

Data assimilation for Earth observation

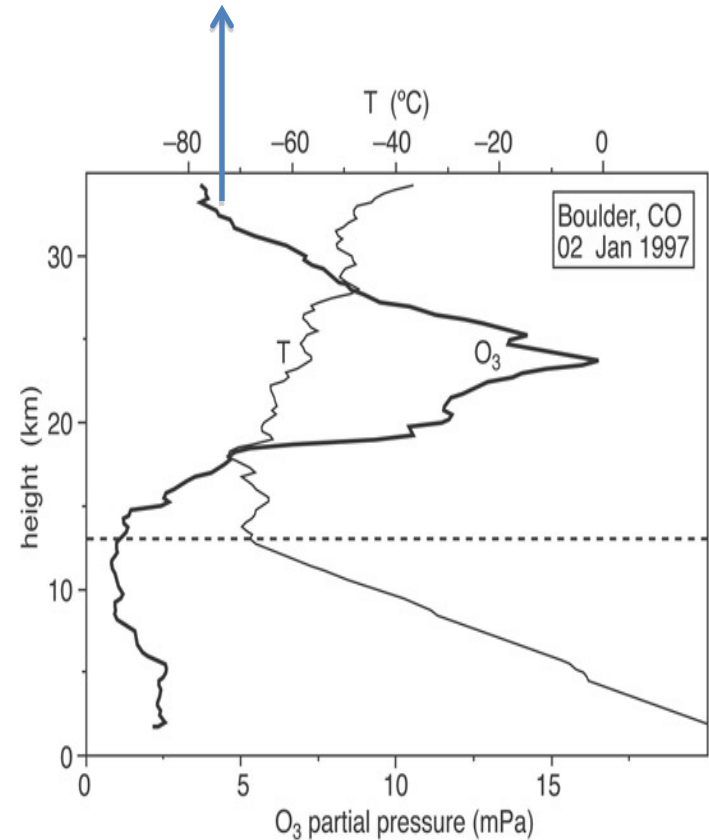
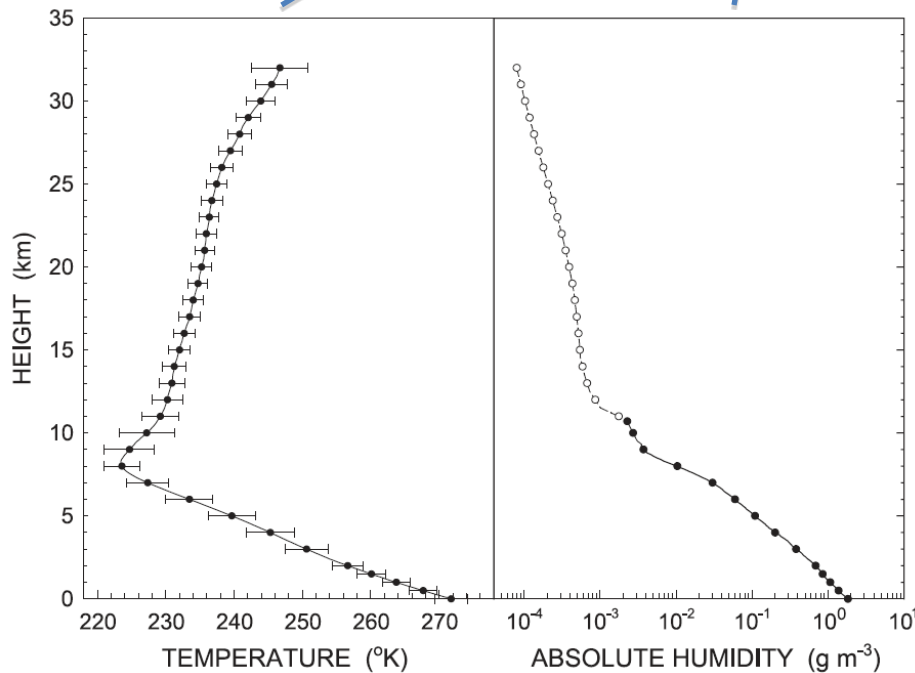
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Using satellite observations

- Voltages from photon counters
- Transformed to geophysical quantities using models of the satellite instrument, e.g. to top of the atmosphere radiances
- How do we use these radiances?

