Russell Seguin

COMMON ERRORS MADE WHEN USING WATER QUALITY MULTI-PROBES IN THE FIELD

The use of submersible multiprobes to measure water quality parameters such as pH/ORP, conductivity, temperature, dissolved oxygen, turbidity, and depth/level has increased over the last few decades. Even with their wide-spread usage, several details regarding the calibration, maintenance, and usage of these instruments are sometimes ignored and can compromise the quality of the data collected. The basics of how each sensor works, what they are really measuring, and which water quality parameters affect their readings will be discussed.|One common challenge is in calibrating equipment for deployment in waters that are much colder than room temperature. Is it better to calibrate at the temperature of the sample water to minimize temperature compensation errors, or is it better to calibrate in the lab under more controlled environmental conditions?|Other factors can affect data quality and sensor performance. High temperature sensitivity, age of the sensors, and non-linear sensor responses may not obvious during calibration and can induce errors under certain conditions. Limitations and recommended procedures for each sensor will be discussed.|

Russell Seguin

A COMPARISON OF LUMINESCENT DO SENSORS AND CLARK ELECTRODES FOR MEASURING DISSOLVED OXYGEN IN NATURAL WATERS

Historically, field measurements of dissolved oxygen (DO) have been made via Winkler Titrations or using a Clark electrode. Winkler titrations are sometimes impractical, suffer from interferences, and are prone to operator errors. DO electrodes are relatively interference free, accurate, and easy to use, but are flow-dependent, require frequent calibration, and suffer from errors due to passive fouling (coating of sensor membrane). In recent years, luminescent DO sensors have emerged that rely on the fluorescent quenching induced by the presence of oxygen.|Luminescent sensors can measure DO from the intensity or lifetime of the measured fluorescence; the pros and cons of each method and a comparison to measurements using a conventional Clark DO cell will be discussed. Details of field use and calibration, as well as data comparing various sensors will also be presented

Russell Seguin

REAL TIME WATER QUALITY MONITORING DURING A 2-MONTH DREDGING PROJECT

This presentation documents the real-world challenges in monitoring the water quality during a large dredging project of a Washington-Oregon river during the winter of 2005-2006. The annual dormant period of an endangered species of salmon limited the duration of the project to 70 days, leaving little time for errors such as equipment failure or mid-stream revisions in procedure. There were strict regulatory limits to the levels of turbidity, pH, dissolved oxygen, and ammonia levels that could be generated during this environmentally-sensitive project.|The project consisted of 10 buoys, each equipped with 2 multi-parameter instruments at two depths, deployed in various locations ahead of and behind the dredgers. The monitoring system included SDI-12 data loggers, radio telemetry, and satellite communication to a secure web site to provided real-time data access and triple redundancy in data storage.|Data monitoring and review, calibration and verification routines, and a brief review of the project results will be presented. During the project, several issues arose that required rapid resolution. These and other challenges and their solutions will be described in more detail.

Sally MacIntyre

DESCRIBING FLUXES WITHIN LAKES USING HIGH RESOLUTION TEMPERATURE ARRAYS

Describing the pathways of nutrient and particle transport is a central goal of physical limnology. In situ temperature data combined with measurements of surface meteorology provide data to compute these pathways, but a number of algorithms based on laboratory experiments, models, and process studies

are required to characterize the fluxes. We describe the algorithms required for assessment of turbulence in the upper mixed layer, metalimnion, and hypolimnion and illustrate a particle tracking model based on the turbulence which enables prediction of when and where fluxes will within the water column.

David Hamilton
THE USE OF LAKE SENSOR DATA IN STUDENT EDUCATION
Community outreach and student education are key components of the Global Lake Ecological Observatory Network (GLEON). As part of this outreach activity a middle/high school teacher has been assisted by the Royal Society of New Zealand to integrate students into trans-disciplinary scientific research that provides exposure to real-time lake data collection, conventional water sampling techniques, and collation and statistical analysis of the data. Following from high school education, an integrated program activity is planned with the Pacific Rim Experiences for Undergraduates (PRIME) program, which provides opportunities for undergraduate students from Pacific Rim nations to learn about lake responses to natural and human-induced impacts, particularly climate, using historical lake observations including high-frequency data. The outreach activity is designed to promote career pathways in sustainable water management utilizing recent advances in sensor and information technologies, and capitalizing on the diversity and skills of a global lake research community.

