



Koninklijk Meteorologisch Instituut

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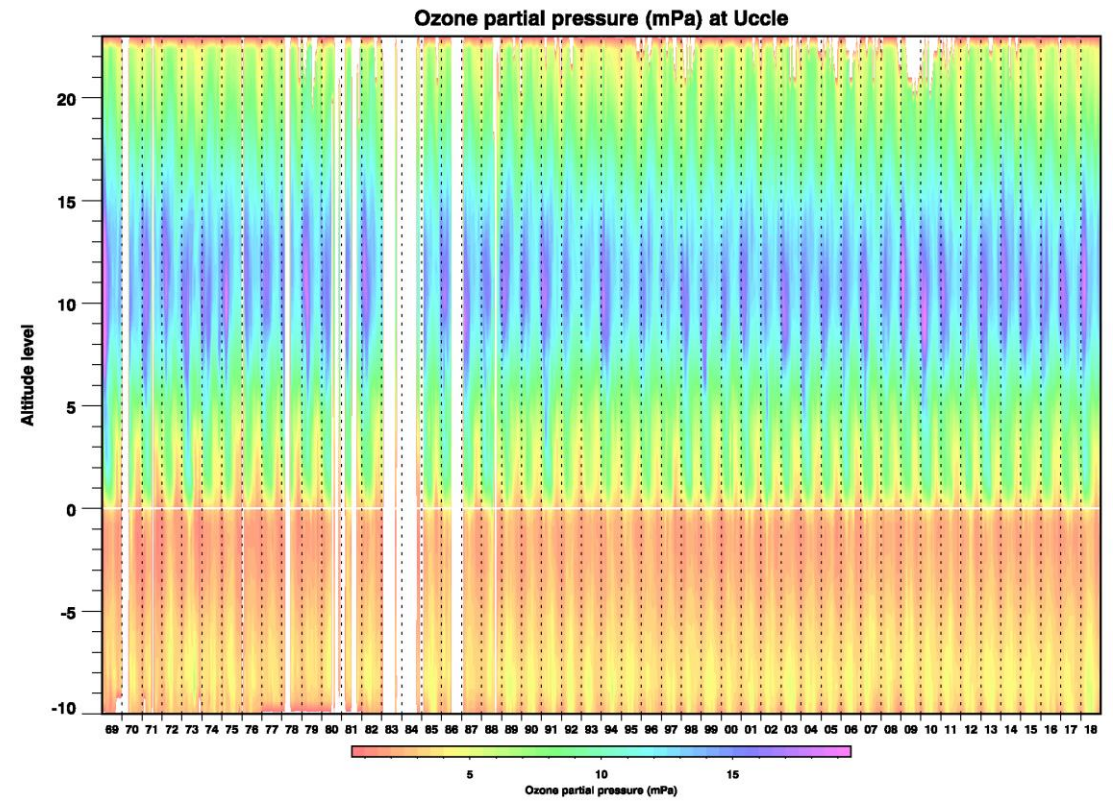
# The importance of the Uccle ozone time series in ozone research

