Section 17-1 Occurrences in outdoor air, indoor air and settled dust, and precipitation tables

These tables belong with the ITRC PFAS Tech Reg Document. They provide information about the studies used in developing the figures included in Section 6. The observed concentrations of PFAS that have been reported in the recent literature are included for outdoor air, indoor air and settled dust, and precipitation. These tables are intended to provide context to the reader and a starting point for further study. Media-specific occurrences of PFAS are constantly being added in the literature and on state, federal, and other countries' PFAS websites.

The user is encouraged to visit the ITRC PFAS web page (http://pfas-1.itrcweb.org) to access the current version of this file. Please see ITRC Disclaimer http://pfas-1.itrcweb.org/about-itrc/#disclaimer.

Table 17-1A. Observed PFAS concentrations in outdoor air[1]

Reference/ Location	Summary	Concentrations (pg/m^3) unless otherwise noted
Karachi, Pakistan (Lin et al. 2022)	Air samples were collected over a 24-hr period from a heavily industrialized area in proximity to major highways, shipyards and other emissions sources, near a facility where all domestic, industrial, hospital, and commercial waste from the city is dumped and where open burning of biomass and refuse occurs. Samples were analyzed for a range of PFAS within the fraction of total suspended particles.	Reported concentrations of PFAS in total suspended particles in outdoor air were [mean (range)]: • PFOS: 1.70 (0.64 – 3.17) • FOSA: 0.36 (0.08 – 1.72) • MeFOSA: 0.19 (ND – 1.92) • EtFOSA: 0.40 (ND – 2.65) • MeFOSAA: 0.06 – ND – 0.29) • 6:2 FTSA: 0.56 (ND – 1.30) • PFBA: 3.11 (ND – 11.4) • PFHxA: 0.71 (ND – 8.33) • PFOA: 2.03 (0.85 – 8.70) • PFNA: 0.11 (ND – 0.46) • PFDA: 0.51 (0.19 – 2.11) • ∑PFAS: 9.73 (4.29 – 39.0)
Dhaka, Bangladesh (Morales-McDevitt et al. 2022)	During January-March 2020, polyethylene sheets were deployed for 28 days as passive samplers to collect 10 outdoor air and 4 water samples for analysis of a range of neutral PFAS. 8 discrete water grab samples were also collected by traditional water sampling methods and analyzed for a range of ionic PFAS.	Reported concentrations of neutral PFAS in outdoor air samples were (range): • 6:2 FTOH: <IDL – 71,000 • 8:2 FTAcr: <IDL – 8,000 • 8:2 FTOH: <IDL – 31,000 • 10:2 FTAcr: <IDL • 10:2 FTOH: <IDL – 18,000 • EtFOSA: <MDL • MeFOSA: <MDL • MeFOSE: <IDL • EtFOSE: <MDL • ΣPFAS: 0 – 128,000

<table>
<tr><th>Reference/ Location</th><th>Summary</th><th>Concentrations (pg/m^3) unless otherwise noted</th></tr>
<tr><td>Andøya and Birkenes, Norway

(Sha et al. 2022)</td><td>Between 2018 and 2019, 115 sea spray aerosol samples were collected in a coastal area of Norway and measured for a range of PFAS to assess their influence on atmospheric concentrations of PFAAs.</td><td>Reported concentrations of PFAS in sea spray aerosol air samples were [mean (range)]:
<table>
<tr><th>PFAS</th><th>Andøya (n=57)</th><th>Birkenes (n=58)</th></tr>
<tr><td>PFHxA</td><td>0.038 (<0.004-0.285)</td><td>0.009 (<0.004-0.191)</td></tr>
<tr><td>PFHpA</td><td>0.046 (<0.004-0.228)</td><td>0.037 (<0.004-0.257)</td></tr>
<tr><td>PFOA</td><td>0.19 (<0.003-1.28)</td><td>0.091 (<0.003-0.811)</td></tr>
<tr><td>PFNA</td><td>0.16 (<0.004-0.467)</td><td>0.12 (<0.004-0.555)</td></tr>
<tr><td>PFDA</td><td>0.14 (0.007-1.01)</td><td>0.044 (<0.007-0.133)</td></tr>
<tr><td>PFUnDA</td><td>0.043 (<0.004-0.112)</td><td>0.039 (<0.004-0.242)</td></tr>
<tr><td>PFDoDA</td><td>0.068 (<0.004-0.331)</td><td>0.16 (<0.004-0.112)</td></tr>
<tr><td>PFBS</td><td>0.004 (<0.007-0.035)</td><td>0.004 (<0.007-0.028)</td></tr>
<tr><td>PFHxS</td><td>0.005 (<0.004-0.019)</td><td>0.009 (<0.004-0.07)</td></tr>
<tr><td>PFOS</td><td>0.040 (<0.004-0.144)</td><td>0.055 (0.006-0.392)</td></tr>
</table></td></tr>
<tr><td>China, Japan, and Malaysia

(Wang S et al. 2022)</td><td>Between July 2019 and May 2020, 35 ambient air samples were collected in urban and suburban areas in China, Japan, and Malaysia and analyzed for a range of neutral and ionic PFAS to assess the occurrence, seasonal variations, sources, and transport of PFAS.</td><td>Reported concentrations of PFAS in air samples were (range):
<table>
<tr><th>PFAS</th><th>Winter</th><th>Summer</th></tr>
<tr><td>6:2 FTOH</td><td>0.0 - 275.8</td><td>0.0 – 135.5</td></tr>
<tr><td>8:2 FTOH</td><td>2.0 - 271.8</td><td>18.3 – 981.0</td></tr>
<tr><td>10:2 FTOH</td><td>0.0 - 64.2</td><td>0.0 – 231.9</td></tr>
<tr><td>MeFOSA</td><td>0.0 – 0.0</td><td>0.0 – 0.0</td></tr>
<tr><td>EtFOSA</td><td>0.0 – 0.0</td><td>0.0 – 45.0</td></tr>
<tr><td>MeFOSE</td><td>0.0 – 0.0</td><td>0.0 – 0.0</td></tr>
<tr><td>EtFOSE</td><td>0.0 – 0.0</td><td>0.0 – 10.3</td></tr>
<tr><td>PFBA</td><td>3.3 - 41.5</td><td>9.1 – 297.9</td></tr>
<tr><td>PFPeA</td><td>0.0 – 0.0</td><td>0.0 – 12.4</td></tr>
<tr><td>PFHxA</td><td>0.0 – 1.2</td><td>0.0 – 6.7</td></tr>
<tr><td>PFHpA</td><td>0.0 – 2.8</td><td>0.1 – 4.4</td></tr>
<tr><td>PFOA</td><td>0.0 – 29.0</td><td>0.2 – 19.9</td></tr>
<tr><td>PFNA</td><td>0.0 – 1.9</td><td>0.0 – 4.5</td></tr>
<tr><td>PFDA</td><td>0.0 – 0.7</td><td>0.0 – 1.0</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Reference/ Location</th><th>Summary</th><th>Concentrations (pg/m^3) unless otherwise noted</th></tr>
<tr><td>Zhangjiakou and Shenyang, China

(Wang Q et al. 2022)</td><td>In 2017 - 2018, 52 air samples, 16 leaf samples, and 8 soil samples were collected in the area of the Three-North Shelter Forest in northern China and analyzed for a range of PFAS to study the effect of the forest on the fate and transport of PFAS.</td><td>Reported concentrations of PFAS in air samples were (range):

<table>
<tr><th>PFAS</th><th>Winter</th><th>Summer</th></tr>
<tr><td>PFBA</td><td>0.39 – 2.79</td><td>0.21 – 3.30</td></tr>
<tr><td>PFPeA</td><td>0.06 – 1.50</td><td>0.12 – 1.94</td></tr>
<tr><td>PFHxA</td><td>0.10 – 1.28</td><td><MQL – 1.79</td></tr>
<tr><td>PFHpA</td><td>0.08 – 0.71</td><td>0.06 – 1.38</td></tr>
<tr><td>PFOA</td><td>0.11 – 2.80</td><td>0.22 – 2.66</td></tr>
<tr><td>PFNA</td><td>0.08 – 2.31</td><td>0.14 – 2.07</td></tr>
<tr><td>PFDA</td><td><MQL – 0.40</td><td><MQL – 0.65</td></tr>
<tr><td>PFUnDA</td><td><MQL – 0.07</td><td><MQL – 0.11</td></tr>
<tr><td>PFBS</td><td><MQL – 0.65</td><td><MQL – 0.39</td></tr>
<tr><td>PFHxS</td><td><MQL – 0.73</td><td><MQL – 0.56</td></tr>
<tr><td>PFOS</td><td>0.08 – 1.18</td><td>0.04 – 1.00</td></tr>
<tr><td>6:2 Cl-PFESA</td><td><MQL – 2.75</td><td>0.04 – 1.37</td></tr>
<tr><td>8:2 Cl-PFESA</td><td><MQL – 0.25</td><td><MQL – 0.37</td></tr>
<tr><td>6:2 FTOH</td><td><MQL – 14.04</td><td><MQL – 13.21</td></tr>
<tr><td>8:2 FTOH</td><td>4.44 – 18.2</td><td>3.22 – 21.24</td></tr>
<tr><td>10:2 FTOH</td><td><MQL – 9.50</td><td><MQL – 11.83</td></tr>
</table>
</td></tr>
<tr><td>Deception and Livingston Islands, Antarctica

