ASSESSMENT OF COASTAL OCEAN OBSERVATIONAL NETWORKS BY ENSEMBLE-BASED REPRESENTER SPECTRAL ANALYSIS

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The design of sustained coastal ocean observing systems, and adaptive/targeted field programs, are topics of considerable interest. Critical support of future satellite missions is also of great importance to coastal oceanography at the present time. The development of coastal ocean modelling in the recent years has allowed an improved representation of the associated complex physics. Such models are probably mature enough be used to design observation networks in coastal areas, using objective metrics, based on ideas such as the idea that a "good" network is a network that is able to detect and control model error.

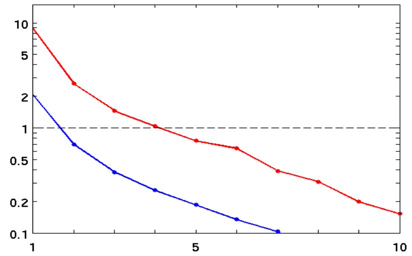

Fig1: Representer matrix eigenspectra for JASON-1 (a nadir-observing altimeter, blue) and SWOT (a wide-swath altimetry project, red). (Log scale.) The observational noise floor is shown as a dotted line. SWOT would be able to detect 4 d.o.f.s (degrees of freedom) of prior state error, while JASON would only detect 1 above the noise floor. But which error modes?

While Observing System Experiments (OSEs) and OSSEs provide an integrated, but methodology-dependent, performance assessment of an observational array, we propose an approach based on the representer matrix spectrum focusing on the capacity of a given array to detect model errors. This can be achieved independently of any data assimilation method, e.g. from stochastic modelling, or as part of an Ensemble Kalman Filter. In our Representer Matrix Spectra (RMSpectrum) method, we combine the prior state error and observation error covariance matrices into a single scaled representer matrix. Its eigenspectrum contains information on which model state error modes a network can detect and potentially constrain, amidst structured observation error background.

The method is applied to a 3D coastal model of the Bay of Biscay, with a focus on mesoscale turbulence errors and wind forcing errors (**Figs. 1 and 2**). In Le Hénaff et al. (2009), the methodology is illustrated through performance tests of various in situ and satellite networks. Although the RMSpectrum technique is easily set up and used as a "black box", the utility of its results is maximised by physical analysis. The technique provides both quantitative (eigenvalues) and qualitative (eigenvectors) tools to study and compare various network options. The qualitative approach is essential to discard possibly inconsistent modes.

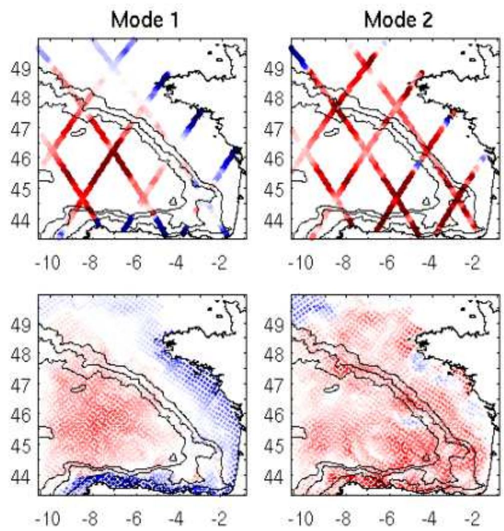

Fig2: Modes 1 and 2 for JASON (top) and SWOT (bottom). Both JASON and SWOT would be able to detect the large-scale water sloshing motion between the shelf and the abyssal plain, but only SWOT could consistently detect coastal mesoscale and high-frequency processes.

Reference: Le Hénaff, M., P. De Mey et P. Marsaleix, 2009 : Assessment of observational networks with the Representer Matrix Spectra method – Application to a 3-D coastal model of the Bay of Biscay. Special Issue of Ocean Dynamics, 2007 GODAE Coastal and Shelf Seas Workshop, Liverpool, UK. Ocean Dynamics, 59, 3-20, DOI 10.1007/s10236-008-0144-7.