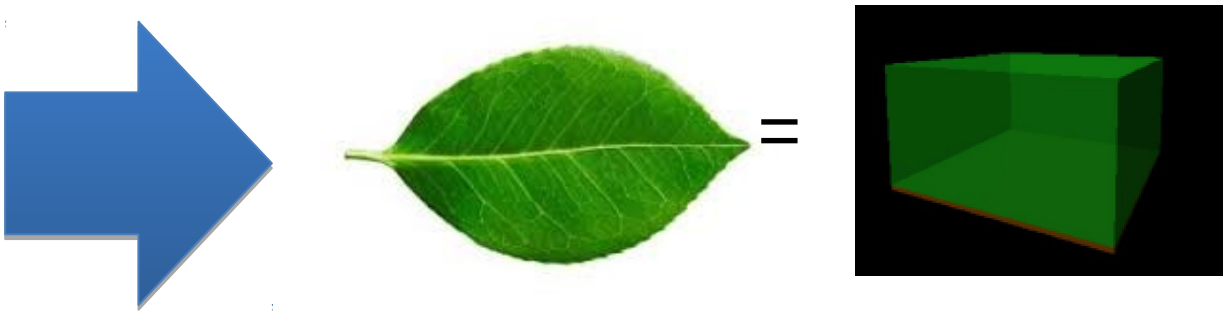
A multi-layer energy balance scheme

- Why a multi-layer energy canopy scheme ?

