5th workshop on "Parameterization of Lakes in Numerical Weather Prediction and Climate Modelling"

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Evaporation from lakes in Antarctica

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Overview …

- Previous measurement campaigns – focus on evaporation;
- Water balance. What for …?
- How evaporation term is calculated?
- What method is the best to calculate evaporation?

- Step forward: future measurement campaign in Antarctica …

Aim, objectives, areas …

Aim: to evaluate the thermal regime and components of the water balance of Antarctic lakes.

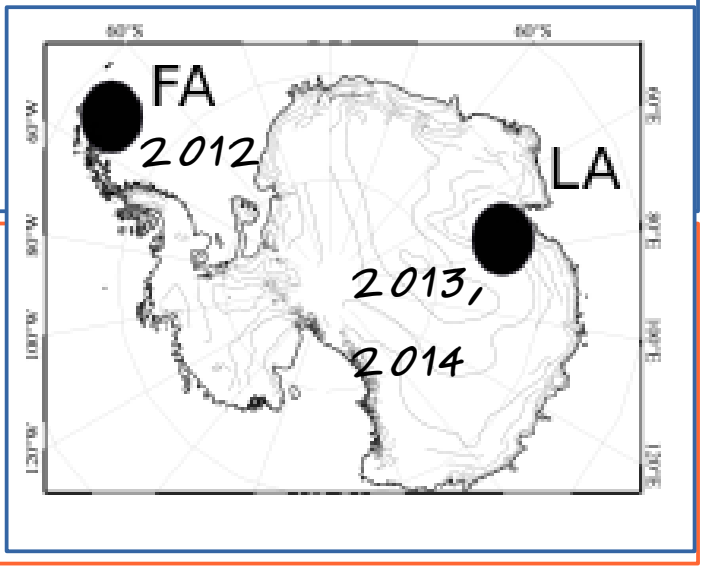
Objectives: … to investigate the connection between the thermal regime and water balance through evaporation.

FA: the Fildes peninsula of King George Island

LA: the Larsemann Hills, Princess Elizabeth Land

FA: six lakes /

LA: six lakes



Measurements and formulas ...

Measurements: lake water level, inflow/outflow water level and discharge, visual observations on ice forms, standard meteorological observations …

Water balance of lakes

$$\frac{dV}{dt} = P + Y_{in} + G_{in} - Y_{out} - E - G_{out} - W$$

$\boldsymbol{V}$ is the lake water volume,
$\boldsymbol{t}$ is the time (the period of observations),
$\boldsymbol{P}$ is the precipitation,
$\boldsymbol{Y_{in}}$ and $\boldsymbol{Y_{out}}$ are the surface inlet/outlet runoff,
$\boldsymbol{E}$ is the evaporation,
$\boldsymbol{G_{in}}$ and $\boldsymbol{G_{out}}$ are the subsurface inflow/outflow runoff,
$\boldsymbol{W}$ is the water supply for human activity.

Evaporation formulas ...

Measurements: lake water surface temperature, standard meteorological observations at nearest WMO station …

Dalton-type empirical formulas:

Evaporation from lakes' surface, mm day^{-1}

$$E = 0.14\,(e_0 - e_{200})\,(1 + 0.72\,w_{200})$$

e_0, hPa is the water vapor pressure at saturation, e_{200}, hPa is the screen level water vapor pressure, w_{200}, m s^{-1} is wind speed. These values are daily averaged.

Evaporation from Flake surface-layer block

Daily values of Evaporation …

	Lake	E, mm day^{-1}	E_{Flake}, mm day^{-1}
FA	Mirage	0.8	1.1
	Slalomnoe	0.8	1.2
	Kitezh	1.0	1.3
	Srednee	0.9	1.2
	Dlinnoe	0.9	1.4
	Glubokoe	1.3	1.3
LA	Stepped	1.6	1.9
	Progress	1.4	1.9
	Sarah Tarn	1.5	1.8
	Scandrett/Nella	1.4	1.8
	Reid	1.7	1.9

