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3DA: Data-Driven Data Assimilation

Applications to the Lorenz system and simulated sea surface heights

Authors

Yicun Zhen
Pierre Tandeo
Stéphanie Leroux
Julien Le Sommer
Pierre Ailliot
Ronan Fablet
Bertrand Chapron
Cedric Herzet
Thierry Penduff
Jacques Verron

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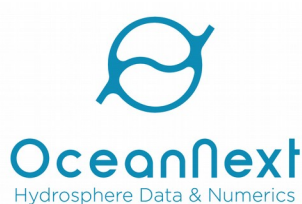
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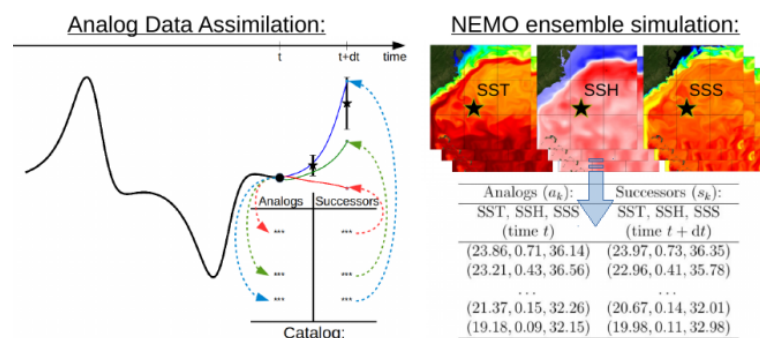
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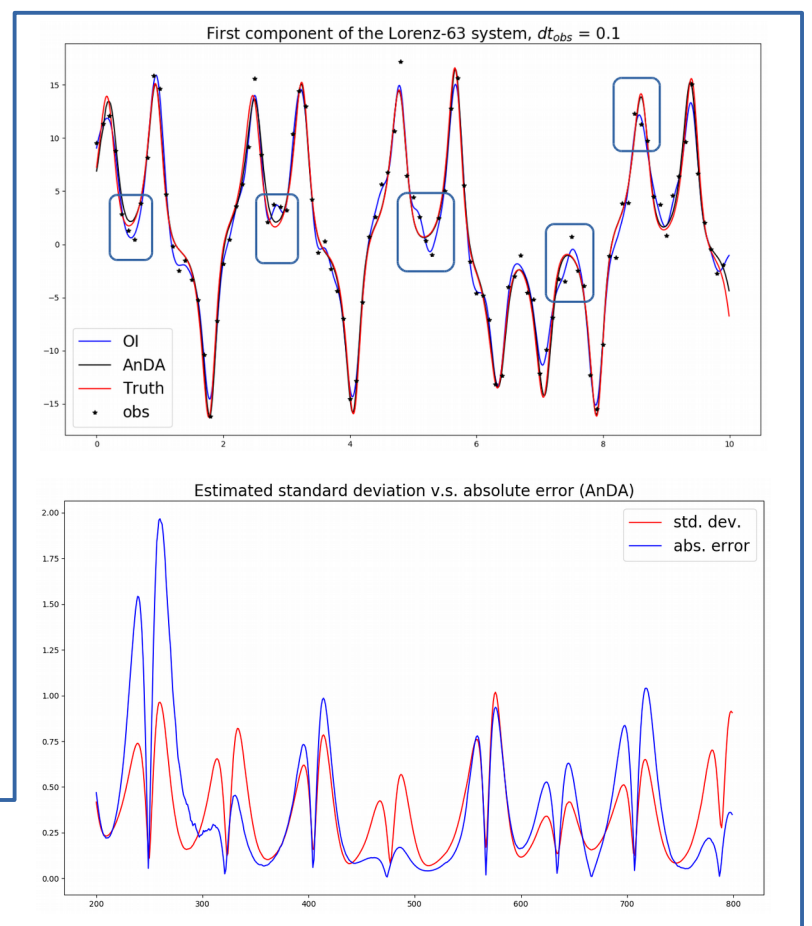


Method[1]: Analog Forecast + EnKS



- ▶ Given a huge historical dataset \mathcal{C} (the catalog);
- ▶ Given the current state estimate x_t , search for the analogs of x_t within \mathcal{C} ;
- ▶ Build a local model based on the analogs and the corresponding successors;
- ▶ Apply the local model on x_t to do the forecast.

Comparison of Analog Data Assimilation (AnDA) with optimal interpolation (OI) on Lorenz 63 model: only the first component is involved.

