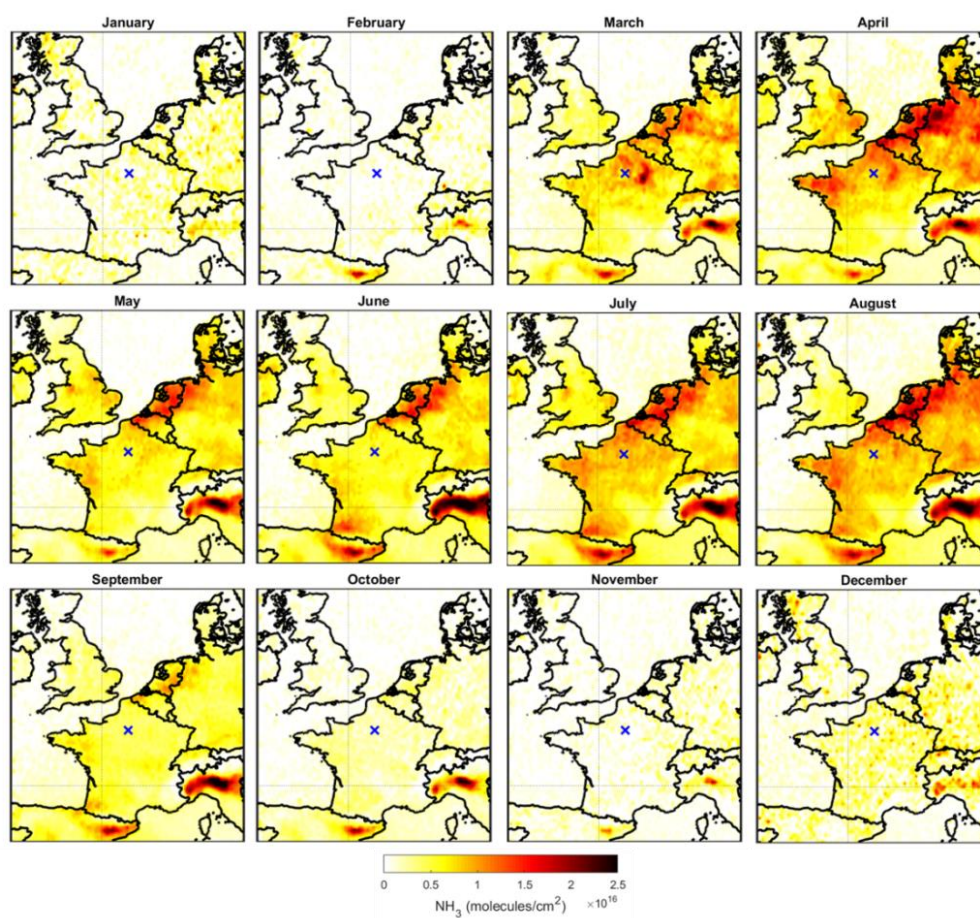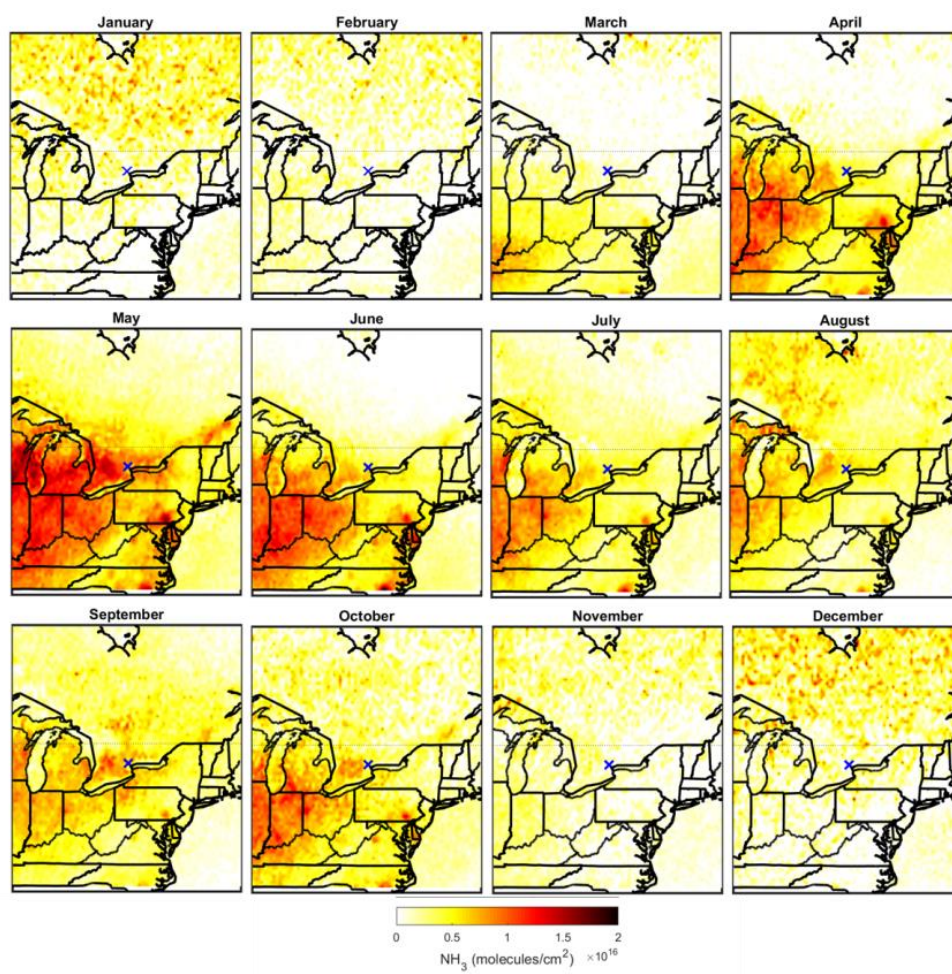# Supplementary information

