Summertime evaporation over glacial lakes in the Schirmacher oasis, East Antarctica

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with the contributions by
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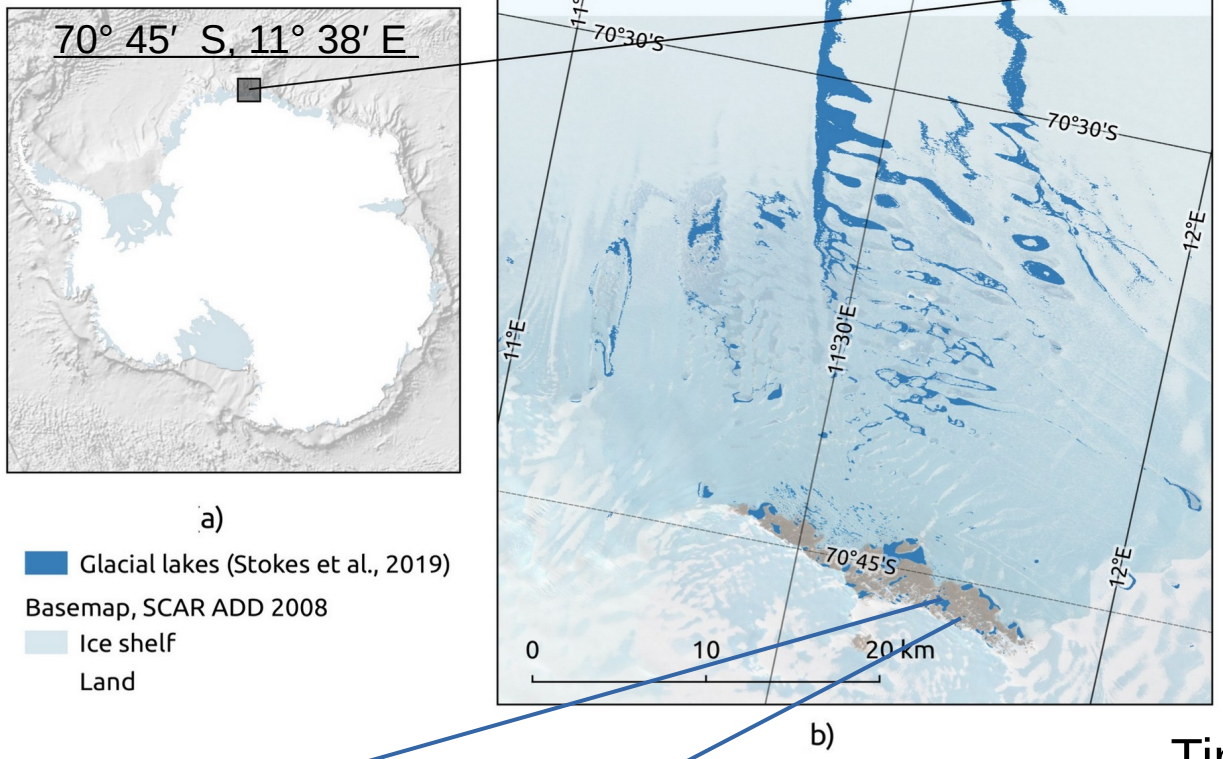

