Lagrangian assimilation by convex optimization

Master of Science in Industrial and Applied Mathematics
2015-2016 Master Thesis Proposal

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The objective of this study is to develop and investigate a new approach to building a "statistically provably good" recovery and testing procedures for inverse problem of *Lagrangian data assimilation* of determining of the velocity field in the ocean from the data acquired through Lagrangian oceanographic instruments – objects transported by fluid velocity field, which transmit information using GPS.

The specific approach we promote relies upon a construction, based on Convex Programming (and thus computationally efficient) allowing, under appropriate assumptions, to build nearly optimal procedures of estimation and hypothesis testing. The spirit of this project is quite different from that of a "classical" statistical inquiry, where the goal is to characterize analytically the minimax rates of estimation or detection for given restricted classes of problems. By contrast, we do not aim at the analytical analysis of the problem, but instead, are interested in the "near optimality" of the proposed procedures. Furthermore, detailed information about practical performance guarantees for the proposed algorithms (say, probability of wrong detection, confidence sets on estimated fields, or the number of observations sufficient to make an inference satisfying given accuracy and/or reliability specifications) should be provided by efficient situation-oriented computation.

Specifically the subject of this thesis will be the extension of results of [1-3] onto inverse problems related to Lagrangian data assimilation framework. We will concentrate on a (linear) model described by the Stokes equations. Though idealized, this model seems to capture the essence of the problem and reproduce key mathematical properties of ocean flows.

The Master thesis will be supervised by Anatoli Iouditski at Laboratoire Jean Kuntzmann (LJK) and Eric Moulines at Centre de Mathématiques Appliquées (CMAP), and is expected to lead to a PhD thesis on the same topic.

[1] Donoho, D., Statistical estimation and optimal recovery. *Annals of Stat.,* **22**(1), 238-270 (1995).
[2] Juditsky, A., Nemirovski, A. Nonparametric Estimation by Convex Programming, *Annals of Stat.*, **37**(5A), 2278-2300 (2009).
[3] Goldenshluger, A., Juditsky, A. Nemirovski. A., Hypothesis testing by convex optimization, *Electron. J. Statist.*, **9**(2), 1645-1712 (2015).