CO_2 and CH_4 monitoring from space

Contribution from LSCE

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Scientific needs : Carbon Cycle

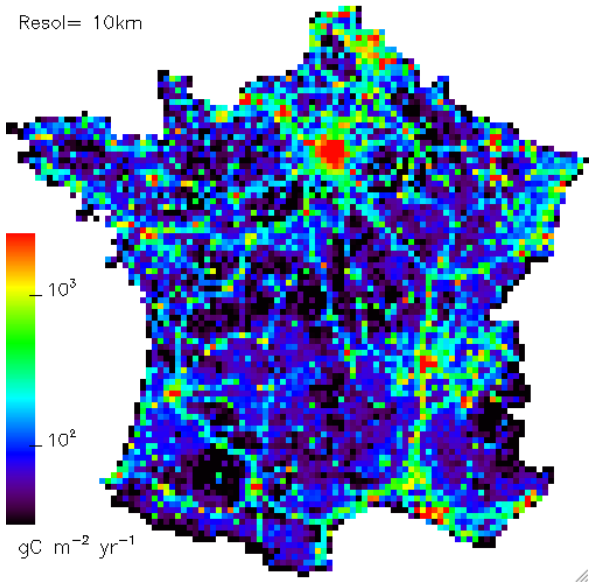
No need to recall the link between Climate Change and Carbon Cycle

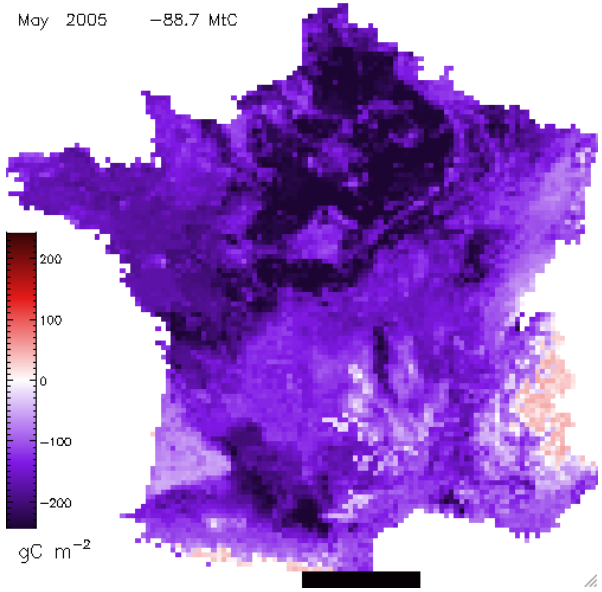
QuickTime™ et un
décompresseur
sont requis pour visionner cette image.

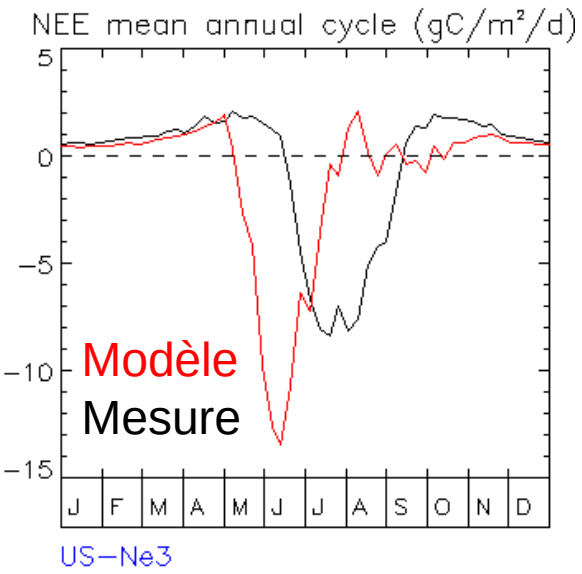
There is a need to monitor natural CO_2 and CH_4 fluxes to understand the processes that control them.