David Hamilton
APPLICATION OF HIGH FREQUENCY SENSOR DATA TO RESOLVE EFFECTS OF MIXING AND STRATIFICATION IN A EUTROPHIC, POLYMICTIC LAKE
Lake Rotorua is a large lake (area=79 sq. km, mean depth=9m) in North Island, New Zealand, that experiences frequent cyanobacterial blooms in late summer. Data from a thermistor chain, a bottom oxygen sensor and a shoreline meteorological station have been used to delineate relationships between climate forcing, water column stratification and bottom-water deoxygenation in Lake Rotorua, and to examine associated changes in nutrient concentrations. Anticyclonic summer weather systems are mostly responsible for inducing short-lived stratification events, of order one week, that induce hypoxia of bottom waters and large increases in nutrient concentrations. The inclusion of Lake Rotorua as part of the Global Lake Ecological Observatory Network (GLEON) provides an opportunity for more extensive examination of climate effects on polymictic, eutrophic lakes. This category of lakes is likely to be sensitive to climatic changes that will alter the frequency and duration of hypoxic or anoxic events, with flow-on effects to nutrient levels and phytoplankton populations.

Vera Istvánovics
LONGITUDINAL VARIABILITY IN PHYTOPLANKTON AND BASIC ENVIRONMENTAL DRIVERS ALONG THE TISZA RIVER, HUNGARY
We aimed at assessing phytoplankton dynamics along the Hungarian section of the Tisza River (nearly 600 km). A 10 days long cruise was organised during low flow (100 m3 s-1). Biomass and composition of phytoplankton have been measured by the on-line delayed fluorescence (DF) spectroscopy with a mean spatial resolution of 1 km. GPS coordinates, turbidity, dissolved oxygen and water temperature were recorded by appropriate on-line sensors every 3 to 90 m. Manual samples were taken at a mean distance of 5.5 km from the Tisza River and from the mouths of its tributaries. Concentrations of various P and N forms, suspended solids and chlorophyll a were determined. |A comparison of DF-chlorophyll and turbidity with the results of manual analyses revealed excellent agreement. The algal biomass was low (1-2 mg m-3) in the upper 70 km of the river. Both light and nutrients might have limited the growth. Downstream the combined effect of nutrient inputs from tributaries and large towns, as well as artificially decreased flow velocities resulted in an increased biomass and altered composition of

phytoplankton. High frequency phytoplankton data coupled with hydrodynamic modelling were used to analyse phytoplankton dynamics along the flow (Honti et al., SIL2007).

Patrick Brezonik
A CONCEPTUALA DESIGN FOR SENSOR NETWORKS AND CYBERINFRASTRUCTURE IN THE WATERS NETWORK, AN NSF ENVIRONMENTAL OBSERVATORY NETWORK
WATERS Network, a proposed major facilities investment of the U.S. National Science Foundation, will be an integrated real-time observing system for water bodies (e.g., rivers, streams, lakes, aquifers) based on a nested watershed design across multiple scales. Its goal is to transform scientific understanding of the biophysical and social processes affecting water by deploying state-of-the-art environmental sensors and information technologies. This platform will improve our ability to forecast quality and quantity conditions in water resources, leading toward more effective management approaches. It is intended to revolutionize environmental research and education by engaging interdisciplinary teams of scientists and engineers to study critical water problems. Design of the network is underway as a collaborative effort of the environmental engineering and hydrologic science academic communities under sponsorship of NSF's Engineering and Geosciences Directorates. This talk will describe the current status of the WATERS Network design, including the grand challenges and major science questions to be addressed, national framework for the network, and nature of the proposed field facilities, including sensor networks to be constructed in natural, managed and built environments.

Tim Kratz
THE GLOBAL LAKES ECOLOGICAL OBSERVATORY NETWORK: MERGING LIMNOLOGY AND INFORMATION TECHNOLOGY TO UNDERSTAND LAKE DYNAMICS AT MULTIPLE SCALES
The Global Lakes Ecological Observatory Network (GLEON, gleon.org) is a grassroots network of limnologists and information technology experts with a common goal of building a scalable, persistent network of lake ecology observatories. Data collected from these observatories are designed to allow us to better understand key processes such as the effects of climate and landuse change on lake function, the role of episodic events such as typhoons in resetting lake dynamics, and carbon cycling within lakes. The observatories consist of moored platforms equipped with sensors measuring water column properties such as temperature, dissolved oxygen, chlorophyll, and water movement, as well as weather. The network also provides a mechanism to share data, expertise and experience in using sensors to make high-frequency observations in lakes. We encourage scientists and students interested in contributing and/or using data and sharing expertise to participate in the network. Currently scientists and information technology experts from Australia, Canada, China, Finland, Israel, Japan, New Zealand, South Korea, Sweden, Taiwan, the United Kingdom and the United States participate. An overview is given of the first synthetic science activities of the network relating to an analysis of the diel patterns of dissolved oxygen dynamics in lakes worldwide.

