Evaluation of an ensemble based 4D Var assimilation
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Aims and model

- Objective:
  - Compare En4DVar with a classic 4DVar method

Incremental 4DVar vs En4DVar assimilation techniques

- Incremental 4DVar assimilation
  - Cost function using static covariance matrices $\mathbb{B}$ and $\mathbb{R}$
  - Adjoint equation determined by TAPENADE

- En4DVar assimilation
  - Cost function using flow dependent background error covariance matrix within the context of the preconditioning techniques $\delta X_b = B^{1/2} Z_b$.

Minimization performed with LBFGS algorithm: limited memory quasi Newton method

Results

- Synthetic data

Background initial condition
- Exact initial condition
- $L = 25cm$
- $W = 10cm$
- $H = 2cm$
- $H_2 = 2cm$
- $H_4 = 2cm$
- $U(x, y, t_0) = \psi(x, y)$
- $U(x, L, t_0) = 0$
- $V(x, y, t_0) = 0$

En4DVar leads to better
- Higher truncation mode
- More computation time
- Lower truncation mode
- More computation time

- Experimental data

We only possess the height observations given by the depth sensor (Kinect sensor)

Conclusions

- Sensibly, the same computational time cost, En4DVar yields better results than the classic 4DVar assimilation when we have only height observations.
- En4DVar is easy to implement for any given model. We gain a lot of time with the parallelization computing technique. En4DVar implemented with only one outer loop iteration and needs about 100 iterations for the optimization. Requires a lot of memory.
- 4DVar requires the tangent and adjoint operators. The assimilation converges with 3 outer loop iterations and requires less inner loop iterations for the optimization.

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