Reply to Anonymous Referee #1

We thank the reviewer for the constructive and thoughtful comments and provide a response to the individual points below.
Reviewer comments are in bold and our replies in a regular font.

1) The study focuses on a single 25-day period, because of the availability of aircraft measurements for comparison. Still, the reader is left wondering how representative the results are for other times of year. The authors could run their model for the full year of 2008 and show figures similar to Figure 8 for all four seasons. In my opinion this would provide a significant step forward from the conclusions of Huang et al. [2010].
We need high resolution simulations of how foreign emissions impact the surface of North America, estimates that up until now have mainly been provided by coarse resolution global CTMs. The high resolution WRF output can provide more details of the impact regions especially the impact of Asian emissions on high elevation vs. low elevations sites. Given that the authors have already provided a lot of model verification in the current version of the paper, I don't think they need to provide any additional verification.

Studying the impacts of pollution inflow in the context of seasonal and inter-annual variability makes an interesting and important study objective, but due to limited computing resources we are not able to easily continue the regional and the global model simulations (which for this study are performed on a rather high spatial resolution) for a full year time period. We further emphasize that our study is intended to support the analysis of the ARCTAS-Carb time period and provide an estimate of all different source contribution during this time period. While pollution inflow is a major contributor, this study is not exclusively focused on Asian pollution transport.
However, the reviewer has brought up some very important points in his comments and addressing these has increased the scientific significance and contribution of this study. The major revision include:

- We added a more detailed analysis about the transport of pollution to the surface over California (Section 4.3 - General Transport Pathways for Pollution Inflow) as suggested by the reviewer in comment 2)
- We followed up on the comment of the reviewer about the representativeness of global models in simulating impacts of foreign emissions, and added a new Section comparing the influence of Asian CO from MOZART-4 and WRF-Chem over California (Section 4.4 – Influence of Pollution Inflow from Global and Regional Modeling). This led to an actually rather surprising result. The overall statistics between the global and the regional model are fairly similar suggesting that, at least for a chemically simple species like CO and a fairly high spatial resolution in the global model, MOZART-4 simulations provide a reasonable representation of the influence of long-range transport on regional air quality.

2) The authors could focus more on the processes that bring background, and especially Asian CO to the surface. Parrish et al. [2010] and Huang et al. [2010] discuss downward mixing of background and Asian CO into the northern Sacramento Valley. How do the Pfister et al. results compare? Judging by Figure 8 there seems to be an enhancement of Asian CO in the Sacramento Valley. And I'm surprised that even though the Asian CO tracer should have greater mixing ratios in the free troposphere than in the marine boundary layer, there does not seem to be a greater impact of Asian CO on the mountains of southern California and the rest of the high elevation regions desert southwest. Instead there is more Asian CO in the marine boundary layer west of southern California. Why? The authors suggest that the Sierra Nevada act as a barrier diverting inflow towards the north and northeast, but I just don't think this is the case. If they were such a barrier to flow (like the Tibetan plateau) this phenomenon would be well known and would be evident in rain fall patterns, storm development and incredible wind speeds around the mountains. Isn't the CO pattern more likely due to the fact that during summer the transport across the desert southwest is southerly, due to the widespread summer monsoon, which keeps the Asian CO further north?

As proposed by Parrish et al. (2010) and also discussed by Huang et al. (2010), our results show that CO inflow can reach the Sacramento Valley via two pathways; the first is by airmasses entering at the Bay area and splitting northward into the Sacramento Valley and southward into the San Joaquin Valley. The other is by downward transport bringing air masses from altitudes below about 2-3 km into the Sacramento Valley. This is discussed in more detail in the new Section 4.3 and shown in the new Figures 9 and 10.

Monthly average wind vector plots at 700, 500 and 250 hPa would be helpful. Also, in springtime is there a stronger impact of Asian CO on the high elevation terrain of the desert southwest? Stohl et al. [2002] show that during springtime the strongest Asian CO plume, on average is found in the mid troposphere at 35 N latitude. How does this compare to summer 2008? Does the Asian plume enter North America at higher latitudes in summertime? Furthermore, there is a discrepancy between Holzer and Hall [2007] and Liang et al [2004] regarding the relevance of low altitude transport of Asian emissions to the western US. How do your results compare?

Average wind vector plots are included in Figure 9 and the vertical distribution of Asian CO inflow is discussed in the new Section 4.3.

References to the listed studies have been included where appropriate.

For example, in Section 4.3 the global model CO tracers are used to look more closely at the transport of Asian CO:
"The tagged tracers from the global model, where anthropogenic and fire Asian sources are separate tags, can give an understanding of different source regions. Analysis of the global tracers (not shown here) shows that the main source for fires in Asia this time of the year is at higher latitudes (above ~40N) and these emissions are predominately transported at lower altitudes towards the US West Coast. In contrast, Asian anthropogenic CO with the major source regions at lower latitudes shows the

highest mixing ratios at altitudes above 5 km, but also significant contributions near the surface. The near-surface mixing ratios of the global model Asian fire tracer over the Eastern Pacific is on the order of 15-20 ppbV compared to 12-15ppbV for the anthropogenic tracer. The importance of low level transport pathways for Asian CO during summertime has also been discussed by Liang et al. [2004] and Holzer et al. [2007]. In summertime the Asian transport is highest at latitudes around 40N (Figure 9), which is further north compared to springtime when Asian export is at its maximum and the major transports occurs at around 35N [Stohl et al., 2002; Liang et al., 2004]."

Note that both Holzer at al. [2007] and Liang et al. [2004] agree in the importance of low level transport of Asian CO during summertime, which is the season of our focus.

Our estimates of Asian influence to surface CO also agree well with Liang et al. [2004] and this has been added to Section 4.1:

"The largest single average contribution comes from CObc with a mean absolute mixing ratio of 99±11ppbV; 26±7 ppbV of this can be attributed to direct emissions from Asia, which is in the range of the study by Liang et al. [2004], who estimate the mean summertime Asian contribution at Cheeka Peak (48.3N, 124.6W) as 24 ppbV."

page 3629 lines 8-10 Are these CO mixing ratios at the surface? Also, here and throughout the paper, seeing as the model CO values are reported in units of ppbv, CO values need to be described as mixing ratios and not concentrations.

We revised the manuscript to refer to mixing ratios instead of concentrations.