Figure S1: Monthly means of NH$_3$ total columns (molecules/cm²) derived from 10 years (2008-2017) of IASI NH$_3$-retrieved columns over the so-called Europe domain. The blue cross indicates Paris location.
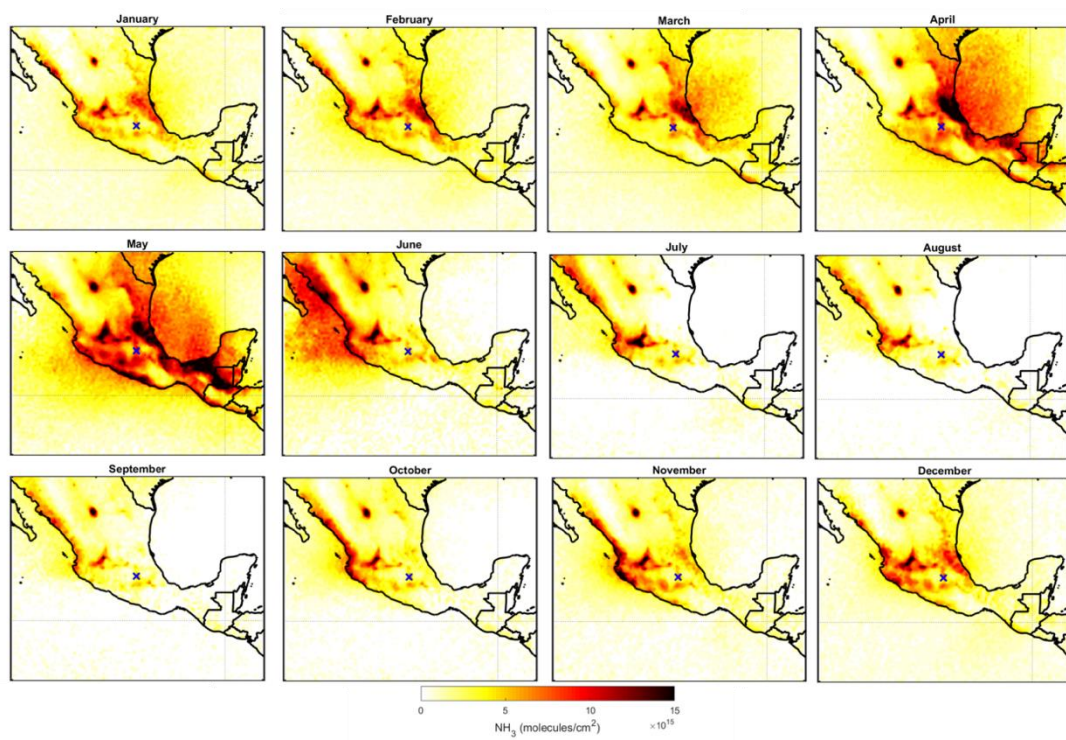
5   Figure S2: Same than figure S1 but for the North America region.

