3.2 AN OVERVIEW OF MAP/GLOBUS NO_x

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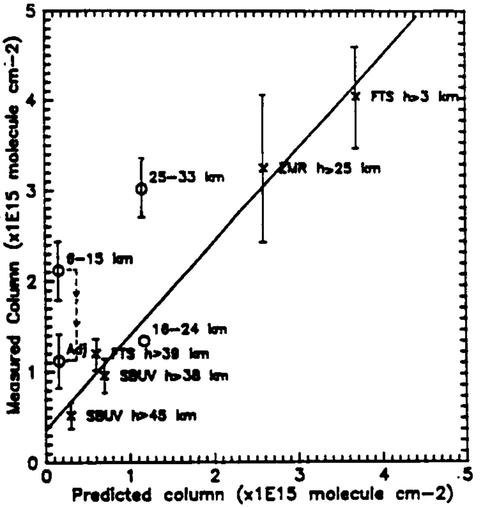
GLOBUS NO_x is a combined observation of nitrogen compounds by more than 20 experiments, from satellites, remote and in situ instruments on board balloons and ground observatories, within a short time period. Held in September 1985 above Southern France, the field campaign has been a technical success. Most of the observations have been achieved as anticipated. NO, NO_2 and relevant species and physical parameters involved in their photochemistry, were measured between 5 km and 40 km at several periods of the day. A first step of data interpretation which consists of instrumental intercomparisons, is now achieved. Several systematic biases between data of various origins which have appeared in the past, are now understood and reduced. A second step which deals with atmospheric photochemistry issues like diurnal cycles and budget, is now on its way. It will be the object of a close exchange between experimenters involved in the campaign and modelers.

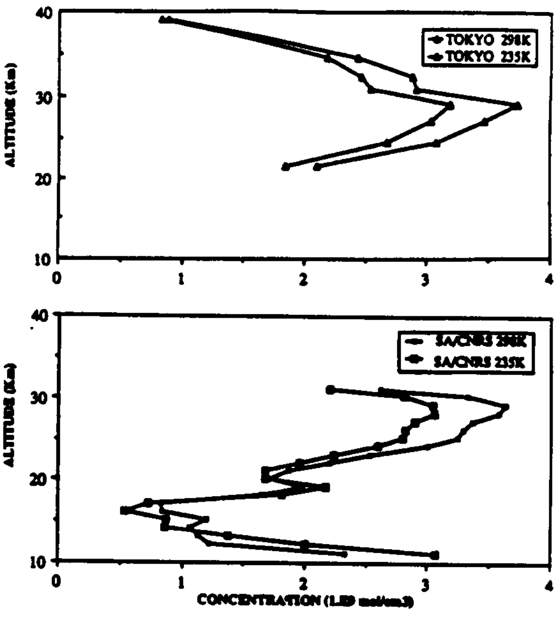
TABLE 1. Measurements Achieved During GLOBUS NO_x

	Balloon	Satellite	Ground	Total
NO_x	11	3	6	20
Other	11	3	5	19
Total	22	6	11	39



Comparison of NO Measurements
- Ground-based ZMR, FT spectrometer
- Balloon-borne IR interferometer
- SBUV
- In situ chemiluminescence.

Figure 1. Intercomparison of NO column measurements during MAP/GLOBUS 1985, R. L. McKenzie, W. A. Matthews, Y. Kondo, R. Zander, P. Demoulin, P. Fabian, D. G. Murcray, F. J. Murcray, O. Lado-Bordowsky, C. Camy-Peyret, H. K. Roscoe, J. A. Pyle, R. D. McPeters, submitted to *J. Atmos. Chem.*, 1988.



NO_2 Remote Sensing Comparison: Solar Visible Occultation from Balloon

- Three instruments on a common balloon gondola (Tokyo, IASB, CNRS)
- Method overestimates NO_2 concentration because of temperature dependence of the absorption cross sections of the gas. Correcting factor between 12% and 18% in the stratosphere
- Total uncertainty: 15% in the stratosphere, 30% in the troposphere

Figure 2. Balloon observations of nitrogen dioxide by visible occultation during GLOBUS NO_x, J. P. Pommereau, F. Goutail, N. Iwagami, K. Shibasaki, P. C. Simon, W. Peetermans, J. P. Naudet, P. Rigaud, D. Huguenin, submitted to *J. Atmos. Chem.*, 1988.

