29 Minutes -- January 21-23, 1998
U.S. JGOFS Scientific Steering Committee Meeting
University of California, Santa Barbara
The Upton Hotel

Attendees

Scientific Steering Committee Members: M. Abbott, R. Anderson, W. Berelson, S. Doney, H. Ducklow (chairman), S. Emerson, P. Falkowski, D. Hansell, G. Jackson, C. Lee, M. Lewis, J. McCarthy, D. McGillicuddy, A. Michaels, R. Najjar, J. Sarmiento, D. Siegel, W. Smith, D. Wallace

Time-series programs: N. Bates, A. Knap, BBSR
Planning Office: M. Bowles, C. Hammond, M. Zawoysky
National Science Foundation: D. Rice, P. Taylor
Guests: J. Alberts, ASA; J. Reichman, NCEAS; R. Smith, UCSB

29.1 Introduction

Chairman Hugh Ducklow opened the meeting with a welcome to the new members of the SSC. Dave Siegel welcomed participants to Santa Barbara and introduced Jim Reichman, director of the National Center for Ecological Analysis and Synthesis (NCEAS).

29.2 National Center for Ecological Analysis and Synthesis

Jim reviewed the history of the center, which is located in downtown Santa Barbara. The center emerged from a series of workshops funded by NSF during the late 1980's and early 90's that focused on the problem of promoting and funding synthesis among the disparate subdisciplines of ecology. The University of California at Santa Barbara won the competition to host the center, for which NSF provides $2 million a year and the state and university, somewhere on the order of $500,000 to $1 million a year.

The center supports analysis and synthesis in ecology in a number of ways. It hosts workshops and working groups and offers some six positions each year for visiting scientists who are on sabbatical from their home institutions. It also supports nine or 10 postdoctoral researchers. The center does not have a permanent faculty, although university faculty members serve as visiting professors there.

Both NSF and the university are letting the center go its own way, Jim said. Those interested in center support for a workshop, project or residency can submit proposals for either of two deadlines a year. Jim encouraged his audience to think of the center as an option for synthetic projects that have an ecological orientation. One of its goals is to encourage scientists to break away from traditional approaches or orientations. He encouraged SSC members to visit the center, look at its brochures or consult the center's

World Wide Web site.

Hugh Ducklow asked how much of the $2 million a year provided by NSF is available to support visiting groups. Jim said that $1.2 million was available for that purpose. The rest goes to postdocs, sabbatical grants and administrative expenses. NCEAS has supported 65 activities in its first three years, he noted, recommending small groups and stays of at least a month.

The center only has small meeting rooms and uses space at The Upham when it needs to. It is in downtown Santa Barbara rather than on the university campus. The distance from the campus is small but valuable, Jim said; visitors at the center thus avoid falling into university patterns of behavior. In answer to a question about interaction with students, Jim observed that the center was more relevant for graduate students and postdoctoral researchers than it was for undergraduates.

After thanking Jim for his presentation, Hugh ran briefly through the agenda for the meeting and asked whether there were any items to add. Ray Najjar asked whether there were any prospects for further research in the North Atlantic. None in U.S. JGOFS, Hugh answered, adding that the program did not include plans for any more major field studies.

29.3 Southern Ocean Process Study (AESOPS)

Antarctic Support Associates representative Jon Alberts began the AESOPS presentation with a discussion of logistics for the Southern Ocean cruises. RVIB *Nathaniel B. Palmer* has carried six AESOPS cruises and R/V *Roger Revelle*, two to date. The second survey cruise in the Antarctic Polar Frontal Zone is at sea aboard *Revelle* at the moment with Kenneth Coale as chief scientist. One more cruise is scheduled for *Revelle* and one for *Palmer*. Wilf Gardner will be chief scientist for the second APFZ process cruise. Sus Honjo will be chief scientist for the benthic processes and mooring recovery cruise, which will collect the 12 bio-optical moorings deployed last November as well as the eight sediment trap arrays deployed late in 1996.

Jon noted the challenges of planning for work on *Revelle*, a new UNOLS vessel operated by Scripps Institution of Oceanography. Scripps and ASA do things quite differently, he said, but everything is working well now. A Scripps representative comes to each port call. AESOPS is the first big project for *Revelle*, and she is doing very well in the rough weather of the Southern Ocean, he added.

Radioactive waste of any sort is a real problem in New Zealand, Jon continued. The authorities are allowing waste from *Revelle* to be trucked to the airport and flown back to Scripps. Radioactive waste from *Palmer* is unloaded at McMurdo and shipped back to the U.S. on *M/V Greenwave,* a private resupply vessel that goes under contract to the U.S. Antarctic program once a year.

Other logistic problems included not quite enough lab space on *Revelle*, an inadequate staging bay, and difficulties operating both a regular and a trace-metal-clean rosette on cruises. The TMC rosette was lost on the first survey cruise, and a replacement had to be found for the first process cruise. A CTD

deployment on Process 1 snagged sediment trap mooring 1, causing it to break partway down; two PARFLUX traps, an array with three IRS traps, and one current meter surfaced prematurely. PARFLUX trap samples were preprocessed on board and sent to Woods Hole. The IRS organic chemistry traps were sent on to McMurdo via *Greenwave* to await the arrival of *Palmer*.

Walker Smith spoke next on the Ross Sea component of AESOPS. The Process IV cruise aboard *Palmer* left Lyttelton Nov. 5 and traversed the 170°W transect southwards, meeting up with *Revelle* in the APFZ just south of 60°S. Scientists aboard both ships conducted SeaSoar surveys; the one aboard *Palmer* had to be terminated after six hours. The Process IV cruise occupied stations at Sei, Orca, Minke, at the edge of the Ross Ice Shelf and all along the JGOFS line at 76°30'S, encountering ice at Sei and along the line on the first transect from east to west. Another SeaSoar survey was conducted during one of the transects.

