Intercomparison of mid latitude storm diagnostics (IMILAST)

Project description (version Nov/20/2009)

Introduction: motivation and background

Diagnostics of the observed and projection of the future changes of extratropical storms are a key issue e.g. for insurance companies, risk management and adaptation planning. Storm-associated damages are amongst the highest losses due to natural disasters in the mid-latitudes. Therefore the knowledge of the future variability and change in extratropical cyclone frequency, intensity and track locations is crucial for the strategic planning and minimization of the disaster impacts. Future changes in the total number of storms might be small but major signals could occur in the characteristics of cyclone life cycle such as intensity, life time, track locations (Bengtsson et al. 2006, 2008, Loeptien et al. 2008, Pinto et al. 2007)

The quantification of such trends, or the detection of extremes, are not independent from the methodologies for storm track detection applied to observational data and models. Recent analysis of Raible et al. (2008) demonstrated that characteristics of cyclone activity may seriously depend on the methodology of cyclone identification and tracking. Comparison of differences in cyclone characteristics obtained using different methods from a single data set may be as large as or even exceed the differences between the results derived from different data sets using a single methodology (e.g. Raible et al. 2008, Trigo 2006). Considering climate variability and change, Ulbrich et al. (2008) and Raible et al. (2008) show, that linear trend magnitude and even sign might depend on the detection and tracking methods of the cyclones. Even more, the metrics used become particularly sensitive, resulting in the fact that scientific studies may find seemingly contradictory results based on the same datasets (Ulbrich et al., 2008). This unsatisfactory situation is related to the fact that mid-latitude cyclones are complex systems, and the temporal development, spatial structures and impacts are highly variable. Thus, the identification of a storm is not always unambiguous, and already requires quite inventive methodologies. The quantification of storm strength in scientific studies is based on meteorological parameters describing different aspects of the dynamic state and development of the systems. The strength, again, is related to the storm impacts in terms of parameters like rainfall (or drought, when cyclone activity is low or absent) or wind, but the relation will differ for different state and impact parameters. Finally, considerable uncertainties in the estimates of cyclone activity may arise from the representation of the results, i.e. the mapping of cyclone numbers and frequencies, in particular the grids used (see, e.g. Sinclair 1994, Zolina and Gulev 2002).

One of the most widely discussed differences in the algorithms relate to the choice of SLP or vorticity as a basic identification/tracking and strength description feature (e.g. Sinclair 1997, Hodges et al. 2003, Rudeva and Gulev 2007, Ulbrich et al. 2008). While vorticity e.g. contains more information on the high-frequency synoptic scale, pressure better resolves the low-frequency scale (Hodges et al. 2003). The combination of both vorticity and SLP in a multifaceted technique can address the weaknesses of using only one of them (Hewson 2008). While there are some potentials for improving tracking skills which are not directly associated with the choice of the fields processed (Wernli and Schwierz, 2006) it must also be taken into account that the different tracking algorithms and different strength definitions depend on space-time resolution of the model/reanalysis output used. Blender and Schubert (2000) analysed the sensitivity of results to different temporal resolution (from 3 to 24 hours) and to various spectral resolution (from T21 to T95) using spectral truncation. Further analysis of the impact of resolution has been performed by Pinto et al. (2005) and Jung et al. (2006) who discriminated the effects of the actual model resolution and of the spectral truncation. Furthermore it has to be considered, that more extreme storms (especially those that hit land) tend to move faster and have shorter lifetimes, which affects required time resolution. It must also be taken into account that data available from model runs may be restricted to a few parameters, and multi-model ensemble studies required for obtaining stable estimates of climate change effects may not be possible if the particular output parameters used by a cyclone algorithm may prevent its application in these studies. Thus, it cannot be expected that there is an optimum or standard scheme that fulfills all needs. Rather, a proper knowledge about advantages and restrictions of different schemes must be obtained to be able to provide a synthesis of results rather than puzzling the scientific and the general public with apparently contradicing statements.

Another importance issue is the consideration of storm tracking results for limited areas. Currently the number of long-term high resolution NWP products is growing rapidly making it also attractive to perform cyclone tracking using such resolution products, as e.g. the NARR (North American Regional reanalysis) and a family of REMO (Regional European model) simulations for American and European continents, respectively. On the one hand these outstanding products may better resolve cyclone characteristics. On the other hand, being non-global, they imply additional uncertainties in the storm tracking results. These uncertainties are first of all associated with the entry/exit problems, affecting parameters like cyclone life time, minimum depth, trajectory length, or deepening rate. Thus, special effort is needed to perform an intercomparison and to quantify these uncertainties.

