Model 3D turbulent floods based upon the Smagorinski large eddy closure

Abstract

Rivers, floods and tsunamis are often very turbulent. Conventional models of such environmental fluids are typically based on depth-averaged inviscid irrotational flow equations. We explore changing such a base to the turbulent Smagorinski large eddy closure. The aim is to more appropriately model the fluid dynamics of such complex environmental fluids by using such a turbulent closure. Large changes in fluid depth are allowed. Computer algebra constructs the slow manifold of the flow in terms of the fluid depth h and the mean turbulent lateral velocities $\bar{u}$ and $\bar{v}$. The major challenge is to deal with the nonlinear stress tensor in the Smagorinski closure. The model integrates the effects of inertia, self-advection, bed drag, gravitational forcing and turbulent dissipation with minimal assumptions. Although the resultant model is close to established models, the real outcome is creating a sound basis for the modelling so others, in their modelling of more complex situations, can systematically include more complex physical processes.

Keywords turbulent flood, tsunami, Smagorinski closure, channel flows