(Casas et al. 2021)</td><td>21 rain samples and 20 air samples were collected during the Antarctic summer of 2017−2018 to assess the potential for rain amplification for different legacies and emerging POPs, including a range of PFAS.</td><td>Reported PFAS concentrations in air were (range):

• PFBS: ND – 0.018
• PFOS: <LOD – 0.0249
• PFBA: 0.007 – 0.53
• PFHxA: <LOD – 0.083
• PFHpA: <LOD – 0.031
• PFOA: <LOD – 0.056
• PFNA: ND – 0.018
• PFDA: <LOD – 0.013
• PFUnDA: 0.000052 – 0.0044
• PFDoDA: ND – 0.00057
• PFTrDA: ND – 0.00007
• PFTeDA: ND – 0.0001</td></tr>
</table>

<table>
<tr><th>Reference/ Location</th><th>Summary</th><th>Concentrations (pg/m^3) unless otherwise noted</th></tr>
<tr><td>Tsukuba City, Japan

(Wu et al. 2021)</td><td>2 air samples were collected at the National Institute of Advanced Industrial Science and Technology (AIST) in July 2020 to validate the performance of a novel air sampling method for the simultaneous analysis of ionic and neutral PFAS in both particulate and gaseous phases. Samples were analyzed for 48 PFAS compounds.</td><td>19 of 48 PFAS compounds were detected. The composition of the samples was dominated by neutral PFAS, which represented 98% of the PFAS present.

The total ∑PFAS on each sampling occasion was 290 and 690.

The highest detected PFAS concentrations were observed for 6:2 and 8:2 FTOHs, accounting for, on average, 40% and 32% of the sum of neutral PFASs (Σn-PFASs), respectively. Average levels of 4:2, 6:2, 8:2 and 10:2 FTOH were 4.0, 190, 160 and 36, respectively.

The average sum of the concentrations of ionizable PFAS (Σi-PFAS) in the air particle phase was 11. The ∑i-PFAS was dominated by PFCAs (78% of the total) with PFHxA being the largest contributor (32%).</td></tr>
<tr><td>Taiwan Western Straight, Arctic Ocean, and Antarctic Ocean

(Yamazaki et al. 2021)</td><td>Simultaneous sampling of atmospheric and seawater samples was performed onboard a research vessel and from a marine station in the Taiwan Western Sea (July 2017), the Western Arctic Ocean (September 2013), and the Antarctic Ocean (December 2012) and were analyzed for a range of PFAS. Air sampling and analysis included characterizing PFAS in both the gas and particulate phases.</td><td>Reported PFAS concentrations in air samples were (range):

<table>
<tr><th rowspan="2">PFAS</th><th colspan="2">Taiwan Western Sea</th><th>Western Arctic Ocean</th><th>Antarctic Ocean</th></tr>
<tr><th>Gas phase (n=4)</th><th>Particle phase (n=4)</th><th>Gas + particle phase (n=4)</th><th>Gas + particle phase (n=11)</th></tr>
<tr><td>PFBS</td><td>0.04-0.17</td><td><0.1-0.58</td><td>0.04-0.15</td><td><0.06-<0.62</td></tr>
<tr><td>PFHxS</td><td>0.05-0.16</td><td><0.1-0.58</td><td><0.07-0.15</td><td><0.02-<0.12</td></tr>
<tr><td>PFOS</td><td>0.16-0.55</td><td>0.30-8.09</td><td>0.23-0.59</td><td><0.04-0.63</td></tr>
<tr><td>PFDS</td><td><0.60-<0.07</td><td><0.03-<0.27</td><td><0.19-<0.27</td><td><0.02-0.12</td></tr>
<tr><td>PFBA</td><td>1.99-4.51</td><td>0.03-1.57</td><td>1.21-1.65</td><td>0.15-1.62</td></tr>
<tr><td>PFPeA</td><td><0.07-0.91</td><td><0.07-1.19</td><td>0.58-1.07</td><td>0.20-1.19</td></tr>
<tr><td>PFHxA</td><td>0.46-2.52</td><td>0.07-0.79</td><td>0.51-1.16</td><td>0.06-0.88</td></tr>
</table>
</td></tr>
</table>

Reference/ Location	Summary	Concentrations (pg/m^3) unless otherwise noted

PFHpA	0.28-1.54	0.05-0.67	0.31-0.50	0.07-0.71
PFOA	0.40-5.05	0.41-4.46	0.62-0.83	0.11-0.46
PFNA	0.10-0.41	0.07-1.03	0.59-0.62	0.09-0.36
PFDA	0.07-0.12	0.06-0.83	0.14-0.56	0.13-0.46
PFUnDA	0.06-0.17	0.07-0.67	0.62-0.93	<0.30-0.66
	(n=5)			
6:2 FTI	<0.6-1			
8:2 FTI	3-12			
10:2 FTI	<7-<12			
PFDoI	<4-<6			
PFBuDiI	18-54			
PFHxDiI	<1-4			
PFDoDII	<4-5			
BTFBB	<0.7-<1			
4:2 FTOH	<0.07-<1			
4:3 FTOH	<7-<12			
6:2 FTOH	64-125			
6:3 FTOH	<4-<6			
8:2 FTOH	89-219			
8:3 FTOH	<1-9			
10:2 FTOH	14-32			
MeFOSA	<15-<23			
EtFOSA	<2-<3			
MeFOSE	<2-<3			
EtFOSE	<0.8-<1			

Reference/ Location	Summary	Concentrations (pg/m^3) unless otherwise noted
North Carolina, USA (Zhou et al. 2021)	Measured concentrations of 34 PFAS compounds in ambient fine particulate matter ($PM_{2.5}$) at 5 locations across North Carolina over a 1-year period in 2019.	The average quarterly PFAS concentrations in $PM_{2.5}$ were (range): • PFOA: <0.005-14.06 • PFOS: <0.004-4.75 • PFHpS: <0.008-0.20 • PFDoDA: <0.005-0.12 • PFHpA: <0.005-0.14 • PFUnDA: <0.006-0.04
Livingston Island, Antarctica (Casas et al. 2020)	7 sea spray aerosol and 17 samples and 17 seawater and sea surface microlayer (SML) samples were collected between January and March 2018 at South Bay of Livingston Island. Samples were analyzed for a range of PFAS.	Reported concentrations of PFAS in sea spray aerosol air samples were (range): PFBS: 0.00527 – 0.0313 PFHxS: ND – 0.00293 PFOS: <LOD – 0.0249 PFBA: 0.223 – 1.696 PFHxA: <LOD – 0.0293 PFHpA: 0.0209 – 0.0391 PFOA: <LOD – 0.0430 PFNA: <LOD – 0.0183 PFDA: <LOD – 0.0133 PFUnDA: 0.00261 – 0.00527 ∑PFAS: 0.348 – 1.772

<table>
<tr><th>Reference/ Location</th><th>Summary</th><th>Concentrations (pg/m³) unless otherwise noted</th></tr>
<tr><td>Asan Lake, South Korea

(Lee et al. 2020)</td><td>4 air, 47 sediment, 48 soil, and 42 fish samples were collected in the Asan Lake area during July – October 2017 and March – May 2018 to evaluate seasonal and spatial variations in PFAS concentrations.</td><td>Reported PFAS concentrations in air were [mean (range)]:

<table>
<tr><th>PFAS</th><th>Gas Phase</th><th>Particulate Phase</th></tr>
<tr><td>PFPeA</td><td>1.58 (ND - 2.69)</td><td>ND</td></tr>
<tr><td>PFHxA</td><td>3.06 (ND – 8.30)</td><td>0.52 (0.48 – 0.61)</td></tr>
<tr><td>PFHpA</td><td>1.01 (ND – 1.57)</td><td>0.17 (ND – 0.67)</td></tr>
<tr><td>PFOA</td><td>37.0 (18.2 – 71.4)</td><td>0.73 (ND – 1.54)</td></tr>
<tr><td>PFNA</td><td>0.28 (ND – 1.11)</td><td>ND</td></tr>
<tr><td>PFDA</td><td>0.29 (ND – 1.15)</td><td>ND</td></tr>
<tr><td>PFUnDA</td><td>0.09 (ND – 0.35)</td><td>ND</td></tr>
<tr><td>PFDoDA</td><td>ND</td><td>ND</td></tr>
<tr><td>PFTrDA</td><td>ND</td><td>ND</td></tr>
<tr><td>PFTeDA</td><td>ND</td><td>ND</td></tr>
<tr><td>PFHxDA</td><td>0.30 (ND – 1.18)</td><td>ND</td></tr>
<tr><td>PFODA</td><td>ND</td><td>ND</td></tr>
<tr><td>PFBS (linear)</td><td>0.67 (ND – 2.66)</td><td>ND</td></tr>
<tr><td>PFHxS (linear)</td><td>0.76 (ND – 1.77)</td><td>0.40 (0.24 – 0.58)</td></tr>
<tr><td>PFOS</td><td>0.34 (ND – 1.35)</td><td>2.56 (1.30 – 3.18)</td></tr>
<tr><td>∑PFAS</td><td>45.4 (18.2 – 93.6)</td><td>4.37 (2.03 – 6.59)</td></tr>
</table>
</td></tr>
<tr><td>China, India, Japan, and South Korea

(Lin et al. 2020)</td><td>A total of 62 particulate matter samples were collected in air from 9 Asian cities between 2016 and 2018. Samples were analyzed for a range of PFAS in 4 size fractions: $PM_{<1}$, $PM_{1-2.5}$, $PM_{2.5-10}$, and $PM_{>10}$.</td><td>Reported range of PFAS concentrations in particulate matter were: [ND - (maximum)]:

<table>
<tr><th>PFAS</th><th>$PM_{>10}$</th><th>$PM_{2.5-10}$</th><th>$PM_{1-2.5}$</th><th>$PM_{<1}$</th></tr>
<tr><td>PFPrS</td><td>0.316</td><td>0.343</td><td>1.39</td><td>0.413</td></tr>
<tr><td>PFBS</td><td>0.182</td><td>0.970</td><td>1.19</td><td>0.584</td></tr>
<tr><td>PFHxS</td><td>1.41</td><td>7.53</td><td>3.77</td><td>1.50</td></tr>
<tr><td>PFHpS</td><td>0.182</td><td>0.261</td><td>0.203</td><td>0.826</td></tr>
<tr><td>PFOS</td><td>1.66</td><td>17.1</td><td>10.41</td><td>1.70</td></tr>
<tr><td>FOSA</td><td>0.198</td><td>0.273</td><td>0.195</td><td>0.405</td></tr>
<tr><td>MeFOSA</td><td>0.324</td><td>0.359</td><td>0.453</td><td>0.531</td></tr>
<tr><td>EtFOSA</td><td>2.35</td><td>1.84</td><td>1.34</td><td>2.27</td></tr>
<tr><td>6:2 FTSA</td><td>0.786</td><td>2.22</td><td>2.84</td><td>1.17</td></tr>
<tr><td>6:2 Cl-PFESA</td><td>ND</td><td>6.05</td><td>1.91</td><td>0.791</td></tr>
<tr><td>PFBA</td><td>3.11</td><td>1.43</td><td>1.06</td><td>4.03</td></tr>
<tr><td>PFPeA</td><td>1.17</td><td>1.38</td><td>0.64</td><td>2.38</td></tr>
<tr><td>PFHxA</td><td>6.60</td><td>10.56</td><td>4.43</td><td>11.39</td></tr>
<tr><td>PFHpA</td><td>1.47</td><td>1.24</td><td>1.30</td><td>6.22</td></tr>
<tr><td>PFOA</td><td>7.64</td><td>11.9</td><td>9.18</td><td>52.9</td></tr>
<tr><td>PFNA</td><td>0.627</td><td>0.703</td><td>0.596</td><td>1.98</td></tr>
<tr><td>PFDA</td><td>0.620</td><td>0.822</td><td>0.699</td><td>1.04</td></tr>
<tr><td>PFUnDA</td><td>0.481</td><td>0.366</td><td>0.279</td><td>0.993</td></tr>
<tr><td>PFDoDA</td><td>ND</td><td>0.185</td><td>ND</td><td>0.443</td></tr>
<tr><td>PFTrDA</td><td>0.184</td><td>0.183</td><td>0.247</td><td>0.786</td></tr>
<tr><td>PFTeDA</td><td>0.193</td><td>0.139</td><td>0.176</td><td>0.270</td></tr>
<tr><td>PFHxDA</td><td>0.284</td><td>0.260</td><td>0.283</td><td>0.412</td></tr>
<tr><td>6:2 FTUCA</td><td>15.3</td><td>7.02</td><td>1.88</td><td>3.49</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Reference/ Location</th><th>Summary</th><th>Concentrations (pg/m^3) unless otherwise noted</th></tr>
<tr><td></td><td></td><td><table><tr><td>HFPO-DA</td><td>2.48</td><td>4.22</td><td>3.13</td><td>12.0</td></tr></table></td></tr>
<tr><td>Nanjing, China

(Yu et al. 2020)</td><td>A novel cryogenic air sampler was used to collect ambient air samples from the top of a building at Nanjing University from October 2017 to March 2018. Nontarget analysis was performed to identify PFAS classes and homologues present in the particulate and gas phases.</td><td>A total of 38 PFAS classes and 117 PFAS homologues were identified in ambient air. Specific concentrations were not reported. The percentage of PFAS classes and homologues in particulate matter was found to be 15.8% and 24.8%, respectively, with the majority of PFAS detected in the gas phase.</td></tr>
<tr><td>Bohai Sea, Northern China

(Zhao et al. 2020)</td><td>A total of 52 surface water samples, 30 sediment samples, and 6 air samples were collected on a research vessel in the Bohai Sea in 2017 to investigate the concentration and distribution of 39 targeted PFAS.</td><td>Reported concentrations of PFAS in air were (range):
• PFBA: 17.0–73.2
• PFPeA: 1.00-28.2
• PFHxA: 23.1-103
• PFHpA: 5.40-28.9
• PFOA: 17.0-92.6
• PFNA: 3.87-32.5
• PFDA: 0.48-7.55
• PFUnDA: 0.36-1.68
• PFDoDA: <MQL-2.09
• PFBS: <MQL-4.75
• PFHxS: 0.70-4.86
• PFOS: 1.76-6.54
• PFDS: <MQL
• 4:2 FTSA: <MQL
• 6:2 FTSA:<MQL
• 8:2 FTSA:<MQL
• 10:2 FTSA: <MQL
• 3:3 FTCA: <MQL
• 5:3 FTCA: <MQL
• 7:3 FTCA: <MQL
• 6:2 FTCA: 3.82-14.3
• 8:2 FTCA: <MQL
• 6:2 FTUCA: <MQL-0.88
• 8:2 FTUCA: 1.92-5.76
• 6: 2 Cl-PFESA: <MQL-0.42</td></tr>
</table>

<table>
<tr><th>Reference/ Location</th><th>Summary</th><th>Concentrations (pg/m^3) unless otherwise noted</th></tr>
<tr><td></td><td></td><td>

8:2 Cl-PFESA: <MQL
6:2 diPAP: <MQL-2.21
8:2 diPAP: <MQL-1.59
HFPO-DA: <MQL
ADONA: <MQL
PFECHS: <MQL
6:2 FTOH: <MQL-4.78
8:2 FTOH: 60.7-368
10:2 FTOH: 17.6-180
MeFOSA: <MQL-0.07
EtFOSA: <MQL-0.09
EtFOSE: <MQL-0.11
MeFOSE: <MQL

