PLASTILAC

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USMB

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The plastic contamination: key Numbers

Global plastic pollution

- Nearly 400 million tons of plastic produced each year

- A significant part ends up in the environment

- 80% of the plastic found in the oceans come from terrestrial ecosystems *(A. L. Andrady, « Microplastics in the marine environment », Marine Pollution Bulletin, vol. 62, n° 8, p. 1596-1605, 2011)*

Microplastic pollution

- Particle sizes ranging from 1 µm to 5 mm

- Microplastics can undergo long range transportation (> 1000 km) over the ocean *(X. Wang, C. Li, K. Liu, L. Zhu, Z. Song, et D. Li, « Atmospheric microplastic over the South China Sea and East Indian Ocean: abundance, distribution and source », Journal of Hazardous Materials, vol. 389, p. 121846, 2020)*

- Multiple sources: wastewater discharge, fragmentation of macro/mesoplastics, tyre abrasion, atmospheric deposition, etc.
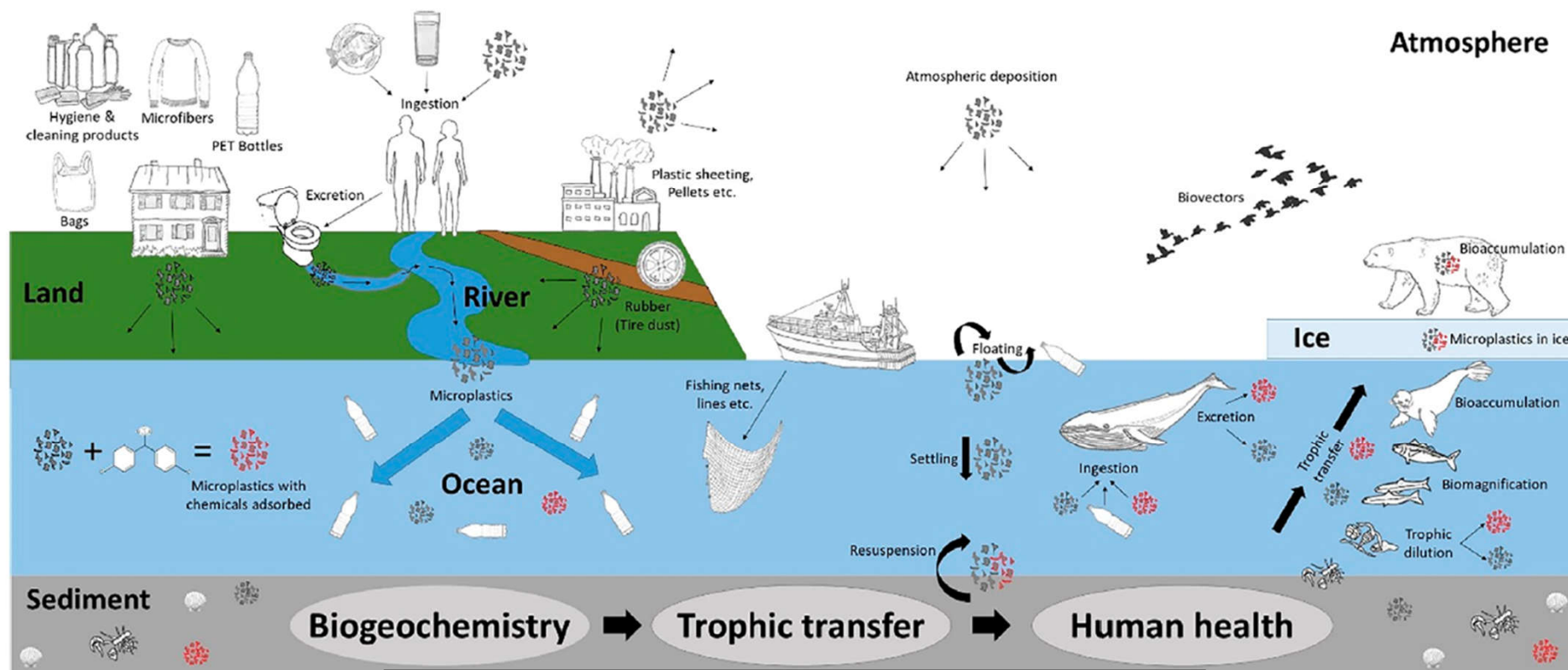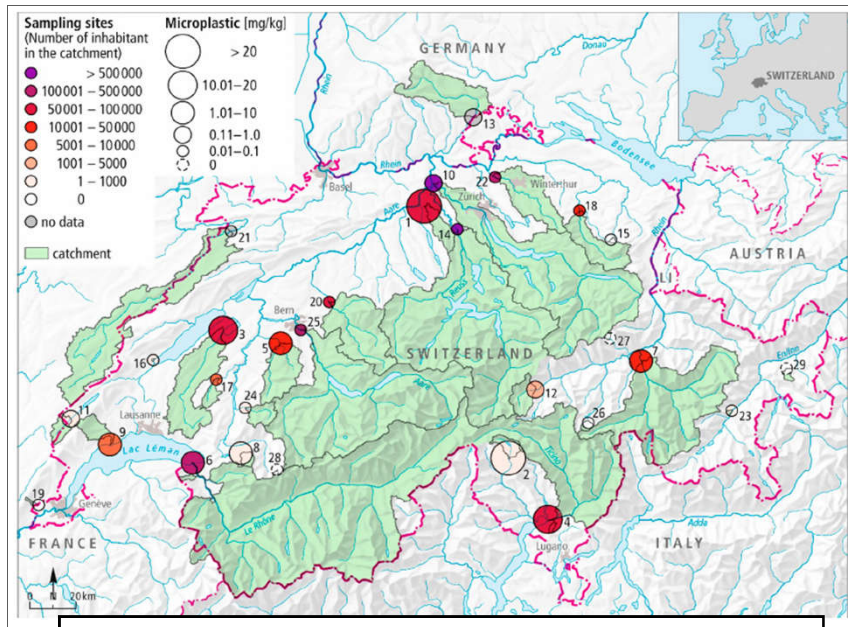
The Plastic Cycle: A Novel and Holistic Paradigm for the Anthropocene
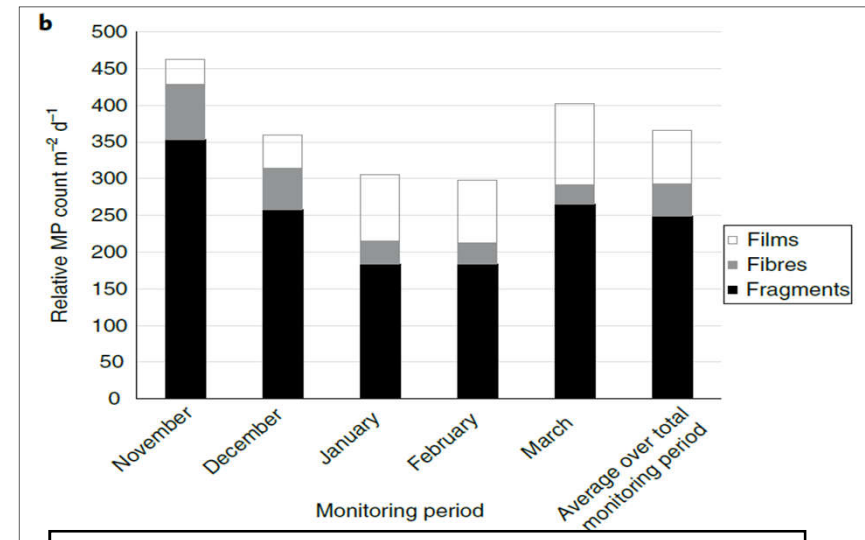Michael S. Bank and Sophia V. Hansson
Environmental Science & Technology **2019** *53* (13), 7177-7179
DOI: 10.1021/acs.est.9b02942

Microplastics in mountainous ecosystems?

