Analysis of multi-year near-surface ozone observations at the WMO/GAW “Concordia” station, Antarctica

Davide Putero[1], Rita Traversi[2], Angelo Lupi[3], Francescopiero Calzolari[1], Maurizio Busetto[1], Laura Tositti[4], Stefano Crocchianti[5], Paolo Cristofanelli[1]

[1]CNR-ISAC, Bologna, Italy (d.putero@isac.cnr.it)

[2]University of Florence, Florence, Italy

[3]CNR-ISP, Bologna, Italy

[4]University of Bologna, Bologna, Italy

[5]University of Perugia, Perugia, Italy

Outline

- Near-surface ozone (O_3) variability at Dome C
- Ozone Enhancement Events (OEEs)
- Possible influence of TCO
- Role of synoptic-scale air mass transport
- Role of deep stratospheric transport
- Upcoming work: the STEAR project

Atmospheric Environment 177 (2018) 54–63

Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

ELSEVIER

Analysis of multi-year near-surface ozone observations at the WMO/GAW "Concordia" station (75°06′S, 123°20′E, 3280 m a.s.l. – Antarctica)

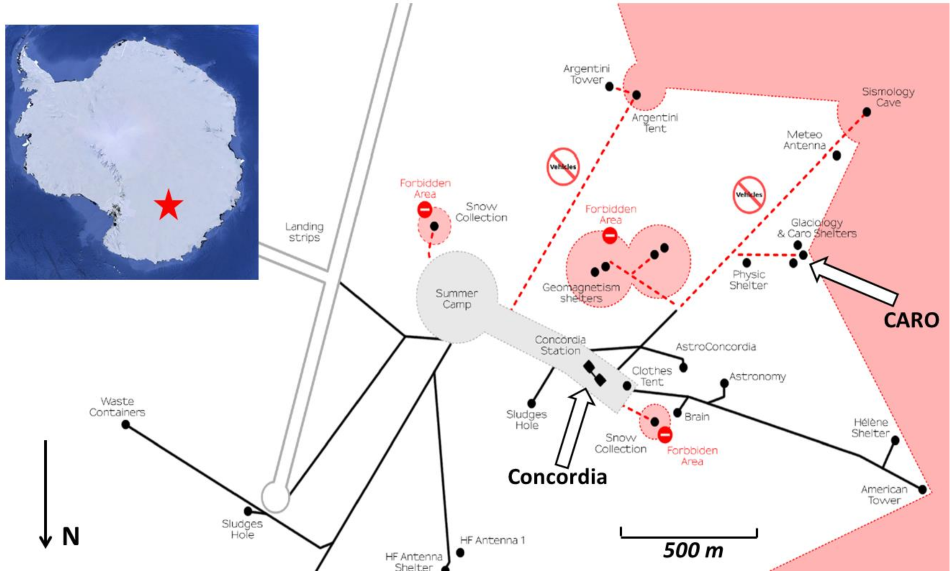
Paolo Cristofanelli[a,*], Davide Putero[a], Paolo Bonasoni[a], Maurizio Busetto[a], Francescopiero Calzolari[a], Giuseppe Camporeale[d], Paolo Grigioni[b], Angelo Lupi[a], Boyan Petkov[a], Rita Traversi[c], Roberto Udisti[c], Vito Vitale[a]

