Reply to the Reviewers comments

We thank the reviewer for his/her insightfully review and constructive feedback. We have therefore revised and modified the original manuscript as to take into account the raised comments. A point to point response to the reviewer's comments follows.

1 Specific comments

$[Reviewer]$ The main outcome of the paper spreads from the comparison of different wake models: two of them are empirical/ engineering models with a quite different approach while the other two actuator disc models seems quite similar and the reader is not able to understand the main reasons for such different results.

$[Authors]$: We thank the reviewer for this comment. We have now included new material in the revised paper (Page 4, lines 7-11, Page 5, lines 1-6 and Table 1).

$[Reviewer]$ To improve the "scientific soundness" of the paper a deeper discussion on the differences between the new and old ACD model is strongly recommended.

$[Authors]$: A deeper discussion on the differences between the new and old ACD model is now included in the revised manuscript. Author's changes in manuscript (Page 4, lines 7-11, Page 5, lines 1-6 and Table 1).

1. $[Reviewer]$: About the new ACD two things need to be better explained: if the equation for the thrust is really different from the old version and how?

   $[Authors]$: We thank the reviewer for this question. The equation used to find the thrust at each cell is slightly different for the new and old ACD methods. In the new ACD method the thrust coefficient updates at each iteration depending on the wind velocity at the rotor position ($u_{1,i}$), whereas in the old ACD the thrust coefficient is kept constant during the simulation and is found by the undisturbed wind velocity. This static behaviour of the old ACD method and it's limitations has been already pointed in Crasto and Gravdahl (2008). The equation used to find the thrust at each cell in our study is Eq. (1) $F_i = C_T\left(U_{1,i}\right)\frac{1}{2}\rho\left(\frac{U_{1,i}}{1-\alpha_i}\right)^2 A_i$ in the old method the equation is the following $t = C_T\frac{1}{2}\rho\left(\frac{1}{1-\alpha}\right)^2$. The reader can verify that the thrust coefficient in the new ACD is a function of the velocity at the turbine position ($C_T(U_{1,i})$) whereas in the old ACD it is dependent on the undisturbed wind velocity (C_T) (Eq. (4) in Crasto and Gravdahl (2008)). Author's changes in manuscript (Page 4, lines 7-11, Page 5, lines 1-6 and Table 1).

2. $[Reviewer]$: How it is performed the estimation of the power output (please explain equation 5) and why you used an average induction to obtain a local undisturbed wind.

   $[Authors]$: The way to calculate the power estimation (including equation 5) is described at page 4 lines 1-6. Furthermore to find the local undistributed wind one may use either the average induction or the local induction a_i. We have tried both cases on a number of simulations and have found that the average gave better results, therefore in this paper we have used the average induction. We understand that this cannot be generalised for all cases and therefore advised WindSim to investigate further this issue.

$[Reviewer]$: Beside this I think that there is also a mistake in the text: in the old version of the ACD there was also already the possibility to have different force distributions and not only the uniform one (this is quite clear from the WindSim web site in the section of the presentation, see the slides from G. Crasto at the user meeting 2011 http://windsim.com/documentation/UM2011 pres/1106_WindSim UM WS Crasto.pdf).

[$Authors$]: The reviewer is correct in pointing out that the old version of the ACD method in WindSim has not only an ACD with a uniform distribution but two more, a polynomial and a parabolic thrust distribution. These were not considered in this study as the power production of the wind turbine for the old ACD is assessed solely from the local velocity at the disc (U_1) at hub height. Hence for distributions other than the uniform the power production of the first wind turbine varied significantly from the measured data. Author's changes in manuscript (Page 5, lines 2-6 and Table 1).

References

Crasto, G. and Gravdahl, A. R.: CFD wake modeling using a porous disc, in: European Wind Energy Conference & Exhibition, 2008.