Correspondence to Referee #1

Thank you for your constructive comments for the manuscript acp-2015-338. The response for each comment is given below and manuscript was revised accordingly.

1. Abstract: The average ozone concentrations for all the period is mentioned, but this does not mean much, since this average is a result of a variety of factors. Throughout the paper, ozone concentrations are noted with the precision of 0.1 ppb, but this is not meaningful. I would suggest just 52 ppb instead of 51.8 ppb, for example.

The average for the entire period was removed from abstract. Also, ozone concentrations were given with two significant digits.

2. Figure 1: The words “Yellow Sea” and “East Sea” are superimposed in the map. However, I find no need to write these names with a scientific importance, and suggest removing from the figure.

Figure 1 was remade to show five measurement sites.

3. Section 3: Diurnal and seasonal variations are discussed with Figures 3 and 4. There are some errors and unclear phrases.
Specifically: Page 16752, Line 24: "monthly" variations should be "seasonal" variations

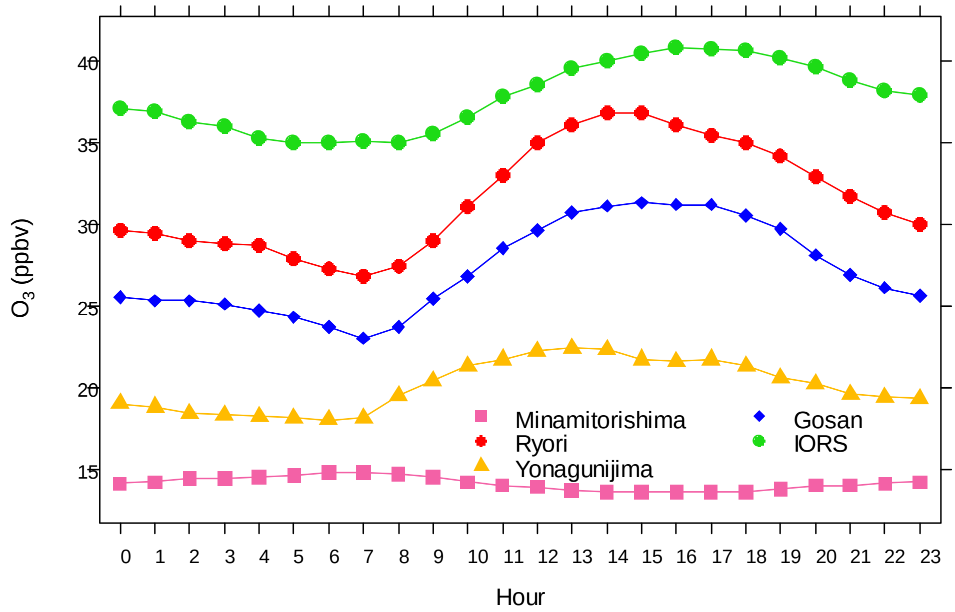
It is probably the page 16751 line 24. In Figure 3b, monthly means are presented for the five sites but they eventually represent seasonal variations. Thus, “monthly” was changed to “seasonal” as you recommended.

4. Page 16752, Line 9-10: Based on diurnal variations, the authors mention that ozone at IORS is influenced by Chinese outflow. This sentence is not logically sound, since diurnal variability is, in most cases, driven by local effects – emissions, chemistry, or meteorology. I would expect discussion of local effects. Also, the diurnal cycles (Figure 3a) are plotted for all the seasons. The appearance and magnitude of diurnal cycles depend on seasons - usually greater in summer than in winter. I would suggest showing seasonal cycles at IORS in four seasons first, and then compare (probably) summertime one with those at other sites.

Of course, the diurnal variation of ozone is driven by in-situ photochemistry. In remote regions with low NOx concentration, therefore, ozone is normally destroyed as what was observed in Minamitorishima. In IORS, however, ozone was found to be increased during the day through the year.