Ecosystem structure

Model representation

Big leaf model

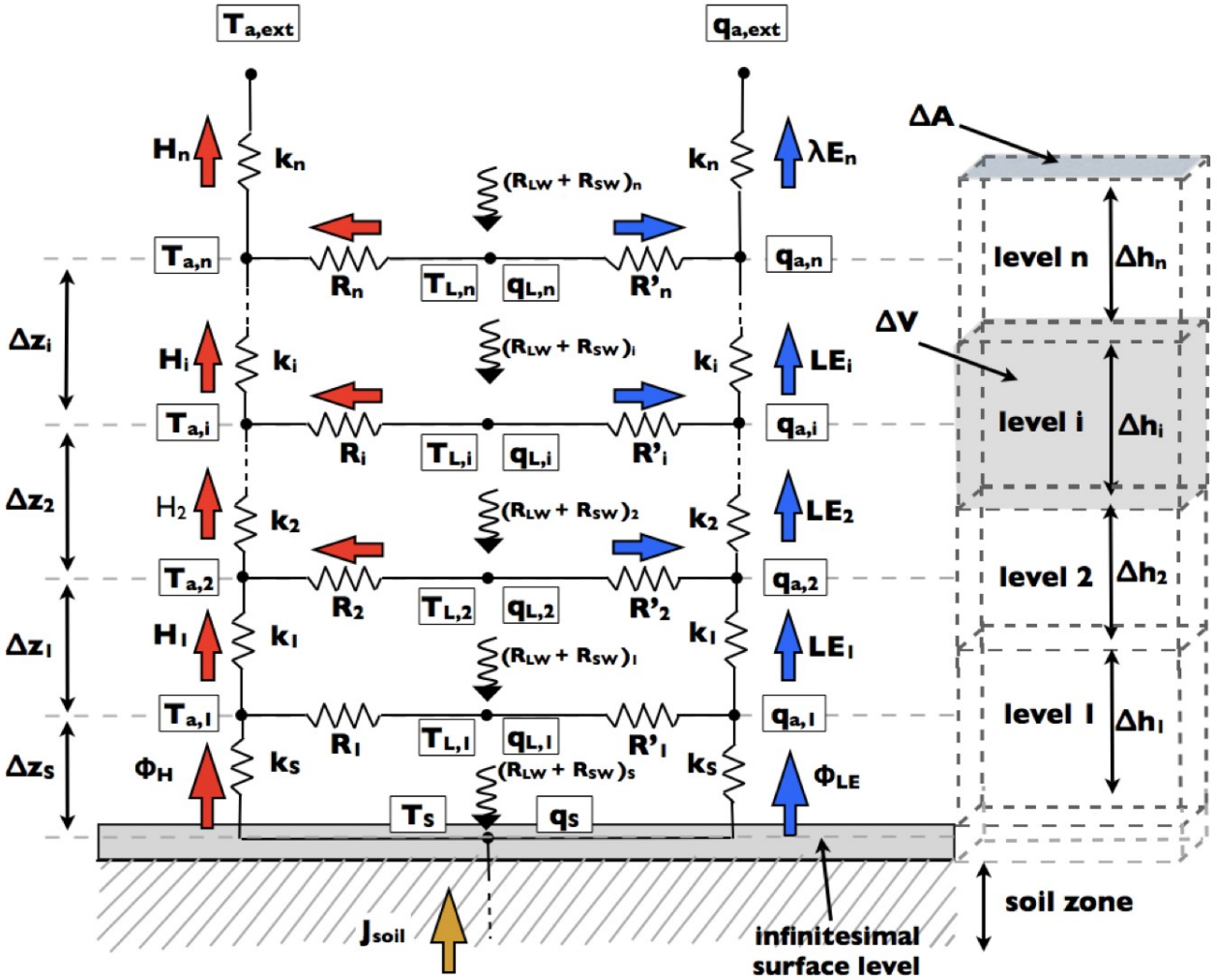


- DGVM still poorly represent site-level heat fluxes
- Canopy space and Trunk crown have different behaviours
- Under-storey vs over-storey representation ?
- Link to ecosystem services: forest canopy climate

Multi-layer energy budget

Ryder et al., 2015

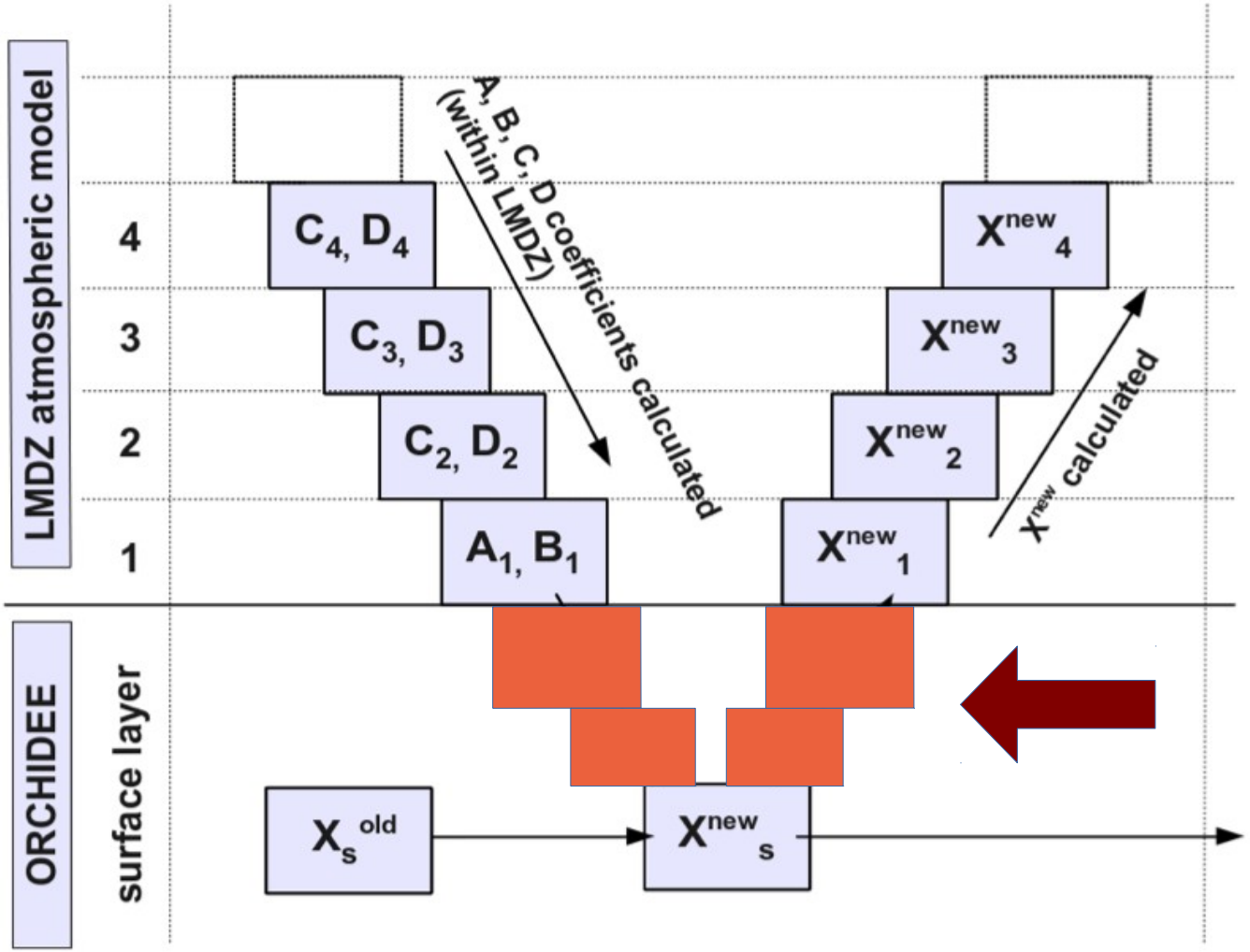
- Free number of layers
- E / W / C exchange at each level
- Turbulent mixing within air canopy
- Light penetration following Pgap model



