Testing the new SFIT4 retrieval algorithm on the Extended-range Atmospheric Emitted Radiance Interferometer (E-AERI) dataset

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Introduction

The E-AERI is a ground-based Fourier transform spectrometer that measures the atmospheric downwelling infrared spectral radiance from 400 to 3000 cm^{-1} with a resolution of 1 cm^{-1} and a high sensitivity to the lower troposphere.

It was installed at the Polar Environment Atmospheric Research Laboratory(PEARL) in Eureka, Nunavut in October 2008 to provide information about radiative balance, trace gases and cloud properties in the Canadian High Arctic.

SFIT2 is a radiative transfer and retrieval algorithm used to derive atmospheric partial/total columns and profiles of atmospheric trace gases from solar absorption spectra. An emission add-on has been developed for use with infrared emission spectra, such as those recorded by the E-AERI. This has been incorporated into the new version of the retrieval code, SFIT4, which was officially released in 2014.

This presentation will show preliminary retrievals of total columns of CO, CH_4 and N_2O from E-AERI dataset for 2008-2009 performed using SFIT4 (v0973), along with comparisons to previous SFIT2 results. Differences encountered will be investigated.

Methods

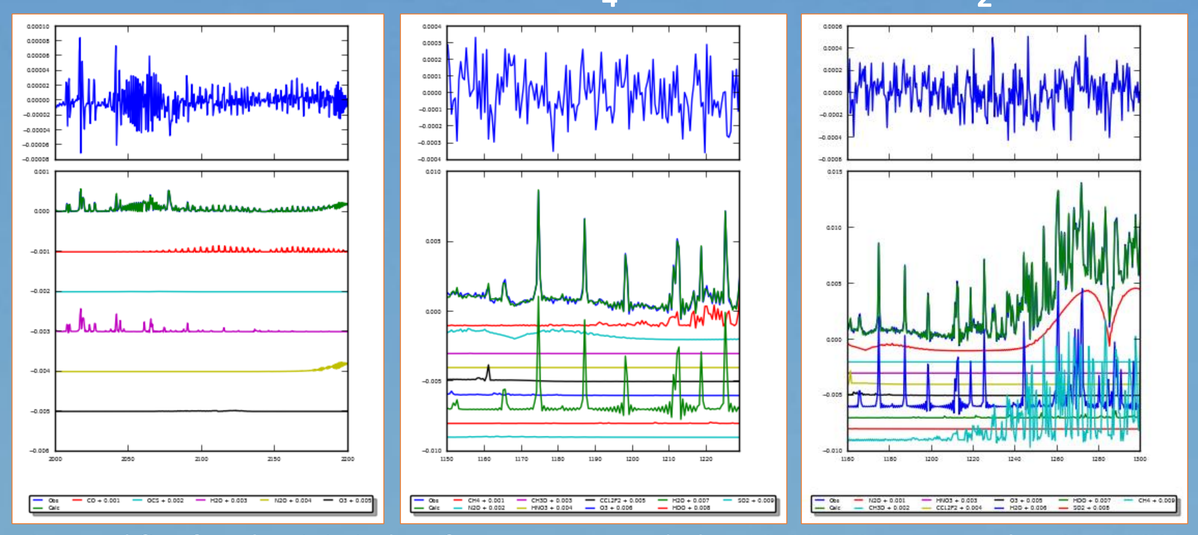
SFIT4 is a new retrieval algorithm based on the Optimal Estimation Method which is intended for wide use in the Network for the Detection of Atmospheric Composition Change (NDACC) Infrared Working Group (IRWG).

To migrate from the SFIT2 to the SFIT4 algorithm, these steps are needed:

- Output E-AERI radiance files as binary files,
- Interpolate a priori and height/pressure/temperature radiosonde profiles onto a 61-layer grid,
- Create a station layers file to specify the retrieval grid,
- Specifiy Noise Equivalent Spectral Radiance so that SFIT4 does not estimate the amount of noise on the spectra,
- Define the input control files. A single input file controls all aspects of the retrieval.

These changes have been made to the necessary E-AERI retrieval codes and permit semi-automated retrievals of CO, CH_4 and N_2O trace gases using SFIT4.

CO **CH_4** **N_2O**



Spectral fit of each miniwindow for spectra recorded at 19:00UTC on December 27, 2008.

Each upper panel shows the residual of the spectral fit and lower panel, the contribution of interfering species in the residual (Meas-Calc. W/[m^2 $srcm^{-1}$]). Strong H_2O and CH_4 spectral lines dominate and interfere with the neighbouring spectral lines of the target species.

Conclusion

These results are only preliminary results. CO total columns retrievals using SFIT4 give good results but for the others trace gases, major differences between SFIT2 and SFIT4 are for now due to errors in the input files. A considerable number of changes, technical in nature, have to be done to move from the SFIT2 to the SFIT4 retrieval code. Many have already been performed but the high values of DOFS show that other parameters still need to be adjusted or corrected.

