The Virtual Center for Decadal Climate Variability

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A DAY IN THE LIFE OF PROFESSOR "SALTY" GYRES AND DR. SEA-OH TU. "Oh dear, I am late!" Professor "Salty" Gyres muttered to himself as he looked at his watch and navigated briskly along the DecVar corridors. "Sea-Oh Tu will be waiting." He passed through the lounge on his way to the discussion room, replying to "good mornings" from some colleagues and declining invitations to join in their discussions. Professor Gyres entered the discussion room where, as expected, he found Dr. Sea-Oh Tu waiting for him. "Let's begin, Professor, when you are quite ready; you said in your message that you have some exciting results that we must discuss right away," Dr. Tu said. The professor quickly opened the file containing figures from his latest analyses of the various oceanographic datasets. "Look, Sea-Oh, these results show a clear interplay between decadal and interannual variabilities in the Pacific, and if you run similar analyses on your rainfall and land surface temperature data, I am sure that they will show a clear interplay between decadal and interannual variabilities in continental climate also," said the professor. Dr. Tu was too engrossed in looking at the professor's figures to reply. Finally, she said, "I would like to take this file, so that I can compare my results with yours." "All yours, Sea-Oh. You know where to find me when you want to discuss your results," said Professor Gyres.

Professor Gyres settled down with the latest issue of Subtle Signals to read the news about decadal variability. After reading the abstract of a recent paper Dr. Model wrote about shallow tropical circulations, Professor Gyres picked up a copy of Model's paper at the library and then went to the lounge to read it during lunch. Afterward, filling a cup with hot coffee, the professor began to draft a *Journal of Climate* manuscript he intended to write with Dr. Tu. It took him several hours to complete the draft to his satisfaction, with occasional visits to the library to read published papers and a visit to the auditorium to consult unpublished presentations made in the last workshop on decadal climate variability. Satisfied with his progress, the professor relaxed.

Meanwhile, Dr. Tu went over the professor's results file, planned the analyses she thought would be complementary to the professor's analyses, and checked the data analysis and visualization system to verify that the datasets she needed for her analyses were available. Just as the professor was drifting off to sleep for his siesta, Dr. Tu opened her file containing the analysis plans she had made. She quickly went up to the data analysis and visualization system and quietly performed the calculations, occasionally smiling or frowning to herself as results flashed on her screen. After running all the calculations she had planned, Dr. Tu compared her results with the professor's and became convinced that the professor's speculation was correct: the interplay between decadal and interannual variabilities was clear over oceans and continents. She summarized her results and conclusions neatly in a document.

Professor Gyres was slowly waking up from his siesta when Dr. Tu announced her presence. He mumbled an excuse to Dr. Tu and ambled over to the coffeemaker to pour fresh coffee in his cup. Returning to his chair, without any preamble he said, "So, Sea-Oh, was I correct or not?" He opened the file containing Dr. Tu's results and scrutinized them in detail, occasionally comparing them with his own results. Without looking up from the results, he pointed to the draft manuscript he had written earlier in the day. Dr. Tu gestured at the file where she had summarized her results and conclusions. Both of them laughed and began editing the draft manuscript. Being the experienced collaborators they were, they finished editing the manuscript quickly for

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submission in the morning to the *Journal of Climate*. "Wait, Sea-Oh, don't forget to thank DecVar in our manuscript," said the professor. "I have built it into my acknowledgements template, Professor, because I use DecVar very often," said Dr. Tu. "Good day, Sea-Oh," the professor said, as he realized that it was way past his bedtime. Looking up at the rising sun, Dr. Tu said, "Good night, Professor."

This is a very realistic, albeit hypothetical, description of research collaboration between two scientists half a world apart in space and time, both working in their offices or homes. The DecVar mentioned in this story is the Virtual Center for Decadal Climate Variability (**www.DecVar.org**), and it is possible to carry out the hypothetical collaborative research between "Professor Gyres" and "Dr. Sea-Oh Tu" with the facilities available in DecVar today.

WHY THE DECVAR SYSTEM WAS DEVELOPED. The community of researchers interested in decadal climate variability problems is worldwide. The Internet and its associated Web software and hardware technologies make it unnecessary to physically collocate researchers to tackle the immense problems of observing, analyzing, simulating, and predicting decadal and longer-term climate variations. Also, progress in solving these problems can occur much more rapidly if researchers can share their problems and results freely, quickly, and easily with other researchers residing anywhere in the world.

Moreover, research on decadal and longer-term climate variability requires past data, instrument-measured and proxy, for analysis, model validation, and predictability studies. Research on decadal and longer-term climate variability also requires ensembles of centuries-long runs of Earth system models for simulation, data assimilation, and predictability studies. A Web-based center would make the output from model runs immediately available to researchers irrespective of their location. Datasets and analysis and visualization systems built into such a Web-based center would render it unnecessary for individual researchers to download and store large datasets. This would free them from routine data processing and software development tasks and the acquisition of resources necessary to perform these tasks. This would result in very efficient use of computing power and researcher time. DecVar is a modest step in this direction.

