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THE COMBINE EFFECT OF AGRICULTURAL PRACTICES AND WATER INPUT ON N₂O EMISSIONS FROM SOUTHWESTERN FRANCE CROPLAND: 5 YEARS OF MONITORING

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THE COMBINE EFFECT OF AGRICULTURAL PRACTICES AND WATER INPUT ON N₂O EMISSIONS FROM SOUTHWESTERN FRANCE CROPLAND: 5 YEARS OF MONITORING

Laurent Bigaignon¹, Valérie Le Dantec¹, Claire Delon², Bartosz Zawilski¹, Franck Granouillac¹, Nicole Claverie¹, Patrick Mordelet¹, Aurore Brut¹, Eric Ceschia¹, Rémy Fieuzal¹, Baptiste Lemaire¹ & Tiphaine Tallec¹



<https://www.cesbio.cnrs.fr>

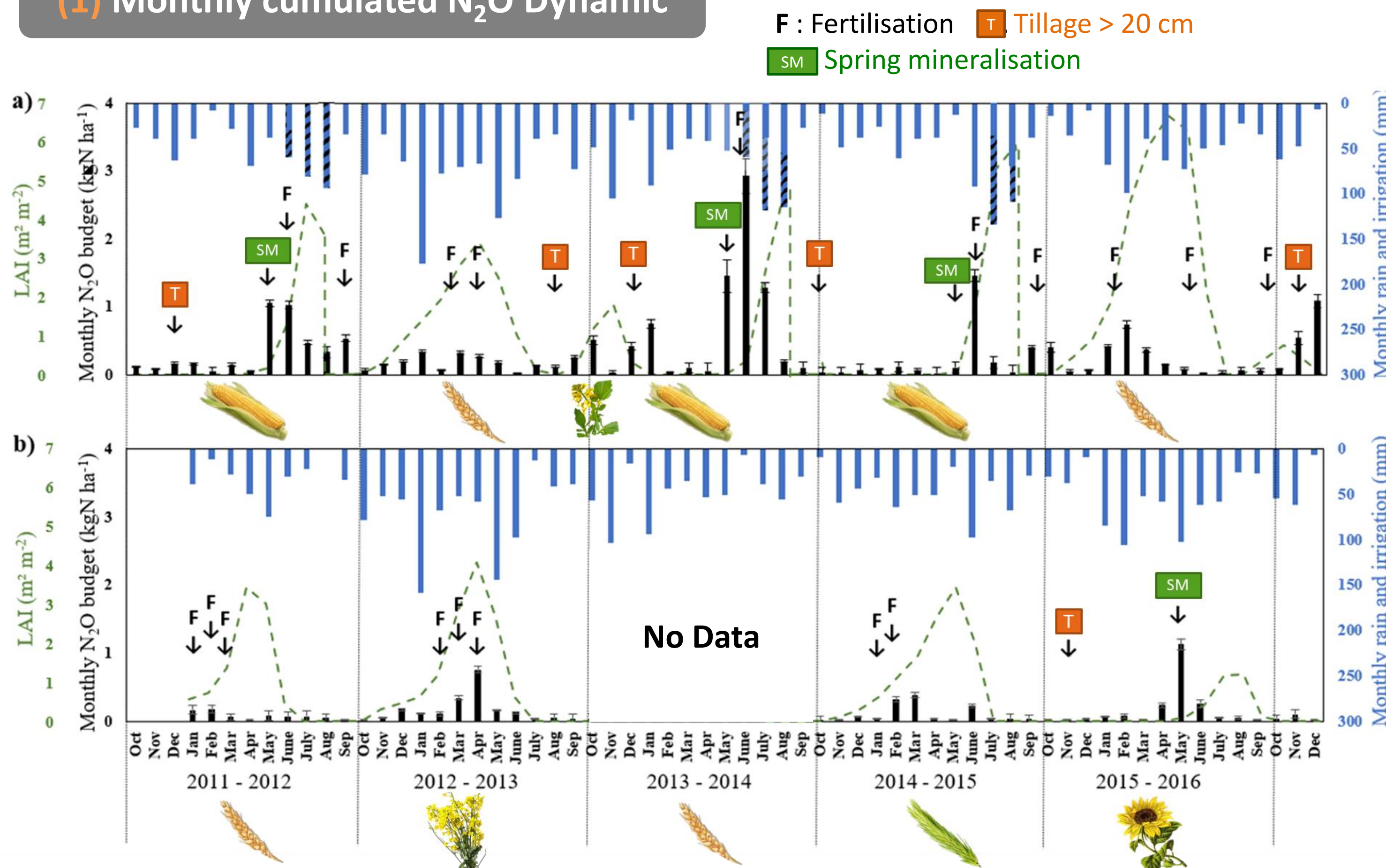
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Context & Objectives

