

EM - 1 PROJECT



*Reservoirs' net greenhouse
gas emissions research project*

GREENHOUSE GAS EMISSIONS FROM QUEBEC HYDROELECTRIC RESERVOIRS AND SURROUNDING NATURAL LAKES: IMPORTANCE OF SPRING FLUXES.

Maud Demarty, Julie Bastien and Alain Tremblay

Why documenting reservoirs GHG emissions

- Increase in energy demand
- Increase in number of reservoirs (irrigation, water supply, hydroelectricity...)
- IPCC 2010 *in prep* (chapter 5 on Energy) :

hydroelectricity = only non-intermittent renewable energy

**"Methane quashes green credentials of hydropower"
Nature 444|30 Nov 2006**

But is renewable energy synonymous of green energy ?

**Dirty Hydro: Dams and Greenhouse Gas Emissions
International Rivers Nov 2008**

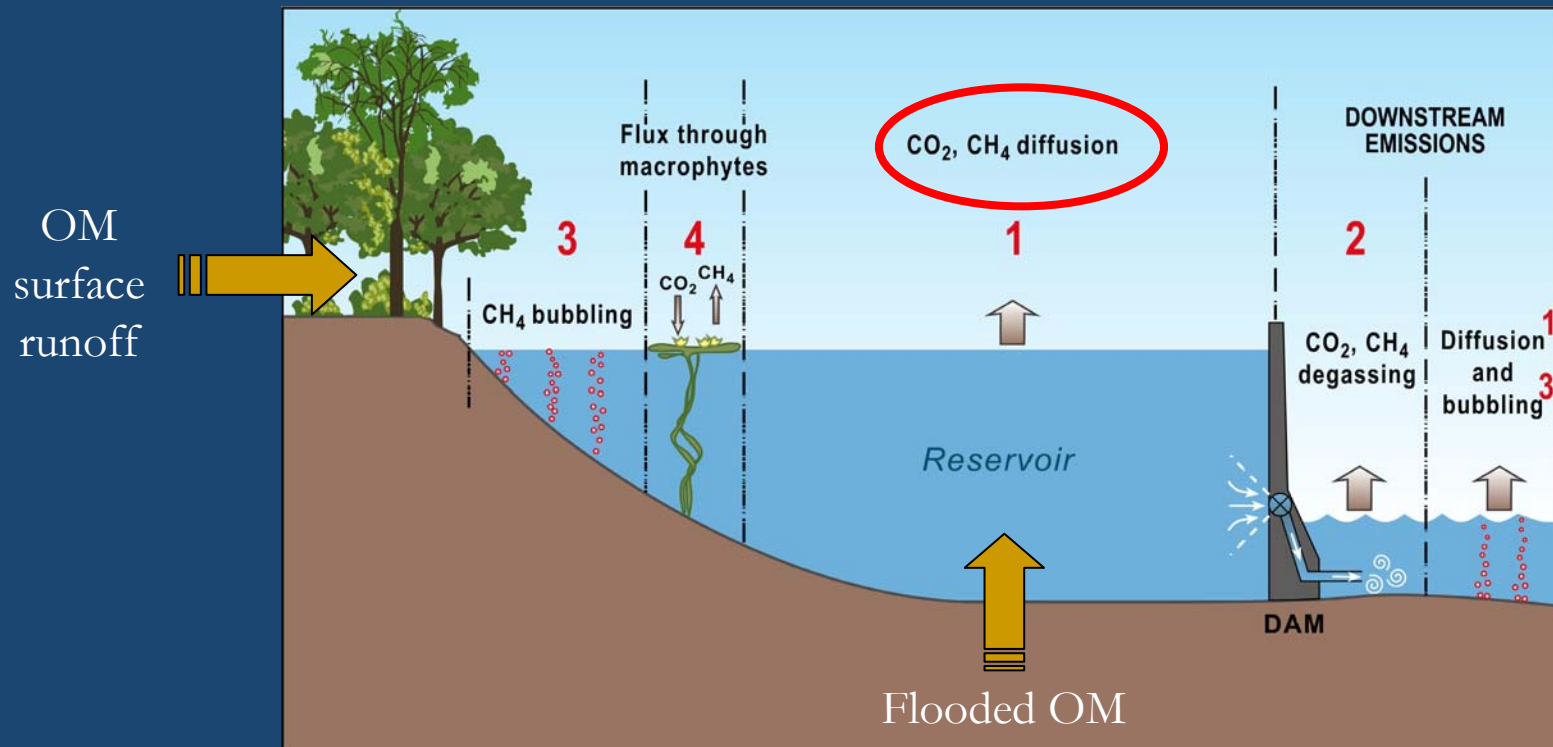


Need to measure the emissions in various type of reservoirs, with common methodology to reduce uncertainty

GHGs emission science: key principles

Reservoir creation...

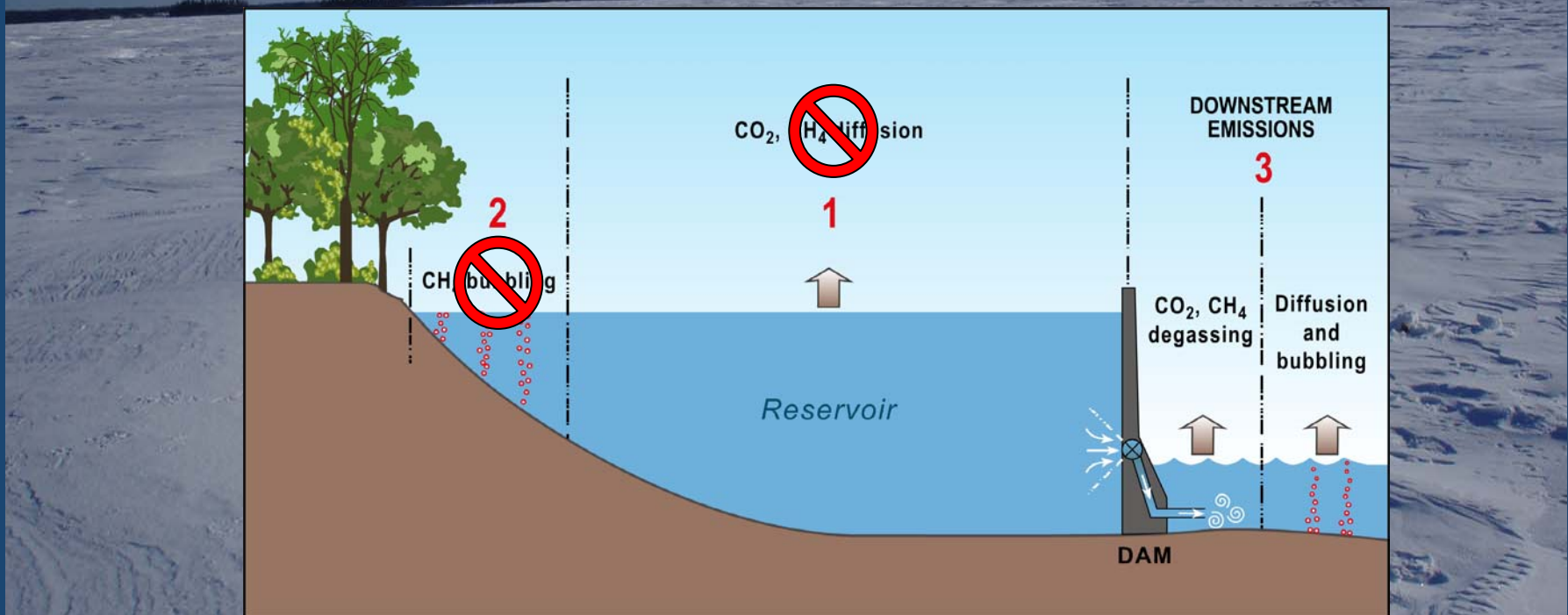
- Enhance degradation of OM accumulated in soils
- Accumulation of OM coming from the watershed
- 4 emission pathways for CO_2 and CH_4 (main products of degradation with GH effect)



GHGs emission science: key principles

Ice cover in boreal systems:

