

# Helen Claire Ward

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## Education

**PhD in Meteorology** **Oct 2009 - Apr 2013**  
King's College London & CEH Wallingford (NERC Algorithm studentship)  
*Energy, water and carbon fluxes in the suburban environment.*  
Passed with no corrections.

**Master of Physics (MPhys) – 1<sup>st</sup> Class** **Oct 2005 - Jun 2009**  
Oxford University  
Final year specialisation in *Climate Physics* and *Geophysical Fluid Dynamics* (also *Particle Physics*).  
Final year research project on temporal variability of surface albedo derived from satellite products.

## Employment

**Senior postdoctoral position** **May 2017 -**  
Department of Atmospheric and Cryospheric Sciences (ACINN), University of  
Innsbruck, Austria  
Investigating turbulent exchange in complex (urban, mountainous) environments.  
Research stipend (May-Nov 2017); Lise Meitner fellowship (Dec 2017-Nov 2019).

**Visiting researcher** **Sep - Oct 2016**  
Department of Atmospheric Sciences, Yonsei University, Korea  
Modelling and observing urban environments.  
Funded by Korean Ministry of Education and National Institute of Meteorological Sciences.

**Postdoctoral researcher** **Apr 2014 - May 2017**  
Department of Meteorology, Reading University, UK  
Modelling of surface-atmosphere exchange in urban environments.

**Scientific researcher** **Apr 2013 - Apr 2014**  
Centre for Ecology and Hydrology (CEH), Wallingford, UK  
Collection and analysis of flux data (spatial and temporal variation in greenhouse gases).  
Development of a prototype network of soil moisture monitoring stations (design, installation,  
automated data collection, analysis of results).

**Research assistant** **2008, 2009**  
CEH Wallingford (two summer placements of 10-11 weeks each)  
Quality control and analysis of meteorological and flux data.  
Field campaigns in the UK, Germany, Sweden and Finland.

## Research interests

- Surface-atmosphere exchange of momentum energy and mass in complex environments (e.g. urban areas, heterogeneous landscapes, mountainous terrain).
- Evaluation and development of meteorological models to improve representation of physical processes.
- Turbulence measurement techniques including eddy covariance and scintillometry.

## Peer-reviewed publications

1. Järvi L, Havu M, **Ward HC**, Bellucco V, McFadden JP, Toivonen T, Heikinheimo V, Kolari P, Riikonen A and Grimmond CSB (2019) *Spatial modelling of local-scale biogenic and*

