Endo.dat input file notes

Developed by Paul Mathewson 1/20/2014

Input Line 1.

* 1st Variable: I have only used ENDOTIME and have no comments on the other options.
* 2nd Variable: Choosing ‘Y’ means that the file HOURPLOT will be written. Choose ‘N’ if you are doing landscape simulations and are only using monthly/yearly outputs. Not having to write the HOURPLOT file will save some time.
* 3rd Variable: Choosing ‘Y’ means that a file called OUTPUT will be created for every run of the endotherm model. This file prints all the inputs and outputs used by the model for the current simulations.
  + Choose ‘N’ if you are doing landscape simulations and are only using monthly/yearly outputs. Not having to write the OUTPUT file will save some time.
* 4th Variable: No comments
* 5th Variable: I would recommend using NDTHRM even when modeling ectotherms. You can still model ectotherms if you want to provide your own expected target metabolic rate (see later lines) but still use ‘NDTHRM’ here. I have not gone through and checked for every instance ‘ECTHRM’ is invoked.
* 6th & 7th Variable: No comments
* 8th Variable: This determines the type of microclimate file the Endotherm model is reading in. Micro2011 creates CSV files, so use ‘CSV’ if using Micro2011. Micro2010 creates .OUT files, so use ‘OUT’ if using Micro2010.
  + If using CSV files from Micro2011, you must also fill out the JULDAY.dat input file. This provides the endotherm model with information contained in microclimate output files from Micro2010, but which is not found in the microclimate output files from Micro2011.
  + 9th Variable: This determines the file type (CSV or .OUT) the Endotherm model writes out for the HOURPLOT, MONTH, and YEAR files.
  + 10th Variable: This allows the user to control the units for some MONTH and YEAR outputs.
* JL: Energetic outputs are in joules and food/water requirements are in grams.
* KJ: Energetic outputs are in kilojoules and food/water requirements are in kilograms.
* MJ: Energetic outputs are in megajoules and food/water requirements are in kilograms.

Input Line 2.

* Do transient?: No comment.
* Transient shelter?: No comment.
* Consider heat storage in energy balance?: This allows users to choose whether they want to include a Qstored term in conjunction with changes in body temperature. Rather than assuming the body instaneously heats up or cools off, this calculated the amount of energy needed to heat up a body or how much heat is released from a cooling body.
* Specific heat: This is where users specify the specific heat for the flesh of the animal they are modeling for use in heat storage calculations.
* Class of animal: I only have experience with MAMMAL, BIRDIE, and to a lesser extent, REPTIL. There may well be issues if using AMPHIB or INSECT.
* Marsupial: The Y/N marsupial input allows the program to distinguish between marsupial mammals and eutherian mammals. These two kinds of mammals have different allometric equations for expected basal metabolic rate.
  + If your model animal is a mammal it is important to make sure this input is correct if you are not providing your own target metabolic rate.

