INTEX-B (& MILAGRO) Mission Spring 2006
H. B. Singh, W. H. Brune, J. H. Crawford, and D. J. Jacob
(White paper http://cloud1.arc.nasa.gov)

**GOAL:** To understand the transport, transformation, & impacts of gases & aerosols on air quality & climate from local to global scales

- **INTEX-A:** Summer 2004
  - large biosphere emissions
  - active photochemistry

- **INTEX-B:** Spring 2006
  - maximum Asian inflow to NA
  - megacity pollution
Outline

• Mission plan & philosophy
• Goals
• Partners
• Airborne platforms & payloads
• Satellites
• Flight plans & coordination
INTEX-A Plan & Coordination

- Inter-comparisons
- Coordinated Science flights
- Sharing of forecasts & data
- Joint publications
INTEX-B/MILAGRO SCIENTIFIC GOALS

- Transport & evolution of Asian pollution to NA and beyond & implications for regional air quality & climate
- Extent, persistence, & transformation of Mexico City pollution plumes
- Validation of satellite observations of tropospheric composition
- Mapping of anthropogenic and biogenic emissions
- Relating atmospheric composition to sources and sinks
- Quantifying radiative properties and effects of aerosols, clouds, water vapor, & surfaces
Mexico City Pollution & 3-Day Forward Trajectories

March Data for 15 years; 33% over US
7-day Forward Asian Trajectories (past 140W)

Local PM (ascending) AIRS CO at 500 mb on 20040701

344 trajectories ~ 10%

$O_3$ trend of 0.5 ppb/yr

One Trajectory per day released from 500 meters AGL from 8 Asian cities. April data 15 years
INTEX-B/MILAGRO Intensive

- **Major Partners:** NASA, NSF, DOE, DLR, Mex, Canada

- **Major Platforms:**
  - **DC-8:** Large scale characterization, inflow/outflow, transport & evolution, satellite validation
  - **C-130/G1/J-31/king Air:** BL & regional characterization, BL/FT exchange, radiation
  - **Falcon-20:** UT/LS processes & exchange, satellite validation
  - **Satellites (Aura/Aqua/Envisat):** Global coverage of selected species
  - **Ground based:** Sondes, lidars, air quality stations
Forecasts & Model Products INTEX-B

- MET data
- Trajectories
- Convective influences
- Fires

- AIRS- CO
- MOPITT- CO
- MODIS- Aerosol
- SCIA- NO2
- GOES- clouds

- GEOS-Chem (Harvard)
- MOZART (NCAR)
- RAQMS (Langley)
- STEM/CFORS (U. Iowa)
- Other models (e.g. PNL)

Global models: 1-5 day forecasts
Regional models: 1-2 day forecasts
Local models: 1 day forecasts
INTEX-B DC-8 Satellite Validations
(TES, OMI, MLS, HIRDLS, AIRS, MODIS, MOPITT, MISR, SCIA, Calipso)

(CO, O₃, HCHO, NO₂, Aerosol, HNO₃, SO₂, H₂O, HCN, Organics)

- Coincident along track observations in UTLS & lidar curtains in strat and trop
- Coincident vertical profile in polluted & clean Trop (0-12 km)
- Limb & cross swath observations in UTLS
- Variety of surface features
- Cloud free conditions
- Day and night

-Satellite tracks and instrument swaths to be available for forecasts
- Definition of INTEX-B preferences from TES
DC-8/SCIAMACHY Trop Column NO$_2$

Heckel et al.
O₃ and Reactive Nitrogen vs models

LAT = 30-50; LONG = 260-320

\[ \text{ALTITUDE, km} \]

\[ O_3, \text{ ppb} \]

\[ \text{NO}_x, \text{ ppt} \]

\[ \text{PAN, ppt} \]

\[ \text{HNO}_3, \text{ ppt} \]
DC-8 INTEX-B Payload

- Mission Mgr. Console
- Navigation
- DACOM/DLH
- SAFS
- DCALS
- PANAK
- PAN/OVOC
- UH/LIA
- ATHOS
- NO
- NO, NO₂
- TAN
- COHEN
- SO₂, HNO₄
- GT-LIF
- TD-LIF
- ICATS
- PANAK
- ATHOS
- NO
- NO, NO₂
- TAN
- COHEN
- SO₂, HNO₄
- GT-LIF
- TD-LIF
- ICATS
- PANAK
- ATHOS
- NO
- NO, NO₂
- TAN
- COHEN
- SO₂, HNO₄
- GT-LIF
- TD-LIF
- ICATS
- PANAK
- ATHOS
- NO
- NO, NO₂
- TAN
- COHEN
- SO₂, HNO₄
- GT-LIF
- TD-LIF
- ICATS
- PANAK
- ATHOS
- NO
- NO, NO₂
- TAN
- COHEN
- SO₂, HNO₄
- GT-LIF
- TD-LIF
- ICATS
- PANAK
- ATHOS
- NO
- NO, NO₂
- TAN
- COHEN
- SO₂, HNO₄
- GT-LIF
- TD-LIF
- ICATS
- PANAK
- ATHOS
- NO
- NO, NO₂
- TAN
- COHEN
- SO₂, HNO₄
- GT-LIF
- TD-LIF
- ICATS
- PANAK
- ATHOS
- NO
- NO, NO₂
- TAN
- COHEN
- SO₂, HNO₄
- GT-LIF
- TD-LIF
- ICATS
Autonomous instruments:
- NO, NOy, O3
- CO, CO2
- PANs
- PILS
- WAS
- SAFS
- SO2

