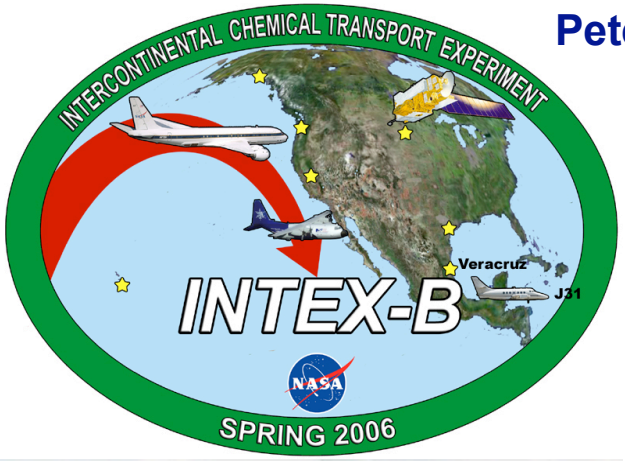
An overview of the J-31 in INTEX-B/MILAGRO: Goals, operations, sample results, and opportunities for collaboration

Phil Russell, Jens Redemann, John Livingston, Qin Zhang, Stephanie Ramirez
Brian Cairns, Charles Gatebe, Omar Torres, Michael King, Brent Holben,
Peter Pilewskie, Sebastian Schmidt,
Rose Dominguez, Warren Gore, Ralph Kahn, Chris Hostetler, John Hair, Richard Ferrare, Edward Browell, Antony Clarke, Yohei Shinozuka, Cam McNaughton
and the rest of the J31 Team



MILAGRO
Science Meeting
23 Oct 2006
Boulder, Co

For INTEX-B/MILAGRO the J31 was equipped to measure solar energy and how that energy is affected by atmospheric constituents and Earth's surfaces.

Because solar energy drives Earth's climate, the J31 suite of measurements helps show how changing atmospheric and surface properties can change the climate

SCIENCE GOALS, J31 in INTEX-B/MILAGRO:

Aerosol, Water Vapor, Cloud, & Surface Properties and Radiative Effects

Characterize the distributions, properties, and effects of aerosols and water vapor advecting from Mexico City and biomass fires toward and over the Gulf of Mexico

- –Aerosol Optical Depth And Extinction Spectra (354-2138 nm)
- –Water Vapor Columns and Profiles
- –Aerosol Radiative Impacts: In Clear Sky (Direct Effect) & Via Clouds (Indirect Effect)

Test the ability of Aura, other A-Train & Terra sensors, & airborne lidar to retrieve aerosol, cloud, and water vapor properties

Characterize surface spectral albedo and bidirectional reflectance distribution function (BRDF) to help improve satellite retrievals

Mexico City

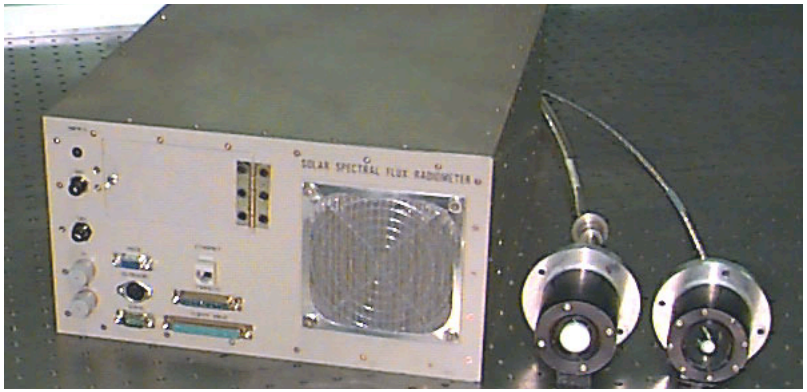
Veracruz

Quantify the relationships between the above and aerosol amount and type

J31 in INTEX-B/MILAGRO: Payload

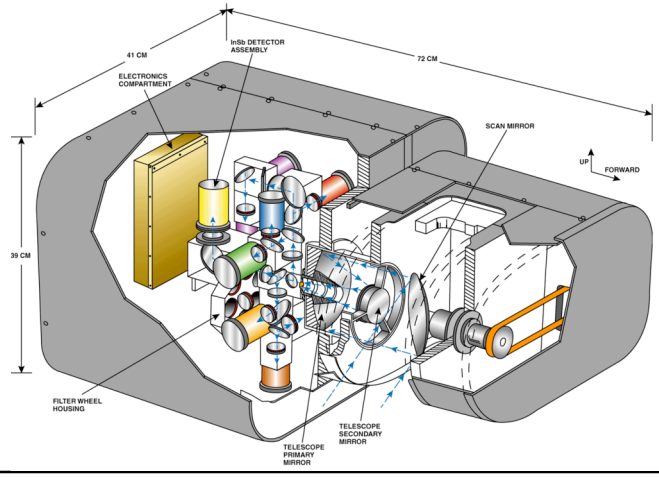
Ames Airborne Tracking Sun-photometer (AATS)

Solar Spectral Flux Radiometer (SSFR)



Research Scanning Polarimeter (RSP)

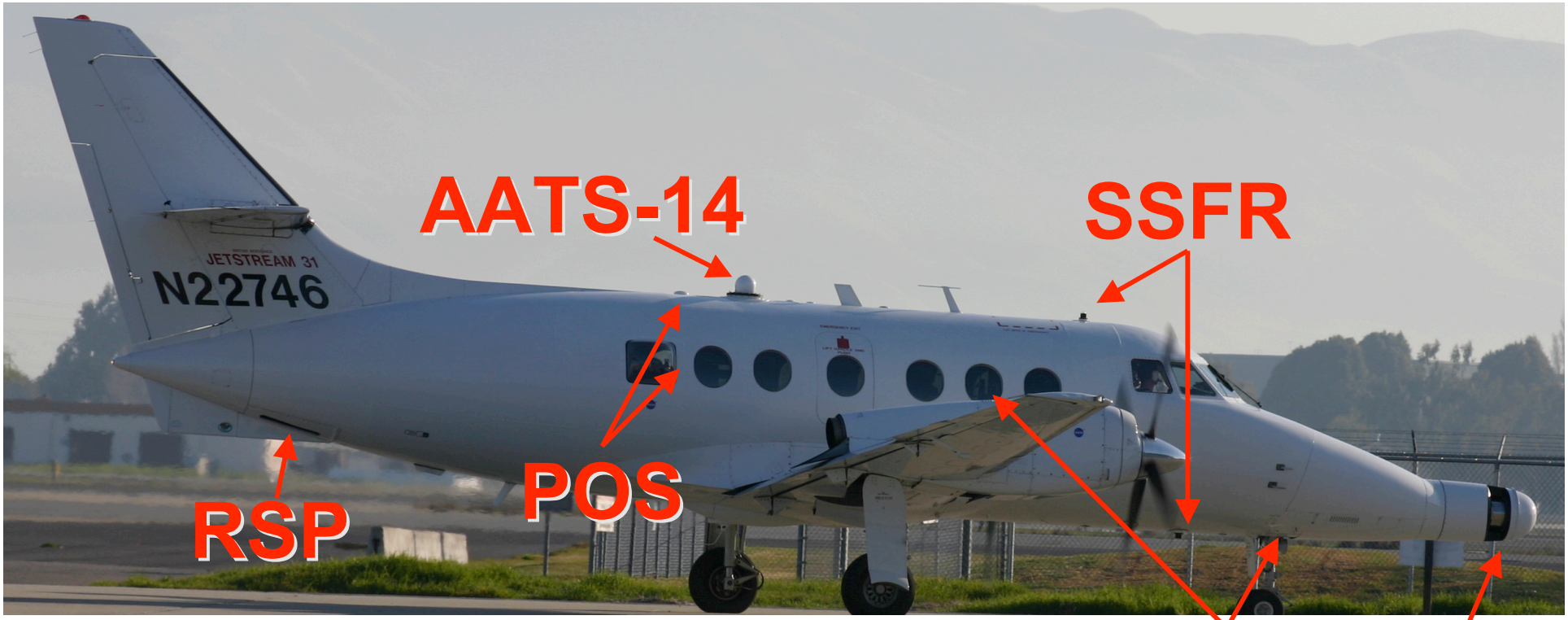
Cloud Absorption Radiometer (CAR)



Position & Orientation System (POS)

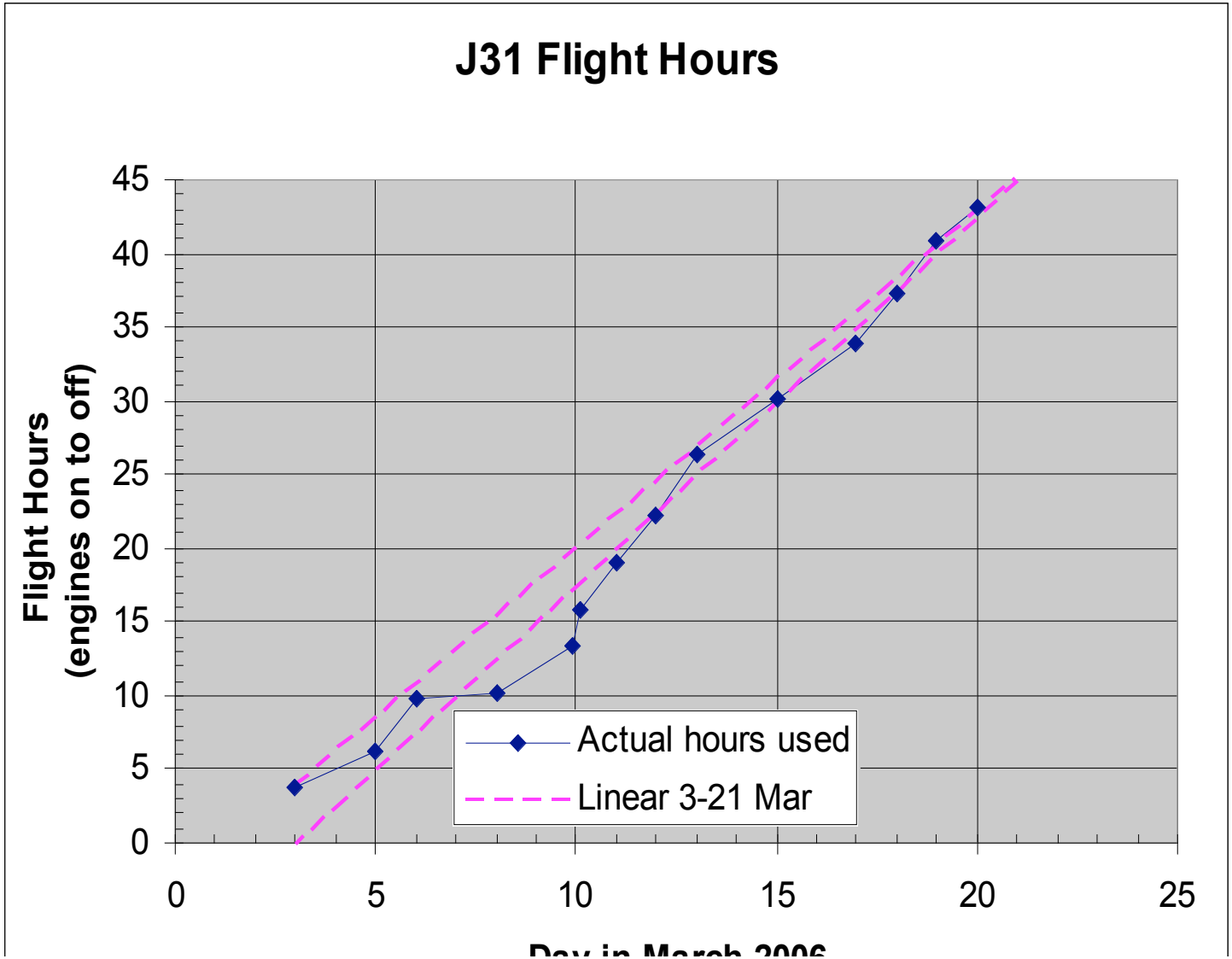
Met Sensors & Nav/Met Data System

J31 in INTEX-B/MILAGRO: Instrument Locations



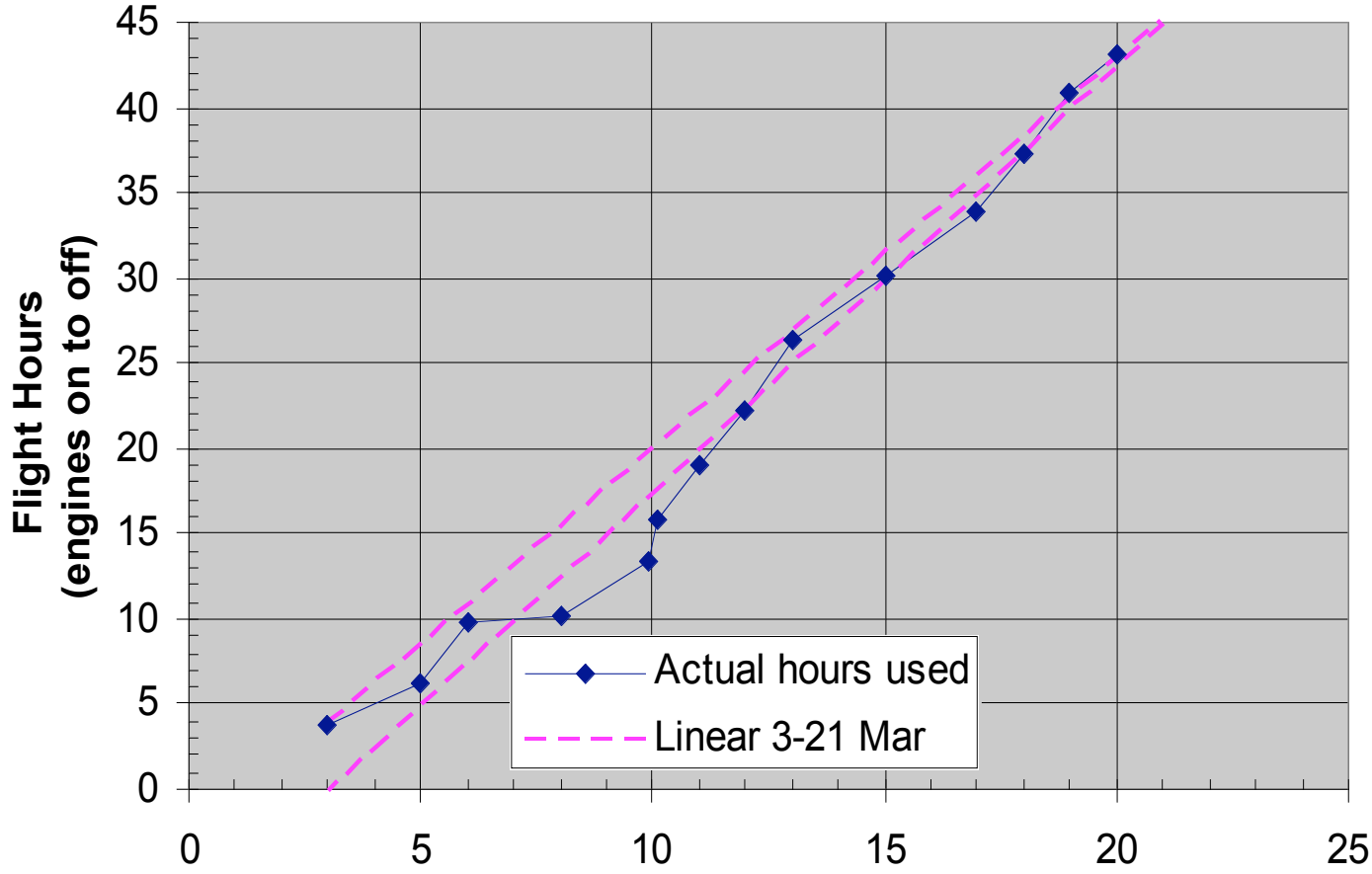
To accomplish these goals and objectives we had:

- 19 Days (3-21 Mar)
- 45 Flight Hours



To accomplish these goals and objectives we had:

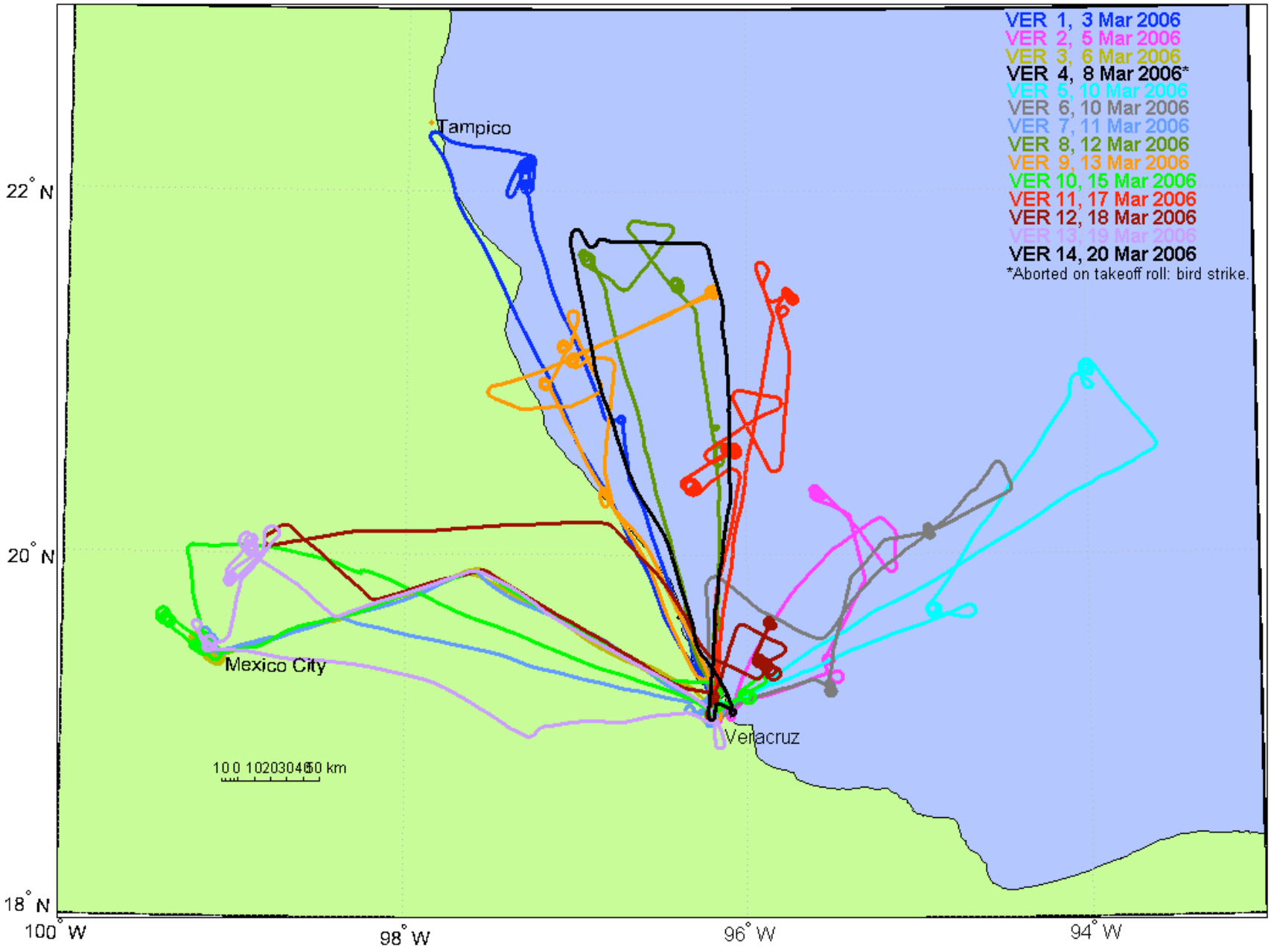
- 19 Days (3-21 Mar)
- 45 Flight Hours



A/C & Instruments performed very well

- A/C available to fly every day
- Instruments had very high data capture rates

Flight Tracks, 13 J31 Flights out of Veracruz



J31 Science Flights out of Veracruz

http://geo.arc.nasa.gov/sgg/AATS-website/index.html

Flt No.	Date, 2006	Track	Comments
VER 01	3 Mar	Gulf of Mexico near VER & Tampico	Terra & A-Train near overpass times, clouds & clear. Profile, RSP legs, CAR circles.
VER 02	5 Mar	Gulf of Mexico NE of VER	Terra, clear. Profile, transects, SSFR fluxes, RSP legs, CAR circles.
VER 03	6 Mar	Mexico City	Terra (MISR LM), clear. Racetrack stepped profile, SSFR fluxes, RSP legs, CAR racetracks near T0 & airport under King Air.
VER 04	8 Mar	Aborted on takeoff roll: bird strike	
VER 05	10 Mar	Gulf of Mexico NE of VER	Aura (OMI), Terra (MISR LM + MODIS), King Air and C-130. Clear + cirrus. 2 profiles, RSP legs.
VER 06	10 Mar	Gulf of Mexico NE of VER	A-Train in MODIS Aqua glint-free. Profiles, SSFR fluxes, CAR circles, RSP legs
VER 07	11 Mar	Mexico City	CAR circles for urban reflectivity. Profile w 18Z sonde at VER on return.

J31 Science Flights out of Veracruz (cont'd)

http://geo.arc.nasa.gov/sgg/AATS-website/index.html

Flt No.	Date, 2006	Track	Comments
VER 08	12 Mar	Gulf of Mexico N of VER	Terra, King Air. Clear + clouds. Profiles, RSP legs. Near AERONET Tampico & Tamihua
VER 09	13 Mar	Gulf of Mexico N of VER	Terra MODIS/Glory glint scenario.
VER 10	15 Mar	Mexico City	Terra (MISR LM), cirrus. Stepped profile, SSFR fluxes, RSP legs, CAR circles at T0 + other point under King Air.
VER 11	17 Mar	Gulf of Mexico N of VER	Aqua, aerosols + cloud experiments. Profiles, SSFR fluxes, RSP legs, CAR circles.
VER 12	18 Mar	Toward Mexico City, then Gulf near VER	Ci over MC caused diversion to Gulf. Profiles, SSFR fluxes, RSP legs, CAR circles w Aqua.
VER 13	19 Mar	T2 & T0 (Mexico City)	Profiles, RSP & SSFR legs with Aqua, POLDER, Aura, DC-8 at T2. Profiles and legs at T0
VER 14	20 Mar	Gulf of Mexico N of VER	H_2O sonde comparison on takeoff. Glint experiment scrubbed by Ci.

Posters Showing J31 Results at This Workshop

- Cairns et al., Polarimetric remote sensing of aerosols and clouds during MILAGRO
- Clarke et al., Airborne Measurements of Aerosol Size Distributions and Related Physiochemical and Optical Properties During MILAGRO
- Gatebe et al., Airborne Spectral Measurements of Surface-Atmosphere Anisotropy over Different Surfaces in Mexico
- Hair et al., Airborne High Spectral Resolution Lidar Observations of Aerosol Spatial Distribution and Optical Properties from MILAGRO
- Kahn et al., MILAGRO/INTEX-B Coordinated Satellite + Sub-orbital Platform Experiments: March 06 & 10, 2006
- Livingston et al., Aerosol Optical Depths from Airborne Sunphotometry in INTEX-B/MILAGRO as a Validation Tool for the Ozone Monitoring Instrument (OMI) on Aura
- Redemann et al., AATS-14 on the J31 in INTEX-B/MILAGRO: Comparisons to data collected by aerosol sensors on Terra, Aqua, and suborbital platforms
- Schmidt et al., Airborne Solar Spectral Irradiance Measurements during the MILAGRO field campaign

Posters Showing J31 Results at This Workshop

- Cairns et al.
- Clarke et al.
- Gatebe et al.
- Hair et al.
- Kahn et al.
- Livingston et al.
- Redemann et al.
- Schmidt et al.

