Assimilation/Model Evaluation

Peking University
Beijing, China
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- Group 1: *Validation*
- Group 2: *Flux inversion*
- Group 3: *Carbon Cycle Data Assimilation*

Validation Papers

- Rykiel, E.J. (1996), Testing ecological models: the meaning of validation. Ecological Modelling 90, 229–244.

Testing ecological models: the meaning of validation

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Abstract

The ecological literature reveals considerable confusion about the meaning of validation in the context of simulation models. The confusion arises as much from semantic and philosophical considerations as from the selection of validation procedures. Validation is not a procedure for testing scientific theory or for certifying the 'truth' of current scientific understanding, nor is it a required activity of every modelling project. Validation means that a model is acceptable for its intended use because it meets specified performance requirements.

Before validation is undertaken, (1) the purpose of the model, (2) the performance criteria, and (3) the model context must be specified. The validation process can be decomposed into several components: (1) operation, (2) theory, and (3) data. Important concepts needed to understand the model evaluation process are verification, calibration, validation,

- Oreskes, N., Shraderfrechette, K., Belitz, K. (1994), Verification, validation, and confirmation of numerical-models in the earth-sciences. Science 263, 641–646.

ARTICLE

Verification, Validation, and Confirmation of Numerical Models in the Earth Sciences

Naomi Oreskes,* Kristin Shrader-Frechette, Kenneth Belitz

Verification and validation of numerical models of natural systems is impossible. This is because natural systems are never closed and because model results are always non-unique. Models can be confirmed by the demonstration of agreement between observation and prediction, but confirmation is inherently partial. Complete confirmation is logically precluded by the fallacy of affirming the consequent and by incomplete access to natural phenomena. Models can only be evaluated in relative terms, and their predictive value is always open to question. The primary value of models is heuristic.

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Mathematical components are sub
verification because they are part of
systems that include claims that are
true as a function of the meanings a
to the specific symbols used to expre
(13). However, the models that us

- Bellassen V, Le Maire G, Guin O, Dhote JF, Viovy N, Ciais P (2011), Modeling forest management within a global vegetation model – Part 2: model validation from tree to continental scale. Ecological Modelling, 222, 57–75.

Modelling forest management within a global vegetation model—Part 2: Model validation from a tree to a continental scale

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A R T I C L E I N F O

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A B S T R A C T

The construction of a new forest management module (FMM) within the ORCHIDEE global vegetatio
model (GVM) allows a realistic simulation of biomass changes during the life cycle of a forest, which make
many biomass datasets suitable as validation data for the coupled ORCHIDEE-FM GVM. This study use
three datasets to validate ORCHIDEE-FM at different temporal and spatial scales: permanent monitorin

- Cadule, P., P. Friedlingstein, L. Bopp, S. Sitch, C. D. Jones, P. Ciais, S. L. Piao, and P. Peylin (2010), Benchmarking coupled climate-carbon models against long-term atmospheric CO2 measurements, Global Biogeochem. Cycles, 24, GB2016, doi:10.1029/2009GB003556.

GLOBAL BIOGEOCHEMICAL CYCLES, VOL. 24, GB2016, doi:10.1029/2009GB003556, 2010

Benchmarking coupled climate-carbon models against long-term atmospheric CO_2 measurements

P. Cadule,[1,2] P. Friedlingstein,[1,3] L. Bopp,[1] S. Sitch,[4,5] C. D. Jones,[6] P. Ciais,[1] S. L. Piao,[7] and P. Peylin[1,8]

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[1] We evaluated three global models of the coupled carbon-climate system against atmospheric CO_2 concentration measured at a network of stations. These three models, HadCM3LC, IPSL-CM2-C, and IPSL-CM4-LOOP, participated in the C^{4}MIP experiment and in various other simulations of the future climate impacts on the land and ocean

Conceptions

- **Verification**: Are we building model right?

  Verification is a demonstration that a modeling formalism is correct; Verification errors: mechanical and logical

- **Validation**: Are we building right model?

  Validation is a demonstration that a model within its domain of applicability possesses a satisfactory range of accuracy consistent with the intended application of the model

- **Credibility**: How confirm the model is?

