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MERCURY IN SHALLOW AND DEEP LAKES WITHIN A MERCURY HOTSPOT OF THE SOUTHEASTERN PATAGONIAN ANDES: INSIGHTS INTO SPATIAL AND SEASONAL PATTERNS

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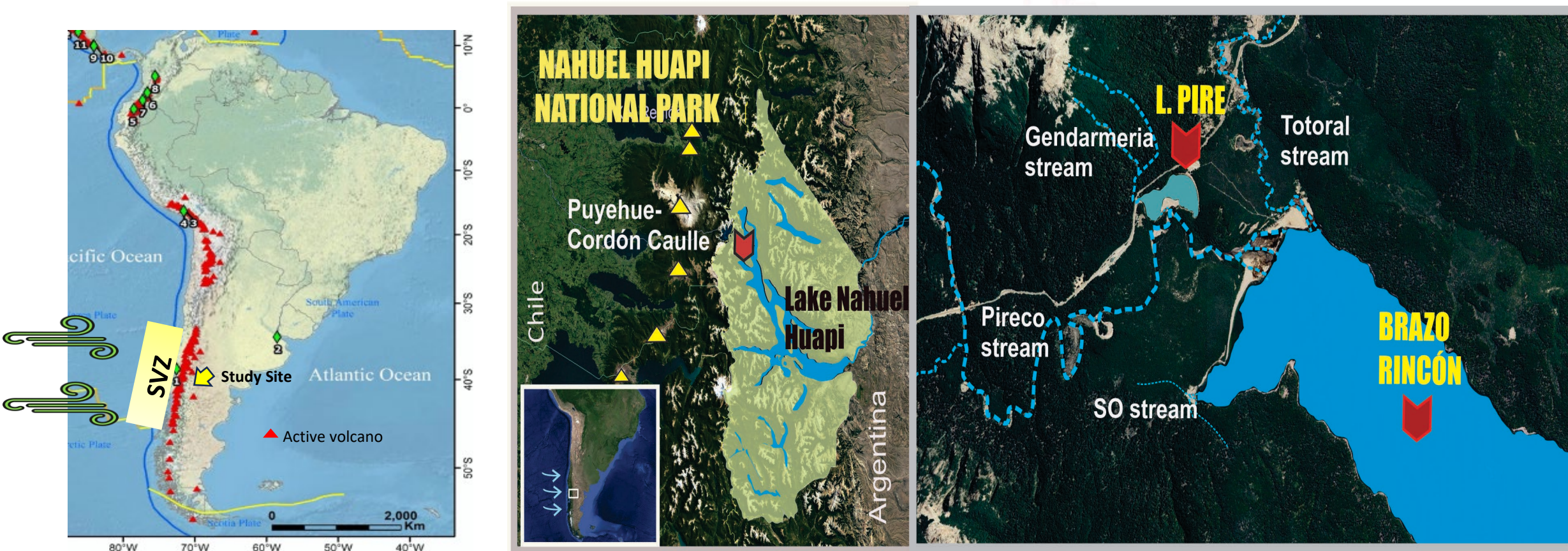
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This study focuses on the characterization of Hg patterns in aquatic systems draining a catchment of the Patagonian Andes, located in the Southern Volcanic Zone (SVZ) and considered a natural hotspot of Hg



WHAT MAKES THIS ANDEAN-PATAGONIAN CATCHMENT INTERESTING FOR THE STUDY OF HG?

SOURCES

- VOLCANIC ACTIVITY IN THE ANDES MOUNTAIN RANGE (SVZ)
- RE-EMISSION FROM THE PACIFIC OCEAN

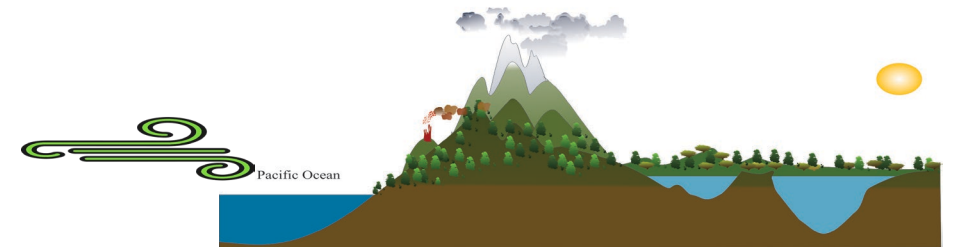
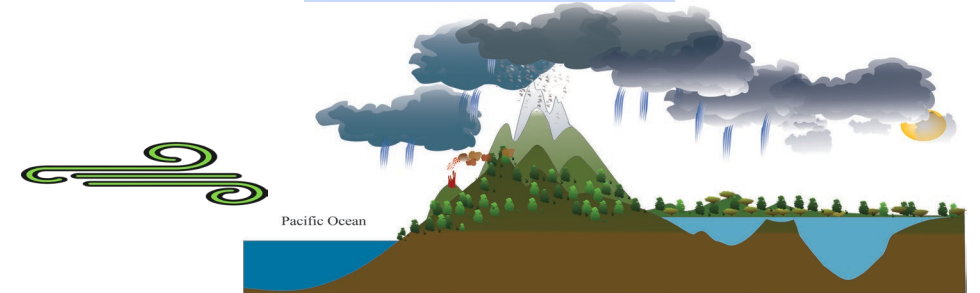
TRANSPORT

