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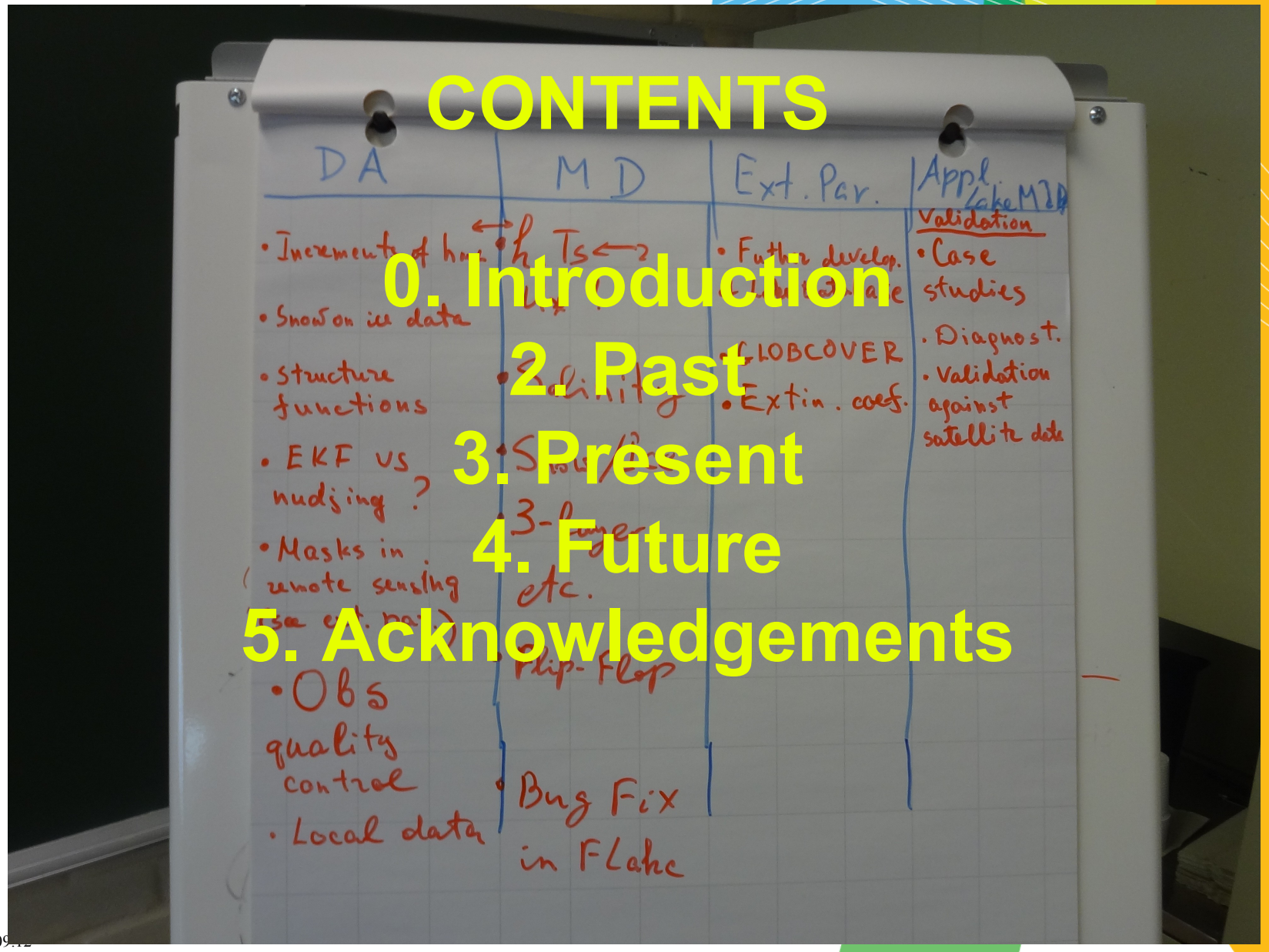
Parameterization of Lakes in Numerical Weather Prediction models

Dmitri Mironov, Laura Rontu, Ekaterina Kurzeneva
& 26 participants of the Lake12 workshop

SRNWP-EWGLAM meeting
Helsinki 8-11 October 2012

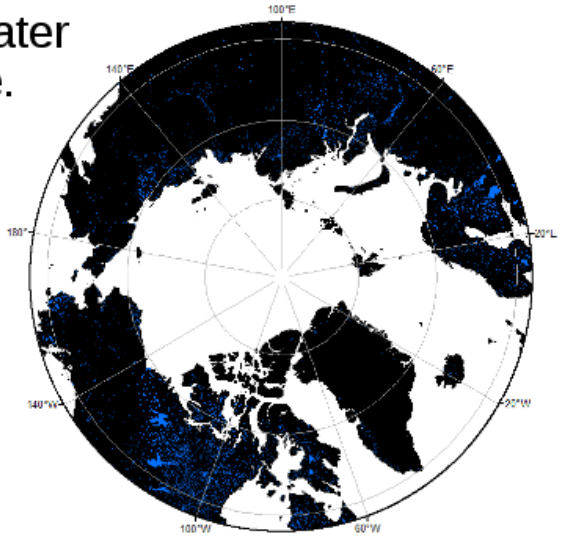
CONTENTS



INTRODUCTION

Lakes in regional weather and climate

- Consideration of lake-atmosphere interactions is an important issue in climate modeling and numerical weather prediction (NWP).
- Lakes have an important role in the surface radiation balance, heat and water vapor exchanges with the atmosphere.
- The presence (or absence) of ice cover on lakes in winter has an effect on the surrounding climate.
- Earlier/later freeze-up and break-up results in ice cover duration change, and this strongly influences the radiation and energy balance.



A good representation of lake ice/temperature-atmosphere interactions is necessary to improve weather forecasting and climate modelling

Slide from the presentation by Homa Kheyrollahpour in Lake12

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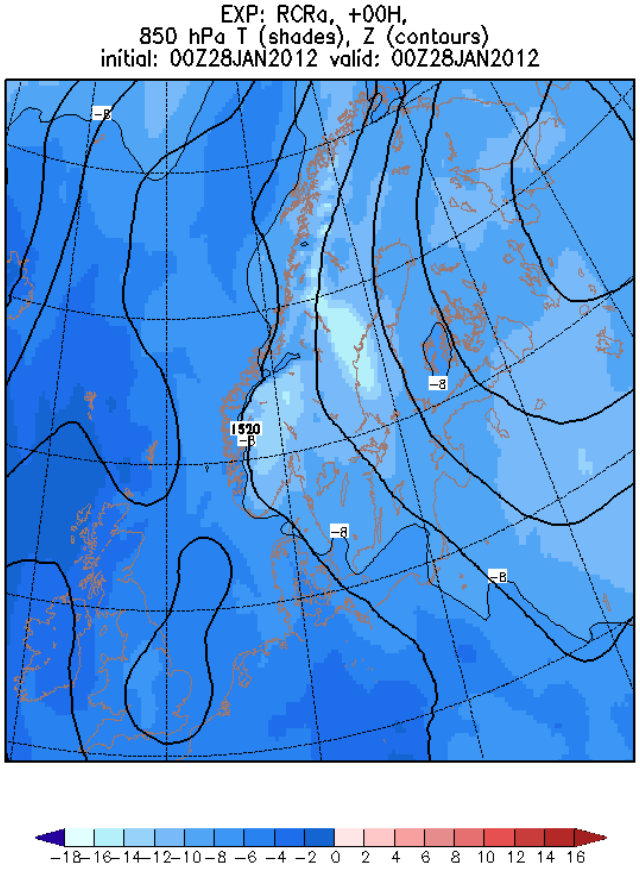
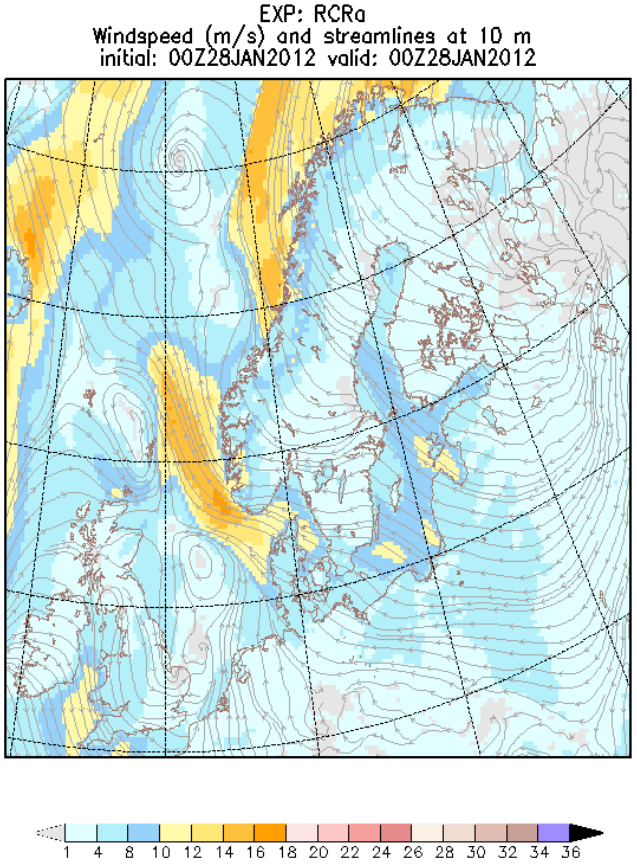
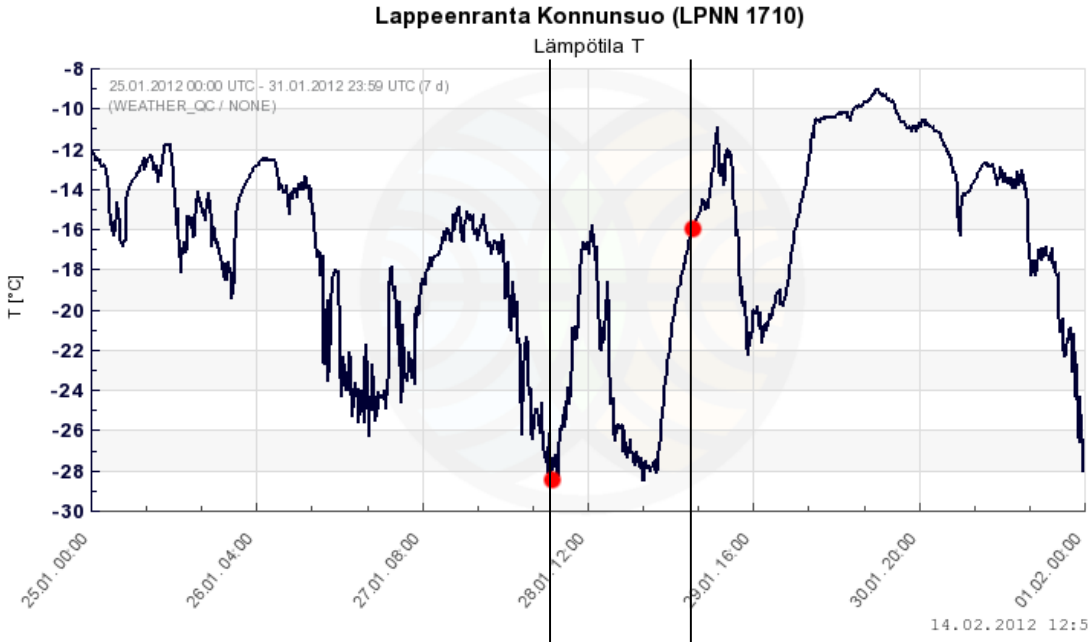
INTRODUCTION

