Jemima M. Tabeart

School of Mathematics,
University of Edinburgh
EH9 3FD

Email: jemima.tabeart@ed.ac.uk
Website: jemimat.github.io

I am a postdoctoral researcher in mathematics with a focus on numerical linear algebra and data assimilation for high-dimensional applications. My work considers mathematical and heuristic techniques to improve the solution of large-scale iterative solvers, via the development of new preconditioners and reconditioning approaches. The projects I have worked on are wide-ranging, incorporating theoretical linear algebra, the design and coding of numerical testbeds, and complex experiments using 1D-Var, 4D-Var, and NEMOVAR schemes at the UK Met Office. I have seven published papers and two in review. I have experience working in cross-institution, interdisciplinary programmes; both during my PhD and in my time as a Postdoctoral Semester Fellow at ICERM, USA. I have received grant funding from Una Europa and won a number of awards including the Best MRes Project from the Mathematics of Planet Earth Centre for Doctoral Training and the Chancellor's Prize for Best Undergraduate Student from the University of Bath in 2015. I am also a co-founder of the Communications in Numerical Linear Algebra (CommNLA) online seminar series.

Employment

- **Hooke Research Fellow** — September 2022 –
  Mathematical Institute, University of Oxford
  Independent research fellowship in the Numerical Analysis Group
- **Fulford Non-Stipendiary Junior Research Fellowship** — October 2022 –
  Somerville College, University of Oxford
- **Postdoctoral Research Associate** — October 2019 – August 2022
  School of Mathematics, University of Edinburgh
  Project: Modern linear algebra for PDE-constrained optimisation models for huge-scale data analysis, Grant EP/S027785/1, working with Dr John W. Pearson.
- **Semester Postdoctoral Fellowship** — January 2020 – April 2020
  Institute for Computational and Experimental Research in Mathematics (ICERM) — *Brown University*
  Fellowship for the program "Model and dimension reduction in uncertain and dynamic systems".

Education

- **PhD** — October 2016 – November 2019
  EPSRC Centre for Doctoral Training in Mathematics of Planet Earth — *University of Reading*
  Thesis title: On the treatment of correlated observation errors in data assimilation
  Supervised by: Professor Sarah L. Dance, Dr Amos S. Lawless, Professor Nancy K. Nichols, Dr Joanne A. Waller, and Dr David Simonin (MetOffice@Reading)
  In collaboration with the National Centre for Earth Observation and the Met Office, my research investigated how correlated observation error can be incorporated into a data assimilation framework whilst reducing the negative impact on convergence that has been observed theoretically and operationally.
- **MRes in Mathematics of Planet Earth (Distinction)** — 2015 – 2016
  Imperial College London and University of Reading
  Project title: On the variational data assimilation problem with non-diagonal observation weighting matrices
  Awarded Best MRes Project.
- **MMath (1st Class Honours), Mathematics with Study Year Abroad** — 2011 – 2015
  University of Bath
  Undertook assessed third year at Université Joseph Fourier (now part of Université Grenoble Alpes) where I completed the Parcours A stream for students preparing to study graduate mathematics.
  Awarded Chancellor's Prize for best final year undergraduate student.

Research Experience

- **Visiting Researcher** — July – August 2018
  Met Office, Exeter, UK
  8 week research project based in Ocean Forecasting and Research Development group to investigate importance of error covariances for sea surface temperature observations. Compared diagnosed errors obtained using method of Desroziers et al. (2005) with estimates produced by ESA CCI SST project, finding significant differences between the two estimate types.
- **Researcher** — July – August 2014
  University of Bath
  8 week research placement based at the Universities of Bath and Cambridge. The bouncing droplet phenomenon, a fluid dynamics problem with parallels in quantum physics, was modelled in 1D using Matlab. The programs, graphs, and final report produced provided a starting point for my undergraduate research project.

- **Research Assistant** July – August 2011
  University of Bath
  Awarded a 5 week Bursary placement in June 2010 – subsequently returned to work on a European-wide project studying Gallium Nitride (GaN). Created a new tool to aid the 3D visualisation of GaN's physical properties, which involved learning to program in Visual Basic, communicating with other scientists on the same project and presenting my work to non-experts. The placement culminated in the publication of a joint paper in Integrated Ferroelectrics (Vol 133 Issue I).

