**Table A1.** GNFR sectors with their description.

| GNFR | Code | Description |
|---|---|---|
| 1 | A_PublicPower | Emissions from plants producing electricity and/or heat for the public grid. |
| 2 | B_Industry | Emissions from combustion and processes in industry. |
| 3 | C_OtherStationaryComb | Emissions from small combustion sectors, e.g. commercial, institutional, residential and agricultural. |
| 4 | D_Fugitives | Fugitive emissions associated with production, refining, transport and storage of fuels. |
| 5 | E_Solvents | Emissions from the use of solvents. |
| 6 | F_RoadTransport | Emissions from road transport. |
| 7 | G_Shipping | Emissions from domestic navigation, i.e. navigation between two domestic ports. Fishing is included under I_OffRoad. |
| 8 | H_Aviation | Emissions from landing and take-off (LTO) both for domestic and international flights. |
| 9 | I_OffRoad | Emissions from machinery used in industry, households, agriculture as well as from railways and fishing vessels. |
| 10 | J_Waste | Emissions associated with waste handling. Waste incineration with energy recovery is included under A_PublicPower or B_Industry. |
| 11 | K_AgriLivestock | Emissions associated with animal husbandry and manure management. |
| 12 | L_AgriOther | All other agricultural emissions, e.g. from application of mineral or organic fertilizer, crops and field operations. |
| 13 | N_Natural | Emissions from natural sources, e.g. volcanoes, forest fires, etc. |
| 14 | O_AviCruise | Emissions from the cruise phase of both domestic and international flights. |
| 15 | P_IntShipping | Emissions from international navigation. |
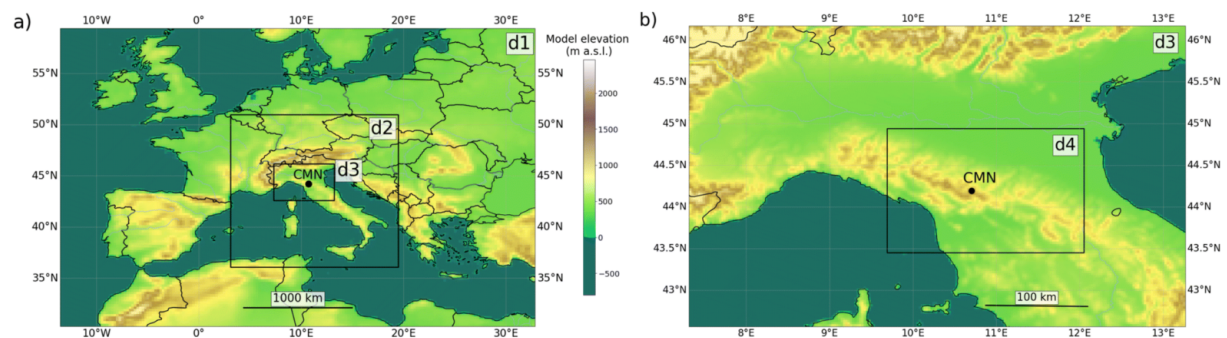
**Figure A1.** a) Position and topography (color shading) of the model domains d1 (27 km resolution), d2 (9 km resolution) and d3 (3 km resolution), (b) zoom-in of domains d3 and d4 (1 km res.). The dot indicates the location of the measurement station. From Vitali et al., 2024.
