Impacts of some ammonia mitigation measures on air quality in southwest Europe

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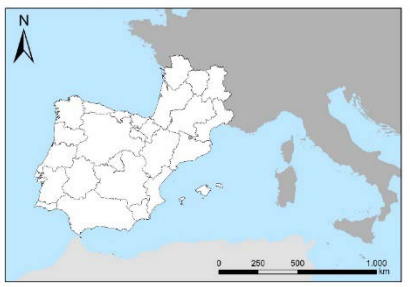
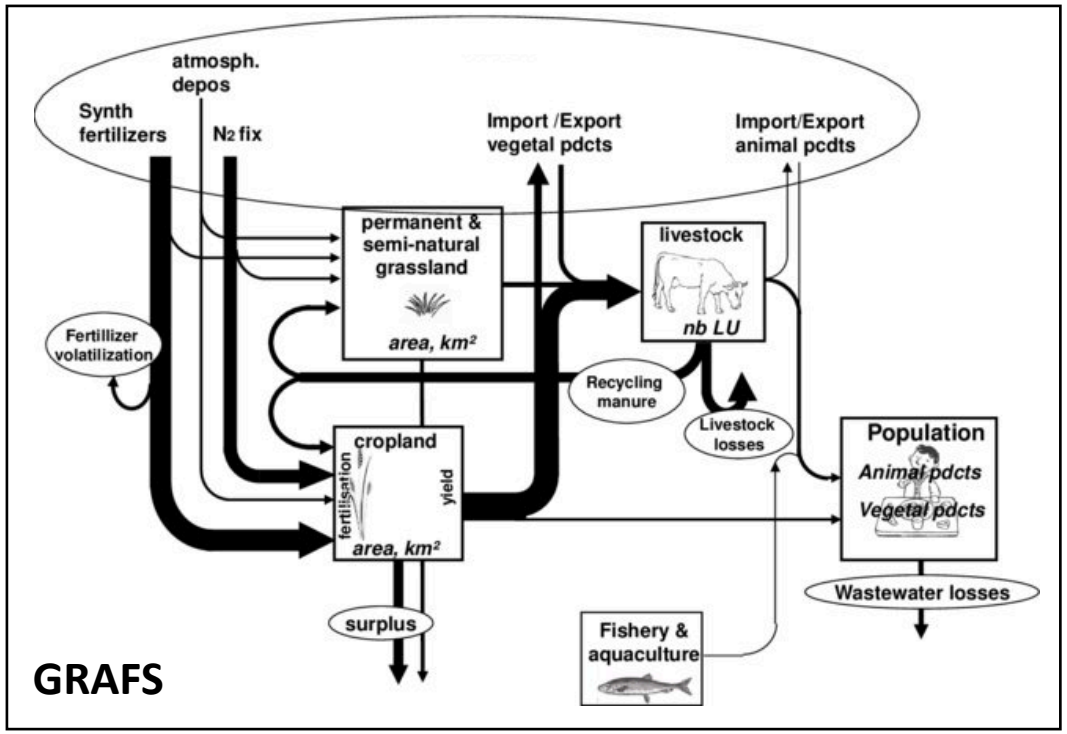
[3] Swedish University of Agricultural Sciences, Uppsala, Sweden
[4] Universidad de Castilla la Mancha



Methodology

- **Annual NH_3 emissions calculated using the GRAFS-MANNER model at NUTS2 level (France, Spain and Portugal)**
- **Emissions calculated for a dry (2017) and wet (2018) year for a basline scenario and three abatement scenarios**
- **CHIMERE chemistry transport model used to calculate atmospheric concentrations and N deposition**
- **Risk assessment carried out for impacts to vegetation**

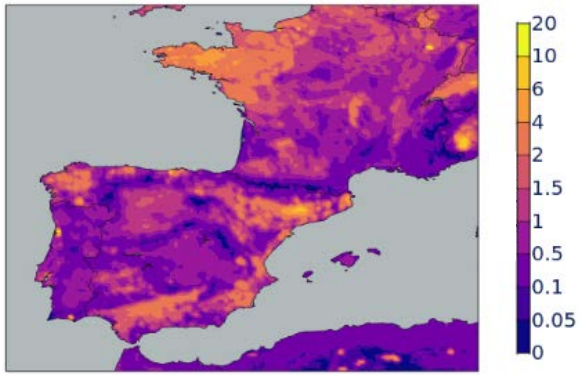
N fluxes



MANNER (MANure Nutrient Evaluation Routine) used to **calculate emissions from field-application of organic and synthetic fertilisers**

Le Noë, J. (2018). Biogeochemical functioning and trajectories of French territorial agricultural systems: carbon, nitrogen and phosphorus fluxes (1852-2014) PhD Thesis, Sorbonne université

Annual NH_3 emissions (Mg/km^2)



Alternative scenarios based on changes in crop management intended to lower environmental impacts from agriculture

S0

Baseline scenario (situation in 2017/2018)

S1

Technical/management improvements

- Remove urea without replacement
- Shift to 100% Calcium ammonium nitrate (CAN)
- Fast incorporation of manure
- 100% drip irrigation
- Exchange green maize for alfalfa
- Efficiency improvement (synthetic fertilizer inputs can be reduced while keeping yields very similar to before)

S2

Extensification and dietary change

- Reduce synthetic N inputs by 50% (Farm to Fork)
- Mediterranean diet (-30% animal protein)

↳ Not implemented yet (On-going work)

S3

Both extensification and efficiency improvements

- -50% synthetic N inputs
- 100% CAN
- Fast incorporation of manure
- Green maize -> alfalfa
- Mediterranean diet

