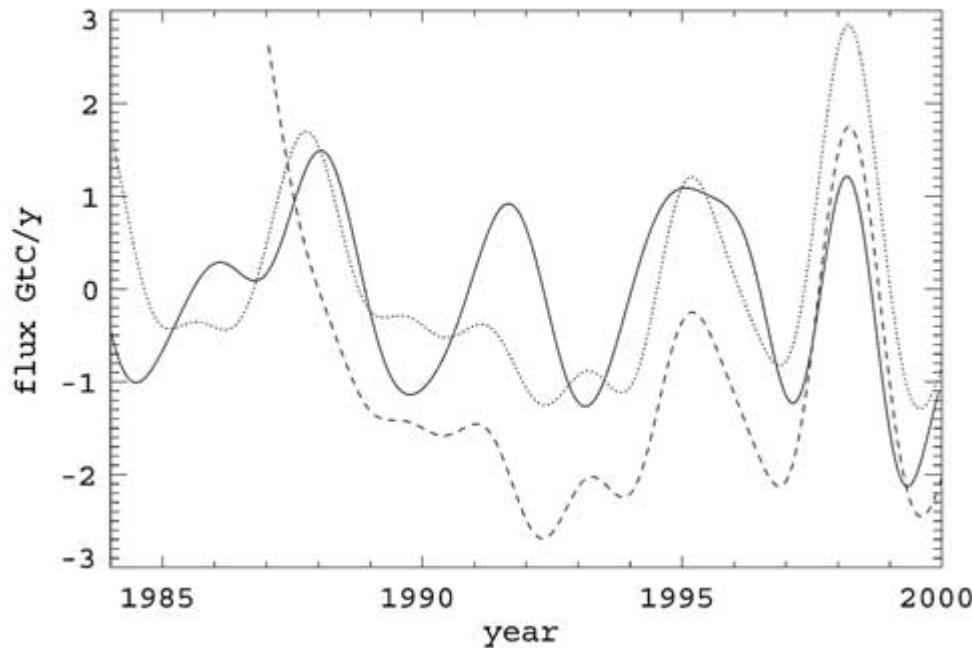


Questions

- Q1) What are the benefits of optimizing model parameters over the more conventional atmospheric CO₂ inversions.
- Q2) What is the potential of using multi-data stream to optimize carbon fluxes
- Q3) What are the limitations of model-parameter optimization and how to evaluate the performance of the optimization

- Q1) What are the benefits of optimizing model parameters over the more conventional atmospheric CO₂ inversions.
 - Processes
 - Timespan

Data fitting



Rayner et al., 2005

Solid line: optimized terrestrial flux

Dash line: inversions using 19 stations

Dotted line: inversions using 16 stations

Processes

- “On interannual timescales the controlling process is net primary productivity (NPP) while for decadal changes the main driver is changes in soil respiration.”
—Rayner et al., (2005)

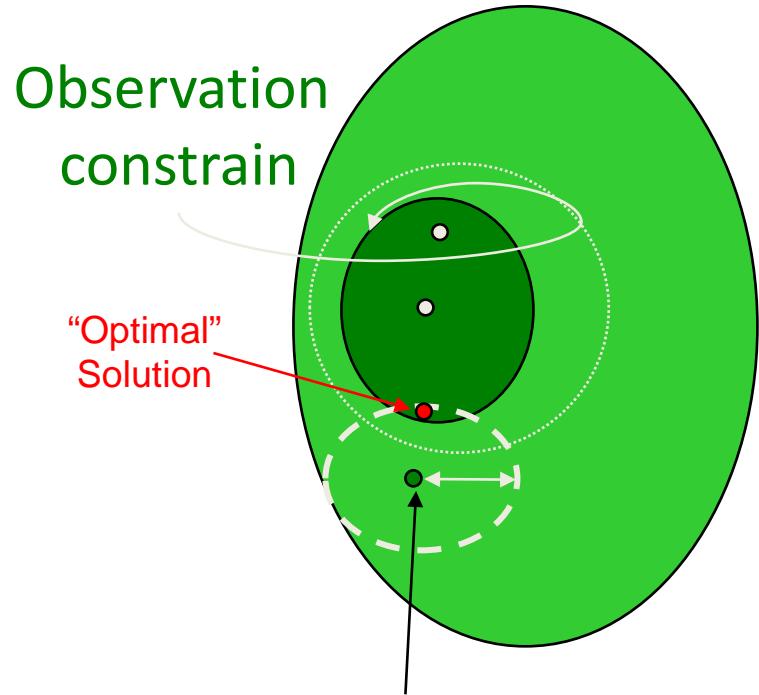
Take the El Nino example
Maximize data utilization

Timespan

- E.g. 50-year reanalysis of vegetation phenology by Stockli et al. (2011) with MODIS data only available since 2000

- Q2) What is the potential of using multi-data stream to optimize carbon fluxes

- “a perfect estimation of the combined posterior model and parameter error by analysis of both the prior model uncertainty and the observation uncertainty”
- Stockli et al., (2011)



A prior parameter

- In practice, there are many limitations...
 - Chosen of observation error (often unknown and thus arbitrary), also true for prior uncertainty
 - Too much freedom (too many parameters but fewer observations)
 - Optimization algorithms (EnKF, variational)

- Q3) What are the limitations of model-parameter optimization and how to evaluate the performance of the optimization

limitations of model-parameter optimization

- Optimization can correct parameters but not structure error.
 - Missing processes, overfitting

evaluate the performance of the optimization

- Using observations not assimilated in the optimization, or comparing with observations in different time scales.
- e.g. in Medvigy et al. (2009)
 - Assimilated data: eddy-flux measurements, satellite-derived phenology observations, and forest inventory data obtained over a two-year period at Harvard Forest
 - Evaluation data: seasonal-to-decadal scale vegetation and carbon dynamics at Harvard forest, seasonal-to-interannual carbon dynamics at Howland Forest and Chibougamou, and decadal vegetation dynamics in the northeastern United States and Quebec

References

- Rayner, P. J., M. Scholze, W. Knorr, T. Kaminski, R. Giering, and H. Widmann (2005), Two decades of terrestrial carbon fluxes from a carbon cycle data assimilation system (CCDAS), *Global Biogeochem. Cycles*, 19, GB2026, doi:10.1029/2004GB002254.
- Stöckli, R., T. Rutishauser, I. Baker, M. A. Liniger, and A. S. Denning (2011), A global reanalysis of vegetation phenology, *J. Geophys. Res.*, 116, G03020, doi:10.1029/2010JG001545.
- Medvigy, D., S. C. Wofsy, J. W. Munger, D. Y. Hollinger, and P. R. Moorcroft (2009), Mechanistic scaling of ecosystem function and dynamics in space and time: Ecosystem Demography model version 2, *J. Geophys. Res.*, 114, G01002, doi:10.1029/2008JG000812.