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Aeroespacial i Audiovisual de Terrassa

ESEIAAT - UPC

# **Study for the computational resolution of conservation equations of mass, momentum and energy. Possible application to different aeronautical and industrial engineering problems: Case 1B**

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Attachment A - Results

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**Degree:** Grau en Enginyeria en Tecnologies Aeroespacials

**Delivery date:** 10-06-2017

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# 1 | Smith-Hutton problem

In the following sections there are represented the results of the Smith-Hutton problem for all the resolution schemes that have been coded.

## 1.1 $\rho/\Gamma = 10$

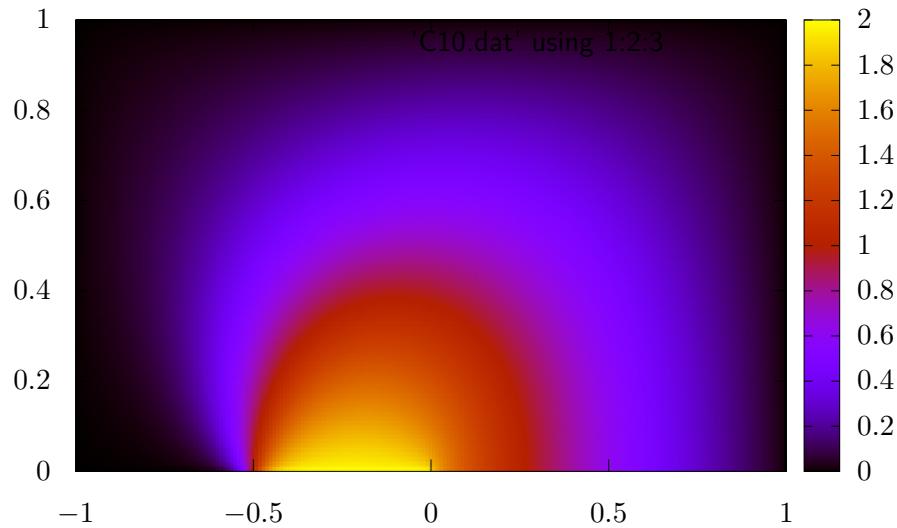


Figure 1.1: Representation of the whole domain for  $\rho/\Gamma = 10$  (CDS)

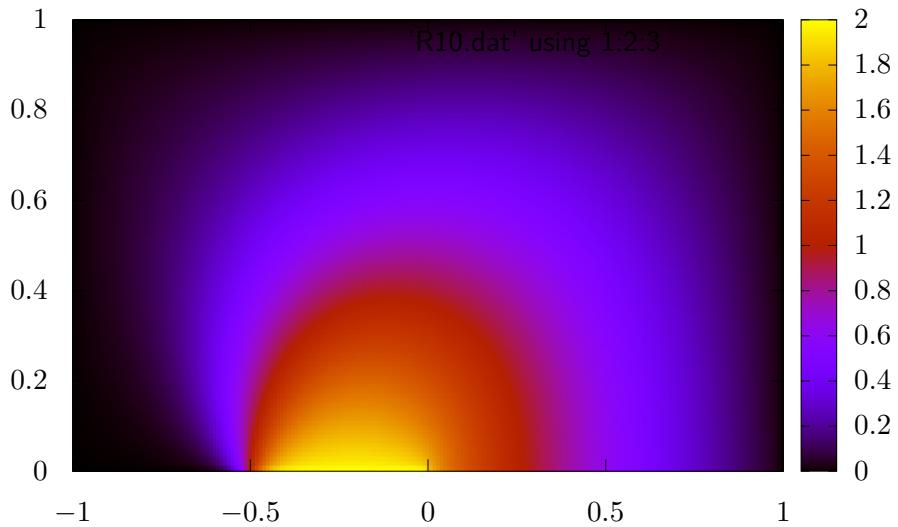


Figure 1.2: Representation of the whole domain for  $\rho/\Gamma = 10$  (UDS)

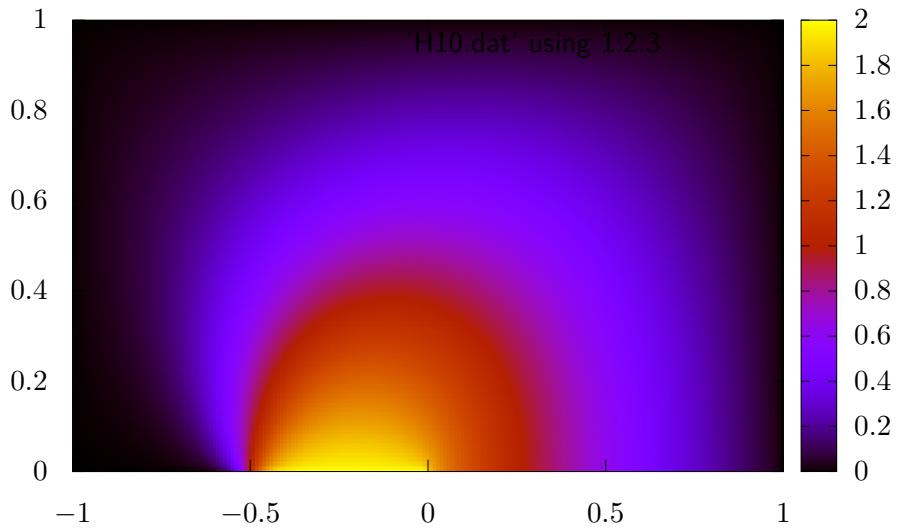


Figure 1.3: Representation of the whole domain for  $\rho/\Gamma = 10$  (HDS)

