



# VERIFY GA meeting #1

March 14, 2019

ECMWF

Reading, UK



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# WP4 – Verification methods for CH<sub>4</sub> and N<sub>2</sub>O emissions

WP lead: Rona Thompson

Presenter: Rona Thompson

VERIFY GA meeting #1 | March 14, 2019 | ECMWF, Reading, UK



# WP General Objectives

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- Deliver estimates of CH<sub>4</sub> and N<sub>2</sub>O fluxes, including anthropogenic as well as natural sources, and build this capacity into a pre-operational system
- Improve the understanding of the processes driving fluxes of CH<sub>4</sub> and N<sub>2</sub>O, and **reduce the uncertainties in their budgets and trends** at national, regional and continental scales



## WP4 – Main objectives M1-M12

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- Compilation of atmospheric observations of CH<sub>4</sub> and N<sub>2</sub>O
- Prepare BU estimates from statistical and process-based models
- Prepare atmospheric inversions for CH<sub>4</sub> and N<sub>2</sub>O



## WP4 – Main objectives until M24

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- First proto-type of the Community Inversion Framework (CIF) working with at least one model
- Prepare emission estimates from BU models for CH<sub>4</sub> including  $\delta^{13}\text{C}$  and ethane emissions
- Evaluation of TROPOMI CH<sub>4</sub> retrievals



## T4.1 – Bottom-up estimates

### Objectives, progress and achievements M1-M12

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- 4.1.1. Agricultural emissions of CH<sub>4</sub> and N<sub>2</sub>O: ready for 2000-2012, preliminary for 2013-2017
- 4.1.2. Non-agricultural anthropogenic emissions of CH<sub>4</sub> and N<sub>2</sub>O: update to 2015 expected mid-2019
- 4.1.3. Uncertainty analysis of anthropogenic sources: ready for CH<sub>4</sub> and in progress for N<sub>2</sub>O
- 4.1.4. Natural fluxes of CH<sub>4</sub>: wetland fluxes available 1981-2017 and inland water fluxes available as climatology
- 4.1.5. Process-based modelling of N<sub>2</sub>O: preliminary results for 2005-2015



## T4.2 – Top-down estimates

### Objectives, progress and achievements M1-M12

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- 4.2.1. Compilation of input data: completed
- 4.2.2. Flux estimates using state-of-the-art inversions: N<sub>2</sub>O completed for 2005-2016, CH<sub>4</sub> preliminary results available
- 4.2.3. Flux estimates using the CIF: a protocol document is completed and a first prototype of the code is implemented with a “dummy” model



## T4.3 – Research and development

### Objectives, progress and achievements M1-M12

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- 4.3.1. A data assimilation system for wetland fluxes of CH<sub>4</sub>: work started
- 4.3.2. Integrating new high-resolution satellite data into regional inversions: work started on reading and assimilation TROPOMI data in TM5
- 4.3.3. Supplementary atmospheric tracers: CTE-CH4 has been adapted to assimilate  $\delta^{13}\text{C}$
- 4.3.4. Development of very high-resolution inversions: a proto-type framework is running coupling TM4-4DVAR and FLEXPART



## WP4 – Status of Deliverables

DEL n°	DEL Title	Leader	Due date	Status	Comments
4.1	First CH <sub>4</sub> and N <sub>2</sub> O fluxes from anthropogenic sources from BU models	JRC	M16	in progress	
4.4	First CH <sub>4</sub> fluxes from wetlands and water bodies from BU models	FMI	M16	in progress	
4.7	First CH <sub>4</sub> and N <sub>2</sub> O fluxes from selected inversion frameworks	EMPA	M18	in progress	



