TRANSCOM Age of Air experiment

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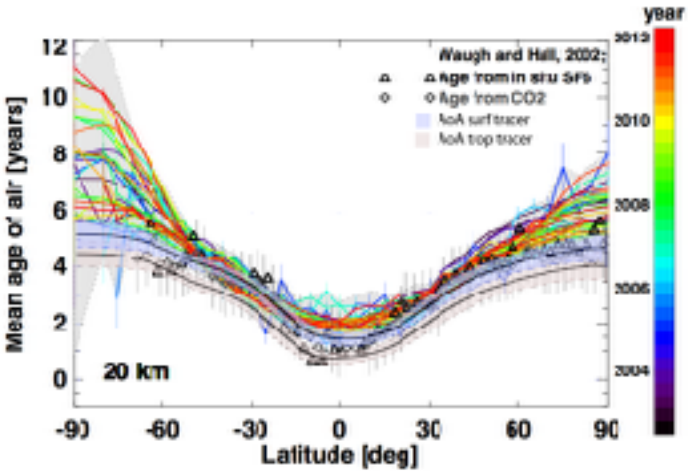
Introduction

Atmospheric constituents may have different lifetimes. Methane (CH_4) has an atmospheric lifetime of about 9 years, SF_6 lives much longer (sink only in the upper atmosphere), and ^{222}Rn has a lifetime of only a few days. Studying the global transport of tracers with varying lifetimes can help to characterise transport in a model. How fast does your model exchange between troposphere and stratosphere? How fast is the inter hemispheric mixing? How efficient is the parameterised convection scheme in vertical redistribution of tracer mixing ratios?



For instance, to characterise stratosphere troposphere exchange, Prather et al. (2011) defined a tracer “e90” with surface emissions and a 90 days decay time to map out the tropopause.

In stratospheric circulation studies, the “age of air” is commonly used concept (Waugh, 2009). Recently, Fu et al. (2015) reported a speed up of the Brewer Dobson circulation, based on stratospheric observations, in line with model predictions.

This model inter-comparison aims to study the “age of air” in the troposphere and stratosphere. Figure 1 (after Douglas et al., 2008, and Haenel et al., 2015) shows the stratospheric age of air at 20 km.

Figure 1: From Haenel et al. (2015), merged with TM5 model results. Results for two Age of Air (AoA) tracers (see below) are presented, and show that the stratospheric AoA in TM5 is slightly too young compared to traditional and MIPAS-derived values.

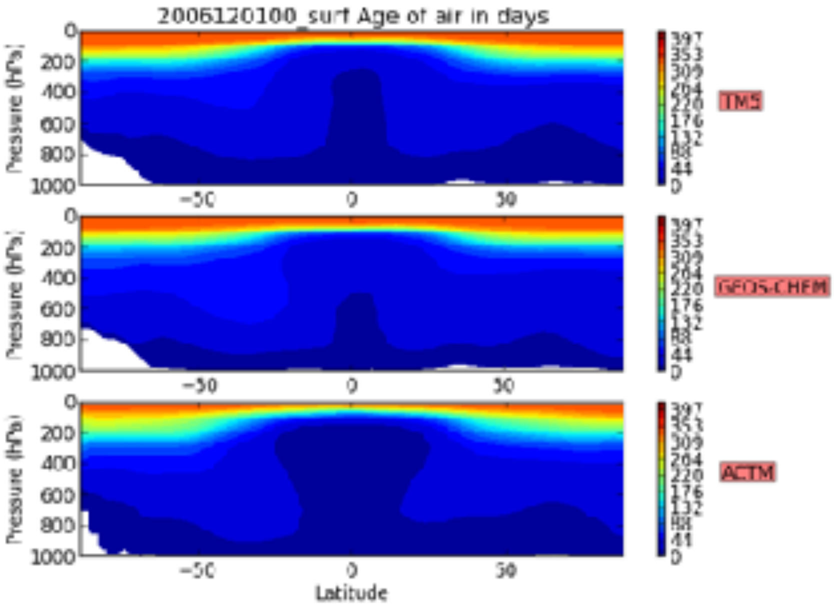
In the tropical upwelling area models find “young” air, while at higher latitudes stratospheric the age of air may reach up to ten years. In the stratosphere the age of air (or more specifically, the age spectrum) can be estimated from tracer observations (e.g. CO_2 and SF_6, tracers with steady increasing atmospheric mixing ratios). Models can readily simulate the mean age of air in the stratosphere (Waugh and Hall, 2002) and the “age of air” concept is now a standard test for stratospheric transport in models. Indeed, Figure 1 includes two estimates of the “age of air” (AoA) estimates calculated with TM5 using this protocol (see below). Apart from this, we want to extend the same technique to quantify the “age of air” in the troposphere. Some recent papers (Holzer and Waugh (2015); Waugh et al. (2013)) follow that idea.