$$\rho/\Gamma = 10^3$$

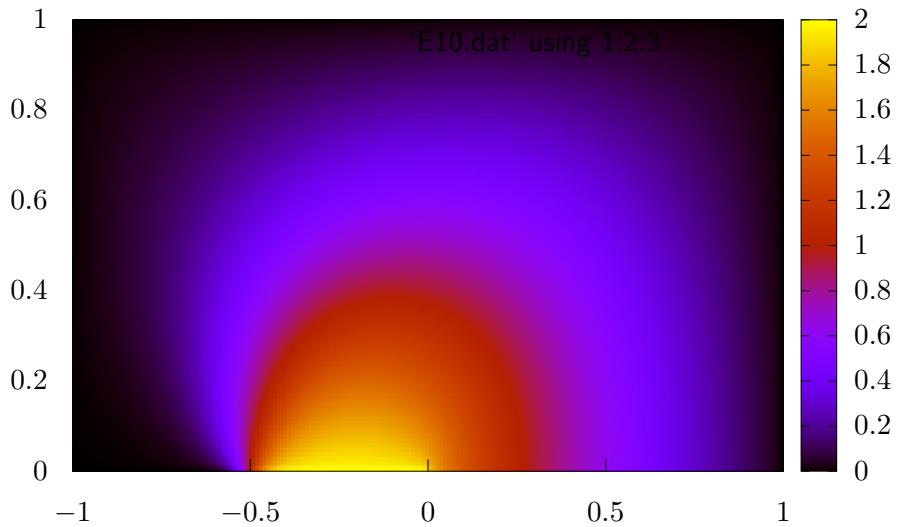


Figure 1.4: Representation of the whole domain for  $\rho/\Gamma = 10$  (EDS)

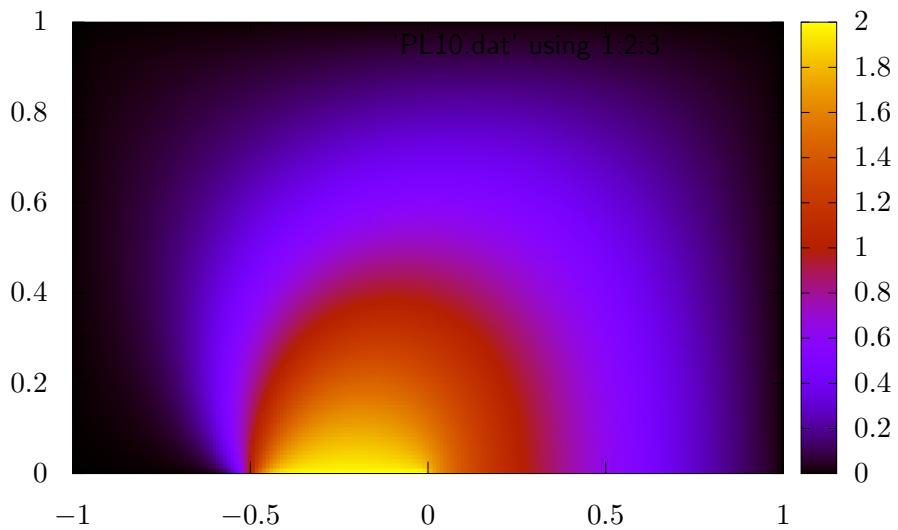


Figure 1.5: Representation of the whole domain for  $\rho/\Gamma = 10$  (PLDS)

## 1.2 $\rho/\Gamma = 10^3$

In this section there is not a solution for the central differencing scheme because it diverges.

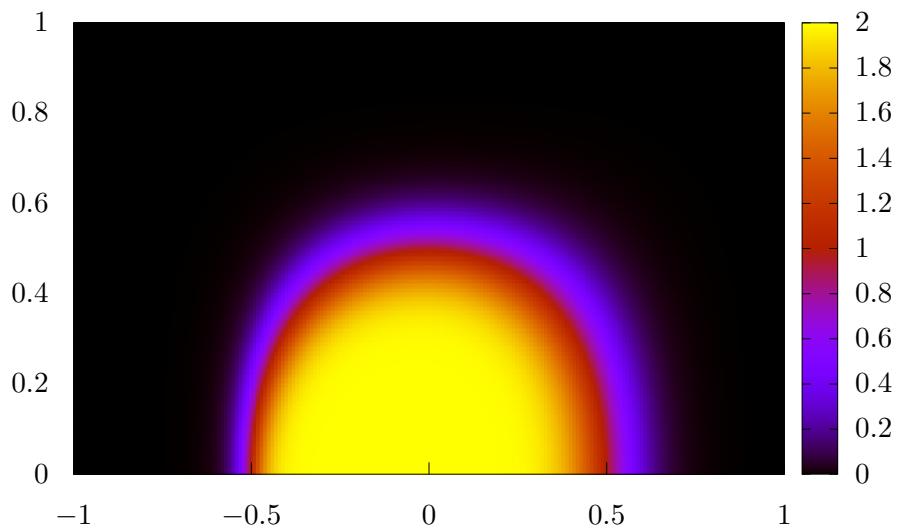


Figure 1.6: Representation of the whole domain for  $\rho/\Gamma = 10^3$  (UDS)

