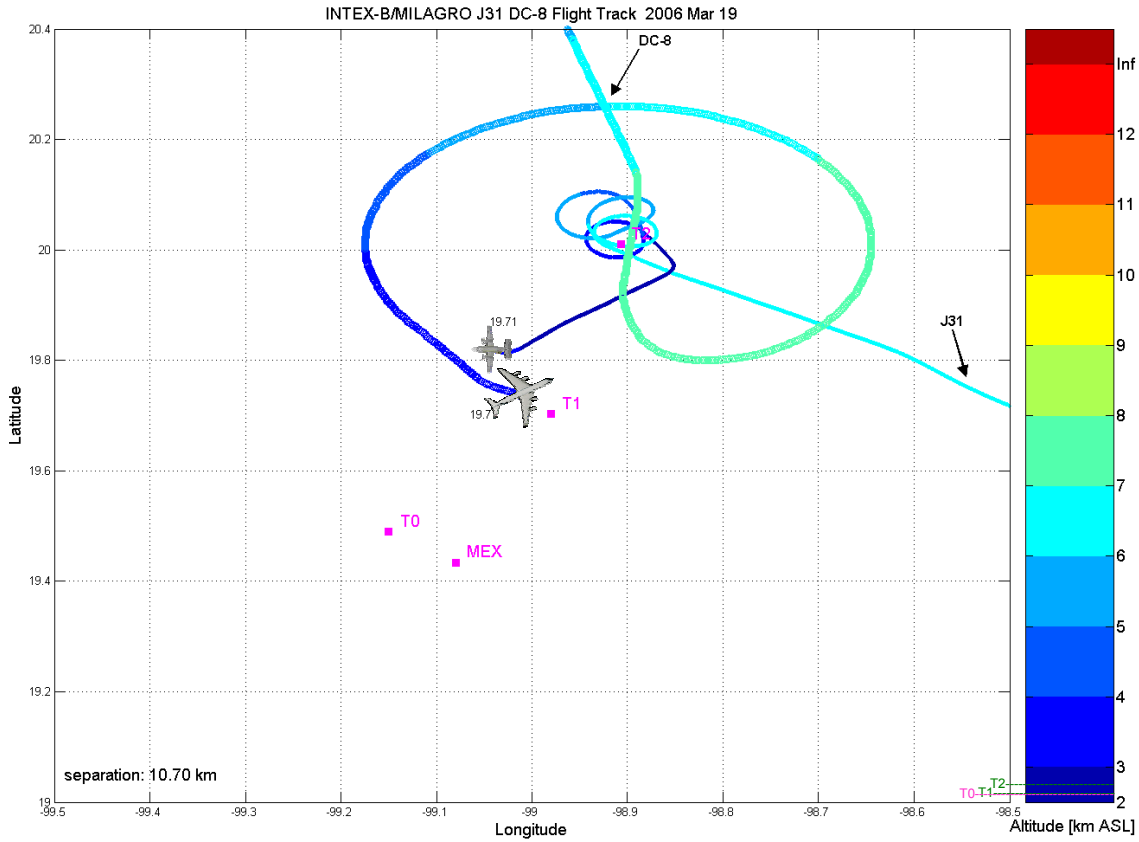

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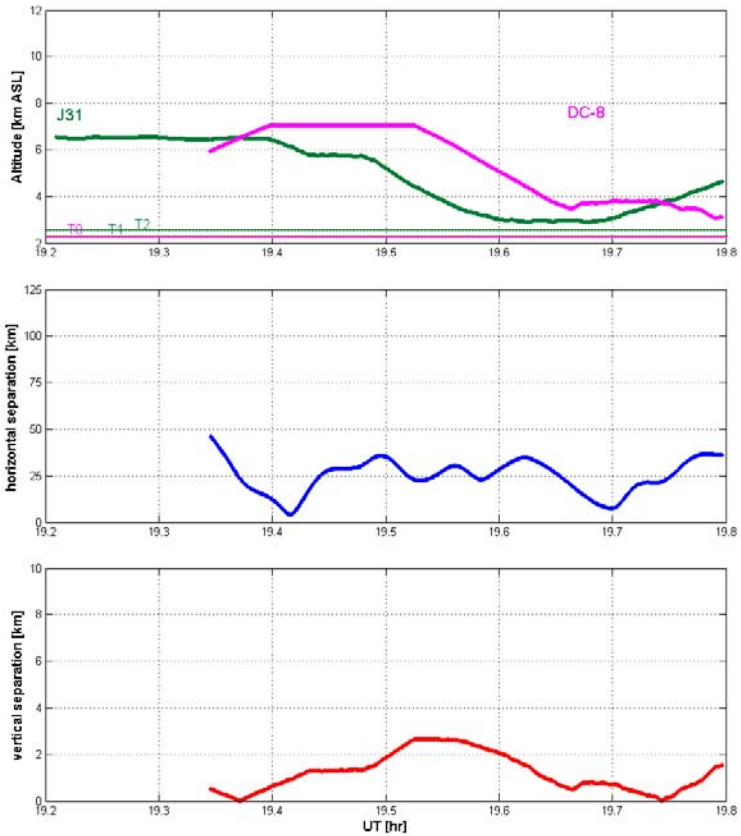

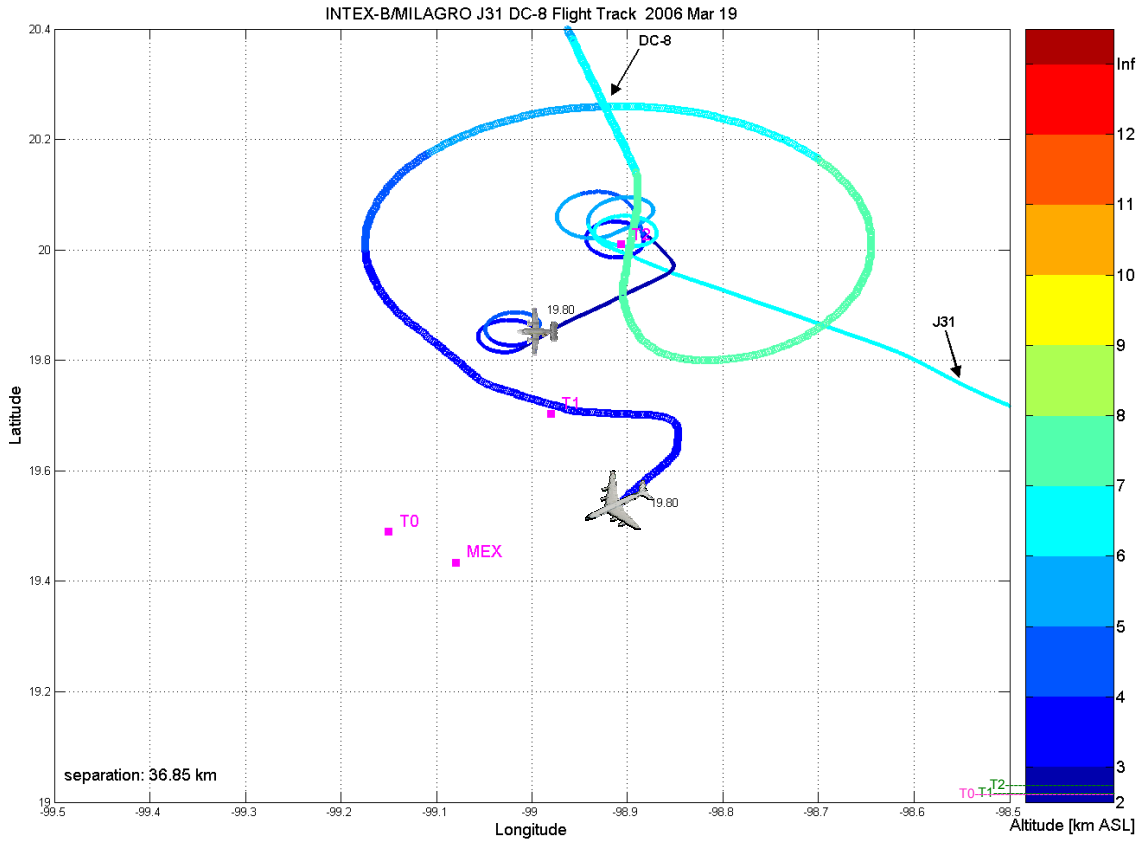

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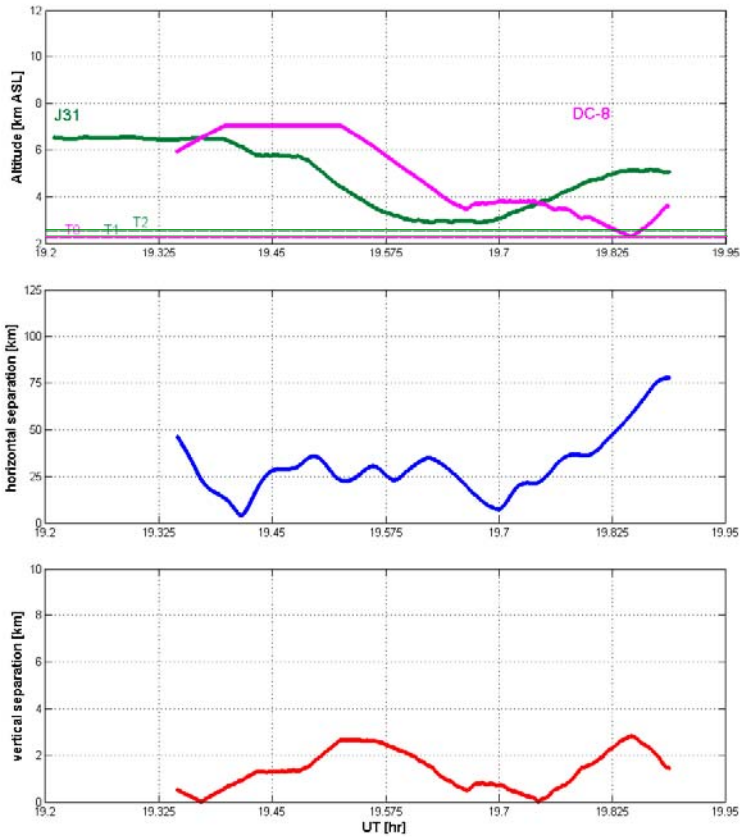

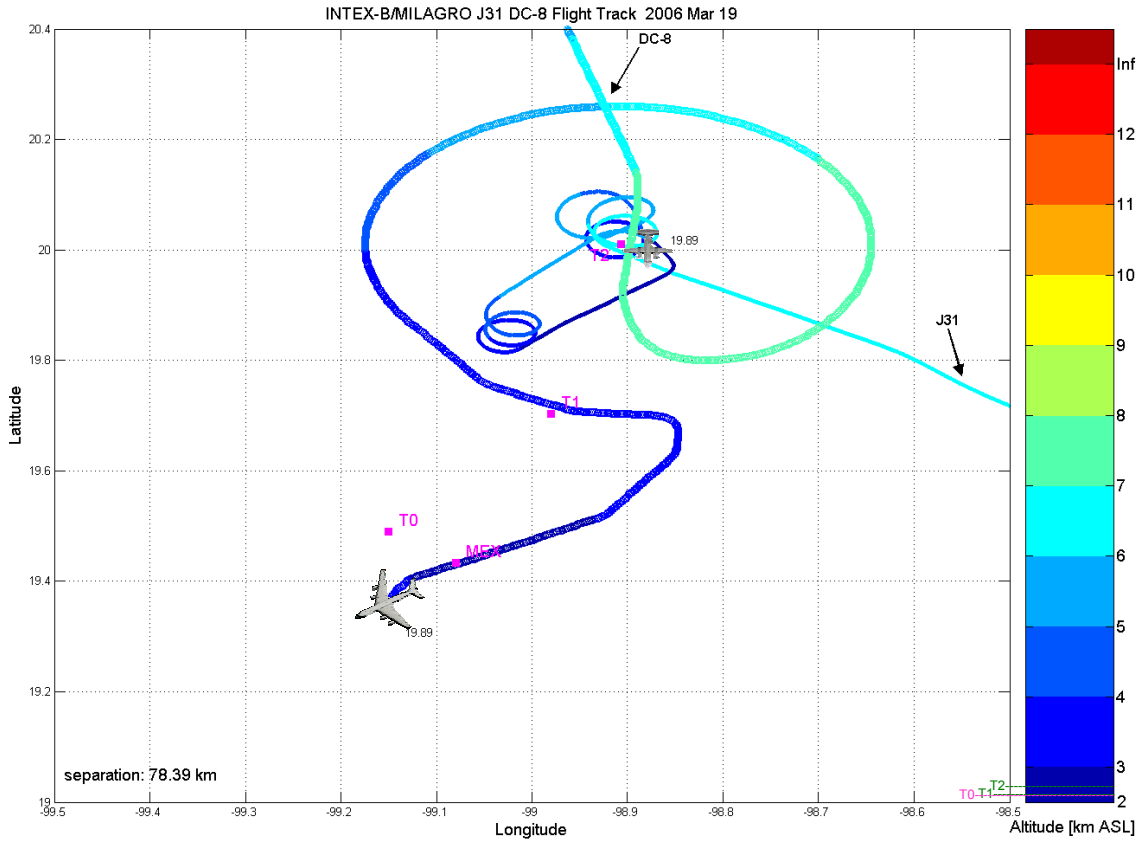

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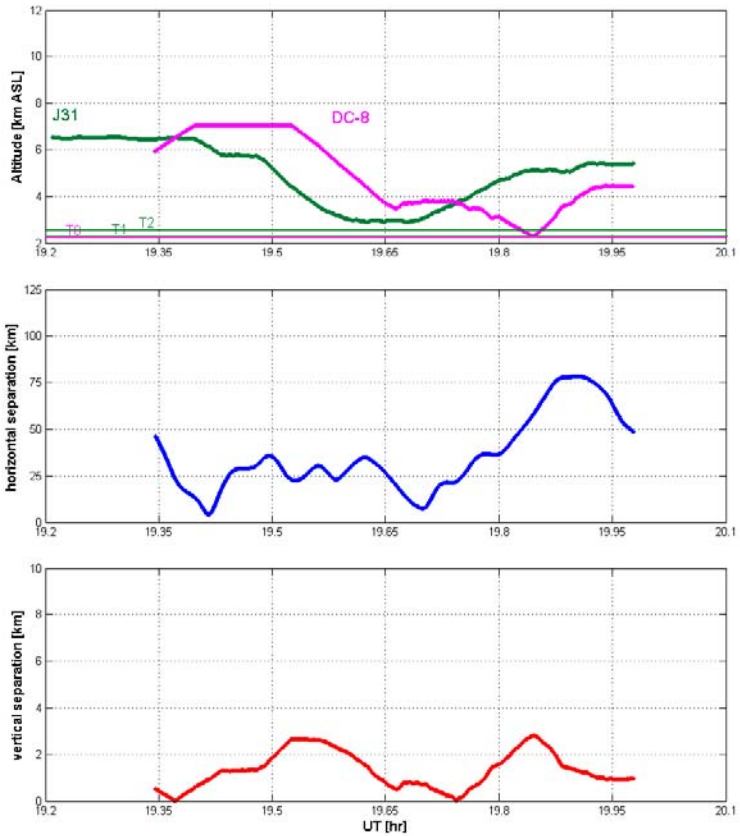

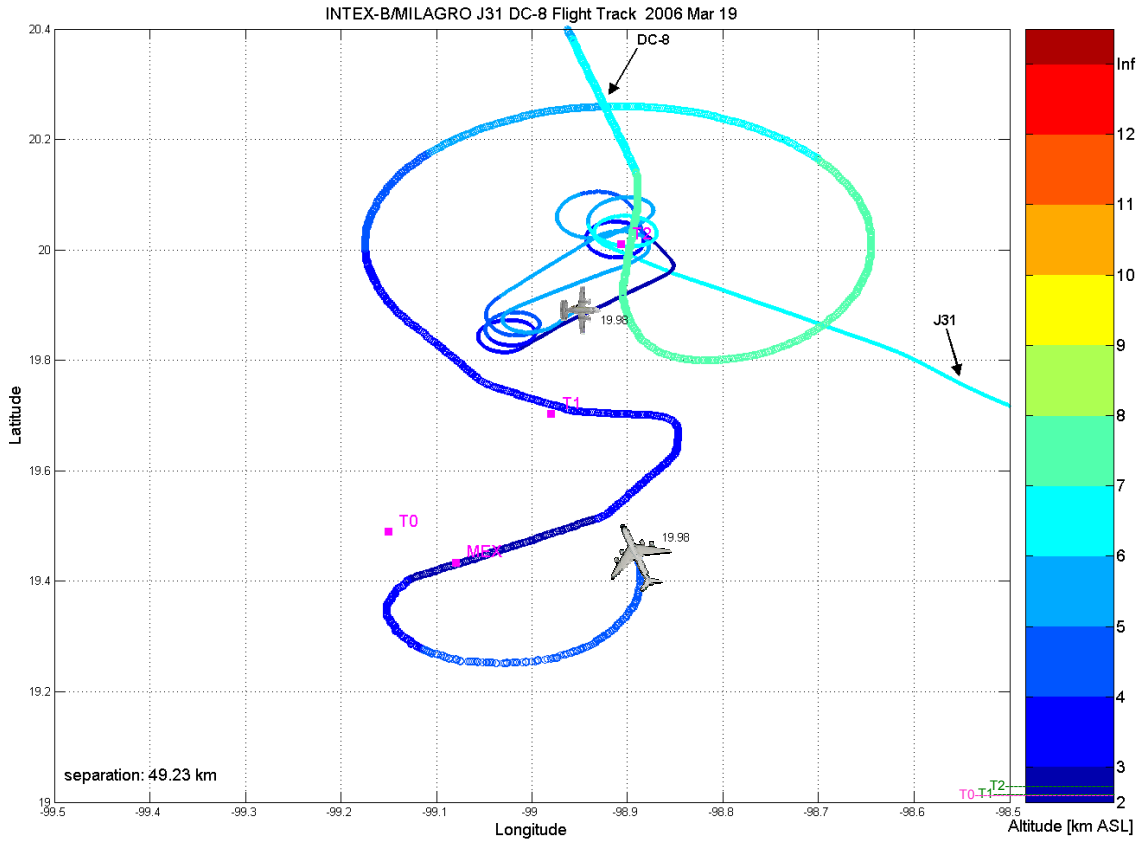

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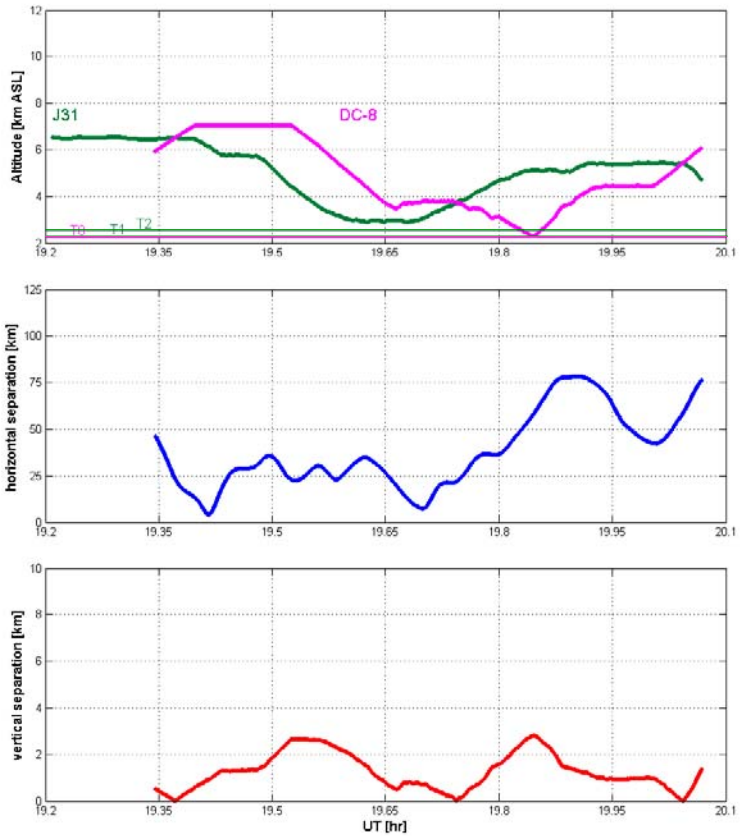

