

Figure S1. Selected data from the downscaling process, a) Daily average A2 raw and downscaled temperature and observed temperature vs day of year for 2008, b) as a) but for 2009, c) Annual mean downscaled temperature (2000-2100).

Figure S2. Simulated vertical temperature profile from DYRESM model forced with A2, B1 and observed meteorological data compared to field measurements on 4 May, 2009 (day of year 124).



Figure S3. May 1water surface temperature vs. (a) NAO index (modelled, observed and total R2 = 0.76, 0.53 and 0.52) and (b) AO index (modelled, observed and total R2 = 0.26, 0.43 and 0.48) for the period 1980-2012, AO index vs. (c) modelled day of onset of stratification (R2=0.52) and (d) modelled length of stratification (R2=0.70) for the period 2000-2012. Simulated (2000-2012; hollow circles) and observed (1980-1999 from LSRCA; filled circles) temperatures are shown.



Figure S4: Temporal trends in observed and modelled mean volume weighted hypolimnetic dissolved oxygen (MVWHDO) on September 15. Observations are from North et al., at station K42. Lines are linear regressions to observations (red) and both A2 and B1 model results (black). The target MVWHDO is 7 mg L-1.

Table S1. Details of data used for initial conditions and boundary conditions. Initial conditions and calibration/validation data were horizontal averages of profiles obtained at stations C1, C6, C9, K39, K42, K45, E51 and S15 on 5-6 May 2008 and 2009 (Figure 1a) by the Ontario Ministry of the Environment Conservation and Parks (MECP) and the Lake Simcoe Region Conservation Authority (LSRCA). For more information on these data see Winter et al. (2011). The inflow data were collected by the Provincial (Stream) Water Quality Monitoring Network (PWQMN; <https://www.ontario.ca/environment-and-energy/map-provincial-stream-water-quality-monitoring-network>).

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| **Parameter** | **DY-CD inflows** | **DY-CD initial conditions and calibration/validation** |
| Temperature | PWQMN1 | MECP/LSRCA1 |
| DO | PWQMN1 | MECP/LSRCA1 |
| PO4 | PWQMN1 | MECP/LSRCA1 |
| DOP | DOP=0.29TP3 | DOP=0.29TP3 |
| POP | POP=0.51TP3 | POP=0.51TP3 |
| NH4 | PWQMN1 | MECP/LSRCA1 |
| NO3 | PWQMN1 | MECP/LSRCA |
| DON | DON=0.67(TKN-NH4) 3 | DON=0.67(TKN-NH4) 3 |
| PON | PON=0.33(TKN-NH4) 3 | PON=0.33(TKN-NH4) 3 |
| DOC | PWQMN1 | MECP/LSRCA1 |
| POC | POC=0.75TSS3 | POC=0.75TSS3 |
| TSS | PWQMN1 | MECP/LSRCA1 |
| Si | Mean of 1994-96 PWQMN1 | Mean of 1994-96 PWQMN |
| Chlorophyll-a Fluorometry | MECP1 | MECP1 (2008 only) |
| Chlorophyll-a Extractions | - | MECP2 |
| Phytoplankton Microscopy | - | MECP2 (2008 only) |

1Measured using standard Ontario MECP analytical methods (Janhurst, 1998)

2Phytoplankton samples were fixed with Lugol's iodine solution in the field and were preserved with two drops of 37% formalin after concentration to 25 ml by sedimentation. Subsamples of each concentrated sample were recombined at the end of each season to obtain one composite sample from each station for each year (Hopkins and Standke, 1992). Phytoplankton counting followed Nicholls and Carney (1979), using inverted microsocopy.

3From data in eastern Lake Erie. See Leon et al. (2011) and references therein.

**References**

Hopkins, G.J., Standke, S.J., 1992. Phytoplankton methods manual. Ontario Ministry of the Environment Report, Queen's Printer for Ontario, Ontario, Canada.

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