CH_4 contribution to greenhouse effect is less than that of CO_2, but potential for large feedbacks (permafrost…)

Natural and anthropogenic fluxes







Anthrop. (annuel) | Natural (May 2006) | An example of annual cycle

Anthropogenic fluxes are positive, very heterogeneous, fairly well known (at the state scale, but not on regional scales), of very high political value

Natural fluxes are either positive or negative, more homogeneous, poorly known. Monthly fluxes are needed for a better understanding of vegetation dynamic. Annual fluxes needed, but difficult as they are the differences between two large numbers (spring sink, winter source)

Atmospheric Transport and Fluxes

CO2 atmospheric transport. From fluxes to concentrations

$$Sc - \nabla \bullet (\rho C \vec{V}) = \frac{\partial}{\partial t}(\rho C)$$

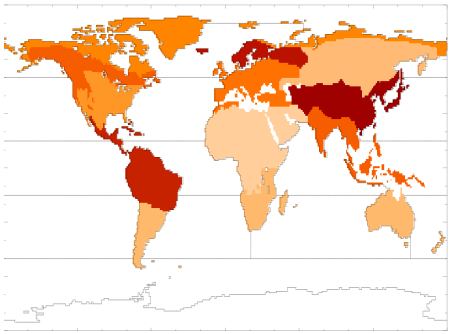
- **CO_2 Sources**
  Regional First guess
  x_b ; *var/cov P*

→ **Atmospheric transport** *H* →

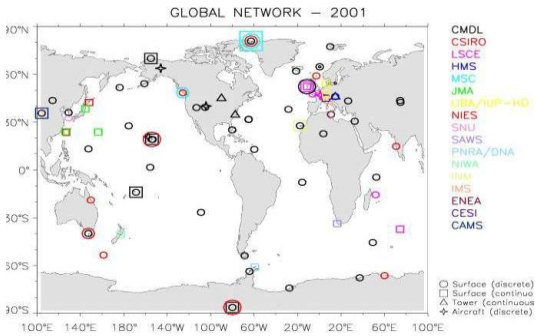
Simulated concentrations
y_{model}

↔

Observations
y_o ; *var/cov R*



$$H\,x = y$$



Inverse approach. From concentrations to fluxes

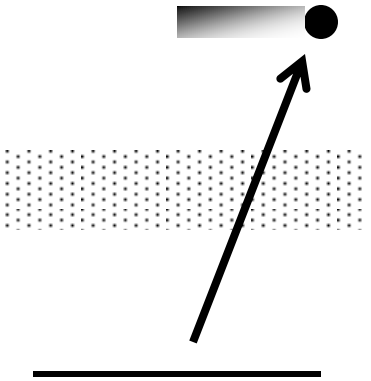
Fluxes (x) are estimated through minimizing obs and y difference

Direct atmospheric measurements

Remote Sensing of $[CO_2]$ and $[CH_4]$

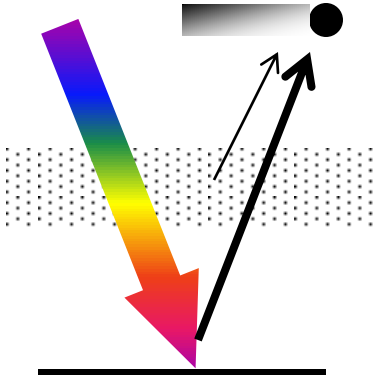
Thermal infrared sounding

TOVS, AIRS, IASI, GOSAT
Upper troposphere sensing



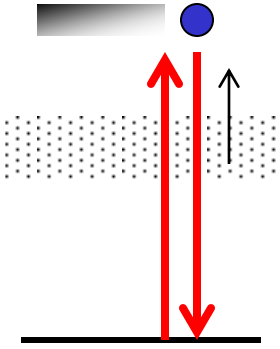
Solar absorption spectroscopy

Sciamachy, OCO, GOSAT
Total column



Active sensing

ASCENT, A-Scope
Total column



International Context

GOSAT. Japan; launched early 2009. Current results are disapointing, but improving. [LSCE in science team]