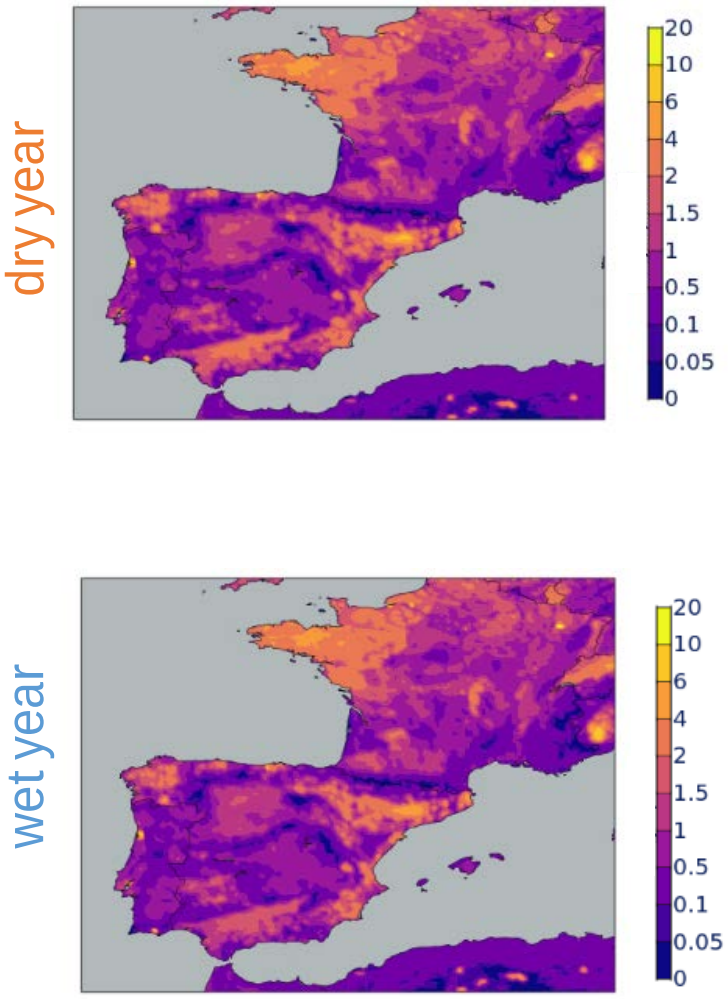
Measures that reduce NH_3 emissions

NH_3 emissions calculated on the EMEP 0.1° grid

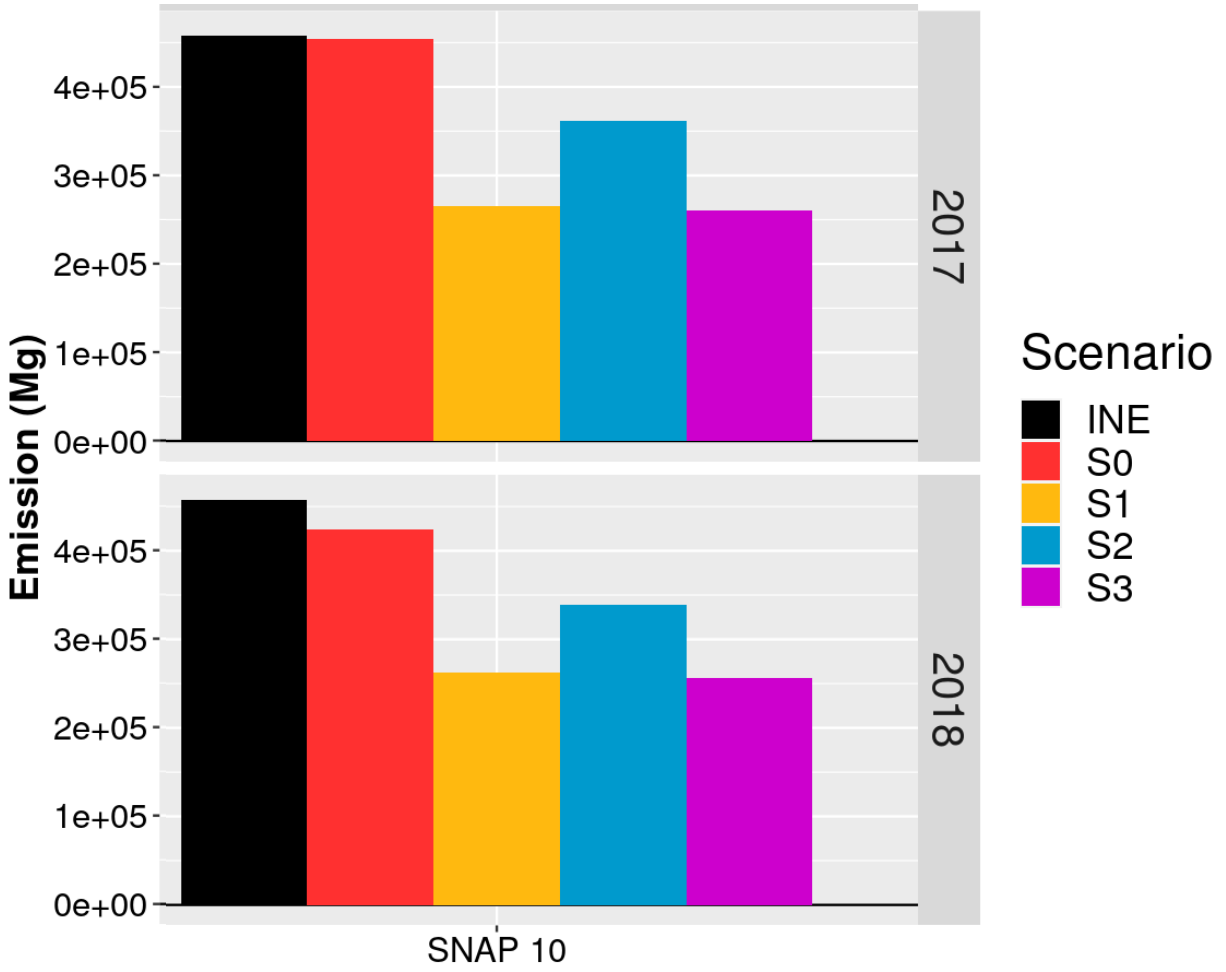
Field-application of fertilisers: GRAFS/MANNER
Other sectors: EMEP

Annual emissions (Mg/km^2)

S0



Spanish emissions (SNAP10)



INE: Spanish National Inventory (= EMEP)

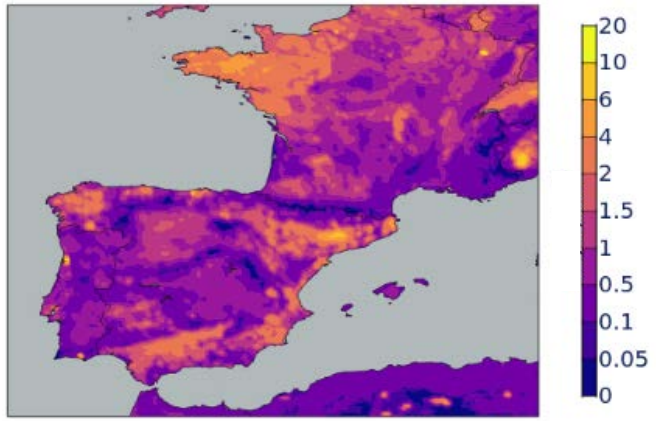
NH_3 emissions calculated on the EMEP 0.1° grid

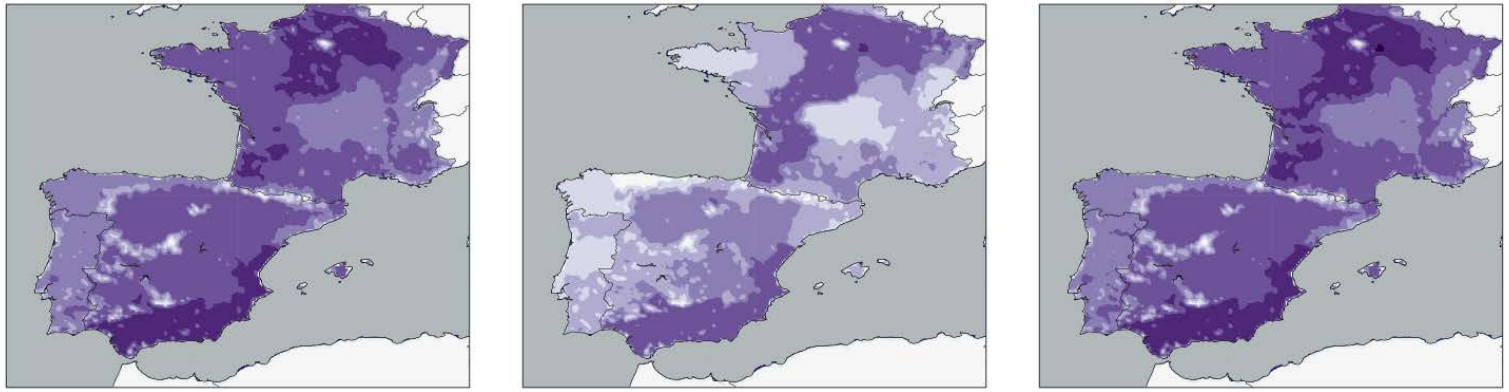
Annual emissions (Mg/km^2)

Relative change with respect to baseline (S0)

