Interactive comment on "Diurnal cycle and multi-decadal trend of formaldehyde in the remote atmosphere near 46 N" by B. Franco et al.

Anonymous Referee #2

Received and published: 14 January 2016

We thank Referee#2 for his/her review and the constructive comments. Please find below our responses written in blue.

This is an excellent and thorough analysis of total column formaldehyde over the Jungfraujoch. The 27 year record provides a valuable insight to changing atmospheric composition in northern mid-latitudes. The trends follow the changing CH4 in the atmosphere.

This work also allows for an understanding of diurnal variability in the remote tropospheric background H2CO from CH4 oxidation, which is both useful in itself and will allow for better source apportionment at other sites more influenced by biogenic VOC emissions closer to the ground. As stated by the authors the parametric modelling of diurnal variability will improve intercomparisons with both satellite-based sensors and models.

This is an interesting paper and highly suitable for publication in Atmospheric Chemistry and Physics after some minor comments are addressed:

1. A pedantic one, but trends exist whether they are measured or not, so the very first sentence of Abstract should be re-written – as "Only very few long-term records of formaldehyde exist" – or perhaps "Only very few long-term records of formaldehyde exist that are suitable for trend analysis" or whatever alternative the authors prefer.

We agree with the Referee. Therefore we have re-written the sentence according to his/her suggestion.

Page 1, lines 1-2: "Only very few long-term records of formaldehyde (HCHO) exist that are suitable for trend analysis."

2. Page 31295, 1st paragraph: Is the QA/QC cut-off of DOFS of 0.35 arbitrary or based on some specific factor. An arbitrary basis is fine – but should be identified as such.

This threshold of 0.35 has been set arbitrary as a compromise between retrieved information content and sufficient statistics at low zenith angles to ensure a proper fit of the diurnal cycle by the Weibull-based parametric model. We now alert the reader about this choice as follows:

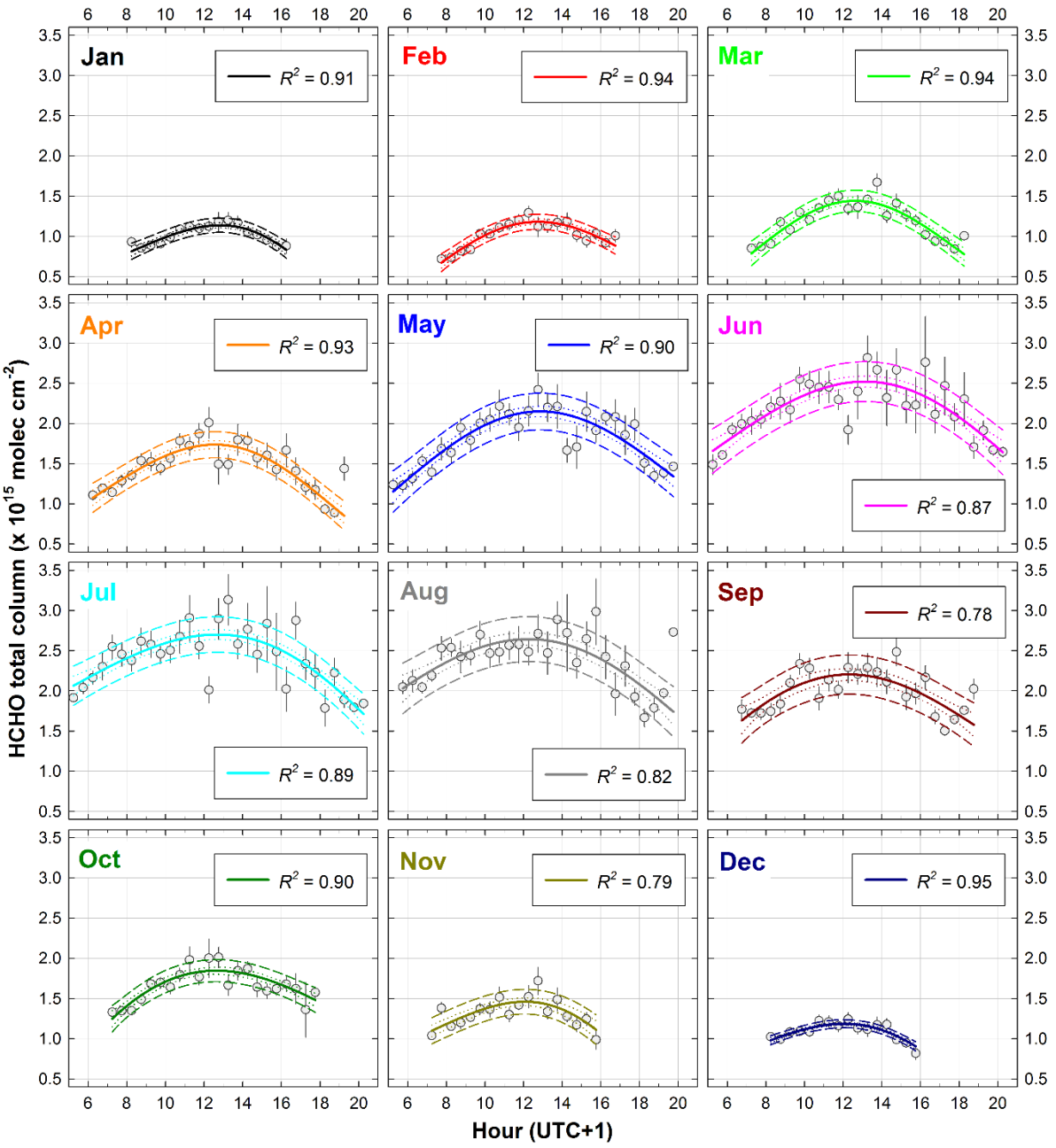
Page 4, lines 288-291: "*…the individual observations characterized by a DOFS value lower than 0.35 have been discarded. This DOFS threshold was set arbitrary to ensure sufficient statistics at low zenith angles for representing the HCHO diurnal cycle around mid-day (see more details in Sect. 3.2). Franco et al. (2015b) also provides a complete error budget…*"

In addition, as requested by Referee#1, we now discuss in Sect. 3.2 the impact of the choice of the a priori profile on the HCHO total columns derived from retrievals characterized by low DOFS values, and

hence on the representation of the diurnal cycle around noontime. Please see our response to Referee#1 comment with respect to this issue.

3. Figure 1: It is unclear why the different months have been split in the way they have been into 4 plots. Are the months chosen just to give the best separation on the y-axis? If so, then this should be stated somewhere for clarity.

Following Referee#1 suggestion, we now provide Fig. 1 as a 12-frame figure, plotting each month separately for visibility purpose. Please find this new Fig. 1 here below.



4. Section 5: Please clarify whether the spectra recorded on the same days represent actual coincident spectra or whether they are recorded at different times of day and corrected via the parametric model to the equivalent 9am values.

In Section 5.1, we only used solar spectra from the 1995-1997 BRUKER and LIEGE data sets recorded on the same days, at different times of day. We accounted for the diurnal modulation of HCHO by indeed correcting these individual observations via the parametric model to the equivalent 9 a.m. values. For more clarity in this Section, we have added the following additional information before the Sect. 5.1.

Page 8, lines 713-719: "*We investigate hereafter the long-term evolution of the HCHO abundance at ISSJ, using both the LIEGE and BRUKER FTIR data sets. We employ the HCHO total columns derived from all individual FTIR observations made over the 1988 – 2015 time period, corrected to the equivalent 9 a.m. values via the parametric model described previously, and eventually combined as daily means.*"