



The EC-Earth modelling challenges

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& EC-Earth & ECMWF teams

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Why EARTH ?

- National weather services and climate services are increasingly integrated in many (smaller) countries
- Seasonal forecasting, decadal prediction and climate projections are increasingly intertwined

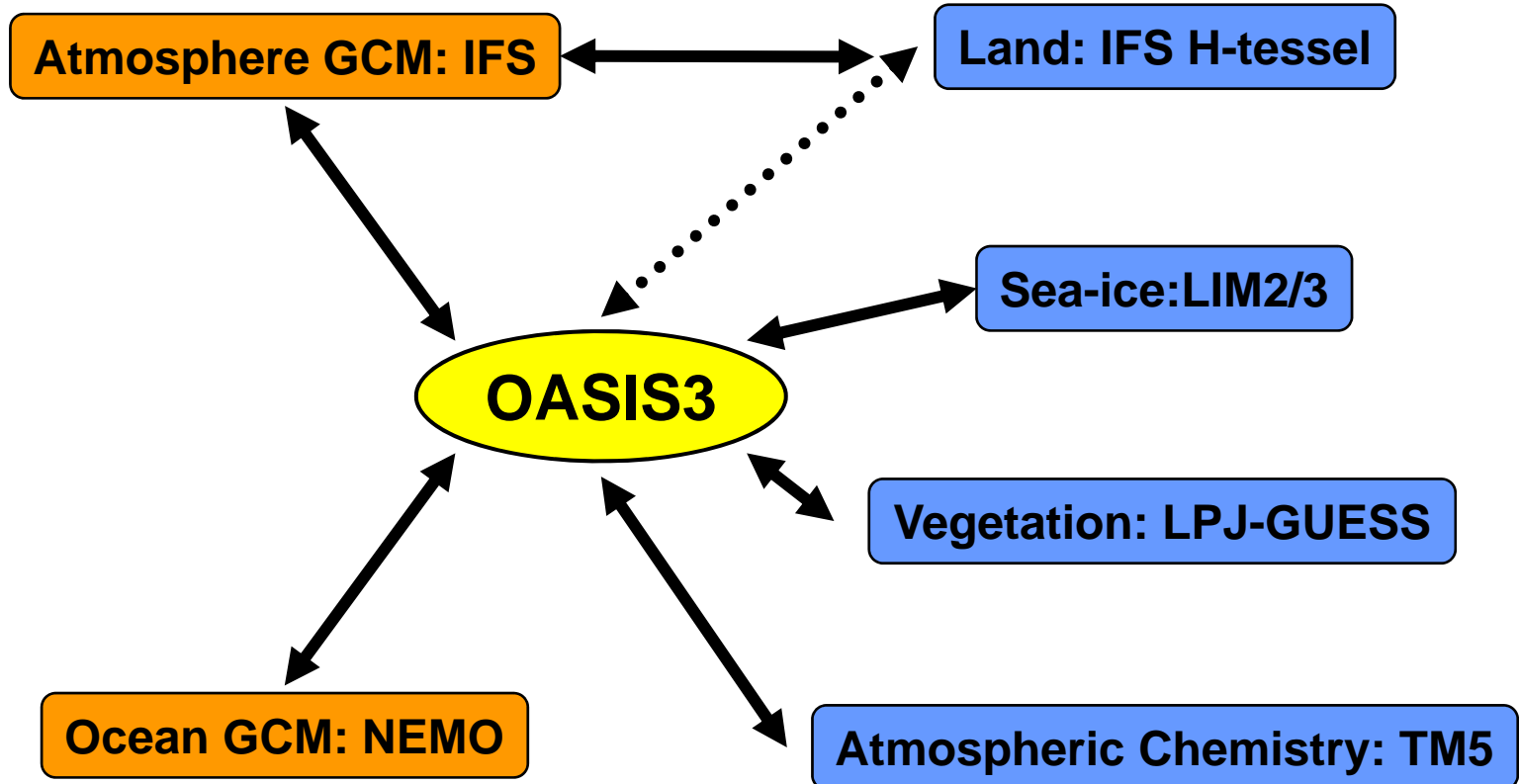


- Let's take a very good NWP/Seasonal Forecasting system as template for a multi-national GCM



-  **ECMWF** is a logical choice

Core structure of EC EARTH



DMI, Denmark

IMAU, The Netherlands

Instituto de Meteorologia, Portugal

Centro de Geofísica, University of Lisbon, Portugal

KNMI, The Netherlands

Meteorologisk Institutt, Norway

Unité ASTR, Belgium

Met Éireann, Ireland

University College Dublin, Ireland

Universiteit Utrecht, The Netherlands

Vrije Universiteit Amsterdam, The Netherlands

Meteorologiska Institutionen, Stockholm, Sweden

Lund University, Sweden

ICTP, Italy

SMHI, Sweden

AEMET, Spain

ETH, Switzerland

BSC, Spain

Universiteit Wageningen, The Netherlands

IRV, Sweden

ICHEC, Ireland

IC3, Spain

European structure
with national teams

- Running spin-up for IPCC AR5 runs
 - C20C
 - Decadal predictions
 - RCP projections
- Partners in European projects
 - COMBINE
 - THOR
 - ISENES
- Key platform in national climate scenario service
- Central modelling platform in Dutch University Research programs

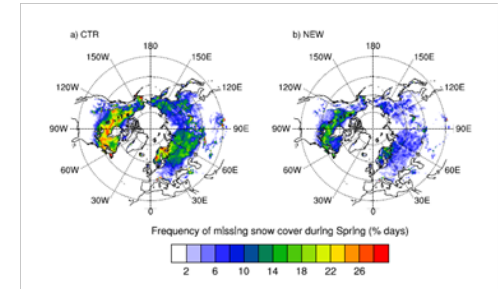
Some of the big challenges!

- Organizational

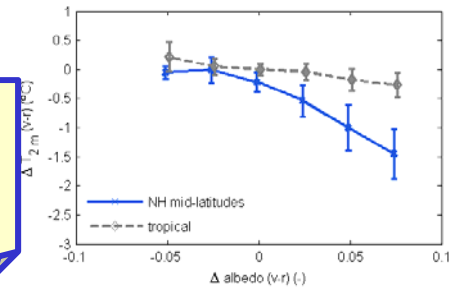
- Keep the model

- snow
 - irrigation, wetlands, lakes
 - phenology, crop
 - urban areas
 - ...

Development of a new snow scheme



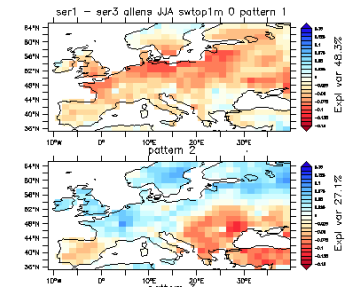
Land use change effects (LUCID)



- Scientific

- Get realistic feedbacks & interactions
 - Verification of feedbacks

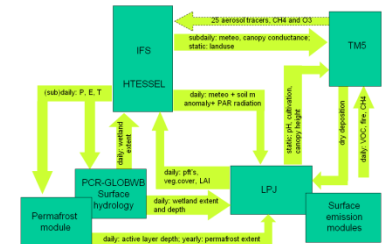
Summer drying in Europe (GLACE2)



- Technical

- Interfacing with routing, dynamic

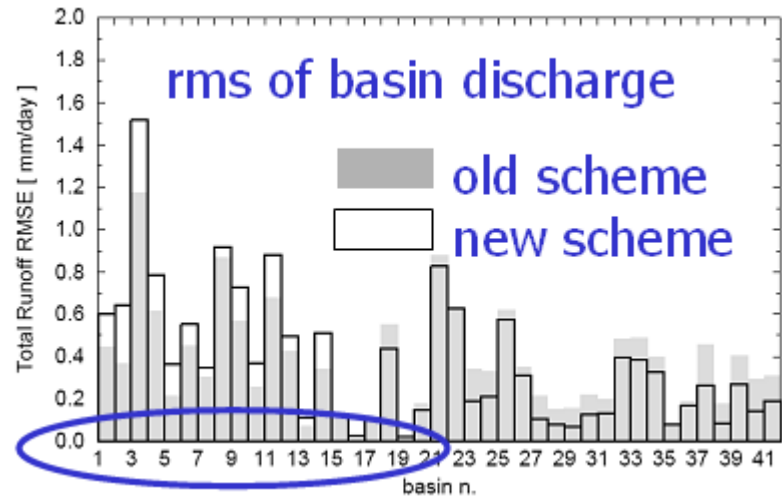
Anticipated coupling to dynamic vegetation



