



Wir schaffen Wissen – heute für morgen

**ME-2 and rolling PMF for analysis of
long-term aerosol chemical speciation
data**

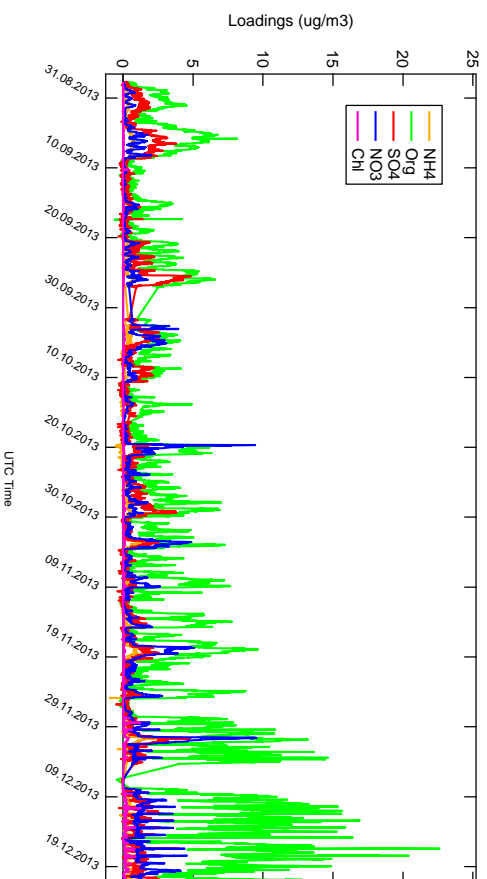
- Automatic rolling PMF algorithm to apportion sources of organic aerosols in a rural site south to the Swiss Alps:
 - ACSM and NABEL station in Magadino
- ACSM measurements in Sept 2013 – Oct 2014
- Auxiliary gas-phase measurements and meteorology
- Filter measurements



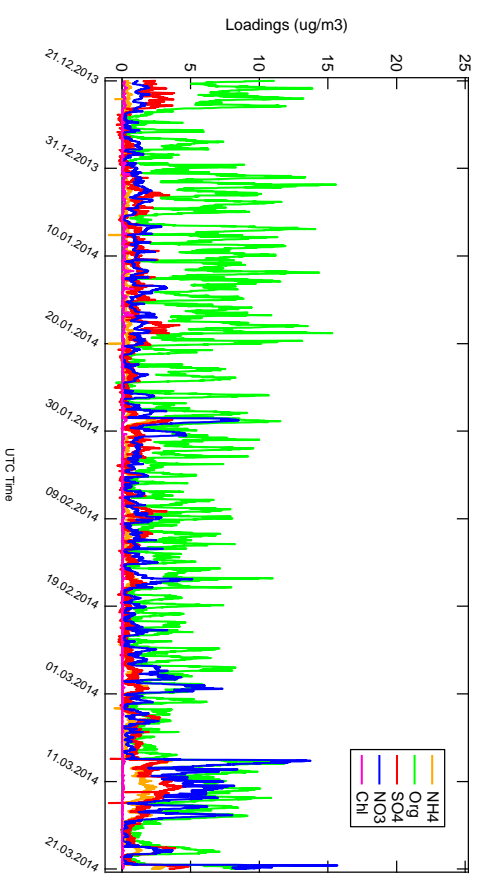
- Despite rural location, quite high PM levels in winter when specific topography of the valley favors accumulation of pollutants (annual average PM_{10} in 2008/09 of $20.9 \mu\text{g m}^{-3}$)*