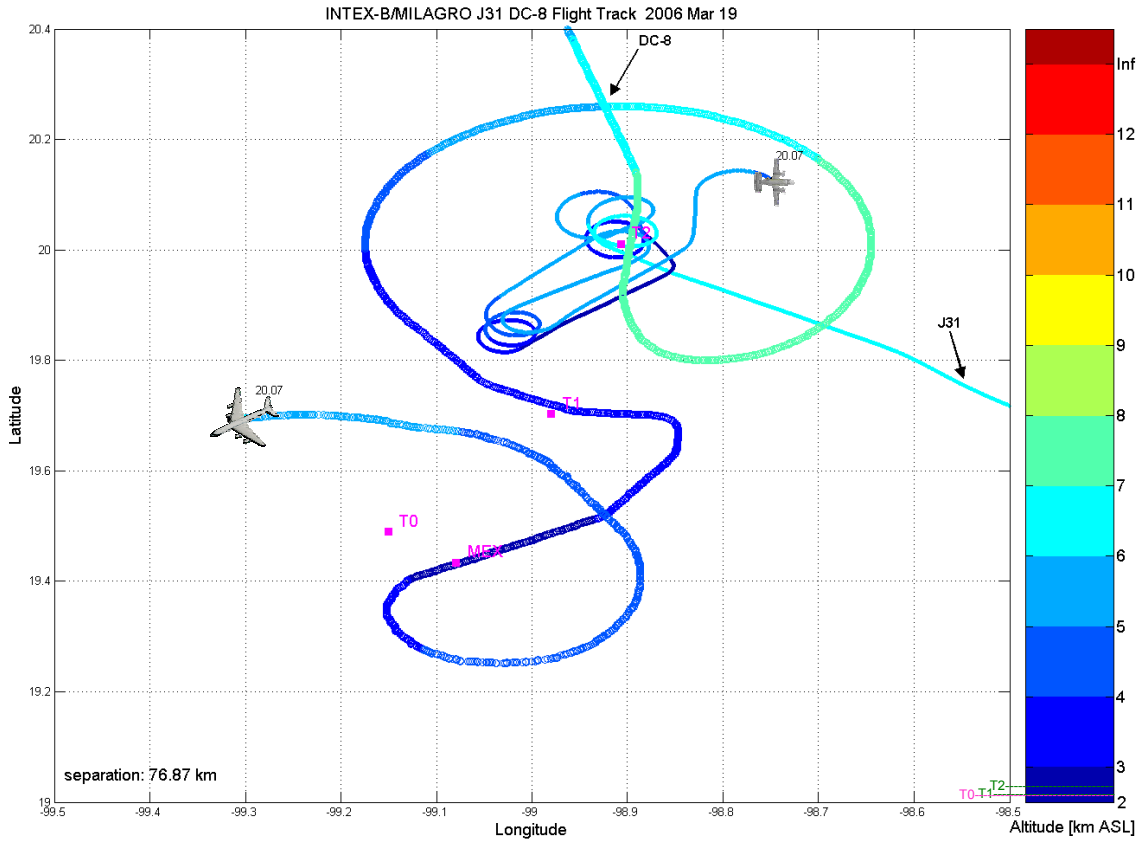

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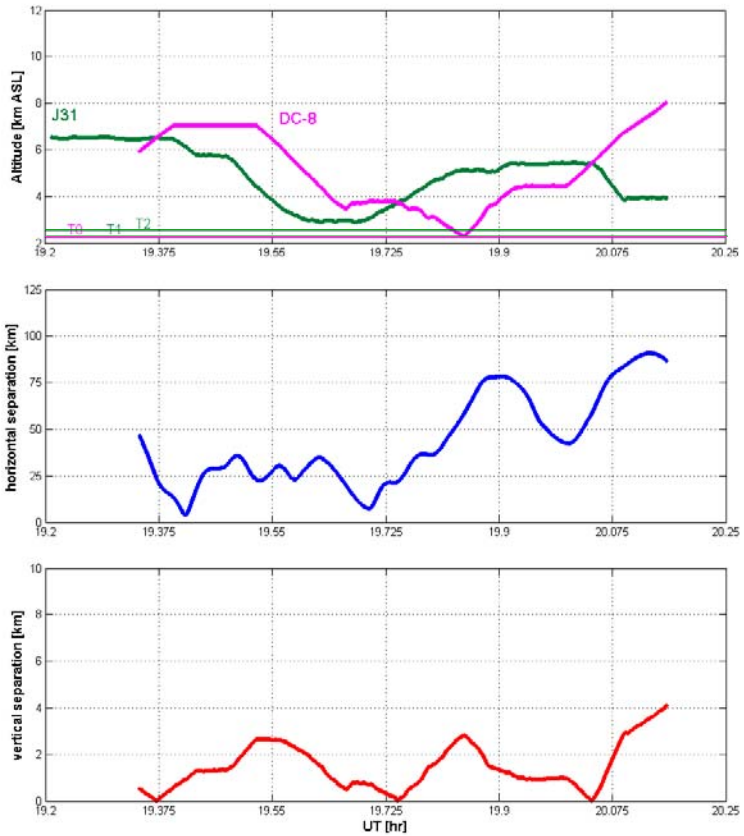

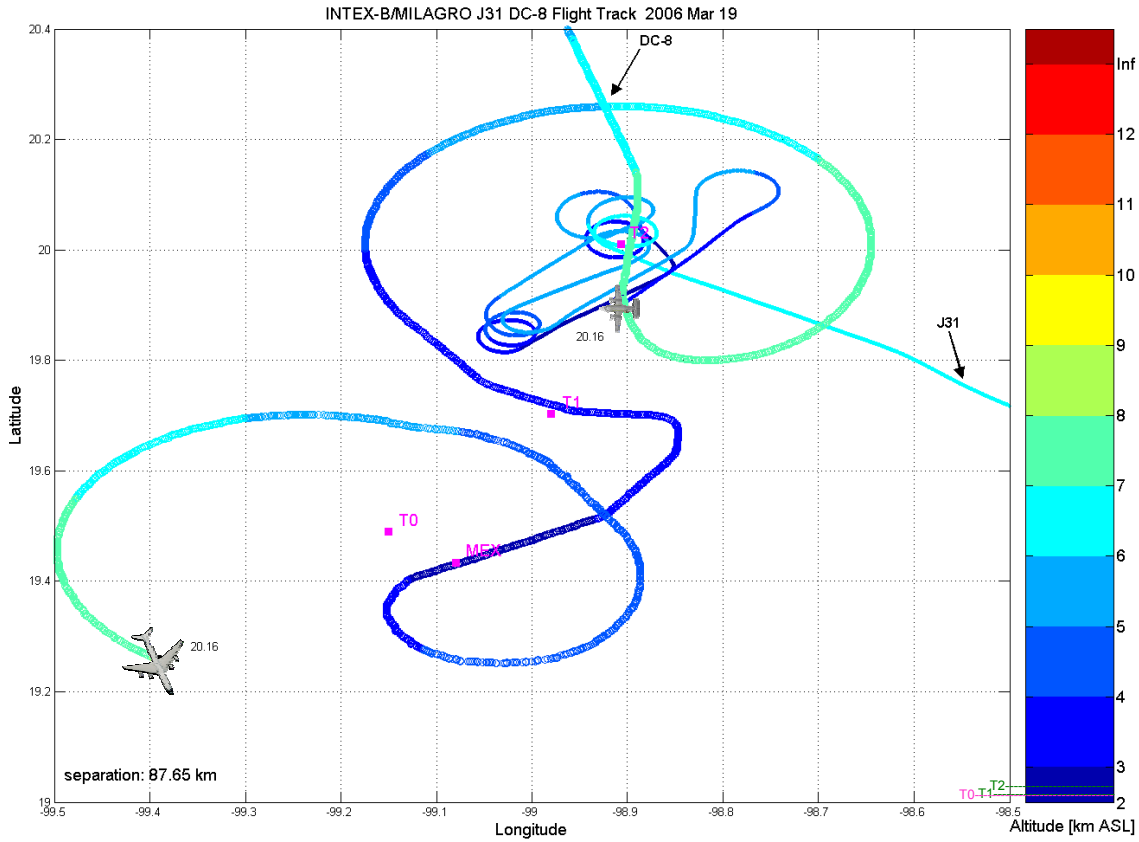

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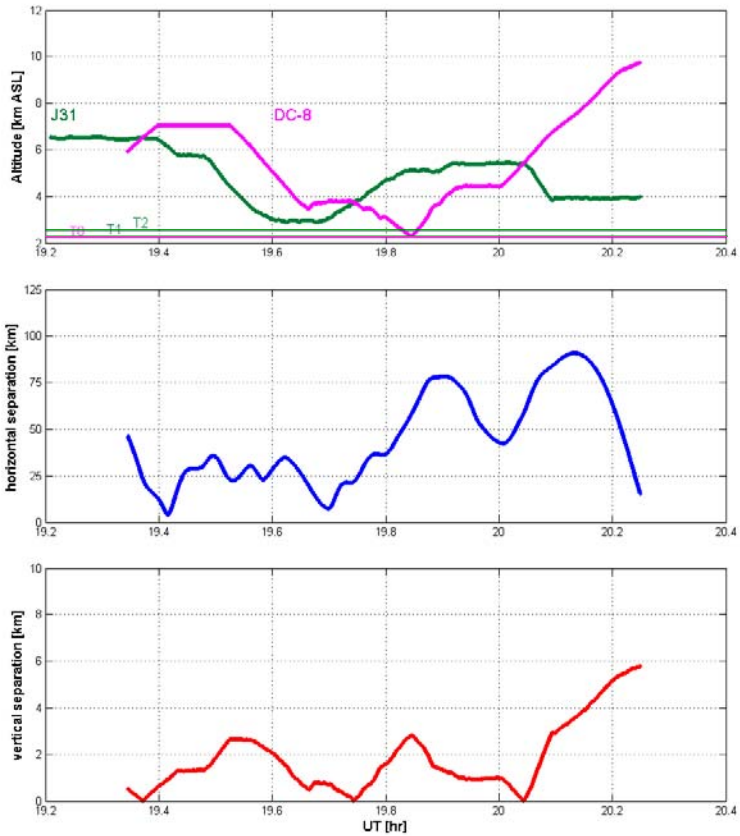

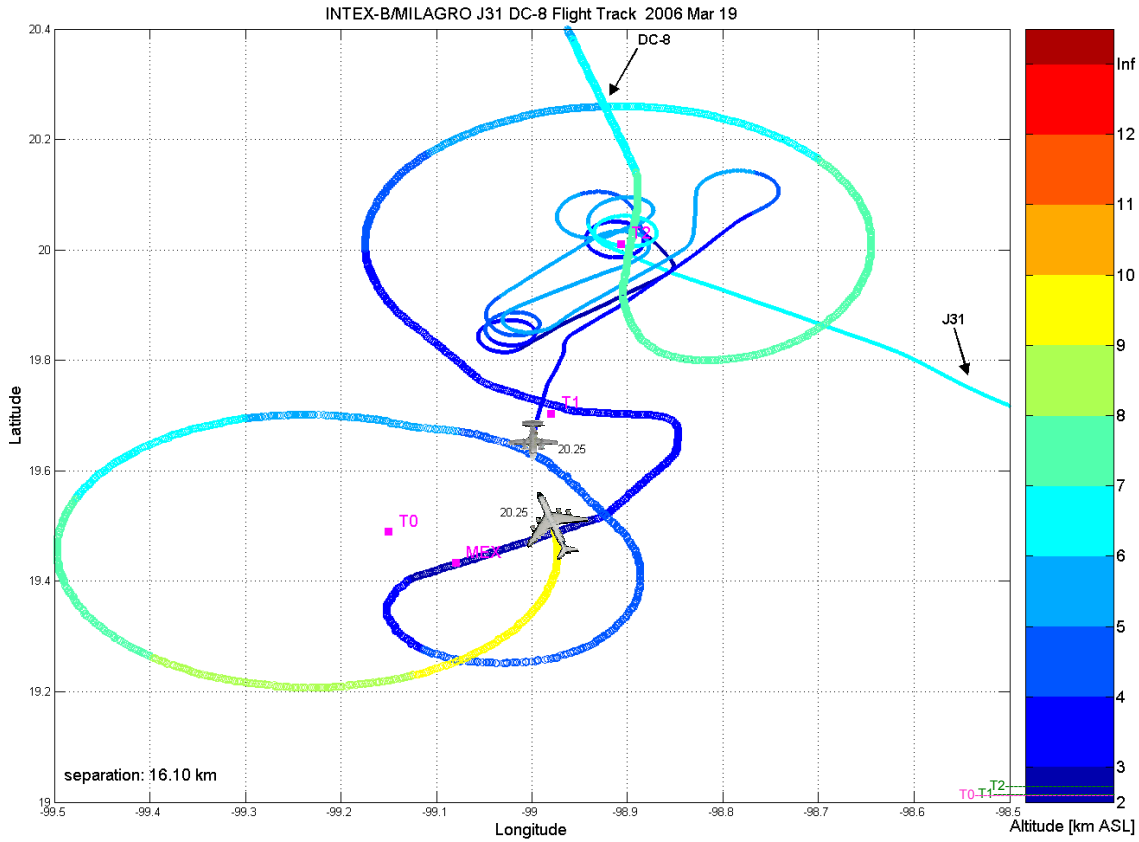

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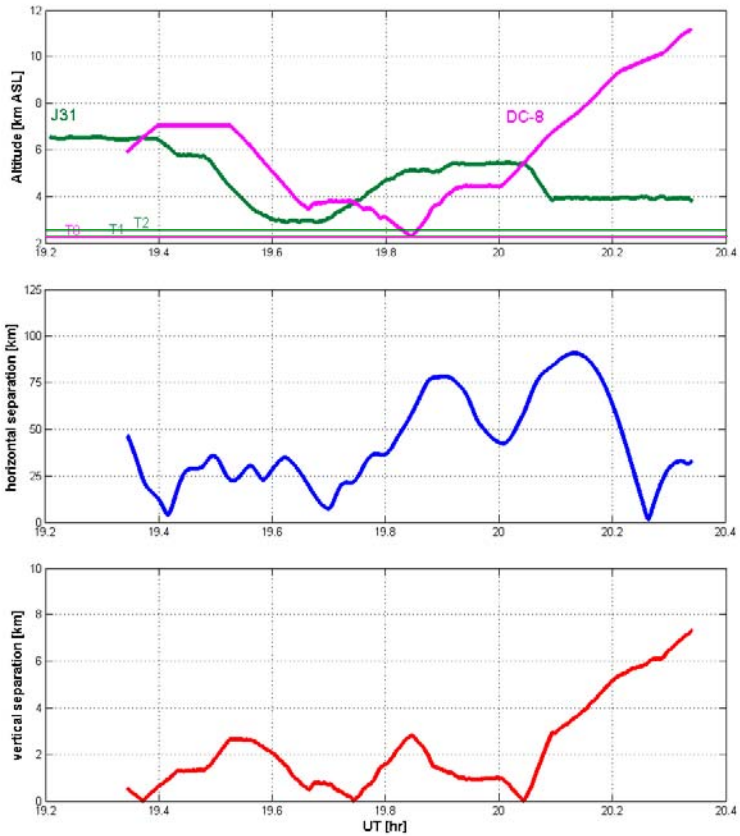

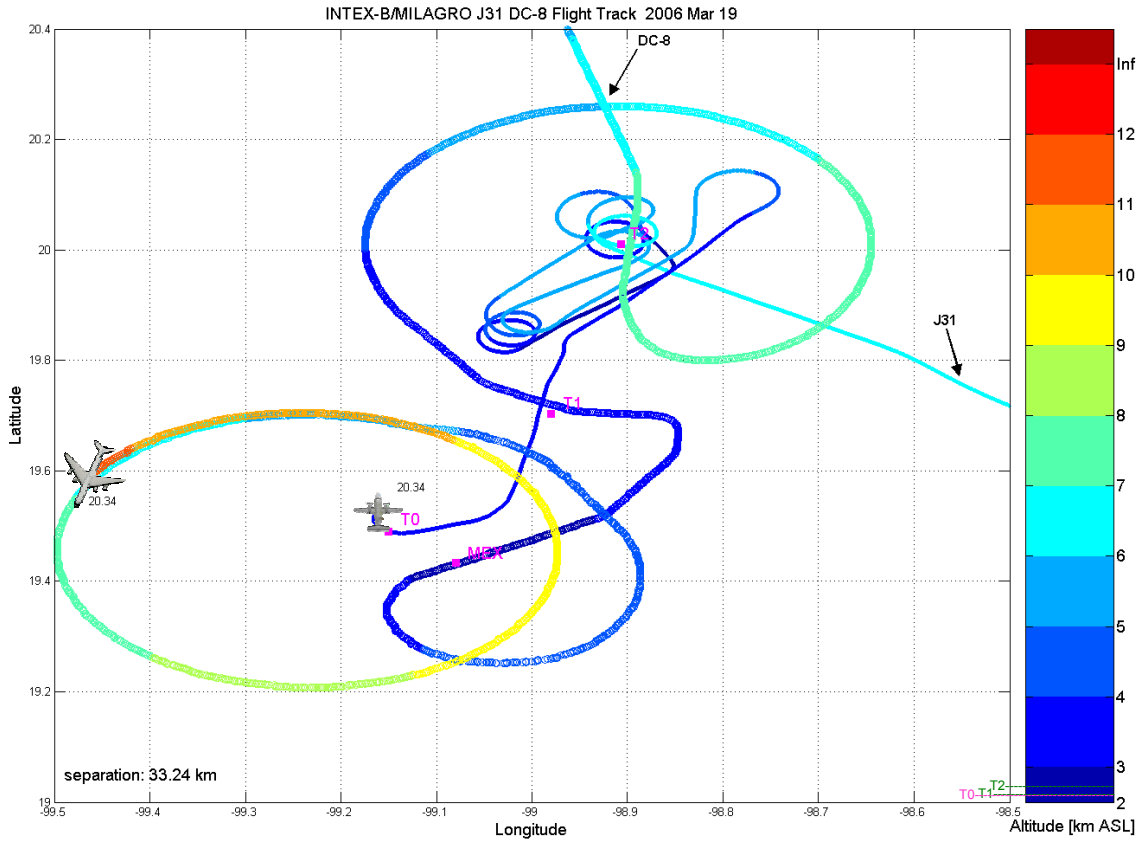

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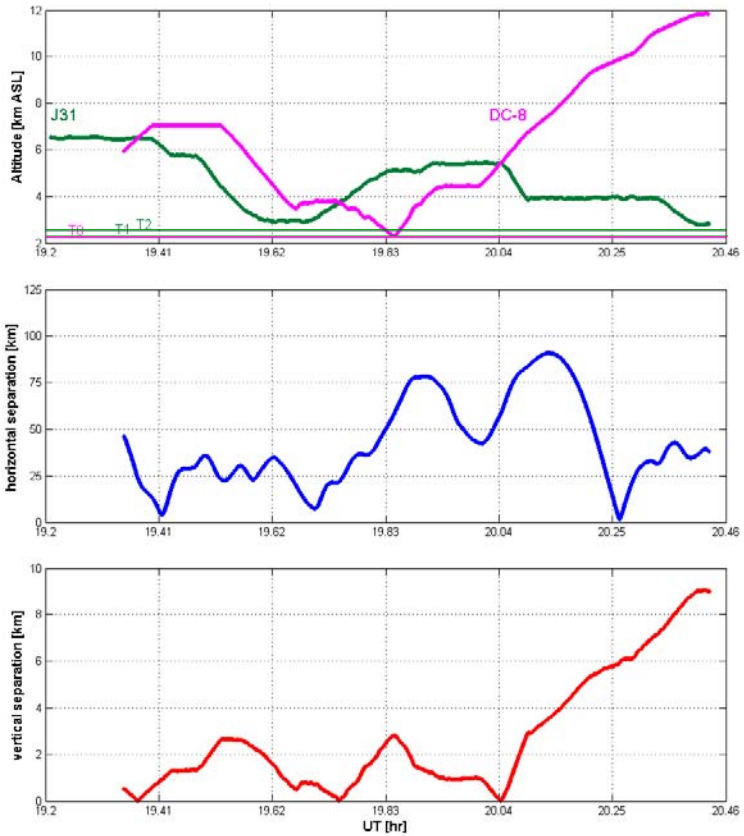

