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AUDIO TRANSCRIPTION

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What is the difference between the weather and the climate? What general implications does the increase in the average temperature of the planet have for the climate? An analysis of the historical series of meteorological data in the case of Turin

Thank you and welcome. Whilst Professor Orombelli has shown us how we seek to reconstruct a paleoclimate with scales of millions of years or even more, when we refine our analysis to consider shorter periods in instrumental measurements, we have, if nothing else, the advantage of knowing the observation methods because it is man who has invented the instruments to understand and measure physical greatness, even if the reference period is much shorter. In the end however, when we have two hundred years' worth of data, we can not consider it of little use for climate analysis, because this data becomes fundamental to adjust both climate models – and therefore here I see Dr. Navarra who certainly becomes the user of a certain kind of data to check whether the climate model simulates the functioning of the planet's atmospheric machine well - and on the other hand we also need it to adjust the methodologies for investigation of past climates, because in some way we at least have this window of a couple of centuries, in which there is a relative anchor in that, if I have a measurement method such as that which we have seen used in the Antarctic glaciers, or such as that which, for example, could be used for fortunate archaeological discoveries which sometimes enlighten us about limited periods or places, - such as, for example, the exceptional discovery of the Otzy mummy from the Copper Age, five thousand three hundred years ago, close to us here in Alto Adige, on the border with Austria (**vp – pag. 2**), which was discovered under the ice and which therefore gives us information about the fact that in some way it was preserved by the ice for these past five thousand years – or the analysis of fossil pollens, we are not going as far afield as the facts about the poles, but certainly, in the deposits of the peat bogs in the lake sediments we have information which is always indirect: it is not like reading a thermometer; when we find a palm pollen, let's say at 3000 m, we can certainly deduce that it was hotter – there was a palm at 3000 m after all – but how much hotter? If in some way I manage to adjust, to time the indirect data, the so-called proxy data, with a series of measured facts, then I can give more specific answers not only about the past but, it is also hoped, the future. Turin is a historical sequence (**vp – pag 12**) which is particularly lengthy, covering more than 2 centuries, and here I will show you (**vp – pag. 2**) what has been a quarter of a century long work which I have carried out, in particular, with my colleague Gennaro di Napoli, and with a staff of experts in other fields who I listed at the beginning. We also start from data which is not expressly measured using instruments. Art can also help us: this, for example, was a painting of a snowfall which was not dated, but for example, here, thanks to the fact that the you can see the Mole Antonelliana in construction – the spire in Turin was not yet completed – then we know that it was around 1870 (**vp – pag. 3**); so it was possible to check data that was measured at the time to see whether there were periods with snowfalls which could have inspired the artist who painted the picture, and at least two episodes of snowfalls of 80 – 90 cm were identified which could relate to that which the painter saw and translated into his image. These are the indirect methods which have recently been developed by the Swiss school, in particular, by Christian Pfister of the University of Berne, which seeks to recover the consistent archive heritage in order to carry out the same task, that is, to use a kind of adjustment of the archive sources and artistic sources for the years for which we also have data measurements, and then seek to extend them for subsequent periods. Here, for example, we have another work of art from Turin from the 1700's (**vp – pag. 4**), which gives us a unique fact; here you can see sleighs: to use a sleigh you need a blanket of snow which has been there for at least a few weeks if not months, otherwise it is pointless inventing and building this means of transport, and this implies that during the winters three hundred years ago the snow in Turin stayed on the ground for a certain length of time and enabled the Court of the House of Savoy to travel by sleigh. When this is cross-checked it is also confirmed by a diary of Francesco Lodovico Soleri, in which the use of a sleigh is mentioned during all the Carnival celebrations of numerous years, thus confirming the veracity of the painting. In 1681 effective measurements began to be taken in Turin of meteorological information with the first thermometers, mainly aimed at the study of snow. In this case, it was a mathematician, Donato Rossetti, who became particularly interested in the form of snow crystals observed under a microscope, and in this very rare publication, which was preserved in the civic library of Turin, we have information on both the temperatures and the number of