Scheurer, M., Bigalke, M., 2018. Microplastics in Swiss Floodplain Soils. Environ. Sci. Technol. 52, 3591–3598. https://doi.org/10.1021/acs.est.7b06003

Allen et al., 2019. Atmospheric transport and deposition of microplastics in a remote mountain catchment. Nat. Geosci. 12, 339–344. https://doi.org/10.1038/s41561-019-0335-5
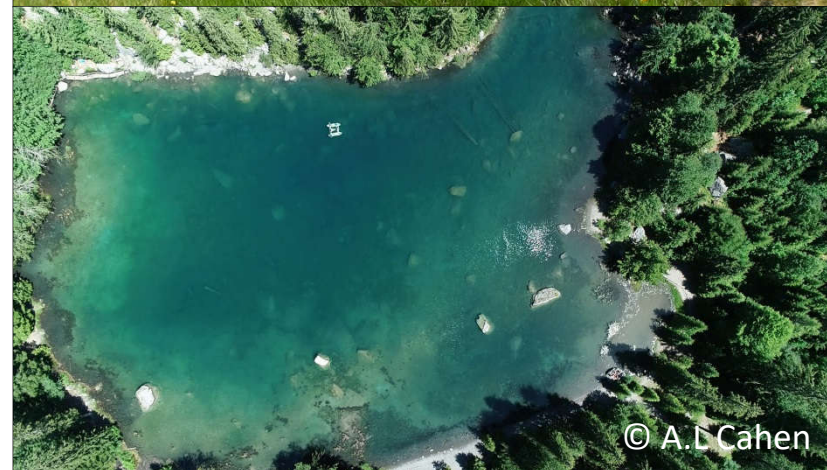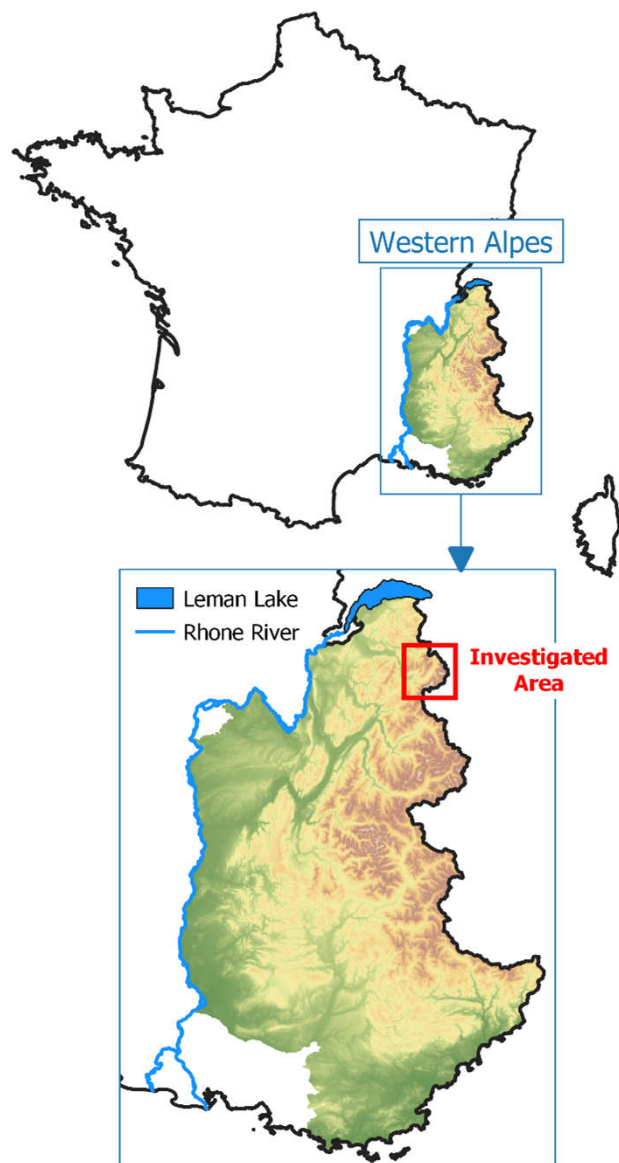
According to literature:
- Plastic microparticles can be found in large amount in alpine soils
- Atmospheric deposition is an input pathway of MP to remote ecosystems