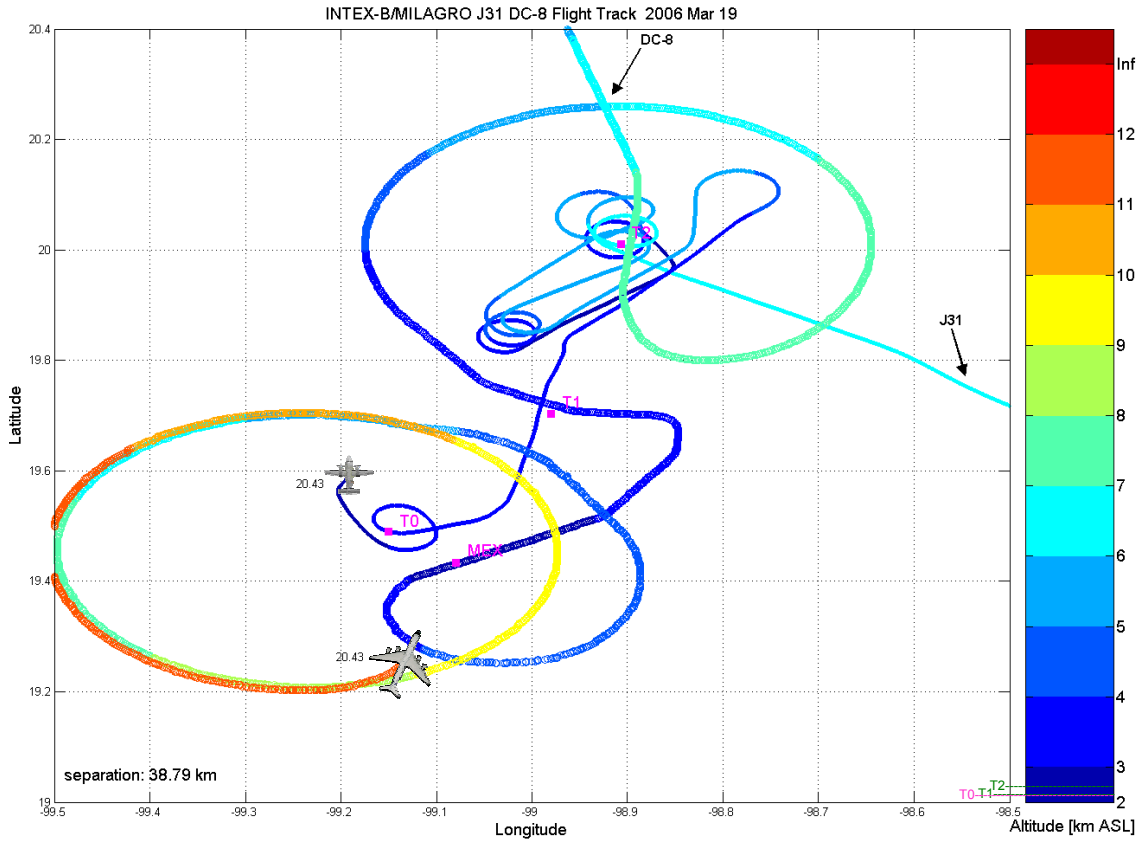

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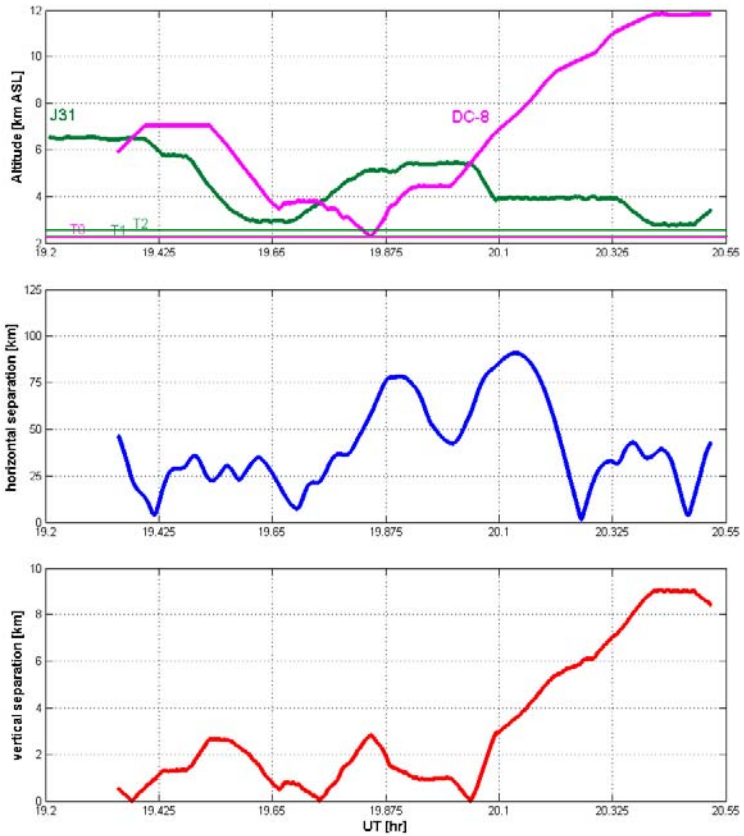
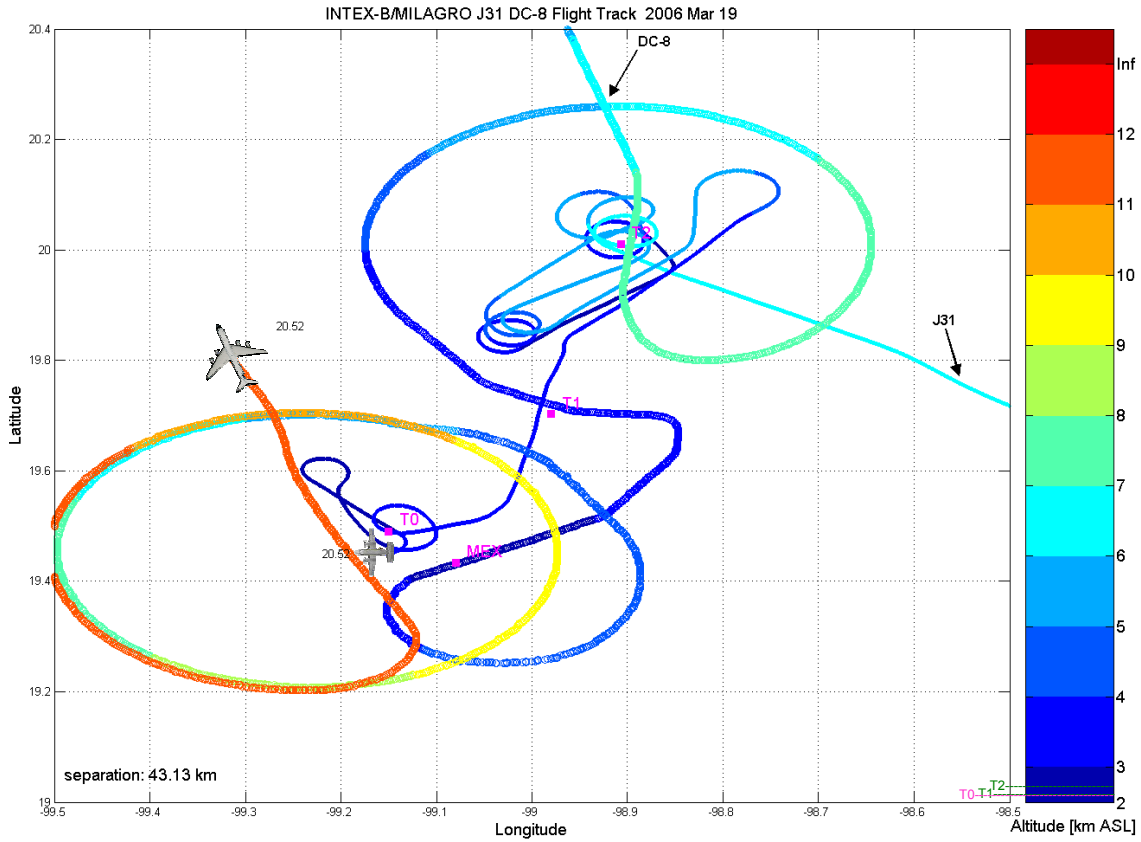
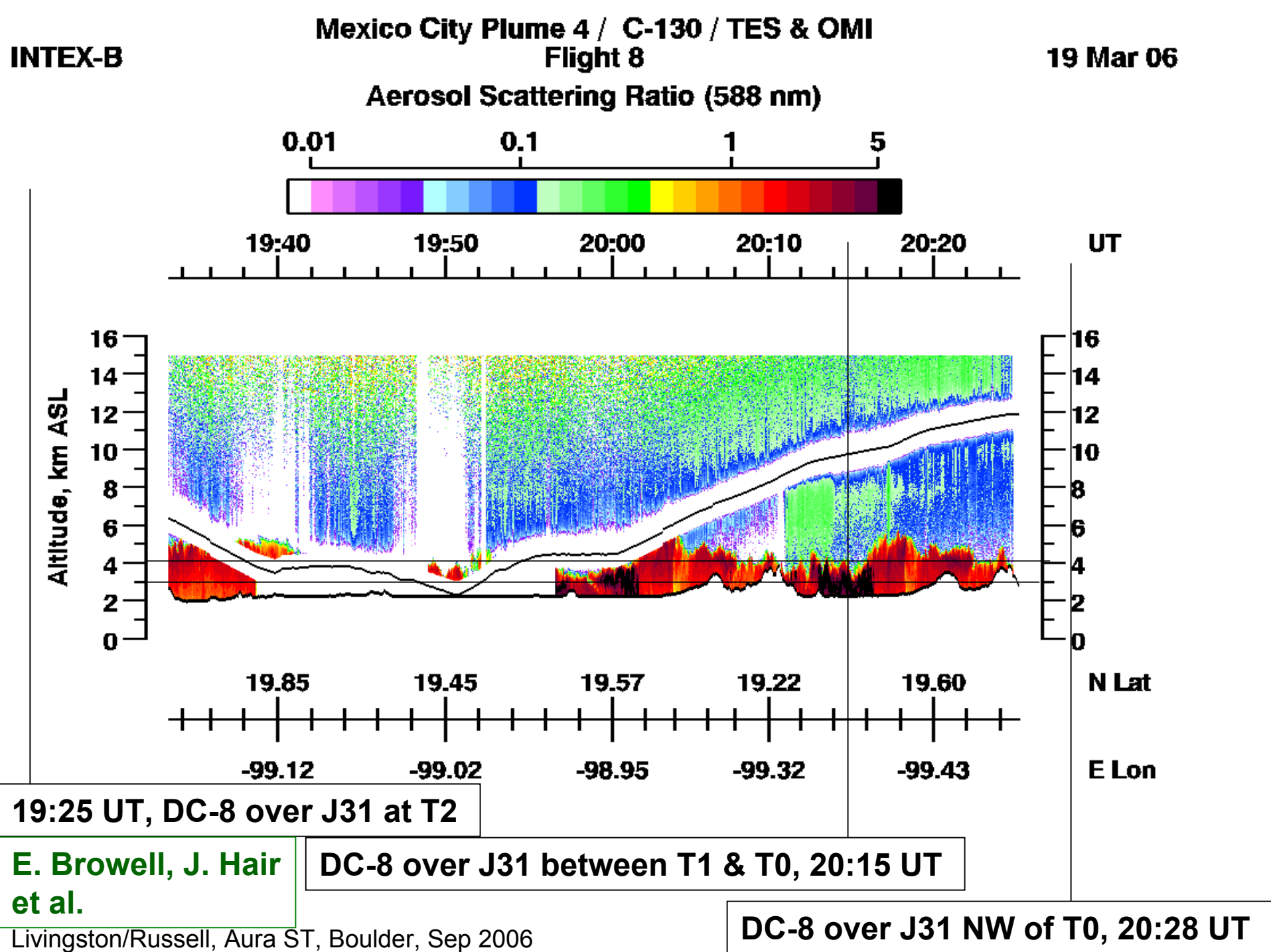
Coordination of DC-8 and J31 Flights, 19 Mar 2006, INTEX-B/MILAGRO

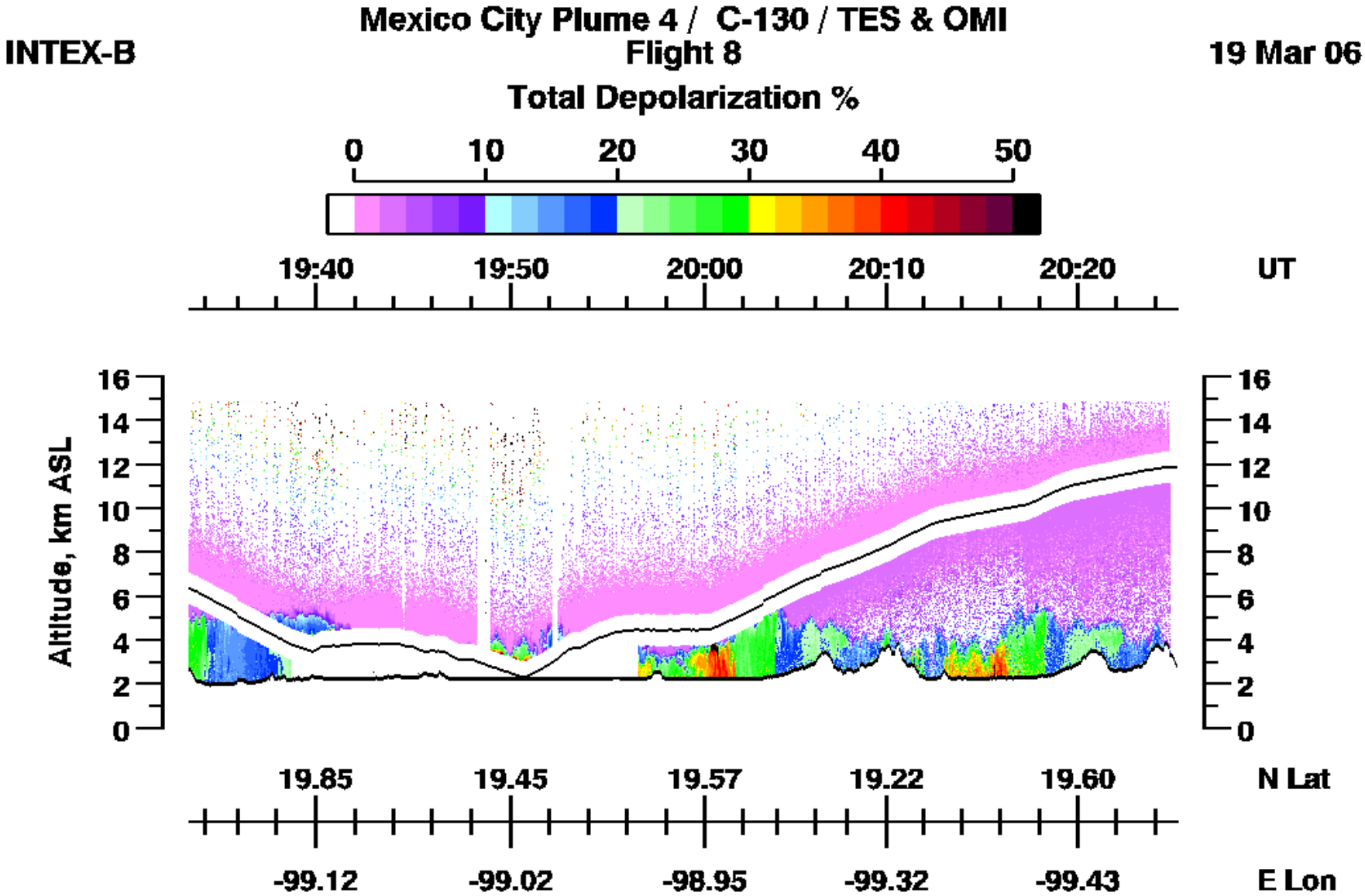




Livingston/Russell, Aura ST, Boulder, Sep 2006



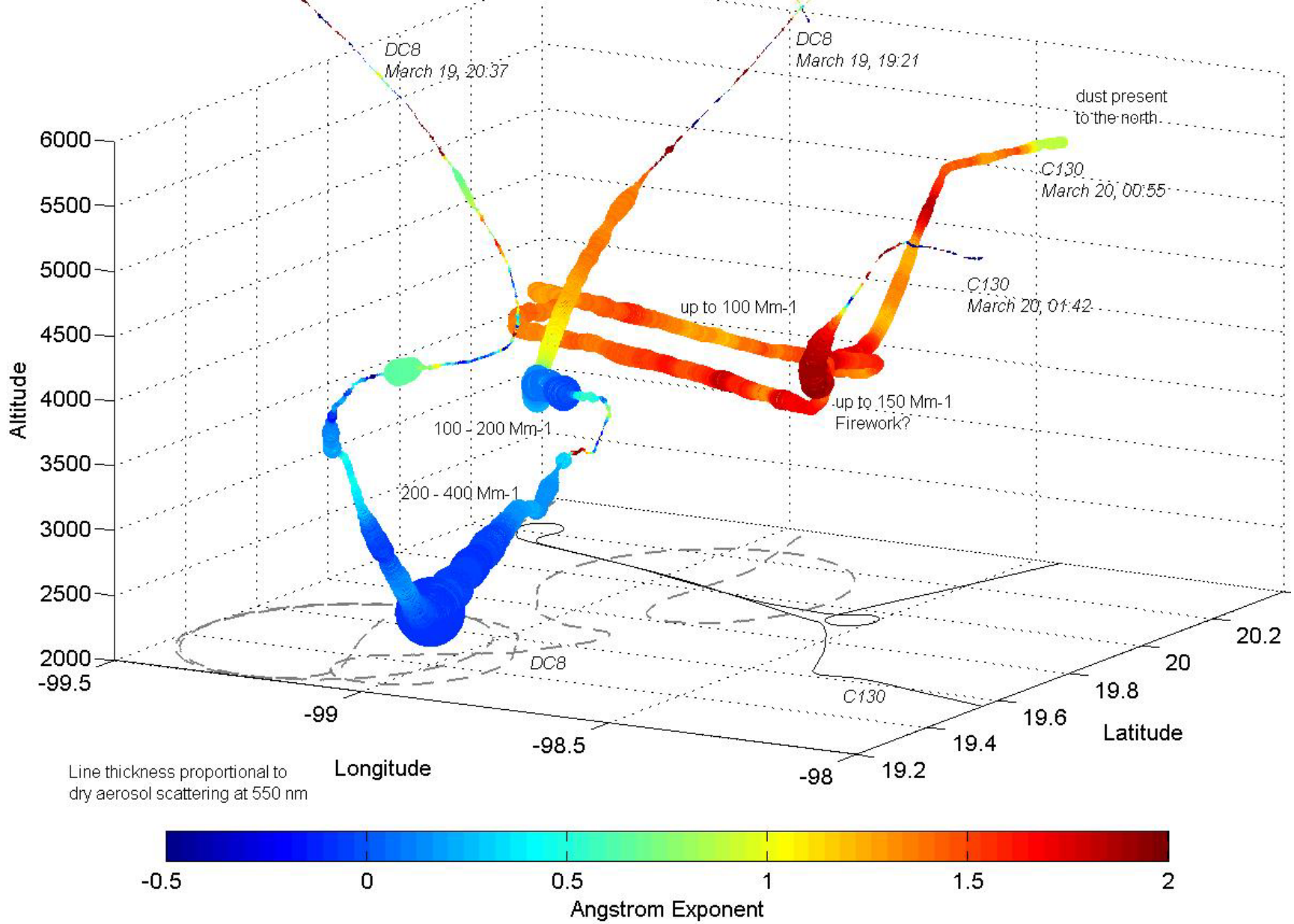
E. Browell, J. Hair et al.



Large depolarization suggests dust: consistent with AOD λ-dep

E. Browell, J. Hair et al.

Livingston/Russell, Aura ST, Boulder, Sep 2006



MIIB20060319MexicoCity3d2dflighttrackwormscav2.fig, proplot3d2dflighttrackwormscav2.m, Yohei, 2006-08-01

Y. Shinozuka, A. Clarke

Summary (work in progress)

- 4 days of OMI-J31 coincidence (so far)
- 10 Mar over Gulf: OMI & AATS AODs agree for OMI cells closest to J31 min-alt leg.

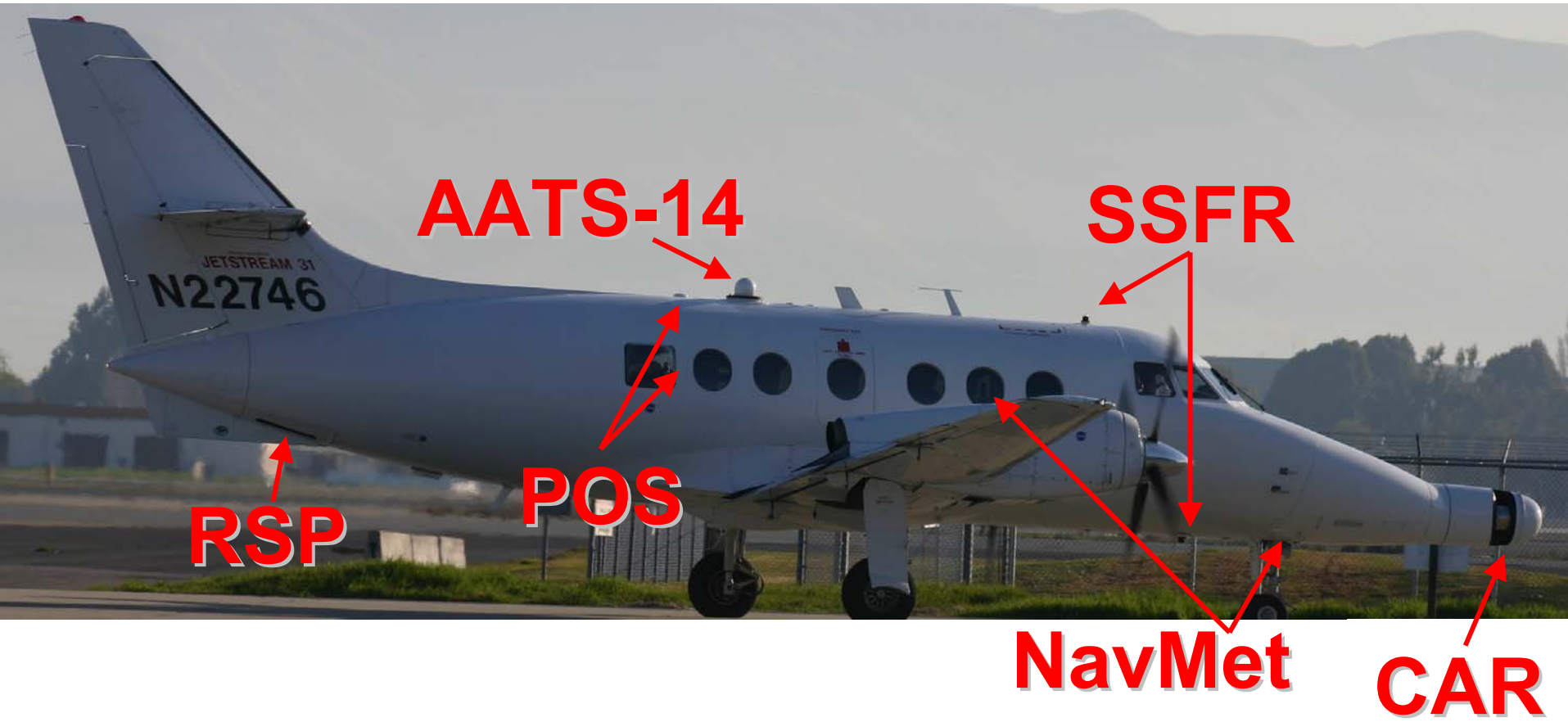
  More cells possible by extending allowed range of OMI SSA
- 3 Mar (not shown) similar agreement over Gulf
- 19 Mar, Mexico City: Much more complicated, but richer data set.

