

CURRICULUM VITAE

Richard Justin Orford Small

QUALIFICATIONS

PhD from National Oceanography Centre (formerly Southampton Oceanography Centre), 2000

‘The refraction, shoaling and structure of non-linear internal waves at a continental shelf margin’, supervised by Professor Steve Thorpe

MSc (Distinction) in Meteorology, from Reading University, 1990

‘Mid-Latitude Storm Tracks in the Northern Hemisphere’, supervised by Professor Brian Hoskins

BSc (Hons) 2.1 in Mathematics, from Nottingham University, 1988

EMPLOYMENT

National Center for Atmospheric Research, Boulder, CO, USA,

June 2010 to present

Project Scientist, Oceanography Group. Working on air-sea interaction processes in high resolution models. Two different projects are underway to investigate the potential improvements to global climate models when mesoscale ocean variability is explicitly simulated. The first, NSF project nests the Regional Ocean Modeling System (ROMS) within the global ocean component of the Community Earth System Model (NCAR-CESM). The second, DOE project utilizes current advances in supercomputing power to run the NCAR-CESM globally at high resolution. In both cases we look for regions where a mesoscale-resolving ocean component improves the sea surface temperature distribution, with the potential to affect climate variability via air-sea interaction.

Jacobs Technology, Contractor to the Naval Research Laboratory, Stennis Space Center, MS, USA

March 2008 to May 2010

Coupled Mesoscale Modeler. Applying and validating a mesoscale coupled model (COAMPS®) to support field investigations of atmospheric and oceanic boundary layers. The model uses the Earth System Modeling Framework (ESMF) for coupling ocean and atmosphere, and incorporates data assimilation. Examples of field experiments include the data-rich Ligurian Sea Air-Sea Interaction Experiment (LASIE07) in the Mediterranean Sea and the CLIVAR MOde Water Dynamic Experiment (CLIMODE). The focus is on assessing where coupled models provide significant improvements over one-component models.

International Pacific Research Center (IPRC), University of Hawaii, USA.

Mar 2005 to Feb 2008

Visiting Assistant Researcher. Climate research, focusing on air-sea interaction processes over ocean eddies and fronts. Specific examples of research topics include the damping of eddies due to the inclusion of surface currents in stress and the deep atmospheric response to the Gulf Stream. This research utilised a regional coupled model and satellite and in-situ observations. *Jul 2001 to Feb 2005.* Post-doctoral fellow in climate studies. Investigating the atmospheric response to Tropical Instability Waves and the eastern Pacific Equatorial Front.

QinetiQ (formerly Defence Evaluation Research Agency (DERA)), Winfrith Technology Centre, Dorchester, UK. *January 1991 to July 2001*

Senior Scientist in Oceanography Group. Modeling and measurement of ocean features and their effect on acoustic propagation. The particular focus was on the evolution of non-linear internal waves such as solitary waves.

ADDRESS FOR CORRESPONDENCE

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PUBLICATIONS IN REFEREED LITERATURE

The following is a list of my publications in chronological order, most recent first:

- Small, R. J., S. Carniel, T. Campbell, J. Teixeira, and R. Allard, 2012. The response of the Ligurian and Tyrrhenian Sea to a summer Mistral event: a coupled atmosphere-ocean approach. *Ocean Modelling*, 48, 30-44. doi:10.1016/j.ocemod.2012.02.003. <http://www.sciencedirect.com/science/article/pii/S1463500312000339>
- Takatama, K., S. Minobe, M. Inatsu, and R. J. Small, 2012. Diagnostics for near-surface wind convergence/divergence response to the Gulf Stream in a regional atmospheric model. *Atmospheric Science Letters*, 1, 16-21. <http://onlinelibrary.wiley.com/doi/10.1002/asl.355/full>
- Jensen, T. G, T. Campbell, R. Allard, R. Justin Small, T. Smith, 2011. Turbulent heat fluxes during an intense cold-air outbreak over the Kuroshio Extension Region: results from a high-resolution coupled atmosphere-ocean model. *Ocean Dynamics*, 61, 657-674, doi: 10.1007/s10236-011-0380-0.
- Small, R. J., T. Campbell, J. Teixeira, S. Carniel, T. A. Smith, J. Dykes, S. Chen and R. Allard, 2011. Air-Sea interaction in the Ligurian Sea: assessment of a coupled ocean-atmosphere model using in-situ data from LASIE07. *Mon. Wea. Rev.*, 139, 1785-1808, <http://journals.ametsoc.org/doi/abs/10.1175/2010MWR3431.1>.
- Small, R. J., S.-P. Xie, E. Maloney, S. P. deSzoeko and T. Miyama, 2011. Intraseasonal variability in the far-east Pacific: investigation of the role of air-sea coupling in a regional coupled model. *Clim. Dyn.*, 36, 867-890, doi: 10.1007/s00382-010-0786-2.
- Carniel, S., L. Kantha, A. Bergamasco, H. Prandke, R. J. Small and M. Sclavo, 2010. Layered structures in the upper Ligurian Sea. *Il Nuovo Cimento*, 125, 1567-1586.
- Kelly, K., Small, R. J., Samelson, R. M., Qiu, B., Joyce, T., Kwon, Y.-O., and Cronin, M., 2010. Western boundary currents and Frontal Air-Sea Interaction: Gulf Stream and Kuroshio Extension., *J. Climate*, 23, 5644-5667, doi: 10.1175/2010JCLI3346.1.
- Small, R. J., Richards, K. J., Xie, S.-P., Dutrieux, P., and T. Miyama, 2009: 'Damping of Tropical Instability Waves caused by the action of surface currents on stress', *J. Geophys. Res. (Oceans)*, 114, C04009, doi:10.1029/2008JC005147.
- Small, R. J., S. P. DeSzoeko, S. P. Xie, L. O'Neill, H. Seo, Q. Song, P. Cornillon, M. Spall and S. Minobe, 2008: 'Air-sea interaction over ocean fronts and eddies', *Dyn. Atmos. Ocean.* 45, 274-319. doi.org/10.1016/j.dynatmoce.2008.01.001
- Minobe, S., Kuwano-Yoshida, A., Komori, N., Xie, S.-P., and R. J. Small, 2008. 'Influence of the Gulf Stream on the troposphere'. *Nature*, 452, 206-209.
- Xie, S.-P., Miyama, T., Wang Y., Xu H., deSzoeko S. P., Small R.J., Richards, K. J., Mochizuki T., and T. Awaji, 2007. 'A regional ocean-atmosphere model for eastern Pacific climate: towards reducing tropical biases'. *J. Climate*, 20, 1504-1522.
- Small, R. J., S. P. deSzoeko and S.-P. Xie, 2007. 'The Central American Mid-summer Drought: regional aspects and large scale forcing'. *J. Climate.*, 20, 4853-4873.
- deSzoeko, S. P., Xie S.-P., T. Miyama, K. J. Richards and R. J. O. Small, 2007. 'What maintains the SST front north of the equatorial cold tongue'. *J. Climate*, 20, 2500-2514.
- Small R. J., Xie S.-P., Y. Wang, S. K. Esbensen and D. Vickers, 2005a. 'Numerical simulation of boundary layer structure and cross-equatorial flow in the eastern Pacific', *J. Atmos. Sci.*, 62, 1812-1830.
- Xu, H., S.-P. Xie, Y. Wang, and R. J. Small, 2005. 'Effects of Central American mountains on the eastern Pacific winter ITCZ and moisture transport'. *J. Climate*, 18, 3856-3873.
- Small R. J., Xie S.-P., and J. Hafner, 2005b. 'Satellite observations of mesoscale ocean features and co-propagating atmospheric surface fields in the Tropical belt', *J. Geophys. Res.*, 110, doi:10.1029/2004JC002598.
- Small, R. J. and R. P. Hornby, 2005. 'A comparison of weakly and fully non-linear models of the shoaling of a solitary internal wave', *Ocean Modelling*, 8, 395-416.
- Hornby R P and Small R J., 2005. Waveform and turbulence generation associated with large amplitude shoaling internal waves in the South China Sea.