Input Line 3: Allometric properties

* Subcutaneous fat: if the fat is subcutaneous, the program models a layer of insulative fat of equal thickness around the flesh of all body parts. This has the effect of slowing heat transfer from the core to the skin, thus reducing heat loss to the environment.
* Whole body geometric approximation: For animals with user supplied allometry this is the geometric shape of the animal when it is curled up and inactive (but see also inactivity options in ALOMVARS.dat) For animals without user supplied allometry, this is the shape of the animal at all times.
* Geom Mult: this establishes the length to width ratio of the geometric shape specified in the previous input.
  + For ellipsoids this is the A semi-major axis to the B semi-minor axis ratio. The program assumes that the B semi-minor axis is the same as the C semi-minor axis.
  + For cylinders this is the length to the skin radius ratio.
* Appendages: This is where you enter the number of appendages the model animal has.
  + For any animal modeled without user supplied allometry you must enter ‘0APNDG’
  + Selecting ‘2APNDG’ causes the program to skip over the forelimbs whenever that body part is encountered in the heat exchange calculations. For examples, birds should be ‘2APNDG’ because the wings are tucked up against the torso.
    - *Note:* do not confuse 2APNDG and type of locomotion in the Alomvars.dat input file. For bipedal animals with 4 appendages, be sure to enter ‘4APNDG’
  + You can use ‘4APNDG’ even if you are using the option for an additional appendage (e.g., large tail or proboscis). This option just tells the program not to skip the front limbs.
* % Ventral area contacting substrate: This tells the program how much of the animal is in contact with the substrate (and thus unavailable for non-conductive heat exchange) when inactive.
  + When active, the program assumes that only the leg end areas are in contact with the ground.
* Include conduction with substrate: This allows conduction with the substrate to be included in the heat balance calculations. The temperature gradient used in this heat exchange calculation is skin temperature and the 2.5 cm depth soil temperature.
  + Note: This calculation should be tested further before using. It provides very large heat fluxes that seem unreasonable.
* Fur compression for conduction: This allows users to estimate how much the fur is compressed when the animal is lying on the ground. Based on this compression, the program calculates a new fur depth and fur thermal conductivity for use in the conduction heat flux calculations.
* Animal density: estimate the density of the animal (usually somewhere between 930 and 1050 kg/m3).
* User supplied allometry: select ‘Y’ if you want to model a multipart animal and then provide the dimensions of each body part with the alomvars.dat input file.
  + If you choose ‘N’ here, you must also choose ‘0APNDG’.

Input Line 4: User-supplied Metabolic Options

* User supplied metabolic rate? Choose ‘Y’ if you have a specific basal metabolic rate for the model animal you want the program to target for its heat balance calculations (e.g., if you have empirical data for a BMR).
  + Choosing ‘N’ tells the program to use an allometric equation to estimate the target metabolic rate based on the animal’s body mass. These equations are different for eutherian mammals, marsupial mammals, birds, and lizards.
* Assume activity contributes to thermoregulation: Choosing ‘Y’ tells the program that heat generated through activity contributes to maintenance of the animal’s core temperature. ‘N’ tells the program that activity does not contribute to the animal’s heat budget.
  + Note: see also later inputs in this line to specify how much of the activity metabolism contributes to the heat budget.
* Decimal variance to trigger thermoregulation: This tells the program how close the metabolic rate calculated in the heat balance solution needs to be for it to be satisfactory (e.g., entering 0.05 tells the program that any metabolic rate within 5% of the target metabolic rate is good enough and no more thermoregulation is needed for that hour).
* Increasing activity hours: this allows users to specify how they want the program to calculate activity hours (which are outputs found in MONTH.out and YEAR.out).
  + Choosing 0.0: activity hours are increased whenever the animal is supposed to be active for that hour, regardless of the metabolic rate that balances the heat budget.
    - E.g., if the animal is diurnal, activity hours will be increased whenever the sun is above the horizon.
  + Choosing 1.0: activity hours increase only if the animal is supposed to be active AND the metabolic rate that balances the heat budget is greater than the animal’s basal metabolic rate.
  + Choosing 2.0: activity hours increase only if the animal is supposed to be active AND the metabolic rate that balances the heat budget is greater than or equal to the animal’s metabolic rate + activity multiplier values (see below for more information about these).
    - Use this when you want to assume that activity contributes to the heat budget.
    - Thus, activity hours will only increase when the animal can maintain its core temperature during that hour even when accounting for activity heat generation.
  + Choosing 3.0: activity hours increase only if the animal is supposed to be active AND the metabolic rate that balances the heat budget is greater than or equal to the animal’s metabolic rate + a minimum foraging activity rate.
    - For example, if you set a target activity rate of 2.5 times basal metabolic rate, but you allow a minimum foraging rate of 1.5 times basal, activity hours will increase whenever a heat balance can be obtained using the 1.5 times basal. However, the program will always attempt to reach 2.5 times BMR when the animal is supposed to be active.
    - Thus, with the 3.0 option, there may be times when the metabolic rate for one hour may represent 2.5 times basal and for another hour it may represent only 1.6 times basal, but both hours will be considered “active” hours. However, if you had chosen 2.0 for this input option, only the former hour will be considered an “active” hour.
  + It is important to understand how you want the program to be calculating activity hours because this is the denominator in the foraging rate outputs found in MONTH.out.
* Minimum forage rate: if choosing 3.0 for the previous option enter a minimum foraging rate as a multiple of basal metabolic rate that is less than the target activity level but which will still allow for enough activity to forage.
* Decimal % energy released from activity that can affect core temperature: If you choose ‘Y’ for activity heat generation contributing to thermoregulation this is where you input how much of the increased metabolic rate due to activity results in heat.
  + 0.0 means that none of the metabolic rate due to activity generates heat contributing to the animal’s body temperature (i.e., activity is 100% efficient: all activity metabolic generation goes directly to powering the activity).
  + 1.0: means that none of the metabolic rate due to activity generates heat contributing to the animal’s body temperature (i.e., activity is 0% efficient: all activity metabolic generation is converted to heat).
* Decimal % energy released from production (growth or reproduction) that can affect core temperature: If you choose ‘Y’ for activity heat generation contributing to thermoregulation this is where you input how much of the increased metabolic rate due to reproductive production results in heat.
  + 0.0 means that none of the metabolic rate due to production generates heat contributing to the animal’s body temperature (i.e., production is 100% efficient: all production metabolic generation goes directly to production).
  + 1.0: means that none of the metabolic rate due to production generates heat contributing to the animal’s body temperature (i.e., activity is 0% efficient: all production metabolic generation is converted to heat).

