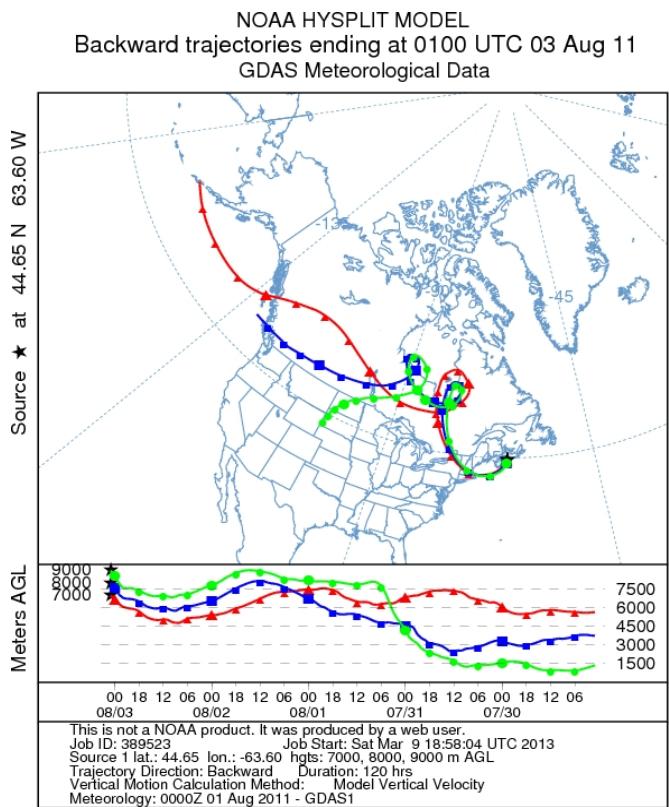


## Response To Anonymous Referee #2 Comments

Major:

Figure1 and Figure2: The source of emission seems to be convincing if we lay trust in the HYSPLIT calculations. However, I wonder if the authors have an explanation for the high IASI observed CO concentrations over southern Quebec east of the IASI retrieval location for the 2nd August 2011. It would also help the authors mark the location of the BORTAS campaign.

HYSPLIT just gives us a general indication of where the air masses are coming from isn't solely used to determine the emission sources. This is why animations are created using the IASI data to visualize plume movement and confirm the trajectory output provided by HYSPLIT. The elevated CO observed over southern Quebec and Maritime Canada in Figure 2 is coming from a mixture of plumes originating from the fires in western Ontario and also concurrent fire activity that was occurring in the Northwest Territories toward the end of July and the beginning of August. Below is the HYSPLIT backtrajectory from Halifax showing the movement of the air masses from the time IASI made the measurement over this geographical region. IASI measurements verify this observation.



A complete description of the location of the campaign has been now published in ACPD by P.I. Palmer et al. in the introductory article of the BORTAS special issue "Quantifying the impact of BOReal forest fires on Tropospheric oxidants over the Atlantic using Aircraft and Satellites (BORTAS) experiment: design, execution and science overview", which was published posterior to this article and has now been cited in this manuscript. It is difficult to show in Figures 1 and 2 the location of the campaign since it is comprised of measurements from numerous source across Canada. The radius of action for the instrument aircraft, which was based in Halifax, Nova Scotia, was 500 nautical miles. On two occasions, suitcase flights were coordinated, which permitted the aircraft to make measurements close to the fires in western Ontario and also measure aged plumes over Newfoundland and Labrador. Ground station measurements were made from

numerous sites in eastern and Atlantic Canada. A balloon sonde network was also in place over a large portion of the country and the satellite measurements obtained during the campaign provided coverage nationwide. So it is difficult to indicate the "location" of BORTAS in Figures 1 and 2 since the measurement campaign encompassed a geographic area much greater than that indicated in the Figures. A general description of location has been provided in the manuscript.

Chapter 2.3 The authors cite a couple of other campaigns: ARCTAS-A, ARCTAS-B, ARCTAS-CARB. I am not sure if this data is available yet but how would BORTAS fit in here and would it support the authors' assumption of the likely source of air masses?

BORTAS sought to complement the ARCTAS campaign. Measurements made during ARCTAS were predominantly of nascent and young Boreal plumes sampled close to the emission source. The BORTAS campaign was designed such that focus would be to sample aged Boreal plumes in an effort to expand upon the data acquired from ARCTAS to obtain a more complete look at the plume chemistry taking place. This is why the base of operations for the instrument aircraft was in Halifax, Nova Scotia. Boreal fires in North America commonly occur in Alaska, the Northwest Territories, northern Alberta and northern Saskatchewan, which are located in the western and central regions of North America. The long-range transport of the pyrogenic outflows from these fires track from west to east across Canada and eventually make their way to the North Atlantic. By having the aircraft based in Maritime Canada, flights could be arranged to make measurements of aged plumes over Eastern Canada and the North Atlantic. Additional text has been added to the manuscript to make note of this.

Chapter 3: The authors find that O<sub>3</sub> is produced/enhanced outside of the plume but it is destroyed inside the plume. Table 1 also shows a negative enhancement ratio of O<sub>3</sub> for the young plume. They support their findings by Figure 3 which shows a HCN and O<sub>3</sub> profile. O<sub>3</sub> in that Figure is markedly decreased inside the plume. However, as the authors acknowledge they plotted just 1 single profile in Figure 3 which is not necessarily representative. This reviewer once more again wonders if BORTAS data would have been available to support the authors and their findings.