Satellite observations

Top of the atmosphere radiance



The need for a geophysical model

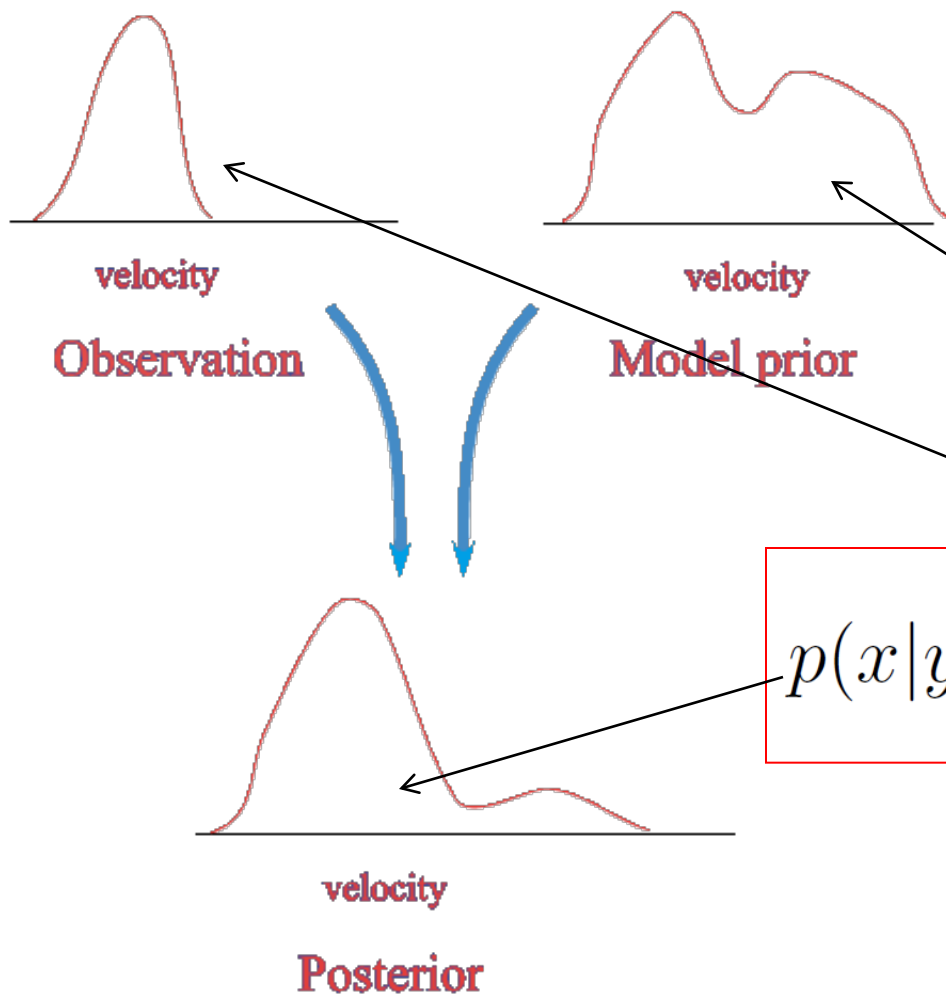
A model of the atmosphere is needed that relates T , q , O_3 etc. to the radiance at the top of the atmosphere:

$$R(\lambda) = f(T(z), q(z), O_3(z), \dots)$$

Which model should we use?

- Typically the function f cannot be inverted: much more unknowns than observations, and several profiles lead to the same radiances.
- So we need prior information on the state of the atmosphere.

