**Definitions of parameters and variables in UEBGrid snow and glacier melting model**

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This document provides a list of parameters and variables used in UEBGrid.

**Param.dat**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Code | Short name | Long name | Definition | Units | Suggested value | Information source or value for HIMALA work |
| irad | irad | Radiation control flag | This is an integer value that controls how the program calculates radiation. Values of 0, 1, 2 or 3 are valid and should be used as follows.  0: No radiation inputs are used. The model calculates radiation based on air temperature diurnal range.  1: Shortwave radiation is input.  2: Both longwave and shortwave radiation data is input.  3: Net radiation is input. |  | 0, 1, 2 depending on data available. 3 is not recommended as it circumvents the sensitivity of outgoing radiation to modeled surface temperature (and has undergone limited testing) | 2 |
| ireadalb | ireadalb | Albedo reading control flag | This is an integer that controls whether snow surface albedo is to be input or computed internally. Values of 0 or 1 are valid and should be used as follows:  0: Model computes albedo.  1: Albedo is input. |  | 0 | 0 |
| tr | tr | Rain threshold temperature | Temperature above which all precipitation occurs in form of rain | ˚C | 3 | 3 |
| ts | ts | Snow threshold temperature | Temperature below which all precipitation occurs in form of snow | ˚C | -1 | -1 |
| ems | ems | Emissivity of snow | Snow emissivity quantifies the emission of longwave radiation energy from the snow surface relative to black body radiation. |  | 0.99 | 0.99 |
| cg | cg | Ground heat capacity | Ground heat capacity is the amount of heat required to change one kilogram of ground beneath the snow by 1˚ C. This applies to ground in the thermally interacting layer beneath the snow. | KJ/kg/˚C | 2.09 | 2.09 |
| z | z | Air measurement height | This is the height above the top of the canopy where air temperature, humidity and wind speed were measured or assumed to be effective. If no canopy, z is height above the ground or snow surface. | m | 2 | 2 |
| zo | zo | Roughness length | Surface aerodynamic roughness length in logarithmic boundary layer wind profile | m | 0.010 | 0.010 |
| rho | rho | Snow density | Density of snow is its mass per unit volume. | kg/m3 | 450 | 450 |
| rhog | rhog | Soil density | Density of soil is its mass per unit volume. | kg/m3 | 1700 | 1700 |
| lc | lc | Liquid holding capacity | The liquid retention capacity of the snowpack as a fraction of snow in ice (solid) phase. This quantifies the amount of liquid water that the snow can hold by capillary forces that has to be filled prior to melt outflow from the base of the snowpack. |  | 0.05 | 0.05 |
| Ks | Ks | Snow saturated hydraulic conductivity | Hydraulic conductivity parameter used in computing snow melt outflow as function of liquid relative saturation in excess of liquid holding capacity | m/hr | 20 | 20 |
| de | de | Thermally active soil depth | The depth of substrate (ground/ice) beneath the modeled snow layer included in energy conservation calculations. This substrate depth is assumed to interact thermally and have the same average temperature as the snowpack. | m | 0.1 | 0.1 |
| avo | avo | Visual new snow albedo | The fraction of the visual part of shortwave radiation (380nm-750nm) reflected by a new snow surface. |  | 0.95 | 0.95 |
| anir0 | anir0 | NIR new snow albedo | The fraction of the near infrared radiation (NIR) part of solar radiation (800 nm to 2500 nm) reflected by a new snow surface. |  | 0.65 | 0.65 |