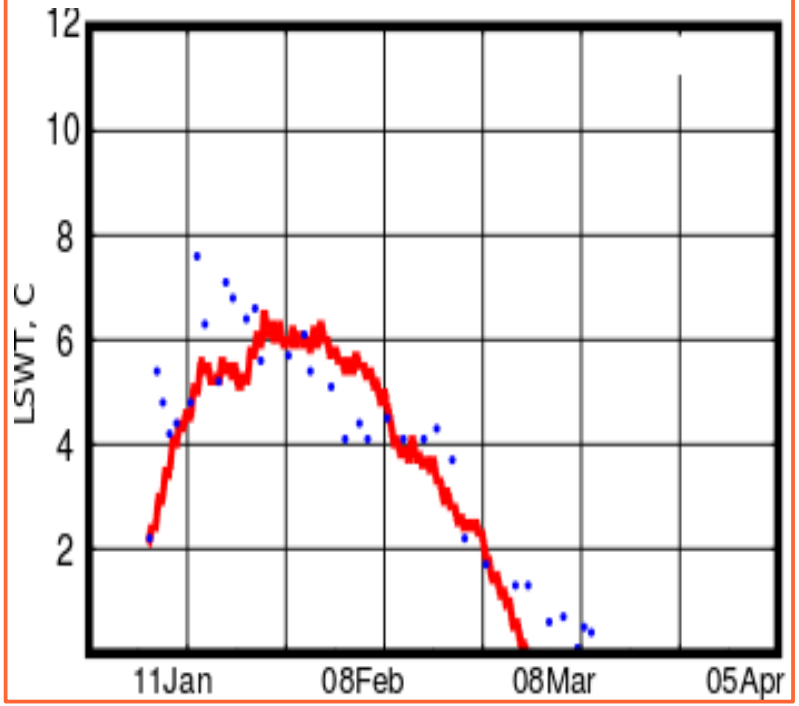
*E … after empirical equation,

** E_{FLake} … after surface-layer block

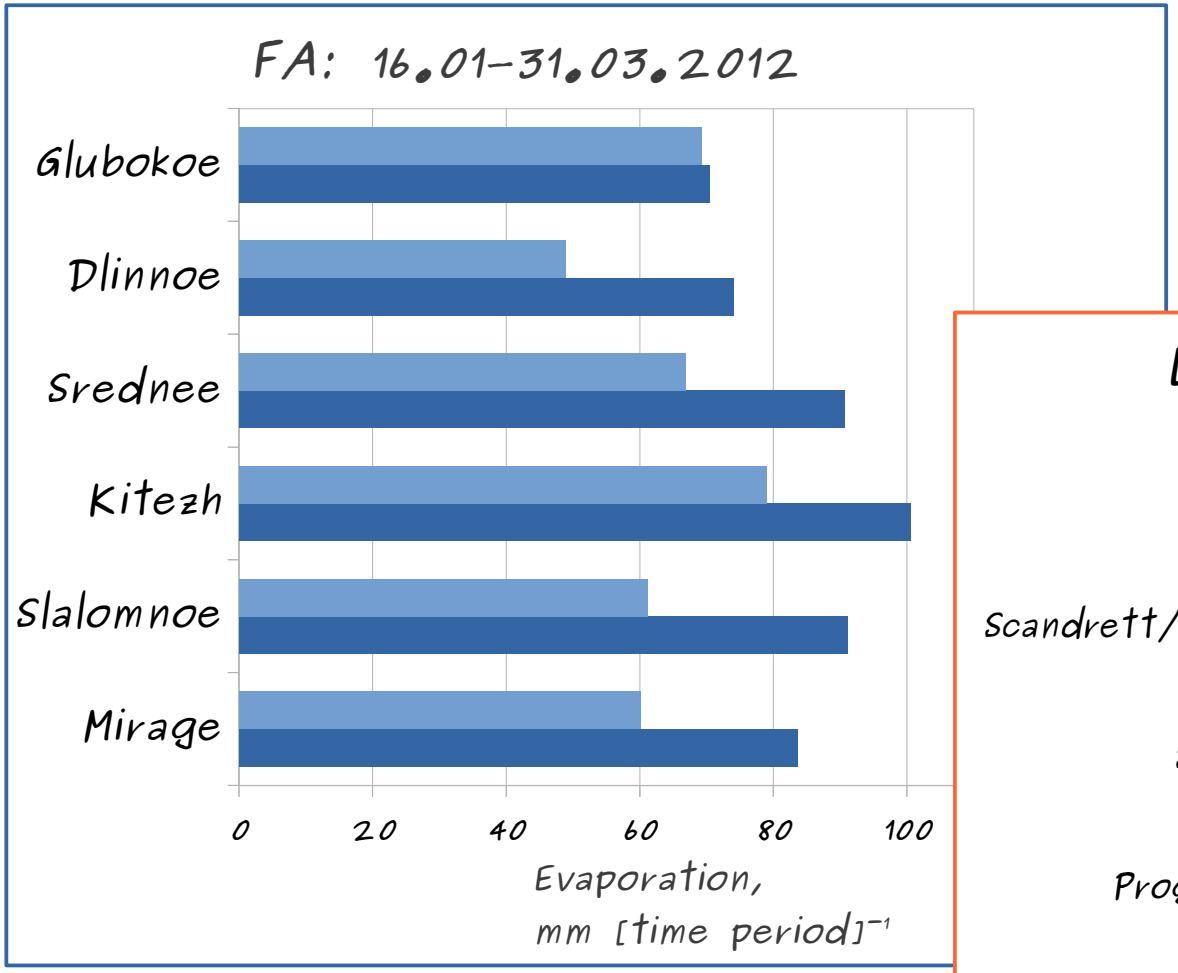
… $LWST_{sim}$ bias was up to 0.6–0.7 oC …

