MUSCATEN arrange
2nd Workshop on Parameterization of Lakes in Numerical Weather Prediction and Climate Modelling

Norrköping, Sweden, September 15-17 2010

List of participants (updated August 16, 2010)

Last name	First name	Affiliation	E-mail
Asensio	Hermann	Deutscher Wetterdienst, Germany	hermann.asensio@dwd.de
Balsamo	Gianpaolo	ECMWF	gianpaolo.balsamo@ecmwf.int
Bazile	Eric	Meteo France	Eric.bazile@meteo.fr
Cheng	Bin	FMI, Finland	Bin.cheng@fmi.fi
Duguay	Claude	University of Waterloo, Canada	crduguay@uwaterloo.ca
Gollvik	Stefan	SMHI	stefan.gollvik@smhi.se
Golosov	Sergei	Institute of Limnology, Russian Academy of Science	sergey_golosov@mail.ru
Goyette	Stéphane	C3i, University of Geneva, Switzerland	stephane.goyette@unige.ch
Homleid	Mariken	Norwegian Meteorological Institute	mariken.homleid@met.no
Kirillin	Georgiy	Leibniz-Institute of Freshwater Ecology, Berlin, Germany	kirillin@igb-berlin.de
Eerola	Kalle	FMI, Finland	kalle.eerola@fmi.fi
Faroux	Stéphanie	Météo France, France	stephanie.faroux@meteo.fr
Kheyrollah Pour	Homa	University of Waterloo, Canada	h2kheyro@uwaterloo.ca
Klaric	Dijana	RC LACE, Meteorological and Hydrological service of Croatia	dijana@cirus.dhz.hr
Kourzeneva	Ekatherina	RSHU, St Petersburg, Russia	kourzeneva@rshu.ru
Le Moigne	Patrick	Météo-France, France	Patrick.LeMoigne@meteo.fr
Martin	Eric	Météo-France, CNRS, France	Eric.Martin@meteo.fr
Martynov	Andrey	University of Quebec at Montreal (UQAM), Canada	andrey.martynov@uqam.ca
Mironov	Dmitrii	DWD, Germany	Dmitrii.Mironov@dwd.de
Nordbo	Annika	University of Helsinki	annika.nordbo@helisnki.fi
Onvlee	Jeanette	KNMI	Onvlee@knmi.nl
Potes	Miguel	Evora Geophysics Centre, Portugal	mpotes@uevora.pt
Rockel	Burkhardt	GKSS Forschungszentrum Geesthacht	Burkhardt.Rockel@gkss.de
Rooney	Gabriel	UK Met Office, UK	gabriel.rooney@metoffice.gov.uk
Rontu	Laura	FMI, Finland	laura.rontu@fmi.fi
Salgado	Rui	Universidade de Évora, Portugal	rsal@uevora.pt
Samuelsson	Patrick	SMHI	patrick.samuelsson@smhi.se
Stepanenko	Victor	Moscow State University, Russia	vstepanenkomeister@gmail.com stepanen@srcc.msu.ru
Schenk	Frederik	GKSS Research Center Geesthacht, Institute for Coastal Resarch, Department of Paleoclimate	frederik.schenk@gkss.de
Subin	Zachary	Lawrence Berkeley National Lab, USA	subin@berkeley.edu
Terzhevik	Arkady	Northern Water Problems Institute, Karelian Scientific Centre, Russ. Acad. Sci.	ark@nwpi.krc.karelia.ru ark1948@list.ru
Wu	Yihua	NOAA/NCEP/EMC, USA	yihua.wu@noaa.gov
Yang	Yu	Department of Physics, University of Helsinki, Finland	yangyang-0606@hotmail.com

List of presentations (updated August 18, 2010)

External Parameters for FLAKE in the numerical weather prediction models COSMO and ICON

Hermann Asensio
Deutscher Wetterdienst, Germany

Numerical weather prediction models and climate models require geographical localized datasets as so-called external parameters.
In particular the parameterisation of lakes with FLAKE needs fields of lake fraction and lake depth.
For the global atmospheric model ICON and the regional model COSMO the information about the lake depth is aggregated onto the model target grid from a lake depth database, the information about the lake fraction is deriverd from the land use datasets GLCC and GLC2000.
A consistency check on the target grid in order to avoid possible inconsistencies between the external parameters will be discussed. These inconsistencies are difficult to avoid a priori since the different external parameter fields are generated on the basis of different independent raw data sets.

