Koninklijk Meteorologisch Instituut

Institut Royal Météorologique

Königliches Meteorologisches Institut

Royal Meteorological Institute

50 years of balloon-borne ozone profile measurements at Uccle, Belgium

Hugo De Backer[1], R. Van Malderen[1], D. De Muer[1], D. Poyraz[1], W. Verstraeten[1], V. De Bock[1], A. Delcloo[1], A. Mangold[1], Q. Laffineur[1], M. Allaart[2], F. Fierens[3], V. Thouret[4].

[1] Royal Meteorological Institute, Belgium
[2] Koninklijk Nederlands Meteorologisch instituut, the Netherlands
[3] Belgian Interregional Environment Agency, Belgium
[4] Université de Toulouse, France

H. De Backer et al, Fifty years O_3 soundings at Uccle, Poster E_261, Quadrennial Ozone Symposium 2021, online, Seoul, South Korea, 3-9 October 2021

The site

- Uccle, a suburb south of Brussels, Belgium (50°48'N, 4°21'E; 100 m asl)
- Started January 1969 with Brewer-Mast (B/M) sensors
- Changed to Z-ECC sensors in 1997
- Different radio sounding systems
- Environmental changes

Several artefacts

↓

Need for homogenisation

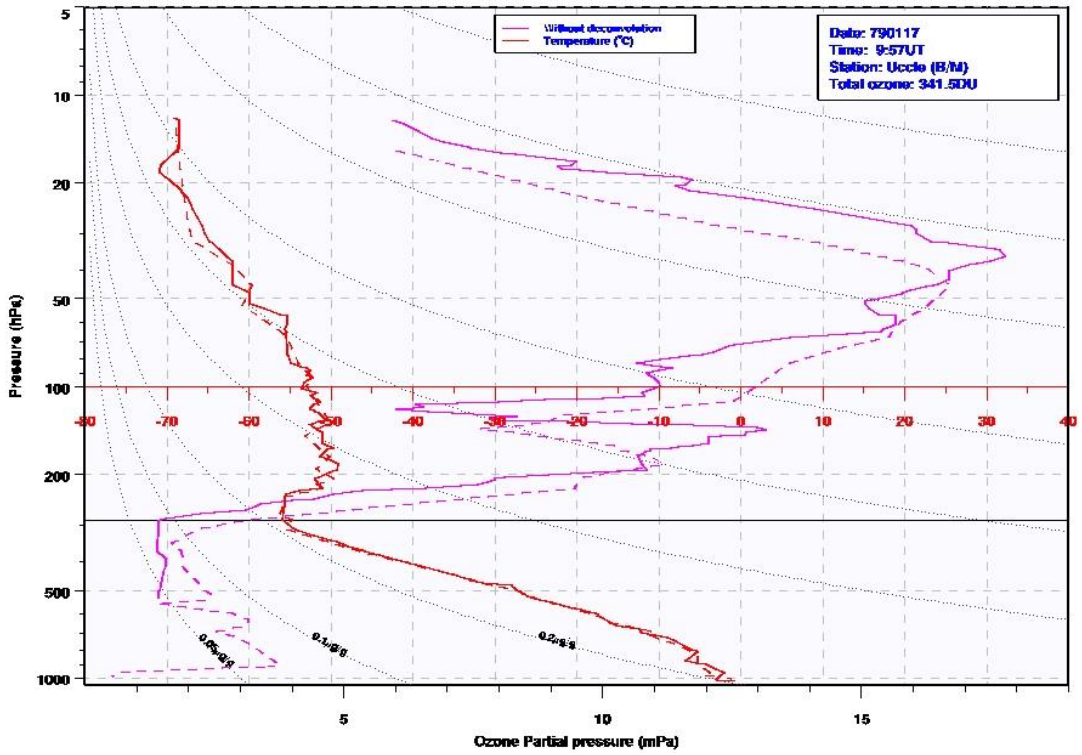
H. De Backer et al, Fifty years O_3 soundings at Uccle, Poster E_261, Quadrennial Ozone Symposium 2021, online, Seoul, South Korea, 3-9 October 2021

