Validation of IASI-NH_3 measurements

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IASI-NH_3 v3

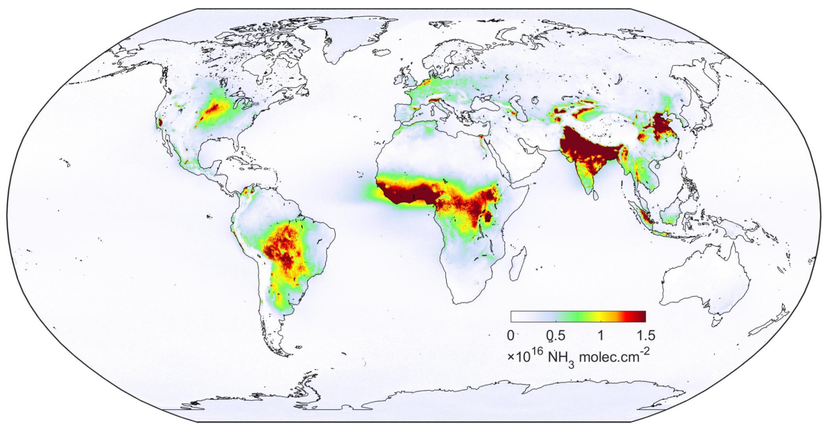

Figure 1: IASI-NH3 total columns distribution (molec/cm²) averaged from 11 years of IASI/Metop-A measurements (1 September 2008 to 31 December 2018, morning overpasses, ANNI-NH3-v3R-ERA5 dataset) on a 0.5° × 0.5° grid.

The version 3 of the IASI-NH_3 dataset was built using the ANNI (Artificial Neural Network for IASI) retrieval framework (Whitburn et al., 2016; Van Damme et al., 2017; Franco et al., 2018; Van Damme et al., 2021). Two datasets are produced: a near-real time dataset, for which the retrieval relies on meteorological information directly obtained from the IASI measurements (August et al., 2012) and a reanalyzed dataset that is based on ERA5 data from the European Centre for Medium-Range Weather Forecasts (ECMWF) climate reanalysis (Hersbach et al., 2020).

Reconstructed columns from in-situ profiles

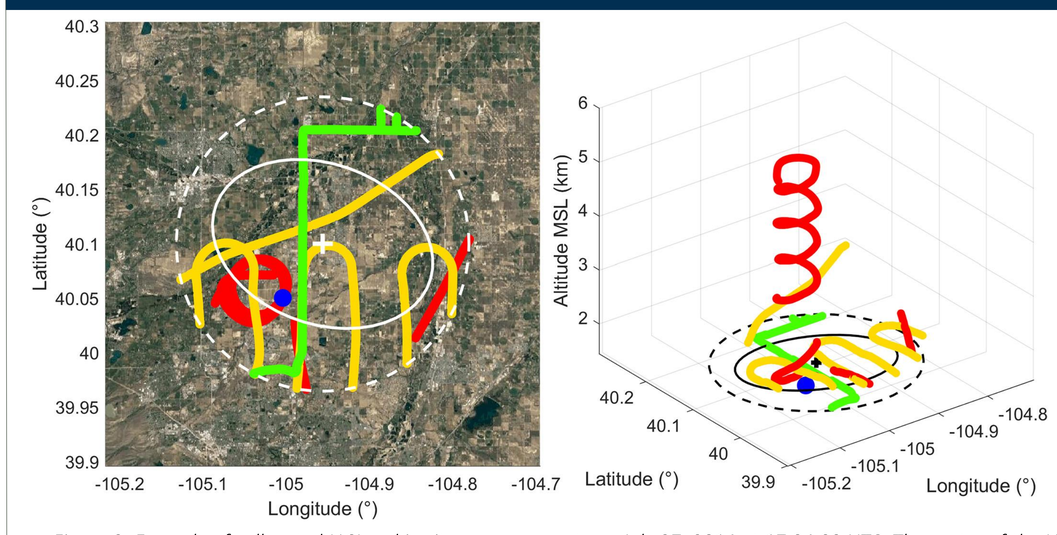

Figure 2: Example of collocated IASI and in situ measurements on July 27, 2014 at 17:34:09 UTC. The center of the IASI pixel is denoted as "+". The solid ellipse marks the boundary of the IASI pixel. The dotted circle represents the ±15 km spatial window. Colored lines show the routes of the in situ platforms: red = P-3B, yellow = C-130, green = Princeton mobile lab, blue dot = BAO tower.

