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**SIMSPHERE MODULE – FORMERLY MAIN.FOR**

(CONTROL MODULE FOR SIMSPHERE FOLLOWS SEQUENCE OF SUBROUTINES)

**INITIALIZATIONS**

**INCLUDE MODVARS** (Common statement, contains declarations; also calls slope routine)

**CALL SLOPE:** Called from **MODVARS**; Calculates slope and azimuth of surface from corner points and corresponding solar angles for tilted terrain)

(THE FOLLOWING SIX CALL STATEMENTS APPLIED ONLY ONCE)

**CALL START** (Start reads the values of various input parameters to get the model started)

**CALL SNDING** (**SNDING** reads in the sounding file.) SEE DETAILS BELOW

**CALL CALC** (Some basic calculations)

**CALL PRFILE** (Set a Geostrophic wind at the surface.) SEE DETAILS BELOW

**CALL GETTBL** (Is the lookup table for subroutine TRANSM which calculates transmission functions for solar radiation) FOR DETAILS SEE BELOW

**CALL PSOIL** (Set up for the soil) SEE DETAILS PAGE 3. SEE DETAILS below)

**\*\*5 CONTINUE (LOOP BACK HERE EVERY 180 SECONDS)\*\*\*CALL SUBROUTINES IN SEQUENCE EACH TIME STEP**

**CALL NETRAD** (net radiation) DETAILS below)

**CALL VEL** (Resistance values in the Transition and Surface Layers. Entry to nighttime formulations (BRI & MOM) through this subroutine)

**CAL AIR** (DAYTIME ONLY - air computes the daytime height of the mixing layer and the potential temperature at height ***ZA***.)

**CALL DAYKM** (DAYTIME ONLY - Computes eddy diffusivities as a function of height, friction

in the atmosphere as a function of height,, friction velocity, and Monin Obukhov length for all the relevant levels in the mixing layer at each time step during the day; using the method of O'Brien. Used in MOMDAY)

. **CONTINUE MAIN PROGRAM BELOW**

SIMSPHERE MODEL; CONTINUE MAIN PROGRAM

**CALL MOMDAY** (DAYTIME ONLY – Computes momentum equations in mixed layer)

**CALL FLUX** (Evaporative flux; surface temperature calculated)

**CALL HOT**  (DAYTIME ONLY - surface temperatures, surface heat fluxes)

 **END ATMOSPHERIC CALCULATIONS**

**CALL BELOW (**Below is called every time step (N+1) to update the sub-surface temp's. )

**CALL OUTPUT** (writes out quantities generated in Simsphere, usually half hour intervals)

 **TIME UPDATEDE EVERY 3 SECONDS**

**IF TIME HAS NOT REACHED SPECIFIED END TIME, GO BACK TO**

**\*\*\* 5 CONTINUE STATEMENT ABOVE\*\*\***

**END MAIN PROGRAM**

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**SUBROUTINE SNDING**

**Continued from MAIN**

**CONSTRUCTS A SOUNDING (TEMPERATURE, SPECIFIC HUMIDITY, WIND VELOCITY)**

**CALL SPLINE (CREATE EQUALLLY SPACED LEVELS)**

**SUBROUTINE PSOIL**

**Continued from MAIN**

Calculates ***LAMBDA***, ***KAPPA*** & Volumetric ***HEAT*** Capacity of the ground (***CG***). See manual for explanation of Lamda & ***KAPPA***.The Thermal Inertia (***TP***) is entered in TI (Wm-2K-1) units Convert to cgs to be able to useregression equation derived from Sellers.

**SUBROUTINE GETTBL**

**Continued from MAIN**

This subroutine takes the precipitable water content (***OMEGA***) and calc's the transmission coefficient for absorption using a lookup table. Interpolate linearly on ***OMEGA***. The lookup table contains-entry tables for ***OMEGA*** from 0 to 5 in increments of 0.5. Note that the maximum value allowed for ***OMEGA*** is 5.0.\*/ The subroutine also copies the scattering (***SCATBL***) and the backscattering (***BSCTBL***) ables from file into the common block.

**SUBROUTINE PRFILE**

**Continued from MAIN**

This routine generates the daytime and night-time vertical wind/ profiles of the geostrophic wind components at intervals of 250m from 50 m (top of sfc layer), from the surface geostrophic winds.

calculated in 3 different ways; specified by user.

**CALL INTPOL** interpolation model

**CALL ADVECT** This subroutine calculates the geostrophic temperature advection based on the thermal wind equation and the vertical distribution of geostrophic wind. Called once

**C**

**BEGIN SEQUENCE OF SUBROUTINES EACH TIME STEP**

**CALL NETRAD**

**Continued from MAIN**

Computes up and down longwave fluxes and the Net Radiation for the appropriate ground conditions. Calculates the effective emissivity of the air and longwave down using a weighted average of surface and air temperature.

**CALL INPUT** (computes solar radiation as a function of the day, season, atmospheric attenuation, and albedo. DETAILS OF INPUT JUST BELOW)

**CALL LWDOWN (**calculates downward long wave radiation)

**CALL UPLONG**  (calculates upward long wave radiation)

**CALL VEGRAD** (Calculates incident solar flux at top of the plant canopy (***SOL***))

**SUBROUTINE INPUT**

**Continued from NETRAD**

**CALL TRANSM**  (calculates solar transmission by using the three-way lookup table produced in **GETTBL.** DETAILS OF TRANSM JUST BELOW)

 **SUBROUTINE TRANSM**

 **Continued from INPUT**

This subroutine takes the precipitable water content (***OMEGA***) and calc's the transmission coefficient for absorbtion using a lookup table. Interpolate linearly on ***OMEGA***. The lookup table contains 46-entry tables for ***OMEGA*** from 0 to 5 in increments of 0.5.