  Credibility is a sufficient degree of belief in the validity of a model to justify its use for research and decision making

Rykiel 1996

Validation Questions:

- Q1.1) What questions need to be asked before a validation is undertaken for a model?
- Q1.2) What are the benefits and limits of validating a model?
- Q1.3) In the selected papers, what are the main lessons learnt from the validation of the models?

1.1. What questions need to be asked before a validation is undertaken for a model?

- Before a validation is undertaken for a model, we should asked these questions:
- (1) What is the purpose of the model?
- (2) What is the performance criteria?
- (3) What is the model context?

- !!! The statement that a model has been validated is misleading without stating the purpose of the model, the validation criteria used and the context to which the claim applies.

Rykiel 1996

1.2. What are the benefits and limits of validating a model?

- Benefits:

  Models can be confirmed by the demonstration of agreement between observation and prediction.

- Limits:

  The confirmation is inherently partial, so the models can only be evaluated in relative terms and their predictive value is always open to question.

Oreskes et al 1994

1.3. In the selected papers, what are the main lessons learnt from the validation of the models?

- Not all models need validation.
- The primary value of models is heuristic: Models are representations, useful for guiding further study but not susceptible to proof.
- Models are most useful when they are used to challenge existing formulations, rather than to validate or verify them.

Rykiel 1996

Oreskes et al 1994

Some Examples

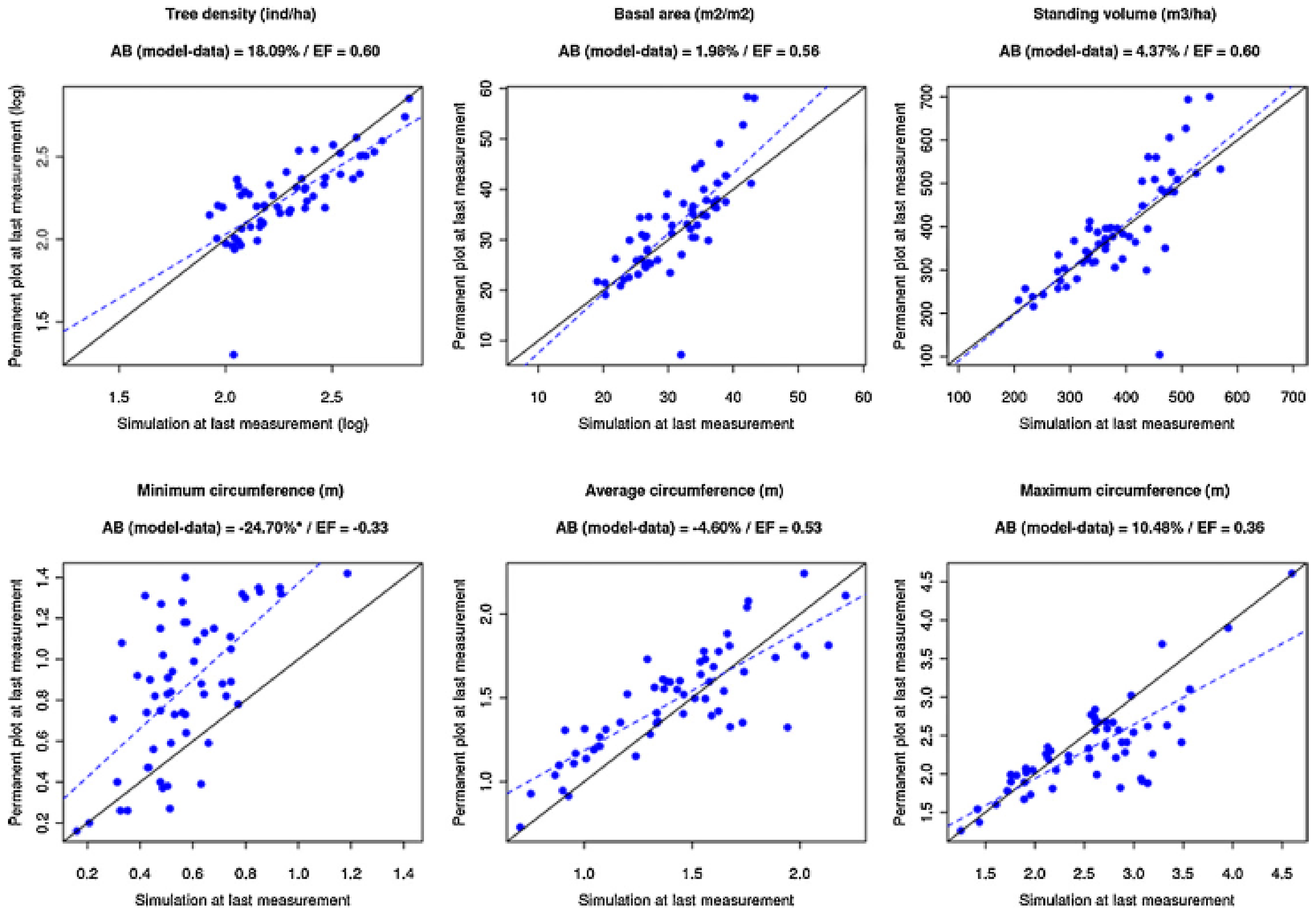

Fig. 3. Validation of stand characteristics: PP_f simulation. Each blue dot corresponds the state of one permanent plot at its last measurement. The dotted blue line represents their linear regression. *AB* and *EF* are average relative bias and model efficiency, respectively. An "*" indicates that the systematic error is higher than the unsystematic error (*RMSEs* > *RMSEu*). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of the article.)

