Historical Perspective

The Salton Sea is California's largest lake with a surface area of more than 370 sq. miles (960 sq. km) and a volume of more than 7.4 million acre-feet (9.14 cubic km). Created when the Colorado River broke through a levee in December of 1904, the lake has no outlet and its volume (see historical graph) is maintained through a delicate balance between tributary inflows, groundwater, and evaporation.

Total dissolved solids concentrations (salinity) have increased from ambient Colorado River levels to about 22% greater than the ocean (approx. 44ppt). At one time supporting an ocean sports fishery and contributing to the area's economy, the lake has recently shown signs of eutrophication, which combined with increasing dissolved solids concentrations endanger the aquatic and avian populations that depend on the lake environment.

The Salton Sea Authority, an organization of local, state, and federal agencies concerned with the fate of the Sea, is investigating alternative means for controlling water levels and salinization, and protecting environmental attributes of the water body. It has authorized the Modeling Group of the Department of Civil and Environmental Engineering at UC Davis to develop and apply mathematical models to characterize wind-driven circulation in the Sea, including the effects of thermal and saline stratification on lake circulation.

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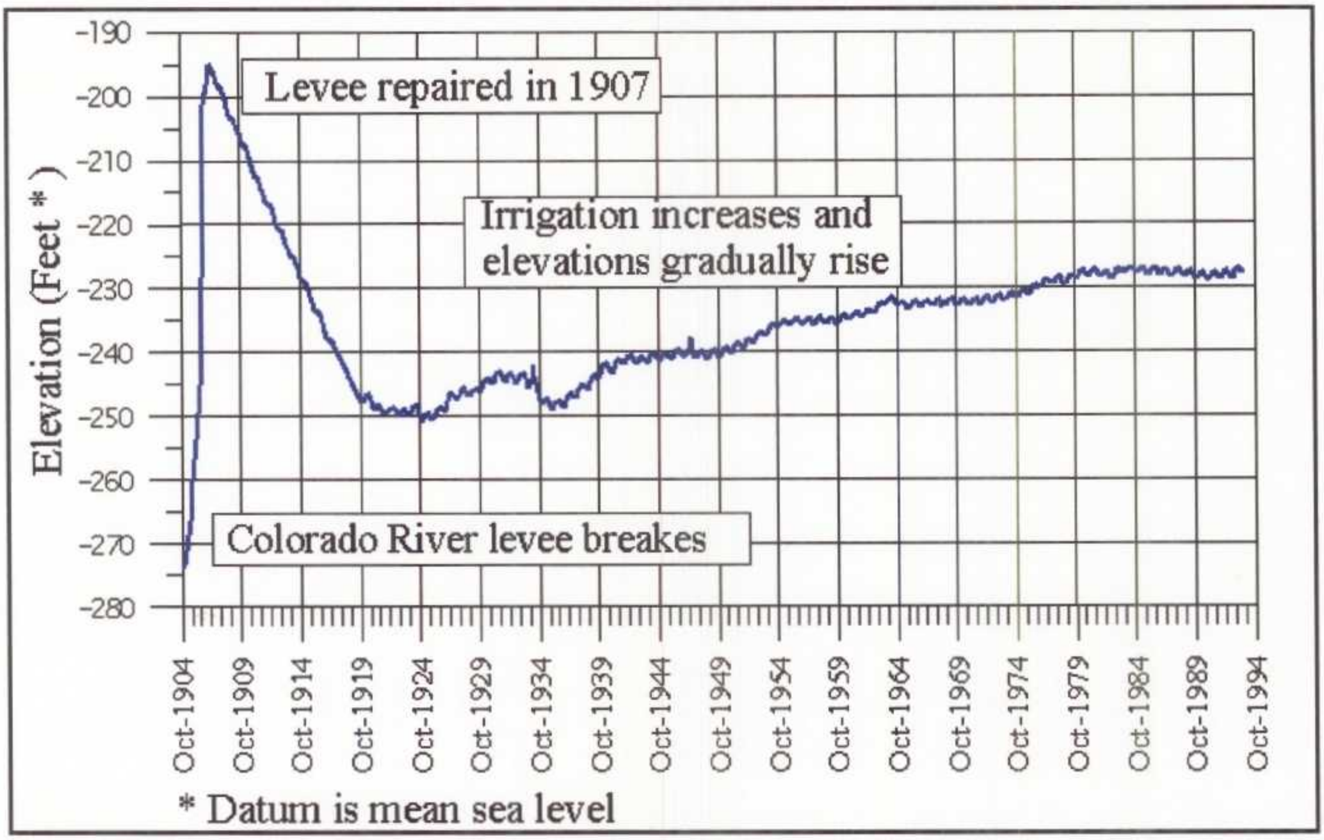
Historical Elevations of the Salton Sea



The water surface elevation of the Salton Sea has varied dramatically since its formation in 1904.

