

**Surface partial pressure of CO₂ off the Galician coast:
Overview of data obtained during the OMEX project**

Alberto Borges & Michel Frankignoulle

University of Liège - Chemical Oceanography Unit
<http://www.ulg.ac.be/oceanbio/co2>

Introduction: The role in the global carbon cycle of continental shelf seas influenced by seasonal upwelling remains controversial because they are sites of processes that have antagonist effects on the flux of CO₂ across the air-sea interface. Upwelling brings to the shelf, water oversaturated in CO₂ with respect to the atmosphere. This water also has an important nutrient content which enhances primary production that in turn reverses the air-sea gradient of pCO₂. To improve our understanding of these regions more field data is needed with an adequate resolution at both daily and seasonal time scales. The net annual air-sea flux of CO₂ can then be estimated from calculations using wind speed, salinity and water temperature. The main objective of the University of Liège in the OMEX project is to contribute to the understanding of inorganic carbon dynamics and identify sources/sinks for atmospheric CO₂. During the three years of the OMEX project, the University of Liège has participated on six cruises. The variability of the distribution of surface seawater pCO₂ and the physical and biological processes affecting it are discussed.

Methodology: The determination of pCO₂ in surface waters is carried out using a direct method that consists to equilibrate seawater with air and then measure CO₂ using an IR analyser.



Underway measurements during the Belgica 99/19 OMEX cruise

Results: The four cruises carried out during summer show, surprisingly, a consistent pattern in the distribution of surface parameters. Near the coast, we observed cool water related to upwelling in contrast with the warm offshore water. Off Cap Finisterre (43°N), oversaturation of pCO₂ with respect to the atmosphere was systematically observed in contrast to the strong undersaturation off the rias bajas region (42.1°N to 42.8°N). In offshore waters, moderate pCO₂ undersaturation was observed except in August when a low temperature and low pCO₂ tongue of water was distinctly observed corresponding to a very important upwelling filament. In September 99, the two legs of the cruise corresponded respectively to relaxation and upwelling conditions. During the first leg the water off Cape Finisterre were undersaturated in CO₂, as opposed to the second leg. The distribution of pCO₂ is controlled by two antagonistic processes: the input by upwelling of water with a high CO₂ content and primary production. Off Cap Finisterre, the input by upwelling of water with a high CO₂ content dominates primary production as opposed to the rias bajas region.

During the two winter cruises, the distribution of surface parameters is influenced by the poleward slope current. In January 98, the saltier and warmer tongue of water related to the poleward current appears very clearly and the fresh water input from the rias bajas was observed as well. During both cruises, undersaturation of pCO₂ was observed. In January 98, the lower pCO₂ values were observed in association to the plume of the rias bajas. These low pCO₂ values can be explained by the cooling of surface seawater. The decrease of temperature affects the equilibrium constants of inorganic carbon species in particular the solubility coefficient of CO₂ inducing the decrease of pCO₂ values.

Conclusions: The distribution of pCO₂ in the OMEX area is controlled by a complex combination of hydrodynamics (upwelling) and biological processes (primary production). During the upwelling season, the pattern of the pCO₂ distribution is relatively consistent from one cruise to another with oversaturation of pCO₂ off Cap Finisterre and undersaturation off the rias bajas region. During the downwelling season, the pattern of the pCO₂ distribution depends on the poleward current and the on the input from the rias bajas.

Acknowledgments: We thank officers and crew of the Belgica, Charles Darwin and Meteor for warm welcome on board, UGMM (Belgium), RVS (United Kingdom) and BSH (Germany) for TSG data, Jake Loncar and Alison Fairclough (BODC) for data management, Renzo Biundo, Claire Daemers and Emile Libert (University of Liège) for technical assistance.