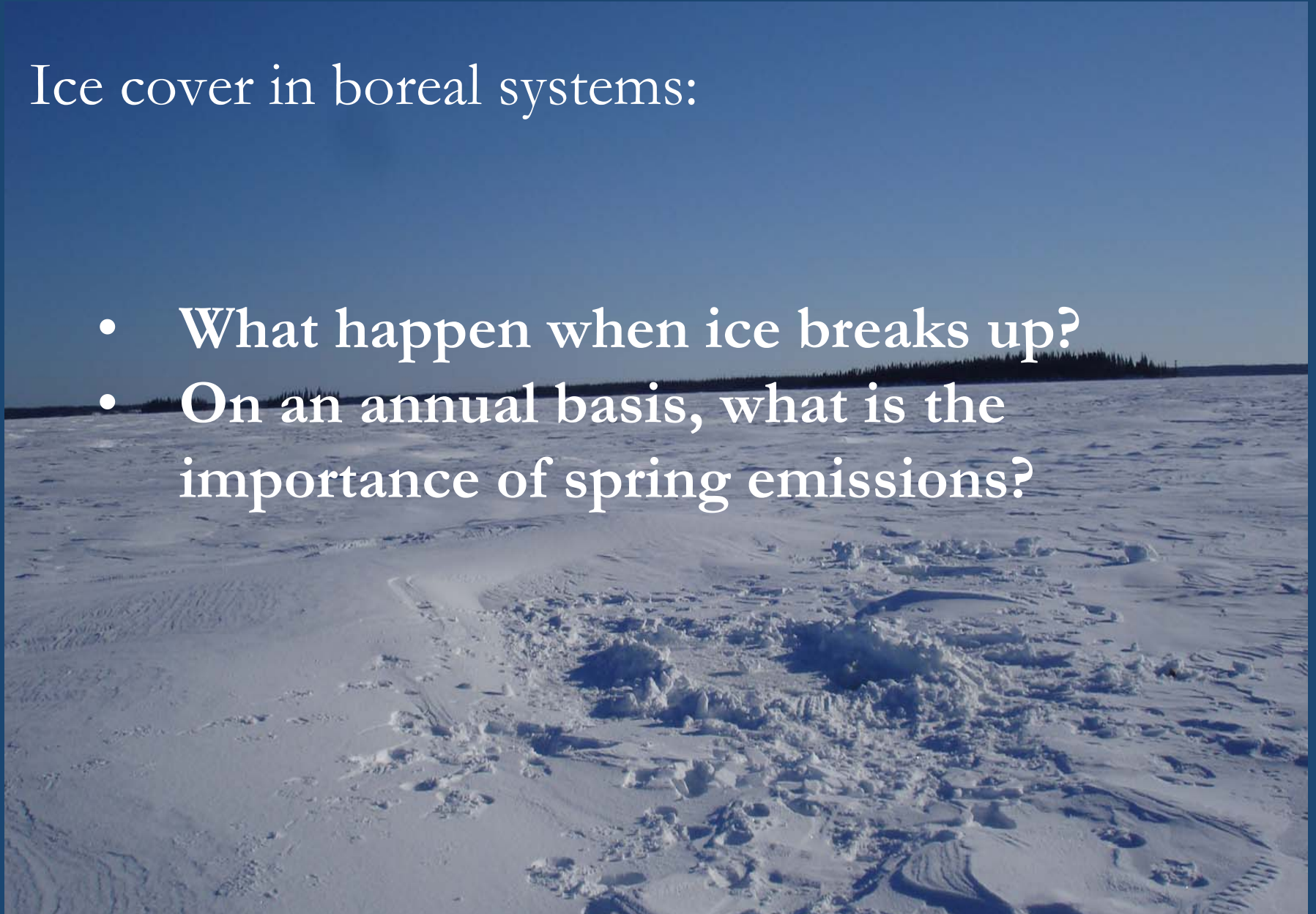
- Prevents gas escape
- Leads to an increase in dissolved GHG concentration