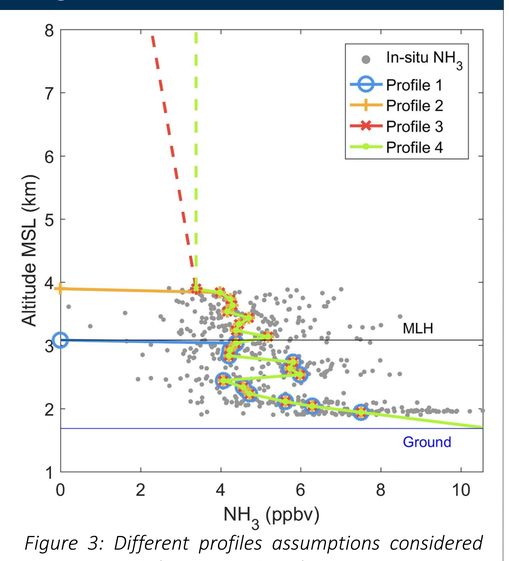

Figure 3: Different profiles assumptions considered to reconstruct the NH_3 in situ columns.

The Deriving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality (DISCOVER-AQ) field experiment was a campaign led by the National Aeronautics and Space Administration (NASA). Figure 2 presents an example of collocated IASI and in situ measurements (Guo et al., 2021). To reconstruct columns from the in-situ NH_3 mixing ratios measured on board the aircraft (grey dots in Figure 3), profiles assumptions have to be made (see Figure 3). The profile assumption in blue, with no NH_3 above the planetary boundary layer (MLH), has been chosen for the comparison with IASI satellite datasets.

The comparison between reconstructed in situ columns and IASI products shows that the IASI-NH_3 version 3 datasets compare well to in situ derived columns, with the reanalysis dataset presenting better statistics (indicated in red on Figure 4).