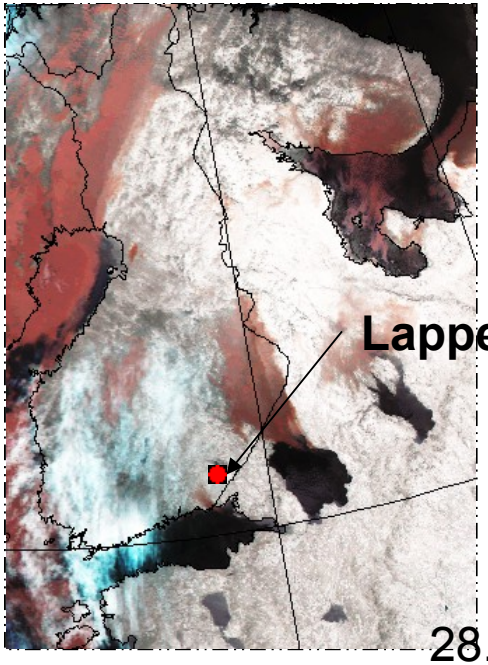
Why to parametrise the lake processes in NWP models?





Example of freezing Ladoga from the presentation by Kalle Eerola in the 3rd Lake workshop





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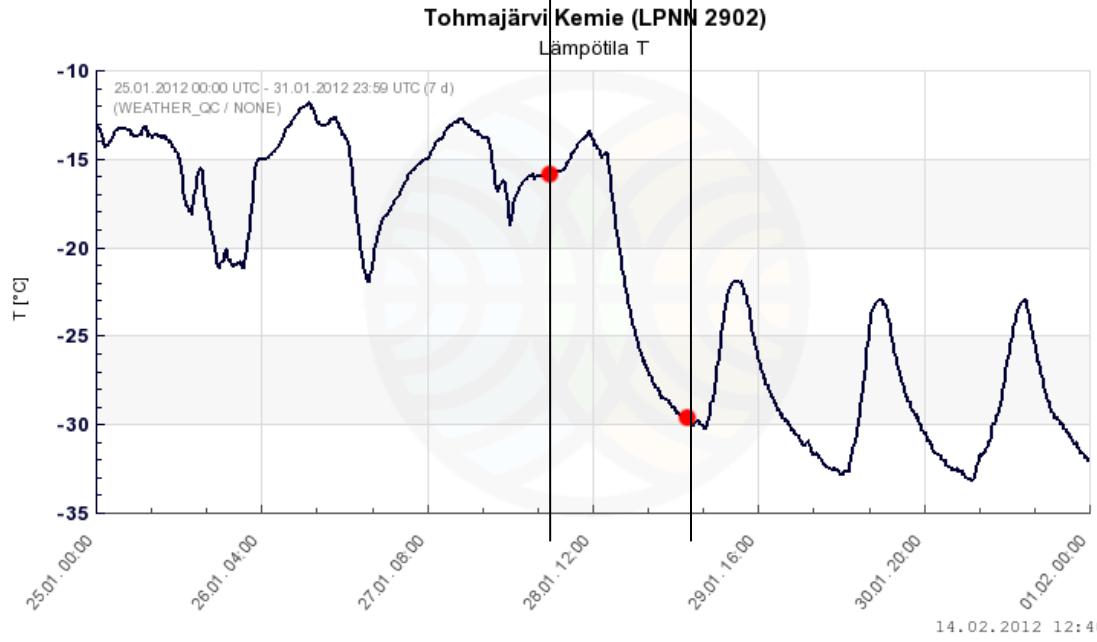

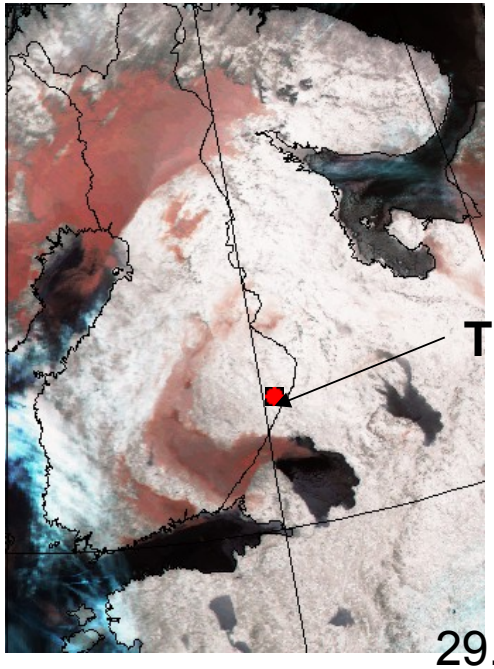

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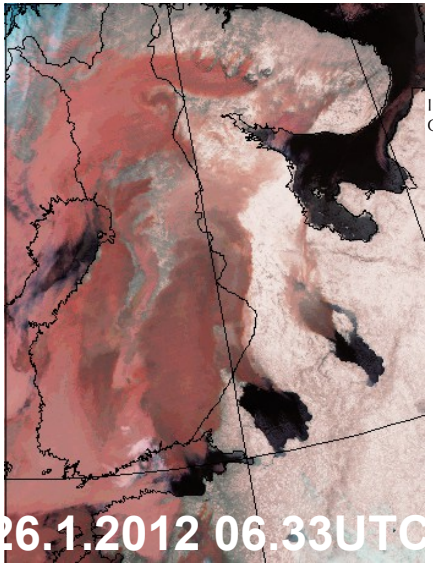
NOAA AVHRR



