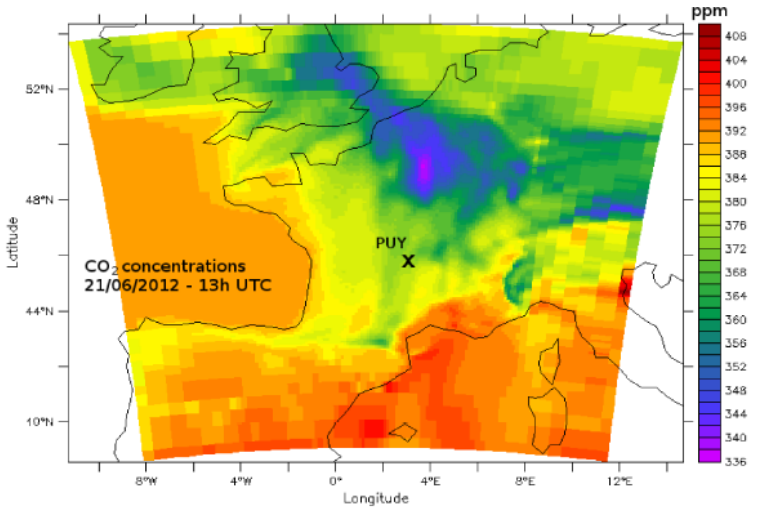
Greenhouse gases measurements

Michel Ramonet

Scientific corrdinator

RAMCES - SNO ICOS-France

LSCE



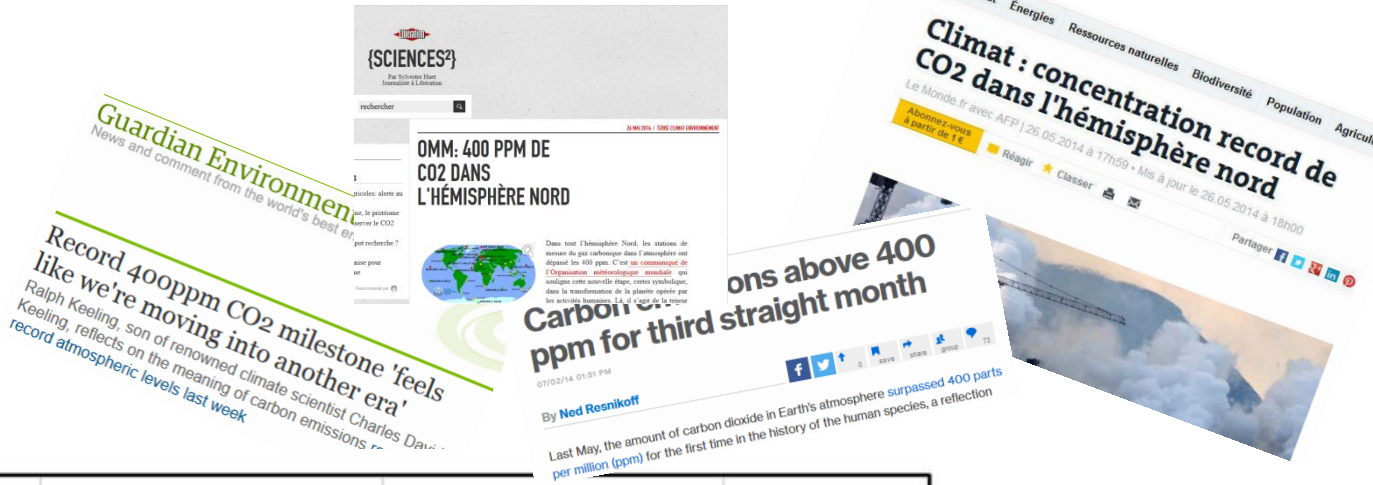
cnrs

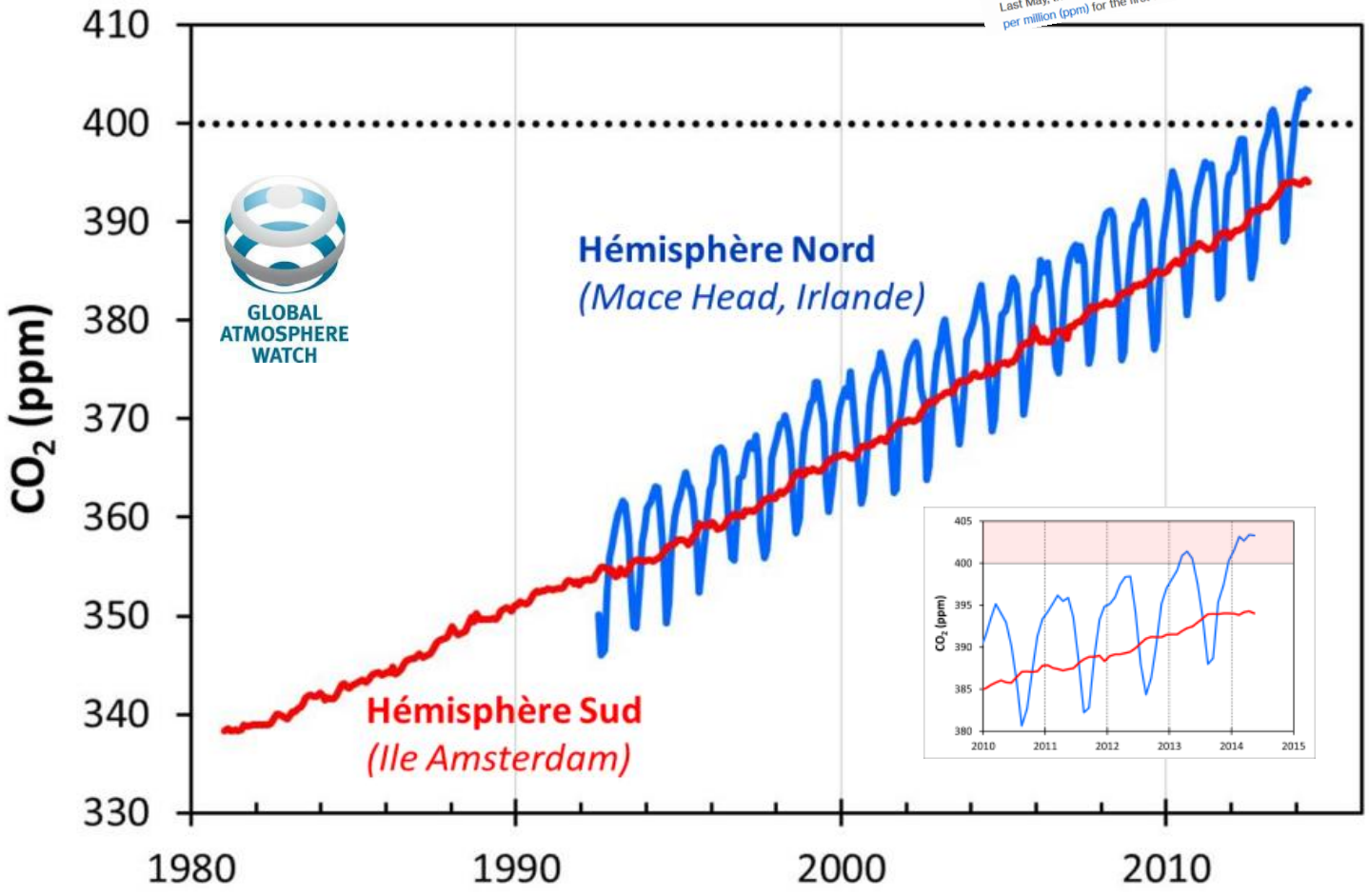
UNIVERSITÉ DE VERSAILLES ST-QUENTIN-EN-YVELINES

OVSQ

cea

400 ppm CO_2

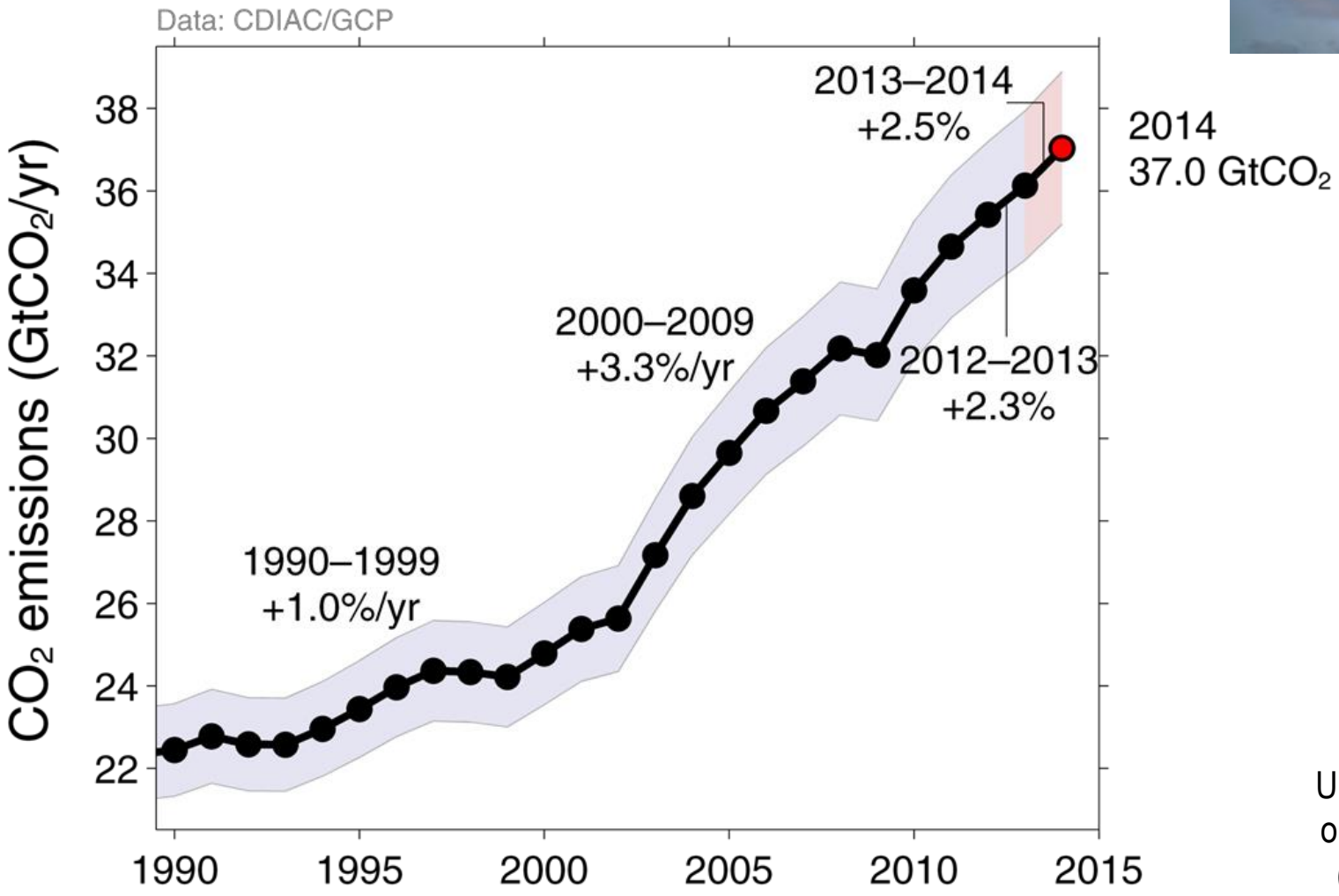




Observatoire de Mace Head, Irlande

Observatoire de l'Ile Amsterdam, TAAF

CO_2 anthropic emissions

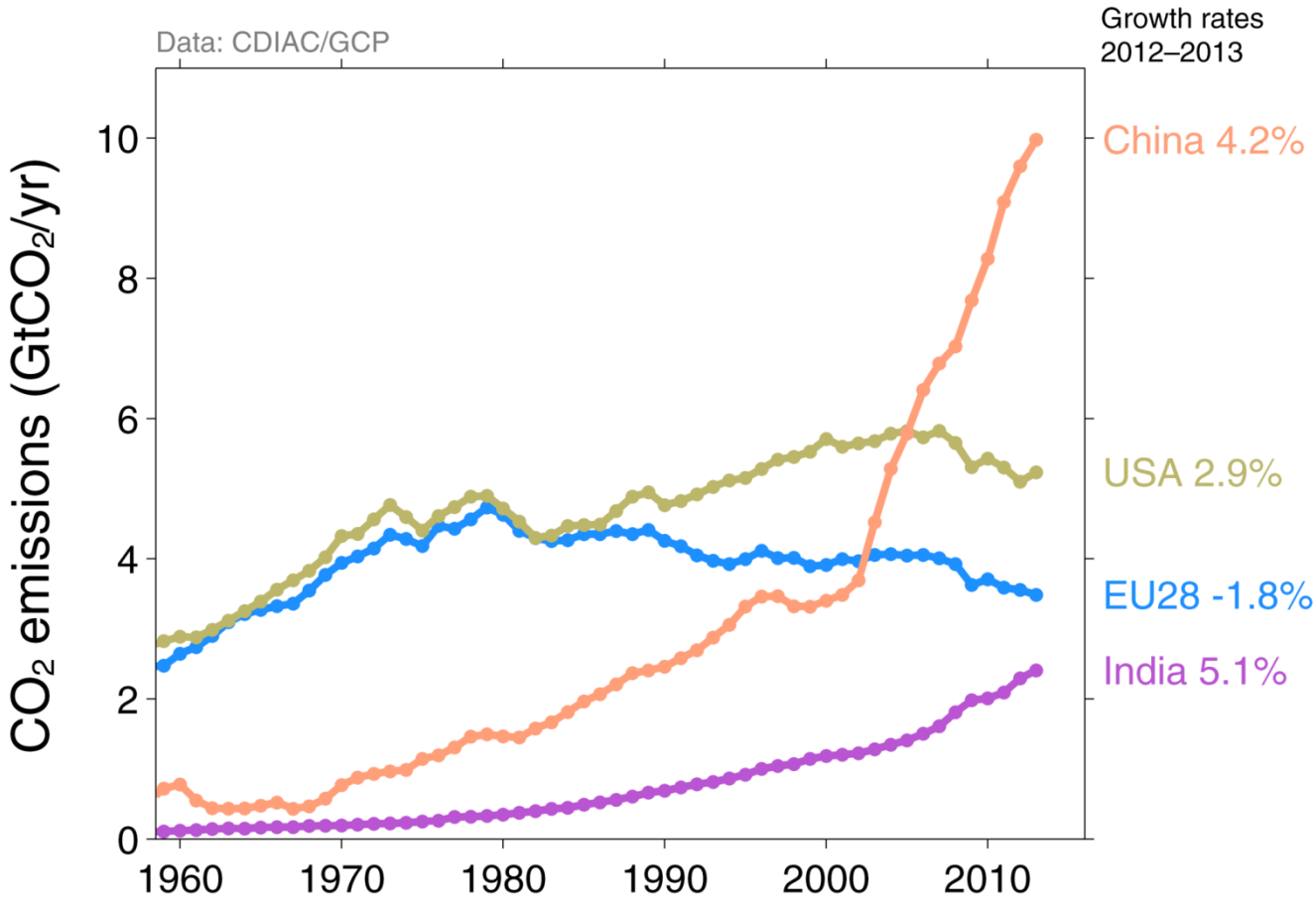


