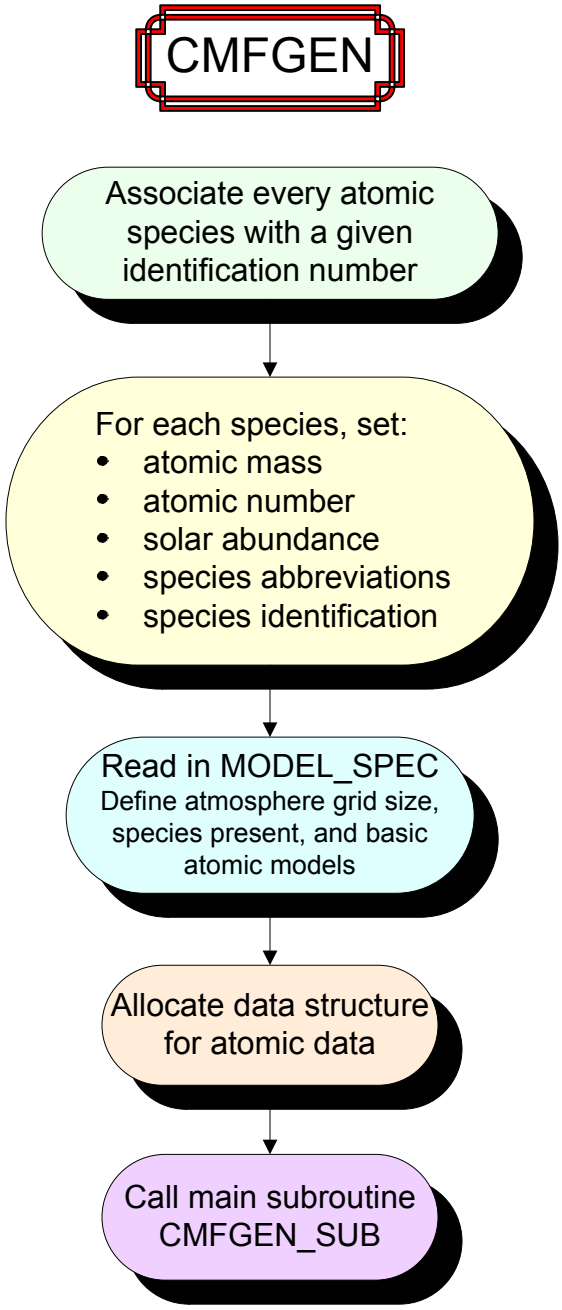
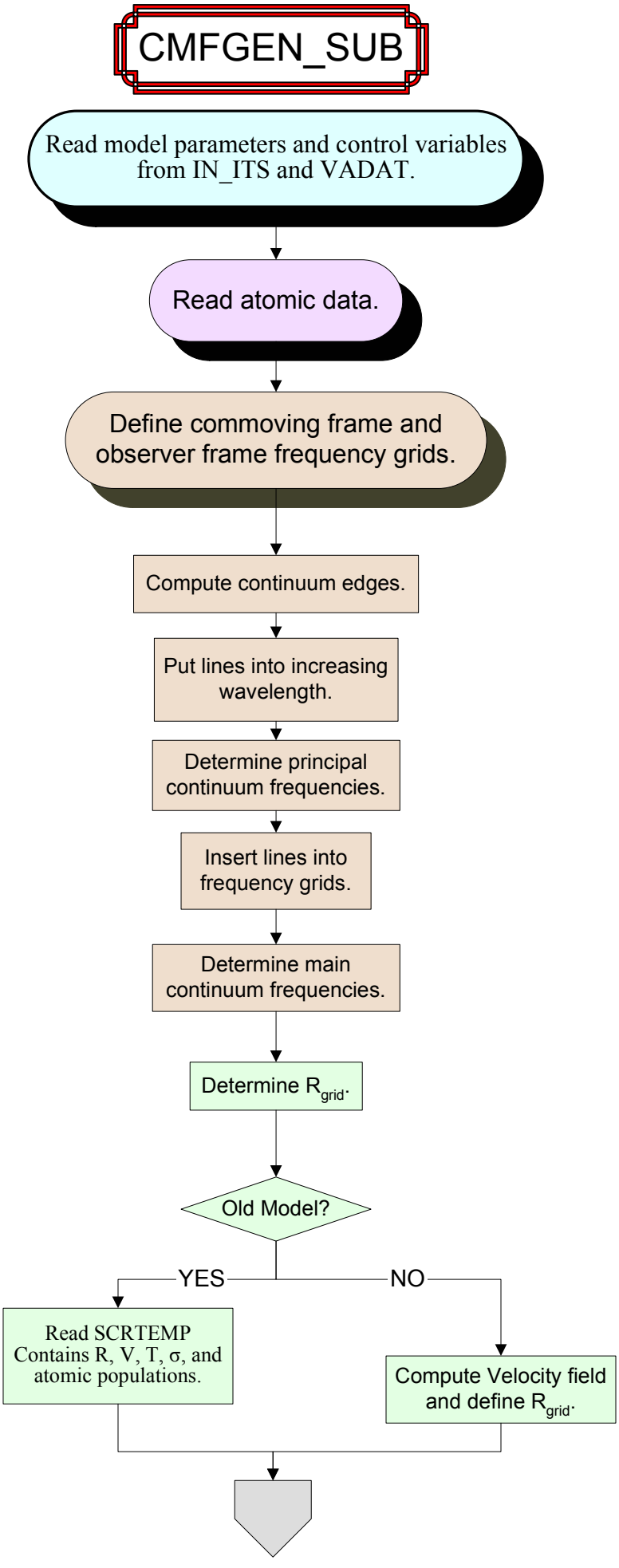
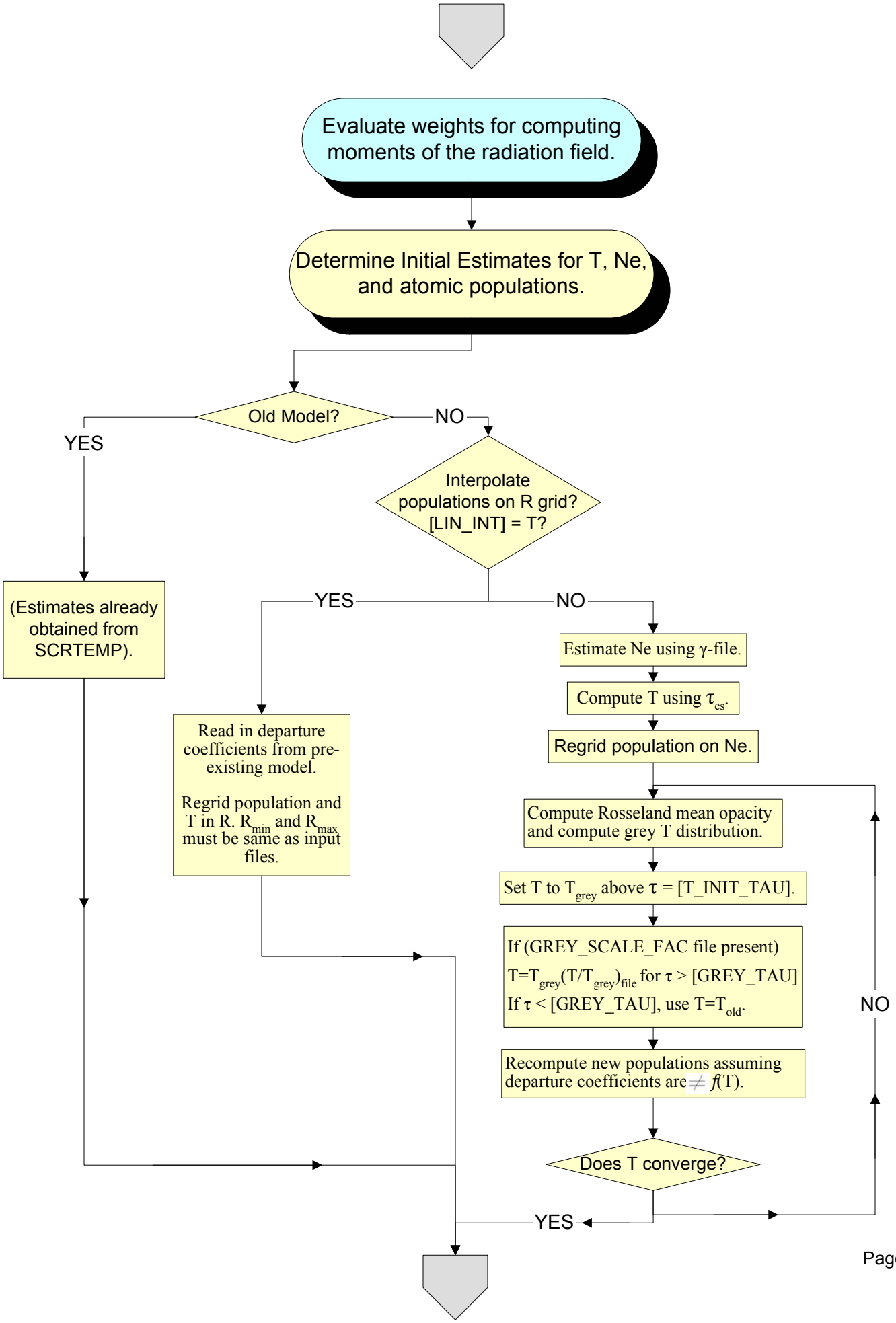
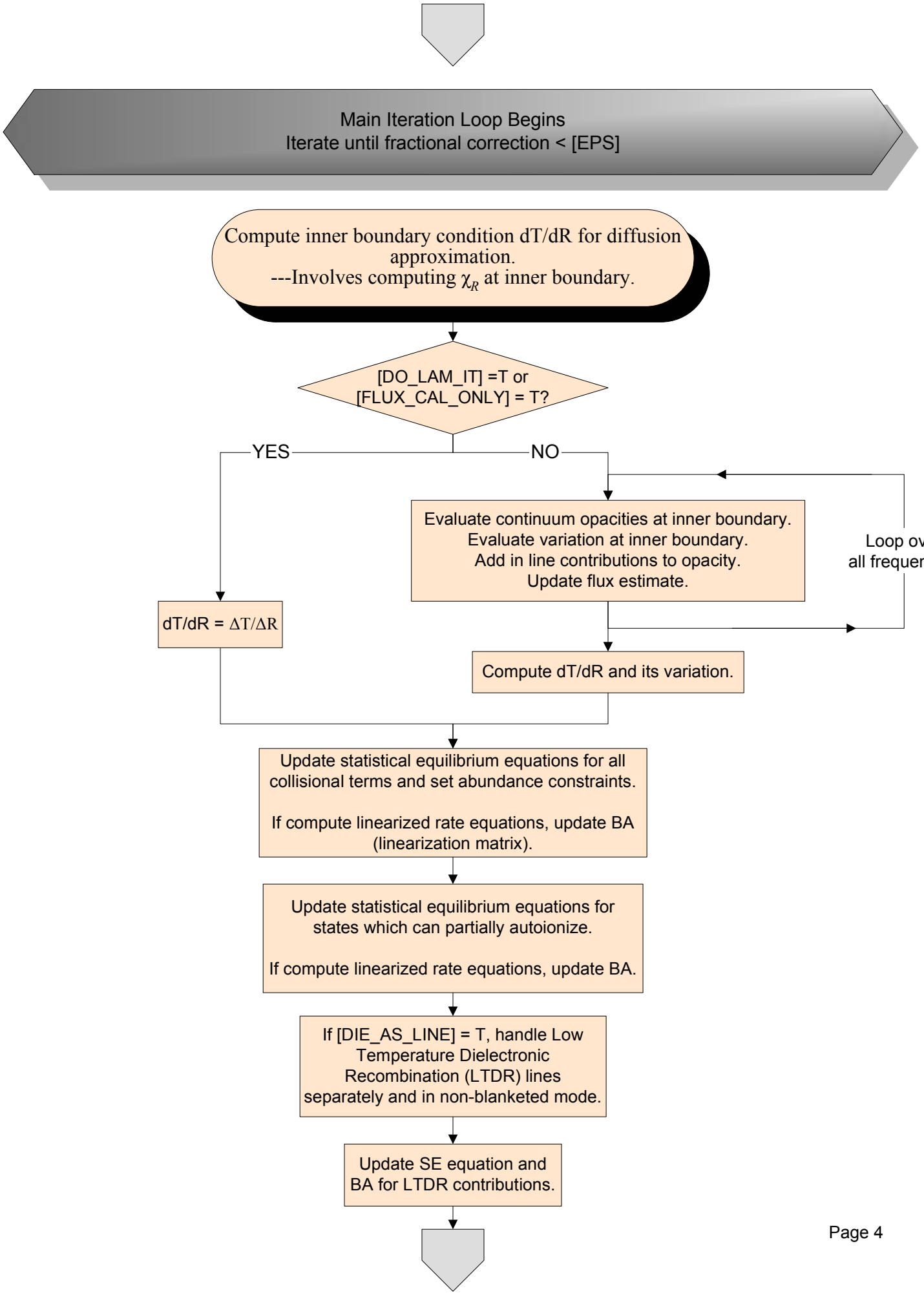