snowfalls (**vp – pag. 4**): it is interesting to extract this very concise information of about 144 snowfalls in six years: 24 snowfalls a year, much higher than the current national average, which is around six or seven episodes per year. Even this year, when it has snowed a lot, we have had fourteen snowfalls in Turin, which leads us to deduce that in that period it snowed much more often. We also have diaries (**vp – pag. 5**). It was doctors who began to study meteorology in a systematic way because, as often happens in science, we go down a path to seek a response to how we are doing today, and the answer is perhaps not along that path but another which has yet to be developed, but we learn something about it which could then be useful to others (this is "serendipity"). Doctors hoped to find correlations between the spread of certain illnesses and meteorological parameters; they did not find any but in their attempts to compare data which had begun to be measured at the time, it was doctors, rather than meteorologists who did not yet exist, who accumulated diaries of observations both seen, and measured with early instruments, information which is very useful to us today. Here, for example, I would like to mention a very intense frost in 1745 which, using the data from instruments mentioned in this diary and which in some way we have been able to reconstruct, lasted for a few days with temperatures of around -20°C. I will now give a rapid overview of these giants; today's initiative has the title "On the shoulders of giants" and even in our field there are giants who have left us information which we can study today and luckily, they have also left us information about instruments which they used and their observation methods, thus a good reconstruction of a climate series also includes the verification of the reliability and quality of this data, or at least the quantification of the type of errors which it could contain in order to reconstruct the continuous series with as few errors as possible. Here, for example, you can see the first observations (**vp – pag. 5**) which were recorded by another doctor, Ignazio Somis, who was the physician to the Court of the House of Savoy in 1753: all the manuscripts have been recovered and the units of measurement translated and the scales of reference have been changed, over the years the instruments changed and new ones were invented; this, for example, is the project for a test tube rain gauge, moving on a clockwork device: we are therefore looking at extremely productive years for scientific research and also, if you will, poetic, very enlightening years (**vp – pag. 6**). Here you will see that the data which we use is on sterile excel sheets, whilst at that time data was decorated with refined water colours and became lovely works of art; this gives you an idea of the importance attributed to observation (**vp – pag. 6**). Finally, in 1787 the first stable observatory was founded in Turin, that is the Observatory of the Academy of Science, which was destroyed by bombing during the last world war, which we can still see in a picture emerging from the rooftops of Turin (**vp – pag. 7**). Almost all the observatories in the past were on top of towers level with the rooftops of cities: this is a fact which needs to be carefully considered so that mistakes are not made when comparing current data; today most modern weather stations, inserted in the dictates of the world meteorological organization, are placed at ground level, approximately a meter and a half above a grassy surface like airport stations. Therefore if current data is compared to that from the past, mistakes are made, because the conditions for measurement were different; therefore it is necessary to make comparisons from within the data which comes, as far as possible, from the same kind of meteorological observatory. The best possible scenario would have meant no changes, but there have almost always been changes over two or three centuries, in almost all observatories. Indeed, in 1866 in Turin, the observatory was moved from the Observatory of the Academy of Science to the roof of Palazzo Madama, again right in the centre of Turin (**vp – pag. 8**), and it stayed there for the next sixty or so years and was moved again at the start of the 20th Century; but fortunately, the Giants of the past always looked ahead and kept portions of readings in parallel, therefore there were periods in common between the observatory which was closing and that which was opening, and this enables us to make the necessary adjustments. Then it was moved to the Institute of Physics at the University, in an area on the outskirts of Turin at the time, and here we also have a photograph which confirms some information which by that time was measured using absolutely certain and scientific methods (**vp – pag. 9**). But look at this slide from the start of the 20th Century: in Turin you could ice skate without needing a cooling system like we do today (**vp – pag. 9**). Several stations were placed around the city, also for teaching and information purposes; they did not conform to specifications but in some cases they were useful to fill in gaps in readings, for example the gaps during wartime or when there were problems due to observatories moving (**vp – pag. 9**). Today we have more than 10 weather stations: we have tried to reinstall them in places as close as possible to those where they were situated in the past, or to keep some on the roofs of buildings to be able adjust the data read under different conditions (**vp – pag. 10**); overall, for the Turin series, we have over nine hundred and three thousand days worth of measurements, with approximately one million figures, and at this point statistical analysis is also carried out using the data from the surrounding areas, in order to cleanse the series of those figures which could invalidate the climate response, for example the well known urban heat islands (**vp – pag. 11**). Cities are warmer because they contain cars and heating systems; there is the same kind of materials which changes the energy balance but today a

