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Detection and Correction of Radiation Spikes in Aeolus Data

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During the analysis of uncorrected Aeolus L1A raw solar background data, single large values have been observed which are obviously outliers. It is assumed that they are caused by cosmic radiation. Since the solar background measurements have been used to correct the atmospheric wind mode data in the Rayleigh and Mie channel, these outliers could potentially have a negative influence on the quality of the wind data product derived by Aeolus. Therefore, investigations have been started to automatically detect outliers in the L1A data product on measurement level and to obtain information on the distribution and percentage of outliers in various datasets.

To start with, different robust and commonly used outlier detection approaches have been implemented and tested. Their performance depends, in particular, on the chosen inherent parameters. An appropriate algorithm with optimised parameter settings has been selected which detects most of the outliers.

Since we have been only interested in outliers which are much larger than the mean signal levels of the considered datasets, spikes have been defined to be upward directed (positive) outliers with certain heights above the mean signal levels. In this way, the number of detected outliers has been reduced to that of the spikes. Different height criteria and thresholds have been introduced and tested to find a balance between the detection of almost all obvious spikes and to avoid to classify real retainable features as spikes.

In order to assist the latter, a spike classification has been introduced: Single isolated spikes, multiple spikes detected in different ACCD pixels at the same time respectively same measurement, and successive spikes detected in fixed pixels but for successive measurements. It could be in particular seen that successive spikes indicate to real atmospheric or ground features. Thus, discarding successive spikes reduces the number of false positives and makes the spike detection applicable not only to the solar background but also to atmospheric range bins. After their automatic detection, large measurement values are flagged as spikes and can be, e.g., replaced by the integer values nearest to the corresponding real median values of the considered datasets which is a general practice to handle outliers.

The outlier and spike detection and correction algorithm has been implemented in the L1B B17 processor. The implementation has been tested against the prototype for various datasets, and will be also part of the scientific testing in 2026. In case of a successful evaluation, it is intended to reprocess all Aeolus data with the option of a spike detection and correction to improve the data quality. This is certainly also of relevance for the processing of the data of the future Aeolus-2 mission.

Our contribution presents examples of all stages described above, i.e., results obtained by different outlier detection approaches, spike criteria, and spikes types for various L1A raw signals, channels, ACCD pixels, number of measurements per observation, and instrument modes. In this way, the reliability and robustness of the chosen approach is demonstrated. Examples of spike statistics and geolocation are also provided and discussed.