[*] Gianini, et al. (2012) Atmos. Env. 54, 149-158

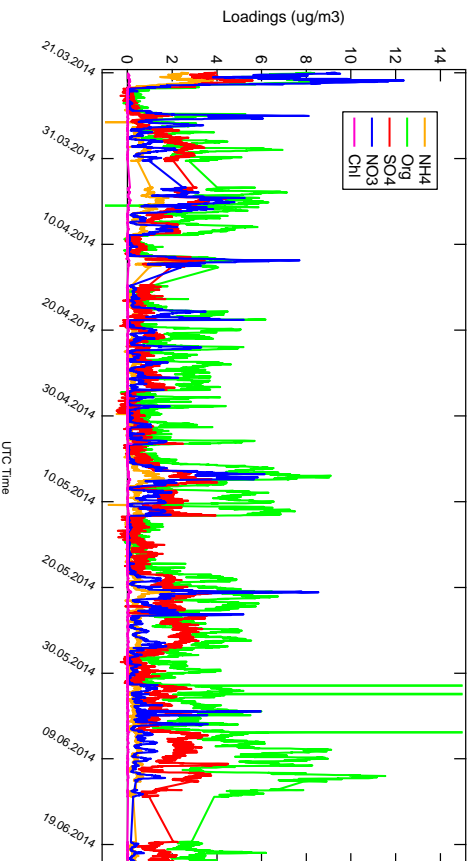
Time Series Fall 2013



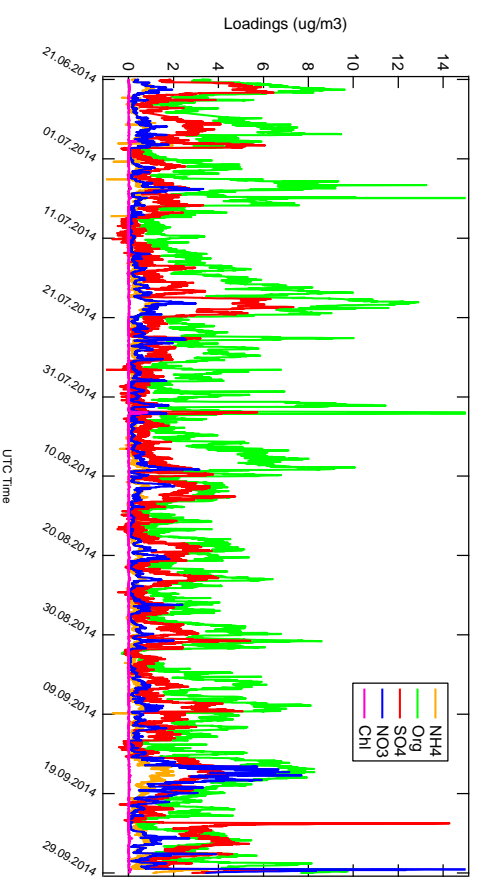
Time Series Winter 2013 / 2014



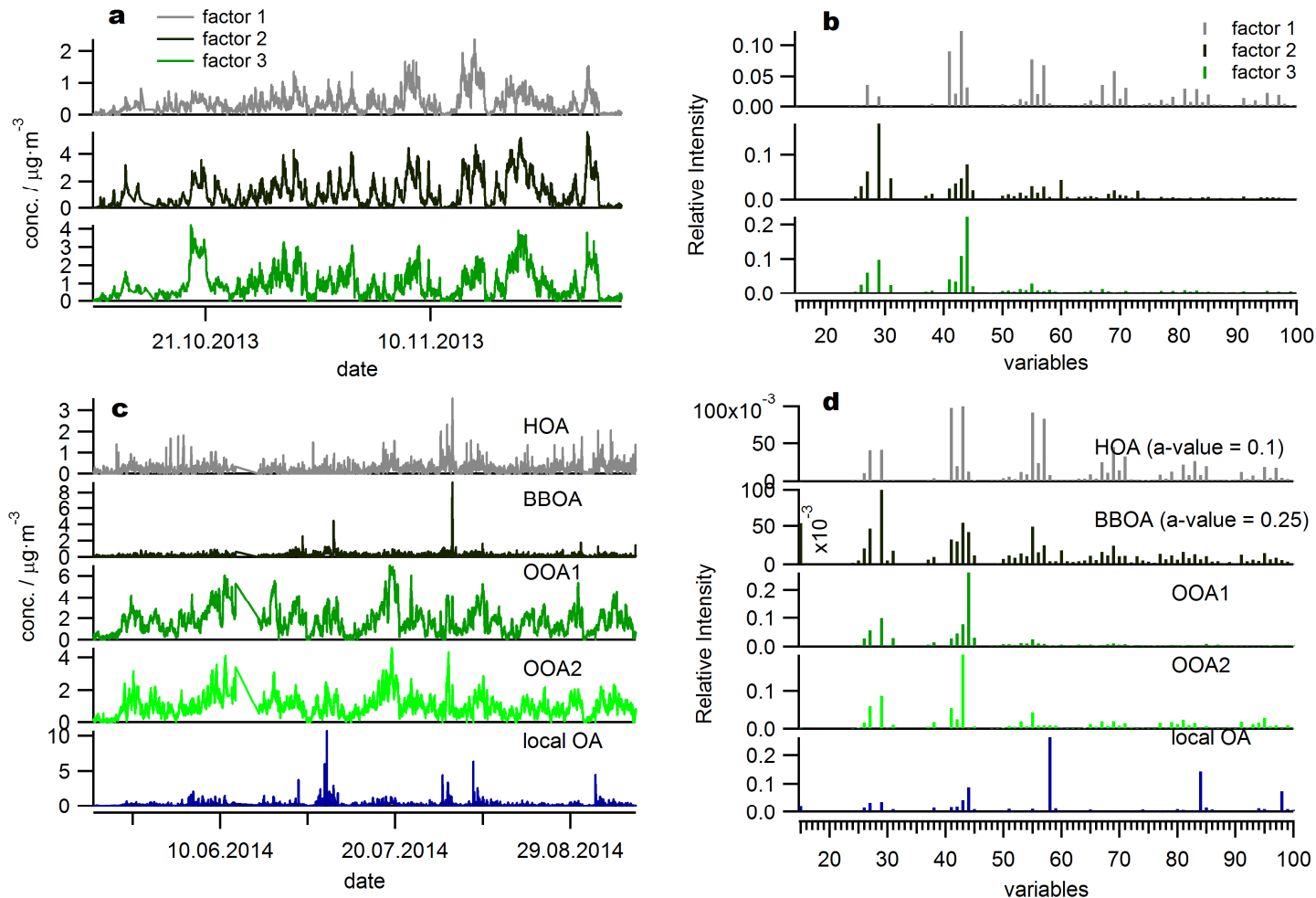
Time Series Spring 2014



Time Series Summer 2014



Pre-analysis: (Un)constrained PMF on different seasons to estimate the number of factors, perform sensitivity tests on constraining parameters, elucidate special features, *etc.*



- Rolling PMF algorithm to account for seasonal and/or meteorological variations in organic aerosol sources
- **PMF window** → a short subset of data (1-2 months) where PMF is run while aerosol sources stay constant.