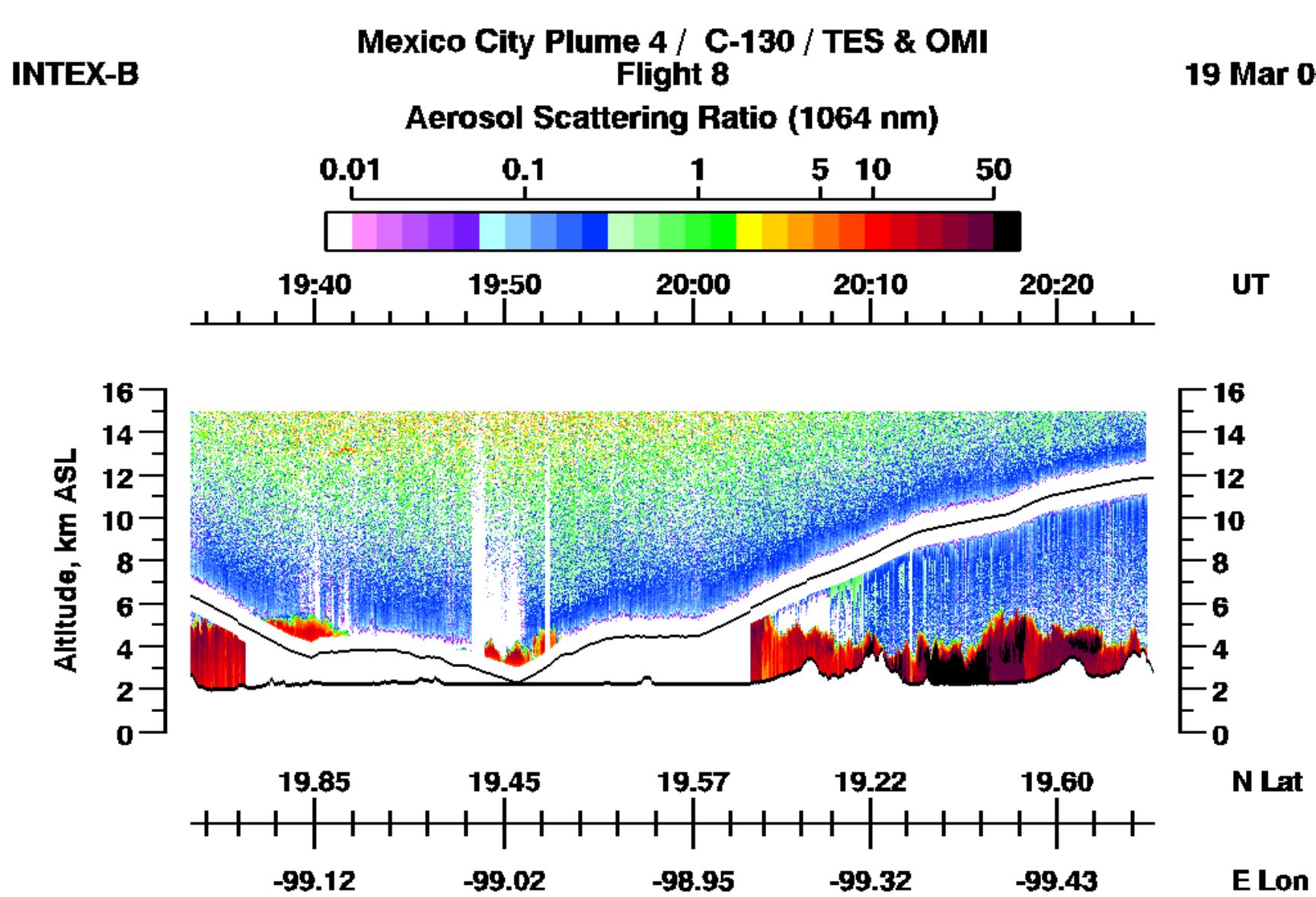
  - DC-8 lidar, in situ
  - Not Shown: J31 RSP (goal: AOD, size, n_r, n_i, shape retrievals below J31)
  - Surface albedo (J31 SSFR) & BRDF (J31 RSP & CAR)

End of Presentation

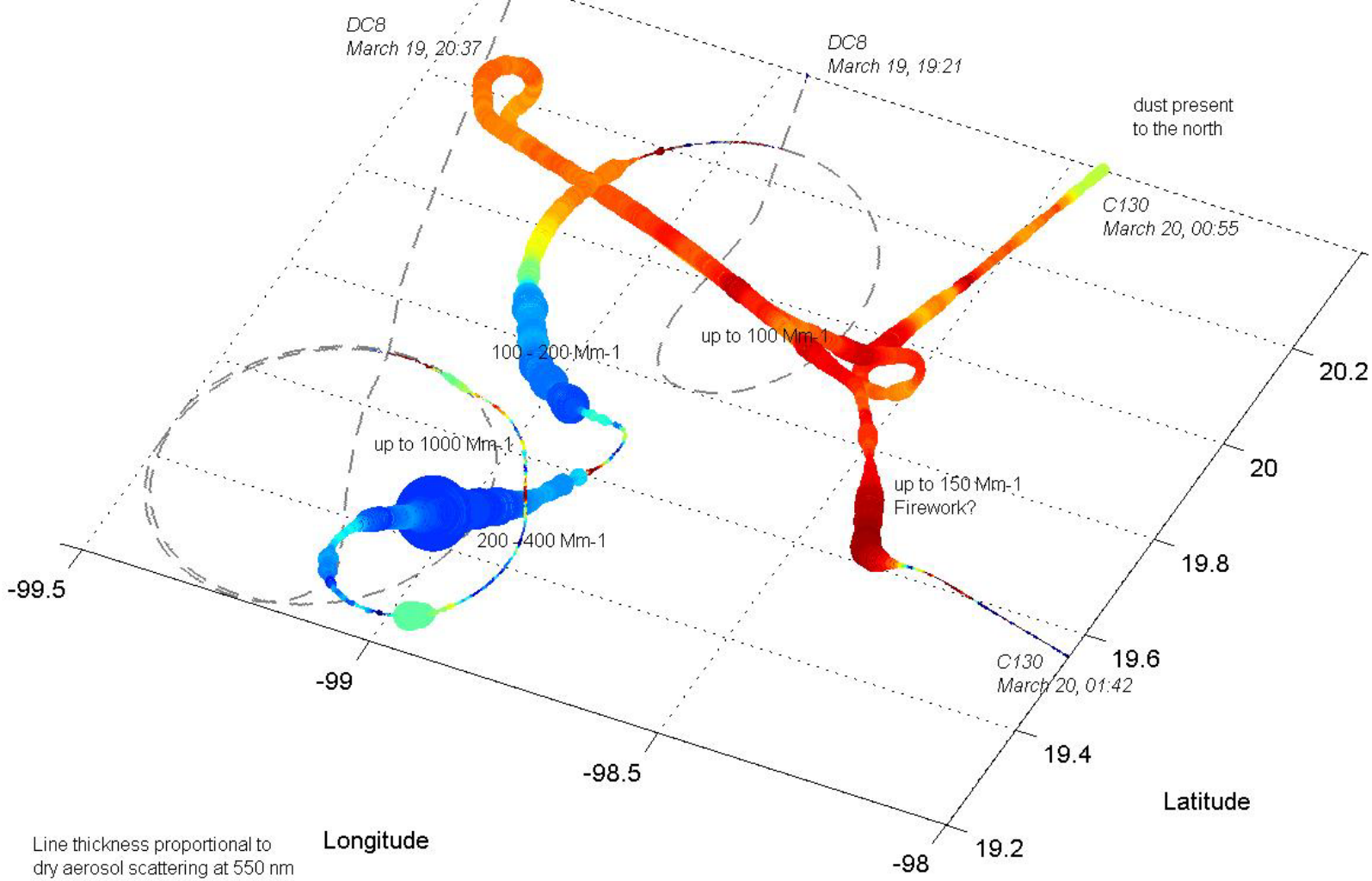
Remaining Slides are Backup

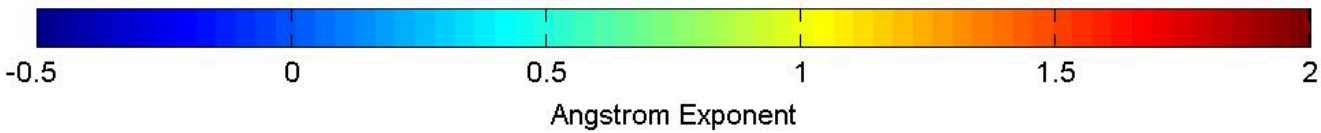
J31 in INTEX-B/MILAGRO: Instrument Locations





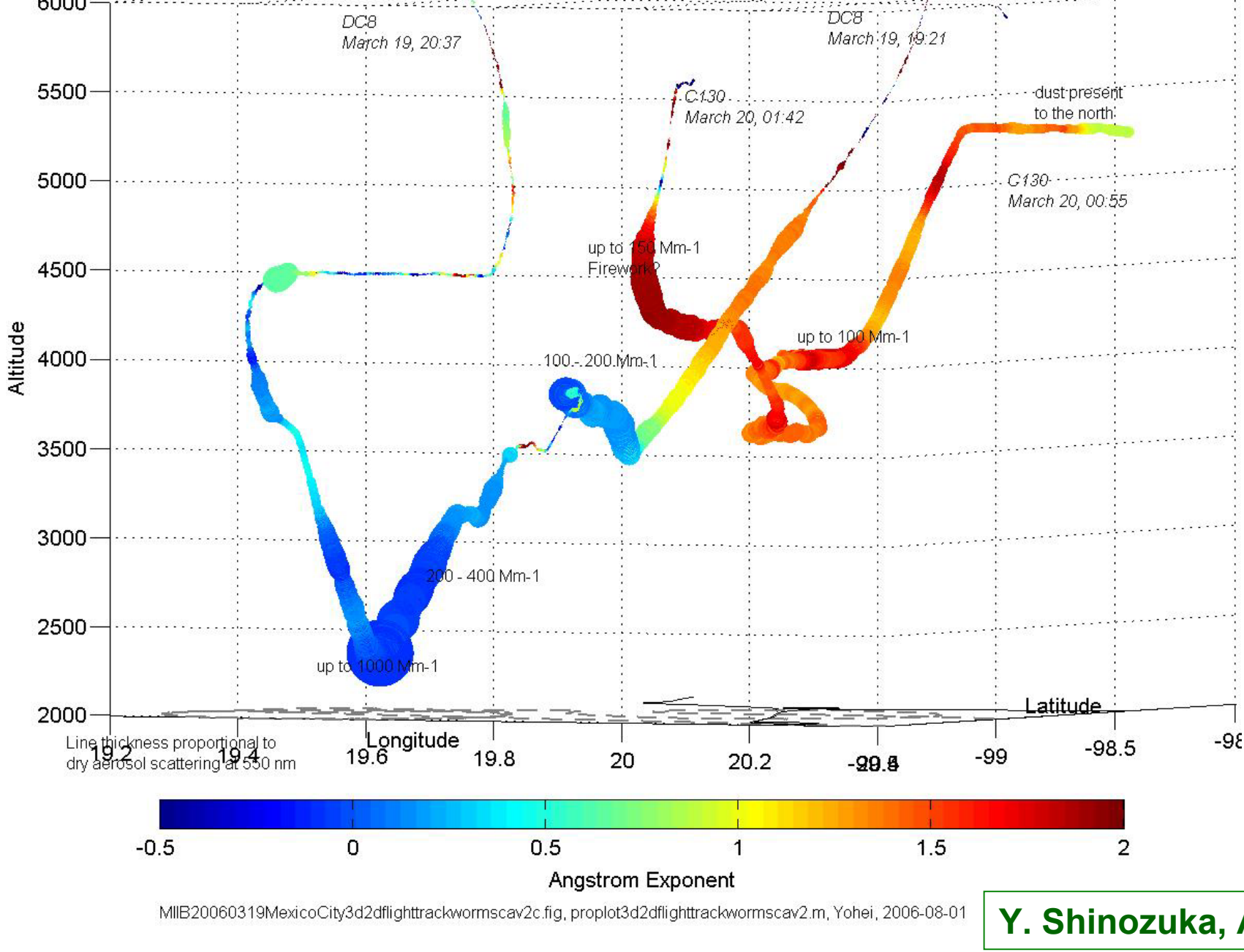
E. Browell, J. Hair et al.





MIIB20060319MexicoCity3d2dflighttrackwormscav2b.fig, proplot3d2dflighttrackwormscav2.m, Yohei, 2006-08-01

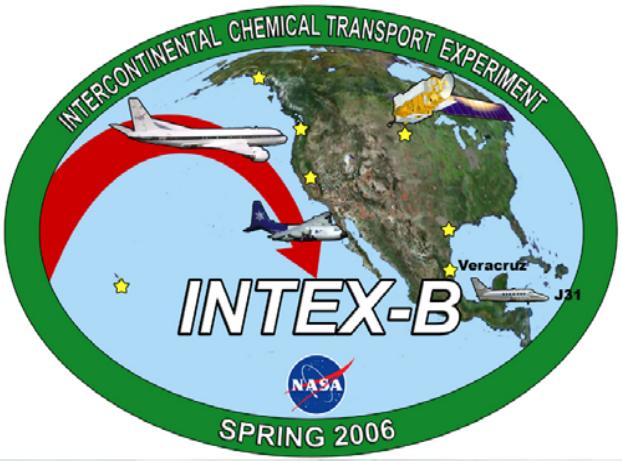
Y. Shinozuka, A. Clarke



MIIB20060319MexicoCity3d2dflighttrackwormscav2c.fig, proplot3d2dflighttrackwormscav2.m, Yohei, 2006-08-01

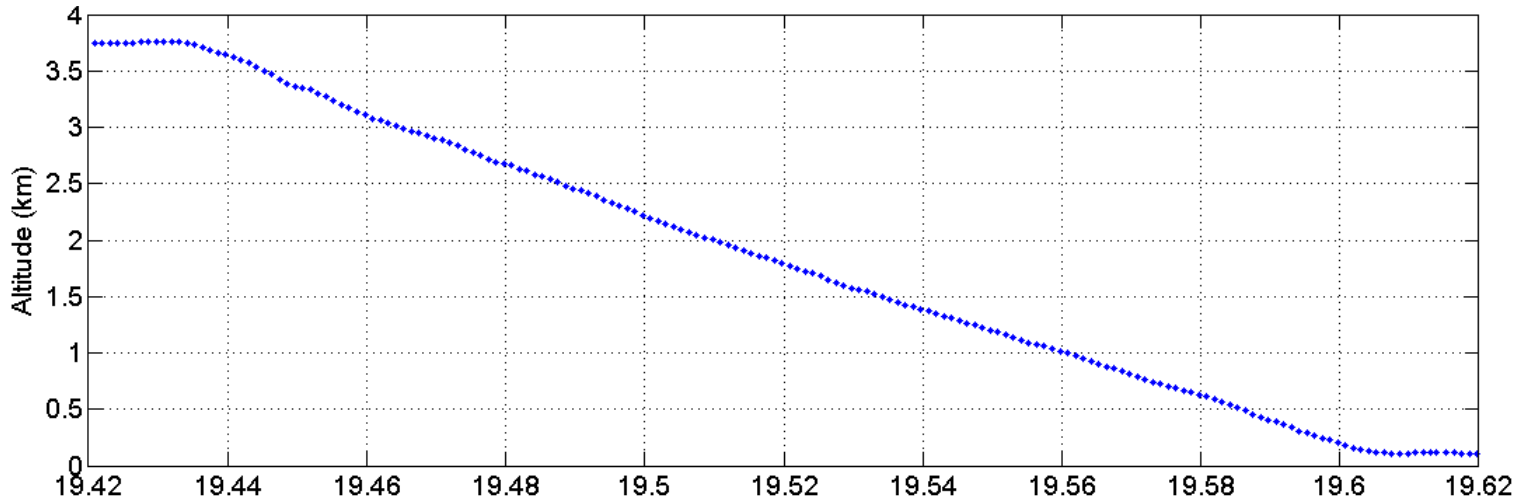
Y. Shinozuka, A. Clarke

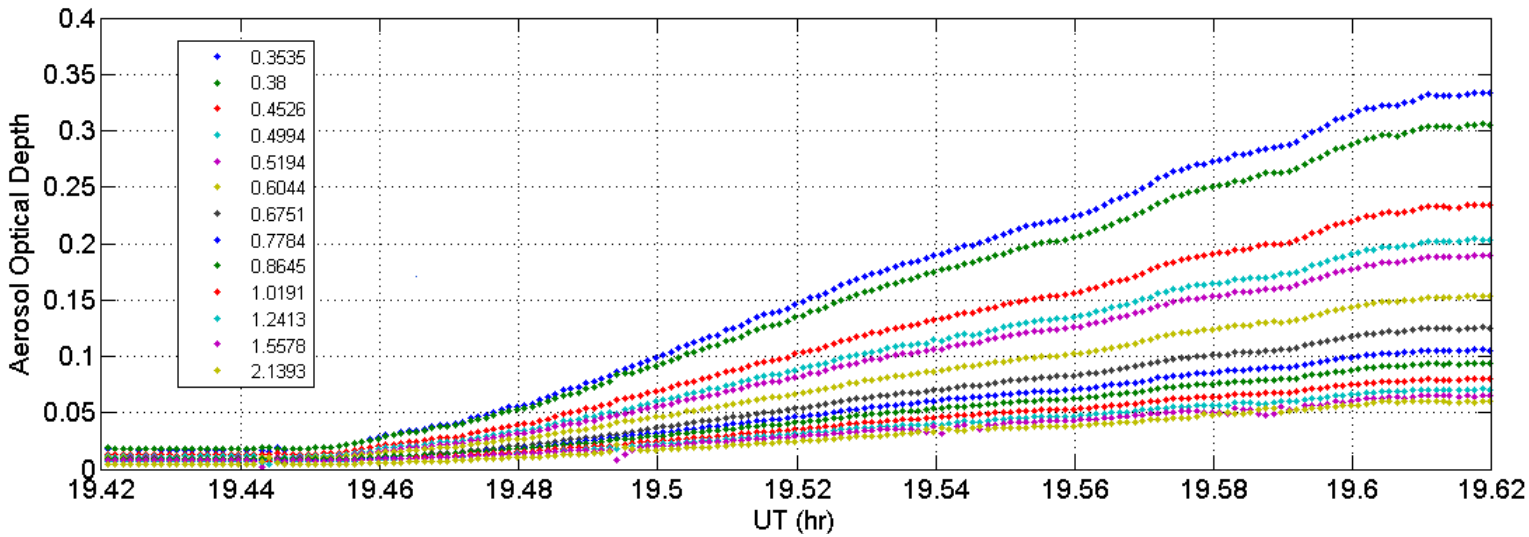
Aerosol Optical Depths from Airborne Sunphotometry in INTEX-B/MILAGRO as a Validation Tool for the Ozone Monitoring Instrument (OMI) on Aura



Aura Validation & Science Team Meeting
Boulder, CO
Sep 2006

10 Mar 2006, J31 Flight VER 05
Altitude & AOD on first descent



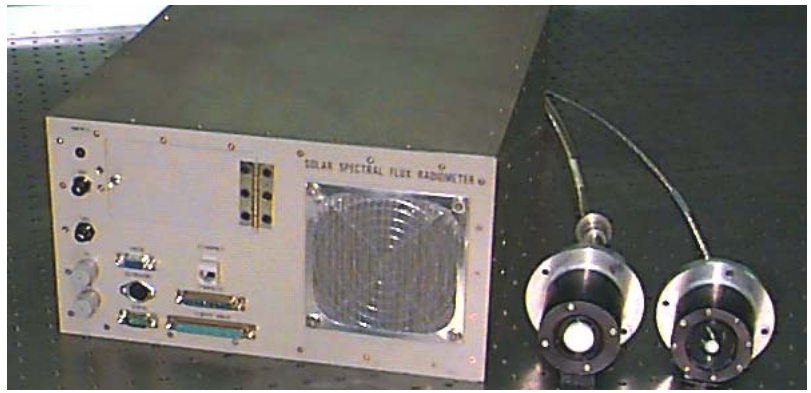


UT

J31 in INTEX-B/MILAGRO: Payload

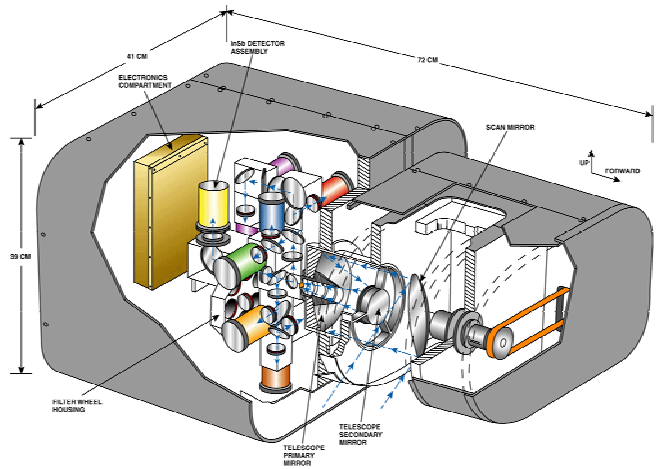
Ames Airborne Tracking Sun-photometer (AATS)

Solar Spectral Flux Radiometer (SSFR)



Research Scanning Polarimeter (RSP)

Cloud Absorption Radiometer (CAR)

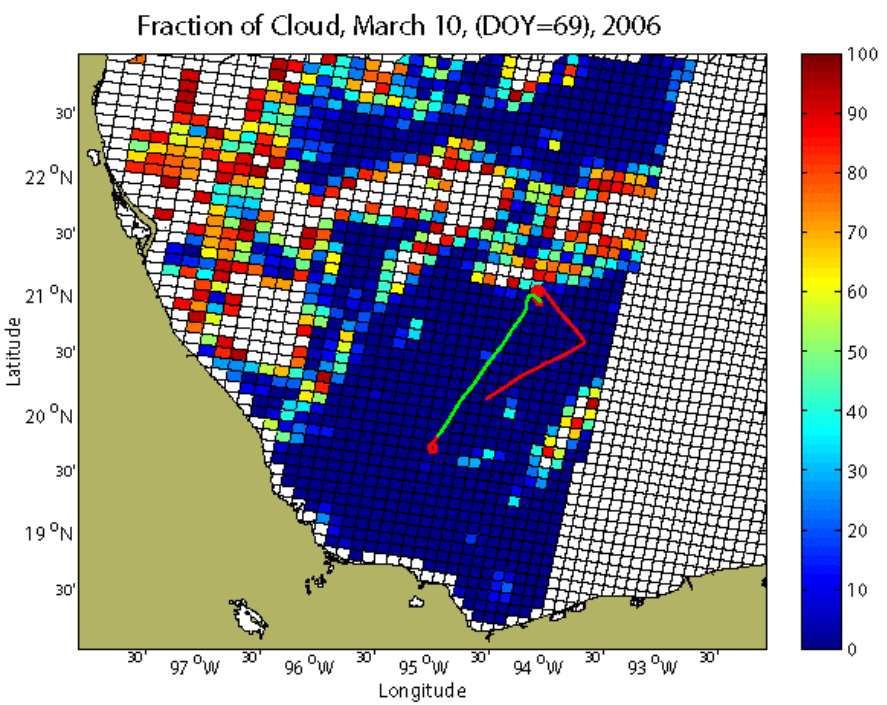


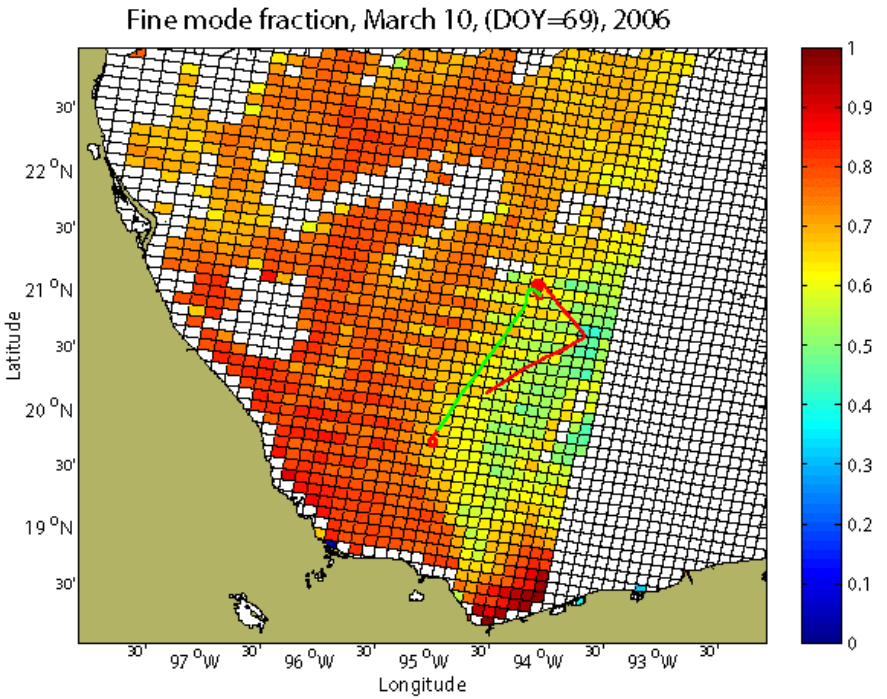
Position & Orientation System (POS)

