

## On how to calculate methane lifetime from OH concentrations (FORTRAN):

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Integer I, J, L      ! counters
Integer IM, JM      ! number of longitudes and latitudes in the model
Integer Ltop(IM,JM) ! number of top layer in the domain (e.g.tropopause)

Real vol(IM,JM,LM) ! total volume of a gridbox [cm3]
Real oh(IM,JM,LM)  ! OH concentration [molecule/cm3]
Real ch4(IM,JM,LM) ! CH4 concentration [molecule/cm3]

Real ch4_sum        ! total number of CH4 molecules within the domain

Real rate(IM,JM,LM) ! rate constant for CH4+OH --> CH3+H2O
                    ! [cm3/(molecule*s)]
Real yield          ! total number of H2O molecules
                    ! produced within the domain [molecule/s]

Real tau_ch4        ! methane lifetime (years)

C Initialize:
  ch4_sum=0.
  yield=0.

C Calculate sums:
  Do J = 1 , JM
    Do I = 1 , IM
      Do L = 1 , Ltop(I,J) ! 1 = surface layer

        ch4_sum = ch4_sum + ch4(I,J,L) * vol(I,J,L)

        yield = yield
&          + rate(I,J,L) * oh(I,J,L) * ch4(I,J,L) * vol(I,J,L)

      End Do
    End Do
  End Do

C Lifetime of CH4:
  tau_ch4=ch4_sum/(yield*86400.*365.)
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On how to calculate a new steady state concentration of CH<sub>4</sub> without modeling it

The method is described in:

Fuglestad, J. S., Berntsen, T. K., Isaksen, I. S. A., Mao, H., Liang, X.-Z., Wang, W.-C.: Climatic forcing of nitrogen oxides through changes in tropospheric ozone and methane; global 3D model studies, Atmospheric Environment, 33, 961-977, 1999.

... in the following called 'F99'.

The formula to use is:

$$[\text{CH}_4]_{\text{ss}} = [\text{CH}_4]_{\text{ref}} * ( 1 + 1.4 * \Delta\tau_0 / \tau_{\text{ref}} )$$

[CH<sub>4</sub>]<sub>ref</sub> is the methane mixing ratio in your reference run, and Δτ<sub>0</sub> is the change in methane lifetime in the perturbation run, i.e. Δτ<sub>0</sub> = τ<sub>per</sub> - τ<sub>ref</sub>, where τ<sub>ref</sub> and τ<sub>per</sub> are the methane lifetimes in your reference and perturbation runs, calculated with the FORTRAN code above. [CH<sub>4</sub>]<sub>ss</sub> would be the new steady state mixing ratio of methane in the perturbation run (if we didn't keep it fixed and ran the model long enough). A feedback factor of 1.4 is used instead of 1.54 (as was suggested by F99) because 1.4 was used in IPCC-TAR (chapter 4) and other publications.

Example:

Say you have set [CH<sub>4</sub>]<sub>ref</sub> = 1790 ppbv and calculate a methane lifetime τ<sub>ref</sub> = 9 yr in your reference run, and a shorter methane lifetime of 8.9 yr in your perturbation run, i.e. Δτ<sub>0</sub> = -0.1 yr. The new steady state methane in the perturbation run would then be:

$$[\text{CH}_4]_{\text{ss}} = [\text{CH}_4]_{\text{ref}} * ( 1 + 1.4 * ( -0.1 \text{ yr} ) / 9 \text{ yr} ) = 1762 \text{ ppbv}$$

This is the value you will report for your perturbation run.