Input Lines 5-8: Fur properties for body parts.

Hair diameter: Enter diameter of individual hair particles. For birds, use barb or barbule diameter.

Hair Length: Enter the total length of individual hairs or feathers.

Fur Depth: Fur depth is the thickness of the fur layer (as measured from skin to top of fur layer) since hairs are not normally standing straight up. For example, an animal may have 20mm long hairs, but the fur depth is only 10mm because they hairs are normally lying at a low angle. However, if the hairs stand straight up, the fur depth and hair length would be the same. The same principles apply to feathers.

* For animals with user-supplied allometry, the fur depth in the ALOMVARS.dat input file overwrites the depth entered here.
  + The exception to this is for the torso. Torso hair lengths and fur depths used by the program are those found in input lines X to Y (see below)
* For 0APNDG animals with no user-supplied allometry, the torso fur properties are used for the entire animal.
* If modeling animals with fur only on the dorsal side you must enter something greater than 0.0mm but less than or equal to 0.1 mm for the depth AND enter a value greater than 0.0 for hair diameter, hair length, hair density, and reflectivity for the side that is supposed to be bare. The fur depth less than or equal to 0.1mm tells the program that the side is supposed to be bare, but having 0.0 in any of the inputs will create mathematical errors.

Hair Density: Enter the density of hair particles per cm2. If modeling birds, you want the density of feather barbs and barbules at a given height within the feathers. Warren has values for ostrich feathers that were embedded in wax while still attached to a skin, to preserve feather spacing. Ostrich values can be found in the appendix of Porter W. P., Budaraju S., Stewart W. E. and Ramankutty N. 2000. Calculating climate effects on birds and mammals: Impacts on biodiversity, conservation, population parameters, and global community structure. Amer. Zool. 40: 597-630.

Fur Reflectivity: Enter the spectral reflectivity of the ventral and dorsal fur.

* If modeling bare-skinned body parts, enter the skin reflectivity instead.

Fur transmissivity: This input is not currently used.

Input Lines 9-12: Time dependent torso fur properties.

* These inputs allow users to allow torso fur properties (dorsal/ventral fur depths and hair lengths) to change over the course of the modeling period.
* It is important to have as many entries in each input line as you have model days.
* The values entered here are what are used for each model day for the torso regardless of what is entered in alomvars.dat or for the torso depth and length values in prior lines in this input file.
* If modeling animals with fur only on the dorsal side you must enter something greater than 0.0mm but less than or equal to 0.1 mm for the ventral depth AND enter a value greater than 0.0 for hair length for the side that is supposed to be bare. The fur depth less than or equal to 0.1mm tells the program that the side is supposed to be bare, but having 0.0 for the length will create mathematical errors.

