

# A Multilevel Preconditioner for Data Assimilation with 4D-Var

Alison Ramage <sup>1</sup>

Kirsty L. Brown <sup>2</sup>

Igor Gejadze <sup>3</sup>

Large-scale variational data assimilation problems are commonly found in applications like numerical weather prediction and oceanographic modelling. The 4D-Var method is frequently used to calculate a forecast model trajectory that best fits the available observations to within the observational error over a period of time. One key challenge is that the state vectors used in realistic applications could contain billions or trillions of unknowns so, due to memory limitations, in practice it is often impossible to assemble, store or manipulate the matrices involved explicitly. In this talk we present a limited memory approximation to the Hessian of the linearised quadratic minimisation subproblems, computed using the Lanczos method, based on a multilevel approach [1]. We then use this approximation as a preconditioner within 4D-Var and show that it can reduce memory requirements and increase computational efficiency.

## References

- [1] K. L. BROWN, I. GEJADZE, AND A. RAMAGE, *A Multilevel Approach for Computing the Limited-Memory Hessian and its Inverse in Variational Data Assimilation*, SIAM J. Sci. Comput., 38:A2934–A2963, 2016.

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<sup>1</sup>Department of Mathematics and Statistics, University of Strathclyde, Glasgow, Scotland (A.Ramage@strath.ac.uk)

<sup>2</sup>Department of Mathematics and Statistics, University of Strathclyde, Glasgow, Scotland

<sup>3</sup>IRSTEA, Montpellier, France