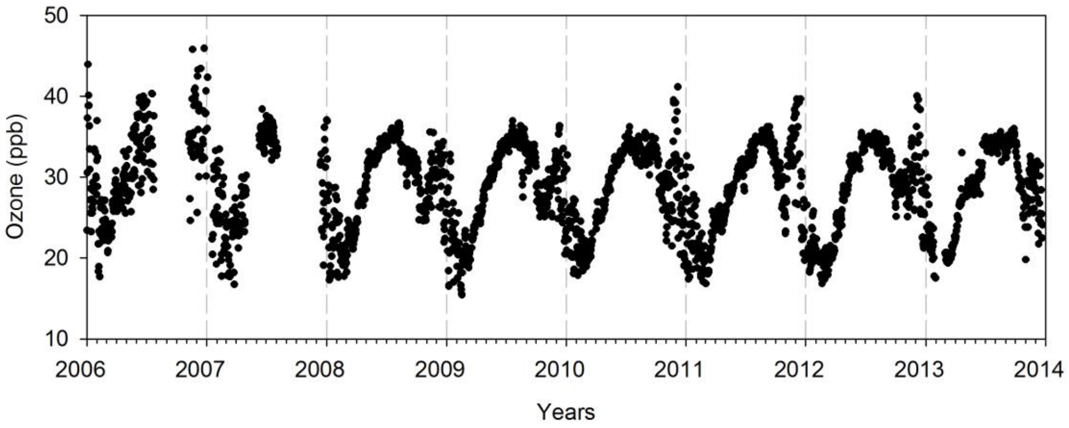
Ozone variability at Dome C

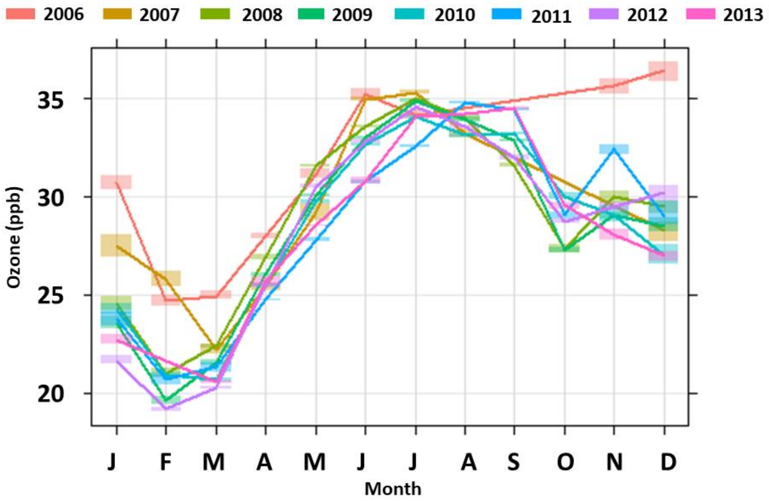
- WMO/GAW “Concordia” station (Dome C) in the Eastern Antarctic plateau (3280 m a.s.l.)

- Location not strongly affected by katabatic winds, prevalent SW wind direction

- Near-surface **O_3 measurements** performed with different UV absorption analyzers (Thermo Tei 49C, Thermo Tei 49i, and Dasibi 1108)



