Land surface modelling for ACCESS in Australia

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ACCESS

• The Australian Community Earth-System Simulator;
• It is based on HADGEM 1 that was imported to Australia last year;
• Modifications will be made to nearly all components of the model by BoM and CSIRO scientists;
• We shall use JULES framework for developing and testing our LSM.
ACCESS – Operational structure

Steering committee
(Love, Morton, Ayers, Smith, Mitchell, Pitman, Puri)

Science advisory group
(Puri:Chair, Smith, Mitchell, Dietermeyer, Steinle, Hirst, Wang, Lynch, England)

atmosphere
Ocean
Land
Coupling
Data assimilation
Model evaluation
Modelling system
The LSM team

Yingping Wang (Team leader)
• Seven staff members from CSIRO
• One from the Bureau of Meteorology
• With strong connection to universities through ARC-earth system science network led by Andy Pitman
• We want to an effective collaborator on JULES
Current efforts in ACCESS

- A full biogeochemical model (C, N and P cycles)
- River routing and land surface model for NWP
- A systematic model calibration framework
- Passive tracers: CO2, O2 and isotopes
- Fire and disturbance
Key science issues:

- feedbacks at different time scales;
- Improving the understanding of underlying processes, such as
  - role of soil P: important for Australian terrestrial biosphere;
  - nutrient competition and vegetation dynamics;
- model calibration: synthesis of observations at different time and spatial scales.
Our plan (2006-2011)

• By June 2007
  – Implementing CABLE to HADGAM
  – First version of plant phenology, growth and death
  – A modeling framework

• By June 2008
  – Global model of biogeochemical cycle of C, N and P
  – Soil hydrology and river routing assessed by 2008
  – Calibrate the terrestrial C cycle

• By June 2009
  – Parameter estimated for C, N P cycle
  – Modify the soil hydrology if necessary
  – Couple terrestrial C and marine C cycle and calibrate

• By June 2010
  – Couple all with HADGAM and obtain the initial C, N and P pool sizes
Progress so far

• Going through the HADGAM, particularly the coupling of land surface model;
• A preliminary version of global phenology, growth and death is being developed;
• A version of global biogeochemical model of C and N cycle has been developed; P cycle will be added soon;
• We are about 4-6 months behind.
Major technical issues encountered

- Global soil P amount data are not available;
- Phenology of subtropical and tropical biomes is difficult to model;
- Coupling components with systematic errors and lack of global estimates of some key model parameters;
- How to utilize the resources in the universities.

In addition

- Very tight timeline and inadequate resources
Phenology model

• We use the global phenology model of Botta et al. and Krinner et al.
• Model was calibrated using the estimates from MODIS satellite measurements.
• Phenology of biomes north of 45° is well modelled; BUT
• Phenology of tropical and subtropical biomes are poorly predicted.
The model: CASACNP

- Leaf 1
- Wood 1
- Root 1

- Leaf 2
- Wood 2
- Root 2

- Litter
- Soil organic matter
- Inorganic N

- Flux in ($F_{in}$)
- Flux out ($F_{out}$)

- N2 fixation

- Ptase
  - Labile $P_i$
  - Sorbed $P_i$
  - Strongly sorbed $P_i$
  - Occluded $P_i$

- Atmosphere
- Parent material
Simulation Results

Boreal Forest

Temperate Forest

Savanna

Tropical Forest

NPP (g C m\(^{-2}\) yr\(^{-1}\))

<table>
<thead>
<tr>
<th>Simulation</th>
<th>N fixation varies with soil temp</th>
<th>Labile P from phosphatase shared</th>
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<tbody>
<tr>
<td>A</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>B</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>C</td>
<td>No</td>
<td>No</td>
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</tbody>
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Calibration strategy

- Flux module (CABLE): using eddy flux data
- Biogeochemistry: using site and regional data
- Phenology: using global dataset
- All above together are calibrated using atmospheric CO2 concentration and isotope measurements, Global calibration using multiple tracers is important.
- Dynamic vegetation model??
How good are our land surface models?

Abramowitz 2005
Domain of the transport model (DARLAM)

Wang and McGregor 2003
Fit to the observed atmospheric CO$_2$ data at Cape Grim using KF technique

Wang and McGregor 2003
Improved the prior estimates (white) using hourly CO2 data at Cape Grim (red)

Wang and McGregor 2003)