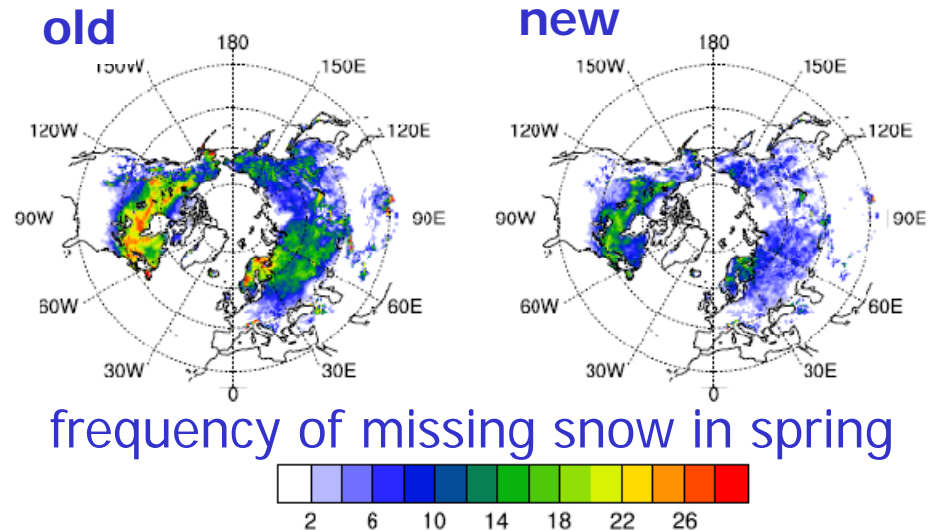
A new runoff scheme at ECMWF

SNOW

Balsamo et al (2009):
New runoff scheme improved discharge, expect in snow dominated basins

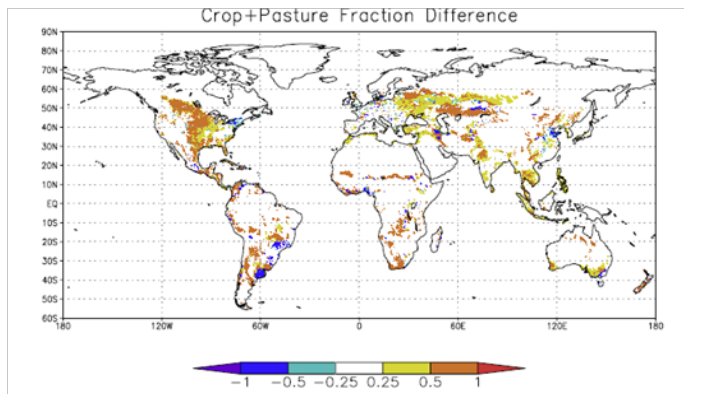


Dutra et al (2009):
New snow scheme improves snow cover period and delays discharge in e.g. Ob basin

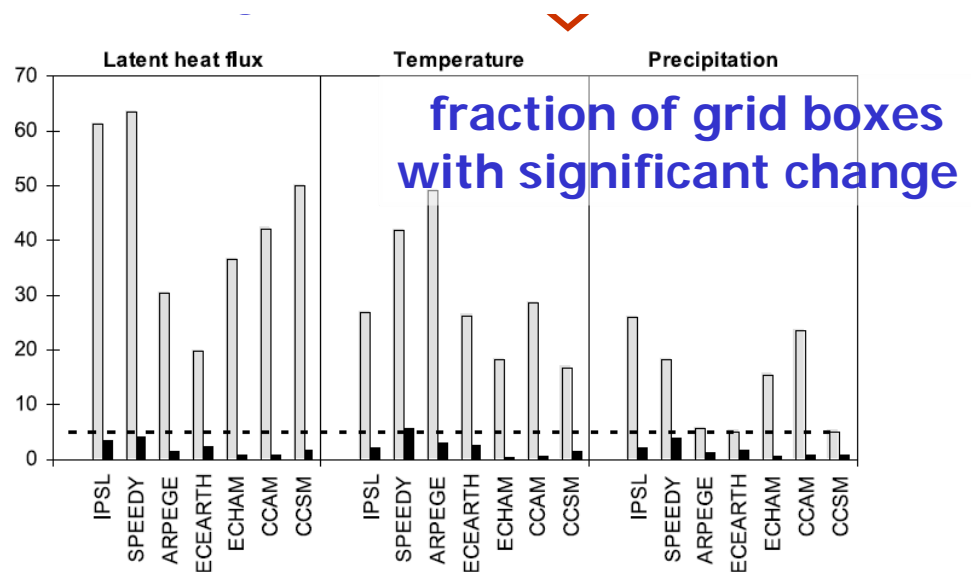


Land Use Experience (LUCID)

- Effects of land use and CO₂ change (1870 – 1992) on (regional) climate
- Multiple models, SST's prescribed



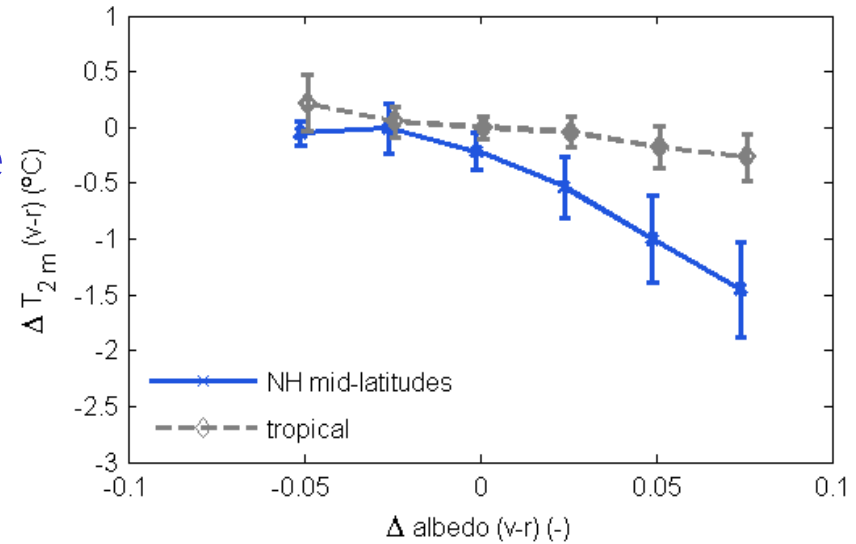
areas with LCC
 remote areas



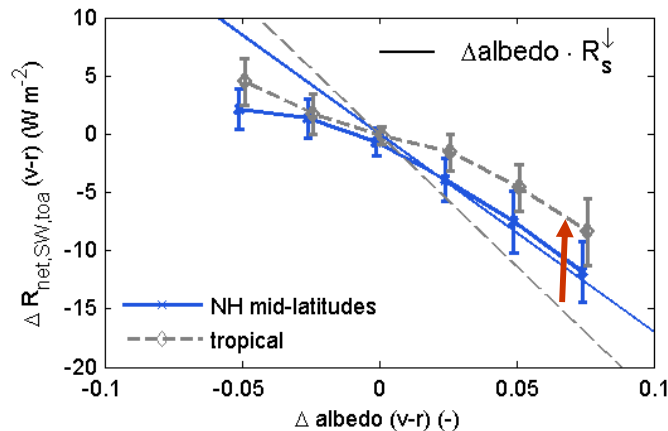
Feedback analysis in (atm only)

temperature response
per unit albedo change

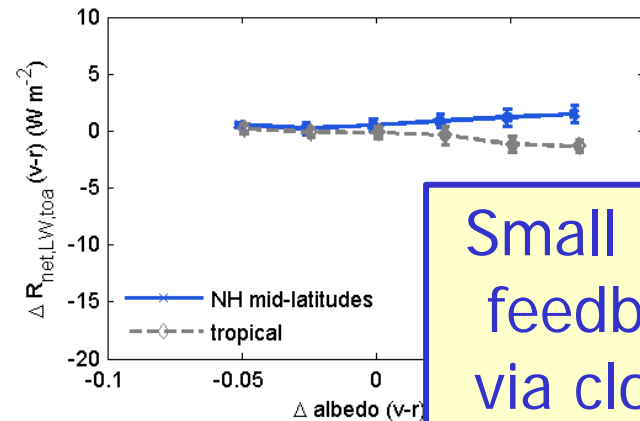
Strong neg. feedback
via clouds in tropics