Uncertainty is ±5% for one standard deviation (IPCC "likely" range)

Estimates for 2011, 2012, and 2013 are preliminary
Source: CDIAC; Le Quéré et al 2014; Global Carbon Budget 2014

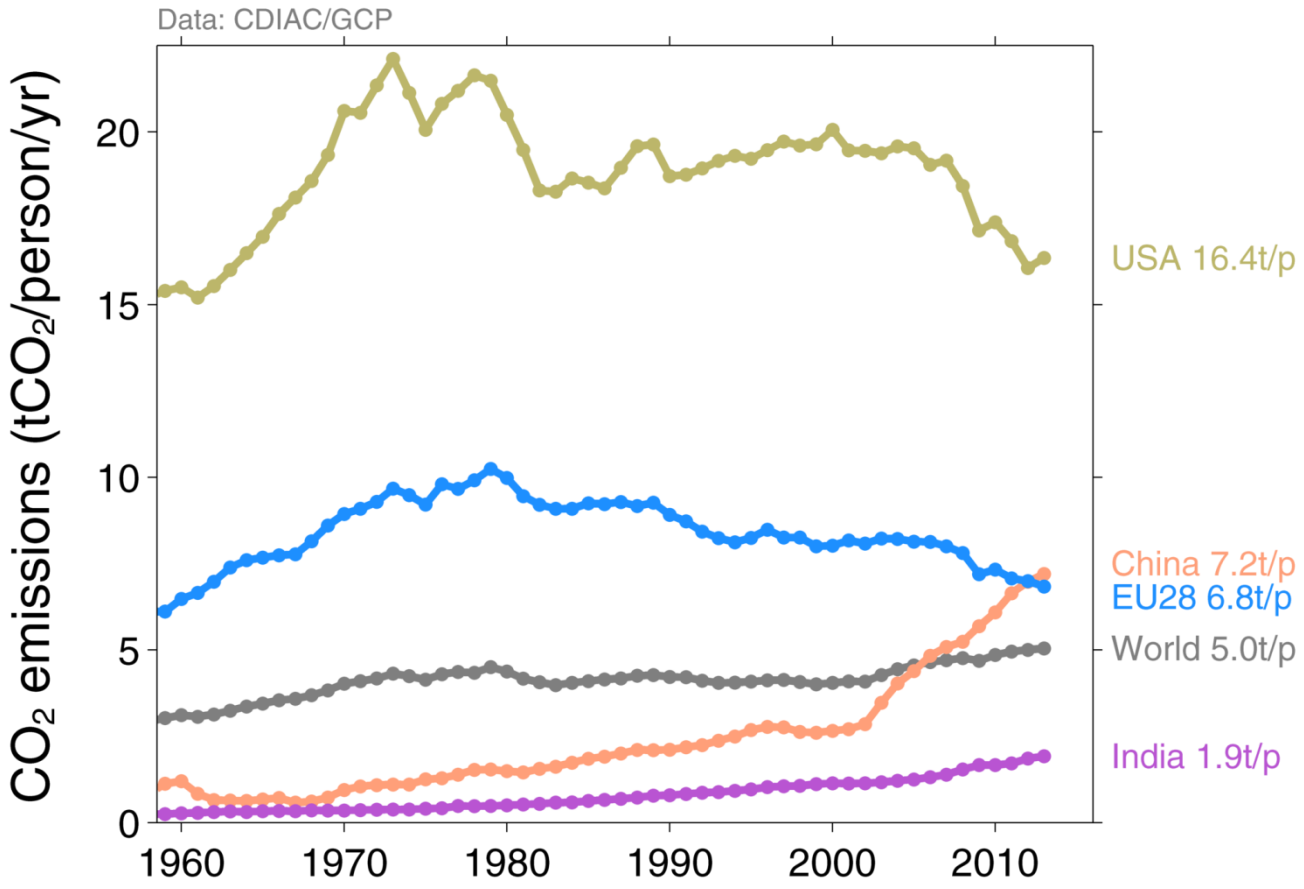
Top Fossil Fuel Emitters (Absolute)

The top four emitters in 2013 covered 58% of global emissions
China (28%), United States (14%), EU28 (10%), India (7%)



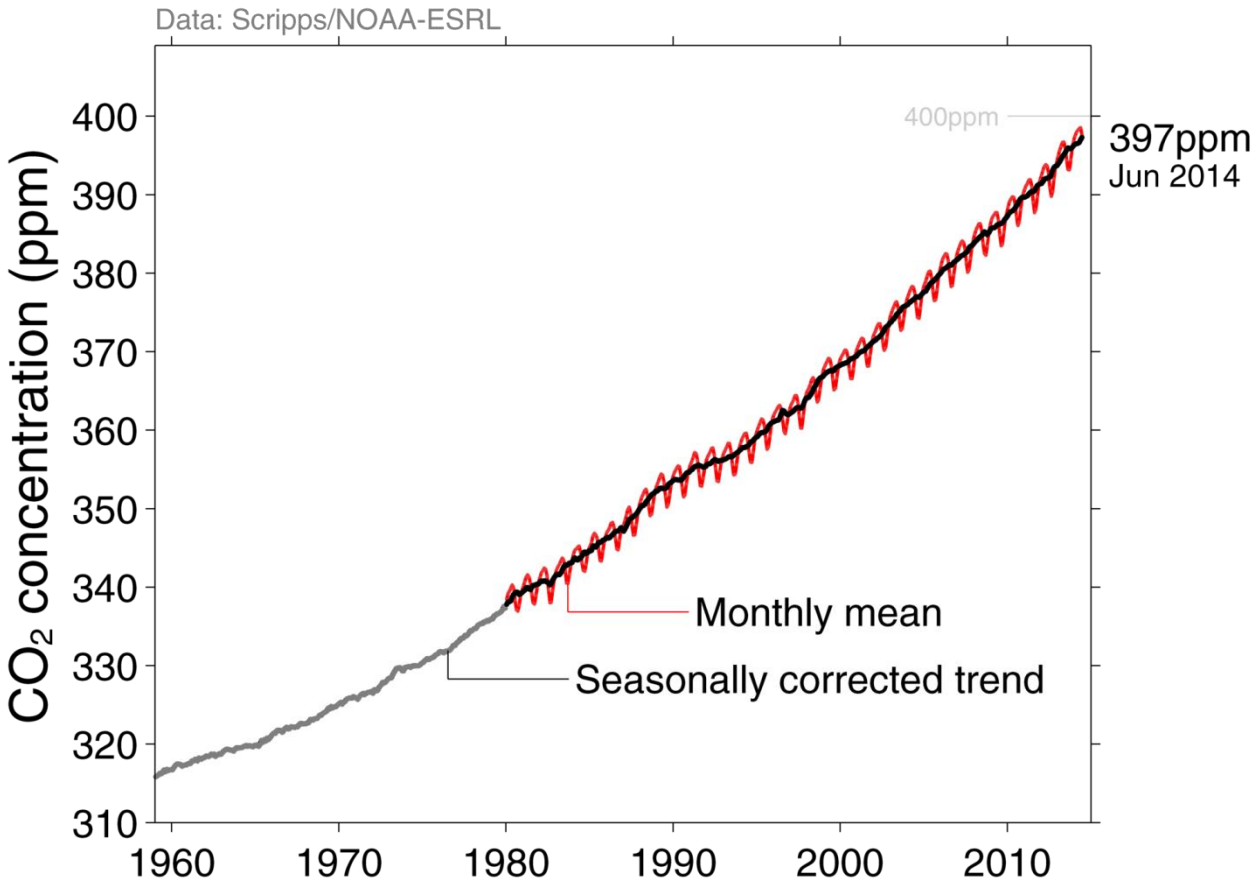
Top Fossil Fuel Emitters (Per Capita)

China's per capita emissions have passed the EU28 and are 45% above the global average



