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Vertical Crustal Movements in Italy from Tide Gauge and Satellite Altimetry data

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Our goal is to determine vertical crustal movement rates from tide gauge and satellite altimetry measurements. Tide gauges measure sea level, but as they are fixed to the coast, they sense both sea surface height variations and vertical crustal movements. Satellite altimetric measurements determine sea surface height variations directly and can be used to separate the crustal signal from the sea surface height variations in tide gauge measurements.
We apply the methodology to the Southern Italy, an area of broad scientific interest, due to its high seismic risk and its location as standpoint for a great bridge that should connect Sicily to the Italian mainland, but it can be exported to any parts of the world where tide gauge observations are available.
Along the Italian coastline 26 tide gauge stations with 10-years of continuous data are available. We have explored the sea level data statistically, including a study of the space-time variation of rates, of the optimal way of calculating rates and of the correlation-coefficients between stations. The tidal sea level change rates have a relatively large variability, greatly ascribable to the short time interval of analysis (10 years), and are comprised between -5 and +9 mm/yr with an approximate uncertainty of 0.5 mm/yr.
The satellite altimetric data pose a challenge to the joint analysis, due to very different time resolution (10 days versus hourly sampling of tide gauges), sparse spatial sampling of the Mediterranean due to track distances, and the difficulty in acquiring altimetric data in the vicinity of the coast. We have analyzed the satellites Topex/Poseidon and Jason1. The study of Envisat data is under way and it could provide more detailed data, since its track distance is sensibly shorter, even if time sampling interval is 35 days.
We explore also the satellite altimetric data statistically, investigating the correlation matrices of the data and the time-space variation of the sea surface change rates.
We move along the tracks, trying to approach the coast as near as possible. We construct time series with 10 day sampling interval at discrete locations with the criterion of covering the Mediterranean homogeneously. We calculate histograms as we go near the coast and we find that at a distance of about 45 km from the coast the number of points drastically is reduced leading to a time series with many interruptions.
We also find that the sea surface change rates derived from the altimeter have an even greater variability compared to the tide gauges for the same years, showing that changes far from the coast are greater than near the coast.
We discuss the problem of how to use the altimeter data in those cases in which the tracks are far from the tide gauges, as is the case for the satellite Topex/Poseidon and the tectonically interesting tide gauge stations of Sicily and Calabria. An adequate space-time interpolation of the satellite data produces maps of spatial variations of sea surface change that are used in the study of the differential sea level rates of tide gauges. We show that geologically consistent crustal uplift rates are found for the highly seismic area of eastern Sicily and Calabria.