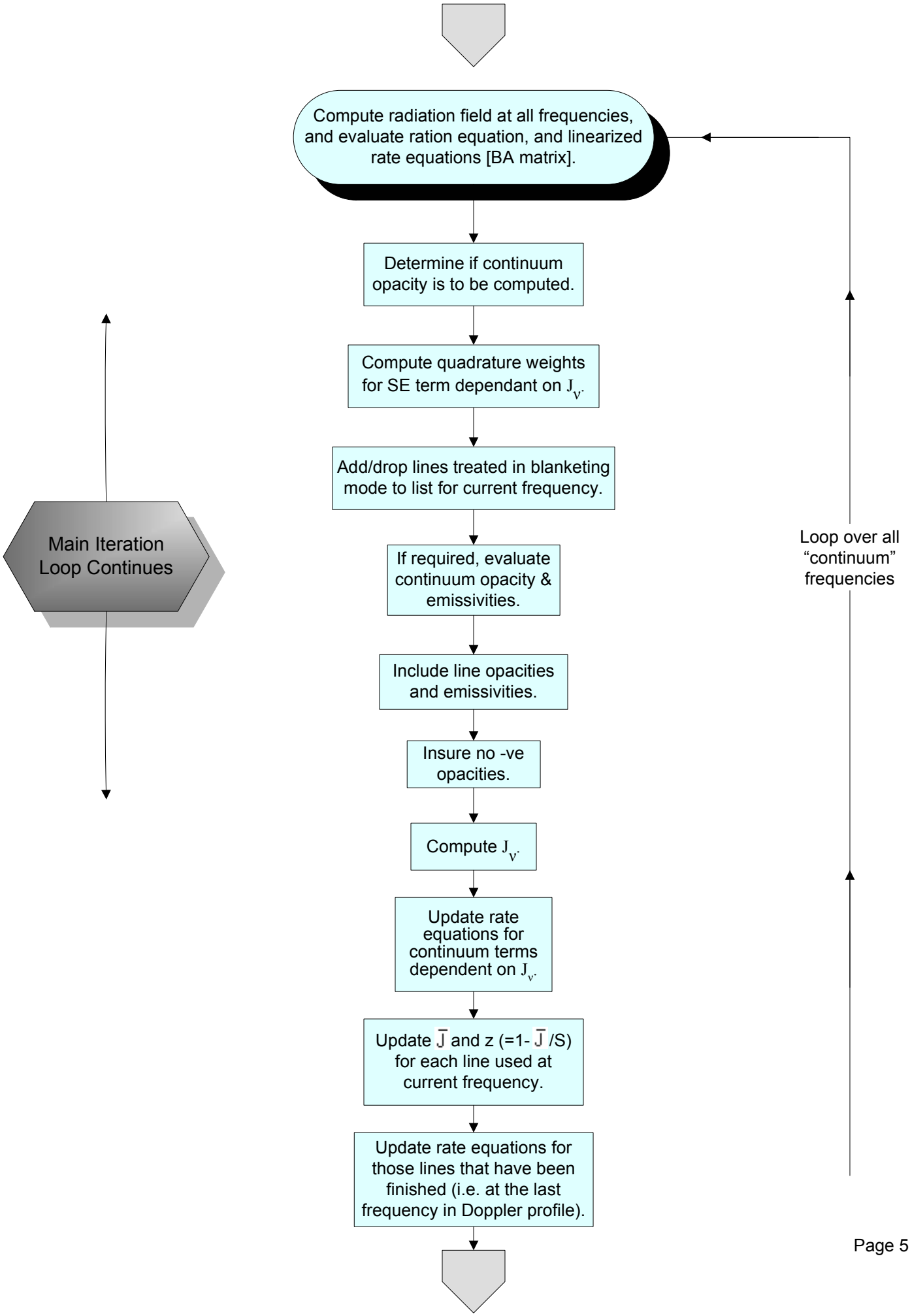
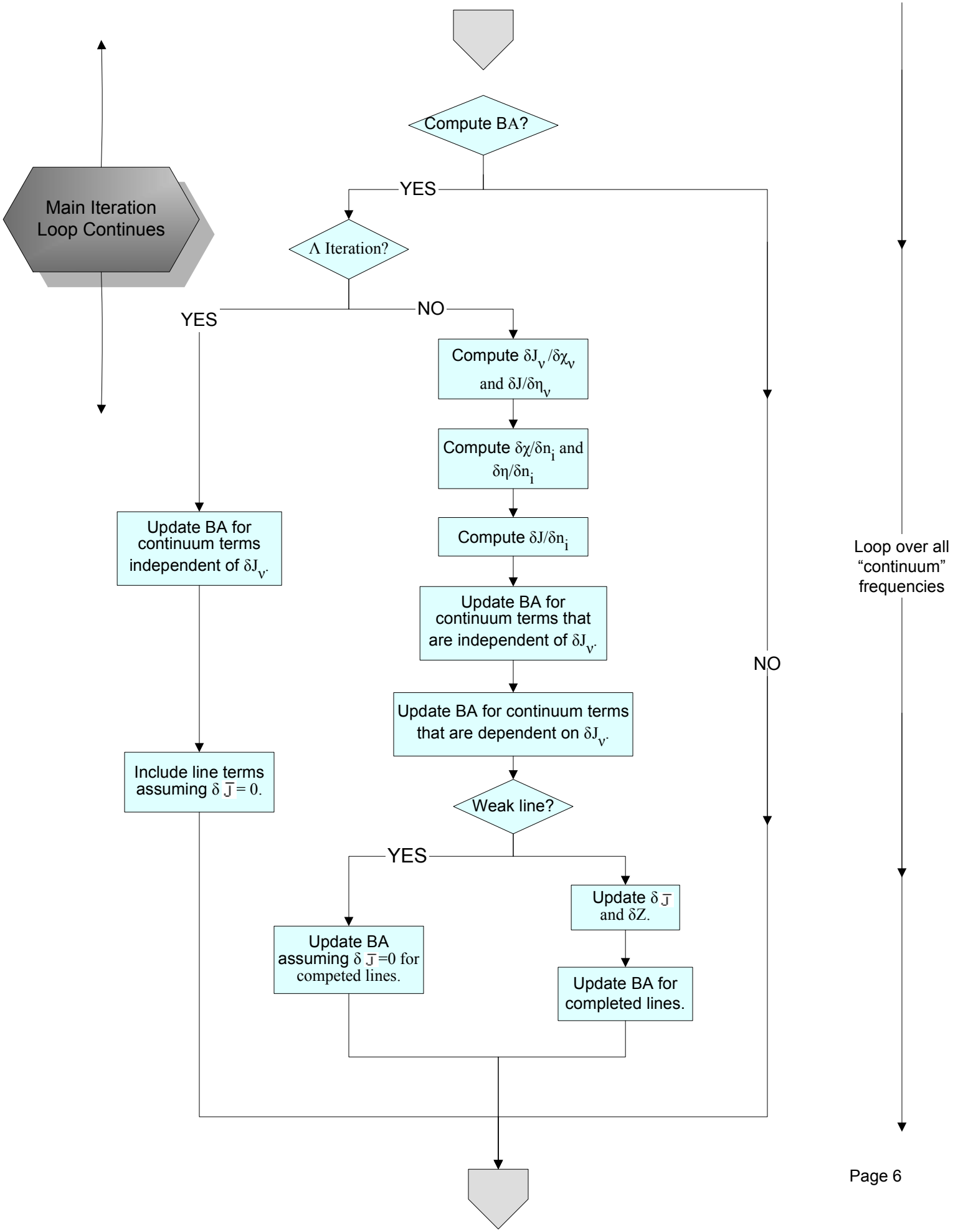

CMFGEN
Associate every atomic species with