CONSTELLATION STUDIES FOR EARTH WIDE MEASUREMENTS OF GNSS AND LEO-LEO OCCULTATION DATA : THE GENESIS OF THE ACE+ ANTI-ROTATING SATELLITES CONCEPT

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The lack of data over the oceans and other remote regions contributes greatly to the uncertainties in the initial state of global weather-prediction models which, in turn, limits their forecast capabilities. The first experimental evidence that radio occultation data may have a positive impact on weather prediction systems was obtained from statistical comparisons of the GPS/MET retrieved refractivity and temperature profiles to global Numerical Weather Prediction (NWP) model analysis. It appeared, that the agreement of the GPS/MET data with NWP was noticeably better over data-dense (U.S., Europe) versus data-sparse (Pacific Ocean) regions. These studies suggest that the GPS radio occultation data are likely to have a significant positive impact on global climate analyses and global weather prediction.
As a result of this, several systems proposed to take advantage of a constellation to provide a better repartition of GPS measurements all over the world, including ADM (Atmospheric Dynamics Mission), ACE (Atmosphere and Climate Explorer) and COSMIC (Constellation Observing System for Meteorology Ionosphere and Climate). On the other hand, a limitation was associated with only GPS data retrieval : models without atmosphere moist were used to retrieve temperature profiles, leading to severe approximations. As a matter of fact, the discrimination of the water vapour quantities and of the temperature profiles is not possible in low atmosphere layers by the only analysis of GNSS signals.
The main improvement of WATS (1) or ACE+ missions (2) with respect to these concept lies in the introduction of a LEO-LEO link, besides of classical LEO-GNSS measurements, which will provide the capacity to discriminate water vapour from temperature profiles, without the need of a huge ground segment spread over the world.
However, the introduction of this LEO-LEO link implies several problems, not the smallest being the selection of a constellation that fits all mission and technological constraints. The ALCATEL mission analysis group, in association with the system architecture department, conduced therefore several studies to propose concepts coping with all scientific mission requirements, instrument technological limitations, and mission analysis intrinsic constraints (such as constellation deployment).
The proposed paper makes therefore a review of the ALCATEL constellation studies and associated trade-off, including the evolution from the initial constellation concepts up to the innovative approach of anti-rotating satellites, that was finally selected in the WATS concept and re-used in the ACE+ mission.

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