Dear Editor and Reviewers,

We highly appreciate the detailed valuable comments of the referees on our manuscript of 'OA-05021'. The suggestions are quite helpful for us and we incorporate them in the revised paper. During the last two months, we have referred to literatures and papers and re-analyzed the collected data and reconstructed the paper to improve the quality of our paper.

As below, on behalf of my co-authors, I would like to clarify some of the points raised by the Reviewers. And we hope the Reviewers and the Editors will be satisfied with our responses to the 'comments' and the revisions for the original manuscript.

Thanks and Best Regards!

Yours Sincerely,

ZHANG Gong

2005-11-12

Journal of Forest Research

Reviewer's Comment to the Author

Manuscript No. OA-05021

Title: Deposition Pattern of Precipitation and Throughfall in a Subtropical Forest, Central-south China

Authors: G. Zhang, G.-M. Zeng, G.-H. Huang, Y.-M. Jiang, J.-M. Yao, R. Jiang & C. Zhang

Comment to Author:

General Comments:

1. The explicit hypotheses or objective of this study in the third paragraph of the Introduction are not well developed in the first two paragraphs of the Introduction. For example, why would you expect a “differences in precipitation quantity, ion concentrations and fluxes in bulk precipitation and throughfall”? It would seem much more relevant to address the literature on dry deposition, canopy leaching and ecological factors for effecting the process of canopy exchange in the first paragraph than briefly mentioning topics like chemical species, forest type and interception of forest. Also the second paragraph of the introduction largely considers the effects of different methods, and the differences of forests in Taiwan and in Hunan, which is not part of this paper. Surely this paragraph would be better exploring the expected pattern with a seasonal basis to support putting up hypotheses or objective in the last paragraph of the Introduction.

2. That the site is located in the central-south China. A map showing geographical location of the site would be better than the description of characters. This site represents a forest type dominated by fir and other tree species. An analysis of species composition and age structure would be required for the study forest.

3. Seasonal trends of mean value of ion concentrations in the data (Table 2, Table 3) need to be assessed statistically. Not only we need to know that the change of ion concentrations with seasons are significant but we need to know the differences of ion

concentration among rainfall events sampled.

4. Results and discussion would be separated in the paper. Discussion should be consistent with introduction of the paper.

Response to general comments: (1) The section of 'Introduction' has been re-written and the comments of the Reviewer were adopted in our revision.

(2) The Figure 1, including the geographical location of the study site and the 10 plots and the layout of the throughfall collectors in each plot, was added in the revised manuscript. The ages and the species analysis were also conducted (see detailed response), which was also listed in the revised manuscript.

(3) The tables have been re-analyzed and slightly modified during revision; we think the modifications will improve the expression and clearance.

(4) The structure of this manuscript was also reconstructed in our revision the paper. To be consistent with the objectivities of this paper, the section of 'Results and discussion' was provided again in the revised manuscript.

Specific comments:

P5L2 - delete sample

Response: The word of 'sample' was deleted in the revised manuscript.

P5L2 at what altitude and in what soil type was the study forest.

Response: (1) The study site is at an altitude of 290 m.

(2) The soil types are yellow and yellowish-brown soils according to Chinese soil classification.

The two points mentioned above about Shaoshan forest are listed in the revised manuscript.

P5L4 – provide a map showing geographical location of the study site

Response: A geographical map (see Fig. 1 in the revised paper) described the location of the study site, the disposition of the 10 plots and the layout of the 16 throughfall collectors.

P5L7 – shows the sources of climatic data

Response: the climatic data are from the measurement by the weather station built in the Shaoshan forest. The data are also available in the papers (Zeng et al. 2005; Zhang et al. 2005).

P5 L11 - age structure analysis of the study forest is needed

Response: The projected canopy coverage of the stand is about 82 % and the age of the trees in Shaoshan forest ranges from 20 to 70 years old.

P6L1 – How big was the catchment and how far apart were the 10 plots in this study?

Response: The area of the forested catchment is about 27 ha and the 10 plots are set at different altitudes: 3 (A-C plot) plots are assigned to the lower parts of the catchment (25-50 m altitude), 5 (D-H plot) to the middle of the catchment (75-100 m altitude) and 2 (I-J plot) to the upper parts (125-170 m altitude) (see Fig. 1 in the revised manuscript).

