Carbon Monoxide Photoproduction In Open Ocean Waters

Aron P. Stubbins, 1,2 and Günther Uher1, C. S. Law3,4, K. Mopper2, C. Robinson3 and R. C. Upstill-Goddard1

1 School of Marine Science & Technology, University of Newcastle, Newcastle upon Tyne, United Kingdom (guenther.uher@ncl.ac.uk)
2 Now at: Department of Chemistry and Biochemistry, Old Dominion University, Norfolk, Virginia, 23529, USA
3 Plymouth Marine Laboratory, The Hoe, Plymouth, PL1 3DH, UK,
4 Now at: NIWA, PO Box 14 901, Wellington, New Zealand

Study Areas

[Image of study areas]

We combined apparent quantum yields (AQYs) of CO photoproduction with coloured dissolved organic matter (CDOM) absorbance data determined with a 2 m pathlength instrument (WiP Ultrapath UV) to obtain CO AQY spectra for open ocean waters (B, C).

Solar irradiance

Estimating global open ocean photoproduction further required latitudinal irradiance data:

\[ \sum \text{irradiance} \times \text{absorption} / \text{ATotal} \times \left[1 - 10^{-\text{ACDOM}}\right] \times \text{AQY}_{CO} \]

Modelling solar irradiance was obtained using SMARTS-2 and the older GC-SOLAR. We further considered non-spectral corrections for cloud cover and seawater albedo.

Light absorbance

[Graph showing light absorbance]

CDOM absorbance along AMT 15 in the Atlantic was low, but dominated seawater absorbance in the UV. Parallel measurements of filtered (0.1 μm) and unfiltered seawater allowed quantification of particulate absorbance.

Apparent quantum yields

[AQYs of CO photoproduction from the Tyne estuary decreased approximately linearly with salinity and coloured dissolved organic matter (CDOM) absorbance.]

We AQYs of CO photoproduction from the Tyne estuary decreased approximately linearly with salinity and coloured dissolved organic matter (CDOM) absorbance.

CO AQYs were extrapolated to average CDOM absorbance from cruise AMT 15, and their wavelength dependence parameterised by 2 power fits joining at 345 nm. We found good agreement with previous work and slightly higher AQYs above 360 nm.

Table 1. Estimates of global CO photoproduction from apparent quantum yield spectra.

<table>
<thead>
<tr>
<th>Source</th>
<th>This work</th>
<th>Zafirou (2003)</th>
<th>Ziaiowski (2001)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMARTS-2</td>
<td>49</td>
<td>38</td>
<td>45</td>
</tr>
<tr>
<td>GC-Solar</td>
<td>54</td>
<td>39</td>
<td>54</td>
</tr>
<tr>
<td>Overall average</td>
<td>47 ± 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conclusions

Our estimates of CO photoproduction varied little with changes in irradiance and AQYs, and fall towards the low end of previous estimates. Given the similarities between CO and CO2 photorelease, we suggest that DOM photoremoval is lower than previously thought.

Many thanks to captain and crew of RRS Discovery during AMT-15; UKORS technical staff (Dawid Mavensfield, Jon Short), Xiang Sun Xie, Lari Ziaiowski, Oliver Zafirou, and Richard Zapp. Funding: UK-NERC Atlantic Marine Pelagic Transect consortium (NERC/01/3/2001/00680) and GRS/13165; US-NSF (OCE0240946 & OCE0274223); University of Newcastle upon Tyne, UK.