the idea of EMBL as a "family" of labs.

Political pressures may soon raise the issue of additions to the lab family. With Italy's future EMBL membership hanging in the balance, Italian biologists see an opportunity to press for their own EMBL facility. "The time is right to consider a serious proposal to have a southern European lab," says Riccardo Cortese, who heads the Institute for Research in Molecular Biology in Pomezia. And John Tooze, executive secretary of the European Molecular Biology Organization, EMBL's sister body, believes that, to secure EMBL's long-term future, "each of the four major states has to have a stake of real estate."

The lab's other main paymasters—Germany, France, and Britain—are all now hosting EMBL facilities, so Italy does seem to have drawn the short straw. But what would an Italian lab do? "Molecular neurobiology is scattered and could do with a boost," says Tooze. And if that doesn't appeal, he says, what about a center working on the biotech applications of bacterial molecular biology? Beyond that, Tooze believes it will be necessary to build from Kafatos' lab twinning program to create formal affiliations with leading centers in the member states, so that most countries feel they have a slice of the EMBL action.

The problem, of course, is that all this will cost money. Kafatos says that he needs a "dowry" from the EMBL member states, just to open up some new positions to kick-start his inclusiveness drive. But this may not be enough: EMBL insiders say that the lab's future may depend heavily on whether Kafatos is able to win major funding from the European Community (EC). At first glance, the prospects don't look good: Philipson resigned over the failure of the EMBL nations to back his spending plans, and he also alienated Brussels officials over the past few years by publicly attacking EC science policy.

But Stephen Fuller, an American who heads EMBL's structural biology program, thinks that Philipson's actions will actually work in Kafatos' favor. By resigning, says Fuller, Philipson transformed the discussion of EMBL's budget from a squabble over next year's funding into a serious debate about the lab's long-term future. And many at EMBL believe that the stark contrast between Philipson's deliberate abrasiveness and Kafatos' consummately diplomatic style may be just what is needed, both to get the EMBL member states to cough up more money, and to build a closer relationship with Brussels.

With Italy threatening to jump ship, and with the EC needing to be wooed, Kafatos' diplomatic skills will be tested to the limit. But if he proves up to the challenge, EMBL may yet emerge as the organization to lead Europe's biologists toward that elusive goal: true European unity.

–**Peter Aldhous**

OCEANOGRAPHY

ERS-1 Gives Europeans New Views of the Oceans

SOUTHAMPTON, UK—Once, the only way to study the mighty oceans was from the pitching deck of a research ship, gathering a smattering of data along the ship's narrow track while criss-crossing the sea at about the speed of a cyclist. The past 20 years have seen the situation slowly change, however. Remote sensing satellites are now providing data that can be as good as, or even better than, on-the-spot measurements—with added benefits of regular supply and global coverage.

At the moment the brightest star in this orbiting firmament is ERS-1, a satellite funded by the 13-nation European Space Agency (ESA) at a cost of $1.2 billion, including its operation and ground facilities. Launched in July 1991, ERS-1 rains down floods of data and stunning images of Earth's surface every day. "Technically, it's quite outstanding. There is no question, it has exceeded all our expectations," says Chris Rapley of the Mullard Space Science Laboratory, part of University College London. "It's the only game in town," adds Tony Hollingsworth, head of research at the European Centre for Medium-Range Weather Forecasting (ECMWF) in Reading, United Kingdom. "It gives Europe a significant lead." The reason for the enthusiasm: ERS-1's unique combination of instruments. Three radar sensors give researchers the unparalleled ability to see through clouds and the darkness of night to monitor wave heights, wind speeds, and the thickness of the polar ice sheets. ERS-1 also carries a sensor that measures ocean surface temperatures with a precision unmatched by any other satellite.