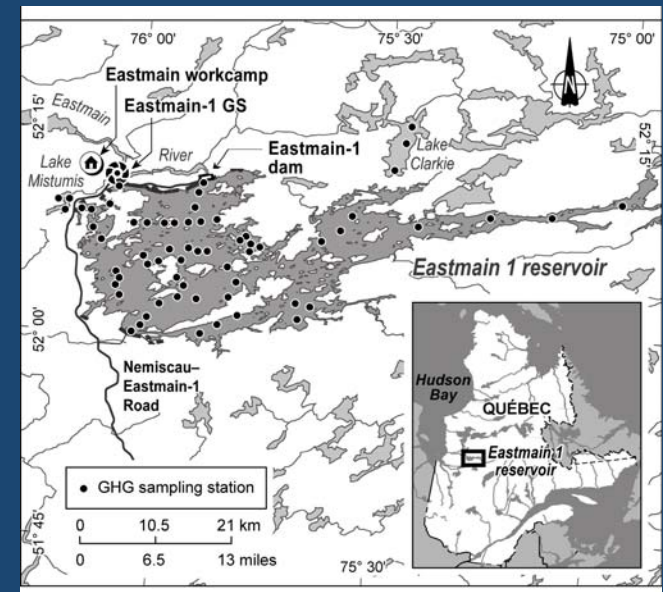
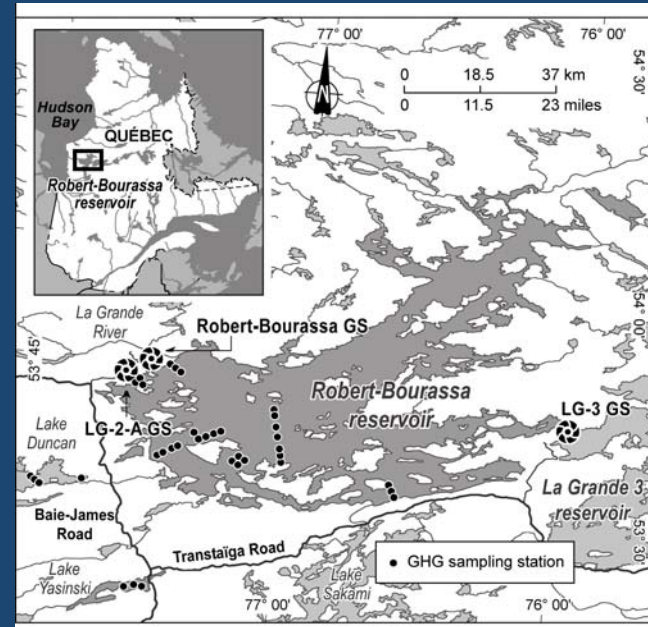
GHGs emission science: key principles

Ice cover in boreal systems:

- What happen when ice breaks up?
- On an annual basis, what is the importance of spring emissions?