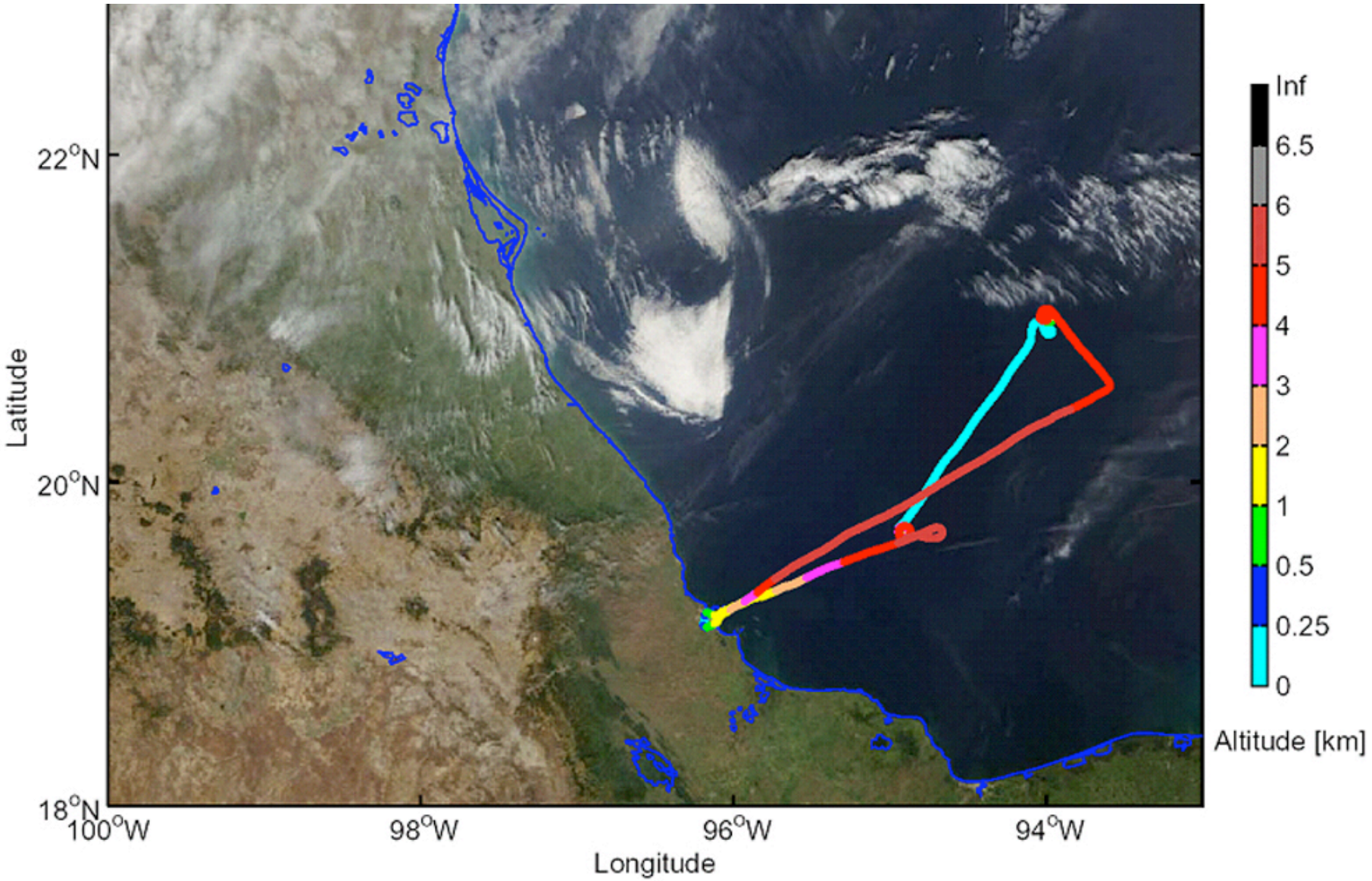
Together these studies include results from coordinated measurements by:

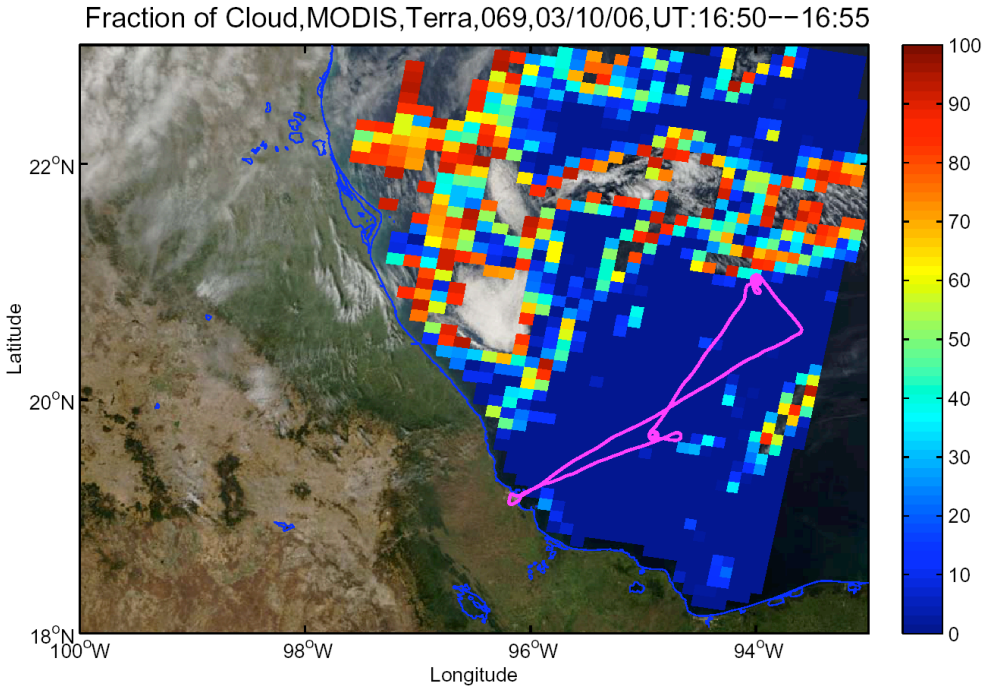
- 4 Satellites: Aura (OMI), Aqua (MODIS), Terra (MISR & MODIS), Parasol (POLDER)
- 4 Aircraft: J31, King Air B200, C-130, DC-8.
- Ground sensors: AERONET, …

J31 Science Flights out of Veracruz
in MILAGRO/INTEX-B

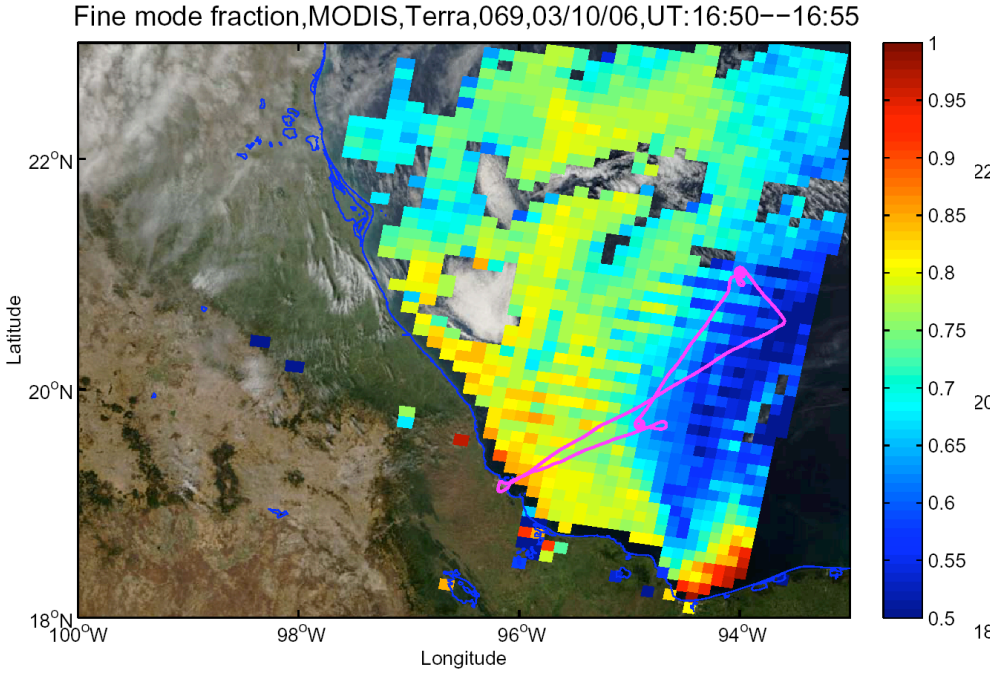
Flt No.	Date, 2006	Track	Comments
VER 01	3 Mar	Gulf of Mexico near VER & Tampico	Terra & A-Train near overpass times, clouds & clear. Profile, RSP legs, CAR circles.
VER 02	5 Mar	Gulf of Mexico NE of VER	Terra, clear. Profile, transects, SSFR fluxes, RSP legs, CAR circles.
VER 03	6 Mar	Mexico City	Terra (MISR LM), clear. Racetrack stepped profile, SSFR fluxes, RSP legs, CAR racetracks near T0 & airport under King Air.
VER 04	8 Mar	Aborted on takeoff roll: bird strike	
VER 05	10 Mar	Gulf of Mexico NE of VER	Terra (MISR LM + MODIS), King Air and C-130. Clear + cirrus. 2 profiles, RSP legs.
VER 06	10 Mar	Gulf of Mexico NE of VER	Aura (OMI), A-Train in MODIS Aqua glint-free. Profiles, SSFR fluxes, CAR circles, RSP legs
VER 07	11 Mar	Mexico City	CAR circles for urban reflectivity. Profile w 18Z sonde at VER on return.

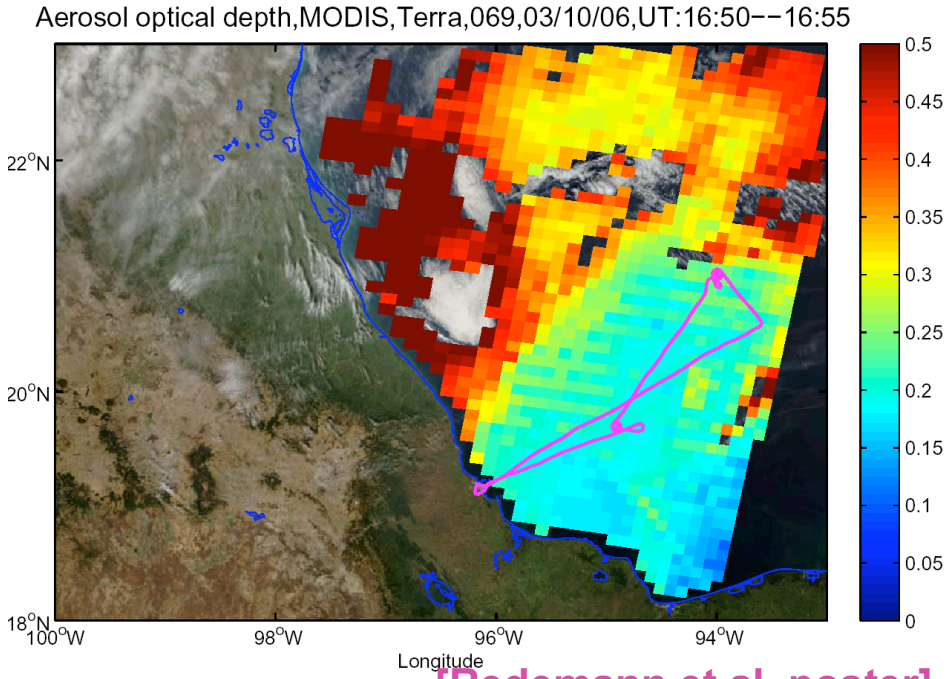
INTEX-B: 10 Mar 2006 J31 flight track on MODIS-Terra true-color image, ~ 1653 UT





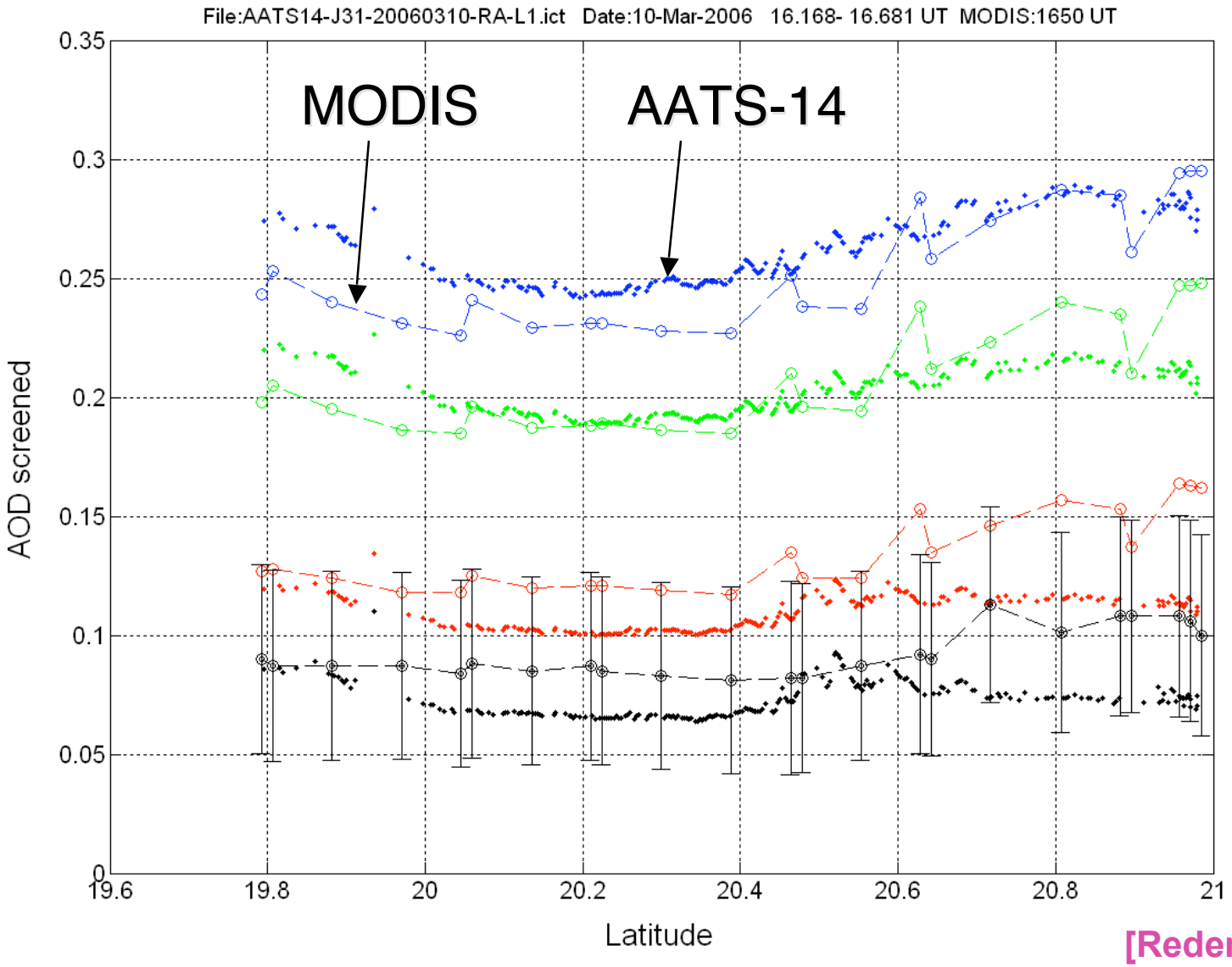
March 10, MISR local mode and MODIS-Terra coincidence over the Gulf of Mexico. Retrieval maps show MODIS-Terra results and J-31 flight track





[Redemann et al. poster]

March 10, 2006 - MODIS-Terra coincidence over the Gulf of Mexico



MODIS/AATS

470 / 453

550 / 519

870 / 864

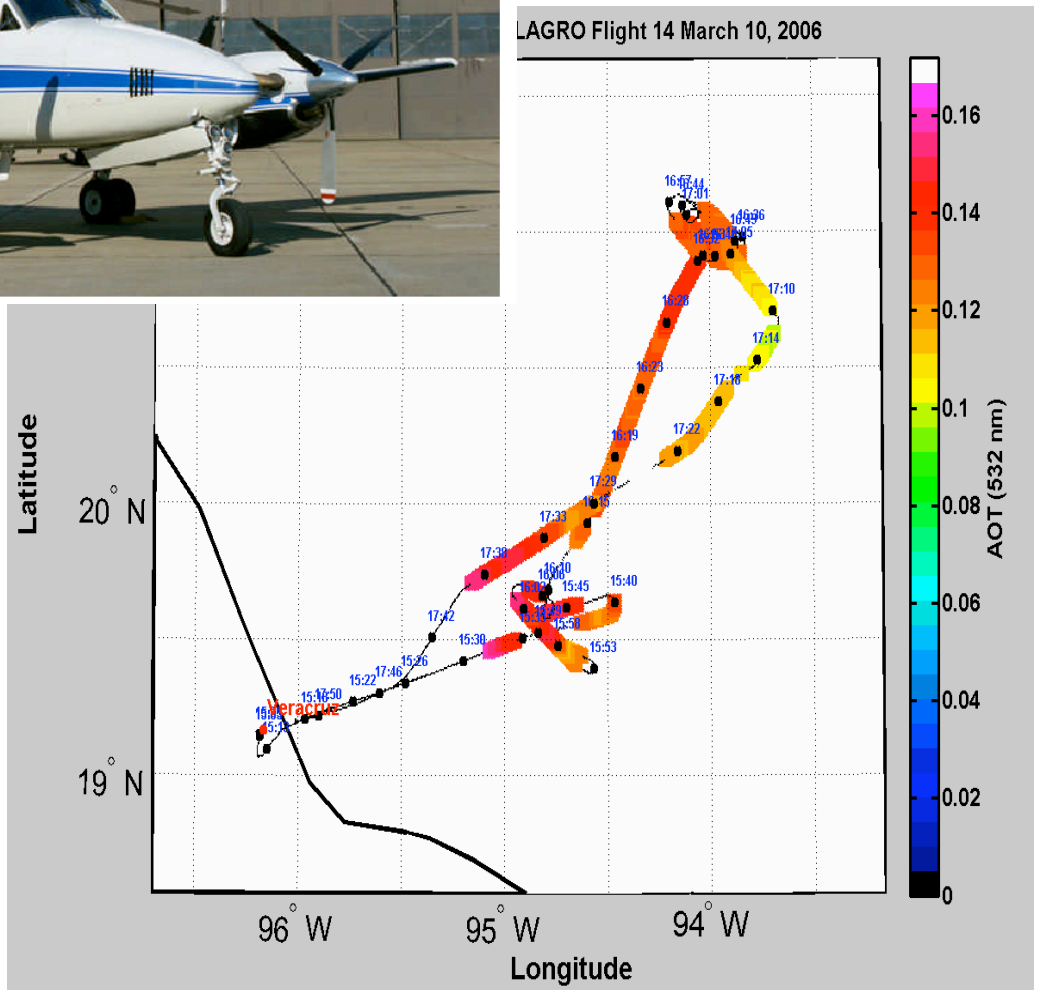
2140 / 2139

[Redemann et al. poster]

LaRC King Air Be-200

<u>One King Air/HSRL Goal</u>: Evaluate/validate the HSRL retrieved profiles of aerosol extinction

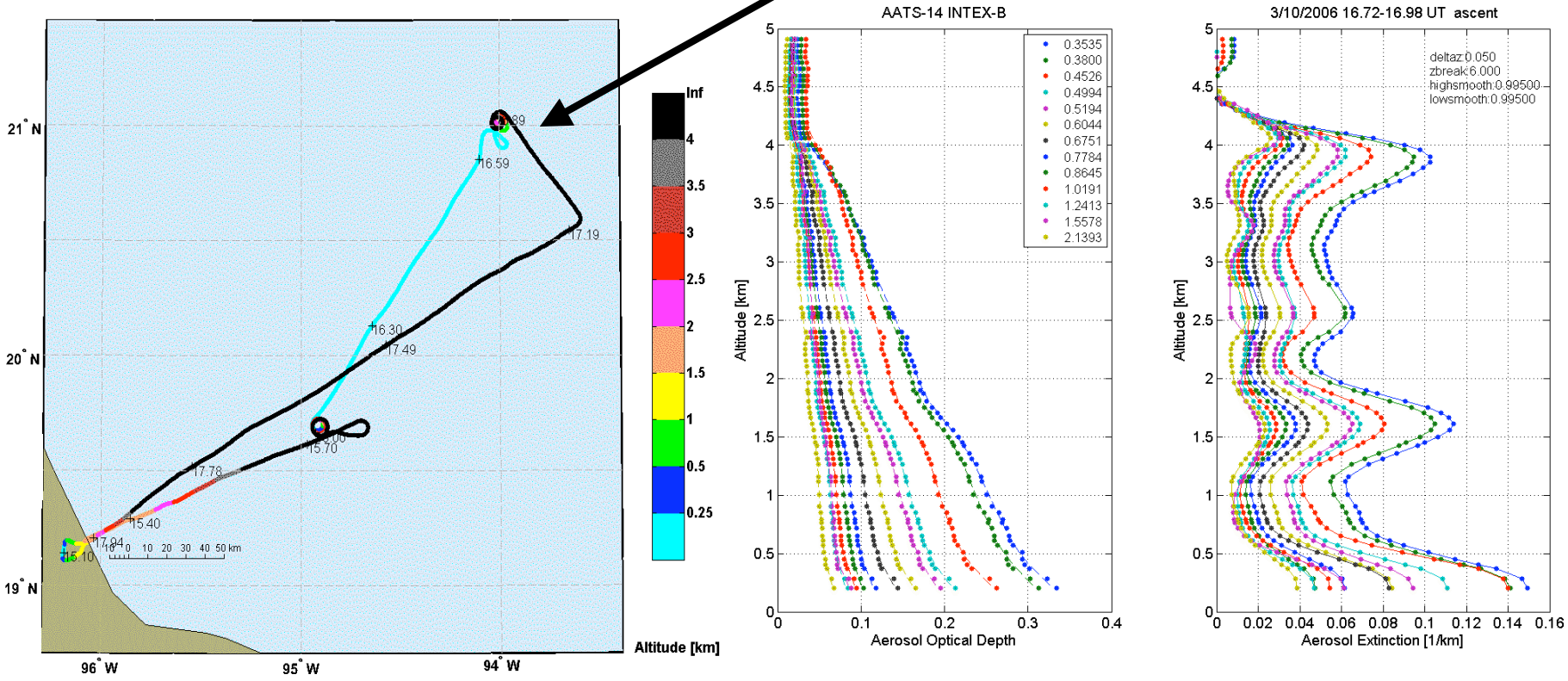
[Hair et al. poster]



Comparison of HSRL extinction/AOT with other instruments

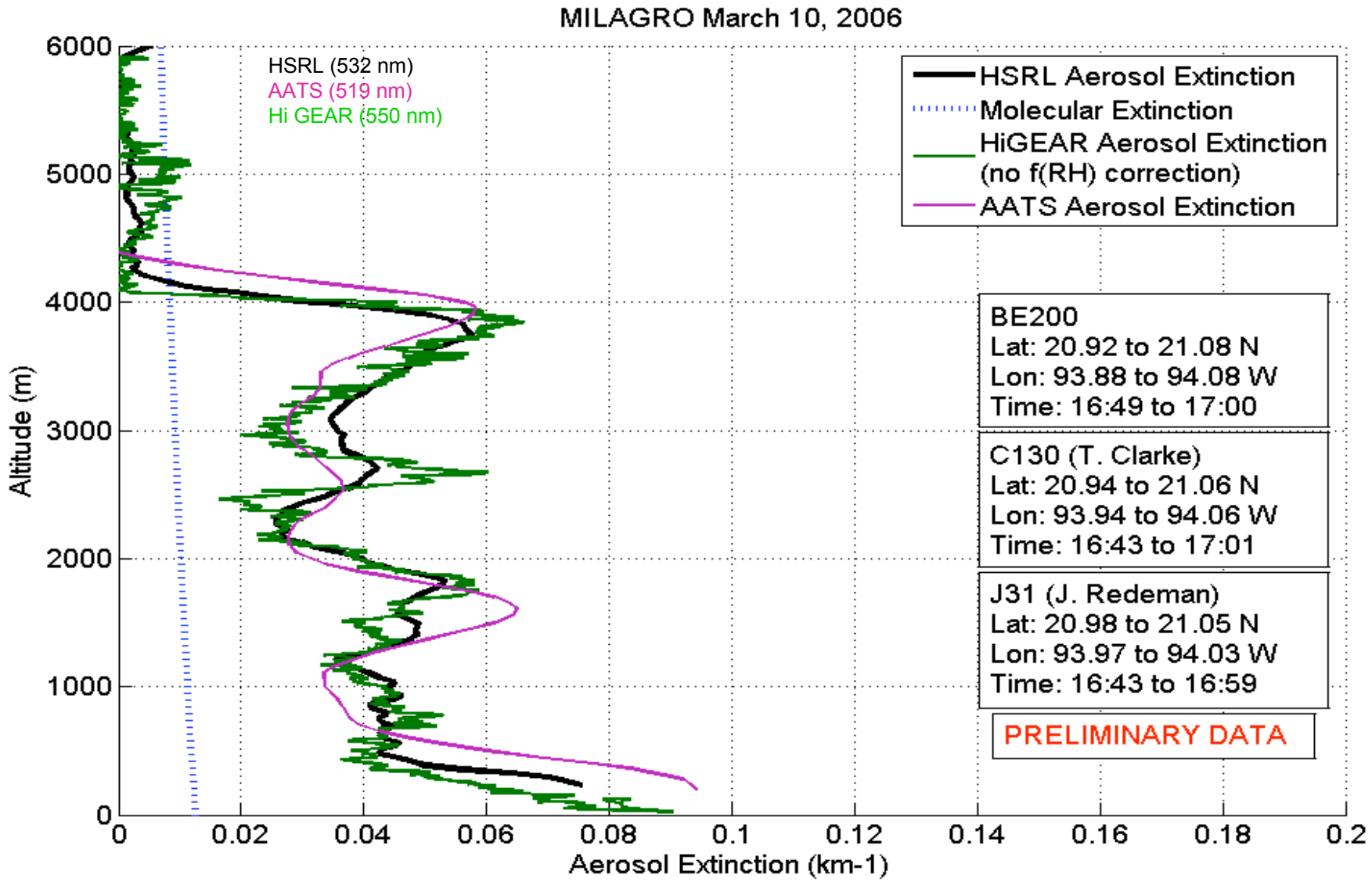
- AATS14 on J-31
  - AATS14 data courtesy of Russell, Redemann, Livingston

Spiral location for J31 & C130



[Redemann, Livingston et al.]

