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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Ozone reservoir layers in a coastal environment – a case study in Southern Taiwan" *by* C.-H. Lin et al.

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The authors would like to thank the reviewer for the valuable suggestions. We have addressed all the concerns raised.

1.General comments

Comment 1: The summary (Section 4) is concise and complete. However, should this summary be somewhat modified to more appropriately become the "Conclusion" of the manuscript?

Response 1: We have proposed a Conclusion Section in the revised manuscript instead of the Summary Section in the previous version.

Comment 2: The scientific methods are clearly outlined. However the presentation of the results/discussion e.g. section 3.2, can be improved for greater clarity and readability. Appropriate paragraphing (instead of long uninterrupted texts) can be considered, and unnecessary repetitions should be avoided wherever possible.

Response 2: We have carefully checked the previous Section 3.2. Appropriate paragraphing is made and unnecessary repetitions are now removed in our revised version.

Comment 3: The language can be further improved to be correct, fluent and precise. Language specialists may help.

Response 3: Grammatical and writing-style errors in the original version have been corrected by our colleague, who is a native English speaker.

2. Specific comments

Comment 1: The "Abstract" has left out the important role of the sea breezes — "the ozone reservoir layers" are actually caused by the inflow of afternoon sea breezes.

Response 1: "The observed ozone reservoir layer is formed by the invasion of a cool, marine air mass into a relatively warm, ozone-rich mixing layer in the evening." This statement is now added in the Abstract of the revised manuscript to point out the import role of sea breezes in the formation of the ozone reservoir layer.

Comment 2: Section 2.3: This late autumn (November) ozone episode may probably be an emerging trend in photochemical pollution in the last decade or so as a result of climate change, as ozone episodes normally occur in summer. It is up to the authors as to whether to write a few lines on summer situations as compared with this autumn event.

Response 2: Southern Taiwan usually experiences its worst ozone pollution episodes in October or November (autumn) (Chen et al., 2004) but in mid-latitude areas, such as those in the eastern United States and Europe, the worst ozone episodes usually occur in the summer (NRC, 1991). This difference is caused by the fact that the

former episodes are caused by a topographical effect, which is the blocking of the CMR (Lin et al., 2007), while the latter are caused by an meteorological conditions that are conducive to the production of ozone, such as the existence of a slow-moving, high-pressure system (NRC, 1991). This description is now included in our revised manuscript.

Comment 3: Section 2.3/Section 3.2: Does this weak anticyclonic condition favour the generation of sea breezes which ultimately lead to the formation of the ozone reservoir layers?

Response 3: Sea breezes actually occurred during the study period, supporting from the landward wind field over Taiwan in the afternoons (Fig. 4) and the vertical diurnal variations of the winds measured by the meteorological radiosondes (Fig. 6). Weak synoptic force is actually favor the development of a sea breeze according the previous studies (Atkinson, 1981; Helmis et al., 1987). Data analysis in this work does support that the observed ozone reservoir layer in this study is caused by the invasion of marine air masses.

Comment 4: Section 3.3: Is this relatively high contribution (over 50 %) by ozone of the previous day also found in other research studies locally or elsewhere?

Response 4: In rural areas, the downward mixing of old ozone from ozone reservoir layers can reportedly dominate daytime ozone increases (Kleinman et al., 1994; Niccum et al., 1995). The contribution of old ozone to a daily ozone increase in a polluted area has seldom been reported. New ozone can be reasonably assumed to dominate daily ozone increases in a polluted area since ozone precursors are abundant there. However, our investigation indicates that even in a polluted area such as southern Taiwan, the contribution of old ozone through downward mixing process to total ozone can be 50% more important than that of ozone newly produced on that day. This discussion is now included in our revised manuscript.

Comment 5: Technical corrections, typing errors etc include the following:

p.1721 line 11-12 : However, an observation-based method has not yet been used to analyze . . .. . .

p.1724 : 2.3 : Synoptic weather and surface ozone levels in Taiwan during 8–11 November 2006

p.1725 line 3 : . . .. . .air stations of the Taiwan Air Quality Monitoring Network. . .. . .(TAQMN).

p.1725 line 15 : Figure 5a plots the time-height relationship of each of the ozone soundings and the corresponding . . ..

p.1726 line 8 : . . ..the daily evolutions of the ozone reservoir layers were quite similar on the three nights . . .. . .

p.1727 line 1 : The possible cause of the elevated ozone depletion will be discussed later in section 3.2 (?).

p.1730 line 20 . . .. The descending in altitude of the daily ozone reservoir layer in stage II. . ...

p.1733 line 13 : The ozone in a daily mixing layer comprises ozone carried over from the preceding day and that produced on the current day.

p.1737 line 13 : This result follows from the fact that most of the ozone produced daily was . . .. . .

p.1738 line 5 : Very similar patterns of ozone reservoir layer evolutions are found in three consecutive nights of the 8-11 November 2006 episode.

p.1739 line 15 : Furthermore, ozone distributions within the ozone reservoir layers are expected to be far from being uniform . . .. . .

Response 5: All the mentioned corrections have been made in our revised manuscript. Additionally, grammatical and writing-style errors in the original version have been cor-

rected by our colleague, who is a native English speaker.

References

Atkinson, B.W.: Mesoscale Atmospheric Circulations. Academic Press. 495 pp, 1981.

Chen, K.-S., Ho, Y.T., Lai, C.H., and Tsai, Y.A.: Trends in concentration of ground-level ozone and meteorological conditions during high ozone episodes in Kao-ping Airshed, Taiwan. Journal of Air and Waste Management Association 54, 36-48, 2004.

Helmis, C.G., Asimakopoulos, D.N., Deligiorgi, D.G., Lalas, D.P.: Observations of sea-breeze fronts near the shoreline. Boundary Layer Meteorology 38, 395–410, 1987.

Kleinman, L., Lee, Y.-N., Springston, S.R., Nunnermacker, L., Zhou, X., Brown, R., Hallock, K., Klotz, P., Leahy, D., Lee, J.H., and Newman, L.: Ozone formation at a rural site in the Southeastern United States; J. Geophys. Res., 99, 3469-3482, 1994.

Lin, C.Y., Wang, Z., Chou, C. C. K., Chang, C. C., and Liu, S. C.: A numerical study of an autumn high ozone episode over southwestern Taiwan, Atmos. Environ., 41, 3684-3701, 2007.

National Research Council (NRC): Rethinking the Ozone Problem in Urban and Regional Air Pollution, National Academy Press, Washington, District of Columbia, 1991.

Niccum, E.M., Lehrman, D.E., Knuth, W.R., 1995. The influence of meteorology on the air quality in the San Luis Obispo County-Southwestern San Joaquin Valley Region for 3-6 August 1990. Special Issue for the Regional Photochemical Measurement and Modeling Studies Specialty Conference, Journal of Applied Meteorology 34, 1834-1847.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 1719, 2010.