Study area

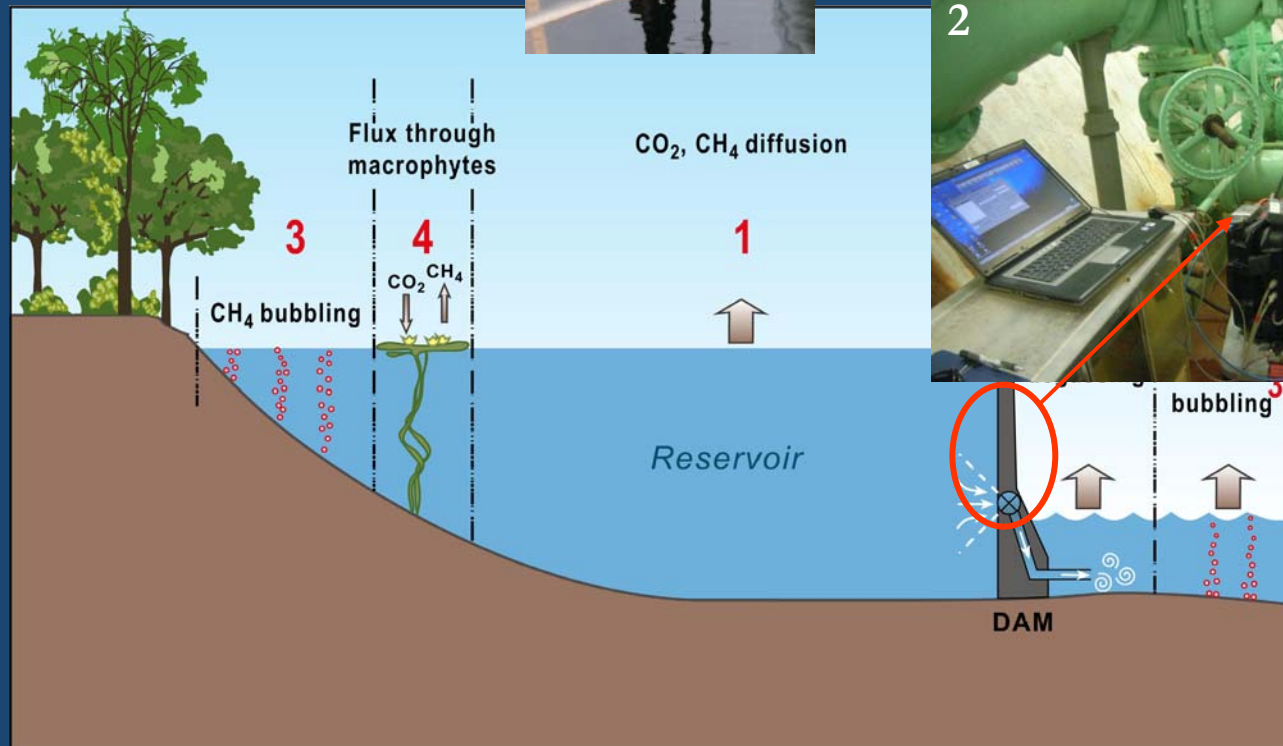


Two methods to calculate reservoir's diffusive emissions from dissolved GHG concentrations



1 Field campaigns

- Many sampling stations (spatial variability)
- Surface measurements



2 Automated systems

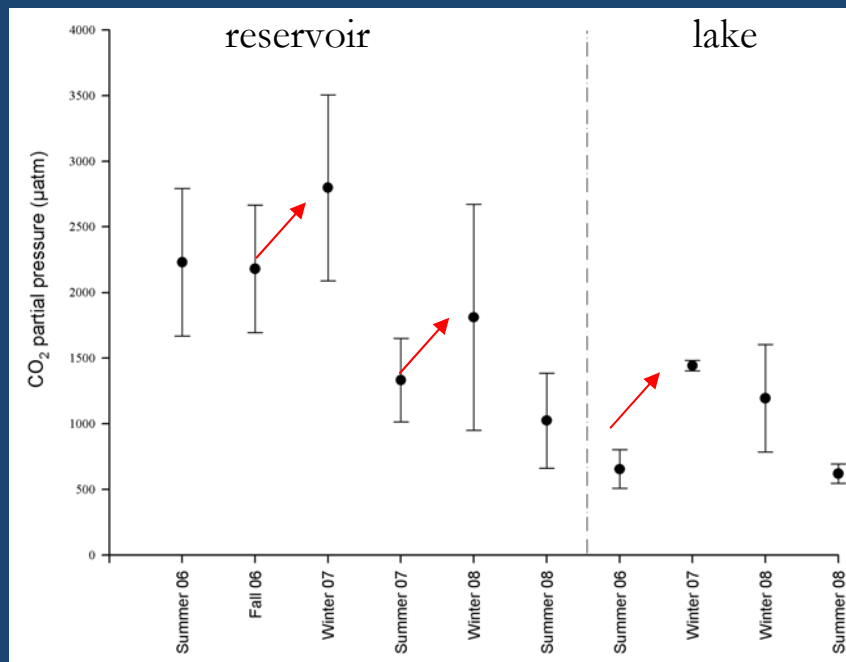
- Temporal variability
- One sampling location
- Representing the whole reservoir

