WEATHER REGIMES, WEATHER TYPES AND THEIR RELATIONS WITH LOCAL SCALE PHENOMENA

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This poster is based on Laura Legnani's physics dissertation at the University of Milan, carried out at ARPA Lombardy (Advisors: Prof Maurizio Maugeri, Dr Gian Paolo Minardi, Dr Orietta Cazzuli)

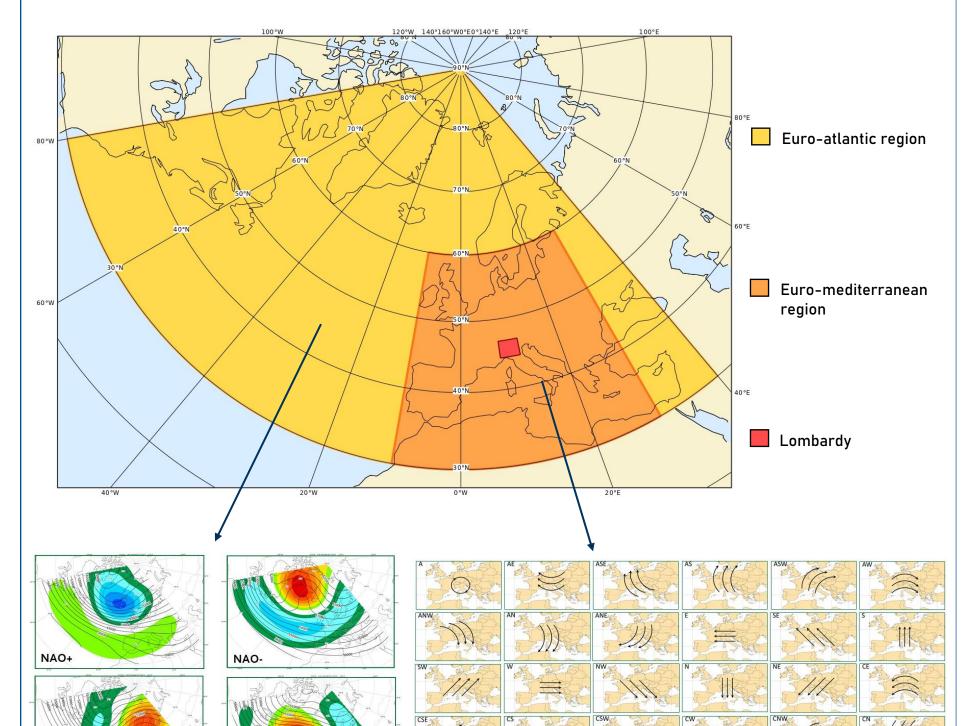
1 WEATHER REGIMES, WEATHER TYPES

The phenomena of interest to operational meteorology, which occur at a local scale, are linked to processes occurring at different spatiotemporal scales. Processes occurring at larger spatio-temporal scales can be predicted at longer time ranges. Consequently, an understanding of the large-scale atmospheric dynamics involved in determining localscale phenomena can be very useful for forecasting purposes.

The aim of this study is to understand the role of largescale circulation patterns in determining weather conditions over Lombardy.

For this purpose, the following spatial domains were considered:

- the Euro-Atlantic region, studied in term of Weather Regimes (WR)
- the Euro-Mediterranean region, analyzed classifying the circulation into Weather Types (WT)



Geographical patterns of the four Euro-Atlantic climatological regimes (both anomalies and full fields) for the cold season (ONDJFMA). The geopotential anomalies (colour shading) and geopotential (contours) at 500 hPa in units of m^2/s^2 are derived from ERA5 reanalysis data.

Some events of interest from the point of view of operational meteorology and their impact were analyzed in terms of weather regimes and weather types.

CASE STUDIES (see below)

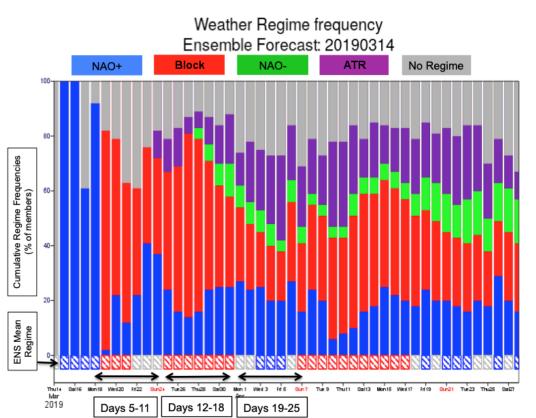
The aim of the investigation is to probe the ability of these schemes to characterize weather-related events occurring in Lombardy.

