Imperial College London

SUPERSONIC RETROPROPULSION FOR MARS ENTRY, DESCENT AND LANDING.

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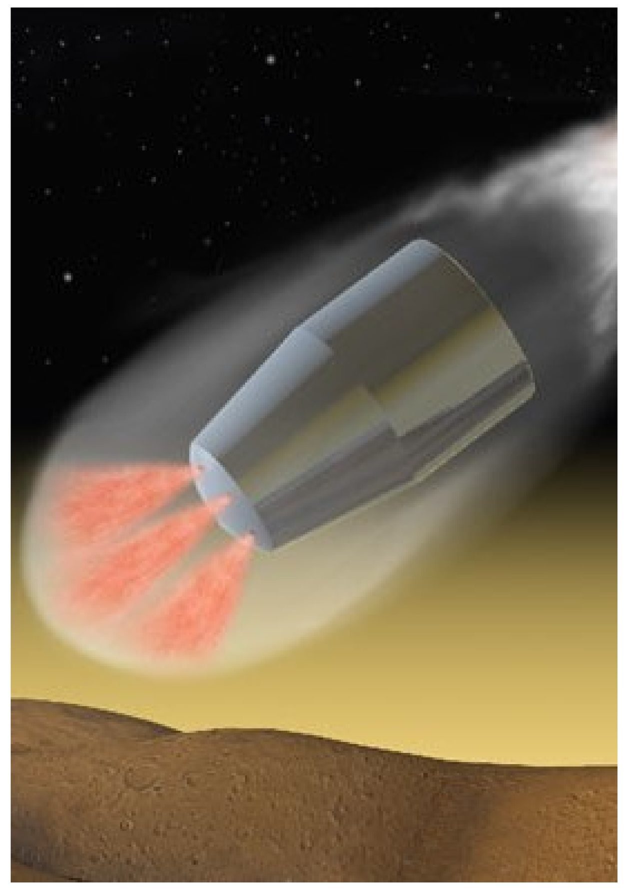
INTRODUCTION

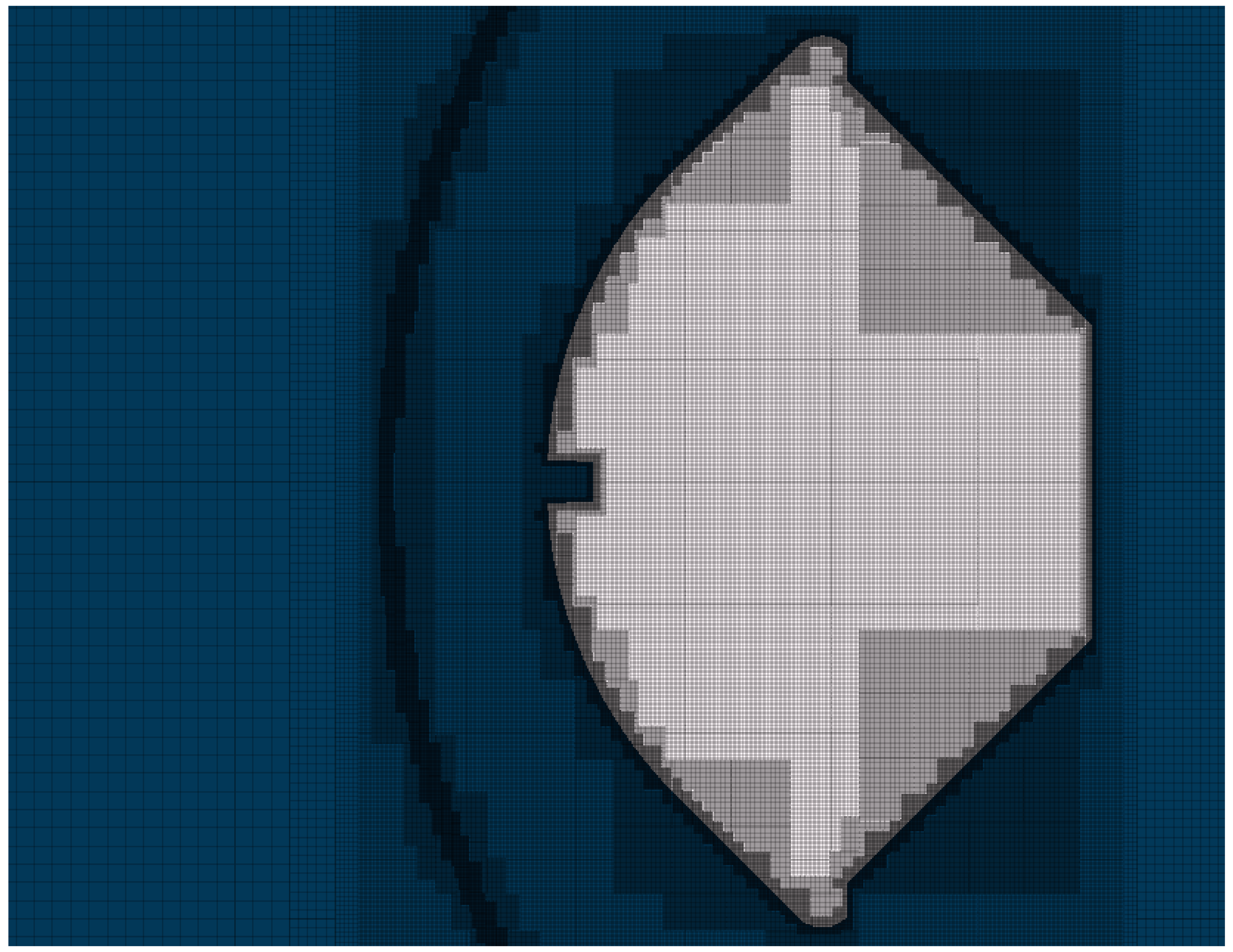
Due to Mars' thin atmosphere, decelerating a craft to a safe landing velocity is extremely difficult. The atmosphere is not dense enough to rely on drag augmentation techniques alone, unlike re-entering Earth's atmosphere. Previous missions have used a combination of supersonic parachutes and subsonic retro-propulsion to land payloads onto the surface safely. However, manned missions to Mars would require payloads of around 40 to 80 tonnes and current EDL technologies, such as supersonic parachutes, cannot decelerate such a craft to a safe landing velocity.



