Introduction

The new generation space borne Lidar mission MERLIN (Methane Remote Sensing Lidar Mission) will make measurements of the CH4 distribution with a precision of < 2% and an unprecedented low systematic error < 0.2%. The latter is a prerequisite for reliable emission estimates by inverse modeling. After its launch, MERLIN will track down sources and sinks of methane on a global scale. MERLIN is an active space-borne instrument using an IPDA (Integrated Path Differential Absorption) Lidar. The difference in atmospheric transmission between a laser emission with a wavelength placed around the center of a CH4 absorption line (λabs ~ 1.68 μm) and a reference wavelength, λref, slightly shifted from λabs by a few tenths of a nm is used to derive the differential absorption optical depth (DAOD) and ultimately the CH4 mole fraction.

MERLIN Products & Processing Chain

The algorithms are developed together by DLR and CNES. DLR has the main responsibility for the Level 0 and Level 1 processing and the instrument monitoring; CNES has the main responsibility for Level 2 and Level 3 processing. The products are:

- **Level 0a**: Time ordered raw data containing the backscatter signal of the shot pairs
- **Level 0b**: L0a parameters converted to physical units and added satellite attitude and position data

Level 1a: Pulse energy corrected, vertically resolved single shot data
Level 1b: DAOD for averaged shot data and single shot data
Level 2: CH4 dry air mole fraction
Level 3: (Regridded) maps of CH4

* distributed to the public

Processing & Auxiliary Data

The raw signal consists of signal values P_{on/off} vs. time for λ_{on/off} and the corresponding energy monitoring signals E_{on/off}. From these signals we
- remove instrument effects and calculate the noise
- calculate the backscatter signal and the range
- finally calculate the DAOD

The current baseline is to provide DAOD for cloud free scenes and also for all scenes. Additionally auxiliary data and quality flags are provided such as
- cloud flag (from range/DEM comparison) and possibly from pulse shape (TBC)
- Signal noise and signal-to-noise ratio
- Averaging parameters (which shots, quality of individual shots, weighting)
- Results of in-flight calibration by FRU and APC to be used in long term monitoring to detect instrument degradation or drifts

Processing Flow (Main Blocks)

The main processing steps are shown below
1. Removal of instrument effects: Background subtraction, non-linearity correction and pulse shape correction.
2. Determination of integration windows and pulse positions for P_{on/off} and E_{on/off}, taking into account possible jitter.
3. From this the range and the backscatter Q_{on/off} = P_{on/off}/P_{off}^2 is calculated.
4. The range is also used to determine if a cloud was in the FoV for a given shot.
5. The backscatter signal of the single shots is then averaged and converted to uncorrected DAOD.

Outlook

The processors will be continuously developed during phase C/D and new requirements that emerge during the instrument building and calibration will be incorporated. At the moment we foresee 3 Level 01 processor versions with an increasing feature set. Version 3 will be the launch ready version. Another update incorporating lessons from the commissioning phase is foreseen 3 months after launch, with 2 further updates during the mission. The road-map for the immediate future is
- Review and optimisation of the GCAPS framework (this is regularly done to keep the framework lean and performant)
- Consolidation of the Level 0a format and start of Level 0 Decommutator coding
- Study and develop missing algorithms
- Consolidation of algorithms (updates of ATBD) and in-flight calibration procedures
- Implementation of Level 0-1 processor

One critical item still to be developed in detail is the averaging strategy. This does not only include the classification of measurements along signal quality and cloud presence and the derivation of a proper weighting of the individual shots, but also the calculation of the most representative coordinate for the averaged DAOD. The algorithm has to be able to adapt to different observed scenes (e.g. broken clouds).

Contact Information

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