Reviewer #1

We thank the reviewer very much for the careful read of our manuscript. The constructive comments and suggestions have greatly improved the quality of this manuscript. Below, we give a point-by-point response to the comments and suggestions of the reviewer, in the order of (1) comments from Referees, (2) author's response, and (3) author's changes in manuscript (referee comments in black; author's response and changes in manuscript in blue).

(1) comments from Referees

General comments

This study reports new measurements of nitrate in a large number of Antarctic surface snow and pit samples collected over several years on a transect between the coast and Dome A. Based on a linear model it is concluded that on the coast nitrate flux to the snowpack is dominated by wet deposition illustrated by a positive correlation with accumulation rates, dry deposition contributing up to 44% and atmospheric nitrate being quite homogeneous. Further inland on the Antarctic Plateau a positive correlation between concentration and acculumlation rate is found suggestive of post-depositional loss. Contrary to a previous coastal study no association between nitrate and sodium in snow was found, but rather with nss-so4 suggesting a role of small sized aerosol in nitrate scavenging and deposition.

This study contributes a large number of new observations from remote areas, which involved careful sampling on locations along the traverse, sample handling and analysis, and they clearly merit publication. The finding that no3 correlates with nss-so4 but not with na is very interesting and new. The main weakness is the discussion on no3 deposition processes, which needs significant improvement before I can recommend publication. In particular, a more thorough comparison with other studies and a critical discussion of model choice and interpretation are required.

(1) author's response

We greatly appreciate the reviewer for the general positive comments of our work. We have revised the discussion on NO_3^- deposition process. In addition, we have expanded the discussion on the potential association between NO_3^- and co-existing ions in the surface snow, and the possible connections.

In the model section, we now present a detailed description of the model choice and results (please also see the comments from Referee #2).

(1) author's changes in manuscript

Following the reviewer's comments, we substantially revised the discussion section. Please see the revised manuscript, sections **4.1.1 NO_3^- in coastal snowpack, 4.1.2 NO_3^- in inland snowpack and 4.2 Effects of coexisting ions on NO_3^-**

(2) comments from Referees

SPECIFIC COMMENTS - The authors apply a linear model to interpret their data. Contrary to their description Eq. 4-6 are esentially the same model, i.e. inserting Eq.4 into Eq.6 yields Eq.5. I strongly suggest to simplify (use maybe the notation of Alley et al, 1995), explain model assumptions, parameters and limitations. Note this model is the simplest plausible model to relate chemical flux and concentration in snow to atmospheric concentrations introduced more than 20yr ago (Legrand, M., 1987; Alley et al., 1995) and is a gross over-simplification of the complex nature of air-snow exchange of nitrate. It's probably ok near the coast, but fails inland due to post-depositional redistribution and loss of nitrate. Negative dry deposition rates can be interpreted as losses and should also be compared to other studies in the regions, e.g. Pasteris et al. (2014) and Weller et al. (2004, 2007). I suspect that precise values for dry deposition rates and fresh snow values depend which and how many locations are included in the regression analysis (and also to a minor extent if you use regression parameters from eq4 or eq5). The discussion on inland snowpack (Section 4.1.2) should be expanded accordingly; e.g. take a closer look at losses shown in Fig 4, how do they compare to loss rate from the regressions, how do they depend on environmental factors?

(2) author's response

We thank the reviewer for the very helpful comments. We agree with the reviewer that the Eqs. 4-6 represent essentially the same model and can be consolidated. In addition, the parameters and limitations of the model should be clarified. We also agree that the model in this work was introduced 20 years ago (Legrand, 1987; Alley et al., 1995) and is a gross over-simplification of the complicated snow-air exchange of NO_3^- in Antarctica, especially in the inland Antarctica (Erbland et al., 2015; Shi et al., 2015; Bock et al., 2016; Zatko et al., 2016). Although a simple model, it provides a simple approach to compare the processes occurring on the coast versus those inland. In addition, this model can provides useful parameter values in modeling NO_3^- deposition/preservation at large scale, considering that observations remain sparse across Antarctica (e.g., Zatko, et al., 2016).

