Reply to the comments made by the Referees and the editor

Firstly, we would like to express our appreciation for the referees' and the editor's thoughtful comments and constructive suggestions.

Our replies to the specific comments made by referee #2 are given below. Their comments are written in regular font style, and our reply is written in italic style.

Reply to Referee #3

General comments:

1) The title and general introduction of the paper do not cover the results that are actually presented. The title states "ensemble forecasting" but actually nothing is forecasted. I would rather call this a scenario study taking into account model uncertainty. Moreover, stating "ensemble forecasting" will lead many people to think that this paper deals with ensemble forecasts made by numerical weather prediction models (whether pertinent or not), but this is not the case.

Reply: *The title has been changed.*

2) The paper strongly focuses on "model coupling" however I do not really see what is so special about this aspect. The default WOFOST model has a 1D soil water balance which has the same purpose as HYDRUS 1D, albeit not as sophisticated. So part of the work is mainly exchanging the default water balance with HYDRUS1D, this is justified given the objectives but not particularly exciting.

Reply: *The soil water balance in WOFOST model was calculated using a tipping bucket approach with three compartment configurations of root zone, transmission zone, and groundwater zone. WOFOST model simulated actual crop transpiration by the relative amount of available water in soil root zone. It is relatively simple and not accurate for the hydrologic cycle simulation during crop growth (Eitzinger et al., 2004; Priesack et al., 2006). However, HYDRUS model simulated actual root uptake by pressure head with method mentioned by Feddes et al.(1978). The method calculated the root water uptake at each vertical discrete depth of the rooted zone. So the root water uptake simulated by HYDRUS was more accurate than the WOFOST. Owing to HYDRUS model's advantage in simulating soil moisture and root water uptake as a physical process, the influence of water stress on photosynthesis was calculated using actual root uptake/potential transpiration, which was calculated by HYDRUS model, multiplying the potential daily gross CO2 assimilation, which was calculated using WOFOST model.*

3) I have some questions about the interpretation of the results of the sensitivity analysis. The results demonstrate that the the HYDRUS parameters are among the parameters which have a strong impact on WOFOST simulated biomass results. If we now look at the setup of the field trial, then is it described that the maize crop received 9 times 100mm of irrigation. Given a growing season length of _150 days, this means that the maize crop could transpire roughly 6mm/day. WOFOST simulations for a somewhat comparable semi-arid climate (south of

spain) demonstrate that a maize on average needs around 600mm of water with a growing season length of 120 days (5mm/day). So basically the crop has plenty of water available to grow, in such cases you do not expect the soil water balance parameters to have so much influence. Unless you push them to extreme values. Also if we look at figure 4, it is unlikely that the crop will experience water stress given that soil moisture is always above 0.3 for the whole soil column.

Reply: *The main objective of coupling is to find optimal irrigation. In the revised version of the manuscript, we listed the constituents of the soil water balance in Table 4. The results show the optimal irrigation scheme is 9 irrigations with 60mm irrigated water each time and total about 500-600mm irrigated water during a growth season. The sensitivity analysis is made under optimal irrigation. However, soil moisture status under realistic irrigation is shown in Fig. 4 for validating the coupled model.*

Detailed comments:
p3844: The discussion of model uncertainty here is a bit out of scope of the rest of the paper.

Reply: *The objective of this paper is to study the effect of model parameters and structure on the maize output estimation during a growth season by the UA/SA method. So we review the studies on numerical model's uncertainty.*

p3847-L25: this is incorrect, in WOFOST leaf growth is always the result of leave biomass time specific leaf area and not a function of temperature.

Reply: *Thanks for your suggestion. Unnecessary details about methods are deleted to simplify the information of the methods used, so this sentence is deleted.*

P3849: How is the pressure head (h) defined? is this an average over the rooted zone, or calculated per compartment?

Reply: *HYDRUS calculated the root water uptake at each vertical discrete depth of the rooted zone. So the simulated soil pressure head have different values at different vertical discrete depth.*

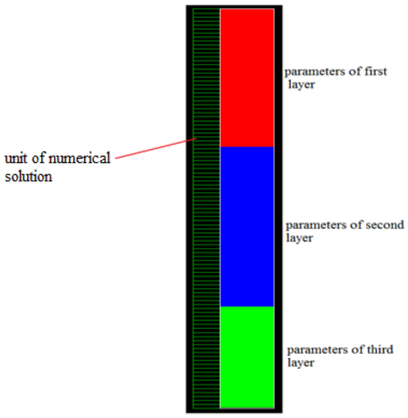
P3850: Where does LAI come from in equation 5, I assume it is modelled by WOFOST?

Reply: *As presented in Fig. 3(Fig 2 is changed to Fig 3 in revised version), LAI is modeled by WOFOST as input of HYDRUS.*

P3850-L20: Why only three layers. To my knowledge the Richardson equation can only be solved numerically when the layer thickness is small (in order of a few centimeters). Why choose such thick soil compartments, or does the HYDRUS1D internally use smaller layers for numerical calculation?

Reply: *To solve the Richardson equation numerically, the soil profile is divided into many layers.*

The parameters of the soil physical properties were generalized to three layers according to the actual soil profile. The calculated units and the layer of the soil physical properties are shown in following figure.



