Comparison of airborne sunphotometer and OMI retrievals of aerosol optical depth during MILAGRO/INTEX-B 2006

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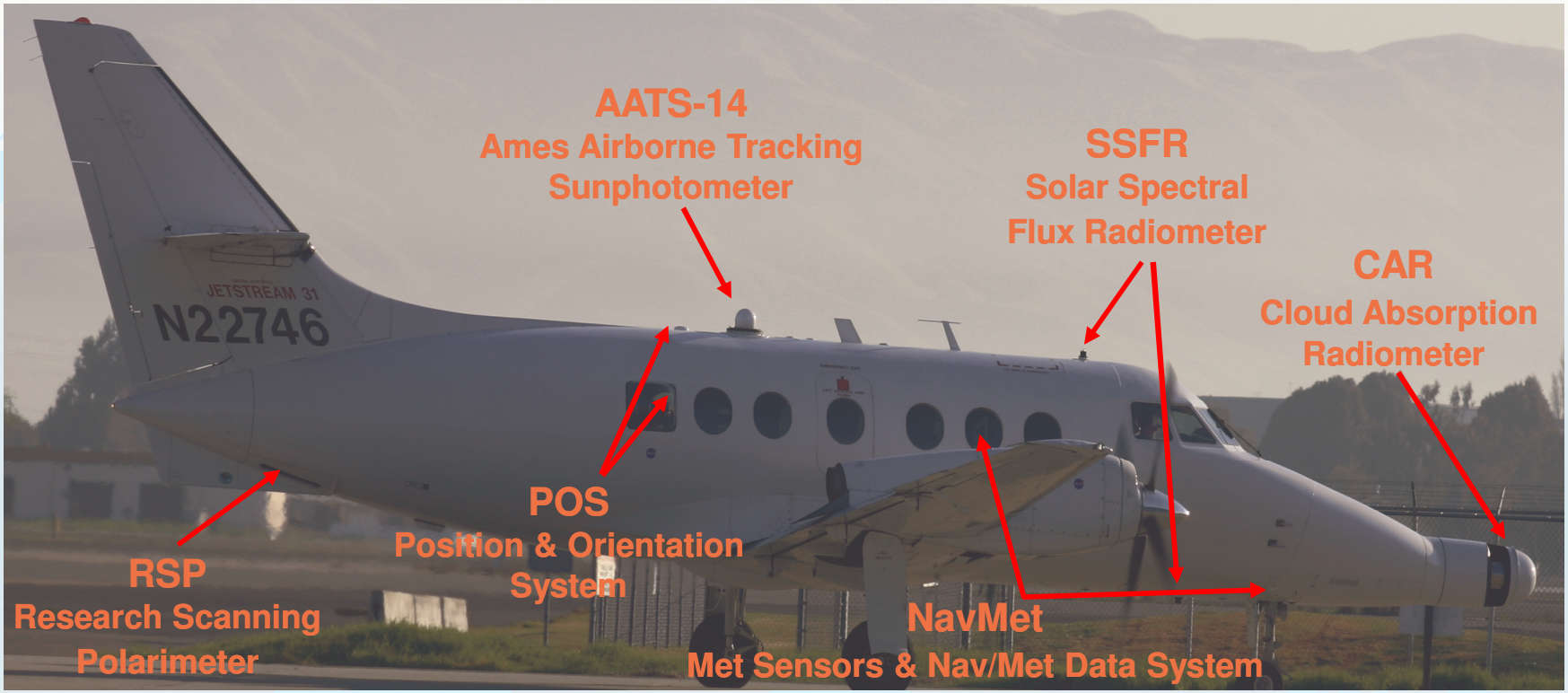
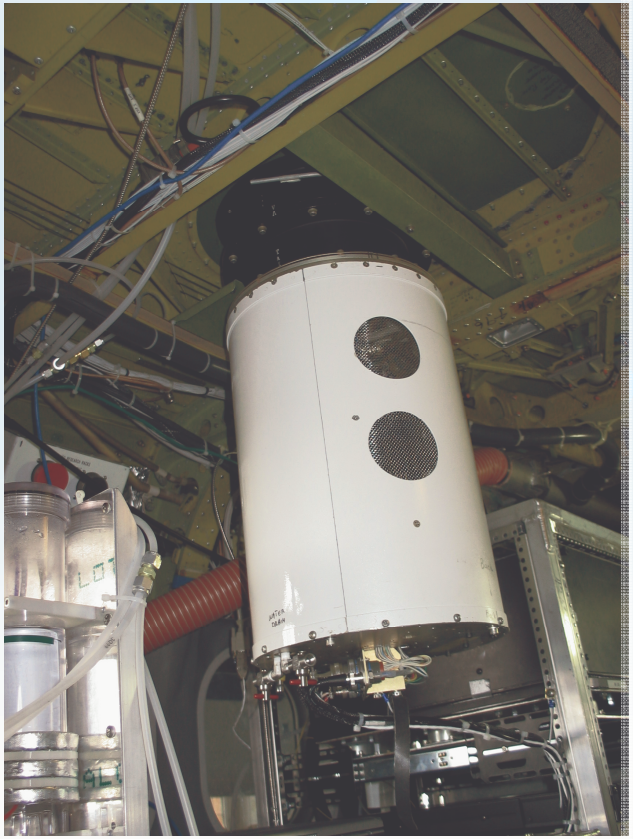
Outline

- Jetstream 31 (J31) instrument payload and flight overview for MILAGRO/INTEX-B 2006
- Airborne, satellite, and ground-based AOD comparisons
  - AATS-14, OMI (UV and MW retrievals), & MODIS over water (3 cases)
    - -10 March (Aqua, Aura)
    - -03 March (Aqua, Aura) *(no coincident MODIS retrieval due to sun glint)*
    - -17 March (Aqua, Aura)
  - AATS-14, OMI, & AERONET over Mexico City (1 case)
    - -19 March (Aura)
- Summary/Conclusions

Jetstream 31 in MILAGRO/INTEX-B: Instrument Locations



RSP	Total & linearly polarized reflectance	412-2250 nm, 9 λ
SSFR	Upwelling & downwelling spectral hemispheric irradiance	300-2200 nm, many λ ~8-12 nm resolution
CAR	Spectral & angular distribution of scattered light from clouds, aerosols, land and water surfaces; imagery of clouds & surface	340-2130 nm



NASA Ames Airborne Tracking Sunphotometer: AATS-14

1. Measures direct solar beam transmission:

353.5	380.0	449.0	499.4	525.0
605.7	675.1	778.4	864.5	939.7
1019.1	1241.3	1557.8	2139.0 nm	

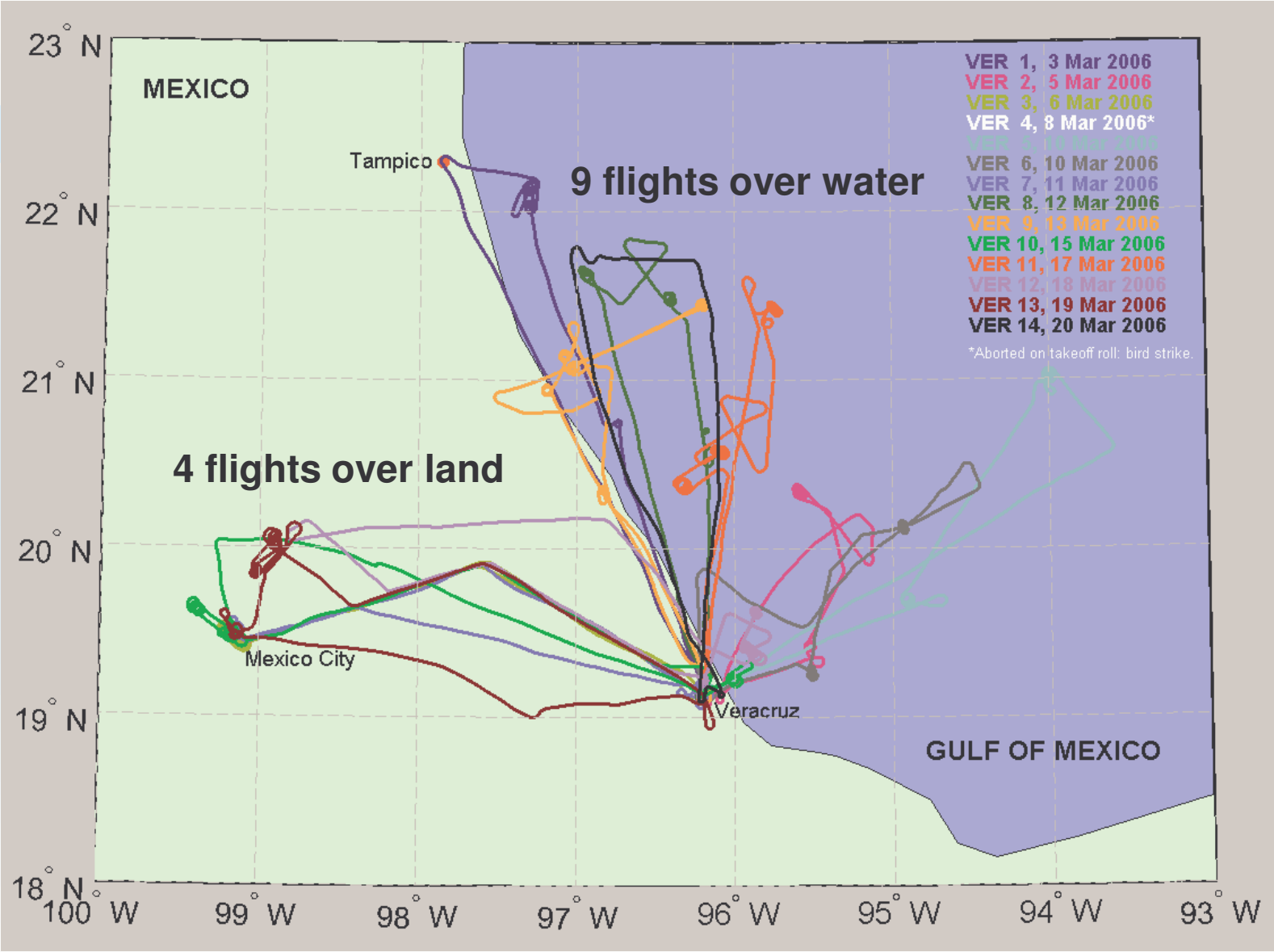
2. Yields:
   aerosol optical depth & columnar water vapor (ozone under certain conditions)

   aerosol extinction & water vapor (ozone) concentration when aircraft flies profiles

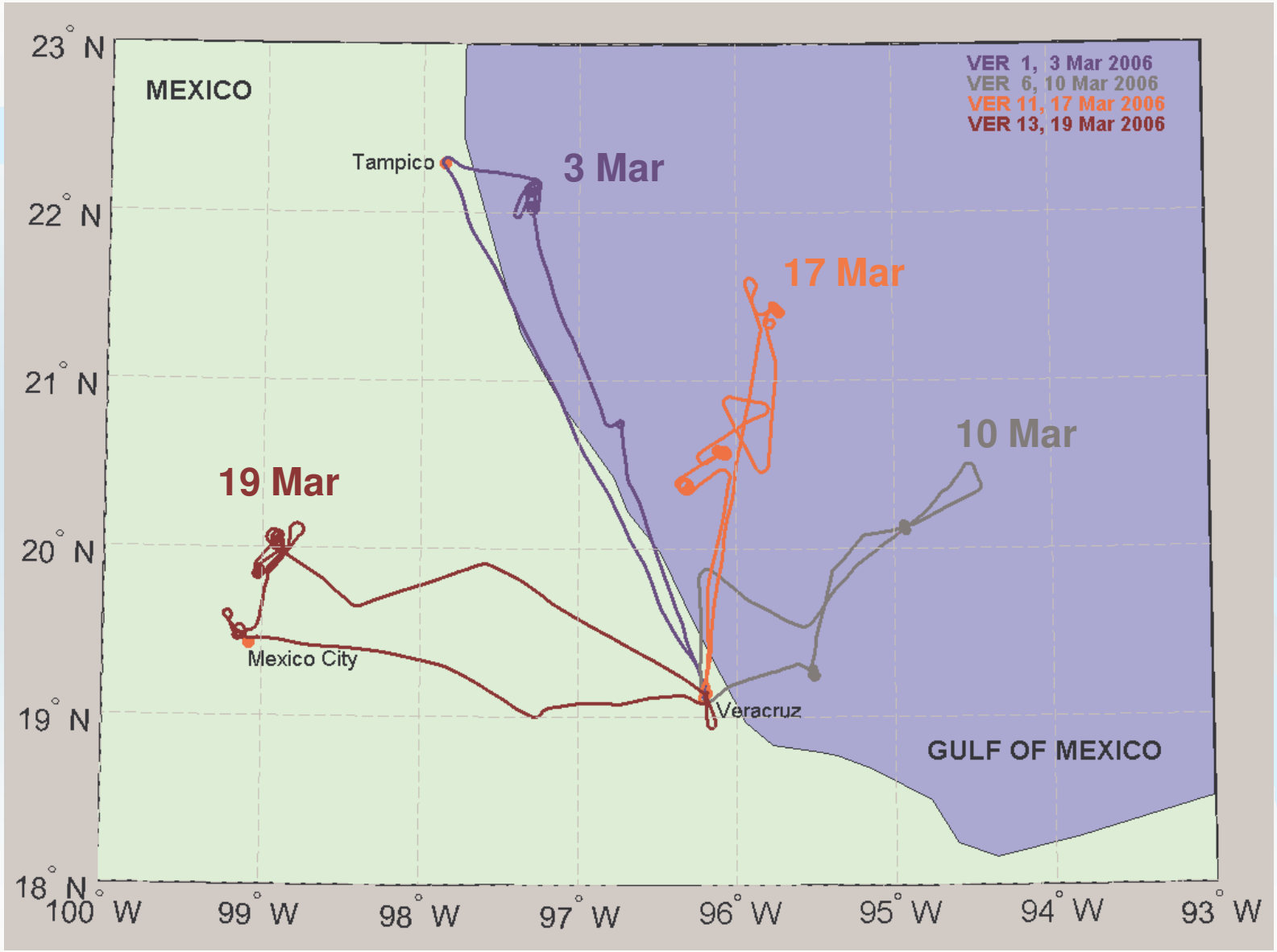
3. Size:
   Telescope dome 8" OD (hemisphere) atop 5" H pedestal. (Total H: 9" above A/C skin), Inside A/C: 12" D x 18" H cylinder.

