Secrétariat général pour l'investissement

PEPR TRACCS Webinar Series | Online, 31 Jan 2025

Combining physics and machine learning in hybrid climate models

Julien Le Sommer,
Institut des Géosciences de l'Environnement, Grenoble

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FRANCE 2030 PROGRAMME DE RECHERCHE CLIMAT

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À VOS CÔTÉS, DANS UN CLIMAT QUI CHANGE

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PEPR TRACCS Webinar Series | Online, 31 Jan 2025

FRANCE 2030 PROGRAMME DE RECHERCHE CLIMAT

COMputing PAradigms towards efficient, modular and trainable Climate Models

J. Le Sommer, S. Valcke, Y. Meurdesoif, T. Dubos, P. Rampal

TRACCS-PC5-COMPACT

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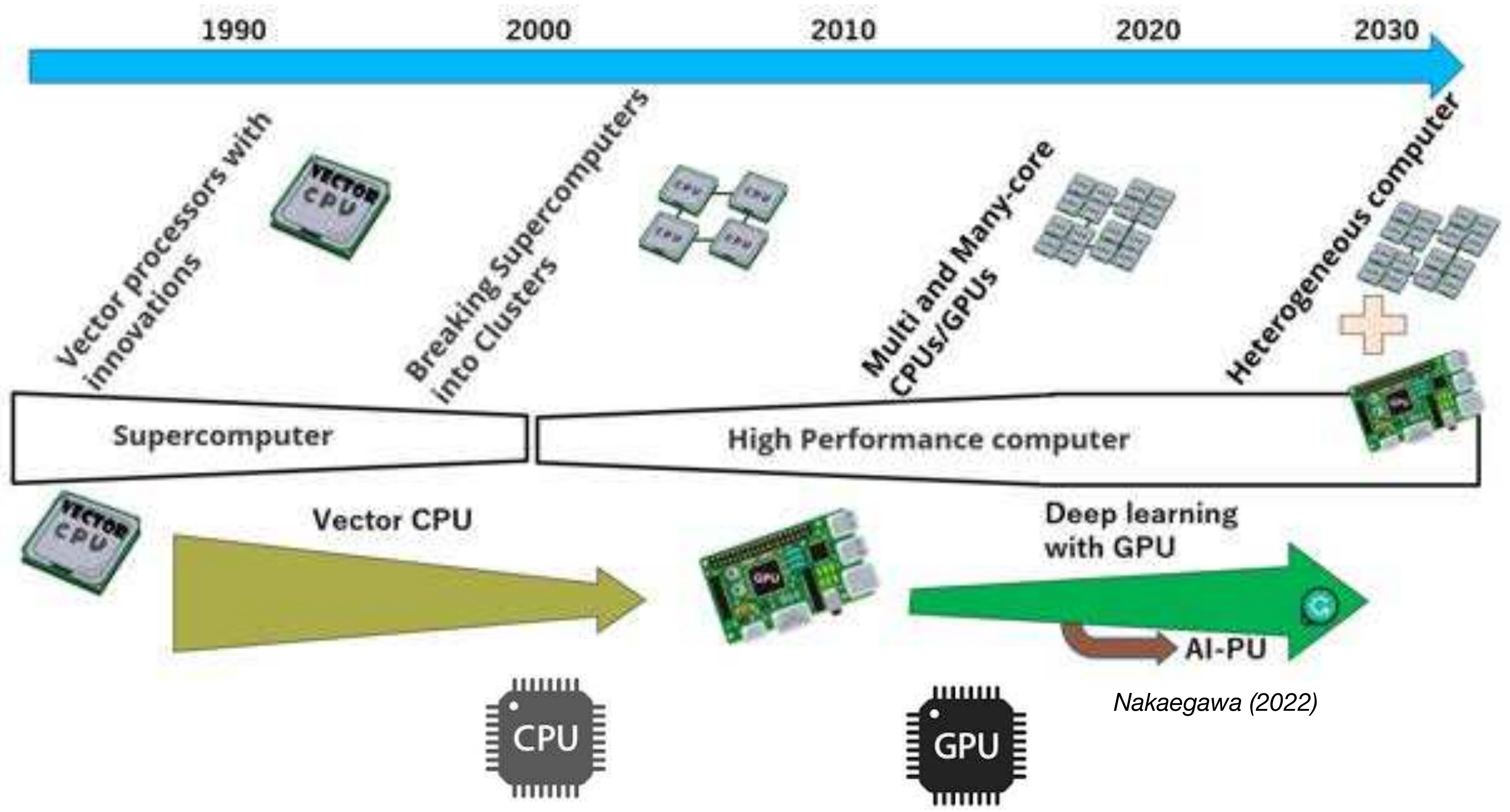
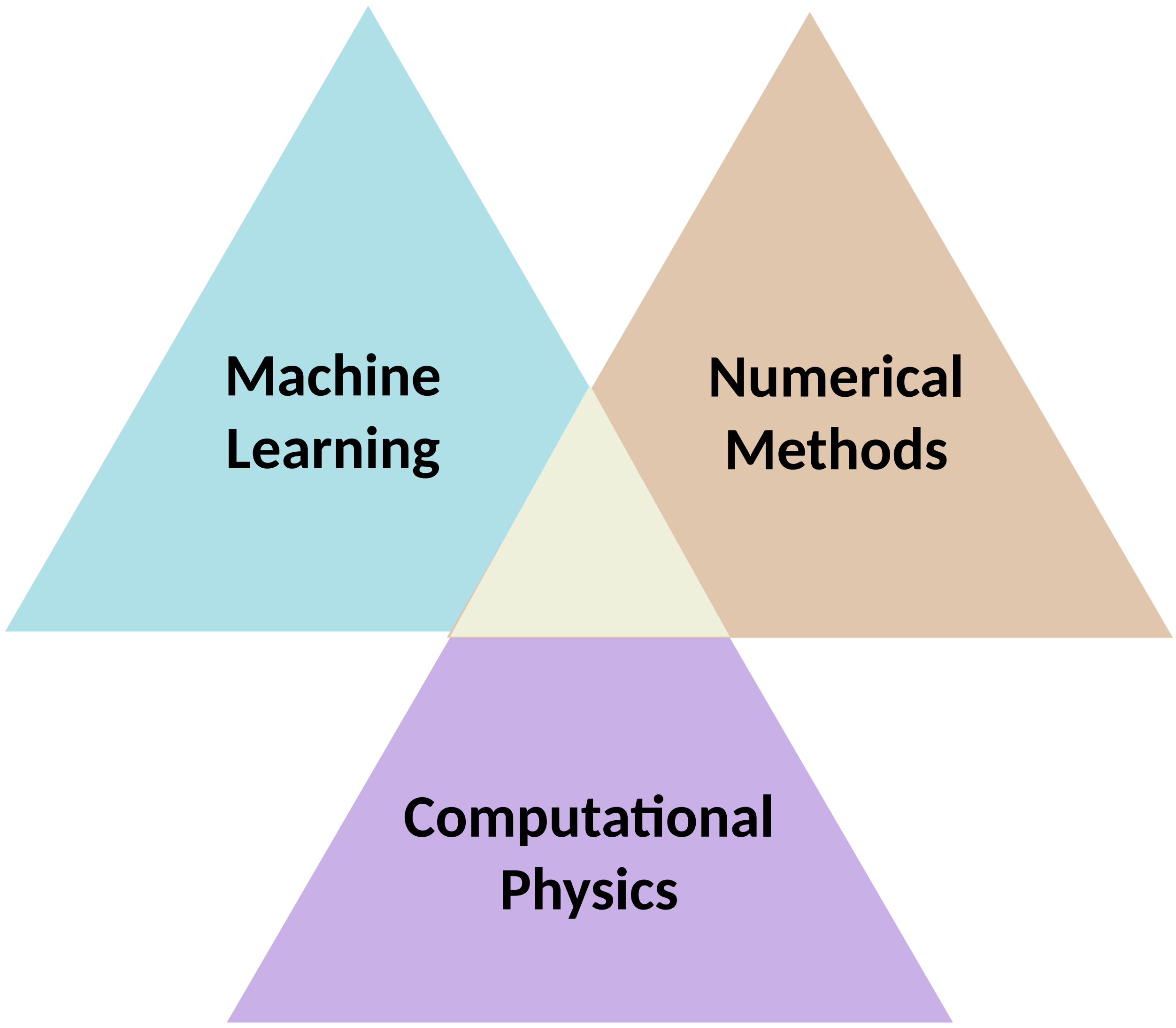
Drivers for TRACCS-PC5-COMPACT project



