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Evaluation of different processing strategies of Continuous GPS (CGPS) observations for landslide monitoring

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The objective of this work is to evaluate several processing strategies of satellite navigation systems observations for the near-real time characterization of landslide displacement from continuous dual-frequency and mono-frequency GPS receivers. By tracking the electromagnetic waves that the satellites are sending continuously, the navigation system can provide the antenna position (longitude, latitude, and height, or X, Y, Z coordinates). The use of the phase measurements allows determining the relative positions of points located as far as several hundred kilometres apart with an accuracy of 2-5 mm in horizontal and 5-10 mm in vertical. This accuracy allows the fast detection of small displacements and, thus the survey of the temporal evolution of crustal deformation and natural hazards (volcanoes, tectonic faults, ice glaciers, landslides).
Since a few years, several CGPS (Continuous Global Positioning System) receivers have been installed on active landslides in France (e.g. La Clapière rockslide, Avignonet and Villerville rotational slides, Super-Sauze and La Valette mudslides). These landslides show very different displacement rates (ranging from a few centimetres to several meters per year) and different kinematic regimes (e.g. continuous displacement of nearly constant rate or succession of periods of acceleration/deceleration). All landslides are part of the French 'Observatory of Landslides' (OMIV), a collaborative structure aiming at collecting the same type of kinematic, hydrologic and seismic observations on landslides and at disseminating the data to the scientific community.
For the monitoring of landslides where the required degree of accuracy in position is about a few mm, GPS has been mainly used for repeated measurements, as a complement to conventional geodetic methods. Permanent monitoring is still not usually performed operationally on landslides mostly because of the cost of the receivers compared to conventional deformation monitoring techniques, and because sophisticated a posteriori data processing techniques are required to process long observation sessions, model errors introduced by variations of the satellite constellation and multi-path effects.
The objectives of this work are to evaluate the performance of PPP (Precise Point Positioning) and DD (Double Difference) processing techniques on observations acquired at the landslides since 2010. The PPP approach is a positioning method used to calculate precise positions using a single receiver from un-differenced phase measurements, precise clocks and precise satellite orbits. The PPP method is different from the DD positioning method which eliminate most errors using one or more reference stations with known positions. Position time series of several GPS located on landslides are computed with the NRCan (Natural Resource Canada) PPP software, the GINS (Géodésie par Intégrations Numériques Simultanées) PPP software and the GAMIT/GLOBK DD software. Evaluation of the results are discussed.