IMECC NA2

Development of a Network Design Tool

FastOpt, LSCE, and University of Bristol

GEOMON & IMECC Meeting, January 2009, Geneva

SIXTH FRAMEWORK PROGRAMME

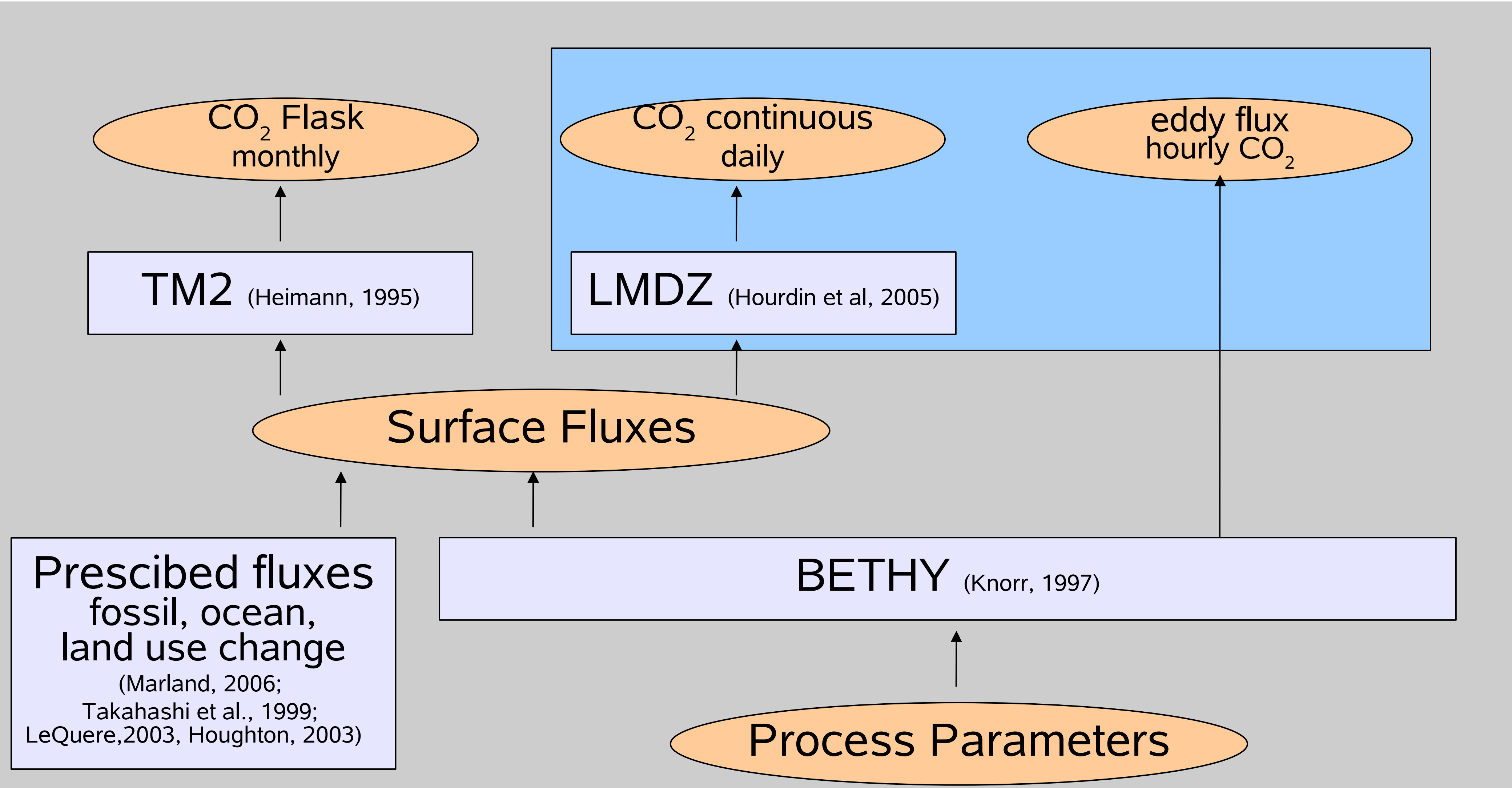
IMECC
Infrastructure for Measurement of the European Carbon Cycle