Although there was ice in the western and eastern parts of the Ross Sea, the polynya had opened up by the time *Palmer* got there. Process IV participants found a steady rise in fluorescence as the bloom developed and reached high levels in the western part of the study area particularly. The sampling plan of this cruise was designed to catch mesoscale variability, which is considerable in this area, Walker said. Even so, the original sampling plan did not allow investigators to get the full picture on biomass; several stations in high biomass areas were added as a result.

This cruise was the first to have SeaWiFS imagery available. The SeaWiFS images of pigment concentrations agreed nicely with what those onboard *Palmer* were seeing and showed clearly the high level of mesoscale variation.

Various questions arose about getting access to SeaWiFS data. Mark Abbott noted that the real complication was how many people at a given site have to be listed as "authorized users" (investigators, graduate students, technical staff). NASA is still wrestling with this problem, he said.

Paul Quay asked about drawdown of nitrogen and phosphorus observed on the cruise. Hugh Ducklow noted a good correlation between fluorescence and pCO2 values from SeaSoar measurements. Doug Wallace asked about range of depths. Some operators are more willing to go near the surface than others, Mark said.

Mark Abbott spoke next on observations in the Antarctic Polar Frontal Zone. The first survey cruise on *Revelle*, which left Lyttelton Oct. 20, focused primarily on mesoscale variation in physical properties rather than biological or chemical. SeaSoar data on temperature and salinity marked the polar front at around 60°S. The SeaSoar provided data on characteristics in the upper 100 meters of the water column to within a couple of meters from the surface.

Twelve bio-optical moorings were deployed between 60°S and 61°S and 169°W to 171°W. High chlorophyll is associated with the troughs of meanders, Mark said. Drifters were also deployed during both APFZ survey cruises, and a large iceberg that hung around the vicinity provided a natural drifter as

well.

The various instruments deployed showed downwelling and convergence as well as upwelling and divergence along a front that meandered between 60°S and 61°S. The aim was to calculate the vertical as well as horizontal movement of water parcels. The drifters are carrying on, for the most part, and showing how the meanders converge and diverge as they move. Local-area coverage data from SeaWiFS will be available for the polar frontal zone. Mark will put the images on the World Wide Web. He noted that one should be a licensed user to get them, but he is not checking.

Bob Anderson continued with reports on the first process and second survey cruises to the APFZ. He showed an overall map of the study region, which was a great help in visualizing the frontal zone. Bathymetric measurements in the area between 60°S and 61°S around 170°W show vertical relief in excess of 1,000 meters over very short distances, he said. The Ross Sea, of course, is much shallower.

Bob described the seasonal evolution of the polar frontal zone, showing changes in nitrate, silicate and sea-surface temperature from south to north as spring blooms progress. The winter ice comes out to 62°S regularly at 170°W, where it is at the northern edge of its range, he said. The Survey II cruise found the ice quite far south at around 67°S. The rapid retreat of the ice has a tremendous effect on the physical characteristics of the water, he added. The surface water warms, and the circumpolar deep water erodes the mixed layer from below.

The Process 1 cruise on *Revelle* also received SeaWiFS images in early December during a brief spell of good weather. They showed the Subtropical and Antarctic convergences and a band of high chlorophyll between 62°S and 64°S around 170°W. These images confirmed that what those on shipboard were seeing was characteristic of the region.

The Process 1 and Survey 2 investigators found the phytoplankton bloom following the retreat of the ice south. Sinking particles and regenerative products such as ammonia seemed to be advected northward. We need to get a better idea of whether we are really looking at northward advection or a more one-dimensional progression that happens in each location as the bloom moves south, Bob said. Is the loss from northward advection and sinking or straight vertical sinking?

Chief scientist Ken Coale faxed up-to-date information from the Survey II cruise transit south earlier this week. He noted that the silica at the front had been almost entirely consumed with a precipitous drop at 65°S to almost nothing. Nitrate was drawn down where the fluorescence was highest; the peak bloom was at about 65°S. "A wildfire moving south, consuming silica as it goes," Ken wrote.

The pCO2 data from the region also show the seasonal evolution in the frontal region, Bob said. The water and atmosphere are in equilibrium in the wintertime, and in the spring a deficit develops between 60°S and 65°S and drawdown begins. Investigators have observed undersaturation of pCO2 in surface waters during austral summers. Observations in February 1997 showed the surface waters returning to equilibrium, and ones made in April 1997 showed the water and atmosphere in equilibrium.

Discussion ensued on what limits the carbon exported from the surface waters to the depths. Cindy Lee noted that silica limits the amount of the flux, while nitrogen and iron limit productivity in the surface waters. The classic question, Bob said, is how so much material gets to the bottom when production is not high. The classic answer, he added, is that regeneration is low. He also pointed out that it is important to know which species are involved.

Bob went on to describe plans for the benthic processes and sediment trap recovery cruise, scheduled for late February through early April aboard *Palmer*. This cruise will have a multicorer, which is needed to capture surface fluff, and Fred Sayles's WHIMP (Woods Hole Interstitial Marine Probe). Good bathymetric data will be a great help; earlier cruises lost all kinds of benthic equipment on the seafloor mountains down there, Bob said. Long as it is, this final cruise has barely enough time to get everything done, he added. The sediment trap and bio-optical moorings will be picked up, and an attempt will be made to retrieve the rest of the broken-off mooring array at Station 1 (53°S, 175°W).

Mark Abbott returned to make a brief presentation on his bio-optical moorings. He is measuring sea-surface fluorescence with 12 optical arrays in order to capture the variability in space and time that is characteristic of the polar frontal region. This variability is associated with a non-equilibrium community of producers and grazers, he pointed out.

