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Past ozone cross–section transitions in Total Ozone measurements

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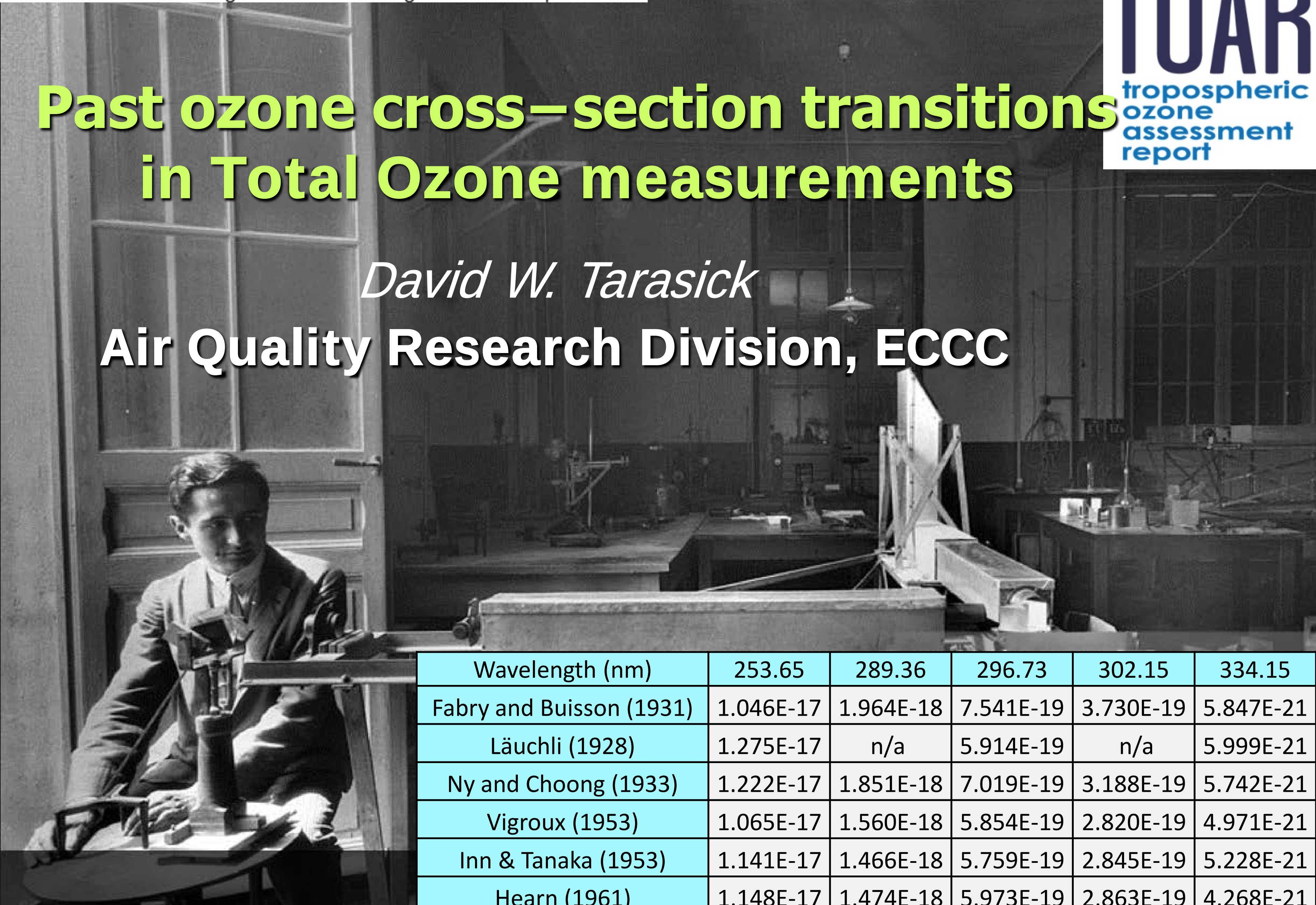
Wavelength (nm)	253.65	289.36	296.73	302.15	334.15
Fabry and Buisson (1931)	1.046E-17	1.964E-18	7.541E-19	3.730E-19	5.847E-21
Läuchli (1928)	1.275E-17	n/a	5.914E-19	n/a	5.999E-21
Ny and Choong (1933)	1.222E-17	1.851E-18	7.019E-19	3.188E-19	5.742E-21
Vigroux (1953)	1.065E-17	1.560E-18	5.854E-19	2.820E-19	4.971E-21
Inn & Tanaka (1953)	1.141E-17	1.466E-18	5.759E-19	2.845E-19	5.228E-21
Hearn (1961)	1.148E-17	1.474E-18	5.973E-19	2.863E-19	4.268E-21



Buisson apparatus to measure atmospheric ozone. Marseilles (Bouches-du-Rhone), 1928.

