EUBREWNET & WMO GAW BREWER OPEN CONGRESS
State Meteorological Agency of Spain, Tenerife, Spain, 24th – 28th March 2014

10-yr measurements of total ozone over Athens, Greece by a Brewer spectrophotometer

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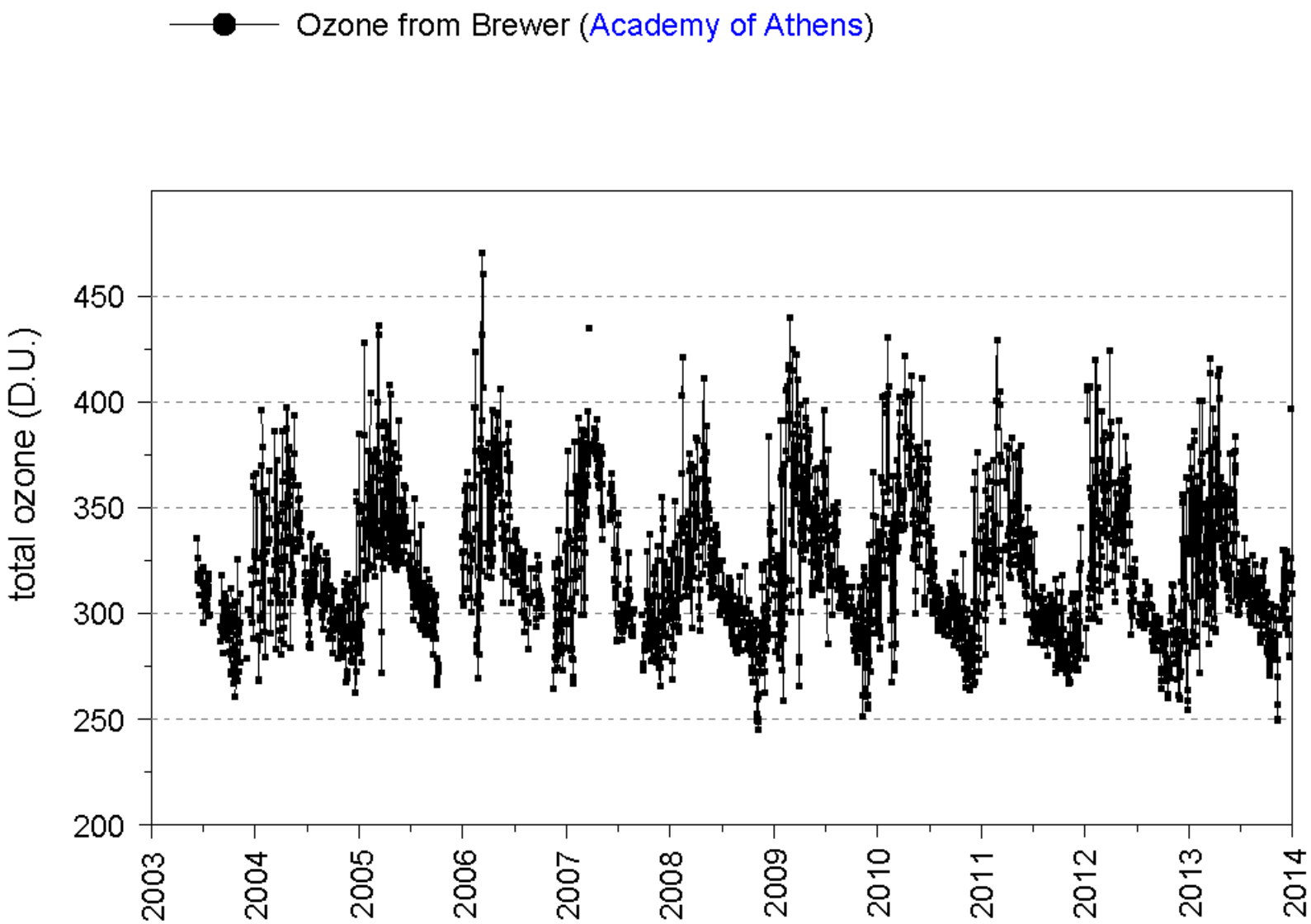
Outline

- Instruments at the Academy of Athens
- Total ozone measurements from the Brewer
- Comparison with Dobson measurements (WMO station 293)
- Comparison with TOMS and OMI satellite overpass data
- Variability in total ozone (seasonal, QBO, ENSO, NAO, solar cycle, tropopause)

Instruments at the Academy of Athens

Instruments	Measuring Parameters
Brewer MKIV Spectroradiometer	Ozone, SO_2, NO_2 columns, UV-B irradiances
CIMEL Sunphotometer (in collaboration with NOA)	Aerosol optical properties (site of the NASA Aerosol Robotic Network)
UV Multi-filter Rotating Shadowband Radiometer – UVMFR-7 (in collaboration with NOA)	Diffuse and global radiation – aerosol optical depth in the UV range
Pyranometer CM11 (Kipp & Zonen)	Total SW irradiance (site of the Hellenic Network for Solar Energy)
NILU-UV Multi-filter radiometer	UV-A, UV-B irradiances and photosynthetically active radiation (site of the Hellenic Network for Solar UV Radiation)

Fig. 1: Daily total ozone over Athens, Greece (2003-2013)



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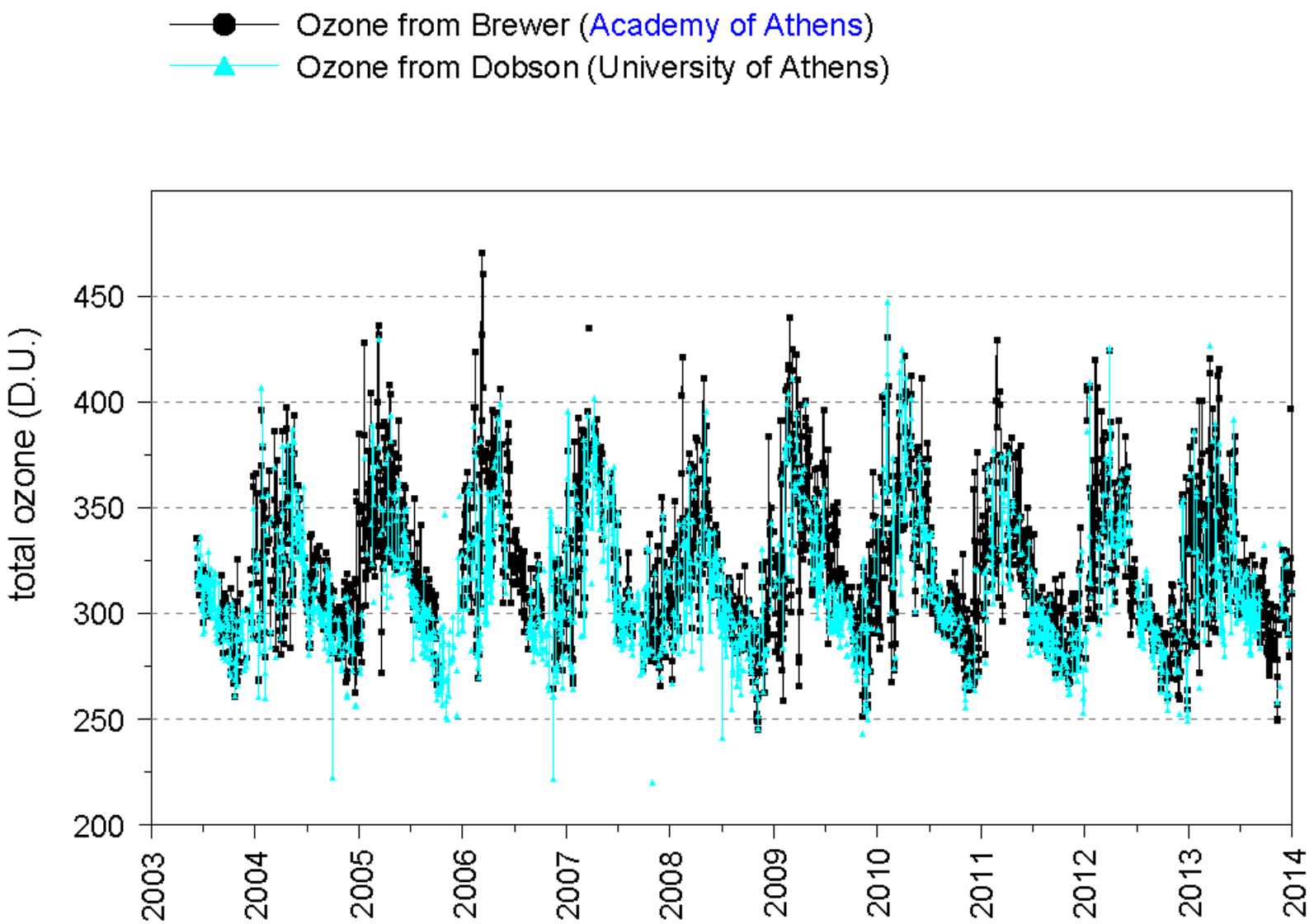

