Atmos. Chem. Phys. Discuss., 10, C4189–C4200, 2010
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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Nitrogen oxides in the boundary layer and free troposphere at the Mt. Bachelor Observatory" *by* D. R. Reidmiller et al.

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Received and published: 18 June 2010

Referee #2

Received and published: 23 April 2010

Reidmiller, D. R., D. A. Jaffe, E. V. Fischer and B. Finley: Nitrogen oxides in the boundary layer and free troposphere at the Mt. Bachelor Observatory, Atmos. Chem. Phys. Discuss., 10, 5751-5801.

General Comments

(1) REVIWER This paper presents a comprehensive summary of NOx observations made from the Mt. Bachelor mountain top observatory over multiple seasons. It also

presents an interesting analysis using meteorological data taken on ski chair lift ascents to separate boundary layer and free tropospheric air. The analysis presented appears to be careful and thorough, though a bit long. The paper is well written with few noticeable grammatical errors. This work is publishable with minor changes and clarifications.

(1) RESPONSE We appreciate this reviewer's careful and positive review of our work.

Specific Comments

(a) REVIEWER Section 3.2 and Figures 4 and 5 I admire the use of the chairlift's to provide sounding data. I find the explanation of the analysis a bit lacking. What in panels a and b of Figure 4 indicates that the rise in NOx in panel c is a result an air mass change? Figure 5 panel a is somewhat confusing and cluttered. If the line is the average of 3 ascents, are the colored data points all the points from each ascent? The date and times clutter the figure. I'm not always certain which time goes with which trace.

(a) RESPONSE We have added text clarifying the analysis to p. 5766, l. 23: "It follows, then, that a change in airmass type (i.e., BL influence) could be detected by a change in the slope of q vs. theta as it approaches zero." We have added text to p. 5766, l. 19: "The increases in T (Fig. 4a) and q (Fig. 4b) observed at the summit of the mountain (i.e., at the bottom part of the respective magenta and orange lines) coincide with a substantial ($\sim$50%) increase in NOx. This simultaneous increase in meteorological and chemical parameters typical of BL-influenced air indicates that some sort of airmass transition is occurring at the time highlighted by the yellow box in Fig. 4." We have eliminated the date and times from the plot for clarity and added an arrow on the plot itself indicating the evolution of the time of day, as well as a second legend indicating the time-of-day represented by each time. We have also added text to p. 5766, l. 28: "The individual points lying along each line are averaged from the 3 ascents, with the line representing a fit to the averaged points."

(b) REVIEWER Page 5767 line 12 - remove comma after 5. I do not follow why the time-of-day segregation is better than that based on specific humidity. For example, what is the significance of the a 14 pptv difference in means in spring 2007?

(b) RESPONSE We have removed the comma between 5 and h. Our intention was to show that with respect to the NOx data only, segregating the timeseries by percentile of water vapor yielded a smaller difference (14 pptv) between the "wet" and "dry" datasets vs. segregating the dataset by time-of-day, which yielded a "day (BL-influenced)" and "night (FT)" dataset difference of 25 pptv. The significance of the 14 pptv difference is irrelevant for our purposes because the NOx datasets show a stronger difference using the time-of-day segregation than the water vapor segregation. We added a line of text to p. 5767, l. 21 to clarify this.

(c) REVIEWER Section 3.3.1 - Other GTE missions, such as Pem Tropics A and B, were instrumented with NO and NO2 and, at least transited through the regions discussed here. Data may be available in the archives, if not published.

(c) RESPONSE Indeed, there are a few flights that occurred between Ames Research Center in southern California and Hawaii, but that is the northernmost extent of PEM-Tropics according to: http://www-gte.larc.nasa.gov/pem/pemt_flt.htm and our focus is on the North Pacific (Asian outflow, trans-Pacific transport and North American inflow regions). Furthermore, data from INTEX-B covers this region, is more recent (2006 vs. 1996) and is already presented in Table 3a with results coming from Bertram, 2006. As a result, we have made no changes to the text.

(d) REVIEWER Section 3.3.2 I think this section is unnecessary. As the second sentence says the observations are dependent on the unique geography of each site. There isn't much comparison, rather explaining why the observations are different. I also do not see how observations from many of those sites could really influence the observations at MBO. I am not opposed to leaving it in but I don't think it adds much to the paper. If left in I do feel care needs to be taken comparing observations of NOx

from the 1984 to 2007. The differences are due not only to geography but the change in the nature of the NOx emissions over the 20+ years.