| lans | lans | Thermal conductivity of surface snow | Parameter that quantifies the rate of conduction of energy into the snow as a function of the temperature gradient. | kJ m-1C-1 hr-1 | 1.0 | 1.0 |
| lang | lang | Thermal conductivity of soil | Parameter that quantifies the rate of conduction of energy into the substrate as a function of the temperature gradient. | kJ m-1C-1 hr-1 | 4.0 | 4.0 |
| wlf | wlf | Low frequency surface temperature parameter | Frequency of slow time scale air temperature fluctuation used in modeling surface temperature. (0.0654 = 2 π rad/96 hr for 4 day cycles). This is intended to quantify time scales longer than a day. | rad hr-1 | 0.0654 | 0.0654 |
| rd1 | rd1 | Damping depth adjustment parameter | Parameter used to adjust the dampening depth for the amplitude of diurnal fluctuations in surface temperature parameterization. |  | 1 | 1 |
| dnews | dnews | New snow threshold depth | New snow depth (expressed as water equivalent) required for albedo to be reset to the albedo of fresh snow. For new snow depths less than this the age of the snow surface is proportionally reduced. | m | 0.001 | 0.001 |
| emc | emc | Canopy emissivity | Canopy emissivity quantifies the emission of longwave radiation energy from the canopy surface relative to black body radiation. |  | 0.98 | 0.98 |
| alpha | alpha | Shortwave leaf scattering coefficient | Scattering coefficient for shortwave radiation passing through the canopy. |  | 0.5 | 0.5 |
| alphal | alphal | Scattering coefficient for long wave radiation | Scattering coefficient for longwave radiation passing through the canopy. |  | 0.0 | 0.0 |
| g | g | Leaf orientation geometry factor | Geometry factor quantifying the fraction of leaf area that intersects a light beam penetrating the canopy. The model takes this to be constant, neglecting changes with solar incidence angle. 0.5 assumes random leaf orientation. |  | 0.5 | 0.5 |
| uc | uc | Unloading rate coefficient | Parameter used in determining the rate of unloading of intercepted snow. Unloading rate is this coefficient times water equivalent of intercepted snow. | hr-1 | 0.00463 | 0.00463 |
| as | as | Cloudy atmospheric transmissivity | Fraction of extraterrestrial radiation incident at surface on cloudy day, Shuttleworth (1993) |  | 0.25 | 0.25 |
| bs | bs | Clear sky atmospheric transmissivity increment | Additional fraction of extraterrestrial radiation received at surface on clear day. The total radiation received at the surface on a clear day is as+bs, Shuttleworth (1993) |  | 0.5 | 0.5 |
| lambda | lambda | Clear sky direct radiation fraction | The fraction of incident radiation at the surface that is taken as direct radiation in clear sky conditions used to partition radiation into direct and diffuse fractions |  | 0.857 | 0.857 |
| rimax | rimax | Richardson number upper bound | Maximum value of Richardson number used in atmospheric stability correction |  | 0.16 | 0.16 |
| wcoeff | wcoeff | Forest wind decay coefficient | Parameter quantifying decay of wind speed through forest canopy. Within canopy wind speed is represented as u = uh exp(-n(1-z/h)) where z is height above surface, h canopy height, uh wind speed at the top of the canopy and n=wcoeff \* LAI where LAI is leaf area index. |  | 0.5 | 0.5 |
| a | a | Transmissivity parameter | Parameter A in Bristow-Campbell formula for atmospheric transmissivity |  | 0.8 | 0.8 |
| c | c | Transmissivity exponent | Parameter C in Bristow-Campbell formula for atmospheric transmissivity |  | 2.4 | 2.4 |