ESA

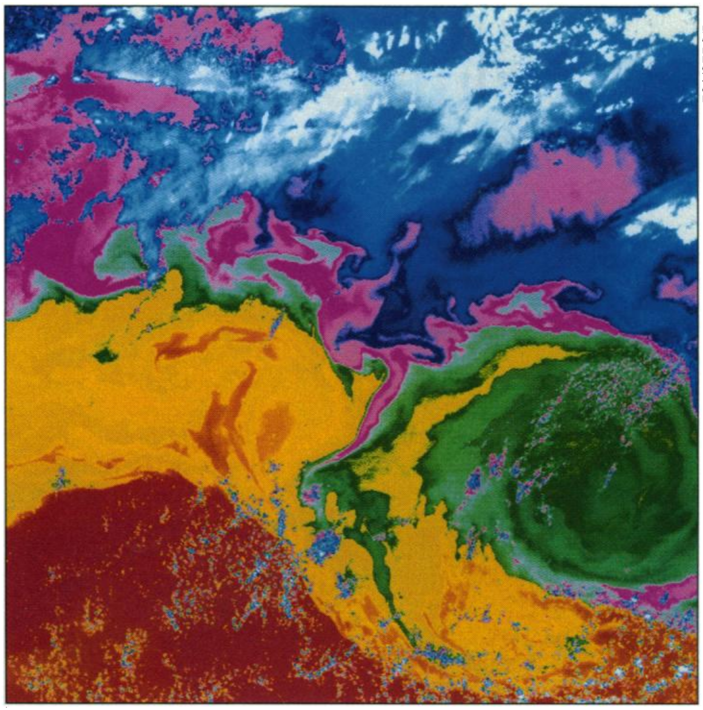
Piercing eye. ERS-1's radar can see at night and through clouds.

But while the satellite itself shines brightly, there are rumblings of dissent back on Earth. In one sense, the satellite is a victim of its own success: Although the agency constructed receiving stations around the world, a coordinating center in Italy, and processing and archiving facilities in four European countries, it has been overwhelmed by the complexity of processing some types of data that researchers need. "We've been hampered to quite a large extent by the inability of ESA to supply data," complains Trevor Guymer of the James Rennell Centre for Ocean Circulation in Southampton.

Guymer and his colleagues' appetite for ERS-1 data was whetted in the late 1970s when the National Aeronautics and Space Administration (NASA) lofted Seasat, the first remote sensing satellite to focus on the oceans. Unfortunately, Seasat's power system failed after just 106 days, leaving oceanographers with a tantalizing glimpse of what the technology was capable of. NASA's plans for a successor never got off the drawing board, although the U.S. Navy launched the first of its Geosat satellites in 1985 with one radar instrument that has provided some data for researchers. So European oceanographers and climatologists began to lobby for a satellite of their own. They got what they wanted when ESA announced plans in 1981 to build ERS-1. Later ESA decided also to build a follow-on, ERS-2, scheduled for launch in 1994, and other space agencies have been quick to follow. Japan launched its JERS satellite in early 1992, NASA and the French space agency took to the air with Topex/Poseidon last summer, and the Canadians will loft Radarsat in 1994 or 1995.

ERS-1's three radar instruments have lived up to the expectations raised by Seasat. Its synthetic aperture radar, or SAR, produces images of Earth's surface. It achieves a very detailed resolution of 25 meters by using a long exposure as it flies along, rather than a snapshot, and electronically sorting the reflected radar signals to form an image. Oceanographers use the images to study the distribution of sea ice, coastal erosion, and ocean features such as currents and temperature fronts. The scatterometer uses three radar antennas to look at the roughness of the sea surface from three angles, ahead, behind, and below the satellite. Combining the data from all three antennas produces maps of wind speed and direction, potentially of great value to weather forecasters. The third radar instrument, the altimeter, bounces radar pulses off the surface directly below the satellite. The round trip time of the pulses gives a measure of the height of the sea surface to an accuracy of just a few centimeters. By looking at how the return signal is smeared, oceanographers can also assess the height of waves, and the signal's amplitude indicates surface roughness, and hence wind speed.

Although ERS-1 is officially an experimental satellite, much of the data pouring down from these instruments is being channeled directly into practical uses. Norway, for example, has built its own receiving station and processing facilities at Tromso, and is churning out SAR images within 2 hours of observation, according to Johnny Johanessen, research director of the Nansen Environmental and Remote Sensing Centre. Johanessen says various institutions are already using these images to monitor sea ice for the shipping and fishing industries, to track ships, and to spot oil spills.



ESA/SERC/RAL

Atlantic jacuzzi. ERS-1's infrared radiometer captured this 200-kilometer-wide swirl of warm water *(shown in green in lower right)* southeast of Cape Cod, where the Gulf Stream and Labrador current meet, in 1991.

Weather forecasters have also been experimenting with wind-speed and direction maps from the scatterometer to try to improve their ability to predict the progress of weather systems over the oceans—although with mixed results. Hollingsworth of the ECMWF has found that, on a global scale, their forecasting model was not much improved by plugging in ERS-1's scatterometer data, largely because the tracks of the satellite are far apart, leaving big gaps in coverage. Tests indicate, however, that the scatterometer data can improve forecasting models in the Southern Hemisphere, where there has traditionally been a lack of observations from ships, says Dave Offiler of Britain's Meteorological Office in Bracknell.