Bellassen et al 2011

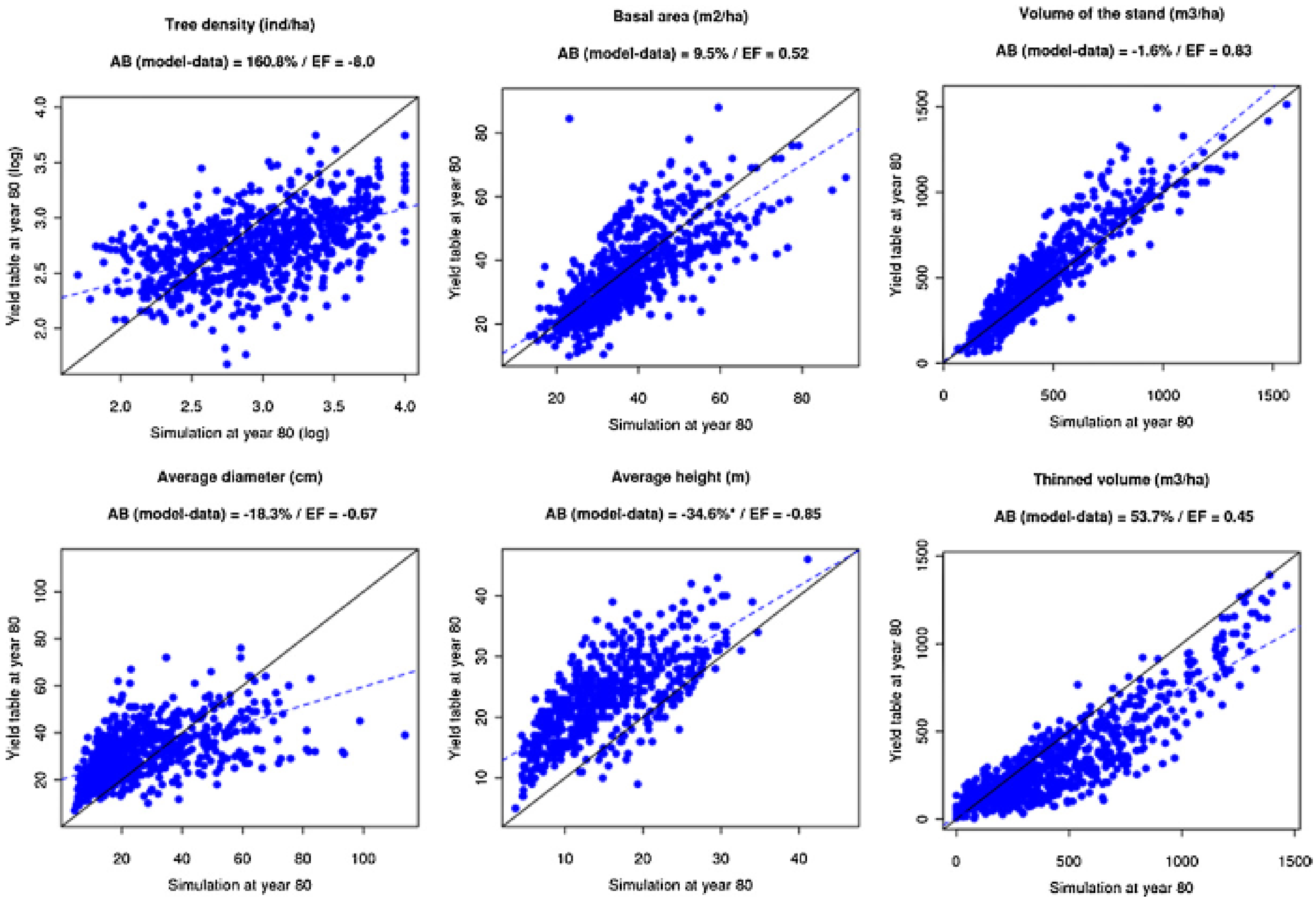

Fig. 6. Validation of stand characteristics: YT_f simulation. Each blue dot corresponds the state of one permanent plot at its last measurement. The dotted blue line represents their linear regression. *AB* and *EF* are the average relative bias and model efficiency, respectively. An "*" indicates that the systematic error is higher than the unsystematic error (*RMSEs* > *RMSEu*). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of the article.)