Roeland Van Malderen

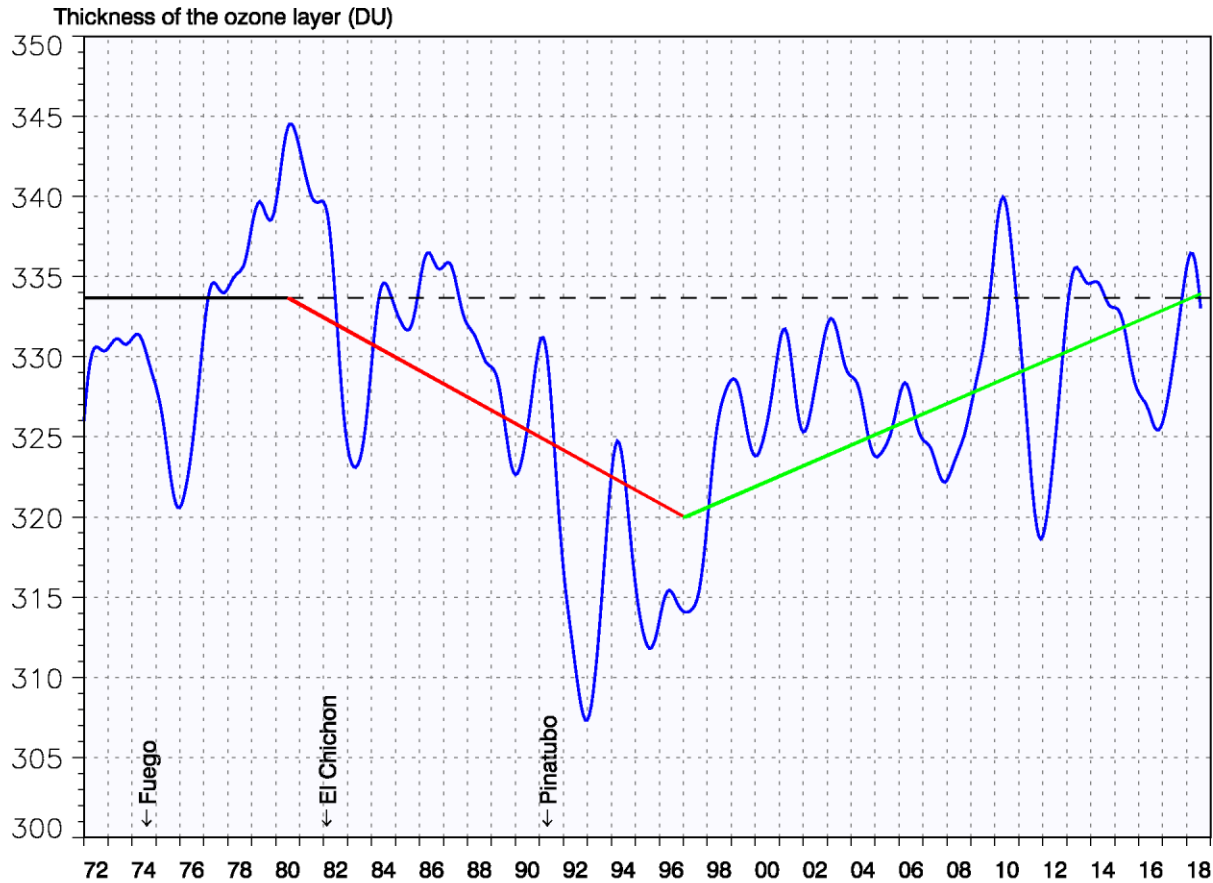
with plots/analyses prepared by Deniz Poyraz, Hugo De Backer, Veerle De Bock  
with input from Willem Verstraeten, Andy Delcloo, Daan Hubert, Marc Allaart, Valérie Thouret, Frans Fierens