P6 L2 - how can forest types and composition of canopy trees not change if the 10 plots are in different parts of the catchment

Response: The trees species in Shaoshan forest are mainly the following four species, i.e. Chinese fir (Cunninghamia lanceolata) dominates the stand, and massoniana pine (Pinus Massoniana) and camphor wood (Cinnamomum camphora) are frequent species; in addition, some bamboos (Phyllostachys pubescens) grow here. Chinese fir approximately accounts for 44 %, massoniana 31 %, camphor 20 %, and bamboo 5 % of the total stand volume (300 m^3 ha^{-1}).

The dispositions of the ten plots in shaoshan forest are described in Fig. 1. Generally, bamboo dominates the plot-C in the lower parts of Shaoshan catchment, but the relatively mixed species of Chinese fir, massoniana and camphor are distributed in the other 9 plots of Shaoshan stand.

P7 L2 – shows the reason or relevant literature for checking the quality of analyzed data.

Response: The quality of the analytical data was checked by comparing the measured conductivity with that calculated from the concentration of all measured ions and their specific conductivities. If the differences were less than 10 %, we consider that the major ions had been analyzed. The analytical procedures are taken from EMEP (Cooperative programme for monitoring and evaluation of long-range transmission of air pollutants in Europe) (1996).

P9 L10 – interception (25%) of the study forest is lower than that (15%) of fir plantation in east-southern China! Are there differences in age structure and canopy density between two fire forests?

Response: The age structure and canopy density between Shaoshan forest and the fir plantation in southeast China are really different from each other. But there are some similar properties. For example, the dominant specie in the two sites is fir and the climate in the two regions is similar, that is the subtropical climate. The comparison of the interceptions is to obtain the interception capacity of the similar specie in different regions.

P9L20 – Fig. 2 ---legend: BP-Bulk precipitation; TF-Throughfall?

Response: The legend of BP is the bulk precipitation and TF the throughfall in Fig. 2, which has been explained in the revised manuscript.

P11 - Table 2- provides the variation (SD or SE) for seasonal mean values for ion concentrations in different seasons.

Response: The standard errors for the parameters are given in Table 2 in the revised manuscript. The Table 2 on the concentrations in the original text was deleted, because the Table 2 and Table 3 differed only by a factor of 'precipitation quantity', which was also suggested by the Reviewer.

Table 3 was divided into two tables in the revised manuscript: one was

Table 2-‘the seasonal mean ion flux in bulk precipitation and throughfall’; the other was Table 3-‘the seasonal net throughfall flux (NTF)’.

P12L10 – “Shaoshan forest is located in the H_2SO_4 –type acid rain polluted region” ---- “This site is 30km away from……, without any significant sulfur emissions” (P5L10). Illogicality?

Response: The statement is not illogical. The reasons why are as following:

(1) Shaoshan forest is 30 km away from the nearest town and 150 km away from Changsha city, the capital city of Hunan province. The surroundings of Shaoshan forest is without sulphur emissions.

(2) Hunan province, including Changsha and other many cities, is under the severe H_2SO_4 –type acid rain pollution, which results from industrial activities in the cities. The atmospheric transportation of pollutants strongly influences the atmospheric chemistry of the regions in or near Hunan region. Shaoshan forest is with no exception. Therefore, we stated that Shaoshan forest is located in the H_2SO_4-type acid rain pollution region, but this statement was modified in the revised manuscript.

P13L4 – Fig. 3 -- BC = Base cation?

Response: The ‘BC’ means base cations in Fig.3.

Literature cited

Chinese Soil Taxonomy Research Group, Institute of Soil Science, the Chinese Academy of Science, 1995, Chinese Soil Taxonomy (Revised Proposal), Beijing: Chinese Agricultural Scientific Publishing House.

Draaijers GPJ, Erisman JW (1995) A canopy budget model to assess atmospheric deposition from throughfall measurements. Water Air Soil Pollut. 85: 2253-2258.

EMEP (1996) EMEP Manual for Sampling and Chemical Analysis, Norwegian Institute for Air Research, EMEP/CCC-Report 1/95.

Zeng GM, Zhang G, Huang GH, Jiang YM, Liu HL (2005) Exchange of Ca^{2+}, Mg^{2+}

and K^+ and the uptake of H^+, NH_4^+ for the canopies in the subtropical forest influenced by the acid rain in Shaoshan forest located in Central-south China. Plant Science 168: 259-266.

Zhang G, Zeng GM, Jiang YM, Yao JM, Huang GH, Jiang XY, Tan W, Zhang XL, Zeng M (2005) Effects of weak acids on canopy leaching and uptake processes in a coniferous-deciduous mixed evergreen forest in central-south China. Water Air Soil Pollut. In revision.