… there was no systematic errors $LWST_{sim}$ …

LA: 2014, Lake Scandrett

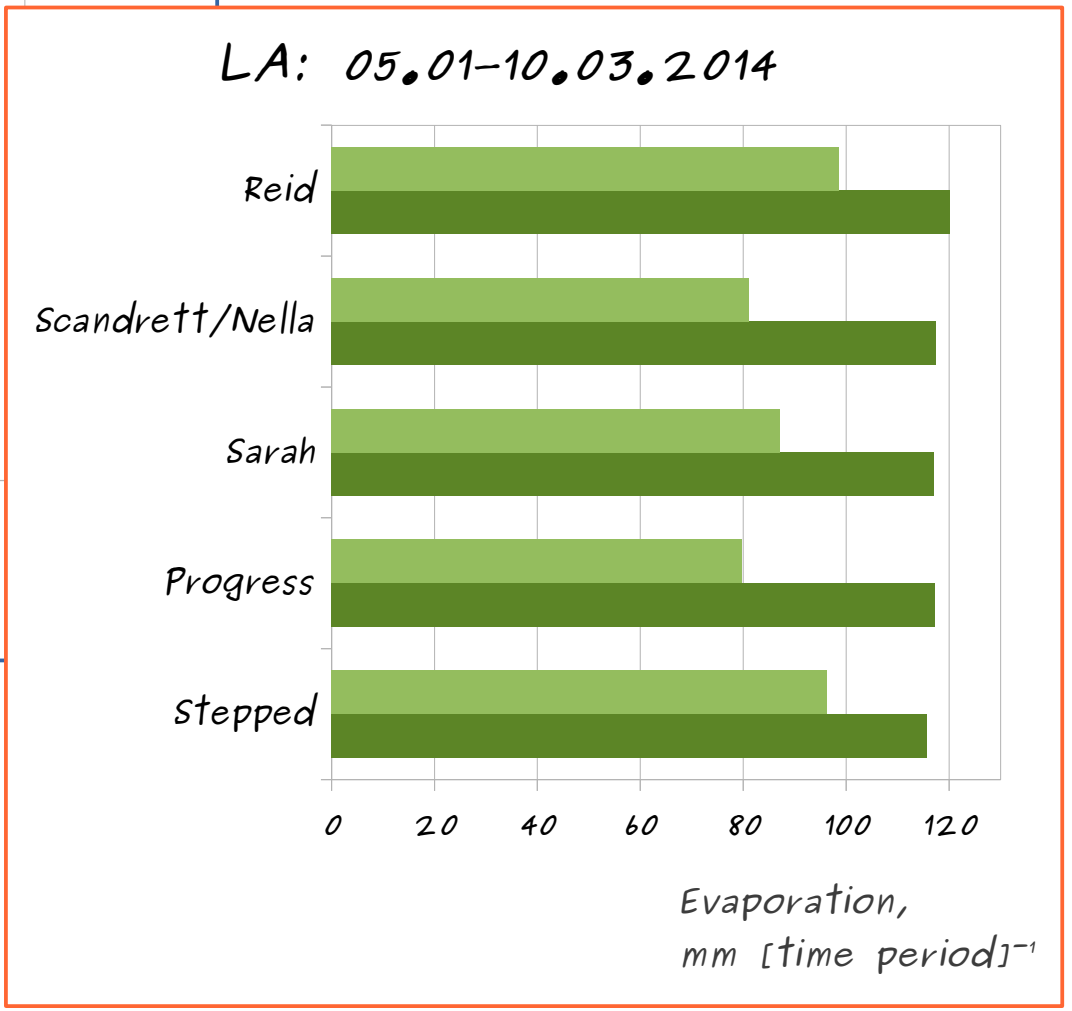


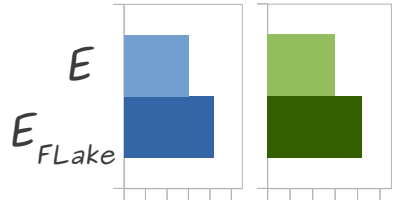
Seasonal values of Evaporation …



$$\frac{(E_{FLake}-E)}{E}$$

aprox. 25 %





Method to calculate evaporation …

Importance of the method used to calculate evaporation

$$D, \% = (E - E_{FLake})/dV$$

where, dV is the seasonal change of the lake volume.

Not important:
the evaporation is <u>small</u> compared to other terms (surface inflow/ouflow)

…Endorheic lakes

Important:
the evaporation is <u>comparable</u> with other terms

… Evaporation and water balance estimated by FLake might be sensitive to the light extinction coefficient…

Conclusions …

… the evaporation calculated by the atmospheric surface-layer block of FLake is 20-40 % larger than the values evaluated from the empirical equation.

… the method of calculating evaporation is important to the water balance calculations for endorheic lakes, and for lakes with a small difference between the surface water inflow and outflow.

Step forward …

… the calculations of evaporation should be further proved by observations.

