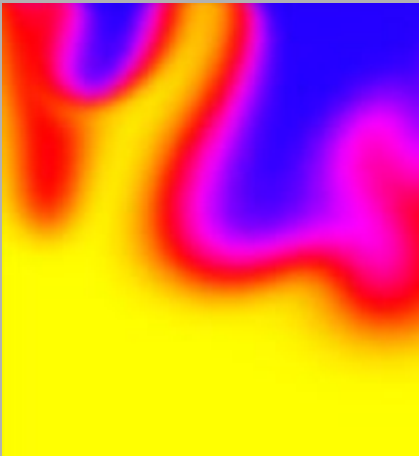


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Earth

Assessing the viability of storing greenhouse gases underground

Geosequestration has been proposed as a way to limit the global warming impact of fossil fuels. The idea is to capture the carbon dioxide gas released by power stations and inject it into deep underground reservoirs.

Dr Jonathan Ennis-King, Dr Lincoln Paterson and colleagues at CSIRO Petroleum Resources in Clayton, Victoria, are modelling geosequestration as part of the Cooperative Research Centre for Greenhouse Gas Technologies.

The work is challenging because it requires modelling of many different physical and chemical processes, which are coupled together across a range of size and time scales. These processes include injection and convection of the carbon dioxide and the formation of carbonate minerals such as calcite and siderite.

The researchers have assembled a 23-processor PC cluster for performing most of the calculations, while the convection modelling is distributed across the CSIRO IT network, "harvesting" spare CPU cycles on desktop PCs. In 2004 the team was awarded the CSIRO Medal for their work on reservoir modelling.

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Water

Tracing environmental contaminants in underground water resources

Australian rural communities and ecosystems depend heavily on water contained in aquifers, which are underground formations of porous rock or sediment. Dr Mike Trefry and his colleagues at CSIRO Land & Water in Floreat, Western Australia, are developing new methods to reduce and repair damage to polluted soil and groundwater systems. The team combines field measurements with hydrogeological modelling, to detect and assess contamination by petroleum and other chemicals.

A typical example is to calculate groundwater pressure during an interfacial tracer test. To test contamination of a layered aquifer, a tracer fluid is injected into a central well. This fluid then flows through the porous material, where it is partly adsorbed by the contaminant. The amount of tracer extracted from surrounding wells can then be used to work out the distribution of the contaminant.

The researchers perform these calculations on a cluster of 14 processors in Floreat. They can now also use the new SGI Altix computer system installed by the Interactive Virtual Environments Centre (iVEC) at the Australian Resources Research Centre in Kensington.

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Fire

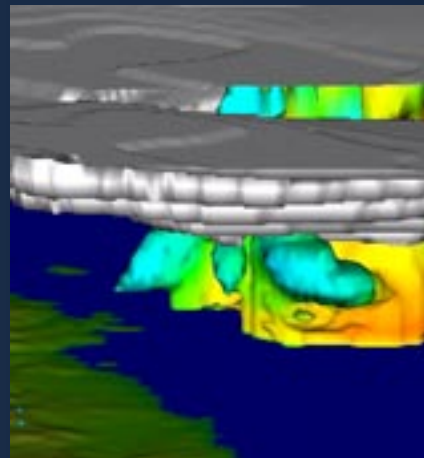
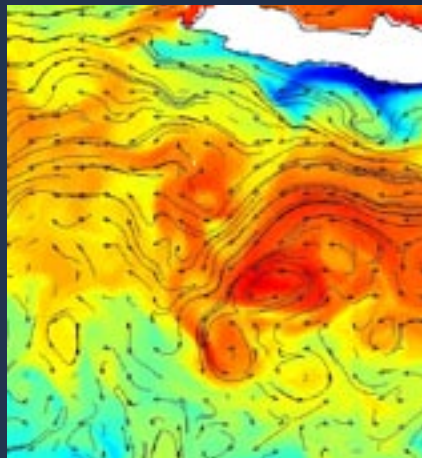
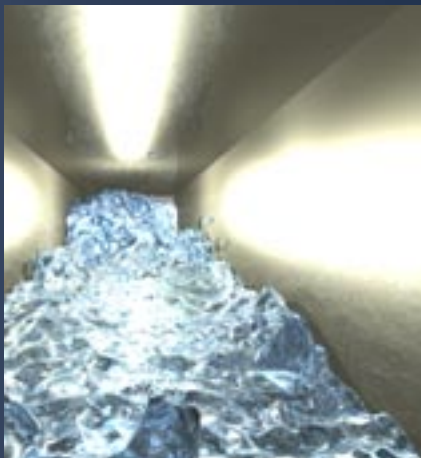
Using modelling to improve fire safety in the built environment

The Fire Science team in CSIRO Manufacturing & Infrastructure Technology develops better fire safety standards through its work on material flammability, fire growth and bushfires. Based at North Ryde in NSW and Highett in Victoria, the group works on a wide range of projects with local and international collaborators.