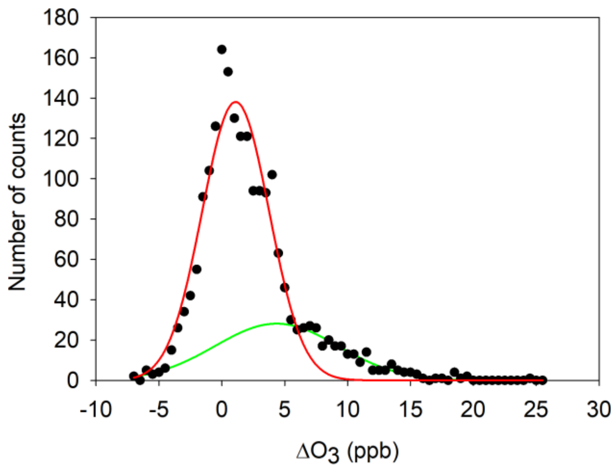


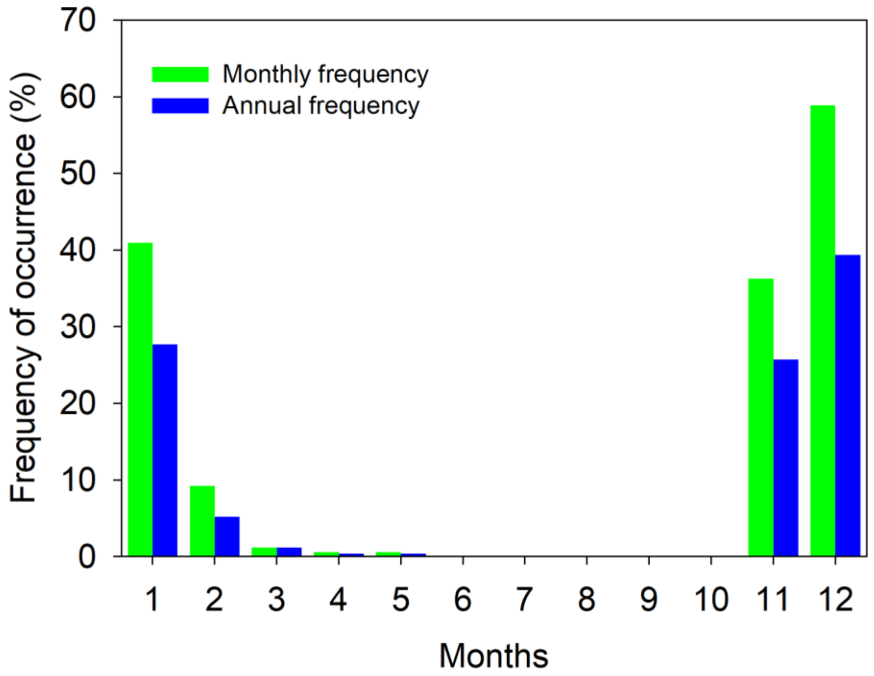


Ozone Enhancement Events (OEEs)

OEEs **selection** based on the following procedure:

- Calculate the «undisturbed» O_3 annual cycle (sinusoidal fit)
- Calculate the PDF of the deviations of daily data from the sinusoidal fit, plus the application of a Gaussian fit to the PDF
- Compute a Gaussian fit for the PDF points beyond 1σ of the Gaussian PDF, and the **intersection** between the two curves is the selected threshold value for identifying OEEs (i.e., 6 ppb)