Data is from:

US Geological Survey, 1904-1970. *Surface Water Supply of the United States Part 10. The Great Basin.* Geological Survey Water Supply Papers, US Department of Interior

US Geological Survey, 1971-1993. *Surface Water Records*, Part 1, Volume 1. *Colorado River Basin, Southern Great Basin, and Pacific Slope Basins Excluding Central Valley.* Water Resources Data for California, US Department of Interior

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UC Davis Data Collection Sites

The UCD Salton Sea Project is conducting long-term data collection at 5 sites around the Sea. These sites were chosen initially to coincide with the longitudinal axis of the Sea. Sites were placed at the mid-point (Site 4) and ends of the major axis (Sites 2 and 5). The section of the Sea between Sites 4 and 2 was halved and a transverse axis was drawn fixing locations of Sites 1 and 3. sites were shifted as necessary to best approximate the Sea's bathymetry.

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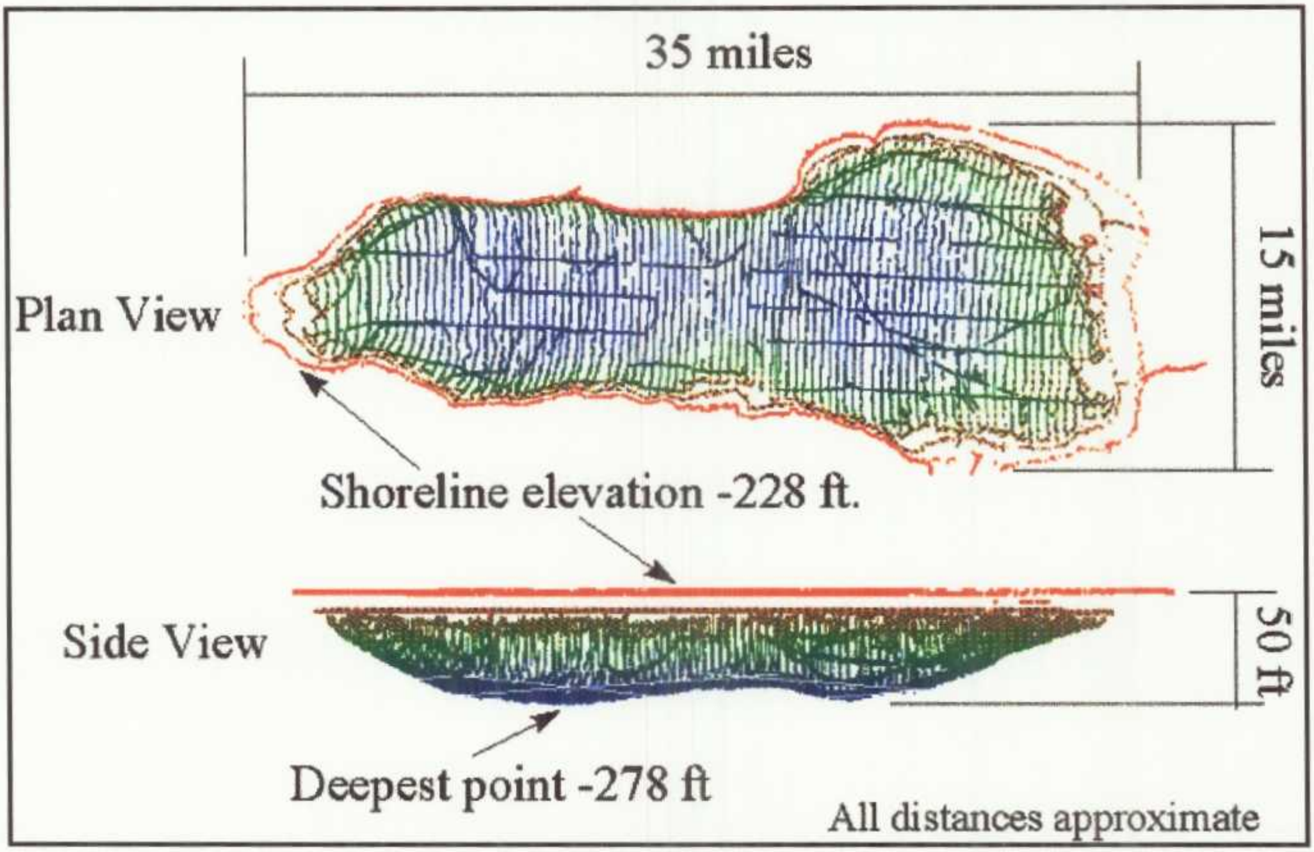
Bottom topography of the Salton Sea