4. Weight:
   131.6 lbs

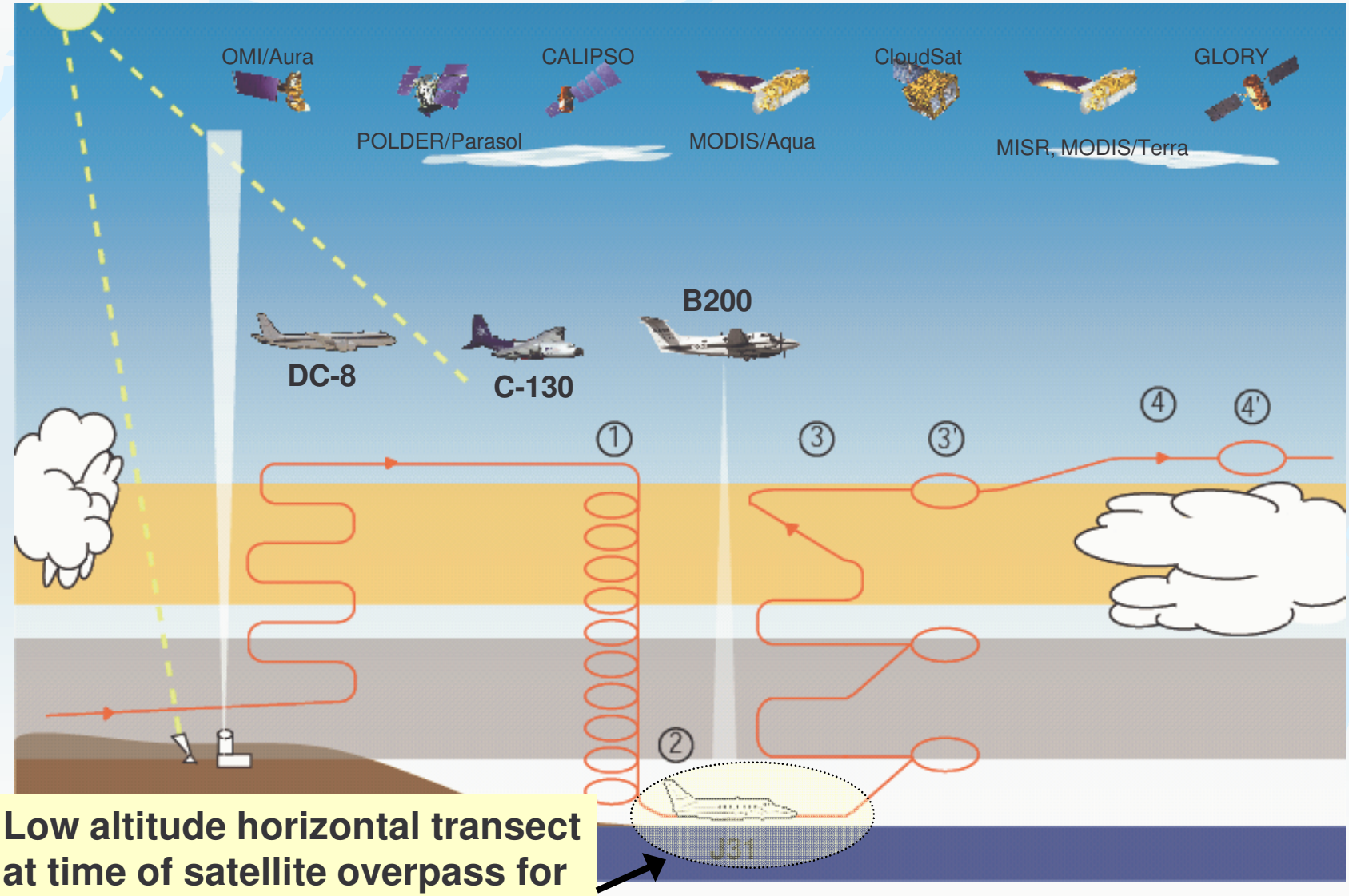
J31 flight tracks: 13 flights out of Veracruz, Mexico



Four J31 flight tracks coincident with OMI overpasses



J31 flight patterns:
Coordinated satellite, in-situ and radiative missions



Low altitude horizontal transect at time of satellite overpass for satellite sensor validation

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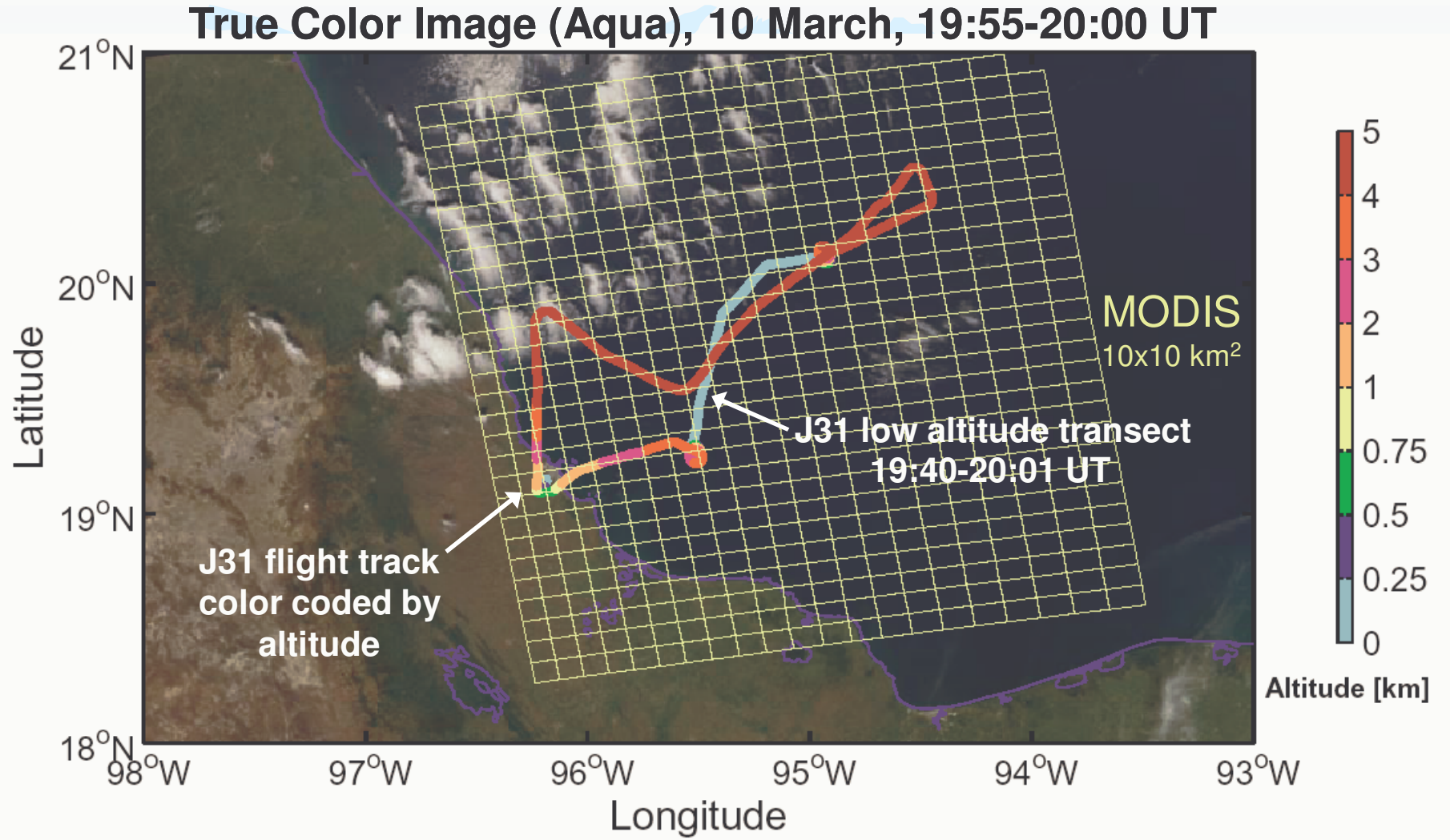
AOD Comparisons, OMI - MODIS - AATS

INTEX-B/MILAGRO, 2006



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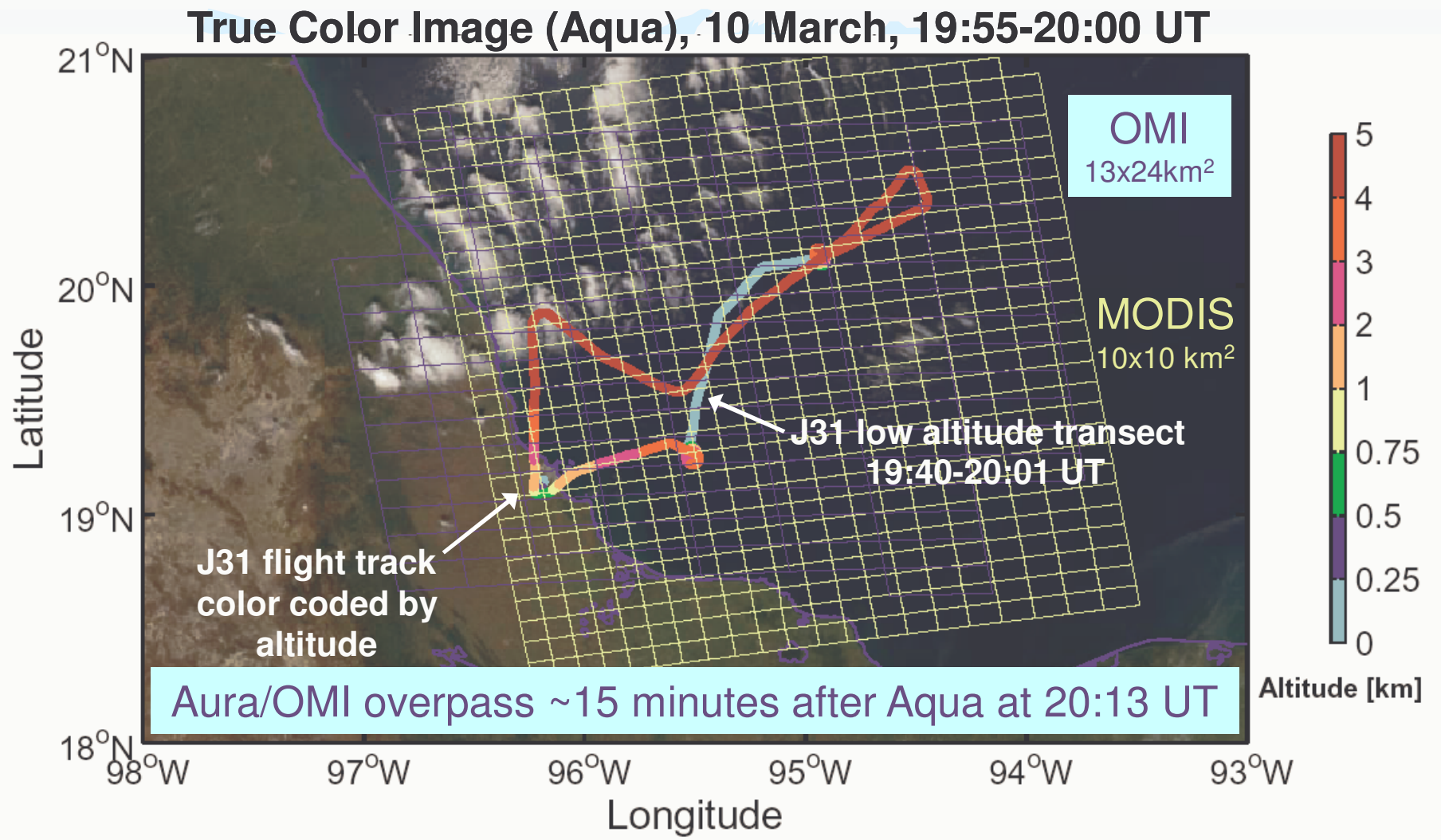
AOD Comparisons, OMI - MODIS - AATS

INTEX-B/MILAGRO, 2006



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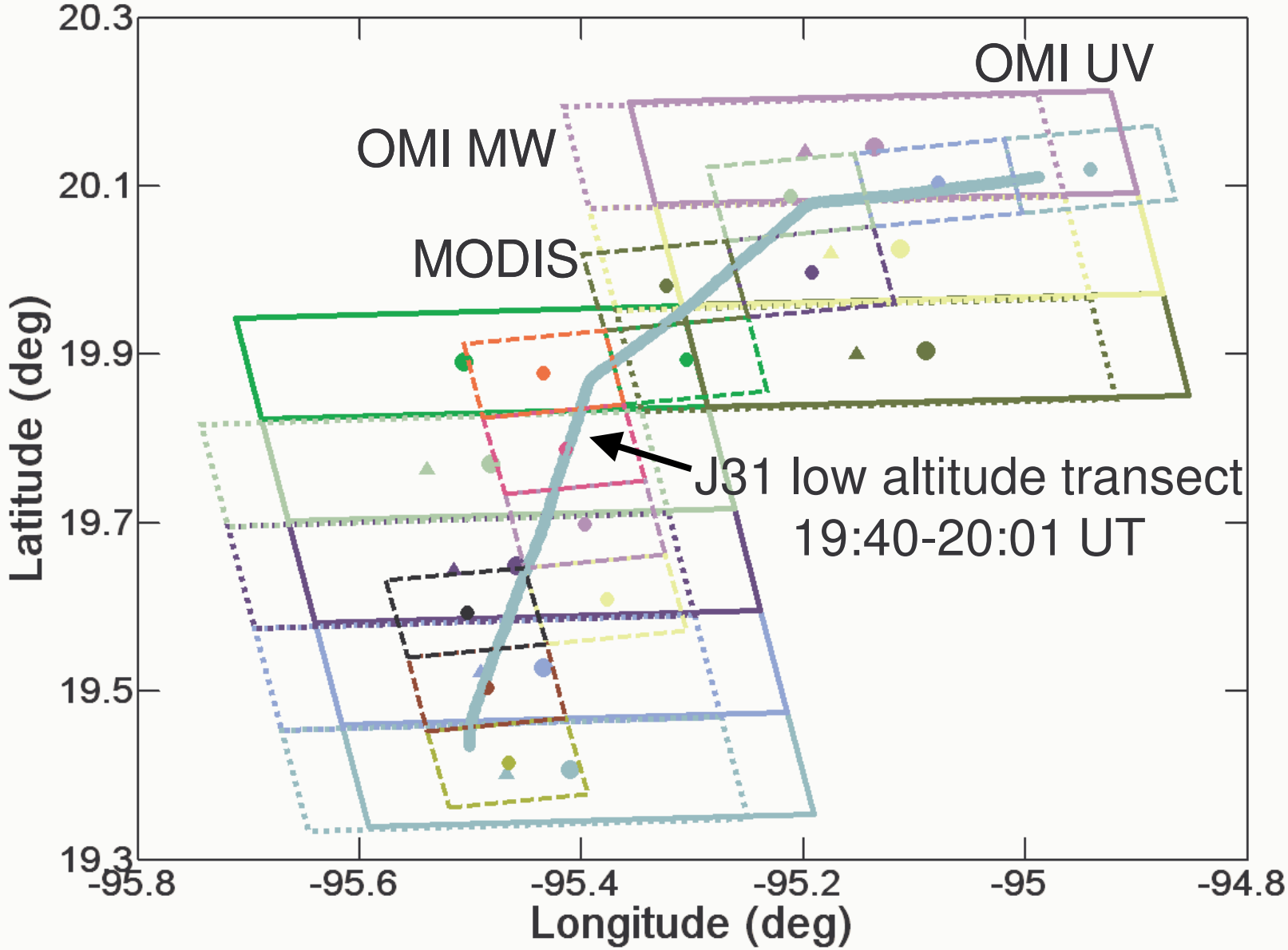
AOD Comparisons, OMI - MODIS - AATS

