Supplementary Material



**Supplementary Figure 1.** Spatial distributions of atmospheric ice over the TP in different seasons retrieved by Terra satellite from 2003-2020. (a) Spring (MAM) (b) Summer (JJA) (c) Autumn (SON) (d) Winter (DJF)

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**Supplementary Figure 2.** Spatial distributions of atmospheric ice over the TP in different seasons retrieved by Suomi NPP and NOAA-20 satellites from 2013-2020. (a) Spring (MAM) (b) Summer (JJA) (c) Autumn (SON) (d) Winter (DJF)



**Supplementary Figure 3.** Vertical integral of divergence of moisture flux over the TP from 2003 to 2020.