SEACS

LOPS (Ifremer)

Fluminance (Inria/irstea/Irmar)

Irmar

Lab-STICC/TOMS

LMBA

Context and objectives

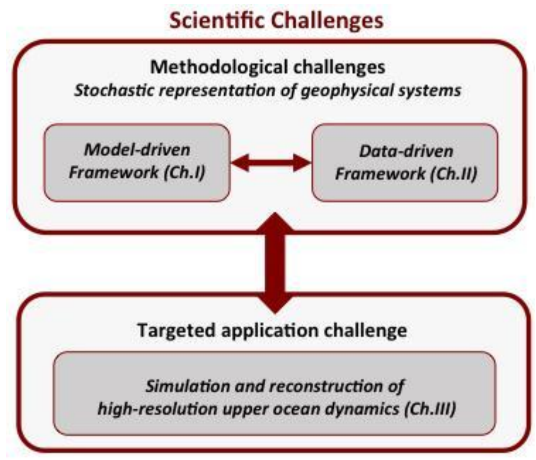
SEACS aims at exploring novel **statistical and stochastic methods to address the emulation, reconstruction and forecast of fine-scale upper ocean dynamics** . Our key objective is to investigate new tools and methods for the calibration and implementation of novel sound and efficient oceanic dynamical models. In this respect, the emphasis will be given to stochastic frameworks to encompass multi-scale/multi-source approaches. SEACS gathers expertise at the frontiers of **Computer Science,**

Targeted challenges and project organization

SEACS addresses two complementary approaches for the stochastic representation of geophysical systems **: model-driven framework** (Challenge I) and **data-driven framework** (Challenge II). The common targeted application challenge is **the simulation and reconstruction of high-resolution upper ocean dynamics** (Challenge III).

Examples of dissemination activities:

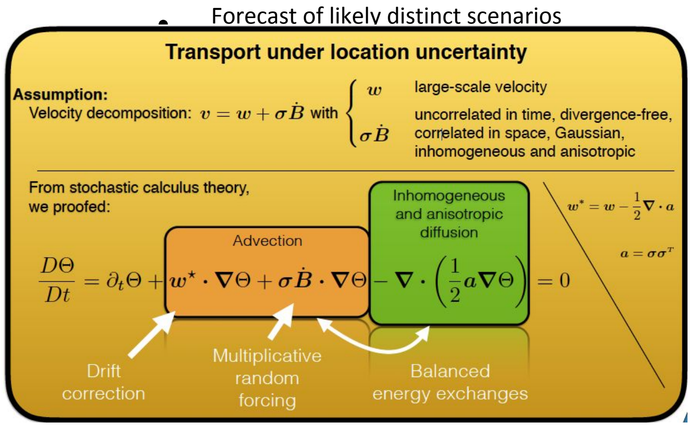
- Data Science & Environment Workshop, Brest, June 2018
- Data Science Training Session, Grenoble, January 2018
- National colloquium on Data Assimilation, Rennes sept. 2018.



Advances on model-driven approaches

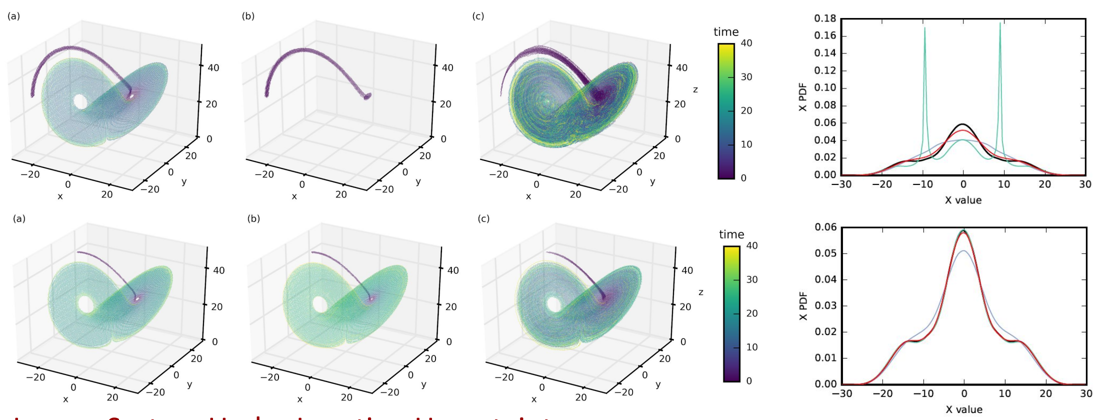
Motivations

- Rigorous identification of subgrid effect
- Take into account random small-scale dynamics
- Forecast of likely distinct scenarios



