Supplement of Quantification of lightning-produced NO_x over the Pyrenees and the Ebro Valley by using different TROPOMI-NO_2 and cloud research products

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1 Introduction

In the main part of this manuscript we have calculated the LNO_x PE from eight cases 29 April, 7 May, 12 May, 21 May, 22 May, 26 May, 28 May and 30 May 2018. However, the main part of this manuscript only includes figures for cases 29 April, 7 May and 28 May. This supplement includes figures corresponding to the cases of 22 May, 21 May, 22 May, 26 May and 30 May 2018 .

2 Further analyzed cases

We show in Figures S1, S2, S3, S4, S5, S6, S7, S8 and S9 similar plots for cases 29 April, 7 May and 28 May 2018. The TROP-DLR research product was not available for the case on 30 May 2018. In addition, the thunderstorm taking place on 26 May 2018 had a significant lightning activity between 45°N and 46°N, but we do not have access to EUCLID data north of 45°N.

As in the case showed in the main part of this manuscript, there are more lightning flashes reported by ENGLN than by EUCLID. There are not significant differences between the SCD of NO_2 for each of the used TROPOMI products, while in general

areas with high lightning activity or areas close to lightning flashes coincide with areas with high SCD of NO_2, suggesting that the LNO_x signal is detectable by TROPOMI. The stratospheric VCD of NO_2 from the TROP-DLR product is slightly larger than from the TROP-KNMI product, while both the stratospheric VCD of NO_2 and the stratospheric AMF of NO_2 are more homogeneous for the TROP-DLR product than for the TROP-KNMI product. There are not significant differences between the cloud products, except for some pixels in which the TROP-DLR product estimates larger cloud fractions.

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Competing interests. Authors declare no competing interests.

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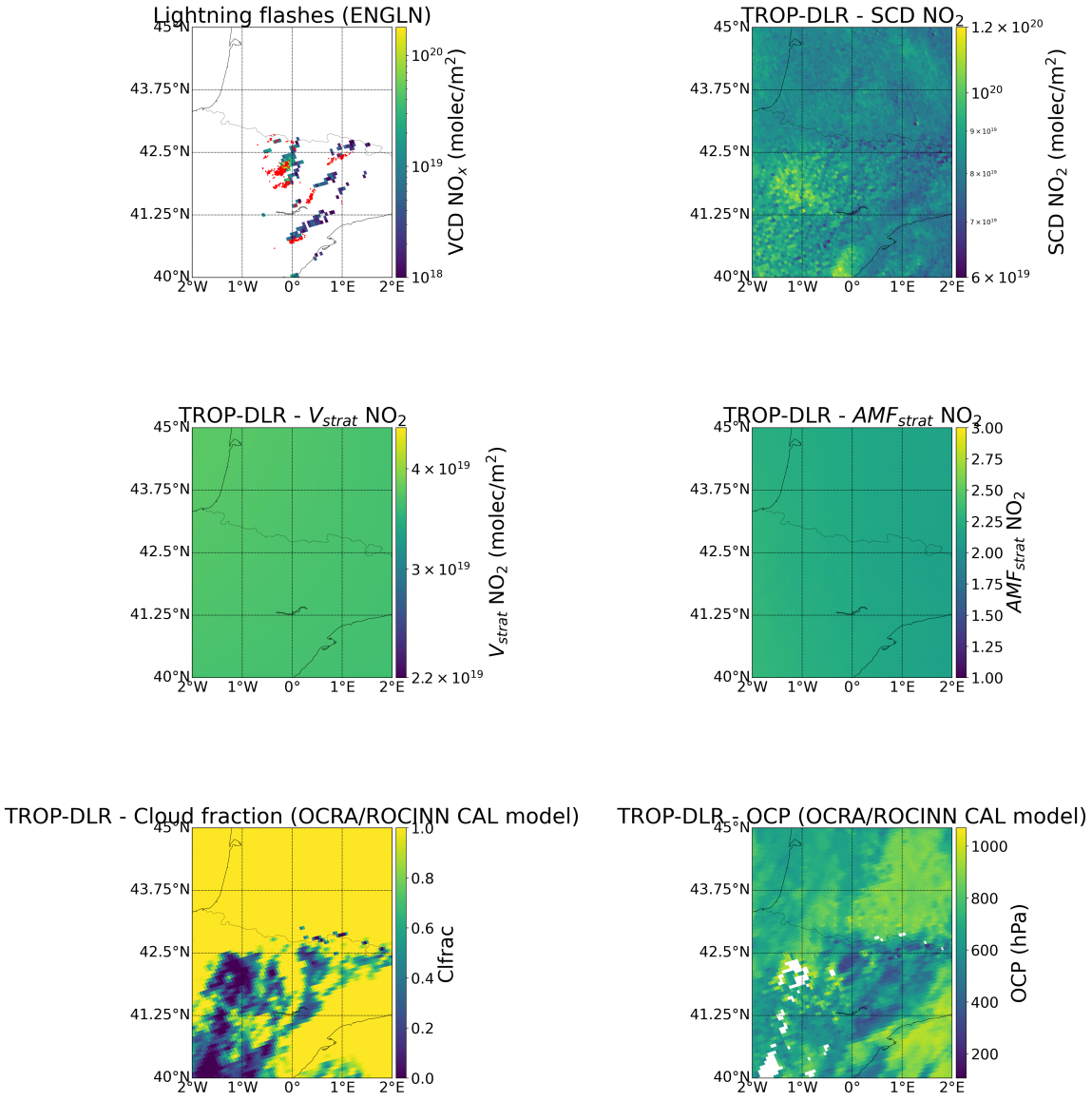

