General Comments:

The paper by Herman and Mao is a study comparing Total Column HCHO, NO2, and O3 from Pandora Spectrometers to OMI and DSCOVER-EPIC. They included multiple pandora stations located at various locations around the globe and during different seasons. They found that agreement is overall good, however OMI does not alawys capture the seasonal variation as seen in the pandoras and may not be sensitive to changes in surface concentrations. DSCOVER-EPIC agrees quite well with the diurnal pandora data. This is a much needed comparison study as there are few publications on the validaty of pandora spectrometers which are to be used in future satellite validation plans. The manuscript requires some minor changes as well as some additional discussion/figures before publication.

Specific Comments:

79-- Introduction mentions airborne data but does not include any in results. I would be interested to see the comparisons. Otherwise remove from introduction.

Removed

83-- Why not use TROPOMI in this study instead of (or alongside) OMI? It is mentioned but not used.

TropOMI Pandora overpass data are not publicly available.

120-- The text files of Pandora do not need to be explained in such detail. However, I would like to know what data quality flags are being used to filter out bad quality data.

I found that the Pandora file names are confusing with regard to the file contents, so I listed example names of the total column density files.

I used the RMS error (Column 45) to filter the data as well as flags for no spectral fitting. OMI data within 50 km of the Pandora location. Other than that, I used all of the data within the time limits specified in each figure.

Fig 01:

-- Why not show a continuous time series for the July and September weeks?

Figure 1 has been redone

-- Change y axis for the NO2 day comparisons to be equal. **Done**

-- Discuss why the Lowess line is important.

The lowess line Lowess(f), f = 0.03, is similar to a 30-day running average except that outliers are weighted less just as in a conventional linear least squares fit. The parameter f is the fraction of the data included in the local least squares.

The text now reads: "For TCNO2, there is only a weak seasonal pattern as shown in the Lowess(0.03) fit to the data (Cleveland, 1979; Clevland and Devlin, 1988) with small maxima in January-February, since the sources of NO_2 are largely from the nearly constant flow of cars and trucks. The parameter 0.03 is the fraction of the data included in the local least squares estimate." **Green color is new text**.

Line 138-- No need to list the file name just state which station is being discussed.

OK Removed

Fig 02:

-- What is the "0.003" listed on the figure? **0.003 = altitude in kilometers. The altitudes are now in Table 1 in meters**

-- Fig 2 and Fig 1 both state that there is a seasonal dependence of HCHO but not NO2. Fig 1 is not necessary unless the daily panels are further discussed.

Figure 2 reduces the noise by using daily averages

Line 145-154-- What is the reasoning behind showing some pandora figures and not others? Why not include a a monthly average time series of all pandoras on one figure or at least group by certain locations. This would also help see the difference in magnitude of TCHCHO and TCNO2.

I am not sure what you are asking. There are about 180 active Pandora spectrometers located all over the world. I cannot include a figure for all of them. I picked a subset that shows typical behavior including some sites that do not have a seasonal HCHO dependence. I have added Lowess smoothed figures to show the differences between Pandora and OMI

Line 154-- Please include a table of all Pandora stations included in this study. The wording is vague about which pandora stations in CT are included in this statement.

There are several stations along the CT coastline. This will also prevent the lat/lon and PI from needing to be stated in every figure.

	Table 1 List of 30 Pandora locations used in this study and figure of appearance		
	Pandora Number	Pandora location name	Lat (deg) Long (deg) Alt(m)
1	Pan 180 Fig.1	Bronx, New York USA	40.868 -73.878 31
2	Pan 64 Fig.3	New Haven, Connecticut USA	41.301 -72.903 4
3	Pan 190 Fig.4	Bangkok, Indonesia	13.785 100.540 6
4	Pan 182 Fig.5	Tel Aviv, Israel	32.113 34.806 8
5	Pan 159 Fig. 6	Wakkerstroom, South Africa	-27.349 30.144 18
6	Pan 20 Fig.7	Busan, Korea	50.798 4.358 107
7	Pan 145 Fig.10	Toronto-Scarborough, Canada	43.784 -79.187 14
8	Pan 134 Fig. 12	Bristol, Pa, USA	40.107 -74.882 10
9	Pan 204 Fig. 12	Boulder, Co USA	40.038 -105.242 161
10	Pan 106 Fig.12	Innsbruck, Austria	47.264 11.385 616
11	Pan 117 Fig.12	Rome Italy	41.907 12.5158 75
12	Pan 193 Fig.12	Tsukuba, Japan	36.066 140.124 51
13	Pan 140 Fig.13	Washington, DC USA	38.922 -77.012 6
14	Pan 166 Fig.7	Philadelphia, Pa USA	39.992 -75.081 6
15	Pan 238 Fig.14	Granada	37.164 -3.605 7
16	Pan 240 Fig. 14	Thessaloniki, Greece	40.6336 22.9561 60
17	Pan 66 Fig.15	Huntsville Alabama USA	34.725 -86.646 22
18	Pan 156 Fig.15	Hampton, Virginia USA	37.020 -76.337 19
19	Pan 39 Figs.12,15	Dearborn, Michigan USA	42.307 -83.149 18
20	Pan 101 Fig.A1	Izania, Spain	28.309 -16.499 24
21	Pan 119 Fig.A1	Athens, Greece	37.998 23.775 130
22	Pan 124 Fig.A1	Comodoro Rivadavia	-45.7833 -67.45 46
23	Pan 131 Fig. A1	Palau	7.3420 134.4722 23
24	Pan 135 Fig.A1	CCNY Manhattan NY USA	40.815 -73.951 34
25	Pan 142 Fig.A1	Mexico City, Mexico	19.326 -99.176 2280
26	Pan 146 Fig.A1	Yokosuka, Japan	35.321 139.651 5
27	Pan 147 Fig.A1	Detroit, Mi USA	42.303 -83.107 178
28	Pan 150 Fig.A1	Ulsan, Korea	35.575 129.190 38
29	Pan 154 Fig.A1	Salt Lake City Ut, USA	40.766 -75,081 1455
30	Pan 162 Fig.A1	Brussels, Belgium	50.798 4.358 107

Line 178-- Why is there a seasonal NO2 pattern if, like NYC, the pandora is near automobile sources?