- SOUTH PACIFIC WINDS BLOWING YEAR-ROUND

(Atmospheric THg ~ 10 ng m⁻³)

DEPOSITION

- WET DEPOSITION FAVORED BY EXTREME OROGRAPHIC PRECIPITATION ON THE ANDES FLANKS
- DRY DEPOSITION FAVORED BY NATIVE FOREST



AND ...



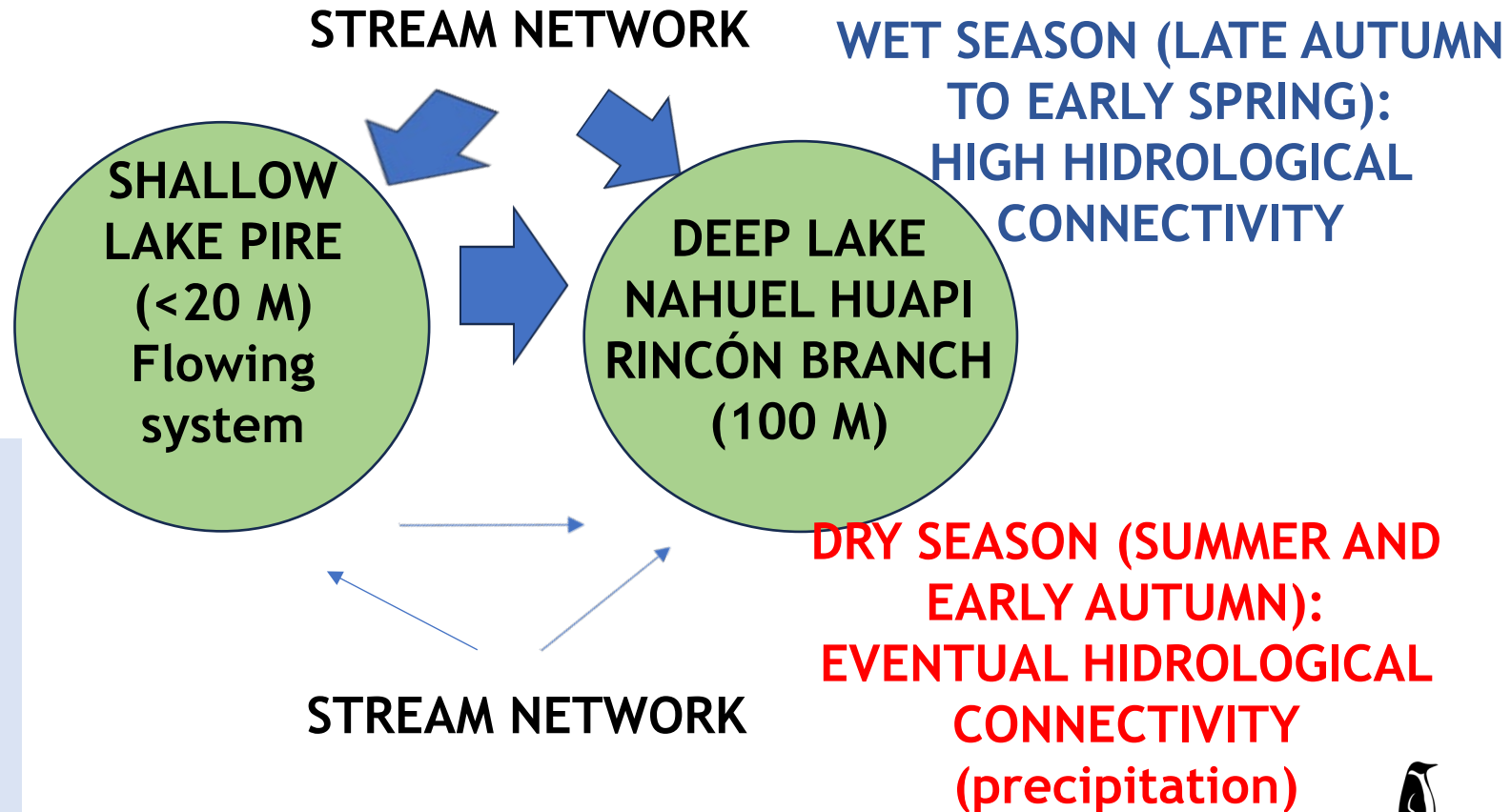
STEEPE LANDSCAPE WITH BROADLEAF DECIDUOUS AND EVERGREEN FOREST ON YOUNG VOLCANIC SOILS

