Supplemental Material of Long-term wintertime trend of zonally asymmetric ozone in boreal extratropics during 1979–2016

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1 Supplemental Figures

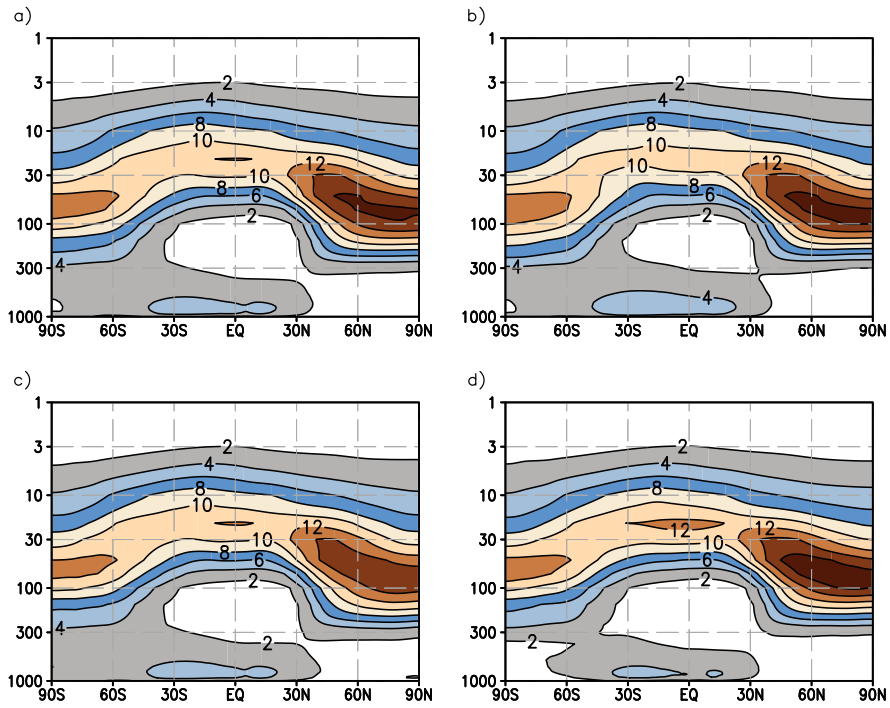

Figure S1: Latitude-height distribution of zonal mean ozone in [DU/km] for (**a**) 1980-2016, (**b**) 1980–1994, (**c**) 1991–2005, and (**d**) 2002–2016 for January using ERA-Interim.

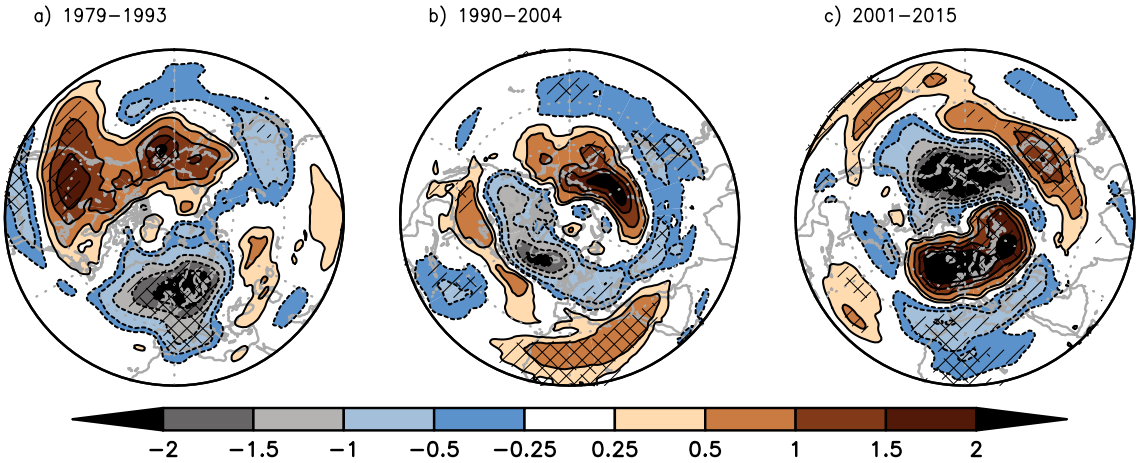

Figure S2: Secular trends (linear regression coefficient) of ZATO in [DU/year] for December for the three stages (**a**) 1979–1993, (**b**) 1990–2004, and (**c**) 2001–2015. Cross (single) hatched regions mark statistically significant trends on a 95% (90%) confidence level.