The 12 moorings have Marlon Lewis's radiometers at the top (50 meters), followed by current meters and, in some cases, microcats (which act like mini-CTDs). These are attached to 37-inch spheres, deployed at 100 meters. The releases hang below the spheres; the rest of each line and the anchors will be abandoned. These moorings were deployed with careful attention to the bathymetry of the region, Mark said.

Walker Smith talked briefly about the first AESOPS data workshop, scheduled for June 17-24 in Knoxville. It will be modeled on the equatorial Pacific workshop in Scottsdale, he said. He and Bob would like to include representatives of other national programs, SMP participants and representatives of other programs, such as GLOBEC, ROAVERRS and the Palmer LTER site. He asked for input from SSC members.

Tony Knap applauded the idea of including modelers, noting the overlap of AESOPS and the Synthesis and Modeling Program (SMP). Scott Doney noted that at least one of the funded SMP projects was particularly relevant to AESOPS interests. Cindy Lee suggested that the international participants come toward the end of the workshop, after US investigators have sorted out their results among themselves.

29.4 Time-series Programs

In Dave Karl's absence, Tony Knap reported on the status and activities of both U.S. JGOFS time-series programs. NSF has refunded both BATS and HOT for three more years. Thus no definite plans have been formulated as yet for the eventual incorporation of the time-series programs into NSF's Long-Term Ecological Research (LTER) program.

Dave sent a HOT progress report to the SSC, and Tony reviewed some of its highlights.

Participants in the WOCE component of the HOT core measurement program will submit a renewal request next month (Feb. 1998).

The HALE ALOHA mooring was recovered and redeployed in December 1997. It is supported by NSF funds other than JGOFS.

The bottom-moored sediment trap at Station ALOHA was also recovered and redeployed in December 1997.

The ship schedule for 1998 includes 12 regular HOT cruises and two mooring recovery and redeployment cruises.

HOT participants are collaborating with several time-series programs of other nations as well as with BATS.

Dave plans to host an international symposium on oceanic time-series to coincide with a HOT 100 science symposium and the 10th anniversary of the U.S. JGOFS time-series programs in 1999.

HOT ship problems continue. R/V *Moana Wave* will be retired. The University of Hawaii is bidding for the operation of a new research vessel, but a gap is likely in any event.

Tony continued with a similar presentation for BATS, which has conducted 112 core measurements cruises, 31 bloom cruises and 19 validation cruises. Ancillary research programs continue to make use of BATS cruises, facilities and measurements. In addition to these projects, BATS technicians take samples for other researchers.

With the departure of Tony Michaels, BATS responsibilities have devolved upon several BBSR staff members, including Debbie Steinberg, Craig Carlson and Nick Bates. Rod Johnson has taken care of the physical measurements since the beginning.

BATS data available via the program's home page include hydrography, nutrients and primary production. The hard-copy data reports are likely to be discontinued, Tony said, and data will all be available electronically. New projects include neutrally buoyant sediment traps, an automated underwater vehicle coming from the U.K. this summer, and possibly some SeaSoar surveys. The Bermuda test-bed mooring (Altomoor) has not yet received NSF funding, but the investigators involved plan to keep trying.

Steve Emerson asked why it is proving to be so difficult to get moorings funded for HOT and BATS.

Tony Michaels pointed out that it is not the expense; these proposals do not review well, and it is hard to get new things started. Steve observed that the SSC should make an effort to get these projects funded if the group thinks that they are really important. Paul Falkowski suggested that NSF approach NOAA, which puts out lots of moorings, to support the mooring itself while NSF funds the projects on the mooring. Mark Abbott cautioned that moorings were being cut back at NOAA.

Cindy Lee asked whether the LTER program was a possible source of support. Phil Taylor pointed out that the LTER program was not focused on monitoring but rather on long-term research. Paul suggested that Tony and Dave agree on what should be on the moorings, get the numbers together and approach NOAA. Don Rice reminded everyone that a proposal to NSF means a reviewing committee. Money and subject are not the issues, he said. Despite the popularity of the time-series stations, the scientific community does not seem to favor testbed moorings. He urged scientists to support NSF's interagency efforts. Ray Smith asked whether support for moorings could come from "platform" funds instead of research funds. Don noted that increasing funds for one category would reduce funds for the other.

Hugh Ducklow asked Steve, Mark, Paul and Tony to get together and to come back to the SSC with a set of recommendations.

Dennis McGillicuddy presented an overview of validation activities at BATS. He and others have been looking at mesoscale variability around the BATS sampling site in order to assess possible island effects and the larger physical and biogeochemical context in which the BATS sampling is conducted. Measurements made aboard validation cruises support a conceptual model of how eddies below the euphotic zone might affect parameters such as surface temperature, nitrate and nitrite, and chlorophyll a in the study region. The 1997 validation activities had the benefit of real-time altimetric measurements of sea-surface height. Eddies appear to bring water bodies in contact with each other and aid in transferring nutrients to the surface.

Nick Bates from BBSR made the next presentation on a number of measurements that have been made over the years on BATS cruises. He showed correlations between eddies and TCO2, pCO2 and chlorophyll levels, for example. He also showed long-term trends in nitrate and phosphate levels measured at BATS as well as changes in carbon isotope ratios and TCO2 and pCO2 levels on a seasonal and interannual basis and at various depths.