Figure S1. TROP-DLR product and ENGLN lightning data for the case 12 May 2018. The upper left panel shows the positions of lightning flashes (red dots) reported by ENGLN 5 h before the TROPOMI overpass and the calculated VCD NO_x The upper right panel shows the SCD of NO_2, center left and right panels show the stratospheric VCD and AMF of NO_2. The lower left and right panels show the cloud fraction and the OCP, respectively.

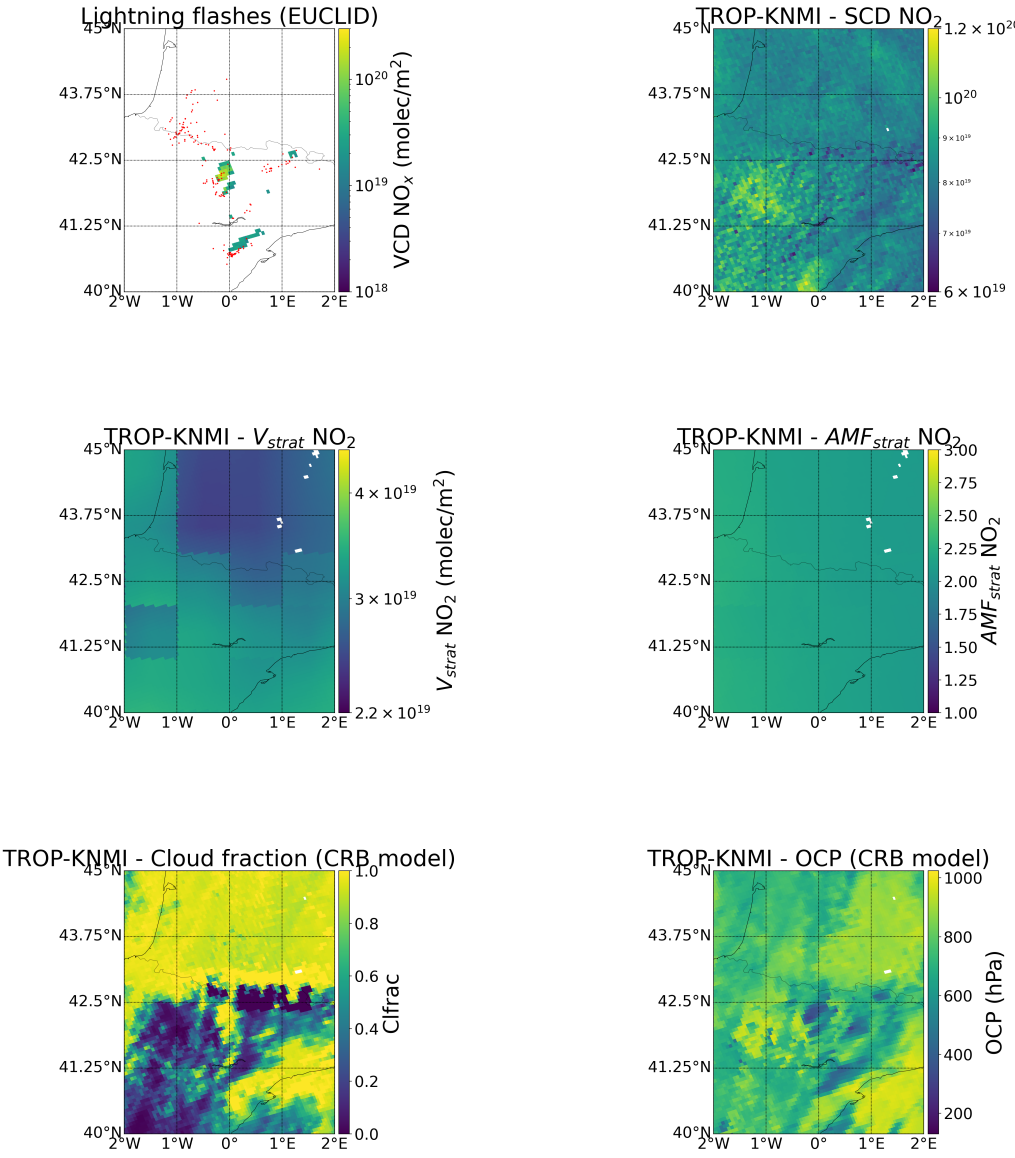

Figure S2. TROP-KNMI product and EUCLID lightning data for the case 12 May 2018. The upper left panel shows the positions of lightning flashes (red dots) reported by EUCLID 5 h before the TROPOMI overpass and the