# Variations in Organophosphate Ester (OPE) Concentrations in Atmospheric Particulate Matter in Klamath Falls, OR Christine Lindholm, Leart Jahaj, and Dr. Adelaide E. Clark **Department of Chemistry and Biochemistry** PROVIDENCE COLLEGE Providence College



## Abstract

Air pollution continues to be a major environmental concern not only to the ecosystem but human health as well. Changes in atmospheric particulate matter (PM) from both natural (wildfire) and anthropogenic (winter home heating) sources can adversely affect human health while also indicating the severity of the harmful chemicals the air contains. Organophosphate esters (OPES) are an example of pollutants which have a wide range of uses within consumer products including flame retardants, plasticizers, and herbicides. Despite its rural location, areas such as Klamath Falls, Oregon, are susceptible to increased levels of PM due to the effects of wildfire season in the summer months, woodstoves for home heat in the winter months, and their geographic "basin" structure, all contributing to the increase of these chemicals within the air throughout the year. Filter-based samples of PM less than 2.5 microns in aerodynamic diameter (PM2.5; inhalable size fraction) were analyzed for 35 OPEs and novel-OPEs. Results suggest a diverse array of sources and correlations between compounds and meteorological parameters. Correlation with elevated air quality index (AQI) was also investigated.

### Introduction

- Organophosphate (OPEs) esters are organic derivatives classified as phosphoric acid.
- Some uses of OPEs are plasticizers, flame retardants, and herbicides.<sup>6,7</sup>
- These compounds have been found within our environment in urban areas at increasingly high concentrations, but at low concentrations in rural areas.<sup>2</sup>
- These compounds have also been found in high concentrations in the burning of e-waste, which suggests that burning consumer products in a wildfire may also result in elevated levels of OPEs.

- examine possible sources.
- temperature and max AQI. different OPE compound
- located sources.

# **Target Analytes**

### OPEs

- Tri-ethyl phosphate (TEP)
- Tri-n-propyl phosphate (TPrP)
- Tri-n-butyl phosphate (TBP)
- Triphenyl phosphate (TPP) Tri-o-tolyl-phosphate (TOTP)
- Tri-m-tolyl-phosphate (TMTP)
- Tri-*p*-tolyl phosphate (TPTP)
- Tris(2-ethylhexyl) phosphate (TEHP)
- Tris(2-chloroethyl) phosphate (TCEP) Tris[1-chloro-2-propyl] phosphate (TCPP)
- Tris(1,3-dichloro-2-propyl) phosphate (TDCPP)
- Tris(2-isopropylphenyl) phosphate (T2IPPP)
- Tris(3,5-dimethylphenyl) phosphate (T35DMPP)
- 2-Ethylhexyl diphenyl phosphate (EHDPP)
- Tris(3-isopropylphenyl) phosphate (T3IPPP)
- Tris(3,4-dimethylphenyl) phosphate (T34DMPP) .
- Tris(3-tert-butylphenyl) phosphate (T3tBPP) Tris(4-isopropylphenyl) phosphate (T4IPPP)
- Tris(4-tert-butylphenyl) phosphate (T4tBPP)

# NOPEs

- Bis(4-isopropylphenyl) phenyl phosphate
- (B4IPPPP)
- Bis(2,4-diisopropylphenyl) phenyl phosphate
- (B24DIPPPP)
- 4-Isopropylphenyl diphenyl phosphate (4IPPDPP)
- Bis(2-isopropylphenyl) phenyl phosphate (B2IPPPP)
- Bis(3-isopropylphenyl) phenyl phosphate (B3IPPPP)
- 2,4-Diisopropylphenyl diphenyl phosphate (24DIPPDPP)
- 3-tert-Butylphenyl diphenyl phosphate (3tBPDPP)
- 4-*tert*-Butylphenyl diphenyl phosphate (4tBPDPP)



**Objectives** 

Report concentrations of OPEs and NOPEs in atmospheric particulate matter in Klamath Falls, OR. Analyze concentrations of OPEs and NOPEs within PM 2.5 samples and Compare day-to-day variability of OPEs and NOPEs with average

Look at correlations between

concentrations for possible co-

• Bis(2-*tert*-butylphenyl) phenyl phosphate (B2tBPPP) Bis(3-tert-butylphenyl) phenyl phosphate (B3tBPPP) Bis(4-tert-butylphenyl) phenyl phosphate(B4tBPPP)

• 2-Isopropylphenyl diphenyl phosphate (2IPPDPP) • 3-Isopropylphenyl diphenyl phosphate (3IPPDPP) 2-tert-Butylphenyl diphenyl phosphate (2tBPDPP)

Figure 1. Map of wildfires occurring in Oregon during late July through late August months (left); and wind trajectory map representing a 24 hour backtrack period showing where the wind came from and what it traveled through until reaching Klamath Falls (each red line representing 1 hour over a 24hr period)(right) Source: Google Maps

Institute Oregon











OPEs to Klamath Falls.

