



ISPRA
Istituto Superiore per la Protezione
e la Ricerca Ambientale



Sistema Nazionale
per la Protezione
dell'Ambiente

LA CRISI CLIMATICA
Stato e trend del clima in Italia
Roma, 13 luglio 2022 | H 14:30 - 16:30

I Climate Normals nell'analisi del clima

Ten. Col. Fabrizio Ciciulla

Centro Operativo per la Meteorologia - Aeronautica Militare

Stato e trend del clima in Italia – 13 luglio 2022 - Roma

CLimate NOrmals



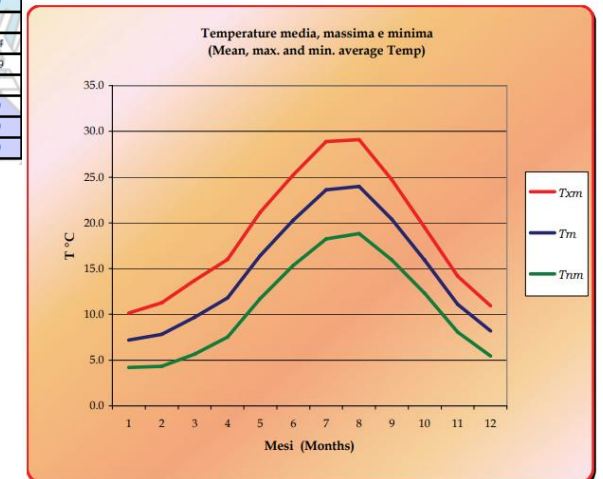
Copyright Aeronautica Militare - Servizio Meteorologico

Sin dalla costituzione degli organismi meteorologici internazionali IMO/WMO è stata avvertita l'esigenza di definire e regolamentare criteri e metodologie per ricavare dei valori climatici di riferimento (in seguito denominati Climate Normals, CNs) al fine di:

- caratterizzare le condizioni meteorologiche medie di una determinata località in un dato periodo dell'anno (condizioni che hanno maggiore probabilità di verificarsi nell'ipotesi di un clima stazionario – in tal senso i CNs possono assumere la funzione di predittori impliciti)
- disporre di una sorta di benchmark ufficiale (riferimento standard) rispetto al quale confrontare condizioni meteo-climatiche passate e attuali a livello locale, regionale o globale
- consentire la costruzione di dataset climatici basati sui valori di anomalia rispetto ai valori standard di riferimento

| VIGNA DI VALLE (Roma) 266 m. s.l.m. (a.s.l.) | | | | | | | | | | | |
|--|----------|-----------|-----------|-----------|----------|----------|---------|-------|-------|-----------|-----------|
| TEMPERATURE | | | | | | | | | | | |
| MM | Tm | Tx 1d | Tx 2d | Tx 3d | Txm | Tn 1d | Tn 2d | Tn 3d | Tnm | Tx P85-15 | Tn P85-15 |
| Gen(Jan) | 7.2 | 9.8 | 10.1 | 10.6 | 10.1 | 4.1 | 4.1 | 4.4 | 4.2 | 5.3 | 5.4 |
| Feb(Feb) | 7.8 | 11.3 | 10.9 | 11.7 | 11.3 | 4.4 | 4.2 | 4.3 | 4.3 | 6.3 | 5.6 |
| Mar(Mar) | 9.7 | 12.6 | 13.8 | 14.7 | 13.7 | 4.9 | 5.6 | 6.5 | 5.7 | 6.4 | 5.3 |
| Apr(Apr) | 11.8 | 15.6 | 15.4 | 17.1 | 16.0 | 7.3 | 7.0 | 8.4 | 7.5 | 6.4 | 4.8 |
| Mag(May) | 16.4 | 19.4 | 21.3 | 22.6 | 21.2 | 10.4 | 11.8 | 12.9 | 11.7 | 7.1 | 4.9 |
| Giu(Jun) | 20.3 | 24.2 | 25.0 | 26.5 | 25.2 | 14.5 | 15.2 | 16.3 | 15.3 | 6.5 | 4.6 |
| Lug(Jul) | 23.6 | 28.0 | 28.8 | 29.8 | 28.9 | 17.6 | 18.2 | 18.9 | 18.3 | 5.4 | 4.1 |
| Ago(Aug) | 24.0 | 30.3 | 29.8 | 27.4 | 29.1 | 19.3 | 19.3 | 17.9 | 18.8 | 6.7 | 4.4 |
| Set(Sep) | 20.4 | 25.9 | 25.0 | 23.4 | 24.7 | 16.6 | 16.1 | 15.2 | 16.0 | 6.4 | 4.6 |
| Ott(Oct) | 15.9 | 21.2 | 19.9 | 17.6 | 19.5 | 13.6 | 12.6 | 10.8 | 12.3 | 7.0 | 6.0 |
| Nov(Nov) | 11.1 | 16.1 | 14.3 | 12.2 | 14.2 | 9.6 | 8.1 | 6.4 | 8.1 | 6.2 | 6.1 |
| Dic(Dec) | 8.2 | 11.3 | 11.2 | 10.4 | 10.9 | 5.8 | 5.6 | 5.0 | 5.4 | 5.8 | 6.2 |
| MM | NgTn ≤ 0 | NgTn ≤ -5 | NgTx ≥ 25 | NgTx ≥ 30 | GrGi > 0 | GrGi > 5 | GrGi 18 | Txx | An Tx | Tnn | An Tn |
| Gen(Jan) | 1.6 | 0.1 | 0.0 | 0.0 | 224 | 71 | 337 | 16.3 | 1975 | -6.2 | 1985 |
| Feb(Feb) | 1.6 | 0.0 | 0.0 | 0.0 | 219 | 79 | 286 | 20.6 | 1990 | -2.7 | 1986 |
| Mar(Mar) | 0.9 | 0.0 | 0.0 | 0.0 | | | | | | | |
| Apr(Apr) | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | | |
| Mag(May) | 0.0 | 0.0 | 4.4 | 0.0 | | | | | | | |
| Giu(Jun) | 0.0 | 0.0 | 16.0 | 2.1 | | | | | | | |
| Lug(Jul) | 0.0 | 0.0 | 28.5 | 11.4 | | | | | | | |
| Ago(Aug) | 0.0 | 0.0 | 28.3 | 12.9 | | | | | | | |
| Set(Sep) | 0.0 | 0.0 | 15.1 | 1.1 | | | | | | | |
| Ott(Oct) | 0.0 | 0.0 | 1.6 | 0.0 | | | | | | | |
| Nov(Nov) | 0.1 | 0.0 | 0.0 | 0.0 | | | | | | | |
| Dic(Dec) | 1.0 | 0.0 | 0.0 | 0.0 | | | | | | | |

VIGNA DI VALLE (Roma) 266 m. s.l.m. (a.s.l.)



CLimate NOrmals



Nel 2015 la WMO (Cg-17, Res 16) decide di adottare una definizione aggiornata e migliorata dei *Climate Normals* la cui novità più rilevante è la seguente:

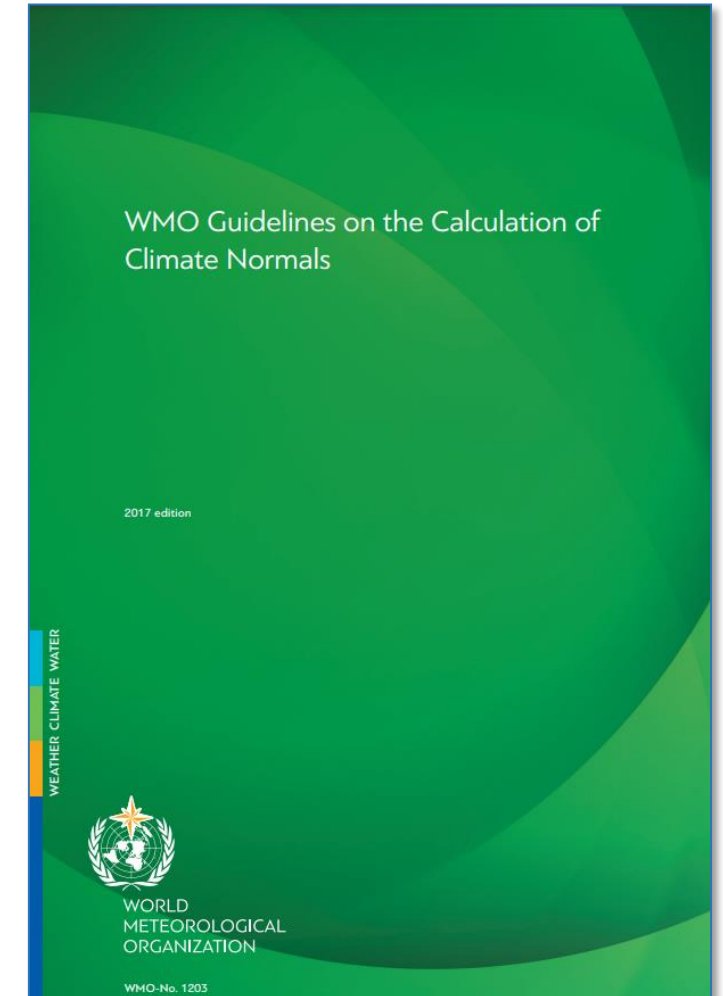
I normali climatici trentennali dovranno essere aggiornati ogni 10 anni e non più, come avveniva in precedenza, ogni 30 anni

(i periodi trentennali avranno così un periodo di sovrapposizione di 20 anni)

Motivazione

in un contesto di cambiamento climatico è più probabile che il periodo più recente sia un riferimento più adeguato per le **applicazioni** climatiche operative e i **servizi** climatici settoriali (si pensi, ad esempio, a quelli relativi al fabbisogno energetico o idrico)

Allo stesso tempo il 1961-1990 viene indicato dalla WMO come il periodo di riferimento ufficiale per la valutazione del cambiamento climatico nel lungo termine, poiché caratterizzato da una relativa stabilità (per tale ragione i CNs 1961-1990 vengono denominati “reference normals”)



CLimate NOrmals

L'Aeronautica Militare elabora e fornisce periodicamente alla WMO, in rappresentanza dell'Italia, i CNs relativi alle stazioni della sua rete sinottica

Nel 2018-2019 la WMO ha lanciato una campagna per la raccolta dei CNs 1981-2010, codificando variabili primarie/secondarie, metodi di calcolo e formati richiesti (WMO-No. 1203, 2017)

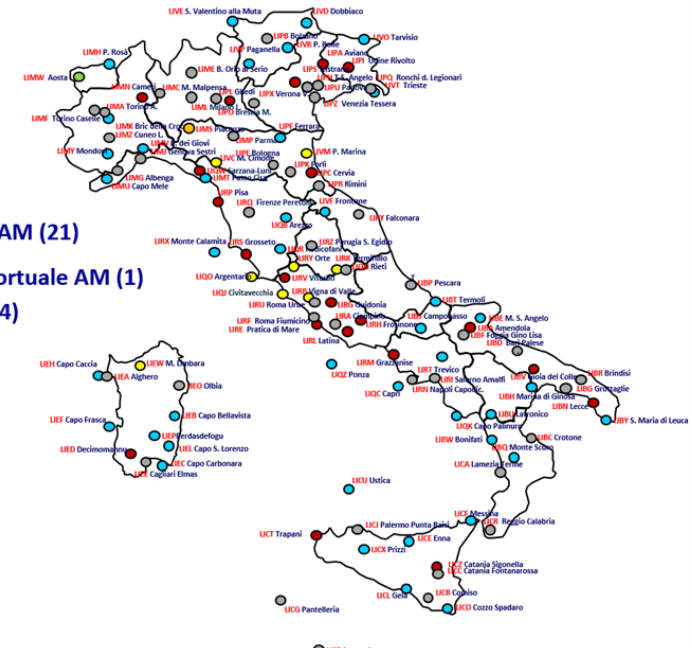
Nel dicembre 2022 terminerà la campagna per la raccolta dei CNs 1991-2020

Vengono adesso presentate alcune elaborazioni relative ai dati della stazione meteo di **Vigna di Valle** (una delle 5 stazioni italiane del programma GCOS) e riferite a variabili e periodi differenti



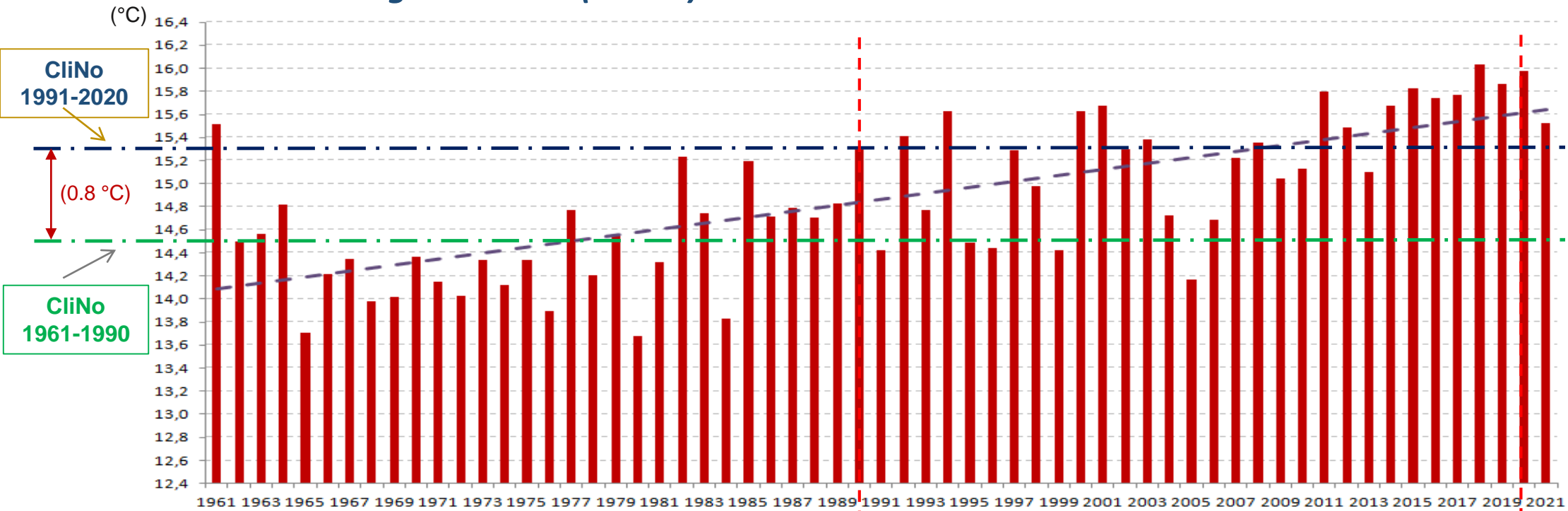
Rete Osservativa Aeronautica Nazionale

- Stazioni Aeroportuali AM (21)
- Distaccamento Aeroportuale AM (1)
- Stazioni isolate AM (44)
- SWS AM (5)
- ENAV (44)
- Altro (1)