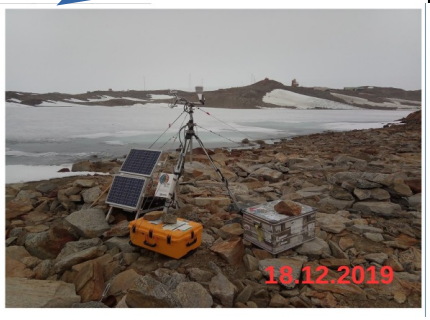

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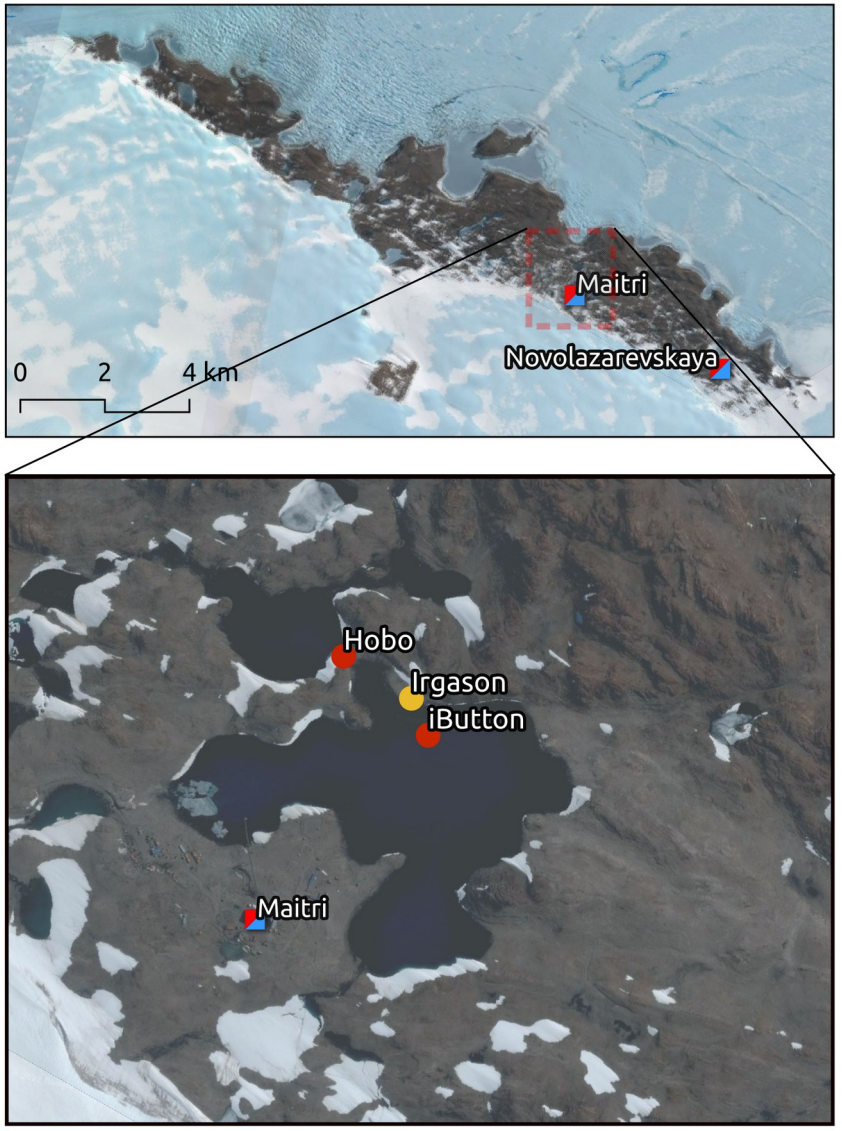
Data: summer 2018, Lake Zub/Priyadarshini



Surface area: 35 000 m^2
Volume: 10 000 m^3
Maximum depth: 6 m
Water temperature in summer: 6-8 °C

1st January
–
9th February

Irgason site:
- 3D wind speed, air temperature, H_2O concentration.

IButton and Hobo:
- lake's surface temperature.

Maitri site:
- air temperature, wind speed.

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Methods: direct and indirect

- **Eddy covariance method, E_{EC} (*ie.* Aubinet et al., 2012)**

Indirect methods, E_{mod}:

- Bulk-aerodynamic method (Heikinheimo et al., 1999);
- Mass (water) balance method;
- Energy balance method;
- Combination equations (Penman, 1948; Doorenbos and Pruitt, 1975; Odrova, 1979; Shuttleworth, 1993) + *new regional coefficents;*
- Isotopes' method ...

+ uncertanties inherent in the indirect methods;

+ efficiency of the indirect methods to reproduce the day-by-day evaporation over the lake surface (by the Pearson correlarion coefficent, the root square standard error and s/σ criteria, *ie.* Popov, 1976).

$$s = \sqrt{\sum_{i=1}^{n} \left(E_{EC}^{i} - E_{mod}^{i}\right)^2 / (n-m)} \qquad \sigma = \sqrt{\sum_{i=1}^{n} \left(E_{EC}^{i} - \bar{E}_{EC}\right)^2 / n}$$

Results

Method	Min/Max, mm	Mean ± SD	Sum, mm
Eddy covariance	**1.4 – 5.0**	**3.0 ± 1.1**	**114**
Bulk-aerodynamic	0.6 / 3.5	2.0 ± 0.8	78
Shuttleworth, 1993	0.2 / 1.8	1.0 ± 0.4	38
Penman, 1948	0.0 / 2.0	1.3 ± 0.5	48
Doorenbos and Pruitt, 1975	0.0 / 2.9	1.8 ± 0.8	68
Odrova, 1979	0.1 / 1.3	0.8 ± 0.3	32

- All methods underestimated the evaporation over the surface of the glacial lake: from 32 % (the bulk-aerodynamic method) to over 40 – 72 % (the combination equations).
- The indexes of the efficiency of the all methods are too low, and it means that none of the methods considered can be suggested to evaluate the day-by-day evaporation.
- The regional coefficients for the combination equation were derived, however the formula needs testing with the independent data.

Conclusions ...

- The results show that in summer up to 5 mm of water evaporated daily from the ice-free surface of the glacial lake located in Antarctica.
- The selected indirect methods underestimated the evaporation over the lakes' surface from 32 to 72%.
- The results are important for estimating the evaporation over polar regions where a growing amount of melted water is recently evident.

… next steps

- to estimate the evaporation over the ice breaking period;
- to investigate the intra daily cycle of the evaporation;
- to evaluate the uncertainties inherent in the energy balance method;
- to estimate the efficiency of new regional combination equation with independent data; ...

Lake Glubokoe: summer 2019-2020

The Cryosphere

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