Use of both in the same systems = innovative approach

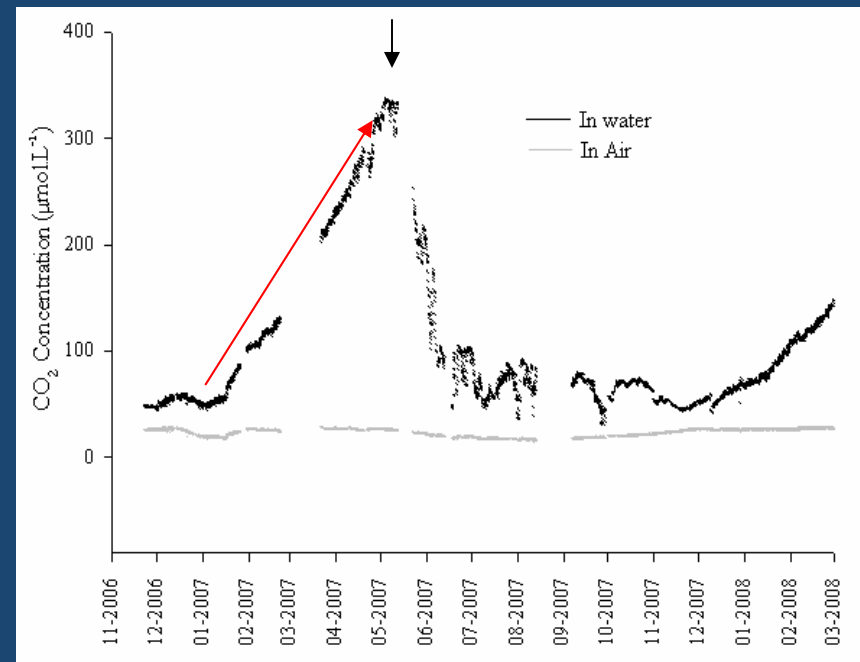
Results

GHG concentration in water (Eastmain 1 area)