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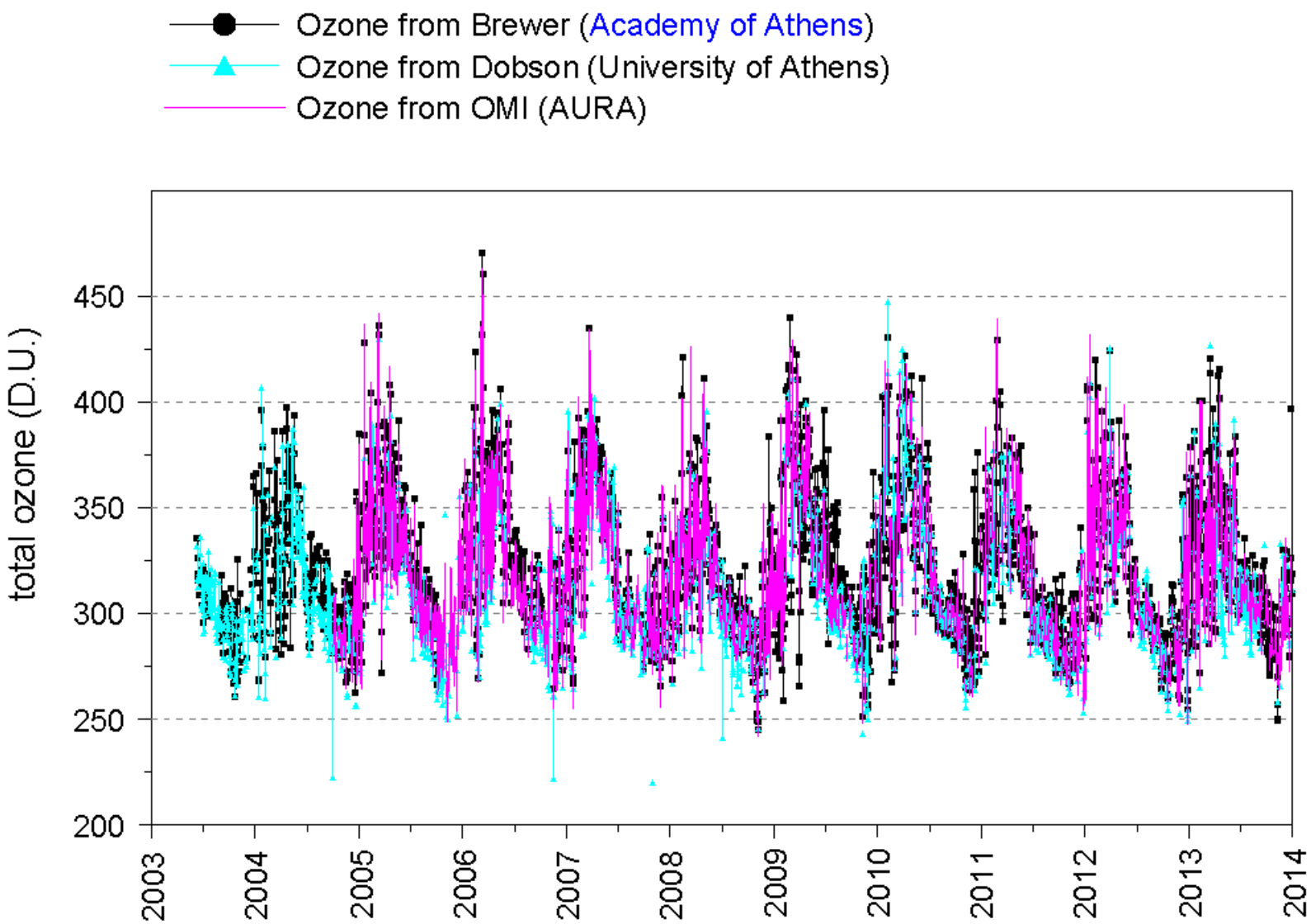

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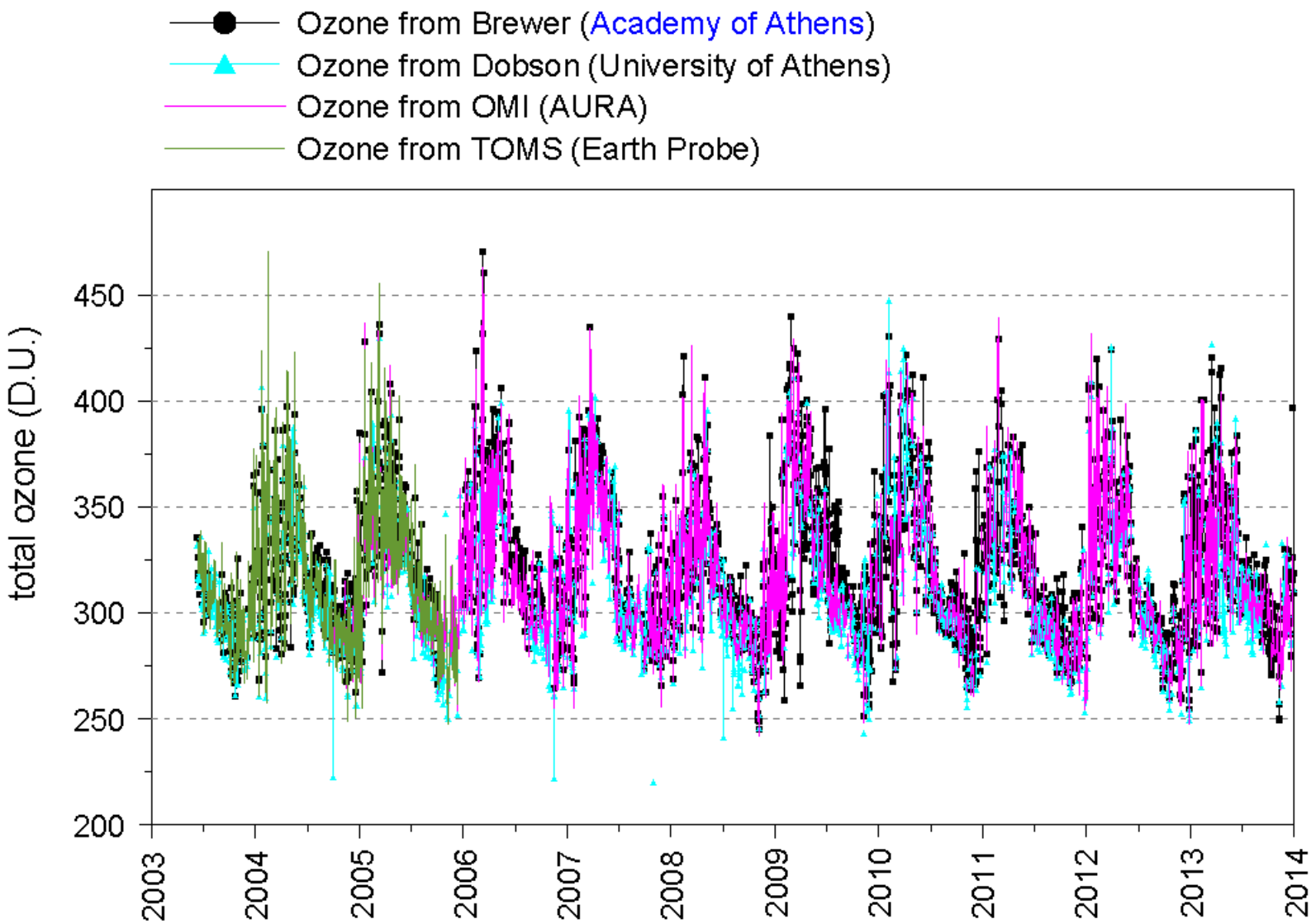
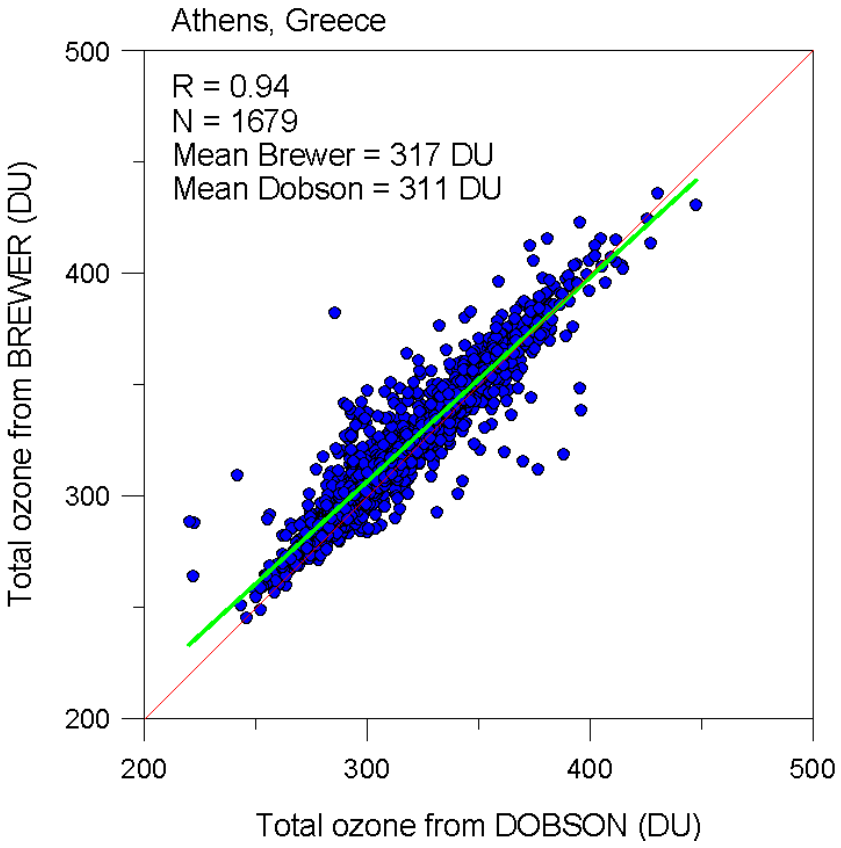
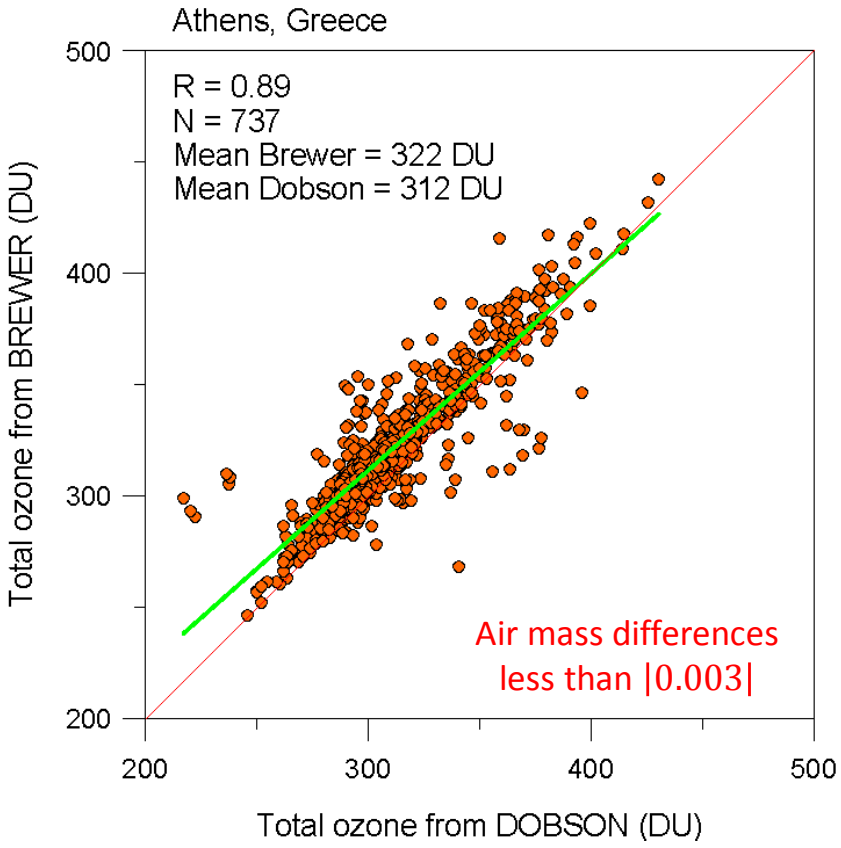


