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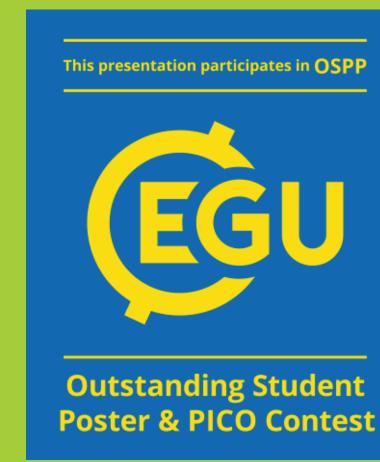
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1. Abstract

derived observations.

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



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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] Observations Equations Reconstruction $\frac{dx}{dt} = \sigma(y - x)$ $\frac{dz}{dt} = x(y - z) - y$ $\frac{dz}{dt} = xy - \beta z$ Analog data assimilation [2] Observations Catalog Reconstruction Weighting Regression

3. Ocean Observing System Simulation Experiment

and along-track nadir observations is considered.

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 satellite-

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 patch-

based analog forecasting operators. Two different types of altimetry data are assimilated: along-

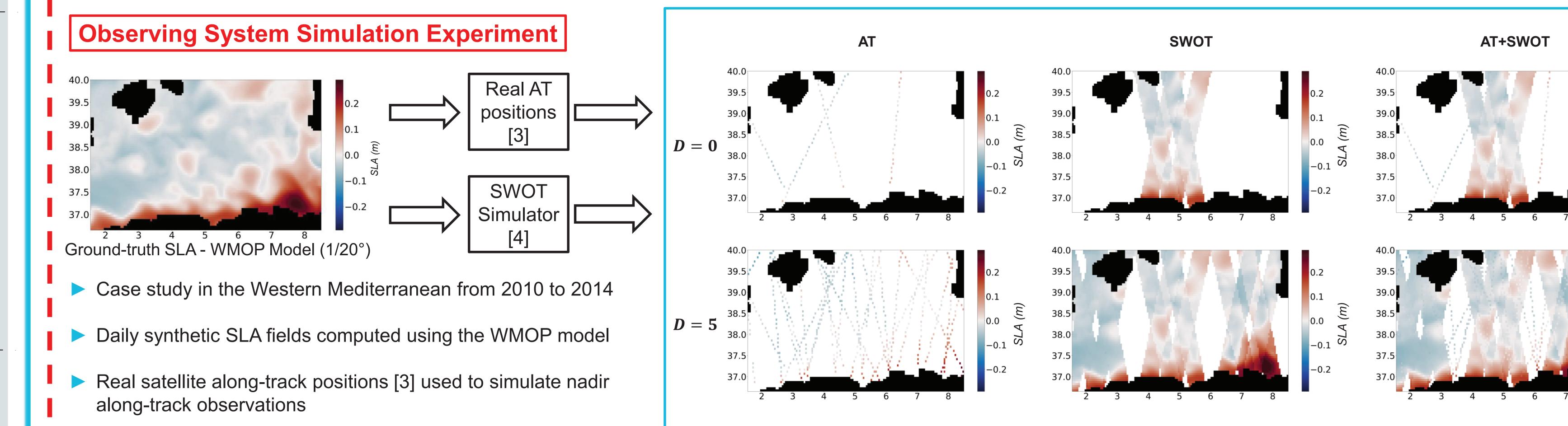
track nadir data and wide-swath SWOT altimetry data. Using an Observing System Simulation

