News of Recent Research Activities

From May 2007 *High Frequency Electronics*

Next Solar Cycle Gets an Updated Prediction

The next 11-year cycle of solar storms will most likely start next March and peak in late 2011 or mid-2012—up to a year later than expected—according to a forecast issued by NOAA's Space Environment Center in coordination with an international panel of solar experts.

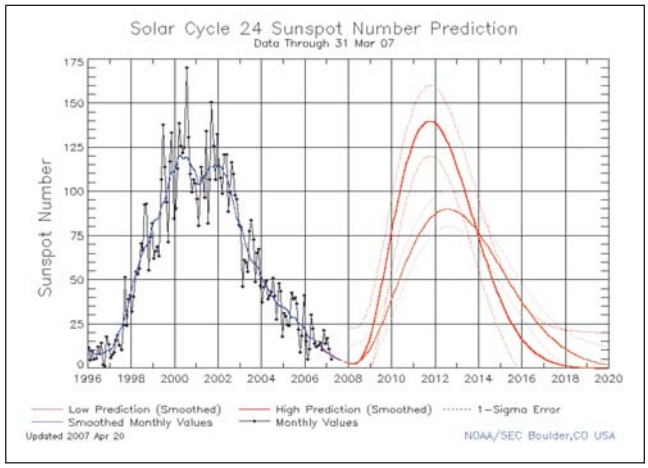
Expected to start last fall, the delayed onset of Solar Cycle 24 stymied the panel and left them evenly split on whether a weak or strong period of solar storms lies ahead, but neither group predicts a record-breaker. The Space Environment Center led the prediction panel and issued the forecast at its annual Space Weather Workshop in Boulder. NASA sponsored the panel.

During an active solar period, violent eruptions occur more often on the Sun. Solar flares and vast explosions, known as coronal mass ejections, shoot energetic photons and highly charged matter toward Earth, jolting the planet's ionosphere and geomagnetic field, potentially affecting power grids, critical military and airline communications, satellites, Global Positioning System signals, and even threatening astronauts with harmful radiation. These same storms illuminate night skies with brilliant sheets of red and green auroras.

In the new cycle forecast, half of the panel predicts a moderately strong cycle of 140 sunspots, plus or minus 20, expected to peak in October of 2011. The other half predicts a moderately weak cycle of 90 sunspots, plus or minus 10, peaking in August of 2012. An average solar cycle ranges from 75 to 155 sunspots. The late decline of Cycle 23 has helped shift the panel away from its earlier leaning toward a strong Cycle 24. Now the group is evenly split between strong and weak.

Scientists have issued cycle predictions only twice before. In 1989, a panel met to predict Cycle 22, which peaked that same year. Scientists met again in September of 1996 to predict Cycle 23—six months after the cycle had begun. Both groups did better at predicting timing than intensity. The current group's confidence level is described as "high" for its estimate of a March 2008 onset and "moderate" for the two estimates of peak sunspot number and when those peaks would occur.

One disagreement among the current panel members centers on the importance of magnetic fields around the Sun's poles as the previous cycle decays. End-cycle polar fields are the bedrock of the approach predicting a weak Cycle 24. The strong-cycle forecasters place more importance on precursors based on a several-cycle history. For example, if Cycle 24 sunspots do not appear by mid 2008, the strong-cycle group might change their forecast.



A NOAA panel has released this prediction for the next solar sunspot cycle, with significant disagreement on its magnitude.

The first year after solar minimum, marking the end of Cycle 23, will provide the information scientists need to arrive at a consensus. NOAA and the panel decided to issue their best estimate now and update the forecast as the cycle progresses, since Space Environment Center customers have been requesting a forecast for over a year.

To arrive at the prediction, the panel examined many individual predictions from researchers around the world, ranging from extensive empirical research to statistical analysis of past sunspot cycles.

(Edited from a NOAA press release—www.noaanews.noaa.gov/)

New Sensor Technology Advances Australia's Water Management

World-class wireless sensor network (WSN) technology, developed by researchers at CSIRO, is ready for deployment to help monitor Australia's scarce water resources. The low-cost network can conduct wireless environmental monitoring in remote areas of Australia, thus reducing the cost of water resources monitoring and increasing water efficiency. The first phase of the network, using "Fleck" sensors, began deployment in Queensland's Burdekin Irrigation Area in early March of this year, to monitor saltwater intrusion.

This is one of the applications in a series of world-class technologies developed by CSIRO as part of developing a national Water Resources Observation Network

CSIRO researcher Peter Corke shows off the "Fleck" wireless sensors used in the Australian Water Resources Observation Network (WRON). *(CSIRO photo)*

(WRON). WRON aims to achieve 20 percent saving in annual costs of water resource management by 2010. WRON technologies will provide accurate and timely water information providing a robust scientific foundation to a transparent, credible and evidence-based water reform process.

In the Burdekin, five CSIRO-designed and built sensor Fleck measurement nodes and two relay nodes were installed to measure salinity, flow and groundwater level in key bores. The nodes self-organize to transmit data over the internet to scientists at CSIRO and the North Burdekin Water Board (NBWB) for analysis. The near real time data will advise local sugar cane farmers of the point at which water becomes too saline to use for irrigation, thus saving water, time, money and crops.

CSIRO is working with State and Federal government agencies and public and private sector organizations to realize the WRON vision of establishing a technology platform to provide an Australia-wide network of water information systems delivering dynamic, timely reporting and forecasting of Australia's water resources.