University of BRISTOL

LSCE

FastOpt

Carbon Cycle Data Assimilation System (CCDAS) Forward Modelling Chain



SIXTH FRAMEWORK PROGRAMME

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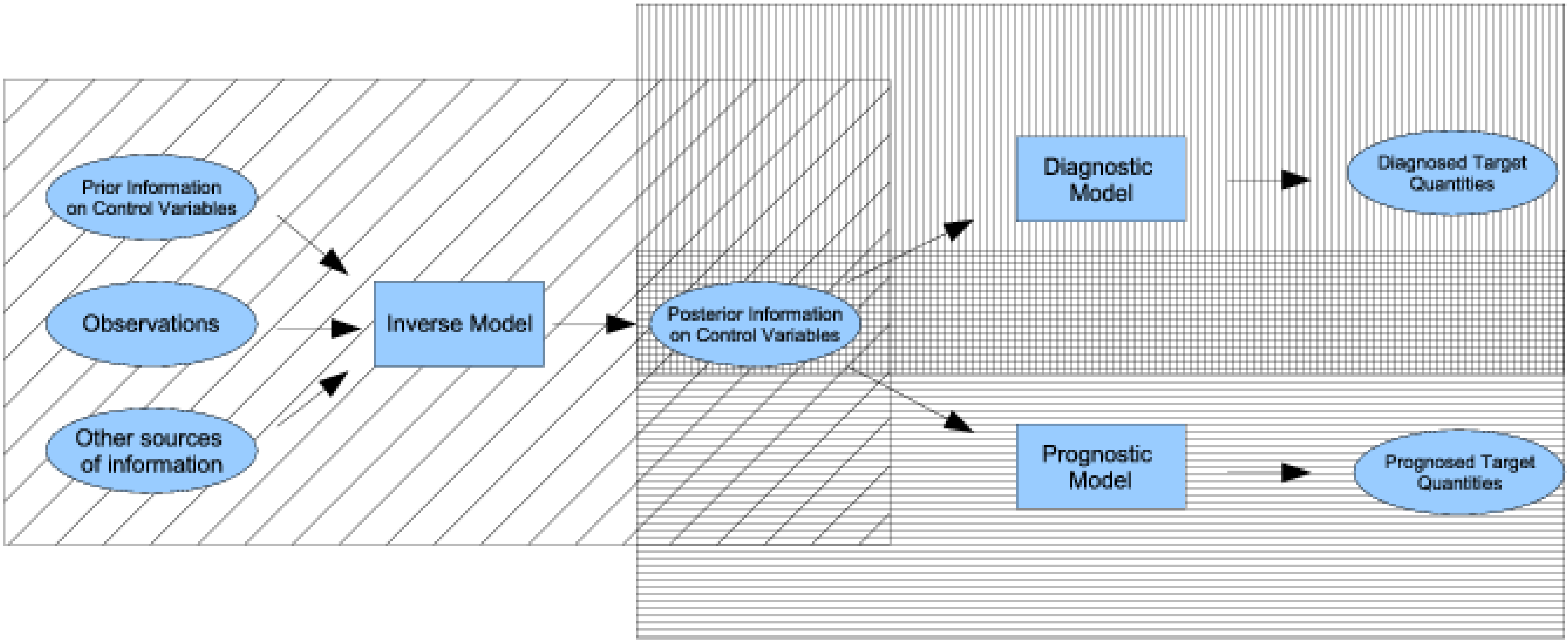
FastOpt

CCDAS scheme



Rayner et al. (2005); Scholze et al. (2007)

Uncertainty calculation in 2 steps

x: Parameters

x_{pr}: Priors

C_{pr}: Uncertainties

$M(x)$: Model

d: Observations

C_d: Their uncertainties

σ_{d_i}: Uncorrelated!

$J(x)$: Cost function

$\frac{d^2 J(x)}{dx^2}$: Hessian

x_{po}: Posterior parameters

C_{po}: Posterior uncertainties

$y(x)$: Target quantity

σ_y: Its uncertainty

All derivative code generated from model code by automatic differentiation tool TAF

Inverse step:

$$J(x) = \frac{1}{2}(x - x_{pr})^T {C_{pr}}^{-1}(x - x_{pr}) + \frac{1}{2}\sum_{i=1,nd}\left(\frac{M_i(x) - d_i}{\sigma_{d_i}}\right)^2$$

$$\frac{d^2 J(x)}{dx^2} = {C_{pr}}^{-1} + \sum_{i=1,nd}\frac{1}{\sigma_{d_i}^2}\frac{d^2}{dx^2}(M_i(x) - d_i)^2$$

uncertainty in observations AND model

- Hessian independent of x for linear model
- For synthetic data use $d = M(x)$.
- Decomposes nicely, can precompute model contribution

$$C_{po} \approx \frac{d^2 J(x_{po})}{dx^2}^{-1}$$

Propagation step:

$$\sigma_y^2 \approx \frac{dy(x_{po})}{dx} C_{po} \frac{dy(x_{po})}{dx}^T \approx \frac{dy(x_{po})}{dx}\frac{d^2 J(x_{po})}{dx^2}^{-1}\frac{dy(x_{po})}{dx}^T$$