Yes, the negative slope of the linear regression between NO_3^- concentration and inverse snow accumulation rate, i.e., the negative dry deposition rates, can be interpreted as losses of NO_3^-. The emission rates of NO_3^- in this investigation can be compared with other reports, e.g., the observations of DML and the Kohnen Station (Weller et al., 2004; Weller and Wagenbach, 2007; Pasteris et al., 2014).

Following the reviewer's suggestion, we re-examined the linear regression between NO_3^-

concentration and inverse snow accumulation rate. It is found that the regression is significantly influenced by two sites, SP10 and Core2 (~800 km from the coast), featured by high snow accumulation rate (> 100 kg m^{-2} a^{-1}; Table 1 and Fig. 1). Consequently, the dry deposition rates (i.e., slope of the linear regression) were changed when the two sites were excluded for the linear fit. In this case, the dry deposition of NO_3^- can be re-calculated for the inland snowpack.

Also, following the reviewer's comment, we calculated the emission flux with the aid of NO_3^- profiles at the inland sites, i.e., the difference between the most recent year mean (Fig. 4) and NO_3^- concentration in the snow layer accumulated during the year before the most recent year can represent the loss rate of NO_3^-. Then, a comparison was made between the observations and the linear model prediction.

(2) author's changes in manuscript

The linear models were simplified and the parameters and the limitations were included, following the notation of Alley et al. (1995).

The negative slope of the linear regression between NO_3^- concentration and inverse snow accumulation rate was explained. In addition, the values in this study were compared with previous reports in the regions.

The linear fit was carried out to test that the slope values depend on which and how many locations are included in the regression analysis. Two sites with snow accumulation rate larger than 100 kg m^{-2} a^{-1} were excluded for the linear fit. Accordingly, the discussion on inland snowpack (Section 4.1.2) was expanded. In addition, the emission rates of NO_3^- were calculated from the snowpits NO_3^- profiles, and a comparison was made between the observations and linear model prediction.

For the changes, please see the revision-tracked version of manuscript, sections **4.1.1 NO_3^- in coastal snowpack, and 4.1.2 NO_3^- in inland snowpack**

(3) comments from Referees

- the authors make surprisingly little mentioning of new isotopic tools in their brief literature review and discussion (including their own study Shi et al;, 2014), which in my view achieved significant reduction of the uncertainties related to post-depositional no3 processes and the origin of no3 maxima in Antarctic snow. I'd recommend to highlight better the progress in no3 air-snow exchange research and integrate it into the discussion. You could set out from the beginning that you don't expect your chosen model to work on the Plateau because of strong losses.

(3) author's response

We thank the reviewer for pointing this out. We agree with the reviewer that the isotope ratios of NO_3^- provide further constraints for NO_x sources and post-depositional processing of NO_3^- in the snow. A brief overview of the contributions from isotope ratios of NO_3^- in Antarctic snow seems to be necessary in the introduction section, although no isotopic data were presented in this study.

In the discussion of NO_3^- losses in the inland snowpack, the previous works on isotopic compositions of NO_3^- in snow from Dome A plateau (Shi et al., 2015) was included. In this case, the uncertainties related to post-depositional processing of NO_3^- would be reduced. The recent works on the air-snow changes of NO_3^- were also included in the discussion (Erbland et al., 2015; Zatko et al., 2016).

In the section of the model introduction, it is clarified that the model could not well depict the complex recycling of NO_3^- in inland Antarctic snow.

(3) author's changes in manuscript

Discussion of advanced understanding based upon NO_3^- isotopes was included in the introduction section.

In the discussion section, 4.1.2 NO_3^- in inland snowpack, previous works on the Dome A plateau were referenced. Also, the previous modeling works on the air-snow transfer of NO_3^- were integrated into the discussion.

For the changes, please see the revision-tracked version of manuscript, sections **4.1.1** and **4.1.2**

(4) comments from Referees

- the authors mention their unpublished measurements of atmosperic no3 on the coast (l337-38) and on the traverse (426-428). Is there any particular reason why they are not part of a manuscript on air-snow exchange of no3? I'd like to see these included in the paper, as they could add significantly to the discussion of deposition and association to nss-so4 and sea salt (the novel part of this paper).