The US Bureau of Reclamation conducted a Hydrographic GPS Survey of the Salton Sea in 1995. This survey measured in detailed the underwater topography of the Sea by collecting over 133,000 data points.



The vertical scale in the figure has been greatly exaggerated to show that there are two distinct basins in the Salton Sea, with the deepest points lying in the northern section.

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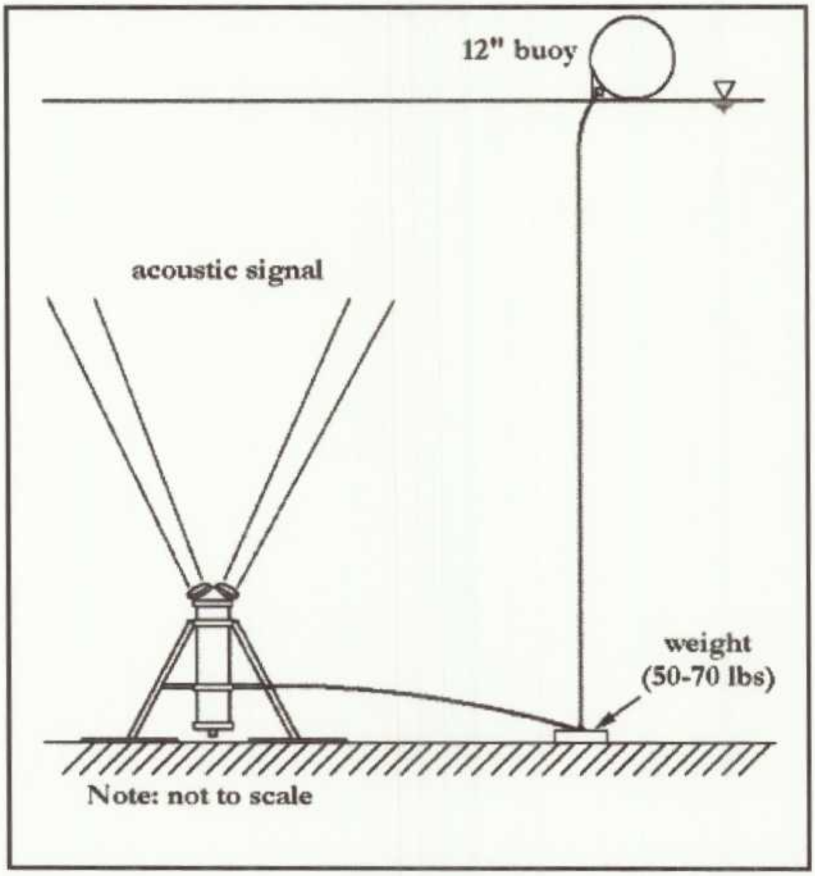
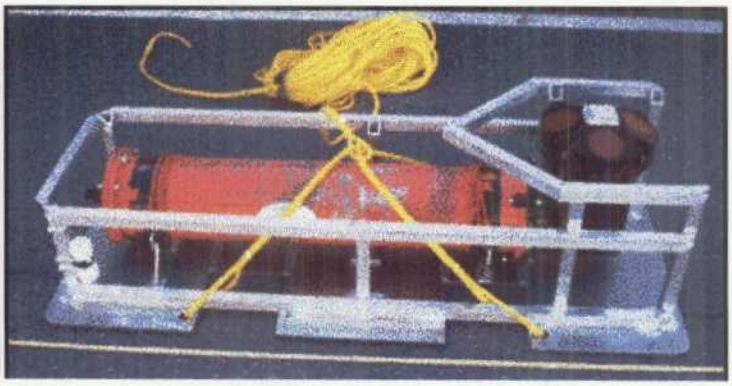
Water Currents and Circulation

Two RD Instruments Broadband Acoustic Doppler Current Profilers (ADCPs), on loan from the University of Hawaii, have been deployed for long-term acquisition of water velocities in the Salton Sea. ADCPs send and receive acoustic signals through the overlying water column. After processing the returned signal, the ADCPs calculate horizontal and vertical water movements.