NO_2 Remote Sensing Comparison: SAGE 2 and Balloon Occultation

- Differences much smaller than Instruments Uncertainties
- Average systematic difference < 4%

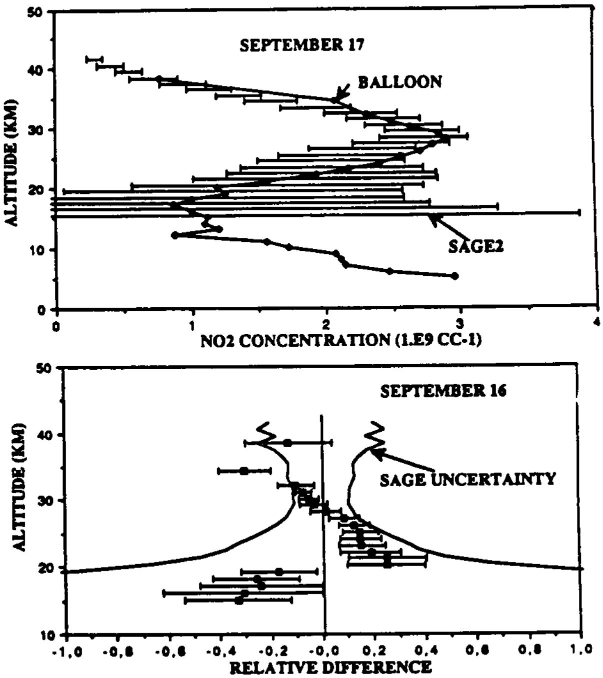
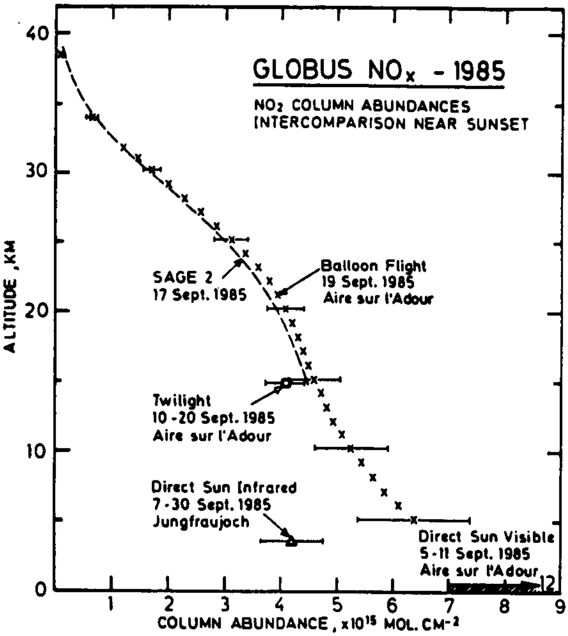


Figure 3. Nitrogen dioxide data comparison with infrared and visible balloon remote sensing measurements during GLOBUS NO_x, J. Lenoble, W. P. Chu, D. G. Murcray, O. Lado-Bordowski, C. Camy-Perret, A. Perring, J. P. Pommereau, F. Goutail, K. Shibasaki, N. Iwagami, and P. C. Simon, submitted to Quad. Ozone Symp., 1988.



Comparison of Ground-Based, Balloon and Satellite NO_2 Measurements

- Data generally consistent when local NO_2 contamination inside the boundary layer absent
- Further simultaneous direct sun IR and visible observations needed

Figure 4. Measurements of column abundances of nitrogen dioxide, NO_2, from the ground during the GLOBUS NO_x campaign, R. Zander, P. Demoulin, G. Roland, W. A. Matthews, P. V. Johnston, J. P. Pommereau, N. Iwagami, K. Shibasaki, submitted to Quad Ozone Symp., 1988.

