SOURCE REGION SPECIFIC AMBIENT AIR SAMPLING OF POP IN THE ALPS

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Abstract

A novel modification of ambient air sampling techniques has been used within the project MONARPOP, which affords the opportunity to attribute measured concentrations of different POP to predefined source regions possibly important for the Alps. Such ambient air samplers have been installed at three high altitude sampling sites Weissfluhjoch (CH; 2663 m), Zugspitze (D; 2650 m) and Sonnblick (A; 3106 m). Presented are the results of five times three months continuous sampling. For most of the POP analysed so far, no predominant source region could be detected, but seasonal differences are obvious.

Introduction

In the years 2005 to 2007 a comprehensive investigation of POP in the Alps was carried out within the framework of the project **MONARPOP (Mo**nitoring **N**etwork in the **A**lpine **R**egion for **P**ersistent and other **O**rganic **P**ollutants) [1,2]. Its main goal was to investigate the present contamination of the Alps with POP and to understand the role of high mountains in the global atmospheric transport of POP [3,4]. One of the main goals of MONARPOP was the evaluation of the influence of long range transport of POP on the Alps. A special question in this context was to identify if source regions exist that are responsible for higher POP air concentrations in the Alps. This required to relate ambient air concentrations at high altitude background sites to the trajectories of the arriving air masses and possible sources along these trajectories. Such geographic specifity can be reached through short-term sampling followed by backward air trajectory analysis [5]. However, detection of some POP, e.g. Dioxins, needs long sampling periods, especially at high altitude background stations where low concentrations can be expected. In addition, we were interested in representative long term air concentrations. This increases the meteorological risk of sampling air from widely varying trajectories and, hence, loss of geographic specifity. Therefore, a new sampling method had to be developed to fulfil these targets.

Material and Methods

High altitude ambient air measurement sites were located at three alpine summits, taking advantage of the infra-structures of well equipped meteorological stations to operate POP samplers. The selected sites were Weissfluhjoch (CH; 2663 m), Zugspitze (D; 2650 m) and Sonnblick (A; 3106 m). These sites are staffed around the year which ensured maintenance and immediate repair of the sampling equipment.

For the measurements existing sampling techniques for POP [6,7] were modified: to avoid the overlay of trajectories (see introduction) during the necessarily long measurement periods, sampling was distributed between separate filters assigned to one of four source regions. Source regions were predefined according to their potential influence on the Alps. The following three regions were selected: 1. the industrial regions of Germany, Great Britain, Belgium, The Netherlands in the Northwest of the Alps, 2. the industrial region of Czech Republic, Slovakia and Poland in the North East of the Alps and 3. the industrial region of the Po basin in Italy.

At every sampling site, two ambient air samplers, one low volume sampler (3 m³/h) and one high volume sampler (8 m³/h) were equipped with four filter cartridges each. Three cartridges were assigned to the predefined source regions. The fourth cartridge collected air during so-called undefined weather situations, when air masses could not be attributed to one of the three predefined source regions. Air masses were considered attributable if their residence time over any of the predefined source regions was at least two days. The appropriate filter cartridges were activated through remote (internet) control based on daily meteorological trajectory forecasts.

Five three-month sampling periods lasted from December 2005 to July 2007. High volume samples were analysed for PCDD/F [at A], PCB [A] and PBDE [E], those from the low volume samplers for OCP [D] and PAH [G].

Results and Discussion

Figure 1 shows ambient air concentrations of the sum of 16 EPA-PAH and figure 2 the ambient air concentrations of the sum of PCDD/F. Concentrations clearly differ between periods and sites. Although, for the compounds analysed so far, no source region prevailed across sites and periods, there are examples where all three sites received POP chiefly from one source region (see PAH concentrations during the cold season autumn-winter 2006/07 in Figure 1). Air concentrations at a given site varied from period to period. For instance, no site or source region showed highest or lowest PAH concentrations over all sampling periods. It is thus likely that various source regions, possibly including local emissions, contributed equally to the pollution. The results presented here are mean concentrations over a sampling period of three months, which means that transient peaks have minor influence on the results. Short term measurements might thus have given a quite different picture of the situation. The conclusion for further projects is that, especially in low pollution mountainous areas, long-term measurements over several seasons are necessary for a representative assessment of atmospheric POP pollution.