## Building up a long time series of ozone measurements for

- trend studies
- validation of (satellite) ozone retrievals
- process studies

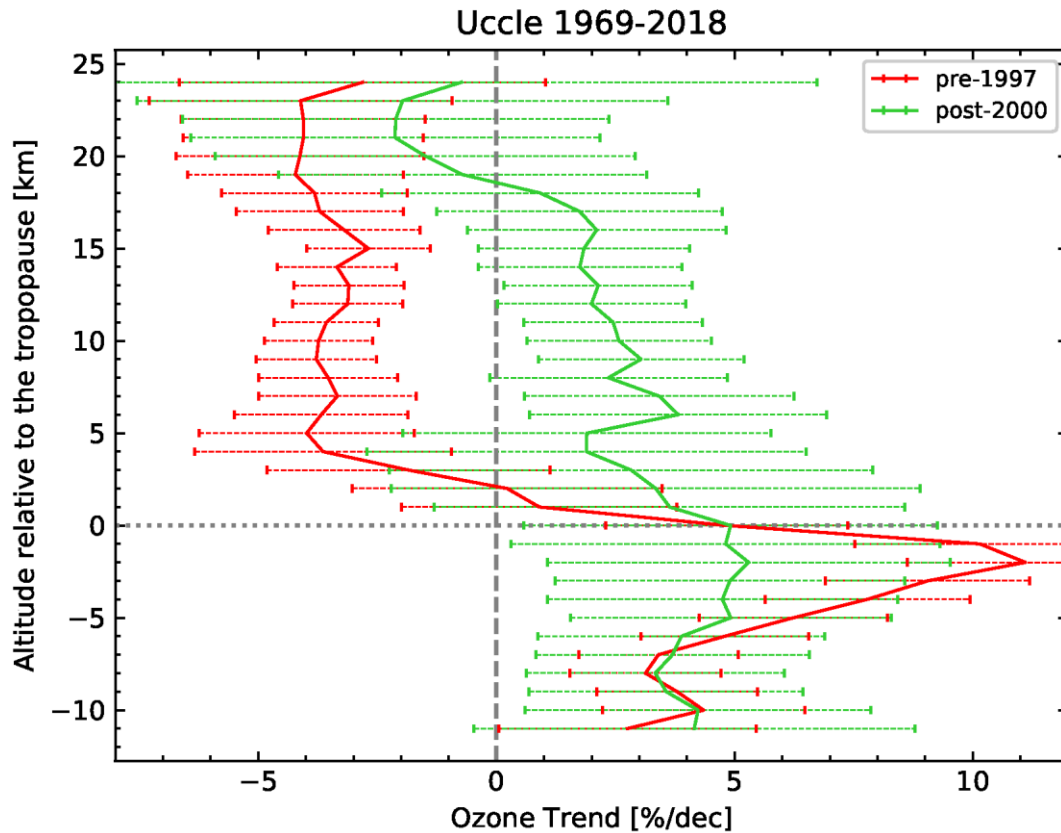


## Total ozone



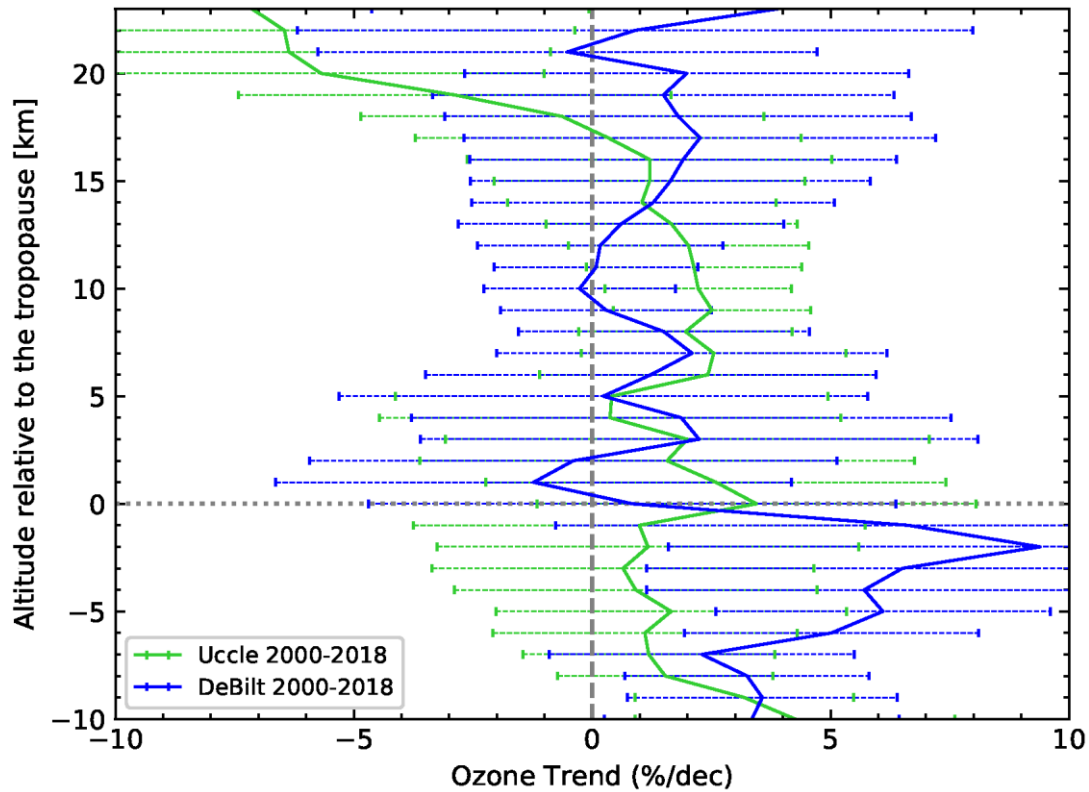
- since 1971: Dobson + Brewer(s)
- effect of volcanos
- 1980-1997: **-0.25%/yr**
- 1997-2018: **+0.20%/yr**

