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# Intercomparison of ground-based microwave remote sensing measurements of stratospheric ozone over the Mendoza region, Argentina with HALOE data

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**Abstract**

The Tropospheric Water Vapour and Stratospheric Ozone (TROPWA) project has measured ground-based stratospheric ozone by means of millimetre wave radiometry tuned at 142 GHz from 1993 to 2000 in Mendoza, Argentina. Additionally, tropospheric water vapour was measured using a 92-GHz radiometer. This paper presents the theoretical error analysis used to characterize the ozone instrument, and a comparative study of the retrieved profiles with the coincident measurements taken with different instruments. To evaluate and validate the retrieved stratospheric ozone profiles, we have used a set of ozone profiles measured with the Halogen Occultation Experiment (HALOE); while the water vapour data was calibrated against a set of 3-year-radiosounding-balloon data taken by the Argentine National Weather Service. This study also includes a comparison of individual ozone profiles measured using a second ground-based millimetre wave radiometer–spectrometer tuned at 276 GHz from the Max-Planck-Institut für Aeronomie (MPAE), Germany. During this particular campaign carried out in November 1994, the ground-based measurements were contrasted with two space-born experiments: the Millimetre Wave Atmospheric Sounder (MAS), flown in the NASA-ATLAS 3 mission and the above-mentioned HALOE.

From the error analysis and the comparison tests, it follows that between 20 to 40 km the TROPWA instrument is able to retrieve ozone profiles with absolute errors varying from 10% to 20%, relative errors less than 5%, and with a height resolution, calculated as full width at half maximum (FWHM), varying from 5 to 11 km depending on the altitude. The major discrepancies between the different set of profiles are about +8% to −10% (+0.4 to −0.8 ppmv), mainly due to the coarser height resolution of our instrument.


*Keywords:* Atmosphere; Stratospheric ozone; Ground-based; Radiometry; Comparison; Validation

## 1. Introduction

The Institute for Environmental Studies (IEMA), University of Mendoza, performed ground-based measurements of tropospheric water vapour and stratospheric ozone by means of millimetre wave radiometry from 1993 to 2000, according to Table 1 and Fig. 1, from Benegas Station (850 m.a.s.l.), 5 km south of the city of Mendoza, Argentina. Additionally, five other measuring campaigns were performed in high locations, i.e., Uspallata (1950 m.a.s.l.), Puente del Inca (2700 m.a.s.l.) and Cristo Redentor (4200 m.a.s.l.)—near Puente del Inca—in the eastern slope of the Argentinean Andes and about 50 to 100 km northwest from the city of Mendoza.

Mendoza (33°S, 68°W, 750 m.a.s.l.) is located in the western semi-arid region of Argentina at the east side of the Andes Range. It has low rainfall of 120–400 mm/year, that is a mean of 230 mm/year which occurs especially during the summer months (November to March). The annual mean wind intensity is 2.6 m/s, with 19% of quiet days. The Andes Range, near the city of Mendoza, reaches an average height of 5000 m with peaks of up to 7000 m. Due to its closeness to the mountains, Zonda winds (from 5–6 to 12 m/s)—

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Table 1
Measurement periods and sites

