Synoptic conditions of extreme windstorms over Switzerland in a changing climate

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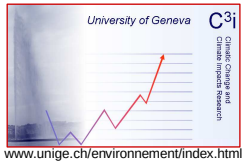

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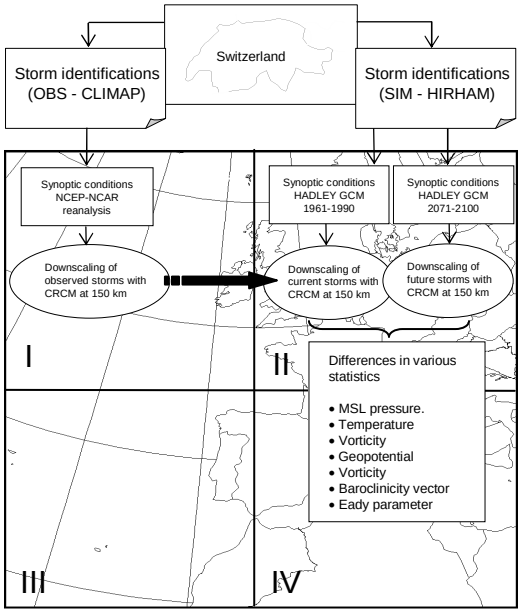
Abstract

The analysis of the change of synoptic conditions of mid-latitude cyclones conducive to extreme windstorms in Switzerland for current and future warming is described (source: Goyette, S.: *Clim. Dyn*., **36,** 845–866). Results indicate that windstorms in a warmer world are generated by a subtle modification of the atmospheric conditions, especially over the ocean and where greater ocean-continent temperature contrasts are simulated during winters.

Rationale

The impacts of mid-latitude cyclones for current and future climate conditions in Switzerland have not much been studied and thus deserve attention. A methodology is thus proposed whereby synoptic conditions of deep cyclones aggregated into composites for current and future climate are selected on the basis of maximum wind speed over the Swiss territory.

Methodology



1) *Storm selection*
- ► from local observations in Switzerland
- ► from HIRHAM simulated outputs

2) *Simulations at LR with the Canadian RCM*
- ► driven with NCEP-NCAR
- ► driven with HADGCM (1961-1990) and (2071-2100) SRES A2 warming scenario

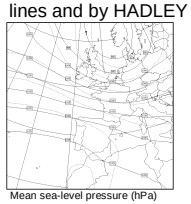
3) *Validation of simulated outputs in the four quadrants (I, II, III, IV)*
- ► (NCEP-NCAR) vs (1961-1990)

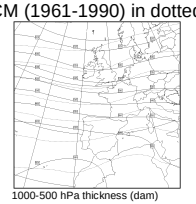
4) *Evaluation of changes in composite statistics*
- ►(2071-00) minus (1961-1990)

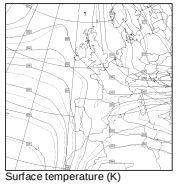
The use of a physically-based Regional Climate Model (RCM) is motivated for a number of reasons. It allows downscaling global reanalyses as well as GCM outputs for selected storms. By using such a downscaling technique, the impacts of storms on the generation of high winds in Switzerland are analysed on a case-by-case study basis using common basic diagnostics on a common grid which make possible and ease the intercomparison. Analysis of composites is then carried out.

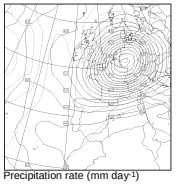
Results

Validation of composite averages: 30 simulations of 150 CRCM driven by NCEP-NCAR in solid lines and by HADLEY GCM (1961-1990) in dotted lines.

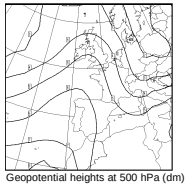

Mean sea-level pressure (hPa)

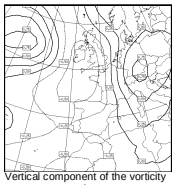

1000-500 hPa thickness (dam)

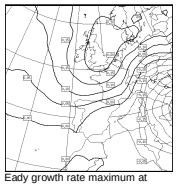

Surface temperature (K)

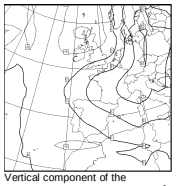

Precipitation rate (mm day^{-1})

Difference of composite averages between (2071-2100) under the SRES A2 warming scenario and (1961-1990) periods (negative differences in dotted lines).

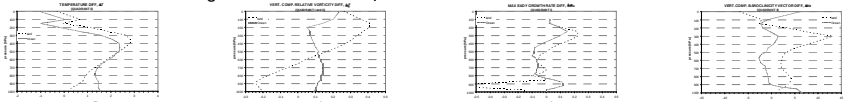

Geopotential heights at 500 hPa (dm)


Vertical component of the vorticity at 300 hPa (day^{-1})

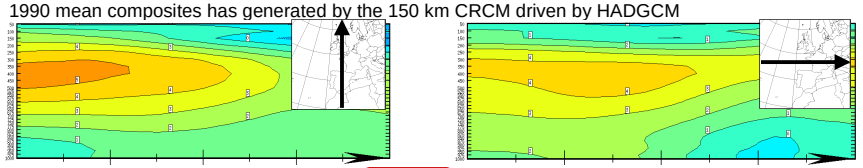

Eady growth rate maximum at 300 hPa (day^{-1})


Vertical component of the baroclinicity vector at 300 hPa (s^{-2})

Comparison of mean composite profile differences for (2071-2100) minus (1961-1990) storm climate conditions averaged over individual quadrants.



Vertical cross-sections of the temperature differences (℃) between the 207 1-2100 and the 1961-1990 mean composites has generated by the 150 km CRCM driven by HADGCM



Main findings

The analysis of the composites has shown subtle changes in the synoptic fields associated with windstorms in Switzerland. There is a stronger positive temperature change in the atmosphere over the ocean to the South of the computational domain than in the North and over the continent. Baroclinicity is strongly modified with altitude, so that windstorms in the warmer climate scenario take advantage of a situation in which a warmer Atlantic Ocean is combined with a colder surfaces on the fringe of the western European continent.

Future developments

The diagnostic software called “Dionysos” (www.dionysos.uqam.ca/publications_e.html) will be used. It includes a complete set of diagnostic equations and enables to separate quantitatively different physical and dynamical process in several important meteorological fields.