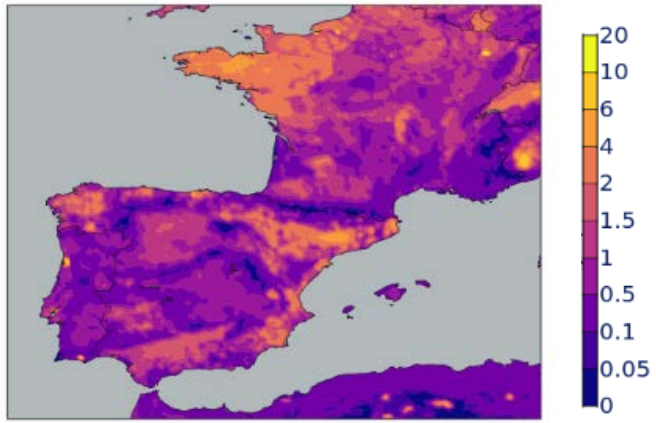
S0 S1 S2 S3

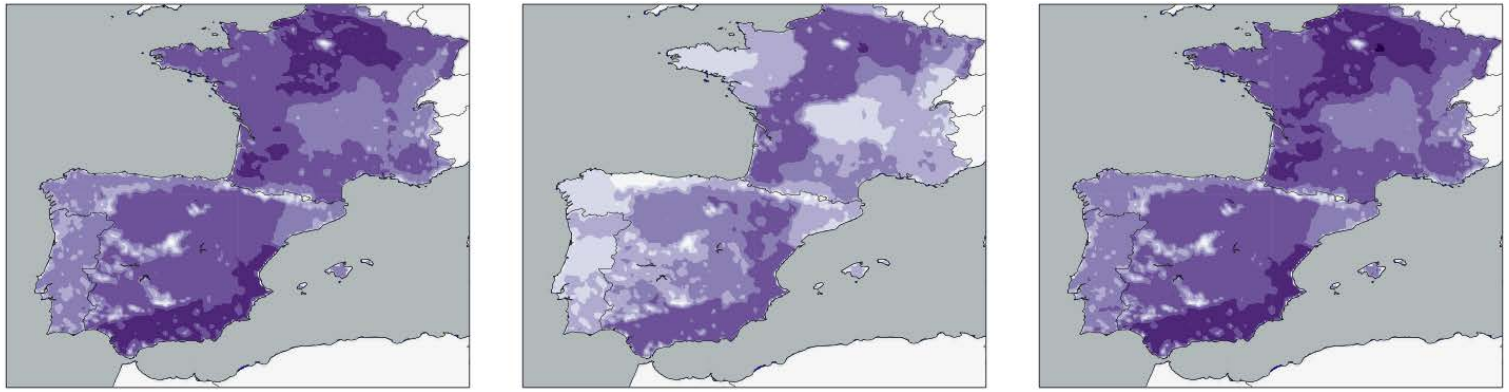
dry year

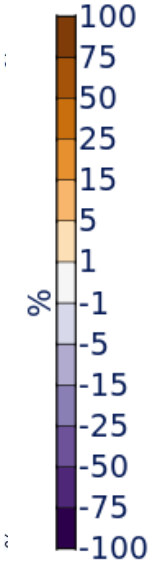




wet year





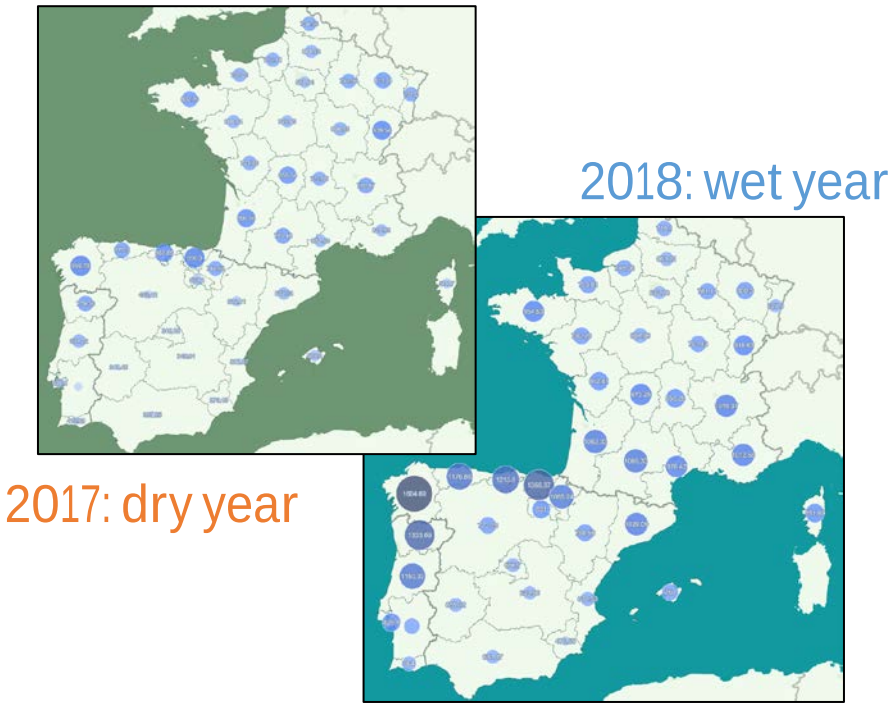


Air quality and deposition:

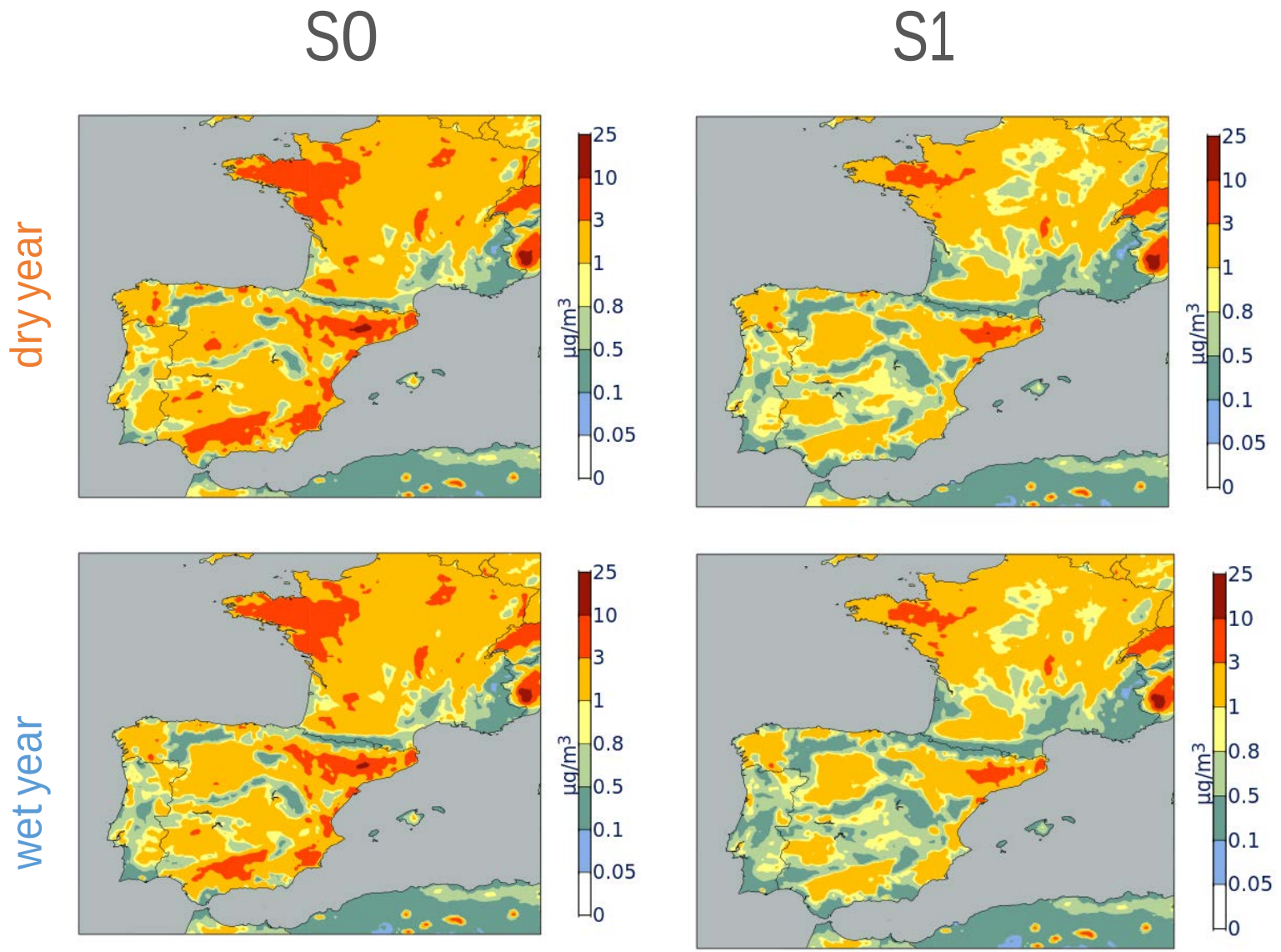
CHIMERE chemistry-transport model

- **0.1° x 0.1° (nested within a European domain at 0.2° x 0.2°)**
- **ECMWF IFS meteorology for 2017 and 2018**

