Geophysical Research Abstracts, Vol. 9, 02190, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-02190

Can Computational Fluid Dynamics be used to study large rivers?

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Our ability to numerically predict the interaction between complex topography and three dimensional flow using Computational Fluid Dynamics (CFD) in large rivers has yet to be fully developed. This is the result of two limiting factors; i) our inability to design numerically stable meshes for complex topographies at these spatial resolutions and ii) our inability to collect high resolution data appropriate and necessary for the boundary conditions of the numerical scheme. This paper deals with the numerical simulation of flow; i) over a $\approx$ 1 km section of natural dune field and; ii) through a large confluence–diffluence unit (w:d ratio $\approx$ 200), both located in the Rio Paraná, NE Argentina. The numerical methodology is based upon the development and application of a new five term mass flux scaling algorithm that modifies the mass conservation equation. For the dune field the simulations are performed within a regular Cartesian discritization, however for the confluence–diffluence unit the methodology is further extended to a hybrid approach where large scale channel morphology is discritized using Boundary Fitted Co-ordinates (BFC) and form roughness is included using the mass flux scaling algorithm. Bathymetric measurements were made in the field using a multibeam echo sounder which provided an unparalleled topographic dataset to test this new numerical modelling approach. Measurements of flow were made using an acoustic Doppler current profiler and are used both as inlet boundary conditions and within domain validation data. The results demonstrate the importance of topographic forcing on determining the flow structures in large rivers. Furthermore, it is suggested

that this provides a new research methodology to understand how small river theory scales upwards to larger spatial scales.