Response to reviewer's comments: First of all, we would like to thank the two reviewers for their comments. The reviewers propose to simplify the method description and discussions on monthly variations to use rather the bi-directional model mainly for NH_3 and other corrections. We have revised our paper taking into account all reviewer's comments. Modifications done in the paper in respect with the different remarks are reported below.

C. Flechard Referee :

General comments

The authors are aware that the savanna sites, especially the dry savannas, are not a permanent NH_3 sink. This paper gives an estimate of dry deposition without denying the existence of emission, otherwise evaluated cited in the paper. We fully agree with the importance to use the NH_3 bidirectional exchange in order to avoid overestimation of dry deposition fluxes, but emission should also be evaluated separately in a case of a budget study.

i) The methodology and results sections have been largely simplified.

ii) We use the bi-directional model of Zhang et al. (2010) to simulate the surface-air exchange for NH_3. For the other gases, we use only the dry deposition model of Zhang et al. (2003b). We assumed that the uni-directional approach for the other gases (NO_2, HNO_3,…) could induce other sources of uncertainty, although this approach is still commonly used for other tropical sites (Trebs et al., 2006; Endo et al., 2011; Pan et al., 2012).
The range values of modelled V_d (NO_2, NH_3, HNO_3) in Delon et al (2010) are included in the table of general comparison of our values with other previous studies (Table 4). We did not make a specific comparison with the model of Wesely (1989) since we now use a bidirectional approach for NH_3.

ii) Published V_d mean/range values for different ecosystem types with different methods are included in Table 4 and compared to our modelled V_d. Thus, we considerably simplified the comparison of annual deposition fluxes in the text.

Specific comments:

P 11692, L24-29: This sentence "The authors are …NO_2 fluxes" is removed.
And the next paragraph is modified by including the application of the two-layer bidirectional model of Zhang et al. (2010).

P11694, L11-18: The sentence is rephrased as follows:
"The inferential method, which combines measured air concentrations and modelled exchange rates, was employed in this study to estimate the dry deposition fluxes of different gaseous species."

P11694-5: HNO_3 interferences
We answered this question in Adon et al. (2010) particularly for the interference of HNO_3 and NO_2. We are aware that by using passive samplers, a potential interference between Nitric acid and NO_2 exists.
During the sampling and analysis of samplers, we tried to minimize the interferences.
All samplers are exposed in pairs in order to reduce data loss if a sampler suffers interference (e.g. HNO_3 and NO_2, NO_2 and O_3; HNO_3 and NH_3 and particulate ammonium, bacterial decomposition, etc). It is important to note that in the passive sampler technique, the adsorption of particles is minimized using a Teflon filter at the inlet.
Concerning the trapping of NO_2, the basic solution, including NaOH, allows simultaneous capture of other gases such as HNO_3 on the whatman filter. To avoid these interferences, it is important to note that the presence of NaOH in the impregnation solution for NO_2 sampler

limits the oxidation of nitrite ion NO_2^- to nitrate ion NO_3^-. During the analysis of NO_2 filters, nitrate concentrations are very low compared to nitrite ion, with a ratio never exceeding 6%. In the case of HNO_3 filters, nitrite ions (NO_2^-) were not detected or at least, they are below the detection limit. So, in our opinion, the concentrations of HNO_3 do not suffer of too much interference from NO_2 or we assume that this interference is negligible.

P11695, L21-26: The paragraph is replaced by:
As a first approximation, the shrub and tree savannas (Lamto, Djougou and Katibougou) were assigned to grassland LUC (long grass), which is the dominant vegetation type in these areas. However, for the calculation of the stomatal resistance, we used the savanna parameters described in Brook et al. (1999).

