Overview of lake-related activities at Météo-France

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Météo-France/CNRM

Outline

Introduction
  - A bit of history

Modelling
  - A mass budget for lakes
  - The LIAISE field campaign
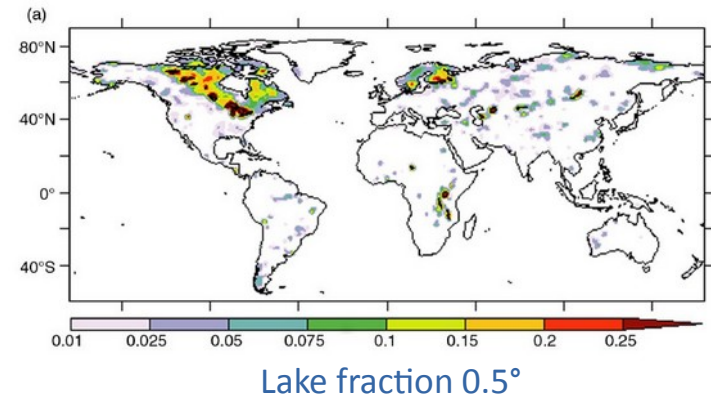
Applications
  - Impact of CC on water resource in France
  - Impact of using FLake on a lake effect situation

What's next?
  - To implement FLake into operations
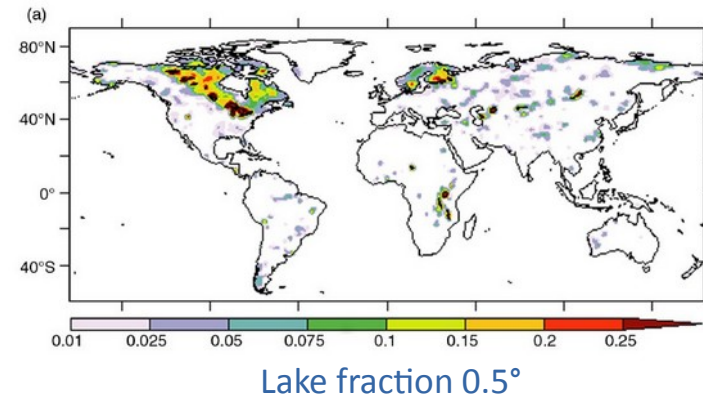 - To improve the water cycle representation

A bit of history

- In 2006 Meteo-France decides to use FLake to represent inland-water surfaces in the land modelling platform SURFEX
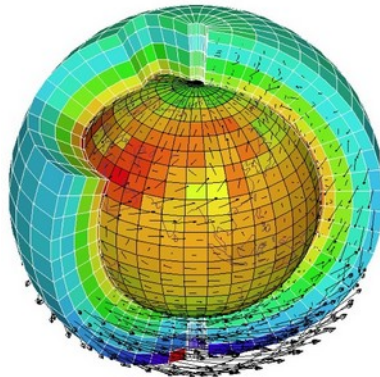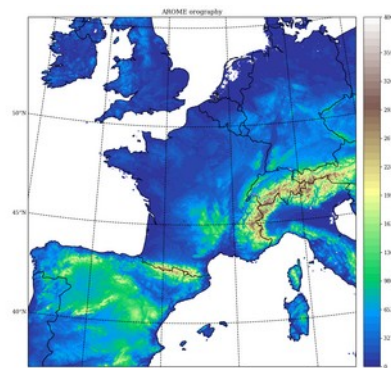

Lake fraction 0.5°

A bit of history

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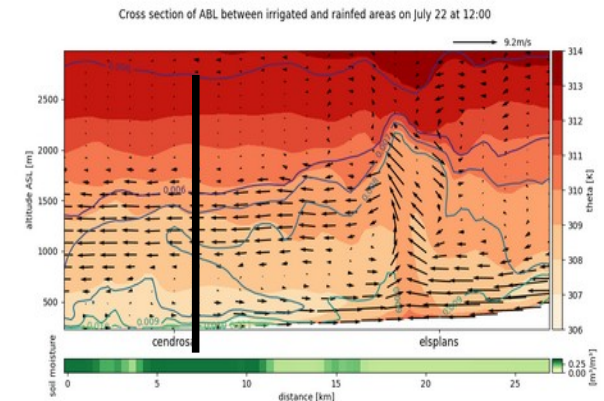

Lake fraction 0.5°

For use in NWP, Climate, Research, Downstream applications...
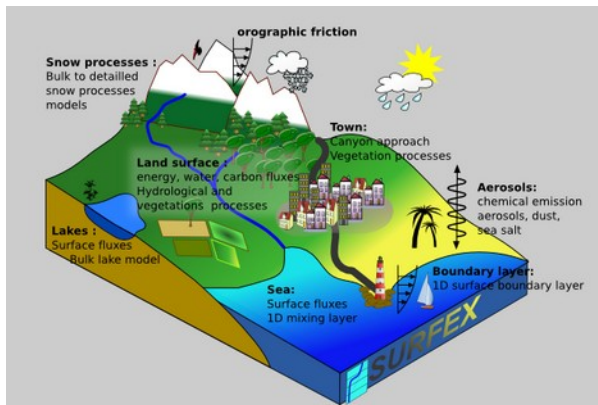

ARPEGE NWP & Climate

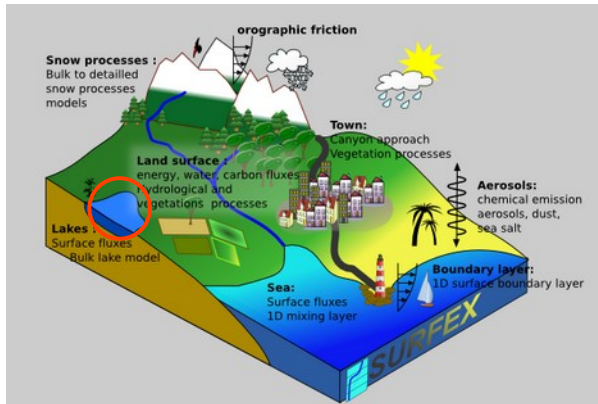AROME-France NWP

Méso-NH research model

A bit of history

- In 2006 Meteo-France decides to use FLake to represent inland-water surfaces in the land modelling platform SURFEX

- 2010: Coupling of the FLake model to the SURFEX externalized land surface modelling platform
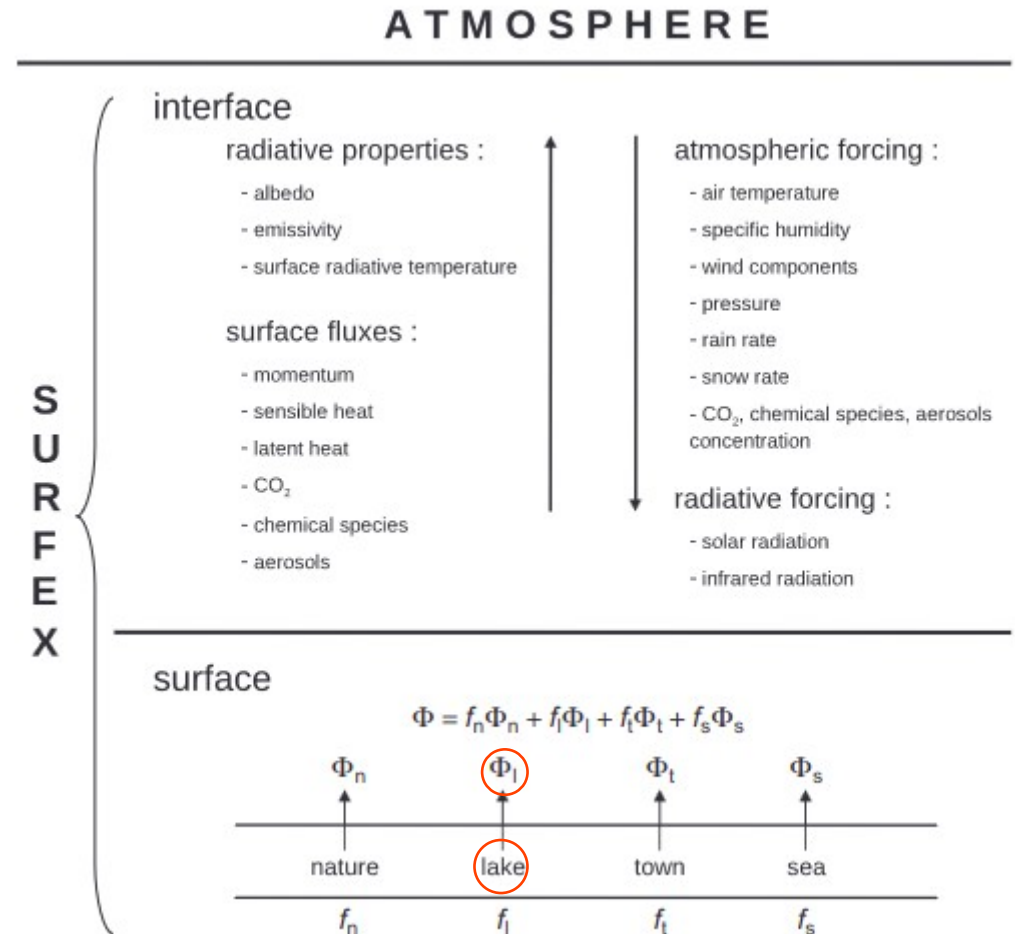

