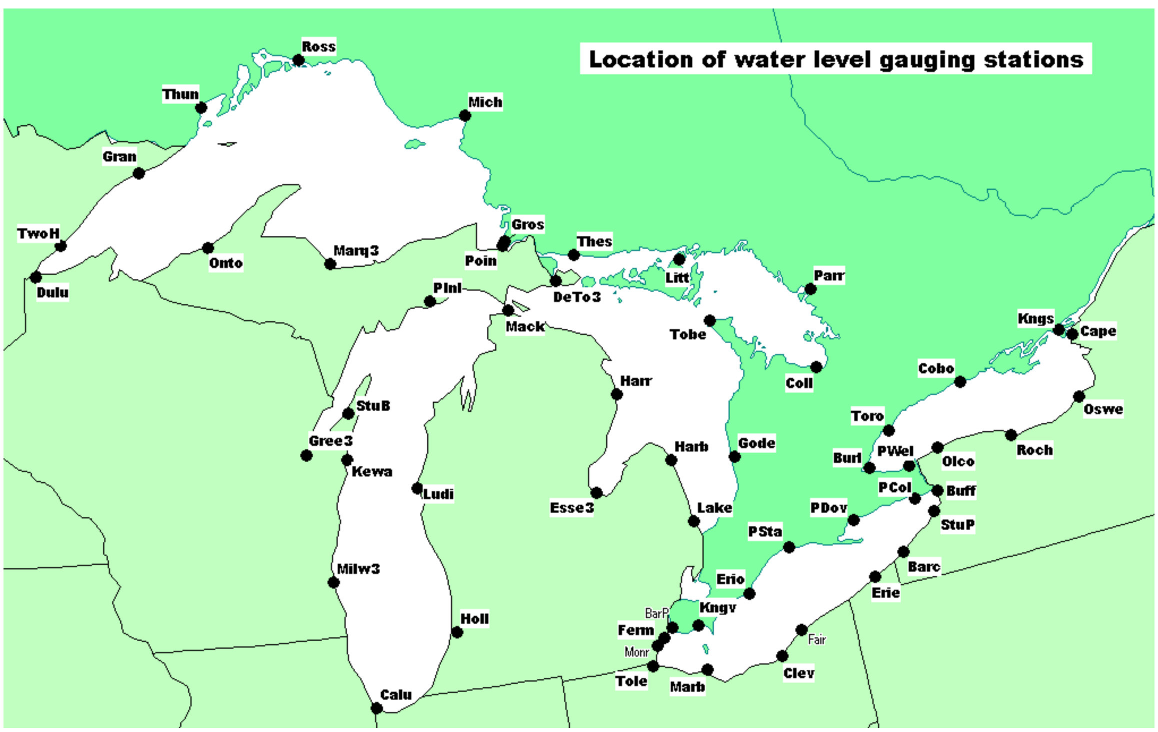
Apparent Vertical Movement
Over the Great Lakes - Revisited

Report prepared by

The Coordinating Committee
On Great Lakes Basic Hydraulic and Hydrologic Data



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Introduction

1. Requirement for International Study. The Earth's crust north of the Great Lakes was pressed down by up to 3 km of ice in some areas during the last glacial era. When the ice melted some 10,000 years ago the crust started rebounding. This is called postglacial rebound (PGR) and it is still going on today. While the land north of the Great Lakes is rising, for equilibrium, the land south of the Great Lakes is subsiding. Hence, residents on the south shores of the Great Lakes have noticed water level rising slowly over time. On the other hand, rising land and shore to the north of the Great Lakes leads to declining water levels relative to the adjacent shoreline. A precise estimation of PGR is achieved by studying water level records from water level gauges of both countries.

The Great Lakes water level averages and other statistics in this study are derived using 55 water level gauges located on both sides of the border. Many of these gauges are used in the regularization of Lakes Superior and Ontario with the network of gauges designed to take into consideration the process of PGR.

The Coordinating Committee's Vertical Control - Water Levels Sub-committee has the mandate to "review and update as necessary the apparent vertical crustal and other movement rates between water level gauge sites in the Great Lakes-St. Lawrence River System, and report coordinated findings".

2. Authority. The Committee instructed its Vertical Control - Water Levels Sub-committee to investigate previous work on vertical movement of the crust in the Great Lakes area, select a method of determining the amount of such a movement and establish coordinated rates of movement between sites on each lake.

3. Purpose and Scope. The purpose of this report is to update the 1977 report of the Committee on the apparent vertical movement by adding more recent water level records and employing better analytical techniques.

The vertical movement identified in this study provides an estimate of the change expected between the published dynamic heights related to the International Great Lakes Datum (IGLD) of 1985 (Coordinating Committee, 1995) and true dynamic heights continuously changing with time. This helps planning for future upgrades of the datum.

4. Acknowledgments. The Coordinating Committee acknowledges and expresses its appreciation of the cooperation, assistance and advice received from the Geodetic Survey Division, Natural Resources Canada; Canadian Hydrographic Service, Fisheries and Ocean Canada; the National Ocean Service and the National Geodetic Survey, National Oceanic and Atmospheric Administration, U. S. Department of Commerce; and the U. S. Army Corps of Engineers. The individual contributions of Messrs. A. Mainville, Ron Solvason, Jeff Oyler, Brooks Widder and Dave Conner are gratefully acknowledged by the Committee.

Methods and Results

5. Previous studies. The Coordinating Committee's 1977 report entitled "Apparent Vertical Movement Over the Great Lakes" provides an excellent summary of the previous studies on postglacial rebound in the Great Lakes region from 1898 to 1977.

Recently, Tait and Bolduc (1985), Carrera et al. (1991), and Tushingham (1992) used basically the same method, each using additional years of water level data, to compute the rates of movement between pairs of gauges. Their results are summarized and compared to ours in Table 5a-d. Compared to these latest studies over the Great Lakes fifteen additional sites and eight additional years of data will be used here. While only the summer months (June to September) were used in these previous studies, the data from all 12 months will be used here.

6. Basic Data. The data used here to determine the vertical movement of the crust at each gauge are monthly mean water levels. The water levels are in metres, relative to IGLD (1985), recorded at 55 gauge sites on the Great Lakes, and published by the U.S. National Ocean Service and the Canadian Hydrographic Service.

A map of the gauge locations is shown on Fig. 1. The sites are listed in Table 1 together with the years that water levels were recorded. When a gauge was moved within a harbor, the data from both gauges was merged as if it was the same gauge. Graphs of the data used at all 55 gauges are available on the web, for each lake: Ontario, Erie, Michigan-Huron and Superior. The black dots are water levels averaged monthly, as provided. The pink dots are monthly levels rejected during the study, as explained later.

Fig. 2 indicates the number of years of recorded data available and used at each gauge site. Table 2 indicates the years data are not available.

7. Computations. After recording the water level at two lake gauges for many years, the apparent vertical movement of a gauge site relative to the second gauge may be computed. Contrary to a tide gauge on the ocean, it takes two gauges on a lake so the seasonal water fluctuation may be removed by subtracting water level at gauge A from that at gauge B. The relative movement is the linear trend seen on the plot of the water level differences with respect to time. An example is provided on Fig. 3 .

The X-axis is the time, the Y-axis is the monthly water level at gauge A (Calumet Harbor) minus the monthly water level at gauge B (Parry Sound). The linear trend (in black) on Fig. 3 is 0.32 m per century. Hence, Calumet Harbor, Michigan, is seen to subside by 32 cm per century relative to Parry Sound, Ontario. Such relative movement was computed for all the pairs of gauging stations seen on Fig. 4.

Due to random errors in the data, the rates obtained as described above are not consistent within any three stations. For example, Calumet Harbour is subsiding by 10 cm relative to Lakeport, Michigan, and Lakeport is subsiding by 25 cm relative to Parry Sound, the sum of which is different from the 32 cm discussed above.

Hence, it is preferable to combine the rates using the least-squares adjustment techniques. The adjustment procedure used is described in a report by Mainville and Craymer (2002). Since the water level of a lake is independent of a second lake, each lake is adjusted individually. Each and every monthly level averages on the lake are entered in the adjustment. The adjustment software rejects outliers using an iterative process. The final adjusted trends are listed in Table 5a-5d (see column 6). The adjusted velocities indicate that Calumet Harbour is subsiding by 34 cm per century relative to Parry Sound. The adjusted trend is the straight line in pink, while the trend prior to the adjustment is in black, see Fig. 3 .

The trends for all the pairs were plotted and are available on the web, for each lake: Ontario, Erie, Michigan-Huron and Superior.

The black dots are the monthly water levels of gauge A relative to gauge B. The black line is the trend of the black dot (before the lake adjustment). The pink line is the best trend found after the lake-adjustment. The pink dots are the outliers rejected by the adjustment.

The trends are listed in Tables 5a-5d. Both the relative velocities prior to and following the adjustment (see column 5 and 6) are given and compared with previous studies.

These velocities and their standard error are summarized by providing the velocities relative to the gauge at the lake outlet as seen on Fig. 5 and Fig. 6 and in Tables 4a-4d.

In addition to the trends, the adjustment computes three other useful values; monthly biases, site biases and residuals.

Each month there is a different bias in the water level due to precipitation, evaporation, barometric pressure, wind, snow melting, water level regularization at dams, etc. The adjustment computes one bias per month common to all gauges on the lake. It indicates the average level of the water after removing the trend and the site bias. The monthly biases are available on the web for each lake: Ontario, Erie, Michigan-Huron and Superior.

The site bias is a bias specific to a gauge site. It may be used to improve the definition of future datum definitions. The biases are listed in Tables 4a-4d and mapped on Fig. 7. They are small in magnitude, mostly below 1 cm, which indicates the stability of the local datum at each gauges, the quality of the data and of IGLD (1985) definition. Their standard error are given as well.

The residuals are the random errors in the data left after removing the monthly biases, the trends (i.e., the vertical movement of the crust at each gauge) and the site biases. The residuals are fairly small in magnitude, below 3, 7, 5 and 4 cm respectively for each lake, an indication of the quality of the data. The residuals are available on the web for each lake: Ontario, Erie, Michigan-Huron and Superior. The residuals at Port Weller, Rochester, De Tour, Ludington and Rossport show undesirable systematic trends. Hence the data at these sites should be investigated in later studies.

8. Rejections. Some water level data points were rejected by the adjustment software. When a residual, as explained earlier, was larger than three times the root mean square of all the residuals, its water level was automatically rejected. The number of outliers at each gauge, and for each month is listed on the web, for each lake, in Table 3a-d. Each outlier and its magnitude is also listed on the web in Table 3e-h. The water levels rejected are plotted on the web for each gauge site, and for each lake: Ontario, Erie, Michigan-Huron, and Superior (in pink). The outliers are best seen plotted on the web for each gauge pair, for each lake: Ontario, Erie, Michigan-Huron, and Superior (in pink).

As seen on Table 3a-d, most outliers occured during the winter months. Previous studies used only the four summer months (June to September) because winter months were found to be noisy. Here 95% of the other 8 months contributed to the solution.

9. Lakewide results. As explained previously, each lake is adjusted independently. Again, the resulting velocities and their standard error are shown on Fig. 5 and Fig. 6, respectively. The velocity and its standard error is given in centimetres per century. Note that the gauge at each lake outlet was assigned a velocity of zero. Hence the velocities are relative to the gauge of each lake outlet. Again, these velocities and their standard error are listed in Tables 4a-4d.

Note that a standard error is the precision with 68% confidence. The standard error multiplied by 2 is the precision with 95.5% confidence, multiplied by 3 it is the precision with 99.7% confidence.

The relative velocities between gauge sites on a lake are computed using the above outlet-relative velocities and are listed in Table 5a-5d (column 6). These velocities are lake-dependent and are listed for each of the lakes.

The velocities provide a sense of the earth crust relative movement. For example, each 100 years the land at Calumet Harbor becomes 10 cm lower than the land at Lakeport, and 34 cm lower than the land at Parry Sound.

The relative velocity between locations on any two lakes is found in the next section.

10. Postglacial rebound (PGR). Here the vertical movement of the crust over the whole Great Lakes region is derived by tying the previous lakewide results together. The outlet-relative velocities on each lake are first mapped using contours. An extrapolation of the contours on lakes Superior and Huron allow us to assign with some confidence the same velocity at Gros Cap and Thessalon. Similarly, Buffalo on Lake Erie is assigned the same velocity as Port Weller on Lake Huron. Finally, Toronto on Lake Ontario is assigned 6 cm/century less than the velocity at Collingwood on Lake Huron. This way the velocities over the four lakes are now connected.