- anthropogenic carbon dioxide emissions in Helsinki*. Journal of Geophysical Research: Atmospheres 124 8363-8384 doi: 10.1029/2018JD029576
2. Ao X, Grimmond CSB, **Ward HC**, Gabey AM, Tan J, Yang XQ, Liu D, Zhi X, Liu H and Zhang N (2018) *Evaluation of the Surface Urban Energy and Water balance Scheme (SUEWS) at a dense urban site in Shanghai: Sensitivity to anthropogenic heat and irrigation*. Journal of Hydrometeorology 19: 1983-2005 doi: 10.1175/JHM
  3. Crawford B, Grimmond CSB, Gabey A, Marconcini M, **Ward HC** and Kent CW (2018) *Variability of urban surface temperatures and implications for aerodynamic energy exchange in unstable conditions*. Quarterly Journal of the Royal Meteorological Society. doi: 10.1002/qj.3325
  4. Stoy P, Peitzsch E, Wood D, Rottinghaus D, Wohlfahrt G, Goulden M and **Ward HC** (2018) *On the exchange of sensible and latent heat between the atmosphere and melting snow*. Agricultural and Forest Meteorology 252: 167-174 doi: 10.1016/j.agrformet.2018.01.028
  5. Lindberg F, Grimmond CSB, Gabey A, Huang B, Kent CW, Sun T, Theeuwes NE, Järvi L, **Ward HC**, Capel-Timms IW, Chang YY, Jonsson P, Krave N, Liu D, Meyer D, Olofson KFG, Tan J-G, Wästberg D, Xue L and Zhang Z (2018) *Urban Multi-scale Environmental Predictor: An integrated tool for city-based climate services*. Environmental Modelling and Software 99, 70-87. doi: 10.1016/j.envsoft.2017.09.020
  6. Kent CW, Lee K, **Ward HC**, Hong J-W, Hong J, Gatey D and Grimmond CSB (2017) *Aerodynamic roughness variation with vegetation: analysis in a suburban neighbourhood and a city park*. Urban Ecosystems. doi: 10.1007/s11252-017-0710-1
  7. Sun T, Kotthaus S, Li D, **Ward HC**, Gao Z, Ni G and Grimmond CSB (2017) *Attribution and mitigation of heat wave-induced urban heat storage change*. Environmental Research Letters 12, 114007. doi: 10.1088/1748-9326/aa922a
  8. **Ward HC**, Tan YS, Gabey AM, Kotthaus S and Grimmond CSB (2017) *Impact of temporal resolution of precipitation forcing data on modelled urban-atmosphere exchanges and surface conditions*. International Journal of Climatology. doi: 10.1002/joc.5200
  9. Barlow JM, Best M, Bohnenstengel SI, Clark P, Grimmond CSB, Lean H, Christen A, Emeis S, Haeffelin M, Harman I, Lemonsu A, Martilli A, Pardyjak E, Rotach MW, Ballard S, Boutle S, Brown A, Cai X, Carpentieri M, Coceal O, Crawford B, Di Sabatino S, Dou J, Drew DR, Edwards JM, Fallmann J, Fortuniak K, Gornall J, Gronemeier T, Halios CH, Hertwig D, Hirano K, Holtslag AAM, Luo Z, Mills G, Nakayoshi M, Pain K, Schlünzen KH, Smith S, Soulhac L, Steeneveld G-J, Sun T, Theeuwes NE, Thomson D, Voogt JA, **Ward HC**, Xie J-T and Zhong J (2017) *Developing a research strategy to better understand, observe and simulate urban atmospheric processes at kilometre to sub-kilometre scales*. Bulletin of the American Meteorological Society. doi: 10.1175/BAMS-D-17-0106.1
  10. Kokkonen T, Grimmond CSB, Rätty O, **Ward HC**, Christen A, Oke TR, Kotthaus S and Järvi L (2017) *Sensitivity of Surface Urban Energy and Water Balance Scheme (SUEWS) to downscaling of reanalysis forcing data*. Urban Climate. doi: 10.1016/j.uclim.2017.05.001
  11. **Ward HC** and Grimmond CSB (2017) *Assessing the impact of changes in surface cover, human behaviour and climate on energy partitioning across Greater London*. Landscape and Urban Planning 165: 142-161. doi: 10.1016/j.landurbplan.2017.04.001.
  12. **Ward HC** (2017) *Scintillometry in urban and complex environments: a review*. Measurement Science and Technology 28: 064005. doi: 10.1088/1361-6501/aa5e85
  13. Crawford B, Grimmond CSB, **Ward HC**, Morrison W and Kotthaus S (2017) *Spatial and temporal patterns of surface-atmosphere energy exchange in a dense urban environment using scintillometry*. Quarterly Journal of the Royal Meteorological Society 143: 817-833. doi: 10.1002/qj.2967
  14. **Ward HC**, Kotthaus S, Järvi L and Grimmond CSB (2016) *Surface Urban Energy and Water Balance Scheme (SUEWS): Development and evaluation at two UK sites*. Urban Climate 18: 1-32. doi: 10.1016/j.uclim.2016.05.001
  15. Evans JG, **Ward HC**, Blake JR, Hewitt EJ, Morrison R, Fry M, Ball LA, Doughty LC, Libre JW, Hitt OE, Rylett D, Ellis RJ, Warwick AC, Brooks M, Parkes MA, Wright GMH, Singer AC, Boorman DB and Jenkins A (2016) *Soil water content in southern England derived from a*