Aerosol extinction comparison from coordinated flights by J31 (AATS), Be200 (HSRL), & C130 (in situ)



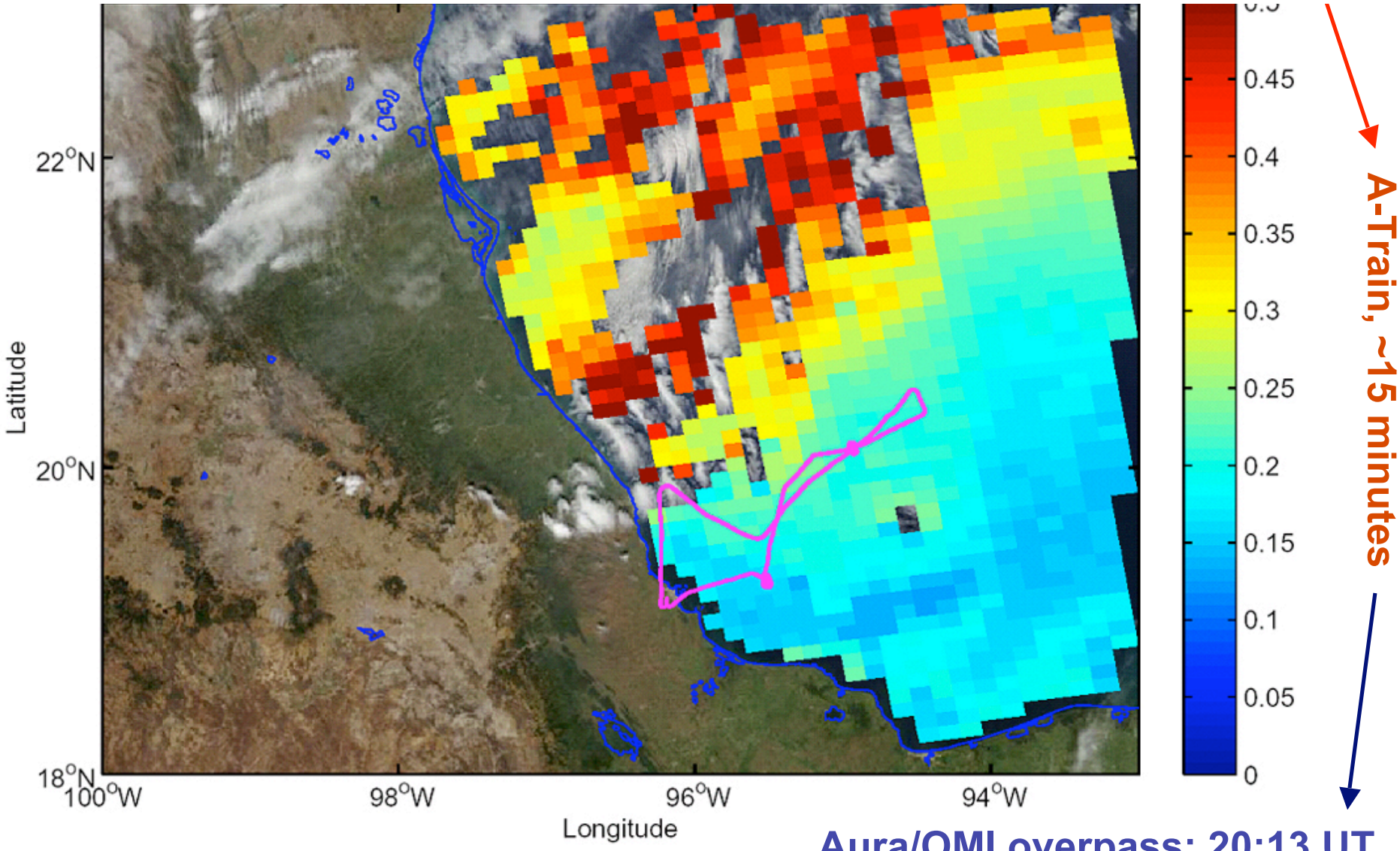
[Hair et al. poster]

[Hair, Hostettler, Ferrare, Redemann, Livingston, Clarke, et al.]

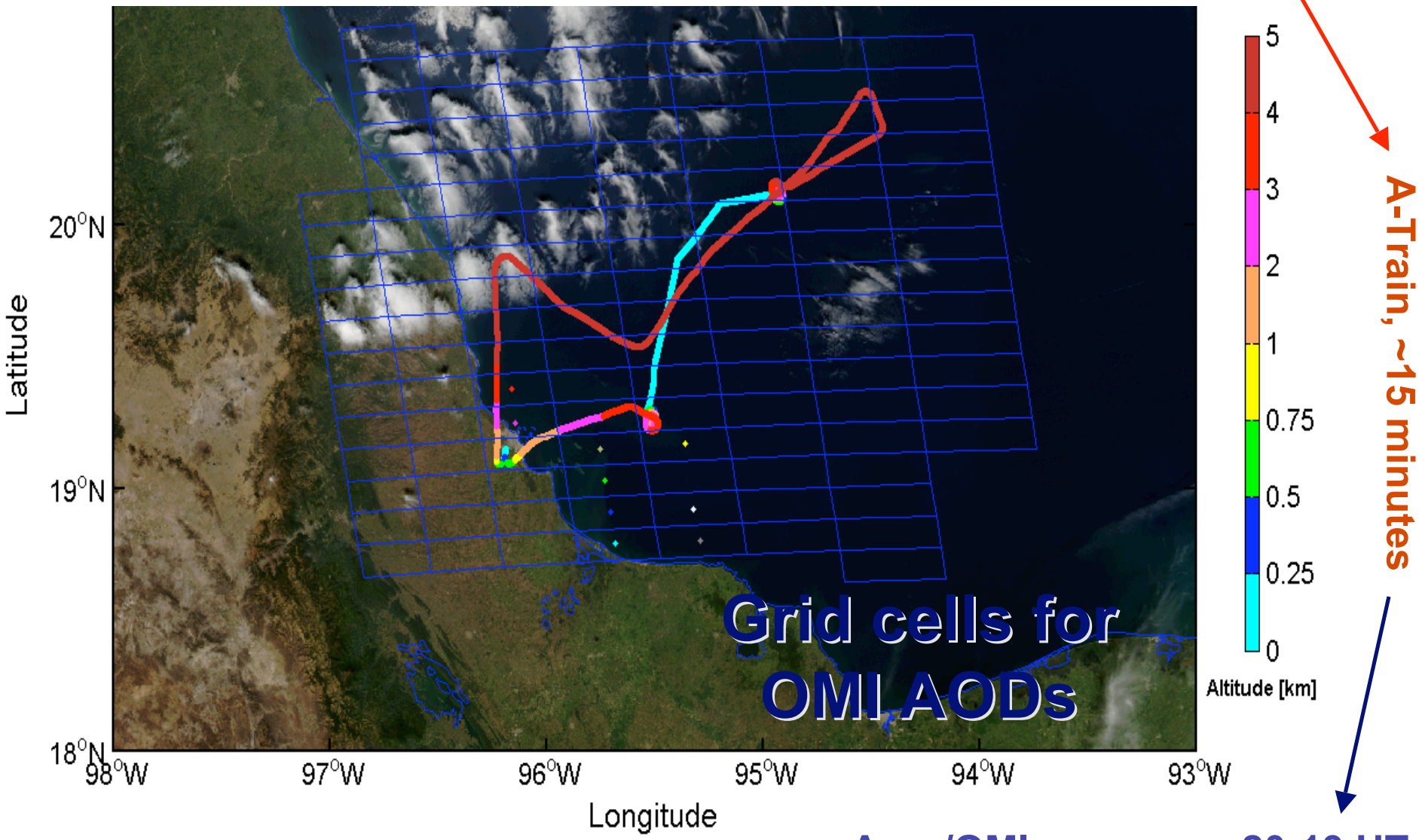
J31 Science Flights out of Veracruz
in MILAGRO/INTEX-B

Flt No.	Date, 2006	Track	Comments
VER 01	3 Mar	Gulf of Mexico near VER & Tampico	Terra & A-Train near overpass times, clouds & clear. Profile, RSP legs, CAR circles.
VER 02	5 Mar	Gulf of Mexico NE of VER	Terra, clear. Profile, transects, SSFR fluxes, RSP legs, CAR circles.
VER 03	6 Mar	Mexico City	Terra (MISR LM), clear. Racetrack stepped profile, SSFR fluxes, RSP legs, CAR racetracks near T0 & airport under King Air.
VER 04	8 Mar	Aborted on takeoff roll: bird strike	
VER 05	10 Mar	Gulf of Mexico NE of VER	Terra (MISR LM + MODIS), King Air and C-130. Clear + cirrus. 2 profiles, RSP legs.
VER 06	10 Mar	Gulf of Mexico NE of VER	Aura (OMI), A-Train in MODIS Aqua glint-free. Profiles, SSFR fluxes, CAR circles, RSP legs
VER 07	11 Mar	Mexico City	CAR circles for urban reflectivity. Profile w 18Z sonde at VER on return.

INTEX-B: 10 Mar 2006 J31 flight track on MODIS-Aqua AOD(550 nm) map, ~19:57 UT

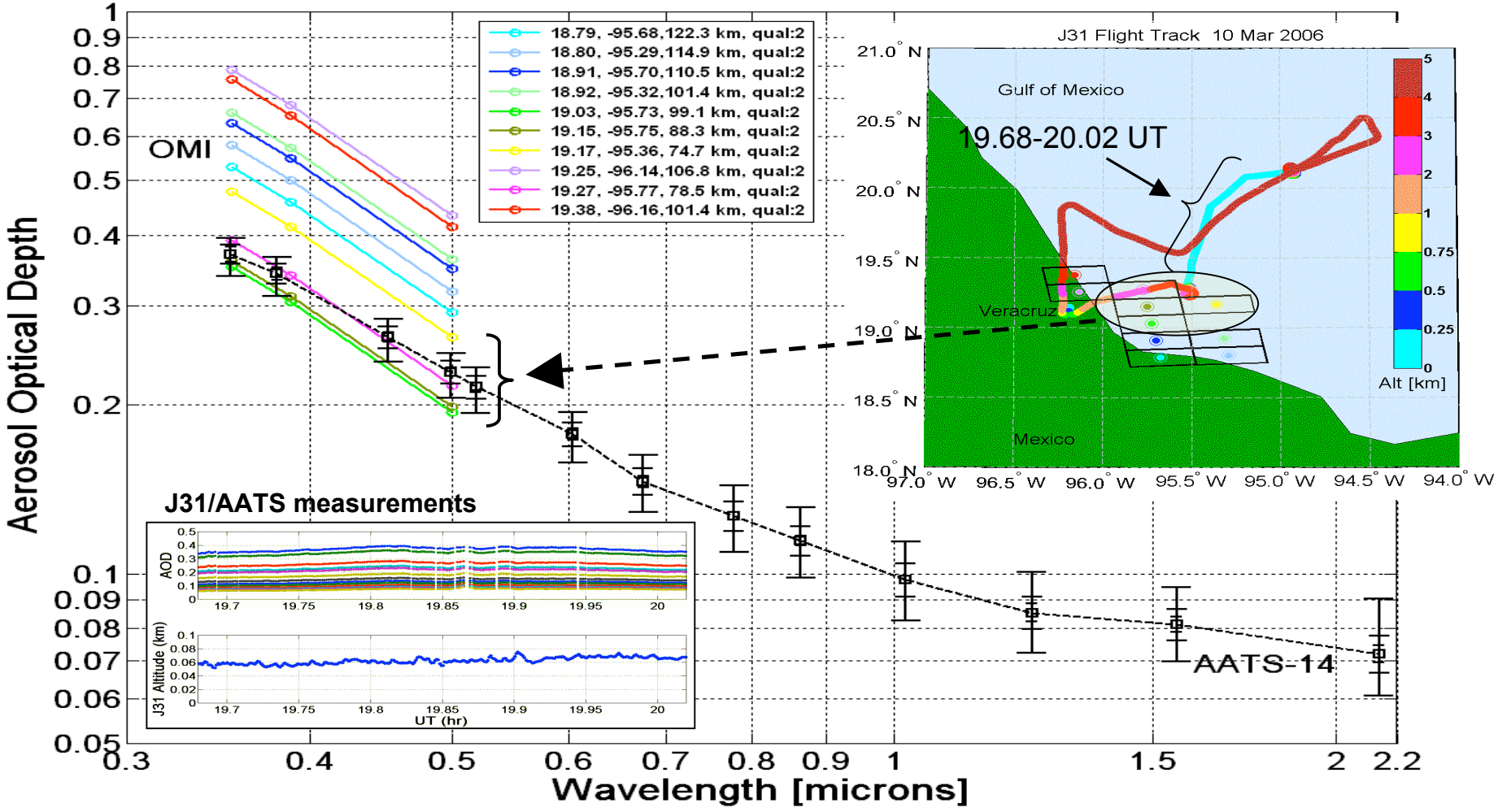


INTEX-B: 10 Mar 2006 J31 flight track on MODIS-Aqua true-color image, ~19:57 UT



[Livingston et al. poster]

Comparison of AOD spectra from AATS & OMI 10 Mar 2006

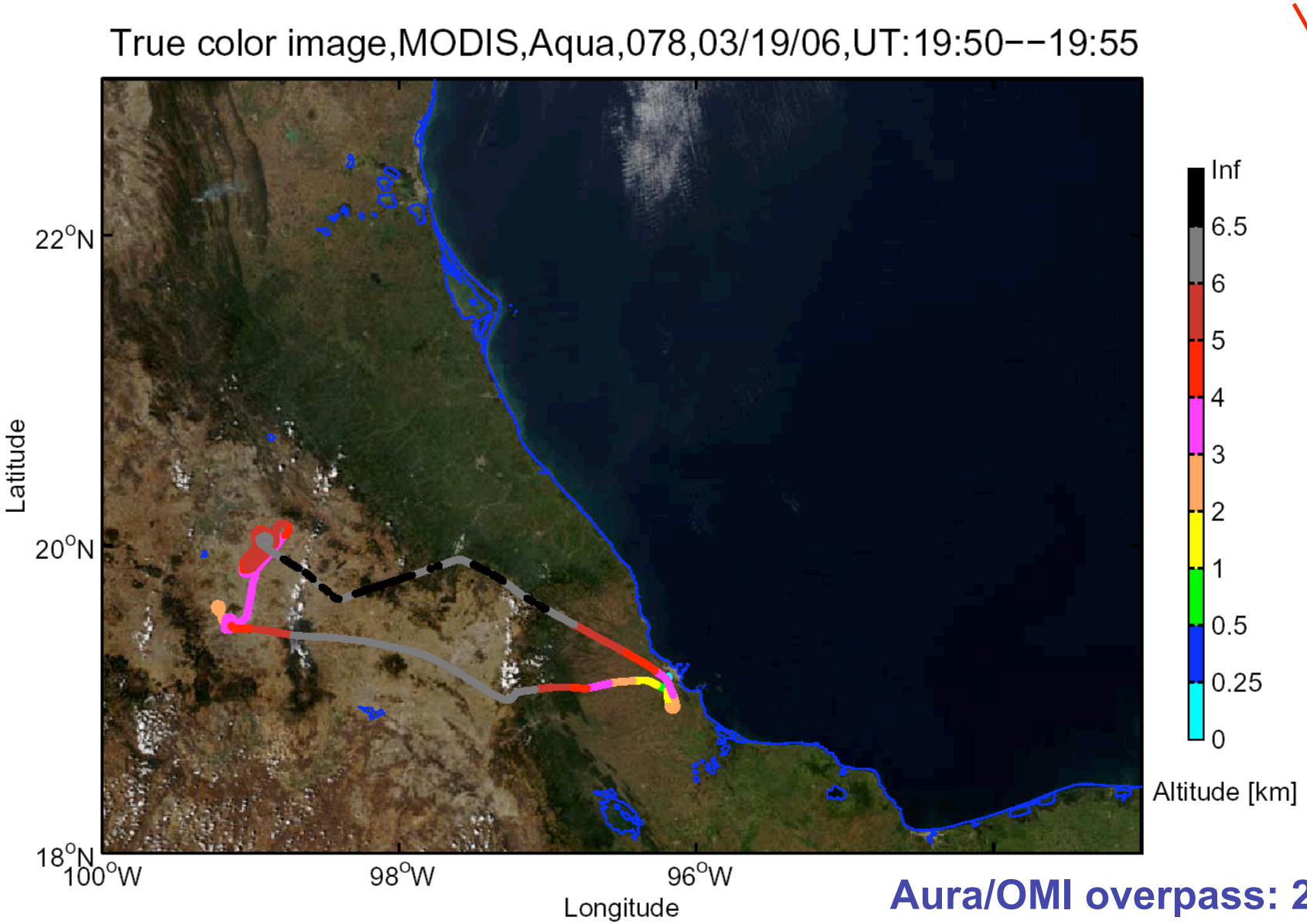


[Livingston et al. poster]

J31 Science Flights out of Veracruz
in MILAGRO/INTEX-B (cont'd)

Flt No.	Date, 2006	Track	Comments
VER 08	12 Mar	Gulf of Mexico N of VER	Terra, King Air. Clear + clouds. Profiles, RSP legs. Near AERONET Tampico & Tamihua
VER 09	13 Mar	Gulf of Mexico N of VER	Terra MODIS/Glory glint scenario.
VER 10	15 Mar	Mexico City	Terra (MISR LM), cirrus. Stepped profile, SSFR fluxes, RSP legs, CAR circles at T0 + other point under King Air.
VER 11	17 Mar	Gulf of Mexico N of VER	Aqua, aerosols + cloud experiments. Profiles, SSFR fluxes, RSP legs, CAR circles.
VER 12	18 Mar	Toward Mexico City, then Gulf near VER	Ci over MC caused diversion to Gulf. Profiles, SSFR fluxes, RSP legs, CAR circles w Aqua.
VER 13	19 Mar	T2 & T0 (Mexico City)	Profiles, RSP & SSFR legs with Aqua, POLDER, Aura, DC-8 at T2. Profiles and legs at T0
VER 14	20 Mar	Gulf of Mexico N of VER	H_2O sonde comparison on takeoff. Glint experiment scrubbed by Ci.