- **RAPID CATCHMENT FLUSHING DURING WET SEASON**

COMPLEX DRAINAGE SYSTEM

ULTRAOLIGOTROPHIC SYSTEMS

- ❖ LOW NUTRIENTS
- ❖ LOW DISSOLVED ORGANIC CARBON
- ❖ LOW AQUATIC PRODUCTION
- ❖ CLEAR WATER: DEEP LIGHT PENETRATION



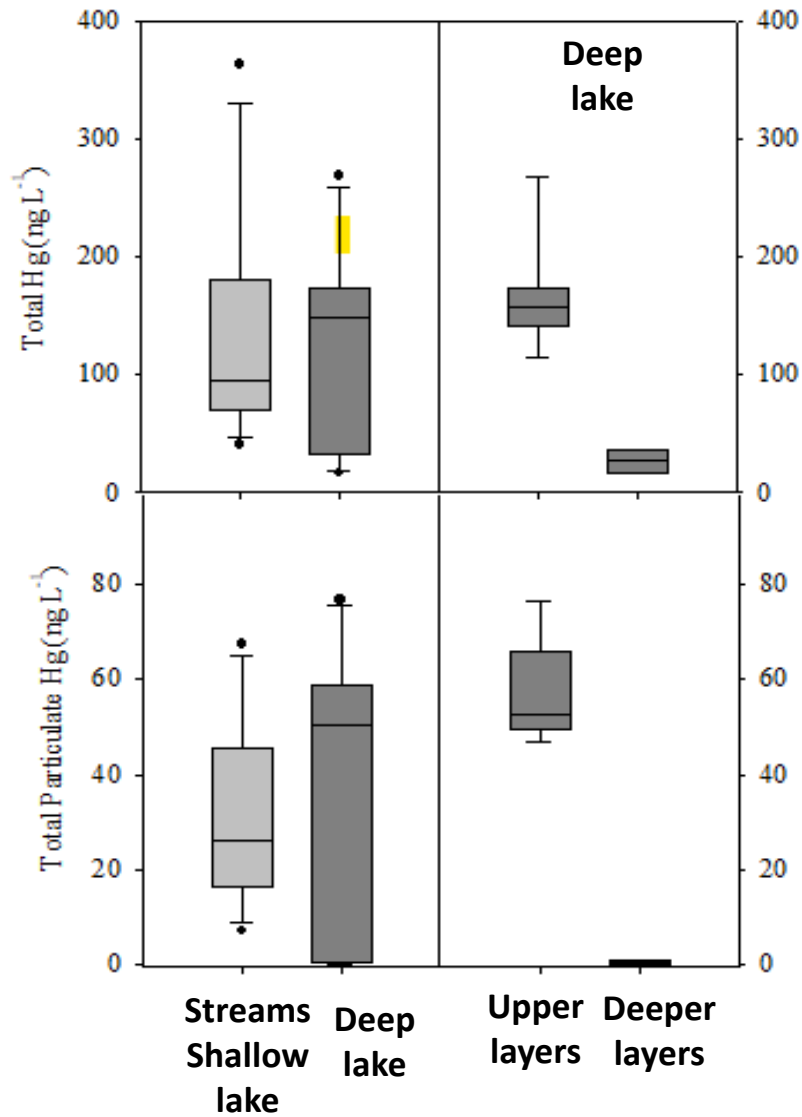
We aim to characterize:

- ❖ Hg speciation in the fluvial continuum from low-order streams to a piedmont shallow lake (flowing system) connected to a deep lake branch (Brazo Rincón) of Lake Nahuel Huapi, during the wet season
- ❖ [Hg] and speciation patterns in the water column the deep lake branch “Brazo Rincón” (Lake Nahuel Huapi)
- ❖ Seasonal patterns of THg in the connected lakes Pire and Nahuel Huapi Brazo Rincón



