Geophysical Research Abstracts,
Vol. 11, EGU2009-8297, 2009
EGU General Assembly 2009

Analysis of sea level oscillations by using methods of nonlinear dynamics

P. Capuano, E. De Lauro, S. De Martino, and M. Falanga
Dept. of Matematica e Informatica, University of Salerno, Fisciano (SA), Italy (pcapuano@unisa.it)

The nonlinear characteristics observed in the tide phenomenon is intrinsically associated with the nonlinearities of the Navier-Stokes equation, governing the water level dynamics. Recently, chaotic behaviors have been related to the tide motion and its predictability introducing the concept of fractal dimensions of the tidal time series. The primary causes of these non-linear effects have been attributed to a variety of factors also looking at different frequency ranges.
Water level time series collected in several areas in the world have been analyzed trying to infer their non linear characteristics. Data belong to different datasets: a) an extensive dataset recorded by several stations located along the Pacific and Atlantic U.S. coast, in Hawaii and Bermuda island, collected from NOAA and sampled at 6-min interval; b) a dataset recorded by several stations managed by ISPRA (Italian Agency for the Environmental Protection and Research) installed along Adriatic and Tyrrhenian coasts and sampled at 10-min interval. We consider the period spanning from January to December 2006.
Data have been analyzed through Independent Component Analysis, a methodology that working in the time domain appears more appropriate to investigate non linear systems than the Fourier-based analyses, verifying that the sea level oscillations can be described as a linear superposition of nonlinear signals, characterizing them in terms of dynamical system. In addition, using False Nearest Neighbours and the estimation of correlation dimension by means of Grasberger and Procaccia integral we define the low dimensionality of the system (about 4). In particular our results show a clear non linear features in all the sites, characterized by second and third order Landau mode. A clear evidence of non linearity is the dependence of oscillation periods by the amplitude. This behavior is well evidenced at ocean, namely a transition occurs from second to third Landau mode looking at different time periods. The Landau modes occurrence appears to be very general and basins distinguish only for the order of mode. This description in terms of self-oscillations well explain different embedding dimension for different areas (basins and ocean) or for different time at the same area (West coast). The enhancement in amplitude forces transition to third order Landau mode, including more characteristic times. The most relevant conclusion of our analysis, verified also for other areas (under investigation), is that standard and harmonic models are not able to reproduce correctly the complex behavior of the sea tide.