Publications

Published

1. E. Qian, **J. M. Tabeart**, C. Beattie, S. Gugercin, J. Jiang, P. R. Kramer, and A. Narayan. "Model Reduction of Linear Dynamical Systems via Balancing for Bayesian Inference", *Journal of Scientific Computing.*, 91, 29 (2022) https://doi.org/10.1007/s10915-022-01798-8
2. **J. M. Tabeart**, S. L. Dance, A. S. Lawless, N. K. Nichols, and J. A. Waller. (2021) "New bounds on the condition number of the Hessian of the preconditioned variational data assimilation problem", *Numerical Linear Algebra with Applications*, e2405. https://doi.org/10.1002/nla.2405
3. S. Vetra-Carvalho, S. L. Dance, D. C. Mason, J. A. Waller, E. S. Cooper, P. J. Smith, and **J. M. Tabeart**. (2020). "Collection and extraction of water level information from a digital river camera image dataset", *Data in Brief*, 33, 106338. https://doi.org/10.1016/j.dib.2020.106338
4. **J. M. Tabeart**, S. L. Dance, F. Hilton, A. S. Lawless, S. Migliorini, N. K. Nichols and J. A. Waller (2020) "The impact of reconditioning of the correlated observation error covariance matrix on the Met Office system", *Quarterly Journal of the Royal Meteorological Society*, 146(728), 1372-1390. https://doi.org/10.1002/qj.3741
5. **J. M. Tabeart**, S. L. Dance, A. S. Lawless, N. K. Nichols, and J. A. Waller (2020). "Improving the condition number of estimated covariance matrices", *Tellus A: Dynamic Meteorology and Oceanography*, 72(1), 1-19. https://doi.org/10.1080/16000870.2019.1696646
6. **J. M. Tabeart**, S. L. Dance, S. A. Haben, A. S. Lawless, N. K. Nichols, and J. A. Waller. (2018) "The conditioning of least squares problems in variational data assimilation", *Numerical Linear Algebra with Applications*, 25(5), e2165. https://doi.org/10.1002/nla.2165
7. M.-L. Hicks, **J. Tabeart**, M. J. Edwards, E. D. Le Boulbar, D. W. E. Allsopp, C. R. Bowen, and A. C. E. Dent. (2012) "High Temperature Measurement of Elastic Moduli of (0001) Gallium Nitride", *Integrated Ferroelectrics*, 133(1) 17-24. https://doi.org/10.1080/10584587.2012.663309

Submitted

1. **J. M. Tabeart** and J. W. Pearson. "Parallelisable saddle point preconditioners for weak constraint 4D-Var", *submitted to Journal of Computational Physics* Preprint arXiv:2105.06975.
2. D. Palitta and **J. M. Tabeart** "Stein-based preconditioners for weak-constraint 4D-Var", Preprint arXiv:2203.17184

In Preparation

1. **J. M. Tabeart** and J. W. Pearson. "Using low-rank observation information to precondition weak-constraint 4D-Var", *In preparation.*
2. **J. M. Tabeart**, S. Gürol, J. W. Pearson and A. Weaver "Block Circulant Preconditioners for Parallel-in-Time diffusion-based correlation operators", *In preparation.*

Funding

Research funding

- Co-investigator Una Europa Seed Funding DIGITALIZED! call (November 2021) for the project 'Tensor-based Optimal Control approaches for Deep Learning' with Dr Davide Palitta (University of Bologna) and Dr Nick Vannieuwenhoven (KU Leuven) https://site.unibo.it/toc4deep/en. Value of award: €11,000

Scholarships and fellowships

- Postdoctoral semester fellowship, ICERM, Brown University (Spring 2020): $26,500 stipend, $800 travel funding
- MRes/PhD studentship at Mathematics of Planet Earth Centre for Doctoral Training. Value approx £100,000 over 4 years.

Travel grants

- Research visit to RIKEN, Japan (January 2019): £1500
- Workshop on Sensitivity Analysis and Data Assimilation (August 2018): DARE training fund €820 euros +£200
- International Workshop on Climate Change and Natural Disasters: £4000
- Imperial College SIAM student conference (June 2018): travel funding.