distinction can be made between the external climate signal and that which comes from the city. This was done for the Turin series.
We now come to the distinction between the weather and the climate: the weather has scales of evolution lasting hours or a few days. This was last week in Turin (**vp – pag. 12**), it shows you the lines traced which represent the historical average of minimum and maximum temperatures for each day over the last thirty years, and this is what happened last week: there was one day with a very obvious Föhn episode which reached 23°C and here the anomaly on this individual day was 10°C higher than the average; a few days later we had 4°C less than minimum temperatures. Overall the entire decade shows the maximum as 4.5°C higher, the minimum as 0.2°C higher and on average the decade was 4.2°C higher. These variations on a daily or ten-yearly basis have no climatological significance. However, when we extend this analysis to years and decades, centuries and millennia we finally get a climatic result. This is the uniform Turin series, where we can see the evolution of average temperatures year by year up to 1753; we can see the block of recent years with a very clear trend during the past 25 years of a thermal increase which has never been seen in the past, the 2008 dot, 2007 was the warmest for Northern Italy, but not globally (**vp – pag. 12**); this confirms what Professor Orombelli said; we must therefore have a vision which starts from an individual local fact and which then extends to a global level. The correlation between some cold years, such as those episodes around 1835, which was perfectly explainable with some big volcanic eruptions, in particular that in Coseguina in Nicaragua which saw three consecutive years with temperatures which were much lower than average, is very interesting. Time is running out and therefore I will limit myself to telling you that when we analyse a historic series of this kind we obviously want confirmation, therefore projects are organized with other colleges in the surrounding regions in order to check that the data is as reliable as possible. These are the results of other European projects such as ALP-IMP and these are the sites of the centuries-old stations taken into consideration (**vp – pag. 13**): among which is Turin. It is often said that data from the cities is not reliable, for the reasons which I have just mentioned; here the various centuries-old series for the alpine region has been separated to see whether the stations high up in the mountains, therefore outside urban areas, show different signs. The signs are similar, therefore once the series is cleansed of the data from the urban heat island, you will see that there is perfect uniformity: it is hot in the city, but it is also hot in the mountains (**vp – pag. 13**). Indirect confirmation comes from the fact that here we are lucky, our observation series are a short distance from the glaciers: these are the glaciers which I have been studying and measuring for approximately 25 years, which are 50 km from the observatory which we just seen and therefore there is a cross comparison. The glaciers have moved back which, in some way, confirms that the data from the instrument readings is reliable. Here you can see small glaciers which over the space of about seventy years have disappeared: this is a glacier which is completely extinct in the Gran Paradiso park; this is another glacier which is getting a lot smaller; this is the Rocciamelone glacier 50 km West, you can even see Turin, from the observatory, and there are new phenomena, such as the appearance of arctic lakes (**vp – pag. 14-15**).
I would like to finish with an image of the snow because it is very topical: it could explain what happened this winter (**vp – pag. 19**). In Turin it snows less, the past twenty years have seen the least snowfall overall compared to the historical series of over two centuries, the longest in the world, with a clear negative trend, but this year, surprisingly, we have had approximately 65 cm of snow: could this be the start of a new fluctuation with an increase in snowfall or is it an isolated event? Obviously the model designers will have to answer this question.

Bibliographical references:
Di Napoli G., Mercalli L., 2008 – Il clima di Torino [The climate of Turin]. SMS, 922 p.