

# Andrew Tedstone

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**Research interests** Ice sheet and glacier mass balance, hydrology, albedo and dynamics, in connection to responses to climate change.

**Employment** *Department of Geosciences, Université de Fribourg*, Switzerland.  
Aug 2019–. Senior Researcher.  
Firn hydrology and mapping the runoff limit of the Greenland Ice Sheet.  
*School of Geographical Sciences, University of Bristol*, UK.  
Jan 2016–Dec 2019. Research Associate.  
Quantifying changes in Greenland Ice Sheet albedo and runoff.

**Education** *School of GeoSciences, University of Edinburgh*, UK.  
2011–2015. Ph.D. Hydrological controls on Greenland Ice Sheet motion.  
Funded by the Natural Environment Research Council (NERC), UK.  
Award conferred 26 November 2015.  
*Scott Polar Research Institute, University of Cambridge*, UK.  
2010–2011. M.Phil. Polar Studies (with Distinction).  
Thesis: Sediment plumes as indicators of Greenland Ice Sheet runoff.  
Funded by the Fitzwilliam Graduate Scholarship for M.Phil. research.  
*Fitzwilliam College, University of Cambridge*, UK.  
2007–2010. B.A. (now M.A.) Hons. Geography (1<sup>st</sup> Class).  
Dissertation: The subglacial drainage system of Hagafellsjökull-Eystri, Iceland.

**First Author Publications** *Google Scholar profile*: 1172 citations, h-index: 18. (21.08.2020)  
*Tedstone, A.*, J. Cook, C. Williamson, S. Hofer, J. McCutcheon, T. Irvine-Fynn, T. Gribbin & M. Tranter (2020). Algal growth and weathering crust state drive variability in Greenland Ice Sheet ice albedo. **The Cryosphere**. DOI: 10.5194/tc-14-521-2020.  
*Tedstone, A.*, J. Bamber, J. Cook, C. Williamson, X. Fettweis, A. Hodson & M. Tranter (2017). Dark ice dynamics of the south-west Greenland Ice Sheet. **The Cryosphere**. DOI: 10.5194/tc-11-2491-2017.  
*Tedstone, A.*, P. Nienow, A. Dehecq, N. Gourmelen, D. Goldberg & E. Hanna. Decadal slowdown of a land-terminating sector of the Greenland Ice Sheet despite warming (2015). **Nature**, 526, 692–695. DOI: 10.1038/nature15722.  
*Tedstone, A.*, P. Nienow, N. Gourmelen & A. Sole (2014). Greenland Ice Sheet motion insensitive to spatial variations in subglacial hydraulic structure. **Geophys. Res. Lett.**, 41(24), 8910–8917. DOI: 10.1002/2014GL062386.  
*Tedstone, A.*, P. Nienow, A. Sole, D. Mair, T. Cowton, I. Bartholomew & M. A. King (2013). Greenland Ice Sheet motion insensitive to exceptional meltwater forcing. **Proc. Nat. Acad. Sci.**, 110 (49), 19719–19724. DOI: 10.1073/pnas.1315843110.  
*Tedstone, A.* & N. Arnold (2012). Automated remote sensing of sediment plumes for identification of runoff from the Greenland Ice Sheet. **Journal of Glaciology**, 58 (210), 699–712. DOI: 10.3189/2012JoG11J204.

