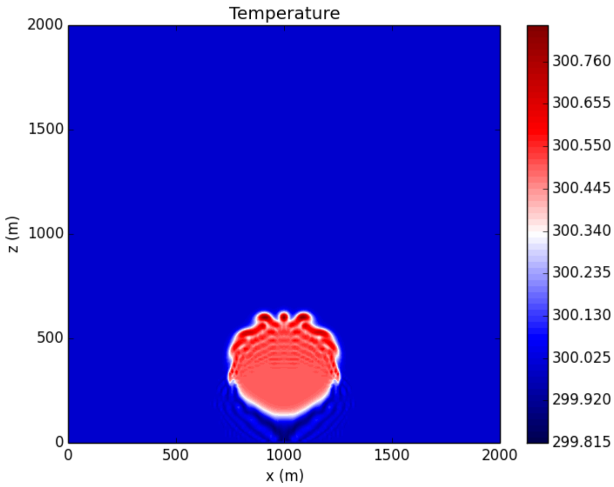
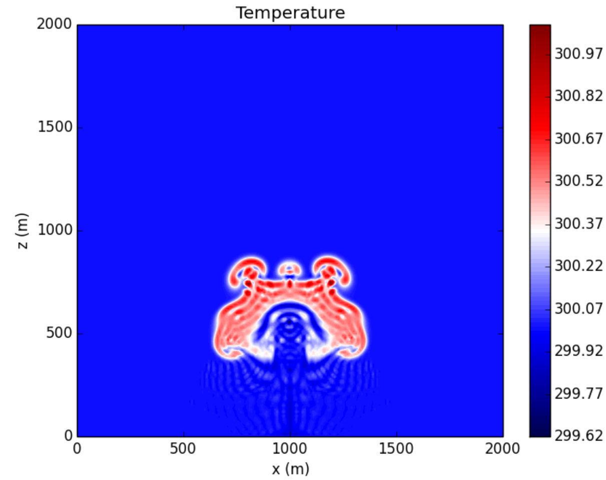
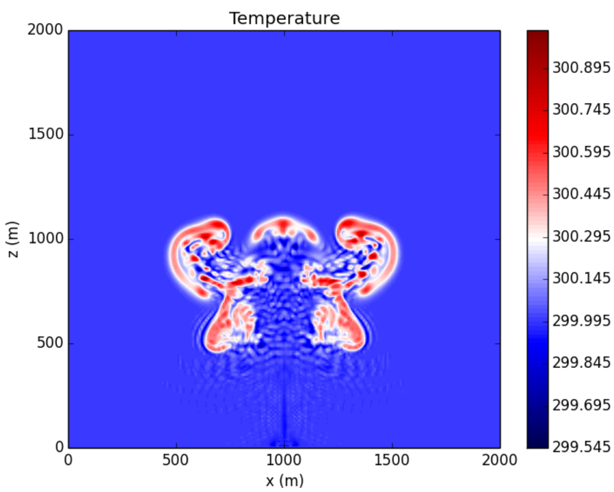
Phoenix Trejo 304482946 AOS180