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

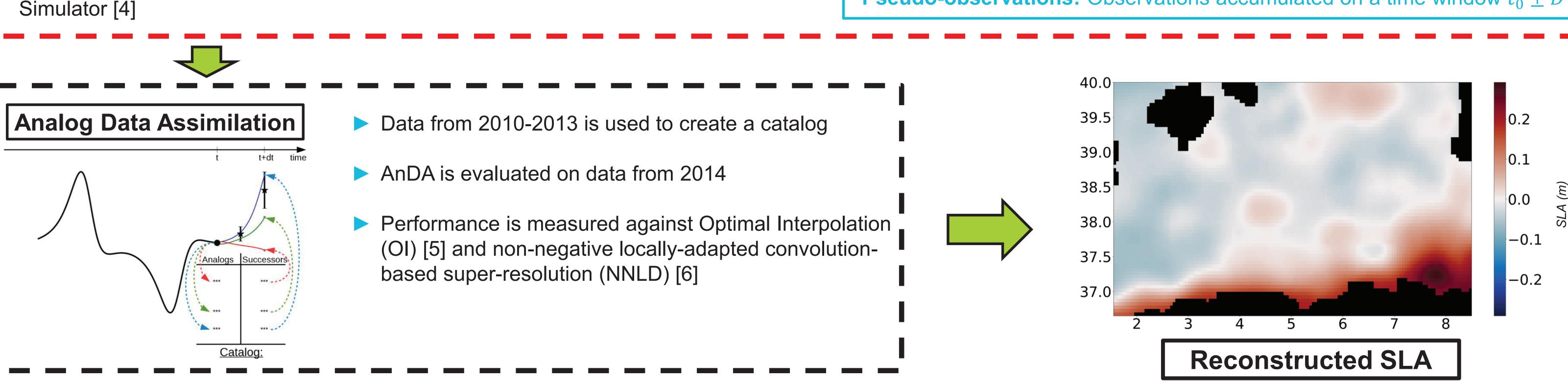
reconstruction RMSE (correlation) improvement of 42% (12%) with respect to Optimal

Interpolation (OI), and suggest an additional potential gain when the joint assimilation of SWOT



Pseudo-SWOT observations generated using the SWOT Simulator [4]

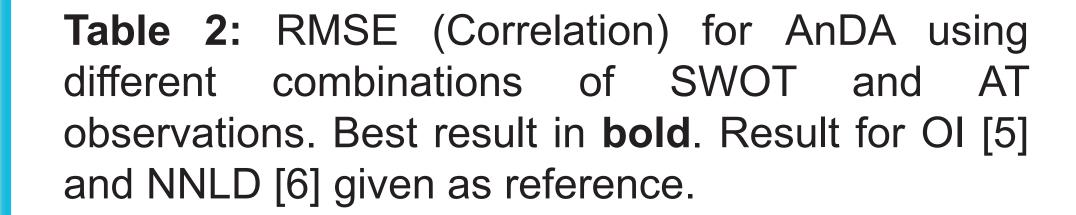
Pseudo-observations: Observations accumulated on a time window $t_0 \pm D$