Heterogeneous computing architectures



Emerging paradigms in scientific computing

New usages of models with climate services

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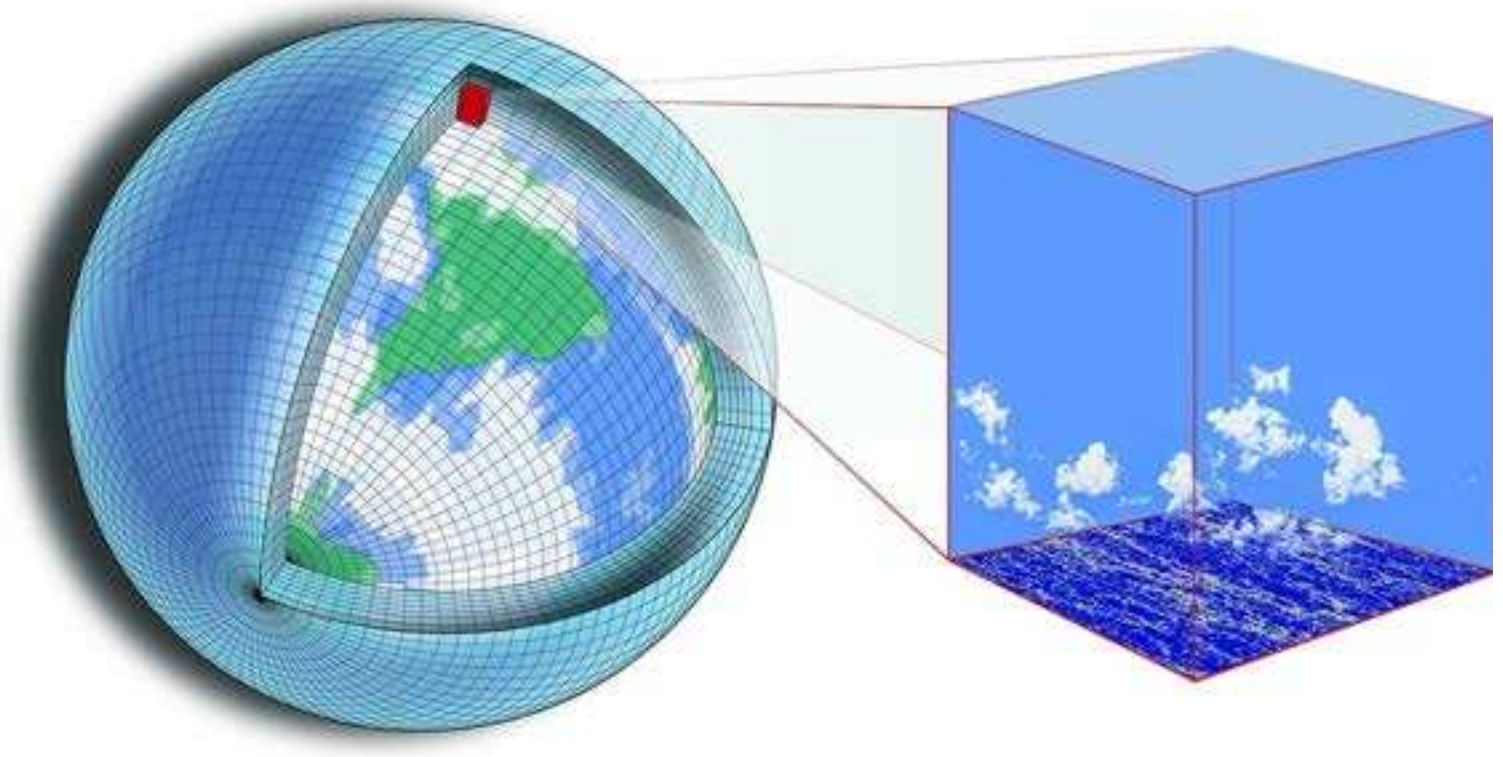
Ambition and positioning of TRACCS-PC5-COMPACT



ESMs as software systems

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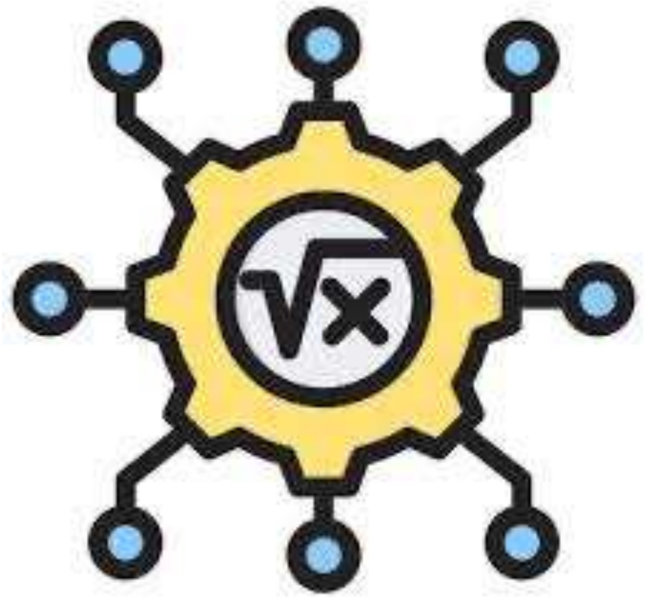
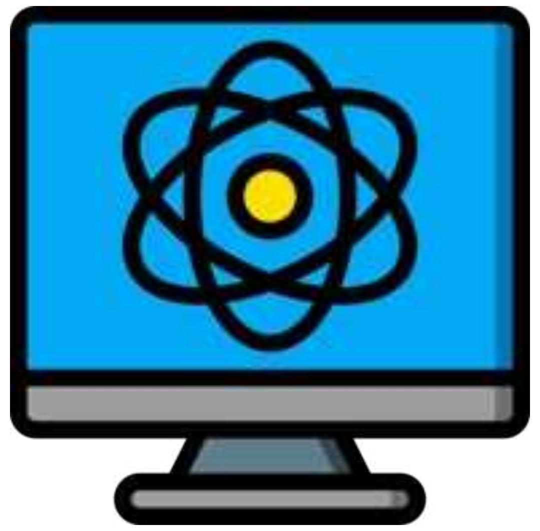
Ambition and positioning of TRACCS-PC5-COMPACT

ESMs as software systems

- gradual evolution of systems
  long term engineer positions
- higher risk / reward activities
  through PhDs / research projects



Applied maths



Computer science

evidence / science based decisions

community / open science driven

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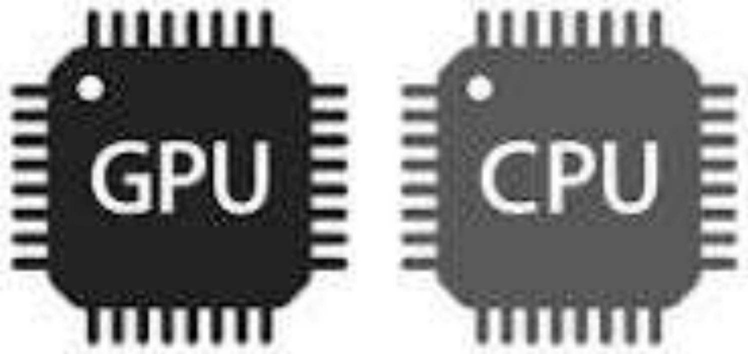
A 8-years roadmap