</td></tr>
<tr><td>Gyeongju and Pohang, South Korea

(Seo et al. 2019)</td><td>In September 2014, multimedia samples were collected along the Hyung-san River, including 9 air, 11 surface water, 3 influent and 3 effluent wastewater treatment plant, 11 soil, 8 sediment, 3 sludge, 11 plant, and 1 fish. Samples were analyzed for a range of neutral and ionic PFAS to confirm the effects of emission sources and the spatial distribution of impacts.</td><td>Reported concentrations of PFAS in air samples were (range):
<table>
<tr><th>PFAS</th><th>Gas Phase</th><th>Particle Phase (ng/g)</th></tr>
<tr><td>PFBS</td><td>10.26-189.16</td><td>0.00-22.12</td></tr>
<tr><td>PFHxA</td><td>9.02-50.10</td><td>72.25-462.79</td></tr>
<tr><td>PFHpA</td><td>1.00-10.26</td><td>4.52-57.14</td></tr>
<tr><td>PFHxS</td><td>0.00-17.57</td><td>0.00-172.89</td></tr>
<tr><td>PFOA</td><td>5.87-85.32</td><td>17.20-191.38</td></tr>
<tr><td>PFNA</td><td>3.35-30.78</td><td>21.53-138.04</td></tr>
<tr><td>PFOS</td><td>0.00-60.05</td><td>40.85-2,047.41</td></tr>
<tr><td>PFDA</td><td>9.87-76.38</td><td>4.46-68.87</td></tr>
<tr><td>PFUnDA</td><td>8.17-139.30</td><td>20.10-809.34</td></tr>
<tr><td>PFDS</td><td>0.00-24.70</td><td>0.00-165.88</td></tr>
<tr><td>PFDoDA</td><td>0.00-50.79</td><td>0.00-44.26</td></tr>
<tr><td>PFTrDA</td><td>0.00-40.23</td><td>0.00-130.64</td></tr>
<tr><td>PFTeDA</td><td>0.00-32.34</td><td>0.00-31.31</td></tr>
<tr><td>FHEA</td><td>0.00-2.10</td><td>0.00-30.03</td></tr>
<tr><td>FOEA</td><td>0.00-3.31</td><td>0.00-18.22</td></tr>
<tr><td>FDEA</td><td>0.00-12.46</td><td>0.00-52.57</td></tr>
<tr><td>MeFOSAA</td><td>0.00-2.44</td><td>0.00-13.02</td></tr>
<tr><td>EtFOSAA</td><td>0.00-4.25</td><td>0.00-20.16</td></tr>
<tr><td>FOUEA</td><td>0.06-49.30</td><td>0.00-32.90</td></tr>
</table>
</td></tr>
<tr><td>Global Monitoring Network

(Rauert at al. 2018a)</td><td>Atmospheric concentrations of PFAS and volatile methyl siloxanes were monitored at 21 sites in the Global Atmospheric Passive Sampling (GAPS) Network. The study reports results from samples collected in 2013 and 2015 and compares these to concentrations previously reported from 2009 to assess trends over</td><td>Reported concentrations of PFAS in air across all monitoring sites in 2013 and 2015 were (range):
<table>
<tr><th>PFAS</th><th>2013</th><th>2015</th></tr>
<tr><td>6:2 FTOH</td><td><0.4 – 138</td><td><0.4 – 85</td></tr>
<tr><td>8:2 FTOH</td><td>1.5 – 73</td><td>1.1 – 121</td></tr>
<tr><td>10:2 FTOH</td><td>0.57 – 22</td><td>0.51 – 37</td></tr>
<tr><td>MeFOSA</td><td><0.8 – 1.7</td><td>0.30 – 1.8</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Reference/ Location</th><th>Summary</th><th>Concentrations (pg/m^3) unless otherwise noted</th></tr>
<tr><td></td><td>7 years of monitoring. The study also compares results by the type of sampling location (polar, background, and urban).</td><td>
<table>
<tr><td>EtFOSA</td><td><0.07 – 1.2</td><td>0.068 – 0.94</td></tr>
<tr><td>MeFOSE</td><td>0.50 – 3.0</td><td>0.22 – 4.4</td></tr>
<tr><td>EtFOSE</td><td><0.2 – 2.5</td><td><0.3 – 1.1</td></tr>
<tr><td>PFBA</td><td>15 – 2,160</td><td>32 - 703</td></tr>
<tr><td>PFPeA</td><td>0.68 - 12</td><td><9 - 25</td></tr>
<tr><td>PFHxA</td><td>0.46 – 11</td><td>1.3 - 22</td></tr>
<tr><td>PFHpA</td><td>0.12 – 6.7</td><td>1.3 – 11</td></tr>
<tr><td>PFOA</td><td>1.0 – 9.9</td><td>0.63 – 24</td></tr>
<tr><td>PFNA</td><td><0.2 – 8.1</td><td>0.33 – 7.6</td></tr>
<tr><td>PFDA</td><td>0.092 – 4.1</td><td>0.24 – 8.3</td></tr>
<tr><td>PFUnDA</td><td><0.05 – 2.2</td><td>0.17 – 2.3</td></tr>
<tr><td>PFDoDA</td><td>0.053 – 1.1</td><td><0.09 – 2.4</td></tr>
<tr><td>PFTrDA</td><td><0.08</td><td>0.15 – 1.9</td></tr>
<tr><td>PFTeDA</td><td><0.08</td><td>0.09 – 0.39</td></tr>
<tr><td>PFHxDA</td><td><0.08</td><td><0.07</td></tr>
<tr><td>PFODA</td><td><0.09</td><td><0.08</td></tr>
<tr><td>PFBS</td><td>0.17 – 5.9</td><td><0.2 - 24</td></tr>
<tr><td>PFHxS</td><td>0.022 – 3.0</td><td><0.02 – 7.6</td></tr>
<tr><td>PFOS</td><td>0.050 – 9.5</td><td><0.5 - 23</td></tr>
<tr><td>PFDS</td><td><0.06</td><td><0.05</td></tr>
</table>
</td></tr>
<tr><td>Central and South America

(Rauert et al. 2018b)</td><td>Between 2014 and 2016, atmospheric concentrations of a range PFAS, flame retardants, plasticizers, and other chemicals of concern were measured across 7 countries in Central and South America within the Global Atmospheric Passive Sampling (GAPS) Network.</td><td>Reported concentrations of PFAS measured in air were (range):
• 6:2 FTOH: <2
• 8:2 FTOH: <4 – 51
• 10:2 FTOH: <2 – 7.7
• MeFOSA: <0.4 – 0.72
• EtFOSA: <0.1 – 2.3
• MeFOSE: 0.19 – 0.91
• EtFOSE: <0.3 – 0.48
• PFBA: <350
• PFPeA: <130
• PFHxA: 18 - <40
• PFHpA: 28 - <30
• PFOA: 7.9 - <15
• PFNA: 4.5 - <9
• PFDA: 3.2 - <5
• PFUnDA: 1.6 - <2
• PFDoDA: <0.8 - 0.65
• PFTrDA: <0.4
• PFTeDA: <0.2
• PFHxDA: <0.4
• PFODA: <0.4
• PFBS: 0.82 – 8.1
• PFHxS: <0.1 – 3.1</td></tr>
</table>

Reference/ Location	Summary	Concentrations (pg/m^3) unless otherwise noted
		• PFOS: 2.5 – 10 • PFDS: <0.3
Bohai Sea, Yellow Sea, and Yangtze River Estuaries, China (Zhao et al. 2017)	15 air samples and 72 surface water samples were collected from a research vessel in 2012. Air samples were analyzed for a range of neutral PFAS.	Reported concentrations of PFAS in air were [mean (range), pg/m^3]: • 6:2 FTOH: 2.9 (0.83-6.7) • 8:2 FTOH: 182 (55-429) • 10:2 FTOH: 34 (13-85) • 12:2 FTOH: 5.5 (1.1-22) • 8:2 FTAC: 0.58 (<0.20-1.4) • MeFOSA: 0.43 (<0.1-1.0) • EtFOSA: 3.0 (0.49-8.5) • MeFBSA: 1.0 (0.63-1.9) • EtFOSE: 0.18 (<0.10-0.27) • MeFBSE: 0.50 (0.14-1.5)
[1] This table includes information pertaining to the occurrence of PFAS in outdoor air based on the recent literature (2017 – 2022). Information on the occurrence of PFAS in outdoor air prior to 2017 has been archived and can be found in section 17.1. LOD = Limit of detection ND = Nondetect MQL = Method quantification limit		

Table 17-1B. Observed PFAS concentrations in indoor air and settled dust[1]

Reference/ Location	Summary	Concentrations
Hong Kong (Li et al. 2021)	Between Autumn 2017 and Spring 2018, indoor air ($PM_{2.5}$), tap water, and urine and hair samples from children were collected across 17 kindergartens in Hong Kong and analyzed for a range of PFAS.	Reported concentrations of PFAS in $PM_{2.5}$ collected from **indoor air** were [mean (range), pg/m^3]: • PFHxA: 15.9 (7.98 – 34) • PFHpA: 326 (83 – 902) • PFOA: 358 (197 – 1,896) • PFNA: 17.7 (10.1 – 28.4) • PFDA: 658 (0.67 – 1,653)
A University in the Northeastern USA (Young et al. 2021)	In 2019, 15 PFAS and 37 flame retardant chemicals were measured in dust in 47 rooms across 21 buildings, including offices, common areas, and classrooms to evaluate the impact of "healthier" materials interventions.	Reported concentrations of PFAS in **dust** were [median (range), ng/g]: • PFHxA: 146 (18.1-8,310) • PFOS: 13.2 (<MDL-2,980) • PFOA: 5.62 (<MDL-296) • PFHxS: 0.672 (<MDL-1,520) • FOSA: 1.39 (<MDL-160) • PFHpA: 2.2 (<MDL-236) • PFPeA: 0.745 (<MDL-1,760) • PFNA: 0.93 (<MDL-455) • PFBS: 0.159 (<MDL-1,480) • PFDS: 0.048 (<MDL-16.1) • PFBA: 0.746 (<MDL-12.5) • PFDA: 0.355 (<MDL-155) • PFUnDA: <MDL • PFDoDA: <MDL • MeFOSAA: <MDL