Impact of lakes in the ECMWF Integrated Forecasting System: Preliminary results and roadmap to an operational implementation.

G. Balsamo, R. Salgado, E. Dutra, S. Boussetta, T. Stockdale

A set of simulations performed with the Tiled ECMWF Scheme for Surface Exchange over Land (HTESSEL) including the Fresh water Lake model (FLake) treated as an extra surface tile and coupled with the ECMWF Numerical Weather Prediction (NWP) model is presented in order to show progress and current issues. In particular, the impact of fully resolved vs. subgrid (unresolved) lakes and the benefits of a more realistic treatment of the lake bathymetry and lake state initial conditions, as opposed to fixed depth and simplified initialization will be illustrated. A roadmap to a future operational implementation will be discussed.

Thermodynamic modelling of snow and ice for in-land water bodies

Bin Cheng

Snow and ice thicknesses for in land water bodies are modelled with a one-dimensional thermodynamic snow/ice model (HIGHTSI). We pay attention to the time series of snow accumulation in a seasonal scale. The model forcing was based on in situ observations from weather stations and numerical weather predication (NWP) results data. The results suggest that precipitation from NWP model and melting process described in sea ice model are equally important to reveal the snow time series against observations

Exploitation of EO-Based Technology for Improving the Characterization of Lake and River Ice Dynamics in Weather Forecasting, Climate and Hydrologic Models – ESA's STSE "North Hydrology" Project

Claude R. Duguay

Interdisciplinary Centre on Climate Change (IC^3)
University of Waterloo
Waterloo, Ontario N2L 3G1
Canada

Lake and river ice play a key role in the physical, biological, and chemical processes of cold region freshwater. The frequency and size of lakes greatly influence the magnitude and timing of landscape-scale evaporative and sensible heat inputs to the atmosphere and are important to regional climatic and meteorological processes. Because lakes are such a major component of most northern atmospheric and hydrologic systems, the ability to determine their annual energy and water budgets is critical to our ability to forecast high latitude weather, climate, and river flow patterns. River-ice is also one of the major components of the terrestrial cryosphere. It affects an extensive portion of the global hydrologic system, particularly in the Northern Hemisphere where major ice covers develop on 29% of the total river length and seasonal ice affects 58%. River-ice duration and break-up exerts significant control on the timing and magnitude of extreme hydrologic events such as low flows and floods. There are long-term observations of lake and river ice for many northern countries. However, the observation networks have been declining dramatically in recent decades. This lack of data hinders the use of river and lake ice data into numerical weather prediction, climate and hydrologic models. In this context, Earth Observation (EO) represents a unique tool to support the scientific and operational communities to characterize and monitor river and lake ice dynamics as a key component of the North Hydrology System.

In this presentation, an overview of a new project sponsored by the ESA's STSE (European Space Agency Support To Science Element) Programme – North Hydrology – will be provided. The North Hydrology project team is lead by University of Waterloo in collaboration with Environment Canada, ENVEO (Austria), the Finnish Environment Institute (SYKE) and the Finnish Meteorological Institute (FMI), INRS – Centre Eau Terre Environnement (Canada), the Northern Research Institute (Norut) and the Norwegian Computing Center (NR), and the Swedish Meteorological and Hydrology Institute (SMHI). The overall goal of North Hydrology is to support the international efforts coordinated by the Climate and Cryosphere (CliC) project of the World Climate Research Programme (WCRP) to exploit the use of EO technology, models and in situ data to improve the characterization of river and lake ice processes and their contribution to the Northern Hydrology system. To this end, North Hydrology aims at developing a portfolio of novel multi-mission geo-information products (maximizing the use of ESA data) to respond to the scientific requirements of the CliC community and the operational requirements of the weather and climate operational agencies (regional to global scale), and the requirements of the operational user community to better characterize river-ice (and glacier temporary lakes) dynamics in flood forecasting models at the basin scale. For this talk, emphasis will be placed on the lake component of the project.