porting codes to GPUs

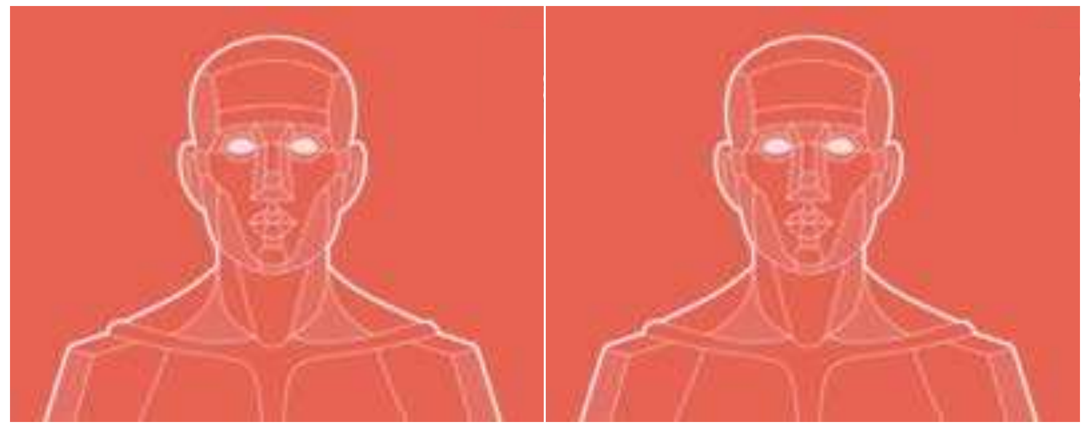
efficient I/Os

Computational **efficiency** and portability

internal interfaces across subcomponents

Modularity, APIs and system-wide design

protocols for online inference



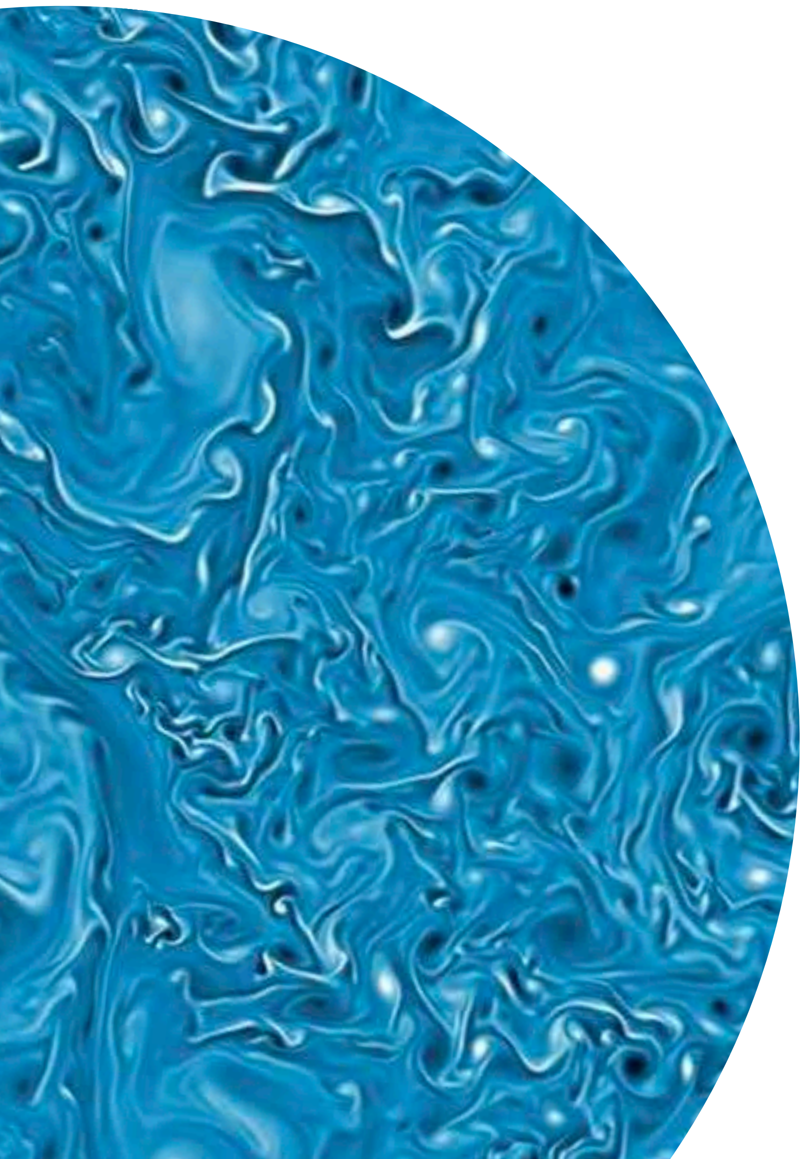
neural emulation of components

AI-readiness, emulation and differentiability

Our **annual meeting** will be held next week in Grenoble on Tue Feb 4th

Combining physics and machine learning in hybrid climate models

Julien Le Sommer - computational oceanographer
Institut des Géosciences de l’Environnement, Grenoble



Objectives of this talk

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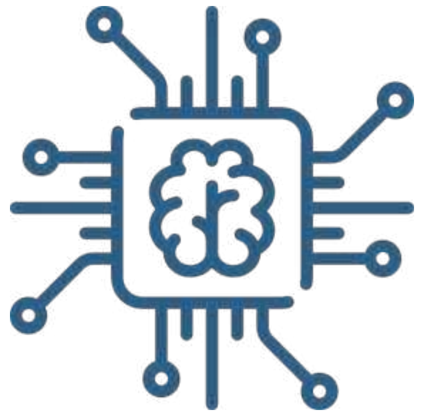

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- how ML is **leveraged** in computational oceanography
- with methods from the **emerging field of SciML**
- how this leads to to **deep changes** in our systems
- and raise interesting **questions** for climate models

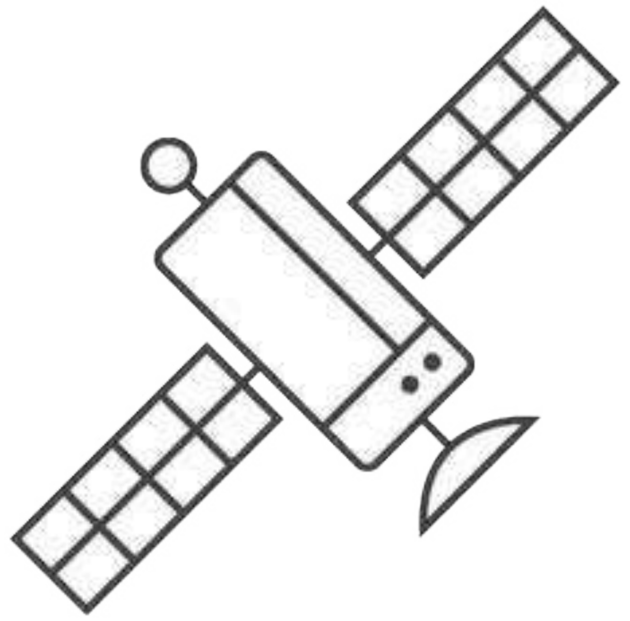
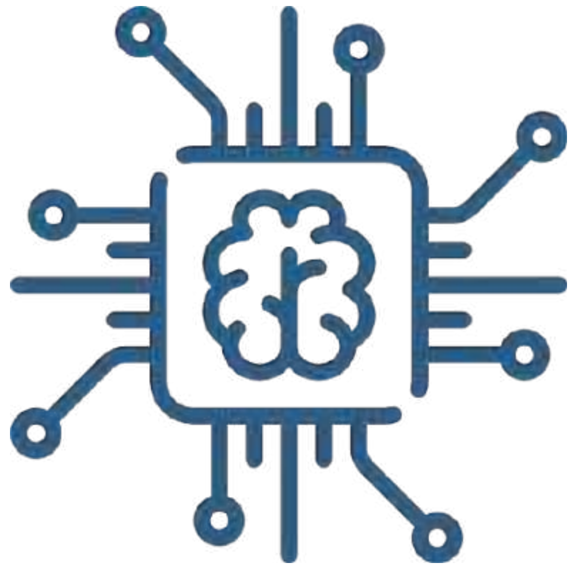
Observations

Models / AI

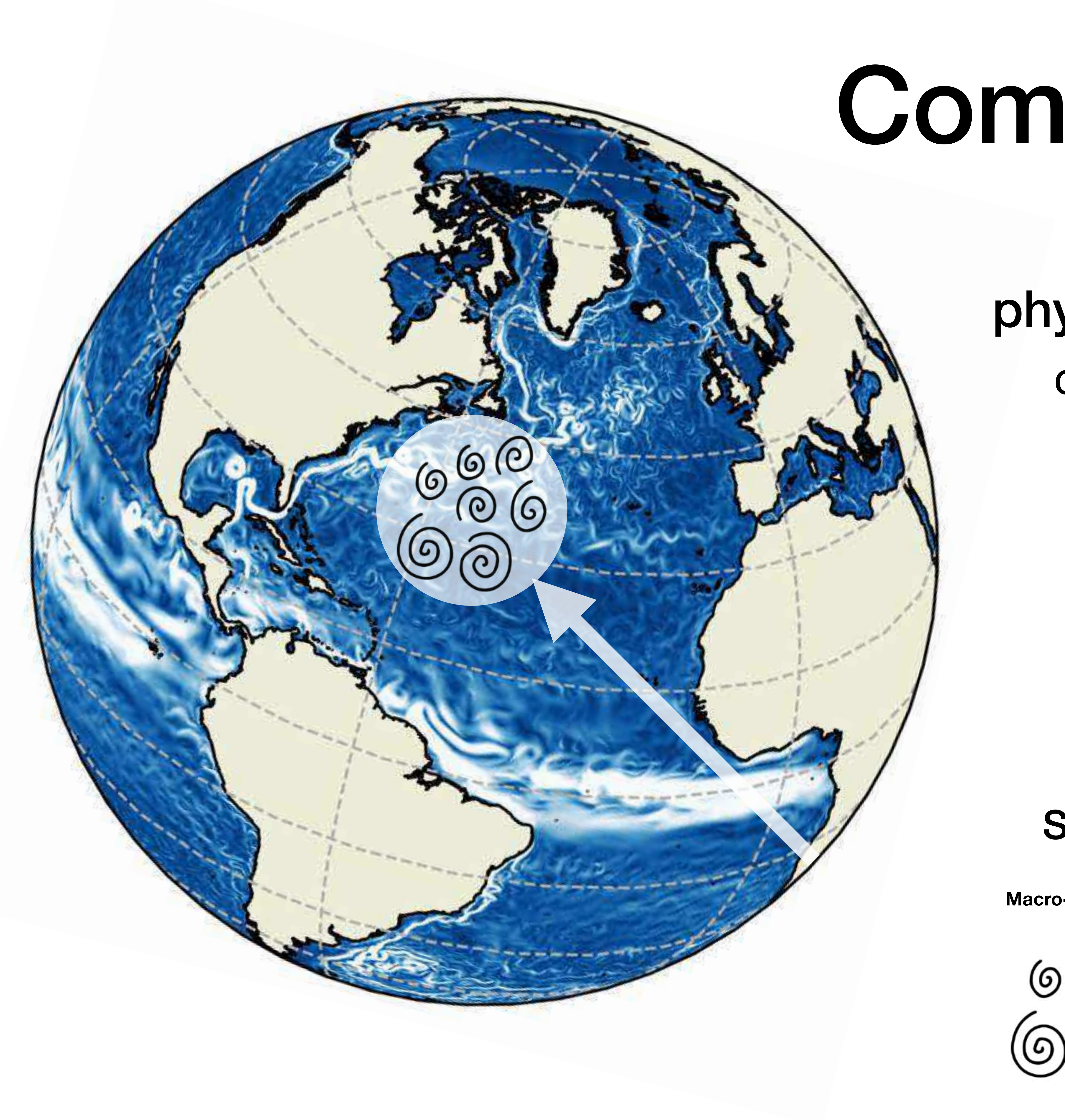
1.

