Characteristics of the Coastal Flow in Southeastern Lake Michigan

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Eulerian Measurements

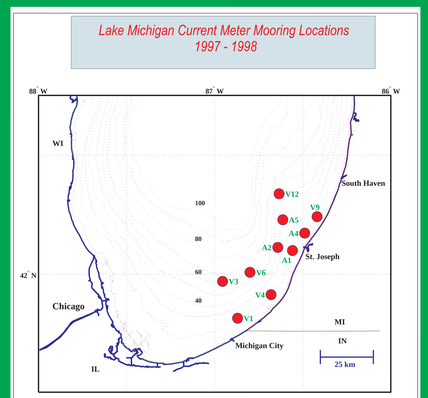
Beginning in October 1997 ten current meter moorings were deployed along the southeastern coast of Lake Michigan to help quantify the offshore - onshore flux of materials. Time series data from the meters are presented to the right with a figure showing the mooring locations.

The "V" and "A" designations correspond to data obtained by a *Vector Averaging Current Meter (VACM)* and an *Acoustic Doppler Current Profiler (ADCP)*, respectively. Data are from the surface VACM (about 12 m below the surface) and from the ADCP bin that corresponds to the 12 m depth. The surface VACMs failed at V4 and V9 so the bottom VACM data are used in their place. All velocity data were rotated to conform to local bathymetry to assist in quantifying the long-shore and cross-shore components of flow. Similarly a right-hand coordinate convention is used with "+" velocities corresponding to onshore and northerly alongshore flows. The oppositely directed flows are identified by a "-" sign. Bathymetric contours are shown at 10 m intervals.

The time series data are from December 1, 1997 through April 30, 1998. The data are presented in two panels representing the alongshore and cross-shore velocity components. The overall mean velocity is shown for each data set in the upper right corner of the subplots. The intense March '98 storm is also highlighted and shows strong offshore flow at nearly all of the moorings and a strong northward directed flow as well.

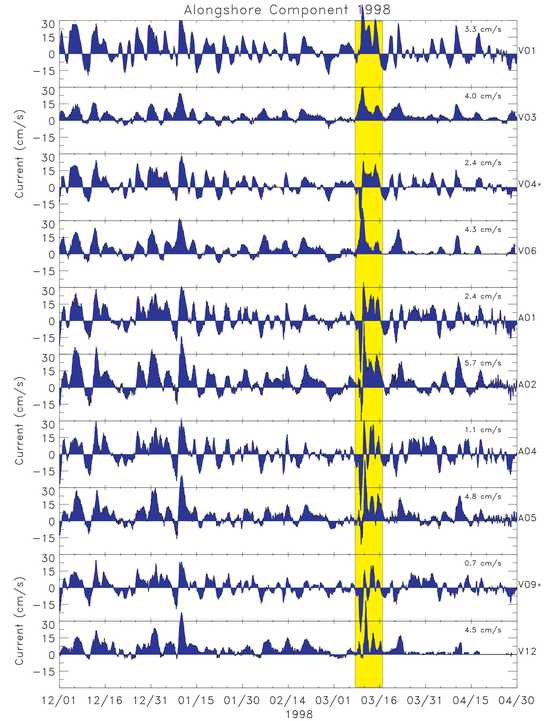
Over longer time scales, the longshore and cross-shore barotropic current response over winter '97 - '98 revealed a dominant longshore flow with mean currents nearly an order of magnitude stronger than the cross-shore component. Time series data show numerous current reversals with data from the shallow 20 m moorings showing a strong coupling with changes in the surface wind stress. Data from the 60 m moorings were more strongly influenced by the large scale circulation. A topographic wave with an approximate four day period, first identified by Saylor et al. (1980), also appears in the coastal data. The averaged currents show a net northerly longshore and a very weak westerly offshore flow.