# WP4 – Status of Milestones

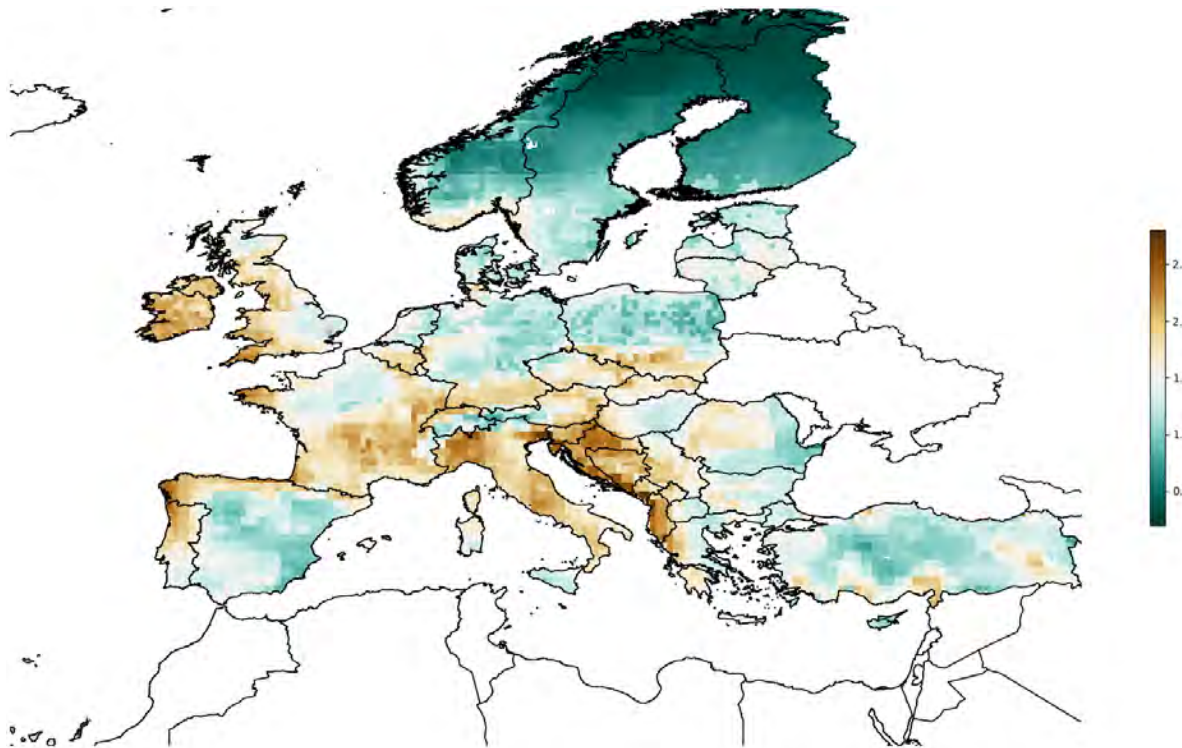
MIL n°	MIL Title	Leader	Due date	Status	Comments
MS20	Compilation of atmospheric observations and uncertainties	CEA	6	complete	
MS21	Design of the CIF and plan for its development	CEA	6	complete	
MS24	Prepare emission estimates from BU models for $\delta^{13}\text{C}$ and ethane	FMI	18	underway	
MS25	Prototype of CIF working for at least one global and one regional model	NILU	18	underway	
MS26	Comparison of TROPOMI XCH <sub>4</sub> retrievals with TCCON and AirCore data	VU	24	underway	



# WP4 – Highlights

## Process-based modelling of N<sub>2</sub>O using ECOSSE

N<sub>2</sub>O emissions for cropland (annual average 2005-2015)



Model approach is still under development - for example:

Problem:  
Emissions in Central (e.g. NL) and Western Europe too low

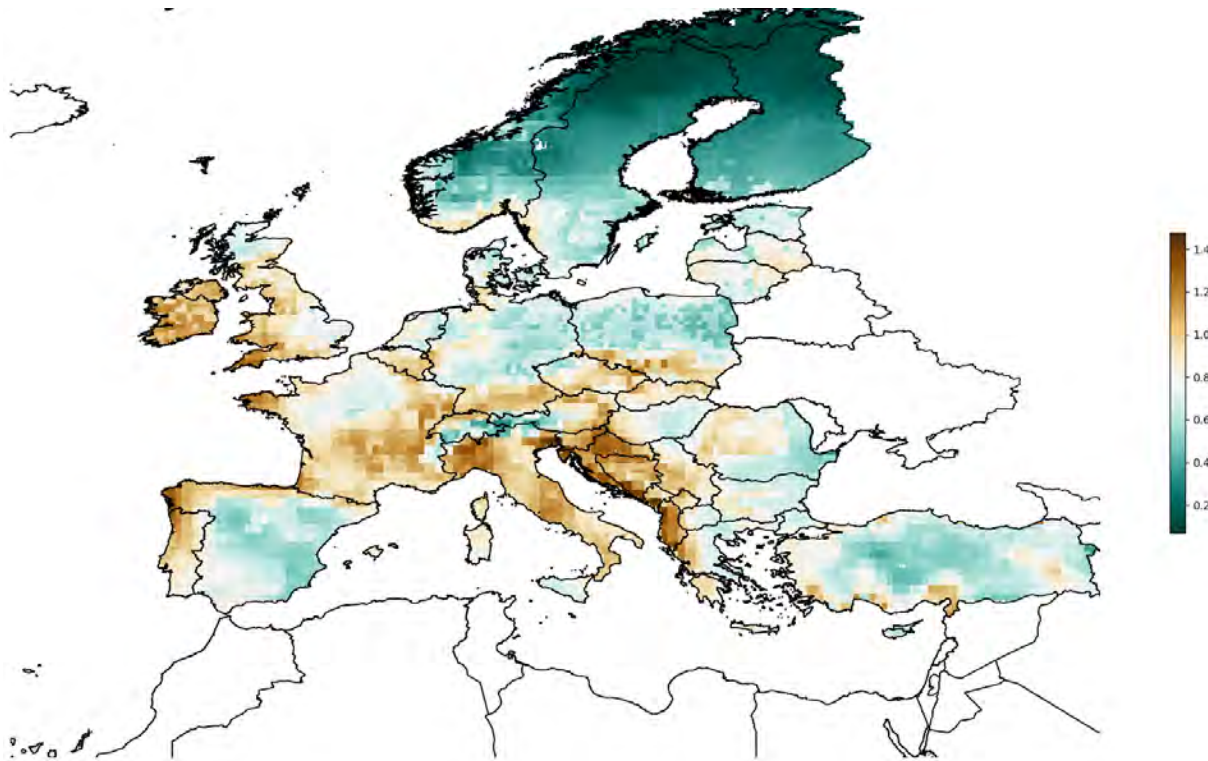
Solution:  
Fertilizer application needs to be changed from fertilizer demand to actual application rate



# WP4 – Highlights

## Process-based modelling of N<sub>2</sub>O using ECOSSE

N<sub>2</sub>O emissions for grassland (annual average 2005-2015)



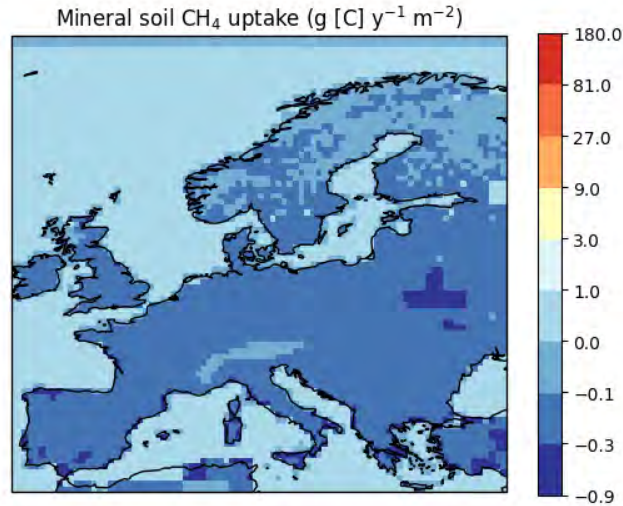
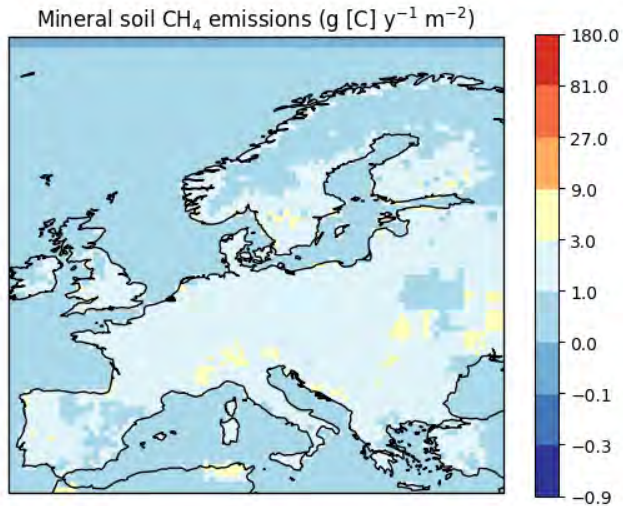
Results are not yet analysed or validated.

