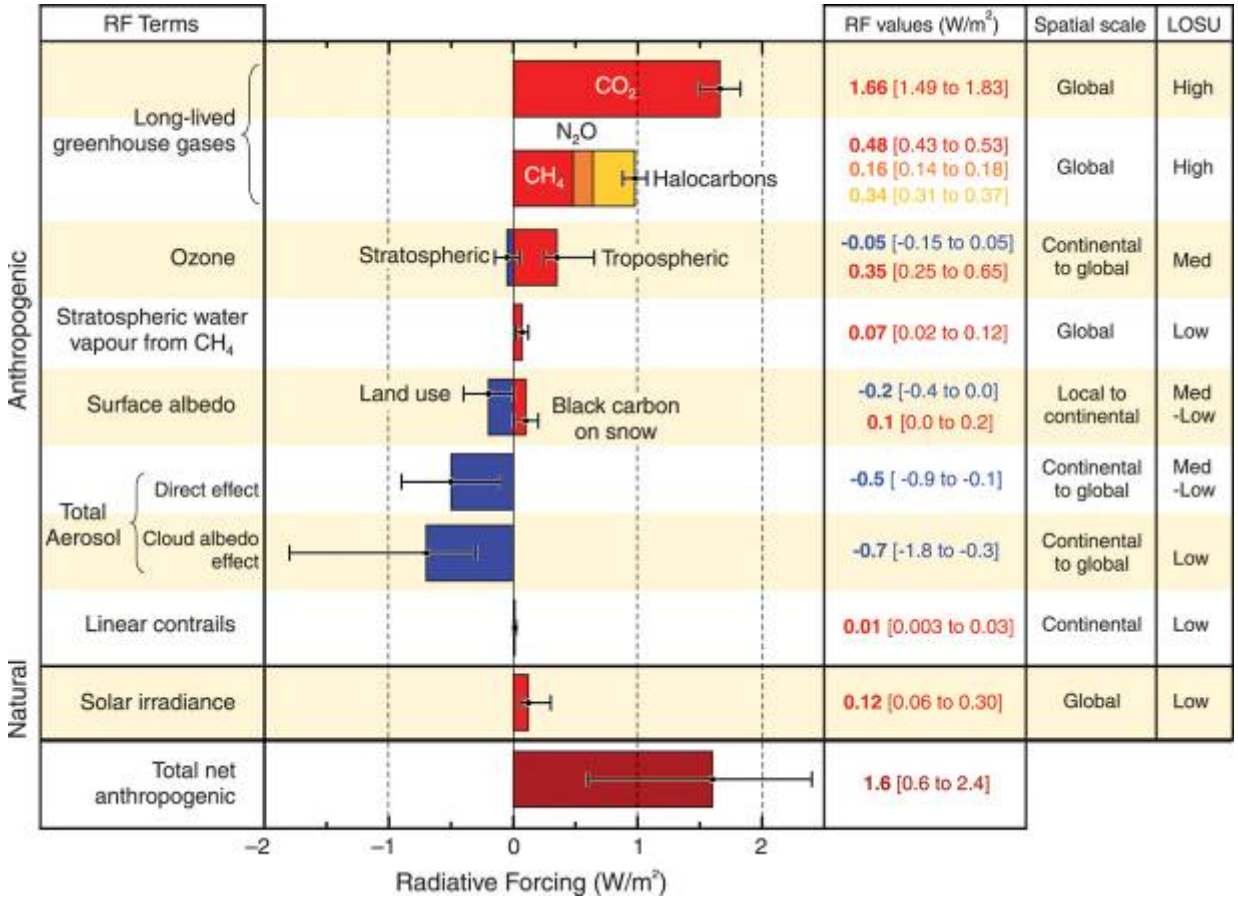
The French-German Climate Monitoring Initiative

CH4 Atmospheric Remote Sensor

Overall context

- Background for a French-German “Climate Monitoring initiative”
  - Development of a joint mission proposal addressing the most important climate questions and to present it to the community on the occasion of COP-15 (Copenhagen, 8.-15.12.09)
- Boundary conditions
  - Innovative mission, should not be redundant with other European initiative
  - High scientific value
  - Demonstrator of a potential series of future operational missions (e.g. monitoring of international agreements of GHGs)
  - Cost target: total around 120 M€, equally shared
  - Launch date objective: planned 2013/2014

Why is it important to measure atmospheric GHGs for climate predictions?