P11696, L3-17: We reduce this paragraph and complete the table 3 with R_g, LAI and Z_0.
More sensitivity tests have been done for several LUC and parameters before choosing savanna parameters in this paper. Some tests are presented in Adon (2011). We did not present them to avoid a too long paper. For example, a sensitivity test with 3 approximations for $Vd(O_3)$ and $Vd(SO_2)$ is given below:

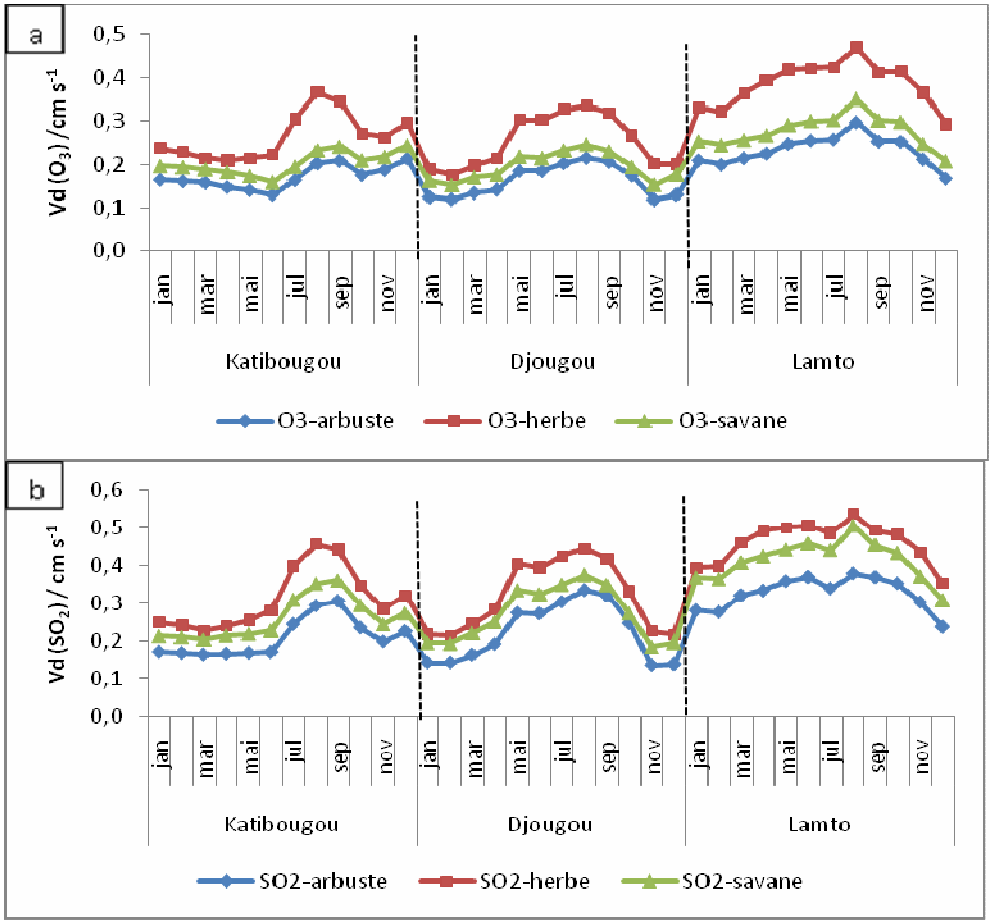

Fig : Monthly evolution of V_d of O_3 (a) and SO_2 (b) with 3 approximations

- 1rst: all parameters of deciduous shrub LUC from Zhang et al. (2003b) (see "arbuste")
- 2nd : all parameters of long grass LUC from Zhang et al.(200b3) (see "herbe")
- 3rd: all parameters of long grass LUC (Zhang et al., 2003b) except for the calculation of R_{st} (Brook et al., 1999) (see "savane"). This last approximation is used for our paper.

Another sensitivity test showed that V_d (O_3) is more sensitive to the minimal stomatal resisitance r_{smin} (100 for long grass (Zhang et al., 2003b) and 150 or 160 for savanna (Brook et al., 1999). We have already assumed in the section 2.3 of the paper that they are uncertainties related to the choice of plant physical parameters.