29.5 LTER Program at Palmer Station on Antarctic Peninsula

Ray Smith of UCSB was invited to speak on the LTER program at Palmer Station and the opportunities for cooperation between this program and U.S. JGOFS. The LTER program has a distinct research niche, focused on long-term and large-scale processes with considerable attention to low-frequency events, Ray said. It was founded by NSF in 1981 and currently has 20 sites and 64 grants. All sites are in the U.S. except one in Puerto Rico and two in Antarctica. Core data on primary productivity, nutrients, organic matter, transport and so forth are collected at most sites. The LTER program has a network office at the University of New Mexico and a link between this office and the NCEAS in Santa Barbara.

The Palmer LTER program, in which Dave Karl is a principal investigator, focuses on the antarctic marine ecosystem south of the polar front. A central working hypothesis is that interannual variations in physical processes affect all levels of the food web in the Southern Ocean. There is a link between the sea ice and seasonal productivity, sedimentation, the microbial loop, krill abundance and the survival of bird species, Ray said. Investigators are seeing evidence of long-term trends in temperature and the extent of sea ice. El Niño years are associated with high ice in the Palmer area, though not the Southern Ocean as a whole, he added. Investigators have created a sea-ice index that serves as an indicator of ecological trends.

Ray also reviewed a number of other programs, national and international, that are taking place on the Antarctic Peninsula. Long-term records show that mid-winter temperatures have increased over the last half century by 4° to 5°C, he said. Effects have included reductions in the size of glaciers and the length of time that fast ice stays along the shores as well as changes in size and distribution of penguin populations.

SSC members expressed their appreciation for Ray's interesting presentation and went on to discuss the future of the time-series programs and the possibilities for placing instrumented moorings in strategic locations. Among the topics were the merits of using more small, inexpensive moorings like the bio-optical array in the Southern Ocean versus deploying fewer large, highly instrumented moorings. Dave Siegel and Marlon Lewis raised the question of putting sensors on the TOGA-TAO moorings in the Pacific.

Don Rice noted that the community outlook on moorings and time-series measurements has changed considerably over the last few years. Instrument packages are being developed that are very important to chemical oceanography; technology has grown exponentially in recent years. One of the objectives of the chemical oceanography program at NSF is going to be to support the development and use of instruments as well as the integration of information from small-scale sensors with satellite data. It's a new time, he said.

29.6 Status of the Planning Office

Hugh Ducklow noted the departure of Hugh Livingston from his position as executive scientist and director of the U.S. JGOFS Planning Office and expressed his tremendous appreciation of all that Hugh had accomplished over the years. There are no plans to move the office from Woods Hole and many reasons to leave it there, he said. Hugh Livingston got the next planning office proposal done before he left, well ahead of time. Funds are now in place for the next three years. Mike Bacon, chairman of the WHOI chemistry department, is filling in as planning office principal investigator for calendar 1998, and chemistry department executive assistant Susan Casso is handling all the budget matters.

Don Rice pointed out that WHOI is the grantee for the planning office grant and has the option of suggesting administrative changes. Suggestions for the future should be made to the investigator of record or to Hugh Ducklow. Hugh observed that, with the planning office at WHOI, it was useful to

have a WHOI person as executive scientist. The position is going to decrease to half-time, he noted. In answer to a question about approval of the choice of the new executive scientist, Hugh said that he would like the whole SSC to approve the choice. Don said that the principal investigator of record (Mike Bacon currently) would make the final decision, but he would listen to all input.

29.7 U.S. JGOFS Budget Projections

The second day of the SSC meeting began with a discussion of U.S. JGOFS budget projections, led by Don Rice. Don first reviewed current support for the Synthesis and Modeling Project (SMP). Since NASA had 1997 funds to expend, the first call for proposals was timed to allow NASA managers to make awards during that fiscal year. NSF and NASA decided to split the proposals up rather than co-fund them. NASA funded 18 proposals, and NSF funded 10.

Don noted that some of the SMP proposals funded for this period received funds "up front" and others, over three years. He also explained that the $90,000 a year for GAIM and SCOR represents U.S. support for the Global Analysis, Interpretation and Modeling (GAIM) project of the International Geosphere-Biosphere Programme (IGBP) and for the JGOFS International Planning Office in Bergen.

Pointing out that funds for U.S. JGOFS activities over the fiscal years 1998 to 2000 will come from NSF's Office of Polar Programs and from NASA as well as from NSF Ocean Sciences, Don then presented projections from all sources.

Fiscal year 2002 is likely to be the last for U.S. JGOFS funding, Don said. Internationally, JGOFS activities are expected to continue until 2004 or 2005. He is expecting to hear from JGOFS executive scientist Roger Hanson on this topic. Funds would have to be allocated in FY 2002 for any U.S. JGOFS activities in the years out to 2004-05.

NSF will solicit U.S. JGOFS SMP proposals for the OCE submission deadline of Aug. 15 each year from 1998 (FY 1999) through 2001 (FY 2002). It is not yet certain whether or not NASA will be able to commit more funds for supporting SMP projects. Proposals that are declined can be refined and resubmitted, Don said, noting that everyone wants to see a good synthesis emerge from U.S. JGOFS. "We will have several opportunities to think about what has been achieved and what remains," he said. Updates on topics of proposals funded to date should be available on World Wide Web sites such as the U.S. JGOFS home page. Awards will become more and more competitive as we go along, as the trend will be to fund proposals up-front, Don said.

Tony Michaels asked whether funds would be provided upfront to support the U.S. JGOFS Planning Office through 2004-05. "The office has to be around to turn out the lights and to do something with the data set," Don said, adding that he was told a year ago that U.S. JGOFS would ramp down rather than be cut off at a certain point. His guess is that the NSF funding that has gone to U.S. JGOFS over the last decade will remain in core budgets and that money would be available, in theory, to be applied to JGOFS needs if absolutely necessary as well as to fund new ocean biogeochemical projects.

