Global Atlas of Ocean Internal Waves

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LONG-TERM GOALS

Our long-term goal is to set up a database of ocean internal waves observed from US space shuttles. Each case includes photographs, interpretation maps, quantitative data and information extracted from images, and boundary conditions collected by in situ measurements. The database will be publicly accessible. Users, who are interested in ocean internal waves, may search for the information they need through the network.

OBJECTIVES

The objectives that pertain to 1998 are: to develop or adopt methods for setting up the database specifically suited for space shuttle photography, to design a home page for the data base and a standard format for an individual case to be stored in the data base, and to collect data and interpretation results, which will be used as basic material for the data base.

APPROACH

Since 1981 the United States has performed Space Shuttle missions and a Space Shuttle Earth Observations Project (SSEOP) database has been set up (Ackleson, 1992; La Voilette, et al., 1990). Our center serves as the Space Shuttle Earth Imagery Analysis Center for analyzing, storing, re-processing, and distributing the photographs to regional users, therefore, we receive the original films of space shuttle photography two to three weeks after the mission. These photographs constitute a major data for the ocean internal wave database (Zheng et al., 1993a,b; 1995a,b). The image orthorectification methods developed by ourselves (Zheng, et al. 1997) is used for quantitative interpretation in order to remove geometric distortion of target images. The directly measurable quantities on space shuttle photographs are not always traditional from the point of view of conventional geosciences. It is necessary, therefore, to interpret or translate these quantities into traditional forms using the correspondence or transfer function between the two. The equations and formulae will be used for deriving the unknown parameters using the measurable parameters as inputs. The test work for setting up the database is done on a PC computer. The operational database will finally be transferred to a UNIX workstation for public access.

WORK COMPLETED

The web site design has been completed. A focal point in the development of this electronic atlas was to make it portable and easily understood by various users.

The ocean internal wave atlas Internet site was developed using advanced HTML code that was later transferred to Microsoft Front Page. This software package allowed for easy integration with our database. The entire site will reside on a server that will be running a Windows NT platform.

Report Documentation Page

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The database allows for queries of many different types. One can search for photographs containing internal wave images by the following fields: ocean basin, latitude/longitude, space shuttle mission number, or date. We are currently developing an interactive world map that will allow for data retrieval by clicking on the site location.

The database currently holds limited information, but will easily be expanded through simple, pre-coded, data entry routines. In addition, two papers have been published in the referred journals and one in proceedings, partially supported by the project in 1998.

RESULTS

A working example of the electronic atlas has yielded excellent results in the beta test phase of the software and integration with our University of Delaware computer network. We have been able to successfully store and retrieve internal wave data through the World Wide Web. Included in this report are examples of the homepage and internal wave atlas, as Figure 1 and Figure 2, respectively.

The current HTML code, including the interactive database and dynamic pages, is stored on our internal network (Intranet). The atlas will soon be relocated to a server that will be able to handle all Internet traffic to the site.

IMPACT/APPLICATIONS

The database to be set up by this project constitutes an electronic atlas of ocean internal waves. This atlas will be publicly accessible and may be utilized by any users who are interested in the behavior of ocean internal waves and upper ocean dynamics. Our project also develops the utilization of space shuttle photography. We demonstrate that space shuttle photographs may serve as an important resource for high resolution observations of various ocean phenomena, in particular for remote ocean areas, which are sparsely investigated and located far away from the fields of view of ground station antennas used by other earth observing satellites.

TRANSITIONS

We have provided the space shuttle photographs to about 30 internal and external users before the database to be operational. The center also serves as an educational facility. One graduate student and one visiting student from Germany are working for their degree/certificate research related to analysis of ocean internal waves using space shuttle data. We made several invited presentations at related conferences and workshops.

RELATED PROJECTS

John Apel (Global Ocean Associates) is working on editing an atlas of ocean internal waves observed by satellite synthetic aperture radar. His project is also supported by ONRPO. He expressed that it will be great for users if his major results are stored in our database.

REFERENCES

Ackleson, S. G., 1992. A summary of hand-held ocean and coastal photography taken during space shuttle missions: 1981-1991 (Abstract), *EOS, Transactions, American Geophysical Union*, 72, 69.

La Voilette, P. E., D. R. Johnson, and D. A. Brooks, 1990. Sun-glitter photographs of Georges Bank and the Gulf of Maine from the space shuttle, *Oceanography*, 3, 43-49.

Zheng, Q., X.-H. Yan, and V. Klemas, 1993a. Derivation of Delaware Bay tidal parameters from space shuttle photography, *Rem. Sen. Environ.*, 45, 51-59.

