MODELING THE MULTIANNUAL THERMAL DYNAMICS OF LAKE ISEO: A 1-D APPROACH

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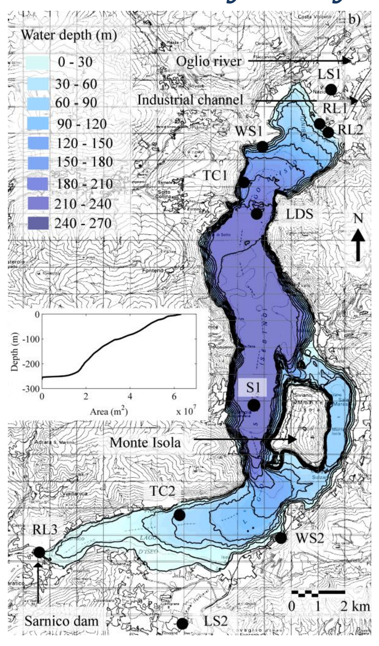
1. STUDIED CASE

Syntetic information about Iseo bathymetry and morphology

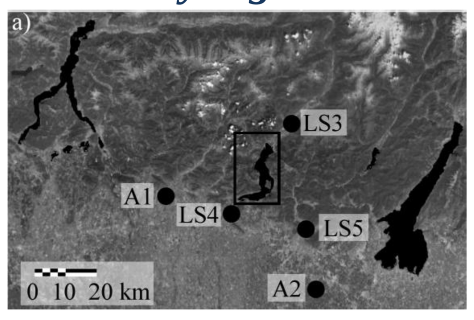
Location	Area	Volume	Average level	Average depth	Max depth	Theor renewal time	Catchment area
N 45°44' - E 10°04'	60.9 km²	7.9 km³	185 m a.s.l.	125 m	251 m	4.2 years	1785 km²

Iseo bathymetry



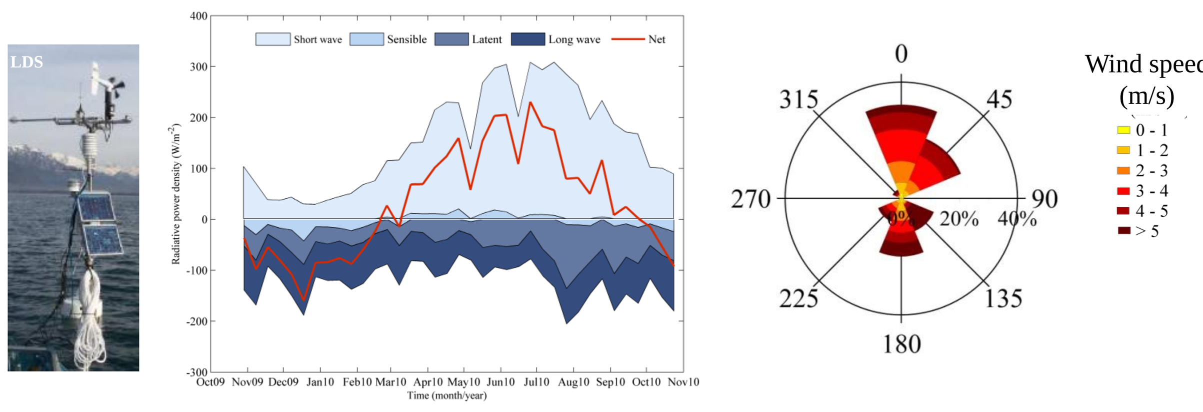
Lake Iseo is a deep prealpine lake located in the northern part of Italy (Lombardy). Historically classified as warm monomictic, starting from the end of the'80 its deep-waters underwent a process of deoxygenation (Garibaldi et al. 1999) so that the possibility of evolution of this lake toward meromixis was postulated (Ambrosetti and Barbanti 2005).
A good understanding of heat distribution in this fragile ecosystem is a prerequisite for investigating the interactions between physical and ecological components and for forecasting its evolution.

