Multi-annual strain variations induced by hydrological cycles in Central Apennines

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Abstract

Multi-year strain variations detected in GPS time series in Central Apennines, are highly correlated with rainfall excess variations. Continuous GPS stations show coherent displacements in the horizontal plane and orthogonal to the normal fault zones of the Apennine mountain range. The displacement repeats periodically back and forth, with amplitude up to 6 mm and period of 4-5 years. The effect of loading processes, caused by mass redistributions in the atmosphere, ocean or continental water, has been excluded. Poroelastic response, as that observed in basin-fill aquifers, are also inadequate to explain the prevailing horizontal displacement, thus a new conceptual model should be adopted. The deformation occurs in a mountain region bounded by two karst aquifers and the amplitude of the displacement decreases with distance as predicted by a tensile source acting in an elastic medium. We interpret this deformation as induced by the opening of a fracture zone in the carbonate matrix as a response to hydrostatic pressure variations. The strain cycle follows the average multiyear rain sequence and foresees a dilatation phase during high rainy seasons and a contraction during drier periods. The estimated depth of the equivalent tensile source range from 1.2 to 1.5 km affecting stations at distances up to 20 km away. Current data do show the movements induced by two nearby aquifers and suggest a mutual interaction in the elastic space as the aquifers stretch. The occurrence of the L'Aquila earthquake (Mw 6.3, April 2009) seems not perturbing the observed strain cycle, although a slight change of the deformation style has been observed.

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