SURFEX

A bit of history

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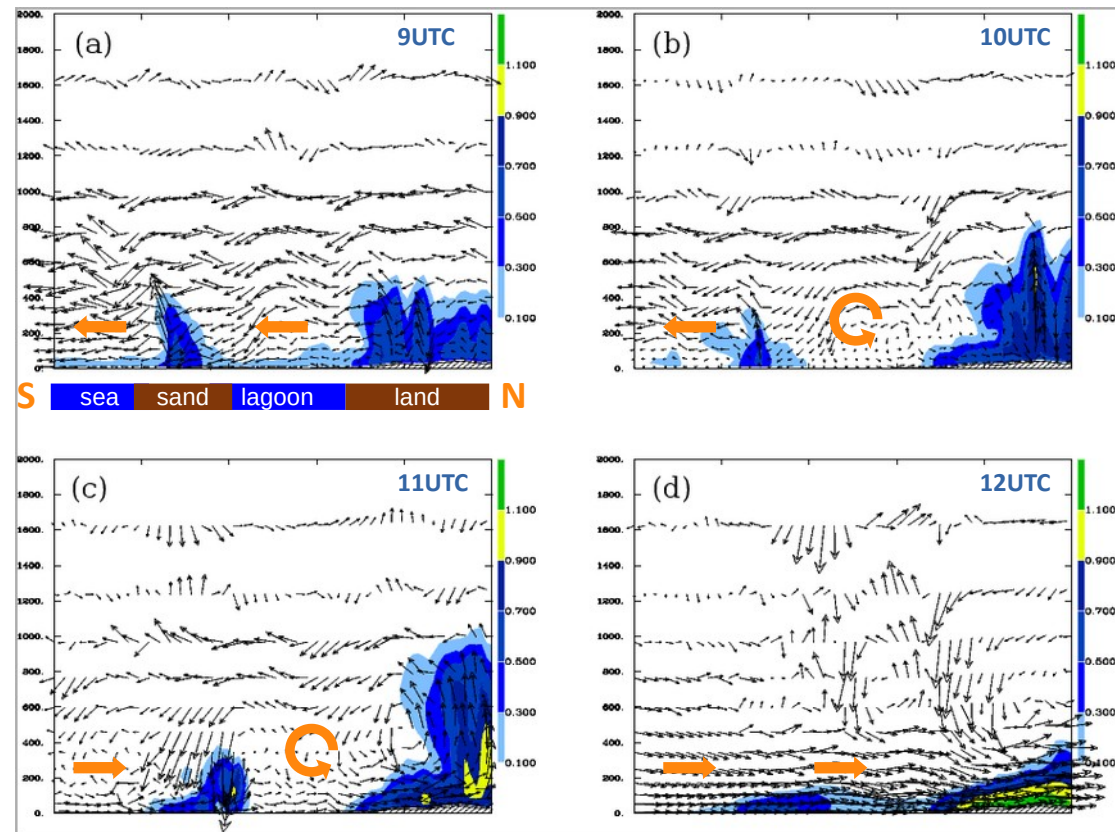

SURFEX

$$\Phi = f_n\Phi_n + f_l\Phi_l + f_t\Phi_t + f_s\Phi_s$$

Salgado and Le Moigne, 2010, *BER*

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- 2013: Evaluation of the lake model FLake over a coastal lagoon during the THAUMEX field campaign


