Introduction

Chloroform (CHCl₃) is a well-documented disinfectant by-product (DBP) of water chlorination. Chloroform is an important atmospheric pollutant by its direct health effects as well as by its contribution to photochemical smog formation. Chloroform outgassing from swimming pools is not typically considered a source of atmospheric chloroform because swimming pools are scarce compared to other sources. However, urban areas in hot climates such as Phoenix generally contain a substantial amount of swimming pools per capita, potentially resulting in significant atmospheric fluxes. In this study, swimming pools as a source of atmospheric chloroform is investigated. Measurements of chloroform concentrations are used to estimate fluxes and determine impacts on Phoenix air pollution.

Chlorination of Swimming Pool Water

![Figure 1: 2012 Average Annual Ambient CHCl₃ concentrations](image1)

![Figure 2: Illustration of chemistry occurring in swimming pool water](image2)

What causes the CHCl₃?

**Chlorine**

- **CHCl₃**
- **DBPs**
- **VOCs**
- **Bacteria**

Chloroform Flux From Pools in Phoenix

\[ F_{a/w} = v_{a/w} \left( c_a - c_w \right) \]

- \( v_{a/w} \): transfer velocity
- \( c_a \): [CHCl₃] in pool
- \( c_w \): [CHCl₃] in air
- \( K_{a/w} \): Henry’s law constant

![Figure 3: CHCl₃ yield per mol C after chlorination of pool water. Shaded region indicates 0.01 mol CHCl₃/mol C as measured by Lee et al. (2007).](image3)

![Figure 4: CHCl₃ yield per mol Cl₂ consumed after chlorination of pool water. Shaded region indicates 0.039 mol CHCl₃/mol Cl₂ as measured by Weng and Blatchley (2011).](image4)

![Figure 5: Phoenix CHCl₃ emission estimates when varying water temperature between 8 °C (winter) and 28 °C (summer).](image5)

Other sources of CHCl₃ in Phoenix?

- **Natural emissions**
- **Anthropogenic emissions**
- **Swimming pool emissions**

![Figure 6: Phoenix CHCl₃ emission estimates](image6)

Future work

- Measure CHCl₃ outgassing from pools for comparison
- Is CHCl₃ being produced in the atmosphere after outgassing of HOCl and Cl₂ from pools? Estimates from previous flux measurements suggest significant outgassing of HOCl and Cl₂. (Chang et al., 2001)

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References