ΔSW_{surf}



ΔLW_{surf}



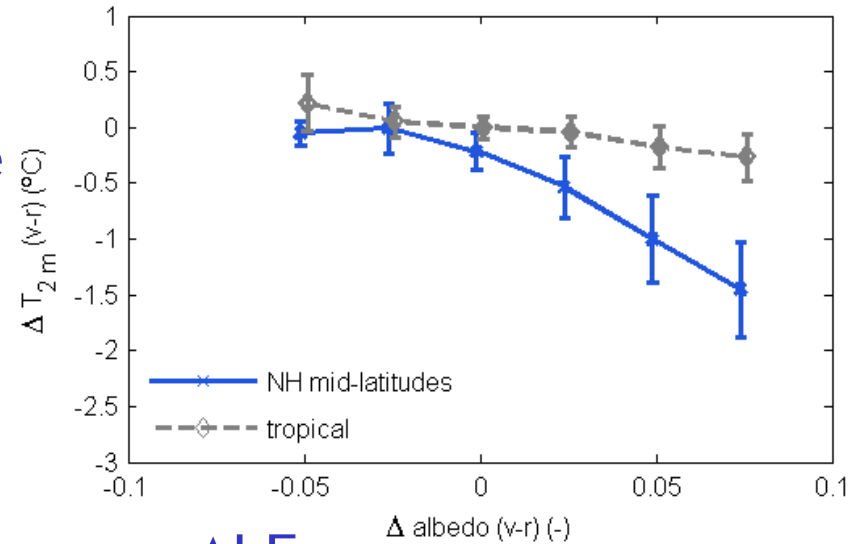
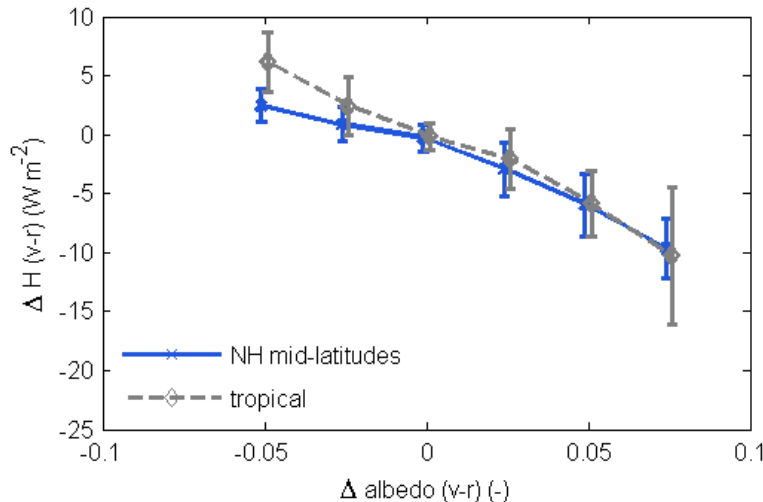
Small neg.
feedback
via clouds
in mid-lat.

Feedback analysis in EC EARTH (atm only)

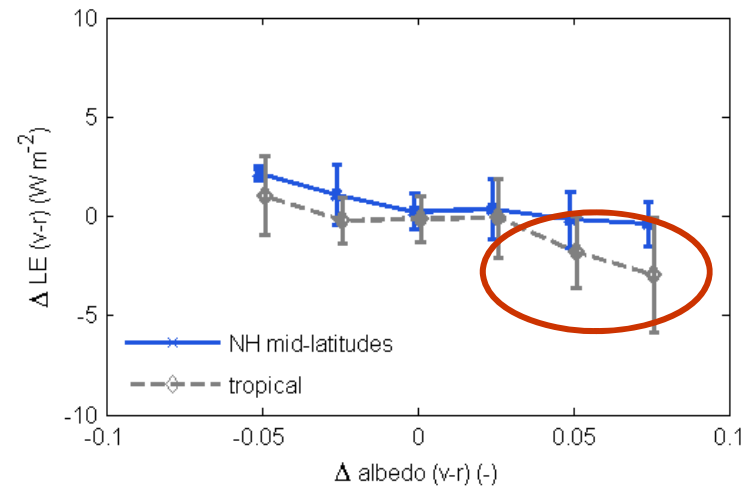
temperature response
per unit albedo change

Less evaporative
cooling in tropics

ΔH



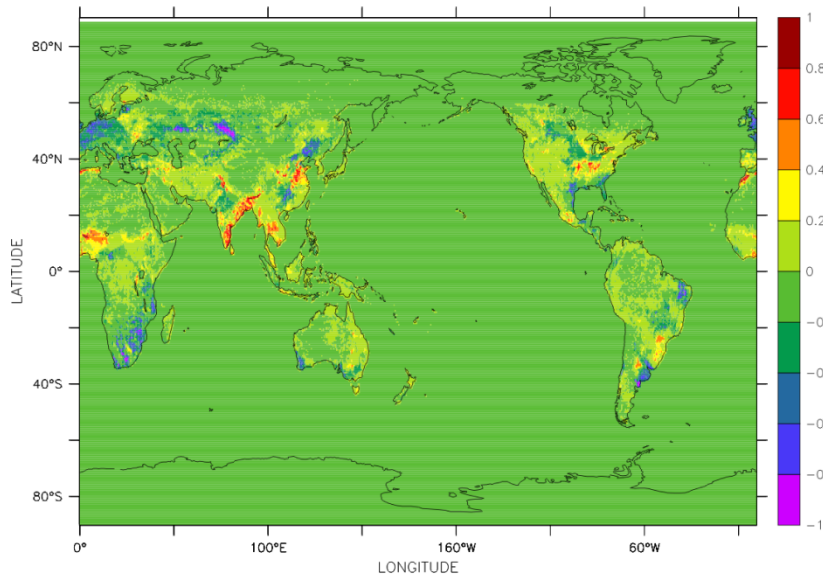
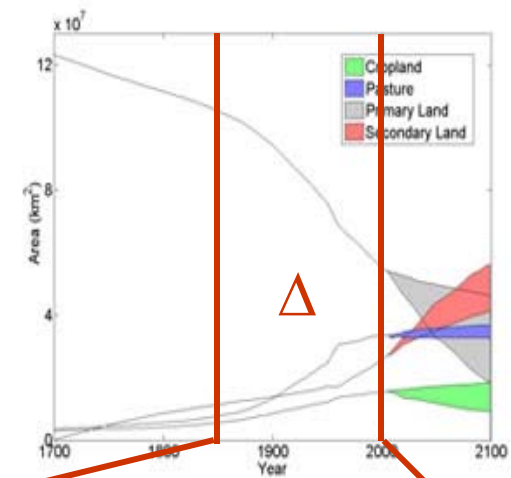
ΔLE