## Vertical ozone trends



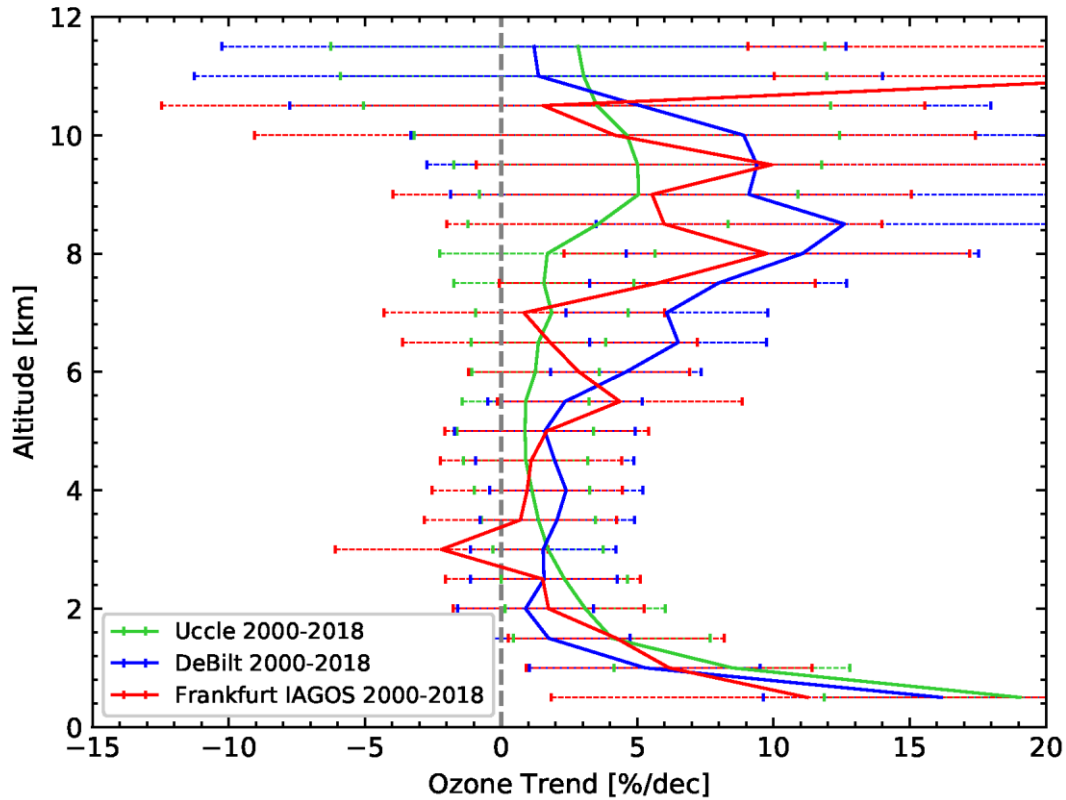
- LOTUS regression model (talk by Daan Hubert)
  - ✓ trends 1969-1997, 2000-2018
  - ✓ multiple linear regression (MLR)
  - ✓ 2 independent linear trends (ILT)
  - ✓ includes QBO (2 orthogonal components), solar flux at 10.7 cm, ENSO (no lag), AOD
- tropo: + 4-10%/dec → +4-5%/dec
- strato: -4-/-3%/dec → +2-3 %/dec
- no decline in LStr >< Ball et al., 2018

