N89-29864

3. GLOBAL BUDGET OF STRATOSPHERIC TRACE CONSTITUENTS (GLOBUS)

3.1 MAP/GLOBUS 1983: A REVIEW

D. Offermann

Physics Department, University of Wuppertal
5600 Wuppertal 1, Federal Republic of Germany

MAP/GLOBUS 1983 was a project for the study of stratospheric trace gases and dynamics. A respective field campaign was performed in September/October 1983 in Western Europe. A large number of measurements were taken by instruments based on the ground, on airplane, balloons, and satellite. The structure of the campaign will be described, and a survey of the results will be given.

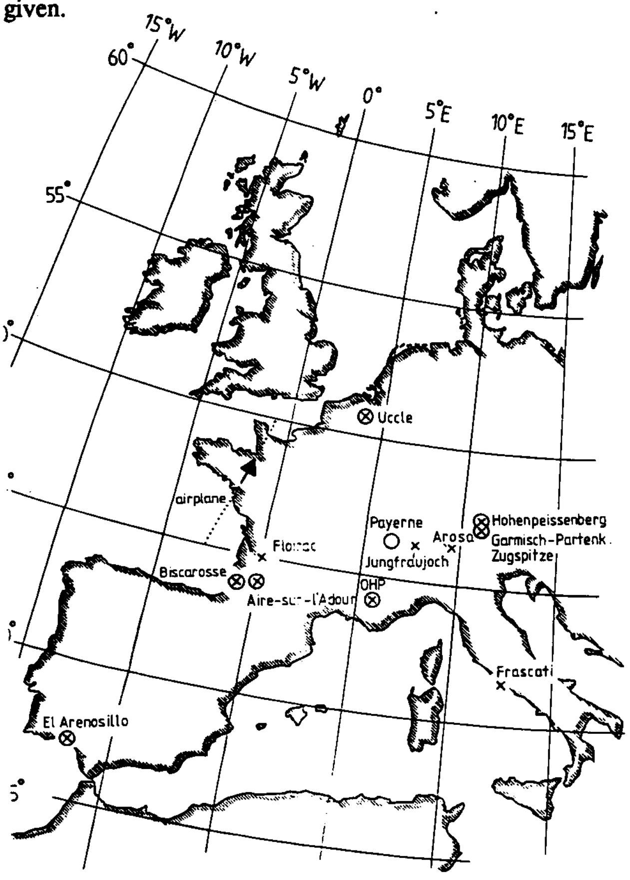


Figure 1. Stations involved in the MAP/GLOBUS 1983 campaign, September 1983: 13 large balloon payloads were launched from Aire-sur-l'Adour. Eleven ground-based experiments were operated almost continuously in Western Europe (crosses). One-hundred-thirty ozone sondes were released from the stations indicated by circles. Six meteorological rockets were launched from El Arenosillo. Dotted line is the trajectory of a research airplane. In total 35 scientific groups participated in the campaign.

Campaign Results

Objective	References
O_3: measurements and intercomparisons	Muller and Krueger, Planet. Space Sci. 35, 539, 1987
	De LaNoë et al., PSS 35, 547, 1987
	Aimedieu et al., PSS 35, 563, 1987
	Robbins, PSS 35, 587, 1987
	Simon et al., PSS 35, 595, 1987
	Matthews et al., PSS 35, 603, 1987
	Attmannspacher et al., BPT-Rep. 5/87 GSF, Munich, 1987
NO_x: measurements and intercomparisons	Fabian et al., PSS 35, 609, 1987
	Pommereau et al., PSS 35, 615, 1987
	Naudet et al., PSS 35, 631, 1987
Source and sink gases: measurements and intercomparisons	Schmidt et al., PSS 35, 647, 1987
	Borchers et al., PSS 35, 657, 1987
	Zander et al., PSS 35, 665, 1987
Ion measurements	Ingels et al., PSS 35, 685, 1987
	Schlager and Arnold, PSS 35, 693, 1987
Stratospheric dynamics	Langematz et al., PSS 35, 525, 1987
	Offermann et al., PSS 35, 673, 1987
Interpretation	Brasseur et al., PSS 35, 637, 1987
	Offermann, Ann. Geophys. 5 A, 187, 1987

Figure 2. Publications of campaign data and results, grouped by scientific objectives. Instrumental papers are not included.