_____, 1993b. Statistical and dynamical analysis of internal waves on the continental shelf of the Middle Atlantic Bight from space shuttle photographs, *J. Geophys. Res.*, 98, 8495-8504.

Zheng, Q., V. Klemas, and X.-H. Yan, 1995a. Dynamic interpretation of space shuttle photographs: Deepwater internal waves in the western equatorial Indian Ocean, *J. Geophys. Res.*, 100, 2579-2589.

Zheng, Q., V. Klemas, X.-H. Yan, and Z. Wang, 1995b. Application of space shuttle photography to studies of upper ocean dynamics, *Proceedings of 1995 Shuttle Small Payload Symposium, NASA Conference Publication* 3310, pp. 275-284.

Zheng, Q., V. Klemas, X.-H. Yan, Z. Wang, and K. Kagleder, 1997. Digital orthorectification of space shuttle coastal ocean photographs, *Int. J. Remote Sensing*, 18, 197-211.

PUBLICATIONS

Zheng, Q., X.-H. Yan, V. Klemas, C.-R. Ho, N.-J. Kuo, and Z. Wang, 1998. Coastal lee waves on ERS-1 SAR images, *J. Geophys. Res.*, 103, 7979-7993.

Zheng, Q., X.-H. Yan, W. T. Liu, Vic Klemas, D. Greger, and Z. Wang, 1998, A solitary wave packet in the atmosphere observed from space, *Geophys. Res. Lett.* in press.

Zheng, Q., X.-H. Yan, W. T. Liu, and V. Klemas, 1998, Coastal lee waves observed from space, *Proceedings of 2nd Conf. Coastal Atmos/Oceanic Prediction and Processes,* Amer. Meteor. Soci., Boston, pp. 84-88.

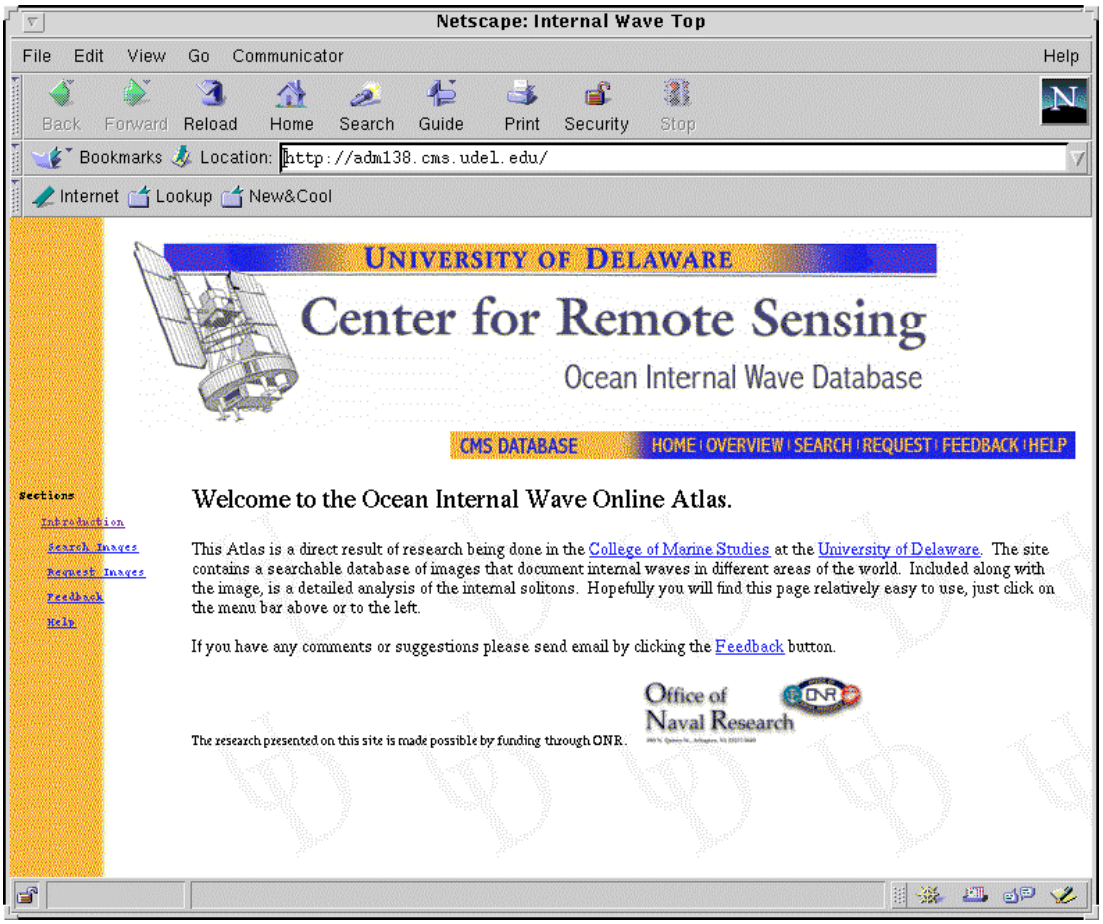

Figure 1: Homepage for the Ocean Internal Wave database.