Prizes and Awards

- Nominated: Outstanding course for tutoring/co-lecturing on Numerical Partial Differential Equations BSc/MSc course, April 2022
- Associate Fellow of the Higher Education Academy, September, 2021
- Poster Prize: LMS Women in Mathematics Day, University of Strathclyde, June 2021.
- Best group project: MPE CDT Industrial Study Group, March 2018. 2 day study group on industrial problem from AIR worldwide. Team of PhD students developed a research idea using industrial data and presented to a panel of academics and industry representatives.
- Best group project: presenting National Centre for Earth Observation science to an industrial audience, NCEO Researchers' Forum, February 2018. Team of researchers from across NCEO developed a presentation on a specified topic to promote novel NCEO research and its societal impacts. Judged by panel of academics and science communication experts.
- Best poster presentation: NCEO Researchers' Forum, February 2018.
- Best MRes project: MPE CDT, March 2017.
- Chancellor's Prize for best final year undergraduate student: University of Bath, June 2015.

Conferences

Invited conference and workshop talks

1. 20th – 22nd June 2022, Sparse Days, Saint-Girons, France
   Stein-based Preconditioners for Weak-constraint 4D-Var
2. 13th – 17th June 2022 (rescheduled from 14th – 19th June 2020), Householder Symposium XXI
   Novel preconditioners for saddle point weak-constraint 4D-Var
3. 6th – 10th June 2022, Numerical Methods for Large Scale Problems, Belgrade, Serbia
   Novel preconditioners for saddle point weak-constraint 4D-Var
4. 11th – 14th July 2021, 31st European Conference on Operational Research (EURO XXXI), Athens, Greece
   Preconditioners for saddle point weak-constraint 4D-Var with correlated observation errors
5. 10th May 2021, Communications in Numerical Linear Algebra seminar series, Online https://bit.ly/3q4sR9T
   Parallelisable preconditioners for saddle point weak-constraint 4D-Var
6. 30th July 2020, Reading student seminar series, University of Reading, UK
   How to use reduced order models in the Ensemble Kalman filter
7. 29th May 2020, Scottish Numerical Methods Network, Workshop on Inverse Problems and Optimisation for PDEs, University of Edinburgh, UK
   Why and how should we use correlated observation errors in data assimilation?
8. 25th September 2019, Royal Meteorological Society Data Assimilation Special Interest Group Meeting, Reading, UK
   Using reconditioning methods to reduce the cost of using correlated observation error information: theory and practice
9. 1st – 2nd July 2019, Advances in Linear Algebra and Huge-Scale Optimization, ICMS, Edinburgh, UK
   Accounting for correlated errors in data assimilation: using linear algebra to improve computational efficiency
10. 11th June 2018, Imperial College SIAM student conference, UK
    How to use correlated covariance information without breaking the bank

Invited seminars

1. 2nd June 2022, Semester Programme Reunion Event, Institute for Computational and Experimental Research in Mathematics, Providence, USA.
   Stein-based Preconditioners for Weak-constraint 4D-var
2. 18th March 2022, Numerical Analysis and Scientific Computing Seminar, University of Manchester, UK
   Novel preconditioners for saddle point weak-constraint 4D-Var
3. 22nd October 2021, Applied Mathematics Seminar, University of Warwick, UK
   Parallelisable preconditioners for saddle point weak-constraint 4D-Var
4. 19th July 2021, Oberseminar Dynamics, Technical University of Munich, Germany
   Parallelisable preconditioners for saddle point weak-constraint 4D-Var
5. 6th July 2021 Algo-Coop seminar, Cerfacs, Toulouse
   New preconditioners for saddle point weak-constraint 4D-Var
6. 14th April 2021, Reading Data Assimilation Research Centre seminar, University of Reading, UK
   Parallelisable preconditioners for saddle point weak-constraint 4D-Var
7. 1st April 2020, NRL seminar, Naval Research Laboratory, Monterey, US
   Including correlated observation error in variational data assimilation problems

8. 28th January 2019, Data Assimilation Seminar Series, RIKEN Centre for Computational Science, Kobe, Japan
   Using reconditioning to study the impact of correlated observation errors in the Met Office 1D-Var system
9. 2nd November 2018, Environmental Research DTP Student Seminar Series, University of Oxford, UK
   How to use observation error information to improve weather forecasts
10. 28th August 2018, Met Office Ocean Group Seminar Series, Exeter, UK
    Estimating correlated observation errors for SST
11. 7th February 2018, Imperial College Junior Applied Mathematics Seminar, UK
    How to use correlated covariance information without breaking the bank