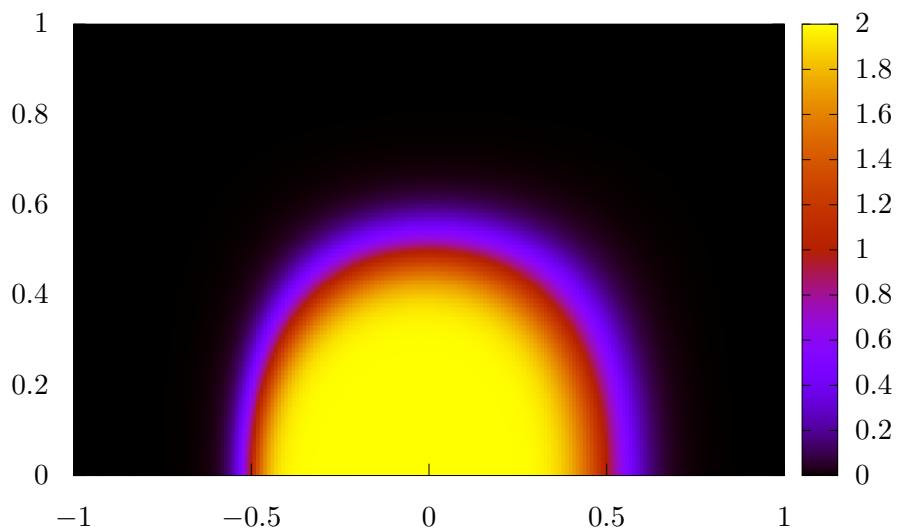


Figure 1.7: Representation of the whole domain for  $\rho/\Gamma = 10^3$  (HDS)

$$\rho/\Gamma = 10^3$$

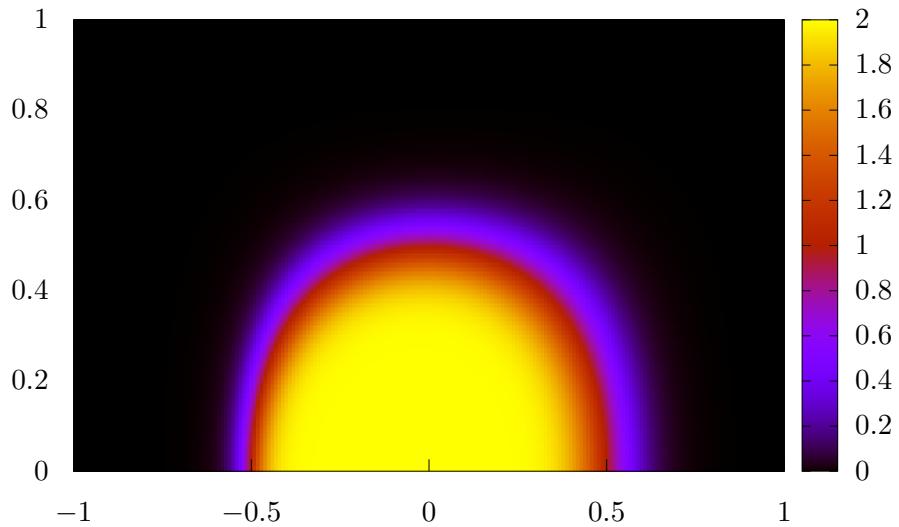


Figure 1.8: Representation of the whole domain for  $\rho/\Gamma = 10^3$  (EDS)

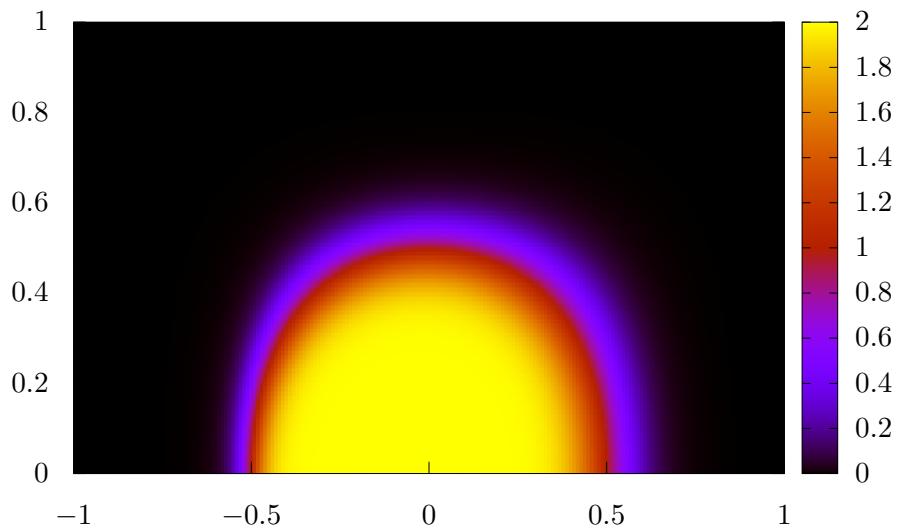


Figure 1.9: Representation of the whole domain for  $\rho/\Gamma = 10^3$  (PLDS)

$$\rho/\Gamma = 10^6$$

### 1.3 $\rho/\Gamma = 10^6$

Like in the previous section, in this case there is no results for the central differencing scheme because of its divergence.

