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# Measuring the Difference between Two Local Vectors: the Gradient of Earth's Gravity Field and the Earth Surface Normal

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Even though concrete support is not yet available, it is widely believed or hoped, that earth quakes, which are generally accidental events on our Earth surface, could be predicted by analyzing historical signals from kinds of geodetic measurements. Directly or indirectly for such a purpose, many comparative analyses have been carried out for constructing an implicit or explicit correlation between the temporal variations of selected measurements and the recorded earthquakes. For instance, in [1] the locally co-seismic and post-seismic variations of the Earth's gravity field for three giant earthquakes (2004, 2010 and 2011) are compared, with a frustrating but just normal conclusion that the observed discrepancies of gravity changes reflect the difference in the settings of the studied earthquakes.

On another hand, based on the development of measurement techniques, geodetic measurements are continually reported with high quality. As an example, ITRF2008 [2] claims a believed origin accuracy at the level of 1 cm over the time-span of 26 year of SLR observations. Integrating four measurement techniques, ITRF2008 provides an accuracy of 8 mm over more than 20 years. With latest technical improvements, it is reasonable to expect even better accuracy in the coming release of ITRF2013 [3].

It seems that a gap between the high quality of geodetic measurements and the relatively less achievement by analyzing them does exist. Normally an accidental event like an earthquake is a local event which happens at a particular time moment covering a close neighborhood of its epicenter. Geodetic measurements are often suffering from densely sampling the dynamical behaviors on Earth. A typical velocity of plate tectonic movements which varies from 1-10 cm/year is indistinguishable from noise in most of daily measurement systems, if the time span is set to be seconds, minutes, or even hours; The system reference of geodetic observation is often set either as man-made satellites, or as natural space objects like lunar or extragalactic reference. These references help us constructing a global coordinate system for geodetic observations with great successes. But still, they are neither convenient nor flexible for densely local observations.

In this paper a new geodetic measurement concept is suggested for local and short time-span observations. Other than going to space pursuing a comparable scale than Earth radius, the suggested concept looks into the atomic scale, while a velocity of 1-10 cm/year is roughly equivalent to 317-3171 pm/s, which is the same scale for observing atomic structures. In this concept a microscope for nano scale observation, e.g., scanning tunneling microscope [4], is required. The observation arm and the sample holding arm are separately assembled as that the observation arm is fixed on the ground, and the sample holder is floating in the air. The sample holder is designed as a long pendulum which keeps pointing to the earth gravity center. The local earth surface normal, and the local gradient of the earth gravity field, are two vectors in the system. Within short time span like seconds it is possible to measure the different temporal variations between them, based on the different earth dynamics of lithosphere and earth mass distribution.

Without systematic ambiguities like non-modeled forces in space, signal delay in ionosphere, as well as the troposphere distortions, the suggested concept physically is promising for a new geodetic measurement.

References:

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