LUCID

(Land-Use and Climate: IDentification of robust impacts)

First results from the LUCID experiments
Implications for experimental design in IPCC-AR5

International project endorsed by IGBP-iLEAPS & GEWEX-GLASS

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GLOBAL LAND ATMOSPHERE SYSTEM STUDY
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Objectives : *identify* and *quantify* the impacts of land-used induced land-cover changes on the evolution of climate between the pre-industrial epoch and present-day.

Use a) multi-model and b) ensemble simulations to *assess the robustness of the identified changes*.

Assessments of the impacts of land cover change *will explore the mean climate, climate variability* and *climate extremes*.

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LUCID *Simulations*

a suite of **ensemble** simulations (with & without land-use changes) :

➔ *Snap-shots pre-industrial (1870-1900), present-day (1992-2002) : prescribed sea-surface temperatures (SSTs), sea-ice extent (SiC) and CO_2 concentrations (equivalent GHG).*

➔ *Historical (1870-2002) : prescribed SSTs, SiC (HadISST) and CO_2 ... link with C20C project **(Protocole en cours de définition. Simulations devraient démarrer dans 2 à 3 mois)***

➔ *Fully coupled historical (Atmosphere-Ocean) ; IPCC-type runs with prescribed CO_2 ...* link with ENSEMBLES European Project (included in IPCC-AR5)

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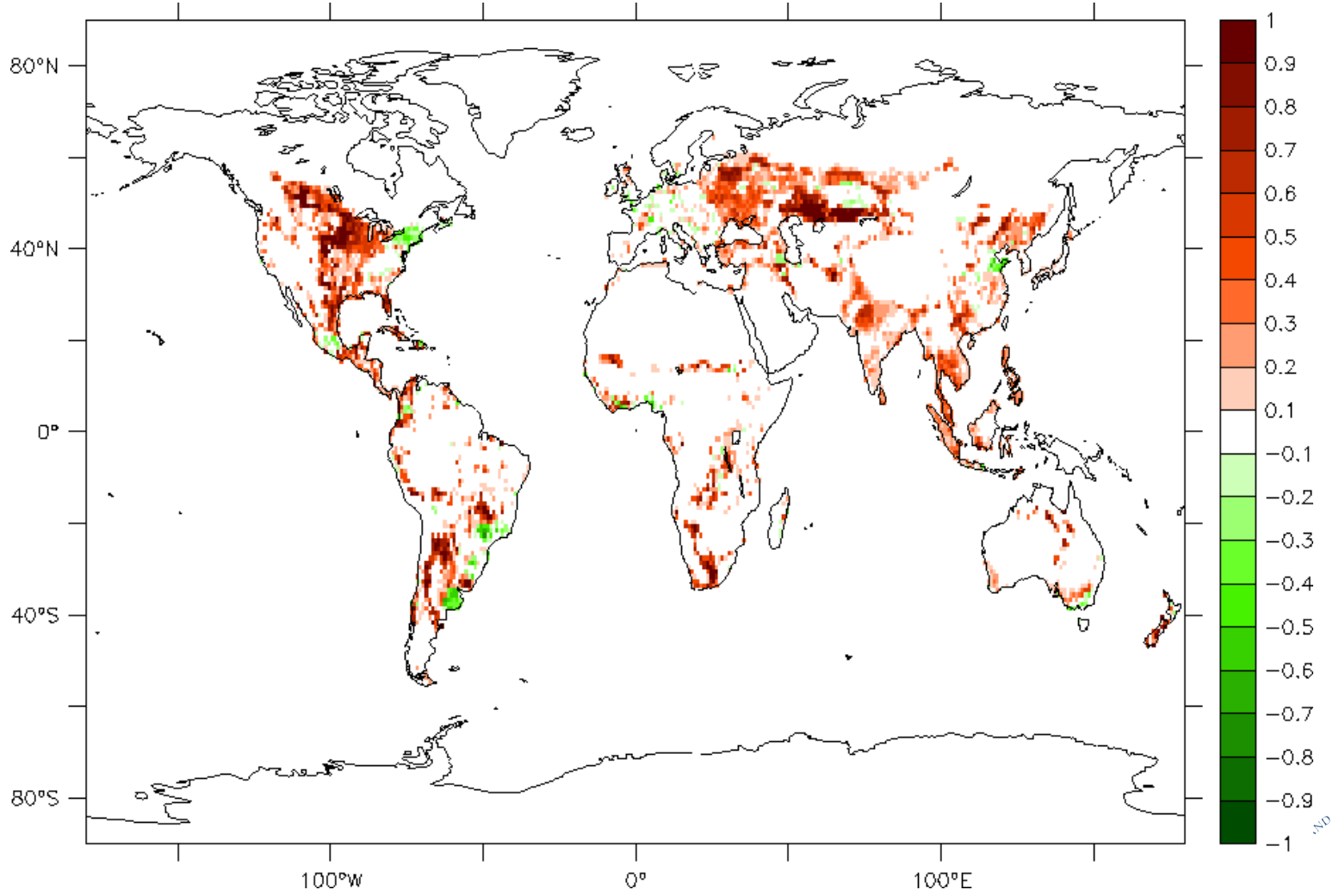
Same crop and pasture maps provided to each group for pre-industrial and present-day time periods (0.5°*0.5°; fractions of grid-cells)

