EGU24-13120, updated on 25 Jan 2025
https://doi.org/10.5194/egusphere-egu24-13120
EGU General Assembly 2024

Local Solid Earth Tides and Their potential use in assessing and forecasting the risk of seismic hazards

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This work presents some results achieved in the frame of TILDE project (Tidal Interplate Lithospheric Deformation of Earth). The main goal of TILDE project was the estimation of Local Solid Earth Tides (LSET); i.e. models which depends on the geographical position of the selected sites. The LSET models are built estimating Love and Shida numbers for each station and for each tidal constituents. The objectives were to investigate possible correlations between LSET and geological/geophysical events, such as tectonic plates movements, earthquakes and volcanic activities. GNSS data collected at 98 stations, split into global and regional networks have been used. The global network consists of 73 GNSS stations which have piled up a stack of data 20 years long. The regional networks consist of 25 stations, 7 located in New Zealand, 1 in Kamchatka, and 17 stations in Italy for which 3 year-long time series of data are available.

The LSET models have been achieved using GNSS coordinates expressed both in geocentric XYZ and local NEU references, estimated in Precise Post Processing mode, with a sampling rate in turn of 1 day and 3 hours. Different GNSS solutions have been generated according the objectives of the project. The first one is the background solution in which the full IERS2010 tides model has been applied. The second solution is obtained by switching off the tides model. The third one is the solution in which only the Long-Periodic Tides (LPT) has been switched off. This last solution has been applied in order to lower the level of flickering of GNSS time series when Love and Shida numbers of LPT had to be estimated.

This analysis showed that there is a correlation between the latitude measured from the tectonic equator and Love numbers. This confirms the theory that moon tides contribute to trigger tectonic movements.

An interesting result, relevant for the assessment and potential precursiveness of the risk of seismic hazards, was the correlation found between the variation in time of Love numbers of diurnal (K1) and semi-diurnal (M2) tides and the occurrence of earthquakes nearby GNSS sites. At this purpose we selected GNSS global stations which were at a distance <200 Km from the epicentre of EQ events. The investigation has outlined that almost the seismic events are got ahead by a downfall of Love numbers. It seems that each earthquake event cannot be characterized only by the type of slip occurred along faults: compressive (i.e., reverse fault), extensional (i.e., normal fault), strike slip or combination of them. This result could be explained with the rigidity of the crust/mantle which play a major role in triggering seismic events. For smaller values of Love number we have indeed a more rigid response of Earth to Tidal forcing.