- **Automatic part** → To determine the number of SOA factors:

- $$\sqrt{(I_{44}(\text{LV-OOA}) - I_{44}(\text{SV-OOA}))^2 + (I_{43}(\text{LV-OOA}) - I_{43}(\text{SV-OOA}))^2} \geq 0.05$$

- → To estimate a goodness of PMF solutions resulted from all model iterations using selection criteria

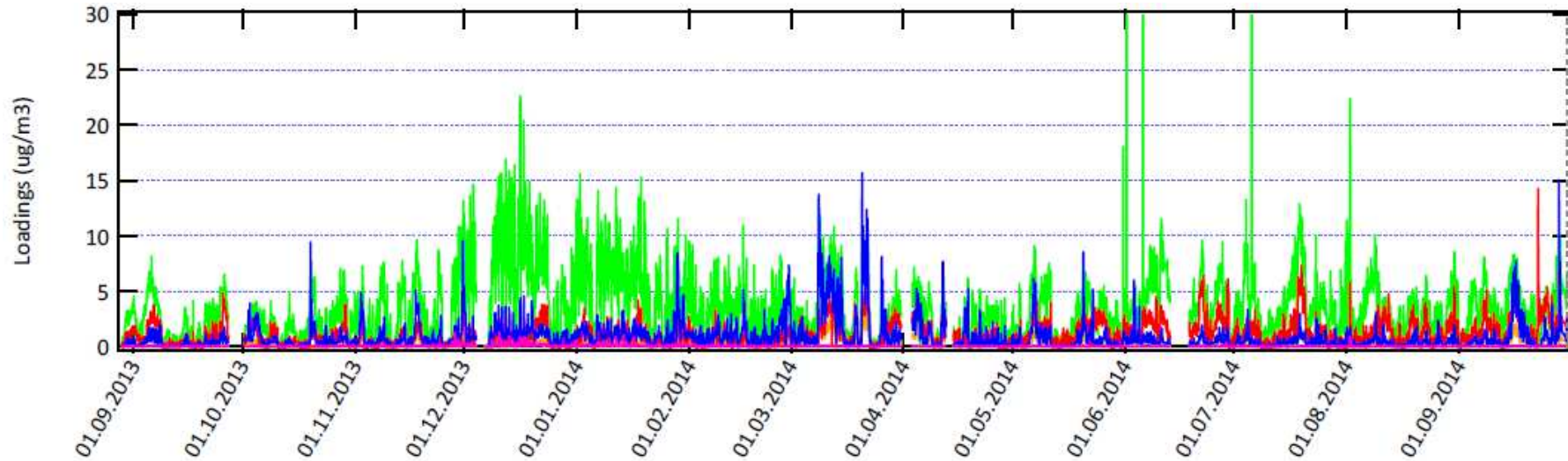
- **Rolling part** → PMF window shift by a short-time interval (1/2 to 8 days).

- AuRo-SoFi is a combination of an automatic rolling PMF window with a graphical user interface SoFi¹ that runs multilinear engine².

[1] Canonaco F, et al. (2013) Atmos. Meas. Tech. 6(12), 3649-61 [2] Paatero P (1999) J. Comput. Graph. Stat. 8(4), 854-88

	Factor	Correlation	Criterion
Primary OA	HOA	Time series, diurnal cycle	$R^2(\text{HOA}, \text{NO}_x)$ $R^2(\text{HOA}, \text{BC}_{\text{traffic}})$
	BBOA	Time series, diurnal cycle	$R^2(\text{BBOA}, \text{BC}_{\text{wood_burning}})$
Secondary OA	SV-OOA	Time series, diurnal cycle	$R^2(\text{SV-OOA}, \text{NO}_3^-)$ $R^2(\text{SV-OOA}, \text{Temperature})$
	LV-OOA	Time series, diurnal cycle	$R^2(\text{OOA}, \text{NH}_4^+)$ $R^2(\text{LV-OOA}, \text{SO}_4^{2-})$

- For each of n PMF windows $\rightarrow k$ solutions with a -value $0 \leq a_{ij} \leq a_{max}$
- Pearson's correlation coefficients between the factor solutions and inorganic species measured by ACSM or an external parameter
- The solution(/s) that maximize(s) the total score (e.g. $\sum R^2$) is to be chosen.

