Analysis of CAIRT tangent point errors

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ABSTRACT

CAIRT (Changing-Atmosphere Infrared Tomography) is a limb sounder project that was selected as one of the two Earth-Explorer 11 candidate mission. The mission is projected to fly in loose formation with IASI-NG, to take advantage of the possible synergies [Raspollini et al., 2023].

CAIRT will sound the atmosphere from the middle troposphere to the lower termosphere with a 50 km step along track, 25 km across track and vertical sampling of 1 km.

One of the main challenges for limb sounders is line tracing, as the trajectory of the lines of sight must account for changes in the atmospheric refraction index, especially for lines reaching the lowest, densest layers of the atmosphere. The trajectories of the lines of sight, and hence the position of the tangent points, depend on the variation of the refraction index, which can be modeled using vertical profiles of pressure, temperature, and water vapor [Ciddor, 1996].

In operational conditions, the actual atmospheric composition is unknown before performing the retrieval. For MIPAS (Michelson Interferometer for Passive Atmospheric Sounding), a first guess for the tangent heights was calculated using the US76 reference atmosphere. In the ESA operational retrieval code ORM (Optimized Retrieval Model), the height of the tangent points was adjusted by recalculating the ray tracing at each iteration of the retrieval. In [Ridolfi and Sgheri, 2014], the vertical error on the tangent heights due to the use of a reference atmosphere was assessed, resulting in errors of up to 200 m for the lowest sweeps.

In the framework of the ASI (Italian Space Agency) project CASIA (Cairt Analysis and Synergy with IASI-NG), we repeat this study using the CAIRT target instrumental characteristics. While the MIPAS study focused only on the vertical displacement of the tangent points, the CAIRT study must assess both radial and angular errors. This study is a necessary preliminary milestone to evaluate the impact on the accuracy of the retrieval of some simplifications that may be needed to perform CAIRT data analysis in an acceptable time frame. This study should also be useful in characterizing the coincidences between CAIRT and IASI-NG atmospheric sounding.

[Ciddor, 1996] Ciddor, P. E.: Refractive index of air: new equations for the visible and near infrared, Appl. Optics, 35, 1566–1573, 1996.

[Ridolfi and Sgheri, 2014] Ridolfi M. and Sgheri L.: Characterization of model errors in the calculation of tangent heights for atmospheric infrared limb measurements, Atmos. Meas. Tech., 7, 4117–4122, 2014

[Raspollini et al., 2023] Raspollini P., Ceccherini S., Cortesi U., Del Bianco S., Poli G., Tirelli C., Kujanpää J., ESA/ESTEC contract 4000136480/21/NL/LF Deliverable D-12, Study of the synergy between CAIRT and IASI-NG/Sentinel 5 - Technical Note 8.7, DEL-12-TN-8.7-CAIRT-Ph0SciReC-1.0, 2023