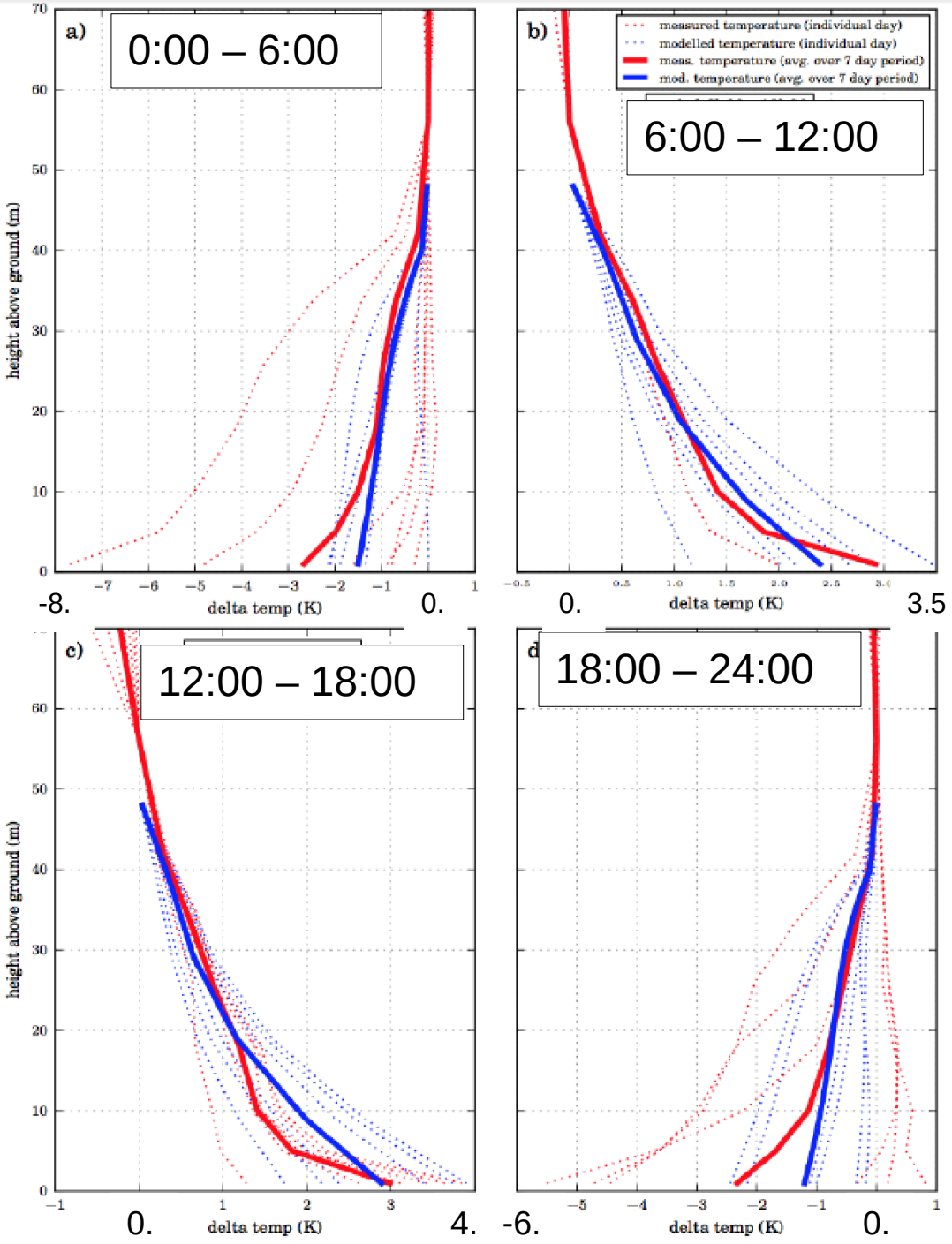
Implementation constraints :

