Dear Reviewer,

Thank you for your review of our manuscript. We appreciate your valuable comments and suggestions and the opportunity to address your concerns and provide clarifications. Below, we respond to each of the major and minor comments raised. Our responses are in blue font.

This study implemented a deposition module into a large-eddy simulation code and presented a case study on the dispersion and deposition of NO_x and NH_3. However, due to the lack of model sensitivity analysis, it remains unclear whether the implemented model accurately reproduces gas-phase deposition. Below are several major concerns:

Before applying the developed deposition module within DALES, a theoretical analysis should be conducted to examine the relationship between deposition velocity and the dry deposition parameters of each gas species in DEPAC. These relationships should then be compared with existing literature to validate the correctness and reliability of the DEPAC implementation.

We understand the need for an evaluation of the DEPAC module, as there are many factors that can influence the deposition velocity of a gas phase species. However, we think that a full theoretical analysis for each gas-phase species is beyond the scope of this paper. Besides, DEPAC has been applied as a standalone deposition module before and has been extensively evaluated against observations. We will refer to the relevant literature on the DEPAC module in Section 2.3.

Added new subsection (P6L152) "Calculation of resistances"

Changed (P6L152): "In this work, the DEPAC deposition module is used, which is an implementation of the resistance model."

To: "The DEPAC deposition module applied in this work is an implementation of the resistance model."

Added (P6L154):

"The DEPAC module is a well-established module for dry deposition calculations. It is used as a dry deposition module in the air quality models LOTOS-EUROS (Manders et al., 2017, 2022) and OPS (Sauter et al., 2020). A theoretical analysis of the sensitivity of DEPAC to several of its input parameters is given by (Van Zanten et al., 2010). Further, it has been evaluated against observed deposition fluxes over forests (Melman et al., 2025; Wintjen et al., 2022) and dune ecosystems (Jongenelen et al., 2025; Vendel et al., 2023). These analyses have shown that the parameterizations of compensation point and the external resistance (R_w)

contribute most to uncertainties in calculated deposition (and emission) fluxes of NH_3."

The condensation and evaporation processes of HNO_3 and NH_3 can have effects comparable to their dry deposition, and different deposition schemes may even reverse the gas-particle partitioning (Lin et al., 2024). However, aerosol dynamics are not considered in this study, which introduces substantial uncertainty into the case study results. The exclusion of this key mechanism undermines confidence in the conclusions drawn from the simulations.

We agree that the condensation and evaporation processes of HNO_3 and NH_3 are critical factors that can influence dry deposition of these species. In the revised manuscript, we will incorporate a discussion on the potential effects of these processes and acknowledge the limitations of not including aerosol dynamics in our current study. Implementing aerosol dynamics in DALES will be addressed in future work.

Added text, P19L425:

"A limitation of our study is the fact that we ignore possible effects of chemistry and aerosol formation on the deposition of NO_x and NH_3. Under atmospheric conditions, NO_x will be partially converted into HNO_3 which deposits more readily than its precursor and which can be neutralized with NH_3 to form ammonium nitrate aerosol. DALES has been used before to study the effects of turbulent mixing on the phase transition of ammonium nitrate. Aan de Brugh et al. (2013) found that aerosol-poor air is transported upward from the surface and aerosol-rich is transported from high altitudes downward, since equilibrium between the gas and aerosol phase is not instantaneous. Further, Barbaro et al. (2015) found large deposition velocities for nitrate due to outgassing near the surface. Finally, a study with another LES code concluded that the effective Henry's law constant is a critical factor for parameterization of dry deposition of gas-phase species in a street canyon (Lin et al., 2024).

Taking into account the effects of gas-phase chemistry and gas-aerosol partitioning will have considerable impacts on the calculated deposition fluxes. We aim to cover the effects of a full coupling between emissions, chemistry, partitioning and turbulent transport in a follow-up study."

The spatial and temporal distributions of Ra, Rb, Rc, deposition velocity, and deposition flux during the simulation period should be provided and discussed. This would allow for a more comprehensive understanding of the deposition process. Furthermore, it is important to clarify which of the resistances (Ra, Rb, or Rc) is the dominant factor under the simulated conditions.

We have added temporal distributions of R_a, R_b, R_c, deposition velocity, and deposition flux during the simulation period to the revised manuscript, in addition to the maps of deposition flux and velocity that were already included (Figures 8 and 9). Since the new Figure 8a and 8b show the concentration time series, these