Relative vertical movement over the region may also be obtained using global postglacial rebound (PGR) models such as ICE-3G (Tushingham and Peltier, 1991), ICE-4G(vm1) and ICE-4G(vm2) (Peltier, 1995) models. The development of the ICE-3G and ICE-4G models did not make use of lake level gauges (Peltier, personal communication, June 1999). The ICE-4G models were tested, but the gradient of the contours was too small compared to the gauge-derived contours. The ICE-3G model agreed better than the ICE4G model to the gauge gradient and was retained. The ICE-3G PGR model is contoured in Fig. 8. One can see the smoothness of the global PGR model over the Great Lakes. The ICE-3G derived velocities over the Great Lakes region were then replaced by the gauge-derived velocities discussed above. A constant of 1.3 cm/century could have been added to the gauge derived velocities so it would agree in average with the ICE3G model. This constant is rather arbitrary since the area with zero velocity over the Great Lakes is unknown at this time. Since the constant is small it is neglected, and Lakeport is kept with its velocity at zero. The final result is shown on Fig. 9. A contour map of the rates in Fig. 9 is shown in Fig. 10. Fig. 9 and 10 are the final results where ICE3G PGR surrounds the gauge-derived PGR.

As seen on Fig. 5, the velocities at Bar Point, Monroe and Fairport don't agree with the other sites. Fig. 2 indicates they have very few years of records, and Fig. 6 shows their large standard error. Hence these three sites were not used to derive the final results on Fig. 9 and Fig. 10.

Finally, the rates on Fig. 10 provide an estimate of the maximum movement expected in the region, i.e., some 57 cm every 100 years between Rossport and Calumet Harbor.

Note, the rates provided by the global PGR models are absolute rates in the sense that they are relative to the whole earth. However their standard error is unknown. Hence, one must use caution in using the velocities at any one location. The relative velocity between two sites on a lake has an excellent standard error. However, the relative velocity between two sites on two lakes likely has a standard error in the order of ± 6 cm/century.

Conclusion and Recommendations

11. Conclusion. The relative movement between 55 Canadian and U.S. lake level gauges on the Great Lakes were computed and are listed in Table 5a-5d. These are the best estimates available from the present state of the art. Their precision was also computed. These velocities and standard errors are summarized in Tables 4a-4d, Fig. 5 and Fig. 6 by providing the velocities relative to the gauge at the lake outlet. The relative velocity over the whole region was also derived and is shown in Fig. 9 and Fig. 10.

Note, the rates provided by the global PGR models and in Fig. 9 and Fig. 10 are absolute rates in the sense that they are relative to the whole earth. However their standard error is unknown. Hence, one must use caution in using the velocities at one location. The relative velocity between two sites on a lake has an excellent standard error. However, the relative velocity between two sites on two lakes likely has a standard error in the order of ±6 cm/century.

12. Recommendations. The Committee recommends that the systematic trend found in some plots of the residuals, and of the outliers be investigated. Systematic trends in the residuals and outliers have not been adequately investigated and may point to errors in the data that could have the largest impact on the accurate determination of the movement rates. Specifically, the residuals at Port Weller, Rochester, De Tour, Ludington and Rossport show undesirable systematic trends. Hence the data at these sites should be investigated in later studies.

The satellite positioning technique GPS is seen as the emerging technology to determine the absolute velocities of the Earth crust. Having gauge sites on each lake permanently equipped with GPS receivers will allow us, after a few years, to accurately link the relative rates of all five lakes (as well as lake St-Clair) and eventually get absolute rates of vertical movement over the region. Obtaining absolute velocities is important in view of upgrading the vertical datum, hydraulic and hydrologic studies, bathymetry, charts, and navigational safety.

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Table 1 – List of 55 water level gauge sites and their period of record

Lake	Name	Abbr.	Id.	Years	Period of Record[1]
Ontario	Burlington	Burl	13150	31	1970 - 2000
	Cape Vincent	Cape	02000	86	1898 - 2000, except.
	Cobourg	Cobo	13590	45	1956 - 2000
	Kingston	Kngs	13988	85	1916 - 2000
	Olcott	Olco	02076	32	1967 - 2000, except.
	Oswego	Oswe	02030	141	1860 - 2000
	Port Weller	PWel	13030	48	1929 - 2000, except.
	Rochester	Roch	02058	97	1860 - 2000, except.
	Toronto	Toro	13320	85	1916 - 2000
Erie	Barcelona	Barc	03032	28	1960 - 1987
	Bar Point	BarP	12005	35	1966 - 2000
	Buffalo Harbor	Buff	03020	124	1860 - 2000, except.
	Cleveland	Clev	03063	141	1860 - 2000
	Erie	Erie	03038	41	1958 - 2000, except.
	Erieau	Erio	12250	44	1957 - 2000
	Fairport Harbor	Fair	03053	26	1975 - 2000
	Fermi Power Plant	Ferm	03090	38	1963 - 2000
	Kingsville	Kngv	12065	39	1962 - 2000
	Marblehead	Marb	03079	40	1959 - 2000, except.
	Monroe	Monr	03087	14	1975 - 1988
	Port Colborne	PCol	12865	75	1926 - 2000
	Port Dover	PDov	12710	43	1958 - 2000
	Port Stanley	PSta	12400	75	1926 - 2000
	Sturgeon Point	StuP	03028	32	1969 - 2000
	Toledo	Tole	03085	95	1877 - 2000, except.
Huron	Collingwood	Coll	11500	74	1927 - 2000
	De Tour	DeTo	05098	43	1896 - 1983, except.
	De Tour Village		05099	23	1977 - 2000
	De Tour Village	DeT2[2]		65	1896 - 2000
	Essexville	Esse	05034	26	1953 - 1978
	Essexville		05035	24	1977 - 2000
	Essexville	Ess2[2]		48	1953 - 2000
	Goderich	Gode	11860	74	1927 - 2000
	Harbor Beach	Harb	05014	141	1860 - 2000
	Harrisville	Harr	05059	37	1961 - 1997

[1] Records are mainly up to December 2000. See Table 2 for periods when data are not available.
[2] Records from two gauges at same location were merged, for this study.

Table 1 - List of 55 water level gauge sites and their period of record (Continued…)

Lake	Name	Abbr.	Id.	Years	Period of Record[1]
Huron	Lakeport	Lake	05002	45	1955 - 2000, except.
	Little Current	Litt	11195	42	1959 - 2000
	Mackinaw City	Mack	05080	102	1899 - 2000
	Parry Sound	Parr	11375	41	1960 - 2000
	Thessalon	Thes	11070	74	1927 - 2000
	Tobermory	Tobe	11690	39	1962 - 2000
Michigan	Calumet Harbor	Calu	07044	98	1903 - 2000
	Green Bay	Gree	07078	29	1953 - 1981
	Green Bay		07079	22	1979 - 2000
	Green Bay	Gre2[2]		48	1953 - 2000
	Holland	Holl	07031	56	1894 - 1997, except.
	Kewaunee	Kewa	07068	24	1974 - 1997
	Ludington	Ludi	07023	69	1895 - 2000, except.
	Milwaukee	Milw	07058	110	1860 - 1969
	Milwaukee		07057	31	1970 - 2000
	Milwaukee	Mil2[2]		141	1860 - 2000
	Port Inland	PInl	07096	37	1964 - 2000
	Sturgeon Bay Canal	StuB	07072	90	1905 - 2000, except.
Superior	Duluth	Dulu	09064	135	1860 - 2000, except.
	Grand Marais	Gran	09090	34	1966 - 2000, except.
	Gros Cap	Gros	10920	40	1961 - 2000
	Marquette	Marq	09016	121	1860 - 1980
	Marquette C.G.		09018	21	1980 - 2000
	Marquette C.G.	Mar2[2]		141	1860 - 2000
	Michipicoten	Mich	10750	70	1931 - 2000
	Ontonagon	Onto	09044	41	1959 - 2000, except.
	Point Iroquois (Brimley)	Poin	09004	66	1930 - 2000, except.
	Rossport	Ross	10220	33	1967 - 2000
	Thunder Bay	Thun	10050	70	1931 - 2000
	Two Harbors	TwoH	09070	54	1887 - 1988, except.

[1] Records are mainly up to December 2000. See Table 2 for periods when data are not available.
[2] Records from two gauges at same location were merged, for this study.

Table 2 - Years with no data (i.e., with no monthly average) available.

Lake	Abbr.	Years	Periods with no data available
Ontario	Cape	16	1899 - 1913, 1915
	Olco	2	1998 - 99
	PWel	24	1932 – 55
	Roch	44	1908 - 34, 1936 - 52
Erie	Buff	17	1870 - 1886
	Erie	2	1998 - 99
	Marb	2	1998 - 99
	Tole	27	1878 - 1903, 1909 - 10
Huron	DeTo	40	1897 - 98, 1900, 1904 - 33, 1937 - 43
	Lake	2	1998-99
Michigan	Holl	49	1898, 1901 - 02, 1904, 1909 - 34, 1936 - 40, 1943 - 55, 1957 - 58
	Ludi	38	1898 - 99, 1901 - 02, 1907, 1909 - 34, 1938, 1940 - 43, 1948 - 49
	StuB	6	1920 - 21, 1923 - 24, 1926, 1998
Superior	Dulu	6	1974 - 79
	Gran	1	1998
	Onto	1	1998
	Poin	5	1945 - 49
	TwoH	48	1888 - 98, 1901 - 29, 1932 - 34, 1936 - 40

Table 3a - Count of outliers per month and per site - Lake Ontario

Month	Burl	Cape	Cobo	Kngs	Olco	Oswe	PWel	Roch	Toro	Total
Jan:	2	7	2	3	0	9	0	4	7	34
Fev:	0	7	1	1	0	8	1	7	3	28
Mar:	0	6	3	2	1	11	0	9	3	35
Apr:	1	5	1	2	0	13	1	12	4	39
May:	0	1	1	2	0	4	1	3	0	12
Jun:	2	0	0	0	0	2	0	2	0	6
Jul:	0	3	1	0	0	4	0	4	0	12
Aug:	0	4	0	0	0	2	3	2	2	13
Sep:	0	1	1	1	0	2	1	2	3	11
Oct:	1	3	1	1	0	5	0	5	2	18
Nov:	3	2	1	2	0	8	3	8	2	29
Dec:	1	9	1	2	0	9	1	8	2	33
Total:	10	48	13	16	1	77	11	66	28	270
# of meas.:	349	997	531	1019	377	1692	567	1143	1018	
% of outliers:	3%	5%	2%	2%	0%	5%	2%	6%	3%	

Table 3b - Count of outliers per month and per site - Lake Erie

Month	Barc	BarP	Buff	Clev	Erie	Erio	Fair	Ferm	Kngv	Marb	Monr	PCol	PDov	PSta	StuP	Tole	Total
Jan:	6	0	23	5	5	0	0	4	0	5	0	16	7	1	13	25	110
Fev:	1	0	2	2	1	0	0	2	0	0	0	0	1	0	0	15	24
Mar:	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	12	15
Apr:	0	0	1	0	0	0	0	1	0	1	0	0	2	0	0	8	13
May:	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	3
Jun:	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Jul:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Sep:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4
Oct:	0	2	5	0	0	0	0	1	0	1	2	1	0	0	1	11	24
Nov:	3	4	33	10	4	0	0	6	2	4	2	15	3	1	11	50	148
Dec:	5	5	37	9	8	1	0	6	5	8	3	19	9	0	14	44	173
Total:	16	11	104	26	18	1	0	20	7	19	7	51	24	2	39	171	516
# of meas.:	306	411	1434	1692	475	510	304	447	456	465	157	900	490	884	383	1085	
% of outliers:	5%	3%	7%	2%	4%	0%	0%	4%	2%	4%	4%	6%	5%	0%	10%	16%	

Table 3c - Count of outliers per month and per site - Lake Michigan-Huron

Month	Calu	Coll	DeTo3	Esse3	Gode	Gree3	Harb	Harr	Holl	Kewa	Lake	Litt	Ludi	Mack	Milw3	Parr	PlnI	StuB	Thes	Tobe	Total
Jan:	8	1	0	3	0	3	1	0	1	1	0	3	1	0	4	1	0	6	1	2	36
Fev:	8	0	0	2	3	2	1	0	0	0	0	0	0	2	5	1	1	4	0	0	29
Mar:	11	1	0	6	0	6	1	0	1	1	0	1	0	2	6	2	0	3	1	0	42
Apr:	9	0	0	6	1	8	3	1	1	1	0	0	1	0	5	1	0	4	0	0	41
May:	2	0	0	1	1	6	0	0	0	0	0	0	0	0	0	1	0	2	0	0	13
Jun:	1	0	0	0	1	1	0	0	1	0	1	1	2	0	0	0	0	4	0	0	12
Jul:	1	0	0	0	1	0	0	0	0	0	1	4	0	0	0	0	0	1	0	0	8
Aug:	1	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	1	0	0	6
Sep:	5	2	1	0	0	1	0	0	0	0	1	3	0	0	1	0	0	1	0	0	15
Oct:	2	1	0	1	0	3	0	0	0	0	0	3	0	0	0	2	0	0	0	0	12
Nov:	10	7	0	10	2	12	1	0	0	2	1	3	0	2	4	4	0	1	4	0	63
Dec:	12	2	0	5	4	10	2	0	0	0	0	3	2	0	7	1	1	5	0	0	54
Total:	70	14	1	34	13	52	9	1	4	5	4	25	6	6	32	13	2	32	6	2	331
# of meas.:	1160	886	686	587	884	588	1692	416	528	286	507	497	669	1213	1687	485	431	1016	866	458	
% of outliers:	6%	2%	0%	6%	1%	9%	1%	0%	1%	2%	1%	5%	1%	0%	2%	3%	0%	3%	1%	0%	