(News release provided by CSIRO—www.csiro.au/)

M/A-COM Awards Research Grant To University of Massachusetts

M/A-COM, a business unit of Tyco Electronics and a provider of wireless radio frequency (RF), microwave and millimeter wave components, has awarded an antenna research grant to the University of Massachusetts Amherst Center for Advanced Sensor and Communications Antennas (CASCA) to facilitate the design and development of advanced antenna technologies for the communications industry.

"By collaborating with M/A-COM, we can leverage resources for the development of antenna technology with direction, purpose and creativity," said Daniel Schaubert, professor of Electrical and Computer Engineering and Director of CASCA. "The teaming of M/A-COM's expertise in developing and manufacturing sophisticated antenna technology with CASCA's experience in ground-breaking technologies has a high potential to produce new products for a wide range of applications in the military and commercial marketplaces."

CASCA was formed in 2003 by the Air Force Research Laboratories Sensors Directorate (AFRL/SN), Antenna Technology Branch and the University of Massachusetts Amherst Electrical and Computer Engineering, Antennas and Propagation Laboratory to develop antenna technologies for advanced military and commercial systems used for communication, radar, security and safety.

(M/A-COM/University of Massachusetts press release—www.ecs.umass.edu/ece/casca)

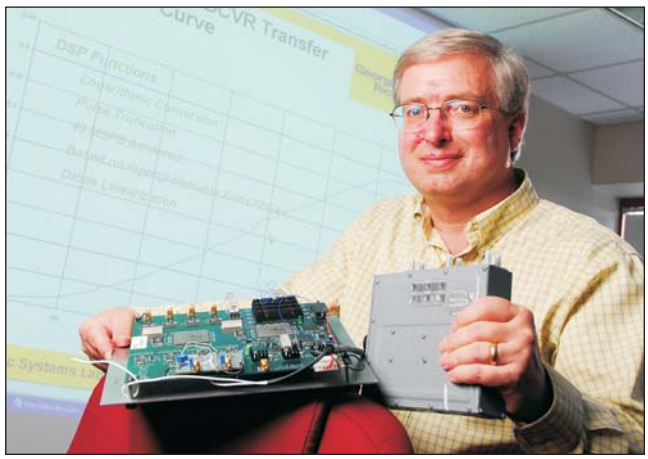
GTRI Researchers Patent Digital Process for Aircraft Radar Warning Receivers

Researchers at the Georgia Tech Research Institute (GTRI) have patented a discovery that could significantly increase reliability and reduce cost in equipment that helps protect U.S. military aircraft from attack.

The patent covers a digital crystal video receiver (DCVR), a vital part of the radar warning receiver (RWR) system that alerts an aircraft crew to enemy ground-radar activity. GTRI researchers Michael J. Willis and Michael L. McGuire, working with Air Force scientist Charlie W. Clark, have patented a way to use digital circuitry to perform many functions formerly allotted to more problematic analog chips.

Specifically, the researchers have moved a critical operation—the logarithmic transfer function—from the analog to the digital domain. The logarithmic transfer function coordinates the input and output of a radar warning receiver's signal-processing system.

"Electronic analog technologies have a number of error sources and limitations when subjected to the extended temperature range that our military requires," said Willis, a principal research engineer with GTRI's Electronic Systems Laboratory (ELSYS). "By moving the logarithmic transfer function into the digital signal-processing domain, we've improved the stability of the cir-



GTRI researcher Mike Willis displays the newly patented digital crystal video receiver. *(Georgia Tech photo by Gary Meek)*

cuit." In radar warning receivers, Willis explains, the continuous-scale analog implementation has been difficult to calibrate and maintain. By contrast, the digital domain needs no calibration and is more robust.

The digital version is also far less expensive to manufacture. Moving the logarithmic transfer function from analog to digital probably reduces production costs of a radar warning receiver by a factor of between five and ten, according to Willis.

(Georgia Tech Research Institute press release—www.gtri.gatech.edu/)

CSIRO Implements Broadband Networks for Radio Astronomy

Astronomers from CSIRO, the Swinburne University of Technology (SUT) and the University of Tasmania have made the first broadband hook-up between Australian radio telescopes, completing in just hours an experiment that would previously have taken weeks.

Data from four telescopes—near Parkes, Narrabri, Coonabarabran and Hobart—were streamed to CSIRO's Parkes Observatory where it was processed by software developed at SUT.

(CSIRO photo)

"Broadband networks are revolutionizing astronomy," says VLBI Operations and Development Manager at CSIRO's Australia Telescope National Facility, Dr Tasso Tzioumis. "We can now do experiments on very short time-scales with real-time transfer of data between telescopes."

This experiment was the first to make extensive use of dedicated 1 Gbps networks that now link the CSIRO observatories in NSW to Sydney and beyond. Installed in 2006, the links were funded by CSIRO and provided by AARNet (the Australian Academic Research Network). The VLBI-over-broadband (e-VLBI) technique has also been tested and is used in Europe and the USA, at similar data rates.

VLBI (Very Long Baseline Interferometry) techniques have traditionally produced results very slowly, usually taking at least a few weeks. Data would be recorded on tapes or disks at each telescope, along with time signals from atomic clocks. The tapes or disks would then be shipped to a central processing facility to be combined.

Being able to move data in vast quantities will be crucial to the operation of future radio telescopes such as the Mileura International Radio Array (MIRA) soon to be built in Western Australia, where each of the facility's 30 dishes will be delivering a terabyte of data per second.

(News release provided by CSIRO—www.csiro.au/)