**Table S1: Number of monthly ACE-FTS occultations measurements taken between 40 and 70º N over the measurement period 2004 – 2022.**

| Year | May | June | July | August | September |
|------|-----|------|------|--------|-----------|
| 2023 | 278 | 87 | 353 | 20 | 151 |
| 2022 | 293 | 95 | 269 | 21 | 164 |
| 2021 | 316 | 93 | 354 | 24 | 163 |
| 2020 | 308 | 89 | 302 | 25 | 160 |
| 2019 | 315 | 115 | 288 | 42 | 164 |
| 2018 | 321 | 117 | 326 | 41 | 171 |
| 2017 | 318 | 112 | 327 | 35 | 173 |
| 2016 | 301 | 109 | 330 | 28 | 160 |
| 2015 | 254 | 98 | 260 | 43 | 146 |
| 2014 | 256 | 81 | 236 | 38 | 151 |
| 2013 | 215 | 66 | 244 | 33 | 151 |
| 2012 | 284 | 92 | 252 | 32 | 152 |
| 2011 | 290 | 82 | 275 | 30 | 157 |
| 2010 | 296 | 82 | 274 | 23 | 154 |
| 2009 | 304 | 70 | 309 | 12 | 80 |
| 2008 | 274 | 61 | 280 | 1 | 150 |
| 2007 | 240 | 43 | 219 | 0 | 91 |
| 2006 | 255 | 50 | 226 | 0 | 103 |
| 2005 | 361 | 68 | 306 | 3 | 149 |
| 2004 | 35 | 31 | 193 | 10 | 100 |
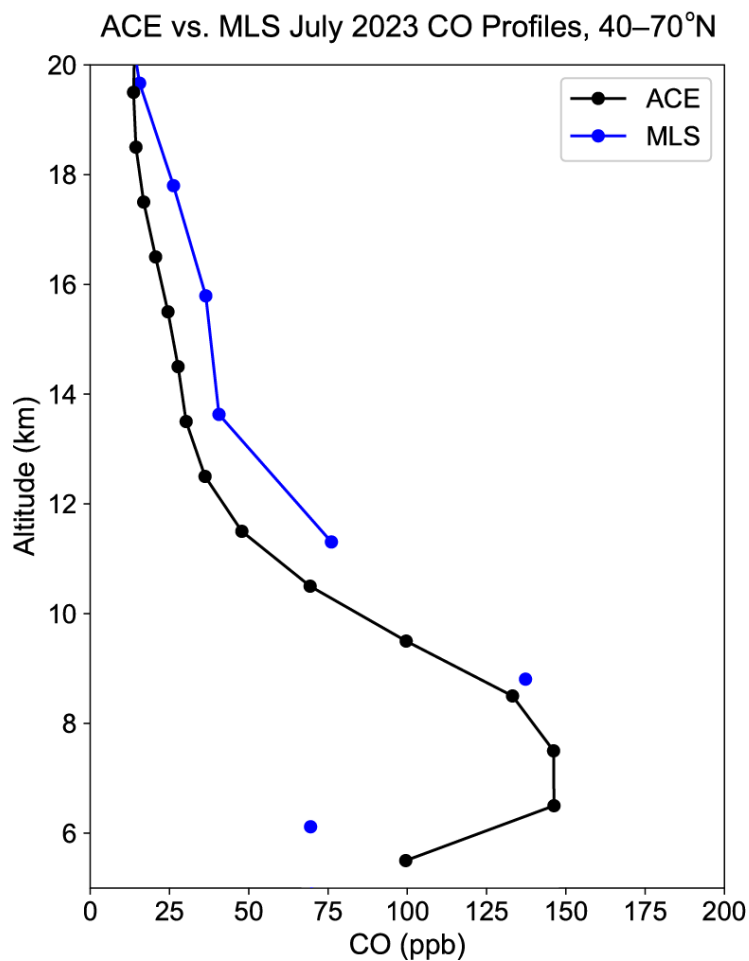