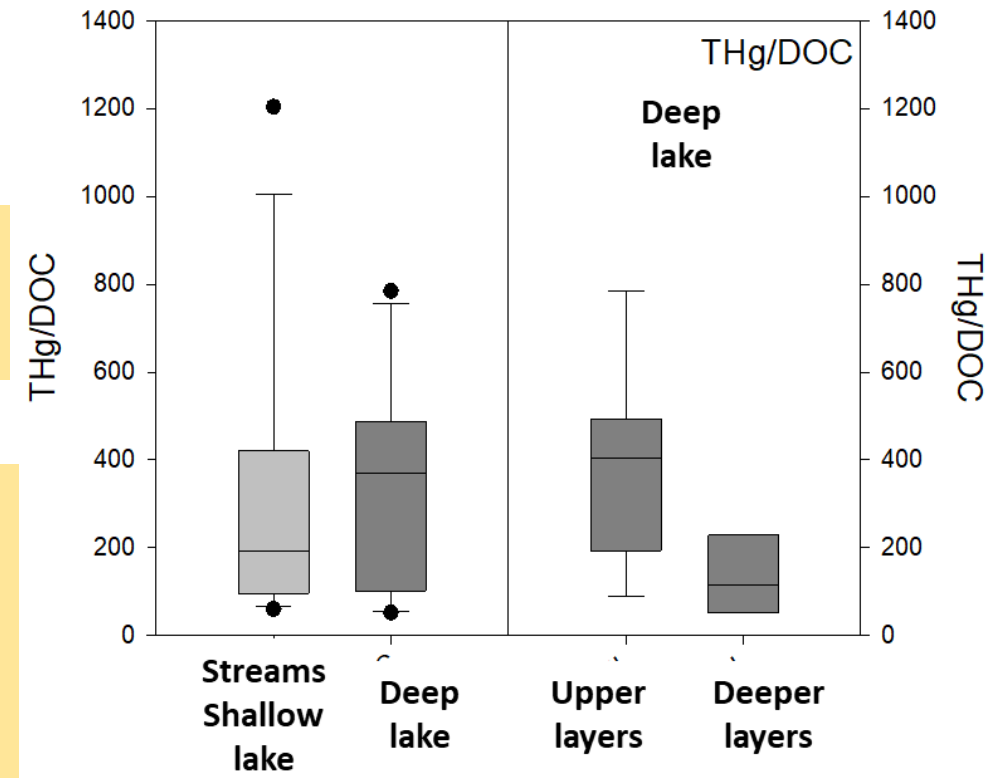
HG CONCENTRATION IN WATER AND PARTICLES IN THE FLUVIAL NETWORK IN THE WET SEASON

PARTICULATE AND DISSOLVED HG



❖ **HIGHLY VARIABLE TGH AND PARTICULATE HG IN THE FLUVIAL NETWORK**

❖ **> THG AND PARTICULATE HG IN UPPER LAYERS OF THE LAKE (COINCIDING WITH INCREASED SURFACE RUNOFF AND CHL a DISTRIBUTION, RESPECTIVELY)**