Response of shallow lakes ecosystems to climate variations: Hind- and forecast

Sergei Golosov

Re-analysis data and different scenarios are used to evaluate effect of varying climate on ecosystems of shallow lakes up to year 2100.

On the sensitivity of the lake thermal profiles to the vertical resolution in numerical models: investigation with SIMSTRAT and FIZC for deep Lake Geneva, Switzerland

Marjorie Perroud[1] and Stéphane Goyette[2]
[1] Cooperative Institute for Limnology and Ecosystems Research (CILER), University of Michigan
[2] Climatic Change and Climate Impacts, University of Geneva, Switzerland

This paper presents some results on the sensitivity of thermal profiles simulated in a mid-latitude deep water body to the vertical resolution of a lake model as well as to that of the driving atmospheric model. On the one hand, the vertical resolution set up in lake models may be of a concern when simulating the thermal evolution of deep lakes, particularly if these are interfaced with geo-chemical modules whose results are to be used and applied by limnologists, biologists, *etc*. On the other hand, high resolution numerical weather prediction and regional climate models mainly require accurate evolving lower boundary conditions, *e.g.* surface water temperatures, which determine the weather and climate in the surrounding region and beyond. The number of layers in deep lake models relevant for limnological applications, which may be not so for weather or climate applications, is thus the main issue of this study. The first question to be addressed is how would the simulated thermal profiles in such deep lakes respond to the reduction of the vertical resolution, or in other terms, how far thermal profiles would deviate from observations when the grid spacing increase in the vertical dimension. The next question to be addressed is related to the sensitivity of the lake thermal profiles to the vertical resolution in the atmospheric model coupled to a lake model. The mid-latitude lake under investigation is Lake Geneva, a large and deep water body located in the western perialpine area of Switzerland bordered by France on its southern shore. The lake model is the one-dimensional finite difference k-ε called SIMSTRAT first driven by observations for which the vertical grid spacing increases from 1 m to few tens of meters. The atmospheric model is the single-column model FIZC which is then coupled to SIMSTRAT for which the number of vertical layers is increased from 10 to 30.

Treatment of the density stratification in the FLake model.

Georgiy Kirillin

The core of the FLake model is its original parameterization of the density stratification based on the idea of self-similarity of the lake thermocline. Initially thought as an elegant phenomenological representation, the thermocline self-similarity had received physical justification in some special situations. Still, representation of the real lake thermocline formation, erosion of its thickness and complete destruction– requires additional time and depth scales introduced in FLake through semi-empirical parameters. These parameters are often completely disregarded by FLake users/testers, resulting in misinterpretation of modelling results. Using observational data from several lakes, I estimate relaxation time scales for the thermocline shape factor and discuss length scales appropriate for parameterization of the thermocline thickness. The latter would allow extending of the FLake to a three-layer model directly applicable to deep lakes.

Simulation of surface water temperature and ice phenology from 1-D lake models: A comparison with in situ and satellite observations,
Great Slave Lake, Canada

H. Kheyrollahpour and C.R. Duguay
Interdisciplinary Centre on Climate Change (IC^3)
and
Department of Geography and Environmental Management
University of Waterloo, Waterloo, ON, Canada N2L 3G1
Email: h2kheyro@uwaterloo.ca

The one-dimensional (1-D) Freshwater Lake (FLake) model and Canadian Lake Ice model (CLIMo) are used to simulate lake surface temperature (LST), freeze-up and break-up dates, and ice thickness for sections of various depths on Great Slave Lake (GSL), Northwest Territories, Canada. Model results are compared with LSTs from satellite remote sensing thermal data (Moderate Resolution Imaging Spectroradiometer (MODIS) and *Advanced Along-Track Scanning Radiometer* (*AATSR*)). Simulated ice conditions from both models are validated against historical data extracted from the Canadian Ice Database (CID). The main goal of this project is to evaluate the known FLake model, which is currently being implemented as a lake scheme in several numerical weather forecasting and regional climate models, for a large and deep lake (GSL) and to improve our understanding of the spatial and temporal variations in surface water/ice temperature on the lake.