THAUMEX IOP2, 2011-08-30

Le Moigne et al., 2013, *Tellus A*

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- 2016: Impact of lake surface temperatures simulated by the FLake scheme in the CNRM-CM5 climate model
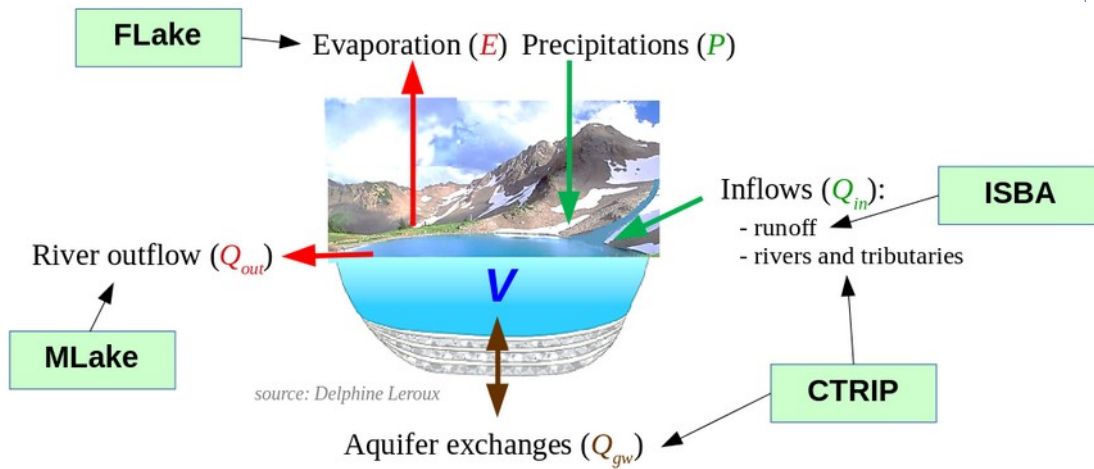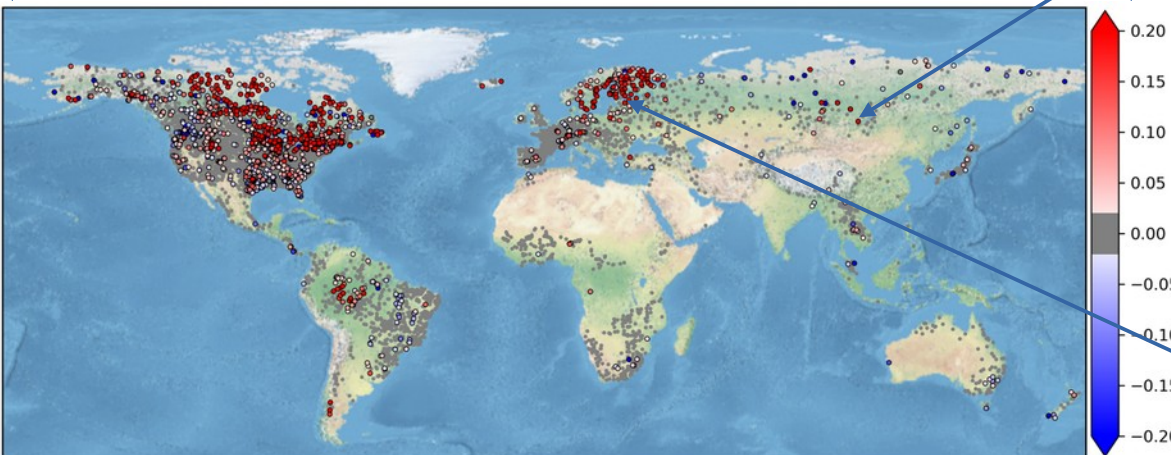
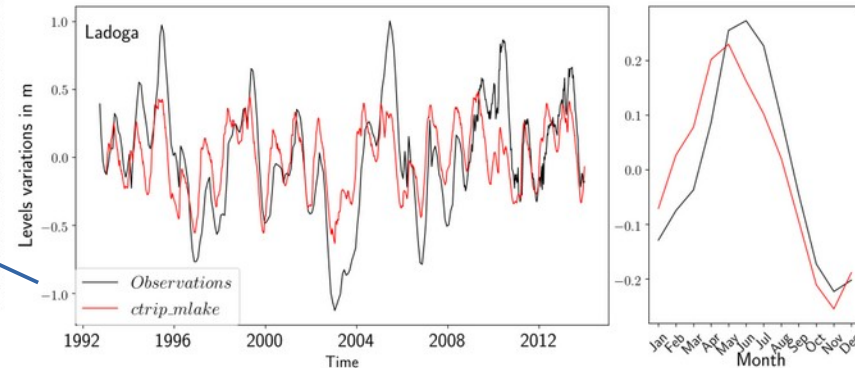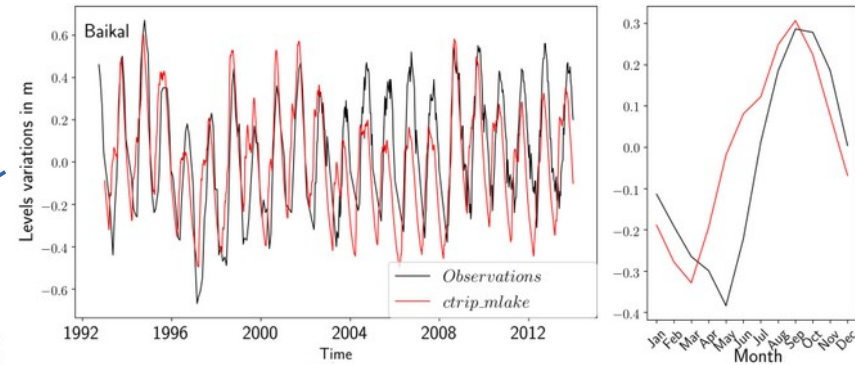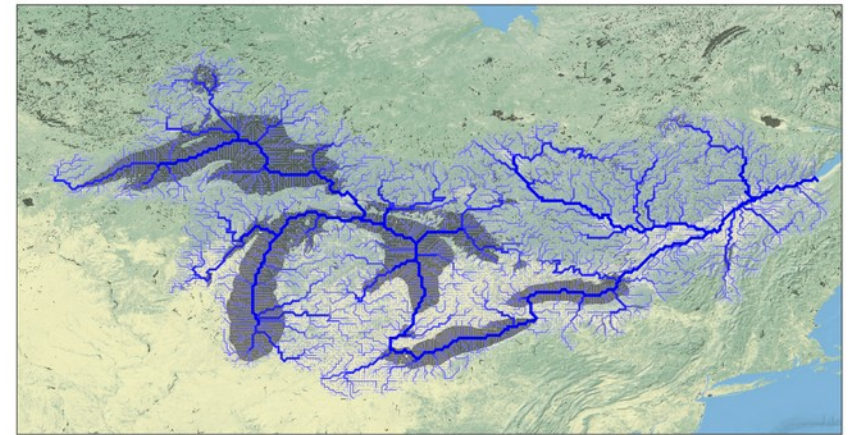Seasonal (JJA) mean differences inline FLake - inline NoFLake
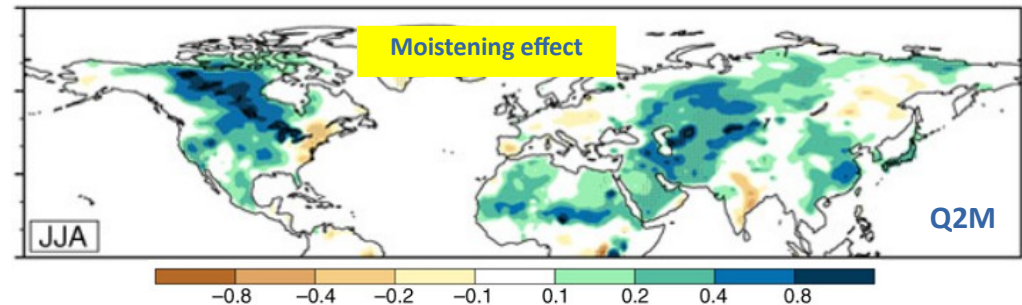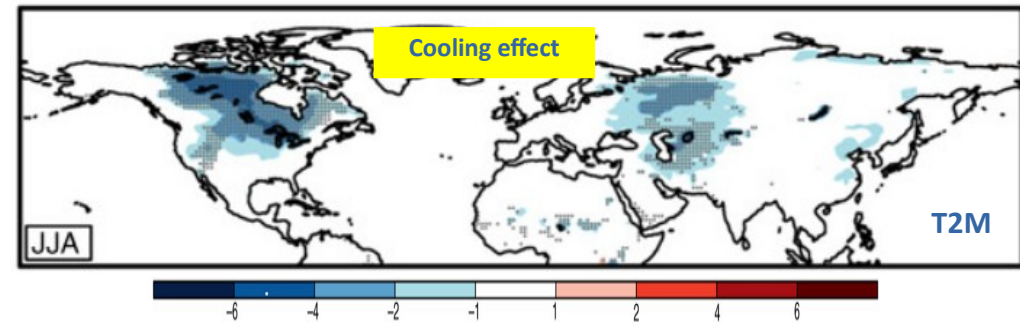
Le Moigne et al., 2016, *Tellus-A*

Modelling 1: A mass budget for lakes (2020)

➤ MLake - CTRIP
  ▪ Thesis Thibault Guinaldo (2017-2020)

FLake → Evaporation (E) Precipitations (P)

River outflow (Q_{out})

MLake

Inflows (Q_{in}):
- runoff
- rivers and tributaries

ISBA

CTRIP
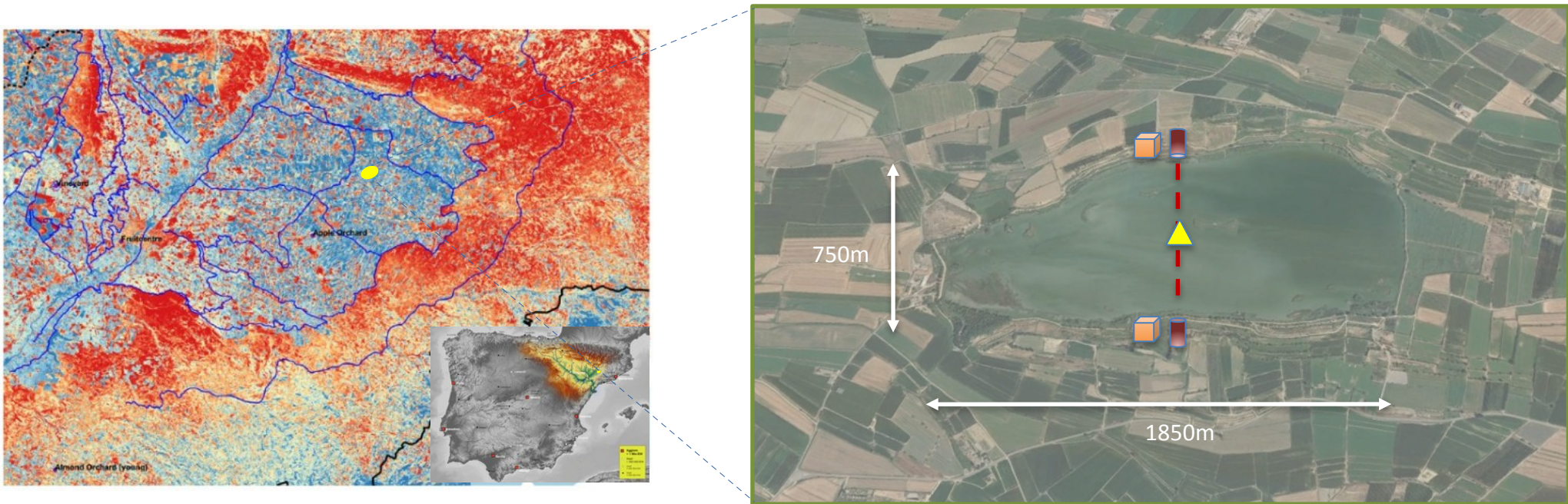
source: Delphine Leroux

Aquifer exchanges (Q_{gw})

