Flame Retardants in Tree Bark from around the Globe

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Flame Retardants: What is the concern?

- Ubiquitous environmental contaminants
- Persistent
- Bioaccumulative
- Adverse effects on endocrine, neurological, and reproductive systems
Advantages of Tree Bark Sampling

- Natural air sampler
- Easy and inexpensive to collect
- Accumulates persistent organic pollutants (POPs) due to high lipid content
- Accumulates both gas and particle phase POPs
- No need for power: remote areas
Atmospheric Sampling

Tree bark is a good alternative!
Pollution Source Tracing with Tree Bark

PBDE manufacturing plants
Dechlororane Plus (DP)

- **Chlorinated** flame retardant
- High production volume chemical, used for over 40 years
- Used in electrical connectors, wires and cables
- The only U.S. manufacturer is OxyChem, Niagara Falls, NY
- Persistent in the environment
Pollution Source Tracing with Tree Bark

- DP manufacturing plant
- DP in tree bark
  - site conc. (ng/g bark)
  - OxyChem plant
  - calculated source
What we did

• Collected bark samples at 12 locations around the globe (Global Atmospheric Passive Sampling (GAPS) Network sites)
• 3-4 bark samples collected at each site (2009 - 2010)
• Samples taken from pine trees closest to the GAPS sampler
• Analyzed for the flame retardants
Bark Sampling Sites

- Birkenes, Norway
- Dhulikhel, Nepal
- Bukit Kototabang, Indonesia
- De Aar, South Africa
- Cape Grim, Tasmania
- Tula, American Samoa
- Whistler, British Columbia
- Downsview, Ontario
- Reykjavik, Iceland
- Malin Head, Ireland
- Košetice, Czech Rep.
- Frasardale, Ontario
- De Aar, South Africa
PBDEs in Bark

Total PBDE conc., ng/g lipid

Urban / Source
- Downsview, ON, Canada
- Chicago, IL, USA
- Cleveland, OH, USA
- Marshall, AR, USA

Rural / Remote
- Sturgeon Point, NY
- Eagle Harbor, MI
- Sleeping Bear Dunes, MI
- Frasardale, ON
- Whistler, BC
- Indonesia
- Nepal
- Czech Republic
- American Samoa
- Cape Grim, Australia
- DeAar, S. Africa

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Bark FR concentrations and population

$r^2 = 0.21$  
$p = 0.024$

Total PBDE conc.

Population

$10^1$  $10^2$  $10^3$  $10^4$  $10^5$  $10^6$  $10^7$  $10^8$

Chicago, Illinois, U.S.
Cleveland, Ohio, U.S.
Downsview, Ontario, Canada
Sturgeon Point, New York, U.S.
Eagle Harbor, Michigan, U.S.
Sleeping Bear Dunes, Mich. U.S.
Frasardale, Ontario, Canada
Whistler, Brit. Columbia, Canada
Bukit Kototabang, Indonesia
Dhulikhel, Nepal
Reykjavik, Iceland
Malin Head, Ireland
Birkenes, Norway
Košetice, Czech Republic
Tula, American Samoa
Cape Grim, Tasmania
De Aar, South Africa
Niagara Falls, New York, U.S.
Trieste, Italy
Beijing, China
Marshall, Arkansas, U.S.
Hanam, South Korea
Xining, China
Guangzhou, China
Flame Retardant Concentrations in Bark Track Those in Air

Total PBDE, $r^2 = 0.64$
$p = 0.0003$

$\text{DP}, \ r^2 = 0.40$
$p = 0.021$

Flame retardant concentrations in bark track those in air.
Conclusions

• Flame retardants are found in bark samples at 12 locations around the globe

• Highest FR concentrations are measured at urban sites or near point sources

• Tree bark is an effective air sampler

• Has potential for unknown contamination screening studies and use in remote places and developing economies.
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