Table 3d - Count of outliers per month and per site - Lake Superior

Month	Dulu	Gran	Gros	Marq	Mich	Onto	Poin	Ross	Thun	TwoH	Total
Jan:	10	0	7	6	2	2	8	2	0	1	38
Fev:	7	0	1	2	0	2	1	0	0	2	15
Mar:	1	1	0	1	0	3	0	2	1	0	9
Apr:	1	0	2	1	0	4	0	1	0	0	9
May:	6	0	2	5	1	1	0	0	0	1	16
Jun:	3	0	2	3	1	0	0	0	0	0	9
Jul:	1	0	2	1	1	1	0	1	0	1	8
Aug:	0	0	2	0	0	0	0	0	0	0	2
Sep:	2	0	3	1	0	0	0	0	0	0	6
Oct:	3	0	0	2	1	0	1	0	0	1	8
Nov:	4	0	2	3	2	0	2	0	0	0	13
Dec:	3	0	4	1	3	1	1	0	0	1	14
Total:	41	1	27	26	11	14	13	6	1	7	147
# of meas.:	1571	398	454	1701	834	450	768	383	839	581	
% of outliers:	3%	0%	6%	2%	1%	3%	2%	2%	0%	1%	

Table 4a - Column 1: Gauge vertical velocity and its standard error in cm/century, relative to lake outlet (relative to Cape Vincent gauge) for Lake Ontario. Column 2: The site bias and its standard error in mm, also relative to the outlet.

	cm/century	mm	
Burlington	-20.0± 0.7	4± 0.7	
Cape Vincent	0	0	< = = outlet
Cobourg	-7.7± 0.4	6± 0.7	
Kingston	2.5± 0.2	3± 0.7	
Olcott	-11.3± 0.6	5± 0.7	
Oswego	-4.5± 0.2	7± 0.7	
Port Weller	-14.7± 0.3	5± 0.7	
Rochester	-10.2± 0.2	6± 0.7	
Toronto	-12.1± 0.2	12± 0.7	

Table 4b - Column 1: Gauge vertical velocity and its standard error in cm/century, relative to lake outlet (relative to Buffalo gauge) for Lake Erie. Column 2: The site bias and its standard error in mm, also relative to the outlet.

	cm/century	mm	
Barcelona	-1.3± 2.1	-1± 3.1	
Bar Point	-16.1± 1.4	-17± 1.8	< = = not used at the end
Buffalo Harbor	0	0	< = = outlet
Cleveland	-9.8± 0.3	-8± 1.6	
Erie	-12.1± 1.2	8± 1.9	
Erieau	-9.6± 1.1	-11± 1.8	
Fairport Harbor	-21.7± 2.2	6± 2.1	< = = not used at the end
Fermi Power Plant	-9.6± 1.3	-16± 1.8	
Kingsville	-10.3± 1.2	-14± 1.8	
Marblehead	-8.4± 1.2	-17± 1.9	
Monroe	-16.0± 5.9	-16± 3.2	< = = not used at the end
Port Colborne	-5.7± 0.5	2± 1.8	
Port Dover	-1.8± 1.1	1± 1.8	
Port Stanley	-7.4± 0.5	1± 1.8	
Sturgeon Point	2.1± 1.6	-2± 1.9	
Toledo	-8.6± 0.4	-9± 1.8	

Table 4c - Column 1: Gauge vertical velocity and its standard error in cm/century, relative to lake outlet (relative to Lakeport) for Lake Michigan-Huron. Column 2: The site bias and its standard error in mm, also relative to the outlet.

Huron:

	cm/century	mm	
Collingwood	16.6± 0.7	-5± 1.3	
De Tour Village	17.3± 0.8	-3± 1.3	
Essexville	-1.3± 0.9	-1± 1.4	
Goderich	-1.5± 0.7	-1± 1.3	
Harbor Beach	0.1± 0.7	6± 1.3	
Harrisville	8.0± 1.1	-3± 1.4	
Lakeport	0	0	< = = outlet
Little Current	27.0± 1.0	-3± 1.3	
Mackinaw City	10.0± 0.7	-3± 1.3	
Parry Sound	24.3± 1.0	-8± 1.4	
Thessalon	20.8± 0.7	0± 1.3	
Tobermory	16.7± 1.0	5± 1.3	

Michigan:

	cm/century	mm
Calumet Harbor	-10.4± 0.7	7± 1.3
Green Bay	-6.2± 0.9	0± 1.4
Holland	-7.9± 0.8	7± 1.4
Kewaunee	-8.5± 1.8	-1± 1.5
Ludington	-12.2± 0.8	-1± 1.3
Milwaukee	-14.4± 0.7	0± 1.3
Port Inland	9.4± 1.1	-4± 1.4
Sturgeon Bay Canal	-3.8± 0.7	-2± 1.3

Table 4d - Column 1: Gauge vertical velocity and its standard error in cm/century, relative to lake outlet (relative to Point Iroquois) for Lake Superior. Column 2: The site bias and its standard error in mm, also relative to the outlet.

	cm/century	mm	
Duluth	-25.3± 0.3	-18± 0.9	
Grand Marais	-7.6± 0.8	-3± 1.0	
Gros Cap	1.6± 0.7	-8± 1.0	
Marquette C.G.	-12.2± 0.3	2± 0.9	
Michipicoten	23.3± 0.3	-4± 1.0	
Ontonagon	-18.7± 0.7	-8± 1.0	
Point Iroquois	0	0	< = = outlet
Rossport	27.5± 0.8	-6± 1.0	
Thunder Bay	2.4± 0.3	-9± 1.0	
Two Harbors	-21.2± 0.5	-2± 1.0	

Table 5a - **Comparison of relative vertical velocities and their standard deviation in cm/century between gauges on Lake Ontario.**

		Coordinating Com., 1977	Tait and Bolduc, 1985	Carrera et al, 1991	Tushingham, 1992	This Study: prior	post
Burl	Cape					18.8 ± 1.8	20.0 ± 0.7
Burl	Cobo					13.5 ± 1.2	12.3 ± 0.8
Burl	Kngs					18.5 ± 1.7	22.5 ± 0.7
Burl	Olco					8.9 ± 0.9	8.7 ± 0.9
Burl	Oswe					13.9 ± 1.6	15.5 ± 0.7
Burl	PWel					4.4 ± 0.9	5.3 ± 0.8
Burl	Roch					13.3 ± 1.2	9.8 ± 0.7
Burl	Toro				21.2 ± 2.0	11.2 ± 1.0	7.9 ± 0.7
Cape	Cobo				-11.5 ± 1.9	-8.2 ± 1.5	-7.7 ± 0.4
Cape	Kngs	5.8 ± 0.6			-4.5 ± 2.2	2.4 ± 1.1	2.5 ± 0.2
Cape	Olco				-14.7 ± 2.6	-11.0 ± 1.4	-11.3 ± 0.6
Cape	Oswe	-2.1 ± 0.6			-2.8 ± 0.4	-4.8 ± 1.2	-4.5 ± 0.2
Cape	PWel				-12.2 ± 2.4	-14.9 ± 1.7	-14.7 ± 0.3
Cape	Roch				-7.7 ± 1.1	-8.2 ± 1.3	-10.2 ± 0.2
Cape	Toro	-11.6 ± 0.9			-11.2 ± 0.7	-12.1 ± 1.7	-12.1 ± 0.2
Cobo	Kngs				9.1 ± 2.3	7.9 ± 1.5	10.2 ± 0.4
Cobo	Olco				1.5 ± 2.4	-3.7 ± 0.9	-3.6 ± 0.7
Cobo	Oswe				6.8 ± 1.6	2.9 ± 1.4	3.2 ± 0.4
Cobo	PWel				-7.4 ± 3.1	-9.2 ± 1.0	-7.0 ± 0.5
Cobo	Roch				3.3 ± 1.3	0.2 ± 1.1	-2.5 ± 0.4
Cobo	Toro			-1.3 ± 1.0	-1.5 ± 1.6	-3.3 ± 1.0	-4.4 ± 0.4
Hami	Toro			0.8 ± 6.4			
Kngs	Olco				-7.4 ± 2.6	-10.0 ± 1.2	-13.8 ± 0.6
Kngs	Oswe	-7.9 ± 0.6	-7.6 ± 0.4	-7.5 ± 0.2	-1.2 ± 1.5	-7.4 ± 1.0	-7.0 ± 0.3
Kngs	PWel				-19.9 ± 2.8	-15.5 ± 1.6	-17.2 ± 0.4
Kngs	Roch				-6.0 ± 1.5	-7.7 ± 1.1	-12.7 ± 0.3
Kngs	Toro	-17.4 ± 0.9	-16.4 ± 0.6		-8.9 ± 2.2	-14.5 ± 1.6	-14.6 ± 0.3
Olco	Oswe				4.9 ± 1.6	5.2 ± 1.0	6.8 ± 0.6
Olco	PWel				-6.6 ± 2.8	-5.6 ± 0.7	-3.4 ± 0.7
Olco	Roch				4.0 ± 1.5	5.1 ± 0.7	1.1 ± 0.6
Olco	Toro			6.6 ± 1.5	3.9 ± 1.7	3.0 ± 0.7	-0.8 ± 0.6
Oswe	PWel				-9.5 ± 2.0	-9.9 ± 1.4	-10.2 ± 0.4
Oswe	Roch			-3.8 ± 0.5	-6.1 ± 0.4	-5.6 ± 1.6	-5.7 ± 0.3
Oswe	Toro	-9.4 ± 0.9	-8.8 ± 0.7	-8.5 ± 0.5	-11.3 ± 0.9	-7.2 ± 1.5	-7.6 ± 0.3
PDal	Toro			1.3 ± 0.6			
PWel	Roch				11.6 ± 2.4	9.0 ± 1.1	4.5 ± 0.4
PWel	Toro			-0.6 ± 0.7	-1.3 ± 2.0	2.7 ± 1.0	2.6 ± 0.4
Roch	Toro				-5.5 ± 0.8	-3.5 ± 1.1	-1.9 ± 0.3

Table 5b - **Comparison of relative vertical velocities and their standard deviation in cm/century between gauges on Lake Erie.**

		Coordinating Com., 1977	Tait and Bolduc, 1985	Carrera et al, 1991	Tushingham, 1992	This Study: prior	post
Barc	BarP					-8.0 ± 4.2	-14.8 ± 2.5
Barc	Buff					6.3 ± 2.0	1.3 ± 2.1
Barc	Clev					-9.1 ± 3.3	-8.5 ± 2.1
Barc	Erie					-7.3 ± 1.6	-10.8 ± 2.4
Barc	Erio			3.8 ± 2.1		-9.3 ± 3.4	-8.3 ± 2.4
Barc	Fair					2.9 ± 2.5	-20.4 ± 3.0
Barc	Ferm					-9.7 ± 4.8	-8.3 ± 2.5
Barc	Kngv					-7.6 ± 4.2	-9.0 ± 2.4
Barc	Marb					-8.3 ± 4.6	-7.1 ± 2.4
Barc	Monr					-14.2 ± 5.1	-14.7 ± 6.3
Barc	PCol					-1.2 ± 1.8	-4.4 ± 2.2
Barc	PDov					-0.4 ± 1.5	-0.5 ± 2.4
Barc	PSta			4.6 ± 2.3		-9.4 ± 2.4	-6.1 ± 2.2
Barc	StuP					16.7 ± 1.9	3.4 ± 2.6
Barc	Tole					-7.8 ± 4.9	-7.3 ± 2.1
BarP	Buff				19.8 ± 5.9	18.7 ± 4.8	16.1 ± 1.4
BarP	Clev				7.0 ± 3.7	9.0 ± 2.3	6.3 ± 1.4
BarP	Erie				6.2 ± 4.9	-0.2 ± 4.1	4.0 ± 1.8
BarP	Erio				6.8 ± 4.9	7.3 ± 2.2	6.5 ± 1.8
BarP	Fair					-1.4 ± 2.8	-5.6 ± 2.6
BarP	Ferm					6.7 ± 1.7	6.5 ± 1.9
BarP	Kngv			2.0 ± 2.5	0.6 ± 6.0	5.6 ± 1.6	5.8 ± 1.8
BarP	Marb				6.6 ± 3.2	7.0 ± 1.9	7.7 ± 1.8
BarP	Monr					8.6 ± 2.3	0.1 ± 6.1
BarP	PCol					13.1 ± 4.6	10.4 ± 1.5
BarP	PDov				14.6 ± 5.0	14.5 ± 4.3	14.3 ± 1.8
BarP	PSta				6.7 ± 3.7	5.5 ± 3.6	8.7 ± 1.5
BarP	StuP				14.5 ± 7.9	19.1 ± 4.8	18.2 ± 2.1
BarP	Tole			2.7 ± 2.7	4.7 ± 3.0	4.7 ± 2.2	7.5 ± 1.5
Buff	Clev	-5.8 ± 1.2			-9.0 ± 0.5	-9.9 ± 4.5	-9.8 ± 0.3
Buff	Erie				-8.8 ± 2.1	-11.5 ± 2.1	-12.1 ± 1.2
Buff	Erio				-7.2 ± 3.0	-9.5 ± 3.8	-9.6 ± 1.1
Buff	Fair					-21.9 ± 2.9	-21.7 ± 2.2
Buff	Ferm					-12.3 ± 5.3	-9.6 ± 1.3
Buff	Kngv				-8.9 ± 4.3	-11.8 ± 4.6	-10.3 ± 1.2
Buff	Marb				-7.3 ± 2.7	-9.1 ± 4.9	-8.4 ± 1.2
Buff	Monr					-26.1 ± 5.5	-16.0 ± 5.9
Buff	PCol	-6.4 ± 0.9		-5.8 ± 0.4		-5.1 ± 1.3	-5.7 ± 0.5