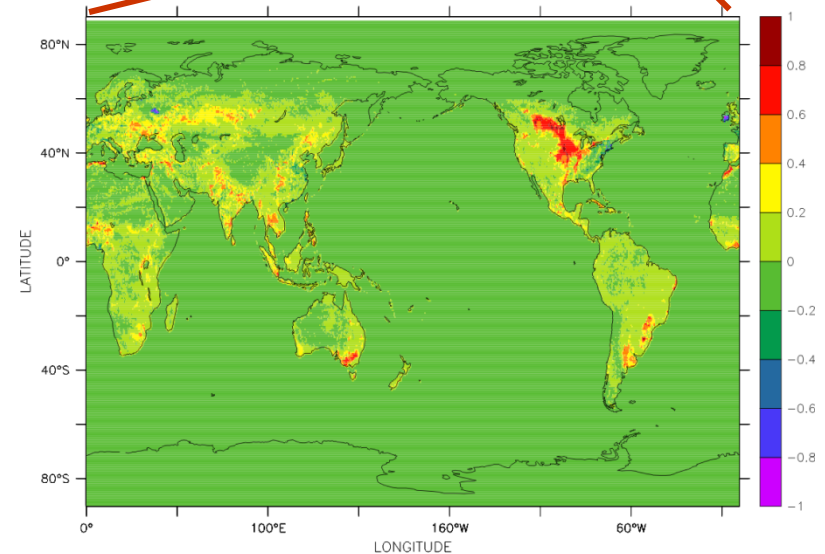
Now: preparing for IPCC 5

Input data:

Land Use Harmonization project



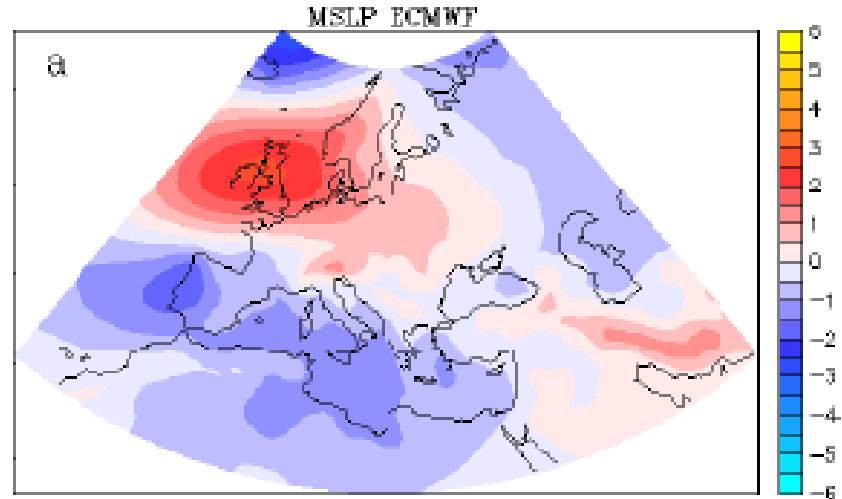
CROP2000- GLCCROP



CROP2000-CROP1850

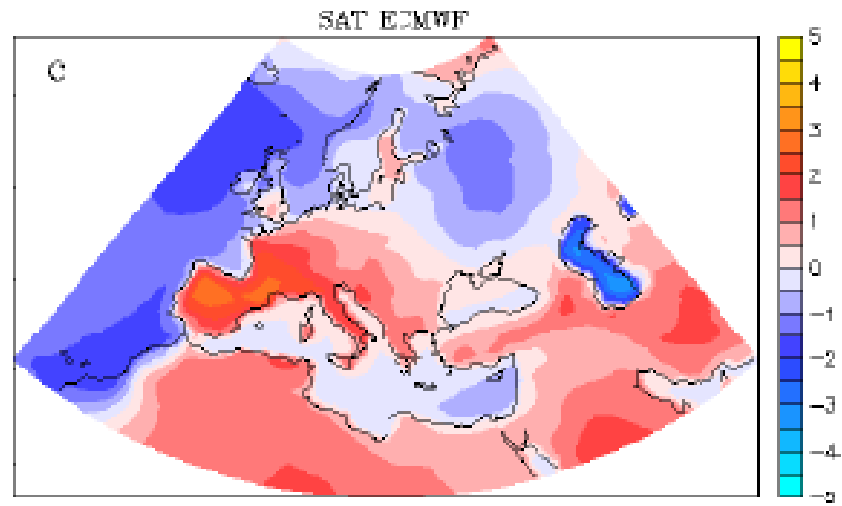
Summer air temperature in Europe

Mean sea level pressure



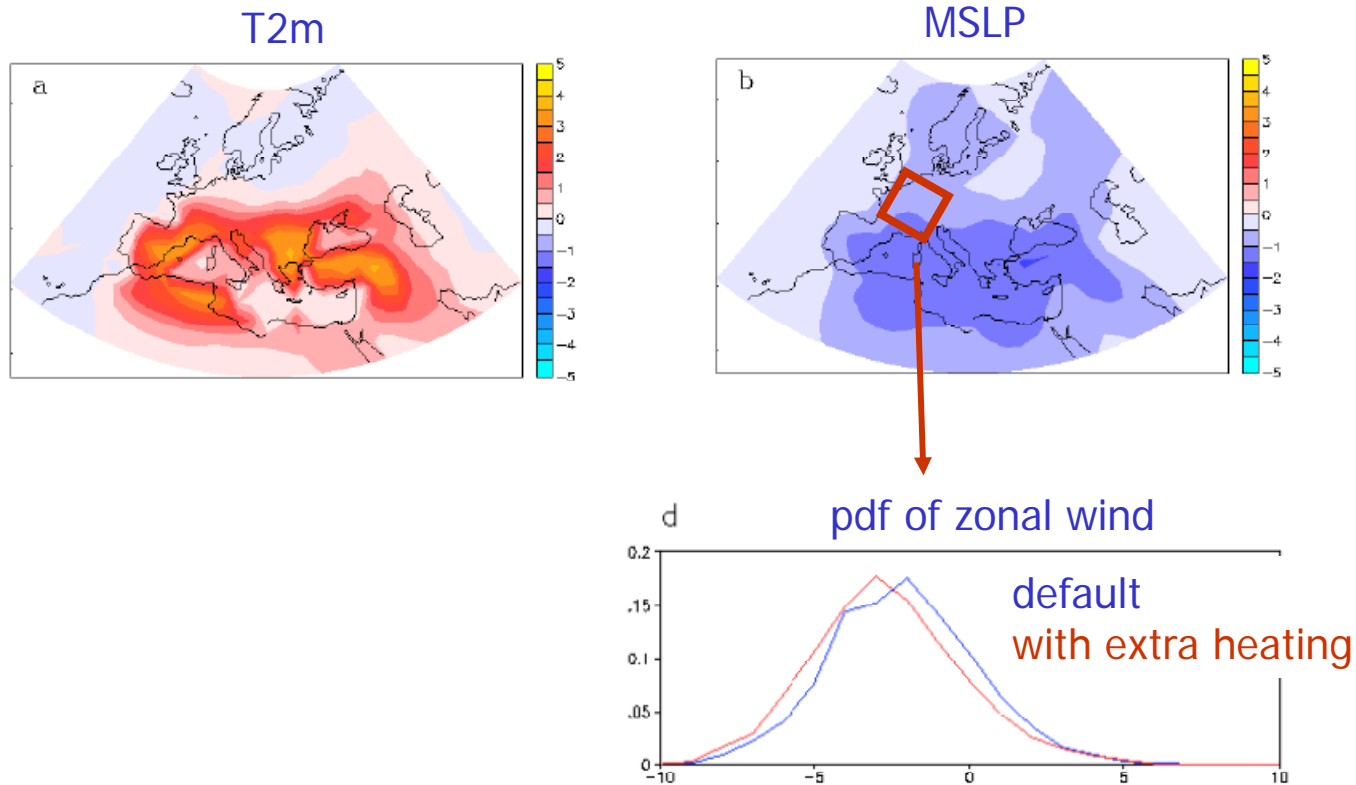
JJA climate change
(1970-2000 → 2071-2100)

