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# Curriculum Vitae

PROF ALBERTO CARRASSI

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## Institutional Address

Department of Physics and Astronomy, University of Bologna, IT

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Webpage @ U Reading: [research.reading.ac.uk/meteorology/people/alberto-carrassi/](http://research.reading.ac.uk/meteorology/people/alberto-carrassi/)

Webpage @ U Bologna: [www.unibo.it/sitoweb/alberto.carrassi/](http://www.unibo.it/sitoweb/alberto.carrassi/)

## Other Current Affiliations and Roles

- Associate Professor at *Dept of Physics and Astronomy - University of Bologna, IT* (50% appointed)
- Professor at the *Dept of Meteorology - University of Reading, UK* (50% appointed)

## Academic Education

2005 PhD, Physics, University of Ferrara, Italy; Title: *Geophysical Data Analysis: A Dynamically Based Assimilation Method*; grade “Ottimo”.

2001 MCs, Physics, University of Ferrara, Italy; Title: *Local Lyapunov vectors and dimension of the Lorenz attractor*; grade 110/110.

## Employment history

01 Nov 2021 – Present *Full Professor*, Dept of Meteorology, University of Reading, UK. (50% appointed)

18 Nov 2019 – 30 Oct 2021 *Full Professor*, Dept of Meteorology, University of Reading, UK.

01 Aug 2019 – 30 Oct 2021 *Full Professor*, Mathematical Institute, Utrecht University, NL (20% appointed).

10/05/2014 – 17/11/2019 *Senior Researcher*, Nansen Environmental and Remote Sensing Center, NO.

01/09/2018 – 15/11/2019 *Associate Professor*, Geophysical Institute, University of Bergen, NO (20% appointed).

01/02/2012 – 09/05/2014 *Researcher* (Marie Curie Fellow), Barcelona Supercomputing Centre, SP.

2011 1 year career break for world travelling.

01/03/2007 – 01/04/2011 *Postdoc*, Royal Meteorological Institute, BE.

2006 *Postdoc*, Laboratoire de Meteorologie Dynamique, Paris, FR.

2005-2006 *Postdoc*, Istituto di Fisica dell'Atmosfera e del Clima, IT.

## Institutional responsibilities

18/11/2019 – 30 Oct 2021 *Divisional Director* for Data Assimilation at National Centre for Earth Observations, UK.

18/11/2019 – 30 Oct 2021 *Director* of the Data Assimilation Research Centre (DARC), UK.

01/01/2016 – 17/11/2019 *Co-leader* of the Data Assimilation group at the Nansen Centre, NO.

## Teaching

2022 – Data assimilation in dynamical systems (52 hrs). MSc Earth System Physics. University of Bologna, IT

2020 – 2021 DARC-ECMWF intensive data assimilation training course, University of Reading, UK

2018 – 2019 Short course on *Data assimilation* (2 hrs; co-taught) at European Geoscience Union General Assembly

2017 – 2018 Graduate course on *Data assimilation* (48 hrs), Dept Mathematics, University of Bergen, NO

2005 – 2008 Under-/Graduate course on *Dynamic meteorology* (60 hrs), Dept Physics, University of Ferrara, IT

2006 Graduate course on *Numerical methods for ODE and PDE* (40 hrs), Dept Physics, University of Ferrara, IT

Lectures at several international schools on *Data Assimilation* and *Dynamical Systems*.

## Selected Honours

2022 *Nonlinear Processes in Geophysics* paper of month (April)

2016 Iktpluss Excellence Research Grant for Big-Data Science, Norwegian Research Council for the project REDDA

2015 Trophée Big Data Paris.

2011 Awarded with the IEF Marie Curie grant.

## Supervision

10 postdoctoral fellows (2016-) / 6 PhD students (2017-) / 6 master students (2006-).

