Feasibility of Using IASI Satellite NH₃ for Air Quality Monitoring

Xuehui Guo 1, Pierre-François Coheur 2, Lieven Clarisse 2, Da Pan 1, Rui Wang 1, Mark A. Zondlo 1

1 Dept. of Civil and Environmental Engineering, Princeton University 2 Univ. Libre Bruxelles

Introduction

Ammonia (NH₃) is an atmospheric trace gas, and contributes to the formation of secondary aerosols and nitrogen deposition. Current NH₃ emission inventories have great uncertainties due to the lack of measurements and significant spatiotemporal variabilities of emissions. Recent advancement of remote sensing techniques has offered great opportunities for improving these inventories and our understanding of NH₃, but satellite NH₃ measurements have not been fully validated.

Validation algorithm

In-situ measurements

In order to validate satellite total columns, vertical profiles of NH₃ concentration are needed. During the 2014 DISCOVER-AQ* Colorado campaign, a suite of instrument was deployed to measure NH₃ including 2 aircraft, 1 tall tower, 4 mobile labs and 1 mobile FTIR. We propose to construct NH₃ vertical profiles by integrating these measurements. However, sampling artifacts of the instrument might affect the results.

Vertical profiles

4 reasonable ways to integrate in-situ NH₃:
- Negligible NH₃ above mixed layer (Profile 1)
- Linearly extrapolate NH₃ concentration to zero from max aircraft altitude to tropopause (Profile 2)
- Negligible NH₃ concentration above max aircraft altitude (Profile 3)
- Constant NH₃ concentration above max aircraft altitude (Profile 4)

Intercomparison

In-situ vs. IASI orthogonal fit using the four assumptions (15 km & 350 min window)

Intercept 0 km 15 km 45 km
20 min -4.3e15 -8.2e15 -1.7e16
60 min -4.6e15 -9.8e15 -2.6e16
180 min -4.9e15 -1.3e16 -3.6e16

Slope 0 km 15 km 45 km
20 min 1.2 ± 0.1 2.2 ± 0.1 3.4 ± 0.1
60 min 1.6 ± 0.2 2.9 ± 0.2 4.3 ± 0.3
180 min 2.1 ± 0.3 3.6 ± 0.3 5.1 ± 0.4

References

* DISCOVER-AQ: Deriving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality

Acknowledgement

We would like to thank NESSF #80NSSC17K0377 for funding, EUMETSAT O3M SAF, the IASI satellite team and Zondlo Group for their support on this research.