Field campaigns



Automated systems

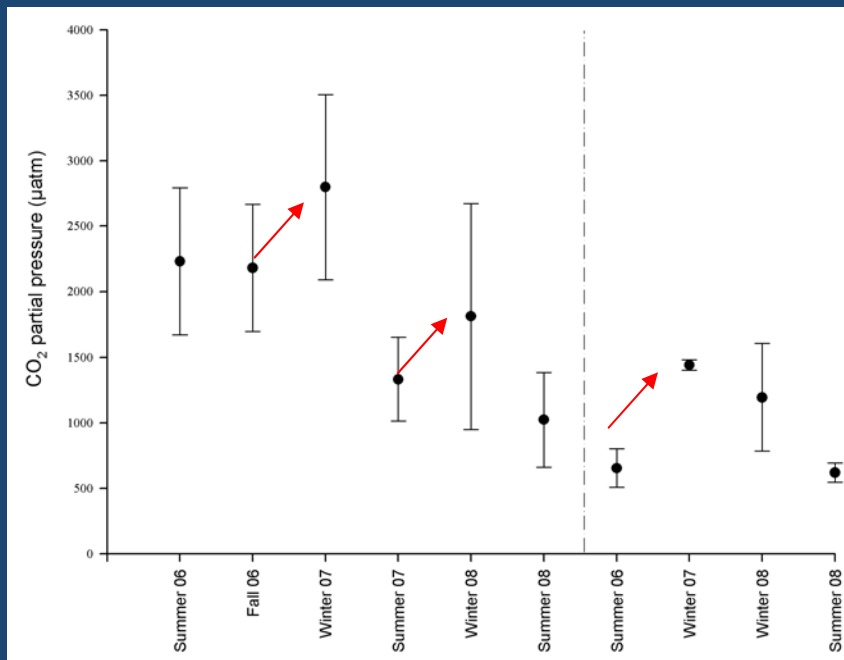


But: No CH₄ accumulation observed under ice-cover

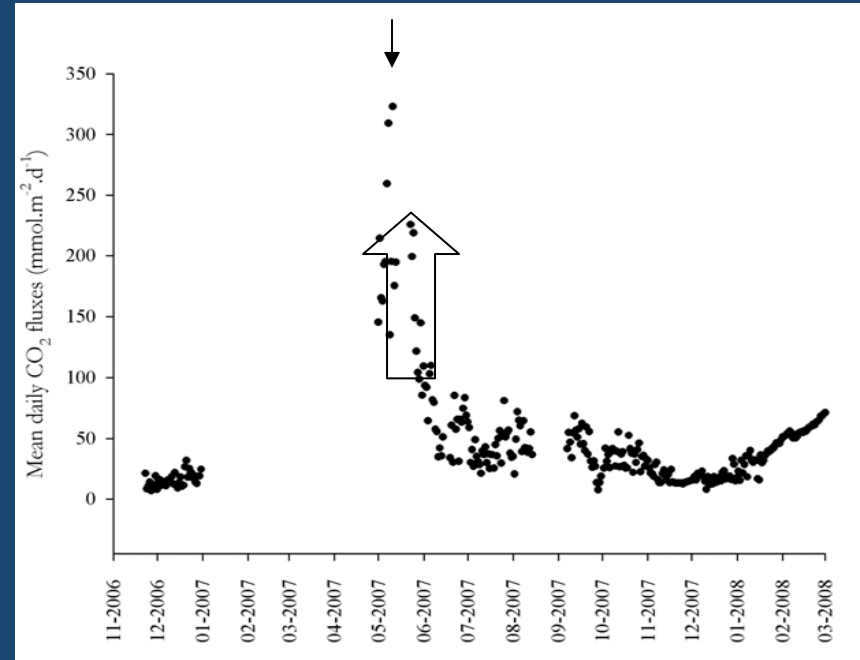
Results

GHG annual fluxes (calculated from concentration-TBL)

