Information Content for Observations of Forest Carbon Stocks and Fluxes when Assimilated with the DALEC Carbon Balance Model PLAN

E. Pinnington

September 30, 2014

Introduction

Motivation for understanding the information content of observations. Important for knowing when and which observations to take to give you the most information possible about the system. [1, 3, 5]

The DALEC Model

Background on DALEC model and how it is implemented in DA. State just five carbon pools, if estimating the parameters also state is approximately twenty elements.[2, 8]

Introduction to Variational Assimilation

For our information content measures we use a variational assimilation framework. 3DVAR/4DVAR. [4]

Information Content Measures

A look at what information content measures are currently in use from [6, 7].

Shannon Information Content

explanation of what SIC is. [6, 7]

SIC for a Single Observation at One Time

A analytic representation of SIC for obs. at a single time. Show NEE's SIC dependence on temperature, net daily irradiance and Cf. Obs. of NEE made in summer months provide more information than those made in winter.

SIC **for Successive Observations over a Time Window**

Show information content when successive observations are added to our assimilation window. Begin with analytical form form successive observations of Cf. For NEE seasonal cycle still clear, if assimilation window begins in summer a higher SIC is reached over a shorter period (refer to graph in previous section). A single observation of NEE made in summer provides the same level of information as 14 observations of NEE made in winter.

Degrees of Freedom for Signal

Backs up findings using SIC. Only observing three carbon pools with NEE does this mean max value $DOFS$ can attain is three? [6]

Conclusions

Summary of what we have found. When it is best to take obs of carbon stocks and fluxes and which obs to take. Although these experiments carried out for DALEC principles will apply for most other carbon balance models.

References

[1] Dennis Baldocchi. Turner review no. 15.'breathing'of the terrestrial biosphere: lessons learned from a global network of carbon dioxide flux measurement systems. *Australian Journal of Botany*, 56(1):1–26, 2008.

[2] Sylvain Delahaies, Ian Roulstone, and Nancy Nichols. A regularization of the carbon cycle data-fusion problem. In *EGU General Assembly Conference Abstracts*, volume 15, page 4087, 2013.

[3] Andrew Fox, Mathew Williams, Andrew D Richardson, David Cameron, Jeffrey H Gove, Tristan Quaife, Daniel Ricciuto, Markus Reichstein, Enrico Tomelleri, Cathy M Trudinger, et al. The reflex project: comparing different algorithms and implementations for the inversion of a terrestrial ecosystem model against eddy covariance data. *Agricultural and Forest Meteorology*, 149(10):1597–1615, 2009.

[4] John M Lewis, Sivaramakrishnan Lakshmivarahan, and Sudarshan Dhall. *Dynamic data assimilation: a least squares approach*, volume 13. Cambridge University Press, 2006.

[5] Andrew D Richardson, Mathew Williams, David Y Hollinger, David JP Moore, D Bryan Dail, Eric A Davidson, Neal A Scott, Robert S Evans, Holly Hughes, John T Lee, et al. Estimating parameters of a forest ecosystem c model with measurements of stocks and fluxes as joint constraints. *Oecologia*, 164(1):25–40, 2010.

[6] Clive D Rodgers et al. *Inverse methods for atmospheric sounding: Theory and practice*, volume 2. World scientific Singapore, 2000.

[7] Laura M Stewart, SL Dance, and NK Nichols. Correlated observation errors in data assimilation. *International journal for numerical methods in fluids*, 56(8):1521–1527, 2008.

[8] Mathew Williams, Paul A Schwarz, Beverly E Law, James Irvine, and Meredith R Kurpius. An improved analysis of forest carbon dynamics using data assimilation. *Global Change Biology*, 11(1):89–105, 2005.