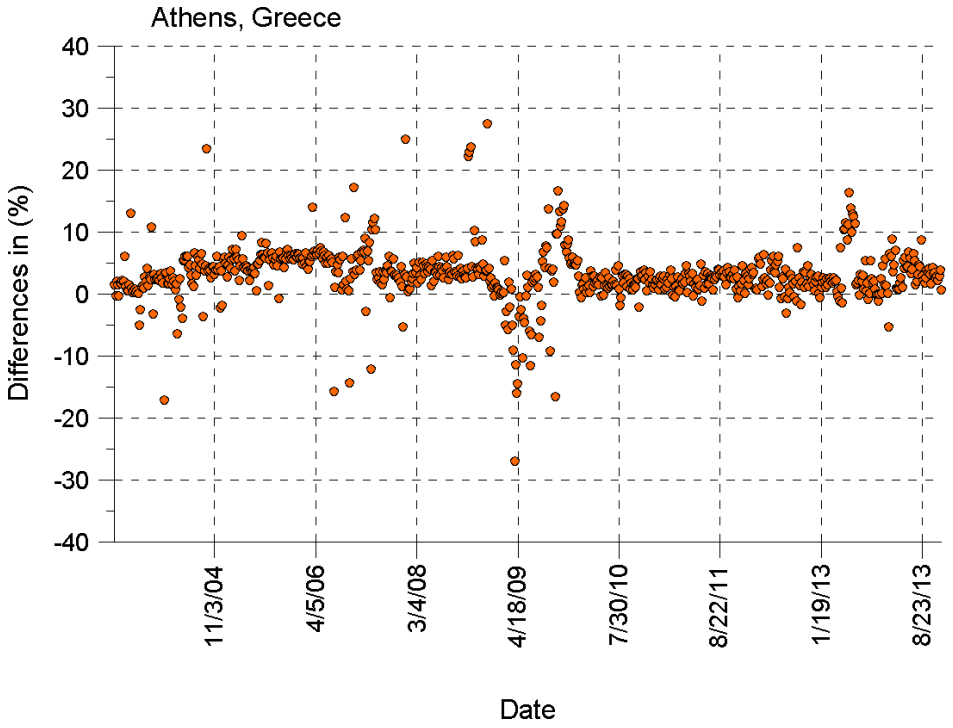
Fig. 2: Correlation with DOBSON measurements

