Updates on biomass burning in relationship with vegetation type

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Introduction

In a recent study by Adam et al. (2020a), the biomass burning measurements at 13 stations in EARLINET over 2008-2017 were analysed by the means of intensive parameters, with focus on biomass burning events measured by two stations, long range transport from North America and statistical analysis for four chosen geographical regions (while the sources were roughly associated with a continent). One of the outcomes of the previous study was that we usually measure "mixed smoke", i.e., a mixture of smoke originating from many different sources.

Currently, we focus on the lidar measurements in Magurele (Romania, latitude 44.3448 N, longitude 26.0123 E) over 2008-2020 period. The data are reprocessed using the latest version of Single Calculus Chain (SCC; v5.2.2) issued in May 2021. The main purpose of the study is to investigate the relationships between the optical properties retrieved from lidar measurements (in particular, intensive parameters) and the vegetation type of the biomass burning. Overall, the data analysis follows the methodology presented by Adam et al. (2020a). Briefly, the biomass burning sources are identified based on the HYSPLIT backtrajectory (https://www.ready.noaa.gov/hypub-bin/trajtype.pl?runtype=archive, last access 20/05/2021), considering as a source the fire/s found within 100 km and +/- 1 h from the airmass trajectory. The fires' locations are provided by FIRMS (https://firms.modaps.eosdis.nasa.gov/, last access 20/05/2021). However, a few improvements have now been added. The most important one is that the injection height is now computed based on the fire radiative power provided by FIRMS, following Amiridis et al. (2010) and Solomos et al. (2019) in order to assess the altitude of the smoke injected in the atmosphere and verify if it reaches the airmass trajectory. As mentioned in a previous presentation (Adam et al., 2020b), the land cover data is provided by MODIS (https://lpdaac.usgs.gov/products/mcd12c1v006/, last access 20/05/2021).

Results and discussion

During 2008 – 2020 a total number of 1702 files were recorded over Magurele, representing 373 time stamps over 116 days. The EARLINET QC rejected 17 files. From 373 time stamps (datasets) we chose 108, representing 3+2+1 measurements. For those, the first QC was visually performed. We have chosen 38 datasets (35%) for which we have 64 layers. The second QC was performed over the optical properties, following Adam et al. (2020). There were 26 datasets (39 layers) passing the criteria (24 % of initial set).

In Fig. 1 we show an example of ensemble HYSPLIT backtrajectories along with the mean trajectory (in red). The ensemble was computed such that the input altitude ranges from bottom of the layer to the top of the layer in discrete altitude increase. The mean trajectory was computed using the trajectory cluster analysis from HYSPLIT. In this particular case, the input altitude ranges from 1323m to 2723m in 50m increments and thus, the ensemble is made of 29 individual trajectories.

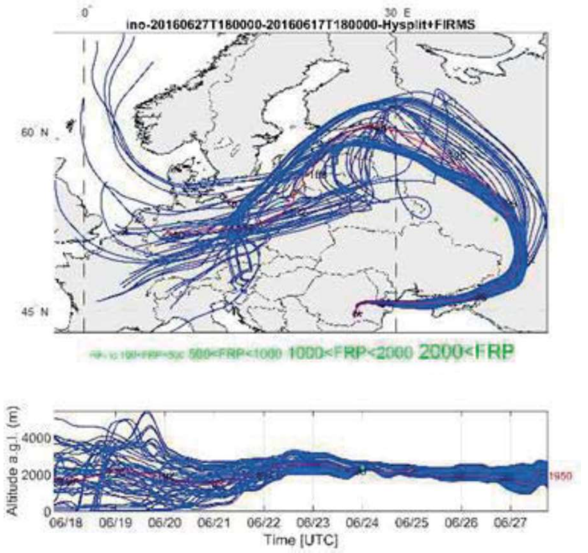

Figure 1. HYSPLIT Ensemble trajectories along with the mean trajectory in red arriving at Magurele at every 50 m between 1323 and 2723m height, 27 June 2016, 1800UTC. The lower plot shows the altitudes of the air mass a.g.l. The location of the fires is shown in green.

The mean trajectory was used to assess if the layers are of biomass burning origin using FIRMS database. The injection height for each fire was computed following Amiridis et al. (2010). Thus, two fires were found to reach the air-mass altitudes (~ 96h back), where the injection heights were 2403m and 4118m, corresponding to air-mass altitudes at 2365m and 2399m. The two fires were detected three times. Thus, at 24 June 2016, 00:00 (air-mass coordinates at 41.048N, 52.708E), the first fire was identified at 39.6375N and 52.5489E where the time of the fire (according to MODIS) was recorded at 23:58 on 23 June 2016 (FRP=53.7MW). One hour backwards (air-mass coordinates at 40.903N and 52.873E), the same fire is observed along with another (39.5806N, 52.5493E, FRP=13.5MW). The time of the fires according to MODIS is 23:58 on 23 June 2016. The land cover corresponding to the two fires are shown in the following table. The preponderant contributions to the fires are deciduous broadleaf forest and evergreen needleleaf forest for the first fire and urban for the second fire. The 'predominant vegetation type' (PVT) is the one for which the coverage percentage is > 50 %. Conversely, the PVT is labelled as mixed. For the current example, PVT is labelled as mixed. The overall predominant vegetation (OPVT) type is taken as the most frequent value of all PVTs. In this example, OPTV is mixed. The lidar measurements were taken around 18:34 on 27 June 2016 and the aerosol pollution layer was between 1083m and 3243m. The lidar intensive parameters are shown in Table 2. CRLR (LR@532/LR@355) is smaller than 1 while EAE=1.45. According to the values of CRLR (<1) and EAE (>1.4), the smoke is labelled fresh (Nicolae et al., 2018). PDR has a low value which characterizes the smoke particles as almost spherical.

Table 1. Vegetation type.

		FireI	**FireII**
#	Vegetation type	%	%
1	Water	0	0
2	Grasses or cereal	14	12
3	Shrubs	0	0
4	broadleaf crops	0	0
5	savannah	11	5
6	evergreen broadleaf forest	0	0
7	deciduous broadleaf forest	41	22
8	evergreen needleleaf forest	32	21
9	deciduous needleleaf forest	0	0
10	unvegetated	0	0
11	urban	2	40

Table 2. Lidar intensive parameters.

LR@355 [sr]	63±0.6
LR@532 [sr]	41±2.5
CRLR	0.65
EAE	1.45±0.15
BAE@355/532	0.37±0.04
BAE@532/1064	1.6±0.03
CRBAE	4.3
PDR@532 [%]	2.4±0.1

The results for entire dataset will be presented during conference. It is expected to find some relationships between IPs, fires' FRP and vegetation type..

Challenges

Current challenges we try to address:

- Do we have enough and reliable lidar data to draw thorough conclusions?
- Which is the best method to compute the mean trajectory for an ensemble trajectory? How do we define the ensemble?
- Establish a method to characterize the "mixed smoke" events and thus the main type of the burnt vegetation.

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