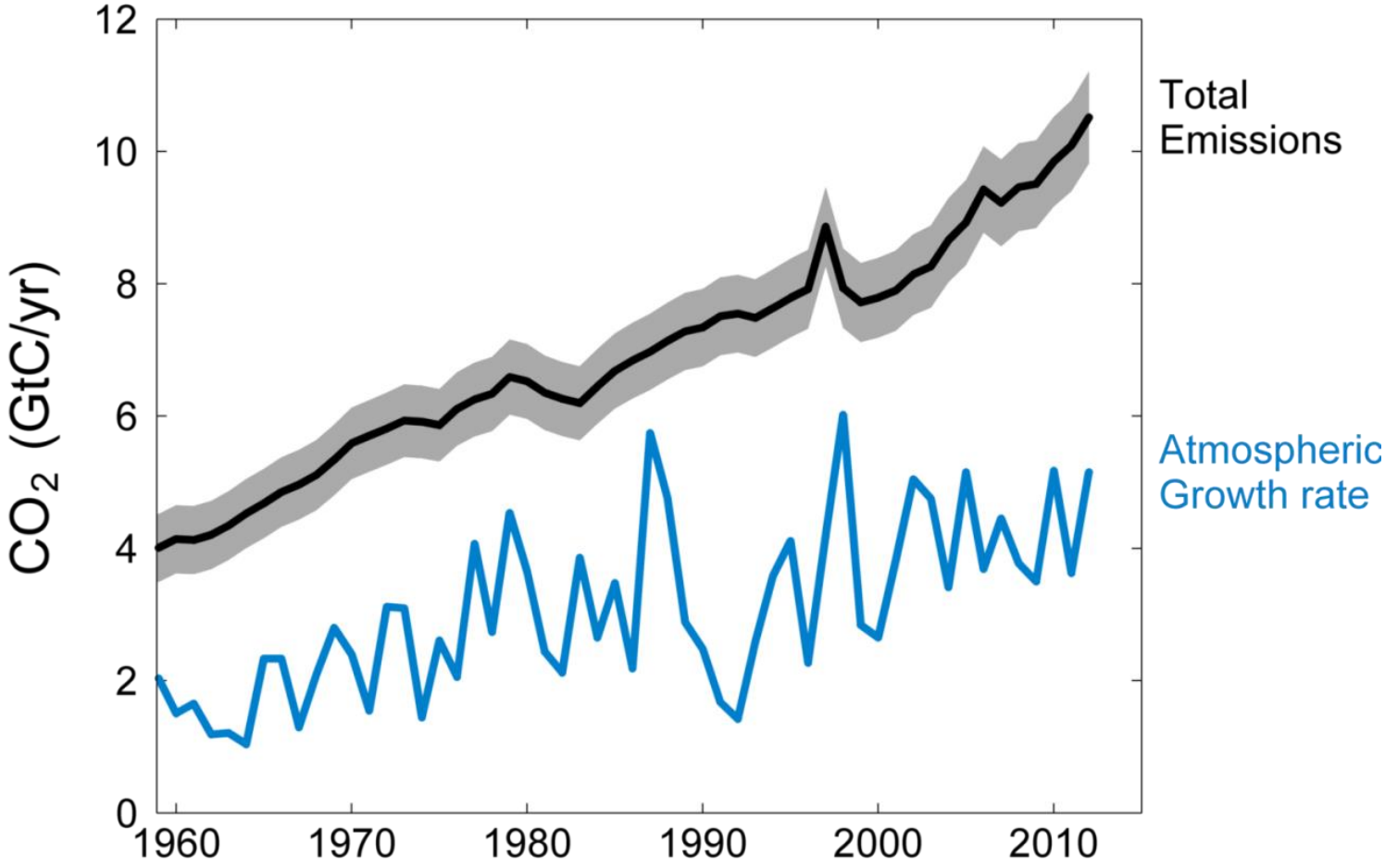
Atmospheric Concentration

The global CO_2 concentration increased from ~277ppm in 1750 to 395ppm in 2013 (up 43%)
Mauna Loa registered the first daily measurements above 400pm in May 2013



Globally averaged surface atmospheric CO_2 concentration
Data from: NOAA-ESRL after 1980; the Scripps Institution of Oceanography before 1980 (harmonised to recent data by adding 0.542ppm)
Source: NOAA-ESRL; Scripps Institution of Oceanography; Global Carbon Budget 2014

Airborne fraction



≈50% of CO_2 emitted by human activities stored in the atmosphere

Global scale Carbon cycle (2003-2012)

8.6 ± 0.4 GtC/yr 92%

0.8 ± 0.5 GtC/yr 8%

+

4.3 ± 0.1 GtC/yr
45%

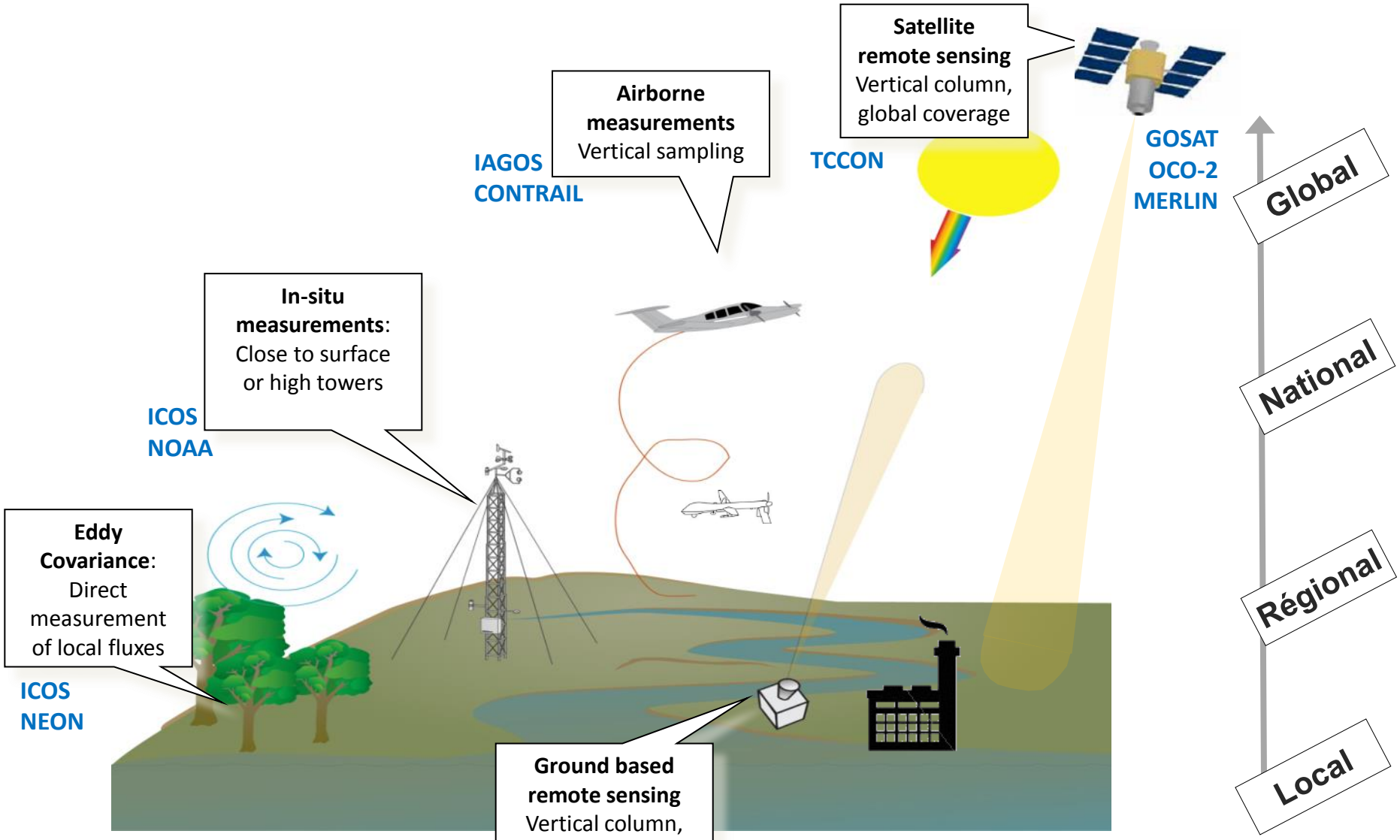
2.6 ± 0.5 GtC/yr
27%

2.6 ± 0.8 GtC/yr
27%

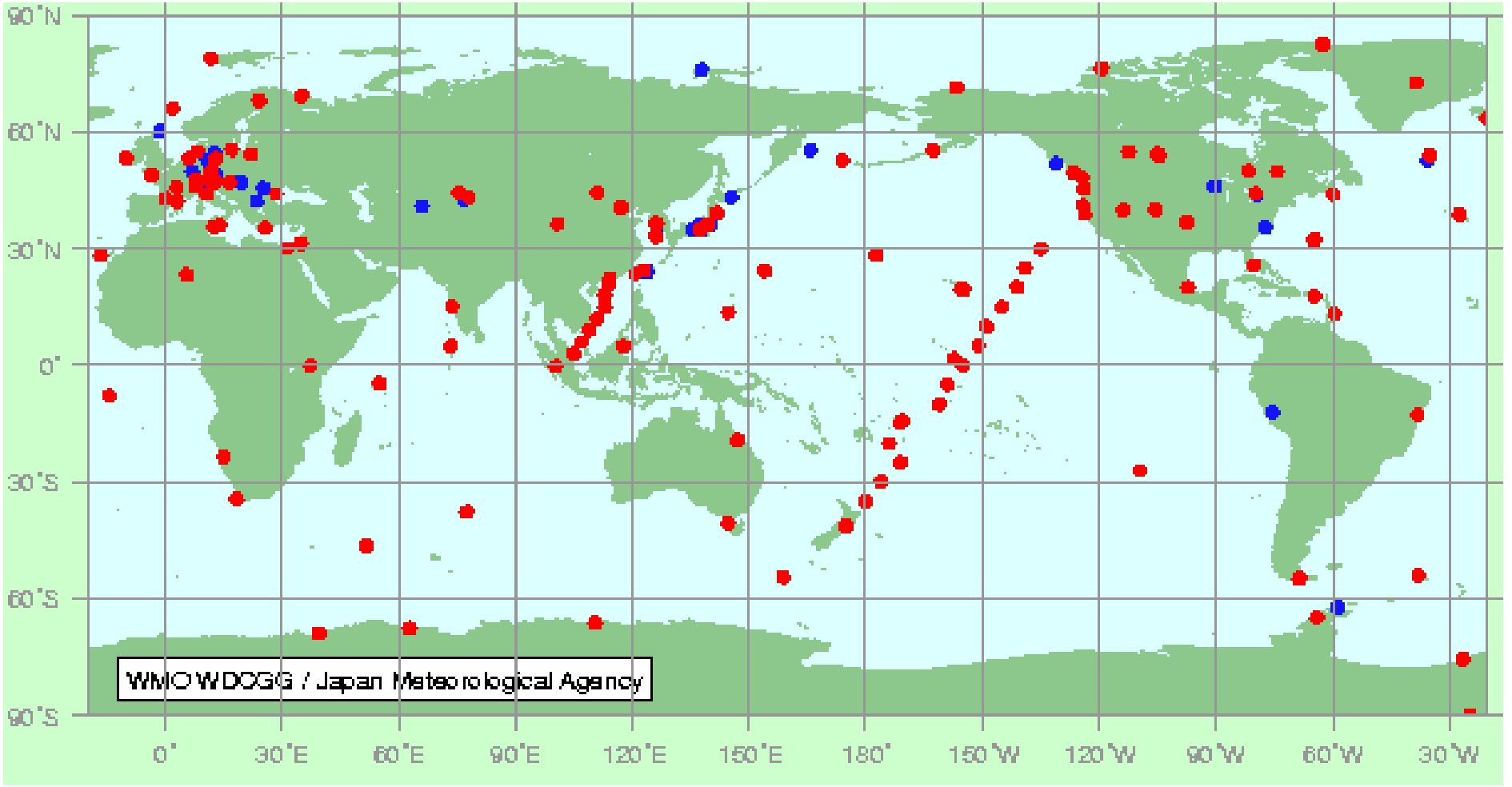
Calculated as the residual
of all other flux components