(4) author's response

We agree with the reviewer that the atmospheric NO_3^- could be helpful to the understanding of snow-air exchange of NO_3^-. In fact, the atmospheric NO_3^- data is a part of another manuscript in preparation, which is focused on the production pathways of atmospheric NO_3^- (i.e., the oxidation channels of NO_x) on the traverse from coast to Antarctic ice sheet summit and in the marine boundary layer. Atmospheric NO_3^- (both particulate and gaseous NO_3^-) were collected on Whatman G653 glass-fiber filters using a high volume air sampler (HVAS), the concentration and

the isotope ratios of NO_3^- ($\delta^{18}O$ and $\Delta^{17}O$) were analyzed. It is noted that the sampling time of the atmospheric NO_3^- is different from that of the snow sample collection in this study. Thus, the atmospheric concentration data was taken as a general reference to calculate the dry deposition velocity of NO_3^- (K_1 in the main manuscript).

(4) author's changes in manuscript

Following the comments of the reviewer, atmospheric concentrations of NO_3^- and SO_4^{2-} are presented in the supporting information of the paper, and the information on atmospheric NO_3^- sampling and analysis, concentration table was included.

Atmospheric NO_3^- sampling and analysis

For investigating NO_3^- levels in the atmosphere, atmospheric NO_3^-, i.e., both particulate NO_3^- and gaseous HNO_3, was collected along the traverse (coastal Zhongshan Station to Dome A) following similar protocols for previous work in East Antarctica (Savarino et al., 2007; Frey et al., 2009; Erbland et al., 2013). The atmospheric samples were collected on Whatman G653 glass-fiber filters (8 × 10 in; prebaked at 550 ^oC for ~24 hr) using a high volume air sampler (HVAS), with a flow rate of ~1.0 m^3 min^{-1} for 12-15 hr. In total, 34 atmospheric samples were collected on the traverse.

In the laboratory, each filter was cut into pieces using pre-cleaned scissors that were rinsed between samples, placed in ~100 ml of Milli-Q water, ultrasonicated for 40 min and leached for 24 hr under shaking. The sample solutions were then filtered through 0.22 μm ANPEL PTFE filters for NO_3^- concentration analysis.

Ion concentrations (NO_3^- and SO_4^{2-}) in extracted solutions were determined using a Dionex ion chromatograph (ICS 3000) following Shi et al. (2012). Final atmospheric NO_3^- concentrations were normalized to standard temperature and pressure (273 K; 1013 hPa), listed in Table S1.

Table S1 Atmospheric concentrations of NO_3^- and SO_4^{2-} on the traverse from coastal Zhongshan Station to Dome A in East Antarctica.

Sampling location		Atmospheric NO_3^-/ng m^{-3}	Atmospheric SO_4^{2-}/ng m^{-3}
Longitude/^{o} E	Latitude/^{o} S		
76.49	69.79	29	183
76.92	70.64	24	154
77.62	71.5	22	204
77.69	72.37	14	163
77.17	73.15	24	165
76.97	73.86	30	117
76.98	74.9	43	163
76.82	75.87	16	176
77.02	76.86	41	289

77.71	77.15	85	268
76.99	78.36	139	162
77.00	79.01	35	130
77.26	79.82	99	177
77.12	80.42	183	496
77.12	80.42	67	371
77.12	80.42	88	341
77.12	80.42	100	310
77.12	80.42	124	415
77.12	80.42	124	317
77.12	80.42	81	240
77.12	80.42	87	178
77.17	79.63	82	228
77.03	78.77	21	246
77.19	77.83	38	261
77.02	76.74	33	257
77.03	76.42	40	331
76.83	75.87	40	249
76.96	75.03	44	256
77.00	74.09	32	216
76.97	73.86	21	202
77.38	72.84	17	225
77.97	71.93	8	223
77.19	70.97	24	209
76.52	69.97	14	188

For the changes, please see the supporting information of the manuscript.

(5) comments from Referees

TECHNICAL CORRECTIONS l35 ... dry deposition velocity and scavenging ratio for NO3- was relatively constant near the coast ... is this not a model assumption? which then allows you to state that atmospheric nitrate is homogeneous on the coast, please clarify how you interpret the linear model.

(5) author's response

Yes, the linear model assumes spatially homogeneous values for the dry deposition velocity. A linear fit in the manuscript (Fig. 5a) supports the assumption of the spatial homogeneity.