## Vertical ozone trends



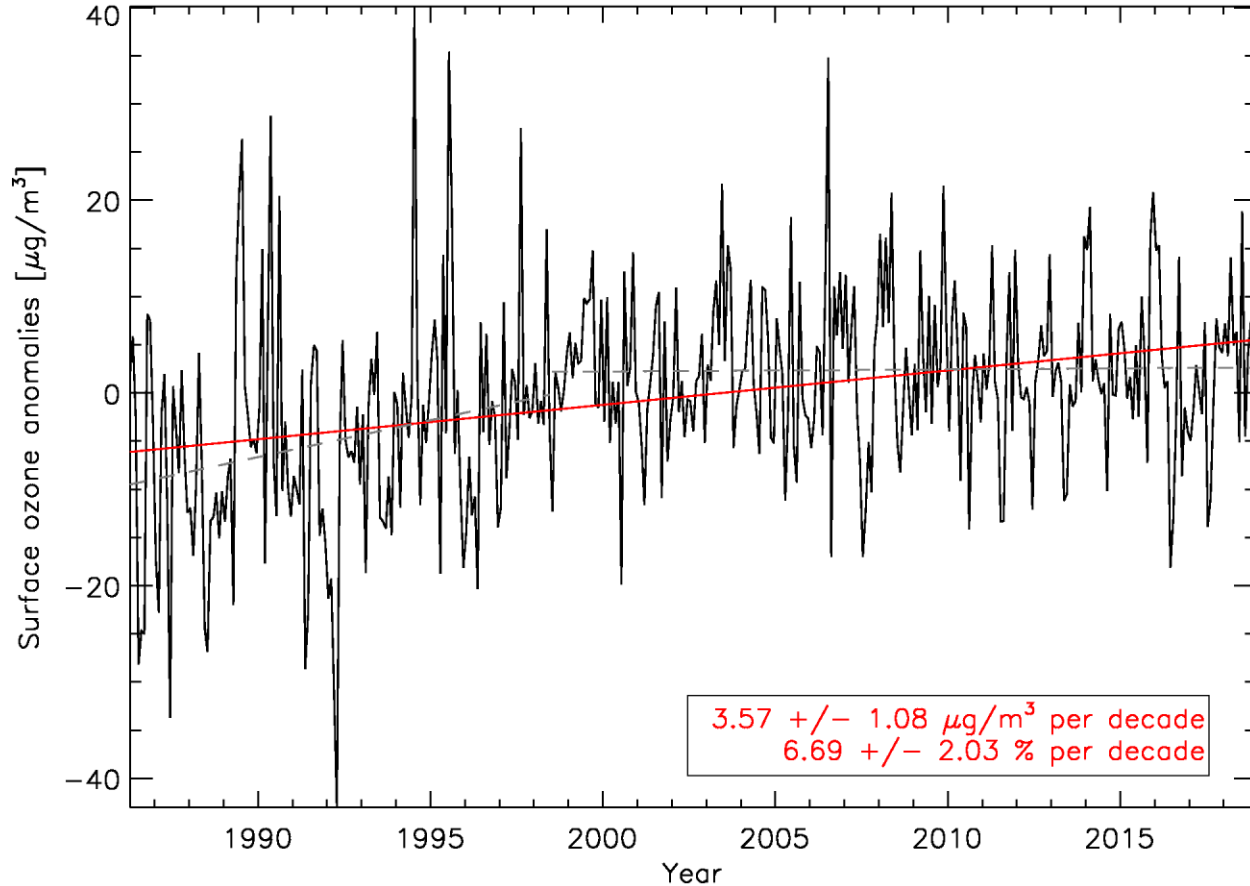
overall consistency with nearby De Bilt (175 km)

## Vertical tropospheric ozone trends



overall consistency in troposphere with nearby De Bilt (175 km) and IAGOS aircraft measurements (see talk by **Valérie Thouret**) at Frankfurt (360 km)

