

#### Analog data assimilation of along-track nadir and SWOT altimetry observations in the Western Mediterranean Sea

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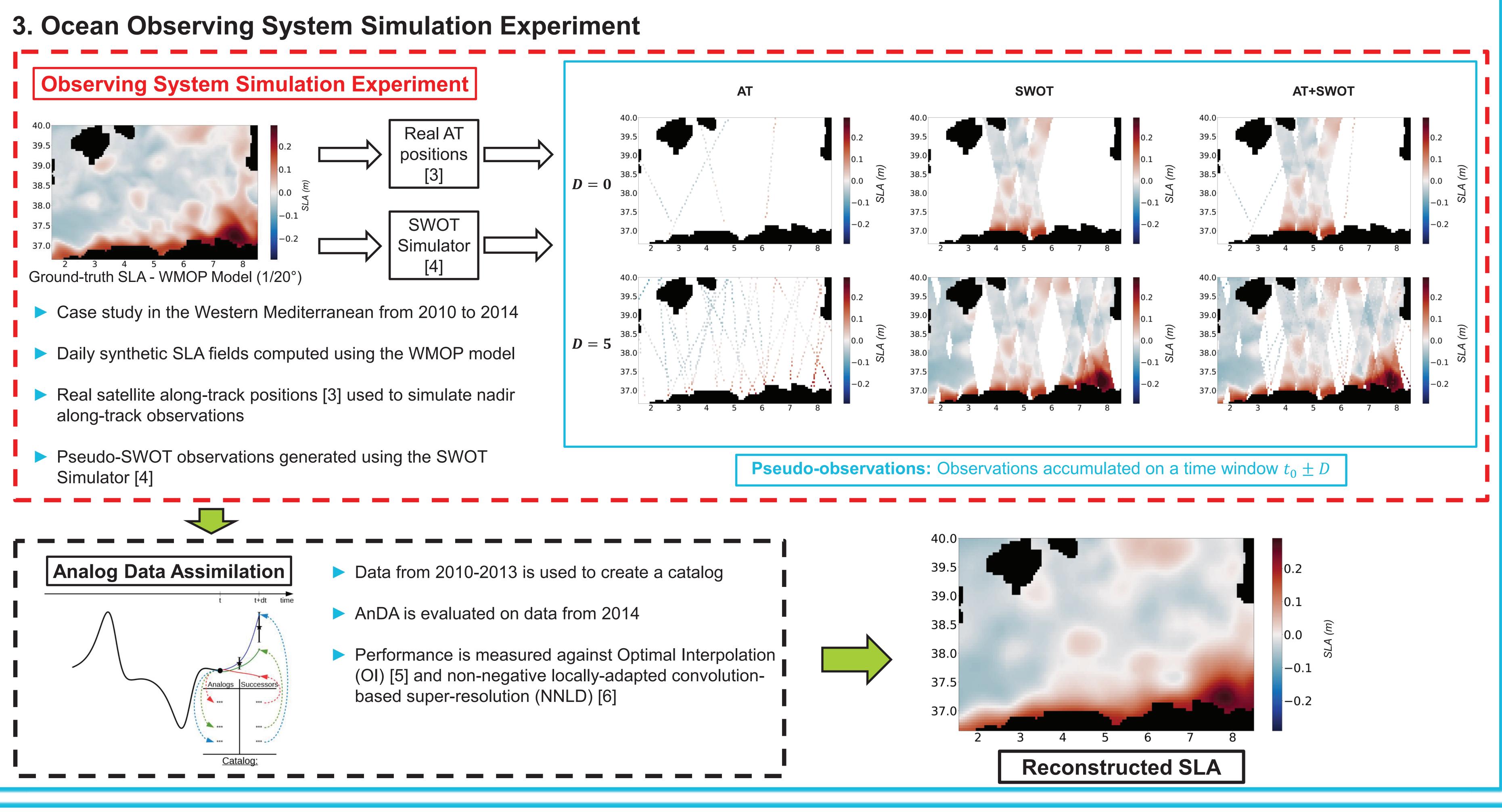
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### 1. Abstract

The growing availability of ocean data brought forth by recent advancements in remote sensing, in situ measurements and numerical models supports the development of data-driven strategies as a powerful, computationally-efficient alternative to model-based approaches for the interpolation of high-resolution, gap-free, regularly-gridded sea surface geophysical fields from partial satellitederived observations.

