Atmos. Meas. Tech. Discuss., 8, C979–C994, 2015
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Atmospheric Measurement Techniques Discussions

Interactive comment on "Diurnal aerosol variations do affect daily averaged radiative forcing under heavy aerosol loading observed in Hefei, China" *by* Z. Wang et al.

Z. Wang et al.

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Final Response: As followings: (1) comments from Referees, (2) author's response, (3) author's changes in manuscript.

(1) comments from Referees: Referee #1: This is not yet a full review, but rather a "quick report", which is often requested (but not this time for some reason). There are clearly few things to be clarified before the paper can be fully evaluated. If we look at the Figure 8 (or panel b of Figure 7), it seems that deltaF (= Fave-Forg) was essentially always positive (only five cases of very small negative value). I have some

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difficulties to believe this. So no single day, out of 196, had an AOD variability that resulted in negative deltaF; always smaller cooling at the surface, if one uses the daily averaged AOD? How about Figure 5, it seems that something is not correct and for instance in that case, deltaF should be negative actually. For some reason, the colors are now opposite to the similar Figure 2, black is Forg and red is Fave, if the bars are with the right color, then the values should have resulted in negative deltaF= -15.6. Block 2127, line 24: it is not clear how you fill up the missing period by using the measurements. The use of measurements only for these periods could introduce a systematic difference, not due to the AOD variability. I think much more consistent way would be simply to assume no difference in ADRF due to AOD when there are no AOD measurements available. Please repeat the analysis this way to see the possible impact by the current choice you have made. Block 2129, the line 9 and the following paragraph (last paragraph of the section 3) was entirely unclear. In the first point, for instance, you mention that SSA and ASY has a smaller impact. How one can see it from the Figure 8 (I assume you meant Figure 8, although you refer there to the Figure 6)? The influence by SSA and ASY was not discussed nor shown in any part of the analysis in this manuscript. How about the second point, what do you mean by "partly related"? Figure 7: the unit of the lowest panel is not correct. Why your small fraction of negative deltaF in the middle panel does not translate to negative fraction also in the lowest panel?

Referee #2: The article submitted by Z. Wang et al. for its review is a short study about the effect of daily averaging the aerosol optical properties before they are used in the estimation of the surface radiative forcing. Previous results show that daiy averaging the aerosol optical properties (the study focuses at the aerosol optical depth mainly) doesn't have a strong effect on the surface radiative forcing, at least in some regions. The authors want to stress out that for regions with a high aerosol optical depth and important daily variations (such as Hefei in China), the daily averaging of the AOD has a strong effect on the SFC, and therefore, instantaneous AOD measurements must be used. General comments: In my opinion, the study has a good presentation and

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has been clearly written (the English grammar is good enough although the text would further benefit from another English review). Although the scientific objective is not exceptional, it is a fair study of a particular issue that affects many other scientific works (such as the evaluation of the aerosol radiative forcing) and therefore I consider it to be suitable for its publication on Atmospheric Measuring Techniques journal. However, the authors still need to make clear some points and correct some errors. Specific comments: - Page 2125, line 22: "the SKYNET sky radiometer". This is a Prede POM radiometer, please indicate. Please also indicate the model used in this study (POM01L, POM02...). - Page 2126, line 28: I have the impression that the authors are using a different definition of the relative differences, based on the magnitudes of these values, when plotted in suvbsequent sections. I think they are using abs(Fave-Forg)/Forg*100, as they are expressed in % and moreover, no negative values appear in some plots. - Page 2128, line 8: it is interesting to include AOD only in the study, but I think the authors should make an extra effort to show that SSA and AS have a negligible effect. I think the paper would improve largely if they were able to apply a similar procedure to show the effect of other parameters to the SFC. - Page 2126: you use SBDART to estimate the surface radaitive forcing. Please briefly comment about the uncertainties involved with this model to complete the discussion about the effect of the averages on the daily SRF estiamation. You can base your estimation on previous cases such as Prasad, A.K., Singh, S., Chauhan, S.S., Srivastava, M.K., Singh, R.P., Singh, R., 2007. Aerosol radiative forcing over the Indo-Gangetic plains during major dust storms. Atmos. Environ. 41, 6289–6301. http://dx.doi.org/10.1016/j.atmosenv.2007.03.060, or A.R. Esteve, V.Estelles, M.P. Utrillas, J.A. Martinez-Lozano, Atmospheric Research 137 (2014) 195–204. - The SKYNET measurement protocol consists of direct sun measurements every 1 minute and diffuse sky measurements every 10 minutes. In contrast, AERONET measures sun component every 15 minutes and diffuse sky every 30-60 minutes. Maybe the authors could comment about the advantage of such a temporal resolution difference? What would be the effect of measuring every 15 minutes instead of 1-min, in terms of the SFC? Technical corrections: - Page 2124, lines 12-

