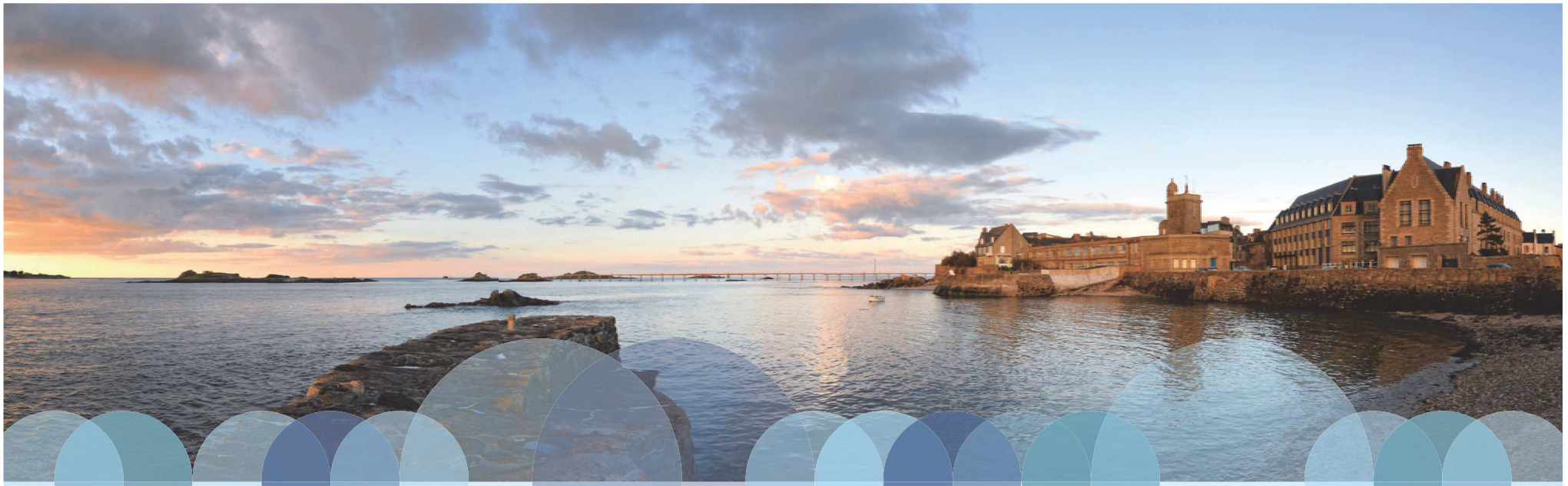

CH_4 (and CO_2) dynamics in the Bay of Morlaix

Preliminary results from SOMLIT and MORGAS experiments

INTERCOMPARAISON SOMLIT

10 OCTOBRE 2019

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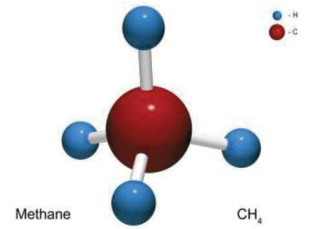
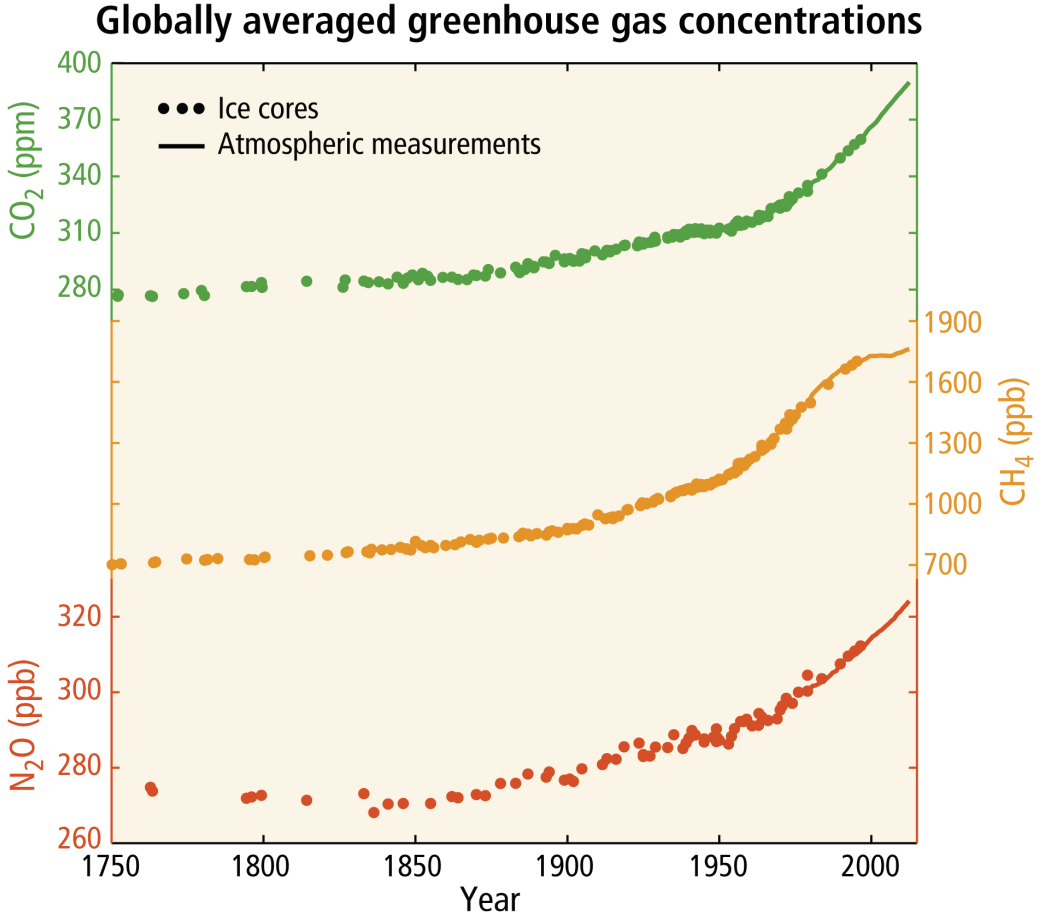
Atmospheric methane (CH_4)