For users of storm track analyses and projections (including regional ones) it would be very helpful if the research community would provide information in a kind of "handbook" which provides definitions of what is meant by a "storm" or "cyclone" and a description of the available 10-15 different identification and tracking schemes as well as of the parameters used for the quantification of cyclone activity. The possibility of an identification of a limited set of methods which can provide the most important informations should be discussed. The use of as simple as possible metrics should be strived for.

Aims of the project

The main **goals** of the project are

- to provide a quantitative comprehensive assessment of all types of uncertainties inherent in the mid-latitudinal storm tracking by comparing different methodologies with respect to data of different resolution (time and space) and limited areas, for both cyclone identification and cyclone tracking respectively.

- to intercompare the metrics of mid latitudinal cyclone activity (identification/tracking) used for different purposes

- to provide definitions of "storms" and "cyclones" and point out the informations that can be drawn from specific methods, depending on data availability (time/space resolution)

- the intercomparison establishes a multi-method storm climatology that could serve as a baseline for climate impact studies

- to provide a "users' guide" explaining the information that can be taken and the restrictions related to the individual standard

In order to achieve these goals the following **objectives** are to be met:

- to provide an inventory of the existing methods for cyclone identification and tracking (catalogue), including their data needs
- to compare the existing identification and tracking methods using data of different space-time resolutions, both in terms of climatologies and in terms of the identification of single storms
- to compare the algorithms' sensitivity to spatial and temporal resolution of the underlying data and to provide information of the relative uncertainties arising from different methods, reanalysis products and model simulations (including results for limited areas).
- to estimate and intercompare the information content provided by the methods
- to provide a systematic intercomparison of different quantities used for describing cyclone activity and strength from a dynamical viewpoint, and to relate them to impact related weather parameters.
- discuss the possibility of recommending specific methods for different purposes and settings

Outcome:

Final Report (or 'white paper') containing
  - an overview of existing methods, including a description of the information contained in the results and the limitations of each individual standard method
  - an overview of standard parameters for the quantification of cyclone activity and intensity characteristics, including their limitations
  - comments on further work to be done

Working plan

The following steps have been taken:
- Collect the existing identification and tracking methods (web-based) (Summer 2009). Prepare the methodologies catalogue with the standardized description of the methodologies
- To invite participants to suggest standard intercomparison experiments, stating explicitly the list of simulations with specified data sets and the list of characteristics to be delivered
- Session at EGU meeting in Vienna (Session CL41, 20 April 2009) with presentations of suggestions concerning the intercomparison experiment (see above), storm definitions, ev. credibility tests
- Workshop after EGU meeting in Vienna (25 April 2009), discussion and decision on intercomparison procedure
- Collect propositions concerning standard definitions of "storms" and parameters (e.g. which basic parameters describing cyclone activity have to be included?) (ongoing)
- To set-up the project data server and to allocate data sets for the intercomparison experiments and output of te experiments (June 2009)
- Session and workshop at EGU meeting in Vienna (May 2010)

Ongoing and planned work:
- Small intercomparison project (climatological studies using specific, different datasets on which the schemes are applied, including studies on individual cyclones) (ongoing)
- Collection of results, analysis (autumn/winter 2010)
- Workshop for discussion of analysis work (spring 2011)
- Preparation of draft report (spring 2011)
- Review of draft report (spring 2011)
- Preparation of Final Report (summer 2011)

Partners

The following scientists have agreed to support this project (list to be extended):

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M. Sinclair/USA, Embry-Riddle Aeronautical University, Prescott, Arizona
O. Zolina/GER, University of Bonn
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C. Raible/SUI, University of Bern
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M. Inatsu/JAP, Hokkaido University
M. dos Santos Mesquita/NOR, Bjerknes Centre, Bergen

Organisational structure:

The project organisation is bottom-up and democratic. The project is intended to be embedded in a world research program (possibly WCRP, CLIVAR).
Organisational tasks (organisation of workshops, preparation of drafts, etc.) are operated by an executive committee.

Members of the executive committee:
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