



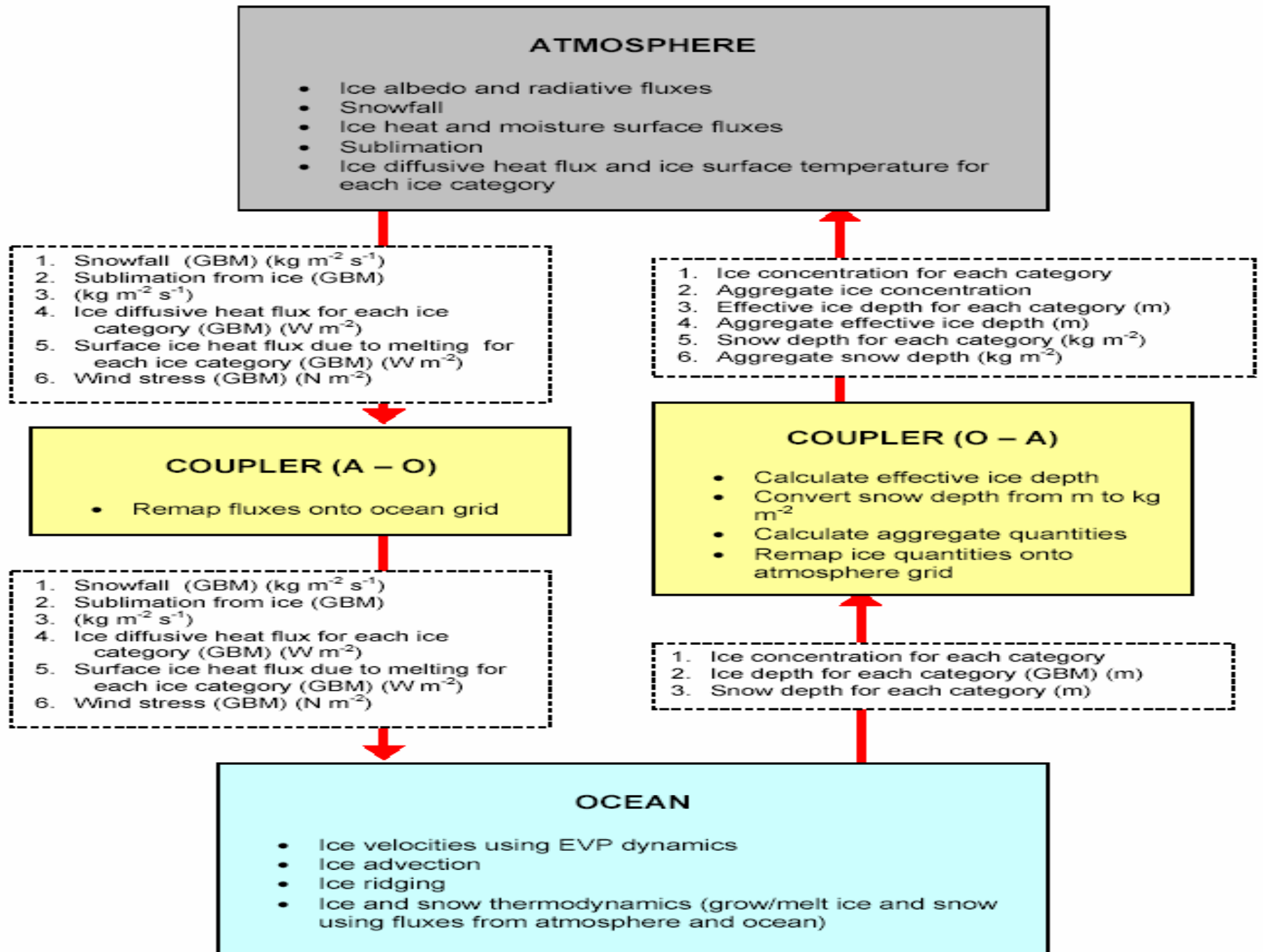
# Met Office plans for sea ice model development within a flexible modelling framework

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- The Unified Model (UM)
- Why change sea ice model?
- FLUME
- Implementing a standalone sea ice component within a coupled climate model
- Timescales

- Unified Model (UM) comprises an atmosphere and ocean model
- Sea ice is split between ocean and atmosphere models
- Sea ice model:
  - Zero layer thermodynamics
  - Multiple ice categories based on US-CICE code
  - Elastic-Viscous-Plastic dynamics based on US-CICE code
  - Based on a latitude-longitude grid



