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Research Article

The economic value of ensemble forecasts as a tool for risk assessment: From days to decades

T. N. Palmer 

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Abstract

Despite the revolutionary development of numerical weather and climate prediction (NWCP) in the second half of the last century, quantitative interaction between model developers and forecast customers has been rather limited. This is apparent in the diverse ways in which weather forecasts are assessed by these two groups: root-mean-square error of 500 hPa height on the one hand; pounds, euros or dollars saved on the other.

These differences of approach are changing with the development of ensemble forecasting. Ensemble forecasts provide a qualitative tool for the assessment of weather and climate risk for a range of user applications, and on a range of time-scales, from days to decades. Examples of the commercial application of ensemble forecasting, from electricity generation, ship routeing, pollution modelling, weather-risk finance, disease prediction and crop yield modelling, are shown from all these time-scales.

A generic user decision model is described that allows one to assess the potential economic value of numerical weather and climate forecasts for a range of customers. Using this, it is possible to relate analytically, potential economic value to conventional meteorological skill scores. A generalized meteorological measure of forecast skill is proposed which takes the distribution of customers into account. It is suggested that when customers' exposure to weather or climate risk can be quantified, such more generalized measures of skill should be used in assessing the performance of an operational NWCP system. Copyright © 2002 Royal Meteorological Society.

REFERENCES

Ångström, A. 1922 On the effectivity of weather warnings. *Nordisk Statistisk Tidskrift*, 1, 394–408

| [Google Scholar](#) |

Buizza, R. and Palmer, T. N. 1995 The singular vector structure of the atmospheric global circulation. *J. Atmos. Sci.*, **52**, 1434–1456

| [Web of Science®](#) | [Google Scholar](#) |

Doblas-Reyes, F. J., Déqué, M. and Piedliefre, J.-P. 2000 Multi-model spread and probabilistic seasonal forecasts in PROVOST. *Q. J. R. Meteorol. Soc.*, **126**, 2069–2088

| [Web of Science®](#) | [Google Scholar](#) |

ECMWF 2000 '*The first twenty-five years (1975–2000)*'. European Centre for Medium-Range Weather Forecasts, Shinfield Park, Reading, RG2 9AX, UK

| [Google Scholar](#) |

Ehrendorfer, M. 1994 The Liouville equation and its potential usefulness for the prediction of forecast skill. Part I. Theory. *Mon. Weather Rev.*, **122**, 703–713

| [Web of Science®](#) | [Google Scholar](#) |

Ehrendorfer, M. and Murphy, A. H. 1988 Comparative evaluation of weather forecasting systems: sufficiency, quality and accuracy. *Mon. Weather Rev.*, **116**, 1757–1770

| [Web of Science®](#) | [Google Scholar](#) |

Evans, R. E., Harrison, M. S. J., Graham, R. J. and Mylne, K. R. 2000 Joint medium-range ensembles from the Met Office and ECMWF systems. *Mon. Weather Rev.*, **128**, 3104–3127

| [Web of Science®](#) | [Google Scholar](#) |

Foresight 2001 'Seasonal weather forecasting for the food chain'. Final report of the Foresight Seasonal Weather Forecasting for the Food Chain Steering Group. Ed. J. Griffin. (Available at www.foresight.gov.uk/fcc)

| [Google Scholar](#) |

Gleick, J. 1992 *Genius. Richard Feynman and modern physics*. Little, Brown and Company, London

| [Google Scholar](#) |

Graham, L. R. 2001 Do mathematical equations display social attributes? *Math. Intel-ligencer*, **22**, 31–36

| [Web of Science®](#) | [Google Scholar](#) |

Graham, R. J., Evans, A. D. L., Mylne, K. R., Harrison, M. S. J. and Robertson, K. B. 2000 An assessment of seasonal predictability using atmospheric general circulation models. *Q. J. R. Meteorol. Soc.*, **126**, 2211–2240