## Selected competitive Funding (Role/Funding Agency/Title/Budget)

- 2021 – 2027 **PI** (one of 5) / VESRI-Schmit foundation / *SASIP* / 10,5MUS\$ of which 1,3MUS\$ to my group  
 2019 – 2022 **Member** / Belgian Scientific Council / *EODAHR* / 250K€  
 2018 – 2020 **PI** / Norwegian Research Council / *GeoML* / 280K€  
 2018 – 2021 **PI** / US Office of Naval Research / *DASIM II* / 520KUS\$  
 2020 **PI** / CIMPA research school / *Mathematics of Climate* / 25K€  
 2018 – 2021 **WP-Leader** / Norwegian Research Council / *Bjerknes Climate Center* / 3M€ of which 0,4M€ to my group  
 2016 – 2020 **PI** / Norwegian Research Council Excellence Individual Grant / *REDDA* / 1,1M€.  
 2016 – 2018 **PI** / Nordic Countries Research Council / *EmblAUS* / 200K€.  
 2015 – 2018 **PI** (one of 3) / French National Research Agency / *DADA* / 155K€.  
 2016 – 2017 **PI** / US Office of Naval Research / *DASIM I* / 120KUS\$  
 2012 – 2014 **PI** / Individual Marie Curie Grant / *INCLIDA* / 160K€.

### Selected invited presentations at Workshops, Conferences and Schools

- 2022 Short-course on Data Assimilation. Imperial College, London, UK  
 WS: Challenges and Benchmarks for quantitative AI in Complex Fluids and Complex Flows. Rome, IT  
 WS: Machine learning and uncertainties in climate simulation. Brest, FR  
 WS: Data Assimilation – Mathematical Foundation and Applications. Oberwolfach, DE
- 2021 SIAM Conference on Computational Science and Engineering, Forth Worth, TX, USA  
 EnKF International Workshop, Bergen, NO  
 SIAM Conference on Application of Dynamical Systems, Portland, USA
- 2020 ECMWF-ESA Workshop on Machine Learning for Earth System, Reading, UK  
 UKRI Workshop on Data Assimilation and Uncertainty Quantification at the exascale, UK  
 Data Assimilation – Mathematical foundation and applications. Oberwolfach, DE  
 US Navy Research Lab Workshop on Atmospheric Data Assimilation, Monterrey, USA
- 2019 Summer School on DA for ocean, hydrology, risk & safety and reservoir. Timisoara, RO  
 ICIAM 2019, Valencia, SP  
 UK MetOffice Next generation modelling workshop. Reading, UK  
 London Mathematical Society Research School: Mathematics of Climate. London, UK  
 EGU 2019 – Solicited talk - Mathematics of planet Earth. Vienna, AT  
 International Symposium on Data Assimilation, Kobe, JP
- 2018 Workshop on Statistical inference in weather and climate science. Lorentz Centre, NL  
 IUGG 2019 Conference on mathematical geophysics. Nizhny Novgorod, RU  
 Workshop on Prediction and data assimilation for non-local diffusion. ICMS, Edinburgh, UK  
 SIAM Conference on uncertainty quantification. Garden Grove, USA
- 2017 SIAM Conference on mathematical and computational issues in the geoscience. Erlangen, DE  
 SAMSI opening keynote. University of North Carolina in Chapel Hill, USA  
 Summer School on DA for ocean, hydrology, risk & safety and reservoir. Sibiu, RO  
 CERFACS Avenue project workshop, Toulouse, FR  
 Workshop - Emerging Applications of Data Assimilation in the Geosciences, Lorentz Center, NL
- 2016 Winter School in Operational Oceanography, Indian Ocean Information Services, Hyderabad, IN  
 Mathematical Aspects of Data Assimilation in the Geosciences, Oberwolfach, DE  
 Workshop on Uncertainty and Causality Assessment in Extreme and Rare Events, Boulder, USA  
 Workshop on Computational and Applied Mathematics: ocean science and medicine, Bergen, NO
- 2015 Workshop on Stochastic GFD, data assimilation, and non-equilibrium phenomena, ICL, UK  
 Workshop on Nonlinear Dynamics, Extremes and Predictability of the Earth System, Hamburg, DE  
 Les Houches Ensemble data assimilation workshop, Les Houches, FR  
 EPSRC Centre for Doctoral Training - Mathematics of Planet Earth, ICL & UoR, UK
- 2014 Workshop on Advances in Climate Theory, Meteorological Institute, Brussels, BE  
 Conference on Nonlinear Filtering and Data Assimilation, ICTS, Bangalore, IN
- 2013 1-Day Focus Workshop on Data Assimilation, University of North Carolina, USA  
 Workshop on Mathematical Paradigms of Climate Science, INAM, Rome, IT
- 2012 Conference on Mathematical Aspects of Atmosphere-Ocean Data Assimilation, Oberwolfach, DE  
 Conference: Exploring Data Assimilation for Detection and Attribution, Buenos Aires, AR
- 2011 Solicited talk at AGU Fall Meeting, San Francisco, USA  
 Workshop - CLIMAQS Data Assimilation in Atmospheric Models, Antwerp, BE
- 2010 Workshop: The complexity paradigm - the dynamics of weather and climate, Brussels, BE  
 Workshop - Exploring Complex Dynamics in High-Dimensional Chaotic Systems, Dresden, DE
- 2009 1-Day workshop - Lyapunov analysis, form theory to geophysical application, Paris, FR