The context of computational oceanography

The context of computational oceanography

 +  +  +  = 

Computational oceanography

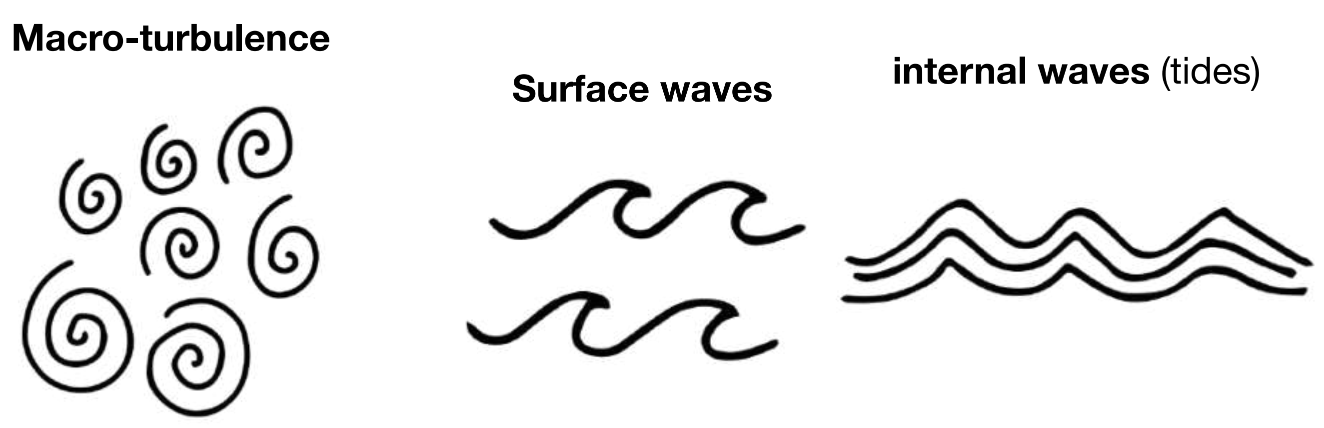


physical oceanography
currents, parameters

→ **understand** the functioning
→ **forecast** its evolution (timescales)

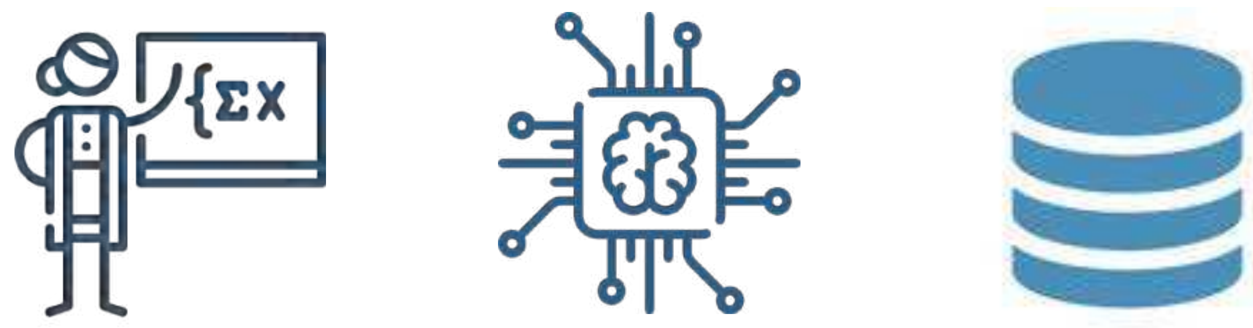
climate - environnemental changes
human activities

