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*Supplement of*

**A model study on changes of European and Swiss particulate matter, ozone and nitrogen deposition between 1990 and 2020 due to the revised Gothenburg protocol**

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## Supplementary material:

Figure S1: Time series of measured (24 ANETZ stations) and modelled (WRF) specific humidity ( $\text{kg kg}^{-1}$ ), air temperature (deg C) and wind speed ( $\text{m s}^{-1}$ ). MBE: mean bias error, r: correlation coefficient.

Figure S2: Annual average  $\text{PM}_{2.5}$  ( $\mu\text{g m}^{-3}$ ) over the European (upper panel) and Swiss (lower panel) domains for the reference case (2005).

Figure S3: Observed yearly average  $\text{PM}_{10}$  values, raw (blue) and adjusted for meteorology (red), the respective trend lines obtained by linear regression (from Barmadimos et al. 2011). The modelled annual average  $\text{PM}_{10}$  values from this study for 1990, 2005 and 2006 are shown with black crosses.

Figure S4: Annual average  $\text{O}_3$  mixing ratios (ppb) over the European (upper panel) and Swiss (lower panel) domains for the reference case (2005).

Figure S5: Relative changes in AOT40 over the European domain, BL 2020- 2005 (upper panel) and MTFR 2020- 2005 (lower panel).

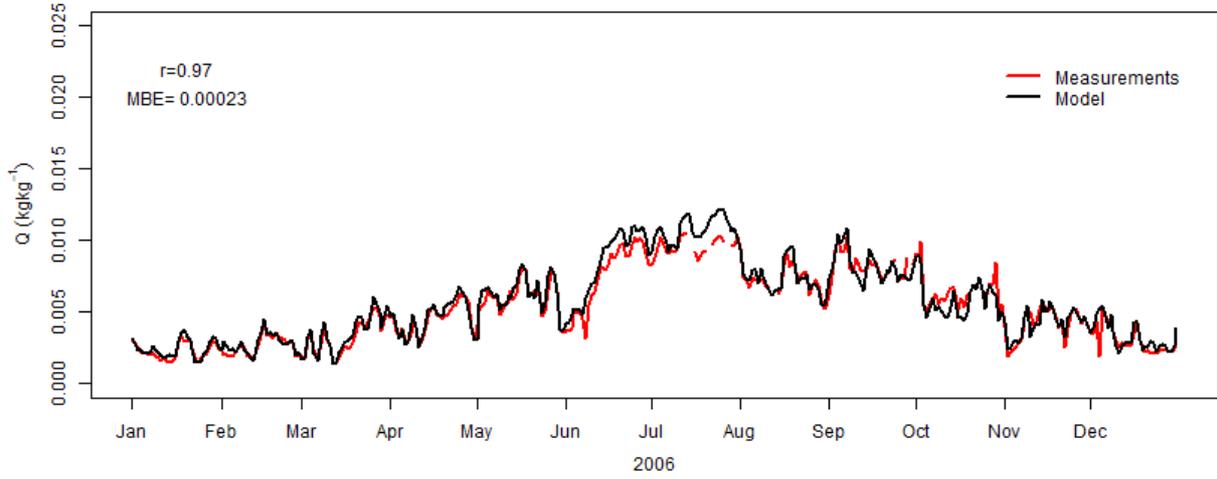
Figure S6: Relative changes in AOT40 over the Swiss domain, BL 2020 - 2005 (upper panel) and MTFR 2020- 2005 (lower panel).

Figure S7: Relative changes in SOMO35 over the European domain for two scenarios: BL 2020- 2005 (upper panel) and MTFR 2020 – 2005 (lower panel).

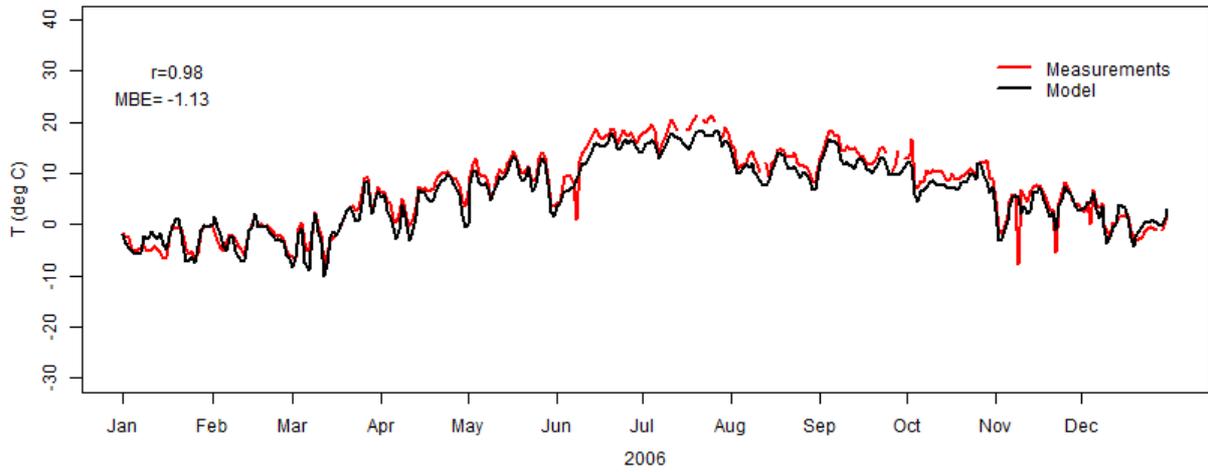
Figure S8: Relative changes in SOMO35 over the Swiss domain for two scenarios: BL 2020- 2005 (upper panel) and MTFR 2020 – 2005 (lower panel).

