Geophysical Research Abstracts
Vol. 21, EGU2019-5325, 2019
EGU General Assembly 2019

Reconstruction of small scales in satellite data using DINEOF and neural networks

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DINEOF (Data Interpolating Empirical Orthogonal Functions) is a technique to reconstruct missing data in remote sensing datasets using a truncated EOF basis. The truncation of the EOF basis is determined by cross-validation and the rejected EOFs often contain noise and transient features that are not well captured by the EOF basis. DINEOF has been used widely with variables like sea surface temperature, colour-related variables, winds and sea surface salinity.

This work aims to improve the quality of the reconstruction of the submesoscale variability using DINEOF, which is often smoothed out by the truncation of the EOF basis. An assessment of the scales of variability retained by DINEOF will be presented using various examples with sea surface temperature and ocean colour. The effect of the number of EOFs used in the spatial and temporal variability of the final product will be also presented. Classic methods for error assessment (like root mean squared error estimates) are not adequate for small scales since they reward smoother results. Alternative error assessment methods, like spectral analysis or process-oriented methods (presence or absence of features) will be compared to study the best approach to determine the quality of the DINEOF reconstructions.

Given that submesoscale features are transient and non-linear, a method combining DINEOF with a neural network approach will be presented. Neural networks are specially well positioned to detect the presence of nonlinear, stochastic features like submesoscale scales in the ocean surface measured by satellite sensors. The combination of DINEOF with a neural network approach in the form of a convolutional autoencoder can therefore allow to overcome the missing data problem and might help in retaining high resolution features present in the data. Autoencoders efficiently compress and decompress data with, ideally, minimal information loss, and the convolutional approach allows to train on local structures, like submesoscale features. Results using a combination of DINEOF with a convolutional autoencoder will be presented.