Appendix 2.3

Bioclimate parameterisations

Overview of parameterisations

The Bioclimate model has eight selectable submodels, and four named parameterizations to select sets of submodels. The submodels and parameterizations are found in Table 1.

Table 1: Bioclimate parameterizations and submodels.

	default	FAO56_daily	FAO56_hourly	SSOC
cloudiness	Taastrup	FAO56	FAO56	Taastrup
net_radiation	brunt	brunt	brunt	brunt
ghf	surface	none	FAO56	surface
pet	(based on data)	FAO_PM	FAO_PM_hourly	(based on data)
svat	none	none	none	SSOC
raddist	default	default	default	sun-shade
difrad	(based on data)	(based on data)	(based on data)	(based on data)
deposition	weather	weather	weather	weather

The four parameterizations

- "**default**" is our recommended submodels based on the available weather information.
- "**FAO56_daily**" and "**FAO56_hourly**" select models in accordance to the FAO56 report, for daily or hourly weather data respectively.
- "**SSOC**" is for experimenting with the SVAT model of the same name, which requires a different radiation distribution model.

The eight submodels

- "**cloudiness**" calculates "cloudiness_index". It is used by the net radiation submodel.
- "**net_radiation**" calculates two values for net radiation, one based on the simulated albedo (Rn), and one based on a reference albedo (Rn_ref). The full Penman-Monteith model (PM) uses Rn, while the FAO pet models use Rn_ref. The 'Makkink' and 'Hargreaves' pet models uses neither, but they are still calculated.
- "**ghf**" calculates ground heat flux (G), which is used by the all the Penman-Monteith based models, but not the rest.
- "**pet**" calculates potential evapotranspiration "ET_C".
- "**svat**" calculates actual transpiration (crop_ea), and other stuff.
- "**difrad**" is for finding diffuse radiation (difrad0), which is only used by the SSOC svat model but always calculated.
- "**deposition**" calculates N deposition. Right now by reading it from the weather files.

The cloudiness models

- "**const**" a fixed value for cloudiness.
- "**weather**" expects cloudiness to be specified in the weather file.

The remaining models are based on the ration between measured global radiation (Si) and a theoretical clear sky radiation (Si0).

- **"FAO56"** calculates clear sky radiation based on extraterrestrial radiation and elevation.
  - **"Kjaersgaard"** is a parameterization of FAO56 adjusted for Danish conditions.
- **"ASCE"** also estimates a clearness index, and adjust clear sky radiation for that.
  - **"Taastrup"** is the "Kjaersgaard" adjustment applied to the ASCE model.

The net_radiation models

The ghf models

- **"const"** a fixed value for ground heat flux
  - **"none"** as above, with the fixed value being 0 W/m^2.
- **"weather"** use the ground heat flux value from in the weather file.
- **"old"** an obsolete model based soil heat flux between soil cell 0 and cell 1.
- **"surface"** the value calculated by the soil heat module.
- **"FAO56"** the value recommended by the FAO56 report.

The pet models

- **"PM"** calculates ET_C directly using the Penman-Monteith equation. Requires weather data measured on the field.

All other models calculates evapotranspiration for a reference surface, a well-irrigated short grass, ET_0. Daisy will then convert ET_0 into ET_C by applying a crop factor.

- **"FAO_PM"** and **"FAO_PM_hourly"** does this by using a modified version of the Penman-Monteith equation, based on daily or hourly weather data respectively.
- **"weather"** simply read ET_0 from the weather file.
- **"Makkink"** simple model based on daily values for global radiation and temperature. Three parameterizations are provided. The choice should depend on the wind and humidity conditions on the individual weather station. Parameters can be calibrated to the wind and humidity conditions on the individual weather station.
  - **"Makkink57"** the original version from 1957.
  - **"AslyngHansen82"** a Danish (Zealand) calibration from 1982.
  - **"deBruin1987"** a Dutch calibration from 1987.
- **"makkink"** (with a small "k"). An older implementation of AslyngHansen82.
- **"Hargreaves"** estimate ET_0 from daily min and max temperature.

Automatically choosing a 'pet' model based on available weather data

If unspecified, Daisy will choose a pet model based on the available weather data. It may switch model dynamically if the available weather data changes during simulation. The following rules are used:

1. If the weather file includes RefEvap, select the "weather" model.
2. Else, if both vapor pressure and wind is available in the weather file, choose one of the Penman-Monteith based models.
   a. If the surface type is 'Field', choose the "PM" model.
   b. Else, if the weather file timestep is less than 4 hours, choose the "FAO_PM_hourly" model.
   c. Else choose the "FAO_PM" model
3. Else, if both min and max temperature is available, choose the "Hargreaves" model.
4. Else, choose the "deBruin87" parameterization of Makkink.

The svat models

- **"none"**: Transpiration is based on ET_C and limited by available soil water.
- **"pmsw"** and **"ssoc"**: Evaporation of free water (ponded, intercepted, etc) is based on ET_C, but transpiration is based on resistances between soil through the crop and canopy, and air.

The raddist models

- **"default"**: Radiation decrease from top to bottom of canopy according to Beer's law.
- **"DPF"** calculates separate radiation levels for sunlit and shadow leaves, taking into account diffuse and direct radiation, and solar angle.

The difrad models

- **"weather"** read diffuse radiation from weather file.
- **"DPF"** estimate diffuse radiation based on air pressure and solar angle.

Automatically choosing a 'difrad' model based on available weather data

If 'DifRad' is specified in the weather file, choose the "weather" model; otherwise choose the "DPF" model.