Any connections that emerge from this analysis apply in the context of the mediumrange forecast.

In particular, it might lead to:

- develop new forecasting tools
- give a more precise meaning to some already available tools, e.g. the ECMWF Weather Regimes Probabilities Chart

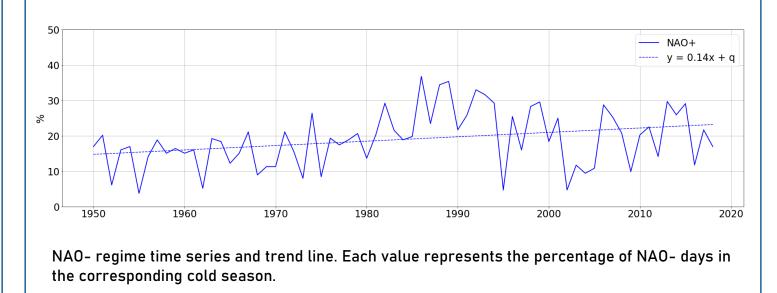
How can the ECMWF Weather Regimes Probabilities chart support meteorologist in Lombardy to provide more accurate forecast?



Daily probabilities for the occurrence of Euro-Atlantic weather regimes. The coloured bars indicate the proportion of ensemble members forecasting a specific regime for each day of the forecast: positive (blue) and negative (green) North Atlantic Oscillation, Scandinavian Blocking (red), Atlantic Ridge (purple).

2 TIME SERIES ANALYSIS

After computing the four WRs over the Euro-Atlantic area (NAO+, NAO-, BLO, AR), the 1950-2019 daily series of occurrence of the regimes was constructed. Trend analysis showed an increase in the occurrence of the NAO- regime during the cold season (ONDJFMA), particularly evident in the time span 1975-90.

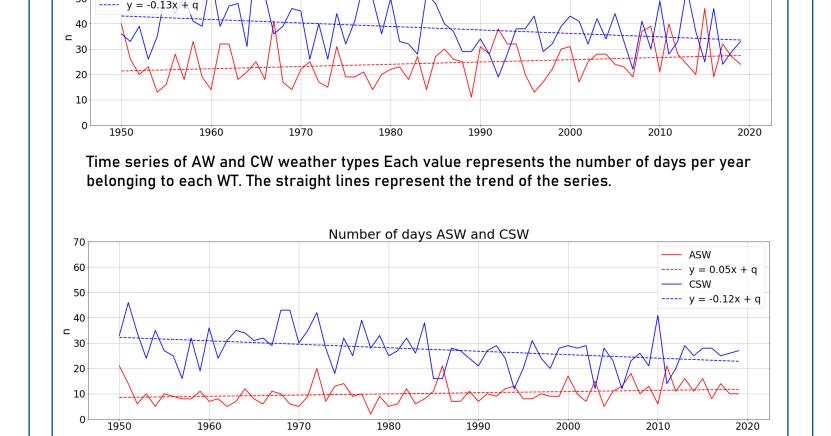


The 1950-2019 daily series of Lamb weather types was constructed using the algorithm of Jenkinson and

Collison.

Increasing trends were found in the occurrence of types AW and ASW, decreasing trends in the series of types CW and CSW