Measurement campaign 2017–2018 …

The Schirmacher Oasis: 70°45'30"S, 11°38'40"E

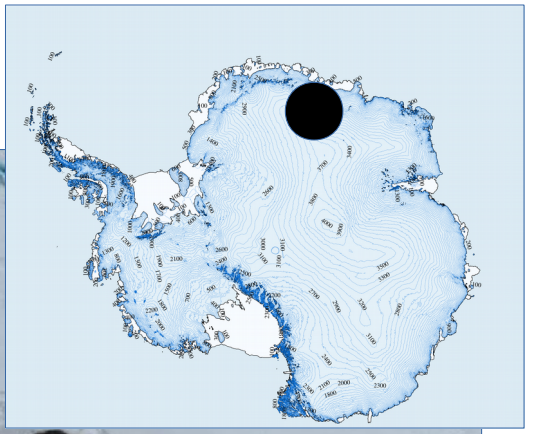
Height – 100 m asl

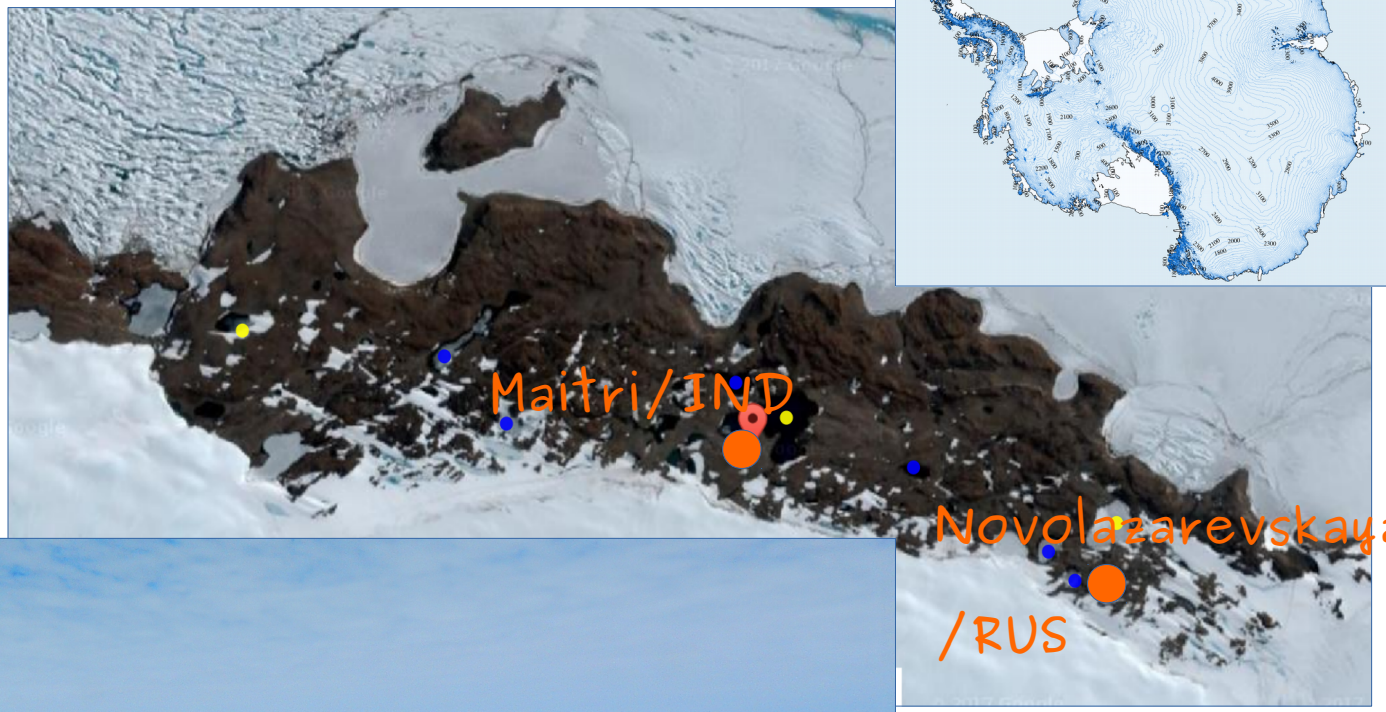
Length – 25 km

Width – 3 km

Area – 35km^2