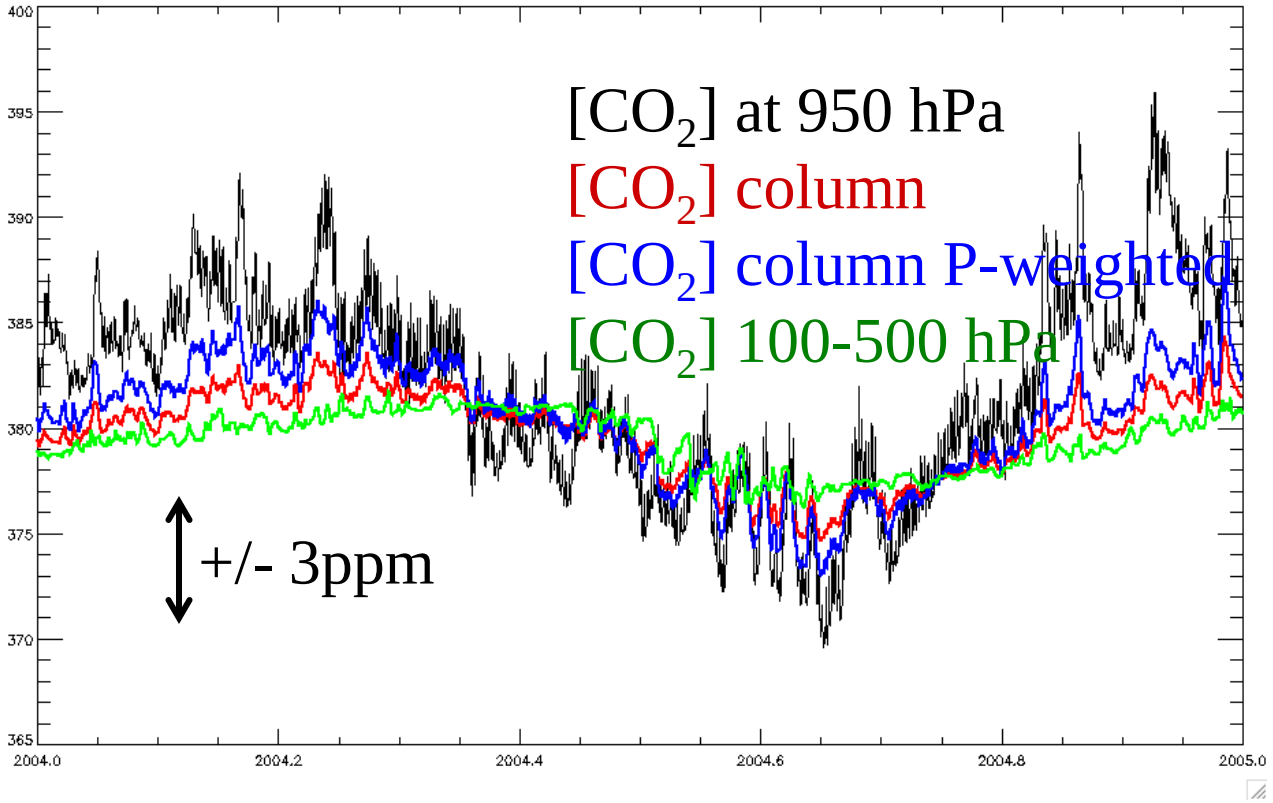
OCO. NASA, launched early 2009. Launch failure. OCO-2 scheduled within 2-3 ans. [LSCE members are co-I]

CarbonSat. Selected by ESA for further analysis. Possible launch at the end of decade [LSCE members are co-I]

MicroCarb CNES, ongoing technical studies for a launch before the end of the decade [LSCE members are PI and co-I]

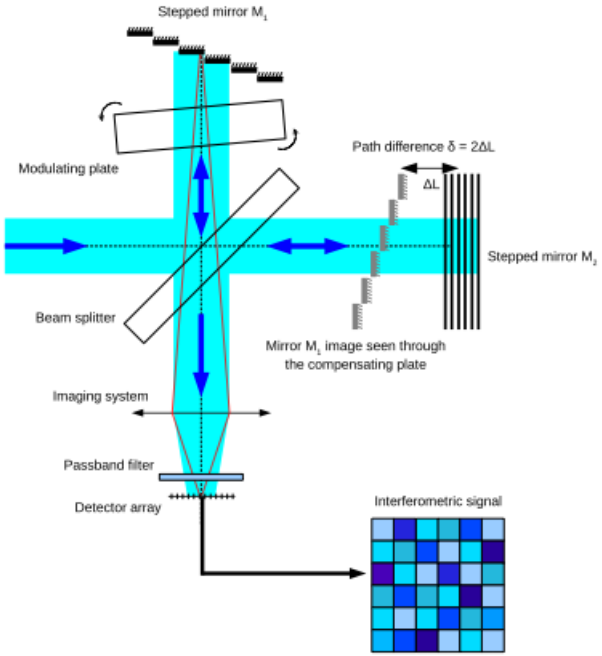
Merlin. CNES/DLR CH4 lidar. [LSCE members are co-I]