Modeling Under Location Uncertainty

- Improved large-eddies simulations (wake flows, Green-Taylor, TBL, …) at variou Re
- Derivation of stochastic geophysical flows dynamics (Boussinesq, QG, etc.)
- Accurate representation of errors but also new analysis tool of the

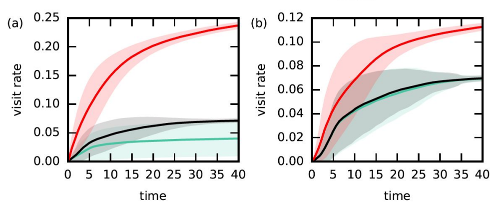


Lorenz System Under Location Uncertainty

Example of trajectories strong noise | PDF X (strong noise)

Example of trajectories low noise | PDF X (Low noise)

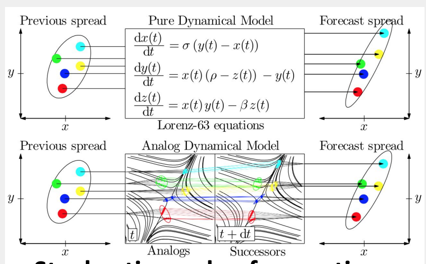
Atractor visiting rates



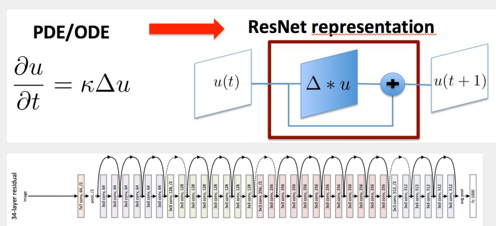
Advances on data-driven approaches

Data-driven models for the reconstruction of geophysical dynamics from partial and/or noisy observations. The focus is given to stochastic data-driven representations of dynamical systems and their exploitation in Kalman-based assimilation schemes. Two categories of approaches have been more particularly explored:

- **the Analog Data Assimilation**, which combines analog forecasting strategies and stochastic filtering schemes.
- **Neural-network (ResNet) formulations to bridge model-driven PDE formulations and data-driven schemes [5]**



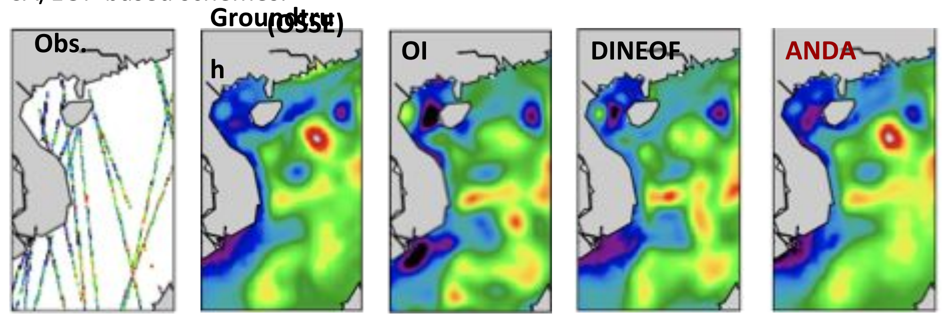
Stochastic analog forecasting strategies



Example of ResNet representation of a PDE (here, the heat equation)

Application to high-dimensional dynamical systems have been developed. Different case-studies for the reconstruction of time series of sea surface parameters (e.g., SST, SSH) from irregularly-sampled satellite-derived observations demonstrate the relevance of the proposed approaches compared to classic optimal interpolation techniques and PCA/EOF-based schemes.

Reconstruction of SLA fields from along-track altimeter data



Selected Publications

V. Resseguier, E. Mémin, B. Chapron, Geophysical flows under location uncertainty, Part I, II & III, Geo. & Astro. Fluid Dyn. 2017

V. Resseguier, E. Mémin, B. Chapron, Stochastic modelling and diffusion modes for POD models and small-scale analysis, J. Fluid Mech., 2017

B. Chapron, P. Derian, E. Mémin, V. Resseguier, Large-scale flows under location uncertainty: a consistent stochastic framework, QJRMS, 2018

R. Fablet, P. Viet, R. Lguensat. Data-driven Methods for Spatio-Temporal Interpolation of Sea Surface Temperature Images. IEEE Trans. on Computational Imaging, 2017

R. Lguensat, P. Tandeo, P. Ailliot, M. Pulido, R. Fablet. The analog data assimilation. MWR, 2017