N₂O is the third gas responsible of the greenhouse effect, with a time life in the atmosphere of 116±9 years. Anthropogenic sources, and notably N fertilizer input, are the main contributor of the imbalance of N₂O in the atmosphere during the last decades. The interactions between the numerous common drivers of N₂O production and transport involve a non-linearity in N₂O emissions (Franco-Luesma et al., 2020). The effect of one management on N₂O emissions can be inhibited or enhanced by another one.

Objectives : (1) to document and enrich literature from the agricultural Southwestern France context (2) to explore the difference in annual and seasonal budgets by monitoring 2 typical summer crops (sunflower and irrigated maize) and 3 winter crops (wheat, barley and rapeseed) (3) to analyze the interacting effects of both agricultural practices overtime on N₂O emissions dynamic and (4) to develop an original methodology to estimate seasonal N₂O budget with few variables.

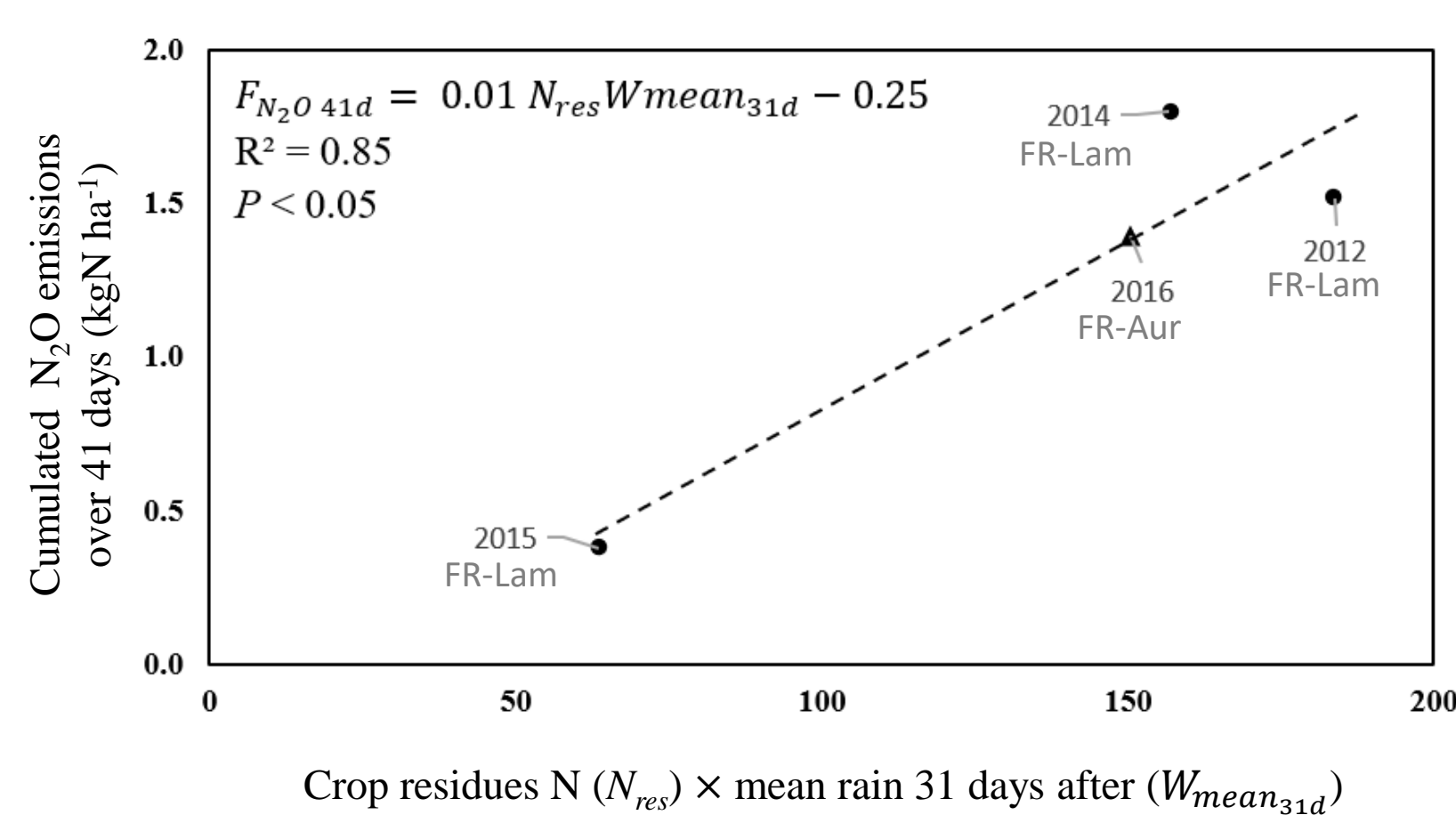
