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Synoptic events force biological productivity in Patagonian fjord ecosystems

Giovanni Daneri (1,2)

(1) Centro de Investigación en Ecosistemas de la Patagonia (CIEP) Chile (gdaneri@ciep.cl), (2) COPAS Sur Austral, Universidad de Concepción, Concepción, Chile

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Giovanni Daneri1,2, Ivan Perez Santos2,4, Paulina Montero1,2, Oscar Pizarro2,6, Marcelo Gutierrez2,4, Manuel Castillo2,6, Fabian Tapia2,4, Humberto Gonzalez2,5, Jose Luis Iriarte2,3, Silvio Pantoja2,4, David Crawford1.

1Centro de Investigación en Ecosistemas de la Patagonia (CIEP), Bilbao 323, Coyhaique, Chile
2Programa COPAS Sur–Austral, Universidad de Concepción, Concepción, Chile
3Instituto de Acuicultura, Universidad Austral de Chile, Puerto Montt, Chile
4Departamento de Oceanografia, Universidad de Concepción, Concepción, Chile
5Instituto de Biología Marina, Universidad Austral de Chile, Valdivia, Chile
6Departamento de Geofísica, Universidad de Concepción, Concepción, Chile

Abstract

The annual cycle of primary productivity of the Patagonian fjords has, to date, been described as a two phase system consisting of a short non productive winter phase (during June and July) and a productive phase extending from late winter (August) to autumn (May). Low levels of primary production, phytoplankton biomass and high concentrations of surface nutrients have been described as characterizing winter conditions while pulsed productivity events typifies the productivity pattern during the extended productive season.

Pulsed productivity events characterize coastal waters where inorganic nutrients in surface layers are replenished following periods of intensive utilization by autotrophs. Freshwater input in Patagonian fjords in southern Chile (41-55°S) results in one of the largest estuarine regions worldwide. Here strong haline water column stratification prevents nutrient mixing to the surface layers thus potentially shutting off algal production.

Our working hypothesis considered that in order to reconcile the observed pulsed productivity pattern, periodic breaking (associated to surface nutrient replenishment) and re-establishment of estuarine conditions (associated to water column stratification) would be required. Up to now however our understanding of the physical processes that control water column conditions in the Patagonian fjord area has been extremely limited.

Here we present evidence linking the passage of synoptic low pressure fronts to pulsed productivity events in the Patagonian fjord area. These front controls and influence local processes of interaction between the fjord and the atmosphere generating a rapid water column response. In the specific case of the Puyuhuapi fjord we have been able to show that such synoptic fronts induce surface flow reversal and water column mixing. Phytoplankton blooming occurs after the passage of the synoptic front once calmer conditions prevail and estuarine conditions are re established.

The occurrence of an extremely productive bloom of the dinoflagellate Heterocapsa sp. in July 2014, after the passage of a synoptic low pressure front provided, for the first time, strong evidence that phytoplankton blooming in the Patagonian fjord ecosystems is controlled by synoptic processes and that they are not limited by light as previously reported.

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