A short overview on the recent methane cycle

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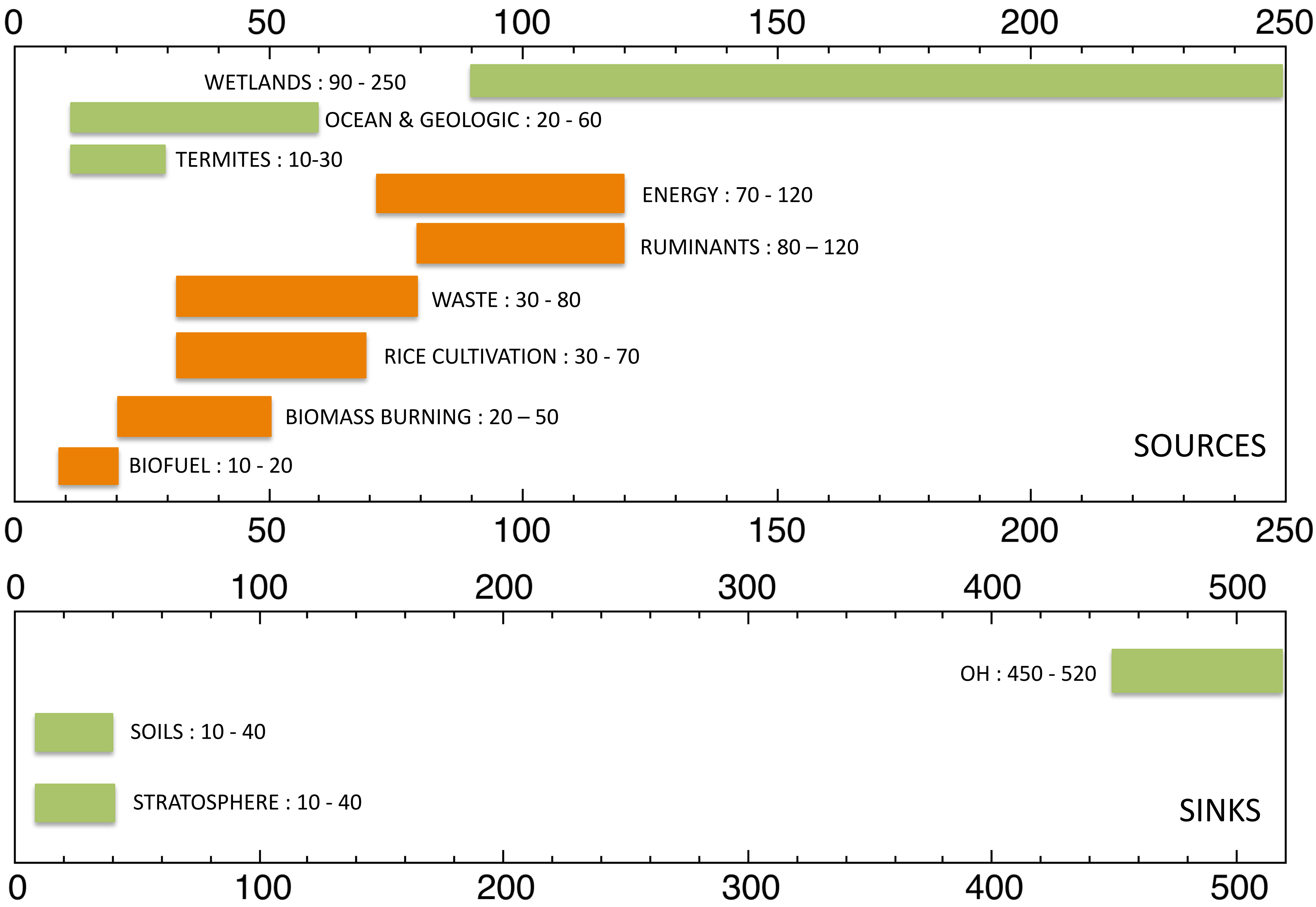
Bruno Ringeval, and Philippe Ciais

LSCE-IPSL, France

Litterature range of methane sources and sinks ($TgCH_4$/yr)