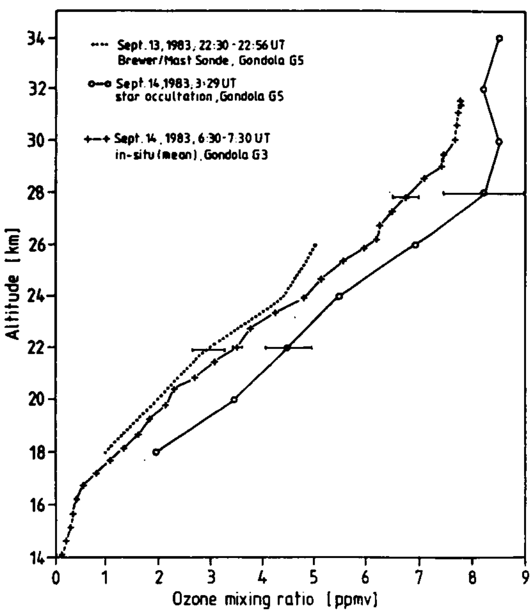


Figure 3. Example for ozone intercomparison. The crosses are weighted mean values of 7 simultaneous *in situ* measurements on one gondola [Aimedieu et al., 1987]. Accuracy is ± 3%. Circles denote a remote sensing experiment. Accuracy is ± 10% [Simon et al., 1987]. There is indication for a systematic difference between *in situ* and remote sensing results, the latter being higher by about 20%.

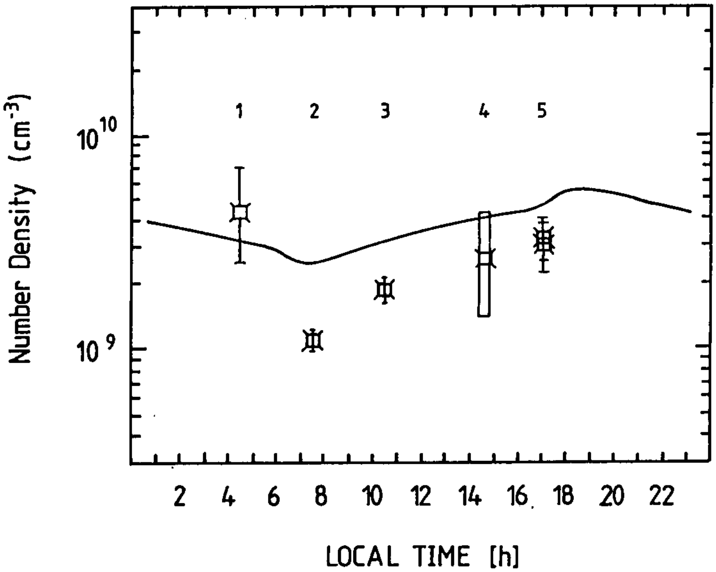


Figure 4. Diurnal variation of NO_2. Squares are data measured by the following techniques: 1) infrared emission; 2,3) matrix isolation; 4) SME; 5) visible absorption (two measurements). Solid line is from a 1-D model calculation by Wuebbles (extrapolated to 44°N). For details see Pommereau et al.[1987], Brasseur et al.[1987], Riese [1988].

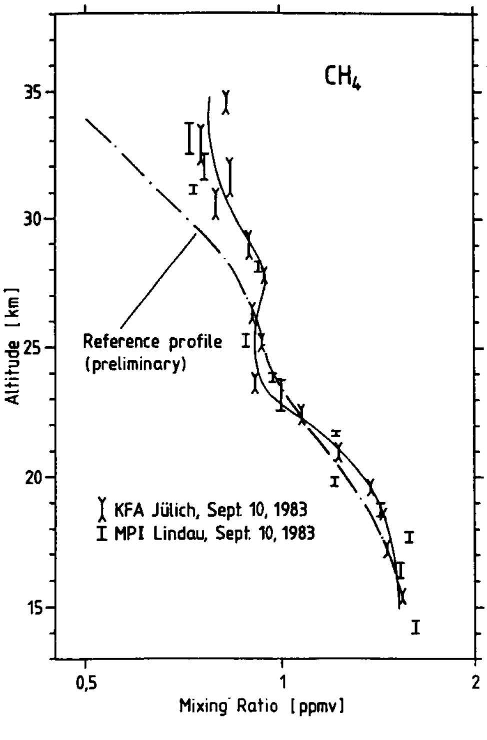


Figure 5. Cryo sampler intercomparison. Accuracy of data points is ± 5%. Measured data points show wave-like structures when compared to the reference profile. For details see Schmidt et al. [1987]; Offermann et al. [1987].