(1) Monthly cumulated N₂O Dynamic



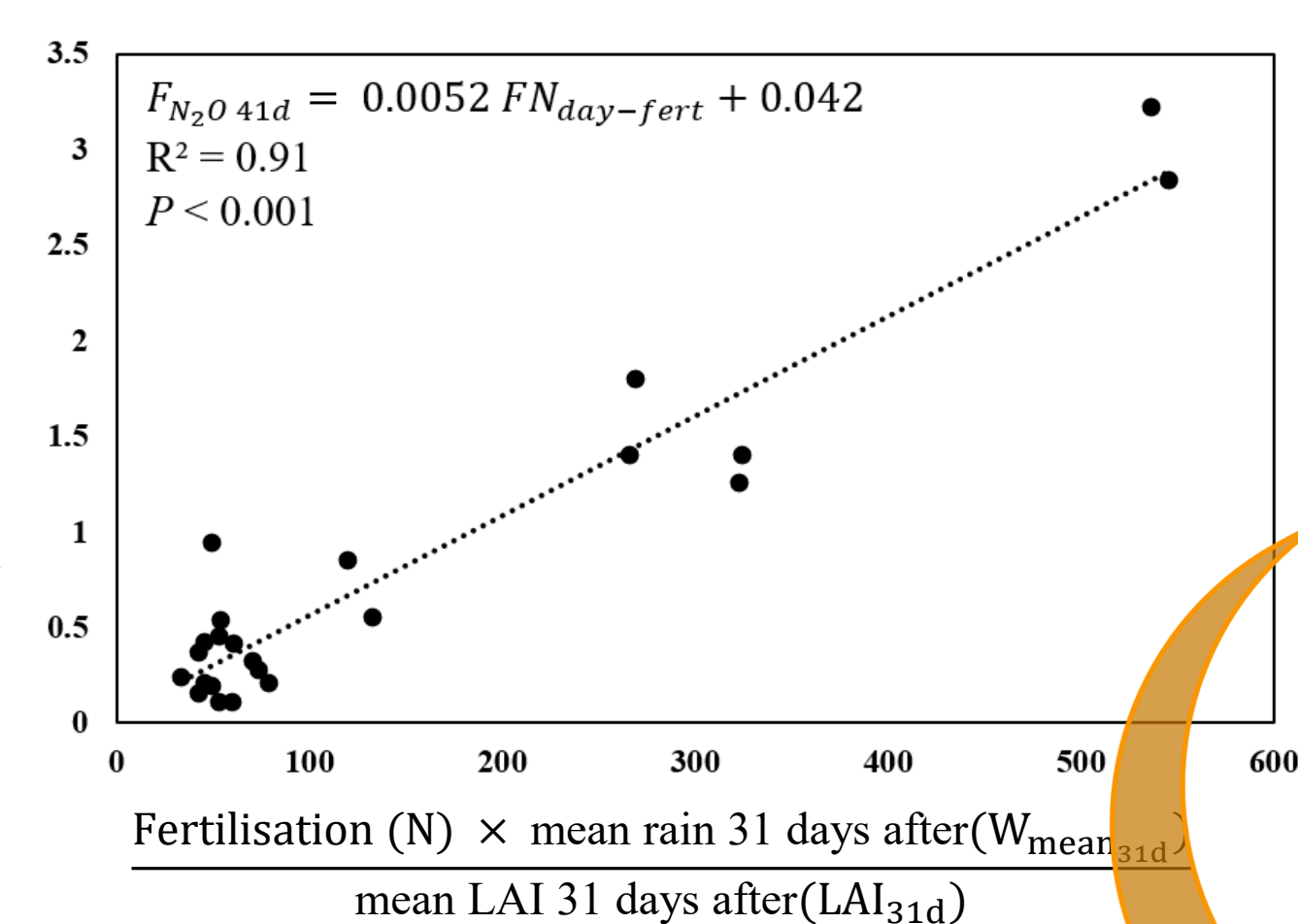
- Classic peaks of N₂O emissions after N fertilizer applications, after tillage > 20 cm which intensity depends on water supply amount (Rain + irrigation) for both and on Leaf Area Index (LAI) for N inputs.
- Highest emissions = during May and/or June before a summer crop on both sites. When the soil is bare, spring mineralisation of organic N residues triggers high N₂O emissions during summer cropping years.

