LMD/CNRS

Institut Pierre Simon Laplace — Sciences de l'environnement

FIRST GLOBAL MEASUREMENT OF MIDTROPOSPHERIC CO_2 FROM NOAA POLAR SATELLITES: TROPICAL ZONE

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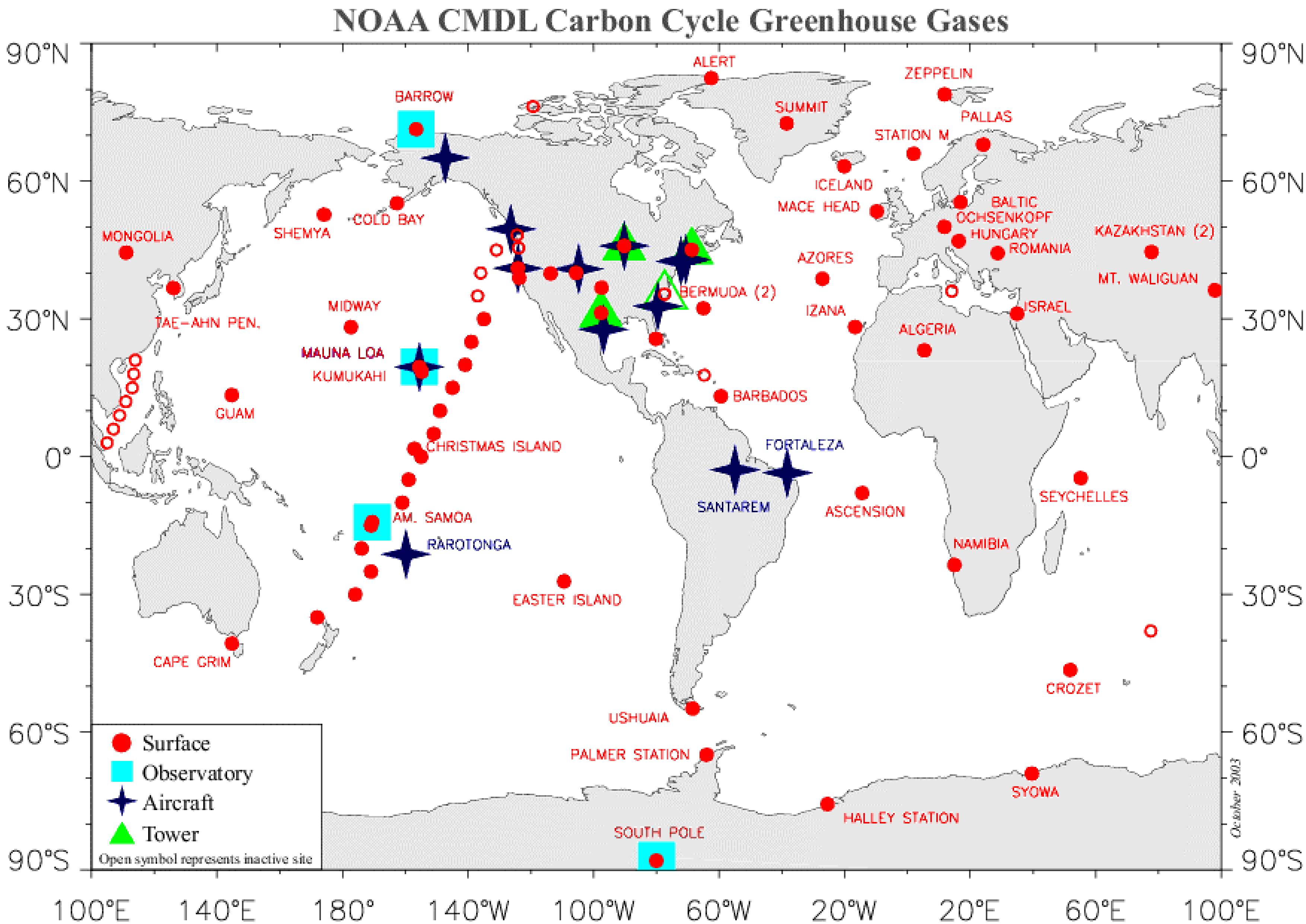
NOAA CMDL CCGG Cooperative Air Sampling Network

