

## ***Interactive comment on “Firewood residential heating – local versus regional influence on the aerosol burden” by Clara Betancourt et al.***

**Anonymous Referee #1**

Received and published: 19 December 2020

General comments:

This manuscript presents the simulated isotope ratios of the biomass burning tracer levoglucosan using Lagrangian Particle Dispersion Model (LPDM) FLEXPART. The authors combine the model results with observed levoglucosan concentrations and  $\delta^{13}\text{C}$  to evaluate the sources of residential burning emission. The simulations indicate the aerosol is 1 to 2 days old aerosol, likely from local to regional sources. The low OH concentrations in winter likely lead to limited levoglucosan photochemical aging. The isotope analysis shows that the observed  $\delta^{13}\text{C}$  is in the range of  $-25.3$  to  $-21.4$  ‰, which is agreed with previous studies on levoglucosan source specific isotopic composition in biomass burning aerosol. The authors present scientific results well using FLEXPART model and isotope analysis and statistical analysis. The overall quality of

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the manuscript is good, although some areas will need improvement. I recommend that the manuscript be published after making the following revisions.

Specific comments:

1. The authors compared the difference between ECMWF and GFS dataset. However, the meteorological data (e.g., cloud fraction, low cloud cover, precipitation, temperature, wind speed) is not shown and compared with observed levoglucosan. Please provide some details for correlation between meteorological factors and observed levoglucosan concentrations.

2. Line 140: Why the in-cloud scavenging is not considered? Cloud/fog scavenging might occur at lower PBL. Have you checked the cloud bottom layer height? Do you have vertical cloud data with relative humidity? Any vertical profile of in-cloud scavenging, blow-cloud scavenging?

3. Line 140-141: The OH-decay rate constant of levoglucosan,  $2.67 \times 10^{-12} \text{ cm}^3 \text{ molecules}^{-1} \text{ s}^{-1}$  is one order of magnitude lower than the  $1.1 \times 10^{-11} \text{ cm}^3 \text{ molec}^{-1} \text{ s}^{-1}$  reported by Hennigan et al. (2010). Please explain why you choose  $2.67 \times 10^{-12} \text{ cm}^3 \text{ molecules}^{-1} \text{ s}^{-1}$ .

4. Line 189-190: Please explain more on why higher residence time of model particles can lead to higher derived levoglucosan concentration. Wind speed, turbulence condition, levoglucosan decay rate can also affect levoglucosan concentration.

5. Line 193: “vertical mixing parameterizations”. Please specify which parameter.

6. Line 194-195: “Due to the higher vertical resolution and ability to more accurately account for topography, ECMWF meteorology was chosen to initialize the model for the future runs.” Did you consider to use WRF meteorological data for comparison?

7. Line 213-214: “. . .levoglucosan is relatively stable during winter due to the low OH concentration.” Is this also due to the lower temperature in winter? What’s the average temperature during sampling periods? The reference from Busby et al. (2016)

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seems does not point out the levoglucosan reactivity in winter is due to the low OH concentration. Please check the reference.

8.Line 255: What are the two major types of sources?

9.Figure 4: Please explain the possible reason for the two outlier points at STYR site. The standard deviation is also higher than others.

Technical corrections:

1.Line 184: Figures 6.1 and 6.2 should be Figures S6.1 and S6.2.

2.Line 258: Figure “ ” is Figure 4?

3.Line 264: Figure “ ” is Figure 5?

4.Line 302: Table 8.3 should be Table S8.3.

5.Line 307: Table 7.3 should be Table S7.3.

6.Supporting Information line 143, 146, 150, 153, 154, 157, 161, 164, 166, 169, page 9: Some equations and words are missing.

7.Supporting Information Table S7.2: and Table S7.3: Some words are missing for the captions. Basic statistics for “.....”.

8.Table S7.4: Some words are missing for the captions. Basic statistics for the difference between “...” and “...”.

9.Supporting Information P.19 Table S8.3 should be Table S8.4.

10.Figure 1: The position of tm /s legend is too close to the latitude “-30”. Please move the legend to a clear region. The unit of tm can be consistent with the figures of height vs. time/h.

11.Figure 5: The color of light green and dark green is too similar, hard to distinguish it.

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