Source: Le Quéré et al 2013; CDIAC Data; Global Carbon Project 2013

Carbon cycle and greenhouse gases monitoring



Atmospheric networks



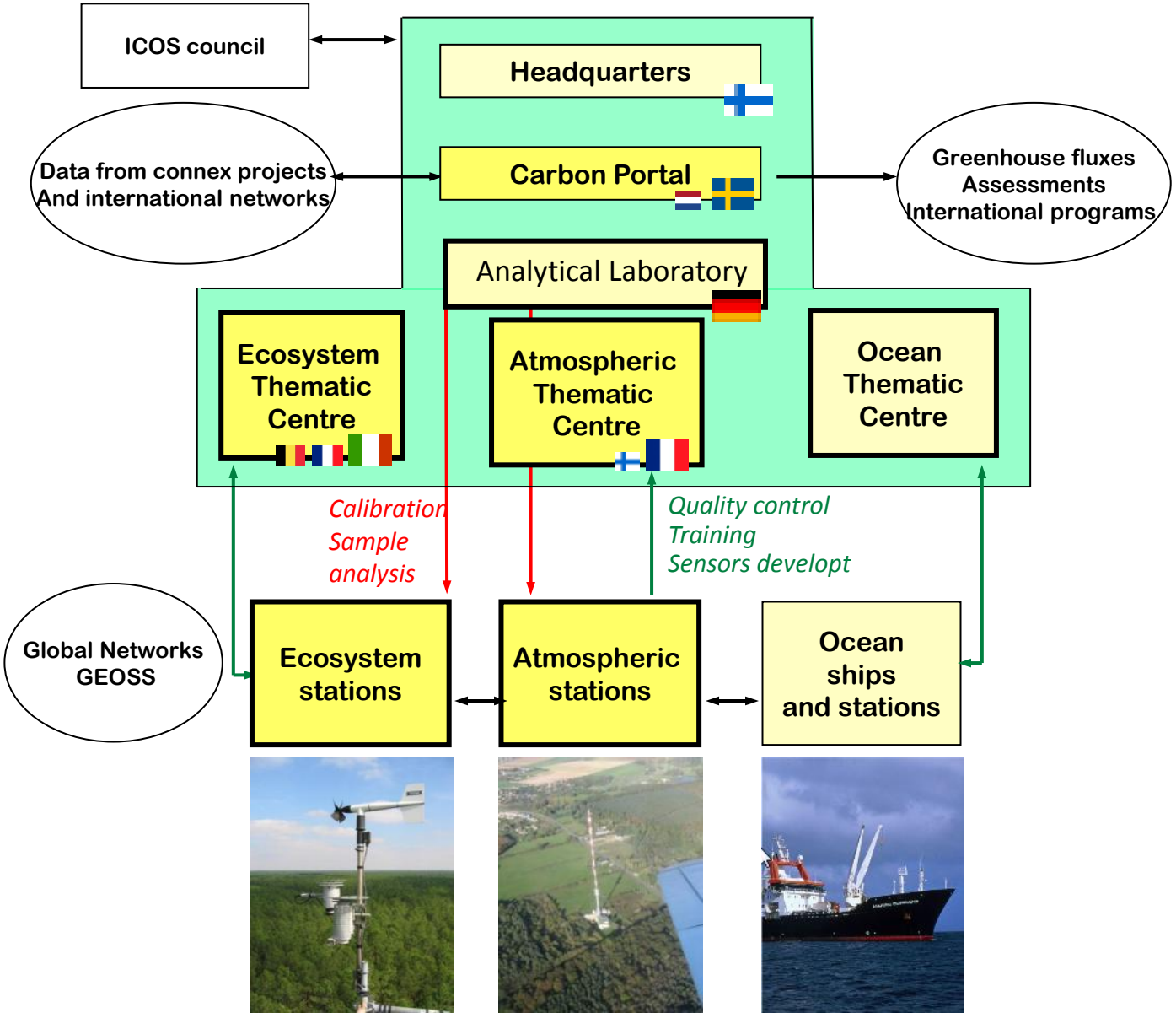
ICOS | INTEGRATED CARBON OBSERVATION SYSTEM

A European research infrastructure to monitor greenhouse gas emissions

- tracks carbon fluxes in Europe and adjacent regions by monitoring the ecosystems, the atmosphere and the oceans through integrated networks.
- provides the long-term observations required to understand the present state and predict future behavior of the global carbon cycle and greenhouse gas emissions.
- monitors and assesses the effectiveness of carbon sequestration and/or greenhouse gases emission reduction activities on global atmospheric composition levels, including attribution of sources and sinks by region and sector.

A European research infrastructure to monitor greenhouse gas emissions

ICOS INTEGRATED CARBON OBSERVATION SYSTEM



Analytical Lab:
Working gases, flask analysis

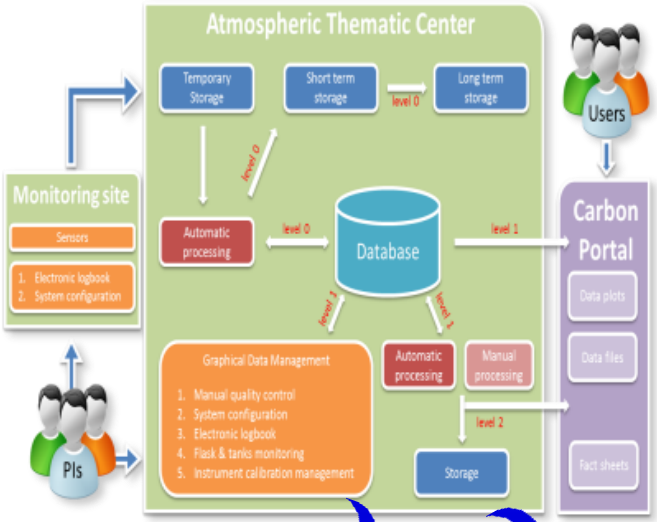
Thematic Centers:
Data processing, technical support to stations, technology survey

Monitoring networks

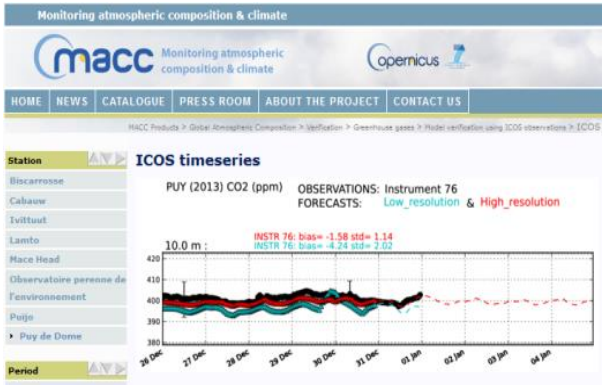
Atmospheric Thematic Center (ATC)

ICOS INTEGRATED CARBON OBSERVATION SYSTEM

Atmospheric Data Center

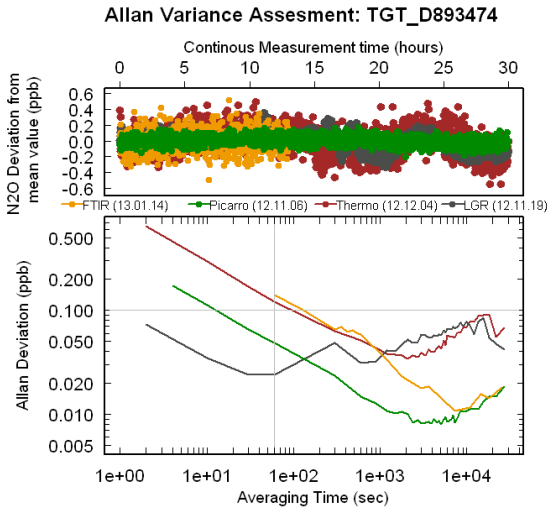


Near real time h+24



Dataset provision for MACC-II COPERNICUS core service

ICOS Atmospheric Metrology Lab



Technology survey & evaluation of sensors and protocols

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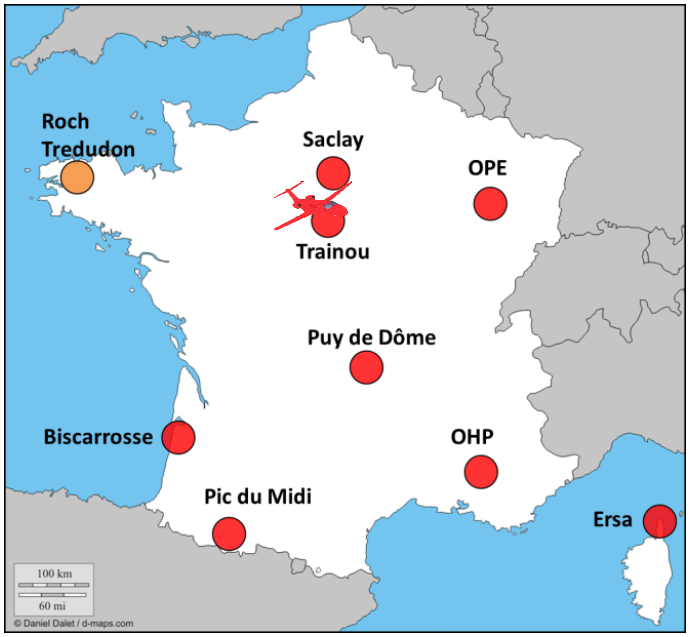
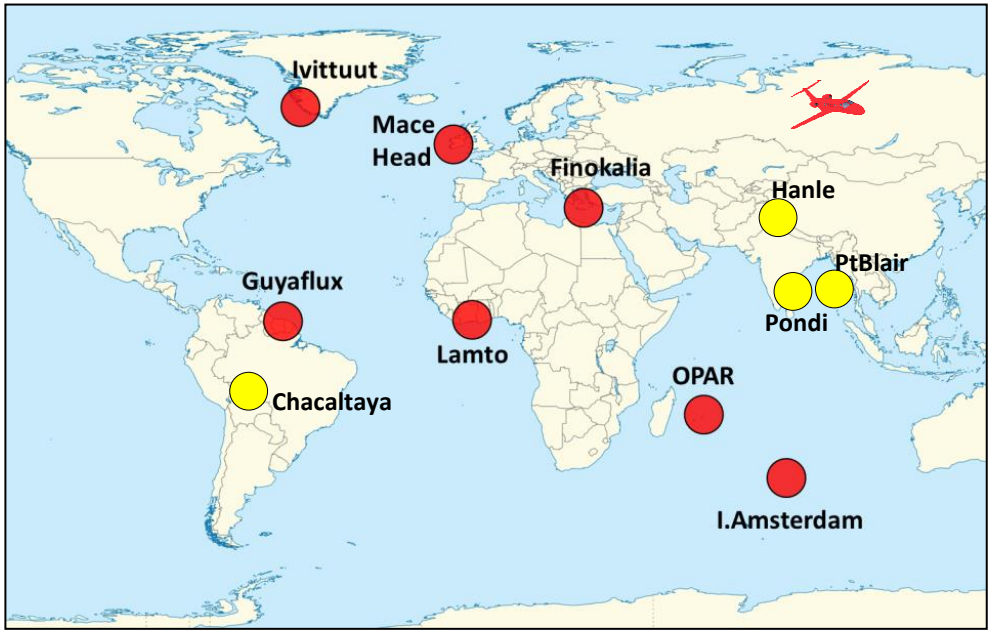
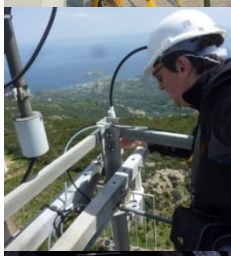
WP2: Autonomous GhG atmospheric sensor systems

- Task 2.1 : Requirements of 'heavy-duty' atmospheric CO_2/CH_4 and Meteo sensor systems for remote areas and challenging environments
- Task 2.2 : R&D to enhance instrument remote-control and station-center data transmission package
- Task 2.3: R&D to enhance instrumental package of ICOS atmospheric GHG stations: New flask sampler

