

COOPERATIVE AGREEMENT PROPOSAL

INSTITUTION: University of Hawaii
Joint Institute for Marine
and Atmospheric Research
(JIMAR)
1000 Pope Road, MSB 312
Honolulu, Hawaii 96822

TITLE: Joint Institute for Marine
and Atmospheric Research

PRINCIPAL INVESTIGATOR: Dr. Thomas A. Schroeder

SPONSORS: National Oceanic and
Atmospheric Administration
University of Hawaii

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I. BACKGROUND

A. Purpose

The Joint Institute for Marine and Atmospheric Research (JIMAR) is a research institute of the University of Hawaii (UH), at Manoa. JIMAR was created in 1977 through a Memorandum of Understanding between the National Oceanic and Atmospheric Administration (NOAA) and the University of Hawaii. It was created as a mechanism by which the resources of a research-oriented state university, the Environmental Research Laboratories (ERL) and other branches of NOAA could be brought together to develop a center of excellence in research in oceanographic and atmospheric sciences. It is the goal of JIMAR to provide:

1. A means to increase the effectiveness of oceanographic and atmospheric research of mutual interest to NOAA and the University of Hawaii,
2. A center at which scientists working on problems of mutual interest may come together,
3. A means to train scientists in the many disciplines involved in the oceanographic, atmospheric, and geophysical sciences,
4. Advice concerning the application of new knowledge to the various areas of special interest to both NOAA and the State of Hawaii (e.g., the Tsunami Warning System; Workshop on Tropical Mesoscale Meteorology; Pelagic Fisheries Management Plan (Western Pacific Regional Fisheries Management Council); International Pacific Desk Trainer).

B. Research Themes

Research in JIMAR has been concentrated in five areas, chosen with the approval of JIMAR's Advisory Board. The themes are: tsunamis and other long period ocean waves, climate, equatorial oceanography, fisheries oceanography, and tropical meteorology. Specific topics under these themes include:

1. Tsunamis (and other long period ocean waves)

- a. Archive of Rapidly-Sampled Hawaiian Sea Level
- b. Infra-gravity Wave Studies
- c. Laboratory and Numerical Modeling of Tsunami Run-up
- d. Field Analysis of Current and Historical Tsunamis

2. Climate

- a. Asia-Pacific Climate Research
- b. Ocean Observations Research and Development
- c. ENSO Dynamics
- d. Dynamics and Predictability of the Coupled System
- e. Modeling on Decadal and Larger Time Scales
- f. Regional ENSO Applications
- g. Analysis and Maintenance of a Long Ocean Time Series
- h. Analysis of JASMINE Results

3. Equatorial Oceanography

- a. Acoustic Doppler Current Profiling (ADCP)
- b. Hawaiian Ocean Mixing Experiment (HOME)
- c. UH Sea Level Center

4. Fisheries Oceanography

- a. Island-flow interactions and recruitment
- b. North Pacific transition zone oceanography
- c. Remote sensing applications to fisheries

- d. Protected species research
- e. Fisheries habitat research
- f. Pacific pelagic fisheries program

5. Tropical Meteorology

- a. Medium- to- short range weather prediction
- b. GPS Applications
- c. Regional modeling
- d. Hurricane structure and intensity
- e. Outreach Activities

Each of these themes continues to be of major scientific, economic and social importance and each has readily identifiable participants from both parent institutions. In addition, we are establishing a new theme in Coastal Research. This initiative conforms with the NOAA strategic plan as well as capabilities recently developed at the University of Hawaii.

6. Coastal Research

- a. Center for Coastal Research

C. Tasks

JIMAR's research program is divided into three budget tasks, as follows:

- 1. Task I** is the base program of JIMAR. It provides research support for the visiting scientist and post-doctoral programs, and the administrative support for the Institute. The University of Hawaii contributes to this task by bearing all the indirect costs, and by paying the salary of the director.
- 2. Task II** provides the support for specific individuals and facilities required by the visiting scientists to carry out their research efforts.

At present this means computer programmer and computing costs are supported under this task. The University of Hawaii contributes to this task by bearing the entire indirect costs.

3. Included in **Task III** are all the specific research programs conducted under NOAA auspices within JIMAR. Individual proposals are submitted by JIMAR scientists to the appropriate NOAA program offices for funds to support these projects.

II. PROPOSED RESEARCH AND SUPPORT FOR FY 2002-2006

JIMAR proposes to continue research and provide supporting activities in the same five research themes as well as initiate the new coastal research theme.