(5) author's changes in manuscript

The assumptions of the interpretation of the linear fit was clarified in the revised manuscript. Then the interpretation of the linear regression parameters (fresh snow concentration and the dry deposition velocity of NO_3^-) was clarified based upon these assumptions, please see section **4.1.1** in the revision-tracked version of the manuscript.

(6) comments from Referees

l36 ... association ... throughout the text you use association but mean probably correlation. Please change and state R and p value

(6) author's response

Thanks for pointing this out. In most cases, the "association" means "correlation".

(6) author's changes in manuscript

Following the reviewer's suggestion, the "association" was replaced with "correlation". The values of R^2 and p were also included in the revised manuscript.

(7) comments from Referees

l55 tropospheric and stratospheric sources

(7) author's response

We agree with the reviewer.

(7) author's changes in manuscript

The "atmospheric" was replaced with "tropospheric" in the revised manuscript.

(8) comments from Referees

l75 isotopes show stratospheric origin of nitrate peak in late winter/ early spring (Savarino, 2007; Frey 2009)

(8) author's response

Agree with the reviewer.

(8) author's changes in manuscript

Changed following the reviewer's suggestion in the revised manuscript.

(9) comments from Referees

l80-84 it seems to me that the SPE hypothesis has recently been basically refuted; please update your summary & citations including e.g. Wolff et al. (2012 & 2016), Duderstadt et al. (2014)

(9) author's response

We agree with the reviewer that the solar proton event (SPE) is generally believed to have negligible effect on the variability of NO_3^- in polar ice core at present. The citations have been updated (Wolff et al., 2008; Wolff et al., 2012; Duderstadt et al., 2016; Wolff et al., 2016).

(9) author's changes in manuscript

Following the reviewer's comment, the summary has been re-stated, and the citations have been updated. Please see the revision-tracked version of manuscript.

(10) comments from Referees

l86 ... the relationship ... varies temporally and spatially

(10) author's response

Agree with the reviewer.

(10) author's changes in manuscript

Changed following the reviewer's suggestion. Please see the revision-tracked version of manuscript.

(11) comments from Referees

l87-89 more correctly: ... Isotope studies suggest that under cold conditions photolytic loss dominates, whereas HNO3 volatilization becomes important at warmer temperatures > -20 ◦C (Frey 2009, Erbland 2013, Berhanu 2015)

(11) author's response

Thanks for the suggestion.

(11) author's changes in manuscript

Restated following the reviewer's suggestion. Please see the revision-tracked version of manuscript.

(12) comments from Referees

l93 and field measurements on the East Antarctic Plateau at Dome C suggest e-folding depths of 10 to 20 cm (France et al., 2011)

(12) author's response

Yes, the field measurements on the East Antarctic Plateau at Dome C suggest z_e of 10 to 20 cm (France et al., 2011), and the depth is dependent upon the concentration of impurities contained in the snow (Zatko et al., 2013).

(12) author's changes in manuscript

Following the reviewer's comments, the statement was rephrased. Please see the revision-tracked version of manuscript.

(13) comments from Referees

l94-95 Clarify that photolysis dominates loss. This is also in support of your own assumption that no3 is archived below the photic zone of ~1m depth, where temperature still varies on diurnal to annual time scales. It implies that physical losses are assumed to be not important throughout the study region.

(13) author's response

We appreciate the reviewer for this point. In the inland regions with low snow accumulation rate, especially on the East Antarctic plateaus, photolysis is thought to dominate the post-depositional losses of NO_3^- (Frey et al., 2009; Shi et al., 2015). This point is crucial to our assumption that NO_3^- is archived below 100 cm.

(13) author's changes in manuscript

This point was clarified following the reviewer's suggestion. Please see the revision-tracked

version of manuscript.

(14) comments from Referees

l105 please add also Bertler et al. 2005, Pasteris et al., 2014

(14) author's response

Agree.

(14) author's changes in manuscript

The two references were included in the revised version (Bertler et al., 2005; Pasteris et al., 2014).

(15) comments from Referees

l122 does SP20 correspond to the location of the station at Dome A?

(15) author's response

Yes, SP20 corresponds to the location of the Chinese inland station, Kunlun Station at Dome A.

(15) author's changes in manuscript

The sampling snowpits were clarified in section **2.2 Sample collection**. In particular, the SP20 located at the Kunlun Station at Dome A was noted. Please see the revision-tracked version of manuscript.