Many Web sites are called "virtual centers." Almost all are essentially one-way, data- and information-access systems, in which there are few, if any, interactive research facilities. DecVar is a unique, integrated, interactive research and communication environment, focused on decadal variability and providing many interactive facilities, including online collaboration capabilities. This is the only such virtual center in the meteorology–oceanography–climate fields. In spite of the underlying complexity of DecVar, all of DecVar's facilities are accessed through a Web browser. DecVar's design and construction are highly modular and flexible, allowing easy expansion and replication. DecVar currently has approximately 200 members from 117 institutions in 27 countries on all continents except Antarctica. The requirement of a membership is a common attribute DecVar shares with many Web sites; there is no membership fee, but a justification for membership request is required.

Fig. 1. The DecVar.org home page. Each hexagonal section represents a single system module.

FACILITIES AND ACTIVITIES. The first operational version of DecVar was designed and developed by the Center for Research on the Changing Earth System (CRCES) and was unveiled in June 2003. DecVar.org (Fig. 1) is designed to emulate a brick-and-mortar research center with a floor plan consisting of hexagonal building blocks. Its main modules, shown in Fig. 2, are "Lobby," "Community," "Library," "In-

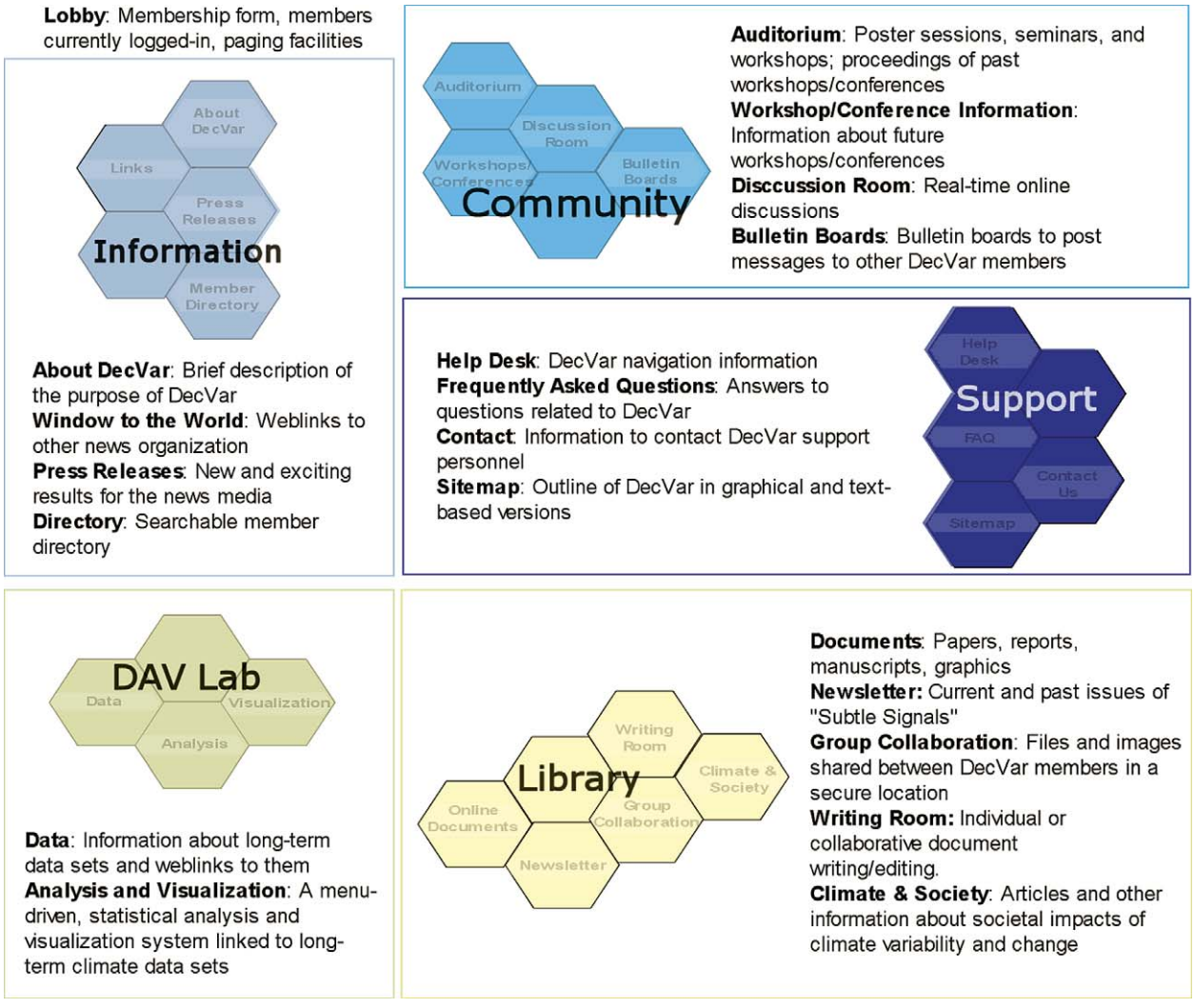

Fig. 2. Brief descriptions of DecVar modules.

formation," "Data Analysis and Visualization (DAV) Lab," and "Support." The interactive and noninteractive facilities in these modules are also shown in Fig. 2. The DecVar facilities, briefly described in Fig. 2 and used by the fictional Professor Gyres and Dr. Tu, include

- the discussion room, the bulletin boards, the DAV Lab, and the writing room;
- submissions, reviews of abstracts, and complete presentation records of workshops/conferences on decadal climate variability; and
- papers on decadal climate variability published in AMS publications in full, and abstracts of papers on decadal climate variability published in American Geophysical Union publications, available free of charge to all DecVar members.