Changes in crop+pasture fractions from 1870 to 1992 derived from Ramankutty & Foley (1999) + Goldewijk (2001)-HYDE2



Pitman, de Noblet-Ducoudré et al. *soumis - GRL*

- 7 groups have run the snap-shot experiments (5 members per ensemble) :
  - ARPEGE (Météo-France)
  - IPSL (LSCE)
  - NCAR (Boulder, USA)
  - ECEarth (Dept of Hydrology and Geo-Environmental Sciences, the Netherlands)
  - ECHAM5 (MPI Hamburg)
  - CCAM (McQuarie university, Australia)
  - SPEEDY (RIVM)
- Some global results

  Pitman, de Noblet-Ducoudré et al. soumis - GRL
- Relative regional importance of LCC versus CO_2+SSTs+SiC
- Preliminary understanding of why the models differ
- Some conclusions

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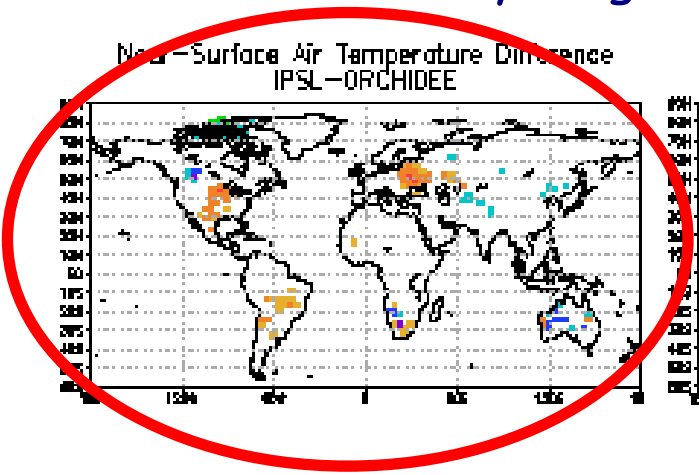
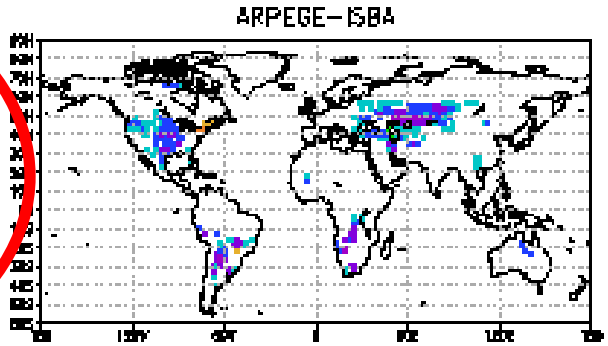
Some global results, statistically significant

Mean June-July-August / Changes in ambient air temperature (°C)