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15: please rewrite this sentence (These errors increase with increasing daily aerosol optical depth (AOD) MEANING THAT high temporal resolution...) - Page 2127, line 22: "may not be negligible" - Page 2128, line 4: "as shown in Fig. 4. The daily averaged..." - Page 2128, line 18-19: please write the correlation coefficient as 0.9945, as it is written in subsequent sections. Correct also in the figures. Correct the sentence "2hich are also examined" - Page 2128, line 26: "AOD at 500 nm and the corresponding" - Page 2129, lines 5-7: please rewrite - Page 2129, line 9: "Average Fave" is redundant. - Page 2129, line 12: "responded to" could meybe written as "related to" - Page 2129, lines 13-18: please rewrite, these items are not clearly understood. - Page 2129, line 20: please remove "frquently" from here. Maybe "frequent heavy aerosol loadings"? - Page 2129, line 22: remove "of them" - Page 2129, line 24: over aiming?. High pollution regionS. - Page 2120, line 8: up to. Line 10:"So we require paying". Line 15: "Care must be taken" Figures and tables: - Figure 1: The last point on the plotted series looks like increasing too fast. Probably it can be removed from the series. - Figure 2: Please indicate the biases names in the in-plot bars. Please, check the colors of the lines and captions. - Figure 3: Please include the 1:1 line and extend the linear fit to the plot limits. Same for figure 6. - Figure 7: Third histogram has wrong labels in the X axis. It must be the relative deltaF, instead of DRAF. It looks like being a relative value to 100 (dF/F*100). - Figure 8: please include the lines resulted from the fittings. Is AOD referred to 500nm?

(2) author's response: Reply to Referee #1: In this paper, we will address the important effect on DRAF when averaged AOP is used to calculate radiative forcing in polluted regions with heavy aerosol loading and strong diurnal variations of AOP. So, I chose two days to prove my points. The first case on Apr.14, 2013 represents a typical light polluted case (mean AOD of 0.57) with moderate diurnal changes of AOP; the second case for a day with large diurnal changes of aerosol loading under high polluted (AOD equals to 1.08 in average) weather condition on 12 February 2008. The result shows that the relative biases are 27.1% and 9.7%, respectively. But in statistical point of view, many factors will be considered, such as sample selection, optics parameters,

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model calculation, which will induce biases. Using all selected 196 days' dataset, the statistical absolute and relative biases for 24 h average F calculation are 5.3+4.4Wm2 and 14.6+9.7%, respectively. We want to stress that care must be given when aiming to accurate radiative transfer calculations in high pollution region based on measured-retrieved long-term high temporal aerosol data. Thanks for your insightful comments. We agree with your opinion. In figure 8 and 7, the absolute and relative biases are deltaF and abs (deltaF / F), we will re-plot the figures including the unit. And in figure 5, the color is not correct, we also change it. As to block 2127, line 24, we use the measurements to fill up the missing period. From figure 3 and 6, some validation is done to make sure we can use measurements only for these periods. For one thing, they agree well; for the other thing, during these periods, the global flux is low and may introduce a systematic difference, but can be ignored. Of course, the more consistent way in your opinion would be simply to assume no difference in ADRF due to AOD when there are no AOD measurements available. I compared them, and not much affect, so I keep my results. As to block 2129, the line 9 and the following paragraph were entirely unclear. I agree. So, we add two figures to address the effect of SSA and ASY. Indeed, SSA will induce a more influence (please refer to figure 9 and figure 10). In the same time, this paragraph will be revised accordingly.