Paul Hanson
PROCESSES CONTRIBUTING TO DIEL DISSOLVED OXYGEN DYNAMICS IN TEMPERATE LAKES
The use of diel dynamics of dissolved oxygen (DO) to estimate metabolism in lake surface waters has increased as technologies for in situ DO measurement have become widely available. Inferences about metabolism rates have been drawn from relatively simple ecological models that subsume DO variability primarily under gross primary production (GPP) and ecosystem respiration (R). However, lakes exhibit complex DO signals that suggest a variety of biological and physical processes contribute to its dynamics. In this study, we measured surface water DO and other limnological and meteorological variables at high frequency in three north temperate lakes. We used these data to discriminate among a series of models

that range in complexity of biological and physical process, with the simplest model being an implementation of the classic Odum (1956) model, and the most complex including irradiance-mediated GPP, photoinhibition and R, as well as light history effects on R. Fits of the simpler models provided reliable parameter estimates for biological processes under a variety of lake conditions. When DO signals were noisy, parameter estimates for complex models were less reliable. Even the best fitting biological models left significant variance in the residuals that appears to relate to lake physical processes not modeled.

Karen Moore
MONITORING COLORED DISSOLVED ORGANIC MATTER (CDOM) INPUTS TO SWEDISH LAKES: DECIPHERING BETWEEN SIGNAL AND NOISE
Watersheds contribute a large subsidy of organic matter to lakes, but assessments of inputs are typically based on a few samples to characterize concentration and flux. We use hourly measurements of colored dissolved organic matter (CDOM) fluorescence as a proxy for dissolved organic carbon (DOC) in three rivers in central Sweden. We measure CDOM fluorescence with a WET Labs WETStar fluorometer at a fixed wavelength (excitation 370 nm/emission 460 nm) and normalize readings to the concentration of a known humic-type standard. We give examples of how high-frequency data provide new insights into patterns (the signal) in organic matter transport from catchments to lakes. We also examine the interferences (the noise) that can create problems for data interpretation. One source of measurement bias arises from the effect of temperature on CDOM fluorescence. We quantified the magnitude of signal quenching for the wide annual range of river and lake temperatures for several water bodies to weigh the importance of correcting for this bias. Monitoring data provide water supply managers with an early warning of high pulses of colored water entering lakes and have contributed data at an appropriate resolution for calibration of a process-based carbon model.

Mark Honti
ASSESSING PHYTOPLANKTON GROWTH ALONG TISZA RIVER (HUNGARY)
A river transports its phytoplankton as a conveyor belt, which steadily varies its speed. A measurement cruise was performed in the summer of 2006 along the Hungarian part of the Tisza River. Phytoplankton data were available for every km of the nearly 600 km section. We aimed at assessing phytoplankton dynamics along the studied section. We applied a 1D hydrodynamic model to calculate water velocities during the measurements. Assuming plug-flow transport, we simulated the path of water parcels meeting the ship. Thereby we identified parcels that were measured at multiple times. Phytoplankton growth rate could be estimated for each river section, which was passed by a multiply measured parcel. Since the covered sections often overlapped, we could make repeated estimates of the average growth rate at a given river kilometer. The results suggest, that phytoplankton coming from the large tributaries (Rivers Szamos and Maros) typically declined in River Tisza itself. The riverine phytoplankton, adapted to continuous turbulence, were especially perishing in the slow waters of the two reservoirs on the river. Sections with a positive biomass changes were clearly related to heterogeneous flow conditions (meanders with sand banks).