- cosmic-ray soil moisture observing system – COSMOS-UK*. Hydrological Processes 30: 4987-4999. doi: 10.1002/hyp.10929
16. Huntingford C, Marsh T, Scaife AA, Kendon EJ, Hannaford J, Kay AL, Lockwood M, Prudhomme C, Reynard NS, Parry S, Lowe JA, Screen JA, **Ward HC**, Roberts M, Stott PA, Bell VA, Bailey M, Jenkins A, Legg T, Otto FEL, Massey N, Schaller N, Slingo J and Allen MR (2015) *Reply to 'Drivers of the 2013/14 winter floods in the UK'*. Nature Climate Change 5: 491-492. doi: 10.1038/nclimate2613
  17. **Ward HC**, Evans JG, Grimmond CSB and Bradford J (2015) *Infrared and millimetre-wave scintillometry in the suburban environment - Part 1: structure parameters*. Atmospheric Measurement Techniques 8, 1385-1405, doi: 10.5194/amt-8-1385-2015
  18. **Ward HC**, Evans JG and Grimmond CSB (2015) *Infrared and millimetre-wave scintillometry in the suburban environment - Part 2: large-area sensible and latent heat fluxes*. Atmospheric Measurement Techniques 8, 1407-1424, doi: 10.5194/amt-8-1407-2015
  19. **Ward HC**, Kotthaus S, Grimmond CSB, Bjorkegren A, Wilkinson M, Morrison WTJ, Evans JG, Morison JIL and Iamarino M (2015) *Effects of urban density on carbon dioxide exchanges: direct observations of dense urban, suburban and woodland areas of southern England*. Environmental Pollution 198, 186-200, doi: 10.1016/j.envpol.2014.12.031
  20. Huntingford C, Marsh T, Scaife AA, Kendon EJ, Hannaford J, Kay AL, Lockwood M, Prudhomme C, Reynard NS, Parry S, Lowe JA, Screen JA, **Ward HC**, Roberts M, Stott PA, Bell VA, Bailey M, Jenkins A, Legg T, Otto FEL, Massey N, Schaller N, Slingo J and Allen MR (2014) *Potential influences on the United Kingdom's floods of winter 2013/14*. Nature Climate Change 4: 769-777. doi: 10.1038/nclimate2314
  21. **Ward HC**, Evans JG and Grimmond CSB (2014) *Multi-scale sensible heat fluxes in the suburban environment from large-aperture scintillometry and eddy covariance*. Boundary Layer Meteorology, 152: 65-89, doi: 10.1007/s10546-014-9916-4
  22. Poyatos R, Heinemeyer A, Ineson P, Evans JG, **Ward HC**, Huntley B and Baxter R (2013) *Environmental and vegetation drivers of seasonal CO<sub>2</sub> fluxes in a sub-Arctic forest-mire ecotone*. Ecosystems, doi: 10.1007/s10021-013-9728-2
  23. Stoy PC, Williams M, Evans JG, Prieto-Blanco A, Disney M, Hill TC, **Ward HC**, Wade TJ and Street LE (2013) *Upscaling tundra CO<sub>2</sub> exchange from chamber to eddy covariance tower*. Arctic, Antarctic, and Alpine Research, 45: 275-284, doi: 10.1657/1938-4246-45.2.275
  24. **Ward HC**, Evans JG and Grimmond CSB (2013) *Multi-season eddy covariance observations of energy, water and carbon fluxes over a suburban area in Swindon, UK*. Atmospheric Chemistry and Physics, 13: 4645-4666, doi: 10.5194/acp-13-4645-2013
  25. **Ward HC**, Evans JG, Hartogensis OH, Moene AF, De Bruin HAR and Grimmond CSB (2013) *A critical revision of the estimation of the latent heat flux from two-wavelength scintillometry*. Quarterly Journal of the Royal Meteorological Society, 139: 1912-1922, doi: 10.1002/qj.2076
  26. Wood CR, Pauscher L, **Ward HC**, Kotthaus S, Barlow JF, Gouvea M, Lane SE and Grimmond CSB (2013) *Wind observations above an urban river using a new lidar technique, scintillometry and anemometry*. Science of the Total Environment, 442: 527-533, doi: 10.1016/j.scitotenv.2012.10.061
  27. Evans JG, McNeil DD, Finch JW, Murray T, Harding RJ, **Ward HC** and Verhoef A (2012) *Determination of turbulent heat fluxes using a large aperture scintillometer over undulating mixed agricultural terrain*. Agricultural and Forest Meteorology, 166-167: 221-233, doi: 10.1016/j.agrformet.2012.07.010
  28. **Ward HC**, Evans JG and Grimmond CSB (2011) *Effects of Non-Uniform Crosswind Fields on Scintillometry Measurements*. Boundary Layer Meteorology, 141:143-163, doi: 10.1007/s10546-011-9626-0

## Non-refereed articles

1. Kotthaus S, **Ward HC**, Grimmond CSB and Evans JG (2012) *Flux Measurements in Southern England by KCL and CEH*. FluxLetter, 5: 25-31