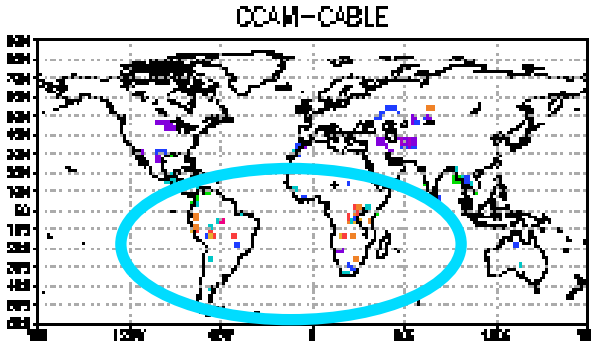


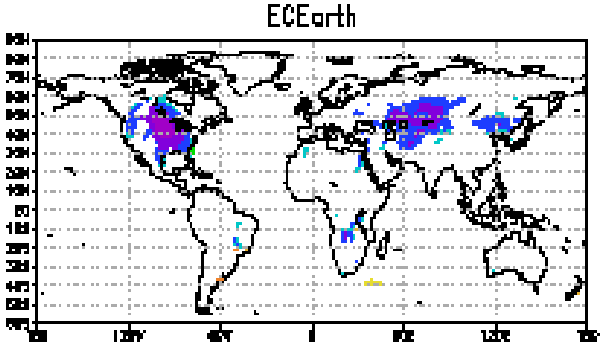


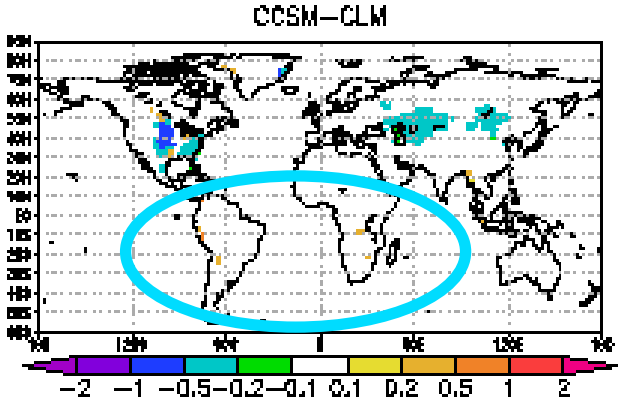
Increased agriculture

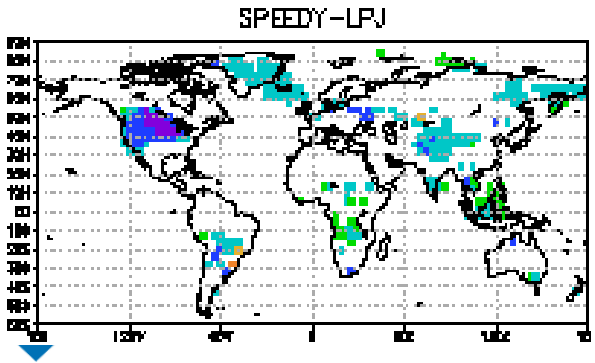
→ local cooling, with few exceptions

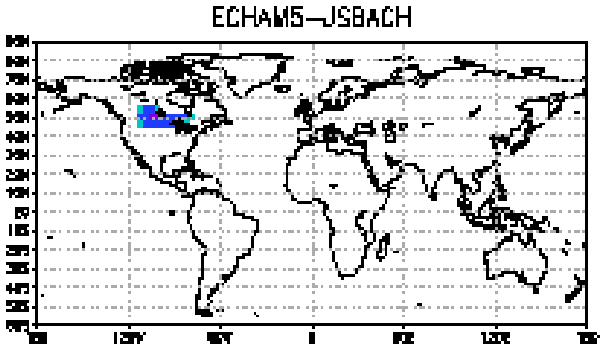
no remote changes







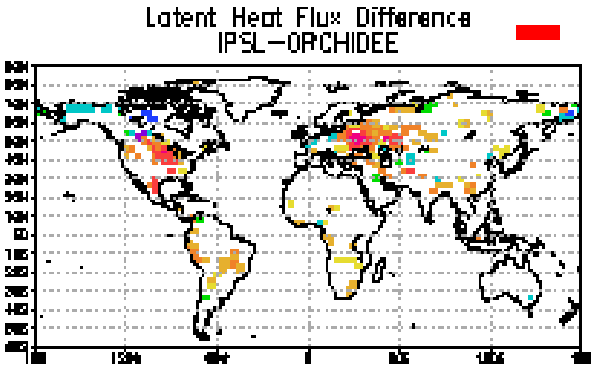


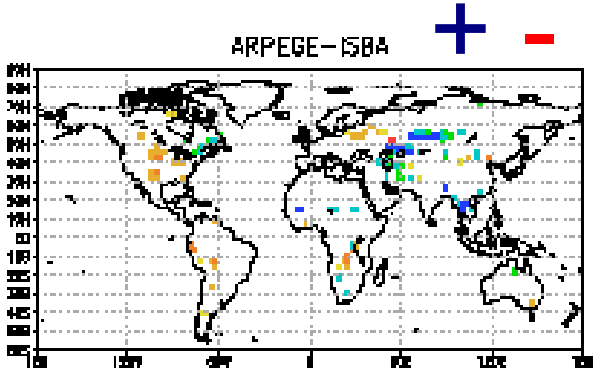


Pitman, de Noblet-Ducoudré et al. *soumis - GRL*