Scale interactions, processes

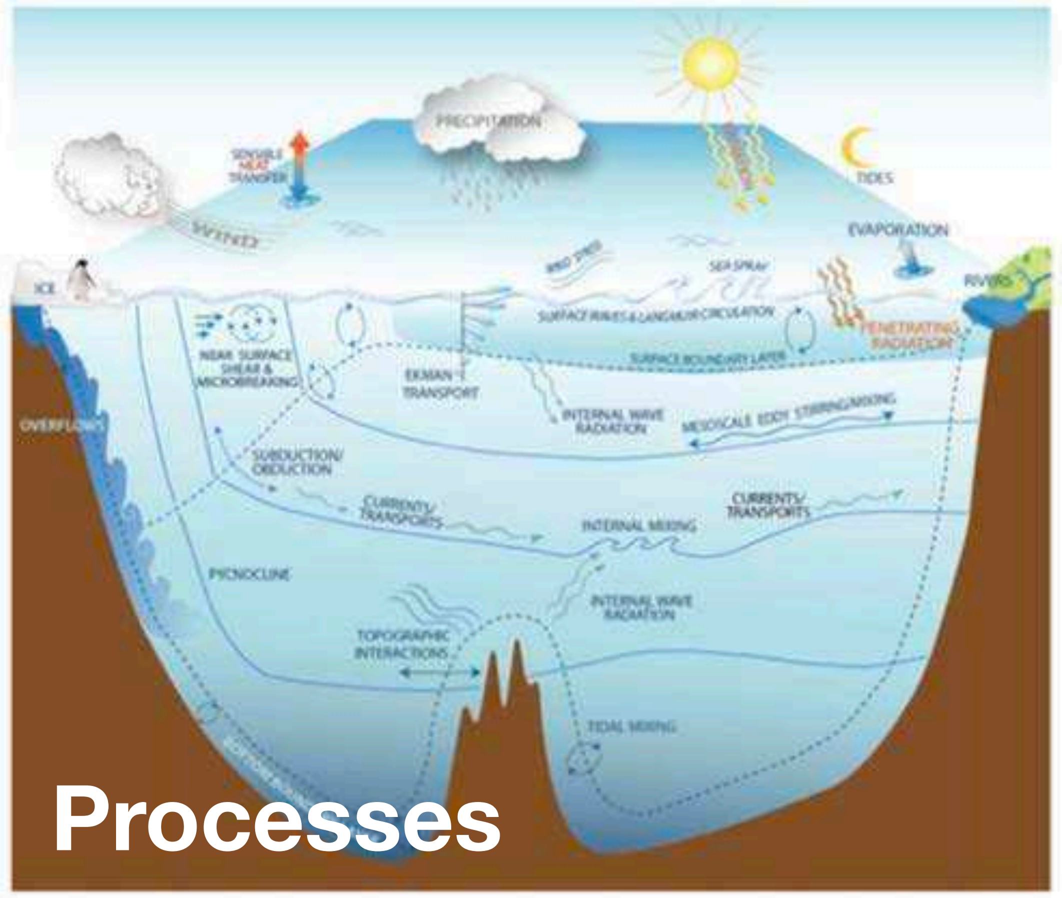


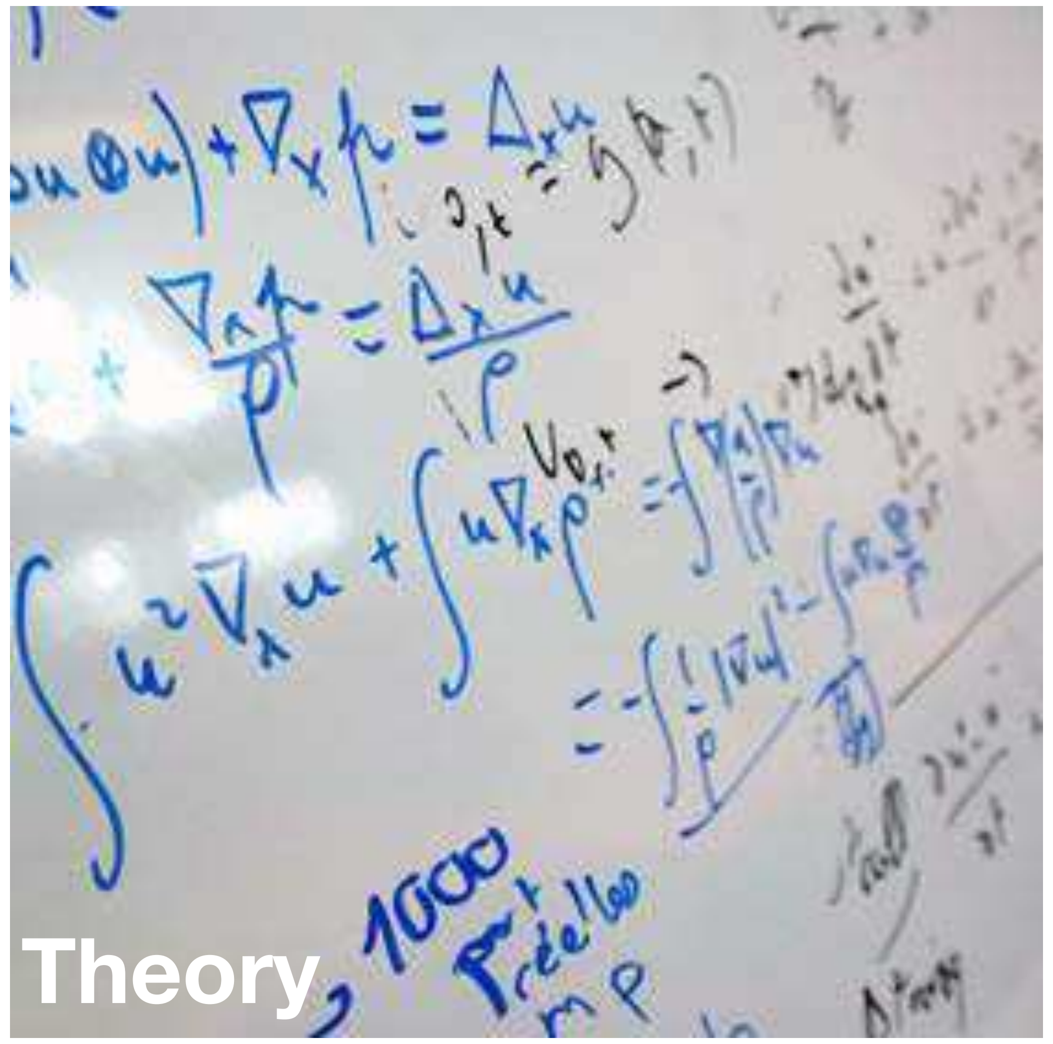
Interactions with components

develops and use **numerical tools** and methods
maths, numerics, compute, data

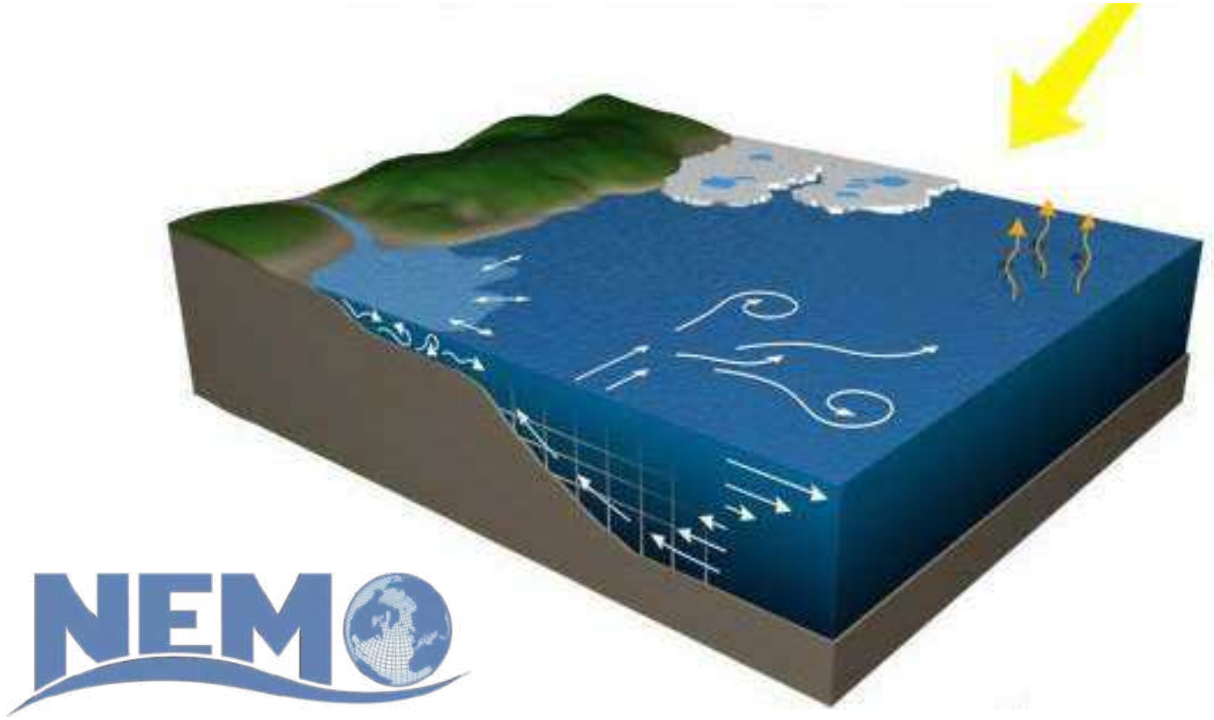


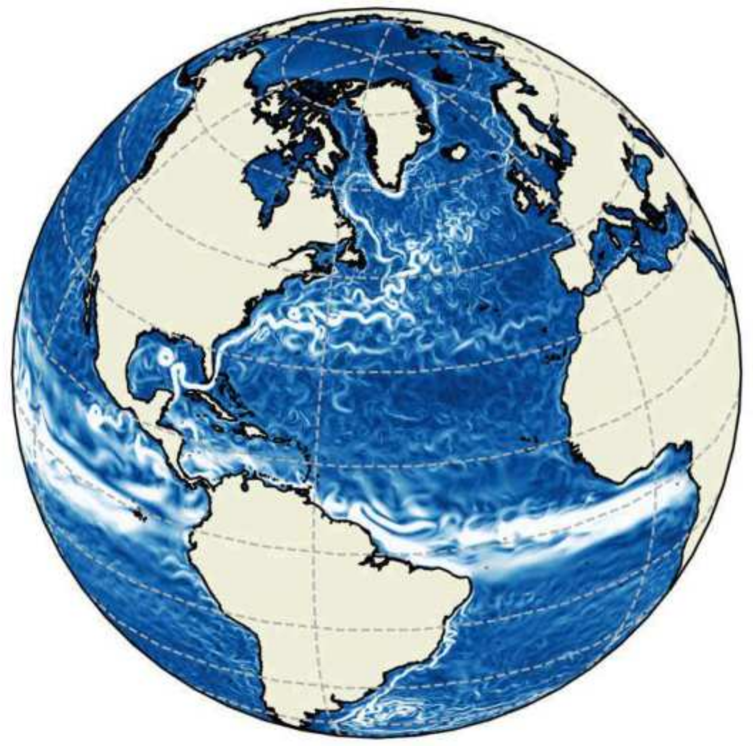
A key tool : ocean models

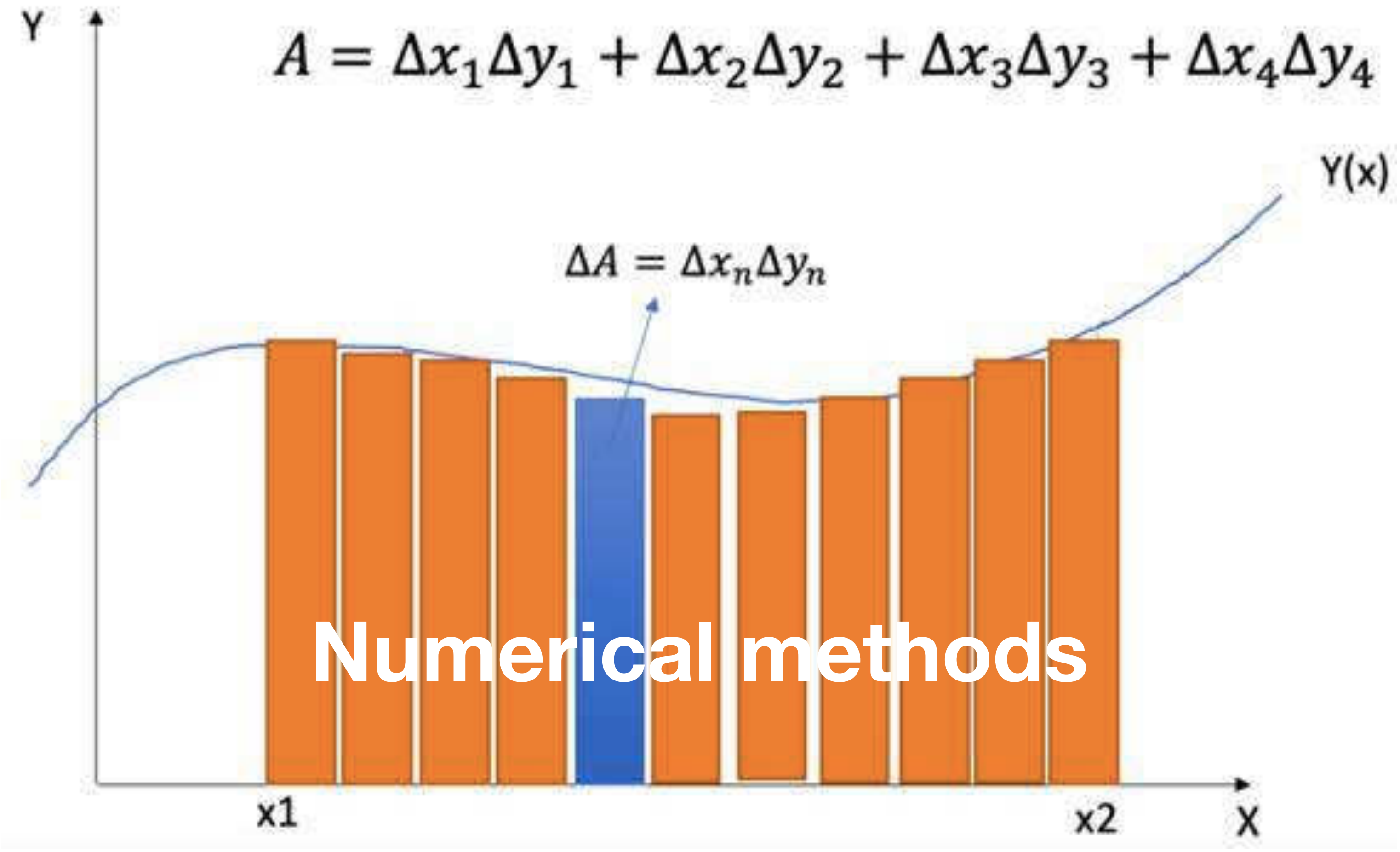




Physics-based models
(ocean circulation models)