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



A-Train, ~15 minutes

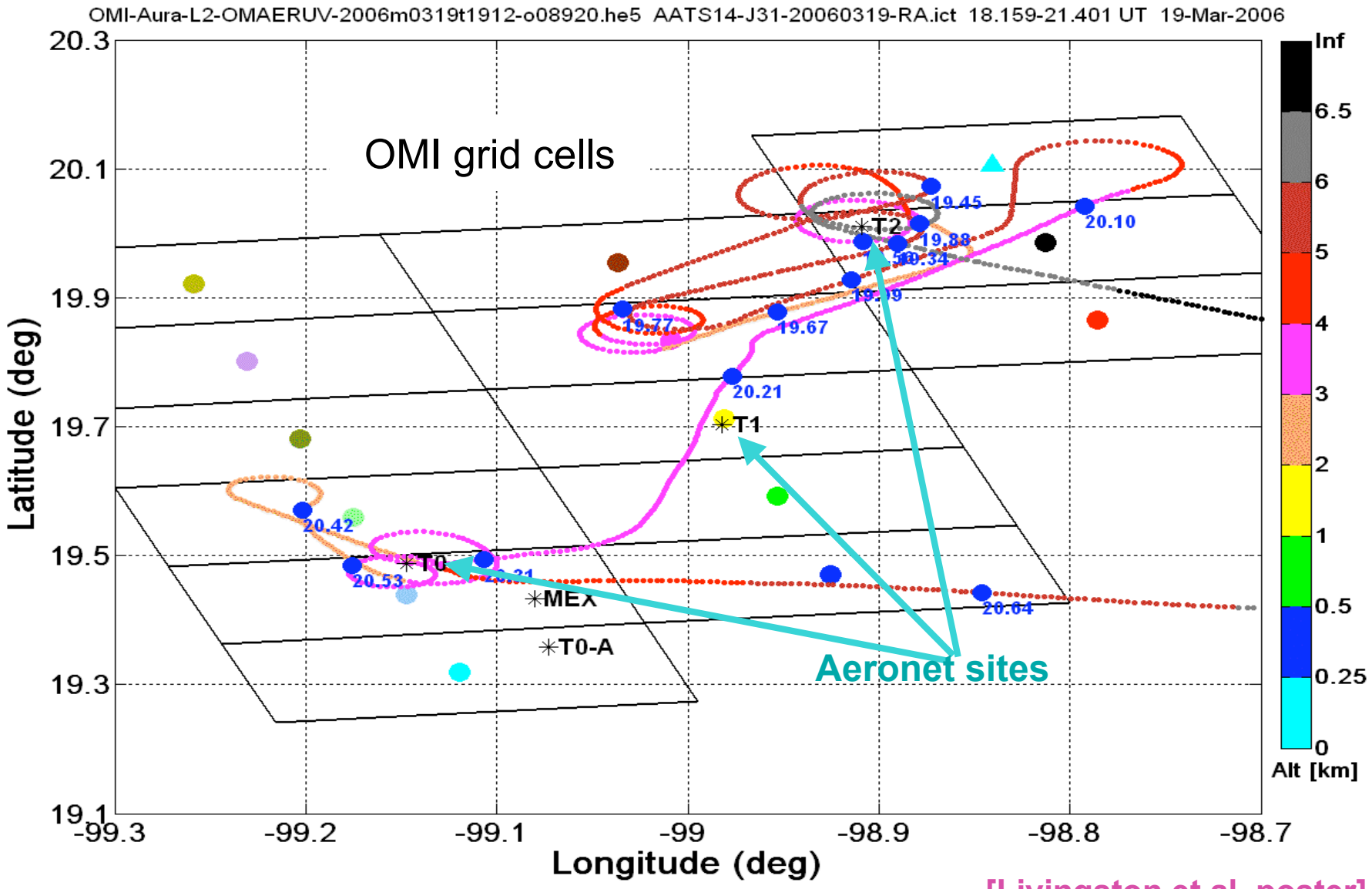
Aura/OMI overpass: 20:07 UT

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

Courtesy of Cam McNaughton

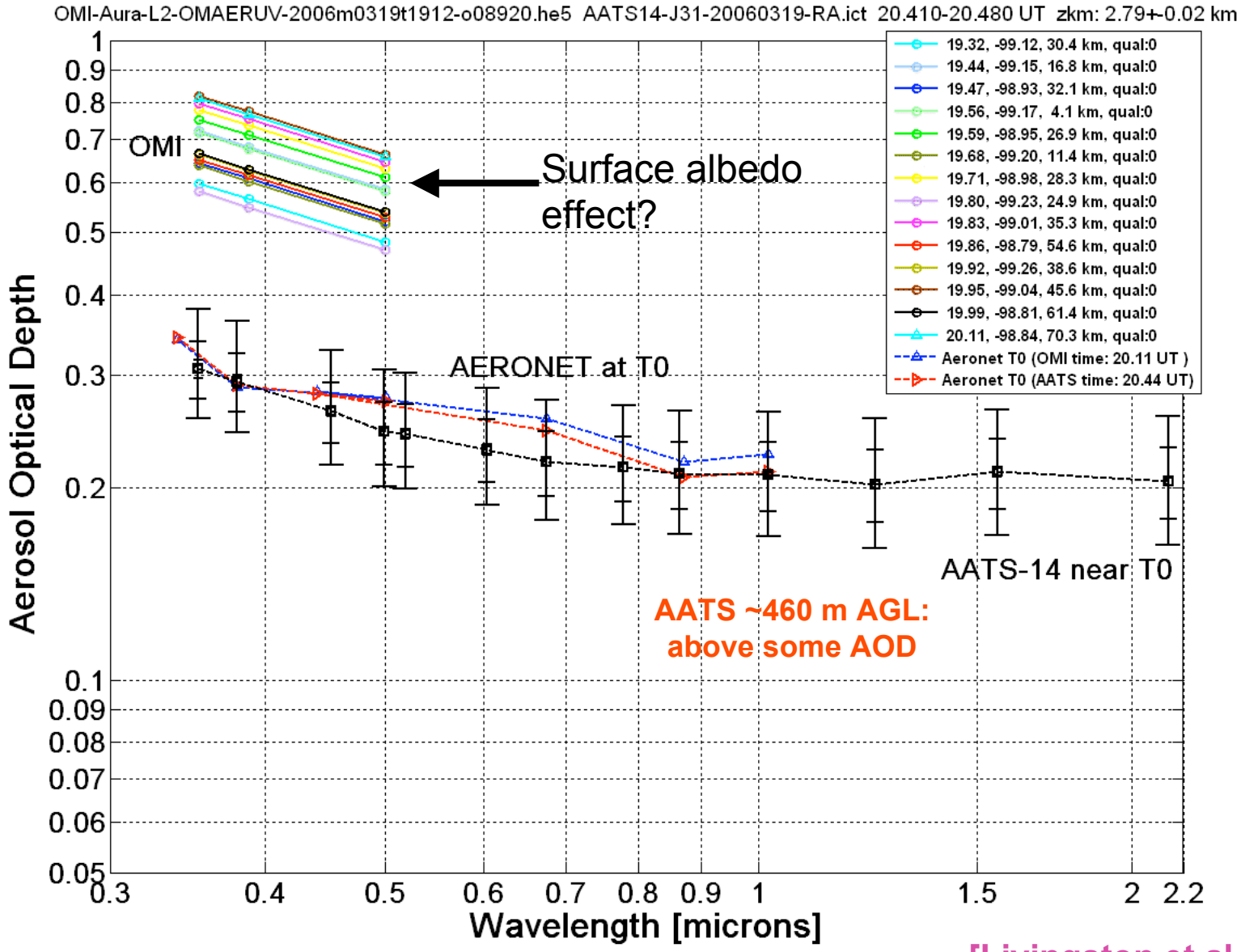
J31 Flight Track, 19 Mar 2006, Mexico City & Downwind

Aura overpass: 20.11 UT



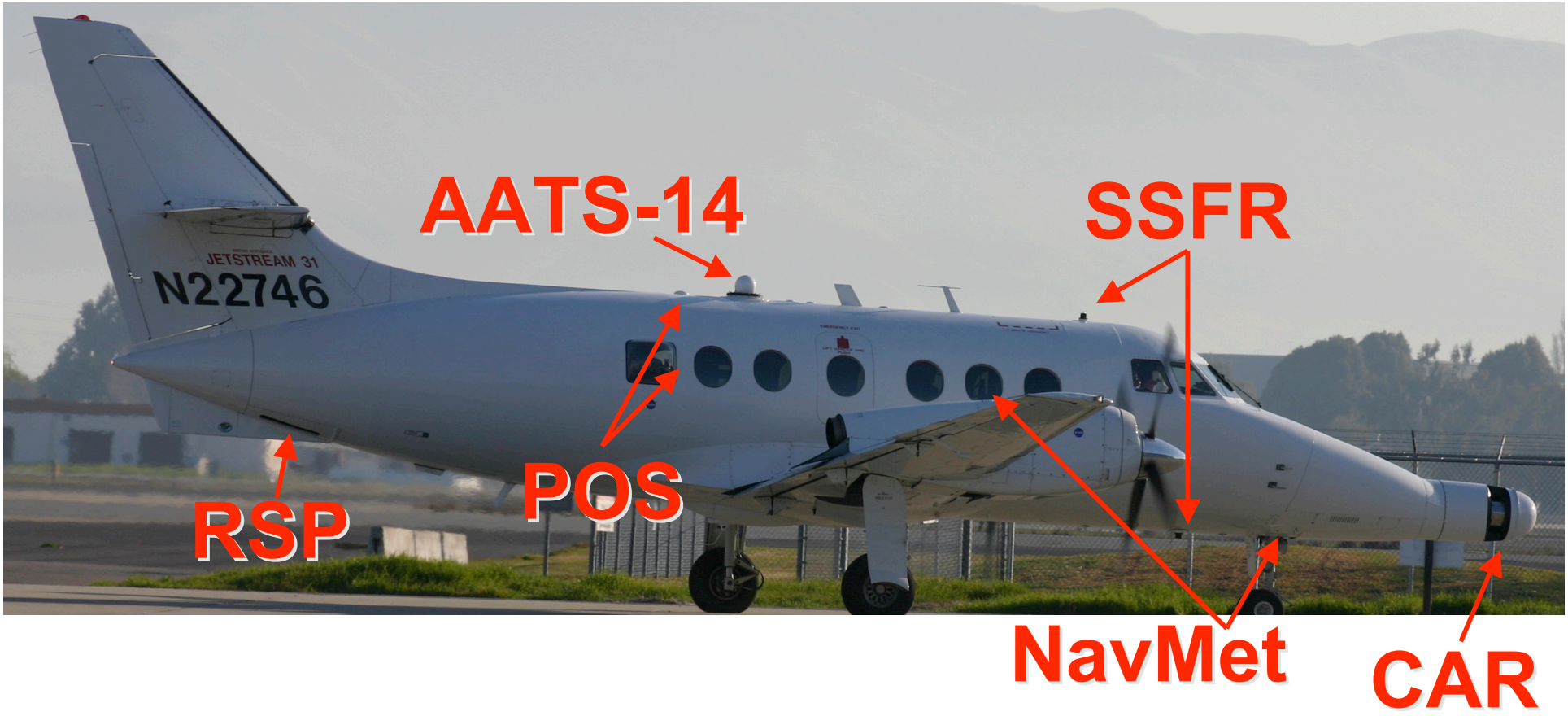
[Livingston et al. poster]

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



[Livingston et al. poster]

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



Location of CAR BRDF measurements in Mexico (shown in red) during the INTEX-B Field Experiment, March 3-20, 2006

See Gatebe et al. poster for examples of CAR BRDF results, Mexico City, 6 Mar 2006

J31 Science Flights out of Veracruz
in MILAGRO/INTEX-B

Flt No.	Date, 2006	Track	Comments
VER 01	3 Mar	Gulf of Mexico near VER & Tampico	Terra & A-Train near overpass times, clouds & clear. Profile, RSP legs, CAR circles.
VER 02	5 Mar	Gulf of Mexico NE of VER	Terra, clear. Profile, transects, SSFR fluxes, RSP legs, CAR circles.
VER 03	6 Mar	Mexico City	Terra (MISR LM), clear. Racetrack stepped profile, SSFR fluxes, RSP legs, CAR racetracks near T0 & airport under King Air.
VER 04	8 Mar	Aborted on takeoff roll: bird strike	
VER 05	10 Mar	Gulf of Mexico NE of VER	Terra (MISR LM), King Air and C-130. Clear + cirrus. 2 profiles, RSP legs.
VER 06	10 Mar	Gulf of Mexico NE of VER	A-Train in MODIS Aqua glint-free. Profiles, SSFR fluxes, CAR circles, RSP legs
VER 07	11 Mar	Mexico City	CAR circles for urban reflectivity. Profile w 18Z sonde at VER on return.

March 6, MISR local mode over Mexico City

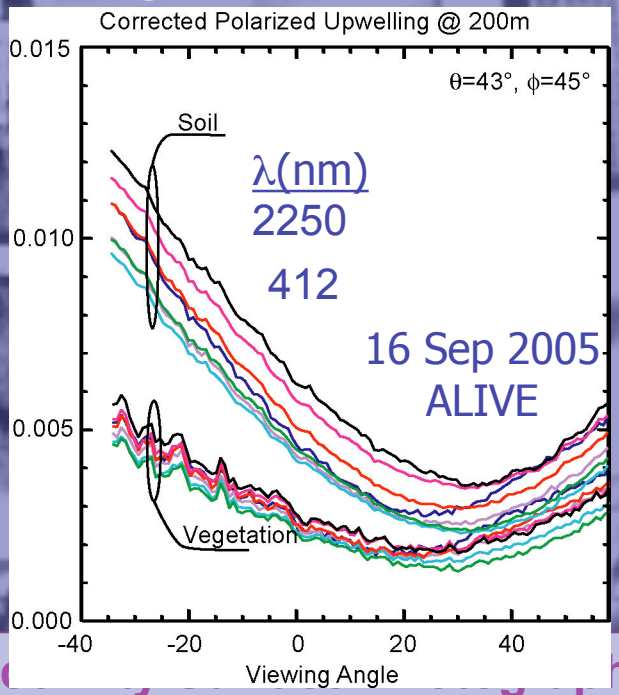
MISR 70 deg aft.

[Kahn et al. poster]

J31: Research Scanning Polarimeter (RSP) Surface Properties

- **A key requirement of satellite remote sensing of aerosols is a good understanding of the surface's spectral albedo and polarized bidirectional reflectance distribution function (BRDF).**

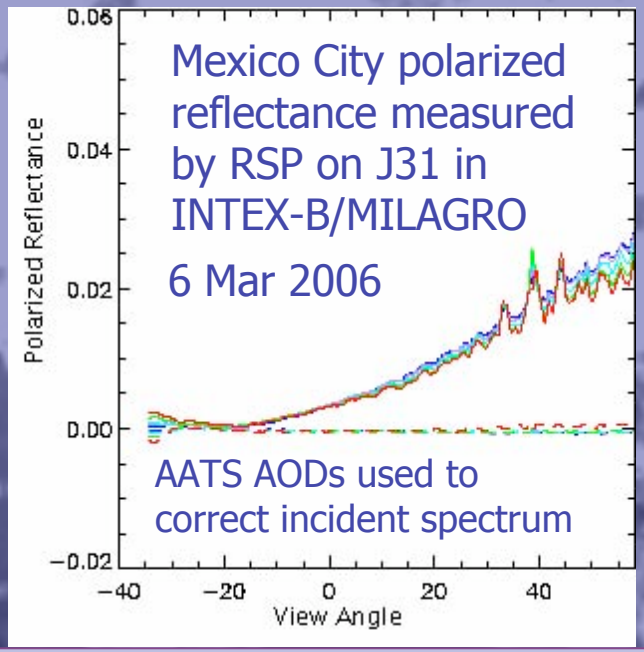
J31 with AATS, RSP, SSFR and CAR provides an ideal platform for characterizing surfaces.



Soils, deserts, farmland and pasture have all previously been seen to have weak spectral variations in polarized reflectance.

If the surface is grey (λ-indep), the color comes from aerosols. This can be used to get AOD, size and refractive index of the aerosols

PRELIMINARY DATA



Mexico City as imaged by Camera (555 nm) on J31 Low-Altitude Leg

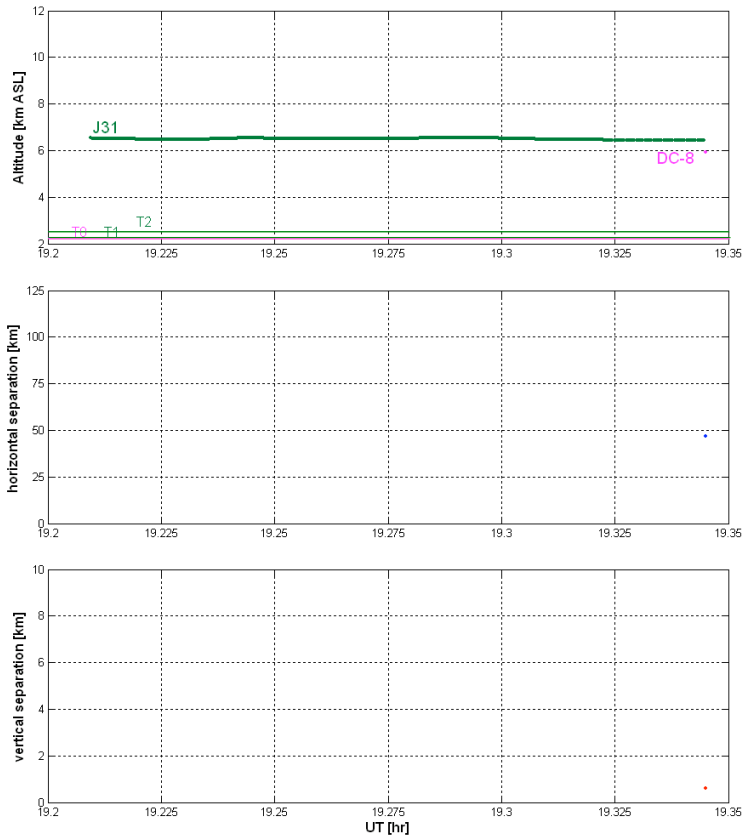
The fact that the polarized reflectance of the urban environment of Mexico City is also spectrally grey facilitates remote sensing of aerosol.

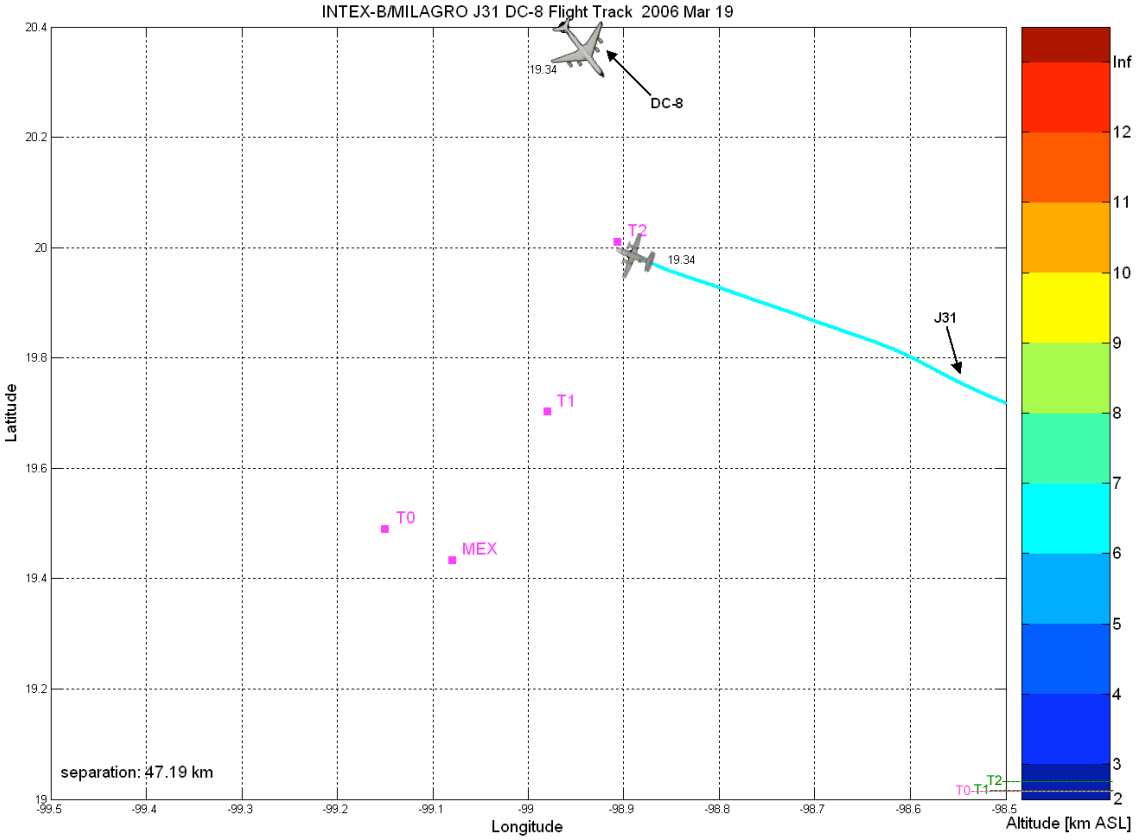
B. Cairns, J. Redemann et al.

J31 Science Flights out of Veracruz
in MILAGRO/INTEX-B (cont'd)

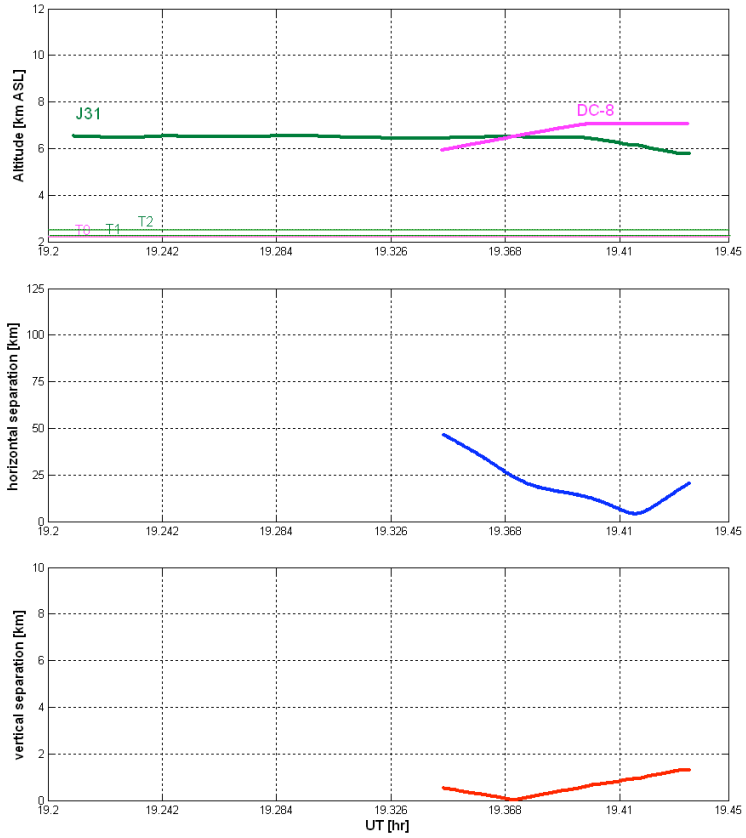
Flt No.	Date, 2006	Track	Comments
VER 08	12 Mar	Gulf of Mexico N of VER	Terra, King Air. Clear + clouds. Profiles, RSP legs. Near AERONET Tampico & Tamihua
VER 09	13 Mar	Gulf of Mexico N of VER	Terra MODIS/Glory glint scenario.
VER 10	15 Mar	Mexico City	Terra (MISR LM), cirrus. Stepped profile, SSFR fluxes, RSP legs, CAR circles at T0 + other point under King Air.
VER 11	17 Mar	Gulf of Mexico N of VER	Aqua, aerosols + cloud experiments. Profiles, SSFR fluxes, RSP legs, CAR circles.
VER 12	18 Mar	Toward Mexico City, then Gulf near VER	Ci over MC caused diversion to Gulf. Profiles, SSFR fluxes, RSP legs, CAR circles w Aqua.
VER 13	19 Mar	T2 & T0 (Mexico City)	Profiles, RSP & SSFR legs with Aqua, POLDER, Aura, DC-8 at T2. Profiles and legs at T0
VER 14	20 Mar	Gulf of Mexico N of VER	H_2O sonde comparison on takeoff. Glint experiment scrubbed by Ci.