Each ADCP is completely self-contained with 30Mb of data storage and battery power sufficient for more than 80 days of recording data at 15 minute intervals.



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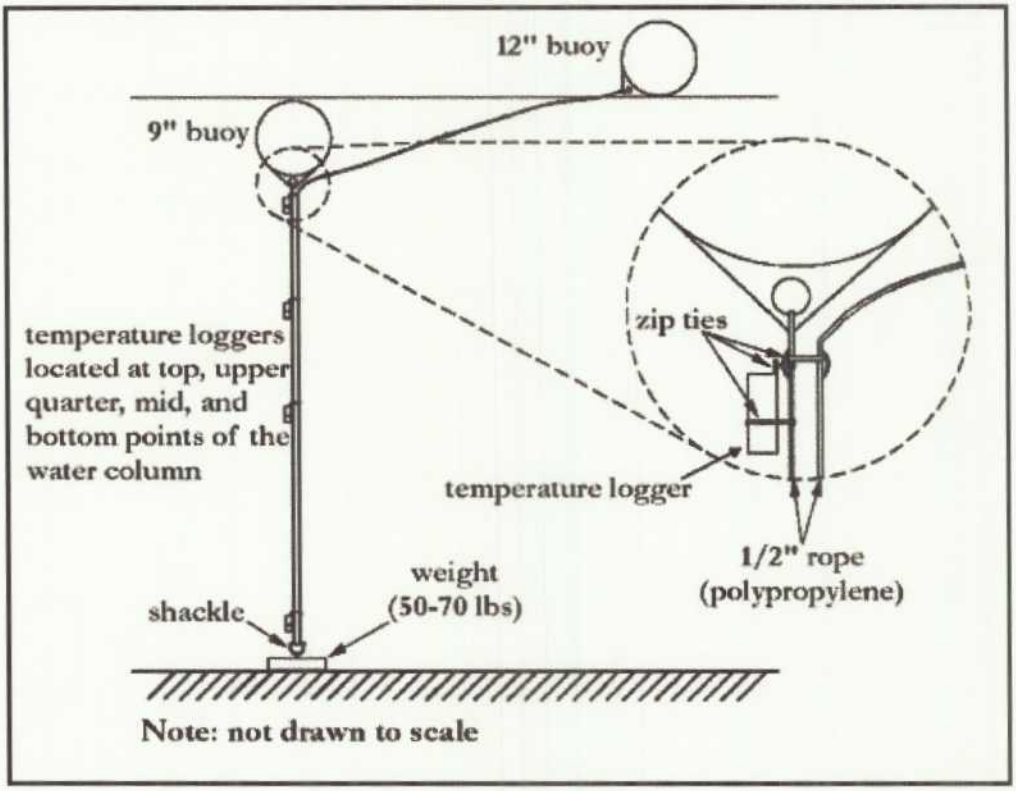
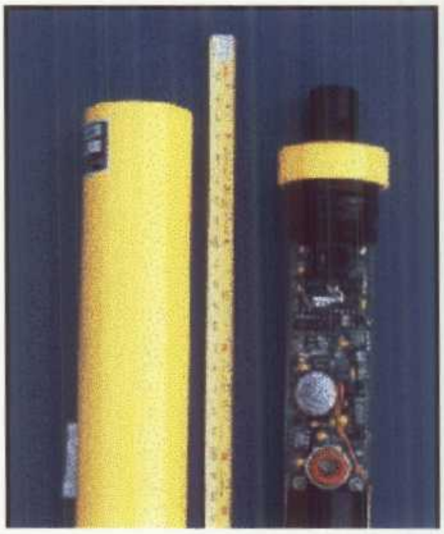
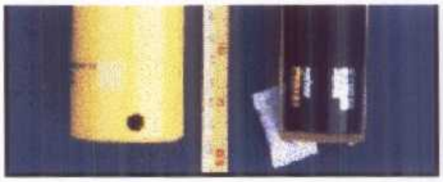
Water Temperature Measurement

Measuring temperature fluctuations in the Salton Sea is a formidable undertaking. Water temperatures vary dramatically with a variety of spatial and temporal scales. In an attempt to measure circulation at both scales, five sites were chosen around the Sea for continuous monitoring. At each site, temperature loggers were deployed in a vertical configuration.