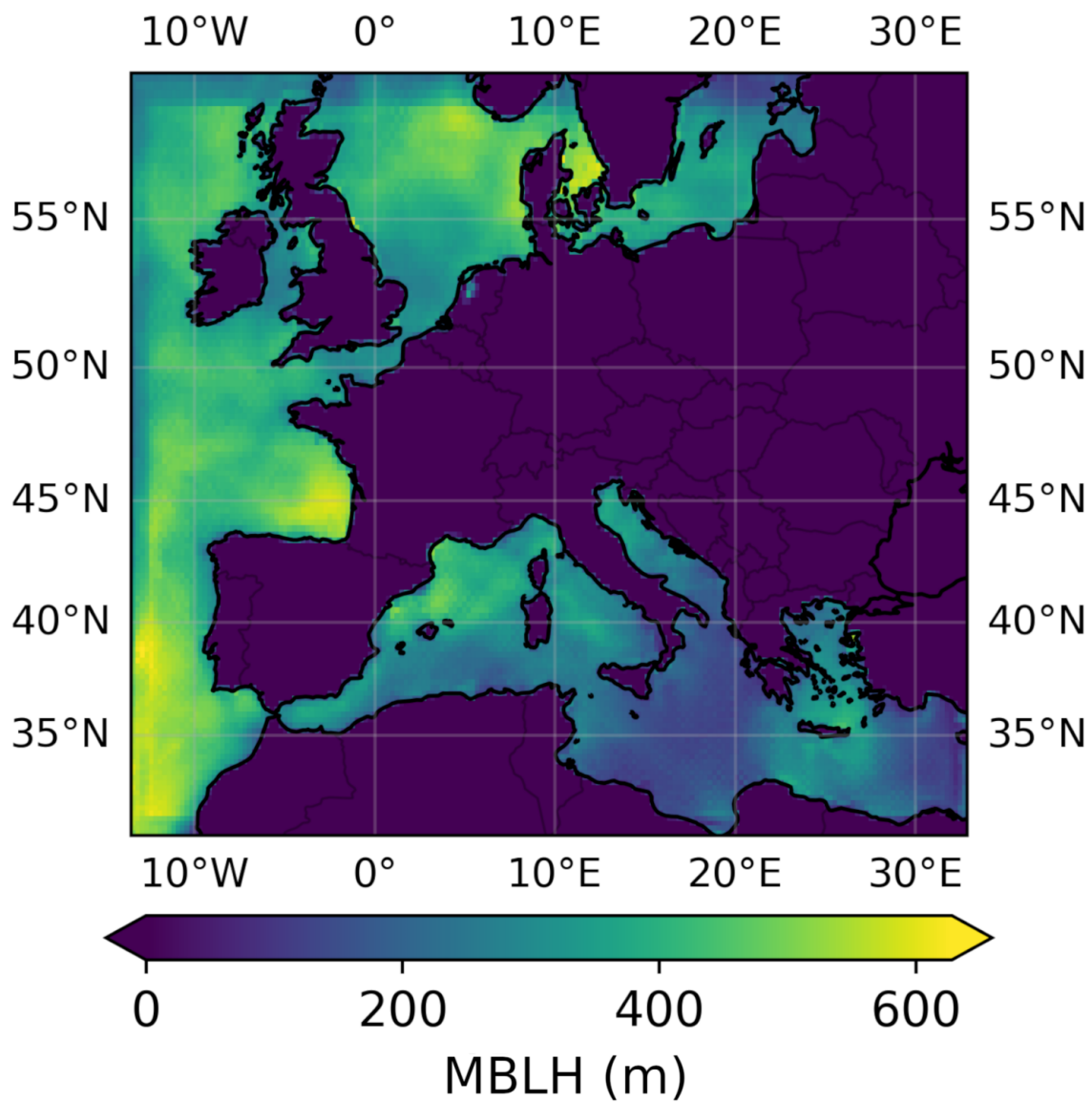
**Figure A2.** Average marine boundary layer height (MBLH) as calculated by WRF.
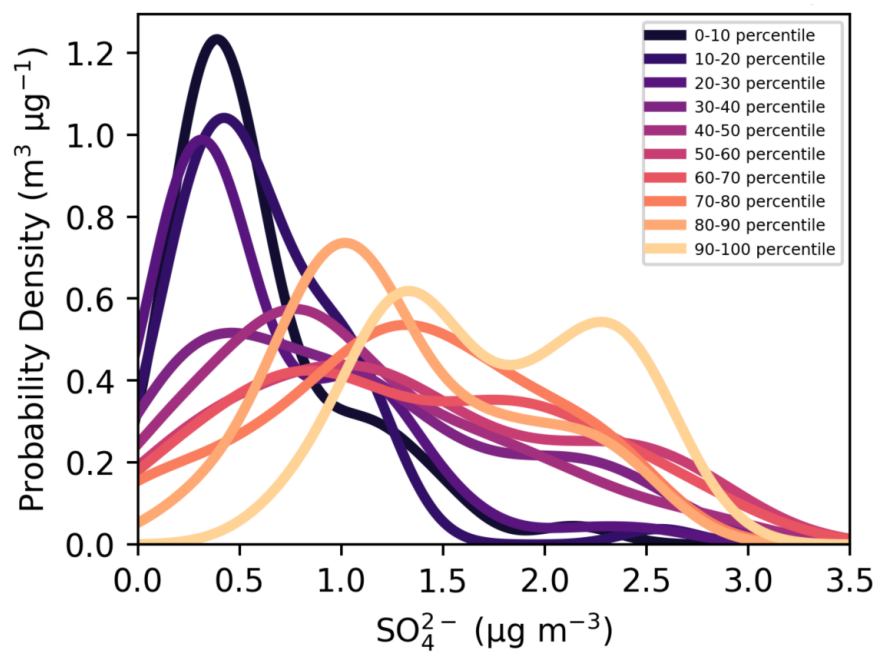
**Figure A3.** $SO_4^{2-}$ distribution at CMN based on the number of hours air masses spent above the sea (below 500 meters altitude) during the 72 hours prior to reaching the site. Each categories represent a decile.