As integrators of atmospheric deposition, **remote elevated lakes** are great study sites to **understand the MP contamination of aquatic ecosystems** from the start
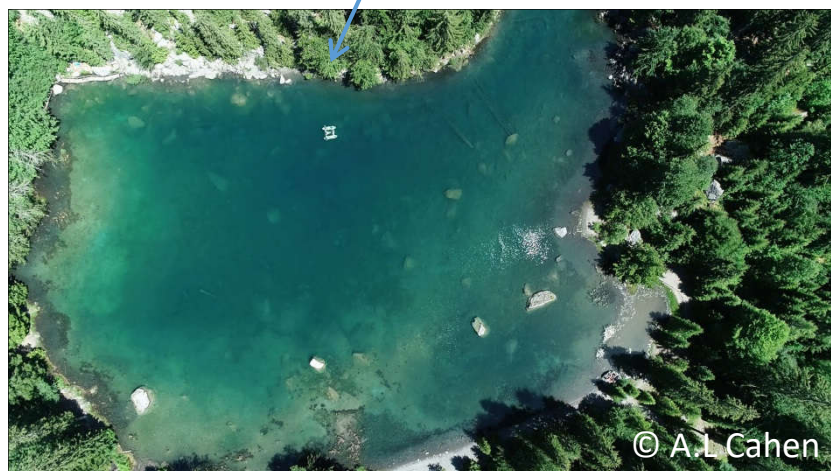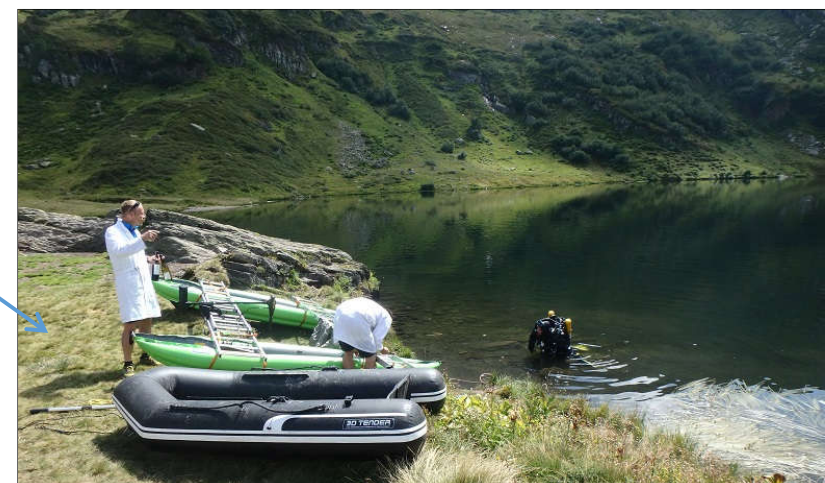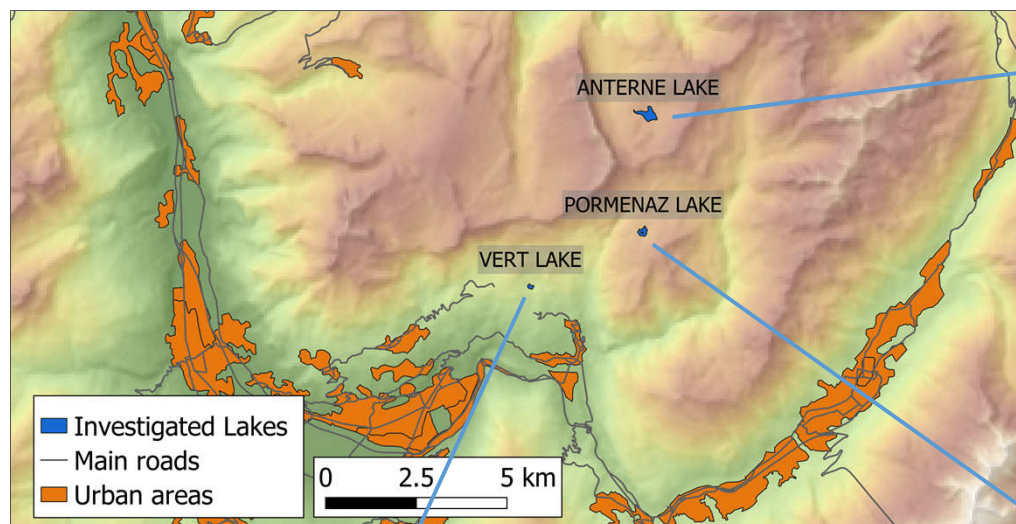
PLASTILAC: Microplastics in elevated lakes?