INTEX-B/MILAGRO, 10 March 2006



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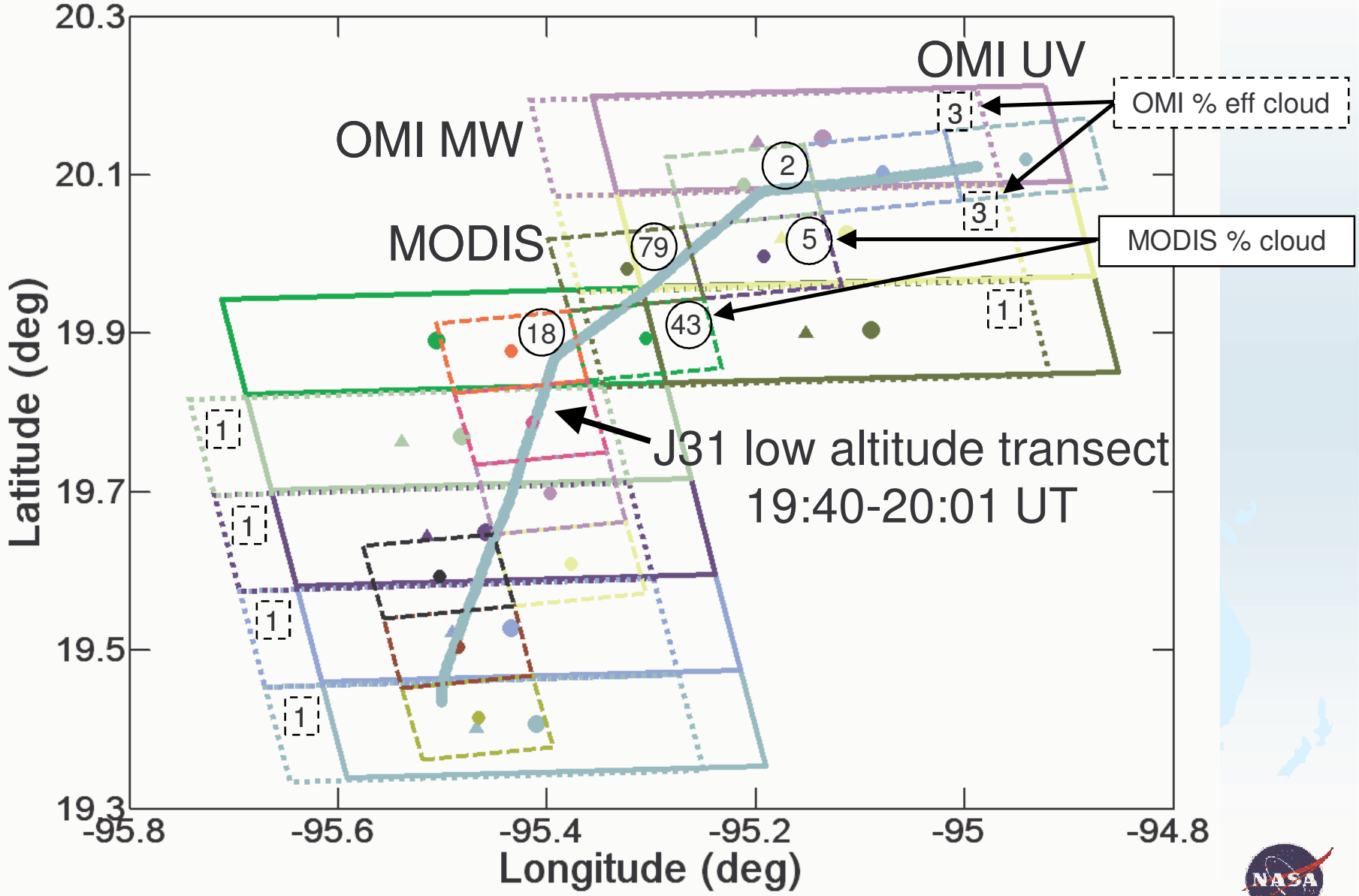
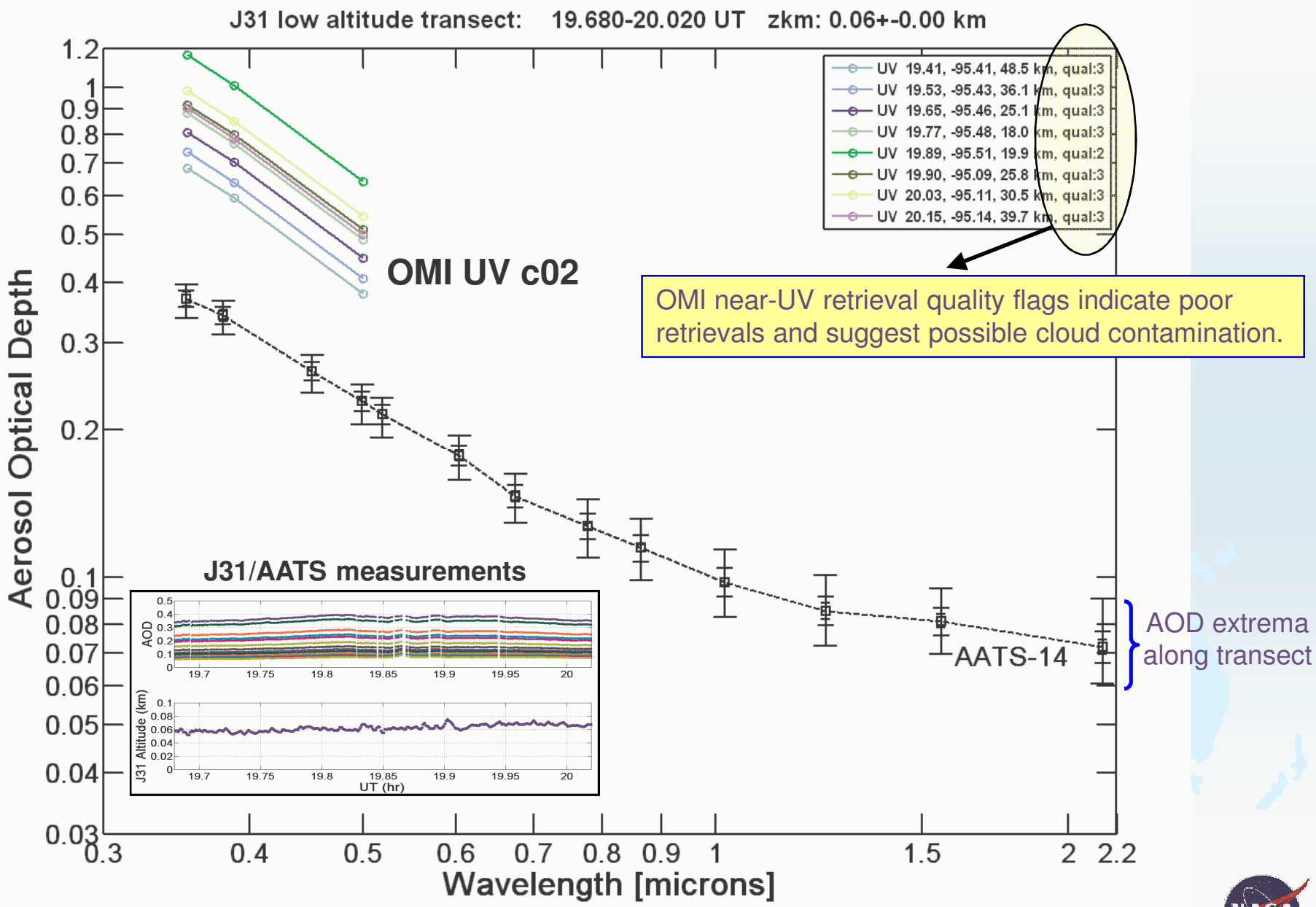
AOD Comparisons, OMI - MODIS - AATS

INTEX-B/MILAGRO, 10 March 2006



10 March 2006 *(over water)*



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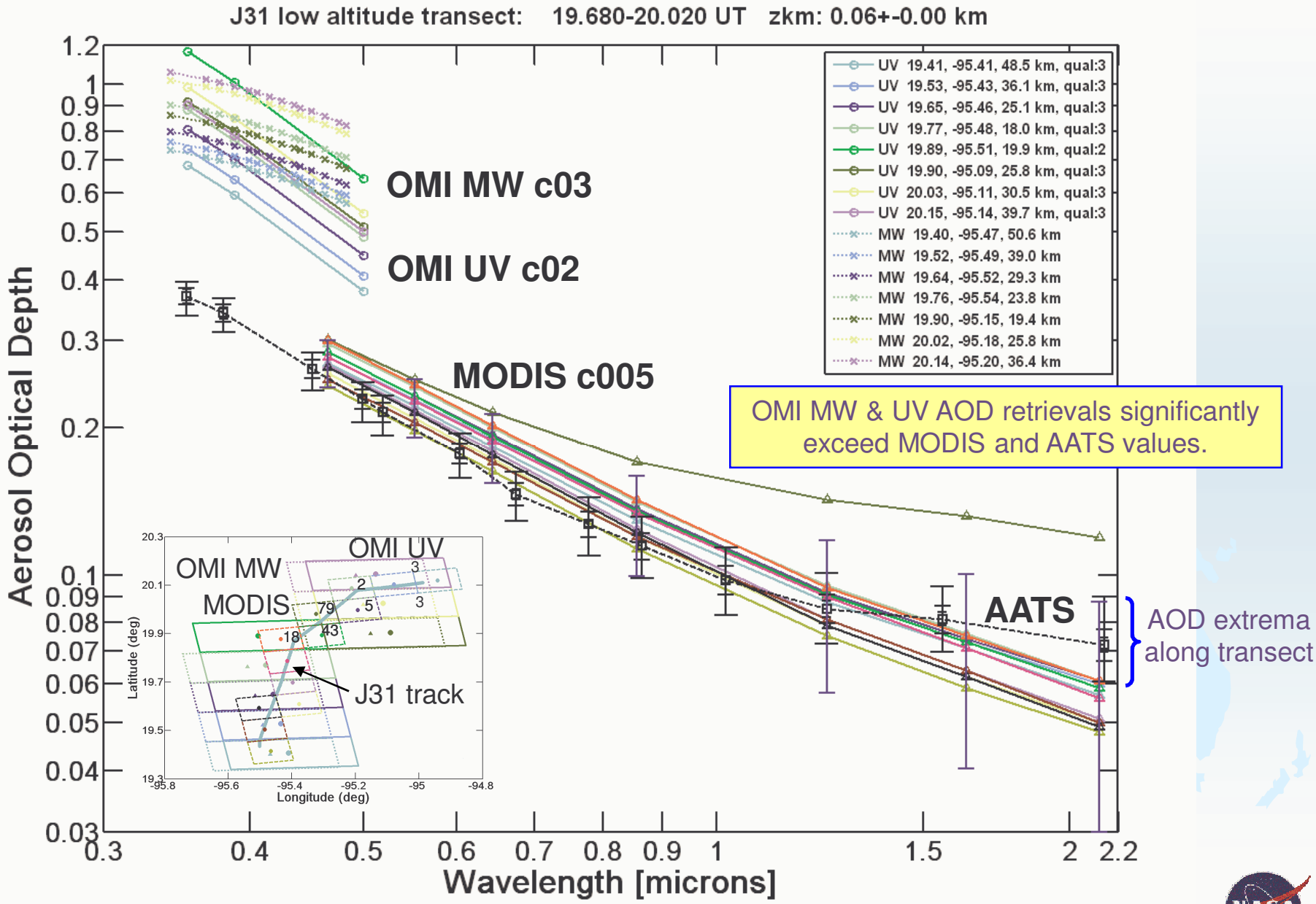
10 March 2006 *(over water)*



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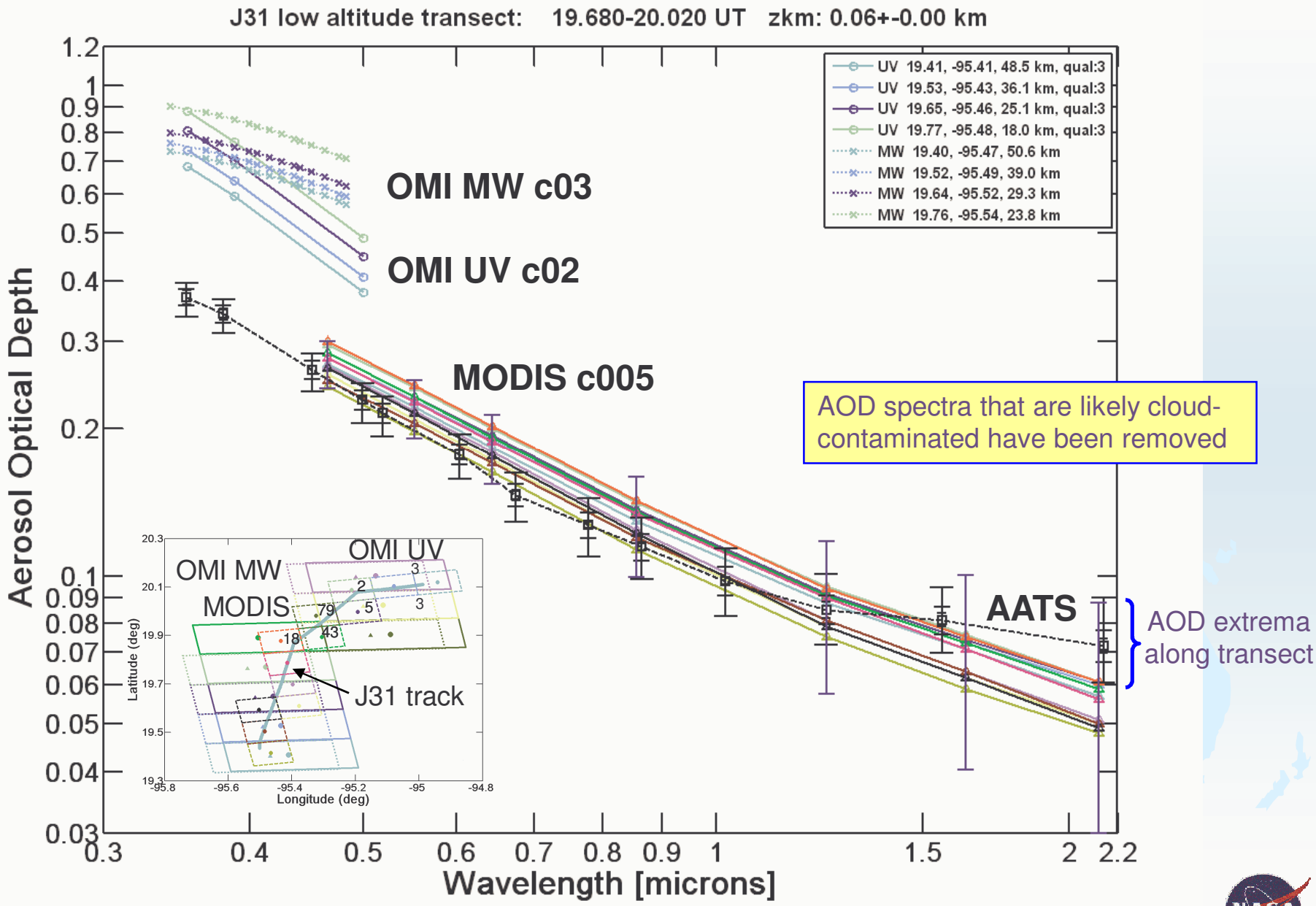
10 March 2006 *(over water)*