### Selection of recently/forthcoming organised events

<u>2021</u>	CIMPA School: Mathematics of Climate Science. Kigali, RW Summer School on Data Assimilation and Machine Learning, Utrecht, NL
<u>2019</u>	SIAM Conference on applications of dynamical systems, Snowbird, USA Workshop Big Data, Data Assimilation and Uncertainty Quantification, IHP Paris, FR
<u>2016, 2018</u>	International Crash Course on Data Assimilation. Bergen, NO (2 editions)
<u>2016-2019</u>	International Annual EnKF workshop. Different locations, NO (4 editions)
<u>2015-2020</u>	EGU Session NP5.1 on Data assimilation and inverse problems. Vienna, AT (6 editions)
<u>2017</u>	Predictability and data assimilation in weather. The legacy of Anna Trevisan. Bologna, IT EGU Session IE1.1/CR1.14/AS4.21/BG9.66 on Atmosphere-cryosphere interaction. Vienna, AT
<u>2016</u>	School in Operational Oceanography. Indian Ocean Information Services, Hyderabad, IN 5 <sup>th</sup> International Conference on Data Analysis and Modelling in Earth Science, Hamburg, DE Office of Naval Research workshop Mathematical Issues in Sea-Ice Modelling, Bergen, NO
<u>2015</u>	Mini-Symposium Nonlinear dynamical aspects of data assimilation, Exeter, UK
<u>2012</u>	Workshop Data Assimilation and Post-Processing for Weather and Climate. Barcelona, SP
<u>2010</u>	Workshop Instabilities properties of regional models, Brussels, BE

### Commissions of trust

- 2021 – Steering committee member of the [Centre for Mathematics of Planet Earth](#) of the University of Reading (UK)
- 2021 – External Advisory Board member of the ERC Synergy “STUOD”. [STUOD/EAB](#)
- 2021 – Co-Lead editor for *Combined machine learning and data assimilation for the atmosphere and ocean sciences*, a special collection of the *Quarterly Journal of the Royal Meteorological Society*.
- 2019 – Associate Editor, *Monthly Weather Review*.
- 2018 – Topical Editor, *Frontiers in Applied Mathematics and Statistics*.
- 2017 – Editor, *Nonlinear Processes in Geophysics*.
- Reviewer for many journals and for funding agencies (e.g. US-NSF, EU-CMEMS, FR-ANR, UK-NERC, BE-BELSP0, AR-CONICET).
- External examiners in PhD committees: 12.

### Bibliometry (as per Mar 30, 2022)

Author of 50 papers in international peer-reviewed journals and 4 chapters in collective peer-reviewed volumes.  
Cited 1670 times in google scholar. H-index of 25 and i10-index of 39.  
[ORCID account](#)

### Manuscripts under review:

- Ayers, D., J. Lau, J. Amezcua, A. Carrassi and V. Ojha: Supervised machine learning to estimate instabilities in chaotic systems: estimation of local Lyapunov exponents. *Q. J. Roy. Met. Soc.* in review 2022. Available [here](#)
- Scheffler, G. and Carrassi, A., and Ruiz, J., and Pulido, M.: Dynamical effects of inflation in ensemble-based data assimilation under the presence of model error. *Q. J. Roy. Met. Soc.* in review 2022.