Note that the maximum value allowed for ***OMEGA*** is 5.0. Inote vegvel called too

The subroutine also copies the scattering (***SCATBL***) and the backscattering (***BSCTBL***) tables from file into the common block.

**END OF SUBROUTINES CALLED FROM NETRAD**

**VEL**

**Called from MAIN**

Computes the Monin Obukhov Length, the Friction

Velocity and the Integral of ***HEAT*** Diffusivity).

**CALL BRI (Nighttime regime)**

**CALL VEGVEL**  (Daytime only)

**BRI**

**Continued from VEL**

BRI computes the M-O-L when BRI is (+) and when Richardson Number is less than

2 it uses the Blackadar model.

**CALL MOM**

**VEGVEL**

**Called from VEL**

**CALL PSLCAL** (Vegetation model; computes water potentials, stomatal resistances)

**PSLCAL**

**Called from VEGVEL**

Module ties leaf, stem. Soil hydraulic potentials and leaf hydraulic potentials to the stomatal resistances through one equation modulated by the critical leaf water potential and the other root, stem and leaf resistance including the minimum stomatal resistance ***RMIN.***

**CALL STOMFS (**The exponential function for solar radiation -- Albert Olioso)

**CALL COND** Deardorf stomatal resistance model, adapted by Odile Taconet

**CALL STOMC** (Calculates the critical stomatal resistance for critical ground water potential)

**CALL CAPAC** (Capacitance mode)

**CALL STOMRS** (Calculates stomatal resistance coefficients in stomc.for\*\*)

\*\*Note: stomc erroneously referred to as stomcof in program comment



**MOM**

**Continued from VEL**

**Called only at night**

MOM calculates the momentum and thermodynamic eqs. in the lowest 500m of the atmosphere and produces profiles of the ***U*** & ***V*** components, humidity and temperature at 50m intervals to couple surface and mixing layers.

**END SUBROUTINES CALLED FROM VEL**

**AIR**

**Called from MAIN**

**Operates only during the daytime**

air computes the daytime height of the mixing layer and the potential temperature at height ***ZA***.

 **DAYKM**

**Called from MAIN**

Computes eddy diffusivities as a function of height, friction velocity and Monin Obukhov length for all the relevant levels in the mixing layer at each time step during the day using the method of O'Brien. Used in MOMDAY.

**MOMDAY**

**Called from MAIN**

Daytime only routine updates the daytime winds ***UD***, ***VD*** and specific humidity ***QD*** using the eddy diff's obtained in DAYKM, assuming similarity between humidity and momentum transfer coefficients. Note that the time step is 120 sec ..this ensures computational stability during periods when ***KM*** values are large.

**CALL FINE** Interpolates part of sounding to a finer vertical resolution

**FLUX**

**Called from MAIN**

During the day FLUX calc's surface temp and surface specific humidity from temp and humidity at ***ZA*** and the sensible & latent ***HEAT*** fluxes. It also computes the updated value of the evaporative flux. During the night it calls GTEMP to calc the temp in the absence of turbulence.

**CALL AVERAGE (called AVR)** (small smoother function)

**CALL VEGFLX** computes soil temperature, interplant veg temperature and humidity, and heat and moisture fluxes for vegetation fraction.

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**VEGHOT**

**Called from HOT**

**CALL CO2FLX Calculates carbon dioxide flux and deposition at soil and plant**

**CALL OZONE**  Calculates ozone flux to soil and canopy

**HOT**

**Called from MAIN**

Subroutine called during the day to compute the sensible ***HEAT*** flux ***HEAT*** from net radiation and the evaporation.

**CALL VEGHOT** Computes various fluxes, temperatures within plant canopy; see FLUX

**CO2FLX**

**Called from VEGHOT**

Calculates carbo dioxide flux to the canopy and to the soil, given the internal leaf and external CO2 concentrations

**OZONE**

**Called from VEGHOT**

Calculates ozone fluxes to plant and soil given external ozone concentration

**END SEQUENCE OF CALLS FROM HOT.FOR**

**BELOW**

**Called from MAIN**

(Substrate temperatures The lowest level has a constant temp ***BTEMP***, whereas the the surface temp has been found previously in FLUX. Use of the leap-frog method computes sub-surface temp's at the next time from those at the current and the previous time step. BELOW. Also calls WATER to update the sub-surface soil moisture status.)

**CALL WATER**

 **WATER**

**Called from BELOW**

Subroutne is based on the technique of Deardroff (1978). It uses the Deardoerff evaporative flux value obtained in FLUX and updates two internal variables ***WGG*** and ***W2G***, which represent the soil moisture content of the soil close to the surface and in the first 50 cm of soil, respectively. The empirical constants can be found in the article.

**END SEQUENCE OF CALLS FROM BELOW**

 **(Return to cycle in MAIN at \*\*\*5 CONTINUE STATEMENT UNTIL END OF SPECIFIED TERMINATION TIME)/**