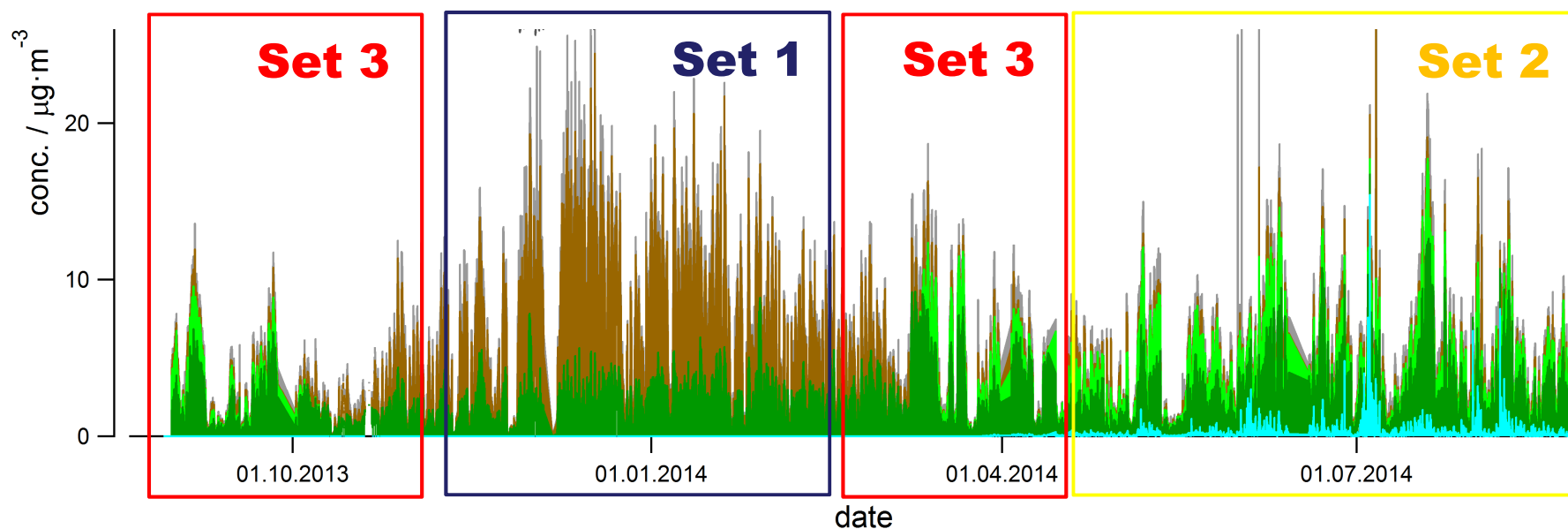


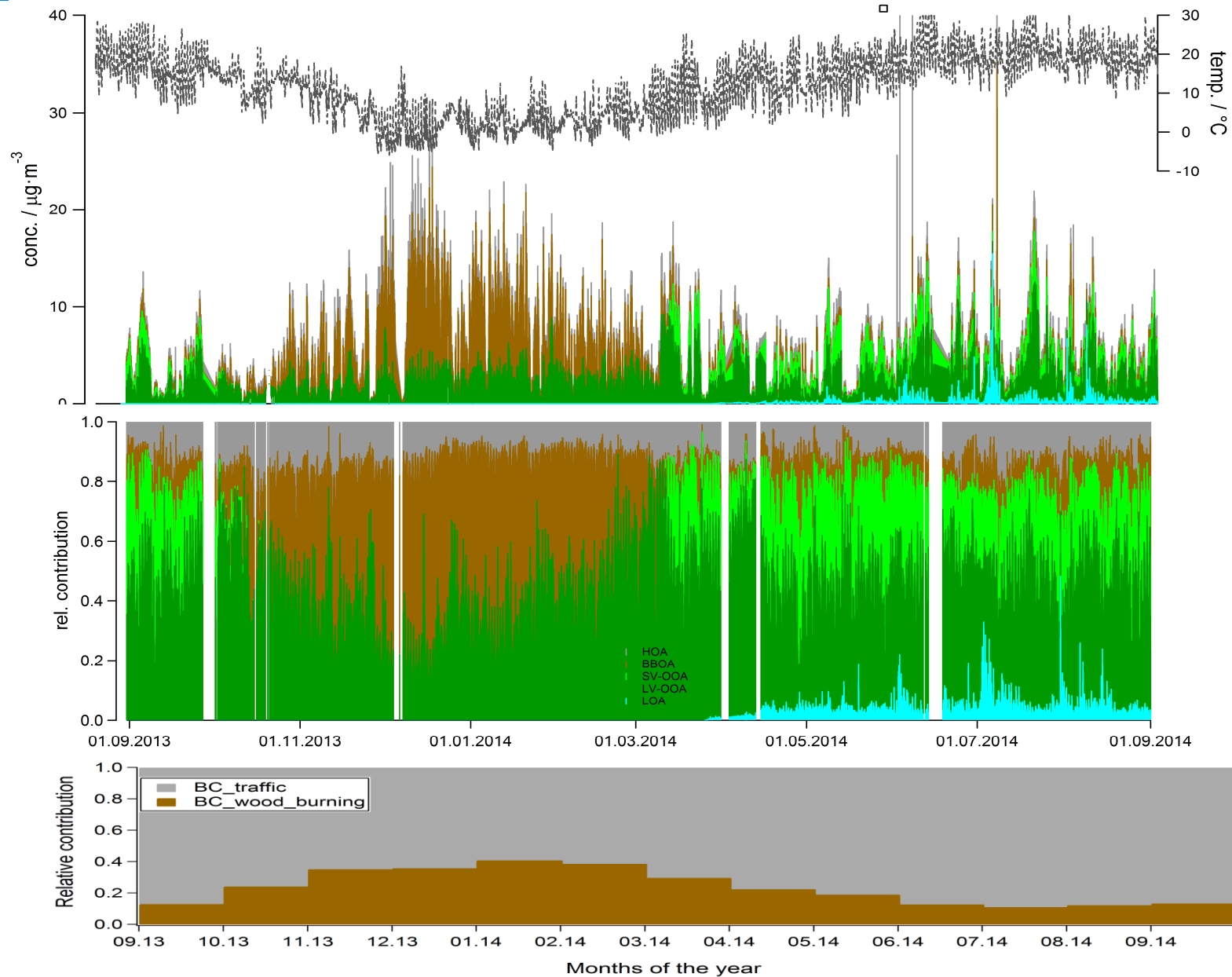
- [AuRo-SoFi model parameters:](#)
- PMF window = 1 month, 25 α -value iterations, window shift 1 days
- HOA reference profile from literature, α -value = [0, 0.6]
- BBOA reference profile from literature, α -value = [0, 0.6]
- Local OA (light blue trace) from PMF on summer data, α -value = [0, 0.05]