❖ **HIGH THG/DOC IN STREAMS AND LAKE**

❖ **> THG/DOC IN UPPER LAYERS OF THE DEEP LAKE**

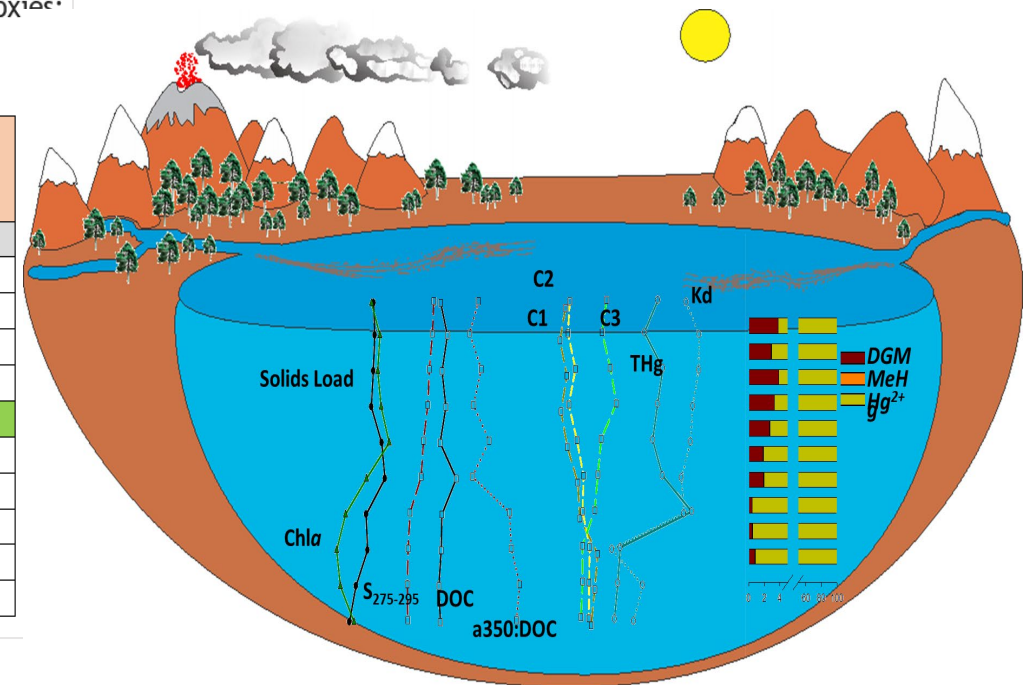
❖ **HIGH HG AVAILABILITY**



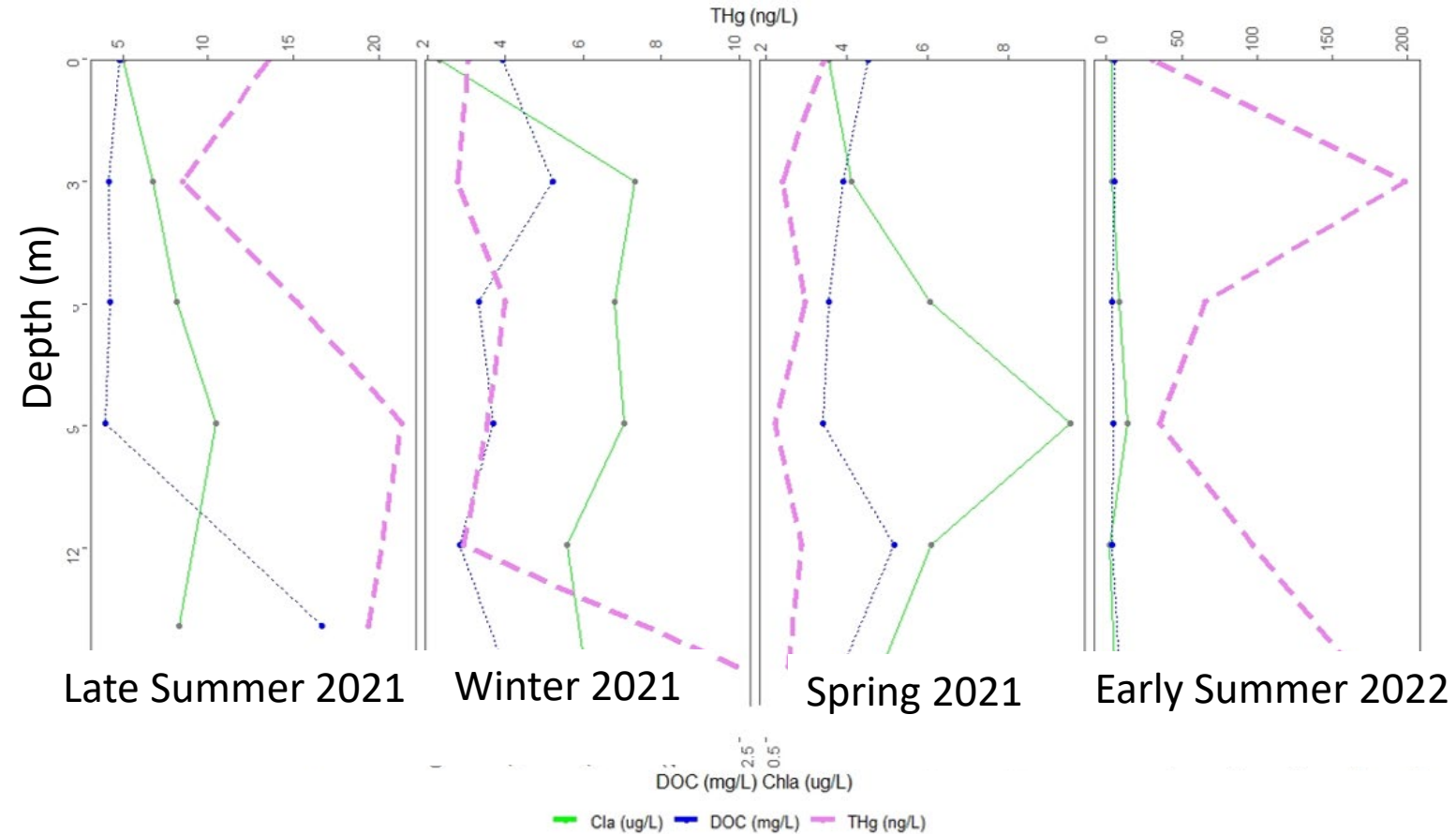
HG SPECIES IN THE STREAMS AND DEEP LAKE: INDICATION OF TERRESTRIAL SOURCE USING DOC QUALITY OPTICAL INDICATORS

