Review of ‘Characterization of atmospheric water-soluble brown carbon in the Athabasca Oil Sands Region, Canada’ by Blanchard et al.

General comments:

The study investigated water-soluble brown carbon (WS-BrC) in the Athabasca Oil Sands Region, Alberta, Canada, using filter-pack sampling and spectroscopic techniques. EEM-PARAFAC analysis identified three fluorescent components, with humic-like (C1) and protein-like (C2, C3) fluorophores linked to oil sands emissions and wildfires. Increased C1 and C3 fluorescence near industrial sites indicated their origin from oil sands activities. C2's high intensity near industrial sites and during wildfires suggested both wildfire-generated and anthropogenic sources. The study demonstrated EEM-PARAFAC's effectiveness in monitoring industrial WS-BrC. However, some comments should be addressed to improve the study.

Specific comments:

1) My main concern is the innovative points of this article. If it emphasizes the impact of industrial operation on this region, the data support of the paper is insufficient. If it is the impact of wildfires, the selection of background sites seems to be inappropriate. If it is the application of monitoring technology, it may also lack validation of other methods. So, you make a revision to clarify the innovative of the paper.
2) Line 108-111: The number of total samples are different in this two sentences. Please check it carefully.
3) Line 195: Misspelling of “Reference”.
4) Line 227-230: Can relative frequency data accurately reflect the impact of industrial facilities on fluorescence, as intersection cannot indicate the emissions and substances emitted by industrial facilities, but only indicates spatial overlap.
5) Table 2: From the MAE365 data, there is no significant difference between the AMS18 site and other sites affected by the oil sands industry. Therefore, it is necessary to consider 1) whether the selection of background sites is reasonable,

or 2) the impact of the oil sands industry on water-soluble BrC from other perspectives, because we know that an important aspect of discussing brown carbon is its light absorption capacity.

6) Line 295-296: “Similar scans of unpaved road dust and sand pit materials displayed comparatively weak fluorescence (⩽ 8 QSU) within these EEM regions”. However, it can be obviously observed in Fig A6. Maybe, you can revise the fig A6c,d to make it more obvious.

7) Line 302-310: I also have concerns on the data processing of EEM: In fact, the three fluorescent components are not relevant with humic-like and protein-like substances that derived from water (phytoplankton)/terrestrail soil, but they should are resided on the same peak positions. Author should give some explanation like this way using references, otherwise, some readers can mistake to have similarly or dissimilarly.

8) Line 416-418: Can certain biomarkers be used to establish this intermediate association? Just like using levoglucosan to represent the contribution of combustion sources, as introduced in the introduction, some chemicals such as polycyclic aromatic compounds, oxygenated polycyclic aromatic hydrocarbons, and naphthonic acids have been found in organic particles produced by oil sands (Introduction, Line 42).