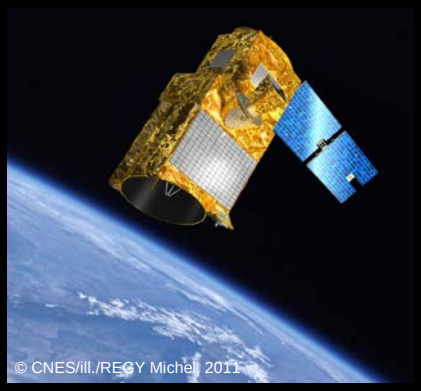
French/German Climate Mission MERLIN

Measurements of Atmospheric Methane from Space

CNES and DLR agreed to develop and implement in a close cooperation a satellite dedicated to the measurements of the green house gas Methane (CH_4). The mission name is MERLIN (Methane Remote Sensing Lidar Mission). It is planned to launch the satellite in the time frame of 2016 with at least 3 years of operation in space. Germany will contribute by providing the instrument payload, a Methane Integrated Path Differential Absorption (IPDA) LIDAR. France will be the mission prime and will contribute by the enhanced version of its space-proven satellite platform MYRIADE and will operate the satellite. Both countries will establish a joint data processing chain to provide the science community with the mission data.



Mission Aims:

- Global information on atmospheric Methane concentration (Methane column density) with an accuracy better than 2% and with a spatial resolution of 50 km along track also under cloudy and variable sun illumination conditions.
- Improved knowledge on anthropogenic contribution to the atmospheric Methane amount, as energy production, wild fires and wetland changes due to climate change, melting of permafrost soils and ocean sediments (hydrates) and their interaction with the Earth climate.
- Improved data quality concerning anthropogenic and natural Methane emissions.
- Significant contribution to climate change prediction
- Contribution to control of the Kyoto protocol aims on Methane emission regulation.
- Demonstrator for future satellite-based IPDA LIDAR mission.
- Compliant with GCOS Climate Monitoring Principles.

Details of Mission:

Launch: in the time frame of 2016;
Mission duration: 3 years (at least)

Orbit:

Type: low polar sun-synchronous Earth orbit
Mean orbit height approx. 500-650km; LTAN: 6:00
Approx. 20 min eclipse per orbit during northern winter (Oct.-Feb.)

Observation Method:

Differential absorption of gaseous methane at two laser wavelengths reflected from Earth surface or dense clouds.

LIDAR (LIght Detecting And Ranging):

“Active“ optical remote sensing instrument for atmospheric parameters or trace gases. Main components are (1) two pulsed high power laser emitters, (2) a telescope to receive the laser light backscattered from atmosphere or Earth surface, (3) a sensitive photon detector.

IPDA (Integrated Path Differential Absorption):

Determination of total Methane column density between satellite and Earth surface or cloud top height. The Methane amount is calculated from different absorption at two laser wavelengths (on-line (λ_{on}) and off-line (λ_{off})), reflected on Earth surface or cloud top. Earth surface or cloud top reflected laser light is used because this is much more intense than backscattered light from aerosol particles in the atmosphere. The attenuation due to atmospheric Methane absorption is strong at the on-line wavelength The off-line “reference” wavelength is selected to be only marginally affected by Methane absorption.

Instrument concept *:

Type: Integrated Path Differential Absorption LIDAR (D)
Pointing: 1-2° off nadir, across track
Emitter: pulsed high power laser with about 24 Hz rep. rate (12 Hz double pulse, λ_{on} & λ_{off} each), approx. 9 mJ pulse energy, mean wavelength 1,645 µm
Receiver: Telescope ø690 mm, APD detector

Satellite type *:

Satellite bus MYRIADE Evolutions (F) :
Mass: approx. 250 kg (Payload: 95 kg)
Dimensions: approx. 80 x 80 x 120 cm^3
Power:
Satellite total power: approx. 280 W
Payload power allocation: approx. 165 W in northern summer
IPDA Lidar instrument power consumption: approx. 111 W.

Launcher:

TBD taking into account the potential co-passenger opportunity and the launcher re-boost capacity..

Communication:

S-Band Downlink for housekeeping data and S-Band Uplink for commanding to CNES-ground station network.
X-Band Downlink for scientific data to CNES-ground station network.

Mission Operation:

CNES Satellite Control Center via CNES S-Band ground station network.

Data Processing:

Joint data processing in France and Germany.

Mission Partners:

This climate mission is a joint French-German cooperation, performed by the national space agencies: CNES and DLR. Both partners share the mission costs; Germany will contribute by providing the Methane IPDA LIDAR instrument, to be developed by German industry and German research institutes. France will contribute by its MYRIADE Evolutions satellite platform and its satellite control center and CNES will operate the satellite.