Jim McCarthy asked about the role of the SMP committee in the process of evaluating SMP proposals. The SMP has research needs that are going to be vetted through this committee, he said, asking Don if that was how he saw its role. Don said that both the SMP committee and the SSC should be involved in assessing what U.S. JGOFS has accomplished and what remains to be done. He pointed out the value of providing such an assessment on the U.S. JGOFS web site.

Further discussion focused on the problem of filling gaps in the knowledge that is needed to meet JGOFS goals. Referring to the charges to the SMP from the steering committee, Jorge Sarmiento argued that fulfilling the responsibility laid on them would require committee members to look carefully at proposals and to make suggestions for filling gaps observed. He also expressed concern about building up synthesis and modeling expertise and maintaining it.

In answer to questions about the practical effects of "front-end" funding, Don explained that the principal investigator population would be low now and increase to its maximum in 2001. In 2002, there would be a substantial drop, but that smaller number of investigators would continue until 2004-05.

Will Berelson asked whether any field work would be funded through the SMP. Don said that the chances were remote and that the case would have to be compelling. Phil Taylor pointed out that it was a mistake to erect a false distinction between JGOFS and non-JGOFS work. There is nothing to keep investigators from submitting proposals for core funds to address JGOFS-type topics, he said. Will asked whether there would be enough money to make sure that former principal investigators could come to the final workshops. Jorge and Scott Doney pointed out that there was money in the SMP budget for workshops.

29.8 Synthesis and Modeling Project (SMP)

Scott Doney began his presentation with an SMP time line (Appendix 1). The current plan is to hold a meeting this spring for funded investigators and the SMP working groups, followed by the annual SMP workshop in July. Second round of proposals are due by Aug. 15, 1998.

SSC members debated the need to hold a principal investigators' meeting in addition to the summer workshops. Cindy Lee pointed out the difference between the practical planning participants in projects need to undertake and the broad perspective and range of topics of the annual workshops. Scott indicated that an investigators' meeting could be held at the beginning of the summer workshop. Hugh Ducklow emphasized the responsibility of the SSC to help define the nature of the SMP as it gets rolling.

"We just have names and titles at this point and do not really know what investigators have in mind," Jorge Sarmiento said. "We need to get everyone together to see what people plan to do and to look at SMP goals as a group." Comparing the SMP workshops to cruises, Cindy emphasized the need to get everyone to look at links and the big picture, to get beyond "I want to measure this." Dave Siegel recalled that the SeaWiFS science team meetings had been held too early to be effective, saying he was leery of holding a meeting soon.

Scott gave a quick overview of the 1997 summer workshop, held in Snowbird July 28 - August 2. Objectives included interaction between modelers and field workers, discussing problems with models and exploring methods for modeling particular processes. He also reviewed the topics of the working groups: community structure and export, parameterizing unresolved processes, remineralization and vertical transport, and Southern Ocean time series.

How well did it work? Mixed results, Scott said. At that point the SMP coordinators and committee had no idea who was funded. Therefore the meeting was more of a science symposium than a workshop. Hugh pointed out that lots of field researchers made presentations that went into detail about processes and measurements, and lots of modelers were listening carefully and participating. Cindy agreed and said that the Snowbird meeting was well balanced.

The summer meeting will include participants other than the funded investigators, Scott said. Marlon Lewis pointed out that these investigators are not all numerical modelers; they include a number of field researchers as well.

Dave asked about getting data sets with fields put together in a synthetic way so that they can be used for intercomparisons. Scott offered an example from the global CO2 survey, showing how data can be converted from an irregularly spaced set of sampling points into a set that can be used to parameterize a model. Cindy noted that participants in the Arabian Sea workshop tried to get all the carbon flux data together into one set, a task that took considerable time and energy. George Jackson cautioned about overlooking problems of interpretation and translation of measurements in the effort to build a big picture.

Discussion followed on how to measure success of synthesis efforts and how to achieve consensus on what matters and what does not for the functioning of a model. Reminding the group of the charges to the SMP, Jorge noted that there were clearly stated goals in the implementation plan but no clear statement of how we know when we have achieved these. One thing we have to develop is a quantitative measure of progress toward achieving goals, he said.

After a brief break, Scott reported on the progress of community ocean modeling and data assimilation efforts. Two NSF-sponsored meetings were held in early 1997. Both Hugh Ducklow and Doug Wallace attended an ad hoc committee meeting last September in Washington, D.C. This committee agreed on the need for data assimilation across the subdisciplines of oceanography, the critical role of good physical measurements, the need to develop community infrastructure, and the need to hold a workshop in May. Scott described a conceptual data assimilation system with hubs and nodes, including centralized data facilities with powerful computers.

One of the tasks of this committee was to make progress on the question of an ocean data assimilation center. Hugh noted the problem of breadth, which was discussed at length at the meeting. If such a center were to be funded, it would have to address the needs of the whole community. He felt reasonably

certain by the end, he said, that this project is not going to be driven by the needs of physical oceanography alone.

Marlon asked what data assimilation meant for this community. Scott mentioned the benefit from historical analysis. Jorge noted that awareness of the connections between changes in ocean circulation and changes in biology has not yet made its way into long-term planning efforts such as GOOS. "We have a responsibility to make sure that these are not overlooked," he said.

Jim McCarthy asked which federal agencies were supporting the planning for a possible ocean data assimilation center. NSF now, Scott said, but NOAA and NASA will be needed as well. This particular planning effort is being promoted by Mike Purdy's office (OCE), Hugh said. Don added that the initial idea emerged from U.S. WOCE and that Mike got involved when the question of relevance for the rest of the oceanographic community arose. It is important for biology, chemistry and geology to have a place at the table, he said. This is an effort to capture new money for NSF's Geosciences Directorate, Hugh said.