Data assimilation



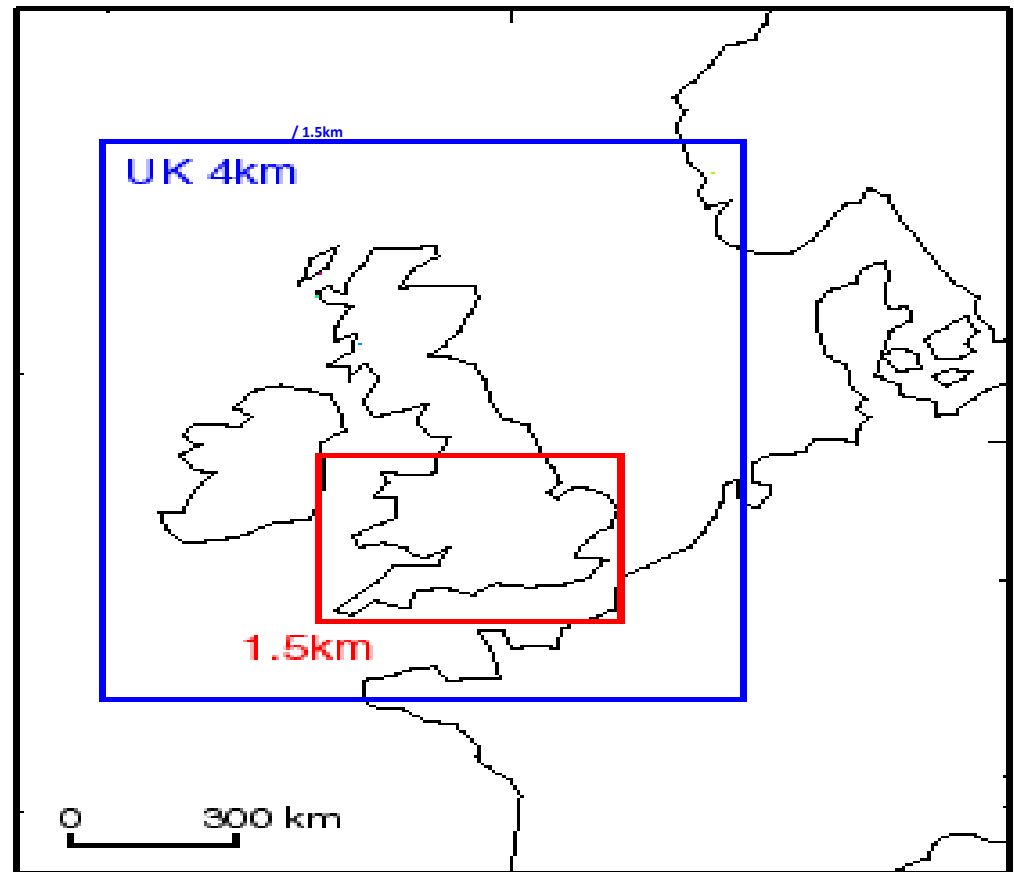
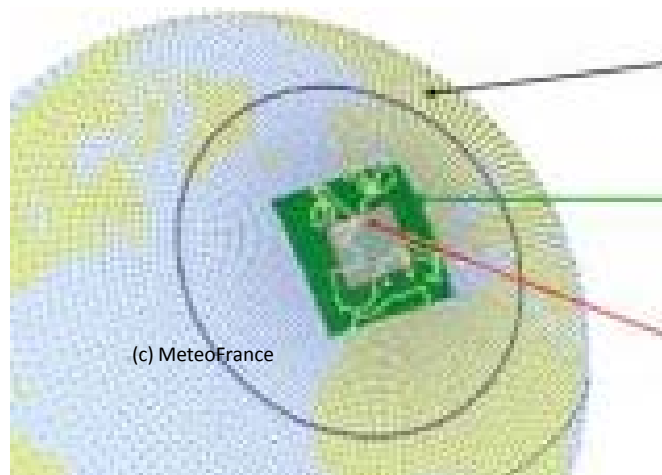
Bayes theorem:

$$p(x|y) = \frac{p(y|x)p(x)}{\int p(y|x)p(x) dx}$$

Solution is pdf!