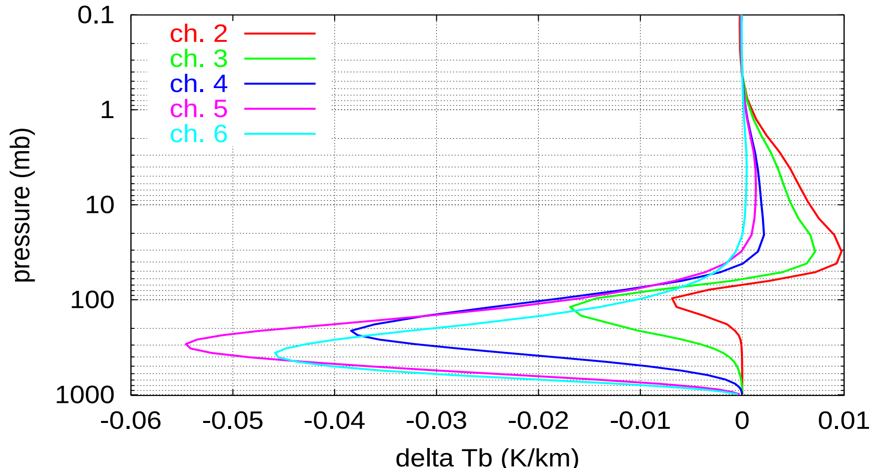


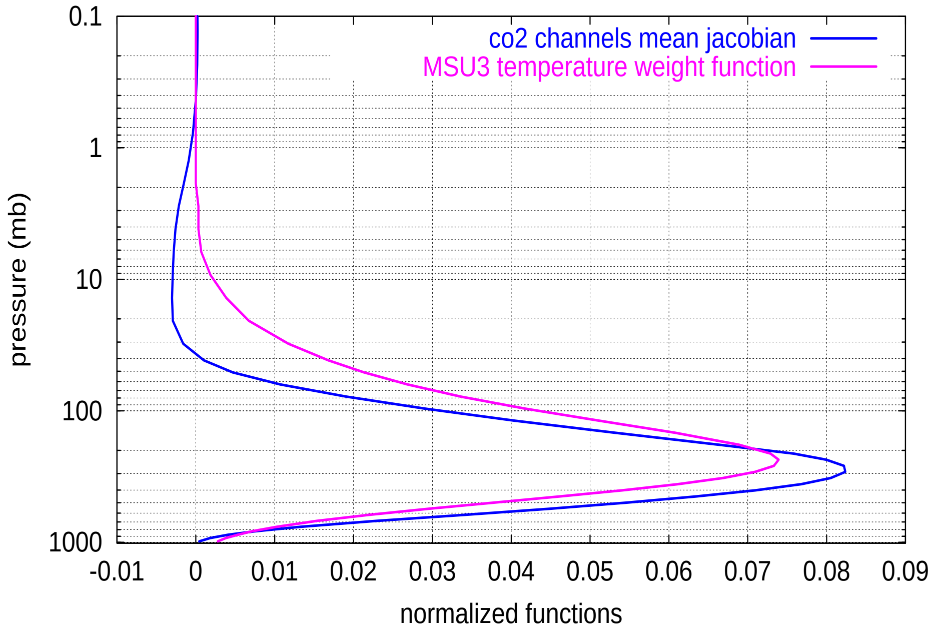
TOVS CO_2- channels selected

Radiative transfer model simulations from a tropical atmosphere data base

Channel	Wavelength, µm	CO_2: +3%
2	14.7	+ 0.13 ± 0.02
3	14.5	+ 0.002 ± 0.02
4	14.2	- 0.27 ± 0.03
5	14.0	- 0.32 ± 0.02
6	13.7	- 0.32 ± 0.02

Mean co_2 jacobians $\partial T_B / \partial q_{CO2}$ – co_2 +3%



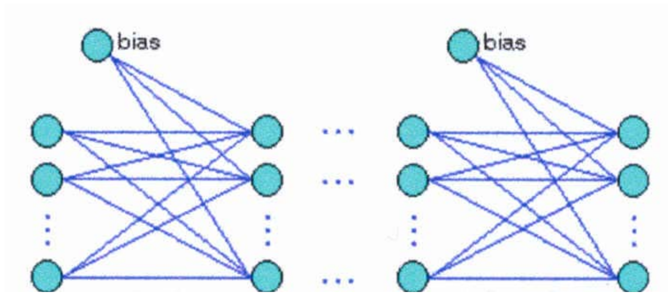


MSU3 temperature weight function and mean co_2 channels weight function cover ~ the same pressure range

Retrieval method of CO_2 from NOAA polar satellites

- A non-linear regression approach : Multilayer 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

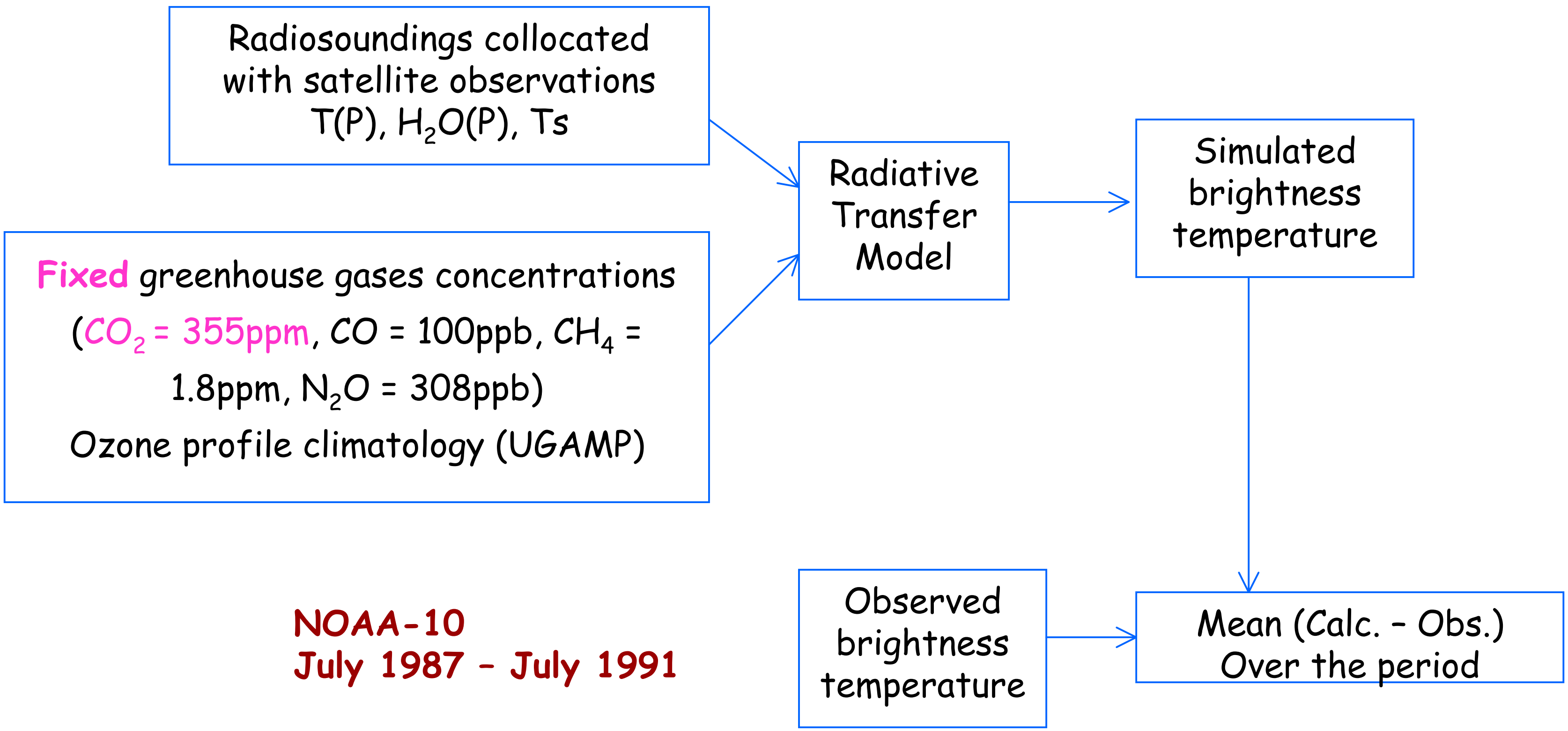
- MLP trained on the TIGR data set with variable q_{co2} drawn at random (341→369 ppm)

