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**FAIRMODE Technical Meeting
WG4 - Planning**

**Testing the Atmospheric Evaluation and
Research system for Spain (AERIS) with
the Delta & FAIRMODE planning tools**

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The AERIS model



- **AERIS** is an air pollution Integrated Assessment Model conceived for Spain and the Iberian Peninsula.
- Addresses **air quality variations** (policy-relevant indicators) as a function of **percentual variations in emissions** against a **reference scenario**.
- **Multi – pollutant** approach: SO_2 , NO_2 , NH_3 , PM_{10} , $\text{PM}_{2.5}$. Describes formation of O_3 and secondary particles.
- Based in the SIMCA – SERCA modeling system: **WRF – SMOKE – CMAQ**.
- Constructed with emissions from the **2007 National Emission Inventories of Spain and Portugal**. **Reference scenario. Activity peak**.

The AERIS model



- **Domain size:** 960 × 1200 km.
- **Cell size:** 16 km. 4500 cells.
- **Domain center:** 40°N, 3°W
- **Spain and Portugal.** Parts of France, Morocco and Algeria.



Provides results for:

- **NO₂ highest 19th hourly concentration**
- **NO₂ annual mean**
- **PM₁₀ highest 36th daily concentration**
- **PM₁₀ annual mean**

Evaluation of Scenarios



In order to run the tool, the following scenarios were produced with respect to a baseline scenario (AERIS 2007 CLE):

- **Scenario 01:** -20% reduction of NO_x
- **Scenario 02:** -20% reduction of SO_x (SO_2)
- **Scenario 03:** -20% reduction of NH_3
- **Scenario 04:** -20% reduction of PPM
- **Scenario 05:** -20% reduction of VOC
- **Scenario 06:** -20% reduction of all precursors

- **Scenario 07:** -50% reduction of NO_x
- **Scenario 08:** -50% reduction of SO_x (SO_2)
- **Scenario 09:** -50% reduction of NH_3
- **Scenario 10:** -50% reduction of PPM
- **Scenario 11:** -50% reduction of VOC
- **Scenario 12:** -50% reduction of all precursors