calculated VCD NO_x The upper right panel shows the SCD of NO_2, center left and right panels show the stratospheric VCD and AMF of NO_2. The lower left and right panels show the cloud fraction and the OCP, respectively.

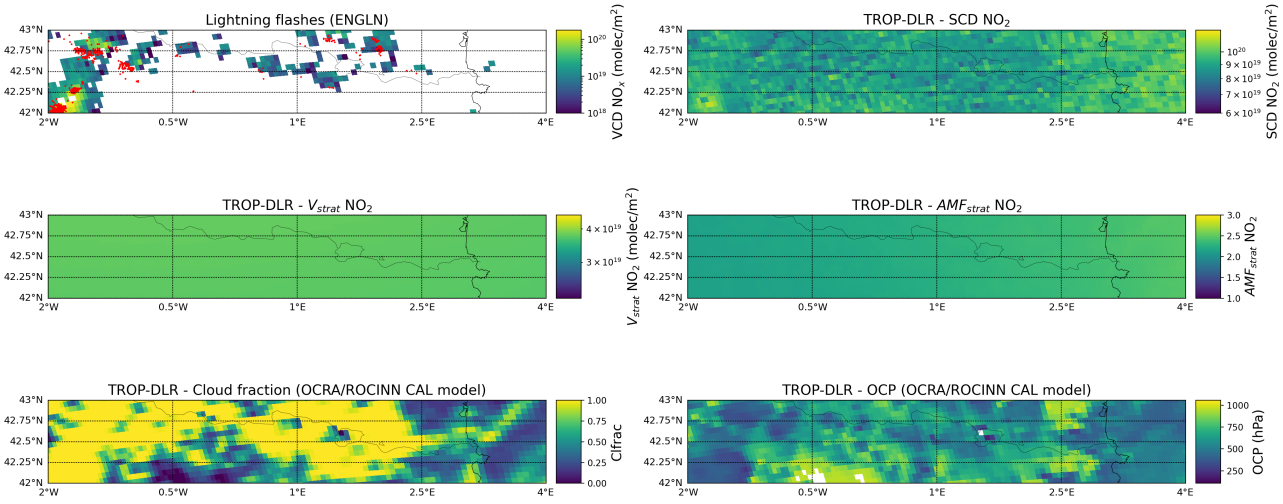

Figure S3. TROP-DLR product and ENGLN lightning data for the case 21 May 2018. The upper left panel shows the positions of lightning flashes (red dots) reported by ENGLN 5 h before the TROPOMI overpass and the calculated VCD NO_x The upper right panel shows the SCD of NO_2, center left and right panels show the stratospheric VCD and AMF of NO_2. The lower left and right panels show the cloud fraction and the OCP, respectively.