# Why change sea ice model?



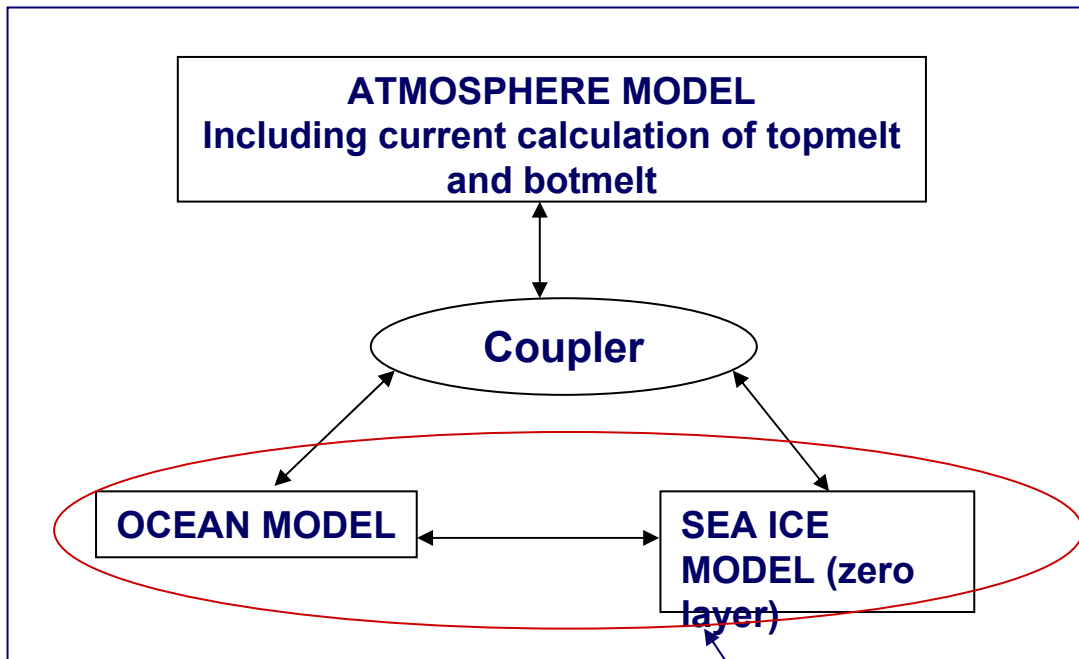
- We are already making the transition from the UM ocean model to NEMO ocean model
- The reasons for changing ocean and sea ice models are:
  - Grid choice: the lat-long grid leads to numerical issues (polar island, instabilities, filtering...)
  - Collaboration: work on shared code
  - Move to a standalone sea ice model
- Sea ice model in NEMO (LIM) is not compatible with the sea ice model in the UM atmosphere

- The sea ice model can be tested and ‘tuned’ independently of the full coupled model (eg, Paul Miller’s work)
- Maintenance of the code will be more efficient as currently we have to modify code in both ocean and atmosphere model
- It would be very difficult to implement multilayer thermodynamics in the current split sea ice model. A standalone sea ice model would allow the introduction of multilayer thermodynamics which should lead to:
  - Improvements in the seasonal cycle due to the inclusion of heat storage (zero layer may overestimate in the amplitude of the seasonal cycle and a lead in the phase)
  - Representation of brine pockets and slow release of salt into the ocean

- Our preferred choice of standalone sea ice model is the CICE model developed at Los Alamos
- The current UM has been modified to include many of the CICE developments; EVP, multiple categories
- We have existing collaborations with groups using CICE (eg, CPOM)
- There are some issues to be resolved in using shared code (eg, copyright, licensing, commercial use...)

- PRISM is a European project to allow coupling of different model components
- FLUME (**FL**exible **U**nified **M**odel **E**nvironment) will be the Met Office version of PRISM
- The scope of FLUME includes:
  - Developing infrastructure to run non-UM models
  - Coupling (probably use the PRISM (OASIS) coupler)
  - Guidelines for development of scientific models
  - Metadata design, diagnostic control, I/O, output format, restartability, user interface, configuration management, etc

- Work is starting on a coupled model prototype within FLUME
- The closest equivalent to HadGEM1 within the FLUME context will be the HadGAM1 atmosphere, NEMO ocean model and CICE sea ice model
- As a first step we will implement CICE with zero layer thermodynamics and leave the atmosphere model unchanged (ie, HadGEM1-equivalent)