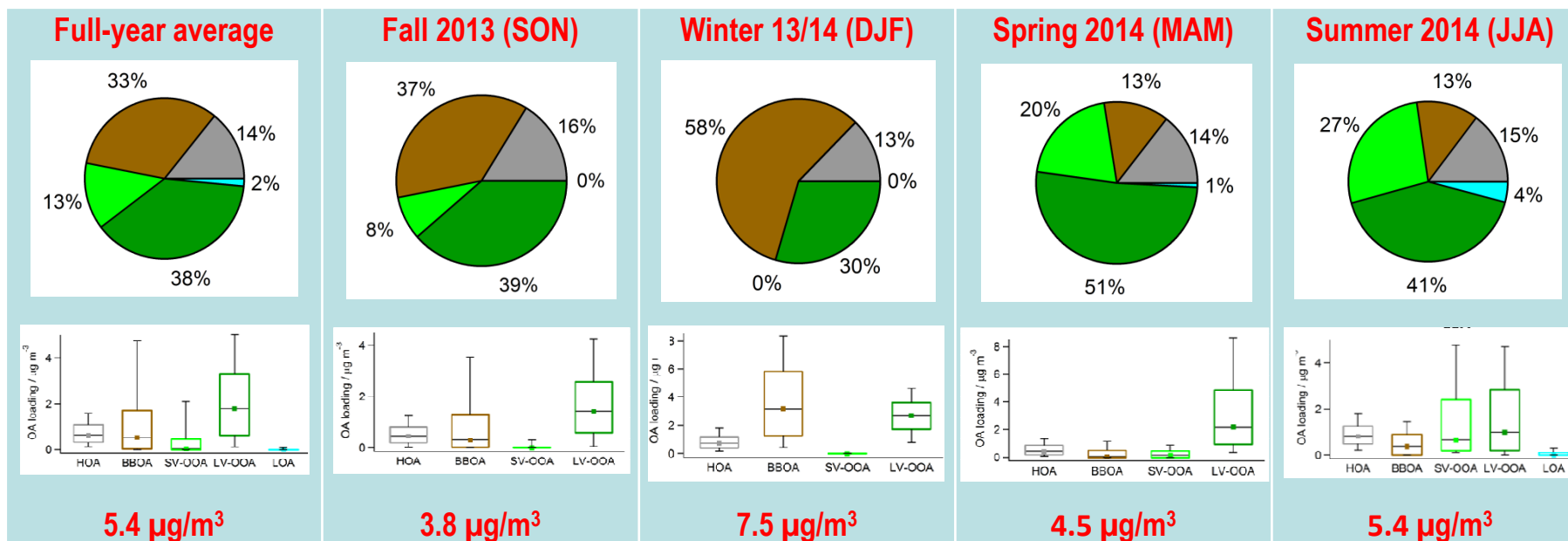
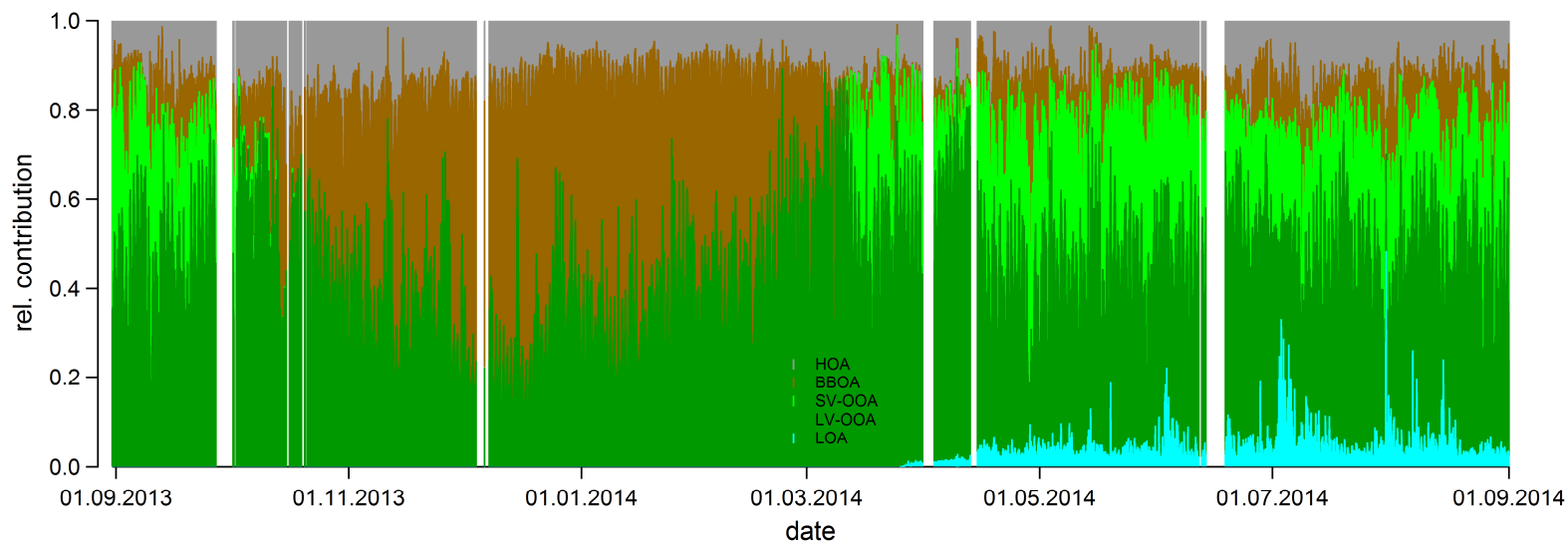
	Correlation of time series							Correlation of diurnal cycles						
Tracer	NO _x	BC _{tr}	BC _{wb}	NO ₃	T	SO ₄	NH ₄	NO _x	BC _{tr}	T	NO ₃	SO ₄	NH ₄	
Factor	HOA		BBOA	SV-OOA	LV-OOA	OOA	HOA		SV-OOA	LV-OOA	OOA			
Set #1	1	1	1	0	0	1	1	1	1	0	0	0	0	
Set #2	1	1	0	1	1	1	1	1	1	1	1	1	1	
Set #3	1	1	1	0	0	1	1	1	1	0	0	1	1	