(16) comments from Referees

l129 add lat/lon and elevation of station

(16) author's response

Agree. The Kunlun Station, 80°25′01.7″S and 77°6′58.0″E, with altitude of 4087 m a.s.l.

(16) author's changes in manuscript

Added in the revised manuscript.

(17) comments from Referees

l134 took OR lasted 4 summer seasons

(17) author's response

Agree. Thanks.

(17) author's changes in manuscript

Corrected in the revised manuscript.

(18) comments from Referees

l194 add a note that so4 fractionation may introduce a bias in nss-so4 (Wagenbach et al., 1998)

(18) author's response

Agree. The SO_4^{2-} fractionation (the precipitation of mirabilite ($Na_2SO_4 \cdot 10H_2O$)) may introduce a bias in $nssSO_4^{2-}$, especially during the winter half year (Wagenbach et al., 1998a).

(18) author's changes in manuscript

The above sentence was added in the revised manuscript.

(19) comments from Referees

l250-52 Please be precise and expand: were the pits dated? do you see 1, 2 or more annual no3 peaks?

(19) author's response

Agree with the reviewer, the section should be expanded. Among the coastal snowpits, water isotope ratios ($\delta^{18}O$ of H_2O) of samples at SP02 were also determined, thus allowing for investigating NO_3^- seasonality (Fig. S2 in supporting information). In general, the $\delta^{18}O(H_2O)$ peaks correspond to high NO_3^- concentrations (i.e., NO_3^- peaks present in summer), indicating a seasonal variability. This seasonal signature is consistent with previous observations of NO_3^- in snow and atmosphere at the coastal Antarctic sites (Mulvaney et al., 1998; Wagenbach et al., 1998b; Savarino et al., 2007).

(19) author's changes in manuscript

Following the reviewer's suggestion, the coastal SP02 snowpit was taken as an example to examine the seasonal signature of NO_3^-.

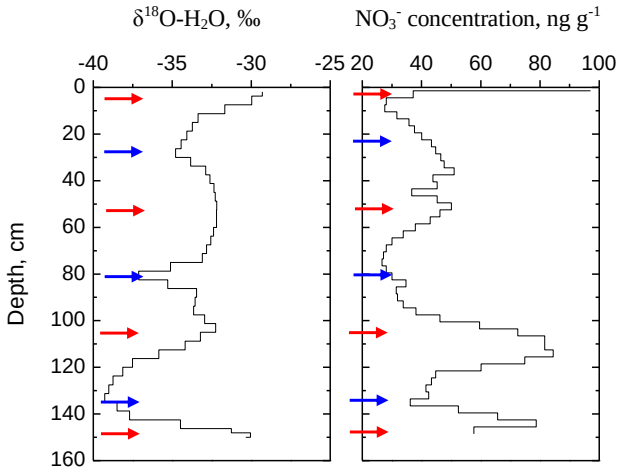

Figure S3 Profiles of $\delta^{18}O$ of H_2O (left panel) and NO_3^- concentration (right panel) in the coastal snowpit SP02. Red and blue arrows represent the middle of the identified warm and cold seasons, respectively. Red solid arrows and blue dashed arrows represent the middle of the identified warm and cold seasons, respectively. One seasonal cycle represents one $\delta^{18}O(H_2O)$ local maxima peak to the next.

For the changes, please see the revision-tracked version of manuscript (section **3.2 Snowpit NO_3^- concentrations**) and the supporting information Figure S3.

(20) comments from Referees

l256 careful with language: not maybe, but yes previous studies inland (on the Antarctic Plateau) have shown that the decrease is due to significant loss/redistribution of NO3-

(20) author's response

Agree with the reviewer. The significant losses are resulted from the post-depositional processing of NO_3^- (e.g., at Dome C; Frey et al., 2009; Erbland et al., 2013)

(20) author's changes in manuscript

Corrected in the revised manuscript.

(21) comments from Referees

l279-80 due to photolysis

(21) author's response

Agree. Thanks.

(21) author's changes in manuscript

Corrected.

(22) comments from Referees

l290-94 note you assume that photolysis is main loss process which is sensible, but explain better in intro (see comment on l94-95)

(22) author's response

We agree with the reviewer. Thanks.