<table>
<tr><th>Reference/ Location</th><th>Summary</th><th>Concentrations</th></tr>
<tr><td>Seattle Washington and Lafayette, Indiana, USA

(Zheng et al. 2020)</td><td>Researchers analyzed dust and nap mats from 8 childcare facilities and evaluated them for a range of neutral and ionic PFAS.</td><td>Reported PFAS concentrations in indoor dust were [median (range), ng/g]:
<table>
<tr><th>PFAS</th><th>Dust</th></tr>
<tr><td>PFBA</td><td>3.2 (ND-9.9)</td></tr>
<tr><td>PFPeA</td><td>0.32 (ND-3.5)</td></tr>
<tr><td>PFHxA</td><td>1.4 (0.17-3.4)</td></tr>
<tr><td>PFHpA</td><td>0.61 (0.14-1.3)</td></tr>
<tr><td>PFOA</td><td>2.0 (0.34-5.1)</td></tr>
<tr><td>PFNA</td><td>1.7 (0.11-13)</td></tr>
<tr><td>PFDA</td><td>0.59 (0.22-2.4)</td></tr>
<tr><td>PFUnDA</td><td>0.65 (0.05-3.0)</td></tr>
<tr><td>PFDoDA</td><td>0.58 (0.26-3.1)</td></tr>
<tr><td>PFTrDA</td><td>0.31 (ND-2.2)</td></tr>
<tr><td>PFTeDA</td><td>0.29 (ND-4.4)</td></tr>
<tr><td>PFHxDA</td><td>ND</td></tr>
<tr><td>PFBS</td><td>0.25 (ND-0.86)</td></tr>
<tr><td>PFHxS</td><td>0.25 (ND-0.89)</td></tr>
<tr><td>PFOS</td><td>1.2 (0.23-4.2)</td></tr>
<tr><td>PFDS</td><td>0.89 (ND-34)</td></tr>
<tr><td>4:2 FTSA</td><td>1.8 (ND-1.8)</td></tr>
<tr><td>6:2 FTSA</td><td>12 (ND-63)</td></tr>
<tr><td>8:2 FTSA</td><td>5.8 (ND-46)</td></tr>
<tr><td>6:2 FTOH</td><td>130 (ND-2,500)</td></tr>
<tr><td>8:2 FTOH</td><td>20 (ND-140)</td></tr>
<tr><td>10:2 FTOH</td><td>40 (ND-460)</td></tr>
<tr><td>MeFOSE</td><td>11 (ND-190)</td></tr>
<tr><td>EtFOSE</td><td>15 (ND-200)</td></tr>
<tr><td>FOSA</td><td>0.05 (ND-0.30)</td></tr>
<tr><td>MeFOSA</td><td>ND</td></tr>
<tr><td>EtFOSA</td><td>ND</td></tr>
<tr><td>6:2 FTAcr</td><td>2.9 (0.07-37)</td></tr>
</table></td></tr>
<tr><td>Shandong and Shanghai, China

(Ao et al. 2019)</td><td>As part of an exposure assessment study, 168 indoor dust samples were collected from households in Shandong and Shanghai between August 2015 and May 2017. 27 drinking water samples were also collected in Shanghai in May 2017,</td><td>Reported PFAS concentrations in indoor dust were [mean (range), ng/g]:
• PFOA: 75.49 (2.54 – 450.96)
• PFOS: 15.13 (ND – 1,999.45)
• PFNA: 27.01 (ND – 123.44)
• PFBS: 131.57 (1.18 – 1,587.54)
• PFHpA: 16.58 (ND – 3,065.53)</td></tr>
</table>

Reference/ Location	Summary	Concentrations
	including tap water, filtered water, and bottled water.	• PFHxS: 491.07 (1.33 – 1,902.24) • ∑PFAS: 756.85 (18.88 – 4,502.21)
Thessaloniki, Greece (Besis et al. 2019)	Measured a range of PFAS in dust accumulated on central air-conditioning filters in a variety of workplace microenvironments from December-June 2012.	Reported concentrations of PFAS in **central air conditioner filter dust** were [mean (range), ng/g]: • PFBS: 22.9 (<MDL – 98.8) • PFHxS: 2.06 (<MDL – 39.9) • PFOS: 23.5 (<MDL – 227) • PFDS: 2.88 (<MDL – 11.6) • FOSA: 0.207 (<MDL – 0.854) • PFBA: 28.8 (<MDL – 164) • PFPeA: 1.51 (<MDL – 11.3) • PFHxA: 11.1 (<MDL – 72.5) • PFHpA: 12.6 (<MDL – 117) • PFOA: 80.0 (<MDL – 653) • PFNA: 2.52 (<MDL – 11.4) • PFDA: 3.41 (<MDL – 7.38) • PFUnDA: 1.50 (<MDL – 3.68) • PFDoDA: 4.92 (<MDL – 13.1)
Belgium, Italy, and Spain (de la Torre et al. 2019)	65 dust samples were collected from domestic vacuum cleaner bags used to clean homes in Belgium (n=22), Italy (n=22), and Spain (n=21) between September 2016 and January 2017. Samples were analyzed for a range of PFAS.	Reported concentrations of PFAS in household **dust** were [median (range), ng/g]: • PFBS: 0.40 (ND – 56.7) • PFHxS: 0.13 (ND – 11.3) • PFOS: 0.28 (ND – 11.9) • PFBA: 0.11 (ND – 20.9) • PFPeA: 0.02 (ND – 21.3) • PFHxA: 0.31 (ND – 28.3) • PFHpA: 1.00 (ND – 105) • PFOA: 1.41 (0.21 – 53.0) • PFNA: 0.04 (ND – 9.04) • PFDA: 0.49 (ND – 25.8) • PFUnDA: 0.17 (ND – 7.68) • PFDoDA: 0.28 (ND – 19.7) • PFTrDA: 0.23 (ND – 11.1) • PFTeDA: 1.11 (ND – 38.4) • PFHxDA: 0.75 (ND – 14.9) • PFODA: 0.46 (ND – 4.96) • FOSA: 0.01 (ND – 1.05) • ∑PFAS: 12.9 (3.13 – 155)

Reference/ Location	Summary	Concentrations
Stockholm, Sweden (Giovanoulis et al. 2019)	Dust samples were collected from elevated surfaces across 20 preschools in the Stockholm area from January to February 2018 to evaluate the impact of interventions undertaken to reduce the presence of hazardous chemicals. Samples were analyzed for a range of PFAS and other chemicals, including plasticizers and organophosphate esters, bisphenols, and polybrominated diphenyl esters.	Reported concentrations of PFAS is **dust** samples were [median (95^{th} percentile), ng/g]: • PFBA: <LOD (18.4) • PFPeA: <LOD (7.61) • PFHxA: <LOD (15.2) • PFHpA: <LOD (8.894) • PFOA: 7.71 (35.1) • PFNA: 1.09 (56.0) • PFDA: <LOD • PFUnDA: <LOD (9.68) • PFDoDA: <LOD (8.03) • PFBS: <LOD • PFHxS: <LOD • PFOS: 12.2 (48.9) • PFDS: <LOD (209) • FOSA: <LOD (0.287) • 6:2 FTSA: <LOD • 6:2 PAP: 151 (2,728) • 8:2 PAP: <LOD (423) • 6:2 diPAP: 1,143 (42,281) • 8:2 diPAP: 35.9 (377) • MeFOSAA: <LOD • EtFOSAA: 18.4 (283) • 6:2 FTOH: 4.05 (399) • 8:2 FTOH: 18.3 (142) • 10:2 FTOH: 12.4 (74.8)
Eastern Finland (Winkens et al. 2018)	Floor dust samples from 65 children's bedrooms in Finland were collected in 2014 and 2015 and analyzed for 62 different PFAS.	Reported concentrations in floor **dust** were (mean ± SD, ng/g) • PFBS: 21 ± 2.87 • PFHxS: 1,420 ± 191 • PFOS: 1,860 ± 256 • PFDS: 403 ± 32 • PFBA: 229 ± 25.2 • PFPeA: 235 ± 24.4 • PFHxA: 349 ± 33.2 • PFHpA: 360 ± 36 • PFOA: 747 ± 26.6 • PFNA: 90.1 ± 12 • PFDA: 66.9 ± 10.7 • PFUnDA: 41.5 ± 4.21