Based on IPCC, 2007



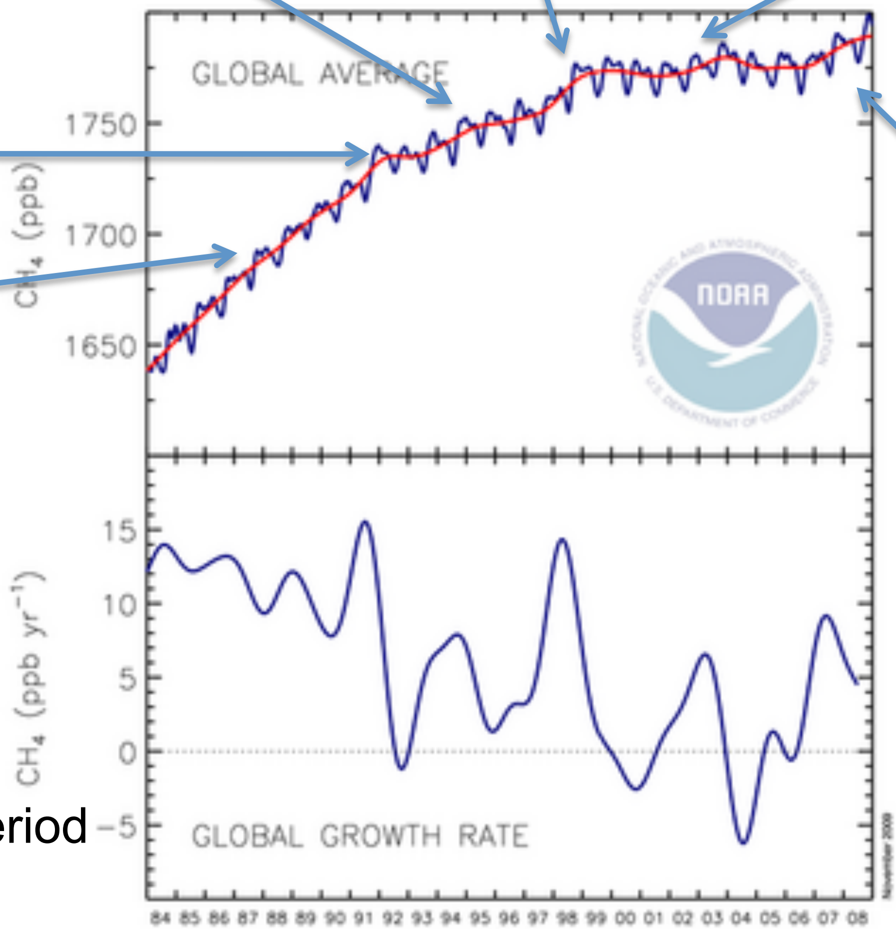
Evolution of atmospheric methane (surface)

