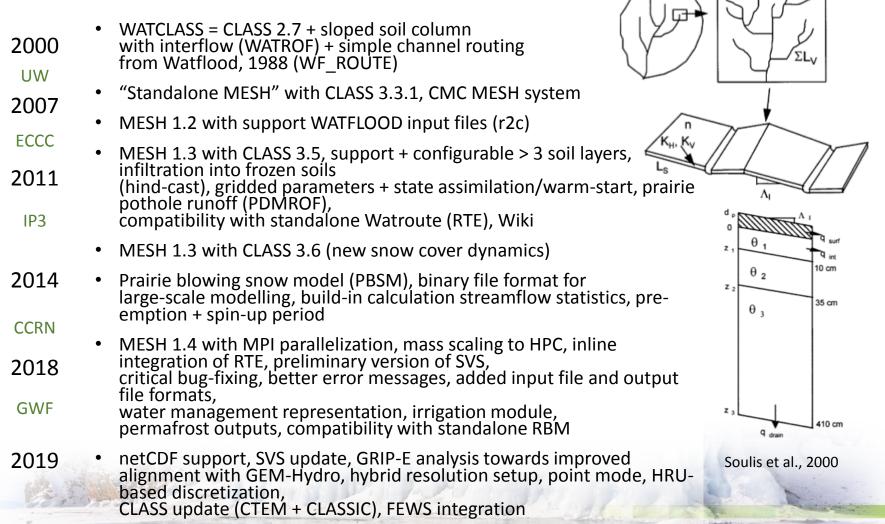


MESH Overview and development updates



Standalone MESH

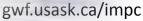
Modélisation Environnementale communautaire – Surface Hydrology



Basin Microdrainage

Program for Canada

Global Water Futures





Global Water Futures

Active collaborators





UNIVERSITY OF SASKATCHEWAN Global Institute for Water Security USASK.CA/WATER





Environment and Climate Change Canada

Environnement et Changement climatique Canada



















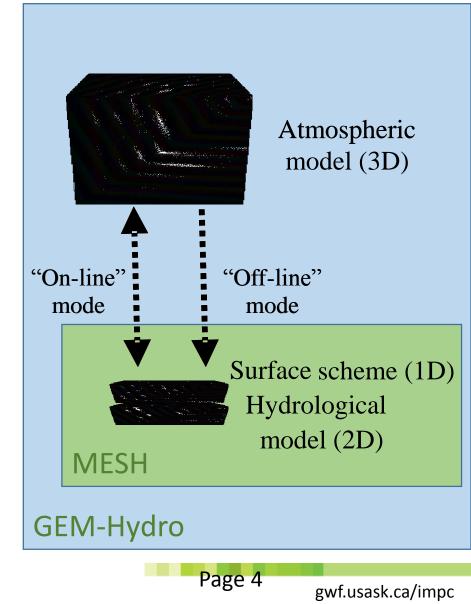
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Global Water Futures

What is MESH?

- Climate model caliber Land Surface Scheme (LSS) coupled with hydrology
- Discretization and regional scale processes compatible with numerical weather prediction (NWP) model outputs
- Ability to run "Off-line" decoupled from NWP infrastructure; suitable for calibration and/or sensitivity analyses of NWP models
- Scalable to high performance computing (HPC) clusters
- Portable to netbooks, laptops, desktops
- Support for various file formats for inputs and outputs, compatibility with other model-specific file formats (WATFLOOD, CLASS/CTEM) – compatible with efficient file formats, but still compatible with human-readable formats for teaching/training
- Flexible modes for discretization, ability to diagnose observation scale processes by running at point scale
- Ability to configure and activate/deactivate components via input files
- Accessible parameters
- Compared to GEM-Hydro, cannot be run in an "On-line" mode (no feedback is possible to atmosphere)





Global Water Futures

MESH "as a framework"

- Many floating variants: MESH-CLASS, MESH-SVS, "Mountain MESH", MESH-RBM, MESH-CTEM, MESH-SED
- Needed: Better organization and inline identification of MESH versions and active sub-components
- MESH "sub-models"? Models implemented in MESH that are not very interoperable with other 'sub-models' of the same type