Preliminary results show that ice-out (break-up) dates obtained with the FLake model occur earlier, when compared to in situ observations and estimates from CLIMo. One possible reason for the discrepancy between FLake and CLIMo ice-out dates is the different albedo schemes used by the two models. A better agreement is also found between CLIMo simulated ice thicknesses and CID in comparison to FLake. The root mean square error (RMSE) for CLIMo and FLake is 9 and 45 cm, respectively, while the mean bias error (MBE) is 6 and 33 cm. The larger overestimation of ice thickness with FLake is likely due to the fact that snow depth on ice is neglected in this model.

Global Lake Database for the parameterization of lakes in NWP and Climate Modelling

Ekatherina Kourzeneva
RSHU, St Petersburg, Russia

To parameterize lakes in Weather Prediction (NWP) and climate models, we need fields of external lake parameters. Fields should be global and should contain information about properties of all existing lakes. Great fidelity of the depth data is not critical, but global coverage is important. The dataset presented in provides the external parameters fields for the parameterisation of lakes in atmospheric modelling. It combines depth information for the individual lakes from different sources with the raster map (for this, the dataset for ecosystems ECOCLIMAP2 is used). As a result, the lake depth is represented on the global grid with the resolution of 30 sec. of arc (approx. 1 km). For some large lakes the bathymetry is included. Additionally, the software to project the lake-related information accurately onto an atmospheric model grid is provided.

Modelling the Thau lagoon in southern France, with FLake model : first results

Patrick Le Moigne

The goal of the study is to evaluate the ability of Surfex/FLake model, to simulate water temperature and surface fluxes of the saline Thau lagoon. For that purpose, a one-dimensional off-line simulation is realized and the results are compared to the available observations. Additionally, FLake behaviour is evaluated when coupled to the mesoscale Meso-NH model for an idealized case (sensitivity to lake stratification, upper-air wind profile).

Interactive Lakes in the Canadian Regional Climate Model, version 5: the Role of Lakes in the Regional Climate of North America

A. Martynov, L. Sushama, R. Laprise

Centre ESCER, Université du Québec à Montréal, 201 Av. du Président-Kennedy, H2X 3Y7, Montréal, Canada

Interactive Lakes were recently introduced into the Canadian Regional Climate Model, version 5 (CRCM5), aiming at better simulation of regional climate, particularly for lake-rich regions, such as the Canadian Shield and the Laurentian Great Lakes region. The lake coupling for both resolved and subgrid lakes is realised, using two different 1D lake models. Simulations over the North-American continent using CRCM5 with interactive lakes will be presented and compared with standard CRCM5 version, which uses prescribed lake water temperature.

The Lake Model Intercomparison Project (LakeMIP): present state and perspectives

Andrey Martynov (1), Stéphane Goyette (2), Victor Stepanenko (3), Marjorie Perroud (4), Xing Fang (5), Klaus Jöhnk (6), and Dmitry Mironov (7)

(1) Centre ESCER, Université du Québec à Montréal, 201 Av. du Président-Kennedy, H2X 3Y7, Montréal, Canada (andrey.martynov@uqam.ca),
(2) Climatic Change and Climate impacts, University of Geneva, Route de Drize 7, Carouge, 1227, Switzerland (stephane.goyette@unige.ch),
(3) Moscow State University, Research Computing Center, Faculty of Geography, Leninskie Gory, building 4, Moscow, GSP-1, 119991, Russia (vstepanenkomeister@gmail.com),
(4) NOAA Great Lakes Environmental Research Laboratory 4840 S. State Rd. Ann Arbor, MI 48108-9719 USA (Marjorie.Perroud@noaa.gov)
(5) Auburn University, Department of Civil Engineering, Auburn Alabama 36849-5337, USA (xing.fang@auburn.edu),
(6) CSIRO Land and Water, Black Mountain, Canberra, ACT, Australia (klaus.joehnk@csiro.au)

