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Supplement of

Optimality-based non-Redfield plankton–ecosystem model (OPEM v1.1) in UVic-ESCM 2.9 – Part 1: Implementation and model behaviour

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Manual

UVic-OPEM Set-Up, Calibration, and Reference Simulations

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1 Setting up UVic-OPEM

1.1 Prerequisites

In order to compile and run UVic-OPEM, first the programs `bash`, `perl`, and a Fortran-90 compiler must be installed. Then the `netcdf` library and its Fortran interface must be compiled with the same Fortran compiler to be used for UVic-OPEM. When installing pre-compiled `netcdf` libraries, make sure it was compiled with the same Fortran compiler as used in your system.

1.2 Obtaining and compiling the code

1. You can obtain the base UVic code from <http://www.climate.uvic.ca/model/>. Switch to a directory selected for your UVic-OPEM installation, untar the base UVic code there, and change to the directory thus created. In the following, this directory will be referred to as `<base>`.
2. Change to the `updates` folder.
3. Download the OPEM v1.1 code from https://dx.doi.org/10.3289/SW_1_2020 and unpack it inside the `updates` folder
4. Create another directory, `<run>` in the following, preferably outside of `<base>`, change to there, and create two sub-folders, `<run>/orig` and `<run>/OPEM`.
5. Copy `mk.in_orig` to `<run>/orig/mk.in` and `mk.in_OPEM` to `<run>/OPEM/mk.in`.
6. Open `<run>/orig/mk.in` with a text editor and replace `<base>` on line 5 with the actual path.
7. In order to obtain the Original UVic executable, change to `<run>/orig` and issue the command `<base>/mk -e` to compile the code. This should generate the executable `<run>/orig/UVic_ESCM` (specified towards the end of `<run>/orig/mk.in` as `Executable_File`). If the compilation failed, examine the file `<run>/orig/mk.log` for error messages.
8. For the OPEM executable (this is the same for both the OPEM and OPEM-H configurations), repeat the previous step for `<run>/OPEM`.

2 Reference (trade-off) simulations

For the reference (trade-off) simulations, create three new folders, e.g., `<run>/ref_orig`, `<run>/ref_OPEM` and `<run>/ref_OPEM-H`, and copy the executables and data folders there (they are the same for OPEM and OPEM-H). Copy `<base>/updates/opem/restarts/restart_*.nc`. The place the `control.in_orig`, `control.in_OPEM` and `control.in_OPEM-H` there as well. Assuming you downloaded the `control.in_*` files to `<run>`:

```

cd <run>
mkdir ref_orig
mkdir ref_OPEM
mkdir ref_OPEM-H
cp -pr <run>/orig/{UVic_ESCM,data} ref_orig/
cp -pr <run>/OPEM/{UVic_ESCM,data} ref_OPEM/
cp -pr <run>/OPEM/{UVic_ESCM,data} ref_OPEM-H/
cp -pf <base>/updates/opem/restarts/restart_orig.nc <run>/ref_orig/data/restart.nc
cp -pf <base>/updates/opem/restarts/restart_OPEM.nc <run>/ref_OPEM/data/restart.nc
cp -pf <base>/updates/opem/restarts/restart_OPEM-H.nc <run>/ref_OPEM-H/data/restart.nc
cp -p control.in_orig ref_orig/control.in
cp -p control.in_OPEM ref_OPEM/control.in
cp -p control.in_OPEM-H ref_OPEM-H/control.in

```

The you can obtain the 1-year reference simulation for the original UVic with

```

cd <run>/ref_orig
UVic_ESCM > log

```

and analogously for OPEM and OPEM-H. Note that these simulations assume that the year has 360 days. Thus, the time integrals must be multiplied with 365/360 to obtain annual rates.

3 Calibration simulations for OPEM and OPEM-H

3.1 Compile UVic_ESCM

The calibration simulations can be set up with the files in <base>/updates/opem/calibration. For these simulations we used 365-day years, so the UVic_OPEM must be recompiled with a different mk.in:

```

cd <run>
mkdir calib
cp -p <base>/updates/opem/{mk.in,calibration/*} calib/

```

Now, again, edit calib/mk.in, replacing <base> with its actual path, and compile:

```

cd calib
<base>/mk -e

```

3.2 Creating parameter files

Inside the calibration folder (<run>/calib) create two new folders, OPEM and OPEM-H and create the 400 control_*.in.in files in each of them:

```

mkdir OPEM
mkdir OPEM-H
cd OPEM
../write_control ../control.in.OPEM
cd ../OPEM-H
../write_control ../control.in.OPEM-H

```

The script write_control substitutes the 400 parameter combinations in the file parameter.txt in the control.in.* templates. The control_*.in.in files are set up for 100,000-year simulations in steps of 1000 years. In order to do these simulations, set up 400 folders, copy the <run>/calib/UVic_ESCM and <run>/calib/data there, and distribute the control_*.in.in files to <run>/calib/{OPEM,OPEM-H}/*/control.in.