Global average radiative forcing (RF) in 2005 with respect to 1750 for CO2, CH4, N2O and other important agents and mechanisms, together with the typical geographical extent (spatial scale) of the forcing and the assessed level of scientific understanding.

Research Objectives and Challenges

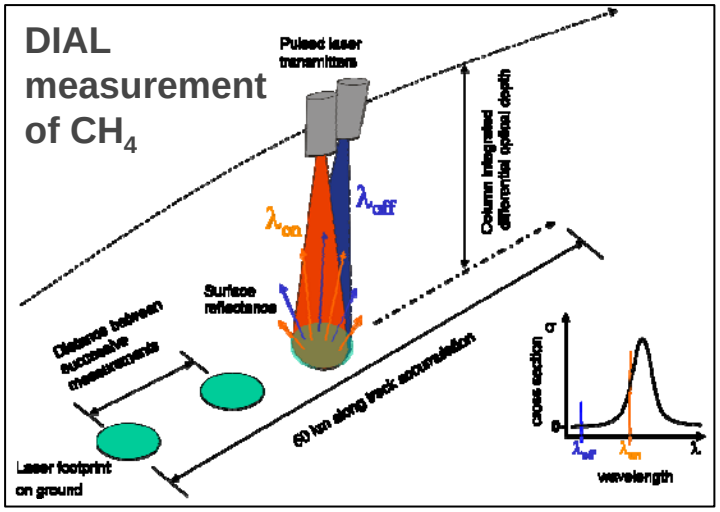
Global carbon cycle and climate change

The F-G mission will measure the **spatial and temporal gradients** of atmospheric CH_4 with high precision and **unprecedented accuracy** to constrain emissions from anthropogenic and natural sources **significantly better** than with the **current observational network**

Kyoto protocol and emission inventories

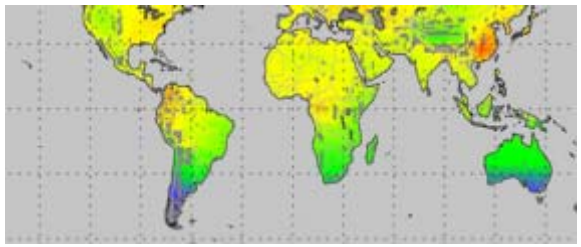
The mission will contribute to an **independent verification** of the national emission inventory with respect to methane as formulated in the **Kyoto Protocol**

Observational Method: Determination of CH4 fluxes by DIAL* Measurements & Inverse Modelling

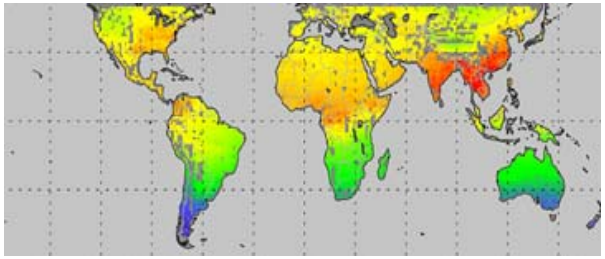


Simulated concentrations using a priori CH_4 fluxes

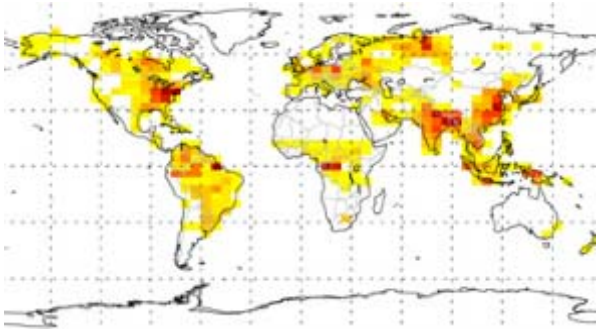
Forward simulation ↓ ↑ **Inverse modelling**