Figure S9: Dry (upper panel) and wet (lower panel) nitrogen deposition ( $\text{kg N ha}^{-1} \text{y}^{-1}$ ) over the European domain (2006).

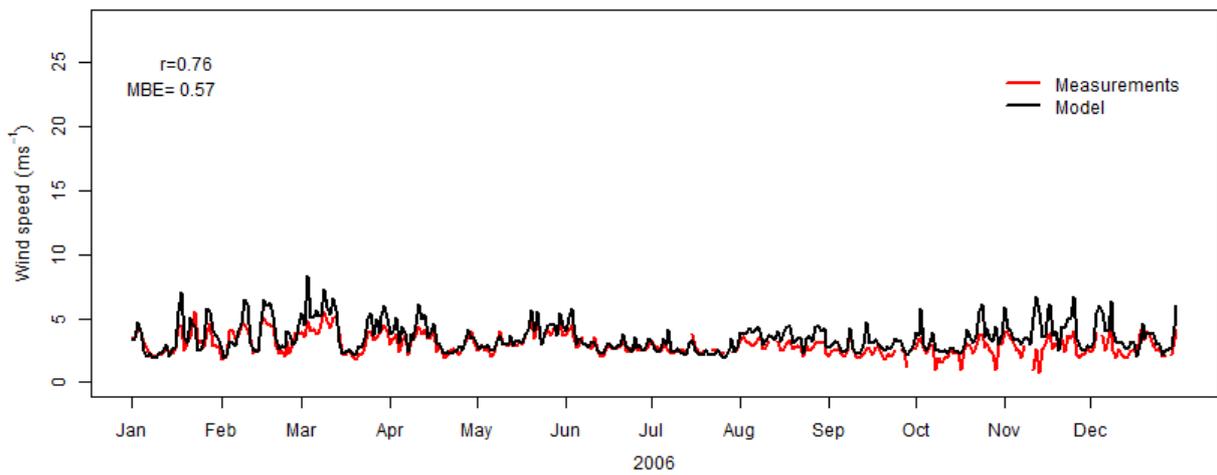
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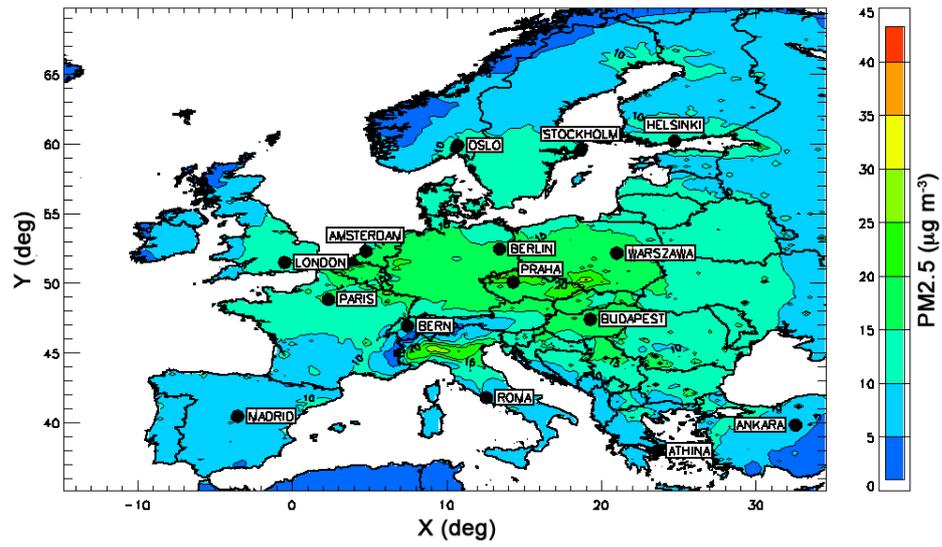
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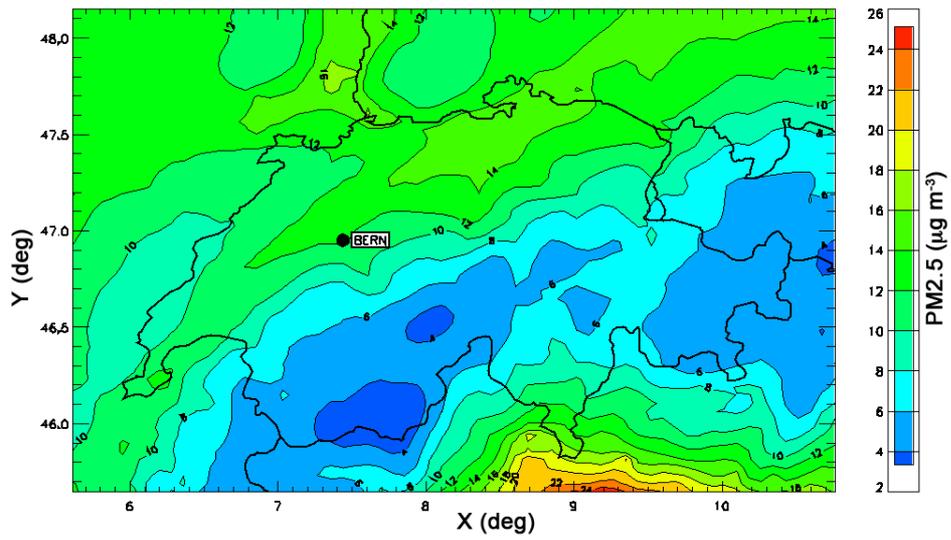
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5 Figure S1: Time series of measured (24 ANETZ stations) and modelled (WRF) specific  
6 humidity ( $\text{kg kg}^{-1}$ ), air temperature ( $\text{deg C}$ ) and wind speed ( $\text{m s}^{-1}$ ). MBE: mean bias  
7 error,  $r$ : correlation coefficient.