In the actual assumptions management is not considered.

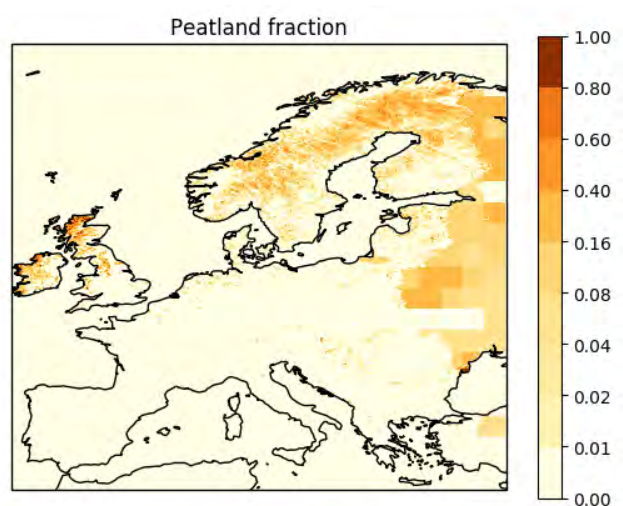
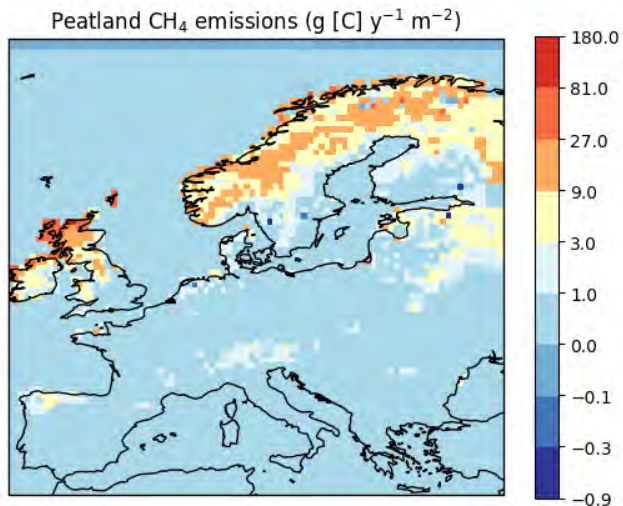


# WP4 – Highlights

## Estimates of CH<sub>4</sub> fluxes using JS-BACH-HIMMELI



Mineral soils both emit and take up methane



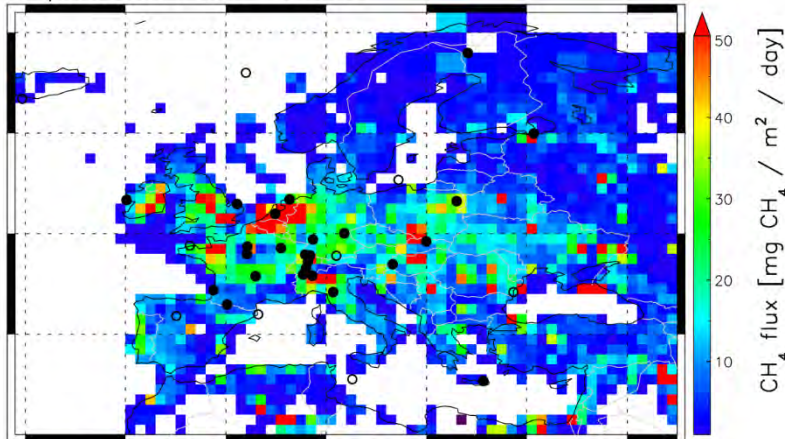
Peatland emissions are predominantly in northern Europe