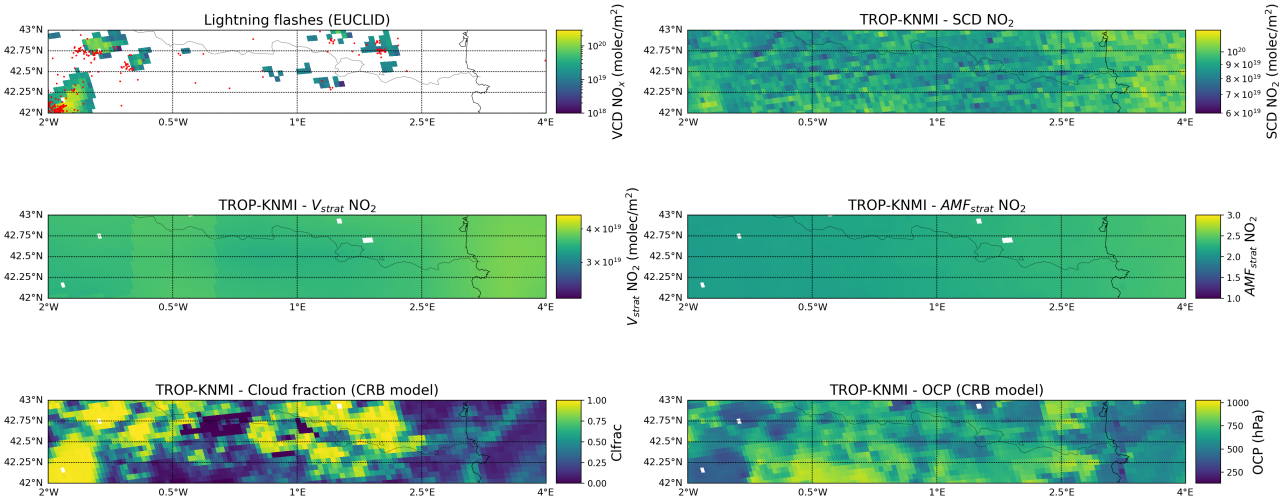

Figure S4. TROP-KNMI product and EUCLID lightning data for the case 21 May 2018. The upper left panel shows the positions of lightning flashes (red dots) reported by EUCLID 5 h before the TROPOMI overpass and the calculated VCD NO_x The upper right panel shows the SCD of NO_2, center left and right panels show the stratospheric VCD and AMF of NO_2. The lower left and right panels show the cloud fraction and the OCP, respectively.

