Geophysical Research Abstracts
Vol. 18, EGU2016-11934-1, 2016
EGU General Assembly 2016

Deviation of Baltic, Adriatic and Black Sea level from the global mean during the 20th century: analysis of the main factors involved and a high-end projection to the end of 21st century.

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The main goal of this work is to investigate which are the main factors determining interannual sea level variability of Baltic, Adriatic and Black seas, and to which extent the sea level of these three basins can deviate from the global mean. The three basins selected are semi-enclosed marginal seas connected with the adjacent seas by narrow straits. 13 sea level timeseries in Baltic Sea, 7 in Adriatic Sea and 5 in Black Sea provided by PSMSL, allowed us to compute a single seamless sea level timeseries representative for each basin from 1900 and for the entire 20th century, using statistical tools (PCA and Least Square method). Comparison with satellite data in the period 1993-2009, confirms that timeseries so computed are good representations of the observed sea level, with correlation values of 0.97, 0.87 and 0.72 for Baltic, Adriatic and Black Sea respectively. At basin scale the sea level has been decomposed in various contributions that have been separately analyzed: local effect of pressure, steric effect due to temperature and salinity variation, boundary forcing, wind effect and river discharge. The annual cycles and their variability, show that the largest contribution is due to the wind for the Adriatic Sea and for the Baltic Sea. In these two basins the inverse Barometer effect plays a minor role and the steric factor is almost negligible. The wind seems to play a negligible role on Black Sea, where the Danube river discharge plays an important role. A linear regression model, built considering large scale sea level pressure distribution as predictor, is capable to explain a further percentage of sea level variability variability (about 20%) left after subtracting all the factors considered above. Sea level of the Baltic and Black Sea show a significant positive correlation (0.3 about) revealing the likely influence of an external common forcing. Past sea level variability shows no strong evidences of large deviation from the global mean sea level. Although a non-negligible fraction of past interannual variability of sea level remains to be explained in this study, a statistical model of basin sea level has been built. On the basis of an estimation obtained by forcing it with the outputs of ten CIMP5 models, it seems unlikely that local factors will be responsible for future large deviations of the regional sea level from the global mean until end of the 21st century. This study is part of the activities of RISES-AM project (FP7-EU-603396).