a given identification number
For each species, set:
• atomic mass
• atomic number
• solar abundance
• species abbreviations
• species identification
Read in MODEL_SPEC
Define atmosphere grid size, species present, and basic atomic models
Allocate data structure for atomic data
Call main subroutine CMFGEN_SUB

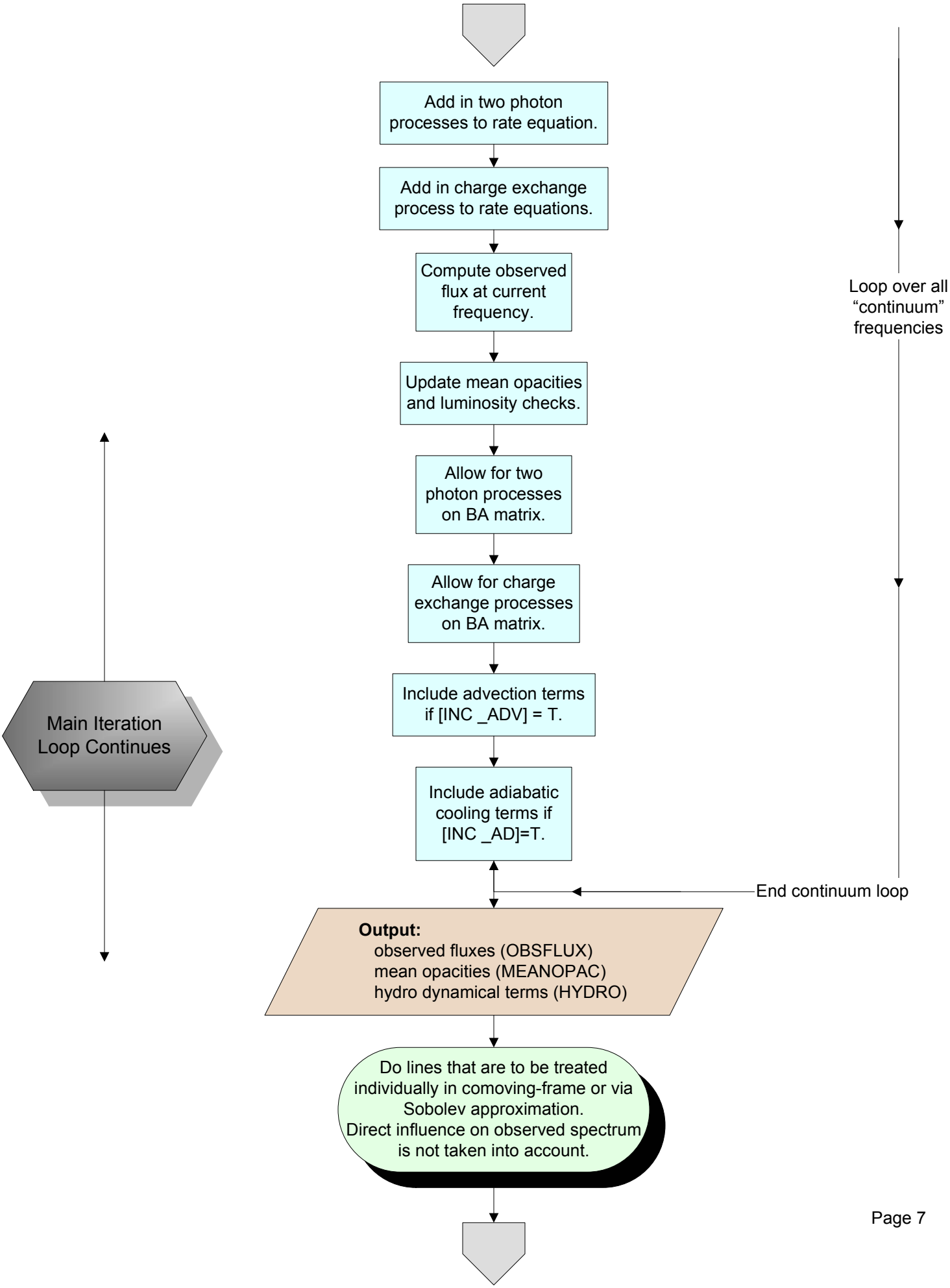

CMFGEN_SUB
Read model parameters and control variables from IN_ITS and VADAT.