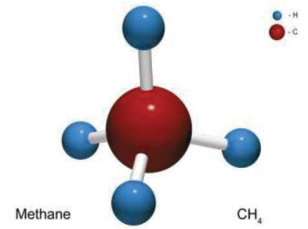


- 2nd greenhouse gas after CO_2
- Radiative power 20 to 30 times more effective than CO_2 over 100 years

- Atmospheric concentrations have tripled during the last 150 years (1.83 ppmV in 2015)

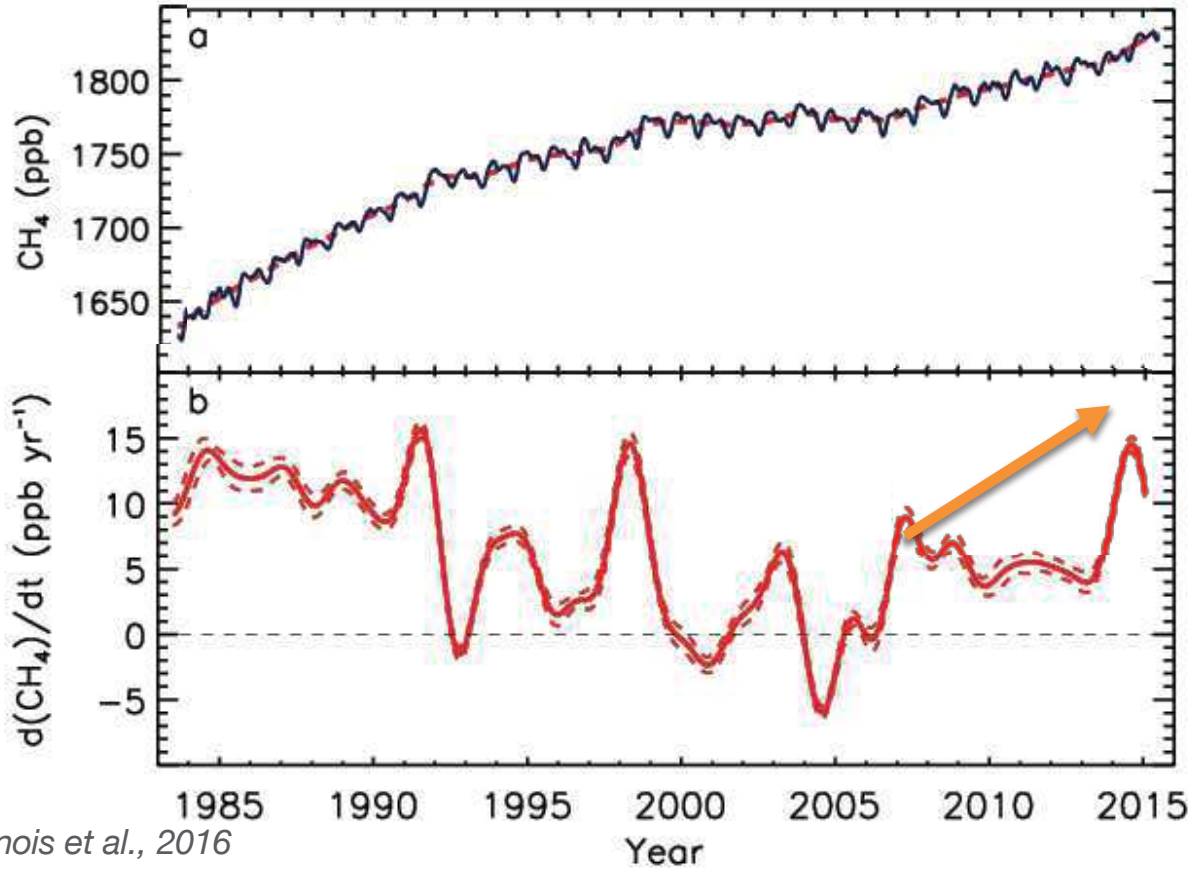


Atmospheric methane (CH_4)



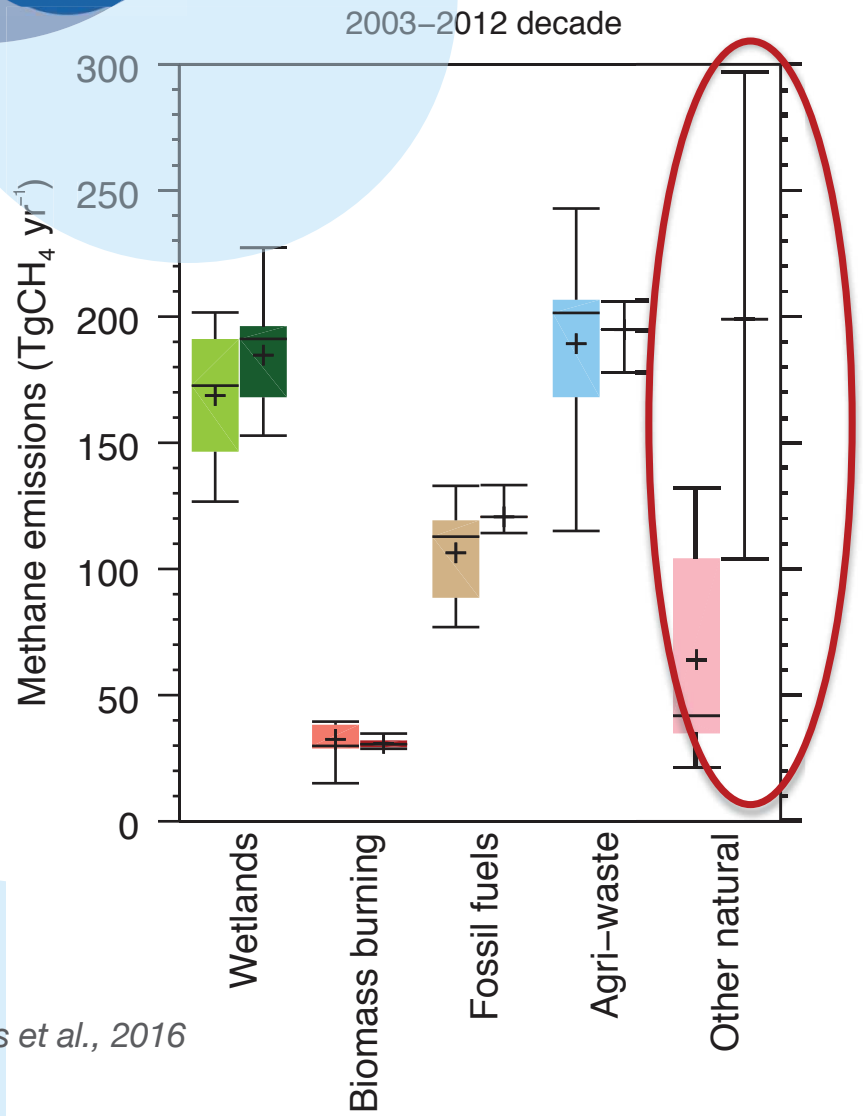
- 2nd greenhouse gas after CO_2
- Radiative power 20 to 30 times more effective than CO_2 over 100 years