lakes – 2km^2





Period:
20Dec,2017 –
8Feb,2018

Instruments …

Water temperature:
termochrone iButtons

LWST

Water Level:
HOBO loggers

WL

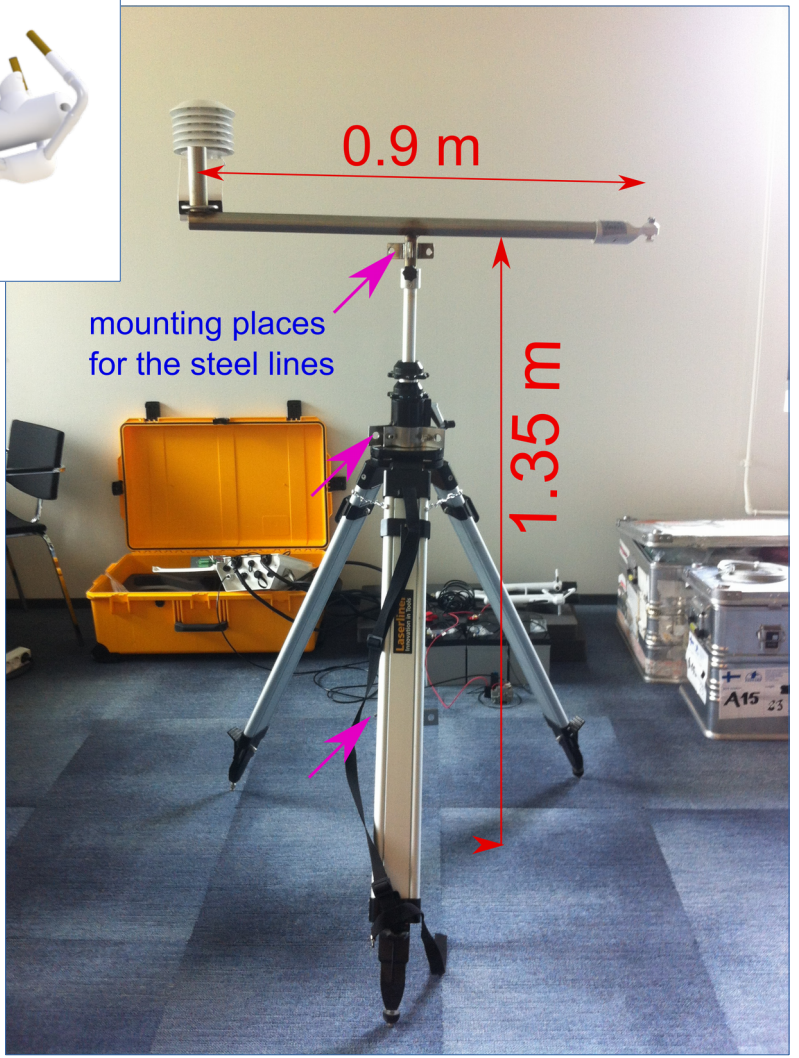
Water discharge:
micro current
meter GR-55