Harrison, M., Palmer, T. N., Richardson, D. S. and Buizza, R. 1999 Analysis and model dependencies in medium-range ensembles: Two transplant case-studies. *Q. J. R. Meteorol. Soc.*, **125**, 2487–2515

| [Web of Science®](#) | [Google Scholar](#) |

Hoffschmidt, M., Bidlot, J.-R., Hansen, B. and Janssen, P. A. E. M. 1999 ‘Potential benefit of ensemble forecasts for ship routeing’. ECMWF Technical Memorandum 287. ECMWF, Reading, UK

| [Google Scholar](#) |

Houtekamer, P. L., Lefavre, L., Derome, J., Richie, H. and Mitchell, H. L. 1996 A system approach to ensemble prediction. *Mon. Weather Rev.*, **124**, 1225–1242

| [Web of Science®](#) | [Google Scholar](#) |

IPCC 2001 ‘Climate change 2001: The scientific basis’. *Contribution of Working Group I to the third Assessment Report of the Intergovernmental Panel on Climate Change*. J. T. Houghton, Y. Ding, D. J. Griggs, M. Noguer, P. J. Van der Linden, X. Dai, K. Maskell and C. A. Johnson, Eds. Cambridge University Press, Cambridge and New York

| [Google Scholar](#) |

R. W. Katz and A. H. Murphy (Eds.) 1997 *Economic value of weather and climate forecasts*. Cambridge University Press

| [Google Scholar](#) |

Krishnamurti, T. N., Kishtawal, C. M., Zhang, Z., LaRow, T., Bachiochi, D. and Williford, E. 2000 Multimodel ensemble forecasts for weather and seasonal climate. *J. Climate*, **13**, 4196–4216

| [Web of Science®](#) | [Google Scholar](#) |

Liljas, E. and Murphy, A. H. 1994 Anders Ångström and his early papers on probability forecasting and the use/value of weather forecasts. *Bull. Am. Meteorol. Soc.*, **75**, 1227–1236

| [Web of Science®](#) | [Google Scholar](#) |

Lorenz, E. N. 1993 *The essence of chaos*. University of Washington Press

| [Google Scholar](#) |

Mason, B. J. 1966 The role of meteorology in the national economy. *Weather*, **21**, 382–393

| [Google Scholar](#) |

Meehl, G. A., Boer, G. J., Covey, C., Latif, M. and Stouffer, R. J. 2000 The coupled model intercomparison project. *Bull. Am. Meteorol. Soc.*, 81, 313–318

| [Google Scholar](#) |

Molteni, F., Buizza, R., Palmer, T. N. and Petroliagis, T. 1996 The ECMWF ensemble prediction system: Methodology and validation. *Q. J. R. Meteorol. Soc.*, 122, 73–119

| [Web of Science®](#) | [Google Scholar](#) |

Murphy, A. H. 1977 The value of climatological, categorical and probabilistic forecasts in the cost-loss ratio situation. *Mon. Weather Rev.*, 105, 803–816

| [Web of Science®](#) | [Google Scholar](#) |

Murphy, A. H. and Ehrendorfer, M. 1987 On the relationship between the accuracy and value of forecasts in the cost-loss ratio situation. *Weather and Forecasting*, 2, 243–251

| [Google Scholar](#) |

Palmer, T. N. 2000 Predicting uncertainty in forecasts of weather and climate. *Rep. Prog. Phys.*, 63, 71–116

| [Web of Science®](#) | [Google Scholar](#) |

2001 A nonlinear dynamical perspective on model error: A proposal for non-local stochastic-dynamic parametrization in weather and climate prediction models. *Q. J. R. Meteorol. Soc.*, 127, 279–304

| [Web of Science®](#) | [Google Scholar](#) |

Palmer, T. N. and Anderson, D. L. T. 1994 The prospects for seasonal forecasting. *Q. J. R. Meteorol. Soc.*, 120, 755–793

| [Web of Science®](#) | [Google Scholar](#) |

Palmer, T. N. and Räisänen, J. 2002 Quantifying the risk of extreme seasonal precipitation events in a changing climate. *Nature*, 415, 512–514

| [CAS](#) | [PubMed](#) | [Web of Science®](#) | [Google Scholar](#) |

Palmer, T. N., Brankovic, C. and Richardson, D. S. 2000 A probability and decision-model analysis of PROVOST seasonal multi-model ensemble integrations. *Q. J. R. Meteorol. Soc.*, 126, 2013–2033

