The influence of environmental drivers on the enrichment of organic carbon in the sea surface microlayer and in submicron aerosol particles

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The export of organic matter from ocean to atmosphere represents a substantial carbon flux in the Earth system, yet the impact of environmental drivers on this transfer is not fully understood. This work presents dissolved and particulate organic carbon (DOC, POC) concentrations, their enrichment factors in the sea surface microlayer (SML), and equivalent measurements in marine aerosol particles across the Atlantic Ocean. High DOC and POC enrichment factors were observed when samples had low concentrations, and lower enrichments when concentrations were high. The impacts of wind speed and chlorophyll-a levels on concentrations and enrichment of DOC and POC in seawater were insignificant. In ambient submicron marine aerosol particles the concentration of water-soluble organic carbon was approximately 0.2 µg m^{-3}. Water-insoluble organic carbon concentrations varied between 0.01 and 0.9 µg m^{-3}, with highest concentrations observed when chlorophyll-a concentrations were high. On the basis of the present ambient concerted measurements, enrichment factors for DOC and POC in ambient marine aerosol particles, hitherto not reported in the literature, were obtained. They ranged from 10^3 to 10^4 during periods of low chlorophyll-a concentrations and up to 10^5 when chlorophyll-a levels were high. The results obtained in the present study support the thesis that elevated local biological activity (as indicated by chl-a concentrations) enhances (primary) organic carbon concentration on aerosol particles. These field results furthermore support the thesis of a chemo-selective transfer of organic compound groups, which has been reported in the framework of studies using artificial bubbling devices. However, a prediction of the WISOC measurement results (transferred to $OMss_A$) by source functions based on wind speed and chl-a levels showed a strong underestimation of $OMss_A$ in oligotrophic regions, especially at high wind speeds. For the North and Central Atlantic Ocean there may be additional parameters – either connected to biological factors not served by chl-a level as an indicator or to factors of a different nature – that must be taken into consideration in order to accurately predict the organic fractions on aerosol particles.