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An update of the acidification and nitrogen status of high altitude lakes in the Alps: 2017 vs 1980s

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UNECE CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION
Joint 34th ICP Waters and 26th ICP IM Task Force Meeting
Warsaw, Poland, 7-9 May 2018

CNR ISE long-term studies on remote lakes

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Earliest study in the 1950s

Water chemistry, biology, palaeolimnology

Atmospheric deposition

Meteo-climate

MOLAR
Mountain Lake Research

Euro-limpacs

wge
Working Group on Effects of the Convention on Long-range Transboundary Air Pollution

EMERGE

RECOVER:2010

ICP WATERS

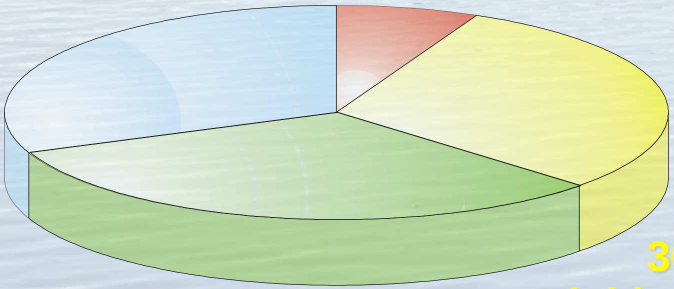
LRTAP
Long-range Transboundary Air Pollution

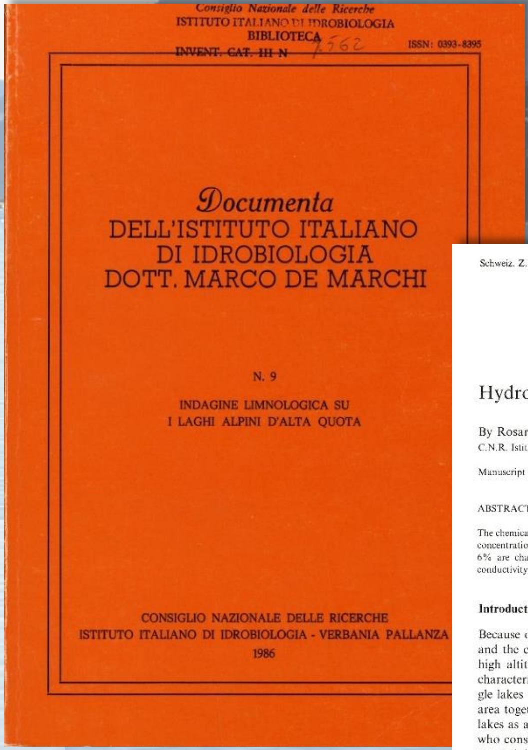
LTER

NextData

Studies on high altitude lakes in the Central Alps

- ✓ 1978: research study on acidification of lakes by CNR
- ✓ 1979: official «call» on the national journal of the Italian Alpine Club (CAI)
- ✓ 1981: 370 samples collected from 207 lakes (900-2800 m a.s.l.) over the Alps





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INDAGINE LIMNOLOGICA SU I LAGHI ALPINI D'ALTA QUOTA

CONSIGLIO NAZIONALE DELLE RICERCHE
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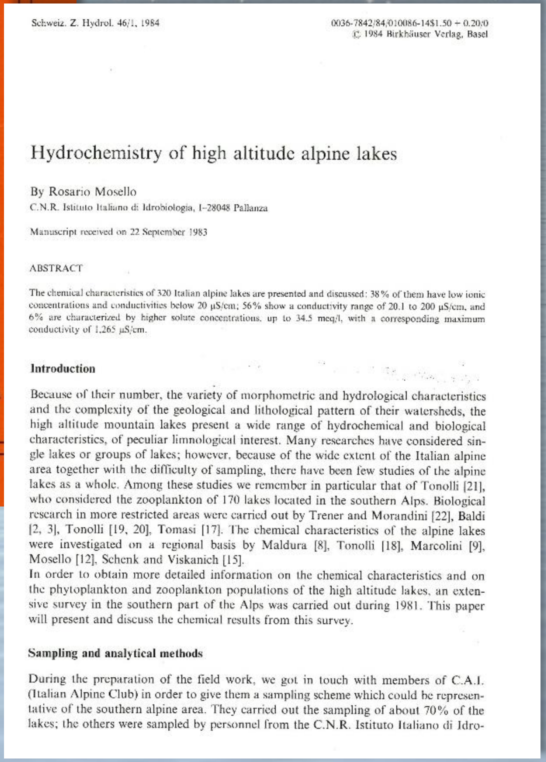
1986



Schweiz. Z. Hydrol. 46/1, 1984

0036-7842/84/010086-14$1.50 + 0.20/0
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Hydrochemistry of high altitude alpine lakes

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Manuscript received on 22 September 1983

ABSTRACT

The chemical characteristics of 320 Italian alpine lakes are presented and discussed: 38% of them have low ionic concentrations and conductivities below 20 µS/cm; 56% show a conductivity range of 20.1 to 200 µS/cm, and 6% are characterized by higher solute concentrations, up to 34.5 meq/l, with a corresponding maximum conductivity of 1,265 µS/cm.