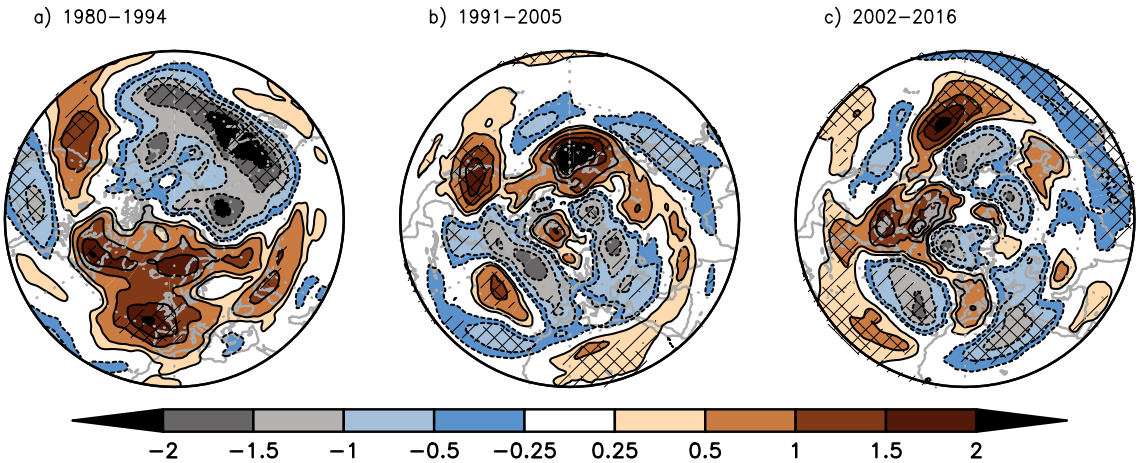

Figure S3: Secular trends (linear regression coefficient) of ZATO in [DU/year] for February for the three stages (**a**) 1980–1994, (**b**) 1991–2005, and (**c**) 2002–2016. Cross (single) hatched regions mark statistically significant trends on a 95% (90%) confidence level.

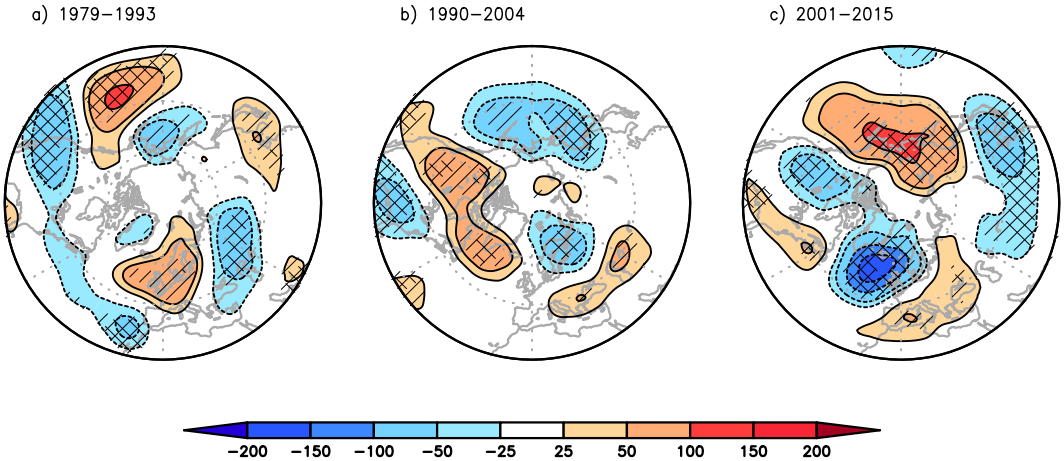

Figure S4: Secular trends (linear regression coefficient) of the geopotential disturbance at 300 hPa in [m^2 s^{-2}/year] for the three stages: (**a**) 1980–1994, (**b**) 1991–2005, and (**c**) 2002–2016 for December ERA-Interim. Cross (single) hatched regions mark statistically significant trends with a 95% (90%) confidence level.