Global distribution of CH_4 ↓



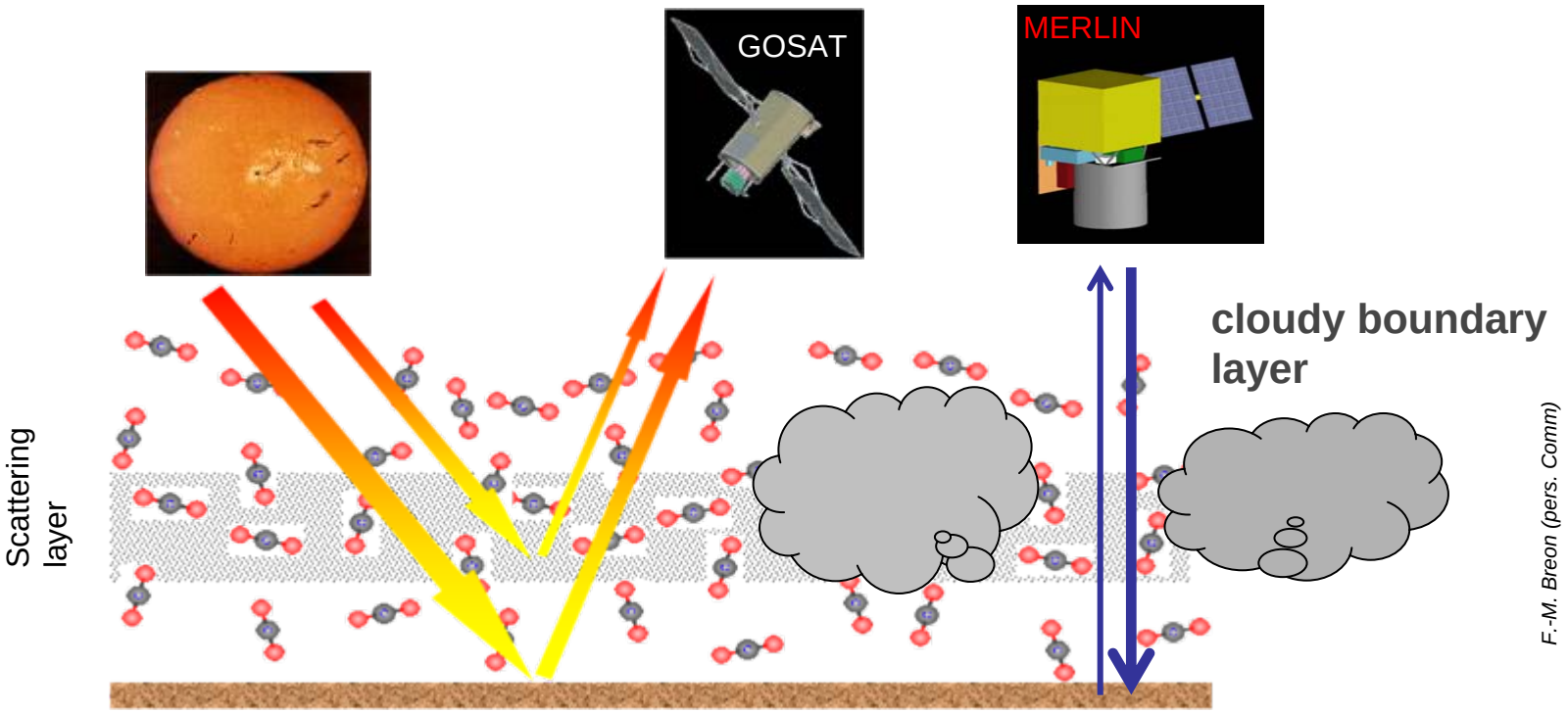
comparison between measurement and model →