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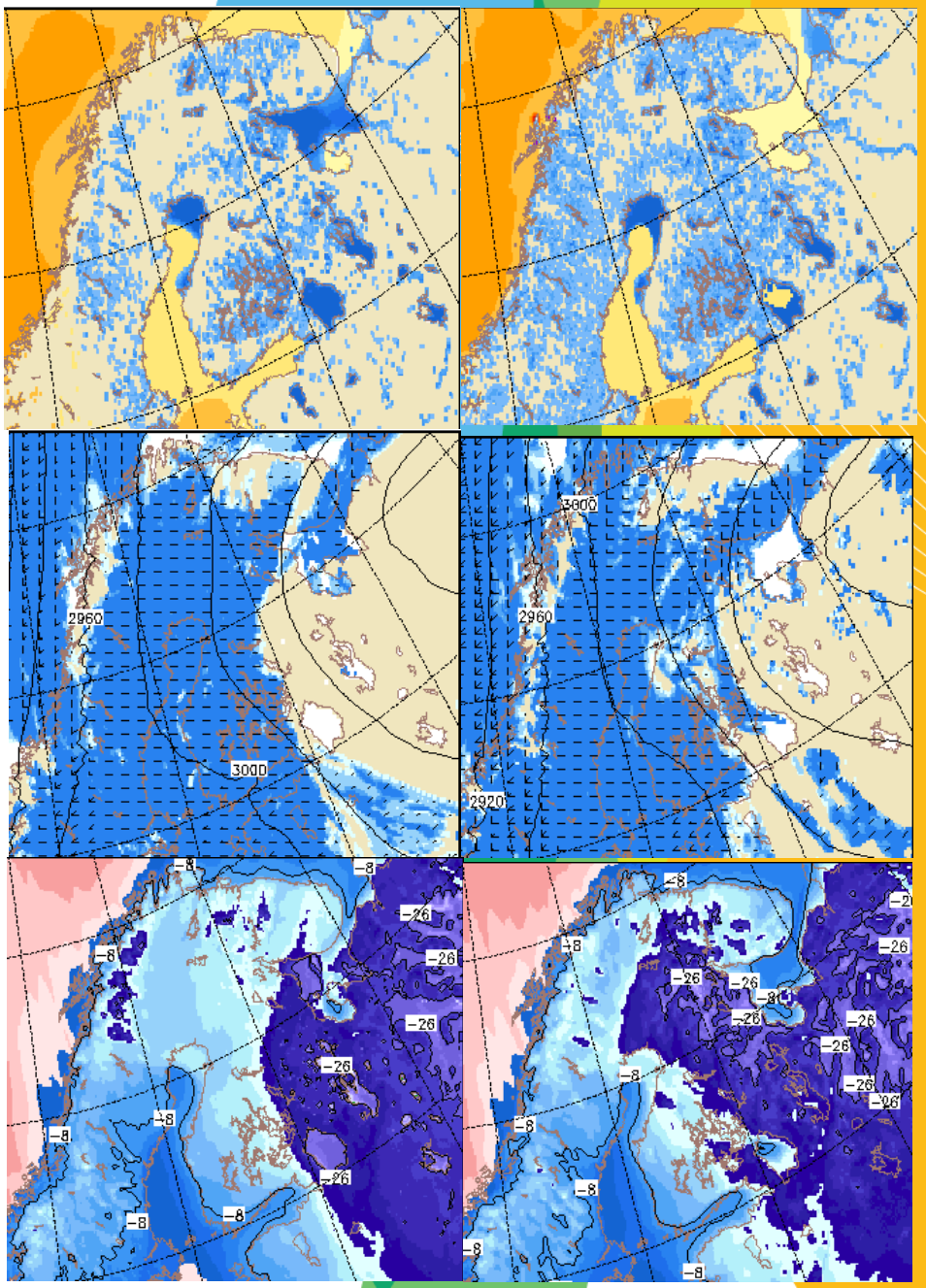

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PAST

Three workshops on parametrisation of lakes in NWP and climate modelling

2008 Zelenogorsk, http://netfam.fmi.fi/Lake08

2010 Norrköping, http://netfam.fmi.fi/Lake10

2012 Helsinki, http://muscaten.ut.ee/Lake12

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Prognostic parametrisations

Assimilation of lake observations

Description of lake physiographic properties

Lake model intercomparison

Applications

Third Workshop on http://muscaten.ut.ee/Lake12

Parameterization of Lakes in Numerical Weather Prediction and Climate Modelling

Finnish Meteorological Insitute, Helsinki, September 18-20 2012

Home
Programme
Committee
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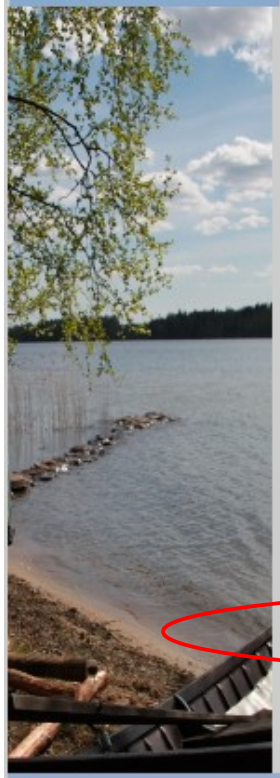
Links



Thank you for participation! Please find the presentations in pdf linked to the programme. We will find out later how to make the Centra recordings available via this page. The draft of discussion notes can be downloaded as pdf. 24.9.2012

Participants on the roof of FMI 20 September. Photo: Markku Kangas.

The third workshop on "Parameterization of Lakes in Numerical Weather Prediction and Climate Modelling" was arranged in Helsinki on September 18-20, 2012.

The aim of the workshop is to discuss and develop the methods of handling lakes in the numerical weather prediction (NWP) and climate models. Attention is paid to the prognostic parametrisations, assimilation of lake observations, description of lake physiographic properties in the models. The Helsinki workshop continues the work started in the previous workshops in Zelenogorsk, 2008, results published in a special issue (No 2, Vol. 15) of Boreal Environment Research and Norrköping, 2010, material to be published in special lake issue of Tellus A in 2012

Home - Programme - Committee - Venue - Accommodation - Travel - Participate - Links

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Two special open access journal issues on lakes

Boreal Environment Research, 2010, No 2, Vol. 15

Tellus A, 2012, Thematic cluster

Thematic cluster - Parameterization of lakes in numerical weather prediction and climate models

Parameterisation of sea and lake ice in numerical weather prediction models of the German Weather Service PDF HTML EPUB XML
Dmitrii Mironov, Bodo Ritter, Jan-Peter Schulz, Michael Buchhold, Martin Lange, Ekaterina Machulskaya

Simulation of surface temperature and ice cover of large northern lakes with 1-D models: a comparison with MODIS satellite data and in situ measurements PDF HTML EPUB XML
H. Kheyrollah Pour, C. Duguay, A. Martynov, L. C. Brown

Data assimilation and parametrisation of lakes in HIRLAM PDF HTML EPUB XML
Laura Rontu, Kalle Eerola, Ekaterina Kourzeneva, Bertel Vehviläinen

Snow and ice on Bear Lake (Alaska) – sensitivity experiments with two lake ice models PDF HTML EPUB XML
Tido Semmler, Bin Cheng, Yu Yang, Laura Rontu

Climate data for parameterisation of lakes in Numerical Weather Prediction models PDF HTML EPUB XML
Ekaterina Kourzeneva, Eric Martin, Yurii Batrak, Patrick Le Moigne

On the contribution of lakes in predicting near-surface temperature in a global weather forecasting model PDF HTML EPUB XML
G. Balsamo, R. Salgado, E. Dutra, S. Boussetta, T. Stockdale, M. Potes

Climate change impact on thermal and oxygen regime of shallow lakes PDF HTML EPUB XML
Sergey Golosov, Arkady Terzhevik, Ilia Zverev, Georgiy Kirillin, Cristof Engelhardt

Global gridded dataset of lake coverage and lake depth for use in numerical weather prediction and climate modelling PDF HTML EPUB XML
Ekaterina Kourzeneva, Hermann Asensio, Eric Martin, Stephanie Faroux

Boreal lakes moderate seasonal and diurnal temperature variation and perturb atmospheric circulation: analyses in the Community Earth System Model 1 (CESM1) PDF HTML EPUB XML
Zachary M. Subin, Lisa N. Murphy, Fuyu Li, Céline Bonfils, William J. Riley

Interactive lakes in the Canadian Regional Climate Model, version 5: the role of lakes in the regional climate of North America PDF HTML EPUB XML
Andrey Martynov, Laxmi Sushama, René Laprise, Katja Winger, Bernard Dugas

Numerical modelling of snow and ice thicknesses in Lake Vanajavesi, Finland PDF HTML EPUB XML
Yu Yang, Matti Leppäranta, Bin Cheng, Zhijun Li

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FLake Freshwater Lake Model

applied as parametrisation scheme in several European and Canadian NWP and climate models

- common platform for development

	Component	ALADIN	COSMO	HIRLAM	UM/JULES	ECMWF
Developing	Snow model	depths) – liquid water in snow pack as an additional prognostic variable	Multi-layer – liquid water in snow pack as additional prognostic variable	Three-layer snow scheme	snow mass, snow density; liquid water in snow pack, dynamic snow layer depths	albedo revision and rainfall interception in the snow pack
	Lake model	bulk fresh water lake model (Flake)	None	FLake in SURFEX/ HARMONIE	FLake coupled via surface fluxes	bulk fresh water lake model (FLake)
	Sea-ice	Sea-ice model	None	Sea-ice model with snow on top	Multi-layer thermodynamics with	None
Present	Snow model	One layer – prognostic variables : snow water equivalent, snow density, snow albedo	One layer - prognostic variables : snow temperature, snow water equivalent, snow density, snow albedo	balance for snow pack and snow interception reservoir (HIRLAM) one layer no separate every budget (HARMONIE)	Zero layer (uses top soil layer) – snow depth, albedo interception on needleleaf trees	One layer – prognostic variable : snow water equivalent, snow albedo. Revised snow density and diagnostic liquid water storage
	Lake model	Prescribed surface temperature (analysis)	FLake	FLake (HIRLAM) and prescribed LST (HARMONIE)	Saturated soil or high thermal inertia	Prescribed surface temperature (analysis)

Background from the SRNWP surface expert group tables (tables under development)

FLake Freshwater Lake Model

is used operationally at the German Weather Service:

since 15 December 2010 Flake within COSMO-EU configuration (ca. 7 km mesh size) of the limited-area NWP model COSMO model,

