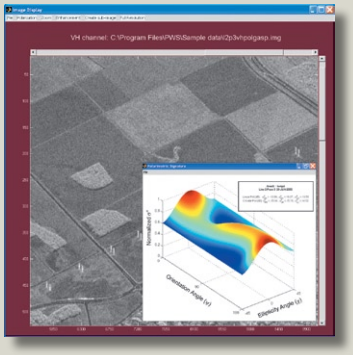
# Earth, Ocean, and Planetary Sciences

Innovative applications of MathWorks products to advance our understanding of the universe, measure and predict natural phenomena, manage resources, and mitigate the environmental effects of industrialization.

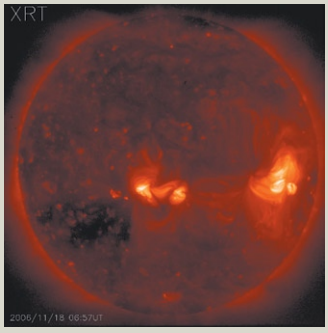
## Using Remote Sensing to Map Agricultural Land Use



The **Department of Agriculture and Agri-Food Canada** (AAFC) developed an agricultural mapping system to support soil conservation and sustainable agriculture in Canada. Using MATLAB®, AAFC analyzed radar images from Earth observation satellites and developed models that extract the radar backscatter responses of agricultural areas. AAFC is using the results of this analysis to assess tillage practices, help farmers improve soil quality, and prevent topsoil erosion. *www.agr.gc.ca*

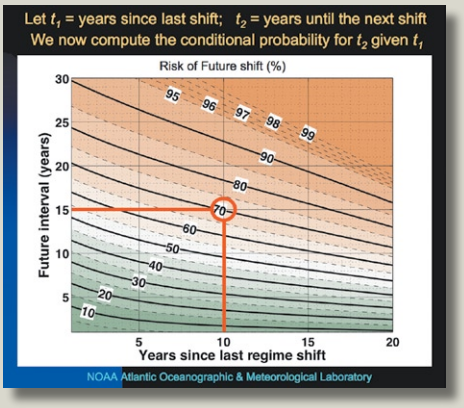
## Studying the Sun's Atmosphere

The **Smithsonian Astrophysical Observatory** (SAO) designed and implemented the X-Ray Telescope (XRT) launched recently on the Hinode spacecraft, a Japan Aerospace Exploration Agency solar mission. SAO used Simulink® to model imaging effects with various sources of distortion. MATLAB enabled them to create data-reduction algorithms that remove artifacts during vibration tests. The XRT is helping scientists better understand the dynamics of the sun's luminous plasma atmosphere, or corona. The XRT's superior imaging resolution has already revealed previously unseen behavior at the interface between the Sun's surface and the base of the corona—high-energy plasmas jetting from the Sun's surface near the polar regions. *cfa-www.harvard.edu/sao-home.html*




## Predicting Climate Shifts

Researchers at the **National Oceanic and Atmospheric Administration** (NOAA) developed tools to predict how sea-surface temperature oscillations in the Atlantic and Pacific oceans will affect climate cycles. The NOAA's Atlantic Oceanographic and Meteorological Laboratory in Miami used MATLAB and Statistics Toolbox to estimate the distribution function for these climate cycles and to calculate the probability of climate shifts within a specified number of years. Researchers reconstructed past oscillations by analyzing rings from 450-year-old trees, and

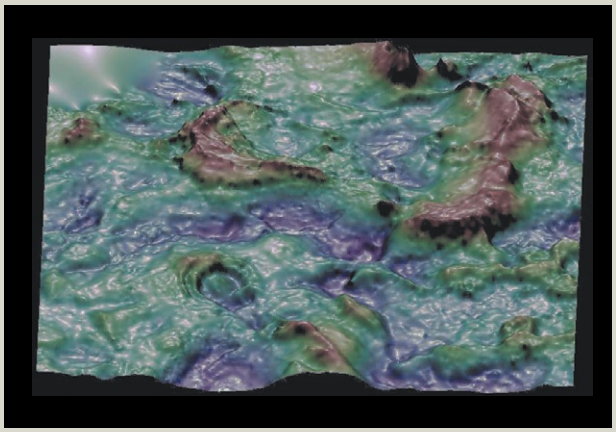



then used Monte Carlo resampling methods to increase the sample size. The climate projection tools will enable scientists and water management engineers to develop long-term projections of rainfall and hurricane activity. *www.aoml.noaa.gov*