Table 1. Correlation coefficients ($p < 0.05$) between the concentration of different Hg species in streams and lakes of Chlorophyll a (phytoplankton), total suspended solids (TSS), dissolved organic C (DOC) and optical DOM quality proxies: molecular size ($S_{275-295}$), aromaticity ($SUVA_{254}$), humification (HIX) and biological production (BIX)

		chl _a	TSS	DOC	DOM mol.size ($S_{275-295}$)	DOM aromaticity (SUVA)	DOM humification (HIX)	DOM biological production (BIX)
STREAMS	THg	NA	-	-	-0.72	0.74	-	-
	PHg	NA	-	-	-	0.66	-	-
	Hg ²⁺	NA	-	-	-0.72	0.74	-	-
	Hg ⁰	NA	-	-	-	-	-	-
	CH ₃ Hg	NA	-	-	-	0.7	-	-
DEEP LAKE	THg	-	-	-	-	-0.71	-	0.65
	PHg	0.68	0.68	-	0.7	-	-0.82	0.85
	Hg ²⁺	-	-	-	-	-	-	-
	Hg ⁰	0.64	-	-	0.75	-	-0.88	0.89
	CH ₃ Hg	-	0.70	0.78	-	-	-	-



SEASONALITY OF TOTAL HG IN THE SHALLOW LAKE



- ❖ >THG IN SUMMER (DRY SEASON=LOW HYDROLOGICAL CONNECTIVITY AND HIGH EVAPOCONCENTRATION)
- ❖ GENERALLY > THG IN DEEPER LAYERS
- ❖ EVENTUAL INPUTS OF HG DUE TO SUMMER PRECIPITATION AND INCREASED RUNOFF