LSS: CLASS, CTEM, CLASSIC, SVS, ICEBAL Routing: WF_ROUTE, RTE

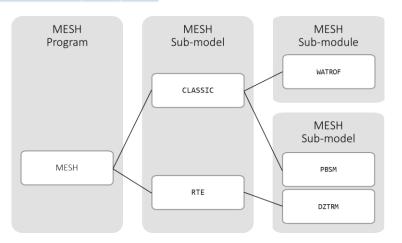
• MESH "sub-modules"? Interoperable with 'sub-models'

LSS: WATROF, PDMROF, PBSM, FROZENINFILFLAG, Solar_Adjust, irrigation Routing: DZTRM, Elevation-Stage-Release table

- Needed: Better streamlining and movement of development algorithms and models back to base MESH version
- Needed: Better archival and movement of development setups and/or established domains back to MESH development for benchmarking/future-compatibility testing

| Module | Coded | Tested | | |
|--|--------------|--------------|--|--|
| Canadian Land Surface Scheme (CLASS) 3.6 | ~ | \checkmark | | |
| CLASSIC | × | × | | |
| Soil-Vegetation-Snow (SVS) 1 | ~ | \checkmark | | |
| SVS 2 | \checkmark | \checkmark | | |
| Canadian Terrestrial Ecosystem Model 2.1.1 | ~ | × | | |
| SUMMA | × | × | | |
| Prairie Blowing Snow Model | ~ | \checkmark | | |
| Infiltration into frozen soils | \checkmark | × | | |
| Prairie pothole model (PDMROF) | ✓ | ✓ | | |
| Sloped interflow (WATROF) | ~ | \checkmark | | |
| WATROUTE (1988, RPN) | ~ | \checkmark | | |
| Dynamically Zoned Target Release Model | ~ | ~ | | |
| Irrigation demand (moisture- content based) | ~ | ~ | | |

| Module | Coded | Tested |
|--|--------------|--------------|
| Reservoir release curves | ~ | ~ |
| Simple aquifer, lower zone storage (Luo, 2012) | ~ | × |
| Simple aquifer, lower zone storage (WATROUTE LZS) | ~ | ~ |
| Permafrost outputs | \checkmark | \checkmark |
| netCDF input (time-series) | \checkmark | ~ |
| netCDF output (time-series) | \checkmark | × |
| Point glacier energy/water balance model (ICEBAL) | ~ | ~ |
| Canadian Small Lake Model | × | × |
| Wetland Model | × | × |
| Irrigation demand (PEVP based) | \checkmark | × |
| Abstraction, diversion | \checkmark | ~ |



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Global Water Futures

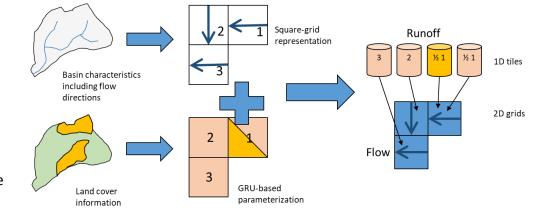
Discretization

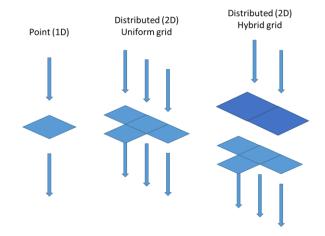
Active

- Distributed (2D) Uniform grid
 - Traditional grid-based implementation
 - Common grid specification for LSS, routing
 - All current examples of MESH in publication
- Point (1D)
 - No grid specification
 - Used to diagnose LSS at point/observatory scale

Experimental

- Distributed (2D) Hybrid grid
 - Different grid specification allowed for LSS than for routing
 - Inline interpolation (using simple nearest)
 - Presently requires both grids to use same datum/ellipsoid and projection