(d) RESPONSE Our intention was to highlight the meridional differences that are observed at sites of a similar latitude, not to show that any of these other sites influences observations at MBO. We have added a sentence to the end of this section in response to reviewer's final statement: "The differences among these sites is not purely due to differing regional geographies, but also by strong regional changes in NOx emissions from 1984-2009 (when NOx observations listed in Table 3b were obtained)."

(e) REVIEWER Section 3.3.3 I think this section is very good and more important than the authors give it. I feel the table in the supplemental section should be in the main text because this shows how these measurements compare to independent instruments from a different platform take at the same time.

(e) RESPONSE We appreciate the reviewer's praise of this section and have moved Supplemental Table 1 to the main text and renumbered subsequent tables accordingly.

(f) REVIEWER Figure 2 The poor contrast between the blue and green make some of the bars difficult to read.

(f) RESPONSE We have changed the blue color to a lighter shade, thereby enhancing the contrast between the blue and green colors. We have also added borders to each bars, so they are shown more distinctly.

(g) REVIEWER Figure 4 Possible show a shorter time series, i.e. 9:50 to 11:16 so the difference between the shaded period and that immediately before is easier to see.

(g) RESPONSE We feel there is great value in showing the entire chairlift sounding dataset for this day as it reveals that the changes observed during the highlighted time period are, indeed, the greatest in the shortest amount of time seen throughout the day. As a result, we have opted not to modify Figure 4.

(h) REVIEWER Figure 5 See above

(h) RESPONSE See response to comment (g); we have opted not to modify Figure 5.

(i) REVIEWER Figure 6 It is somewhat difficult to read the letters on top of the shaded regions.

(i) RESPONSE We have changed the text color to white for some of the boxes and added a “shading” feature to each letter, in the hopes that it brings out the letters more vividly.

(j) REVIEWER Figure 8 The outline of the white boxes is hard to see

(j) RESPONSE We have made the outline to these boxes thicker and changed the color from white to black.

(k) REVIEWER Table 3a The font in the table is smaller than that in tables 1 and 2 and is difficult to read

(k) RESPONSE Tables were provided to publisher with the same font; this is an artifact of scaling and formatting for ACPD and we authors presume the publication office will take note of this and scale the table accordingly.

(l) REVIEWER Table 3b Same critique of the fonts and the the underscores in the conditions column should be removed.

(l) RESPONSE Tables were provided to publisher with the same font; this is an artifact of scaling and formatting for ACPD and we authors presume the publication office will take note of this and scale the table accordingly. We have removed the underscores from the Table.

(m) REVIEWER Table 5 Same critique of fonts. I find the change in font sizes from table to table to be distracting.

(m) RESPONSE Tables were provided to publisher with the same font; this is an artifact of scaling and formatting for ACPD and we authors presume the publication office will take note of this and scale the table accordingly.

Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/10/C4189/2010/acpd-10-C4189-2010-supplement.pdf

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Interactive comment on Atmos. Chem. Phys. Discuss., 10, 5751, 2010.

