Abstract
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The air-sea fluxes of CO₂, hydrography and distribution of carbonate system parameters have been studied in two major upwelling foci off central (30°S) and northern Chile (23°S) during 1996 and 1997. The upwelling of cold and CO₂-rich subsurface waters maintains a higher fugacity of CO₂ (fCO₂) in the surface water than in the atmosphere, leading a strong CO₂ outgassing (Papers I-IV). Coastal CO₂ supersaturation can exceed 200% when deep, cold and salty water reaches the surface during wind-forced upwelling (Papers I and III). Wind-driven upwelling events occur on weather-related time scales (days), and lead to periods of intense upwelling and strong CO₂ outgassing, which can be followed by a relaxation in which the CO₂ outgassing is weak or even reversed to an uptake flux (Paper I). Upwelling events and the associated CO₂ outgassing have been observed during both winter and summer at 30°S (Paper IV), and even during warm El Niño periods (Paper II). However during austral summer, the surface water can be strongly stratified and undersaturated in CO₂, since the CO₂ uptake by phytoplankton exceeds the supply of CO₂ from deeper waters (Papers III and V). Off northern Chile between 29° and 24°S during austral summer 1997, biological uptake of CO₂ sequestering follows complex patterns associated with filaments of cold and phytoplankton rich surface waters, which contrast with the surrounding oligotrophic and CO₂-saturated open ocean subtropical waters (Paper V). The intensity of CO₂ outgassing caused by upwelling increases towards the south along north-central Chilean coast, following latitudinal gradients in the wind forcing of upwelling (Paper III).

Keywords: Carbon dioxide, coastal upwelling, air-sea exchange, Pacific Ocean, Chile, El Niño
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