TEMPORAL TRENDS OF PERSISTENT ORGANIC POLLUTANTS (POPs) IN LAKE SEDIMENTS IN THE NORTH- PATAGONIAN AREA IN SOUTHERN CHILE.

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Abstract
This paper presents some recent results regarding the presence of anthropogenic pollutants in the Patagonian Area in Chile, subjected to increasing human influence during the last 20 years. Sediment cores of three lakes, were analyzed for PCBs (GC-ECD) and PBDEs (GC-MSNCI) for determining pollutant fluxes. Results showed very low concentrations PCBs (Sum 7 congeners) ranging from non detected values to 10 ng g^{-1} dw, being the highest concentrations usually found on the top core. PBDEs concentration were even lower with values nd up to average 0.32 ng g-1 dw, representing three major congeners (47, 99 y 100), sediment cores were dated (Pb210. Cs137,Volcanic tephra). The higher concentrations of POPs (PCBs 16 ng g^{-1} d.w., PBDEs 0,44 ng g^{-1} d.w, congeners 47 and 153) were observed in the lake sediments located in the coldest areas. Depositional fluxes were 5,000 ng g^{-1} m^2 y^{-1} and 186 ng g^{-1} m^2 y^{-1} for PCBs and PBDEs, These results point out that anthropogenic pollutants are arriving to remote systems in southern Chile, however a delay is being observed for both PCBs (detected since the beginning of the 90's) and PBDEs, being the latter more recently (~5 years) arriving into the system.

Introduction

Recent reports have hypothesized that certain geographic areas (e.g. alpine and cold areas) could act as contaminant convergence zones due to their natural characteristics, allowing a selective trapping of anthropogenic pollutants transported by the air[1]. These areas could be considered as natural traps for several persistent organic pollutants (POPs). The presence of POPs in remote areas have increased the concern to understand the fluxes of these elements in pristine ecosystems, considering that atmospheric deposition could be an input pathway of POPs to such regions. Due to their peculiar geographic features we have chosen the Aysen Region (Patagonia) for verifying the existence of such convergence zones in remote areas in Southern Chile. Due to the great variability of physico-chemical properties and environmental behavior of the POPs, these compounds are ideal for the study of the contamination and the understanding of the sources and mechanisms of partition in the atmosphere[2]. The origin of this contamination with POPs in remote zones of Chile is still uncertain, but as this area is located far from direct pollution sources and urban contamination, probably the observed concentrations obey to phenomena of atmospheric deposition. The trends observed in Chile, indicate that the depositional fluxes of PCBs in sediments of Andean and coastal lakes are greater in the recent times, an opposite trend to the observed one in the Northern hemisphere where the greater fluxes have been observed in the decade of `70-80s, whit a high correspondence with the intensive use of PCBs in this hemisphere[2,3].

Materials and Methods

Sediment cores were collected in the deepest part of the lakes in January and February 2006 (Los Palos and Burgos lakes), and February 2006 (Lake Coipos) with an Uwitec corer. Sediments were sliced into 1 cm intervals in situ and transported to the laboratory in an ice cooler. Details on meteorological conditions, geomorphological and limnological characteristics are listed in Table 1. Samples were weighed and stored in clean, solvent-rinsed glass bottles to avoid contamination. Freeze dried sediments (3 - 5 g) were placed in cellulose thimbles (pre-cleaned by Soxhlet extraction), and extracted using 100 ml of n-hexane for 24 hours[2,3]. The extracts were reduced for evaporation between 35 and 40ºC until 10 ml and then cleaned-up with cooper for 24 hours and cleaned up on a florisil column. The target chemicals were eluted with isoctane elution (10 ml). In the figure 1 this outlined the extraction procedure. PCBs were analized with GC-ECD and PBDEs with GC-MS NCI.

Table 1: Geographical and geomorphologic characteristics of the remote lakes.

	Lake Palos	Lake Coipos	Lake Burgos
Latitude	45º 19'00''	45º 25' 15''	45º 42' 05''
Longitude	72º 42'00''	72º 40' 19''	72º 12' 53''
Altitude (m.a.s.l)	30	15	389
Max. Depth (m)	59	10	30
Precipitation (mm)	3100	3100	920
Average Temperature air (ºC)	9	9	7
Surface area (km^2)	5,28	0,11	0,035
Salmon Culture	yes	no	no

Results and Discussion

In figure 1 and 2 the results shows the concentrations and calculated fluxes of PCBs and PBDEs in the different lakes and the comparison with the levels and fluxes of other remote and contaminated lakes in the northern hemisphere.