Introduction

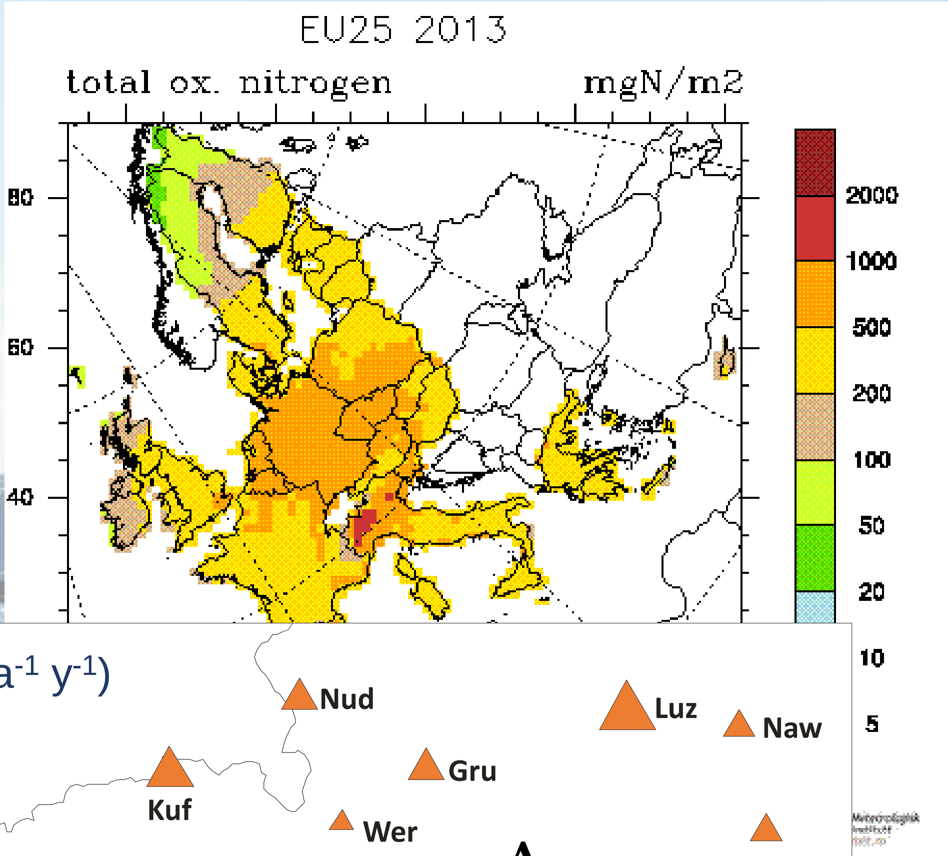
Because of their number, the variety of morphometric and hydrological characteristics and the complexity of the geological and lithological pattern of their watersheds, the high altitude mountain lakes present a wide range of hydrochemical and biological characteristics, of peculiar limnological interest. Many researches have considered single lakes or groups of lakes; however, because of the wide extent of the Italian alpine area together with the difficulty of sampling, there have been few studies of the alpine lakes as a whole. Among these studies we remember in particular that of Tonolli [21], who considered the zooplankton of 170 lakes located in the southern Alps. Biological research in more restricted areas were carried out by Trener and Morandini [22], Baldi [2, 3], Tonolli [19, 20], Tomasi [17]. The chemical characteristics of the alpine lakes were investigated on a regional basis by Maldura [8], Tonolli [18], Marcolini [9], Mosello [12], Schenk and Viskanich [15].
In order to obtain more detailed information on the chemical characteristics and on the phytoplankton and zooplankton populations of the high altitude lakes, an extensive survey in the southern part of the Alps was carried out during 1981. This paper will present and discuss the chemical results from this survey.