Bellassen et al 2011

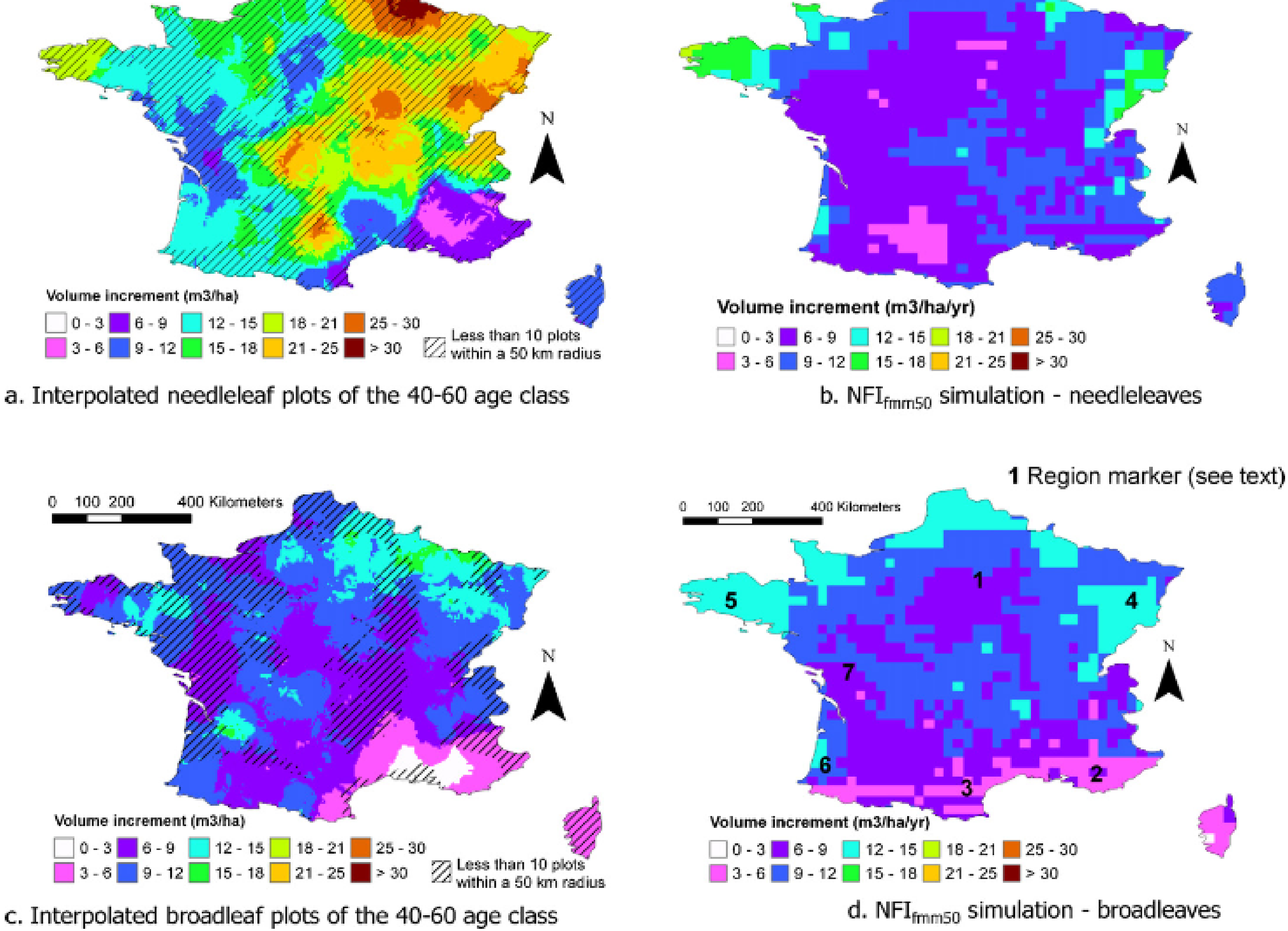

Fig. 8. Validation of the volume increment at a regional scale. "Interpolated data" maps (a and c) are derived from National Forest Inventory plots, and "*NFI$_{fmm50}$* simulation" maps (b and d) represent the output of ORCHIDEE-FM simulations for 50-year-old stands.