Read atomic data.
Define commoving frame and observer frame frequency grids.
Compute continuum edges.
Put lines into increasing wavelength.
Determine principal continuum frequencies.
Insert lines into frequency grids.
Determine main continuum frequencies.
Determine R_{grid}.
Old Model?
YES
NO
Read SCRTEMP Contains R, V, T, σ, and atomic populations.
Compute Velocity field and define R_{grid}.

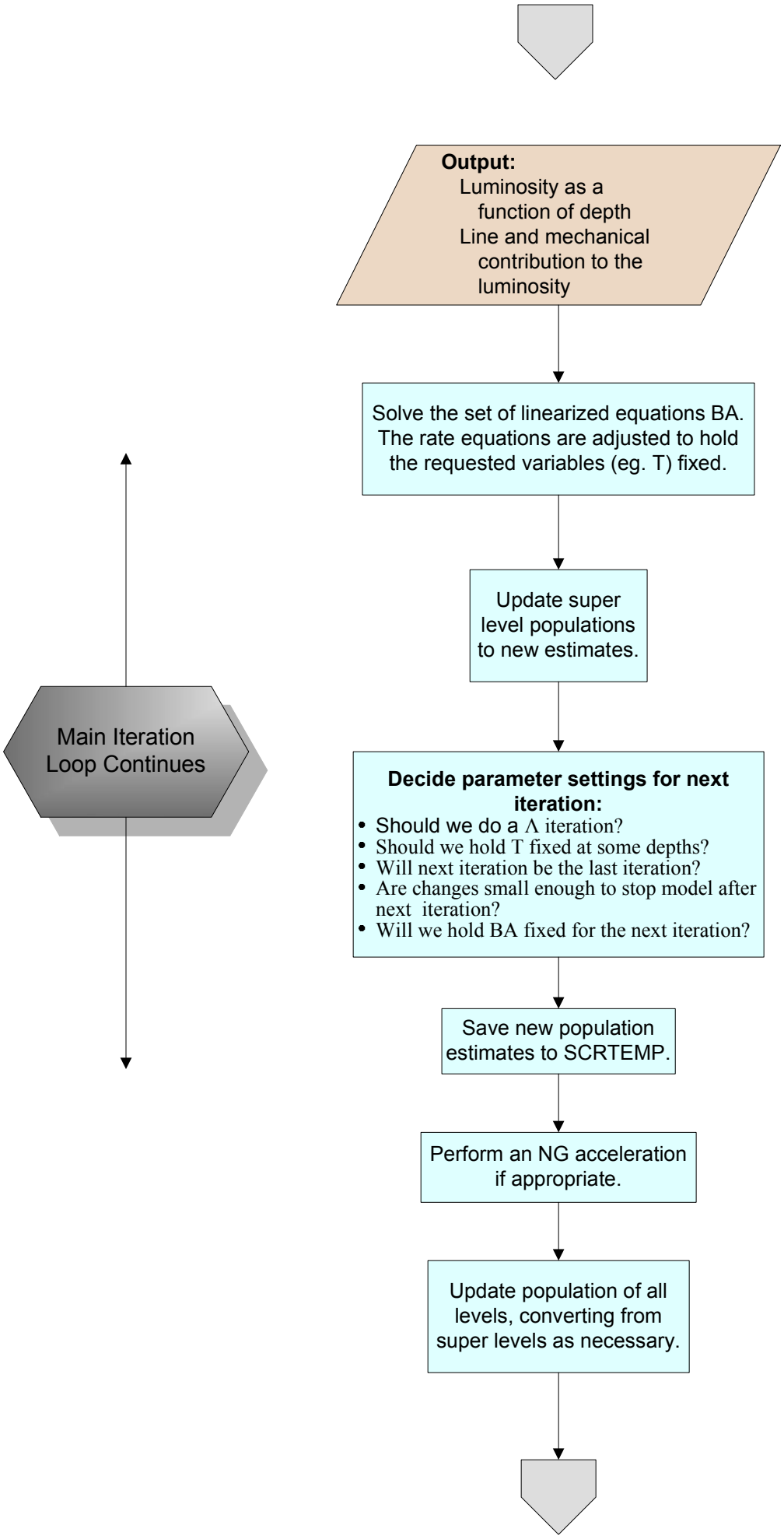

Evaluate weights for computing moments of the radiation field.
