

## Supplementary

$$\chi(r, t) = \int_{-\infty}^t \chi_0(t') \cdot G(r, t') \cdot L(r, t') dt'$$

$\chi(r, t)$  : Mixing ratio of a tracer at a specific location in the stratosphere

$\chi_0(t')$  : Tropospheric mixing ratio of the tracer

$G(r, t')$  : Age spectra or transit time distribution

$L(r, t')$  : Loss function depending on the path spectra and the sink distribution in the stratosphere