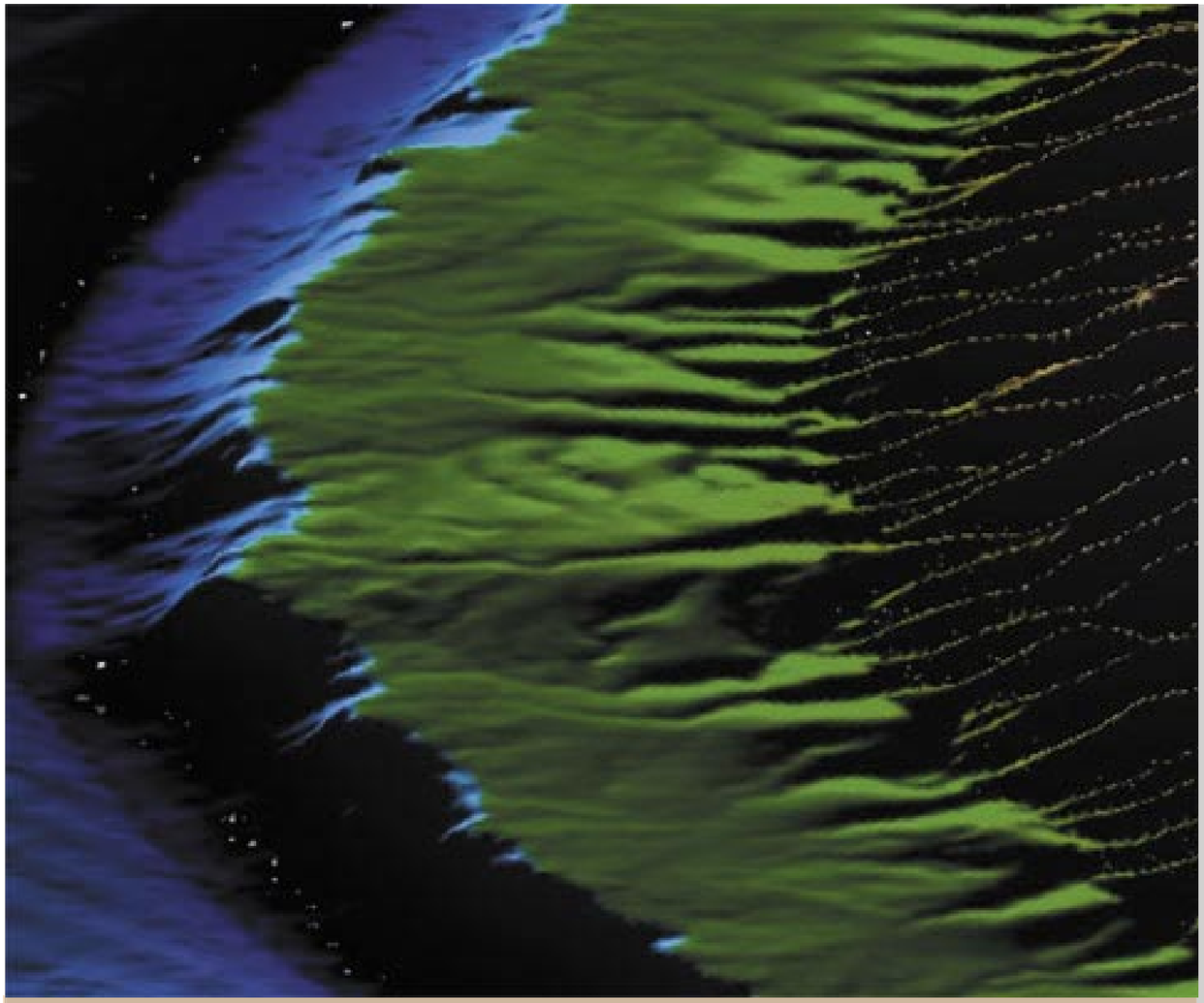
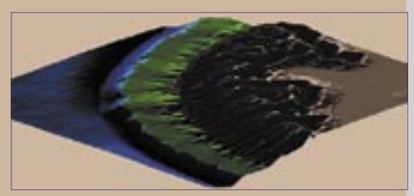


Developing an efficient parallel version of the Cascade Surface Process Modelling package





<<< Landscape Evolution in Parallel: SPModel

The modelling of landscape evolution, or geomorphology, is important because it allows us to understand how mountain ranges, river systems, and other landscape features came to be as they are, and how they will change in future. This in turn can help to elucidate how our climates, ecologies and fauna evolved; a heavily eroded landscape supports less forest, rainfall is affected by mountain topology, and so on. The application of surface process modelling could produce enormous economic and societal benefits in a raft of fields such as petroleum resource evaluation, land degradation, pollution dispersal, mine site rehabilitation and flood mitigation.

Surface process modelling is also a necessary counterpart to solid earth geophysics to provide the complete picture of a geological system. Indeed, the two processes are coupled; tectonic uplift affects the rate of erosion, while the movement of sediments changes the gravitational stress over an area and the build-up of heat, influencing what goes on below the continental crust.

SPModel models two key components of erosion:

1. Short-range (hillslope) processes, (such as the sides of a valley gradually caving in), modelled by a simple linear diffusion equation;
2. Long-range (river) processes, modelled by an equation of reaction between water flowing in a river network and the substratum. A rain model regularly dumps water into the system at certain areas using a user-specified algorithm.
3. It also allows the user to specify tectonic uplift occurring at the same time as the simulation.

SPModel Significantly Speeds Up Modelling Process

VPAC, in collaboration with The University of Melbourne and the Australian National University (ANU), analysed Cascade, primarily developed by VPAC collaborator Jean Braun at the ANU. After analysing the performance of the code as it stood and identifying bottlenecks, VPAC redesigned the serial algorithm used so that as much of the sedimentation transport processing as possible could be done in parallel.

The serial version, SPModel, was successfully completed, producing very significant speedups. It can be observed from the table below that SPModel runs at least 2.8 times faster in serial over the same problems than Cascade, because of improvements to the algorithm that determines where sediment is transported each timestep. The parallel version is still being completed, from which VPAC expects a further substantial increase in performance power.

All problems run on auto-generated test data, for 10,000 time iterations				
Mesh size (per side)	Total Nodes	Cascade2002 runtime (sec)	SPModel runtime (sec)	**Speedup**
36	1296	76.88	27.38	2.807889
71	5041	396.72	126.72	3.130682
101	10201	965.61	312.62	3.088766

Once the parallel version is complete, the further performance improvement will allow tackling of problems on a tectonic scale, or small problems to a much finer resolution. Initial studies will be in areas such as the Flinders Rangers. Since the new SPModel uses the StGermain framework, VPAC will also be able to develop an interface for SPModel to be coupled with Snark, and run coupled simulations with interacting surface and solid-earth processing.

Further Information

This project was completed in 2004. For further information please email geophysics@vpac.org, or call +61 3 9925 4645.

VPAC
VICTORIAN PARTNERSHIP FOR ADVANCED COMPUTING