Result: True regional CH_4 fluxes through minimizing the distance between measurement and simulation

*DIAL = Differential Absorption Lidar

Mission Uniqueness: Breakthrough in Data Quality



Active instrument much less sensitive to biases than passive instruments

- pulsed DIAL permits to distinguish between the contribution from surface and atmospheric scattering layers
- allows to sound in cloud holes and through thin cirrus layers
- enables measurements at day and night time (high latitude coverage)

Mission Architecture Overview

GROUND SEGMENT

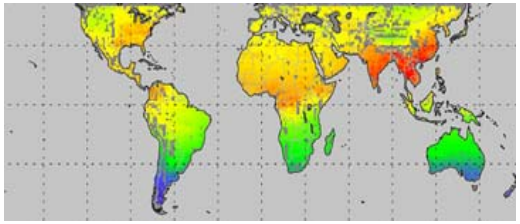
Flight Operations Segment

Flight Operation Control Centre

Payload Data Ground Segment:
Data Acquisition Station
Processing and Archiving Element

Ancillary Data :
Numerical Weather Prediction (NWP) Centres
Cal / Val measurements, Airborne Campaigns

USER SEGMENT:
Climate Modelling/Research Centres

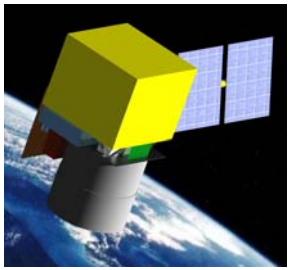


SUBJECT:
Column-weighted dry air mixing ratio of CH_4
Vegetation canopy height Cloud boundaries
Latitude range ±80°

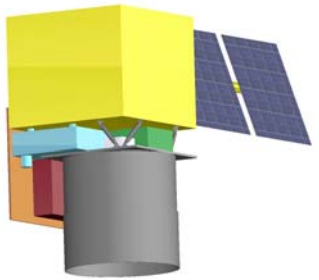
Mission Elements

LAUNCHER

(450 KM PREFERED)



ORBIT:
Sun-Synchronous
650 km, LTDN tbd (not critical
repeat cycle tbd (not critical)