Surface air temperature



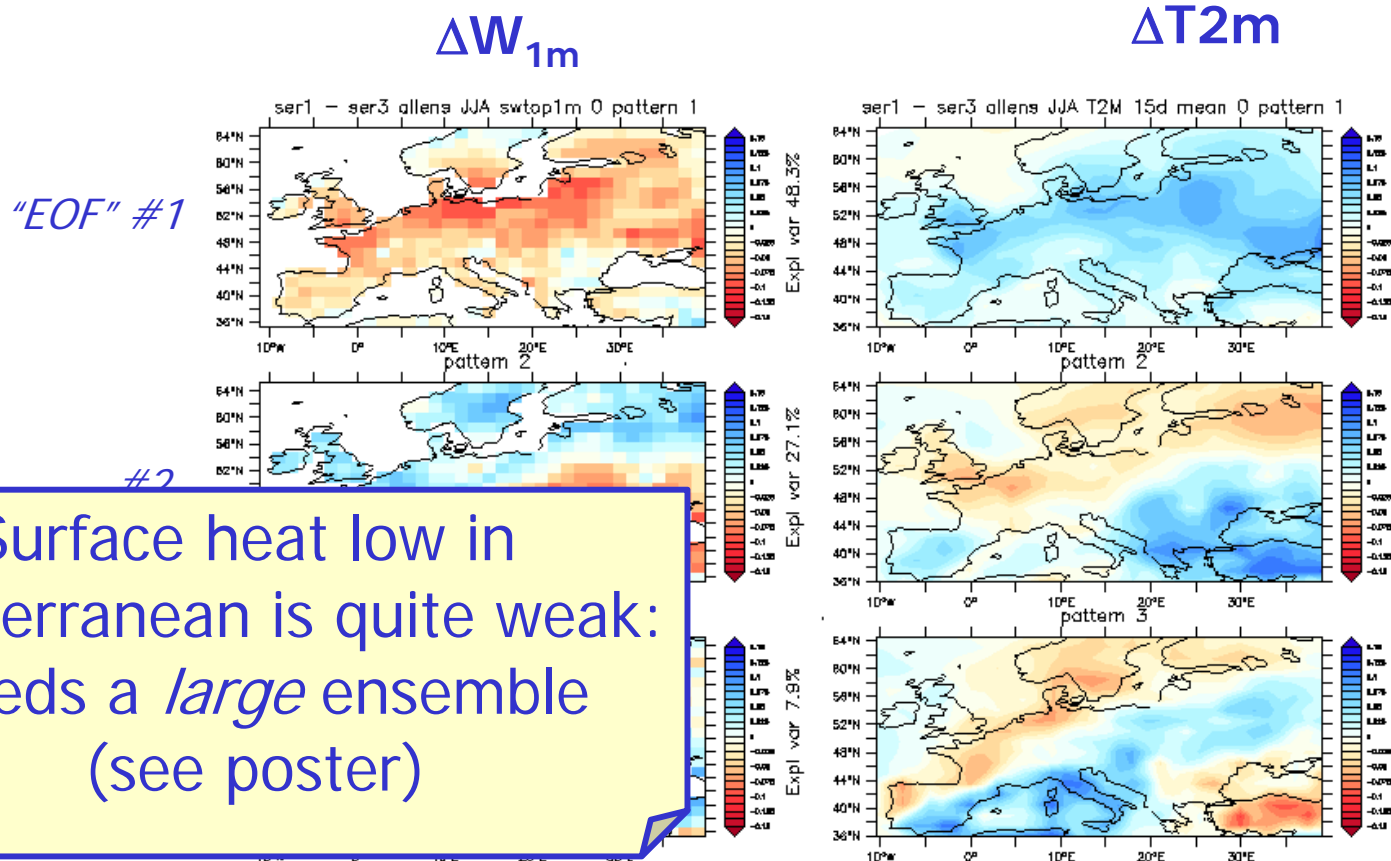
Summer air temperature in Europe

- Effect of imposing a heat anomaly (20 W/m^2) in Mediterranean:



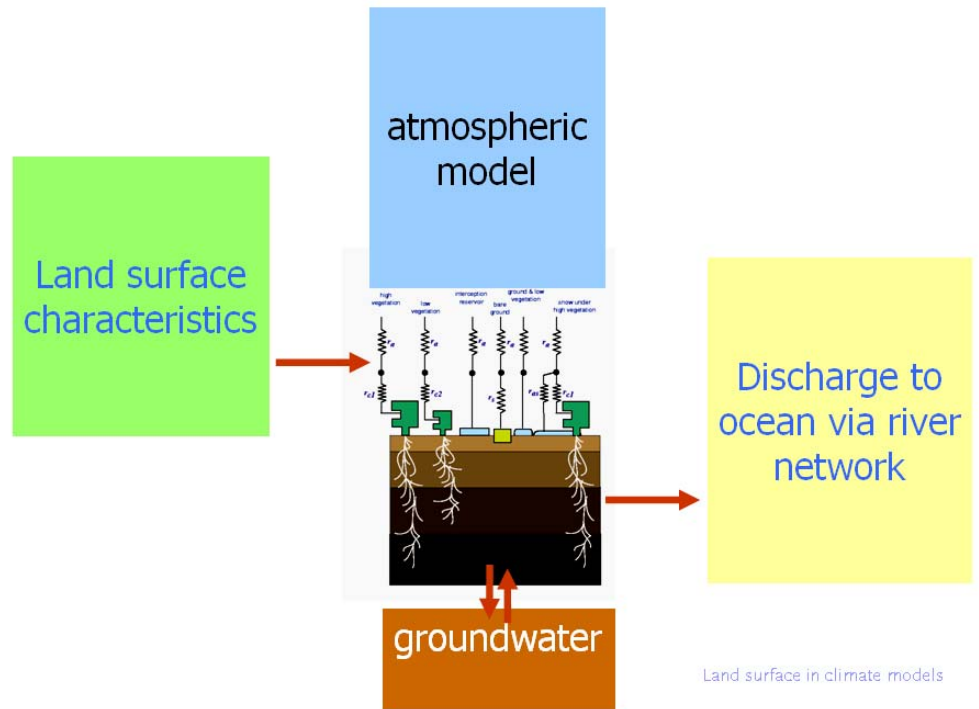
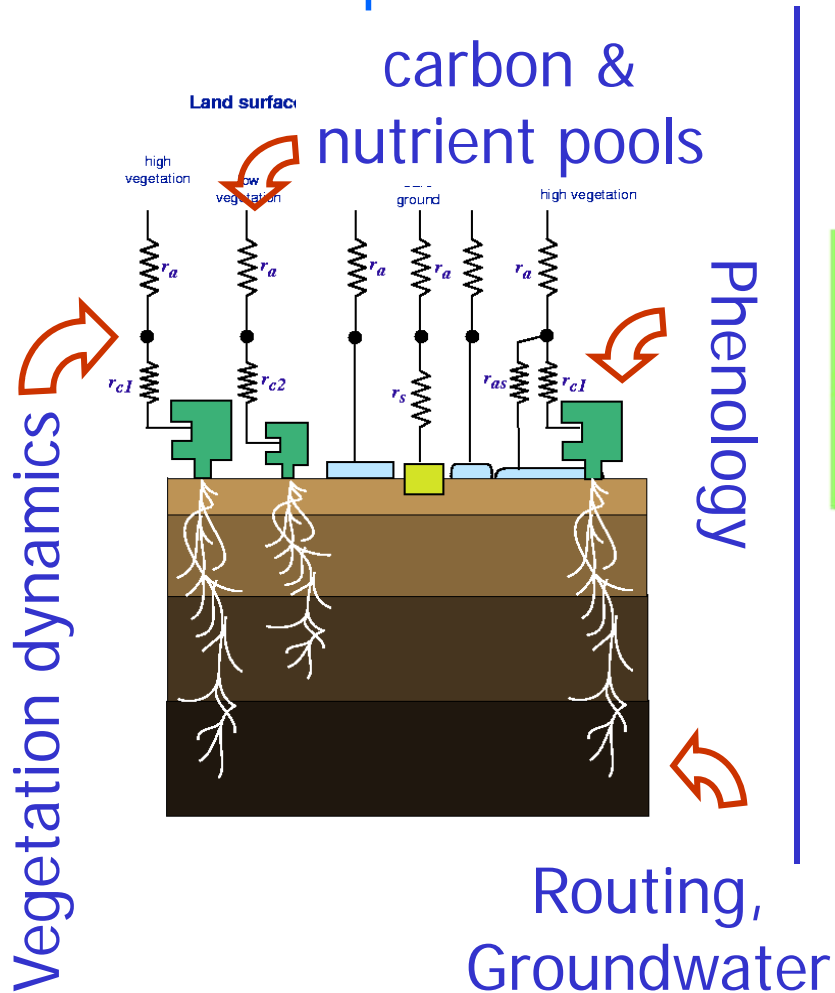
Findings from GLACE2