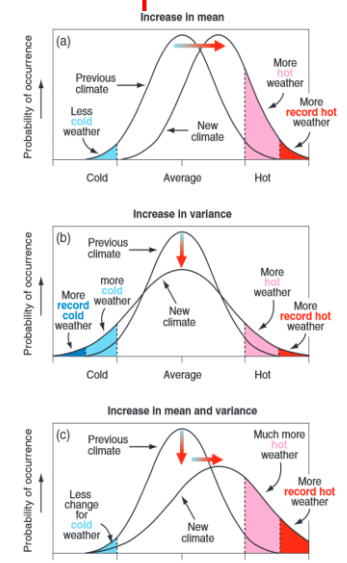
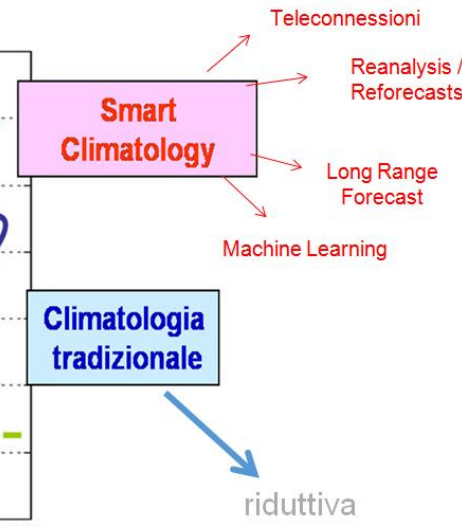
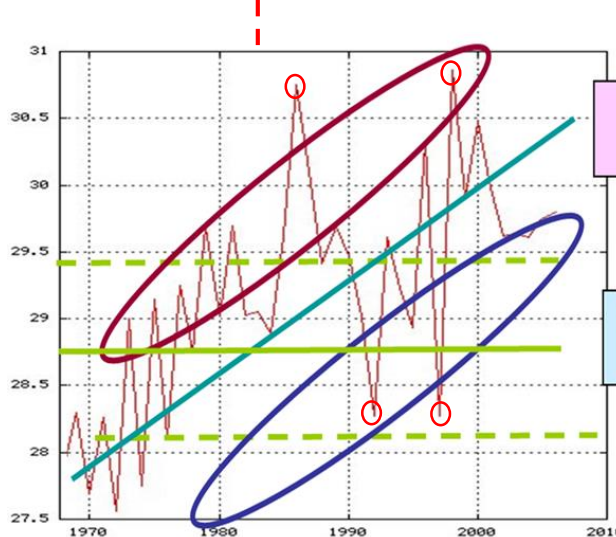
Vigna di Valle (16224)

T-MEAN

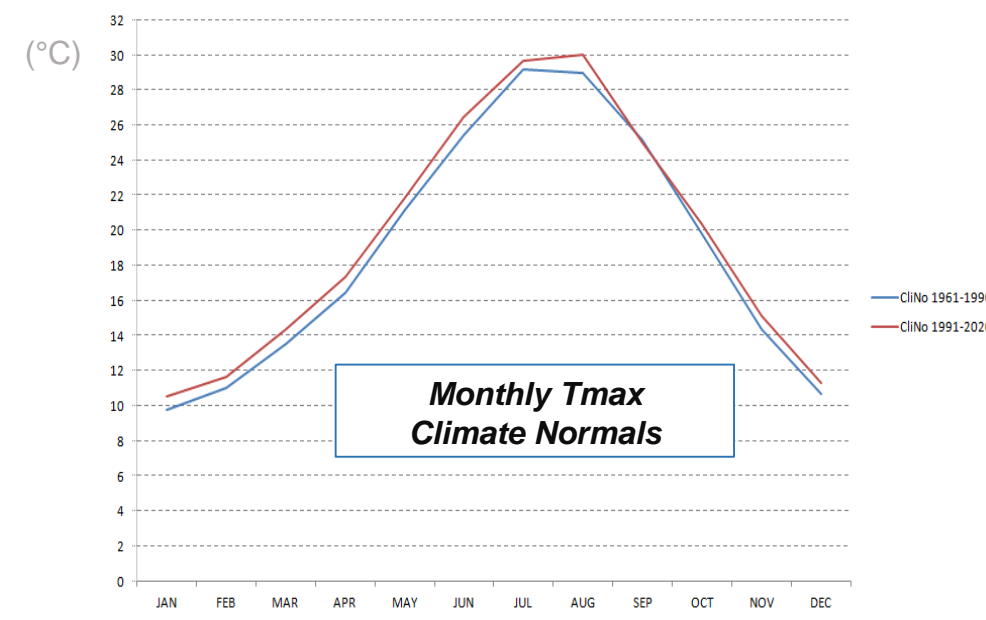
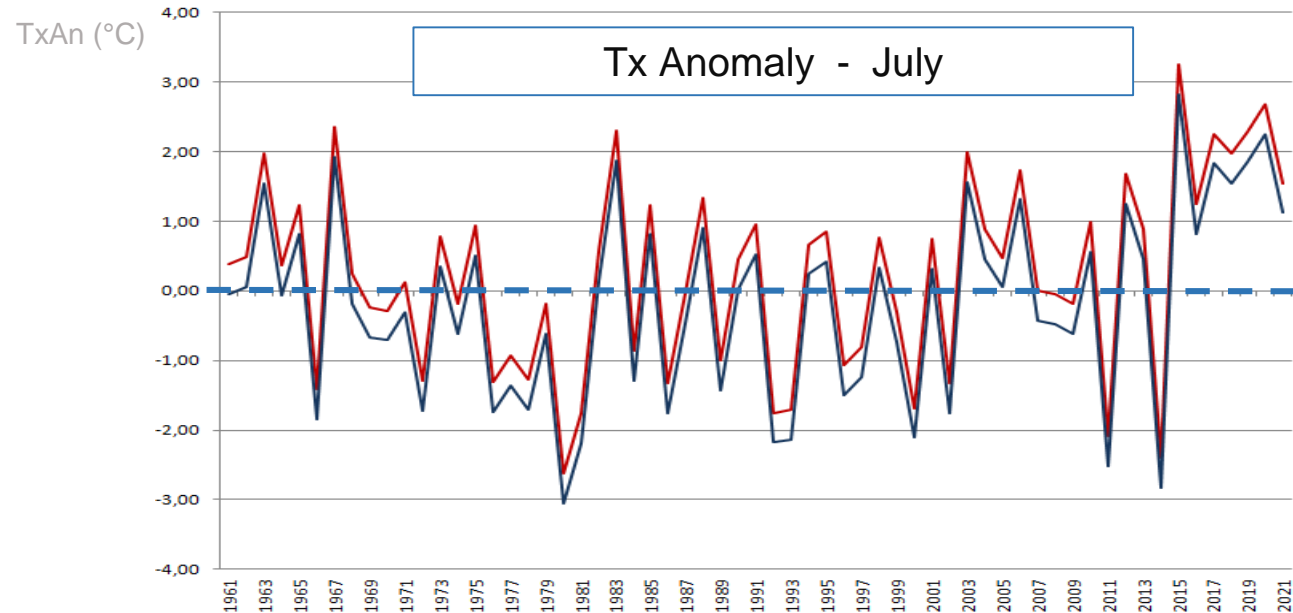
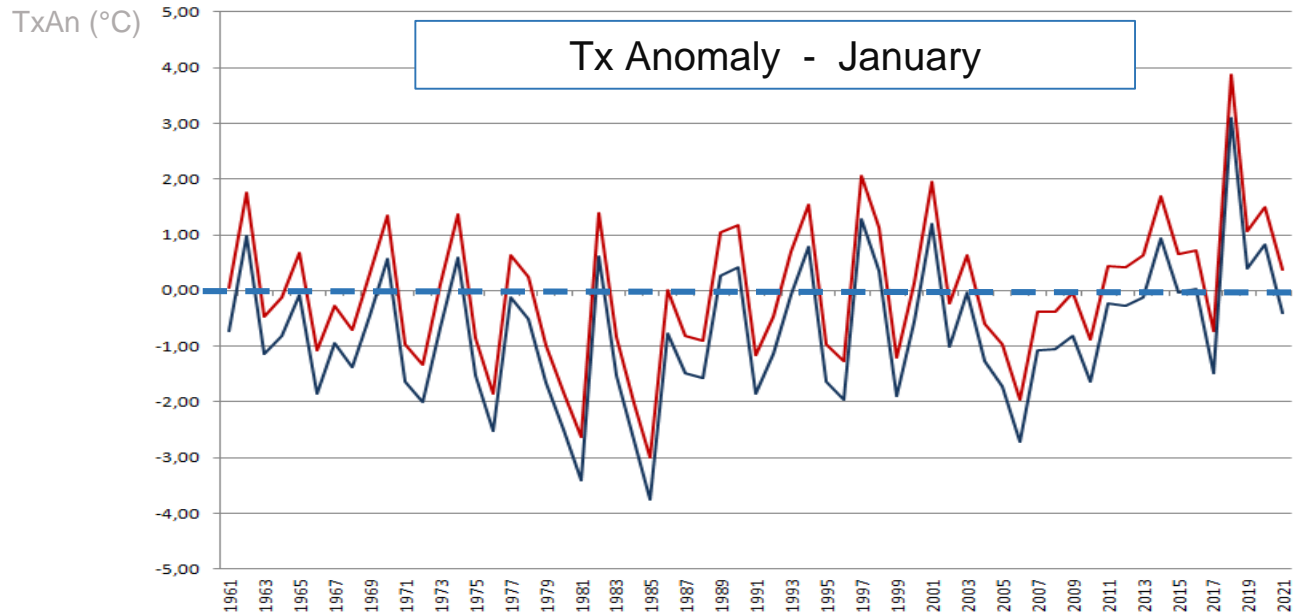


Il concetto di Smart Climatology

- non solo medie di lungo periodo
- analisi su periodi non standard (più brevi del trentennio e più recenti)
- più attenzione al trend, alle fluttuazioni climatiche ad alta frequenza e ai valori estremi