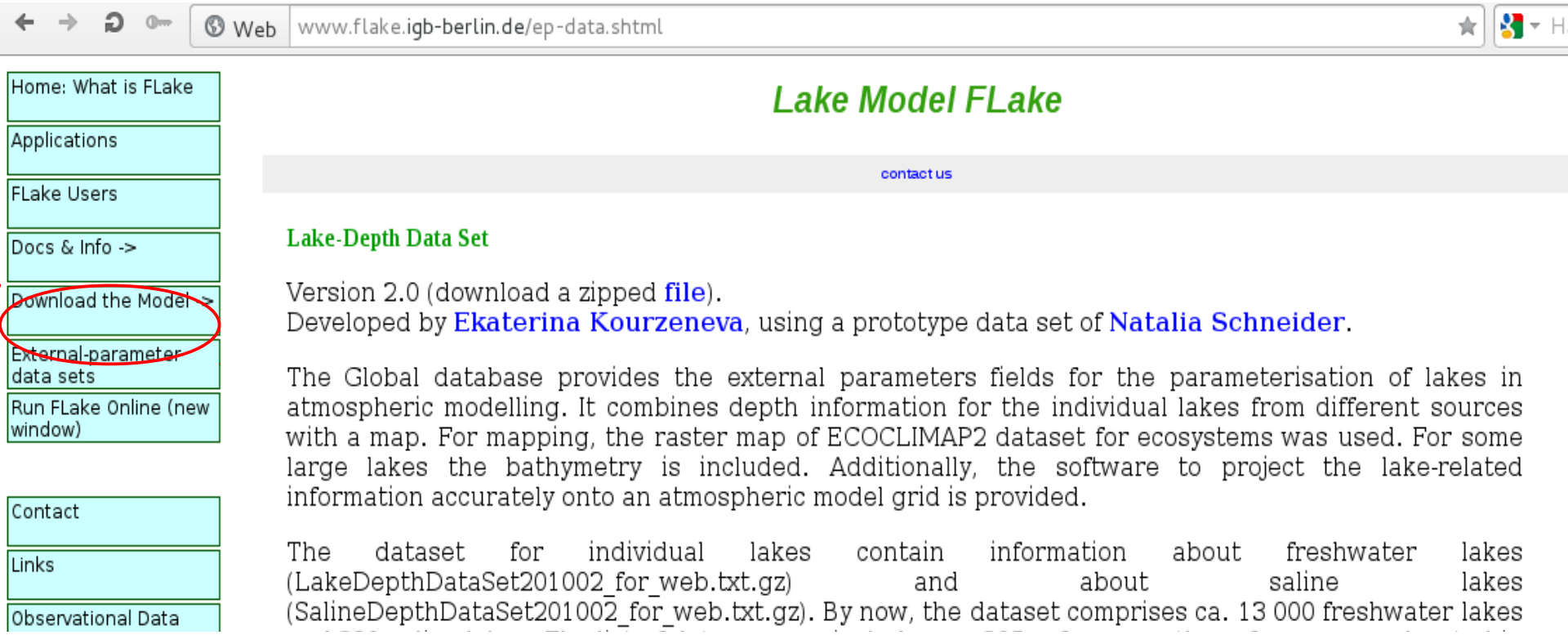
and since 1 April 2012 within COSMO-DE configuration (ca. 2.8 km mesh size).

It seems that FLake within COSMO is the first successful attempt to use a prognostic lake model (parameterization scheme) in operational (!) NWP practice.

Lake description

Global lake depth data base

Available at http://www.flake.igb-berlin.de/ep-data.shtml



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LAKEMIP (LAKE MODEL INTERCOMPARISON PROJECT)

University of Geneva > Climate Research > LakeMIP > Experimental setup

Lake Model Intercomparison Project - LakeMIP

http://www.unige.ch/climate/lakemip/

- Lake models
- Case studies
- Experimental setup
- Intercomparison
- Results
- Other lake modelling communities
- Contacts
- Intranet

MODEL EXPERIMENTS

The setup of model experiments should eliminate model discrepancies due to any source except the model physics. That means the initial and boundary condition at the lake-atmosphere interface must be the same for all models. In order to ensure this, and unifying some other setup parameters, the following conditions will be provided:

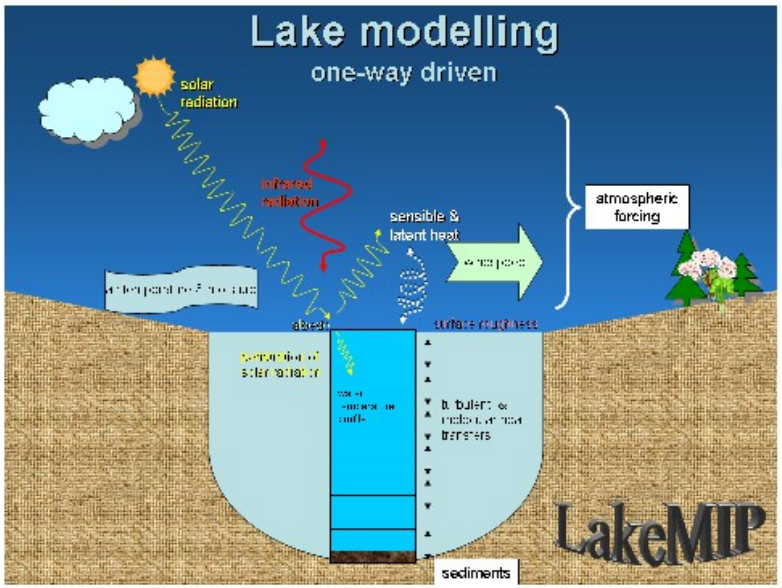
1) All models will use the same scheme for the computations of sensible, latent heat and momentum fluxes [illegible] parameterization of water surface roughness parameter and the usual scaling of the atmospheric forcing level.

2) the surface radiation parameters (shortwave and longwave albedos, longwave emissivity for water, ice and snow) will be identical

3) The initial profiles of temperature and other common variables of lake models will be provided by observations, if they exist; otherwise, the initial lake state will be generated individually by every model during the spinup

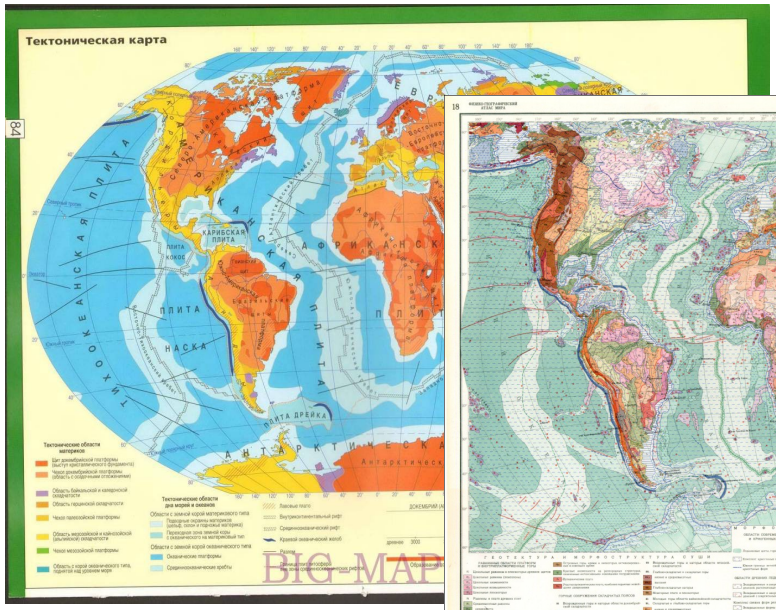
4) The unique lake depth for all models will be the depth in the point of observations

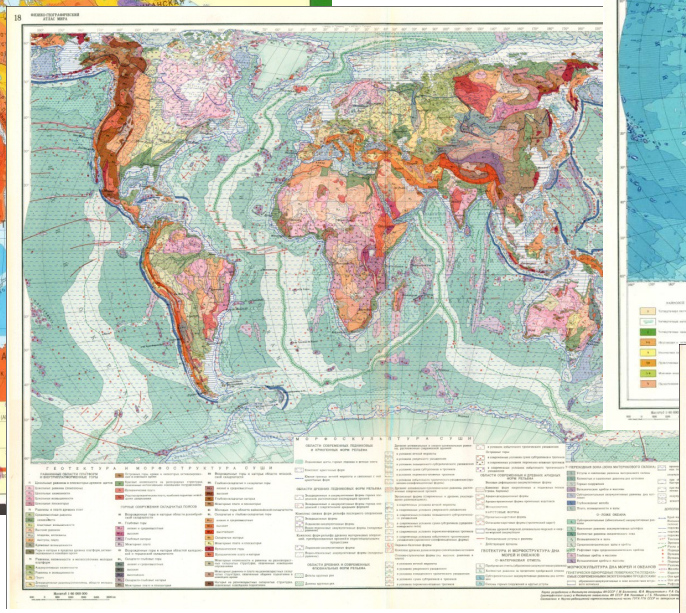
5) The strategy on vertical resolution of 1D models must be discussed

