Accelerating climate changes in Antarctic by extreme values theory

G. Prete, V. Capparelli, F. Lepreti, S. Mazzà, V. Carbone



Società Italiana di Fisica

Academic year 2019/2020



giuseppe.prete@unical.it



- Polar regions showed a rapid rates of warming during the last years
- The actual trend of climate changes has many consequences:
 - ice melting;
 - terrestrial and freshwater species;
 - communities and ecosystems.
- The recent "abnormal" temperature registered on Marambio Antarctic Base represents a cry alarm for the future of the whole planet
- Crucial question : is it possible understand and mitigate these effects?



In the context of climate changes, the probability distribution function (PDF) of the events are shifted to more extreme values and wings can be enhanced







Generalized Extreme Value distribution (GEV)

into a unique one:

$$\hat{G}(x) = exp\left\{ \begin{array}{c} \cdot \\ \cdot \end{array} \right.$$

Consider an ordered block of maxima $x_1 \leq \ldots \leq x_N$, the empirical distribution function is $\tilde{G}(x_i) = i/(N+1)$. The probability plot and the quantile plot are:

$$\left\{ \left(\hat{G}(x_i), \tilde{G}(x_i) \right), \quad i = 1, \dots, N \right\}$$

The return level plot consist in detecting the return represents the maximal/minimal temperature expected once every 1/p years

$$\left(T_p(x), -log(1-p)\right)$$

EVT is described by three different distributions: Gumbel, Fréchet and Weibull. They can be combined

$$-\left[1+\hat{\xi}\left(\frac{x-\hat{\mu}}{\hat{\sigma}}\right)\right]^{-\frac{1}{\hat{\xi}}}\right\}$$

$$\left\{ \left(\tilde{G}^{-1} \left(\frac{i}{N+1} \right), x_i \right), \quad i = 1, \dots, N \right\}$$

Immulevel
$$T_p(x) = \hat{\mu} - \frac{\hat{\sigma}}{\hat{\xi}} \left\{ 1 - \left[-\log(1-p)\right]^{-\hat{\xi}} \right\}$$
 when









Rothera Met Maxima

Results





Rothera Met Minima





Halley Met Maxima

Results





Halley Met Minima





Dubois Station Maxima

Results





Dubois Station Minima



Comparison between the distribution of the maxima for the three stations

Results



Conclusions

the planet as the Antarctica

extreme, and could lead to the crossing of the tipping point, causing dramatic consequences.

The acceleration of climate change is underway, especially in most vulnerable region of

We analyzed the annual maxima of temperature with GEV theory, and we found that there is a discrepancy with the theory, symptom of the fact that increments are very local

Warming and consequent loss of ice-mass will produce climate changes even more

