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The Atmosphere and Climate Explorer mission ACE+: Analysis of performance and climate science utility

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The European Space Agency (ESA) has in 2002 pre-selected the Atmosphere and Climate Explorer (ACE+) radio occultation (RO) mission as top priority out of 25 proposed Earth Explorer Opportunity Missions. Whilst, for reasons currently under clarification, ACE+ was then not proceeded towards full implementation in a selection round in May 2004, this pre-selection has allowed to undertake complete and successful Phase A studies within 2003–2004 and to prepare a mission concept ready for implementation.

The ACE+ constellation of 4 Low Earth Orbit (LEO) satellites utilizes GPS, Galileo, and LEO-LEO signals for RO sounding of fundamental atmospheric variables such as humidity and temperature. ACE+ will acquire over 4000 GPS/Galileo RO soundings per day and demonstrate the novel LEO-LEO concept by about 230 LEO-crosslink soundings per day. The readiness achieved during Phase A enables development within 4 years towards launches in 2009, followed by a nominal 5 years operational phase.

The primary ACE+ mission goals are focused on climate science and include, based on accurate observation of variability and trends in temperature, humidity, and geopotential heights, issues like improved climate change monitoring, detection and attribution, improved understanding of climatic feedbacks, and climate model validation and improvement.

The key innovation compared to existing and planned GPS RO missions is the novel

use of Galileo and LEO-LEO signals. Especially the LEO-LEO signals placed at 3 frequencies within 9–23 GHz, from center to wing of the 22 GHz water vapor absorption line, will allow RO measurements of humidity without temperature-humidity ambiguity and up through the free troposphere. For example, the LEO-LEO data have potential to furnish upper troposphere humidity profiles with an unprecedented accuracy of better than 5% in specific humidity.

The presentation will start with a brief overview of the ACE+ mission along the lines above, with emphasis on the climate science rationale and the novel LEO-LEO capability. The main focus will then be on end-to-end performance analysis results, both regarding retrieval accuracy and climatological utility, obtained during the ACE+ Phase A within 2003–2004. The results will, in particular, be discussed in light of the goal to provide accurate, unbiased, and consistent measurements of temperature, humidity, and pressure, which can serve as novel benchmark measurements for future monitoring of climate variability and change.