(7) Deutscher Wetterdienst, Forschung und Entwicklung, FE14; Frankfurter Str. 135, D-63067 Offenbach am Main, Germany (Dmitrii.Mironov@dwd.de)

The Lake Model Intercomparison Project (LakeMIP) is an international project initiated by participants of the workshop “Parameterization of Lakes in Numerical Weather Prediction and Climate Modelling” held in September 2008 in St. Petersburg (Zelenogorsk), Russia. This is a voluntary project, open to all researchers.

The LakeMIP project is intended to test the performance of different lake models driven by similar external forcing conditions, and corresponding to different types of lake environments, in order to provide a feedback to lake model developers and users on the validity ranges of different lake models and on their strengths and weaknesses, so to come up with recommendations on lake model implementation in different applications. The project also provides a communication ground to both lake model developers and users.

The first phase of the project includes testing different lake-model formulations, using observed meteorological data to drive them in a stand-alone mode. Lake model outputs (water temperature profiles, surface temperature, heat fluxes, ice thickness, etc.), compared among them and with available observations, are revealing their capabilities and limitations. Lakes, representing different climate conditions and mixing regimes, were chosen for simulation in order to encompass the variety of hydrological and thermodynamicAL regimes. Three lakes have currently been taken into account: Sparkling Lake in Wisconsin, USA, Lake Michigan, USA, and Kossenblatter See in Germany.
Other lakes are considered for further experiments, including Toolik Lake in Alaska, USA. More detailed analysis of large and deep lakes, such as Laurentian Great Lakes, is also envisaged. Further steps will INCLUDE surface parameterisation schemes for heat flux, momentum transfer as well as different representations for ice and snow cover.
The intercomparison of lake models, coupled with atmospheric models, used for NWP and/or climate change simulations, is also considered for the next phases of LakeMIP.

Parameterisation of lake and sea ice in the NWP models of the German Weather Service

Dmitrii Mironov and Bodo Ritter

German Weather Service, Offenbach am Main, Germany
(dmitrii.mironov@dwd.de, bodo.ritter@dwd.de)

Experience in treating sea and lake ice within the NWP models of the German Weather Service (DWD) is discussed. A thermodynamic sea ice parameterisation scheme is used operationally within the global model GME since 2004 (Mironov and Ritter 2003, 2004), whereas no separate lake ice parameterisation scheme is implemented into GME. Within the limited-area model COSMO, the lake ice is treated by the ice module of the lake parameterisation scheme FLake (Mironov 2008, Mironov et al. 2010). At the moment FLake is tested pre-operationally within COSMO. The implementation of the sea ice scheme into COSMO is underway.
Both the sea ice and the lake ice parameterisation schemes account for thermodynamic processes only, i.e. no ice rheology is considered. The heat transfer through the ice is treated using the integral (bulk) approach. It is based on a parametric representation (assumed shape) of the evolving temperature profile within the ice and the integral heat budget of the ice layer.

Simple thermodynamic arguments are invoked to compute the ice thickness. The result is a system of two ordinary differential equations for the two time-dependent quantities, viz., the temperature at the air-ice interface and the ice thickness. Snow over sea/lake ice is not considered explicitly at present. The effect of snow over sea/lake ice is accounted for implicitly (parametrically) through an empirical temperature dependence of the ice surface albedo with respect to solar radiation. The horizontal distribution of sea ice is governed by the GME data assimilation scheme. If a GME grid box has been set ice-free during the initialisation, no ice is created over the forecast period. If observational data indicate open water conditions for a given grid box, residual ice from the model forecast is removed and the water surface temperature is set to the observed value. As different from the sea ice, no data are assimilated into the lake ice scheme; lakes freeze up and melt themselves in response to atmospheric forcing.
Operational (GME) and pre-operational (COSMO) testing indicates a satisfactory performance of ice parameterisations schemes. Numerical results show little sensitivity to the details of the ice scheme itself. This justifies the use of a simplified bulk approach to model the ice thermodynamics in NWP. As compared to the finite-difference heat-transfer approach, the bulk approach allows to save computational resources without a detectable loss in accuracy. The ice surface temperature is sensitive to cloud cover as it controls the radiation energy budget, particularly during winter, and to ice albedo with respect to solar radiation, particularly during summer. Further efforts should go into the development of a refined formulation for the ice albedo. The fractional ice cover and an explicit treatment of the snow layer over the ice may also need to be considered.

