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Large hydrographical changes at the Bay of Biscay after the extreme winter mixing of 2005 from an open-ocean monthly time series of profiles.

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The Spanish Institute of Oceanography (IEO) has carried out since the late 1980's an oceanographic time-series monitoring program (RADIALES project, www.seriestemporales-ieo.net), which regularly occupies standard sections for hydrobiological sampling along the Spanish coast mainly covering the continental slope. Due to the proximity of the shelf-break in the South-eastern Bay of Biscay it was possible to set a monthly sampling of waters down to 1000 m depth. In 2003 a biannual series of cruises covering the whole water column and surrounding North and Northwest Spanish coast was added to the IEO monitoring strategy (VACLAN project, www.vaclan-ieo.es). These timeseries provide a tool for studying the hydrographical variability and tendencies in the water masses, timing properly any pronounced shift and thus allowing looking for the causes.

The most conspicuous shift observed in the series followed the extremely cold and dry winter of 2005 in south-western Europe. This event caused a profound transformation of the upper ocean hydrographical structure at the Bay of Biscay area, making it completely different than what it was in the previous decade. The strong local cooling and the precipitation deficit resulted in the highest density flux estimated since the sixties, which triggered the mixed layer to reach remarkable depths, affecting directly water levels of local East North Atlantic Central Water (ENACW) that are usually unconnected to air-sea interaction. As a result, the stratification of the upper permanent

thermocline was dramatically reduced. The water column between 200 and 300 dbar entered in a process of cooling from 2005 to 2006 which compensated in two years the 0.5ž C gained in the period 1994-2004. Local ENACW suffered a substantial structure and thermohaline properties modification that are currently ongoing. The event caused a downwards salt injection that made all ENACW and specially the salinity minimum level begin a process of warming by isopycnal change, something never observed during the 1990's for this deeper layer. The anomaly observed in the south-eastern corner of the Bay of Biscay had a substantial spatial extension and remained for two years below the seasonal thermocline development, constituting a typical case of re-emergence mechanism, but was abruptly interrupted in the warmest on record winter of 2007. Further the hydrographical changes, this event seems to have caused an important effect in the marine ecosystem. The extreme mixed layer depths reached in 2005 and 2006 ventilated the ENACW level favouring the supply of nutrients from this water mass into the mixed layer, causing a nutrient content increase in the upper layers and affecting the levels of biological activity with an enhancement in the primary production in this area.