In this work, we investigate such data-driven strategies for the **spatio-temporal interpolation** of **Sea** Level Anomaly (SLA) fields in the Western Mediterranean Sea from satellite-derived altimetry data. We develop and evaluate an Analog Data Assimilation (AnDA) framework, which exploits patchbased analog forecasting operators. Two different types of altimetry data are assimilated: alongtrack nadir data and wide-swath SWOT altimetry data. Using an Observing System Simulation Experiment (OSSE), we demonstrate the relevance of AnDA as an improved interpolation method, particularly for mesoscale features in the 20-100 km horizontal scale range. Results report an SLA reconstruction RMSE (correlation) improvement of 42% (12%) with respect to Optimal Interpolation (OI), and suggest an additional potential gain when the joint assimilation of SWOT and along-track nadir observations is considered.



## 5. Conclusion

We developed an application of the Analog Data Assimilation (AnDA) to the reconstruction of SLA fields in the Western Mediterranean Sea from satellite along-track nadir data. The AnDA framework can be regarded as a means to exploit high-resolution numerical and wide-swath SWOT data. simulation datasets for the reconstruction of SLA fields from partial satellite observations. The report a clear improvement of 42% (12%) in terms of SLA RMSE (correlation) and 30% (27%) in terms of SLA report a clear improvement of 42% (12%) in terms of SLA RMSE (correlation) and 30% (27%) in terms of SLA report a clear improvement of 42% (12%) in terms of SLA report a clear improvement of 42% (12%) in terms of SLA report a clear improvement of 42% (12%) in terms of SLA report a clear improvement of 42% (12%) in terms of SLA report a clear improvement of 42% (12%) in terms of SLA report a clear improvement of 42% (12%) in terms of SLA report a clear improvement of 42% (12%) in terms of SLA report a clear improvement of 42% (12%) in terms of SLA report a clear improvement of 42% (12%) in terms of 52% (1 gradient RMSE (correlation) with respect to OI when considering along-track nadir observations. However, additional preprocessing should be carried out to filter out the correlated noise in SWOT and along-track nadir observations. data. Future work will focus on combining such preprocessing strategies with the AnDA framework in order to develop useful tools to process real observations from the future SWOT altimetry data as well as considering research avenues include the combination of the different sources of altimetry data as well as considering research avenues include the combination of the different sources of altimetry data as well as considering research avenues include the combination of the different sources of altimetry data as well as considering research avenues include the combination of the different sources of altimetry data as well as considering research avenues include the combination of the different sources of additional ocean dynamical tracers (e.g. sea surface temperature, sea surface salinity, ocean color, etc.). The exploitation of structural information present in wide-swath observations, for example by means of numerically resolved SLA gradients and/or finite size Liapunov exponents (FSLE), is also an appealing research direction.