## Analyzing Gravitational Fields to Identify Natural Resources

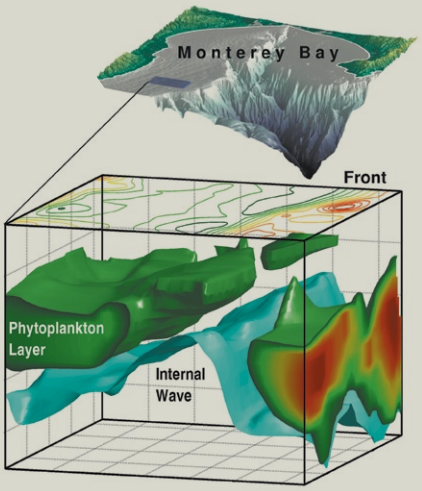
In Johannesburg, South Africa, **University of the Witwatersrand** geophysicists use measurements of Earth's gravity and magnetic fields to search for minerals and other natural resources, including gold, platinum, oil, and ground water. Using MATLAB to perform Fourier and wavelet transforms, the geophysicists interpret magnetic field measurements gathered by aircraft. The

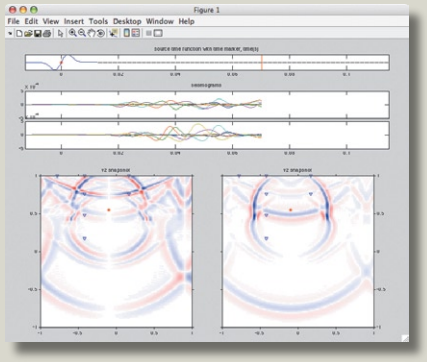
group also uses Wavelet Toolbox to correlate time and spatial data series and produce pseudogravity profiles. Geophysicists compare these profiles with gravity profiles to help interpret an area's geology and identify its magnetic resources. *www.wits.ac.za/science/geophysics/gc.htm*



## Exploring the Ocean from Top to Bottom

The **Monterey Bay Aquarium Research Institute** (MBARI) in California uses autonomous underwater vehicles (AUVs) to rapidly survey physical, chemical, biological, and geological conditions from the ocean's surface to the sea floor. MBARI researchers used MATLAB to develop automated tools for rapidly analyzing and visualizing AUV data. These MATLAB tools improve AUV operation and enable the rapid production and visualization of quality controlled scientific data. Researchers use the data to investigate upper-ocean phenomena, including red tides and harmful algal blooms, and to develop high-resolution sea floor maps for studies of geology, geochemical venting, and deep-sea biological communities. *www.mbari.org*



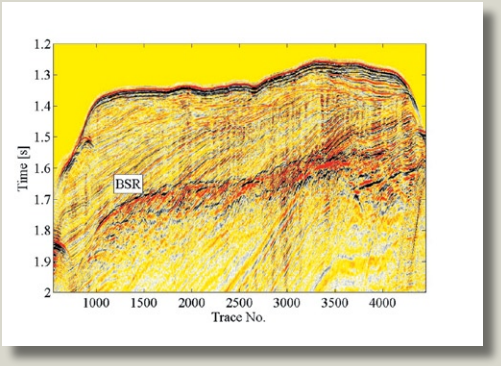



## Simulating Seismic Wave Propagation

Scientists at the **National Institute of Geophysics and Volcanology** in Bologna, Italy (INGV-Bologna) used MATLAB to simulate seismic wave propagation and ground motion following an earthquake. As part of the SPICE (Seismic Wave Propagation and Imaging in Complex Media) project funded by the European Union, INGV-Bologna and cooperating institutions developed computational seismology tools and algorithms that model the structural complexity of Earth and provide accurate projections of Earth's response to earthquakes. The algorithms will enable scientists to better understand the Earth's structure and the physical processes of seismic events. *www.spice-rtn.org, www.bo.ingv.it*

## Studying Methane Hydrate Deposits

Researchers at **Kyoto University** are exploring the potential of methane hydrate deposits under the ocean floor as an alternative energy source. The university's Engineering Geology group uses MathWorks tools to examine the physical properties of methane hydrate using geophysical and geological techniques. With MATLAB and Signal Processing Toolbox they process data gathered from seismic exploration, well logging, and core samples. MATLAB graphing and plotting capabilities enable them to rapidly visualize and interpret results. Scientists are using the group's findings to help locate methane hydrate reservoirs and improve methods for extracting this emerging energy resource.




*www.kyoto-u.ac.jp/index-e.html*

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