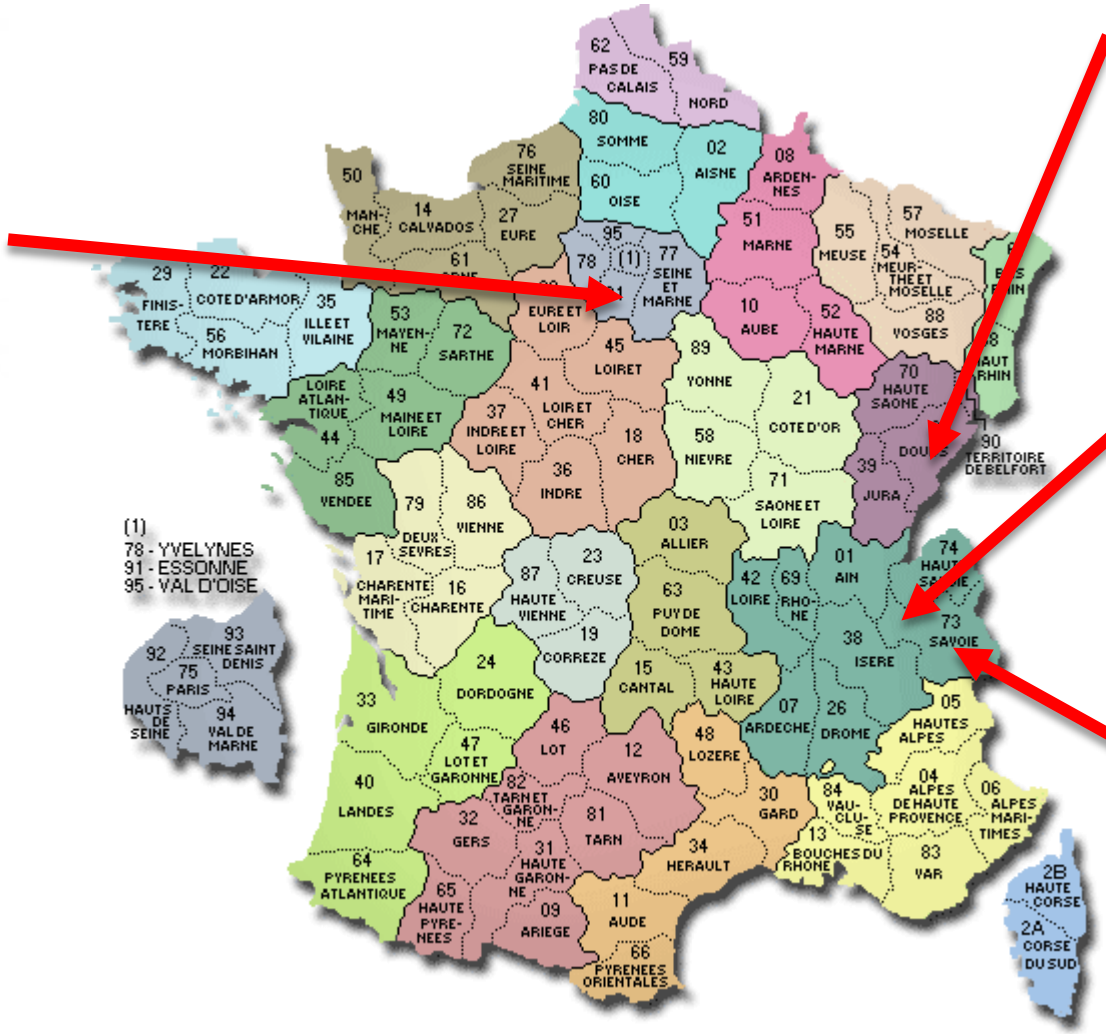
Super-low background environmental radioactivity measurements for geosciences