Lower growth rate period
1991-1996

El Niño
1997-1998

Stabilisation period
1999-2006

Pinatubo,
USSR collapse
1991-

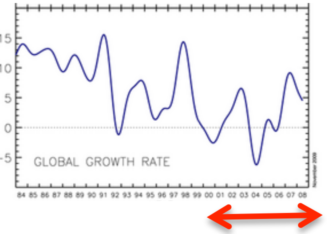


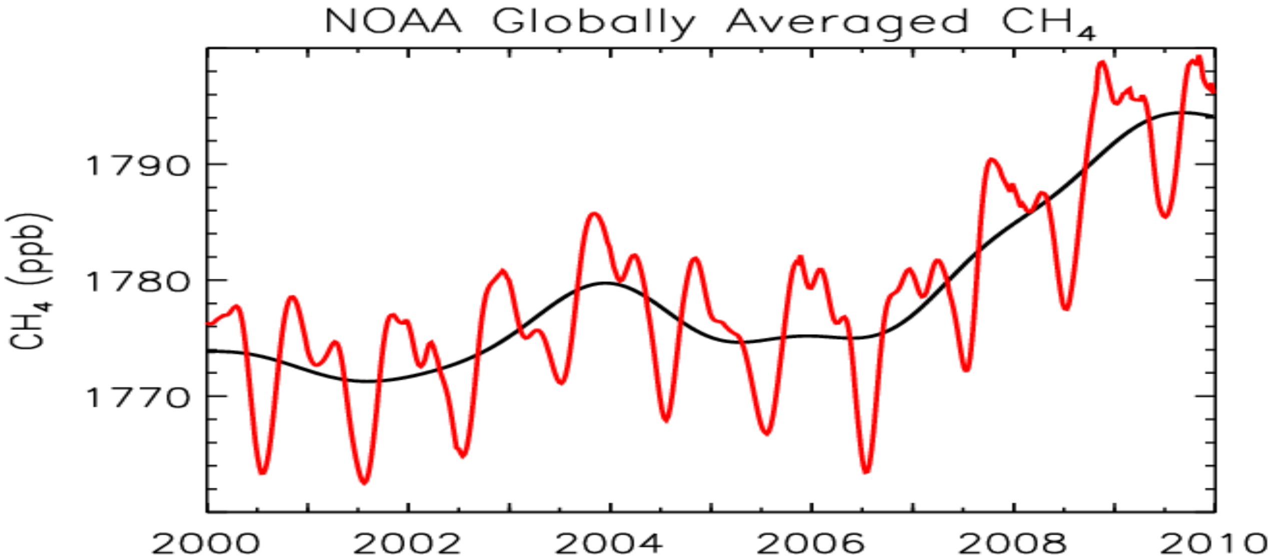
Recent increase
2007-?