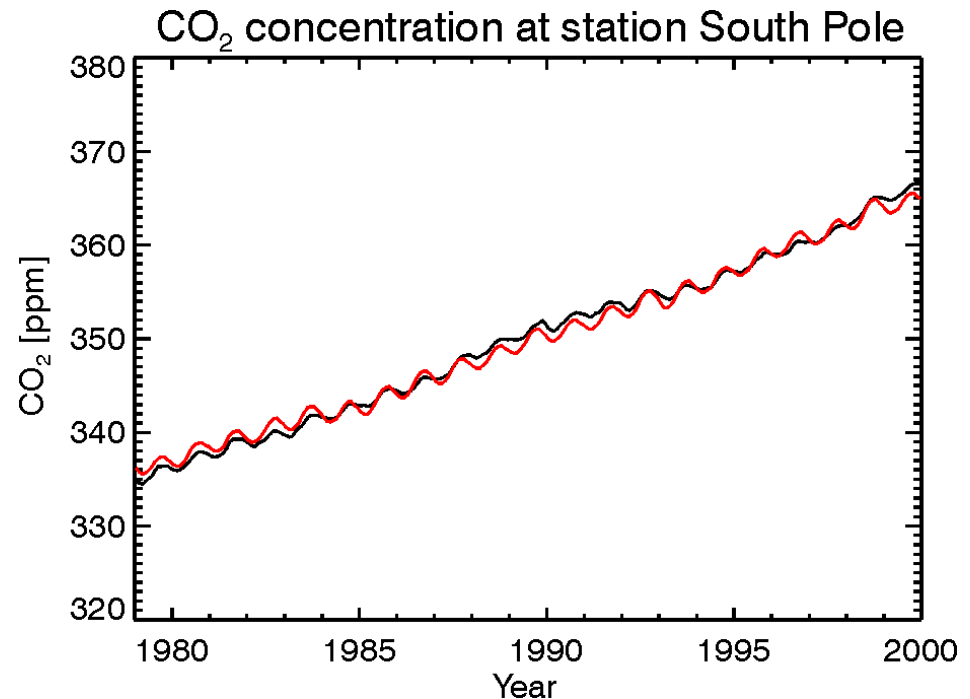
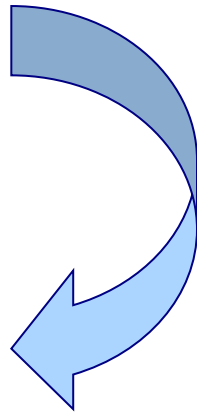
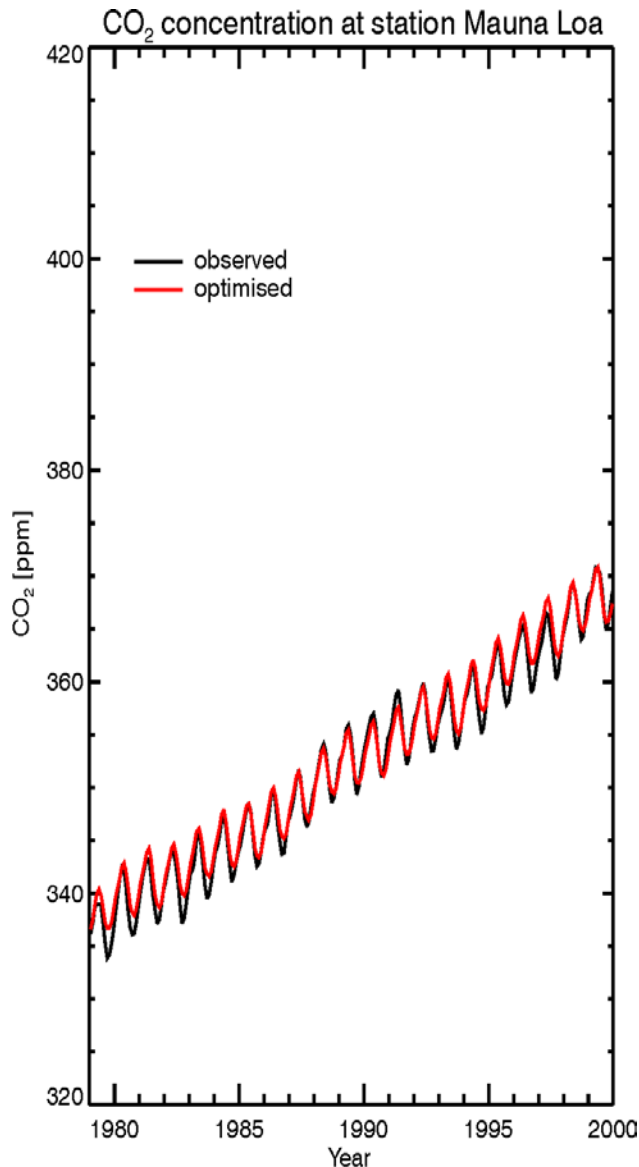
NO INVERSION !!!