French contribution to the GhG monitoring network







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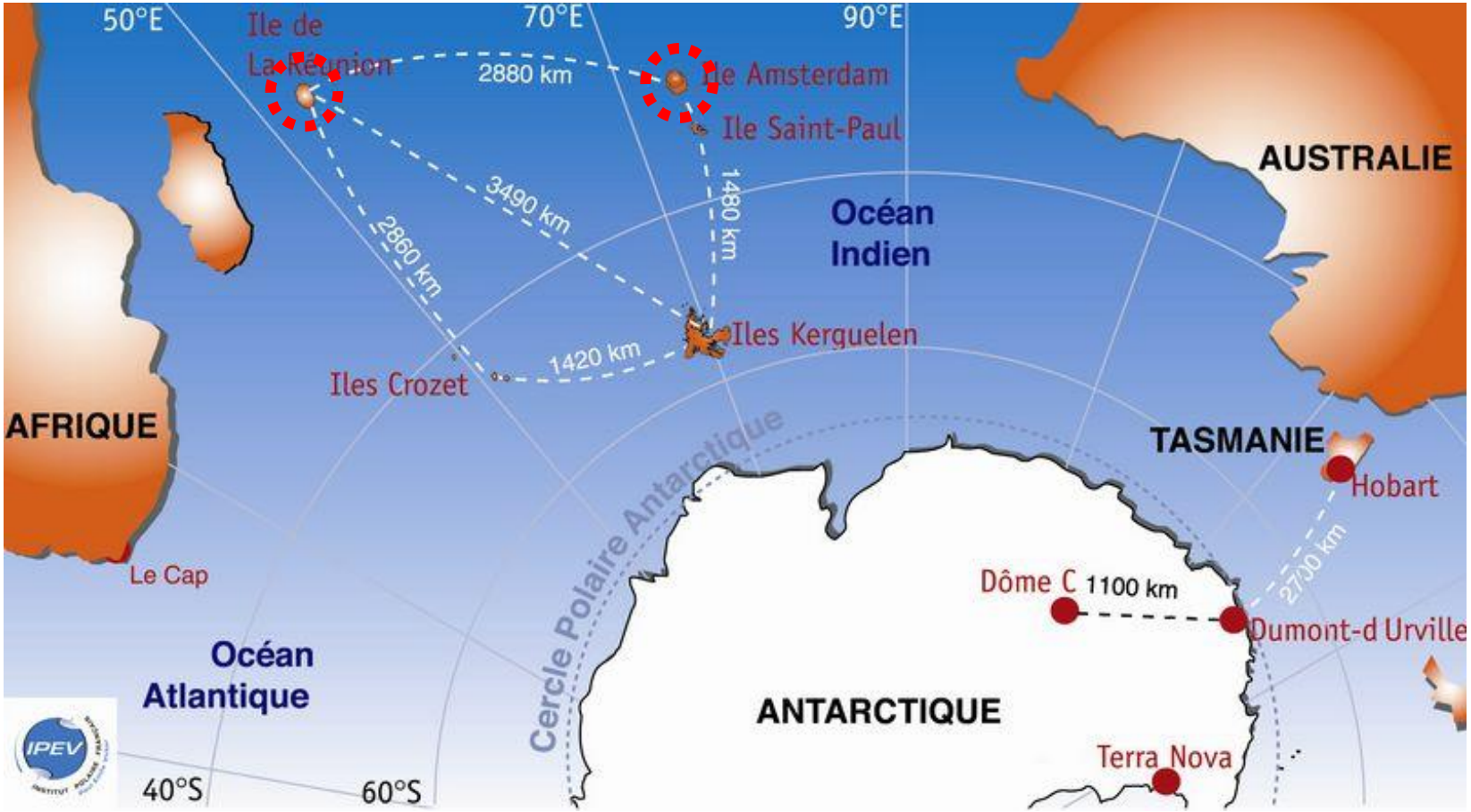
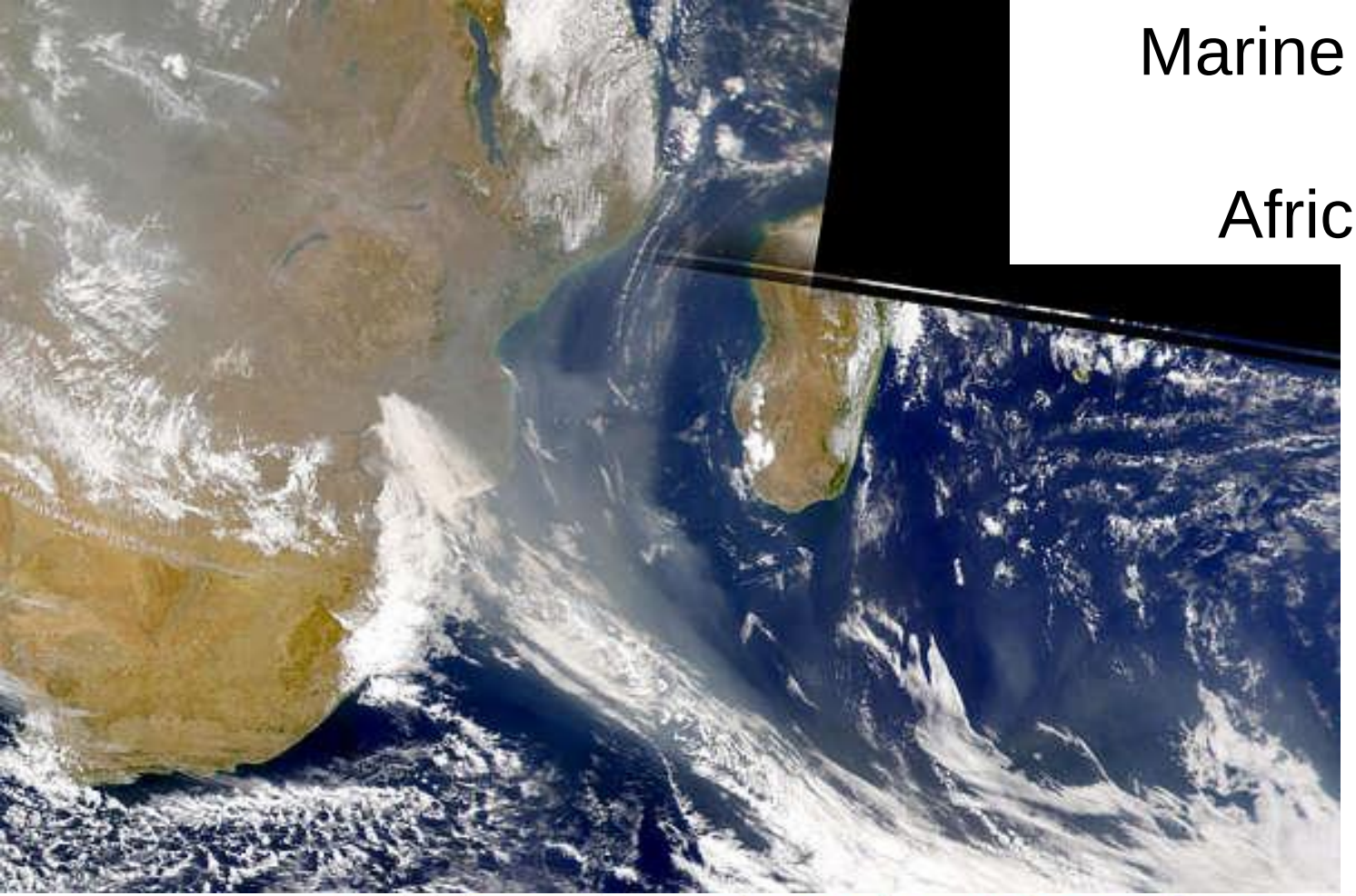
French territories in Indian Ocean

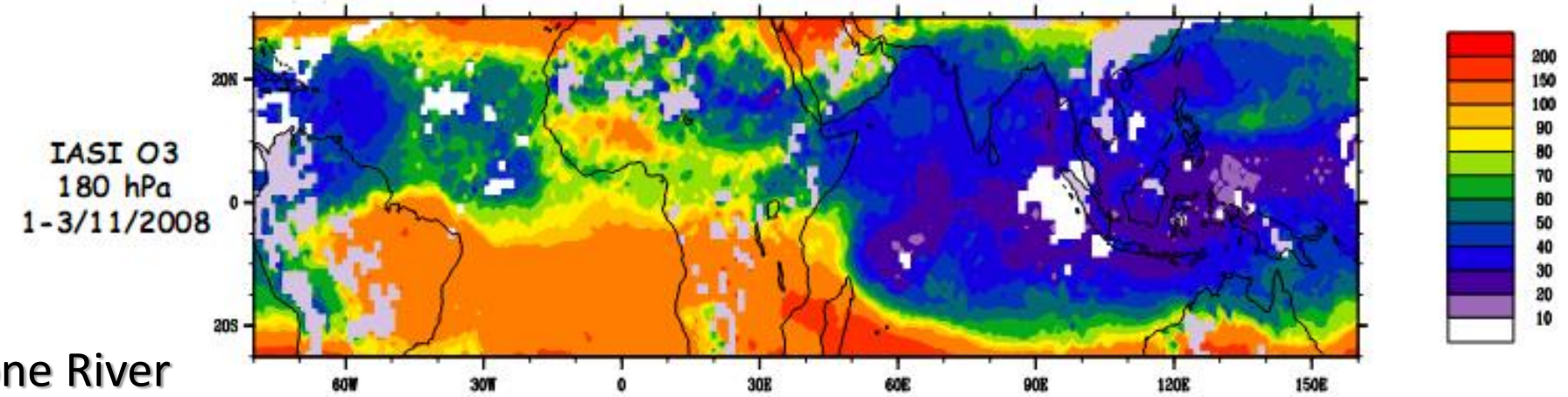


Marine background

+

African episodes





Ozone River

Amsterdam Island

Background observatory of the atmosphere

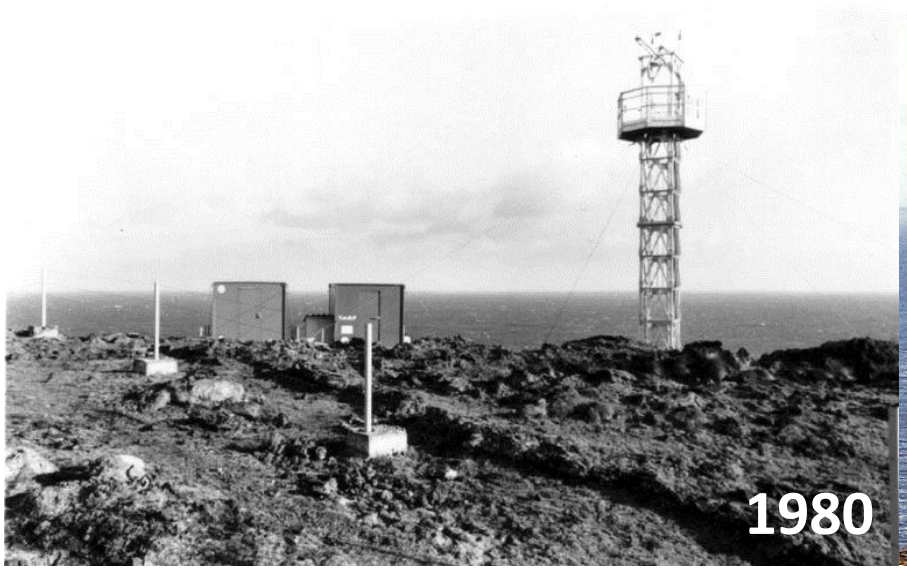
Meteorology
Greenhouse gases
Aerosols
Sulphur compounds
Radon
Mercury