- 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



NOAA-10
July 1987 – July 1991

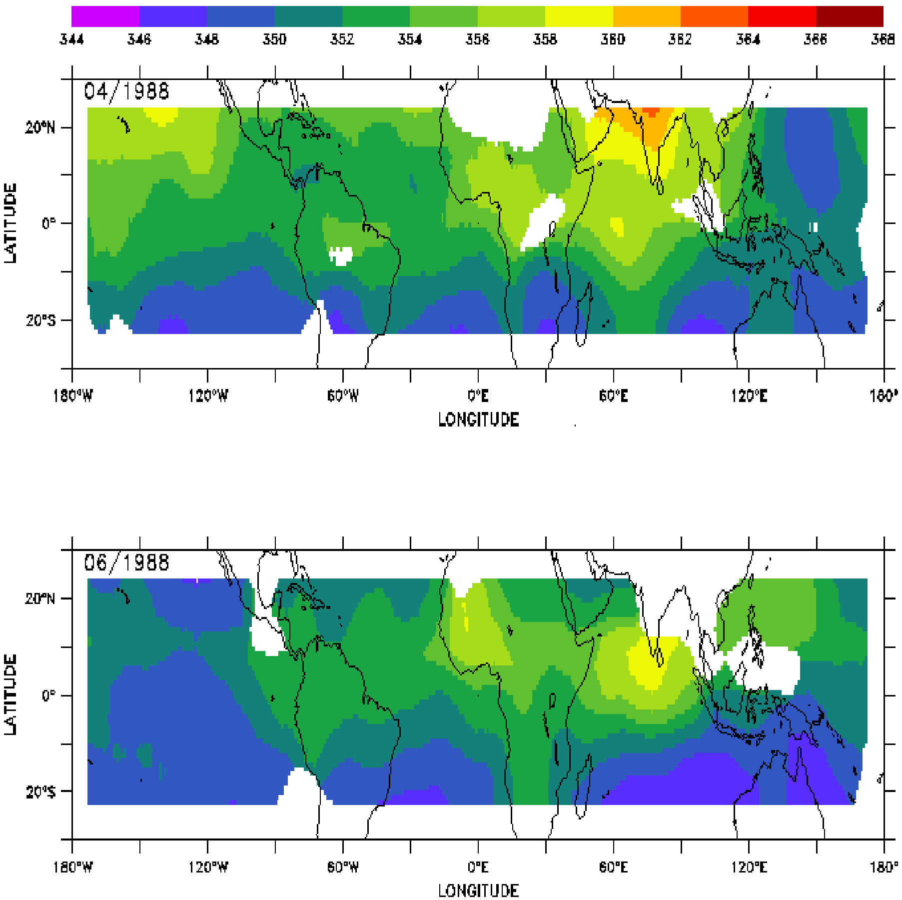
these biases allow connection between 'simulations world' and 'observations world'

T_Bs in NN inputs are $T_B$obs + Mean (calc. – Obs.)

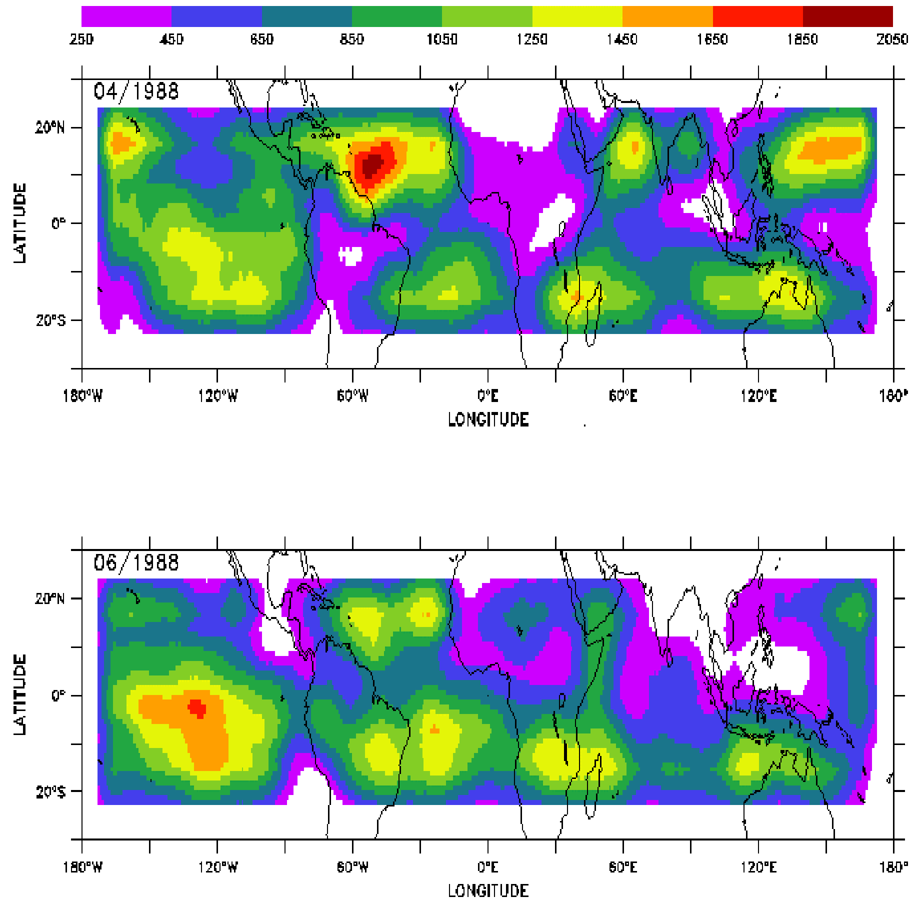
Global Maps of Mid-to-High tropospheric CO_2

Monthly - 15°X15° (1° moving average)

CO_2 (ppmv)