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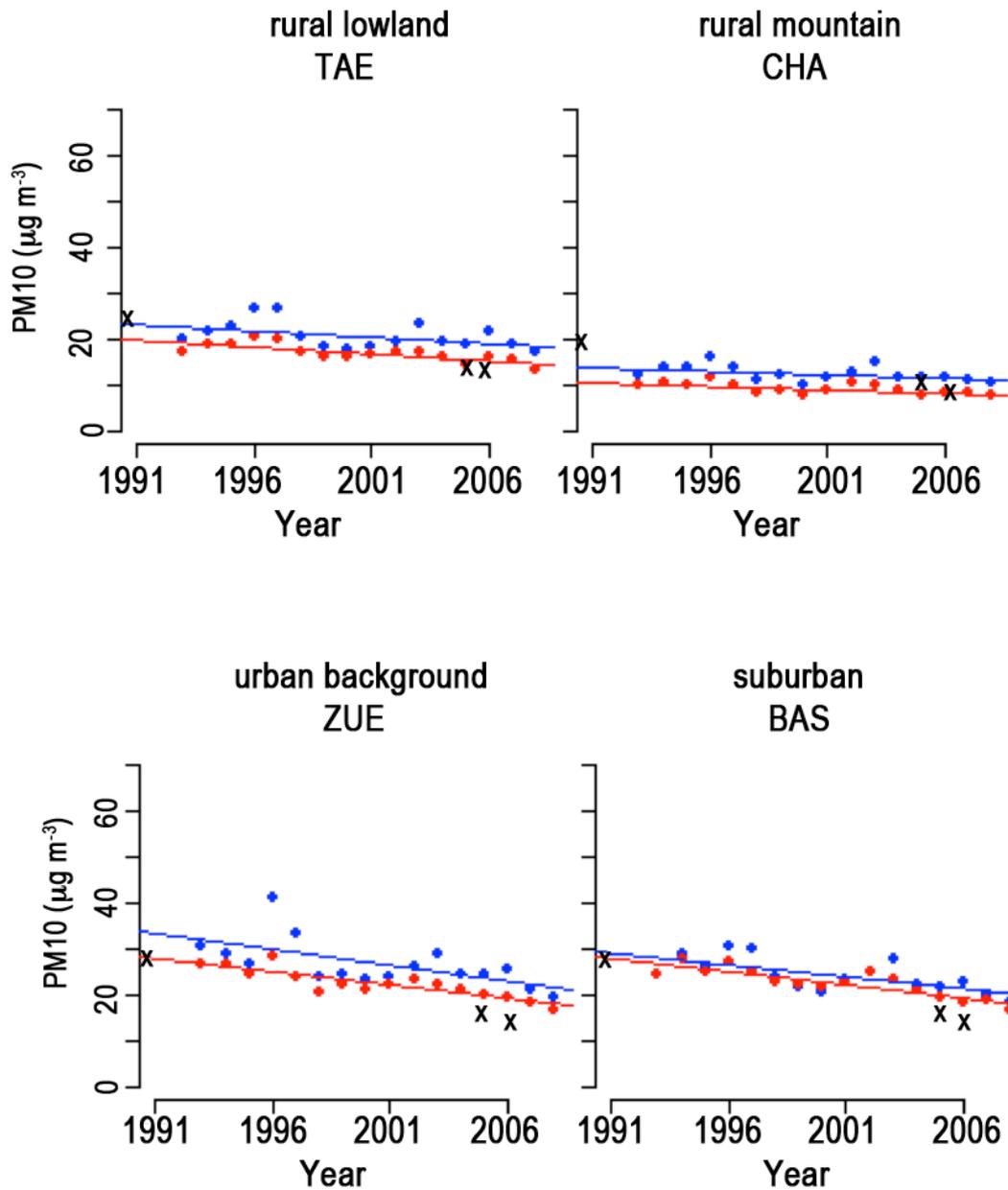
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4 Figure S2: Annual average PM<sub>2.5</sub> ( $\mu\text{g m}^{-3}$ ) over the European (upper panel) and Swiss  
5 (lower panel) domains for the reference case (2005).