SPACE SEGMENT:
Platform MYRIADE
Payload CH_4 DIAL
3 year lifetime

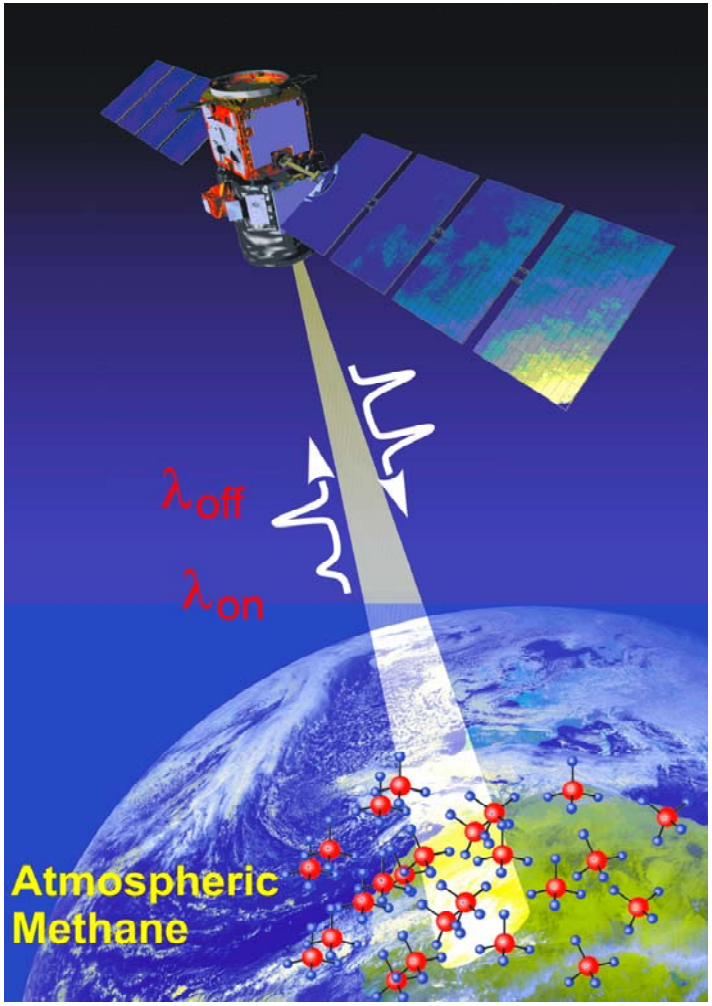
Conclusion

The **French-German CH4 mission** will be **worldwide** the **first active optical** greenhouse gas monitoring **instrument in space**

It will contribute to **verify** the **anthropogenic** methane **emissions** which are banned by the **Kyoto Protocol**

It will pave the way to a **new generation** of active optical **sensors** with a large application potential within the well established **Global Climate Observing System (GCOS)** from WMO

Active optical instruments like the **CH4** mission in space will become an **indispensable** observational **tool** for reliable **climate prediction** and verification of future **climate conventions** on greenhouse gas reduction


λoff
λon
Atmospheric
Methane

Back up slides for French-German Climate Monitoring Initiative

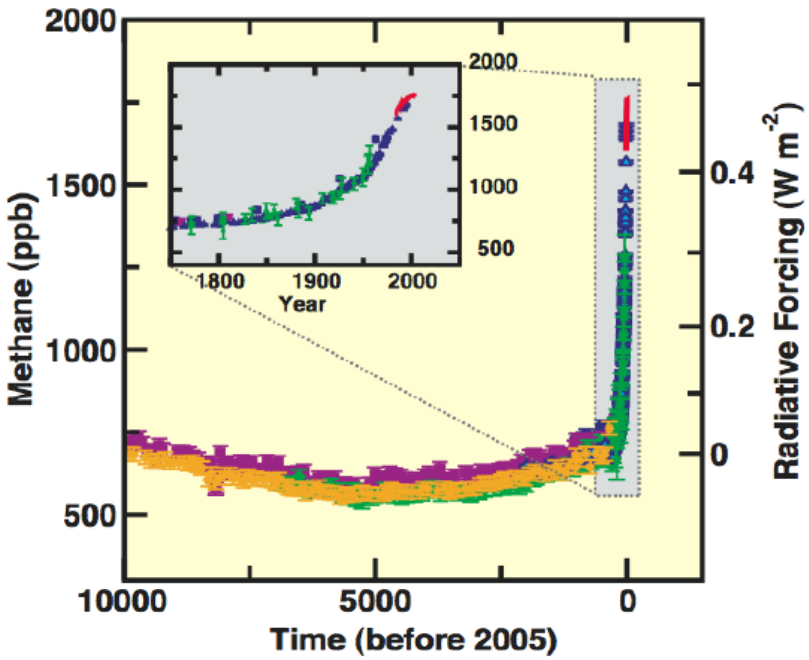
Scientific Background

- CH4 is second most abundant **anthropogenic greenhouse gas** with a **Global Warming Potential (GWP)** that is **25 times larger** than that of CO2

- **Strongest change** in concentration due to **human activities** led to **doubling of its abundance** since pre-industrial times whilst CO2 increased by 30%, "only"

- **Anthropogenic emissions** from gas leaks and incomplete combustions are **much more uncertain** than man-made emissions of CO2

- The climate impact of the **reservoir of CH_4 in Arctic permafrost** is an important **unknown** in modelling **future climate**