**SiteInitial.dat**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Code** | **Short name** | **Long name** | **Definition** | **Unit** | **Information source or value for HIMALA work** |
| USic | USic | Snow energy content | Initial value of energy content state variable giving the energy content of the snow pack plus thermally active soil per unit of horizontal area defined with respect to solid (ice) phase snow at 0 °C. | kJ/m2 | 0 or an output grid from a previous model run if the model is being restarted |
| WSis | WSis | Snow water equivalent | Initial value of the snow water equivalent state variable giving the water equivalent of snow on the surface (ground or glacier) | m | 0 or an output grid from a previous model run if the model is being restarted |
| Tic | Tic | Age of snow surface | Initial value of the dimensionless age of the snow surface state variable used in albedo calculation |  | 0 or an output grid from a previous model run if the model is being restarted |
| WCic | WCic | Canopy snow water equivalent | Initial value of intercepted snow state variable giving the water equivalent of snow held as interception in the canopy | m | 0 or an output grid from a previous model run if the model is being restarted |
| df | df | Drift multiplier | A factor that precipitation in the form of snow is multiplied by to account for drift accumulation |  | 1 |
| apr | apr | Atmospheric pressure | Atmospheric pressure of a grid or a particular site. An average is sufficient as the model uses a constant value (does not accommodate weather fluctuations) in its sensible and latent heat flux calculations | Pa | A grid computed based on elevation and standard atmospheric pressure elevation function given below |
| Aep | Aep | Albedo extinction coefficient | Depth threshold used to interpolate albedo for shallow snow. When snow depth is shallower than apr, albedo is interpolated between snow value and substrate value. This should reflect the surface roughness or shrub height in combination with penetration depth of solar radiation into snow. | m | 0.1 |
| cc | cc | Canopy cover fraction | The fraction of ground area covered by the vertical projection of tree crown |  | A grid based on MODIS land cover class per attached lookup table |
| hcan | hcan | Canopy height | Height of canopy | m | A grid based on MODIS land cover class per attached lookup table |
| lai | lai | Leaf area index | Leaf area index (LAI) is defined as one half the total leaf area per unit of horizontally projected surface area |  | A grid based on MODIS land cover class per attached lookup table |
| sbar | sbar | Interception capacity | Maximum snow load held per unit leaf area | kg/m2 | 6.6 |
| ycage | ycage | Forest canopy structure flag | A parameter required for wind speed profile parameterization. Valid values are 1, 2 or 3 reflecting canopy structure  1: young coniferous  2: deciduous  3: mature coniferous  (based on Paw U and Meyers, 1987) |  | A grid based on MODIS land cover class per attached lookup table |
| Slope | Slope | Slope | The slope angle measured from horizontal | degrees | Derived from DEM |
| Aspect | Aspect | Aspect | **Aspect** is the direction the slope faces measured clockwise from North. | degrees | Derived from DEM |
| Latitude | Latitude | Latitude | Geographic Latitude in decimal degrees | degrees | Derived from geographic location (see note below on precision) |
| Longitude | Longitude | Longitude | Geographic Longitude in decimal degrees (West is negative) | degrees | Derived from geographic location |
| subalb | subalb | Substrate albedo | The fraction of shortwave radiation (fraction 0-1) reflected by the substrate beneath the snow (ground or glacier) |  | A grid based on glacier extent mapping by ICIMOD or Adina with the following values: 0.25 for ground, 0.7 for Clean ice, 0.25 for Debris covered ice, 0.25 for excluded (excluded value is not used). |
| subtype | subtype | Snow substrate type | Type of beneath snow substrate encoded as: 0 = Ground/Non Glacier, 1=Clean Ice/glacier, 2= Debris covered ice/glacier, 3= Excluded area. Excluded area may include the glacier accumulation zone or any other area such as lakes where the snowmelt model is not run. No output is produced over excluded area. |  | A grid based on glacier extent mapping by ICIMOD or Adina |
| gsurf | gsurf | Fraction of surface melt | The fraction of surface melt that runs directly off without infiltrating the snowpack (e.g. from a glacier) |  | 0 |
| b01 | b01 | January mean diurnal temperature range | Monthly mean of daily temperature range for January used in Bristow Campbell formulas for atmospheric transmissivity | ˚C | A grid determined from climatology. Maura's downscaling should produce this. |
| b02 | b02 | February mean diurnal temperature range | Monthly mean of daily temperature range for February used in Bristow Campbell formulas for atmospheric transmissivity | ˚C | A grid determined from climatology. Maura's downscaling should produce this. |
| b03 | b03 | March mean diurnal temperature range | Monthly mean of daily temperature range for march used in Bristow Campbell formulas for atmospheric transmissivity | ˚C | A grid determined from climatology. Maura's downscaling should produce this. |
| b04 | b04 | April mean diurnal temperature range | Monthly mean of daily temperature range for April used in Bristow Campbell formulas for atmospheric transmissivity | ˚C | A grid determined from climatology. Maura's downscaling should produce this. |
| b05 | b05 | May mean diurnal temperature range | Monthly mean of daily temperature range for May used in Bristow Campbell formulas for atmospheric transmissivity | ˚C | A grid determined from climatology. Maura's downscaling should produce this. |
| b06 | b06 | June mean diurnal temperature range | Monthly mean of daily temperature range for June used in Bristow Campbell formulas for atmospheric transmissivity | ˚C | A grid determined from climatology. Maura's downscaling should produce this. |
| b07 | b07 | July mean diurnal temperature range | Monthly mean of daily temperature range for July used in Bristow Campbell formulas for atmospheric transmissivity | ˚C | A grid determined from climatology. Maura's downscaling should produce this. |
| b08 | b08 | August mean diurnal temperature range | Monthly mean of daily temperature range for August used in Bristow Campbell formulas for atmospheric transmissivity | ˚C | A grid determined from climatology. Maura's downscaling should produce this. |
| b09 | b09 | September mean diurnal temperature range | Monthly mean of daily temperature range for September used in Bristow Campbell formulas for atmospheric transmissivity | ˚C | A grid determined from climatology. Maura's downscaling should produce this. |
| b10 | b10 | October mean diurnal temperature range | Monthly mean of daily temperature range for October used in Bristow Campbell formulas for atmospheric transmissivity | ˚C | A grid determined from climatology. Maura's downscaling should produce this. |
| b11 | b11 | November mean diurnal temperature range | Monthly mean of daily temperature range for November used in Bristow Campbell formulas for atmospheric transmissivity | ˚C | A grid determined from climatology. Maura's downscaling should produce this. |
| b12 | b12 | December mean diurnal temperature range | Monthly mean of daily temperature range for December used in Bristow Campbell formulas for atmospheric transmissivity | ˚C | A grid determined from climatology. Maura's downscaling should produce this. |