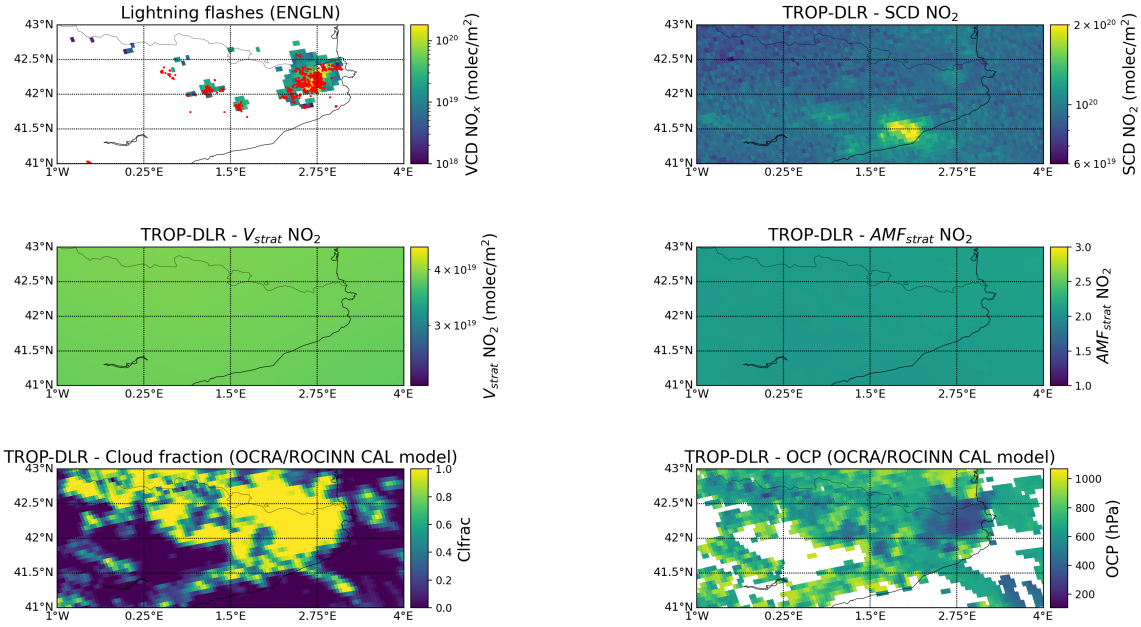

Figure S5. TROP-DLR product and ENGLN lightning data for the case 22 May 2018. The upper left panel shows the positions of lightning flashes (red dots) reported by ENGLN 5 h before the TROPOMI overpass and the calculated VCD NO_x The upper right panel shows the SCD of NO_2, center left and right panels show the stratospheric VCD and AMF of NO_2. The lower left and right panels show the cloud fraction and the OCP, respectively.

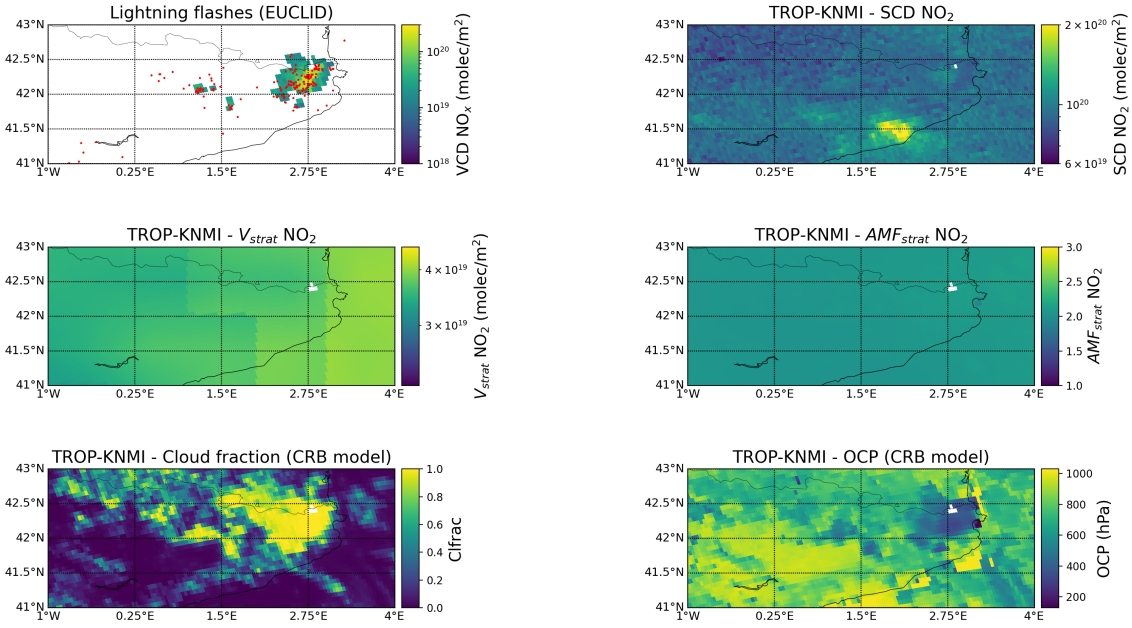

Figure S6. TROP-KNMI product and EUCLID lightning data for the case 22 May 2018. The upper left panel shows the positions of lightning flashes (red dots) reported by EUCLID 5 h before the TROPOMI overpass and the calculated VCD NO_x The upper right panel shows the SCD of NO_2, center left and right panels show the stratospheric VCD and AMF of NO_2. The lower left and right panels show the cloud fraction and the OCP, respectively.