- Patterns of soil moisture and temperature vary very similarly



Basic philosophy of terrestrial components in

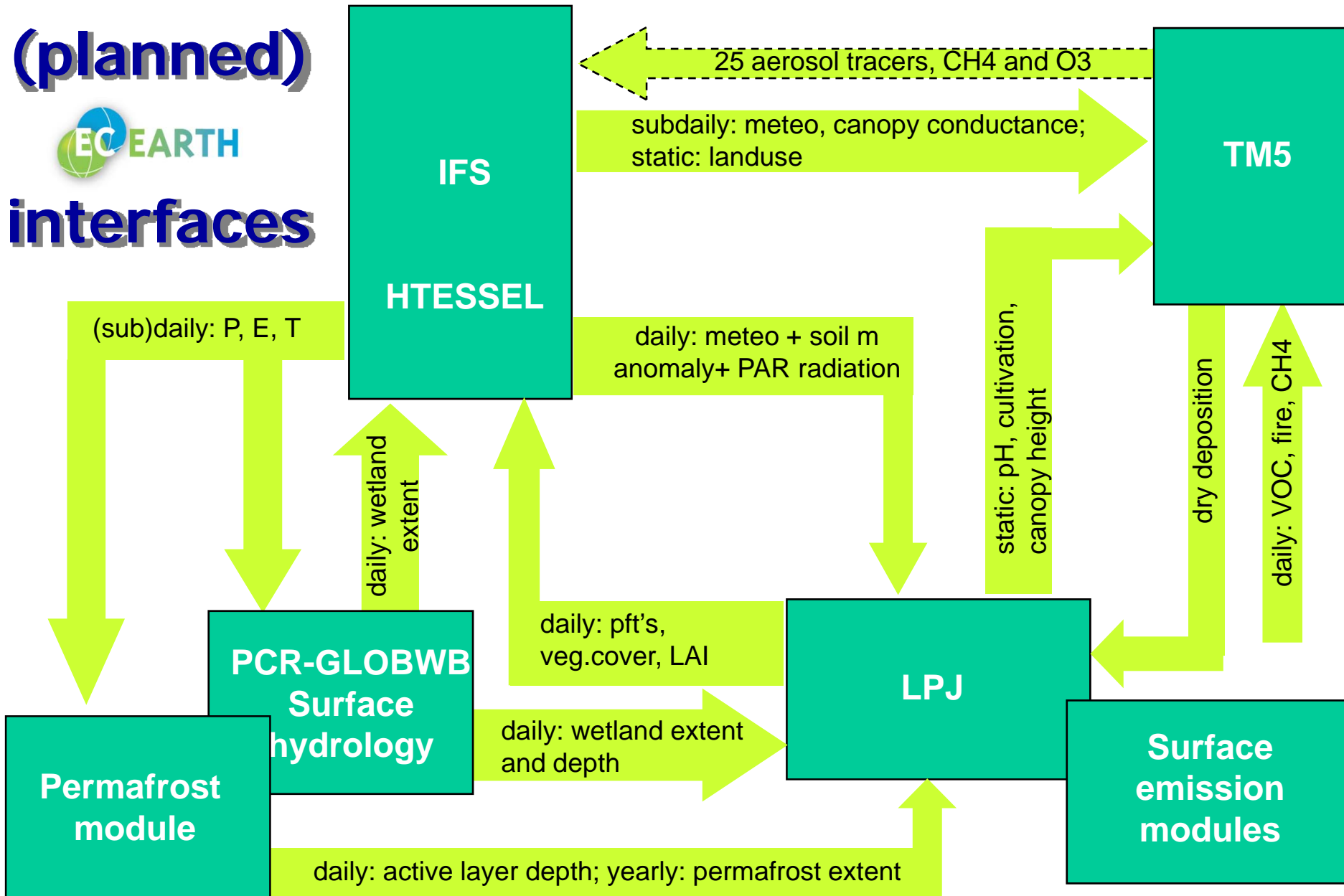
- Two options:



(planned)



