Mexican activities with regard to TEMPO

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Second Tempo Science Team Meeting
May 21-22, 2014
Hampton, Virginia
Mexican activities with regard to TEMPO

Location

UNAM Team

2nd TEMPO Science Team Meeting
two main ground stations

2,240 m a.s.l. UNAM

4,000 m a.s.l. ALTZOMONI

Mexican activities with regard to TEMPO Measurement strategy

2nd TEMPO Science Team Meeting
experiments

FTIR for Solar Absorption Infrared Spectroscopy
MAX-DOAS for Multi-Axis Differential Optical Absorption Spectroscopy

SAIRS

DOAS
Mexican activities with regard to TEMPO

MAX-DOAS

UNAM Team
2nd TEMPO Science Team Meeting

MAX-DOAS instrument

- Made at UNAM (6 instruments built, 4 installed)
- 280 – 450 nm spectrometer (Res=0.6 nm, Ocean Optics USB2000+)
- ± 0.1 °C temperature controlled (Peltier element + ventilation)
- Scanning unit with stepper motor (-90 to 90 ° elev. angle)
- 2” concave lens (f=10 cm) telescope
- Linux based program for system control & data acquisition
MAX-DOAS sites

UNAM

FAC

C5

CUT
Mexican activities with regard to TEMPO

OMI (NASA-Aura)

NO₂ Map

2nd TEMPO Science Team Meeting

OMI/Aura data set version 003, level 2,
NO₂ data product version 1.1.4.4 (Claas, 2012)
cloud fraction below 20%
2006 - 2011

NASA’s Goddard Earth Sciences Data and
Information Services Center (GESDISC)
(http://disc.sci.gsfc.nasa.gov/Aura/data-holdings/OMI)
MAX-DOAS retrievals

- **MAX-DOAS measurements**
  - **DOAS Technique**
    - QDOAS
      - Target gas dSCD + $\varepsilon$
      - $O_4$ dSCD + $\varepsilon$

- **Aerosol optical prop (AERONET)**
  - known $O_4$ profile

- **A priori profile**
  - Radiative Transfer Model
    - VLIDORT
    - Sim. $O_4$ dSCD

- **Optimal Estimation**

- **P, T-profiles, $\sigma, \beta$**
  - A priori profiles
  - Radiative Transfer Model
    - VLIDORT
  - Sim. target gas dSCD

  **iteration**

- **Optimal Estimation**

- **Target gas profiles**

**UNAM Team**

2nd TEMPO Science Team Meeting
NO$_2$ spectral fit

<table>
<thead>
<tr>
<th>Window</th>
<th>405 – 465 nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO$_2$ @ 294K</td>
<td>Vandaele et al., 1998</td>
</tr>
<tr>
<td>O$_3$ @ 221, 241K</td>
<td>Burrows et al., 1999</td>
</tr>
<tr>
<td>O$_4$</td>
<td>Hermans et al., 1999</td>
</tr>
<tr>
<td>Ring spectrum</td>
<td>273K</td>
</tr>
</tbody>
</table>
Preliminary NO$_2$ retrieval

$AOD : 0.05$

$DOFs : 1.0$

$VCD_{NO_2} = 0.5 \times 10^{16} \text{ molec/cm}^2$
Preliminary NO$_2$ retrieval

AOD : 0.12
DOFs: 1.8

\[ VCD_{NO_2} = 2.0 \times 10^{16} \text{ molec/cm}^2 \]
HCHO spectral fit

- HCHO
- Ring
- O₃
- NO₂

Mexican activities with regard to TEMPO
MAX-DOAS

UNAM Team
2nd TEMPO Science Team Meeting
OMI (NASA-Aura)

HCHO Total Column

[Latitudes and Longitudes with concentration values]

[molec./cm²]
Mexican activities with regard to TEMPO
Tijuana – San Diego

2nd TEMPO Science Team Meeting

Tijuana – San Diego Area

Cal-Nex / Cal-Mex
May-June 2010

- PQM DOAS
- PQM in situ
- UTT

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Number of occurrences</th>
<th>Frequency (%)</th>
<th>Dispersion pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>2976</td>
<td>45</td>
<td>towards east-southeast</td>
</tr>
<tr>
<td>b</td>
<td>2699</td>
<td>41</td>
<td>towards east-northeast</td>
</tr>
<tr>
<td>c</td>
<td>634</td>
<td>10</td>
<td>towards north-northeast</td>
</tr>
<tr>
<td>d</td>
<td>264</td>
<td>4</td>
<td>towards west</td>
</tr>
</tbody>
</table>
Tijuana – San Diego Area

OMNO2 Level 2
2006 – 2011

Cloud fraction < 20%
High Altitude site “Altzomoni”
3,985 m a.s.l.

Solar absorption FTIR (HR120/5)
MAX-DOAS (NO₂, SO₂, HCHO, ...)
DS-DOAS, 2D-DOAS
Thermal emission FTIR (2D)
Ceilometer (commercial LIDAR)
GPS (precipitable water column)

Remote Sensing

Meteorology (WS, WD, T, P, RH, Rain)
Reactive Gases (O₃, CO, NOₓ, SO₂)
GHG* (CO₂, CH₄, H₂O)
PM, Black Carbon*
Wet/Dry deposition (Chem/Isotope)

* not yet installed
O₃ (Altzomoni)

Retrieval: PROFFIT (KIT)
O$_3$ (Altzomoni)

3.7 DOFs in the retrieval justifies the separation of two partial columns

Retrieval: PROFFIT (KIT)
**O₃ TC annual cycle**

**Strat vs Trop.**

**Biomass Burning**

**Retrieval:** PROFFIT (KIT)
O$_3$ (Altzomoni)

Stratospheric intrusion in the Winter 2012-2013

Retrieval: PROFFIT (KIT)
Summary

• Mexico can participate in the validation efforts of TEMPO
• Ground-based MAX-DOAS network in and around Mexico City
• Solar absorption FTIR at 2 sites: $O_3$, HCHO and other gases
• Collaborations, intercomparisons, visits, etc. are welcome!!

Thank you

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