Number of days AW and CW



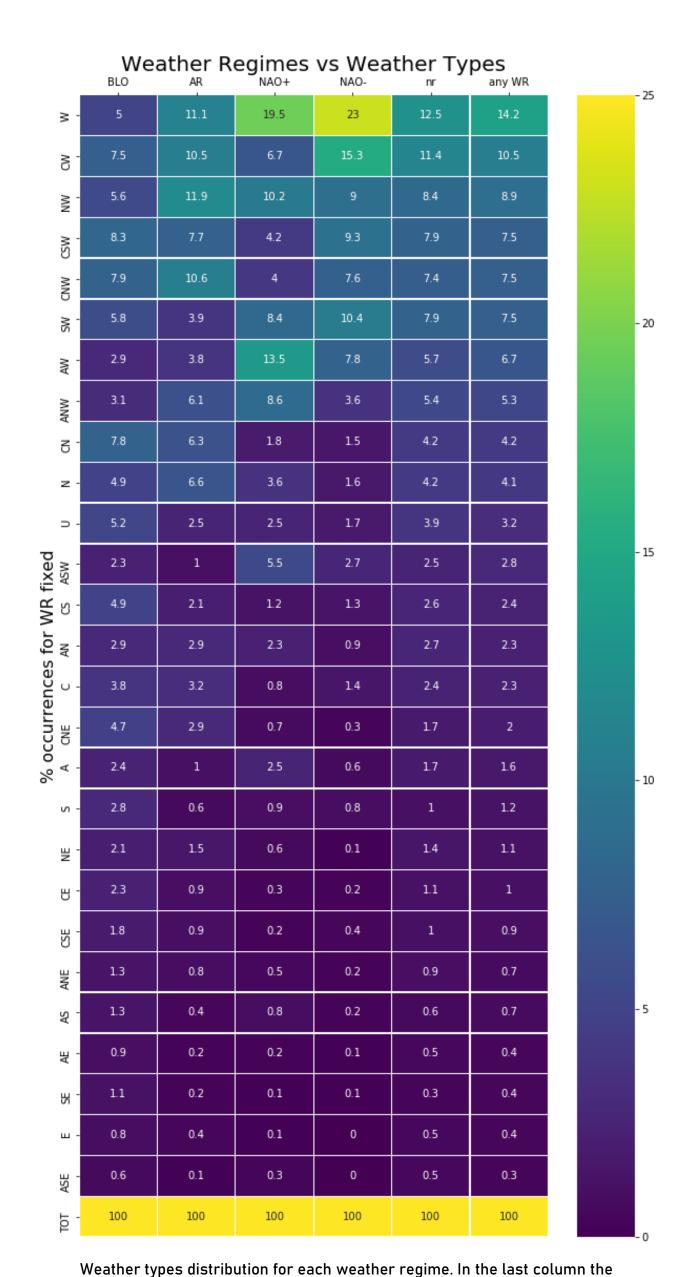
Time series of ASW and CW weather types Each value represents the number of days per

year belonging to each WT. The straight lines represent the trend of the series.

3 COMPARING THE TWO SCHEMES

For each regime, the percentage of occurrence of WTs has been computed.

The table below shows how each WR over the Euroatlantic area affects the distribution of weather types over the Euro-mediterranean area.



4 CASE STUDIES

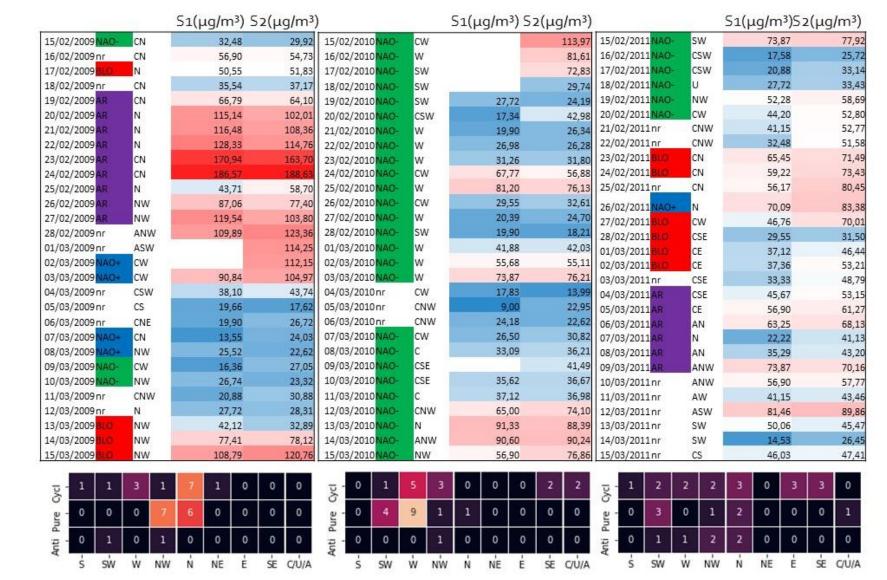
PM10 concentrations drop in winter 2010

In 2010 an unexpected drop in PM10 winter concentrations was recorded in Lombardy. PM10 values measured by two stations in Milan in the years 2009, 2010, 2011 are compared together with WR and WT occurrences in the period 15 February - 15 March.