- Atmospheric concentrations have tripled during the last 150 years (1.83 ppmV in 2015)
- General increase of natural emissions since 2007 (+12.5 ppb/yr in 2015)



Saunois et al., 2016

Atmospheric methane (CH_4)

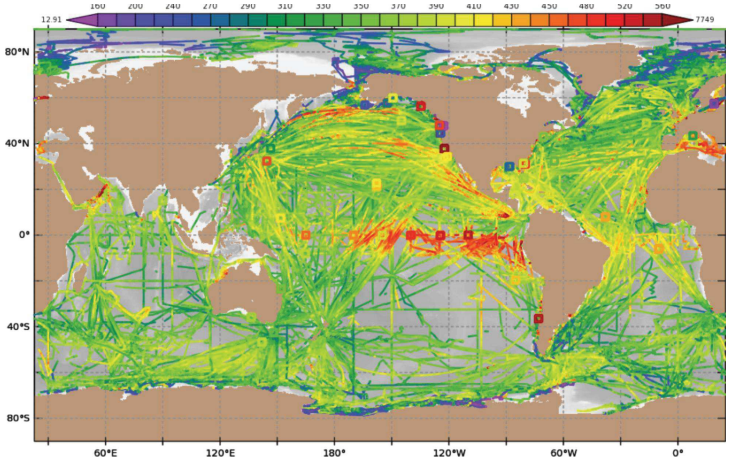


Saunois et al., 2016

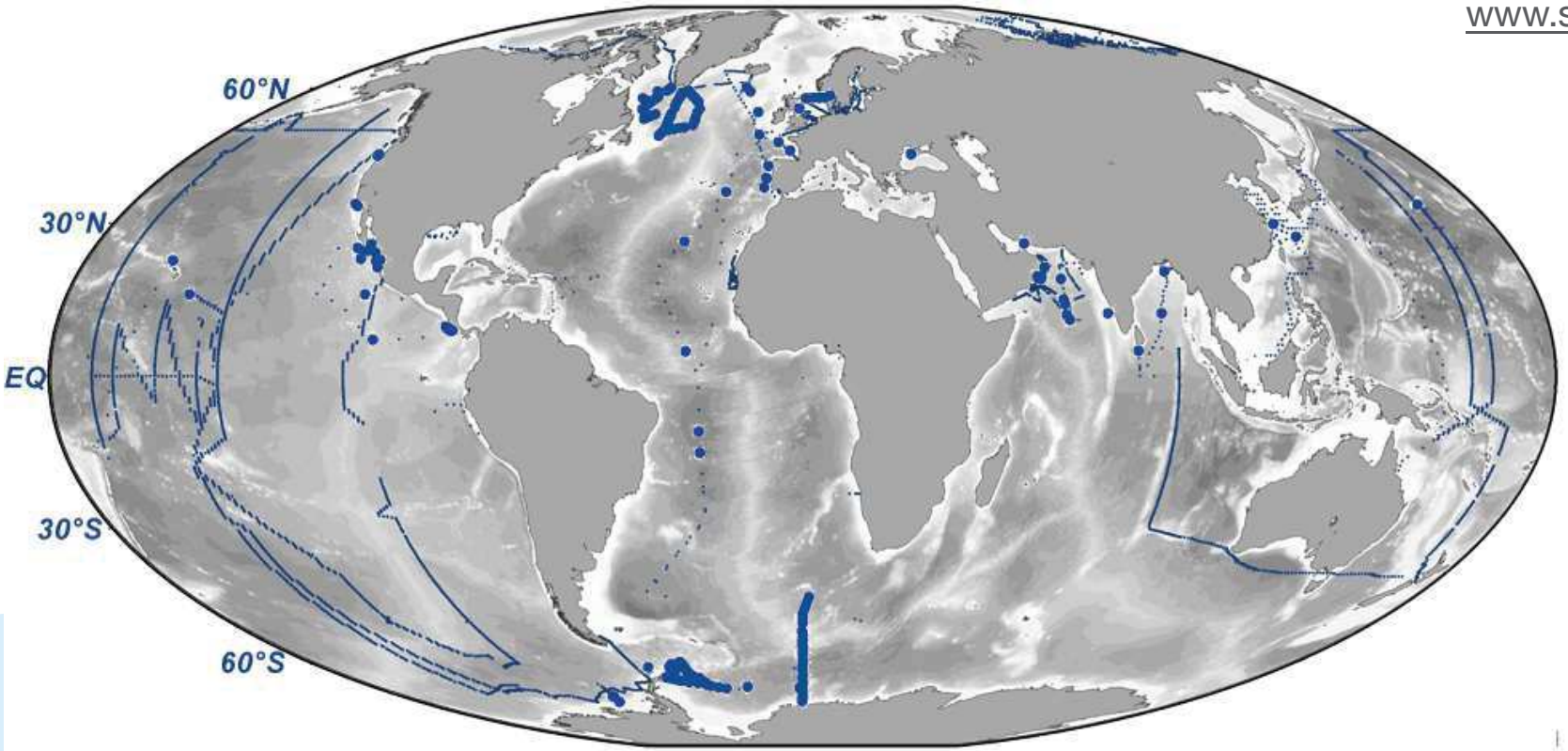
- Natural sources represent 40% of the total emissions
- Huge uncertainties on 'other natural' sources
- One of the 'other natural' is the marine environment
- **But there is a lack of marine measurements…**