Ozone Measurements 30-55 km

- Microwave at Bordeaux Observatory
- Umkehr at Haute-Provence Observatory
- Satellite EXOS-C BUVa

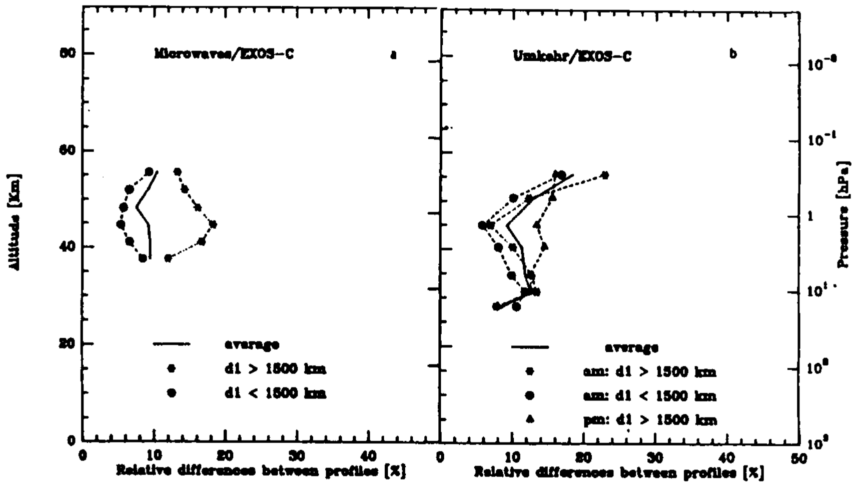


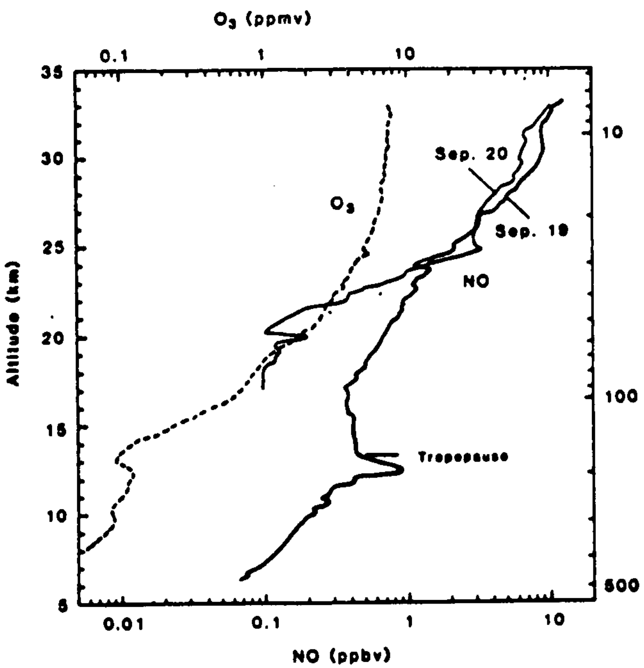
Figure 5. Comparison of stratospheric and mesospheric ozone profiles obtained by ground-based and satellite observations, J. de La Noe, M. Koike, T. Ogawa, P. Marché, submitted to Quad Ozone Symp., 1988.

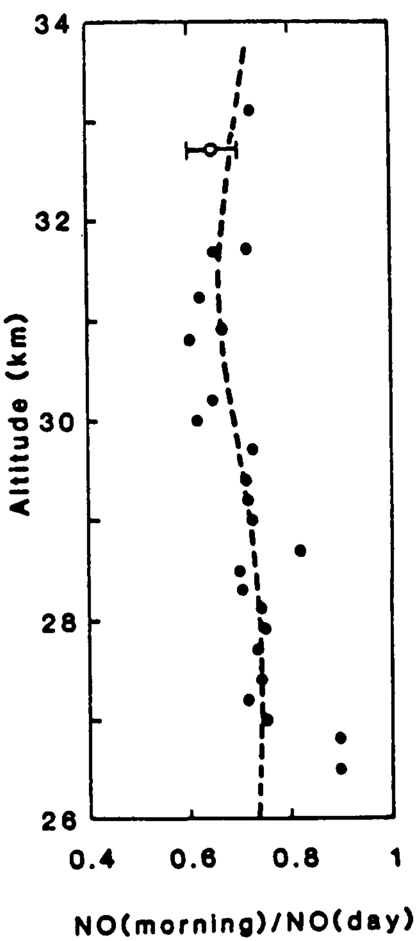
Ozone Instruments Total Accuracy

-In situ UV Photometer: 3% Total Uncertainty
-Remote Visible Occultation: 5-10%
-SAGE II: 10%
-In situ Gas Phase Chemiluminescence: 10%
-Umkehr: Layers 4 and 5, 10%; Layer 6, 15%
-SBUV: 10% Average, Peak Systematically Lower
-EXOS-C BUV: 10-15%
-Brewer-Mast Sondes: 5-10% between 18 and 25 km, 15-20% above
-Solar UV Occultation: Systematic Underestimation by 30-35%