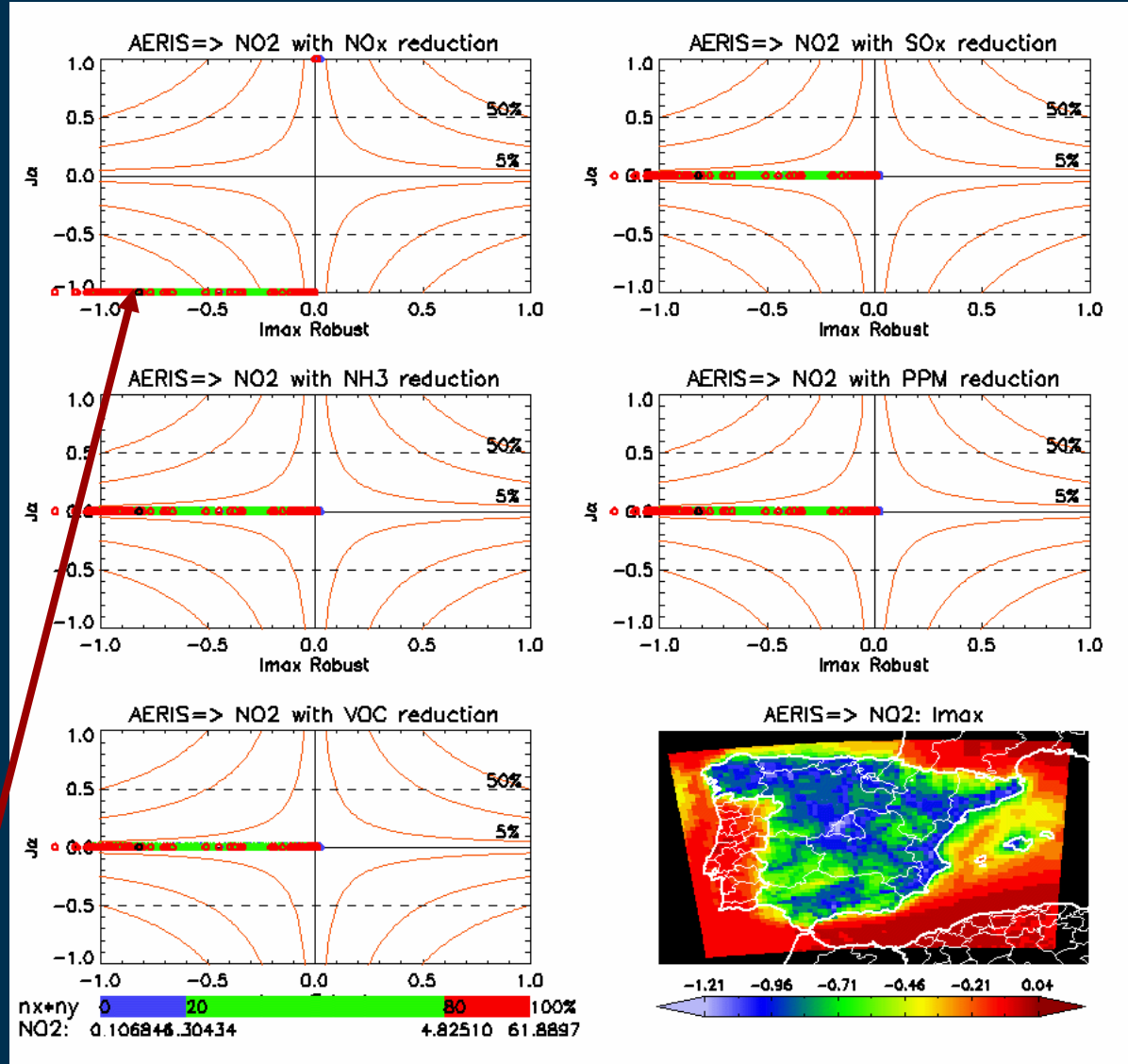
Planning Tool Results



Results for NO₂

- The NO₂ concentration in AERIS depends only on NO_x changes ($J_{\alpha}^k=0$).
- National domain – points dominated by local effects and other by regional effects (see Madrid).
- I_{max} values < -0.46 for most cells within Spain.
- I_{max} values > -0.21 for most cells in Portugal, France and North Africa.