Lamb weather types scheme.: the atmospheric flow is classified

on the basis of its direction and curvature

- > the NAO- regime prevails during periods of low pollution levels
- > the persistence of the regimes appears to be decisive in influencing PM10 concentrations
- > the combination WR -WT appears also to play a relevant role



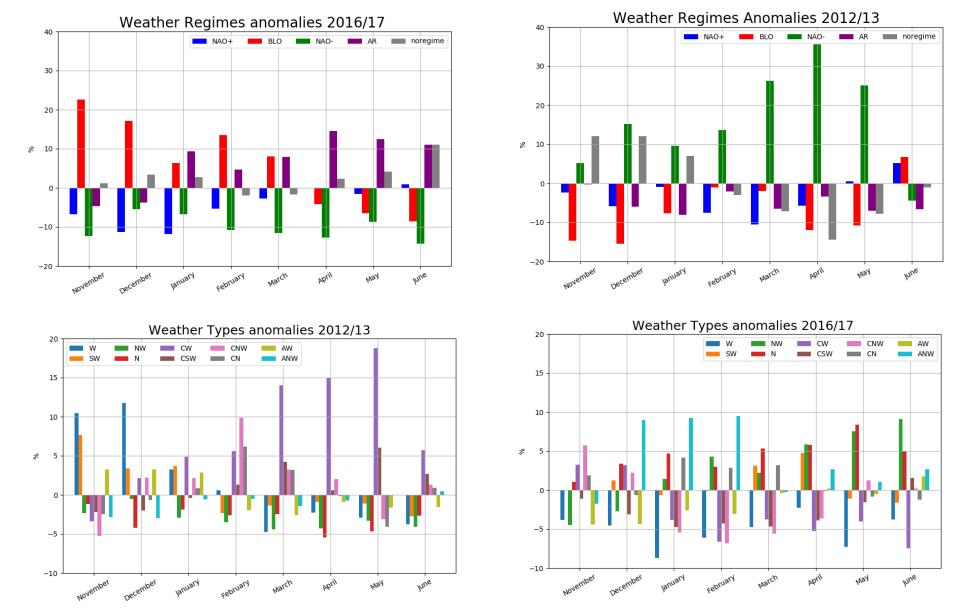
Wetaher regimes, weather types and PM10 daily concentrations measure by two station in Milan (Città studi and Verziere). 15 february – 15 march of the years 2009, 2010, 2011. The heatmaps represent the WTs distributions.

Drought in 2017

In 2017 early summer a water crisis was recorded due to the scarcity of rainfall during the preceding months.

The distribution of WRs and WTs over time spans of 3 or 6 months for this period was compared to the distribution for a wet period:

- \succ The dry period is characterized by the prevalence of the BLO and AR regimes, the wet period is associated with the presence of the NAO- regime.
- > The distributions of WT in the dry and wet periods show very different, in some ways opposite, characteristics



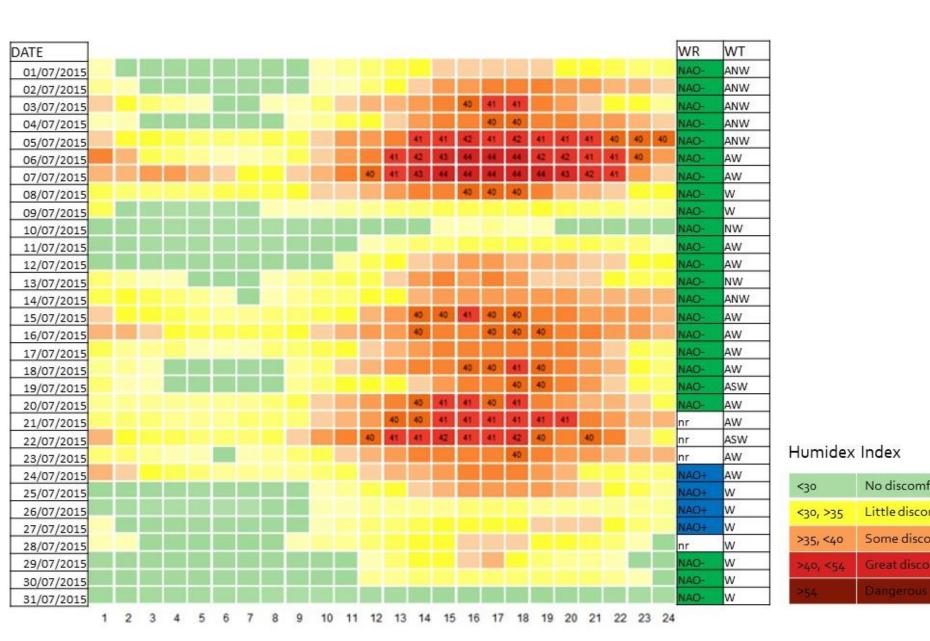
Weather regimes distribution anomalies (up) and weather types distribution anomalies (down). A dry period (left) and a wet one (rigth) compared. Distributions are calculated over 3-months time span. Only the ten more frequent WTs are represented.