Bellassen et al 2011

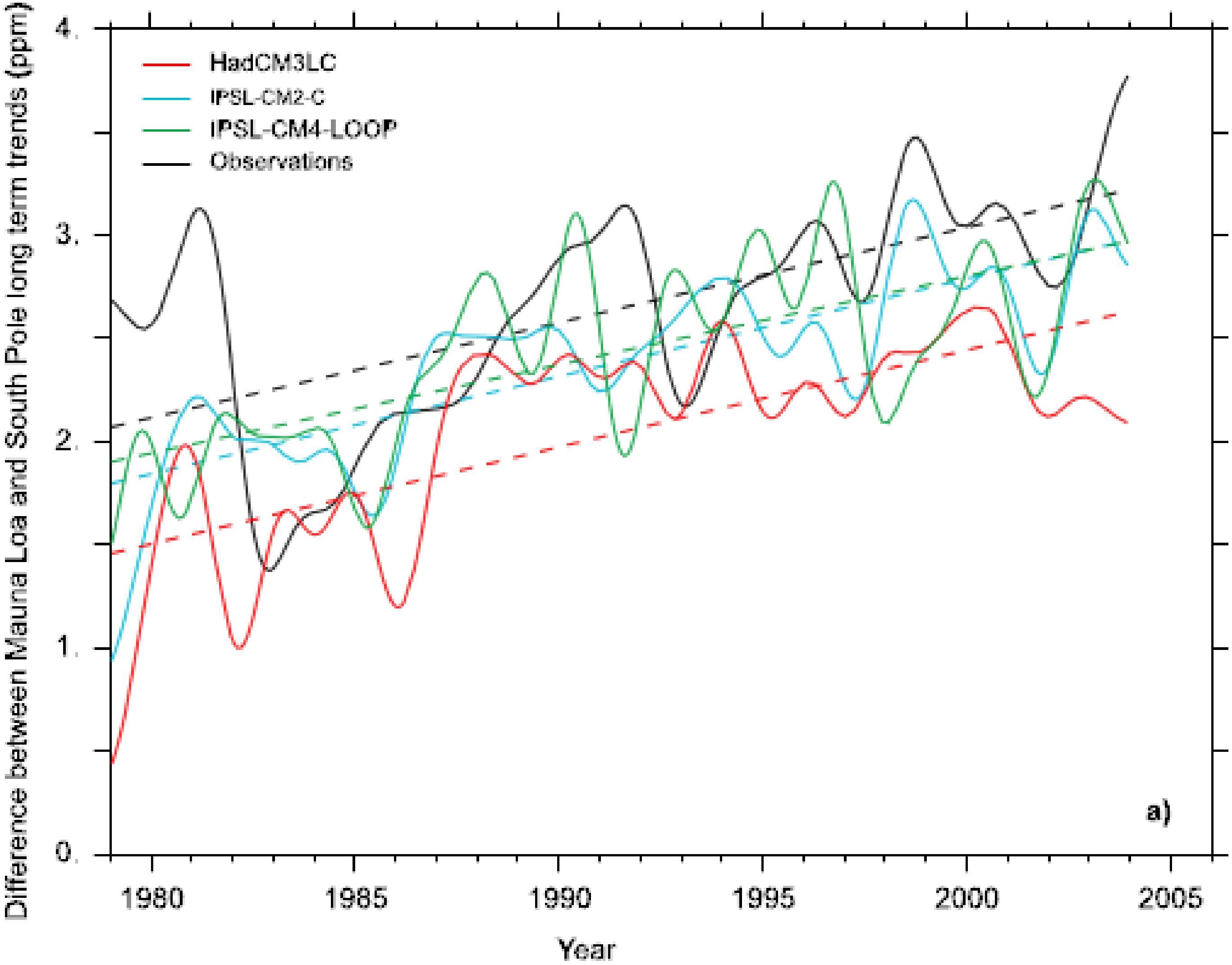

Figure 5. Time evolution of the interhemispheric gradient of atmospheric CO_2, defined here as the difference between the deseasonalized annual CO_2 concentration at MLO and SPO.