High growth rate period
< 1991

NOAA, ESRL

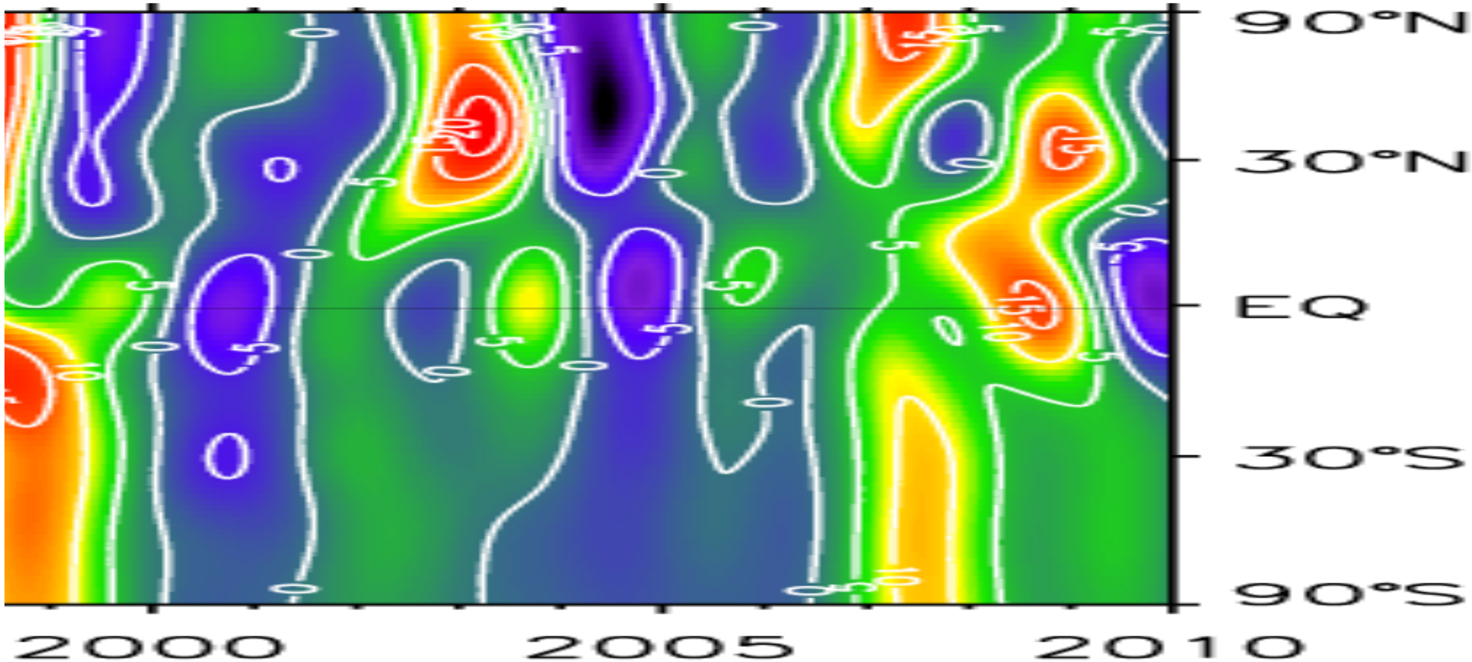
Atmospheric methane since 2000





ΔCH_4

2007	**7.9 ± 0.6 ppb**
2008	**7.0 ± 0.6 ppb**
2009	**2.4 ± 1.8 ppb**



Atmospheric growth rate

Dlugokencky, pers. Comm.

Top-down modelling

PRIOR FLUXES

Forcing data

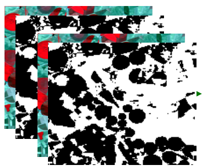
Assimilation data

Meteo. data
Prior param.
calibration

Anthropogenic
and natural
sources & sinks

Validation data

Satellite data



Atmos. Conc.

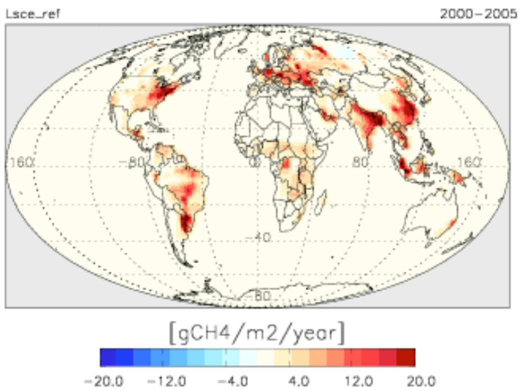
CH_4 vertical Profiles

Satellite data

ATMOSPHERE
LMDZ

$$J(\mathbf{x}) = \frac{1}{2}(\mathbf{y}-\mathbf{Hx})^T\mathbf{R}^{-1}(\mathbf{y}-\mathbf{Hx}) + \frac{1}{2}(\mathbf{x}-\mathbf{x}^b)^T\mathbf{B}^{-1}(\mathbf{x}-\mathbf{x}^b)$$