Left: Top-down models
Right: bottom-up inventories

Marine methane

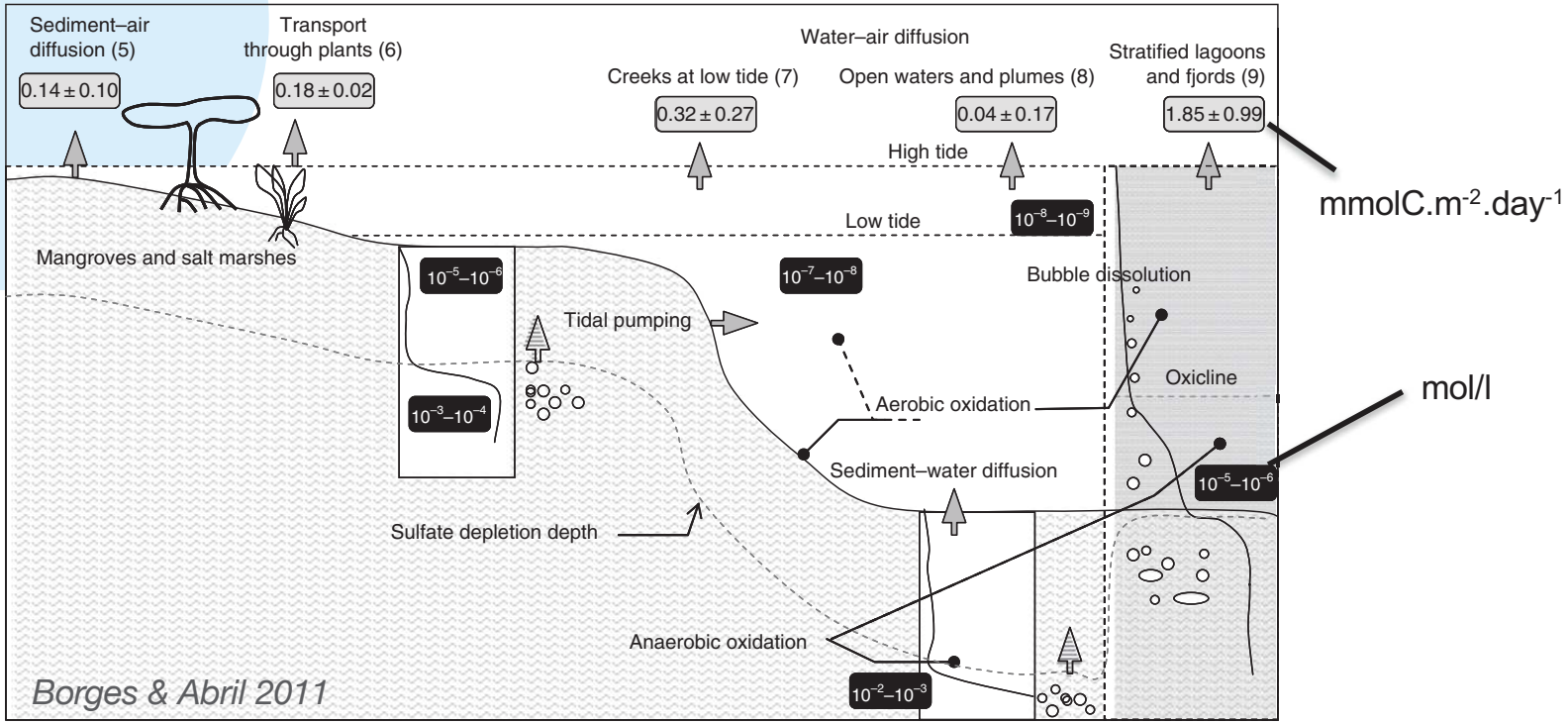


www.socat.info



www.memento.geomar.de

Methane in coastal environments



- Estuaries and continental shelves represent **65 to 75%** of marine CH_4 inputs to the atmosphere, i.e. 14 to 20 $TgCH_4/yr$
- Most of the CH_4 comes from the degradation of organic matter in anoxic sediments
- Minor production in water column
- CH_4 fluxes to the atmosphere results from the balance of microbial oxidation and production processes

Methane in coastal environments

- What is the contribution of megatidal coastal environments and small estuaries to the CH_4 budget?

