Trend analysis of tropical stratospheric NO_2 columns

Maud Pastel[1], Florence Goutail[1], Jean-Pierre Pommereau[1], Andrea Pazmiño[1]

In collaboration with **Gerhard Held[2]**

[1]Service d'Aéronomie, Institut Pierre Simon Laplace (IPSL), Verrières-le-Buisson, France

[2]Instituto de Pesquisas Meteorológicas, Universidade Estadual Paulista, Bauru, Brazil

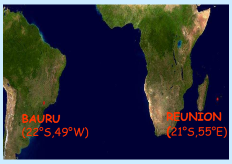
UV-VISIBLE SAOZ

Zenith sky visible spectrometer.
Differential Optical Absorption Spectroscopy
O_3: 451-550 nm
NO_2: 410-530 nm

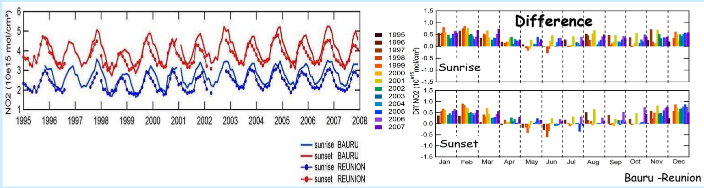
Sunrise and sunset measurements
Consistency between stations: 3%
(NDSC Intercomparisons)

SAOZ at Saint Denis, Reunion Island (21°S, 55°E)

SAOZ locations



NO_2 column in Bauru and Reunion



Amplitude of seasonal cycle:
Bauru 3.4±1*10e15 mol/cm²
Reunion 3.0±1*10e15 mol/cm²

Larger total column in Bauru during Convective season: Contribution lightning NOx in UT.

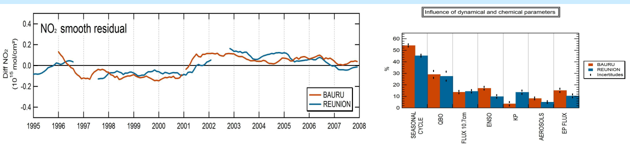
Saoz not sensitive to PBL

Multiple linear regression analysis

Proxies used in this analysis: QBO, ENSO, Solar flux, Kp, vertical composante of EP flux. After 1995 only because of Pinatubo

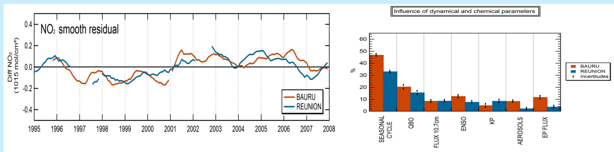
Comparison between SAOZ stations

Sunrise



Trends (10^{15} molecules*cm^{-2}/decade) ±std dev:
Bauru:0.13±0.03 => 4.8%±1.1%/dec
Reunion:0.09± 0.02 => 3.9±1%/dec

Sunset



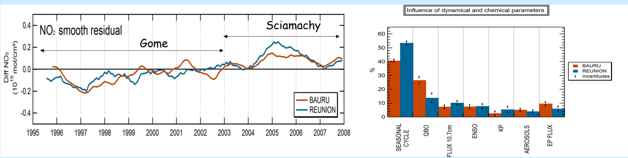
Trends (10^{15} molecules*cm^{-2}/decade) ±std dev:
Bauru:0.14±0.03 => 3.8% ±0.9%/dec
Reunion:0.05± 0.01 => 1.46%±0.8%/dec

Same evolution at both stations: jump in 2001 (~0.2*10^{15} mol*cm^{-2}/decade)

AO and QBO contributions larger in Bauru consistent with the UT contribution.

Comparison Satellites at Sunrise above the two stations

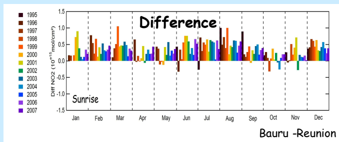
Satellites stratospheric column used: Gome V.4 (1995-2002) and Sciamachy IUPB V2.0 (2003-2008) normalized on Saoz, Gome:10h30 Loc. equator crossing (50° to 20°) ,SAOZ : 90° at sunrise, Sciamachy:10h Loc equator crossing (50° to 25°)



Trends (10^{15} molecules*cm^{-2}/decade) ±std dev:
Bauru:0.18±0.02 => 6.8%±1%/dec
Reunion:0.22±0.03 => 9.3%±1.3%/dec

Gradual increase at both stations ~8%, more important compare to Saoz.