## Surface ozone trends

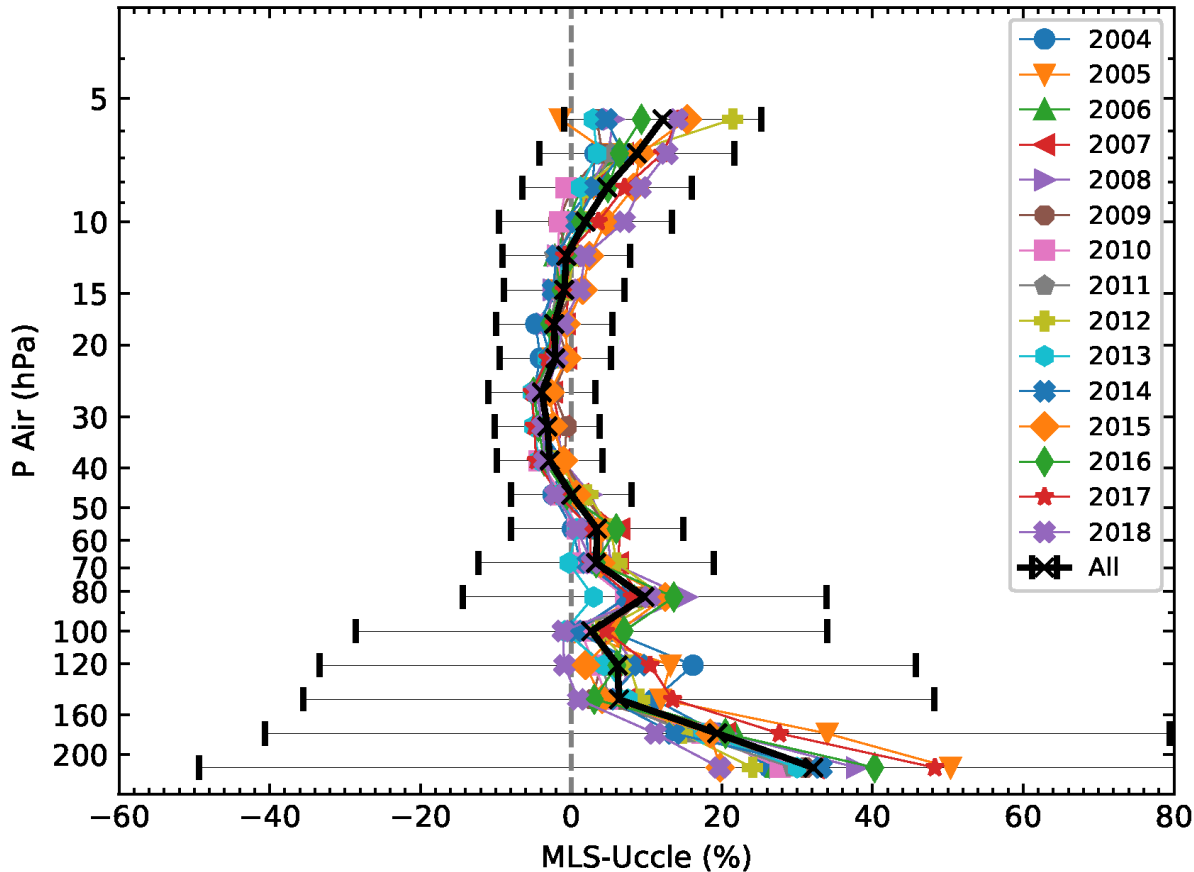


- data at Uccle site from Belgian Interregional Environment Agency
- increase in surface ozone, but especially in beginning of time period (before 2000)
- decreasing concentrations of CO, NO, NO<sub>2</sub>

- in operational context: EUMETSAT AC SAF
  - ✓ GOME, GOME-2, IASI
  - ✓ at RMI: Andy Delcloo
  - ✓ talk by **Federico Fierli**
- assessment of the bias and long-term stability of satellite ozone profile data records
  - ✓ talk by **Daan Hubert**
- here: AURA-Microwave Limb Sounder (MLS) vs Uccle