For this model intercomparison the idea is that, in analogue to the stratospheric studies, a tracer is provided to models with a linearly increasing boundary condition. The longer an air-mass is out of contact with that “boundary”, the “older” its age will be. We will show that, by providing different sets of boundary conditions (e.g. land, northern hemisphere, stratosphere) specific transport times can be obtained in the model. Thus the main aim is to classify models according to their transport characteristics. In the next section we will outline the way in which the boundary condition works in calculating an “age of air” in the troposphere.

Age of Air in the troposphere

We will calculate the age of air in the atmosphere from simulated mixing ratios of artificial tracers X. These mixing ratios can be evaluated in every grid box of an Eulerian model, and can also be evaluated at specific stations. Suppose we provide a boundary condition at the Earth' surface that grows linearly in time:

$$B = f.t \qquad (1)$$



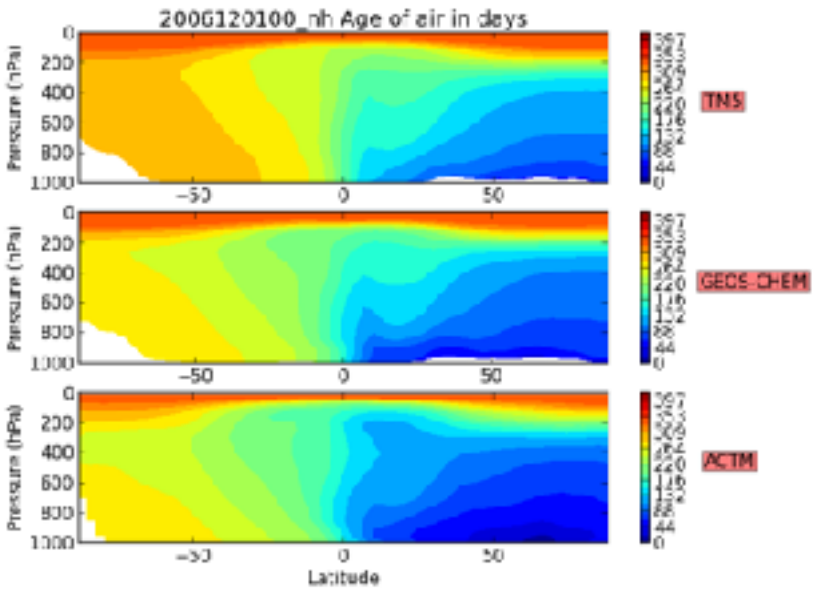
where B represents the mixing ratio that will be "set" at the surface or volume, "f" a constant in s^{-1}, and t the time elapsed since the start of the simulation (s). This results in an increasing mixing ratio X in the atmosphere, and the age of an air parcel with mixing ratio X can be calculated as:

$$L = (t - X/f) \qquad (2)$$

with L the age of air in s. It can easily be verified that the mixing ratio in close proximity with the boundary will have X = B = f.t, and thus an age of 0. The longer the atmospheric air has been away from the boundary, the lower its mixing ratio will be, and the older its age. Although this concept is relatively straightforward, there are a number of considerations to make. First, however, we would like to show some results from a first study with three atmospheric transport models.

