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Spatial-temporal variation of winter warm spells in Italy over the period 1993-2022

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BACKGROUND AND AIMS

One of the worst side effects linked to climate change and to the rising temperatures is the increased frequency of heat waves, both during summer and winter periods.

During the winter, the increase in air temperatures gives rise to the so-called winter warm spells (WWS), which are still scarcely studied although they have significant consequences mainly on biochemistry, phenology, and agriculture (Tomczyk et al., 2019).

In this contribution, the WWS events are detected according to the definition proposed by the Expert Team on Climate Change Detection and Indices (ETCCDI), by examining the wintertime (December, January, February) daily maximum temperatures measured in eight Italian airport sites.

The main objectives of this contributions are:

- ❖ to analyse the temporal and spatial variability of WWS occurred over Italy during the period 1993-2022;
- ❖ to examine the synoptic-scale meteorological conditions characterising the WWS events involving the whole Italian Peninsula or large portions of it;
- ❖ to assess how the reduction of the WWS period length threshold influences the identification of the events.

DATA AND METHODS

Period under investigation:
Wintertime (D,J,F) 1993-2022

Criteria for stations' selection:
- airports (not urban sites, which may be influenced by local effects such as urban heat islands)
- availability of daily maximum temperature (TX) > 95% for the period under investigation
- homogeneous distribution over the Italian peninsula
- belonging to different Köppen-Geiger climate classes

Final dataset: 8 stations

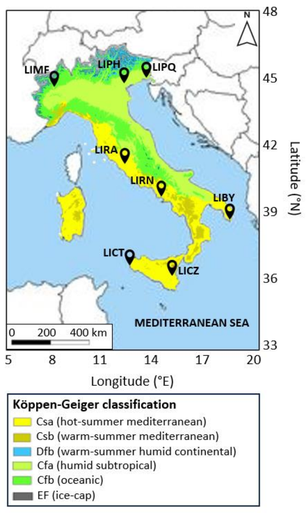

Figure 1: Geographic map of the area under study, Köppen-Geiger climate classification (Beck et al., 2018), and location of the airport meteorological stations identified using the International Civil Aviation Organization (ICAO) codes.

Table 1: List of the stations considered in the present study.

Station	ICAO code	Lat. (°) N	Lon. (°) E	Altitude (m a.s.l.)	Climate classification	Percentage of missing data
Trieste - Ronchi dei Legionari	LIPQ	45.83	13.47	12	Cfa	2.2%
Treviso - Sant'Angelo	LIPH	45.65	12.19	17	Cfa	2.8%
Torino - Caselle	LIMF	45.20	7.65	302	Cfb	2.9%
Roma - Ciampino	LIRA	41.80	12.60	130	Csa	2.9%
Napoli - Capodichino	LIRN	40.89	14.29	90	Csa	4.8%
Santa Maria di Leuca	LIBY	39.82	18.35	112	Csa	3.7%
Trapani - Vincenzo Florio	LICT	37.91	12.49	7	Csa	2.1%
Sigonella	LICZ	37.40	14.92	24	Csa	0.2%

IDENTIFICATION OF *WINTER WARM SPELLS*

A **winter warm spell** is a "*sequence of at least six consecutive days when the daily maximum temperature ($TX_{i,j}$) on the i-th day during j-th period exceeds the calendar day 90th percentile of the base period ($TX90_{i,ref}$)*" (Karl et al., 1999). The 90th percentile is computed for each calendar day by considering a 5-day window centred on a given day, as required by ETCCDI, assuming the base period 1993-2022.

RESULTS

SPATIAL-TEMPORAL DISTRIBUTION OF WWS

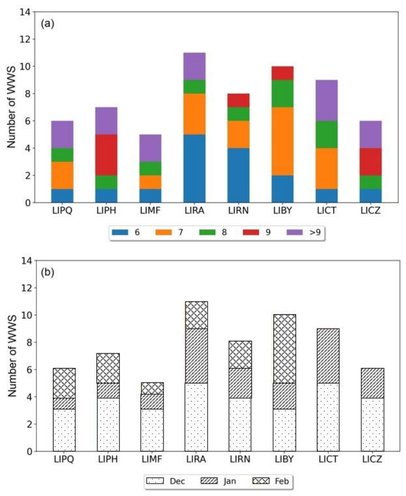

Figure 3: Number of WWS (vertical axis) by (a) duration, expressed in days, and (b) month of occurrence in the winters 1993-2022. Stations are listed in decreasing order of the latitude from left to right.