Lombardy region

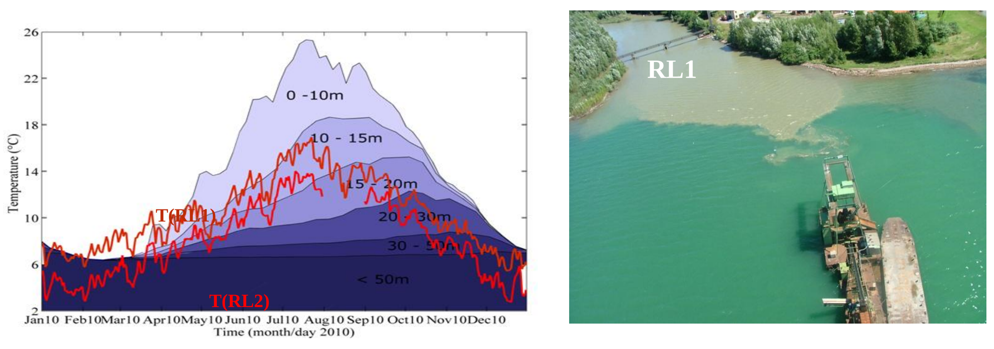


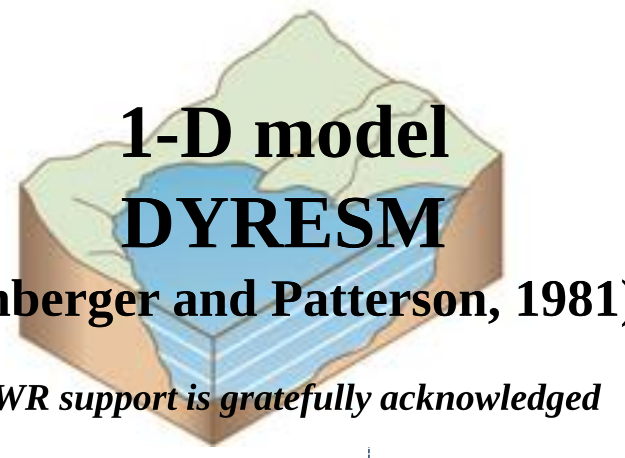
2. MODEL CALIBRATION (2010)

2A. Thermal fluxes and wind speed on the lake surface



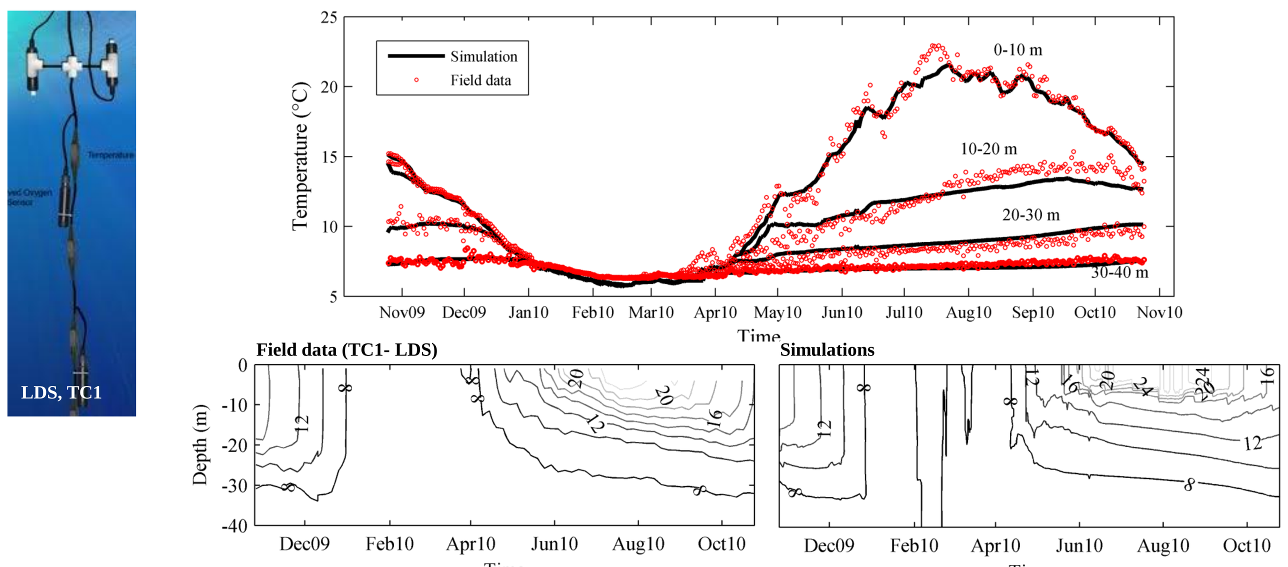
2B. Main affluents : temperature, discharge