First Results

Three models (TM5, GEOS-CHEM, and ACTM) simulated a fixed boundary condition at the Earth surface (B = f.t, see equation 1). One year (2006) was simulated and the monthly average mixing ratio of the last month (December) was transformed into "age of air" using eq. 2. For this, we used the "monthly mean" time (t = mid-december). The maximum age of air is therefore 11.5 month (349.5 days) and this would correspond to zero mixing ratios. These values are found in the upper stratosphere. Logically, close to the surface we find young air, because this air has been "reset" most recently by the boundary condition. All three models show a similar pattern, but differences are also apparent. GEOS-CHEM (see figure top of the page) shows smallest vertical mixing, and ACTM finds the youngest air in the tropical upper troposphere, but also a less distinct separation between stratosphere



and troposphere. We also tested a boundary condition in which the “forcing” is applied at all land masses on the Northern Hemisphere (NH). For this setting it becomes apparent that TM5 has the slowest inter hemispheric mixing time, because the age-of-air at the Southern Hemisphere (SH) is significantly older than in the other models. This observation supports the conclusion of Patra et al. (2011), a study in which TM5 also showed slower interhemispheric transport for SF_6 and CH_4 compared to other models. These two examples illustrate that the tropospheric “age-of-air” simulations can identify model-to-model differences. Unfortunately, there exists no “experimental” estimate of the tropospheric age of air. However, Patra et al. (2011) and Belikov et al. (2013), have shown that tracers like SF_6, and ^{222}Rn, may be used as tracers for inter hemispheric and vertical transport. We propose a second ^{222}Rn tracer (called ^{222}RnE), with higher emissions in the latitude band 60-70, zero emissions over oceans, and specific emissions for the years 2006–2010 over Europe (provided by Ute Karstens). The main idea is therefore to simulate a number of “age of air” tracers in combination with traditional tracers (SF_6, ^{222}Rn, e90) to investigate the usefulness of the “age of air” tracers to identify specific model characteristics.

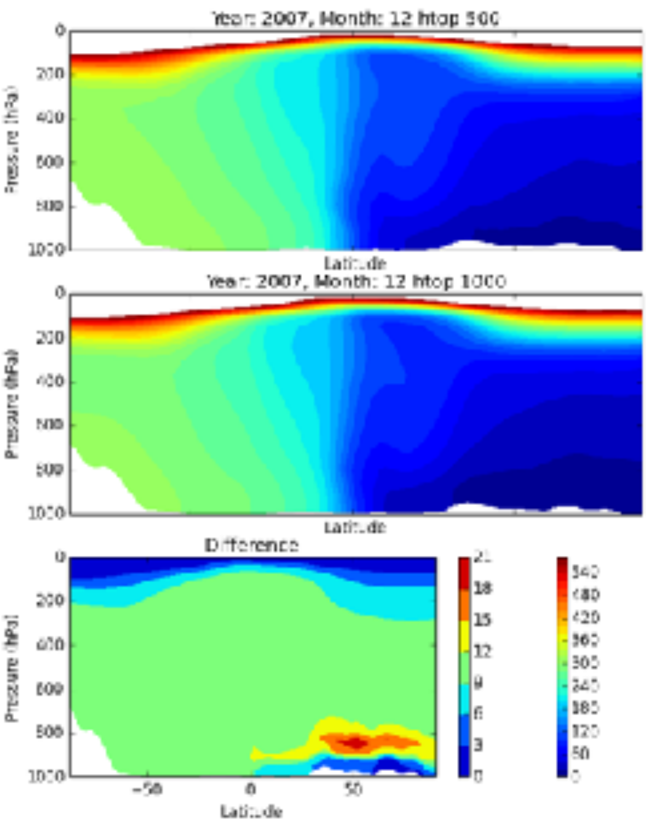
Table 1: proposed tracers

Tracer	Boundary Condition	Atmospheric Lifetime	Sensitivity
^{222}Rn	Land emission	5.5 days (e-folding)	Vertical mixing
^{222}RnE	Land emission (EU spec)	5.5 days (e-folding)	Vertical mixing
e90	surface emissions	90 days	strat-trop exchange
SF_6	surface emissions	3200 year	inter-hemispheric transport
surface	Earth surface	(age of air tracer)	vertical mixing, strat-trop
stratosphere	Stratosphere	(age of air tracer)	strat-trop exchange
troposphere	Troposphere	(age of air tracer)	stratospheric age of air
NH surface	NH surface	(age of air tracer)	inter-hemispheric transport
SH surface	SH surface	(age of air tracer)	Inter-hemispheric transport
land	All land masses	(age of air tracer)	Lifetime over oceans
ocean	All water bodies	(age of air tracer)	Lifetime over land