High-resolution weather prediction Met Office system

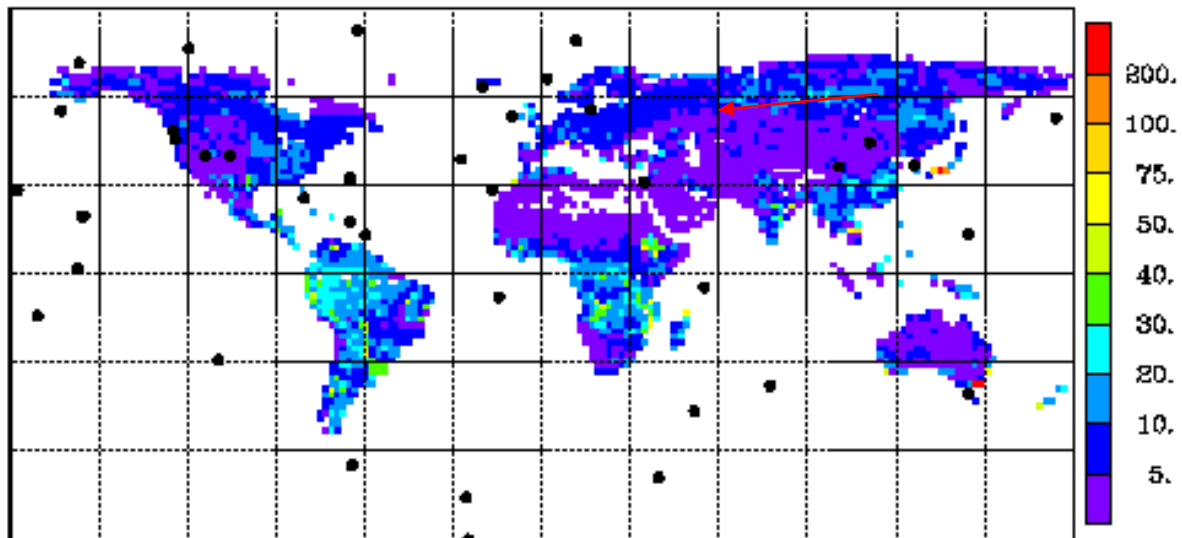
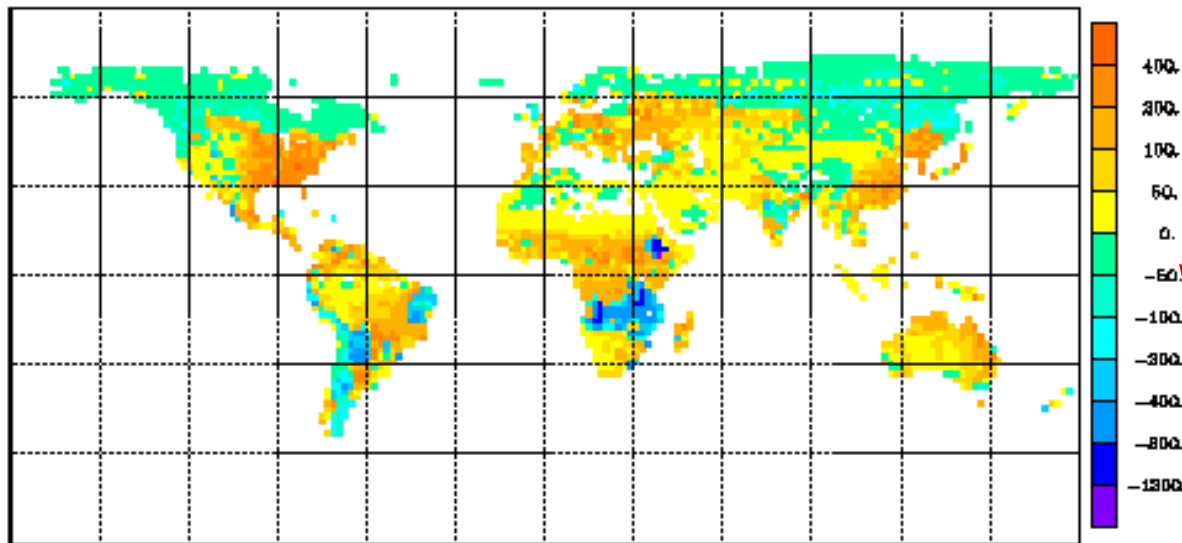


