Summary of the tracers in the GMI "tracer" mechanism:

Species number: Species name:

1. Age:

Used for looking at residual circulation and mixing.

Tracer emitted for first 30 days from 10N to 10S, surface to 800 hPa - set to 1.0. After 30 days the source region becomes a sink region - set to 0.0.

Issue: No inter-hemispheric asymmetry (in the UT/LMS as you would expect for 'observed' age calculated from CO2 or SF6)..

2. e90: (from Prather et al., JGR, 2011)

Used for looking at the location of the tropopause.

e90 emitted at the surface such that the global burden is 100ppbv. e90 loss is 90 day e-fold time.

3. tm25 (from POLMIP)

Used for looking at stratospheric influence on the troposphere.

Tracer is fixed in the "stratosphere" to 200ppbv.

Tropopause determined by function: P = 230-148*(cos(lat))**4 (units: hPa) => P_tropopause = 82 hPa at the equator and 230 hPa at the poles. tm25 destroyed with 25 day e-fold time in "troposphere".

4-6. Radon/Lead/Lead-stratosphere:

Used for looking at convection over land and strat-trop exchange.

Radon emitted over land (1 atoms/cm^2/s), limited by temperature (below 273K drops emission to 0.333 atoms/cm^2/s), snow/ice cover (0 atoms/cm^2/s) and limited poleward of 60 (0.005 atoms/cm^2/s) and eliminated poleward of 70.

Radon emitted over ocean (0.005 atoms/cm^2/s), except poleward of 70, where there are no emissions.

Radon decayed to lead with an e-fold time of 5.5 days to Lead. Lead decayed with an e-fold time of 11742.8 days. Lead settled and washed out as aerosol.

7-10. Beryllium 7/10 and Beryllium 7/10-stratosphere:

Used for looking at strat-trop exchange.

Tracers emitted according to a function that depends on latitude and pressure (Koch table). Beryllium 7 decayed to boron (not carried) with an e-fold time of 53.3 days. Beryllium 10 decayed to boron (not

carried) with an e-fold time of 5.84d8 days. Beryllium 7 and 10 settled and washed out as aerosols. Some parts from Hongyu Liu, NASA LaRC.

11. CH3I:

Used for looking at marine convection.

Tracer emitted over oceans (1 molecule/cm^2/s). Decayed with an e-fold time of 5 days.

12 . fCO2:

Used for looking at inter-hemispheric transport and strat-trop exchange.

Emitted at the surface according to Prather's data. Issue: Needs to be revisited because of gridding of emissions.

13. Linoz:

Used for looking at strat-trop exchange

Uses Prather's linearized ozone parameter file which contains monthly, zonally averaged: Ozone climatology, Temperature climatology, Column Ozone climatology, Ozone Production - Loss climatology, d(Ozone Production - Loss)/d(Ozone) climatology, d(Ozone Production - Loss)/d(Temperature) climatology, and d(Ozone Production - Loss)/d(Column Ozone) climatology. This is used with the temperature and mass field and solar zenith angle to approximate ozone. These calculations are done between 0.2371374 hPa and 273.842 hPa. Linoz is relaxed (2 day) to surface climatological values (30 ppb) below 486.967 hPa and set to zero above 0.2371374 hPa. There is a parameterized PSC loss poleward of 40 degrees if there is sun and cold temperatures.

14. Synoz:

Used to look at strat-trop exchange and stratospheric ozone in the troposphere

Synthetic ozone emitted in the tropical lower stratosphere - from 30N to 30S and 10 to 70 hPa. Source flux of 550 Tg/yr. Synoz lost at the surface - relaxed to 2.5e-8 with 2 day time.

Issue: No gradients in lowermost stratosphere.

15. SF6:

Used for looking at inter-hemispheric transport of anthropogenic source gases.

Source emissions from Bryan Duncan - varies by year.

16. CLOCK:

Used for looking at residual circulation and mixing.

The model time step (in days) is added to every grid box every time step with a total sink at the surface every time step. Coding came from Eric Nielsen (GSFC) from the GEOS CCM.

17. Uniform

Used for looking at tropospheric mixing. A CO-like tracer (25 day lifetime) with a uniform surface emission (2400 Tg/yr).