Determine Initial Estimates for T, Ne, and atomic populations.
Old Model?
YES
NO
(Estimates already obtained from SCRTEMP).
Interpolate populations on R grid? [LIN_INT] = T?
YES
NO
Read in departure coefficients from pre-existing model.
Regrid population and T in R. R_{min} and R_{max} must be same as input files.
Estimate Ne using γ-file.
Compute T using τ_{es}.
Regrid population on Ne.
Compute Rosseland mean opacity and compute grey T distribution.
Set T to T_{grey} above τ = [T_INIT_TAU].
If (GREY_SCALE_FAC file present)
$T=T_{grey}(T/T_{grey})_{file}$ for τ > [GREY_TAU]
If τ < [GREY_TAU], use $T=T_{old}$.
Recompute new populations assuming departure coefficients are $\neq f(T)$.
Does T converge?
NO
YES

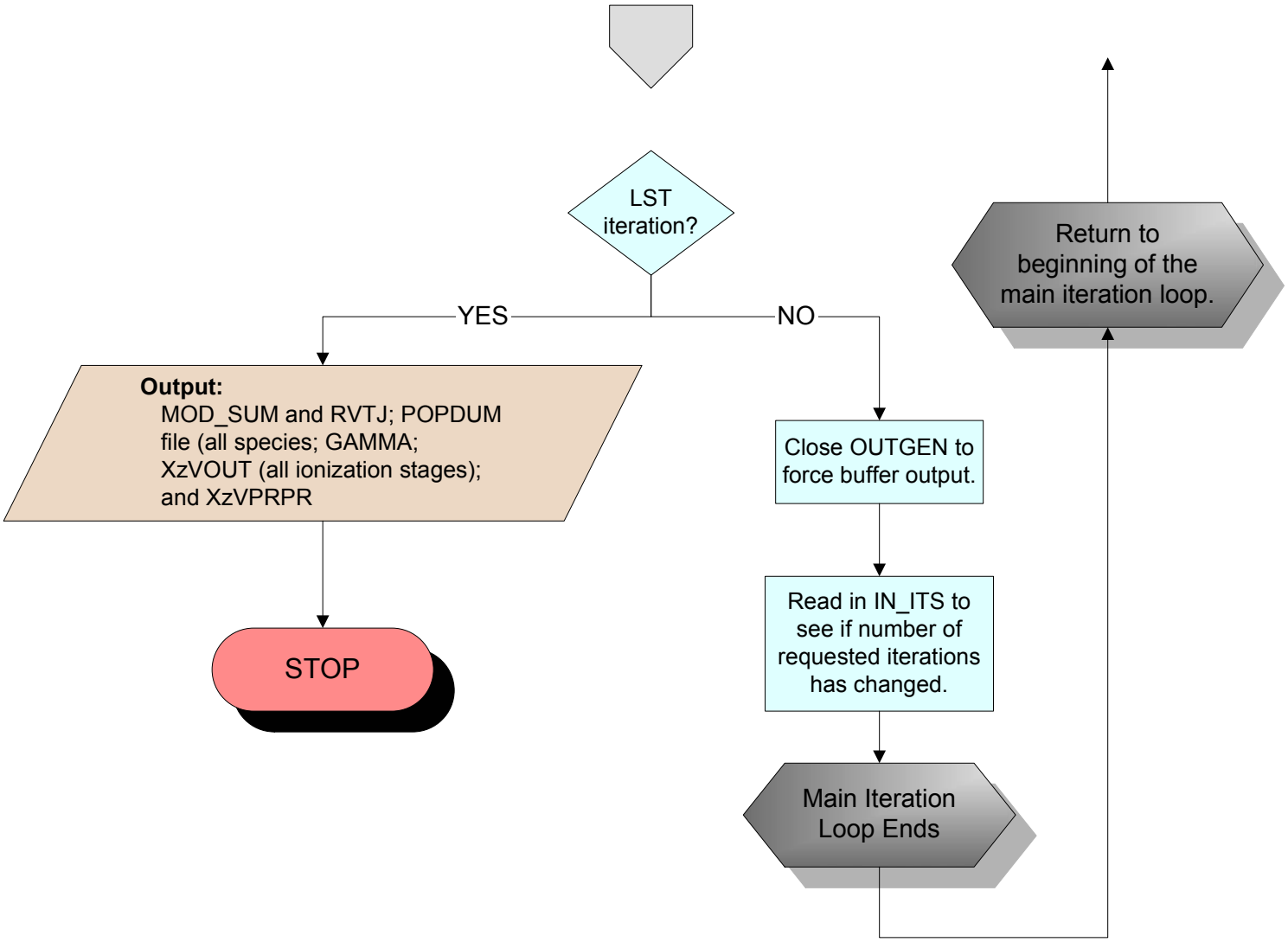

Main Iteration Loop Begins
Iterate until fractional correction < [EPS]
Compute inner boundary condition dT/dR for diffusion approximation.