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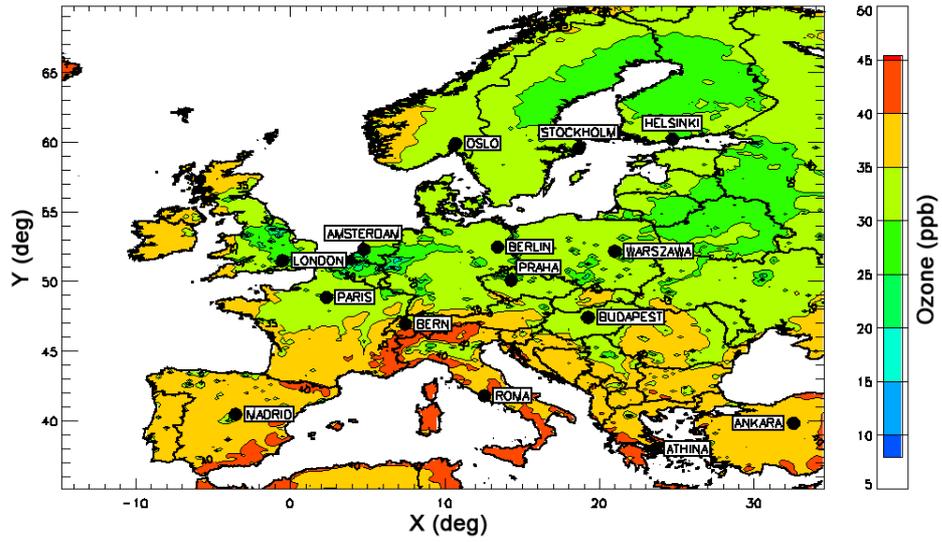
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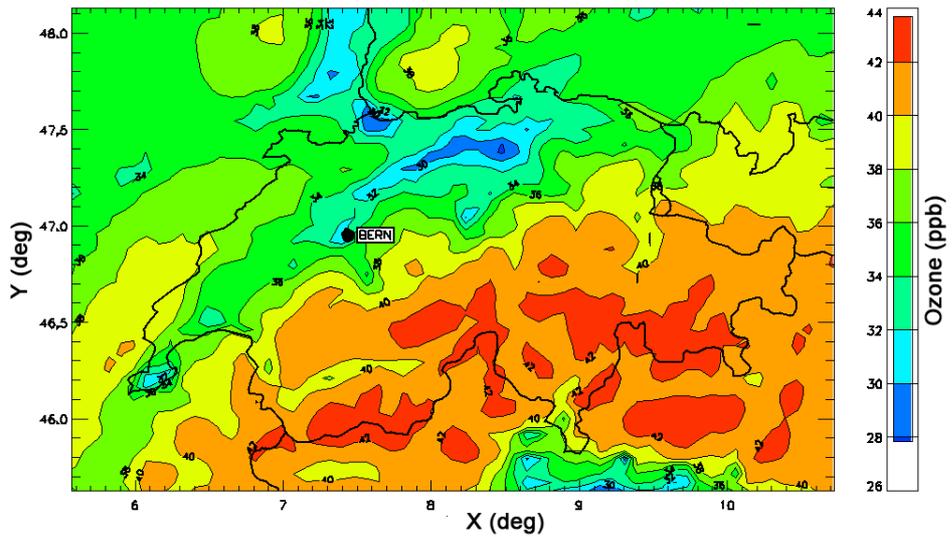
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4 Figure S3: Observed yearly average PM10 values at four stations (TAE: rural, lowland,  
 5 CHA: rural, mountain, ZUE: urban background, BAS: suburban), raw (blue) and adjusted  
 6 for meteorology (red), the respective trend lines obtained by linear regression (from  
 7 Barmpadimos et al. 2011). The modelled annual average PM10 values from this study  
 8 for 1990, 2005 and 2006 are shown with black crosses.