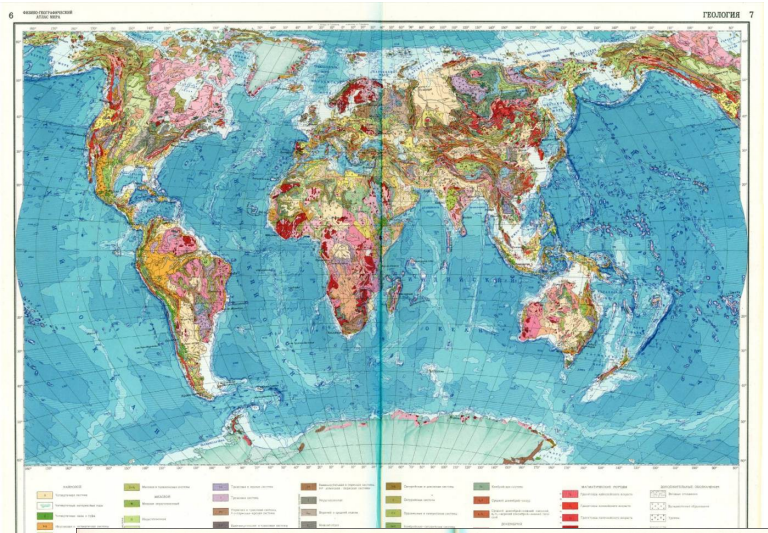


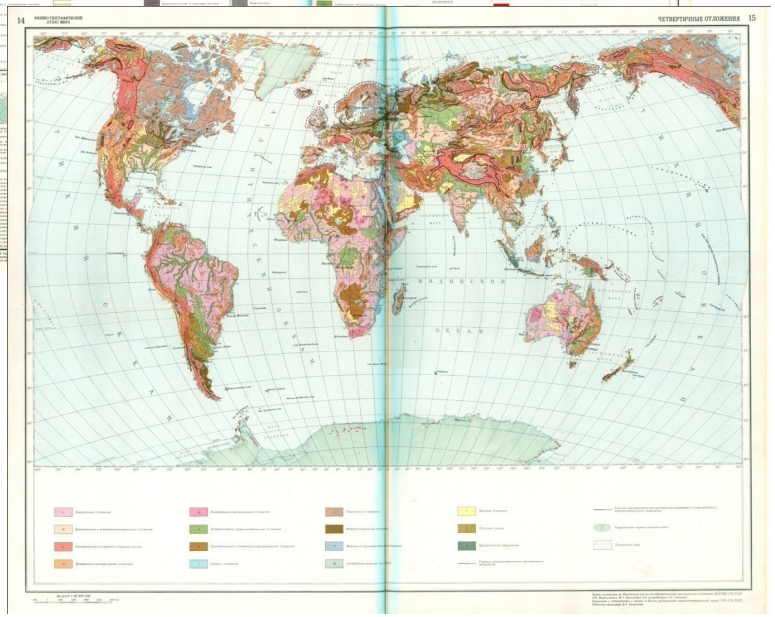
PRESENT

Further development and maintenance of the global lake depth data base









Tectonic map of the world

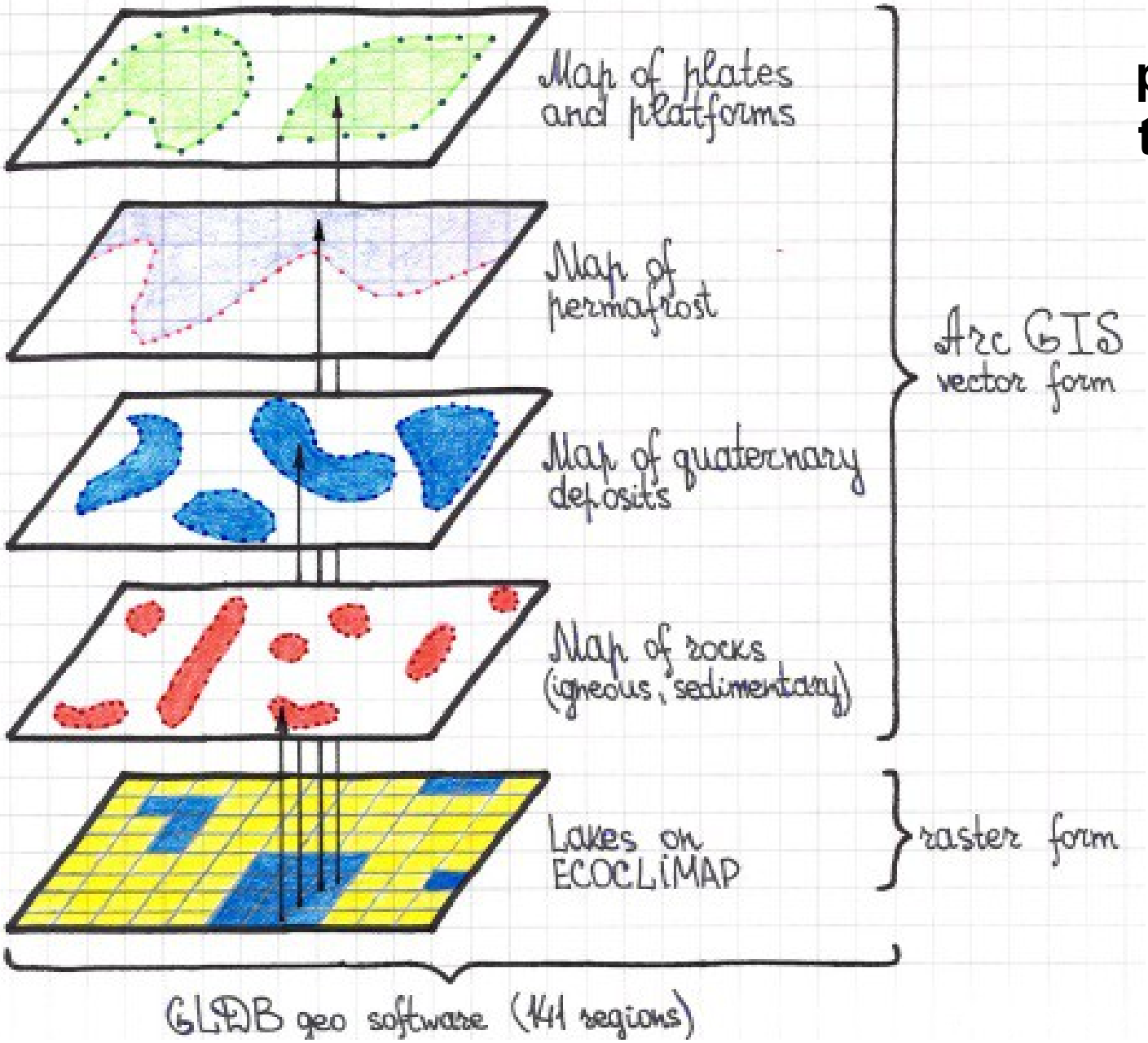
Geo-morphological map of the world

Actual geological map of the world

World map of quaternary deposits

From slides by Margarita Choulga in Lake12

Automatic processing of the materials



Gridded lake climatology

is needed for the Cold Start of any operational NWP model coupled with a lake model

CliLake1:

model lake climatology from off-line runs of FLake

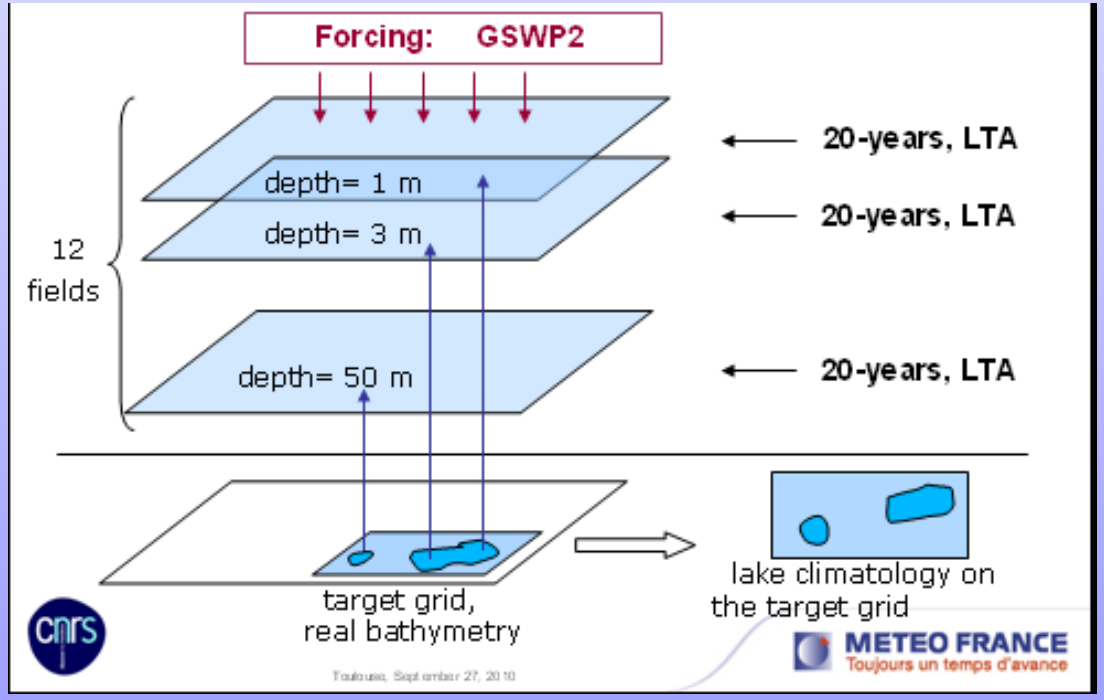
20 year global runs

with a resolution of 1^0

12 different depths

Annual cycle with resolution of 10 days

Serious **errors in spring** - corrected in **CliLake2,** version to be released



Slide based on the presentation by Yuri Batrak & Ekaterina Kurzeneva in Lake12

PRESENT

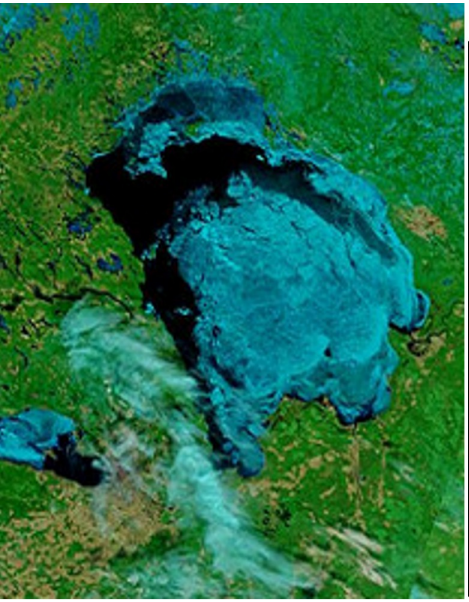
Development of data assimilation for lakes