(22) author's changes in manuscript

Following the reviewer's suggestion, this point was explained in the introduction.

(23) comments from Referees

l302 do you mean deposition velocity or flux? explain model assumptions (see above)

(23) author's response

We mean the dry deposition flux of NO_3^-. The assumptions of the interpretation of the linear model are spatial homogeneity of fresh snow NO_3^- levels and dry deposition flux in the regions, which were explained in the revised manuscript.

(23) author's changes in manuscript

Following the reviewer's suggestion, this section was re-organized. Please see the revision-tracked version of manuscript (section **4.1.1 NO_3^- in coastal snowpack**).

(24) comments from Referees

l306, 329-30 consolidate your model (see above)

(24) author's response

Agree with the reviewer.

(24) author's changes in manuscript

This section was re-organized. Please see the revised manuscript (section **4.1.1 NO_3^- in coastal snowpack**).

(25) comments from Referees

l311 use consistently r or r2 throughout the paper, and include p value

(25) author's response

Agree.

(25) author's changes in manuscript

Corrected throughout the manuscript, following the reviewer's suggestion.

(26) comments from Referees

l337-38 are these annual mean and std of atmospheric nitrate? Coastal observations (Neumayer, Halley, DDU) show a distinct annual cycle. how would that affect your estimate of deposition velocity?

(26) author's response

The data is the average atmospheric NO_3^- concentration (19.4 ng m^{-3}) on the coast during the austral summer time. According to previous coastal observations (e.g., Dumont d'Urville, Neumayer and Halley), atmospheric NO_3^- concentration exhibits a seasonal variation with maximum usually observed in late spring-summer (Mulvaney et al., 1998; Wagenbach et al., 1998b; Savarino et al., 2007). In those studies, the atmospheric NO_3^- concentration mainly varied from 10 to 70 ng m^{-3}. For the calculation of the dry deposition velocity (K_1) in this study, a lower

atmospheric NO_3^- concentration will yield a higher value of K_1. This point is clarified in the revised manuscript.

(26) author's changes in manuscript

A notation was added in the revised version, as follows,

It is noted that the true K_1 value could be higher than the calculation here due to the high atmospheric NO_3^- concentrations in summertime on the coast (Mulvaney et al., 1998; Wagenbach et al., 1998b; Savarino et al., 2007).

For the changes, please see the revision-tracked version of manuscript (section **4.1.1 NO_3^- in coastal snowpack**).

(27) comments from Referees

l340 "... compares well to ..." I disagree, this is a large uncertainty, a range of 0.5 to 0.8 cm/s can make a big difference when modeling no3 in surface snow (see for example Erbland et al. 2013, Fig.7)

(27) author's response

We thank the reviewer for pointing this out. Yes, a difference of 0.3 cm s^{-1} will result in a large difference when modeling NO_3^- in the surface snowpack (Erbland et al., 2013).

(27) author's changes in manuscript

This sentence was re-written. Please see the revised manuscript.

(28) comments from Referees

l352 is negatively correlated with

(28) author's response

Agree.

(28) author's changes in manuscript

The “tied to” is replaced with “correlated with”.

(29) comments from Referees

l354 based on what exactly? the R value? please explain

(29) author's response

Yes, based on R^2 values of the regression analysis (Figs. 5b and c). A strong positive correlation between NO_3^- flux and snow accumulation rate (R^2=0.97), while a negative relationship between flux and the archived concentration of NO_3^- was found. In this case, it is proposed that NO_3^- flux is more accumulation dependent compared to the concentration.

(29) author's changes in manuscript

Clarified in the revised manuscript.

(30) comments from Referees

l365 correlation

(30) author's response

Agree.

(30) author's changes in manuscript

Replaced with “correlation”.

(31) comments from Referees

l370 the correlation ... is reatively weak and of opposite sign

(31) author's response

Agree.

(31) author's changes in manuscript

Replaced with “correlation”.

(32) comments from Referees

l375 why act surprised? we know based on previous work that this is of course due to losses, the model application is limited inland

(32) author's response

Agree.

(32) author's changes in manuscript

Following the reviewer's suggestion, this part is re-phrased.

(33) comments from Referees

l404-05 but uncertainties have been reduced over the last decade (see comment above)

(33) author's response

Agree with the reviewer.