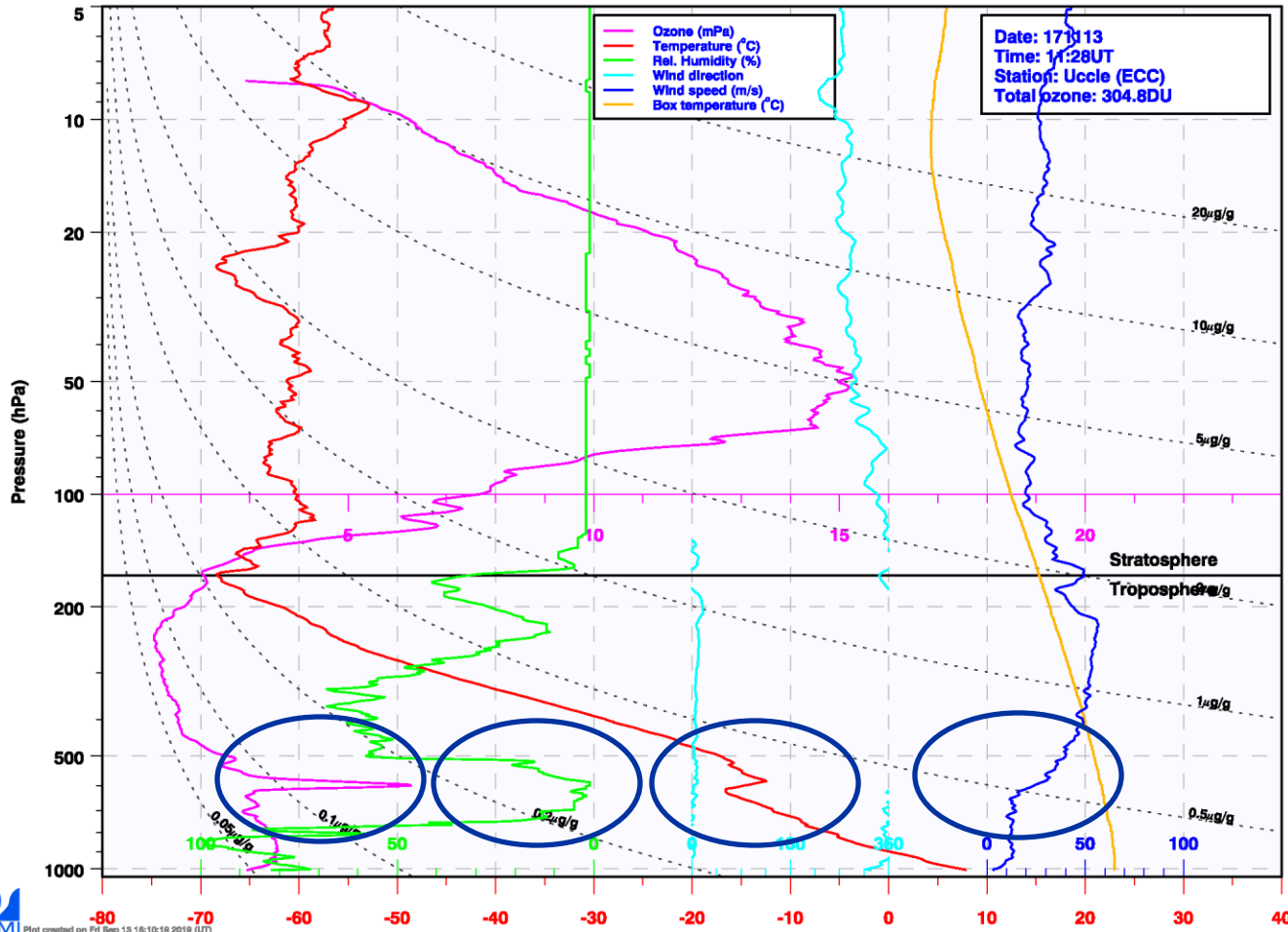


## MLS vs. ozonesonde at Uccle



- $\approx 3000$  profiles (min distance,  $\pm 6$ h)
- $\pm 5\%$  difference between 10-70 hPa
  - ✓  $< 10$  hPa: sonde problems
  - ✓  $> 80$  hPa: MLS retrieval more challenging
- consistent over the years