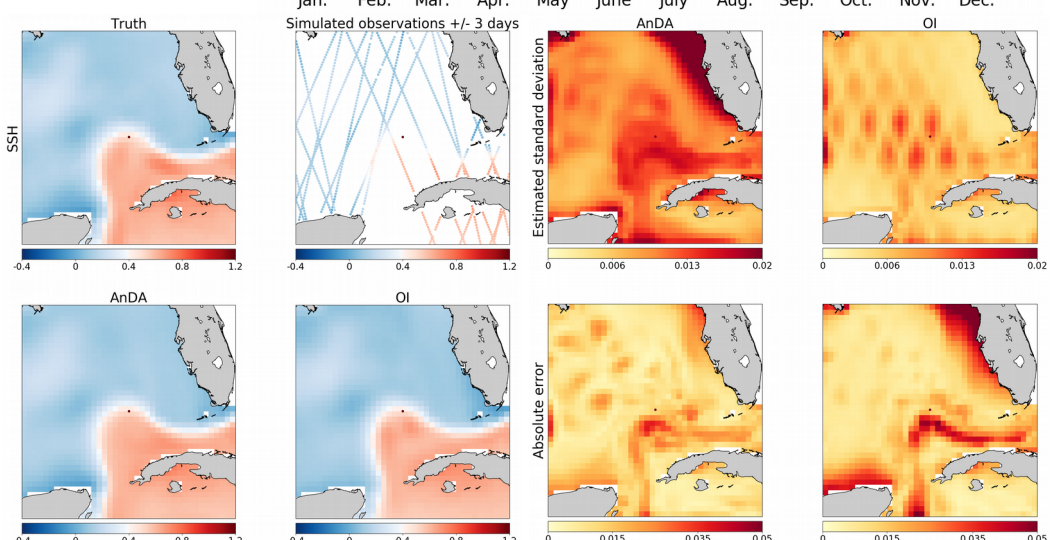
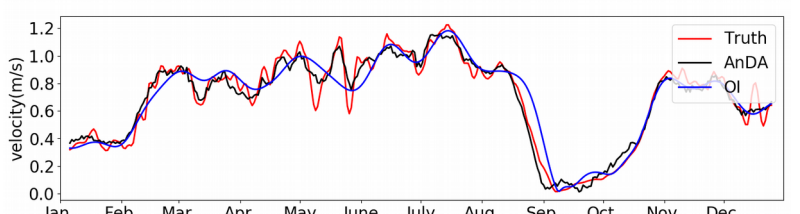
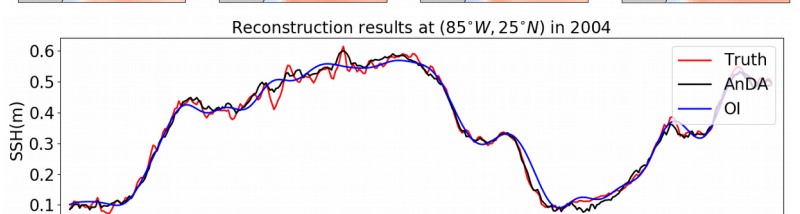
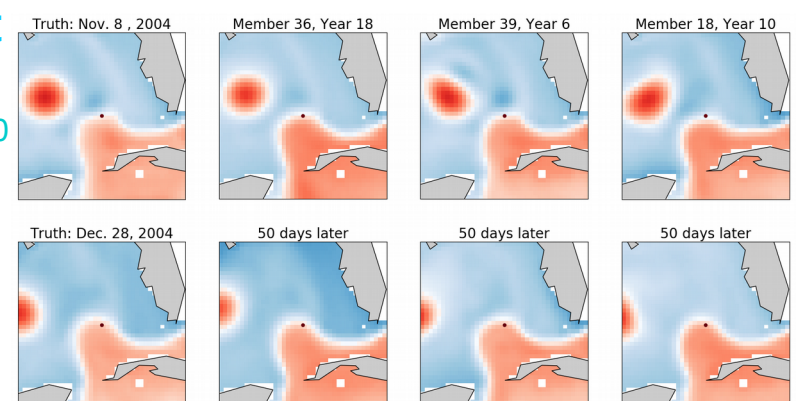
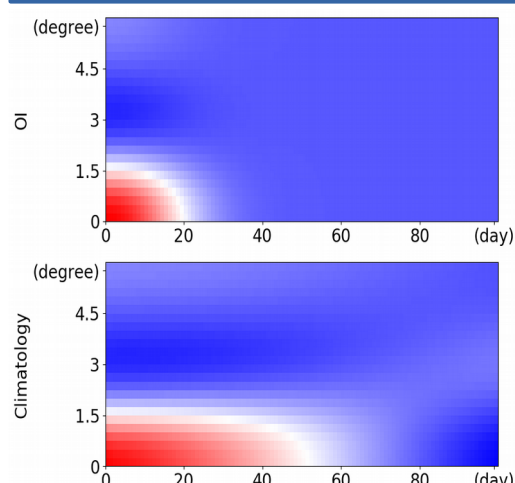


OSSE of simulated sea surface height (SSH) in the Gulf of Mexico

- ▶ Dataset: the OCCIPUT[2] simulated SSH, 50 members, 20 years
- ▶ Truth: member #1 in year 20
- ▶ Observations: simulated along-tracks from the real altimetry in 2004
- ▶ (AnDA) catalog: member #2-#50, in year 1 - year 19
- ▶ (AnDA) ensemble size: 1000
- ▶ (OI) $B = B_{clim,x} \otimes \exp(dt^2/L_t^2)$ where $B_{clim,x}$ is the spatial climatology calculated from the OCCIPUT dataset
- ▶ (OI) $L_t = 20$ (days)
- ▶ (OI) radius of influence = 1.5 (degrees)

Summary:

- ▶ AnDA captures more small scale flows
- ▶ AnDA produces more informative variance maps
- ▶ AnDA relies on catalog



References:

- [1] R. Lguensat et al., The analog data assimilation, MWR, 2017
- [2] L. Bessi eres et al., Development of a probabilistic ocean modelling system based on NEMO 3.5: application at eddy resolution, GRL, 2017

Contact : yicun.zhen@imt-atlantique.fr