Optimal interpolation of in-situ and remote sensing observations

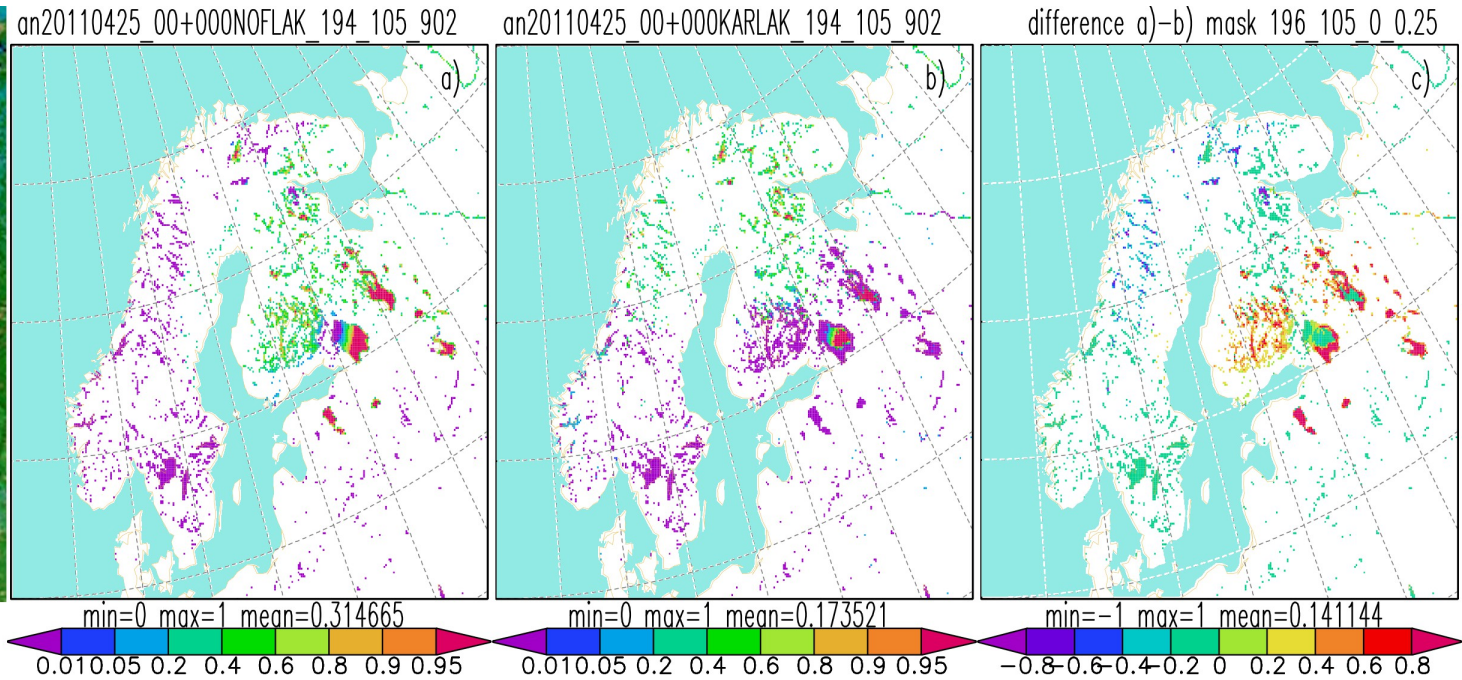
Assimilation of lake observations into the lake model and parametrisations using extended Kalman filter or nudging

Several presentations in the Lake12 workshop

Optimal interpolation of lake observations for independent analysis of LWST / ice cover



MODIS Terra thermal image
25th April 2011



Example of a different analysis due to different background (climate or Flake)

HIRLAM

»

Figure from presentation by Homa Kheyrollahpour in Lake12

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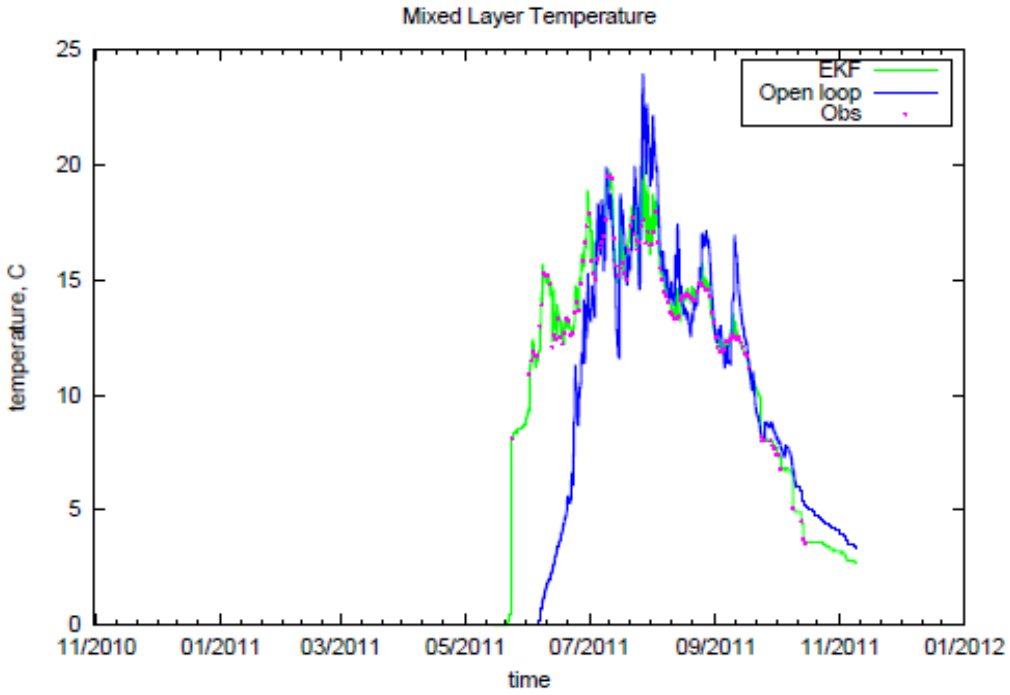
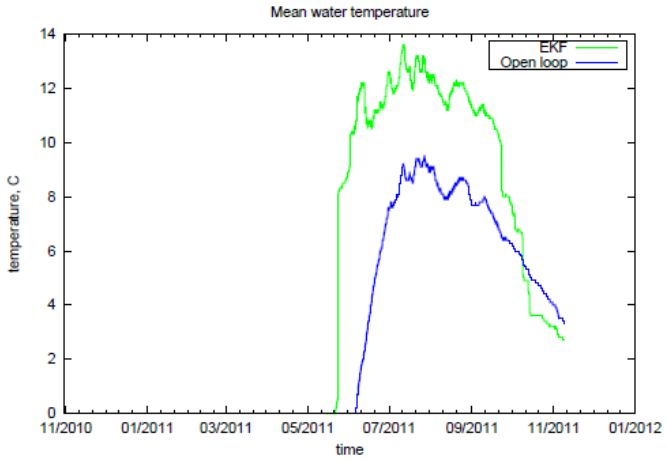
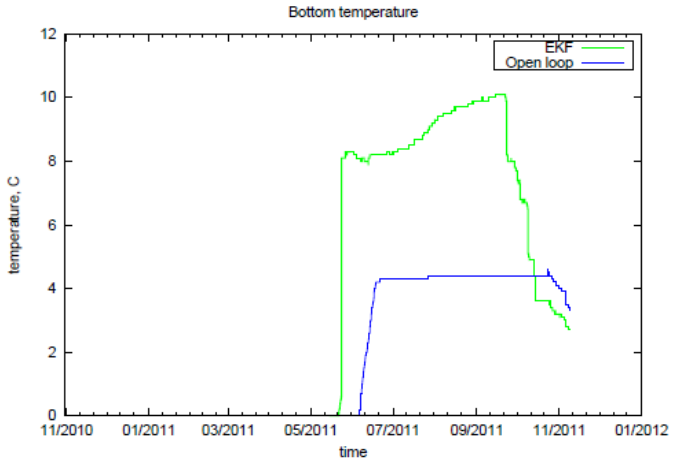
Assimilation of SYKE obs

