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Atmospheric Chemistry and Physics Discussions

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14, C1940–C1945, 2014

Interactive Comment

Interactive comment on "Overview of the Manitou Experimental Forest Observatory: site description and selected science results from 2008–2013" *by* J. Ortega et al.

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We sincerely appreciate the reviewers for agreeing to thoroughly review our manuscript and thank them for their helpful comments.

There were numerous discussions regarding whether or not this manuscript should include case study data in an overview. While we see the reviewer #1's argument that it goes beyond the scope of just a site description, many of the co-authors were strongly in favor of including specific gas- and particle-phase data in this paper in addition to the basic site description. We did our best to come up with a compromise and believe that including specific data strengthens the manuscript. Part of this includes simplifying the manuscript and attempting to put the entire text in "one voice" (the 1st author's).

To address the reviewer's comment regarding solar radiation and eco-physiology, a new figure (2) has been added that shows net radiation, sensible heat flux, latent heat flux and CO2 fluxes in the 4 seasons. The following paragraph has been added to section 1.2.

Like much of Colorado, the site has a high frequency of sunny days during most of the year. During mid-day in July 2011, approximately 90% of the days had PAR values (photosynthetically active radiation between 400 and 700 nm) above the canopy that exceeded 2100 umol m-2 s-1, and part of every day reached a PAR value of at least 2000 umol m-2 s-1. Frequent afternoon thunderstorms can temporarily reduce the solar insolation, but rarely for more than three hours. Figure 2 shows the diel cycles of net longwave and shortwave radiation, latent heat flux, sensible heat flux and net CO2 flux (calculated using the eddy covariance method) from four representative months during 2011. Each point represents the 30 minute average for that time period. The net radiation is calculated from the difference between the downwelling radiation and the upwelling radiation from the radiometers at the top (28 m) of the chemistry tower. It is interesting to note the net carbon uptake in the spring (April) and autumn (October) during the day, and the large nighttime respiration flux in July.

To address the reviewer's comments regarding soil properties, we added additional information about soils and topography in section 1.2:

Soils underlying the tower site and in surrounding area are classified as deep, well-drained sandy loams and sandy gravelly loams largely existing as alluvial deposits weathered from underlying arkosic sandstone formations as well as nearby granite formations (Soil Conservation Service, 1992). Although numerous outcroppings of partially-weathered sandstone exist around the site, the average depth to bedrock is estimated to be between 1-1.8 m (36-60 inches) below ground surface. Soil acidity

ACPD

14, C1940–C1945, 2014

ranges from slightly acidic to moderately alkaline (pH 6.1-7.8) with little organic matter content (1-4%) and rooting depths reported to be in excess of 1.3 m (40 inches). Soil permeability on undisturbed soils is characterized as moderately rapid (approx. 50-150 mm hr-1). However rapid runoff generation and sediment transport has been observed at the site on compacted road surfaces, and other areas void of significant ground vegetation. The tower site is on an alluvial bench, formed by the erosion of underlying granite. It is situated in a broad, shallow valley approximately 1 km west of an intermittent creek. The terrain slope is asymmetric across this valley with the east side of the valley being steeper and the west side being more gradual (gradient between 3-8%).

To address the reviewer's concern about flux footprint, we have provided the following information in section 1.3.

The suitability of these towers for making eddy covariance flux measurements in the surrounding landscape was analyzed by Kaser et al. (2013b). Briefly, the flux footprint was found to extend to 900 m for unstable boundary layer conditions and to 2500 m for stable conditions. However, because there is more heterogeneity in the forest composition and proximity to former burn areas inside the 2500 m radius, a practical limit of 1850 m beyond the tower was used as the criteria for valid flux data. A paved road $\sim$ 500 m east of the site caused data to be eliminated if wind direction was from that sector.

To address the reviewer's concern about physiological parameters, we have included additional information in Section 1.3. Just prior to this insertion, we have also emphasized that ponderosa pine is the only significant type of woody biomass surrounding the observatory. Leaf-level gas exchange was measured during peak sun exposure (9am - 2pm) on sunlit needles $\sim$ 10m above the ground. Each measurement was made on 6-10 mature needles. Mature needles were defined as needles that been on the branch through at least one winter. Gas exchange measurements were made using an LI-6400 portable gas exchange system (LI-COR Biosciences, Lincoln, NE) and photosynthesis, stomatal conductance, and transpiration calculations were made using total

ACPD
14, C1940–C1945, 2014

leaf area (measurement as described in Eller et al., 2013). The effects of high solar insolation, warm temperatures, and low humidity just prior to monsoon precipitation are demonstrated by the low stomatal conductance and photosynthesis values in July.

Since another figure was added to an already long manuscript, we have removed the original Figure 3. We have simplified the meteorology section (1.4).

Table 1 and Figure 2 have been attached to this response in pdf format.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 1647, 2014.

Table 1: Mean values for needle-level gas exchange measured on mature *P. ponderosa* needles at the Manitou Experimental Forest Observatory. All calculations are based on total, rather than projected, leaf area. Values in parentheses give the range of dates (2011 day of year) when measurements were made. Standard deviations are given in italics (n=3).

	May (136-149)	June, July (178-185)	August (230-233)	September (263-265)
Net Phosynthesis (A)	2.9	0.9	3.2	3.5
µmol CO_2 m^{-2} s^{-1}	*0.6*	*0.6*	*0.8*	*0.2*
Stomatal conductance(g_s)	28	7	29	30
mmol H_2O m^{-2} s^{-1}	*9*	*5*	*12*	*6*
Transpiration	0.49	0.35	1.00	0.64
mmol H_2O m^{-2} s^{-1}	*0.13*	*0.28*	*0.22*	*0.07*

Fig. 1.

ACPD
14, C1940–C1945, 2014

Interactive Comment

ACPD

14, C1940–C1945, 2014

Interactive Comment

Figure 2: Average diel net radiation (downwelling minus upwelling), latent heat flux, sensible heat flux and net CO_2 flux for four representative months. All properties were measured from 28 m at the top of the chemistry tower in 2011. Each data point represents a 30 minute average for that time period. The y-axis limits are the same for each plot except for January, where the scale is ½ of the other three months. The shaded area for net radiation and error bars for CO_2 flux represent ± 1 standard deviation. Error bars for sensible and latent heat fluxes have been omitted for clarity.

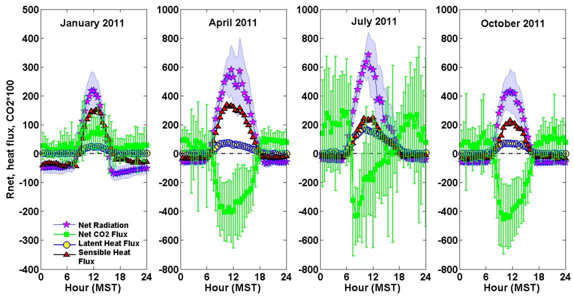

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Fig. 2.

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Interactive Discussion

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