Impact of a LEO Formation and a LEO/GPS Dual Constellation on the IGS Products

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The two GRACE satellites, flying in a LEO formation with an inter-satellite distance of about 200 km, can be used to form a continuously observed GPS baseline in space. When the ambiguities are resolved for such a space-borne GPS baseline, very accurate inter-satellite orbit information between the two GRACE satellites can be obtained with mm-accuracy. The strength of such a baseline can be further improved by adding KBR measurements, mainly improving the along-track orbit information. Such a GPS baseline can be seen as an orbiting 3D-vector in space, of which the magnitude and orientation is governed by the gravity field and the non-conservative forces acting on the satellites. If we increase the number of LEO satellites to more than two, as e.g. in the case of the six COSMIC satellites, we finally end up with a global coverage and a fully connected, continuously tracked LEO constellation network with baseline lengths up to 13'000 km.

Using simulated GPS data for the COSMIC constellation, we already showed that ambiguity resolution considerably increases the strength of the LEO network and strongly ties the LEO constellation to the GPS constellation of ~30 satellites, thus forming a LEO/GPS dual constellation. Based on such a hybrid constellation, orbits of the GPS satellites can be estimated simultaneously with the orbits of the LEO satellites, even without using measurements from the ground GPS network. However, in such a case the orbit of one reference satellite has to be kept fixed and assumed to be known or a corresponding datum constraint has to be applied to the dual satellite constellation. The dual LEO/GPS constellation forms a unique network with satellites orbiting the Earth at very different altitudes. Any change in the Earth's gravity field or Earth's rotation and geocenter motion differently affects the LEO satellites close to the Earth and the GPS satellites high above the Earth. Finally, adding the network of ground stations as a third level, the dual satellite constellation can be firmly tied to the Earth's surface.

In this contribution we study, how different scenarios of LEO formations and constellations combined with the GPS system affects the IGS products. Thereby, real measurements from the GRACE mission as well as simulated GPS measurements for the 6 COSMIC satellites and other constellations are used.