Western Alpes

Leman Lake
Rhone River

Investigated Area

© M. Lopez

© A.L Cahen

© L. Bernard

3 investigated lakes

© L. Bernard

Map legend:
- Investigated Lakes
- Main roads
- Urban areas

Map labels: ANTERNE LAKE, PORMENAZ LAKE, VERT LAKE

Scale: 0 2.5 5 km

© A.L Cahen
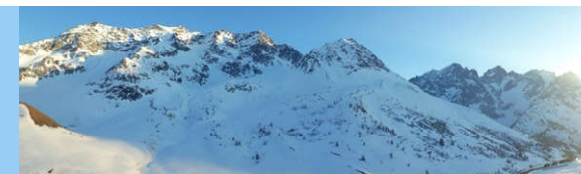
Lacs	Area [ha]	Depth [m]	Alti. [m]
Vert	1,5	9,3	1267
Pormenaz	4,4	9,5	1945
Anterne	11,1	13,2	2060

Monitoring the MP contamination in remote lakes

© M. Lamboley

Mantamaran

© P. Gallinelli

Continuous monitoring of the filtration speed
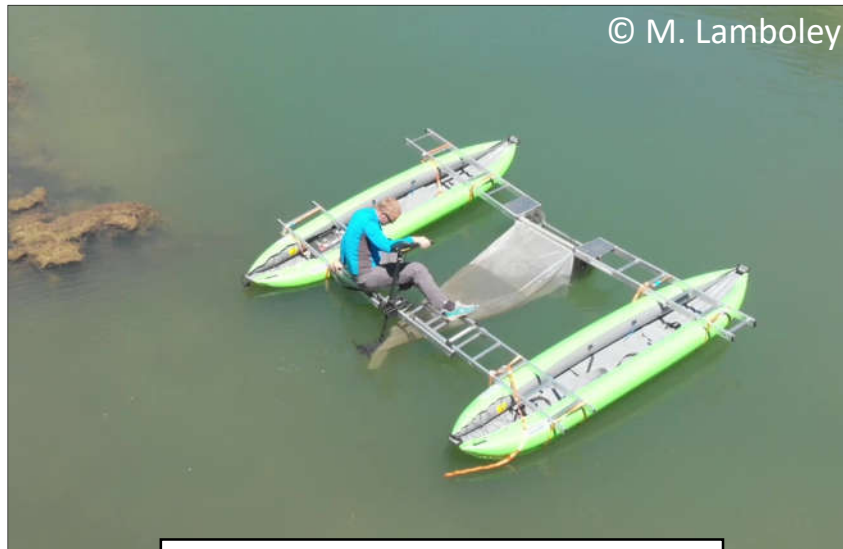
Mantamaran