METHODOLOGY/NUMERICAL SETUP

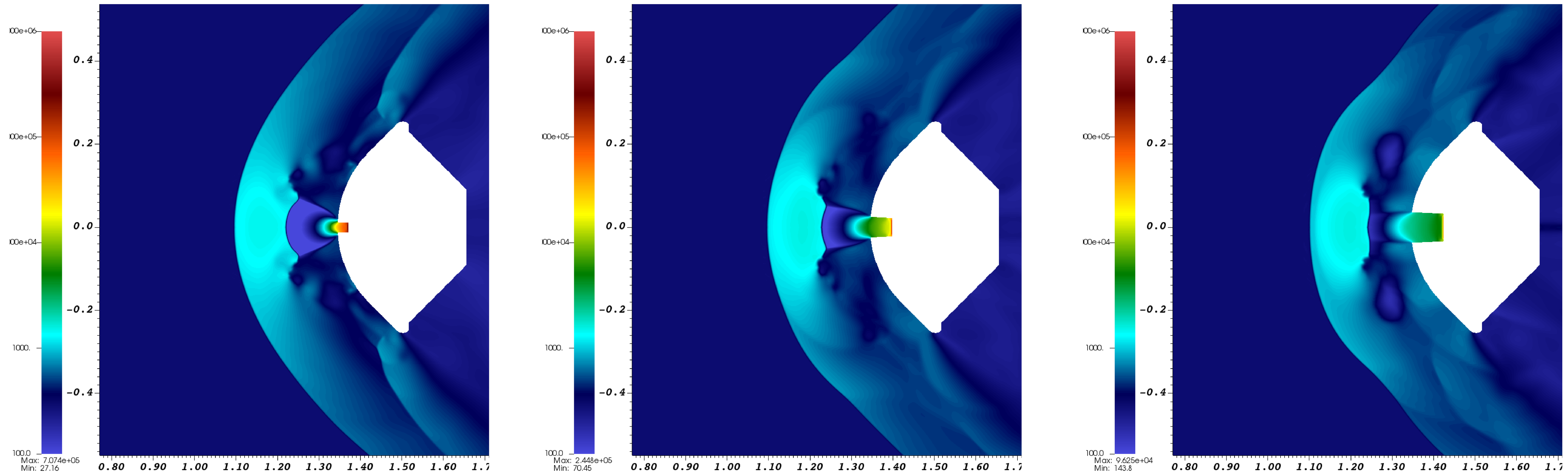
- CFD code: CompReal - Inhouse compressible Navier Stokes solver.
- Adaptive mesh refinement (AMR).
- Non-slip isothermal boundary conditions.
- Mars atmosphere at 10 km, $Ma = 2$, $Re = 6500$.
- Linearly change C_T over time.