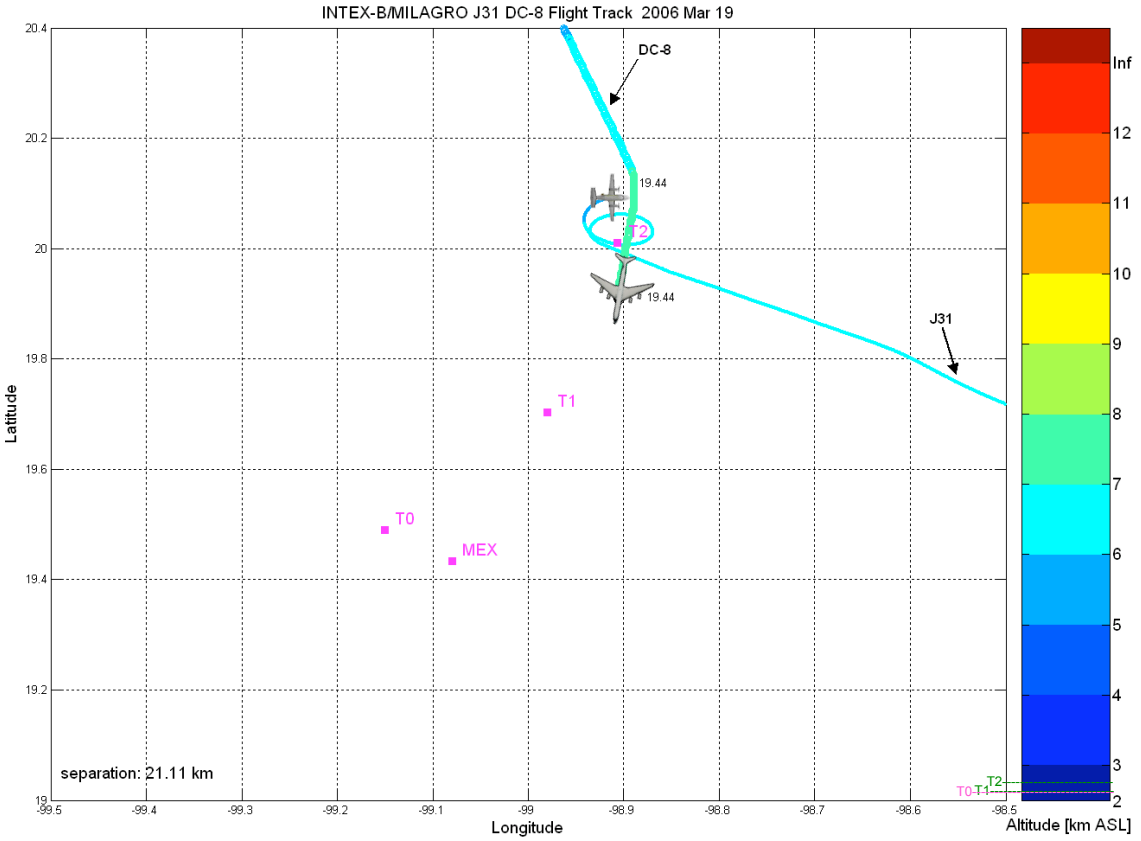
Coordination of DC-8 and J31 Flights, 19 Mar 2006, INTEX-B/MILAGRO



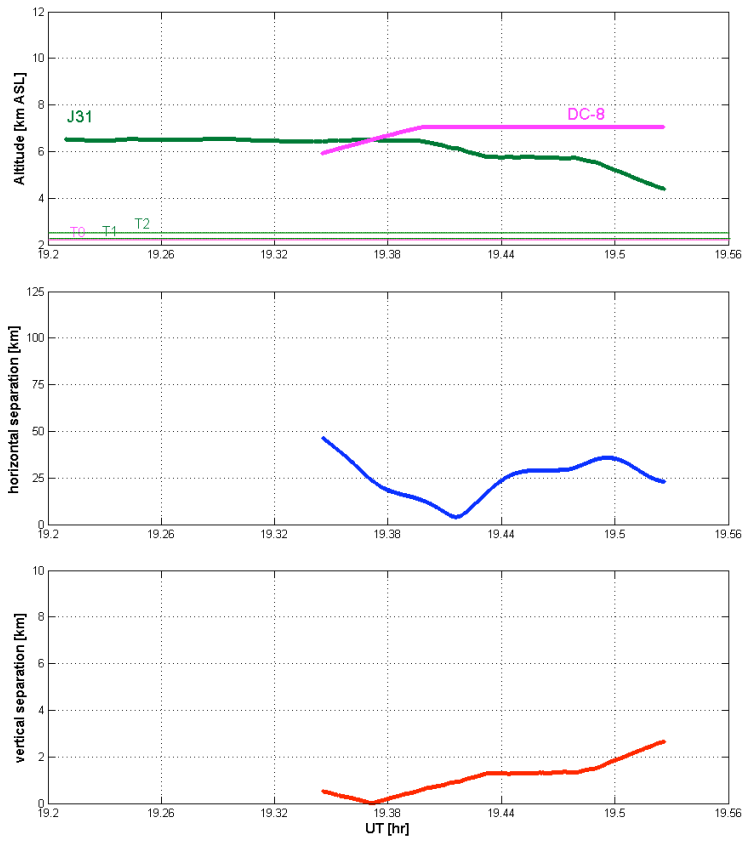


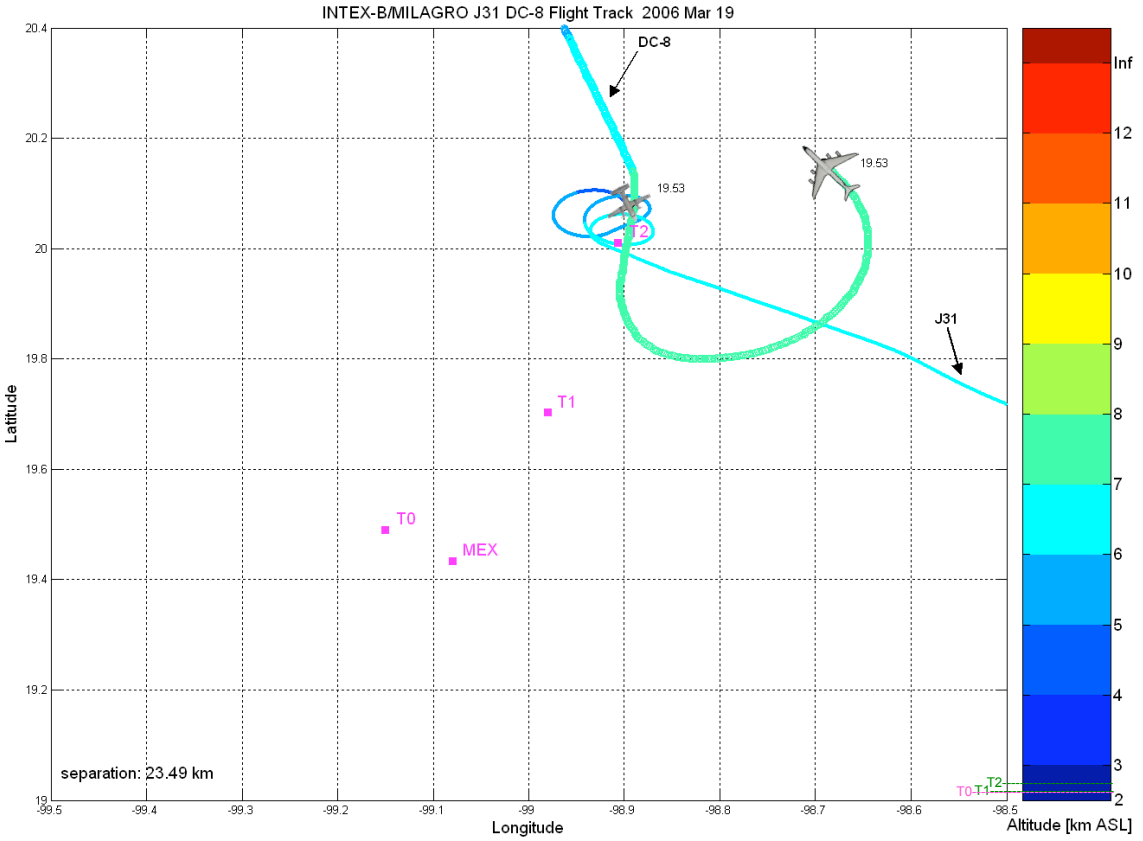
Coordination of DC-8 and J31 Flights, 19 Mar 2006, INTEX-B/MILAGRO



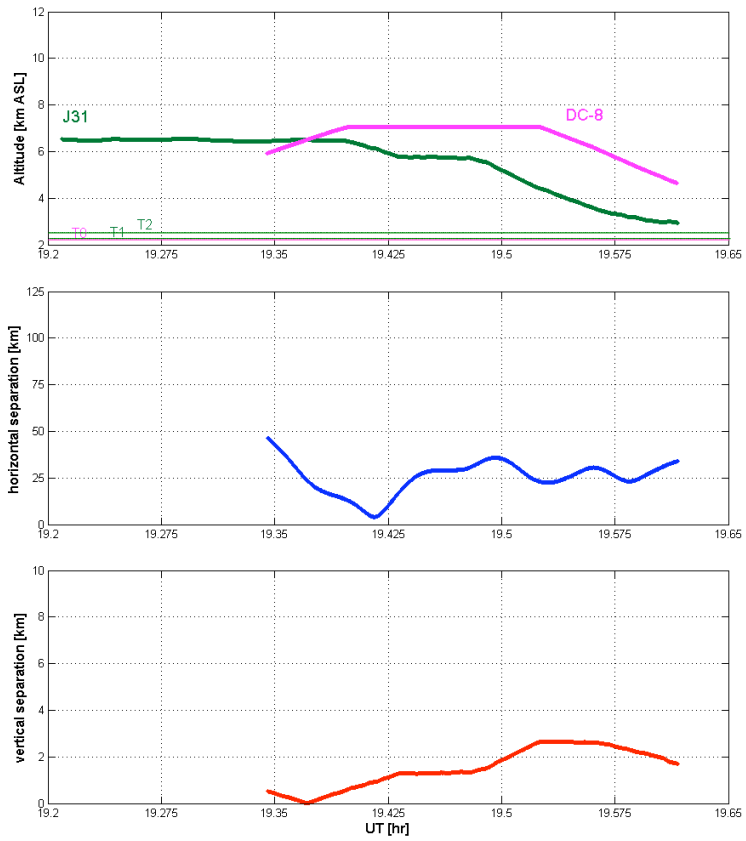


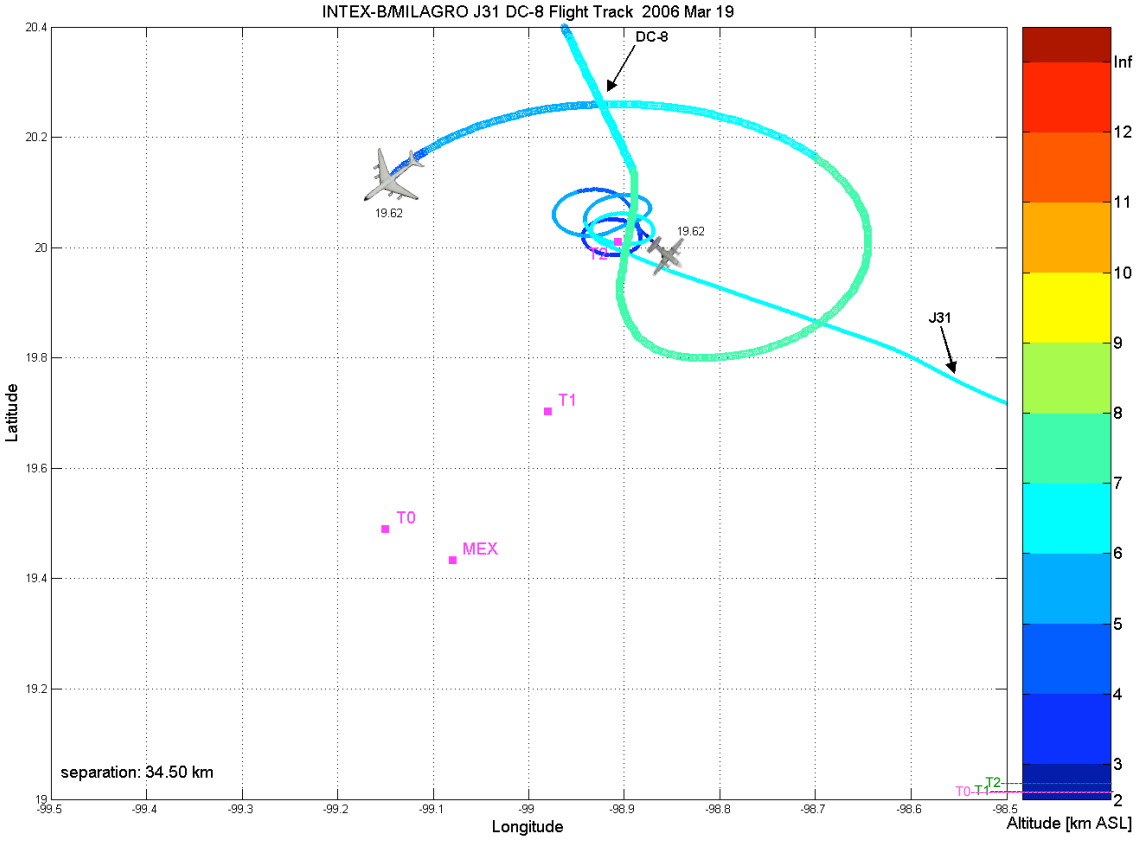
Coordination of DC-8 and J31 Flights, 19 Mar 2006, INTEX-B/MILAGRO



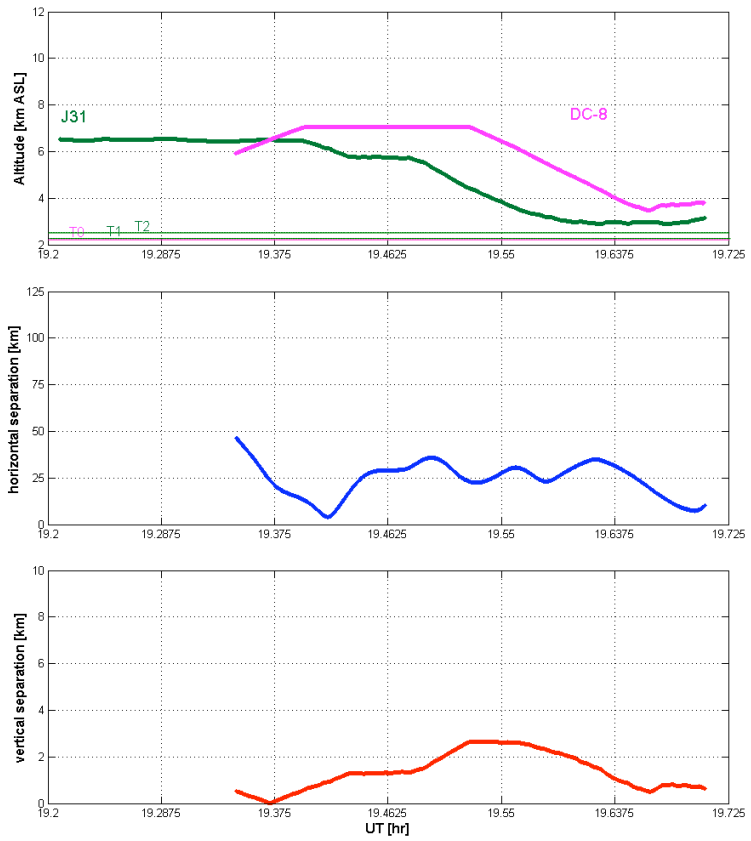


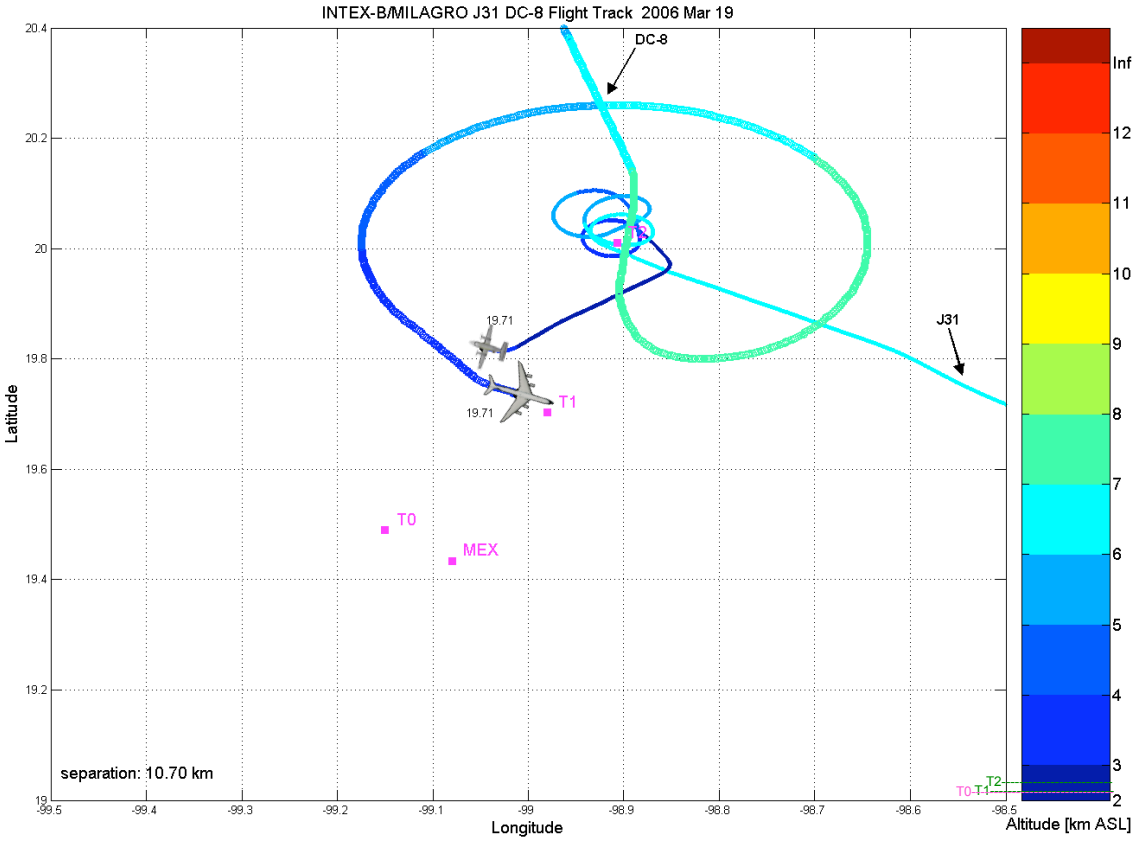
Coordination of DC-8 and J31 Flights, 19 Mar 2006, INTEX-B/MILAGRO



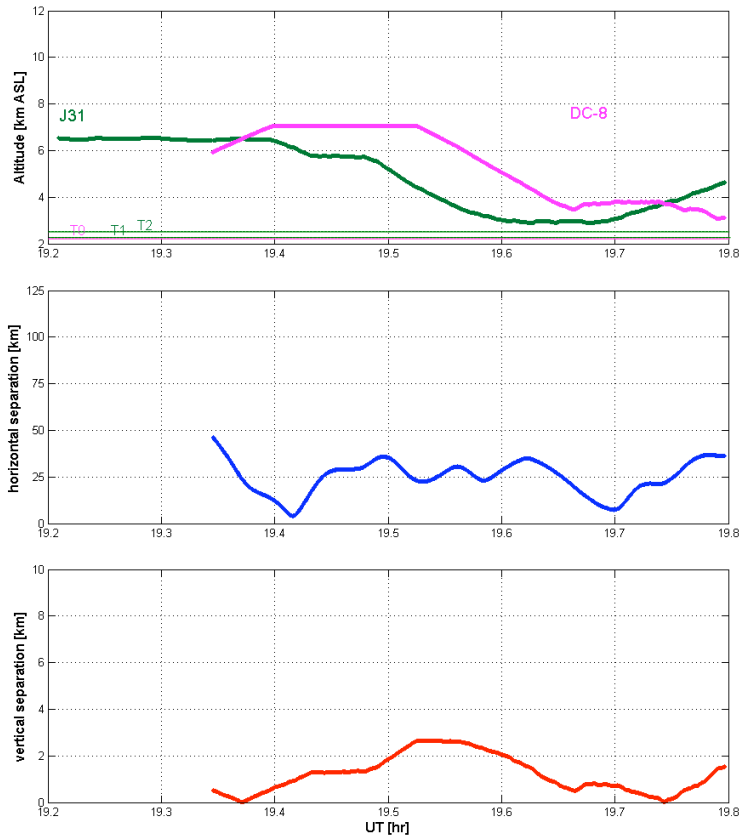


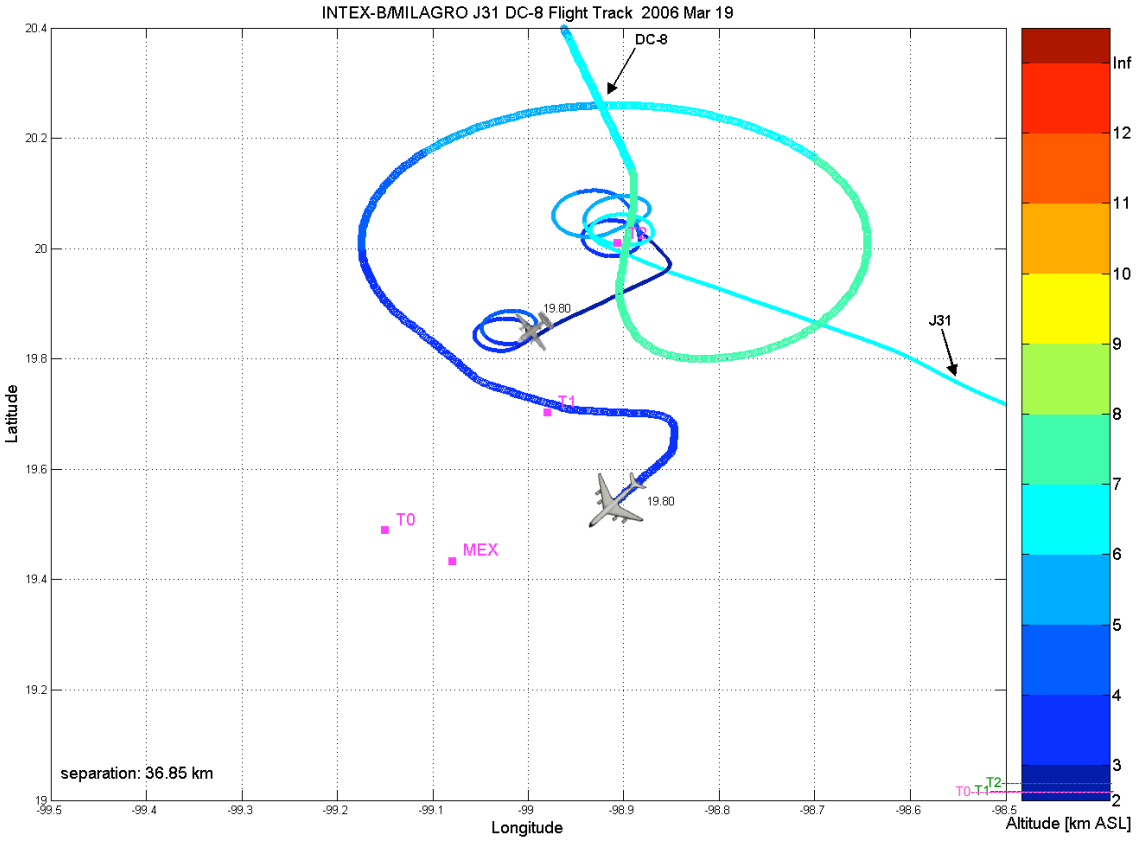
Coordination of DC-8 and J31 Flights, 19 Mar 2006, INTEX-B/MILAGRO



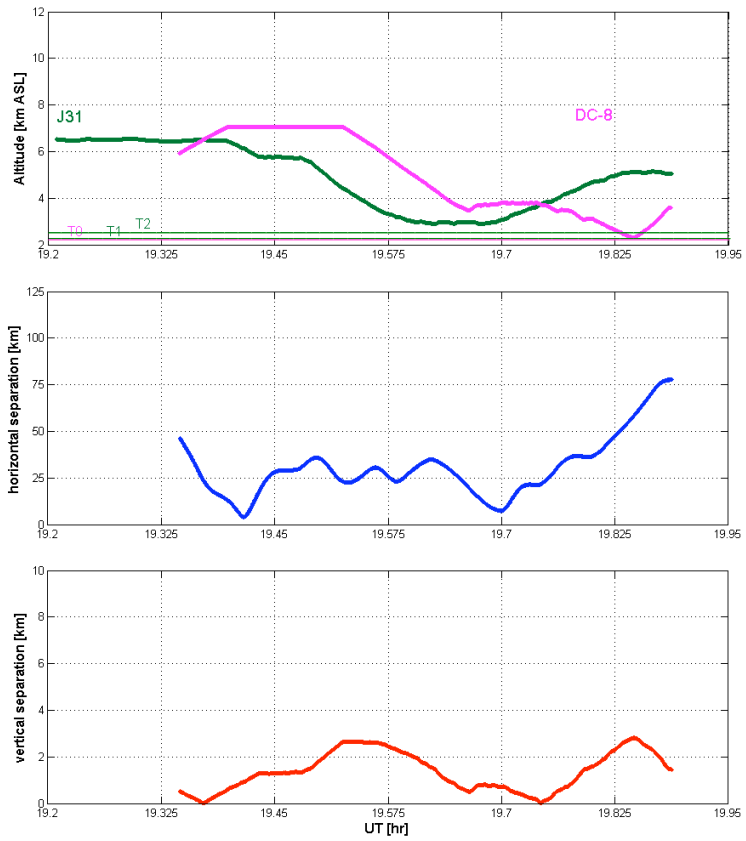


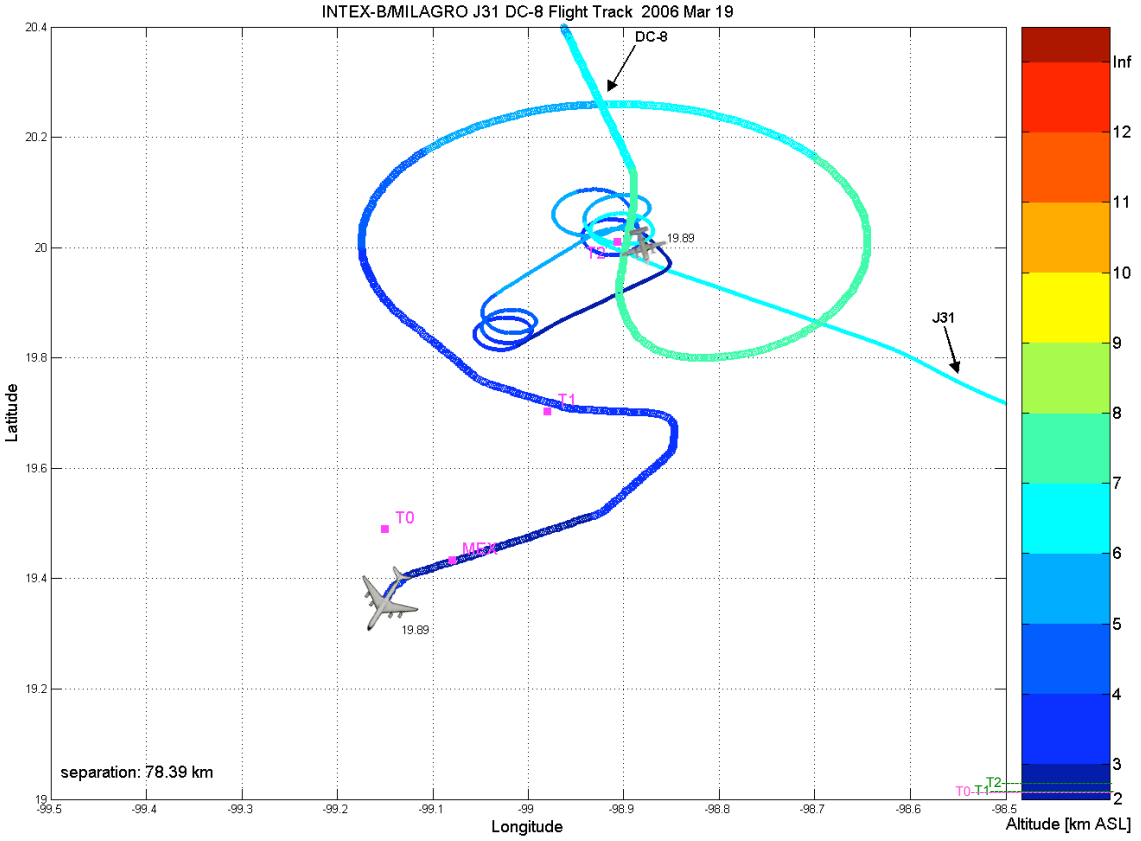
Coordination of DC-8 and J31 Flights, 19 Mar 2006, INTEX-B/MILAGRO