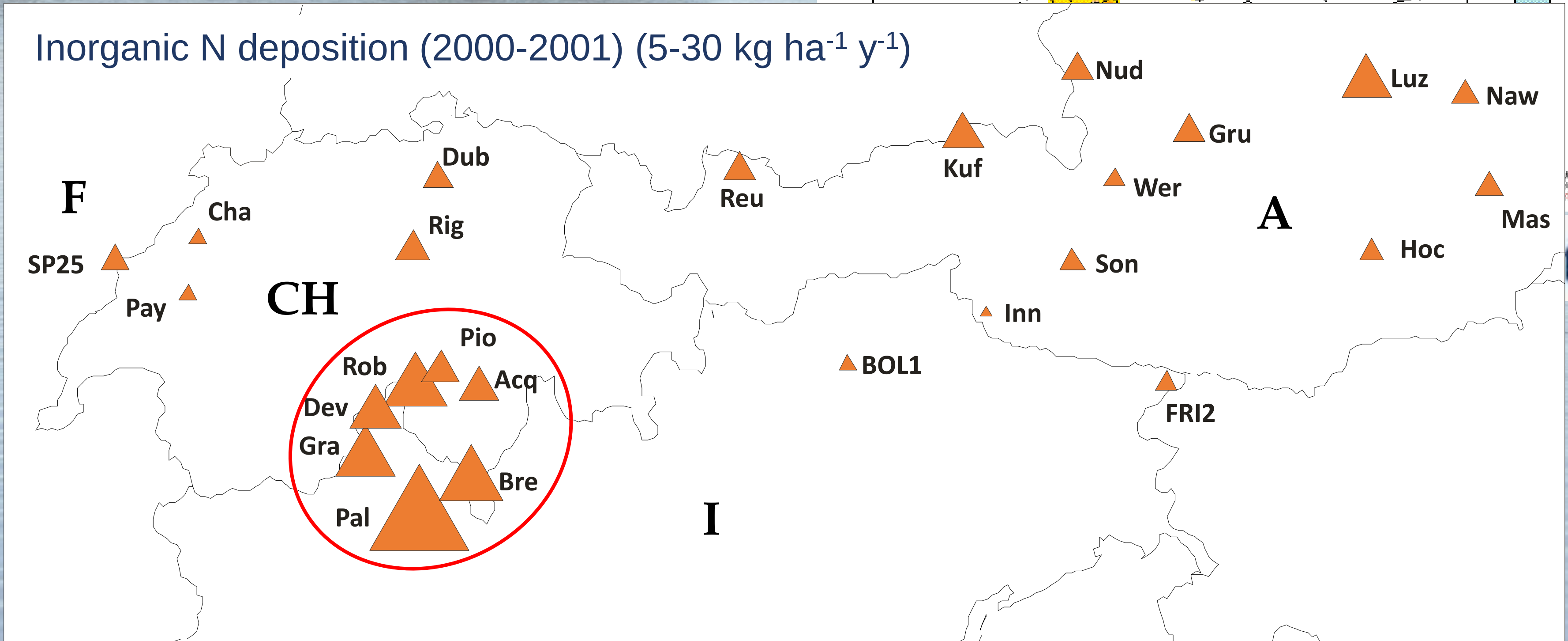
Sampling and analytical methods

During the preparation of the field work, we got in touch with members of C.A.I. (Italian Alpine Club) in order to give them a sampling scheme which could be representative of the southern alpine area. They carried out the sampling of about 70% of the lakes; the others were sampled by personnel from the C.N.R. Istituto Italiano di Idro-

Study area

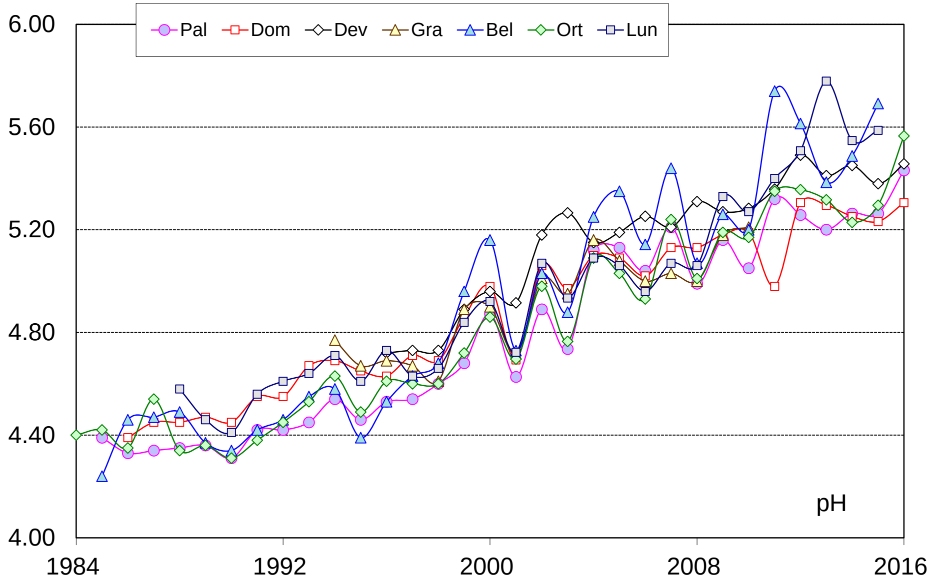
The study area (Lake Maggiore watershed, North-Western Italy) has always been a «critical» area from the point of view of acidity and nitrogen deposition, due to its location North of the Po Valley