Number of items averaged



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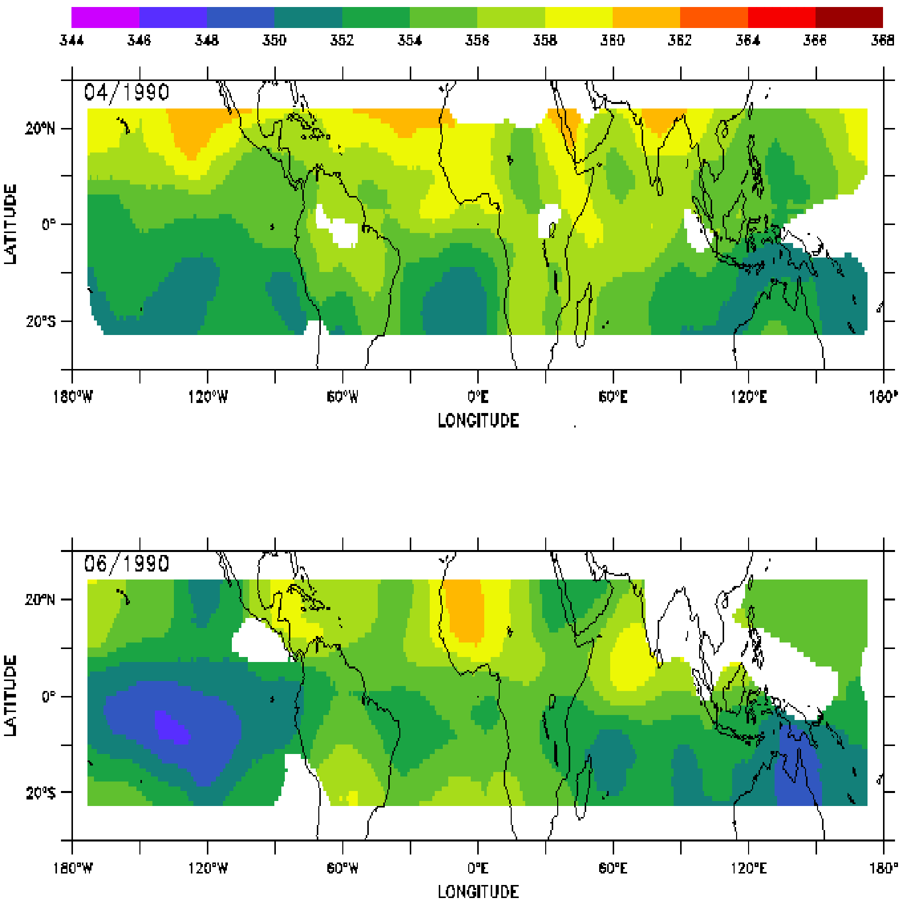

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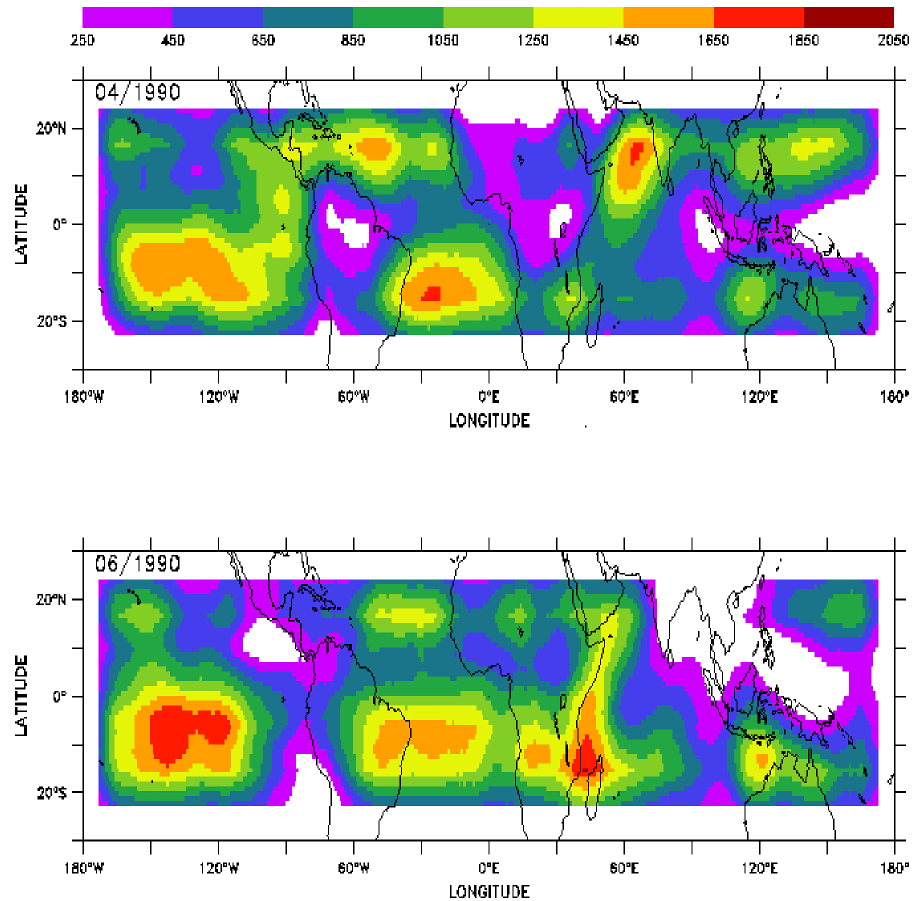
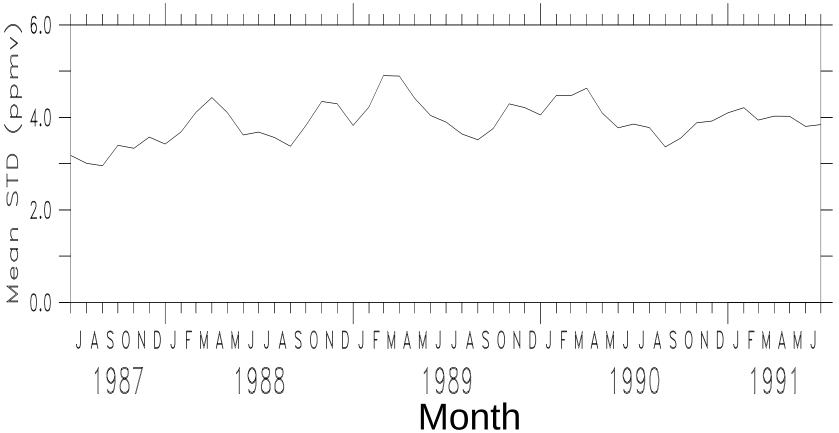