Lake Inari, mean depth 14m

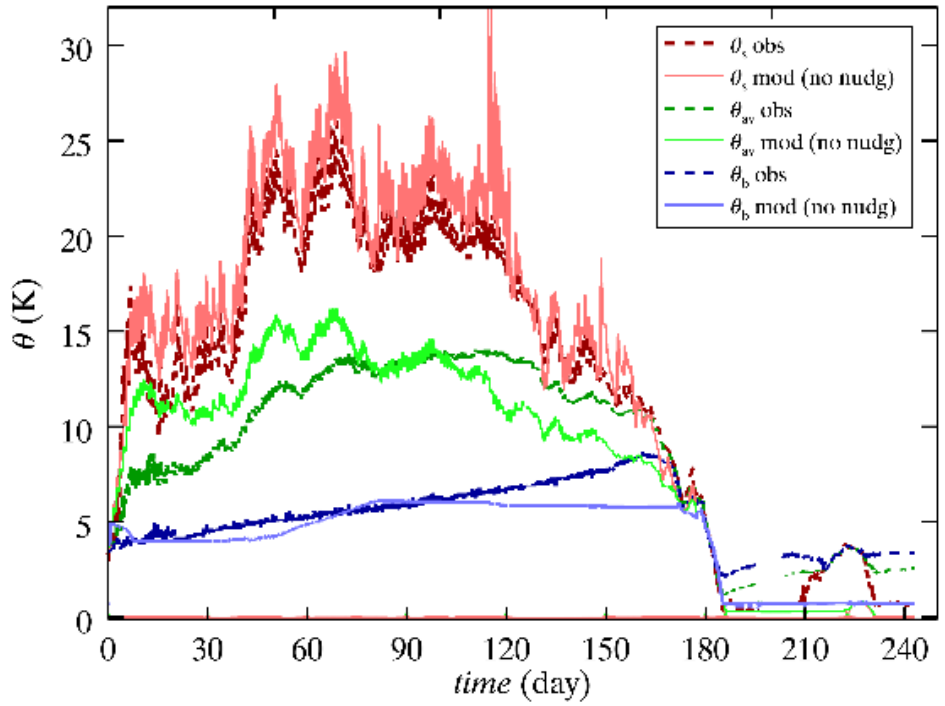




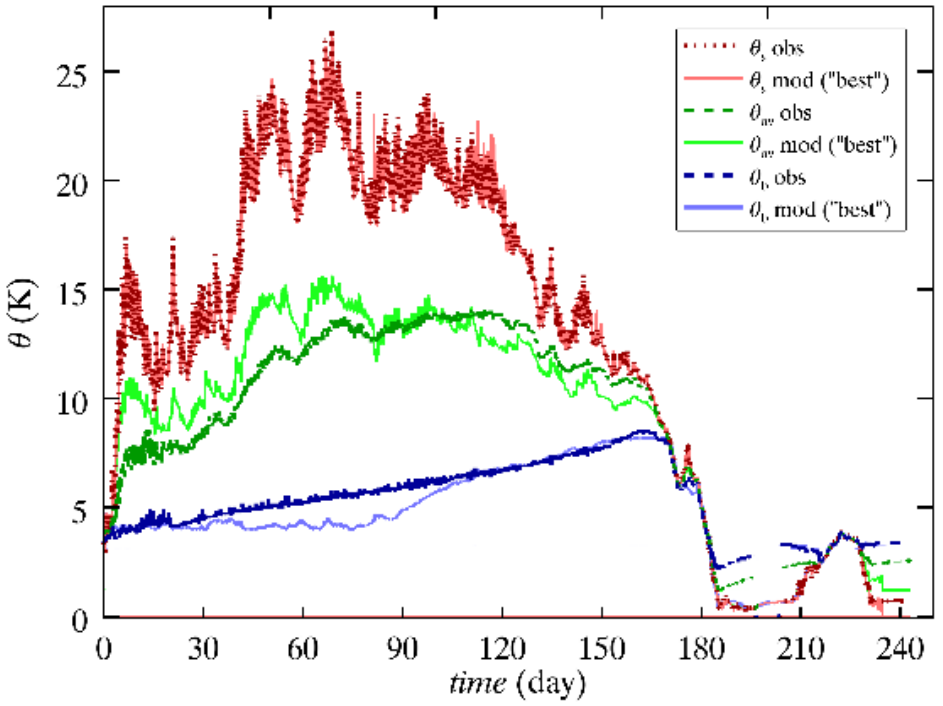


From the presentation by Ekaterina Kurzeneva in Lake12

Lake Valkea-Kotinen: effect of assimilation (nudging) of water-surface temperature data



no nudging



with nudging

Mixed-layer temperature (red), mean temperature of the water column (green) and bottom temperature (blue) in Lake Valkea-Kotinen over the period from 2 May to 31 December 2006. Dotted curves show observational data. Solid curves are computed by FLake: left panel – no nudging, right panel – with nudging, using "best choice" values of the relative weights α_{av}, α_b, α_c and α_h.

Slide from presentation by Dmitri Mironov in Lake12

PRESENT

Applications of lake modelling

WMO Lake Victoria initiative

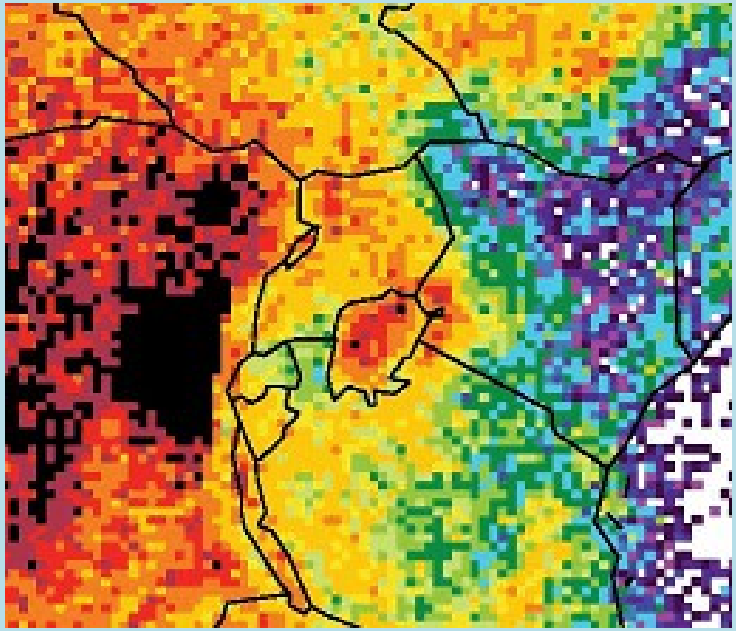
Usage of FLake for ice forecast in the Netherlands

Ecological modelling and water quality studies

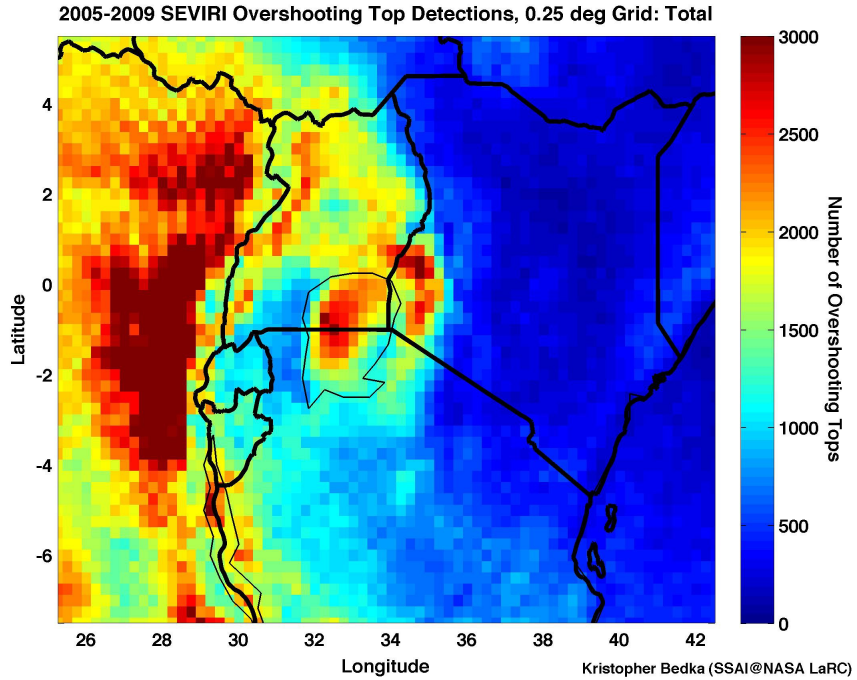
Use of online Flake for education and off-line studies by anyone interested

