Air/Sea Transfer of Gases and Aerosols

Eric S. Saltzman
Department of Earth System Science
University of California at Irvine
Irvine, CA 92697
phone (949) 824-3936 fax (949) 824-3256 email esaltzma@uci.edu

Warren De Bruyn
Department of Earth System Science
University of California at Irvine
Irvine, CA 92697
phone (949) 824-5391 fax (949) 824-3256 email wdebruyn@uci.edu

Grant Number: N00014-99-1-0066:
http://www.uci.edu

LONG-TERM GOALS

Our long range goals for this project are to: 1) understand the effect of various physical and chemical properties of the air-sea interface on gas exchange, and 2) characterize the sea surface texture and turbulent boundary layers. These studies will provide a basis for future work on the active and passive microwave remote sensing of the sea surface and the estimation of surface wind vectors and gas transfer velocities from such information.

OBJECTIVES

This project is a collaborative experimental study of wave dynamics, boundary layer turbulence, and gas exchange in a salt-water wind-wave tank. Our objectives are: 1) to relate surface texture and boundary layer turbulence to imposed surface wind stress and gustiness, and atmospheric stability to provide insight into the factors controlling remote sensing of the ocean surface, and 2) to relate direct measurements of air-sea gas fluxes to the surface water chemistry and texture and boundary layer turbulence.

APPROACH

Our approach is to carry out laboratory experiments under controlled conditions, in which we can extensively characterize the state of the fluids and interface. The experiments will be carried out using a new facility, the Air-Sea Interaction Salt-water Tank (ASIST) which has recently been constructed at RSMAS, University of Miami. ASIST is a linear, recirculating wind/wave tank. During these experiments, water surface textures will be characterized using an imaging slope gauge and scanning slope gauge. Turbulence measurements in air and water will be made using hot x-films and a conical hot film probe carried by a wave follower. Turbulence measurements and visualization in the water will also be made using particle image velocimetry. Gas exchange will be studied using eddy correlation flux measurements involving fast-response chemical detection for carbon dioxide via IR absorption, and for other gases (such as dimethylsulfide, ammonia, and sulfur dioxide) by chemical

Report Documentation Page

Form Approved OMB No. 0704-0188

1. REPORT DATE **30 SEP 2001**	2. REPORT TYPE	3. DATES COVERED **00-00-2001 to 00-00-2001**

4. TITLE AND SUBTITLE **Air/Sea Transfer of Gases and Aerosols**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Department of Earth System Science,,University of California at Irvine,,Irvine,,CA, 92697**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR’S ACRONYM(S)
	11. SPONSOR/MONITOR’S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Our long range goals for this project are to: 1) understand the effect of various physical and chemical properties of the air-sea interface on gas exchange, and 2) characterize the sea surface texture and turbulent boundary layers. These studies will provide a basis for future work on the active and passive microwave remote sensing of the sea surface and the estimation of surface wind vectors and gas transfer velocities from such information.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a REPORT **unclassified**	b ABSTRACT **unclassified**	c THIS PAGE **unclassified**	**Same as Report (SAR)**	**5**	

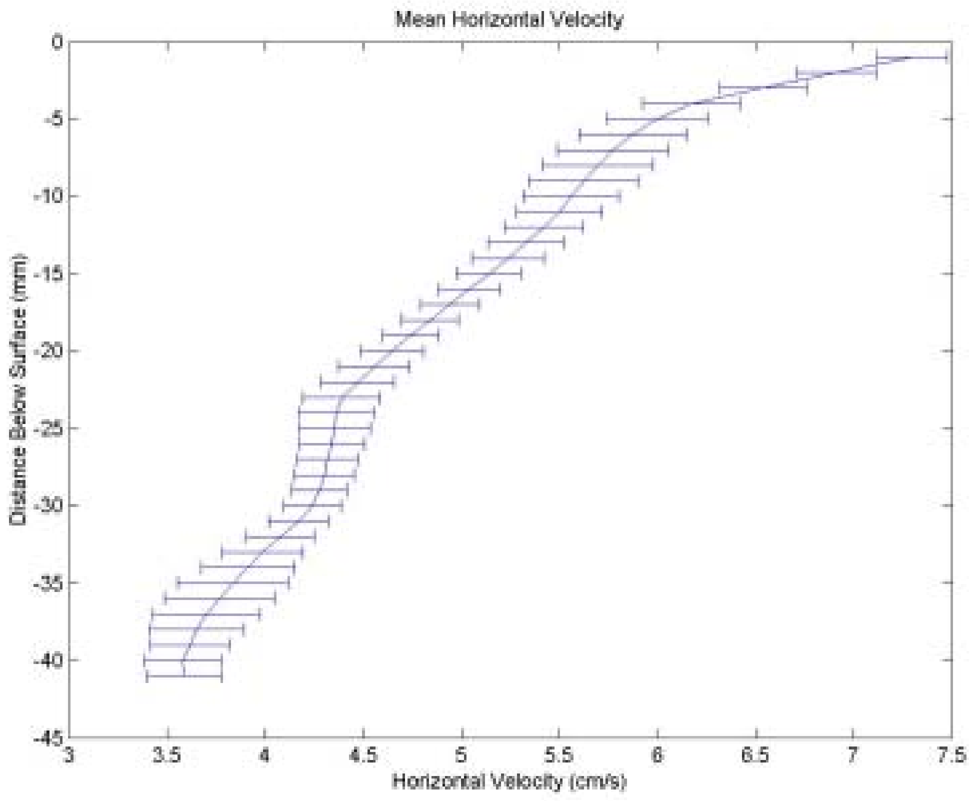
ionization mass spectrometry. The key personnel involved in the project are Drs. Eric Saltzman (gas exchange), Mark Donelan (turbulence, wave properties, and remote sensing), and Warren De Bruyn (mass spectrometry).

