Extreme extratropical storms in the Euro-Atlantic region in the ensemble of 20th Century Reanalysis (20CRv2)

Margarida L. R. Liberato
CGUL, IDL, University of Lisbon, Lisbon, Portugal
School of Sciences and Technology,
University of Trás-os-Montes e Alto Douro, Vila Real, Portugal

Isabel F. Trigo
Institute of Meteorology, Lisbon, Portugal

Ricardo M. Trigo
CGUL, IDL, University of Lisbon, Lisbon, Portugal
Engineering Department, University Lusófona, Lisbon, Portugal,

Over the Northern Hemisphere (NH) extratropical cyclones are one of the most important features for mid-latitude climate. On short timescales intense cyclones are often associated with extreme weather conditions, in terms of wind and precipitation extremes and they are among the most severe natural hazards affecting Europe. Recent winters have been prone to extreme events, namely several destructive European storms, which caused considerable social and economical losses. Subtle shifts in the North Atlantic (NA) storm track may have a major impact on the moisture transport and precipitation patterns, and therefore lead to profound impacts on the climate, both locally and throughout the hemisphere.

Understanding changes in storm tracks over longer time scales is a challenging research theme, particularly in the NA. Changes in the extratropical storm tracks under global warming would impact the transport of momentum, energy and water in the atmosphere, the ocean circulation and carbon cycle, and therefore society through changing weather patterns. Thus it is of utmost importance to well understand past and present long term changes in the frequency and severity of extreme extratropical cyclones.

The Twentieth Century Reanalysis (20CR) project is an international effort to produce a comprehensive global atmospheric circulation dataset spanning the whole twentieth century. It uses an Ensemble Kalman Filter data assimilation method with background 'first guess' fields supplied by an ensemble of forecasts from a global numerical weather prediction model. This directly yields a global analysis every 6 hours as the most likely state of the atmosphere, and also an uncertainty estimate of that analysis. The analysis fields are available from 1871 to the present at 6-hourly temporal and 2 degree horizontal resolution. Selected fields from individual ensemble members were used in this work to assess extreme extratropical cyclone activity and evaluate historical trends.

On the other hand, on the last two decades a number of algorithms have been proposed for the identification and cyclone tracking of mid-latitude storms. In general these methods are based on sub-daily charts of sea level pressure fields where SLP (or vorticity) minima can be tracked. Within the IMILAST intercomparison project (http://www.proclim.ch/imilast/index.html) extratropical cyclones were identified using multiple identification and cyclone tracking algorithms, enabling an evaluation and comparison of the cyclogenesis, deepening rates, cyclolysis and track characteristics of several selected extreme storms and storms which lead to strong socio-economic impacts. This community effort showed that extratropical cyclones are

not yet being equally described by all methodologies and the intercomparison does not allow to know which method is closest to reality. This result stresses the need of comparing tracks of extreme storms directly with observations, studying historical cases.

In this paper we perform an analysis of the space time variability and main characteristics of extreme cyclones for 1871-2008 (138 years), for each of the 56 ensemble members of the 20th Century Reanalysis (20CRv2) spanning the extended winter seasons (October to March), for the Euro-Atlantic sector. We focus, in particular, on a number of selected case studies corresponding to intense storms in the Euro-Atlantic and Mediterranean region. This analysis is based on the SLP cyclone detecting and tracking algorithm first developed for the Mediterranean region and later extended to a larger Euro-Atlantic region by Trigo (2006). Finally results are put into perspective with previously published results using other reanalysis datasets (NCEP/NCAR, ERA40 and ERA-Interim).

This work was partially supported by the FCT (Portugal) through projects PEst-OE/CTE/LA0019/2011-IDL and PTDC/AAC-CLI/103567/2008.

Corresponding Author:
Name: Margarida L. R. Liberato
Organization: University of Trás-os-Montes e Alto Douro
Address: School of Sciences and Technology
Quinta de Prados, Apt. 1013
5001-801 Vila Real
Portugal
Email Address: mlr@utad.pt