

Interactive comment on “Observing the timescales of aerosol-cloud interactions in snapshot satellite images” by Edward Gryspeerd et al.

Anonymous Referee #2

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General comments:

This study proposes a method that uses snapshot polar-orbit satellite measurements, together with meteorological reanalysis data, to analyze time dependence of aerosol-cloud interactions for shiptrack phenomena. The authors conduct a careful analysis for identifying satellite pixels influenced by ship-emitted pollutants and associated cloud properties (Nd, LWP and cloud fraction), which are then investigated as a function of time since emission inferred from the distance from the source ship and near-surface wind fields. As a consequence of such an analysis, the authors obtained a series of interesting results regarding temporal evolutions of cloud responses to aerosol perturbations. I think this is a very nice study proposing a novel methodology that adds “time dimension” to the aerosol-cloud interaction analysis, and the results obtained are also

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insightful for understanding the time-dependent processes of aerosol impacts on cloud. I would recommend this paper be published in Atmospheric Chemistry and Physics after my specific questions/concerns listed below are addressed appropriately.

Specific comments:

Page 3, Line 29: “. . .more than 2 standard deviations above the background” What variable/parameter do the authors talk about for this standard deviations criteria?

Page 5, Line 6: “these shiptracks are typically shorter and have a length that is less sensitive to the size of the aerosol perturbation” Is this argument based on Figure 6d? I see some differences of the shiptrack length between low and high SO_x emissions in the plot. Where in the plot do the author refer to for “less sensitive to the size of the aerosol perturbation”?

Page 12, Line 14: “This increase comes from an increase in CF in around 10% of segments within the first 5 hours of the shiptrack (Fig. 7e)” I don’t understand this statement. Can the authors clarify how Fig. 7e is interpreted to reach this statement?

Page, Line 17-22: I don’t understand this whole paragraph. Can the authors instruct how several statements contained in the paragraph are derived from specific characteristics of Fig. 7e? I could not follow the argument just looking at Fig. 7e. I would appreciate the authors’ guide on where to look at in Fig. 7e for each statement in this paragraph.

Page 12, Line 25: “making it a plausible measure for the fraction of aerosol-limited cases in this region” Probably because of my lack of understanding for the previous paragraph, I don’t understand how this statement is derived. Can the authors explain it?

Page 15, Line 10: “until almost 15 hours after emission” In Fig. 9b, I don’t see the difference between the low and high emission cases for 15 hours – I see the difference until about 10 hours. Can you clarify what “15 hours” refers to?

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Page 16, Line 6: “With eN decreasing as eL increases” What is a physical cause for this anti-correlation between eN and eL?

Page 17, Line 5: “shiptracks are more likely to form in regions with a low cloud top humidity” Can the authors briefly describe a possible mechanism for this?

Page 20, Line 5: “this appears to suggest that the increase in sensitivity is almost exactly offset by the decrease in eN” How is this statement derived from? Which figure should the reader refer to?

Figure 14: This is a very useful plot, and I’m also curious how time series of potential radiative forcing (PRF) itself looks like. Can the authors also show them, which should be time derivatives of the integrated forcings shown here?

Page 22, Line 32: “The almost instantaneous LWP adjustment may indicate a retrieval bias” Can the authors briefly discuss how instantaneous negative response of LWP arises from retrieval errors? I don’t understand why the DSD-relevant retrieval bias is a potential cause for the negative sensitivity of LWP although discussed in Page 23, Line 4.

Page 26, Line 27: “around 5-10% of clear sky cases in this region are aerosol-limited” Where does this conclusion come from?

Minor points:

Page 3, Line 5: properties (Nd, LWP) shiptracks -> properties (Nd, LWP) of shiptracks

Page 3, Line 26: based the method -> based on the method

Page 8, Line 5: These -> There

Page 10, Line 13: Delete “are”

Page 12, Line 31: microphysical -> microphysics

Page 19, Line 24: Delete “a be” prior to “a poor”

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Page 24, Line 4: the extent to which -> to which extent?

Page 25, Line 8: take -> taken

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