Notes on final discussion of the

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

SMHI, Norrköping, September 15-17 2010

Seven topics for discussion and formulation of the workshop proposals were raised in the final discussion at 17 September 2010:

1. **Publication**
2. **Lake data base – suggestions**
3. **Lake initialisation & assimilation**
4. **Physical parameterizations**
5. **Beyond physics**
6. **LakeMIP – continuation**
7. **Next workshop**

1. Publication

As a first response 15 people indicated that they are interested to contribute to a new lake special issue. The first special issue was published in the journal Boreal Environment Research (http://www.borenv.net/). However, it was considered to be quite expensive although it has the advantage to be fully open access. To alternative journals were mentioned:

- Tellus A (http://www.wiley.com/bw/journal.asp?ref=0280-6495)
- JAMES: Journal of Advances in Modeling Earth Systems (http://adv-model-earth-syst.org/)

The organisation committee will investigate these two alternatives further.

2. Lake data base – suggestions

The great work by Ekatherina Kourzeneva for her development of the lake data base was acknowledged at the Workshop. An initial documentation is already available as ALADIN Newsletter No 37 (http://www.cnrm.meteo.fr/aladin/IMG/pdf/FULL-3.pdf).

New ideas and suggestions on further improvement that were discussed are

- An uncertainty was raised if areas with many small lakes are correctly represented in physiographic data bases. Should be checked.
- Specific bathymetry exists already for some large/deep lakes but the data base needs to be updated with bathymetry for more such lakes. Such information could be available from e.g. navigation maps.
- Certain artefacts have been identified and corrected for in ECOCLIMAP. Examples on artefacts are missing islands in big lakes, missing water fraction where lakes evidently exists and ill defined coast lines. Artefacts are still present in ECOCLIMAP and certainly in similar physiographic data bases. Thus, more work is needed to eliminate these.
- Work is still needed on how to divide rivers from lakes and coastal lagoons.
- The importance of a correct value of the lake extinction coefficient was raised in many presentations. Therefore, inclusion of extinction coefficient values in the data base would be very valuable. However, the difficulty on how to estimate such values was discussed as very few insitu observations exists. One possibility may be to combine remote sensing estimates of extinction coefficient (see presentation by Miguel Potes) with modelling of extinction coefficient (see presentation by Sergei Golosov).
- For many lakes in the boreal areas where lake depth information is still missing it may be possible to combine lake location with knowledge of geomorphological conditions for at least some rough estimates of lake depth. Master work on this issue is ongoing at RSHU, St Petersburg.
- More information on lake depth is needed from these regions/countries: South America, North America, … People with knowledge on who to contact in these regions are encouraged to inform Ekatherina about this.
- Should wetland characteristics be part of the lake data base?
- Including a flag in the data base indicating if a lake is saline or fresh water can be useful for how it should be treated in a modelling system.
- How should maintenance of data base and software be organised? For our modelling community it is important that such maintenance is secured and formally structured. Presently the data base and software is available at http://lakemodel.net.

Ekatherina is asked by the Workshop to make a priority list of these topics along with an estimate of man-months needed. This list should be forwarded to the theme on Surface and soil processes under SRNWP (Short-Range Numerical Weather Prediction Programme).
How continuous development of data base and software should be financially supported is at the moment an open question.

3. Lake initialisation & assimilation

Climatology database for cold start/initialisation is created by, and available from,

- Ekatherina Kourzeneva who forced FLake offline by data from GSWP2 (Global Soil Wetness Project) for a 20 year period on 1° resolution for different classes of the lake depth and with 10-day representation of the annual cycle.

- Gianpaolo Balsamo and Rui Salgadowho who forced FLake-HTESSEL offline by data from ERA-INTERIM for a 20 year period on 80 km resolution (LAKEPLANET setup).

Both these climatologies need documentation in form technical reports.