Examples of two different types of temperature loggers used in this project are shown below.





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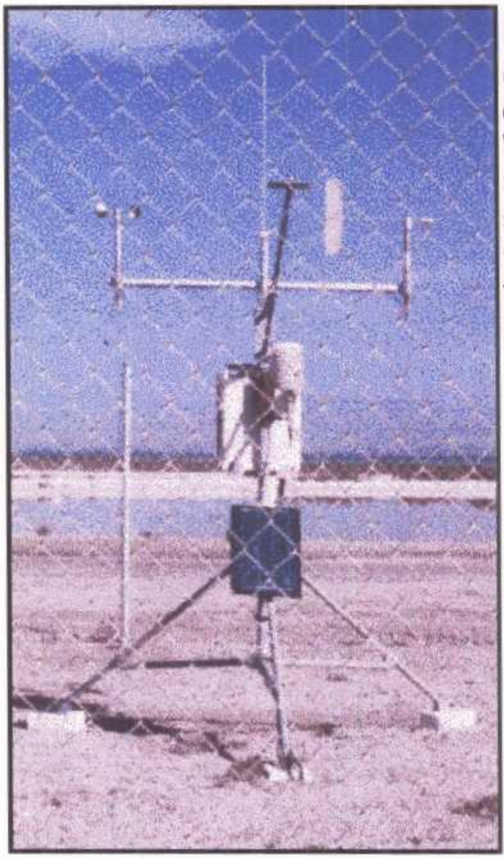
Meteorological Measurements and Conditions



Meteorological data has been obtained from the CIMIS (California Irrigation Management Information System) database maintained by the California Department of Water Resources. CIMIS stations measure direct solar radiation, air temperature, relative humidity, and wind speed and direction. All measurements are reported hourly as averages for the preceding hour. There are four CIMIS stations located near the shores of the Sea (see basin map).

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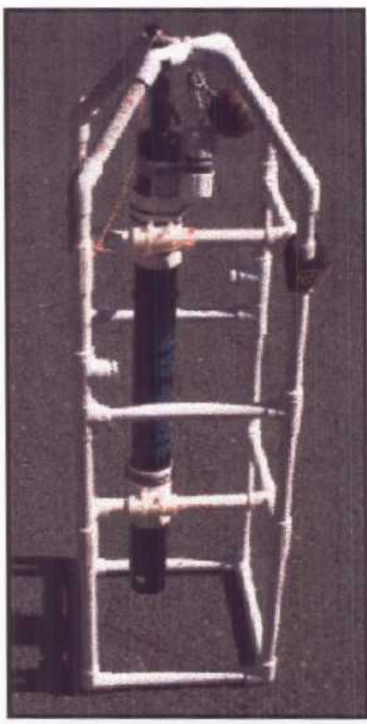
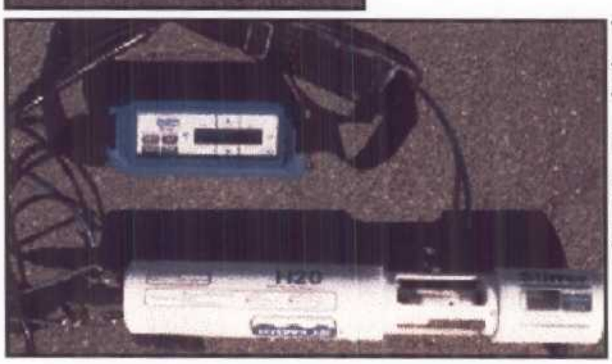
Electrical Conductivity and Other Water Quality Measurements

The ability of water to conduct an electrical current is proportional to its total dissolved solids concentration and water temperature. All conductivity data collected during this project are derived from instantaneous vertical profiles collected while maintaining and deploying temperature and velocity instruments.