Adam Kovacs
FATE OF SUSPENDED SOLIDS AND PARTICULATE PHOSPHORUS IN TISZA RIVER, HUNGARY
The aim of this study was to assess the importance of in-stream retention of suspended solids (SS) and particulate phosphorus (PP) at low flow condition. We used the results of a water quality measuring program carried out in the Tisza River. In July 2006, various water quality parameters were detected during a 10 days long cruise along the Hungarian section of the river (nearly 600 km). Mean flow rate was about 100 m3 s-1 in the inflow section of the river. SS and PP were measured manually every half an

hour (ca. 5.5 km). Samples were also taken from the mouths of the main tributaries. Additionally, concentration of SS was calculated from on-line turbidity records taken at every 10 m and calibrated against SS data. 1D hydrodynamic model was used to calculate the velocity field of the river.|Mass balance for SS and PP was calculated for different river sections. Retention was determined and related to flow velocity. Simple first order equations were adjusted to the measured sediment and phosphorus fluxes to describe their transport. Three typical large and a number of smaller retention areas have been identified in the Tisza River.

Ian Jones
AUTOMATIC IN-LAKE MONITORING IN THE ENGLISH LAKE DISTRICT
A network of four automatic monitoring buoys is deployed on lakes in one region of northern England, the English Lake District. These buoys continuously measure a variety of meteorological and in-lake parameters at a temporal resolution of up to one minute frequency. Examples are shown that illustrate the advantages of continuous high frequency data over more traditional data sets for addressing limnological issues such as quantifying the dyamics of change within a lake, capturing the effect of short-lived extreme events, quantifying coherence of response across lakes, linking meteorological forcing to lake response and understanding the environmental causes of change in phytoplankton populations.

Hampus Markensten
LONG TERM AND HIGH FREQUENCY MONITORING OF BEAM ATTENUATION COEFFICIENT AS A PROXY FOR SUSPENDED PARTICULATE INORGANIC MATTER: USE IN THE CALIBRATION OF A SEDIMENT RESUSPENSION MODEL
A simple dynamic model predicting daily variations of suspended particulate inorganic matter (SPIM) from wind speed and river discharge has been developed in a large (61 km2), and shallow (mean depth 3.4 m) wind exposed basin of lake Mälaren in Sweden. In order to calibrate and verify this model we developed a measuring system to provide a unique long-term (2.5 year) record of high frequency (3 hour) measurements of beam attenuation. The system used a 10cm Wet Labs transmissometer, moored near the center of the basin and mid-depth in the water column. The signal from the instrument was transmitted over a 500 m underwater cable to a data logging system on a small island, where meteorological data were also recorded. The beam attenuation measurements were improved using an antifouling system that greatly reduced the need for service of the underwater instrument. An initial calibration of the model published by Markensten and Pierson* was made using a three month high-resolution record of beam attenuation, with reasonably good results. The longer dataset was used for model calibration and upgrading.||*Markensten, H., and D. C. Pierson. 2003. A dynamic model for flow and wind driven sediment resuspension in a shallow basin. Hydrobiologica 494:305-311.

Don Pierson
USE OF AUTOMATED MONITORING TO SUPPORT THE MONITORING AND MODELING OF TURBIDITY IN A DRINKING WATER RESERVOIR
New York City obtains its drinking water from a system of 19 interconnected reservoirs. Selective use and mixing of these different water sources is an important means of maintaining high quality drinking water. Two reservoirs in this system, which supply approximately 25% of the total water supply capacity, are subject to periodic events of elevated turbidity associated with storms, high river discharge and erosion of glacial clay deposits. Monitoring and modeling these turbidity events is an important source of information used to guide reservoir operations and minimize the impact of these events on the water delivered to New York City consumers.|In this paper we describe two high frequency turbidity monitoring systems: one pumping flow through system located on the major inflow to Ashokan Reservoir; and a second buoy profiling system located toward the center of the reservoir adjacent to a

dike dividing the reservoir into two basins, and near the reservoir aqueduct withdrawal location. We will illustrate the use of these data to follow the progress of turbidity inputs moving through the reservoir, and we will also show how these data are used to verify model simulations of turbidity transport through the reservoir.

