Modeling 3D Hydrodynamics and Shelf Flushing

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Outline

• Physical processes impacting the southern shelf

• Background on 3D hydrodynamic model

• Adding point sources to 3D model

• Using 3D model to compute flushing time and residence times on southern shelf
Physical Processes

- Tributaries
- Effluent
- Internal Waves

Wind Histogram

Figure 2: Sampling sites for LSC monitoring program, within the context of the entire Cayuga Lake basin. Sites sampled during the 1994 - 1996 study (P2, P4 and S11; Stearns and Wheler 1997) are included for reference. Locations of sampling sites and outfalls are approximate.

Figure 1: Sampling sites, setting, approximate bathymetry, for LSC monitoring program, southern end of Cayuga Lake. Sites sampled during the 1994 - 1996 study (P2, P4 and S11; Stearns and Wheler 1997) are included for reference. Locations of sampling sites and outfalls are approximate.

Figure 4.6: Histogram of wind direction and scatter plot of wind direction and velocity during April - October as measured at the Game Farm Road meteorological station. Dashed line marks approximate orientation of Cayuga Lake's main axis - 340° ± 160°. Directions plotted are relative to true north.

4.4.1 Internal seiche and (longitudinal) tilting of the thermocline

The following is a general overview of the main effects of the tilt of the thermocline proposed in the thesis. It is intended to provide a simplified description of the main effect of the thermocline's longitudinal tilt near the shelf break. In reality the dynamics on the shelf will be more complex. The forcing conditions of the shelf constantly change and there is a balance of the different processes, operating on different timescales, that controls the movement of water on the shelf - the wind's forcing of internal motions as described here, the oscillations...
Conditions after a Rainfall Event
Internal seiche

Figure 1: Sampling sites, setting, approximate bathymetry, for LSC monitoring program, southern end of Cayuga Lake. Sites sampled during the 1994 - 1996 study (P2, P4 and S11; Stearns and Wheler 1997) are included for reference. Locations of sampling sites and outfalls are approximate.

Internal Waves Impact the Southern Shelf
Why 3D?
Why 3D?

Tracer field 10/11/2011 at 600

Wind to North (m/s)

Wind to East (m/s)

Inlet Flow (m³/s)

Temperature (°C) String 1-3 (x)

Depth (m)

Julian day, 2011
Why 3D?
Why 3D?
Why 3D?
Why 3D?
Tracer field 10/12/2011 at 1200

Why 3D?
Tracer field 10/12/2011 at 1800

Why 3D?
Why 3D?
Tracer field 10/13/2011 at 600

Why 3D?
Why 3D?
Why 3D?
Why 3D?
Tracer field 10/14/2011 at 600

Why 3D?
Why 3D?
Why 3D?

Tracer field 10/14/2011 at 1200
Why 3D?
Why 3D?
Why 3D?
Why 3D?
Why 3D?
Tracer field 10/16/2011 at 600

Why 3D?
Why 3D?
Why 3D?

Tracer field 10/16/2011 at 1800

Wind to North (m/s)

Wind to East (m/s)

Inlet Flow (m$^3$/s)

Temperature (°C) String 1-3 (x)

Depth (m)

Julian day, 2011
Tracer field 10/17/2011 at 0

Why 3D?
Why 3D?
Why 3D?
Why 3D?
Why 3D?
Why 3D?
Tracer field 10/18/2011 at 1800

Why 3D?
Why 3D?
Why 3D?
Why 3D?
Why 3D?
Why 3D?
Why 3D?
Why 3D?
Tracer field 10/20/2011 at 1800

Why 3D?
Tracer field 10/21/2011 at 0

Why 3D?
Tracer field 10/21/2011 at 600

Why 3D?
Why 3D?
Why 3D?
Tracer field 10/22/2011 at 0

Why 3D?
Tracer field 10/22/2011 at 600

Why 3D?
Why 3D?
Why 3D?
Why 3D?
Why 3D?
Tracer field 10/23/2011 at 1200

Why 3D?
Why 3D?
Why 3D?
Why 3D?
Why 3D?
Why 3D?
Why 3D?
Why 3D?

Tracer field 10/25/2011 at 600
Why 3D?
Why 3D?

Tracer field 10/25/2011 at 1800

Temperature (°C) String 1-3 (x)

Inlet Flow (m³/s)

Depth (m)

Wind to North (m/s)

Wind to East (m/s)
Why 3D?