**Figure S1: Comparison between MLS and ACE-FTS CO profiles. The average July 2023 values between 40 and 70 °N for MLS data are shown here in blue, and the average of every ACE occultation measurement taken between the same latitude range is shown in black. The MLS data is connected up to the lowest point of recommended use (215 hPa), and the remaining data is plotted as isolated points. The ACE data has higher vertical resolution and better signal lower in the atmosphere.**
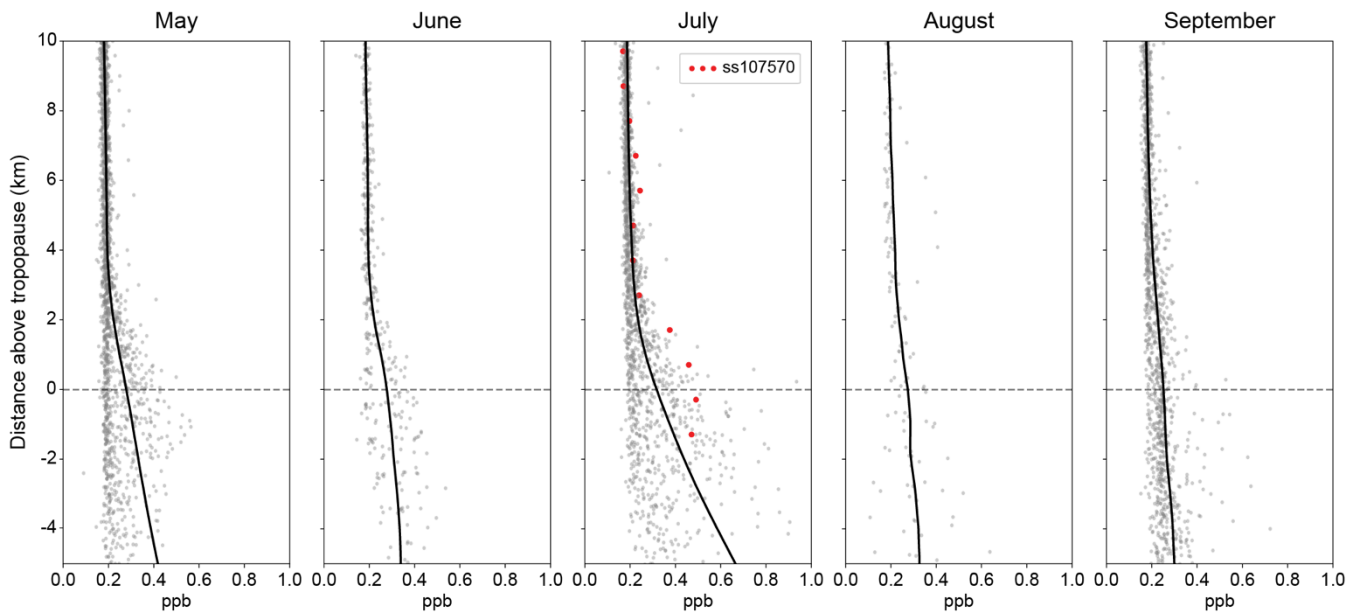
**Figure S2: Individual ACE-FTS HCN measurements for May through September 2023. Each occultation is plotted relative to its self-consistent tropopause height calculated from concurrent temperature profiles. The average of these tropopause-adjusted occultations for each month is shown in black. Occultation ss107570 is highlighted in red because it is a unique measurement that shows both elevated HCN and aerosol extinction in the stratosphere (main text). Other occultations that exhibit enhanced HCN in the stratosphere do not exhibit similarly high aerosol extinction measurements, complicating interpretation of stratospheric entry.**
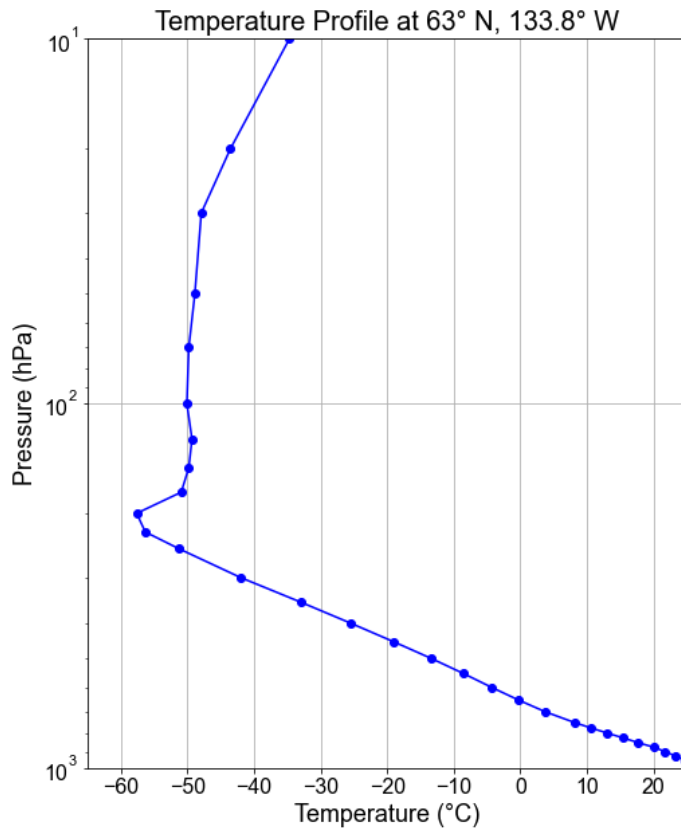