Table 5b - **Comparison of relative vertical velocities and their standard deviation in cm/century between gauges on Lake Erie. (Continued…)**

		Coordinating Com., 1977	Tait and Bolduc, 1985	Carrera et al, 1991	Tushingham, 1992	This Study: prior	This Study: post
Buff	PDov				-3.1 ± 2.7	-2.5 ± 1.9	-1.8 ± 1.1
Buff	PSta	-0.3 ± 1.5			-0.5 ± 0.9	-6.1 ± 3.3	-7.4 ± 0.5
Buff	StuP				-0.1 ± 1.6	1.5 ± 1.1	2.1 ± 1.6
Buff	Tole				-4.5 ± 1.0	-7.8 ± 5.7	-8.6 ± 0.4
Clev	Erie				-1.2 ± 1.5	-3.2 ± 3.0	-2.3 ± 1.2
Clev	Erio				-0.1 ± 2.2	0.0 ± 1.4	0.2 ± 1.1
Clev	Fair			-6.9 ± 3.6		-16.6 ± 1.4	-11.9 ± 2.2
Clev	Ferm					-2.4 ± 2.6	0.2 ± 1.3
Clev	Kngv				-0.5 ± 2.8	-2.7 ± 1.9	-0.5 ± 1.2
Clev	Marb			0.6 ± 1.3	0.8 ± 1.3	-0.3 ± 2.2	1.4 ± 1.2
Clev	Monr					-12.0 ± 2.9	-6.2 ± 5.9
Clev	PCol	-0.6 ± 1.2	0.3 ± 0.9			3.8 ± 4.0	4.1 ± 0.6
Clev	PDov				6.2 ± 2.1	6.8 ± 3.0	8.0 ± 1.1
Clev	PSta	5.5 ± 1.5	4.9 ± 1.1	4.1 ± 0.5	5.8 ± 0.9	2.4 ± 2.2	2.4 ± 0.6
Clev	StuP				10.2 ± 3.2	8.7 ± 3.5	11.9 ± 1.6
Clev	Tole			2.1 ± 0.7	1.8 ± 0.7	0.1 ± 3.1	1.2 ± 0.5
Erie	Erio				1.0 ± 2.9	2.5 ± 2.9	2.5 ± 1.6
Erie	Fair					-5.0 ± 2.2	-9.6 ± 2.5
Erie	Ferm					4.8 ± 4.8	2.5 ± 1.8
Erie	Kngv				2.6 ± 3.0	3.7 ± 4.0	1.8 ± 1.7
Erie	Marb				2.5 ± 2.2	4.0 ± 4.3	3.7 ± 1.7
Erie	Monr					-2.0 ± 4.8	-3.9 ± 6.0
Erie	PCol					6.9 ± 1.9	6.4 ± 1.3
Erie	PDov				5.3 ± 2.6	9.6 ± 1.4	10.3 ± 1.6
Erie	PSta			1.1 ± 2.1	0.2 ± 2.2	1.9 ± 1.9	4.7 ± 1.3
Erie	StuP				10.7 ± 4.2	15.4 ± 1.8	14.2 ± 2.0
Erie	Tole				2.4 ± 2.4	1.8 ± 4.8	3.5 ± 1.3
Erio	Fair					-14.1 ± 1.4	-12.1 ± 2.5
Erio	Ferm					-1.7 ± 2.7	0.0 ± 1.7
Erio	Kngv				2.9 ± 4.0	-1.7 ± 2.0	-0.7 ± 1.6
Erio	Marb				-0.3 ± 1.9	-0.3 ± 2.4	1.2 ± 1.6
Erio	Monr					-4.3 ± 3.0	-6.4 ± 6.0
Erio	PCol					5.5 ± 3.7	3.9 ± 1.2
Erio	PDov				6.1 ± 4.4	7.3 ± 3.0	7.8 ± 1.6
Erio	PSta			5.5 ± 2.0	2.2 ± 3.2	-0.5 ± 2.1	2.2 ± 1.2
Erio	StuP				10.7 ± 4.2	10.3 ± 3.5	11.7 ± 1.9
Erio	Tole				-0.5 ± 2.6	-2.7 ± 3.1	1.0 ± 1.2

Table 5b - **Comparison of relative vertical velocities and their standard deviation in cm/century between gauges on Lake Erie. (Continued…)**

		Coordinating Com., 1977	Tait and Bolduc, 1985	Carrera et al, 1991	Tushingham, 1992	This Study: prior	This Study: post
Fair	Ferm					14.1 ± 3.3	12.1 ± 2.6
Fair	Kngv					10.1 ± 2.6	11.4 ± 2.5
Fair	Marb					13.8 ± 3.0	13.3 ± 2.5
Fair	Monr					-8.0 ± 3.7	5.7 ± 6.3
Fair	PCol					15.8 ± 3.0	16.0 ± 2.3
Fair	PDov					19.9 ± 2.4	19.9 ± 2.5
Fair	PSta					12.9 ± 1.4	14.3 ± 2.3
Fair	StuP					22.3 ± 2.9	23.8 ± 2.7
Fair	Tole					13.0 ± 3.6	13.1 ± 2.2
Ferm	Kngv					-0.4 ± 1.4	-0.7 ± 1.8
Ferm	Marb					1.4 ± 1.3	1.2 ± 1.8
Ferm	Monr					-2.7 ± 1.1	-6.4 ± 6.0
Ferm	PCol					6.6 ± 5.2	3.9 ± 1.4
Ferm	PDov					7.6 ± 4.9	7.8 ± 1.7
Ferm	PSta					-0.8 ± 4.1	2.2 ± 1.4
Ferm	StuP					10.5 ± 5.2	11.7 ± 2.1
Ferm	Tole			1.6 ± 1.3		-1.4 ± 1.3	1.0 ± 1.4
Kngv	Marb				3.1 ± 2.3	1.6 ± 1.4	1.9 ± 1.7
Kngv	Monr					5.2 ± 1.7	-5.7 ± 6.0
Kngv	PCol					7.2 ± 4.6	4.6 ± 1.3
Kngv	PDov				8.8 ± 3.8	8.6 ± 4.1	8.5 ± 1.6
Kngv	PSta				-4.8 ± 3.6	-0.3 ± 3.4	2.9 ± 1.3
Kngv	StuP				11.0 ± 6.6	12.6 ± 4.5	12.4 ± 2.0
Kngv	Tole				4.7 ± 2.6	-0.7 ± 2.1	1.7 ± 1.3
Marb	Monr					-5.5 ± 1.5	-7.6 ± 6.0
Marb	PCol					4.6 ± 4.9	2.7 ± 1.3
Marb	PDov				5.4 ± 3.0	6.2 ± 4.5	6.6 ± 1.6
Marb	PSta				-1.0 ± 2.7	-1.3 ± 3.8	1.0 ± 1.3
Marb	StuP				7.4 ± 3.5	9.0 ± 4.9	10.5 ± 2.0
Marb	Tole				0.0 ± 1.1	-2.0 ± 1.8	-0.2 ± 1.3
Monr	PCol					7.2 ± 5.5	10.3 ± 5.9
Monr	PDov					11.0 ± 5.0	14.2 ± 6.0
Monr	PSta					6.8 ± 4.4	8.6 ± 5.9
Monr	StuP					24.1 ± 5.3	18.1 ± 6.1
Monr	Tole			6.6 ± 4.3		3.6 ± 1.4	7.4 ± 5.9
PCol	PDov					1.9 ± 1.5	3.9 ± 1.2
PCol	PSta	6.1 ±	4.6 ± 1.2	3.8 ± 0.6		-1.0 ± 2.9	-1.7 ± 0.7
PCol	StuP			4.6 ± 2.4		4.6 ± 0.9	7.8 ± 1.7

Table 5b - **Comparison of relative vertical velocities and their standard deviation in cm/century between gauges on Lake Erie. (Continued…)**

		Coordinating Com., 1977	Tait and Bolduc, 1985	Carrera et al, 1991	Tushingham, 1992	This Study: prior	post
PCol	Tole					-2.3 ± 5.4	-2.9 ± 0.6
PDov	PSta			-7.0 ± 2.3	-5.7 ± 3.1	-8.1 ± 1.8	-5.6 ± 1.2
PDov	StuP				8.0 ± 3.5	4.6 ± 1.4	3.9 ± 1.9
PDov	Tole				4.7 ± 3.7	-8.5 ± 4.9	-6.8 ± 1.2
PSta	StuP				11.4 ± 3.3	12.0 ± 2.3	9.5 ± 1.7
PSta	Tole				-2.8 ± 1.3	-2.2 ± 4.0	-1.2 ± 0.6
StuP	Tole				-10.3 ± 4.5	-12.2 ± 5.5	-10.7 ± 1.6

Table 5c - **Comparison of relative vertical velocities and their standard deviation in cm/century between gauges on Lake Michigan-Huron.**

		Coordinating Com., 1977	Tait and Bolduc, 1985	Carrera et al, 1991	Tushingham, 1992	This Study: prior	This Study: post
Calu	Coll	31.7 ± 2.1			29.1 ± 1.5	26.7 ± 3.9	27.0 ± 1.0
Calu	DeTo3					27.0 ± 3.2	27.7 ± 1.1
Calu	Esse3				10.5 ± 2.0	8.0 ± 2.1	9.1 ± 1.1
Calu	Gode	10.4 ± 2.4			8.9 ± 1.0	8.5 ± 3.5	8.9 ± 1.0
Calu	Gree3				5.0 ± 2.3	3.0 ± 2.1	4.2 ± 1.1
Calu	Harb	12.5 ± 1.8			13.2 ± 1.1	11.7 ± 2.9	10.5 ± 1.0
Calu	Harr				13.3 ± 3.2	16.1 ± 2.9	18.4 ± 1.3
Calu	Holl				3.6 ± 1.6	3.2 ± 1.9	2.5 ± 1.1
Calu	Kewa					-0.9 ± 1.8	1.9 ± 1.9
Calu	Lake				11.0 ± 1.9	9.6 ± 2.6	10.4 ± 0.7
Calu	Litt					34.3 ± 3.9	37.4 ± 1.2
Calu	Ludi				-5.3 ± 1.8	-3.0 ± 2.4	-1.8 ± 1.1
Calu	Mack	20.1 ± 2.1			22.1 ± 1.1	20.5 ± 3.3	20.4 ± 1.0
Calu	Milw3	-4.9 ± 1.2		-4.5 ± 0.7	-2.4 ± 1.0	-5.1 ± 1.8	-4.0 ± 1.0
Calu	Parr				29.2 ± 3.7	32.2 ± 4.0	34.7 ± 1.2
Calu	PInl				17.0 ± 3.9	16.7 ± 2.7	19.8 ± 1.3
Calu	StuB	7.6 ± 1.8			10.5 ± 1.4	6.9 ± 2.3	6.6 ± 1.0
Calu	Thes	31.4 ± 2.1			29.4 ± 1.3	31.1 ± 3.4	31.2 ± 1.0
Calu	Tobe				15.3 ± 5.0	24.5 ± 3.8	27.1 ± 1.2
Coll	DeTo3					3.0 ± 1.8	0.7 ± 1.1
Coll	Esse3				-13.7 ± 2.1	-15.1 ± 3.1	-17.9 ± 1.1
Coll	Gode	-20.4 ± 1.5	-20.6 ± 1.6	-18.9 ± 0.4	-18.7 ± 0.7	-18.2 ± 1.5	-18.1 ± 1.0
Coll	Gree3				-17.1 ± 2.2	-20.2 ± 3.9	-22.8 ± 1.1
Coll	Harb	-19.2 ± 0.6			-15.8 ± 0.4	-14.5 ± 1.6	-16.5 ± 1.0
Coll	Harr				-4.2 ± 2.8	-6.0 ± 1.6	-8.6 ± 1.3
Coll	Holl				-19.8 ± 3.0	-23.8 ± 3.2	-24.5 ± 1.1
Coll	Kewa					-22.1 ± 3.5	-25.1 ± 1.9
Coll	Lake				-11.7 ± 2.1	-14.0 ± 2.0	-16.6 ± 0.7
Coll	Litt					14.9 ± 1.9	10.4 ± 1.2
Coll	Ludi				-31.8 ± 2.0	-30.7 ± 3.0	-28.8 ± 1.1
Coll	Mack	-11.3 ± 1.2			-7.2 ± 0.7	-5.9 ± 2.1	-6.6 ± 1.0
Coll	Milw3	-36.3 ± 1.8			-31.4 ± 0.8	-32.4 ± 3.7	-31.0 ± 1.0
Coll	Parr			12.0 ± 1.2	12.2 ± 1.9	11.0 ± 1.1	7.7 ± 1.2
Coll	PInl				-0.6 ± 3.6	-3.0 ± 2.7	-7.2 ± 1.3
Coll	StuB	-24.1 ± 1.5			-19.1 ± 0.8	-20.8 ± 3.3	-20.4 ± 1.0
Coll	Thes	0.0 ± 0.9		1.8 ± 0.6	1.7 ± 0.7	4.1 ± 1.7	4.2 ± 1.0
Coll	Tobe			4.2 ± 1.8	4.3 ± 2.9	3.4 ± 1.3	0.1 ± 1.2