### Publications:

- [1] A. Carrassi, M. Bocquet, J. Demaeyer, C. Grudzien, P. Raanes, and S. Vannitsem. *Data Assimilation for Chaotic Dynamics*, pages 1–42. Springer International Publishing, Cham, 2022.
- [2] F. J. Schevenhoven and A. Carrassi. Training a supermodel with noisy and sparse observations: a case study with cpt and the synch rule on speedo - v.1. *Geoscientific Model Development Discussions*, 2021:1–23, 2021.
- [3] C. Sampson, A. Carrassi, A. Aydoğdu, and C. K. Jones. Ensemble kalman filter for nonconservative moving mesh solvers with a joint physics and mesh location update. *Quarterly Journal of the Royal Meteorological Society*, 147(736):1539–1561, 2021.
- [4] G. Evensen, J. Amezcua, M. Bocquet, A. Carrassi, A. Farchi, A. Fowler, P. Houtekamer, C. Jones, R. de Moraes, M. Pulido, A. Sampson, and F. Vossepoel. An international initiative of predicting the sars-cov-2 pandemic using ensemble data assimilation. *Foundations of Data Science*, 3(3):413–477, 2021.
- [5] Y. Chen, A. Carrassi, and V. Lucarini. Inferring the instability of a dynamical system from the skill of data assimilation exercises. *Nonlinear Processes in Geophysics*, 28(4):633–649, 2021.
- [6] J. Brajard, A. Carrassi, M. Bocquet, and L. Bertino. Combining data assimilation and machine learning to infer unresolved scale parametrization. *Philosophical Transactions of the Royal Society A*, 379(2194):20200086, 2021.