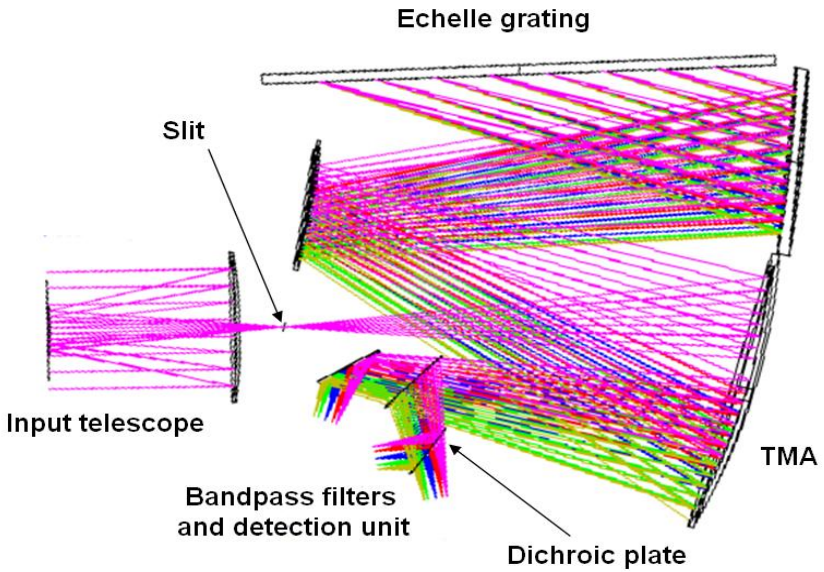
Signal : CO_2 variability



Atmospheric CO_2 variability is rather small
The information on regional scale fluxes is contained in the synoptical variations of CO_2 ≈ +/- 3 ppm at the surface; +/- 1 ppm for the total column => accuracy requirements

MicroCarb Instrument concepts



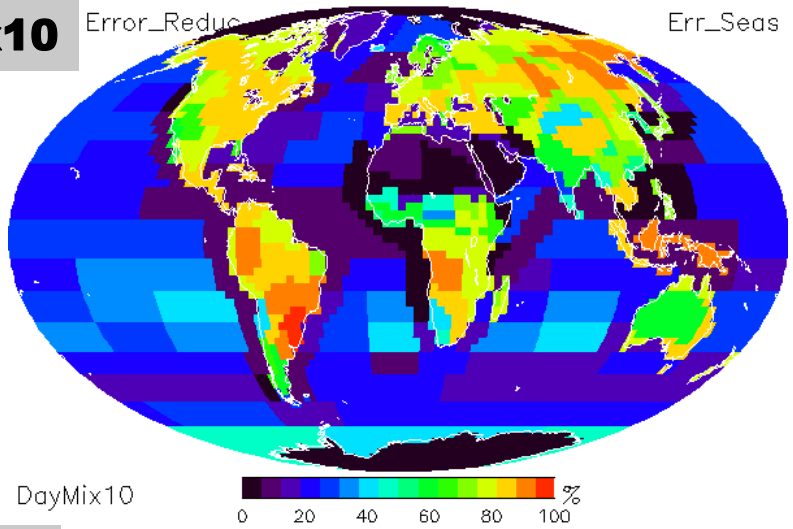


Several instrument concepts (Static interferometrer, grating spectrometers) are under study

