Blasius outflow notes

**3.4.1.1 Outflow condition**

The modeling of Blasius type flows in LES3D-MP involves the development of inflow and outflow boundary conditions. An inflow boundary condition can be easily specified by providing stream-wise and vertical velocity profiles that are consistent with the Blasius solution. On the other hand, outflow boundary conditions are challenging since we would like the code the compute the flow naturally. To do this, an Orlansky boundary condition [7] is utilized where a convective non-reflective boundary condition is applied. A transient hyperbolic wave equation is specified based on a convective velocity, *Uc.* The convective velocity can be specified as the mean or maximum velocity computed at the outflow boundary. It has the following form,

For the simulations discussed in this section we have found very little differences using a mean or maximum velocity so a conservative mean convective velocity is utilized. Mass conservation in LES3D-MP is enforced only at the interior nodes by the fractional step numerical scheme as was discussed earlier in chapter 2. However, boundary conditions must also apply this restriction in order to prevent instabilities and unphysical wave propagation back into the domain. This is achieved by computing the mass flux across each boundary, the volumetric flow dilatation component and writing a conservation statement that will correct the velocity and scalars at the outflow boundary nodes. This is done by accounting for the following conservation coefficient, alpha:

**3.4.2.1 Outflow condition**

Similar to the Blasius case an outflow condition is specified as part of the problem configuration. The same mass conservative restrictions are applied at the outflow ghost point to prevent unphysical phenomena and pollution of the wave. A new modification was implemented to account for variations in density. This term provides a better description of the flow since it is consistent with streamwise component of the momentum equations,

Currently, it is found that this term is not sufficient in providing a continuously smooth solution near the outflow. This is probably not surprising since the hyperbolic equations derived by Orlansky have normally been applied to momentum-driven flows where the effect of the diffusive terms is negligible. To circumvent this outflow inconsistency we propose to use a sponge (buffer) region with an increasingly coarser mesh. This has the effect of separating the domain into a physical and unphysical sections where we can disregard the subsection closer to the outflow.