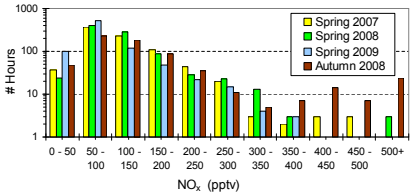

Fig. 1. No change to caption text

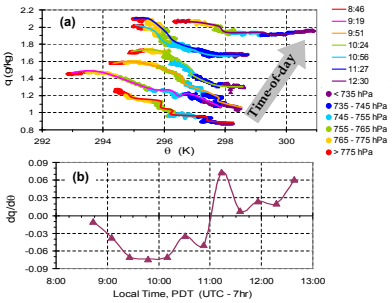

Fig. 2. Changes made; see response to review

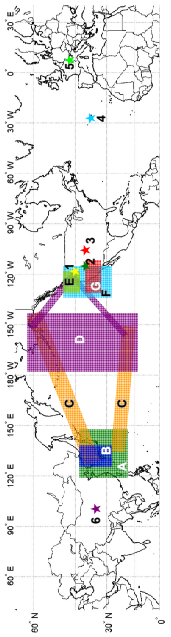

Fig. 3. No changes made

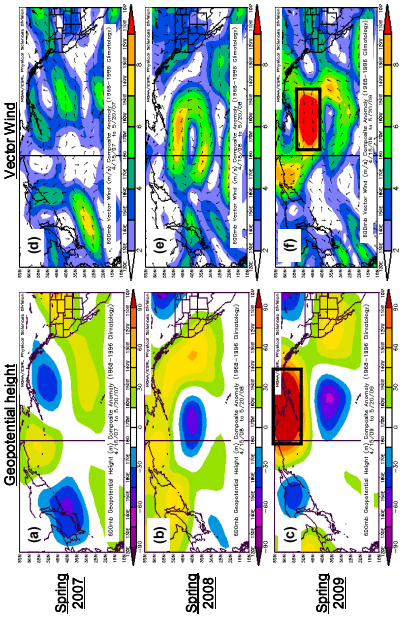

Fig. 4. Changes made; see response to review

Site	Legend	Coordinates	Elevation (km ASL)	Conditions	NO (pptv)	NO_2 (pptv)	NO_x (pptv)	NO_y (pptv)	Reference
Mt. Bachelor	**1**	44.0°N, 121.7°W	2.73	2007-09 Spring All	7	78	92	--	this work
				2007-09 Spring_Day / BL	21	81	103	--	
				2007-09 Spring_Night / FT	3	77	82	--	
Big Hill	**2**	38.84°N, 120.41°W	1.86	2003 Summer Day	--	319	--	1864	Murphy et al., 2006
				2003 Summer Night	--	198	--	1321	
Niwot Ridge	**3**	40.2°N, 105.32°W	3.05	1984 Summer Day	--	--	510*	1120*	Fahey et al., 1986
				1984 Summer Night	--	--	550*	1050*	
				1984 Autumn Day	--	--	610*	1000*	
				1984 Autumn Night	--	--	250*	780*	
Pico Mtn	**4**	38.47°N, 28.40°W	2.20	2002-05 Spring	--	--	26*	180*	Val Martin et al., 2008b
				2004 Summer	--	--	27	169	
				2005 Summer	--	--	28	234	
				2002-05 Spring Day	7	21	26	178	Val Martin et al., 2008a
				2002-05 Spring Night	0	18	18	166	
Jungfraujoch	**5**	46.55°N, 7.98°E	3.58	1998 Spring All	15	155	170	957	Zanis et al., 2000
				1998 Spring Day	37	168	205	--	
				1998 Spring All FT	9	79	88	625	
				1998 Spring Day FT	22	83	105	--	
				1997 Summer All	12	170	192	913	Zellweger et al., 2000
				1997 Summer FT	<DL	76	77	231	
				1997 Summer BL	11	168	188	958	
				1997-99 Spring FT	--	--	98	581	Zellweger et al., 2003
				1997-99 Spring FT-BL mix	--	--	204	981	
				2005 Spring Background	16*	42*	52*	740*	Balzani Lööv et al., 2008
				2005 Summer Background	15*	50*	56*	879*	
				2005 Autumn Background	9*	14*	14*	489*	
Mt. Waliguan	**6**	36.28°N, 100.90°E	3.82	2003 Spring Downslope	13*	--	--	3950*	Wang et al., 2006
				2003 Spring Upslope	72*	--	--	3700*	
				2003 Summer Upslope	47*	--	--	3820*	

Fig. 5. No changes mades

Date	Local Time (PDT)	NO (pptv)		NO_y / NO		
		MBO	C-130	MBO*		C-130
		mean ± 1σ	mean ± 1σ	median	mean ± 1σ	mean ± 1σ
4/24/2006	12:08	39 ± 11	43 ± 13	2.3	3.1 ± 2.2	1.1 ± 0.4
5/3/2006	12:35	23 ± 7	16 ± 2	2.9	3.7 ± 3.3	2.6 ± 0.8
5/8/2006_A	10:05	12 ± 1	10 ± 1	3.2	4.6 ± 4.4	3.9 ± 1.4
5/8/2006_B	16:06	18 ± 2	17 ± 7	2.8	3.7 ± 3.2	3.0 ± 0.8

Fig. 6. Table moved from Supplemental Material to Main Text