Network design in ICOS
some issues

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What did we promise in ICOS?

Task 5.1 Network design Roles:

LSCE, MPI-BGC, UNITUS, VUA

- To select the main sites, first, detailed assessment of past performance and suitability performed by VUA and MPI-BGC.
- UNITUS will estimate ecosystem parameters and errors from ecosystem data.
- The network design shell developed in IMECC will be applied to generate optimum network density and site location (LSCE, VUA).

- D5.1 First network design simulations (Month 12)

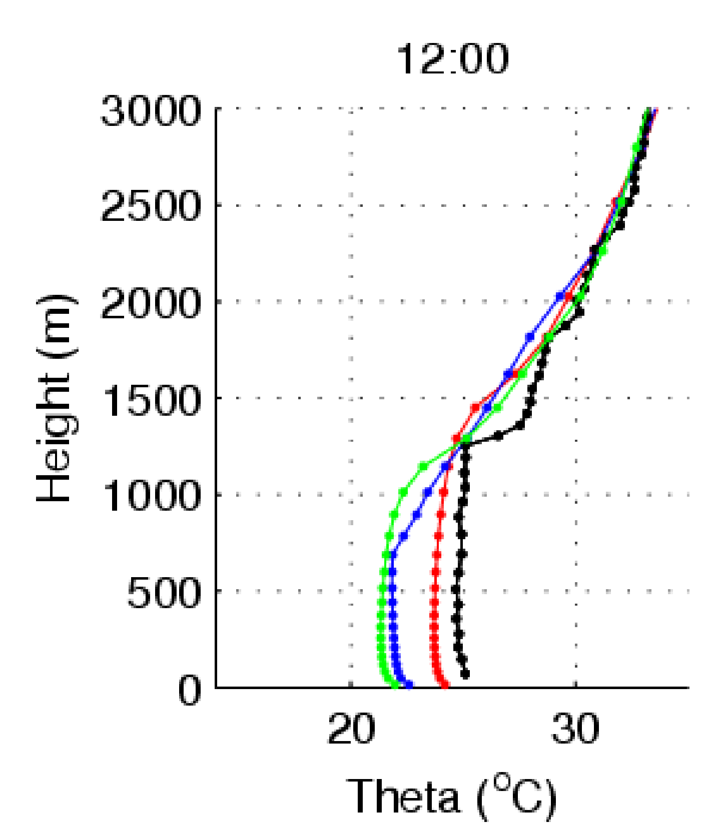
What have we learned from the past

- It turns out to be awfully hard to define an "optimal network"
- Site selection is usually based on funding availability and local logistical concerns
- We have certainly an "unknown" redundancy in flux sites, less so for concentration (?) but we cannot objectively say where the redundancy is in terms of network design
- We probably need to think how to define a "rational" network
- Are there issues we can learn from regional forward modelling?

Uncertainty in meteorology simulation

- PBL height is a large source of uncertainty: ~1.5 ppm in the well-mixed PBL

⇒ Add PBL height observations
  – Aircraft profiles
  – Radiosondes
  – Ceilometers / Lidars



Potential temperature profile, observed (black) and simulated with different settings (blue, green, red)

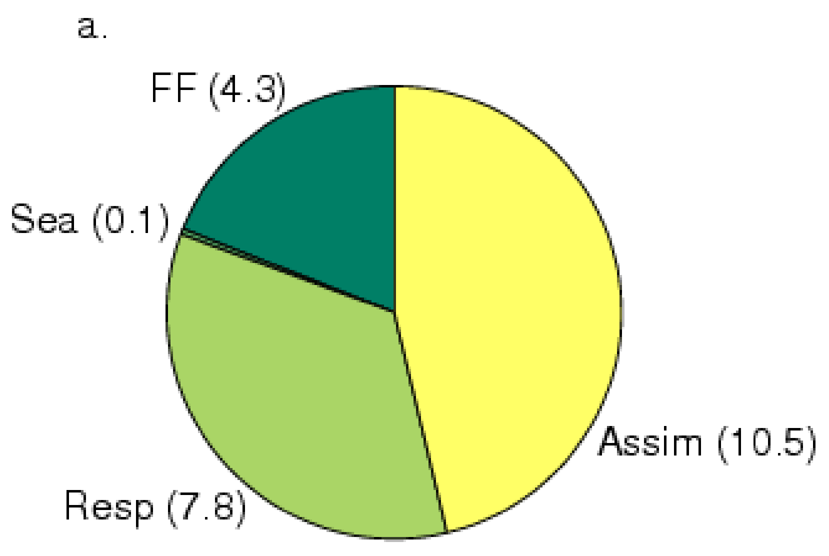
Fossil Fuel CO_2 flux impact

- FF fluxes have a important influence on the CO_2 mixing ratio and variability at Cabauw