Annual precipitation



NH_3 Mean Air Concentrations

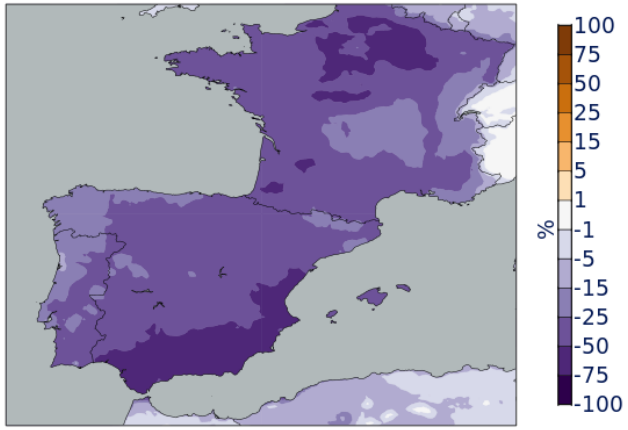


Differences in Mean Air Concentrations

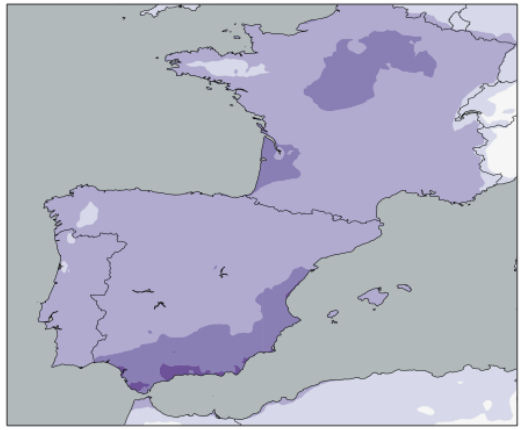
2017 – DRY YEAR

S1-S0

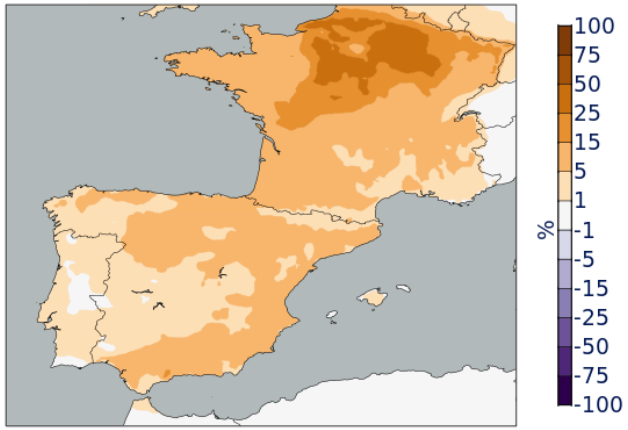
NH_3



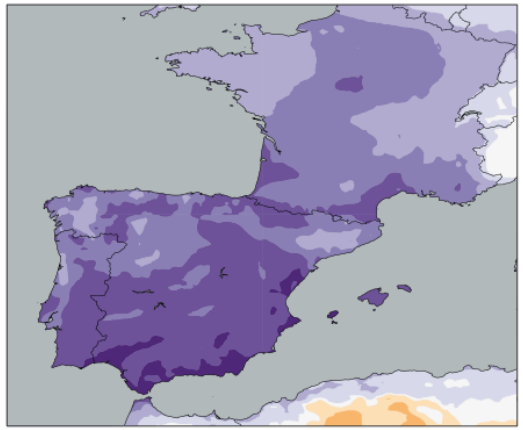
PM ammonium



HNO_3



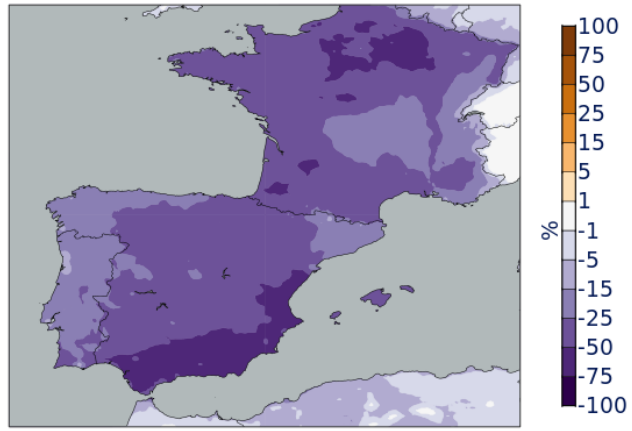
PM nitrate



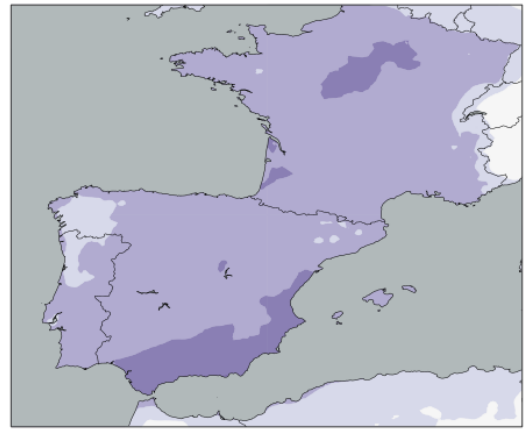
2018 – WET YEAR

S1-S0

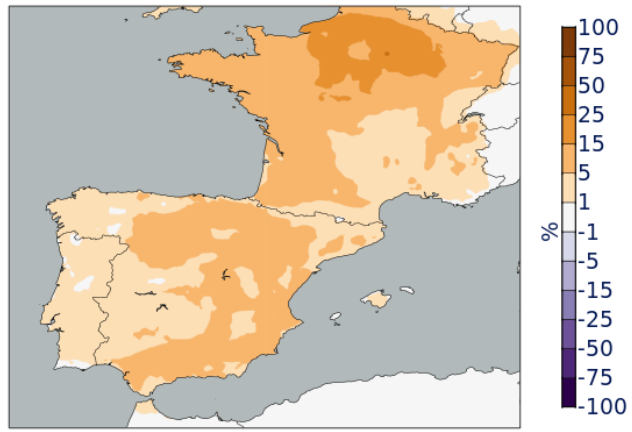
NH_3



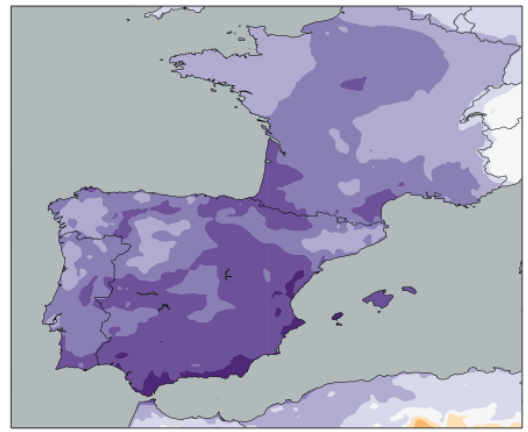
PM ammonium



HNO_3



PM nitrate



Effects on PM, SO_2 and NO_2

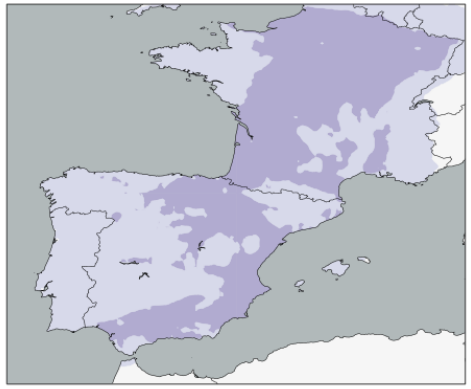
2017 – DRY YEAR

2018 – WET YEAR

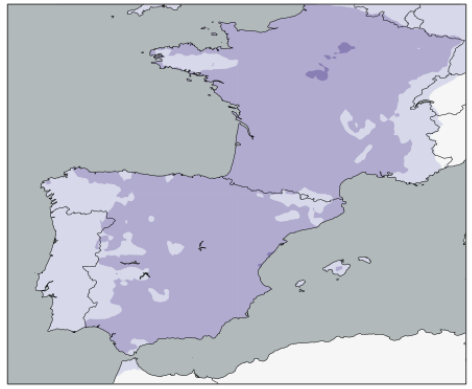
S1-S0