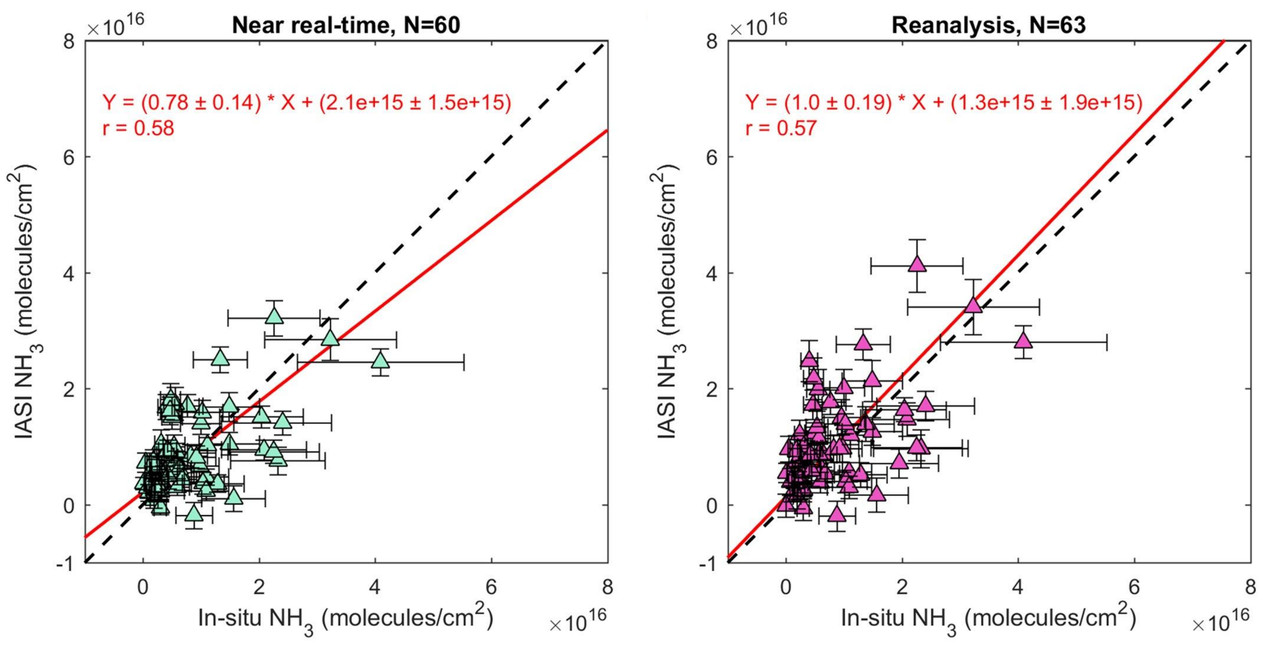

Figure 4: Near real-time (left) and reanalysis (right) IASI-NH_3 products versus the in situ NH_3 columns in Colorado (summer 2014) based on the ±15 km and ±60 min window and mixed layer height assumption. Red line shows the best fit using orthogonal regression. Dashed line represents the 1:1 slope.

Hysteresis in the sampling of NH_3 mixing ratio on board the aircraft has been identified. It is due to adsorption/desorption effects of ammonia on the PTR-MS instrument inlet that lead to slow response times.. Figure 5 shows the difference in statistics obtained when separating the reconstructed columns from ascending and descending flights. More attention needs to be paid to this effect.

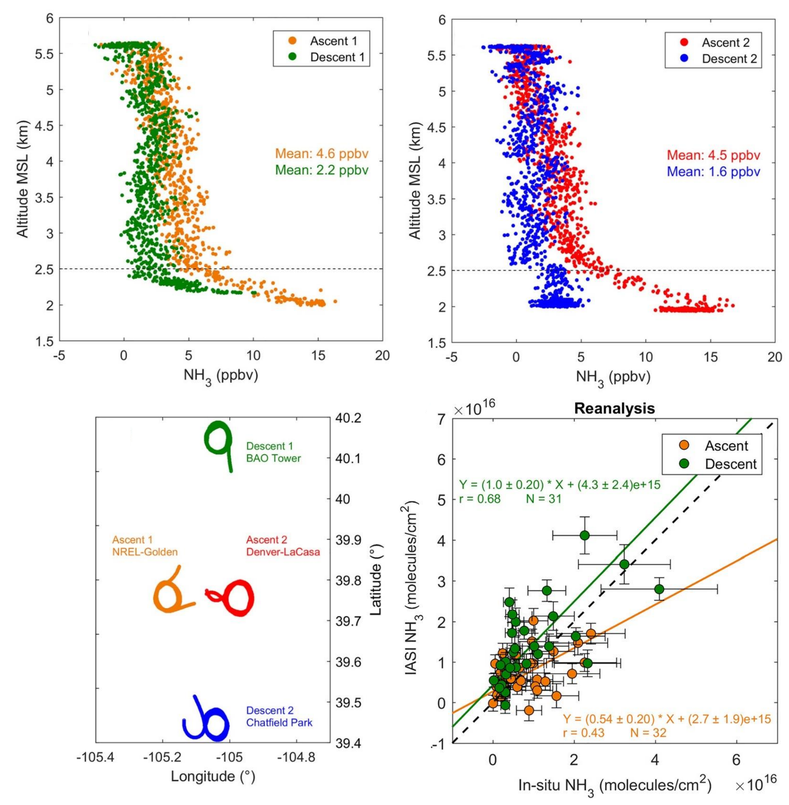

Figure 5: (top) Illustration of the in situ NH_3 mixing ratios for two couples of ascending and descending flights shown in the bottom-left panel. (Bottom-right) Reanalysed IASI-NH_3 product versus the in situ NH_3 columns in Colorado with ascent (orange) and descent (green) aircraft profiles analyzed separately (same data replotted from Figure 4).

FTIR

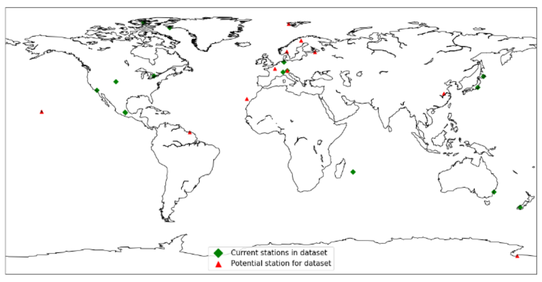

Figure 6: FTIR stations from Network for the Detection of Atmospheric Composition Change (NDACC).