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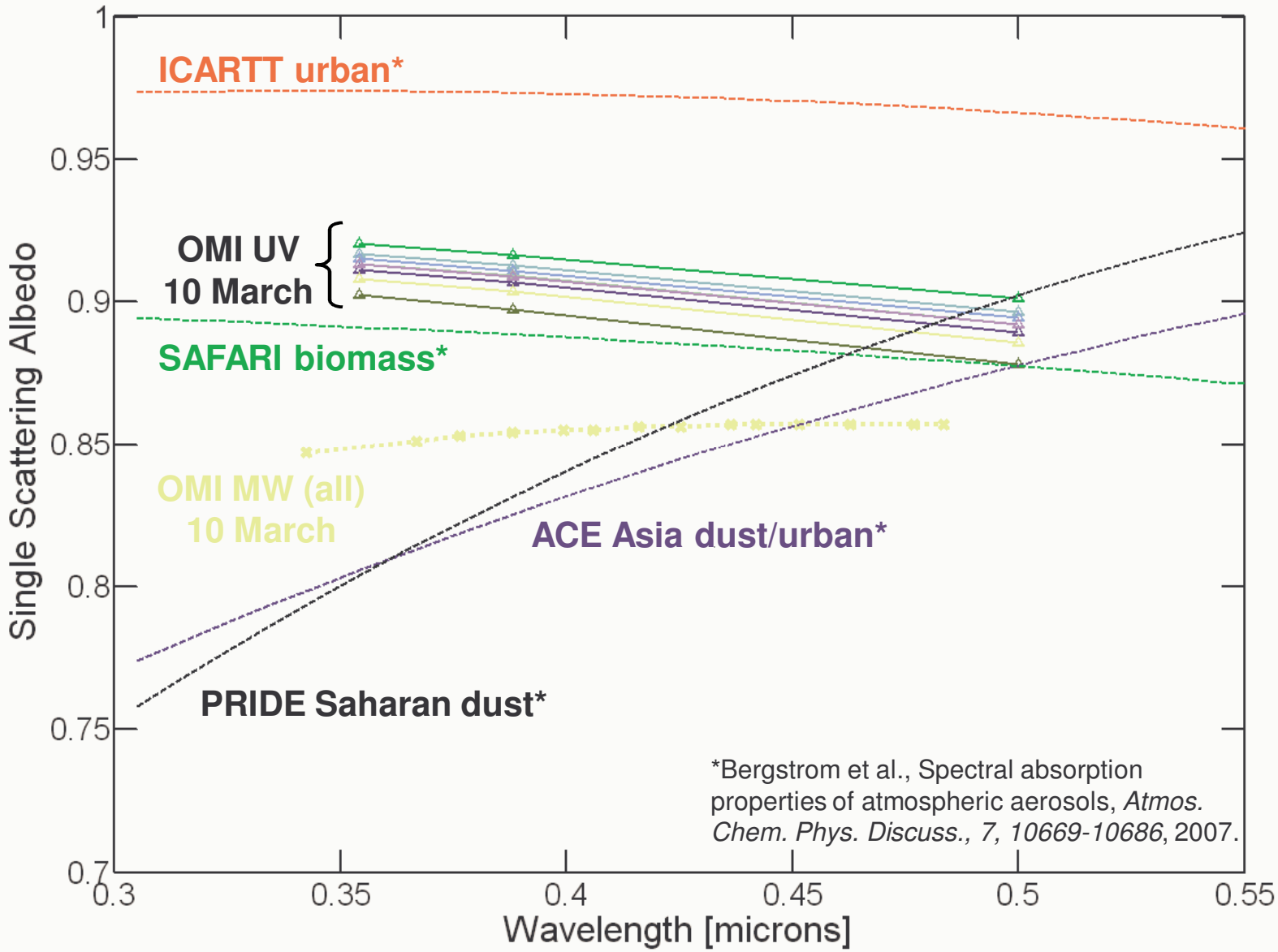
Comparison of OMI SSA retrievals for 10 March to results from other field campaigns



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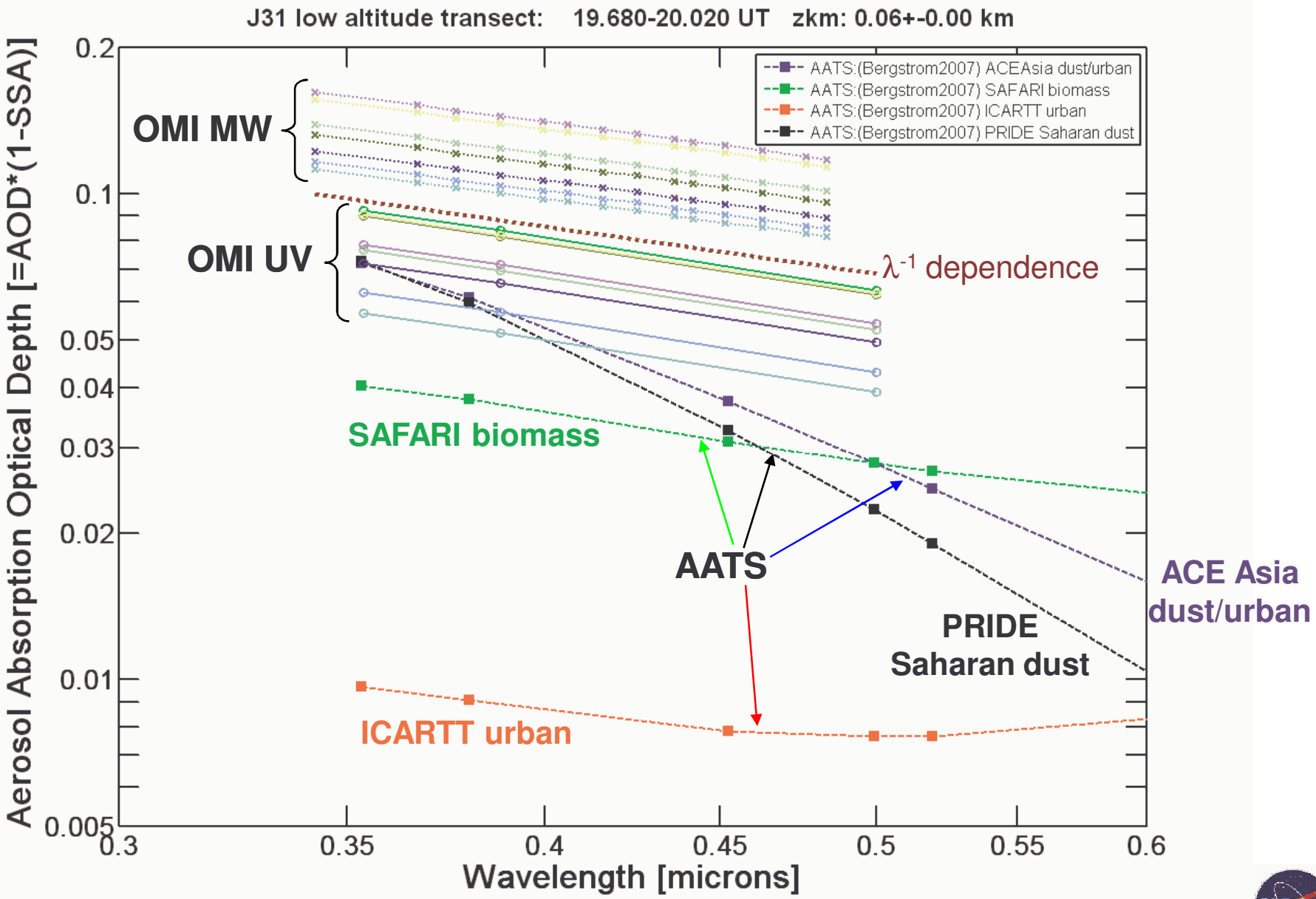
Aerosol Absorption Optical Depth for 10 March 2006



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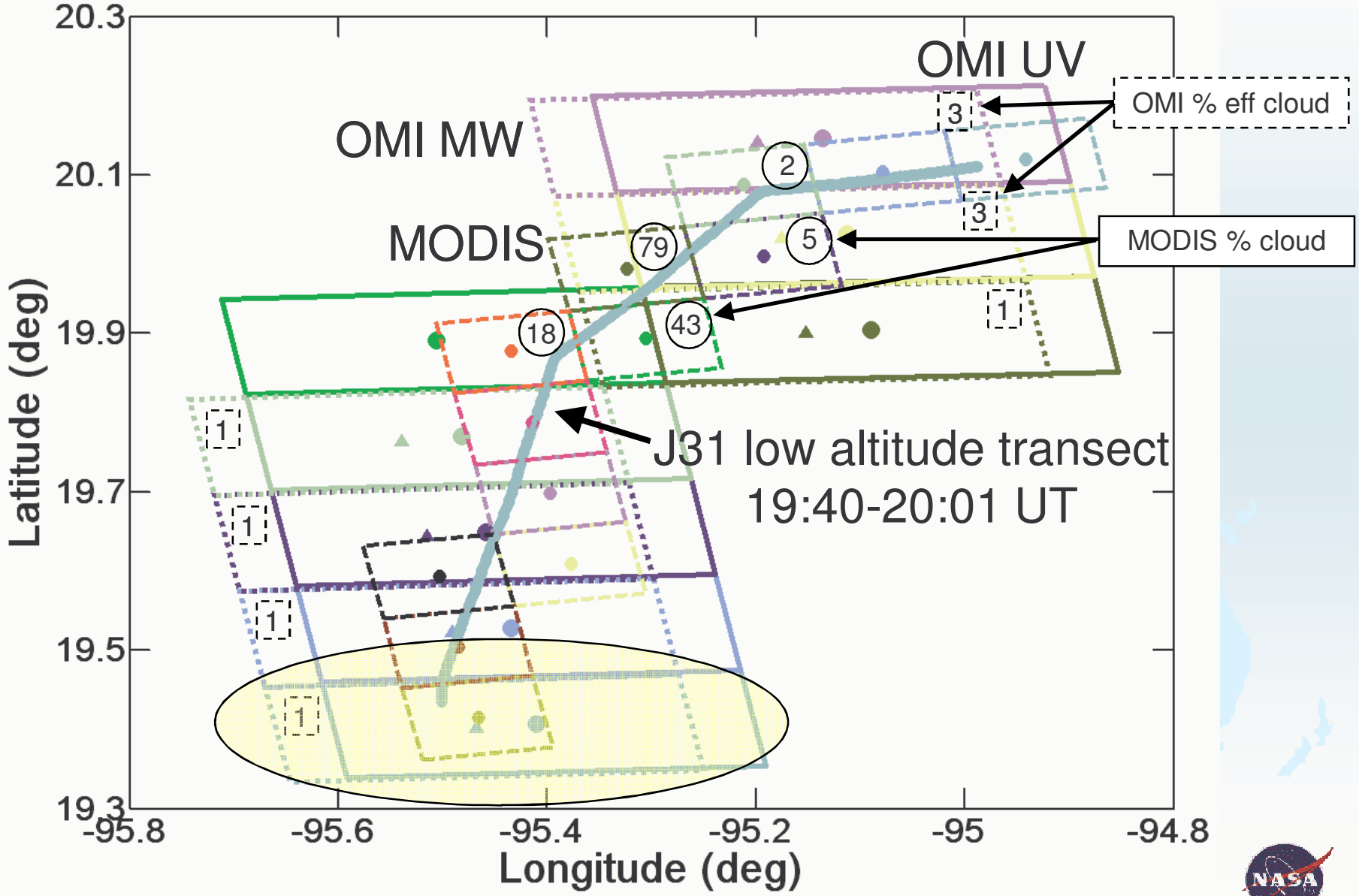
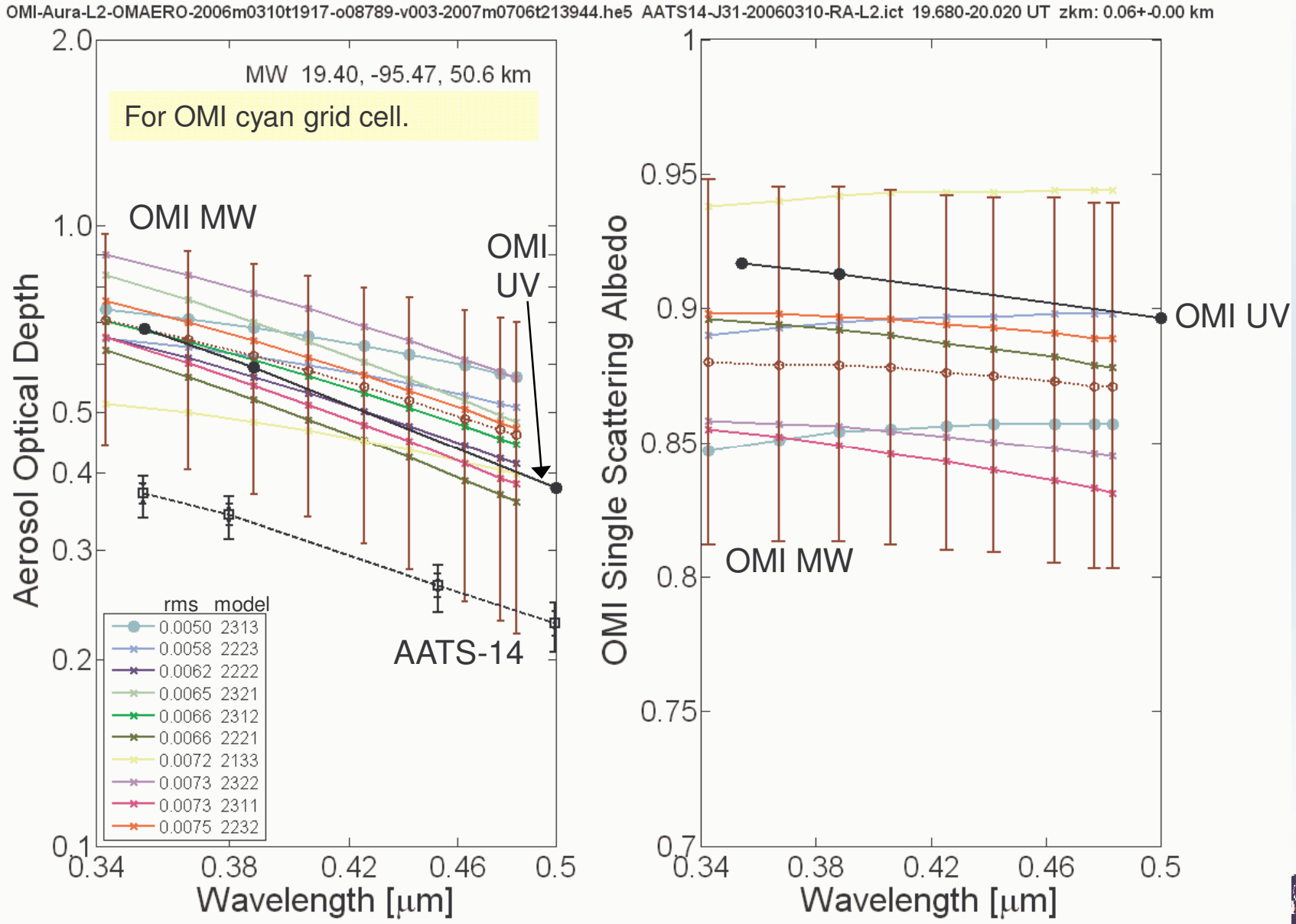
AOD Comparisons, OMI - MODIS - AATS