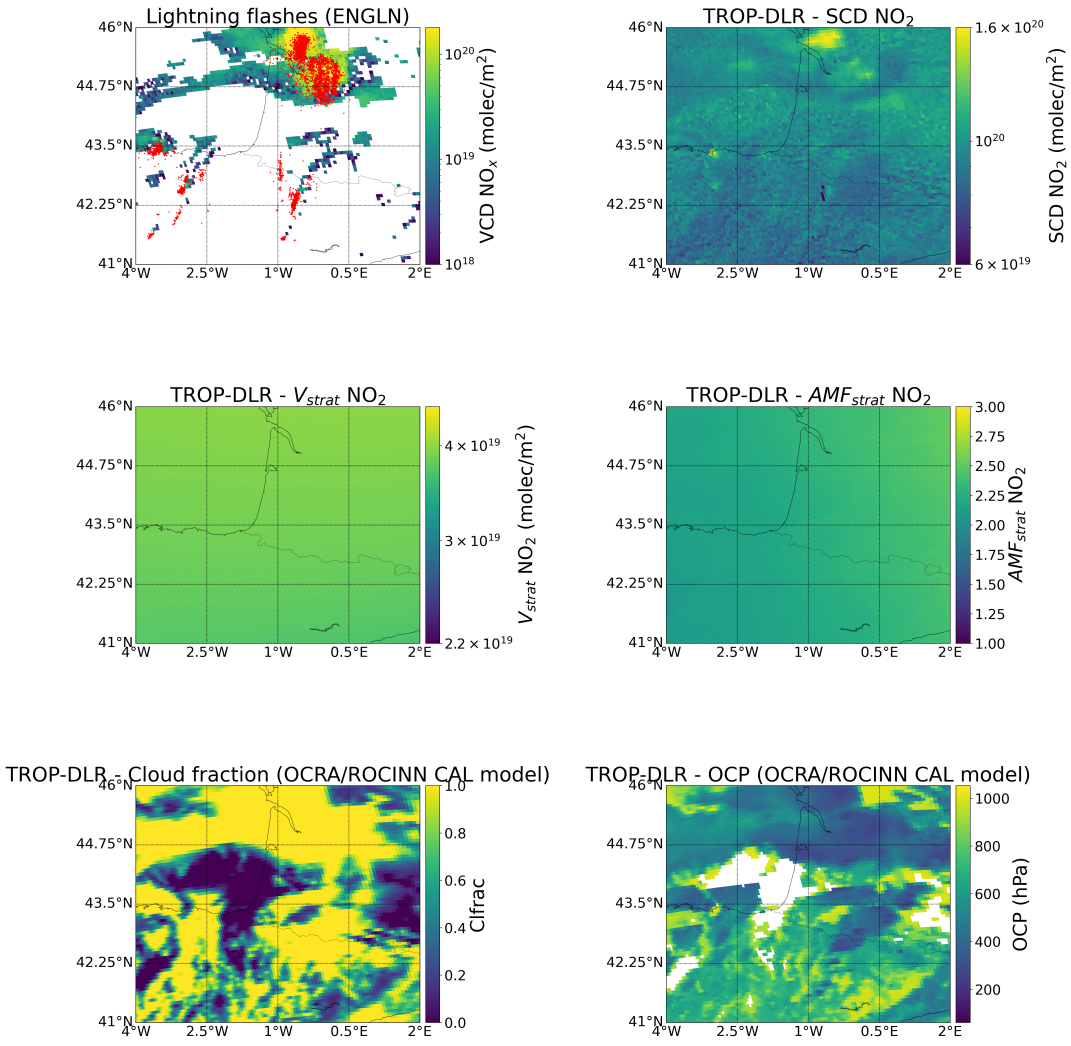

Figure S7. TROP-DLR product and ENGLN lightning data for the case 26 May 2018. The upper left panel shows the positions of lightning flashes (red dots) reported by ENGLN 5 h before the TROPOMI overpass and the calculated VCD NO_x The upper right panel shows the SCD of NO_2, center left and right panels show the stratospheric VCD and AMF of NO_2. The lower left and right panels show the cloud fraction and the OCP, respectively.