Figure 6. Measurements of stratospheric ozone during the MAP/GLOBUS NO_x campaign, D. Robbins, P. Aimedieu, J. Pelon, J. P.Pommereau, F. Goutail, N.Iwagami, K. Shibasaki, T. Ogawa, M. Koike, P.Marché, J. P. Naudet, P. Rigaud, D. Huguenin, J. Lenoble, G. Maddrea Jr., submitted to *J. Geophys. Res.*, 1988.

NO Vertical Profiles by In situ Chemiluminescence

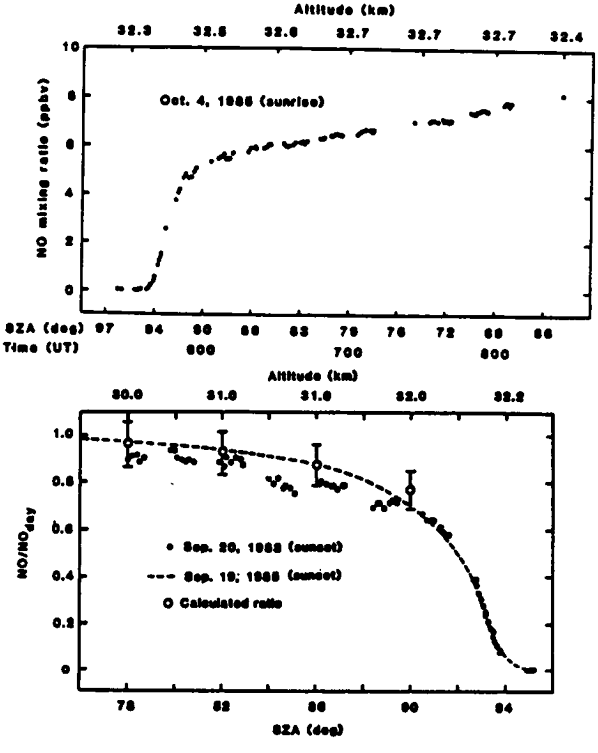




-University of Nagoya, Pel NZ
-MPAE, FRG
-Reasonable agreement above 23 km
-Ratio between measurements at noon and on following morning compatible with N_2O_5 photochemistry
-Difference below 23 km?

Figure 7. Nitric oxide profiles measured in situ during the GLOBUS 85 campaign, W. A. Matthews, Y. Kondo, P. Fabian, and B. C. Kruger, submitted to *J. Atmos. Chem.*, 1988.