OpenSeaMap

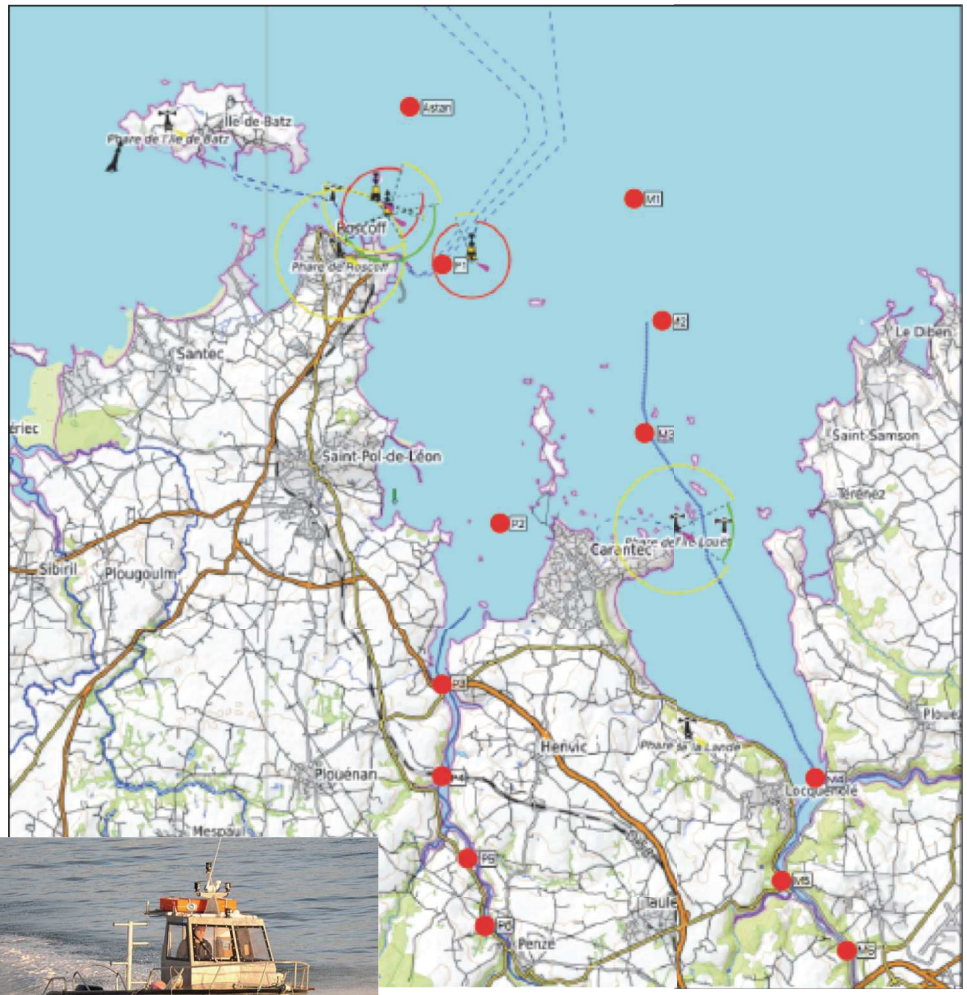
The Bay of Morlaix

- Megatidal regime
- 2 rivers: Morlaix & Penzé
- Catchment basins mostly agricultural (60-65%)

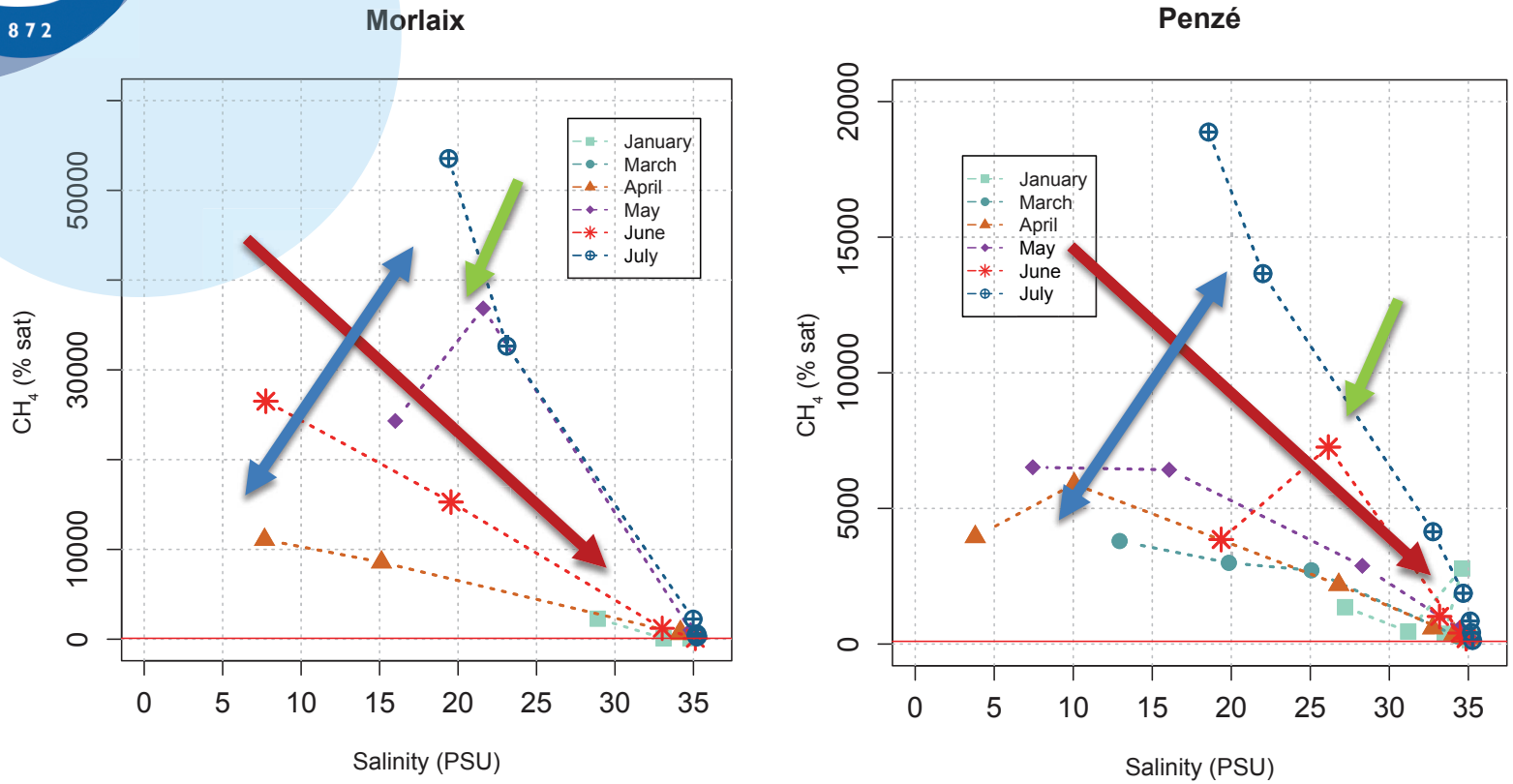
- **What is the distribution of dissolved CH_4 both in rivers and in the Bay?**
- **Is there any significant inputs of CH_4 to the Bay and/or to the atmosphere?**

Sampling and analyses

- Water sampling across salinity gradient at ebb tide (Niskin) (MORGAS) and at Astan (SOMLIT)
- CTD measurements
- Sampling for nutrients, pH, pCO_2, alkalinity, DO, dissolved gases (CH_4)
- CH_4 analysed by headspace extraction followed by GC-BID (Shimadzu GC2030 + HS20)