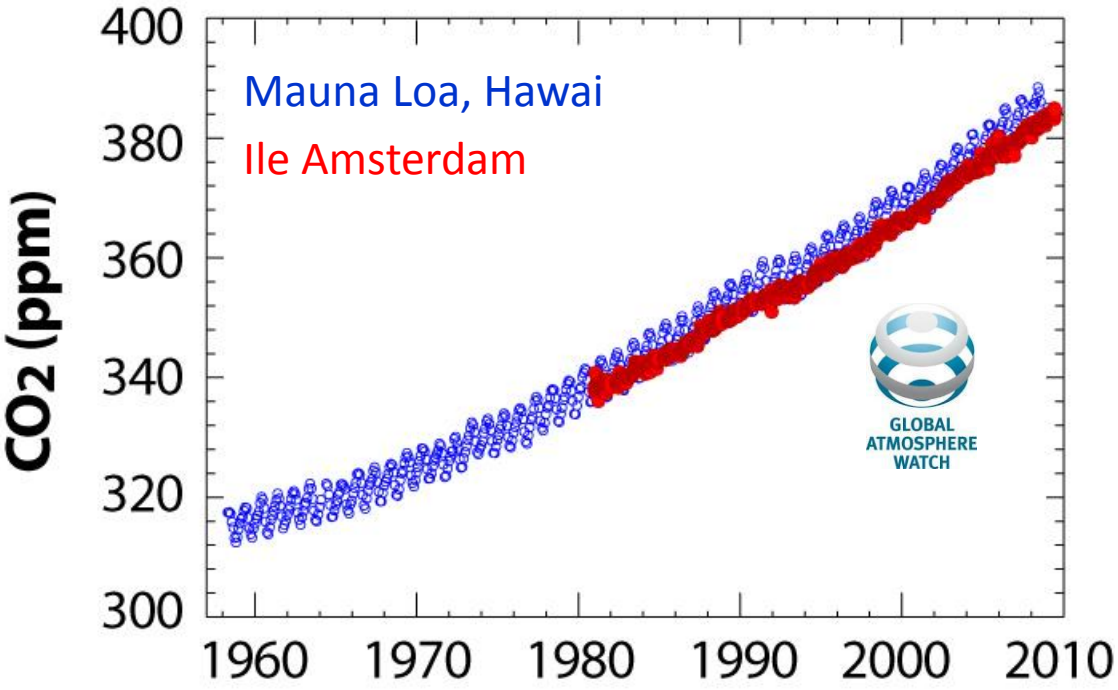
1949: Installation of the weather station

La première mission d'hivernage pour une photo souvenir :
Au premier rang, de gauche à droite : L. Courtois, sergent J. Lechevallier, P. Ratsimandresi, adjudant chef D. Herraye. A. Faure, H. Treussart, A. Abassi Saïd ; au deuxième rang : B. Rassata, Radavidra, sergent H. Félard, adjudant chef H. Delsalle, P. de Martin de Viviès, sergent A. Parent, B. Sahy, A. Saïd. (cliché et légende H. Treussart

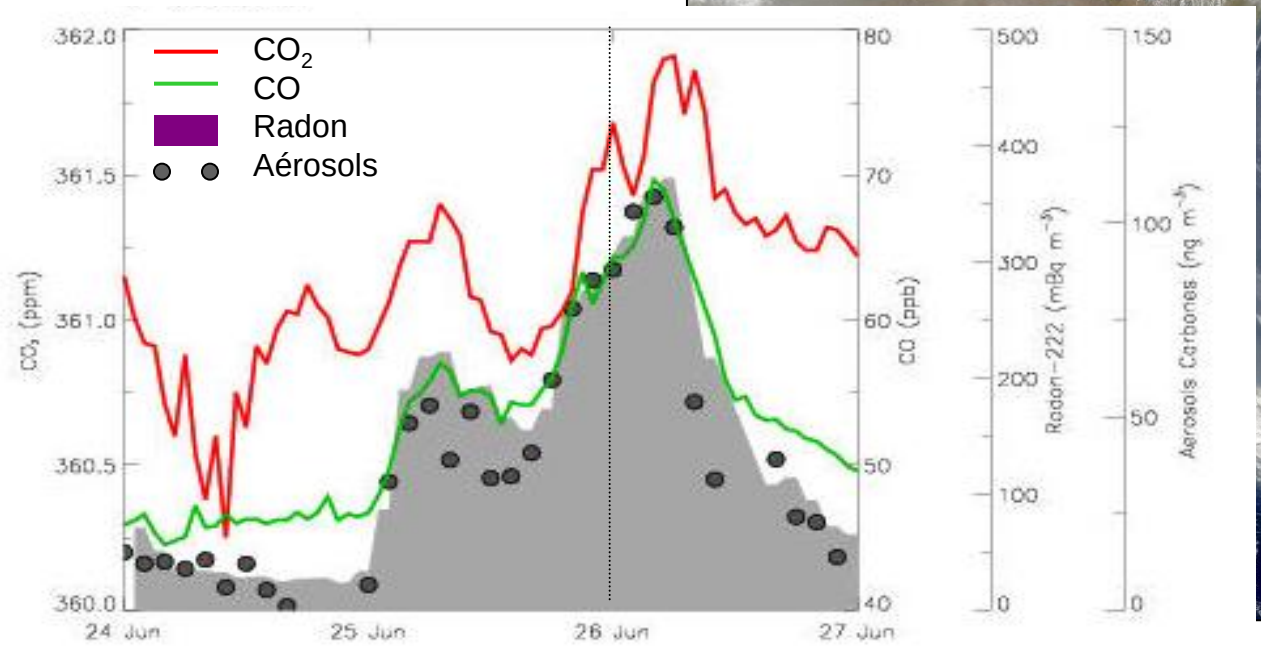
La base au départ de la première mission (photo H. Treussart)

Suivi à long terme du CO_2 atmosphérique

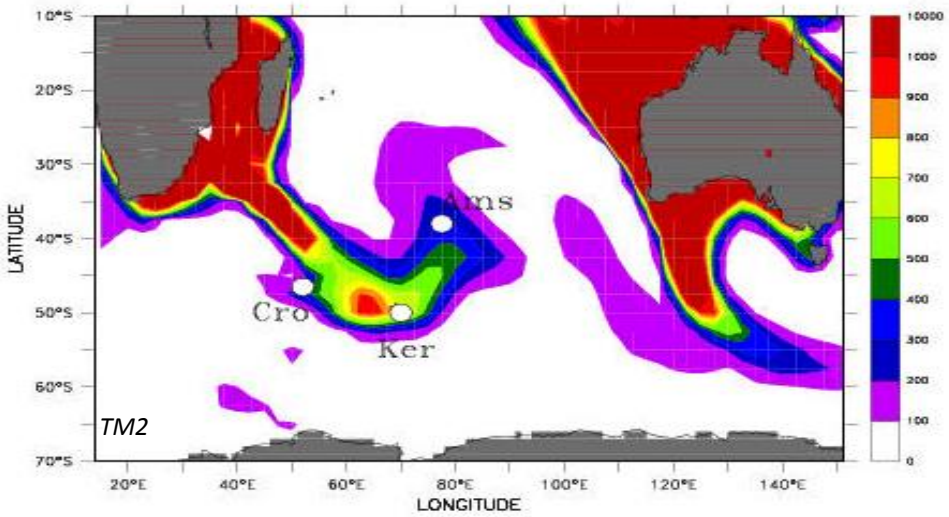




Panache sud-africain à l'Ile Amsterdam



1997



Radon simulation

Emissions

$CO_2 = 4.2$ millimol CO_2 m^{-2} h^{-1}

$CO = 1.5$ mgC m^{-2} h^{-1}

La Réunion Island

Atmos. Meas. Tech., 6, 2865–2877, 2013
www.atmos-meas-tech.net/6/2865/2013/
doi:10.5194/amt-6-2865-2013

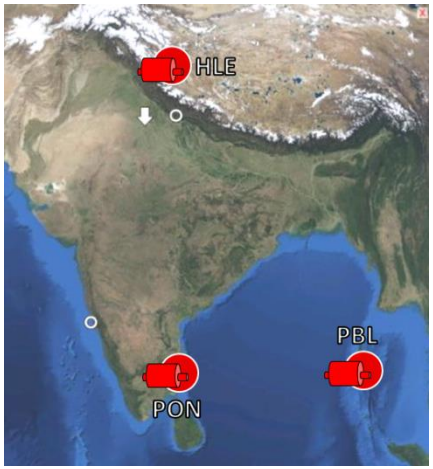
Atmospheric Measurement Techniques Open Access

Maïdo observatory: a new high-altitude station facility at Reunion Island (21° S, 55° E) for long-term atmospheric remote sensing and in situ measurements

J.-L. Baray[1,2,3], Y. Courcoux[4], P. Keckhut[4], T. Portafaix[1], P. Tulet[1], J.-P. Cammas[1,2], A. Hauchecorne[4], S. Godin Beekmann[4], M. De Mazière[5], C. Hermans[5], F. Desmet[5], K. Sellegri[3], A. Colomb[3], M. Ramonet[6], J. Sciare[6], C. Vuillemin[6], C. Hoareau[7], D. Dionisi[4], V. Duflot[1,2,8], H. Vérèmes[1,2], J. Porteneuve[4], F. Gabarrot[2], T. Gaudo[2], J.-M. Metzger[2], G. Payen[2], J. Leclair de Bellevue[1], C. Barthe[1], F. Posny[1], P. Ricaud[9], A. Abchiche[10], and R. Delmas[1,2]

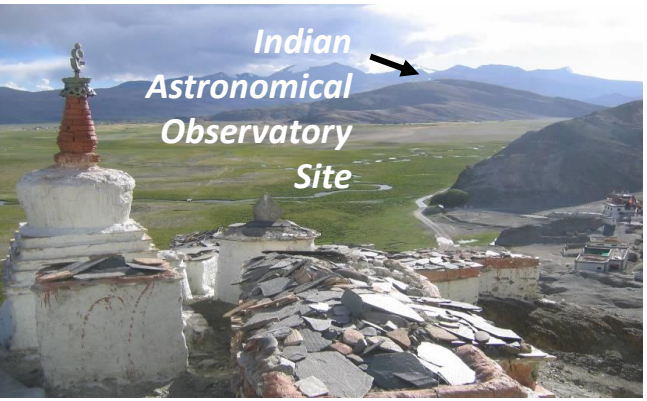
Indo-French collaboration for GhGs inversions

- Hanle (HLE), *32.779°N - 78.964°E - 4517 m asl*
- Pondicherry (PON), *12.01°N - 79.86°E - 30 m asl*
- Port-Blair (PBL), *11.65°N - 92.75°E - 30 m asl*
- Hosokote, Bangalore > 2015