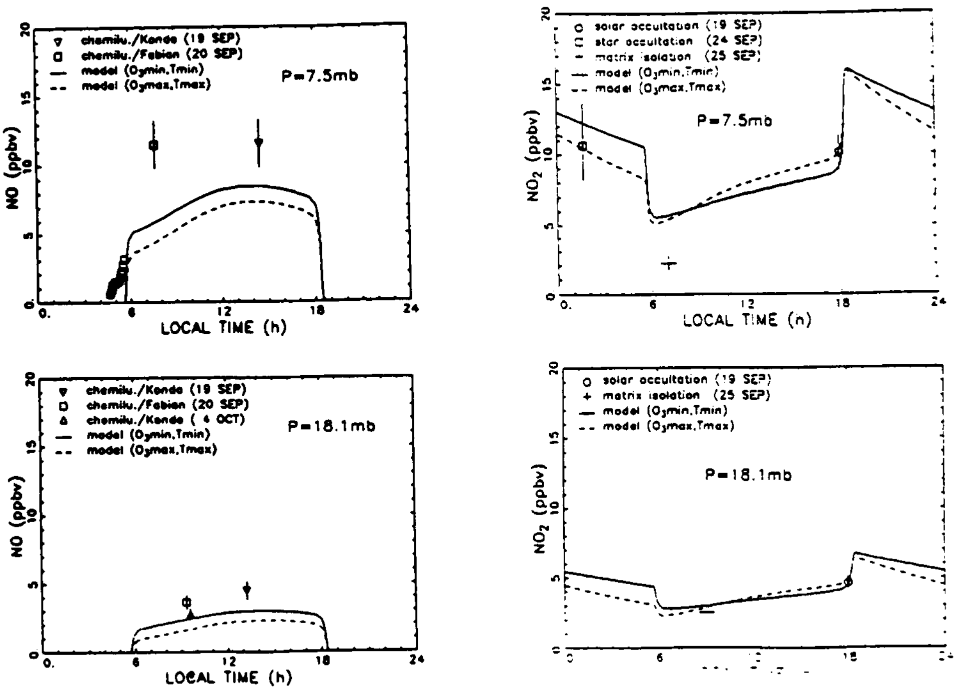
NO Diurnal Variation



-Variation observed in situ from sunrise until sunset around 32 km with two balloon flights
-From rate of increase of NO during morning: $[N_2O_5]$ at the end of the night = 3.9 ± 1.5 ppbv
-NO decrease at the end of afternoon at SZA > 80°, requires decrease of J_{NO_2}

Figure 8. Diurnal variation of nitric oxide at 32 km: measurements and interpretation, Y. Kondo, W. A. Matthews, P. Aimedieu, D. E. Robbins, *J. Geophys. Res.*, in press, 1988.

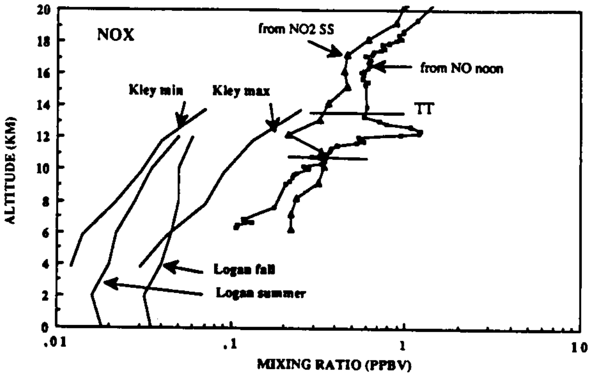
NO/NO_2 Diurnal Variation. Model Comparisons



-Agreement between NO_2 Predicted and Measured (Night, Morning, Evening)
-Much More NO than Predicted, Partitioning between NO and NO_2 differs from that
Observed, Difference Increases at High Altitude
-NO decay in the Afternoon at SZA > 80°. J_{NO_2} Reduced by Multiple Scattering?

Figure 9. Diurnal variation of stratospheric NO and NO_2 from MAP/GLOBUS 1985, J. P. Naudet, M. Pirre, R. Ramaroson, P. Rigaud, P. Fabian, M. Helten, N. Iwagami, K. Shibasaki, T. Ogawa, Y. Kondo, W. A. Matthews, J. P. Pommereau, F. Goutain, P. C. Simon, W. Peetermans, submitted to Quad. Ozone Symp., 1988.

A NO_x Source in the Upper Troposphere?



-NO_x Observed Larger than Predicted by Factor 3 to 10
-Models Include Mean Transport from Stratosphere
-Local Transport from 20 km at Least, Would Have Left Signature on Potential Temperature and Ozone
-Transport from Surface Level Would Require Much More than NO_x Lifetime [Kley et al., 1981]

Conclusion: Source present in Upper Troposphere

Figure 10. Observed and predicted NO_x below 20 km [Logan et al., 1981; Kley et al., 1981]. A NO_x source in the upper troposphere?, J. P. Pommereau, F. Goutail, Y. Kondo, W. A. Matthews, M. Helten, submitted to Quad. Ozone Symp., 1988.

CONCLUSIONS

Experimental

- Better evaluation of NO, NO_2, O_3 experimental uncertainties
- Instruments improvements: Result of previous campaigns
- Systematic errors found and reduced
- Consistency of all NO data after correction of chemiluminescence data?
- Further comparison between IR and visible ground-based NO_2 instruments still required
- Interpretation of NO_x measurements by chemiluminescence and converter still to come

NO_x Photochemistry

- Excess of NO compared to NO_2 in the stratosphere. Significant? Mechanism?
- NO decrease in the afternoon after SZA 80°. J_{NO_2} decrease? Effect of multiple scattering?
- Source of NO_x in the upper troposphere. Aircraft emission? Lightning¿
- Interpretation will follow on. Data base (NO_x constituents, related species and atmospheric parameters) available for further studies