Early measurements of coefficients varied often by 20-30%

Wavelength (nm)	253.7	263.3	265.2	269.9	275.2	280.4	289.4	292.5	296.7	302.2	302.5	312.5	334.2
Fabry and Buisson (1931)	0.93	0.93	0.97	1.00	0.94	1.14	1.10	1.09	--	1.08	1.11	1.04	0.97
Läuchli (1928)	1.14	--	1.12	--	--	1.01	--	--	0.96	--	--	1.13	1.22
Ny and Choong (1933)	1.09	--	--	--	--	--	1.20	--	1.14	1.05	--	--	1.16
Vigroux (1953)	0.95	--	--	--	--	--	1.01	--	0.95	0.93	--	--	1.01
Inn & Tanaka (1953)	1.02	1.00	1.02	0.97	0.98	0.95	0.95	0.95	0.94	0.94	0.94	1.04	1.06
Hearn (1961)	1.02	--	--	--	--	--	0.96	--	0.97	0.94	--	--	0.97
Mauersberger et al. (1986)	1.01	--	--	--	--	--	--	--	--	--	--	--	--
Malicet et al. (1995)	1.01	--	--	--	--	--	0.98	--	1.00	0.98	--	--	0.95
Gorshelev et al. (2014)	1	1	1	1	1	1	1	1	1	1	1	1	1
Viallon et al. (2015)	1.00	--	--	--	--	--	--	--	--	--	--	--	--
Hodges et al. (2019)	1.01												

[*Tarasick, Galbally et al.*, 2019]

Global total ozone observations

- Fabry and Buisson 1913
- Early network total ozone measurements:
  - 1926-29 (Dobson): sites in UK, Europe, Chile, India, Egypt, USA, NZ.
  - Expanded 1930-57
- 1948: International Ozone Commission (IOC)
- 1957: Global network formally established as part of IGY

"The first spectrograph was built in the summer of 1924 at Dobson's laboratory and workshop in a hut built for the purpose in the grounds of his home, Robin Wood, Boars Hill, near Oxford. Extensive measurements made from Boars Hill during 1925 established the main features of the seasonal variation of ozone, the maximum in the spring and the minimum in the autumn, and also demonstrated the close correlation between ozone amount and the meteorological conditions in the upper troposphere and lower stratosphere."

So … if you're dedicated … it is possible to work from home even if you're doing groundbreaking experimental work.

Ozone absorption coefficients for total ozone

- Early network total ozone measurements (Dobson) used Ny and Choong (1933)
- During IGY, Vigroux (1953) adopted; older values converted by multiplying by 1.36
- Inconsistencies in ozone values from different wavelength combinations prompted modified Vigroux (1967) coefficients; adopted in 1968
- These changes affected Dobson spectrometer measurements made with some wavelength pairs
- Bass and Paur (1985) coefficients formally adopted in 1992

Ozone absorption coefficients for total ozone

- Brewer spectrometers (now standard, then new) already used BP coefficients
- Effective BP absorption coefficients for Dobson spectrometers, weighted with the instrument slit function, at an ozone-weighted mean atmospheric temperature, were published (IOC, 1991; Komhyr et al., 1993)
- BP coefficients adjusted to account for the temperature dependence (Barnes and Mauersberger, 1987) of the Hearn (1961) 253.7 nm coefficient.

Ozone absorption coefficients for total ozone

- Most pre-1992 Dobson values in the World Ozone and UV Data Centre were adjusted downwards by 2.6% (coordinated by WOUDC)
- Some C- & CD-pair observations that used Vigroux (1953) corrected by 4.1% and 7.5%
- Errors estimated at <0.3%
- Filter ozonometer measurements, linked to Dobson AD values, were also corrected by 2.6%
- No problems ensued…

Current situation

- Bass and Paur (1985) measurements are relative to the Hearn (1961) value for the 253.7 nm coefficient, adjusted to account for its temperature dependence (Barnes and Mauersberger, 1987).
- Both Dobson and Brewer instruments currently use BP coefficients, so a change from Hearn will affect total ozone measurements
- *But*… GAW Report #218: Absorption Cross-Sections of Ozone (ACSO), 2015; recommends use of Serdyuchenko et al. (2014), and Gorshelev et al. (2014)

More recent work

Orphal, et al., 2016. Absorption Cross-Sections of Ozone in the Ultraviolet and Visible Spectral Regions – Status Report 2015. *J. Mol. Spectroscopy.* **327:** 105-121. doi:10.1016/j.jms.2016.07.007.

(a) BP (1985) should no longer be used …

(b) The data of SER (2014) are recommended … When SER (2014) is used, the difference between total ozone measurements of Brewer and Dobson instruments are very small and the difference between Dobson measurements at AD and CD wavelength pairs are diminished.

(c) For ground-based LIDAR measurements the use of BDM (1995) or SER (2014) is recommended.

(d) For satellite retrieval the … data of BDM (1995) should be used ... due to a deficiency in the signal-to-noise ratio in the SER (2014) dataset.

Other remarks...

- ACSO recommendations not implemented yet, so ground-based observations (WOUDC) still use BP coefficients
- Revision is a complex process & instrument dependent: slit functions; optical path, stray light (*e.g.* Moeini et al., 2019)
- All historical data will need to be reprocessed! Data critical for trends (*e.g.* to evaluate Montreal Protocol), also satellite validation.
- Change will improve agreement of potassium iodide ozonesondes (currently sondes measure ~1-5% too high in the troposphere).

References

Komhyr, W.D., Mateer, C.L., and Hudson, R.D. (1993), Effective Bass-Paur 1985 ozone absorption coefficients for use with Dobson ozone spectrophotometers, *J. Geophys. Res.*, *98*(D11), 20451– 20465, doi:10.1029/93JD00602.

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