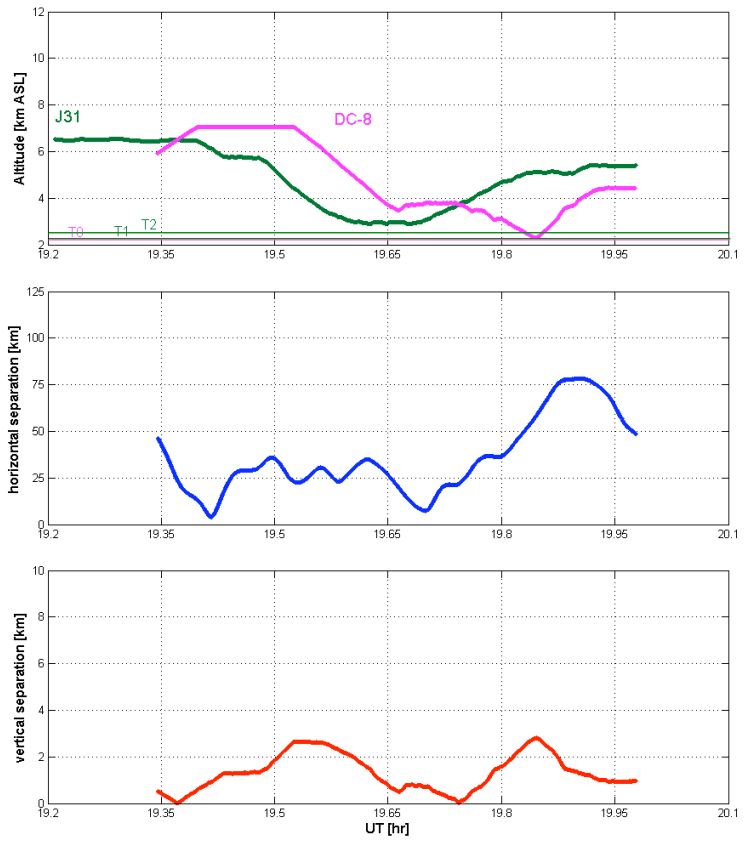


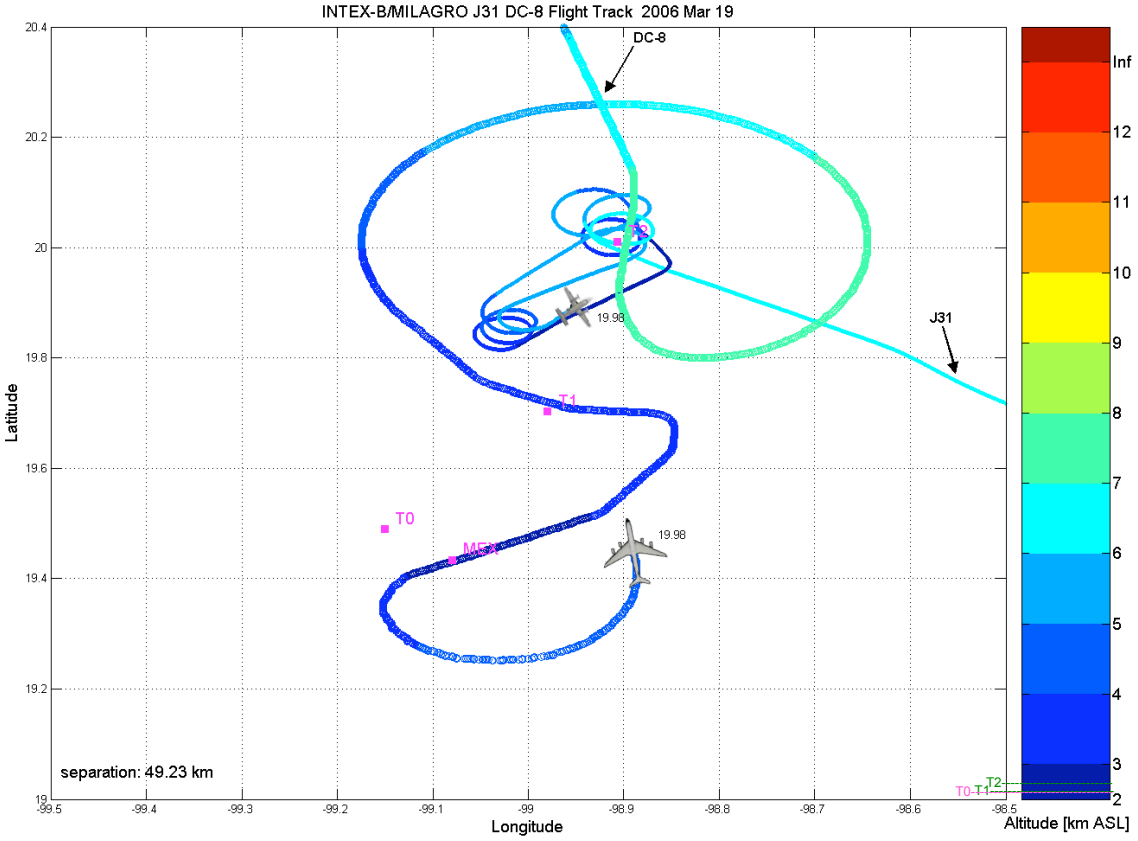
Coordination of DC-8 and J31 Flights, 19 Mar 2006, INTEX-B/MILAGRO



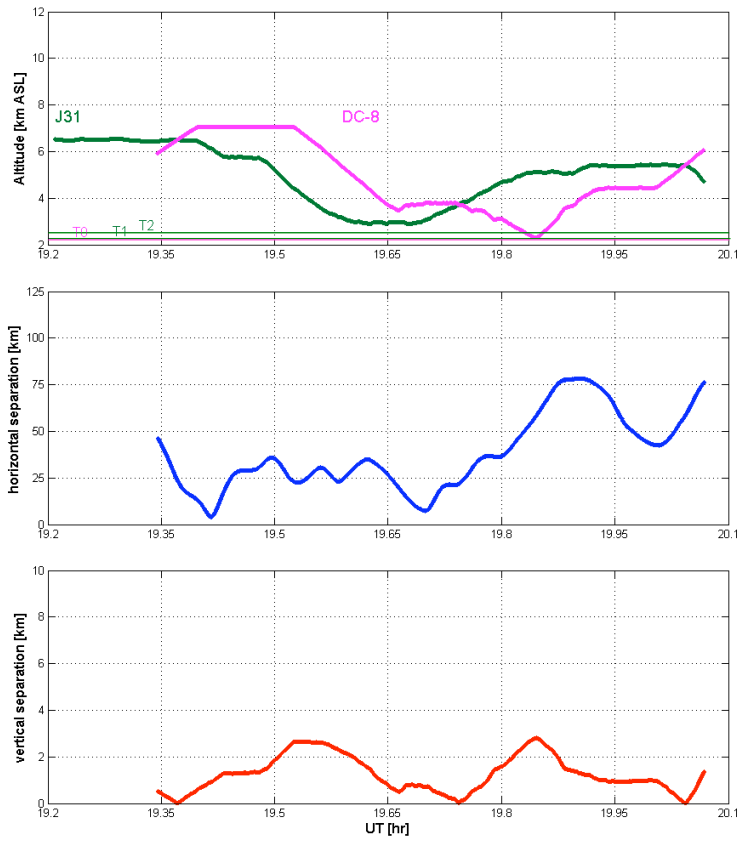


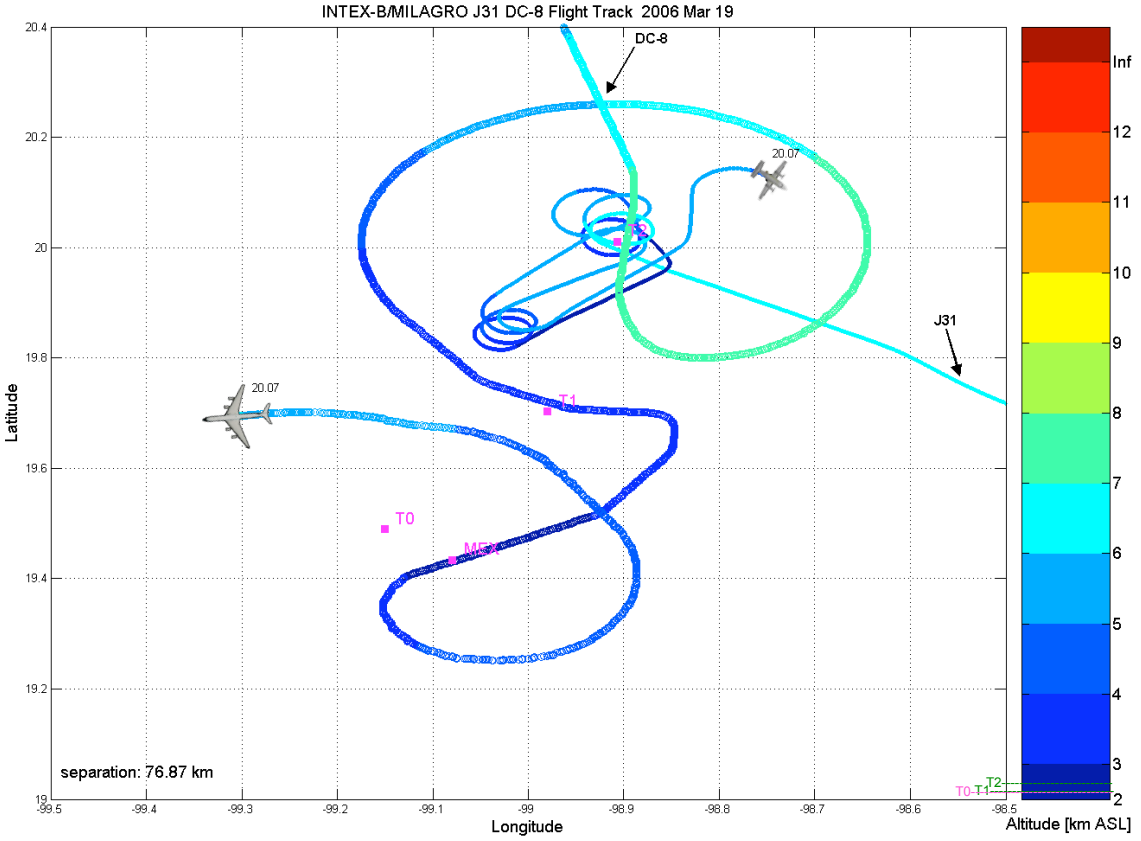
Coordination of DC-8 and J31 Flights, 19 Mar 2006, INTEX-B/MILAGRO



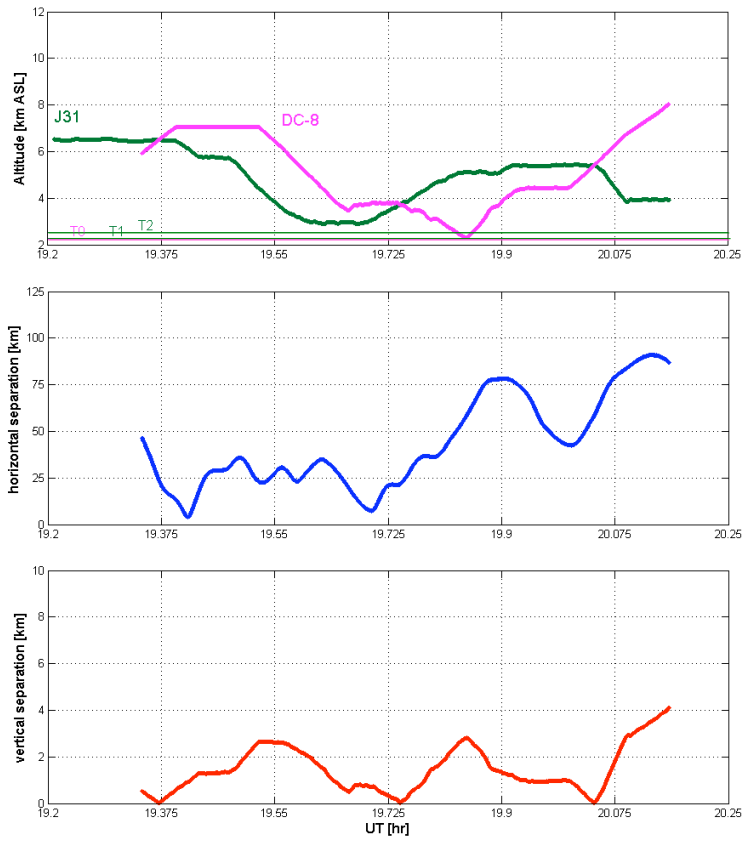


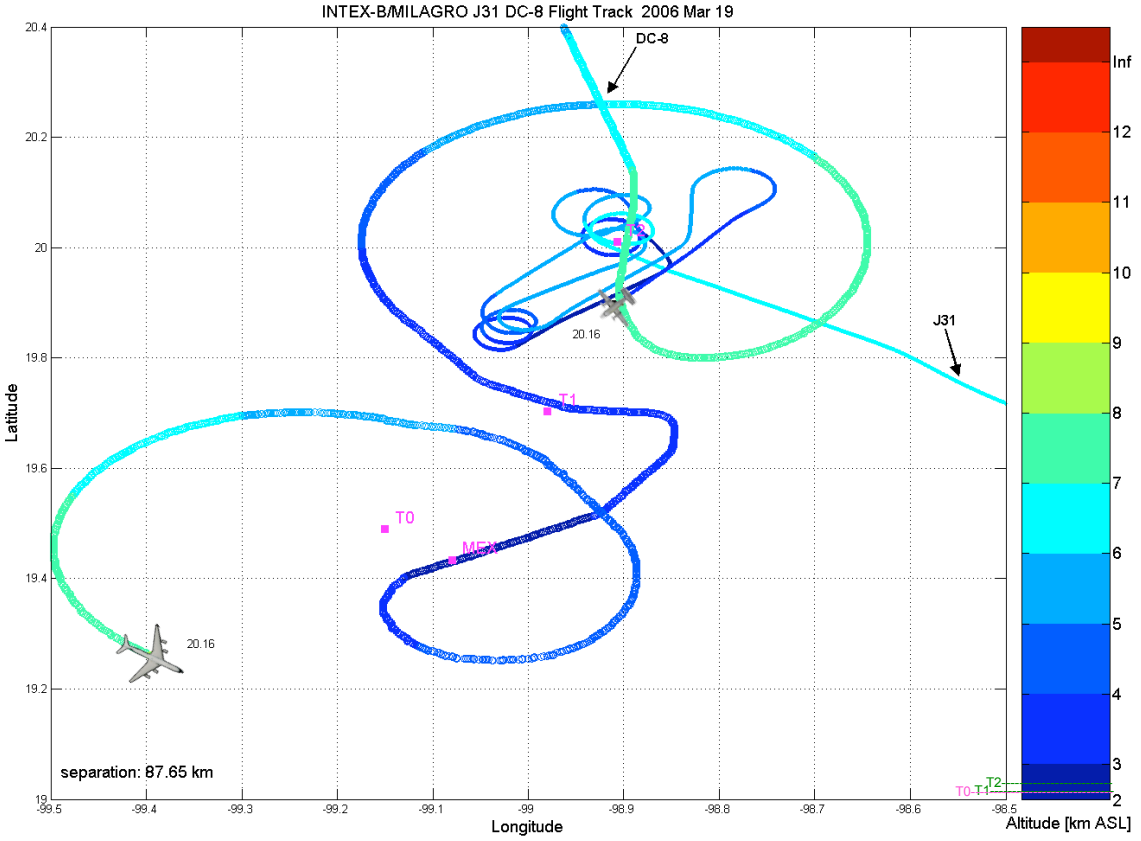
Coordination of DC-8 and J31 Flights, 19 Mar 2006, INTEX-B/MILAGRO



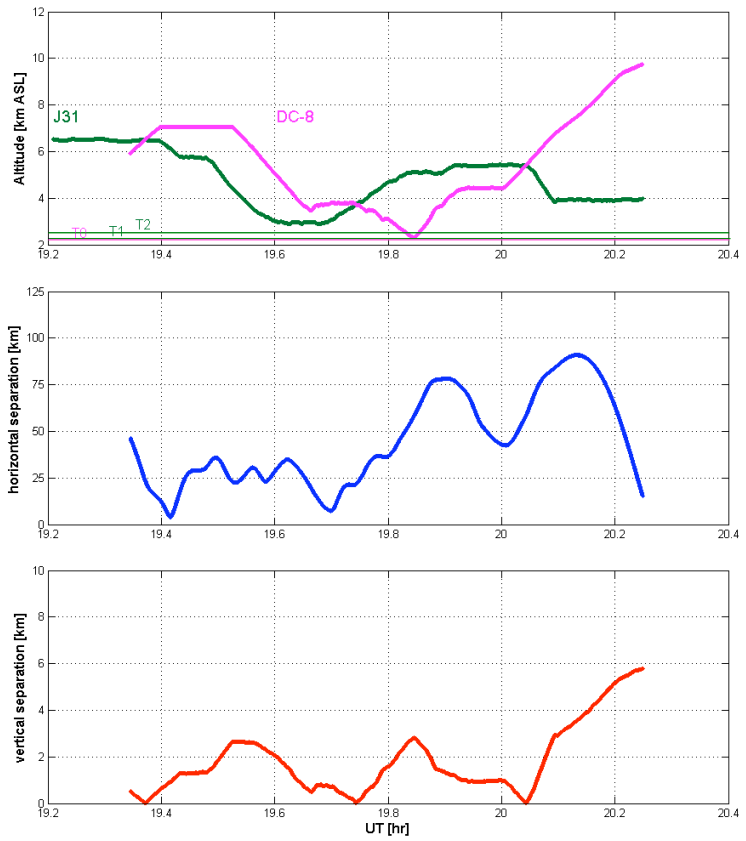


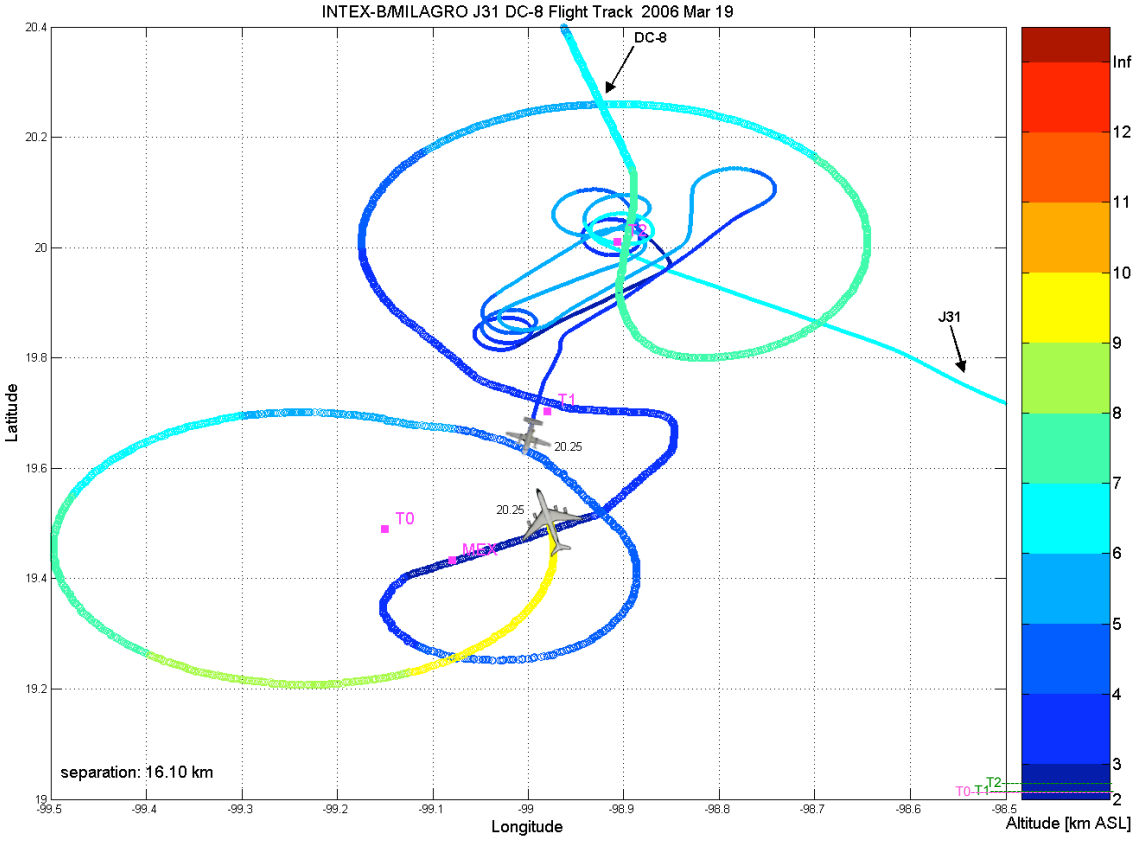
Coordination of DC-8 and J31 Flights, 19 Mar 2006, INTEX-B/MILAGRO