Fabien Arnaud
Délégué scientifique / Scientific deputy

3 CNRS research units are operating ultra-low background germanium detectors @ LSM for geoscience purposes

LSCE

LABORATOIRE DES SCIENCES DU CLIMAT & DE L'ENVIRONNEMENT



CHRONO ENVIRONNEMENT

laboratoire edytem

environnements dynamiques lointains montagnes

LSM

Laboratoire Souterrain de Modane

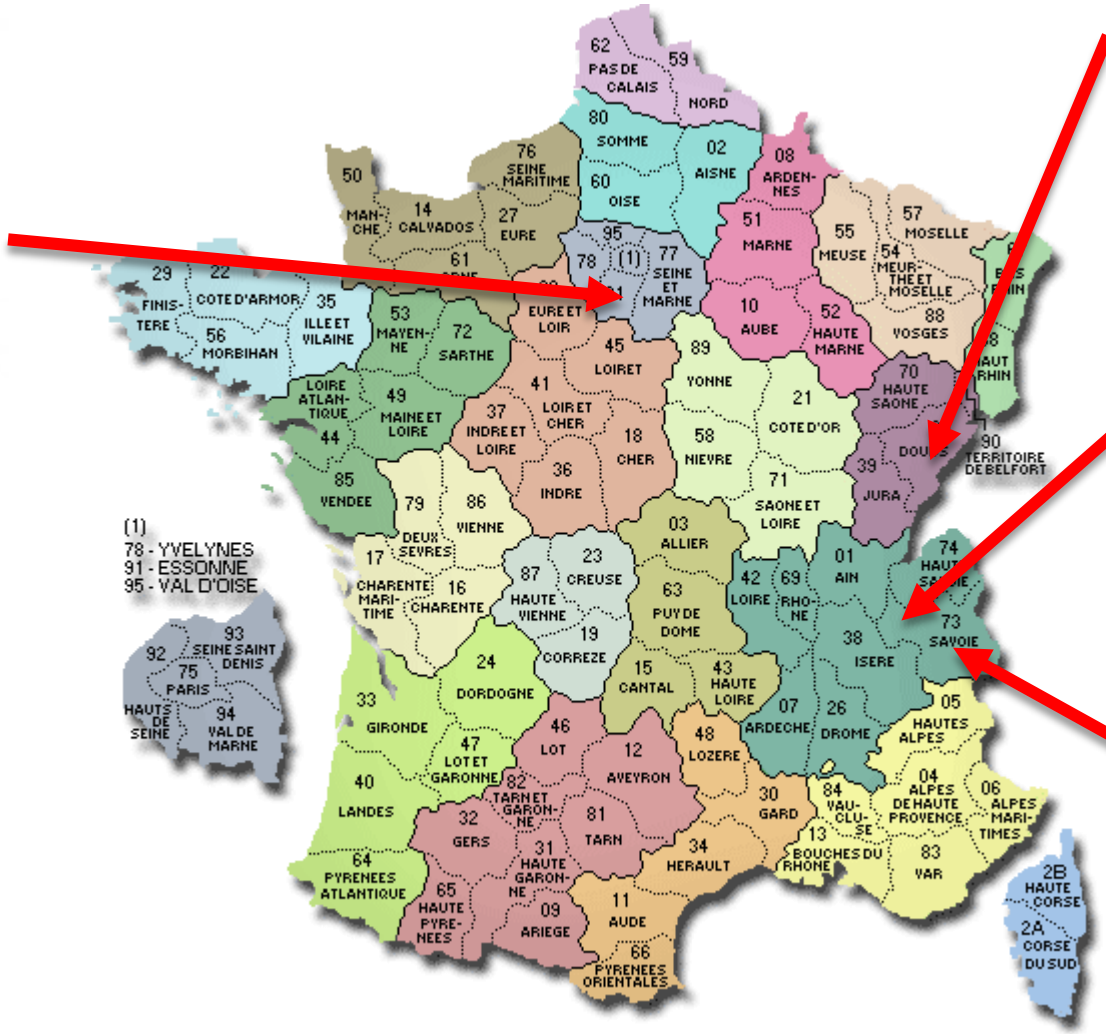
Usage statistics

Unit	Main CNRS institute	Person in charge (science)	Person in charge (technics)	Dedicated soft money agent	Intern or collaboration / extern	Number of detectors	Number of sample / year	% of potential machine time usage
EDYTEM	INEE	Pierre Sabatier	Anne-Lise Develle	Alice Mollard	70%	2	566	ca. 100%
LSCE	INSU	Olivier Evrard	Irène Lefèvre	-	30%	3	134	30 %
Chronoenvironnement	INEE	Damien Rius	Christophe Mavon	-	66%	1	?	60 – 90 %

