General comments:
This manuscript analyzed the relationship of surface temperature with aerosol optical thickness (AOT) during a two-day smoke event. Some interesting results about operational forecast errors of surface temperature during this smoke event are presented. The authors attribute these forecast errors to missing aerosol radiative effects in the forecast models. However, the analysis is not convincing. The presentation needs some improvements.

We thank the reviewer for his/her constructive suggestions. We have taken the suggestions seriously and have carefully addressed the issues as shown below. The impact of smoke plumes to temperature forecasts has been documented in the past (also referenced in this paper). In fact, we are not the only one to notice the impact of smoke aerosols on surface temperatures for this smoke event. The local National Weather Service station has also recognized the issue and documented the potential impact of smoke plumes to temperature forecasts. For example, the Area forecast discussion issued by the Grand Forks NWS station at 10:00am CDT on June 29, 2015 mentions that "VERY THICK SMOKE TODAY WILL LIMIT TEMPERATURE RISE AT LEAST 2 TO 5 DEGREES...SO HAVE LOWERED TEMPS SOME AT LEAST. THIS IS VERY THICK SMOKE SO TEMPS COULD BE HELD DOWN INTO THE 70S...SO WILL MONITOR. THERE COULD BE SOME SHOWERS AND STORMS MAINLY EAST OF THE VALLEY THROUGH 00Z. OTHER THAN THE TEMP CHANGE...NO MAJOR CHANGES PLANNED TODAY."

Major Comments:

1. The manuscript has a lot of descriptions of geographical locations, such as upper Midwest, Upper Mississipi, Ohio River Valley, etc. However, they are not identified on the figures. For readers who are not familiar with American geography, it is hard to follow the discussions.

Thanks for the suggestion. We have added a figure (now Figure 1), that provides a map of all of the geographic locations listed.

2. L372-375: Could you give some discussion about the meaning of forcing efficiencies and their relationship with surface temperature?

As suggested, we have added the following discussion:
"Note that TOA (surface) aerosol forcing efficiency is defined as the amount of change in upward (downward) short-wave radiation at TOA (surface) for a unit change in AOT. Negative surface aerosol forcing efficiencies indicate a reduction in short-wave radiation reaching the surface and mostly likely linkage to a decrease in surface temperature."

3. L377-380: Figure 1e shows several points of high AOT (>1) between Jun 29 and July 1 at Ames.

We have revised the sentence to:

"the averaged AOT (0.5 µm) is around 0.5 for the Ames site, whereas the averaged AOT (0.5 µm) for the other sites range from 0.8-1.4 (Table 2)."

4. Section 3.2 and section 3.3: As shown in Figure 3, the interested regions are covered by two different synoptic systems, high pressure system to the southwest of the plume and low pressure system to the northeast of the plume. The sharp gradient of surface temperature in the interested regions are mainly due to the difference of the synoptic systems. For discussing aerosol impacts on surface temperature, differences in dynamical environment must be considered.

We agree that differences in the dynamical environment should also be considered. Still, for this case, the approximated MODIS AOT (based on the nearest available MODIS data), at 17:45 UTC on June 29, 2015, is 0.35 over Bismarck and is 4.43 over Grand Forks. If we assume an average aerosol surface forcing efficiency of $-120\ W\ m^{-2}\ \tau_{500}^{-1}$ (e.g. Table 2), the difference in surface downward SW flux is ~480 W m^{-2} between Bismarck and Grand Forks (300km apart) due to the smoke plume alone, which will introduce a non-negligible difference in surface temperature.

In fact, we are not the only one to realize the impact of smoke plumes on surface temperature. The Area Forecast Discussion issued by the Grand Forks NWS station at 10:00am CDT on June 29, 2015 suggested that "VERY THICK SMOKE TODAY WILL LIMIT TEMPERATURE RISE AT LEAST 2 TO 5 DEGREES...SO HAVE LOWERED TEMPS SOME AT LEAST."

Also, the near surface wind speed is around 4.6m/s over Grand Forks and is around 5m/s over Bismarck (based on METAR data), indicating that "the difference of the synoptic systems" may have a marginal impact to this study.

We agree that the dynamical environment could be a factor as well and thus we have added the discussion:
"Lastly, besides the aerosol direct surface cooling effects, surface temperatures could also be impacted by differences in dynamical environments, which adds uncertainties to the study."

5. L434-436: How do you get these numbers of _5_C and -1.5_C/__550?

On a monthly average, for the daily maximum temperature, Bismarck was historically warmer than Grand Forks by 1.0 ±2.0° C (June 15th - July 14th 2015, excluding June 29th), with a correlation of 0.90. On June 29th, a ~8 degree daily maximum temperature difference is found between Bismarck and Grand Forks (25.6ºC and 33.3ºC for Grand Forks and Bismarck). By considering the historical mean and standard deviation of the temperature difference between Bismarck and Grand Forks (1.0 ±2.0° C), it is approximated that the smoke plume introduced a ~5degree difference in the daily maximum temperature between the two cities.

The daily mean AERONET AOT is around 3.4 (0.55 um) over Grand Forks and the approximated MODIS AOT over Bismarck is 0.35 (0.55 um , no AERONET data available), and by dividing -5 degrees with the AOT difference of ~3 gives us the approximated aerosol cooling efficiency of ~ -1.5°C/τ_{550}.

6. L467-469: Will this assumption induce bias in AOT?

This assumption could introduce a bias in AOT. We have revised the paper to document this. "Note that this assumption may introduce a bias in the estimated MODIS AOTs."