(a) Daily averages



(b) coincident measurements





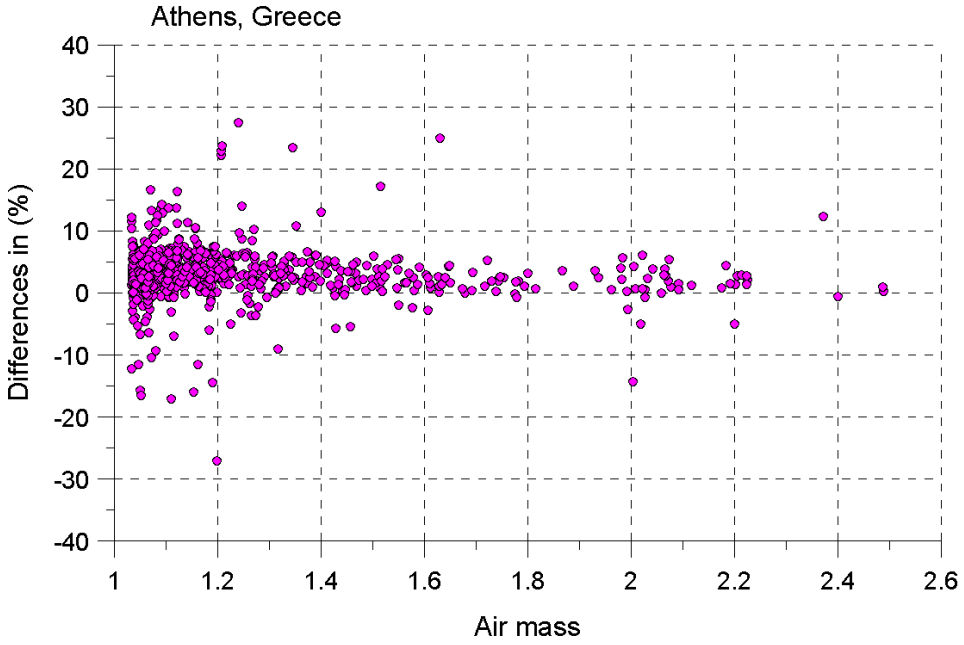


Fig. 3: Relative differences (%) of coincident measurements

$$\frac{Brewer - Dobson}{Brewer} \; x \; 100$$

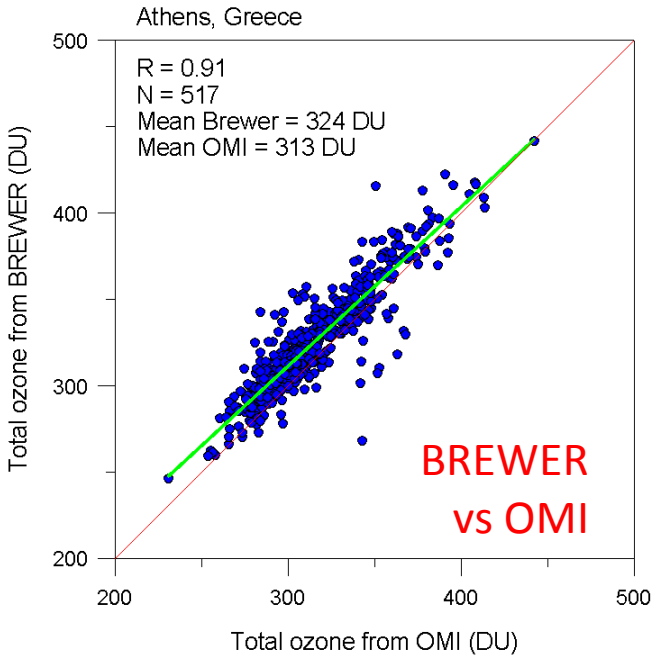
Statistics of differences

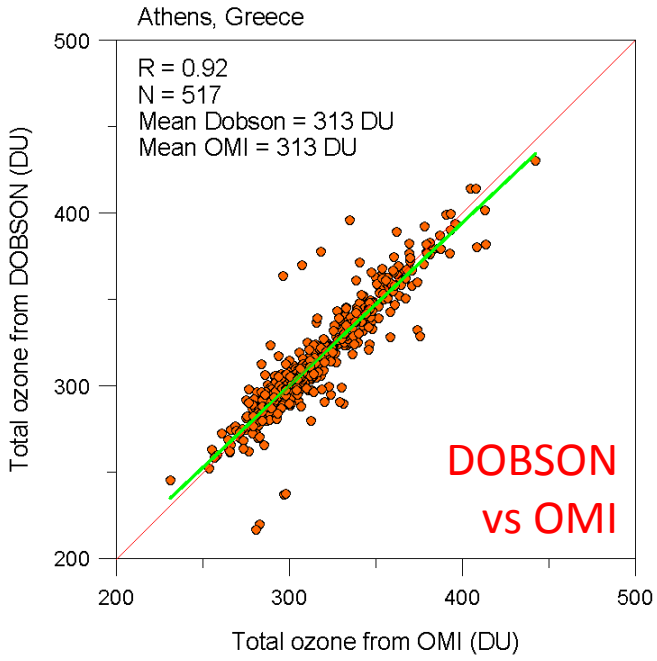
mean = 10 DU (3%)

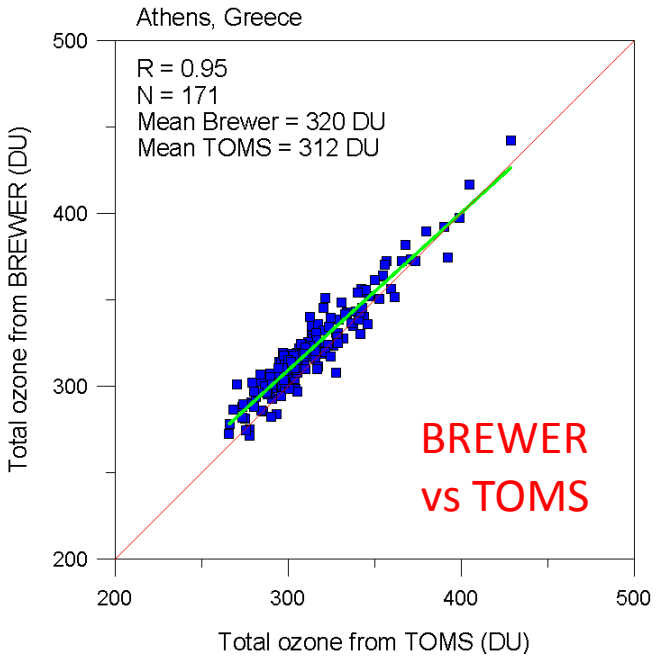
st.dev. = 14 DU (4%)

max = 82 DU (28%)

min = -73 DU (27%)







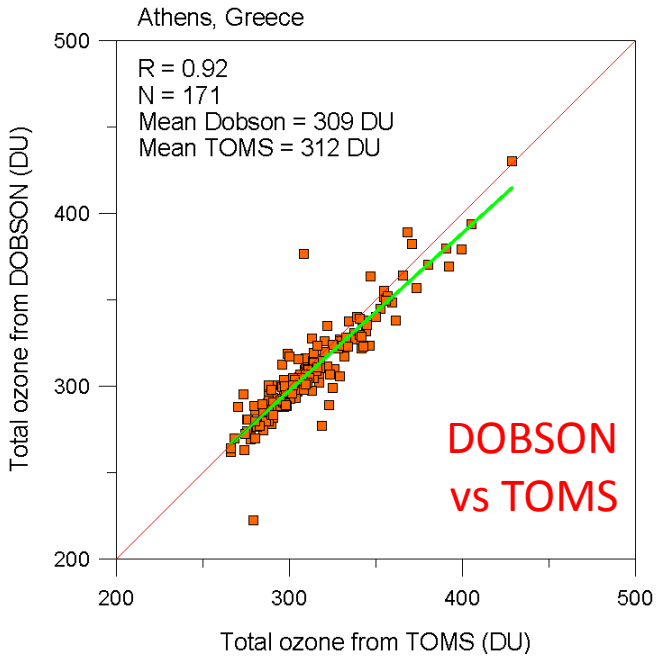
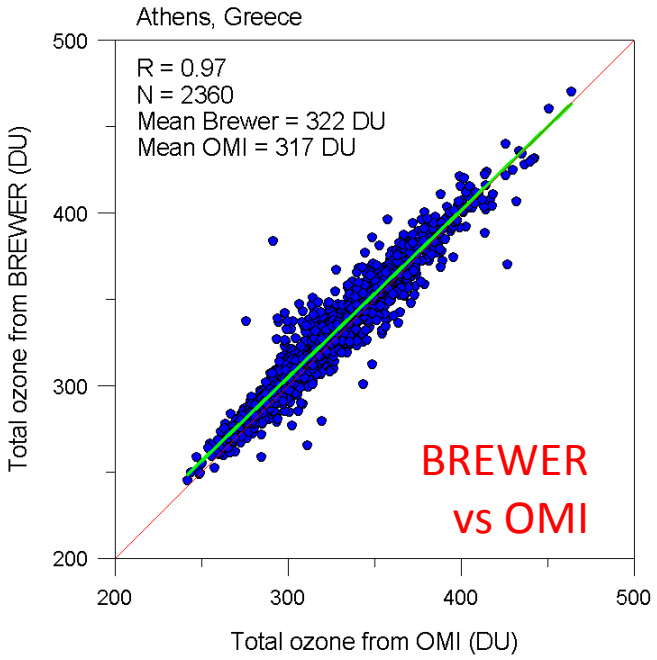


Fig. 4:

Correlation with OMI

Coincident Brewer, Dobson measurements

Correlation with TOMS



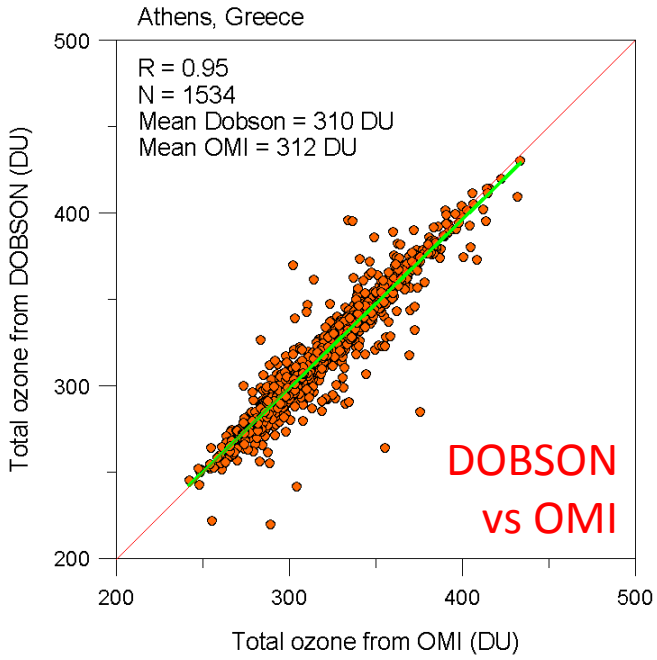
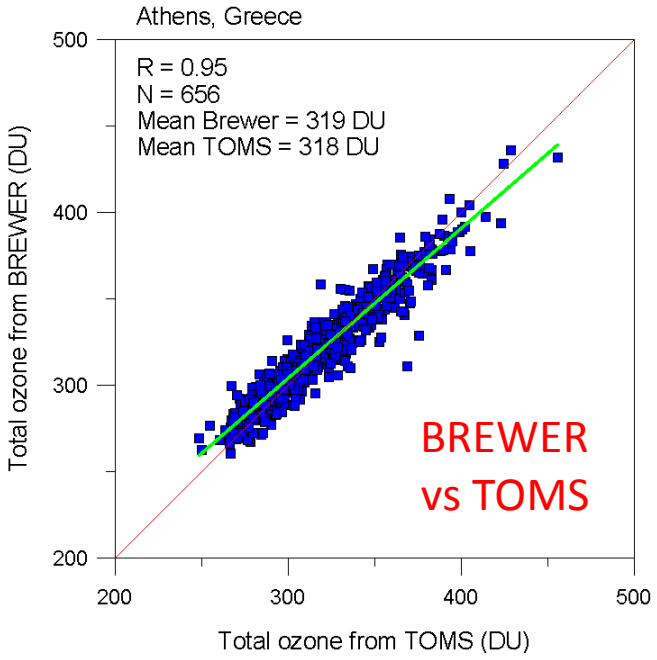
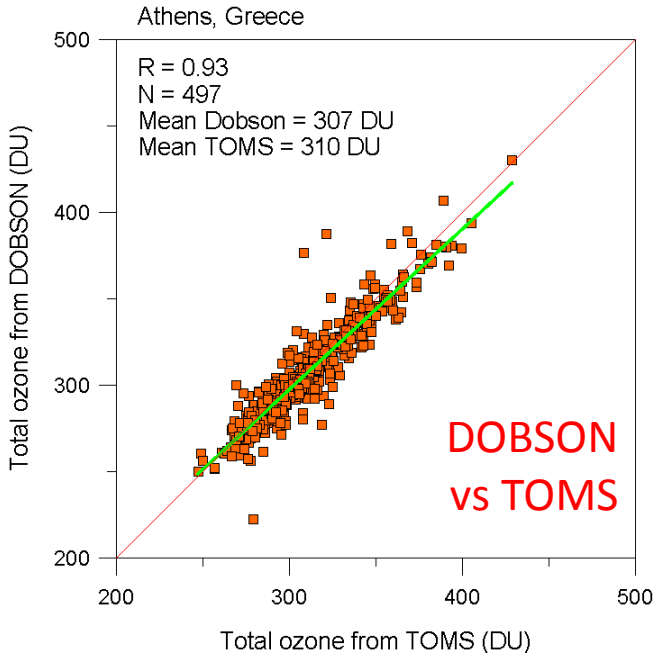


Fig. 5:

Correlation with OMI

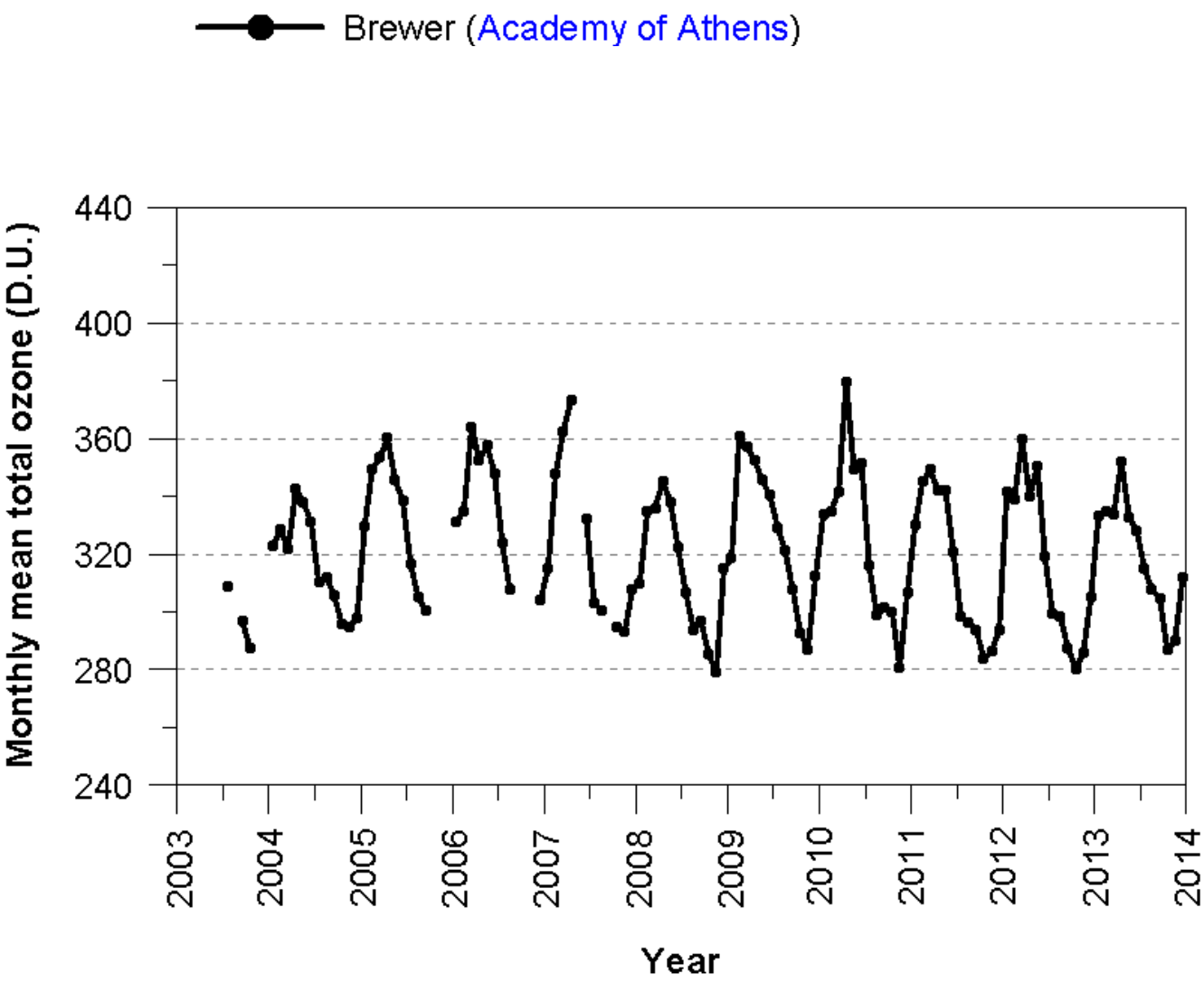
Daily averages





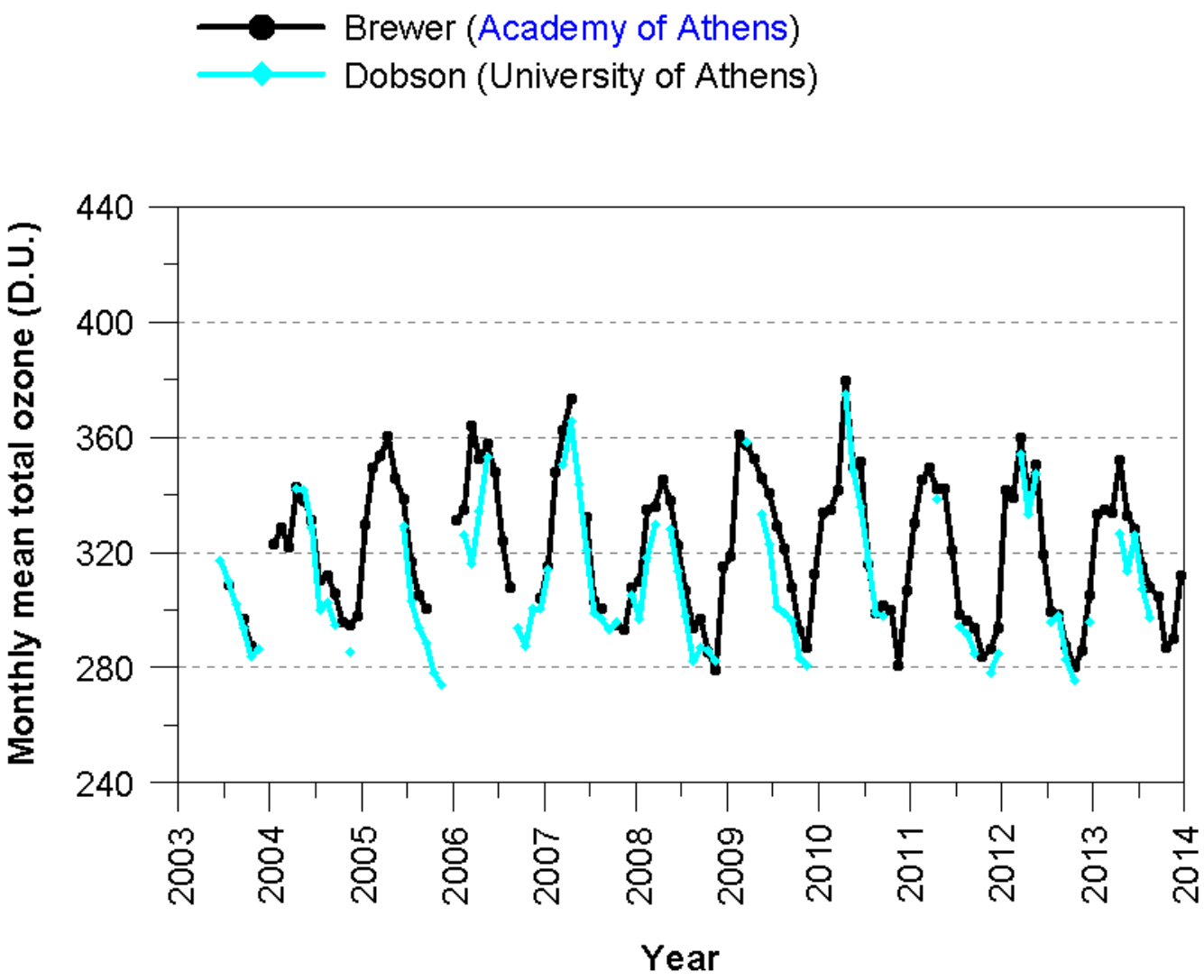
Correlation with TOMS

Fig. 6: Monthly mean total ozone from the Brewer (2003-2013) calculated from at least 14 daily averages



Brewer = 320 ± 24 DU

Fig. 6: Monthly mean total ozone from the Brewer (2003-2013) calculated from at least 14 daily averages



Brewer = 320 ± 24 DU
Dobson = 311 ± 22 DU

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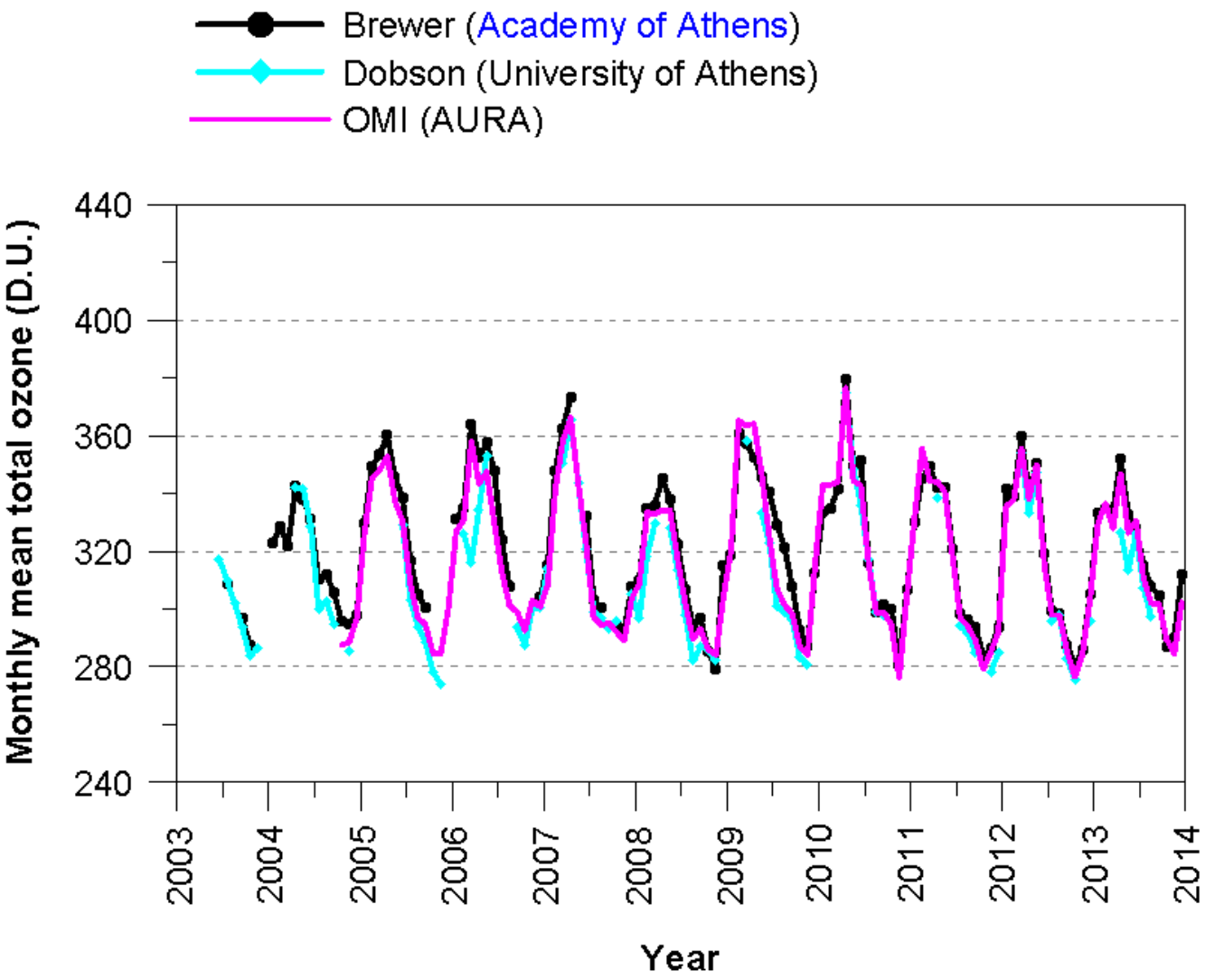