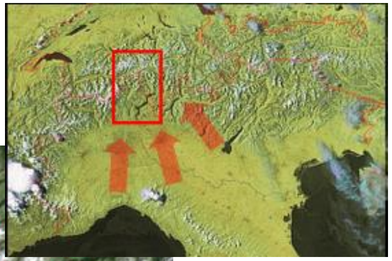


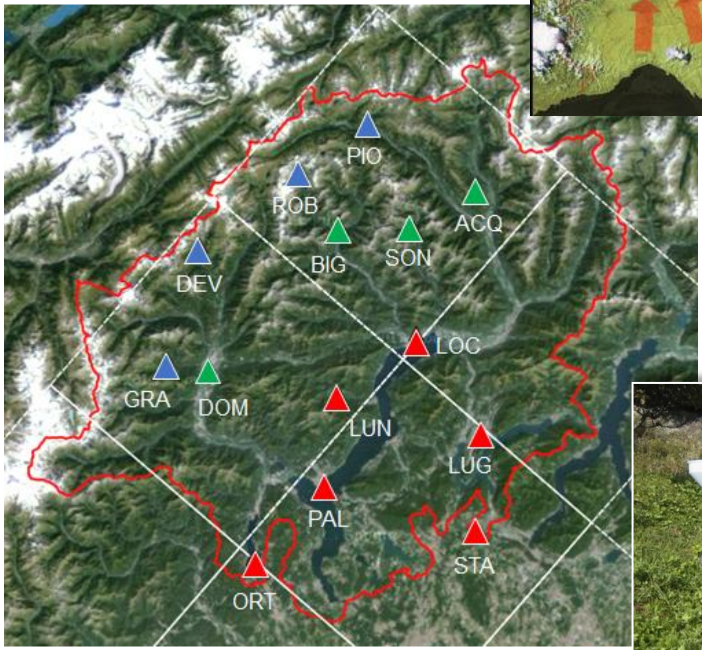


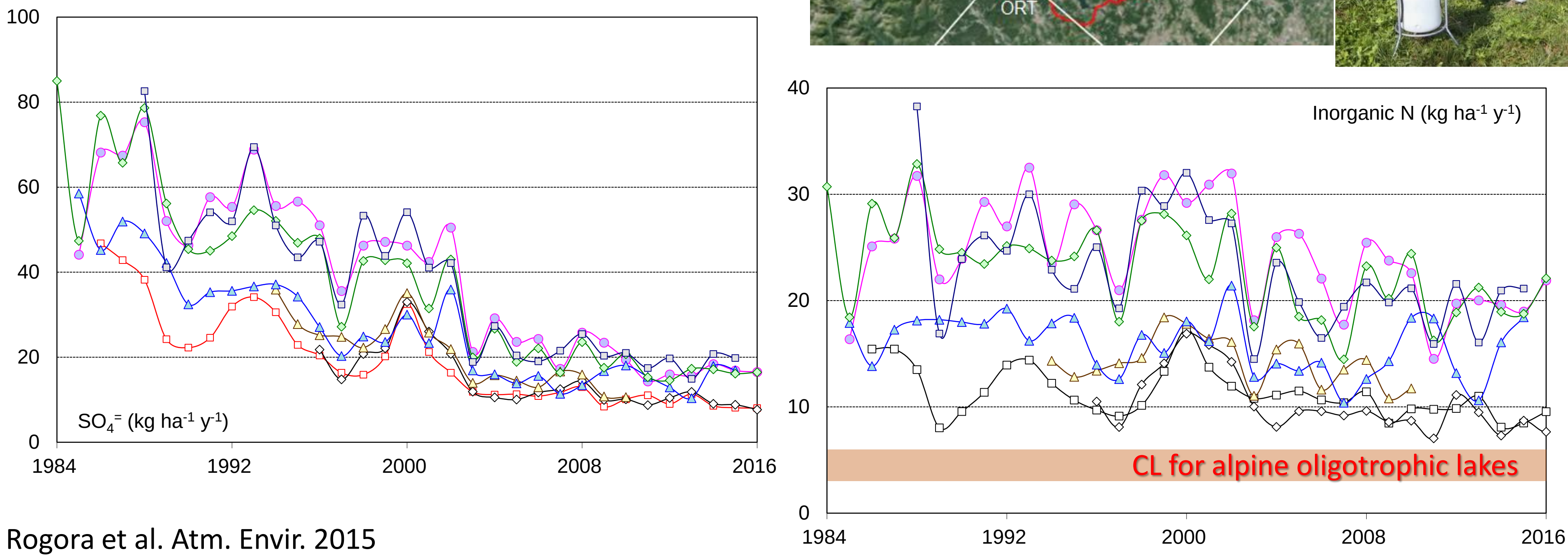
Rogora et al. Hydrobiologia. 2006.

Long-term trends of atmospheric deposition









Rogora et al. Atm. Envir. 2015

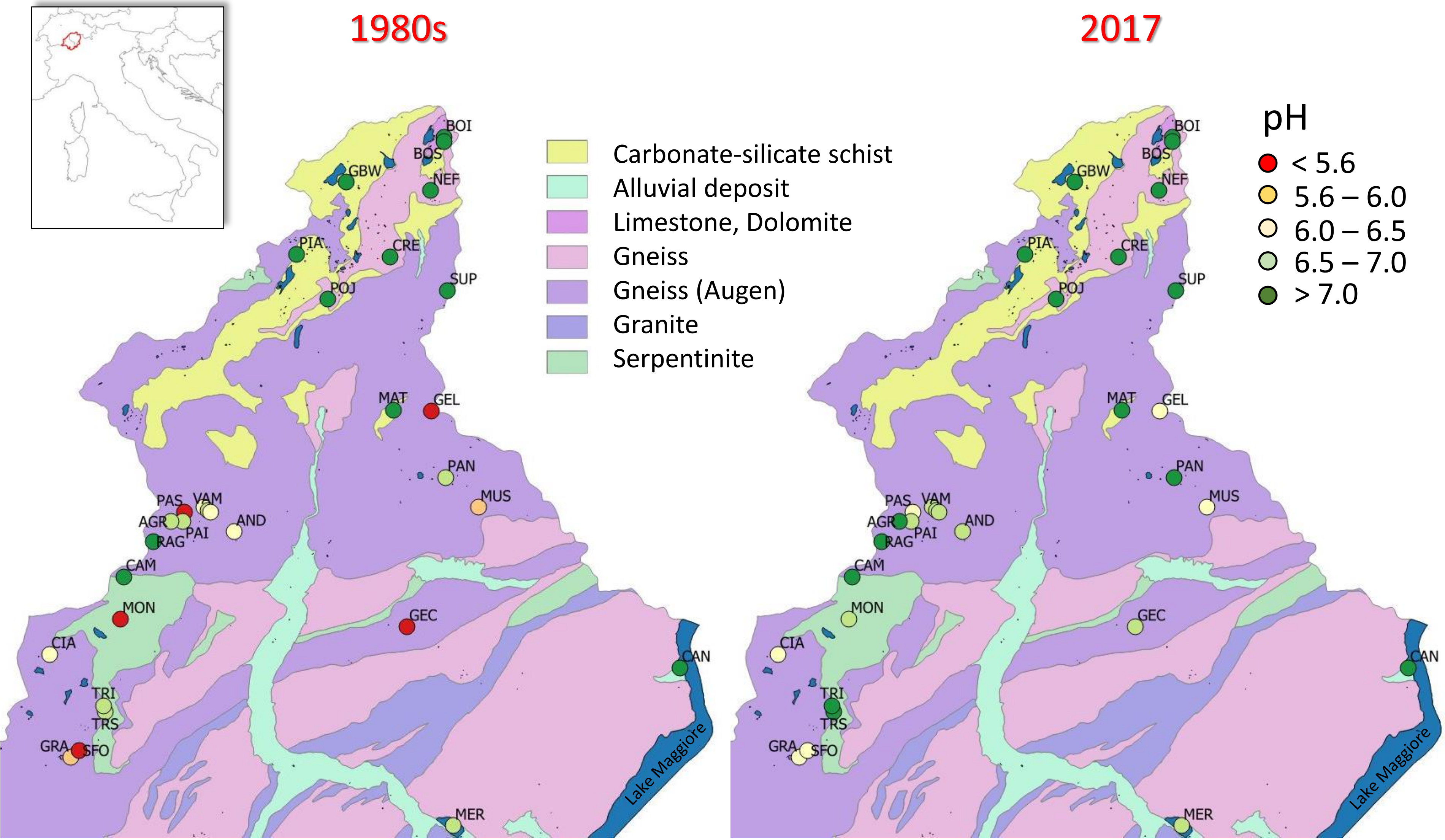
Update of monitoring data for ICPW sites and high altitude lakes