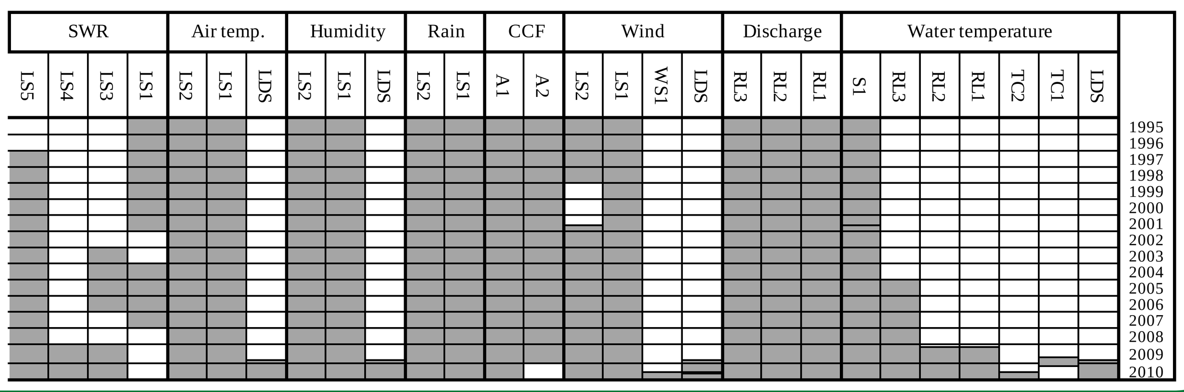
2C. Results

Parameter	Calibrated value	Unit
Vertical mixing coeff. (Yeates et al. 2003)	5000	-
Minimum layer hight	3	m



3. MODEL VALIDATION (1995 – 2010)

Data availability:

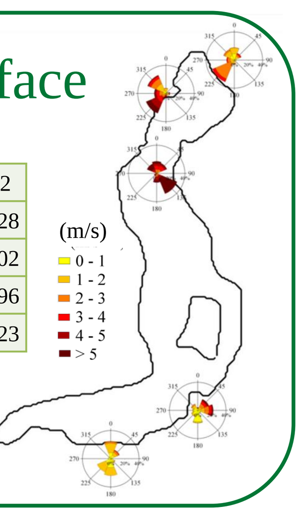


3A. Thermal fluxes and wind speed at the lake surface

$$Wsp = \begin{cases} M_1 \cdot Wsp(LS1) & [\text{h. } 22\text{-}06] \\ M_2 \cdot Wsp(LS1) & [\text{h. } 06\text{-}11] \\ M_3 \cdot Wsp(LS1) & [\text{h. } 11\text{-}18] \\ M_4 \cdot Wsp(LS2) & [\text{h. } 18\text{-}22] \end{cases}$$

	01	02	03	04	05	06	07	08	09	10	11	12
M1	3.51	2.52	3.30	2.40	2.48	3.82	3.15	3.91	3.49	4.47	4.85	5.28
M2	3.26	4.04	3.64	3.67	2.96	2.83	2.89	2.96	3.01	3.35	3.70	4.02
M3	2.63	2.39	2.37	2.31	2.07	2.05	2.14	2.12	2.21	2.32	2.64	2.96
M4	3.02	2.57	2.36	2.20	2.27	2.33	2.30	2.39	2.48	2.48	2.87	3.23

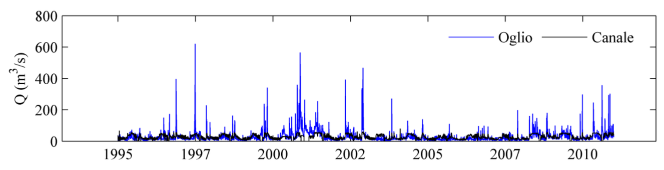
$$QN_{lw} = \left(1 - r_a^{lw}\right)\left(1 + 0.17CCF^2\right)\varepsilon_a \sigma \left(T_a + 273.15\right)^4 - \varepsilon_w \sigma \left(T_w + 273.15\right)^4$$