Table 5c - **Comparison of relative vertical velocities and their standard deviation in cm/century between gauges on Lake Michigan-Huron (Continued…)**

		Coordinating Com., 1977	Tait and Bolduc, 1985	Carrera et al, 1991	Tushingham, 1992	This Study: prior	This Study: post
DeTo3	Esse3					-19.3 ± 2.7	-18.6 ± 1.2
DeTo3	Gode					-21.0 ± 1.9	-18.8 ± 1.1
DeTo3	Gree3					-24.3 ± 3.1	-23.5 ± 1.2
DeTo3	Harb					-15.3 ± 1.6	-17.2 ± 1.1
DeTo3	Harr					-9.9 ± 1.3	-9.3 ± 1.4
DeTo3	Holl					-26.2 ± 2.4	-25.2 ± 1.1
DeTo3	Kewa					-27.6 ± 2.6	-25.8 ± 2.0
DeTo3	Lake					-17.9 ± 2.0	-17.3 ± 0.8
DeTo3	Litt					9.9 ± 1.7	9.7 ± 1.3
DeTo3	Ludi					-34.2 ± 2.1	-29.5 ± 1.1
DeTo3	Mack					-6.1 ± 1.1	-7.3 ± 1.1
DeTo3	Milw3					-31.8 ± 2.9	-31.7 ± 1.1
DeTo3	Parr					6.5 ± 1.7	7.0 ± 1.3
DeTo3	PInl					-9.0 ± 1.5	-7.9 ± 1.4
DeTo3	StuB					-22.4 ± 2.4	-21.1 ± 1.1
DeTo3	Thes			3.2 ± 0.8		2.7 ± 1.1	3.5 ± 1.1
DeTo3	Tobe					-1.4 ± 1.5	-0.6 ± 1.3
Esse3	Gode				-3.3 ± 2.9	-1.6 ± 2.9	-0.2 ± 1.1
Esse3	Gree3				-4.9 ± 1.4	-5.0 ± 2.2	-4.9 ± 1.3
Esse3	Harb			1.7 ± 1.9	3.7 ± 1.3	4.5 ± 2.2	1.4 ± 1.1
Esse3	Harr				8.4 ± 2.3	10.8 ± 2.4	9.3 ± 1.4
Esse3	Holl				-7.8 ± 1.9	-6.2 ± 2.1	-6.6 ± 1.2
Esse3	Kewa					-6.3 ± 2.1	-7.2 ± 2.0
Esse3	Lake				1.1 ± 1.4	1.4 ± 1.9	1.3 ± 0.9
Esse3	Litt					30.5 ± 3.3	28.3 ± 1.3
Esse3	Ludi				-16.5 ± 1.7	-14.8 ± 2.4	-10.9 ± 1.2
Esse3	Mack				12.7 ± 1.8	14.4 ± 2.7	11.3 ± 1.1
Esse3	Milw3				-15.3 ± 1.8	-13.5 ± 2.2	-13.1 ± 1.1
Esse3	Parr				25.8 ± 3.4	27.3 ± 3.4	25.6 ± 1.3
Esse3	PInl				10.7 ± 3.1	12.5 ± 2.5	10.7 ± 1.4
Esse3	StuB				-4.7 ± 1.6	-3.4 ± 2.0	-2.5 ± 1.1
Esse3	Thes				16.7 ± 2.4	22.6 ± 2.9	22.1 ± 1.1
Esse3	Tobe				16.4 ± 4.0	20.3 ± 3.2	18.0 ± 1.3
Gode	Gree3				-0.8 ± 3.5	-3.4 ± 3.8	-4.7 ± 1.1
Gode	Harb	1.5 ± 1.2	3.7 ± 1.4	2.3 ± 0.4	2.3 ± 0.6	3.7 ± 1.4	1.6 ± 1.0
Gode	Harr				8.6 ± 4.9	9.8 ± 1.6	9.5 ± 1.3

Table 5c - **Comparison of relative vertical velocities and their standard deviation in cm/century between gauges on Lake Michigan-Huron (Continued…)**

		Coordinating Com., 1977	Tait and Bolduc, 1985	Carrera et al, 1991	Tushingham, 1992	This Study: prior	This Study: post
Gode	Holl				-4.9 ± 3.8	-5.9 ± 2.9	-6.4 ± 1.1
Gode	Kewa					-3.4 ± 3.2	-7.0 ± 1.9
Gode	Lake			2.8 ± 1.6	3.8 ± 2.7	2.3 ± 1.9	1.5 ± 0.7
Gode	Litt					30.5 ± 2.3	28.5 ± 1.2
Gode	Ludi				-14.6 ± 2.4	-13.4 ± 2.9	-10.7 ± 1.1
Gode	Mack	9.4 ± 1.5	11.7 ± 1.5		11.6 ± 0.7	12.4 ± 2.2	11.5 ± 1.0
Gode	Milw3	-14.9 ± 1.8	-13.1 ± 1.6		-12.7 ± 0.9	-14.3 ± 3.3	-12.9 ± 1.0
Gode	Parr				26.8 ± 3.6	27.0 ± 1.9	25.8 ± 1.2
Gode	PInl				8.7 ± 5.8	11.9 ± 2.7	10.9 ± 1.3
Gode	StuB	-3.0 ± 1.5			-1.4 ± 0.8	-2.6 ± 3.1	-2.3 ± 1.0
Gode	Thes	20.7 ± 1.2	21.5 ± 1.6		20.8 ± 0.9	22.4 ± 1.9	22.3 ± 1.0
Gode	Tobe				16.9 ± 5.8	19.0 ± 1.9	18.2 ± 1.2
Gree3	Harb				8.1 ± 1.4	9.7 ± 3.1	6.3 ± 1.1
Gree3	Harr				13.1 ± 2.2	15.5 ± 3.1	14.2 ± 1.4
Gree3	Holl				-3.5 ± 1.5	-1.7 ± 2.0	-1.7 ± 1.2
Gree3	Kewa					1.3 ± 1.7	-2.3 ± 2.0
Gree3	Lake				6.1 ± 1.7	6.8 ± 2.9	6.2 ± 0.9
Gree3	Litt					33.6 ± 3.8	33.2 ± 1.3
Gree3	Ludi				-11.5 ± 1.3	-10.0 ± 2.1	-6.0 ± 1.2
Gree3	Mack				18.0 ± 2.1	19.4 ± 3.0	16.2 ± 1.1
Gree3	Milw3				-11.0 ± 1.7	-8.7 ± 1.8	-8.2 ± 1.1
Gree3	Parr				29.1 ± 2.7	31.7 ± 4.1	30.5 ± 1.3
Gree3	PInl				14.3 ± 2.8	16.0 ± 2.4	15.6 ± 1.4
Gree3	StuB			-1.7 ± 1.7	0.0 ± 1.6	1.3 ± 1.6	2.4 ± 1.1
Gree3	Thes				21.5 ± 2.4	27.5 ± 3.2	27.0 ± 1.1
Gree3	Tobe				17.9 ± 3.2	23.7 ± 3.8	22.9 ± 1.3
Harb	Harr			4.7 ± 1.2	4.9 ± 1.2	5.2 ± 0.9	7.9 ± 1.3
Harb	Holl				-11.9 ± 1.5	-8.7 ± 2.3	-8.0 ± 1.1
Harb	Kewa					-11.0 ± 2.6	-8.6 ± 1.9
Harb	Lake				-2.5 ± 1.1	-3.2 ± 0.9	-0.1 ± 0.7
Harb	Litt					24.8 ± 2.0	26.9 ± 1.2
Harb	Ludi				-20.2 ± 1.1	-13.6 ± 2.6	-12.3 ± 1.1
Harb	Mack	7.6 ± 1.2			9.1 ± 0.4	8.9 ± 1.8	9.9 ± 1.0
Harb	Milw3	-17.1 ± 1.5			-13.7 ± 0.4	-14.5 ± 2.9	-14.5 ± 1.0
Harb	Parr				21.7 ± 1.8	21.9 ± 1.8	24.2 ± 1.2
Harb	PInl				7.1 ± 2.3	6.8 ± 2.1	9.3 ± 1.3

Table 5c - **Comparison of relative vertical velocities and their standard deviation in cm/century between gauges on Lake Michigan-Huron (Continued…)**

		Coordinating Com., 1977	Tait and Bolduc, 1985	Carrera et al, 1991	Tushingham, 1992	This Study: prior	This Study: post
Harb	StuB	-5.2 ± 1.2			-3.3 ± 0.6	-5.3 ± 2.5	-3.9 ± 1.0
Harb	Thes	19.2 ± 1.2			17.5 ± 0.6	18.7 ± 1.6	20.7 ± 1.0
Harb	Tobe				11.2 ± 2.6	14.2 ± 1.6	16.6 ± 1.2
Harr	Holl				-16.1 ± 2.1	-17.0 ± 2.3	-15.9 ± 1.4
Harr	Kewa					-15.9 ± 2.6	-16.5 ± 2.1
Harr	Lake				-6.8 ± 2.3	-8.1 ± 1.4	-8.0 ± 1.1
Harr	Litt					17.7 ± 1.7	19.0 ± 1.5
Harr	Ludi				-21.0 ± 2.1	-23.2 ± 2.2	-20.2 ± 1.4
Harr	Mack				6.9 ± 2.2	5.9 ± 1.5	2.0 ± 1.3
Harr	Milw3				-19.2 ± 2.8	-21.7 ± 2.8	-22.4 ± 1.3
Harr	Parr				17.5 ± 2.3	17.6 ± 1.7	16.3 ± 1.5
Harr	PInl				2.6 ± 2.6	1.4 ± 1.9	1.4 ± 1.6
Harr	StuB				-10.0 ± 2.1	-11.9 ± 2.4	-11.8 ± 1.3
Harr	Thes				11.3 ± 3.4	13.6 ± 1.5	12.8 ± 1.3
Harr	Tobe				6.6 ± 2.9	8.8 ± 1.6	8.7 ± 1.5
Holl	Kewa					-0.4 ± 1.4	-0.6 ± 2.0
Holl	Lake				10.3 ± 1.7	8.1 ± 2.3	7.9 ± 0.8
Holl	Litt					35.5 ± 3.2	34.9 ± 1.3
Holl	Ludi				-5.5 ± 1.4	-3.2 ± 1.5	-4.3 ± 1.1
Holl	Mack				24.7 ± 2.4	18.1 ± 2.4	17.9 ± 1.1
Holl	Milw3			-14.7 ± 1.3	-2.8 ± 1.4	-7.3 ± 1.6	-6.5 ± 1.1
Holl	Parr				32.8 ± 2.8	33.1 ± 3.4	32.2 ± 1.3
Holl	PInl				19.1 ± 2.6	18.2 ± 1.9	17.3 ± 1.4
Holl	StuB				5.8 ± 1.4	4.2 ± 1.4	4.1 ± 1.1
Holl	Thes				26.5 ± 2.9	30.2 ± 2.5	28.7 ± 1.1
Holl	Tobe				21.3 ± 3.7	25.5 ± 3.0	24.6 ± 1.3
Kewa	Lake					6.9 ± 2.5	8.5 ± 1.8
Kewa	Litt					31.0 ± 3.4	35.5 ± 2.1
Kewa	Ludi					-5.2 ± 1.5	-3.7 ± 2.0
Kewa	Mack					20.1 ± 2.4	18.5 ± 1.9
Kewa	Milw3					-8.1 ± 1.3	-5.9 ± 1.9
Kewa	Parr					31.7 ± 3.7	32.8 ± 2.1
Kewa	PInl					17.0 ± 1.9	17.9 ± 2.1
Kewa	StuB			14.5 ± 3.3		4.9 ± 1.0	4.7 ± 1.9
Kewa	Thes					34.1 ± 2.8	29.3 ± 1.9
Kewa	Tobe					32.0 ± 3.5	25.2 ± 2.1