Reference/ Location	Summary	Concentrations
		• PFDoDA: 37.9 ± 4.15 • PFTrDA: 29.6 ± 4.4 • PFTeDA: 30.8 ± 5.88 • FOSA: 6.77 ± 1.42 • EtFOSA: 7.26 ± 1.02 • MeFOSAA: 64.5 ± 18 • EtFOSAA: 444 ± 54.6 • 6:2 FTSA: 404 ± 139 • 8:2 FTSA: 212 ± 50.6 • 6:2 PAP: 208 ± 26.1 • 8:2 PAP: 190 ± 27.1 • 6:2 diPAP: 675 ± 28.3 • 8:2 di PAP: 227 ± 27.3
St. Lawrence Island, Alaska, USA (Byrne et al. 2017)	Measured a range of PFAS and polybrominated diphenyl ethers in 2013 and 2014 in different media in two remote native Alaskan villages, including house dust from 49 households, blood serum from 85 island residents, and two sentinel fish species.	Reported concentrations of PFAS in household **dust** were [median (25^{th} – 95^{th} percentile), ng/g]: • PFBA: <LOD (<LOD – 0.40) • PFPeA: <LOD (<LOD – 1.09) • PFHxA: <LOD (<LOD – 2.29) • PFHpA: 0.39 (<LOD – 3.22) • PFOA: 0.76 (0.34 – 3.37) • PFNA: <LOD (<LOD – 1.93) • PFDA: <LOD (<LOD – 2.16) • PFUnA: <LOD (<LOD – 0.38) • PFDoDA: <LOD (<LOD – 1.13) • PFBS: <LOD (<LOD – 1.76) • PFHxS: <LOD (<LOD – 3.13) • PFOS: 1.40 (<LOD – 23.56) • PFOSA: <LOD

<table>
<tr><th>Reference/ Location</th><th>Summary</th><th>Concentrations</th></tr>
<tr><td>Oslo, Norway

(Padilla-Sanchez et al. 2017)</td><td>Between November 2013 and April 2014, 61 residential indoor air and 15 personal air samples were collected in the area of Oslo, Norway and analyzed for 7 volatile PFAS as part of a comprehensive exposure assessment study.</td><td>Reported concentrations of PFAS measured in residential indoor air and from personal air samples were [mean (range), pg/m³]:
<table>
<tr><th>PFAS</th><th>Residential Indoor Air</th><th>Personal Air Samples</th></tr>
<tr><td>6:2 FTOH</td><td>8,550 (604-101,000)</td><td>4,870 (543-37,000)</td></tr>
<tr><td>8:2 FTOH</td><td>29,400 (1,220-446,000)</td><td>11,400 (2,690-57,800)</td></tr>
<tr><td>10:2 FTOH</td><td>12,300 (697-255,000)</td><td>2,550 (170-9,000)</td></tr>
<tr><td>MeFOSA</td><td>1,350 (<MDL-78,300)</td><td>< MDL (<MDL-225)</td></tr>
<tr><td>EtFOSA</td><td>69 (<MDL-1,350)</td><td><MDL</td></tr>
<tr><td>MeFOSE</td><td>2,050 (<MDL-38,800)</td><td><MDL (<MDL-1,105)</td></tr>
<tr><td>EtFOSE</td><td>776 (<MDL-13,200)</td><td><MDL</td></tr>
</table></td></tr>
<tr><td>Eastern Finland

(Winkens et al. 2017)</td><td>Indoor air samples were collected in children’s bedrooms in 57 households and analyzed for 17 PFAAs and 9 precursors.</td><td>Reported concentrations in indoor air were [mean (range), pg/m³]; if no mean was reported only the range is shown:

PFBS: (BDL-15.0)
PFHxS-branched: (BDL-0.30)
PFHxS-linear: (BDL-1.61)
PFOS-branched: 0.74 (BDL-2.93)
PFOS-linear: 1.33 (BDL-5.04)
PFHxA: 13.5 (BDL-144)
PFHpA: (BDL-12.6)
PFOA-branched: (BDL-2.65)
PFOA-linear: 21.2 (BDL-99.8)
PFNA: 3.06 (0.95-16.5)
PFDA: 6.01 (1.27-29.6)
PFUnDA: 1.04 (BDL-8.24)
PFDoDA: 1.18 (BDL-5.65)
PFTrDA: (BDL-2.22)
PFTeDA: 0.44 (BDL-1.79)
PFPeDA: (BDL-1.06)
6:2 FTAC: (BDL-61.2)
6:2 FTMAC: 285 (BDL-13,000)
6:2 FTOH: 1,810 (BDL-8,060)
8:2 FTOH: 4,250 (1,290-13,500)
10:2 FTOH: 1,240 (210-8,950)
EtFOSA: (BDL-340)
MeFOSA: (BDL-20.0)
EtFOSE: 24.1 (BDL-132)
</td></tr>
</table>

<table>
<tr><th>Reference/ Location</th><th>Summary</th><th>Concentrations</th></tr>
<tr><td></td><td></td><td>MeFOSE: 89.9 (BDL-394)</td></tr>
<tr><td>Alberta, Canada

(Beesoon et al. 2012)</td><td>In September 2018, carpet, vacuum dust, and indoor air samples were collected from a family home to investigate potential sources of PFAS exposure where residents were found to have abnormally high PFHxS serum levels. Samples of blood, urine, and stool were also collected from all family members in November 2008. A subsequent sample of vacuum dust was also collected in 2012.</td><td>Reported concentrations of PFAS in vacuum dust were (ng/g):

<table>
<tr><th>PFAS</th><th colspan="2">Vacuum Dust</th></tr>
<tr><th></th><th>2008 (n=1)</th><th>2012 (n=1)</th></tr>
<tr><td>PFOS</td><td>1,090</td><td>184</td></tr>
<tr><td>PFOA</td><td>555.0</td><td>88.0</td></tr>
<tr><td>PFHxS</td><td>2,900</td><td>253</td></tr>
</table>

Reported concentrations of PFAS in indoor air were (range, pg/m³):

<table>
<tr><th>PFAS</th><th>Indoor Air (n=2)</th></tr>
<tr><td>8:2 FTOH</td><td>3,280 – 4,640</td></tr>
<tr><td>10:2 FTOH</td><td>831 – 1,470</td></tr>
<tr><td>MeFOSE</td><td>1,210 – 8,400</td></tr>
<tr><td>EtFOSE</td><td>680 – 1,110</td></tr>
</table></td></tr>
<tr><td colspan="3">[1] This table includes information pertaining to the occurrence of PFAS in: (a) indoor air based on the recent literature (2017 – 2022) and (b) new information on indoor settled dust that was not included in the previous version of the PFAS Technical and Regulatory Document. Information on the occurrence of PFAS in indoor air prior to 2017 has been archived and can be found in section 17.1.