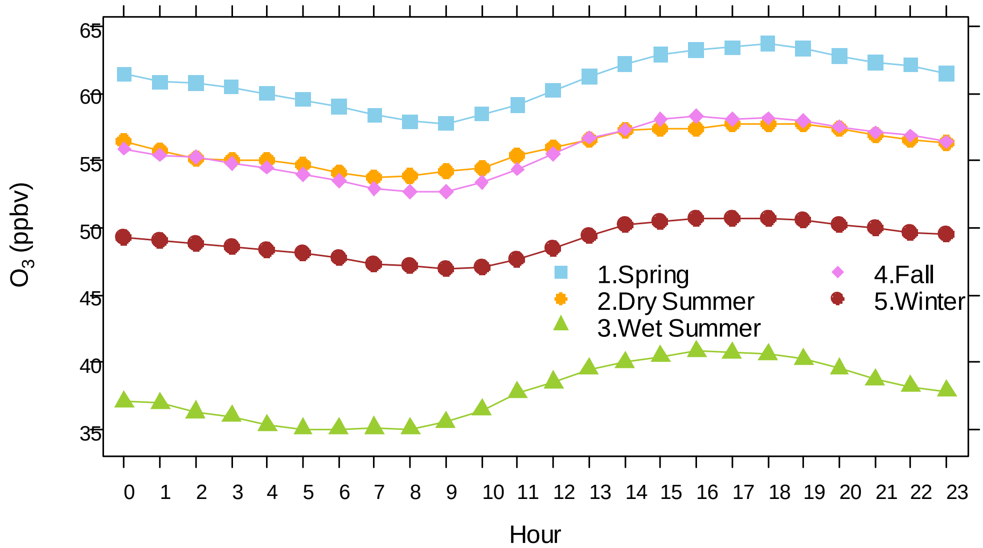
If comparing diurnal variations among seasons (Fig. 3a), the daytime buildup of ozone (the difference between the max. and min.) varied little: 6 ppbv in spring (Mar-Apr), 4 ppbv in dry summer (May-Jun), 6 ppbv in wet summer (Jul-Aug), 6 ppbv in fall (Sep-Nov), and 4 ppbv in winter (Dec-Feb). In contrast, the background concentrations were much different in seasons with being the highest in spring and the lowest in wet summer. The seasonal average was 61 ppbv in spring, 56 ppbv in dry summer, 38 ppbv in wet summer, 56 ppbv in fall, and 49 ppbv in winter. These results imply that ozone concentrations were greatly dependent on air masses, reflecting the degree of impact by continental outflows, which determined the background level of ozone..

At IORS, the daily buildup relative to the mean was 16 % in wet summer and was less than 10 % in the rest seasons. It was the highest during July-August, indicating the local effect as you said. This summertime buildup of 6 ppbv was higher than that of Yonagunijima (3 ppbv) and lower than that of Gosan (8 ppbv) and Ryori (10 ppbv), which also reveals the proximity to the land. The following figure shows the diurnal variations of O_3 at five sites only during wet summer (July~August).

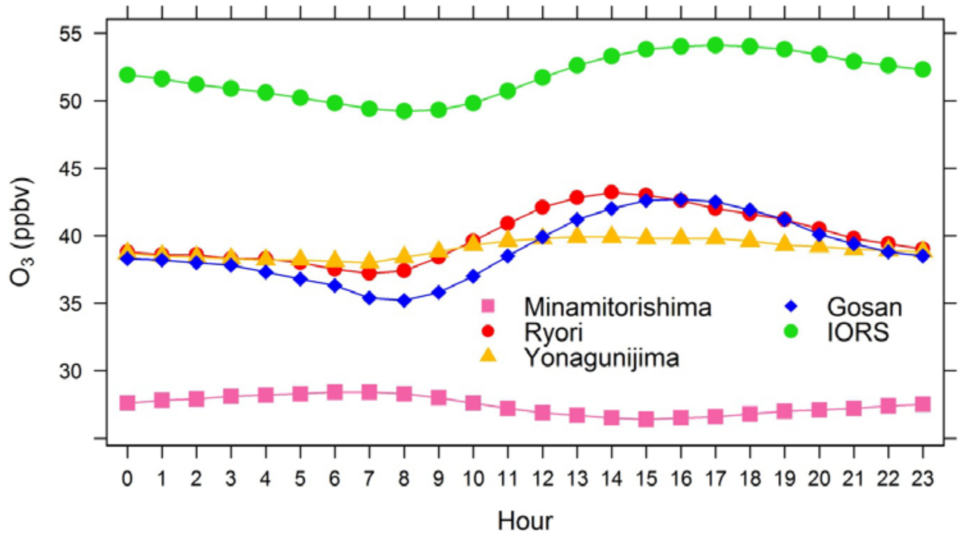


In the revised manuscript, Gosan data were replaced with those of Trinidad Head. Accordingly, text and Figure 3 were revised.

a)


65
60
55
50
45
40
35
O3 (ppbv)
1.Spring
2.Dry Summer
3.Wet Summer
4.Fall
5.Winter
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Hour

b)


55
50
45
40
35
30
O3 (ppbv)
Minamitorishima
Ryori
Yonagunijima
Gosan
IORS
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Hour

c)