(3) Combine effect of management and water input overtime

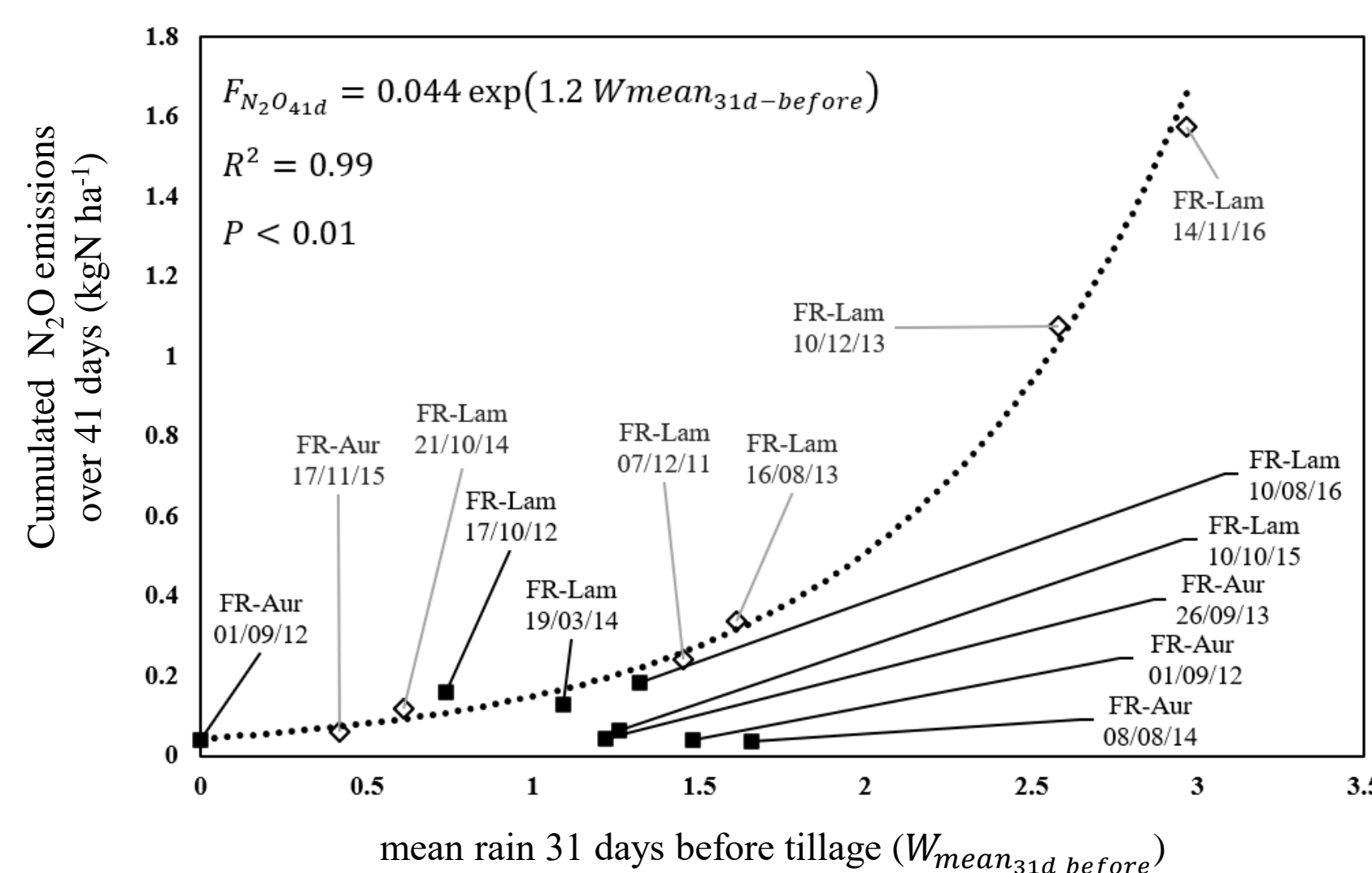
N residues + water effect



N fertilisation + GAI + water effect

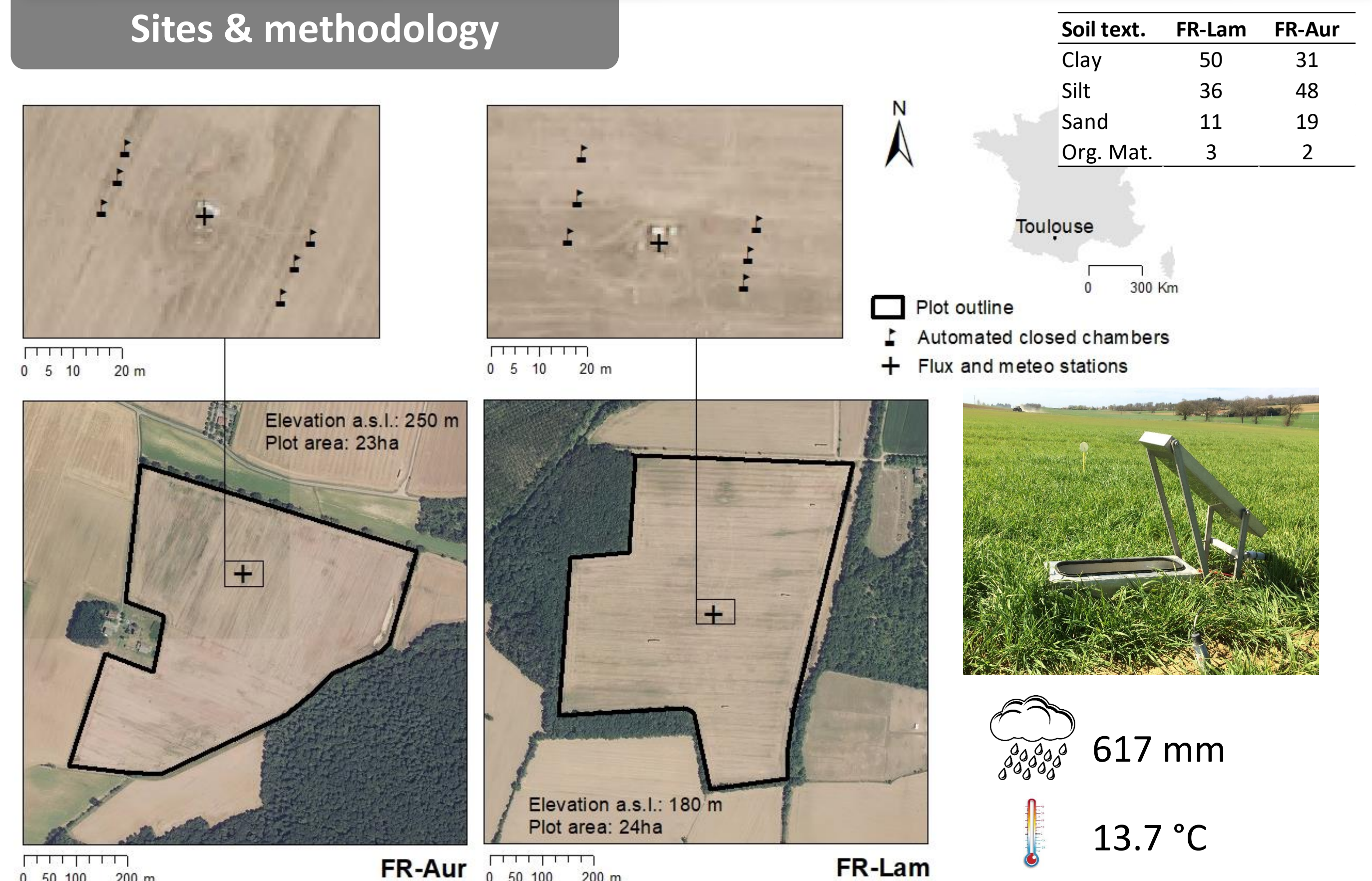


Tillage depth + water effect



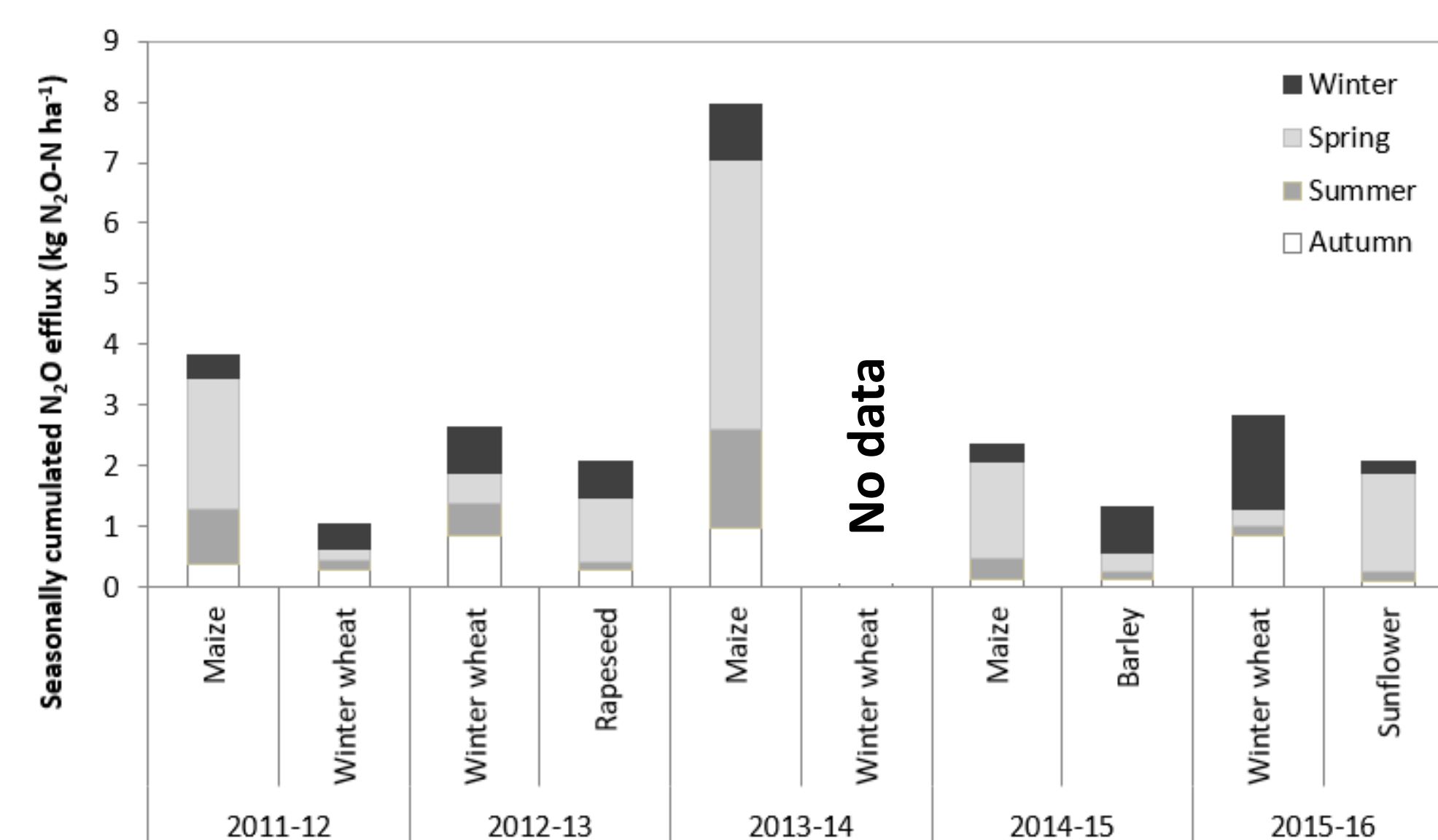
- All drivers effect depended on water amount (rain+irrigation)
- Previous crop residues N amount were highly correlated with the spring emissions observed before a summer crop when soil is bare.
- N fertilisation effect was attenuated by stage of crop development; higher GAI = better N uptake = lesser N₂O emissions
- Tillage >20 cm, after a long period of humid conditions, enhanced higher N₂O emission than a tillage < 20 cm.

Sites & methodology



- A set of 6 automated chambers installed on each site ; Measurement cycle every 6 hours during 17.5 minutes (00, 06, 12, 18h).
- N₂O fluxes calculated, filtered and gap-filled according to Tallec et al. 2019 and Bigaignon et al. 2020 respectively.