Long-term energy flux measurements over a small boreal lake

Annika Nordbo, Samuli Launiainen, Ivan Mammarella, Matti Leppäranta, Jussi Huotari, Anne Ojala and Timo Vesala

The four main energy balance components -water heat storage change, net radiation and the turbulent sensible and latent heat fluxes- were measured during four consecutive open-water periods at a small boreal lake (area 0.041km², mean depth 2.5m) in southern Finland. The lake appeared isothermal after ice break-up around April, but the development of a thermocline was induced in May by low water clarity and a sheltered location. The thermocline deepened toward fall hindering the interaction between the atmosphere and the deeper water layers, and a complete turnover was observed around September when the thermocline was at the depth of 3.5 m. The sensible heat flux peaked in the morning and had its minimum in the afternoon. The monthly means ranged from -9 Wm^{-2} to 24 Wm^{-2} and the largest amplitude in monthly mean diurnal courses was 43 Wm^{-2}. The latent heat flux had an opposite diurnal phase and was generally larger. The monthly means were from 4 Wm^{-2} to 77 Wm^{-2} and the largest monthly mean amplitude was 78 Wm^{-2}. Furthermore, the lake heat storage change and net radiation both peaked around midday and had negative values during night. The monthly mean diurnal amplitudes were as high as 440 Wm^{-2} and 550 Wm^{-2}, respectively. On a longer temporal scale, the lake acted as a heat sink until July/August when the cumulative heat storage was 230 MJm^{-2}.

Abstract based on a manuscript submitted to Journal of Geophysical research 3.6.2010: Long-term energy flux measurements and energy balance over a small boreal lake using eddy covariance technique. Annika Nordbo, Samuli Launiainen, Ivan Mammarella, Matti Leppäranta, Jussi Huotari, Anne Ojala and Timo Vesala

Study of the water quality using satellite data

Miguel Potes

The successful launch of ENVISAT in March 2002 has given a great opportunity to understand the changes of water colour with high spatial resolution. In this study, the potential of MERIS sensor to describe variations of optically active substances in a Portuguese artificial lake, the Alqueva reservoir, is investigated. Regular *in situ* measurements, once a month, are used in combination with MERIS acquisitions. The surface reflectance is derived from Level 1b MERIS data, combined with radiative transfer calculations to account for the atmospheric effects. The parameterizations obtained are used to map some pigments. The results obtained are also compared with independent *in situ* measurements.

Effects of LST initialisation in long-term simulations with COSMO-CLM performed with and without Flake

Burkhardt Rockel

The standard initialisation and boundary conditions of the lake surface temperature (LST) in CCLM is taken from the driving global climate model. In cases where lakes are not resolved by the GCM the SST of the nearest ocean grid point is used. This can lead to substantial differences compared to the real LST, especially when the lake is located far from the next ocean or in high elevation area. A sensitivity experiment is performed to assess the influence on long-term simulations with the CCLM.

Interfacing Flake with the Met Office Unified Model

Gabriel Rooney

Results will be presented from the process of embedding FLake in the Met Office Unified Model, via the land-surface module JULES (www.jchmr.org/jules/).