P11697, L1, We include the definition of MODIS LAI in the paper:
"The MODIS LAI is the ratio of one-sided green foliage area per unit horizontal ground area in broadleaf canopies, or the projected needleleaf area per unit ground area in conifer canopies, and is given in m^2/m^2 (Myneni, 1999)".

P11698-699: This sentence is removed.

P116999, L14-15: We modified the sentence as follows:
"Indeed, we investigate each specific vegetal cover representative of each IDAF measurement sites in this study."

P11700, L1-21: Ok.

P11701, L5-6,: " dry deposition velocities" is replaced by "modelled exchange rates".

P 11701, L9-10: We have answered this question (see **P11694-5:** HNO_3 interferences). However, instead of generalizing, we modified the sentence as follows:
"Part of uncertainties linked to the measurement of gas concentration using IDAF passive samplers have been given by the covariance of duplicates (reproducibility), between 10 and 20 % according to the species (Adon et al., 2010). Other parts are related to the measurement techniques of passive samplers".

P11701, L11-12: .We modified the sentence like this:
"One of the uncertainties of the dry deposition velocities is related to the wind forcing."

P11701, L26-28: the paragraph has been modified.

P11702, L5-6: the sentence is replaced as follow:
"Moreover, multiple species model intercomparison show factors of 2-5 differences in exchange rates between models, depending on the chemical species (Flechard et al., 2011)."

P11702, L7-12: The paragraph is removed.

.**P11703, L4-5**: We reformulate the explanation:
"In fact, in this model of deposition, the NO_2 V_d is parameterized similar to the one of O_3 due to similar behavior for a variety of conditions and the importance of their stomatal uptake (Zhang et al., 2002a). However, some studies pointed out the importance of the non-stomatal deposition fluxes in the case of O_3 (Fowler et al., 2001; Stella et al., 2011)."

P11703, L8-9: The sentence is reformulated:
"Even if the chemical characteristics of NH_3 are not the same than SO_2, the NH_3 V_d is parameterized similar to SO_2 in this deposition model (Zhang et al.2002a, 2003b)".

P11706, L5-10: In order to simplify the results section, some sentences were removed and others synthesized; and some paragraphs modified.
The reviewer mentions that the higher NO_2 concentration in the wet season may also partly result from in-canopy NO oxidation by O_3, leading to diminish the magnitude of the downward NO_2 flux and sometimes cause it to be directed upward. We agree with this remark and the need of flux measurement by other methods. We also agree with the need to consider the photo-chemical reactions of NO, NO_2, O_3 and the compensation point concentrations in the deposition models. As we mention in the general comment, we are aware of the uncertainty linked to the uni-directional approach used in this study for NO_2 and HNO_3. Note that the bi-directional exchange of NO_2 is not well developed in the models, contrary to NH_3

exchange. This approach remains difficult for African ecosystems due to a lack of input data. A rather large uncertainty has to be applied on NO_2 deposition fluxes as mentioned in Delon et al. (2010). In the review paper, at the end of NO_2 section, we added a paragraph concerning the NO_2 compensation point.

P11708, R_c for HNO_3
Although previous studies showed that dry deposition of HNO_3 is mostly controlled by aerodynamic resistances, a small surface resistance is assigned to HNO_3 in the big leaf model of Zhang et al. (2003b) used in this study (Zhang et al., 2002a). Thus, R_c of HNO_3 is calculated in this model and constrained to a lower limit value of 10 $s.m^{-1}$. This is indicated at the end of "Appendix A". In our study for the remote African sites, we have not necessary data to discuss gas/particle interactions of the triad $NH_3/HNO_3/NH_4NO_3$.

P11709, L4-5: We compare HNO_3 V_d in Table 4, thus we removed the paragraph of comparison of monthly deposition fluxes of HNO_3.