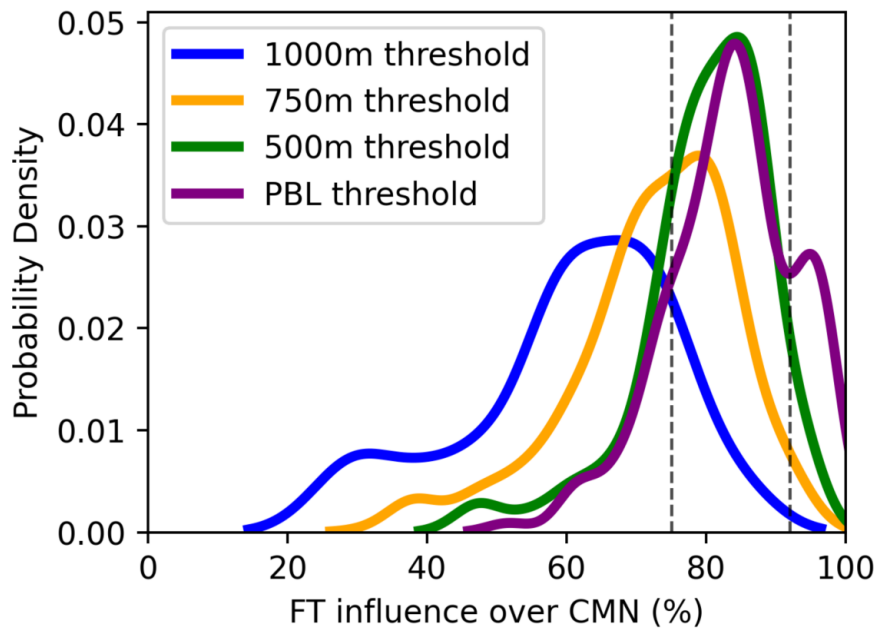
**Figure A4.** FT influence ($FT_{SRR}$) distribution calculated using different constant pseudo-PBL height as threshold (blue, orange and green line), and by using a changing threshold based on the PBL height calculated by WRF (purple line). The two vertical dashed line represent the division between the $FT_{SRR}$ categories used in the analysis.
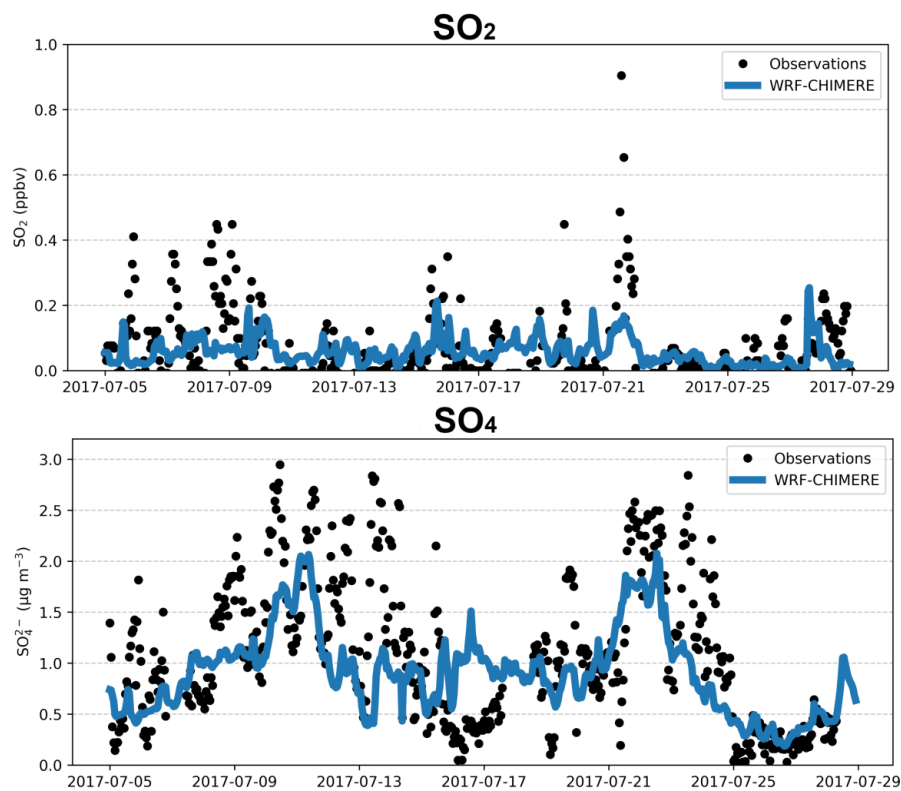
**Figure A5.** Hourly timeseries of the modelled (blue line) and observed (black dots) sulphur dioxide (top plot) and sulphate (bottom plot) concentration.