## Book chapters

1. Grimmond CSB and **Ward HC** (accepted) *Urban measurements and interpretation* in Springer Handbook of Atmospheric Measurements, edited by Foken T. Springer
2. Beyrich F, Hartogensis OK, De Bruin HAR and **Ward HC** (accepted) *Scintillometers* in Springer Handbook of Atmospheric Measurements, edited by Foken T. Springer
3. Grimmond CSB, **Ward HC** and Kotthaus S (2016) *How is urbanization altering local and regional climate?* in The Routledge Handbook of Urbanization and Global Environmental Change, edited by Seto KC, Solecki WD, Griffith CA. Routledge, 582 pp
4. Cooper DJ, Bell J, Hodnett M, Beven K, Gilman K, Haria A, Gardner C, Robinson M, Evans JC and **Ward HC** (2015) *Terrestrial Hydrological Processes in Progress in Modern Hydrology: Past, Present and Future*, edited by Rodda JC, Robinson M. Wiley-Blackwell, 408 pp

## Manuals

1. **Ward HC**, Järvi L, Onomura S, Lindberg F, Gabey A and Grimmond CSB (2016) *SUEWS Manual V2016a* <http://urban-climate.net/umep/SUEWS>
2. Lindberg F, Grimmond CSB, Chang YY, Gabey A, Järvi L, Kent CW, Kokkonen T, Krave N, Olofson F, Onomura S, Sun T, Tan JG, **Ward HC**, Xue L and zum Berge K (2016) *Urban Multi-scale Environmental Predictor (UMEP) Manual* [http://urban-climate.net/umep/UMEP\\_Manual](http://urban-climate.net/umep/UMEP_Manual)

## Published datasets

1. Morrison R, Clark E, Lloyd C, **Ward HC**, Evans JG, Brooks M, Rowe R and McNamara NP (2019) *Eddy covariance measurements of carbon dioxide, energy and water fluxes at a commercial Miscanthus x. giganteus plantation, Lincolnshire, UK, 2008 to 2013*. NERC Environmental Information Data Centre, doi: 10.5285/00487c70-b74e-4c91-ab0c-31735c2e3b13

## Conference presentations (presenting/first author only)

1. **Ward HC**, Umek L, Rotach MW, Gohm A, Graus M, Karl T, Haid M and Muschinski T, *Assessing the performance of WRF/urban for the alpine city of Innsbruck*. 35th International Conference on Alpine Meteorology, 02-06 Sep 2019, Riva del Garda, Italy
2. **Ward HC**, *Flux measurements in complex environments*. 20th Anniversary of EUROFLUX workshop, 10-14 Dec 2018, Hyytiälä Forestry Field Station, Hyytiälä, Finland
3. **Ward HC**, Rotach MW, Graus M, Karl T, Gohm A and Muschinski T, *Turbulent exchange at an urban site in highly complex terrain*. 10th International Conference on Urban Climate, 06-10 Aug 2018, New York, New York, USA
4. **Ward HC**, Rotach MW, Graus M, Karl T, Gohm A, Muschinski T, Umek L, Haid M and Lehner L, *Turbulent exchange over the alpine city of Innsbruck*. 18th Conference on Mountain Meteorology, 25-29 Jun 2018, Santa Fe, New Mexico, USA
5. **Ward HC**, Rotach MW, Graus M, Karl T, Gohm A, Muschinski T, Umek L, Haid M and Lehner L, *Turbulence exchange over the city of Innsbruck*. 30 May 2018, ACINN Graduate Seminar, Innsbruck University, Innsbruck, Austria
6. **Ward HC** and EAPL, *Evaluation of SUEWS (Surface Urban Energy and Water balance Scheme) at multiple sites in South Korea*. 27 Oct 2016, Department of Atmospheric Sciences, Yonsei University, Korea
7. **Ward HC** and Grimmond CSB, *Using biophysical modelling to assess the heat-stress risk across Greater London*. Public Health England meeting, 02 Aug 2016, University of Reading, UK
8. **Ward HC** and Grimmond CSB, *Biophysical modelling to understand the impact of decisions in the context of heatwave resilience in London*. emBRACE project meeting, 08-10 Sep 2015, London, UK
9. **Ward HC**, Grimmond CSB, Kotthaus S, Järvi L, Lindberg F, Evans JG, Morrison W and Mustchin J, *Using observations to improve modelled energy, water and carbon exchanges for urban areas*. 9th International Conference on Urban Climate, 20-24 Jul 2015, Toulouse, France

