



2013-2014 winter storms: climatological assessment and impacts upon the Cantabrian coastline (Northern Spain)

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The northern coast of the Iberian Peninsula experienced, during the 2013-2014 winter, an outstanding episode of coastal storminess. The impact of this episode on the coastal environment was remarkable: urban promenade seafronts were flooded, sediment remobilization ended into huge beach erosion, and many infrastructures suffered generalized damages. The total cost of the cleaning and reparation of the damages has been estimated by the Spanish authorities in more than 40 million euros.

A comprehensive analysis of oceanographic (tide gauges, buoys) and meteorological data (synoptic reports from stations, a circulation pattern catalogue and a cyclone track database, both derived from NCEP/REANALYSIS data) has been enterprise to characterize the event and to place it in relation with the recent climate evolution of the Gulf of Biscay area.

Three episodes of severe storminess can be detected during the 2013-2014 winter. An earlier stormy period, from mid-December 2013 to early January 2014, did not cause too much impact, because of the predominance of southerly flows upon northern Spain and the distance of the cyclone cores. The second episode, encompassing the end of January and the beginning of February, was much more severe, due to the combination of strong westerly winds and large waves, resulting from closer storm tracks. However, the most damaging episode occurred during the night of March 3th-4th, when a combination of a deep low crossing the Atlantic Ocean from Newfoundland, strong westerly winds developing a long fetch and a high sea level created waves in excess of 11 m of significant wave height, and a storm surge which flooded many areas along the northern coast of Spain.

A retrospective analysis of the atmospheric and oceanographic conditions associated with the winter 2013-2014 shows that the episode in the area was, indeed, remarkable. However, no extreme records were broken; instead, its exceptionality derived from the accumulation of energy during the whole period of storminess, characterized by the succession of storms. High seas (e.g. significant wave heights above 3 m) were persistent (almost 50 % of the time) and pushed by strong westerly and northwesterly winds, conditions embedded into a long term trend of sea level rise in the Gulf of Biscay area.