Journal of Forest Research

Reviewer's Comment to the Author

Manuscript No. OA-05021

Title: Deposition Pattern of Precipitation and Throughfall in a Subtropical Forest, Central-south China

Relevance: the manuscript reports about measurements and analyses of precipitation and throughfall in a subtropical forest. As such, it is not a contribution with new methods, but an application to a new site. The number plots, samplers and analyses is high compared to usual standards and the duration of the measurements is sufficient to draw conclusions. It is thus more the achieved precision than its novelty which makes this contribution worth a publication.

Abstract: the abstract covers the content of the article, but on several points it is not clear enough (see details below).

Introduction and objective: the introduction gives a good overview of the topic. However, a few points in the logical construction should be improved (see details below). The objective of the study is clearly stated and in line with the content.

Material and methods: most of the necessary information is given, but some aspects are missing. Too many points are unclear, partly (it appears) because of writing errors.

Results and interpretations: the structure of the results and discussion is not really logical, which results in several redundancies and in a text going several times back and forth between topics. Most interpretations are correct, but some must be questioned (see details below).

Conclusion: the conclusion is more a summary of the results and discussion. Make it a real conclusion (with some new ideas) or just drop it.

Writing: for a reviewer not speaking English as first language, the writing of the manuscript appears to contain too many mistakes, making it often difficult to understand.

Figures and tables: they are appropriate. Table 2 (concentrations) and 3 (fluxes) are essentially redundant as they differ only by a factor (precipitation amount). In this case, however, this can be accepted because it helps reading the text if both concentrations and fluxes are given.

Response to General comments: We thank the Reviewer very much for his/her kind comments on Abstract, Introduction, Results and interpretations, conclusions, and Figures and tables. The detailed comments have been replied one by one.

Generally, the section of 'Results and discussion' was re-written and the original section of 'Results and discussion' was divided into three-sections: Precipitation and canopy interception; Ion flux in bulk precipitation and throughfall; Factors regulating throughfall flux which includes four sub-sections: Dry deposition; Canopy leaching; Precipitation ion concentration; and Precipitation acidity.

The mentioned Table 2 was deleted in the revised manuscript and Table 3 was divided into two parts as following: Table 2: The seasonal ion flux in bulk precipitation (BP) and throughfall (TF) (mmol m^{-2} $season^{-1}$) and precipitation quantity (H_2O, mm) in Shaoshan forest; Table 3: Seasonal net throughfall flux (NTF) of ions in Shaoshan forest (mmol m^{-2} $season^{-1}$).

And Fig.4 was deleted (see our response to the comment on Fig.4) in the revised manuscript.

DETAILLED COMMENTS

p.2: is this an evergreen or a deciduous forest (from the abstract, it can be supposed that it is evergreen, but this information is too important to be omitted).

Response: The studied Shaoshan forest belongs to a deciduous and coniferous mixed evergreen forest.

p.2: balanced / unbalanced chemistry: this concept is neither common (at least for me) nor defined in the abstract.

Response: The definition of the balanced / unbalanced chemistry was deleted in the revised version.

p.2: contributions of dry deposition vs. canopy leaching: it is not clear from which measurements and calculations this comparison can be done.

Response: The mentioned contribution of dry deposition and canopy leaching to the NTF was from calculations.

p. 2: precipitation quantity controlling leaching: it should at least be written in which direction this effect goes.

Response: The relation between precipitation and canopy leaching is positive, indicating that the canopy leaching increases along with the precipitation quantity.

p. 2: the multiple regression model: this is written as if this model would be unique or already defined in the abstract, neither of which is the case.

Response: In the abstract, “the multiple regression model” should be a multiple regression analysis method or approach, which was taken into account in the revised manuscript.

p. 2: leaching of base cations corrected by the weak acid: what is the purpose of this correction and how is it done?

Response: The process of the canopy leaching of base cations induced by proton neutralizes the acid precipitation. However, the canopy leaching of base cations induced by weak acids does not neutralize the acid precipitation. The correction in our original manuscript is to estimate the canopy leaching of base cations flux, which neutralized the acid precipitation. The correction method was referred to Draaijers and Erisman (1995) and Zeng et al. (2005).

p. 2: net throughfall flux: it would be better to define it (throughfall - precipitation).

Response: We thank the reviewer for his/her comment, so we defined the net throughfall flux (NTF) as throughfall minus precipitation in the revised paper.

p. 2: potential damages: not enough support is given to this hypothesis.