Instrumental effects: response time (B/M)

For ECC sensor response time see poster E_154 or Vömel et al. https://doi.org/10.5194/amt-13-5667-2020

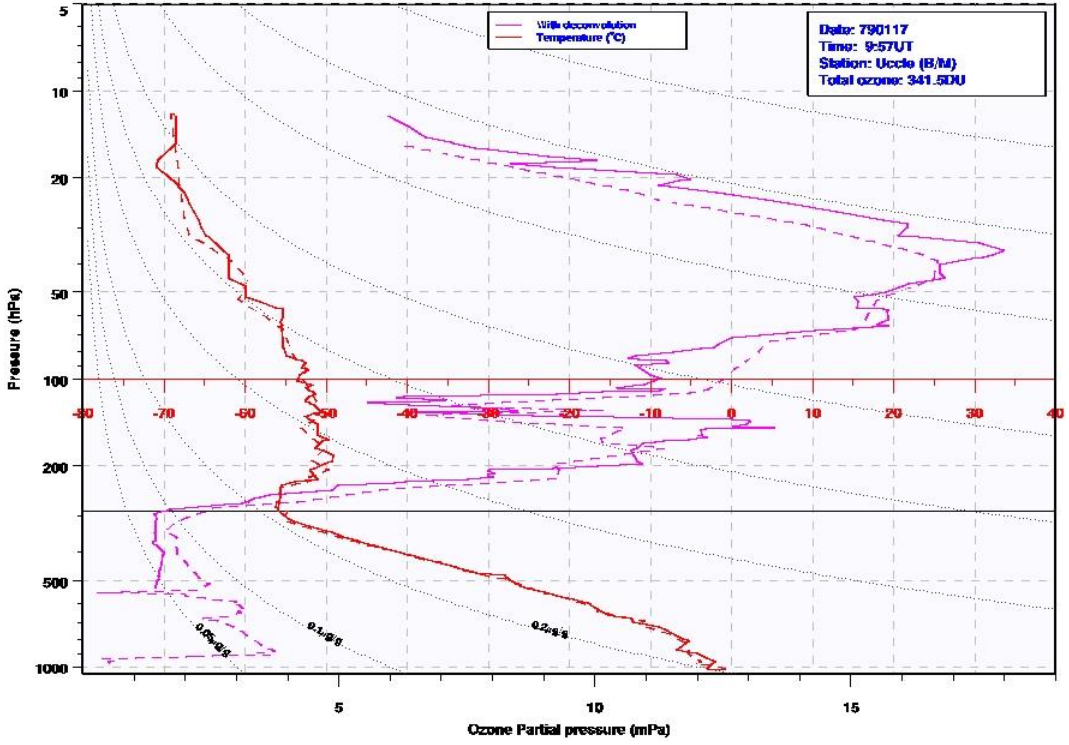
Without deconvolution:

Shift between ascent (full) and descent (dashed)



With deconvolution:

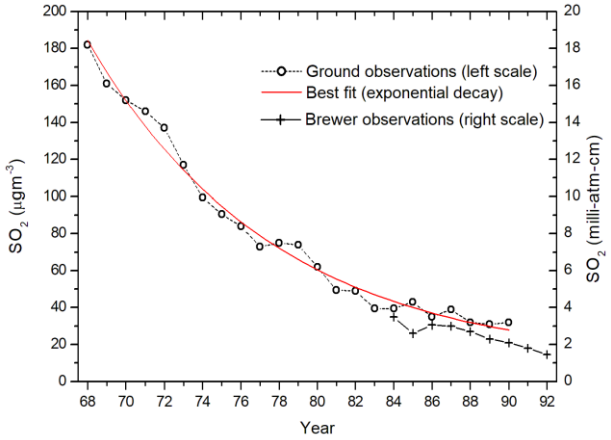
Better agreement between ascent and descent profile

