FIRST GLOBAL MEASUREMENT OF MIDTROPOSPHERIC CO2 FROM NOAA POLA SATELLITES: TROPICAL ZONE

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NOAA CMDL CCGG Cooperative Air Sampling Network
TOVS $\text{CO}_2$- channels selected

Radiative transfer model simulations over tropical atmospheres data base

<table>
<thead>
<tr>
<th>Channel</th>
<th>Wavelength, $\mu$m</th>
<th>CO2: +3%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>14.7</td>
<td>0.13 ± 0.02</td>
</tr>
<tr>
<td>3</td>
<td>14.5</td>
<td>0.002 ± 0.02</td>
</tr>
<tr>
<td>4</td>
<td>14.2</td>
<td>0.27 ± 0.03</td>
</tr>
<tr>
<td>5</td>
<td>14.0</td>
<td>0.32 ± 0.02</td>
</tr>
<tr>
<td>6</td>
<td>13.7</td>
<td>0.32 ± 0.02</td>
</tr>
</tbody>
</table>

Mean co2 jacobians - co2 +3%

MSU3 temperature weight function and mean co2 channels weight function cover ~ the same pressure range
Retrieval method of CO₂ from NOAA polar satellites

A non-linear regression approach: Mulilayer Perceptron (Rumelhart, 1986)

HIRS and MSU → 2 hidden layers
→ q_{co2 var} − q_{ref}
→ T_{B co2 var} − T_{B TIGR}

q_{ref} = 355 ppmv
~ central value for NOAA-10

MLP trained on the TIGR data set with variable q_{co2} drawn at random (341–369 ppm)

Noised T_{B} (instrumental and model noises)

49 MLPs trained (6 surface elevations (1013 to 875 hPa) over land and one over sea, and 7 viewing angles (from nadir to 40°))

Application of Neural Network to observations requires knowledge of systematic biases
Between simulations and observations
(Simulations - Observations) systematic biases calculation

Radiosoundings collocated with satellite observations
T(P), H₂O(P), Ts

Radiative Transfer Model

Simulated brightness temperature

Fixed greenhouse gases concentrations
(CO₂ = 355ppm, CO = 100ppb, CH₄ = 1.8ppm, N₂O = 308ppb)
Ozone profile climatology (UGAMP)

NOAA-10
July 1987 - July 1991

Observed brightness temperature

Mean (Calc. - Obs.) Over the period

these biases allow connection between ‘simulation world’ and ‘observation world’
Global Maps of Mid-to-High tropospheric CO2

15°×15° (1° moving average)

CO₂ (ppmv)  Number of items averaged

04/1988

06/1988
Global Maps of Mid-to-High tropospheric CO₂

15°X15° (1° moving average)

CO₂ (ppmv)  Number of items averaged

04/1990

05/1990
Dispersion of CO2 retrievals

Global Maps 15°X15° (1° moving average)

Standard deviation seasonal variability

Minima in summer maxima in spring
Stdv of the method ($Std_M$) $\sim 3$ ppm

Is the natural variability the cause of the difference?
Dispersion of CO2 retrievals

higher Stdv often localised in regions of CO₂ strong gradients
Mean Seasonal Cycles

As seen by NOAA-10 (5-14 km; 1987-1991)

As measured in situ (8-13 km; 1993-1999)

Commercial aircrafts (Matsueda et al., 2002)
Time variations of the CO$_2$ concentration
As seen by NOAA-10

CO$_2$ retrievals - 5° zonal means

Solid line: sum of the long term trend and four harmonics
CO₂ Growth Rate as seen by NOAA-10 (1987-1991)

Mean Northern hemisphere 1.76 ppm/yr
Mean Southern hemisphere 1.80 ppm/yr

Values consistent with the one observed at the surface = ??
(Conway et al., 1994)
CO₂ and ENSO

As seen by NOAA-10
(Chédin et al., 2003)

(a) Growth rate (GR) time evolution

(b) SOI index time variation

(c) Correlation SOI/GR

As measured in situ
(Matsueda et al., 2001)
Conclusions and perspectives

The method used to infer CO$_2$ from NOAA polar satellites has proven its ability to retrieve important features of the distribution of CO$_2$ and its time evolution:

- Mean rate of rise of CO$_2$ of 1.75 ppm/yr over NOAA-10 period
- Seasonal cycle and impact of ENSO in agreement with Matsueda findings

And now?

Analys CO$_2$ data in the tropics and elucidate factors influencing its variation (sources, sinks, transport)

Extend the period to the 25 years of NOAA/TOVS observations (1979-2003)