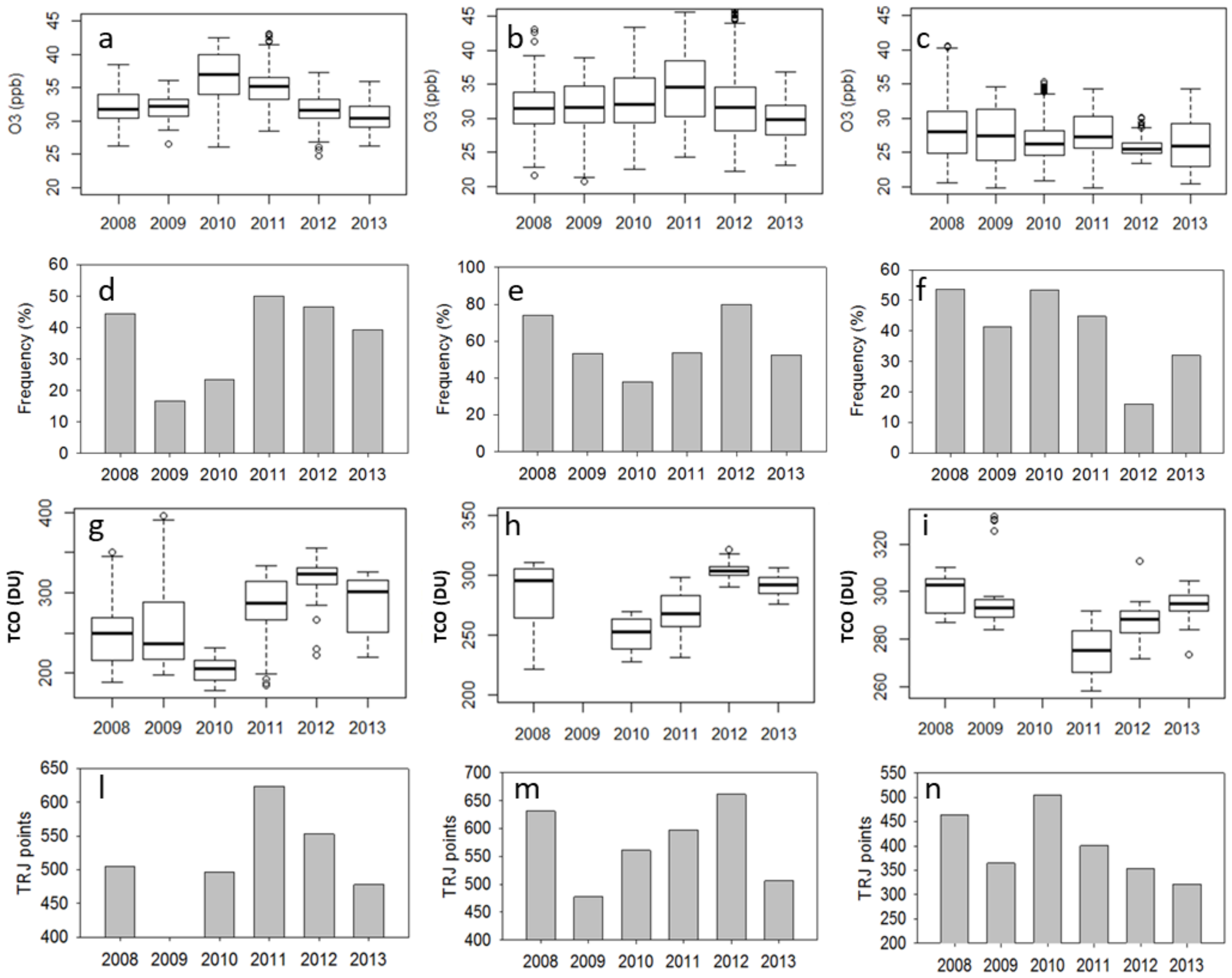


246 days (11.6% of the dataset) were selected as affected by anomalous OEEs: 25.7% in Nov., 39.3% in Dec., 27.7% in Jan. and 5.1% in Feb.

Average occurrence of the anomalous events peaking in December

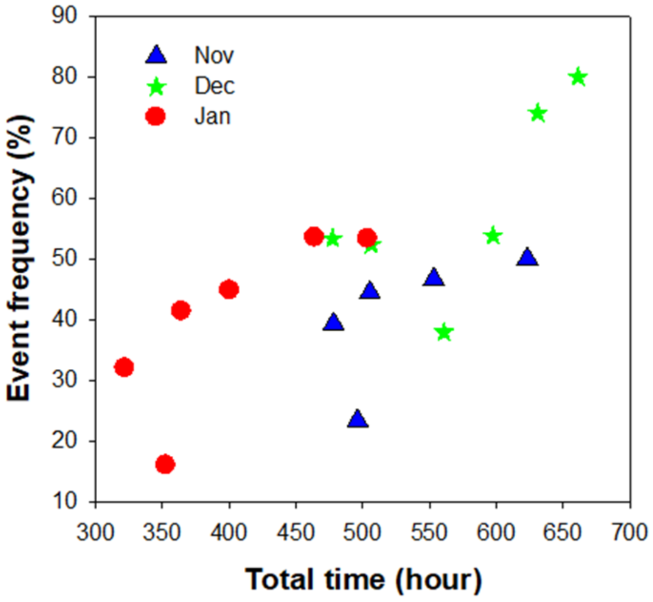
Possible influence of total column of ozone