PANs analyzer, might be in rack, decision mid-October
DLR/Falcon INTEX-B Instrumentation

• Chemical Measurements
  Gases:
  Nitrogen- NO, HNO₃, NOₓ
  Carbon- CO, CO₂, CH₂O
  Oxidants- O₃
  Sulphur- SO₂

Aerosols:
  Aerosol size distribution (0.004 - 20 µm)
  volatile/semi-volatile aerosol fraction

• 5+ missions to coincide with INTEX-B/Part 2
- Characterize the distributions, radiative properties, and effects of aerosols and water vapor
- Test the ability of satellite sensors & airborne lidar to retrieve aerosol, cloud, and water vapor properties
- Characterize surface spectral albedo and bidirectional reflectance to help improve satellite retrievals
- Quantify relationships between the above & aerosol amount and type
# Satellites & Priority Chemicals

<table>
<thead>
<tr>
<th>Satellite Platform*</th>
<th>Instruments</th>
<th>Some key data products</th>
<th>Vert. resol.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aura: <a href="http://eos-aura.gsfc.nasa.gov/">http://eos-aura.gsfc.nasa.gov/</a></td>
<td>TES, OMI, MLS</td>
<td>CO, CH₄, O₃, HNO₃, NO₂, O₂, NO₂, SO₂, HCHO, H₂O, HCN, CO</td>
<td>Trop col./4 km</td>
</tr>
<tr>
<td>Aqua: <a href="http://eos-pm.gsfc.nasa.gov/">http://eos-pm.gsfc.nasa.gov/</a></td>
<td>MODIS, AIRS</td>
<td>Aerosol optical depth CO</td>
<td>Trop col./4 km</td>
</tr>
<tr>
<td>Terra: <a href="http://eos-am.gsfc.nasa.gov/">http://eos-am.gsfc.nasa.gov/</a></td>
<td>MOPITT, MISR, MODIS</td>
<td>CO, Aerosol optical depth, Aerosol optical depth</td>
<td>Trop col./4 km</td>
</tr>
<tr>
<td>Envisat: <a href="http://envisat.esa.int/">http://envisat.esa.int/</a></td>
<td>SCIAMACHY, MIPAS</td>
<td>O₃, NO₂, CH₂O, Trace organics</td>
<td>Trop col./4 km</td>
</tr>
<tr>
<td>Calipso: <a href="http://www.calipso.larc.nasa.gov/">http://www.calipso.larc.nasa.gov/</a></td>
<td>CALIOP</td>
<td>Aerosol distribution</td>
<td>High resolution</td>
</tr>
</tbody>
</table>

**Satellite Platforms:**
- **Aura:** Satellites & Priority Chemicals
- **Aqua:** Trop col./4 km
- **Terra:** Trop column
- **Envisat:** Trop column
- **Calipso:** High resolution

**Chemicals:**
- O₃, NO₂, HCHO, SO₂, Aerosol
- CO, O₃, H₂O, HCN (UT/LS)
INTEX-B/MILAGRO Grand Plan for Spring 2006

Down period: 23 Mar-11 Apr

19 flights (140 flight hours):
USD (2 test flights)
Houston (5 local flights)
Hawaii (3 local flights)
Anchorage (4 local flights)
5 transit flights

DC-8 transits
C-130 transits
DC-8 locals
Nominal C-130 operations
Operations of foreign partners (DLR/Falcon-20)
DC-8 & C-130 Coordination in INTEX-B/Part 1
DC-8 & C-130 Coordination in INTEX-B/Part 2
# INTEX-B/DC8 Schedule

<table>
<thead>
<tr>
<th>Location</th>
<th>Event</th>
<th>Date (2006)</th>
<th>Flights</th>
<th>Flight hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>UND (Grand Forks)</td>
<td>Integration</td>
<td>1/16-2/16</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>UND</td>
<td>Test flights</td>
<td>2/17-2/27</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Transit to Houston</td>
<td>Transit</td>
<td>2/28</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Houston Local</td>
<td>Science Flights</td>
<td>3/1-3/21</td>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td>Transit to UND</td>
<td>Transit</td>
<td>3/22</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Break</td>
<td>Break</td>
<td>3/23-4/11</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>UND Prep</td>
<td>Preparation</td>
<td>4/13-4/16</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Transit to Hawaii</td>
<td>Transit</td>
<td>4/17</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Hawaii Local</td>
<td>Science Flights</td>
<td>4/18-4/28</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Transit to Anchorage</td>
<td>Transit</td>
<td>4/29</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Anchorage Local</td>
<td>Science Flights</td>
<td>4/30-5/14</td>
<td>4</td>
<td>35</td>
</tr>
<tr>
<td>Transit to UND</td>
<td>Transit</td>
<td>5/15</td>
<td>1</td>
<td>6</td>
</tr>
</tbody>
</table>

| Total                     |              | 19          |         | 140          |

*Additional flight hours, if available, will be used to add 1 flight each at Houston & Anchorage*