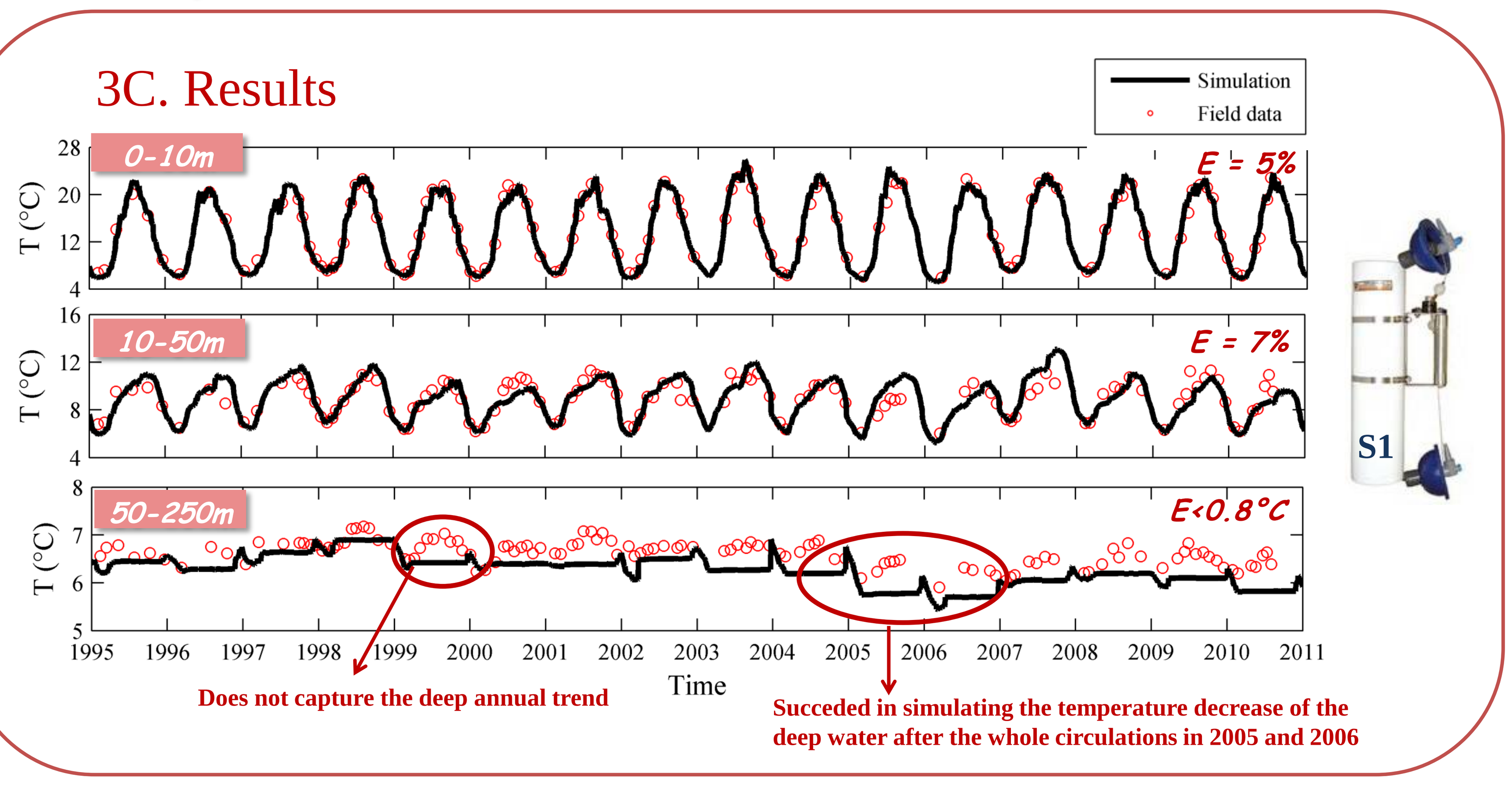
3B. Main affluents : temperature, discharge

$$T(RL1) = \begin{cases} 5.9 + 0.357T_{air} & (22/06\text{-}1/03) \\ 6.29 + 0.263T_{air} & (1/03\text{-}22/06) \end{cases};$$

$$T(RL2) = -2.92 + 1.073T(RL1)$$



3C. Results



4. CONCLUSIONS

✓DYRESM proved effective in simulating the thermal structure of the lake over the last 15 years, reproducing both the seasonal trend of the surface layers and some important aspects of the deep water interannual dynamics. This is of particular relevance in the prealpine area, where the deep-water mixing of several deep lakes resulted susceptible to interannual variations in meteorological condition (e.g. Livingston, 1997).

✓ The discrepancies between the observed and simulated temperatures are probably due to an insufficient modelling of internal mixing, partially compensated by the calibration of an high CLN value, as already reported for other deep lakes (e.g. Perroud et al., 2009).

✓ Interflow dominates Iseo affluent regime during most of the year, so becoming an important regulator of lake thermal regime.

✓ The model sensitivity highlighted the key-role played by the wind on the water temperature distribution, so emphasizing the need of direct wind measurements on the lake surface, especially in presence of a rugged topography such as the one that surrounds most alpine and prealpine lakes.

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