$$\frac{dV}{dt} = (P - E)*A_{lake} + Q_{in} - Q_{out} + Q_{gw}$$

Modelling 2: LIAISE (2023)

- The LIAISE field campaign: to improve our understanding of key natural and anthropogenic land processes and boundary layer feedbacks. In particular impact of irrigation on coupling in semi-arid area.
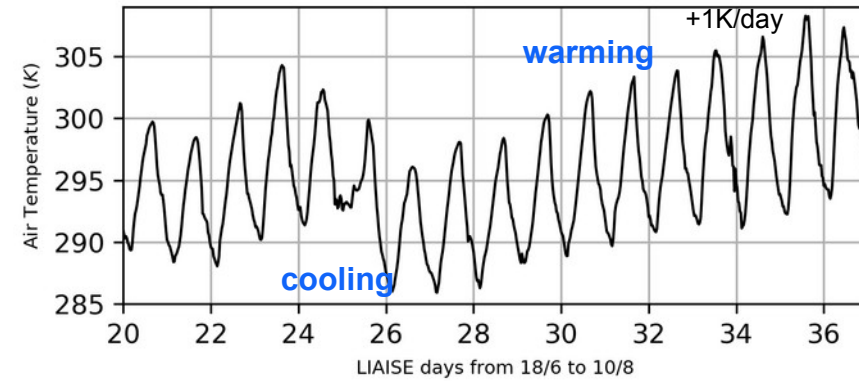- 9 SEB stations including a lake

Lake Ivars

- ❑ A SEB station (catamaran) 🔺 anchored on Lake Ivars was used to provide continuous time series of near-surface variables and study surface fluxes at the interface between the lake and the atmosphere.
- ❑ 2 AWS 🔶 P, T, RH, radiation were deployed
- ❑ A scintillometer ▮ was installed on the shores of the lake (WUR)