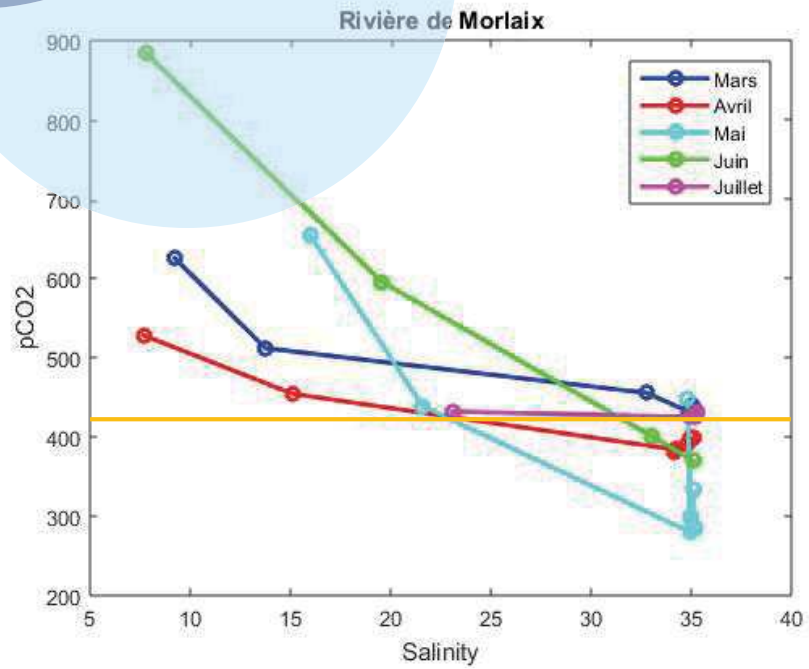


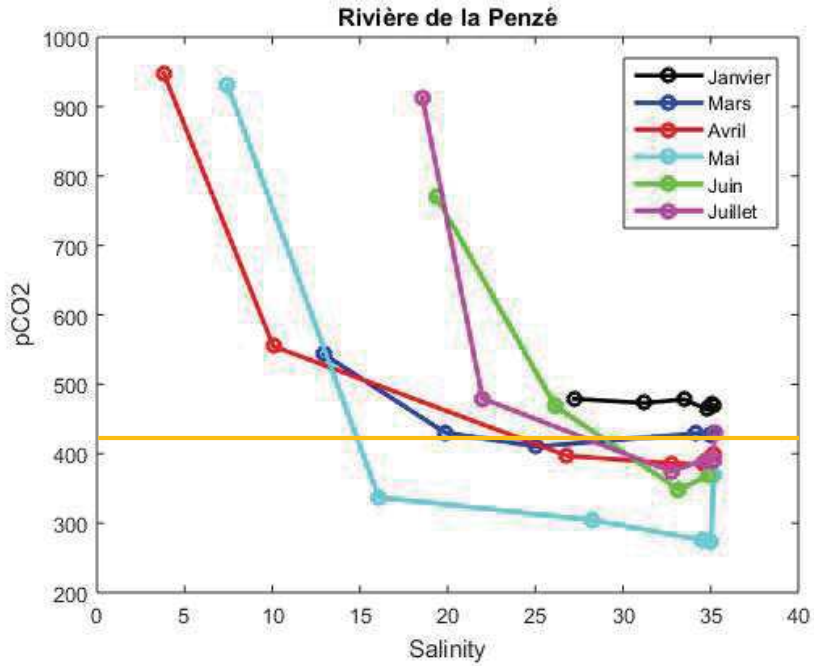
Distribution of CH_4 and pCO_2



- Oversaturation of surface waters up to 55000% (1.3 µmol/l)
- CH_4 Mx >> CH_4 Pz
- General decrease of CH_4 conc. towards seawater
- Seasonal variability of CH_4 conc. across the salinity gradient
- Local inputs of CH_4 (tidal pumping, groundwater discharge,…)