Main achievements

LSCE

LABORATOIRE DES SCIENCES DU CLIMAT & DE L'ENVIRONNEMENT



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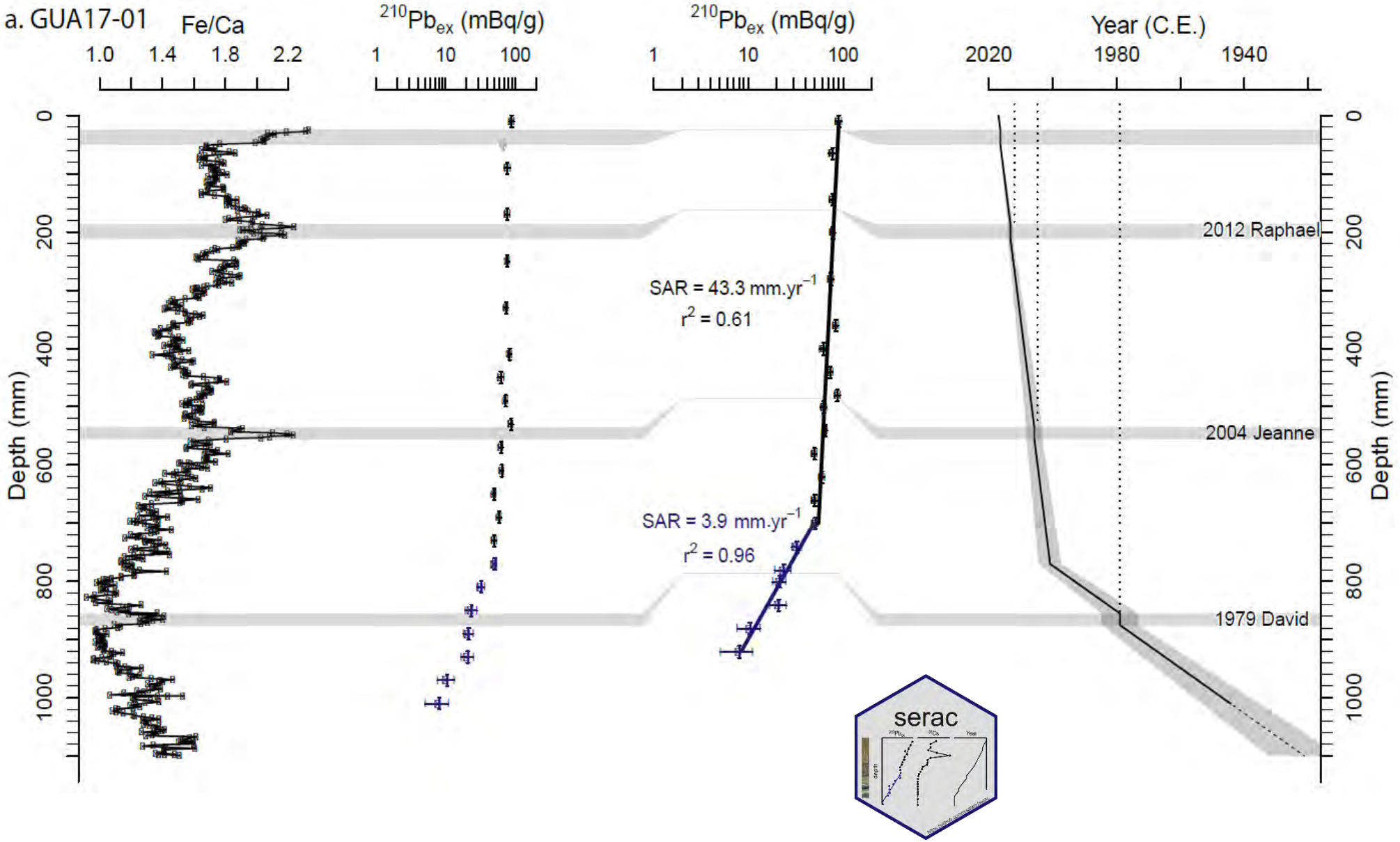