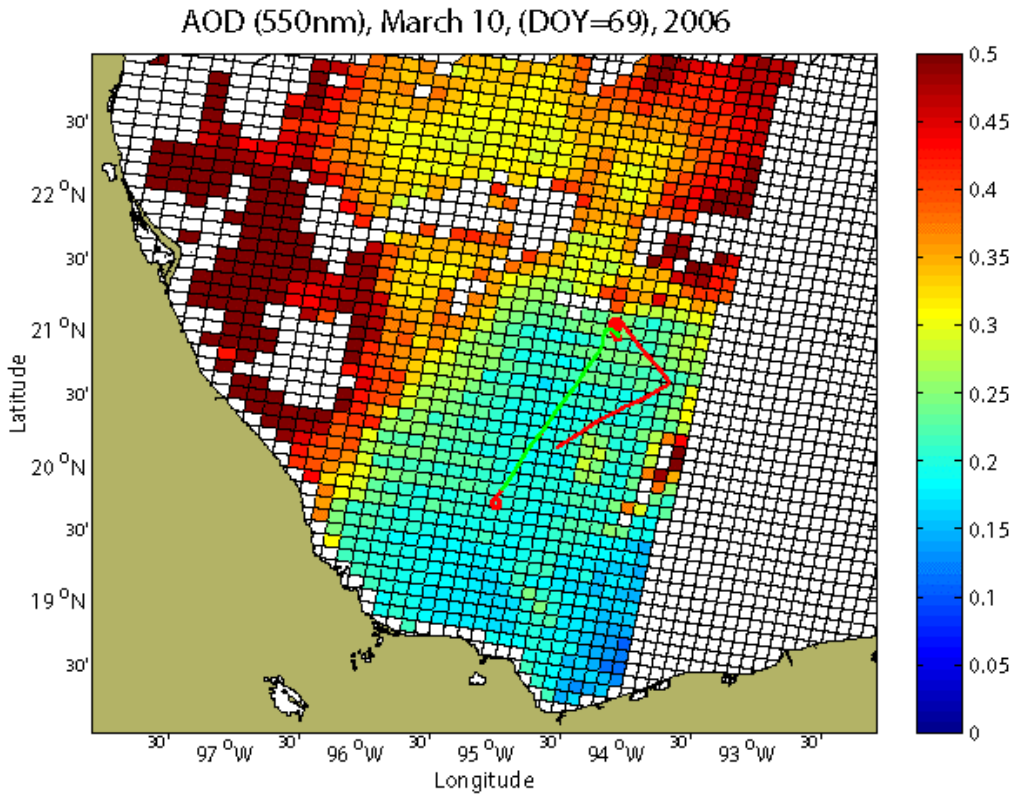
Met Sensors & Nav/Met Data System

BACKGROUND

MODIS-Terra cloud & aerosol products, 10 Mar 2006 with J31 flight track superimposed



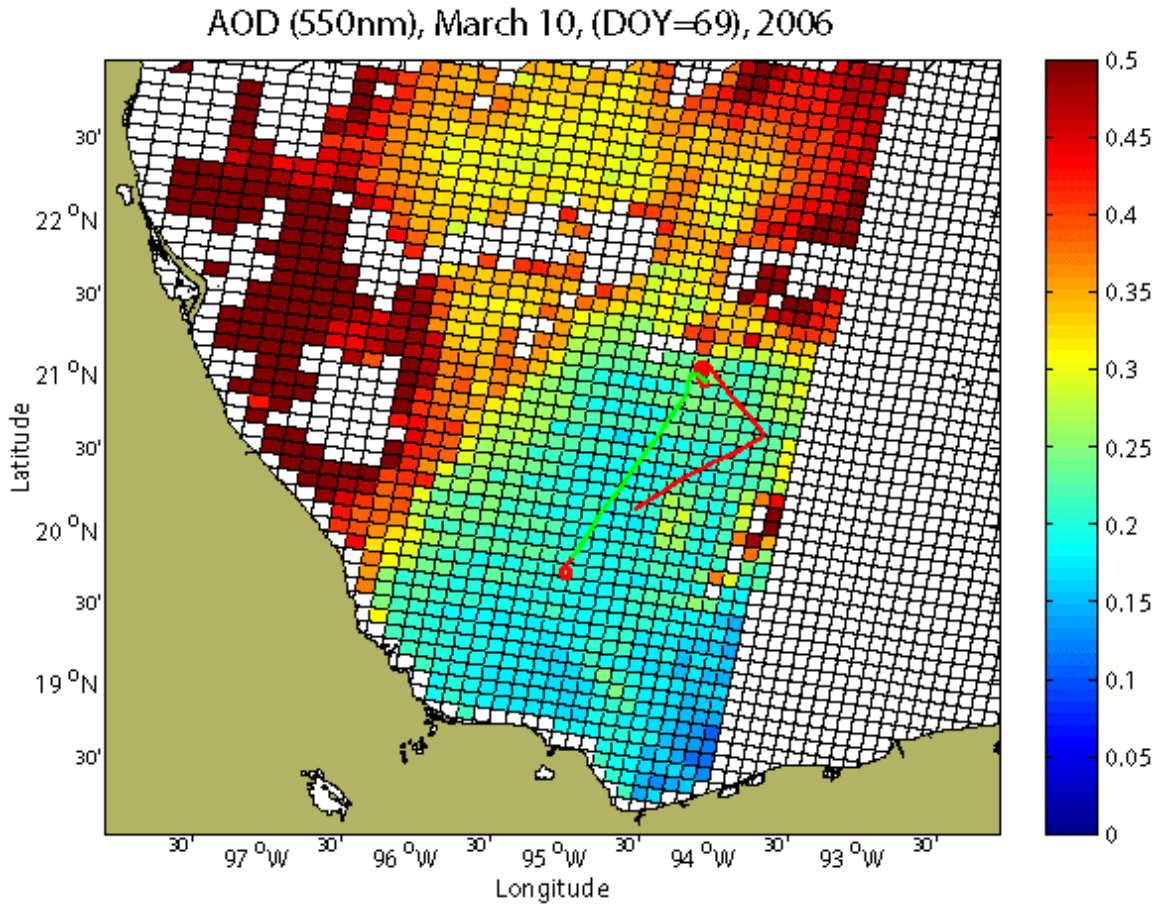




Goal: Compare Aerosol Optical Depth (AOD) from AATS Measurements and OMI Retrievals

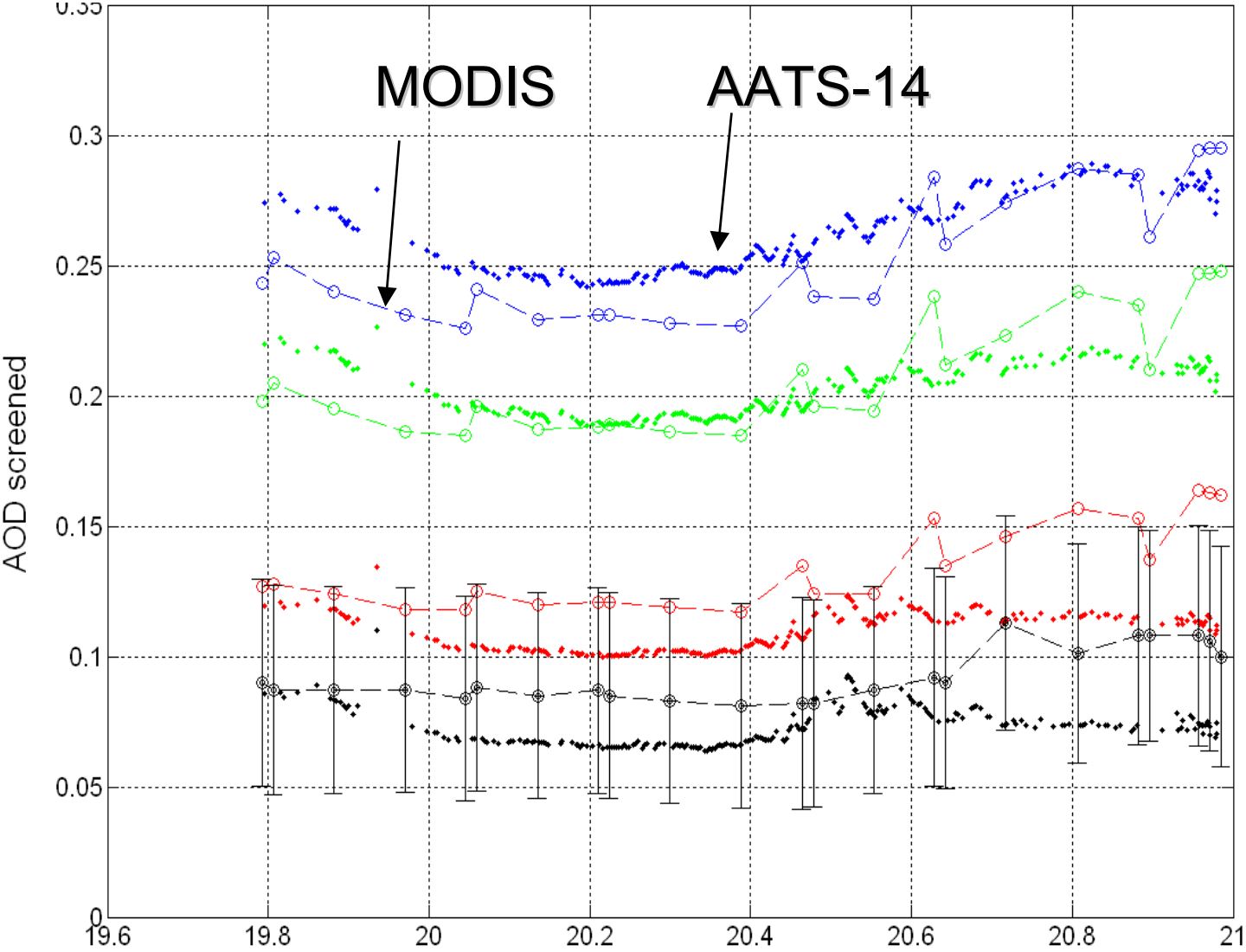
BACKGROUND

MODIS-Terra AOD Field, 10 Mar 2006 with J31 flight track superimposed



) 2006

Comparison of Aerosol Optical Depth (AOD) from MODIS-Terra and AATS-14 in INTEX-B



March 10, 2006. MODIS-Terra/J31 coincidence over Gulf of Mexico

MODIS/AATS

Wavelengths (nm)