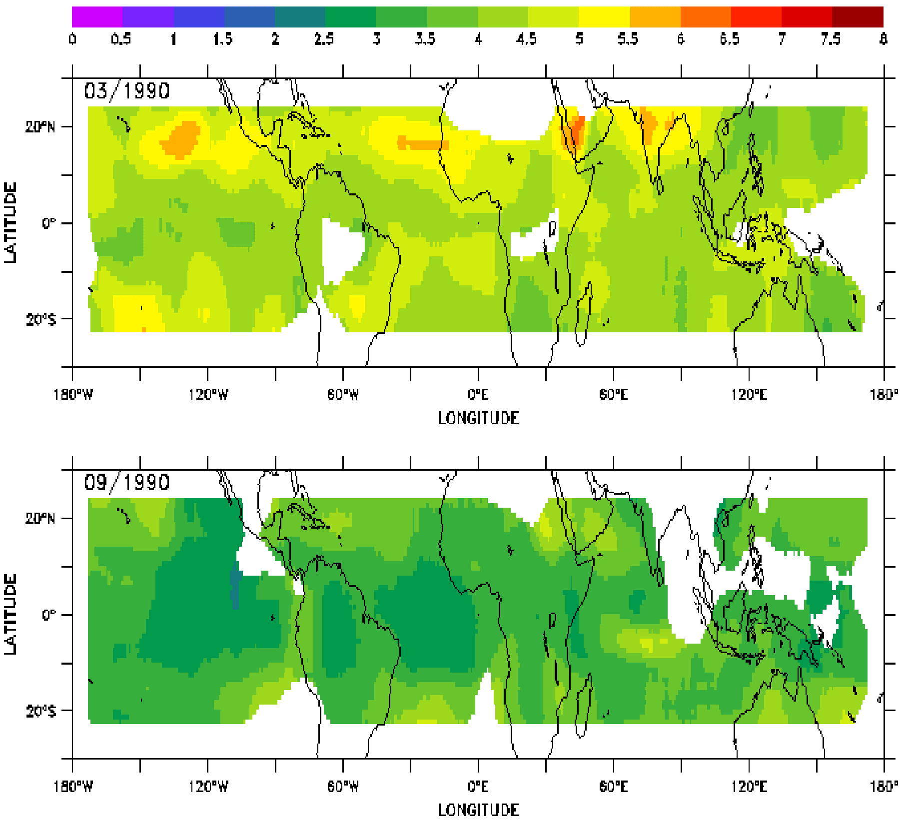
Dispersion of CO_2 retrievals

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

Standard deviation seasonal variability



Stdv in ppmv



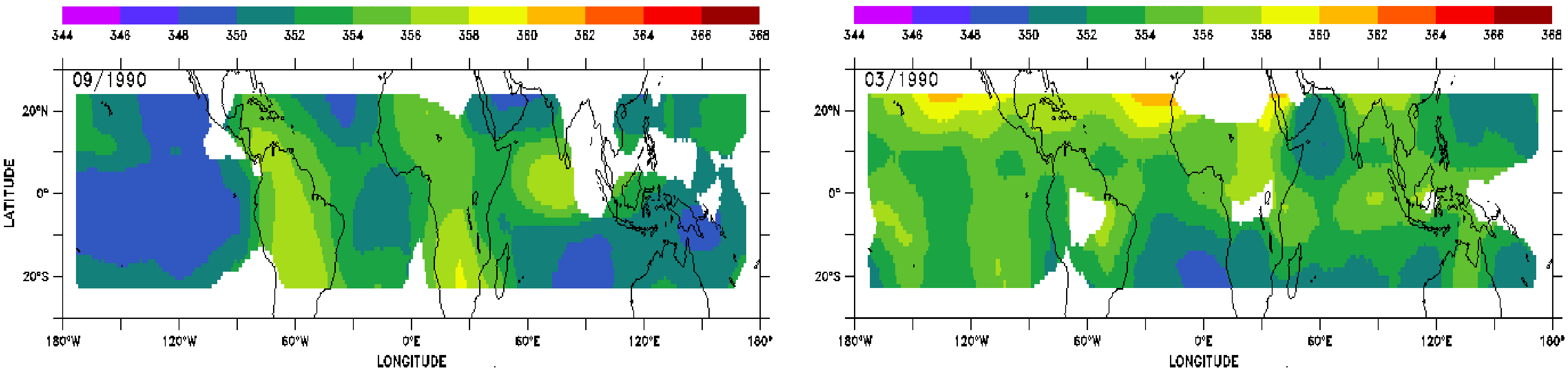
Minima in summer maxima in spring

Stdv of the method (Std_M) ~ 3 ppm

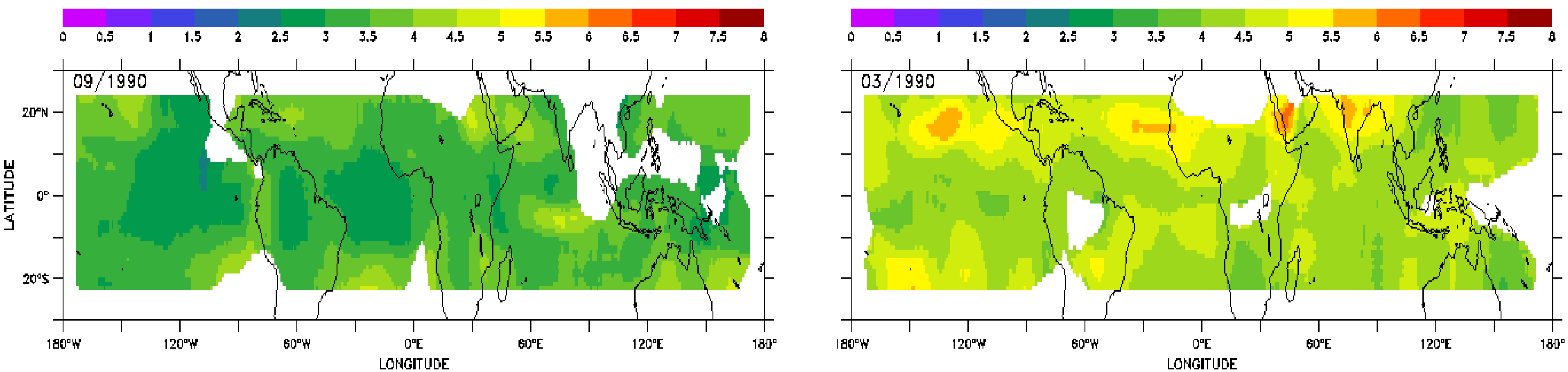
Is the natural variability the only cause of the difference?