## Co-author Publications

- Williamson, C., J. Cook, **A. Tedstone**, M. Yallop, J. McCutcheon, R. Perkins, E. Poniecka, T. Irvine-Fynn, J. McQuaid, L. Benning, A. Hodson, J. Bamber, M. Tranter & A. Anesio (2020). Glacier algae photophysiology drives darkening and melt of the Greenland Ice Sheet. **Proceedings of the National Academy of Sciences (USA)**. 10.1073/pnas.1918412117.
- Segal, R., R. Scharien, S. Cafarella & **A. Tedstone** (2020). Characterising winter landfast sea ice surface roughness in the Canadian Arctic Archipelago using Sentinel-1 synthetic aperture radar and the Multi-angle Imaging SpectroRadiometer. **Annals of Glaciology**. 10.1017/aog.2020.48.
- Cook, J., **A. Tedstone** and 22 co-authors (2020). Glacier algae accelerate melt rates on the western Greenland Ice Sheet. **The Cryosphere**. DOI: 10.5194/tc-14-309-2020.
- Hofer, S., **A. Tedstone**, X. Fettweis & J. Bamber (2019). Cloud microphysics and circulation anomalies control differences in future Greenland melt. **Nature Climate Change**. 10.1038/s41558-019-0507-8.
- Holland, A., C. Williamson, F. Sgouridis, **A. Tedstone**, J. McCutcheon, J. Cook, E. Poniecka, M. Yallop, M. Tranter & A. Anesio (2019). Dissolved organic nutrients dominate melting surface ice of the Dark Zone (Greenland Ice Sheet). **The Cryosphere**. DOI: 10.5194/bg-16-3283-2019.
- Dukhovskoy, D., I. Yashayaev, A. Proshutinsky, J. Bamber, I. Bashmachnikov, E. Chassignet, C. Lee & **A. Tedstone** (2019). Role of Greenland Freshwater Anomaly in the Recent Freshening of the Subpolar North Atlantic. **Journal of Geophysical Research: Oceans**. DOI: 10.1029/2018JC014686.
- Lamarche-Gagnon, G., J. Wadham, B. Sherwood Lollar, S. Arndt, P. Fietzek, A. Beaton, **A. Tedstone**, J. Telling, E. Bagshaw, J. Hawkings, T. Kohler, J. Zarsky, M. Mowlem, A. Anesio and M. Stibal (2019). Greenland melt drives continuous export of methane from its bed. **Nature**. DOI: 10.1038/s41586-018-0800-0.
- Hawkings, J., J. Hatton, K. Hendry, G. De Souza, J. Wadham, R. Ivanovic, T. Kohler, M. Stibal, A. Beaton, G. Lamarche-Gagnon, **A. Tedstone**, M. Hain, E. Bagshaw, J. Pike and M. Tranter (2018). The global silicon cycle impacted by past ice sheets. **Nature Communications**. DOI: 10.1038/s41467-018-05689-1.
- Bamber, J., **A. Tedstone**, A. Proshutinsky, D. Dukhovskoy, E. Enderlin, I. Howat, M. King, B. Noel and M. van den Broeke (2018). Land ice budget of the Arctic and North Atlantic Oceans. Part I: Data, methods and results. **Journal of Geophysical Research: Oceans**. DOI: 10.1002/2017JC013605.
- Williamson, C., A. Anesio, J. Cook, **A. Tedstone**, E. Sypianska, A. Holland, D. Fagan, M. Tranter, X. Fettweis and M. Yallop (2018). Ice algal bloom development on the surface of the Greenland Ice Sheet. **FEMS Microbiology Ecology**. DOI: 10.1093/femsec/fiy025.
- Cook, J., A. Hodson, A. Gardner, M. Flanner, **A. Tedstone**, C. Williamson, T. Irvine-Fynn, J. Nilsson, R. Bryant & M. Tranter (2017). Quantifying bioalbedo: A new physically-based model and critique of empirical methods for characterizing biological influence on ice and snow albedo. **The Cryosphere**. DOI: 10.5194/tc-11-2611-2017.
- Hofer, S., **A. Tedstone**, X. Fettweis & J. Bamber (2017). Decreasing cloud cover drives the recent mass loss on the Greenland ice sheet. **Science Advances**. DOI: 10.1126/sciadv.17005844.
- Kohler, T., J. Žárský, J. Yde, G. Lamarche-Gagnon, J. Hawkings, **A. Tedstone**, J. Wadham, J. Box, A. Beaton & M. Stibal (2017). Carbon dating reveals a seasonal