Reply to Referee #2: Thanks for your positive and constructive comments. We will make clear some points and correct some errors accordingly. - Page 2125, line 22: This is a Prede POM-02 SKYNET Skyradiometer. - Page 2126, line 28: The definition will be deltaF and abs (deltaF / F), we will re-plot the figures including the unit. - Page 2128, line 8: Yes, the effect of the other parameters, such as SSA and ASY will be shown in the paper. Some figures are supplemented. - Page 2126: the uncertainties involved with the SBDART model will be considered and briefly commented. - Yes, the advantage of such a temporal resolution measurement protocol for SKYNET will cover all variations of AOP in the whole day. - As to technical corrections: We will revised them in the paper. - Figure 1: The last point on the plotted series looks like increasing too fast. I checked the raw data and lidar data, when the aerosol loading is much more

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rich. So, we will keep it. - Figure 2: There is some error with it and we re-plot the figure. - Figure 3: Yes we include the 1:1 line and extend the linear fit to the plot limits. Same for figure 6. - Figure 7: figure 7 is re-plotted and improved. - Figure 8: Yes, we include the lines resulted from the fittings. And AOD is referred to 500 nm.

(3) author's changes in manuscript.

Change list1: in page 2124, line13: revised as "These errors increase with increasing daily aerosol optical depth (AOD) and decreasing daily single-scattering albedo (SSA) meaning that the high. . . . . " Change list2: in page 2125, line22: revised as "The SKYNET Prede POM-02 sky radiometer measures the direct and diffuse solar radiations every 10 min in the daytime, which is an advantage with high temporal resolution measurement to cover all variations of AOP in the whole day. . . . . " Change list3: in page 2126, line28: definition revised as " " Change list4: in page 2127, line10: revised as "But they may also introduce biases. Thus, we will consider AOD variability in the following discussions, as well as SSA and ASY." Change list5: in page 2127, line17: "AOD" revised as "AOP" Change list6: in page 2127, line22: revised as "may not be. . . . . " Change list7: in page 2128, line4: "And the" revised as "The. . . . . " Change list8: in page 2128, line8: "So, we will consider . . . " is deleted Change list9: in page 2128, line18: revised as ". . . . . with a high correlation coefficient 0.9945. So, we can use measured data to fill up Forg values during the missing periods, which are alsoexamined in figure 3." Change list10: in page 2128, line24: "AOD" revised as "AOP" Change list11: in page 2128, line25: "AOD" revised as "AOP" Change list12: in page 2128, line26: revised as ". . . . . daily mean AOD, SSA, and ASY at 500 nm. . . . . " Change list13: in page 2129, line2: "In figure 7b and 7c, the daily averaged SSA and ASY are also shown with variations ranging from 0.85 to 0.99 and from 0.61 to 0.73, respectively." is added Change list14: in page 2129, line4: "If we consider that the uncertainty in the estimated forcing due to deviations in the SBDART simulation is in the range $\sim$10–15% [Prasad et al., 2007], the relative biases will be enlarged furthermore." Is added Change list15: in page 2129, line5:

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revised as “. . . . . considered here. This finding is different from the others in some regions, where the observed conditions without heavy aerosol loading (AOD less than 0.4) are. . . . . ” Change list16: in page 2129, line12: “responded” revised as “related” Change list17: in page 2129, line12: “Then the figure 9 and figure 10 give relationship between DARF at SFC and the other two parameters (i.e., SSA and ASY). Only to find that there is also an increase trend of for 24-h average F calculation with decreasing daily mean SSA ( ) at 500 nm, which means the more light absorption of aerosol, the more contribution to the absolute biases.” Is added Change list18: in page 2129, line12: “figure 6” revised as “figure 8-10” Change list19: in page 2129, line16: “partly” revised as “also” Change list20: in page 2129, line18: revised as “. . . . . AOD, variation of aerosol absorption property and/or. . . . . ” Change list21: in page 2129, line20: revised as “. . . . . with frequent heavy aerosol loadings, such as. . . . . ” Change list22: in page 2129, line22: “of them” is deleted Change list23: in page 2129, line23: revised as “Thus, in order to accurate radiative transfer calculations in high pollution region, the observation-based long-term high temporal aerosol data must be considered.” Change list24: in page 2130, line10: revised as “so, we . . . . . ” Change list25: in page 2130, line13: revised as “. . . . . AOD and decreasing daily mean SSA at 500 nm. . . . . ” Change list26: in page 2130, line15: revised as “. . . . respectively, which will be more due to deviations in the SBDART model. Thus, care must be taken when aiming to. . . . . ” Change list27: in page 2132, line27: “Prasad, A.K., Singh, S., Chauhan, S.S., Srivastava, M.K., Singh, R.P., Singh, R., 2007. Aerosol radiative forcing over the Indo-Gangetic plains during major dust storms. Atmos. Environ. 41, 6289–6301. http://dx.doi.org/10.1016/j.atmosenv.2007.03.060. ” is added Change list28: figure 2 is re-plotted and corrected Change list29: figure 3 is re-plotted and 1:1 line is added Change list30: figure 5 is re-plotted and corrected Change list31: figure 6 is re-plotted and 1:1 line is added Change list32: figure 7 is re-plotted and parameters are added Change list33: figure 8 is re-plotted and fitting line is added Change list34: figure 9 is added Change list35: figure 10 is added