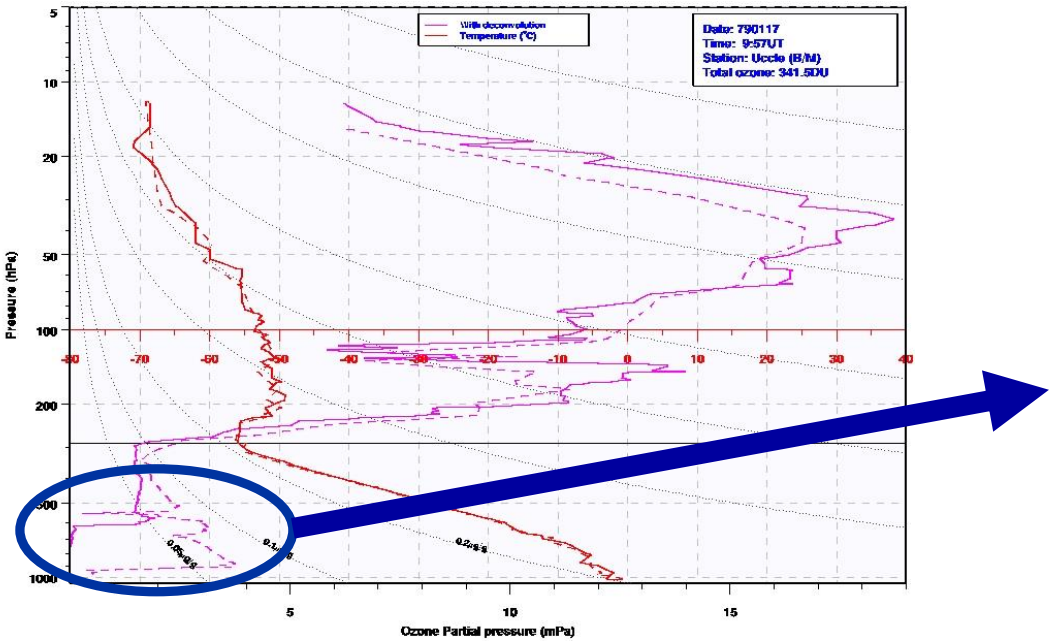


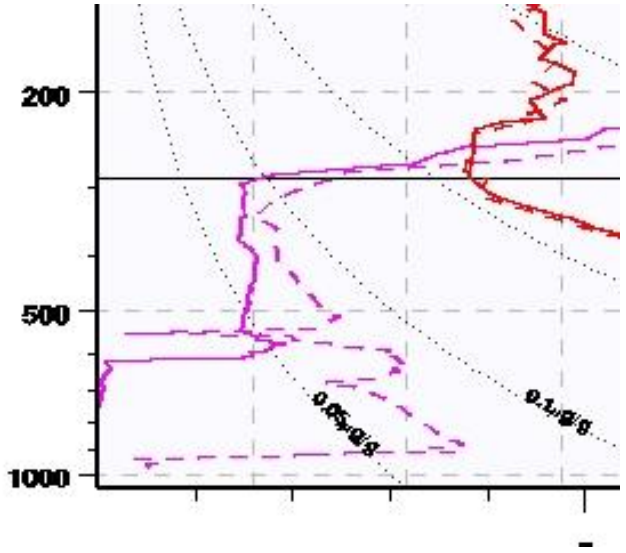
Instrumental effects: SO_2 interference

SO_2 causes an inverse reaction in the sensor

If signal is not zero -> correction possible with data from air quality network







H. De Backer et al, Fifty years O_3 soundings at Uccle, Poster E_261, Quadrennial Ozone Symposium 2021, online, Seoul, South Korea, 3-9 October 2021

Instrumental effects: sensor type

Brewer-Mast

1997

Z-ECC

- A change was made from the Brewer-Mast to the Z_ECC sensors.
- Documented by 26 dual sounding during a period of one year
- A pressure dependant correction method eliminated the large differences as function of altitude