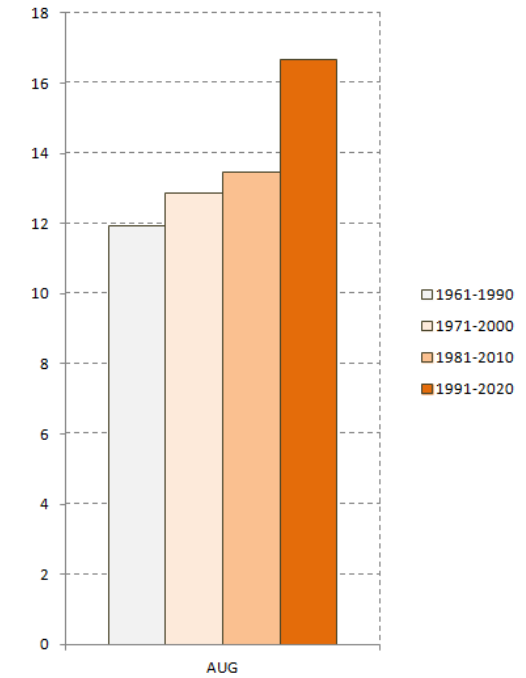


Confronto tra periodi trentennali differenti

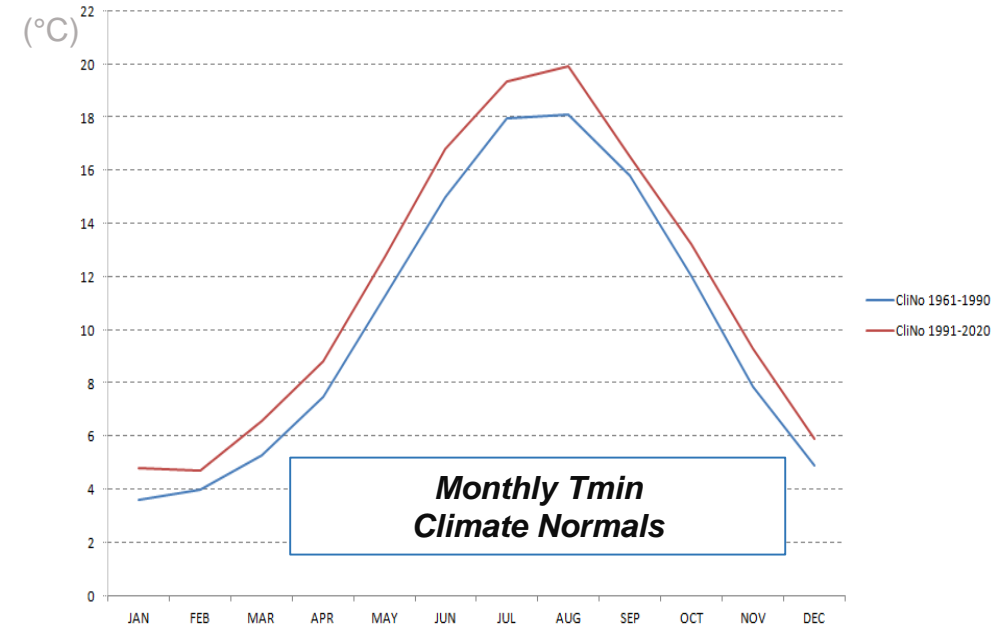
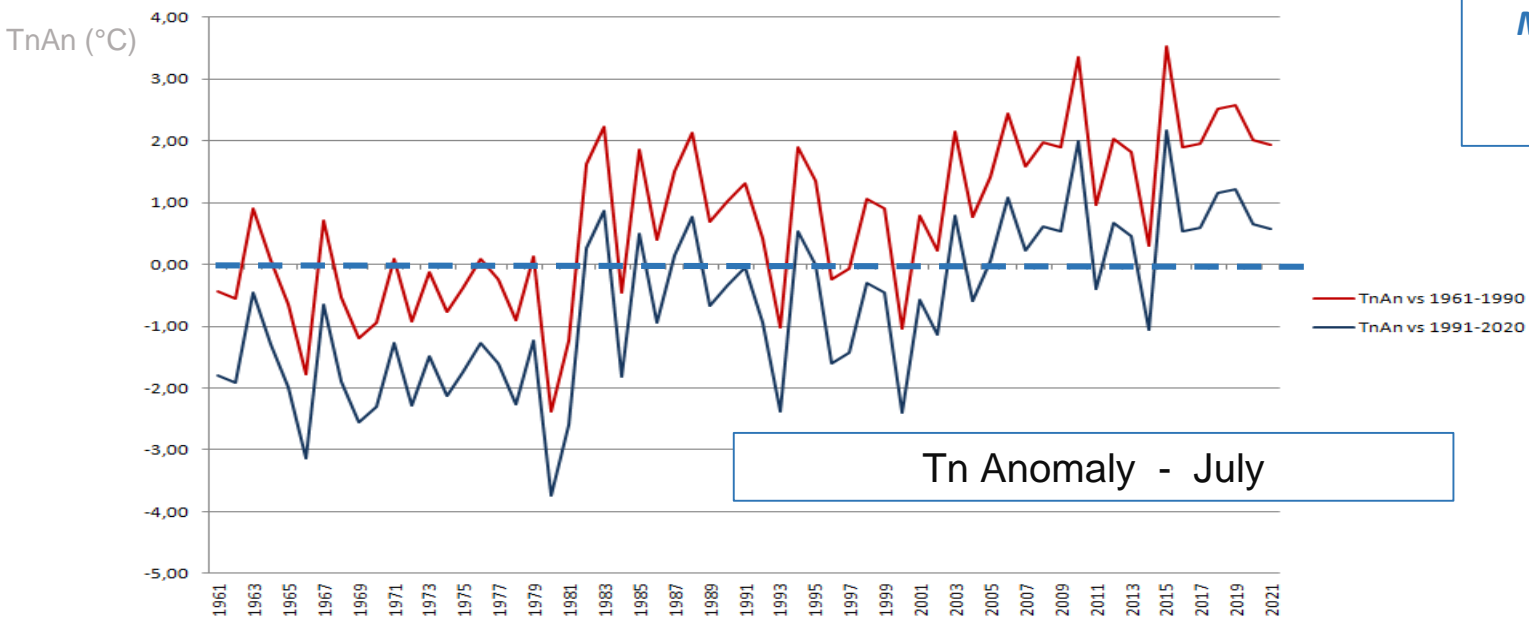
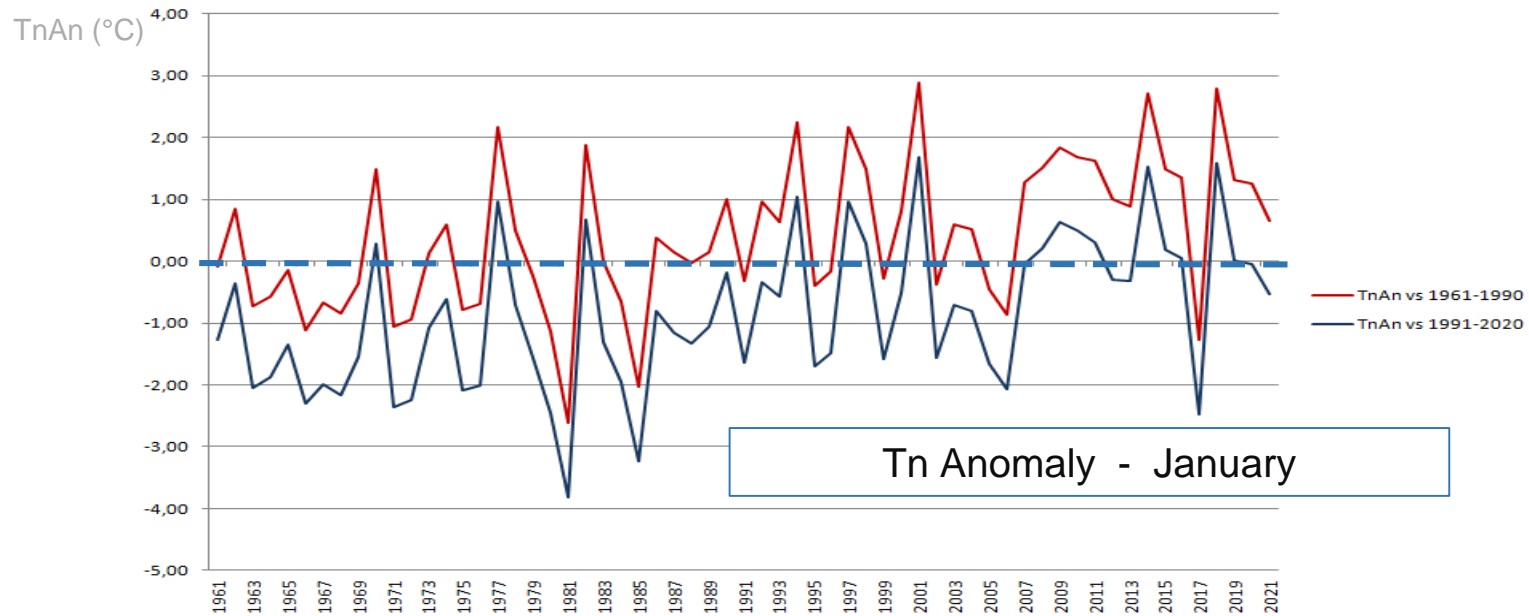


Mean Number of Days with $T_x \geq 30^\circ\text{C}$ (summer days)

Mese di Agosto

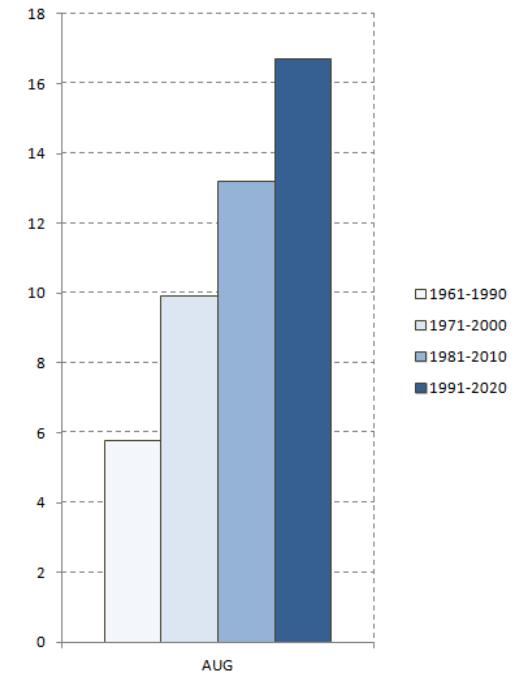


Confronto tra periodi trentennali differenti



Mean Number of Days with
 $T_n \geq 20^\circ\text{C}$
(tropical nights)

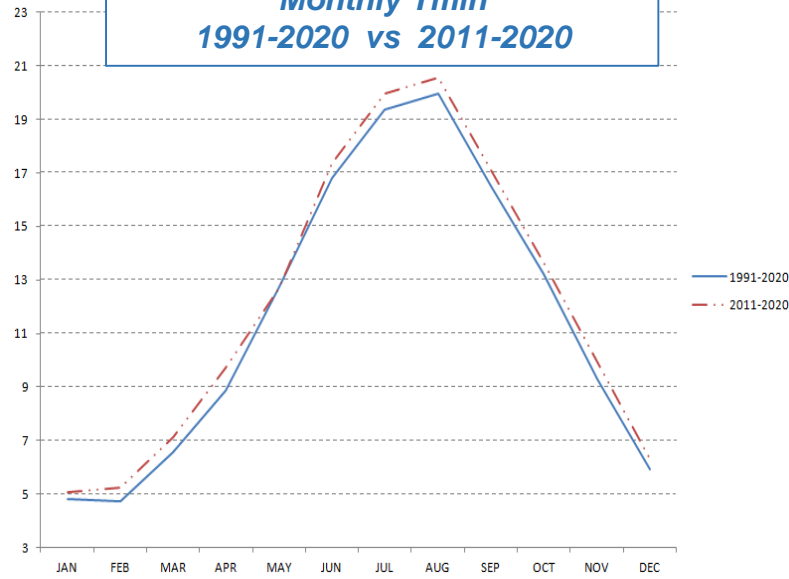
Mese di Agosto



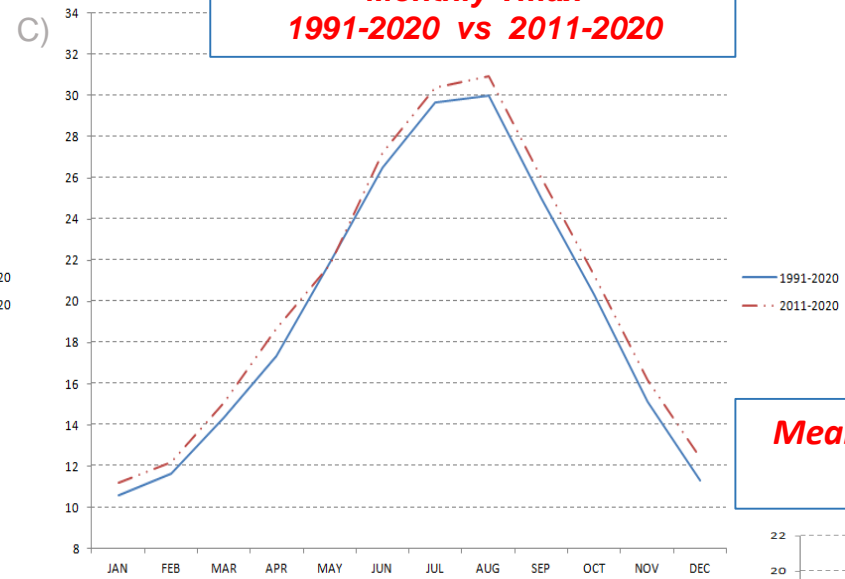
Confronto tra periodo trentennale 1991-2020 e suo ultimo decennio

(°C)

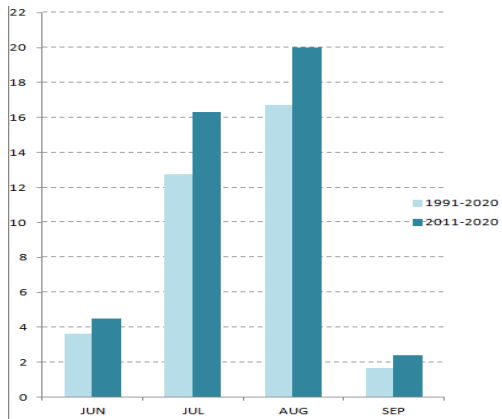
Monthly Tmin 1991-2020 vs 2011-2020



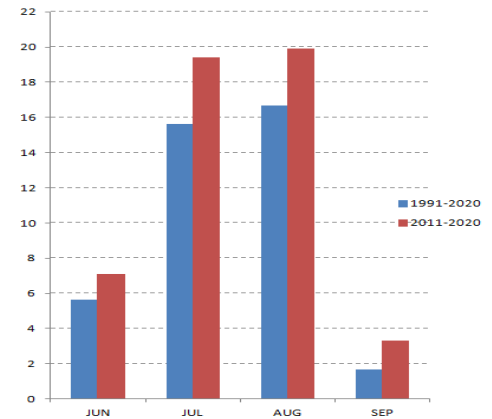
Monthly Tmax 1991-2020 vs 2011-2020



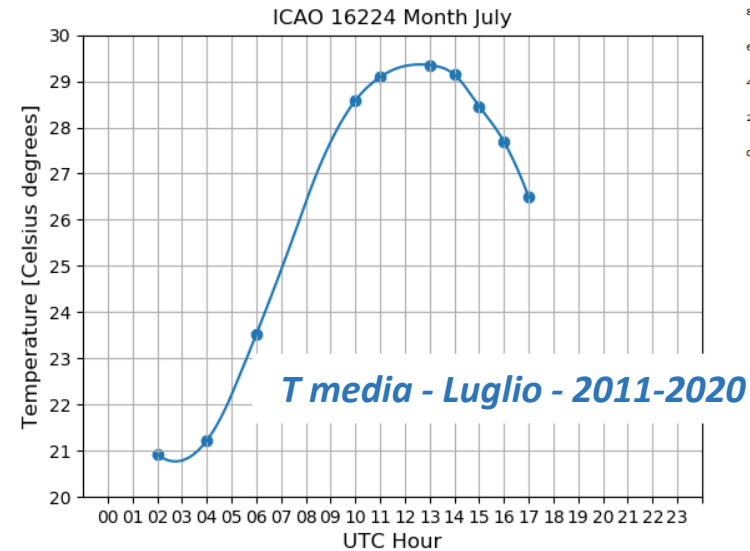
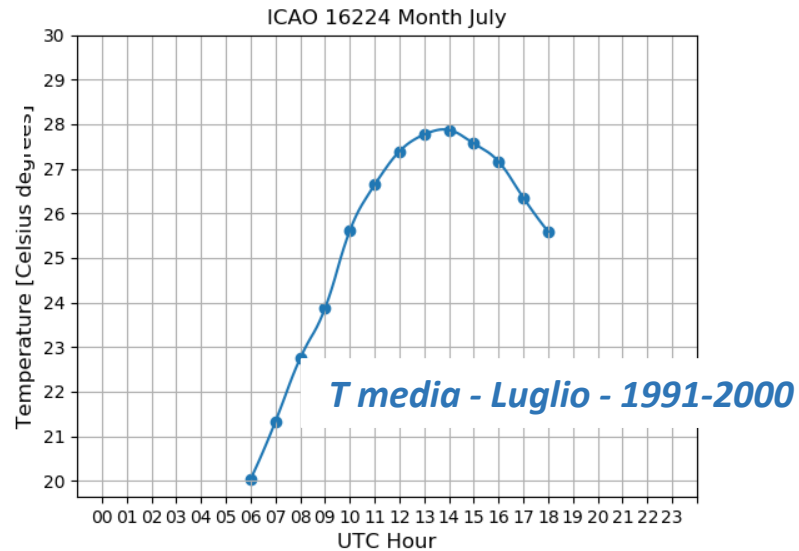
Mean Number of Days with $T_n \geq 20^\circ\text{C}$