- Specifically designed to collect MP in remote lakes

- Man portable

- Powered by electric engine

Filtration

- 50 µm inox mesh

- Samples last for ~ 30 minutes to filter 100 to 200 m^3

- Velocity flow within the net is monitored though the sampling to insure there is no clogging

Monitoring of incoming and outgoing fluxes

Tributaries and outlets

© F. Gillet

Atmospheric deposit

© F. Gillet

© D. Gateuille

Tributaries and outlet: device similar to the net used for the water column. Flow velocity is also monitored through the experiment.

Atmospheric deposition: 0.6 m² collector combined to a 50 µm inox mesh. Sampling for 1 to 2 months.
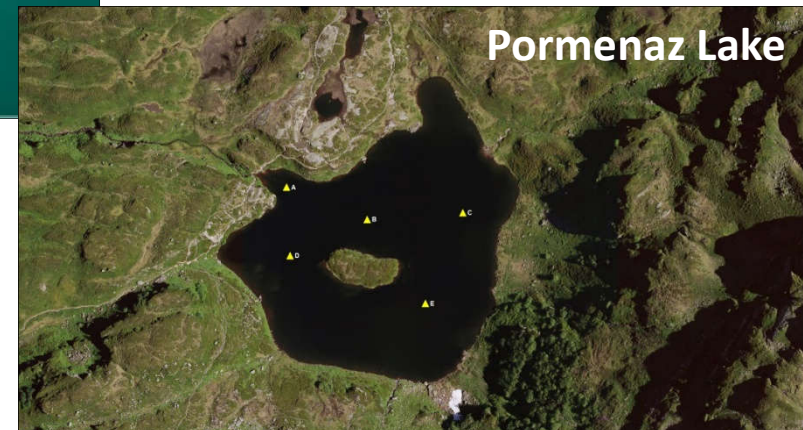
Monitoring the MP contamination in sediment