The Ocean Sensors Model OS200 CTD is self-contained and measures conductivity, temperature, and pressure. The instrument is deployed by dropping it through the water column from the boat. As it falls through the water column the instrument gathers data. It is then retrieved, and the recorded data is downloaded. The results are detailed profiles of water quality through the water column.



The Hydrolab H20 measures conductivity, temperature, dissolved oxygen, pH, and depth. The continuously monitoring instrument is not self-contained; the sensors are lowered separately through the water column. Measurements from the sensors are displayed at the surface and manually recorded.

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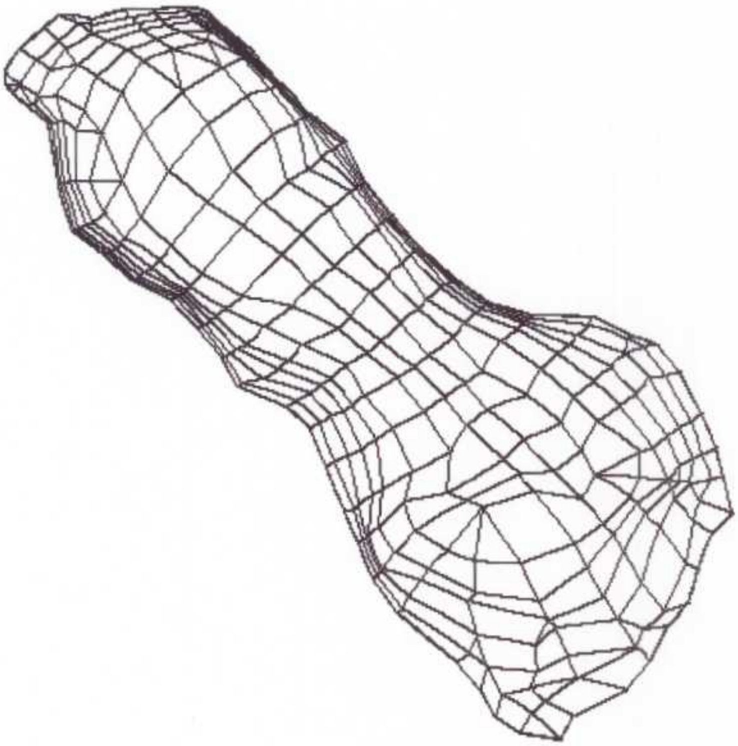
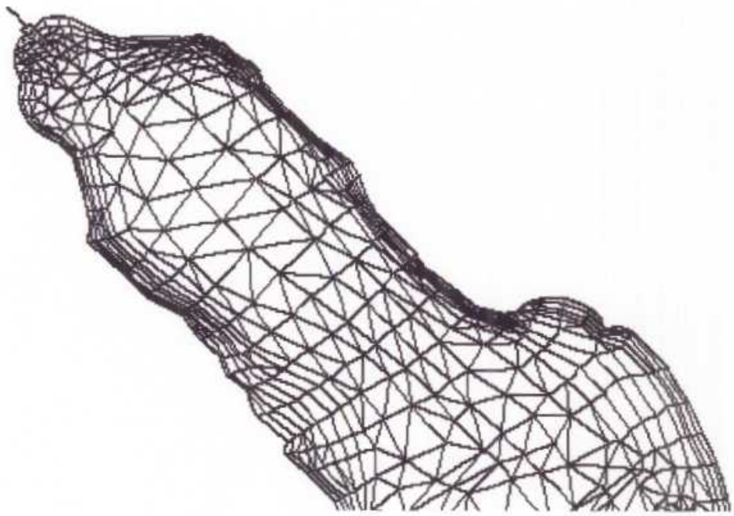
Finite Element Computational Grid

The Salton Sea is represented mathematically using a network of elements and nodes, called a finite element grid. This grid defines the boundaries of the Sea and tributary system to be studied. Several grids have been developed of varying complexity. As the grid becomes more refined, the computational solution becomes more detailed and computational intensity increases. Therefore, a balance is required, trading off complexity (detail) with computational intensity (time).

As an example, the following two grids have been used in this project.



This is a relatively coarse grid, consisting of 335 elements and 1034 nodes.



This grid is more refined, especially in the southern portion of the Sea where the New and Alamo Rivers enter. It is composed of 1553 elements and 4073 nodes.