Mean Number of Days with $T_x \geq 30^\circ\text{C}$



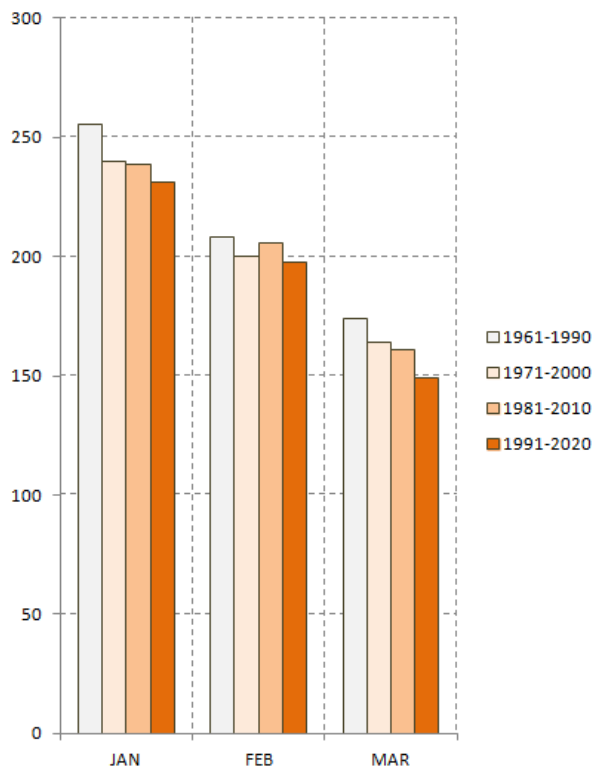
Ciclo diurno termico medio – Mese di Luglio (primo e ultimo decennio del 1991-2020)