Lakes in wintertime HIRLAM

Laura Rontu and Kalle Eerola

During winter 2009-2010, the next reference HIRLAM (HIgh Resolution Limited Area Model) version 7.3 has been extensively validated and tested within the international HIRLAM programme. This version includes, among other updates, renewed surface parametrizations (the "newsnow" scheme) and a new way to treat the surface state of water bodies in the surface data assimilation. Recently, the FLake (Freshwater Lake Model) has been implemented as a parametrization scheme within the new version. The main difference between this HIRLAM+FLake version and the one presented in the first lake workshop (2008) and reported in the Bor. Env. Research (2010) is a correction of simple technical error in the FLake interface, which prevented the correct evolution of mean lake temperature. In addition, the basic HIRLAM has evolved towards more stable and error-free code.

In the presentation, lessons of HIRLAM experiments covering the period from November 2009 to May 2010 will be analysed from the point of view of freezing and melting of lakes. The results of the new reference HIRLAM with and without FLake parametrizations will be compared with observations of lake temperatures in Finland. The first impression is that in a Nordic domain, usage of FLake allows to significantly improve the simulation of lakes and lake-atmosphere interactions during the cold season.

Lake parameters climatology for cold start runs (lake initialization) in the ECMWF forecast system

R. Salgado, G. Balsamo, E. Dutra, S. Boussetta and M.Potes.

The use of the FLake lake model inside an weather forecast system requires the knowledge of the initial conditions of its variables. These variables are currently not treated by the data assimilation systems. One possible solution is to create a climate of FLake variables from off-line long periods simulations. For the ECMWF system, this climatology was generated from the Lake-Planet experiment, which consisted of an off-line HTESSEL coupled to FLake run forced by the ERA-interim reanalysis (1989-2009) and considering Earth's surface entirely covered bye lakes. The depth of the lakes was obtained from the Kourzeneva database, the bathymetry of the Caspian Sea and assumed a value of 30 m at the grid points where there are no information on the presence of lakes. In order to validate the Lake-Planet experiment the following datasets were used: MODIS SST data, the IMS snow cover / sea ice product, the "Global Lake and River Ice Phenology" dataset.

The model for methane emissions from lakes in the permafrost zone

Victor M. Stepanenko

The permafrost zone in the Northern hemisphere is nowadays widely recognized as an important source of methane due to emissions from bogs and lakes, expected to increase while the climate is warming. Numerous observational and modelling efforts have been performed to assess the current magnitude of methane emissions from bogs and their potential positive feedback to the future climate change. However, much less attention has been paid to lakes that occupy a significant fraction of permafrost area. Particularly, thermokarst lakes which abundance is up to 40% in some Siberian regions are worth mentioning when considering the methane fluxes. Recent observations indicate thermokarst lakes as an important methane source likely to provide a positive feedback to climate warming since thermokarst lakes' area tends to expand when permafrost thaws. Hence, a modelling tool is needed to assess this feedback in future. In this talk a one-dimensional process-based model of a lake, that quantifies production, transport and sink of methane in the water column and the ground below is presented. Among other physical processes, the model takes into account the processes of heat and moisture transport in permafrost explicitly. The model thermodynamics and hydrodynamics are briefly described. More attention is paid on the methane model, discussing the main assumptions used to derive the equation set, its capabilities, limitations and perspectives. The model is verified and calibrated using the available data on measured methane fluxes over the thermokarst lake Shuchi in North-Eastern Siberia, that are kindly provided by Katey Walter, University of Fairbanks. The first results of coupling the lake model to regional atmospheric model are presented.

LakeMIP: the effects of mixing parameterizations and interaction with bottom sediments in a shallow lake

Stepanenko, V.M., A.Martynov, S.Goyette, M.Perroud, X.Fang, K.Jöhnk, D.Mironov and F.Beyrich.