6

7   Figure S3: Same than figure S1 but for the southern North America region.

8
9

10   Figure S4: Evolution of NH₃ with respect to land surface temperature (upper panels) and relative humidity (lower
11   panels) from ERA5 in the 3 study domains. The figure is done by averaging IASI NH₃ total columns per bins of
12   ERA5 skin temperatures, with an interval of 1°C. Blue dots: Yearly IASI NH₃ total columns (molecules/cm²)
13   averaged per bins of ERA5 skin temperature in the upper panel (relative humidity in the lower panel) with an
14   interval of 1°C (1% of RH) between each consecutive bin. We do not consider bins that contain less than 5% of
15   the maximum number of measurements per bin; hence, the averages with not enough measurements per bins
16   are excluded. The regions considered here are the regions presented in Table 1 above Europe (left panel), North
17   America (middle panel), and southern North America (right panel). The red line is a polynomial fit of second
18   order, and the relevant r² is shown on each panel.
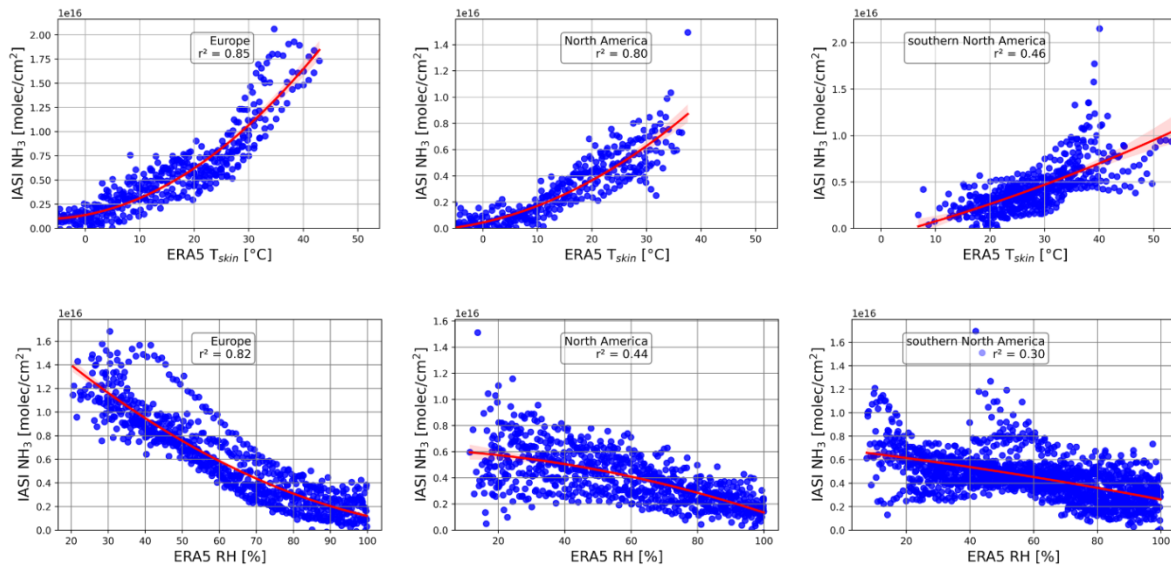
21   The effect of relative humidity on NH₃ concentrations is different in each of the study domains, as we
22   can see in the lower panels of Figure 4. The highest correlation factor we observe is over Europe, and
23   it accounts to r² = 0.82 (lower left panel). A study by Reynolds and Wolf (1987) concluded that the
24   relative humidity of the air does not play a major role in NH₃ volatilization unless the soil is dry. In fact,
25   soil is drier in Europe than both of the other regions, with North America being the most humid area.
26   This can explain why we see a good correlation in Europe and lower one in North America. In southern
27   North America, however, throughout the year we observe high temperatures and high humidity, which
28   can explain the low correlation factor r² = 0.30 (lower right panel).