H. De Backer et al, Fifty years O_3 soundings at Uccle, Poster E_261, Quadrennial Ozone Symposium 2021, online, Seoul, South Korea, 3-9 October 2021

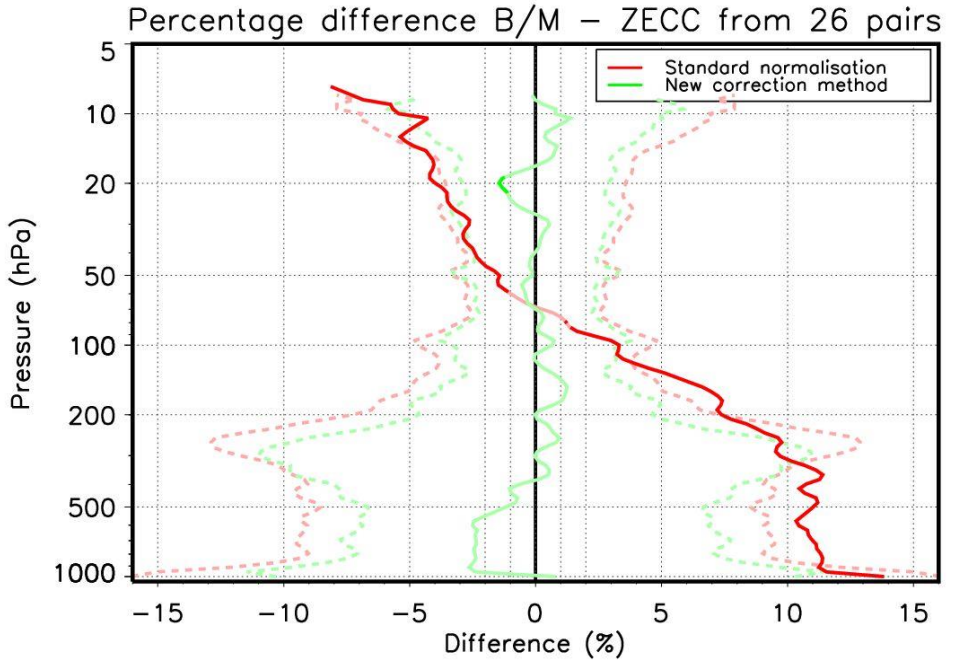
PRESTO correction

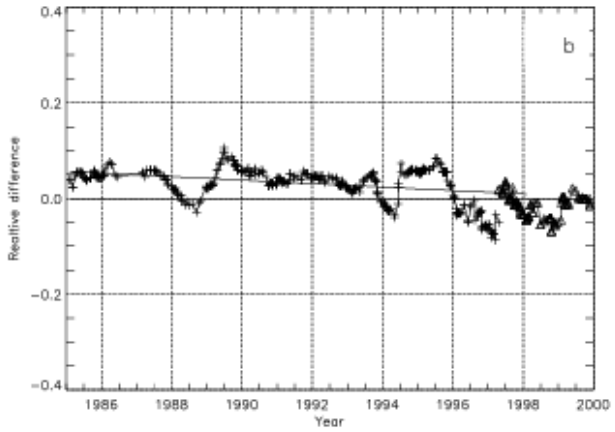
Pressure and temperature dependent

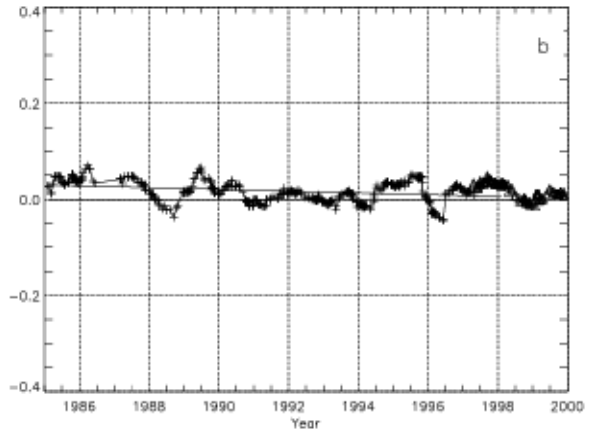
SO_2 & total O_3 corrected

Removes bias between BM and Z-ECC

Less variability and drift with respect to SAGE-II dataset (e.g. at 22-26 km altitude)