**Land Class Site Variable Mappings based on MODIS land cover classes**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| MODIS Identifier | MODIS Class | cc | hcan (m) | LAI | ycage |
| 0 | Water | 0 | 0 | 0 | 2 |
| 5 | Mixed Forests | 0.8 | 10 | 4 | 3 |
| 7 | Open Shrublands | 0 | 0 | 0 | 2 |
| 8 | Woody Savannas | 0.5 | 8 | 1 | 2 |
| 10 | Grasslands | 0 | 0 | 0 | 2 |
| 15 | Snow and Ice | 0 | 0 | 0 | 2 |
| 16 | Barren or Sparsely Vegetated | 0 | 0 | 0 | 2 |

**Standard atmospheric pressure elevation function**

where

Po = standard sea level pressure = 101325 Pa

To = standard sea level temperature = 288.15 K

g = Earth gravitational acceleration = 9.81 m/s2

z = Elevation above sea level in m (determined from DEM)

R = gas constant for dry air = 287.04 J kg-1 K-1

λ = Standard temperature lapse rate = -0.0065 K/m

Representative values



If the elevation range of the watershed is less than 1000 m an average pressure based on the average elevation can be used as a fixed value for the entire domain. This will be within 5% of the correct value and is precise enough for the snowmelt model. If the elevation range is more than 1000 m then distributed pressure values over a grid are suggested.

**Note on latitude and longitude precision**

If the latitude or longitude range is less than 2 degrees a single value representative of the center of the domain is sufficient for these inputs as precision smaller than a degree is not really meaningful in the solar radiation calculations that depend on these. However for larger latitude and longitude ranges a grid giving latitude and longitude for each grid cell should be used.

**Inputcontrol.dat**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Code** | **Short name** | **Long name** | **Definition** | **Unit** | **Information source or value for HIMALA work** |
| Ta | Ta | Air temperature | Air temperature | ˚C | A 3-D grid constructed from lapse rate adjustment of point measurement near the surface and DEM |
| Prec | Prec | Precipitation | Precipitation that is the sum of both rain and snowfall expressed as water equivalent | m/hr | A 3-D grid from MERRA downscaling following Maura's script based on MicroMet |
| V | V | Wind Speed | Wind Speed at a point z m above the snow surface or top of canopy if present | m/s | A 3-D grid from MERRA downscaling following Maura's script based on MicroMet |
| RH | RH | Relative humidity | Relative humidity at a point z m above the snow surface or top of canopy if present |  | A 3-D grid from MERRA downscaling following Maura's script based on MicroMet |
| Qsi | Qsi | Shortwave radiation | Incoming shortwave radiation measured or that would be measured on a horizontal surface above the snow and canopy if present | kJ/m2/hr | A 3-D grid from MERRA downscaling following Maura's script based on MicroMet |
| Qli | Qli | Longwave radiation | Incoming longwave radiation that would be measured above the snow and canopy if present | kJ/m2/hr | A 3-D grid from MERRA downscaling following Maura's script based on MicroMet |
| Qnet | Qnet | Net radiation | Net radiation that would be measured on a horizontal surface above the snow and canopy if present. This is only required if irad=3. | kJ/m2/hr | Not used |
| Snowalb | Snowalb | Snow albedo | The fraction of incident solar radiation reflected by the snow surface (in the range 0 to 1). This is only required as an input if ireadalb=1. For other values of ireadalb, the snow albedo is calculated internally based on snow surface age. |  | Not used |
| Qg | Qg | Ground heat flux | Ground heat flux | kJ/m2/hr | 0 |

