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Session IWG-14: “From Multi-sensors observation towards Inter-disciplinary study of
Mega Earthquakes”

**Inter-disciplinary validation of pre earthquake signals.
Case study for major earthquakes in Asia (2004-2010) and for 2011
Tohoku earthquake.**

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We carried out multi-sensors observations in our investigation of phenomena preceding major earthquakes. Our approach is based on a systematic analysis of several physical and environmental parameters, which we found, associated with the earthquake processes: thermal infrared radiation, temperature and concentration of electrons in the ionosphere, radon/ion activities, and air temperature/humidity in the atmosphere. We used satellite and ground observations and interpreted them with the Lithosphere-Atmosphere-Ionosphere Coupling (LAIC) model, one of possible paradigms we study and support. We made two independent continuous hind-cast investigations in Taiwan and Japan for total of 102 earthquakes ($M > 6$) occurring from 2004-2011. We analyzed: (1) ionospheric electromagnetic radiation, plasma and energetic electron measurements from DEMETER (2) emitted long-wavelength radiation (OLR) from NOAA/AVHRR and NASA/EOS; (3) radon/ion variations (*in situ* data); and 4) GPS Total Electron Content (TEC) measurements collected from space and ground based observations. This joint analysis of ground and satellite data has shown that one to six (or more) days prior to the largest earthquakes there were anomalies in all of the analyzed physical observations. For the latest March 11, 2011 Tohoku earthquake, our analysis shows again the same relationship between several independent observations characterizing the lithosphere /atmosphere coupling. On March 7th we found a rapid increase of emitted infrared radiation observed from satellite data and subsequently an anomaly developed near the epicenter. The GPS/TEC data indicated an increase and variation in electron density reaching a maximum value on March 8. Beginning from this day we confirmed an abnormal TEC variation over the epicenter in the lower ionosphere. These findings revealed the existence of atmospheric and ionospheric phenomena occurring prior to the 2011 Tohoku earthquake, which indicated new evidence of a distinct coupling between the lithosphere and atmosphere/ionosphere.