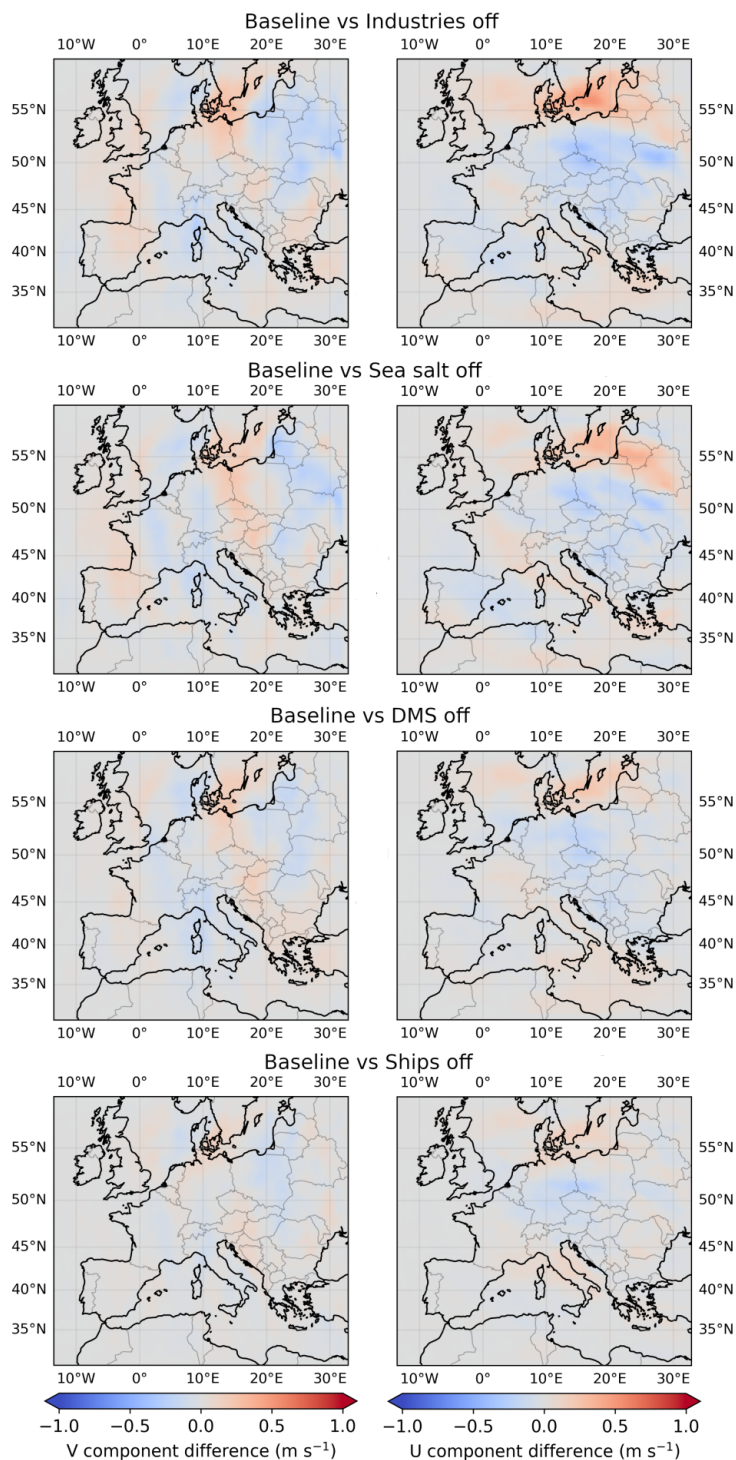
**Figure A6.** Average wind components difference between baseline simulation and the sensitivity simulations.