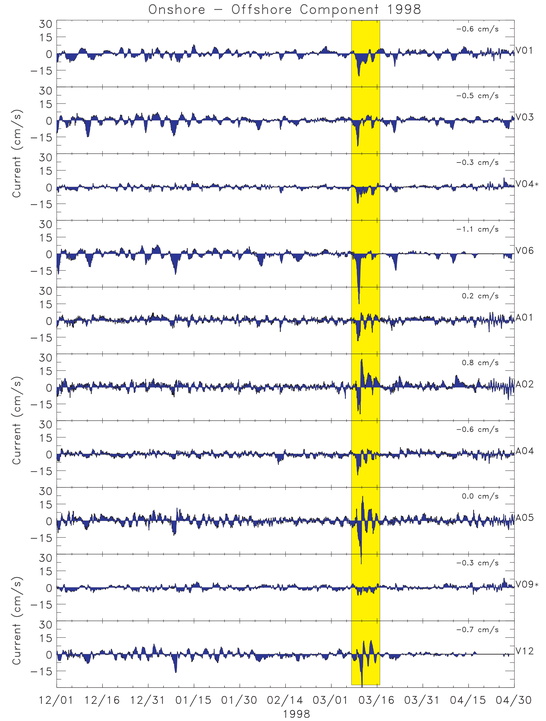
Lake Michigan Current Meter Mooring Locations 1997 - 1998



The effects of coastal stratification are seen to begin near the middle of April when inertial oscillations appear in the time series. Only the shallow moorings show these oscillations in April. The 60 m deep moorings do not stratify until May.

Surface flow characteristics were also observed using satellite reporting drifting buoys during April '98 and '99.





Lagrangian Measurements (April 1999)

During April 1998 and 1999 satellite-reporting drifters were used to study the surface flow field of the lake. In 1998 eight drifters were deployed 25 km apart along the 20 m depth contour from a USCG helicopter. Based upon results from that experiment the 1999 efforts were modified. One drifter was deployed at each of 5 different sites every 2-3 days during the first two weeks of April. A total of 25 drifters were deployed from USCG surface vessels operating out of stations: St. Joseph, Michigan City, and Calumet Harbor.

Preliminary results from the April '99 experiment are shown to the right.

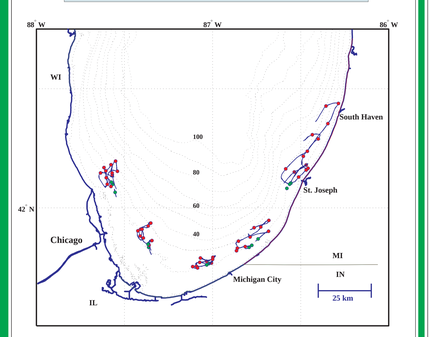
In general the drifter trajectories show numerous current reversals with the strongest currents occurring along the eastern shore. The trajectories tend to follow the bathymetry with the longest episode of significant offshore transport seen in late April. The mean drifter speed was 16 cm/s.

More detailed analyses will require resolving the surface wind field which exhibited complex flow associated with several frontal systems that passed through the study region.

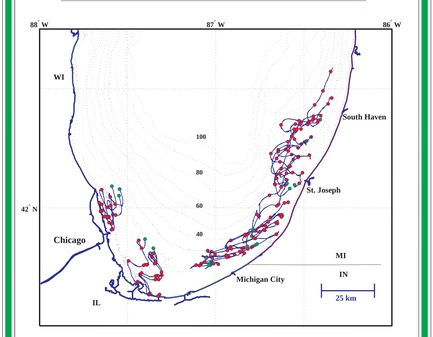
A total of 8 drifters were lost in '99. The spring 2000 experiment will use all remaining drifters (17) and the study area will be concentrated along the southern and eastern shores.

CODE type drifter deployed in Lake Michigan

Drifter Trajectories for April 2 - 10 (Green dot = start, red dot = 24 h locations)



Drifter Trajectories for April 10 - 20 (Green dot = start, red dot = 24 h locations)



Drifter Trajectories for April 20 - 30 (Green dot = start, red dot = 24 h locations)