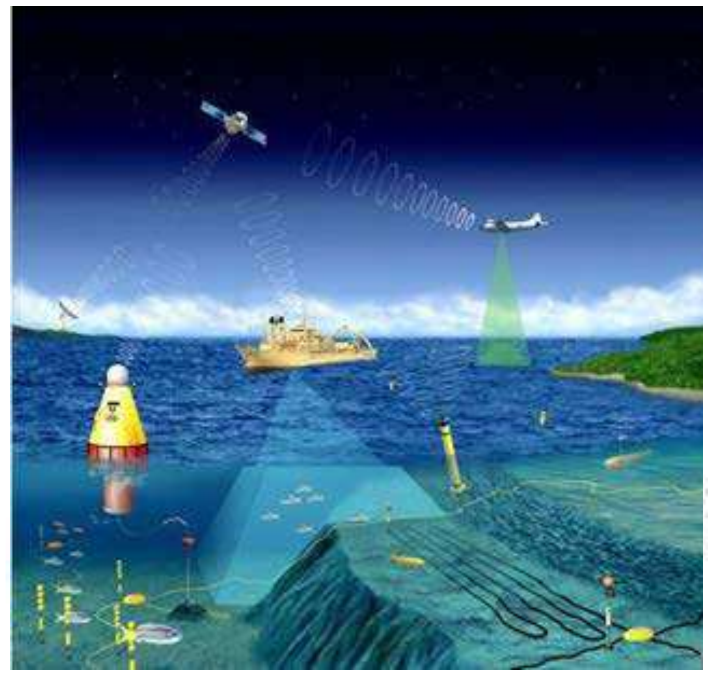


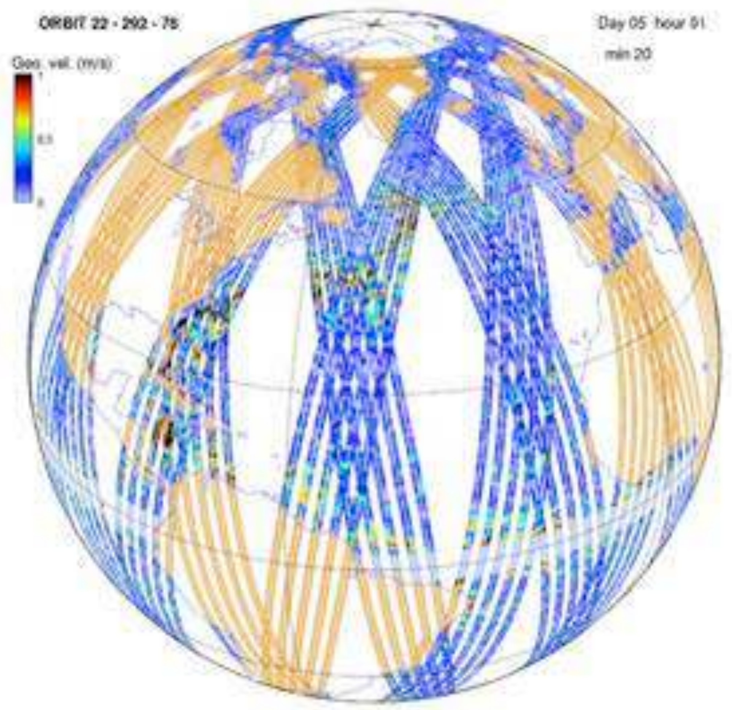


Physical models summarize our understanding of physical systems

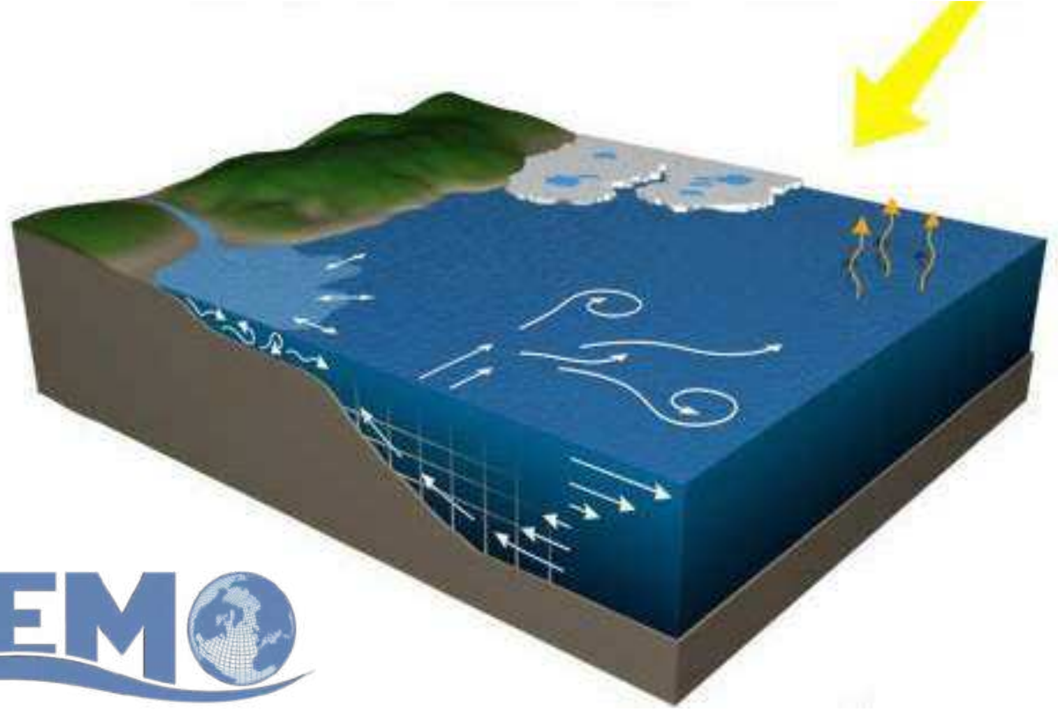
Our toolboxes

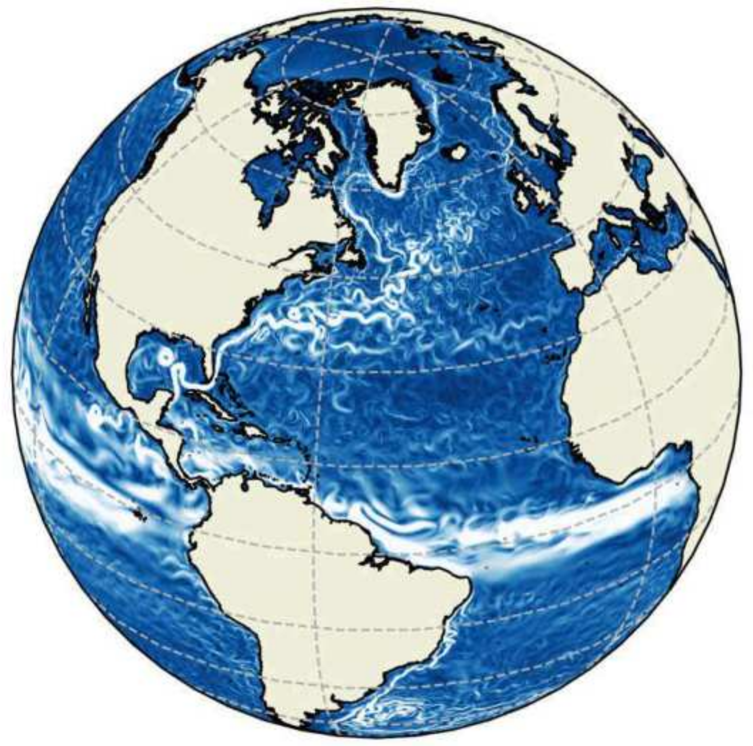
Observations
(in situ/satellite)