SYNOPTIC-SCALE CONDITIONS DURING SELECTED WWS

The investigation of the occurrence of WWS in the period 1993-2022 allowed for the identification of peculiar events that affected:
- Italian peninsula (all the sites selected): 26-31 December 2022
- only sites in northern Italy (LIPQ, LIPH, LIMF): 13-21 February 1998
- only sites in central Italy (LIRA, LIRN): 09-14 January 1996
- only sites in southern Italy (LIBY, LICT, LICZ): 18-23 January 2007

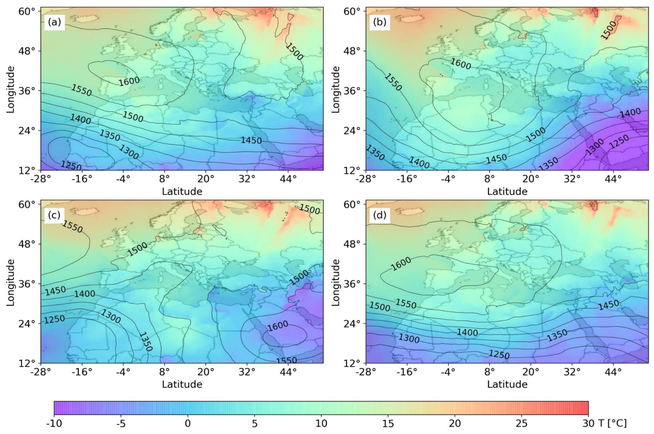

Figure 4: Average ERA5 geopotential heights (black lines) and air temperature (colour shades) at 850 hPa for WWS over (a) Italy on 26-31 December 2022, (b) northern Italy on 13-21 February 1998, (c) central Italy on 09-14 January 1996, and (d) southern Italy on 18-23 January 2007. Charts refer to 12:00 UTC.

REDUCTION OF TEMPORAL THRESHOLD FOR WWS IDENTIFICATION

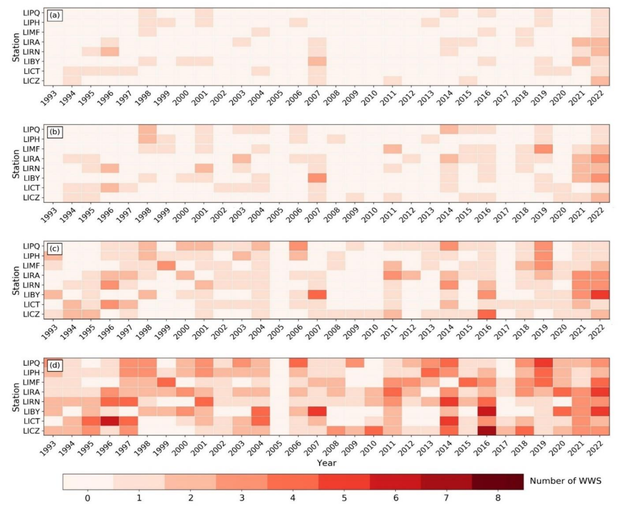

Figure 5: Temporal changes in WWS events fixing the temporal threshold at (a) six, (b) five, (c) four, and (d) three days.

		Station							
		LIPQ	LIPH	LIMF	LIRA	LIRN	LIBY	LICT	LICZ
WWS duration	6 days	5	7	5	11	8	10	9	6
	5 days	11	10	15	18	15	15	13	11
	4 days	29	24	24	32	26	28	25	26
	3 days	57	50	48	60	53	48	51	59

Table 2: Number of WWS for each station varying the temporal threshold.

CONCLUSIONS

- ➢ Over the period 1993-2022 only one WWS that affected the entire Italian territory was identified.
- ➢ WWS are most likely to occur during December in all the sites.
- ➢ The synoptic conditions associated with WWS are, on average, characterised by anticyclonic systems centred on western Mediterranean, responsible for persistent high-pressure conditions.
- ➢ In orographically heterogeneous areas, the definition of WWS provided by ETCCDI allows to capture synoptic scale events, losing information on moderate warm spells (lasting at least three days);
- ➢ For the investigation of complex orographic areas, it is suggested to reduce the period length threshold for the identification of WWS to three days.

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