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3 Figure S4: Annual average O<sub>3</sub> mixing ratios (ppb) over the European (upper panel) and  
 4 Swiss (lower panel) domains for the reference case (2005).

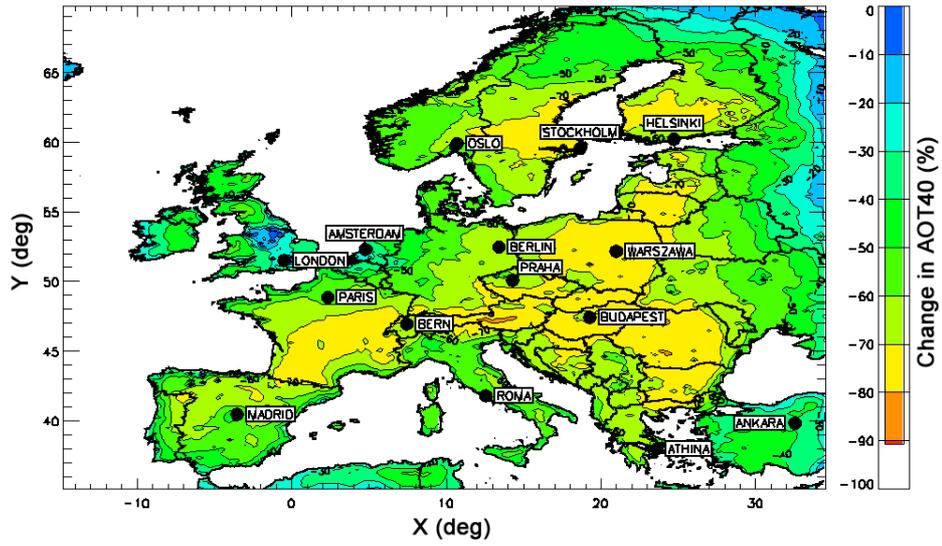
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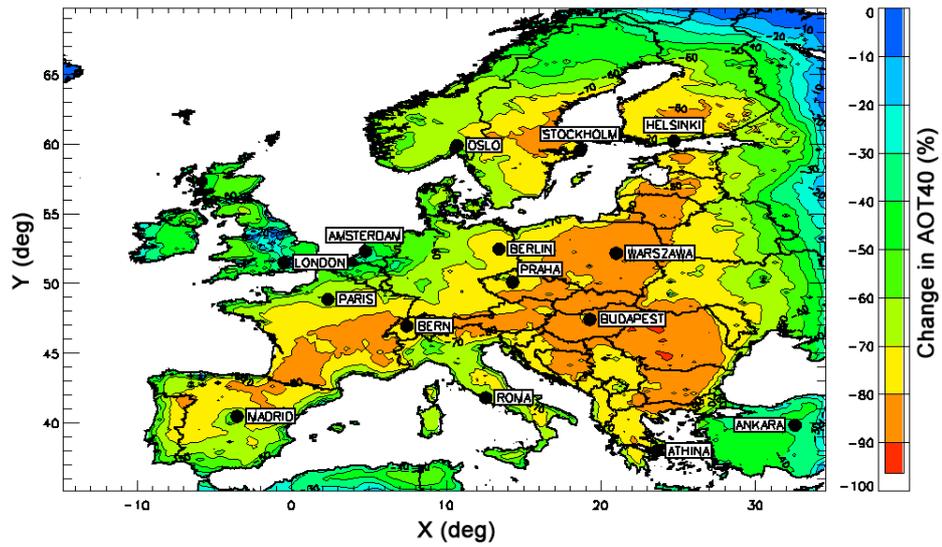
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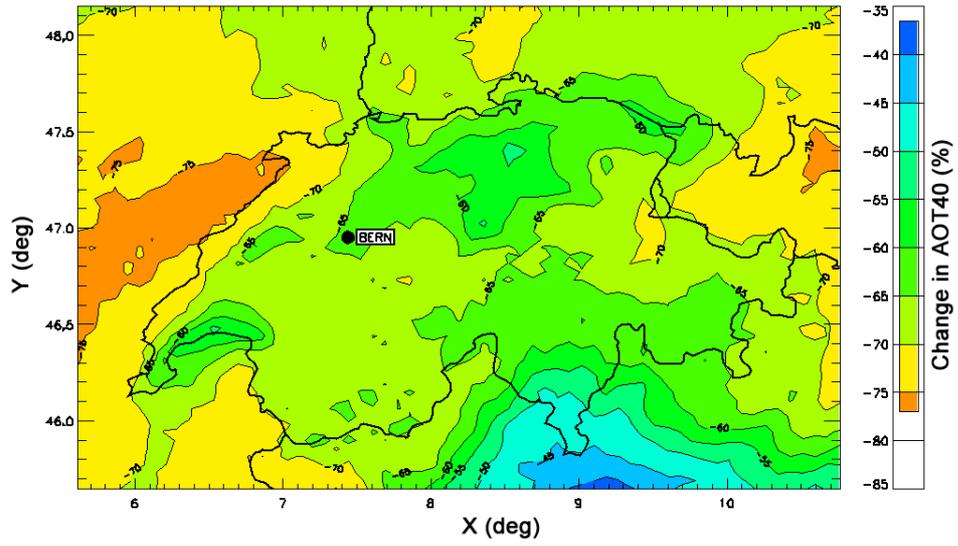
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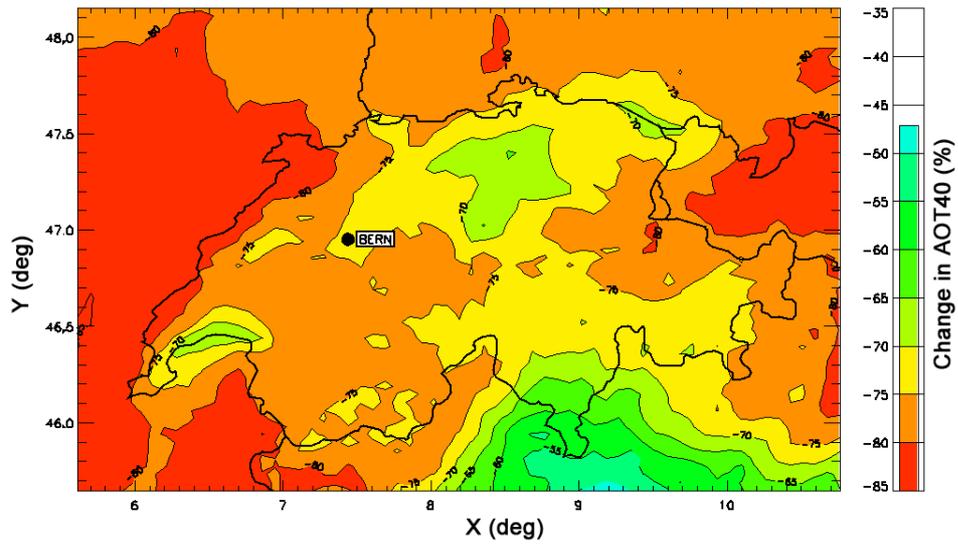
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3 Figure S5: Relative changes in AOT40 over the European domain, BL 2020- 2005  
 4 (upper panel) and MTR 2020- 2005 (lower panel).