**OutputControl.dat**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Code** | **Short name** | **Long name** | **Definition** | **Unit** |
| Year | Year | Model year | Year of beginning of time step (integer) |  |
| Month | Month | Model month | Month of beginning of time step (integer) |  |
| Day | Day | Model day | Day of beginning of time step (integer) |  |
| Hour | Hour | Model hour | Hour of beginning of time step (may be fraction) | hr |
| ATF-BC | ATF-BC | Atmospheric transmission factor | The fraction of radiation at the top of the atmosphere that reaches the top of the canopy or in its absence, the snow surface. |  |
| HRI | HRI | Radiation index | Integration of solar radiation incident angle cosine over time step. When radiation data is not input, IRAD flag (in param.dat file) set to 0, incoming solar radiation is calculated as Tf \* HRI \* Solar constant. |  |
| Eacl | Eacl | Clear sky emissivity | Clear sky emissivity quantifies the emission of longwave radiation energy from a cloud free atmosphere towards the surface relative to black body radiation at the air temperature |  |
| Ema | Ema | Atmospheric emissivity | Atmospheric emissivity quantifies the emission of longwave radiation energy from the atmosphere towards the surface relative to black body radiation at the air temperature. The emission from clouds is included |  |
| Ta | Ta | Air temperature | Air temperature at a point z m above the snow surface or top of canopy if present | C |
| P | P | Precipitation | Precipitation that is the sum of both rain and snowfall expressed as water equivalent | m/hr |
| V | V | Wind speed | Wind speed at a point z m above the snow surface or top of canopy if present | m/s |
| RH | RH | Relative humidity | Relative humidity at a point z m above the snow surface or top of canopy if present | RH |
| Qsi | Qsi | Shortwave radiation | Modeled incoming shortwave radiation accounting for slope and aspect of the surface. This may be different from input Qsi for sloping surfaces | kJ/m2/hr |
| Qli | Qli | Longwave radiation | Modeled incoming longwave radiation | kJ/m2/hr |
| QnetOb | QnetOb | Observed net radiation | Observed net radiation that was input to the model | kJ/m2/hr |
| Cos | Cos | Cosine of illumination angle | Cosine of solar illumination angle (accounts for slope) | Degree |
| Ub | Ub | Energy content | State variable that gives the energy content of the snow pack plus thermally active soil per unit of horizontal area defined with respect to solid (ice) phase snow at 0 °C.. | kJ/m2 |
| SWE | SWE | Surface snow water equivalent | State variable that gives the Snow Water Equivalent (SWE) of snow on the surface. It can be considered as the depth of water that would theoretically result if the whole snow pack instantaneously melts. This tracks snow accumulation and ablation on top of a substrate layer which may be ground or glacier. In the case that the substrate is glacier this does not track the quantity of glacier ice. | m |
| tausn | tausn | Dimensionless snow surface age | Dimensionless age of the snow surface state variable to account for aging of the snow surface dependent on snow surface temperature and snowfall |  |
| Prain | Prain | Precipitation in the form of rain | Amount of precipitation that occurred in the form of rain at any time step | m/hr |
| Psnow | Psnow | Precipitation in the form of snow | Amount of precipitation that occurred in the form of snow at any time step expressed as water equivalent | m/hr |
| Albedo | Albedo | Snow surface albedo | **The fraction of shortwave radiation reflected by the snow surface.** |  |
| Qh | Qh | Surface Sensible heat flux | Surface sensible heat flux is the flux of energy transferred from the snow surface to the atmosphere by air movement (wind and turbulence). | kJ/m2/hr |
| Qe | Qe | Surface Latent heat flux | Surface latent heat flux is the flux of energy transferred from the snow surface to the atmosphere by water vapor carried in air movement (wind and turbulence). | kJ/m2/hr |
| E | E | Surface sublimation | Amount of water removed from the snow surface by sublimation | m |
| SWIT | SWIT | Total outflow | Total outflow from the base of the snowpack (and glacier). This includes rainfall, melt from seasonal snow and melt from glaciated surface. | m/hr |
| Qm | Qm | Outflow energy flux | Energy removed from the snowpack by total outflow | kJ/m2/hr |
| Q | Q | Net surface energy exchange | The net sum of all surface layer (snow plus thermally interacting substrate) energy fluxes | kJ/m2/hr |
| dM/dt | dM/dt | Net surface mass exchange | The net sum of all surface layer mass fluxes | m/hr |