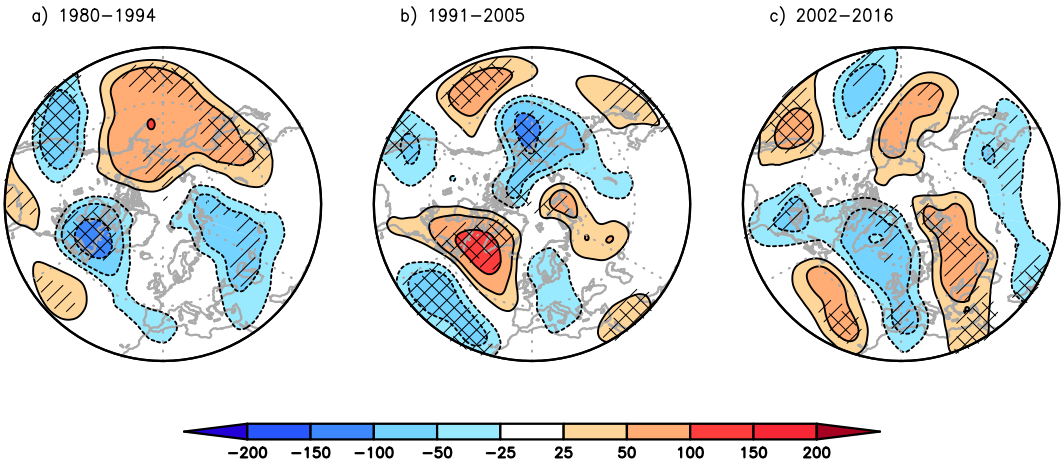

Figure S5: Secular trends (linear regression coefficient) of the geopotential disturbance at 300 hPa in [m^2 s^{-2}/year] for the three stages: (**a**) 1980–1994, (**b**) 1991–2005, and (**c**) 2002–2016 for February ERA-Interim. Cross (single) hatched regions mark statistically significant trends with a 95% (90%) confidence level.

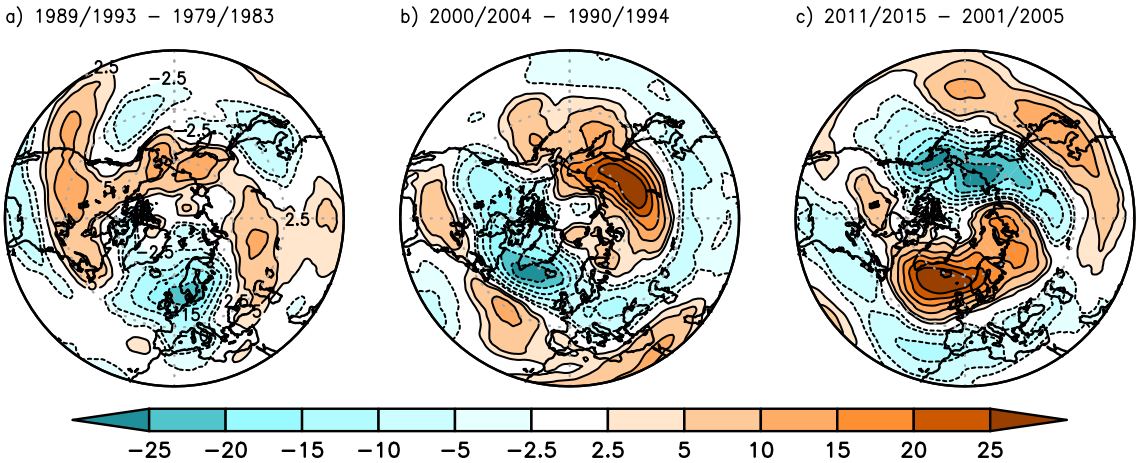

Figure S6: Trend-like pattern determined by the difference of 5-year means of ZATO for December in [DU/decade]. The three stages are described by the following difference (**a**) 1989/1993 - 1979/1983, (**b**) 2000/2004 - 1990/1994, and (**c**) 2011/2015 - 2001/2005.