Acknowledgement

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References

1. Bassan R., Belis C., Heublein D., Iozza S., Jakl T., Jakobi G., Kirchner M., Knoth W., Kräuchi N., Levy-Lopez W., Luchetta A., Magnani T., Moche W., Oehme M., Offenthaler I., Perthen-Palmisano B., Schmid D., Schramm K.-W., Schrott H., Schröder P., Sedivy I., Simončič P., Uhl M. and Weiss P. *Organohalogen Comp* 2005; 67: 1839.
2. MONARPOP. <http://www.monarpop.at/ (April 15, 2008)>
3. Daly G.L. and Wania F. *Environ Sci Technol* 2005; 39: 385.
4. Vighi M., Ed. *Ecotoxicology and Environmental Safety* 2006; 63: 1.
5. Cheng H., Zhang G., Jiang J.X., Li X., Liu X., Li J., Zhao Y. *Atmospheric Environment* 2007; 41: 4734
6. Standard VDI 3498 Part 1: 2002-07 Ambient air measurement, Indoor air measurement, Measurement of polychlorinated Dibenzo-p-dioxins and Dibenzofurans, Method using large filters, Berlin: Beuth Verlag
7. Standard VDI 4300 Part 2: 1997-12 Measurement strategy for polycyclic aromatic hydrocarbons (PAHs), polychlorinated dibenzo-p-dioxins (PCDD), and polychlorinated dibenzofurans (PCDF) and polychlorinated biphenyls (PCBs), Berlin: Beuth Verlag
8. Alpine Space Programme. <http://www.alpinespace.org/ (April 15, 2008)>
9. http://had.co.nz/ggplot2/

Figure 1: Total concentration [ng / standard m³] of 16 EPA-PAH in air from three source regions (NW, NE and S; circle: “undefined origin”).

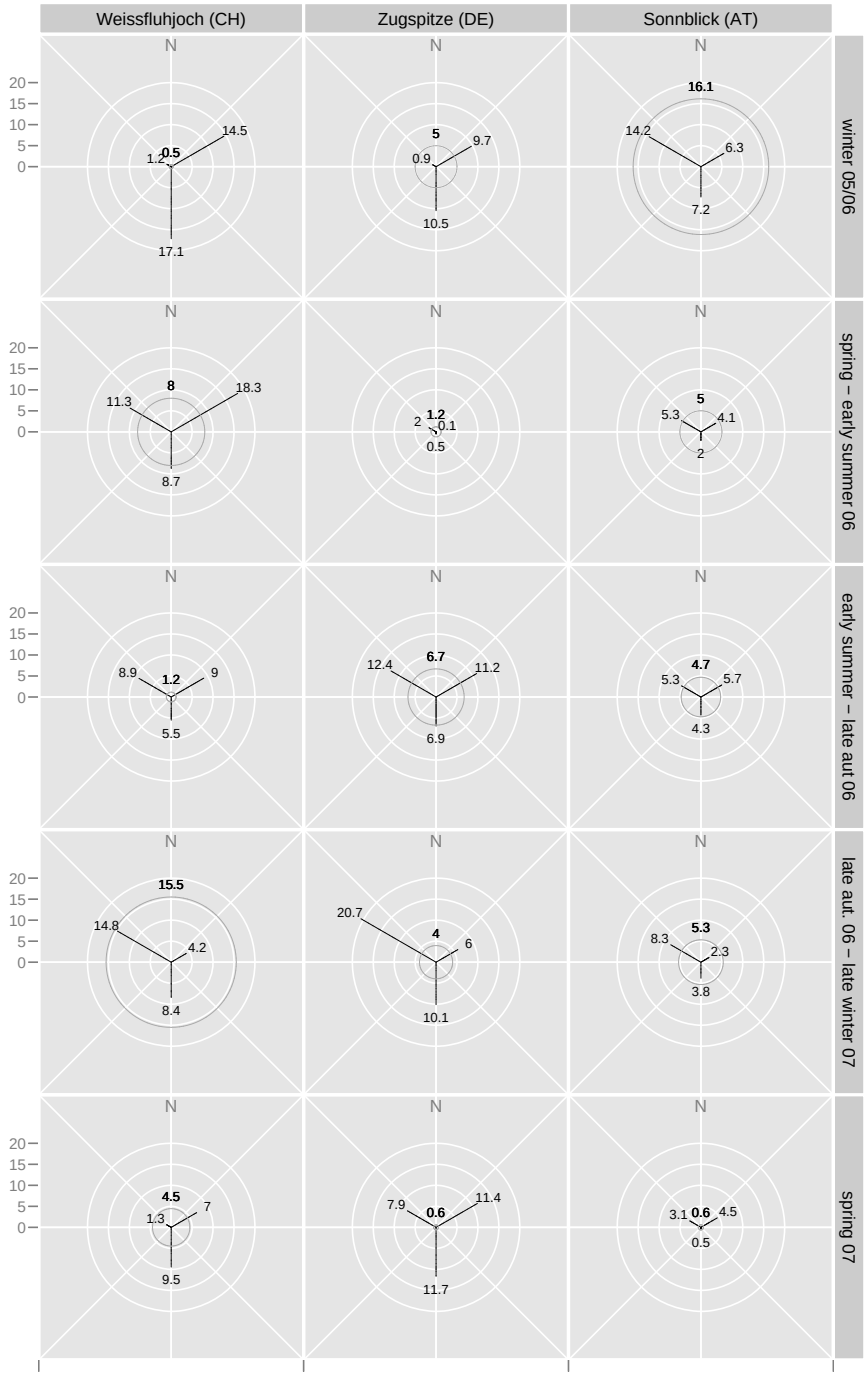

Figure 2: Total dioxin and furan concentration [fg / standard m³] in air from three source regions (NW, NE and S; circle: "undefined origin"). Note different scales as indicated in the top right quadrant.