# Analog Data Assimilation of Along-track Nadir and SWOT Altimetry **Observations in the Western Mediterranean Sea**

# 2. Analog Data Assimilation

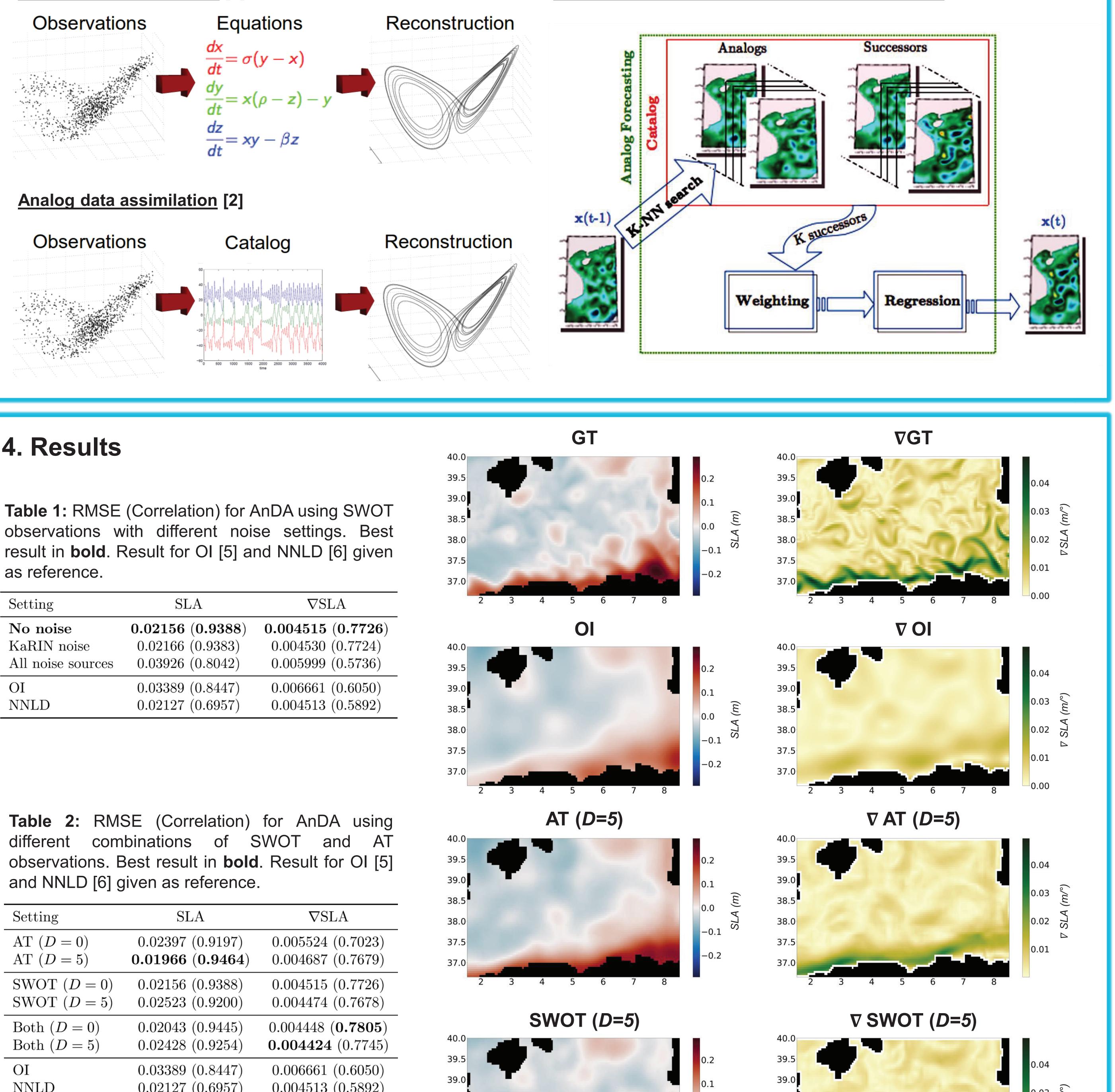
**Data Assimilation:** Combine a model and observations for reconstruction

