Impacts of climate change on chemical environmental fate processes

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Background

- **Worldwide megatrends** including urbanisation, competition for resources, environmental pollution and **climate change** ultimately affect how humans and the environment are exposed to chemicals¹,².
- Increases in mean **global temperatures** are expected in the future, and relative concentration pathway 8.5 (RCP8.5) forecasts a mean increase of between 2.6-4.8°C by 2081-2100³ if societal practices continue as “business as usual”.
- In the European Union (EU), the extent of these temperature shifts will vary regionally and seasonally across countries located at Northern, Central and Southern latitudes of the EU⁴.
- Therefore, it is important to consider how future temperature changes could impact specific chemical environmental fate processes among different climatic regions, as temperature is an important modulator of physical and environmental processes⁵, and could drive changes in exposure patterns⁶.

Overall Goal

To investigate the overall effects and trends of predicted changes in temperature on chemical fate and exposure in freshwater systems leading up to years 2081-2100.

Objectives

1. Review literature to determine the impacts of temperature changes on key environmental fate processes (i.e. sorption, volatilisation, and degradation).
2. Gain an improved understanding of how temperature-corrections are considered and implemented into environmental risk assessment of chemicals.

Discussion

- Biodegradation and volatilisation data was predominantly pesticides, and often lacked tests conducted at more than three temperatures.
- For chemical sorption, compounds with higher Kd tended to show decreased sorption as temperature increases, whereas compounds with lower Kd showed increased sorption as temperature increases.
- Arrhenius-based temperature corrections in REACH guidance might not accurately predict the effects of temperature on biodegradation⁷,⁸.

Methods

**Summary of literature review**

**Number of total chemicals**

- Sorption: 17 studies which determined sorption coefficients (Kd) for 42 total chemicals across a temperature range of 2.3-40°C.
- Volatilisation: 7 studies which determined Henry’s Law constant coefficients (KH) for 41 total chemicals across a temperature range of 4.2-40°C.
- Degradation: 25 studies which determined chemical half-lives for 47 total chemicals across a temperature range of 4-37°C.

**Results**

- Within the study temperature range:
  - Increased Kd: 17 compounds
  - Decreased Kd: 25 compounds
  - Greatest increase, carbofuran, (106%)
  - Greatest decrease, PCB28, (89.3%)
  - Increased KH: 39 compounds
  - Decreased KH: 2 compounds
  - Greatest increase, chlorpyrifos, (17314%)
  - Greatest decrease, diazinon, (91%)
  - Increased DT50: 47 compounds
  - Decreased DT50: None
  - Greatest increase, chlorotetracline, (98.6%)
  - Smallest increase, chlorpyrifos, (20.7%)

References