Table 5c - **Comparison of relative vertical velocities and their standard deviation in cm/century between gauges on Lake Michigan-Huron (Continued…)**

		Coordinating Com., 1977	Tait and Bolduc, 1985	Carrera et al, 1991	Tushingham, 1992	This Study: prior	This Study: post
Lake	Litt					28.2 ± 2.5	27.0 ± 1.0
Lake	Ludi				-17.1 ± 1.9	-16.2 ± 2.4	-12.2 ± 0.8
Lake	Mack				12.9 ± 2.0	13.9 ± 2.2	10.0 ± 0.7
Lake	Milw3				-16.2 ± 1.8	-14.9 ± 2.5	-14.4 ± 0.7
Lake	Parr				22.8 ± 2.5	24.9 ± 2.3	24.3 ± 1.0
Lake	PInl				9.9 ± 3.1	10.6 ± 2.3	9.4 ± 1.1
Lake	StuB				-5.7 ± 1.6	-5.0 ± 2.4	-3.8 ± 0.7
Lake	Thes				16.4 ± 2.8	21.5 ± 2.2	20.8 ± 0.7
Lake	Tobe				11.7 ± 3.9	16.5 ± 2.2	16.7 ± 1.0
Litt	Ludi					-41.6 ± 3.0	-39.2 ± 1.3
Litt	Mack					-13.3 ± 1.8	-17.0 ± 1.2
Litt	Milw3					-39.3 ± 3.7	-41.4 ± 1.2
Litt	Parr					-3.2 ± 1.6	-2.7 ± 1.4
Litt	PInl					-14.4 ± 2.3	-17.6 ± 1.5
Litt	StuB					-30.5 ± 3.3	-30.8 ± 1.2
Litt	Thes			-20.4 ± 2.4		-4.4 ± 1.7	-6.2 ± 1.2
Litt	Tobe					-8.2 ± 1.5	-10.3 ± 1.4
Ludi	Mack				29.1 ± 1.4	23.7 ± 2.3	22.2 ± 1.1
Ludi	Milw3			-2.6 ± 1.5	0.9 ± 1.5	-3.6 ± 2.1	-2.2 ± 1.1
Ludi	Parr				38.7 ± 2.3	39.2 ± 3.2	36.5 ± 1.3
Ludi	PInl				22.0 ± 1.6	23.0 ± 1.4	21.6 ± 1.4
Ludi	StuB			11.6 ± 0.7	11.5 ± 0.9	10.3 ± 1.4	8.4 ± 1.1
Ludi	Thes				34.2 ± 1.5	37.1 ± 2.2	33.0 ± 1.1
Ludi	Tobe				28.4 ± 2.9	31.1 ± 2.9	28.9 ± 1.3
Mack	Milw3	-24.7 ± 1.5			-24.2 ± 0.6	-25.3 ± 2.9	-24.4 ± 1.0
Mack	Parr				8.2 ± 2.7	10.0 ± 2.0	14.3 ± 1.2
Mack	PInl			-6.8 ± 1.8	-4.3 ± 2.1	-4.3 ± 1.4	-0.6 ± 1.3
Mack	StuB	-12.8 ± 1.2		-13.9 ± 0.6	-12.0 ± 0.6	-14.0 ± 2.5	-13.8 ± 1.0
Mack	Thes	11.6 ± 1.2		9.2 ± 0.5	9.4 ± 0.8	10.1 ± 1.3	10.8 ± 1.0
Mack	Tobe				2.6 ± 3.6	3.1 ± 1.8	6.7 ± 1.2
Milw3	Parr				35.3 ± 3.6	37.2 ± 3.9	38.7 ± 1.2
Milw3	PInl				23.2 ± 3.4	22.9 ± 2.2	23.8 ± 1.3
Milw3	StuB	12.2 ± 1.2			12.5 ± 0.5	11.8 ± 1.7	10.6 ± 1.0
Milw3	Thes	36.0 ± 1.5			34.5 ± 1.1	36.8 ± 3.0	35.2 ± 1.0
Milw3	Tobe				22.8 ± 4.6	30.2 ± 3.6	31.1 ± 1.2

Table 5c - **Comparison of relative vertical velocities and their standard deviation in cm/century between gauges on Lake Michigan-Huron (Continued…)**

		Coordinating Com., 1977	Tait and Bolduc, 1985	Carrera et al, 1991	Tushingham, 1992	This Study: prior	This Study: post
Parr	PInl				-15.1 ± 2.7	-14.3 ± 2.6	-14.9 ± 1.5
Parr	StuB				-27.2 ± 2.5	-28.0 ± 3.5	-28.1 ± 1.2
Parr	Thes				-4.2 ± 2.2	-2.4 ± 1.7	-3.5 ± 1.2
Parr	Tobe				-10.1 ± 3.2	-8.5 ± 1.3	-7.6 ± 1.4
PInl	StuB				-14.9 ± 1.8	-13.1 ± 1.6	-13.2 ± 1.3
PInl	Thes				10.2 ± 2.9	13.2 ± 1.7	11.4 ± 1.3
PInl	Tobe				9.0 ± 3.7	7.8 ± 2.4	7.3 ± 1.5
StuB	Thes	24.4 ± 1.2			23.7 ± 0.8	25.0 ± 2.6	24.6 ± 1.0
StuB	Tobe				16.2 ± 3.9	20.1 ± 3.2	20.5 ± 1.2
Thes	Tobe				-2.6 ± 2.9	-5.5 ± 1.4	-4.1 ± 1.2

Table 5d - **Comparison of relative vertical velocities and their standard deviation in cm/century between gauges on Lake Superior.**

		Coordinating Com., 1977	Tait and Bolduc, 1985	Carrera et al, 1991	Tushingham, 1992	This Study: prior	post
Dulu	Gran				22.3 ± 1.2	19.4 ± 1.2	17.7 ± 0.9
Dulu	Gros				29.5 ± 4.1	28.6 ± 2.5	26.9 ± 0.8
Dulu	Marq3	11.3 ± 0.9			11.7 ± 0.4	13.1 ± 2.5	13.1 ± 0.4
Dulu	Mich	52.1 ± 1.5	50.9 ± 1.0		47.1 ± 0.9	50.2 ± 2.5	48.6 ± 0.4
Dulu	Onto				8.0 ± 1.9	8.5 ± 1.8	6.6 ± 0.8
Dulu	Poin	23.5 ± 1.2			25.8 ± 0.8	26.9 ± 2.6	25.3 ± 0.3
Dulu	Ross					55.1 ± 2.2	52.8 ± 0.9
Dulu	Thun	29.0 ± 1.2	29.9 ± 0.9	30.8 ± 0.4	29.9 ± 0.6	29.4 ± 1.5	27.7 ± 0.4
Dulu	TwoH			5.9 ± 0.5		4.9 ± 0.9	4.1 ± 0.6
Gran	Gros				9.5 ± 14	7.2 ± 1.8	9.2 ± 1.1
Gran	Marq3				-2.7 ± 1.8	-0.7 ± 1.3	-4.6 ± 0.9
Gran	Mich				22.5 ± 2.8	29.6 ± 1.8	30.9 ± 0.9
Gran	Onto				-15.0 ± 2.5	-12.1 ± 1.3	-11.1 ± 1.1
Gran	Poin				9.6 ± 2.0	9.0 ± 1.8	7.6 ± 0.8
Gran	Ross					35.0 ± 1.8	35.1 ± 1.1
Gran	Thun			15.3 ± 2.2	15.3 ± 3.5	10.0 ± 1.2	10.0 ± 0.9
Gran	TwoH					-11.9 ± 0.8	-13.6 ± 0.9
Gros	Marq3				-14.4 ± 4.0	-10.7 ± 1.4	-13.8 ± 0.8
Gros	Mich				17.1 ± 4.2	18.9 ± 1.4	21.7 ± 0.8
Gros	Onto				-20.5 ± 11	-20.7 ± 2.0	-20.3 ± 1.0
Gros	Poin			3.4 ± 4.0	3.4 ± 9.7	-0.2 ± 1.2	-1.6 ± 0.7
Gros	Ross					27.2 ± 2.0	25.9 ± 1.1
Gros	Thun				0.6 ± 5.1	0.2 ± 2.1	0.8 ± 0.8
Gros	TwoH					-21.4 ± 2.3	-22.8 ± 0.9
Marq3	Mich	40.8 ± 0.9	39.4 ± 0.8	35.4 ± 0.5	33.7 ± 0.8	33.9 ± 1.3	35.5 ± 0.4
Marq3	Onto			-7.5 ± 2.1	-12.4 ± 1.8	-9.4 ± 1.5	-6.5 ± 0.8
Marq3	Poin	12.2 ± 0.6			11.1 ± 0.5	10.6 ± 1.1	12.2 ± 0.3
Marq3	Ross					35.7 ± 1.9	39.7 ± 0.9
Marq3	Thun	17.7 ± 1.2	17.5 ± 1.1	18.7 ± 0.5	16.9 ± 0.6	13.0 ± 1.8	14.6 ± 0.4
Marq3	TwoH					-9.0 ± 1.8	-9.0 ± 0.6
Mich	Onto				-36.7 ± 2.7	-39.1 ± 1.7	-42.0 ± 0.8
Mich	Poin	-29.0 ± 0.9		-25.4 ± 0.5	-25.3 ± 0.8	-23.3 ± 1.3	-23.3 ± 0.3
Mich	Ross					5.7 ± 2.0	4.2 ± 0.9
Mich	Thun	-23.2 ± 1.5	-21.0 ± 1.2		-17.3 ± 1.0	-20.9 ± 2.0	-20.9 ± 0.4
Mich	TwoH					-45.0 ± 2.3	-44.5 ± 0.6
Onto	Poin	23.5 ± 1.2			20.5 ± 2.0	19.2 ± 1.8	18.7 ± 0.7
Onto	Ross					46.3 ± 2.0	46.2 ± 1.1
Onto	Thun				26.8 ± 2.5	21.1 ± 1.5	21.1 ± 0.8

Table 5d - **Comparison of relative vertical velocities and their standard deviation in cm/century between gauges on Lake Superior. (Continued…)**

		Coordinating Com., 1977	Tait and Bolduc, 1985	Carrera et al, 1991	Tushingham, 1992	This Study: prior	post
Onto	TwoH					1.2 ± 1.7	-2.5 ± 0.9
Poin	Ross					25.8 ± 2.1	27.5 ± 0.8
Poin	Thun	5.8 ± 1.2			5.8 ± 0.9	2.5 ± 2.2	2.4 ± 0.3
Poin	TwoH					-20.5 ± 2.3	-21.2 ± 0.5
Ross	Thun			-27.4 ± 3.2		-24.9 ± 1.7	-25.1 ± 0.9
Ross	TwoH					-57.7 ± 2.2	-48.7 ± 0.9
Thun	TwoH					-23.8 ± 1.4	-23.6 ± 0.6

Fig. 1 - Location of water level gauging stations.

