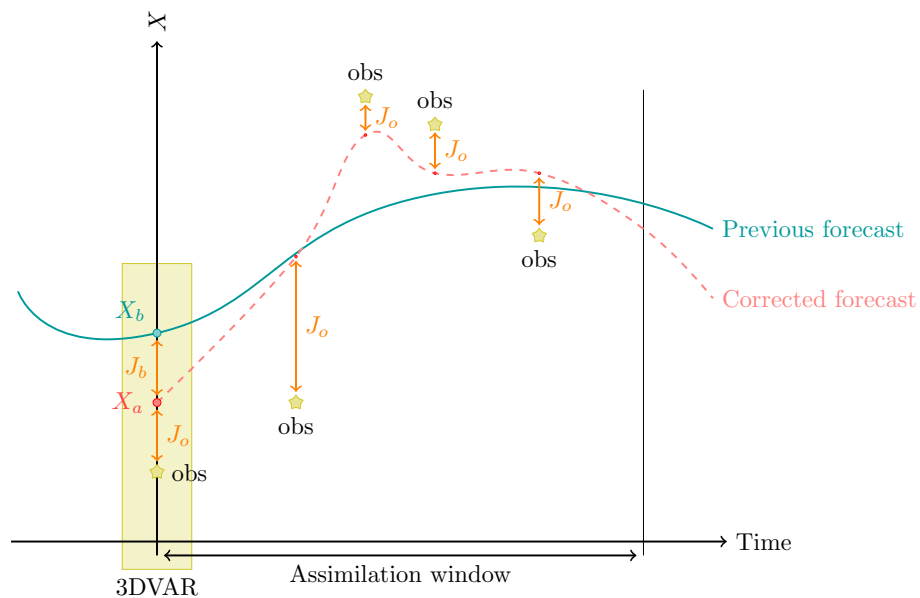# SciML and Data Assimilation

Mark Asch - CSU/IMU/2023

Statistical Data Assim. - M. Asch

Outline of the Basic course

Adjoint methods and variational data assimilation (4h)

1. Introduction to data assimilation: setting, history, overview, definitions.

2. Optimization methods.

3. Adjoint method.

4. Variational data assimilation methods:

   (a) 3D-Var,
   (b) 4D-Var.

Statistical estimation, Kalman filters and sequential data assimilation (4h)

1. Introduction to statistical DA.

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2. Statistical estimation.

3. The Kalman filter.

Outline of the Advanced course

Statistical estimation, nonlinear Kalman filters and sequential data assimilation (4h)

1. Introduction to statistical DA.

2. Statistical estimation.

3. The Kalman filter.

4. Nonlinear extensions and ensemble filters.

Scientific Machine Learning for DA

1. See SciML lectures, since DA is just a special case of an Inverse Problem.

Codes

Various open-source repositories and codes are available for both academic and operational data assimilation.

1. DARC: `https://research.reading.ac.uk/met-darc/` from Reading, UK.

2. DAPPER: `https://github.com/nansencenter/DAPPER` from Nansen, Norway.

3. DART: `https://dart.ucar.edu/` from NCAR, US, specialized in ensemble DA.

4. OpenDA: `https://www.openda.org/`.

5. Verdandi: `http://verdandi.sourceforge.net/` from INRIA, France.

6. PyDA: `https://github.com/Shady-Ahmed/PyDA`, a Python implementation for academic use.

7. Filterpy: `https://github.com/rlabbe/filterpy`, dedicated to KF variants.

8. EnKF; `https://enkf.nersc.no/`, the original Ensemble KF from Geir Evensen.

References

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