Ocean Sci. Discuss., 9, C1476–C1479, 2013
www.ocean-sci-discuss.net/9/C1476/2013/

Ocean Science Discussions

Interactive comment on "Mapping flow distortion on oceanographic platforms using computational fluid dynamics" *by* N. O'Sullivan and B. Ward

S. Popinet (Referee)

s.popinet@gmail.com

Received and published: 11 January 2013

This manuscript describes experimental and numerical estimates of wind flow distortion at anemometer sites around R/V Celtic Explorer. CFD calculations are performed for a range of parameters: wind speed, wind direction, ship tilt etc... Conclusions are drawn regarding the best placements of anemometers on the vessel and also pointing out that both wind speed and ship tilt are independent factors controlling the amount of distortion.

I feel that the authors can be commended for the amount of work which was clearly invested in this study, however I have strong reservations about the analysis of the results as currently presented in the manuscript. Also, based on these results and analysis, I cannot agree with most of the conclusions drawn by the authors.

The central issue is the confusion regarding the independent parameters controlling the problem. As quoted in section 4 the authors assume:

"In accordance with Popinet et al. (2004) two assumptions were made:

1) The wind speeds measured at different locations should scale linearly with some reference velocity, meaning the fluid flow is essentially independent of the Reynolds number,

2) The averaged velocity depends only on the relative wind direction."

If assumption 1) is verified then, by definition, the wind speed is only a scaling factor for the problem, or expressed differently; the solution for any wind speed can simply be obtained by multiplying the solution for a given wind speed by the ratio of the reference (e.g. undisturbed) wind speeds. From a numerical perspective, the practical implications of this assumption are of course important, since in this case, it is only necessary to perform simulations at a single wind speed (rather than the 41 simulations performed by the authors).

An important question is of course: is assumption 1) verified in reality? We have shown in Popinet et al. (2004) that wind direction relative to the ship can explain more than 90% of the variations in averaged (relative) wind speed measurements (and also standard deviations) for a particular vessel for a range of different measurement locations, sea state, ship speeds etc... This means that all other factors (tilt, roll, waves, ship speed etc... including wind speed) are below 10%. I would expect the same to hold for R/V Celtic Explorer. The authors can easily check this, but this is not done in the current version of the paper. The authors focus on "wind speed difference" between sites which is obviously not a quantity which is independent from the wind speed. If assumption 1) is verified, then wind speed dependence should disappear (to within 10%) when the authors consider, for example, the _relative_ wind speed difference (or equivalently the wind speeds ratio as in Popinet et al. (2004)). Figures 5, 7, 8, 11 should be redone. Fig. 5 in particular, should reveal clearly whether assumptions 1) and 2) are verified. If this is the case experimentally, then one can assume this should also hold numerically (I would trust experimental results more than CFD for turbulent flow modelling). This means that CFD results need to be obtained only for a single wind speed and that "details" such as turbulence models, boundary conditions on the sea surface, inflow profiles etc... should not play a role (as they don't in reality). Note also that in this context, the corrections applied to each measurement site are _factors_, not absolute wind speed differences. The conclusions drawn in the paper need to be reinterpreted in this light too.

A second important issue is the results displayed in Figure 13. This graph shows that (according to the CFD results) up to velocities of 15 m/s, the wind speed difference between the sonic site and the undisturbed flow is constant (i.e. independent of both wind speed and tilt angle) and that above 15 m/s, this difference suddenly becomes erratically dependent on both wind speed and tilt angle. This seems very suspicious to me... I can't see any physical explanation on why the (real) flow would suddenly change regime above 15 m/s, however I can imagine many reasons causing simulations to behave erratically (and incorrectly) above some threshold. Furthermore, even the behaviour below 15 m/s is suspicious, since one would expect (according to assumption 1)) that the wind speed difference should scale with the wind speed: i.e. the difference should treble when the wind speed goes from 5 to 15 m/s, not stay constant. Note that the analysis of the experimental results suggested above should allow to confirm or infirm this relation (thus validating or infirming the results of fig 13, at least below 15 m/s).

This figure seems to be the basis for the authors' conclusion that both wind speed and ship tilt are independent factors affecting flow distortion. Based on the comments above, I cannot agree with this conclusion.

Some specific comments on these and other minor points follow:

1) "The Courant number is the speed of sound..." Are you really solving for a com-

pressible flow? (with sound waves)

2) p. 3493: "Since the ratio between model and domain size is less than 1%, this creates an infinite domain". How about "The influence of boundaries is minimised by using a ratio of ..."

3) p. 3495: "The total number of simulations run for all the variations test was 59". I don't really understand how this can match with 41 wind speeds and 13 wind directions.

4) p. 3496: "the generated shock-wave". There an't any "shock waves" in this flow, unless your vessel is travelling close to the speed of sound...

5) section 4.1, 2nd paragraph: this paragraph should be rewritten with the updated Figure 7.

6) section 4.2: "shockwave" again.

7) section 4.3: what is the wind direction? I assume it is 0 degrees (i.e. "bow on").

8) Conclusions need to be rewritten.

9) Figure 13: it looks like there are many more than 41 data points (for the wind speed dependence). Where do these points come from?

Interactive comment on Ocean Sci. Discuss., 9, 3485, 2012.