- Computational Methods and Experimental Measurements XII eds Brebbia C A and Carlomagno G M. WIT Press Southampton.
- Small J., Xie S-P and Y. Wang, 2003. 'Numerical simulation of atmospheric response to Tropical Instability Waves', *J. Climate*, 16, 3723-3741.
- Small, J., 2003. 'The refraction and shoaling of non-linear internal waves at the Malin shelf break'. *J Phys. Ocean*, 33, 2657-2674.
- Small J., 2002. 'Internal Tide transformation across a continental slope off Cape Sines Portugal', *J Marine Systems*, 32, 43-69.
- Small J. and J. R. Martin, 2002. 'The generation of non-linear internal waves in the Gulf of Oman', *Cont Shelf Res*, 22(8), 1153-1182.
- Hornby R. P. H. and J. Small, 2002. 'PHOENICS predictions of the shoaling of a large amplitude internal wave', *PHOENICS Journal*, 14, 126-137.
- Small J., 2001b. 'A nonlinear model of the shoaling and refraction of interfacial solitary waves in the ocean. Part II. 'Oblique refraction across a continental slope and propagation over a seamount'. *J Phys. Ocean.*, 31, 3184-3199.
- Small J., 2001a. 'A nonlinear model of the shoaling and refraction of interfacial solitary waves in the ocean. Part I. Development of the model and investigations of the shoaling effect'. *J Phys. Ocean.*, 31, 3163-3183.
- Hallock Z., Small J., George J., Field R. L., and J. C. Scott, 2000. 'Shoreward propagation of internal waves at the Malin shelf edge', *Cont. Shelf Res*, 20, 2045-2057.
- Small J., Sawyer T., and J. Scott, 1999b. 'The evolution of an internal bore at the Malin shelf break', *Annales Geophysicae*, 17(4), 547-565.
- Small J., Pavey G., Hallock Z. and J. Scott, 1999a. 'Observation of large amplitude internal waves at the Malin Shelf edge during SESAME 1995', *Cont. Shelf Res.*, 19, 1389-1436.
- Small J., Shackleford L. and Pavey G., 1997. 'Ocean feature models - their use and effectiveness in ocean-acoustic forecasting', *Annales Geophysicae*, 15, 101-112.
- Heathershaw A. D., Small J. and C. E. Stretch, 1994. 'Frictional formulations in Numerical Ocean Models and their effect on simulated acoustic fields', *J. Phys. Oceanogr.*, 24, 2.

PAPERS IN PREPARATION AND SUBMISSION

- Curchitser, E., R. J. Small, B. Kauffman, W. Large, J. Hurrell, M. Alexander, Z. Powell, 2012. Regional downscaling and upscaling in a coupled climate model: the North-East Pacific. In preparation.
- Small, R. J., R. A. Tomas and F. Bryan, 2012. Storm track response to sea surface temperature gradients. In preparation.

RECENT PRESENTATIONS

I have previously given a number of presentations at international geophysics conferences including the following recent talks and posters (since 2010):

- Small, **R. J.**, R. Tomas, F. Bryan, 2012 (upcoming). Community Atmosphere Model simulations of the climate response to ocean fronts. Invited talk to be given at JPGU meeting, Tokyo, Feb. 20-24, 2012.
- Small, **R. J.**, R. Tomas, F. Bryan, 2012. Community Atmosphere Model simulations of the climate response to ocean fronts. Poster given at Ocean Sciences Meeting, Salt Lake City, Feb. 20-24, 2012.
- Curchitser, E., R. J. Small, B. Kauffman, W. Large, J. Hurrell, M. Alexander. Embedding a high resolution regional ocean model of the North-East Pacific in a coupled Global Climate Model. (New) Poster given at Ocean Sciences Meeting, Salt Lake City, Feb. 20-24, 2012.
- Small, **R. J.**, B. Kauffman, E. Curchitser, K. Hedstrom, W. Large, J. Hurrell, 2011. Nested Regional Climate Model (nRCM) update. Talk given at Ocean Modeling Working Group meeting, Dec 8-10 2011, Boulder.
- Small, **R. J.**, E. Curchitser, B. Kauffman, W. Large, J. Hurrell, Mike Alexander. Embedding a high resolution regional ocean model of the North-East Pacific in a coupled Global Climate Model. Poster presented at World Climate Research Program (WCRP) meeting, Denver, Oct. 24-28, 2011.