A. Task I

This task includes the visiting scientist and post-doctoral fellowship program, and the administration of JIMAR. It provides salary and research support for post-doctoral fellows who are normally appointed for one year with the possibility of renewal for a second year. The post-doctoral fellows work closely with a JIMAR fellow on a research problem of mutual interest. The visiting scientist program comes under this task. It provides travel costs and honoraria for short term visitors who give seminars and/or collaborate with JIMAR fellows. It provides partial salary and research support for longer term visitors on leave from their home institutions. The administrative portion of this task applies to JIMAR as a whole, and is not specific to a particular research area. The Director, Dr. Thomas Schroeder, is a regular U.H. faculty member, paid entirely by the University. A Program Administrative Manager, Assistant

Program Administrative Manager and Fiscal/Administrative Support Specialist is paid from this task, with the university contributing the indirect costs. They are responsible for the entire operation of JIMAR, including preparation of proposals and reports, budget management, hiring personnel, arranging for visiting scientists, interaction with UH and NOAA scientists and administrators, and facilitating JIMAR's research activities. The main output of JIMAR's efforts are research results, in the form of papers published in refereed journals. The JIMAR office handles the manuscript preparation for many of these papers.

B. Task II

This task provides salary support for a computer programmer, and computer time, in support of research conducted by visiting scientists. This support is available for visiting scientists working on any of the four JIMAR research themes.

This task also provides salary support for the Program Manager for the Pacific Pelagic Fisheries Program, a Pelagic Fisheries Researcher, and Administrative Coordinator for that program.

In addition, support for fisheries oceanography personnel and graduate assistants to work with JIMAR Senior Fellows and other JIMAR investigators is included.

C. Task III

1. Tsunami Research

JIMAR originated from cooperative research between UH and NOAA in tsunami research. Tsunami remains a fundamental JIMAR research theme. In 1997 a partnership was formed among four Federal Agencies (NOAA, USGS, FEMA and NSF) and five states

(Alaska, California, Hawaii, Oregon and Washington) to reduce the threat of loss of life and property by tsunamis along the Pacific Ocean coastlines of the United States. These partners are producing tsunami inundation maps, upgrading tsunami warning operations and establishing mitigation plans in the form of the National Tsunami Hazard Mitigation Program (NTHMP). Under the NTHMP, scientists have created improved numerical models to simulate hypothetical tsunamis that could strike U.S. coastlines and have studied the deep ocean propagation and near-shore inundation of these tsunamis. JIMAR activities include development and maintenance of an Archive of Rapidly-Sampled Hawaiian Sea Level (ARSHSL), field study of propagation of infra-gravity wave propagation, numerical and laboratory modeling and study of current and historic tsunamis at coastal sites.

In 1996, Douglas Luther and the UH Sea Level Center established ARSHSL. The intent is to acquire, edit and store in an electronically accessible location all rapidly-sampled sea level data collected from gauges at the shores of the Hawaiian Islands. These gauges are a combination of NOS gauges (6) and Pacific Tsunami Warning Center (PTWC) gauges (14). Historically the NOS gauge data have been available to the community in coarse resolution (6 minutes) and the PTWC gauges only when interrogated in the event of a tsunami. Through ARSHSL each gauge is regularly interrogated by telephone to capture the high-resolution data (resolutions of 5 to 15 seconds). Neighbor Island data are retrieved via the Internet from modem-equipped computers.

This data rescue activity ensures that even data containing weak tsunami signals are archived in a consistent manner and, as a serendipitous by-product of the daily access of each gauge, gauge failures are rapidly detected and reported thus ensuring network availability. This activity is intended to provide as complete a database as possible of tsunami and infra-gravity wave fluctuations around the Hawaiian Islands for the purpose of validation and calibration of numerical models of tsunami and infra-gravity wave propagation.

Collection, processing and dissemination (through ARSHSL) of rapidly-sampled sea level will continue. JIMAR support for programmer salaries has been essential to this program. Enhancements of this archive that are planned include improved automation of the processing of analog (five second sample interval) data available from seven PTWC gauges and provision of concatenated and filtered sea level data for low-frequency studies. Now that ARSHSL has been in existence for several years, the data are being used to study phenomena beyond the tsunami band. NSF-funded projects are using ARSHSL data to study coastal-trapped internal waves at periods of one to five days and free internal waves at tidal periods.

The near-shore structure of tsunamis can be described as a modification of the open ocean tsunami spectrum by the spectrum of the so-called local transfer function (principally a function of topography). Not enough is known about the variation of local transfer functions around islands because of the rarity of basin-wide tsunamis and the limited number of onshore sea level stations. ARSHSL is

intended to help mitigate the latter problem for Hawaii. Unfortunately it is impossible to generate open ocean tsunamis like seismologists can generate synthetic earthquakes with explosives and other approaches are needed to address the former problem. There is a characteristic of the background infra-gravity wave field (in the tsunami period band at 1-15 minute periods) in the North Pacific that suggests that pseudo-tsunamis naturally exist which may be exploited to observe the evolution of deep ocean long period gravity waves into shallow water.