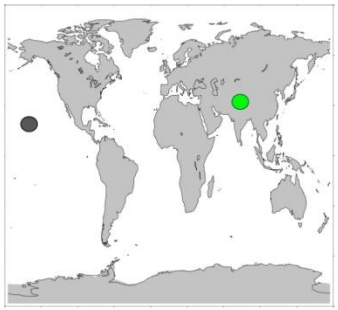
LSCE

C-MMACS

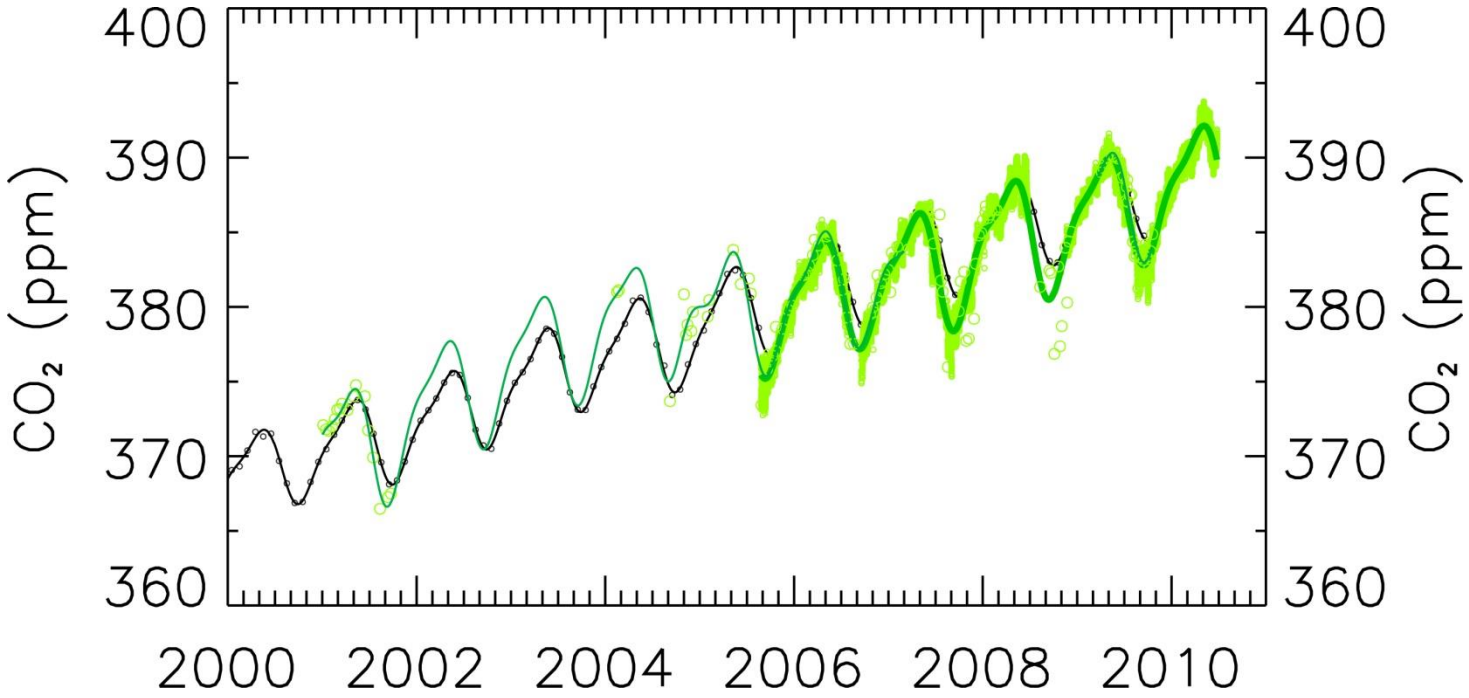


Hanle: a background station for Asia

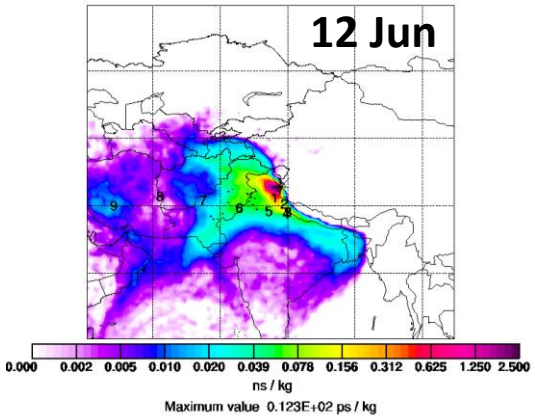
Mauna Loa

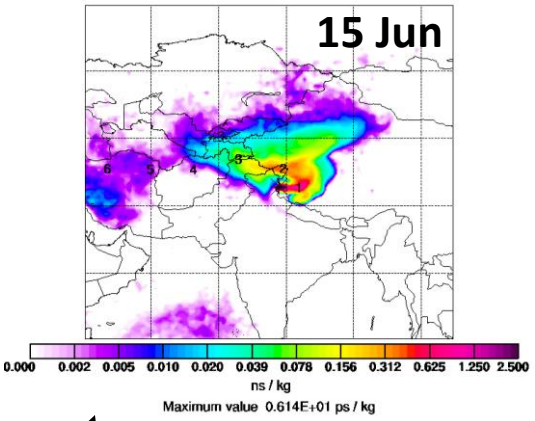


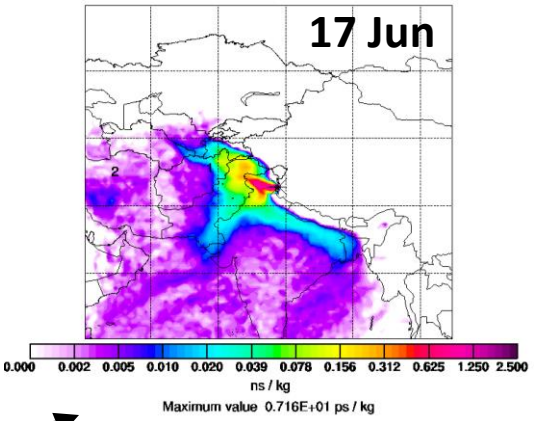
Hanle

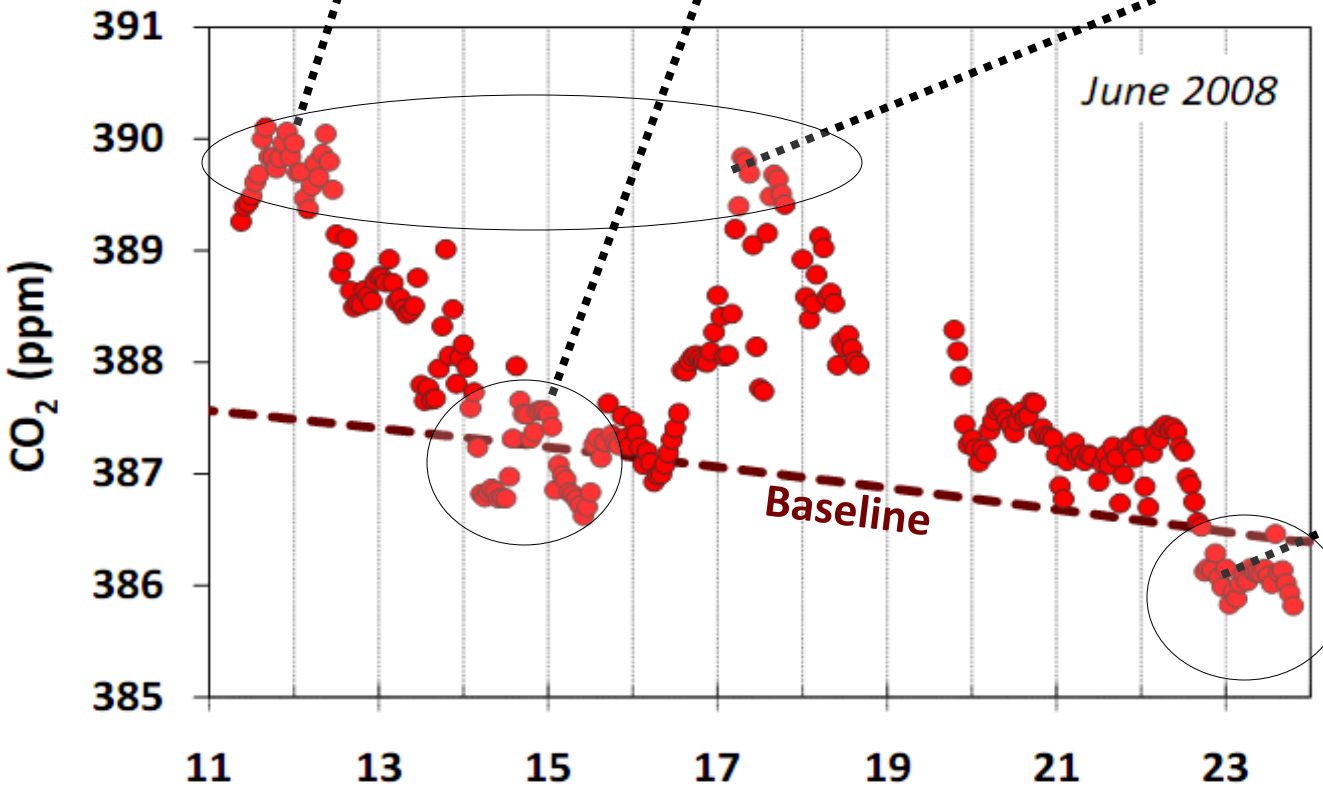


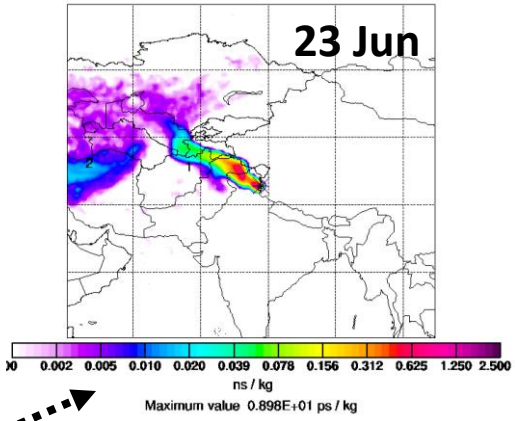
Synoptic scale variations at Hanle





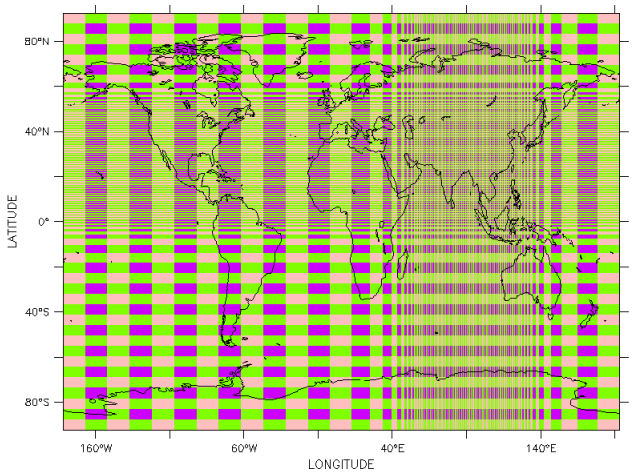






Asian zoom version of LMDz transport model

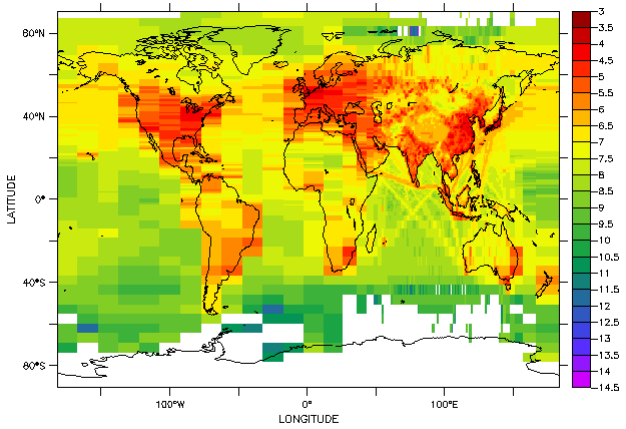
PhD : Xin Lin



≈0.5x0.5° over Asia

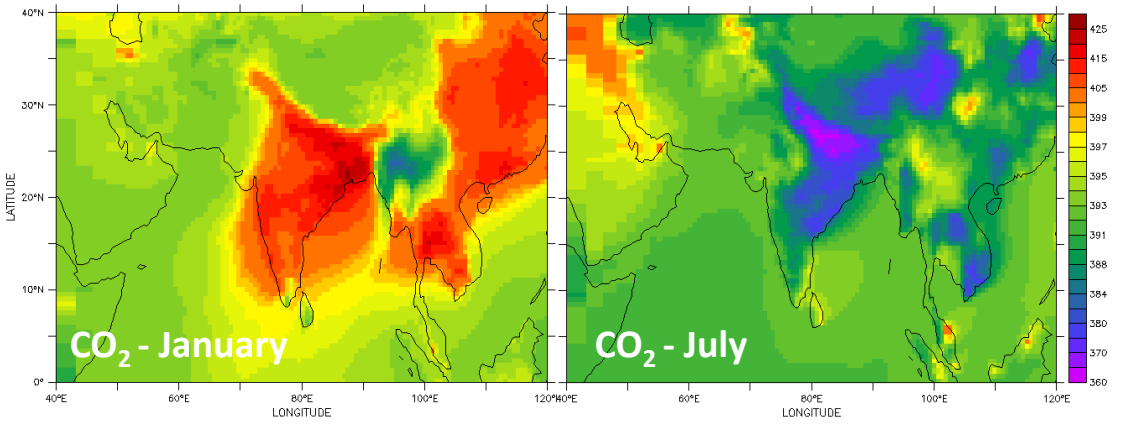
A priori surface fluxes

CO2	Source	interann./clim.	time step	resolution
Anthropogenic	IER products for CARBONES; GEOCARBON products	interannual	monthly	1°
Biomass burning	GFEDv3.1	interannual	monthly	0.5°
Land flux	ORCHIDEE outputs for CARBONES	interannual	daily	0.72°
Ocean flux	NOAA/AOML product; Park *et al.* (2010)	interannual	monthly	4° ×5°
CH4	**Source**	**interann./clim.**	**time step**	**resolution**
Anthropogenic	EDGARv4.2	interannual	yearly	0.1°
Wetland	Kaplan *et al.* (2006)	climatological	monthly	1°
Biomass burning	GFEDv3.0	interannual	monthly	0.5°
Termite	Sanderson *et al.* (1996)	climatological	monthly	1°
Soil	Ridgwell *et al.* (1999)	climatological	monthly	1°
Ocean	Lambert & Schmidt (1993)	climatological	monthly	1°