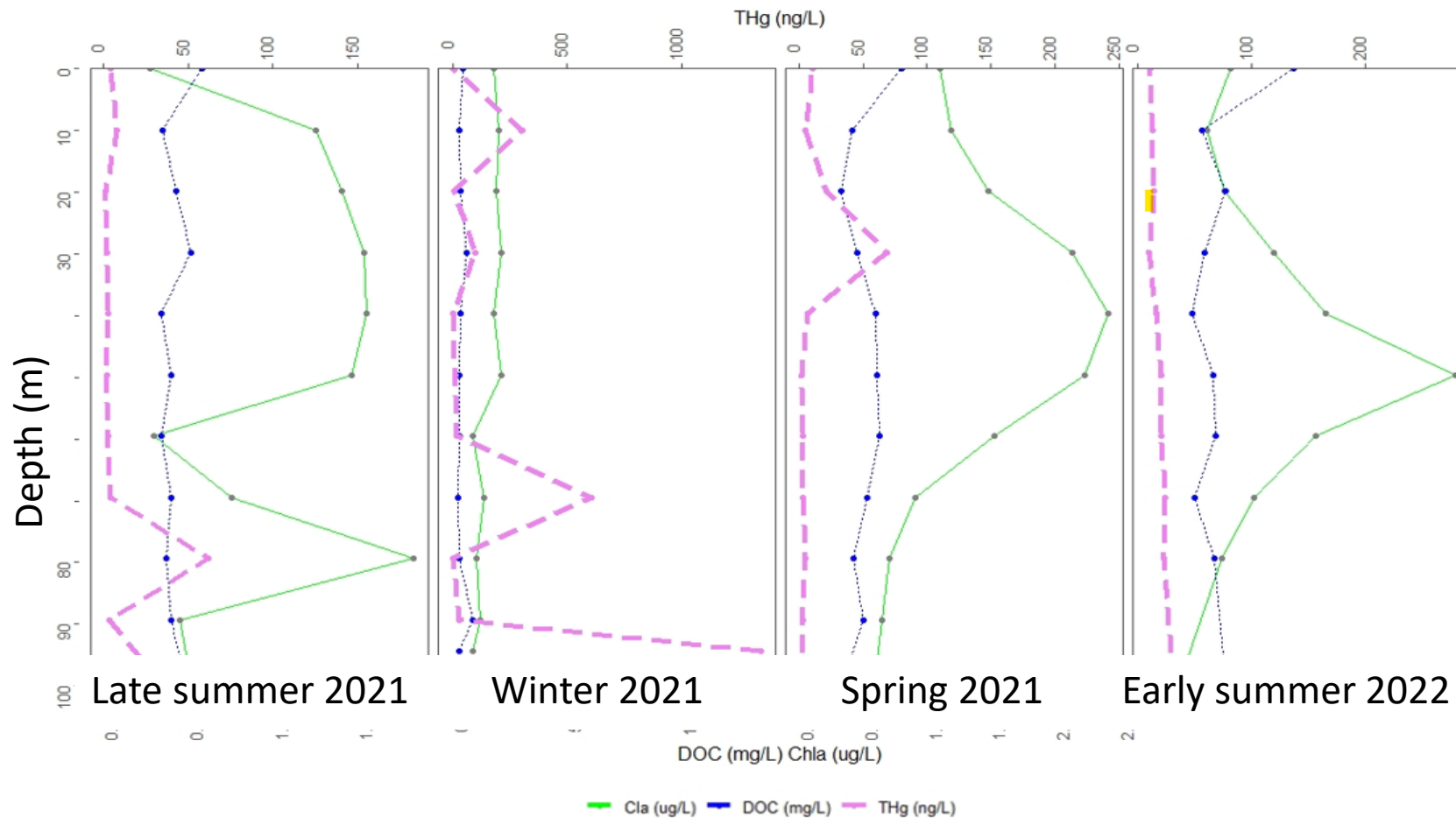
SEASONALITY OF TOTAL HG LEVEL IN THE DEEP LAKE

WET SEASON (HIGH HYDROLOGICAL CONNECTIVITY)

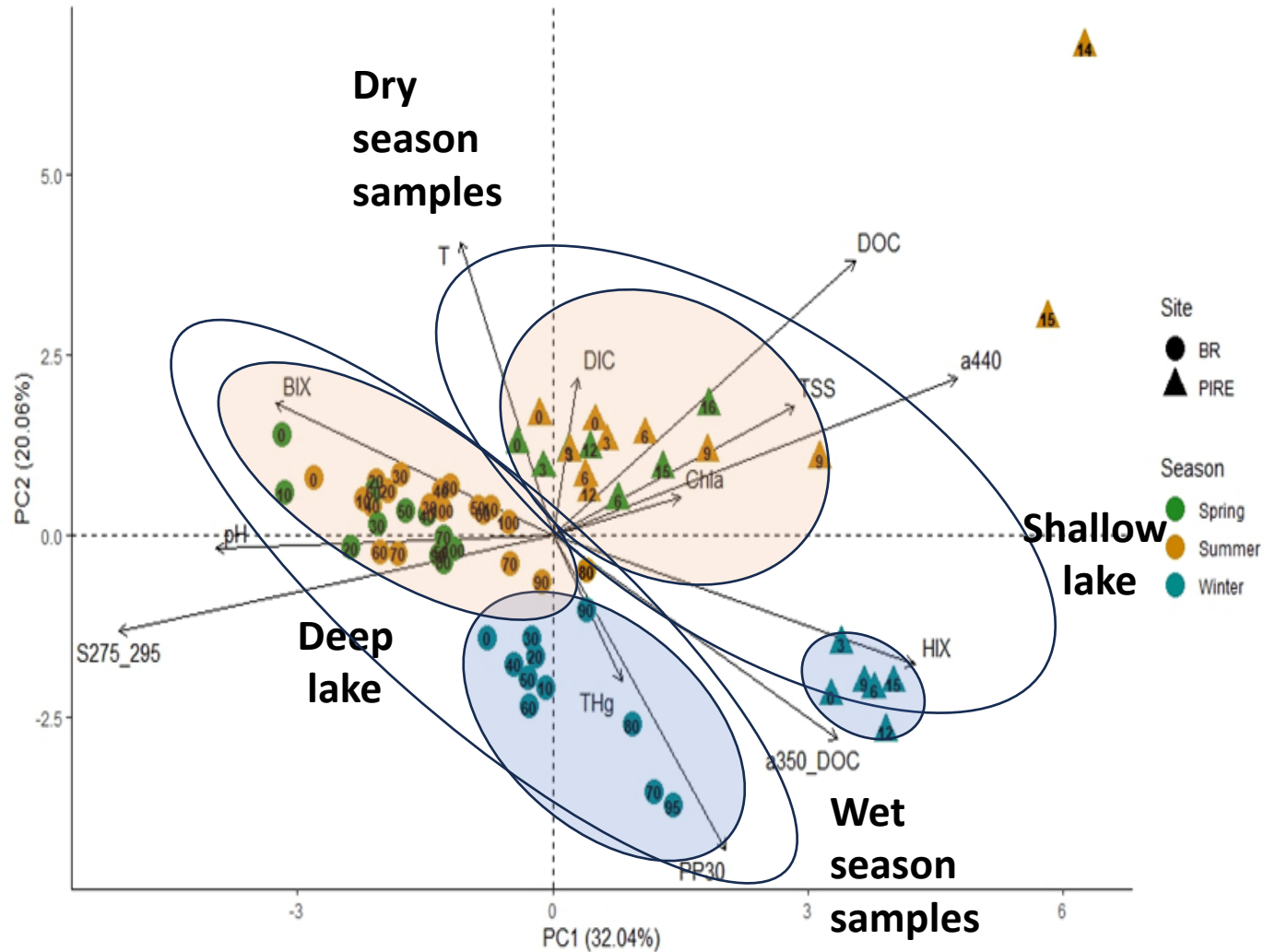
- ❖ OVERALL HIGH THG CONCENTRATION IN PROFILE
- ❖ HIGH HG CONCENTRATION IN BOTTOM LAYERS IN WINTER