Next steps:

- Investigate and fix error in input files
- Troubleshooting for ozone total column retrievals
- Adapt input files for error calculation for CO, CH_4, N_2O and O_3
- Retrieve total columns of these gases for 2011 and 2013
- Compare the new results to SFIT2 retrievals
- Compare SFIT4 total column retrievals for these gases with those measured by the PEARL Bruker 125 HR Fourier transform infrared spectrometer for 2008 -2013

→ Investigate the differences encountered.

First results

The following figures show the comparison of CO, CH_4 and N_2O total columns retrievals using SFIT2 and SFIT4 algorithm.
Degree of freedom for signal (DOFS) represents the number of independent quantities that can be determined from a single measurement. It is calculated as the trace of the averaging kernel matrix, and quantifies the information content of each measurement.
The unrealistically high values of DOFS here indicate that the retrieval using SFIT4 needs to be more constrained. SFIT2 retrievals have DOFS of 0.9-1.

CO

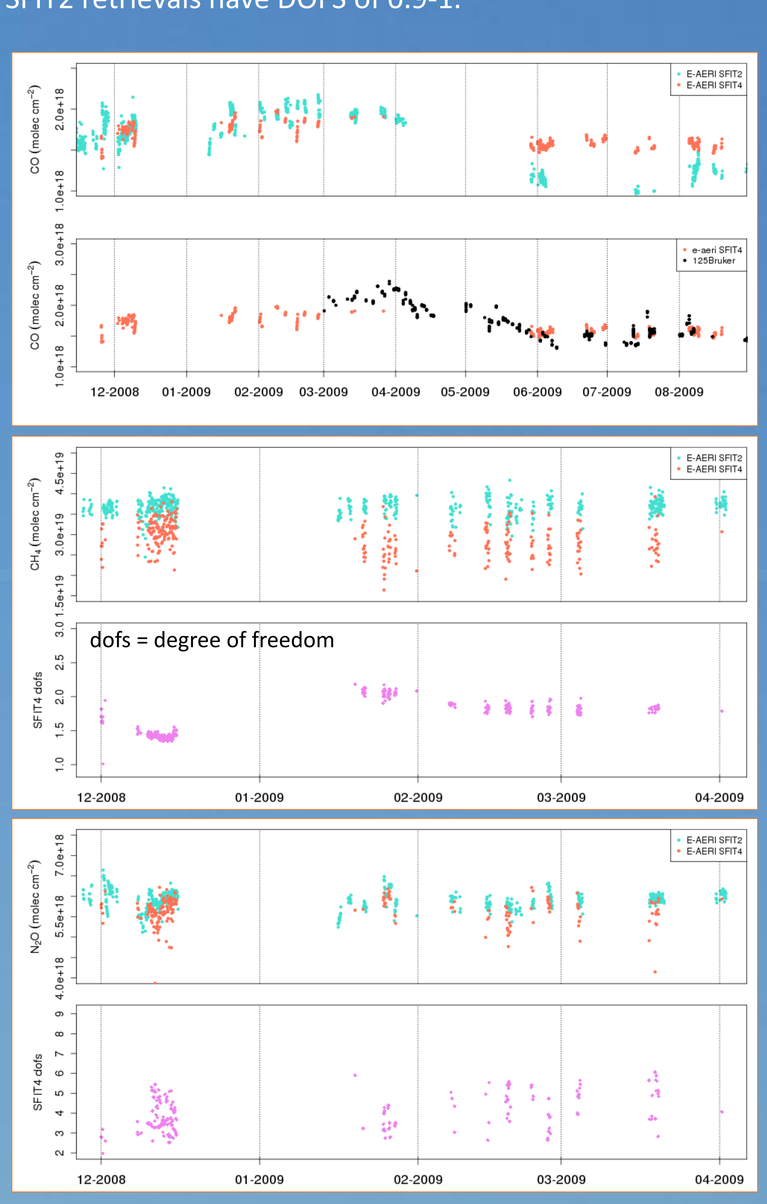
SFIT4 CO total columns retrievals are higher by 34% than SFIT2 retrievals from Apr to Sep 2009 and fit well with 125HR Bruker measurements. The effect of the collision-induced absorption of N_2 has been implemented in the new SFIT4 code. Dofs are ~1.

CH_4

SFIT4 CH4 retrievals show a large variability and lower estimation of total columns concentration compared to SFIT2 retrievals. Values of dofs are high.

N_2O

SFIT4 N2O retrievals give total columns concentration slightly lower that SFIT2 results but the degrees of freedom are still high. The retrievals parameters need to be re-adjusted.



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