Bruce Hargreaves
HIGH FREQUENCY DATA FROM A SMALL-CATCHMENT MID-LATITUDE LAKE & WETLAND STREAM PROVIDE COMPLEMENTARY INFORMATION ABOUT HYDROLOGIC EXCHANGE
Hydrologic exchange of water & dissolved materials is important in lakes & streams. To explore dynamics of dissolved organic carbon (DOC) in freshwater ecosystems we characterized the hydrology of two small-catchment aquatic ecosystems using a network of sensors recording data at 15-minute intervals. One is a lake partially surrounded by a bog (with a small outlet stream but no inlet streams). The other is a stream that passes through a raised bog. These systems are about 75 km apart on the Pocono Plateau in Eastern Pennsylvania, USA. ||Underwater pressure sensors recorded water level changes. At 5 locations along the bog stream these were converted to discharge through rating curves derived from periodic velocity profiles with a magnetic flowmeter; diurnal patterns at low flow were used to infer rates of lateral recharge (nightly rise). In both systems the daytime excess drawdown of water level was used to calibrate an evaporation model based on data from a meteorologic station located in the center of each system. In each system the data will be used to justify further study using indicator cations and shallow wells to further constrain the water budget, and other sensors and samples to monitor DOC and phytoplankton.

Justin Brookes
APPLICATION OF ON-LINE SENSORS FOR RISK MANAGEMENT IN LAKES, RESRVOIRS AND RIVERS
Three case studies are presented that demonstrate the application of on-line sensors to risk management in reservoirs and rivers.|(1). Pathogens are transported rapidly through reservoir during rain event inflows. Using online sensors the depth and speed of the intrusion has been identified using permanently deployed thermistors. In Myponga reservoir, South Australia the nominal retention time based on abstraction is 3 years but during rain events the riverine intrusion can rapidly travel the 5km length of the reservoir presenting a pathogen challenge to the treatment plant within 24 hours.|(2). Thermal stratification in rivers can lead to excessive cyanobacterial growth. Thermistor deployment in the River Murray, Australia enabled the critical flow leading to stratification to be determined and facilitated river management to avoid stratification and cyanobacterial growth.|(3). Low dissolved oxygen can lead to reduced habitat and sediment nutrient release. DO sensors in the Torrens Lake identified a significant oxygen demand from contaminants washed in during rain events. This demand is relieved during winter when temperature controls microbial activity.

Jeng-Wei Tsai
TYPHOON DISTURBANCECES ON THE ECOSYSTEM METABOLISM OF A SUBTROPICAL ALPINE LAKE
Large-scale disturbances such as typhoons and tropical storms have the potential to affect ecological processes in lakes. Yet, because of the difficulty inherent in making observations immediately before, during, and after these episodic events, the influence of major storms on lakes is poorly understood. This study aims to understand how typhoons disturbances influence the metabolism of a subtrophical alpine lake (Yuang-Yang Lake (YYL), Taiwan). A permanent wireless sensor network established in YYL in 2004 provided near real-time, high-frequency dissolved oxygen, water temperature profiles, and meteorological data, which we used to estimate daily values of gross primary production (GPP), ecosystem respiration (ER), and net ecosystem production (NEP) for the lake. Our observations revealed that the metabolism of YYL exhibited both significant seasonal variations and short-term responses to

typhoons. GPP and ER were both higher in spring and early summer, and lower in winter and during the high-precipitation typhoon season in late summer and fall. Storms with more than about 200mm of total precipitation decreased both GPP and NEP, whereas storms of lesser intensity increased GPP and NEP. Most of the typhoons increased ER. This differential response of YYL's metabolism to storm intensity is likely linked to storm-induced changes in DOC quantity and quality.

Laurence Choi
ANALYSIS OF ANOMALIES IN DIEL PATTERNS OF SURFACE DISSOLVED OXYGEN CONCENTRATION IN LAKES WORLDWIDE
Dissolved oxygen concentrations in surface waters often undergo diel fluctuations, increasing during the day and decreasing during non-daylight hours. This diel pattern has been used to estimate lake metabolic parameters such as gross primary production, ecosystem respiration and the difference between the two, net ecosystem production. These estimates assume that, after accounting for atmospheric flux, increases in dissolved oxygen are due to the excess of primary productivity over respiration and decreases during non-daylight hours are due to ecosystem respiration. We examined dissolved oxygen concentration patterns for lakes around the world in the Global Lakes Ecological Observatory Network (GLEON) and found in several lakes on certain days an unexplained increase in dissolved oxygen concentration during non-daylight hours. This increase could not be explained by increased atmospheric flux due to cooling water temperatures and was named the midnight surge. |We developed an algorithm to extract features of the diel dissolved oxygen time series, and then detect the presence and strength of the midnight surge. The algorithm compares well with expert judgment. We describe this automated detection algorithm and propose a plausible hypothesis that may help explaining the midnight surge phenomenon in terms of weather or fine-scale water temperature profiles in these lakes.

