Anatomy of a CCDAS

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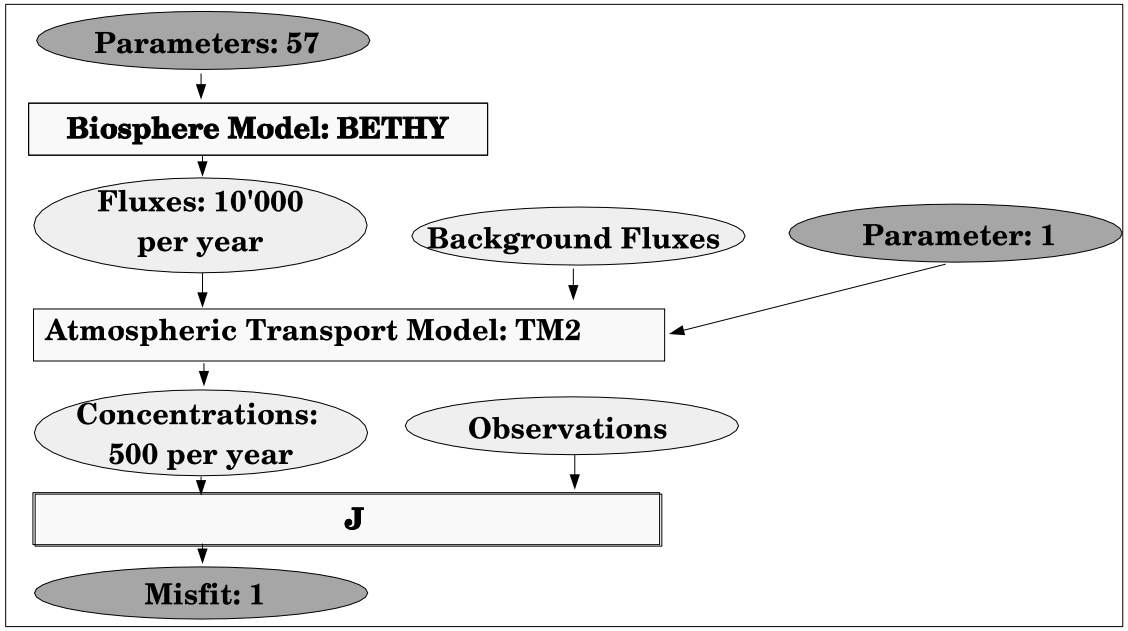
Outline

- What is a CCDAS?
- Why would we want one anyway?
- A brief anatomical tour.
- What is general, what is specific?
- What do we need to learn?

What must a CCDAS contain?

- A model of processes
- Some uncertain parameters or state
- A mapping of model quantities to observations (observation operator)
- Some method for combining streams of information (usually probability distributions)

Parameter Optimization



Flow of information in the coupled model. Oval boxes show the various quantities. Rectangular boxes denote the mappings between these fields.

An Example

- Kaminski et al., GBC, 2002
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$$
\begin{aligned}
\mathrm{NPP} &= \underline{\epsilon}\mathrm{FAPAR} \\
\mathrm{RESP} &= \alpha \underline{Q}_{10}^{T/10} \\
0 &= \overline{\mathrm{RESP} - \mathrm{NPP}} \\
D &= \mathbf{T}(\mathrm{RESP} - \mathrm{NPP})
\end{aligned}
$$

Pros and Cons

Advantages

- Fewer parameters
- Consistent dynamics
- Multiple observations
- Predictive capability

Disadvantages

- Needs Model
- Immune to surprises
- Technically challenging

Sensory Organs

- Not passive.
- Map internal state to observables
- Usually require reverse mapping
- Potentially general but depends on details of state variables

Muscles (model equations and timestepping)

- Responsible for model trajectory through phase space
- May or may not require forward and reverse mappings
- Linearized version used for error propagation

Brain (optimization algorithm)

- Responsible for reconciling internal and external states
- Beware of psychotic delusions
- Must know what to believe and when
- OPTIC intercomparison

Error Statistics

- "Anything you can't model is noise" (I. Enting, mists of antiquity)
- Ergo error statistics are model dependent.
- $$\chi^2 = [Y - \mathbf{H}X_0]^T \left[\mathbf{HPH}^T + \mathbf{R}\right] [Y - \mathbf{H}X_0]$$
- Michalak et al. GBC 2005

What can we develop collectively?

- Education
- Optimization algorithms
- Observation Operators
- Data sets

What can we not develop collectively?

- Models
- Error statistics