WD

- Lake morphometry, groundwater level, snow properties, etc: … GPS, lines, wells, tape, sticks, weight kit etc …

Evaporation: IRGASON by Campbell

EVA

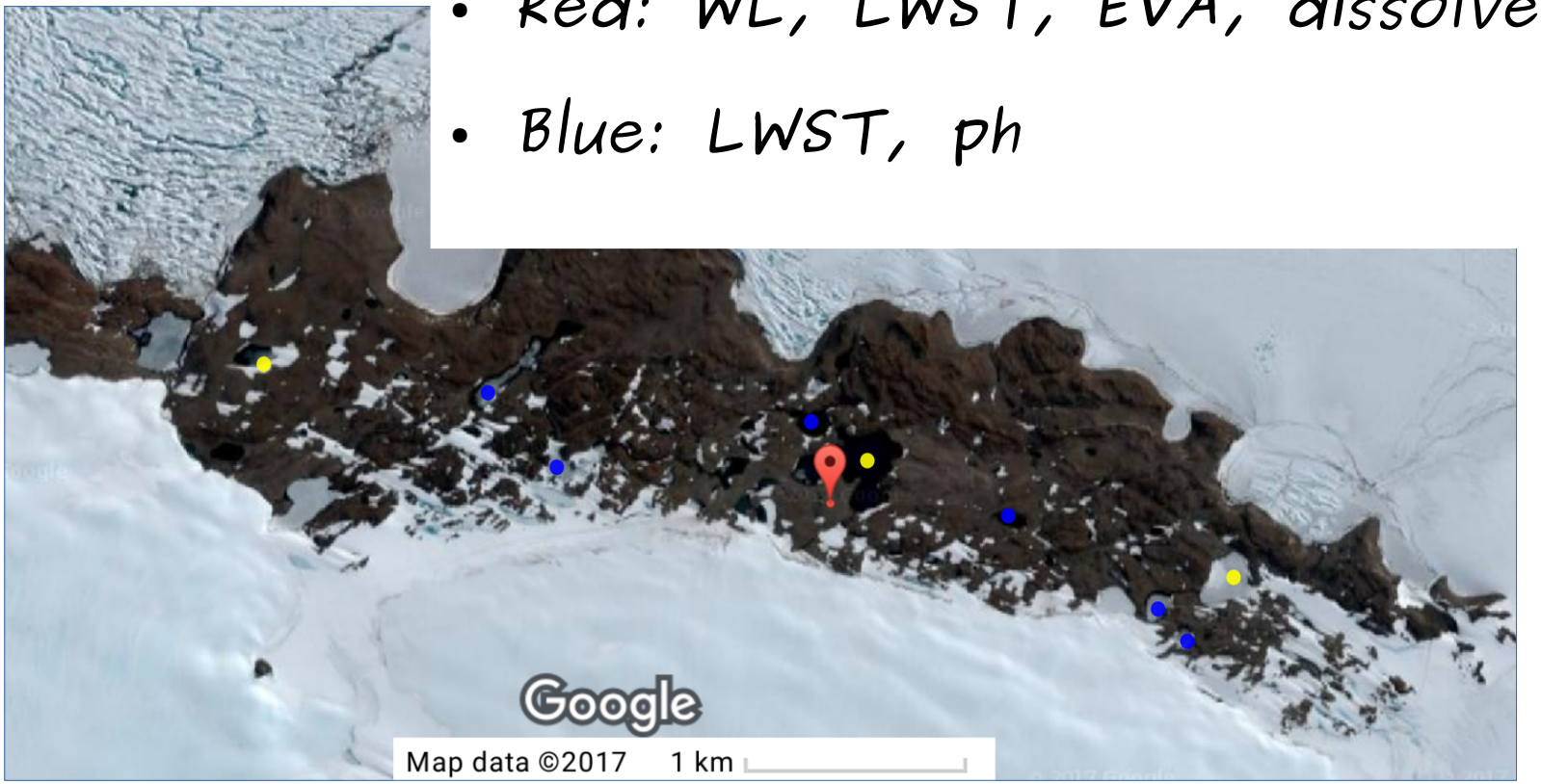


Measurements:

- absolute carbon dioxide
- water vapor densities
- three-dimensional wind speed
- sonic air temperature
- air temperature
- barometric pressure

Places and measurements …

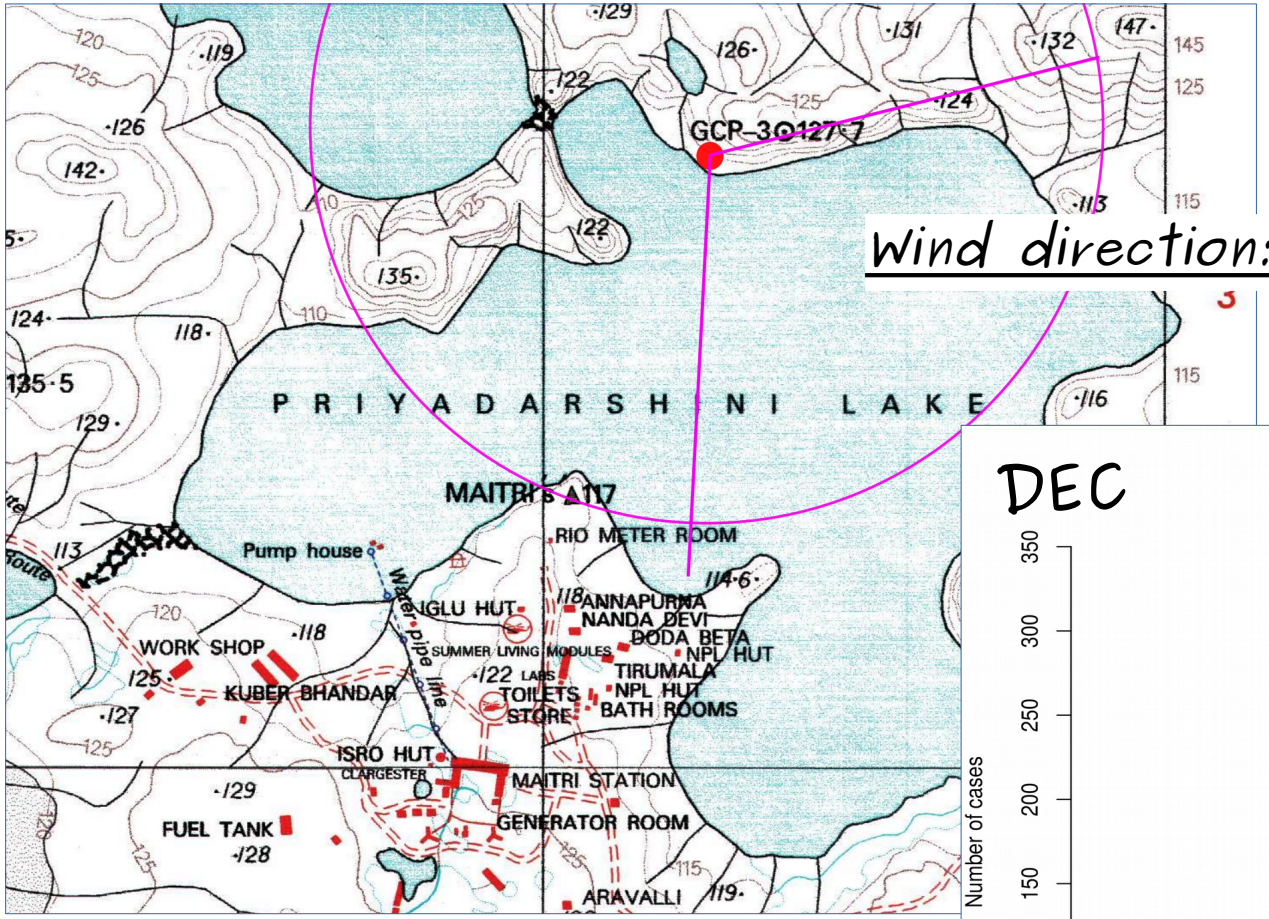
- Yellow: WL, LWST, ph
- Red: WL, LWST, EVA, dissolved CO2 (?)
- Blue: LWST, ph