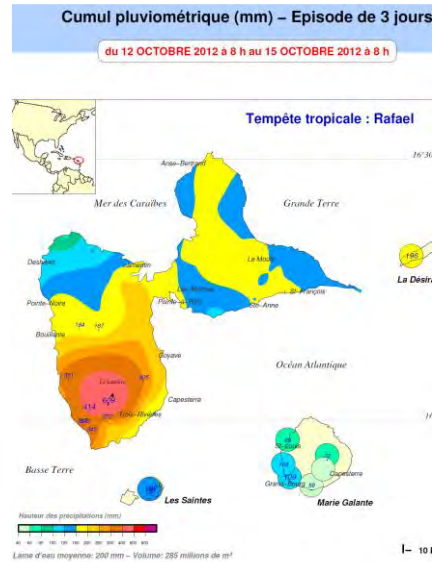
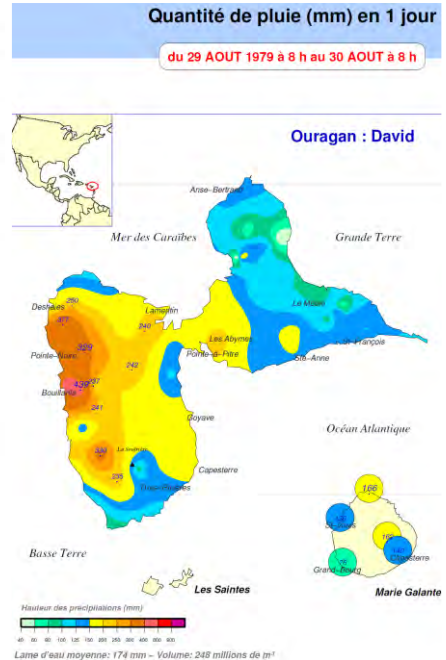
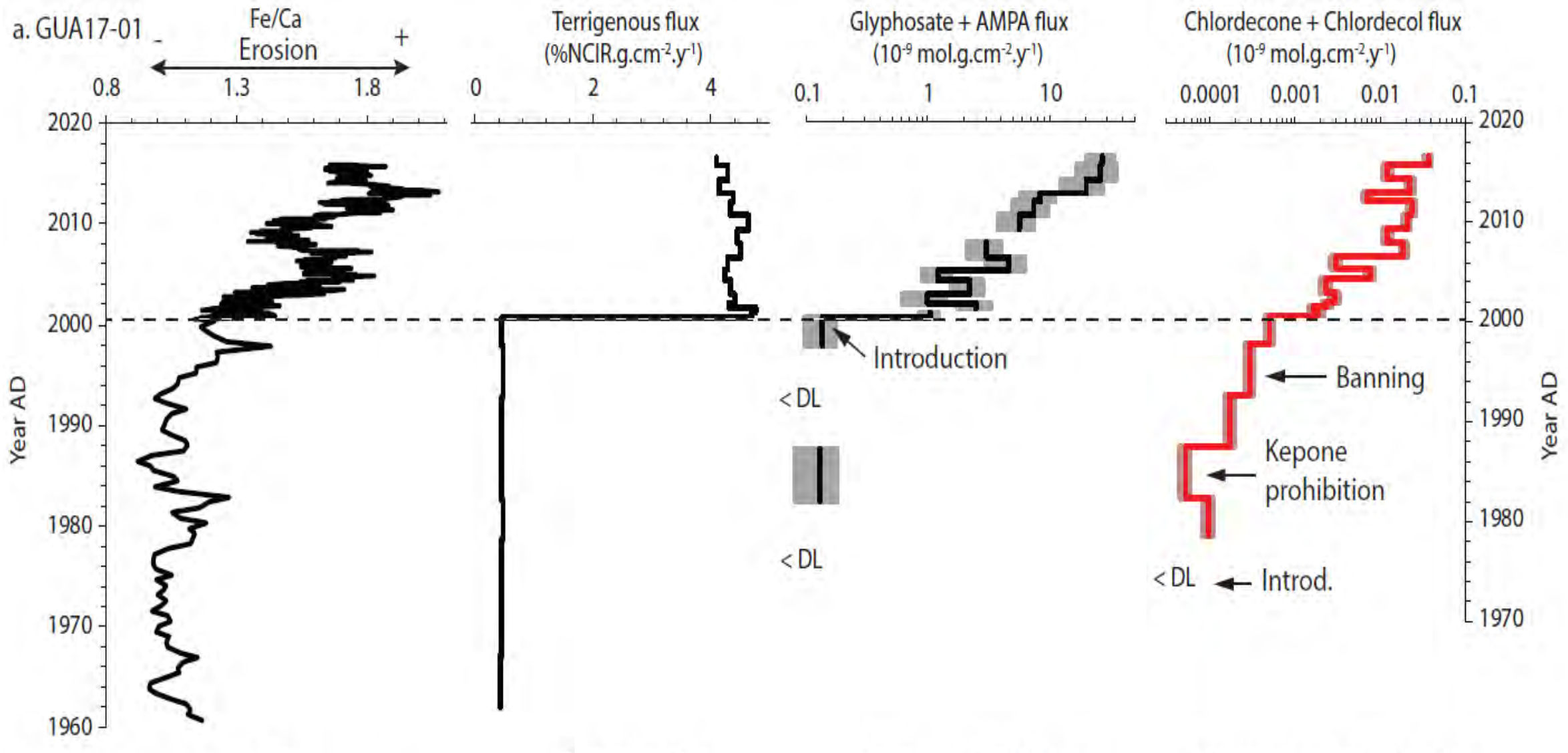
Guadeloupe Island : dating hurricane-triggered deposits