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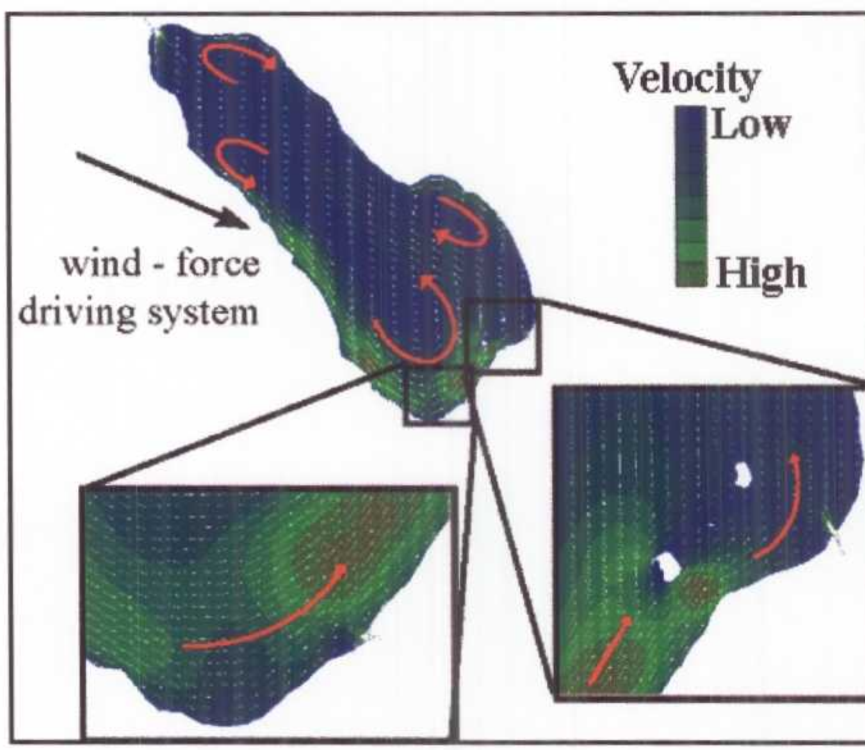
Two-Dimensional Hydrodynamic Model

A two-dimensional hydrodynamic model of the Salton Sea has been developed. After the model has been run, the hydrodynamic results can be linked with a particle tracking model, giving exciting animations of the results. The computational model is titled RMA-2 and was developed by Professor Ian King both at UC Davis and Resource Management Associates.

RMA-2 is two-dimensional because the equations for fluid motion have been depth integrated. This model is appropriate for use when horizontal velocities are relatively homogenous vertically throughout the water column and vertically velocities can be assumed negligible. These assumptions are generally appropriate when the Salton Sea is not stratified vertically which usually occurs during the winter.

Though limited model results are available, data to calibrate and verify the model are just now being gathered.