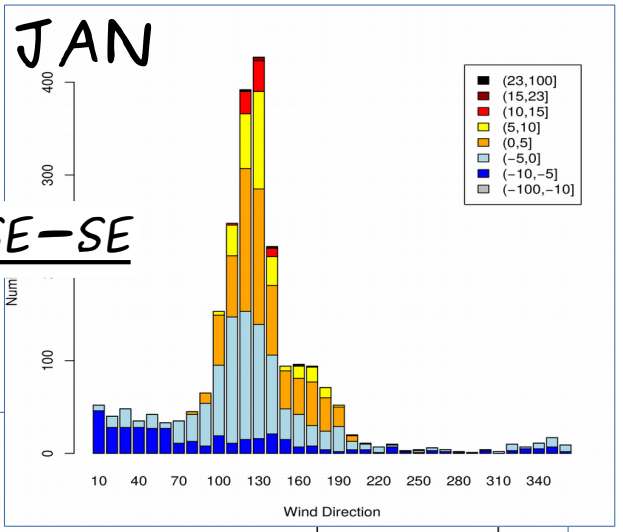
- Surface inflow/outflow, ground water level, snow properties …

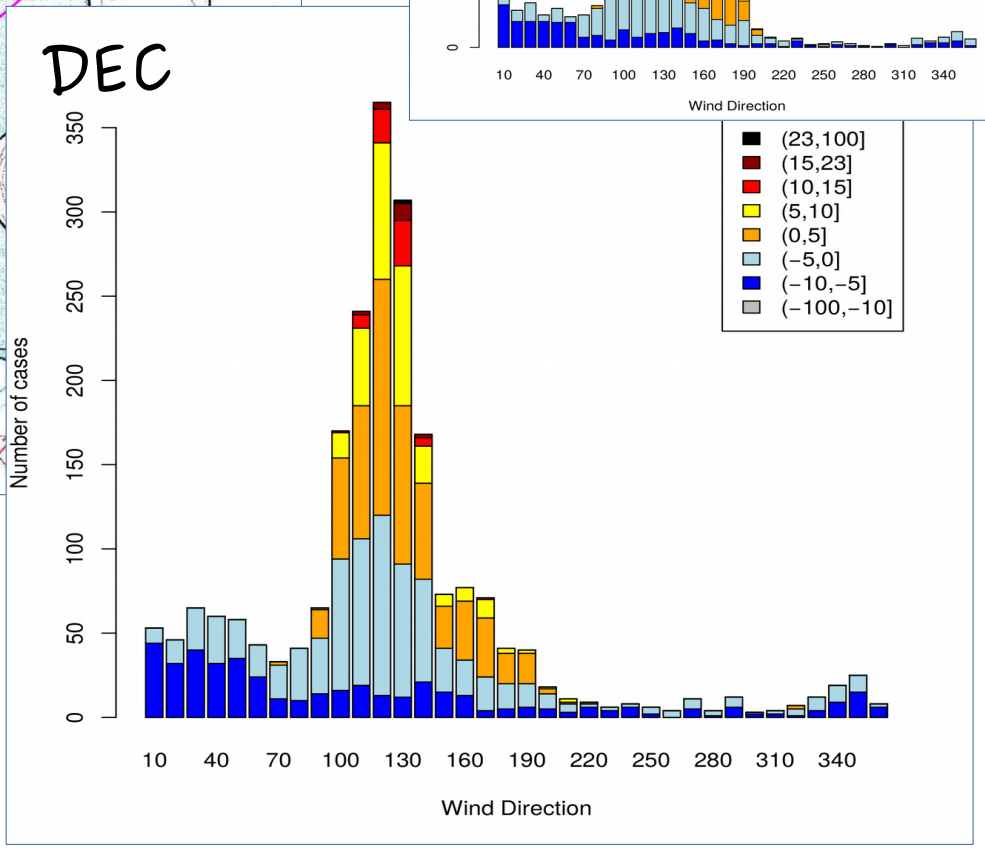
Lake ZUB/PRIYADARSHINI

Surface area: 0.46 km², max depth: 6 m



Wind direction: ESE–SE





Location of the towel on the coast: the sector indicates prevailing wind direction for DEC–JAN: (the fragment of the map 1:10000 by Indian Geodesic Survey, 2014).

Conclusions …

- The calculations of evaporation from lakes should be proved by direct measurements;
- The evaporation term could be important for endorheic lakes located in the polar regions;
- Our first Antarctic experiment with measuring by evaporation with method of eddy-covariance;
- Looking for questions and suggestions…

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Thank you for attention!

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