Guadeloupe Island : linking pesticide usage and dispersal with erosion processes



Guadeloupe Island : linking pesticide usage and dispersal with erosion processes

Scientific publication

Environmental Science & Technology

pubs.acs.org/est Article

Evidence of Chlordecone Resurrection by Glyphosate in French West Indies

Pierre Sabatier,* Charles Mottes, Nathalie Cottin, Olivier Evrard, Irina Comte, Christine Piot, Bastien Gay, Fabien Arnaud, Irène Lefevre, Anne-Lise Develle, Landry Deffontaines, Joanne Plet, Magalie Lesueur-Jannoyer, and Jérôme Poulenard

Cite This: https://dx.doi.org/10.1021/acs.est.0c05207 Read Online

Mediatic and societal outcome

L'impact de la chlordécone aux Antilles françaises

Mars 2023

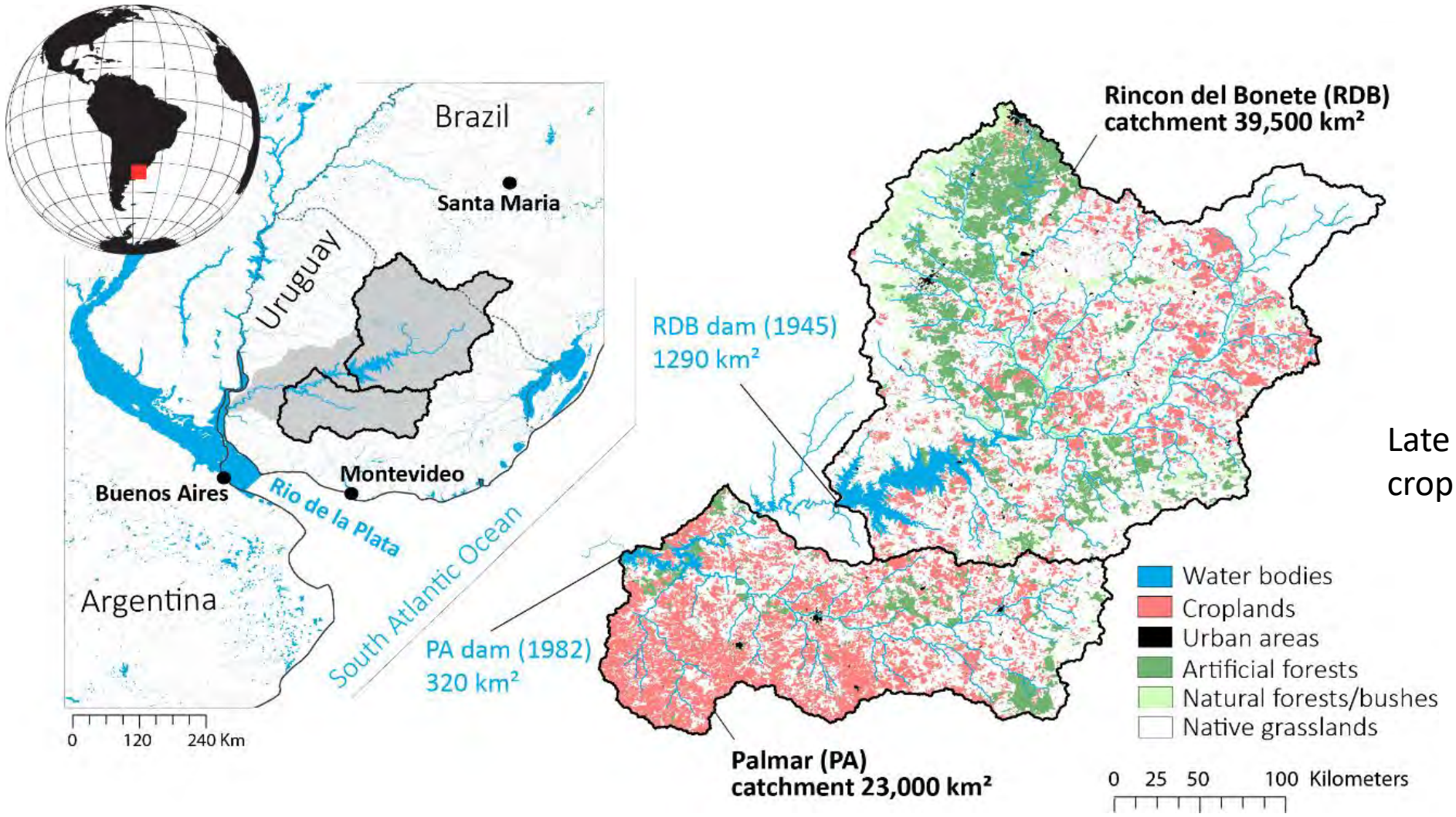
Inexorable land degradation due to agriculture expansion in South American Pampa

nature sustainability

LSCE

Agriculture expansion in the South American Pampa grassland led to an inexorable increase in land degradation (1982-2019)

Anthony Foucher[1] ✉, Marcos Tassano[2], Pierre-Alexis Chaboche[1], Guillermo Chalar[3], Mirel Cabrera[2], Joan Gonzalez[2], Pablo Cabral[2], Anne-Catherine Simon[4], Mathieu Agelou[4], Rafael Ramon[5], Tales Tiecher[6] & Olivier Evrard[1]

