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Huygens VLBI trajectory - evidence for meridional wind in Titan's upper atmosphere

S.V. Pogrebenko (1), L.I. Gurvits (1), I.M. Avruch (1, 2), G. Cimo (1) and Huygens VLBI experiment team

(1) Joint Institute for VLBI in Europe, Dwingeloo (JIVE), The Netherlands (pogrebenko@jive.nl , phone +31 521596523), (2) State University of Groningen (RUG), Groningen, The Netherlands

Abstract

On 14 January 2005 the ESA/NASA/ASI Huygens Probe descended trough the atmosphere of Titan. The Probe was tracked with a global VLBI network of radio telescopes. The principles of this experiment are described in [1]. VLBI observations were part of the global ground-based observational campaign [2]. For VLBI, we used a phase referencing technique, with a reference source (the quasar J0744+2120) at distance of 30 arc minutes apart from the position of Titan and S-band flux density of 45 mJy. Reference phases were obtained after a broad-band correlation of the signal from the quasar using EVN-MarkIV Data Processor at JIVE [3], while the narrow band signal from the Probe was processed with a purpose-developed software correlator. We used a far field delay model for the reference source, and a near field model for the Huygens' signal. Both were computed with the "Consensus VLBI model" compatible software VTD [4]. Residual phases of the Probe's signal were calibrated with reference phases on certain baselines, for which the sensitivity was good enough for both the calibrator and the Probe. Because VLBI measurements are sensitive only to lateral coordinates, we used the Probe's altitude [5] in the Titan-centric frame as a constraint to derive a 3D descent trajectory. The trajectory reconstruction was possible only for the time interval when the Probe was visible by the NRAO Green Bank telescope, and covered the Titan-graphic altitude range from 120 to 20 km. Detailed description of the signal processing and trajectory reconstruction technique of this experiment is presented in [6]. The semi-axes of the error scatter ellipse of the Probe's position determination are estimated as 0.5 km and 2.0 km in projection onto the Titan surface, with the minor semi-axis oriented along the longest baseline of the VLBI array, e.g. Green Bank (USA) - Mopra (Australia). The achieved accuracy of the trajectory estimation allows us to derive the average magnitude of the meridional component of the wind in the upper layers of the Titan's atmosphere, and estimate it as 3.5 +/ 0.5 m/s in the southern direction.

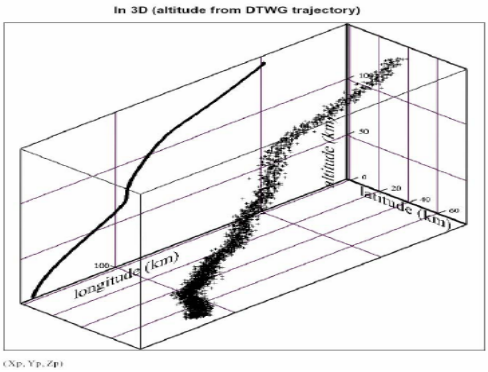

Figure 1: A 3D reconstruction of the descent trajectory of the Huygens Probe.

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