Kossenblatter See is a 2 m deep (mean value) lake 60 km South East of Berlin, Germany. This lake has been chosen for lake model intercomparison for it being a typical representative of many shallow lakes in midlatitudes. Lakes of this size (1-2 km in horizontal scale) remain subgrid in large scale atmospheric models and thus have to be treated by one-dimensional (in vertical) parameterization. A detailed observational study on this lake including both near water surface meteorology and water temperature profiles was performed during the warm season of 2003 by Meteorological Observatory of Lindenberg (German Weather Service). Three k-ε models (Simstrat, LAKEoneD and LAKE) and three models employing simpler vertical mixing schemes (Hostetler's model, FLake and MINLAKE96) were used to hindcast temperature structure and heat balance of the lake. Additionally a bulk model assuming homogeneous temperature profile in a lake and zero heat flux at the bottom was used to test if this simple parameterization could be reasonable for relatively well-mixed Kossenblatter See. Significant differences in the modelled lake stratification as well as in the surface temperature were found comparing k-ε models and the other models. A further significant difference between model simulations occurs in case models taking explicitly into account the heat exchange of the water column with the bottom sediments or not. For the usability of the different models in regional or large scale atmospheric model studies the comparison of simulated heat fluxes to the atmosphere versus observed ones is also discussed.

Can the Baltic Sea be modelled as a fresh or salt water lake?

Frederik Schenk

FLake is used as lake parameterization scheme in the regional climate model COSMO CLM. In a first model setup, the Baltic Sea is implemented as a fresh water lake including a highly resolved bathymetry. In a second model setup, FLake is modified to read in surface salinity concentrations from an external data file to calculate freezing temperature, maximum density and temperature of max. density as a function of salinity of the horizontal fields (Slake). The model skill of both cases is estimated by comparing sea-ice concentrations with observational data and simulations using no FLake for the Baltic Sea.

Developing a new lake model in CCSM: Model Development, Sensitivity, and Effects on Regional and Global Climate

Zachary Subin
University of California, Berkeley / Lawrence Berkeley National Lab

Compared to solid ground, lakes tend to have lower albedo, larger surface heat conductance, and larger effective sub-surface heat capacity. Lake properties can influence both regional and global climate, yet some general circulation models have only a highly simplified treatment of lakes and substantially under-estimate global lake area. Moreover, expansion of thermokarst lakes in the Arctic could induce positive geophysical and biogeochemical feedbacks to climate warming, and a detailed thermal lake model is required to predict fine-scale thermokarst lake dynamics.

We updated the lake model in CCSM4.0 to improve the characterization of lake surface energy fluxes, eddy diffusivity, and convective mixing, and added new snow physics, phase change and ice physics, and soil layers beneath the lake. We are also considering several options for simulating subgrid thermokarst lake dynamics, including modeling an ensemble of lakes of different size categories with dynamic subgrid area. We tested the new lake model against observations for a dozen lakes with diverse geometries and climates, and compared to predictions of the old lake model at several of these sites. Unlike the old lake model, thermal predictions from the new lake model match the vertical and seasonal patterns in observed lake water temperature for all lakes, with typical errors of about 3 K.

We performed sensitivity experiments to estimate the effect of modeled lake properties and processes on the predicted surface fluxes when forced with historical atmospheric reanalysis data. The modeled lake depth, optical properties, snow properties, and inclusion of phase change physics all have significant impacts on predictions of seasonal and regional surface fluxes; differences in seasonal latent heat flux compared to the new lake model were as large as 100 W m^{-2}. Coupling the lake model into a regional climate model (WRF3-CLM3.5) altered surface air temperatures in the Great Lakes region by 1-3 K, either improving or worsening the model bias compared to observations, depending on the season. We tested the sensitivity of the coupled global climate to the new lake model in CCSM4.0 and to the effect of increasing the lake area to a more realistic value. Canada and Northern Europe experienced broad summer cooling of about 1K, and changing atmospheric transport caused significant changes in remote areas. We conclude that global climate model predictions would benefit from a more realistic representation of lakes.

Observational data: Use and misuse

Arkady Terzhevik

A thermodynamic model of Finish lake ice

Yu Yang

Freshwater ice plays an important role in physical, geochemical and biological process in cold-regions lakes. This study employs a one-dimensional thermodynamic snow/ice model (HIGHTSI) to simulate the freshwater ice thickness in lake Vanajavesi in Finland. The model forcing was based on weather station data. Comparison with the field thickness measurements showed good agreement between the modelled and observed results.