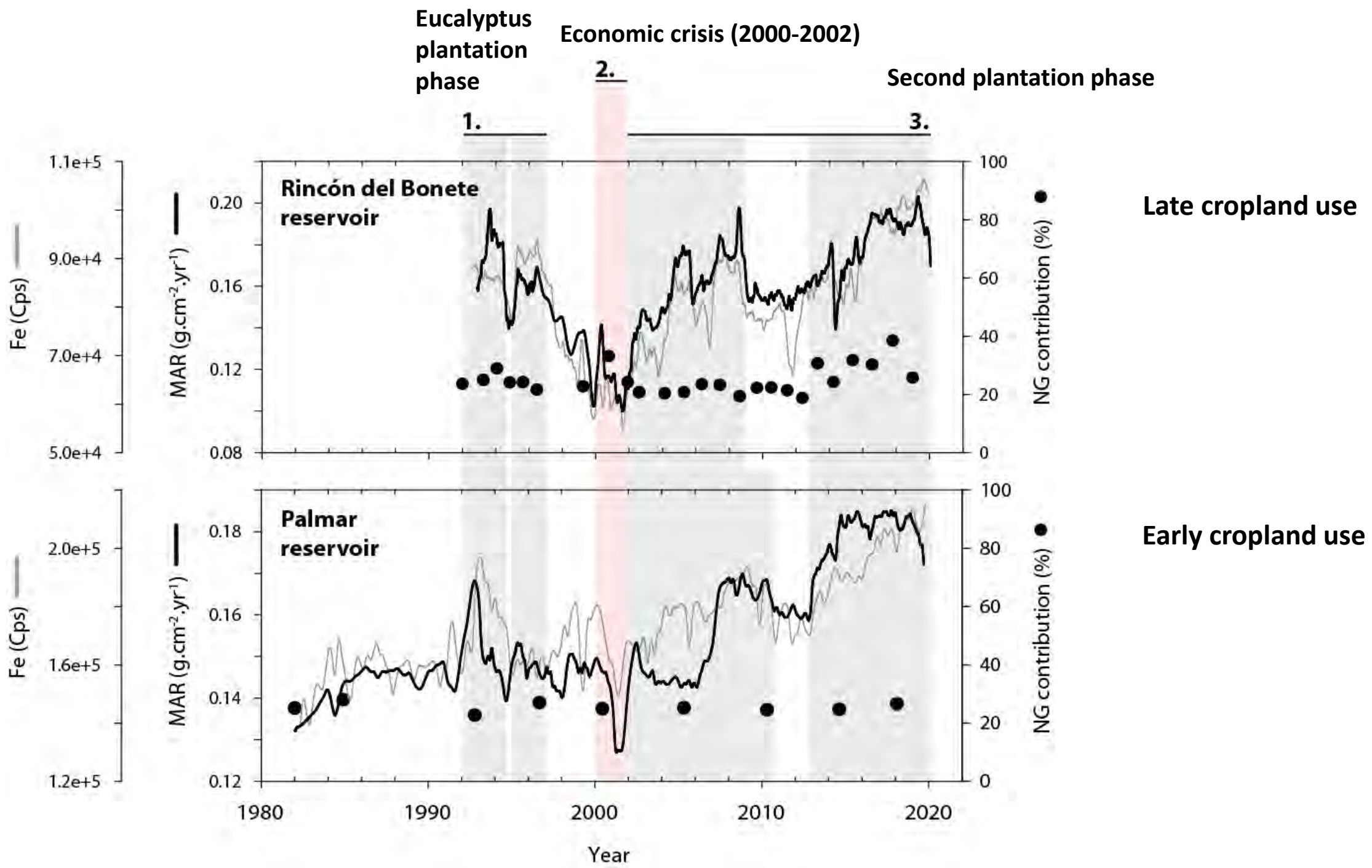


LSCE

Late cropland use

The surface area cultivated with soybeans has increased by 1,000% between 1990 and 2020 in Uruguay.

Early cropland use



Late cropland use

Early cropland use

nature COMMUNICATIONS

CHRONO ENVIRONNEMENT

ARTICLE

Check for updates

https://doi.org/10.1038/s41467-020-17682-8 OPEN

Assessing the response of micro-eukaryotic diversity to the Great Acceleration using lake sedimentary DNA

François Keck[1,2], Laurent Millet[3], Didier Debroas[4], David Etienne[5,2], Didier Galop[6,7], Damien Rius[3] & Isabelle Domaizon[1,2]✉