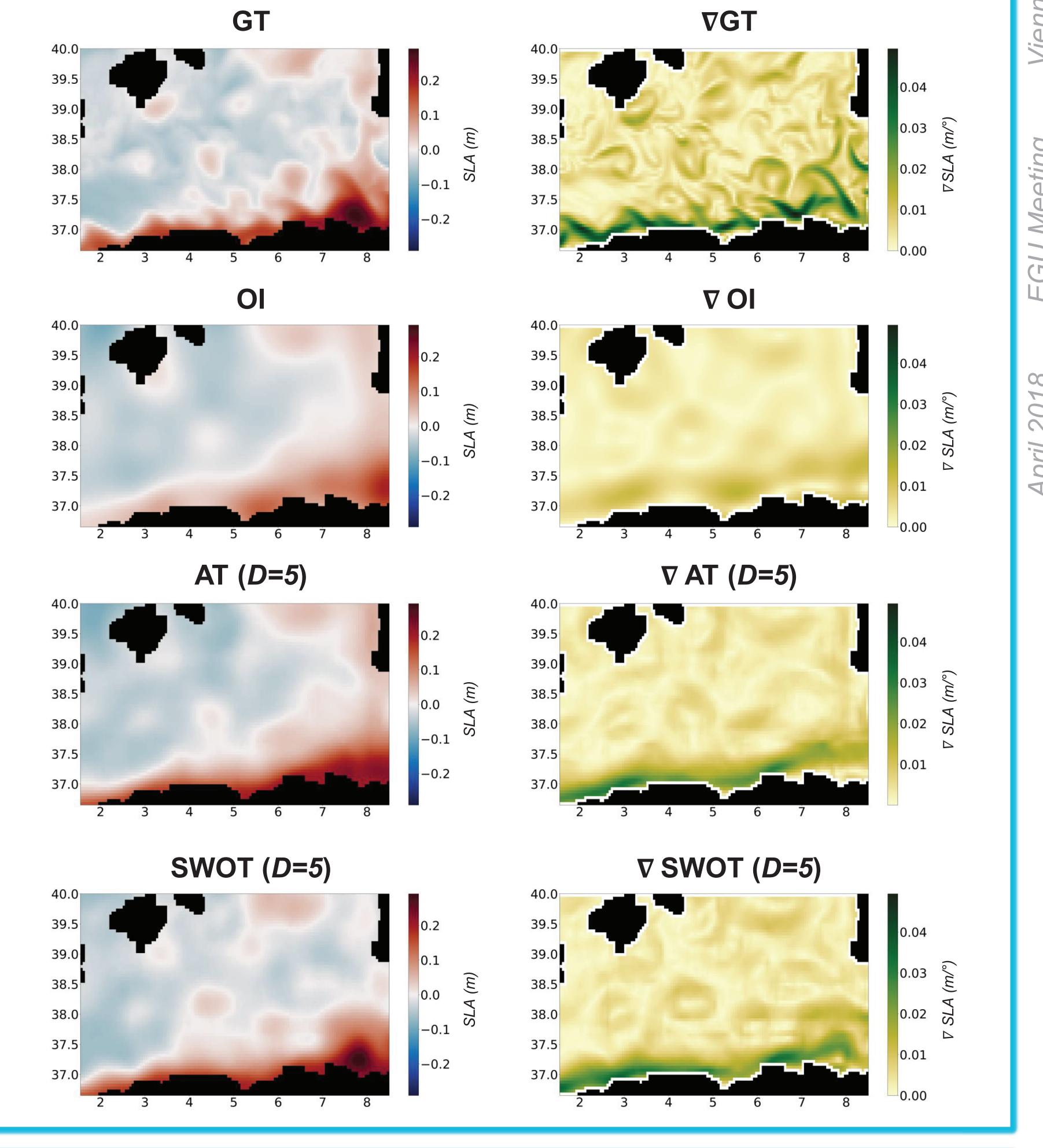
4. Results

Table 1: RMSE (Correlation) for AnDA using SWOT observations with different noise settings. Best result in **bold**. Result for OI [5] and NNLD [6] given as reference.

Setting	SLA	$ abla \mathrm{SLA}$
No noise	$0.02156\ (0.9388)$	$0.004515\ (0.7726)$
KaRIN noise	$0.02166 \ (0.9383)$	$0.004530 \ (0.7724)$
All noise sources	$0.03926 \ (0.8042)$	$0.005999 \ (0.5736)$
OI	$0.03389 \ (0.8447)$	$0.006661 \ (0.6050)$
NNLD	$0.02127 \ (0.6957)$	$0.004513 \ (0.5892)$



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



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 altimetry data, namely satellite along-track nadir data and wide-swath SWOT data. The AnDA framework can be regarded as a means to exploit high-resolution numerical simulation datasets for the reconstruction of SLA fields from partial satellite observations. The reported OSSE support the relevance of AnDA with respect to state-of-the-art approaches (OI and NNLD). For instance, we report a clear improvement of 42% (12%) in terms of SLA gradient RMSE (correlation) with respect to OI when considering along-track nadir data. Our experiments also suggest an additional preprocessing should be carried out to filter out the correlated noise in SWOT 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 mission. Other interesting research avenues include the combination of the different sources of altimetry data as well as considering 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.