Catamaran

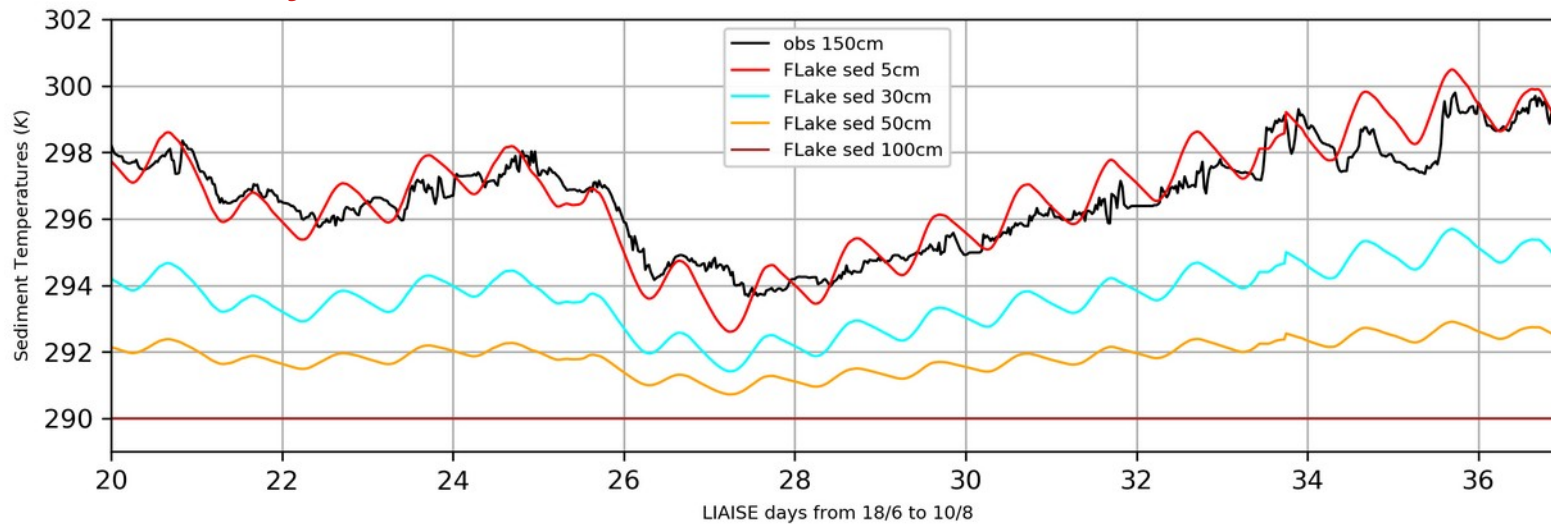Young: dd, ff @6.5m

IRT @4m

3D Sonic + Licor EC @3m
Inertial unit

P, T, RH @2.4m

Radiometer
CNR4 @50cm

T @50cm

5cm
10cm
30cm
50cm

Average depth 1.5m

100cm
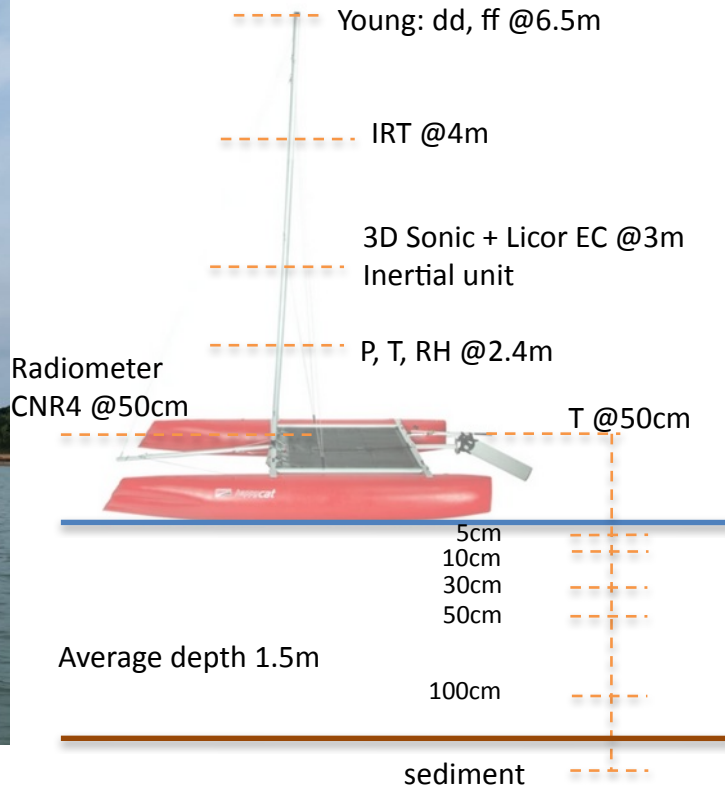
sediment

Air temperature

Measured temperatures
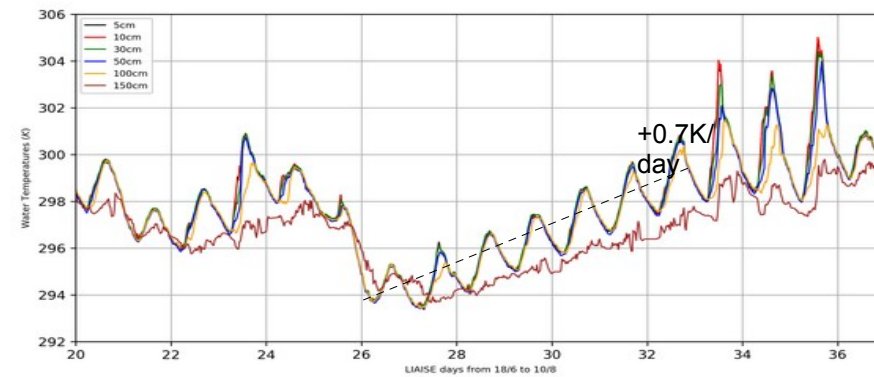
Sediment layer

Surface fluxes

Sensible heat flux
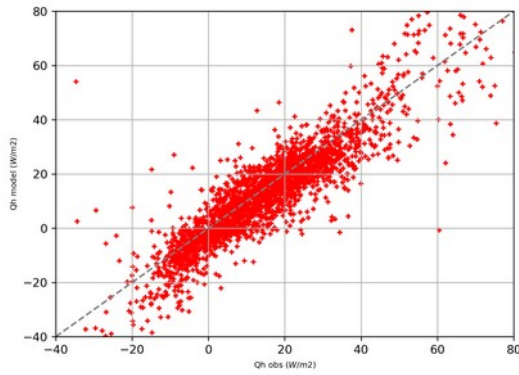
Latent heat flux
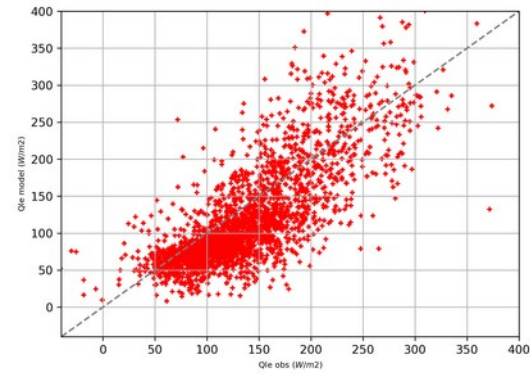
Heat storage
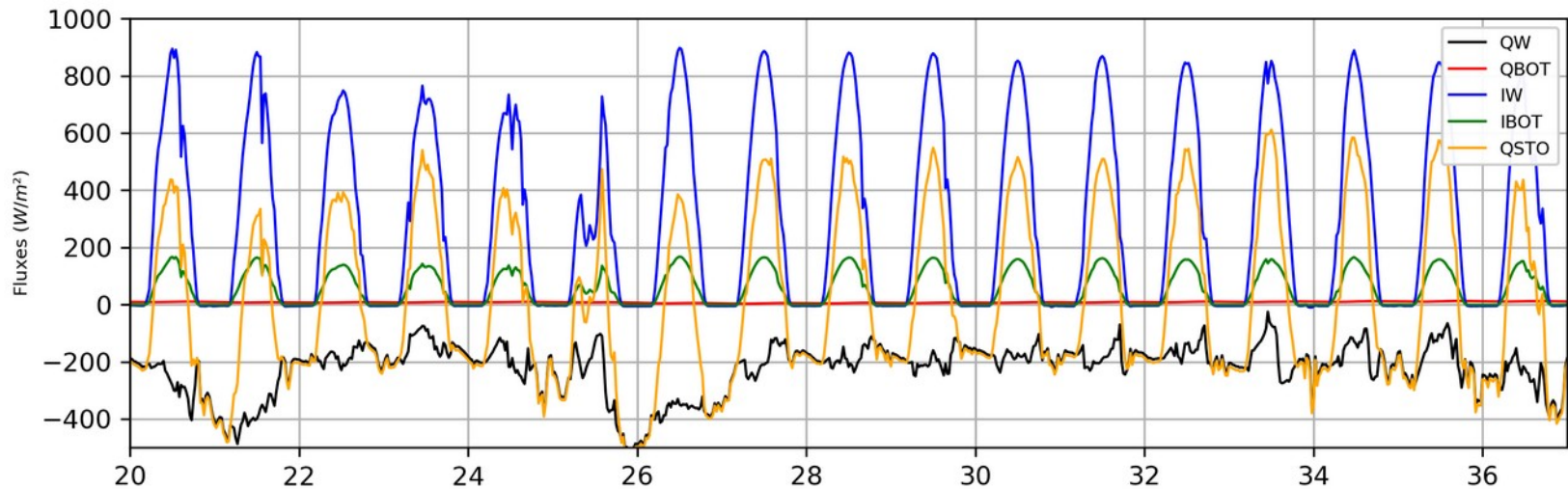
QSTO = QW + IW − QBOT - IBOT

QW	heat flux through the air-water interface
IW	radiation flux through the air-water interface
QBOT	heat flux through the water-bottom sediment interface
IBOT	radiation flux through the water-bottom sediment interface

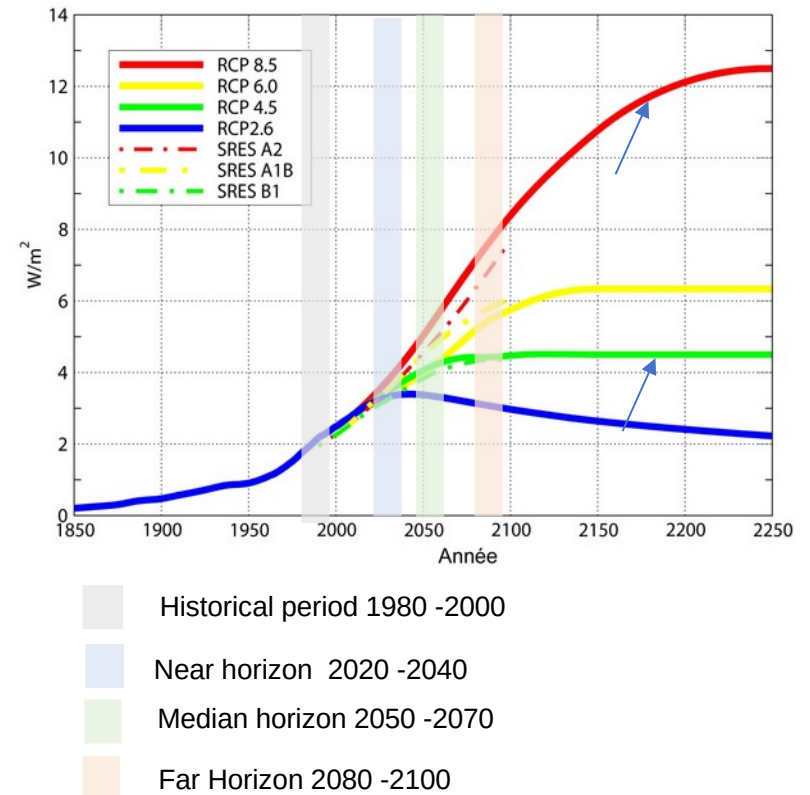# Application 1: Impact of CC on water resource in France (2021)

SAFRAN : Meteorological reanalysis 1958 – 2018 @8 km ; 9892 points

⬇

SURFEX / FLake : lake model

⬇
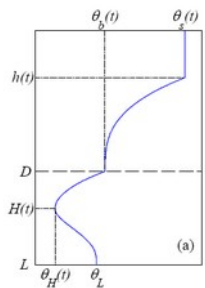
**Surface temperature (LST)
Evaporation (EVAP)**

