Model Entry form

|  |  |
| --- | --- |
| ***General Information*** | |
| Acronym of the model: | GOTM |
| Full name of the model: | General Ocean Turbulence Model |
| Model components: | Hydrodynamics  Chemistry  Biology |
| Supported platforms: | Windows  Mac  Linux |
| Programming languages: | Fortran |
| Still maintained: | Yes, by Bolding & Bruggeman  No |
| Most recent version | 5.2 |
| ***Model Structure and Spatial Domain*** | |
| Needs compilation  Executables are available | |
| 0D  1D  2D (horizontal)  2D (vertical)  3D | |
| Flexible grid  Fixed grid Other: | |
| Mass balance included  Catchment model | |
| ***Model Description*** | |
| Model Objective: | It is a one-dimensional water column model for the most important hydrodynamic and thermodynamic processes related to vertical mixing in natural waters. |
| Specific application:  *(Please include example(s))* | Modelling 1-dimensional thermodynamics in a lake, modelling DOC dynamics in a lake |
| Background knowledge needed to run model: | Knowledge of how to work with namelist files. Basic understanding of lake physics |
| Basic procedures:  (*Describe the procedure step-by-step*) | Formatting of input files, editing of XML file, using python editscenario to prepare namelist files to run the model, run the model |
| *Here you can add a more detailed description of the model here (up to 250 words)*: | |
| Link to website(s) and/or manual: | <https://gotm.net/>  <https://gotm.net/manual/stable/pdf/a4.pdf> |
| ***Model Characteristics*** | |
| Input variables: | *Obligatory*:  Hypsograph (for lakes)  Meteorlogical variables (wind speed, MSLP, air temperature, relative humidity, cloud cover) |
| *Optional*:  Initial temperature profile  Water level  Inflows  Outflows  Shortwave radiation |
| Input file format: | ASCII  .netcdf  .csv  .xls  Other, namely: namelist and yaml files |
| Output variables: | potential temperature  salinity  potential density  observed temperature  observed salinity  x-velocity  y-velocity  observed x-velocity  observed y-velocity  extra friction coefficient in water column  drag coefficient in water column  shear frequency squared  shear production  variance of u-fluctuations  variance of v-fluctuations  variance of w-fluctuations  buoyancy frequency squared  contribution of T-gradient to buoyancy frequency squared  contribution of S-gradient to buoyancy frequency squared  buoyancy  (half) buoyancy variance  destruction of buoyancy variance  buoyancy production  production of buoyancy variance  extra turbulence production  eddy diffusivity  turbulent kinetic energy  energy dissipation rate  turbulence length scale  turbulent diffusivity of momentum  turbulent diffusivity of heat  turbulent diffusivity of salt  non-local flux of u-momentum  non-local flux of v-momentum  non-local buoyancy flux  non-local heat flux  non-local salinity flux  stability function for momentum diffusivity  stability function for scalar diffusivity  non-dimensional non-local buoyancy flux  non-dimensional buoyancy time scale  non-dimensional shear time scale  non-dimensional buoyancy variance  turbulent time scale ratio  gradient Richardson number  flux Richardson number  surface friction velocity  10m wind (x)  10m wind (y)  2m air temperature  air pressure  dew point temperature  saturation water vapor pressure  actual water vapor presure  saturation specific humidity  specific humidity  air density  cloud cover  albedo  precipitation  evaporation  integrated precipitation  integrated evaporation  integrated short wave radiation  integrated surface heat fluxes  integrated total surface heat exchange  incoming short wave radiation  sensible heat flux  latent heat flux  long-wave back radiation  net surface heat flux  wind stress (x)  wind stress (y)  sea surface temperature  observed sea surface temperature  sea surface salinity  sea surface elevation  surface mixed layer depth  bottom friction velocity  bottom stress  bottom mixed layer depth  short-wave radiation  fraction of visible light that is not shaded by overlying biogeochemistry  coordinate scaling  hypsograph at grid interfaces  layer thickness  integrated total water balance  inflows over water column  salt inflow  temperature inflow  vertical water balance advection velocity  vertical water balance flux  residual water balance inflows  integrated inflow  integrated outflow  kinetic energy  potential energy  turbulent kinetic energy |
| Output file format | ASCII  .netcdf  .csv  .xls  Other, namely: |
| Biogeochemical model components:  (*Which nutrients, phytoplankton, zooplankton, etc., including number of different groups*) | O2, CO2, NO3, NH4, PO4, cyanobacteria, small phytoplankton, large phytoplankton, zooplankton, macrophtes , DOC  cyanobacteria chlorophyll concentration  cyanobacteria gross primary production  cyanobacteria net primary production  cyanobacteria concentration  diatoms chlorophyll concentration  diatoms gross primary production  diatoms net primary production  diatoms concentration  dom labile  dom semi-labile  flagellates chlorophyll concentration  flagellates gross primary production  flagellates net primary production  flagellates concentration  selma nitrate conc in mass unit  selma ammonium conc in nitrogen mass unit  selma phosphate conc in phosphorus mass unit  selma oxygen in O2 mass unit  selma denitrification pelagic  selma denitrification benthic  selma sediment burial  selma phosphorus burial  selma oxygen surface flux (positive when into water)  selma detritus  selma ammonium  selma nitrate  selma phosphate  selma oxygen  selma PFe\_w  selma fluff  selma PFe\_s  zooplankton concentration  total\_nitrogen\_calculator result  total\_carbon\_calculator result  total\_phosphorus\_calculator result  total\_chlorophyll\_calculator result  attenuation\_coefficient\_of\_photosynthetic\_radiative\_flux\_calculator result  total\_carbon\_at\_interfaces\_calculator result  total\_phosphorus\_at\_interfaces\_calculator result |