Science activities are led by two Co-Principle-Investigators from the French Laboratoire de Météorologie Dynamique (LMD) from CNRS and the German Institute for Atmospheric Physics (IPA) from DLR, with additional support of several French and German Research Institutes.

* All technical parameters are preliminary and subject to further analyses by CNES and DLR.

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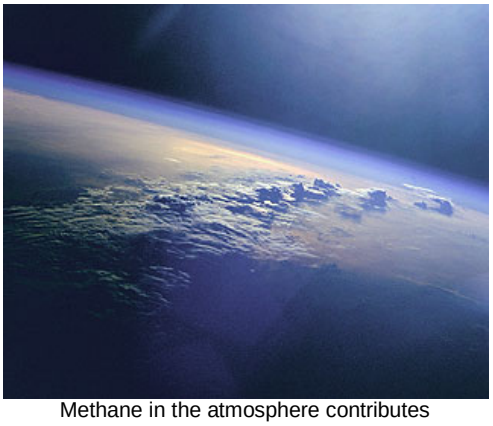
World map of Methane concentrations



Methane in the atmosphere contributes significantly to global warming

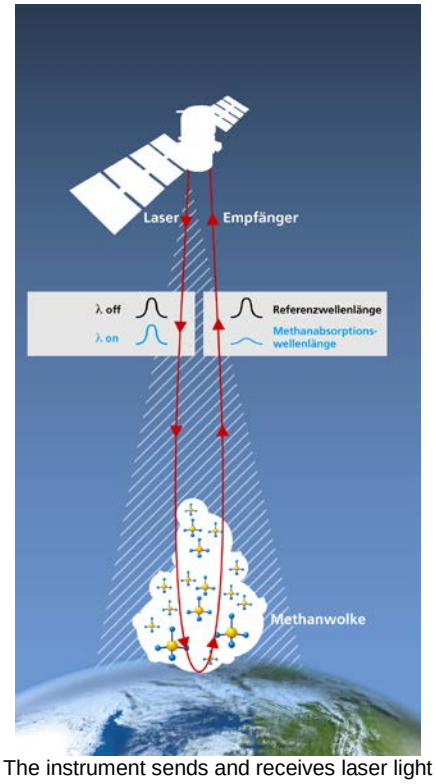
What works on a small scale also works on a large scale. For the last several years, a helicopter-mounted measuring instrument developed by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) has been hard at work detecting Methane leaks from gas pipelines. From 2016, a similar instrument will be used on a German/French satellite in a low polar Earth orbit. The mission (designated mission name is MERLIN: Methane Remote Sensing Lidar Mission) will track down the greenhouse gas Methane around the globe.

This Franco-German collaborative venture has one principal objective – to obtain more and higher-precision data on Methane emissions. Methane and carbon dioxide both cause global warming, although the impact of Methane is 25 times more powerful than of carbon dioxide. Now, at a time when there is much discussion about mankind being directly responsible for the rise in the emission of greenhouse gases, Methane emission levels already far outstrip carbon dioxide. Since pre-industrial times, the amount of Methane in the atmosphere has more than doubled, whereas the growth in carbon dioxide levels during the same period has been 'only' thirty per cent. Alongside carbon dioxide, Methane is one of those gases for which the Kyoto Protocol stipulates that cuts must be achieved.

Tried and tested measuring principle

The Methane LIDAR instrument (Light Detection and Ranging, sometimes referred to as 'light radar') transmits pulses of light towards Earth, and then receives the radiation that is reflected back from Earth's surface, again in pulse form. Whenever one of these pulses encounters Methane, its signal strength is reduced and the instrument detects this reduction.

The space-borne instrument will seek out both natural Methane sources and those due to human activities at a speed of 25,000 kilometres an hour. It will send its laser beam to and from Earth 24 times a second. With the measured values, a world map showing atmospheric Methane concentrations can be produced and also regional differences can be highlighted.



The instrument sends and receives laser light

Conclusions drawn about Methane sources

About 70 percent of global Methane emissions are caused by humanity – for example, from rice paddies, animal husbandry, biomass decomposition, landfill sites or energy generation. Natural sources include swamps and marshlands as well as thawing permafrost. However, data collected so far have not provided much information regarding the contribution of each source to overall emission levels. The MERLIN data will enable scientists in both countries to draw conclusions about the various different sources of Methane emissions (e.g. impact of rising levels of energy production, implications when tracts of permafrost release Methane as they start to thaw, implications for our climate). The data obtained can also be used to monitor compliance with conventions such as the Kyoto Protocol.

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