- [7] M. Bonavita, R. Arcucci, A. Carrassi, P. Dueben, A. J. Geer, B. Le Saux, N. Long  p  , P.-P. Mathieu, and L. Raynaud. Machine learning for earth system observation and prediction. *Bulletin of the American Meteorological Society*, 102(4):E710–E716, 2021.
- [8] M. Tondeur, A. Carrassi, S. Vannitsem, and M. Bocquet. On temporal scale separation in coupled data assimilation with the ensemble kalman filter. *Journal of Statistical Physics*, 179:1161–1185, 2020.
- [9] P. Tandeo, P. Ailliot, M. Bocquet, A. Carrassi, T. Miyoshi, M. Pulido, and Y. Zhen. A review of innovation-based methods to jointly estimate model and observation error covariance matrices in ensemble data assimilation. *Monthly Weather Review*, 148(10):3973–3994, 2020.
- [10] C. Grudzien, M. Bocquet, and A. Carrassi. On the numerical integration of the lorenz-96 model, with scalar additive noise, for benchmark twin experiments. *Geoscientific Model Development*, 13(4):1903–1924, 2020.
- [11] S. Cheng, A. Aydođdu, P. Rampal, A. Carrassi, and L. Bertino. Probabilistic forecasts of sea ice trajectories in the arctic: Impact of uncertainties in surface wind and ice cohesion. *Oceans*, 1(4):326–342, 2020.
- [12] J. Brajard, A. Carrassi, M. Bocquet, and L. Bertino. Combining data assimilation and machine learning to emulate a dynamical model from sparse and noisy observations: A case study with the lorenz 96 model. *Journal of Computational Science*, 44:101171, 2020.
- [13] M. Bocquet, J. Brajard, A. Carrassi, and L. Bertino. Bayesian inference of chaotic dynamics by merging data assimilation, machine learning and expectation-maximization. *Foundations of Data Science*, 2(1):55–80, 2020.
- [14] F. Schevenhoven, F. Selten, A. Carrassi, and N. Keenlyside. Improving weather and climate predictions by training of supermodels. *Earth System Dynamics*, 10(4):789–807, 2019.
- [15] P. N. Raanes, M. Bocquet, and A. Carrassi. Adaptive covariance inflation in the ensemble kalman filter by gaussian scale mixtures. *Quarterly Journal of the Royal Meteorological Society*, 145(718):53–75, 2019.
- [16] S. Metref, A. Hannart, J. Ruiz, M. Bocquet, A. Carrassi, and M. Ghil. Estimating model evidence using ensemble-based data assimilation with localization—the model selection problem. *Quarterly Journal of the Royal Meteorological Society*, 145(721):1571–1588, 2019.
- [17] M. Bocquet, J. Brajard, A. Carrassi, and L. Bertino. Data assimilation as a learning tool to infer ordinary differential equation representations of dynamical models. *Nonlinear Processes in Geophysics*, 26(3):143–162, 2019.
- [18] A. Aydođdu, A. Carrassi, C. T. Guider, C. K. T. Jones, and P. Rampal. Data assimilation using adaptive, non-conservative, moving mesh models. *Nonlinear Processes in Geophysics*, 26(3):175–193, 2019.
- [19] J.-I. Yano, M. Z. Ziemiański, M. Cullen, P. Termonia, J. Onvlee, L. Bengtsson, A. Carrassi, R. Davy, A. Deluca, S. L. Gray, et al. Scientific challenges of convective-scale numerical weather prediction. *Bulletin of the American Meteorological Society*, 99(4):699–710, 2018.
- [20] M. Rabatel, P. Rampal, A. Carrassi, L. Bertino, and C. K. Jones. Impact of rheology on probabilistic forecasts of sea ice trajectories: application for search and rescue operations in the arctic. *The Cryosphere*, 12(3):935–953, 2018.
- [21] M. Pulido, P. Tandeo, M. Bocquet, A. Carrassi, and M. Lucini. Stochastic parameterization identification using ensemble kalman filtering combined with maximum likelihood methods. *Tellus A*, 70(1):1442099, 2018.
- [22] C. Grudzien, A. Carrassi, and M. Bocquet. Chaotic dynamics and the role of covariance inflation for reduced rank kalman filters with model error. *Nonlinear Processes in Geophysics*, 25(3):633–648, 2018.
- [23] C. Grudzien, A. Carrassi, and M. Bocquet. Asymptotic forecast uncertainty and the unstable subspace in the presence of additive model error. *SIAM/ASA Journal on Uncertainty Quantification*, 6(4):1335–1363, 2018.
- [24] A. Carrassi, M. Bocquet, L. Bertino, and G. Evensen. Data assimilation in the geosciences: An overview of methods, issues, and perspectives. *Wiley Interdisciplinary Reviews: Climate Change*, 9(5):e535, 2018.
- [25] K. S. Gurumoorthy, C. Grudzien, A. Apte, A. Carrassi, and C. K. Jones. Rank deficiency of Kalman error covariance matrices in linear time-varying system with deterministic evolution. *SIAM J. Control Optim.*, 55(2):741–759, 2017.
- [26] A. Carrassi, M. Bocquet, A. Hannart, and M. Ghil. Estimating model evidence using data assimilation. *Q J Roy. Meteor. Soc.*, 143(703):866–880, 2017.
- [27] M. Bocquet, K. S. Gurumoorthy, A. Apte, A. Carrassi, C. Grudzien, and C. K. Jones. Degenerate Kalman filter error covariances and their convergence onto the unstable subspace. *SIAM/ASA J. Uncertainty Quantification*, 5(1):304–333, 2017.
- [28] M. Bocquet and A. Carrassi. Four-dimensional ensemble variational data assimilation and the unstable subspace. *Tellus A*, 69(1):1304504, 2017.
- [29] D. Pazo, A. Carrassi, and J. Lopez. Data assimilation by delay-coordinate nudging. *Q J Roy. Meteor. Soc.*, 142:1290–1299, 2016.