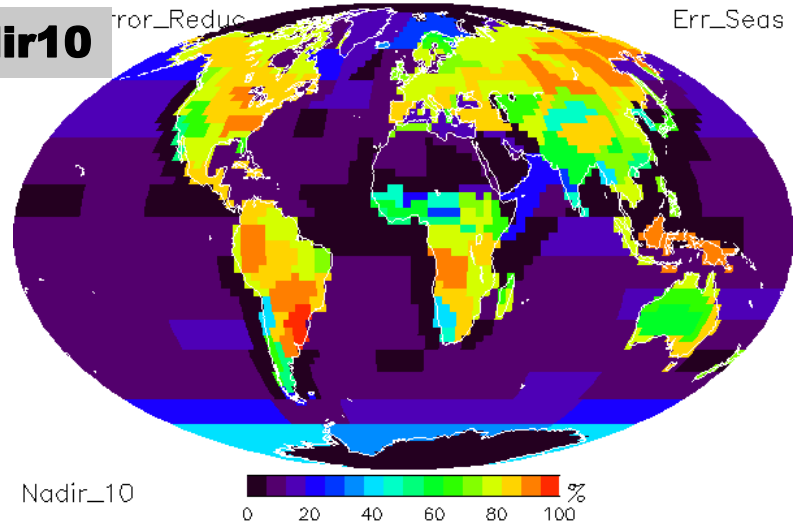
These studies will lead to a final selection at the end of 2011, and will permit a full quantification of the potential performances

Error reduction on annual fluxes

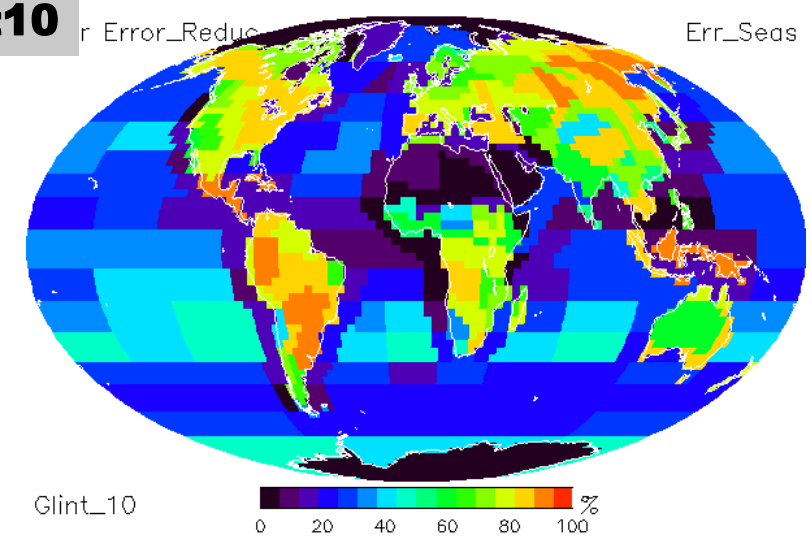
DayMix10



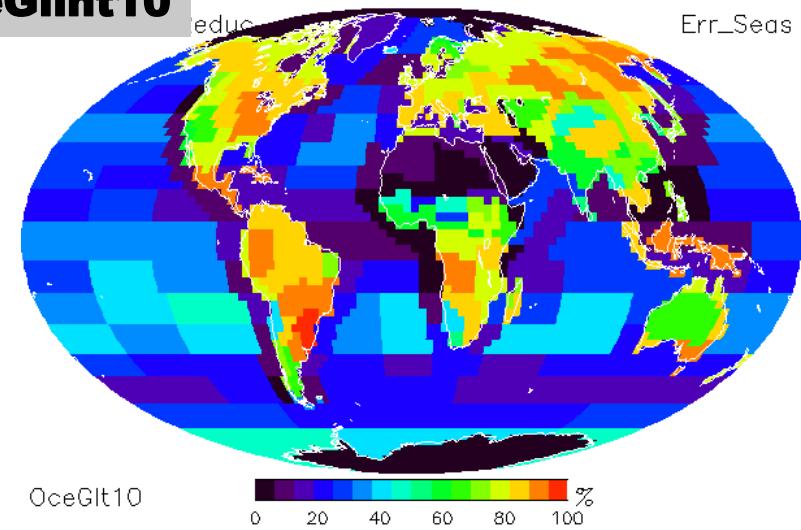
Nadir10



Glint10



OceGlint10



Simulations to quantify the potential impact on the flux knowledge

Conclusions

International efforts to measure [CO_2] and [CH_4] from space

Several missions flying (GOSAT), planned (OCO-2) or under study (MicroCarb, CarbonSat)

LSCE is involved in the preparation and analysis of these spaceborne missions

Difficult task because the signal to measure is small

Interest both for a better understanding of the Carbon Cycle and its interaction with climate, and for the monitoring of international treaty compliance.