Historical period 1980 -2000

Near horizon 2020 -2040

Median horizon 2050 -2070

Far Horizon 2080 -2100

2 scenarios:
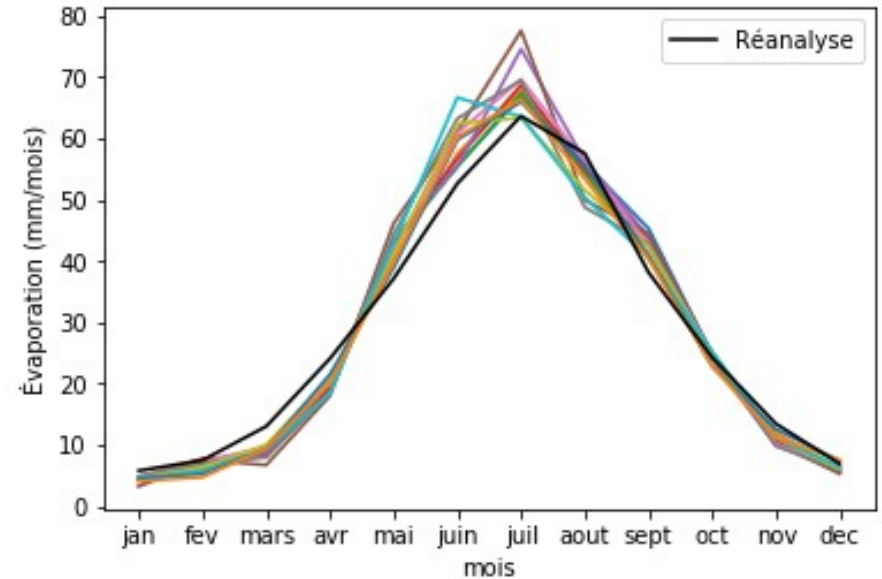**RCP4.5** (10 GCM/RCM couples)
RCP8.5 (12 GCM/RCM couples)

METEO FRANCE — cnrs

Application 1: Impact of CC on water resource in France

Multi-model probabilistic approach to uncertainty
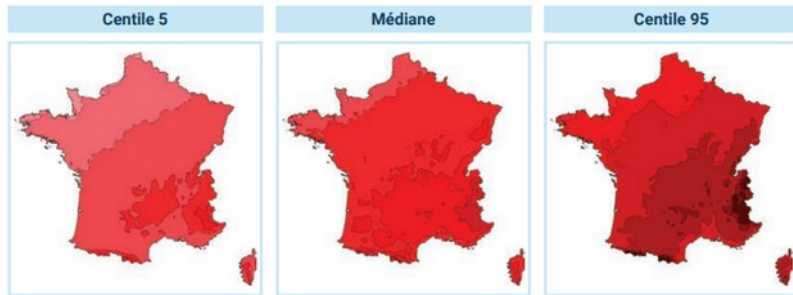
1 single FLake configuration:

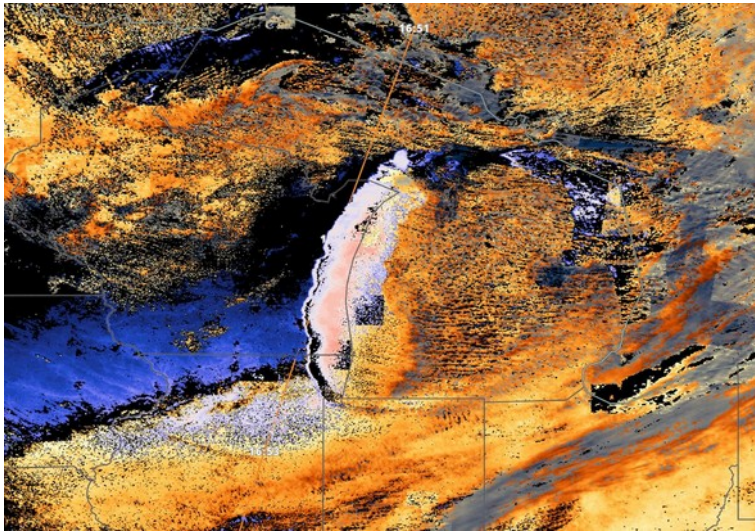- shallow $d = 2\ m$
- Clear $k = 0.5\ m^{-1}$
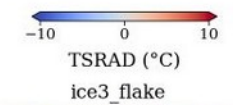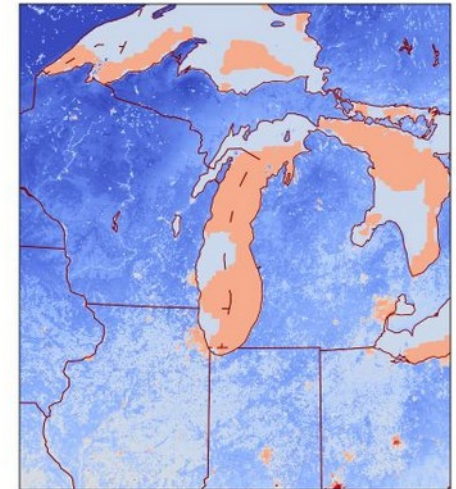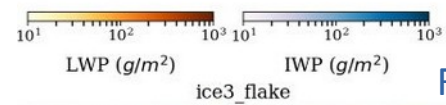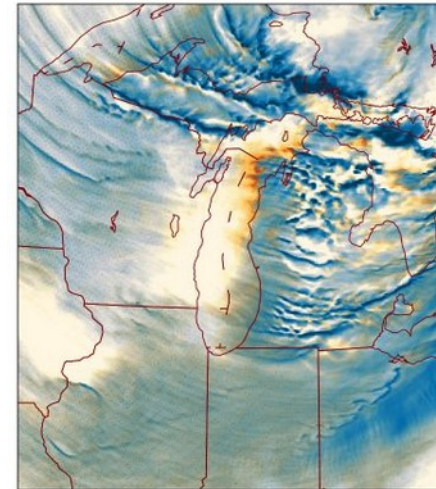