The DAV Lab contains many long-term climate datasets and analysis and visualization software linked to these datasets. A sequential menu allows a user to select a dataset by variable type or family, space and time domains of analysis, the analysis technique to be applied, and the visualization format. It is also possible for a user to download data or results in a digital format to his/her computer. Sample output from the DAV Lab is shown in Fig. 3.

Among special activities conducted via DecVar since its inception are a quarterly newsletter titled *Subtle Signals,* which includes information about various aspects of decadal variability, and a monthly "Ask An Expert" program, started in June 2004, in which DecVar members can interact with invited experts on various aspects of decadal climate variability in a bulletin board setting. A "live" tutorial

seminar about DecVar was given, using the DecVar seminar facility and the analogy of two research collaborators working together from offices half a world apart, to the WMO- and IOC-sponsored OceanOps04 Workshop in Toulouse, France, from the CRCES office in Columbia, Maryland, in May 2004. While the seminar was well-received by the workshop participants, they suggested enhancing DecVar's seminar facility by adding audio and video capabilities in a future version.

DecVar's capabilities can be further expanded by adding "live" audio and video conferencing facilities and an interactive "white board" to the discussion room, and by adding to the DAV Lab data "mining" software to search, access, and analyze publicly available datasets not integrated into the DAV Lab. Also, the DAV Lab's capabilities can be further enhanced by adding more long-term datasets and analysis and visualization software. These enhancements of the virtual center concept, coupled with further developments in Internet and Web-based technologies, has the potential to bring any researcher with Web access into the mainstream of Earth science research; to free researchers from the need to possess large data-storage resources and from mundane tasks associated with processing and visualizing large and rapidly growing Earth science datasets so that they can focus their energies on research; and to make true globalization of research possible. It is our hope that the integrated capabilities of DecVar will serve as a model for research, communication, and collaboration in many disciplines of Earth science.

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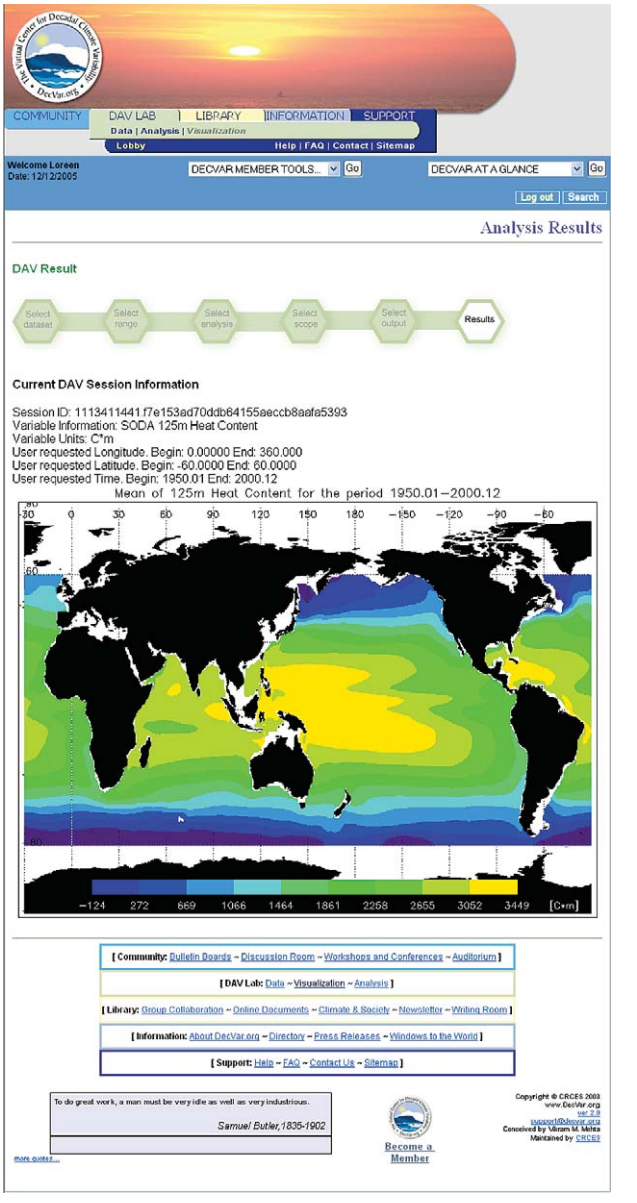

FIG. 3. Sample Data Analysis and Visualization Lab output, showing average surface-to-125-m ocean heat content for 1950–2000 from the Simple Ocean Data Analysis dataset.