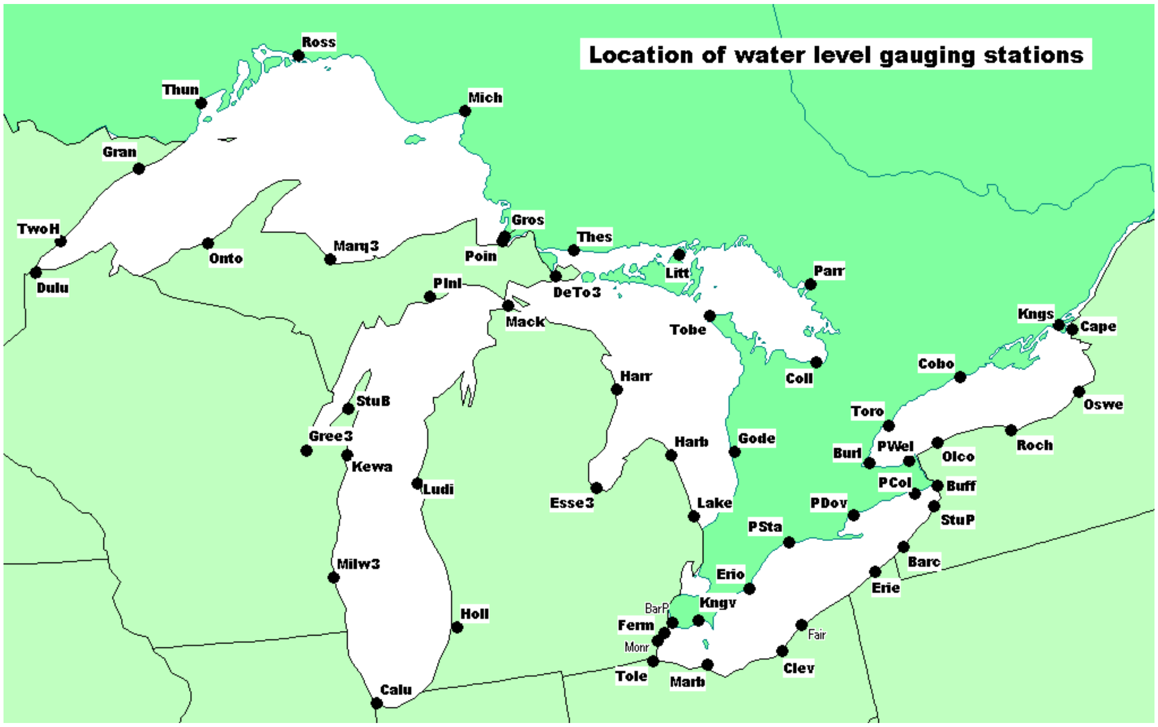

Fig. 2 - Number of years of recorded water levels at each gauge.

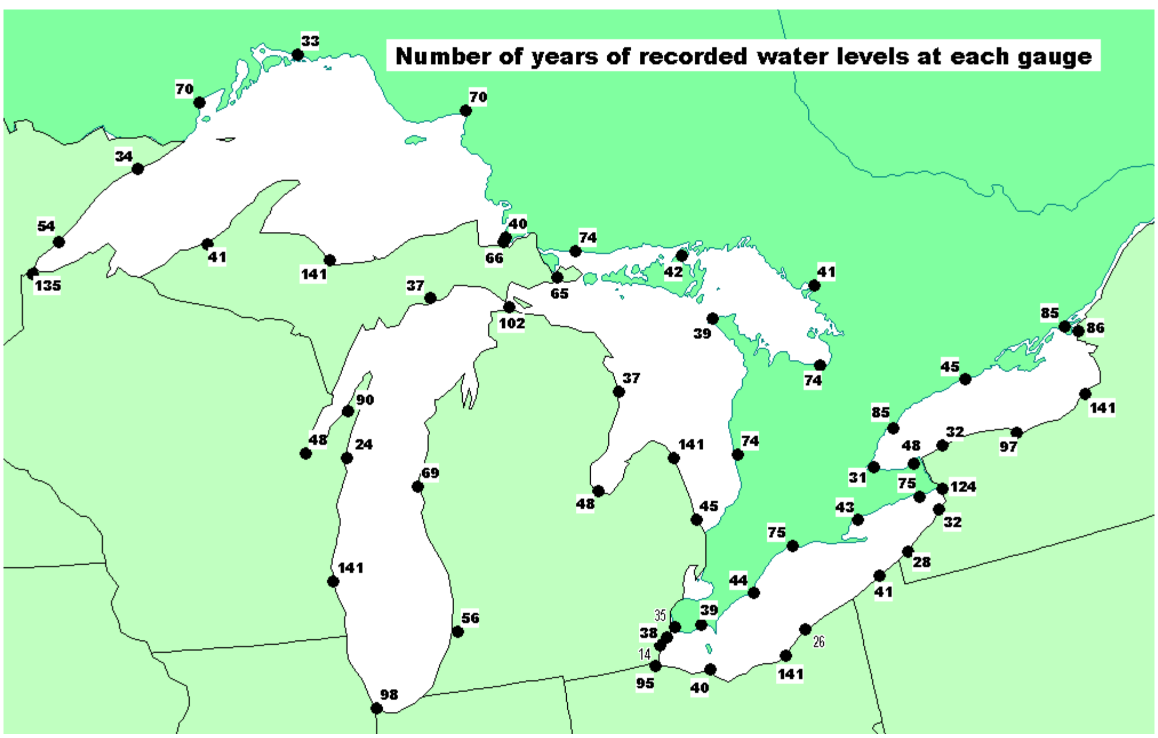

Fig. 3 - Relative vertical crustal velocity - a sample. The vertical crustal movement is estimated using a pair of water level gauges. The difference between the monthly lake level recorded at both gauges, here Calumet Harbour, Michigan, and Parry Sound, Ontario, is plotted for every month recorded (here 1860 - 2000) and indicates a linear trend. The X-axis indicates the years and months from 1860 to 2000. The Y-axis is the average of the lake level in metres for a month minus the same for the other gauge. The black straight line is the linear trend obtained by regression. It fits the data, and indicates that Calumet Harbour is subsiding by 32 cm per century relative to Parry Sound. The pink straight line is the linear trend obtained after a least squared adjustment that takes into account all gauges on the lake. It indicates that Calumet Harbour is more exactly subsiding by 35 cm relative to Parry Sound.

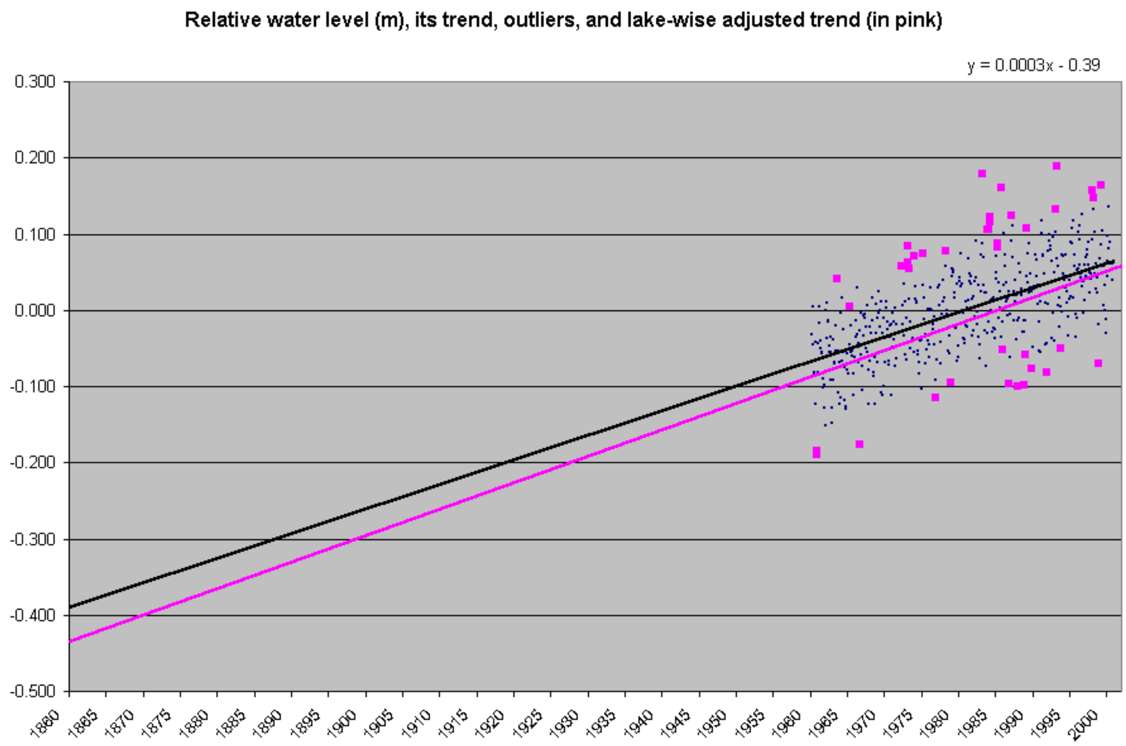

Fig. 4 - Location of lake level differences.

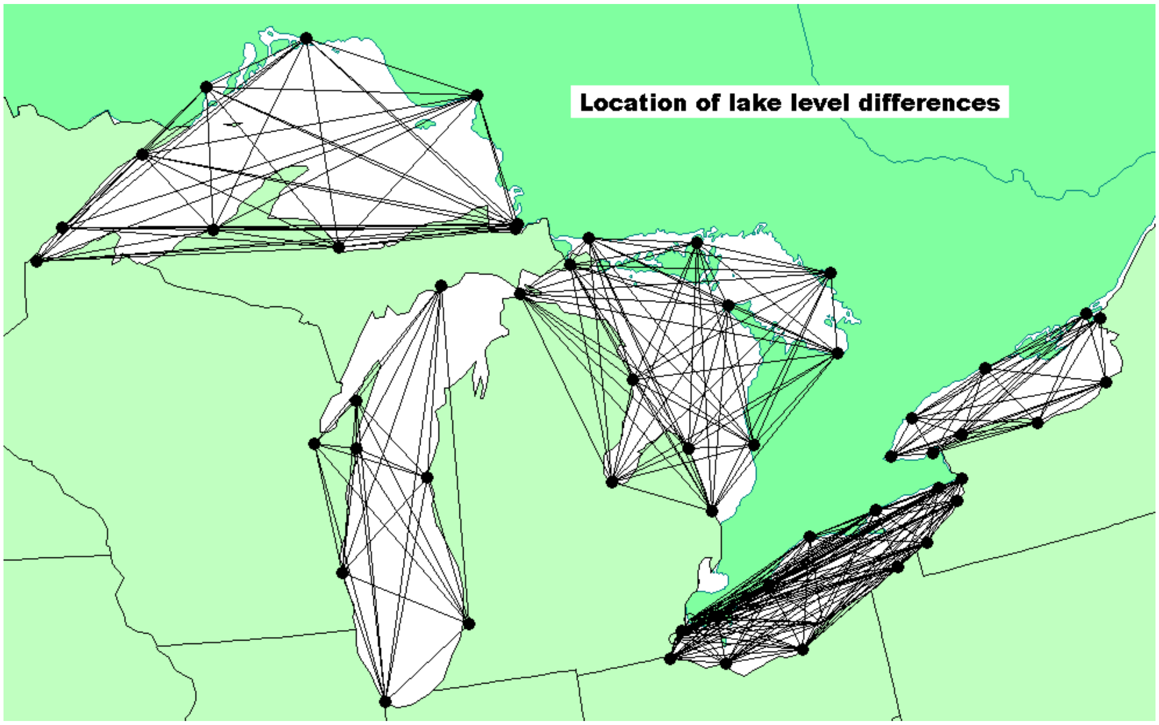

Fig. 5 - Vertical velocity relative to each outlet: Cape Vincent for lake Ontario, Buffalo for lake Erie, Lakeport for lakes Michigan-Huron, Point Iroquois for lake Superior, in cm/century.

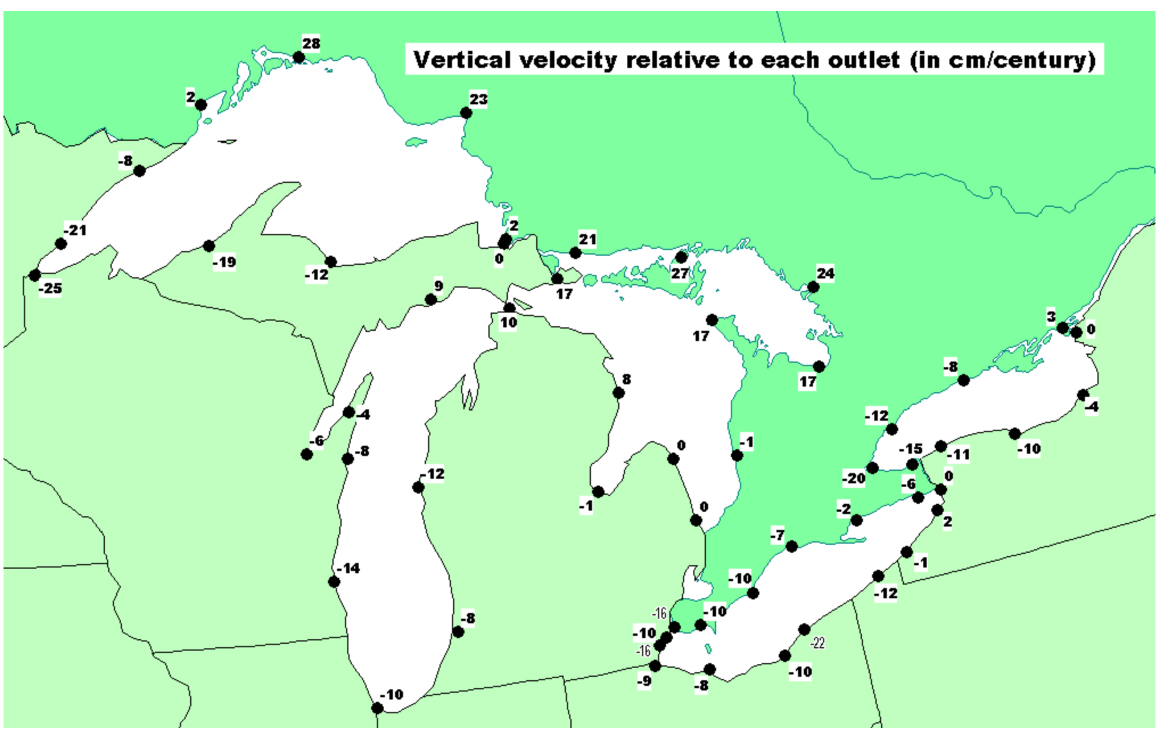

Fig. 6 - Standard error of vertical movement rates relative to each outlet in cm/century.

