

# Wall-Modelled Large-Eddy Simulation of Separated Channel Flow

A. Morgan, J. Rivera, K. Chen - Placeholder Journal of Fluid Mechanics (dummy paper for template testing)

## Abstract

This placeholder paper describes a wall-modelled large-eddy simulation (WMLES) framework for separated turbulent channel flow over periodic hills. We compare an equilibrium wall model against a non-equilibrium model that integrates the thin boundary-layer equations, and we report that the non-equilibrium model improves the prediction of the separation and reattachment points by roughly thirty percent at a Reynolds number of 10,595. All numbers in this document are fictional.

## 1. Introduction

Separated flows are a persistent challenge for turbulence modelling because the near-wall region departs from the classical logarithmic law. Wall-resolved LES is accurate but expensive, scaling roughly with the Reynolds number to the power  $13/7$ . Wall models reduce this cost by replacing the inner layer with a modelled shear-stress boundary condition. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat.

The key contribution of this dummy study is a simple sensor that switches between equilibrium and non-equilibrium wall models based on the local pressure gradient parameter. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat.

## 2. Method

The filtered incompressible Navier-Stokes equations are solved with a second-order finite-volume method on a curvilinear mesh. Sub-grid stresses use the dynamic Smagorinsky model. The wall model is applied at the third off-wall cell, and the exchange location is chosen to avoid the log-layer mismatch. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat.

## 3. Results

The mean reattachment length predicted by the non-equilibrium model is 4.3 hill heights, compared with 4.6 in the reference data and 5.4 with the equilibrium model. Skin friction recovery downstream of reattachment is also improved. Computational cost is about two percent of the wall-resolved reference simulation. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat.

## 4. Conclusions

A pressure-gradient-aware switch between wall models gives a good trade-off between accuracy and cost for separated flows. Future work will extend the approach to compressible flows and to rough walls. This document is placeholder content generated for an academic portfolio template.