Synthetic eutrophication trajectories from 46 lakes

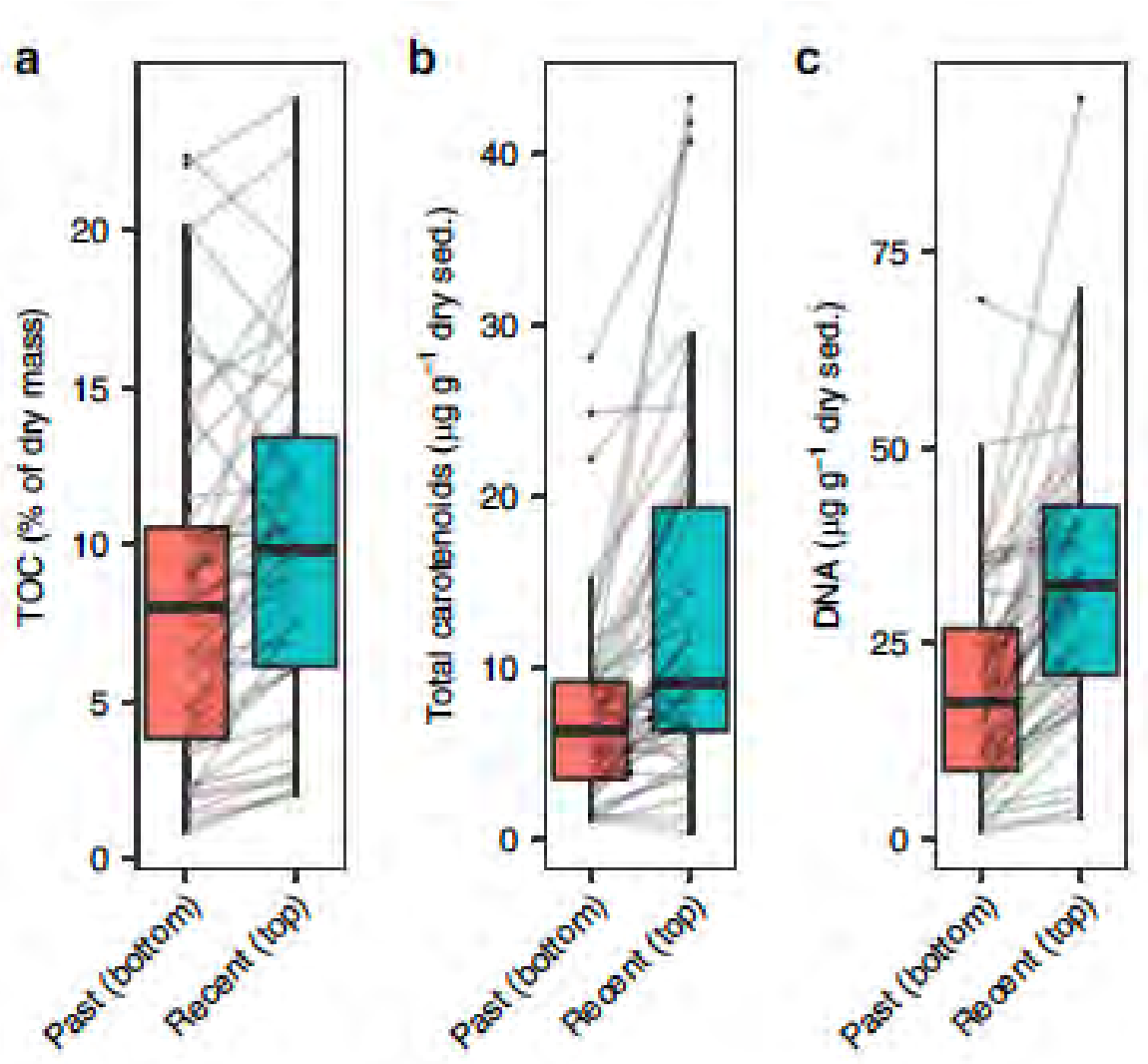


Fig. 1 Differences between the recent (top) and past (bottom) sediment strata. a Proportion of total organic carbon (TOC) in dry sediments ($n = 46$ lakes), **b** concentrations of total carotenoid pigments expressed in µg per g of dry sediment ($n = 44$ lakes) and **c** concentrations of DNA expressed in µg per g of dry sediment in the recent (top) and past (bottom) strata ($n = 48$ lakes) of the sediment cores. Boxplots depict medians, first and third quartiles, and full ranges (bounded at 1.5 × interquartile range). Gray lines connect values from the same lake.

Major ongoing programmes
DEEP-C & CarboNium (PEPR FairCarbon > 1 M €)

PEPR Faircarbon : 2 projets financés pour les 5 prochaines années

Projet ciblé CarboNium

CarboN dynamic in the terrestrial- aquatic continuum

J. Nemery L.Gandois

Projet Deep-C

Carbon sink or methane source – local to global scale assesment of lentic waters' role in the climate system

J-P Jenny L. Millet

Projet région Graduate School Transbio CARLA

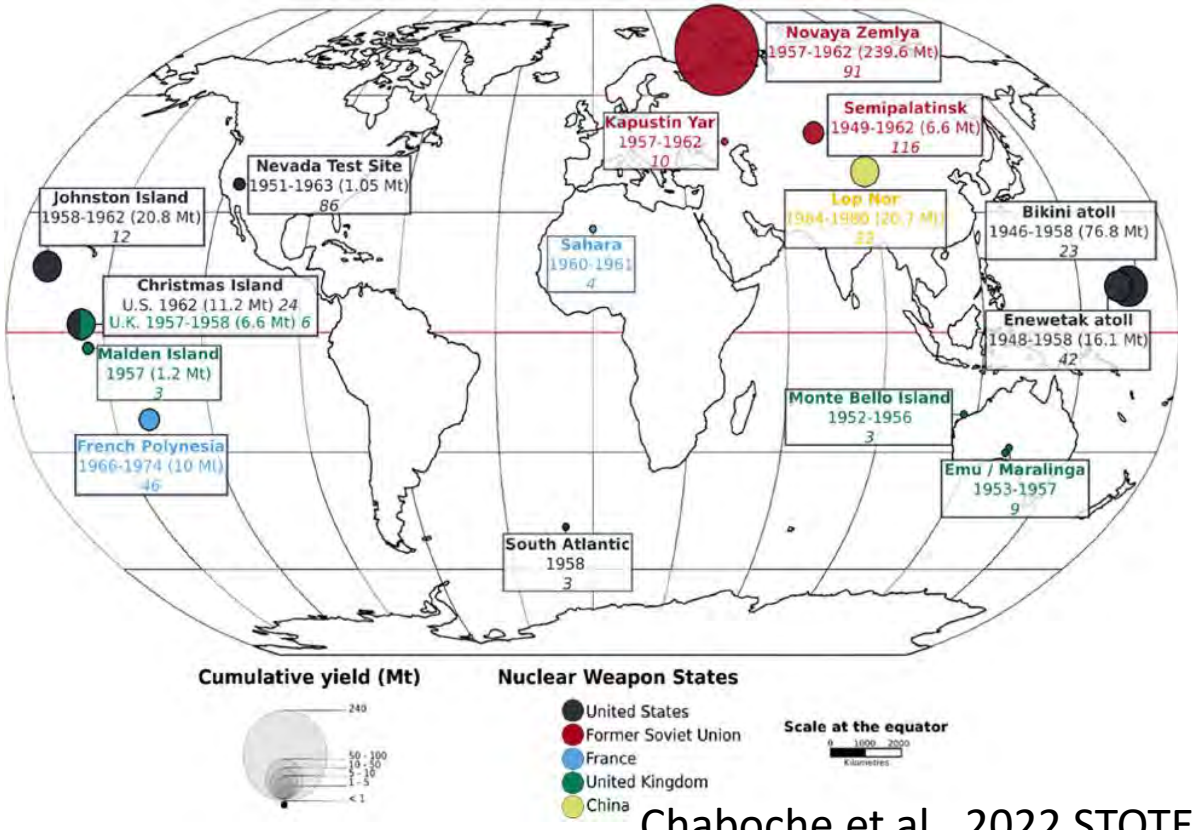
Projet OSU Stock-Car, convention PNR Jura …

