The supplement of Performance characterization of a laminar gas-inlet

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To understand the relation between turbulence in the freestream and that in the inner shroud, simulations for the freestream velocities of 75 to 180 m s^{-1} were repeated for freestream turbulence intensities ranging from 0.5 % to 3%. The simulations were conducted under ground conditions listed in Table 1. The turbulent intensities (TI) obtained in the inner shroud at a selected location H (see Fig. 1) just upstream of the sub-sampling inlet are shown in Figure S1.

The CFD results show that the turbulence intensity at location H upstream of the sample tube increased with increasing free stream velocity and freestream turbulence. For all cases studied, turbulence intensity at location H calculated from the k-ε model was nearly twice that predicted by the SST model.

The outer shroud is used not only to decrease the flow velocity but also to ensure that the sample flow is insensitive to the aircraft's angle of attack. We simulated the performance of the inlet with 25mm restrictor for 3° and 20° angle of attack for 4 different free stream velocities corresponding to wind-tunnel experimental conditions. As shown in Figure S2, less than 5% difference in flow velocities at different locations within the shroud for all simulation cases. The CFD results suggest that the shroud ensures sampling performance that is independent of angle of attack.

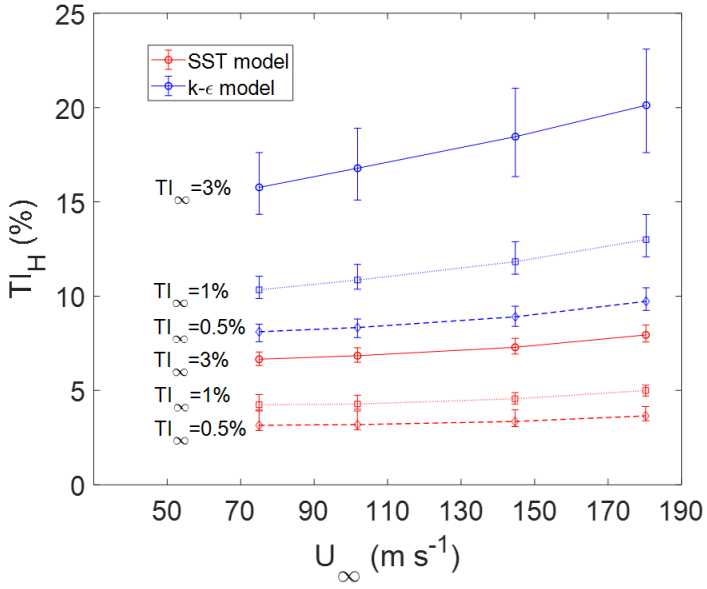

Figure S1: Comparisons of turbulent intensities obtained with k-ε and SST models at ground-level Turbulent intensity is reported at location H in the inner shroud, corresponding to the location where a hotwire probe is located. The uncertainty bar in this plot represents the range of intensity for a 0.5*1cm^2 area at this location.

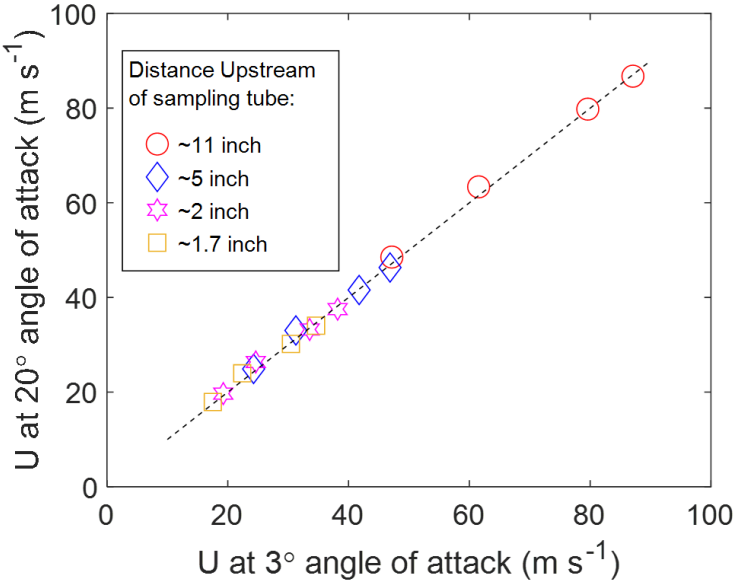

Figure S2: Comparisons for flow velocities (U) at different locations within the shroud, for two angles of attack: 3° and 20° and range of freestream velocities. The modelling conditions were freestream pressure of 0.957 atm, restrictor size 25mm and sample velocity of 2.4 m s^{-1} (Table 1)