The Carbon Cycle Data Assimilation System

Assimilation of FAPAR and atm. CO₂ flask data to optimise parameter values (and uncertainties) of a process-based terrestrial ecosystem model (BETHY). (Scholze et al., Bristol)

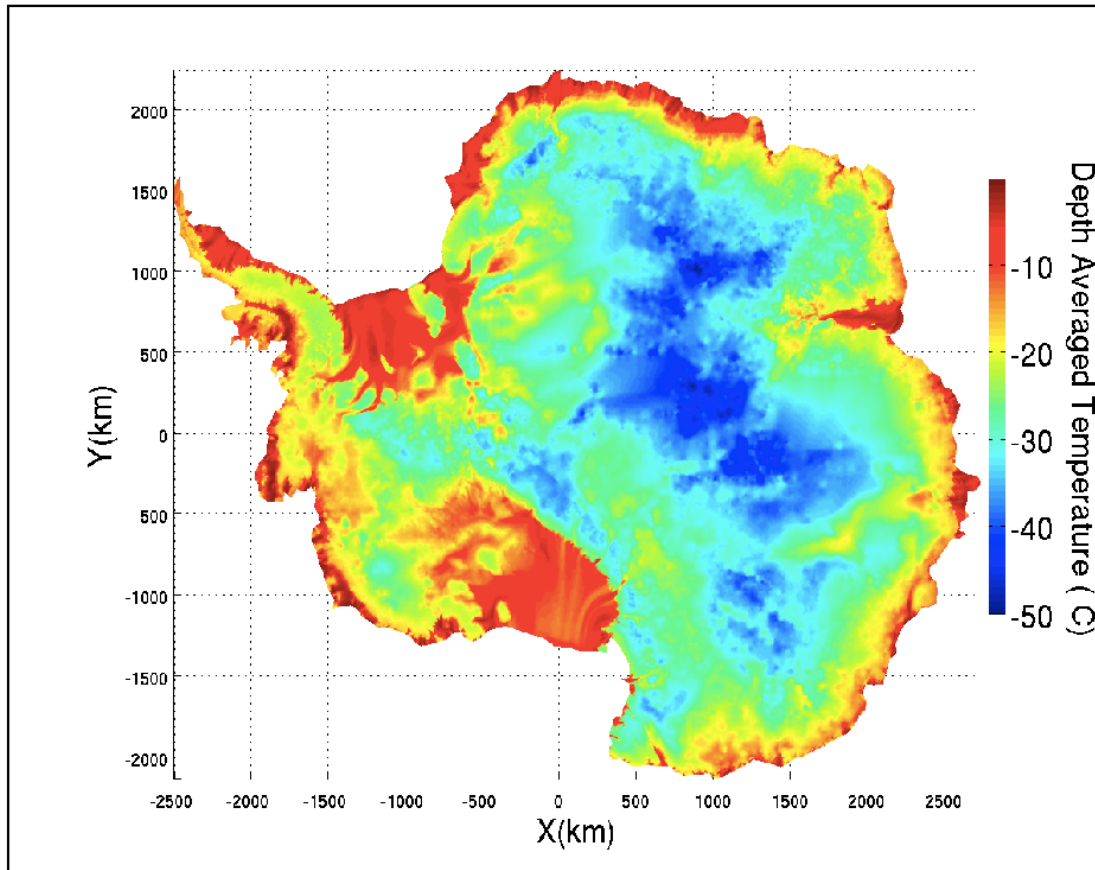


Net C fluxes and their uncertainties



Long term mean
fluxes to
atmosphere
(gC/m²/year) and
uncertainties

Ice sheet data assimilation



Challenge:
Data assimilation
on a moving mesh.

New data assimilation methods

- Move removed, doesn't run on Windows.

Concluding remarks

- Satellite observations need a geophysical model to be used, so we need data assimilation.
- NCEO develops data-assimilation algorithms for geophysical satellite observations for atmosphere, ocean, cryosphere, carbon cycle, etc.
- NCEO does exciting new theoretical work on data assimilation.
- NCEO improves geophysical models (e.g. weather, climate) through data assimilation.
- Data-assimilation@NCEO is well embedded internationally (EU, ESA, METEOSAT, NASA, ...).