Chemical survey of 31 sites in 2017:

- 29 high altitude lakes, including ICPW IT01and IT03 (> 2000 m a.s.l.)
- 1 subalpine lake (IT02), 1 stream (IT04)

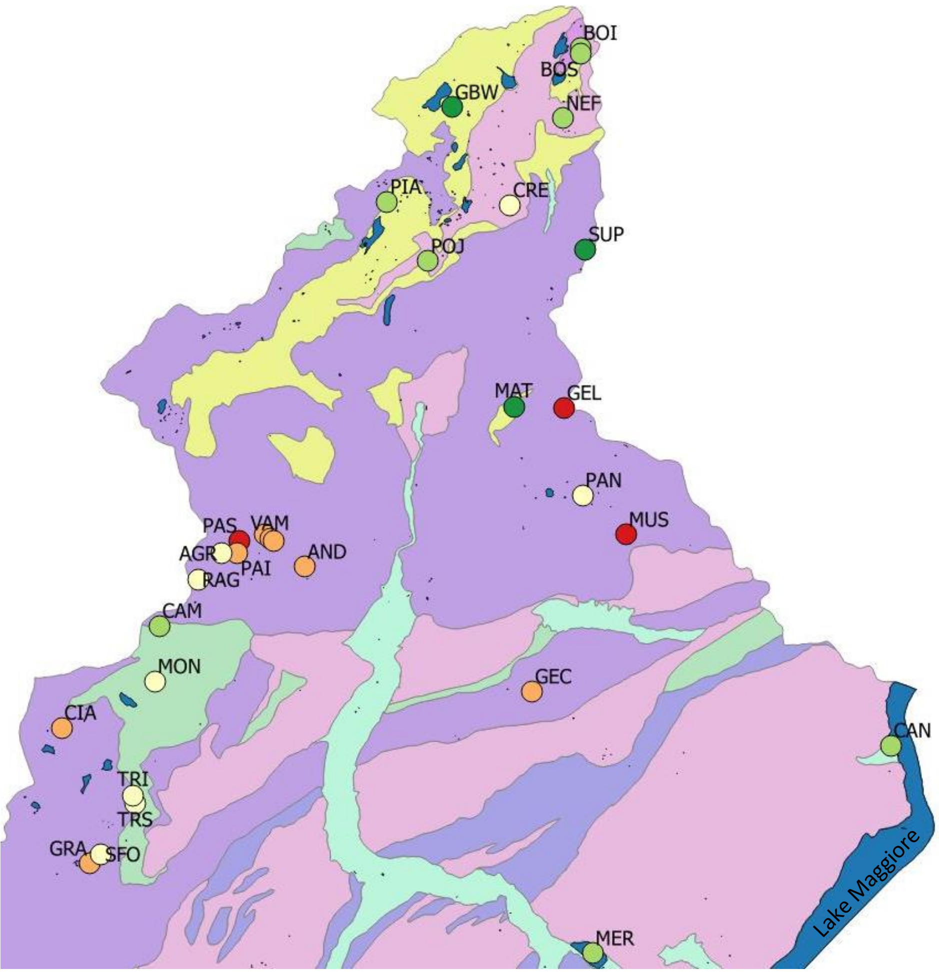
Long- term continuous data for ICPW sites, sparse surveys for the high altitude lakes since the 1980s