Considerations

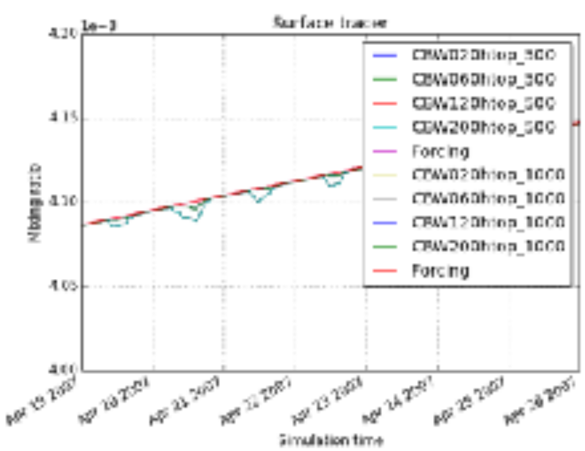
Table 1 lists the proposed 11 tracers for this experiment. The only three tracers with atmospheric observations are ^{222}Rn, ^{222}RnE, and SF_6, and we will follow the set-up of previous intercomparisions (see protocol below). The ‘e90’ tracer will receive an atmospheric lifetime (e-folding) of 90 days, and the surface emissions will be chosen such that the steady-state concentration in the atmosphere will be 100 ppb.
All other tracers will be of type “age of air” and will be exposed to a linearly increasing mixing ratio as boundary condition. The exact way to to this requires some considerations:

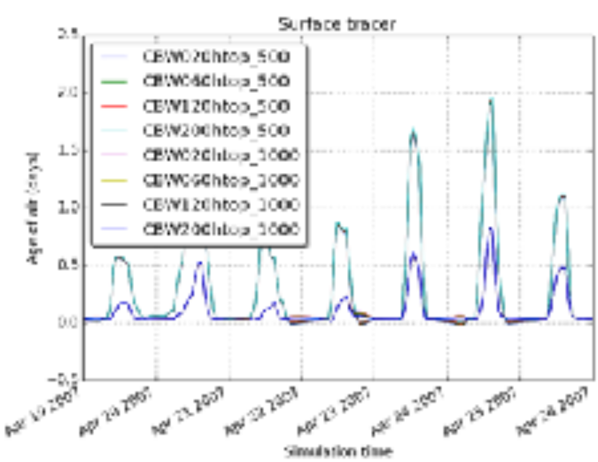
1. The requested output will be simply be the mixing ratio at stations and monthly means, and we will use a factor f (equation 1) of 1×10^{-15} mol/(mol.s). After three years, the boundary mixing ratio will therefore be 94.608 ppbv (nmol/mol).



2. The way the mixing ratios are sampled will be important. For instance, the TM5 model samples the output after vertical mixing (convection and vertical diffusion). Also, the frequency at which the boundary conditions are set will probably have an influence. We need to document these model characteristics.

3. The “volume” that is used to set the boundary condition will influence the results. In order to get comparable results, we need to define exactly over which layer the boundary is set. As an example, we forced a “nh-land” tracer in the TM5 model in two ways: (i) over the lowest 500 m from the surface (ii) over the lowest 1000 m from the surface (example code will be provided). The figure shows that, although the general pattern looks similar (age of air in days shown in the rightmost color bar) substantial differences occur, not only in the region where the mixing ratios are set (NH land), but also in the background, with air older by 9-12 days in the background troposphere (difference plot uses leftmost color bar). This can easily be explained by the volume over which the boundary condition is applied: 500 m (upper panel) vs. 1000 m (middle panel).





To illustrate the effect of forcing layer depth further, the figure above shows on the lefthand site the sampled mixing ratio, along with the applied forcing. As expected, the deeper forcing (htop_1000) stays closer to the forcing. When converting into age of air (righthand plot) large differences are found, with younger air for the top_1000 simulation. The sampling sites (Cabauw tower, 20, 60, 120, 200 m) are all within the “forcing” layer and the “age of air” is almost the same along the tower. However, the lifetime is still different for the different forcing depths, because the boundary layer mixing during day brings in “older” air from the free troposphere. Since the TM5 model samples after vertical mixing, this effect of forcing-depth is clearly visible. But the results will be different for different sampling strategies (see point 2 above). The results will also depend on the vertical mixing scheme of the models. Since we are interested in these boundary layer mixing effects, we need to make sure that we force the models within the boundary layer. We therefore decided to use a forcing depth of **100 m** for the tracers that are “forced” to boundary conditions at the surface.