Luther has observed from ocean bottom pressure records that in the North Pacific during most of fall, winter and spring the 1-15 minute infra-gravity wave band is dominated by energy emanating from a single source in the vicinity of Vancouver Island. The source is hypothesized to be the result of a local resonance forced by impinging swell (5-25 second gravity waves) from North Pacific storms. The specific dynamics (and location) of this process are still unclear. However, since the source is spatially confined, the infra-gravity waves emanating from it can be considered to be a continuous stream of weak amplitude tsunamis and can therefore be exploited to study the evolution of long gravity waves from deep water to shallow water.

In the future, Luther, with Dr. Bernard and Gonzalez of PMEL, will submit a proposal to deploy PMEL and UH bottom pressure recorders in deep and shallow water off Maui and the island of Hawaii for the purpose of observing the evolution of Vancouver Island infra-gravity waves from deep to shallow water. The principal question is whether locally-generated infra-gravity waves will mask the signal from Vancouver Island. Should the evolution of the Vancouver Island pseudo-tsunamis be observable into shallow water (and via ARSHSL

gauges, at the shoreline), data should then be available (and obtainable from many other shoreline locations) to estimate transfer functions and to validate tsunami propagation models. An additional aspect of the proposal will be to explore with existing bottom pressure arrays the possibility that during the summer a discrete source of infra-gravity waves exists in the South Pacific, a possibility suggested from Luther's earlier work. The existence of multiple surrogate tsunami sources would be valuable because of the need to identify directional effects, i.e. different sources cause different effects at each inshore location.

JIMAR and Hawaii Sea Grant have supported a series of numerical and laboratory modeling efforts conducted by faculty of the Departments of Civil Engineering (Michelle Teng) and Ocean and Resource Engineering (Kwock-Fai Cheung). The initial phase was development of laboratory apparatus to simulate tsunami run-up on an inclined beach. The goal was verification of both a numerical and an analytic solution to the run-up of a solitary wave on an inclined beach. The resulting model will be applied to analyzing inundation risk analysis for the Hawaiian Islands. This analysis will consist of both scenario analysis using the numerical model and statistical analysis. The scenario approach begins with tsunamis generated by differing earthquake scenarios then proceeds to numerical solution of the non-linear shallow-water equations to predict maximum run-up. The statistical approach begins with calculation of probability of earthquake occurrence in each Pacific source region based upon historical data. The tsunami run-up response curve to earthquake forcing will be obtained numerically. The exceedance probability for

certain heights at certain coastal locations in Hawaii will be determined from the earthquake statistics through the run-up response curve. Hilo Bay will be used as a case study for validation of this method. This ongoing work represents one component of modeling efforts by JIMAR scientists. Additional efforts are being supported by the Pacific Disaster Center and State of Hawaii Office of Civil Defense. Part of this support is via the NTHMP.

In addition, JIMAR has continued to apply its limited resources to maintaining the capability of field analysis of recent, historic and prehistoric tsunamis. We have deployed UH scientists to both the recent Papua New Guinea and Marquesas Islands local tsunamis. These are of interest because of their causes, namely local aerial or subaerial landslides. The local landslide has been identified as a serious cause for concern in Hawaii for local rapid-onset tsunami generation as well as a source of Pacific Rim tsunamis. There is a growing body of geological evidence that major slippage of volcanic islands have produced large tsunamis and pose future threats not only to the Pacific but also the Atlantic Rim. The Pacific Disaster Center is also supporting study and simulation of landslide induced tsunamis in the Hawaiian Islands.

2. Climate Research

Climate research at JIMAR has benefited from several initiatives within the School of Ocean and Earth Science and Technology (SOEST). A climate initiative led to recruitment of new faculty in atmospheric and ocean modeling. The interdisciplinary nature of SOEST has fostered interactions among biologists, chemists

and physical oceanographers leading to fundamental discoveries concerning the role of the ocean in global climate. In 1996 the University of Hawaii and the Science and Technology Agency of Japan entered into a cooperative agreement creating the International Pacific Research Center (IPRC). IPRC has a fundamental mission of studying the processes and predictability of regional Asia-Pacific climate variability. Initial support for IPRC has come from the government of Japan as well as the U.S. National Aeronautics and Space Administration (NASA) and NOAA. JIMAR has been a significant partner in the development of IPRC and hopes to continue to support IPRC goals.

In partnership with PMEL (JIMAR's sister laboratory) IPRC has proposed the development of a Data Research Center for Asia-Pacific Climate Studies (APDRC). The APDRC mission is to increase understanding of climate variability in the Asia-Pacific region by developing the computational, data-management and networking infrastructure necessary to make data resources readily accessible and usable by researchers, and by undertaking data-intensive research activities that will advance knowledge and lead to improvements in data collection and preparation. The linkage of data collection and preparation to research activities in a single center is novel. The combination should lead to increased data usage, to improvements in data products and hence to more rapid scientific

process. The project brings together the expertise in research activities of IPRC and the design of computational infrastructure resident at PMEL.