| Model structure/mathematical framework (e.g., ODE, PDE, empirical model,...) |  |
| Temporal resolution:  (*minimal and maximal)* | [0.001, 86400s] – integration timestep |
| Minimal spatial resolution: | [1, 1000] levels to resolve the water column |
| Variables needing calibration: | Wind\_factor, swr\_factor, g1, g2 (light attenuation), shf\_factor, k\_min (minimum turbulence kinetic energy) |
| Has successfully been used in:  (*e.g. Climate change scenarios, lake management support, etc. Please provide a reference*) | |
| Climate Change Scenario | Ongoing ISIMIP work |
| Shallow Lake/Reservoir |  |
| Deep Lake/Reservoir | Sachse et al., 2014; Kerimoglu et al., 2017 |
| Oligotrophic Water |  |
| Mesotrophic Water |  |
| Eutrophic Water |  |
| Ocean | Ciglenečki et al., 2015 |
| Management Support |  |
| ... |  |
| Countries in which the model has been applied | Ireland, Sweden, Norway, Denmark, Israel |
| Which Institutes have applied the model | Aarhus University, Denmark  Dundalk Institute of Technology (DkIT), Ireland  Uppsala University, Sweden  NIVA, Norway |
| Has coding for: | |
| Ice dynamics  Sediment heat flux  Sediment dynamics  ...  Internal waves  ... | |
| ***Accessibility*** | |
| Open-Source  Open-to-Use  Licensed | |
| Prompt-based  GUI | |
| Test cases available | |
| Available tools for pre- and post-processing: | R package: ‘gotmtools’ |
| Support:  (*Community forum, mailing list, “help”-manual, contact, etc.)* | Google group |
| Can be coupled to the following models: | PCLake  ERGOM  AED |
| How can someone get access to this model:  (*Please provide a URL or contact person*) | <https://github.com/gotm-model/code> |
| ***Miscellaneous*** | |
| *Comments (things not covered by the form):*  Ice model is currently being developed | |
| *Useful tricks and hints for other users (on handling input files, running the model, numerics,...):*  Input files are tab-delimited | |
| Links (*Please add links to the model’s developer’s website and the model’s resources, like forums, manuals, support, contact,...*):  WET – user interface for GOTM <http://projects.au.dk/wet/>  GOTMr – package for running GOTM in R <https://github.com/tadhg-moore/GOTMr>  gotmtools - package for pre and post-processing <https://github.com/tadhg-moore/gotmtools>  FABM - <https://github.com/fabm-model/fabm/wiki>  GOTM Google group - <https://groups.google.com/forum/#!forum/gotm-users>  Bolding & Bruggeman (Developers) - <https://bolding-bruggeman.com/> | |
| *Reference list (Please add several references in which the model has been applied*):  Belolipetsky, P. V., Belolipetskii, V. M., Genova, S. N., & Mooij, W. M. (2010). Numerical modeling of vertical stratification of Lake Shira in summer. *Aquatic Ecology*, *44*(3), 561–570. https://doi.org/10.1007/s10452-010-9330-z  Bruggeman, J., & Bolding, K. (2014). A general framework for aquatic biogeochemical models. *Environmental Modelling and Software*, *61*, 249–265. https://doi.org/10.1016/j.envsoft.2014.04.002  Burchard, H., & Baumert, H. (1995). On the performance of a mixed-layer model based on the κ-ε turbulence closure. *Journal of Geophysical Research*, *100*, 8523–8540. https://doi.org/10.1029/94JC03229  Burchard, H., Bolding, K., Kühn, W., Meister, A., Neumann, T., & Umlauf, L. (2006). Description of a flexible and extendable physical-biogeochemical model system for the water column. *Journal of Marine Systems*, *61*, 180–211. https://doi.org/10.1016/j.jmarsys.2005.04.011  Burchard, H., & Petersen, O. (1999). Models of turbulence in the marine environment - A comparative study of two-equation turbulence models. *Journal of Marine Systems*, *21*(1–4), 29–53. https://doi.org/10.1016/S0924-7963(99)00004-4  Joehnk, K. D., Stepanenko, V. M., Bueche, T., Gal, G., Goyette, S., Janssen, A. B. G., … Wen, L. (2015). Integrated modelling of lakes in the climate system - a summary from ASLO Granada and more. *4th Workshop on “Parameterization of Lakes in Numerical Weather Prediction and Climate Modelling"*, (August). https://doi.org/10.13140/RG.2.1.2658.1924  Umlauf, L., & Burchard, H. (2003). A generic length-scale equation for geophysical turbulence models. *Journal of Marine Research*, *61*(2), 235–265. https://doi.org/10.1357/002224003322005087  Umlauf, L., & Burchard, H. (2005). Second-order turbulence closure models for geophysical boundary layers. A review of recent work. *Continental Shelf Research*, *25*(7–8 SPEC. ISS.), 795–827. https://doi.org/10.1016/j.csr.2004.08.004 | |
| Form was updated (YYYY-MM-DD) | 2019-07-29 |