| HALOE | | | | TROPWA | | |
|---|---|---|---|---|---|---|
| Profile # | Date | Lat | Long | Profile # | Date | Site |
| 1 | 30-oct-93 | −34.67 | −70.36 | 1 | 21-nov-93 | Puente del Inca |
| 2 | 20-nov-93 | −32.31 | −64.63 | 2 | 22-nov-93 | Puente del Inca |
| 3 | 21-nov-93 | −36.24 | −67.94 | 3 | 23-nov-93 | Puente del Inca |
| 4 | 23-mar-94 | −32.01 | −65.04 | 4 | 24-nov-93 | Puente del Inca |
| 5 | 12-apr-94 | −33.08 | −79.53 | 5 | 25-nov-93 | Puente del Inca |
| 6 | 14-may-94 | −41.00 | −68.40 | 6 | 26-nov-93 | Puente del Inca |
| 7 | 23-jun-94 | −35.08 | −72.31 | 7 | 15-dec-93 | Benegas |
| 8 | 14-jul-94 | −36.46 | −68.20 | 8 | 25-apr-94 | Benegas |
| 9 | 15-jul-94 | −33.62 | −71.05 | 9 | 1-jul-94 | Benegas |
| 10 | 16-jul-94 | −36.46 | −68.20 | 10 | 3-aug-94 | Benegas |
| 11 | 13-aug-94 | −38.68 | −59.05 | 11 | 4-aug-94 | Benegas |
| 12 | 28-sep-94 | −31.23 | −76.70 | 12 | 5-aug-94 | Benegas |
| 13 | 26-oct-94 | −32.78 | −75.86 | 13 | 8-nov-94 | Puente del Inca |
| 14 | 16-nov-94 | −34.13 | −68.74 | 14 | 9-nov-94 | Puente del Inca |
| 15 | 18-mar-95 | −33.93 | −66.82 | 15 | 10-nov-94 | Puente del Inca |
| 16 | 19-mar-95 | −29.30 | −68.29 | 16 | 11-nov-94 | Puente del Inca |
| 17 | 8-apr-95 | −35.01 | −60.71 | 17 | 10-apr-95 | Benegas |
| 18 | 7-may-95 | −35.18 | −65.93 | 18 | 12-jun-95 | Uspallata |
| 19 | 30-may-95 | −35.17 | −68.03 | 19 | 13-jun-95 | Uspallata |
| 20 | 31-may-95 | −30.77 | −66.69 | 20 | 14-jun-95 | Uspallata |
| 21 | 10-jul-95 | −34.60 | −75.89 | 21 | 15-jun-95 | Uspallata |
| 22 | 18-jul-95 | −32.31 | −70.92 | 22 | 16-jun-95 | Uspallata |
| 23 | 30-aug-95 | −34.11 | −71.41 | 23 | 22-sep-95 | Uspallata |
| 24 | 24-sep-95 | −32.94 | −61.77 | 24 | 26-sep-95 | Uspallata |
| 25 | 27-sep-95 | −33.24 | −60.39 | 25 | 18-oct-95 | Benegas |
| 26 | 22-oct-95 | −31.05 | −61.65 | 26 | 19-oct-95 | Benegas |
| 27 | 10-nov-95 | −27.61 | −70.59 | 27 | 20-oct-95 | Benegas |
| 28 | 11-nov-95 | −31.94 | −73.56 | 28 | 19-mar-96 | Benegas |
| 29 | 12-mar-96 | −35.73 | −66.94 | 29 | 11-jun-96 | Benegas |
| 30 | 13-mar-96 | −31.36 | −68.60 | 30 | 23-aug-96 | Benegas |
| 31 | 14-mar-96 | −26.46 | −70.22 | 31 | 1-oct-96 | Benegas |
| 32 | 2-apr-96 | −32.83 | −63.17 | 32 | 13-aug-97 | Benegas |
| 33 | 3-apr-96 | −37.11 | −63.47 | 33 | 15-sep-97 | Benegas |
| 34 | 30-apr-96 | −30.94 | −62.07 | 34 | 16-sep-97 | Benegas |
| 35 | 1-may-96 | −34.91 | −64.94 | 35 | 17-sep-97 | Benegas |
| 36 | 2-may-96 | −38.32 | −67.76 | 36 | 8-oct-97 | Benegas |
| 37 | 24-may-96 | −37.06 | −68.28 | 37 | 9-oct-97 | Benegas |
| 38 | 25-may-96 | −33.18 | −67.20 | 38 | 10-oct-97 | Benegas |
| 39 | 14-jun-96 | −38.02 | −77.66 | 39 | 5-may-98 | Benegas |
| 40 | 2-jul-96 | −40.24 | −68.13 | 40 | 7-may-98 | Benegas |
| 41 | 3-jul-96 | −38.11 | −70.73 | 41 | 8-may-98 | Benegas |
| 42 | 4-jul-96 | −35.63 | −73.46 | 42 | 11-may-98 | Benegas |
| 43 | 5-jul-96 | −32.78 | −76.32 | 43 | 12-may-98 | Benegas |
| 44 | 12-jul-96 | −29.56 | −68.33 | 44 | 29-jul-98 | Benegas |
| 45 | 13-jul-96 | −33.16 | −71.26 | 45 | 31-jul-98 | Benegas |
| 46 | 3-aug-96 | −38.83 | −66.58 | 46 | 3-aug-98 | Benegas |
| 47 | 4-aug-96 | −35.19 | −65.66 | 47 | 4-aug-98 | Benegas |
| 48 | 24-aug-96 | −32.32 | −67.38 | 48 | 5-aug-98 | Benegas |
| 49 | 25-aug-96 | −36.57 | −67.57 | 49 | 26-aug-98 | Benegas |
| 50 | 26-aug-96 | −40.17 | −67.86 | 50 | 28-aug-98 | Benegas |
| 51 | 19-sep-96 | −35.10 | −59.99 | 51 | 31-aug-98 | Benegas |
| 52 | 20-sep-96 | −40.43 | −77.24 | 52 | 10-sep-98 | Benegas |
| 53 | 5-nov-96 | −29.82 | −67.03 | 53 | 28-oct-98 | Benegas |
| 54 | 30-jun-97 | −34.04 | −65.85 | 54 | 29-oct-98 | Benegas |
| 55 | 1-jul-97 | −30.95 | −68.77 | 55 | 5-may-99 | Benegas |
| 56 | 14-sep-97 | −29.32 | −73.36 | 56 | 9-jun-99 | Benegas |
| 57 | 15-sep-97 | −37.38 | −75.09 | 57 | 7-jul-99 | Benegas |
| 58 | 16-sep-97 | −33.12 | −66.34 | 58 | 26-jul-99 | Benegas |
| 59 | 17-sep-97 | −25.45 | −68.36 | 59 | 28-mar-00 | Benegas |
| 60 | 13-oct-97 | −25.71 | −74.30 | 60 | 29-mar-00 | Benegas |
| 61 | 18-apr-98 | −34.41 | −60.91 | | | |