Roger Lukas has led the effort to create a NSF Science and Technology Center (STC) at the University of Hawaii. The proposed name of the center is the Center for Ocean Observations Research and Development (COORD). COORD brings together UH, Woods Hole Oceanographic Institution (through their cooperative institute (CICOR)), Oregon State University, Scripps Institution of Oceanography, University of Washington, University of Maryland, NASA Goddard Space Flight Center, NOAA, Jet Propulsion Laboratory and non-governmental partners (East-West Center and Pacific Resources for Education and Learning). The COORD mission is to develop, support and transfer scientific, technological and educational capabilities required to achieve an integrated ocean observing system (IOOS) in the next decade. The center's geographic focus will be the Hawaiian Islands and U.S. Affiliated Pacific Islands (USAPI) but its products will be broadly applicable. It is intended to eventually expand the center's scope to other Pacific Islands and the western Pacific marginal seas. In addition to meeting high-priority regional needs, the center activities will also provide proof-of-concept demonstrations of innovative approaches to observing system design; establishing and sustaining links with users; and educating the next

generation(s) of observational scientists. The center will support the development of a strong regional contribution to IOOS; the integration of observations to address a high-priority global change research problem with significant societal implications (the carbon cycle); and the development of future generations of ocean (observational) scientists and technicians.

Fundamental climate research at JIMAR will proceed independently of the success of IPRC and COORD. Drs. Bin Wang and Fei-Fei Jin have major modeling efforts examining aspects of ENSO variability. Wang will continue development of his intermediate coupled model and Jin will continue his fundamental studies of the dynamics and predictability of the coupled system. They will also continue to examine climate variability at longer time scales. This work has been supported via the Pan-American Climate Studies (PACS) program of NOAA.

In 1994 JIMAR cooperated with the NOAA Office of Global Programs, the National Weather Service Pacific Region, the Pacific Basin Development Council, and the University of Guam to establish the Pacific ENSO Application Center (PEAC) Pilot Project. PEAC developed fundamental climatologies for the USAPI, conducted training sessions throughout the basin, developed experimental precipitation forecasts and established a periodic newsletter. The Center was well-received by its constituency. Eventually the NWS

took over funding support for PEAC. During the 1997-1998 El Nino the PEAC concept proved its worth as PEAC issued timely advisories to regional governments and PEAC staff worked with local governments to develop mitigation strategies for the forecast drought. A measure of PEAC's success is the effort on behalf of regional (non USAPI) governments to establish similar programs. We expect PEAC to continue with support from the NOAA climate services initiative.

Another on-going UH effort involving JIMAR researchers and directly related to climate is the Hawaiian Ocean Time-Series (HOT) program. Now in its twelfth year, the HOT program has served as a model for duplicate long-term monitoring sites globally. The results from this interdisciplinary program have changed our views of oceanic productivity processes, the relationship of productivity to carbon fluxes at the air-sea interface and from the surface waters into the ocean's interior and interdependence of C, N, and P cycling on climate, including ENSO. In 1996 a deep-ocean mooring was deployed to supplement ship-based sampling programs with continuous measurement of air-sea processes, upper ocean optics and biological processes and nutrient dynamics. Principal scientists of this fundamental ocean observation program are Roger Lukas and David Karl. Primary support for HOT has come from NSF but the site is becoming increasingly important to all agencies supporting in climate and global change research.

In May 1999 Roger Lukas and Peter Hacker collaborated with an international team of scientists to conduct the Joint Air-Sea Monsoon Interaction Experiment (JASMINE). JASMINE is a collaborative study of air-sea fluxes, convection and upper-ocean response to atmospheric forcing in the tropical eastern Indian Ocean. The field phase coincided with the turn-on phase of the southwest monsoon and its subsequent evolution. The first post-cruise year was devoted to final editing of ocean data sets and on preliminary analysis addressing the ocean component goals. Current efforts include:

1. Documentation of the intra-seasonal variability of the upper ocean temperature, salinity and velocity fields, the mixed and barrier layer structures, and the heat and salt budgets,
2. Use of the data in international planning efforts for design of monitoring activities and process studies for the Indian Ocean.
3. Evaluation of model simulations of the observed upper-ocean fields.

JASMINE analysis will continue and should evolve into future Indian Ocean studies as mentioned above.

3. Equatorial Oceanography Research

The area of equatorial oceanography has remained at the core of JIMAR research. JIMAR scientists have been involved in every major physical oceanography experiment in the tropical Pacific since JIMAR was founded. These programs include NORPAX, EPOCS,

PEQUOD, Tropic Heat, WEPOCS, TIWE, TOGA, and COARE. Recently JIMAR scientists ventured into the equatorial Indian Ocean (JASMINE, discussed under Climate theme). This concentration of projects in the tropical oceans is at least partly due to the strong coupling of the tropical ocean and global atmosphere. The strong coupling extends to JIMAR research discussions as the themes of Climate and Equatorial Oceanography have tremendous overlaps. Other global oceanographic programs with which JIMAR has participated (e.g. WOCE and JGOFS) have a strong equatorial or tropical component.

