CART - the Constituent Oriented Age and Residence time Theory

A holistic approach to the understanding of the results of complex marine models

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http://www.climate.be/CART

Motivation

- Make sense of the huge amounts of results produced by complex numerical models;
- Not ignore 99 % of the information (space-time slices of the output) ;
- Drastically reduce the amount of data
- End-users require simple answers / figures

$\Rightarrow$ Holistic methods : Statistics and **timescale analyses** taking into account all/most of the results and all the processes.

Characteristic time scales

Residence time, turnover time, age, transit time, renewal time, flushing time,...

Aim : Quantify the renewal of water masses or input and output of contaminants

⇒ Relevant diagnostic for the dynamics of water masses

⇒ Relevant diagnostic for pollution issues

⇒ Relevant diagnostic for eutrophication problems

⇒ ...

Common approaches (1)

- Flushing time :

$$\tau = \frac{\text{Volume}}{\text{Flux}}$$

+ tidal prism and Knudsen estimates

- e-folding time :

$$M(t) = M_0 \exp\left(-\frac{t}{\tau}\right)$$

Common approaches (2)

- Correlation time scale :

$$\tau(x) = \underset{\theta}{\operatorname{argmax}} \frac{< S(t)C(x,t+\theta) >}{\sqrt{< S(t)^2 >}\sqrt{< C(x,t)^2 >}}$$

where $S(t)$ = concentration at the source
or incoming flux.

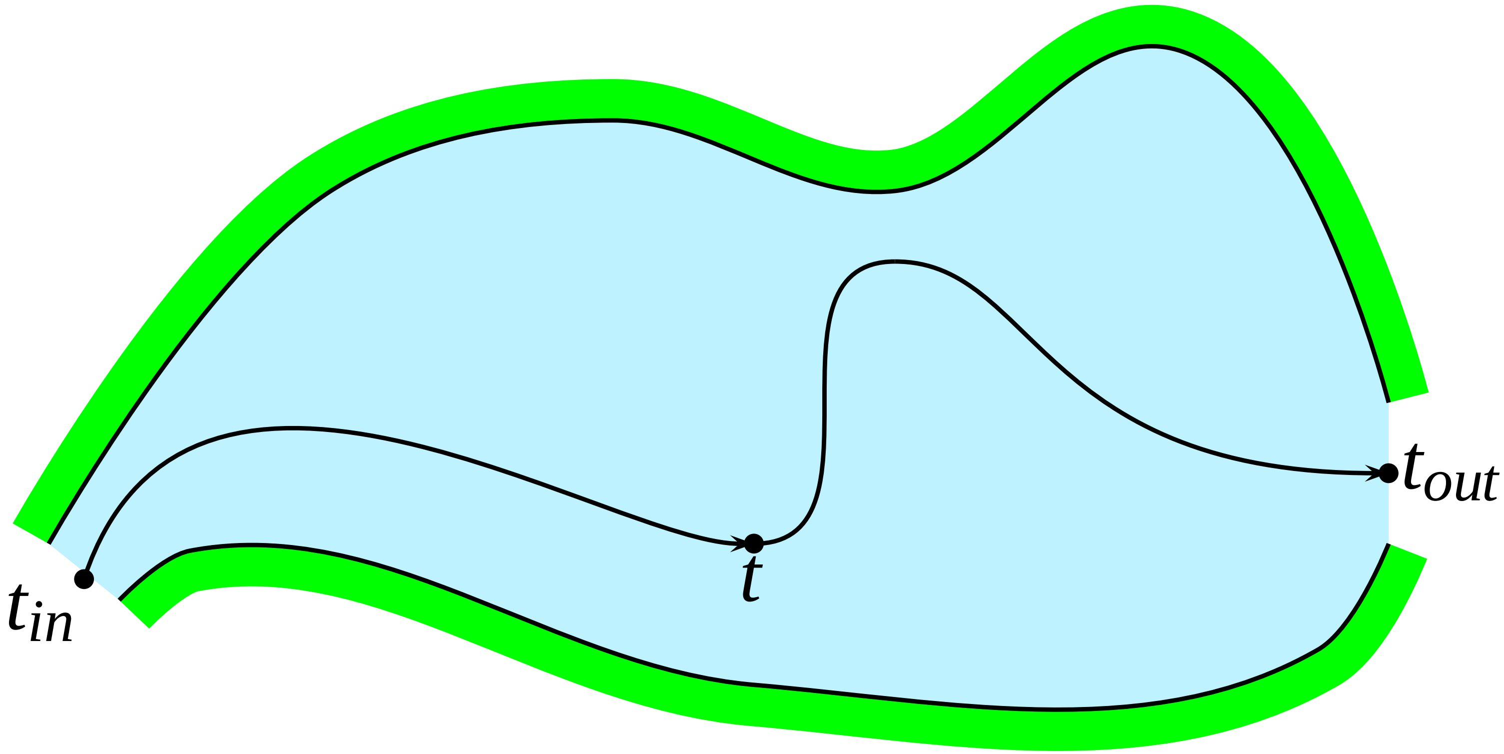
- Radio-age :
Assume $C_\gamma(t) \propto \mathrm{e}^{-\gamma t}$, then

$$\tilde{a}_\gamma(x,t) = \frac{1}{\gamma} \ln \frac{C_0(x,t)}{C_\gamma(x,t)}$$

Problems / issues

- Definitions are often unclear / confusion of concepts;
- Diffusion is not properly taken into account;
- Space and/or time dependency;
- Oversimplification of the dynamics;
- A single time scale to describe different tracers.

Some definitions



- Age = $t - t_{in}$
- Residence time = $t_{out} - t$
- Transit time = $t_{out} - t_{in}$

CART - 2007