For initial tests with assimilation of lakes in NWP models it was suggested to start with already available observations (surface temperature and ice) based on MODIS data and utilize new data when they become available. E.g. from North Hydrology project (see presentation by Claude Duguay) remote sensing products on high resolution will be available (e.g. lake surface temperature, ice cover, ice on/off time). The Workshop requested a list of already available information and a list of data that can be expected in the future (including a tentative time schedule).

Regarding assimilation methods the Workshop concluded that the following issues must be considered:
- Consistency between the (FLake, ISBA etc) parametrizations inside lake, in ice and snow and data assimilation of the lake surface state: water surface temperature and ice fraction (to the knowledge of the workshop, ice and snow thickness are presently not assimilated in any of the atmospheric models). A possible first step towards lake data assimilation, an approach of "peaceful coexistence" between FLake parametrizations and optimal interpolation analysis was discussed in the presentation by Laura Rontu et al. In this approach, FLake provides a first guess for the data assimilation but the analysis does not influence the evolution of the prognostic lake variables.
- A unified system of data assimilation of the lake surface state and in-lake variables should be the next step, which would require variational or Kalman-filter type approaches. To the knowledge of the workshop, applications for projects for this kind of work have been made in Meteo France and in Finnish Meteorological Institutes, but no work is yet ongoing.
- Development of the method of spatialisation. Normally, optimal interpolation (or the method of successive corrections) is applied for SST and also lake surface state data assimilation. For lakes, spread of information from one lake to another is, strictly speaking, incorrect.
- Questions of quality control and representativeness of the observations. Quality control is done by comparing neighbouring observations with each other and with the first guess provided by previous forecasts. As different types of observations and "observations" (climatology based) may enter in the beginning and during the forecast cycles, determination of corresponding weights for them and the forecast fields is necessary, requiring further development and testing.
- Consistency between the surface and upper air analysis, between lake and sea surface state analysis should be born in mind.

These data assimilation issues should also be forwarded to SRNWP theme on Surface and soil processes.

4. Physical parameterizations

General issues:

- The roughness length used for momentum/heat for water/snow/ice could be an issue in some lake simulation studies which could be important to investigate and understand further. Here, direct flux observations would be useful (see presentation by Annika Nordbo as well as upcoming paper by Nordbo et al. in Journal of Geophysical research "Long-term energy flux measurements and energy balance over a small boreal lake using eddy covariance technique").
- The questions was raised how important it is to consider fractional ice in 1D lake modelling.
- Questions on how to treat ponds/slush on ice/snow were raised and how important such processes are for lakes in NWP and climate simulations.

FLake specific issues:

- The Workshop would like to see better performance of FLake for deep lakes. A presentation by Georgiy Kirillin with title "Treatment of the density stratification in the FLake model" (see list of abstracts) looked promising with respect to this issue but unfortunately Georgiy could not make it to the Workshop. Patrick Samuelsson contact Georgiy to ask him if he could provide a report with his ideas.
- Based on presentations by Frederik Schenk and Gianpaolo Balsamo who applied FLake for sea areas the idea was raised to make an extension of FLake appropriate for upper ocean conditions (e.g. include the effect of salinity). This is comparable to the 1D ocean layer model as part of SURFEX (Gaspar et al., 1990).
- The recommendation by Dmitrii is to run FLake with the snow module switched off since it has not been thoroughly tested. However, this situation is not satisfactory since the insulation of snow has an impact on ice growth and on the surface fluxes. Tido Semmler at Met Éireann made some tests and modifications of the FLake snow routine for the HIRLAM community. He and Laura Rontu wrote a report on the tests: "Sensitivity studies on the parametrisation of snow on lake ice in the SURFEX model". The report is available on request from Tido Semmler (tido.semmler@met.ie).
- It is not necessarily so that the best representation of a lake depth for FLake is the mean depth of the lake. Depending on available depth information one could consider e.g. a combination of mean and maximum depth or some depth based on a PDF of lake bathymetry information.
- It would be useful with some evaluation of simulated bottom fluxes in FLake.
- The need for fractional ice in FLake was raised.