Some global results, statistically significant

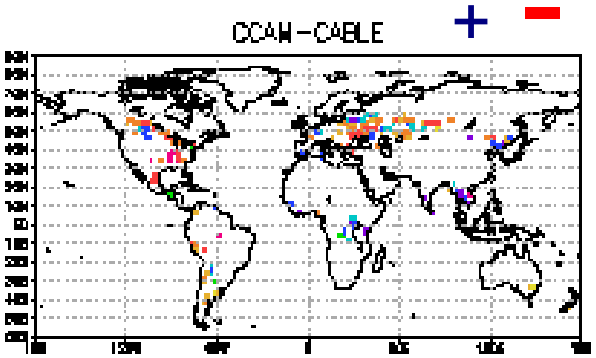
Mean June-July-August / Changes in latent heat flux (W/m2)

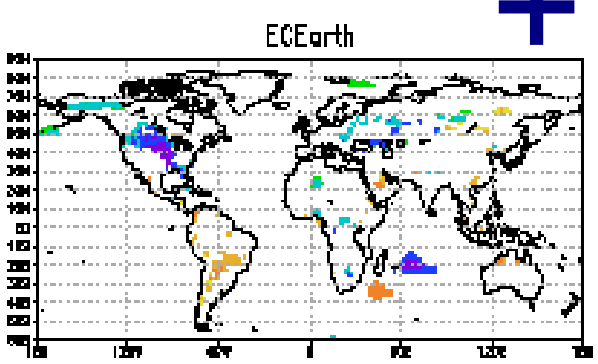


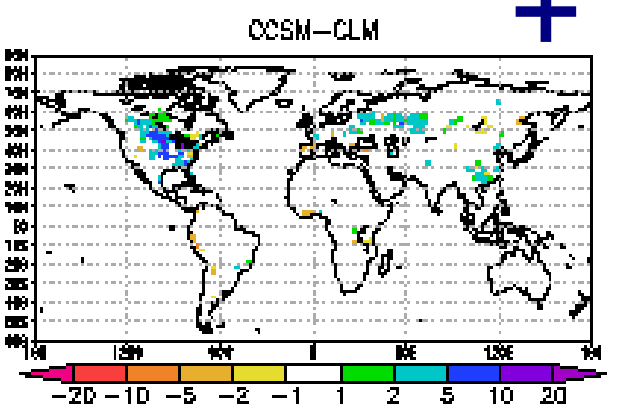


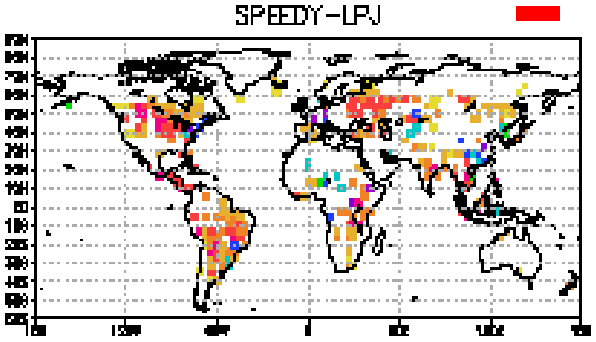
Increased agriculture

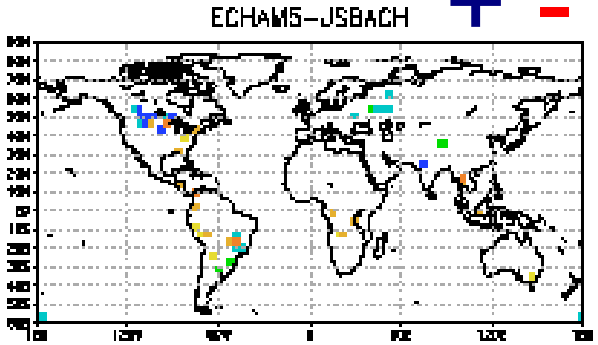
- no coherent changes in latent heat flux
- no common remote changes