The Joint Archive for Shipboard ADCP (JASADCP) continues to serve as a central repository for shipboard ADCP data sets from around the world with many contributions from foreign institutions as well as from the US. Not only will the importance of this function continue to grow during the next five years, but plans are underway to begin archiving and distributing Lowered ADCP data as well.

Support for the Shipboard ADCP on the TAO support ship, the Ka'imimoana, has continued despite lack of funding; and the resulting data set has been central to three recent publications. During the next five years we would like to continue expanding, improving and analyzing this data set in collaboration with Greg Johnson of PMEL, and others. We would like to see the instrumentation and data

acquisition system upgraded to improve the range under all conditions, and the reliability of the data in rough weather.

We have found that the JAMESTEC GCM promises to be a powerful tool for understanding puzzles of equatorial circulation. We are aware of no other model which approaches its ability to simulate the subsurface countercurrents (SSC's) in the Pacific, and it appears to be simulating aspects of the deeper circulation also. Evaluation and diagnosis of the JAMESTEC model, in collaboration with Akio Ishida and Humio Mitsudera (facilitated by the IPRC) will be primary activities during the next five years.

Additional interactions with JAMSTEC, facilitated by the IPRC, have led to JIMAR participation in JAMSTEC cruises as part of their Tropical Ocean Climate Study (TOCS). Firing and Hacker have provided a Lowered ADCP component to these cruises. The results are the first survey of currents in the central Celebes and Maluku Seas, and the first measurements of deep currents east of Mindanao. The latter found energetic cyclonic eddies with little vertical shear between 200 and 2000 m along the Mindanao Coast. We intend to sample this deep circulation at additional times and locations to characterize its variability and its role in water mass mixing and transport. We hope to use the JAMSTEC model to further understand the source and dynamics of this feature.

We also intend to continue the study of central and eastern Pacific circulations, both observationally and via analysis of model output. Observational methods under consideration include moored current meter arrays to determine the temporal variability at selected locations, and RAFOS floats to show the recirculation pathways of strong zonal currents such as SCC's. One of the primary keys to modeling the role of the oceans is understanding and parameterizing the process of mixing in the ocean. The Hawaii Ocean Mixing Experiment (HOME) was designed to investigate the role of internal tide generation by topography in the local and global budgets of internal wave energy and mixing. Researchers from five U.S. academic institutions (including UH/JIMAR), and from the Honolulu Laboratory of the Southwest Fisheries Laboratory (NMFS) are engaged in HOME. NOAA directly supports HOME through the JASADCP which provides information on shear magnitudes and proximity to topography. Shear is a proxy for mixing. NOAA-supported Conductivity-Temperature-Depth (CTD) observations through the HOT program (see Climate discussion) provide essential data on stratification of the waters near Hawaii.

NOAA contributes to HOME indirectly through the UH Level Center and the ARSHSL (see Tsunami discussion). The contribution is a sea level data set that permits validation of models of both barotropic and baroclinic tides around Hawaii, and may provide

information on the low-frequency modulation of the internal tide generation process.

During the next five years, Luther, Firing, Finnigan, and R. Brainard (NMFS) will continue the analysis of NOAA-supported historical data sets in order to extract information relevant to HOME goals. As these analyses proceed, it is expected that additional data needs will be identified and field programs proposed.

The UH Sea Level Center (UHSLC) has been a major component of equatorial oceanography (and climate) research at JIMAR . Founded by Klaus Wyrtki, it is now directed by Mark Merrifield. UHSLC collects, processes, and distributes tide gage data from around the world in support of various climate research activities. The data are used in evaluation of numerical models (e.g. operational models at NCEP), joint analyses with satellite altimeter data sets, the calibration of the altimeter data, production of oceanographic products through the Integrated Global Ocean Services System (IGOSS) program, and analysis of interannual to decadal climate signals. Also, in support of satellite altimeter calibration and validation, the UHSLC is installing Co-located GPS (CGPS) systems at various tide-gage stations.

Primary UHSLC operations are funded as part of NOAA's ENSO Observing System sponsored through OAR. CGPS is supported by NOAA's Office of Global Programs (OGP) and by

NASA. UHSLC is working with other groups associated with the observing system to provide synthesis of the various data sets and to compile and distribute associated data products. UHSLC staff have worked with PMEL and the IPRC in preparation of the Data Research Center for Asia-Pacific Climate Studies (APDRC) discussed above under Climate Research.

UHSLC, in collaboration with the Pacific GPS facility, will increase the number of tide gage station with contiguous GPS at a rate of approximately one per year. At the end of five years the total of such gages will be 12 with GPS time series approaching seven years. It is becoming apparent that processing of GPS data by different groups is required for reliable estimates of vertical position and drift. We intend to establish a processing center for all GPS station data that are used for positioning tide gages in support of global sea level rise monitoring and research.