Surface temperature

Evaporation
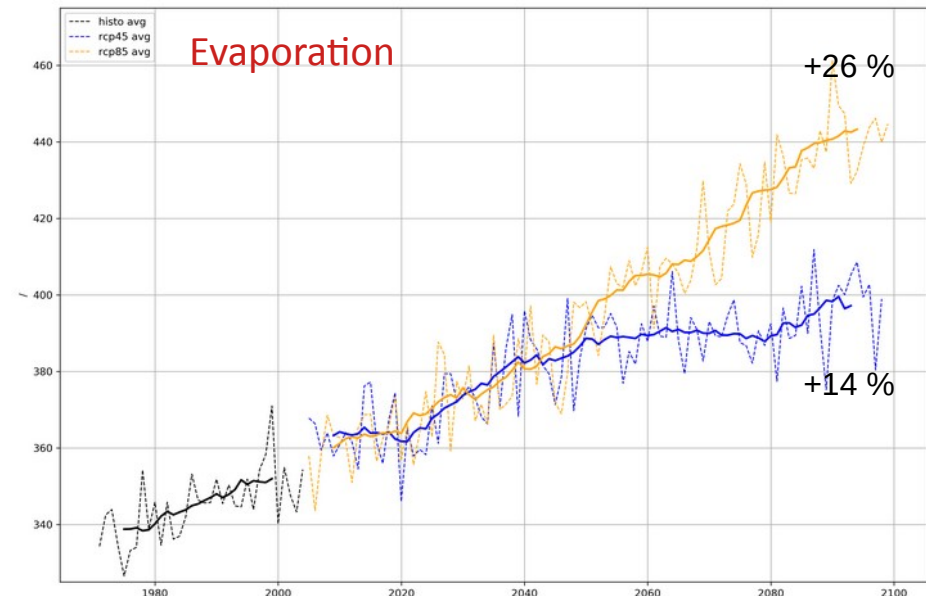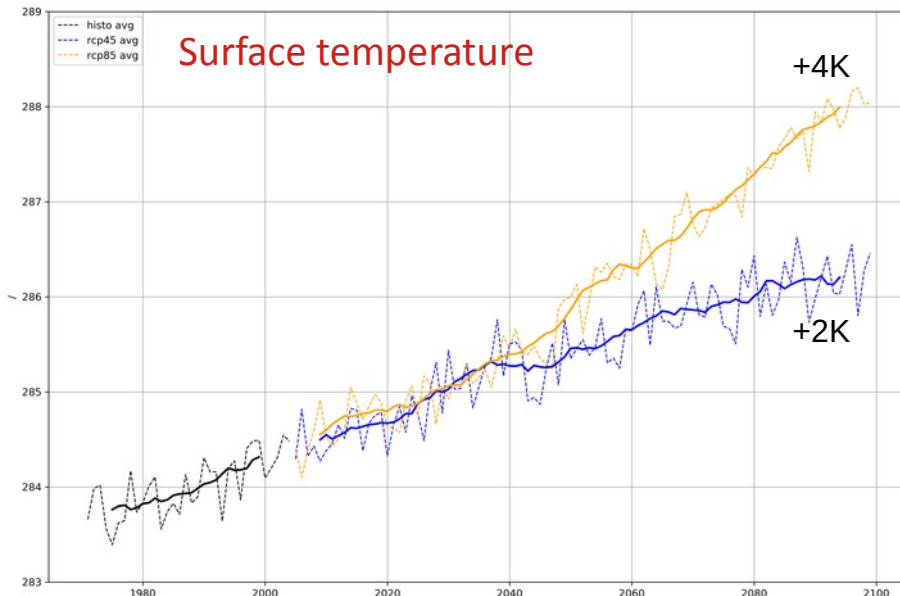
Application 2: Lake effect over lake Michigan (2024)
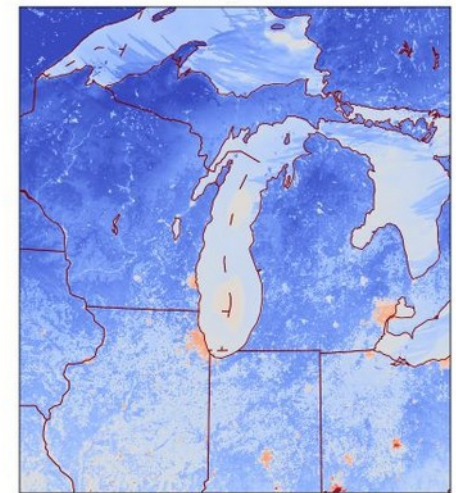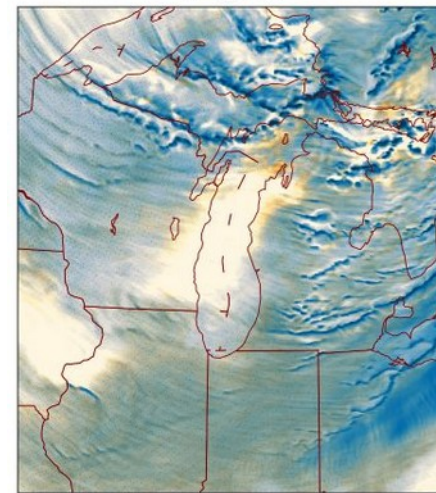
ICICLE campaign
Situation of 2019/3/5 17UTC

MODIS Terra image
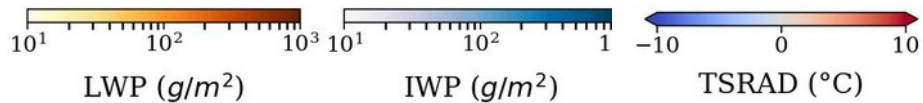
No-FLake
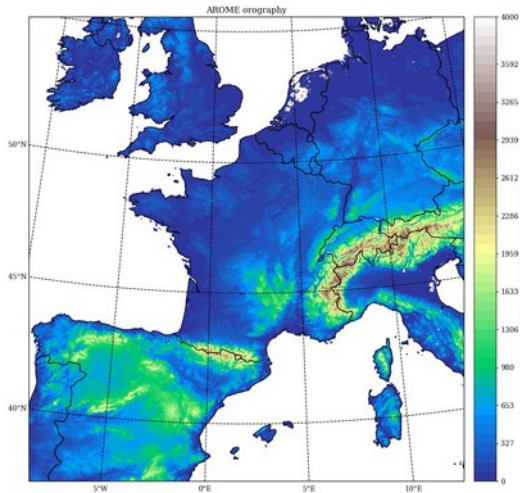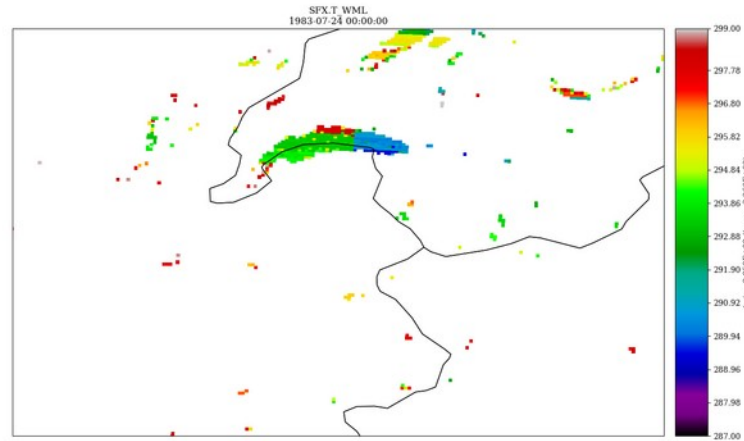
FLake