Atmospheric concentration of methane and corresponding radiative forcing over the last 10,000 years taken from ice core and atmospheric samples (red lines)

Scientific Justification

- Increases in Anthropogenic Sources?
- Decreased Chemical Loss Rate?
- Fires?
- Increased Wetland Emissions (including arctic & tropical forest)?
- CH4 “Burp” from Permafrost Decomposition, Hydrates or Clathrates? (time bomb is starting to go off)

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Arctic 'methane chimneys' raise fears of runaway climate change

Researchers say evidence suggests that the frozen seabed is perforated and is starting to leak methane, but other scientists urge caution

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Study says methane from ocean floor is 'time bomb'

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By The Canadian Press

Methane 'Fart' from the Earth Poses Enormous Global Warming Risk

By Steve Connor, The Independent UK. Posted September 24, 2008.

Melting in the Arctic has caused the release of millions of tons of methane -- a gas 20 times more damaging than carbon dioxide.

Tools
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131 COMMENTS

User Communities interested in CH4 data

Scientific Programmes

- *GCOS, WCRP, and IGBP*

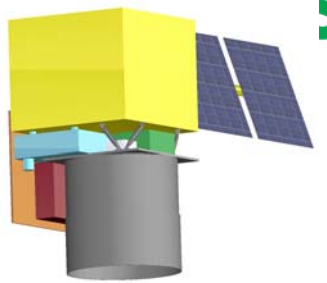
Organizations

- ***France: IPSL*** *= LMD, LSCE, LATMOS (*Climate study, Tropospheric Chemistry, Inverse Modelling, Assimilation, + ONERA and others
- ***Germany:*** **DLR**, MPI für Biogeochemie (Jena), *Carbon Cycle modelling*; University (Jena), *Atmosphere/Biosphere Interaction*; MPI für Chemie (Mainz), *Fires&Tropospheric Chemistry*; Alfred Wegener Institute (Kiel), *Permafrost*; IFM-GEOMAR (Kiel) *Gas Hydrates* and others
- ***EU:*** ECMWF (Readings), *data assimilation*; EC-JRC (Ispra, Italien), *Inverse Modelling*, Univ. Utrecht (Netherlands), *Inverse Modelling*
- ***Global:*** NASA-GSFC-GMAO (USA), *Assimilation & Inverse Modelling*; Harvard Univ. (USA), *Assimilation & Inverse Modelling*; NOAA (USA), *Carbon Cycle modelling*; NIES (Japan), Inverse Modeling

User Readiness

Very high. Inverse modelling methods are already developed for the current missions SCIAMACHY, AIRS, IASI, and GOSAT

Technical heritage



- Large number of **mission elements** are **space qualified**
- The mission will benefit from development of
  - Complete **Airborne Lidar CHARM-F**, kick-off Oct'09
  - **EQM** of **Laser-Transmitter** (most critical item), kick-off Nov'09
- MYRIADE platform space proven, e.g. Demeter, Parasol
- Joint heritage by common studies on Wind Lidar projects (ADM-Aeolus, Airborne WIND)

→ Due to the technical heritage and the joint preparatory work the mission can be realised in a **short timeframe** and with **low budget**

Technical Summary

Mass:	80kg Instrument + 100kg Platform = 180kg
Lifetime:	3 years
Launch date:	planned 2013/2014
Launcher:	VEGA as baseline, if qualification and reliability proven in time (backup tbd)
Platform:	MYRIADE
Instrument:	CH4 DiAL, pressurized N:YAG pumped OPO
Orbit:	450-650km
Power:	60-80W
Data rate:	300kBps
Dimension:	60x60x80 cm3
Products:	column integrated CH4, Canopy height, Cloud boundaries

Programmatic Summary

- DLR provides CH4 Lidar instrument, CNES provides the platform (and its control centre)
- Overall mission cost estimate: ~120 Mio. € (w/o science activities), equally shared
- Planned launch date: 2013/2014
- Joint agency management and science teams