Occurrence of Polychlorinated Biphenyls (PCBs) in the Chilean atmosphere using passive air samplers PUF Disk

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Introduction

PCBs have been widely used in industries and are characterized by low vapor pressure, low water solubility and environmental persistence[1]. PCBs are considered immuno-toxic and have been proven to impact reproduction processes adversely. In Chile, PCBs were used intensively over the past 50 years; their main commercial sources were principally in electrical equipment as dielectric oils (e.g., in transformers). Chile carried out a national inventory of PCBs in 2004 and determined that the total volume present in the country reached 569,547 L of dielectric oil, of which 57% was in use. Additionally, the PCBs inventory for other uses determined that in Chile from 2002 to 2008, nearly 38,820 metric tons of products were imported and suspected of containing PCBs[2,3]. In Chile, previous studies have documented atmospheric contamination by POPs using different sampling techniques; conventional procedures rely principally on active air sampling[4,5]. In Chile, several studies have used PUF disk passive air sampling (PAS) to measure POPs [6,7,8,9,10,11,12]; however, there is still no comprehensive assessment of POPs in Chile to date which include information on atmospheric transport, fate, ecosystem and human exposure, and effects. The primary objectives of this study are i) to assess the spatial distribution and seasonal variations of POPs in the Chilean atmosphere.

Materials and methods

Polyurethane foam (PUF) disks were deployed in thirteen cities in Chile across a range of sampling sites with different geographical and climatic conditions, and characterized by different predominate anthropogenic activities The cities investigated in this study represent the largest cities in Chile: E1: Iquique (Complejo Deportivo La Pampa); E2: Antofagasta (Liceo Industrial); E3: Tierra Amarilla (Enami); E4: Valle Alegre; E5: RM-El Parque; E6: RM-Talagante ; E7: Talca (Universidad de Talca); E8: Punto 1 Concepción (Cerro Merquín) ; E9: Punto 2 Concepción (Kingston College); E10: Temuco (Las Encinas); E11: Coyhaique (II); E12: Punta Arenas, E13: Juan Fernández (Isla) (see Fig. 1). Sampling periods corresponded to Period I: 13 January-21 March (2017), Period II: 22 March - 21 June (2017), Period III: 22 June-21 September (2017), Period IV: 22 September - 21 December (2017). Sampling was carried out simultaneously at all sites throughout the study.

Sample analysis

The surrogate recovery standards (PCB30 and PCB185 for PCBs) were spiked on each sample before extraction. One laboratory blank and one reference material were analysed with each set of ten samples. All samples were extracted with dichloromethane in a Büchi System B-811 automatic extractor. After extraction, the sample was and analyzed using a GC-MS instrument (GC 7890/MS-MS Triple Quadruple 7000B (Agilent) with a J&W Scientific fused silica column DB-5MS (5% Ph) in electron impact ionization and MS/MS mode for PCBs: PCB28, PCB52, PCB101, PCB118, PCB153, PCB138, PCB180 and PCB209.

Quality Assurance/Quality Control

Recoveries were determined for all samples by spiking with the surrogate standards before extraction. Recoveries were 76-100 % for PCBs. Recovery of native analytes measured for the reference material varied from 88 to 103 % for PCBs. Details for laboratory procedures were reported in Prybilova et al., 2012[13].

Results and Discussion

Air concentrations for ∑PCBs were detected in all sampling sites with a range from 0,3 to a 38 pg/m^3 (see Figure 1). The highest levels of ∑PCBs concentrations were 14 pg/m^3 in the RM –El Parque (E5) (urban site) and 13 pg/m^3 at Tierra Amarilla (ENAMI) (E3) during period I (summer). These results are related to the urban and industrial development activities of these areas. However, the highest concentrations were detected with 38 pg/m^3 in Temuco-Las Encinas (E10) (urban) during period II (autumn). These results are linked to the high consumption of wood as heating system, in particularduring autumn and winter seasons. High levels, in this study were also measured in urban areas with PCBs concentrations of 17 pg/m^3 at El Parque (E5) and 37 pg/m^3 in Punta Arenas (E12), during period II and III, respectively. CONAMA 2004 reported PCBs were used intensively in Chile, principally in electrical equipment (e.g., transformers). PCB stocks have been estimated to be 700 tons with a 50% still in use[14]. These results are lower than PCB levels reported from other studies around the world at urban– industrial locations. For instance, Motelay–Massei et al. reported PCBs concentrations in the air of 200 to 800 (pg/m^3) in Toronto Canada[15]. Pozo et al. reported PCB levels ranging from 300 to 600 pg/m^3 in other urban areas monitored under the global atmospheric passive sampling (GAPS) network[16]. This study represents one of the few efforts to characterize the composition of POPs, especially PCBs in the ambient air of urban and industrial areas of Chile. The results of this work will inform the efforts within Chile and the GRULAC region under the Global Monitoring Plan of the Stockholm Convention on POPs to assess air concentrations of POPs and the effectiveness of control to make future regulations for emission of pollutants in Chile.