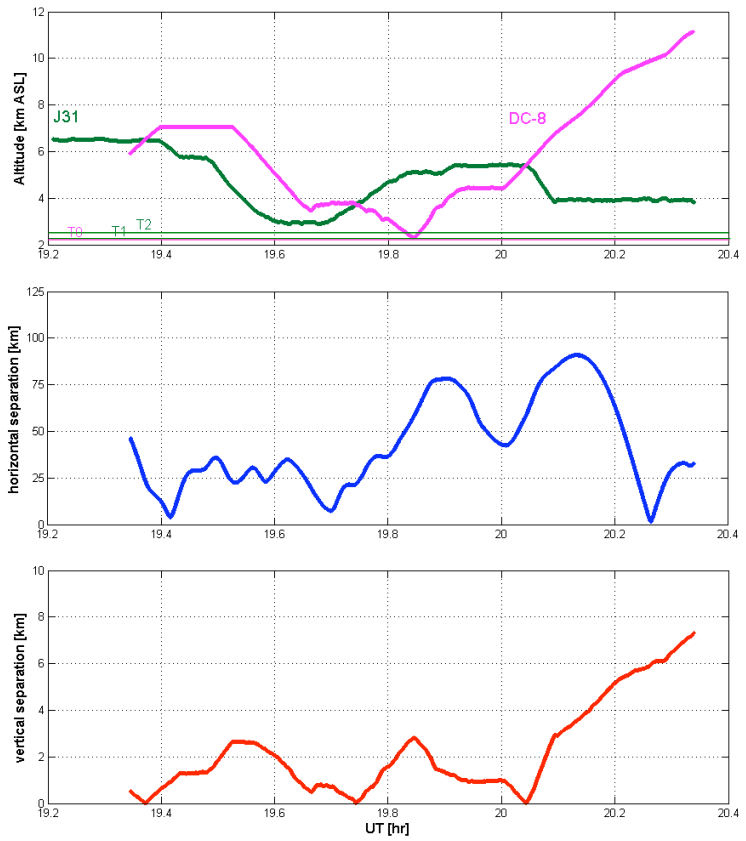


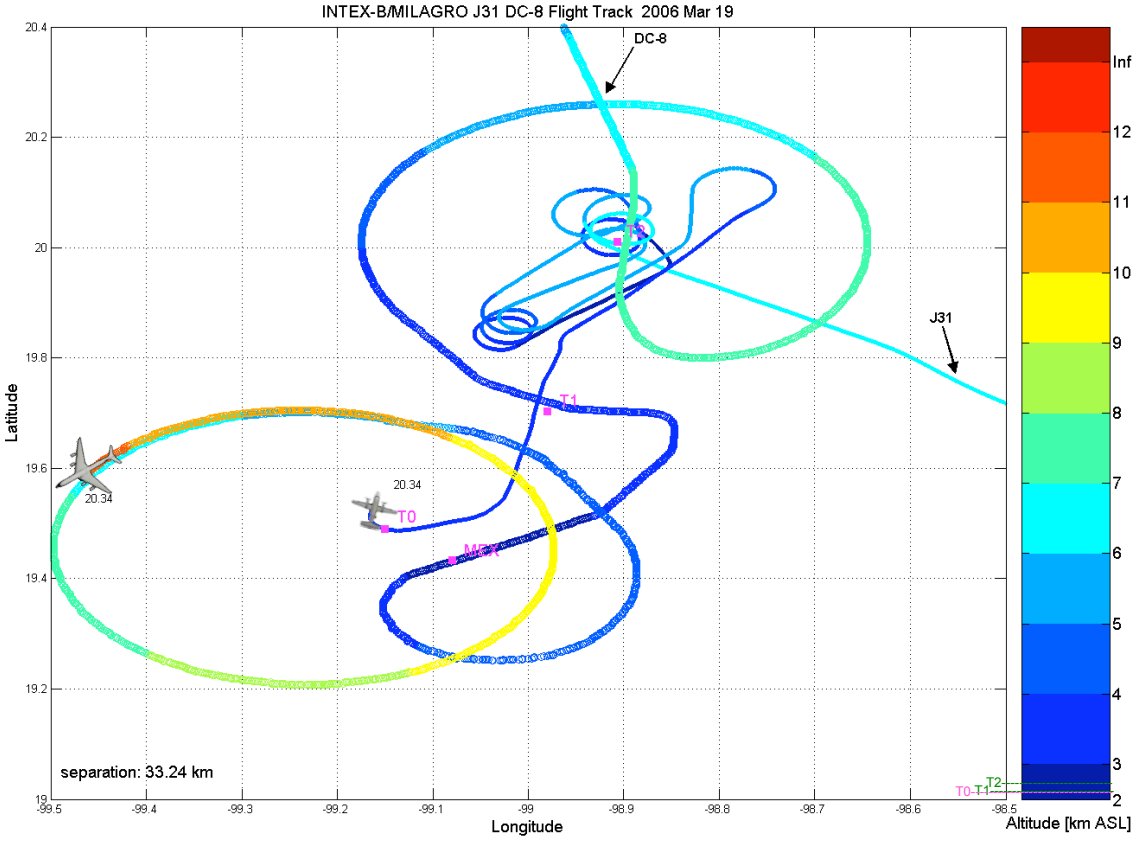
Coordination of DC-8 and J31 Flights, 19 Mar 2006, INTEX-B/MILAGRO



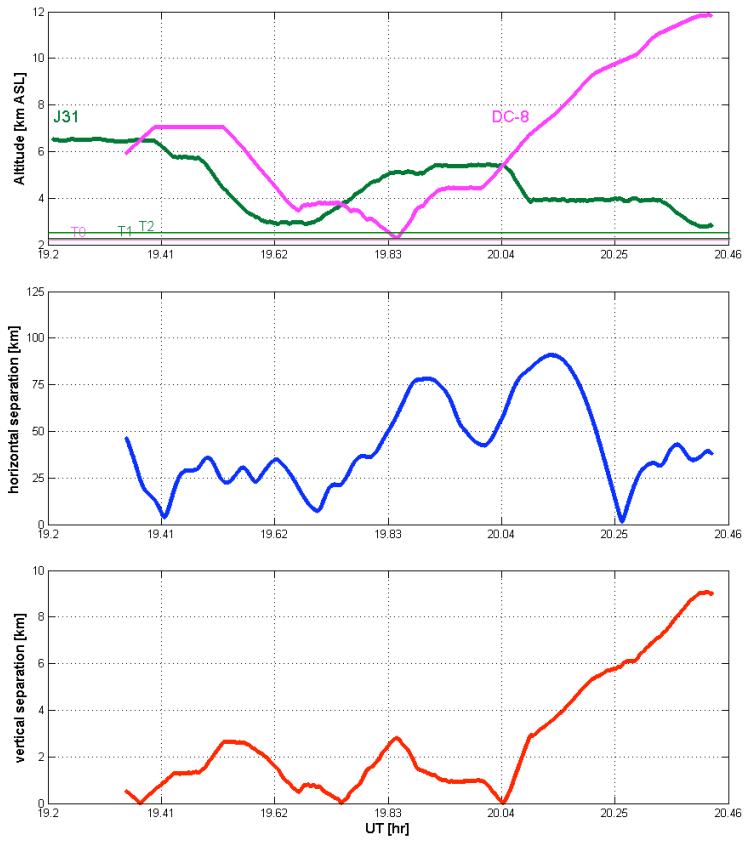


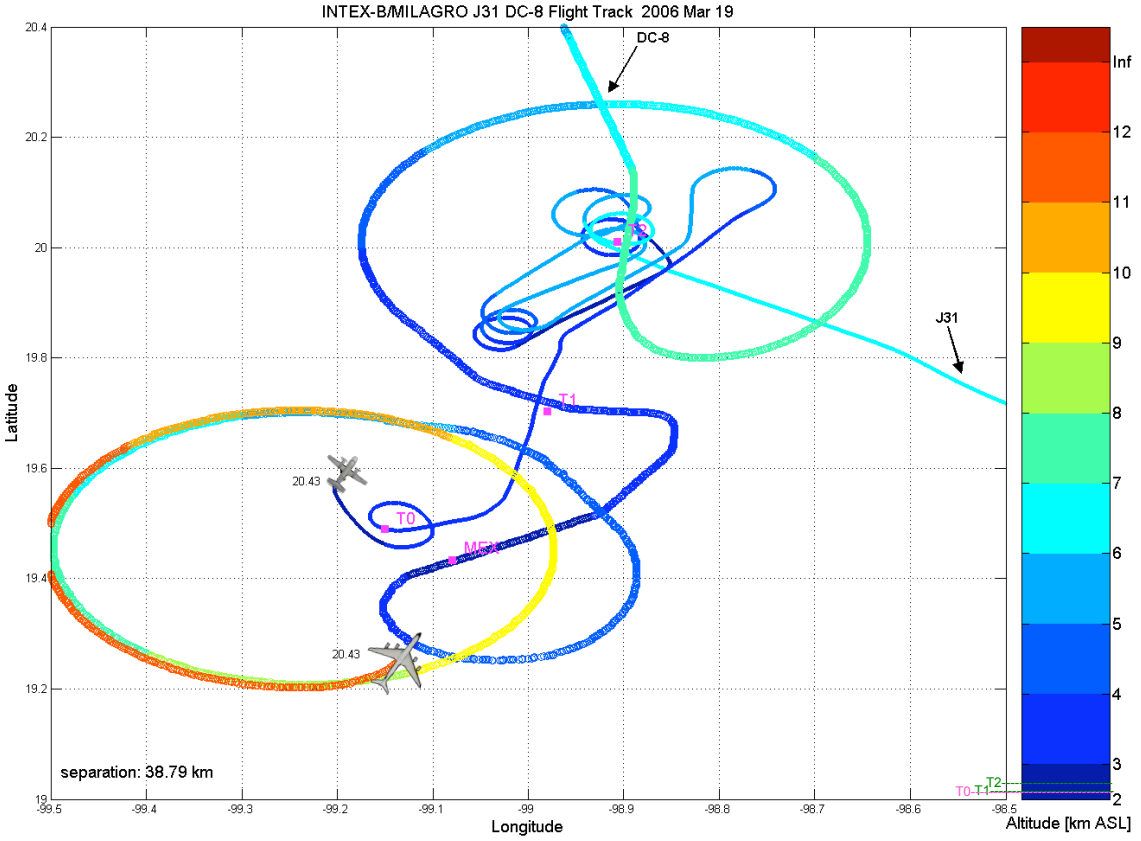
Coordination of DC-8 and J31 Flights, 19 Mar 2006, INTEX-B/MILAGRO



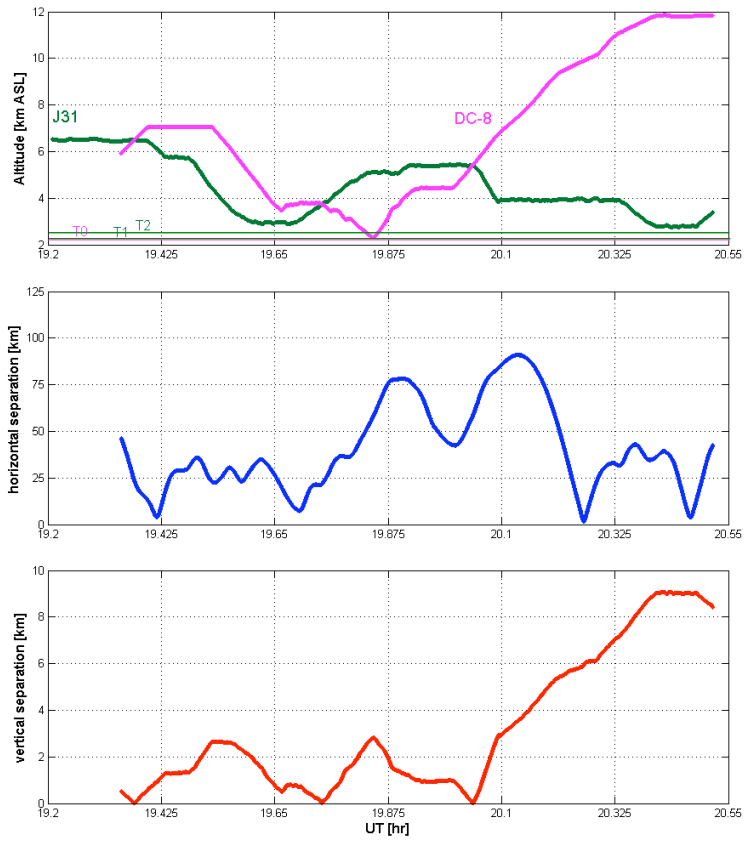


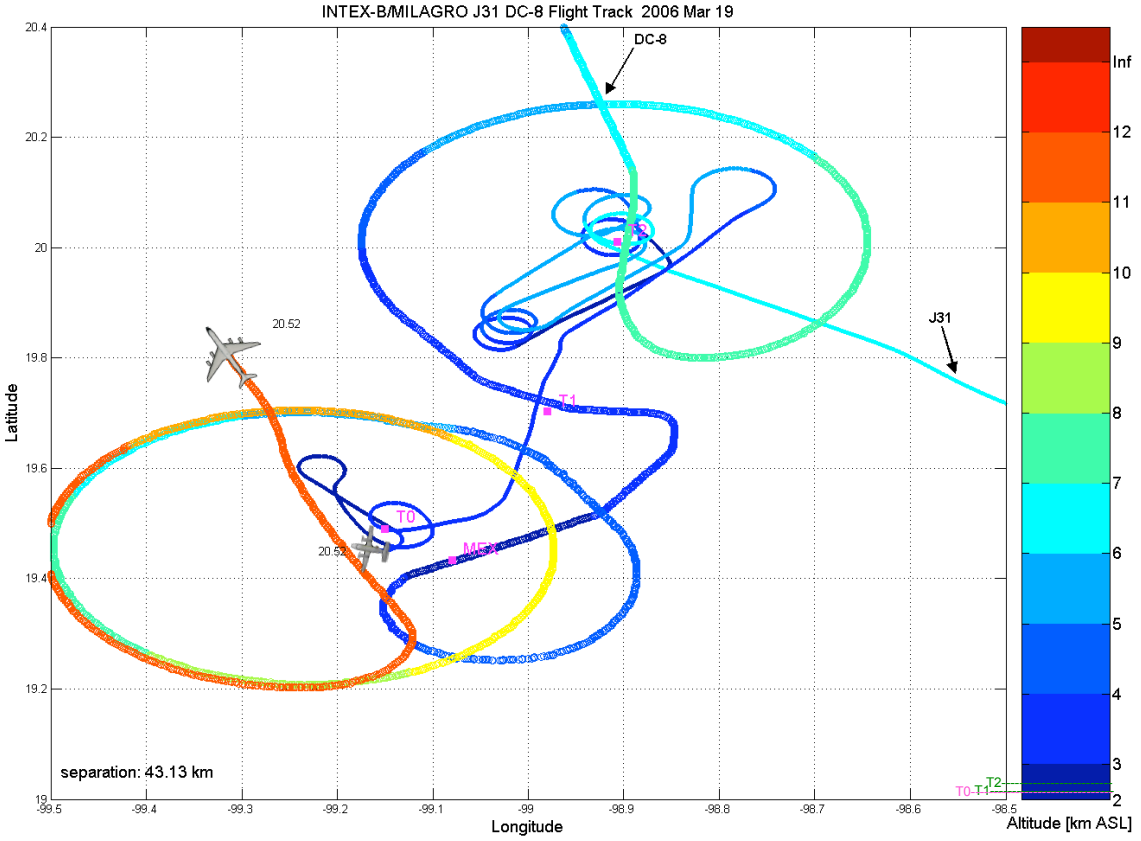
Coordination of DC-8 and J31 Flights, 19 Mar 2006, INTEX-B/MILAGRO

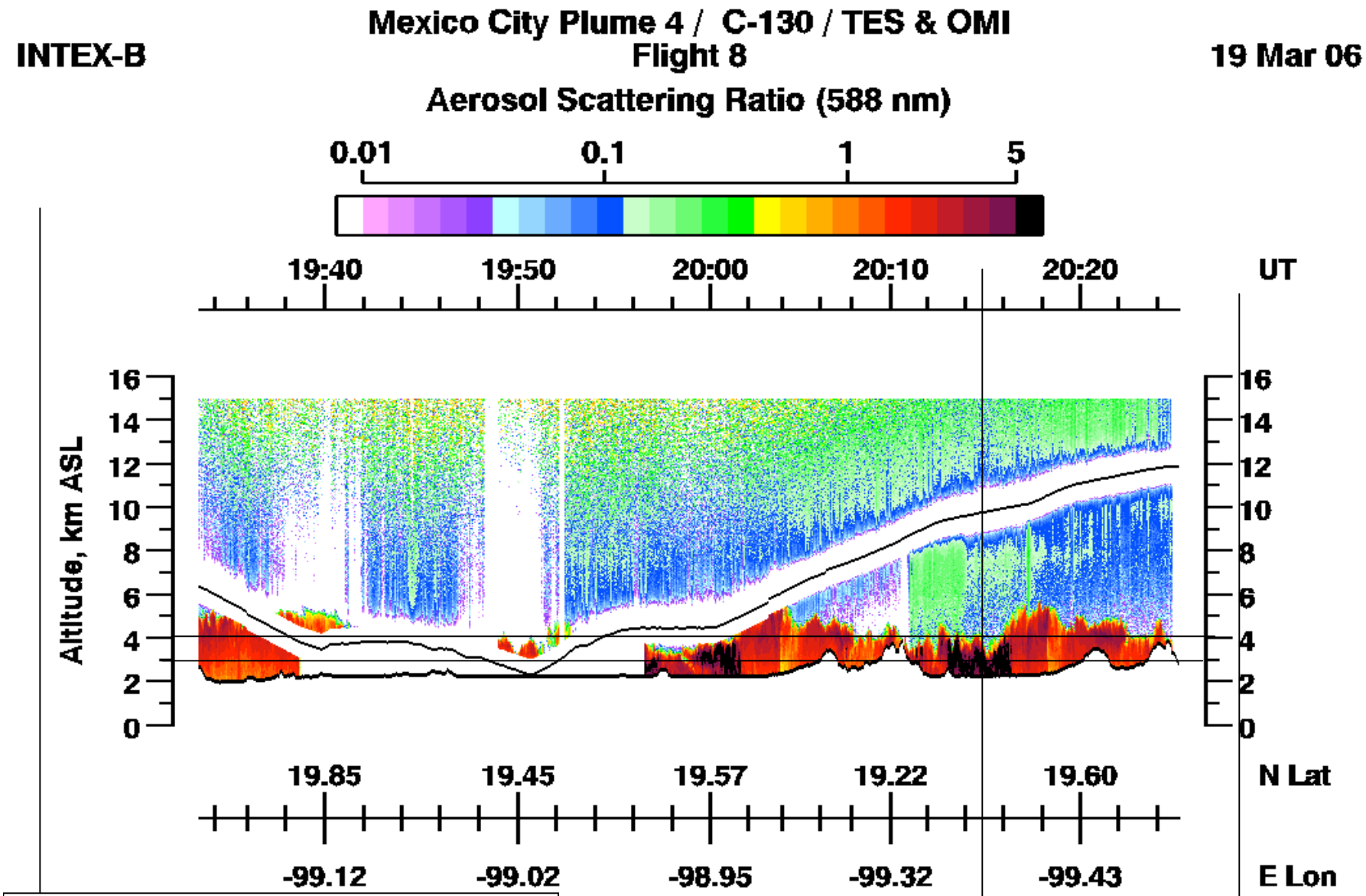




Coordination of DC-8 and J31 Flights, 19 Mar 2006, INTEX-B/MILAGRO





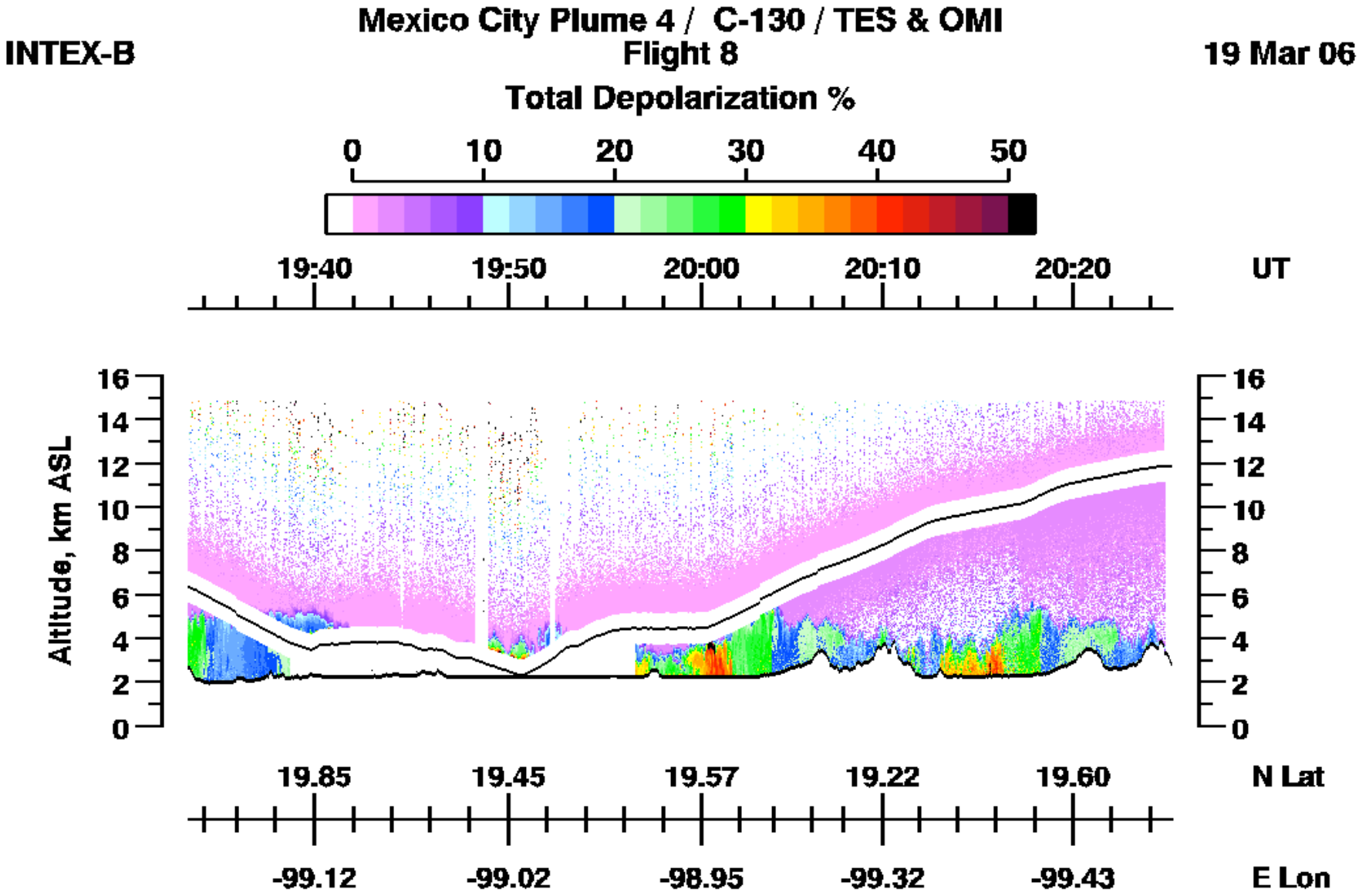


19:25 UT, DC-8 over J31 at T2

E. Browell, J. Hair et al.

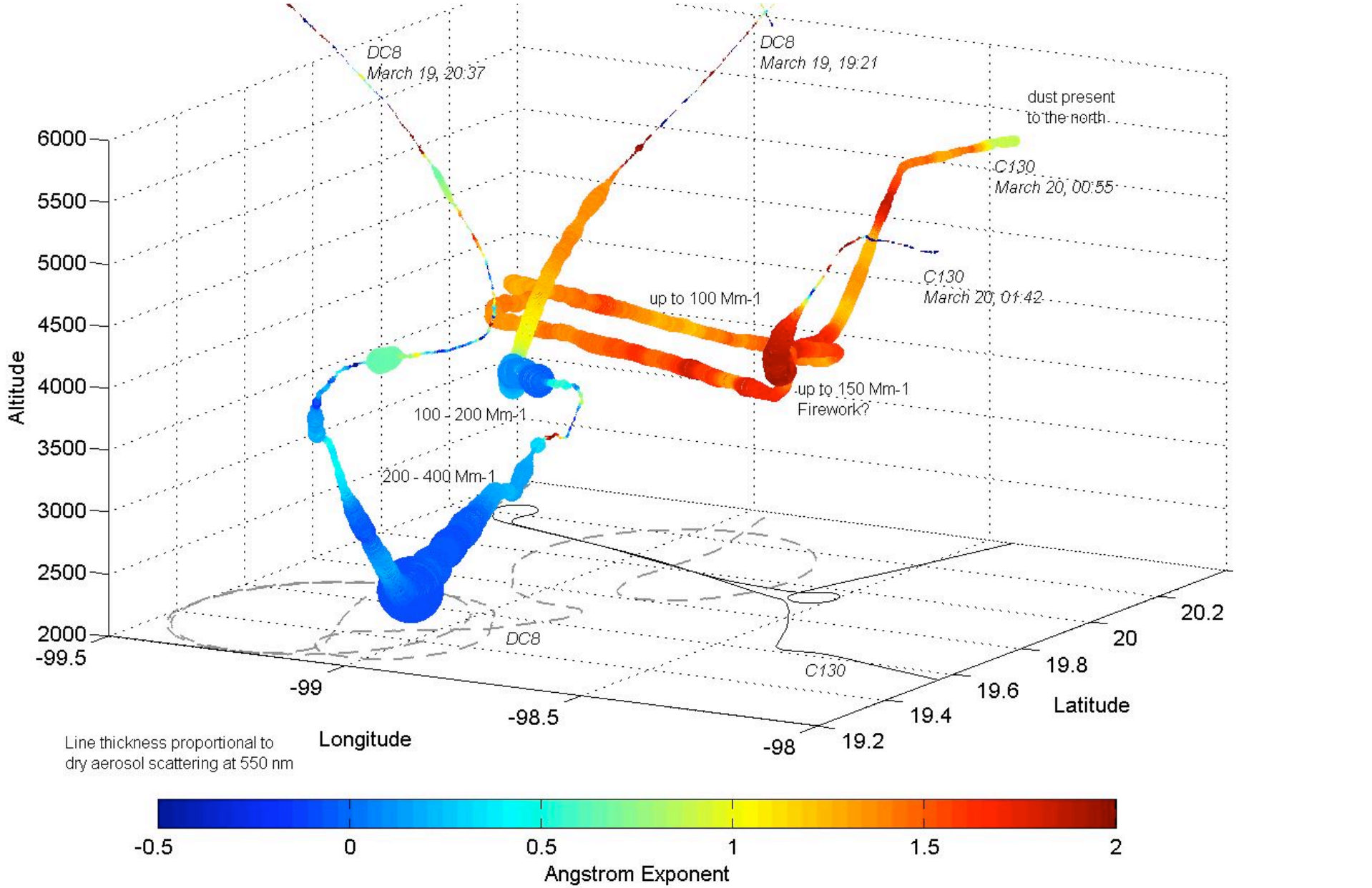
DC-8 over J31 between T1 & T0, 20:15 UT

DC-8 over J31 NW of T0, 20:28 UT



Large depolarization suggests dust: consistent with AOD λ-dep

E. Browell, J. Hair et al.



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

Clarke, Shinozuka et al.

