Response to comments from Referee 3

Black: Referee's comments; Blue: Authors' answers

We thank referee #3 for the review and for providing useful feedback.

Referee:

This paper describes the problem of optical interferences occurring in FTIR spectrometers that are used in NDACC: it describes some laboratory experiments aiming at identifying and characterising these interferences in about 25 of the NDACC FTIR spectrometers and attributes the interferences to the optical elements inside the spectrometers. It is shown that it is essentially the beamsplitter that causes these interferences. These interferences cause channeling in the spectra that make the observation of weak absorptions in atmospheric spectra difficult. The paper also shows test with beamsplitters with different wedges and concludes that beamsplitters (BS) with a wedge of the gap between the BS and the compensator plate of 0.8_ (instead of the actual standard 0.5_) would be a good choice to minimize the channeling and at the same time avoid re-alignments when exchanging BS.

General comments:
The paper is essentially a technical paper. It is very concise and reads easily; the objectives, methodology and conclusions are clearly formulated. However, being a technical paper, I have the feeling that some technical details are missing, or not clearly spelled out.
- Equation (1) provides the formula for the Free Spectral Range of a Fabry-Pérot (FP) etalon, but it is not mentioned how FSR is calculated for 'a resonator due to both substrates, the beamsplitter and the compensator plate' (line 165).

The formula calculates the resulting frequency out of the cavity length. Here, it is used the other way around. The observed channeling frequency is used to calculate the optical thickness. A channeling frequency of 0.11 cm^{-1} corresponds to 30 mm of KBr which includes beam splitter and compensator plate.

- Tables 3 and 4: at some sites, like Harestua, Garmisch, Altzomoni in Table 3, or Harestua, Zugspitze, Altzomoni in Table 4, some frequencies appear that are very different from the other ones, without any explanation as to their origin: are they due to window effects ? Why are some of these different frequencies classified in Table 2 as the 'standard' F2 or F3 frequencies ?

Yes, this kind of channeling is caused by the detector window.
Line 166f states 'A few spectrometers show an additional channeling fringe with a frequency of about 3 cm^{-1}. This is due to the detector window that is often made of sapphire or calcium fluoride (CaF_2).' And similar in line 193f:
'Two spectrometers show an additional channeling frequency of 2.17 and 3.85 cm^{-1}, indicating that the wedge of the detector window is not sufficient in these cases.'
We added the site names to clarify this.
Please also note the color code in Figs. 4 and 5 to indicate the origin of the channeling with the largest amplitude at each site.

Table 2 or 3 (We guess you refer to Table 3):

If the standard F2 or F3 frequency was not observed other frequencies moved forward (Toronto, Harestua, Garmisch, Zugspitze and Altzomoni).

- In Table 4, A4 (= 21 pro mille) at Ny Alesund corresponds to F4 . Why is this amplitude included in the range of amplitudes of the channeling caused by the gap of the BS, with frequency F1 = 0.9 cm^{-1}) ?

Yes, F4 (2.17 cm^{-1}) is attributed to an optical window, for example the detector window, see line 193-194. Also in Fig. 5 color code denotes F4 as caused by a window (in blue) not the gap of the BS.

The range covers the entire range observed not only due to BS channeling. For clarity, the sequence of sentences has been changed in line 195f: Instead of 'Figure 5 shows the amplitude of the strongest channeling frequency of each spectrometer. In most cases, channeling caused by the gap of the beam splitter is the most pronounced one. The amplitudes range from 0.3 to 21 ‰ with …' has been changed to 'Figure 5 shows the amplitude of the strongest channeling frequency of each spectrometer. The amplitudes range from 0.3 to 21 ‰ with … . In most cases, channeling caused by the gap of the beam splitter is the most pronounced one.'
And similar in line 170-172.

- In Table 4: why at Lauder, 2 different frequencies are assigned to F1 ? The same question holds for a few other sites and other frequencies (F2) in Table 4.

If the FFT analysis yields channeling at two frequencies close to each other the corresponding amplitudes were listed in the same column. You're right, for Lauder the second frequency in the F1 column does not fit here. It is changed in Table 4.

Specific comments:
- Line 49: I would specify 'total and partial column abundances' instead of simply 'column abundances'

Done.

- Line 93-94: The sentence is erroneous as it is formulated here. I suggest to replace it as follows: "The Fabry-Pérot etalons generated by these optical components have rather low etendu and therefore the undesired parasitic effects caused in their spectral transmission is well described as an harmonic oscillation." I believe that this is what the authors intend to say. It would also be good to give the definition of 'etendu of a FP' here, or to add a reference to a definition.

Sentence is corrected as suggested. Thanks for pointing to this paragraph and we also found a mix-up of terminology: we intended to refer to the finesse of the resonator here, not to the etendue. The low reflectivity yields a low finesse. The finesse is a measure of the number of reflections within a cavity and a low reflectivity means a low finesse and small number of reflections within the cavity.

- Table 1: Apparently the FSR given in the table assumes theta = 0_. However, in the standard NDACC FTIR spectrometer configuration, theta is typically 45_ for the beamsplitter. So I am confused: how has the experiment been set up exactly ?

You're right, the FSR given in the table is calculated with theta = 0. In the NDACC FTIR spectrometer configuration theta is 30°. However, due to refraction theta is smaller inside the beam splitter. According to Snell's law theta is 19° for n=1.5. *Cos* 19° is about 0.95 and therefore close to 1.0.

- Line 117: It is stated that NDACC filters with a wedge of 10’, if properly oriented, do not cause channeling. Don’t they cause any channeling at all, or are the frequencies of the channeling such that they don’t disturb significantly the retrieval of typical NDACC atmospheric spectra ?

If the wedge is sufficient they don’t cause any channeling at all. The reflecting beams do not overlap and thus do not interfere with each other.

- Figure 2: Why has the x-axis been given in 1/Frequency whereas Figure 3 has an x-axis in frequency ?

In the OriginTM software the inverse FFT has been applied which calculates the results as function of 1/frequency as shown in Fig. 2. For the presentation and discussion of the results the results were given in terms of frequency to be consistent with the spectra shown in Figs. 6 and 7.

The paper deserves being published, after some revisions to cope with the above comments.