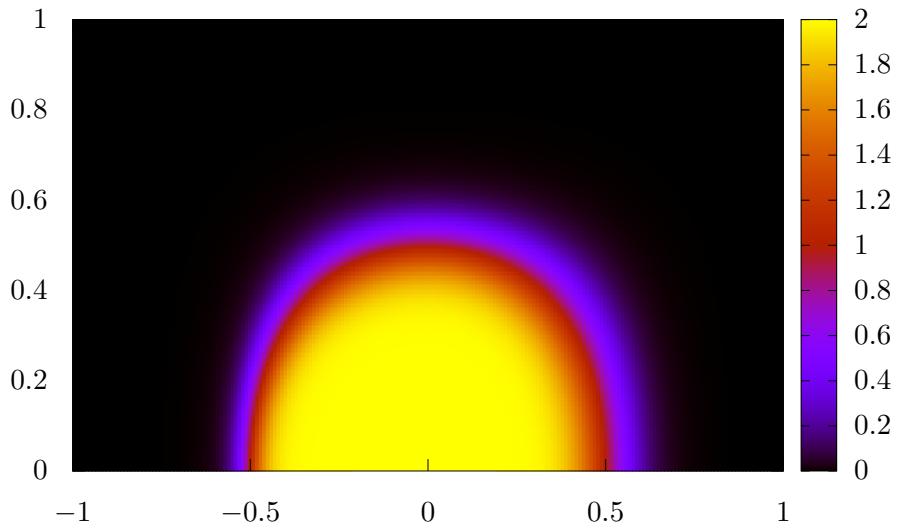


Figure 1.10: Representation of the whole domain for  $\rho/\Gamma = 10^6$  (UDS)

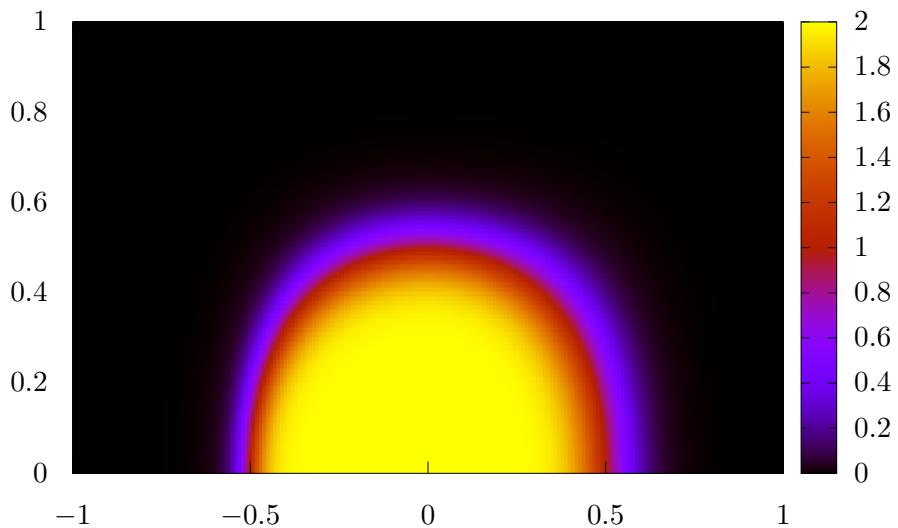


Figure 1.11: Representation of the whole domain for  $\rho/\Gamma = 10^6$  (HDS)

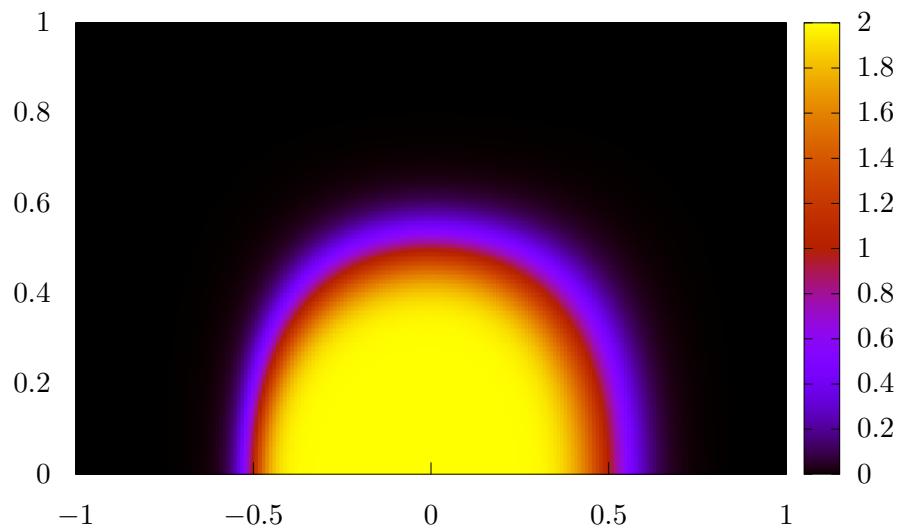


Figure 1.12: Representation of the whole domain for  $\rho/\Gamma = 10^6$  (EDS)