Nowhere in the manuscript is it documented that the results seen in Figure 3 are unique; it is an example of many similar measurements of biomass burning (Boreal or otherwise) made by ACE-FTS. Unfortunately, there were no coincident measurements made by ACE-FTS and the instrument aircraft or any of the ground stations during the campaign to permit a direct comparison. Below is a figure created by Kim Sakamoto of the Dalhousie University Ground Station (DGS) generated from data recorded by the Dalhousie Raman LIDAR (backscatter coefficient) compared to aircraft data (CO and O<sub>3</sub>). The aircraft CO and O<sub>3</sub> were measured using a VUV fluorescence analyzer and a UV absorption photometer, respectively. The comparative measurement stems from an event which occurred on 21 July 2011, in which a large Boreal plume originating from the fires occurring in western Ontario, was forecasted to pass directly over the DGS. The instrument aircraft was instructed to fly in a spiral formation above the DGS to record vertical profiles which could be compared to the DGS measurements. Here the aircraft observes a similar behavior in the young plume that is emulated by the ACE-FTS data plotted in Figure 3. The LIDAR and enhancements in CO observed from the aircraft clearly indicate that the plume overhead is located at an altitude range of 3.5-6.5 km. The enhancements seen below 2.5 km are due mainly to local pollution. We observe a decrease of ~25% in the concentration in O<sub>3</sub> recorded at 8 km (outside of the plume) to the average concentration observed at 3.5-6.5 km (inside the plume) suggesting a destruction process for O<sub>3</sub> is occurring in the plume. As the aircraft exits the plume, descending below 3.5 km, the concentration of O<sub>3</sub> increases once again as CO decreases. It should be also noted that the off-plume concentration of O<sub>3</sub> recorded at 8 km is highly elevated, much higher than typical tropospheric background concentrations, which was also depicted in Figures 3 and 4. The data reported in the figure below will be reported by Kim Sakamoto in a subsequent publication by the DGS for the BORTAS special issue.

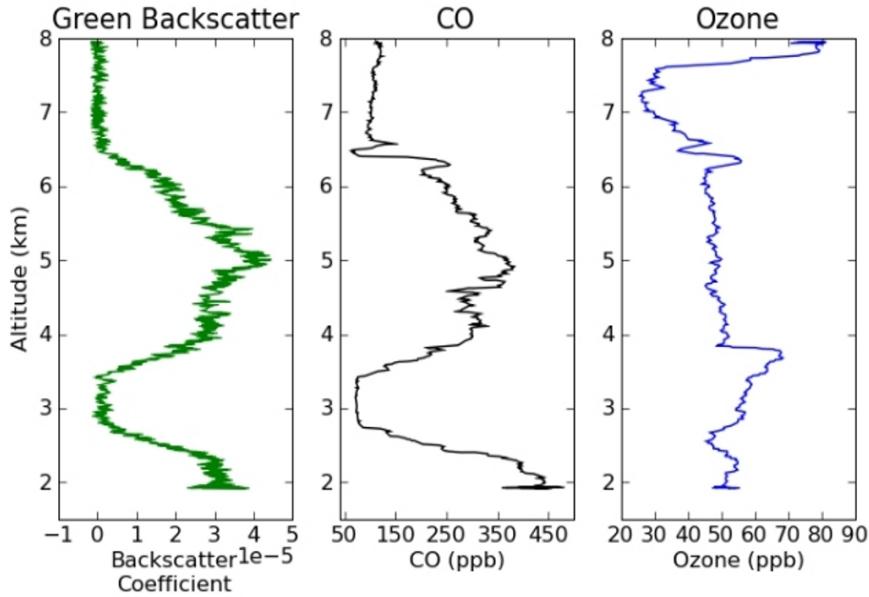


Figure 4 and Figure 5: Please give the number of used profiles.

The number of occultations have now been indicated.

Chapter 4: The authors speculate that strong pyroconvective updrafts inject sufficient mass into the stratosphere in turn facilitating a stratospheric to tropospheric exchange of O<sub>3</sub>. This reviewer once more again wonders where is the link to BORTAS? Has BORTAS measured plumes high in altitude supporting the assumption of the high injection heights? The authors talk about pyroconvective updraft vaulting emissions high into the upper troposphere as if it were an everyday occurrence. We know fires frequently develop pyroconvective updraft injecting emissions into the upper atmosphere but this is not a daily phenomenon. I would suggest the authors find evidence for strong pyroconvective events at the time and location of their retrieved ACE-FTS profiles. If July/August 2011 was marked by severe pyroconvective events in Canada there must be recorded accounts. The main author could for example contact Mike Fromm as he is known for documenting almost every publicly available data of pyroconvective events that would lead to upper troposphere/lower stratosphere injection heights.

Smoke can be injected in the upper troposphere by isolated convection that is not fire-related as well as by pyroconvection, regardless of pyrocumulonimbus cloud formation, this is not a remarkable event. As a member of Mike Fromm's pyroCb Yahoo group, I can confirm that independent pyroCb/pyroconvective events were observed from fires in Western Ontario and Northern Minnesota during the BORTAS campaign. Furthermore, ACE-FTS is measuring the trace gas emissions from the fires, not smoke, which may or may not have been lofted to the same altitudes as the heated gases emitted from the fires. I will reword the manuscript accordingly.

It is difficult to make comparative measurements regarding strat-trop exchange with BORTAS since the ground stations and the aircraft are not making measurements at altitudes near the tropopause. In fact, the instrument aircraft was not allowed to fly at these altitudes and had remain at altitudes well below those of commercial air traffic during the campaign.

Minor:

Figure 7: I cannot find the reference to this Figure from within the main text.

Reference made to Figure 7.