P11709, L19: Using the bidirectional exchange model, the paragraph has been modified but the higher NH_3 V_d at Katibougou and at Lamto are explained in the section "total nitrogen dry deposition fluxes".

P11709, L26-27: Using the bidirectional exchange, this figure and the paragraph have been modified. But we must consider that the nitrogen budget is equilibrated according to previous studies (Delon et al., 2010, 2012). In this budget, emission and deposition were decoupled; but for each component, NH_3 dominated among the other gases. We assumed that a large part of NH_3 emitted in arid regions is returned to surface by deposition (dry and wet, (Bouwman et al., 2002a).

P11710, L7-9: Please, see the response of P11709, L19.

P11715, L26 to P11716, L13: The paragraph has been modified.
In this study, the O_3 deposition fluxes are lower due to low concentrations. Thus, the O_3 damage on vegetation would need a whole research study and is beyond the scope of this paper.

P11716, L20-22: This sentence is replaced by:
"Surface and meteorological conditions specific to IDAF sites have been used in the deposition models".

P11717, L22-24: The sentence is completed:
"To improve this work, it is important to not only address the uncertainties in the determination of dry deposition velocities but also use the bi-directional approach for other gases such as NO_2; more investigation on the ground emission potential in the case of NH_3 surface–atmosphere exchange is needed."

Technical corrections:

"of the same order" is used when appropriate, rather than "of the same order of magnitude"
P11692, Flechard et al., 1999 is added to the reference list.
P11696, L17, This sentence has been removed when reducing the text.
P11704, L18: the paragraph has been modified.
P11708, L10: "is" is replaced by "are"
P11709, L11: "ammoniac" is changed to "ammonia".
P11715, L10 "interannual" ok
Table 1: LAI range is added rather to Table 3.
The canopy height of savannas is not uniform, it varies from grass to shrub or tree, according to the season.

For example, at Lamto savanna, the height of the gass stratum ranges from 0 to 2 m, shrub stratum from 2 to 8 m and trees are over 8 m (Abbadie et al., 2006, Ecological studies, 179, 415 pp)
Figure 2: Zoetele station is added
Figures 5-9: spacing is inserted between the adjacent column charts of the different sites

Anonymous Referee #1:

As we mentioned in our responses to the other Referee, the method descriptions and the discussions on monthly variations are significantly simplified. Thus, the paper focuses on dry/wet seasonal and annual results on the transect of ecosystems. In addition, the bi-directional approach with the model of Zhang et al. (2010) is used for NH_3 fluxes. This paper states that dry deposition process in gaseous form contributes to 31-68% of the total (dry+wet) N deposition fluxes over African ecosystems (section 3.2.1. "Total nitrogen dry deposition fluxes").

P11690, L17-18: We indicated that aerosols are not included in this paper due to low concentrations measured at IDAF sites. We do not have mentioned the percentage contribution from any individual N species.

P11699, L25-P11701, L3: Concentrations measured at 3 m below the canopy have been corrected experimentally for NH_3 and O_3.
For HNO_3 and SO_2, we have indicated that:
"Contrary to our observation for HNO_3 and SO_2, Hicks (2006) observed a ratio of 1.34 and 1.26, respectively, between concentrations measured above the treetops and within the canopy of forests."
In the last paragraph we noted that "the dry deposition fluxes of HNO_3 and SO_2 using the forest-clearing concentration may be underestimated as discussed by Hicks (2006)."

P11705, L11: Now we used V_d from each year and the 6 year V_d but a sensitivity test showed no difference in the results due to lower inter annual variability of V_d.

P11706, L5-10: The paragraph has been modified.
In the section of "Total nitrogen dry deposition fluxes…" we mentioned the relative contribution of dry to total (dry and wet) deposition fluxes, as the reviewer suggested.

We sincerely hope that you will consider our responses and modifications of the paper as acceptable. With many thanks,
Regards

Marcellin Adon