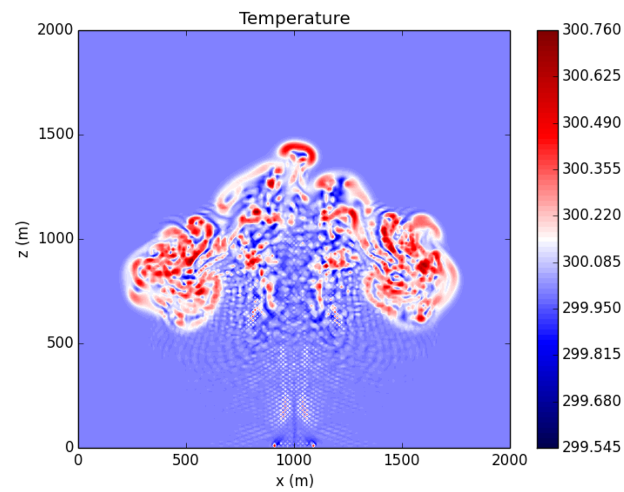
Modeling Task 7

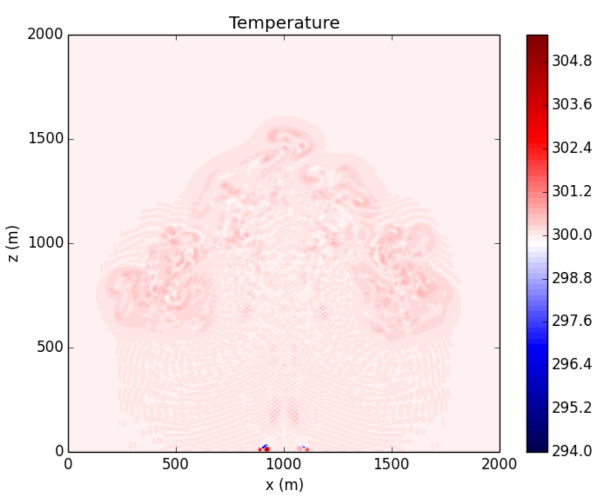
<u>201x201 Grid, Δt = 2, Δx,z = 10</u>

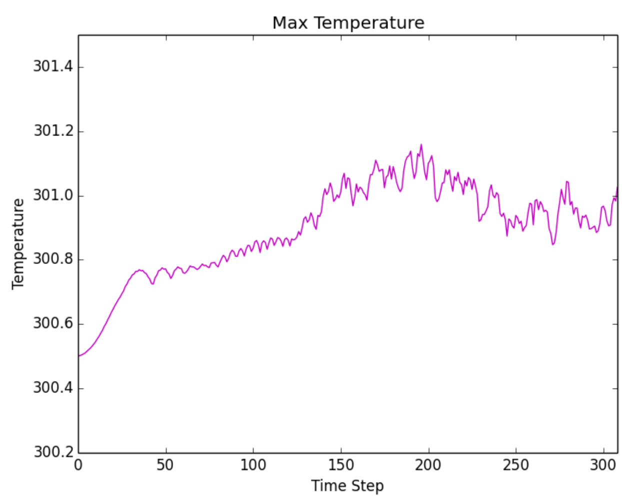






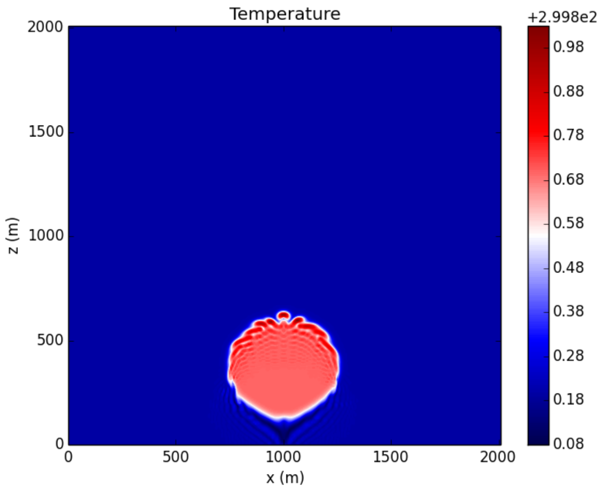


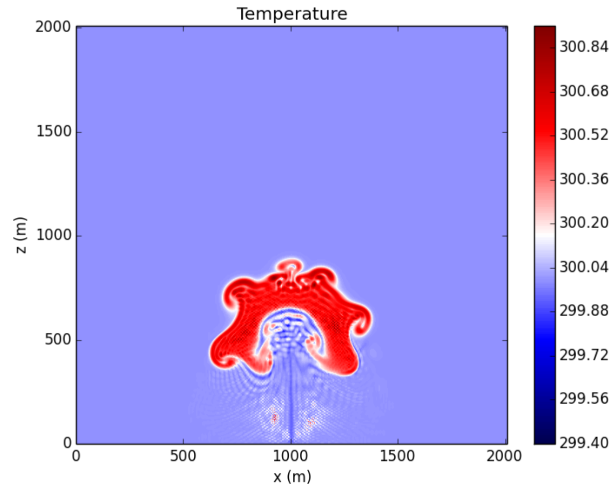


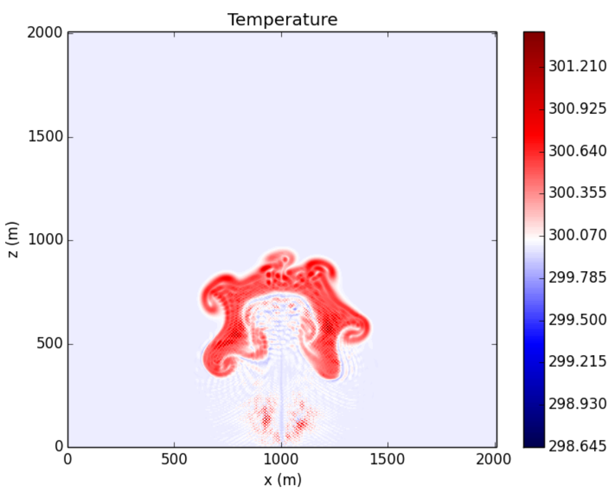


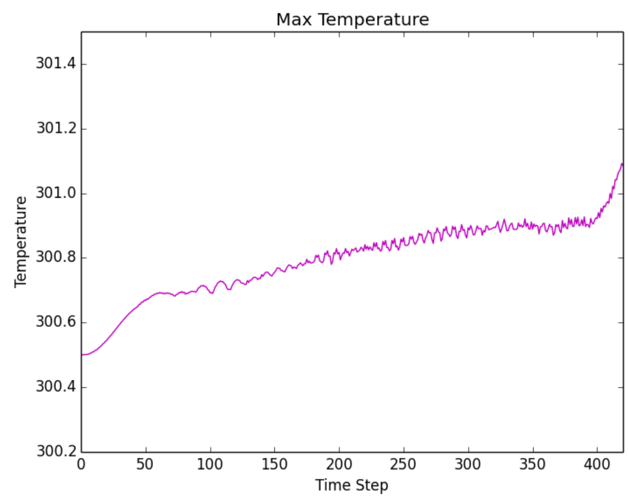
The first three plots are from times in the 620 second interval, while the next two are from running the simulation further in time to see how the thermal bubble rises. We see the bubble begin to rise with slight deformation occur before it begins to spread and be torn and the initial heat be diffused into the surrounding area. The max temperature plot shows a sharp incline in temperature as the bubble warms the surrounding air before exhibiting a more linear trend as the initial warming slows. In comparison to Smolarkiewicz and Pudykiewicz (1992), The bubble in the graphs above closely mirror the bubble they had in figure 3a) and 3b) before we see the bubble be torn which the fourth plot resembles their 4a). This resemblance is a good indicator that the simulation is indeed valid. As for differences, this simulation does not have the small plume at the top of the bubble that rises over time. We also see this simulation does not capture the details of the more rounded edges seen in theirs.

<u>301x301 Grid, Δt = 1, Δx,z = 6.7</u>









Moving to a higher resolution grid allows for the curvature in the deformation to be seen better, along with the diffusion of heat into the surrounding area. In the max temperature plot we see more steady oscillations and a smoother trend in the increase of the temperature, not the larger jags seen in the 201x201 grid.