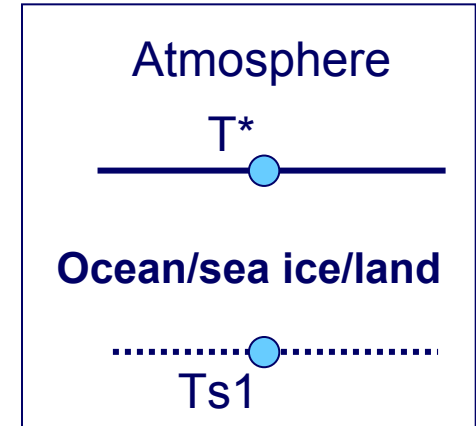
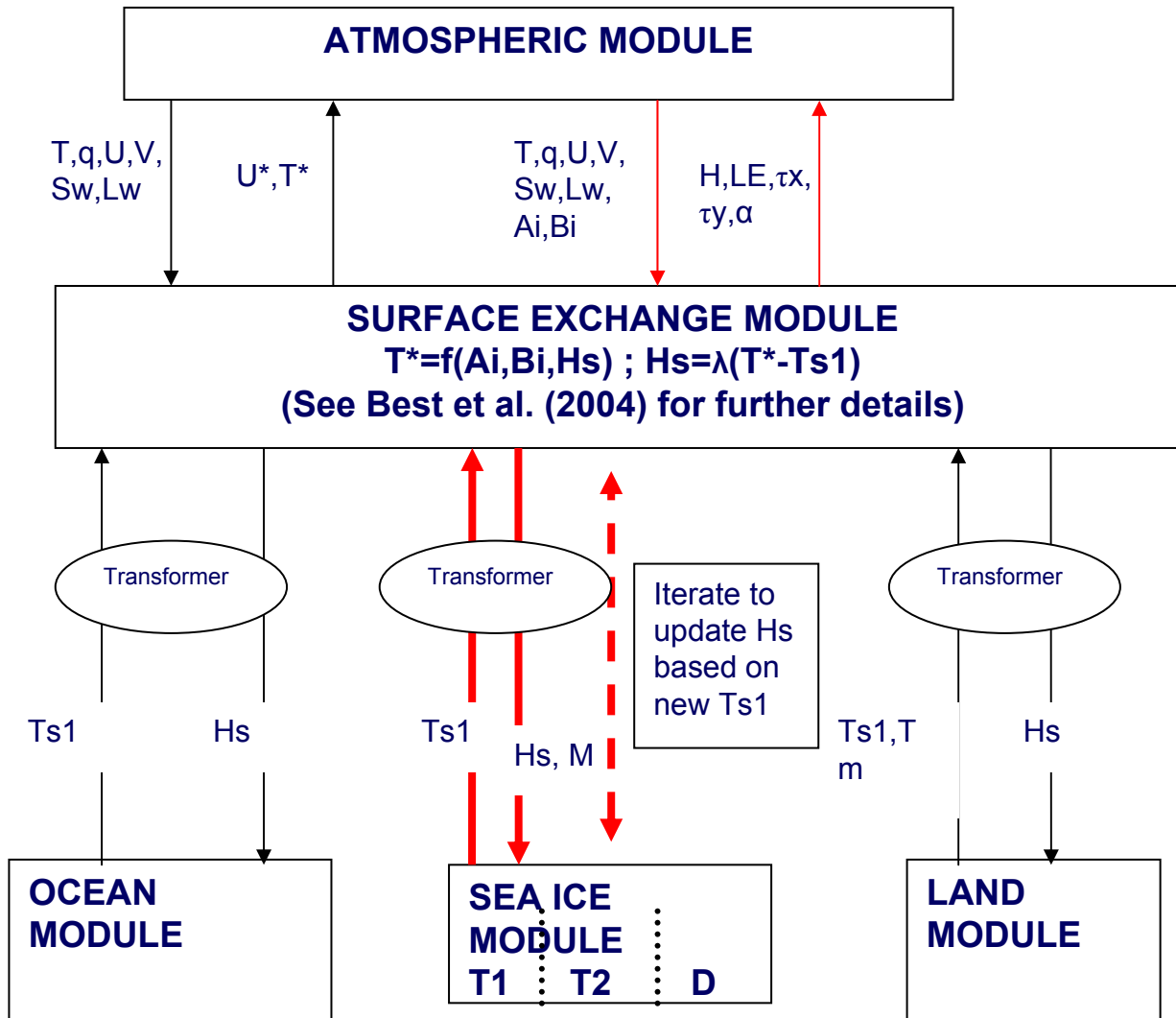
```
do day=1,360
  do hour=1,24
    call atmosphere
  enddo
call coupler
do hour=1,24
  call ocean
  call sea ice
enddo
enddo
```

- Run the model with 3 parallel executables
- ‘Puts’ and ‘gets’ of coupling data within atmosphere and ocean/sea ice model

## The next steps are to:

1. Introduce a surface exchange module
  - continue to run zero layer thermodynamics but with sea ice as a fully standalone model
  - this will also allow land models to be interchanged
2. Introduce multilayer thermodynamics in the sea ice model
  - investigate the requirements for numerical stability with the multilayer thermodynamics
  - iterations of the sea ice model may be required
  - issues with using different grids for atmosphere and sea ice

# Schematic of standalone sea ice model (including multilayer thermodynamics) within the coupled climate model



Ocean and land can use  $T_{s1}$  from previous timestep - this may not be possible for sea ice because  $T_{s1}$  may change significantly over a timestep (thin snow layers)

- The provisional timescales for working towards this are:
  - April 2006: begin to set up CICE at the Met Office with zero layer thermodynamics
  - April 2007: coupled model prototype ready (HadGAM1-NEMO-CICE zero layer)
  - April 2009: Surface exchange module and multilayer thermodynamics included