Field campaigns



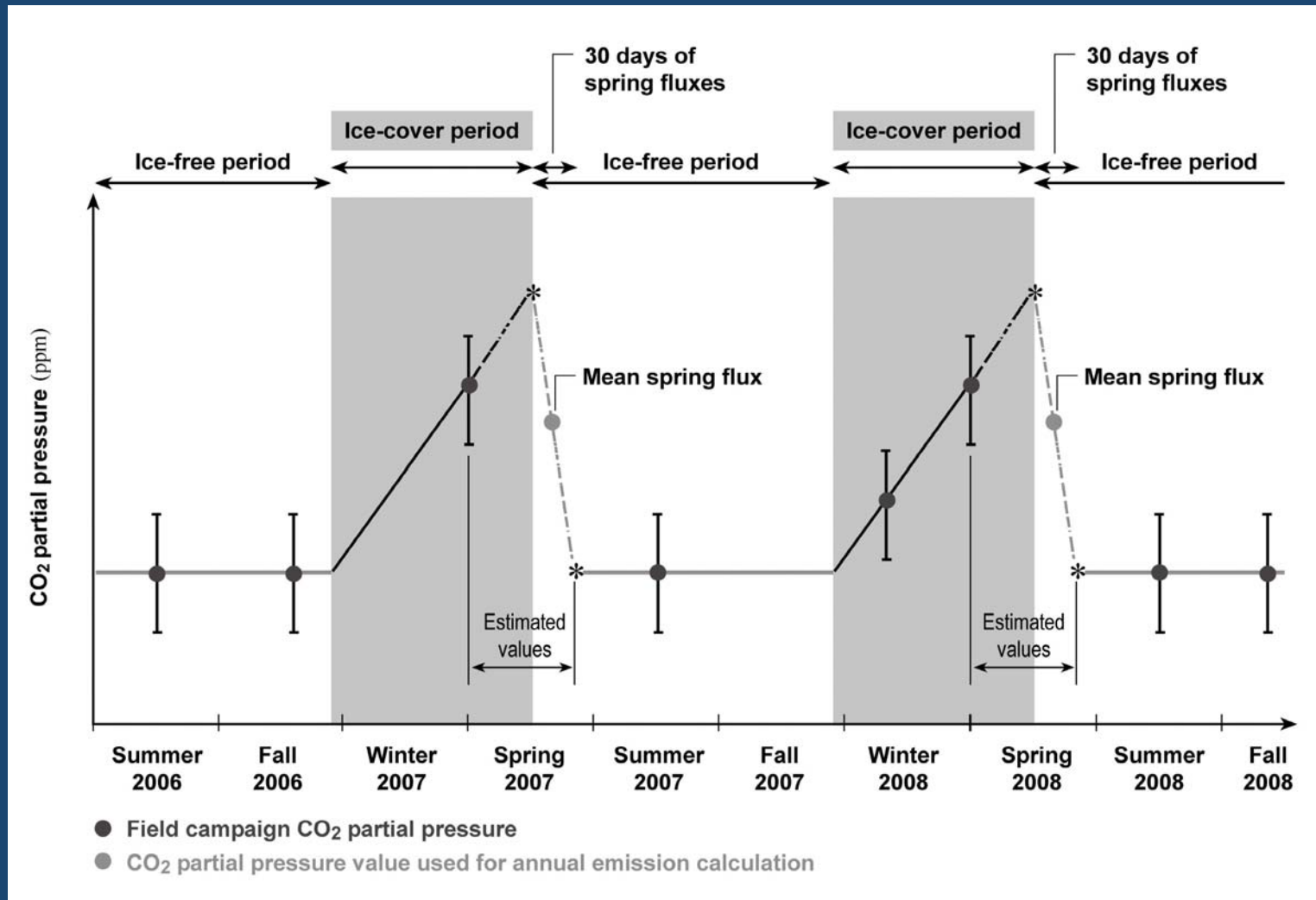
Automated systems



How to compute annual fluxes from
punctual concentration
measurements?

Easy calculation of annual emissions
for GS equipped with AS
=
Sum of fluxes

Model for annual estimation of emissions from field campaigns



Conclusions



Annual emissions calculated from field campaigns data

(EM1-2008: $12.2 \text{ molCO}_2\text{eq} \cdot \text{m}^{-2} \cdot \text{yr}^{-1}$)

=

Annual emissions calculated from continuous monitoring (AS)

(EM1-2008: $13.6 \text{ molCO}_2\text{eq} \cdot \text{m}^{-2} \cdot \text{yr}^{-1}$)

Study site and period	CO ₂				CH ₄				GHG	
	Ice free period CO ₂ emission	Spring CO ₂ emission	Annual CO ₂ emission	Spring flux/annual flux	Ice free period CH ₄ emission	Spring CH ₄ emission	Annual CH ₄ emission	Spring flux/annual flux	Annual GHG emissions	CO ₂ contribution
	mmol.m ⁻²			%	mmol.m ⁻²			%	gCO ₂ eq.m ⁻²	%
Eastmain-1 R. 2007-2008	8747	2654	11401	23	7	1	7	7	509	98.6%
Eastmain-1 R. 2008-2009	7374	3348	10723	31	20	1	21	5	493	95.6%
Mistumis L. 2007-2008	3248	1392	4640	30	2	0	3	12	207	98.8%
Mistumis L. 2008-2009	1528	1658	3186	52	8	1	10	13	150	93.5%
Clarkie L. 2008-2009	903	834	1737	48	3	1	3	18	80	95.9%
Robert Bourassa R. 2006-2007	2208	676	2884	23	26	3	29	11	156	81.2%
Yasinski L. 2006-2007	3448	664	4112	16	8	1	9	11	190	95.1%

“Spring GHG diffusive emissions represented a higher proportion of annual GHG emissions than previously observed, with CO₂ being largely responsible for the total annual diffusive emissions “

Conclusions

➤ Two ways to get annual estimates of GHG diffusive emissions from reservoirs, taking spring emissions into account



- One single sampling station to study a system
- Low cost for a continuous monitoring
- Easy spring emission estimates



- Several sampling stations (at least 3)
- Two (or more) sampling campaigns
- Focus on spatial variability (many reservoirs/sampling campaigns)
- Needed to calibrate the AS results

Perspectives for ice covered systems

- Two ways to get annual estimates of GHG diffusive emissions from reservoirs, taking spring emissions into account
- Reliable results for Canadian boreal systems (mostly oligotrophic)

Need to document other systems



Global model of reservoir diffusive emissions



Thank you for your attention



GHGs emission science: key principles

