

Evaluating Fast Linear Retrievals with IASI

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Retrievals of **trace gases** in the Earth's atmosphere can be obtained using data from instruments such as the Infrared Atmospheric Sounding Interferometers (**IASI**), which are nadir-viewing Fourier transform **spectrometers** flown on MetOp satellites. Each of the three instruments measures over a million spectra per day, so it is a challenge to process the data fast enough to interpret it in near real-time.

As a result, many fast 'linear' retrievals have been developed. These involve effectively taking a dot product of a pre-defined gain vector with the spectrum. This is something of an oversimplification, however, as spectra depend on many atmospheric parameters. **Scaled Linear Retrievals (SLRs)** aim to compensate for this with the introduction of a **scaling factor** – a retrieved parameter which can account for external influences. This factor not only appears to improve the accuracy of the retrieval, but also helps to provide a meaningful error estimate.



Evaluating NH₃ Retrievals

A **scaled linear retrieval** of NH₃ was carried out globally, an example of which can be seen in **Figure 1**. The atmospheric concentration of ammonia is highly variable, so there are still uncertainties in models and retrievals.

The SLR was compared to other retrievals as a means of evaluation. A month of various NH₃ retrievals over South Asia in August 2010 were combined and divided into quartiles. Co-located points between different retrievals were compared and, for each day, the percentage of points which were in matching quartiles for two retrievals was calculated. This is referred to as the **quartile diagnostic**, and should indicate how well retrievals agree without considering bias correction.

The two retrievals used for this comparison were the **MORSE**¹ optimal estimation scheme, and the IASI NH₃ neural network retrieval algorithm (**ANNI**)², which uses similar linear methods to the SLR.

Figure 2 is an example of the comparison between the SLR and the ANNI retrieval on 1st August 2010.

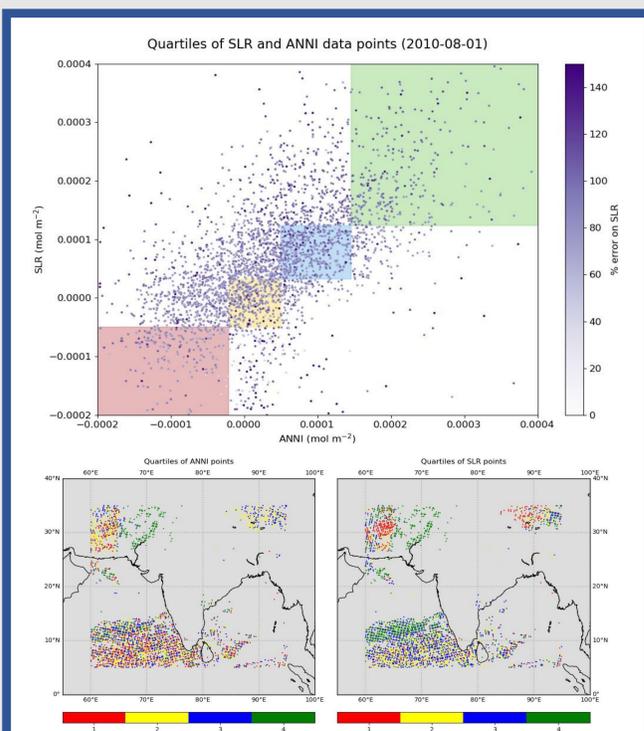


Figure 2: (a) A scatter plot of co-located retrieved column amounts in the SLR and ANNI retrievals on 01/08/2010, with the quartiles illustrated in the background. The quartile diagnostic (here, 42.5%) is a count of the points that fall within the coloured rectangles divided by the total number of points. (b) Maps of the retrieved points, coloured by quartile, for ANNI and SLR retrievals.