Scott observed that physical oceanographers have a huge number of observations; they need to put then together to make good use of them. We do not have the same scale of need that the physicists do, Hugh said, but such a center needs broad support and we will need this capability before long. We should not miss this train, he added. Doug said that the CO2 survey data was almost ready for the sort of inverse calculations that the WOCE scientists want to do with their data.

Scott went on to list the tentative SMP working groups, made up of the principal investigators. The current list is:

Global and regional mass balances: Hansell, C. Keeling

Euphotic zone production and export: Carpenter, Falkowski, Jackson, Laws, Arrigo, Carr, McGillicuddy, Muller-Karger, Walsh

Transport and remineralization: Roman

Sediment diagenesis: no one listed

Extrapolation and prediction: Barber et al., Caldeira, R. Keeling, McClain et al., McGillicuddy, Najjar et al., Marshall and Fellows, Siegel

The next topic was the SMP steering committee. Scott Doney and Jorge Sarmiento serve as co-chairmen, and Rob Armstrong serves as SMP project scientist. Current members are Dick Barber, Eileen Hofmann, Marlon Lewis, Tony Michaels and Jim Murray. The committee is proposing that Eileen, Tony and Jim rotate off, and that Dennis Hansell, Dennis McGillicuddy, Ray Najjar and Dave Siegel join the committee.

George expressed concern that the committee thus constituted would be strongly global in orientation and that it should have someone interested in processes. Jorge agreed that all were global in outlook but were also interested in a variety of processes. Although the committee would like to keep her, Eileen is unable to continue. Neither Tony nor Jim are SMP principal investigators.

Tony asked about the point of the new committee. Its predecessor had been responsible for putting together the implementation plan, but that was done. This group will help the co-chairmen with the management of the SMP, Jorge said. Phil Taylor asked whether the group was sufficiently diverse, noting that many of them would be working together as investigators. Tony Knap and Jim McCarthy pointed out that many of the persons listed were on the SSC and that they were going to be helping the co-chairmen anyway. Jorge agreed that the SMP did not really need a steering committee and that an informal management committee might be a more useful concept.

Next topic of discussion was the upcoming SMP summer workshop, which will be held July 13-17 in Durham, New Hampshire. Scott's outline proposed a two-day investigators' meeting, followed by a three-day international meeting titled " The Response of Ocean Biology to Global Warming." Thirty-six SMP investigators and 20 other persons will be invited. Scott mentioned Mike Fasham from the United Kingdom and Berrien Moore, SSC chairman for GAIM.

The global warming scenarios that are emerging from modeling simulations provide the scientific motivation for a workshop on this topic, Jorge said. These scenarios project big increases in ocean stratification, especially in the high latitudes as freshwater inputs increase, and suggest that biological processes have an important role in modulating the effects of warming on ocean CO2 uptake. The purpose of the meeting will be to exchange information and identify the issues that need to be addressed.

Noting that this topic addresses one of the goals of the SMP, Cindy asked how the SMP would address its other goals. Jorge noted that global warming has the potential to affect the entire water column and said that he was eager to understand how ocean phenomena could change under the warming and stratification scenarios.

Discussion moved on to the question of whether the workshop should include a principal investigators' meeting, or whether SMP workshops on broader topics should be held separately from such meetings. Jorge observed that he would like to be able to present scenarios to people at the SMP workshops and to get them thinking about how changes would affect processes and organisms. Some participants promoted the Gordon conference approach for discussions of broad and important topics. Scott pointed out that funds are in the budget for one summer workshop and several working group meetings. Both GAIM and the international JGOFS office are willing to contribute travel funds for international participants.

The consensus that emerged was in favor of holding the summer workshops and SMP investigators' meetings separately. U.S. JGOFS should organize and lead a workshop each year dedicated to assessing

a big topic and questions of future directions for research that arise from this topic. These workshops should attract broad participation rather than being restricted to SMP investigators. Funds are available for SMP PI meetings as well; these should be held separately, at least once a year.

29.9 U.S. JGOFS Data Management Office

After a break for lunch, Christine Hammond reported on the status of the U.S. JGOFS Data Management Office. David Schneider has joined Chris on a part-time basis to handle the collection of data and quality-control procedures, activities he has taken over from George Heimerdinger, National Ocean Data Center liaison officer for the northeast.

Chris reviewed current data management activities:

Investigators from the Arabian Sea Expedition have been great about getting their data in. Some 83% of the data are being served from the DMO; the rest are sediment trap data, which take longer to prepare for submission to the DMO.

Data from earlier process cruises are now open to all; passwords are no longer required, except for ONR and NASA data from the Arabian Sea study.

The office staff is preparing U.S. JGOFS CTD data from the Arabian Sea for inclusion in a JGOFS Data Management Task Team CD-ROM. This is an international project.

The ultimate strategy for archiving JGOFS data will be making and distributing CD ROM's, Chris said. There are none for EqPac or NABE, except for a British one with BOFS data. U.S. JGOFS data are currently served on the World Wide Web instead. Dennis Hansell asked whether ONR Arabian Sea data could be obtained on disk, noting that they were not available on the web at the moment. Ray asked why U.S. JGOFS data should be put on CD ROM's if web access is working well. Chris noted that web access was not permanent and that not everyone in the world could download data easily. George agreed, pointing out that it is not always easy to get large data sets via the web.

Turning to AESOPS, Chris said that the DMO had event logs and sampling inventories but no data yet. Walker promised to lean on the investigators. Some have their data ready to send in but are waiting for core measurement data. Both Chris and Dave will attend the AESOPS data workshop in June and be available to assist investigators.