(33) author's changes in manuscript

This sentence was rephrased.

(34) comments from Referees

l406 and snow optical properties (e-folding depth)

(34) author's response

Agree.

(34) author's changes in manuscript

Changed.

(35) comments from Referees

l426-428 I'd be very interested to see the atmospheric data; why are they not included in this

manuscript?

(35) author's response

Agree with the reviewer. See response above.

(35) author's changes in manuscript

The atmospheric data was included in the supporting information.

(36) comments from Referees

l463-464 I don't understand, please expand (mirabilite is Na2SO4-10H2O)

(36) author's response

The fractionation of Na^+ can occur due to mirabilite precipitation in sea-ice formation at <-8 ^oC (Marion et al., 1999), possibly leading to the positive $nssCl^-$. Even if all of SO_4^{2-} in sea water is removed via mirabilite precipitation, only 12% of sea salt Na^+ is lost (Rankin et al., 2002). Considering the smallest sea ice extent in summertime in East Antarctica (Holland et al., 2014), the very high Cl^-/Na^+ ratio (mean = 2.1 versus 1.17 of sea water, in μeq L^{-1}) in surface snow is unlikely from sea-salt fractionation associated with mirabilite precipitation in sea-ice formation.

(36) author's changes in manuscript

Following the reviewer's suggestion, this point was expanded. Please see section **4.2 Effects of coexisting ions on NO_3^-** in the revised manuscript.

(37) comments from Referees

FIGURES

Fig3 possibly add accumulation rate into ea figure to understand better at which threshold no3 spikes disappear

(37) author's response

Agree.

(37) author's changes in manuscript

Snow accumulation was added in each panel in Fig. 3, as below.