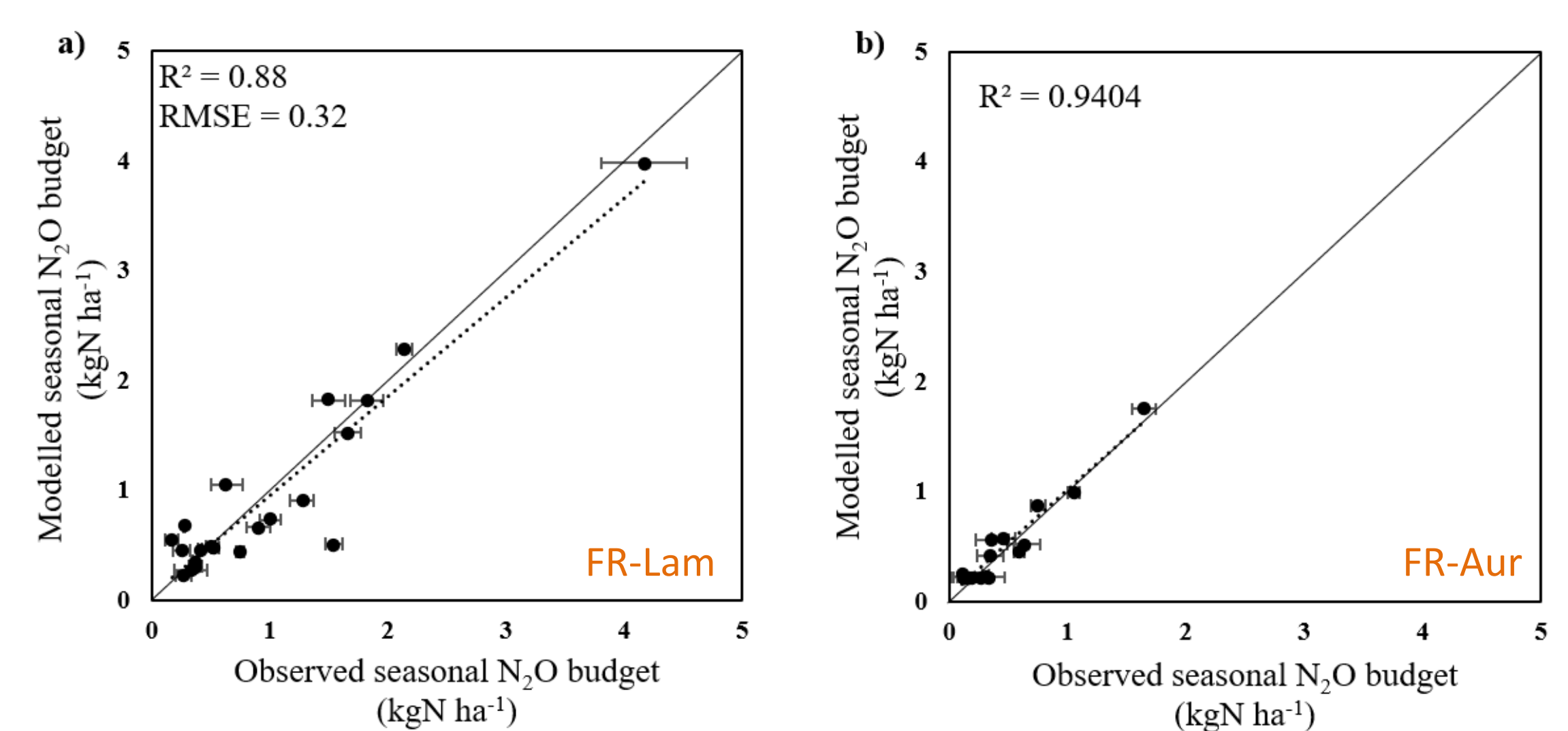
(2) Annual N₂O budgets and seasonal contributions



- Summer crops tended to present higher annual N₂O budgets ranging from 2.1 ± 0.1 to 8.0 ± 0.4 kgN ha⁻¹ than winter crops ranging from 1.0 ± 0.5 to 2.8 ± 0.1 kgN ha⁻¹.

- Summer crops : spring season accounted for more than 50% of the annual N₂O budget whatever the cropping year for maize crop at FR-Lam and reached 80 % of annual N₂O emissions for the sunflower crop at FR-Aur.
- Winter crops : the winter season contribution = on average > 40% of the annual N₂O emissions with high contribution of autumn season at FR-Lam due to manure spreading

(4) Seasonal N₂O budget simulation



- Based on the relationship relating explanatory drivers and observed emissions, an empirical system of equations was developed (Bigaignon et al, in preparation) to simulate seasonal N₂O budget.

Perspectives

- To apply modelling experiment (NOE2-STICS) to simulate a control treatment, to analyse the N cycle (mineralisation, N-uptake, etc.), to precise the involved processes (denitrification, nitrification)... on our sites.
- To evaluate N-N₂O loss effects on agronomical performance, i.e. crop yield.
- To test the empirical methodology developed on other soil and climate conditions -> toward a better informed inventory from few variables