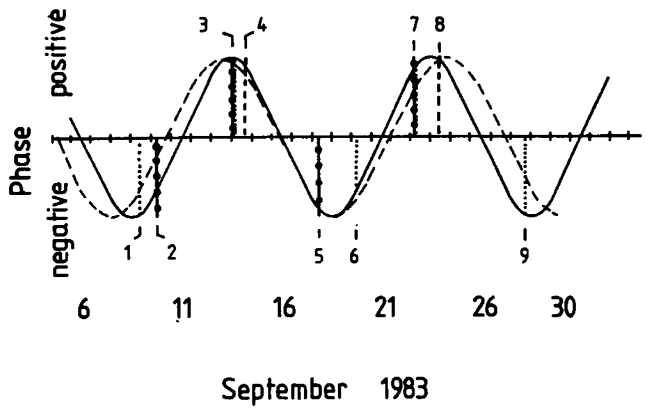


Figure 6. Wave action on trace gas mixing ratio results in positive or negative deviations (phases) from reference values. These are shown for various measurements: 1,6) matrix isolation; 2) cryo sampler; 3) star occultation; 4,8) UV photometer (*in situ*); 5) ion spectrometer; 7) infrared emission; 9) visible absorption spectrometers. Solid curve was adjusted to the data in a preliminary analysis. It has a period of 10 days [Offermann, 1987]. Dashed curve is from an independent wave analysis performed recently.

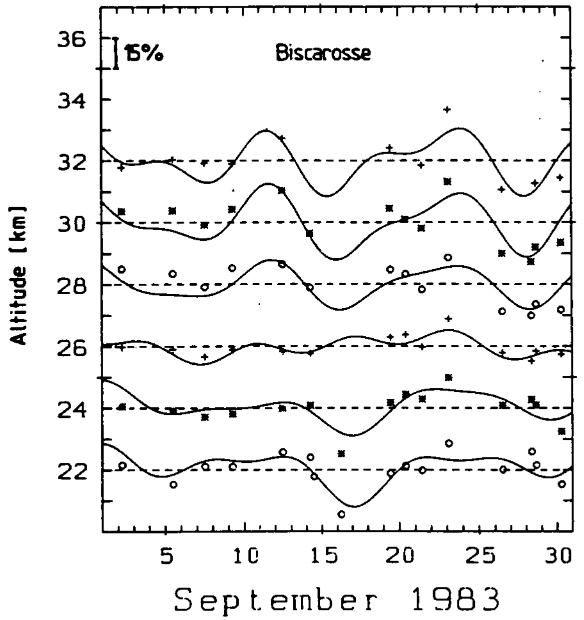


Figure 7. Relative variations of ozone densities during September 1983 as measured by ozone sondes above Biscarosse (symbols). Similar measurements were taken at six other stations (see Figure 1). Solid curves are the result of a least square fit using three superimposed harmonic functions. The three functions are required to have the same periods at all seven stations. Amplitudes and phases, however, are free fit parameters at all stations and altitudes (at altitude steps of 1 km).

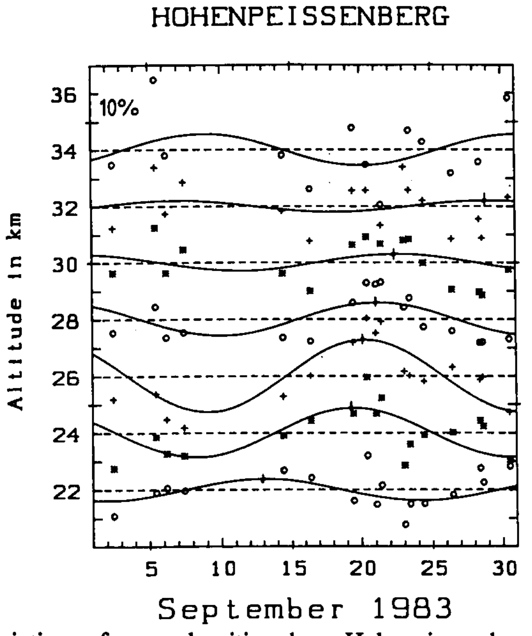
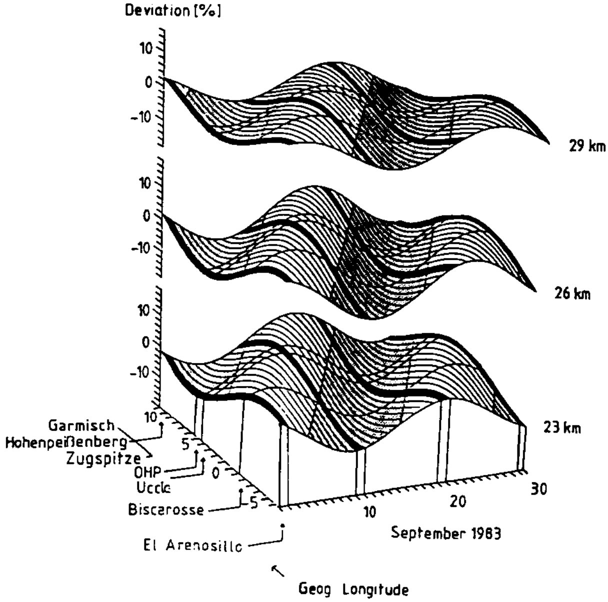