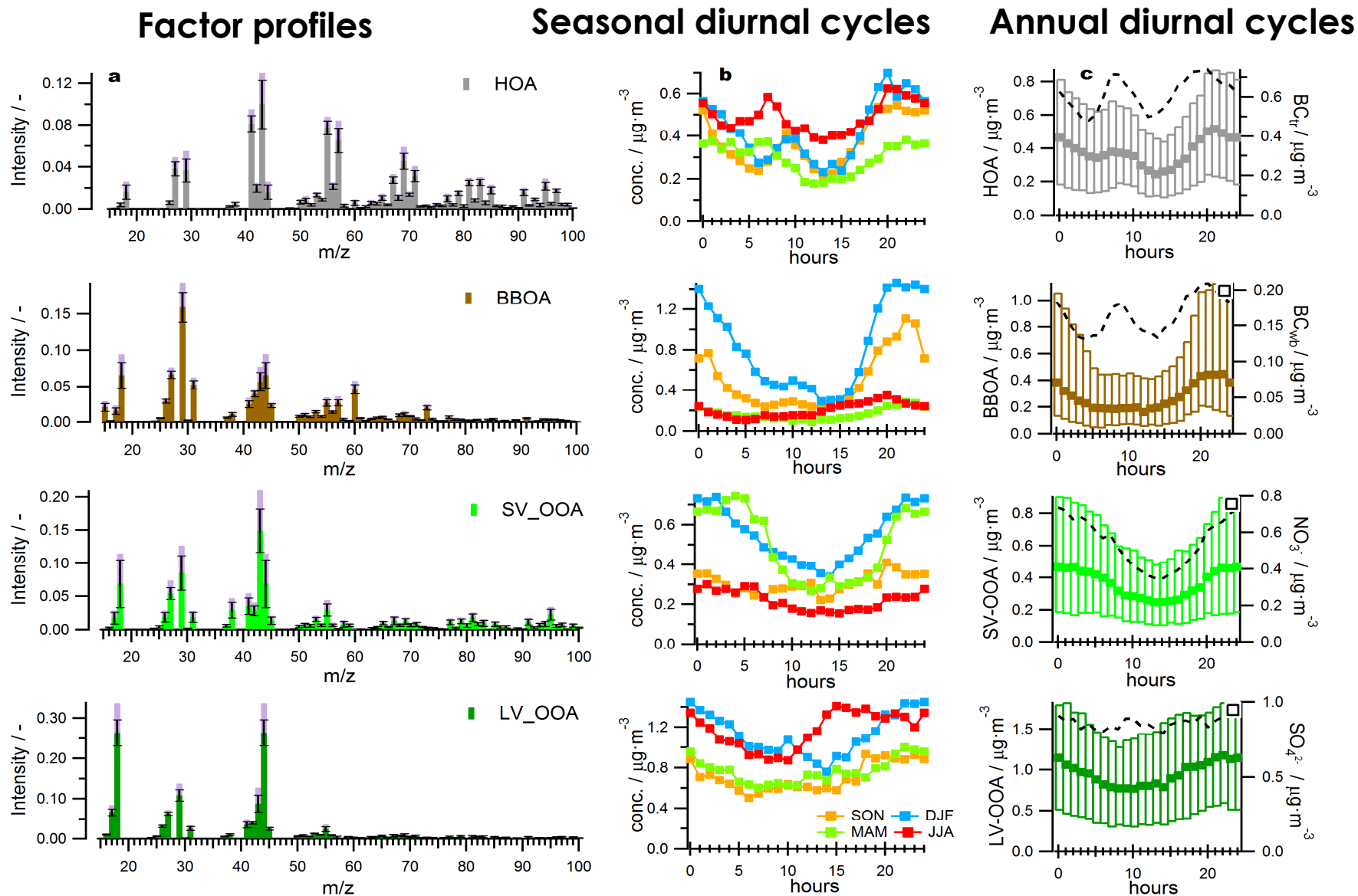
4/5-factor solution

25 α -value iterations, window shift of 1day

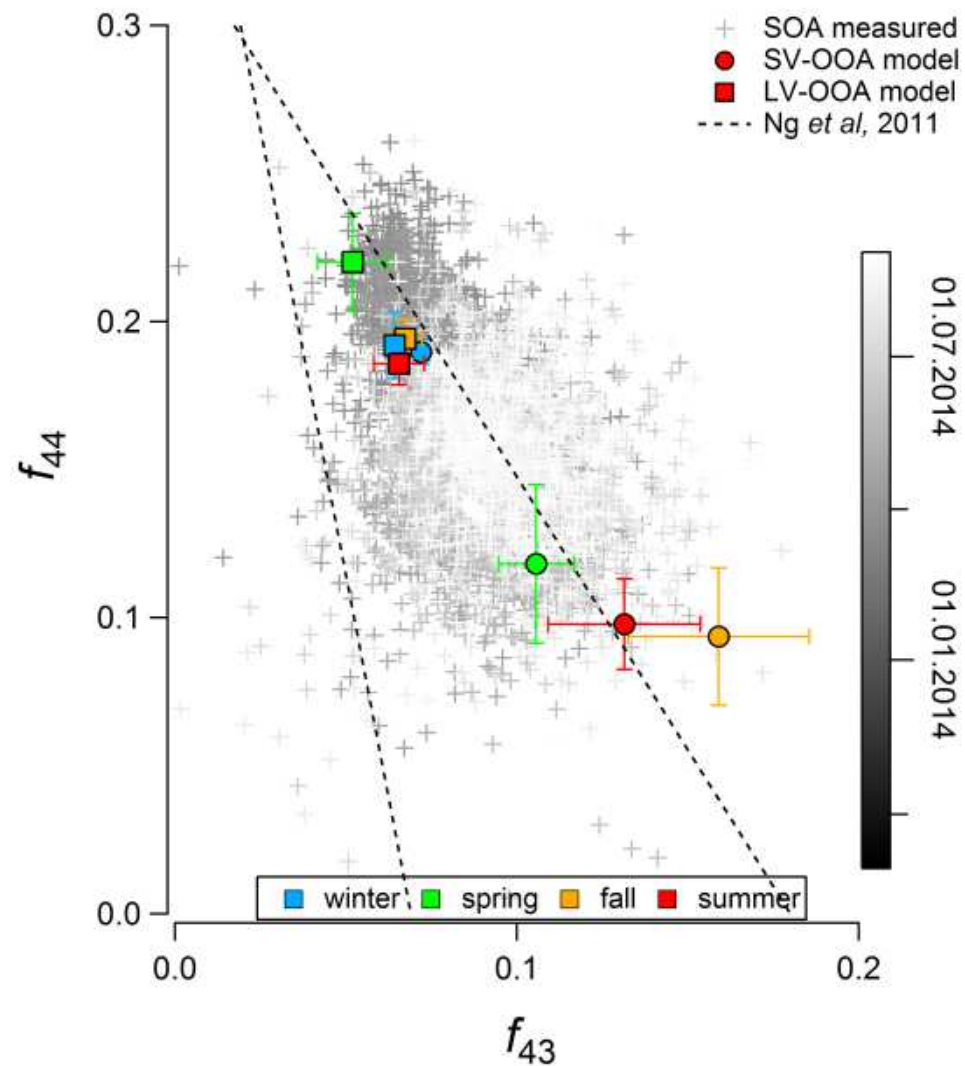








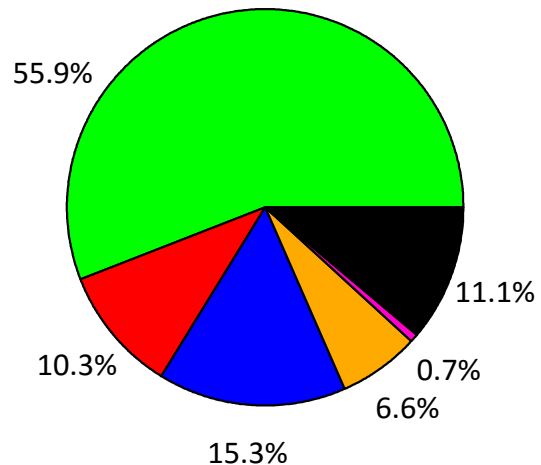
The error bars span the range between the 3rd and 1st quartiles; the bars - between the 90th and 10th percentiles.



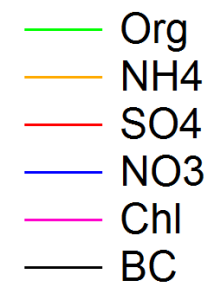
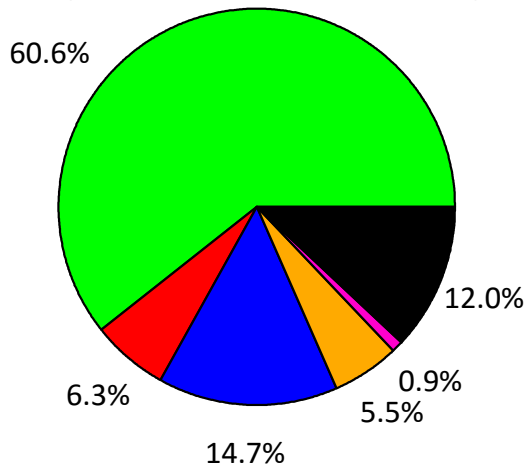
- Implement an AuRo-SoFi panel into the latest version of SoFi-6 source apportionment software
- Implement post-analysis criteria-based selection procedure for the cut-off of the group of the “best” PMF solutions (within SoFi-6)
- Investigate the seasonal dependence of the selection criteria