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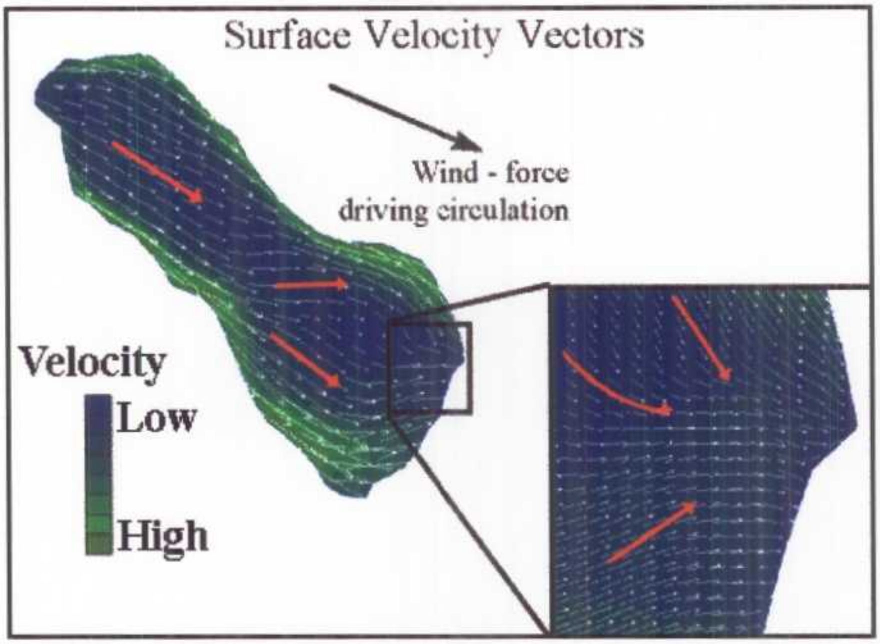
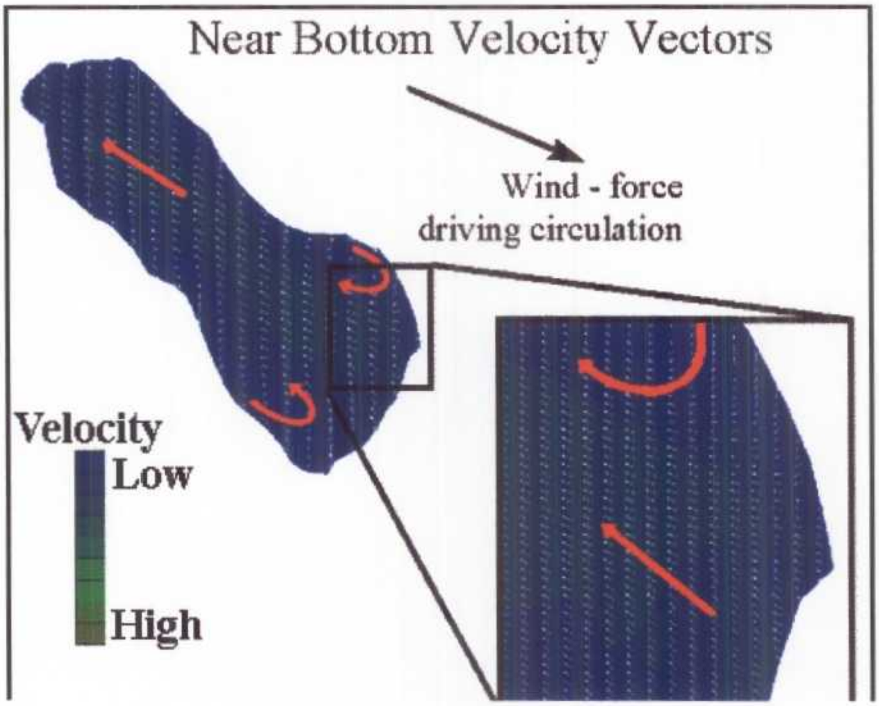
Three-Dimensional Hydrodynamic Model

A three-dimensional hydrodynamic model of the Salton Sea has been developed. The computational model is titled RMA-10 and was developed by Professor Ian King both at UC Davis and Resource Management Associates.

Though limited model results are available, data to calibrate and verify the model are just now being gathered.





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Project Reports/Technical Papers

Several reports have been generated documenting this project.

Christopher B. Cook, D.W. Huston, M.R. Jensen, G.T. Orlob, S.G. Schladow, *Internal Dynamics of a Large Saline Lake: Field Investigation and Monitoring of the Salton Sea, California*, 1998 Ocean Sciences Meeting, AGU and ASLO. (In preparation; to be presented Feburary 1998).

Christopher B. Cook and Gerald T. Orlob, *Field Monitoring and Hydrodynamic Modeling of the Salton Sea, CA*, Environmental and Coastal Hydraulics: Protecting the Aquatic Habitat, Vol. 1, 27th Congress of the International Association for Hydraulic Research, August 1997, pp 659-664.

Christopher B. Cook, M.R. Jensen, D.W. Huston, G.T. Orlob, S.G. Schladow, *Salton Sea Project Phase II-A Report*, Modeling Group, Center for Environmental and Water Resources Engineering, Department of Civil and Environmental Engineering, Univeristy of California, Davis, May 1997, 24 pgs.

Christopher B. Cook and Gerald T. Orlob, *Two- and Three-Dimensional Modeling of Salton Sea, California*, North American Water and Environment Congress, American Society of Civil Engineers. June 1996, 6 pgs.

Christopher B. Cook, G.T. Orlob, S. Breithaupt, J.D. Anderson, J. Fellows, *Salton Sea Project Phase I Final Report*, Modeling Group, Center for Environmental and Water Resources Engineering, Department of Civil and Environmental Engineering, Univeristy of California, Davis, September 1995, 42 pgs.

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