Brewer = 320 ± 24 DU
Dobson = 311 ± 22 DU
OMI = 317 ± 25 DU

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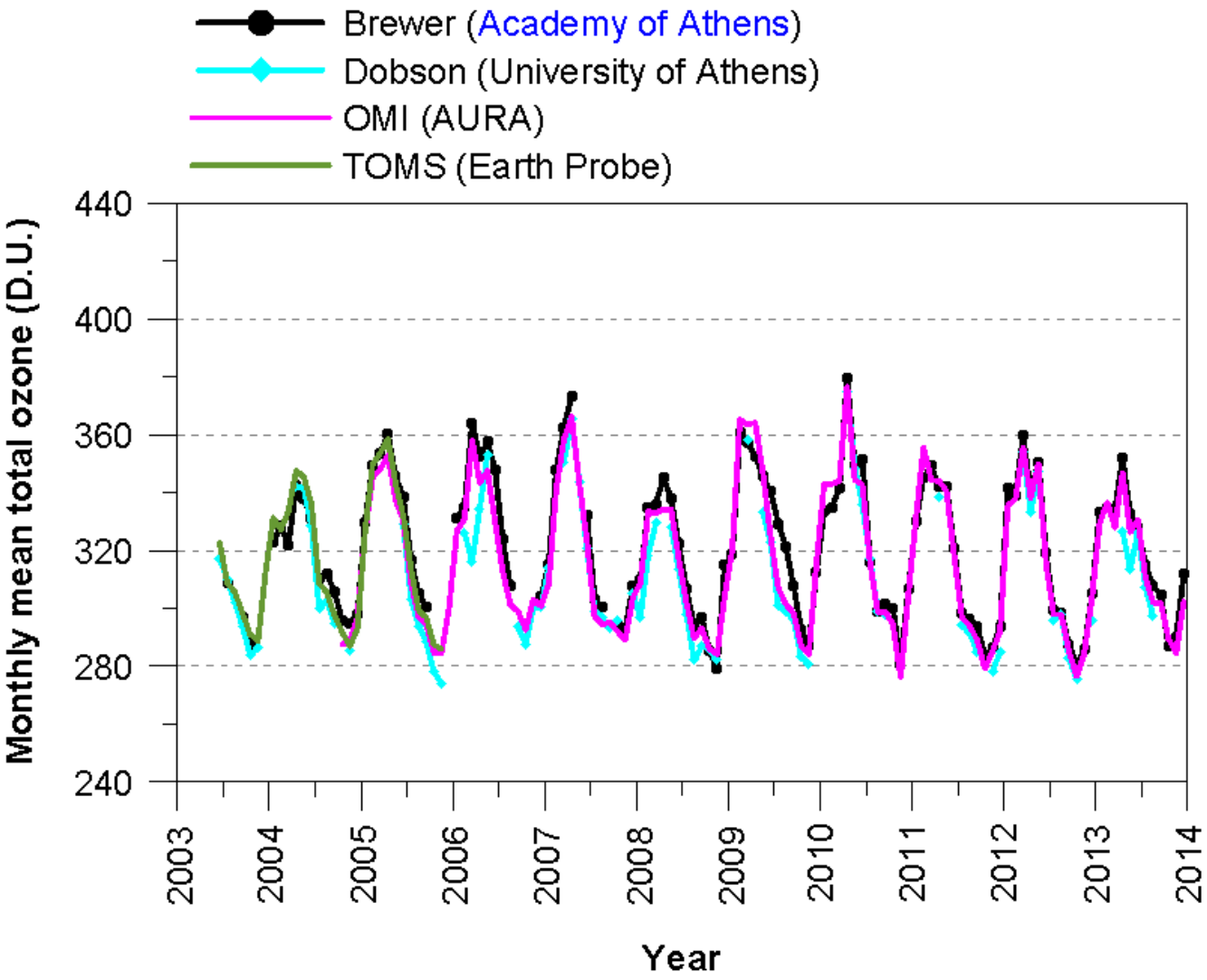
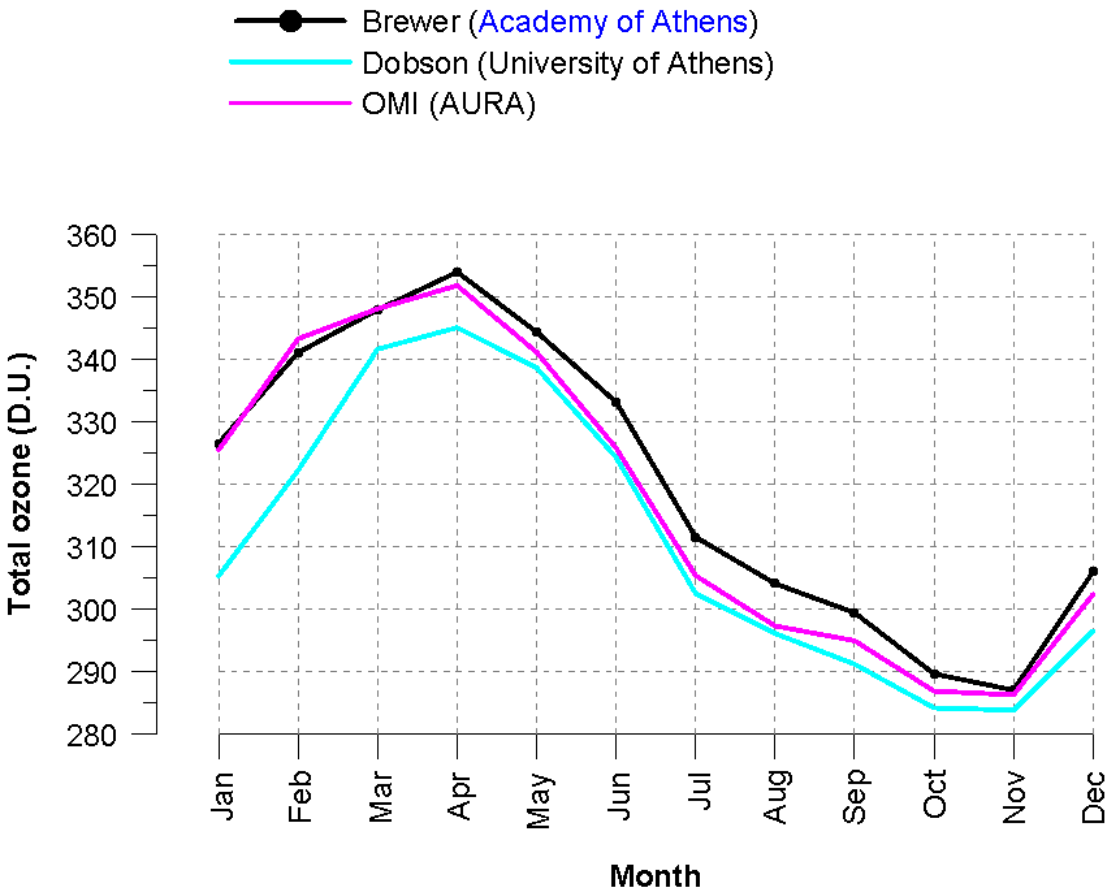


Brewer = 320 ± 24 DU
Dobson = 311 ± 22 DU
OMI = 317 ± 25 DU
TOMS = 319 ± 23 DU

Fig. 7: Annual cycle of total ozone over Athens, Greece (2003-2013)



	Brewer-Dobson	Brewer-OMI	Dobson-OMI
Jan	6.5% (21 DU)	0.3% (1 DU)	-6.6% (-20 DU)
Feb	5.5% (19 DU)	-0.6% (-2 DU)	-6.5% (-21 DU)
Mar	1.8% (6 DU)	0.0% (0 DU)	-1.9% (-6 DU)
Apr	2.5% (9 DU)	0.6% (2 DU)	-2.0% (-7 DU)
May	1.7% (6 DU)	0.9% (3 DU)	-0.7% (-2 DU)
Jun	2.7% (9 DU)	2.2% (7 DU)	-0.5% (-2 DU)
Jul	2.9% (9 DU)	2.0% (6 DU)	-0.9% (-3 DU)
Aug	2.6% (8 DU)	2.2% (7 DU)	-0.4% (-1 DU)
Sep	2.7% (8 DU)	1.5% (4 DU)	-1.3% (-4 DU)
Oct	1.9% (5 DU)	1.0% (3 DU)	-0.9% (-3 DU)
Nov	1.1% (3 DU)	0.3% (1 DU)	-0.9% (-2 DU)
Dec	3.1% (9 DU)	1.2% (4 DU)	-2.0% (-6 DU)
Mean	**2.9% (9 DU)**	**0.9% (3 DU)**	**-2.1% (-6 DU)**

(~ 1 % = ~ 3 DU)

Fig. 8: Study the effect of known natural fluctuations (QBO, ENSO, NAO, solar cycle)