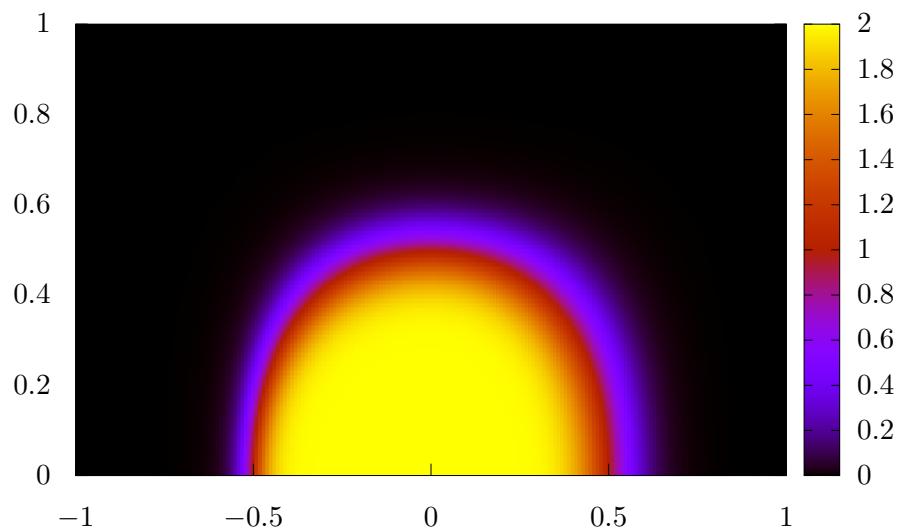
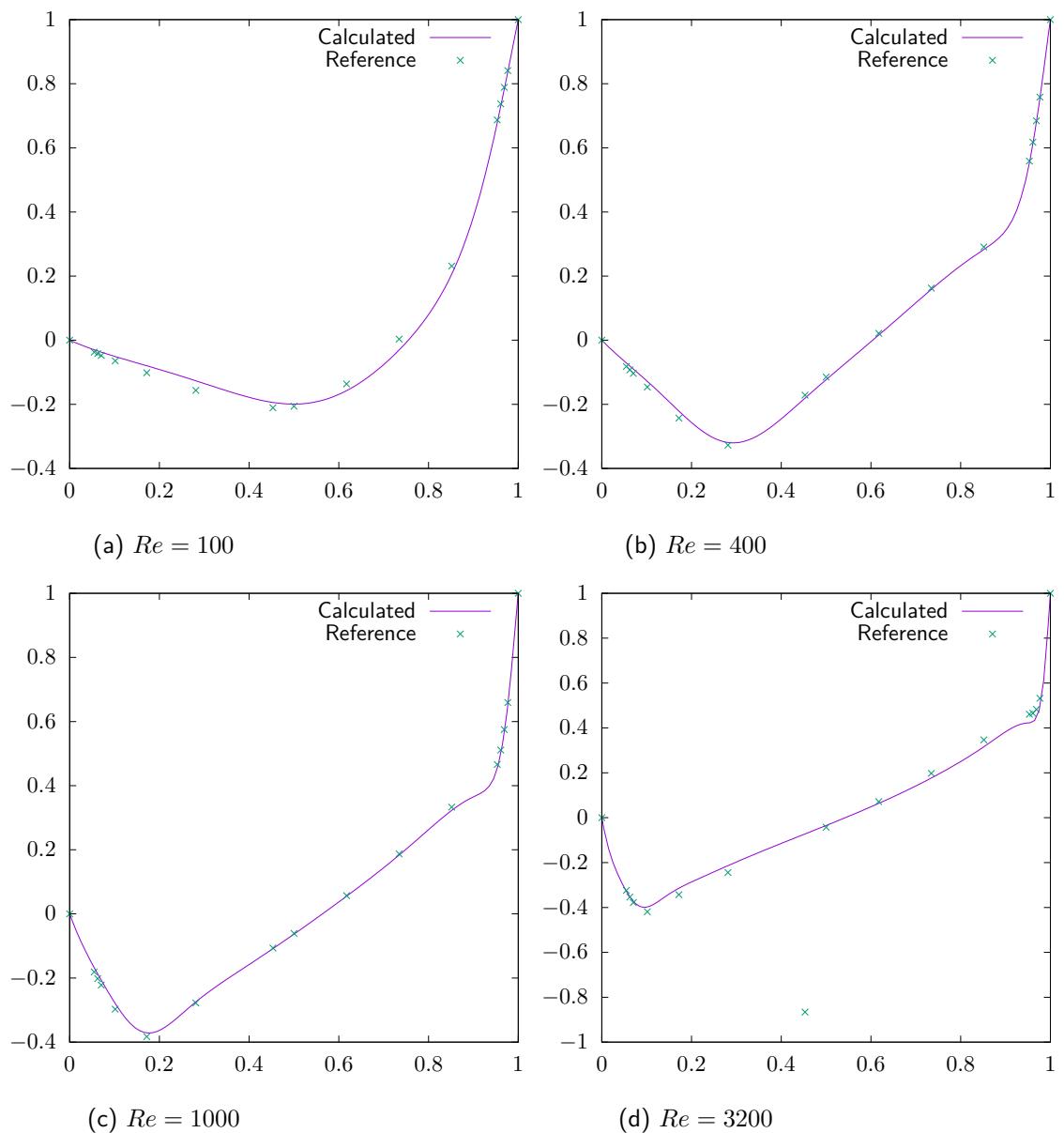


Figure 1.13: Representation of the whole domain for  $\rho/\Gamma = 10^6$  (PLDS)

