Dear Reviewers,

Thank you for your thorough reviews. We adapted the manuscript based on your comments. On the following pages, you find our point-to-point response to your comments including references to manuscript sections.

Yours sincerely,
Maximilian Mork

Reviewer 1:

Remark of the authors with regard to the change of the forecast errors: After an internal discussion between all three authors, one forecast error (for the ambient temperature) was replaced by a forecast error for the air exchange. According to the authors, a forecast error for the ambient temperature of that high, oscillating dynamics (as shown in former Figures 7 and 10) is not physically plausible and not aligned with the inert dynamics of the ambient temperature. It was therefore replaced by the higher dynamics within the air exchange of a building (with ambient air), which is a much more dynamic phenomenon due to dynamic wind pressure forces on the building envelope. This physical phenomenon can be represented more accurately by the artificially generated forecast error. All forecast errors are explained in Section 3.

Despite the topicality of the paper, the novelty/originality of the manuscript is not much evident.

There are lots of simulative implementations for Model Predictive Control in buildings (particularly, with perfect forecasts of disturbance quantities, e.g., solar radiation, ambient temperature, number of occupants, occupant behavior) but rare cases of practical implementations. A hindrance for a real-world implementation could be constituted by deviations between the forecasted and really occurring disturbance quantities. The proposed MPC method tackles this challenge with a hierarchical approach and is applicable to multi-zone buildings with its distributed composition. The work builds on individual optimization algorithms in a hierarchical [23] and distributed [24] form. The novelty of this work (described at the end of Section 1) is splitting the computational complexity in both the temporal and spatial dimension by using a coupled hierarchical and distributed MPC and testing the MPC approach in a real-world-comparable environment, where disturbance quantities deviate from its forecasts.

Moreover, while the modelling part is accurately described and discussed, little attention is paid to the energy aspect. Authors are invited to address these problems.

The energy aspect was addressed in the introduction by referring to [4] (*Drgo ˇna, J., Arroyo, J., Cupeiro Figueroa, I., Blum, D., Arendt, K., Kim, D., Oll ´ e, E. P., Oravec, J., Wetter, M., Vrabie, D. L., Helsen, L. All you need to know about model predictive control for buildings. Annu. Rev. Control, 50:190–232, 2020. doi: 10.1016/j.arcontrol.2020.09.001*), whose authors have written a comprehensive review on Model Predictive Control in buildings including the demonstrated energy savings. Due to the high share of building energy consumption in the global consumption ("Introduction" section), the relevance of energy-efficient control of buildings is manifested.
The cost function containing different forms of energy consumption for the Concrete Core Activation, convectors and artificial lighting is specified in Equation 1.
The energy-efficient behavior of the MPC is described in subsection 4 - Forecast scenario (σ = (0,0,0)) addressing the splitting of the total heat load in the base load for the CCA (with a higher energy efficiency due to lower supply temperatures) and a peak load compensated by the convectors. The energy-efficient operation of the room temperatures near their comfort bounds, the lower bound during the heating period and the upper one during the cooling period reducing energy consumption for heating and lighting, is highlighted as well. These points are elaborated more accurately in the section now.
Energy efficiency comparisons of the general MPC approach to conventional, reference control approaches have been performed in previous works, [23] and [24].

Reviewer 2:

Remark of the authors with regard to the change of the forecast errors: After an internal discussion between all three authors, one forecast error (for the ambient temperature) was replaced by a forecast error for the air exchange. According to the authors, a forecast error for the ambient temperature of that high, oscillating dynamics (as shown in former Figures 7 and 10) is not physically plausible and not aligned with the inert dynamics of the ambient temperature. It was therefore replaced by the higher dynamics within the air exchange of a building (with ambient air), which is a much more dynamic phenomenon due to dynamic wind pressure forces on the building envelope. This physical phenomenon can be represented more accurately by the artificially generated forecast error. All forecast errors are explained in Section 3.

Two major problems of the paper are the following:

1. While the modelling/mathematical point of view is accurately described and commented, little attention is paid to the energy aspect.
The energy aspect was addressed in the introduction by referring to [4] (*Drgoˇna, J., Arroyo, J., Cupeiro Figueroa, I., Blum, D., Arendt, K., Kim, D., Oll ´ e, E. P., Oravec, J., Wetter, M., Vrabie, D. L., Helsen, L. All you need to know about model predictive control for buildings. Annu. Rev. Control, 50:190–232, 2020. doi: 10.1016/j.arcontrol.2020.09.001*), whose authors have written a comprehensive review on Model Predictive Control in buildings including the demonstrated energy savings. Due to the high contribution of building energy consumption to global consumption ("Introduction" section), the need for energy-efficient control of buildings is revealed. This work focuses on a specific form of Model Predictive Control for buildings, which splits the high computational complexity (introduced by nonlinear controller models) in the temporal and spatial dimension by employing a hierarchical distributed optimization approach.
The cost function containing different forms of energy consumption for the Concrete Core Activation, convectors and artificial lighting is specified in Equation 1.
The energy-efficient behavior of the MPC is described in subsection 4 - Forecast scenario ($\sigma = (0,0,0)$) addressing the splitting of the total heat load in a base load for the CCA (with a higher energy efficiency due to lower supply temperatures) and a peak load compensated by the convectors. The energy-efficient operation of the room temperatures near their comfort bounds, the lower bound during the heating period and the upper one during the cooling period reducing energy consumption for heating and lighting, is highlighted as well. These points are elaborated more accurately in the section now.
Energy efficiency comparisons of the individual MPC approaches to conventional, reference control approaches have been performed in previous works, [23] and [24].

2. The paper merges together two previous publications of the authors ([23] and [24]). The methodology is an integration of distributed and hierarchcal MPC which have been previously discussed by the authors and the novelty/originality is not much evident. Even some figures are the same.
There are lots of simulative implementations for Model Predictive Control in buildings (generally, with perfect forecasts of disturbance quantities, e.g., solar radiation, ambient temperature, number of occupants, occupant behavior) but less commonly applied cases of practical implementations. A hindrance for a real-world implementation is constituted by deviations between the forecasted and

really occurring disturbance quantities. The proposed MPC method tackles this challenge with a reactive, hierarchical optimization approach and is applicable to multi-zone buildings based on its distributed composition. The work builds on individual optimization algorithms in a hierarchical [23] and distributed [24] form. The novelty of this work (described at the end of Section 1) is splitting the computational complexity in both the temporal and spatial dimension by using a coupled hierarchical and distributed MPC and testing the MPC approach in a real-world-comparable environment, where disturbance quantities deviate from its forecasts. Individual figures (1 and 5 and subplots of figure 7) from [24] are reused in this work Figure 5, as the non-hierarchical distributed MPC forms the reference control in the simulative case study, which is outperformed by the proposed coupled hierarchical distributed MPC.

Authors are invited to address these two major problems. Moreover, proofreading is recommended. The manuscript must be adapted to the ECOS template.

The ECOS template was checked and the manuscript was read again. One keyword (now five keywords) has been removed. “\frac” has been replaced by the fractional sign slash in Equation (1). “Fig. 10” was replaced by “Figure 10” at the beginning of the sentence. In references with only two authors, commas were missing to separate the authors. The commas are included now.