I do not know. The Pandora in Tel Aviv is located in the middle of the University not far from the coast and not in a main traffic area as is the case for NYC. There is a highway, Route 20, about 1 km from Pandora 182. The apparent peak occurs in January, which is the rainy season. Maximum power generation is during the summer, while the TCNO2 peak is in the winter. This is an observation of data for which I do not have an explanation.

Line 191-- How were these days chosen? Is the OMI agreement dependant on the diurnal pattern of HCHO?

The days were selected just to give a sample of OMI vs Pandora comparisons. With some days having good comparison and many days having large differences.

Fig7:

--How were the pandoras used for the OMI comparison chosen out of a total of 147?

The Pandoras were chosen just to give a sample of the Pandora sites. I have added a plot of 20 randomly chosen sites in the appendix

--Where is the monthly average TCHCHO comparison figure?

I have added 3-Month average figures for TCHCHO

Line 203-- Reword. It isn't that OMI and Pandora TCNO2 agree more at the overpass time, it is that the overpass time is the only available data for comparison.

Changed to: **This shows that OMI and Pandora TCNO2 agree more closely when the comparison is restricted to the overpass time.**

Line 205-- What method are you using to compare OMI and Pandora. Is it a single pixel that overlaps the pandora? A given radius in km?

A new sentence has been added

The original OMI data has a resolution of 13 x 24 km^2 at the center of the OMI side-to-side scan. The closest OMI pixel to each Pandora site is used for the time matched comparison. The largest distance is 50 km.

Line 220-225-- If the HCHO comparison results are due to the ozone retrieval influences then what is the TCO3 at these dates? Is NO2 better because it is not impacted by ozone spectral fingerprint?

The TCO3 and TCHCHO are retrieved by spectral fitting in an overlapping spectral range 300 to 340 nm. The retrieval method for TCO3 used in this analysis mimics the TOMS wavelength ratio algorithm that is not significantly affected by HCHO. After TCO3 is determined, spectral fitting of the residual is formed to retrieve TCHCHO. Some of the differences of OMI TCHCHO relative to Pandora may be caused by small errors in TCO3 or by reduced sensitivity in the OMI retrieval to

HCHO in the lowest altitudes. Retrieval of TCNO2 is also accomplished by spectral fitting in the blue wavelength range 405 – 450 nm that is not affected by ozone and has better sensitivity at the lowest altitudes because of less Rayleigh scattering than in the 300 – 340 nm range.

Line 220-- I would be interested in seeing a scatter plot comparing 13-14:00 UTC Pandora total column with OMI for all days of these Pandora stations. That way we can see if there is a constant bias and by how much. Otherwise explain why these days were chosen out of three years of data.

Instead of a scatter plot, I have now presented the results of a low-pass filter that shows the bias. The bias varies with the site location. The particular sample days for Spring, Summer, and Winter were selected when the Pandora results showed that the effect of clouds was at a minimum (less minute-by-minute scatter)

Figure 10a and b should be separate figure numbers.

Figure 10b has been removed. A new Fig.11 has been added.

Separate figure numbers for figure 13a and b **Done**

Fig 13-- why are these days and pandora sites chosen? Are others worse?

These days and sites are typical. The agreement with TCO between Pandora and OMI is very good on most days. I included a day when OMI was 3% lower than Pandora (Washington DC on 21 August) but matched EPIC more closely.

Line 267-- No figure showing the OMI seasonal variation in TCHCHO.

New figures show OMI TCHCHO seasonal variation

Line 274-279-- This paragraph needs reworked. I can't tell if you are trying to say if OMI and Pandora agree on total column amounts or not. Line 276 says agreement is only good between the hours of 13-14 UTC, but what other time period would you be comparing to OMI? **OMI comparisons are best made with Pandora at 13-14 hours local solar time. OMI and Pandora do not agree on magnitude of TCHCHO and TCNO2 but do agree with TOC**

Line 282-- Authors only show data for 6 pandora stations in comparison with DSCOVR-EPIC. All in Eastern US and Canada and in August. Yet this statement suggests that all pandoras have good agreement. I would like to see a figure with all pandoras (or grouped by either time of year or location) before I accept that pandoras as a whole agree with DSCOVR-EPIC.

You are right. I have not checked all 150 working locations against EPIC ozone. However, so far, I have found 6 Pandora sites with possible stray light problems Pan 63 La Porte Texas, Pan 78 Banting, Pan 73 Islamabad, Pan 260 Cameron LA, Pan 183 Londonderry New Hampshire, and Pan 77 Singapore that cannot be used for comparisons with EPIC or OMI. The ozone comparisons were included to show that both OMI and Pandora instrument calibrations are correct since total column ozone changes slowly with distance making the spatially coarse OMI retrievals comparable to Pandora, unlike NO_2 and HCHO.

Technical Corrections:

Line 148—typo **Fixed**

Line 239-- typo on figure number **Fixed**

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