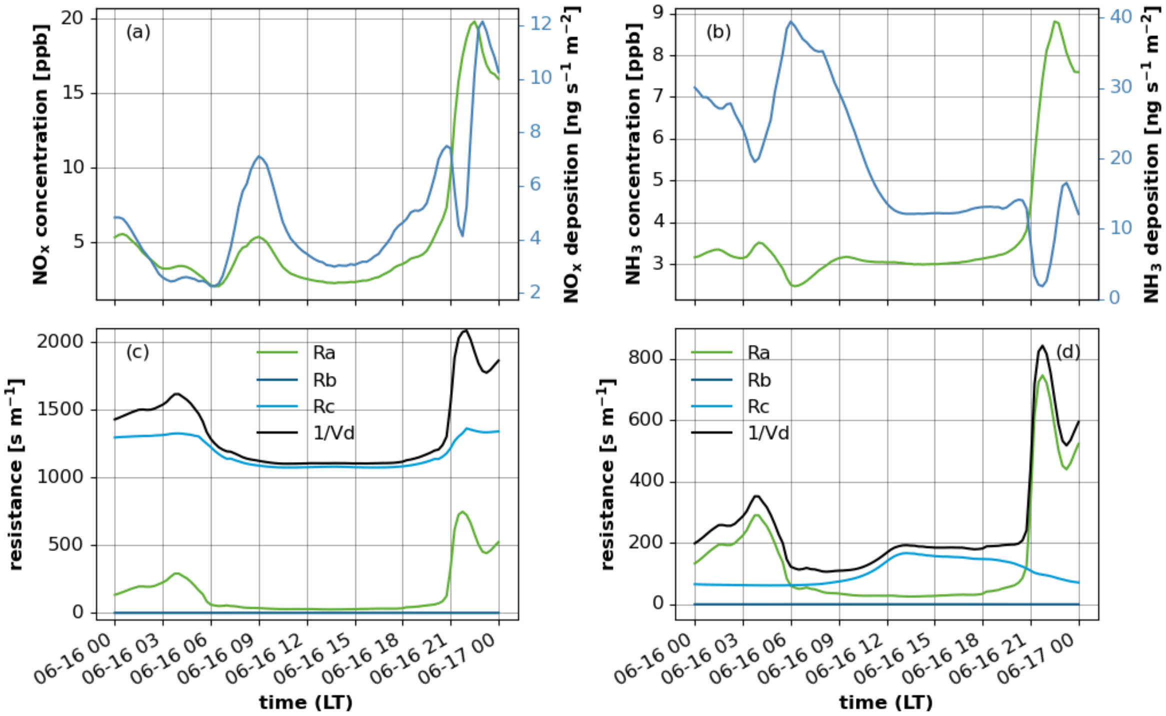

Figure 1(Fig. 8 in the revised MS): diurnal cycle of concentration and deposition flux of NO_x (a) and NH_3 (b), and of the deposition velocities and the aerodynamic (R_a), the quasi-laminar (R_b) and canopy (R_c) resistance for NO_x (c) and NH_3 (d).

were removed from the current Figure 7e.

P16L381:

"The diurnal cycle of NO_x shows a strong relationship between the concentration and the flux (Figure 8a), indicating that the deposition flux is mainly driven by the concentration gradient between the atmosphere and the surface. It also shows that during most of the day, the canopy resistance (R_c) is the most important factor that drives the deposition velocity (V_d; Figure 8c). For NO_x, the R_c mostly follows the stomatal resistance, as shown by the decreasing R_c during daytime. Only during nighttime, the aerodynamic resistance (R_a) plays a significant role in determining the deposition velocity.

For NH_3, a different picture emerges (Figure 8b). During nighttime (between 00:00 and 06:00 LT), the NH3 concentration and deposition are coupled, but during the morning (between 06:00 and 10:00 LT), the concentration increases while the deposition flux decreases. This is driven by an increasing R_c (Figure 8d). For NH_3, the uptake on wet external surfaces is the most important contribution to the canopy uptake, and this pathway decreases when dew on the leaves evaporates. During daytime (10:00 to 20:00 LT), concentration and flux remain relatively constant. In the evening (between 20:00 and 00:00 LT), the deposition flux increases due the increased concentration, while the R_c decreases again due to dew formation. The V_d is dampened by the rising R_a.

For both species, R_b only plays a minor role in determining the deposition velocities during the whole day."

Minor comments:

Line 196:' In addition, a sensitivity analysis in a related project pointed out that the effect of switching between dry and wet land on the deposition fluxes of NH3 is not very strong.'

Please provide a citation or additional evidence to support this statement. Without substantiation, the conclusion may appear speculative.

This statement was found to be erroneous on further investigation of the related project. The deposition velocity for NO and NO_2 only differ by approximately 12% between a completely wet domain vs a dry surface (save for some waterways). The difference for NH_3 is much larger. Note that this is a worst case scenario, where the complete surface is saturated with water. In that case, NH_3 deposition is controlled by the high solubility of NH_3 in water.

We did want to be sure that working only with the equations for dry would be justified. KNMI weather data at the location of Eindhoven Airport showed that the date of our simulations was preceded by a prolonged period of dry conditions (11 days without any precipitation). We have added a line in the discussion of the Eindhoven case study stating this and the statement on the related project was deleted.

In P8L196, we replaced:

"Here, we circumvented this problem by selecting dry days in a period with little or no rain. In addition, a sensitivity analysis in a related project pointed out that the effect of switching between dry and wet land on the deposition fluxes of NH_3 is not very strong."

By:

"In our case study, we circumvented this problem, since the KNMI weather data at the location of Eindhoven Airport showed that the date of our simulations was preceded by a prolonged period of dry conditions (11 days without any precipitation)."

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