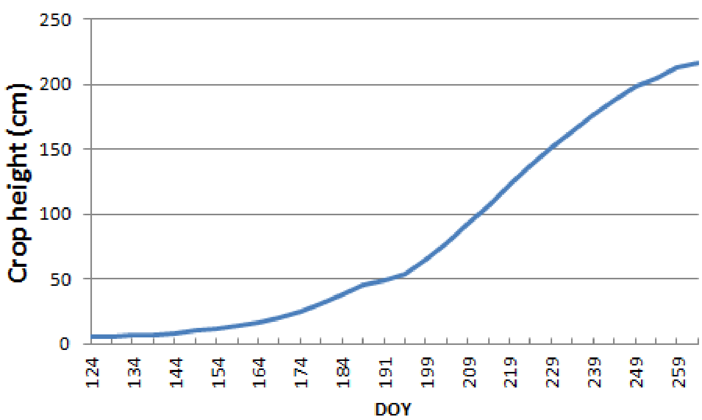
P3851-L10: Again the Richardson equation in the HYDRUS model cannot be solved at daily time steps, so I assume internally a smaller time-step is used?

Reply: *HYDRUS can calculate at daily–step, which be controlled by input time-scale. The numerical solution of HYDRUS should be at a small time –step based on iterative method. To realize the coupling, we set the output of HYDRUS1D with a daily scale to same as the output time-step of WOFOST.*

P3852-L1: crop height is not a WOFOST output variable, please specify how you derived it.

Reply: *As you said, crop height was not a WOFOST output variable. But Crop height was one of inputs to HYDRUS. To couple WOFOST model and HYDRUS model, we used Logistic Model to simply descript the relationship between TSUM (temperature sum) and crop height. The simulated result was presented as follow.*

Crop height =281.4/{1+EXP[-0.00310×(TSUM-1281.3)]}



P3852-L15: The Boons-Prins reference actually quotes multiple sets of parameters for different parts of Europe. Please tabulate the one you used for your study.

Reply: *The characteristics of the maize variety studied here are similar with those of grain maize 203 variety of Europe, such as drought-resistant, cold-resistant, plant height, leaf width, full grain, etc. So, the maize data set (MAG 203), which is provided by European Community (Boons-Prins et al., 1993), are chosen for the parameters of crop characteristics in the model.*

P3853: It is actually not clear to me if the results presented in figure 5 and 6 have been obtained by only calibrating the soil water balance? Or has there been some calibration on the observed time-series of LAI, WSO and TAGB as well.

Reply: *The LAI, WSO, TAGB and the soil moisture are diagnostic variables of the coupled HYDRUS and WOFOST. The simulated LAI, WSO, TAGB and the soil moisture were simultaneously calibrated with the observed time-series.*

P3854: It is not very clear how the ranges for the WOFOST model parameters were derived. Were these taken from the ranges specified by the parameter database in the WOFOST model installer?

Reply: *The ranges for the WOFOST model parameters were taken from literature review, and default, minimum and maximum values of WOFOST databases.*

P3855: What is described here is a scenario analysis taking into account the model uncertainty. It has nothing to do with forecasting.

Reply: *The scenario analysis taking into account the model uncertainty is used to reveal the risk of facing a loss of crop production as irrigation decreases. The word 'forecasting' is deleted.*

P3856-L18: I would rather say here that water limitation becomes the major yield determining factor, which is logical.

Reply: *Thanks for your suggestion. We have revised it.*

Table 4: The problem here is that the TAGP does not equal the sum of WLV, WST and WSO. This is because you tabulate the weight of the living plant material instead of the total weight (living + dead). Please use the total weight stems, total weight storage organs, total weight leaves here.

Reply: *WLV, WST and WSO are replaced by TWLV, TWST and TWSO respectively.*

Table 5: You list here both the parameter AMAXTB as well as the individual X-Y pairs AMAXTB1, AMAXTB2, etc. How did you make the sensitivity analysis on the AMAXTB table parameter? Shifting individual XY pairs is not a good solution from my point of view because it may lead to unrealistic shapes of the AMAX curve with development stage. This remark also applies to the SLATB parameter.

Reply: *Thanks for your suggestion. We also considered it. We simply limit maximum leaf CO2 assimilation rate at different development stages of the crop growth within different interval and add a conditional judgment between individual XY pairs to ensure the AMAX curve with development stage (e.g. AMAXTB1⩾AMAXTB2). The handling of SLATB parameter is same to AMAXTB.*

Table 6: this table should be reformatted because it is not clear that the first column continues in the 4th column.

Reply: *This problem has been resolved. We added a blank column between the 3rd column and the 4th column.*

figure 4: change the observations into point instead of connected lines.

Reply: *This problem has been resolved.*

Figure 5: why are some of the observations connected with lines while others are not.

Reply: *This problem has been resolved.*

Figure 6: The X-axes title should read "day since 1 of January" not date. This applies to other figures as well.

Reply: *'date' is changed to 'DOY '. 'DOY' means the day of year.*

figure 7: it is difficult to judge from this figure how well observed and simulated actual evapotranspiration match.

Reply: *According to the suggestion, we added the following descriptions.*

The RMSE and NSE values for actual evapotranspiration are 0.721 mm and 0.783, respectively.

Figure 9: Please align the x-axes here for all figures: currently we see the same histogram with a varying x-axis.

Reply: *This problem has been resolved.*