29   Despite the differences in the correlations, we can still see a decreasing trend of ammonia as the
30   relative humidity of the air increases. We looked at the times during which the NH₃ concentrations
31   where detected and we summarize them below:

32   • RH = 0 − 40%: Most of the NH₃ detected in all regions is during the spring season when the
33   concentrations are the highest. One note that when $0 \leq RH \leq 25\%$, April dominates in Europe
34   and May dominates in North America and southern North America.
35   • RH = 40 − 60%: The NH₃ detected is during summer and spring, hence the lower average as the
36   RH increases when the summer approaches.
37   • RH = 60 − 85%: The NH₃ is decreasing as RH increases and as the time approaches winter (when
38   RH is highest). In southern North America, however, these ammonia measurements
39   correspond to the spring season mostly.
40   • RH = 85 − 100%: Most of NH₃ detected are during winter in southern North America and
41   Europe, and evenly distributed throughout the year in North America.

42 Figure S5: Yearly IASI NH$_3$ total columns (molecules/cm²) averaged per bins of ERA5 skin temperatures (°C), with
43 an interval of 1°C between each consecutive bin. The red circles denote the growing seasons, at least 60% of the
44 NH$_3$ are detected during March-May and Sept-Nov periods. The regions considered here are the regions
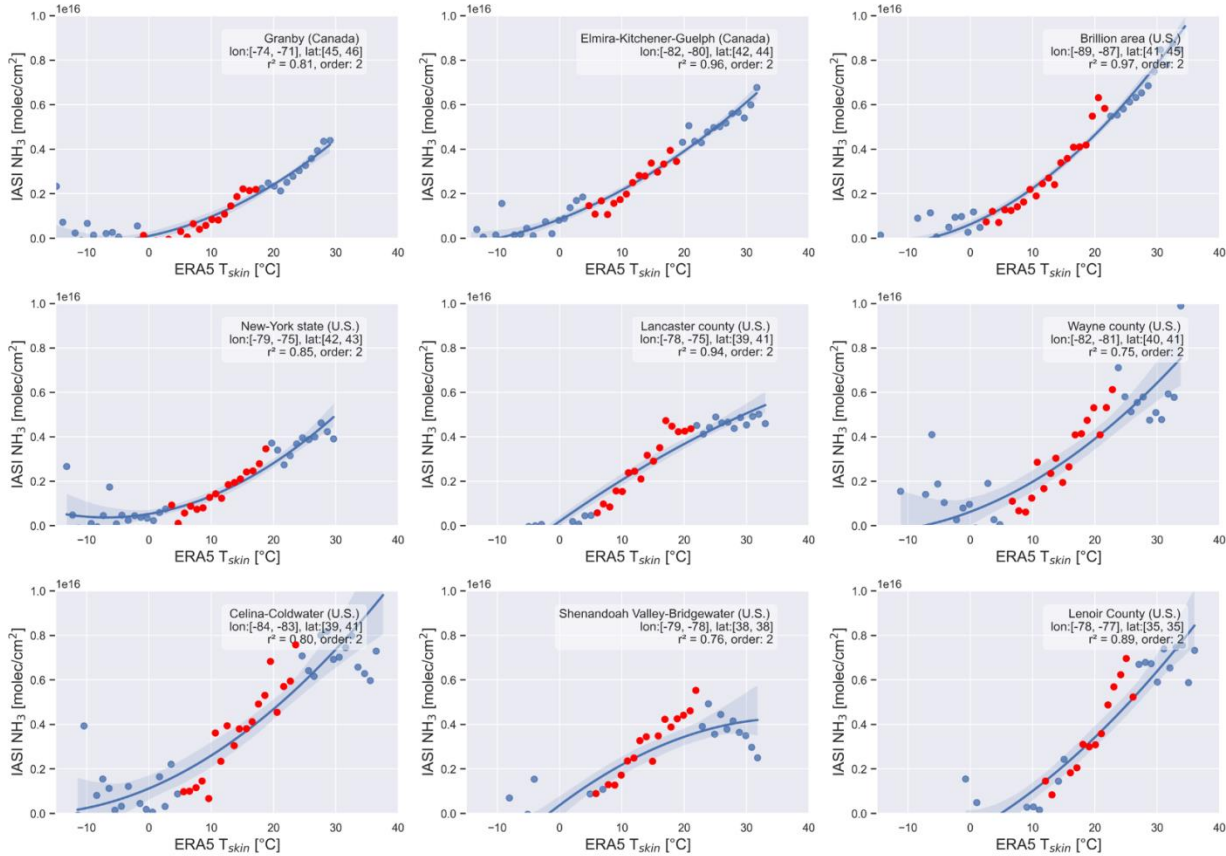45 presented in Table 1 in North America.