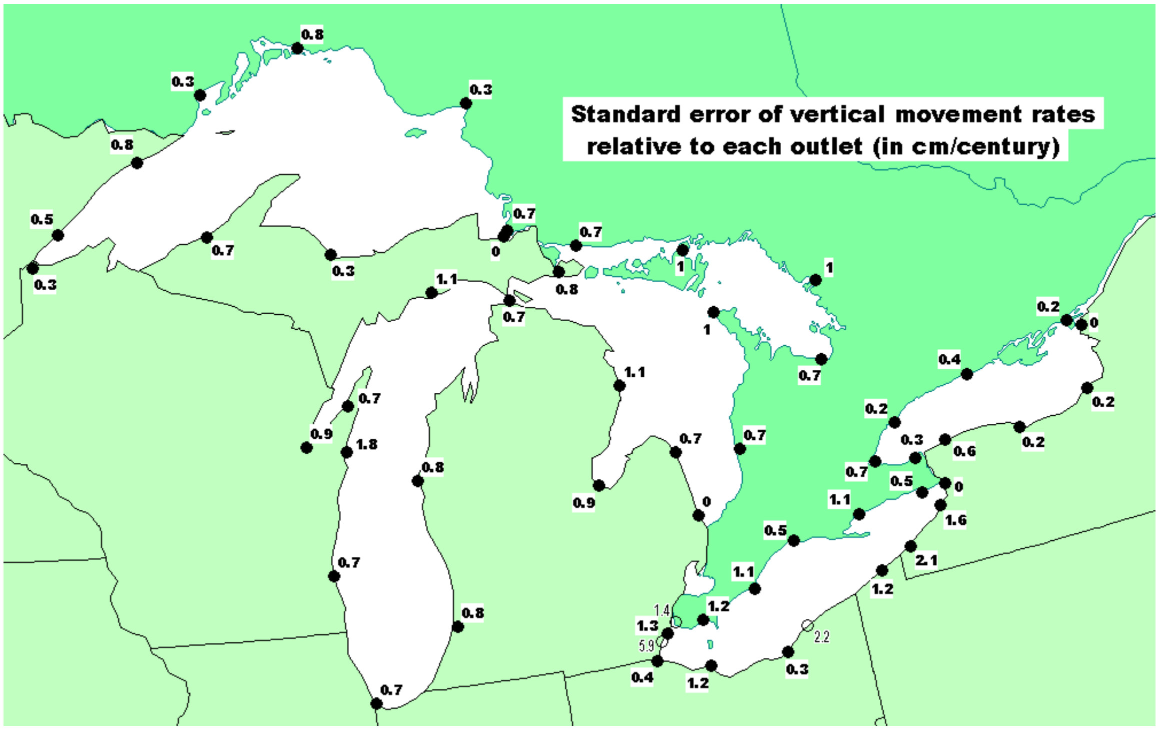

Fig. 7 - Sites bias relative to each outlet in mm.

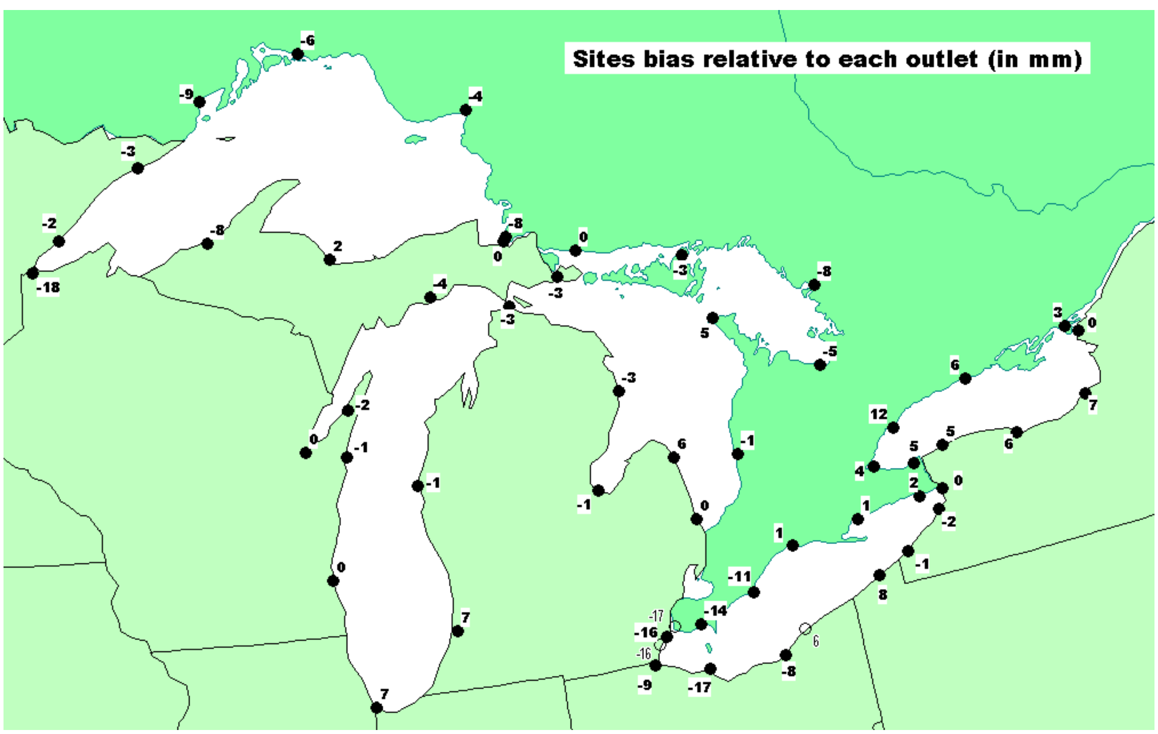

Fig. 8 - Contour map of global postglacial rebound model ICE-3G in the Great Lakes area in cm/century. Contour interval : 3 cm/century.

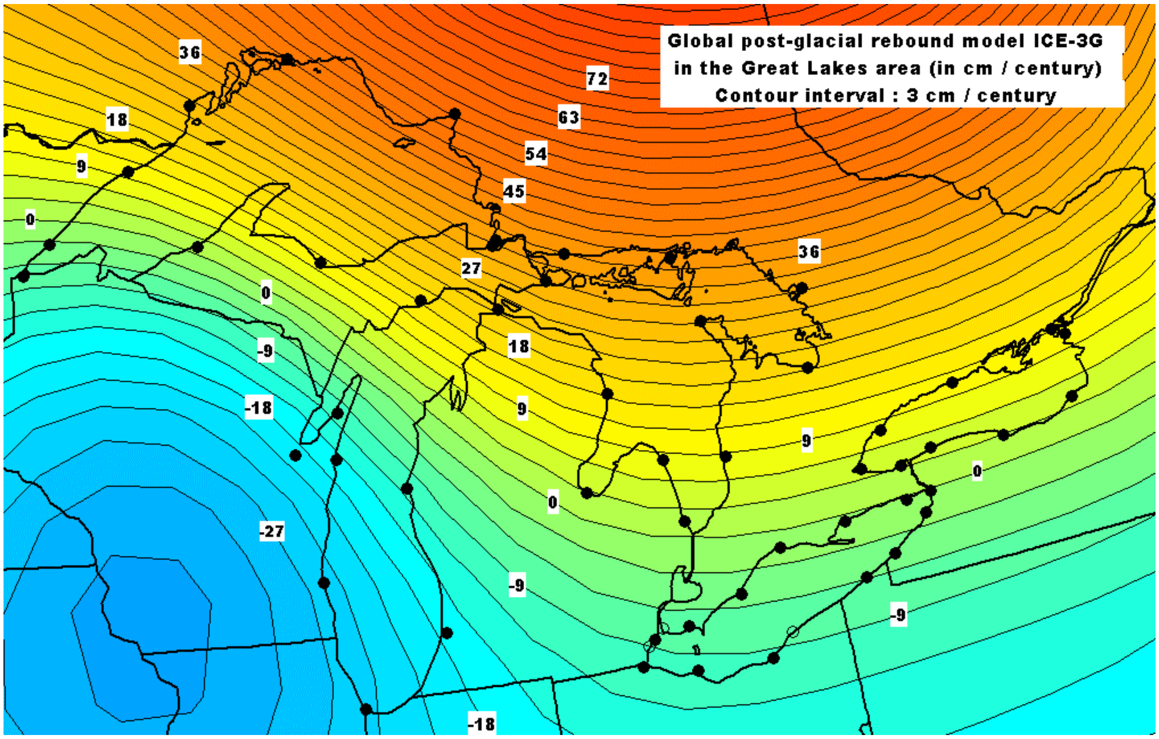

Fig. 9 - Water level gauge derived vertical velocities over the Great Lakes surrounded with global model ICE-3G velocities in cm/century

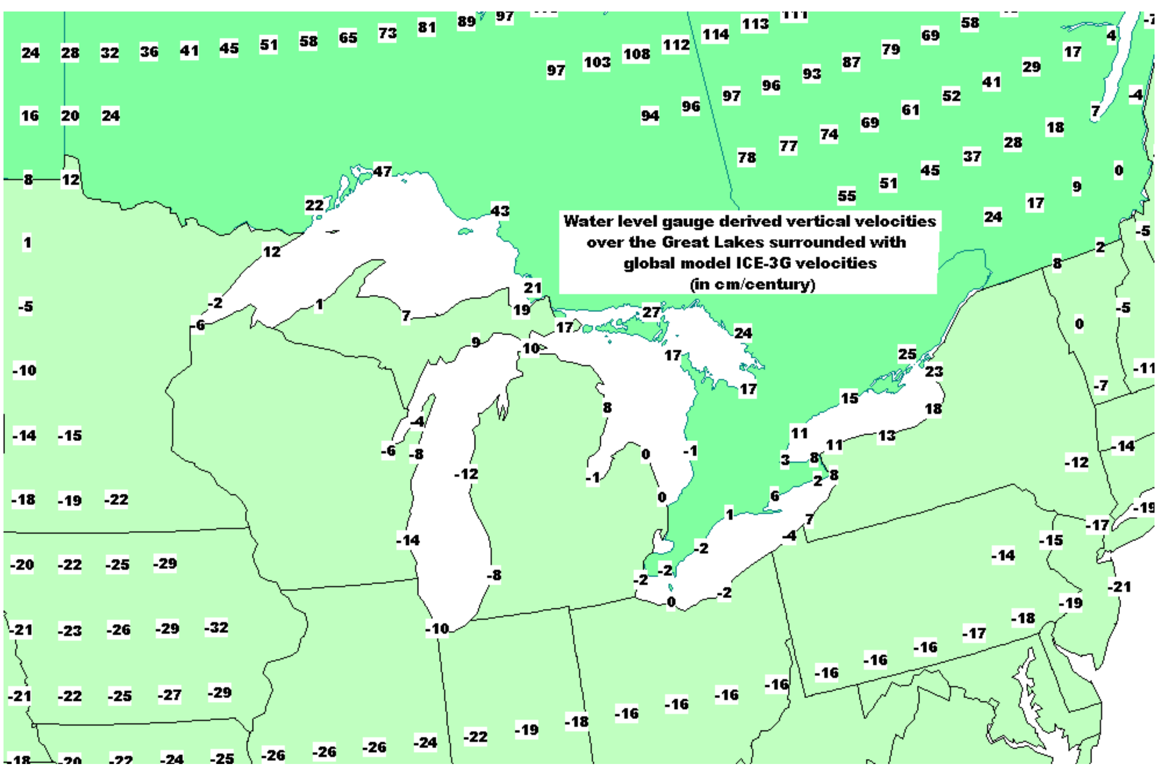

Fig. 10 - Contour map of water level gauge derived vertical velocities over the Great Lakes surrounded with global postglacial rebound model ICE-3G velocities, in cm/century. Contour interval : 3 cm/century