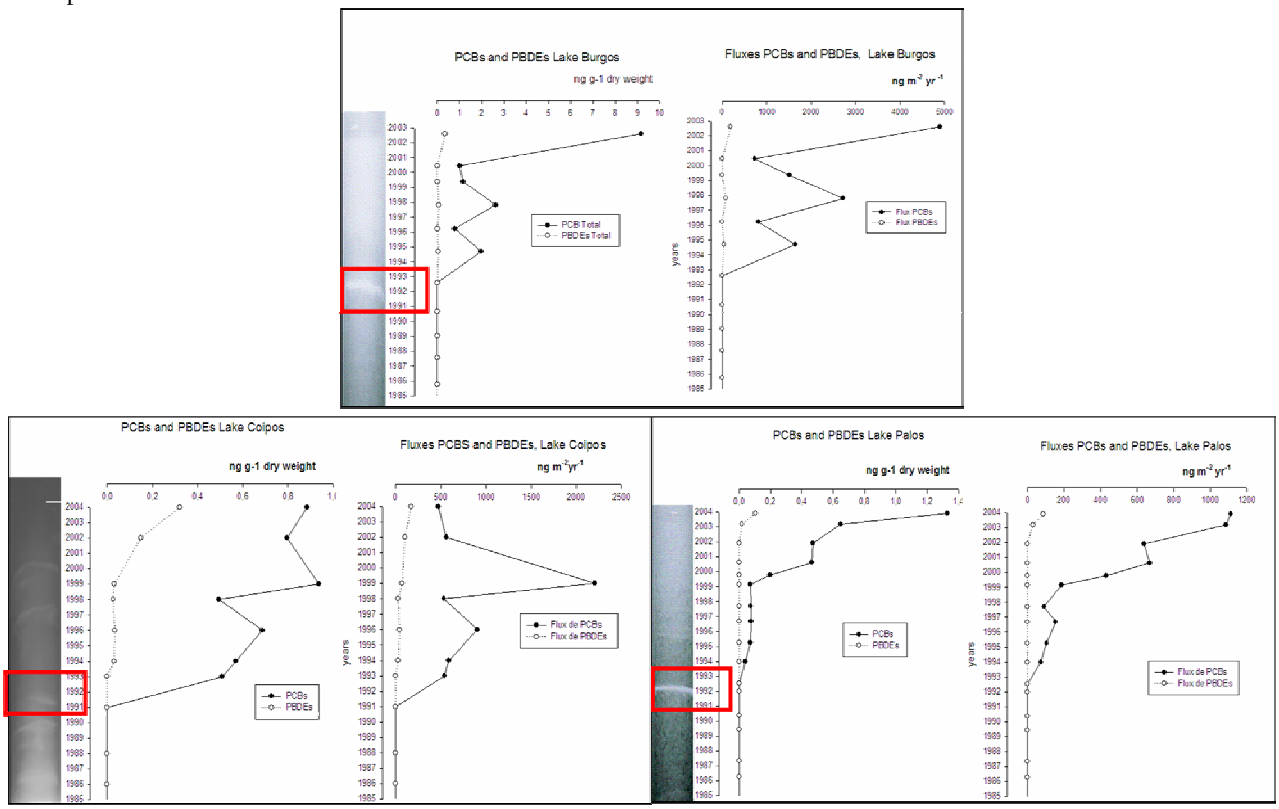

Figure 2. Levels and fluxes of PCBs and PBDEs in the different lakes.

The trends observed in the lake sediments, show that depositional fluxes of PCBs of these lakes are increasing in the recent times, Lake Burgos have higher depositional fluxes of PCBs and it is located in colder and at high altitude areas, despite precipitation rates are lower than the other two lakes. In Lake Los Palos fish farming was

established in 1996, but this fact seems to have no influence the levels of PCBs and PBDEs in sediments. Lake Los Coipos is located near Lake Los Palos but it is not influenced by fish farming and levels are quite similar.

These results point out that anthropogenic pollutants are arriving to remote systems in southern Chile however a delay is being observed for both PCBs (detected since the beginning of the 90's) and PBDEs, being the latter more recently (~5 years) arriving into the system, but concentrations are very low, difficult the data interpretation. Estimated sedimentation rated based on radiometric measures agree with some natural markers (eruption volcano Hudson, 1991).