The protocol

We propose to run the experiment with the 11 tracers in table 1. For ^{222}Rn and SF_6 we will follow the TRANSCOM 2010 experiment.

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^{222}Rn

EMISSIONS

Construct your own radon emission distribution based on the surface type in each grid-cell using prescribed fluxes in table 2. For models with a defined land fraction, use the appropriate proportion of land and ocean emissions. We do not want the emission field to be rescaled to match a global total source but you should check that you produce a global radon source of approximately $2.2\text{x}10^{-6}$ mol s^{-1}. We also provide a standard emission file (RN222_flux_old.nc), with emissions on a 1x1 degree grid in kg/gridbox s^{-1}.

Surface type	latitude range	flux (mol.m^{-2}.s^{-1})
land and ocean	70°N-90°N, 70°S-90°S	0.0
land and ocean	60°N-70°N, 60°S-70°S	$8.3\text{x}10^{-23}$
land	60°S-60°N	$1.66\text{x}10^{-20}$
ocean	60°S-60°N	$8.3\text{x}10^{-23}$

Table 2: Emission strength of ^{222}Rn. Global source strength should be around $2.2\text{x}10^{-6}$ mol s^{-1}.

DECAY

^{222}Rn decays in the atmosphere with a half-life of 3.8 days. At each model time-step in the model, apply the following

Rn(i,j,k) = exp(-dtime*2.11e-6)*Rn(i,j,k)

where *Rn(i,j,k)* is the radon mixing ratio at all grid-points and *dtime* is the model time-step in seconds.

^{222}RnE

EMISSIONS

We constructed one file per year, with monthly emissions on a 1x1 degree grid in the unit kg/gridbox s^{-1}. Most of the files are identical, but for 2006–2010, we included specific information over Europe, kindly provided by Ute Karstens, see mail:

Mail from Ute Karskens to Maarten Krol 3/2/2015:

```
As already mentioned in my previous email we have two versions of the Rn
emission map based on different soil moisture reanalysis. We decided now to
provide both maps and - as we cannot clearly prefer one of the maps based on
comparisons with observations - also the mean of both maps. This 'ensemble'
mean might indeed be the best choice.

The maps are in netcdf and I hope the files contain all required information.
Land regions not covered by our map and oceans are set to missing values.

The time periods are different: 2006-2012 for fluxes based on GLDAS-Noah and
2006-2010 based on ERA-Interim/Land and for average fluxes.

There are also global maps available combining the new map for Europe and
constant fluxes for land surfaces outside Europe:
1 atom cm-2 s-1 between 60S and 60N
0.5 atom cm-2 s-1 between 60N and 70N (excluding Greenland)
……
```

We used the global product, and converted the fluxes to kg/gridbox s^{-1}. Implementation of the emissions should be similar as for SF_6, see below. Names of the files are: RN222_flux_<yyyy>.nc, with <yyyy>=1988–2014.

DECAY

^{222}Rn decays in the atmosphere with a half-life of 3.8 days (an e-folding time of 5.5 days). At each model time-step in the model, apply the following

Rn(i,j,k) = exp(-dtime*2.11e-6)*Rn(i,j,k)

where *Rn(i,j,k)* is the radon mixing ratio at all grid-points and *dtime* is the model time-step in seconds.

SF_6

EMISSIONS

We use EDGAR 4.0 emissions, with global totals corrected as suggested by Levin (sf6_emi1987-2015.nc). It contains the yearly emissions in kg SF_6 $m^{-2}s^{-1}$. Based on a molar mass of 146.0564192 g SF_6 mol^{-1}, yearly total SF_6 sources in mmol s^{-1} are given in table 3.

Emissions in the recent years are extrapolated from 2010.

year	**source** mmol.s^{-1}	year	**source** mmol.s^{-1}	year	**source** mmol.s^{-1}	year	**source** mmol.s^{-1}	year	**source** mmol.s^{-1}
1988	934	1994	1381	2000	1201	2006	1366	2012	1685
1989	938	1995	1392	2001	1197	2007	1475	2013	1729
1990	1036	1996	1312	2002	1223	2008	1555	2014	1772
1991	1116	1997	1208	2003	1258	2009	1577	2015	1816
1992	1210	1998	1162	2004	1268	2010	1599		
1993	1303	1999	1177	2005	1299	2011	1642		

Table 3: Global yearly source of SF_6 in mmol s^{-1}.