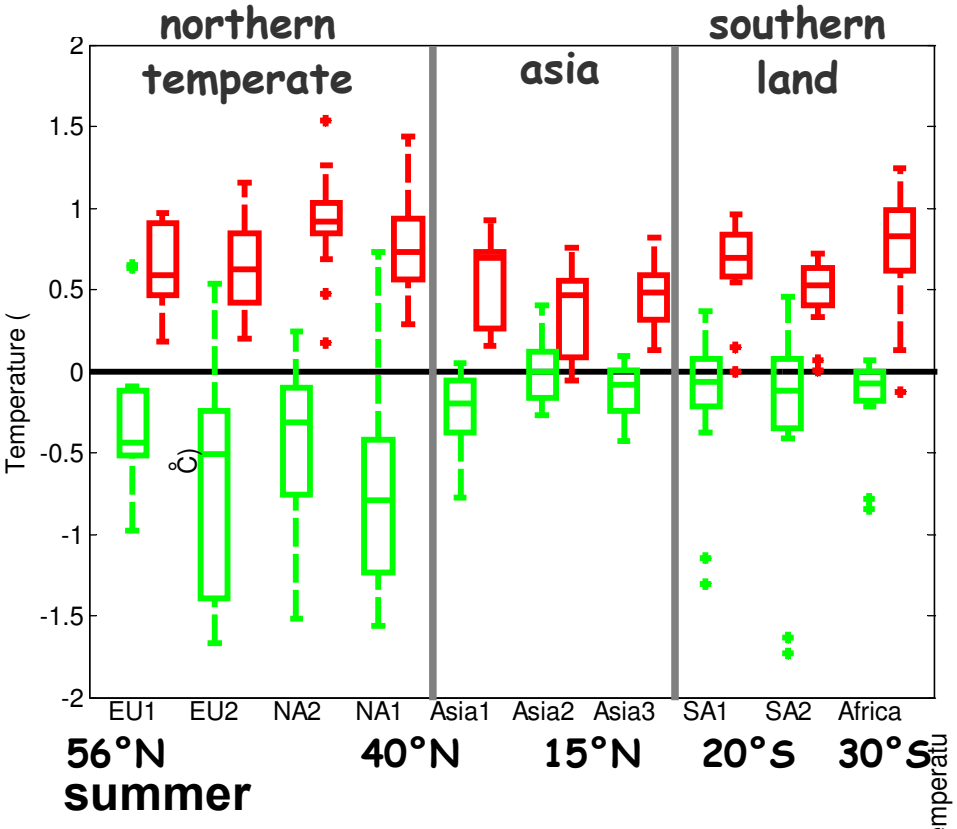




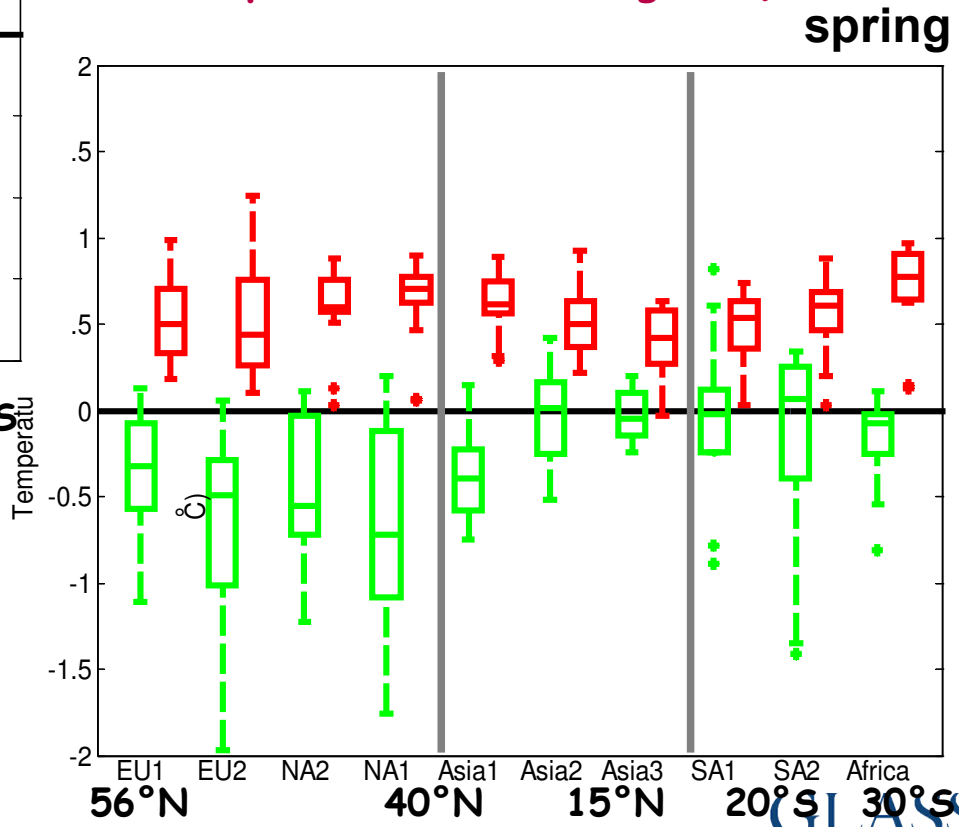
Pitman, de Noblet-Ducoudré et al. *soumis - GRL*