10. **Ward HC**, Grimmond CSB, Kotthaus S, Järvi L, Lindberg F and Morrison W, *Using observations to improve modelled energy, water and carbon exchanges for urban areas*. Urban Met seminar, 16 Jul 2015, University of Reading, UK
11. **Ward HC**, Grimmond CSB, Kotthaus S and Sun T, *Integration of the three modelling components and an overview of the biophysical model*. TRUC 2<sup>nd</sup> project meeting, 24-25 Feb 2015, Kolkata, India
12. **Ward HC** and Grimmond CSB, *Integrated risk and resilience analysis: model connection points, limits and opportunities*. TRUC 2<sup>nd</sup> project meeting, 24-25 Feb 2015, Kolkata, India
13. **Ward HC**, *Turbulent fluxes from eddy covariance and scintillometry in a suburban area*. Urban Met seminar, 17 Jul 2014, University of Reading, UK
14. **Ward HC**, Evans JG and Grimmond CSB, *Turbulence measurements over a suburban landscape using scintillometry and eddy covariance*. 21st Symposium on Boundary Layers and Turbulence, 09-13 Jun 2014, Leeds, UK
15. **Ward HC**, Kotthaus S, Grimmond CSB, Bjorkegren A, Wilkinson M, Morrison W, Christen A, Evans JG and Morison JIL, *Linking carbon dioxide fluxes to urban density*. EGU 2014, 27 Apr-2 May 2014, Vienna, Austria
16. **Ward HC**, Aurela M, George CT and Hayman G, *Up-scaling methane fluxes from plot to the landscape*. MAMM Science meeting, 26-27 Feb 2014, University of Manchester, UK
17. **Ward HC**, Evans JG and Grimmond CSB, *Two-wavelength scintillometry over the suburban environment*. Tübingen Atmospheric Physics Symposium 'Scintillometers and Applications', 07-09 Oct 2013, Tübingen, Germany
18. **Ward HC**, Evans JG and Grimmond CSB, *Large-area heat fluxes from two-wavelength scintillometer systems over suburban surfaces*. Tübingen Atmospheric Physics Symposium 'Scintillometers and Applications', 07-09 Oct 2013, Tübingen, Germany
19. **Ward HC**, Evans JG and Grimmond CSB, *Multi-seasonal energy, water and carbon fluxes for a suburban area in the UK*. EMS 2013, 09-13 Sep 2013, Reading, UK
20. **Ward HC**, Evans JG and Grimmond CSB, *Large-area heat fluxes from two-wavelength scintillometry in the suburban environment*. EMS 2013, 09-13 Sep 2013, Reading, UK
21. **Ward HC**, Evans JG and Grimmond CSB, *Controls on suburban evaporation: first results from the Swindon experiment*. 8<sup>th</sup> International Conference on Urban Climate, 06-10 Aug 2012, Dublin, Ireland
22. **Ward HC**, Evans JG and Grimmond CSB, *Urban Scintillometry*. LITFASS project meeting, 17 Nov 2011, German Meteorological Service (Deutscher Wetterdienst, DWD), Meteorological Observatory Lindenberg, Germany
23. **Ward HC**, Evans JG and Grimmond CSB, *Comparing bichromatic scintillometry with the two-wavelength method: first results from Chilbolton*. 3<sup>rd</sup> Scintillometer Workshop, 18-19 Apr 2011, Wageningen, The Netherlands
24. **Ward HC**, Evans JG, De Bruin HAR and Grimmond CSB, *Ground-based remote sensing of surface fluxes and crosswind using scintillometry over complex terrain (POSTER)*. Remote Sensing and Hydrology 2010 Symposium, 27-30 Sep 2010, Jackson Hole, Wyoming, USA
25. **Ward HC**, Evans JG, De Bruin HAR and Grimmond CSB, *Scintillometry with Non-Uniform Crosswind Fields (POSTER)*. AMS 2010, 02-06 Aug 2010, Keystone, Colorado, USA