470 / 453

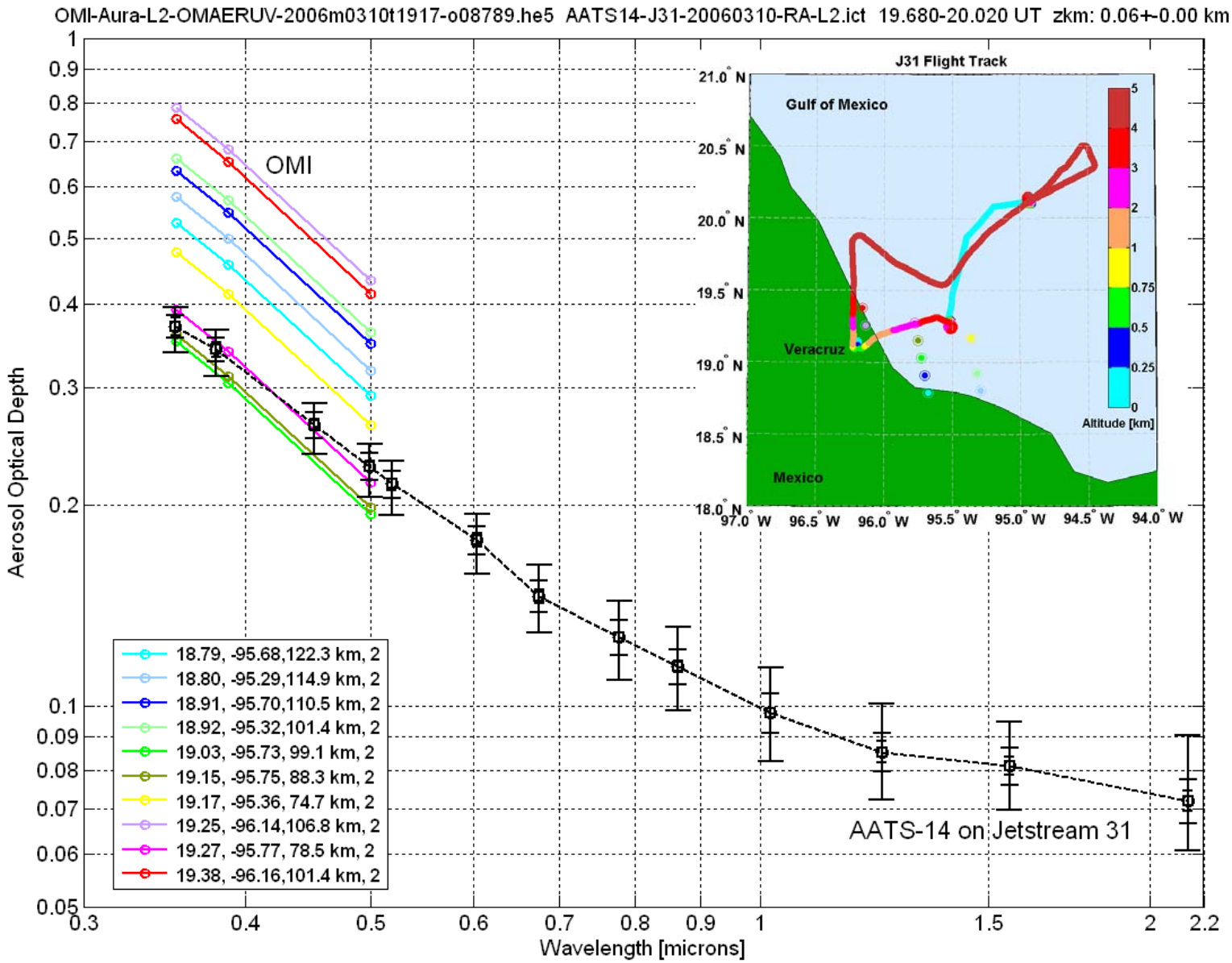
550 / 519

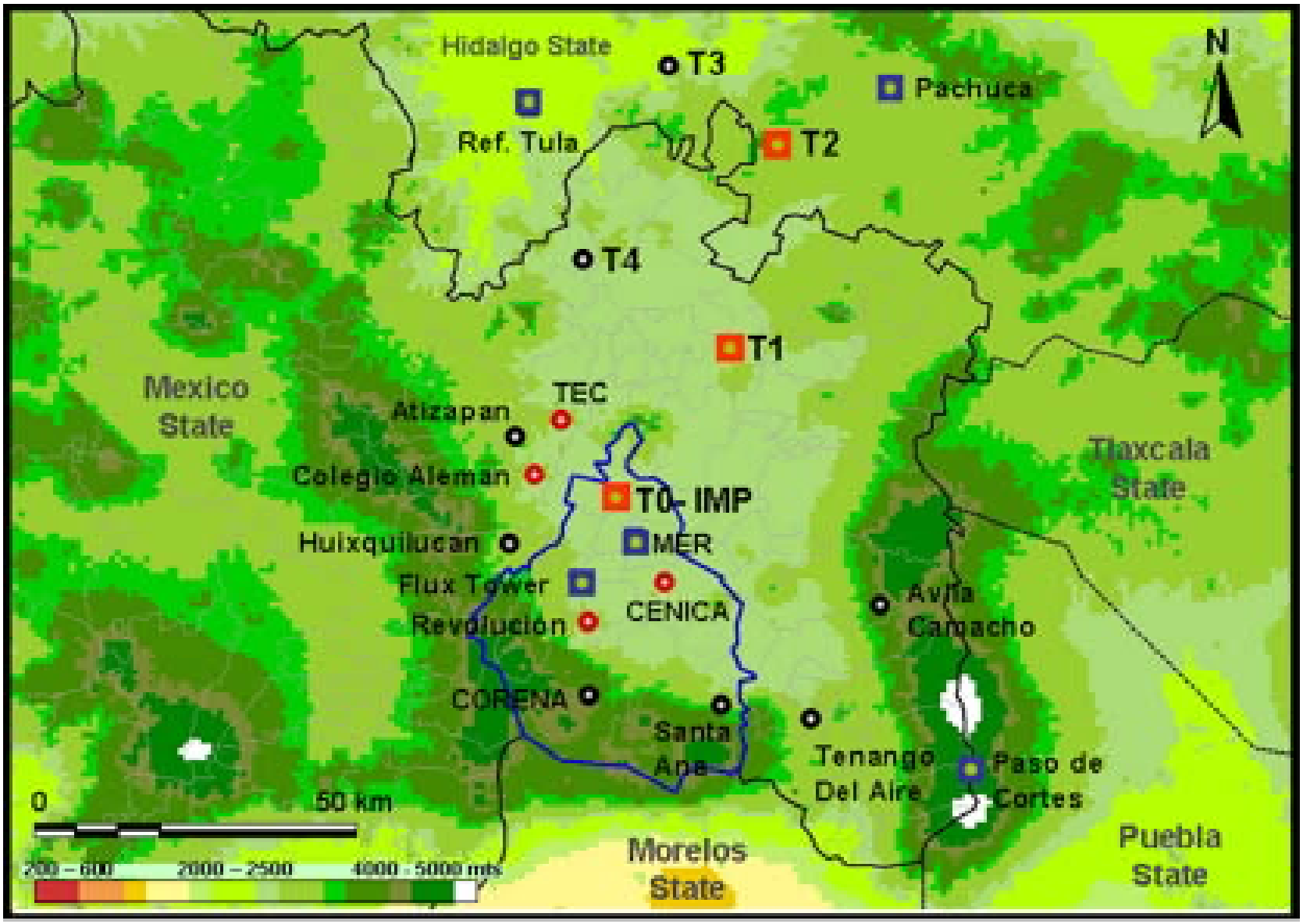
870 / 864

2140 / 2139

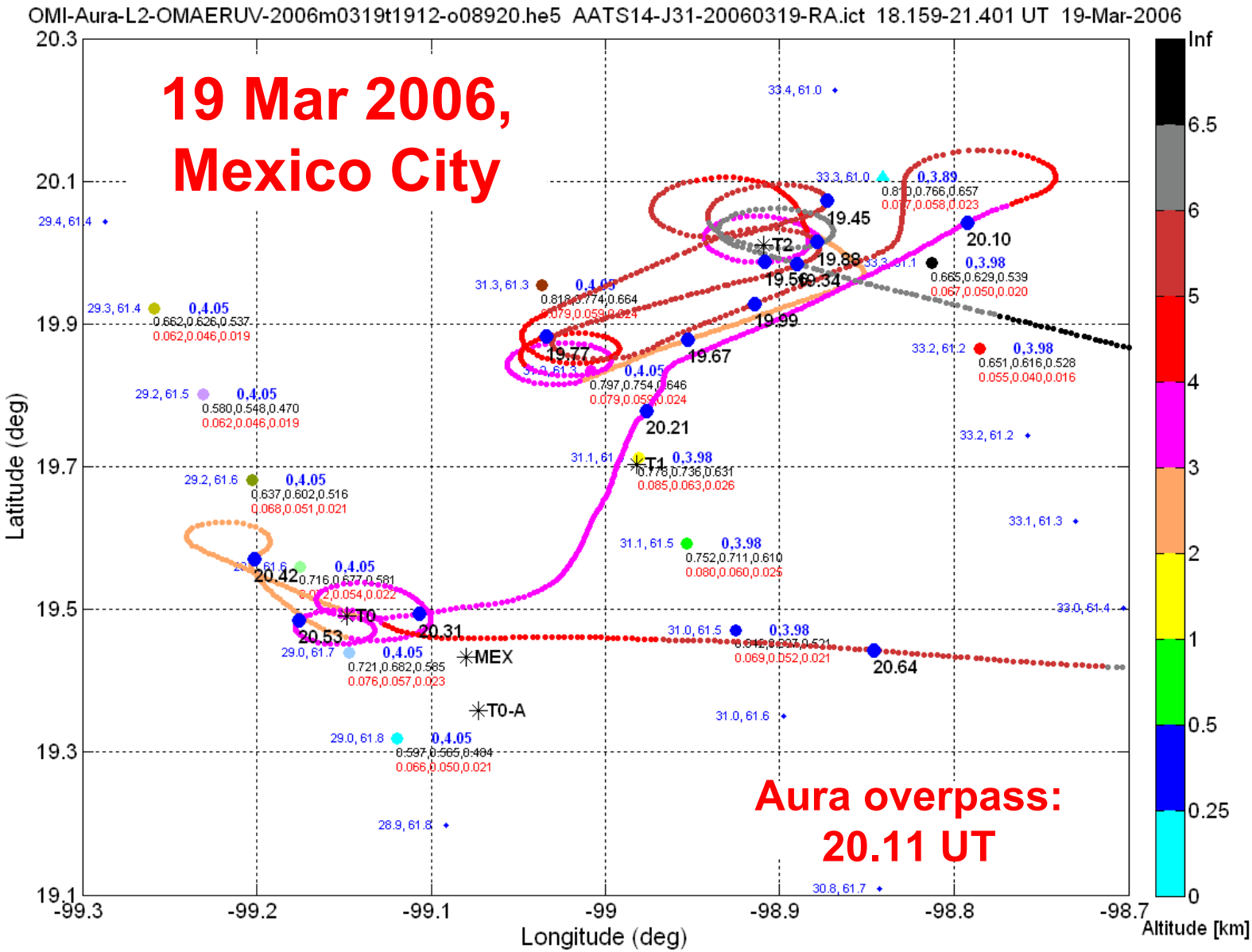
PRELIMINARY DATA

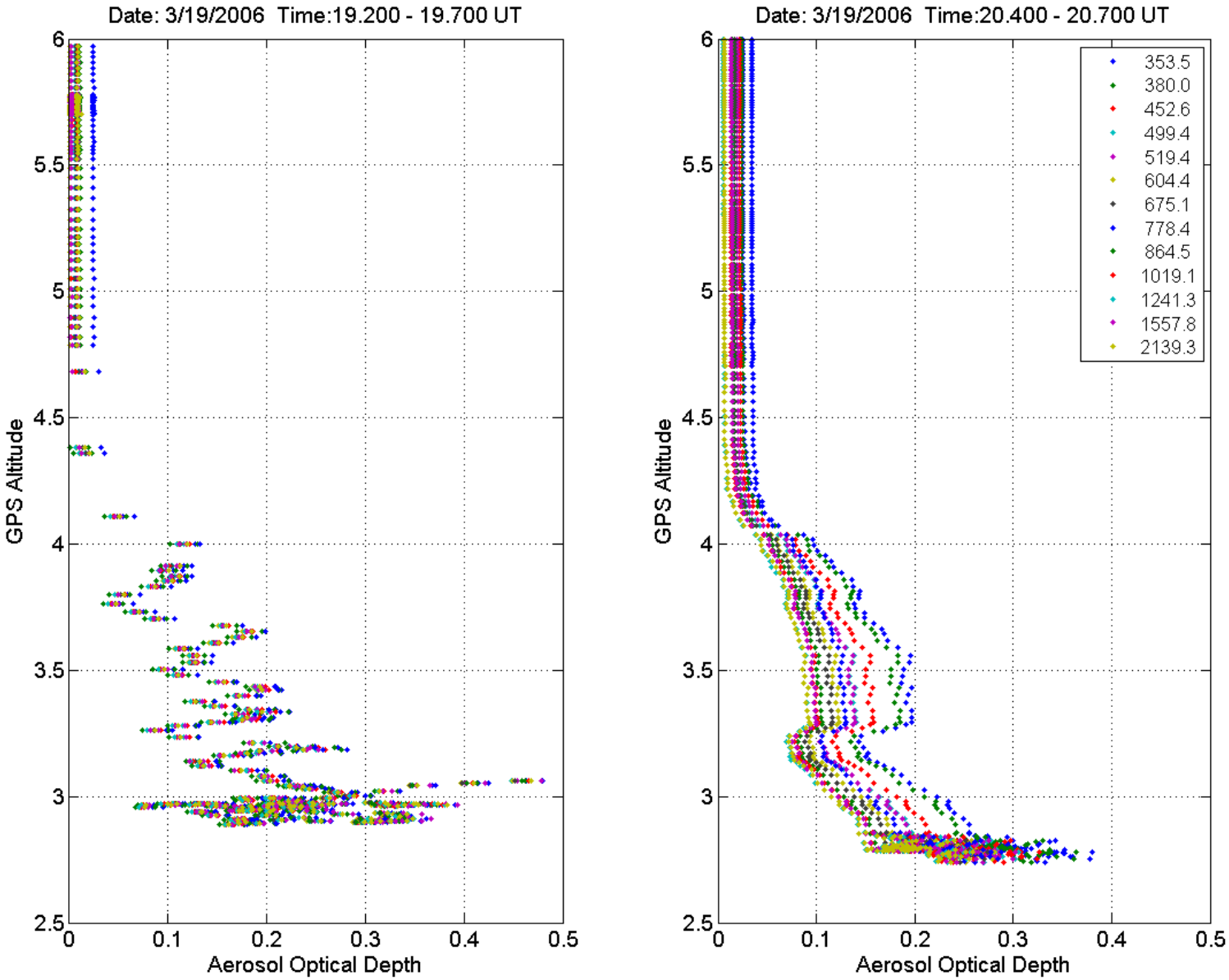
J. Redemann, J. Livingston et al.


OMI-Aura-L2-OMAERUV-2006m0310t1917-o08789.he5 AATS14-J31-20060310-RA-L2.ict 19.680-20.020 UT zkm: 0.06+-0.00 km
Aerosol Optical Depth
Wavelength [microns]
OMI
AATS-14 on Jetstream 31
J31 Flight Track
Gulf of Mexico
Veracruz
Mexico
Altitude [km]
21.0° N
20.5° N
20.0° N
19.5° N
19.0° N
18.5° N
18.0° N
97.0° W
96.5° W
96.0° W
95.5° W
95.0° W
94.5° W
94.0° W
18.79, -95.68,122.3 km, 2
18.80, -95.29,114.9 km, 2
18.91, -95.70,110.5 km, 2
18.92, -95.32,101.4 km, 2
19.03, -95.73, 99.1 km, 2
19.15, -95.75, 88.3 km, 2
19.17, -95.36, 74.7 km, 2
19.25, -96.14,106.8 km, 2
19.27, -95.77, 78.5 km, 2
19.38, -96.16,101.4 km, 2

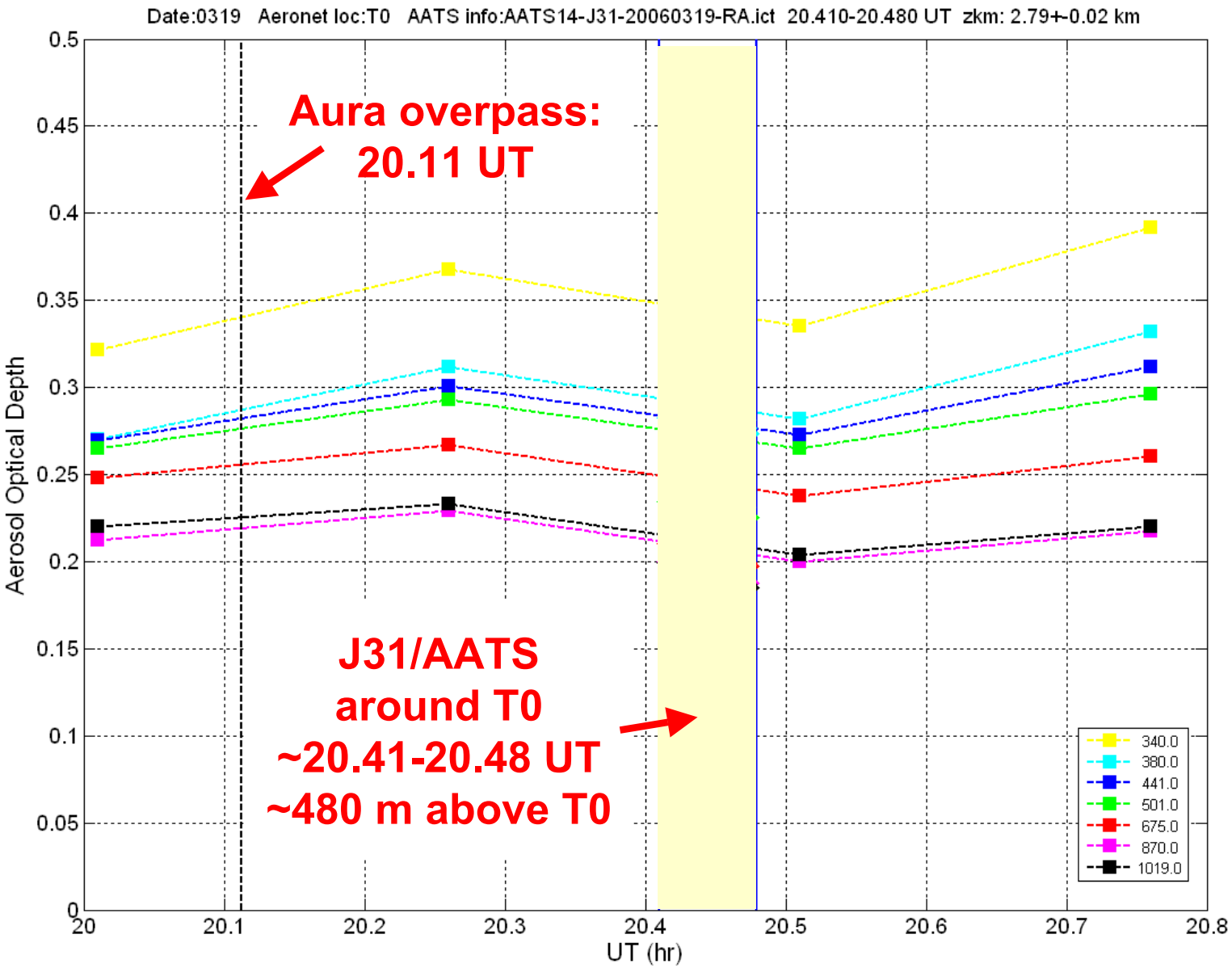

Hidalgo State
T3
Pachuca
N
Ref. Tula
T2
T4
T1
Mexico State
TEC
Atizapan
Colegio Aleman
T0 - IMP
Tlaxcala State
Huixquilucan
MER
Flux Tower
Revolucion
CENICA
Avila Camacho
CORENA
Santa Ana
Tenango Del Aire
Paso de Cortes
0
50 km
2000 – 2500
4000 - 5000 mts
Morelos State
Puebla State
Fixed site
Mobile site
Supersite
Other measurements

glint angle, satellite elev viewing angle printed in blue to left of each OMI location

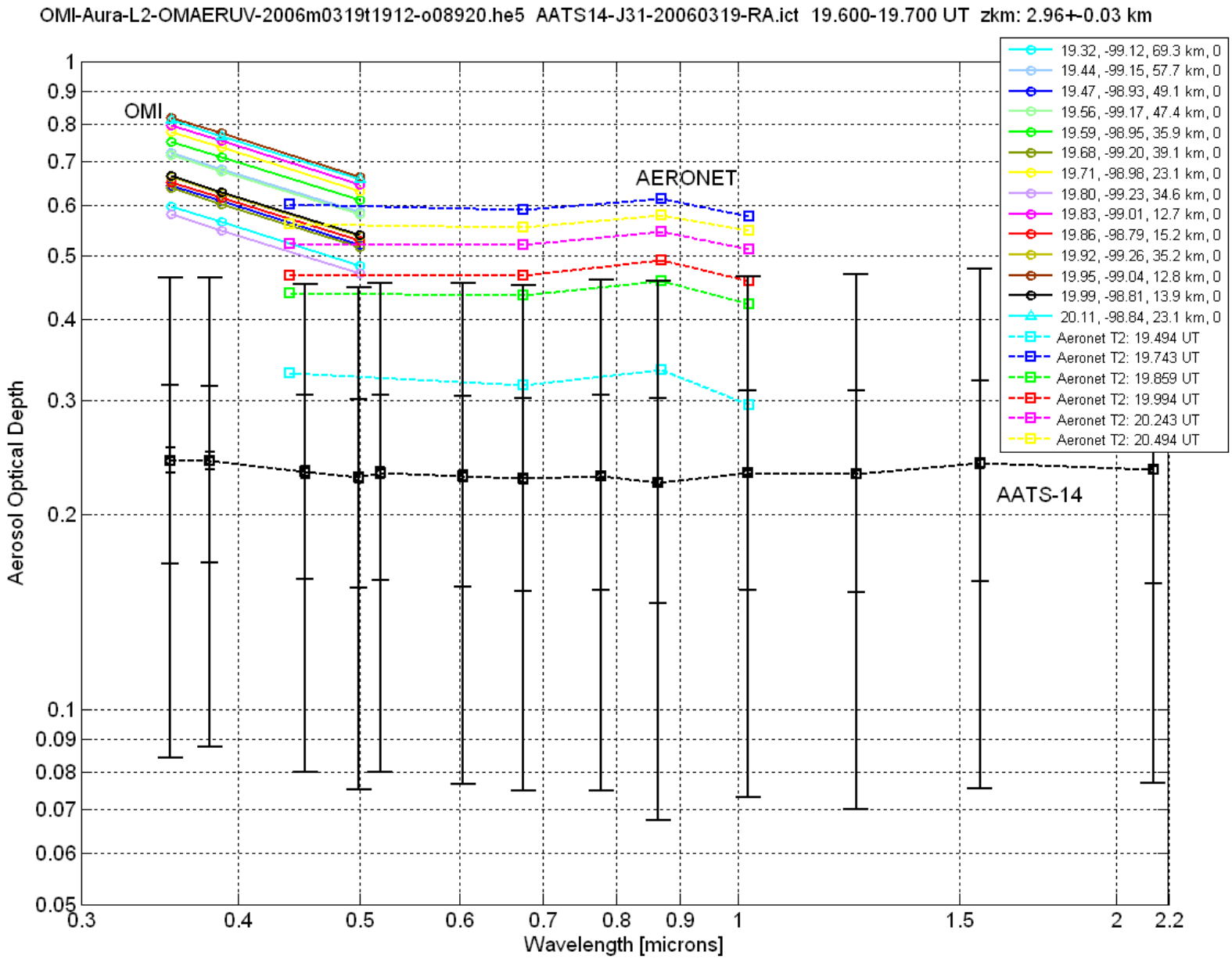



Date: 3/19/2006 Time:19.200 - 19.700 UT
GPS Altitude
Aerosol Optical Depth
6
5.5
5
4.5
4
3.5
3
2.5
0
0.1
0.2
0.3
0.4
0.5
Date: 3/19/2006 Time:20.400 - 20.700 UT
GPS Altitude
Aerosol Optical Depth
353.5
380.0
452.6
499.4
519.4
604.4
675.1
778.4
864.5
1019.1
1241.3
1557.8
2139.3

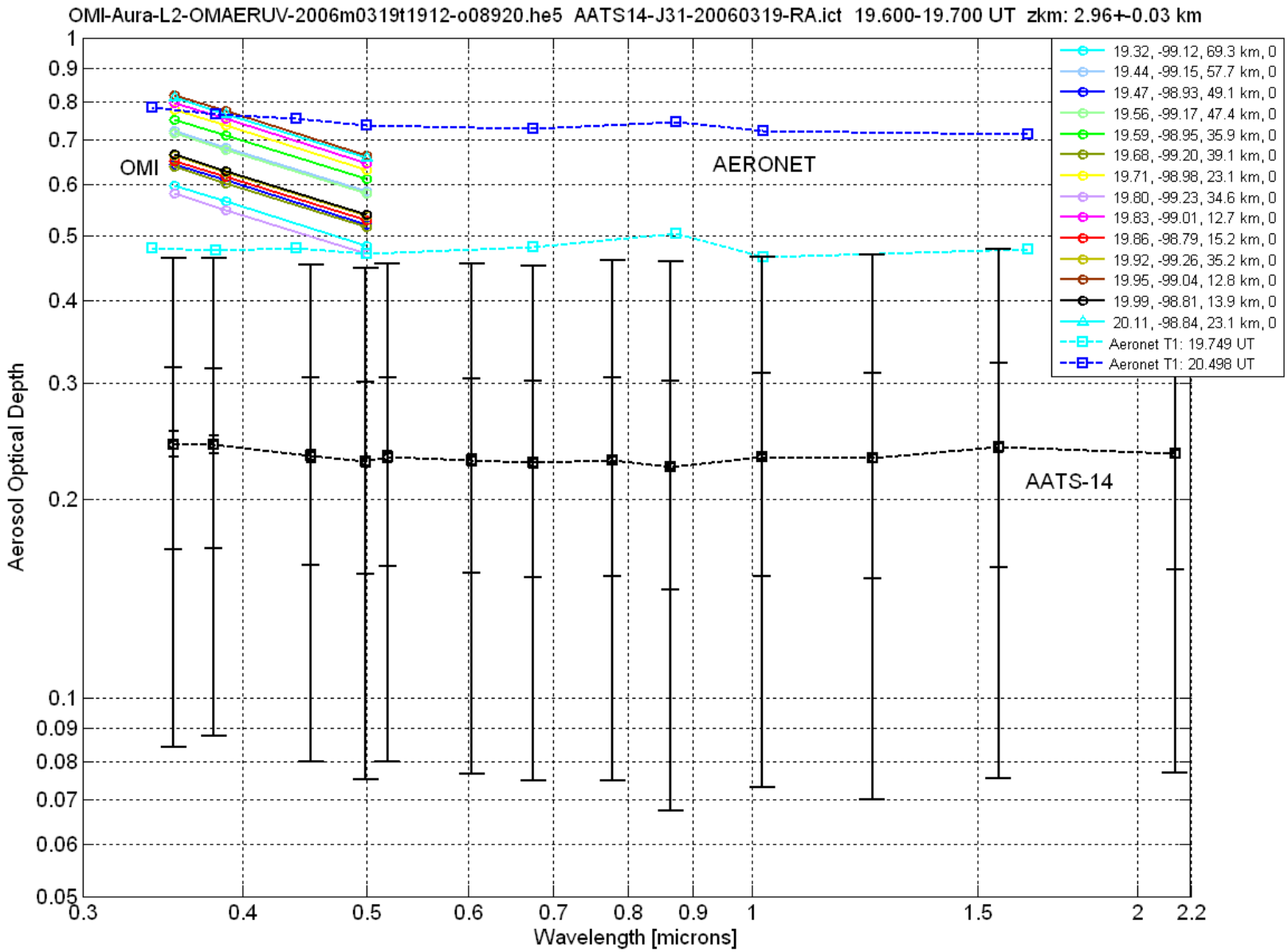
AERONET AOD at T0-A, 19 Mar 2006



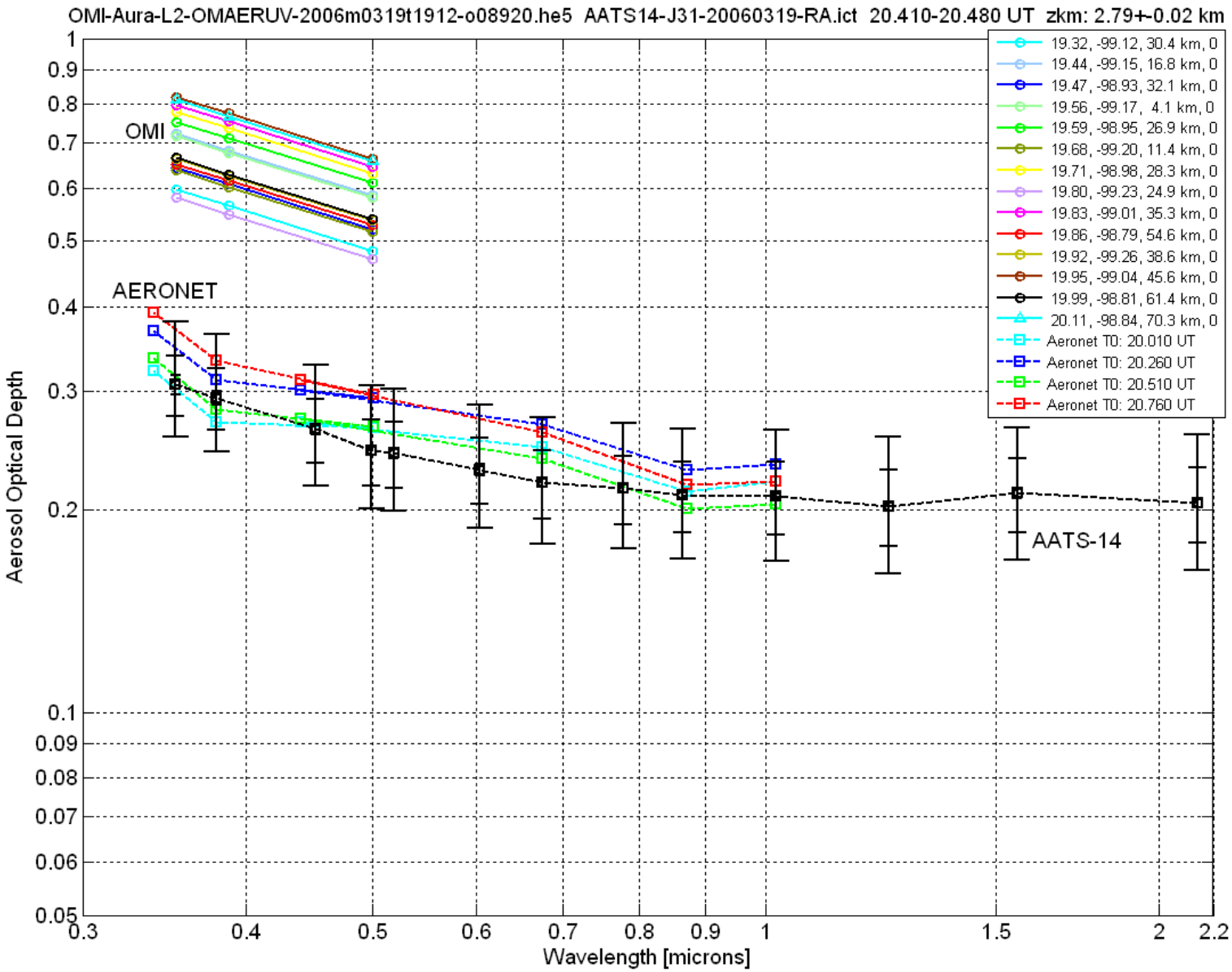
Aeronet T2; AATS near and SW of T2, NNW of T1