Madrid



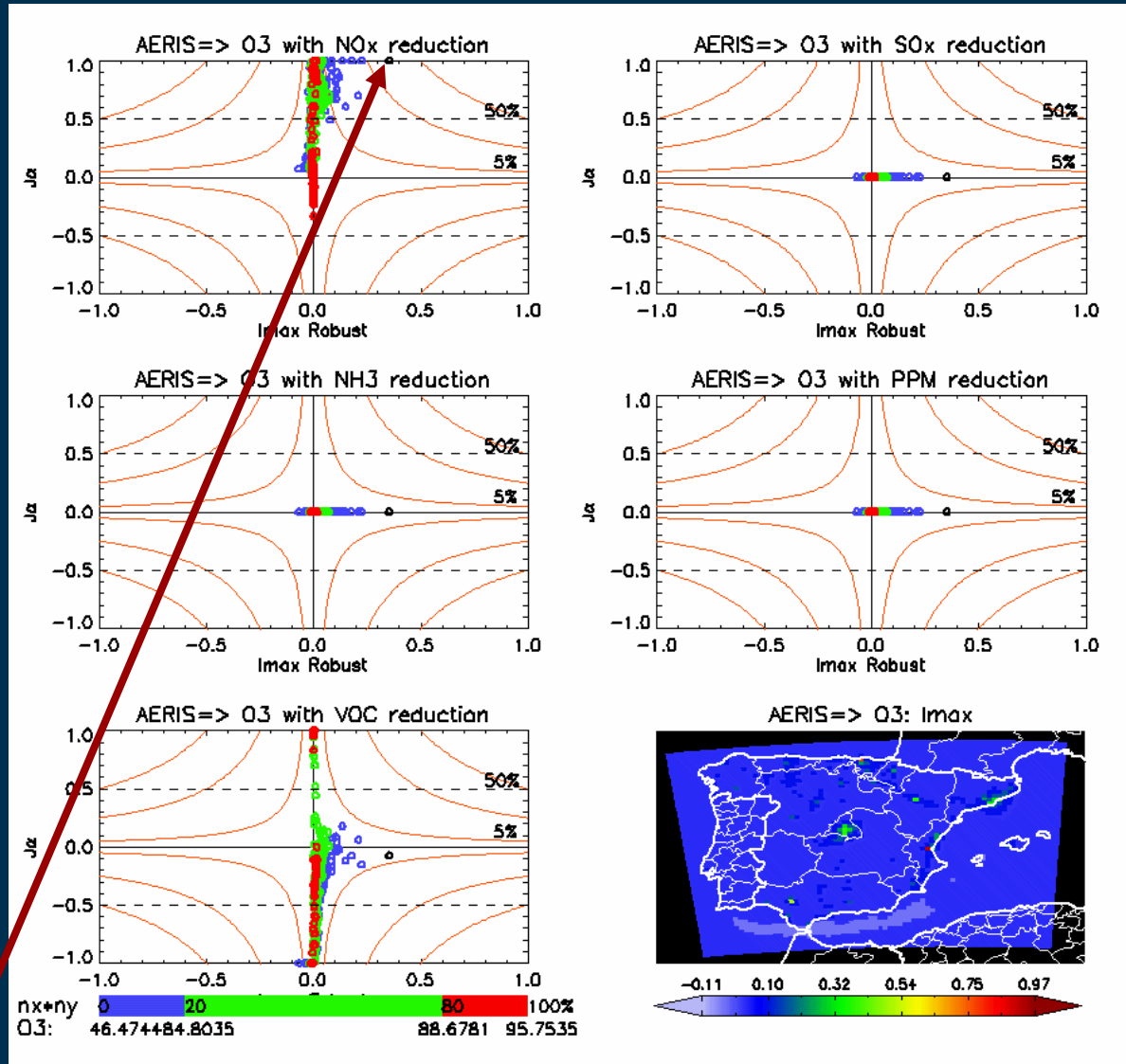
Planning Tool Results



Results for O_3

- The O_3 concentration in AERIS depends on marginal changes in NO_x and VOC ($J_{\alpha}^k \neq 0$).
- National domain – O_3 chemistry in AERIS is determined by BC from CMAQ (regional background). High dominated regimes.
- I_{max} values > -0.11 for all cells within the domain.
- I_{max} values > 0.32 for Madrid, Valencia, etc. (titration effect).