46

47 Figure S6: Yearly IASI NH_3 total columns (molecules/cm²) averaged per bins of ERA5 skin temperatures (°C), with
48 an interval of 1°C between each consecutive bin. The red circles denote the growing seasons, at least 60% of the
49 NH_3 are detected during March-May and Sept-Nov periods. The regions considered here are the regions
50 presented in Table 1 above southern North America: (a) sub-regions A to I, (b) sub-regions J to S.
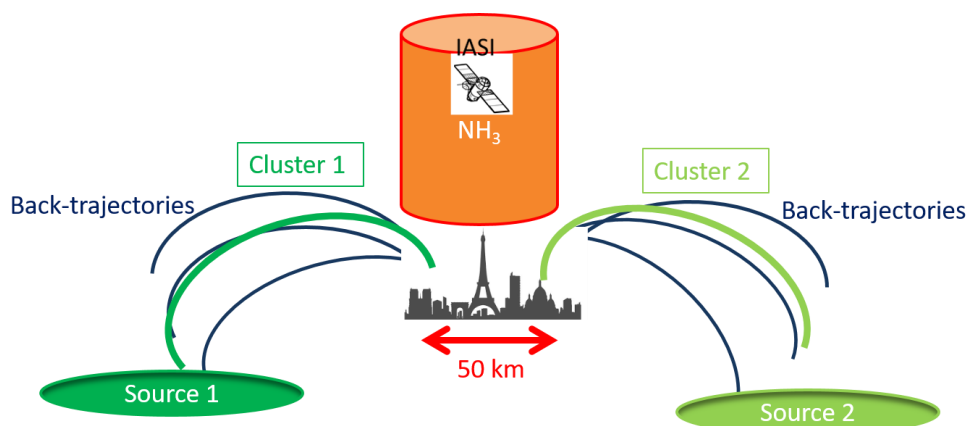
51 (a)