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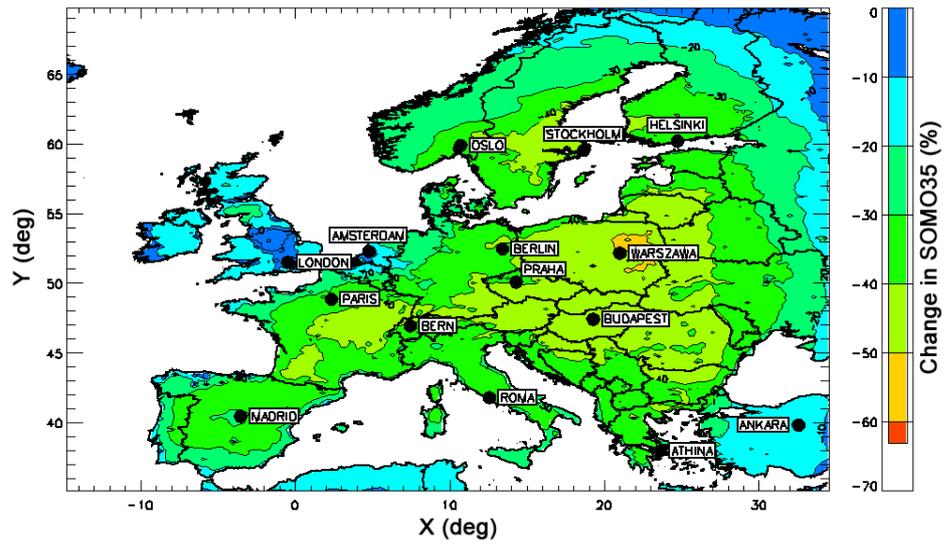