FIGURE 1



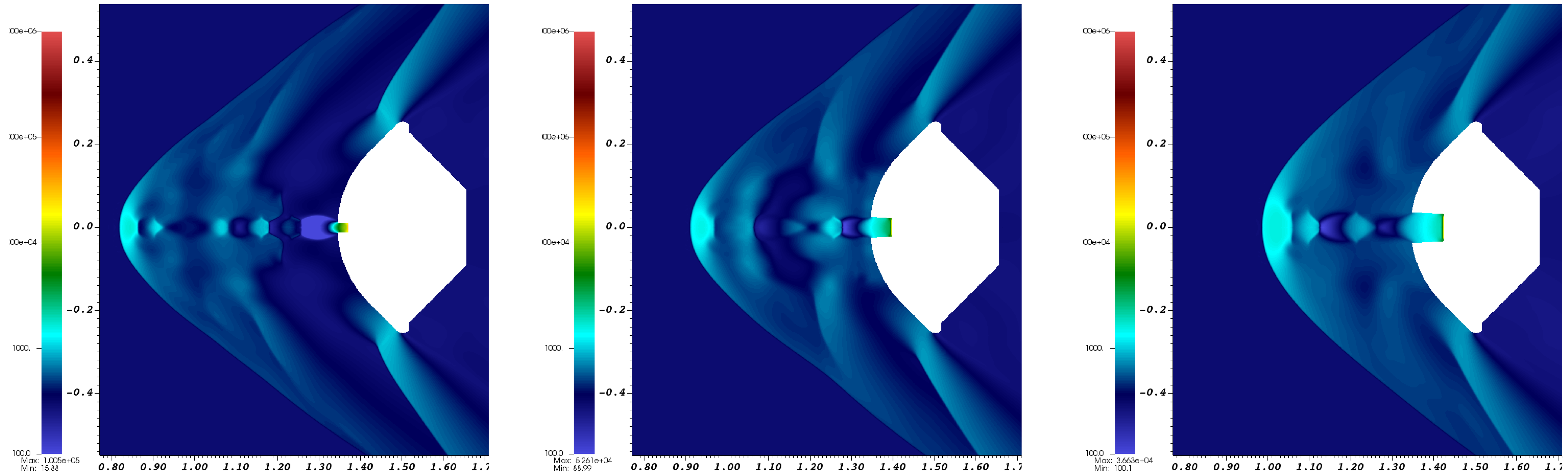
Detail of adaptive mesh refinement in CompReal. Pictured is the Phoebus supersonic retropropulsion demonstrator provided by the European Space Agency.

FIGURE 2



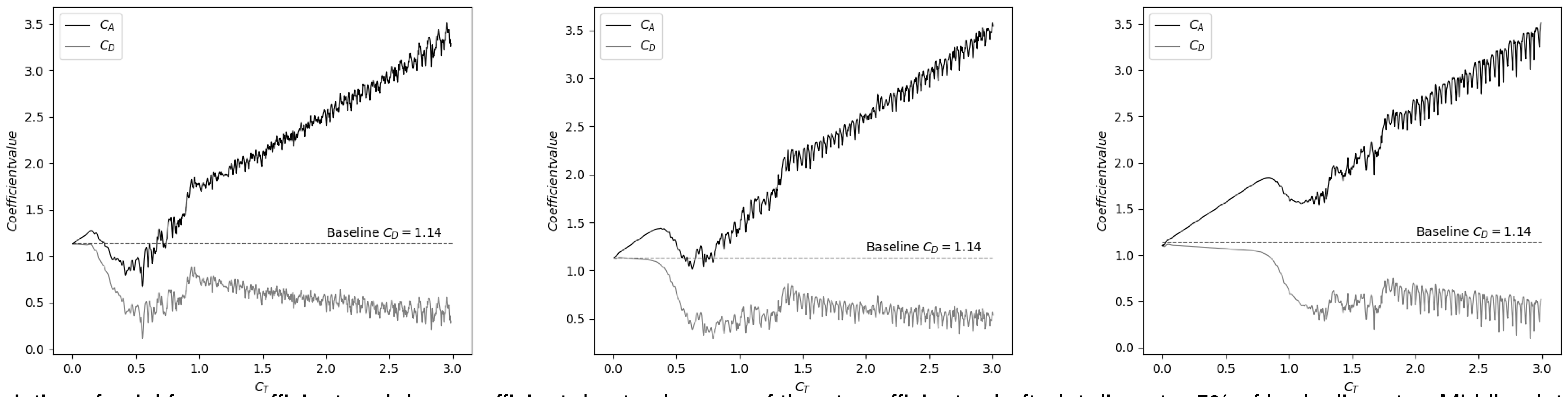
Pressure contours of three different jet diameters in the blunt penatration mode - Left: Jet diameter 5% of body diameter. Middle: Jet diameter 10% of body diameter. Right: Jet diameter 15% of body diameter.

FIGURE 3



Pressure contours of three different jet diameters in the long penatration mode - Left: Jet diameter 5% of body diameter. Middle: Jet diameter 10% of body diameter. Right: Jet diameter 15% of body diameter.

FIGURE 4



Variation of axial force coefficient and drag coefficient due to changes of thrust coefficient. - Left: Jet diameter 5% of body diameter. Middle: Jet diameter 10% of body diameter. Right: Jet diameter 15% of body diameter.