Chris also reviewed systems activities. U.S. JGOFS web site documents are being maintained by Mary Zawoysky. A secure server is ready for the AESOPS data. The office has released an improved version of the U.S. JGOFS data system, an object-oriented, distributed system developed by Glenn Flierl, Dave Glover and Jim Bishop. It includes an installation page for downloading, a field width assessment function and a variety of other enhancements.

Not all U.S. JGOFS data are served from the DMO. BATS and HOT data are served from their own sites, both of which have recently upgraded systems. Some data from ancillary projects at the time-series sites are available online and some are not. CO2 survey data are served from the Carbon Dioxide Analysis and Information Center. Some of the Arabian Sea investigators supported by ONR have submitted their data to the DMO; this is voluntary on their part.

Chris also demonstrated the uses of the data projector that the DMO has acquired. The device can be used with a computer to project whatever is on the computer's screen. The office also plans to buy a CD writer, which will give it the capacity to make CD-ROM's. Chris concluded her presentation by urging SSC members to use the DMO as a resource.

Hugh Ducklow then invited Tony Michaels to speak on data issues in the SMP. Tony noted that U.S. JGOFS had a farsighted data management system with enduring value. Should we have a policy for archiving the output of models for the long term and providing access to this information as we do to data from field studies? If so, how do we do it? This output is a critical part of our legacy, he said. How do we develop standards?

Jorge observed that efforts by Geoff Evans, John Woods and others at the international level have not taken off. Cindy said that early in the program an agreement was reached that instruments acquired or developed during JGOFS would be the property of the program. Would that agreement apply here? Scott said that scientists at NCAR deal with these problems every day and that they are obliged to share both data and code.

Scott then put up a set of points to consider in developing a data policy for modeling:

What are similarities and differences between modeling and conducting field research?

Are models tools or scientific products (as oppposed to their output)?

How are models more than a set of equations?

What are the resources needed for storage, transfer and analysis of large simulations?

How should we compare and validate models?

How should we support development of "community models"?

Goals for a model data policy should include scientific replication, public access for comparing models to each other or to data, and the development of community models and code/model resources, Scott continued. Minimum model data requirements would include documenting equations and numerical algorithms in literature and technical reports, making public information on forcing functions, boundary conditions, validation and some form of final solutions, and contributing to the development of

community models.

Committee members discussed the pros and cons of sharing code and data sets. Jorge reminded everyone that a goal of the SMP is to develop models and make them available. He and Scott agree that a data policy is essential for the SMP. Duck wondered whether SMP investigators funded by NSF were subject to same data-availability requirements as ocean-going researchers. Jorge observed that the relevant NSF language seemed only to apply to measurements. Duck requested that the SMP management committee come to next SSC meeting with a model data policy. Dave Siegel asked whether US JGOFS requirements would apply to SMP investigators supported by NASA as well as those supported by NSF.

29.10 Arabian Sea Expedition

Cindy Lee gave an Arabian Sea report for Sharon Smith, who was ill and thus unable to attend the SSC meeting. She began by describing a joint Oman/U.S. symposium on the Arabian Sea that was held in Muscat last October. At that event Don Rice and Phil Taylor presented a plaque to Thabit Al Abdessalaam, director of the Omani Marine Science and Fisheries Center, in recognition of his contribution to the success of the Arabian Sea Expedition. Dennis Hansell gave a fine presentation, she reported.

Cindy mentioned several other noteworthy items. The satellite receiving station in Oman has been upgraded to collect SeaWiFS data. Some 36 manuscripts have been submitted for a special volume of *Deep-Sea Research*. Sharon is working on an Arabian Sea atlas. Cindy presented some sample figures from the atlas and asked for comments.

Plans for the future include a symposium at UNESCO headquarters in Paris after the TOS meetings in June. The JGOFS Indian Ocean Planning Group will meet at the ASLO/AGU Ocean Sciences meeting in February to discuss plans for workshops during 1998 and 1999.

Taking up the topic of synthesis of Arabian Sea data, Cindy cited as an example a multi-investigator effort to put together average annual carbon flux data from many sources. An article on their results is under review. The authors are bringing together particle flux data from the five Arabian Sea sediment-trap mooring stations, primary production measurements, thorium-235 measurements and cores. After reviewing the evidence provided by each sort of measurement and the variations in pools and fluxes among sites, Cindy pointed out that the Arabian Sea seems to be preserving 10 times as much carbon in its sediments as is preserved in the equatorial Pacific.

This sort of synthesis of field data will help modelers, Cindy said, stressing the importance of regular conversations between modelers and those who collect the data and the importance of workshops to bring people together.

Offering another example of synthesis of field measurements, Dennis Hansell noted that comparisons of

DOC data from different regions of the ocean have made it possible to see a gradient in DOC in the deep ocean (greater than 2,000 meters). DOC is highest in the North Atlantic and lowest in the Gulf of Alaska, he said, relating these figures to the age of water in different ocean basins. "We can now talk about DOC in terms of science rather than in terms of noise," Cindy said, noting the evolution of knowledge about DOC over the last decade.

29.11 Global CO2 Survey

Doug Wallace presented an update on the global survey of CO2 in the ocean. The survey has been completed with five WOCE cruises in the North Atlantic over the last year, two meridional sections and three to the subpolar gyre. The NOAA OACES program has one final cruise underway along 24°N. The German research vessel *Meteor* conducted a survey along 48°N last summer, and the survey was able to collect DOC and DIC data on this cruise, he added.

U.S. JGOFS is providing support for one more meeting of the CO2 survey science team; it will be held next month. Data on DIC and alkalinity are complete, along with information on methods and the like, for everywhere except the North Atlantic, Doug said. Crossover analyses, used as checks on internal consistency, are also underway for survey data from the Pacific, Indian and Atlantic oceans. The data set is being assembled at the Carbon Dioxide Information and Analysis Center (CDIAC) at Oak Ridge, and some data are available on line.