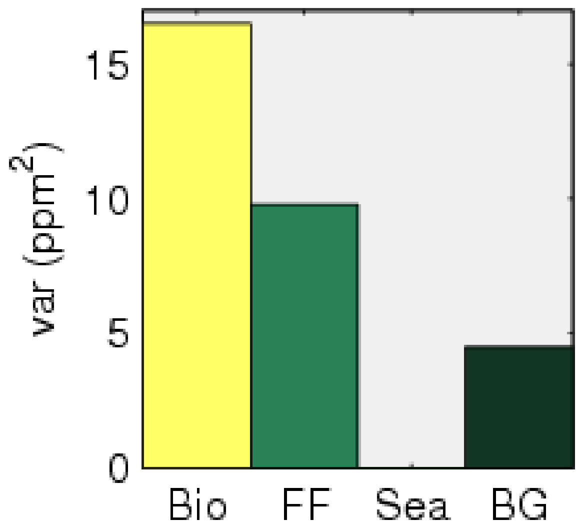
  ⇒ Add observations to constrain FF

  - ^{14}C, CO, SF_6, …

CO_2 mixing ratio (ppm)



CO_2 variance (ppm^2)

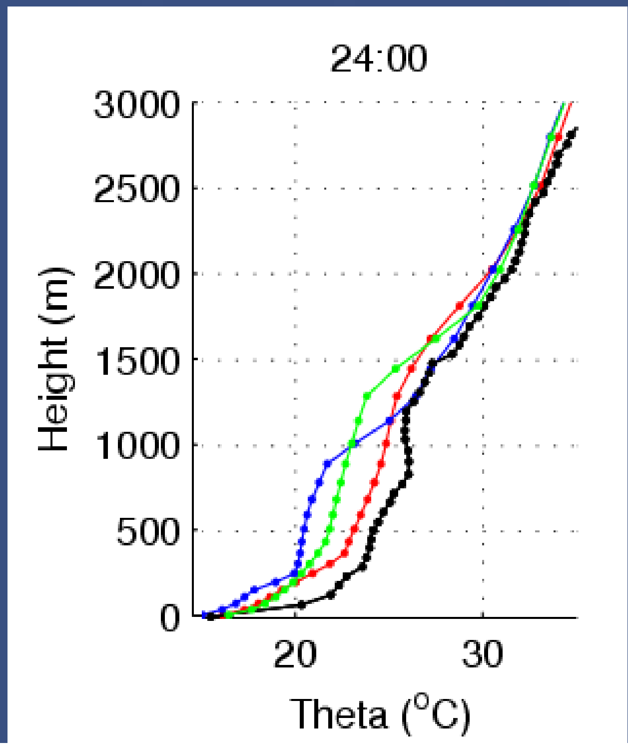


Use of the full CO_2 time series (1)

- Full CO_2 time series: including nocturnal observations
- Potential useful to constrain respiration apart from assimilation
- Simulations of the nocturnal PBL not yet unbiased

⇒Improvement of nocturnal PBL simulation needed

Potential temperature profile, observed (black) and simulated with different settings (blue, green, red)



Use of the full CO_2 time series (2)

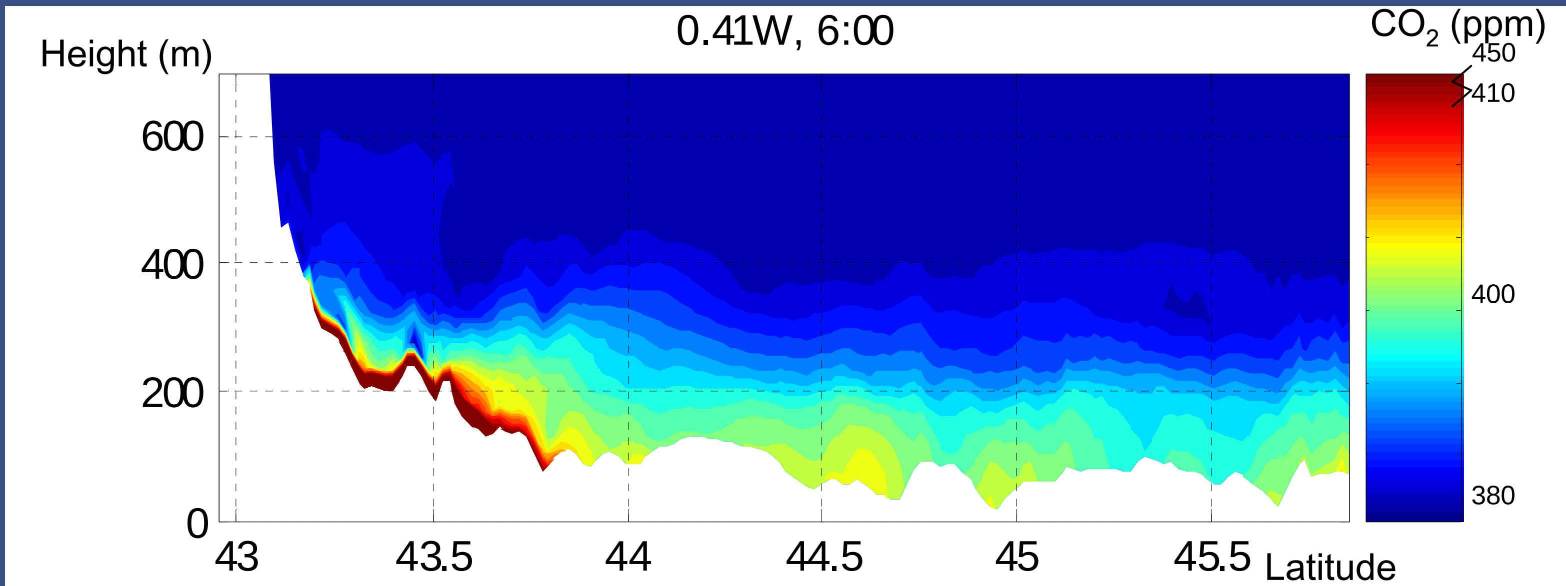
Anticipating on future use of nocturnal observations:

- Katabatic flows influence nocturnal CO_2 mixing ratios
  - accumulation in the valleys

⇒ Avoid hilly terrain, river beds etc.

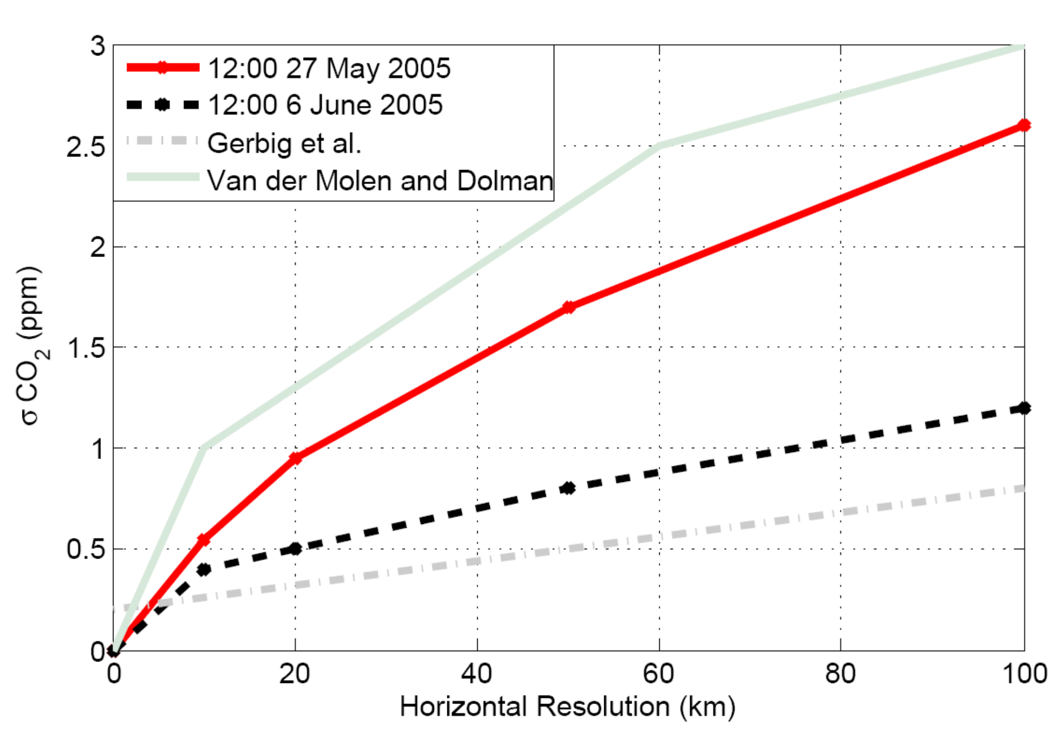
  - also small scale topography (<100m)

⇒ Or use towers both on top and bottom of topography



Representation errors (RE)

- RE due to small scale CO_2 mixing ratio variability: model grid cell average ⇔ point observations
  ⇒ Increase simulation resolution
- RE largest near fronts
  ⇒ Avoid observation locations near mesoscale circulations
- RE due to convective structures and CO_2 flux variability: 0.25 - 1.5 ppm at 10 - 100 km resolution



To learn…..