- [30] A. Hannart, A. Carrassi, M. Bocquet, M. Ghil, P. Naveau, M. Pulido, J. Ruiz, and P. Tandeo. DADA: data assimilation for the detection and attribution of weather and climate-related events. *Climatic Change*, 136(2):155–174, 2016.
- [31] A. Carrassi and S. Vannitsem. Deterministic treatment of model error in geophysical data assimilation. In *Mathematical Paradigms of Climate Science*, pages 175–213. Springer, 2016.
- [32] A. Carrassi, V. Guemas, F. Doblas-Reyes, D. Volpi, and M. Asif. Sources of skill in near-term climate prediction: generating initial conditions. *Clim. Dyn.*, 47(12):3693–3712, 2016.
- [33] R. J. Weber, A. Carrassi, and F. J. Doblas-Reyes. Linking the anomaly initialization approach to the mapping paradigm: a proof-of-concept study. *Mon. Weather Rev.*, 143(11):4695–4713, 2015.
- [34] P. N. Raanes, A. Carrassi, and L. Bertino. Extending the square root method to account for additive forecast noise in ensemble methods. *Mon. Weather Rev.*, 143:3857–3873, 2015.
- [35] L. Mitchell and A. Carrassi. Accounting for model error due to unresolved scales within ensemble kalman filtering. *Quarterly Journal of the Royal Meteorological Society*, 141(689):1417–1428, 2015.
- [36] A. Carrassi, R. Weber, V. Guemas, F. Doblas-Reyes, M. Asif, and D. Volpi. Full-field and anomaly initialization using a low-order climate model: a comparison and proposals for advanced formulations. *Nonlinear Proc. Geoph.*, 21(2):521–537, 2014.
- [37] L. Palatella, A. Carrassi, and A. Trevisan. Lyapunov vectors and assimilation in the unstable subspace: theory and applications. *J. Phys. A: Math. Theor.*, 46:254020, 2013.
- [38] A. Carrassi, R. Hamdi, P. Termonia, and S. Vannitsem. Short time augmented extended Kalman filter for soil analysis: a feasibility study. *Atmos. Sci. Lett.*, 13(4):268–274, 2012.
- [39] A. Carrassi and S. Vannitsem. Treatment of the error due to unresolved scales in sequential data assimilation. *International Journal of Bifurcation and Chaos*, 21(12):3619–3626, 2011.
- [40] A. Carrassi and S. Vannitsem. State and parameter estimation with the extended Kalman filter: an alternative formulation of the model error dynamics. *Q J Roy. Meteor. Soc.*, 137(655):435–451, 2011.
- [41] A. Carrassi and S. Vannitsem. Accounting for model error in variational data assimilation: A deterministic formulation. *Mon. Weather Rev.*, 138:3369–3386, 2010.
- [42] S.-C. Yang, M. Corazza, A. Carrassi, E. Kalnay, and T. Miyoshi. Comparison of local ensemble transform Kalman filter, 3DVAR, and 4DVAR in a quasigeostrophic model. *Mon. Weather Rev.*, 137(2):693–709, 2009.
- [43] F. Porcu and A. Carrassi. Toward an estimation of the relationship between cyclonic structures and damages at the ground in europe. *Natural Hazards and Earth System Sciences*, 9(3):823–829, 2009.
- [44] A. Carrassi, S. Vannitsem, D. Zupanski, and M. Zupanski. The maximum likelihood ensemble filter performances in chaotic systems. *Tellus A*, 61:587–600, 2009.
- [45] A. Carrassi, S. Vannitsem, and C. Nicolis. Model error and sequential data assimilation: A deterministic formulation. *Q J Roy. Meteor. Soc.*, 134:1297–1313, 2008.
- [46] A. Carrassi, A. Trevisan, L. Descamps, O. Talagrand, and F. Uboldi. Controlling instabilities along a 3DVar analysis cycle by assimilating in the unstable subspace: a comparison with the EnKF. *Nonlinear Proc. Geoph.*, 15:503–521, 2008.
- [47] A. Carrassi, M. Ghil, A. Trevisan, and F. Uboldi. Data assimilation as a nonlinear dynamical systems problem: Stability and convergence of the prediction-assimilation system. *Chaos*, 18:023112, 2008.
- [48] F. Porcù, A. Carrassi, C. M. Medaglia, F. Prodi, and A. Mugnai. A study on cut-off low vertical structure and precipitation in the mediterranean region. *Meteorology and Atmospheric Physics*, 96(1-2):121–140, 2007.
- [49] A. Carrassi, A. Trevisan, and F. Uboldi. Adaptive observations and assimilation in the unstable subspace by breeding on the data-assimilation system. *Tellus A*, 59:101–113, 2007.
- [50] F. Uboldi, A. Trevisan, and A. Carrassi. Developing a dynamically based assimilation method for targeted and standard observations. *Nonlinear Processes in Geophysics*, 12(1):149–156, 2005.