Atmospheric inversion



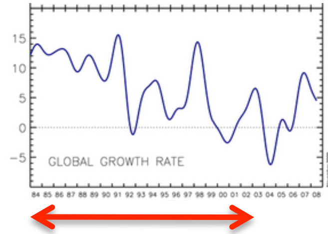
Optimized Carbon fluxes

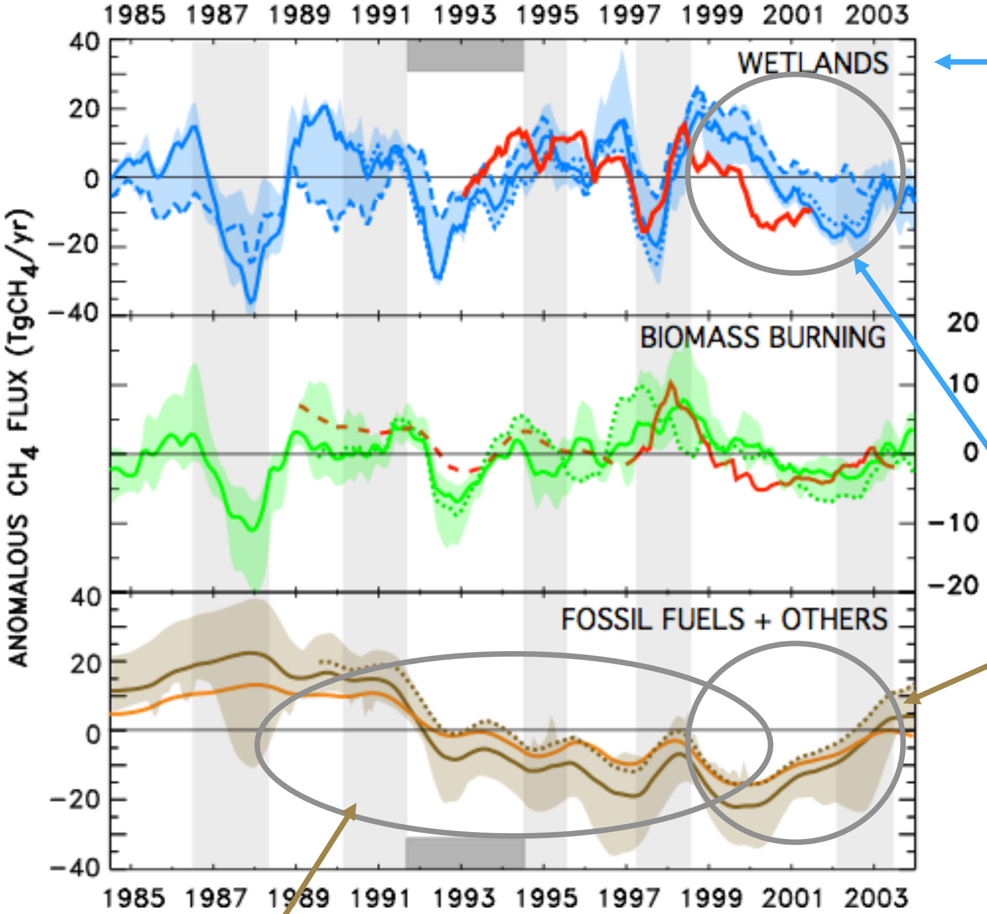
(values & uncertainties)

Courtesy Peylin

Inversion of methane emissions : 1984-2003

Bousquet et al., Nature, 2006





Wetlands are the largest contributor to year-to-year variations of methane emissions

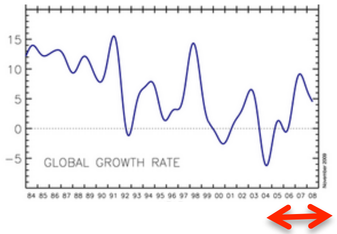
Between 1999 and 2004, increasing anthropogenic emissions (mainly North Asia) compensate decreasing wetland emissions (NH droughts) and maintain a small growth rate..