# WP4 – Highlights

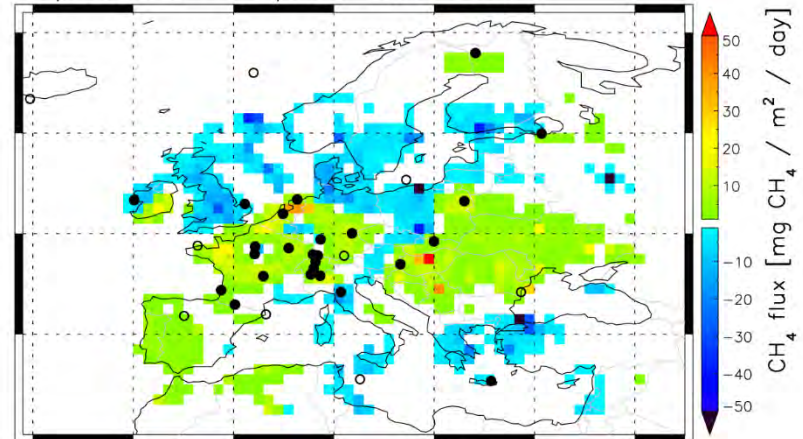
## First inversion results for CH<sub>4</sub> from TM5-4DVAR

a posteriori TM5-4DVAR

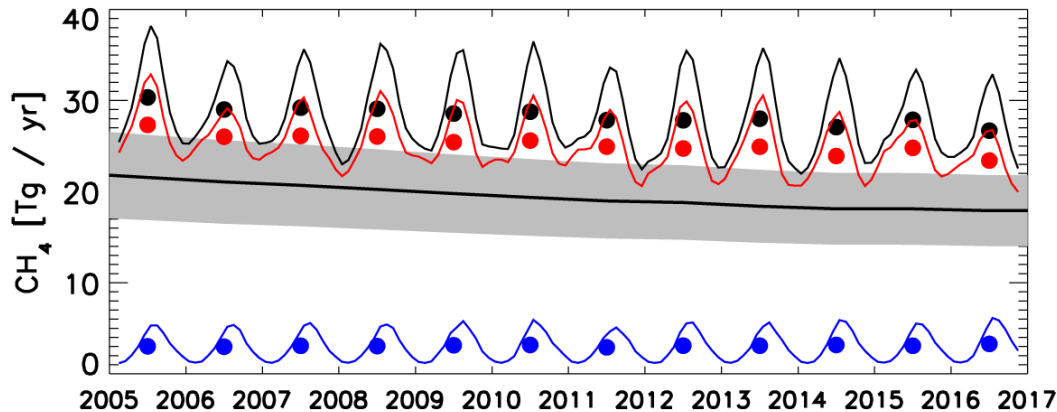


VAR\_M08\_ECC\_CH4\_eur\_EU501\_GCP2018\_TM\_EC\_V01\_I3

a posteriori – a priori TM5-4DVAR



EU-28

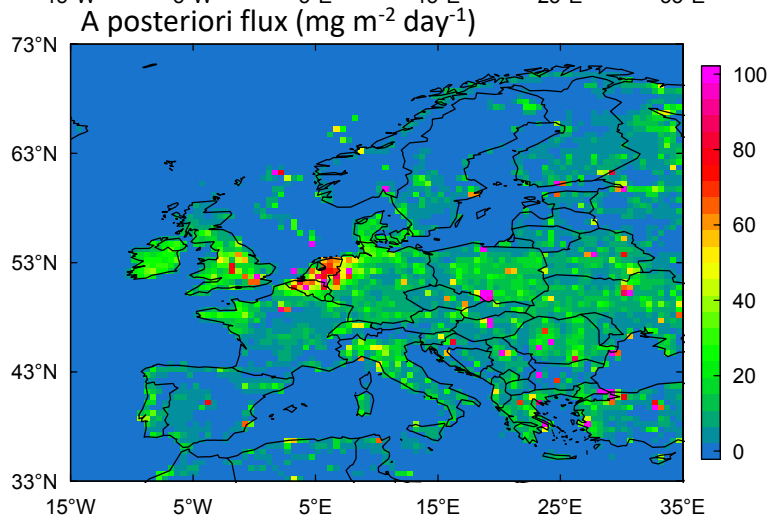