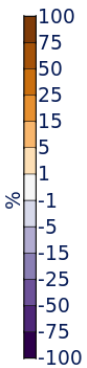
S1-S0

PM10

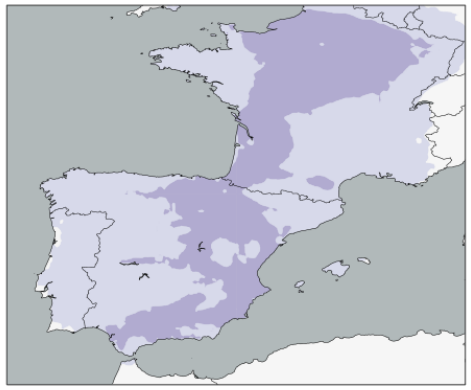


PM2.5

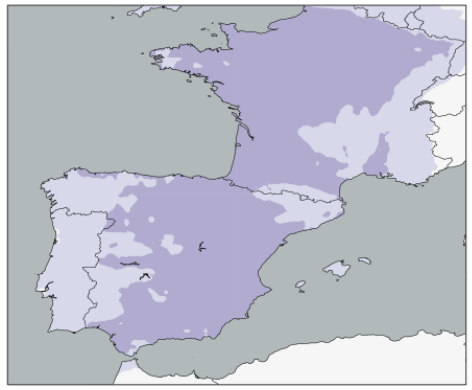


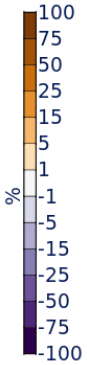


PM10

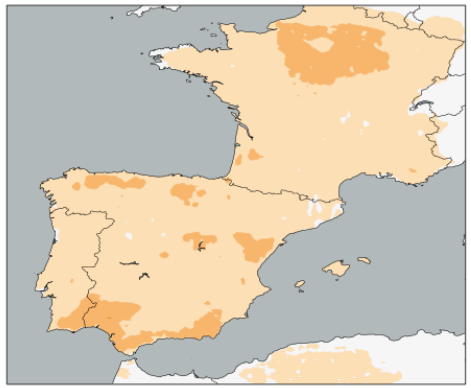


PM2.5

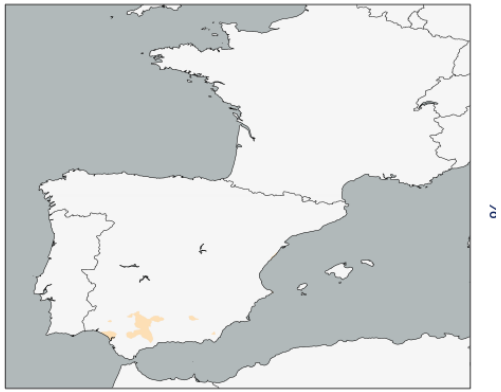


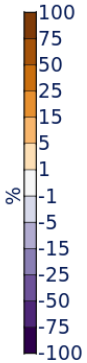


SO_2

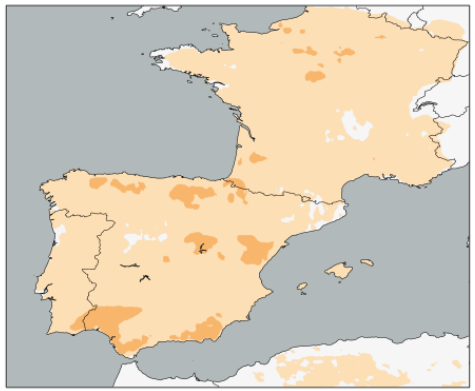


NO_2

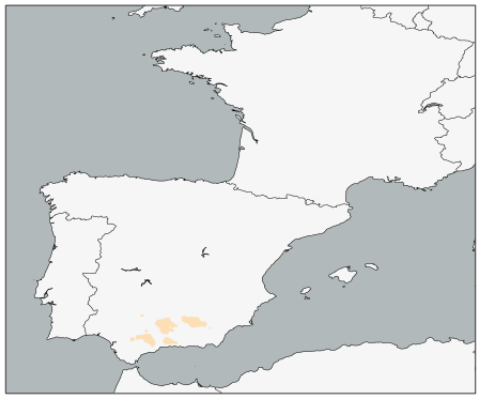


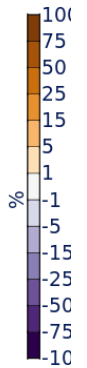


SO_2



NO_2

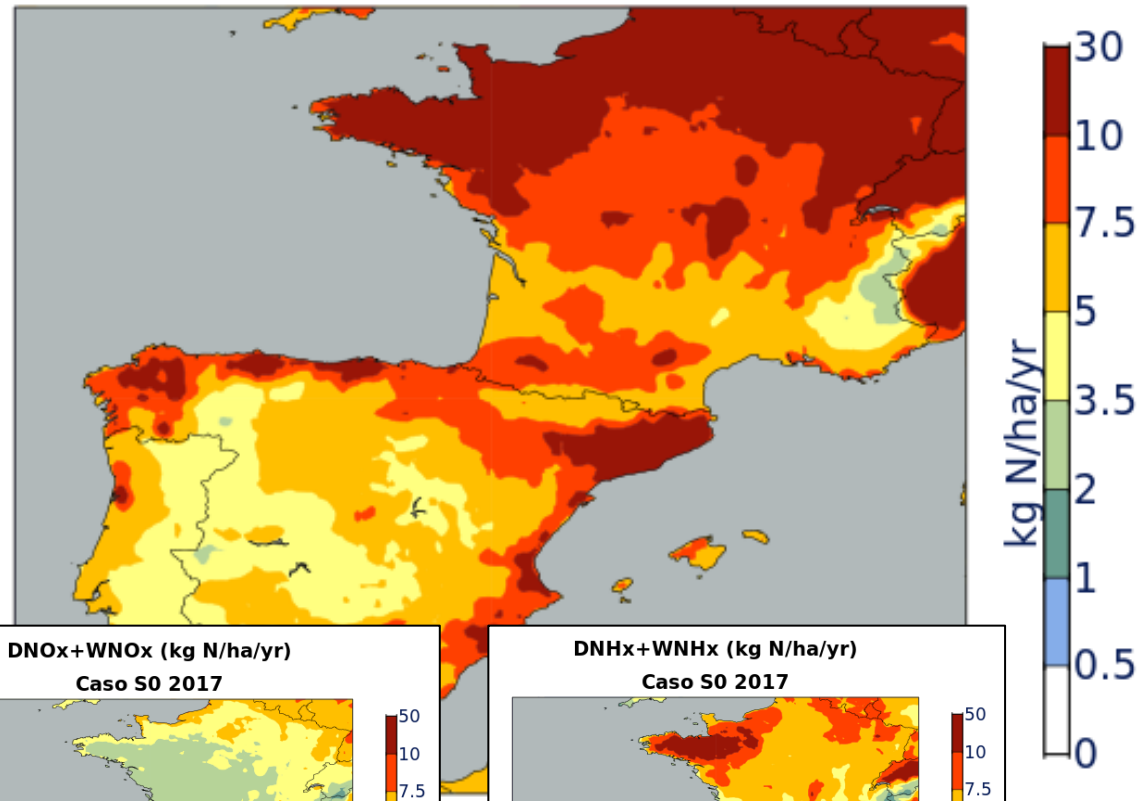


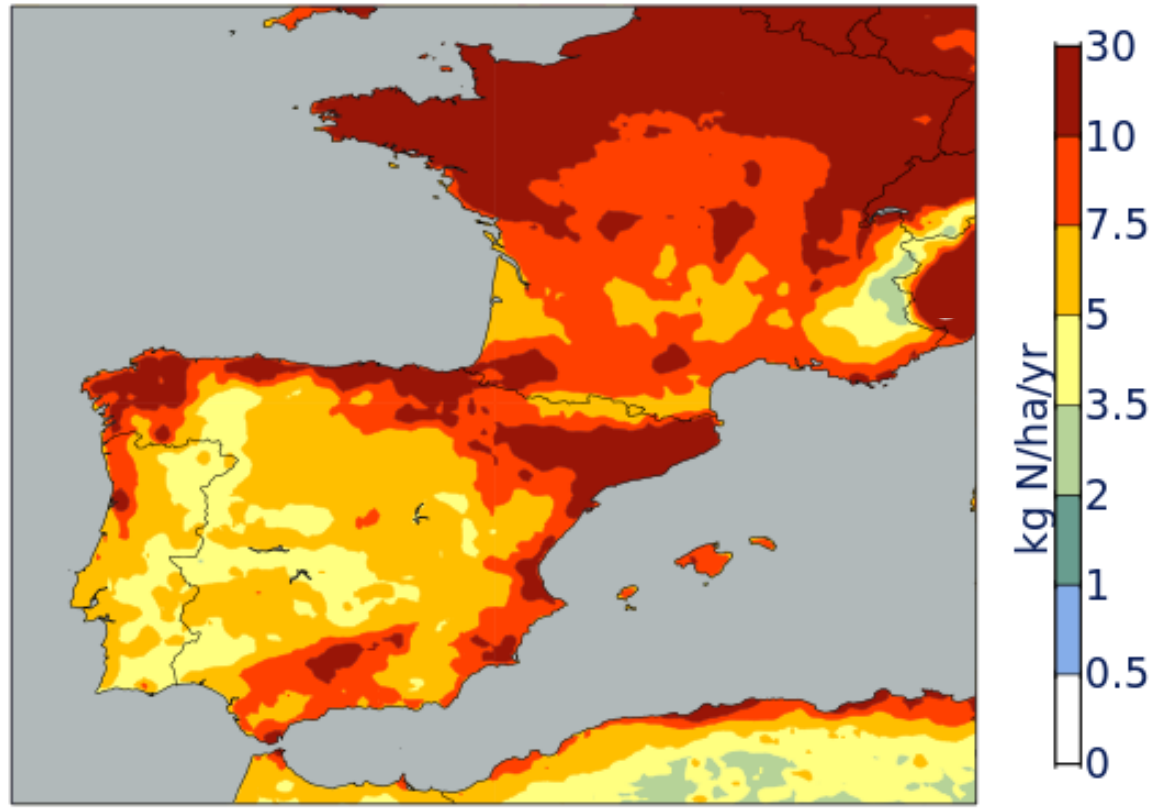


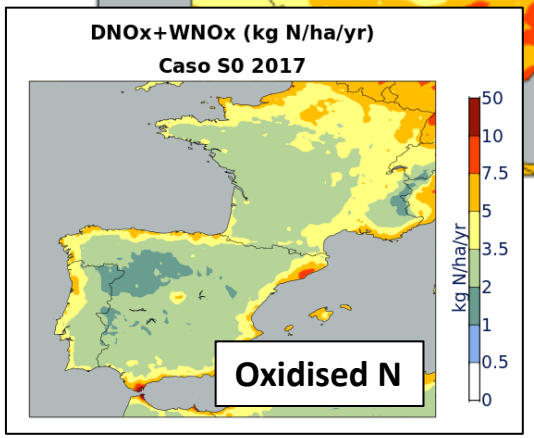
Nitrogen deposition

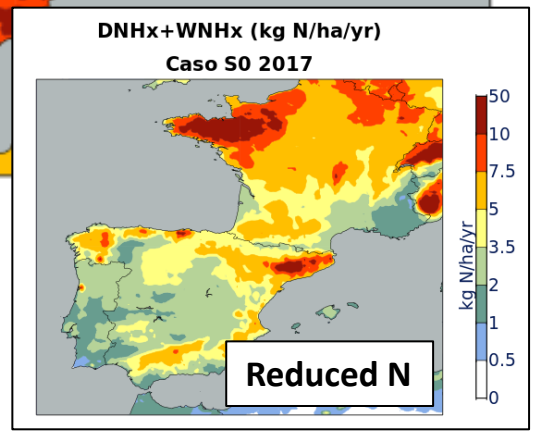
2017 – DRY YEAR **Total N deposition** **2018 – WET YEAR**