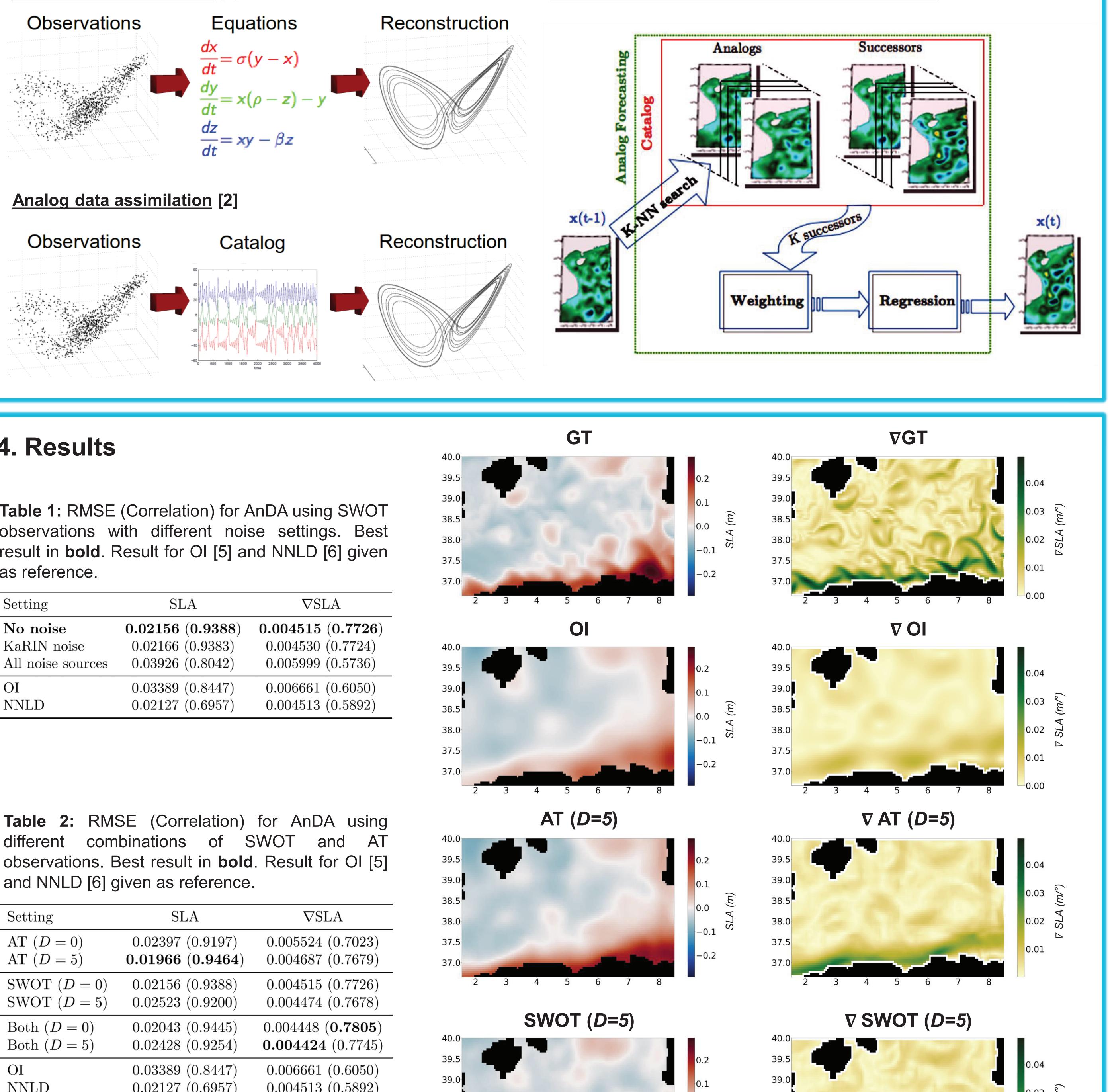
- Observations can be noisy and/or partial
- Models can be non-consistent with observations, uncertain or even unknown
- Running models can be computationally expensive

**Idea:** Replace the model-based forecasting step of data assimilation with a data-driven approach

- Dynamical models can be built directly from a catalog of realistic simulations of system state dynamics
- Forecast can be made by exploiting the similarity between the current state and simulated states within the catalog

#### **Classic data assimilation** [1]





Analog Data Assimilation for Geophysical Fields

#### 4. Results

as reference.

Setting	SLA	$\nabla SLA$
<b>No noise</b> KaRIN noise All noise sources	$\begin{array}{c} \textbf{0.02156} \ (\textbf{0.9388}) \\ 0.02166 \ (0.9383) \\ 0.03926 \ (0.8042) \end{array}$	$\begin{array}{c} \textbf{0.004515} \ (\textbf{0.7726}) \\ 0.004530 \ (0.7724) \\ 0.005999 \ (0.5736) \end{array}$
OI NNLD	$\begin{array}{c} 0.03389 \ (0.8447) \\ 0.02127 \ (0.6957) \end{array}$	$\begin{array}{c} 0.006661 \ (0.6050) \\ 0.004513 \ (0.5892) \end{array}$

Setting	SLA	$\nabla SLA$
$\begin{array}{l} \text{AT} \ (D=0) \\ \text{AT} \ (D=5) \end{array}$	0.02397 (0.9197) <b>0.01966 (0.9464</b> )	$0.005524 \ (0.7023) \\ 0.004687 \ (0.7679)$
$\begin{array}{l} \text{SWOT} \ (D=0) \\ \text{SWOT} \ (D=5) \end{array}$	$0.02156 \ (0.9388) \\ 0.02523 \ (0.9200)$	$\begin{array}{c} 0.004515 \ (0.7726) \\ 0.004474 \ (0.7678) \end{array}$
Both $(D = 0)$ Both $(D = 5)$	$\begin{array}{c} 0.02043 \ (0.9445) \\ 0.02428 \ (0.9254) \end{array}$	0.004448 ( <b>0.7805</b> ) <b>0.004424</b> (0.7745)
OI NNLD	$0.03389 \ (0.8447) \\ 0.02127 \ (0.6957)$	$\begin{array}{c} 0.006661 \ (0.6050) \\ 0.004513 \ (0.5892) \end{array}$

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