INTEX-B/MILAGRO, 10 March 2006



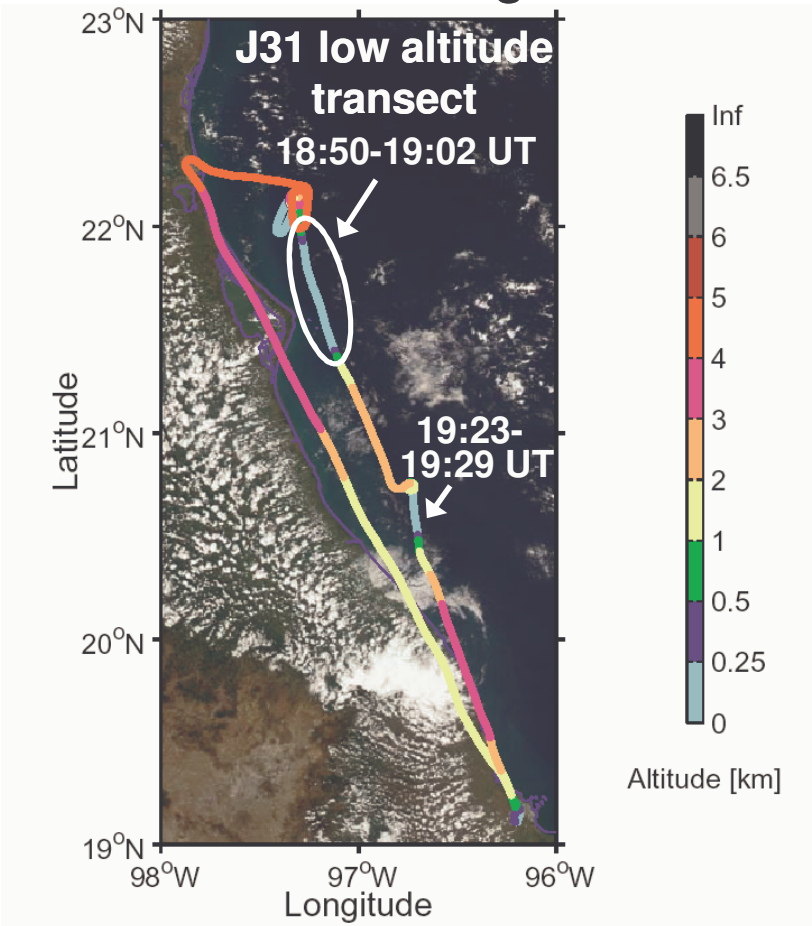
Cyan: OMI MW retrieval with lowest rms residual

Brown: OMI MW mean +-2 std for all retrievals passing threshold

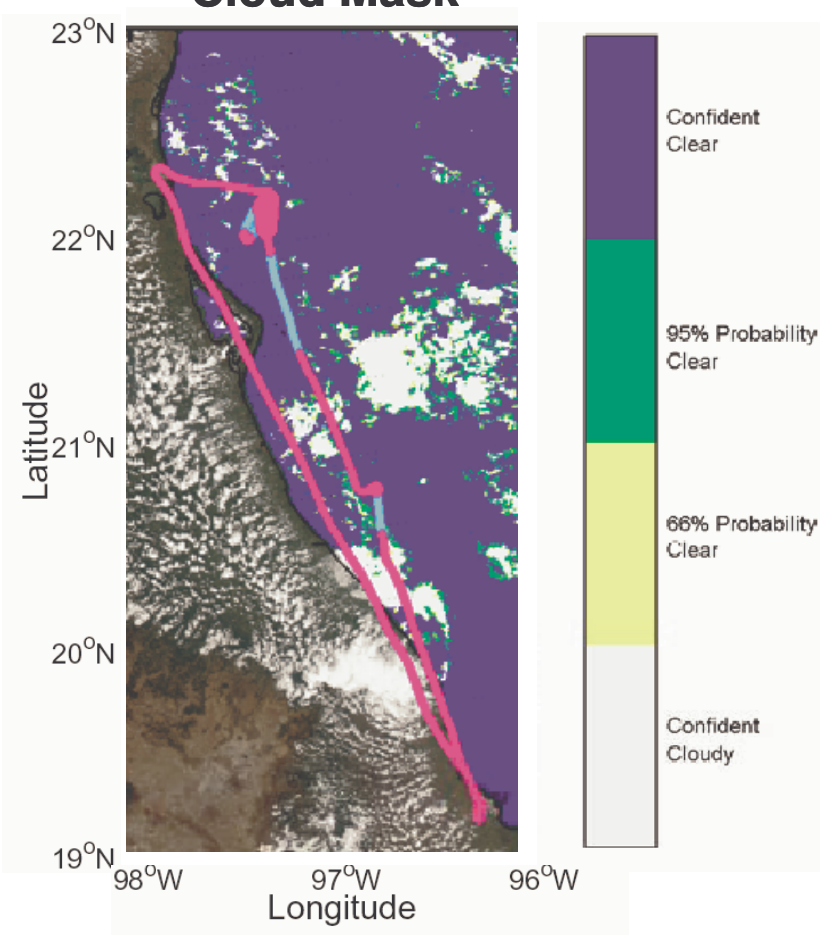


Aqua MODIS 03 March 2006 19:50-19:55 UT

True Color Image



Cloud Mask



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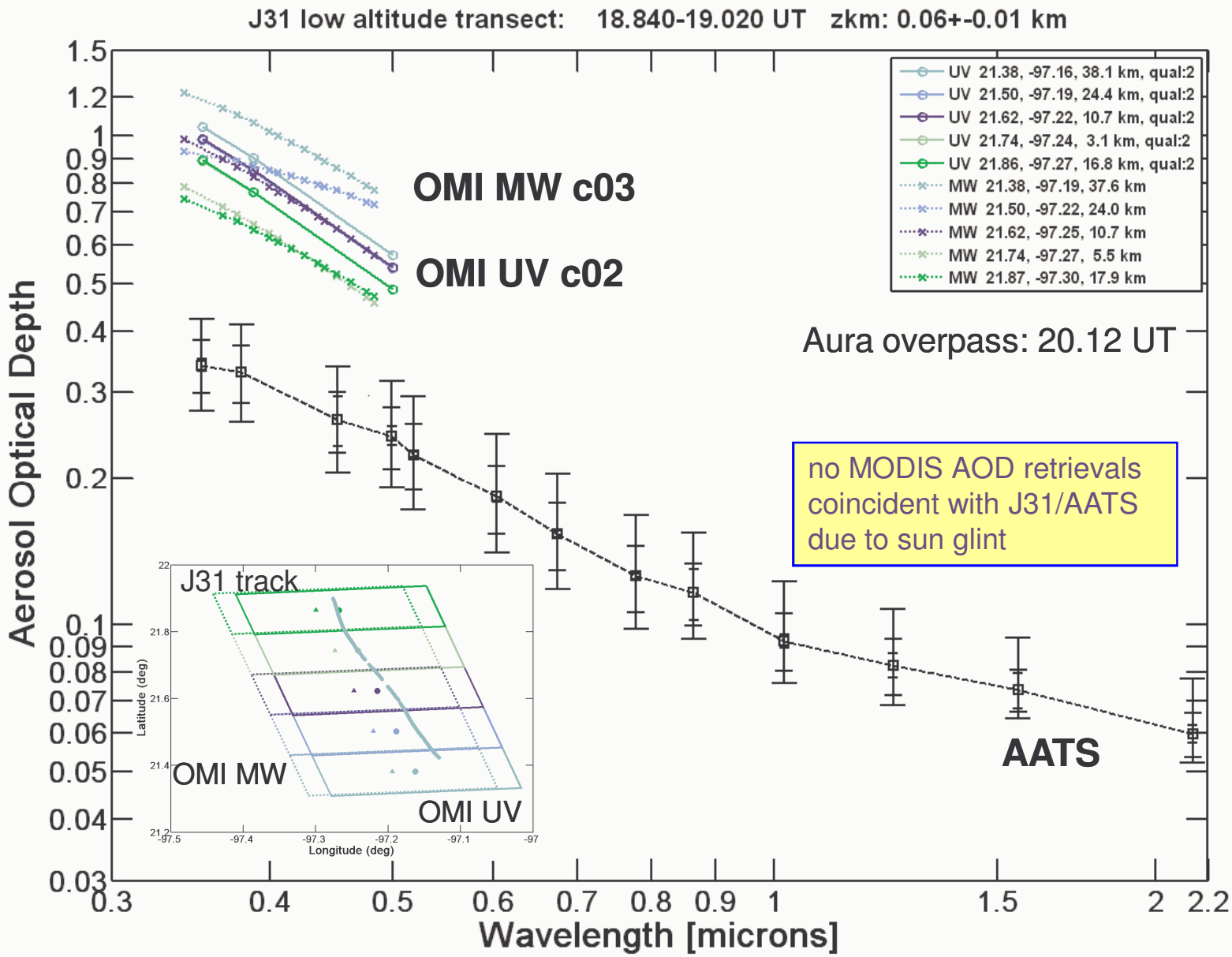
03 March 2006 *(over water)*



no MODIS AOD retrievals coincident with J31/AATS due to sun glint

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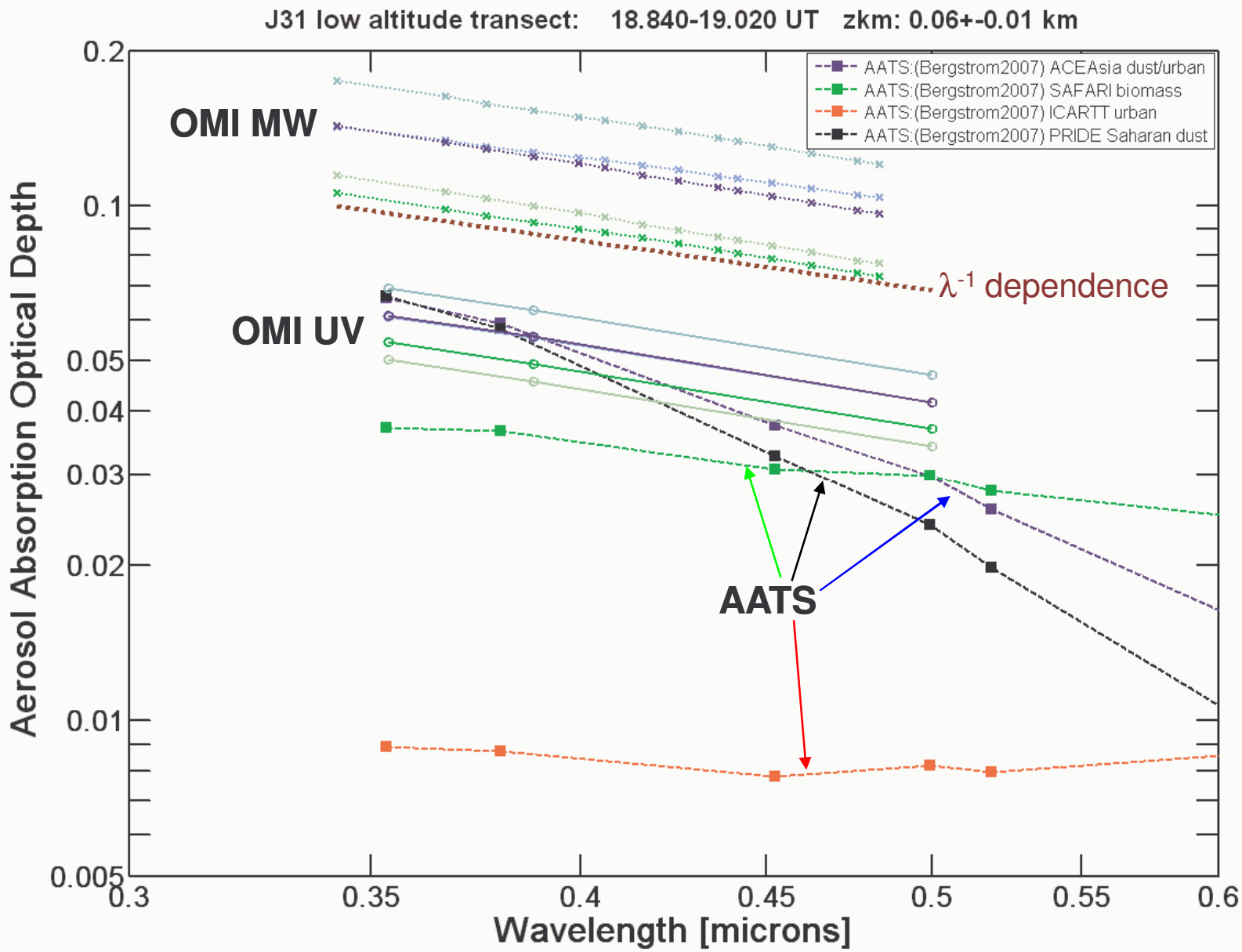
Aerosol Absorption Optical Depth for 03 March 2006



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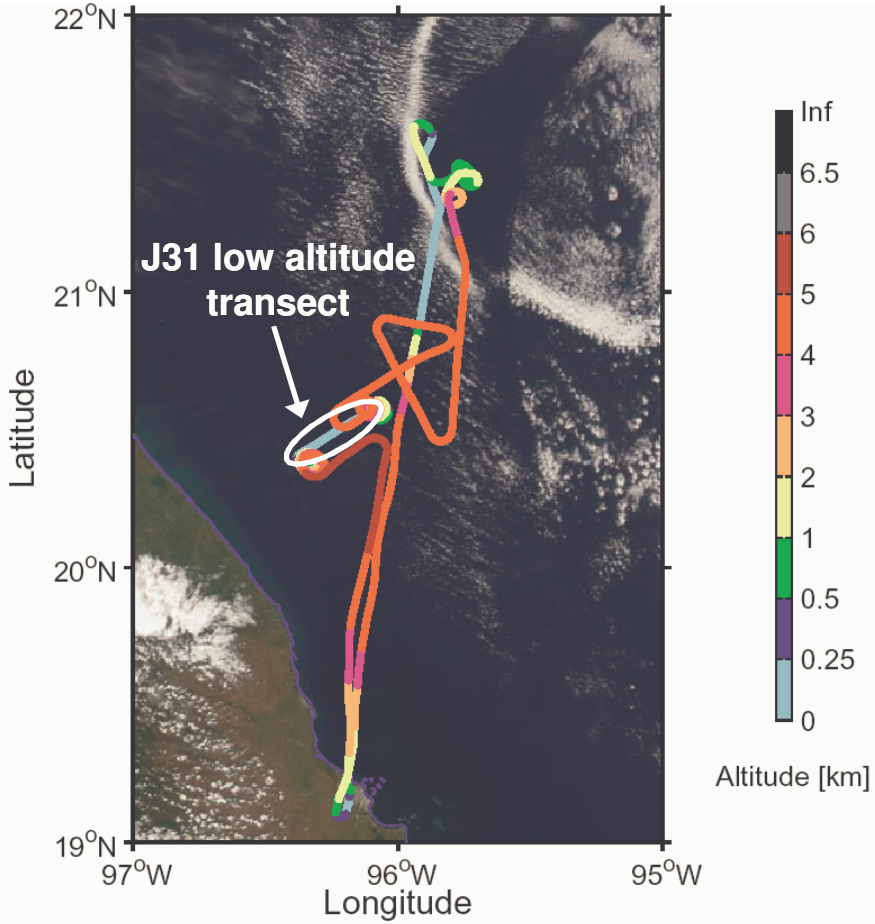
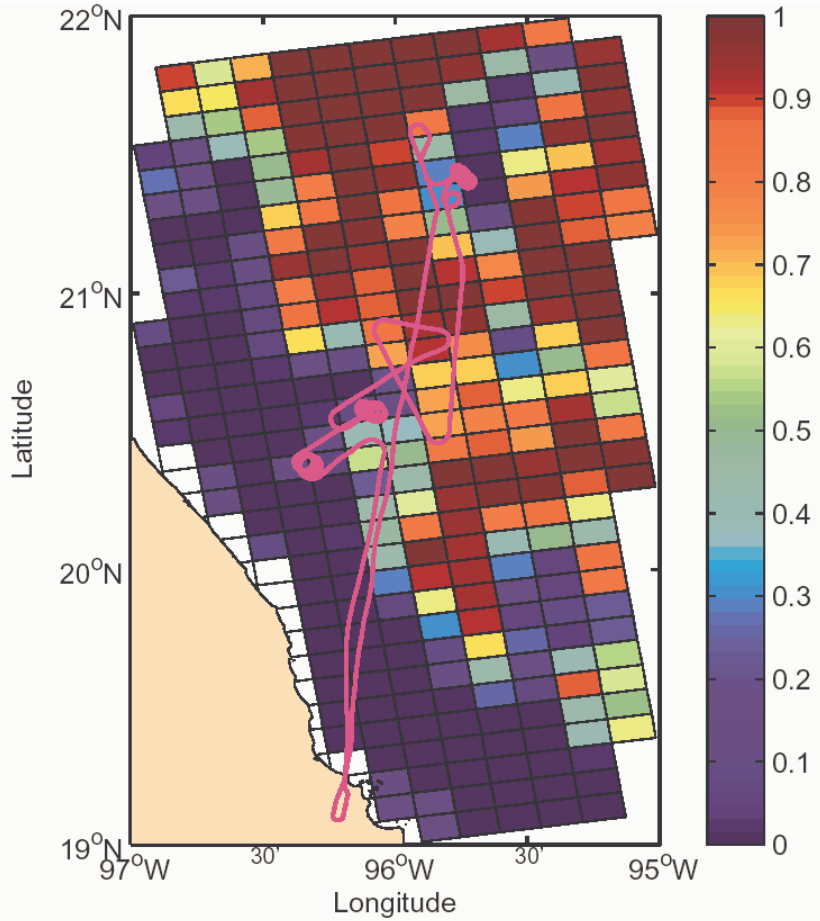
Aqua MODIS 17 March 2006 20:00-20:05 UT