| Tave | Tave | Average snow temperature | Average temperature of the snow and thermally interacting substrate. | Degree C |
| Ts | Ts | Surface snow temperature | Temperature at the surface of the snow | Degree C |
| CumP | CumP | Cumulative precipitation | Cumulative precipitation from beginning of model run | m |
| CumE | CumE | Cumulative surface sublimation | Cumulative sublimation from beginning of model run | m |
| CumMelt | CumMelt | Cumulative surface melt | Cumulative melt outflow from beginning of model run | m |
| NetRads | NetRads | Surface net radiation | Modeled net radiation exchange between the snow surface and atmosphere above and canopy above if present. | kJ/m2/hr |
| Smelt | Smelt | Melt generated at surface | Amount of melt generated at the snow surface due to rain, snowmelt or glacier melt. Smelt does not include snow melt from the canopy. Smelt also does not equate to melt outflow since it infiltrates into the snow and is subject to refreezing or liquid retention depending on the thermal state of the snow. | m/hr |
| RefDepAct | RefDepAct | Active refreezing front depth | The depth of a refreezing front that is active in impacting surface temperature. This quantifies the depth that refreezing has propagated into the snowpack where liquid water is present. This is reset to 0 when it exceeds the depth to which diurnal temperature fluctuations propagate and refreezing becomes inactive in snow surface temperature and energy exchange. | m |
| RefDep | RefDep | Refreezing front depth | The depth the refreezing front has propagated into the snowpack where liquid water is present. This is physically the same as RefDepAct but is not set to 0 when it exceeds the depth to which diurnal temperature fluctuations propagate, so records refreezing depth whenever there has been refreezing and there is still liquid water present. | m |
| Cf | Cf | Cloudiness fraction | The fraction (between 0 and 1) of the sky occupied by clouds. |  |
| Taufb | Taufb | Direct solar radiation atmospheric transmissivity | The part of the atmospheric transmissivity that quantifies direct solar radiation, defined as the ratio of top of atmosphere radiation to direct solar radiation at the surface or top of canopy if present. |  |
| Taufd | Taufd | Diffuse solar radiation atmospheric transmissivity | The part of the atmospheric transmissivity that quantifies diffuse solar radiation, defined as the ratio of top of atmosphere radiation to diffuse solar radiation at the surface or top of canopy if present. |  |
| Qsib | Qsib | Direct solar radiation | The incident solar radiation received at the surface or top of canopy if present as direct solar radiation. | kJ/m2/hr |
| Qsid | Qsid | Diffuse solar radiation | The incident solar radiation received at the surface or top of canopy if present as diffuse solar radiation. | kJ/m2/hr |
| Taub | Taub | Direct solar radiation canopy transmission fraction | The fraction of direct solar radiation incident at the top of the canopy that is transmitted through the canopy as direct solar radiation without being scattered or absorbed. |  |
| Taud | Taud | Diffuse solar radiation canopy transmission fraction | The fraction of diffuse solar radiation incident at the top of the canopy that is transmitted through the canopy without being scattered or absorbed. |  |
| Qsns | Qsns | Surface shortwave absorption | Amount of solar radiation absorbed at snow surface | kJ/m2/hr |
| Qsnc | Qsnc | Canopy shortwave absorption | Amount of solar radiation absorbed in canopy | kJ/m2/hr |
| Qlns | Qlns | Surface longwave absorption | Amount of longwave radiation absorbed at snow surface | kJ/m2/hr |
| Qlnc | Qlnc | Surface longwave absorption | Amount of longwave radiation absorbed in canopy | kJ/m2/hr |
| Vz | Vz | wind speed beneath canopy | Modeled wind speed beneath canopy at height z above the surface | m/s |
| Inmax | Inmax | Interception capacity | Maximum amount of snow that a canopy can hold during a snowfall. This is a function of maximum snow load per unit leaf area, leaf area index and the density of fresh snow. | m |
| int | int | Interception flux | The flux if precipitation that is intercepted by the canopy. This is a function of the interception capacity and intercepted snow state variable. | m/hr |
| ieff | ieff | interception efficiency | Fraction of precipitation intercepted by the canopy |  |