DRY SEASON: LOW HYDROLOGICAL CONNECTIVITY

- ❖ LOWER TOTAL HG IN PROFILE
- ❖ HG PEAKS COINCIDING WITH ELEVATED PRIMARY PRODUCTION (CHLa)



SEASONALITY AND PROCESSES INDICATED BY THE VARIABILITY OF DOC CONCENTRATION AND QUALITY, AND THG



- ❖ Precipitation and temperature separate samples from the wet (high temperature-low precipitation) and dry season (low temperature-high precipitation)
- ❖ Samples from the shallow and deep lake separate seasonally due to contrasting TSS, DOC, Chla concentrations, DOM quality, and THg level.
- ❖ THg and allochthonous DOM signals (humification and aromaticity) correlate positively suggesting their co-transport from the catchment in both lakes during the wet season.



Remarks

- ❖ Along the fluvial continuum draining the Brazo Rincón subcatchment (Nahuel Huapi National Park), streams and connected lakes showed high variability in THg (16-363 ng L⁻¹), in a period of high hydrological connectivity
- ❖ Hg²⁺ was found as the dominant species, >98%, in all aquatic systems and CH₃Hg accounted up to 2% of THg
- ❖ Hg⁰ attained higher concentrations in the upper layers of the deep lake due to photo- and biological reduction of Hg²⁺ and Hg-DOM complexes (suggested by optical proxies of DOM degradation and biological production)
- ❖ Direct association of PHg and THg and Hg species (Hg²⁺, Hg⁰ and MeHg) with terrestrial DOM optical signals indicate the major contribution of the catchment

- ❖ Seasonality in THg concentration in the lakes was marked and influenced by hydrological inputs during the wet season and evapoconcentration processes in the dry season
- ❖ THg dynamics related to seasonal hydrologic inputs and terrestrial dissolved organic carbon (DOC) fluxes.
- ❖ Despite differences in THg concentrations, all systems showed high Hg availability due to extremely low DOC concentrations ($< 1 \text{ mg L}^{-1}$) resulting in high THg/DOC
- ❖ Seasonal overlap of high Hg availability and high phytoplankton primary production during the dry season would favor Hg entry into pelagic food webs

A photograph showing three people on a boat on a body of water. In the foreground, a woman in a teal jacket and sunglasses smiles at the camera. In the middle ground, a person in a white jacket and yellow gloves is focused on a task. In the background, a woman in a dark blue jacket and orange sunglasses also smiles. The background features a large lake and snow-capped mountains under a clear blue sky.

Thanks!

Laboratorio GESAP INIBIOMA CONICET, Universidad Nacional del Comahue

<https://youtu.be/EA8MHwkokPA?si=WQnMbvP-YIQLmsQI>

<https://www.instagram.com/p/C56lCw4JsAr/>

All Hg studies in Nahuel Huapi National Park have been carried out with the invaluable help and encouragement of Hg scientists who see the great potential in exploring the uniqueness of Patagonian ecosystems. Fortunately, the list is long: Sergio Ribeiro, María Arribére, Claudia Queimaliños, Milena Horvat & group, George Aiken, Nicola Pirrone, Francesca Sprovieri, Mariantonia Bencardino, Mariana Lozada, Raquel Quatrini...

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