Riverine Carbonate System, CO_2 Partial Pressure and CO_2 Emission from a Subtropical Karst River Network, South China

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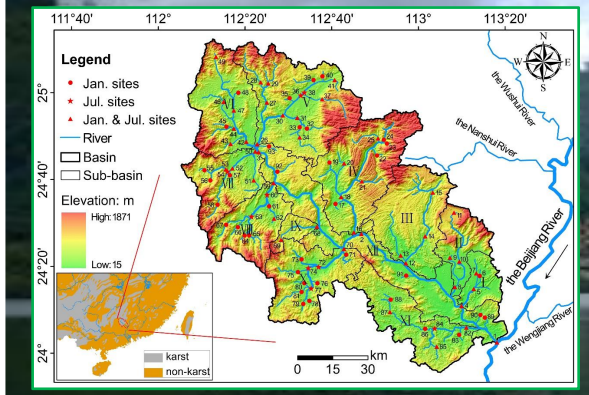
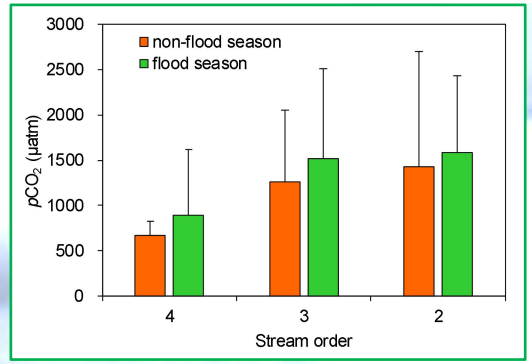
Introduction

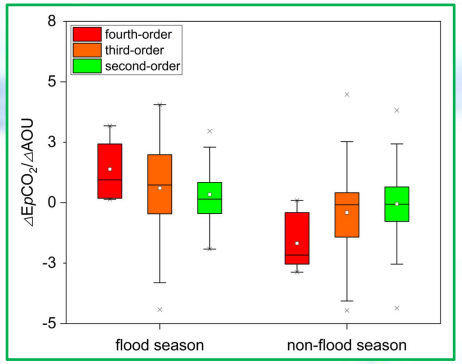
Understanding the CO_2 emissions from low-order river and stream is of great significance to the global carbon budget and climate change research.

We sampled and analyzed the chemical composition of runoff in multiple sections (84 sections in January and 55 sections in July 2018, respectively) along the mainstream and tributaries of the Lianjiang River, the largest tributary of the Beijiang River (a tributary of the Pearl River) flowing through a karst area in South China.

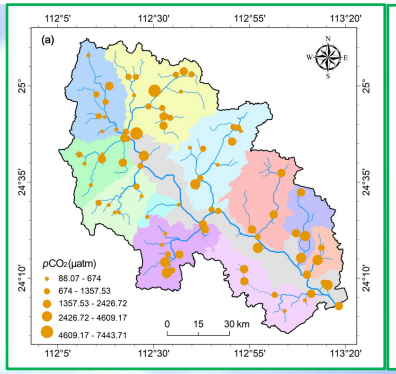
Systematically studied the carbonate system of the river water using the CO2SYS program. The formation of CO_2 in river were analyzed, the CO_2 degassing flux through the water-air interface was calculated, and the significance of CO_2 degassing was evaluated.