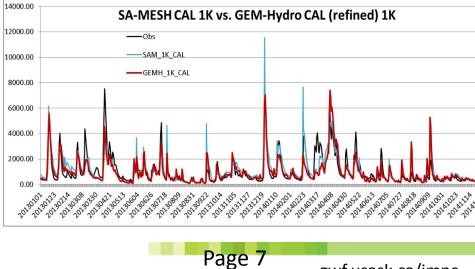
Page 6

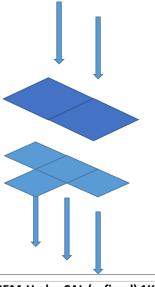
GRIP-E + GEM-Hydro alignment

Integrated Modelling Program for Canada Global Water Futures

Distributed (2D) Hybrid grid

- Existing implementation for GRIP-E
 - SVS updated in MESH
 - Scripts created to convert GEM-Hydro setups from 'Standard File Format' (FST) to r2c (point-by-point conversion)
 - Sub-grid GRUs/tiles deactivated (per GEM in GEM-Hydro)
 - Grid-based parameterization (fully-distributed)
 - Proper support added for Vegetation Fraction (VF) based weighted parameterization (to support all 26 sub-grid land cover types)
 - SVS modified to use user-specified soil layer discretization
 - Grid-based state initialization re-enabled for RTE (formerly disabled by CCRN-era MESH redevelopment)
- Initial findings
 - Calibrated parameter set of MESH does not perform the same in GEM-Hydro
- Identified issues
 - MESH missing non-SVS tiles: water, urban/town, etc..
 - SVS connector in MESH was implemented using an old SPS (GEM-Hydro) driver – out-of-date, does not match current SPS driver
- Next steps
 - Needed: A better strategy and support for moving updates between GEM-Hydro/MESH
 - (Also applies for CLASSIC/CLASS)
 - (Also applies for moving development/research code to operational systems)
 - MESH-SVS connector recoded based on current SPS driver
 - Implementation of the remaining GEM-Hydro tiles





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Wiki and code management

Wiki

- Hosted at University of Saskatchewan
- Public access for viewing, controlled access for editing pages
- Confluence GUI, intuitive for editing pages

https://wiki.usask.ca/display/MESH/MESH+User+Page

Please contribute

Repository (SVN)

- Presently using Subversion (SVN)
- Presently hosted at University of Waterloo
- Controlled access
- Multiple GUIs and command-based options across Linux, Mac and Windows

| | | | Organize + Inclu | de in library | | ¦≣ • [| 1 0 | | | |
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| hydrology land-surface scheme (HLSS) of Environment and Climate Change | | | 🚽 Music | model_output.190 | 1/16/2018 10:40 AM F90 File | Revision Actions | | ate | Message | |
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| 2007), and is complimentary to ECCC's GEM-Hydro modelling platform. MESH allows different surface component models to coexist within the same modelling | Daniel - view change | Spaces + People Browse + Create Q 🔍 🔘 + 🚨 👤 + | Subversion | module_files.50 | 12/16/2017 6:07 PM F90 File | 1248 | | iday, January 12, 2018 5:17:39 P | | 'DAILY' accumulators with n |
| tranework so that they can easily be compared for the same experiment using | Debugging with gdb (GNU) | | 🚼 Videos 😑 | module_files_variables.f90 | 12/16/2017 5:11 PM F90 File | 1245 Ø | | lednesday, January 10, 2018 4:4 | | f and 'rchg' variables of 'sta |
| exactly the same forcings, interpolation procedures, grid, time period, time step and | Dec 13, 2017 • updated by Princz, | to the Standalone MESH Wild / Releases / Interim releases | | module_files_variabletypes.f90 | 7/10/2017 8:59 AM F90 File | 1244 0 | | lednesday, January 10, 2018 2:3. lednesday, January 10, 2018 12:3 | | date routine to pull from 'sta where (var == NO_DATA)" |
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| model. This makes it possible to test changes to the land surface schemes offline | (Subversion, SVN) | | Data (D:) | R2C_DATA.F90 | 7/10/2017 8:59 AM F90 File | 1240 | | onday, January 08, 2018 5:10:35 | | s_grid' instead of 'stas' to pr |
| and to drive the HLSS with forcing data from other sources such as direct | Dec 05, 2017 • updated by Princz, Eaniel • view change | | Generation (∖\ja: State interest of the state of the sta | read_basin_structures.190 read_config_output.190 | 12/16/2017 6:07 PM F90 File 7/10/2017 8:59 AM F90 File | 1239 | Daniel.Princz Mi | onday, January 08, 2018 3:25:10 | PM Added reset and upda | ate to the init routine in outp |
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| currently with the Global Institute for Water Security (GIWS), located at the | Cytowin Terminal | ance file and added options for daily, hourly, monthly, or per time-step (its) output; the output frequency is configured by the | Cabinet (T:) | read_initial_inputs.tsu read_initial_states.f90 | 12/16/2017 3:10 PM F90 File | 4 | | | | |
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