Invited workshop participant

1. 2nd – 5th November 2020, ECMWF/EUMETSAT NWP SAF Workshop on the treatment of random and systematic errors in satellite data assimilation for NWP, European Centre for Medium-Range Weather Forecasts, Reading, UK
2. 5th – 6th February 2018, NCEO Researchers' Forum, University of Leicester, UK
   Poster: Accounting for correlated observation errors in variational data assimilation
3. 29th August – 2nd September 2017, International Workshop on Climate Change and Natural Disasters, Cemaden/INPE, São Jose dos Campos, Brazil
4. 19th – 20th March 2018, MPE CDT Industrial Study Group, University of Reading, UK
5. 20th – 21st March 2017, MPE CDT Industrial Study Group, Imperial College London, UK

Selected contributed presentations

International oral presentations

1. 6th – 10th June 2022, International Symposium on Data Assimilation, Fort Collins, USA
   Novel preconditioners for saddle point weak-constraint 4D-Var
2. 17th – 21st May 2021, SIAM Conference on Applied Linear Algebra, New Orleans, USA
   Preconditioners for saddle point weak-constraint 4D-Var with correlated observation errors
3. 24th November 2020, Sparse Days, Cerfacs, Toulouse, France
   Preconditioners for saddle point weak-constraint 4D-Var with correlated observation errors
4. 15th – 19th July 2019, International Congress on Industrial and Applied Mathematics, Valencia, Spain
   How to use observation error information to improve weather forecasts
5. 21st – 24th January 2019, 7th International Symposium on Data Assimilation, RIKEN Centre for Computational Science, Kobe, Japan
   Improving the conditioning of estimated observation error covariance matrices
6. 1st – 6th July 2018, Workshop on Sensitivity Analysis and Data Assimilation in Meteorology and Oceanography, Meli Ria Hotel, Aveiro, Portugal
   Improving the condition number of estimated covariance matrices

International poster presentations

1. 21st – 24th January 2019, 7th International Symposium on Data Assimilation, RIKEN Centre for Computational Science, Kobe, Japan
   The impact of using reconditioned correlated observation error covariance matrices in the Met Office 1D-Var system

National oral presentations

1. 19th – 21st September 2018, CliMathNet Conference, University of Reading, UK
   Improving the condition number of estimated covariance matrices
2. 27th – 30th June 2017, National Centre for Earth Observation and Centre for Earth Observation Instrumentation annual conference, University of Bath, UK
   Accounting for correlated observation errors in variational data assimilation
3. 19th June 2017, Imperial College SIAM Student Conference, Imperial College London, UK
   Accounting for correlated observation errors in variational data assimilation

National poster presentations

1. 16th June 2021, LMS Women in Mathematics Day, University of Strathclyde, UK
   Saddle point preconditioners for weak-constraint 4D-Var
2. 4th – 7th September 2018, National Centre for Earth Observation Conference, University of Birmingham, UK
   Improving the condition number of estimated covariance matrices

3. 30th April – 1st May 2018, LMS Women in Maths Days, Isaac Newton Institute, Cambridge, UK
   Improving the condition number of estimated covariance matrices
4. 21st March 2018, MPE CDT Jamboree, University of Reading, UK
   Improving the condition number of estimated covariance matrices
5. 22nd March 2017, MPE CDT Jamboree, Imperial College, London, UK
   Accounting for correlated observation errors in variational data assimilation

Teaching Experience

- **Guest Lecturer** January – March 2022
  Numerical Partial Differential Equations (4th/5th year BSc/MSc) *University of Edinburgh*
  Lectured on spectral methods
  Managed and marked computational assessment for 65 students.
  Nominated for Outstanding Course (Edinburgh University Students' Association Teaching Awards)

- **Co-Lecturer** October – November 2021
  Computational methods for data driven modelling (PhD level) *University of Edinburgh*
  Lectured on: optimization, gradient descent, convex optimization, mirror descent.
  Managed and marked assessment for 18 students.