- progression in the source of particulate organic carbon exported from the Greenland Ice Sheet. **Geophysical Research Letters**. DOI: 10.1002/2017GL073219.
- Musilova, M., M. Tranter, J. Wadham, J. Telling, A. **Tedstone** & A.M. Anesio (2017). Microbially driven export of labile organic carbon from the Greenland ice sheet. **Nature Geoscience**. DOI: 10.1038/ngeo2920.
- Linhoff, B., M. Charette, P. Nienow, J. Wadham, A. **Tedstone** & T. Cowton (2017). Utility of  $^{222}\text{Rn}$  as a passive tracer of subglacial distributed system drainage. **Earth and Planetary Science Letters**. DOI: 10.1016/j.epsl.2016.12.039.
- Hawkings, J., J. Wadham, L. Benning, K. Hendry, M. Tranter, A. **Tedstone**, P. Nienow & R. Raiswell (2017). Ice sheets as a missing source of silica to the polar oceans. **Nature Communications**. DOI:10.1038/ncomms14198.
- Wadham, J., J. Hawkings, J. Telling, D. Chandler, J. Alcock, E. O'Donnell, P. Kaur, E. Bagshaw, M. Tranter, A. **Tedstone** & P. Nienow (2016). Sources, cycling and export of nitrogen on the Greenland Ice Sheet. **Biogeosciences**. DOI: 10.5194/bg-13-6339-2016.
- de Fleurian, B., M. Morlighem, H. Seroussi, E. Rignot, M. R. van den Broeke, P. K. Munneke, J. Mouginot, P. C. J. P. Smeets & A. **Tedstone** (2016). A modeling study of the effect of runoff variability on the effective pressure beneath Russell Glacier, West Greenland. **Journal of Geophysical Research: Earth Surface**. DOI: 10.1002/2016JF003842.
- Hawkings, J., J. Wadham, M. Tranter, J. Telling, E. Bagshaw, A. Beaton, S-L. Simmons, D. Chandler, A. **Tedstone** and P. Nienow (2016). The Greenland Ice Sheet as a hotspot of phosphorus weathering and export in the Arctic. **Global Biogeochemical Cycles**. DOI: 10.1002/2015GB005237.
- Hawkings, J., J. Wadham, M. Tranter, E. Lawson, A. Sole, T. Cowton, A. **Tedstone**, I. Bartholomew, P. Nienow and D. Chandler (2015). The effect of a warming climate on nutrient and solute export from the Greenland Ice Sheet. **Geochemical Perspectives Letters**, 1, 94-104. DOI: 10.7185/geochemlet.1510.
- Hawkings, J., J. Wadham, M. Tranter, R. Raiswell, L. Benning, P. Statham, A. **Tedstone**, P. Nienow, K. Lee & J. Telling (2014). Ice sheets as a significant source of highly reactive nanoparticulate iron to the oceans. **Nat. Comm.**, 5, 3929. DOI: 10.1038/ncomms4929.
- Sole, A., P. Nienow, I. Bartholomew, D. Mair, T. Cowton, A. **Tedstone**, & M. King (2013). Winter motion mediates dynamic response of the Greenland Ice Sheet to warmer summers. **Geophys. Res. Lett.**, 40, 3940–3944. DOI: 10.1002/grl.50764.

## Skills

**Scientific Programming:** Python, FORTRAN, bash, MATLAB. Git version-control. Super-computer deployments.

**Geospatial data analysis:** Automated processing of big environmental data, particularly from satellites (MODIS, Landsat, Sentinel-2, UAV missions, MISR, feature tracking), GDAL, QGIS, ESA SNAP, Kinematic GPS processing (TEQC/TRACK), AgiSoft PhotoScan, automated processing chains, lab-based sensor calibrations, climate simulations using the Modèle Atmosphérique Régionale (MAR).

**IT:** Unix, Windows, Office,  $\text{\LaTeX}$ , vector and raster image editing, Dask, VirtualBox, Vagrant.

**Fieldwork:** In brief: development and maintenance of autonomous logging of ice motion and firn properties. Multi-spectral and ortho-photo UAV flight missions.

Hyper-spectral field spectroscopy. River discharge gauging. Experienced in field leadership and logistics.

**Languages:** English (native), French (DELF A2/B1).

## Recent Presentations

MAR Model Users Workshop, Feb 2020, Paris. *Talk: Incorporating glacier algae and weathering crust processes into MAR's bare ice albedo scheme.*

European Association of Remote Sensing Laboratories Land Ice and Snow Workshop, Feb 2020, Bern. *Poster: Fusion of multispectral UAV acquisitions with Sentinel-2 measurements to examine Greenland Ice Sheet albedo.*

European Space Agency Living Planet Symposium, May 2019, Milan. *Poster: Fusion of multispectral UAV acquisitions with Sentinel-2 measurements to examine Greenland Ice Sheet albedo.*

European Geophysical Union General Assembly, April 2019, Vienna. *Poster: Modelling algal growth and its impact upon Greenland Ice Sheet melting.*

University of Edinburgh GeoSciences, March 2019. *Invited talk: Greenland Ice Sheet Melting and Darkening.*

International Glaciological Society British Branch Meeting, September 2018. *Talk: Assessing the impact of bio-albedo upon Greenland Ice Sheet melting.*