Response: We agree with the viewpoint on potential damages. The hypothesis was not listed in the revised abstract in the revised paper.

p. 3: the atmospheric species: this is not clear. Even if one understands that these are chemical species, then the main atmospheric species are molecular nitrogen, oxygen, water, carbon dioxide... and not those substances considered here.

Response: We are in agreement with the reviewer's comments on the atmospheric species in the original manuscript. The term of 'atmospheric species' was changed to 'atmospheric chemical compositions' in the revised version.

p. 3: below-canopy chemistry: what kind of canopy is meant here? Only forests or also other plant canopies like grassland or crops?

Response: Below-canopy chemistry means the chemistry of the forested throughfall and stemflow, which only means the Shaoshan forest canopies.

p. 3: chemistry of events: too much a shortcut (it is the chemistry of the water of a precipitation event).

Response: We agree with the comment of the Reviewer and the suggestion has been applied in the revised manuscript.

p. 3: ecological factors of the canopy exchange: the list (1-5) somehow mixes causes (factors) and mechanisms (processes).

Response: The original five ecological factors have been incorporated into three in the revised paper as following: (i) the duration, quantity and acidity of precipitation (Cao et al. 1989; Baumler and Zech 1997; Feng et al. 2001), (ii) the species and ecological settings (Lindberg et al. 1986; Campo et al. 2000; Fan and Hong 2001), and (iii) forest soil characteristics, such as extractable amount of base cations and soil types (Lovett and Lindberg 1984; Lovett and Schaefer 1992).

p. 3: reference Lovett & Lindberg: 1986 in the text, but 1984 in the reference list.

Response: There is a mistake about the reference of 'Lovett & Lindberg 1986' in the original manuscript. This cited reference in the text should be 'Lovett & Lindberg 1984'.

p. 4: distinguished seasonality: redundancy (if there is a seasonality, that the seasons are distinguished).

Response: We are in agreement with the Reviewer at this point for seasonality, and correct it in the revision.

p. 4: Hunan, Taiwan, Shaoshan: it is not clear why the Hunan and Taiwan forests are described in particular and what is their relation to the Shaoshan forest of the present study.

Response: (1) Shaoshan is situated in the central part of Hunan province. The subtropical climate in Hunan province (Central-south China) is similar to that of Taiwan, but the climate of Taiwan is influenced by typhoon (Lin et al. 2003).

(2) The studies on the atmosphere-canopy interactions in these similar subtropical climate forests are few or limited to be available.

The results in Shaoshan forest have been compared with that of Nanping fir plantations in Fujian province and Fushan forest in Taiwan to obtain the representative dynamics of elements in the atmosphere-canopy interactions in the subtropical forests.

p. 5: first sentence: too complicated (and wrong) structure.

Response: The mentioned sentence has been corrected to: “The study was conducted on Shaoshan evergreen forest catchment (27 ha) in the central part of Hunan Province, Central-south China (27^{o} 51´ N, 112^{o} 24´ E) (Fig. 1a). The catchment varies in elevation from 25 to 290 m. The obtained data were collected from ten 30 m × 30 m plots in the forest from January 2000 to December 2003.’’.

p. 5: two-dimensioned canopy structure: what does this mean?

Response: “two-dimensioned canopy structure” means that the canopy structures in Shaoshan forest are the two layers, i.e. the top-layer and the sub-layer. The top-canopy layer is about 10-30 m-high, while the sub-canopy layer is approximate 0.8-3.5 m-high.

p. 5: altitude: this precision (0.1 m) is not necessary. If the study area covers different parts of a catchment (p. 6), then the altitude is anyway not a constant, and a range should be given.

Response: For the 10 plots in the studied stand, 3 plots are located in the lower parts of the forest (25-50 m altitude), 5 plots in the middle of the forest (75-100 m altitude) and 2 plots in the upper parts (125-170 m altitude).

p. 5: seasons: in meteorology, the 4 seasons have a different standard definition (in the northern hemisphere, spring is from March to May etc.).

Response: The definition of the seasons has been carefully referred to the local meteorological literatures during the revision and the statement of seasons has been corrected to: “The climate of Hunan province is subtropical and monsoonal with four seasons a year, i.e. spring (March to May), summer (June to August), autumn (September to November) and winter (December to February)”.

p. 5: missing information: the soil type and the age of the trees should be given. The deposition climate should be described in just a few more words (something on a scale between pristine and heavily impacted by S, N, acidity).

