"Shallow marine sedimentation and coastal stability under changing sea-level"

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Riassunto: Marine sediments play a fundamental role in reconstructing past ice-sheets fluctuations. These are responsible for global ocean volume variations that can be extracted from the isotope record and that also show up as relative sea-level (RSL) changes in the geomorphological and stratigraphic records. The consequent bathymetric variations, which result in changes of accommodation space and distance from shore, affect the deposition of marine sediments. The RSL changes that stem from the exchange of mass between the continental ice-sheets and the oceans are not globally uniform. According to the theory of glacial isostatic adjustment (GIA), the meltwater redistribution is accompanied by solid Earth deformations and perturbation of the gravity field. The GIA signal is a function of the ice-sheets thickness chronology as well as of the solid Earth's rheology and it strongly depends on the distance with respect to the ice sheets. In the proximity of a fluctuating ice sheet, the RSL changes are opposite in sign and up to one order of magnitude larger than the global average (eustatic). A clear example of this discordance is found in the geological record of the Eocene-Oligocene Transition (~34.0 Ma). The first appearance of the Antarctic Ice Sheet (AIS), in fact, was accompanied by a regressive phase in the northern hemisphere (~70 m RSL drop, Priabona, North Italy) while sediments were deposited and preserved in the proximity of the AIS margins (Wilkes Land, East Antarctica) in response to a local RSL rise (>100 m) and consequent increase of accommodation space. In this work the contribution of GIA-driven RSL changes in drawing the architecture of stratigraphic sections is investigated by means of a novel numerical modeling approach. The latter consists in the full coupling between a GIA model, which is based on the Sea Level Equation, and two sedimentation models that are based, respectively, on (i) fuzzy logic and on (ii) the numerical solution of the diffusion equation. Among the several variables that regulate marine sedimentation, changes in bathymetry and distance from shore and ice-sheet margin are directly linked to the gravitationally self-consistent RSL changes that are driven by GIA. The latter is also influenced by the load of the sediments that contribute to solid Earth and gravitational perturbations. The proposed algorithm, therefore, handles the biunivocal relationship between RSL changes and sediment loading in a synergistic manner. Preliminary results show that the reconstructed ice-proximal stratigraphic sections, either based on fuzzy logic or diffusion, are significantly affected by the GIA process and that the eustatic approximation should be discarded. This model is proposed as a tool for the geology community.