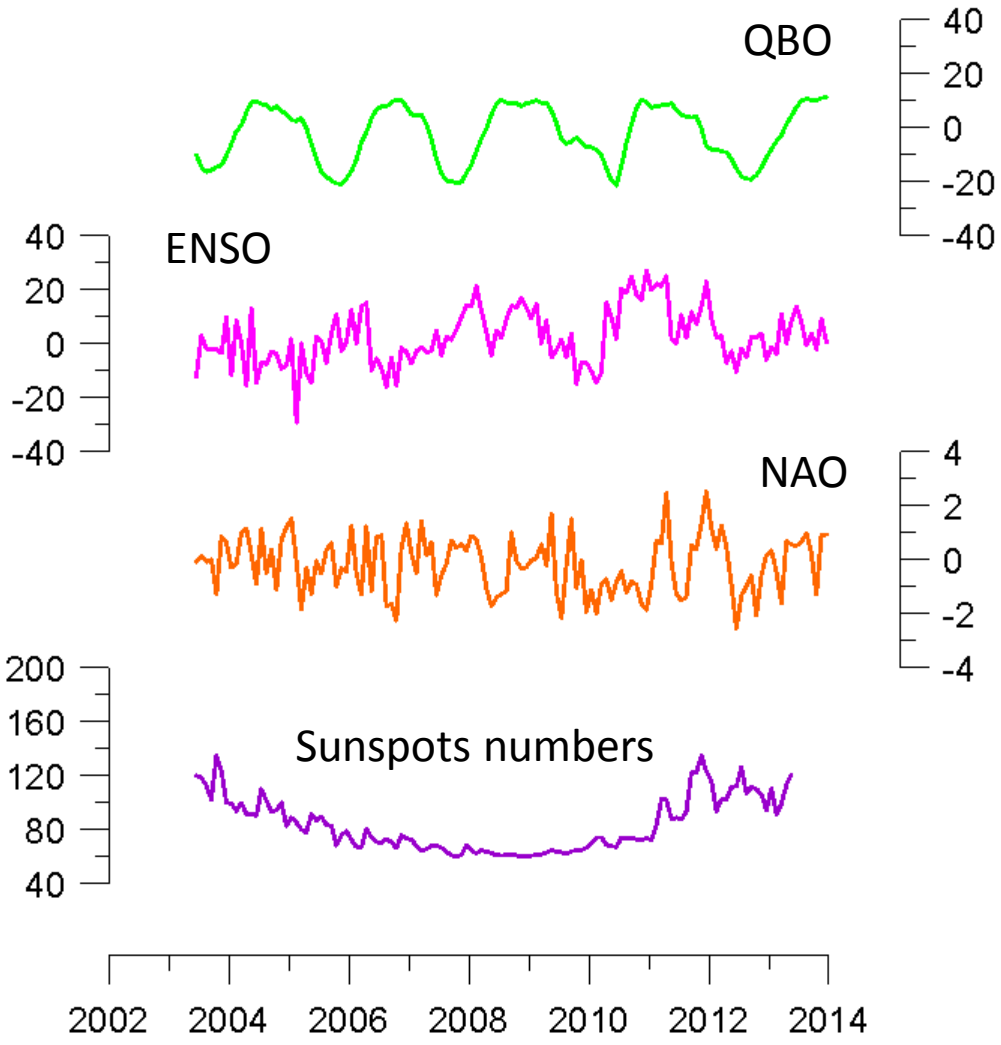
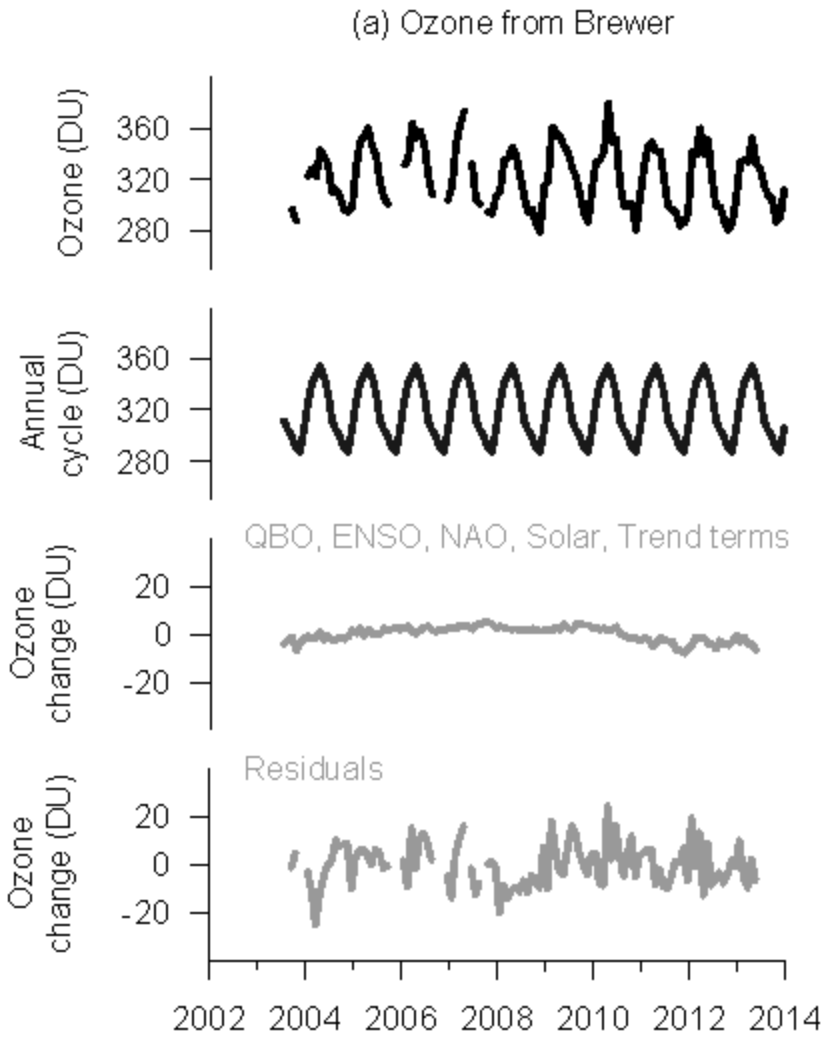


Fig. 9: Variability in total ozone



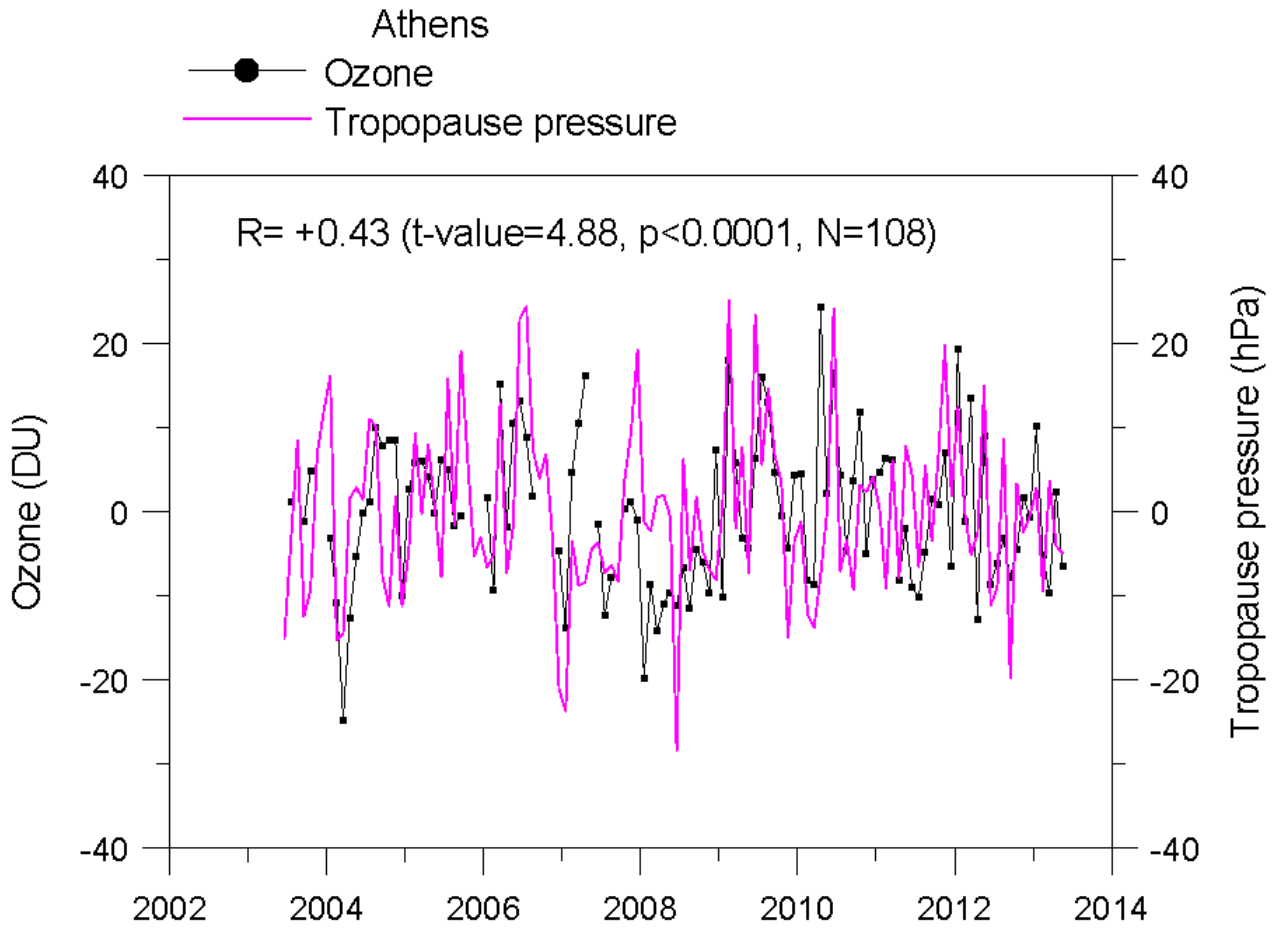
Amplitude = 33 DU

66% of the total variance

Amplitude = 7 DU

10% of the total variance

Fig. 10: Correlation with tropopause variability
(seasonal, QBO, ENSO, NAO, solar cycle and trend effects removed)



Conclusions

We have analysed 10 years of measurements of total ozone over Athens, Greece, by a Brewer spectrophotometer. Preliminary results indicate:

- Strong correlations between total ozone from Brewer, Dobson and satellites (OMI, TOMS) of about 0.9.
- Seasonal variability explain 66% of the variability in total ozone over Athens.
- Natural fluctuations (QBO, ENSO, NAO, solar cycle, trend) explain 10% of the total ozone variability.
- Correlations between total ozone and tropopause pressure variability are the order of 0.4.