Madrid



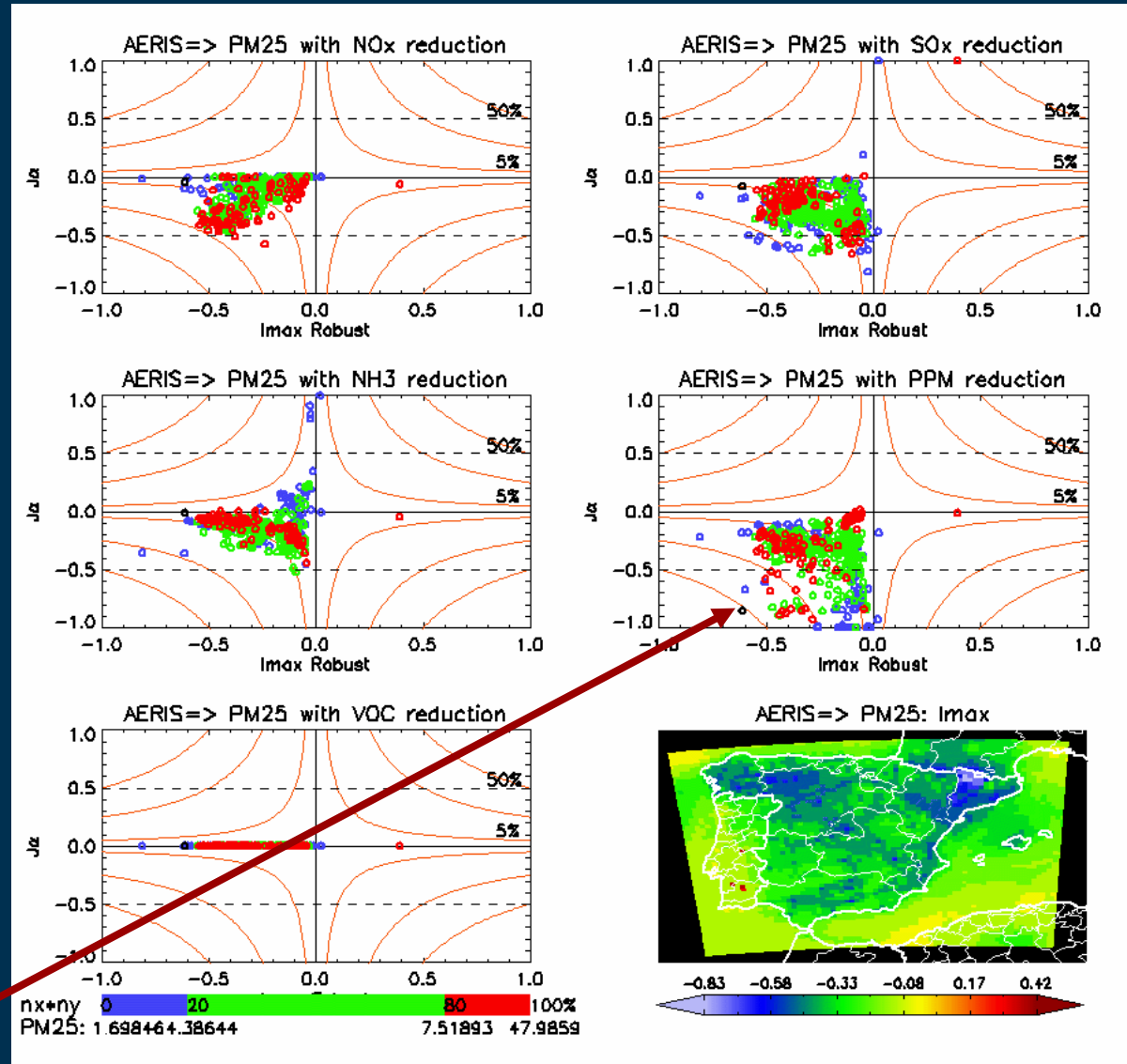
Planning Tool Results



Results for PM_{2.5}

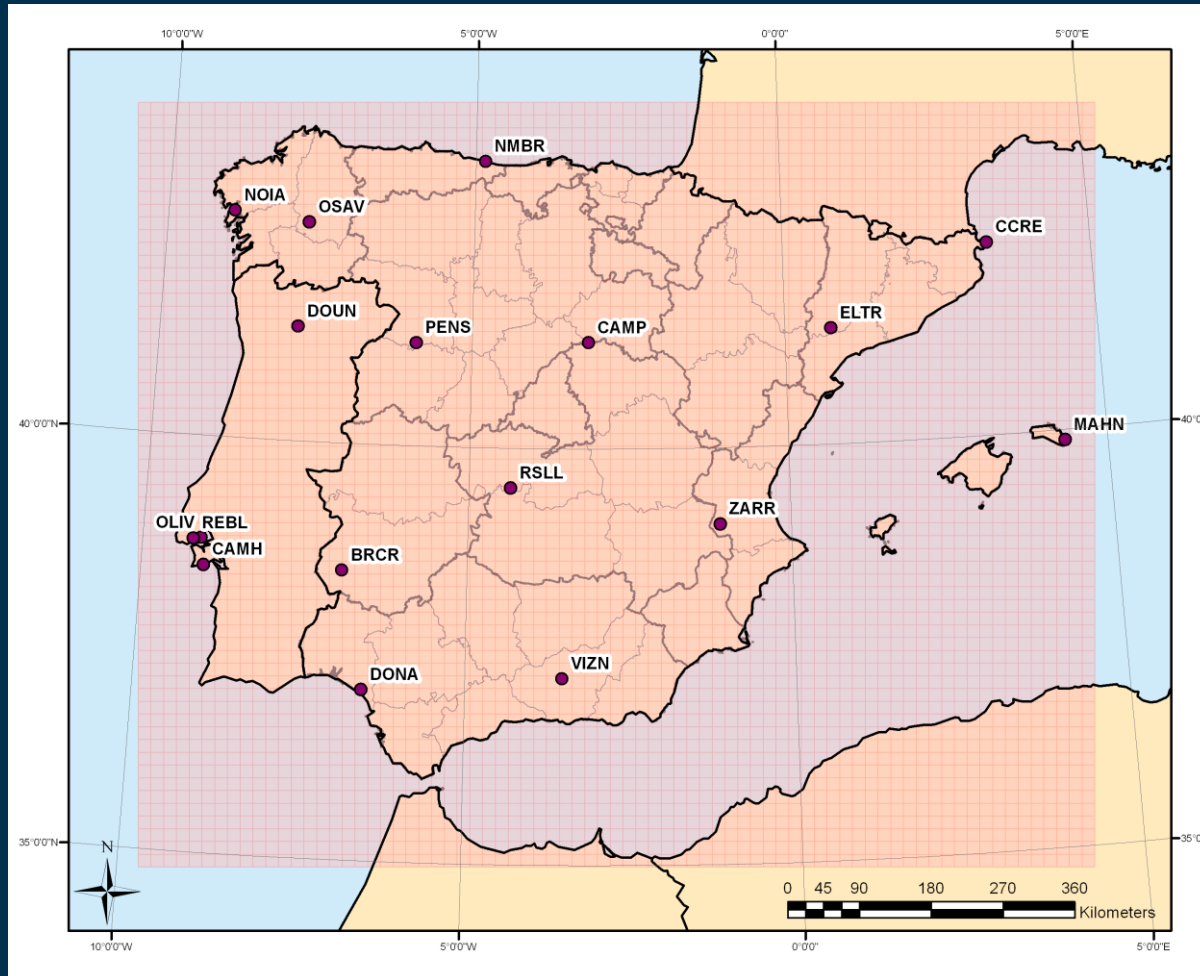
- The PM_{2.5} concentration in AERIS depends on changes in PPM as well as NO_x, SO_x and NH₃ ($J_{\alpha}^k < 0$).
- Regions such as Catalonia, Castilla-Leon and Madrid exhibit local effects (related to agriculture and traffic).
- I_{max} values < -0.08 for almost all cells within the domain.
- I_{max} values < -0.5 for urban centres.