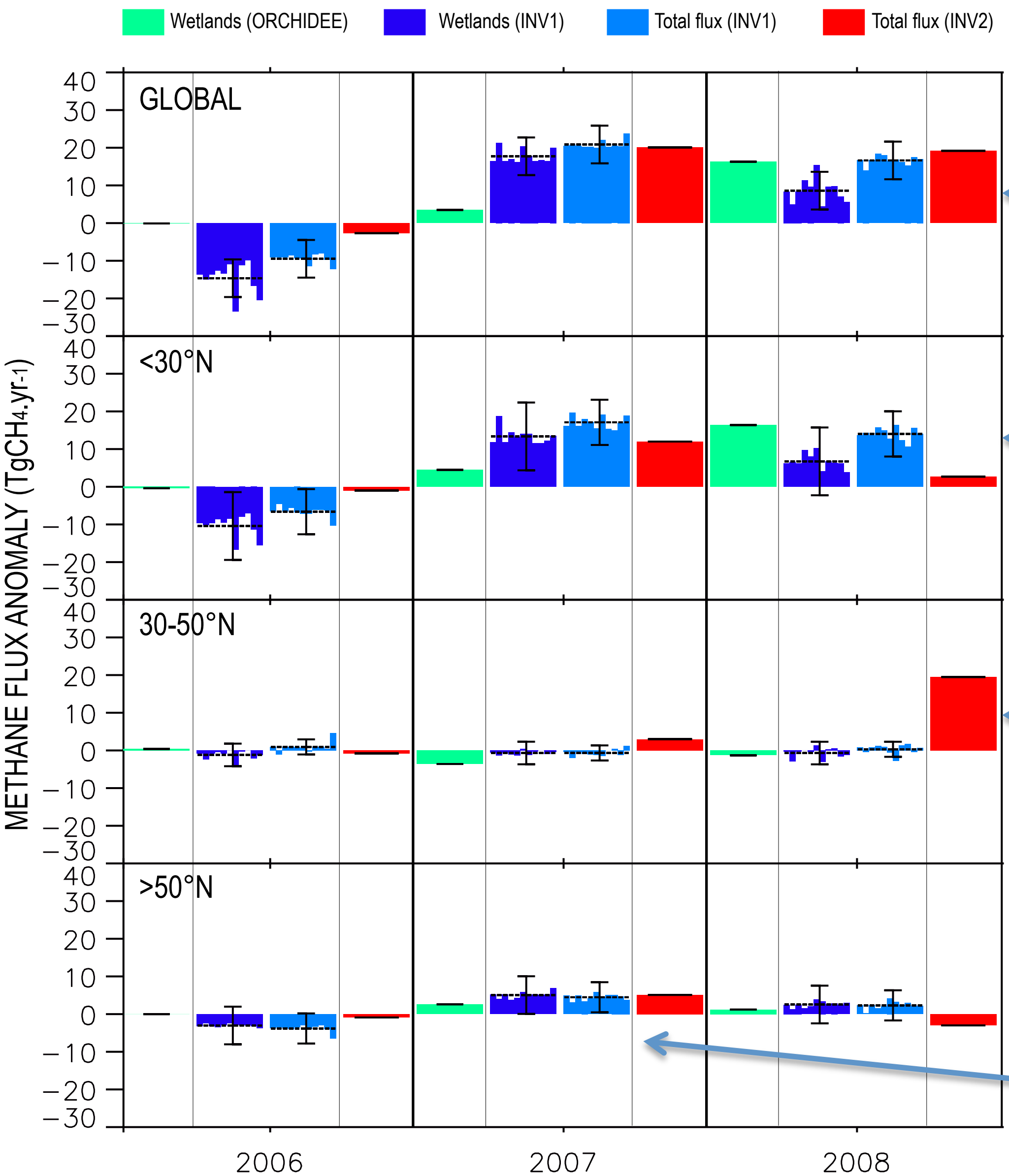
The long-term reduction in growth rate is mostly due to anthropogenic emissions

Inversion results are in good agreement with bottom-up models based on satellite retrievals and process models.

Inversion of methane emissions : 2006-2008

Bousquet et al., 2010, in revision for ACP





Negative global anomaly of methane flux in 2006, followed by positive anomalies in 2007 and 2008 (ref=1999-2006)

Tropical natural wetlands contributes mostly in 2006 and 2007 and for 50% in 2008

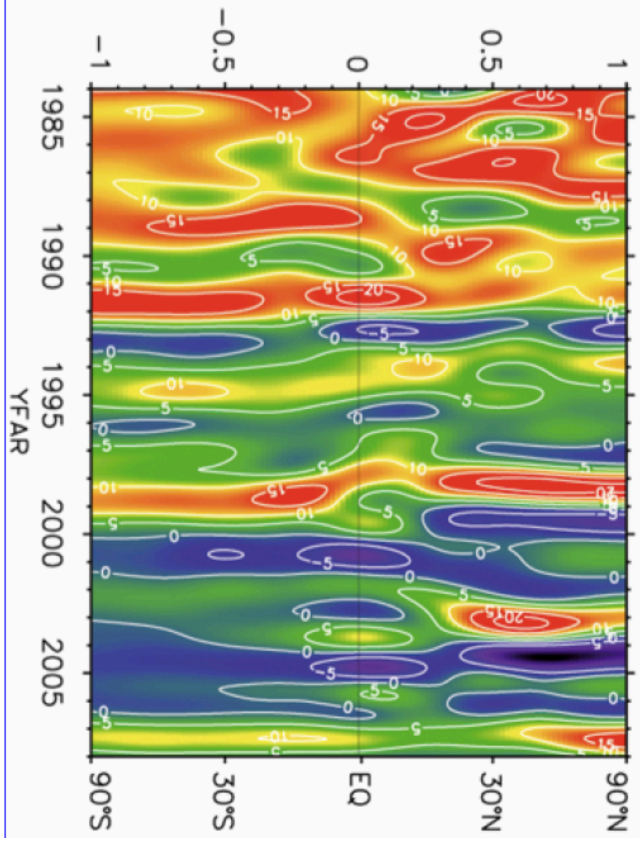
The two inversion models give consistent results, except in 2008