We provide yearly files with monthly emissions on a 1x1 degree grid in the unit kg SF_6/gridbox s^{-1}. Names of the files are: SF6_flux_<yyyy>.nc, with <yyyy>=1988–2015.

INITIAL CONDITIONS AND DECAY

We provide a 3D initial fields for 1988 and 2000 on the ftp site (SF6init_*.nc). No atmospheric decay has to be applied

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E90

EMISSIONS

The tracer e90 is introduced as an emission at the model surface. For the emission strength we will request a global steady state mixing ratio of 100 ppbv. Accordingly, the following fortran90 lines calculate the emission strength and the lifetime, assuming a tracer with the same mass as dry air:

```
real,parameter     ::  pi = 3.14159265358979
real,parameter     ::  ae = 6.371e6      ! radius Earth (m)
real,parameter     ::  e90_ilt = 1./(3600.*24.*90) ! 1/s
real,parameter     ::  atm_mass = 5.14e18    !kg
real,parameter     ::  eq_mr = 100.0e-9      ! equilibrium mixing ratio
real,parameter     ::  e90 = atm_mass*eq_mr*e90_ilt/(4*pi*ae**2)! kg/(m2.s)
```

The addition of e90 (kg in boxes adjacent to the surface) should then look like:

```
loop over i and j:
mass_e90[i,j,1] = mass_e90[i,j,1] + e90*dtime*area[i,j]
```

With *dtime* the time step, and *area* the surface area of the grid cell *i,j*. Emissions are applied over land and water.

DECAY

The decay of e90 should look like:

```
loop over i,j,k:
e90[i,j,k] =  e90[i,j,k]*(1. - dtime*e90_ilt)
```

With *dtime* the time step.

Age of air tracers

INITIAL CONDITIONS

All initial conditions are taken as 0. For models that cannot handle negative concentrations, a fixed initial value of 100 ppb ("offset" mixing ratio 10^{-7} , see below) can be used that is then subtracted from the final output.

BOUNDARY CONDITION

The mixing ratio in the boundary volume will be set in each time step to a mixing ratio *xset*, which is calculated as (see also equation 1):

```
xset = time*f   (+ offset)
```

with *time* the number of seconds elapsed since the start of the simulation (January, 1, 1988) and *f* a constant, which we take as 1×10^{-15} s^{-1}. For the age-of-air tracers we have to calculate the fraction of the grid cell that has to be set. The example code below shows how this can be done for the mixing ratio of tracer "NH surface" *(mr_nhsurf)* for a grid cell that extends from -0.5 degree S to +0.5 degree N. The array *gph* contains the Geopotential height array (m) from the surface (l=1, bottom of the lowest layer) to the top of the atmosphere (l = lm+1, top of the highest layer):

```
real:: htop = 100.0   ! we force the tracer up to htop (m)of 100 m.
fac = 0.5             ! fraction of the cell on the NH
height = 0.0

hl :do l = 1, lm      ! lm = number of layers in the model
    dz = gph(l+1) - gph(l)    ! thickness of layer l (m).
    height = height + dz

    if (height < htop) then
       ! set the entire cell in the vertical:
       mr_nhsurf =  xset*fac + (1. - fac)*mr_nhsurf
    else ! this layer contains the 100 m level
       height = height - dz
       fac = fac*(htop - height)/dz
       mr_nhsurf =  xset*fac + (1. - fac)*mr_nhsurf
       exit hl
    endif
enddo hl
```

Similarly, for the "land" tracer, or the ocean tracer, we replace *fac* by:

```
fac_land = land_frac         ! fraction of the cell on land
fac_ocean = (1. - land_frac)
```

Finally, we need to define the "troposphere" and "stratosphere" concerning the boundary conditions. To keep things simple, we define the tropopause by a pressure level that depends on latitude *(lat)*.

$$P\_trop = (30000. - 21500*(\cos(lat))^2)$$

This leads to a tropical (cos(lat) = 1) tropopause of 8500 Pa, and a polar (cos(lat) = 0) tropopause of 30000 Pa. Again, we loop over the layers to find the fraction of the cell in the troposphere. Note that we assume two arrays: p_top(:,:,1:lm) and p_bottom(:,:,1:lm) that represent the top and bottom pressures of *lm* layers.

```
loop over i,j:
lat = latitude(i,j)
P_trop = (30000. - 21500*(cos(lat))**2) !assumed tropopause pressure

pl: do l = 1, lm                ! corrected: was l = 2, lm
   pres = p_top(i,j,l)
   if ( pres > P_trop) ) then  ! entire layer below tropopause
      mr_trop = xset
   else ! layer contains tropopause pressure
      fac = (P_trop - pres)/(p_top(i,j,l-1)—pres)
      mr_trop = xset*fac + mr_trop*(1-fac)
      exit pl
   end if
enddo pl
```