Madrid



Monitoring Stations

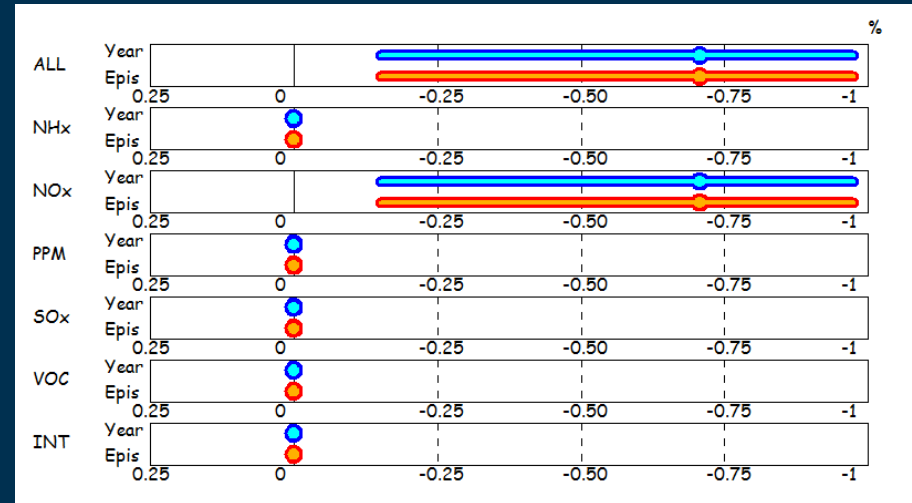
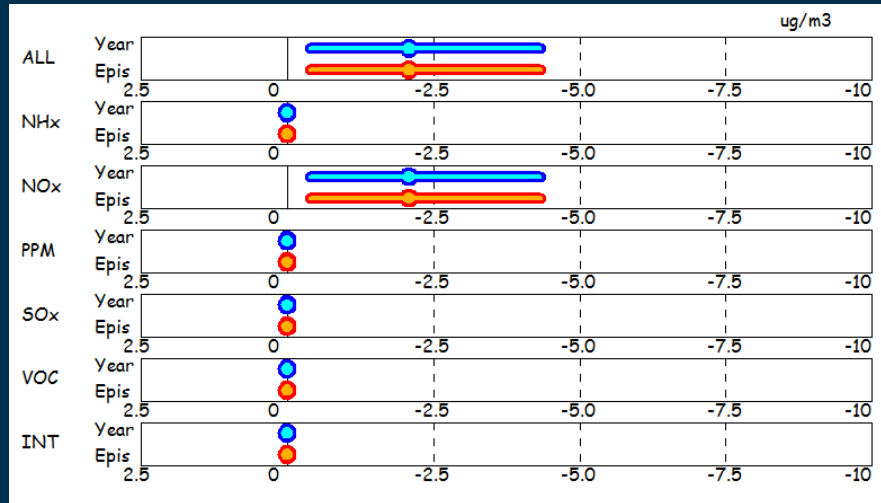
Air Quality Monitoring Stations in Spain (EMEP Network).



