

PhD Outline

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1 Introduction

- Why is understanding the carbon balance of forests important?
- Terrestrial ecosystems and oceans responsible for removing around half of all human emitted carbon-dioxide from the atmosphere and therefore greatly reduce the effect of anthropogenic induced climate change. Terrestrial ecosystem carbon uptake is the least understood process in the global carbon cycle. It is vital that we improve understanding in order to better constrain predictions of future carbon budgets (IPCC report).
- Thesis aims and outline.

2 Literature Review

- Variational data assimilation, in particular 4D-Var. Possibly also touch on MCMC techniques. Automatic differentiation for TLM and minimisation routines in Python.
- DALEC2 and the processes it models.
- Information content measures.
- Desroziers and how to represent B and R.
- NEE measurements, error and footprint model.

3 Methods

- Outline of LAI measurement campaign.

4 Chapter one: 4D-Var and information content in carbon balance observations with DALEC2

- Introduce explicit expressions for information content for observations relating to DALEC2 at a single time.
- Results from IC experiments.
- Begin by considering information content in the context of a set of twin experiments using DALEC2.

- Measures: SIC, DOFS, Adjoint Sensitivity, Forecast Sensitivity to obs.
- Apply results to actual data acquired from Alice Holt.
- Results: temporal information content in observations. What set of observations is best?
- Investigate effect of data drop out, miss-specification of errors (twin experiments), quantity and time of sampling.
- Possibility of using SiPNET model to repeat IC experiments (only if not a huge task).

5 Chapter two: Improving the representation of background and observational error covariance matrices in carbon balance models

- Following on from chapter one (IC in Cpool obs > IC in NEE obs, no. of Cpool obs << no. of NEE obs). Spread info in NEE obs by moving away from a diagonal representation of R.
- Hopefully use a method such as Deroziers to improve our estimates of B and R. Does this improve our results from the data assimilation experiments? Could use twin experiments here.
- Apply this to 4D-Var and MCMC techniques to compare effect on both.
- If this method is effective and JULES 4D-En-Var is easily runnable with parameter estimation, we could attempt to apply techniques to JULES.

6 Chapter three: Effect of disturbance on the Alice Holt research forest

- Split NEE data into multiple data sets using footprint model, then parameterise DALEC2 for each data set. Compare the differences between the parameterisations with particular focus on the thinned/unthinned halves of the forest.
- Compare the model parameters for LAI to observations taken in a planned field work campaign.
- Any changes to model (variable time step, phenology)? Could implementing a better phenology model in DALEC2 improve our LAI estimates and maybe capture litter fall more accurately?
- Possibility of including understory hazel in DALEC2, does this improve our estimates? Comparison with Eric's SPA which includes understory.

7 Conclusion

- Summary and future work.