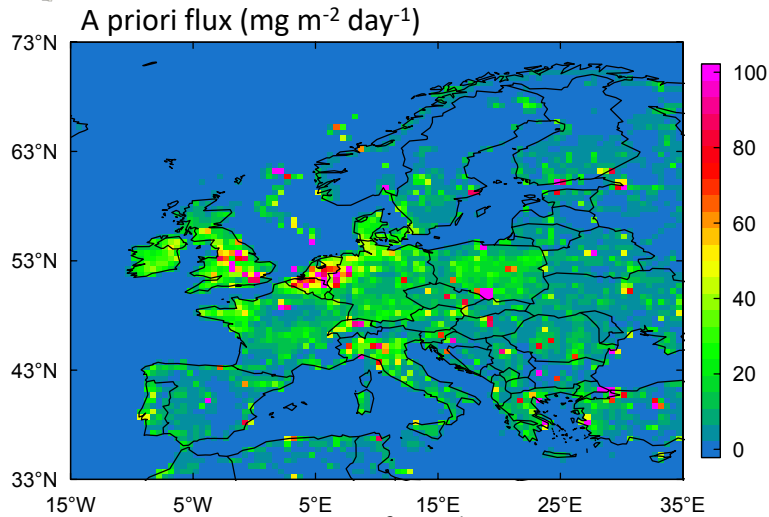


- total
- anthrop.
- natural
- UNFCCC (subm. 2018)



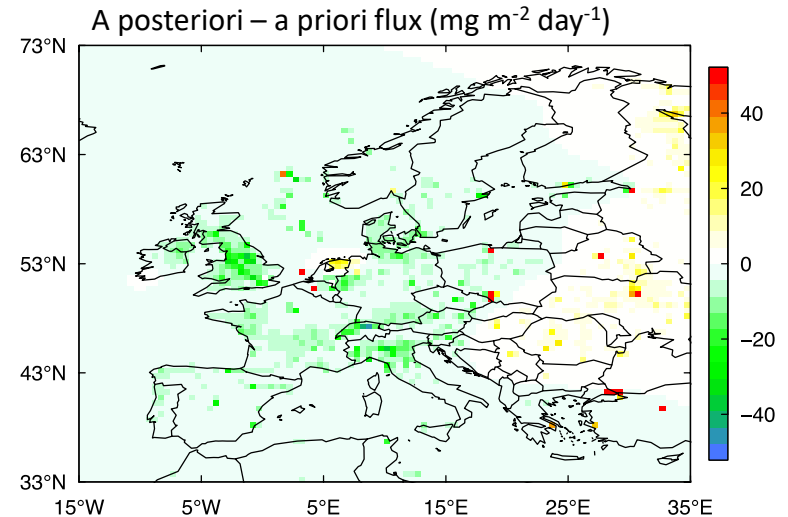
# WP4 – Highlights

## First inversion results for CH<sub>4</sub> using Flexpart-ExKF



### Preliminary results

- Model: FLEXPART-ExtKF
- Resolution: 0.5°×0.5°
- Period: 2005-2016 (shown for 2010)
- Priori estimate: based on EDGAR

