Evaluation of AIRS and IASI Trace Gases using \textit{in situ} measurements from START08

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MOTIVATION

• Evaluate tracer measurements from AIRS and IASI
  – Plans to have these measurements for ~20 years
    • Global and long-term studies
  – 4x daily coverage between the 2 instruments

• Exploit wide horizontal coverage of satellite instruments to provide large-scale context for aircraft measurements
OUTLINE

• Data description

• Aircraft – AIRS/IASI O$_3$
  – Vertical Profiles
    • Comparisons to Aura/MLS
  – Horizontal Variability
  – O$_3$-PV Analysis

• Aircraft – AIRS/IASI CO
  • Comparisons to MOPITT
Stratosphere-Troposphere Analysis of Regional Transport Experiment (START08)
and
HIAPER Pole-to-Pole Observations of Atmospheric Tracers (Pre-HIPPO)

April – June, 2008

Science Goals:

- Characterize the chemical and dynamical properties of the extratropical UT/LS

- Investigate the role of different transport pathways on the distribution of key chemical tracers in the UT/LS region

- Provide key measurement information to improve the coupling between chemistry and dynamics in chemistry-climate models

- Map the distribution of greenhouse gases to track seasonal changes in sources and sinks
Participants:
- NCAR
- NOAA
- Univ. of CO
- Harvard Univ.
- Texas A&M Univ.
- Univ. of Miami

Gulfstream-V (GV)

NSF/NCAR High-performance Instrumented Airborne Platform for Environmental Research (HIAPER)

18 Research Flights, 123 Flight Hours
AIRS

• 2,378 spectral bands in the IR (3.7 – 15.4 μm) and 4 in the Visible (0.4 – 1 μm)
• +/- 49.5 degree swath
• 9 FOV, 45 km horizontal resolution at L2
• Launch: May 2002
• PM Equator-crossing
• Aboard Aqua

IASI

• 8,461 spectral bands in the IR (3.7 – 15.4 μm)
• +/- 48.3 degree swath
• 4 FOV, 50 km horizontal resolution at L2
• Launch: October 2006
• AM Equator-crossing
• Aboard METOP-A (plans for METOP-B in 2010 and METOP-C in 2015)
# AIRS Information Content

## TABLE I

**Mean Degrees of Freedom as Calculated from Equation 7 for Various Atmospheres for Version 5**

<table>
<thead>
<tr>
<th>Retrieved Quantity</th>
<th>Tropical</th>
<th>Mid-latitude</th>
<th>Polar</th>
</tr>
</thead>
<tbody>
<tr>
<td>T(p)</td>
<td>6.67</td>
<td>6.40</td>
<td>5.65</td>
</tr>
<tr>
<td>q(p)</td>
<td>4.46</td>
<td>3.85</td>
<td>2.89</td>
</tr>
<tr>
<td>O₃(p)</td>
<td>1.36</td>
<td>1.64</td>
<td>1.66</td>
</tr>
<tr>
<td>CO(p)</td>
<td>0.78</td>
<td>0.84</td>
<td>0.65</td>
</tr>
<tr>
<td>CH₄(p)</td>
<td>1.06</td>
<td>0.94</td>
<td>0.70</td>
</tr>
</tbody>
</table>

Maddy and Barnet, IEEE, 2008
AIRS $O_3(p)$ KERNEL Functions: 910 → 1140 cm$^{-1}$

AIRS(v8b) f/ Mid-Lat Case: ozone Kernel functions: $10 \times \frac{d[\Delta \tau/\Delta \ln(O_3)]}{dz}$

[Image of a scientific graph showing a color-coded contour plot with axes labeled for altitude in km and wavenumber in cm$^{-1}$]
Vertical Profiles:

How good do AIRS and IASI capture Troposphere-Stratosphere Transition in Ozone?
Three Trapezoids in the UT/LS region
START08

Pressure (hPa)

GV Res.

Trapezoid Res.

Number of Observations

103
142
212
300

1x10^1 1x10^2 1x10^3 1x10^4

START08

Pressure (hPa)

GV NOAA

AIRS

IASI

Average O₃ (ppbv)

0 200 400 600 800

START08

Pressure (hPa)

AIRS - GV

IASI - GV

Satellite - Aircraft O₃ (%)

-30 -20 -10 0 10 20 30
Horizontal Variability:

How good do AIRS and IASI capture Ozone gradients in the horizontal?
Ozone – PV Analysis:

A valuable application for the AIRS and IASI datasets
CO
(400-600 mb)

Satellite vs GV
Conclusions

- AIRS and IASI provide daily observations with wide horizontal coverage, which allow for a better dynamical and chemical characterization of the UT/LS

- AIRS and IASI show agreement with GV in: large-scale O₃ features, horizontal gradients in O₃, and large-scale CO variability

- AIRS and IASI show comparable performance to satellite instruments with well-established data characterization
Tropospheric Intrusion Flight

Graphs showing pressure and number of observations.
Stratospheric Intrusion Flight
Stratosphere

Tropopause Region

100 < P (mb) < 212

212 < P (mb) < 300
Stratosphere
(with Tropospheric Intrusion)

Tropopause Region
Stratosphere

Troposphere
(with Stratospheric Intrusion)