Doug reported next on the development of certified reference materials (CRMs), undertaken by Andrew Dickson and colleagues at Scripps. Doug noted that some 18,000 bottles of CRMs have been used in CO2 system measurements since 1990, 68% by U.S. investigators. Andrew has developed a very solid certification method for total alkalinity measurements. The DIC certification has been done in C.D. Keeling's lab. Andrew is trying to compare results from manometric techniques with those from Keeling's lab. DOE support for CRM development has expired; NSF is supporting the effort currently. OACES does not provide support for this work.

Various synthesis efforts are underway. Chris Sabine, Robert Key and other members of the DOE science team are working on the Indian Ocean excess CO2 inventory. Doug Wallace and Martin Holfort are working on South Atlantic transport. Catherine Goyet is working on three-dimensional interpretation and extrapolated fields. Both the DOE and the NOAA science teams are working on the problems of internal data consistency.

Goals of synthesis efforts include: a global ocean inventory; change in that inventory over time; ocean CO2 transport; a reassessment of air-sea fluxes; gridded products; interrelationships among nutrients, CO2 and alkalinity; methods for analyzing excess CO2. Many of these hoped-for results have links to WOCE synthesis goals.

Doug Wallace continued his presentation on the status of the global CO2 survey with a discussion of the scientific issues and methods involved in an approach to calculating the transportation of CO2 among

regions of the ocean. He is using an inverse modeling approach to calculating CO2 transport for the South Atlantic. Among his conclusions are that the northward transport of excess CO2 into the North Atlantic is large and that in the South Atlantic it is highest at 5°S and lowest at 35°S. The net preindustrial transport is to the south.

This approach is useful for getting at preindustrial CO2 transport and for separating out where CO2 is accumulating in the ocean. It is not a way to calculate the present-day air-sea flux of CO2, Doug said.

SSC members discussed the suitability of this topic for a future SMP workshop. Doug indicated that there was lots of interest in coming to grips with this issue. All agreed that synthesis of CO2 survey data, including working out calculations for physical and chemical processes at various latitudes, was important to the goals of the SMP.

Jorge followed with a presentation on a new estimate for part of the global carbon sink. In this project, he and his colleagues are trying to separate the sink into various regions. He began by showing the currently accepted figures for the terrestrial, oceanic and atmospheric sinks and sources in the global carbon cycle. He then explained how he and his coworkers developed a modeling project designed to sort out where the large carbon sink postulated for the northern hemisphere was actually located. This is a question with political as well as environmental implications, everyone agreed.

The modelers divided the terrestrial biosphere into three regions and evaluated each as a sink and a source of CO2. The results suggest that fossil fuel emissions and net ecosystem productivity (NEP) are close to balanced over the North American continent and that Eurasian emissions are considerably greater than NEP. Because of the relative lack of ocean data from the southern hemisphere, Jorge said, it is very hard to figure out the contribution of the land area of that hemisphere to the carbon cycle. He noted how valuable the new CO2 survey data set will be for pinning down what is happening in the ocean regions of the southern hemisphere.

More and better ocean measurements will make all the difference in these calculations, Jorge said. Knowing how large the North Atlantic sink is will be critical to solving the problem of the northern hemisphere sink. We need to develop techniques for reducing uncertainties in ocean sinks and sources and to show where in the world more stations are needed.

29.12 SeaWiFS Update

Mark Abbott reported that the SeaWiFS instrument and the satellite on which it is mounted were both performing as expected. Although data from the ocean color instrument are now freely available, Orbital Sciences is expected to start encrypting data later this month. SeaWiFS project managers want all users to register and obtain authorization, including students. The data policy is still evolving, Mark said.

Data are available through the Goddard distributed active archive center (DAAC), and reprocessing began in late December. Navigation, calibration and processing are all being improved. Data can be

obtained on tape or via ftp, either by order or by subscription. Unprocessed HRPT data are also available; Mark showed a map of stations for which HRPT data are being collected.

Plans are afoot to reprocess some of the CZCS data. There is a certain amount of interest in developing a chlorophyll product for the 1978-81 period.

A series of other satellites are scheduled for launch over the next two years. MODIS, which is part of EOS, is to be launched in June 1998. It will have a better signal-to-noise ratio than SeaWiFS, but it will cover a smaller area. NASA plans to launch a scatterometer (Quick Scat) in November 1998. Version 2 processing is complete for OCTS. MERIS will be launched in 1999 and GLI in 2000. A second MODIS satellite is scheduled for 2000 as well.

Land vegetation measurements are available from the SeaWiFS project as well as ocean color measurements. They are better than the ones available from AVHRR data, Mark said.

29.13 International News

Hugh Ducklow reported that Michael Fasham of Southampton Oceanography Centre, UK, is the new chairman of the JGOFS SSC. The international committee has a growing appreciation of the need for a serious investment of time, energy and resources into synthesis, he said. A data and synthesis meeting is planned for September in Bergen, Norway, and some colleagues from other national programs will be coming to the SMP workshop this summer. The book on the Villefranche symposium in 1995 will be published this year.

29.14 Other Business

Doug Wallace said that he was taking up a new job in Kiel, Germany, this fall and asked whether he should remain on the U.S. JGOFS SSC. Hugh asked him to stay on.

Noting that it would be advantageous to have two steering committee meetings a year, Hugh opened discussion about where and when to hold the next one. Dennis Hansell offered to check the availability of space in Bermuda during late August. David Karl has offered to host an SSC meeting in Hawaii in early 1999.

The meeting was adjourned at 11:30 A.M.