| [Web of Science®](#) | [Google Scholar](#) |

Poincaré, H. 1909 *Science and method*. Reprinted by Dover Publications, 1952

| [Google Scholar](#) |

| [Google Scholar](#) |

Räisänen, J. and Palmer, T. N. 2001 A probability and decision-model analysis of a multi-model ensemble of climate change simulations. *J. Climate*, 14, 3212–3226

| [Web of Science®](#) | [Google Scholar](#) |

Richardson, D. S. 2000a Skill and relative economic value of the ECMWF ensemble prediction system. *Q. J. R. Meteorol. Soc.*, 126, 649–668

| [Web of Science®](#) | [Google Scholar](#) |

2000b ‘Applications of cost-loss models’. Proceedings of seventh workshop on meteorological operational systems. ECMWF, Reading, UK

| [Google Scholar](#) |

2001 Measures of skill and value of ensemble prediction systems, their interrelationship and the effect of ensemble size. *Q. J. R. Meteorol. Soc.*, 127, 2473–2489

| [Web of Science®](#) | [Google Scholar](#) |

Roebber, P. J. and Bosart, L. F. 1996 The complex relationship between forecast skill and forecast value: a real-world analysis. *Weather and Forecasting*, 11, 544–559

| [Web of Science®](#) | [Google Scholar](#) |

Smith, L. A., Roulston, M. S. and von Hardenberg, J. 2001 ‘End-to-end ensemble forecasting: towards evaluating the economic value of the ensemble prediction system’. ECMWF Technical Memo No. 336. ECMWF, Reading, UK

| [Google Scholar](#) |

Stanski, H. R., Wilson, L. J. and Burrows, W. R. 1989 ‘Survey of common verification methods in meteorology’. WMO WWW Tech. Report No. 8, WMO, TD No. 358

| [Google Scholar](#) |

Stockdale, T. N., Anderson, D. L. T., Alves, J. O. S. and Balmaseda, M. A. 1998 Global seasonal rainfall forecasts using a coupled ocean-atmosphere model. *Nature*, 392, 370–373

| [CAS](#) | [Web of Science®](#) | [Google Scholar](#) |

Taylor, J. W. and Buizza, R. 2002 Using weather ensemble predictions in electricity demand forecasting. *Int. J. Forecasting*. In press

| [Google Scholar](#) |

Thompson, J. C. 1952 On the operational deficiencies in categorical weather forecasts. *Bull. Am. Meteorol. Soc.*, **33**, 223–226

| [Web of Science®](#) | [Google Scholar](#) |

Thomson, M. C. and Connor, S. J. 2001 The development of malaria early warning systems for Africa. *Trends in parasitology*, **17**, 9438–9445

| [Web of Science®](#) | [Google Scholar](#) |

Thomson, M. C., Palmer, T. N., Morse, A. P., Cresswell, M. and Connor, S. J. 2000 Forecasting disease risk with seasonal climate predictions. *Lancet*, **355**, 1559–1560

| [CAS](#) | [PubMed](#) | [Web of Science®](#) | [Google Scholar](#) |

Thornes, J. E. and Stephenson, D. B. 2001 How to judge the quality and value of weather forecast products. *Meteorol. Apps.*, **8**, 307–314

| [Web of Science®](#) | [Google Scholar](#) |

Toth, Z. and Kalnay, E. 1997 Ensemble forecasting at NCEP and the breeding method. *Mon. Weather Rev.*, **125**, 3297–3319

| [Web of Science®](#) | [Google Scholar](#) |

Wandishin, M. S., Mullen, S. L., Stensrud, D. J. and Brooks, H. E. 2001 Evaluation of a short-range multi-model ensemble system. *Mon. Weather Rev.*, **129**, 729–747

| [Web of Science®](#) | [Google Scholar](#) |

Wilks, D. S. 1995 *Statistical methods in the atmospheric sciences*. Academic Press, London

| [Google Scholar](#) |

Wilks, D. S. and Hamill, T. M. 1995 Potential economic value of ensemble forecasts. *Mon. Weather Rev.*, **123**, 3565–3575

| [Web of Science®](#) | [Google Scholar](#) |



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