Spatial patterns in CO_2 evasion from the global river network

R. LAUERWALD[12]*, G. G. LARUELLE[1], J. HARTMANN[3], P. CIAIS[4] AND P. REGNIER[1]

[1]Department of Earth and Environmental Sciences, Université Libre de Bruxelles, 1050 Brussels, Belgium (*correspondence: ronny.lauerwald@ulb.ac.be)
[2]Institut Pierre-Simon Laplace, CNRS – FR636, 78280 Guyancourt cedex, France
[3]University of Hamburg, Institute for Geology, 20146 Hamburg, Germany
[4]LSCE IPSL, UMR8212, F-91191 Gif Sur Yvette, France

CO_2 evasion from rivers (FCO_2) is an important component of the global carbon budget. Here, we present the first global maps of CO_2 partial pressures (pCO_2) in rivers and the resulting FCO_2 at 0.5° resolution constructed with a statistical model. We first derived a pCO_2 prediction function trained on data from 1182 sampling locations covering the full spectrum from high to low latitudes. The predicted pCO_2 map was then combined with spatially explicit estimates of stream surface area A_{river} and gas exchange velocity k calculated from published empirical equations and data sets to derive the FCO_2 map.

At the global scale, we estimate an average river pCO_2 of 2400 (2019-2826) μatm and a FCO_2 of 650 (483-846) Tg C yr^{-1} (5^{th} and 95^{th} percentile of confidence interval). Our maps reveal strong latitudinal gradients in pCO_2, A_{river} and FCO_2. The zone between 10°N and 10°S contributes about half of the global CO_2 evasion. Collection of pCO_2 data in this zone, in particular for African and South East Asian rivers is a high priority to reduce uncertainty on FCO_2. Additionally, we also used our model to simulate projections of the gobal pCO_2 and FCO_2 distribution in the year 2100 following the IPCC scenario RCP8.5. We predict an increase in CO_2 evasion of about 60% compared to present-day conditions, due to the combined effects of ice and snow cover, changes in temperature, terrestrial NPP and population density.