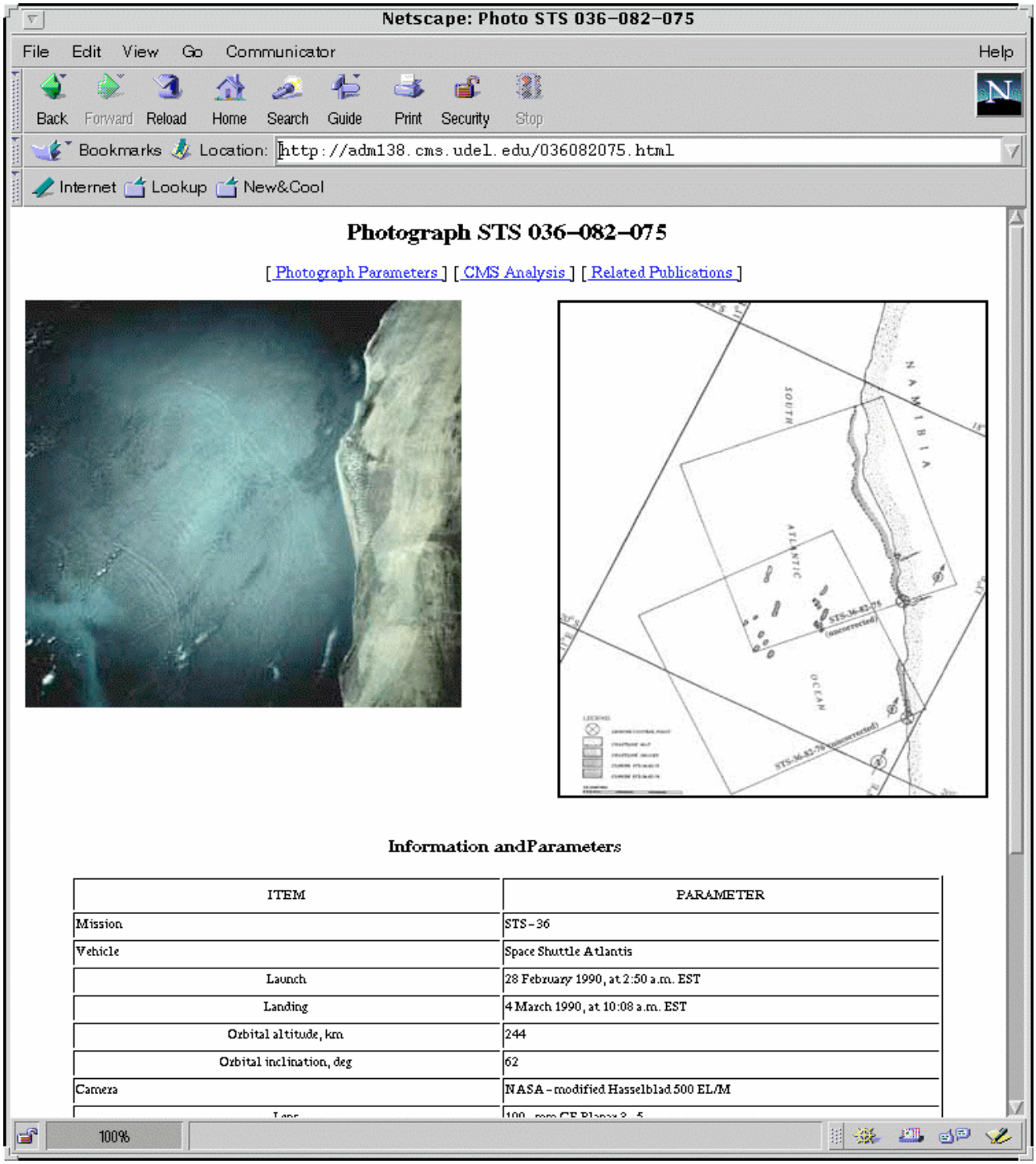

Figure 2: An example of a page from the atlas.