Input Line 13: Physiological properties – temperature and water loss from metabolism and skin.

* Core regular is the core body temperature the animal attempts to maintain.
* Core max T is the upper core temperature that the program will allow for thermoregulation (to simulate heat storage).
* Core min T: the lower core temperature that the program will allow for thermoregulation (to simulate body cooling).
  + NOTE: This should match the temperature entered in line 32 (Hibernation core temperature), which is what the program automatically sets the minimum core temperature to.
* % skin wet: this sets the baseline for evaporative heat and water loss from the skin even before thermoregulation is engaged.
* Max % skin wet: the maximum amount of skin surface area that can be wet to simulate sweating. The thermoregulatory subroutine incrementally increases the % wet value from the baseline up towards the maximum until a heat balance is reached close enough to the target metabolic rate.
* Sweat OK: This allows users to choose whether their animal sweats. If ‘Y’, the sweating subroutine can be engaged as previously described. If ‘N’ the only evaporative heat/water loss from the skin is from the baseline amount of wet skin no matter how hot the animal is.
* Piloerect OK: This allows users to choose whether to allow their animals to be able to erect their fur/feathers when cold to increase insulation.
* Starting/Min/Max Flesh Thermal Conductivity: User provides the starting point for flesh thermal conductivity as well as maximum and minimum values used in thermoregulation to simulate vasodilation (used when animals are hot to move blood to the surface of the skin) and vasoconstriction (used when animals are cold to keep blood away from the skin), respectively.
  + Note: it is important that the starting value is between the minimum and maximum values.
  + Note: if you are providing user-supplied allometry it is important that none of the minimum values for any individual body part is either less than the minimum value are greater than the maximum value listed here.
* User supplied fur thermal conductivity: allows users to enter a known fur thermal conductivity value. If choosing ‘N’ the program calculates a fur thermal conductivity based on the fur properties provided above.
* Depth in fur for radiant exchange: radiant exchange with the environment occurs at many different levels within in the fur. This input tells the program what point along the fur temperature profile (0.0 = at the skin surface; 1.0 = at the fur-air interface) to use as a representative point to model radiant exchange. Typically this is somewhere between 0.75 and 1.0.

Input Line 14: Physiological properties- lungs and gut

O2 Extraction Efficiency (Max): This is the baseline oxygen extraction efficiency for the animal and is used to calculate respiratory heat and water loss.

O2 Extraction Efficiency (Min): This is the minimum oxygen extraction efficiency for the animal. When thermoregulating, the program will incrementally decrease this value down towards the minimum value to simulate panting.

* + If you do not want your animal to be able to pant, set the minimum and maximum to the same value.

Gut passage time:. This value does not actually get used in the model at present.

Fecal water %: No comment.

Urea in urine (dec. %): Used to calculate water lost with urine. If you are modeling an insect or bird (which produces uric acid) the model assumes that no water is lost with uric acid and does not use this input value.

Input Line 15: Time-dependent core temperature

* Enter the core temperature maintained for each model day in your simulations.
* Ensure that you have as many inputs here as you have model days and that the value here is in between the minimum and maximum values listed in input line 13.

Input Line 16: Time dependent digestive efficiencies

* Enter the animal’s digestive efficiency for its diet at different times throughout the model period.
* Ensure that you have as many inputs here as you have model days.
* This value to used to determine how much food the animal needs to eat once daily energetic requirements have been calculated.

Input Line 17: Time dependent activity multipliers

* Ensure that you have as many inputs here as you have model days
* This is where users specify activity levels as a multiplier of basal.
* Note: The way that total target metabolic rate is calculated with respect to activity is: Metabolic rate = BMR + (ACTIVITY MULTIPLIER-1)\*BMR
  + Thus, the multiplier for no activity = 1.0.