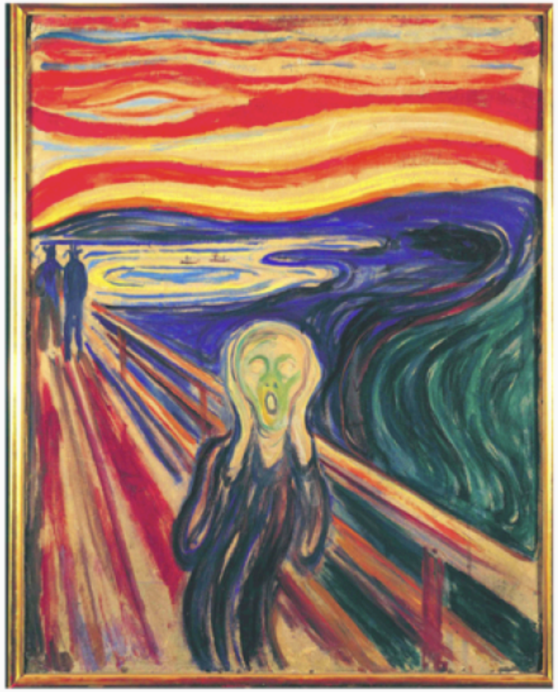
Bottom-up and top-down approaches give anomalies of the same sign

Boreal natural wetlands play a role in 2007

And for the future ?