For the tracer that is set in the stratosphere, this looks like:

```
loop over i,j:
lat = latitude(i,j)
P_trop = (30000. - 21500*(cos(lat))**2)

pl: do l = lm,1                 ! corrected was l = lm-1,1
   pres = p_bottom(i,j,l)
   if ( pres < P_trop) ) then  ! entire layer above tropopause
      mr_strat = xset
   else ! layer contains tropopause pressure
      fac = ( p_top(i,j,l-1) - P_trop)/(p_top(i,j,l-1)—pres)
      ! was wrong: fac = (pres - P_trop)/(pres - p_bottom(i,j,l+1))
      mr_strat = xset*fac + mr_strat*(1-fac)
      exit pl
   end if
enddo pl
```

DECAY

No decay should be applied

Period and Output

The target simulation period is 1-1-1988 to 31-12-2014. Modellers are free to choose their vertical and horizontal resolutions. Multiple resolutions can be submitted. Please document the model resolution carefully in the requested *NetCDF4* output. Also make sure that you document how you sample the output at stations (e.g. after emission, after mixing). For convenience, we use where possible the same output structure as the latest CH_4 intercomparison.

To address the targets of this intercomparison, the following output is expected for all model simulations:

Monthly mean mixing ratios

For most modellers, the monthly mean mixing ratios is a standard output. Note that this output should be dimensionless (or, more correctly, (mol tracer)/(mol air)). For SF_6, E90 and ^{222}Rn, the mixing ratios correspond to physical values. For the lifetime tracers, we will transfer the mixing ratios to Age of Air. Please make sure that the value for “B” in the simulation is defined according to equation (1), with $f = 1x10^{-15}\ s^{-1}$ and t in seconds since 1-1-1988.

Filename	mmean.your_model.your_institution.tracer_name.nc
Datasets	latitude[nlat],longitude[nlon],pressure[nlev],time[ntime]
Datasets	conc[nlon,nlat,nlev,ntime]

ntime: 12 month per year from 1988–2014 (324)
pressure: should be ordered from surface upward
conc: units should be volume mixing ratio (no conversion to ppt, ppb, etc.)
time: hours since 1-1-1988

Hourly output at TRANSCOM station list (247): surface concentrations

Like earlier protocols, we collect hourly mixing ratios at a predefined list of stations, provided as input for the protocol. Again, SF_6, E90 and ^{222}Rn have physical interpretation. The Age of Air tracers will be used to investigate boundary layer mixing, deep convection, inter-hemispheric mixing, and stratosphere troposphere exchange.

Filename	all.your_model.your_institution.year.nc (e.g. all.ACTM.RIGC.yyyy.nc)
Input file	site.list.all (contains the information of the [nsite=247] stations
Datasets	latitude[nsite],longitude[nsite],level[nsite],land[nsite]
Datasets (cont)	tracer_name[ntracer], conc[nsite,ntracer,ntime], time[ntime]

longitude: One value per site. Give the longitude of the model grid point that you sampled for this site or the real longitude if you interpolated between grid points.
latitude: One value per site. Give the latitude of the model grid point that you sampled for this site or the real latitude if you interpolated between grid points.
level: One value per site. Give the number of the model level that you sampled for this site (counting the model levels from the surface upwards). If you interpolated between model levels give the model level as a decimal, for example use 1.3 to represent level_1*0.7+level_2*0.3. If the interpolation changed in time, give an average value.

land: One value per site. Give the surface type of the sampled grid point using 0 for ocean and 1 for land. If you model has fractional land then give the appropriate value between 0 and 1.
concentration: A three dimensional array, conc[nsite,ntracer,ntime] where nsite=247, ntracer=11 and ntime=8760 (8784 for leap year). The tracers should be ordered as in Table 1 above. The concentrations should be hourly, instantaneous values starting at 01:00Z on 1 January and ending at 24:00Z 31 December of each year. If possible try to sample the model output at the „end" of the timestep, that is after mixing and chemistry have affected the emissions or boundary condition forcing. The units for all tracers should be volume mixing ratio (no conversion to ppb, ppt, etc.).
time: hours since 1-1-1988