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Please also note the supplement to this comment:
http://www.atmos-meas-tech-discuss.net/8/C979/2015/amtd-8-C979-2015-supplement.pdf

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Interactive comment on Atmos. Meas. Tech. Discuss., 8, 2123, 2015.

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Interactive Comment

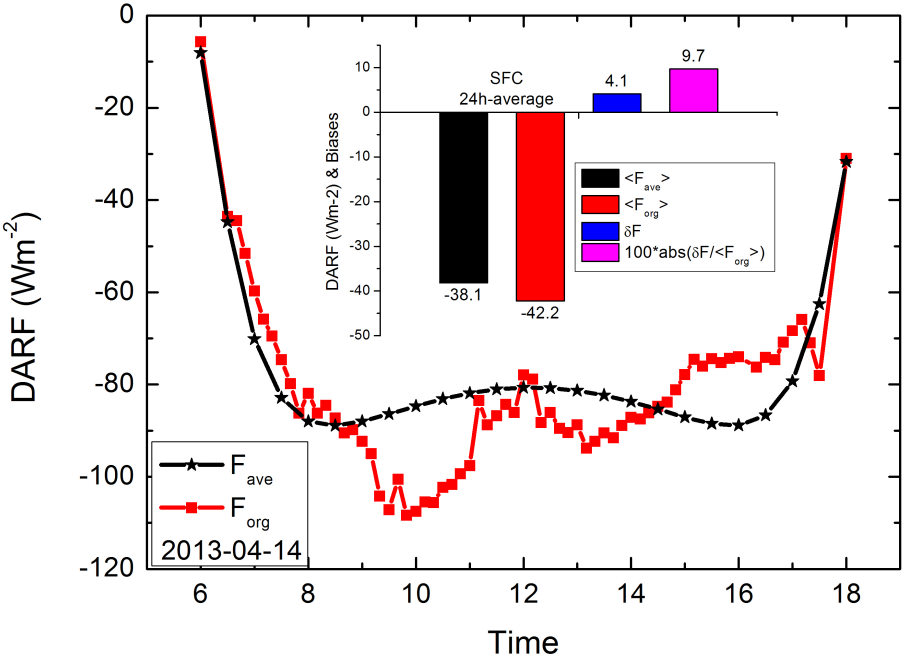

Fig. 1. figure2

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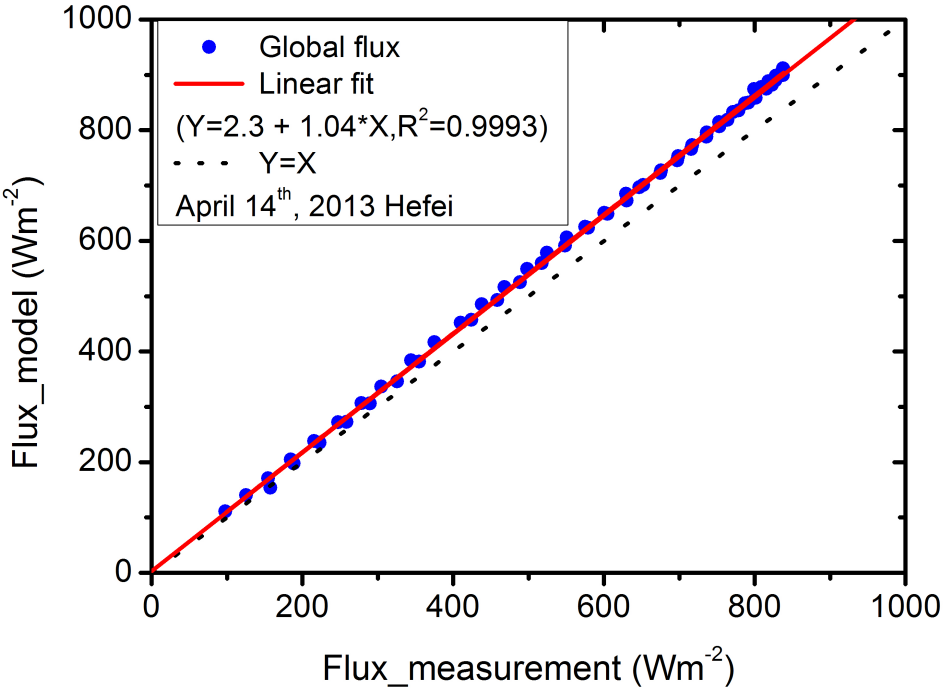