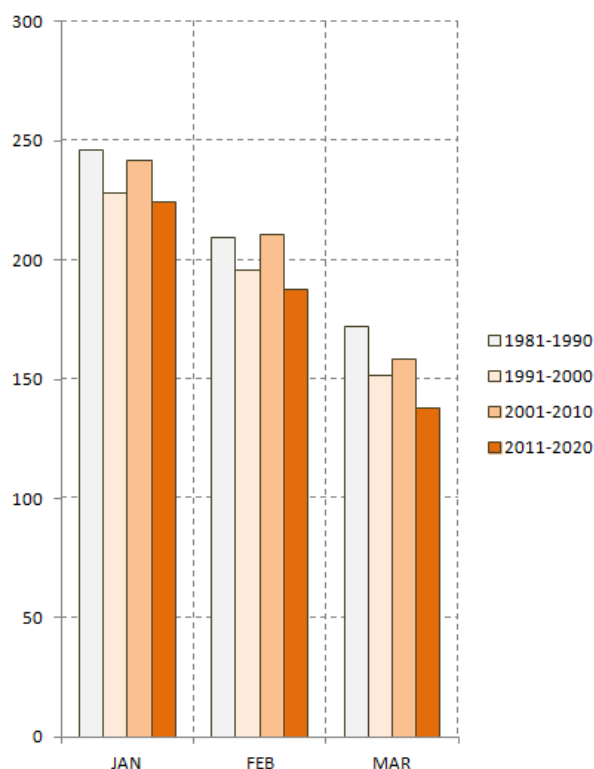
Gradi Giorno

**HEATING DEGREE
DAYS
(HDD15)**

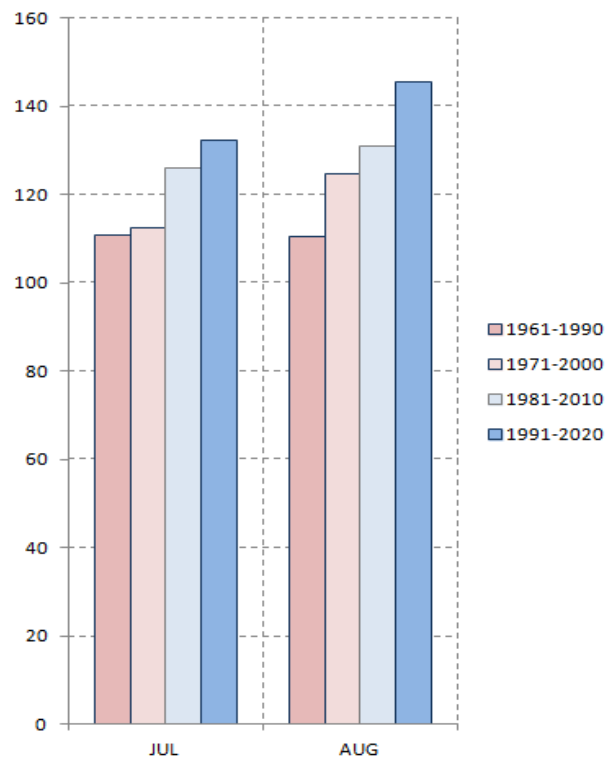
**COOLING DEGREE
DAYS
(CDD20)**



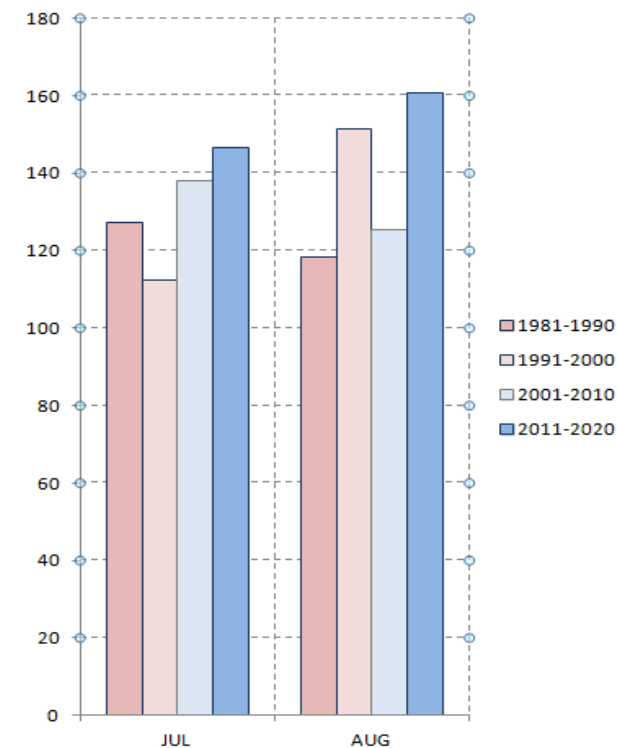
Trentenni



Decenni



Trentenni

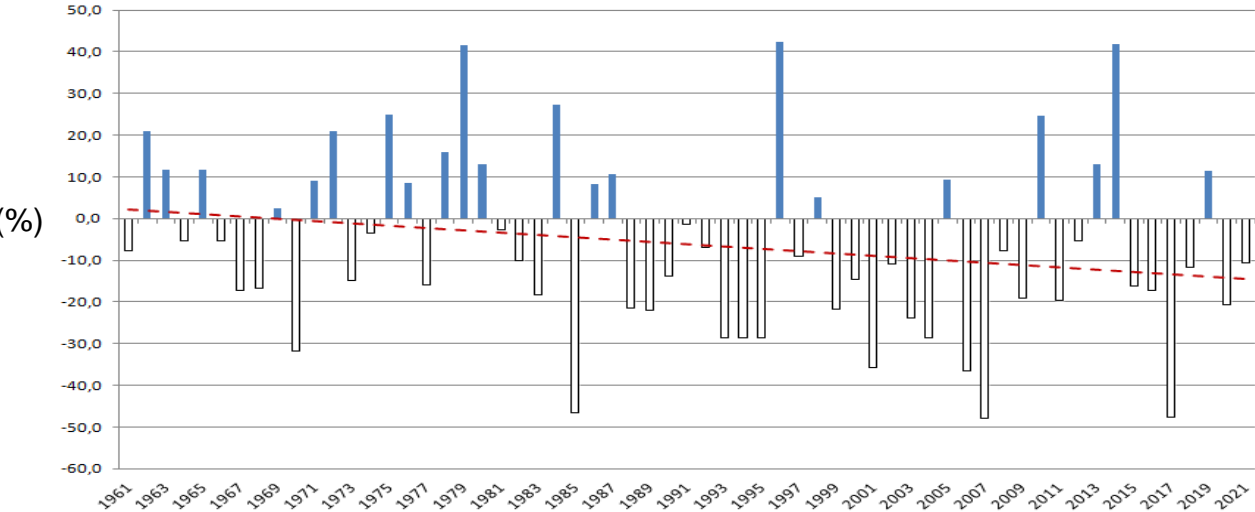


Decenni

Precipitazione

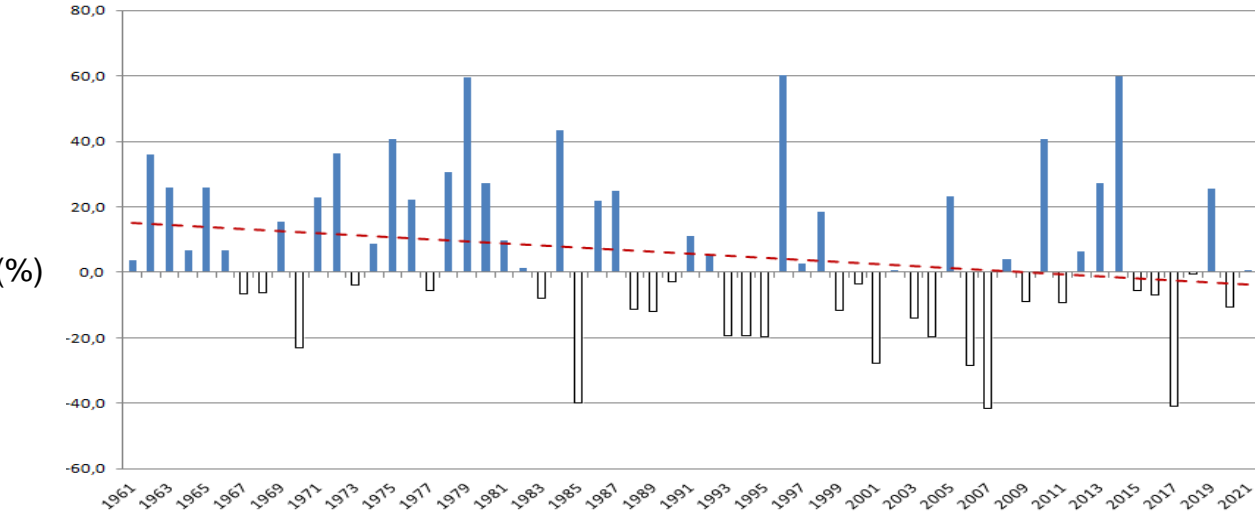
Annual Precipitation

PercAnom vs CliNo 1961-1990

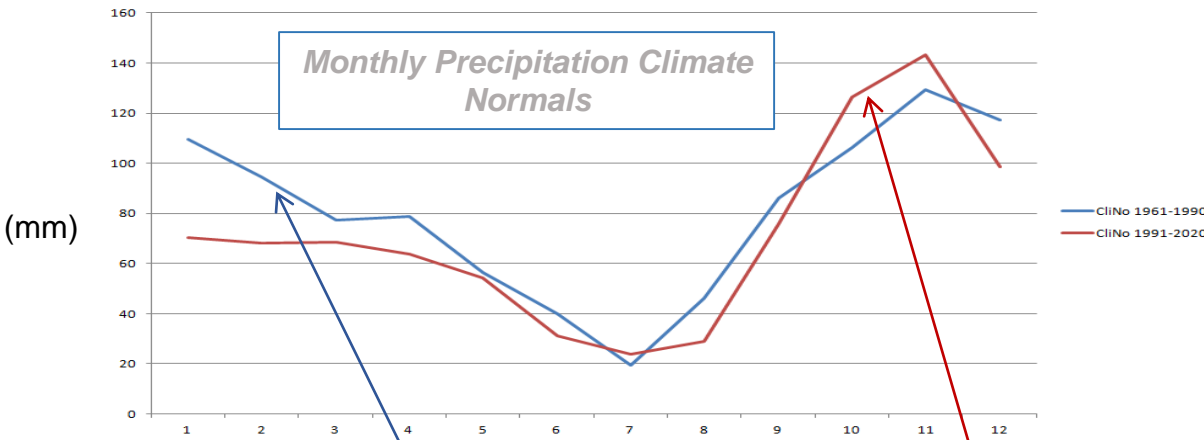


Annual Precipitation

PercAnom vs CliNo 1991-2020

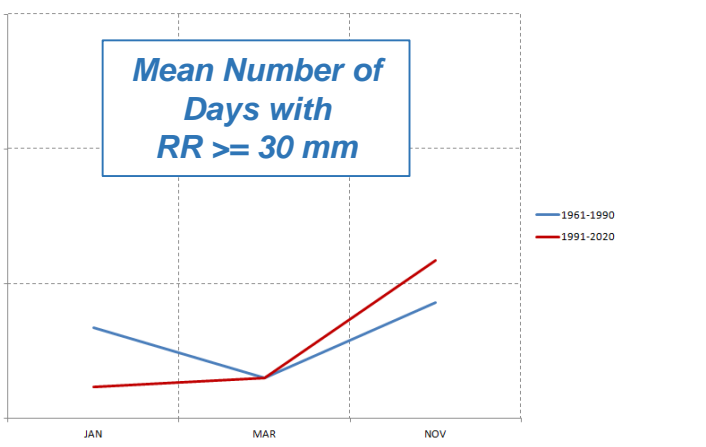
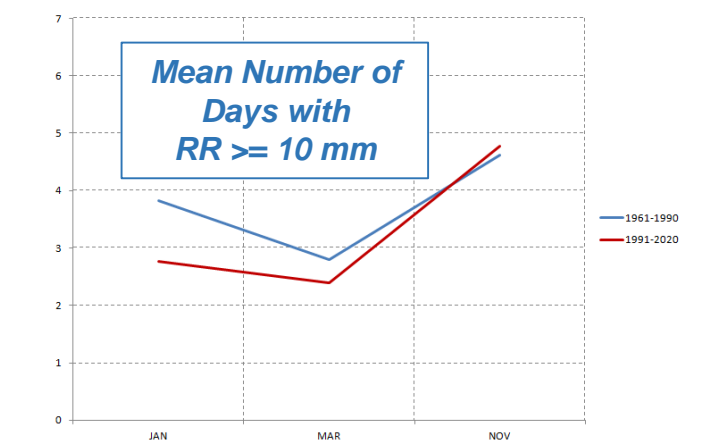
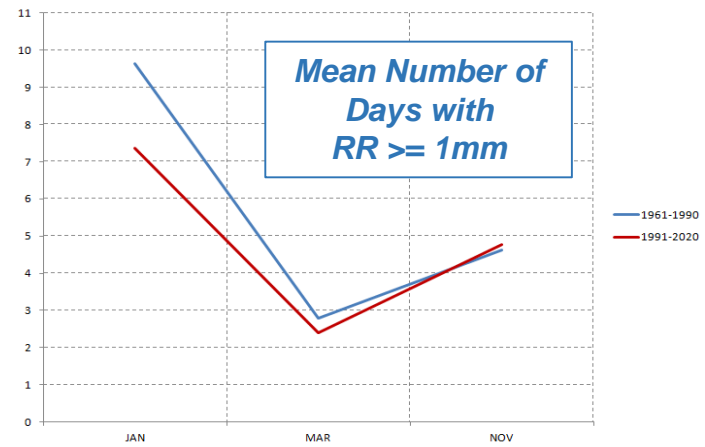
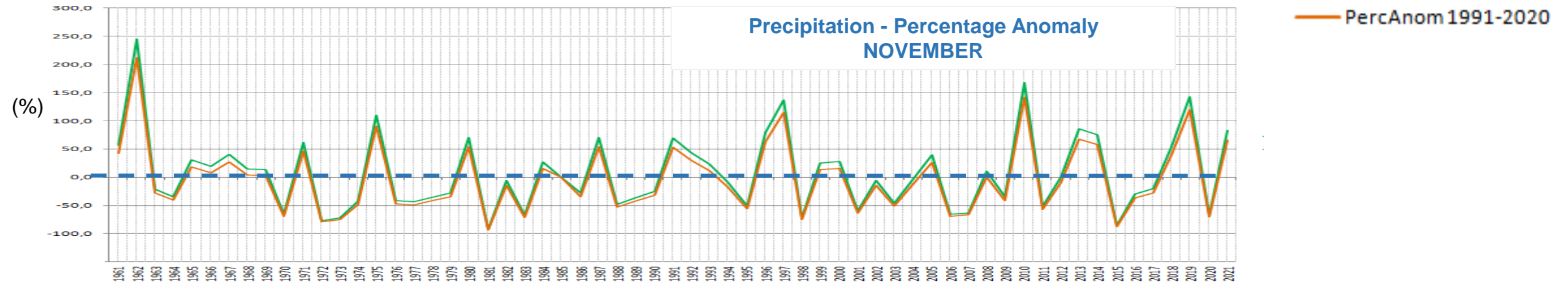
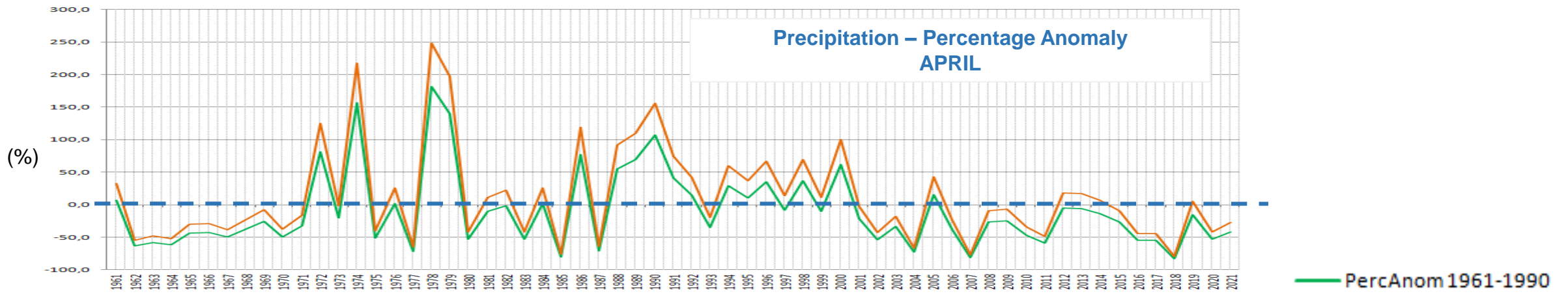


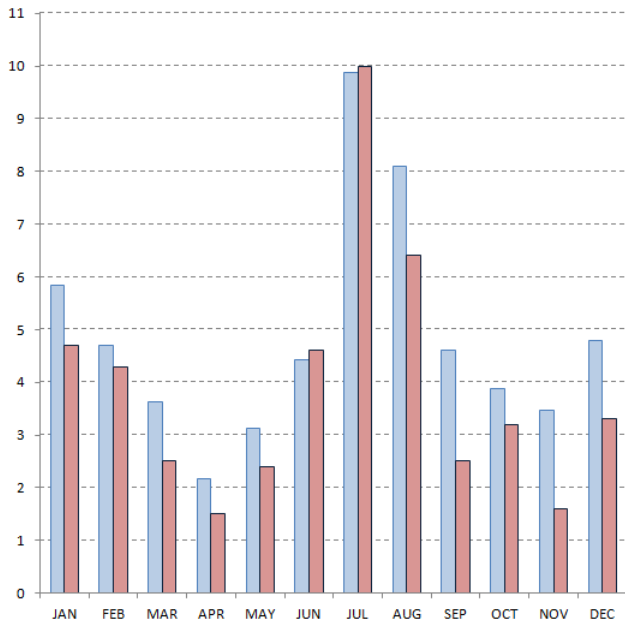
Monthly Precipitation Climate Normals



CliNo 1961-1990

CliNo 1991-2020

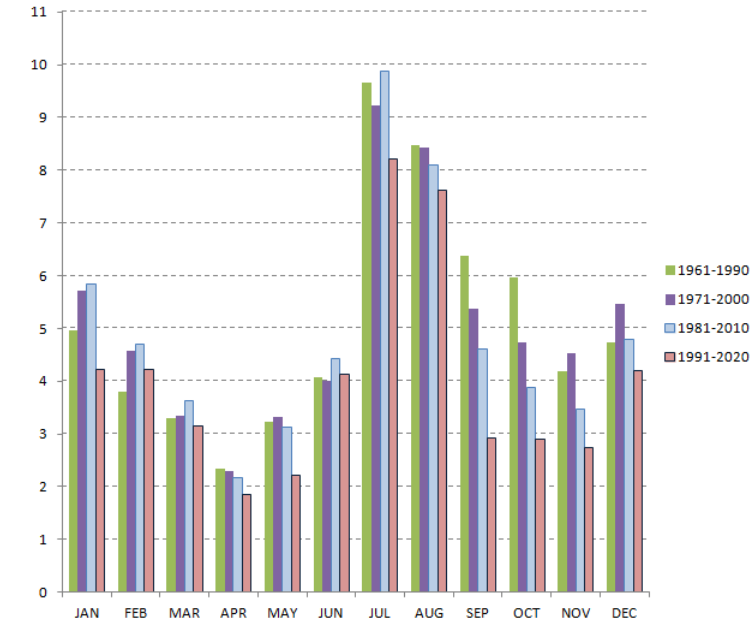




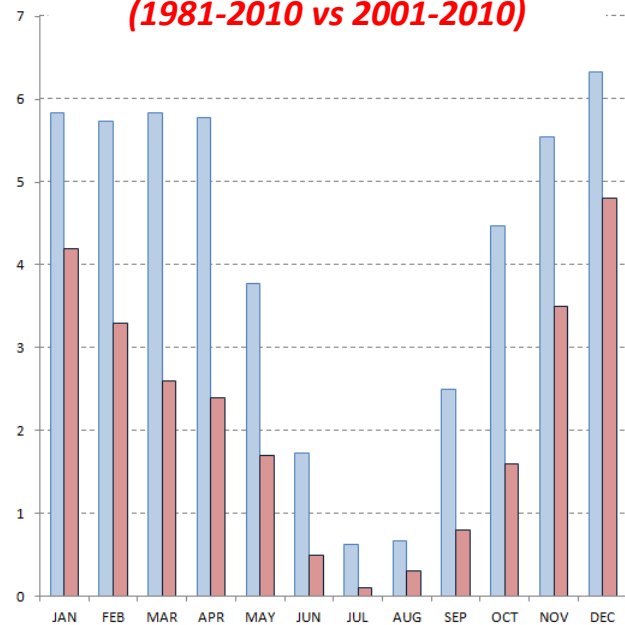
Numero medio di giorni durante i quali la copertura nuvolosa non ha mai superato i 2 ottavi (sereno o poco nuvoloso)

Cloud Cover ≤ 2 oktas

Copertura Nuvolosa



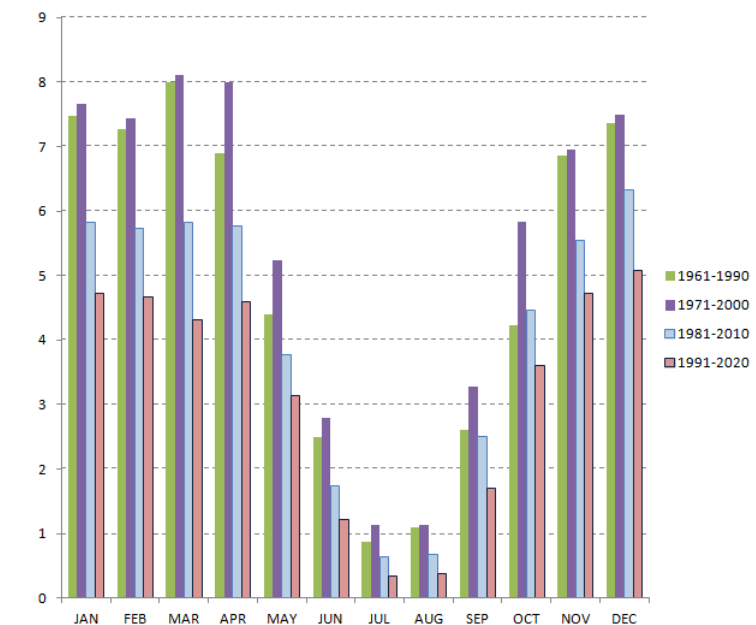
Trentennio vs Decennio
(1981-2010 vs 2001-2010)

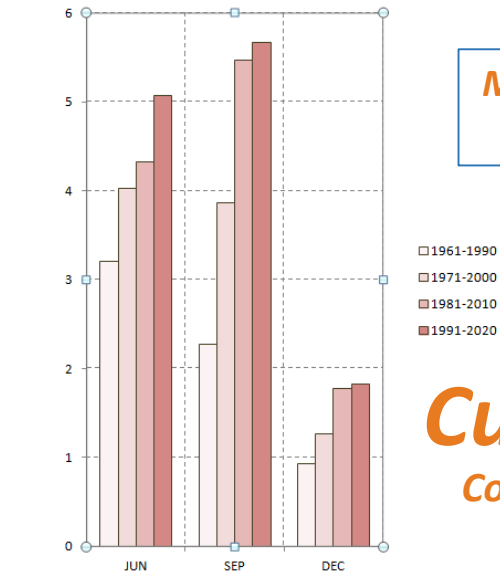


Numero medio di giorni durante i quali la copertura nuvolosa non è mai scesa sotto i 6 ottavi (molto nuvoloso o coperto)

Cloud Cover ≥ 6 oktas

Confronto tra trentenni

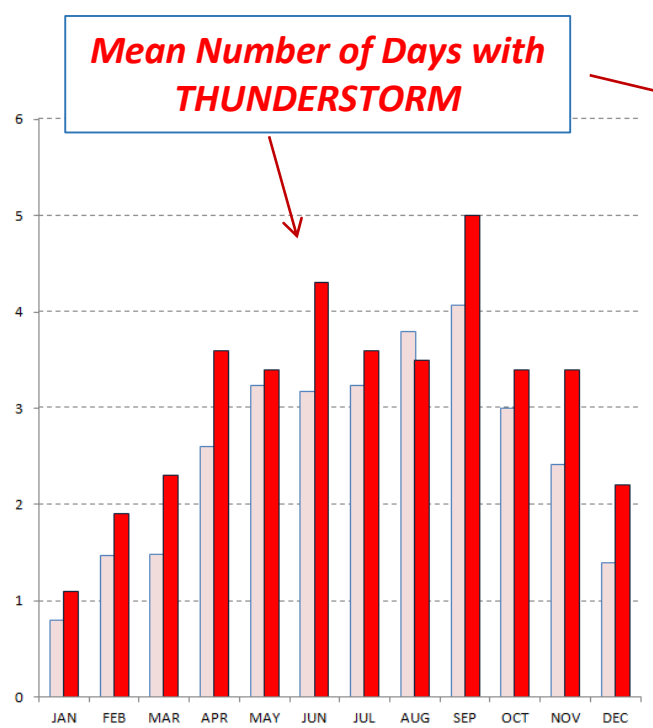




Mean Number of Days with CB

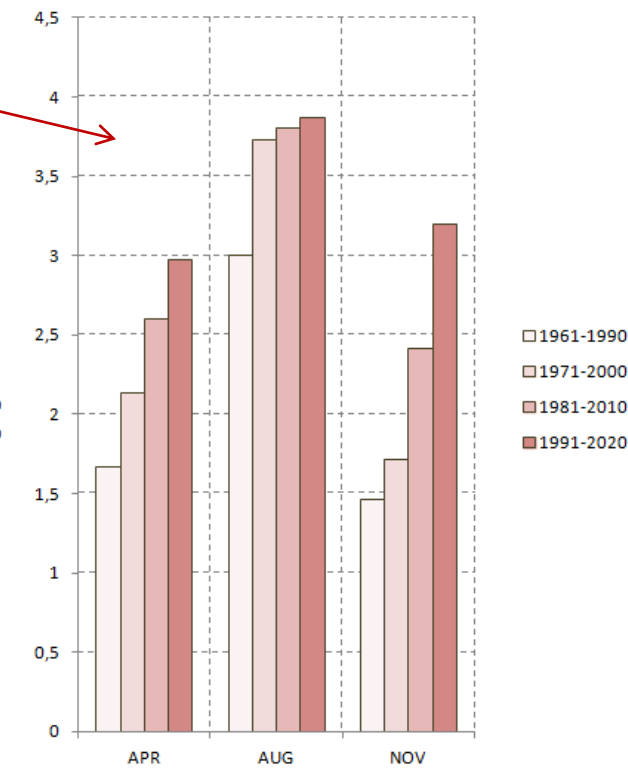
Cumulonembi

Confronto tra Trentenni

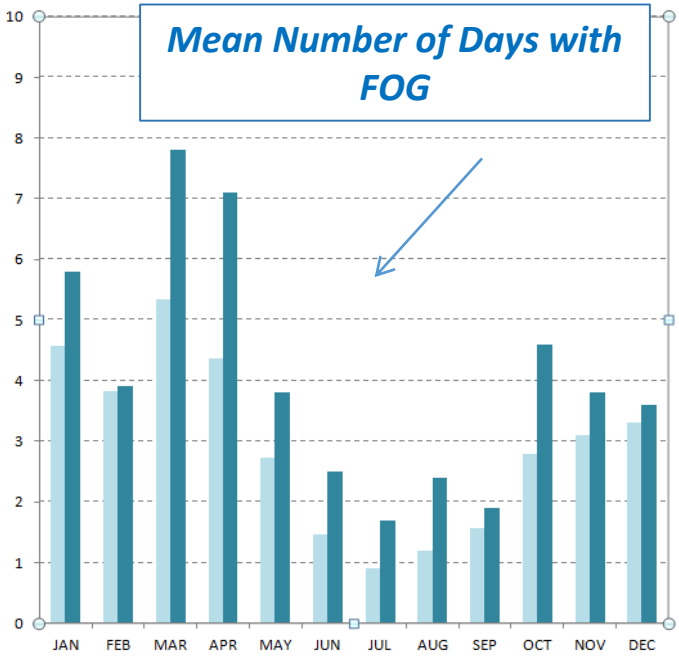


Mean Number of Days with THUNDERSTORM

Trentennio vs Decennio (1981-2010 vs 2001-2010)