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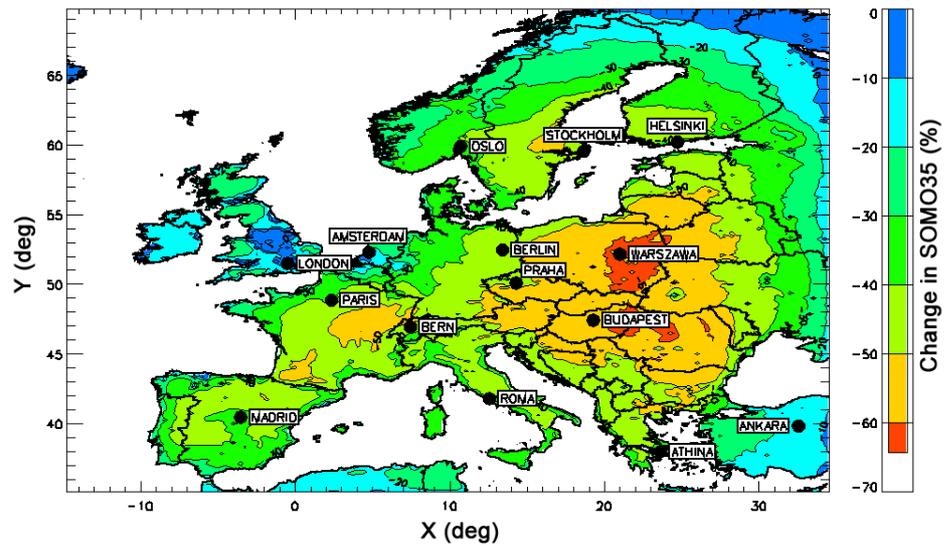


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 3 Figure S6: Relative changes in AOT40 over the Swiss domain, BL 2020 - 2005 (upper  
 4 panel) and MTFR 2020- 2005 (lower panel).  
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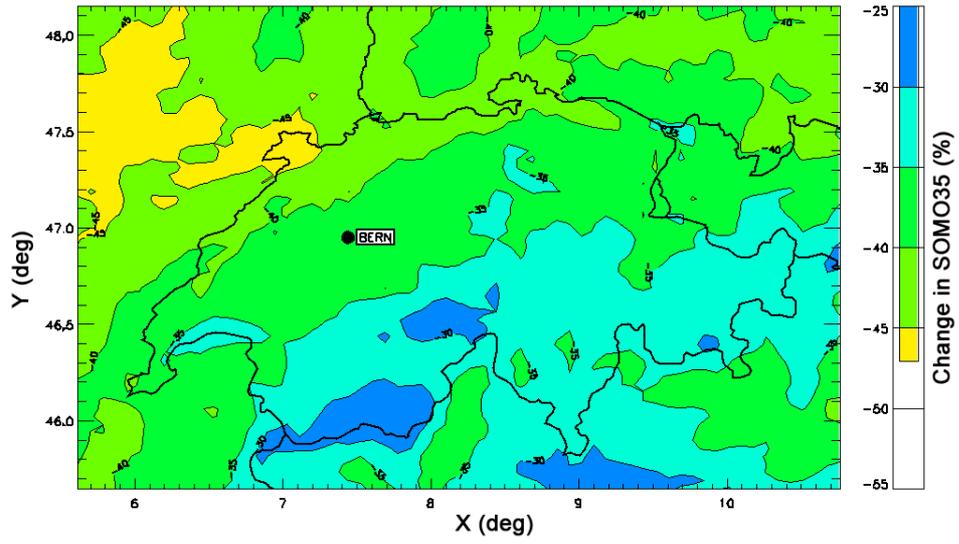
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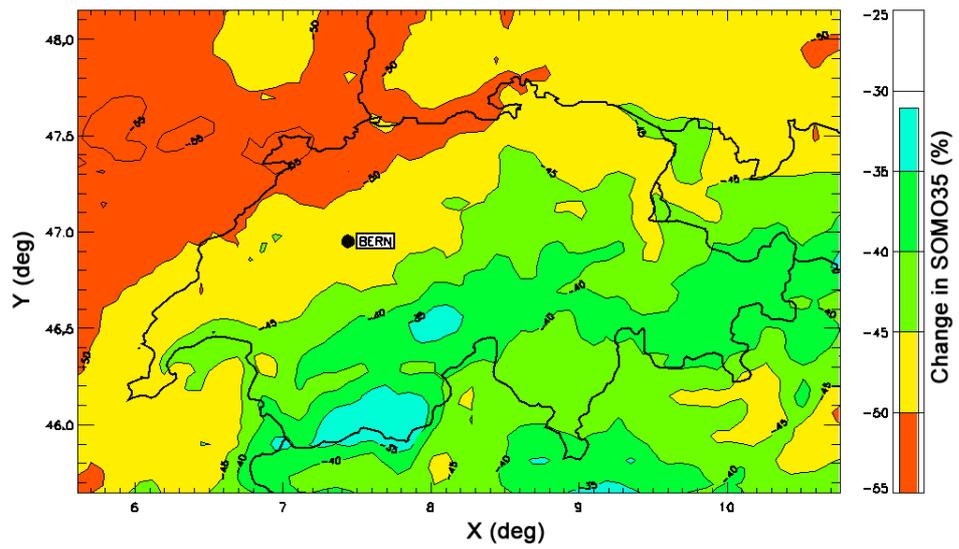
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4 Figure S7: Relative changes in SOMO35 over the European domain for two scenarios:  
5 BL 2020- 2005 (upper panel) and MTFR 2020 – 2005 (lower panel).

