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Isolation of Earthquake Precursory Signal from Multi-Parameteric Geophysical Time Series: A Mathemetical Challenge

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In a quest to document and understand the nature of earthquake precursors in a Himalaya, Wadia Institute of Himalayan Geology has established first Indian Multi-Parametric Geophysical Observatory (MPGO) at Ghuttu, Central Himalaya. Located in a narrow belt of high seismicity, just south of the Main Central Thrust, this segment has not witnessed any great earthquake at least in last two centuries, but has been a seat of number of large earthquakes, the last being the 1991- Uttarkashi and 1999- Chamoli earthquakes, both M> 6. A noble feature of the observatory that is equipped with most modern and sophisticated equipments like Superconducting Gravimeter, overhauser magnetometer, tri-axial fluxgate magnetometer, ULF band search coil magnetometer, radon data logger, water level recorders, etc. and are backed up by broad band seismometers and GPS.
Although the high precision equipments have the requisite sensitivities to record characteristic stress-induced perturbations, the isolation of weak precursory signals is still mathematical challenge as each geophysical time series has characteristic time variability related to inter-planetary, terrestrial, hydrological, tectonic sources. The formulation of principal component analysis is found effective in isolating waveform related to magnetospheric and seismotectonic origin in geomagnetic field intensity. Fractal approach are successfully distinguishes the varied dimension component associated with distant EM waves resulting from solar wind-magnetospheric interactions and those from near surface waves emanating from the straining of crustal rocks. The usefulness of data adoptive techniques like wavelet and singular spectrum analysis developed to denoise and estimate time varying amplitude of tidal effects as well as atmospheric pressure and hydrological influence on high resolution gravity field measured to a sensitivity of $< \mu$ gal. Major emphasis is on to develop a tailor made approach which allows to parameterize the influence of tides, pressure and hydrology so the residual time series can be examined in real time in search for earthquake precursors. The presentation shall solicit and highlight the advances made so far in processing complex time series in isolating earthquake precursors.