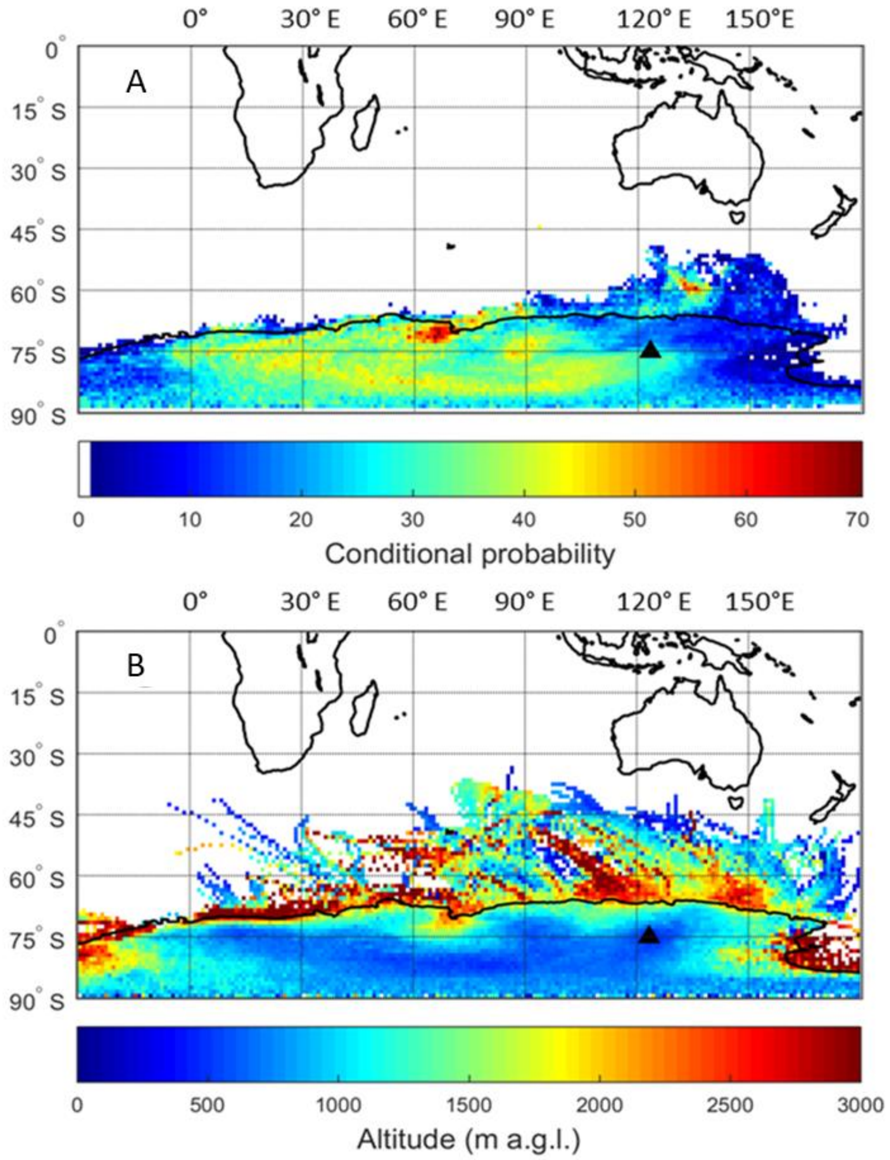
- No clear anti-correlation between TCO and O_3 values during OEEs
- Positive significant correlation between OEEs and TCO observed in November
- This supports the finding by Frey et al. (2009) that the flux of NO_X in the surface atmospheric layer (and thus O_3 production) **only depends on second order from TCO variability**



Role of synoptic-scale air mass transport

- 5-days LAGRANTO back-trajectories at Dome C
- Application of the **potential source contribution function** (PSCF)
- Connection between OEEs and the air masses which traveled over the East Antarctic plateau
- The **permanence of air masses** over the continental plateau is an important driver for the occurrence of OEEs at DMC, through accumulation processes