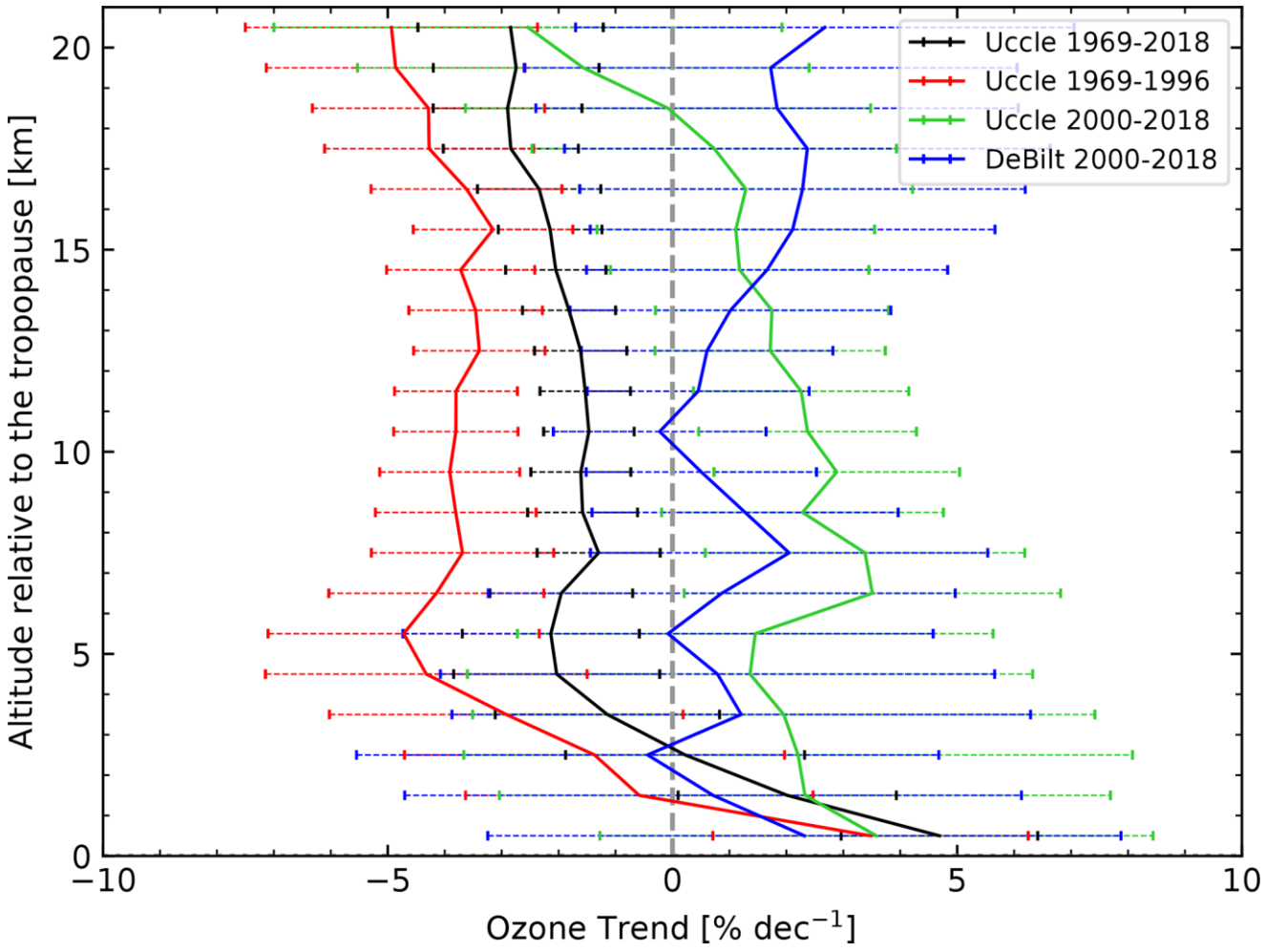


Combined time series suitable for trend analysis

H. De Backer et al, Fifty years O_3 soundings at Uccle, Poster E_261, Quadrennial Ozone Symposium 2021, online, Seoul, South Korea, 3-9 October 2021