True Color Image



Fraction of Cloud



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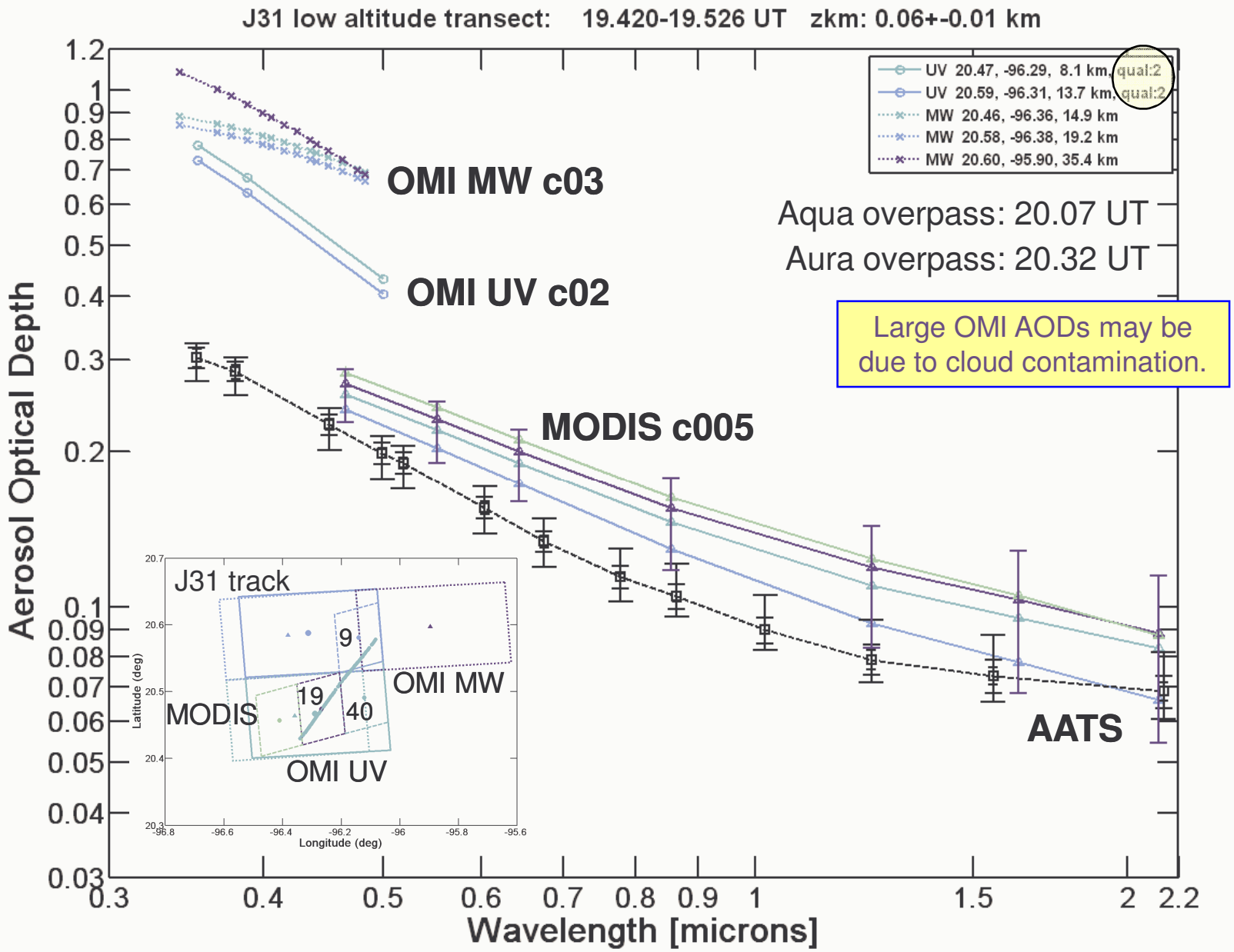
17 March 2006 *(over water)*



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Aerosol Absorption Optical Depth for 17 March 2006

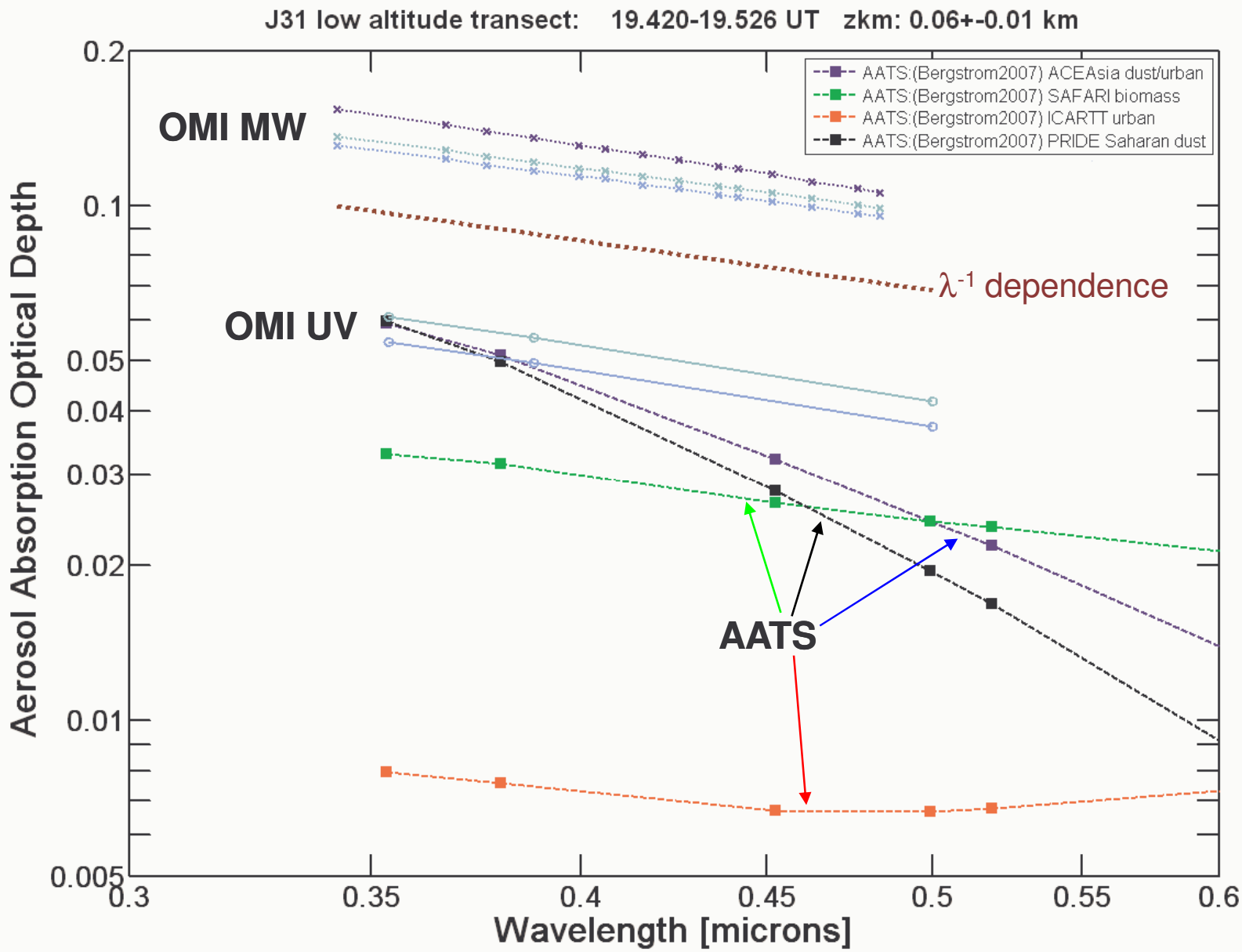

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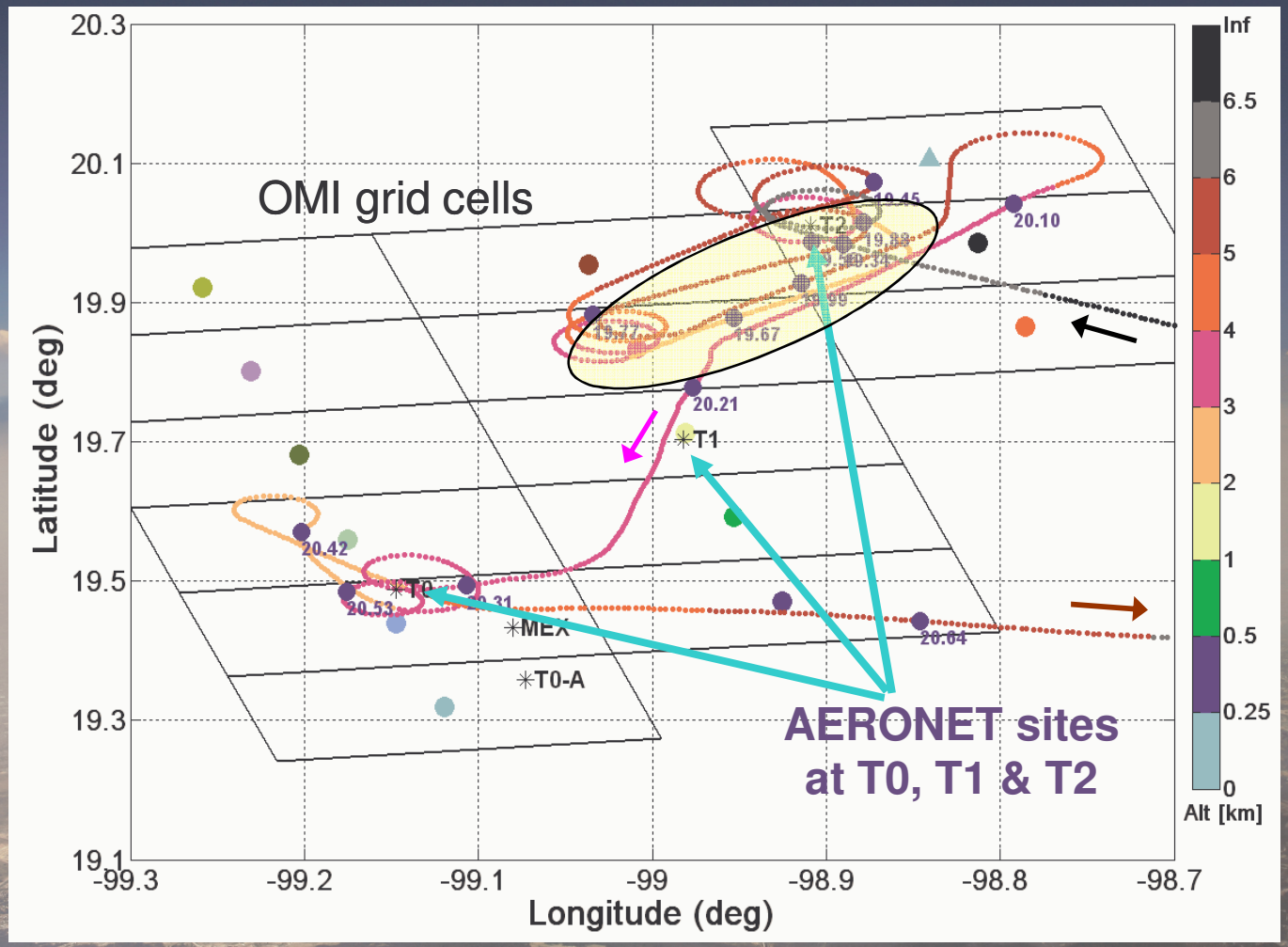
Photo from DC-8 over Mexico City, 19 Mar 2006

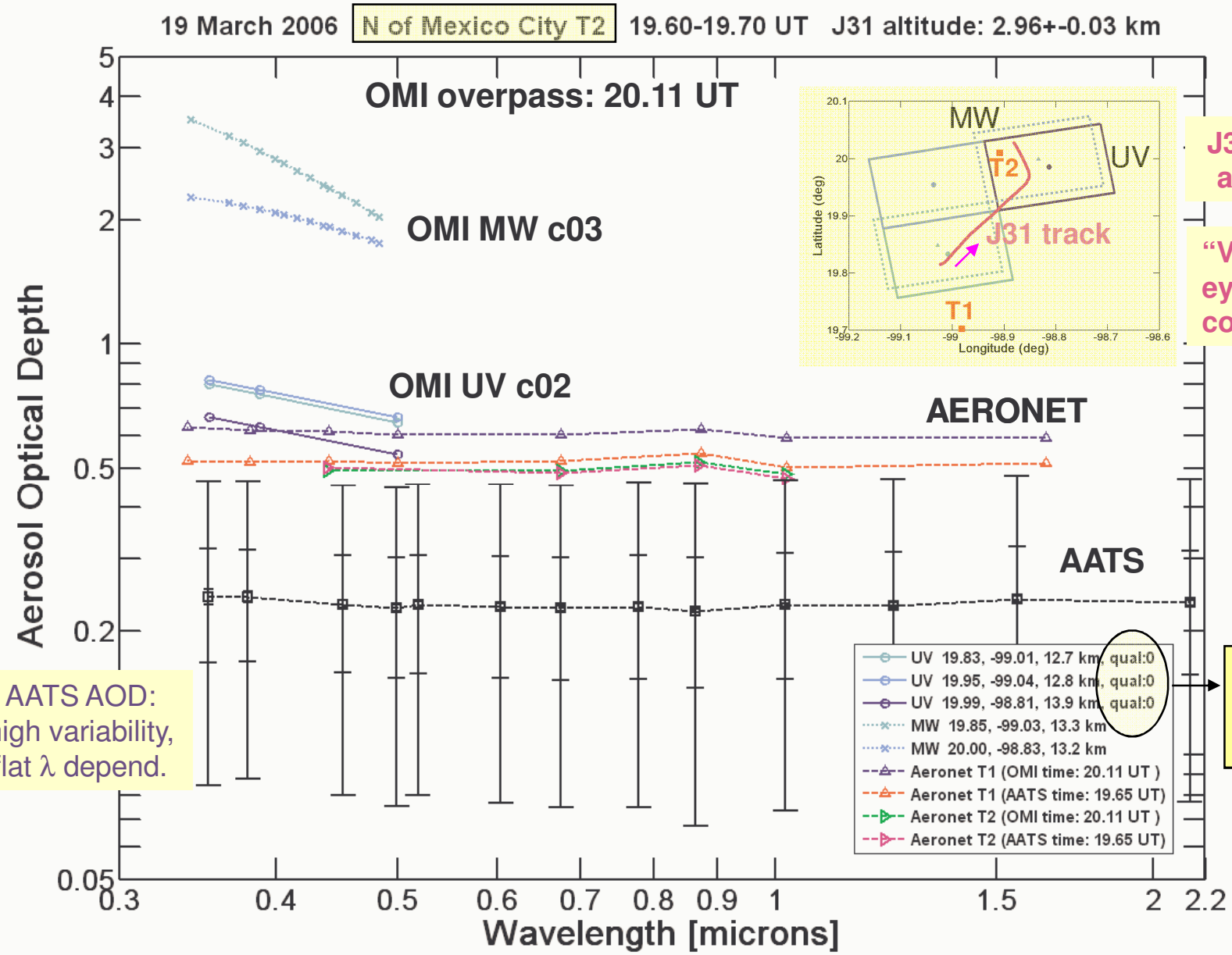
Courtesy of Cam McNaughton (Univ. of Hawaii)

19 March 2006 J31 flight to Mexico City

(rendezvous with C-130, B200, DC-8)



19 March 2006 *(over land)*



J31 ~450-750 m above surface

"Visibility poor; eyes burning in cockpit…"

highest quality retrieval

AATS AOD: high variability, flat λ depend.

