General remarks:

This paper presents long term measurements of SO_2, O_3, Aiken mode (60 nm) particle and equivalent black carbon (EBC) concentrations at two stations (Ny Ålesund and Zeppelin) in Svalbard. The authors separated the data into two groups according to the presence of cruise ships in the Kongsfjord area. The results showed enhanced SO_2, Aiken mode particle and EBC concentrations and decreased O_3 concentration when cruise ships were present although ship plumes were infrequently sampled. The fact that even measurements at remote Arctic station can be affected by ship emissions implies that what has been conventionally used as background measurements should be used with caution.

Considering the anticipated increase of ship traffic in the Arctic due to the decreasing Arctic sea ice, these types of long-term measurements showing the influence of ship emissions on the atmospheric trace species are deemed valuable. Some analysis methods are somewhat arbitrary and qualitative (*e.g.* using 50 passengers as a threshold for the case 'ships') but the conclusions presented are thought to be robust. Although the text is generally well-written, some parts are confusing (please see major comments below) and should be clarified. Also, English grammar (especially use of the past tense to write the methods section) and usage could be improved (please see minor comments).

It is recommended that the article is **accepted after minor revisions**.

Major comments:

1. 'However, 500 passengers were used as a threshold for 24-h samples of SO_2 (see <u>Sect. 1.4</u>).' (p.3076, lines 24 – 25) I think you mean Sect 2.4, not Sect 1.4. But even in Section 2.4, I don't think a clear explanation is given. Could you please explain what you mean by using 500 passengers as a threshold for 24-h samples?

2. Section 2.2: You assume the measurements at Zeppelin to be affected by ship from the time of arrival in Ny Ålesund until 4 hours after the departure from Ny Ålesund. For measurements at Ny Ålesund, you assume the measurements to be affected by ship from its arrival in Ny Ålesund until 2 hours after its departure from Ny Ålesund. Did I understand this correctly? If so, then I find Fig 3 (b) strange. You state in Section 3 that Vistamar and Athena arrived at 7:30am and 10:30am respectively. But in Fig 3 (b), both ships seem to have arrived much earlier (*e.g.* increase in the passenger number due to the arrival of Athena occurs just after 8am). Could you please explain why this is the case?

1

3. I find p.3081, lines 15 – 17 confusing. I think you mean that you wanted to exclude the possibility that the differences you observed between 'ships' and 'no ships' were really due to the presence of ships and not due to the daily cycle of pollutants. Could you please reword the sentence?

4. The meaning of the phrase 'taking into account the different frequency of periods with or without ships' (p.3081, lines 25 – 26 and also p.3083, line 1) is not very clear. Do you mean that the days when ships were present were rare? What percentage of days was affected by ships?

5. You say that 'Figure 5 shows that the EBC and PN60 concentrations are higher in the afternoon than in the morning regardless of ship presence' (p.3081, lines 18 – 19) but this is not very obvious to me. Also, I find the colour scheme in Fig 5 misleading. In my opinion, it would be better to use different colours for 'ships' and 'no ships.' As for Fig 3, the x-axis label is too cluttered. You could get rid of ':00' for time to make it more readable.

Minor comments:

1. The phrase 'when no ships were present' (e.g. p.3072, line 6) is used many times in the text. I think it's better to say 'when ships were not present.'
2. 'enhancements of 72 and 45% respectively relative to' (p.3072, line 10)
3. 'sampled relatively infrequently even when ships are present although they carry high pollutant concentrations' (p.3072, line 16 – 17)
4. 'Zeppelin remains as one of the most valuable' (p.3072, line 23)
5. 'pan-Arctic conditions if …' (p.3072, line 27), no comma needed
6. 'due to climate warming is likely to prompt' (p.3073, line 18)
7. 'has been already increased' (p.3073, line 27)
8. 'Major touristic destinations' (p.3073, line 28)
9. 'likely to be conservative' ('p.3074, line 15)
10. 'characterised by its composition of spherules' (p.3074, line 23) Perhaps better to say 'characterised by its fractal-like morphology'?
11. 'some 35' (p.3075, line 6), 'some 2 km away' (p.3075, line 12), 'some 15%' (p.3076, line 16) Do you mean around 35, ~2 km away, approximately 15% and so on?
12. 'inside the fjord and surface wind' (p.3075, line 17), no comma needed
13. 'not representative of general wind conditions' (p.3075, line 18)
14. 'made predictions of' (p. 3076, line 2)
15. 'ships are not registered' (p.3076, line 10)
16. 'allow estimation of its pollutant emissions' (p.3076, line 19)