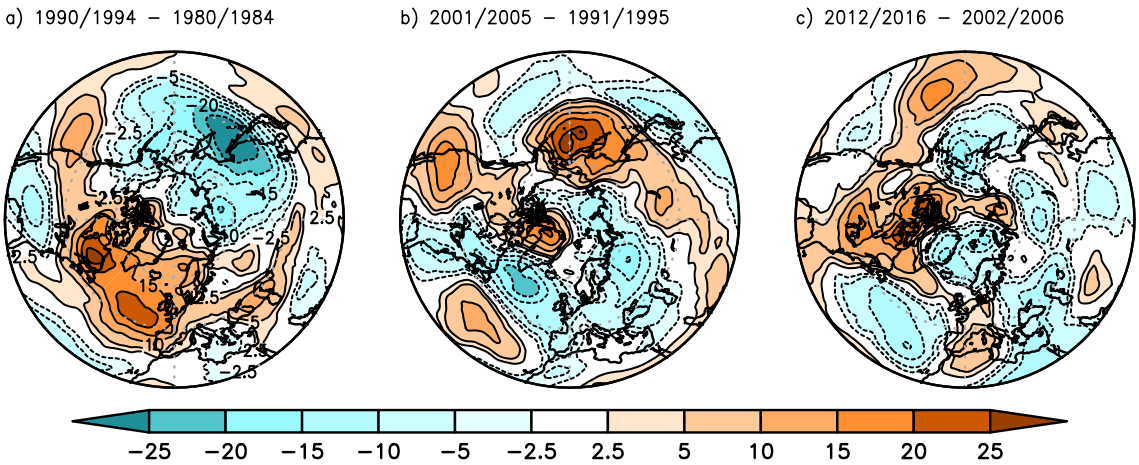

Figure S7: Trend-like pattern determined by the difference of 5-year means of ZATO for February in [DU/decade]. The three stages are described by the following difference (**a**) 1990/1994 - 1980/1984, (**b**) 2001/2005 - 1991/1995, and (**c**) 2012/2016 - 2002/2006.

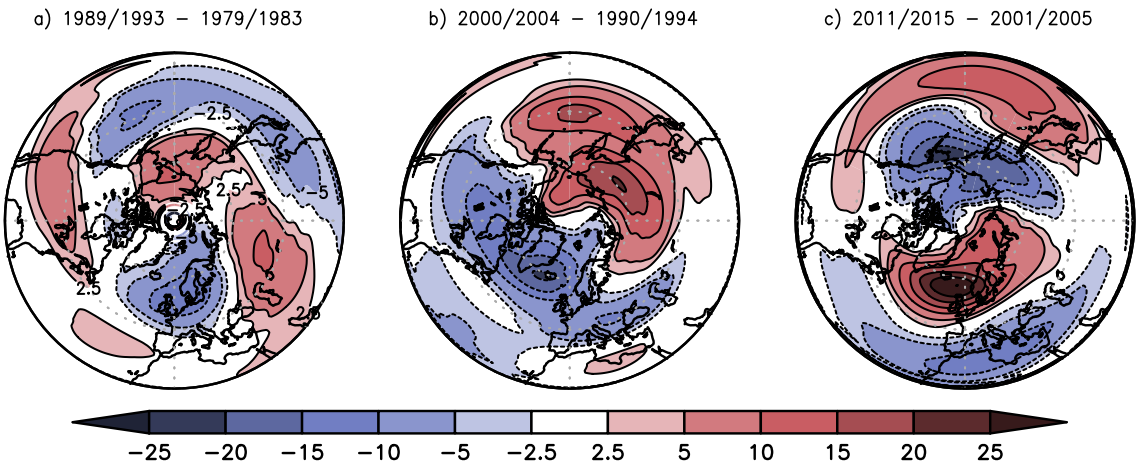

Figure S8: Trend-like pattern determined by the difference of 5-year means of ZATO for December but using the linear transport model result with contributions of wave 1–4.

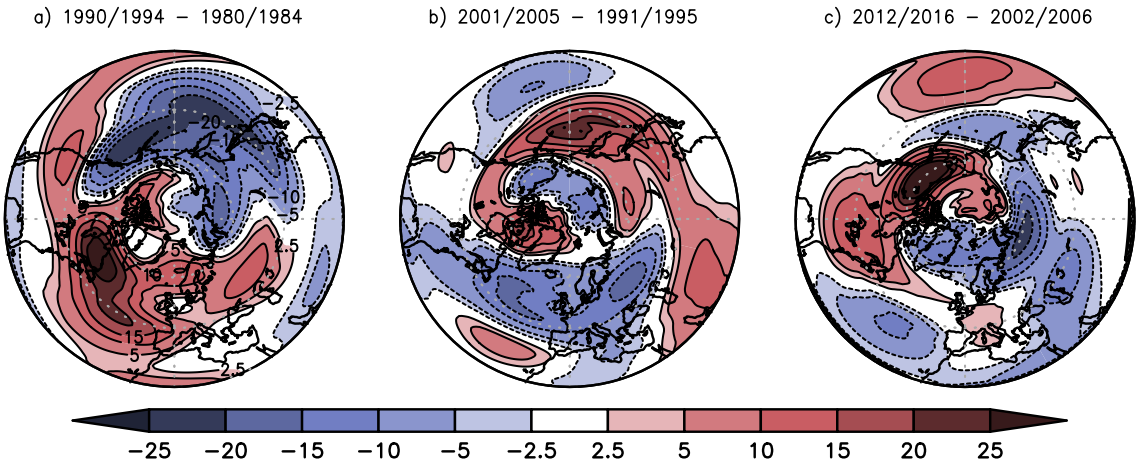

Figure S9: Trend-like pattern determined by the difference of 5-year means of ZATO for February but using the linear transport model result with contributions of wave 1–4.