European Geophysical Union General Assembly, April 2018, Vienna. *Talks: (1) Assessing the impact of bio-albedo upon Greenland Ice Sheet melting; (2) Land Ice Contribution to the Fresh Water Budget of the Arctic and North Atlantic Oceans.*

Natural Environment Research Council, Swindon, November 2017. *Talk: How do we measure bio-albedo?*

Indo-UK workshop on Bio-climatic Feedbacks of Melting Himalayan Ice, JNU, New Delhi, September 2017. *Talk: Bio-albedo of Ice: Earth Observation and Modelling.*

Data Intensive Research in Environment: Challenges and Opportunities for the GW4 Alliance, University of Exeter, May 2017. *Talk: Challenges in projecting the sea level rise contribution of the Greenland Ice Sheet.*

AGU Fall Meeting, San Francisco, December 2016. *Talk: Physical controls on dark ice presence in south-west Greenland.*

## Funding

PI. of Swiss Polar Institute Exploratory Grant, 'HI-SLIDE'. CHF 35,000. 2020-22.

Marie Skłodowska-Curie Actions Individual Global Fellowship, 'IceMelt3D'.

€ 231,191.36. Score: 97.8%, funding threshold: 92.6%. February 2019. *I did not pursue this Action owing to uncertainty in funding continuity following the UK's exit from the EU.*

Scottish Alliance for Geoscience, Environment and Society (SAGES). Postdoctoral and Early Career Researcher Exchange program, to Université de Savoie, Annecy, France. £2,375. 2014.

SAGES Theme 3 Research Support. £200. 2014.

SAGES Theme 1 Research Enabling Funding for Conference Support. £220. 2013.

University of Edinburgh Club of Toronto (EDUCT) Geography Fund. £360. 2013.

University of Edinburgh Mackay Greenland Fund. £600. 2013.

University of Edinburgh Moss Scholarship. £5,000. 2012.

Natural Environment Research Council PhD studentship. £68,000. 2011.

Undergraduate dissertation research – £1,200 from various funding sources. 2009.

- Teaching** *Research Student Supervision:* **S. Hofer** (*M.Res.*, then *Ph.D.*, 2016–2019); **N. Jullien** (*Ph.D.*, 2019–, as lead); **N. Clerx** (*PhD*, 2019–); **T. Gribbin** (*BSc* dissertation 2018); **F. Baldacchino** (*MSc* dissertation 2018); **R. Pappas** (undergraduate from Montana State University, USA - term project in remote sensing).
- Fundamentals of Glaciology:* Wrote and delivered two lectures on subglacial hydrology and dynamics for 2<sup>nd</sup> year undergraduates at the University of Bristol, 2017, 2018 and 2019.
- Scientific Computing for Geosciences:* 1-day geospatial programming course (March 2020) for new Ph.D students at the University of Fribourg. 3-day course (October 2016) for new Ph.D students at the University of Bristol. Python, Git, Unix, server-based computing.
- Tutoring and Demonstrating:* ~200 hours of contact time. Geomorphology (including GIS practicals), 2012–15; Environment Sensitivity and Change, 2011–2012; Plotting in Python, 2012; Quantitative Methods in Geography, 2011. Assistant Course Organiser for Geomorphology, 2013–2015, including development of tutorial materials.
- Field:* Experience totalling ~7 weeks. U.Bristol Study and Field Skills (Arolla, Switzerland), 2019. U.Edin. Iceland Undergraduate Elective, 2013, 2014 and 2015 — 10-day intensive field course covering glaciology, geomorphology, tephrochronology and GIS, including co-leadership of the 2014 Elective. Cairngorms, Scotland, short courses 2011, 2013, 2014, 2015 — glacial geomorphology.
- Feedback Award* nominee, Edinburgh University Student Association, 2013.
- Service** *Reviewer* for Proceedings of the National Academy of Sciences (America), Nature Scientific Reports, Journal of Glaciology, Annals of Glaciology, The Cryosphere, Journal of Geophysical Research: Earth Surface, Geoscientific Model Development, Geografiska Annaler.
- Lead Convenor* of EGU General Assembly 2019 session CR5.2 "Advances in measuring and modelling ice sheet and glacier surface mass balance and atmospheric interaction"; Edinburgh GeoSciences Hutton Club seminar series for 2013–14.
- Vice-President* of the Edinburgh GeoSciences GradSchool (2012–2013)  
Co-organiser for the School's annual 3-day conference for 120 delegates.
- Research Group Website* design and development of the Edinburgh Cryosphere website, 2012–2015.
- Vice-President* of Cambridge University Geographical Society (2009–2010).
- Fieldwork Experience** ~9 months experience across ice sheet and alpine glacier environments.
- K-Transect, south-west Greenland* April 2020, postponed to April 2021. Leading the design and installation of 5x firn evolution monitoring sites and 5x GNSS sites to measure ice motion.
- K-Transect, south-west Greenland* July-August 2020. Hydrological and unmanned aerial system measurements of the runoff limit.
- Upernavik, north-west Greenland* July 2018. Surface sampling and reflectance measurements, unmanned aerial surface imaging.
- Himachal Pradesh, Indian Himalayas* September 2017. Bio-climatic characterisation of Chotta Shigri, as part of a Bristol collaboration with Jawaharlal Nehru University.