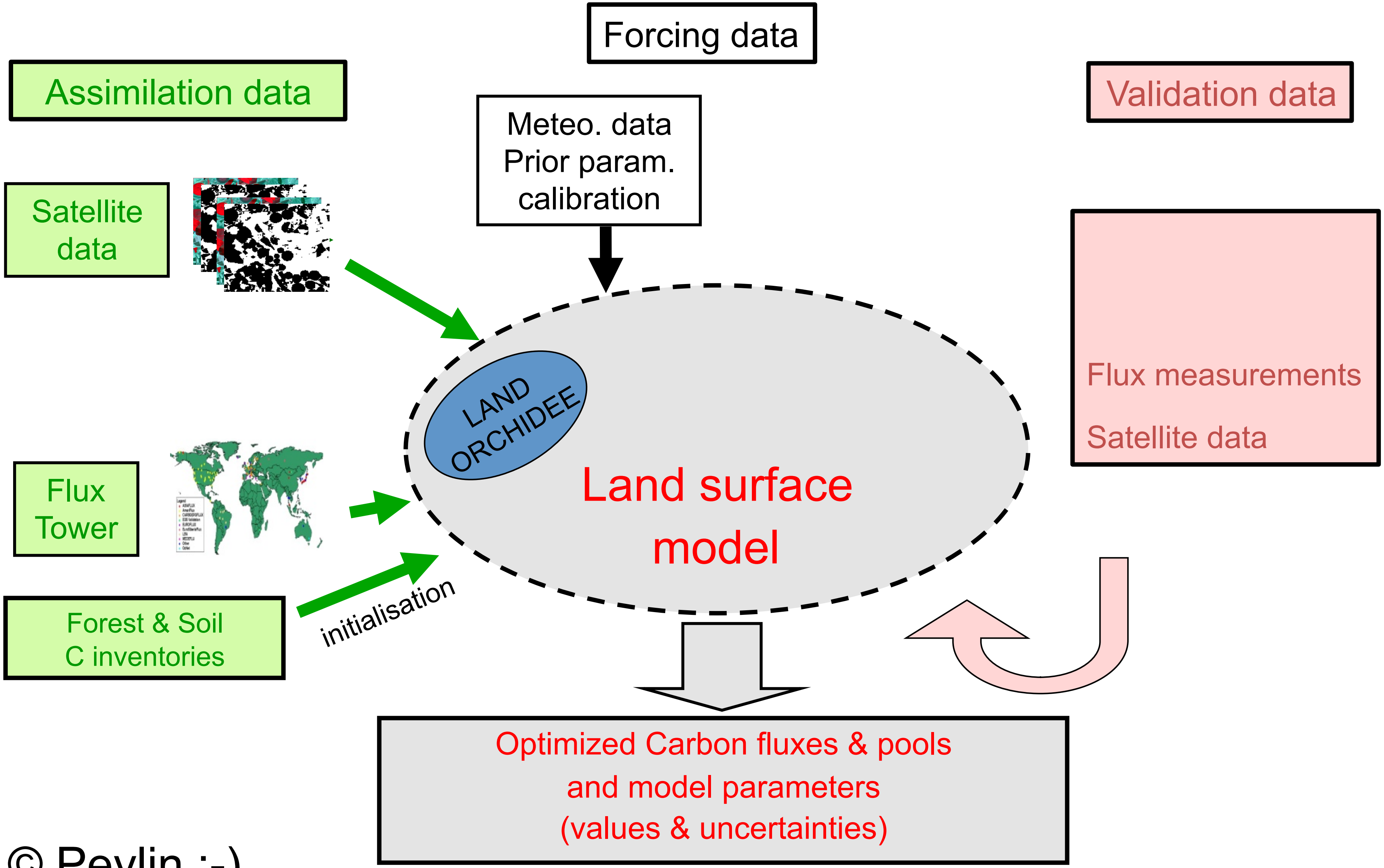
Ed Dlugokencky, NOAA





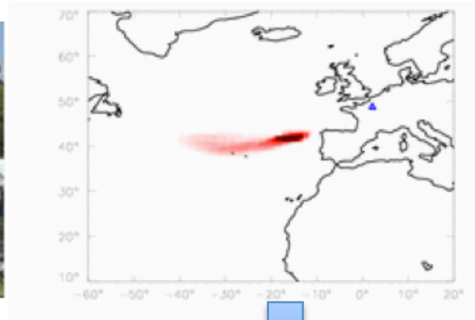
To be continued …

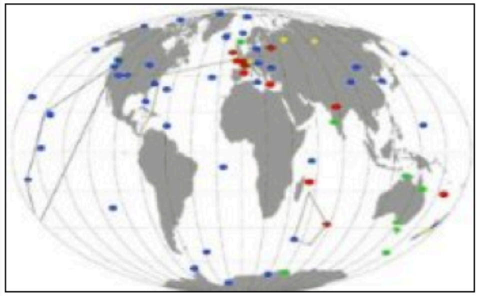
Bottom-up modelling



Atmospheric inversion

A priori flux → Chemistry-transport model → Mixing ratios

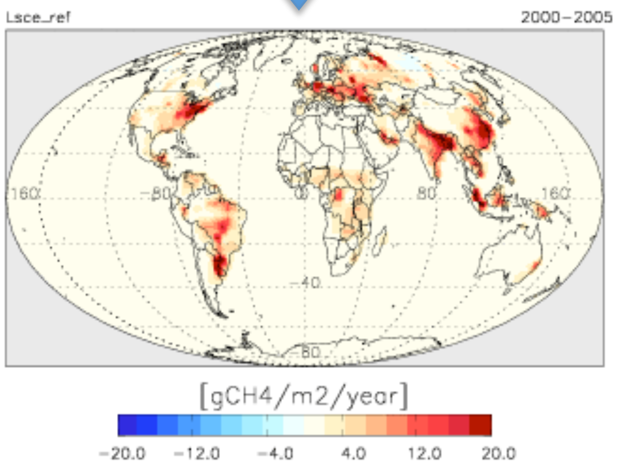




$$J(\mathbf{x}) = \frac{1}{2}(\mathbf{y} - \mathbf{Hx})^T \mathbf{R}^{-1}(\mathbf{y} - \mathbf{Hx}) + \frac{1}{2}(\mathbf{x} - \mathbf{x}^b)^T \mathbf{B}^{-1}(\mathbf{x} - \mathbf{x}^b)$$

Atmospheric Inversion

Methane flux



+ Uncertainties