Implementation of the FLake lake model in the Joint UK Land Environment Simulator (JULES)

Gabriel Rooney
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JULES and the Unified Model

• The Met Office Unified Model (UM) is used for both climate and NWP.

• The land surface in the UM is modelled by the Met Office Surface Exchange Scheme, MOSES (e.g. HCTN 30, or Rooney & Claxton, QJRMetS 2006)

• A stand-alone version of MOSES was produced at UM Version 5.5.

• This led to the release of the academic community resource JULES, http://www.jchmr.org/jules/
Overview of JULES

9 tiles, 5 veg + 4 non-veg

Forced with observables: T, P, q, DWSW, DWLW, windspeed, rain, snow

Yields:
surface (canopy) T, sensible + latent heat fluxes, soil temperature and moisture

`Lake’ tile is more like a bog (soggy soil).
Interfacing Flake with JULES

• JULES already calculates surface fluxes, so the SfcFlx part of FLake is not used.

• The lake part of FLake replaces the lake tile.

• The forcings passed to FLake are DWSW, the sum of all other heat fluxes and the momentum flux.

• Also passed are the timestep, Coriolis parameter, lake depth.

• JULES stores FLake outputs between timesteps.
Fixes and adaptations (1)

Presently, JULES does not use the lake surface temperature as diagnosed by FLake.

Instead, the subsurface temperature is used in a diffusive calculation, with the (liquid) thermal conductivity increased by an effective Nusselt number, currently with a fixed value of $\text{Nu}=100$. 
The JULES snow scheme is used as on all other tiles.

JULES limits the surface temperature to 0°C in the presence of a snow layer, however no such limit applies to snow-free `ground’. Thus a further limiting of the lake surface temperature is applied if an ice layer exists.

A check is applied such that snow cannot accumulate without the presence of an ice layer.
JULES / Flake comparisons

Since the I/O of the two models is similar, it is straightforward to compare model performance between JULES, FLake and J/F.

Year-long forcing, 30-minute resolution, from two sites:

**Loobos (Netherlands)**
Example forcing provided with JULES, begins in January.

**Abisko (Sweden)**
Cold-region dataset (snowfall OFF or ON), begins in August.

Running with lake fraction = 1.
Surface temperature

Abisko: snow
surface T (K)

Abisko: no snow
surface T (K)

JULES+FLake
FLake
JULES
Ice thickness

- Abisko: snow
  - Ice thickness (m) over days
  - Sample graphs showing ice thickness change over time with and without snow.

- Loobos
  - Graph showing ice thickness change over days.

- JULES+FLake
  - FLake
  - Additional graphs comparing different models.

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heat fluxes: unmodified JULES

Abisko: snow

Abisko: no snow

Loobos

SENSIBLE
LATENT
heat fluxes: JULES/FLake

Abisko: snow

Abisko: no snow

Loobos

SENSIBLE
LATENT
Future plans

- MOSES
- JULES1.0
- JULES/FLake
- JULES2.?
- UM5.5
- UM7.0
- UM7.? (DONE)
- JULES (PLANNED)
FLake in the UM

• ancillary data: lake database
• lakes covering more than one gridbox
• initialisation, data assimilation
• satellite lake products
(A) ATSR Lake Temperatures (1)

- (Advanced) Along-Track Radiometer
  - Space-borne instrument designed to observe ‘skin’ surface temperatures
- Spatial Resolution: ~1 km (global)
- Temporal Resolution: 1-3 days
- Lake surface temperatures included in operational Land Surface Temperature (LST) product
  - Available for ~1991 to present.
  - Accuracy ~0.5 K or better
Some issues:

- Not all lakes processed correctly – to be rectified.

Plans in pipeline to produce, consistent, high-accuracy, high-quality lake-surface temperature data set (>17 years)

Reference:


Operational info/data:

http://www.neodc.rl.ac.uk/ (select (A)ATSR multi mission)
http://envisat.esa.int/handbooks/aatsr/
Conclusion

FLake improves JULES...

…and will hopefully go on to improve the UM very soon!