|  |  |
| --- | --- |
| Please tick this box if we can acknowledge your contribution on the wiki. Your name would be placed on the "List of Contributors" tab of the wiki. |  |

(Bruggeman & Bolding, 2014)

(Burchard et al., 2006)

(Burchard & Baumert, 1995; Burchard & Petersen, 1999)

(L. Umlauf & Burchard, 2003; Lars Umlauf & Burchard, 2005)

(Joehnk et al., 2015)

(Belolipetsky, Belolipetskii, Genova, & Mooij, 2010)

Belolipetsky, P. V., Belolipetskii, V. M., Genova, S. N., & Mooij, W. M. (2010). Numerical modeling of vertical stratification of Lake Shira in summer. *Aquatic Ecology*, *44*(3), 561–570. https://doi.org/10.1007/s10452-010-9330-z

Bruggeman, J., & Bolding, K. (2014). A general framework for aquatic biogeochemical models. *Environmental Modelling and Software*, *61*, 249–265. https://doi.org/10.1016/j.envsoft.2014.04.002

Burchard, H., & Baumert, H. (1995). On the performance of a mixed-layer model based on the κ-ε turbulence closure. *Journal of Geophysical Research*, *100*, 8523–8540. https://doi.org/10.1029/94JC03229

Burchard, H., Bolding, K., Kühn, W., Meister, A., Neumann, T., & Umlauf, L. (2006). Description of a flexible and extendable physical-biogeochemical model system for the water column. *Journal of Marine Systems*, *61*, 180–211. https://doi.org/10.1016/j.jmarsys.2005.04.011

Burchard, H., & Petersen, O. (1999). Models of turbulence in the marine environment - A comparative study of two-equation turbulence models. *Journal of Marine Systems*, *21*(1–4), 29–53. https://doi.org/10.1016/S0924-7963(99)00004-4

Joehnk, K. D., Stepanenko, V. M., Bueche, T., Gal, G., Goyette, S., Janssen, A. B. G., … Wen, L. (2015). Integrated modelling of lakes in the climate system - a summary from ASLO Granada and more. *4th Workshop on “Parameterization of Lakes in Numerical Weather Prediction and Climate Modelling"*, (August). https://doi.org/10.13140/RG.2.1.2658.1924

Umlauf, L., & Burchard, H. (2003). A generic length-scale equation for geophysical turbulence models. *Journal of Marine Research*, *61*(2), 235–265. https://doi.org/10.1357/002224003322005087

Umlauf, L., & Burchard, H. (2005). Second-order turbulence closure models for geophysical boundary layers. A review of recent work. *Continental Shelf Research*, *25*(7–8 SPEC. ISS.), 795–827. https://doi.org/10.1016/j.csr.2004.08.004