Plinius Conference Abstracts,
Vol. 11, Plinius11-168, 2009
11th Plinius Conference on Mediterranean Storms

Effects of storm events on the shelf-to-basin sediment transport in the southwestern end of the Gulf of Lions (Northwestern Mediterranean)

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Shelf-to-basin sediment transport during storms was studied at the southwestern end of the Gulf of Lions from November 2003 to March 2004. Waves, near-bottom currents, temperature and sediment fluxes were measured on the inner shelf at 28 m depth, in the Cap de Creus submarine canyon head at 300 m depth and in the northwestern Mediterranean basin at 2350 m depth. During this winter, there were high river discharges from December to February, two severe E–SE storms during which significant wave heights reached 8.4 m (3-4 December 2003) and 7 m (20-22 February 2004) and several moderate storms with significant wave heights between 2.5 and 4 m. During these storms, colder coastal water was exported off-shelf producing strong near-bottom currents (up to 82 cm s^{-1}) on the canyon head due to storm-induced downwelling, which was enhanced by dense shelf water cascading from January to May. These strong currents resuspended sediment on the Cap de Creus canyon head increasing the downcanyon sediment fluxes. In addition, the highest waves during the peak of the December and February severe storms also resuspended sediment on the canyon head and the adjacent outer shelf. Although similar significant wave heights were reached during both storms, the sediment flux increase in the canyon head was much larger (1-2 orders of magnitude) during the February storm than during the December storm. At the basin site, particle fluxes also increased drastically (1-2 orders of magnitude) immediately after the February storm and not during the December storm or the other moderate storms. One of the main differences between the two main storms was that the February event occurred during the dense shelf water cascading period, whereas the December event was at the end of the water stratification period, without cascading. The downwelling induced by the December storm resuspended the canyon head sediment, but it ended quickly and suddenly due to restoration of shelf water stratification and it was too short (9 h) to allow the advection of sediment resuspended on the shallow shelf to reach the canyon head. In contrast, the February event, reinforced by dense shelf water cascading, was long enough (43 h) to transfer large amounts of resuspended sediment from shallow shelf areas to the canyon head and from there to the basin. This storm resuspended and flushed out most of the material recently deposited on the continental shelf, after a major flooding season. Thus, in the western Gulf of Lions, severe (H_s >6m) winter E–SE storms associated with cascading, even if moderate, can cause significant sediment transport events able to reach the deep areas of the northwestern Mediterranean basin. The transferred material, including contaminants and organic matter, has still an unknown impact in the deep ecosystem.