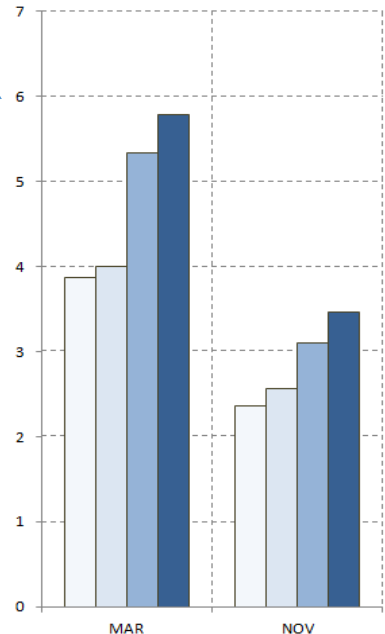
Confronto tra Trentenni



Mean Number of Days with FOG

Trentennio vs Decennio (1981-2010 vs 2001-2010)

Nebbia

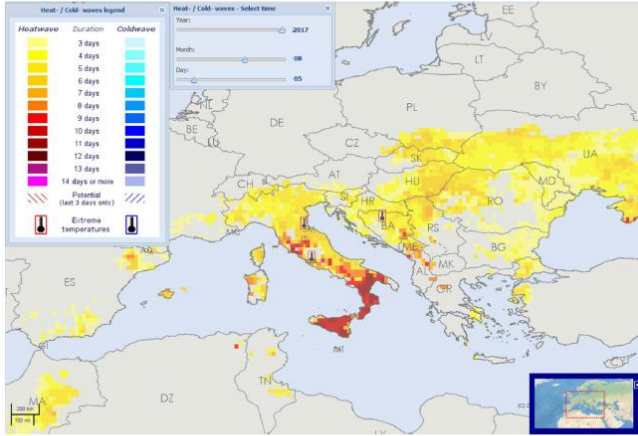


Confronto tra Trentenni

Temporali

Heat and Cold Wave Index (HCWI)

| Variables | Temporal scale | Spatial scale | Coverage |
|--|----------------|-----------------------|----------|
| Daily minimum and maximum temperatures | Daily | 0.25 degrees (~25 km) | Europe |



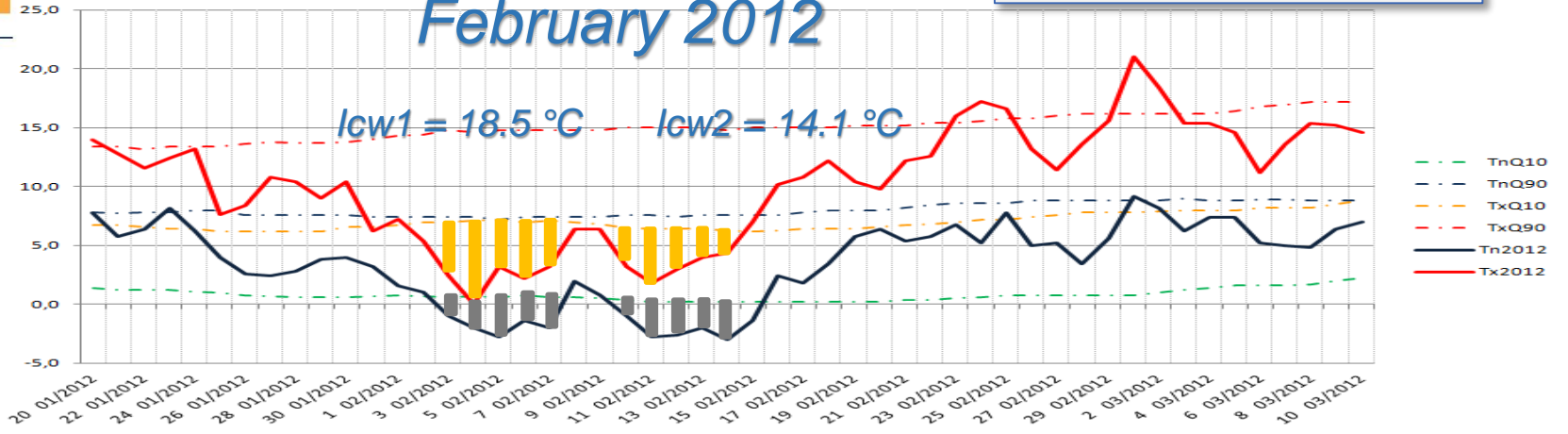
Example of the continuously updated HCWI indicator, produced by the Copernicus European Drought Observatory (EDO), showing the second major heat wave of the summer of 2017, with extreme temperatures of over 40°C (shown by the thermometer symbols) in Italy and Bosnia.

Copernicus EDO
 (European Drought
 Observatory)
 Indicators -
 JRC European
 Commission

Lavaysse et al. 2018

Cold Waves February 2012

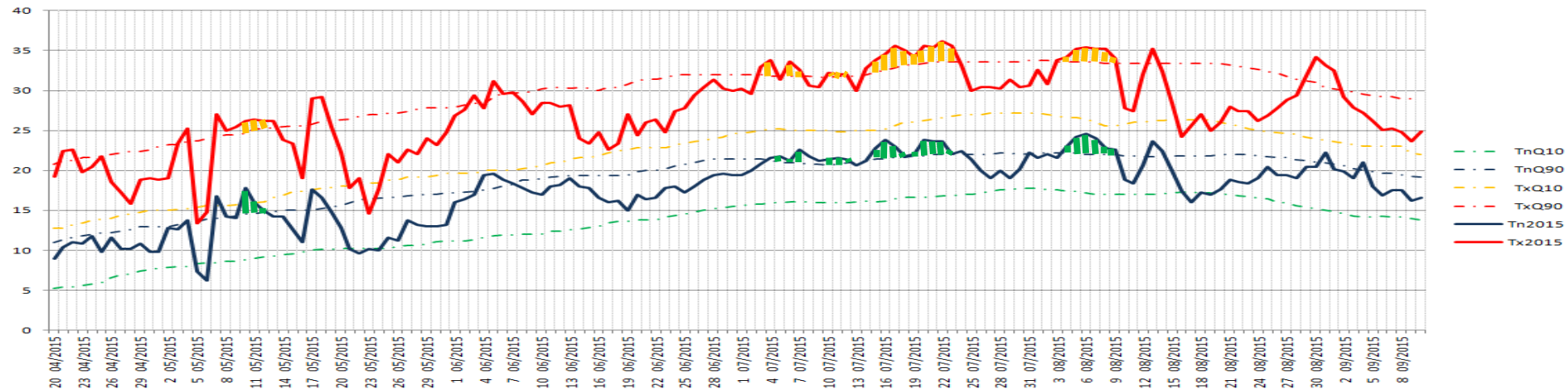
vs CliNo 1981-2010



Heat Waves May-August 2015

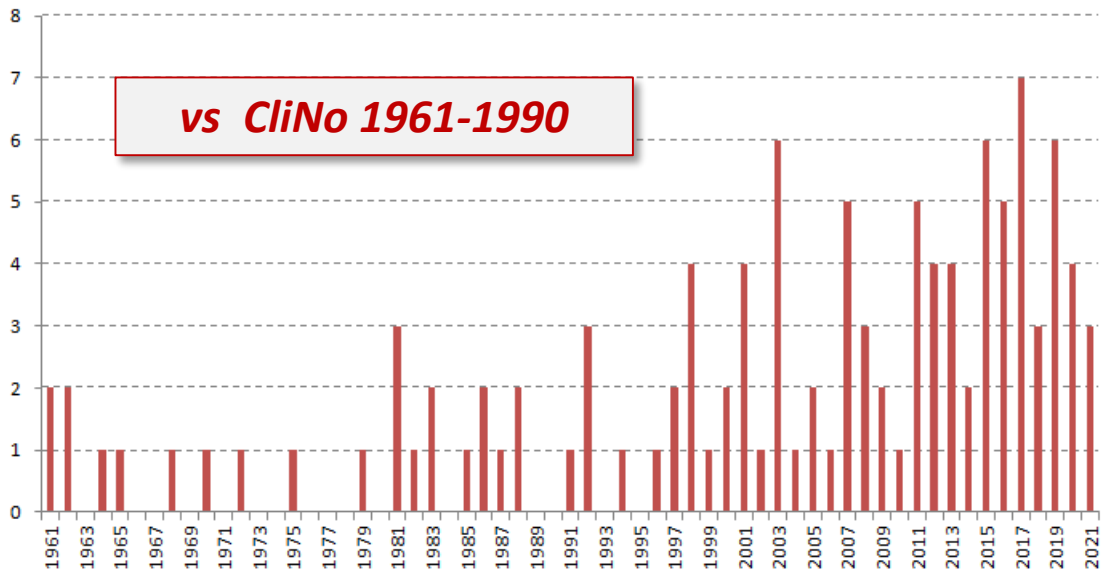
vs CliNo 1981-2010

lhw1 = 4.3 °C lhw2 = 3.4 °C lhw3 = 1.5 °C hw4 = 13.2 °C hw5 = 8.4 °C

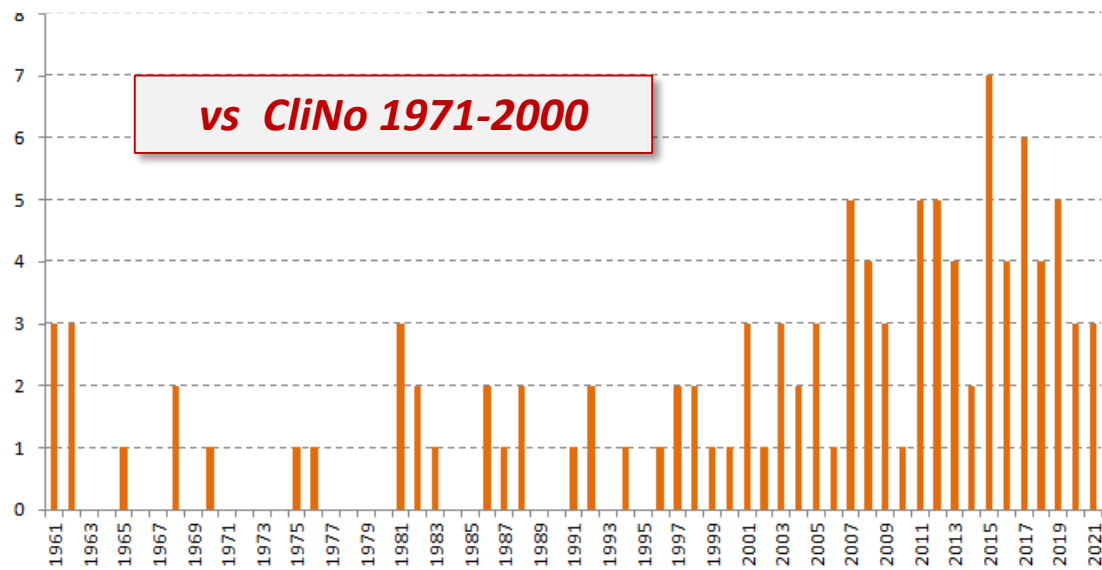


Numero "Heat Waves"

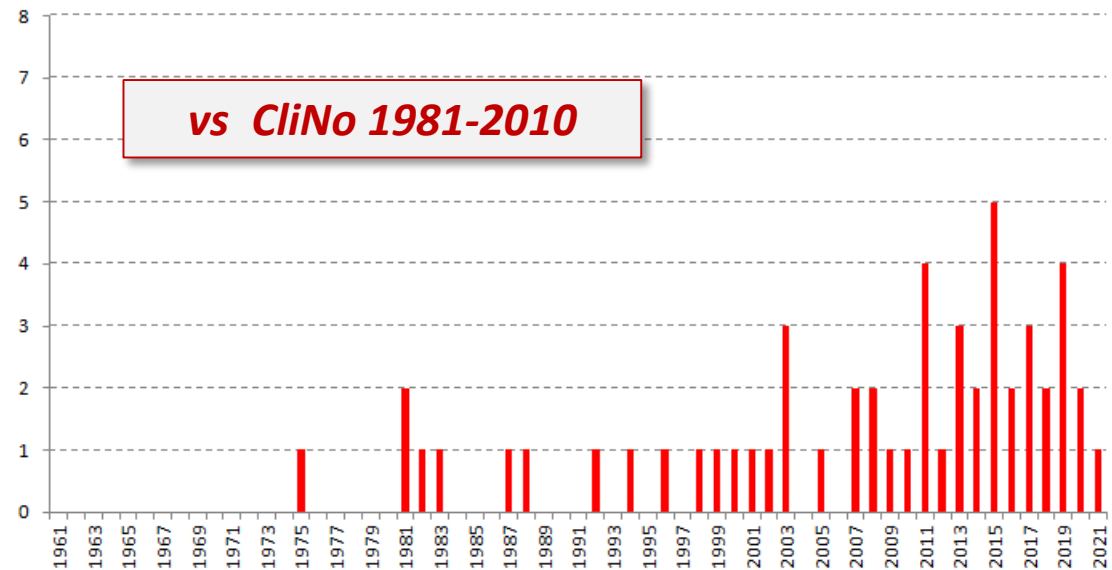
Heat Waves Number
vs
CliNo 1961-1990 temperature percentiles