Relative importance of a) land-cover changes .vs. b) changes in SSTs, SiC and CO_2 concentration on the simulated surface climate

Changes in ambient air temperature (°C ; summer-JJA ; spring – MAM)



- magnitude of changes = same order
- larger dispersion resulting from LCC in temperate regions
- Opposite regional changes (LCC dampens the climate signal ?)



Impact of LCC

Impact of SSTs+SiC+CO_2

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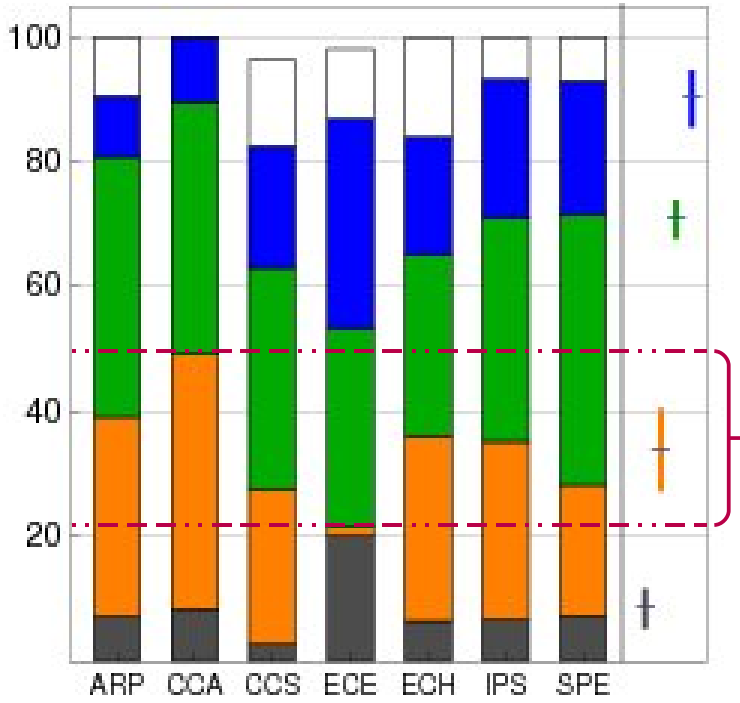
Preliminary understanding of why the models differ

The resulting vegetation map differs from one model to another,

although they have used the same crop & pasture map

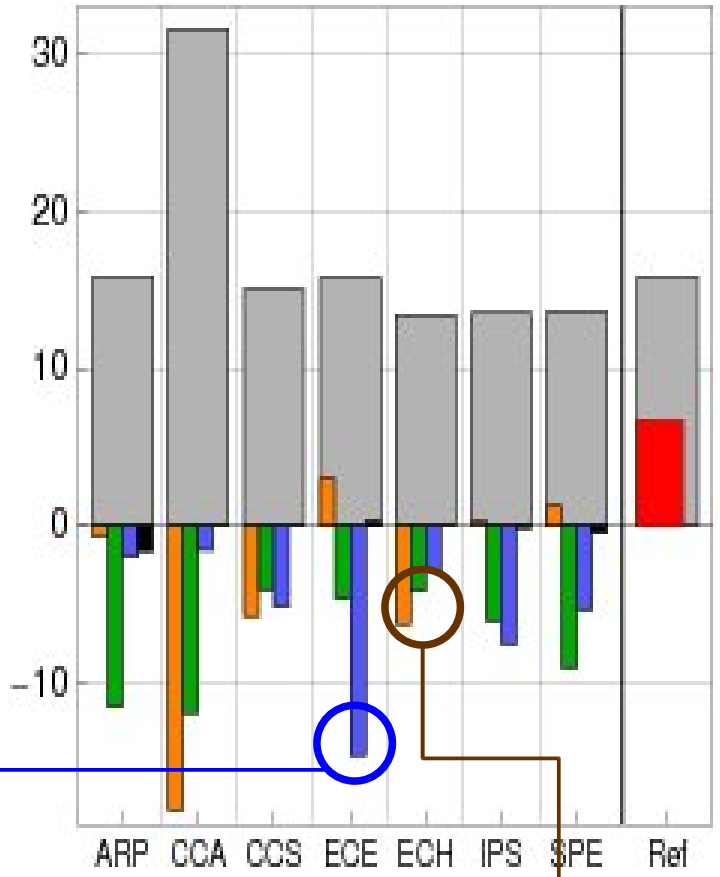
Illustration of vegetation distribution per model (% of total), for North America