WORK COMPLETED

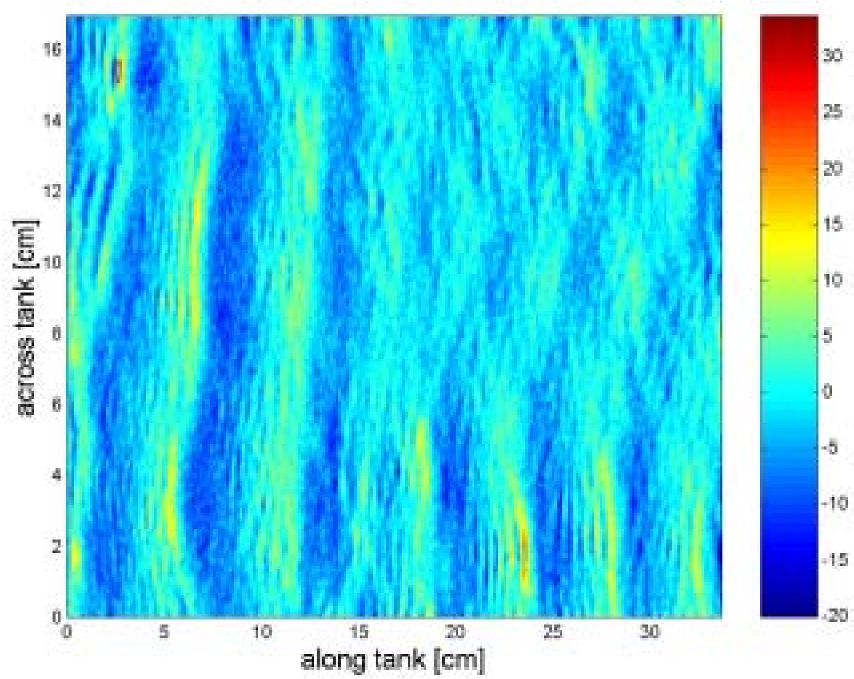
The work to date has focused on constructing and testing the various components of the experiment. Some preliminary flux experiments have been carried out in the wind/wave tank to assess the performance of various systems. The construction of a fast response chemical ionization mass spectrometer has been completed, and we are in the process of optimizing its performance (ionization chemistry and source optics) for field and laboratory use. The scientific goal of linking observations of water turbulence to direct flux measurements has not yet been achieved. However, our preliminary measurements suggest that all the necessary components of such an experiment are now operational.

RESULTS

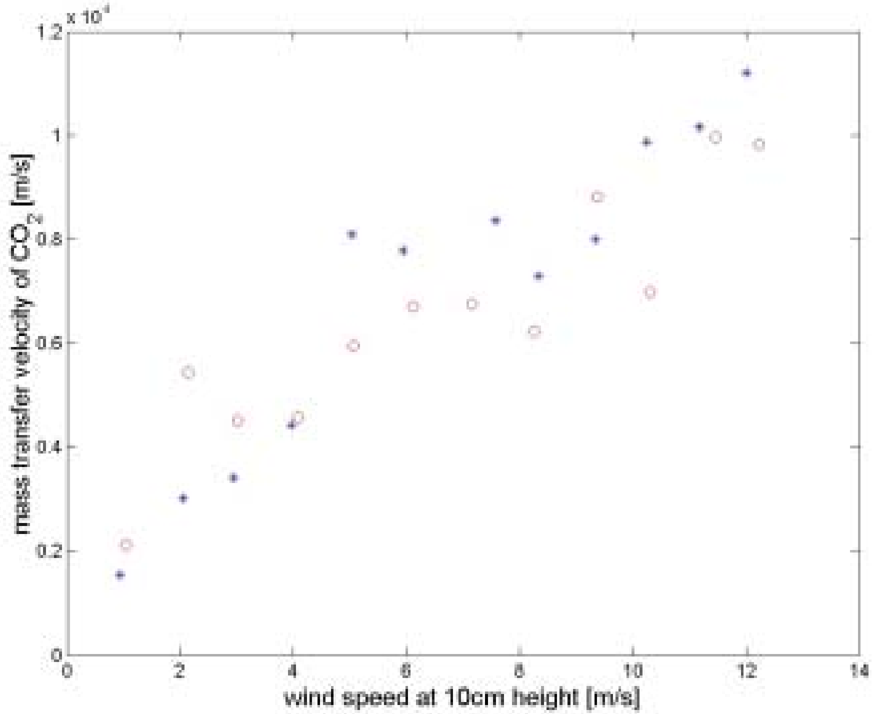
Preliminary results are presented as a series of figures illustrating the capability to observe surface wave properties, water turbulence, and mass transfer using a variety of techniques.