Heat waves in July 2015

During July 2015 two strong heat waves caused a drop in the number of visitors at the EXPO event in Milan.

frequencies over the total number of days. 1950-2019 period.

- > Long NAO- sequences seem to be associated with high temperatures in
- > July 2015 is characterized by the prevalence of <u>AW</u> and <u>ANW</u> weather types and the absence of CW, CNW and SW weather types

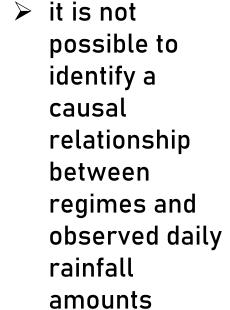


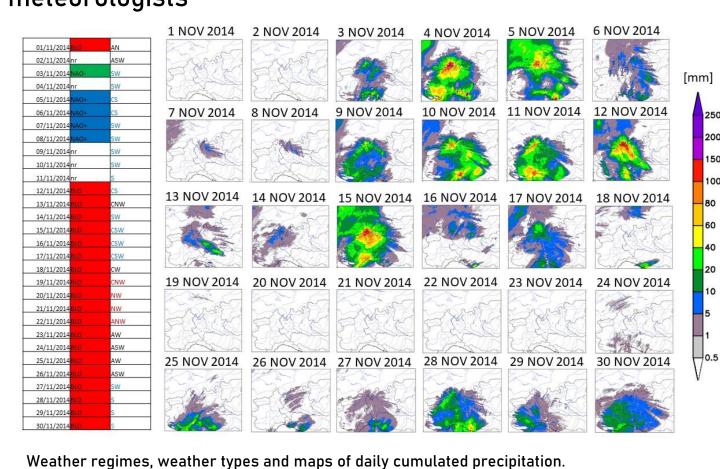
Hourly Humidex values measured at Milan EXPO site, weather regimes and weather types. July 2015.

Heavy rainfall in November 2014

Between 3 and 18 November 2014 heavy rainfall occurred in Lombardy, totals above 700mm in some parts.

> The correspondence between WTs and rainfall is straightforward, as well known by local meteorologists





Wildfires in spring 2017

A well above-average of wildfires was recorded during spring 2017 in the Alps, favoured by dry and windy(foehn) conditions

- > the AR regime, which prevailed in April 2017, could play a role in determining weather conditions that help the ignition and spread of
- > March and April 2017 were characterized by WT with N and NW components

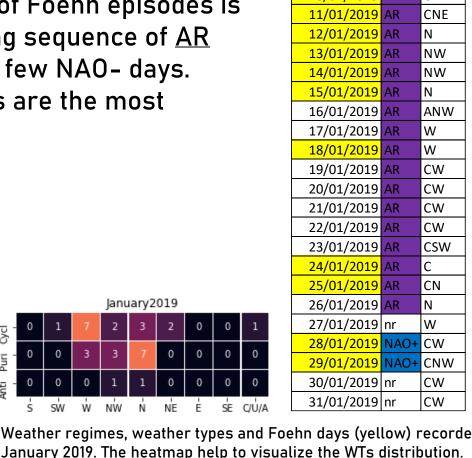


Weather regimes, weather types and number of wildfires recorded in April 2017. The heatmap help to visualize the WTs distribution.

Foehn episodes in winter 2018–19

Winter is the season most exposed to foehn winds in Lombardy. From December 2018 to March 2019 a total of 48 foehn days was recorded.

- > the month with the highest number of Foehn episodes is January 2019, characterized by a long sequence of AR
- > In the whole period there were very few NAO- days.
- \triangleright The WTs with N and NW components are the most frequent, as expected



Weather regimes, weather types and Foehn days (yellow) recorded in January 2019. The heatmap help to visualize the WTs distribution.

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