- There is a clear seasonality in NR-PM₁ measured by ACSM, and in BBOA factor retrieved by PMF, with an increase in winter.
- The total contribution of the OOAs increases in summer.
- The two oxygenated OA factors show high seasonal variability of their profiles.
- BBOA contributed on average 58% in winter, which is lower compared to the offline analysis.

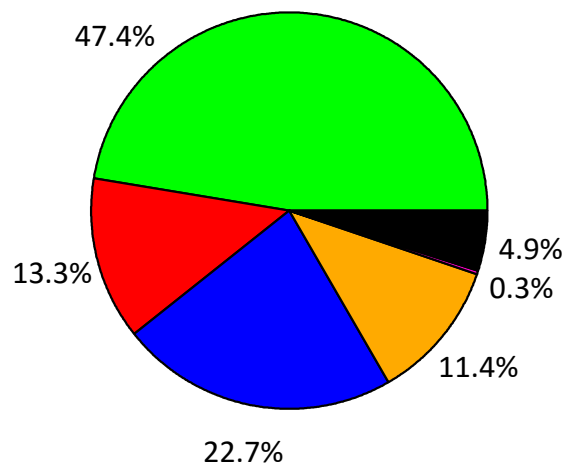
SON
Average total concentration: 7.37 ug/m³



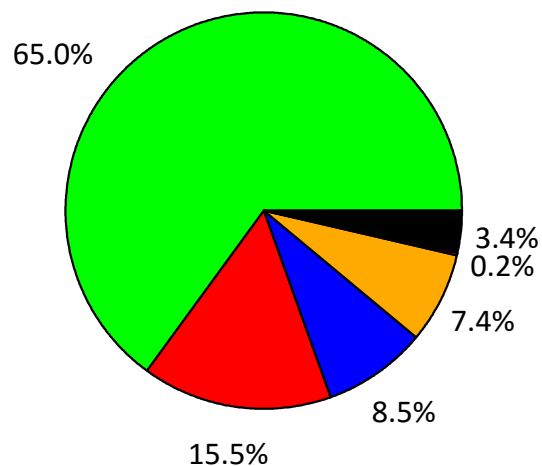
DJF
Average total concentration: 13.85 ug/m³



MAM
Average total concentration: 9.79 ug/m³



JJA
Average total concentration: 9.68 ug/m³



full year
Average total concentration: 10.20 ug/m³