- All background locations.
- Representative of the domain scale.
- Stations in Portugal were not considered.
- Measurements from 2007 for the 3 studied pollutants.

Delta Tool Results

Results for NO₂

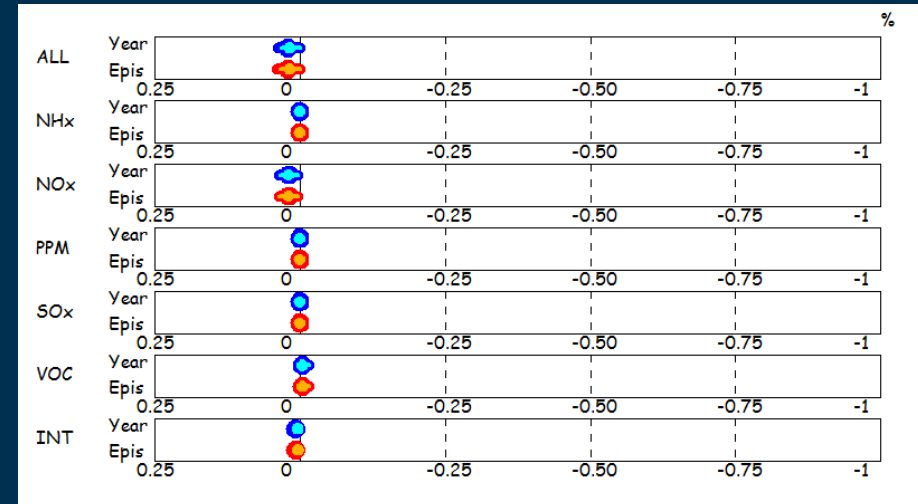
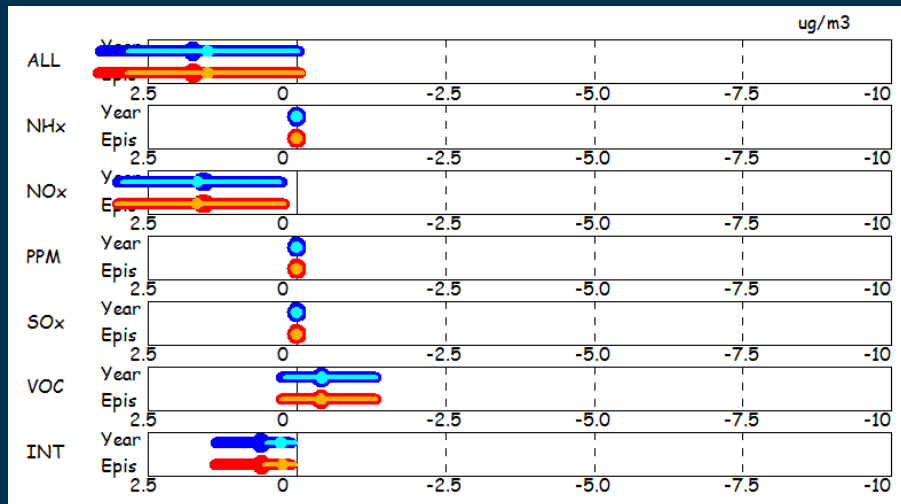


- In AERIS, the main contribution in the formation of NO₂ is due to changes in NO_x emissions.
- The formation of NO₂ is very linear as the potentials computed for 2 different reduction levels are similar. No interactions.
- Episode and annual values are identical because AERIS does not provide hourly concentrations of NO₂, but rather annual averages.