| Ur | Ur | Canopy unloading rate | The flux of snow unloaded from the canopy. Unloading rate is the intercepted snow state variable times the unloading rate coefficient and represents the transfer of snow from the canopy to the surface. It quantifies snow water equivalent removed from the canopy and added to the surface snow water equivalent. | m/hr |
| SWEc | SWEc | Canopy snow water equivalent | Intercepted snow state variable giving the water equivalent of snow held as interception in the canopy. | m |
| Tc | Tc | Canopy temperature | Temperature of the leaves and branches within the canopy. This is used in the calculation of energy fluxes between the canopy and within canopy air. | Degree C |
| Tac | Tac | Air temperature within canopy | Temperature of air within the canopy. This is used in the calculation of energy fluxes between the canopy and within canopy air, and in the calculation of energy fluxes between within canopy air and the atmosphere above, and snow surface below. | Degree C |
| QHc | QHc | Canopy sensible heat flux | Energy flux from the air within the canopy to the canopy. This is positive towards the canopy and is calculated based on temperature gradient and bulk leaf boundary layer resistance. | kJ/m2/hr |
| Qec | Qec | Canopy latent heat flux | Latent energy flux from the air within the canopy to the canopy. This is positive towards the canopy and is calculated based on the vapor pressure gradient and bulk leaf boundary layer resistance. It represents the energy flux associated with the phase change due to sublimation (removal) or condensation/deposition (addition) of canopy intercepted snow from water vapor in the air. | kJ/m2/hr |
| Ec | Ec | Canopy sublimation | The flux, expressed as snow water equivalent, of removal of snow from canopy interception by sublimation. This is positive away from the canopy. | m/hr |
| Qpc | Qpc | Precipitation energy flux to canopy | The flux of energy added to the canopy by interception. This represents the flux due to the energy difference between the phase and temperature of precipitation and the reference condition of 0 °C solid phase. | kJ/m2/hr |
| Qmc | Qmc | Canopy melt energy | The flux of energy removed from the canopy due to melt. This represents the energy flux due to the latent heat of fusion energy difference between melt water and the reference condition of 0 °C solid phase. This is subtracted from the canopy and added to the surface snow energy content. | kJ/m2/hr |
| Mc | Mc | Melt from canopy | The flux, expressed as snow water equivalent, of removal of snow from canopy interception by melting. This is subtracted from the intercepted snow and added to surface snow. | m/hr |
| FMc | FMc | Net canopy mass exchange | The net sum of all canopy mass fluxes | m/hr |
| MassError | MassError | Mass balance closure error | A running total of the sum of all inputs to and outputs from the model. Theoretically this should be 0, but practically differs from 0 due to numerical precision and rounding errors in the computation. It is included as a check on the functioning of the model and if significantly different from 0 is indicative of a problem. | m |
| SWIGM | SWIGM | Glacier melt outflow | The part of outflow from the base of the snowpack and glacier that is generated from glacier melting. SWIGM includes melt originating from glacial ice, as well as outflow that may occur due to rain on a glacier, as any precipitation that falls on the snow or glacier surface is first added to the snow/glacier to account for its energy in the total energy content then melt outflow occurs if the energy content results in liquid water in excess of the liquid holding capacity. | m/hr |
| SWIR | SWIR | Rainfall outflow | The part of outflow that is due to rain or snow that immediately melts. This only occurs on a non-glacier surface and when the surface snow water equivalent is 0. Precipitation that is rain, or that is snow that immediately melts due to a high temperature of the thermally active ground layer comprises this outflow. | m/hr |
| SWISM | SWISM | Snowmelt outflow | The part of outflow that is due to the melting of the seasonal snow pack. SWISM includes melt originating from the seasonal snow as well as outflow that may occur due to rain on a snowpack, as any precipitation that falls on the snow or glacier surface is first added to the snow/glacier to account for its energy in the total energy content then melt outflow occurs if the energy content results in liquid water in excess of the liquid holding capacity. If surface snow is present then melt outflow is generated from the surface snow. Glacier melt outflow is only generated when the surface snow water equivalent ablates to 0 and the substrate is glacier. | m/hr |