Response: The information of the soil type and the trees ages are given as below: (1) Forest soil types in Shaoshan stand are yellow and yellowish-brown soils according to Chinese soil classification (Chinese Soil Taxonomy Research Group et al. 1995); (2) The trees’ age in Shaoshan forest ranges from 20 to 40 years old.

The deposition climate has been described as: “The site is 30 km away from the nearest town, Xiangtan city (60 thousand inhabitants) and 150 km away from Changsha city, the capital city of Hunan province (1.7 million inhabitants). Hunan province is heavily impacted by sulphur compounds”.

The two points mentioned above are also listed in our revised paper.

p. 5: plant species: most of them are not correctly spelled: Cunninghamia lanceolata, Pinus massoniana, Cinnamomum camphora, Euonumus (or Euonymus) japonicus. Check if it is requested or not to give the authorities of species names in J. For. Res. (e.g. Cunninghamia lanceolata (Lamb.) Hook.)

Response: The names of the four plant species have been re-spelled carefully according to the suggestions of the Reviewer.

p. 5: MISU: is this an abbreviation, the name of the model, the name of the factory? (As a rule, apparatus are described by: model, manufacturer, place).

Response: The wet-only collector used in our study is from MISU (Department of Meteorology, Stockholm University, Sweden).

p. 5: wet-only collector: incorrect sentence construction.

Response: This sentence has been rewritten in our revised manuscript. For example, “A wet-only collector from MISU (Department of Meteorology, Stockholm University, Sweden) was placed on a 10 m-high tower adjacent to canopy covered throughfall plots.”.

p. 5: bulk collector: not understandable (wrong sentence construction). Which collector was used for the precipitation: bulk or wet-only (or both)?

Response: The sentence has been changed as: “The throughfall collector is made of a plastic bottle (2 L), a plastic funnel (d=11.5 cm), a connector with a filter (nylon screen), and a mounting equipment” in the revised paper. The wet-only collector has been used in our study.

p. 6: the catchment: which catchment?

Response: The catchment is the Shaoshan forested catchment.

p. 6: disposition of the collectors: avoiding clearings means no random placement, i.e. the collectors are not representative of the entire forest, only of its denser parts.

Response: There is a mistake in the expressions in our original version. The expression of the disposition of the collectors has been revised. The placements of the collectors were placed to avoid trunks but not clearings in our present study.

p. 6: collectors placed on the selected trunk: in contradiction with fig. 1, where the collectors are around the selected trunk.

Response: The schematic trunk in Fig.1 means the tree with DBH (diameter at breast height) normally larger than 15 cm. The selected trunks (DBH: 4-6 cm) are used as the mounting equipment to install the throughfall collectors. So the throughfall collectors were marked in Fig.1 but not the mounting equipment.

p. 6: nucleopore: same comment as for MISU.

Response: The nucleopore (0.45 μm membrane filter) is used to filter the precipitation and the throughfall samples prior to analysis.

p. 6: the fiber plugs were displaced: unclear (which plugs, displaced from where to where?)

Response: The word of displace should be a mistake in expression in the original text. The throughfall collectors are placed under vegetation canopies and 1.0 m above the forest ground. The throughfall collector is made of a plastic bottle (2 L), a plastic

funnel (d=11.5 cm), a connector with a filter (nylon screen), and a mounting equipment. The filter is replaced by a new one after weekly collection.

p. 6: for determination: determination of what? Better use the word analysis, which is sufficient by itself.

Response: The word of analysis instead of determination was used in our revised manuscript.

p. 6: Dionex: same comment as for MISU. Do not write several sentences within parentheses.

Response: The ion chromatography (IC) is operated on the 'Dionex 320 system' from USA, i.e. Dionex 320 system, USA.

p. 7: making the necessary conversions: should be obvious, can thus be dropped.

Response: We are in agreement with the comments of the Reviewer. The words of "making the necessary conversions" were deleted in the revised version.

p. 7: same comment as for MISU; (R) sign usually not necessary in scientific publications.

Response: We are in agreement with the comments of the Reviewer. The sign was deleted in the revised paper.

p. 7: NTF: undefined abbreviation!

Response: We defined the net throughfall flux (NTF) as throughfall minus precipitation in the revised paper.

p. 8: eq. 1: single characters (symbols) should be used instead of abbreviations like NTF in equations (even if this rule is often violated). Use subscripts if necessary. Also: X and i are here redundant: just use i.

p. 8: still about eq. 1: b3 could also be explained (saturation effect). Since acid-induced leaching is discussed further in the article, why do not use the acidity in the equation, like in Lovett et al. (1996)?