S0









Nitrogen deposition

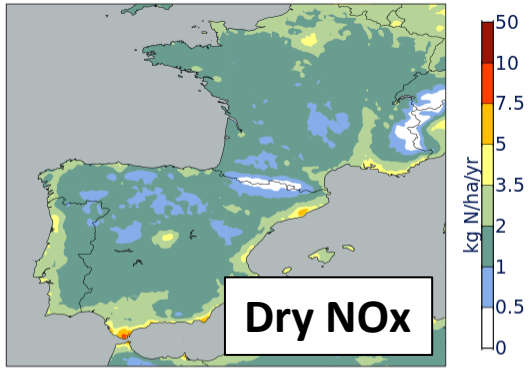
N deposition components

2017 – DRY YEAR

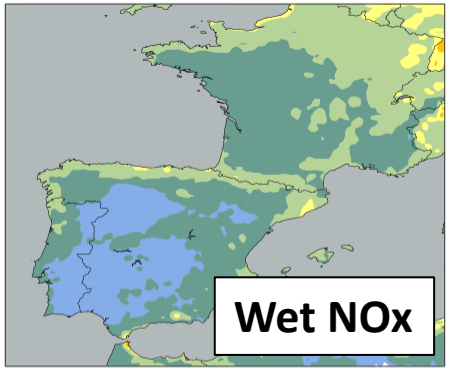
2018 – WET YEAR

S0

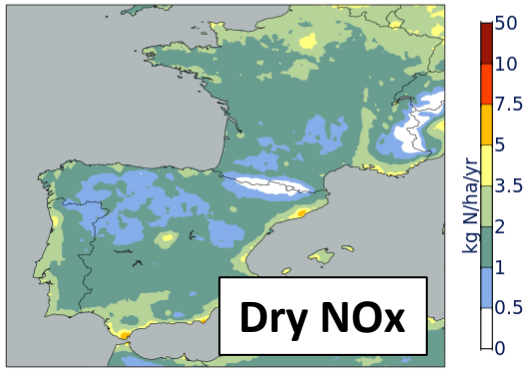
DNOx (kg N/ha/yr)
Caso S0 2017



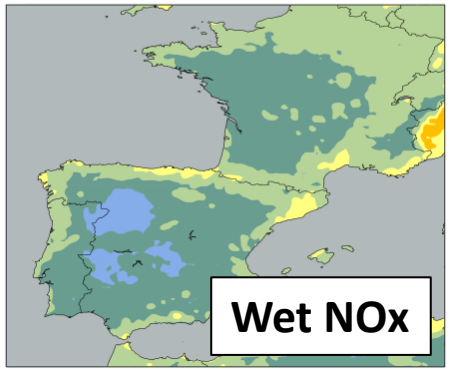
WNOx (kg N/ha/yr)
Caso S0 2017



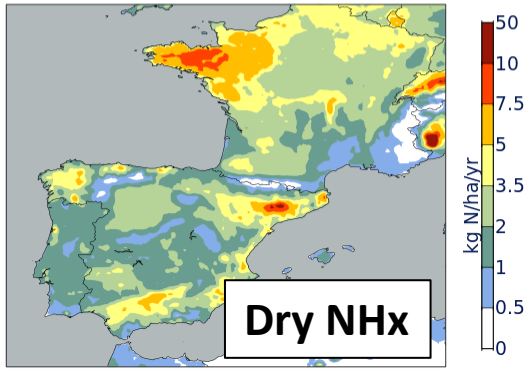
DNOx (kg N/ha/yr)
Caso S0 2018



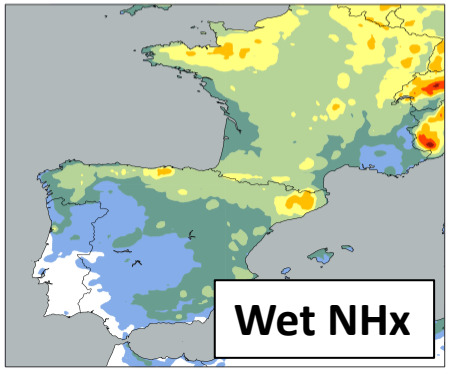
WNOx (kg N/ha/yr)
Caso S0 2018



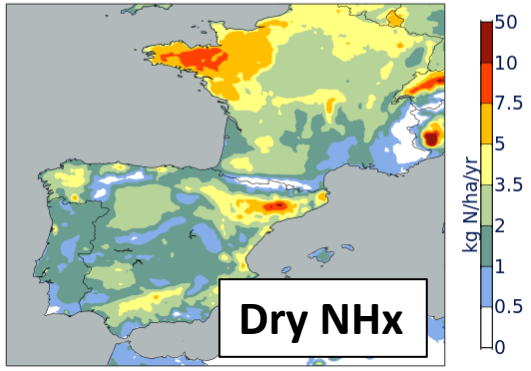
DNHx (kg N/ha/yr)
Caso S0 2017



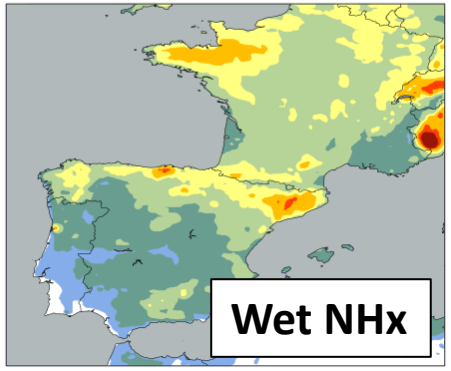
WNHx (kg N/ha/yr)
Caso S0 2017



DNHx (kg N/ha/yr)
Caso S0 2018



WNHx (kg N/ha/yr)
Caso S0 2018



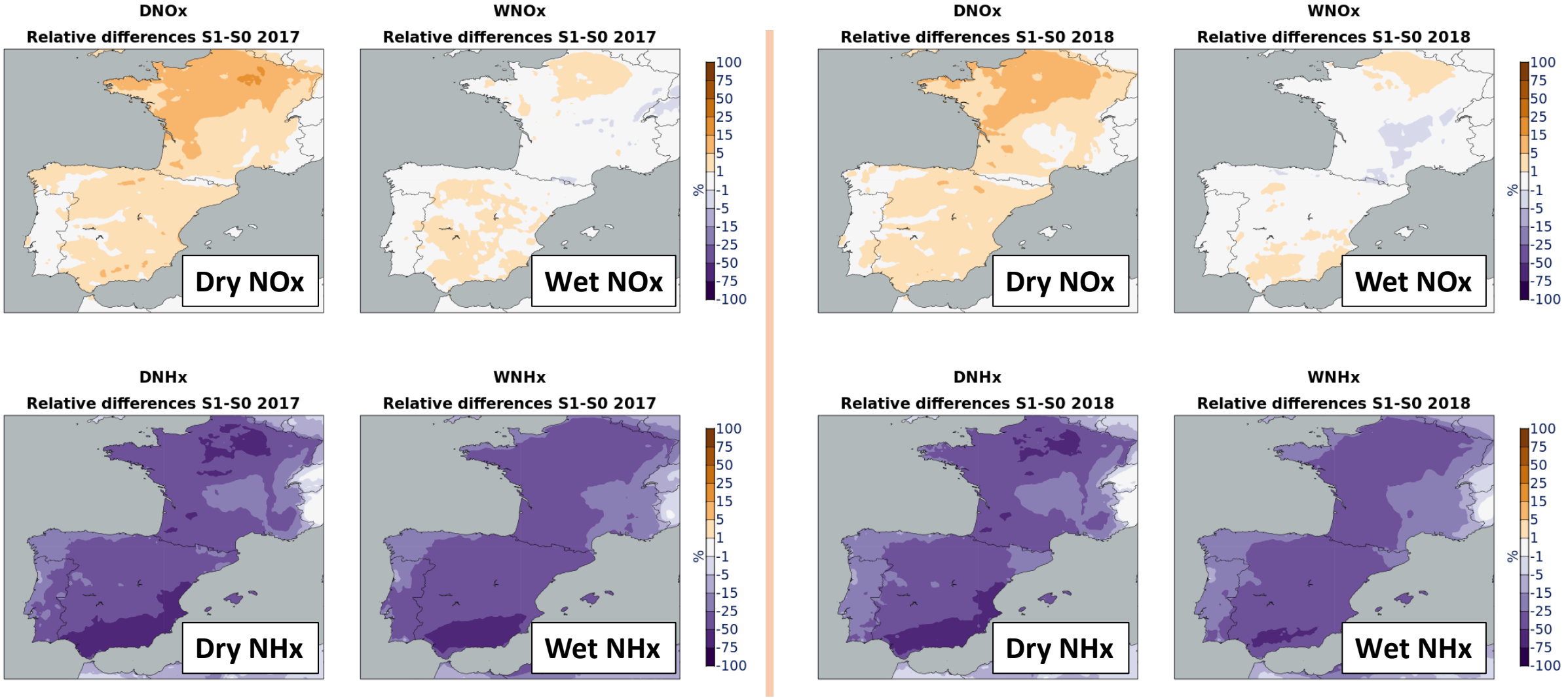
Impact of scenarios on nitrogen deposition components

Changes in N deposition components

2017 – DRY YEAR

2018 – WET YEAR

S1



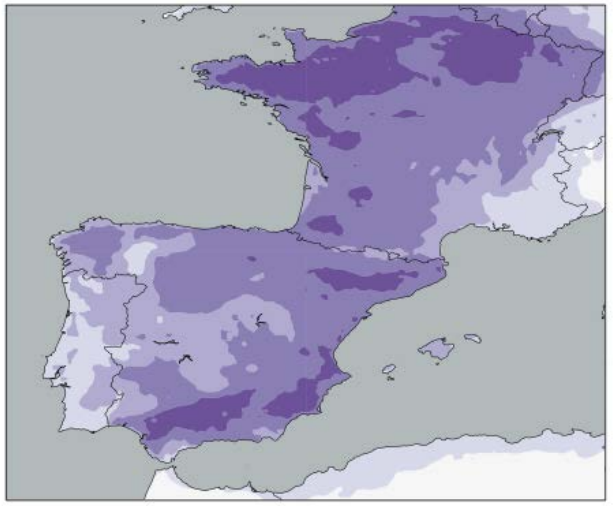
Impact of scenarios on total N deposition