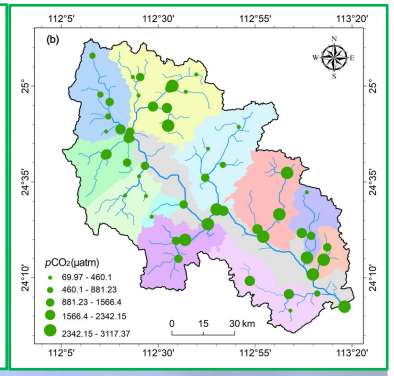






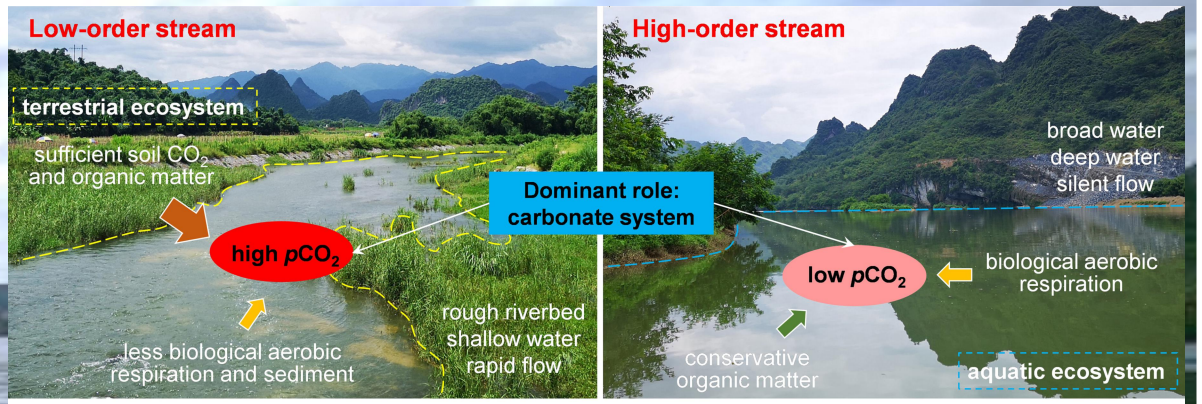
pCO_2 and $\Delta Ep CO_2/\Delta AOU$ in the Lianjiang River Network





River	Climate	FCO_2 (mmol/m²/d)	References
Large rivers			
Québec rivers	Temperate	16.2	Teodoru et al., 2009
Hudson River	Temperate	26.5	Li et al., 2013
Ottawa River	Temperate	80.8	Telmer and Veizer, 1999
Yangtze River	Subtropical	93.97	Wang et al., 2007
Yukon River	Temperate	171.2	Striegl et al., 2012
Elbe River	Temperate	180	Frankignoulle et al., 1998
Lower Mekong River	Tropical	194.5	Li et al., 2013
Yellow River	Temperate	201.1	Ran et al., 2013
Mississippi River	Subtropical	270	Li et al., 2013
Xijiang River	Subtropical	272.6	Yao et al., 2007
Amazon River	Tropical	327	Alin et al., 2011
African inland rivers	Tropical	667.5	Borges et al., 2015
Mesoscale rivers			
LR	Subtropical	35.04	this study
Hongshuihe River	Subtropical	43	Xu and Liu, 2010
Beipanjiang River	Subtropical	78	Zou, 2016
Eastmainopomoca rivers	Temperate	78.4	Richey et al., 2002
Alps rivers	Temperate	188	Schelker et al., 2016
Thames River	Temperate	290.14	Frankignoulle et al., 1998
Eastern Malaysia	Tropical	758.3	Müller et al., 2015
Global average		70.7	Lauerwald et al., 2015

Global riverine CO_2 degassing rates through the water-air interface



pCO_2 declines with the increase of Horton stream order in both seasons (without considering the first-order stream), riverine carbonate system dominates the spatial pattern of pCO_2.

Conclusions: (1) The pCO_2 is respectively 1282±1030 and 1390±949 μatm in the non-flood and flood season and lower than the global average of 2400 μatm. The pCO_2 shows a spatial pattern of "lower in upstream and higher in downstream" in the mainstream and main tributaries, and descends with the increase of stream order from the classification of river networks. (2) pCO_2 across the river system in non-flood season is not evidently affected by biological aerobic respiration and the effect on fourth-order stream is more prominent in flood season based on the comparison of $\Delta Ep CO_2/\Delta AOU$ ratios. $pCO2$ is positively correlated with TAlk., H_2CO_3* and TDS, and negatively correlated with water pH in both seasons, and the riverine carbonate system constrained by chemical weathering of carbonate rocks is the controlling factor of the pCO_2 in the LR, which contribution rate is more than 60%. (3) The CO_2 outgassing rate through the water-air interface is 35.04 mmol/m²/d, which is much lower than those of large rivers all over the world. Subtropical mesoscale karst rivers, such as the LR, the Hongshuihe River and the Beipanjiang River, are characterized by lower CO_2 outgassing rates worldwide and poor sources of atmospheric CO_2, which is inconsistent with the usual belief and should be given necessary attention in the accurate evaluation of global carbon budget.

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