Dispersion of CO_2 retrievals

CO_2 in ppmv



Stdv in ppmv

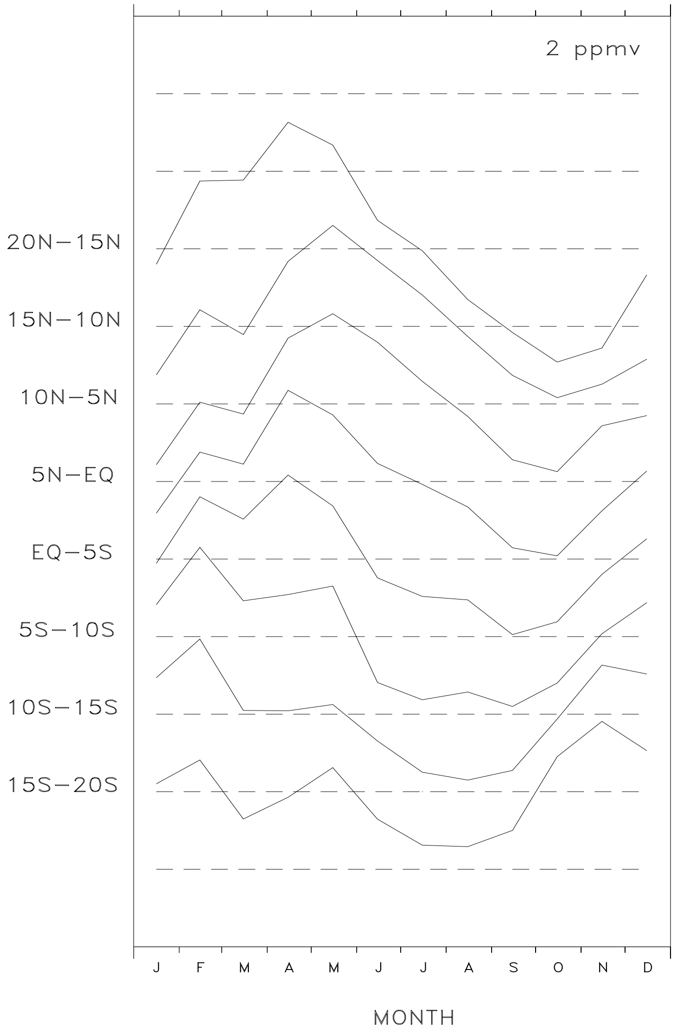


higher Stdv often localised in regions of CO_2 strong gradients

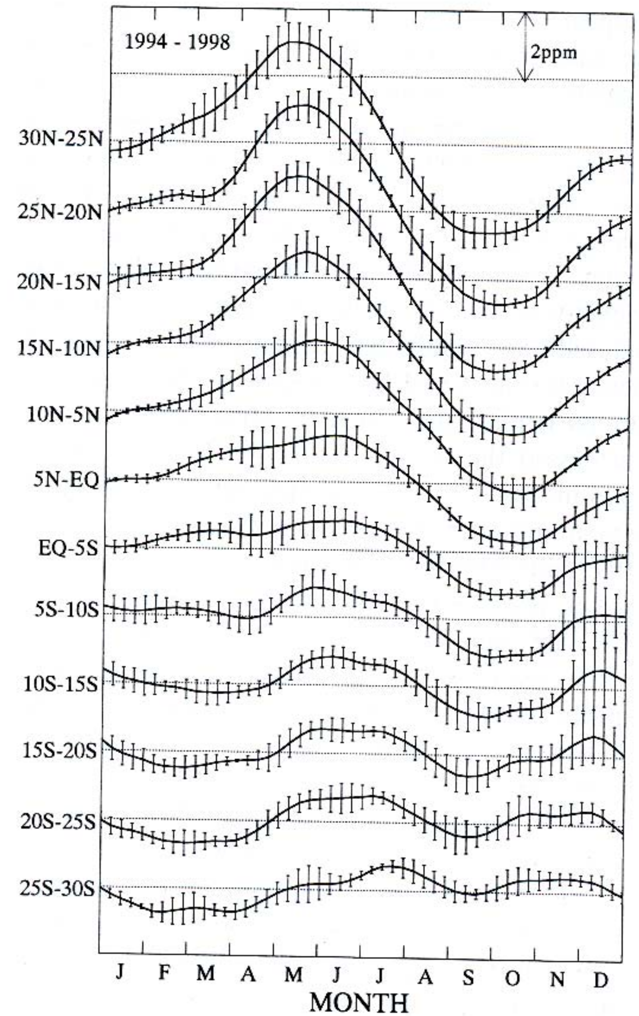
causes other than natural variability have been considered
(tropospheric ozone variation, aerosols)

Mean Seasonal Cycles

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



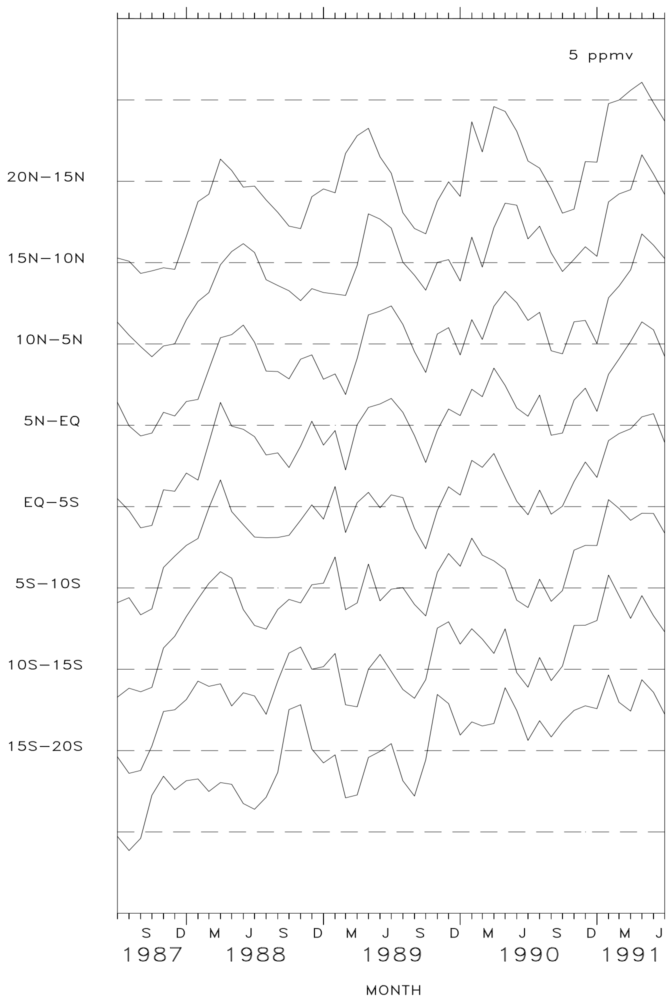
As measured in situ (8-13 km; 1993-1999)