17. 'is probably week' (p.3076, line 22), I think the term 'relatively' doesn't add much to the sentence.
18. 'emissions are also likely to be higher' (p.3076, line 28)
19. 'no information is available to us' (p.3077, line 1), 'data were not available to us' (p.3077, line 19) The use of the term 'to us' sounds informal and is not needed.
20. The term 'air concentrations' (p.3077, line 16) doesn't make sense. You mean 'pollutant concentrations'?
21. 'measured using a Teledyne' (p.3077, line 21), please remove 'model'
22. Which DMA (maker & model) did you use? (p.3078, line 17)
23. 'which represents' → 'because it represents'
24. p.3078 line 25 to p.3079 line 8: Since this part describes the experimental method, everything should be written in the past tense (e.g. 'SO_2 was sampled')
25. '07:30a.m.' (p.3079, line 11), if you're going to use a.m. and p.m., please be consistent.
26. '73 people' (p.3079, line 14)
27. 'The measurements in Ny Ålesund showed a first peak in SO_2' (p.3079, lines 17 – 18), not necessary to repeat 'SO_2'
28. 'Two peaks could be also identified' (p.3079, line 20)
29. '2nd SO_2 peak' (p.3079, line 21), '90th percentile' (p.3079, line 25)
30. What do you mean by 'hourly peak' (p.3079, line 21)? Do you mean the maximum value in the hourly average?
31. 'SO_2 concentration of 1.1μg m^{-3}' (p.3079, line 22),
32. Please remove 'respectively' if you are going to put the values in brackets (p.3079 lines 20 – 25)
33. 'we also analysed the aerosol size distribution and found that it had a similar shape…as determined in a laboratory study' (p.3080, lines 5 – 7)
34. Do you mean 'There is a strong decreasing trend of the summer-mean EBC concentrations at Zeppelin between 2003 – 2005 and 2006 – 2011 periods'? (p.3080, lines 16 – 17)
35. 'values measured during 2003 – 2005' (p.3080, line 18), stating the actual years is better than saying 'previous years'
36. 'the mean concentrations are 0.28 μg m^{-3} for the group "no ships" and 0.40 μg m^{-3} for "ships".' (p.3080, lines 23 – 24)
37. '75th and 95th percentile' (p.3081, line 3)
38. 298 cm^{-3} and 173 cm^{-3} (p.3081, line 6), please use whole numbers for particle number concentration
39. 'two classes were even larger' (p.3081, line 11), 'period 2003 – 2010 were 81% higher' (p.3081, line 12)
40. 'for summer including also night time periods' (p.3081, line 29)
41. 'relative increase in the' (p.3082, line 1), 'increase in the mean concentrations' (p.3082, line 5)

42. 'showed enhancements of 45, 44 and 72%' (p.3082, line 17), Where were these results presented? Are you referring to the case study results?

43. 'slightly lower; 37 and 58%' (p.3082, line 20)

44. 'high pollutant concentrations'(p.3082, line 18)

45. 'increases in the summer mean concentrations' (p.3083, line 3)

46. 'These increases were 15, 11 and 18% for SO_2, EBC and PN60 respectively' (p.3083, lines 4 – 5)

47. 'influence of ships was negligible' (p.3083, line 7)

48. 'It can be also expected that summer time BC deposition is enhanced by a similar factor as the measured atmospheric BC concentrations' (p.3083, lines 11 – 12)

49. 'This means that even the periods classified as without ships may be influenced by local ship emissions to some extent and thus may not fully represent…' (p.3083, lines 20 – 22)

50. 'Zeppelin remains as one of the' (p.3084, line 5)

51. 'local ship emissions for only around 60 h' (p.3084, line 9)

52. 'since most of the samples will be influenced by ship plumes to some extent' (p.3084, lines 11 – 12)

53. 'can already have' (p.3084, line 13), 'can already now' sounds weird

54. 'If Arctic shipping in summer increases as predicted … (e.g. Corbett et al., 2010), the entire' (p.3084, lines 15 – 16)

55. Fig. 3: I still find the axis labels too cluttered. You could remove the x-axis label for (b) to give more space for (c) y-axis labels since the x-axis labels for (b) and (c) are the same For (a), you don't have the x-axis label so you could do the same for (b).