© F. Moreau

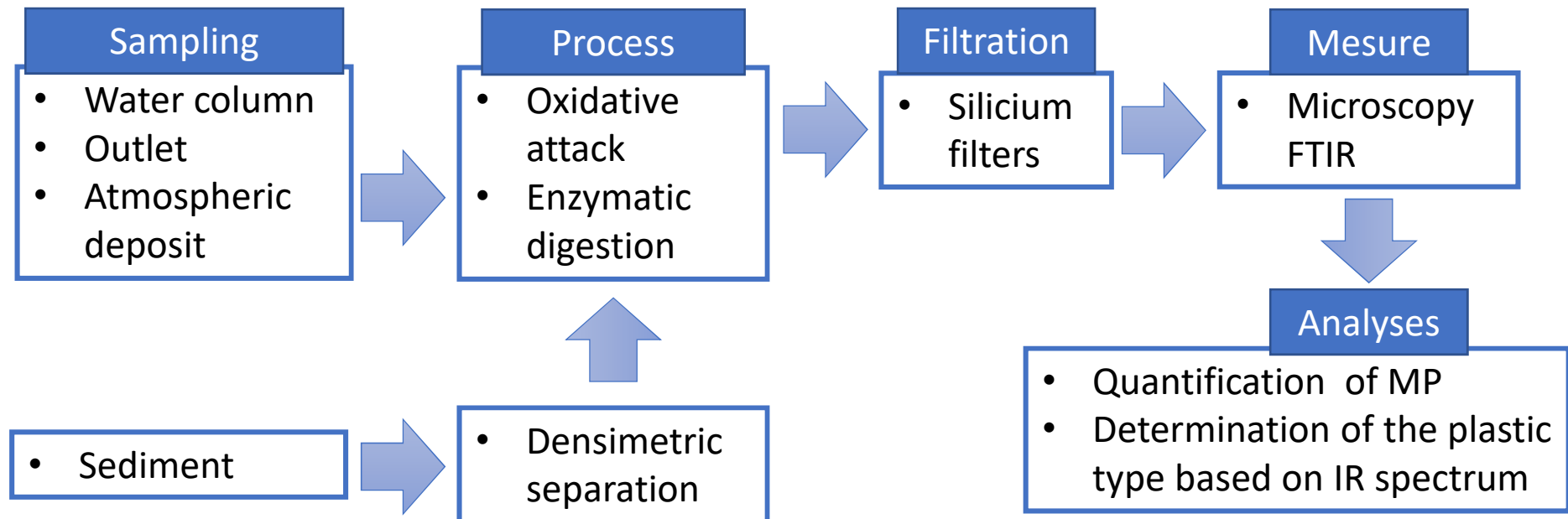**Anterne Lake**

Sediment sampling locations

Pormenaz Lake

Sediment sampling locations

Sediment:
- samples collected by scuba divers
- Bulk sampling of the 5 top centimetres
- Direct observation of the lake bottom by divers helps choose the best sampling strategy

Analyses workflow

Sampling
- Water column
- Outlet
- Atmospheric deposit

Process
- Oxidative attack
- Enzymatic digestion

Filtration
- Silicium filters

Mesure
- Microscopy FTIR

Analyses
- Quantification of MP
- Determination of the plastic type based on IR spectrum

- Sediment

- Densimetric separation

To prevent contamination:

- Field blanks

- Lab blanks

- The IR spectra of plastic tools used during the field campaign were added to the spectrum library used for the MP analyses

2019 field campaign

Sampling	Vert Lake	Anterne Lake	Pormenaz Lake
Water column	1	2	2
Outlet	0	1	1
Sediment	8	9	5
Atmospheric deposit	-	2	-

© M. Lopez

© P. Gallinelli

→ Analyses of the water column samples at LEESU (University Paris Est Creteil)
→ Analyses of sediment, atmospheric deposit and outlet at USMB
(University Savoie Mont Blanc) postponed due to Covid-19 outbreak