- **Teaching assistant** 2021 – 2022
  Numerical Partial Differential Equations (4th/5th year BSc/MSc) *University of Edinburgh*
  Leading Zoom and in-person workshops and Python computer labs

- **Teaching assistant** 2017 – 2019
  Numerical Methods for Financial Engineering (MSc Finance) *University of Reading*
  Co-leading computer practicals for 16 students assisting with Visual Basic

- **Teaching assistant** 2016 – 2019
  Linear Algebra (1st year BSc) *University of Reading*
  Co-leading weekly workshops for 30 students, and marking termly summative assignments for 210 students

- **Teaching assistant** 2015 – 2016
  Linear Algebra (1st year BSc) *University of Bath*
  Leading and preparing weekly tutorials for 16 students. Marking weekly formative problem sets for 30 students

Supervision

- **MSc project supervision** Summer 2020 and 2021
  University of Edinburgh
  Sole supervisor for 3× students on Computational and Applied Mathematics MSc and 2×Operational Research MSc project. Students obtained Distinction (×2), Merit (×2) and Pass.

Leadership

- **Workshop co-organiser** April/July/September 2022
  Universities of Edinburgh, Bologna and KU Leuven
  Co-organiser of 3 hybrid workshops as part of the TOC4Deep Una Europa grant, hosted at the University of Edinburgh (April), University of Bologna (July) and KU Leuven (September) https://site.unibo.it/toc4deep/en/agenda

- **Workshop co-organiser** April 2022
  International Centre for Mathematical Sciences, Edinburgh
  Recent Advances in Numerical Linear Algebra for PDEs, Optimization, and Data Assimilation Conference website

- **Communications in Numerical Linear Algebra** September 2020 – June 2021
  Online seminar series
  Co-founder and co-organiser of CommNLA, online seminar series for early career researchers in Numerical Linear Algebra
  Hosted traditional seminars, panel discussions and industry themed sessions. 41 seminars talks to date.
  Between 15-40 live viewers on Zoom/Youtube per session. 140 subscribers to the Youtube channel and 3,454 views of recorded videos.

- **Communications Officer/Secretary** October 2016 – September 2018
  University of Reading SIAM–IMA Student Chapter
  Co-organised annual conference for over 50 PhD students from across the South West (June 2017 and May 2018).
  Awarded £100 additional funding to enable gender diversity of keynote speakers.

- **Trustee** 2016 – 2018
  Reading University Students' Union
  Served as Deputy Chair, 2017 – 2018.
  Represented the views of post-graduate students.
  Ensured the organisation continued to act in the best interest of its members.

Reviewing

Peer reviewed papers for journals including BIT Numerical Mathematics, Tellus A: Dynamic Meteorology and Oceanography, Geoscientific Model Development, Computers & Operations Research, Electronic Transactions in Numerical Analysis.

Professional Memberships

- Society for Industrial and Applied Mathematics
- Edinburgh Mathematical Society
- GAMM Activity Group on Optimization with Partial Differential Equations
- GAMM Activity Group on Applied and Numerical Linear Algebra
- UK Higher Education Academy

Outreach activities

- Delivered a taster lecture at Piscopia Initiative Forum. (September 2020)
- Ran online presentation and discussion sessions to families as part of the Skype a Scientist Programme. (April 2020)
- Designed and led outreach sessions for 10 Year 8 classes at Bulmershe School, Woodley. Demonstration of how curriculum mathematics is used in real-world scenarios and research – presentation and group activities. (May and June 2019)
- Completed University of Reading Students in Schools programme, weekly volunteering in GCSE mathematics classes. (March – July 2019)
- Undertook school visits to promote STEM careers with 14–18 year old students. (January 2018 – June 2019)
- Blogs about conference attendance and summarising research including: lay summary of recent paper NCEO website, article in Mathematics Today (August 2017) about SIAM Student Conference.

Training courses

- NERC training course Oceans in Weather and Climate, 12th – 16th March 2018
- EUMETSAT/ECMWF NWP-SAF Satellite Data Assimilation, 3rd – 7th April 2017
- ECMWF Data Assimilation Course, 27th – 31st March 2017
- Met Office internal training: Using Rose and Cylc, 9th – 10th May 2016

Computing

Highly proficient with Unix, Matlab, Python, LaTeX
Significant experience with high performance computing, using the Met Office Rose/Cylc system, netCDF

Languages

Native English speaker, fluent in French (C1 level)

References

- Dr John W. Pearson (current Principal Investigator), Reader at the University of Edinburgh, j.pearson@ed.ac.uk.
- Professor Sarah L. Dance (PhD supervisor), Professor of Data Assimilation at the University of Reading, s.l.dance@reading.ac.uk
- Dr Alison Ramage, Reader at the University of Strathclyde, a.ramage@strath.ac.uk