

**Supporting Information for  
“4D-Var inversion of European NH<sub>3</sub> emissions using CrIS NH<sub>3</sub> mea-  
surements and GEOS-Chem adjoint with bi-directional and uni-  
directional flux schemes”**

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1. Figures S1 to S3

## Supporting figures and tables

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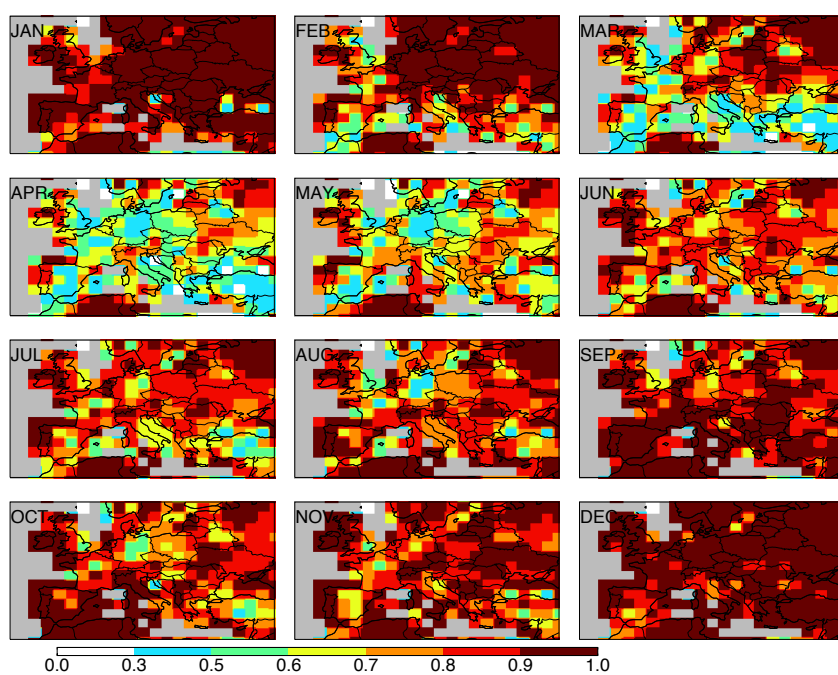


Figure S1: MASAGE-based ratio of monthly livestock NH<sub>3</sub> emissions to monthly total anthropogenic NH<sub>3</sub> emissions.

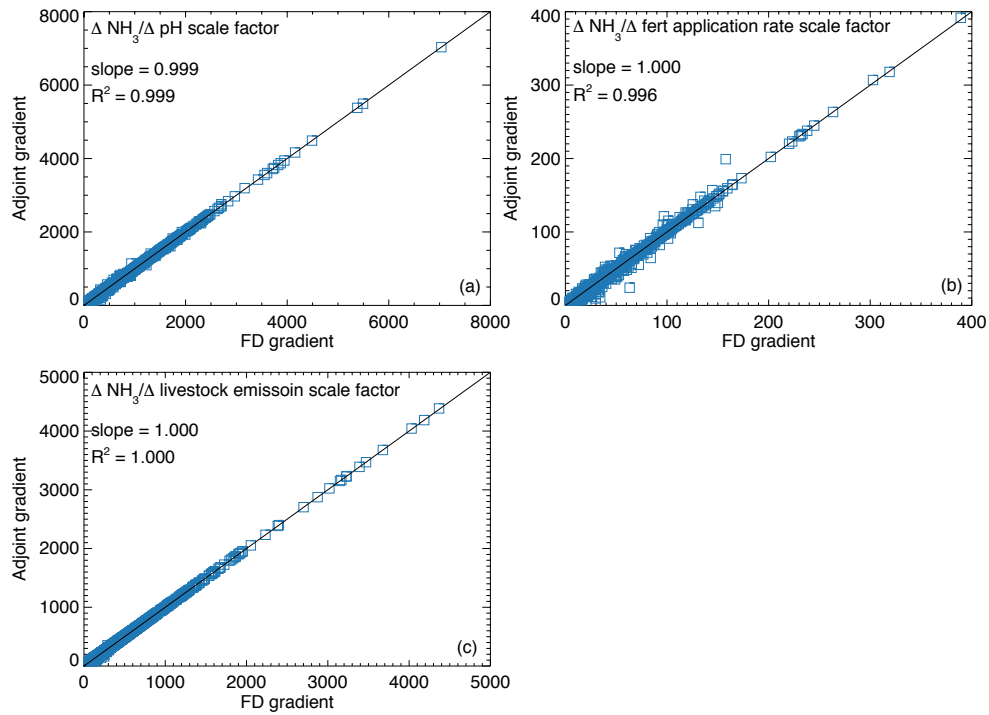


Figure S2: Scatter plot between adjoint gradient and finite difference (FD) gradient of simulated  $\text{NH}_3$  with respect to pH scale factor (a), fertilizer application rate scale factor (b) and livestock emission scale factor (c), respectively, from July 1<sup>st</sup> to 7<sup>th</sup> 2016 for the Europe domain at  $0.3125^\circ \times 0.25^\circ$ .

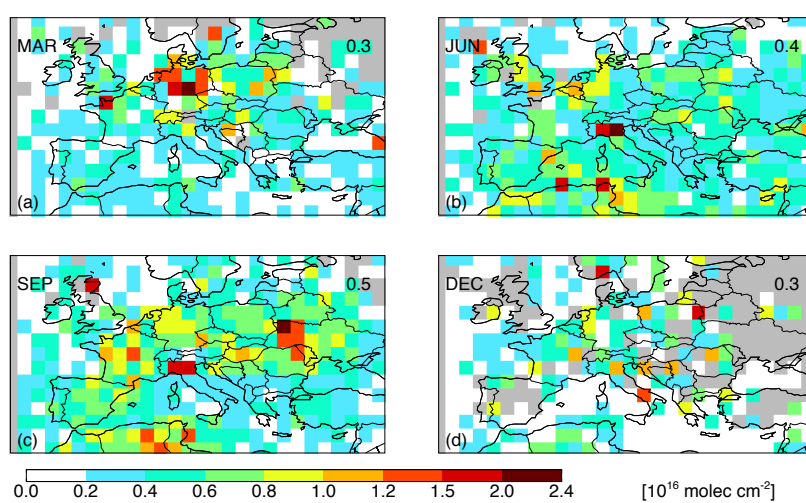


Figure S3: Monthly mean IASI  $\text{NH}_3$  column concentration averaged at  $2^\circ \times 2^\circ$  during March (a), June (b), September (c) and December (d) in 2016. Grids with valid pixels less than 10 were set to NaN value (in gray color). Domain average was shown on the top-right of each sub-figure.