From North Ryde, Dr Yunlong Liu uses the SGI Altix at the HPCCC to run fire dynamics simulation software developed by the National Institute of Standards and Technology (NIST) in the United States. His calculations simulate fire growth within confined spaces such as buildings and vehicles. Such simulations provide a relatively cheap and safe source of data to complement the group's full scale experimental fire tests.

One such project is to simulate the spreading and ventilation of smoke for different fire scenarios in the Sydney Harbour tunnel. Another project in conjunction with Queensland Rail is to calculate the rate at which heat is released during fires in train carriages.

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Model

Using new fluid dynamics techniques to create realistic images of flowing liquids

Computer generated imagery (CGI) is now a familiar aspect of the motion picture industry. However, creating good animations of freely moving liquids remains an important challenge.

The most convincing effects are generally based on physically realistic equations of motion. However, features such as drops, splashes and waves create complex boundaries between the liquid and its surroundings. Such boundaries are difficult to capture in detail using traditional fluid dynamics methods, which treat the liquid as a continuous medium.

The Computational Fluid Dynamics group at CSIRO Mathematical and Information Sciences in Clayton, Victoria, is using the smoothed particle hydrodynamics method to generate realistic simulations of complex fluid motions. The simulations are then rendered using ray-tracing calculations, which determine the surface appearance of the fluid based on how it reflects and scatters light.

Dr Joseph Ha uses the IBM eServer cluster at the HPCCC, which enables him to perform many of these long calculations at once.

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Visualise

Creating a national ocean forecasting service

The prediction of day-to-day changes in currents, eddies, temperatures and salinity in coastal and open-ocean waters will be crucial to Australia's maritime, commercial, search-and-rescue, environmental monitoring and defence fleets.

The BLUELink project is a major collaboration between CSIRO, the Bureau of Meteorology and the Royal Australian Navy, to produce these forecasts, using a new composite Ocean Forecasting Australia Model that combines several elements.

- The Ocean Data Assimilation System combines experimental ocean observations with model projections, to refine the initial conditions for the model.
- The Ocean Reanalysis program uses detailed "hindcasts" of historical ocean data to improve the accuracy of the forecasting.
- The Relocatable Ocean Atmosphere Model provides accurate, high resolution predictions for local regions, such as circulation currents in bays and estuaries.

Dr Russell Fiedler and the other team members at CSIRO Marine and Atmospheric Research in Hobart run these programs using the NEC SX-6 vector supercomputer and data processing facilities at the HPCCC.

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Predict

Developing better predictions of severe weather events

Researchers at CSIRO Marine and Atmospheric Research in Aspendale, Victoria, use high performance computing to model the earth's climate, assess the impact of global warming, improve regional weather forecasting and predict the spread of atmospheric pollution.

Dr Debbie Abbs and her colleagues are developing the atmospheric component of the Relocatable Ocean Atmosphere Model. This coupled, high-resolution, local forecasting system will be used by the Royal Australian Navy in its coastal operations.

The atmospheric model is currently being tested in standalone mode for a variety of cases, such as tropical cyclones and other severe weather phenomena. It is also being run in forecast mode to assist the Navy in its relief missions in Aceh and the Solomon Islands.

Dr Abbs utilises a range of computer hardware in her work. At the HPCCC she uses the IBM cluster, as well as the SGI server and StorageTek tape systems that form the CSIRO Data Store. She also performs runs on the cluster systems at the APAC National Facility in Canberra.

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Services

High Performance Scientific Computing

CSIRO HPSC provides a range of services to researchers including:

- Access to vector supercomputing through the High Performance Computing and Communications Centre (HPCCC) managed in partnership with the Bureau of Meteorology;
- Access to the supercomputing systems of the National Facility through membership of the Australian Partnership for Advanced Computing (APAC);
- Access to the SGI Altix at the Interactive Virtual Environments Centre (iVEC) through joint investments in resources in Perth;
- Access to cluster compute and storage systems including petabyte storage owned by the HPSC and installed at the HPCCC; and
- Access to a range of application software to run on HPSC and other computers.

HPSC also engages and co-invests with internal partners such as CSIRO IT, the CSIRO Bioinformatics Facility in Canberra and individual research teams, including management of clusters dedicated to specific research projects.

HPSC is a vital element of CSIRO's eScience capabilities.

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Hardware

Class of system	CSIRO Share (Tflop/s)	Vendor	CPUs	Memory (GBytes)	Peak Speed (Tflop/s)	Facility
Vector	0.3	NEC SX-6	224	1,792	1.8	HPCCC
Cluster	1.1	IBM eServer	168	224	1.1	HPCCC
Shared Memory	1.3	SGI Altix	1,664	3,584	9.8	APAC
			160	320	1.0	iVEC
			128	238	0.7	HPCCC

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