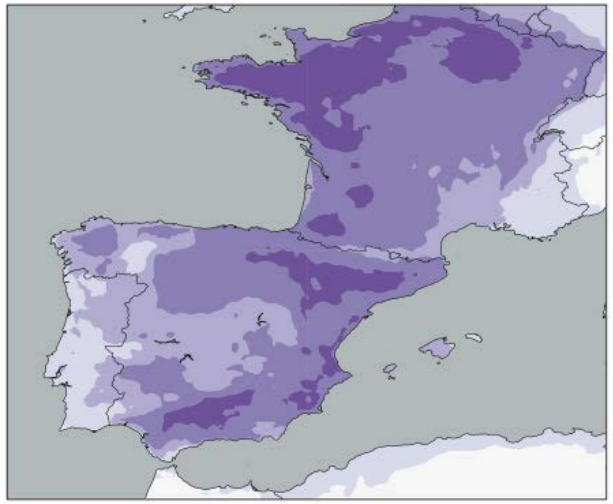
2017 – DRY YEAR

Changes in total N deposition

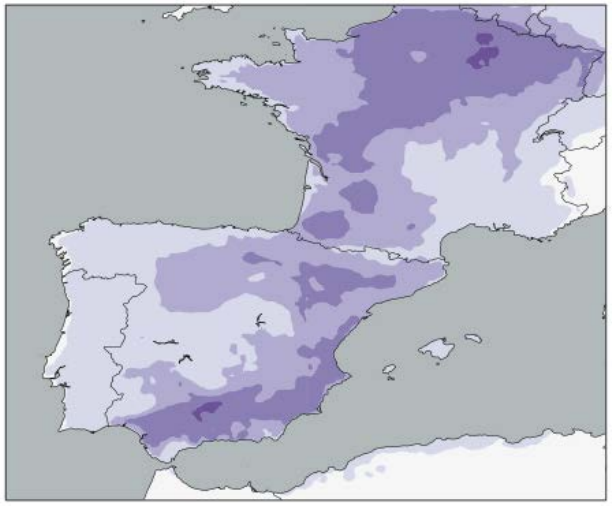
2018 – WET YEAR

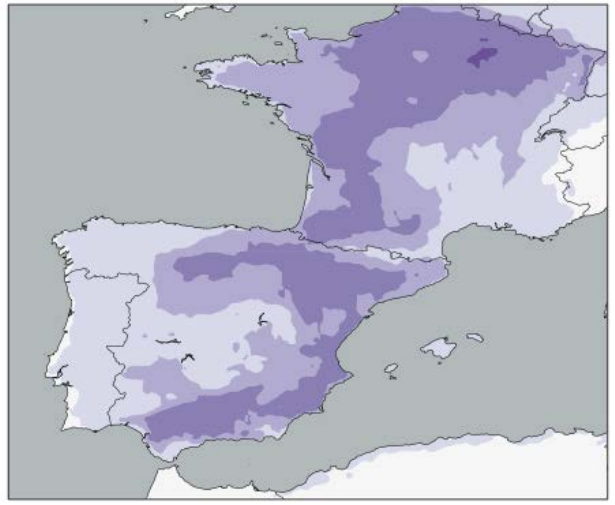
S1

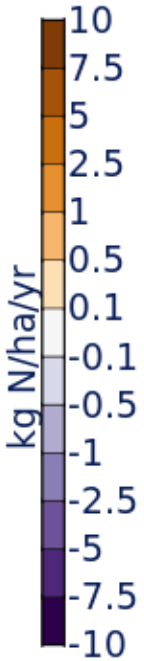


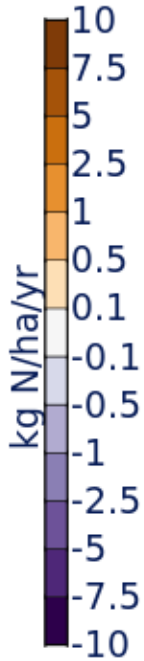


S2







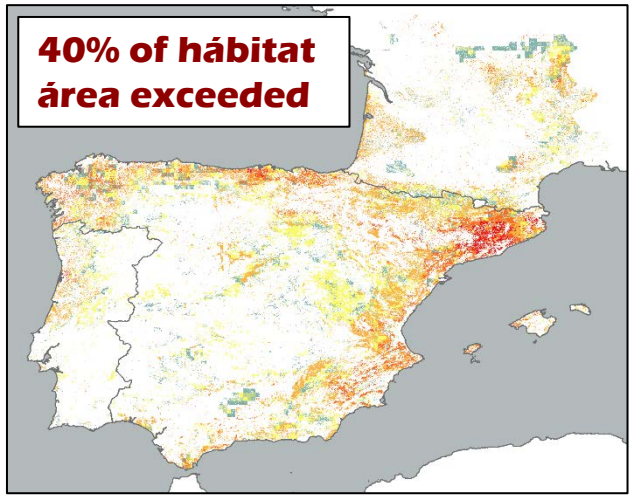


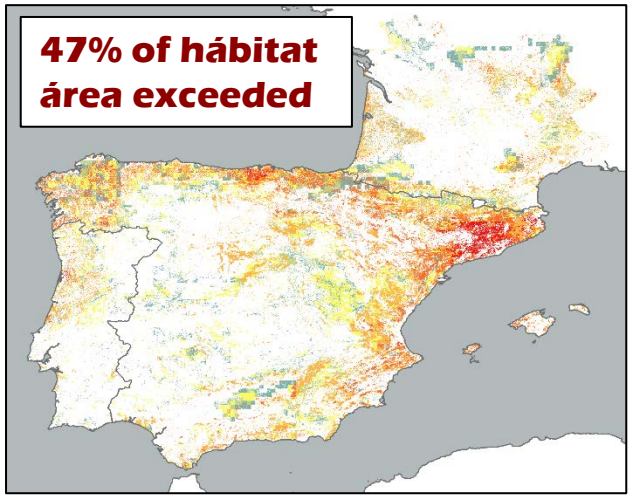
Exceedances of empirical critical loads for nitrogen

2017 – DRY YEAR

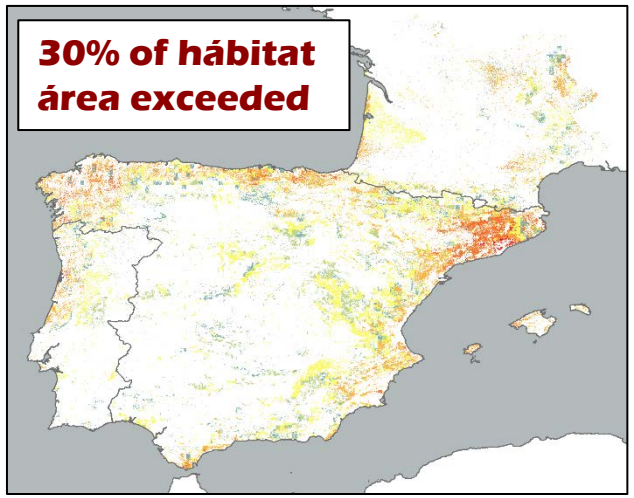
2018 – WET YEAR

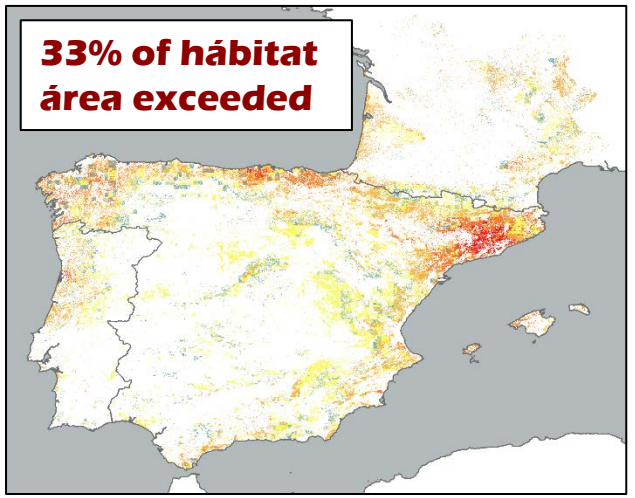
S0





S1





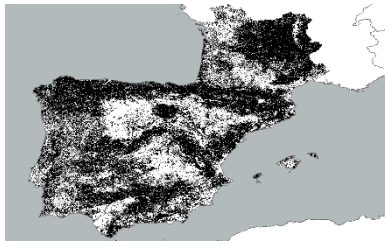
Exceedance (kg N ha^{-1} yr^{-1})

- No exceedance
- 0 – 0.5
- 0.5 – 1.0
- 1.0 – 2.5
- 2.5 – 5
- 5 – 10
- 10 – 25

Exceedance (kg N ha^{-1} yr^{-1})

