

# Reduced Order Information Filter (ROIF)

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- What is it?

An approximate extended Kalman filter (EKF),  
in which the covariance matrix is represented by a truncated  
(Fisher) information matrix.

Such an information matrix specifies:

- a Gaussian Markov Random Field (GMRF)
- a reduced order spatial regression
- a diagnostic partial difference equation

representation for the estimation error fields.

References:

Chin/Karl/Willsky (1992) *Signal Processing* 28.

Chin/Mariano/Chassignet (1999) *JGR* 104(C4).

Chin/Haza/Mariano (2002) *J. Atmos. Ocean. Tech.*

- Data targeted (so far)
  - Topex/Poseidon SSH anomaly.
  - Near-surface velocity (drifters, etc.)
  
- Recent technical developments
  1. Positive definiteness and a measure of accuracy:  
Chin (2001) *IEEE Trans. IP*.
  2. First (internal) release for the HYCOM version 2
    - being implemented via `openMP` parallel coding.
    - inversion engine for ROIF.
  3. continuous-domain ROIF (“c-ROIF”)  
(Mariano/Chin, present ONR funding).
    - analytic function representation (over space).
    - differential operators instead of finite differencing.
    - dramatic speed up of ROIF.
  4. Pilot study for ensemble/empirical statistics ROIF (“En-ROIF”)
    - use of data- and/or model-sample statistics.
    - “seeding” of ensemble.
    - links for other works by HYCOM assimilation team.