Input Line 18: Time dependent discretionary activity

* Ensure that you have as many inputs here as you have model days
* This is where users specify any growth or reproductive activity (e.g., pregnancies).
* Note: unlike activity multipliers, this is an additive term. The way that total metabolic rate is calculated with this discretionary production activity is: Metabolic rate = BMR + (TIMDIS\*BMR).
  + Thus, to simulate no reproduction, users should enter 0.0, NOT 1.0.

Input Lines 19-22: Food properties

* In these lines you enter the properties of the food in the animal’s diet over the course of the model period.
* Ensure that you have as many inputs here as you have model days

Input lines 23-25: Behavioral properties – animal activity pattern

* Ensure that you have as many inputs here as you have model days
* These inputs inform the program when the animal is potentially active.
  + The program considers an hour to be *nocturnal* if the sun is below the horizon and there is no skylight. An hour is *crepuscular* is when the sun is below the horizon but there is still some skylight. All other hours are *diurnal* hours (sun above the horizon).
    - The microclimate subroutine calculates hourly sunlight and sun position based on the geographic location of the site, time of day, date and ground slope angle (if any).

Input lines 26-27: Hibernation inputs

* Ensure that you have as many inputs here as you have model days

Input lines 28-29: Active/inactive on land or water.

* Ensure that you have as many inputs here as you have model days
* Active/inactive on water should be interpreted as animals that float on the water surface.
  + When choosing W, users must also fill out the DIVETABL.dat input file
  + When an animal is active/inactive on the water the program models each body part as being partially submerged and partially exposed to the air with the exception of the legs, which are assumed to be fully submerged. Users specify what proportion of each body part should be submerged.
* To model animals that spend some time on land and some time in the water, enter ‘L’ in these input lines as appropriate and then use the dive option in line X and the dive table to schedule time in the water.
  + Using the dive option causes the entire animal to be submerged unlike floating animals.

Input lines 30-31: Time dependent mass and body fat

* Ensure that you have as many inputs here as you have model days
* If these values change over the modeling period, the program automatically updates body dimensions and fat thicknesses to reflect the change using the ALOM or USRALOM3 subroutines.

Input line 32: Hibernation body temperature:

* Ensure that you have as many inputs here as you have model days
* NOTE: The program sets the minimum core temperature for each model day to the value entered in this line.