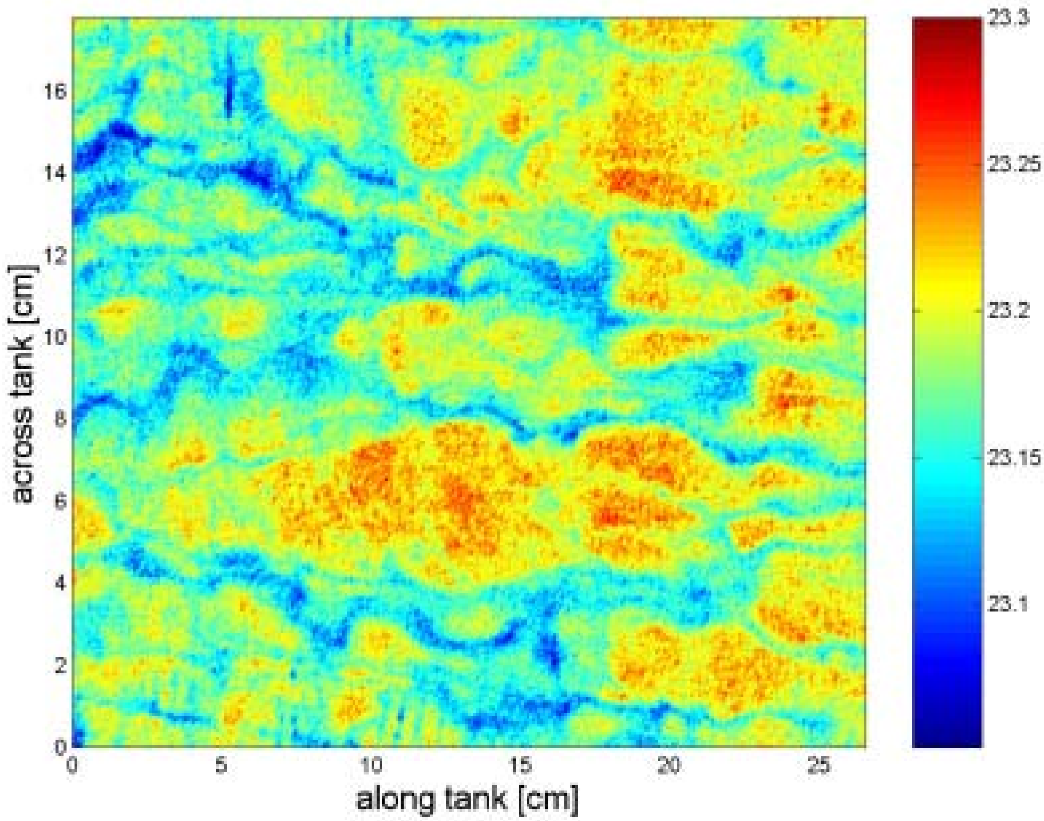
PIV profiles. Velocity profiles just beneath the surface. The wind speed was about 3 m/s and the surface was disturbed by capillary-gravity waves. The profiles were obtained using Particle Image Velocimetry and are 12 second averages at each point. Error bars are +/- 1 std.dev of 40 (12 second ave) profiles each 1.22 mm apart in the horizontal. These profiles were obtained at the same time as the slope and infra-red images.



Downwind wave slopes obtained with 2-D imaging slope gauge.
The color bar indicates the slope in degrees.



Preliminary mass transfer of CO2 across a water surface estimated by the "direct" eddy correlation method and corrected to a Schmidt number of 600. The different symbols correspond to different fetches: * = 14m; o = 7m.



Infra-red image. This image of the surface shows the temperature variations in the skin layer. The skin is cool and the thin blue streaks reflect the turbulent structures in the skin layer, while the larger (orange-red) structures reflect the disruption of the surface skin layer by deeper warmer fluid.

TRANSITIONS

We expect that this project will eventually result in two types of transitional developments: 1) a flux measurement capability for eddy-correlation measurements of trace gases at sea, and 2) improved algorithms relating the state of the air/sea interface to remotely sensed properties.

RELATED PROJECTS

This project is closely related to a DURIP award for the construction of the ASIST wind/wave facility.