Michael Dietze
On The Communication between Models & Data
CLIMATE CHANGE IMPACTS

What is the strength of the terrestrial carbon sink and how will it change?

How are ecological communities going to change in their structure and composition?
Model-Data comparison

- Walker et al. 2014 JGR-B
- De Kauwe et al. 2014 New Phytologist
- De Kauwe et al. 2013 GCB
- Schwalm et al. 2010 JGR-B
- Dietze et al. 2011 JGR-B
- Stoy et al. 2013 Biogeosciences
- Richardson et al. 2012 GCB
- Keenan et al. 2012 GCB
- Schaefer et al. 2012 JGR-B
- Fisher et al. 2014 Biogeosciences
- Mathney et al. 2014 JGR-B
- Zaehle et al. 2014 New Phytologist
“assumption-centred” model intercomparison

Medlyon et al. in review
North American Carbon Program MIP
Flux Tower NEE

Used Data Assimilation

Schwalm et al 2010 JGR-B
Model - Data Fusion

- Input / Driver
- “Trait” —> Direct Parameter Estimation
- Observation —> Indirect Parameter Estimation
- Observation —> Model State
PRIORS

Specific Leaf Area

Data from Wright et al 2004, Graminoids
META-ANALYSIS
POSTERIORS

Specific Leaf Area

m2 kg⁻¹
SENSITIVITY ANALYSIS

Specific Leaf Area

NPP (Mg/ha)

m² kg⁻¹
VARIANCE DECOMPOSITION

*can easily be extended to driver and IC uncertainties*
MODEL-DATA FEEDBACK

- Focus field research on most important processes
- Compare apples to apples
- Power analysis
- Error reduction per unit sampling effort
- Within vs across site sampling
- Refine data synthesis
- Direct data assimilation
BAYESIAN DATA ASSIMILATION

Generalized Priors (weak) → Meta-analysis Posterior

Prior → Posterior

Eddy Flux

Prior → Posterior

Forest Inventory

Prior → Posterior

Hydrology

Prior → Posterior

Experiments

Prior → Posterior

Remote Sensing

Prior → Posterior
DA Gotchas

- Don’t fit one model to another model
- GPP & Reco are models not data
- Gap-filled “observations” are models not data
- Autocorrelated data leads to overconfident DA
- Uninformative uniform priors:
  - Trait data are “gold standard”, shouldn’t ignore
  - Increased risk of biologically implausible estimates
  - Sensitivity, not Uncertainty Analysis
- Ignoring model error  —> fit parameter
\[ P(\theta|y) \propto P(y|\theta) P(\theta) \]

Updated State  Data  Model
LAI assimilation: Willow Creek, WI

Viskari et al in press
Hyperspectral Assimilation

AVIRIS/Imaging Spectroscopy

Ecosystem Model

RTM

Assimilation

Other RS Data

(a) Reflection (%)

(b) Reflection (%)

(c) Reflection (%)

(d) Reflection (%)

NASA S. Serbin, P. Townsend
TREE GROWTH INFERENCES AND PREDICTION FROM DIAMETER CENSUSES AND RING WIDTHS

JAMES S. CLARK,1,2,3,4,6 MICHAEL WOLOSIN,2,3 MICHAEL DIETZE,2,3 INÉS IBÁÑEZ,2,3 SHANNON LADEN,2,3,7
MIRANDA WELSH,1 AND BRIAN KLOEPEL5
Three 0.05ha plots
Data: Sam Pecoraro

6 - Prairie Peninsula
Weather Forecasting: An initial Conditions Problem

State Space → Kalman Filter

Slingo & Palmer. 2011. Phil. Trans. R. Soc. A
On The nature of
The Ecological Forecasting Problem

Heterogenous
Stochastic
Memory

State Space  ???

Process error?  Updatable hierarchical models?
State convergence?  Fusing multiple data?
Challenges

- Data synthesis: volume, diversity
- Modeling not scalable
- Models are not accessible
Challenges

• Data synthesis: volume, diversity
• Modeling not scalable
• Models are not accessible
Challenges

- Data synthesis: volume, diversity
- Modeling not scalable
- Models are not accessible
The PEcAn Project: Carbon-Cycle Reanalysis Facilitated by Model-Data Ecoinformatics