First results

Anterne Lake

Pormenaz Lake
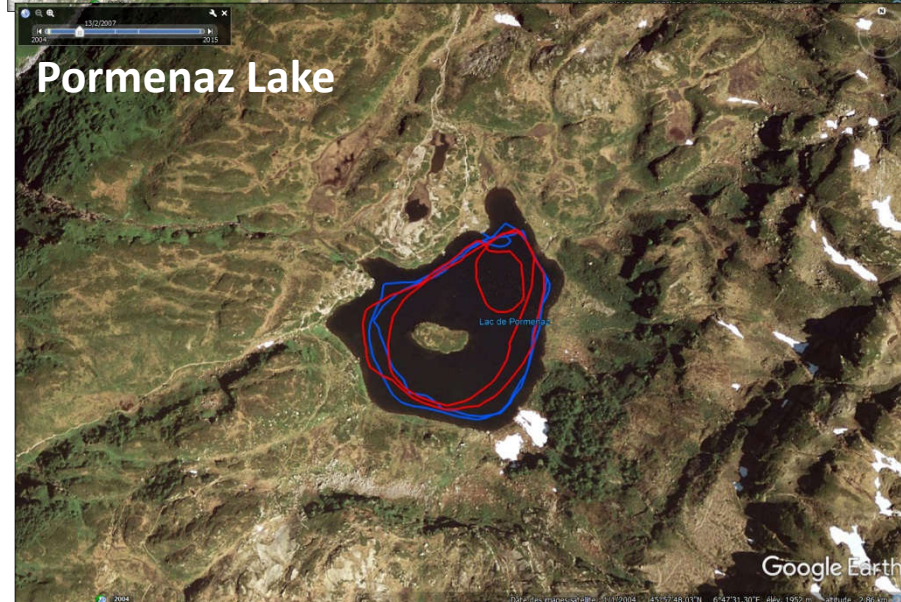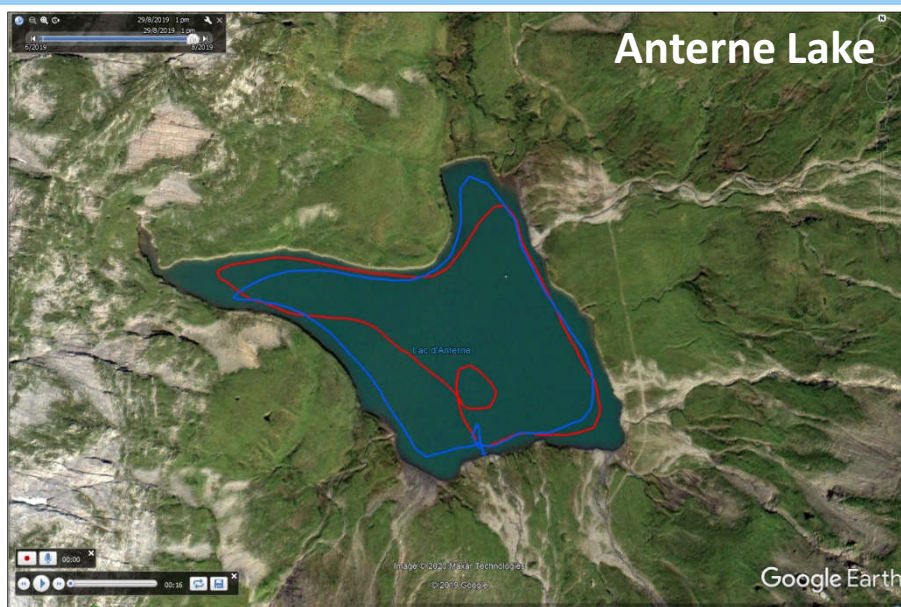
Due to the **corona outbreak** and the resulting lab closure, **95% of the samples have not been analysed yet** and the following **results must be cautiously considered**

Anterne Lake (water column #2):
- Filtered volume: 118 m³
- Methodological issues related to rock flour
- Microplastics : 2 fibres
    - ➤ **No significant contamination**

Pormenaz Lake (water column #2) :
- Filtered volume: 130 m³
- Microplastics: 156 fibres
    - ➤ **1,2 microfibers per m³**

Discussion

The two lakes are 3km apart and
there is a significant difference in the MP contamination

Hypothesis 1: Anterne Lake sample poorly processed due to rock flour (underestimated contamination)

→ Ongoing analysis of the 2nd sample

Hypothesis 2: Temporary contamination of Pormenaz Lake (overestimated contamination)

→ Ongoing qualitative analysis of the sample and analysis of the 2nd sample

Hypothesis 3: The contamination difference is related to contrasting atmospheric deposit

→ Analysis of meteorological data and of the sediment samples

Hypothesis 4: The contamination difference is related to contrasting sediment dynamics (scavenging)

→ Analysis of sediment samples

Conclusions

1. Presence of microplastics in certain altitude lakes

2. Great spatial variability of the MP contamination

3. Limited contamination in comparison to urban water bodies

4. Contamination mainly due to fibres

5. Methodological issues specific to altitude lakes

6. Influence of the contamination mode on the type of PM to be studied

7. Duration of contamination is a crucial parameter to consider for future studies

Acknowledgement
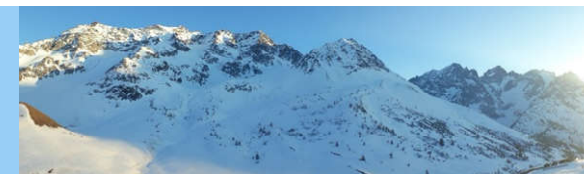
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