5. **Beyond physics**
   - Oxygen model as part of Flake is being developed. Is there an interest in the NWP / climate community for this? Cold start issue**.**
   - Inclusion of biochemistry processes in lake models as part of NWP systems can increase the number of products to NWP end users (offline and online).
   - Biochemistry lake processes as part of NWP and climate models could be introduced via e.g. SURFEX which already includes FLake as lake componenet.
   - Modelled extinction coefficient which is connected to nutrient load connected to watershed modelling.

6. **LakeMIP**

LakeMIP1:

Experimentalists or owners of in situ data on lake sites (meteorological, hydrological characteristics, eddy covariance measurements) expressed an interest to provide their data for LakeMIP. There are the following sites:

1. Valkea-Kotinen lake (Finland, data provided by Annika Nordbo)
2. Thou lagoon (South of France, data provided by Patrick LeMoigne)
3. Great Slave Lake (Canada, data provided by Patrick LeMoigne)
4. Alqueva reservoir (Portugal, data provided by Rui Salgado)

This makes possible first to verify the previously obtained results of lake models' capabilities and limitations on similar water bodies (Valkea-Kotinen lake is similar in terms of depth and turbidity to Kossenblatter See, studied in LakeMIP before) and second to assess ability of lake models to simulate very large lakes (Great Slave Lake).

The version of Hostetler model from Community Land Model will be now validated in LakeMIP along with other models (ran by Zack Subin, California).

Sensitivity of lake models' performance to initial and external parameters (depth, transparency, T profile, etc.), given there will always be inaccuracy in lake parameters provided by datasets.

More attention to surface flux parameterization!!!

GENERAL RECOMMENDATION TO ALL LAKE MODEL / LAKE DATABASE DEVELOPERS:
FIX model/database versions ("Lake depth database 1.1.2, Flake 2.3.4") and keep old versions available for backward compatibility!
REGULAR (SCHEDULED) model/database updates: otherwise, difficult to follow.

LakeMIP2:

LakeMIP2 is intended to study the lake impact on lower troposphere dynamics in coupled models (NWP or climate models including lake models in their surface schemes). The motivation for intercomparison between coupled models is that during workshop there were identified somewhat contradictory results on lakes' impact on the lower atmosphere dynamics, obtained by different atmospheric models. This can be attributed to different atmosphere-surface coupling algorithms, including subgrid tiling

implementation and surface turbulent flux schemes. These contradictions were obtained in coupled models using the same lake model (FLake), however, it is natural to expect an additional source of uncertainty in surface layer meteorology if different lake models are used.

To simplify the coupled model intercomparison: use existing RCM MIP domain settings (e.g. ENSEMBLES and CORDEX) for RCM configuration and boundary forcing (data assimilation issue – climate models first?) or using an “ensemble” of RCMs. The coupled models should use the same lake database version by Ekatherina Kourzeneva.

Gianpaolo Balsamo proposed an idea of "constructing" a network of in situ measurements on lakes, similar to FLUXNET, that could be used in NWP and climate model validation. We already have several lake sites in Europe that are ready to provide data (those mentioned above + probably F.Beyrich with Kossenblattrer data), and Gianpaolo proposed to form a common protocol and data format convections for representing these digital data to be conveniently assimilated in atmospheric models.

Potential participants of LakeMIP2. An initial list was created, including developers of surface schemes in NWP and climate models. Inform us on your interest by E-mails to Andrey Martynov (andrey.martynov@uqam.ca) and Victor Stepanenko (vstepanenkomeister@gmail.com).

General discussion on project scope will be arranged by Emails, etc.

Organizational issues:

A short document, describing the project scope, have to be prepared.
Formal recognition and financial issues need to be worked on.
A proposal for COST project could be a good step for start up, since it allows involving non-EU states (Canada, Russia, USA, Australia).

Results of the project should include, besides scientific conclusions, detailed recommendations for lake models and coupled models developers. First internal reports to LakeMIP members, then official publications?

Making LakeMIP known – participation in conferences, mentioning everywhere, possibly applying for sessions at AGU and EGU.

7. **Next workshop**
   Next Workshop may be organised in Finland in 2012.