BDL = Below detection limit

LOD = Limit of detection

ND = Nondetect

MDL = Method detection limit

SD = standard deviation</td></tr>
</table>

Table 17-1C. Observed PFAS concentrations in Precipitation

<table>
<tr><th>Reference/ Location</th><th>Summary</th><th>Concentrations (ng/L)</th></tr>
<tr><td>Deception and Livingston Islands, Antarctica
(Casas et al. 2021)</td><td>21 rain samples and 20 air samples were collected during the Antarctic summer of 2017−2018 to assess the potential for rain amplification for different legacies and emerging POPs, including a range of PFAS.</td><td>Reported concentration ranges for PFAS in rainwater were:
• PFBS: 0.005-0.33
• PFOS: ND-0.31
• PFBA: ND-6.6
• PFHxA: ND-0.36
• PFHpA: 0.013-0.38
• PFOA: 0.020-0.531
• PFNA: 0.012-0.414
• PFDA: 0.011-0.280
• PFUnDA: 0.0035-0.088
• PFDoDA: 0.0025-0.085
• PFTrDA: ND-0.021
• PFTeDA: ND-0.098</td></tr>
<tr><td>European High Arctic
(Garnett et al. 2021)</td><td>In August 2019, snow, sea ice, melt ponds, and near-surface seawater were sampled at two ice-covered stations located north of the Barents Sea and analyzed for a range of PFAS.</td><td>Reported concentrations of PFAS in snow, sea ice, and melt ponds were (mean ± SD):
<table>
<tr><th>PFAS</th><th>Snow (n=6)</th><th>Sea Ice (n=34)</th><th>Melt Pond (n=6)</th></tr>
<tr><td>PFBA</td><td>2.629 ± 0.705</td><td>1.384 ± 3.083</td><td>0.835 ± 0.174</td></tr>
<tr><td>PFBS</td><td>< MDL</td><td>1.259 ± 3.403</td><td><MDL</td></tr>
<tr><td>PFPeA</td><td>0.088 ± 0.030</td><td>0.030 ± 0.055</td><td>0.060 ± 0.015</td></tr>
<tr><td>PFHxA</td><td>0.070 ± 0.049</td><td>0.080 ± 0.186</td><td>0.058 ± 0.013</td></tr>
<tr><td>PFHpA</td><td>0.125 ± 0.086</td><td>0.085 ± 0.087</td><td>0.120 ± 0.025</td></tr>
<tr><td>PFOA</td><td>0.041 ± 0.017</td><td>0.146 ± 0.294</td><td>0.042 ± 0.010</td></tr>
<tr><td>PFOS</td><td><MDL</td><td>0.013 ± 0.018</td><td>0.004 ± 0.009</td></tr>
<tr><td>PFNA</td><td>0.064 ± 0.020</td><td>0.043 ± 0.033</td><td>0.046 ± 0.021</td></tr>
<tr><td>PFDA</td><td>0.022 ± 0.009</td><td>0.077 ± 0.112</td><td>0.005 ± 0.005</td></tr>
<tr><td>PFUnDA</td><td>0.021 ± 0.011</td><td>0.023 ± 0.036</td><td>0.006 ± 0.006</td></tr>
<tr><td>PFDoDA</td><td>0.015 ± 0.021</td><td>0.020 ± 0.030</td><td>0.010 ± 0.009</td></tr>
<tr><td>PFTrDA</td><td><MDL</td><td>0.003 ± 0.006</td><td><MDL</td></tr>
<tr><td>PFTeDA</td><td><MDL</td><td>0.001 ± 0.003</td><td><MDL</td></tr>
</table></td></tr>
<tr><td>Ohio, Indiana, and Wyoming, USA
(Pike et al. 2021)</td><td>Rain samples were collected at 7 locations across 3 states during the summer of 2019 and analyzed for a range of PFAS.</td><td>Reported concentration ranges for PFAS in rainwater were:
• TFA: 50-1,200
• PFBA: 0.002-290
• PFPeA: 0.01-120</td></tr>
</table>

		• PFHxA: 0.05-80 • PFHpA: 0.08-50 • PFOA: 0.03-30 • PFNA: 0.01-10 • PFDA: 0.02-20 • PFOS: 0.07-50 • HFPO-DA: 0.0005-5
Antarctica (Xie et al. 2020)	Concentrations of 16 PFAS, 9 organophosphate esters, and 17 polycyclic aromatic hydrocarbons were investigated in surface snow samples collected at Dome C on the Antarctic Plateau during the summer of 2016.	Reported PFAS concentrations in surface snow were [mean (range)]: • PFPeA: 0.175 (0.073-0.446) • PFHxA: 0.222 (0.092-0.373) • PFHpA: 0.183 (0.094-0.266) • PFOA: 0.358 (0.273-0.539) • PFNA: 0.073 (0.038-0.095) • PFDA: 0.030 (0.022-0.041) • PFUnDA: 0.008 (0.0056-0.011) • PFDoDA: 0.0039 (0.0023-0.0063) • PFTrDA: 0.0021 (0.0005-0.0036) • PFTeDA: 0.0023 (0.0009-0.0043) • PFBS: 0.024 (0.017-0.035) • PFHxS: 0.006 (0.0013-0.012) • PFHpS: 0.0015 (0.0006-0.0044) • PFOS: 0.046 (0.036-0.062) • PFDS: 0.0003 (0.0001-0.0008) • HFPO-DA: 0.0092 (0.0063-0.013)
Mainland China (Chen et al. 2019)	39 samples of rainwater were collected across 28 cities in Mainland China and analyzed for a range of PFAS to investigate the occurrence, spatial distribution, and fluxes in precipitation at a nationwide scale in urban areas across mainland China.	Reported PFAS concentrations in rainwater were (range): • TFA: 8.8-1,800 • PFPrA: ND-24 • PFBA: ND-41 • PFPeA: ND-22 • PFHxA: ND-18 • PFHpA: ND-54 • PFOA: 0.30-100 • PFNA: ND-13 • PFDA: ND-22 • PFUnDA: ND-6.6 • PFDoDA: ND-1.7 • PFBS: ND-51 • PFHxS: ND-4.3 • PFOS: 0.90-20 • 8:2 FTUCA: ND-2.1 • 6:2 FTSA: ND-3.6 • 6:2 Cl-PFAES: ND-6.5 • 6:2 diPAP: ND-0.16 • 8:2 diPAP: ND-9.2

<table>
<tr>
<td>Great Lakes, USA
(Gewurtz et al. 2019)</td>
<td>Precipitation and surface water samples were collected throughout the Great Lakes from 2006 to 2018 and analyzed for a range of PFAS to evaluate time trends and seasonal variability.</td>
<td>The reported PFAS concentrations in precipitation were [median (maximum)]:
• PFBA: 0.93 (14)
• PFPeA: <RL (1.3)
• PFHxA: 0.23 (7.4)
• PFHpA: 0.29 (2.7)
• PFOA: 0.46 (11)
• PFNA: 0.30 (2.5)
• PFDA: 0.15 (2.0)
• PFUnDA: <RL (4.5)
• PFDoDA: <RL (5.3)
• PFOS: 0.93 (14)</td>
</tr>
<tr>
<td>Ellesmere Island, Nunavut, Canada
(MacInnis et al. 2019)</td>
<td>In 2013 and 2014, integrated snowpack samples, including dust-impacted light and dark snowpack samples were collected from the ice-covered Lake Hazen surface and from the surrounding landscape and analyzed for a range of PFAS.</td>
<td>Reported concentrations of PFAS in snowpack were (range):
• PFBA: 1.2-52
• PFPeA: 0.083-1.6
• PFHxA: 0.12-1.6
• PFHpA: 0.29-4.3
• PFOA: 0.35-10
• PFNA: 0.37-5.3
• PFDA: 0.082-1.7
• PFUnDA: 0.048-0.80
• PFDoDA: 0.010-0.31
• PFTrDA: <0.002-0.10
• PFTeDA: <0.003-0.023
• PFBS: <0.002-0.40
• PFHxS: <0.001-0.44
• PFOS: 0.009-1.0
• PFECHS: <0.001-0.059</td>
</tr>
<tr>
<td>Western China
(Wang et al. 2019)</td>
<td>In 2017, 15 surface snow and 3 subsurface snow samples were collected across a vast area of western China to investigate the concentrations, composition profiles, and deposition fluxes of PFAS.</td>
<td>Concentrations of PFAS in surface and subsurface snow were (range):
<table>
<tr><th>PFAS</th><th>Surface Snow</th><th>Subsurface Snow</th></tr>
<tr><td>PFBS</td><td>0.0055-0.0678</td><td>BDL-0.0638</td></tr>
<tr><td>PFHxS</td><td>0.0018-0.0092</td><td>ND-0.0192</td></tr>
<tr><td>PFHpS</td><td>0.0003-0.0033</td><td>ND-0.0112</td></tr>
<tr><td>PFOS</td><td>0.1096-0.9947</td><td>.025-0.6533</td></tr>
<tr><td>PFDS</td><td>0.0005-0.0052</td><td>ND-0.0324</td></tr>
<tr><td>PFBA</td><td>0.0985-0.7833</td><td>0.079-0.5954</td></tr>
<tr><td>PFPeA</td><td>0.0245-0.1036</td><td>0.0035-0.1924</td></tr>
<tr><td>PFHxA</td><td>0.0113-0.0647</td><td>BDL-0.0492</td></tr>
<tr><td>PFHpA</td><td>0.0224-0.1053</td><td>0.0045-0.1253</td></tr>
<tr><td>PFOA</td><td>0.0478-1.089</td><td>0.0789-0.889</td></tr>
<tr><td>PFNA</td><td>0.0679-0.6542</td><td>0.0235-0.7542</td></tr>
<tr><td>PFDA</td><td>0.0344-0.5646</td><td>0.0264-0.2348</td></tr>
<tr><td>PFUnDA</td><td>0.0153-0.0762</td><td>ND-0.0284</td></tr>
<tr><td>PFDoDA</td><td>0.0034-0.0123</td><td>0.0023-0.0178</td></tr>
<tr><td>PFTrDA</td><td>0.0015-0.0234</td><td>ND-0.0055</td></tr>
</table>
</td>
</tr>
</table>