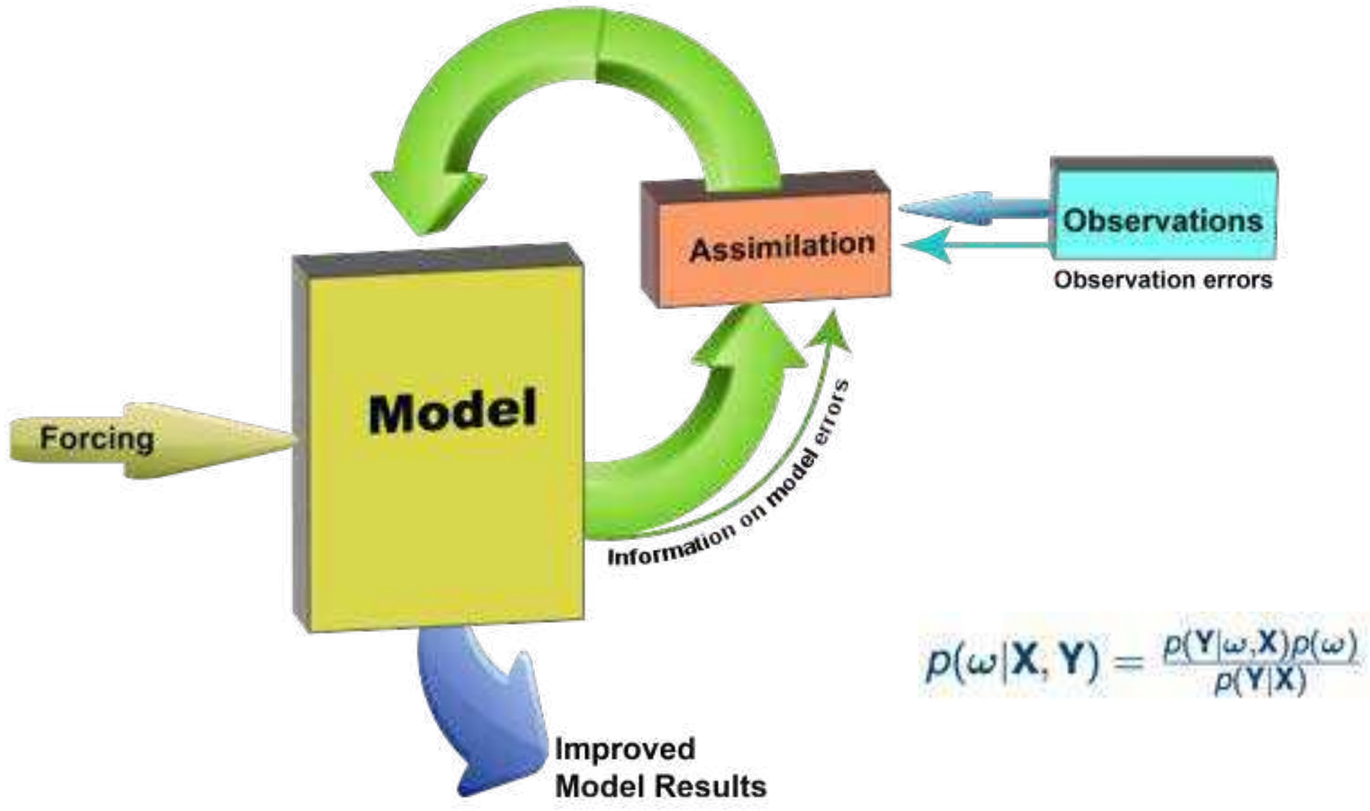


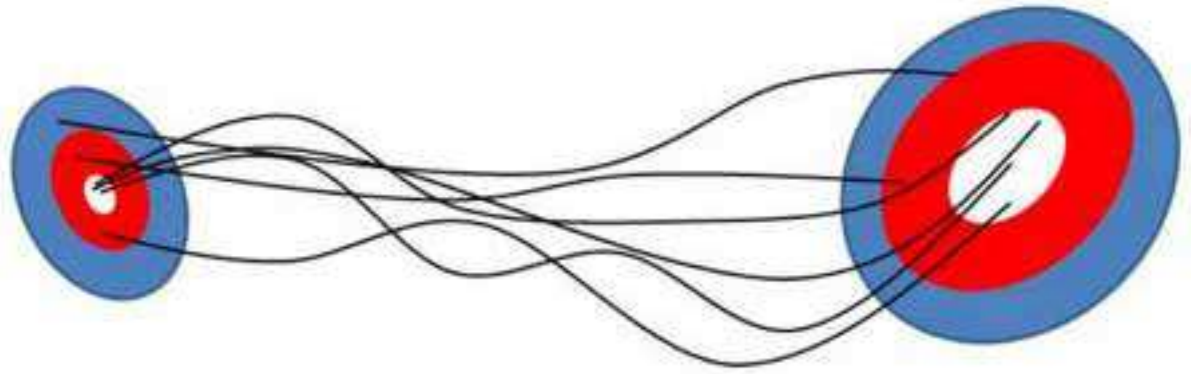
Physical models
(ocean circulation models)





Inverse methods
(data assimilation)



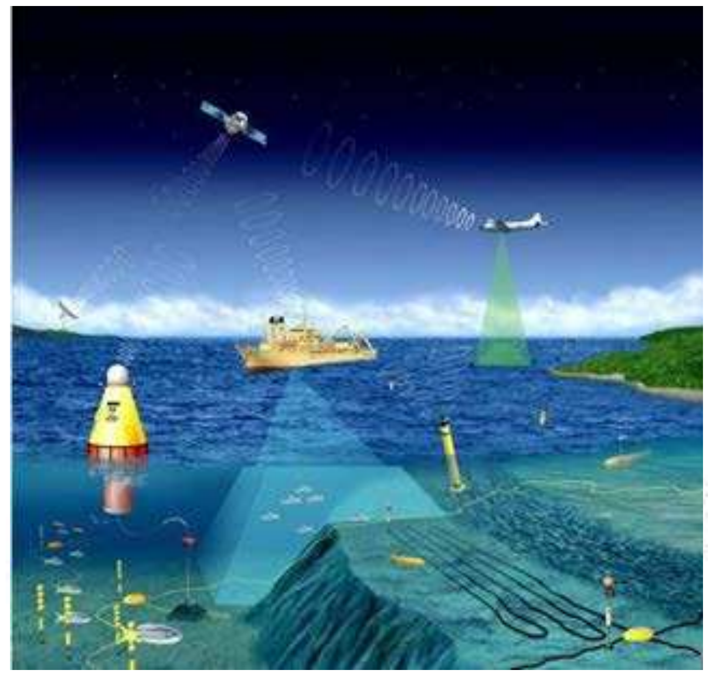


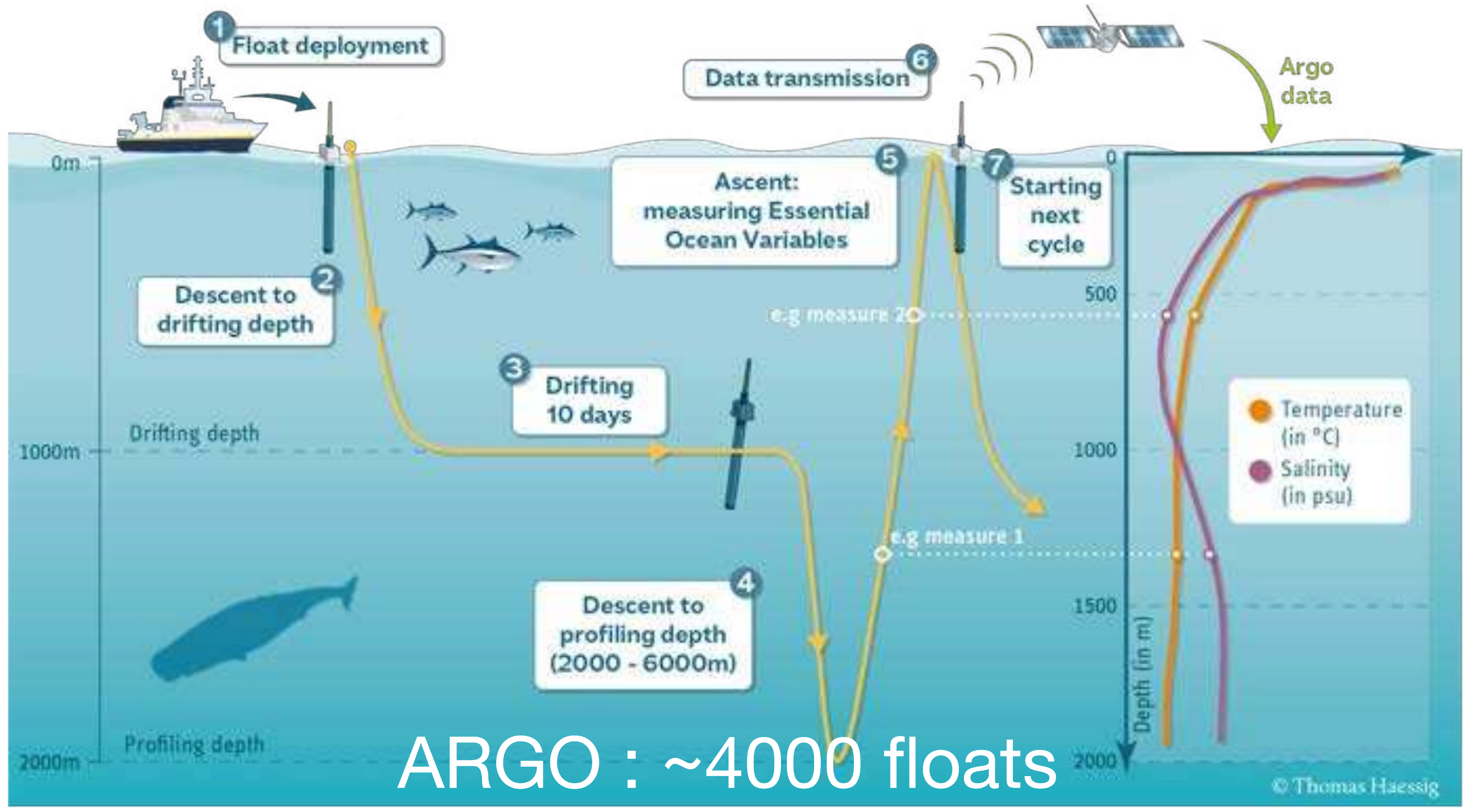
Tools for understanding but also monitoring and forecasting ocean circulation