Hourly output at 119 selected sites: profiles

Filename	profiles.your_model.your_institution.year.nc (e.g. profiles.ACTM.RIGC.yyyy.nc)
Input file	site.list.profile (contains the information of the [nsite=119] stations
Datasets	latitude[nsite],longitude[nsite],land[nsite], lev[nsite,nlev]
Datasets (cont)	tracer_name[ntracer], conc[nsite,ntracer,nlev,ntime], time[ntime]

longitude: One value per site. Give the longitude of the model grid point that you sampled for this site or the real longitude if you interpolated between grid points.
latitude: One value per site. Give the latitude of the model grid point that you sampled for this site or the real latitude if you interpolated between grid points.
land: One value per site. Give the surface type of the sampled grid point using 0 for ocean and 1 for land. If you model has fractional land then give the appropriate value between 0 and 1.
lev: the pressure of the mid-model levels over all stations. Use initial, final, or average pressures. Unit: Pa. "nlev" will depend on the model.
concentration: A four dimensional array, conc[nsite,ntracer,nlev, ntime] where nsite=119, ntracer=11 and ntime=8760 (8784 for leap year). The tracers should be ordered as in Table 1 above. The concentrations should be hourly, instantaneous values starting at 01:00Z on 1 January and ending at 24:00Z 31 December of each year. If possible try to sample the model output at the „end" of the timestep, that is after mixing and chemistry have affected the emissions or boundary condition forcing. The units for all tracers should be volume mixing ratio (no conversion to ppb, ppt, etc.).
time: hours since 1-1-1988

Meteorological output at 119 selected sites

Filename	met.your_model.your_institution.year.nc (one file per year)
Input file	site.list.profile (contains the information of the [nsite=119] stations
Datasets	latitude[nsite],longitude[nsite],land[nsite], lev[nsite,nlev]
Datasets (cont)	u[nsite,nlev,ntime], v[nsite,nlev,ntime], height[nsite, nlev, ntime], ps[nsite, ntime] blh[nsite, ntime], time[ntime]

longitude: One value per site. Give the longitude of the model grid point that you sampled for this site or the real longitude if you interpolated between grid points.
latitude: One value per site. Give the latitude of the model grid point that you sampled for this site or the real latitude if you interpolated between grid points.

land: One value per site. Give the surface type of the sampled grid point using 0 for ocean and 1 for land. If you model has fractional land then give the appropriate value between 0 and 1.
lev: the pressure of the mid-model levels over all stations. Use initial, final, or average pressures. Unit: Pa. “nlev" will depend on the model.
u: the eastward component of the wind vector in $m.s^{-1}$. Use the value at mid-model levels over all stations.
v: the northward component of the wind vector in $m.s^{-1}$. Use the value at mid-model levels over all stations.
height: the height above the surface in m. Use the value at mid-model levels over all stations.
ps: the surface pressure in Pa. Give one value per station and time step.
blh: the height of the boundary layer in m. Use one value per station and time step.
time: hours since 1-1-1988

Input and Submission

We created and ftp-site for submission of the output. Also, input files and a pdf version of this protocol can be found there.

sftp g_beta0010@ftp.science.uu.nl
password: <upon request>
cd /storage/age-of-air/input

README_Age-of-air.txt: find information about the files, and grids.

RN222_flux_old.hdf : the Radon flux in kg 222RN / 1x1box / s of the Transcom CH4 experiment
RN222_flux_<yyyy>.nc : the new Radon flux at monthly resolution in kg 222RN / 1x1box / s
SF6_flux_<yyyy>.nc: SF6 fluxes at monthly resolution in kg SF6 / 1x1box / s

SF6_init1988_<resol>_<resol>.nc: initial mixing ratios of SF6 in 1988
SF6_init2000_<resol>_<resol>.nc: initial mixing ratios of SF6 in 2000

site.list.all: coordinates of 247 output locations
site.list.profile: coordinates of 119 profile output locations

age-of-air.pdf: this document

Ssh
To submit your results: create a directory and upload your results!

Deadline: 1-1-2016

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