Fig. 2. figure3

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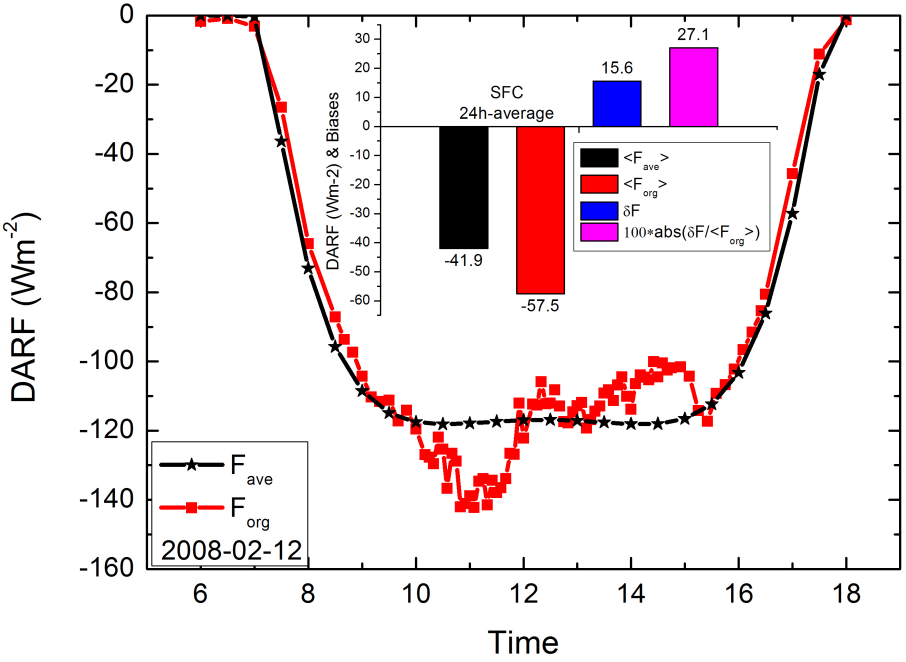

Fig. 3. figure5

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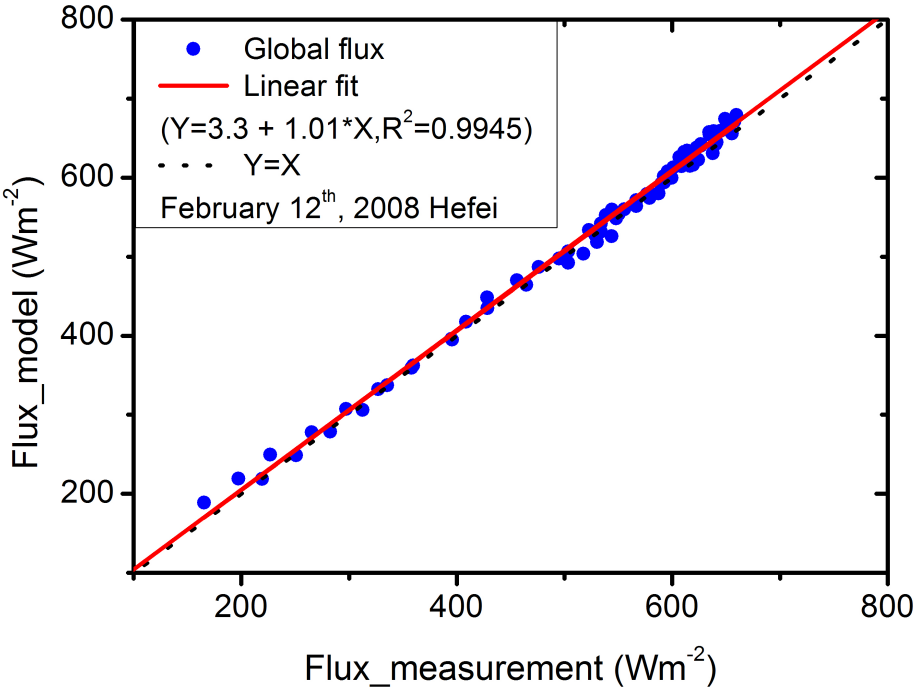