Currently available retrievals

C2H2
C2H6
CCL4
CH3CL
CH3O3
CO
F11
F12
F14
HCN
HCOOH
NH3
NO2
OCS
PAN
SO2

Scaled Linear Retrievals

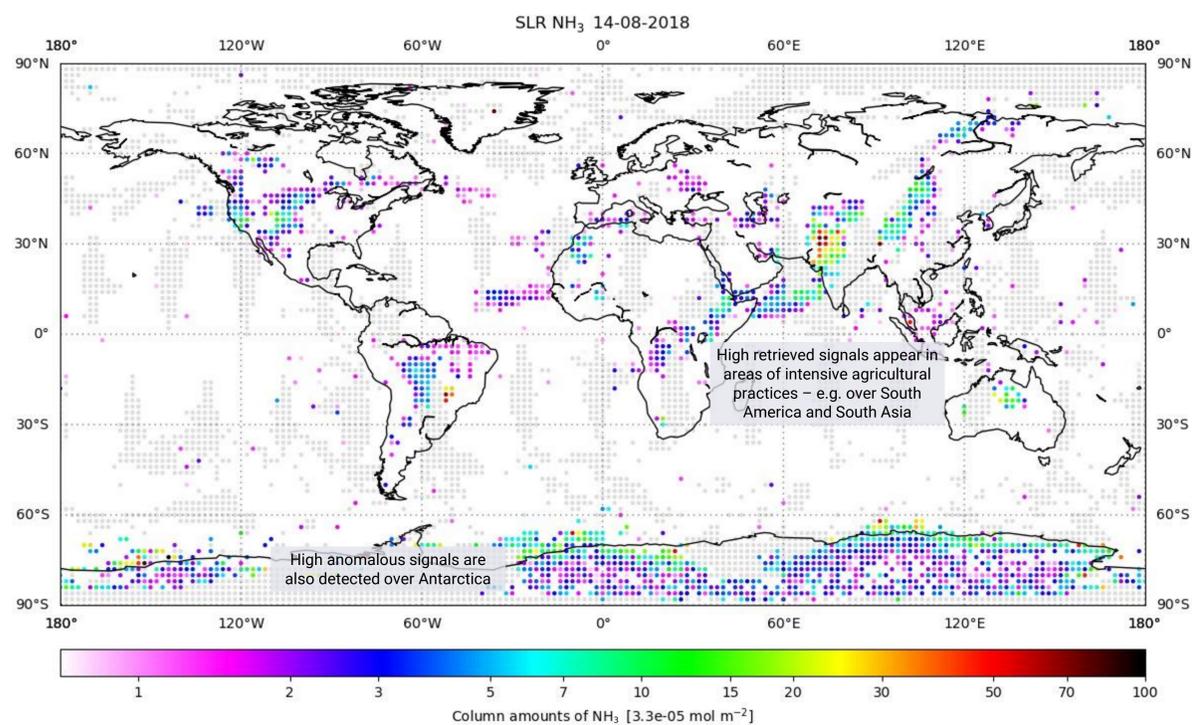
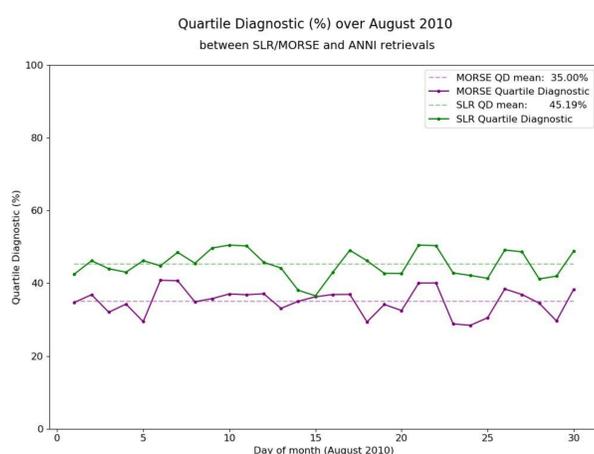


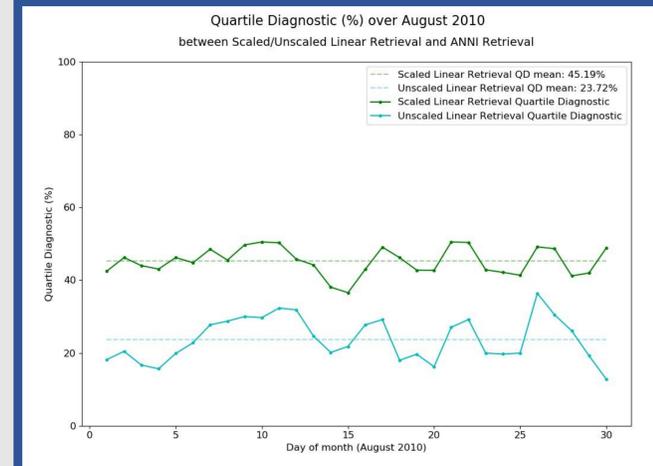
Figure 1: Global scaled linear retrieval of ammonia (NH₃) on 14th August 2018. The points displayed here show the median value of all data points in each 2° lat/lon box. Grey points indicate that no spectra were retrieved in that box.

MORSE Retrievals



MORSE is an iterative retrieval which we might expect to be more reliable than the relatively simple linear technique used by **SLR**. However, comparison of the MORSE and SLR retrievals to the neural net retrieval indicates that SLR shows much better agreement with **ANNI** than MORSE over the course of August 2010 over South Asia. The exact reasoning behind this difference in agreement is undetermined, but could be linked to the fact that ANNI and SLR use more similar methods.

The Scaling Factor



The **unscaled** retrieved values from the linear retrieval method can also be compared to the **ANNI** retrieval. We can clearly see that the scaling factor makes a huge difference in how well the retrieval matches with ANNI. This indicates that the use of the scaling factor is, in fact, appropriate and does make a positive difference to the accuracy of the retrieval.

References:

- MORSE v4, EODG, <http://eodg.atm.ox.ac.uk/MORSE/>, 2018.
- Van Damme et al., Version 2 of the IASI NH₃ neural network retrieval algorithm: near-real-time and reanalysed datasets, AMT, 10, 4905–4914, 2017.

For more scaled linear retrievals, scan QR code or visit <https://bit.ly/32djN3C>

