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Interactive comment on "Identifying fire plumes in the Arctic with tropospheric FTIR measurements and transport models" *by* C. Viatte et al.

Anonymous Referee #3

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The paper of Viate et al., adresses an important topic, since the authors want to quantify emission factors of biomass burning in the Arctic by ground based column observations. They use multiannual timeseries of observations of several tracers including CO, HCN, HCHO, C2H2, C2H6, HCOOH and CH3OH in Thule and Eureka to identify plumes. Frome the enhancement ratio of the tracers they estimate emission factors. They do this by using a combination of Lagrangian tools (HYSPLIT, STILT), and satellite observations to estimate the source region and transport time. The trace gas observations are compared to the results of the MOZART-4 model, which according to the authors shows a good agreement between the observations. Exception is Ethane during winter, when the model is far too low. The authors conclude that the model generally underestimate the emissions compared to the observations.

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The paper is well written and clearly adresses an aspect of high interest, which is in the scope of ACP. My main points are a clarification of the statistics to derive the emisson factors based on the enhancement ratios. Second the plume travel and source fire determination need to be clarified, which is important for the short-lived species. In particular the altitude of the plume location from the column measurements is not motivated at all. This however strongly determines the initialisation of the Lagrangian tools and therefore source region and travel time. Therefore the initialization altitude of the Lagrangian analysis needs to be adressed, since it determines strongly the source region (fire type!) as well as travel time. I therefore recommend the paper for publication after the following points are adressed.

Major: For the enhancement ratios the slopes between species have to be calculated. Which algorithm is used and how is the error in both species accounted for in the regression? The differences from the respective fit algorithm can be substantial particularly when neglecting the fact, that both quantities carry errors and the number of pairs per fit is samll (six pairs is the minimum according to the statment on p.26367, l.24). See Cantrell, ACP, 2008.

To estimate the potential fire source region from a column measurement you need to initilize the Lagrangian tools in the whole column. How does this affect the estimates of travel time and source region? The air in the boundary layer can have a totally different origin than just above the inversion or in the troposphere. How is the altitude for the HYSPLIT or STILT initialisation determined? It is only stated that STILT footprints are generated (p.26360), but not mentioned, how this is achieved (i.e. initilized).

Fig.4 and related discussion (p.26360, l.24 ff.): What is the benefit of the HYSPLIT trajectories in addition to the STILT dispersion model, which also relies on a Lagrangian backward calculation?

Concerning HYSPLIT: It is stated that an ensemble of trajectories is calculated: How large is the ensemble and how is it initialized? A cluster in different altitudes? An

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ensemble of only three trajectories would be not very satisfying.

To estimate the effect of the correction from travel time it would be helpful to include the enhancements before and after the correction applied in a Table to estimate the importance of travel time.

Furthermore: How is the travel altitude considered for the chemical correction of the plume (or the vertical column)? The chemical degradation strongly depends on the altitude, which therefore needs to be known.

Minor: Does the FINN biomass burning data set contain daily variability? On which observations is it based on?

p.26369: Although enhancement ratios are more robust against mixing than single mixing ratios it would be could to shortly adress the effect of mixing during travel time.

Table 3: Although given in Viate, 2014, it would be good to repeat the lifetimes in the table.

References: Cantrell, C. A.: Technical Note: Review of methods for linear least-squares fitting of data and application to atmospheric chemistry problems, Atmos. Chem. Phys., 8, 5477-5487, doi:10.5194/acp-8-5477-2008, 2008. http://www.atmos-chem-phys.net/8/5477/2008/acp-8-5477-2008.html

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