---Involves computing χ_R at inner boundary.
[DO_LAM_IT] =T or [FLUX_CAL_ONLY] = T?
YES
NO
Evaluate continuum opacities at inner boundary.
Evaluate variation at inner boundary.
Add in line contributions to opacity.
Update flux estimate.
Loop over all frequencies
dT/dR = ΔT/ΔR
Compute dT/dR and its variation.
Update statistical equilibrium equations for all collisional terms and set abundance constraints.
If compute linearized rate equations, update BA (linearization matrix).
Update statistical equilibrium equations for states which can partially autoionize.
If compute linearized rate equations, update BA.
If [DIE_AS_LINE] = T, handle Low Temperature Dielectronic Recombination (LTDR) lines separately and in non-blanketed mode.
Update SE equation and BA for LTDR contributions.


Compute radiation field at all frequencies, and evaluate ration equation, and linearized rate equations [BA matrix].
Determine if continuum opacity is to be computed.
Compute quadrature weights for SE term dependant on J_ν.
Add/drop lines treated in blanketing mode to list for current frequency.
If required, evaluate continuum opacity & emissivities.
Include line opacities and emissivities.
Insure no -ve opacities.
Compute J_ν.
Update rate equations for continuum terms dependent on J_ν.
Update $\bar{J}$ and z (=1- $\bar{J}$ /S) for each line used at current frequency.
Update rate equations for those lines that have been finished (i.e. at the last frequency in Doppler profile).
Loop over all "continuum" frequencies
Main Iteration Loop Continues


Main Iteration Loop Continues
Compute BA?
YES
NO
Λ Iteration?
YES
NO
Compute $\delta J_\nu/\delta\chi_\nu$ and $\delta J/\delta\eta_\nu$
Compute $\delta\chi/\delta n_i$ and $\delta\eta/\delta n_i$
Compute $\delta J/\delta n_i$
Update BA for continuum terms that are independent of δJ_ν.
Update BA for continuum terms that are dependent on δJ_ν.
Update BA for continuum terms independent of δJ_ν.
Include line terms assuming $\delta\bar{J}=0$.
Weak line?
YES
NO
Update BA assuming $\delta\bar{J}=0$ for competed lines.
Update $\delta\bar{J}$ and δZ.
Update BA for completed lines.
Loop over all "continuum" frequencies


Add in two photon processes to rate equation.
Add in charge exchange process to rate equations.
Compute observed flux at current frequency.
Update mean opacities and luminosity checks.
Allow for two photon processes on BA matrix.
Allow for charge exchange processes on BA matrix.
Include advection terms if [INC _ADV] = T.
Include adiabatic cooling terms if [INC _AD]=T.
Loop over all "continuum" frequencies
End continuum loop
Main Iteration Loop Continues
Output:
observed fluxes (OBSFLUX)
mean opacities (MEANOPAC)
hydro dynamical terms (HYDRO)
Do lines that are to be treated individually in comoving-frame or via Sobolev approximation.
Direct influence on observed spectrum is not taken into account.


Output:
Luminosity as a function of depth
Line and mechanical contribution to the luminosity
Solve the set of linearized equations BA. The rate equations are adjusted to hold the requested variables (eg. T) fixed.
Update super level populations to new estimates.
Main Iteration Loop Continues
Decide parameter settings for next iteration:
• Should we do a Λ iteration?
• Should we hold T fixed at some depths?
• Will next iteration be the last iteration?
• Are changes small enough to stop model after next iteration?
• Will we hold BA fixed for the next iteration?
Save new population estimates to SCRTEMP.
Perform an NG acceleration if appropriate.
Update population of all levels, converting from super levels as necessary.


LST iteration?
YES
NO
Output:
MOD_SUM and RVTJ; POPDUM file (all species; GAMMA; XzVOUT (all ionization stages); and XzVPRPR
STOP
Close OUTGEN to force buffer output.
Read in IN_ITS to see if number of requested iterations has changed.
Main Iteration Loop Ends
Return to beginning of the main iteration loop.