

DataSet: Shockwave/boundary-layer interactions with sidewall effects in the OpenSBLI code-generation framework

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Introduction

This document describes the data contained in the dataset deposit: <https://doi.org/10.5258/S0TON/D1302>. The data collection period was 14/09/2016 to 20/03/2020. The PhD project was funded by an EPSRC Centre for Doctoral Training grant (EP/L015382/1). Compute resources used in this work were provided by the ‘Cambridge Service for Data Driven Discovery’ (CSD3) system operated by the University of Cambridge Research Computing Service (<http://www.hpc.cam.ac.uk>) funded by EPSRC Tier-2 capital grant EP/P020259/1, and the IRIDIS5 High Performance Computing Facility, and associated support services at the University of Southampton. The data corresponds to a selection of the figures presented in:

[1] D.J. Lusher. *Shockwave/boundary-layer interactions with sidewall effects in the OpenSBLI code-generation framework*, PhD thesis, University of Southampton (2020). Awarded by the University of Southampton. ORCID: 0000-0001-8874-5290.

The data follows the ordering of the figures in the thesis [1]. Each of the ‘.txt’ files contain column data to reproduce the line plots in the thesis. A header is given in each file to label the columns unless explicit guidance is given in this document. In the following sections, a description of each of the datasets is given. Chapters 1-3 are omitted as they contain only the literature introduction and descriptions of the methods and software. Datasets for figures using data already tabulated within the thesis are also omitted.

Chapter 4

- Figure 4.1: x coordinates and three density profiles for the three schemes.
- Figure 4.4.u: y coordinates, analytic velocity profile and two numerical velocity profiles for the two schemes.

- Figure 4.4_T: y coordinates, analytic temperature profile and two numerical temperature profiles for the two schemes.
- Figure 4.8: Simulation time and streamwise separation bubble length.
- Figure 4.10: x coordinate, normalised wall pressure, and wall skin-friction distribution.
- Figure 4.12: Eight data files: each containing y^+ coordinates and a flow quantity. Includes \bar{u} , $\langle u'u' \rangle$, $\langle v'v' \rangle$, $\langle w'w' \rangle$, at two simulation times of $T = 500, 1000$.
- Figure 4.13: Sixteen data files: each containing y^+ coordinates and a flow quantity. Includes \bar{u} , $\langle u'u' \rangle$, $\langle v'v' \rangle$, $\langle w'w' \rangle$, at four different grid resolutions.
- Figure 4.14: Thirty two data files: each containing y^+ coordinates and a flow quantity. Includes \bar{u} , $\langle u'u' \rangle$, $\langle v'v' \rangle$, $\langle w'w' \rangle$, for eight different numerical scheme options.

Chapter 5

- Figure 5.2: Six data files corresponding to grid resolutions of $N = 64^3, 128^3, 256^3, 512^3, 768^3, 1024^3$. Each data file has 5 columns corresponding to: simulation time, kinetic energy, dilatational dissipation, solenoidal dissipation, density. The kinetic energy, dilatational dissipation and solenoidal dissipation should be divided by the density column. The dilatational and solenoidal components should be scaled by $4Re/3$ and $1/Re$ as in the thesis.
- Figure 5.3_5.4: Six data files corresponding to reference Mach numbers of $M_\infty = 0.1, 0.25, 0.5, 0.75, 1.0, 1.25$. The columns are the same as for Figure 5.2.
- Figure 5.11: Seven data files corresponding to a reference result and computations from six numerical schemes. Four columns corresponding to simulation time, kinetic energy, enstrophy, and density integrated over the volume. The values for kinetic energy and enstrophy in the figures are divided by the density. There is also a $2Re/3$ scaling factor applied in the figure.
- Figure 5.12: Eight data files corresponding to a reference result and computations from seven numerical schemes. The five columns are the same as those described for Figure 5.2.
- Figure 5.14.a: x coordinates, wall pressure for two forcing configurations.
- Figure 5.14.b: x coordinates, skin friction for two forcing configurations.
- Figure 5.16.a: x coordinates, wall pressure for four grid resolutions.

- Figure 5.16.b: x coordinates, skin friction for four grid resolutions.
- Figure 5.17.a: x coordinates, w velocity for a fine mesh and five schemes.
- Figure 5.17.b: x coordinates, skin friction for a fine mesh and five schemes.
- Figure 5.19.a: x coordinates, wall pressure for four grid resolutions.
- Figure 5.19.b: x coordinates, skin friction for four grid resolutions.
- Figure 5.20.a: x coordinates, pressure for six schemes.
- Figure 5.20.b: x coordinates, pressure for two weightings.
- Figure 5.21: Three data files for the reference, optimized weights and standard weights. In the same format as for Figure 5.2.
- Figure 5.22.a: x coordinates and pressure for two weightings.
- Figure 5.22.b: x coordinates and skin friction for two weightings.

Chapter 6

- Figure 6.2.b: Simulation time and centreline separation bubble length.
- Figure 6.3: x coordinates, centreline wall pressure and skin friction distribution for four grid resolutions.
- Figure 6.4: x coordinates, centreline wall pressure and skin friction distribution for four shock generator lengths.
- Figure 6.5: x coordinates, centreline wall pressure and skin friction distribution for four shock generator lengths.
- Figure 6.7.a: x coordinates, centreline skin friction for three cases.
- Figure 6.7.b: x coordinates, wall skin friction at 3 y heights.
- Figure 6.14: x coordinates, and skin friction for five aspect ratios.
- Figure 6.16.b: x coordinates, and sidewall pressure profiles at four y heights.
- Figure 6.18.a: x coordinates, and streamwise wall pressure for four shock strengths.
- Figure 6.18.b: x coordinates, and streamwise skin friction for four shock strengths.

Chapter 7

- Figure 7.3_a: x coordinates, and centreline wall pressure for two forcing configurations.
- Figure 7.3_b: x coordinates, and centreline skin friction for two forcing configurations.
- Figure 7.7_a: x coordinates, and centreline wall pressure for two forcing configurations.
- Figure 7.7_b: x coordinates, and centreline skin friction for two forcing configurations.
- Figure 7.10_a: x coordinates, and pressure at $y = 105$, $z = 20$ for two forcing configurations.
- Figure 7.10_b: x coordinates, and pressure at $y = 105$, $z = 87.5$ for two forcing configurations.