- Small, R. J., F. Bryan, J. Tribbia, S. Park, J. Dennis, R. Saravanan, N. Schneider, Y.-O. Kwon. Ocean-Atmosphere Interaction From Meso- to Planetary-Scale. Poster presented at DOE Annual meeting of Climate and Earth System Modeling PIs, Washington DC, Sep. 19-22, 2011.
- Small, R. J., Kauffman, B., Curchitser, E., Hedstrom, K., Large, W., and J. Hurrell. Upwelling and regional response to embedding ROMS in CCSM3 at an eastern boundary. Talk given at CESM Workshop, June 20-23, 2011, Breckenridge.
- Small, R. J., Curchitser, E. Wolfe, J., Kauffman, B., Large, W., and J. Hurrell. Upwelling and regional response to embedding ROMS in CCSM3 at an eastern boundary. Ocean Modeling Working Group meeting, Dec 8-10 2010, Santa Fe.
- Smith, T. A., R. A. Allard, R. J. Small, T. J. Campbell, P. J. Martin, and E. Rogers. Air-sea-wave coupled modeling in the Mediterranean Sea. AMS 17th Conference on Air-Sea Interaction, Annapolis, September 26-30, 2010. http://ams.confex.com/ams/17Air17Sat9Coas/techprogram/paper_174189.htm
- Small, R. J. O., R. Allard, T. J. Campbell, J. Teixeira, and S. Carniel. The effect of ocean-atmosphere coupling on a summer Mistral event. AMS 17th Conference on Air-Sea Interaction, Annapolis, September 26-30, 2010. http://ams.confex.com/ams/17Air17Sat9Coas/techprogram/paper_174191.htm
- Teixeira J., Small, R. J., T. Campbell, T. A. Smith, J. Dykes S. Chen and R. Allard. Air-sea interaction in the Ligurian Sea: Assessment of the coupled Coamps model using LASIE07 data. Poster presented at Ocean Sciences 2010, Portland, Oregon, February 22-26, 2010. Eos Trans. AGU, 91(26), Ocean Sci. Meet. Supp., Abstract PO45R-02.
- Small, R. J., T. Joyce, T. Campbell, T. Jensen, S. Chen and R. Allard. Air-sea interaction over the Gulf Stream: results from a high resolution coupled model assessed using CLIVAR MODE Water Dynamic Experiment (CLIMODE). Poster presented at Ocean Sciences 2010, Portland, Oregon, February 22-26, 2010. Eos Trans. AGU, 91(26), Ocean Sci. Meet. Supp., Abstract PO45B-07.

REVIEWS AND PANELS

I have reviewed papers for several journals including Journal of Physical Oceanography, Continental Shelf Research, Journal of Climate, Journal of Geophysical Research (Oceans, Atmosphere), Climate Dynamics, Physics Essays, Computers and Fluids, Quart. J. Roy. Met. Soc., Geophysical Research letters, Boundary Layer Meteorology, and Deep Sea Research.

I have participated in a panel review of US NSF Physical Oceanography proposals, in November 2010, and in a panel review of US NOAA CLIVAR proposals, in November 2005. I have reviewed applications to NSF.

I have been a member of the CLIVAR working group on Western Boundary Current Air-Sea Interaction, and am currently a member of the AMS Air-Sea Interaction committee and am organizer of the 18th meeting of this group in July 2012.

PROFESSIONAL MEMBERSHIPS

American Geophysical Union, member from 1998
Institute of Physics, Chartered Physicist, from 2001
American Meteorological Society, member from 2006
JPGU, member, 2012