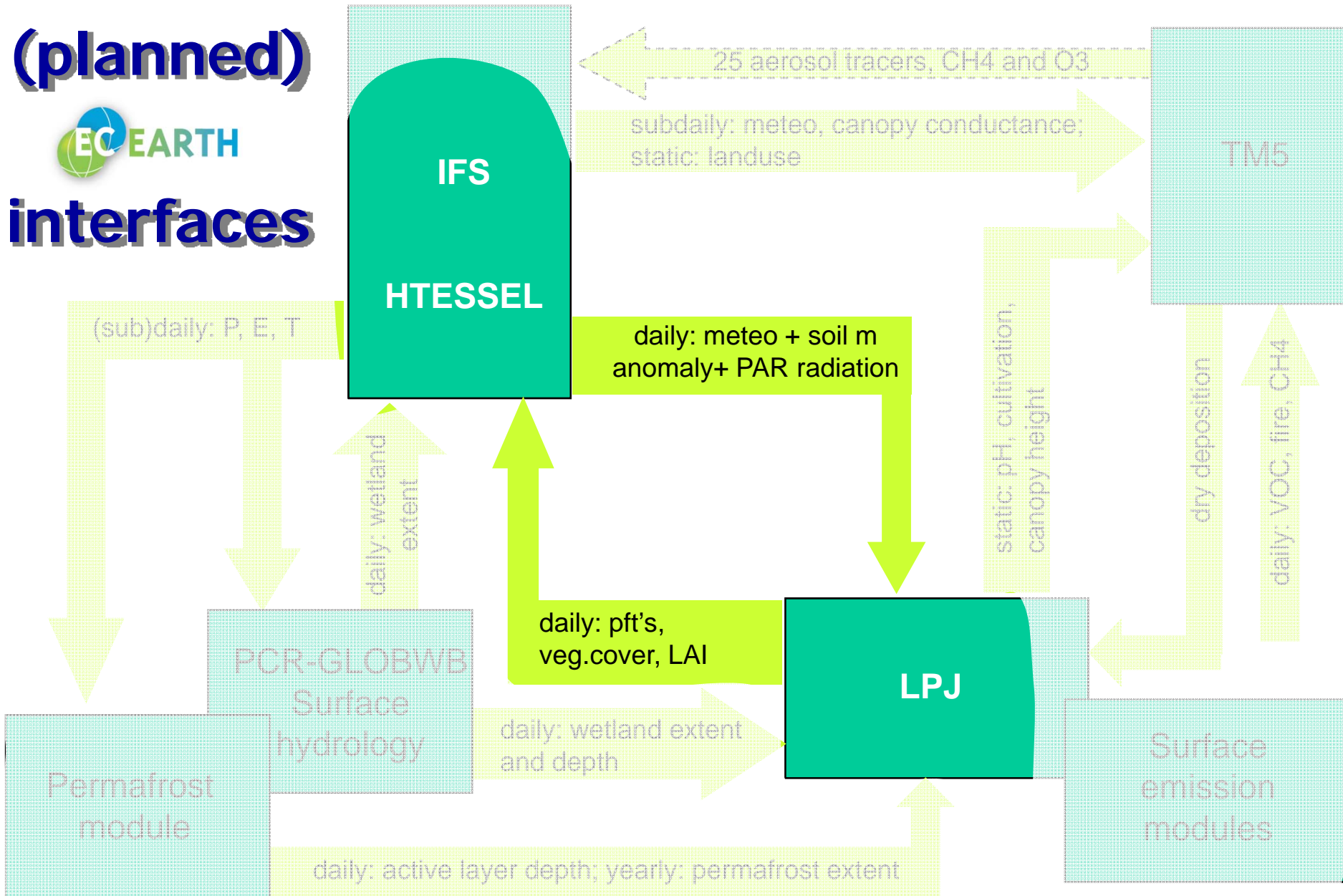
interfaces



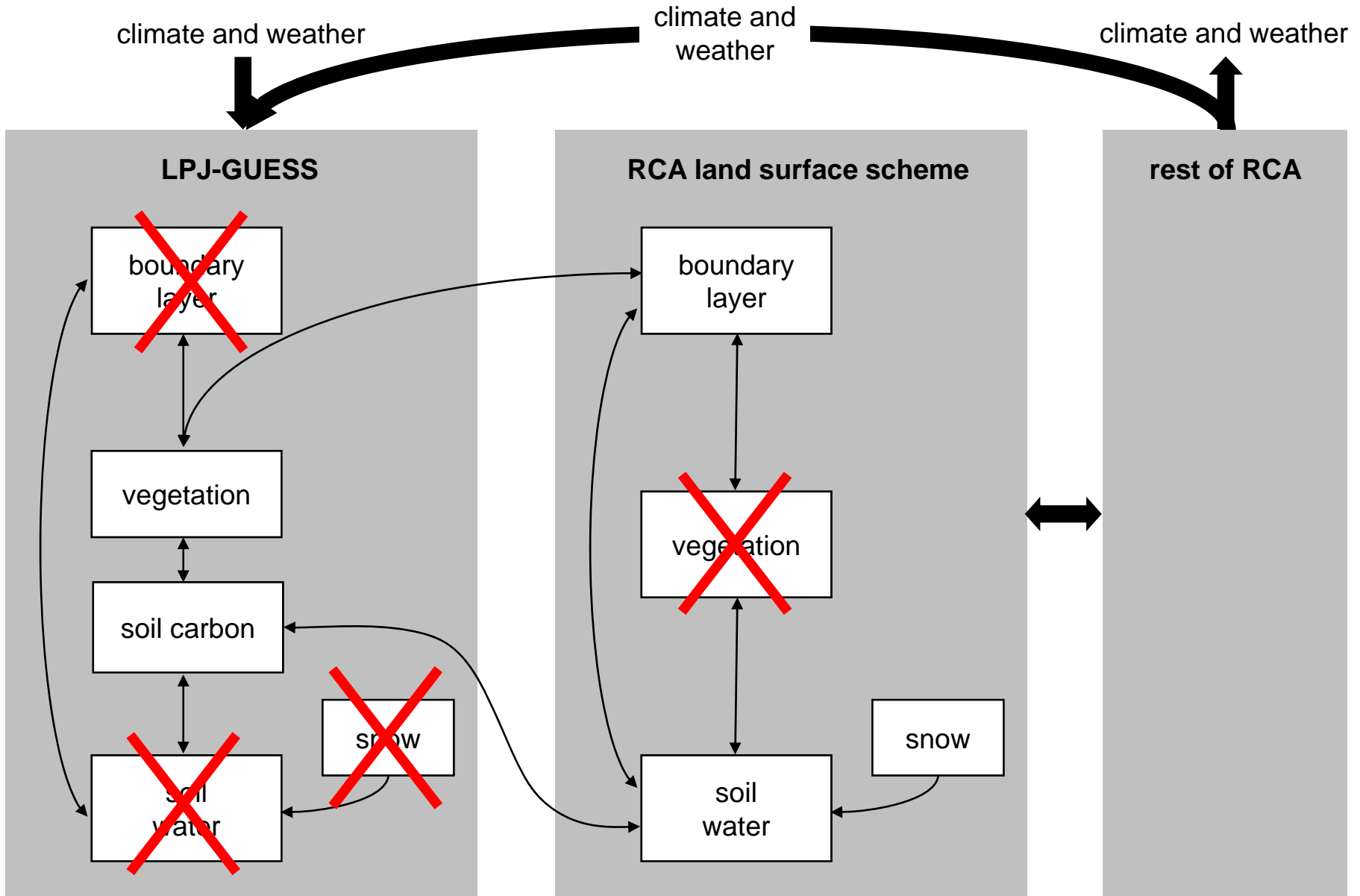
(planned)



interfaces



Example: RCA with LPJ-Guess



The information exchange

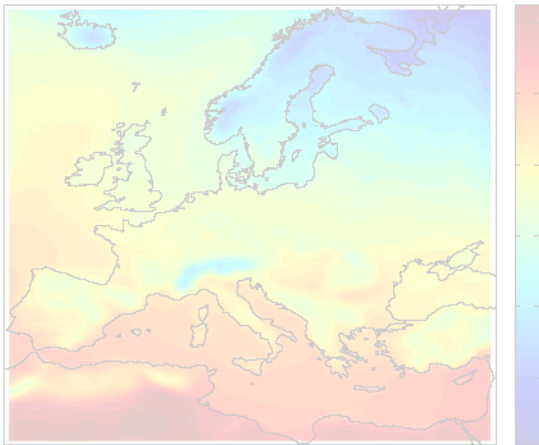
Wramneby et al, 2009

GUESS tells RCA	Used by RCA for	RCA tells GUESS	Used by GUESS for
<p>fraction of conifer, broadleaved forest, open land, bare ground</p> <p>leaf area index (LAI)</p>	<p>roughness, albedo, displacement height, evaporation, transpiration</p> <p>interception, displacement height, radiation partitioning, transpiration</p>	<p>incoming SW radiation</p> <p>near-canopy temperature</p> <p>soil water</p> <p>soil temperature</p>	<p>photosynthesis, stomatal conductance</p> <p>respiration, photosynthesis, canopy conductance, fire</p> <p>stomatal conductance, soil respiration, fire</p> <p>respiration</p>