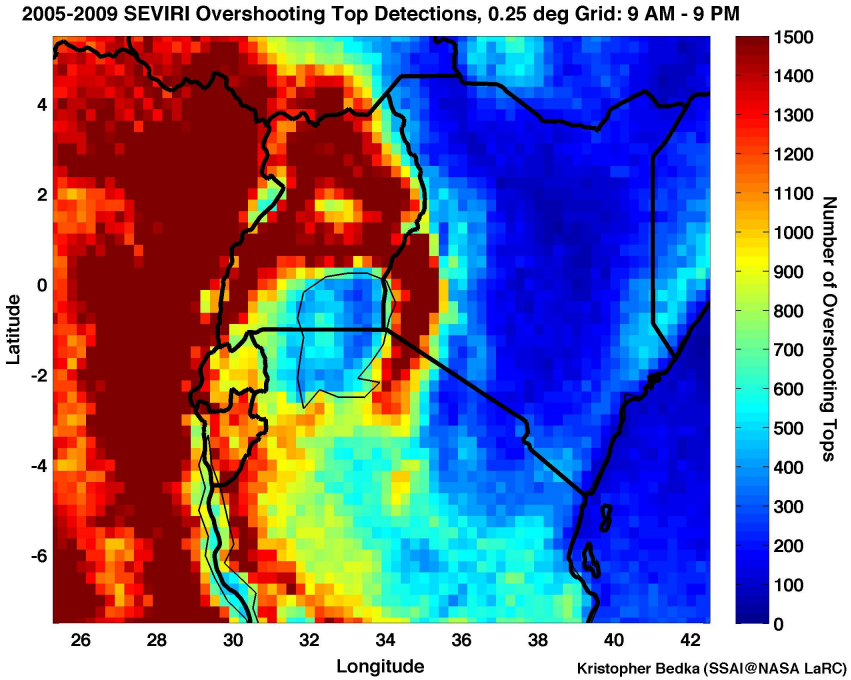
The problem of Lake Victoria

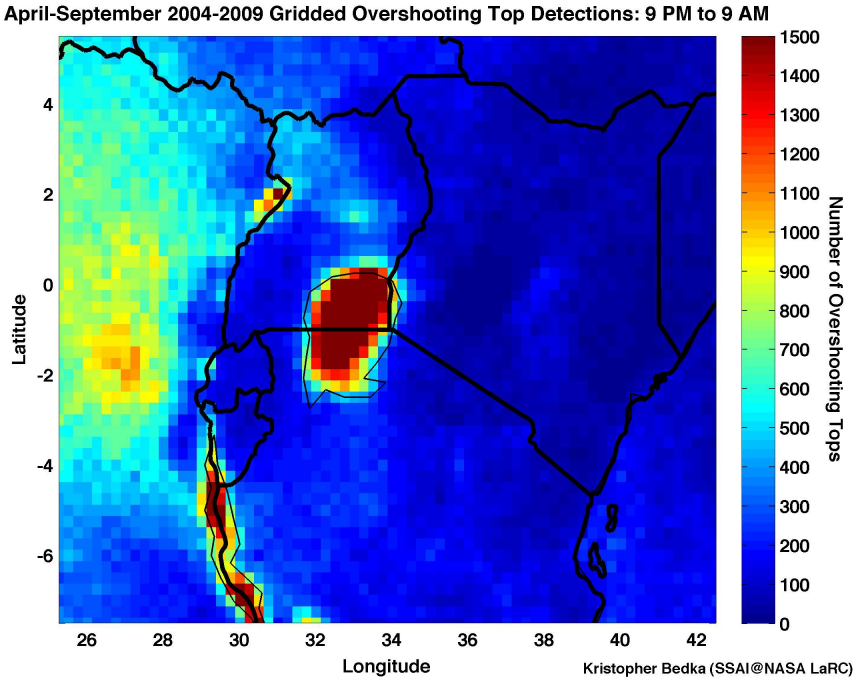
- Frequent severe thunderstorms over the lake, mostly at night
  - 200,000 fishermen active
  - 5000 deaths / year? Many presumed weather-related
  - Local weather/lake conditions/casualty information poorly known from observations
  - National weather services (NMS) in surrounding countries: little experience with warning services for severe weather
- NMS's requested WMO assistance
- Gaps:
  - Observations/Technology
  - Understanding (Nocturnal thunderstorms)
  - Knowledge/Capacity
  - Concept of Operations for Warnings
  - Warning services to the lake community
- Satellite, lightning and NWP based nowcasting / forecasting systems needed



From the slides by Jeanette Onvlee in Lake12







Overshooting top detections – indicator of high convective clouds

Top left: 24h average

Top right: daytime average

Bottom left: nighttime average

Recommendations on the Lake Viktoria WMO initiative

WMO initiative presented in Jeanette's talk

Lake MIP single column experiments in several points?

3D lake models done already and more needed?

Lake climatology runs with bathymetry and varying forcing done by Katya et al. when preparing FLake climatology

Climate model results of coarse resolution, with FLake included, exist in Canada by Andrey et al

Problem of the lack of continuous observation data

Exchange of information: send to

jeanette.onvlee at knmi.nl > WMO

From final notes of Lake12 discussions

Motivation

- Interest by ice skaters for frozen waterways in the Netherlands
- Interest by transport sector for navigable waterways
- Need for interactive tool for ice prediction

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- Interest by ice skaters for frozen waterways in the Netherlands
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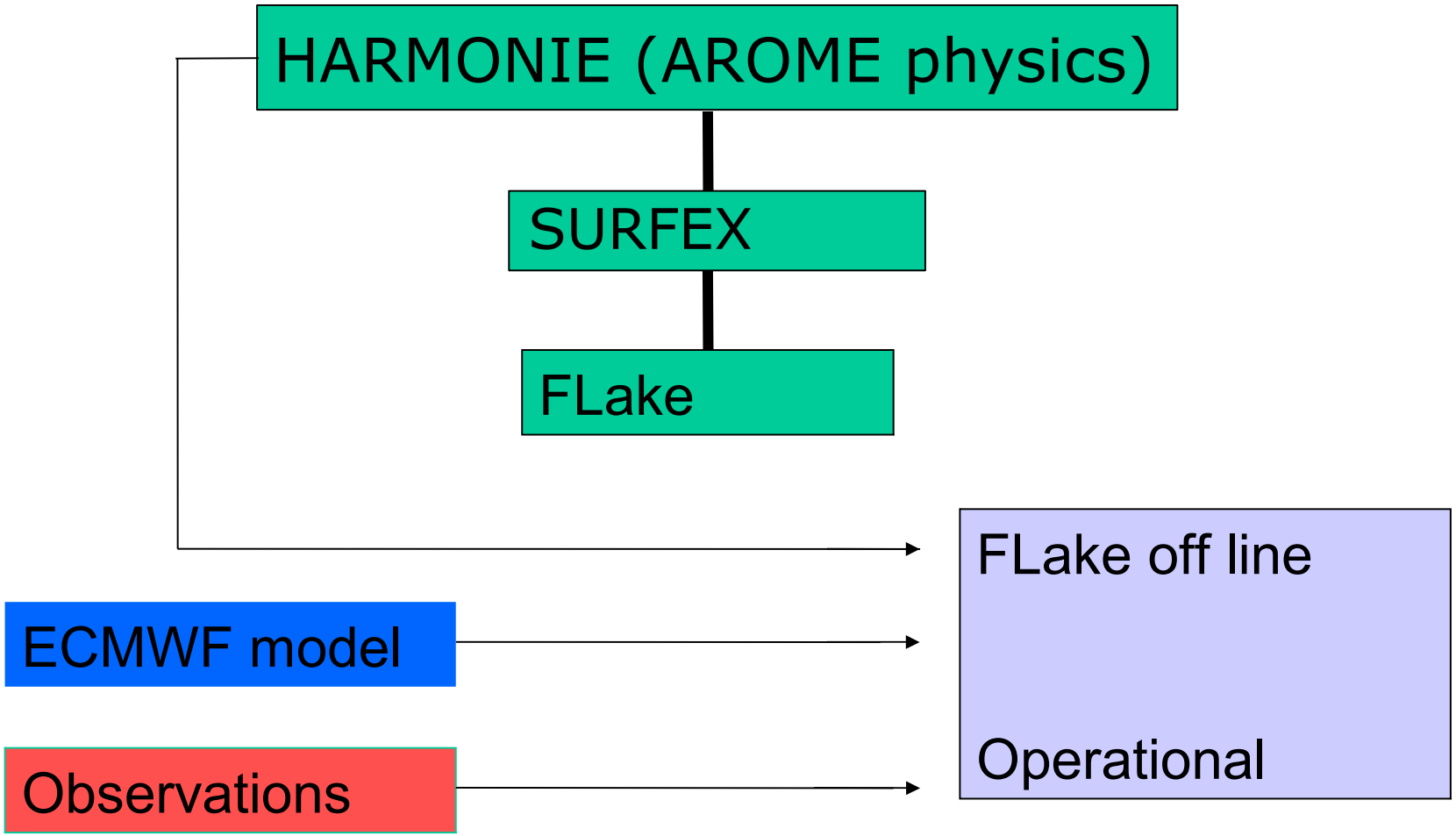
HARMONIE (AROME physics)
SURFEX
FLake
FLake off line
ECMWF model
Operational
Observations

FUTURE
- key tasks from the point of view of NWP

Improvement of FLake model used as a parametrisation scheme in NWP: snow on ice, three-layer structure, salinity?

Usage of remote sensing observations on lake water surface temperature and ice cover

Development and operational application of in-lake data assimilation in NWP models which apply prognostic lake parametrisations

Improvement of physiographic and climatological input data: lake depth, cover, extinction coefficient

Possible role of SRNWP in coordinating the lake - NWP work in the future?

Three workshops on parametrisation of lakes in NWP and climate modelling

2008 Zelenogorsk, http://netfam.fmi.fi/Lake08

2010 Norrköping, http://netfam.fmi.fi/Lake10

2012 Helsinki, http://muscaten.ut.ee/Lake12

2014 Evora/Berlin?

Two special open access journal issues on lakes

Boreal Environment Research, 2010, No 2, Vol. 15

Tellus A, 2012, Thematic cluster

Journal, 2014, Special issue

Acknowledgements

ECMWF supports the Lake Depth Database work

Nordic Research Board (NordForsk) supported arrangement of the Lake workshops 2008, 2010, 2010