Spatial clustering of pre-earthquake anomalies as an indicator of the preparation/activation zone

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We present an interdisciplinary study of observations of pre-earthquake processes associated with major earthquakes based on integrating space and ground- data. We are exploring the general temporal-spatial and evolution patterns of these pre-earthquake signals as a function of both their type and the earthquake magnitude. We examined the possible correlation between the spatial clustering of pre-Earthquake anomalies and the size of earthquake preparation/activation (Dobrovolsky-Bowman zone) in the framework of the Lithosphere-Atmosphere-Ionosphere Coupling (LAIC) concept. For this analysis we selected six most massive earthquakes from the last decade with differing geographic and seismo-tectonics regions: (1) M9.3, Off the West Coast of Northern Sumatra, Dec 26, 2004; (2) M9.0 Great Tohoku Earthquake, , Japan, March 11, 2011; (3 and (4) M7.8 and M7.3 Gorkha, Nepal, 2015; (5); M8.2 Tehuantepec, Mexico, September 8, 2017 and; (6) M7.1, Puebla central Mexico earthquakes, Mexico, September 19, 2017.
Four physical parameters were measured from ground and satellite were used in the temporal-spatial patterns: 1) Ground Radon variation; 2) Outgoing Long-wavelength Radiation (OLR obtained from NPOESS, NASA/AQUA) on top of the atmosphere (TOA); 3) Atmospheric Chemical Potential (ACP) obtained from NASA assimilation models and; 4) electron density variations in the ionosphere via GPS Total Electron Content (GPS/TEC).

Our preliminary results of temporal-evolution patterns indicate an enhancement of radon (about a week to ten days prior) followed by the increase in the atmospheric chemical potential measured near the epicenter from both satellite and subsequently with an increase of OLR observed on the TOA from NOAA/NASA (a week in advance). Finally, GPS/TEC data indicate an increase in electron concentration 1-4 days before the earthquakes. Although the radon variations, some of satellite OLR and GPS/TEC anomalies were observed far (>2000km) from the epicenter areas, the anomalies were always inside the estimates of the Dobrovolsky-Bowman area of preparation. This finding provides new metrics in the assessment of pre-earthquake signals according to LAIC for both sea and land earthquakes possible only by integrating satellite and ground observations. A detailed summary of our approach to this study of pre-earthquake research has just been published as AGU/Wiley Geophysical Monograph Series No. 234.

Keywords: earthquake forecasting, pre-earthquake, LAIC, GPS/TEC, satellite thermal anomaly, radon