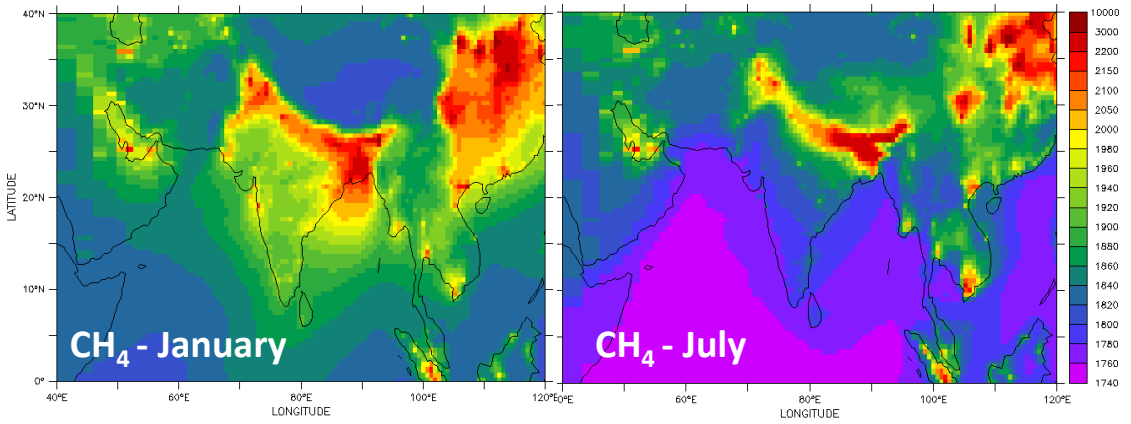


Fossil fuel CO2 emissions (kgC m−2 h−1,log scale)

Surface molar fractions

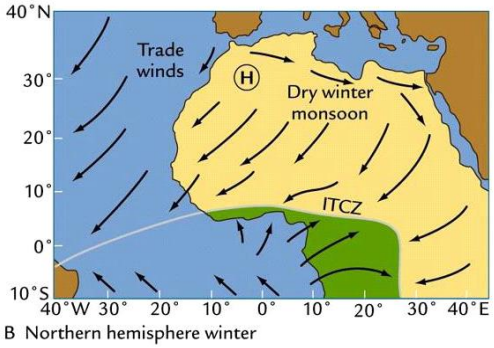


CO2 (ppm) CO2 (ppm)

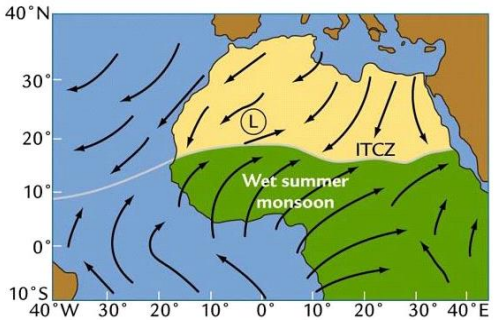


CH4 (ppb) CH4 (ppb)

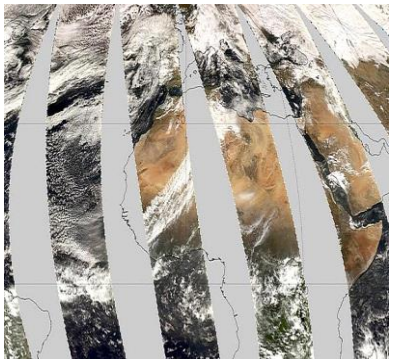
LAMTO, Ivory Coast

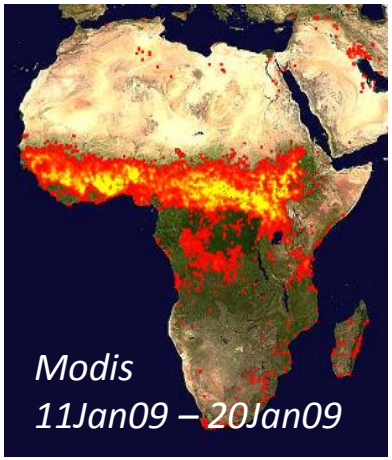


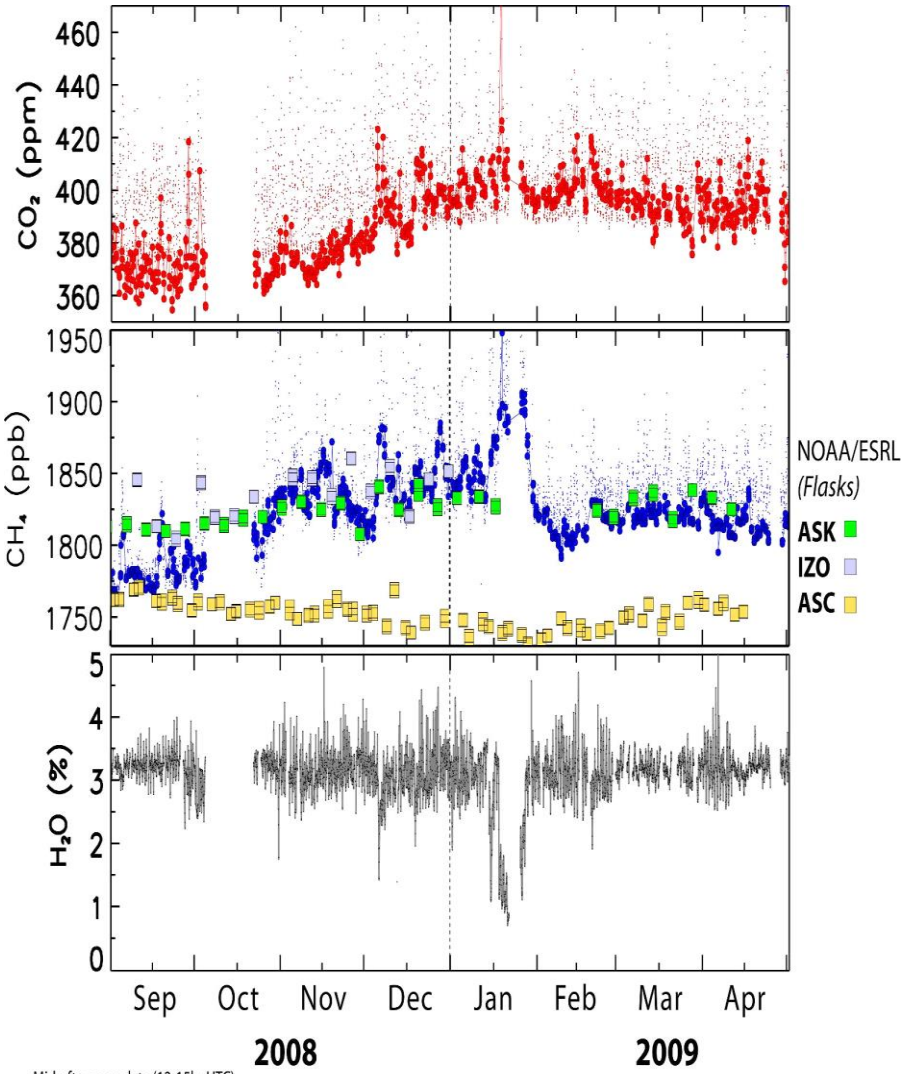
B Northern hemisphere winter



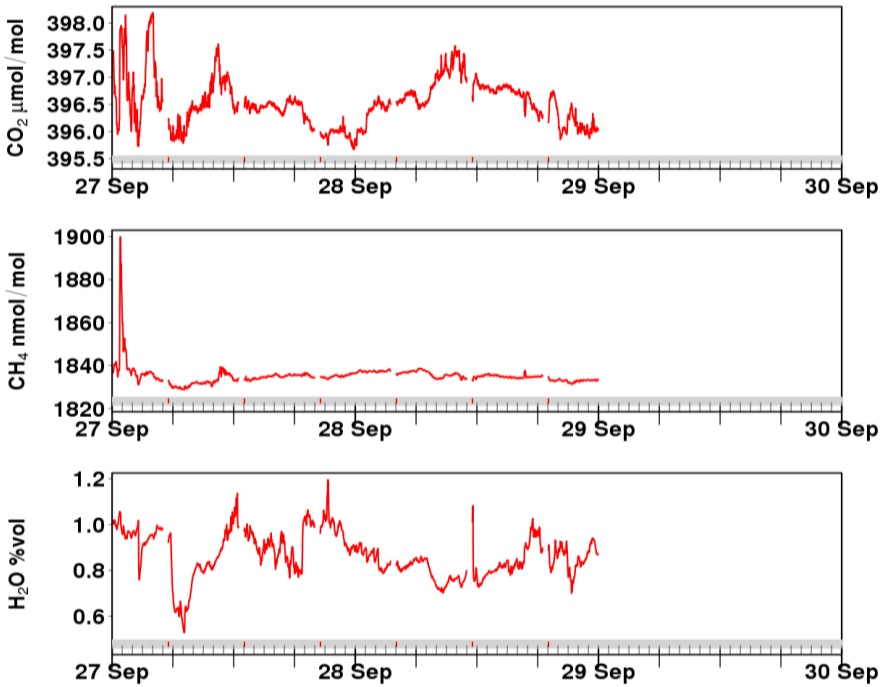
A Northern hemisphere summer

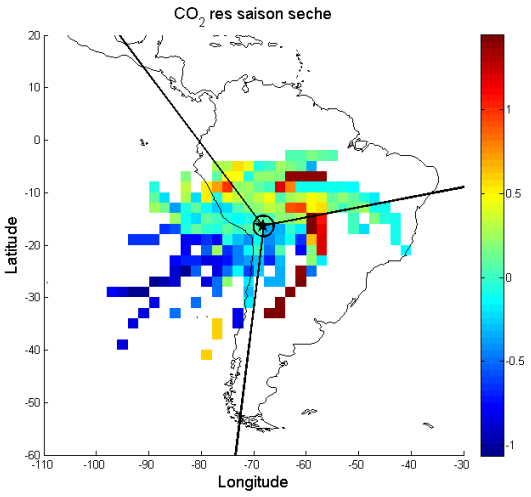


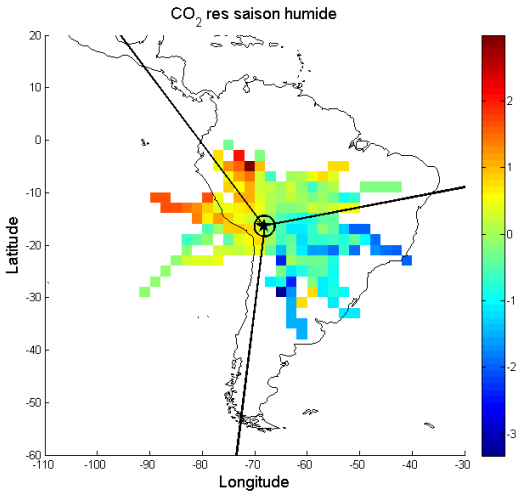




Chacaltaya, Bolivia, 5240m asl







Greenhouse gases monitoring (CO_2, CH_4, N_2O)

- Long term (>10 years) and high precision calibrated measurements are required for a better understanding of sources/sinks of long lived greenhouse gases.
- New technology (laser diodes) enables high precision measurements, with relatively low maintenance, if proper protocols (air inlet, calibration, …) are used.
- Expert meetings organized by WMO/GAW every two years (provide recommendations)
- ICOS infrastructure to develop and standardize the monitoring network in Europe. ICOS-Inwire EU project for more robust setup.
- Observations are missing in many places of the world
- Near real time access to the measurements
- Satellite observations will provide major contribution (GOSAT, OCO, Carbonsat)
- Challenge of putting together large and heterogeneous data flows…

Different observations

One carbon cycle to understand