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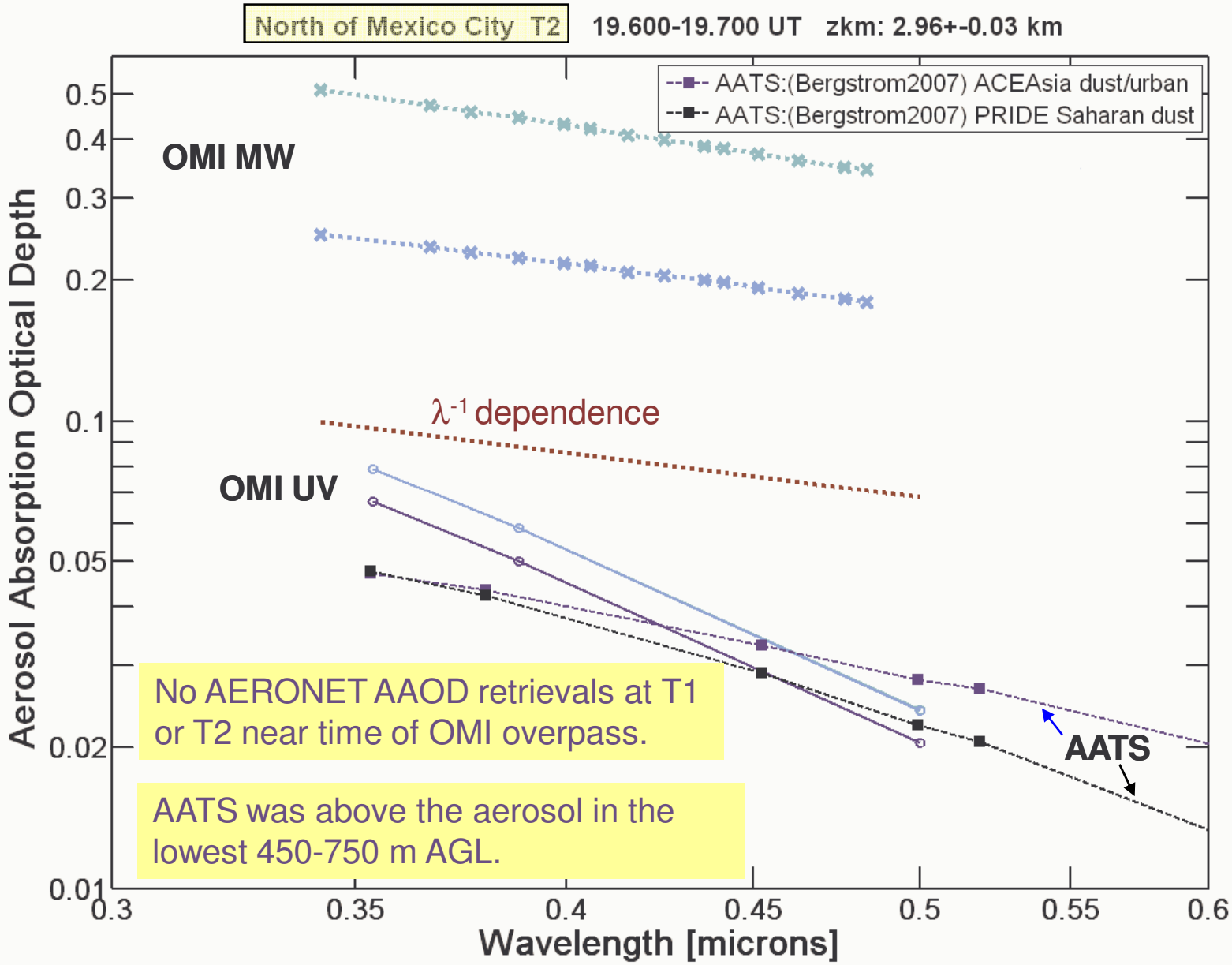
19 March 2006 *(over land)*



No AERONET AAOD retrievals at T1 or T2 near time of OMI overpass.

AATS was above the aerosol in the lowest 450-750 m AGL.

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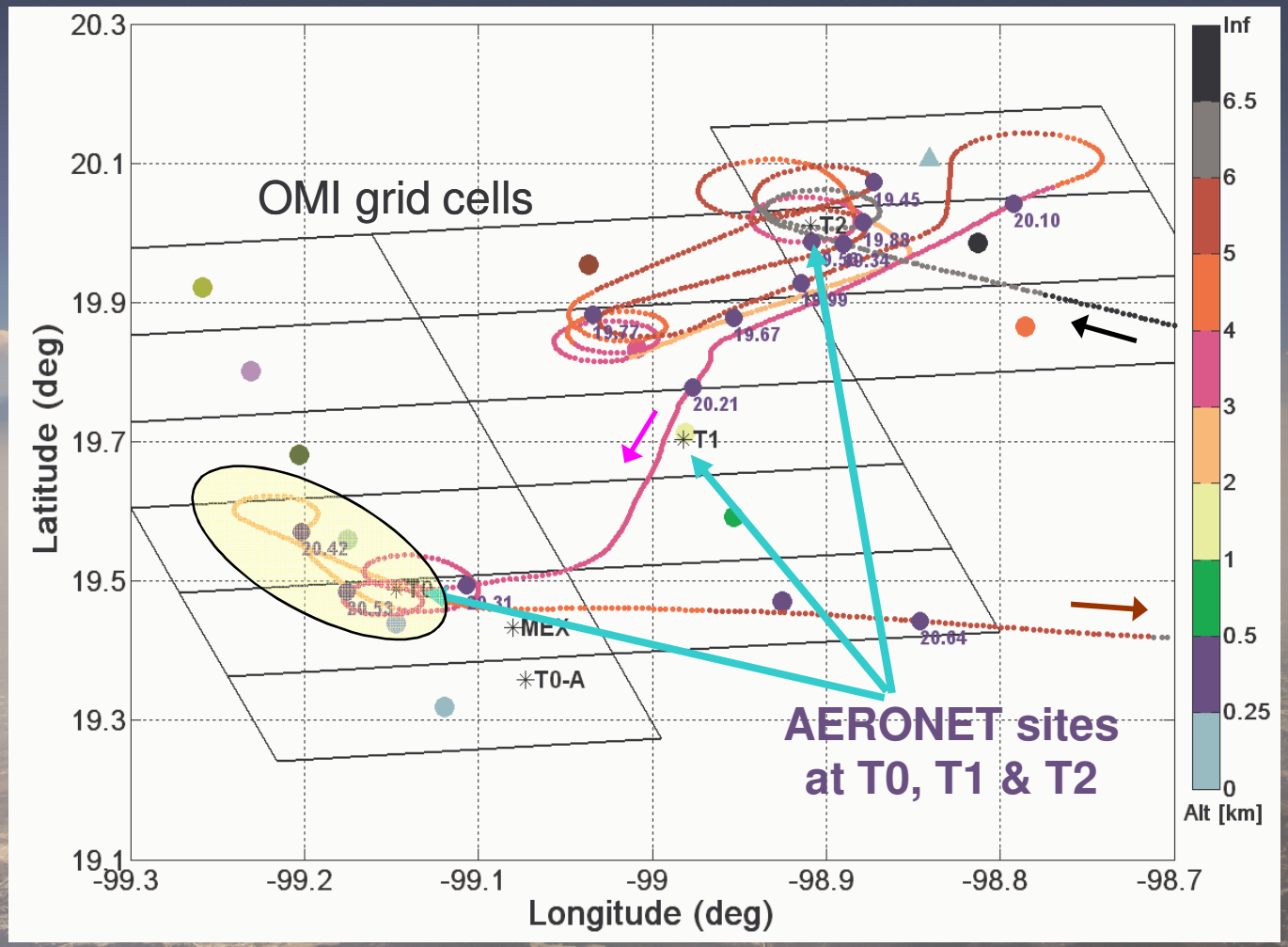
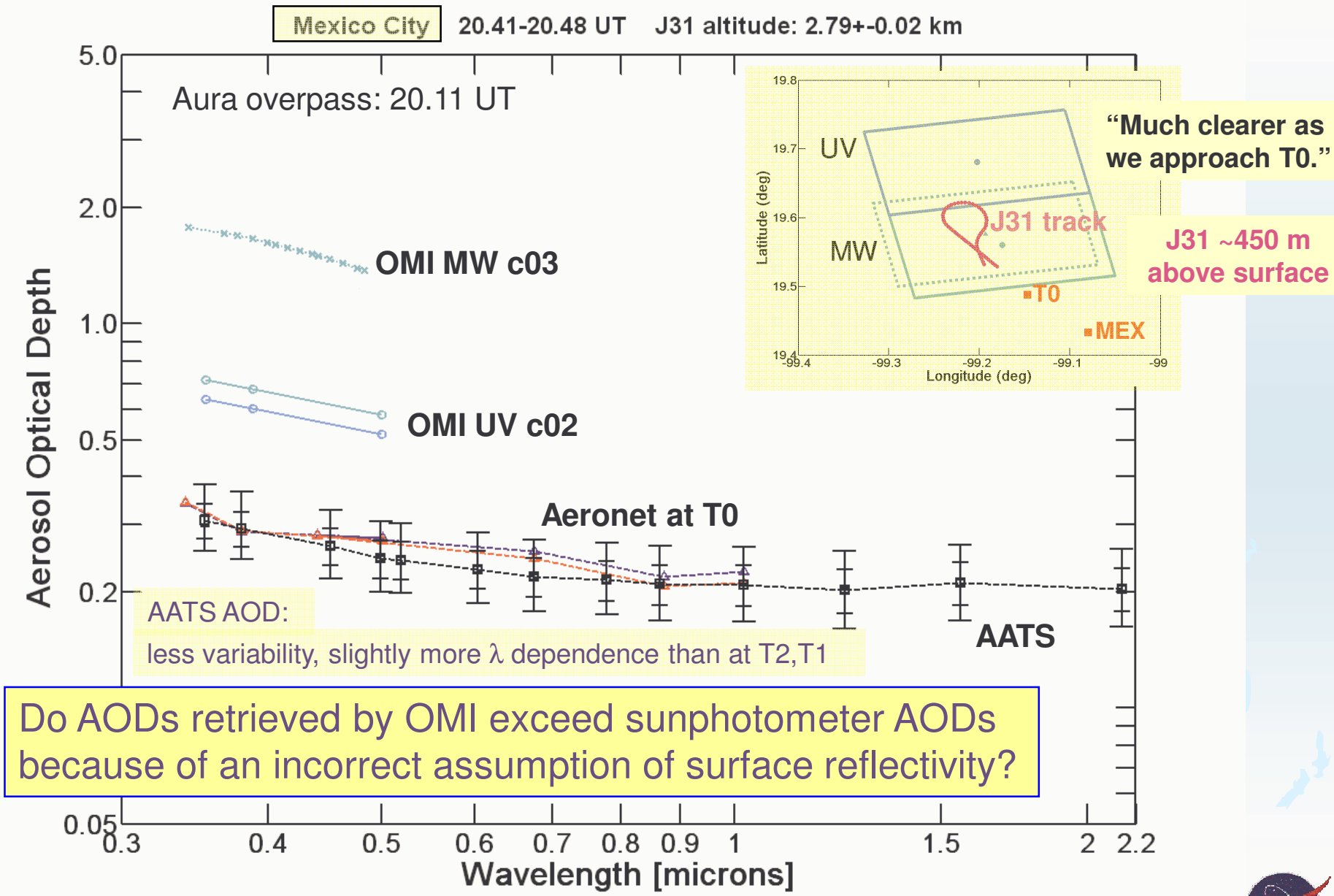
19 March 2006 J31 flight to Mexico City

(rendezvous with C-130, B200, DC-8)



19 March 2006 *(over land)*



AATS AOD:
less variability, slightly more λ dependence than at T2,T1

Do AODs retrieved by OMI exceed sunphotometer AODs because of an incorrect assumption of surface reflectivity?