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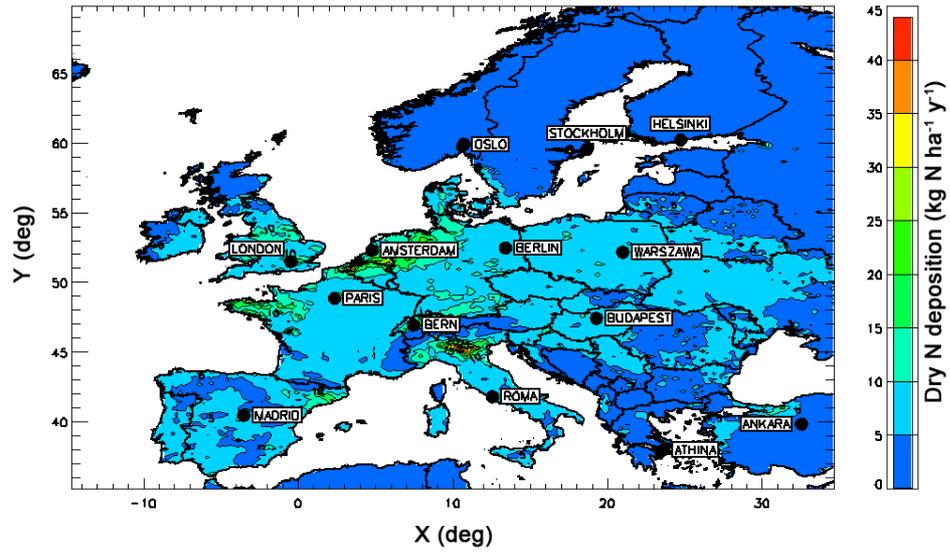


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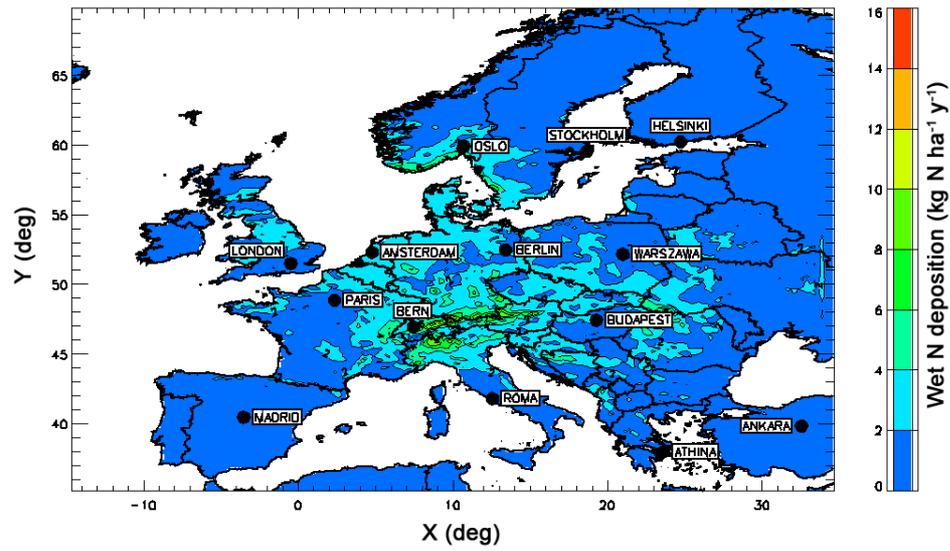


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 3 Figure S8: Relative changes in SOMO35 over the Swiss domain for two scenarios: BL  
 4 2020- 2005 (upper panel) and MTFR 2020 – 2005 (lower panel).

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 3 Figure S9: Dry (upper panel) and wet (lower panel) nitrogen deposition ( $\text{kg N ha}^{-1} \text{y}^{-1}$ )  
 4 over the European domain (2006).

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