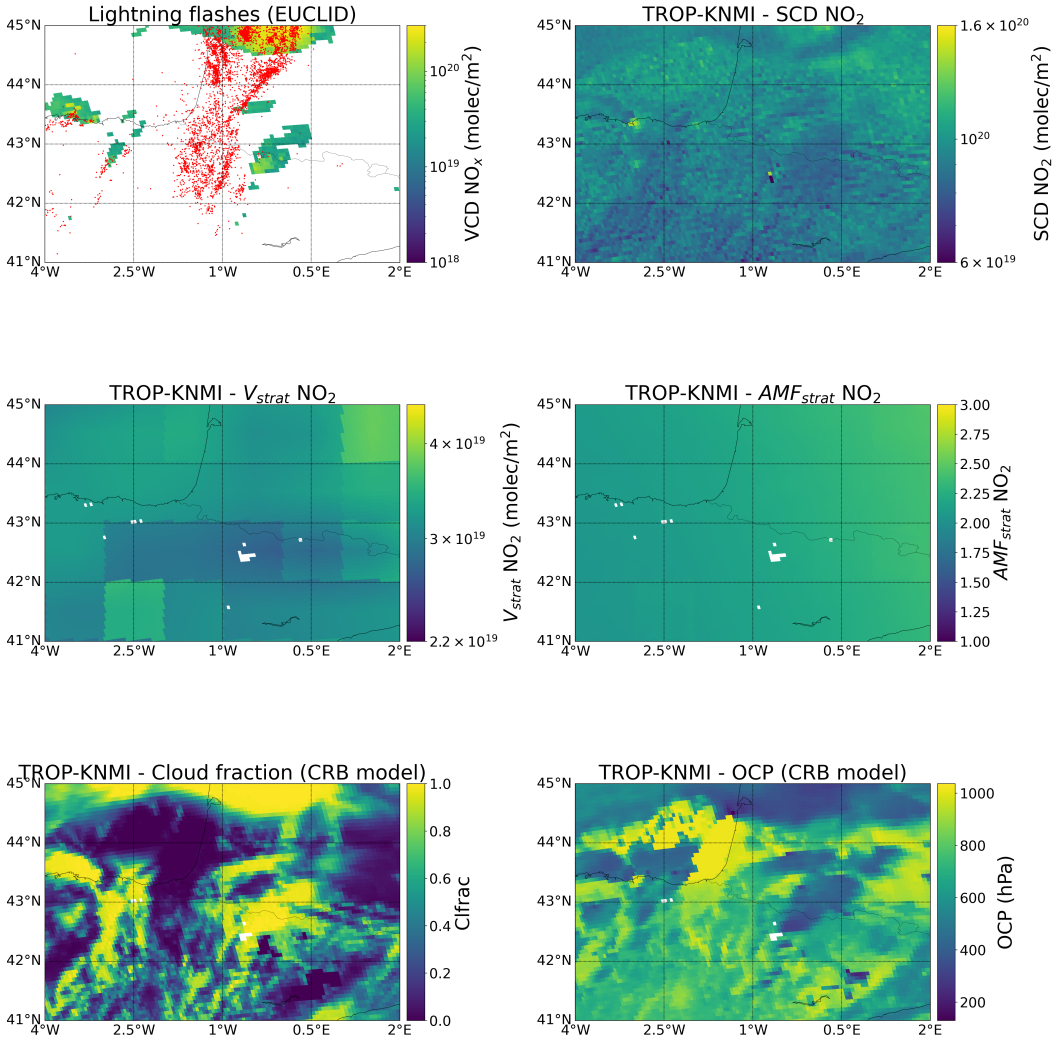

Figure S8. TROP-KNMI product and EUCLID lightning data for the case 26 May 2018. The upper left panel shows the positions of lightning flashes (red dots) reported by EUCLID 5 h before the TROPOMI overpass and the calculated VCD NO_x The upper right panel shows the SCD of NO_2, center left and right panels show the stratospheric VCD and AMF of NO_2. The lower left and right panels show the cloud fraction and the OCP, respectively.