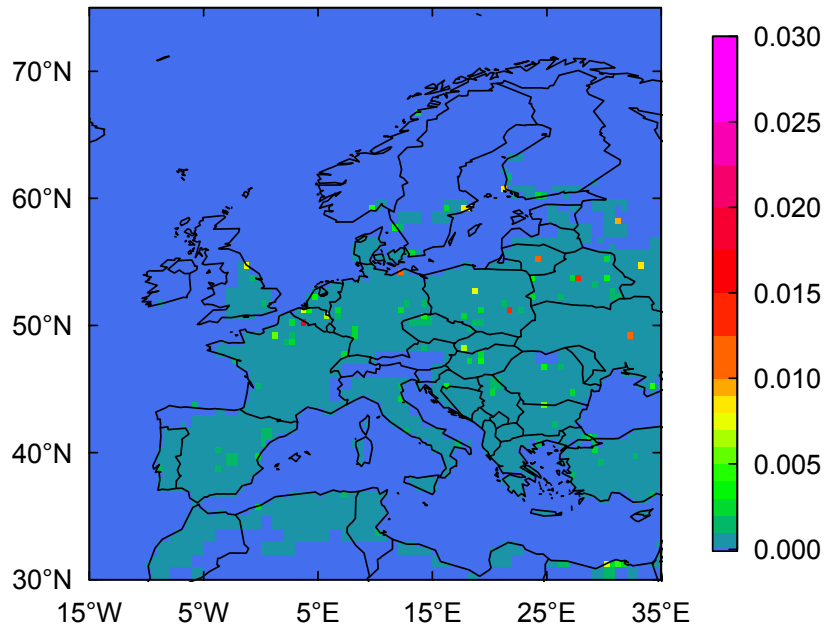




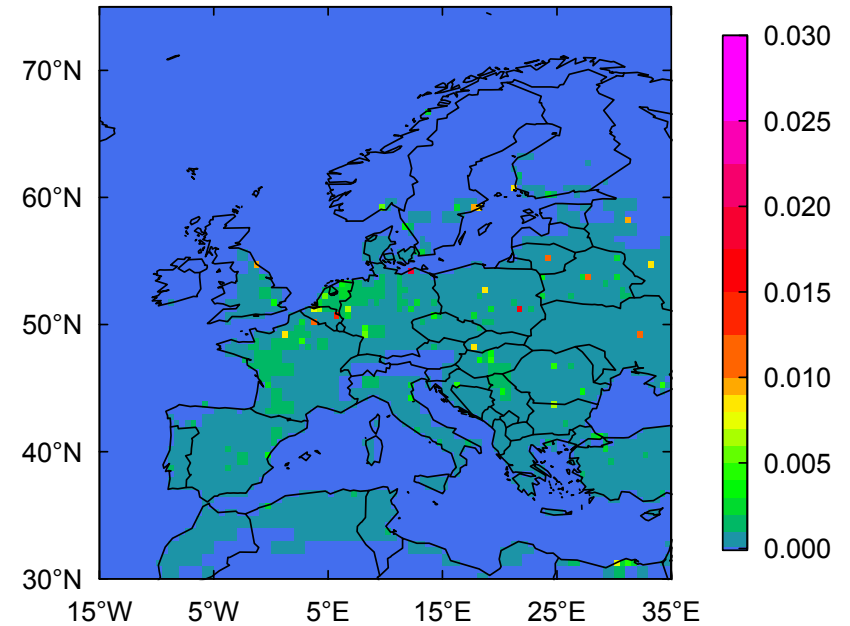
# WP4 – Highlights

## First inversion results for N<sub>2</sub>O from FlexInvert

Mean prior emissions (gN m<sup>-2</sup> d<sup>-1</sup>)



Mean posterior emissions (gN m<sup>-2</sup> d<sup>-1</sup>)





## WP4

### Dissemination activities on WP level

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- Plan to prepare 2 papers examining effects of 2018 drought on  $\text{CH}_4$  and  $\text{N}_2\text{O}$ , respectively, using both process-models and inversions



## WP4

### Conclusions and critical/open issues

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- WP4 is progressing well
- No foreseen delays with deliverables



**Thank you for your attention.**