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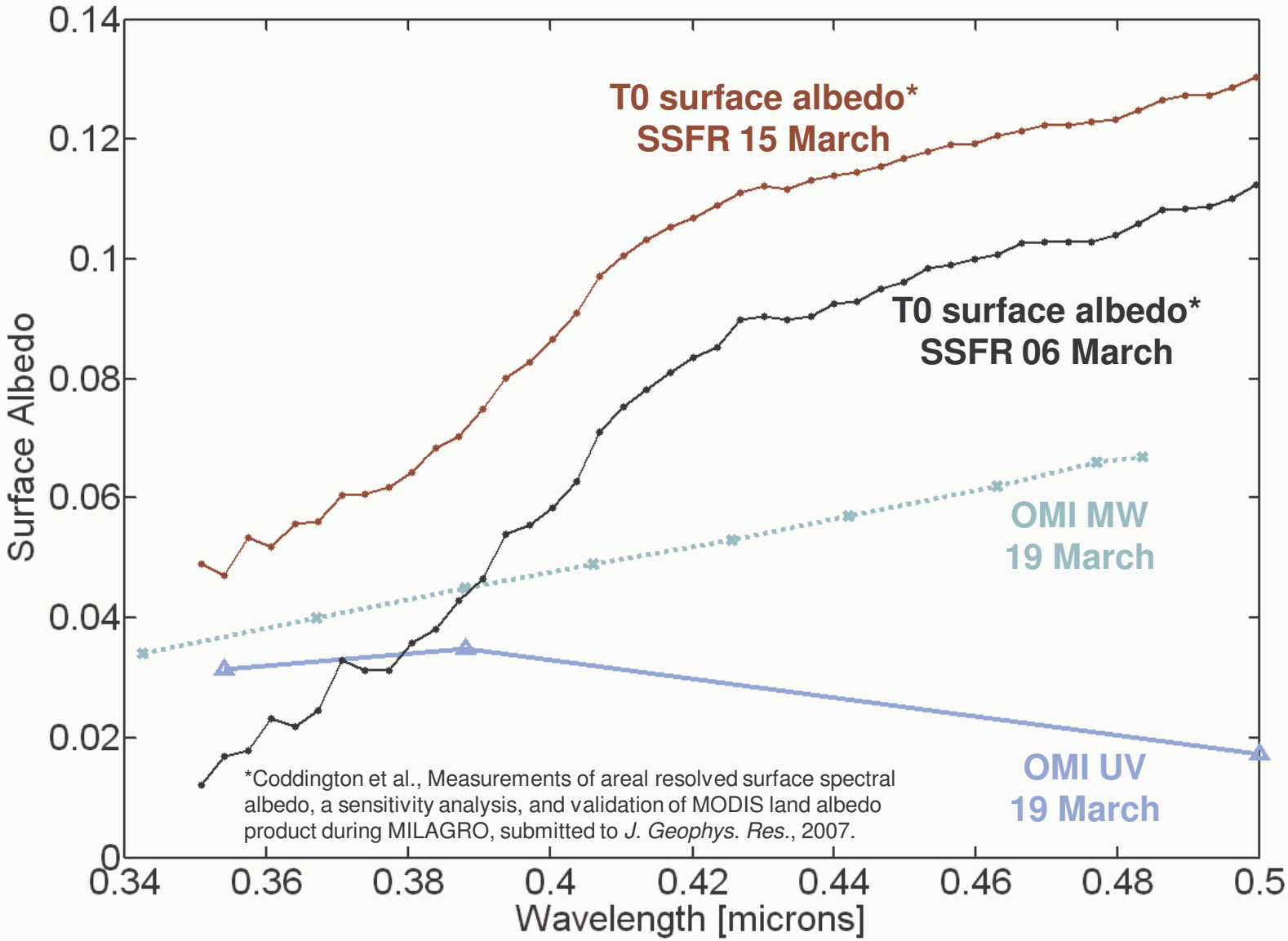
SSFR T0 Surface Albedo Retrievals for 06 & 10 March; OMI Retrieval Surface Albedo Assumptions for 19 March



*Coddington et al., Measurements of areal resolved surface spectral albedo, a sensitivity analysis, and validation of MODIS land albedo product during MILAGRO, submitted to *J. Geophys. Res.*, 2007.

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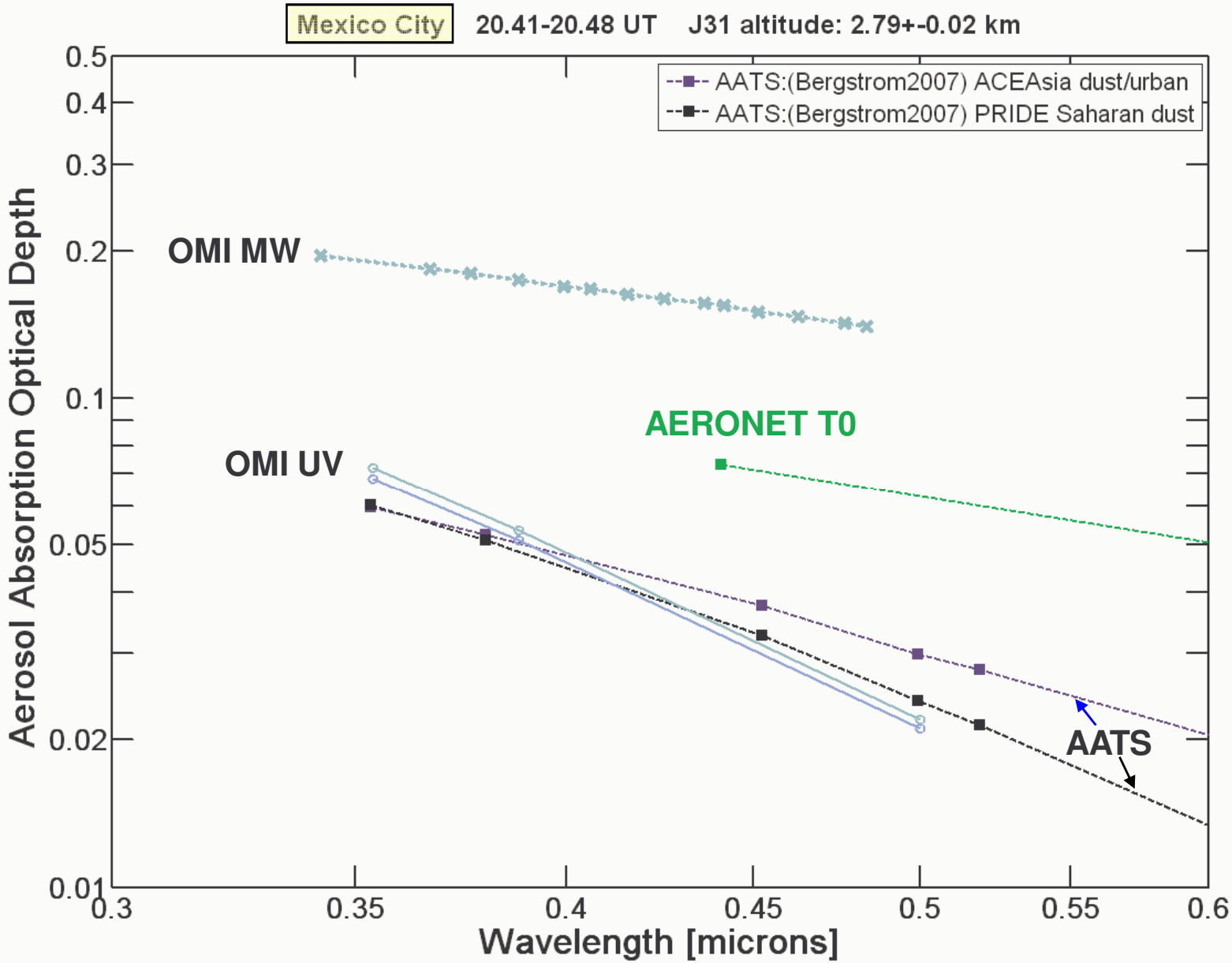
Aerosol Absorption Optical Depth for 19 March 2006



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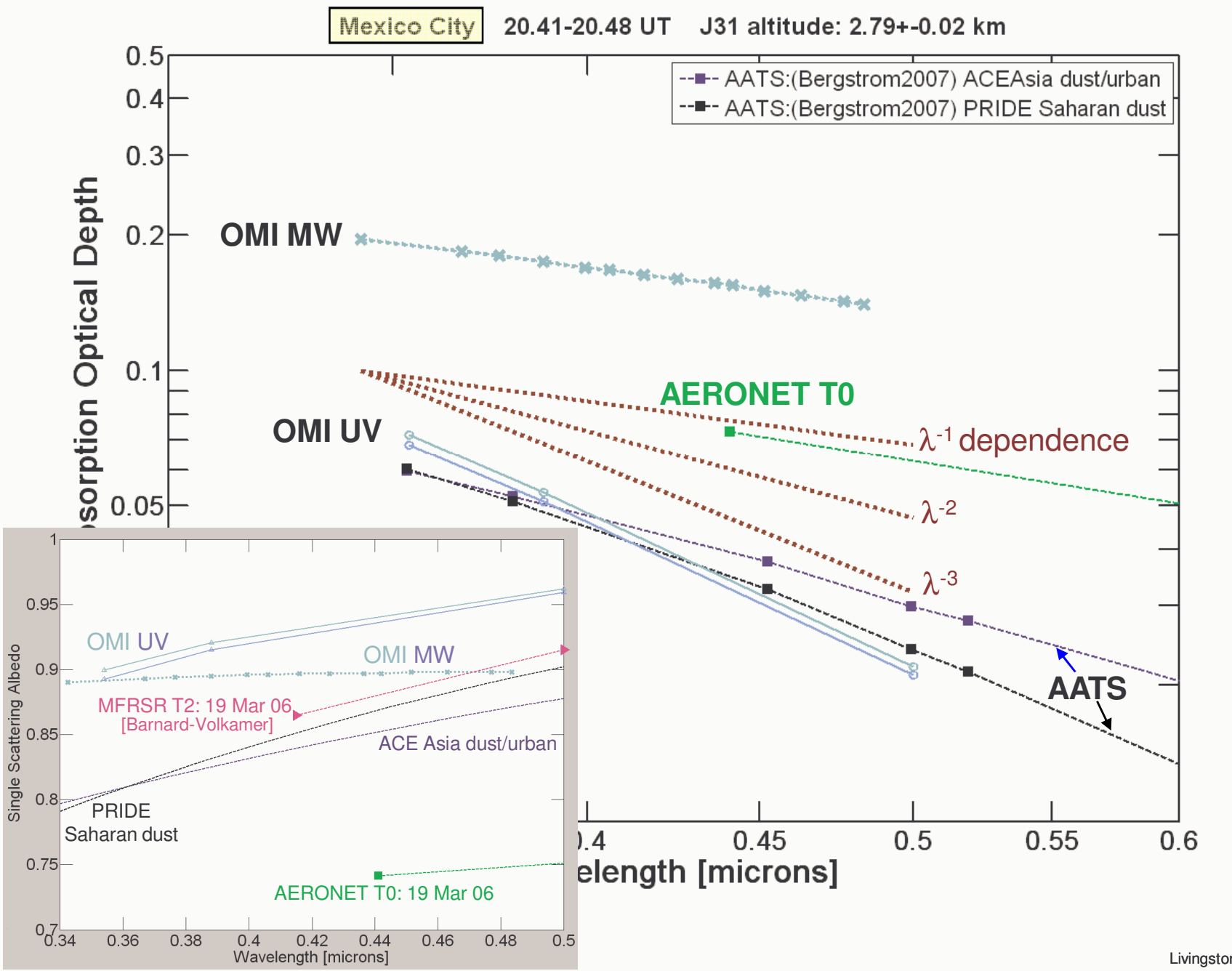
Aerosol Absorption Optical Depth for 19 March 2006



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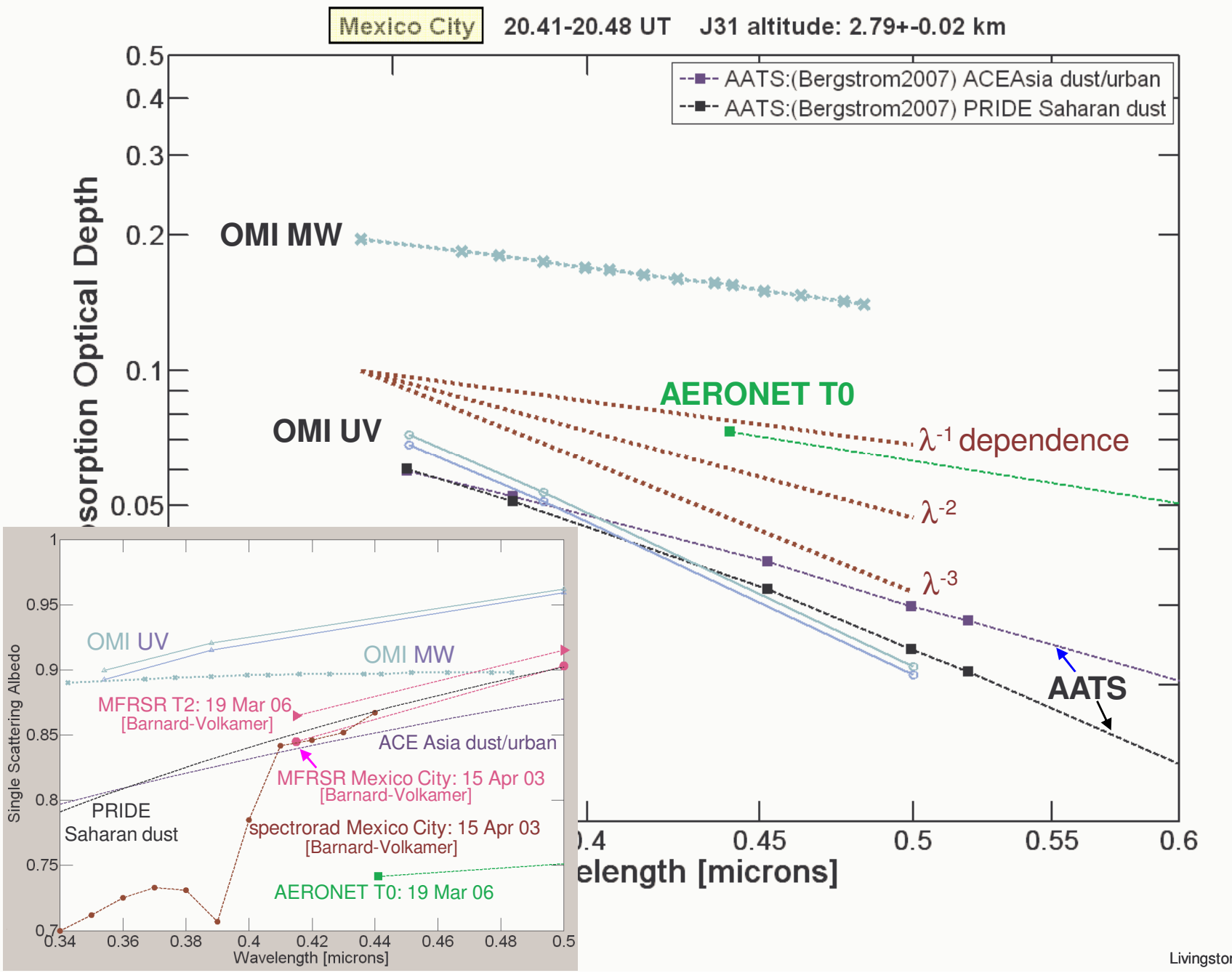
Aerosol Absorption Optical Depth for 19 March 2006



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Summary/Conclusions

- During MILAGRO/INTEX-B 2006, AATS-14 acquired near-surface AOD measurements coincident with four Aura OMI overpasses: three over the Gulf of Mexico and one over Mexico City.

- Aqua-MODIS AOD retrievals are available for two of the three over-water AATS/OMI events, and these agree well with the corresponding AATS AOD spectra. For the Mexico City event, AATS AOD spectra agree with coincident surface-based AERONET retrievals at the T0 site.

- For all AATS/OMI coincidences, OMI near-UV and MW AOD retrievals significantly exceed AATS AODs. Differences may be due to enhanced absorption in the UV due to organic aerosol, OMI instrument calibration, incorrect surface albedo assumptions by the OMI algorithms over land, or cloud contamination over water.

- OMI retrievals yield Aerosol Absorption Optical Depth (AAOD) directly, but a SSA spectrum must be assumed to calculate AAOD from AATS AOD. We have estimated AATS AAODs by assuming SSA values previously measured for Saharan dust (PRIDE, 2000) and for a mixture of dust and urban pollution (ACE-Asia, 2001). OMI near-UV and estimated AATS AAOD spectra agree better than do the OMI near-UV and AATS AOD spectra. However, comparisons of OMI MW and estimated AATS AAOD spectra show little improvement in agreement over the OMI MW and AATS AOD comparisons.

- Inversions of AERONET direct sun and almucantar measurements acquired at the T0 site in Mexico City on 19 March near (~20 min before and 40 min after) the time of Aura overpass yield SSA values (0.733 and 0.758) at 441 nm that are significantly less than the OMI retrievals. The corresponding AERONET AAOD value of 0.073 falls between corresponding OMI UV and MW retrievals of AAOD.