Delta Tool Results



Results for O_3

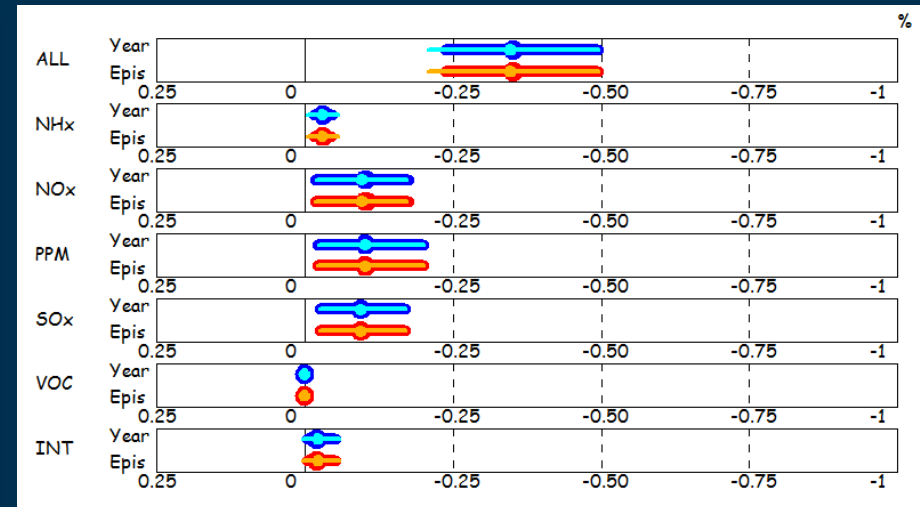
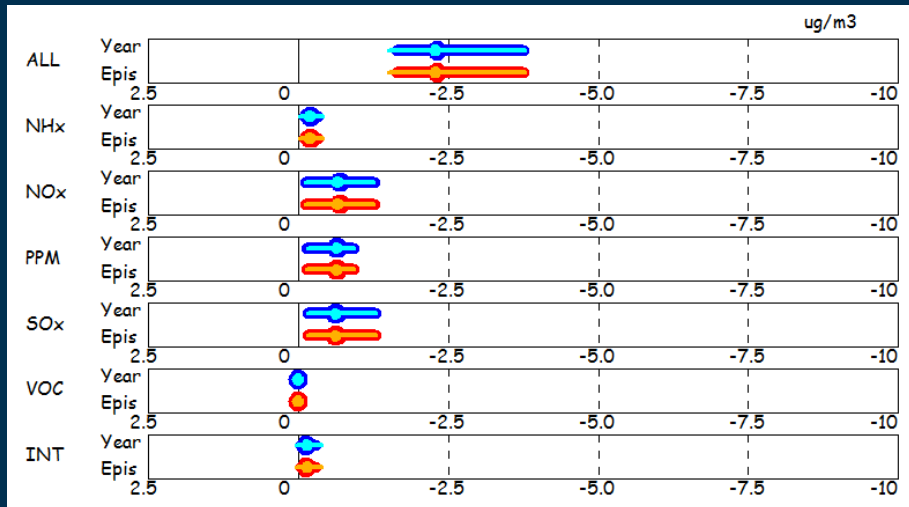


- In AERIS, O_3 formation is caused by NO_x and VOCs exclusively.
- The positive potential in NO_x means that its contribution is negative – VOC limited regime. Reductions in VOC emissions reduce O_3 concentrations.
- Small relative potentials indicate that the contribution of NO_x /VOC emission reductions to O_3 concentrations is small. WRF-CMAQ estimates high concentrations of O_3 due to regional boundary conditions.

Delta Tool Results



Results for $PM_{2.5}$



- The main contributors to $PM_{2.5}$ formation in AERIS are **PPM, NO_x and SO_x** .
- Marginal contribution of **NH_3** to the formation of $PM_{2.5}$.
- The formation of $PM_{2.5}$ is **very linear** – potentials for 2 different reduction levels are very similar and the **interaction terms are very low**.

Final Remarks



- The **Planning** and **Delta tool** were useful resources for analysing the interactions between pollutants that the **AERIS** Integrated System considers.
- The **effect of emission changes** in the **concentration** of pollutants in AERIS is **mainly linear**. This is **consistent** with the initial formulation of the integrated assessment model as a (linear) simplification of the **WRF-CMAQ** model ensemble of the SERCA project.
- Main **limitation** of the analysis: the possibility of retrieving an **individual value** for each of the cells in the modelling grid at a time (**annual average**). No hourly profiles available.
- In the **near future**, a **comparison** between the performance of **AERIS** and its **parent air quality model** (WRF-CMAQ) will be carried out with the Delta tools to assess **similarities** in its diagnostic accuracy and performance.
- Using and configuring the Planning and Delta tool was not straightforward and required **substantial guidance** from developers, especially during the **preparation of input files**.



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END

Thank you for your attention!

Delta Tool Results



AERIS estimates against WRF-CMAQ for O_3

