Notes: don’t need to mention the re-gridding of the UCI data and the manual shifting through UCI data to find longitude and latitude coordinates. Only include relevant information

**Air archive analyses (how the values were obtained)**

**Observed data calculations**

The observed annually averaged ethane mixing ratio is calculated using data from Oregon Graduate Institute (OGI, 1982-1987), University of California – Irvine (UCI, 1984- 2009), and National Oceanic and Atmospheric Administration Earth System Research Laboratory Global Monitoring Division (NOAA, 2005- 2015). The UCI data is only available in March, June, September, and December to represent each season; to keep all three networks consistent, only the aforementioned months from NOAA and OGI are used. The UCI data is distributed from latitude 50° South to 75° North; NOAA and OGI data have better latitudinal coverage than UCI, therefore the subsequent analyses are constraint by the UCI availability.

The Earth’s atmosphere is divided into 5 latitudinal bands: 50°S - 30°S, 30°S - 0°, 0° - 30°N, 30°N - 50°N, 50°N - 75°N. The data in each band is deseasoned by subtracting its seasonal average. A Gaussian fit is applied to the deseasoned data to obtain to the standard deviation (σ) (how to refer to the Coyote algorithm?) of the latitudinal band. We removed data that is 3σ away from the mean.

The annual latitudinal band average is calculated as the mean of each season’s means in one year. The standard error (SE) of each latitudinal band is the propagation of error resulted in the following

where SEseason is the standard error of each season, which is calculated as

n is the number of samples in a season. The annual hemispheric means are calculated from the weighted mean of the latitudinal bands as follow for the northern hemisphere

and for the southern hemisphere

**Simulation modeling**