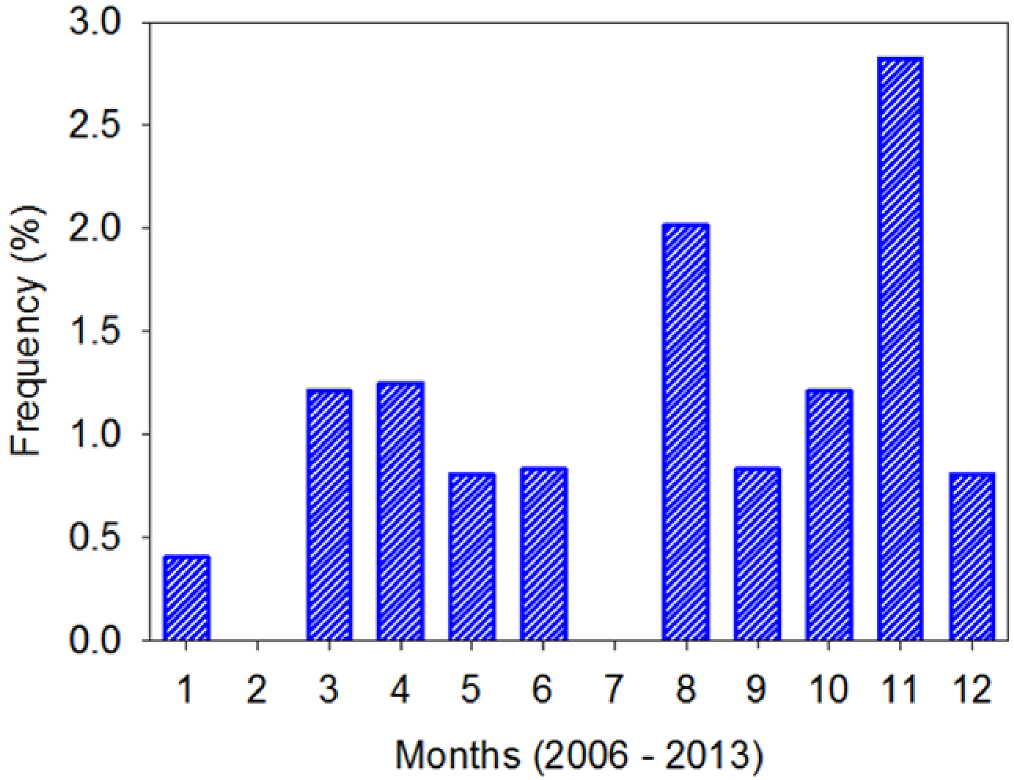


Role of «deep» stratospheric transport

- Application of the **STEFLUX tool** (Putero et al., 2016) over a target region around Dome C for investigating deep stratosphere-to-troposphere transport (STT) events

- Despite no clear seasonal cycle is visible, the occurrence of STT events is **lower than 2%** on a monthly basis

- STT can represent a **source of nitrates** for the Antarctic atmosphere through different processes



→ STT can be an input of nitrates, which can be recycled by the snowpack and released as NO_X under sunlight conditions, thus possibly favoring OEEs

Upcoming work: the STEAR project

STEAR – Stratosphere-to-Troposphere Exchange in the Antarctic Region
2020–2022, funded by the Italian Antarctic Research Program (PNRA)

- Provide an assessment of **stratosphere-to-troposphere exchange** (STE) events in Antarctica, by using both observations and modeling outputs
- Continuous measurements of **^{7}Be at Dome C**, for the whole project duration
- Investigation of the **STE impact** on near-surface ozone, total ozone, aerosol chemistry, and nitrate in surface snow
- Analysis of simultaneous atmospheric composition datasets from **Antarctic coastal observatories** (i.e., Mario Zucchelli and Jang Bogo stations)
- **Modeling analyses** performed on different time scales, by using Lagrangian models (i.e., FLEXPART, HYSPLIT, and STEFLUX)