UHSLC is the distribution center for Fast Delivery sea level data from the Global Sea Level Observing System (GLOSS) network of tide gages. This is a continuation of the Data Assembly Center established under WOCE. These data are routinely used in numerical model validation, assessment of satellite altimeter drifts and monthly IGOSS sea level products distributed by UHSLC. Our goal for the next five years is to increase the number of GLOSS stations that contribute data by 50 %.

Many of the tide gage stations operated by UHSLC are approaching 30 years of service. We intend to invest in instrument upgrades in the next five years. In particular, we will phase out conventional float gages for acoustic gages wherever feasible.

UHSLC's general research goal for the next five years is to continue to determine how best to extract oceanographically relevant information from tide gages over the complete spectrum of time and space scales. In particular, we intend to expand our numerical modeling component to this research in coming years.

4. Fisheries Oceanography Research

Fisheries oceanography research is a major theme within JIMAR. JIMAR enjoys close cooperation with the Honolulu Laboratory of the National Marine Fisheries Service (NMFS) directed by Dr. R. Michael Laurs. In addition, JIMAR manages a Pacific Pelagic Fisheries Research Program in support of the Western Pacific Regional Fisheries Management Council (WPRFMC). The goals are to conduct research in support of the management of important pelagic fish species in the vicinity of Hawaii and the central and western Pacific Ocean and recovery of protected marine species in Hawaii and the central North Pacific. The objectives of the research are to understand 1) the biology, ecology, and stock dynamics of commercially and recreationally important large pelagic fish species in the vicinity of Hawaii and the central and western North Pacific; 2) the affects of marine environmental factors on the distribution, availability,

abundance, and vulnerability to capture of these fish stocks; 3) the dynamics of the Hawaii-based fisheries operating on these fish stocks; and 4) to define and understand the interactions between and among these three categories. Additional objectives are to 5) gain scientific understanding required to recover highly endangered Hawaiian monk seal populations throughout the Hawaiian Archipelago, and 6) to recover threatened and endangered Pacific sea turtles.

JIMAR fisheries oceanography research is multi-disciplinary, covering a wide spectrum of research topics. Topics include fishery stock dynamics, habitat of pelagic fishes, application of satellite remote sensing technology to fisheries research, the influence of atmospheric and oceanographic conditions and factors on the population dynamics of pelagic fishes and protected species, fisheries interactions, fisheries bycatch, basic biological and ecological research on pelagic fishes and protected species, technical support of research operations, collection of statistics and information required to understand fishing fleet dynamics, rehabilitation of undersized Hawaiian monk seal pups. Field studies on sea turtles, and related research operations and activities.

Congress includes annual funds in NOAA's budget for the Pelagic Fisheries Research Program (PFRP). The mission of the PFRP is to provide information to the WPRFMC in support of management of fisheries for highly migratory species in the central and western Pacific Ocean. The PFRP is managed by Dr. John Sibert and supports an interdisciplinary suite of projects. Research priorities for the PFRP are set by a steering committee composed of representatives from the University of Hawaii, WPRFMC and NMFS.

Research proposals are solicited from the international scientific community to address these priorities and vetted by a peer review process before funding. The PFRP has initiated over 30 projects during the current cooperative agreement. These projects are funded for periods of up to five years. During the next five years new projects will be initiated as current projects wind down. The direction and subject matter of the new projects will depend on results of the existing projects and on rapidly evolving challenges of fisheries management in the Pacific. Several reviews of PFRP have recommended the establishment of graduate fellowships to assist in increasing the pools of trained fisheries management professionals in the Pacific. We shall initiate this program in the next five years.

5. Tropical Meteorology

The National Weather Service Honolulu Forecast Office officially moved to the UH campus in June 1995. This move had long been anticipated. Recognizing the potential for close collaboration between NWS and University meteorologists, the JIMAR Administrative Board approved a new research theme in tropical meteorology. Several collaborative efforts began prior to the NWS move. The NWS Pacific Region Fellowship program supported students working on research topics associated with NWS interests in the Pacific Region. This program has continued since the NWS move. In addition JIMAR scientists have established collaborations with the

Hurricane Research Division of the Atlantic Oceanographic and Meteorological Laboratory (AOML). JIMAR scientists and students have visited AOML and AOML scientists are JIMAR Senior Fellows and serve as members of UH graduate dissertation committees. JIMAR Senior Fellows Gary Barnes and Steven Businger have participated in prospectus development teams for the U.S. Weather Research Program (USWRP), Barnes for tropical cyclones at landfall and Businger for heavy precipitation.

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Barnes in collaboration with HRD has been especially active in the field phase and analysis of data for land falling tropical cyclones. This work has received additional support from the NSF. The continuing field experiments and post-analysis are expected to continue throughout the next five years. JIMAR tropical cyclone studies also include analysis of interannual variability of cyclone occurrence for the Central Pacific and other basins. This work is supported via NWS funds but crosses the boundary between weather and climate (seasonal to interannual) research, both JIMAR themes.