Response to the two comments above: The two comments seem to be both on Eq.1. We are in agreement with the suggestions of the Reviewer. To be consistent with Lovett et al. (1996) and take the suggestion on the acidity into account, the original regression equation was changed as following:

$$NTF_{X\,i} = a + b_1 \cdot A + b_2 \cdot P + b_3 \cdot C_{X_i} \qquad \text{(Original)}$$

$$N_{TF,x} = a + b_1 \cdot A + b_2 \cdot P + b_3 \cdot C_x + b_4 \cdot C_{H^+} \qquad \text{(Revised)}$$

where $N_{TF,x}$ is the net throughfall flux of solutes (x) (mmol m^{-2}), A the dry period (day), P the amount of precipitation (mm), C_x and C_{H^+} the concentration (µmol L^{-1}) of particular solute (x) and H^+ in incident precipitation. a is the intercept term and b_1-b_4 are the regression coefficients. Units of the regression coefficients are mmol m^{-2} per day for A (representing mean dry deposition rates) and mmol m^{-2} per mm for P (representing mean canopy exchange rates) and mmol m^{-2} per µmol L^{-1} for C_x and C_{H^+} (representing effects of acid precipitation on the NTF).

p. 8: eq. 2: X is the given ion: is it the concentration or the flux or what?

Response: The given ion in the original text was the concentration. But Eq.2 was deleted in the revised manuscript; because we think the sentence is of the same function of Eq.2, i.e. the data series of this study are the averaged values of the same season in the four observed years.

p. 8: w. a.: this abbreviation is apparently never used in the text, only in tables; then better define it in the tables, not here.

Response: We agree with the Reviewer's comment on the weak acids, and we define it in the tables but not in text in the revised paper.

p. 8: no statistical differences in throughfall and bulk precipitation: this must be a mistake, because if nothing is significant then you can finish the article right here!

Response: We are grateful with the Reviewer's kind comment. Indeed, there is a mistake in the expression of the statistical differences in throughfall and bulk precipitation in our original text.

It was corrected to "No statistical difference in the bulk precipitation quantity as well as that in the throughfall was found among the 10 plots in Shaoshan forest".

p. 9: 210 rain samples: from p. 6, the rain samples are analysed daily; does this mean that it rained during 210 days within the 4 years?

Response: In our original text, the expression of the sampling and laboratory analysis may be too shortcut. In the revised manuscript the statement of this part may be much clearer than the original one. And we hope these revisions and statements will be clearly understood:

The rain samplings are described as "The wet deposition samples are collected daily, but the daily samples are pooled to weekly samples prior to chemical analysis". The throughfall samples are described as: "At weekly intervals, the collected throughfall volume in the 16 collectors per plot is pooled and weighed. Chemical analysis for throughfall is done at monthly intervals in pooled samples".

p. 9: interception similar to the temperate forests and the fir plantations...: written like this, it means that you compare to these forest types in general, but the given references are rather for a few single sites, not for entire forest types and regions. Do not exaggerate how representative single-site studies are.

Response: We are in agreement with the comments on the comparison of canopy interception. In the revised paper, we also compared Shaoshan forest with the two specific subtropical forested sites, i.e. the Nanping fir plantation in Fujian province and the Fu-shan Experimental forest in Taiwan. We think this comparison may examine the canopy interception capacity in the similar climate forests with similar dominant species.

p. 9: Pg: what is the meaning of the subscript g? TF: same comment as NTF in eq. 1.

Response: P_g means the gross precipitation quantity and the subscript of *g* means the gross amount in the original text. To be consistent with the expression of rain quantity in text, "*P*" was used to indicate the precipitation quantity. TF was changed to 'T_f' in our revised paper.

p. 9: Interception + throughfall is not equal to precipitation: why? (With such coefficients of determination, it does not seem to be just due to the errors of the regressions.)

Response: Taking the comments into account, we re-examine the relationships of precipitation vs. throughfall and precipitation vs. canopy interception quantity and find that the sum of the linear coefficients of 0.76 for throughfall and 0.22 for canopy interception is closed to 1.0, which is also not equal to precipitation due to the canopy evaporation loss and the unmeasured stemflow. The re-examined linear equations are as following:

$T_f\,(mm) = 0.76 \cdot P(mm) + 2.4(mm)$, $P<0.05$, $R^2= 0.87$;

$I_c(mm) = 0.22 \cdot P(mm) - 1.1(mm)$, $P<0.05$ $R^2 = 0.79$.

p. 9: reference Cappellato & Peters 1993: should be Cappellato et al..