## 2 | Driven cavity problem



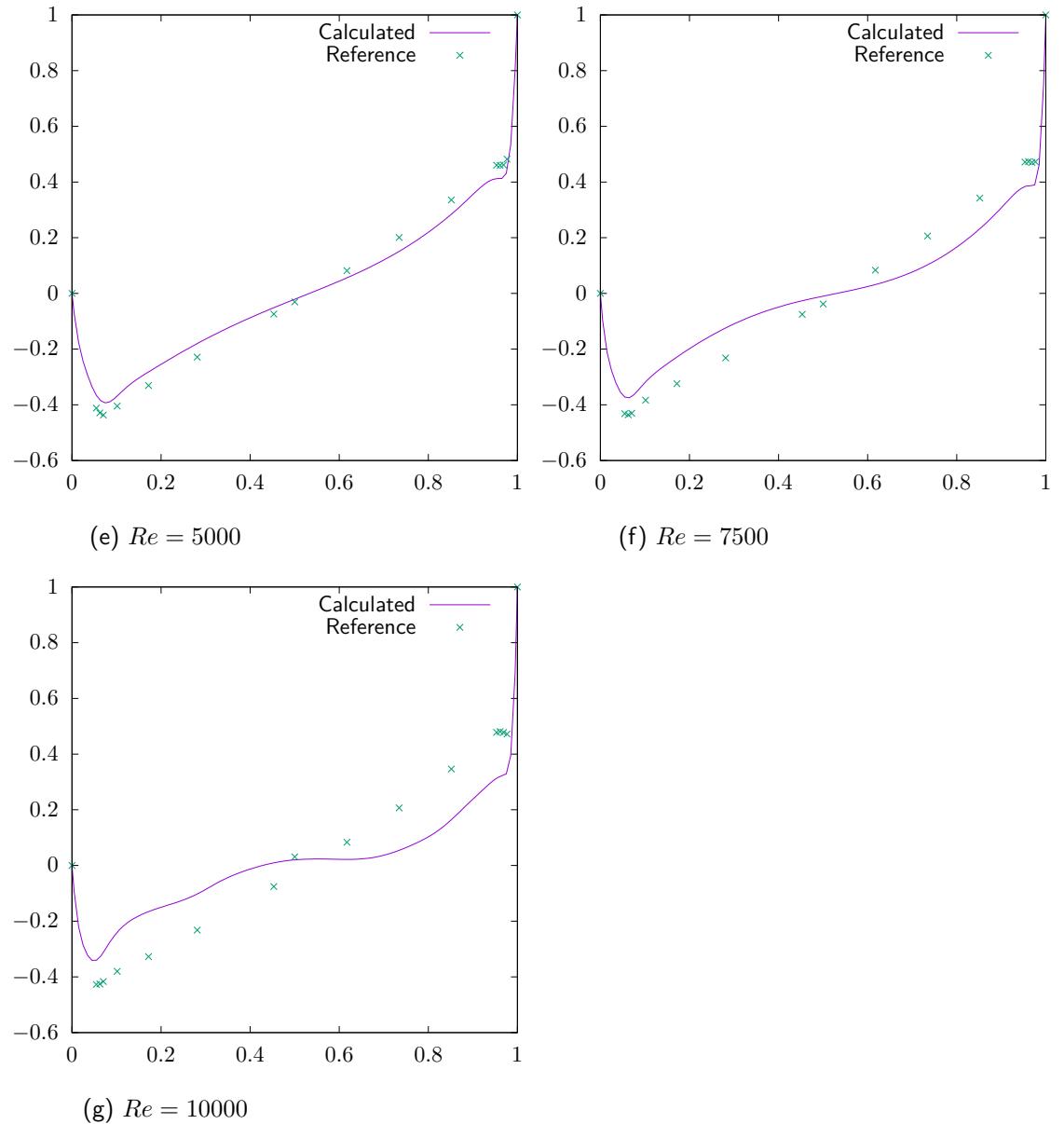
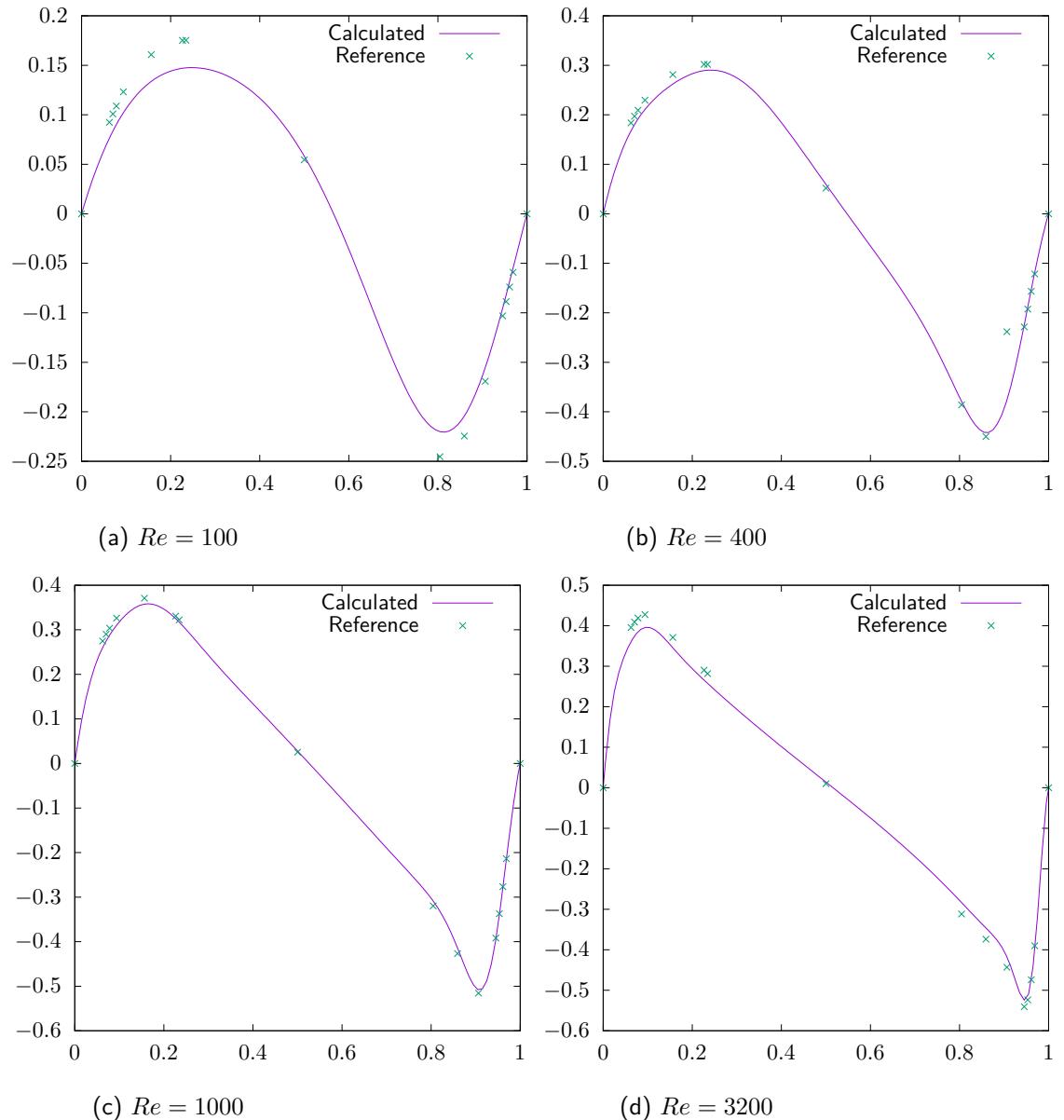