Fig. 4. figure6

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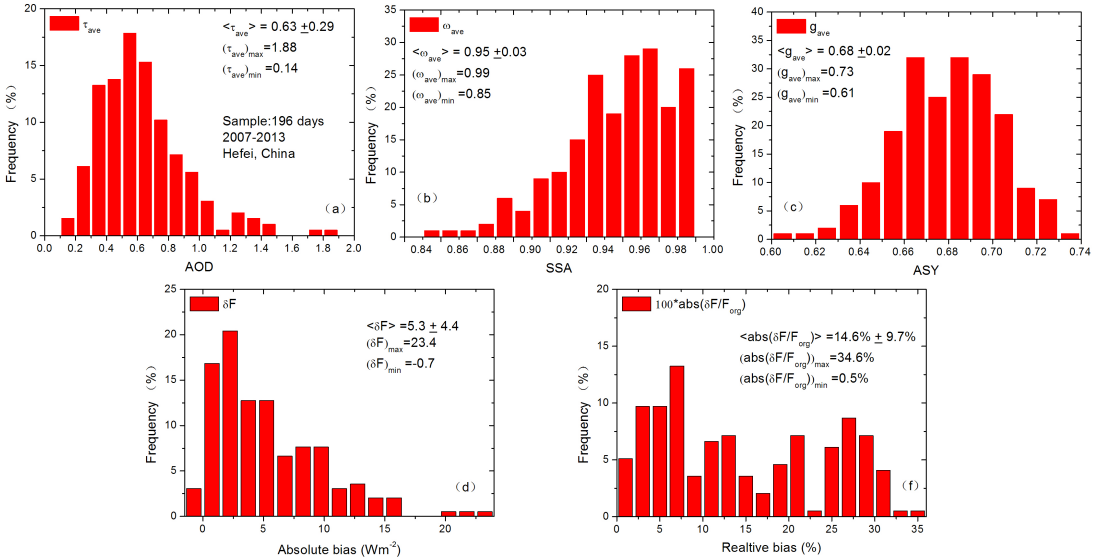

Fig. 5. figure7

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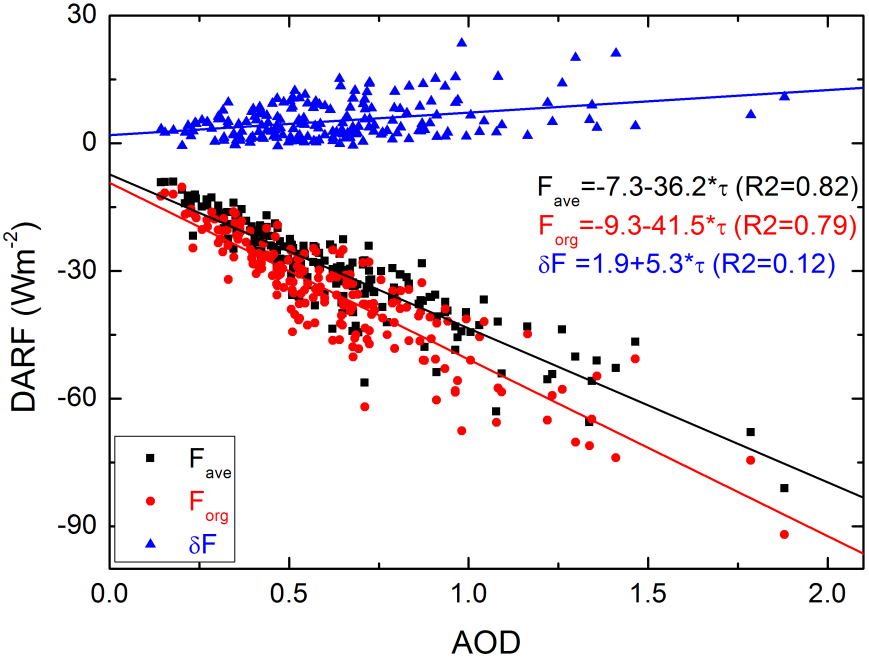