ERS-1 data appear to have the most potential for improving forecasting of small weather systems with intense winds, such as hurricanes, typhoons, and polar lows, says Hollingsworth. Most weather satellites can only infer winds from the movements of clouds, and ships and aircraft tend to steer clear of hurricanes. The scatterometer's fine resolution can give a much clearer picture of the scale and structure of the storm. "If you get a hit, you can get a better fix on these damaging types of storms," he notes. Sometimes, however, getting a hit has proved difficult: Although ERS-1 passed right over Hurricane Andrew, it returned no scatterometer data on the storm. The reason? The SAR and the scatterometer cannot be operated simultaneously, and at that time the SAR was switched on.

Data delay. With all this emphasis on operational uses, some researchers feel they are being forgotten. They need more carefully processed data than weather forecasters do, with better corrections for variations in the satellite's orbit, tides, the curvature of Earth's surface, and atmospheric distortions. And although ERS-1 has produced some spectacular research material, many researchers think that the satellite's high-precision data has been too slow in coming.

Rapley's group at the Mullard Space Science Laboratory, for example, has been hampered in its efforts to use the altimeter to gauge whether the ice sheets covering Antarctica and Greenland are growing or shrinking. "The data we have received so far have produced stunning topographical maps," says Rapley, "but it is not detailed enough for a mass balance."

Guymer's group, too, is making slow progress in exploring a possible relationship between El Niño and the height of waves in the Northern Atlantic and Pacific oceans. They saw hints of a relationship in data from the altimeter on board the Geosat satellite, but because Geosat was able to capture only one cycle of El Niño, it was impossible to look for consistent patterns. Guymer hopes that with ERS-1 and ERS-2 they will get a couple more cycles. "With many years of radar altimeter data we will be able to unravel some of the mechanisms involved," he predicts. By late April this year, however, Guymer's group had received highly processed altimeter data from ESA only up to early July 1992.

Frustration at such delays boiled over at a symposium ESA held in Cannes in November last year to look at the first research results using ERS-1 data. Guymer's group convened a splinter meeting of disaffected researchers. "It was clear that there were a lot of unhappy people in the international community," Guymer says.

Stefano Bruzzi, assistant mission manager for ERS-1 at ESA's Paris headquarters, admits that there have been delays in producing the high-precision data some researchers need. "ESA underestimated the processing power required to generate such [high-quality] products in massive quantities," Bruzzi told *Science*. And, because only about 18 research groups require the type of data Rapley is holding out for — compared with hundreds of groups that want other types of data— "They came to the bottom of the list of things to do."

In the meantime, Guymer's group is filling the gap by getting some detailed ERS-1 data from an unlikely source: the United States. Through an agreement with ESA, the U.S. National Oceanic and Atmospheric Administration (NOAA) receives the fast-processed altimeter data from ERS-1. Robert Chaney of NOAA's satellite and ocean dynamics branch is making his own corrections and his souped-up data can be obtained by any of ESA's nominated scientists through a computer network within 2 weeks of observation.

Thanks to such stopgap measures and the promise of better things to come, ERS-1 is creating a tangible buzz among researchers. Chaney, for example, is also using his improved data to probe El Niño, and he sees the satellite as a boon. "ERS-1 had the only altimeter viewing [during the 1991-92 El Niño] and its precision and accuracy were a great success," he says. Unusually, a second warm current began late last year, straight after the last one, and is still evolving now. "ERS-1 is the only satellite with a complete record," says Chaney.

And European researchers are looking forward to many years of similar continuity. ERS-2 is a virtual carbon copy of ERS-1 with the addition of a sensor for atmospheric ozone. Later in the decade, the first of Europe's large polar platform satellites, Envisat-1, will be launched with many of the same radar sensors and others as well, giving researchers more than 10 years of data to work with—a time scale that is essential to tease out some of the infinitesimal effects of global warming.

Taking the long view helps Johannessen, at least, be philosophical about the delays. "When people want the best data possible, you will have delays. ESA is learning: It will be much better prepared for ERS-2 and the polar platforms." Chaney looks at ERS-1 from a different perspective. He's delighted by the cooperation between the United States and Europe in sharing ERS-1 data, but he bemoans the failure of NASA to capitalize on the promise of Seasat. "The balance of power," he says, "seems to have shifted."

–**Daniel Clery**