**South-west Greenland ablation zone** July 2017. Surface reflectance measurements using ASD FieldSpec Spectro-radiometer and unmanned aerial system with multispectral camera.

**Svalbard** March 2017. Unmanned aerial system tests; pingo hydrochemistry sampling for A. Hodson. Undertook UNIS Rifle and Snowmobile training.

**South-west Greenland ablation zone** August 2016. Albedo measurements of the ice sheet surface. Led organisation of field logistics for the 15-person, 6-week campaign consisting of three work packages spread across five institutions. Coordination of several tonnes of outbound freight and multiple helicopter flights.

**Leverett Glacier, south-west Greenland** May 2015: hydrological gauging for the University of Bristol.

**Leverett Glacier, south-west Greenland** May–August 2012 & May 2013: Dye dilution river discharge gauging, ablation measurements and  $SF_6$  gas tracer sampling at a remote ice-marginal field camp. Deployment of differential GPS units, meteorological sensors and time lapse cameras along a 115 km transect.

**Hagafellsjökull-Eystri, Iceland** July–August 2009 (2 weeks). Hydrological measurements (stage, salt dilution gauging and hydrochemistry).

## Impact

**Media Outreach:** Creation of short films for social media networks. Film segments featured in Research Council films. Filmed with BBC News on the Greenland Ice Sheet during July 2017. Contributor to 'Ice Alive' short film, 2018 and to Dark Snow Project video updates, 2017.

**Equal Access:** Developed and delivered lectures and practical workshops for students with no family university background as part of the Lothians Education Access Programme.

**Public Outreach:** Presentation to Swindon University of the Third Age (U3A), July 2019; presentation to Swansea U3A, 2017; Public outreach exhibition at Dynamic Earth, Edinburgh, 2011.

**Geography Ambassador** with the Royal Geographical Society, 2010-2011.

## Awards

SAGES Best Postgraduate Research Paper Prize, 2015 (for **Nature** study).  
Best 3<sup>rd</sup> year presentation, Edinburgh GeoSciences GradSchool Conference, 2014.  
Best Feedback Award nominee, Edinburgh University Student Teaching Awards, 2013.  
Highly Commended in British Hydrological Society Student Dissertation Awards, 2010.  
1912 Senior Scholar, and Cockle Prize recipient, Fitzwilliam College, 2010–2011.

## Ongoing Learning

**Short courses:** Lecturing for Research Staff; Programming with OpenMP; Beginning Fortran; Publishing Research Software; Statistics refresher; How to peer-review research manuscripts for journals; Science communication; Presentation Skills; MATLAB.

**Summer Schools:** Karthaus Course on Glaciers and Ice sheets in the Climate System, September 2014 (Institute for Marine and Atmospheric Research, Utrecht)

## Other Experience

**Web Developer**, NERC E<sup>3</sup> Doctoral Training Partnership. July–September 2015.

**Scout Leader** at Avon District Explorer Scouts (2016–2019), 1<sup>st</sup> Histon Scout Group, Cambridge (2010–2011) and 1<sup>st</sup> Purton & Lydiard Scout Group, Wiltshire (2004–2019, including web and advertising).

***Activities Instructor*** at Bonaly Scout Activity Centre, Edinburgh (2013–2015)

***Technical Director*** for student theatre productions in Cambridge (2007–2010)

***Sales Assistant***, Millets (outdoor equipment retailer) (2006–2010)

Advising customers; covering supervisory duties; occasional store management.