The stations part of the Network for the Detection of Atmospheric Composition Change (NDACC) offer a diversity of ground-based sites accommodating a Fourier Transform InfraRed (FTIR) instrument. The locations of the site providing NH_3 measurements are shown in Figure 6. Figure 7 compares the NH_3 total columns from IASI with the FTIR total columns for a selection of stations and for the entire dataset. The collocation criteria chosen are ± 90 min, ± 50 km (Dammers et al., 2016).

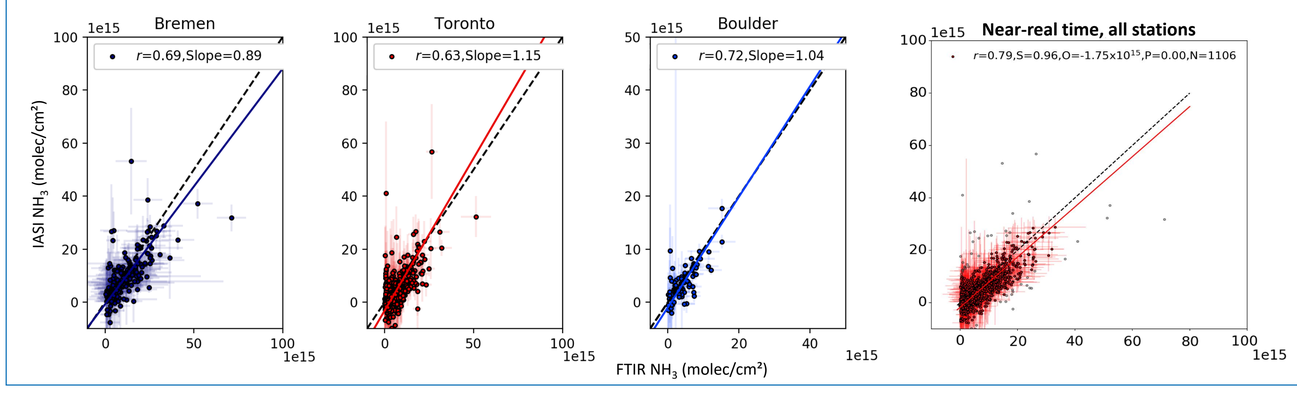

Figure 7: IASI-NH_3 total columns (molec/cm²) versus FTIR total columns for a selection of stations (from left to right: Bremen (Germany), Toronto (Canada) and Boulder (United-States)) and for all stations (right panel). Statistics are indicated as inset and the dashed line represents the 1:1 slope.

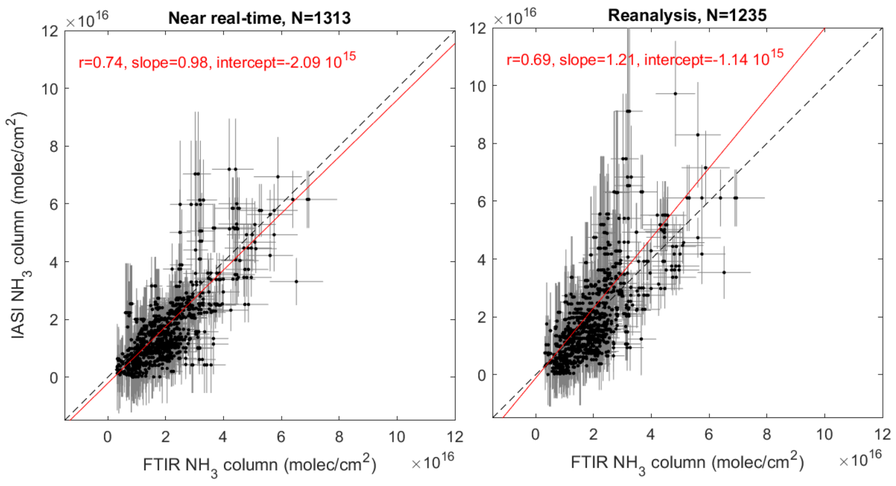

Figure 8: IASI-NH_3 total columns (molec/cm²) versus FTIR total columns for the Hefei site (China). Statistics are indicated as inset and the dashed line represents the 1:1 slope.

For a few years, FTIR NH_3 total columns measurements are also performed at the Hefei site (China), which have been compared to both IASI-NH_3 datasets (Figure 8). The collocation criteria chosen here are ± 60 min, ± 25 km.

References

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