7. Section 3.4: Similar to comment 4, will smoke Aerosol Direct Surface Cooling Efficiency be different in different dynamic environment? Also, studies have shown that aerosols can change thermodynamic environment or change cloud formation (as some clouds shown on Figure 6c and 6d), resulting in differences on model forecasts. Will these aerosol effects contribute to biased model forecasts on surface temperature?

We believe the smoke Aerosol Direct Surface Cooling Efficiency may also be a function of different dynamic environments. However, to draw a conclusion, more than one case study is needed to categorize the Aerosol Direct Surface Cooling Efficiency under different dynamic environments, which is beyond the scope of this study. Still, we have mentioned the potential impact of dynamic environments in this paper as suggested from the response to comment 4.

In this paper, only the smoke Aerosol Direct Surface Cooling effect, which is the change in surface temperature due to smoke induced reduction in surface SW downward radiation, is studied. As the reviewer mentioned, aerosol particles can affect surface temperature indirectly through methods such as modifying cloud properties (e.g. Tao et al., 2012), however, these effects are beyond the scope of the study. But this is a legitimate point and we have added the following discussion to reflect the issue.

"Note that this study is focused on cloud free conditions and only the direct smoke aerosol surface cooling effect is studied. Still, aerosol particles may indirectly affect weather by altering cloud microphysics in both strati-form and convective clouds (e.g. Tao et al., 2012). Such effects warrant further discussions and evaluations."

Minor comments:

1. L113-115: Any references?

We have added two references: Robock 1991; Mulcahy et al., 2014

2. L137-151: The WRF-Chem model has been extensively used in weather research and forecasting. Some references, such as Chapman et al. [2009, ACP] and Grell et al. [2011, ACP], can be cited.

We have added the discussion accordingly.

“some earlier studies have used WRF-Chem for aerosol related weather research and forecasting (e.g. Chapman et al. 2009; Grell et al. 2011).”

3. L162-165: What’s the MODIS AOT at Grand Forks?

The approximated MODIS AOT, based on the nearest available retrieval method as mentioned in the paper, is 4.3 (0.55µm).

4. L224-229: A scatter plot between AERONET and MODIS may help.

We didn’t add the plot, as evaluating the MODIS AOT product is not the focus of the paper and such effects have been documented in a few of our previous papers (Zhang and Reid, 2006; Shi et al., 2011; Hyer et al., 2011).

Shi, Y., Zhang, J., Reid, J. S., Holben, B., Hyer, E. J., and Curtis, C.: An analysis of the collection 5 MODIS over-ocean aerosol optical depth product for its implication in aerosol assimilation, Atmos. Chem. Phys., 11, 557-565, doi:10.5194/acp-11-557-2011, 2011.

Hyer, E. J., Reid, J. S., and Zhang, J.: An over-land aerosol optical depth data set for data assimilation by filtering, correction, and aggregation of MODIS Collection 5 optical depth retrievals, Atmos. Meas. Tech., 4, 379-408, doi:10.5194/amt-4-379-2011, 2011.

Zhang, J. and Reid., J.S., MODIS Aerosol Product Analysis for Data Assimilation: Assessment of Level 2 Aerosol Optical Thickness Retrievals, *J. Geophysical Research-Atmospheres*, VOL. 111, D22207, doi:10.1029/2005JD006898, 2006.

5. L240-248 is similar to L251-260. It is better to combine these two paragraphs.

L240-248 refers to data from the National Weather Service. L251-260 refers to data from the Automated Surface Observing System. Data reported from the NWS may include data from the ASOS stations. But to be clear with the data sources, we reported them separately.

6. L267-269: Confused. Please reword.

We have revised the sentence to:
“2 m surface temperate forecasts for the 18:00 Z valid times (30 and 54 hour forecasts) were examined.”

7. L281: “at 18:00 UTC”?

Yes, and we have modified the text accordingly.

8. Should L288-293 be inserted to L282?

We believe this is a writing style related issue and thus we didn't make changes.

9. L323: "500 hPa" or "700 hPa"?

We believe this is related to the statement "…winds that were west-northwesterly veering to north-north west at 500 hPa (see the 700 hPa height and wind analysis from the ECMWF reanalysis in Figure 3)." To prevent misinterpretation, the sentence is now modified to:

"The rapid transport of this smoke event was related to a persistent longwave high over the western United States, and corresponding trough over the eastern seaboard. The resulting in lower free tropospheric winds were west-northwesterly (e.g. see 700 hPa height and wind analysis from the ECMWF reanalysis in Figure 4 (note, new figure numbering). These winds veered to north-north west at 500 hPa."

10. L326: The color bar of wind speed in Figure 3 has a maximum of 20 m/s.

Yes. This is for 700 hPa. Wind speeds are higher at higher levels.

11. L335: "500 hPa" or "700 hPa"?

500 hPa. For brevity we showed 700 hPa in Figure 3, as representative of the lower free troposphere. But in the text we do discuss other levels.

12. L367-368: For this smoke event?

Yes.

13. L376-377: Which time are the outliers are at? Are the outlier retrievals just for surface forcing efficiencies, or also including AOT, SSA etc.?

These were listed on Table 2. It was high on downward surface forcing, and low on single scattering albedo and size. To reinforce the point we made regarding the potential sampling bias in the region, we now list the AOT values for the retrievals in Table 2 as well.

14. L571: Isn't C__ the same under similar conditions? Why should we expect different C__ for lower aerosol loading?

We have removed ", as well as a lower aerosol loading" as suggested.