pre-industrial : 1870



crops
pasture
grasses
evergreen trees
deciduous trees
desert

changes : 1992 - 1870



Extent of herbaceous-type vegetation very different from one model to the other, at pre-industrial times

<u>large reduction</u> in tree cover

<u>small reduction</u> in tree cover

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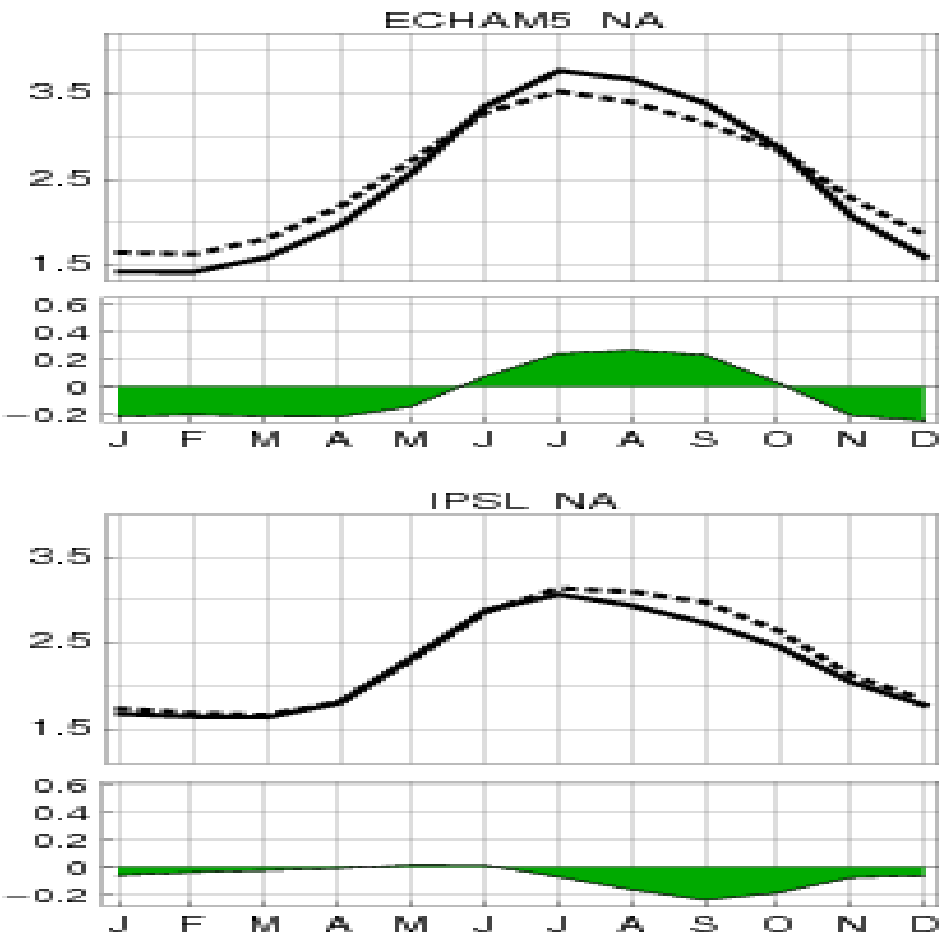
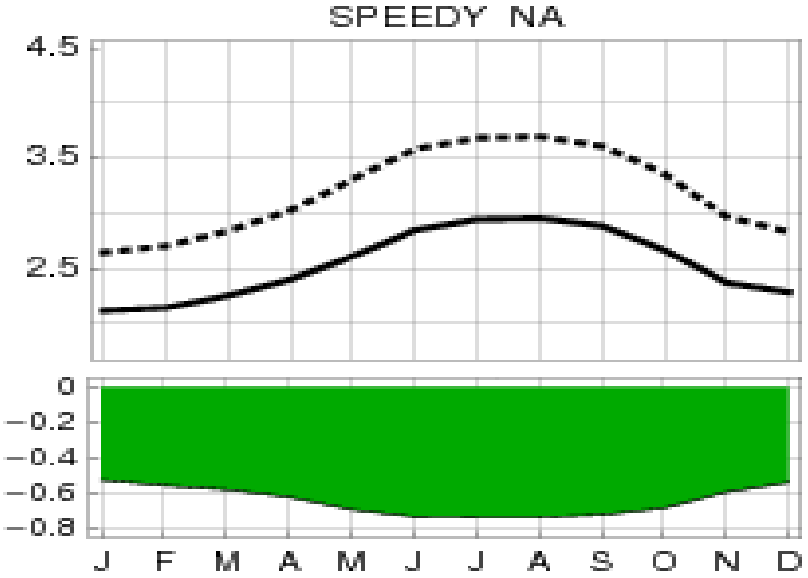
Preliminary understanding of why the models differ