Aeronet T1; AATS near and SW of T2, NNW of T1

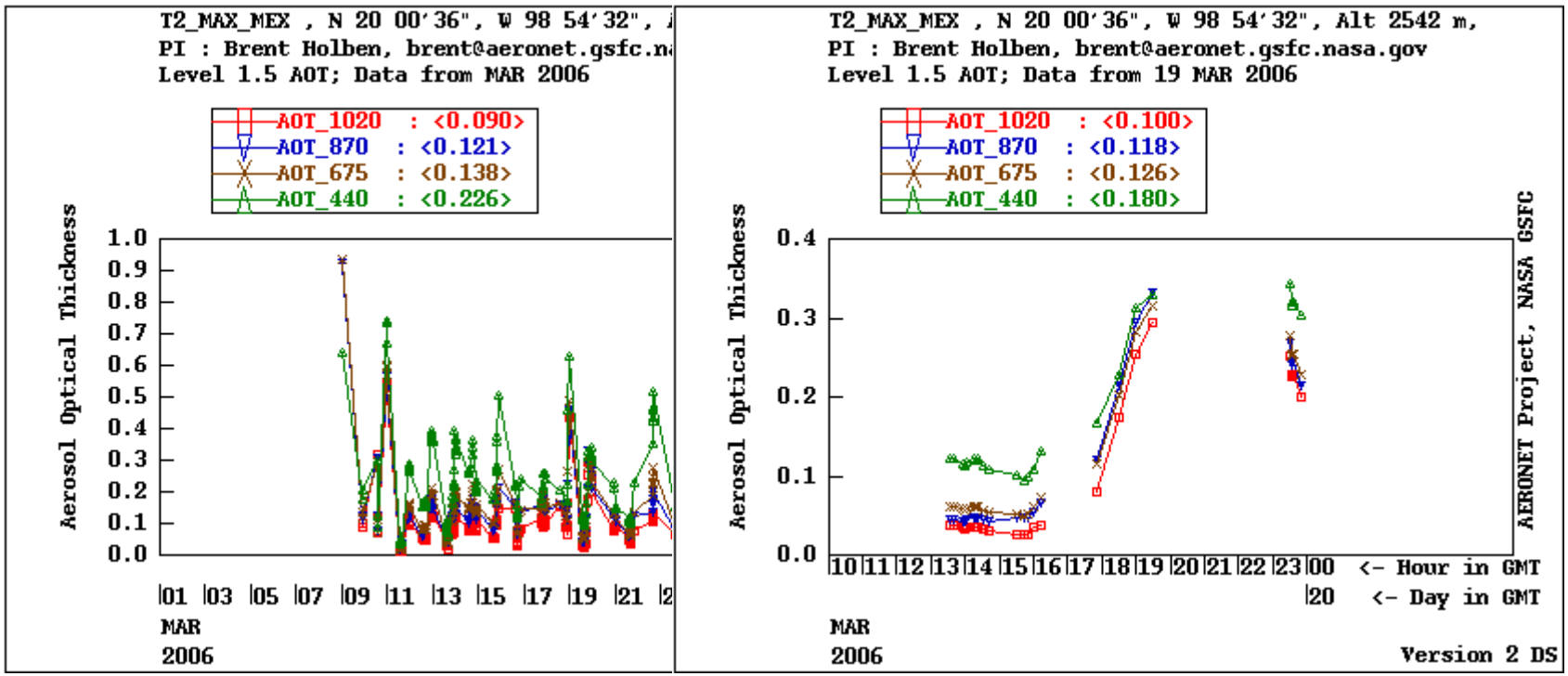


Aeronet T0; AATS NW of T0



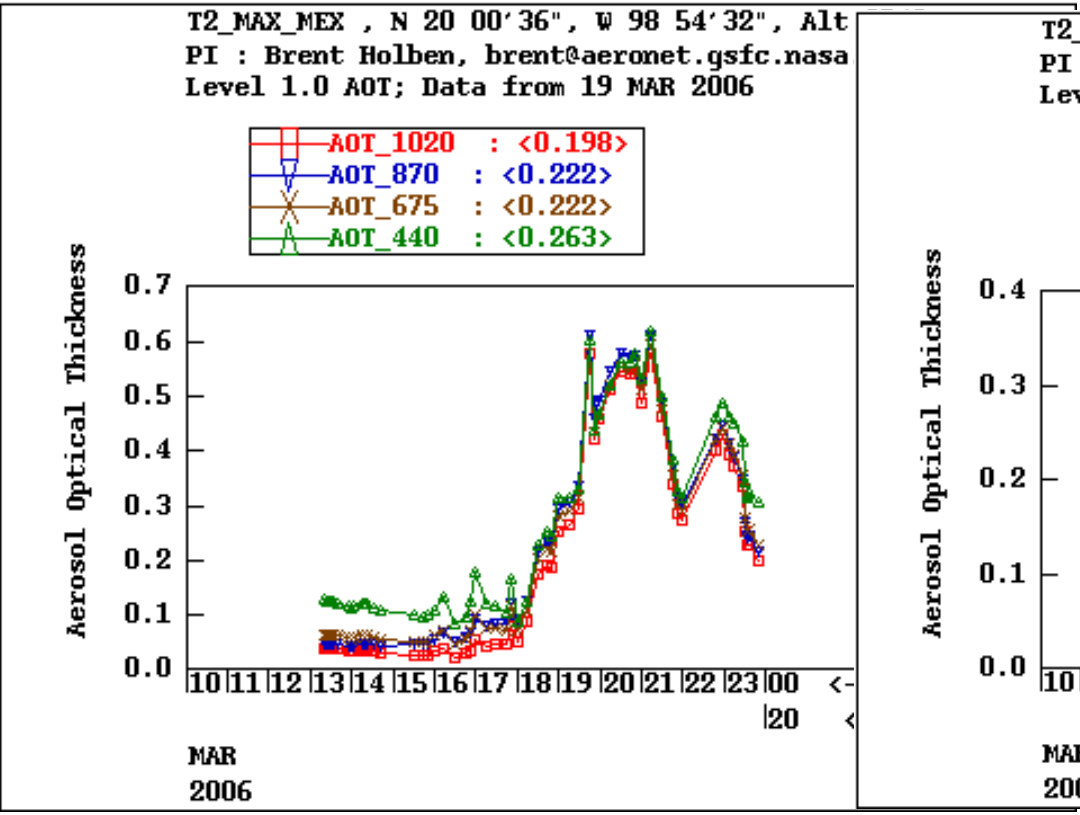
AERONET T2

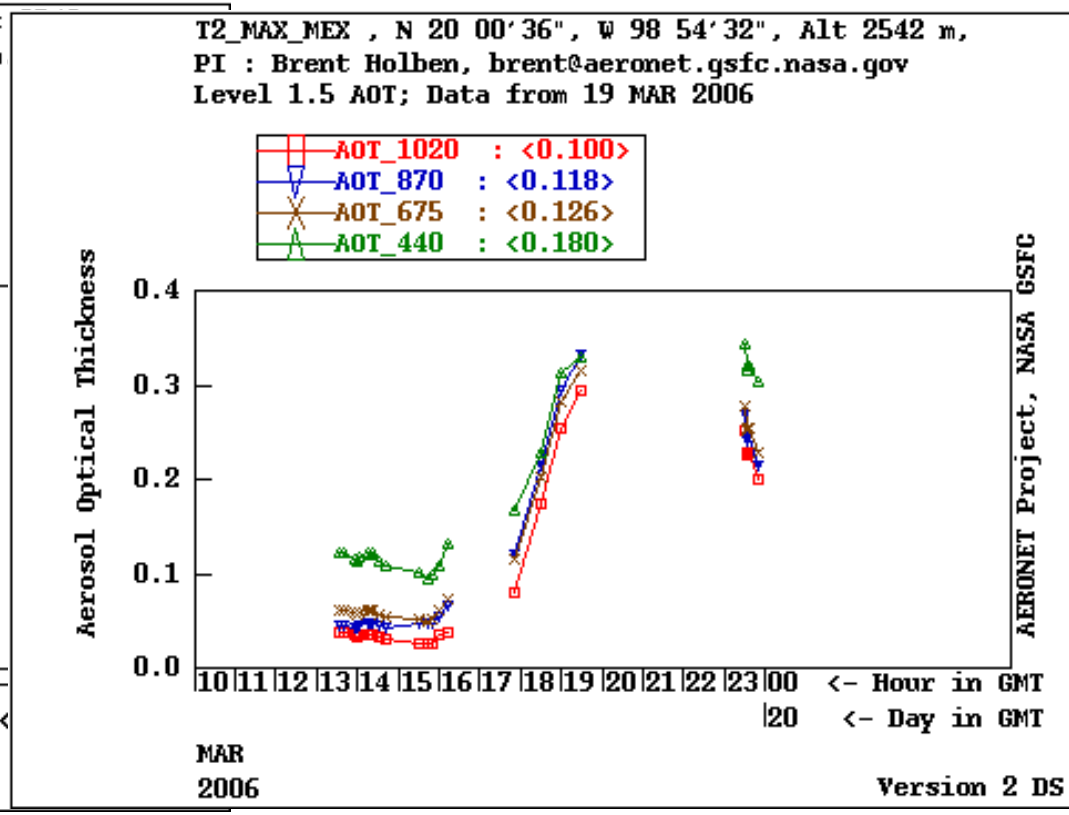
AOD Level 1.5 data from MAR 19 of 2006



B. Holben et al.

AERONET T2

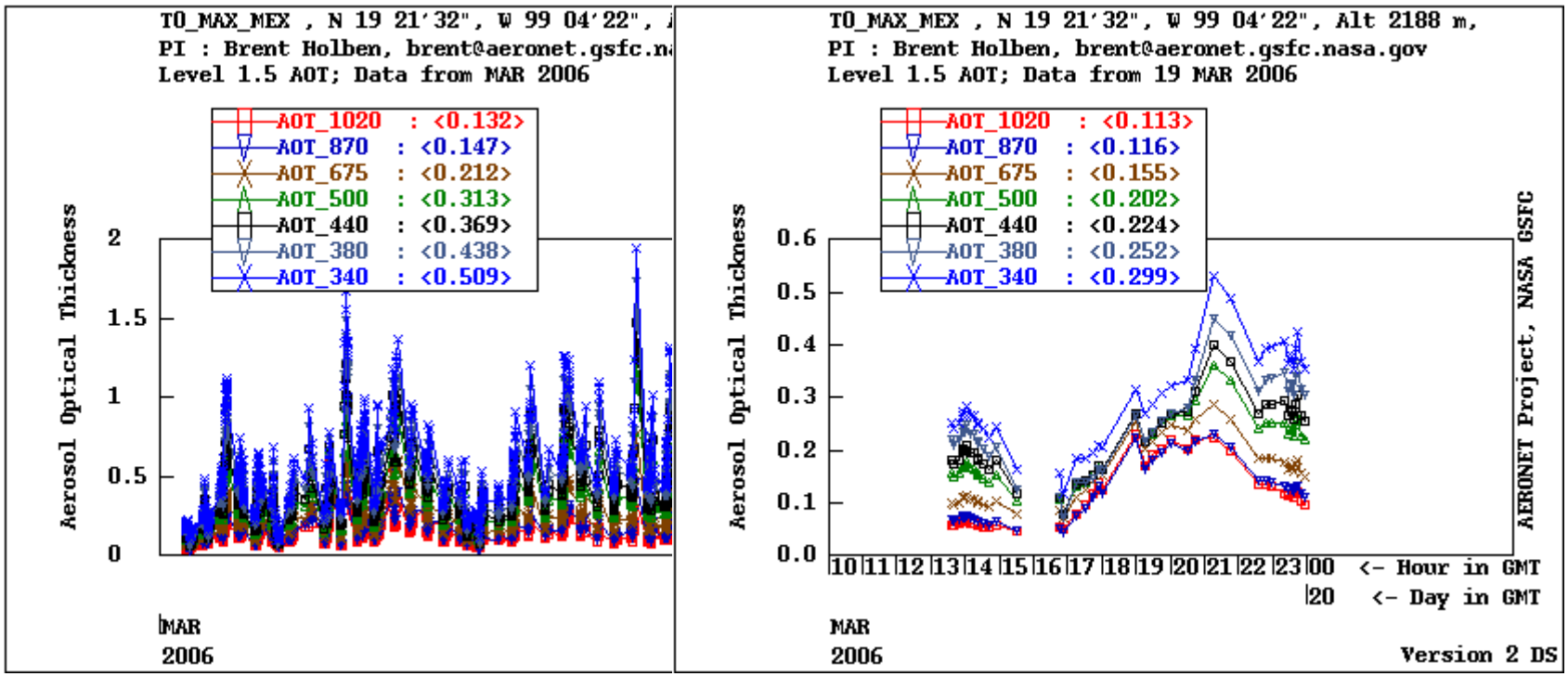




B. Holben et al.

AERONET T0

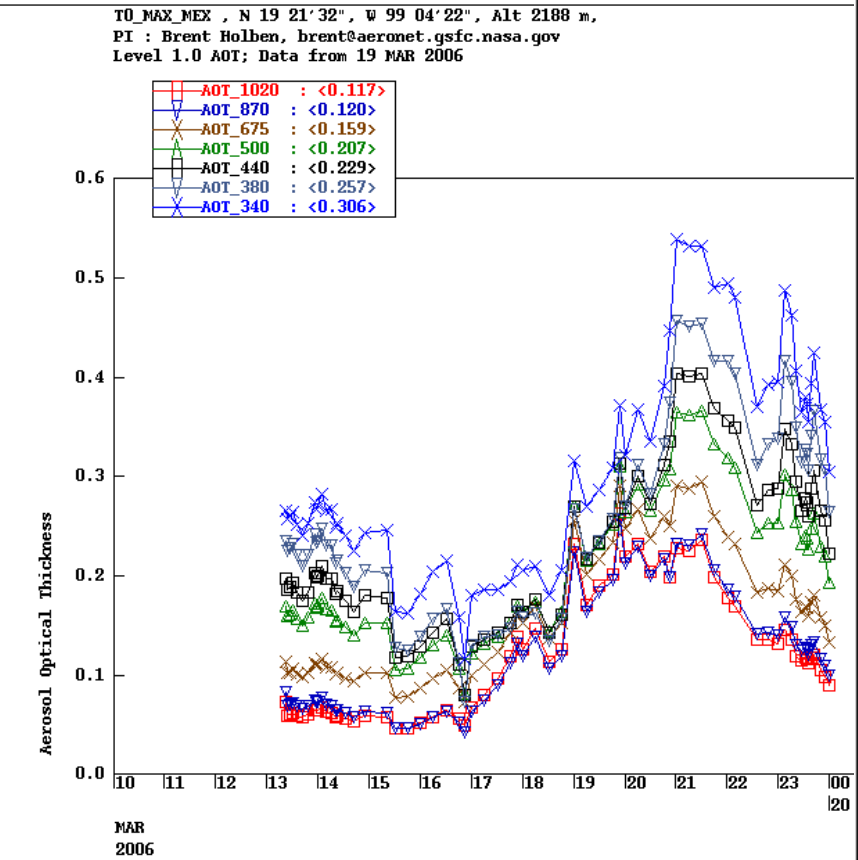
AOD Level 1.5 data from MAR 19 of 2006

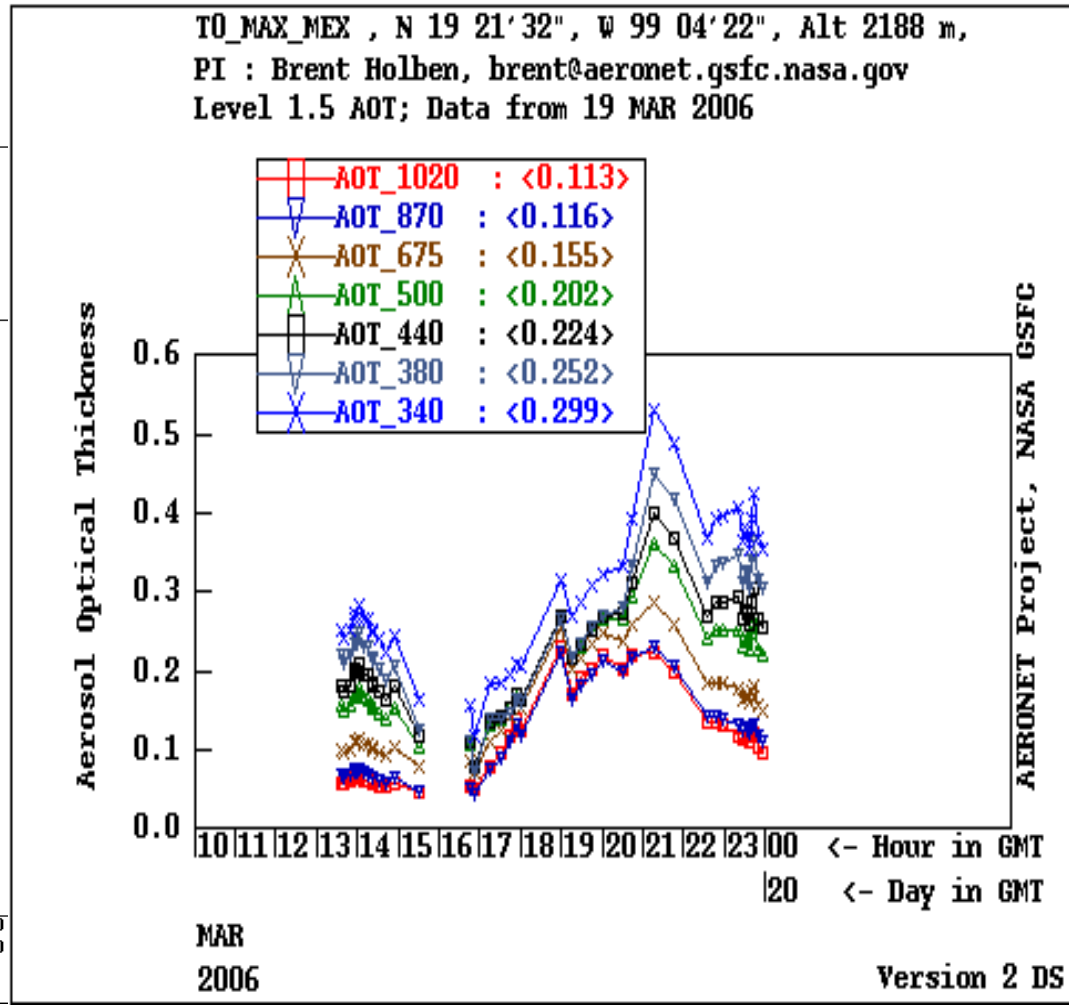


B. Holben et al.

AERONET T0

AOD Level 1.0 data from MAR 19 of 2006

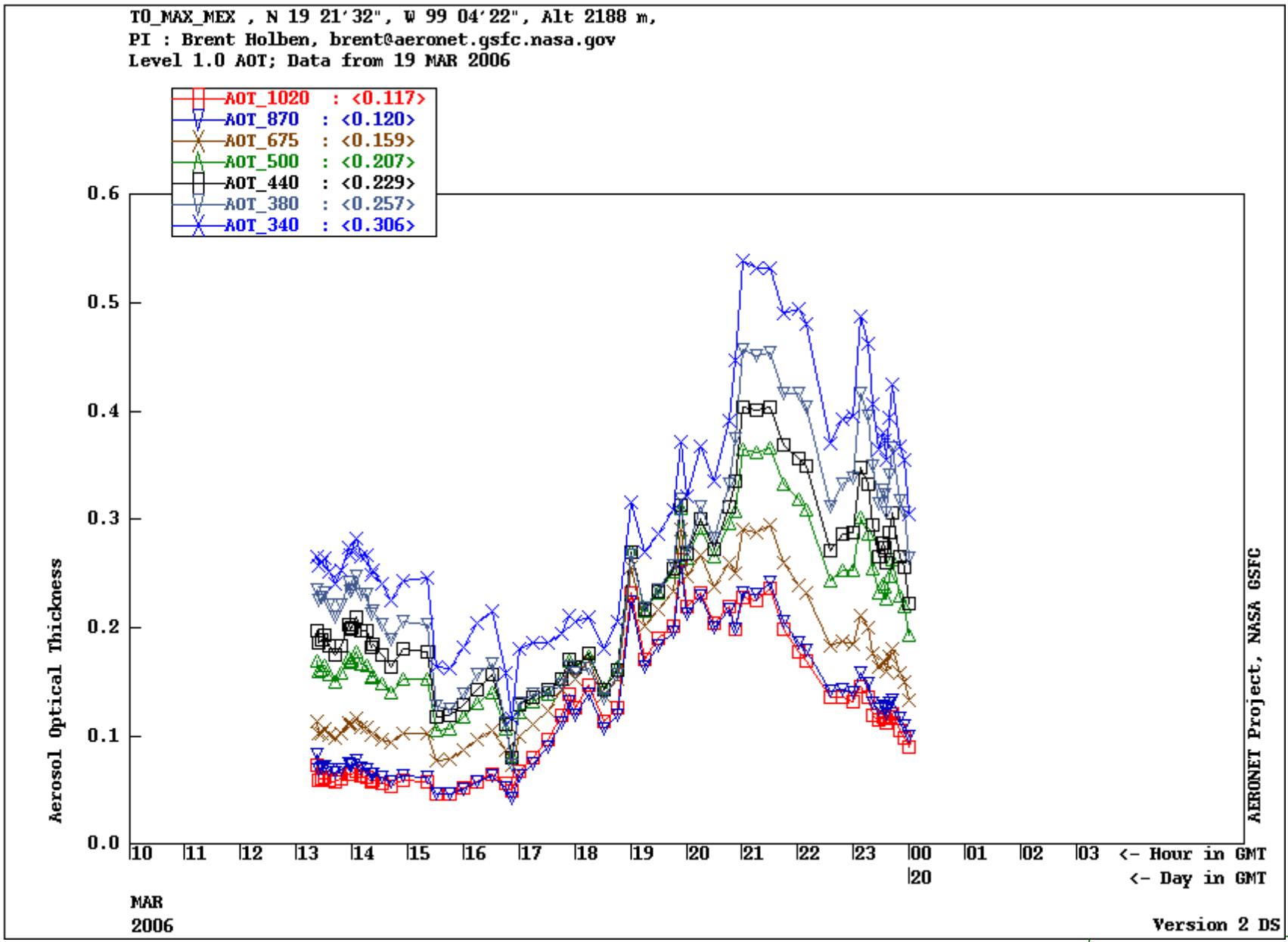




B. Holben et al.

AERONET T0

AOD Level 1.0 data from MAR 19 of 2006



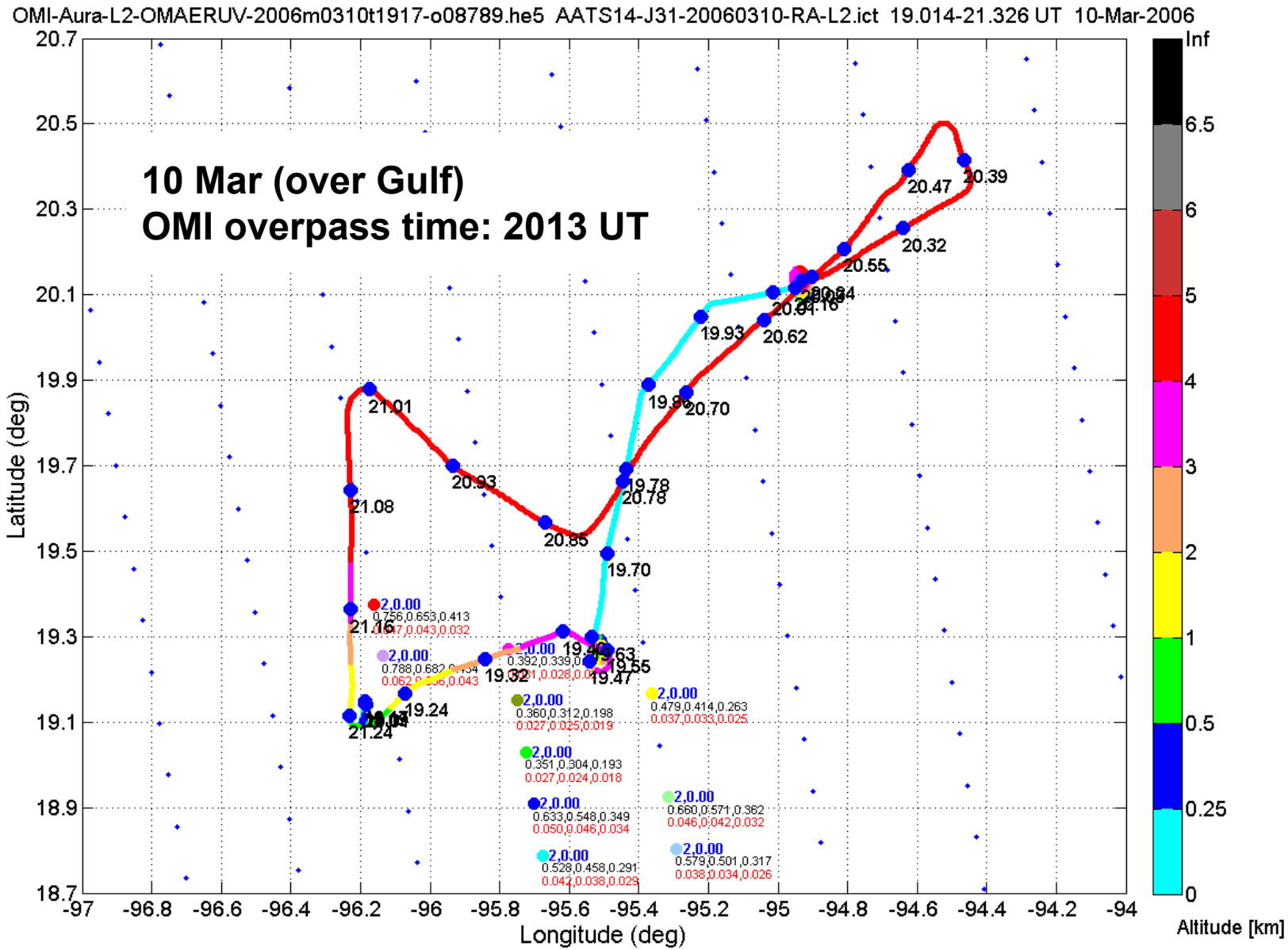
Livingston/Russell, Aura ST, Boulder, Sep 2006

B. Holben et al.

19 Mar 2006 times when DC-8 was above & near J31

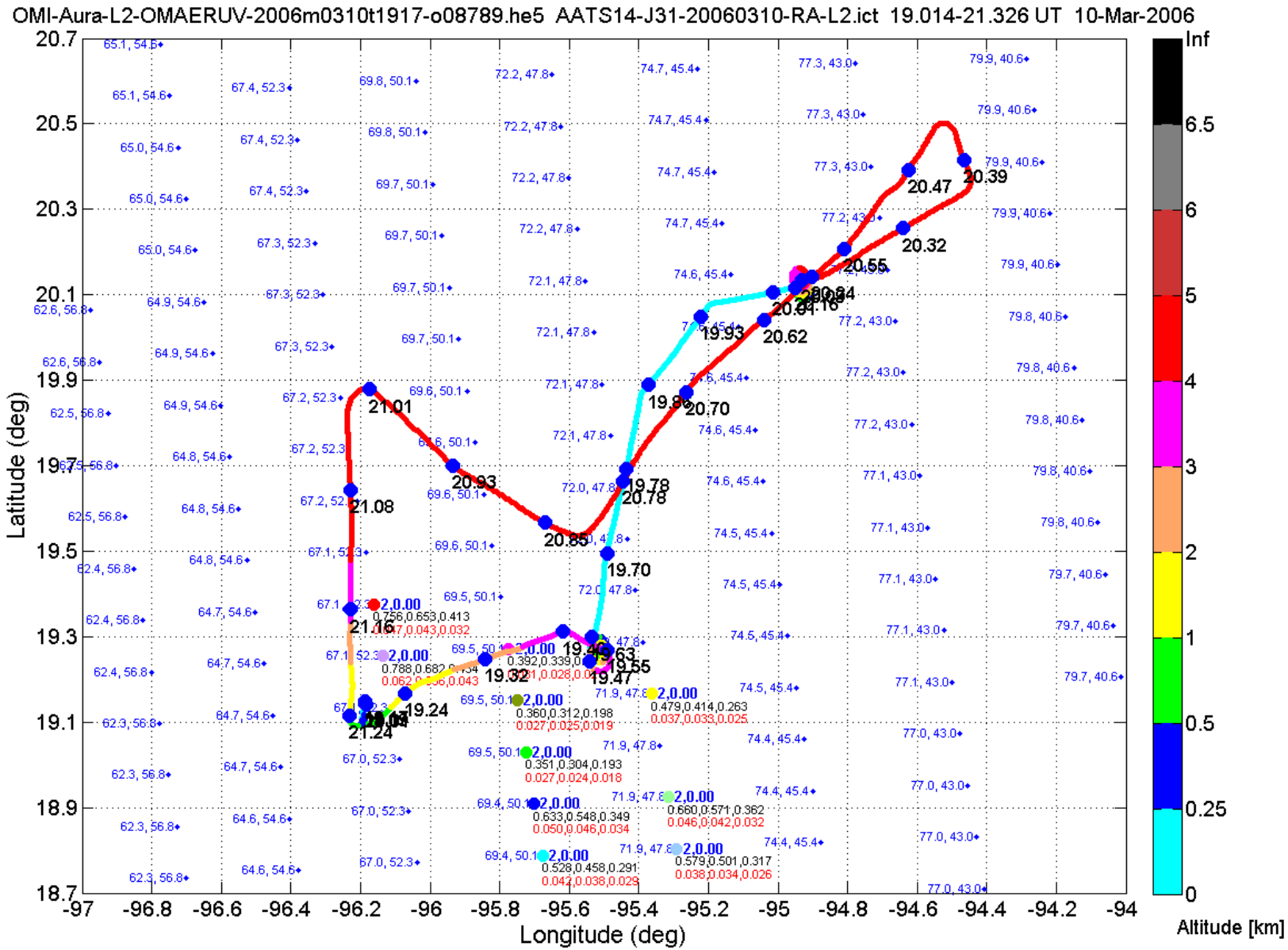
(i.e., J31 near DC-8 lidar curtain—if lidar was not turned off or J31 in convergence layer)

19.42 (19:25) near T2
19.69 (19:41) N of T1
20:22 ( ) T1
20.26 (20:16) en route, T1 to T0
20.46 (20:28) NW of T0



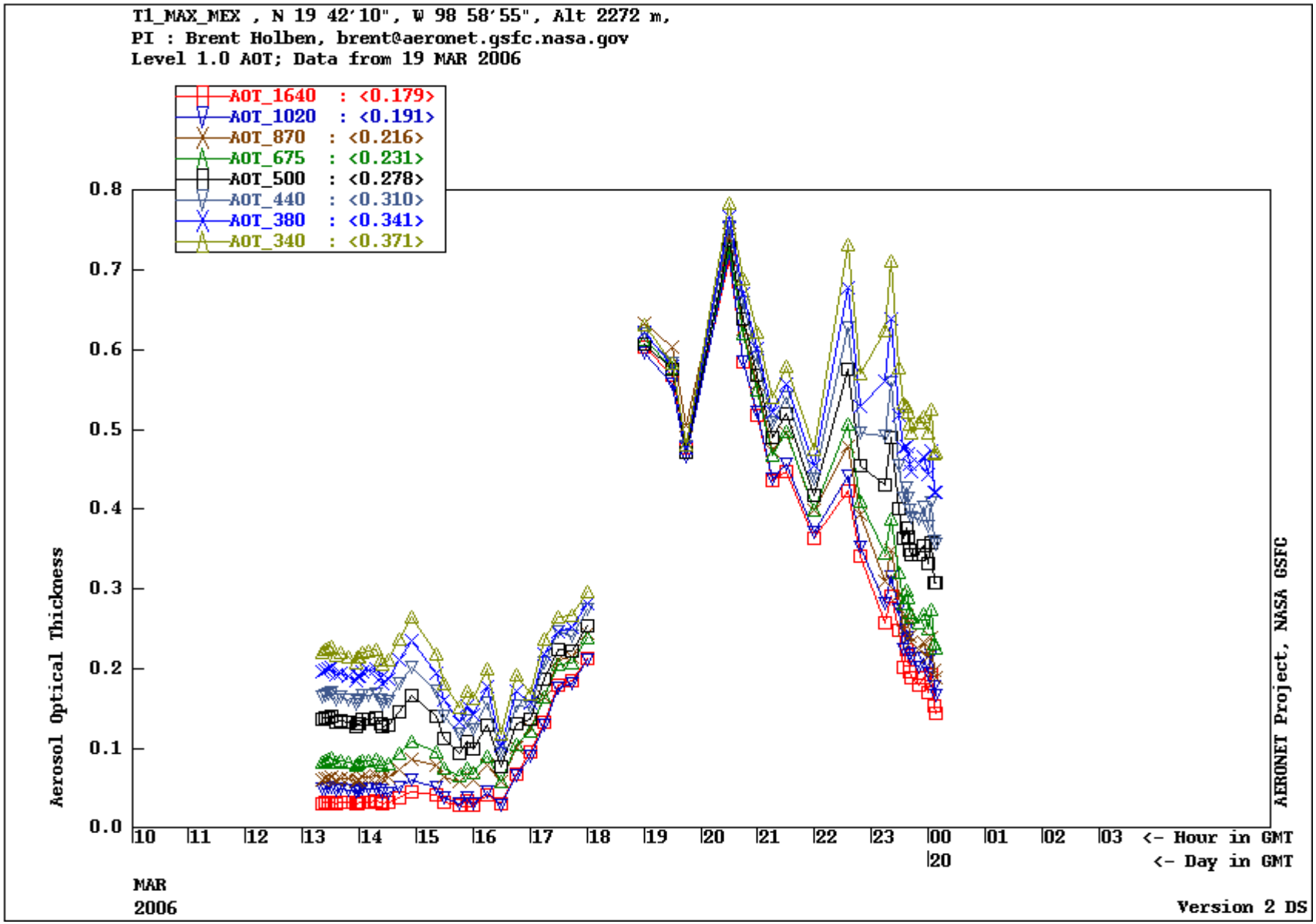
OMI-Aura-L2-OMAERUV-2006m0310t1917-o08789.he5 AATS14-J31-20060310-RA-L2.ict 19.014-21.326 UT 10-Mar-2006