What's next? Implementation of FLake into operations

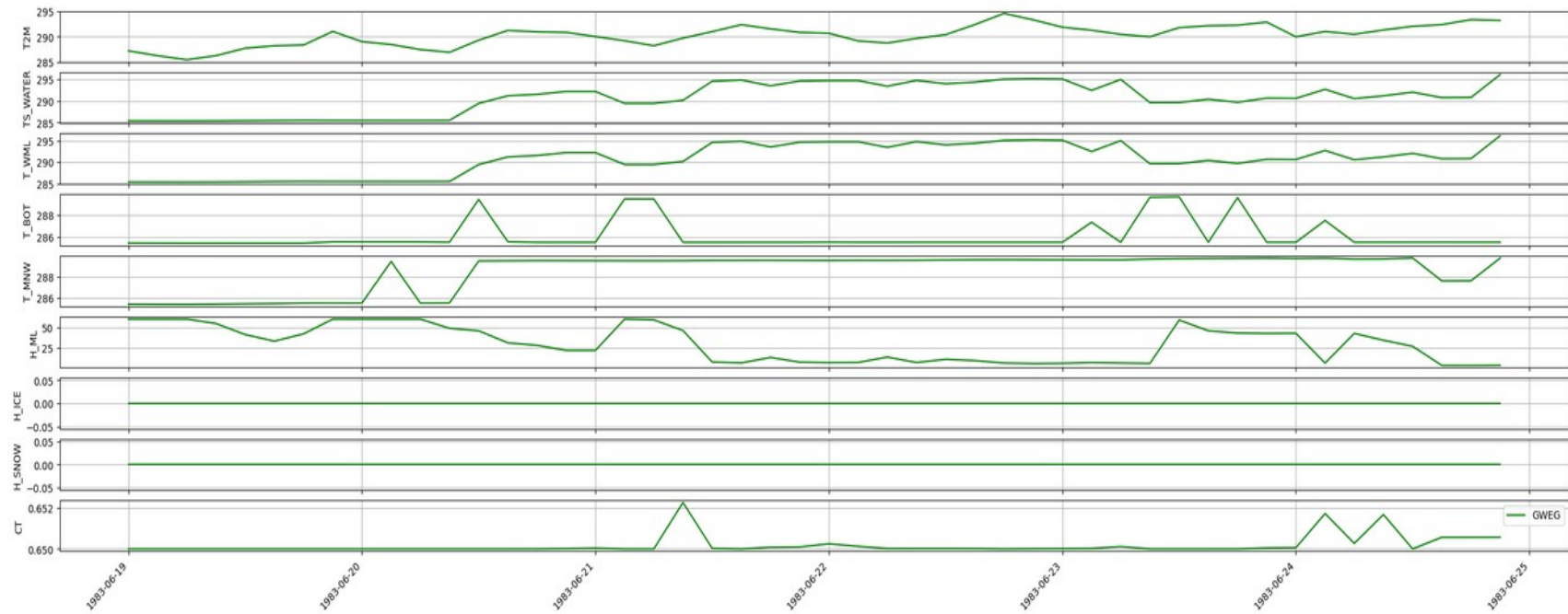At Meteo-France, 2 internal projects: MASCOT and ARRA
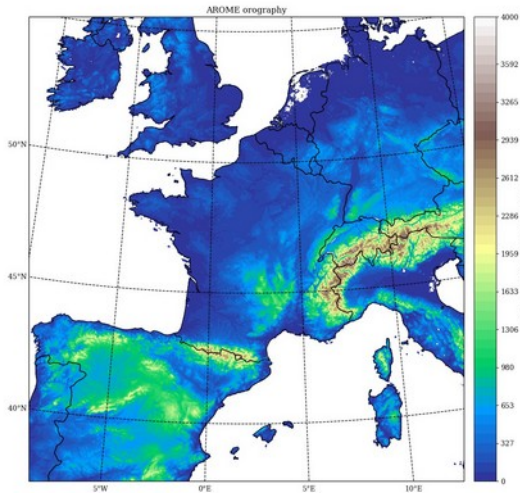
Reanalysis ARRA
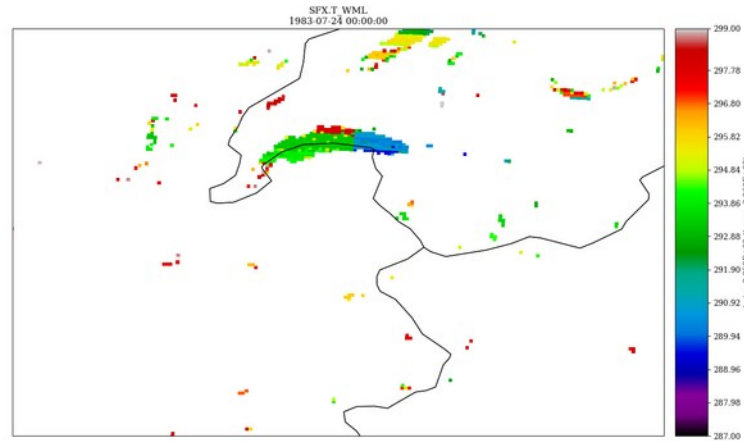AROME France 1.3km

FLake activated

AROME forecast with FLake

What's next? Implementation of FLake into operations

At Meteo-France, 2 internal projects: MASCOT (ISBA DIF, ES, MEB + FLake) and ARRA
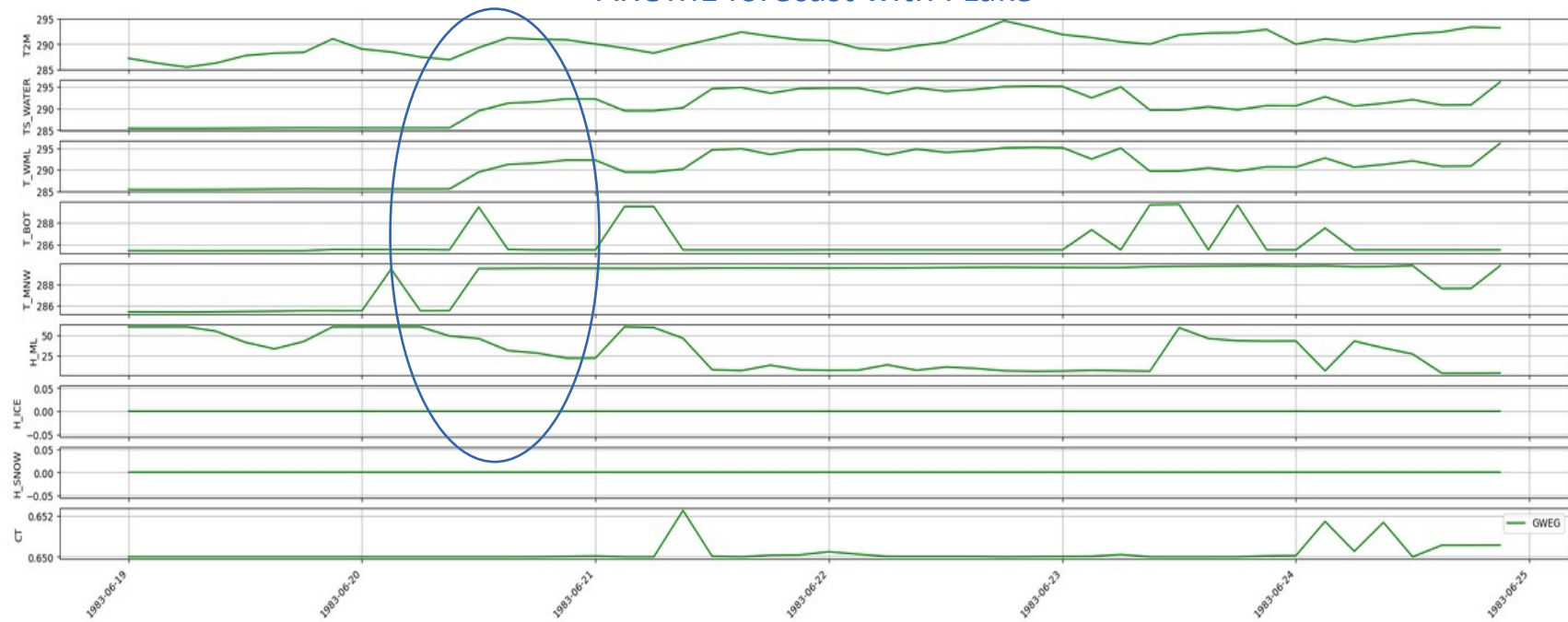
Reanalysis ARRA
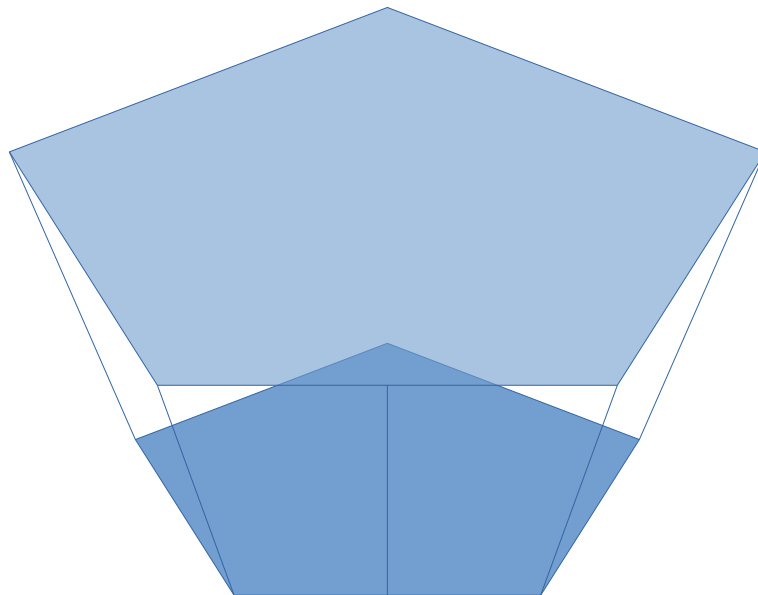AROME France 1.3km

FLake activated

AROME forecast with FLake

What's next? Improve the water cycle representation

Development of MGB a megabasin model in FLake:

- To study for the impact of varying water height and surface on the basin evaporation
- Varying water height with FLake model
- Varying surface and volume in MGB

- Polyhedron with 2 // surfaces

Thank you for your attention !