- No exceedance
- 0 – 0.5
- 0.5 – 1.0
- 1.0 – 2.5
- 2.5 – 5
- 5 – 10
- 10 – 25

Habitat Area

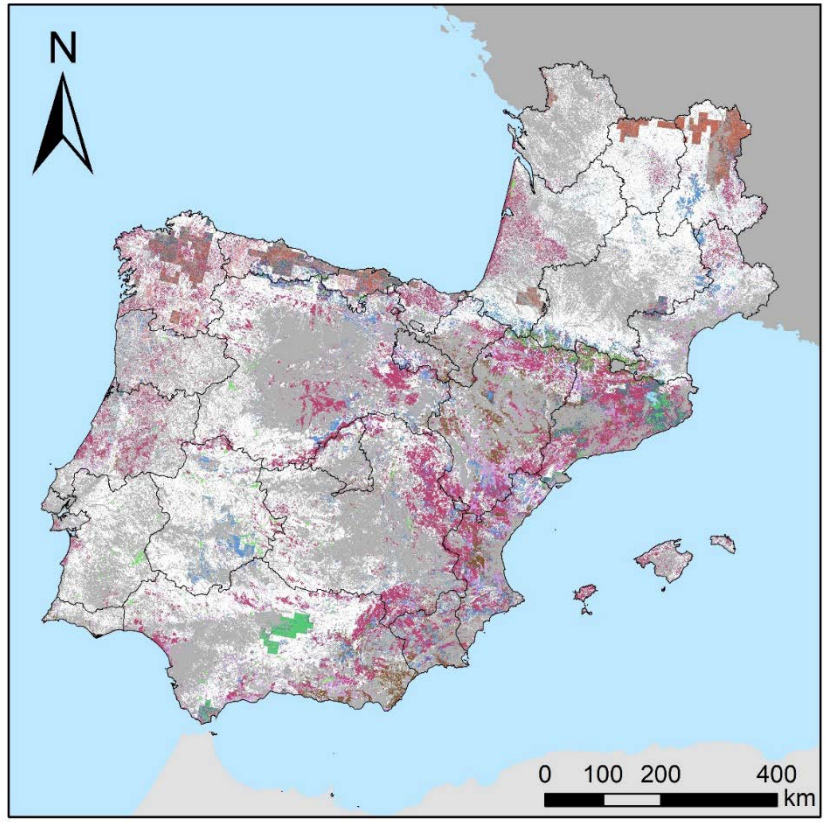


Minimum value of critical load range used / Ecosystem types of Europe. 1:1M. Ecosystem Type Map v3.1 (Technical paper N° 11/2018; EEA)

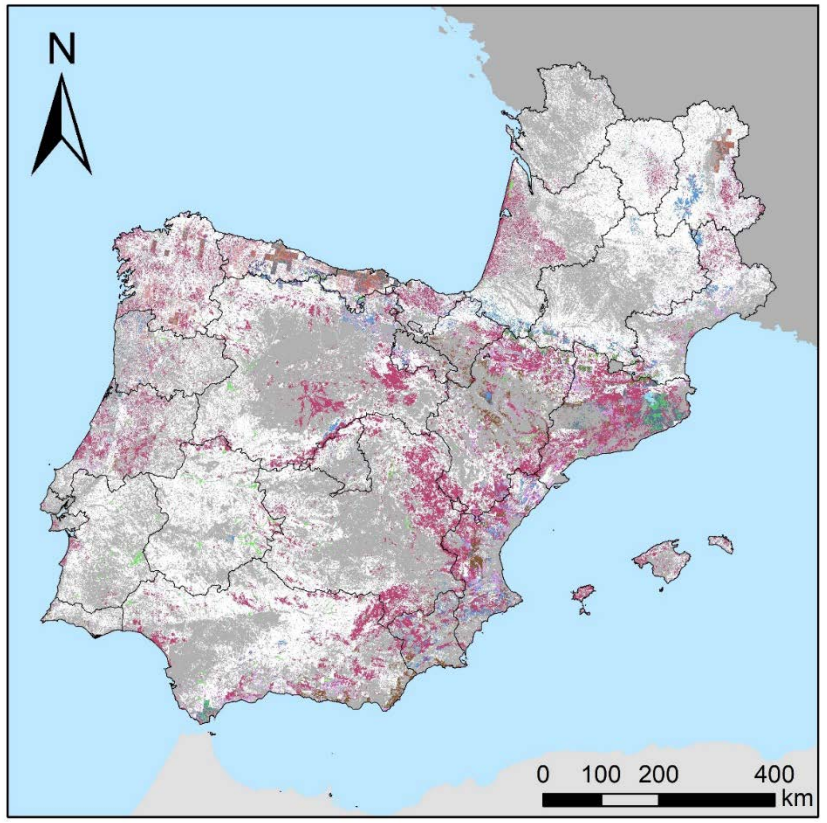
Areas at risk to N deposition

2017 – DRY YEAR

S0



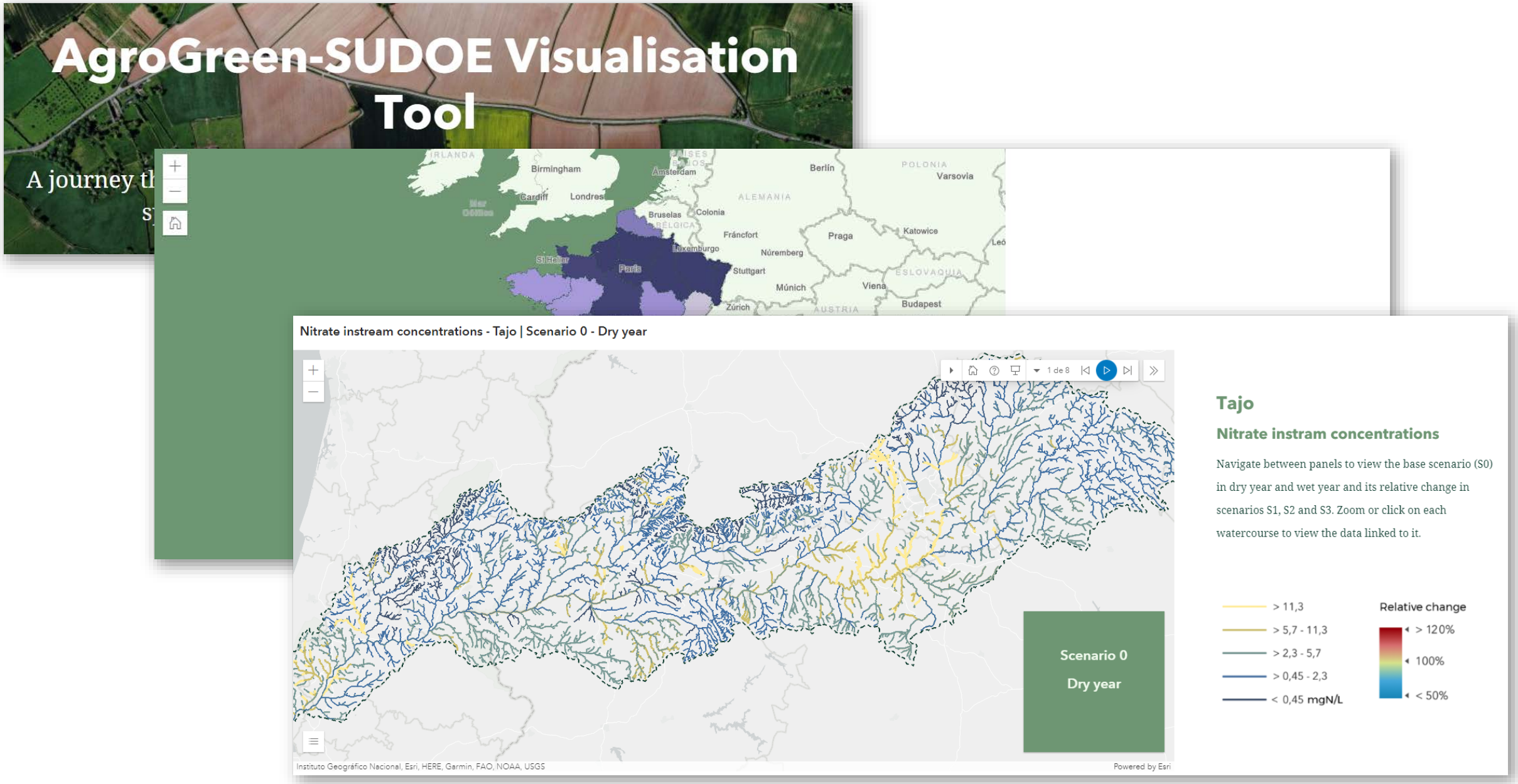
S1



EUNIS

- B1 Coastal dunes and sandy shores
- C1 Surface standing waters
- D1 Raised and blanket bogs
- D2 Valley mires, poor fens and transition mires
- D4 Base-rich fens and calcareous spring mires
- E1 Dry grasslands
- E2 Mesic grasslands
- E3 Seasonally wet and wet grasslands
- E4 Alpine and subalpine grasslands
- F2 Sparsely wooded grasslands
- F3 Arctic, alpine and subalpine scrub
- F4 Temperate and mediterranean-montane scrub
- F5 Temperate shrub heathland
- F6 Maquis, arborescent matorral and thermo-Medit. brushes
- G1 Garrigue
- G2 Broadleaved deciduous woodland
- G3 Broadleaved evergreen woodland
- G4 Coniferous woodland
  Mixed deciduous and coniferous woodland

AgroGreen-SUDOE Visualisation Tool



https://agrogreensudoe.org/en/impact-visualizer/

Summary

- Simulations with the CHIMERE chemistry model have been used to estimate the impacts of selected NH_3 emission abatement scenarios (fertiliser application) in SW Europe
- The scenarios are estimated to reduce NH_3 and PM concentrations and increase HNO_3 and SO_2 concentrations
- The impacts of the scenarios on concentrations are slightly larger for a dry year compared with a wet one
- Although exceedances of the NH_3 critical levels (concentrations) are reduced in the scenarios, they are still expected to occur throughout SW Europe (need livestock measures)
- Total N deposition is larger for the wetter year (more wet deposition)
- The impacts of the scenarios on total N deposition is slightly larger for a dry year compared with a wet one (in relative terms)
- Even without measures for livestock (or NOx), the NH_3 emission abatement scenarios substantially reduce exceedances of critical loads in SW Europe

Thank you!

Funding:

Collaboration:

https://agrogreensudoe.org/en/impact-visualizer/