**Figure S3: Atmospheric profile during the 03:00 UTC July 24ᵗʰ Yukon pyroCb at 63.0º N, 133.8º W. The cold-point tropopause is –57.6 ºC, warmer than the reported pyroCb cloud-top brightness temperature of -62.2 ºC.**

**Figure S4: 72 hour HYSPLIT forward-trajectories originating from the pyroCb located at 63.00º N, 133.80º W with an estimated injection height of at least 10.5 km. Trajectories are initialized from this location in 12 hour increments with the earliest start time occurring on July 24th 2023, 04:00 UTC (the time of pyroCb detection) and the latest start time on July 27th 2023, 16:00 to compensate for limited ACE-FTS coverage.**
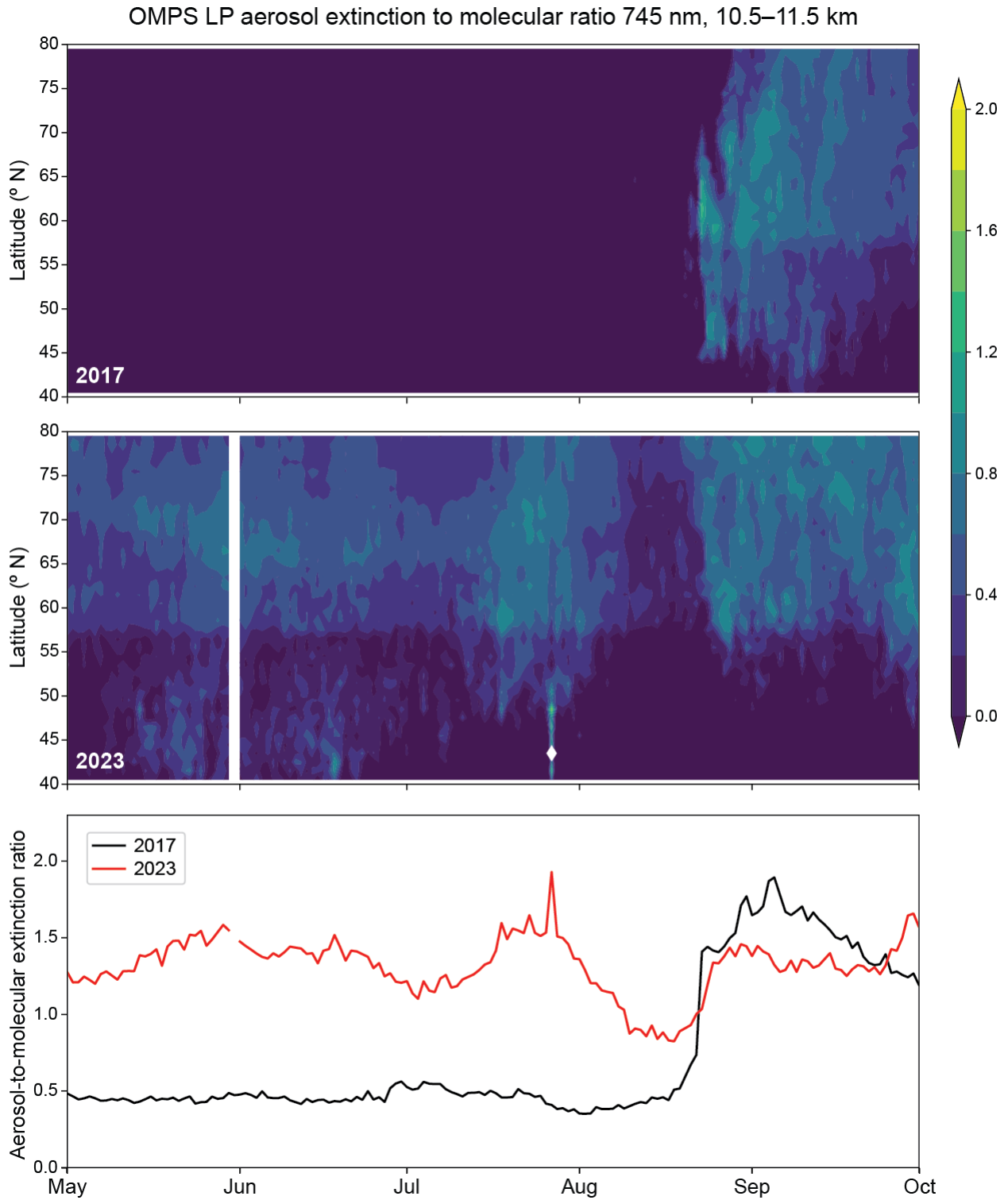
**Figure S5: Top panel:** 2017 zonally averaged OMPS aerosol-to-molecular extinction ratio between 10.5 and 11.5 km, 40 to 80° N. **Middle panel:** 2023 zonally averaged OMPS aerosol-to-molecular extinction ratio between 10.5 and 11.5 km, 40 to 80° N. **Bottom panel:** average OMPS aerosol-to-molecular extinction ratio from 40 to 80° N, 11.5 to 16.5 km compared between 2017 (black) and 2023 (red).