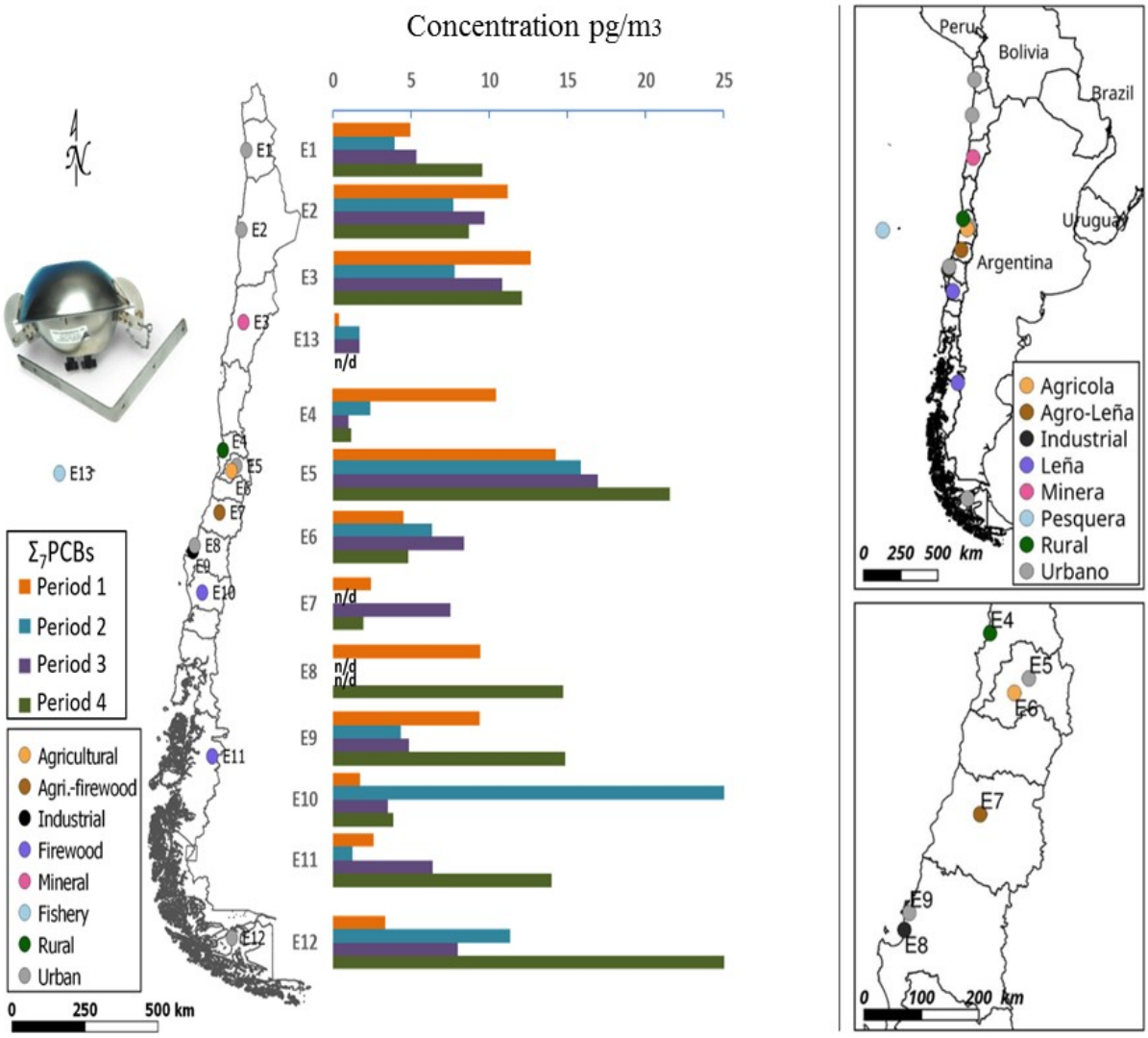

Figure 1. PCB Concentrations (pg/m^3) and sampling sites location for passive air sampling during one year (December 2016-December 2017). E1: Iquique (Complejo Deportivo La Pampa); E2: Antofagasta (Liceo Industrial); E3: Tierra Amarilla (Enami); E4: Valle Alegre; E5: RM-El Parque; E6: RM-Talagante; E7: Talca (Universidad de Talca); E8: Punto 1 Concepción (Cerro Merquín) ; E9: Punto 2 Concepción (Kingston College); E10: Temuco (Las Encinas); E11: Coyhaique (II); E12: Punta Arenas, E13: Juan Fernández (Isla).

Acknowledgments
The authors thank project Fondecyt 1161673 (PI: Karla Pozo) in Chile. This research was supported by the RECETOX Research Infrastructure (LM2015051 and CZ.02.1.01/0.0/0.0/16_013/0001761).

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