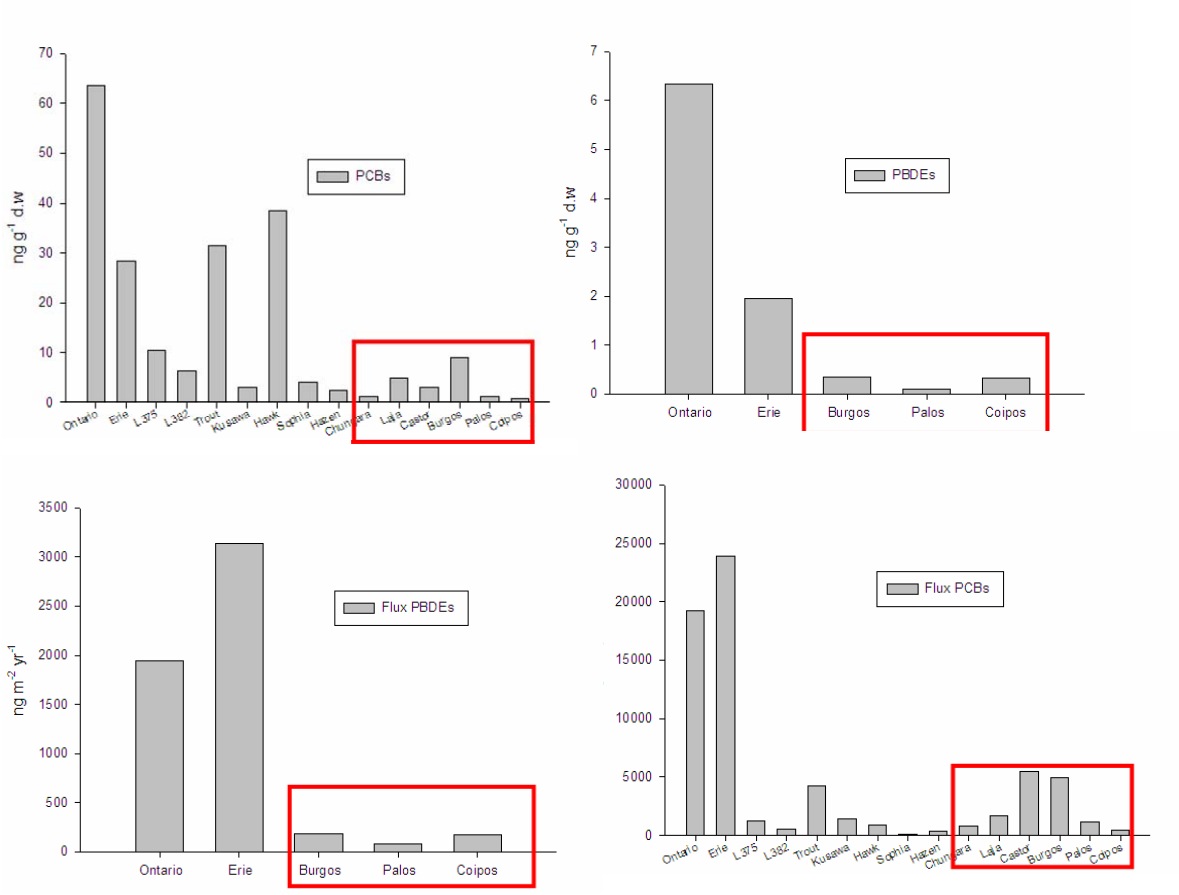

Figure 3. Comparison of the concentrations and fluxs with other lakes of the world.

The temperature effect seems to control the observed levels of POPs in these Patagonian lakes, since the higher levels are found in cooler areas, this fact can be explained by the efficient scavenging role of snow where temperatures are below 0°C, being described as a dominant process of deposition in high mountain and latidtude areas [4]. As our group as shown in previous work by using different matrices of analysis (soil, mosses and sediments) in remote areas from Chile[5]. The temperature factor explain near the 50% of the obtained variability of the observed concentrations of PCBs.

The sources of the pollutants found in this study may come both from distant sources but also from regional sources, even we did not detect an influence of fish farming in the levels of POPs found in the two lakes located in the coast (Coipos and Palos), and the obvious source may be the atmospheric deposition, other sources such as

the biotransport with migrating animals (mostly salmonids fish) could not be excluded. This biotransport could be also a consequence of the escaping fish from fish farms which have been established in the area since the last 15 years. This hypothesis is worth to be tested in the forthcoming years.

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