Progress in coupling Soil C and N routines into JULES

Chris Jones²
Kevin Coleman¹, Jo Smith³
Pete Falloon², Bente Foereid³, Stephen Sitch², Pete Smith³, Andy Whitmore¹

¹ Rothamsted Research
² Met Office Hadley Centre
³ University of Aberdeen

JULES Science meeting
28th June 2007
Introduction

- Importance of soil C and N in global climate system
- Overview of existing models / components
- Aspects of coupling
- Future plans
There is a consensus that climate change will weaken natural carbon uptake

- Especially on land
- Friedlingstein et al, 2006 (C4MIP)

Response of soil carbon to changing climate and plant inputs is a key component

Need to represent soil carbon processes and dynamics

Regulates C-cycle through plant growth

Importance of soil nitrogen

- Regulates C-cycle through plant growth
- N-greenhouse gases

- Both natural ecosystems
- And, importantly, agriculture

Source: IPCC AR4
Overview of models

- **JULES-1 (and HadCM3LC)**
  - Single soil C pool
  - Driven by soil T & moisture

- **RothC**
  - 4 pool C dynamics
  - Driven by air T & precip. & ET
  - Use in HadGEM2-ES
- **DPM** – short lived: **RPM** – short lived relative to **HUM**
  - Relatively quick turnover of fresh litter
  - Increased litter inputs slowly increase SOC
- **HUM** – long lived
  - Majority of RothC soil carbon
  - Slower response to changes in temperature than smaller, faster pools
Overview of models

- **JULES-1 (and HadCM3LC)**
  - Single soil C pool
  - Driven by soil T & mois

- **RothC**
  - 4 pool C dynamics (show schematic)
  - Driven by air T & precip. & ET
  - Use in HadGEM2-ES

- **SUNDIAL/ECOSSE**
  - Incorporates RothC soil C
  - Treats soil N
Nitrogen Components of SUNDIAL/ECOSSE

- $\text{N}_2\text{O}$ & $\text{N}_2$
- $\text{NH}_3$
- $\text{NH}_4^+$
- $\text{NO}_3^-$

Inputs:
- NPP, LU Type
- Soil water
- Temperature
- Acidity

Outputs:
- Leached N
- DON

Modules:
- Water Module
- Temperature Module
- Texture Module
- Oxygen Module
- Acidity Module

Processes:
- Decomposition
Existing JULES-1 scheme

JULES

Soil T
Soil moisture
Litter carbon

Soil Carbon pool

Respiration (CO2)
### JULES-SUNDIAL/ECOSSE

#### JULES (soil)

#### JULES (vegetation)
Offline test of ECOSSE-JULES C and N routines

Harvard Forest

Mass loss

Red pine
r=0.67
M=-45

Red maple
r=0.62
M=-53

Nitrogen content

Red pine
r=0.68
M=0.065

Red maple
r=0.59
M=0.74
- JULES-SUNDIAL/ECOSSE-VegN
- 2 way coupling
- **JULES-SUNDIAL/ECOSSE-VegN** within full Earth System GCM

**GCM**

- Energy, moisture
- C flux (CO2, CH4)
- N flux
- Veg structure (roughness, albedo)

**JULES**

- Soil T, mois litter
- avail N

**Anthro emissions, Land use, management etc**
Future developments – beyond N

- More processes
  - Peat/organic soils – in ECOSSE, evaluate (SEERAD / QUEST)
  - Wetlands & methane – in ECOSSE, evaluate (NERC proposal - University of Edinburgh (lead), University of Warwick & University of Aberdeen)
  - Permafrost – still in planning