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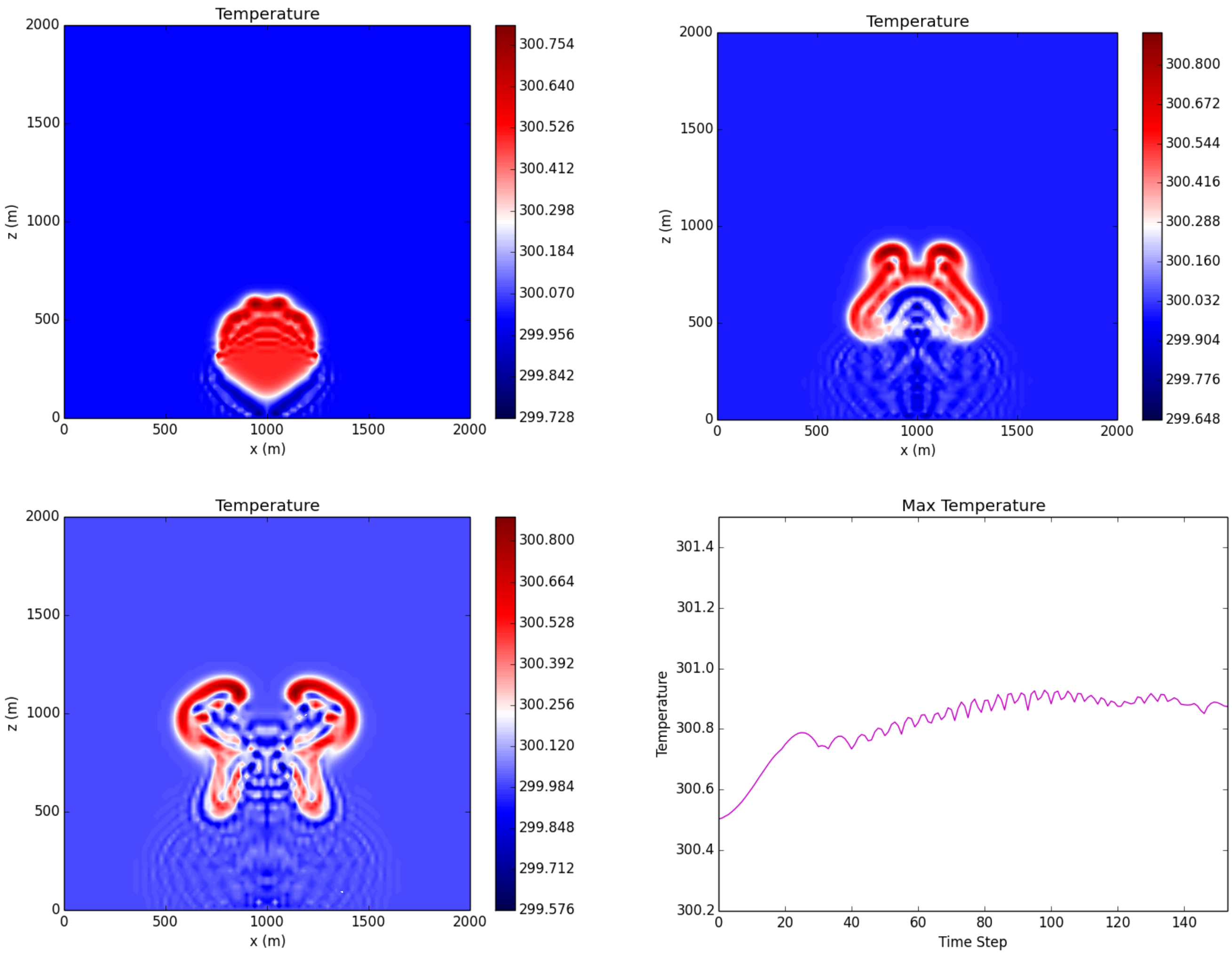
101x101 GridΔ, t = 4, Δx,z = 20



In the 101x101 grid a lot of the detail is lost giving only a general idea of how the bubble is evolving in time. The small plume at the top is lost and the shape seen in the higher resolution grids is lost. For the max temperature plot, the finer details is again lost giving a general idea of the trend as the spacing between only allows for rougher oscillations.

Implementation: The first time step for advancing temperature and vorticity is done with an 1st order EF scheme and the corresponding jacobians. The a new psi is calculated from the new vorticity which is then fed in to the main loop. The main loops consists of solving the three jacobians for temperature and the three for vorticity then advancing the two in time by averaging the three respective jacobians. Boundary conditions are then applied to in the x direction by updating the ghost nodes for the next iteration. Boundary conditions in the z-direction are handled by not updating the top and bottom rows. A new psi is calculated for the next iteration and the loop ends with updating the grids and outputting data. Artificial diffusion was added to both the temperature and vorticity time advancement in the main loop with a value K=0.1.