Redefining and quantifying the role of lakes and soils in carbon storage

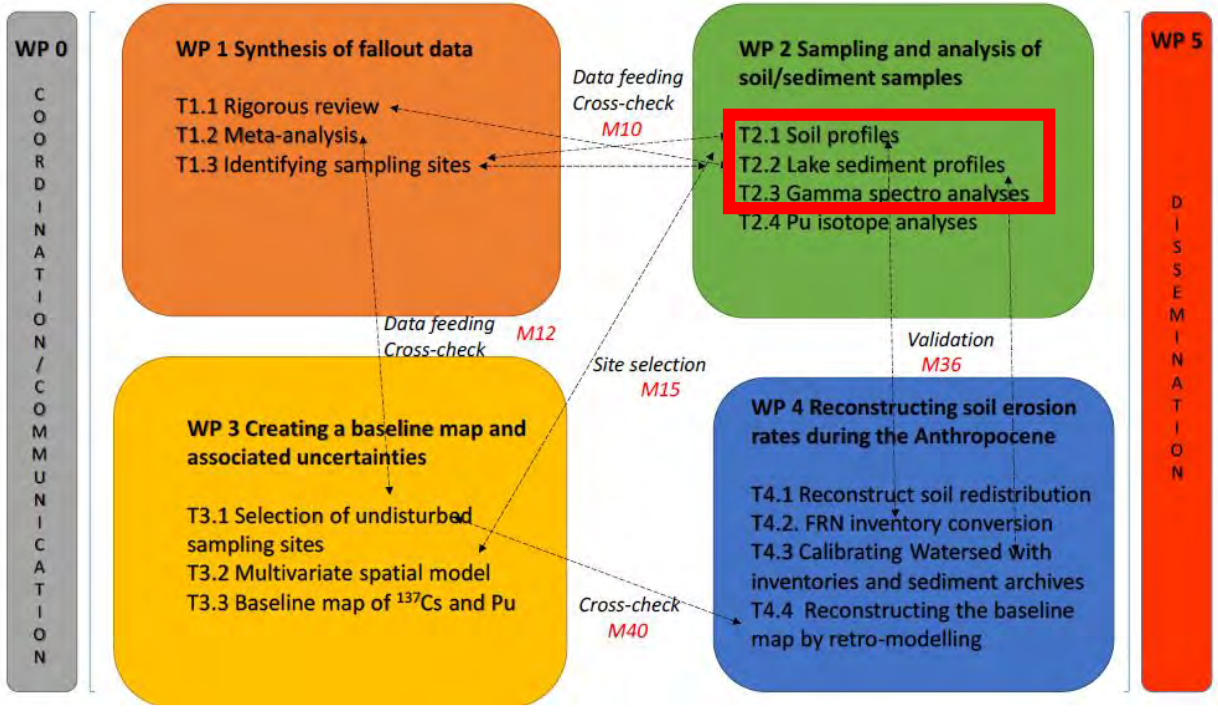
Major ongoing programmes

AVATAR : A reVised dATing framework for quantifying geomorphological processes during the AnthRopocene (French-Swiss joint national programme)

- Southern hemisphere 137Cs fallout map
- Relative contribution of latter French bomb tests (Pu isotopes)
- Enhance the reliabitity and precision of radionuclide-based erosion reconstruction over large catchment areas



Chaboche et al., 2022 STOTEN



Returns of experience

Unit	Comments (usage)	LSM strengths	LSM issues
EDYTEM		- Low background - Dedicated staff support - Discussion with other users	- Errors in sample labelling - Lack of fexibility in sample counting time - Degraded background (radon) and phonic conditions (detectors errors) since the onset of the common shielding - Users meeting late announcement
LSCE	Mainly very low activity ➔ lower potential number of samples / year		
Chronoenviron.			

Potential of development

Unit	Structure/technique/ organisation	Science
EDYTEM	- Radon shielding tent and helium flux (lower background) - Automatic sample robot	- Radium-226 excess in carbonaceaous lake and marine sediment (dating span : 10 to 1000 years)
LSCE		- Very low activity and very small samples (efficiency gain)
Chronoenviron.		-