- Coupling with plant growth / harvesting module (variable plant height)
- Implicit coupling with Atmospheric model (30' step)
- Parametrisation of intra-canopy turbulence

implicit coupling



Continuation of atmospheric levels into the land surface model BUT inclusion of vegetation interactions and transport



Daily temperature

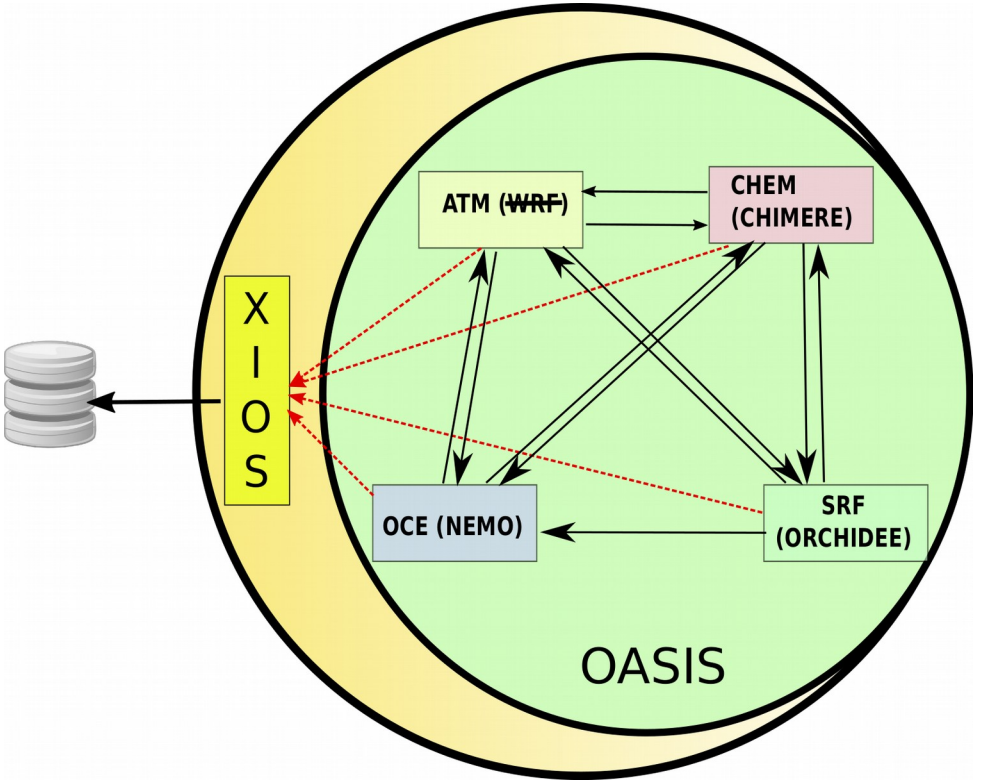
Temperature profile at Tumbarumba site

Observations

Model

Ryder et al., 2015

Coupling within RegIPSL



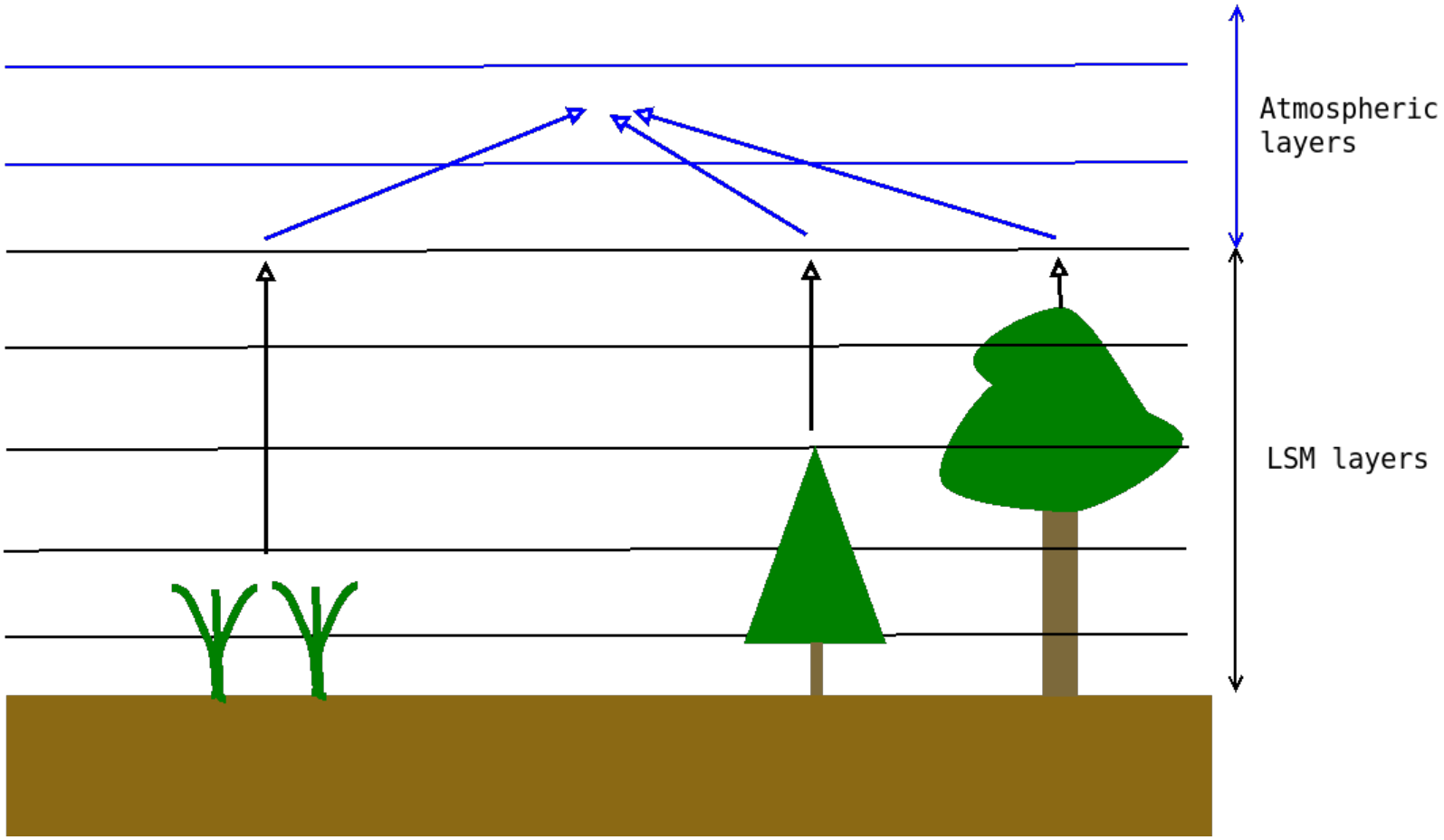
- At 20km resolution the atmosphere uses a 90s time-step Thus the coupling can be explicit.
- With 90s we are at the upper limit of the CFL criteria of the dynamics.
- OASIS only passes the “B-coefficients” in the elimination.
- OASIS also passes river discharge directly to NEMO at the resolution of the routing (1km).

- Having ORCHIDEE as a separate executable offers some flexibility :
  - Task parallelisation can be used,
  - Another domain decomposition than the atmosphere is possible (Current parallelisation is not adapted for a routing with a 1h timestep).
- OASIS is not the ideal tool as it adds a lot of complexity.
- As soon as XIOS will manage the exchange of variables between components it will be an excellent replacement and simplify coupling.

Challenges for the coupling to the atmosphere

- Atmospheric model levels are now well within the canopy (i.e. < 10m)
- LSMs start to represent in-canopy turbulence (Ryder et al., ….)
- The surface heterogeneities remain and still need to be better represented.
- Proposed solution :
  - The first AGCM levels should counted starting at the highest vegetation covers (i.e. within the surface layer).
  - The LSM will represent the turbulence within the canopy or up to the first atmospheric level (The layers where vertical exchanges and surface heterogeneities dominate).
  - This vertical diffusion represented in the LSM will be per PFT or surface type and without lateral exchanges.

Could this be a solution ?



- The lower boundary condition of the GCM would be purely in fluxes (Neumann closure) : turbulence and radiation
- That interface would also be the merger point of sub-grid surface variability.