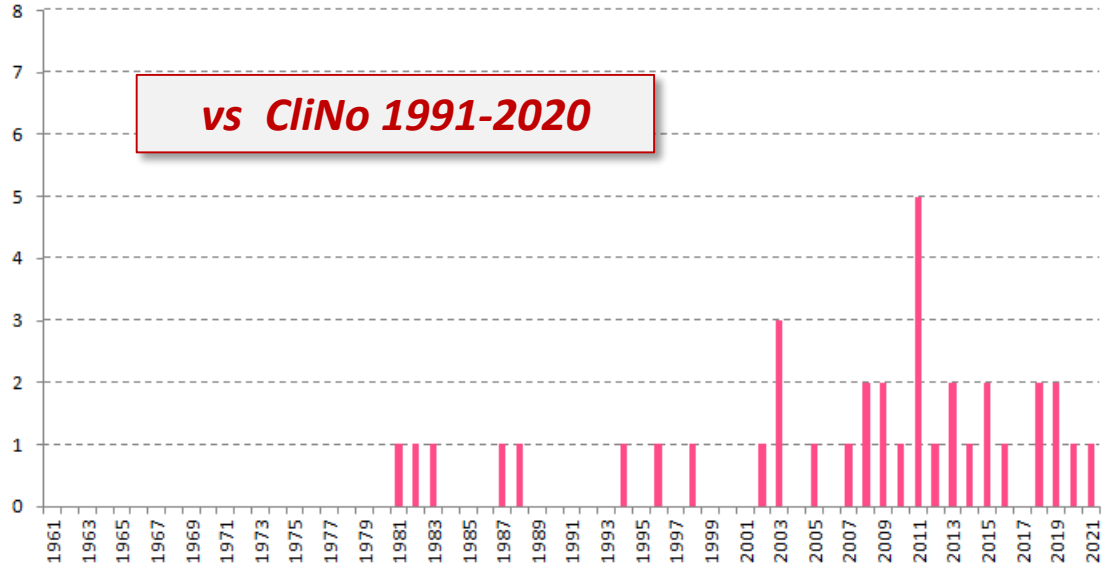
Heat Waves Number
vs
1971-2000 temperature percentiles



Heat Waves Number
vs
CliNo 1981-2010 temperature percentiles

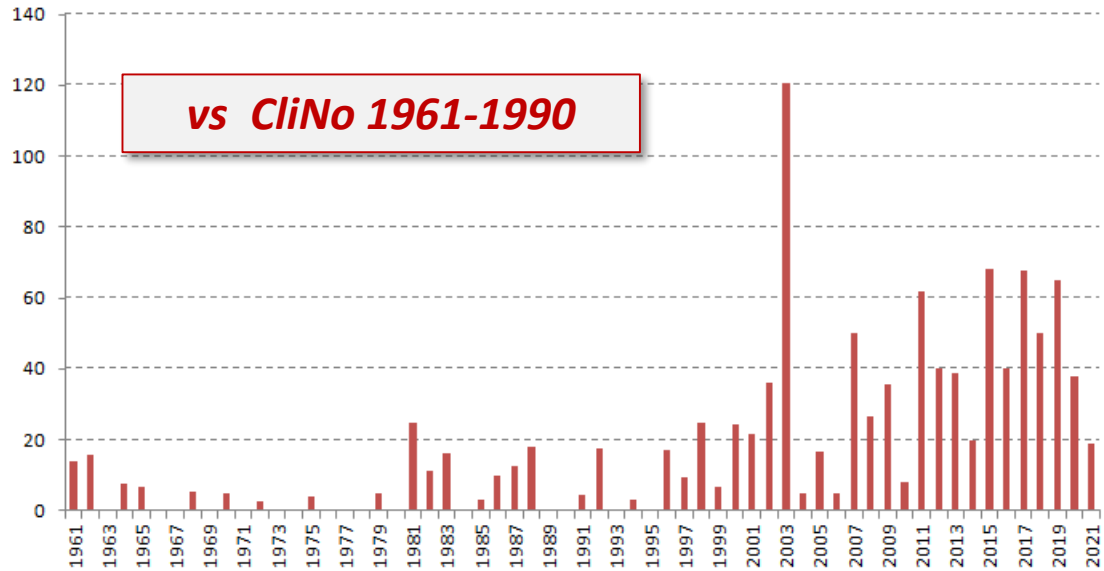


Heat Waves Number
vs
CliNo 1991-2020 temperature percentiles

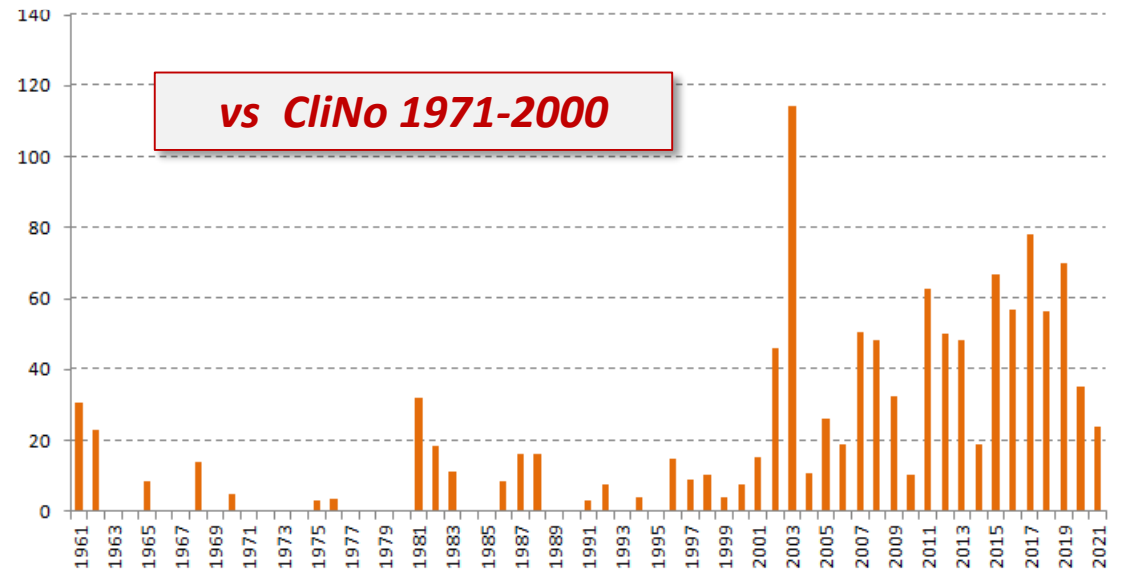


Intensità "Heat Waves"

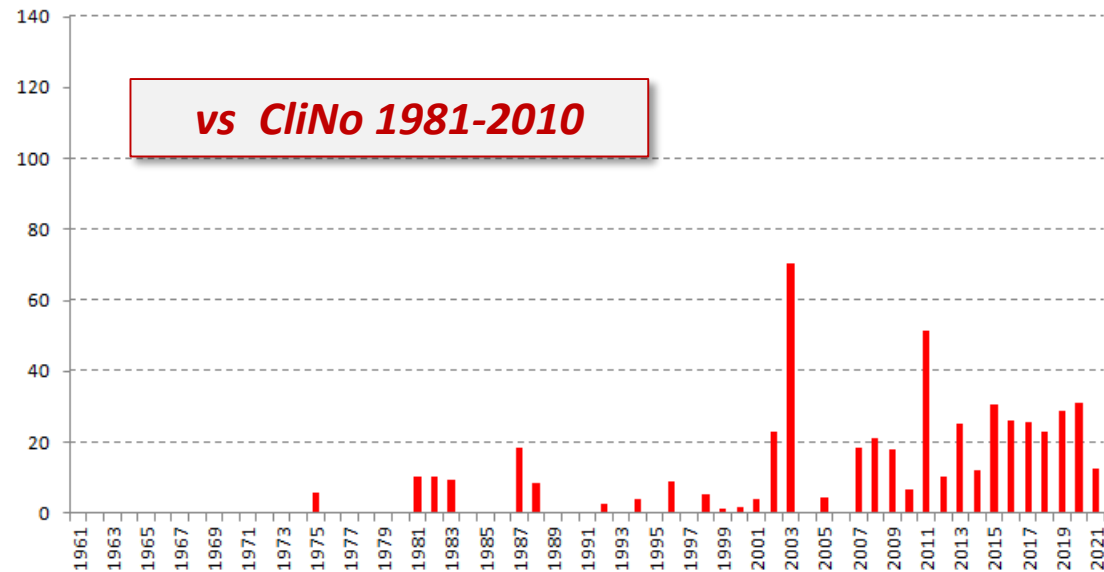
Heat Waves Intensity
vs
CliNo 1961-1990 temperature percentile:



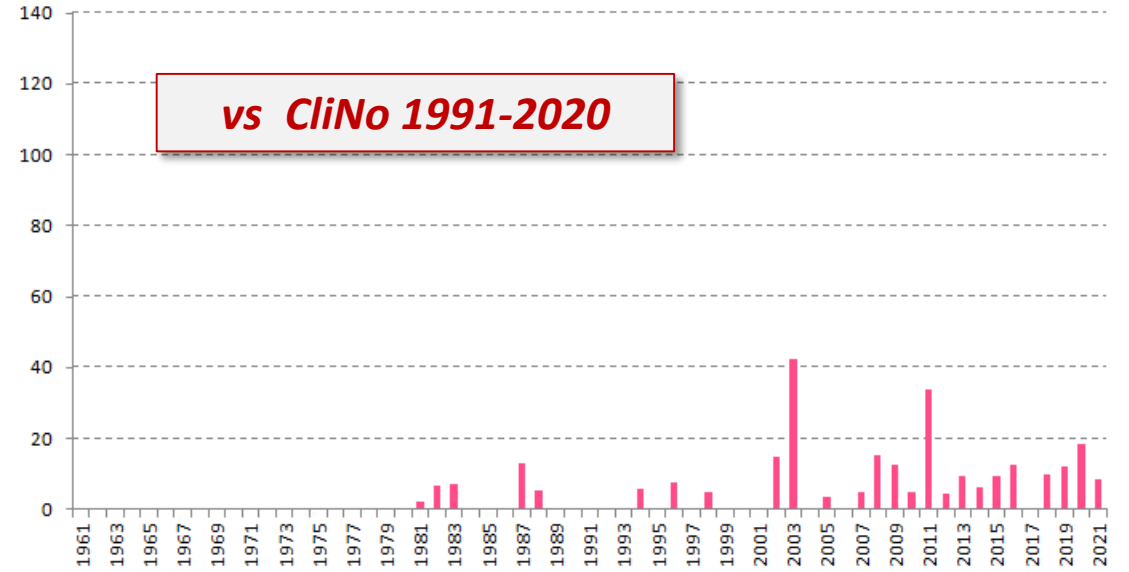
Heat Waves Intensity
vs
1971-2000 temperature percentiles



Heat Waves Intensity
vs
CliNo 1981-2010 temperature percentiles

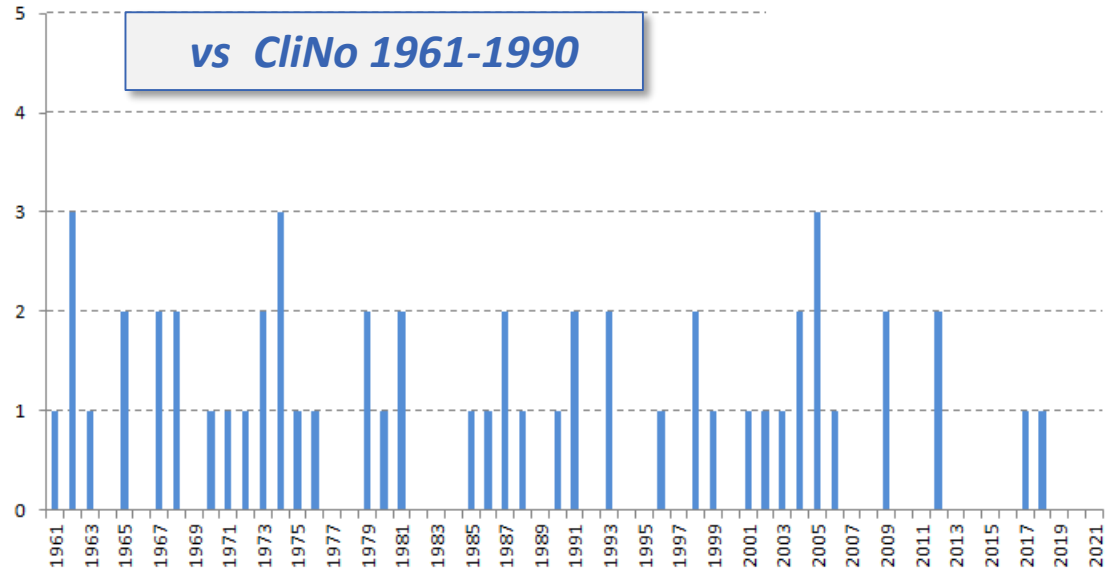


Heat Waves Intensity
vs
CliNo 1991-2020 temperature percentiles

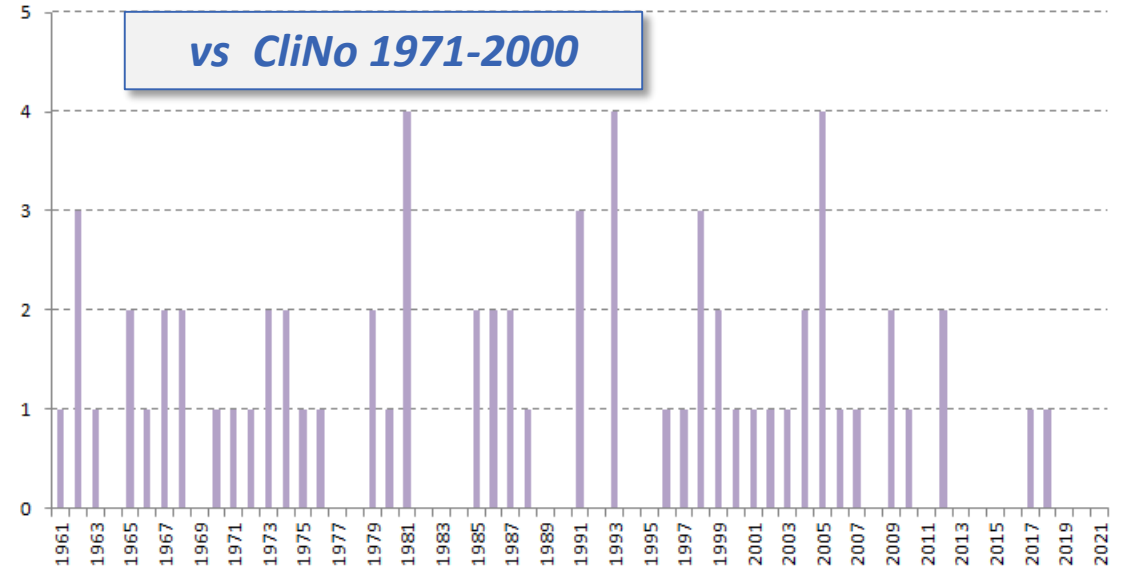


Numero "Cold Waves"

