Revisiting GLACE: The Role of the Land Surface in Land-Atmosphere Coupling

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The GLACE method is applied to a new AGCM to establish:
• How does the new model compare to our old model where coupling was weak?
• What difference does a soil parameter change make to the coupling diagnostic?

Background: The GLACE Method
The Global Land-Atmosphere Coupling Experiment (GLACE; Koster et al., 2004, 2006) established a method for measuring the influence of soil moisture on precipitation in a GCM. Two ensembles are run for the model and:

GLACE coupling diagnostic = Ω(S)−Ω(W)
- Similarity of precipitation across ensemble “S” (all members forced with same soil moisture)
- Similarity of precipitation across ensemble “W” (free running soil moisture)

About The Correction
K_s and Ψ are derived from the equations of Cosby et al. (1984), but an error was recently found with the way they are implemented for the UKMO model

Soil Parameter and Variable Changes:
K_p and Ψ are strongly related to soil moisture availability.

New Model: HadGEM3-A
• Latest MOHC AGCM, under development (this version ~2 years old)
• Used for seasonal forecasting
• Atmosphere much developed from HadAM3
  – New dynamics
  – New convection and boundary layer parameterizations
  – Higher resolution: 1.875° lon x 1.25° lat; 85 vertical levels
• Land surface scheme similar to HadAM3

HadGEM3-A Coupling Strength

![Diagram of HadGEM3-A Coupling Strength](image)

New atmospheric configuration more sensitive to soil moisture variability

BUT a recent correction to soil hydraulic parameter derivation reduces the GLACE signal

Mean and variability of evaporation are both strongly affected by moisture availability:

Effect via evaporation variability is dominant for our case.

Summary
HadGEM3-A has stronger land-atmosphere coupling than its predecessor HadAM3
This is due to changes in the atmospheric, rather than the land surface configuration

• Land surface changes do make some difference, but with competing effects
  – Decreased moisture availability ➔ Increased soil moisture-evaporation coupling
  – Decreased evaporation ➔ Decreased evaporation variability

References