Figure 8. Relative variations of ozone densities above Hohenpiessenberg. Solid curves show one (#2) of the three harmonic fit functions. They indicate a vertical phase progression. Combination of these data with those of the six other stations yields the horizontal and vertical wavelengths for the harmonic function #2. Similar analyses can be performed for the other two fit functions.

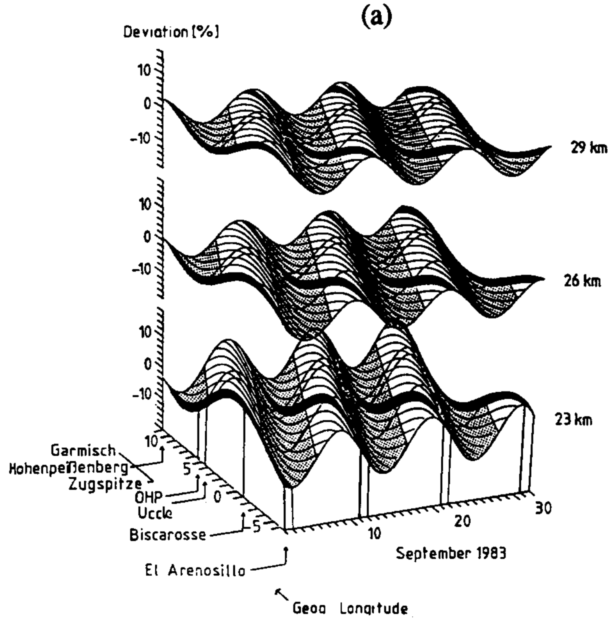
Results of the Harmonic Analysis

Parameter derived	*Fit Functions*		
	#1	*#2*	*#3*
Period	22.3 days	11.1 days	6.5 days
Horizontal wavelength	1630 km	1300 km	1630 km
Horizontal phase speed	0.85 m/s	1.4 m/s	2.9 m/s
Vertical wavelength	35 km	26 km	26 km
Vertical phase speed	1.8 cm/s	2.7 cm/s	-4.6 cm/s
Polarization angle		tbd	

Figure 9. The harmonic analysis allows determination of horizontal and vertical phase speeds. Horizontal wave propagation is almost entire from west to east. Vertical propagation is upward for waves #1 and #2, and downward for wave #3. Vertical wavelengths (and phase speeds) are estimates only, as the altitude range covered by the measurements is only a fraction of the wavelengths obtained.

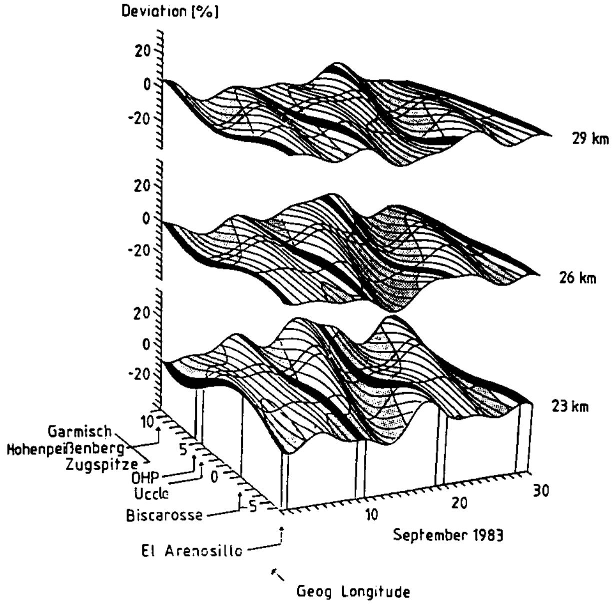


(a)