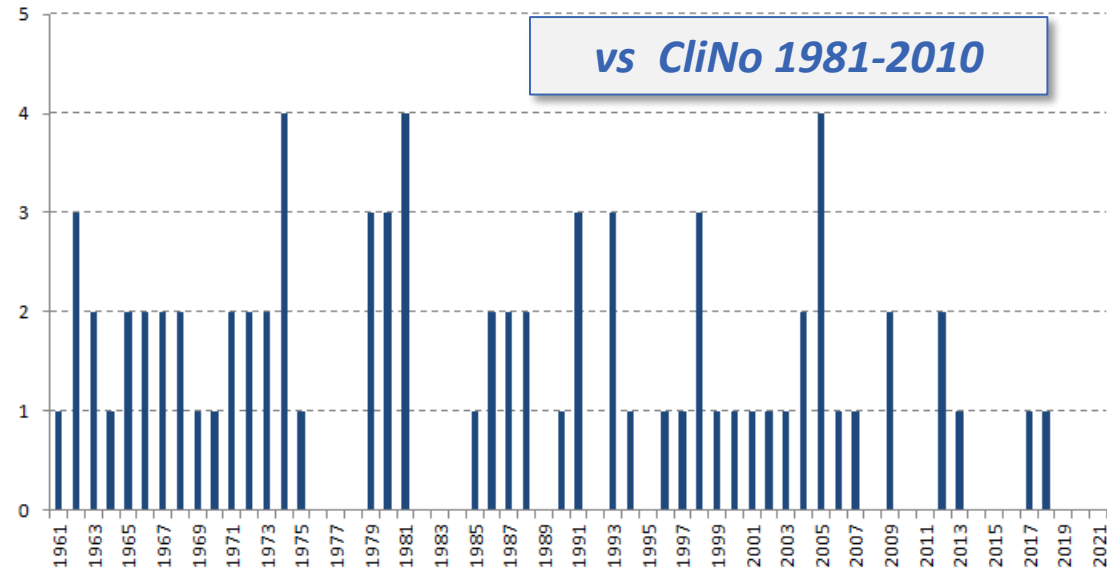
Cold Waves Number
vs
CliNo 1961-1990 temperature percentiles



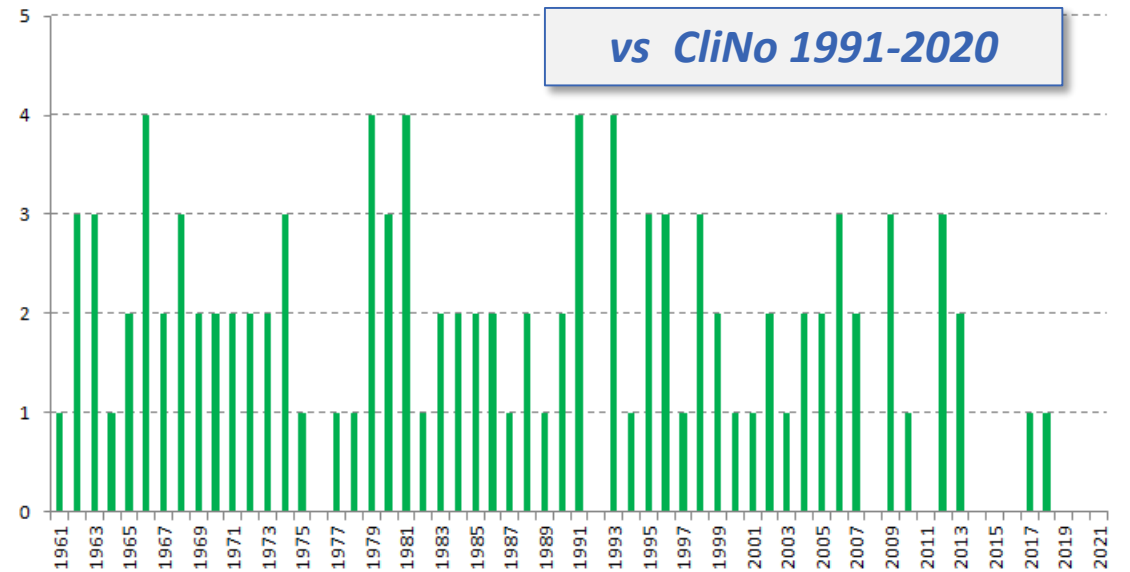
Cold Waves Number
vs
CliNo 1971-2000 temperature percentiles



Cold Waves Number
vs
CliNo 1981-2010 temperature percentiles



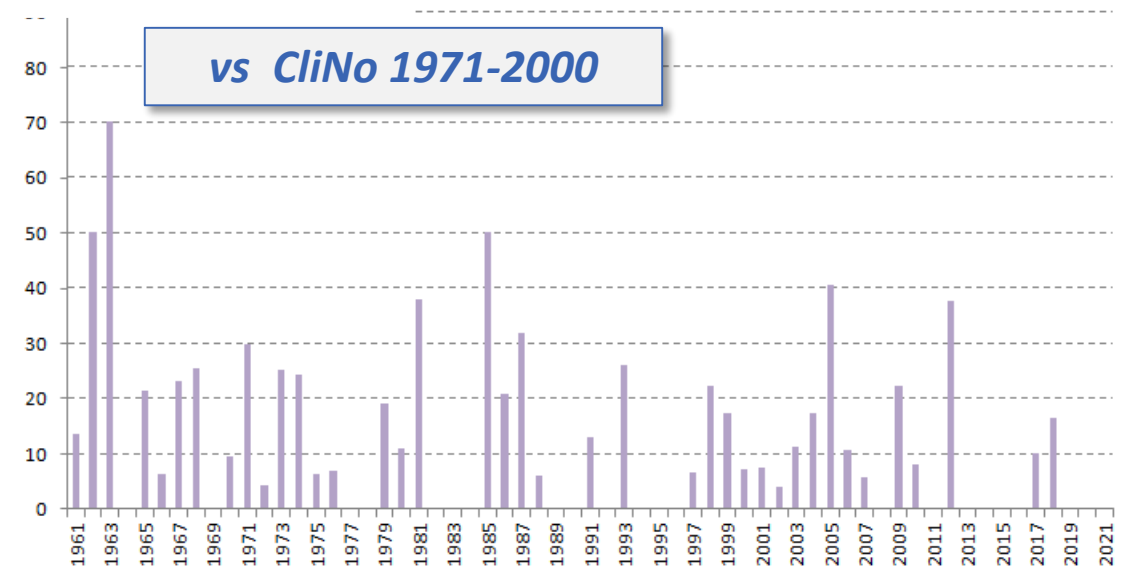
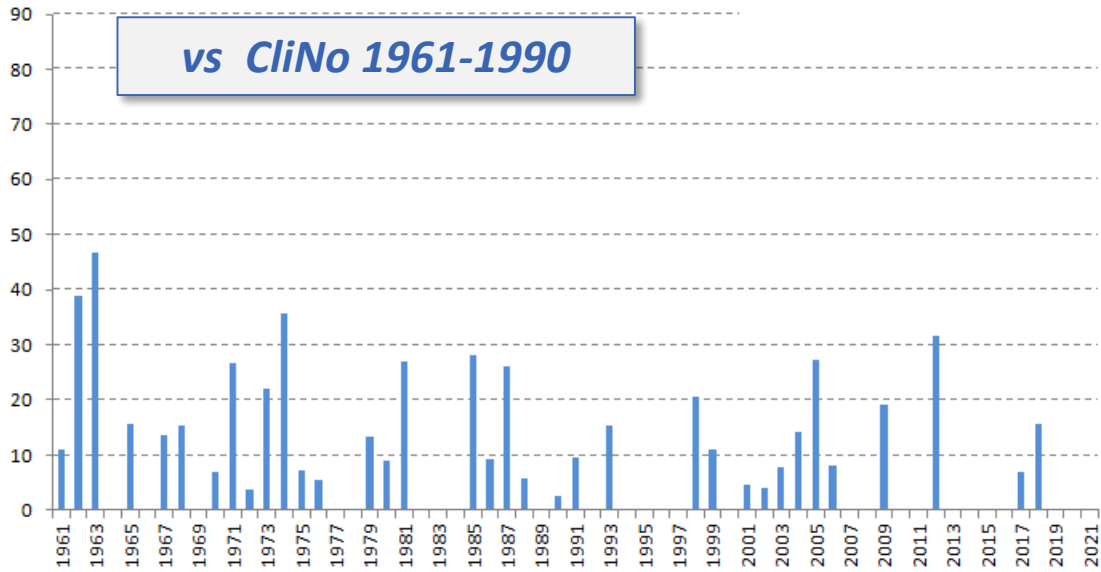
Cold Waves Number
vs
CliNo 1991-2020 temperature percentiles



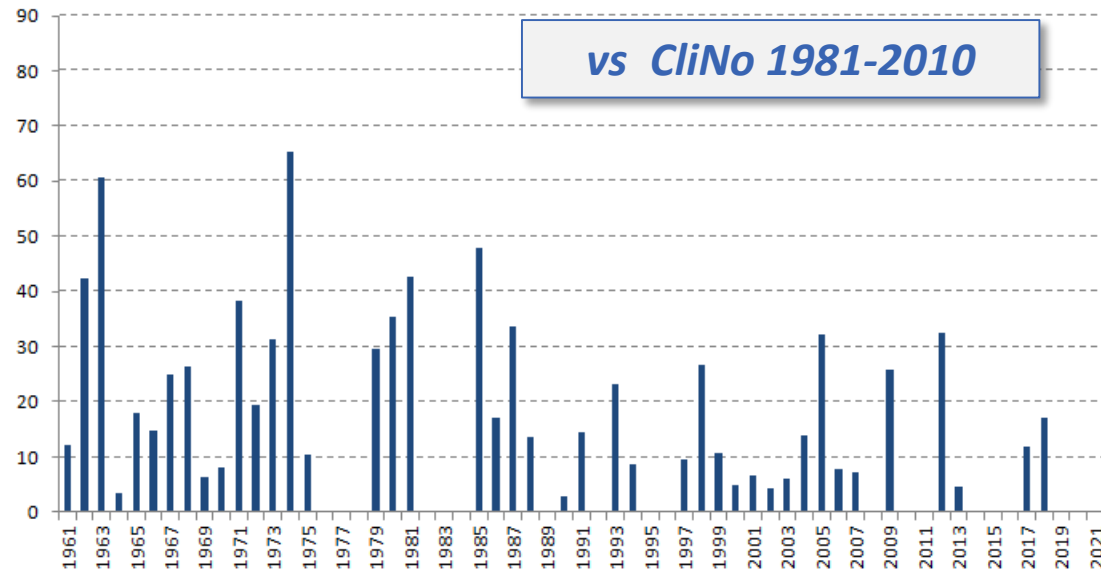
Cold Waves Intensity
vs
CliNo 1961-1990 temperature percentik

Intensità "Cold Waves"

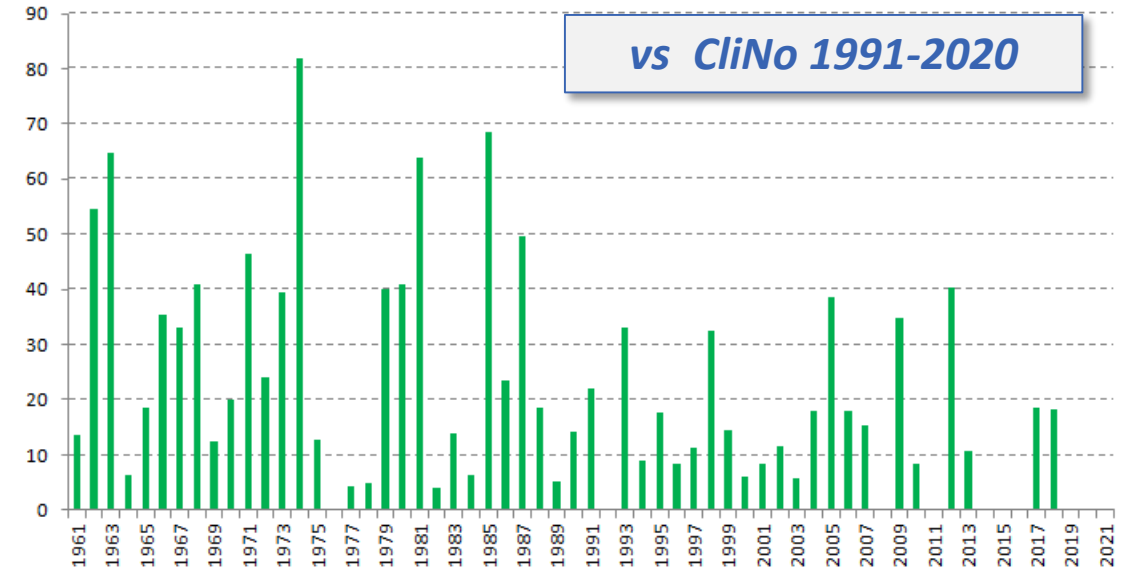
Cold Waves Intensity
vs
o 1971-2000 temperature percentiles



Cold Waves Intensity
vs
CliNo 1981-2010 temperature percentiles



Cold Waves Intensity
vs
CliNo 1991-2020 temperature percentiles



Considerazioni finali

I Climate Normals (CNs) dovranno essere aggiornati ogni 10 anni

Si tratta di medie non pesate su periodi di 30 anni, in cui gli anni più lontani del trentennio contano quanto quelli più recenti

Il cambiamento climatico indebolisce la valenza e la rappresentatività di questi indicatori medi di lungo periodo, specie se utilizzati come predittori

La comunità scientifica si sta interrogando su come superare questi limiti di rappresentatività

Il nostro suggerimento è quello di valutare con attenzione la finalità dell'elaborazione a cui si sta lavorando e la tipologia di utente e comunicare sempre con chiarezza il periodo di riferimento utilizzato

Ai fini dell'analisi climatologica tener conto della valenza assegnata al CLiNo 1961-1990 dalla WMO e usare congiuntamente (come fotogrammi di una stessa storia) i CNs calcolati su finestre temporali e per variabili meteoclimatiche differenti, valutando globalmente alla fine del processo i risultati ottenuti



Grazie per l'attenzione !

Riferimenti

WMO 2017: WMO Guidelines on the Calculation of Climate Normals (WMO-No. 1203)

WMO 2007: The Role of Climatological Normals in a Changing Climate. WCDMP-No. 61, WMO-TD/No. 1377, World Meteorological Organization

Huang et al. 1996 - Long-lead seasonal temperature prediction using optimal climate normals

Livezey et al. 2007, Estimation and extrapolation of climate normals and climatic trends

Arguez and Vose 2011, The Definition of the Standard WMO Climate Normal

Lavaysse et al. 2018, Towards a monitoring system of temperature extremes in Europe (Natural Hazards and Earth System Sciences)

HCWI Factsheet - Copernicus EDO (European Drought Observatory) Indicators - JRC European Commission
https://edo.jrc.ec.europa.eu/documents/factsheets/factsheet_heatColdWaveIndex.pdf

Tom Murphree, (2005), “Smart Climatology: concepts and products”, MR3610. Course Module 22, Dept. of Meteorology, Naval Postgraduate School