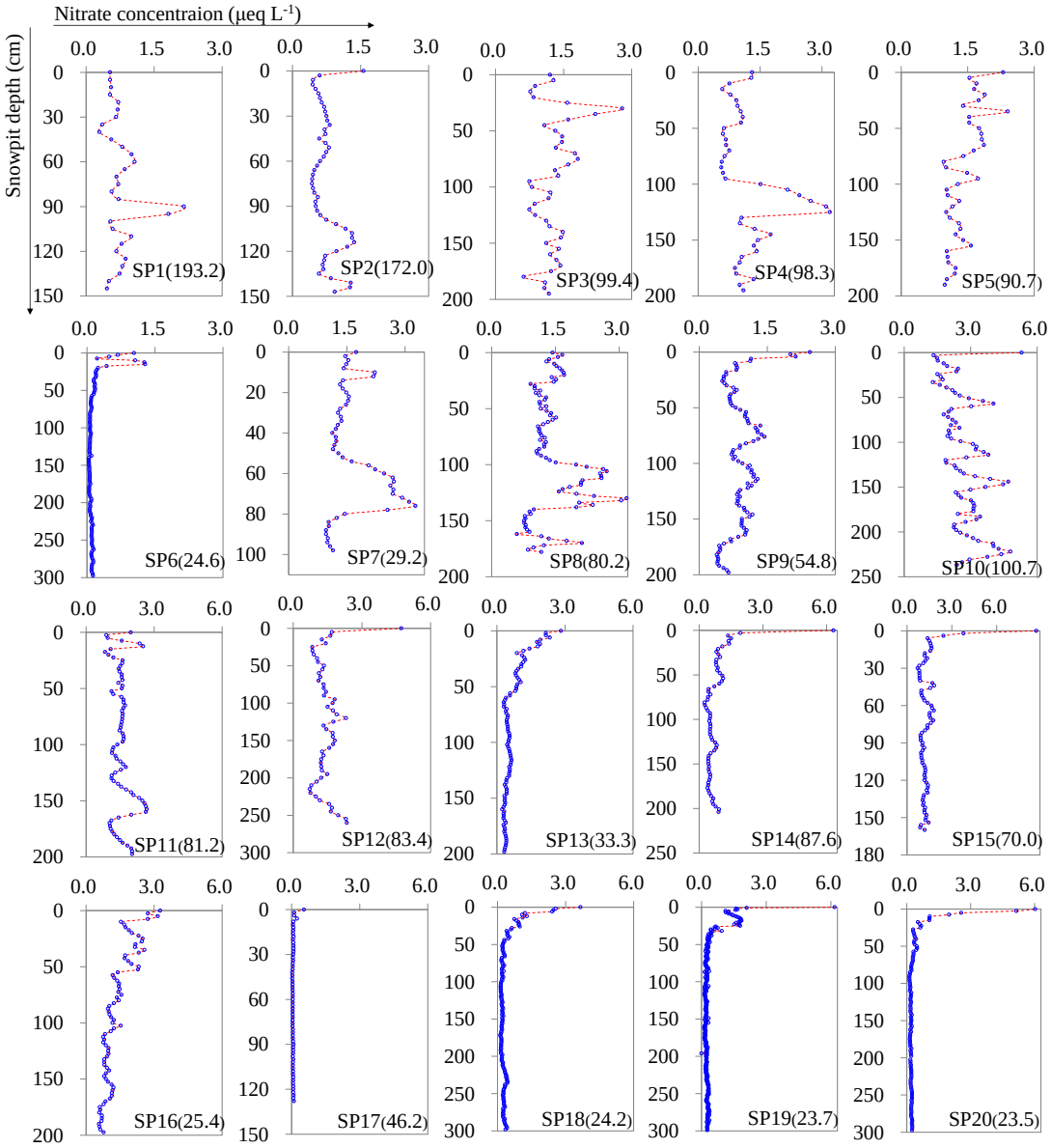

Figure 3. The full profiles of NO_3^- concentrations for snowpits collected on the traverse from the coast to Dome A, East Antarctica (SP1 is closest the coast; SP20 the furthest inland; see Figure 2). The details on sampling of the snowpits refer to Table 1. The numbers in parentheses in each panel denote the annual snow accumulation rates (kg m^{-2} a^{-1}). Note that the scales of x-axes for the snowpits SP1 – SP9 and SP10 – SP 20 are different.

(38) comments from Referees

Fig4 possibly add site ID on the x-Axis to follow better the discussion

(38) author's response

Agree with the reviewer.

(38) author's changes in manuscript

Site ID was added on the x-axis. Please see the revised manuscript Fig. 4, as below.

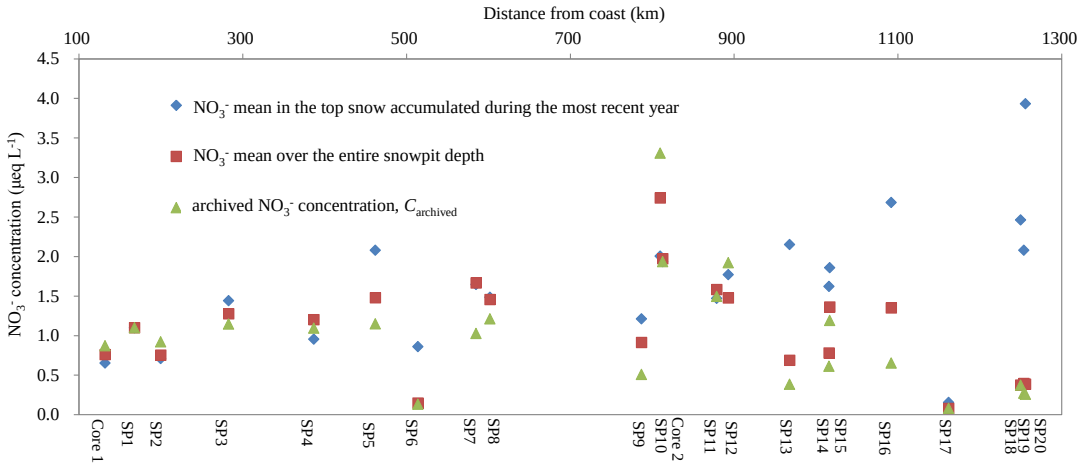

Figure 4. Mean concentrations of NO_3^- for the entire snowpit depth (in square), the uppermost layer covering one-year snow accumulation (in diamond) and the bottom layer covering a full annual cycle of deposition (archived NO_3^- concentration, $C_{archived}$, in triangle).

(39) comments from Referees

Fig5 improve figure readability (size, label font)

(39) author's response

Agree.

(39) author's changes in manuscript

Changed.

End of responses to Referee #1.

References

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End of the responses.