Weak correction of the tropospheric part in Reunion
Maximun in winter (biomass burning and pollution from Sao Paulo)
Weaker column in Bauru during the convective season compare to Saoz



No jump in 2001 but gradual increase at both stations.

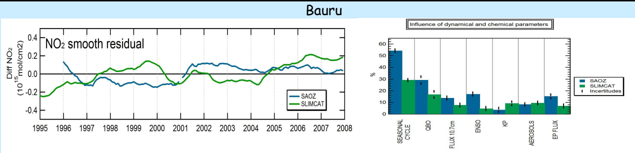
Larger column at Bauru compare to Reunion

Inappropriate correction of surface NO_2 ? (urban pollution, biomass burning, Satellites little sensitive to LNOx in UT)

Comparison Saoz and Slimcat at sunrise

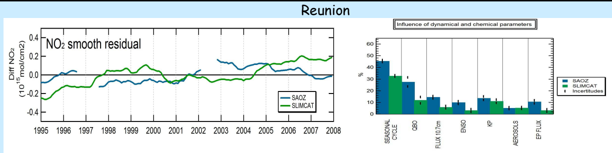
Slimcat model forced with ECMWF ERA 40 and operational analysis

Bauru



Trends (10^{15} molecules*cm^{-2}/decade) ±std dev:
Saoz :0.13± 0.03 => 4.8±1.1%/dec
Slimcat:0.17±0.02 => 6.2%±1%/dec

Reunion



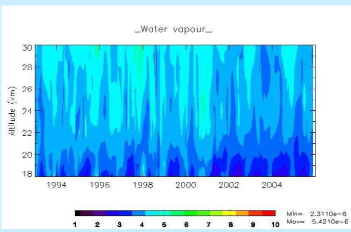
Trends (10^{15} molecules*cm^{-2}/decade) ±std dev:
Saoz :0.09± 0.02 => 3.9±1%/dec
Slimcat:0.20±0.02 => 7.2%±0.9%/dec

No jump in 2001 from Slimcat but gradual increase at both stations.

Underestimation of the Season and the QBO at both stations. Inappropriate transport model.

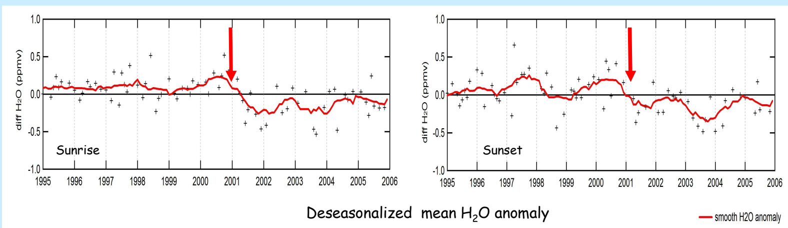
Possible links to NO_2 jump in 2001: Variation of H_2O from HALOE

Haloe data used at latitude 22°S from 1995 to 2005



Trend of H_2O :
from 1995 to 2000: 0.94% ± 0.62%/ 5years
from 2001 to 2005:-2.07% ± 1.05%/5 years

At 25 Km



Deseasonalized mean H_2O anomaly

•The oscillation due to QBO and El-niño effect
•Drop of ~0.2 ppmv after 2001

Jump in 2001 during sunrise and sunset

Anticorrelation with SAOZ NO_2 jump, consistent with the enhanced of tropical Brewer-Dobson upwelling as suggested by Randel et al., 2006

Summary:

- **Increase of NO_2 stratospheric column at both stations in 2001 consistent with H_2O drop (Randel et al.,2006)**
- **Correction for surface NO_2 in satellites inappropriate?**
- **Dynamics in SLIMCAT / ERA40 erroneous**

Acknowledgments: SAOZ is part of NDACC network, funded by CNRS, CNES,ADEME in France. The authors are grateful to the personnel of LACY and IPMET for running the instruments, to the HALOE science team for the hight-quality HALE data set. In this study data from the Ozone Monitoring Instrument (NIVR/KNMI, FMI, NASA) aboard the NASA EOS-Aura satellite has been explored. SCIAMACHY data search and extraction was carried out with a software tool, developed by K. Bramstedt (University of Bremen). Non-operational (scientific) data of SCIAMACHY stratospheric NO_2 column was provided by A. Richter (University of Bremen). We acknowledge The Ozone Processing Team of NASA for the Toms Data. The Toms data was obtained via the World Data Center for Remote Sensing of the Atmosphere (WDC/RSAT). We would like to thank Mr Wuhu Feng for providing us Slimcat data.