



Supplement of

Global sensitivity and uncertainty analysis of an atmospheric chemistry transport model: the FRAME model (version 9.15.0) as a case study

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Figure S1 shows spatial distribution of the emissions of NO_x, SO₂, and NH₃ used as inputs in the FRAME model. The maps of NO_x and SO₂ emissions for the year 2012 were obtained from http://naei.beis.gov.uk/data/map-uk-das last access: 9 March 2018. The NH₃ emission map was obtained from AQPI Summary Report – Emissions of Air Quality Pollutants – 1970-2011 (https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1305031312_EoAQP1970-2011_pq.pdf, last access: 9 March 2018)

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Figure S2 shows annual average surface concentrations of particulate NH_4^+ , NO_3^- , SO_4^{2-} , and annual wet and dry deposition of SO_v calculated by the FRAME model with baseline emissions for the year 2012.

Figures S3 and S4 show spatial distributions of regression coefficients for NH_3 , NO_x , SO_2 , HNO_3 and wet and dry deposition of NH_x and NO_y with respect to input emissions of the pollutant in brackets.

Figure S5 shows spatial distributions of the relative uncertainties in surface concentrations of NH_3 , NO_x , SO_2 and HNO_3 and dry and wet deposition of NOy and NHx for uncertainties of ± 4 %, ± 10 %, and ± 20 % in emissions of SO_2 , NO_x and NH_3

15 respectively. The uncertainty values are represented as +/- range relative to the baseline value and with the full range represents the 95 % confidence interval.

Figures S6 and S7 show spatial distributions of the squared SRC values which represent the fractional contribution of the uncertainty in the input emissions given in brackets to the overall uncertainty in NH₃, NO_x, SO₂, HNO₃ and dry and wet deposition of NOy and NHx.



SI Figure 1 Spatial distribution of the UK NO_x, SO₂, and NH₃ emissions. The maps of NO_x and SO₂ emissions were obtained from http://naei.beis.gov.uk/data/map-uk-das, last access: 9 March 2018. The NH₃ emission map is obtained from AQPI Summary Report – Emissions of Air Quality Pollutants – 1970-2011 (https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1305031312_EoAQP1970-2011_pq.pdf, last access: 9 March 2018)



SI Figure 2 Annual average surface concentrations of particulate NH_{4^+} , NO_{3^-} , $SO_{4^{2^-}}$, and annual wet and dry deposition of SO_y calculated by the FRAME model for 2012.



SI Figure 3 Spatial distributions (at the 5 km \times 5 km model grid resolution) of RCs for NH₃, NO_x, SO₂, and HNO₃ as a function of variation in input emissions of SO₂, NO_x or NH₃. The model input emissions for which the RC quantifies the output variable sensitivity is given in the brackets in each panel.



SI Figure 4 Spatial distributions (at the 5 km × 5 km model grid resolution) of RCs for wet (w) and dry (d) deposition of NO_y and NH_x as a function of variation in input emissions of SO_2 , NO_x and NH_3 . The model input emissions for which the RC quantifies the output variable sensitivity is given in the brackets in each panel.



5 SI Figure 5 Spatial distributions (at the 5 km × 5 km model grid resolution) of the relative uncertainties in surface concentrations of NH₃, NO_x, SO₂ and HNO₃ and dry and wet deposition of NO_y and NH_x for uncertainties of ± 4 %, ± 10 %, ± 20 % in emissions of SO₂, NO_x and NH₃ respectively. The uncertainty values are represented as a range of +/- the baseline value and represent the 95 % confidence interval.



SI Figure 6 Spatial distributions (at the 5 km × 5 km model grid resolution) of the squared SRC values which represent the fractional contribution of the uncertainty in the input emissions given in brackets to the overall uncertainty in NH₃, NO_x, SO₂ and HNO₃. The uncertainties in the input emissions are ± 4 %, ± 10 % and ± 20 % for SO₂, NO_x and NH₃ respectively.



SI Figure 7 Spatial distributions (at the 5 km × 5 km model grid resolution) of the squared SRC values which represent the fractional contribution of the uncertainty in the input emissions given in brackets to the overall uncertainty in the dry and wet deposition of NO_y and NH_x . The uncertainties in the input emissions are ± 4 %, ± 10 % and ± 20 % for SO₂, NO_x and NH₃ respectively