pH

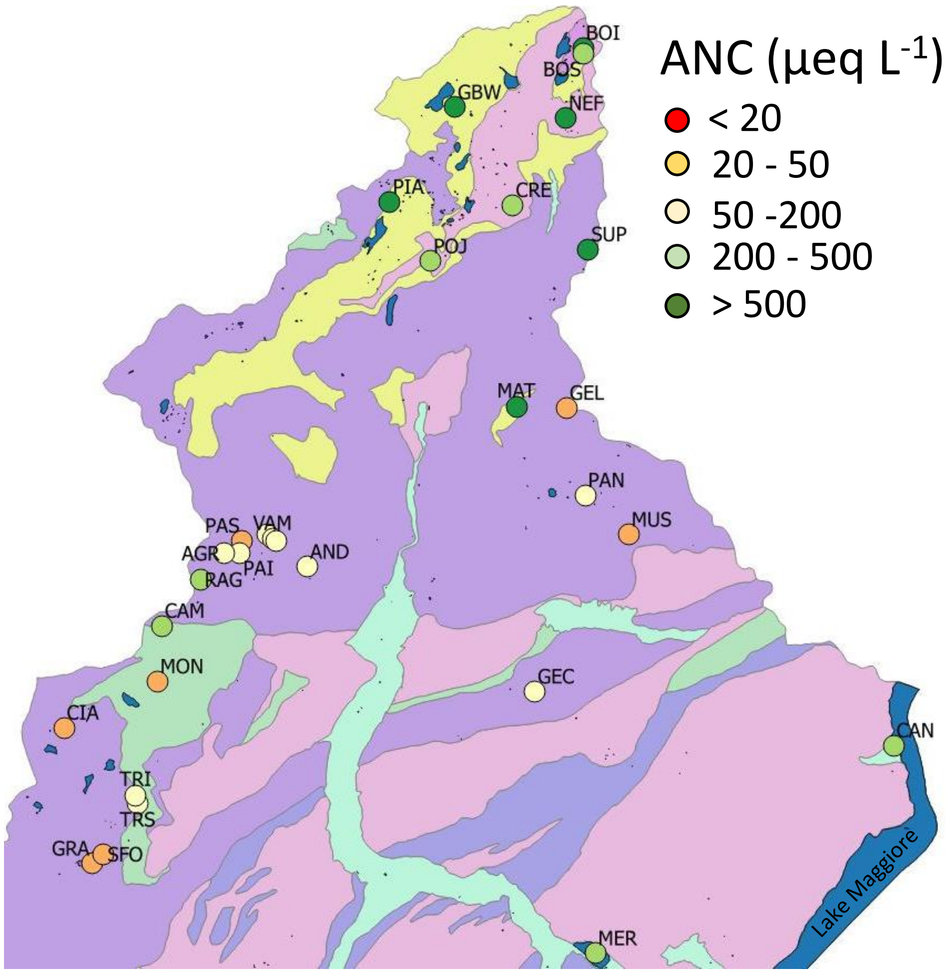

1980s
2017
Carbonate-silicate schist
Alluvial deposit
Limestone, Dolomite
Gneiss
Gneiss (Augen)
Granite
Serpentinite
pH
< 5.6
5.6 – 6.0
6.0 – 6.5
6.5 – 7.0
> 7.0
BOI
BOS
NEF
GBW
PIA
CRE
POJ
SUP
MAT
GEL
PAN
MUS
PAS
VAM
AGR
PAI
AND
RAG
CAM
MON
GEC
CIA
CAN
TRI
TRS
GRA
SFO
MER
Lake Maggiore