Response: The mentioned reference was corrected to Cappellato et al. 1993 in the revised paper.

p. 10: proportions of sulfate, ammonium and calcium: giving numbers (%) makes the previous sentences (pp. 9-10) useless (redundant).

Response: We agree with the comments on the redundant sentences and delete them in our revised paper.

p. 10: pedogenic sources for calcium, sulfate and nitrate: right for calcium, but not for sulfate and nitrate!

Response: We agree with the comments on the pedogenic sources and delete the sulphate and nitrate in the revised manuscript.

p. 10: high ratios of sulfate / nitrate were in bulk precipitation: in contradiction with the previous lines (throughfall having higher ratios)!

p. 10: contribution of sulfur compounds: what does it mean to make the comparison with nitrogen, but relative the type of pollution? This is either an overcomplicated comparison or a bad sentence construction.

Response to the two comments above: The statements on the ratios of SO_4^{2-}/NO_3^- and the contribution of sulphur compounds were deleted because the ion concentration in Table 2 in the original text was deleted in our revised paper.

p. 11: weak acid concentration: this paragraph deals with exactly the same matter as the paragraph about charge balance on p. 10, but it is presented as having nothing to do with it.

Response: We agree with the comments on weak acid, but the analysis of weak acid only represents the unmeasured organic acidity in our study.

p. 11: references: DeHaye... or Dehaye? Cao 1989: should be Cao et al..

Response: The 'DeHaye' was revised to 'Dehaye'; and the 'Cao 1989' was also revised to 'Cao et al. 1989'.

p. 11: nitrate was retained by canopy: redundant with p. 10.

Response: The redundant sentence about the canopy uptake of nitrate was deleted in the revised manuscript.

p. 12: leaching from the bark and stemflow: these are not distinct causes but two steps of a single cause. Anyway, this let the question arise about the importance of stemflow in the forest of the present study...

Response: We are in agreement with the Reviewer's comments on stemflow. The two steps were combined into one factor in the revised paper.

The high coverage of canopy (82 %) and the two-layer canopies significantly hinder the stemflow generated from the barks of tree. Although many authors emphasized the importance of stemflow on the forest nutrient cycling, the stemflow was not measured in our present case study, because the volume of stemflow was too little (< 3 % of the incident event) to collect in field experiment (Zeng et al. 2005).

p. 12-13: leaching of sulfate: it may be an effect of the concentration in precipitation, with leaching being compensated by absorption when there is much sulfate in rain water.

Response: We thank the Reviewer for his/her suggestion on forest cycling of sulphate. Many authors assumed that the canopy leaching of SO_4^{2-} was negligible (Bredemeier, 1988; Butler and Likens, 1995; Draaijers and Erisman, 1995), which may base on that the canopy leaching of sulphate can be compensated by the absorption from soil and rain water (Likens et al. 2002; Piirainen et al. 2002; Finér et al. 2004). The mechanisms were added into the revised paper.

p. 13: solute contents: the correct word is concentration, not content (content is an mass, concentration is a ratio mass / mass or mass / volume). Even if this mistake is very common, better avoid it.

Response: We are in agreement with the Reviewer's comments on solute content and correct it during revision.

p. 13: bivalent cations more susceptible to acid inducing leaching: not understandable, or do you mean acid-induced leaching?

Response: There is a mistake in the expression of the canopy leaching capacity for base cations in the original text and the correct statement should be: K^+ is found to be relatively more susceptible to be leached from the canopy compared with Mg^{2+} and Ca^{2+} because it is not so tightly bound in structural tissues or enzyme complexes.

p. 13: Brumme et al.: missing in the reference list.

Response: The missing reference was added in the revised manuscript:

Brumme R, Borken W, Finke S. (1999) Hierarchical control on nitrous oxide emission in forest ecosystems. Global Biogeochem. Cycl. 13: 1137-1148.

p. 13-14: last sentence of this paragraph: Lovett et al. (1996) also found this.

Response: The reference of Lovett et al. (1996) was added in the revised manuscript.

Lovett GM, Nolan SS, Driscoll CT, Fahey TJ (1996) Factors regulating throughfall flux in a New Hampshire forested landscape. Can. J. For. Res. 26: 2134-2144.

p. 14: dry deposition and canopy exchange: this title covers topics already discussed before. The chapter results and discussion is not well structured.