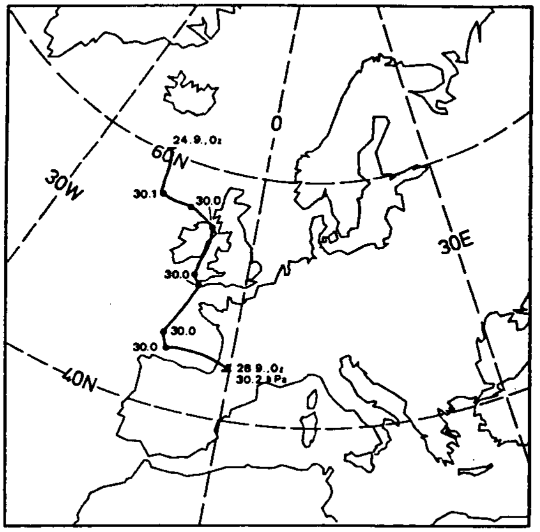


(b)

Figure 10. a-c Three-dimensional space/time plots of a) wave #1; b) wave #2; and c) superposition of waves #1, #2, and #3 from Figure 9. Three selected altitudes are given.



(c)
Figure 10 continued.



Trajectory on 600 K ending at Aire-sur-l'Adour on 28. September 1983, 00 UT and calculated backwards till 24. September 1983, 00 UT. Along the trajectory pressure is indicated.

Figure 11. Trajectory (4 days) of an air parcel arriving at Aire-sur-l'Adour on September 28, 1983. Altitude level is 600 K, i.e., about 30 hPa. (For details see Langematz et al., 1987). The last two days of the trajectory are used for the subsequent analysis in Figure 12.

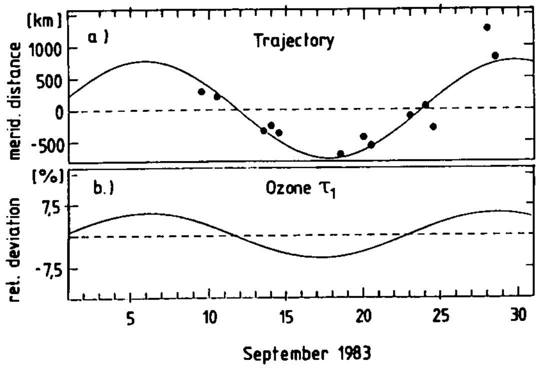


Figure 12. a) Meridional component of two-day-trajectories (30 hPa) versus time. b) Ozone wave #1 from Figures 9 and 10a for the altitude of 30 hPa at Aire-sur-l'Adour. The similarity of the two oscillations suggests that wave #1 observed in the ozone densities results mostly from horizontal transport.

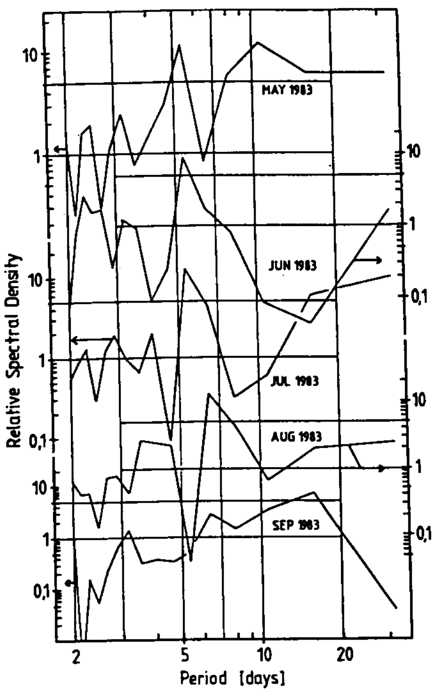


Figure 13. Spectral analysis (FFT) of upper mesosphere temperatures at 86 km. Temperatures were measured before and during the MAP/GLOBUS campaign by an OH^+ spectrometer at Wuppertal and Belfast. A strong mesospheric oscillation at 5.3 days is found during all of the summer, which shifts to 6.4 days in the beginning autumn. These measurements as well as their evaluation were made independently from the GLOBUS campaign.

Wave results

1. Waves consistently found in: a.) ozone densities (3D)

    b.) various trace constituents

    c.) trajectories

    d.) mesospheric temperatures

2. Compatible with planetary waves

3. Horizontal wavelengths extremely short

4. Wave *2: first harmonic of wave *1?

5. Strong influence on trace gas mixing ratios.

    => Polarization angle between horizontal and vertical motion (?)

Figure 14. Summary of results obtained for the stratospheric waves.