seasonal cycle of leaf area index also **differs from one model to the other**

due to different parameterization of processes

(dashed lines = 1870-"natural", solid lines = 1992-"crops") ; for North America





➔ large LAI decrease for SPEEDY

➔ increased LAI for ECHAM, with shortening of growing season

➔ shortening of growing season for IPSL

→ **Land-surface models need to be thoroughly evaluated !**

Some conclusions

- **Two robust conclusions :**
  - **The magnitude of regional changes resulting from LCC perturbation is as large as the magnitude resulting from changes in SSTs+SiC+CO_2**
  - **There is no significant export of LCC perturbations, the impacts therefore remain limited to the area perturbed.**
- **Regional dispersion of models'responses to climate change increase when LCC is included.**
- **There is a crucial need to better thoroughly evaluate our land-surface models, comparing their simulated fluxes / quantities per vegetation type** (albedo, latent and sensible heat, roughness length, impact of changing land-cover, ...).

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Implications for experimental design in IPCC-AR5

LCC will be included in IPCC-AR5.

There is a risk of increased regional dispersion of impacts from model to model if models do not share the 'exact' same vegetation map ... and they will never share the same vegetation map (some models use their DGVMs ... i.e. compute their natural vegetation).

LUCID cannot help prevent these uncertainties (by putting more constraints on the climate models) within the given time frame of IPCC ... but may help to better understand them.

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Usage des terres dans IPCC-AR5

Cartes d'usage des terres (passé-HYDE3/futur-scénarios) fournies par :
University of New Hampshire, Durham (George Hurtt et al.)

Sont particulièrement intéressantes pour les émissions de GES
fournissent les fractions de chaque pixel ayant été converties de prairies en agriculture ou vice-versa .... + les quantités de bois récoltées permettant de mieux calculer les flux résultant de la déforestation.

Par contre lors de la conversion de végétation naturelle en agriculture/prairie ne fournissent pas d'infos concernant l'historique : est-ce la forêt ou la prairie qui a été préférentiellement mise en culture ? Dans quelles proportions ? ...

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LUCID & IPCC-AR5

Objectif : se servir des simulations IPCC pour quantifier les feedbacks respectivement biophysiques & biogéochimiques (CO2) issus des changements d'usage des terres dans le passé et dans le futur.

→ des simulations supplémentaires seront nécessaires

→ Choisir 2 scénarios futurs contrastés ...
(plutôt en émissions si possible)

→ Anticiper sur les scénarios d'usage des terres ayant le plus d'impact potentiel en faisant tourner les modèles de surface off-line (forcés par une même climatologie)

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LUCID & IPCC-AR5

Des groupes de travail sont en train de se mettre en place :
IGBP-iLEAPS ; IGBP-AIMES ; GEWEX-GLASS
(1er meeting les 5-6 Mai 2009)

→ définir des protocoles communs d'incorporation des cartes d'usage des terres (avec des règles de décision)

→ Choisir les 'bons' scénarios RCP + LUCC

→ Parmi les IAMs pour proposer divers scénarios possibles de LUCC au sein d'un même objectif en termes de RCP

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