## On-going ROIF-development activities

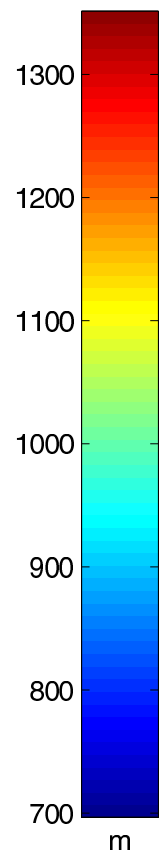
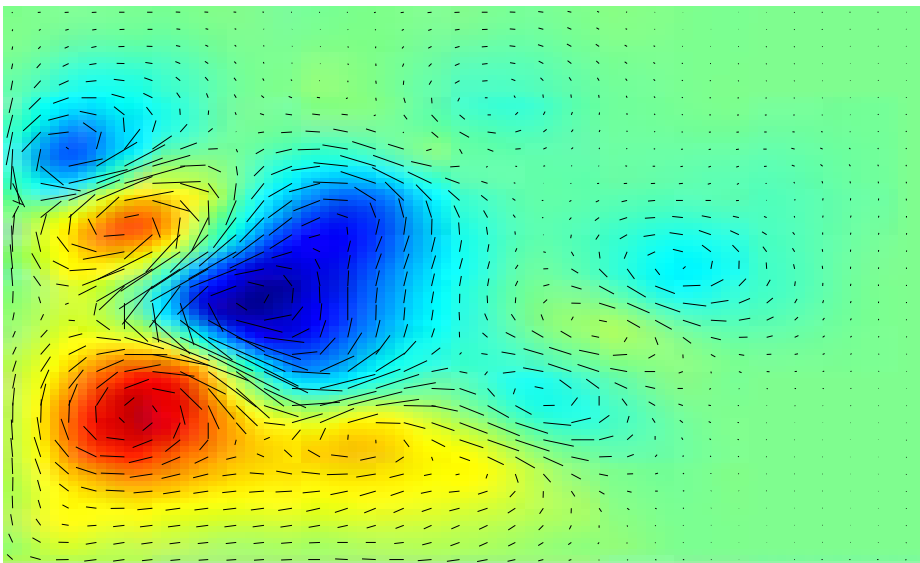
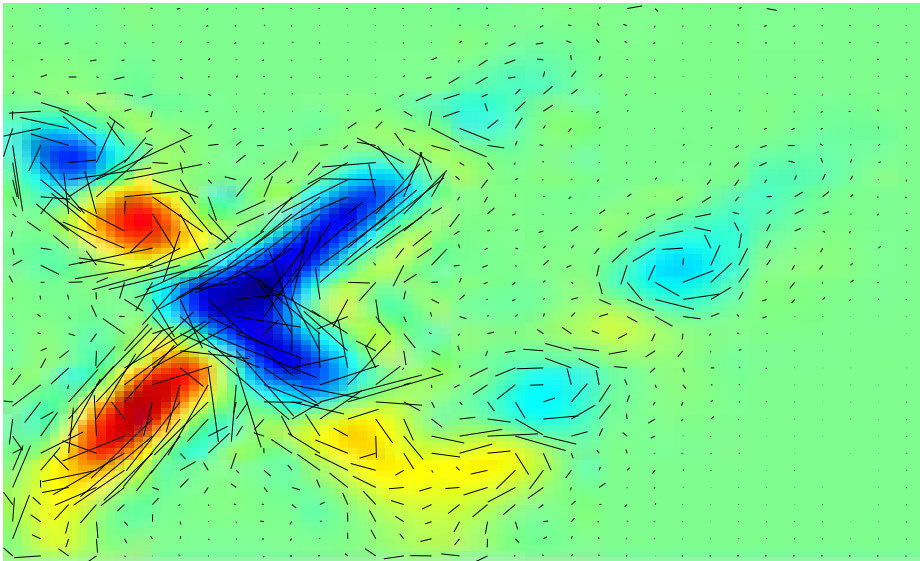
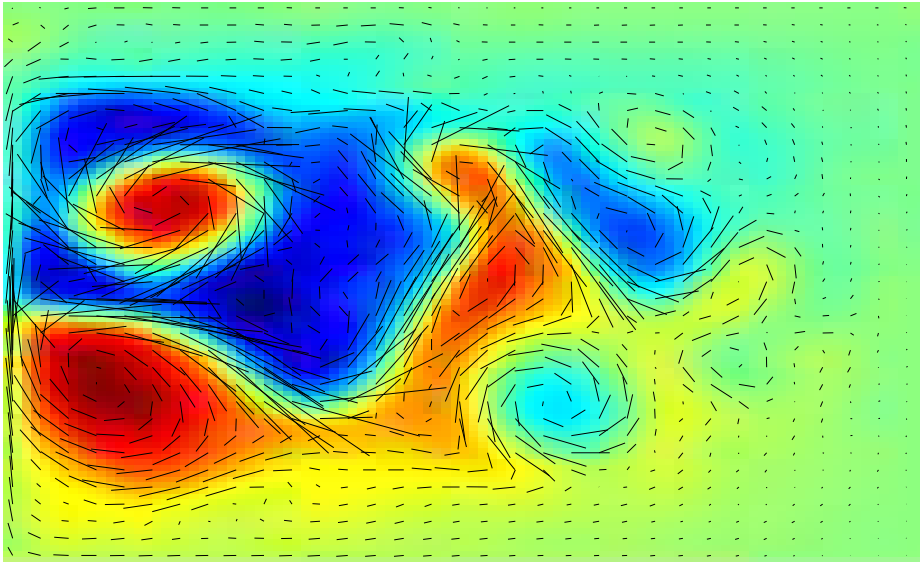
- Design and implementation of EnROIF:
  - “seeding” of ensemble.
  - merging of model- and observation-based variances/covariances.
- Implementation of c-ROIF inversion engine:
  - speed-up

### **c-ROIF example figures**

A preliminary result of the new continuous-domain ROIF (“c-ROIF”) is shown. On the following page, the surface topography from MICOM 100x100 reduced-gravity shallow-water configuration is shown in color with the velocity vectors: the truth (top), T/P sampled data assimilated using the traditional ROIF (middle), and using the c-ROIF (bottom). c-ROIF is an implementation of the ROIF equations using an analytic function basis (e.g., using derivatives instead of finite difference), and it seems to avoid producing spurious small-scale features. In particular, the T/P sampling tracks are clearly visible with the traditional, grid-based ROIF (middle) while this is not obvious with the new c-ROIF (bottom). These differences between the traditional ROIF and c-ROIF are not apparent from the basin-wide error statistics, plots of which are presented on the proceeding page, where the c-ROIF (red curve) and ROIF (green curve) show similar mean error values. Finally, c-ROIF can be nearly two orders of magnitude faster to execute than the old ROIF.

The c-ROIF algorithm is being tested for robustness and planned to be implemented as the inversion engine in the overall ROIF scheme.

day 2



→ 1 m/s

# Effect of collocation of T/P samples (c-ROIF)