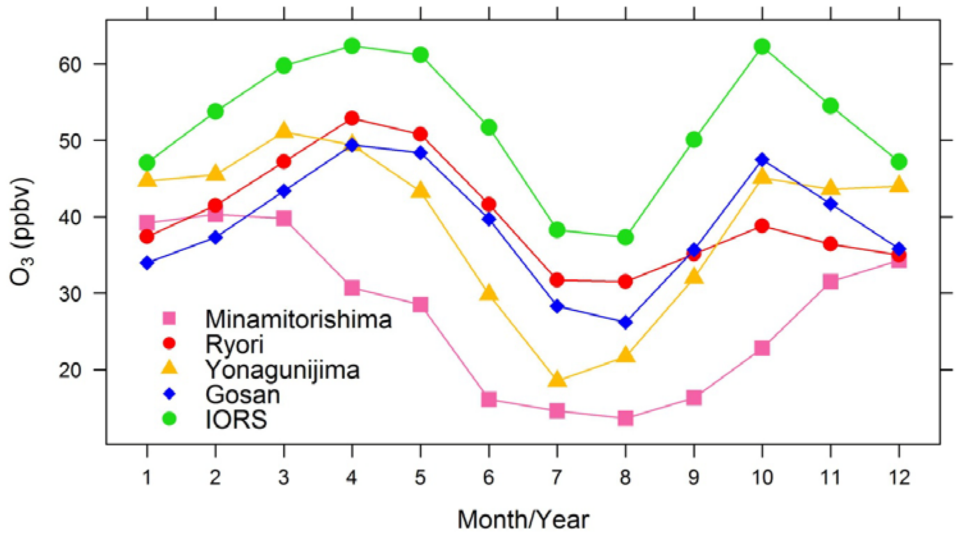


Figure 3. Comparison of diurnal and seasonal variations of O_3 concentrations at remote sites in the Northwest Pacific region including IORS, Gosan, Yonagunijima, Ryori, and Minamitorishima. All data were averaged for 8 years (2003–2010) and seasons were divide into spring (May-April), dry summer (May- June), wet summer (July-August), fall (September-November), and winter (December-February). a) diurnal variations of O_3 at IORS in different seasons, b) diurnal variations of O_3 at five sites, and b) monthly variations of O_3 at five sites.

5. Figure 3: The seasonal maximum is actually in autumn, not spring. Correct? There are both spring (higher) and autumn (lower) peaks observed at EANET stations, so this is consistent. A unique phenomenon is that the autumn peak is higher than the spring one here at IORS. Also, I would say that the spring peak is not April but "April-May". Latitudinal differences in the timing of the spring peak in this region is found in Tanimoto et al., GRL, 2005, so please look at it and add a bit more discussion.

At IORS, the monthly mean was the highest in April and October (62 ppbv), followed by May (61 ppbv). There is just 1 ppbv difference between April and May. Gosan showed similar tendency in their monthly distribution with the highest in April (49 ppbv), May (48 ppbv), and October (47 ppbv). In Figure 3c, the second peak is evident for these two sites. Tanimoto et al. (2005) found the second peak of O3 in October, which was more evident in their CTM (chemical transport model) results. As you mentioned, the data from IORS and Gosan may be good compliments for the EANET dataset, with which the characteristics of O3 in the northeast Asia would be better understood.

The relevant discussion (Page 16752 lines 13-20) was rewritten as follows.

At IORS, the monthly averaged O_3 concentrations were the highest in April and October (62 ppbv) and lowest in August (37 ppbv) (Fig. 3c). The O_3 concentrations remained high during March ~ May, resulting in a broad spring peak which was in contrast to a sharp fall peak. This is in accordance with a typical pattern that has been observed in other remote sites over Northeast Asia during the past decades (Chan et al., 2002; Jaffe et al., 1996; Kanaya et al., 2015; Kondo et al., 2008; Oltmans and Levy II, 1994; Tanimoto et al., 2005; Tanimoto et al., 2009; Watanabe et al., 2005; Weiss-Penzias et al., 2004). In particular, the second peak of O_3 was the most noticeable at IORS along with Gosan in October, of which tendency was observed in previous studies (Kanaya et al., 2015; Tanimoto et al. 2005).

Abstract was also rephrased, stating specific month, for which O3 was the lowest and highest.

6. Figure 3 again: I am not comfortable to see the plots of Trinidad Head, in particular for the diurnal cycles, since we can expect no link to IORS and other East Asian sites.
7. Figure 3 again: I think ozone data is available at Gosan site on Jeju Island. Can you compare IORS and Gosan?

For 6 and 7, the measurements of Trinidad Head were replaced with those of Gosan and the discussion was revised accordingly.

8. Page 16752, Line 23: Do you mean ozone is removed by rain? The solubility of ozone is not high, so my understanding is that ozone itself is not effectively removed by rain. Can you please clarify or elaborate more?

This part (Line 21-25) was rewritten for clarification as follows.

In summer, the study region is under influence of Asian monsoon system which brings moist air from the Pacific Ocean. Meteorological parameters including relative humidity, wind speed, and visibility indicate a clear shift in air mass from pre-monsoon to monsoon season (Fig. 4b). At IORS, O3 concentration was noticeably decreased during summer, even though temperature was high. Likewise, the O3 level of Gosan was reduced down to the minimum in summer, when the levels of precursors were the lowest with heavy rainfall.

9. Page 16754, Line 3-12: This paragraph should be moved to 2. Methodology section. "w.e.re" must be a typo.

The background information on trajectory analysis was moved to the end of the methodology section. Typo was corrected.