

TRENDS OF ATMOSPHERIC TRACE ELEMENTS AT A SUB-ARCTIC SITE PALLAS IN FINLAND IN 1996-2014

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Introduction

Atmospheric trace elements have been collected for twenty years at a sub-arctic site Pallas in Northern Finland. The station is part of many international programs such as WMO/GAW, EMEP, AMAP, IM and GMOS. In general, the air quality at Pallas has improved over the time of the measurements due to decreased emissions in Finland and elsewhere in Europe (Lohila et al., 2015). Here we present the trends of twelve (Al, As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, V and Zn) trace elements in particulate matter (PM10).

Methods

The sampling site is a background station located in Northern Finland (68 N, 24 E). More details of the station characteristics are given in Lohila et al., 2015. The trace element PM10 samples were collected weekly on Teflon filters, digested in the laboratory and analyzed with ICP-MS. The trend analysis was calculated by Generalized Least-Squares (GLS) regression with classical decomposition and AutoRegressive Moving Average (ARMA) errors applied for monthly mean values (*see e.g. Anttila and Tuovinen, 2010*).

Results

The atmospheric concentrations of trace elements at Pallas are rather low compared to other European sites. This is due to minor domestic emissions in the sub-arctic area and long distance to the large European source areas. In Figure 1, the measured and modeled atmospheric PM10 concentrations with annual trends are shown for arsenic, cadmium, nickel and lead. These are the four trace elements the EU member countries are obliged to monitor according to the European legislation. The annual concentrations were from the lowest values to highest Co<Cd<<Cr<As<Mn<Cu, Ni, V<Pb<Zn<<Al<Fe. The seasonality of the elements varies. Some elements, e.g. As, Cd, Pb, V and Zn have strong seasonality with peaks in the late winter due to the higher amount of energy production. For elements of significant soil dust origin, e.g. Al, Co, Fe and Mn, the highest concentrations are observed during the spring and early summer after snow melt due to re-suspension.

The trend analysis showed that most of the elements are decreasing 2-3 % per year. These decreases are substantial resulting in decreases of 34-55 % during the whole measurement period. Only chromium and zinc did not have statistically significant trends.

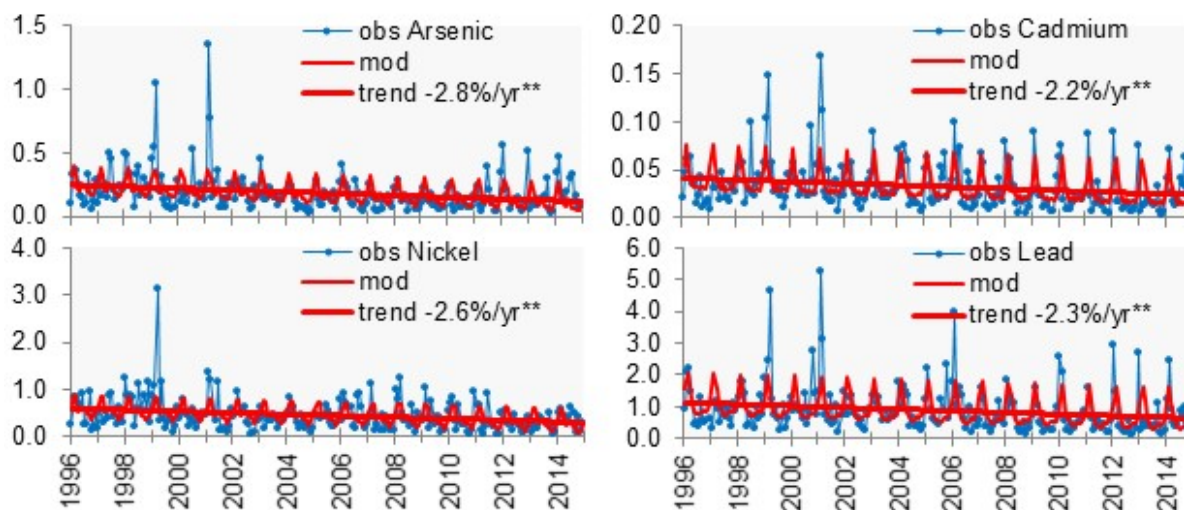


Figure 1. Atmospheric measured and modelled concentrations (in ng m⁻³) with annual trends of arsenic, cadmium, nickel and lead at Pallas in 1996-2014. The trends are significant at the 99 % confidence level (**).

Conclusion

We discovered that besides Cr and Zn, the atmospheric concentration of trace elements has reduced substantially during the last twenty years. This is due to the emission reductions in Finland and broader in Europe. Additionally, the high As, Ni and Cu emissions from the metallurgical industry in Kola Peninsula (about 300 km from Pallas) have previously been connected to elevated deposition at the site (Kyllönen et al., 2009). There is no official emission records available for the smelters but our results indicate the emissions have possibly been reduced. Our results give evidence that the emission reductions have had a positive impact on the air quality.

References

- Anttila, P.; Tuovinen J.-P. (2010). Trends of primary and secondary pollutant concentrations in Finland in 1994–2007. *Atmos. Environ.*, 44, 30–41.
- Kyllönen, K.; Karlsson, V.; Ruoho-Airola, T. (2009). Trace element deposition and trends during a ten year period in Finland. *Sci Tot Environ*, 407, 2260–2269
- Lohila, A.; Penttilä, T.; Jortikka, S.; Aalto, T.; Anttila, P.; Asmi, E.; Aurela, M.; Hatakka, J.; Hellén, H.; Henttonen, H.; Hänninen, P.; Kilkki, J.; Kyllönen, K.; Laurila, T.; Lepistö, A.; Lihavainen, H.; Makkonen, U.; Paatero, J.; Rask, M.; Sutinen, R.; Tuovinen, J.-P.; Vuorenmaa, J.; Viisanen, Y. (2015). Preface to the special issue on integrated research of atmosphere, ecosystems and environment at Pallas. *Boreal Env. Res.*, 20, 431–454.