- RE and transport errors > measurement accuracy

⇒ Increase simulation resolution
  - Reduces RE and some of the transport errors (i.e. mesoscale circulations)
  - Cannot avoid errors in PBL height modelling, but can we evaluate performance of the transport model used in QND?

⇒ Use additional observations (done to large extent)
  - PBL height
  - FF tracers (needs attention)

⇒ Clustered towers may be favourable over a regularly spaced network to reduce RE, use also a regional QND?
  - e.g. WLEF ring of towers
  - e.g. Dutch BSIK project

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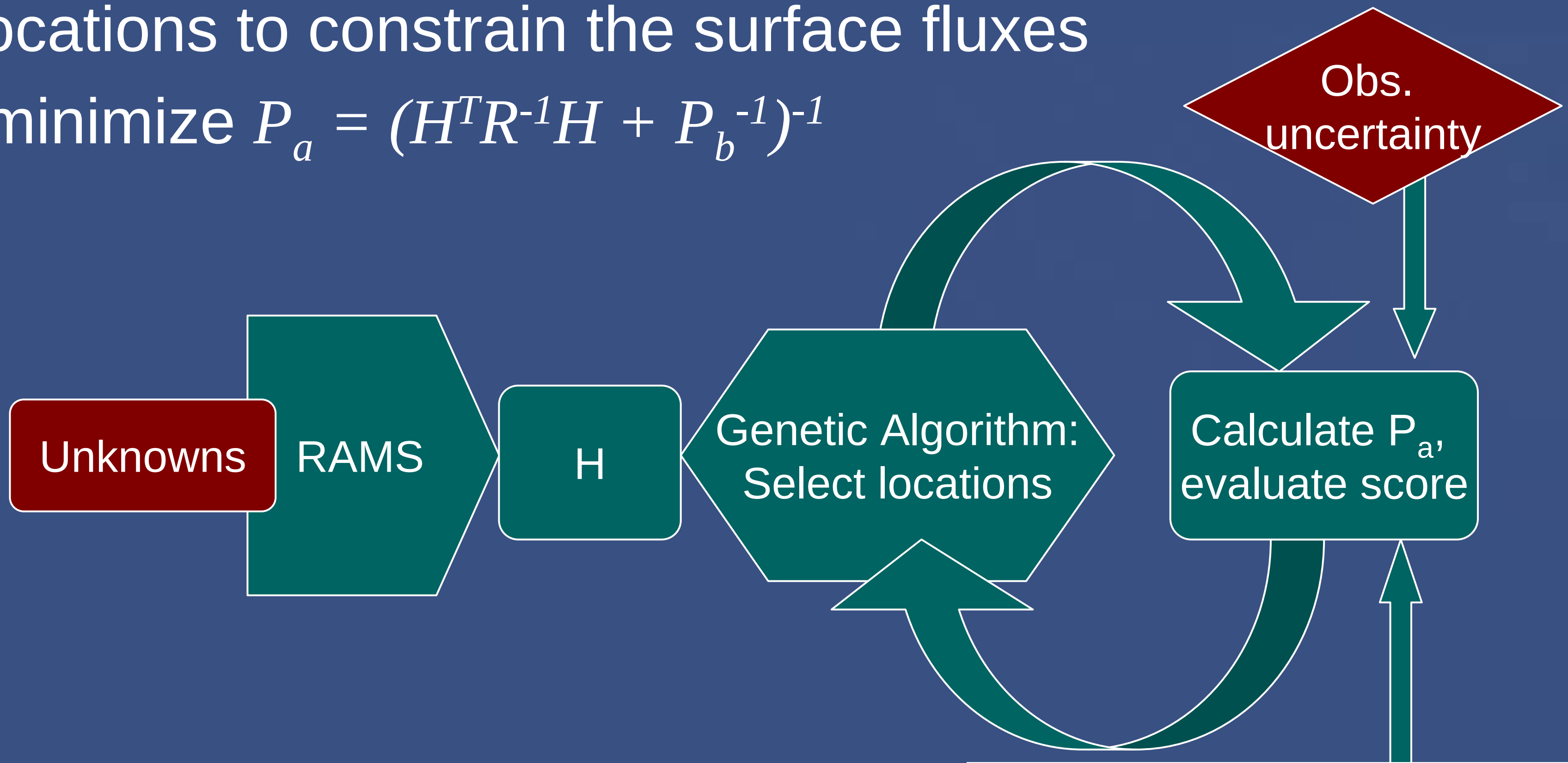
Quantitative Network Design

- Purpose: find the optimal observation locations to constrain the surface fluxes

$\Rightarrow$ minimize $P_a = (H^T R^{-1} H + P_b^{-1})^{-1}$



System available and running

but so far only with “bad” transport

Score formulation:

- all land use types
- dominant land use types
- total area flux