JIMAR scientists have become involved in GPS Meteorology. The wet-delay in the GPS signal arrival time has been demonstrated to be equivalent to columnar precipitable water and provides an additional source of a critical atmospheric property as GPS receivers multiply throughout the planet. JIMAR has two programs in GPS meteorology. Steven Businger and Michael Bevis work with the Forecast Systems Laboratory on the NOAA/FSL Water Vapor Demonstration Project. The goal of this effort is to provide GPS water vapor estimates in nearly real-time with sufficient accuracy for ingestion into numerical weather prediction models.

The second GPS program comprises of a collaboration between JIMAR and its sister laboratory, CIRA (Cooperative Institute for Research in the Atmosphere). The respective directors agreed to jointly fund a GPS installation at Lihue, Kauai. Lihue is an NWS radiosonde site and represents the best trade wind site in the Hawaiian Islands. CIRA's interest is in augmenting water vapor data bases as part of the international GEWEX (Global Energy and Water Experiment). The global trade wind belts have few representative island stations. JIMAR's interest is in the relationship between precipitable water (an excellent proxy for trade wind moist layer depth) and trade wind weather.

JIMAR and the NWS are collaborating on an outreach program to the Pacific Basin. The principle is establishment of a training facility (The International Pacific Desk) at the Honolulu Forecast Office. The goal is to bring meteorologists from Pacific Island nations to Honolulu to the NWSFO and the University (JIMAR and UH Meteorology) for training in modern analysis and forecast techniques as well as to expose the trainees to the research environment of JIMAR and UH. The trainees will return home with modern equipment and some degree of research experience which can be applied to their national meteorological services. The first trainee is expected to arrive in Spring 2001.

6. Coastal Research (A New Theme)

The U.S. coastal zone is one of the greatest economic and environmental assets of the nation. A national migration toward the shoreline occurred in the last half of the 20th century and continues to this day. This burgeoning population depends upon limited natural resources. In Hawaii, population has more than doubled since statehood (1959) and is confined to the flat lands of the coastal zone. The level of stress on coastal resources has reached alarming proportions. Superimposed on the stresses imposed by population growth are constant threats from high waves, tsunamis, flash floods, hurricanes and sea level rise. NOAA recognized the threat to coastal ecosystems in its strategic plan by identifying “Sustain healthy coastal ecosystems” as a strategic goal.

County, state and federal resource managers are caught in a convergence of forces. Agencies must balance the pressure to develop the shoreline, the need to conserve natural resources, the economic necessity of reducing community exposure to natural hazards, and the historical imperative to rectify existing problems of resource depletion stemming from past practices. As managers struggle to achieve a sustainable balance under present conditions, future global change possibilities such as sea level rise, increasing sea surface temperatures, amplified ENSO impacts, etc. places an additional challenge and responsibility into the hands of regulators.

A new coastal initiative at JIMAR can assist regulators and planners as they address the challenge and meet the new responsibility. JIMAR is well situated to undertake this initiative. UH has an exceptionally talented coastal research group within SOEST. UH coastal researchers already interact with the stakeholders. There have been discussions of collaboration between UH researchers and NOAA's Coastal Services Center. The Congress has identified funds to extend NOAA's coastal mission to Hawaii. JIMAR can function as a conduit through which the nation's best scientific minds will conduct research on coastal processes and channel research projects to assist the Hawaii and U.S. resource management community. Through JIMAR a factual and secure scientific foundation can become the underpinnings for new policies and directions of natural resource management in the next decade.

Establishment of the JIMAR coastal initiative will:

1. Establish a conduit for data and technology transfer between the research community and government agencies as end-users;
2. Broaden the University research community to establish (in concert with NOAA) new directions of critical inquiry and reinforce the proven core of national leadership in coastal sciences;
3. Enable University and NOAA researchers to expand their activities to provide tailored research products directly to decision-

makers tasked with sustaining island and marine resources in the Pacific.

Research carried out under the new theme would be used to :

1. Build predictive numerical models of natural coastal processes to identify future trends and patterns, define interrelationships among diverse coastal systems and provide a testbed for new conceptual management policies;

2. Design and implement new mapping technologies for coastal environments such as reefs, estuaries and mid-depth nearshore substrates;

3. Apply an integrative and multidisciplinary format for research to such cross-disciplinary issues as coastal circulation, sediment flux, coastal hazards, and the biogeochemistry of coastal ecologies;

4. Develop enhanced and in-depth four-dimensional coastal and marine databases for the use of resource managers to focus energy on critical challenges and highlight management directions and conservation practices; and

5. Provide training for resource managers and decision-makers.

III. PERSONNEL

A. Senior Fellows	24
B. Research Scientists	13
C. Research Associates	41
D. Professional Research Assistants	13
E. Graduate Research Assistants	13
F. Other Research Students	27
G. Administrative Staff	<u>10</u>
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IV. BUDGET JUSTIFICATION