Response: The chapter of results and discussion was re-structured in our revised manuscript, which was split into three-sections: Precipitation and canopy interception; Ion flux in bulk precipitation and throughfall; Factors regulating throughfall flux which includes four sub-sections: Dry deposition; Canopy leaching; Precipitation ion concentration; and Precipitation acidity.

p. 14: dry deposition of protons in % of bulk precipitation: a mass or flux of protons cannot be compared to a mass or flux of water, except if a concentration of protons in the water is meant, which is obviously not the case for these numbers.

Response: The percentage (%) is obtained from the dry deposition flux of proton/the bulk precipitation flux. The two terms are in the same unit, mmol m^{-2} $seaon^{-1}$.

p. 14: dry deposition of ions: which ones do you sum up (e.g. acidity included or not)? And how do you sum up, by molar concentrations, or by charges?

p. 14: leaching of base cations: same question about summing up.

Response to the two comments above: Given the coefficients of dry period (*A*) and precipitation quantity (*P*), measurements of the days with rain-free weather and the quantity of rainfall, the dry deposition and canopy exchange can be estimated. The

estimated fluxes of the dry deposition and canopy exchange are given in Table 5. The total ionic flux of the dry deposition and canopy leaching (including weak acids) in each season is calculated by mmol m^{-2} $season^{-1}$.

p. 15 and fig. 4: relating the weak acids and potassium may lead to wrong conclusions because potassium concentrations are used to calculate weak acids. This should be briefly discussed in view of the observed concentrations.

Response: We are in agreement with the comment of the relationship between weak acids and potassium. The Fig.4 was deleted in the revised manuscript.

p. 15: excretion of weak acids: it is not obvious that the weak acids are coming from inside the leaves. It may also be that weak acids are produced on the surface of the foliage (possibly by microorganisms), and the consumption of protons may be linked to this.

Response: We agree with the comment on 'excretion of weak acids', the mentioned mechanism on the production of weak acids was adopted in the revised manuscript.

p. 15: acid inducing leaching by protons: difficult to understand, it should probably again be acid-induced rather than acid inducing...?

Response: We are in agreement with the suggestion of the Reviewer. The term of 'acid inducing process' was changed to 'acid-induced process' in the revised manuscript.

p. 15: negative canopy exchange for protons, nitrate and ammonium: redundant with p. 10 and with p. 11.

Response: The redundant expressions were deleted in the revised manuscript.

p. 16: precipitation quantity controlling canopy leaching: this is a basic assumption of the multiple regression model and thus not a result!

Response: The conclusion on precipitation quantity controlling canopy leaching was not listed in conclusion section of the revised paper.

p. 16: negative net throughfall flux to base cations: is it not rather a positive flux of base cations?

Response: We thank the Reviewer for the comment on the net throughfall of base cations, and they should be a positive flux in our study.

p. 17: continuous loss of nutrients: it is actually a continuous recycling because they go to the soil, not away from the ecosystem. It seems unlikely that it should become a problem. There is really a lack of evidence for this hypothesis of a damage to the ecosystem.

Response: Based on the comments of the Reviewer and the analyses in the text, we re-examine the conclusion and agree with the viewpoint of the Reviewer.

The conclusion was corrected to: Based on the multiple regression analysis on the four-year observations in Shaoshan forest, the study revealed the effects of the dry deposition, canopy exchange, precipitation ion concentration, and precipitation H^+ concentration on the NTF.

Regression analysis indicated that the canopy exchange flux was the most important factor regulating the NTF and the dry deposition was a minor term. The component of the canopy leaching of base cations accounted for approximate 15-43 % the NTF. The analysis also showed that the increasing NH_4^+ and H^+ concentrations in the bulk precipitation were accompanied by the increasing canopy retention of NH_4^+ and H^+. The retained rate of proton in the canopy was close to the canopy leaching rate of base cations corrected by the weak acids, suggesting that the canopy leaching

process neutralized acid precipitation in Shaoshan forest.

Up to date, the significant phenomena of the canopy leaching flux induced by acid precipitation have been observed in the forest in central-south China, but the damages in forest productivity have not been reported as in southwest China (Jiang et al. 2003; Larssen et al. 1998). The effects of acid deposition on the forest ecosystems should be attached great importance, and the future work need to be done is to elucidate the mechanisms regulating elements cycling in the forest ecosystem.

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