Input line 33: Behavioral thermoregulatory options

* Burrow OK: ‘Y’ means that animals can retreat to burrows in order to thermoregulate for cold or heat. Animals retreating to burrows are automatically set to be inactive regardless of time of day.
* Nest for thermoregulation: ‘Y’ means that animals can retreat to nests in order to thermoregulate for cold or heat. Animals retreating to nests are automatically set to be inactive regardless of time of day.
* Climb to cool: ‘Y’ means that hot animals can climb trees to reach cooler temperatures.
* Ground seeking shade: ‘Y’ means that hot animals can seek shade during daylight hours. The program will incrementally increase shade levels up to the specified maximum from the Micro.dat input file.
* Dive to cool: ‘Y’ means that hot animals can swim in water to cool off. If choosing ‘Y’ users must also fill out the Divetabl.dat input file.
  + When this option is employed, the program automatically checks to make sure that swimming does not make things worse (either warmer than before or making the animal colder than it was hot). If things are made worse, the animal is put back on land.
  + This should only be used when modeling animals in landscape areas with water available.
* Seek wind protection: ‘Y’ means that cold animals can seek shelter in a forest to get out of the wind.
  + When this option is employed, the program automatically checks to make sure that getting into the forest does not make things worse (either colder than before or making the animal warmer than it was cold). If things are made worse, the animal is put back out into the open.
  + This should only be used when modeling animals in landscape areas with forest cover available.
* Night shade: ‘Y’ means that animals cold at night can move into a forest area where the microclimate conditions are warmer than being out in the open under a cold nighttime sky.
* Dive?: ‘Y’ means that the animal regularly dives during certain hours of the day. Users must fill out the Divetabl.dat input file when using this option.
* Active in the shade during the day?: ‘Y’ means that animals seeking shade during the day to thermoregulate can still stay active (e.g., an animal seeking shade in the forest can still forage for food).
* Daytime shade stand or lie: For animals that are inactive in the shade during the day (i.e., users said ‘N’ for the previous input), users can choose whether the animals are standing up (S; all body parts still modeled separately) or lying down (L, body parts modeled in the inactive posture).
* Thermoregulatory order: Behave First?: ‘Y’ means that the program first tries behavioral thermoregulation options before moving on to physiological options. Choosing ‘N’ means that the program first tries physiological options and then moves on to behavioral options.
  + The order of thermoregulation options for a hot animal is as follows when choosing ‘Y’: Climb to cool (if allowed) > Seek ground shade (if allowed)> Enter a burrow (if allowed) > Enter a nest (if allowed) > Dive to cool (if allowed) > Increase flesh thermal conductivity to maximum > Increase core temperature to maximum > Pant by reducing oxygen extraction efficiency to minimum > Sweat (if allowed).
  + The order of thermoregulation options for a cold animal is as follows when choosing ‘Y’: Enter a burrow (if allowed) > Enter a nest (if allowed) > Enter a forest to get out of the wind (if allowed) > Change posture to reduce surface area if inactive > Piloerect fur or feathers (if allowed) > Reduce flesh thermal conductivity to minimum > Decrease core temperature to minimum.
  + The order of thermoregulation options for a hot animal is as follows when choosing ‘N’: Increase flesh thermal conductivity to maximum > Increase core temperature to maximum > Pant by reducing oxygen extraction efficiency to minimum > Sweat (if allowed) > Climb to cool (if allowed) > Seek ground shade (if allowed)> Enter a burrow (if allowed) > Enter a nest (if allowed) > Dive to cool (if allowed).
  + The order of thermoregulation options for a cold animal is as follows when choosing ‘N’: Piloerect fur or feathers (if allowed) > Reduce flesh thermal conductivity to minimum > Decrease core temperature to minimum > Enter a burrow (if allowed) > Enter a nest (if allowed) > Enter a forest to get out of the wind (if allowed) > Change posture to reduce surface area if inactive.
* Burrow and nest thermoregulatory option: This for users that want their model animals to be able to seek shelter in a nest or burrow to thermoregulate.
  + 1.0 means that animals will retreat to a nest or burrow if it is hot or cold out in the open.
  + 2.0 means that animals will retreat to a nest or burrow only if it is hot out in the open.
  + 3.0 means that animals will retreat to a nest or burrow only if it is cold out in the open.

Input Line 34: Flight variables

* Flight OK? (Y/N): This where users specify whether they want the animal to be able to fly during portions of hours.
  + If modeling flying animals, users must also fill out the FLYTABL.dat input file.
* Flight metabolism: This is where users specify the animal’s metabolic rate while flying.
* Flight velocity: This variable does not get used as far as I can tell.
* Average flight load: This variable does not get used as far as I can tell.

Input Line 35: Fossorial/nest options

* No comments

Input line 36: Configuration factors

* FAsky is the proportion of the animal that “faces” the sky for heat exchange purposes. Typically this is 0.5.
* FAgrd is the proportion of the animal that “faces” the ground for heat exchange purposes. Typically this is somewhat less than 0.5 (usually 0.3 or 0.4) since when considering the ventral side of animals, there is heat exchange from leg to leg and torso to leg rather than it all being with the ground.
* FAbush is the proportion of the animal facing a nearby object like a large rock. Typically this is 0.0 and it is currently not used by the program.

Input line 37: Nest properties

* No comment

Input line 38: Air properties

* No comments

Input line 39: Soil properties

* No comments

Input line 40: Shelter/nest properties 1

* No comments

Input line 41: Shelter/nest properties 2

* No comments

Input line 42: Transient for Shelter or Animal

* No comments

Input line 43: Node locations

* No comments