Toward better forecasting of fish resources

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The measuring instrument OCARINA during the oceanographic campaign AMOP. Credit: INSU / H. Barrois

Its turbid cold waters are home to the largest fish stocks in the world: the Humboldt Current system, which runs along the Peruvian and Chilean coasts, boasts exceptional biological productivity thanks to a very intense coastal upwelling phenomenon – ascents of deep nutrient-rich waters. Thanks to high-resolution models of the oceanic circulation and water oxygen content, IRD researchers and their partners have now quantified

this ecosystem's sensitivity to various disturbances in the equatorial Pacific. This work should eventually enable a regional modelling platform to be set up integrating the oceanic, biogeochemical and atmospheric components of the Peru-Chile upwelling.

A very special ecosystem

The Humboldt Current provides Peru and Chile with waters containing the largest fish stocks on the planet. This ecosystem, which alone provides 5 to 10% of the world's catches, owes its exceptional productivity to the nutrients provided by upwellings of deep, cold, nutrient-rich water along the coasts. But this phenomenon, called "upwelling" has a very variable intensity due to the variability of the currents in the Pacific Basin, to which other ocean and climate forcing mechanisms are added.

A low-oxygen zone maintained from the equator

To better understand how these mechanisms interact and influence the upwelling process and therefore the biological productivity of the Humboldt system, the IRD and its Peruvian partners, the IGP and the IMARPE, have been conducting modelling work since the 2000s. An initial high-resolution study shows that off Peru the ocean layer called "oxygen minimum" where life is limited is sensitive to the intensity of the seasonal current from the equator that brings water containing little oxygen to the coastal ecosystem. Thus, this current called "secondary Tsuchiya jet" indirectly impacts from the equator the fishery resources along the Peruvian and Chilean coasts.

Surface temperature controlled by coastal winds

A second modelling study provides information that gives a better

understanding of the biological response in Peru's upwelling to disturbances that occur in the equatorial Pacific. In particular, it shows that it is the action of coastal winds that regulates surface temperature variations off Peru, on timescales of around two months. Contrary to what researchers previously believed, at these frequencies, the equatorial ocean waves called Kelvin that spread from west to east across the whole of the Pacific ocean, have little effects on the surface. They do, however, spread along the coast at around 50 metres deep, modifying the vertical thermal structure along the way and thus modulating the mechanical action of the winds that generate the upwelling process in the Peruvian open sea.

All this modelling work, combined with in situ measurements (oceanographic campaigns recently carried out as part of the AMOP project) help improve our understanding of the interactions between biogeochemistry, atmospheric circulation and oceanic circulation. They should lead to a dynamic modelling platform being set up for the ecosystem, integrating key parameters which are oxygen, wind patterns and Kelvin waves, allowing potential changes in fish stocks to be predicted, particularly anchovy stocks.

More information: Montes I., Dewitte Boris, Gutknecht E., Paulmier Aurélien, Dadou I., Oschlies A., Garçon Véronique. "High-resolution modeling of the Eastern Tropical Pacific oxygen minimum zone: Sensitivity to the tropical oceanic circulation," *J. Geophys. Res. Oceans*, 119, DOI: 10.1002/2014JC009858.

Illig Serena, Dewitte Boris, Goubanova K., Cambon G., Boucharel J., Monetti F., Romero C., Purca S., Flores R. (2014), "Forcing mechanisms of intraseasonal SST variability off central Peru in 2000–2008," *J. Geophys. Res. Oceans,* 119, DOI: 10.1002/2013JC009779.

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