### Invited presentations

1. **Ward HC**, *Measuring and interpreting CO<sub>2</sub> fluxes in urban areas*. 1<sup>st</sup> ICOS workshop on strategies to monitor greenhouse gases in urban environments, 01-04 Jul 2019, Hyytiälä Forestry Field Station, Hyytiälä, Finland
2. **Ward HC**, *Turbulent exchange in and around the alpine city of Innsbruck*. 16 May 2019, Institute of Meteorology and Climatology, Leibniz University Hannover, Hannover, Germany
3. **Ward HC**, *Turbulence observations in urban and complex landscapes*. 30 Nov 2017, Institute of Meteorology and Climate Research, Karlsruhe Institute of Technology (KIT), Garmisch-Partenkirchen, Germany

4. **Ward HC**, *Turbulence observations in urban areas*. 15 Mar 2017, ACINN Graduate Seminar, Innsbruck University, Innsbruck, Austria
5. **Ward HC**, *Urban flux measurements and modelling in the UK*. 19 Oct 2015, Department of Atmospheric Sciences, Yonsei University, Korea
6. **Ward HC**, *Understanding the urban environment using observations and modelling (KEYNOTE)*. 15-16 Oct 2015, International Conference on Urban Meteorology, Jeju, Korea
7. **Ward HC**, *Fluxes obtained from eddy covariance and scintillometry in the suburban environment*. 28 Jan 2014, Laboratoire LTHE, Grenoble, France
8. **Ward HC**, *Estimating NPP using flux towers*. Terrestrial NPP Discussion meeting, 17-18 Dec 2013, CEH Lancaster, Lancaster Environment Centre, UK

## Organised workshops

2013                    Joint organiser: *Quality control of eddy covariance data for the Ecosystem Land Use Modelling (ELUM) Project*, 05-06 Mar 2013, University of Southampton, UK

## Teaching experience

March 2019            ‘*Introduction to scintillometry*’  
Feldkurs Atmosphärenwissenschaften, Innsbruck University  
Lecture + tutorial exercise (3 hr)

March 2018            ‘*Introduction to scintillometry*’  
Feldkurs Atmosphärenwissenschaften, Innsbruck University  
Lecture + tutorial exercise (3 hr)

March 2017            ‘*Introduction to scintillometry*’  
Feldkurs Atmosphärenwissenschaften, Innsbruck University  
Lecture + tutorial exercise (2 hr)

Autumn 2011        ‘*Understanding and managing the urban atmosphere*’, King’s College London  
Lecture course (8 hours) + marking assignments

2015-2017            A-level physics tuition, A-level maths tuition, GCSE-level further maths tuition

## Supervisory experience

2017- (PhD)        Member of supervisory committee for Alexei Perelet, University of Utah, *Experiments to expand the application of scintillometers as a valuable tool for micro-meteorology*

2015 (MSc)        Ishani Bhattacharya, Reading University, *An investigation of anthropogenic heat fluxes and carbon dioxide emissions in urban areas*

2015 (MSc)        Tan Yin San, Reading University, *Assessing the impacts of temporal resolution of precipitation forcing data on the surface energy and water balance*

2013                Supervision of a 7-week student placement at CEH Wallingford

2010-2016        Regular provision of support and training to undergraduates, visiting students and work placements at Reading University and King’s College London

## Professional activities

2019-                Board member of the International Association for Urban Climate (elected)

2019-                IAUC Awards Committee chair

2016-                Urban Projects editor, International Association for Urban Climate newsletter

2014-2015        JULES Science and Applications Committee member and vice-chair

## Journals refereed

Agricultural and Forest Meteorology (2012); Atmospheric Chemistry and Physics (2016, 2016); Atmospheric Environment (2017); Atmospheric Measurement Techniques (2014, 2015); Biogeosciences (2016); Boundary-Layer Meteorology (2011, 2012, 2014, 2014); International Journal of Climatology (2017, 2017, 2017, 2018); Journal of Atmospheric and Oceanic Technology (2012, 2012, 2013); Meteorologische Zeitschrift (2012, 2013); Meteorology and Atmospheric Physics (2012, 2017); Wetlands (2016)

## Awards and scholarships

Board of the Austrian Science Fund (FWF) Lise Meitner fellowship (2017-2019)

Innsbruck University Research stipend (support for scientific purposes) (2017)

NERC Algorithm PhD studentship (2009-2012) + additional 6 months' funding (2013)

Oxford University Lincoln College Scholarship 2008

Oxford University Lincoln College Exhibition 2007

Oxford University Lincoln College Exhibition 2006