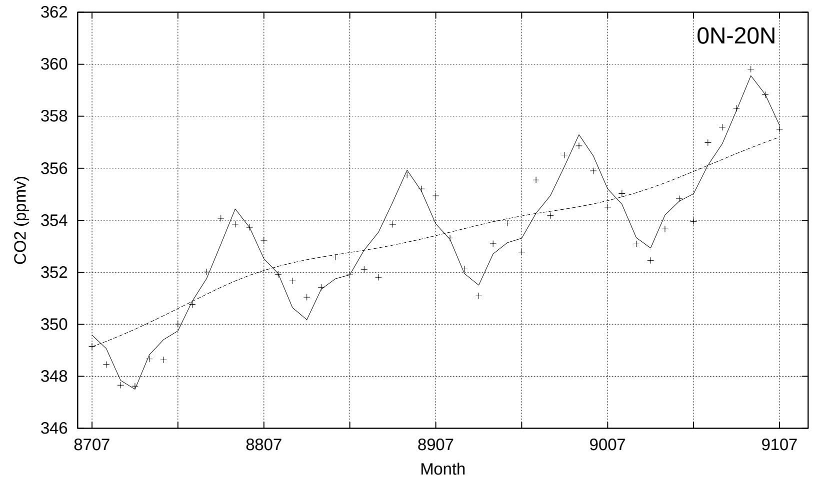


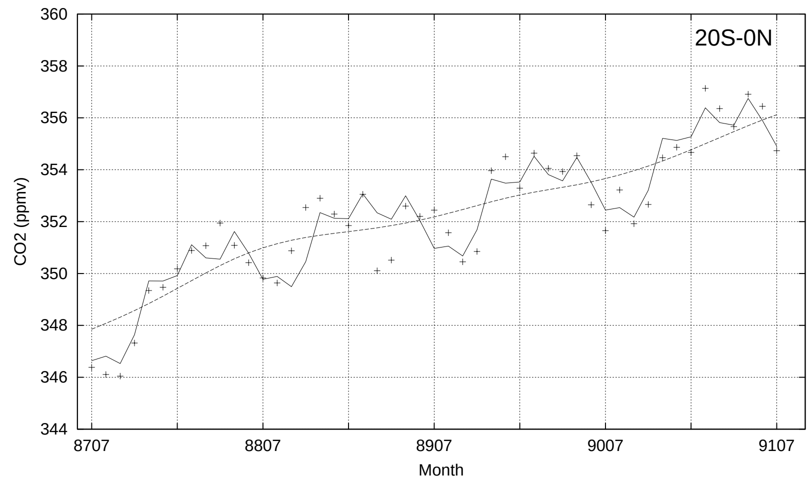
Commercial aircrafts (Matsueda et al., 2002)

Time variations of the CO_2 concentration as seen by NOAA-10

CO_2 retrievals - 5° zonal means

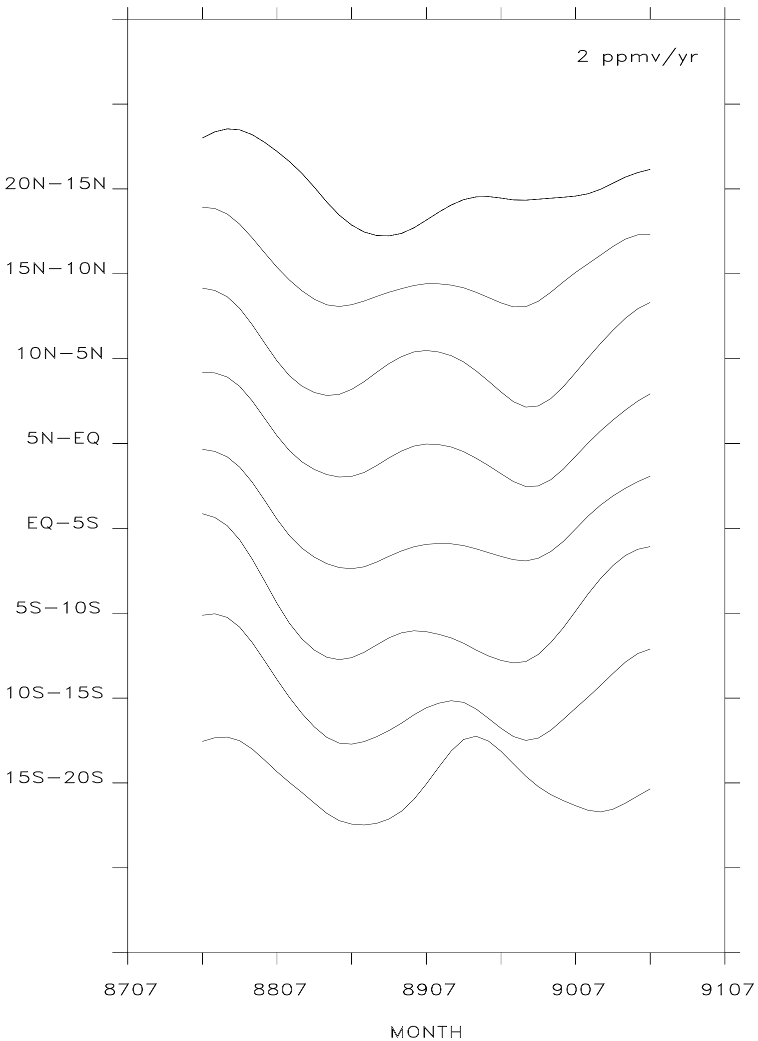






Solid line : sum of the long term trend and four harmonics

CO_2 Growth Rate as seen by NOAA-10 (1987-1991)