10 Mar (over Gulf)
OMI overpass time: 2013 UT
Latitude (deg)
Longitude (deg)
Altitude [km]
Inf

glint angle, satellite elev viewing angle printed in blue to left of each OMI location



AERONET T1

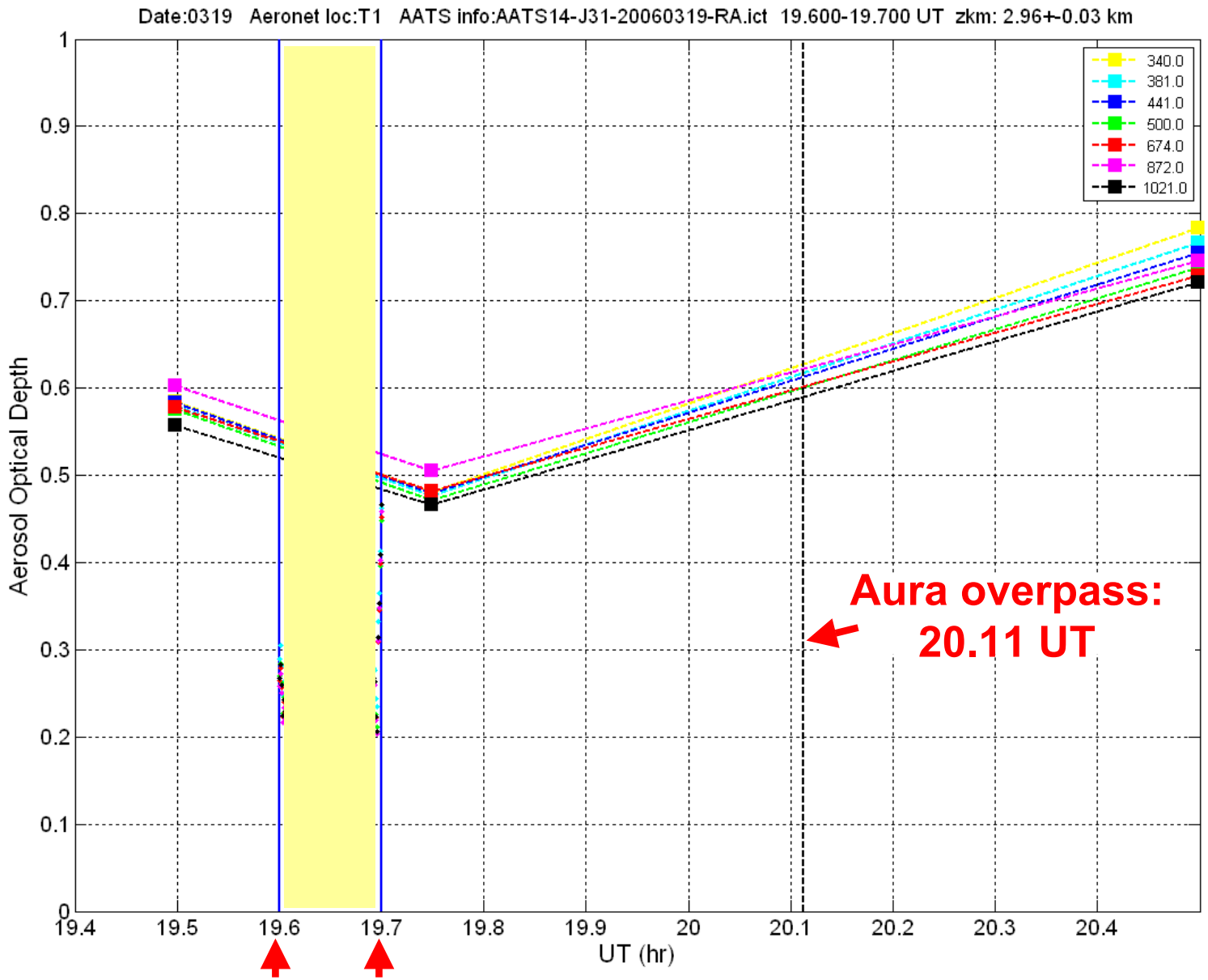
AOD Level 1.0 data from MAR 19 of 2006

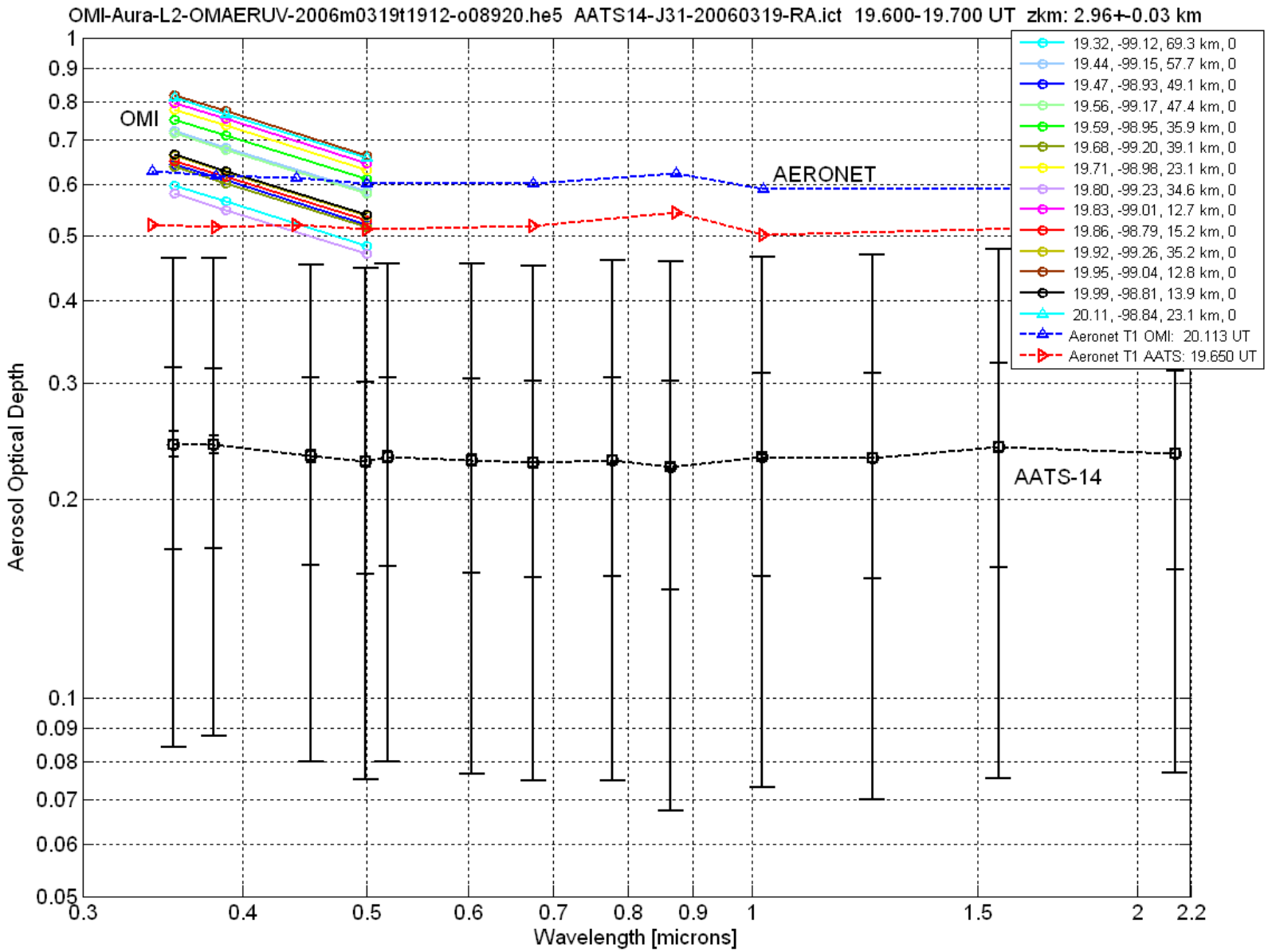


Livingston/Russell, Aura ST, Boulder, Sep 2006

B. Holben et al.

AERONET AOD at T1, 19 Mar 2006




OMI-Aura-L2-OMAERUV-2006m0319t1912-o08920.he5 AATS14-J31-20060319-RA.ict 19.600-19.700 UT zkm: 2.96+-0.03 km
OMI
AERONET
AATS-14
19.32, -99.12, 69.3 km, 0
19.44, -99.15, 57.7 km, 0
19.47, -98.93, 49.1 km, 0
19.56, -99.17, 47.4 km, 0
19.59, -98.95, 35.9 km, 0
19.68, -99.20, 39.1 km, 0
19.71, -98.98, 23.1 km, 0
19.80, -99.23, 34.6 km, 0
19.83, -99.01, 12.7 km, 0
19.86, -98.79, 15.2 km, 0
19.92, -99.26, 35.2 km, 0
19.95, -99.04, 12.8 km, 0
19.99, -98.81, 13.9 km, 0
20.11, -98.84, 23.1 km, 0
Aeronet T1 OMI: 20.113 UT
Aeronet T1 AATS: 19.650 UT
Aerosol Optical Depth
Wavelength [microns]
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.09
0.08
0.07
0.06
0.05
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.5
2
2.2