Figure 2.1: Comparison between the reference solution and the calculated one of the horizontal velocity along the vertical line in the geometric center of the cavity [1]



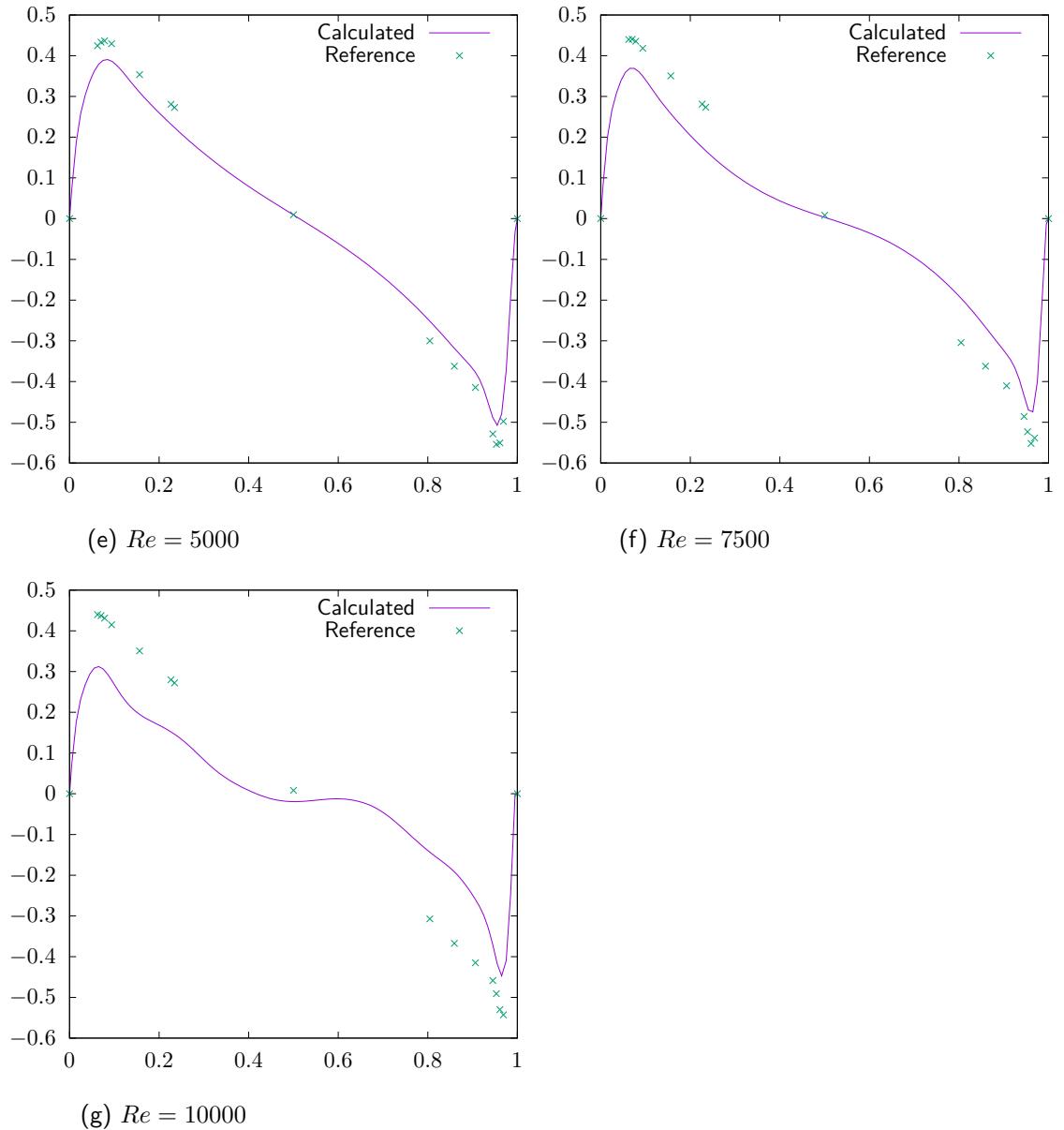


Figure 2.2: Comparison between the reference solution and the calculated one of the vertical velocity along the horizontal line in the geometric center of the cavity [1]

