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TITLE: MERLIN: The German-French Methane Remote Lidar Mission
NAME & First name of main author: KIEMLE Christoph
NAME & First name of co-authors: - EHRET Gerhard - BOUSQUET Philippe - FIX Andreas - WIRTH Martin
Address (Department/Institute): DLR Institut für Physik der Atmosphäre
E-mail address of main author: Christoph.Kiemle@dlr.de
Phone number of main author: +498153282525
Date of birth of all authors: 1952 - 1964 - …

Understanding the global carbon cycle, and predicting its evolution under future climate scenarios is one of the biggest challenges facing science today with huge societal implications. Current uncertainties in the spatio-temporal distribution of atmospheric CO_2 and CH_4 fluxes, two key elements of the carbon cycle, are very large because of severe observational gaps. For well-informed policy actions aiming to curb down the future increase of CO_2 and CH_4, these uncertainties must be reduced. Therefore the Global Earth Observation System of Systems (GEOSS) recommends an increased, improved and coordinated carbon cycle observing system with particular emphasis on observations with global cover.

An increase by a factor of 2.5 since pre-industrial times today makes methane the second most important anthropogenic greenhouse gas, contributing 18 % of the total radiative forcing on a 100-year time horizon. Taking into account additional indirect effects, methane contributes about 30% of the emission-based radiative forcing (IPCC). Besides its role as greenhouse gas, methane is also an important player in determining the hydroxyl-radical based self-cleansing capacity of the atmosphere. Moreover, it serves, through its oxidation, as an important source of stratospheric water vapour, which is also important for climate. Since the atmospheric lifetime of methane is about ten times shorter than that of carbon dioxide, its radiative forcing on a 20-year time horizon is about the same, and reductions in its emissions would quickly slow down the current rate of global warming. At the same time, however, natural methane sources have the potential to significantly amplify human-induced climate change, for instance due to the significant dependence of methane wetland emissions on climate, release from permafrost soils and continental shelves, and potential destabilization of methane hydrates from the ocean floors.

Global satellite observations with high accuracy are required to monitor these issues and to identify changes in both anthropogenic and natural methane emissions. Passive satellite sensors measuring the frequency-resolved solar backscattered radiation from the Earth surface either with an imaging absorption spectrometer like SCIAMACHY on ENVISAT or with the Fourier Transform Interferometer on GOSAT have proven to achieve a high measurement precision. Of particular concern using these sensors, however, is the inability to make measurements in the high-latitudes during the winter months, leaving large areas of the globe unobserved for a considerable amount of time. On the other hand, infrared sensors like AIRS and IASI are not sensitive close to the methane sources on ground due to their unfavorable weighting function. Space-based active remote sensing using differential absorption lidar is a new and complementary approach in the sense that it is more sensitive near earth's surface, essentially has zero aerosol/cloud biases, and can measure at day and night time e.g. in dark polar regions and also over water surfaces.

Consequently, a "Methane Remote Lidar Mission" (MERLIN) was proposed by the German and French space agencies DLR and CNES. MERLIN has successfully completed Phase B; launch is foreseen in 2020.

Primary objective is to provide accurate global observations of methane concentration gradients for inverse numerical models in order to better quantify regional fluxes. Spin-off products are global cloud cover and canopy height. Wetlands, the most important natural methane sources, show at the same time the largest uncertainty and variability. Wetlands are abundant in remote tropical and high-latitude regions, challenging the deployment of in-situ instrumentation. On the other hand, space-borne passive remote sensing is hindered in the tropics by frequently occurring deep convection, and blind at high latitudes due to lack of sunlight. In the tropics it is expected that MERLIN will measure in between clouds, thanks to its small field of view, while its coverage at high latitudes will be particularly dense thanks to overlapping ascending and descending orbits.

Figures

Figure: MERLIN satellite, artist's view.

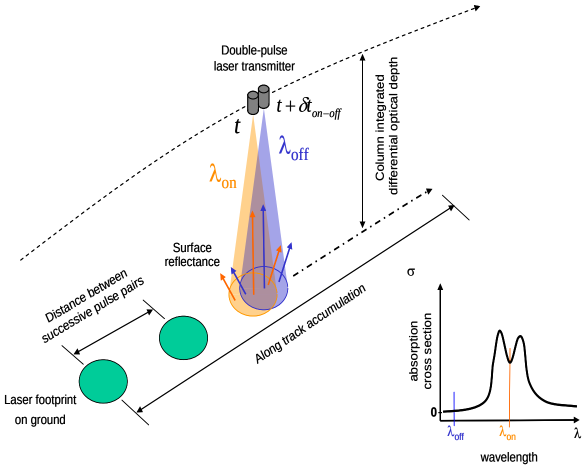

Figure: Integrated path differential absorption (IPDA) lidar.

References

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