Multi-parameter assessment of pre-earthquake atmospheric/ionospheric signals and their potential for short-term prediction

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In this study we are exploring retrospectively/prospectively the potential of atmospheric and ionospheric signals to alert for large earthquakes. A new R&D geospace approach has been developed studying specific physical parameters variation in the atmosphere and ionosphere that we found connect with the earthquake preparation processes. We developed our approach based on the Lithosphere-Atmosphere - Ionosphere coupling (LAIC) concept. A detail summary of our approach will be subsequently published in a new volume as part of the AGU Geophysical Monograph series and is intended to show the variety of parameters seismic, atmospheric, and geochemical and the historical perspective of this research and could bring this topic to a broader geosciences community.
The Multi Sensor Networking Analysis (MSNA) is our method for validation and is based on a joint analysis of several physical and environmental parameters (Satellite transient infrared radiation anomalies (STIR), Seismo-ionospheric anomalies (SIA) based in electron concentration in the ionosphere (GPS/TEC), radon/ion activities, air temperature and seismicity patterns) that were found to be associated with earthquakes. The MSNA is based on multi disciplinary approach, because it is widely recognized that our understanding of geophysical processes is improved by integration of studies from seismology, geochemistry, geomagnetism, atmospheric science and geology. To quantify our validation, we start computing Molchan Error Diagram (MED) retrospectively and prospectively for anomalous ionospheric /atmospheric signals.
Our validation processes consist in two steps: (1) A retrospective analysis since 2004 of major earthqaukes preformed over the regions with high seismicity- Taiwan, Japan, China California, Mediterranean, Mexico, Chile (2) Prospective testing of with potential for M7+ events for 2014-2015 on global scale and a special tests for M6+ over the Japanese region. We started prospectively in survey mode since 2013. We also test in enhanced mode over several validation regions with ground support and with a high seismicity rate that includes Japan. Most of the global M7+ events during 2014-2015 have been alerted days in advance. Still an average false alarm ratio of ~25% exists, but the method has the potential for improvements, with more research. For example the latest M7.8 event in Nepal of April 25, 2015 was alerted (low accuracy forecast) a month in advance. The second M7.3 event in Nepal of May 12, 2015 was forecast 8 days in advance.
Our results suggest that: (1) Pre-earthquake atmospheric/ionospheric signals follow a general temporal-spatial evolution pattern (with 1-30 days time-lag), which has been seen in other large earthquakes worldwide; (2) MED test results indicates that pre-earthquake atmospheric anomalies could provide short-term predictive information of major

earthquakes in the tested regions; and (3) Testing of pre-earthquake signals shell continue with an extended multi-parameter analysis.

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