Accurate Monitoring of Surface Ozone
Virtual Workshop
5-9 October 2020

Implementing a Globally Coordinated Change in Ozone Cross Section Value for Surface Ozone Monitoring

Paul Brewer
5 October 2020
Introduction


• Powerful oxidant, can impair the functioning of the human respiratory and cardiovascular systems
• Ozone pollution can affect the main ecosystem services provided by terrestrial plants
• Many countries have implemented ozone air quality standards for the protection of human health
• Role in climate
Ozone cross section at 254 nm (air)

Why is accuracy important?

- Comparable and accurate measurements of atmospheric ozone concentrations essential for human health and the environment
- Prevalence of standards and instruments based on the absorption of UV radiation at the mercury-line wavelength of 253.65 nm (air) for amount fraction measurements of surface ozone
- The uncertainty in the value of the ozone absorption cross-section per molecule is the biggest impediment to achieving accurate and SI-traceable values from ozone reference photometers that are useful to end users
- The value is an important anchor point for referencing the absorption cross-sections of ozone throughout the electromagnetic spectrum

Why change?

- Ozone cross-section data (at 254 nm) suggests that historical data is biased by about 2%, confirmed by non-UV absorption measurements (Gas Phase titration)
- Recommendations of ACSO – change consistent with expected changes in values at other wavelengths
CCQM task group

Traceability for surface ozone measurements is established through ozone reference photometers, and the GAWG is the expert body in CCQM to recommend values for use in BIPM.QM-K1

- Established under the CCQM Gas Analysis Working Group
- Recommend SI-traceable value and uncertainty for O₃ cross section at 253.65 nm (air)
- Compare, evaluate, and review O₃ absorption cross section data in the scientific literature
- Assess completeness of the uncertainty budgets and quantify possible biases in published values
- Scientifically rigorous strategy to yield the recommended cross section and combined uncertainty
- Summarise results in an appropriate peer-reviewed journal
- Inform CCQM-GAWG regarding the recommended value for use in future BIPM.QM-K1 comparisons
CCQM task group

<table>
<thead>
<tr>
<th>Ref.</th>
<th>$\sigma \left(10^{-17} \text{ cm}^2/\text{molecule}\right)$</th>
<th>w.r.t. to Hearn</th>
<th>rel. std. unc. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^1$Hearn-61</td>
<td>1.147</td>
<td></td>
<td>1.9</td>
</tr>
<tr>
<td>$^2$ACSO/GAW</td>
<td>1.137</td>
<td>-0.9 %</td>
<td>0.8</td>
</tr>
<tr>
<td>This work</td>
<td>1.1329</td>
<td>-1.23 %</td>
<td>0.31</td>
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Recommendation of a consensus value of the ozone absorption cross-section at 253.65 nm based on a literature review


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Abstract
A detailed review and analysis of literature values for the absorption cross-section of ozone at 253.65 nm was undertaken. A total of 14 independent sets of measurements spanning the years 1990-2016 were considered. The present analysis is based upon a revised assessment of all Type A and Type B uncertainty components for each previously reported cross-section. A consensus value for the absorption cross-section of ozone at 253.65 nm is recommended, which is consistent with calculations based on statistical analysis of the weighted data. This new cross-section value is 1.27% lower and its uncertainty is 0.0035 x 10^-10 cm^2 smaller than the uncertainty of the conventionally accepted reference value reported by Heinm (1969, Proc. Phys. Soc. 78: 932-940).

Keywords: ozone, absorption cross-section, reference data, troposphere.

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CCQM task group

Paper published in Metrologia

CCQM-20/30 Recommendation document approved by the CCQM in September

• The 2019 value of $1.1329 \times 10^{-17}$ cm$^2$ and standard uncertainty $0.0035 \times 10^{-17}$ cm$^2$ be adopted for the ozone absorption cross-section per molecule at 253.65 nm (air) for use in ozone measurement standards maintained at the BIPM and for the calculation of the reference value for the BIPM.QM-K1

• The BIPM and the NMI work with the atmospheric monitoring community and other stakeholders towards a global implementation of the 2019 value

• The date of implementation of the 2019 value for the ozone absorption cross-section per molecule at 253.65 nm (air) be decided after consultation with stakeholder communities
Workshop Aims

To develop a plan and timetable for a globally coordinated and universal implementation of the ozone absorption cross-section value at 253.65 nm, published in 2019, for the measurement of surface ozone concentrations around the world.

Open sessions

5 October Surface Ozone Measurements and its Impact
6 October International Standards, Calibration Services and Monitoring Networks
7 October Air Quality Normative Aspects, Ozone Analyser Manufacturing

Task groups

<table>
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<tr>
<th>1 Identifying and implementing change</th>
<th>2 Time line for change</th>
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<tbody>
<tr>
<td>How do we clearly identify the change being made?</td>
<td>How much time is required to prepare for change?</td>
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<td>Will a change be mandatory or voluntary?</td>
<td>What is a reasonable implementation date and schedule?</td>
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<th>3 Communicating change</th>
<th>4 Managing change</th>
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<tbody>
<tr>
<td>How do we best publicise the change and its date/schedule?</td>
<td>How do we best identify risks in making the change and mitigate them?</td>
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<tr>
<td>What information needs to be provided for stakeholders?</td>
<td>How do we deal with historic data?</td>
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8 October Breakout Sessions for Task Groups
9 October Feedback from Task Groups, Conclusions and Recommendations
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Acknowledgements

CCQM-GAWG Ozone Task Group

Workshop Steering Committee Members
P Brewer (NPL) | J Viallon (BIPM) | R.I. Wielgosz (BIPM) | S. Lee (KRISS) | I Chubchenko (VNIIM) | J Carney | J.T. Hodges | J Norris (NIST) | K Saarnio (FMI) | N Ntsasa (NMISA) | A Borowiak (JRC)