# 3 | Buoyancy

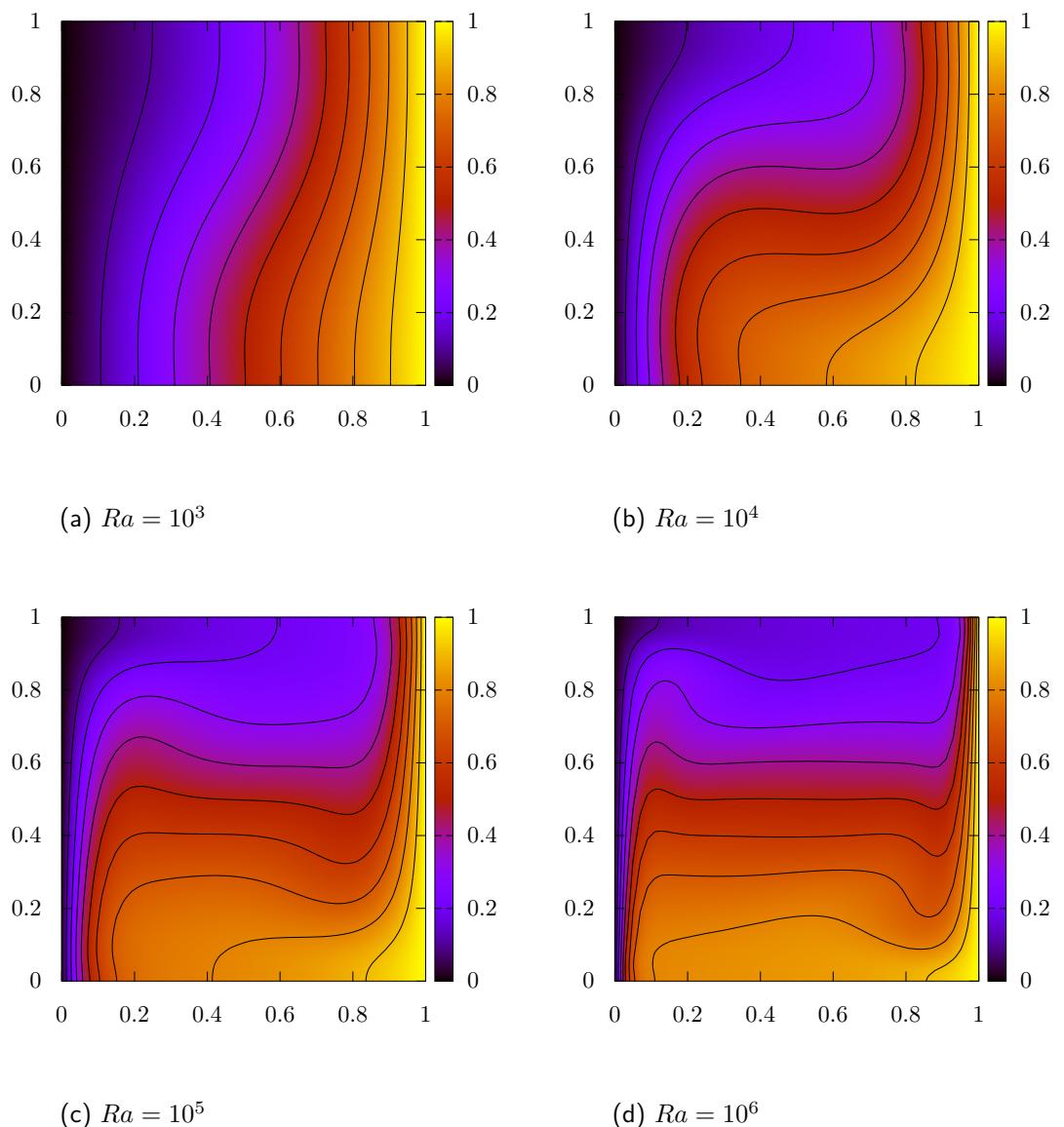


Figure 3.1: Contour plots of the temperature

## 4 | Bibliography

- [1] U. Ghia, K. N. Ghia, and C. T. Shin. High-Re solutions for incompressible flow using the Navier-Stokes equations and a multigrid method. *Journal of Computational Physics*, 48:387–411, 1982.