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Future sea-level rise in the Mediterranean Sea

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Secular sea level variations in the Mediterranean Sea are the result of a number of processes characterized by distinct time scales and spatial patterns. Here we predict the future sea level variations in the Mediterranean Sea to year 2050 combining the contributions from terrestrial ice melt (TIM), glacial isostatic adjustment (GIA), and the ocean response (OR) that includes the thermal expansion and the ocean circulation contributions. The three contributions are characterized by comparable magnitudes but distinctly different sea-level fingerprints across the Mediterranean basin. The TIM component of future sea-level rise is taken from Spada et al. (2013) and it is mainly driven by the melt of small glaciers and ice caps and by the dynamic ice loss from Antarctica. The sea-level fingerprint associated with GIA is studied using two distinct models available from the literature: ICE-5G(VM2) (Peltier, 2004) and the ice model progressively developed at the Research School of Earth Sciences (RSES) of the National Australian University (KL05) (see Fleming and Lambeck, 2004 and references therein). Both the GIA and the TIM sea-level predictions have been obtained with the aid of the SELEN program (Spada and Stocchi, 2007). The spatially-averaged OR component, which includes thermosteric and halosteric sea-level variations, recently obtained using a regional coupled ocean-atmosphere model (Carillo et al., 2012), vary between 2 and 7 cm according to scenarios adopted (EA1B and EA1B2, see Meehl at al., 2007). Since the sea-level variations associated with TIM mainly result from the gravitational interactions between the cryosphere components, the oceans and the solid Earth, and long-wavelength rotational variations, they are characterized by a very smooth global pattern and by a marked zonal symmetry reflecting the dipole geometry of the ice sources. Since the Mediterranean Sea is located in the intermediate far-field of major ice sources, TIM sea-level changes have sub-eustatic values (i.e. they do not exceed the global average) and show little (but still significant) variations across the basin associated with the subsidence driven by the meltwater load. For year 2050, TIM calculations predict a sea-level rise of $\sim$10 and $\sim$30 cm for the mid range and the high end scenarios, respectively. Mainly because of the distinct mantle viscosity profiles adopted in ICE-5G(VM2) and KL05, the GIA patterns differ significantly and, in contrast with the TIM fingerprint, are both characterized by strong variations across the Mediterranean Sea, showing maximum values in the bulk of the basin. For the OR component, a significant geographical variation is observed across the Mediterranean sub-basins, corresponding to different Atlantic boundary conditionsAccording to this study, the total future sea-level rise for year 2050 will reach maximum values for the extreme scenario (hig-hend prediction for TIM, KL05 for GIA and EA1B2 for OR) of $\sim$ 27 cm in average with peak of $\sim$ 30 cm in the central sub-basins. Our results show that when these three components of future sea-level rise are simultaneously considered, the spatial variability is enhanced because of the neatly distinct geometry of the three fingerprints. References: Carillo, A., Sannino, G., Artale, V., Ruti, P., Calmanti, S., DellAquila, A., 2012, Clim. Dyn. 39 (9-10), 2167-2184; Fleming, K. and Lambeck, K., 2004, Quat. Sci. Rev. 23 (9-10), 1053-1077; Meehl, G.A., and 11 others, 2007, in Climate Change 2007: The Physical Science Basis, Cambridge University Press; Peltier W.R., 2004, Annu. Rev. Earth Pl. Sc., 32, 111-149; Spada, G. and Stocchi, P., 2007, Comput. and Geosci., 33(4), 538-562; Spada G., Bamber J. L., Hurkmans R. T. W. L., 2013, Geophys. Res. Lett., 1-5, 40.