LOTUS trends

- Stratospheric trends calculated with the Long-term Ozone Trends and Uncertainties in the Stratosphere multiple linear regression model.
- -4% per decade in 1969-1996
- +2% per decade in 2000-2018 but only in lower stratosphere



H. De Backer et al, Fifty years O_3 soundings at Uccle, Poster E_261, Quadrennial Ozone Symposium 2021, online, Seoul, South Korea, 3-9 October 2021

Conclusion

After taking into account **instrumental artefacts** the long-term data set of ozone profiles at Uccle is suitable for **trend analysis** but also for:

- Validation of Ozone profiles from satellites
- Studies of particular events (e.g. tropopause folds)
- Comparison with observations from aircraft and surface air pollution observations

Examples are on the pdf poster and in an ACP publication (next slide)

The data are stored at WOUDC (Uccle is WMO station 53) and NDACC and are also available from the authors.

H. De Backer et al, Fifty years O_3 soundings at Uccle, Poster E_261, Quadrennial Ozone Symposium 2021, online, Seoul, South Korea, 3-9 October 2021

More details

https://doi.org/10.5194/acp-21-12385-2021

Atmos. Chem. Phys., 21, 12385–12411, 2021
https://doi.org/10.5194/acp-21-12385-2021

Atmospheric Chemistry and Physics Open Access EGU

Fifty years of balloon-borne ozone profile measurements at Uccle, Belgium: a short history, the scientific relevance, and the achievements in understanding the vertical ozone distribution

Roeland Van Malderen[1], Dirk De Muer[1], Hugo De Backer[1], Deniz Poyraz[1], Willem W. Verstraeten[1], Veerle De Bock[1], Andy W. Delcloo[1], Alexander Mangold[1], Quentin Laffineur[1], Marc Allaart[2], Frans Fierens[3], and Valérie Thouret[4]

[1]Scientific Division Observations, Royal Meteorological Institute of Belgium, 1180 Uccle (Brussels), Belgium
[2]Research and Development of Satellite Observations, KNMI, 3730 AE De Bilt, the Netherlands
[3]Belgian Interregional Environment Agency (IRCEL – CELINE), 1030 Brussels, Belgium
[4]Laboratoire d'Aérologie, Université de Toulouse, CNRS, UPS, 31400 Toulouse, France

Correspondence: Roeland Van Malderen (roeland.vanmalderen@meteo.be)

Received: 16 July 2020 – Discussion started: 2 December 2020
Revised: 31 May 2021 – Accepted: 2 June 2021 – Published: 18 August 2021

THANK YOU

The Royal Meteorological Institute

Het Koninklijk Meteorologisch Instituut

L'Institut Royal Météorologique

Das Königliche Meteorologische Institut

The RMI provides reliable public service realized by empowered staff and based on research, innovation and continuity.

Het KMI verleent een betrouwbare dienstverlening aan het publiek en de overheid gebaseerd op onderzoek, innovatie en continuïteit.

L'IRM fournit un service fiable basé sur la recherche, l'innovation et la continuité au public et aux autorités.

Vertrauenswürdige Dienstleistungen für Öffentlichkeit und Behörden begründet auf Forschung, Innovation und Kontinuität.

RMI

H. De Backer et al, Fifty years O_3 soundings at Uccle, Poster E_261, Quadrennial Ozone Symposium 2021, online, Seoul, South Korea, 3-9 October 2021