Parameterisation of bromine chemistry

In contrast to E39C, E39C-A considers a parameterisation for bromine chemistry (ClO/BrO-cycle). The parameterisation is based on a scaling of the ozone destruction via the ClO-ClO-cycle. The implementation of the parameterisation is given below (Markus Rex, personal communication):

```matlab
if ((clox .ge. 0.25) .and. (p .le. 80.) .and. (p .ge. 20.)
    t = t + max(p - 60., 0.)/2.
    factor = abs(&
        exp(-0.064996 - 0.8939601*log(clox)) + &
        exp(-3.760605 - 0.9998547*log(clox)) * (t - 195.) - &
        exp(-3.674095 - 1.0190500*log(clox)) * (p -50.)
    )
else
    factor = 0.
end if

deltao3 = factor * 2. * photcl2o2
```

- **p**: pressure [hPa], with 20 hPa ≤ p ≤ 80 hPa
- **t**: temperature [K], with 170 K ≤ T ≤ 250 K
- **clox**: mixing ratio of (ClO+2*Cl2O2) [ppbv], with 0.25 ppbv ≤ clox ≤ 4 ppbv
- **photcl2o2**: number of Cl2O2 molecules photolysed during one timestep [molec/cm$^3$]
- **deltao3**: number of ozone molecules destroyed by ClO/BrO-cycle during one timestep [molec/cm$^3$]

The parameterisation is adapted for chemical conditions in polar winter. It is based on in-situ measurements of BrO:

S 1: Comparison of global mean temperature anomalies in the lower stratosphere (15 to 23 km) derived from observations (MSU Channel 4, blue) and equivalent values calculated from results of the model simulations with E39C (black) and E39C-A (red).
S 2: Climatological zonal mean CH$_4$ mixing ratios [ppmv] at 10 hPa for E39C-A using an upper boundary condition with a meridionally varying CH$_4$ gradient (orange) and HALOE observations (black). The HALOE climatology is normalised to the CH$_4$ mixing ratio in the inner tropics (10$^\circ$N-10$^\circ$S). The normalised CH$_4$ gradient is prescribed at the model top. At each time step the normalised gradient is multiplied with the actual simulated CH$_4$ mixing ratio in the inner tropics to receive the upper boundary condition in the model. The upper boundary condition is based on annual mean values and does not consider the annual cycle.

S 3: Climatological mean CH$_4$ mixing ratios [ppmv] at 50 hPa in October for E39C-A (left) and E39C (right) including the upper boundary condition for CH$_4$. 
S 4: Climatological mean HCl vertical profile at the Equator in April and zonal mean mixing ratios [ppbv] at 50 hPa in April (left) and November (right). The grey areas show HALOE plus and minus 1 standard deviation about the climatological zonal mean. Observations taken from Eyring et al. (2006), their Fig. 11.

S 5: Modeled total column ozone climatologies (1980 to 1999) for E39C and E39C-A compared to merged satellite and NIWA assimilated data (taken from Eyring et al. (2006), their Fig. 14).