ANC

1980s



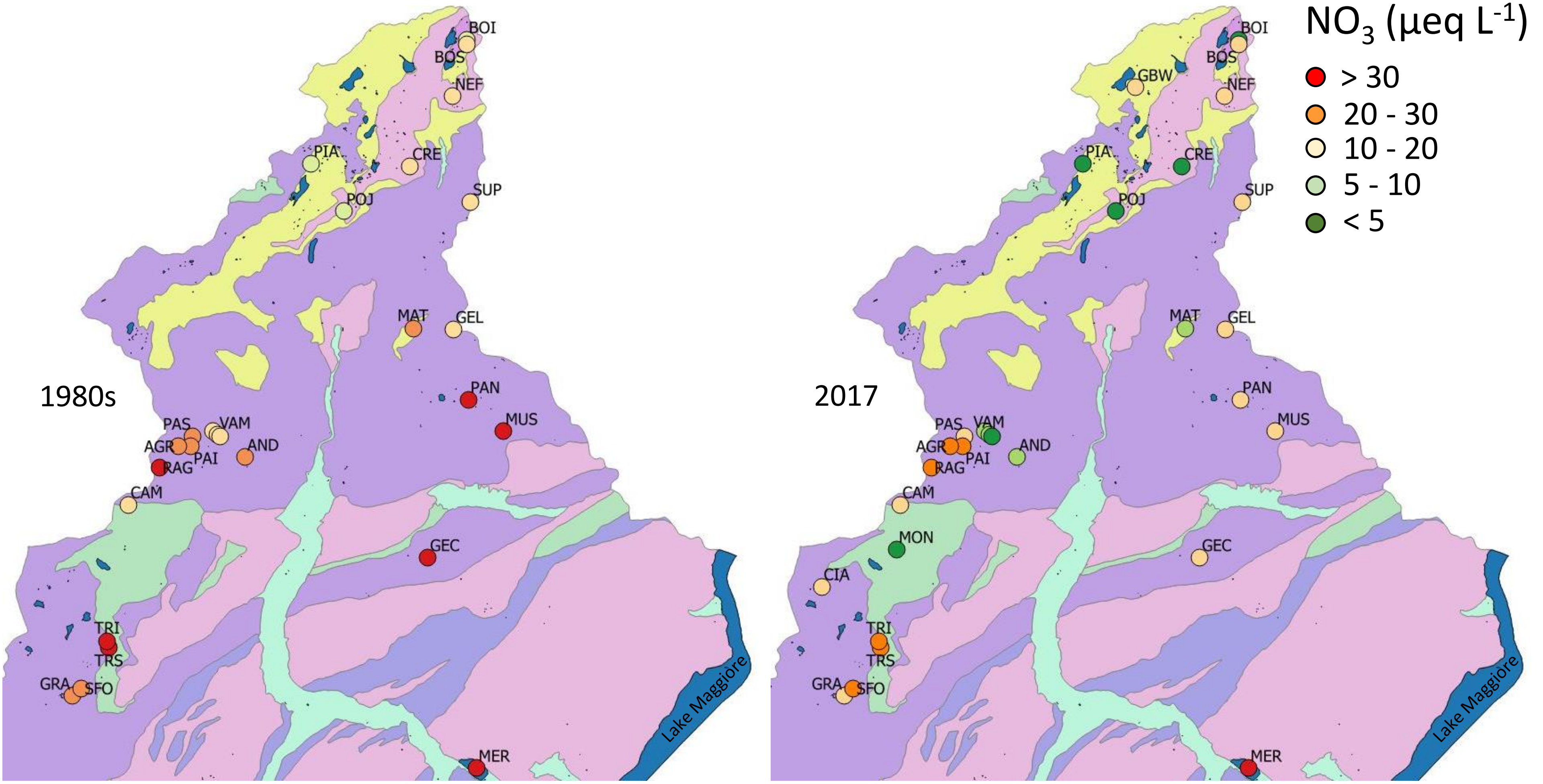
2017

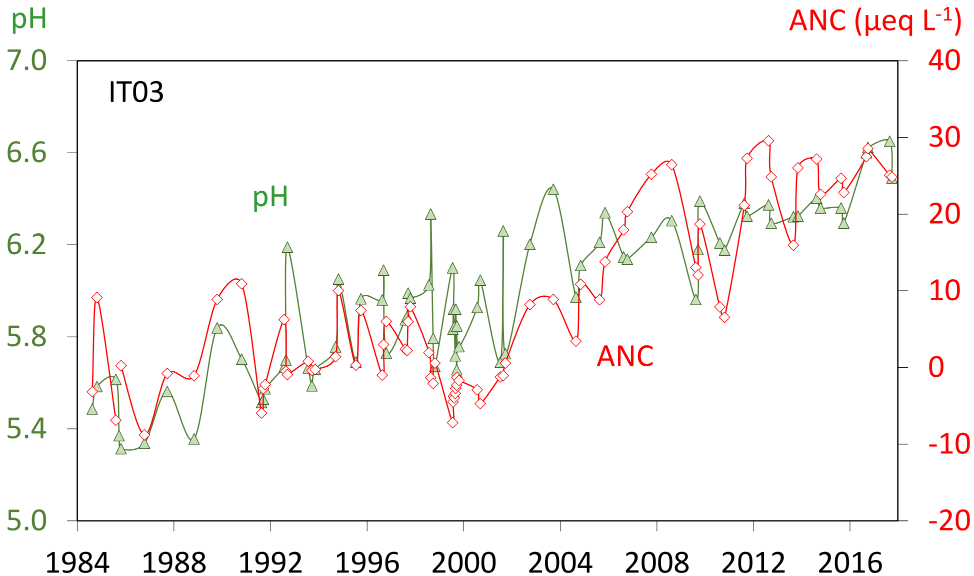


NO_3

1980s

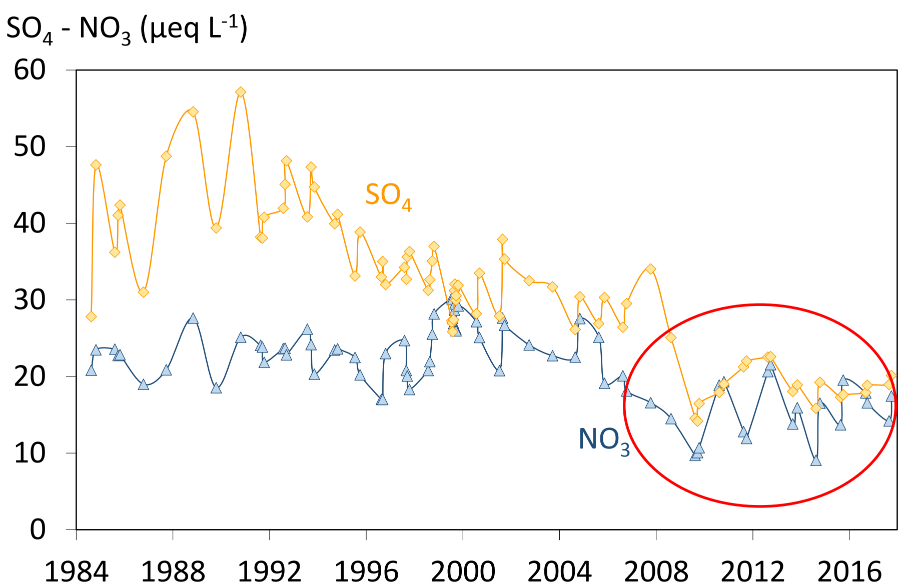
2017

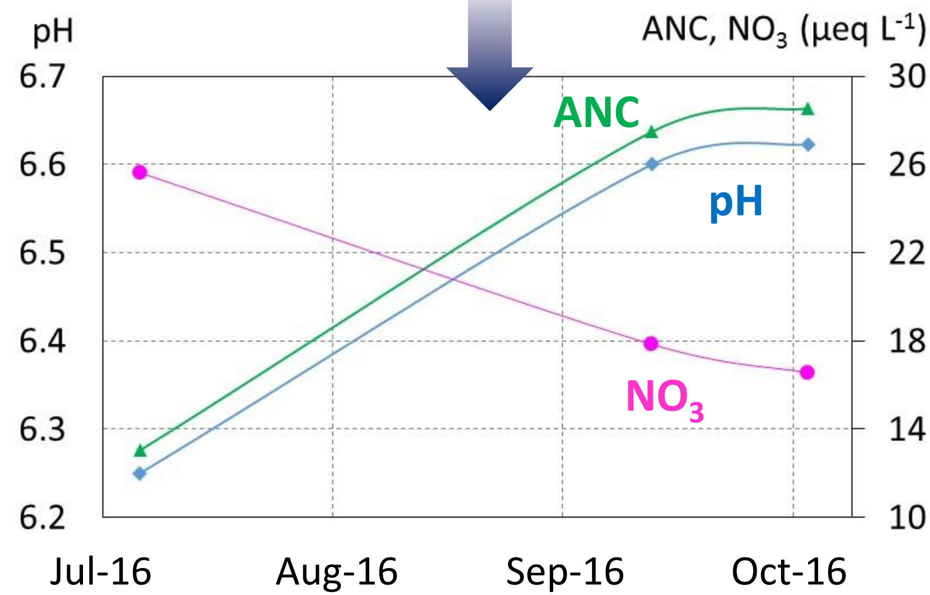




Despite the recent decrease of NO_3 concentrations, NO_3 is at present the main acidifying agent for these lakes

The effects are mainly evident at snowmelt





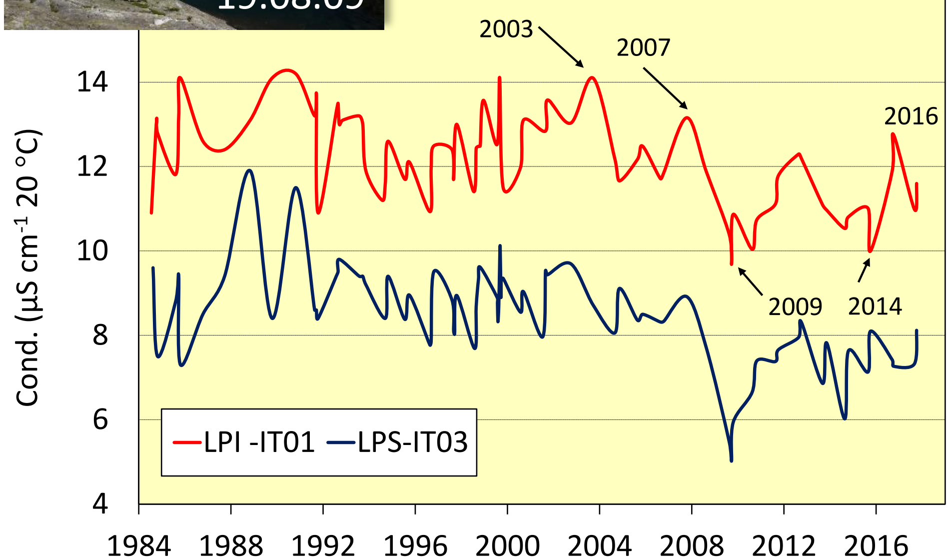
Seasonal and short-term variability

Mean differences between the values of the main chemical variables in autumn (late September/early October) and at snowmelt (late June/early July) for 20 lakes

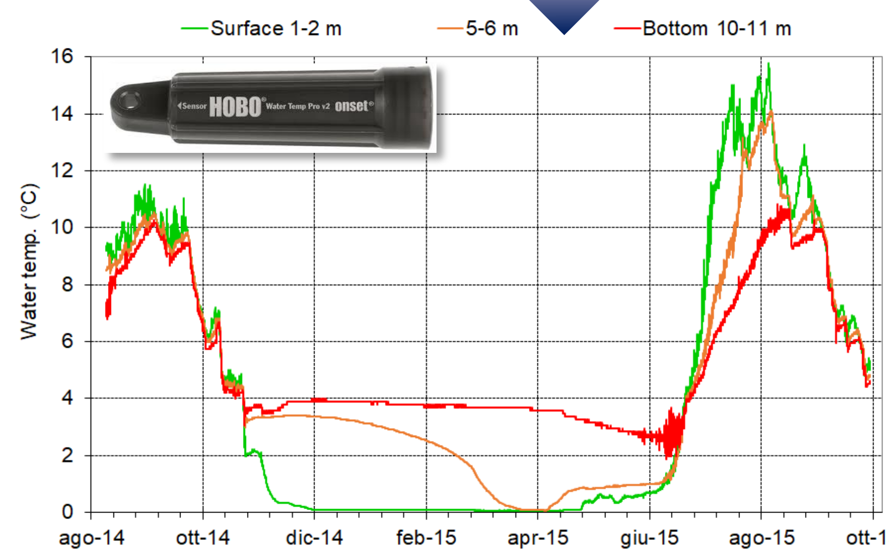
Rogora et al., WASP 2013

	Cond.	H^+	Ca^{++}	Mg^{++}	Na^+	K^+	Alk.	$SO_4^=$	NO_3^-	Cl^-	RSi	DOC
Mean diff.	1.55	−0.01	12.75	1.72	2.34	1.16	8.18	7.59	−0.23	0.11	0.13	0.15
N (*t* test)	14	6	16	15	13	10	14	17	4	–	13	13

Climate role: short-term effects (↓pH, ↓Alk, ↑NO_3, ↑Al) more pronounced after winter with above-average amount of snow



High-frequency monitoring of lake water temperature and level



The study lakes showed an evident recovery from acidification

N deposition is still important and NO_3 is at present the main acidifying agent for the lakes

It is important to consider interannual variability and effects of climate drivers in the overall assessment of acidification status

Thank you for your attention

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