Fig. 6. figure8

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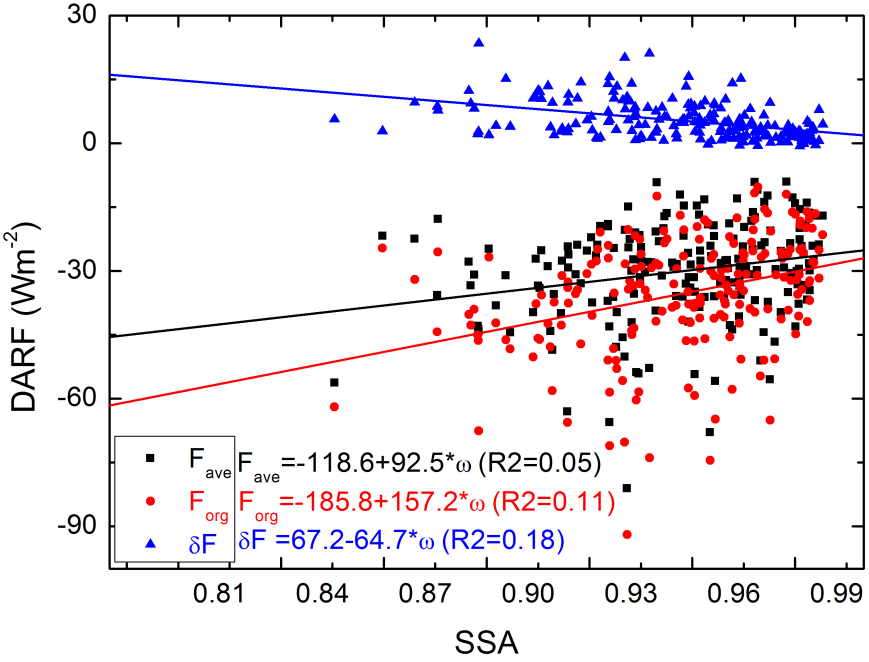

Fig. 7. figure9

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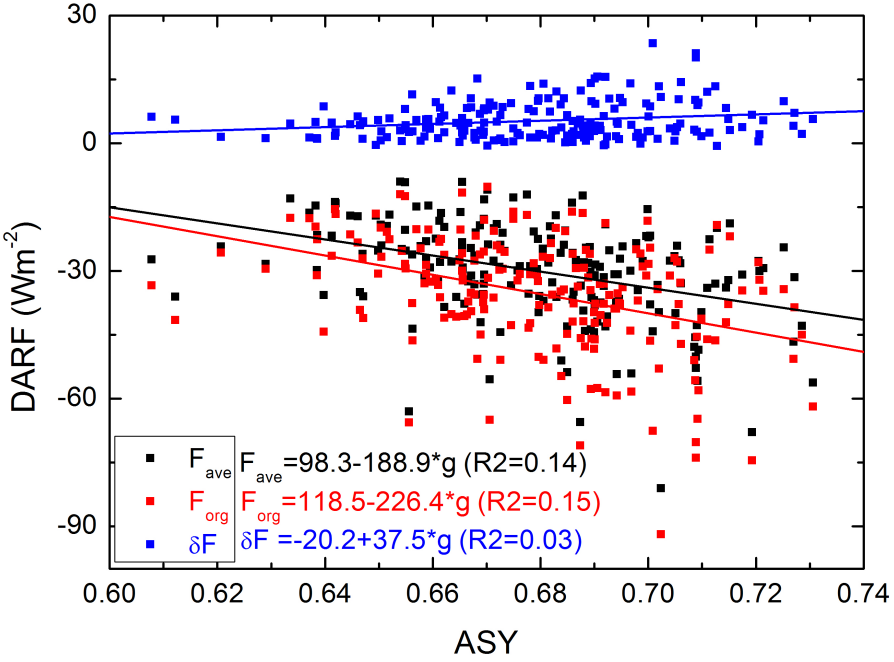

Fig. 8. figure10

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