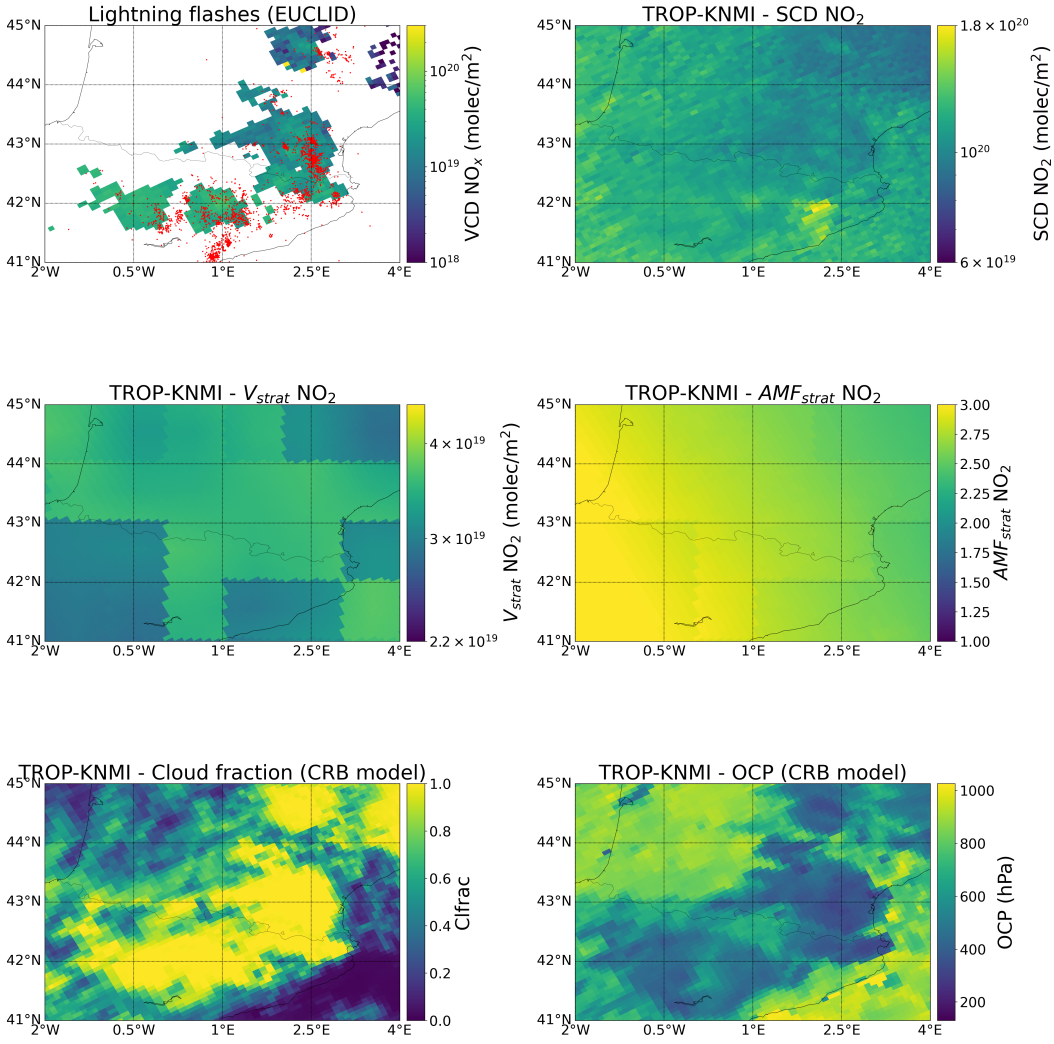

Figure S9. TROP-KNMI product and EUCLID lightning data for the case 30 May 2018. The upper left panel shows the positions of lightning flashes (red dots) reported by EUCLID 5 h before the TROPOMI overpass and the calculated VCD NO_x The upper right panel shows the SCD of NO_2, center left and right panels show the stratospheric VCD and AMF of NO_2. The lower left and right panels show the cloud fraction and the OCP, respectively.