5C07: DIRECT EVALUATION OF THE SUBGRID-SCALE SCALAR FLUX IN TURBULENT PREMIXED FLAMES WITH CONDITIONED DUAL-PLANE STEREO PIV.

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There are two main errors that warrant some discussion. The first is the bias that results from PIV as the interrogation box overlaps the flame zone and contains heavy and light seeding density. This biases the velocity towards the heavier seeding. The second error is the thermophoretic force on the seed particles which are important very close to the flame zone. While the velocity error is low, it should be compared to typical radial velocities and some error assessment be performed. Perhaps the authors might consider a repeat of a laminar Bunsen flame experiment [1, 2] where experiments can be compared to predictions [3], but with a more careful emphasis on the types of errors discussed here.

References:

[1]. Tarek Echekki, M.G. Mungal, Proc. Combust. Inst. 23 (1) (1990) 455–461.
[2]. M.G. Mungal, L.M. Lourenco, A. Krothapalli, *Comb. Sci. and Tech*. 106, 4-6, (1995) 239–265.
[3] T. Poinsot, T. Echekki, M.G. Mungal, *Comb. Sci. & Tech*., 81, (1992) 45–73.

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Indeed, the mentioned influences are relevant for the measurement of the flow field of reacting fluids with density and temperature gradients by particle image velocimetry.

The weighting of the measured particle displacement in ROIs being directly overlapped by the flame front towards the unburnt part (with lower velocities) depicts a source of bias. With increasing ROI size the influence of this systematical error increases. In [1] we have analyzed this influence with a ROI size of 180 µm.

For this we have compared the pdf-distribution of the ensemble averaged radial component being calculated via a normal cross-correlation procedure with the results of an area weighted cross-correlation (see Fig. 1). For the chosen 1.5 times larger ROI size we have found, that neglecting that fact can introduce an average bias of 20 cm/s in average.

We have estimated this influence on the accuracy of the presented values of the radial component of the SGS scalar flux by an artificial case study, where we compare the original SGS flux with the associated value based on the biased velocities at the flame front. For a typical distribution where the flame front divides the filtered ROI into two equally spaced parts we have found a relative accuracy of the SGS scalar flux measurement of <-1%, whereby we assume even a lower influence for the ROI size in this study.

Especially in premixed flames, the additional slip velocity on a single particle caused by the steep temperature gradient inside the reaction zone can contribute to the overall bias error to a

magnitude of up to several cm/s. Even for the case of turbulent flames like in our investigation where the radial velocity amounts to around 1 m/s this error should be considered. Following [2], the influence of thermophoresis is estimated to be less than 0.30 m/s. However, it needs to be emphasized that this maximum bias only occurs for particles which are located in close vicinity of the reaction zone other regions of interest are not affected. Again, the influence on the measured SGS scalar flux has been evaluated to be less than -1%.

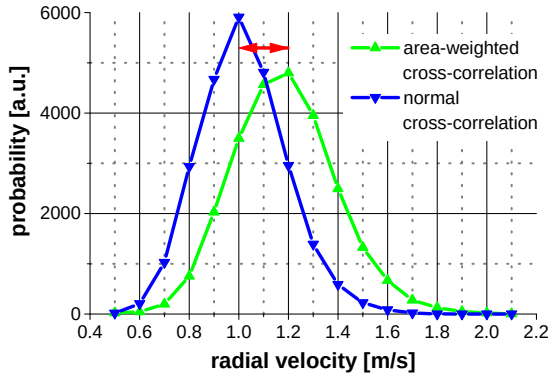

Fig. 1: Difference between standard and conditioned cross-correlation for ROIs overlapping the flame front.

References:

[1] S. Pfadler, F. Beyrau, J. Scheuerlein, A. Leipertz, in European Combustion Meeting 2007, Chania (Greece), 2007, paper 7-1.

[2] L. Talbot, R. K. Cheng, R. W. Schefer, D. R. Willis, *J. Fluid Mech.* 101 (4) (1980) 737–758.