Cadule et al 2010

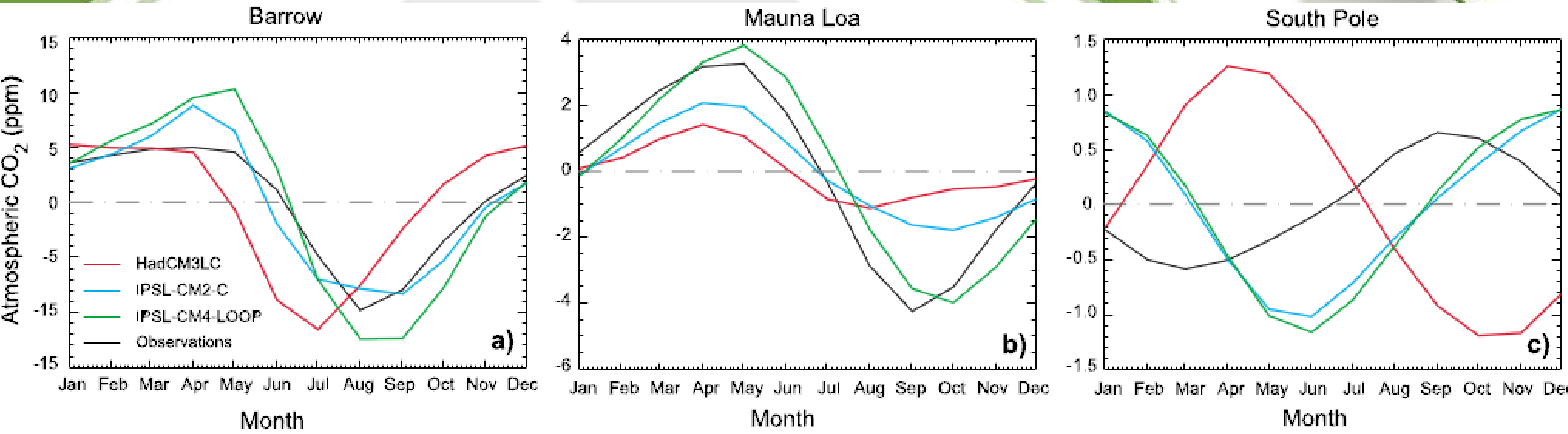

Figure 6. Simulated and observed climatologic averaged CO_2 seasonal cycle at BRW, MLO, and SPO.

Cadule et al 2010

ANY QUESTION?