Applying a Computational Fluid Dynamics model to understand flow structures in a large river: the Rio Paraná

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Our understanding of large rivers is limited due to the difficulties in obtaining field data at these large scales. Data rich results may be obtained using computational fluid dynamic (CFD) models permitting the investigation of detailed flow patterns that would otherwise not be available. However, the application of these models to large rivers is not without its own complications and has yet to be fully developed. This is the result of two limiting factors, our inability; i) to design numerically stable meshes for complex topographies at these spatial resolutions; and; ii) to collect high resolution data appropriate for the boundary conditions of the numerical scheme. Here, we demonstrate a five-term mass-flux scaling algorithm (MFSA) for including bed topography in a very large river, where the discretised form of the mass and momentum equations are modified using a numerical blockage. Converged solutions were obtained using the Reynolds-averaged Navier stokes (RANS) equations modelling turbulence with a κ–ε RNG turbulence model. The boundary conditions were supplied from a field investigation of the Rio Paraná upstream of the Paraguay–Paraná confluence. A 38 km long reach was investigated where topographic and velocity data was collected using an acoustic Doppler current profiler (aDcp) and a single beam echo sounder. The model was validated against the aDcp data and in general showed good agreement. The model was then used to explore the impacts of roughness height upon key characteristics of the 3D flow field in large rivers. The results demonstrate the importance of topographic forcing on determining flow structures including the detection of large helical flow structures.