52
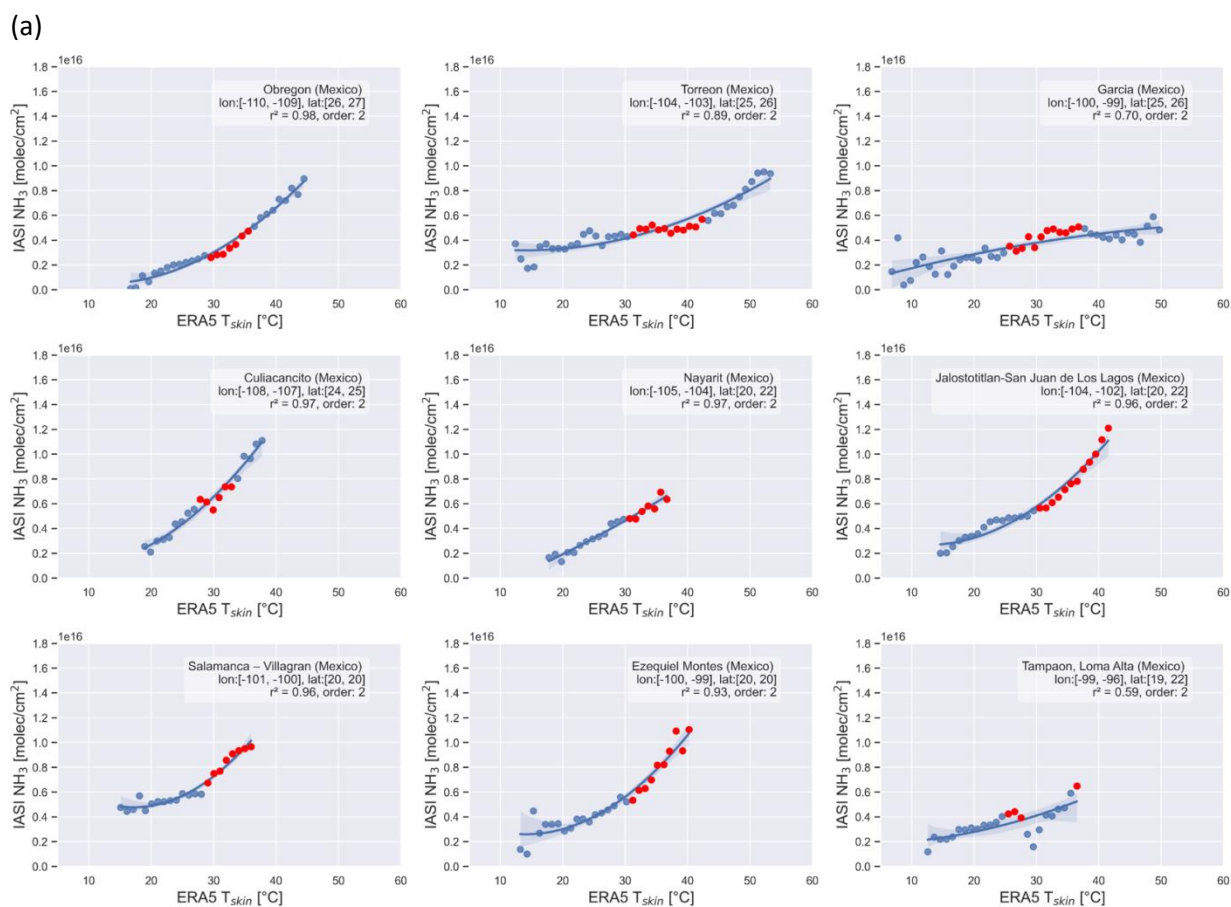
53 (b)
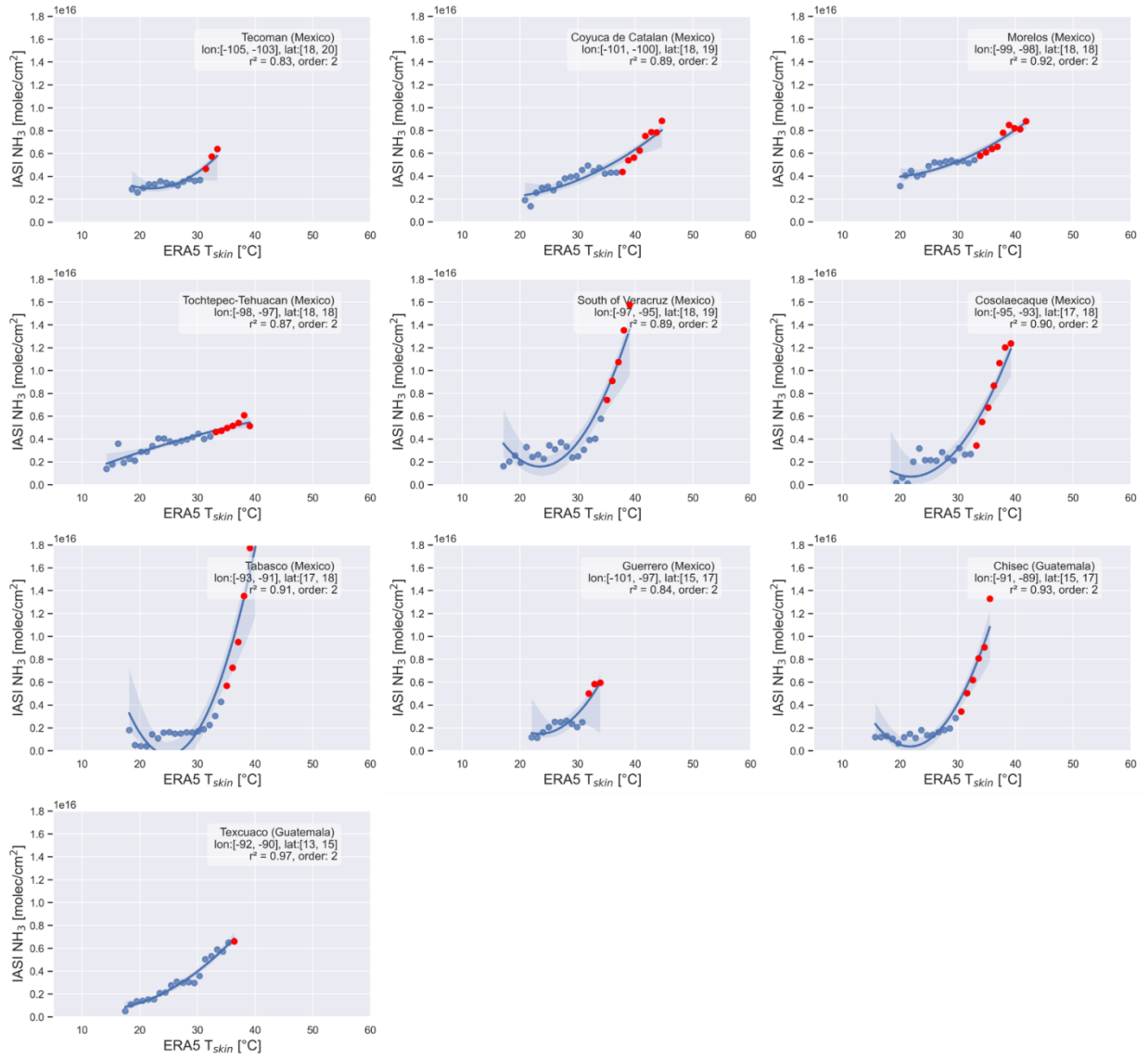
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Figure S7: Cluster analysis - method to analyze the impact of long-range transport on NH$_3$ concentrations measured over the cities.

1) For each day, we have run HYSPLIT back-trajectories ending in the cities at the overpass time of the IASI satellite (blue lines in Figure S7).

2) For each day, we have calculated the amount of NH$_3$ derived from IASI observations within a circle of 50km radius around the cities (orange cylinder in Figure S7).

3) We have run the cluster analysis to merge trajectories that are near each other (green lines in Figure S7). The cluster analysis computes the spatial variance and minimize differences between trajectories within a cluster while differences between clusters are maximized [Abdalmogith et al., 2005; https://www.ready.noaa.gov/documents/Tutorial/html/traj_cluseqn.html]. NH$_3$ mean concentrations measured inside the cities by IASI have been allocated to the different mean cluster trajectories according to the corresponding back-trajectories.

Abdalmogith, S. S. and Harrison, R. M.: The use of trajectory cluster analysis to examine the long-range transport of secondary inorganic aerosol in the UK, Atmos. Environ., 39(35), 6686–6695, doi:https://doi.org/10.1016/j.atmosenv.2005.07.059, 2005.