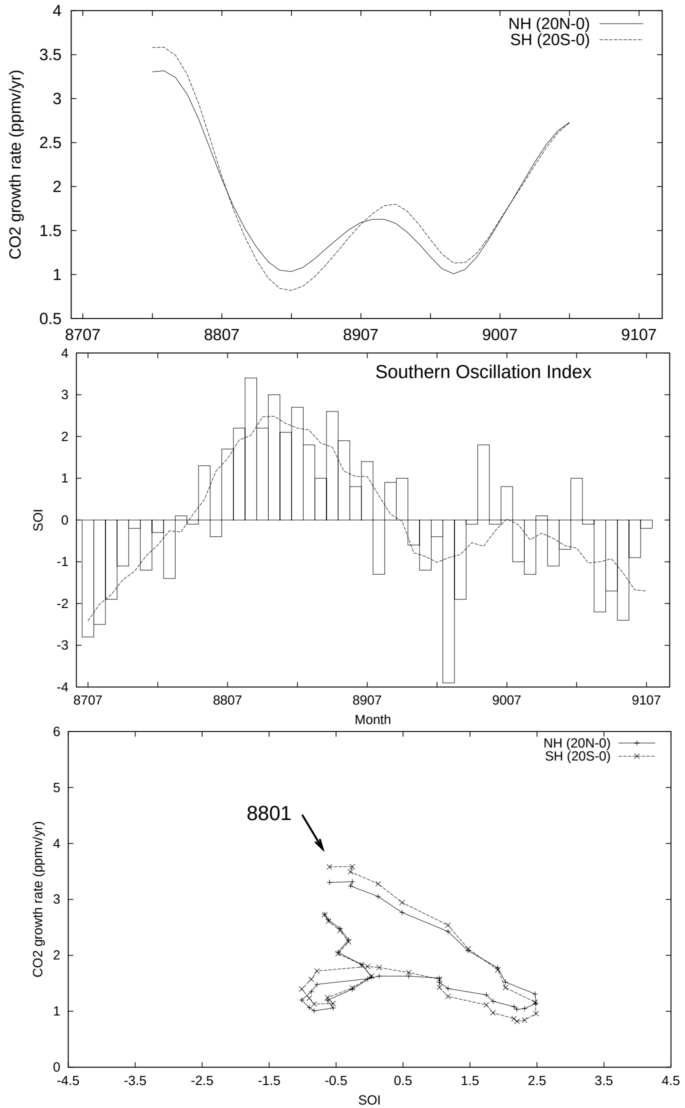
Mean Northern hemisphere 1.76 ppm/yr

Mean Southern hemisphere 1.80 ppm/yr

Values consistent with the one observed at the surface = 1.75ppm/yr (Conway et al., 1994)

CO_2 and ENSO

As seen by NOAA-10 (Chédin et al., 2003) (1987-1991)



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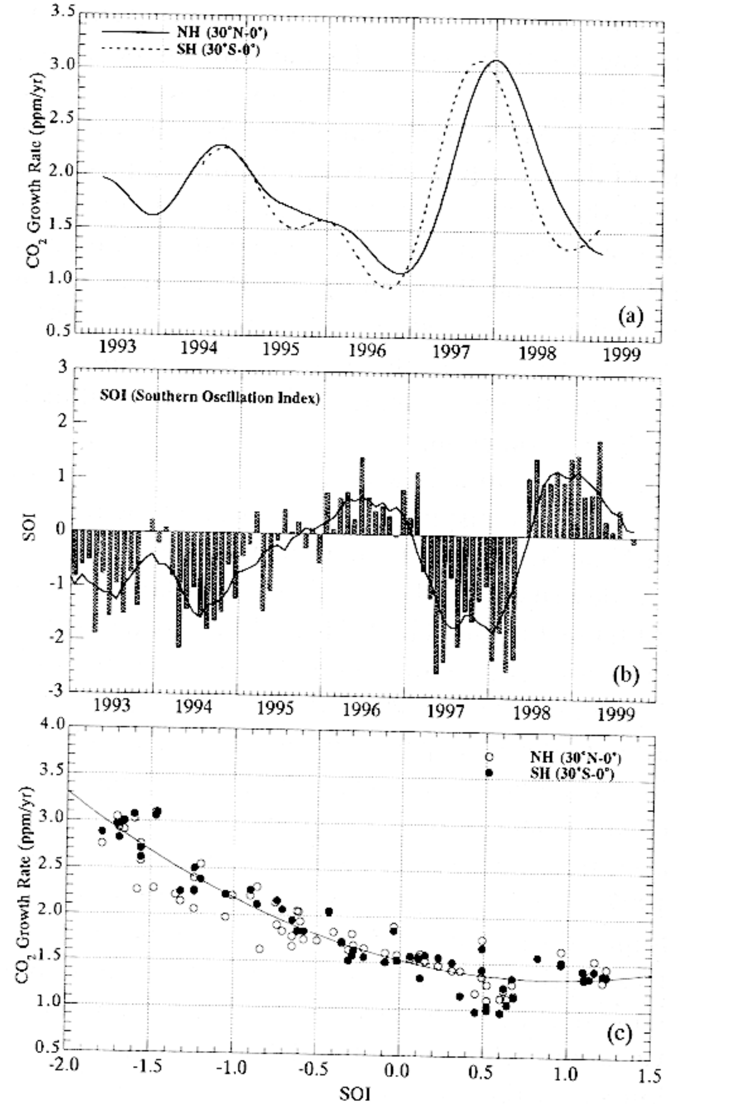

Growth rate (GR) time evolution

SOI time variation

Correlation SOI/GR

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 (monthly, seasonaly and yearly) :

- Mean rate of rise of CO_2 of 1.78 ppm/yr over NOAA-10 period
- Seasonal cycle and impact of ENSO in agreement with Matsueda findings from in situ observations

And now ?

Analyze 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)