

# Set up water temperature (T2) simulations with HYPE

Assuming that you have a model setup for simulating water flow with HYPE, here is described the additional information (settings and parameters) that is needed to [simulate water temperature](#), i.e. substance T2.

## Simulation settings

In [info.txt](#):

substance T2

modeloption lakeriverice 1 or 2 (default is 0 and cannot be used with substance T2)

## Input data and forcing

The water temperature model uses a radiation dependent term for heat-exchange and ice calculations. Shortwave radiation can be given as forcing ([SWobs.txt](#)) or calculated from other input data. To [calculate shortwave radiation](#) at least *latitude* and *elevation* from [GeoData.txt](#) is needed, but additional forcing temperatures, [TMAXobs.txt](#) and [TMINobs.txt](#), are also useful.

## Parameters

### Soil temperature and soil frost depth

T2 of runoff is set from [soil temperature](#) which is calculated separate from the T2 substance in soil water. T2 of surface runoff depend on T2 of precipitation and soil water though.

The following parameters need to be set: *deepmem*, *surfmem*, *depthrel*, *frost*, *sfrost*, *init2*.

### Surface water temperature

The following parameters need to be set: *init2*, *upper2deep*.

For temperature exchange between air and water surface two alternative models exist. The following parameters are needed if lakeriverice model 1 is used: *t2trlake*, *t2trriver*. The following parameters are needed if lakeriverice model 2 is used: *tcfriver*, *scfriver*, *ccfriver*, *lcfriver*, *tcflake*, *scflake*, *ccflake*, *lcflake*, *stbcorr1*, *stbcorr2*, *stbcorr3*.

The following parameter can be used to limit how water with small water depth is treated regarding

heat-exchange with the air: *limt2exch*.

The following parameters can be used to reduce the river surface area at small volumes/low flows. The reduced area is used for calculation of river evaporation, surface water heat balance and river ice: *flexe*, *flexm*. This will affect the simulated water flow.

## Lake and river ice

The [lake and river ice](#) model is necessary for simulating T2.

The following parameters are needed if `modeloption lakeriverice` is set (1 or 2): *licewme*, *licetf*, *licesndens*, *licekika*, *licekeexp*, *licetmelt*, *licewcorr*, *ricewme*, *ricetf*, *ricesndens*, *ricekika*, *ricekeexp*, *ricetmelt*.

## River area and depth

If the river area is not given as a class area (for all rivers!), the river area is approximated by HYPE.

The following parameters are then used for calculating river area and need to be set: *rivvel1*, *rivvel2*, *rivvel3*, *rivwidth1*, *rivwidth2*, *rivwidth3*, *maxwidth*.

The river depth can be increased by having a dead volume. It will not affect the flow, only substances in the water. It is useful for reducing problems with T2 calculations for very small river volumes. The following parameters need to be set: *deadl*, *deadm*.

The following parameters can be used to reduce the river surface area at small volumes/low flows. The reduced area is used for calculations of river evaporation, surface water heat balance and river ice: *flexe*, *flexm*. This will affect the simulated water flow.

## Water temperature of lake outflow

The outflow from lake may be given temperature from the upper part of the lake (the part above the lake outflow threshold). The [outflow temperature](#) may be determined as the mean from the temperature of the water sources (FLP, SLP). The upper part temperature is default for outlet lakes, while for internal lakes the outflow mean temperature is always used. Using the outflow mean temperature can be used for outlet lakes to hide the negative temperature of the upper part before the lake freezes.

The following parameter is set to use outflow mean temperature for outlet lakes: *t2mix*. It is both a general parameter and parameter that can be set in LakeData.txt for specific lakes.

## Output variables

HYPE has three output variables from the model that simulate water temperature as a substance T2:

- *csT2* - simulated water temperature of soil water (set from soil temperature)

- coT2 - simulated water temperature of local runoff from land
- ccT2 - simulated water temperature of outflow from outlet lake/subbasin

Some output temperature variables are part of the T2 model, but do not have a corresponding water body in HYPE:

- river temperatures used for calculating water surface heat exchange (mrst, mrwt)
- lake temperatures of stratified lake used for calculating water surface heat exchange (olst, olut, ollt, olwt, ilst, ilwt)

HYPE has other output related to temperature. These outputs are not based on simulation of T2:

- air temperature (temp, ctmp)
- soil temperature (stmp, stm1, stm2, stm3)
- river and lake water temperature used for calculation of nutrient processes (lrto, ilto, mrto, olto)
- subbasin outflow temperature (based on water temperature used for nutrient processes) (wtmp, wtm0)