Aminadav Nishri
THE MIXING BETWEEN HYPOLIMNETIC AND EPILIMNETIC WATER AS REFLECTED BY CONTINOUS MONITORING OF DO AND PH
This study is based on continuous monitoring of pH, DO, electrical conductivity, temperature and turbidity by Hydrolab and YSI devices installed at both, the center and littoral areas of the relatively alkaline Lake Kinneret, Israel. In the epilimnion of this lake the pH of the water is buffered solely by the carbonate system. Hence from alkalinity and pH data it is possible to calculate the molar concentration of CO2 at any time. It is found that the slope of the linear correlation curve between DO and CO2 varies with time and water layer. In spring (May-June) while the hypolimnion gradually becomes anoxic the slope of ?DO/?TCO2 curve in this layer is different than the respective slope in the epilimnion. In surface water of littoral areas the mixing between seich induced uplifting of DO depleted; CO2 enriched colder hypolimnetic water and epilimnetic water produce different slopes for the ?DO/?TCO2 curve as compared to typical lake interior epilimnetic ratios. The mechanisms involved in forming the different slopes are discussed.

Boqiang Qin
HYPOXIA AND ITS INFLUENCING FACTORS IN A LARGE, SHALLOW AND EUTROPHIC LAKE TAIHU, CHINA
To understand the processes and the relative environmental factors of hypoxia in a large, shallow, eutrophic Lake Taihu, a month high frequency sensor monitoring for dissolved oxygen (DO) was carried in summer, 2006. As a polymictic lake with strong wind-wave disturbance, it is surprising that hypoxia was often found in the eutrophic bay with serious Microcystis algae bloom in summer. The high frequency DO monitoring revealed that all the hypoxia (DO < 3 mg/L) occurred since the nighttime of from 20:00 pm to 3:00 am. Normally, hypoxia lasted 1 to 10 hours. Sometimes the hypoxia was lasted

until 9:10 am of the next morning. High temperature during daytime and almost no wind-wave disturbance, along with the serious algae blooms, contributed to the extremely high DO peak value in daytimes, as well as extreme low value of DO in the nighttime. The result suggested that hypoxia could occurred even in very shallow lakes like Lake Taihu, which the mean depth of only 1.9 m and the area of over 2000 km2. The subsequent ecological effects of hypoxia must be concerned in such a shallow, large subtropical lake.

Yves Prairie
INSIGHTS ON RIVERINE METABOLISM FROM CONTINUOUS MEASUREMENTS OF CDOM FLUORESCENCE IN EASTMAIN-1 RESERVOIR, QUEBEC
Prior to the flooding of the Eastmain-1 reservoir in Quebec's boreal zone, we monitored basic chemical properties of the Eastmain river with a satellite-linked high frequency (8 measurements per day) autonomous station. Continuous CDOM measurements by in situ fluorometry were strongly correlated with measured DOC concentrations and revealed strong diurnal variations probably reflecting changes in the optical properties of the DOM with sunlight. Seasonal variations in CDOM fluorescence were strongly correlated with changes in dissolved oxygen departures from atmospheric equilibrium. High CDOM flurorescence was associated with strong oxygen undersaturation, suggesting that in situ DOC decomposition can be modeled as a first-order reaction with DOC abundance. We explore whether this relationship is similar to that observed in lakes.

David Livingstone
THE USE OF LONG-TERM, HIGH-FREQUENCY, AUTOMATIC SAMPLING DATA IN A COMPARATIVE STUDY OF THE HYPOLIMNIA OF TWO DISSIMILAR ALPINE LAKES
Temperatures and particle fluxes were measured continuously at high resolution between 2002 and 2006 in high-altitude, proglacial Lake Silvaplana, Switzerland (1800 m a.s.l.), which is ice-covered for 4-5 months of the year. These data are compared to similar high-resolution data from lowland, Mediterranean Lago Maggiore, Italy (200 m a.s.l.). Results from both lakes demonstrate the influence on the hypolimnia of short, intense events such as periods of heavy rainfall, and/or of seiche-like internal mixing resulting from meteorological forcing. Temperatures in the lowermost part of the hypolimnion of Lake Silvaplana fluctuate with a distinct, diel cycle, whereas in Lago Maggiore, temperatures measured in the middle of the hypolimnion tend to fluctuate with a period of 4 to 7 days.