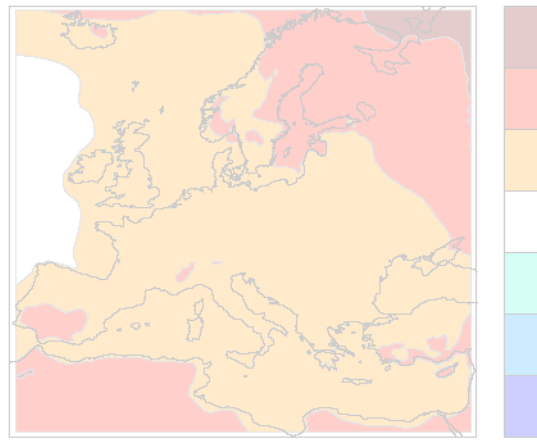
The vegetation feedback on temperature

Wramneby et al, 2009

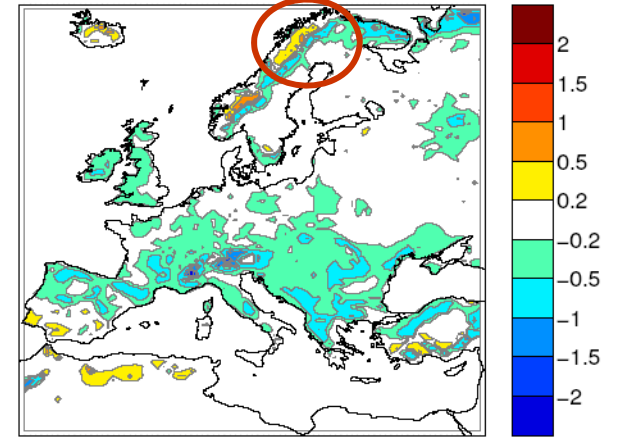
Temperature MAM 1961-1990 T °C



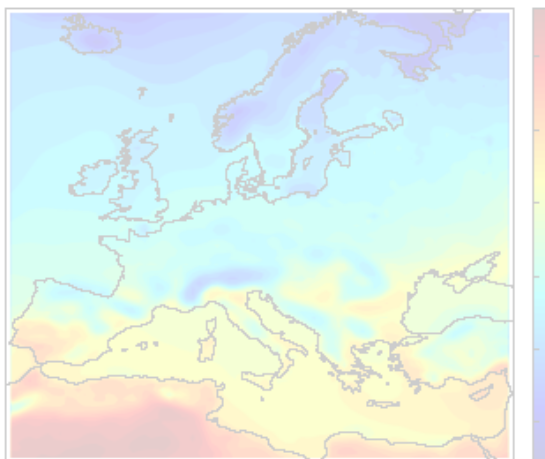
Change by 2071-2100 ΔT



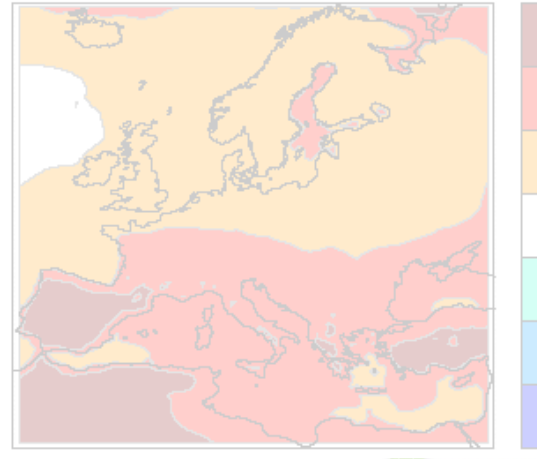
warming
Feedback contribution $\Delta T_{RCAG} - \Delta T_{RCA}$



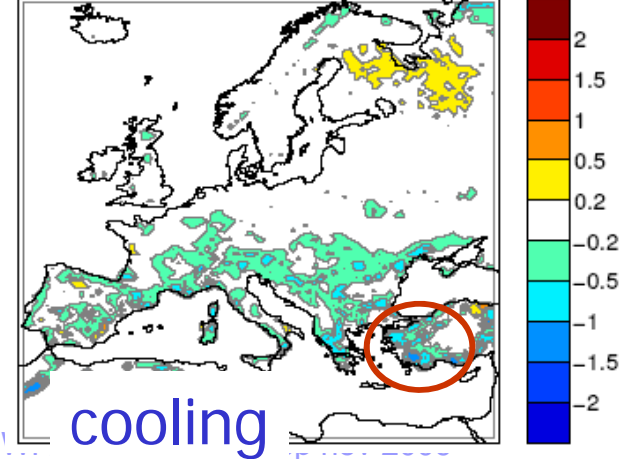
Temperature JJA 1961-1990 T °C



Change by 2071-2100 ΔT



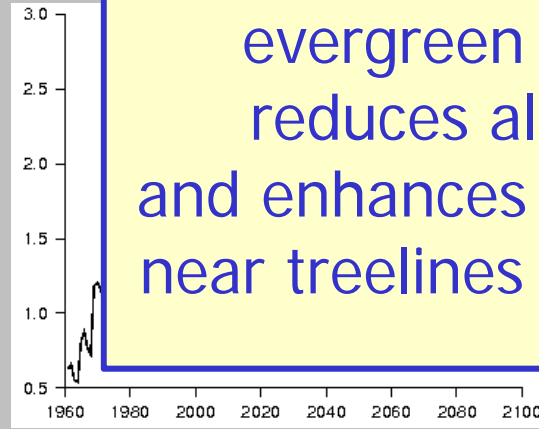
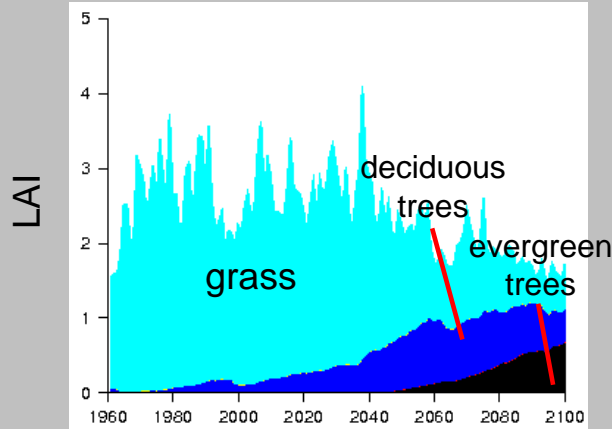
Feedback contribution $\Delta T_{RCAG} - \Delta T_{RCA}$



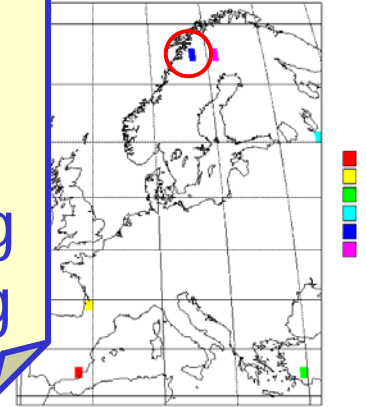
Attribution to vegetation

Wramneby et al, 2009

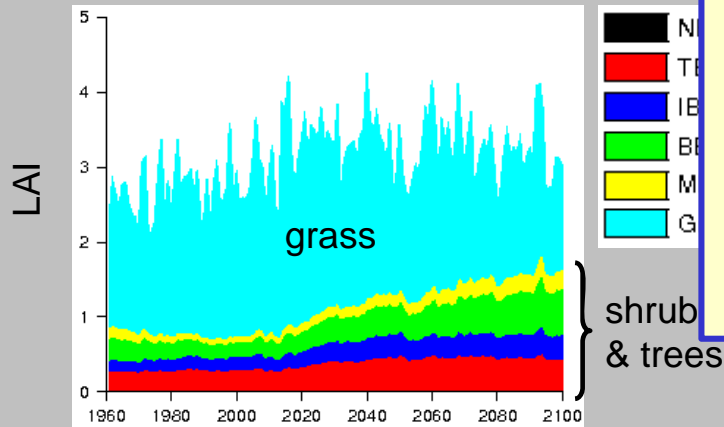
Forest



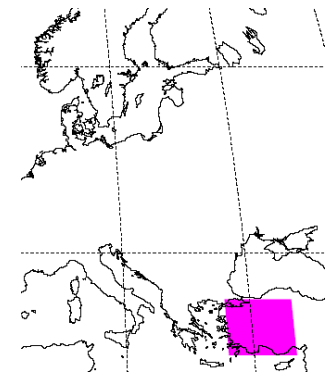
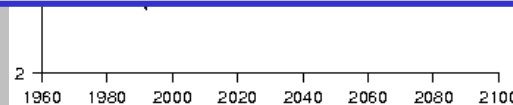
Increased cover by evergreen trees reduces albedo and enhances warming near treelines in spring



Forest



Increased leaf area results in increases evapotranspiration and a cooler surface climate in semi-arid areas



More big challenges

- Organizational

- Keep the model up to date
 - snow
 - irrigation, wetlands, lakes
 - phenology, carbon/nutrient cycle
 - urban areas
 - ...

- Keep the scientists involved and make use of their results
- Communication with stakeholders (e.g. users of climate projections)

- Scientific

- Get realistic feedbacks & interactions
- Effect of systematic biases on the interactions & feedbacks**
- Verification of feedbacks

- Technical

- Interfacing with external modules (e.g. river routing, dynamic vegetation)
- Compatibility with other ancillary data (e.g. albedo)**
- Computer resources**

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 Unité ASTR, Belgium
Met Éireann, Ireland
 University College Dublin, Ireland
 Universiteit Utrecht, The Netherlands
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