Data assimilation in land surface schemes

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The problem of scale in global models

- The best data on the state of the C cycle come from flask [CO$_2$]
- The best process data come from eddy flux towers and field sites
- How can we connect these data across the scale difference?
- The data assimilation theme attempts to connect global to local data sets, to generate new insights and more powerful models
The benefits of linking models to data

• To guide parameterization
• To determine the uncertainty on predictions
• To test processes understanding
• To link to multiple observation data streams to improve predictions
• To determine what new measurements should be gathered
• To guide construction of observing networks
What is currently funded in JULES DA?

- QUEST/Exeter and Met Office
  - Assimilating flask/satellite CO$_2$ data
  - Adjoint of JULES, CCDAS
- CTCD/NCEO
  - Assimilating eddy flux, optical remote sensing and inventory data, tall tower/satellite CO$_2$ data.
  - Ensemble Kalman Filter, observation operators
Current activities

- Testing parameterization schemes: Reflex
REgional Flux Estimation eXperiment (REFLEX)

- To compare the strengths and weaknesses of various model-data fusion techniques
- To quantify errors and biases introduced when extrapolating fluxes in space and time
- More details at www.carbonfusion.org
REgional Flux Estimation eXperiment (REFLEX)

FluxNet data
MODIS

Assimilation

MDF

DALEC model

Output

Full analysis
Model parameters

Training Runs

Deciduous forest sites
Coniferous forest sites
Synthetic evergreen forest
2 years obs., 1 year prediction
REgional Flux Estimation eXperiment (REFLEX)

- FluxNet data
- MODIS

MDF

DALEC model

Full analysis
Model parameters

Testing site forecasts with limited EO data

MODIS

Assimilation

Analysis
A DA strategy for JULES?

- **LOCAL**: DA for local parameter PDFs, process testing, C-water interactions, full state descriptions. *FluxNet, IPSL, NCAR, ACCESS.*

- **REGIONAL**: upscaling, coupling to/inverting atmospheric data/models. *CarboEurope, ABACUS.*

- **GLOBAL**: Global assimilation with optical, CO$_2$, water, temperature remote sensing, flasks. *NCEO & CCDAS.*
Connecting to other JULES themes

• What parameters are poorly determined in each module?
• What time series data are suitable/available for assimilation?
• What data form the most stringent test of process representation?
• How are state variables related to observations? (EO…)
Thanks to Andy Fox