Observations of the ocean

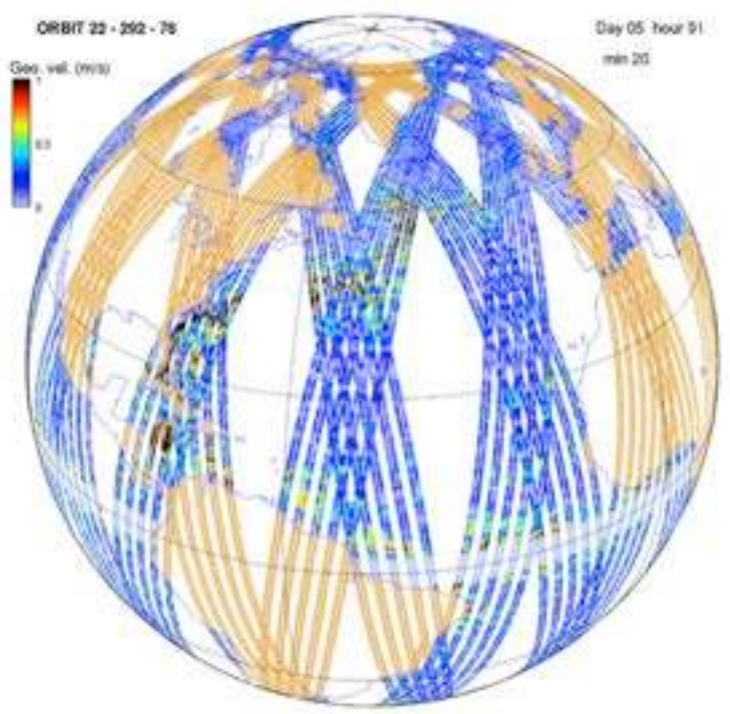
Observations

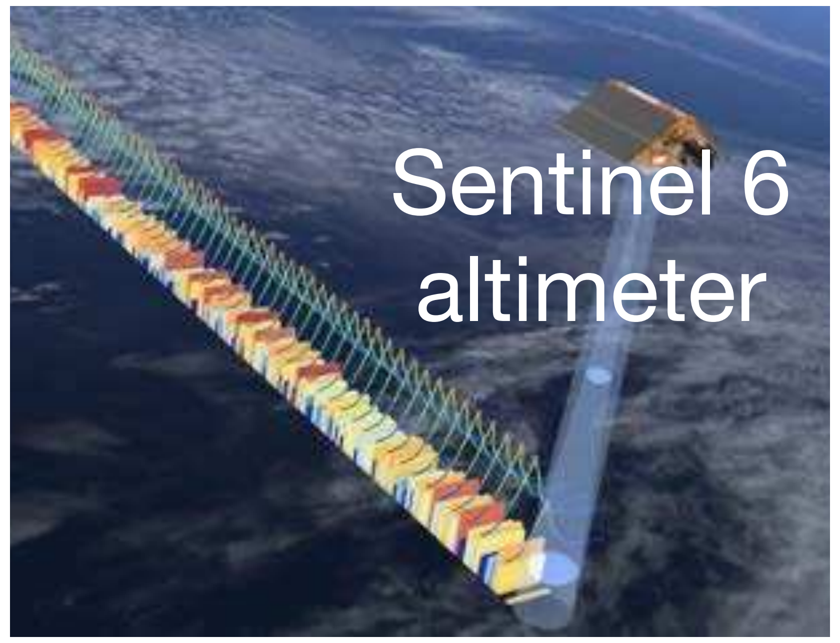
in-situ

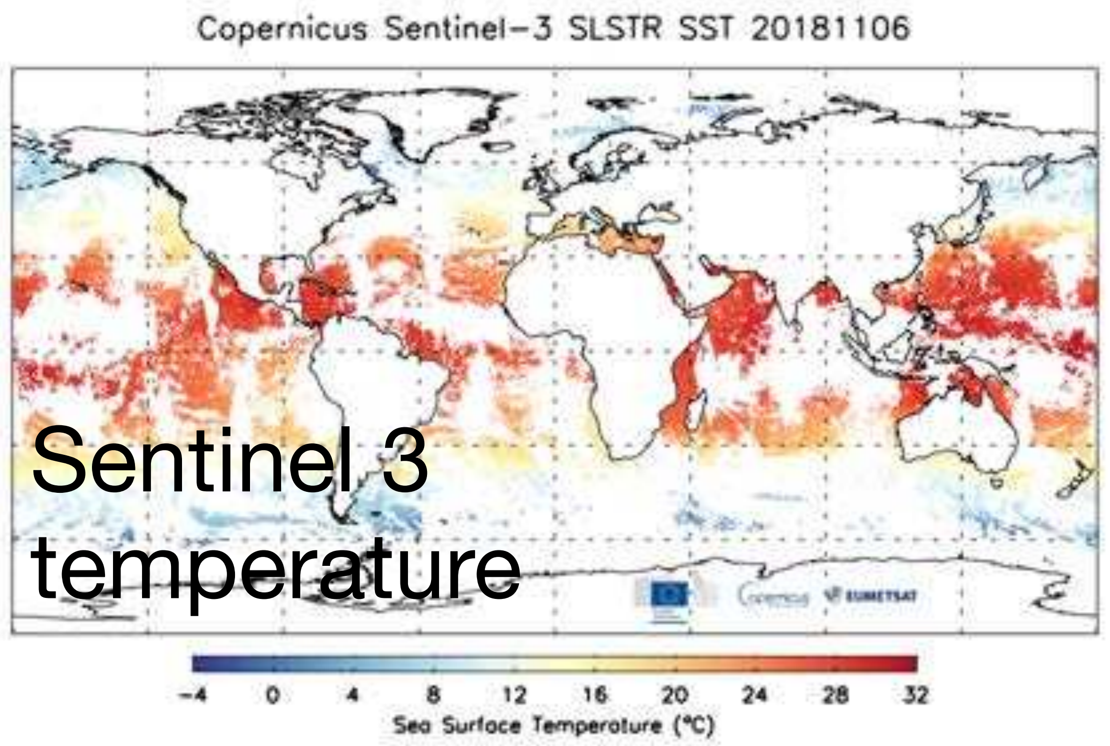


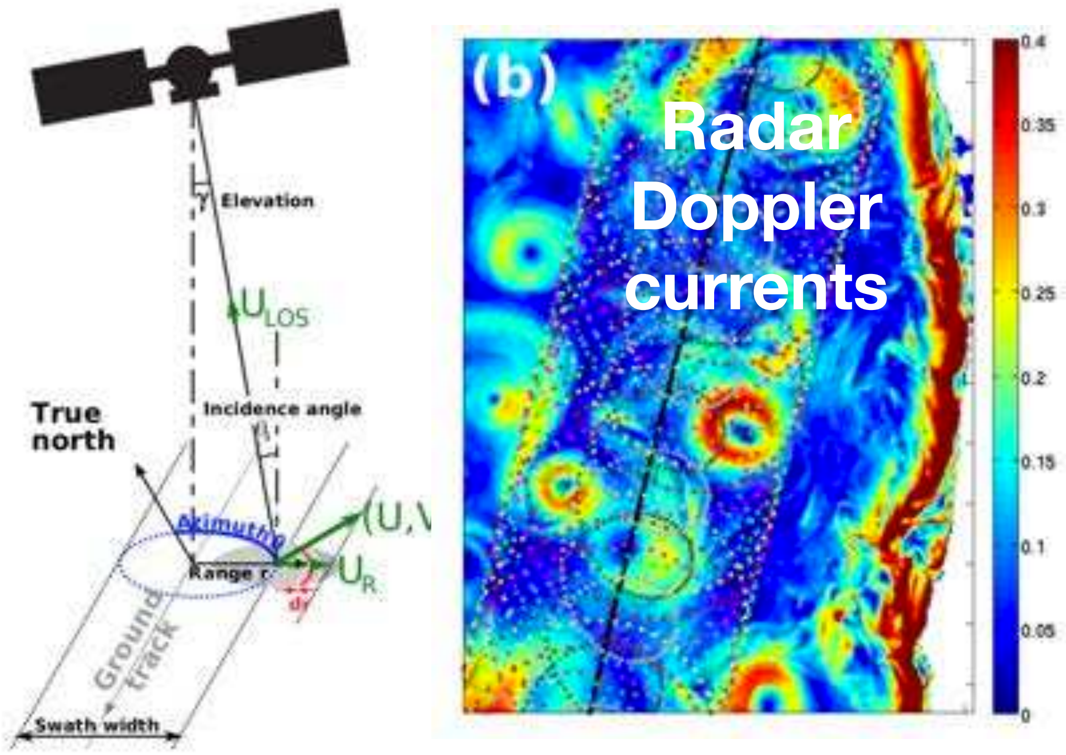


satellite









Continuously operated networks

New platforms