		PFTeDA / 0.0013-0.0092 / ND-0.0026
Svalbard, Norwegian Arctic (Skaar et al. 2018)	Soil, freshwater, seawater, meltwater, runoff water, surface snow, and coastal sediment samples were collected from Longyearbyen (Norwegian mining town), NyÅlesund (research facility) and the Lake Linnévatnet area (background site) during several campaigns (2014–2016) and analyzed for 14 individual PFAS.	Reported concentrations in meltwater runoff and surface snow were (range): • ∑PFAS (meltwater, n=2): 1.1-4.2 • ∑PFAS (surface snow, n=2): 1-2
Livingston Island, Antarctica (Casal et al. 2017)	Fresh snow deposition, surface snow, streams from melted snow, coastal seawater and plankton samples were collected from December 2014–February 2015 at Livingston Island to evaluate the role of snow deposition as an input of PFAS to Maritime Antarctica.	Reported concentrations is snow (range): • PFHxS: ND-0.023 • PFOS: 0.0013-0.750 • PFDS: ND-0.0013 • PFBA: ND-0.530 • PFPeA: ND-0.053 • PFHxA: ND-0.230 • PFHpA: ND-0.310 • PFOA: 0.029-1.300 • PFNA: ND-0.330 • PFDA: 0.0031-0.600 • PFUnDA: ND-0.150 • PFDoDA: ND-0.180 • PFTrA: ND-0.032 • PFTeA: ND-0.020 • ∑PFAS: 0.082-3.600
Eastern China, Yangtze River Delta (Lu et al. 2018)	17 soil, 23 river water, 17 groundwater, 4 tap water, and 20 rainwater samples were collected in 2015 and 2017 and analyzed for a range of PFAS to evaluate impacts in the vicinity of a fluorochemical industrial park.	Reported PFAS concentrations in rainwater were (range): • PFBA: <0.1 – 44.9 • PFPeA: <0.2 – 22.0 • PFHxA: 0.4 – 151.1 • PFHpA: 0.6 – 16.0 • PFOA: 6.7 – 324.7 • PFNA: 0.4 – 8.1 • PFDA: <0.2 – 7.2 • PFUnDA: <0.2 – 6.7 • PFBS: <0.5 • PFHxS: <0.5 – 3.7 • PFOS: <0.5 – 6.2

<table>
<tr>
<td>Arctic Ocean
(Yeung et al. 2017)</td>
<td>Vertical profiles from the Central Arctic Ocean and shelf water, snow, and melt pond water samples were collected in 2012 and analyzed for a range of PFAS.</td>
<td>Reported concentrations of PFAS in snow and melt pond water were (range):
<table>
<tr><th>PFAS</th><th>Snow</th><th>Melt Pond Water</th></tr>
<tr><td>PFHxA</td><td>0.026-0.109</td><td>0.016-0.150</td></tr>
<tr><td>PFHpA</td><td>0.014-0.049</td><td>0.029-0.039</td></tr>
<tr><td>PFOA</td><td>0.072-0.294</td><td>0.057-0.062</td></tr>
<tr><td>PFNA</td><td>0.033-0.253</td><td>0.085-0.106</td></tr>
<tr><td>PFDA</td><td>0.033-0.142</td><td>0.014</td></tr>
<tr><td>PFUnDA</td><td>0.021-0.092</td><td>0.013</td></tr>
<tr><td>PFDoDA</td><td>0.088</td><td>-</td></tr>
<tr><td>PFHxS</td><td>0.018</td><td>-</td></tr>
<tr><td>PFOS</td><td>0.034-0.343</td><td>0.034-0.042</td></tr>
<tr><td>PFDS</td><td>0.011</td><td>-</td></tr>
<tr><td>MeFOSAA</td><td>0.036</td><td>-</td></tr>
<tr><td>EtFOSAA</td><td>0.009-0.036</td><td>-</td></tr>
<tr><td>FOSA</td><td>0.020-0.156</td><td>0.023</td></tr>
</table>
</td>
</tr>
<tr>
<td>Antarctica
(Zhen et al. 2015)</td>
<td>33 air samples were collected onboard a research vessel during an expedition research cruise across the Atlantic Ocean, Southern Ocean, and the Antarctic Peninsula from October 2010 to January 2011. 12 snow samples were also collected on the Antarctic Peninsula in January 2011.</td>
<td>Reported concentrations of PFAS in snow were [mean ± SD (range)]:
• 6:2 FTOH: 0.026 ± 0.029 (0.005-0.115)
• 8:2 FTOH: 0.077 ± 0.025 (0.040-0.130)
• 10:2 FTOH: 0.024 ± 0.0083 (0.0093-0.036)
• 12:2 FTOH: 0.013 ± 0.0041 (0.0056-0.019)
• MeFBSA: 0.0009 ± 0.0005 (0.0002-0.0021)
• MeFOSA: 0.003 ± 0.001 (0.0012-0.0048)
• EtFOSA: 0.0016 ± 0.0007 (0-0.003)
• MeFBSE: 0.0028 ± 0.0012 (0.0014-0.0054)
• MeFOSE: 0.048 ± 0.016 (0.024-0.074)
• EtFOSE: 0.010 ± 0.0046 (0.0038-0.020)
• 6:2 FTA: 0.0014 ± 0.0005 (0.0007-0.0021)
• 8:2 FTA: 0.0009 ± 0.0005 (0-0.0018)
• ∑PFAS: 0.209 ± 0.057 (0.125-0.303)</td>
</tr>
<tr>
<td>Tsukuba City and Kawaguchi City, Japan
(Taniyasu et al. 2008)</td>
<td>2 rainwater samples were collected from each city in May and July 2007 and analyzed for a range of PFAS.</td>
<td>Reported concentrations of PFAS in rainwater were (range):
• PFOS: 0.132-1.02
• PFOSA: 0.064-0.170
• EtFOSAA: 0.039-0.326</td>
</tr>
</table>

<table>
<tr><td></td><td></td><td>• PFDoDA: 0.135-0.248
• PFUnDA: 0.348-0.723
• PFDA: 0.519-0.846
• PFNA: 1.04-4.17
• PFOA: 0.991-3.78
• PFHpA: 0.486-3.06
• PFHxA: 0.483-2.76
• PFPeA: 0.244-1.11
• PFBA: 0.769-2.22
• PFPrA: 7.33-10.3
• TFA: 39.3-75.9
• 8:2 FTCA: 1.04-1.94
• 10:2 FTUCA: 0.009-0.014
• 8:2 FTUCA: 0.035-0.230
• 6:2 FTUCA: 0.022</td></tr>
<tr><td>Parkersburg West Virginia
(Barton, Kaiser, and Russel 2007)</td><td>Concurrent rain and air samples were collected at 9 locations in the vicinity of a manufacturing facility during 4-hr precipitation event in August 2005. Continuous air and precipitation sampling was also performed over a 24-hr period in August 2006. All samples were analyzed for PFOA.</td><td>Reported PFOA concentration in rainwater was (range):
• PFOA: <8.8-1,660</td></tr>
<tr><td>Albany, New York, USA
(Kim and Kannan 2007)</td><td>Lake water (n=26), rainwater (n=11), snow (n=27), and surface runoff water (n=7) samples were collected in an urban area between February 2006 and March 2007 and analyzed for a range of PFAS.</td><td>Reported concentrations in rainwater and snow were [mean (range)]:
<table>
<tr><th>PFAS</th><th>Rainwater</th><th>Snow</th></tr>
<tr><td>PFHpA</td><td>0.69 (<0.25-2.32)</td><td>0.45 (<0.25-1.61)</td></tr>
<tr><td>PFOA</td><td>2.53 (<0.75-7.27)</td><td>4.89 (<0.75-19.6)</td></tr>
<tr><td>PFNA</td><td>1.27 (<0.25-3.48)</td><td>0.91 (<0.25-4.94)</td></tr>
<tr><td>PFDA</td><td>0.41 (ND-1.14)</td><td>0.45 (ND-1.37)</td></tr>
<tr><td>PFUnDA</td><td>0.44 (<0.25-0.86)</td><td>0.30 (ND-1.08)</td></tr>
<tr><td>PFDoDA</td><td><0.25 (<0.25-0.71)</td><td><0.25 (<0.25-0.41)</td></tr>
<tr><td>PFHxS</td><td><0.25 (ND-0.36)</td><td><0.25 (ND-0.35)</td></tr>
<tr><td>PFOS</td><td>0.36 (<0.25-1.51)</td><td>0.62 (<0.25-1.93)</td></tr>
<tr><td>PFDS</td><td><0.25 (ND-0.41)</td><td>ND</td></tr>
<tr><td>PFOSA</td><td>ND</td><td><0.25 (ND-0.57)</td></tr>
<tr><td>6:2 FTSA</td><td><0.25 (ND-0.41)</td><td><0.25 (ND-0.34)</td></tr>
<tr><td>8:2 FTSA</td><td>0.56 (<0.25-3.19)</td><td>0.44 (ND-3.37)</td></tr>
</table></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="3">BDL = Below detection limit
IDL = Instrument detection limit
MDL = Method detection limit
MQL = Method quantification limit
ND = Nondetect
RL = Reporting limit
SD = Standard deviation</td></tr>
</table>

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