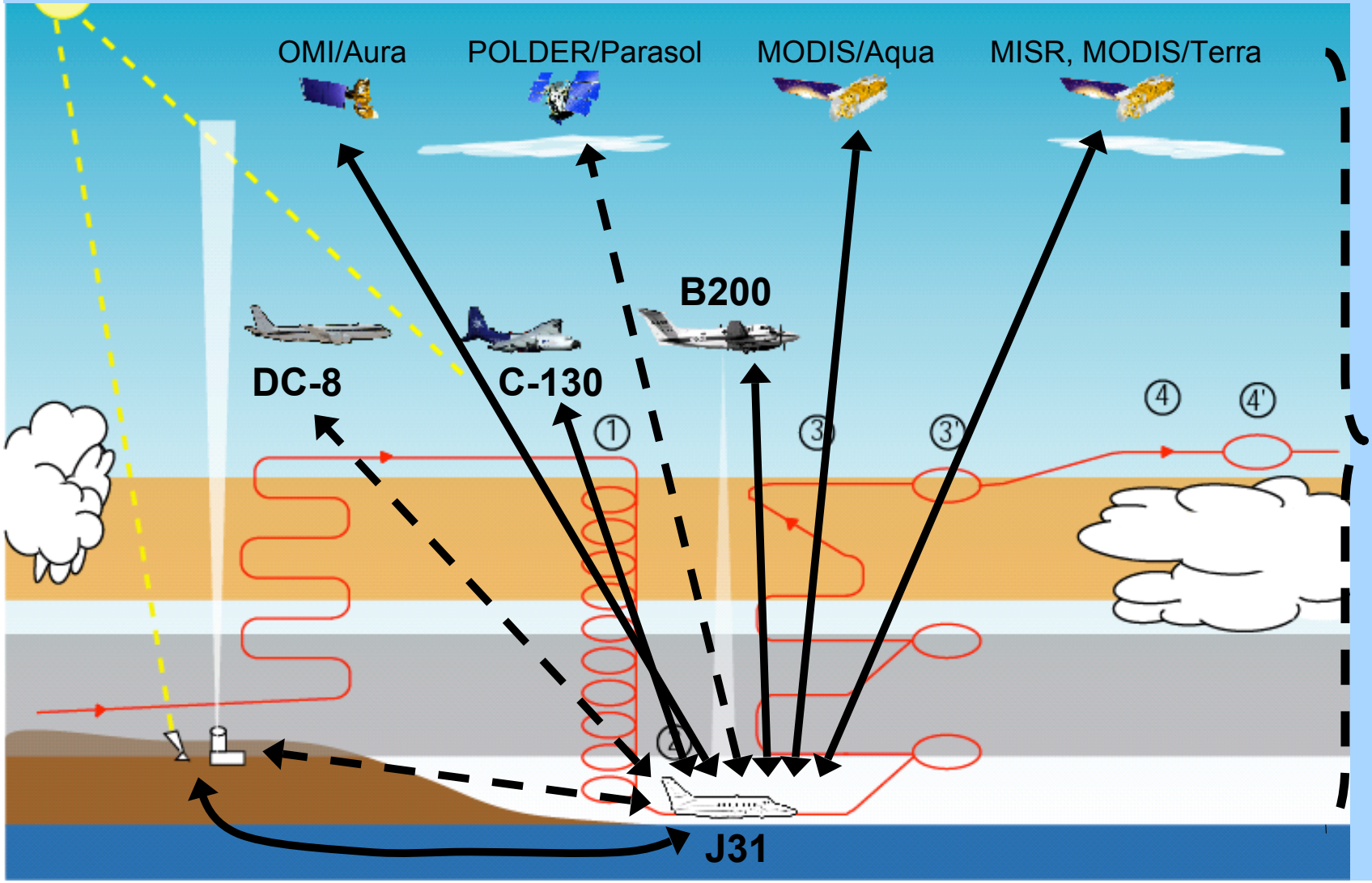
J31 Collaborations

- Current: ⟷
- Potential: ← – →

J31 Collaborations

-Current: ⟷

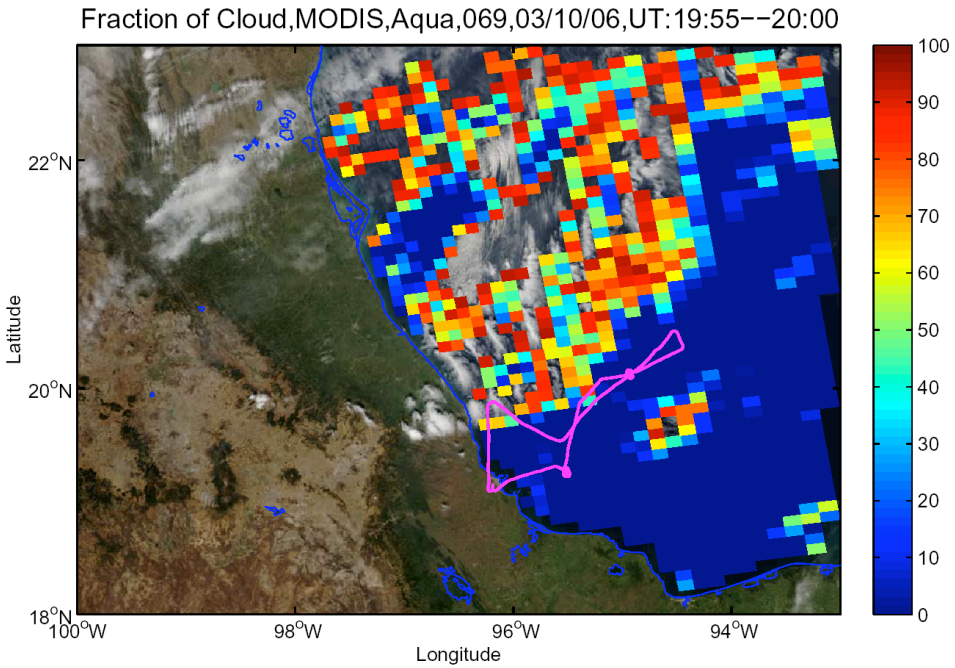
-Potential: ← – →



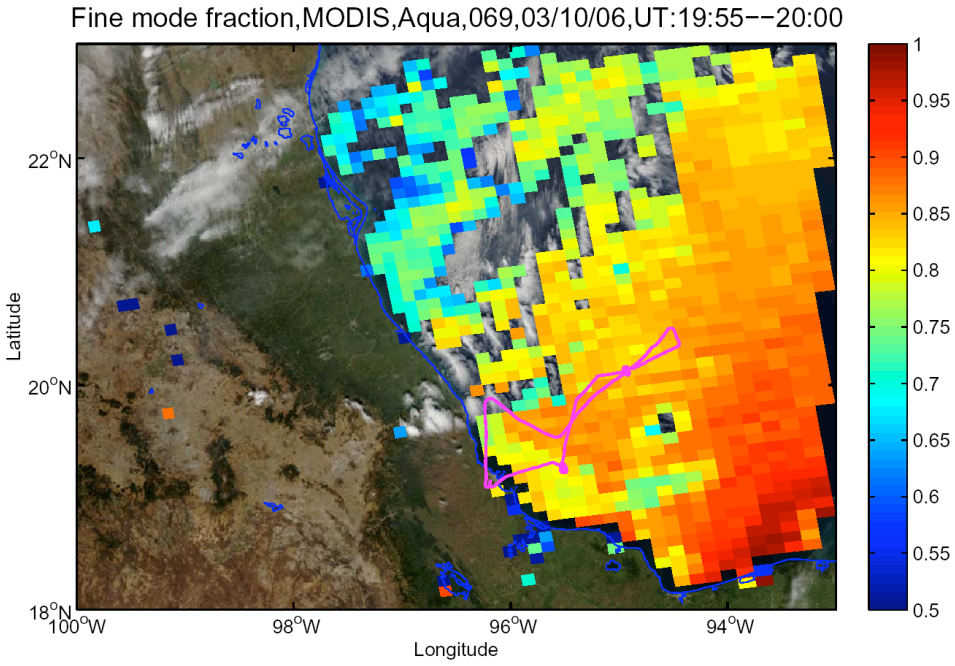
Models of:
- Chem & Trans
- Rad Effects

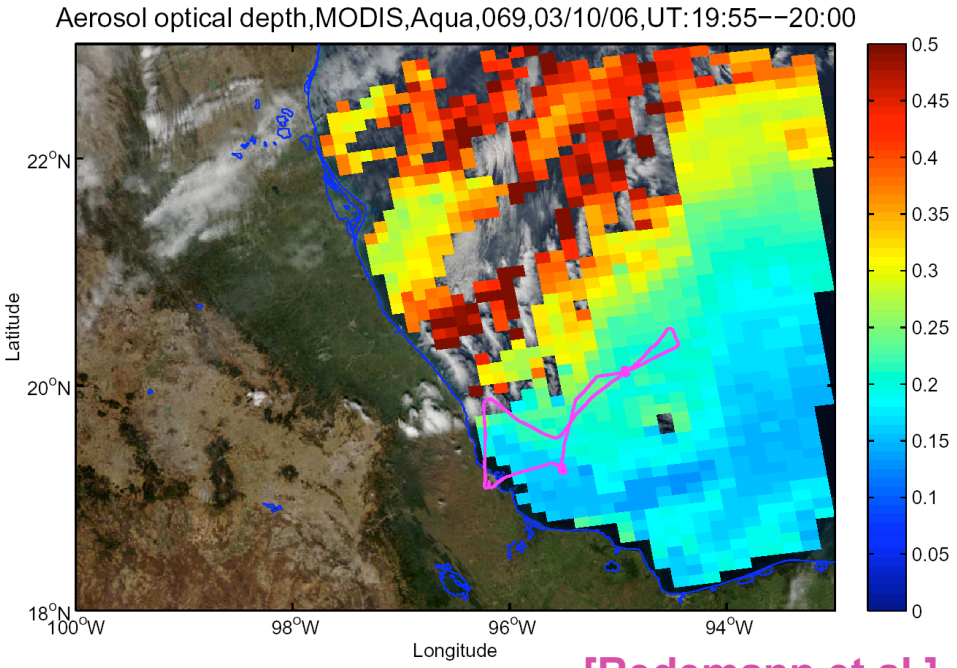
End of Presentation

Remaining Slides are Backup



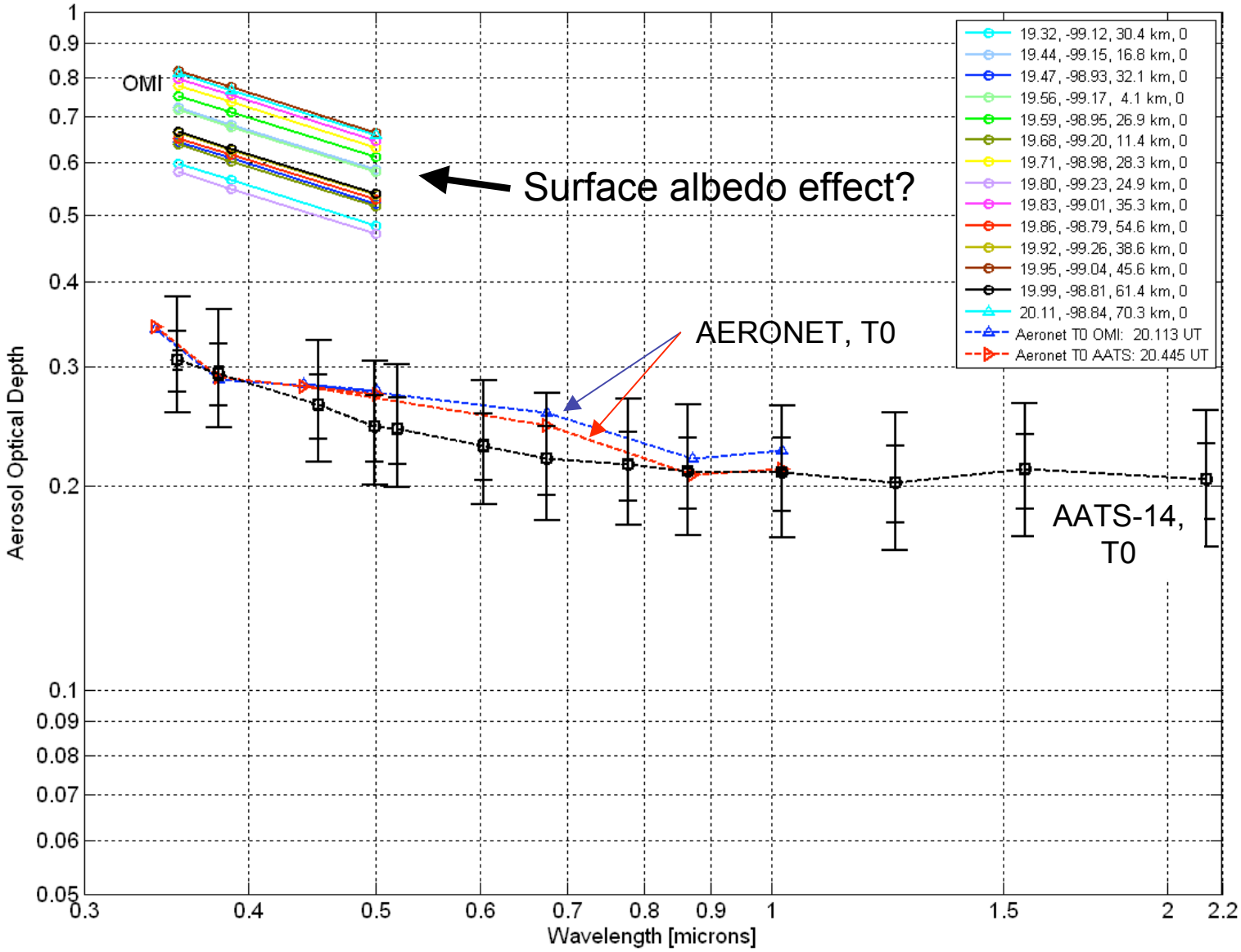
March 10, MODIS-Aqua over the Gulf of Mexico. Retrieval maps show MODIS-Aqua results and J-31 flight track





[Redemann et al.]

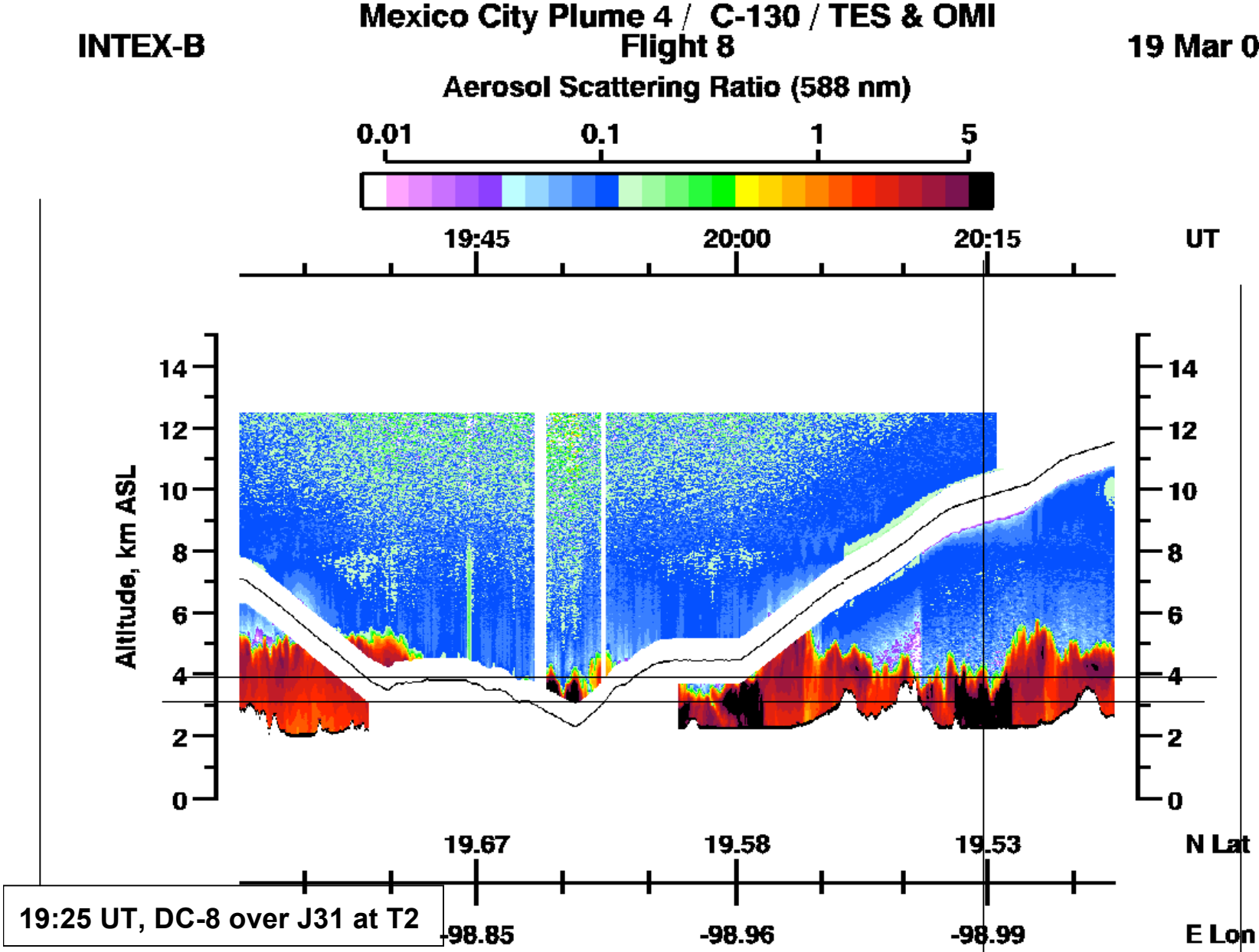
Comparison of OMI, AATS, & AERONET AOD at T0, 19 Mar 2006



INTEX-B

Mexico City Plume 4 / C-130 / TES & OMI
Flight 8

19 Mar 06

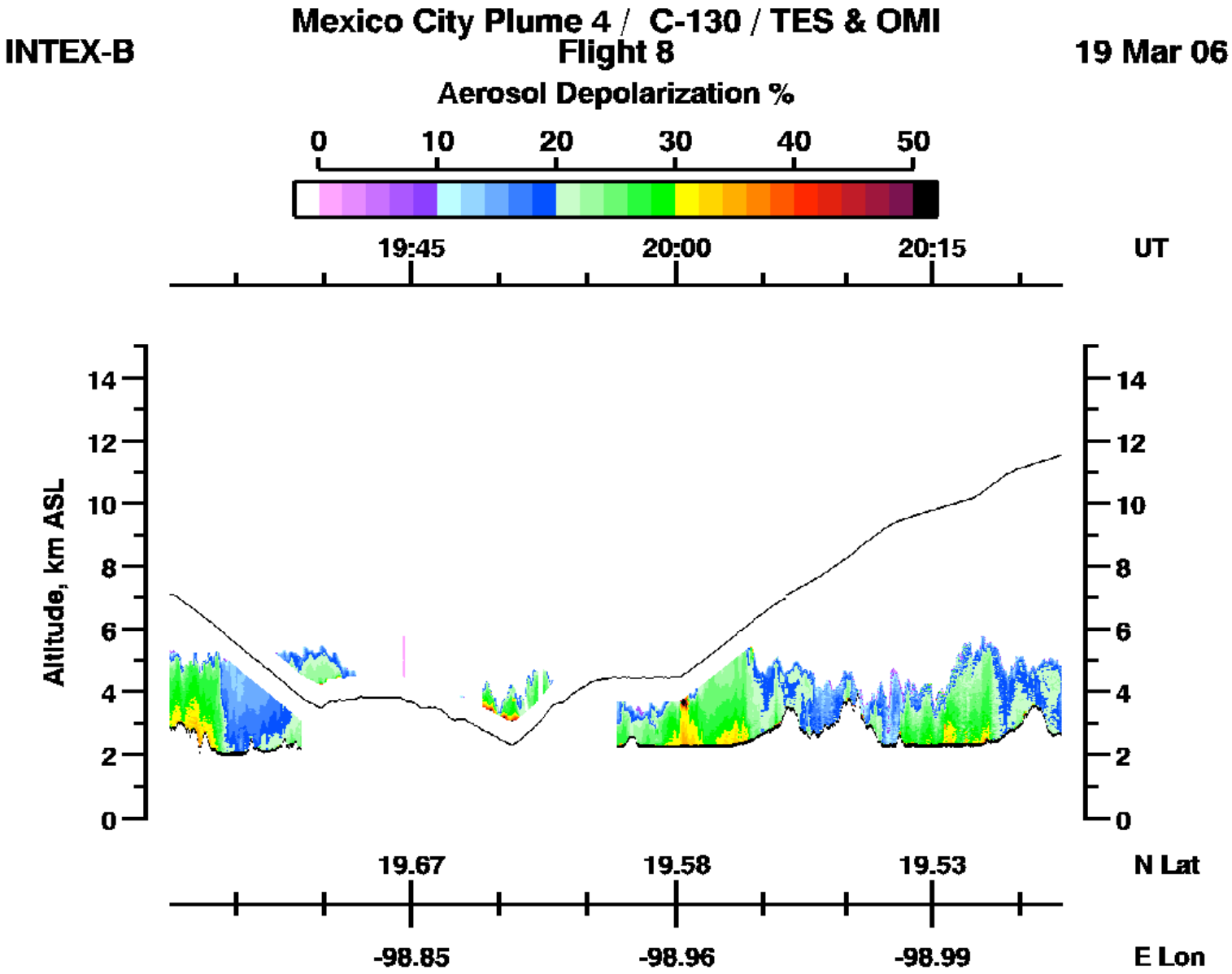


19:25 UT, DC-8 over J31 at T2

DC-8 over J31 between T1 & T0, 20:15 UT

DC-8 over J31 NW of T0, 20:28 UT

J. Hair, E. Browell et al.



Large depolarization suggests dust: consistent with AOD λ-dep

J. Hair, E. Browell et al.