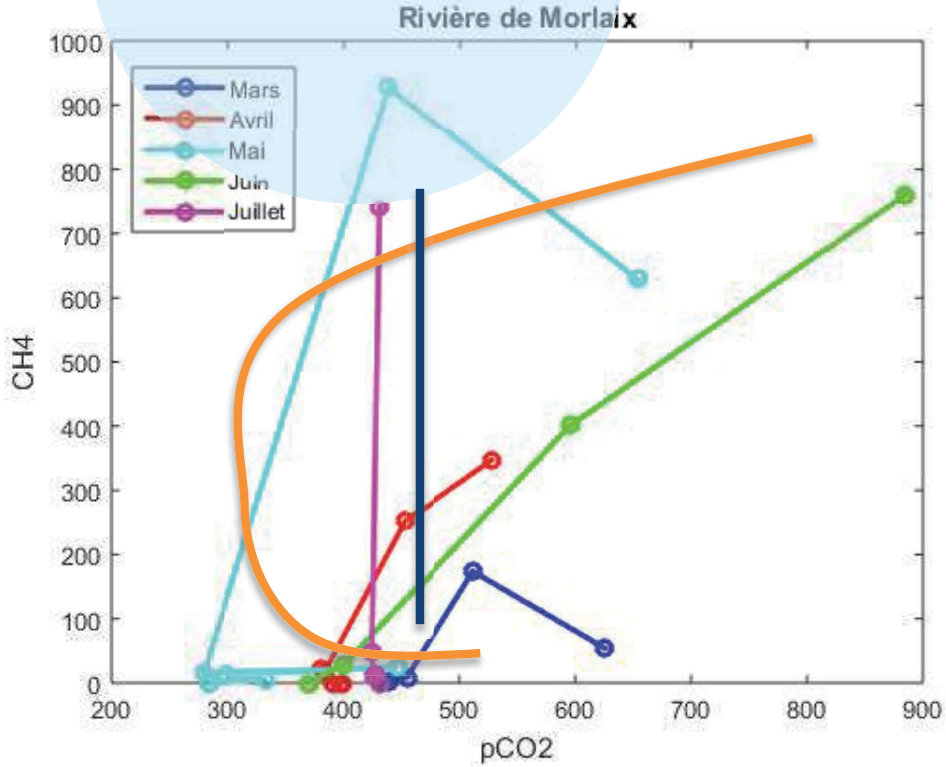
Distribution of CH_4 and **pCO_2**

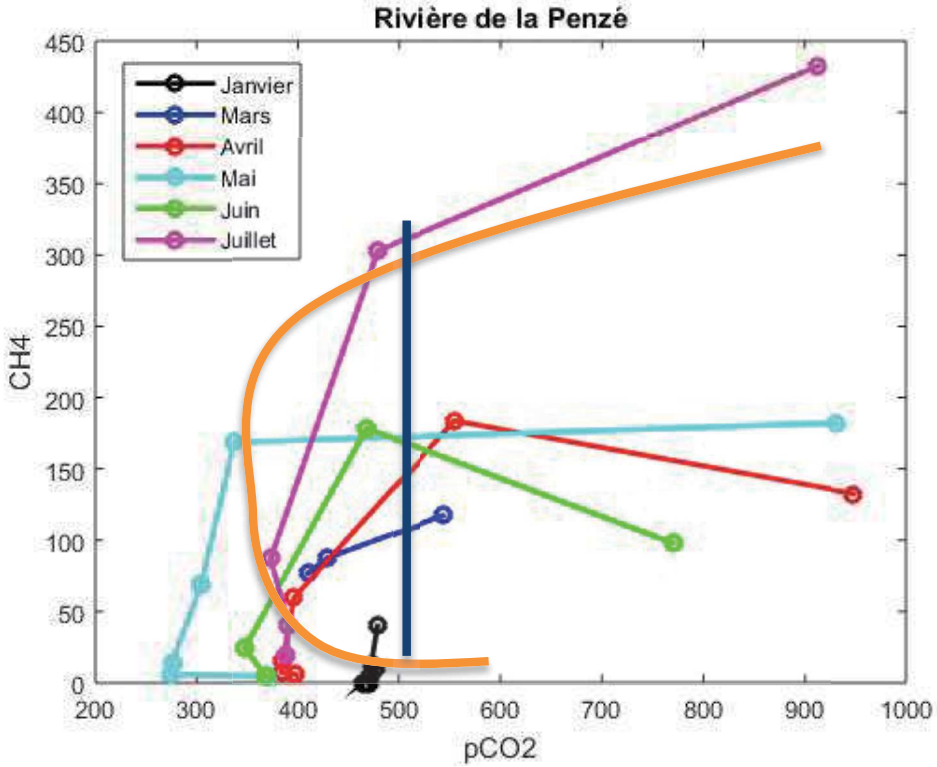




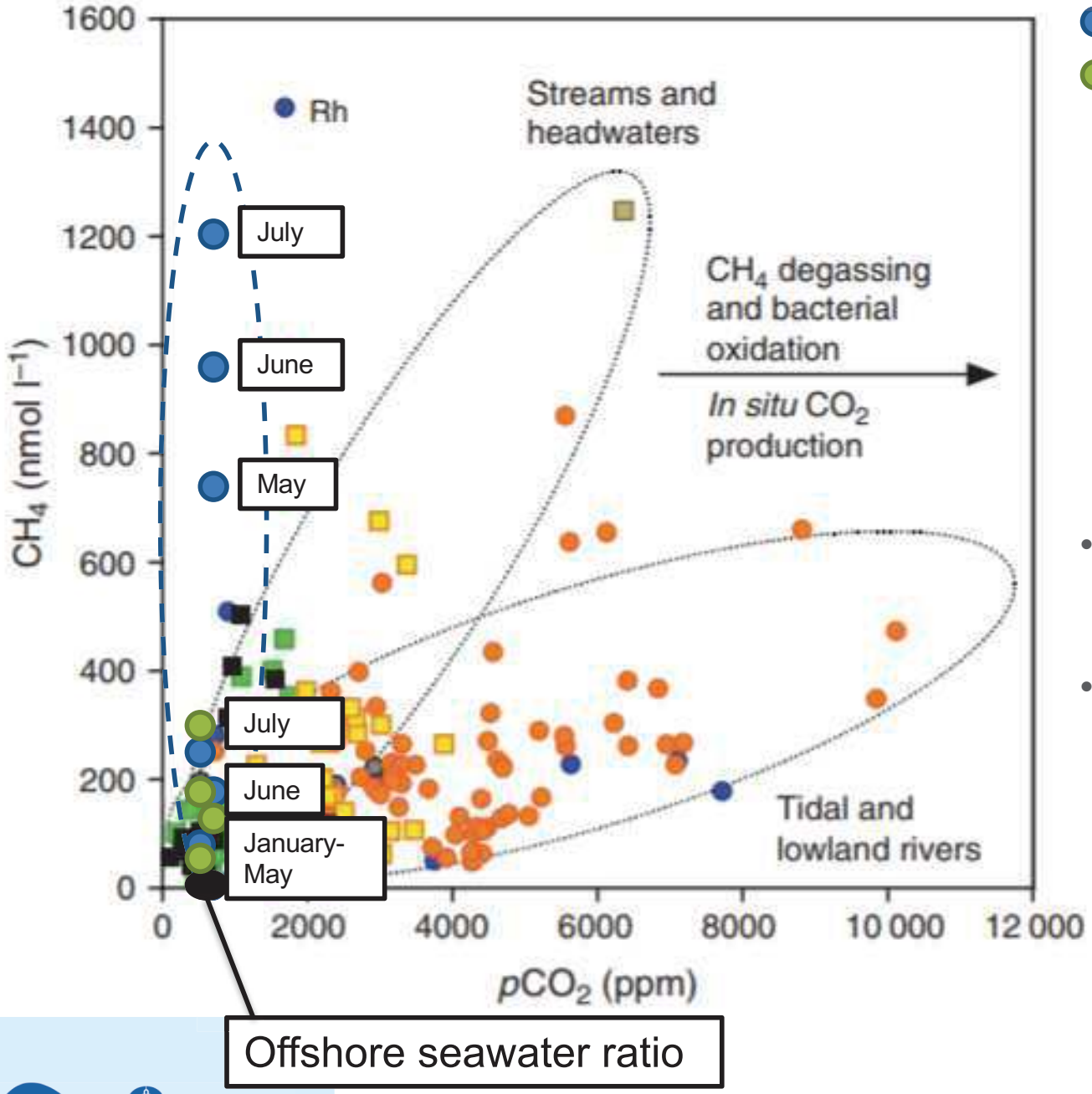
- pCO_2 gradient along the salinity gradient
- Oversaturation of surface waters at salinity <20
- Above S20, undersaturation during phytoplanktonic blooms
- Seasonal variability

Dynamics of CH_4 and pCO_2





- Non productive period: pCO_2 stable, CH_4 variable
- Productive period: variability depending on salinity
- Various biogeochemical processes controlling the dynamics of both gases
- More data are required !