This proposal is concerned with establishing a new, five-year Cooperative Agreement for the continued support of the joint institute, JIMAR. A five-year summary is presented for the Federal share of Tasks I, II and III combined, followed by budget details for each task for each year. The University of Hawaii's estimated contribution to this cooperative research effort is also shown for each of the tasks. This contribution consists of funding the Director's salary and a waiver of overhead charges on the core budget (Tasks I and II) commensurate with the provisions of the Memorandum of Understanding. Also as part of its financial contribution, the University provides office space and facilities which house JIMAR. The University may charge up to 36.30% of modified total direct costs for on-campus research activity, in accordance with the most recent Federally-audited indirect cost agreement. These arrangements are commensurate with the provisions of JIMAR's Memorandum of Understanding, and consistent with practice throughout the 23 years that this cooperative partnership has existed.

It should be noted that the budgets presented cover the entire period of this five-year proposal, it is recognized that proposals are reviewed and funded on the basis of 12-month, or shorter, funding periods. The budgets are divided into three major Tasks, as discussed in the narrative, and can be severed proportionally on a needed basis. Since JIMAR's cooperative agreement operates on a research exchange basis, results of the research conducted with funds under this agreement will (to the point of being severed) be documented and submitted to NOAA as our product unless other specific arrangements are made.

V. PERFORMANCE MEASURES

JIMAR will deliver to NOAA a copy of its annual report for inclusion in the NOAA/ERL Programs and Plans Book. The annual report covers its activities and its research progress and results. Individual major projects funded under various tasks will provide NOAA with comprehensive reports and copies of any publications derived from research results. Visiting scientists will provide lectures and seminars on their areas of research in residence.

VII. LIST OF ACRONYMS

ADCP	Acoustic Doppler Current Profiler
AOML	Atlantic Oceanographic & Meteorological Laboratory
APDRC	Asia-Pacific Data Research Center
ARSHSL	Archive of Rapidly-Sampled Hawaiian Sea Level
CGPS	Co-located GPS
CICOR	Cooperative Institute for Climate and Ocean Research
CIRA	Cooperative Institute for Research in the Atmosphere
COARE	Coupled Ocean Atmosphere Response Experiment
COMET	Cooperative Meteorology Education and Training
COORD	Center for Ocean Observations Research and Development
CTD	Conductivity-Temperature-Depth
ENSO	El Nino/Southern Oscillation
EPOCS	Equatorial Pacific Ocean Climate Studies
ERL	Environmental Research Laboratories
FEMA	Federal Emergency Management Agency
GEWEX	Global Energy and Water Experiment
GLOSS	Global Sea Level Observing System
GPS	Global Positioning System
HOME	Hawaiian Ocean Mixing Experiment
HOT	Hawaii Ocean Time-series
HRD	Hurricane Research Division
IGOSS	Intergovernmental Ocean Service System
IOOS	Integrated Ocean Observing System
IPRC	International Pacific Research Center
JAMESTEC	Japan Marine Science and Technology Center
JASADCP	Joint Archive for Shipboard ADCP
JASMINE	Joint Air-Sea Monsoon Interaction Experiment
JGOFS	Joint Global Ocean Flux Studies
JIMAR	Joint Institute for Marine and Atmospheric Research
MSM	Non-Hydrostatic RSM
NASA	National Aeronautics and Space Administration
NCEP	National Center for Environmental Prediction
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOAA/FSL	National Oceanic and Atmospheric Administration Forecast Systems Laboratory
NORPAX	North Pacific Experiment
NOS	National Ocean Service
NSF	National Science Foundation
NTHMP	National Tsunami Hazard Mitigation Program
NWS	National Weather Service
NWSFO	National Weather Service Forecast Office
OAR	Office of Oceanic and Atmospheric Research

OGP	Office of Global Programs
PACS	Pan-American Climate Studies
PEAC	Pacific Enso Applications Center
PEQUOD	Pacific Equatorial Ocean Dynamics
PFRP	Pacific Pelagic Fisheries Research Program
PMEL	Pacific Marine Environmental Laboratory
PTWC	Pacific Tsunami Warning Center
RAFOS	Reverse Technique of "SOFAR" (Sound Fixing and Ranging)
RSM	Regional Spectral Model
SOEST	School of Ocean and Earth Science and Technology
SSC	Simulate Subsurface Countercurrents
STC	Science Technology Center
TAO	Tropical Atmosphere-Ocean Array
TIWE	Tropical Instability Wave Experiment
TOCS	Tropical Ocean Climate Study
TOGA	Tropical Ocean-Global Atmosphere
UH	University of Hawaii
UHSLC	University of Hawaii Sea Level Center
USAPI	United States Affiliated Pacific Islands
USGS	United States Geological Survey
USWRP	United States Weather Research Program
WEPOCS	Western Equatorial Pacific Ocean Circulation Study
WOCE	World Ocean Circulation Experiment
WPRFMC	Western Pacific Regional Fisheries Management Council