## Tropopause folds

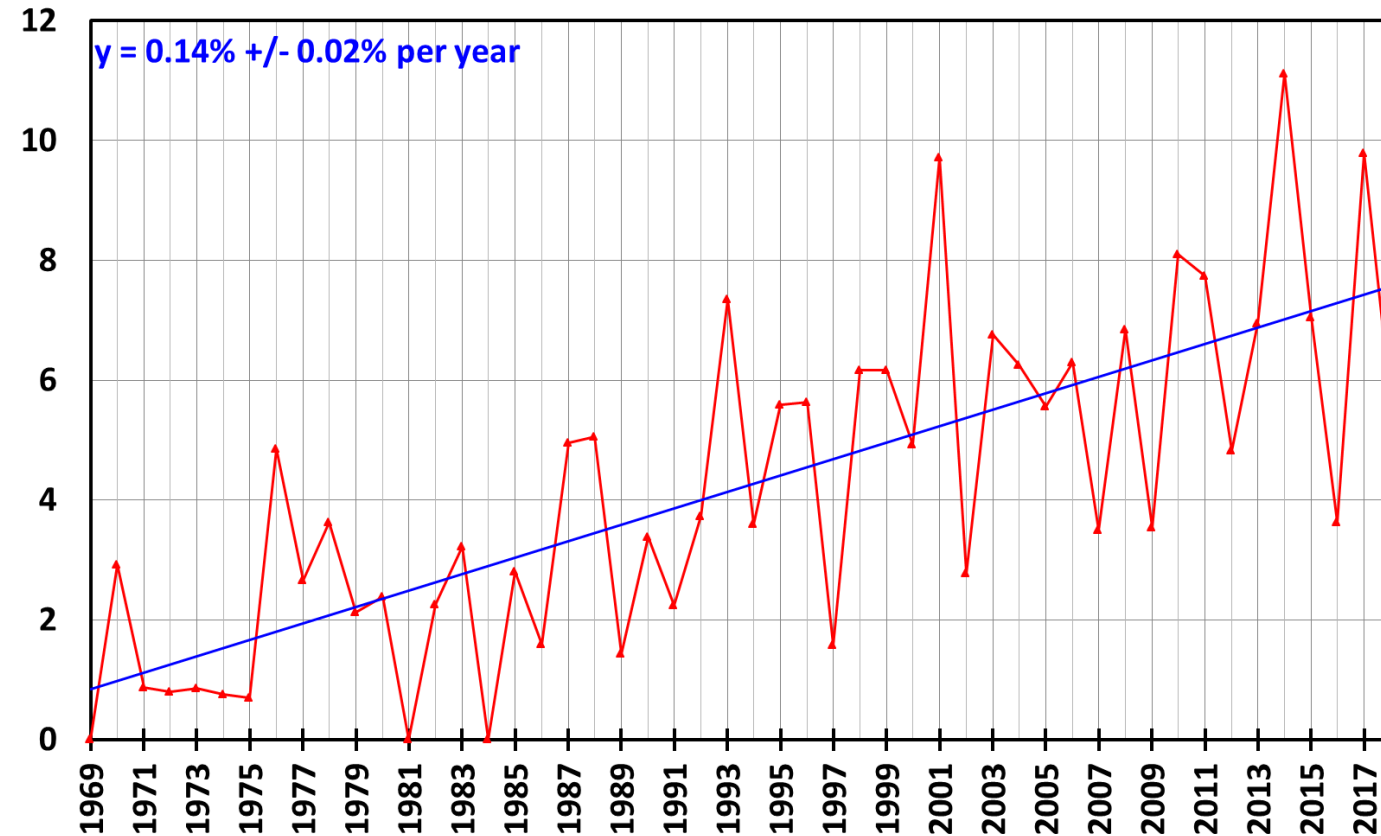


- pronounced ozone max in free troposphere
- very low RH
- vertical stability ( $-\text{d}\theta/\text{d}p > 11.5 \text{ K}/100\text{hPa}$ )
- high wind speed ( $> 20 \text{ m/s}$ ) & vertical gradient of wind speed  $> 5 \text{ m/s/km}$   
 ➔ presence of polar jet stream

Van Haver et al., 1996

## Tropopause folds

% of tropopause events per year



- relative frequency of 4.4%/yr
- significant increase of this frequency
- with climate change
  - ✓ increase planetary wave activity
  - ✓ accelerated BDC
  - ✓ increased transport of (higher) ozone through STT

Tarasick et al., 2019

talk by **Guy Brasseur?**

I hope we convinced you of the value that such a long, high frequency, high quality time series of ozonesonde measurements has!

Thank you Dirk De Muer & Hugo De Backer

... Geert Desadelaer, *for technical support*

... Martin Lebrun, Jean-Claude Grymonpont, André Massy, Jozef Bartholomees, Daniel Wattez, Eli Weerts, Kevin Knockaert, Roger Ameloot  
*for preparing and launching those ozonesondes!*

Let's go for another **50** years!

# THANK YOU

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