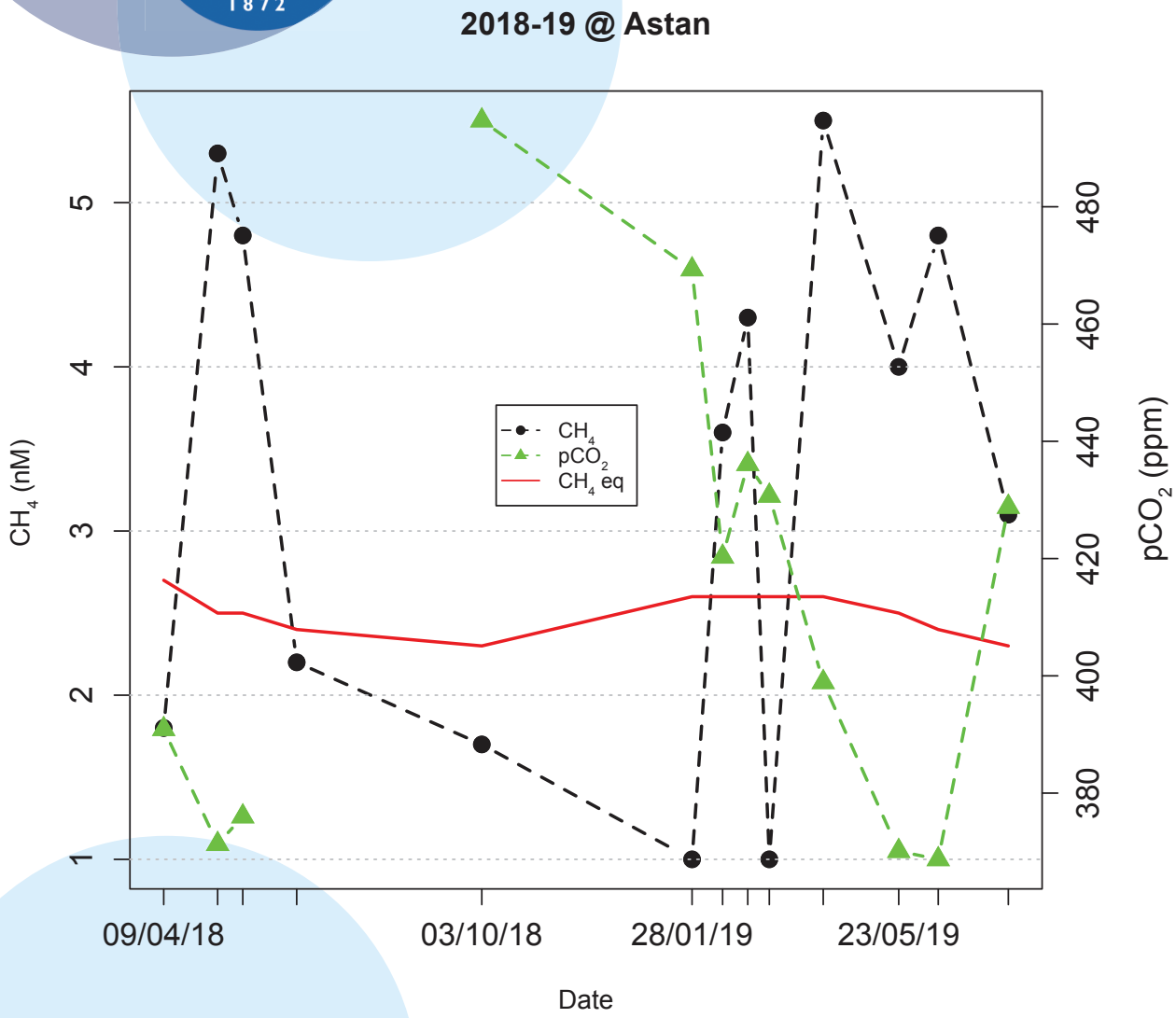
- Maximum Morlaix
- Maximum Penzé

- EU tidal rivers
- Mekong tidal river
- Ivory Coast lowland rivers
- Kivu streams
- Tana streams
- Temmesjoki River
- Little River and Little Pigeon River
- Great Smoky Mountains National park (headwater)
- Pearl River

- Low variability of pCO_2 (influence of seawater 'buffering' pCO_2)
- Strong variability of CH_4, especially in Spring-Summer

Borges & Abril 2011

Dynamics of CH_4 and pCO_2 at Astan



- Only 1 year of measurement for CH_4
- in low productive period: low CH_4 (below saturation) and high pCO_2
- In productive period: low pCO_2 followed by high CH_4 levels

Conclusions and questions !

- Oversaturation of surface waters up to 55000% (1.3 µmol/l) in rivers
- General decrease of CH_4 conc. towards seawater
- Seasonal oversaturation of marine waters (up to 400%)
- Seasonal variability of CH_4 conc. across the salinity gradient and in seawaters
- Possible correlation with pCO_2
- Small megatidal rivers have the same pCO_2/CH_4 ratios as some megatidal estuaries (e.g. Rhine)

- **What are the sources of CH_4?**
- **What are the biogeochemical processes controlling the CH_4 concentrations (and fluxes) in rivers and seawater?**
- **What is the global impact of the 'small' coastal rivers on both marine inputs and atmospheric inputs?**
- **What are the air-sea CH_4 fluxes?**

What's next?

- Mid to long-term observations of CH_4 concentrations at Astan and across the Western English Channel (SOMLIT, Ferrybox, MORGAS 2)
- Identify the sources of CH_4 => measurements of $\partial^{13}C\text{-}CH_4/\partial^{13}C\text{-}DIC$
- Metagenomics studies
- Estimation of the air-sea fluxes
- Development on *in-situ*, high resolution sensors for deployments on various platforms (In Situ Mass Spectrometer, LICOR, …)