GIANCARLO SPEZIE

What general implications does the increase in the average temperature of the planet have on climate? The case of the hydrosphere

Thank you, Dott. Caprara, good morning everyone. My task is not a banal one and neither is it simple, because in 20 minutes I have to give a reply about the ocean, and oceanography only started up a little while ago, it's a very young discipline. If meteorology is young, oceanography is a babe in arms, because to study the ocean also means to go and investigate the depths of the ocean. The satellite certainly helps us, but the satellite cannot penetrate, and so we need an extremely complicated observation network, but anyway we try to do what we can. And I have to speak slower because I have been told that, for the simultaneous translation for our foreign guests, I should not go too fast. Generally speaking, texts tell us that the astronomical position of our planet, its exposure to solar radiation, forces a surplus of energy in the equatorial regions and a deficit of energy in polar areas, and this would appear to be quite a banal system. We have to transfer energy from where there is more to where there is less, and therefore classic meteorology teaches us that the wind circulation system, etc has this task and it is a task it certainly does (**see page 2**). Instead, the ocean is still more difficult, because oceans respond in a highly differentiated manner. This clip shows the anomalies (**see page 3**). It's a short period, but it will give you an idea of how variegated and differentiated the response is. It's not as if something becomes heated and this something is uniformly heated, and the entire system plays on fundamental points, on crucial points which are the points where the mechanism that has already been called a conveyor belt has been started up, a sort of moving walkway, a belt which transports frigories and calories from one side of our planet to the other to permit a balancing, and two of these points are concentrated in the North Atlantic, two in the Antarctic, and the Mediterranean Sea is tiny, it's a small lake, but it plays an extremely delicate role in our system (**see page 4**). Here we are, this is a picture of the conveyor belt that Professor Orombelli showed you as a diagram (**see page 4**). Instead, it shows you how it is much more complex. You must above all bear in mind a number of areas which are those in the North Atlantic and these two areas here in the polar regions, because the crucial points of this system are in those areas. So the first question arises: could this conveyor belt collapse (**see page 5**)? Could this system break up and what would be the consequences? Well, it's possible, and there's a short Al Gore film that many of you have seen and that certainly enables you to better understand what can happen in the North Atlantic due to a softening of superficial waters resulting from excessive rainfalls or the melting of ice in Greenland. Naturally, by softening the superficial waters, the system prevents sinking and consequently blocks this conveyor belt. Of course there would be disastrous results because, as this film very clearly shows, see this softening, the slowing of the conveyor belt and the subsequent gradual cooling of the whole of Europe, there would therefore be a return to a phase of glaciation. So it's already a paradox: global warming that triggers glaciation, and this is already a very strong sign of what could happen, not in an evenly distributed way but on a regional basis. And so lets stop to think a moment about how the poles respond at present: the Arctic has experienced a progressive reduction of about 3% per decade; the situation is a bit different in the Antarctic where, following a rapid decline halfway through the 70s, it appears to have stabilized (**see page 6**). I have also got a clip here, here we are: this is a circulation which is important because it completely isolates the Antarctic, there are some crucial points, where the frigories can be transferred to the conveyor belt area, and one of these points is the so-called Ross Sea Gyre, a huge vortex situated on the opposite side to Weddell (**see page 7**). Now you are looking at Weddell, you should soon see Ross, where the Italian base is also located. It's one of the points producing the cold. Frigories are produced here, in this Ross Sea Gyre region, and are transferred into the oceans by means of these circulation mechanisms. It's a fairly complicated system: waters arrive in the North Atlantic and are submitted to the action of the atmosphere that causes considerable cooling and consequent re-descent as bottom water, waters that enter the system, and this system diffuses these waters on the bottoms of all our oceans (**see page 8**). The crucial point of this whole system is in this area where polynyas are localized (**see page 9**). The polynyas are characteristic areas of polar regions that are always free from ice and they are formed in a recurrent manner, in the same areas in the same periods of the year. In our area, in the bay of Newfoundland, here at the Italian base, there is a permanent polynya (**see page 9**). By chance we encountered one of the more interesting natural laboratories, so rich in information, provided by the Antarctic system. So, a point emerges from our studies - we have by now an observation system there, which started in 1995 - that is naturally worrying, because the polynyas do not only produce ice but they also produce salt: they create salty waters which, with the lowering of the temperature, constitute those bottom waters responsible for transferring frigories into the global system. And in that area, which is one of the crucial points of this system, at the bottom, the salinity in time tends to diminish, as you can see, and - in brief - there has been a net freshening of high salinity fresh water, namely an excess of salty water (**see page 11**). Then, up until 2000 there was an increase, from 2000 to 2004 again a very considerable decrease, and there will again be a freshening in the 2005/2006 period. This is another question mark, because it means producing less bottom waters and therefore feeding, giving less strength to, that conveyor belt circuit. On the whole, the warming of the southern ocean translated into an increase of 0.17°C. Between 1950 and 1980, and to the right in the last picture, you can see the anomalies that have occurred in this area (**see page 12**). Another crucial point, as I told you before, is our Mediterranean. The Mediterranean is a small sea closed by Gibraltar, with a threshold of 330 m, which prevents the penetration of cold waters from the ocean, so that it is - in the main - a warm basin, submitted to the action of the North Atlantic region and, in particular, of two especially well-known barycenters, the low pressure of Iceland and the high-pressure of the Azores (**see page 12**). From the positioning of these two areas we have a trend that is called the NAO index, but we shall not go into detail, where there is an alternative positive and negative position that leads to a clear-cut difference in the action of the atmosphere, the ocean and the Mediterranean Sea, on the circulation of the waters. This is the situation with a negative NAO index (**see page 13**), hence the penetration of the disturbance on the Mediterranean, while this is positive, and it prevents the transmission of this disturbance, which means that our basin, which in turn involves motor centers as we have seen on a global scale, we now see it on a regional scale, and these motor centres depend on the condition of the North Atlantic (**see page 14**). That is why it is necessary to examine these aspects on a regional scale, because if one of these motor centers stops the Mediterranean's system changes, also from a biological standpoint, and consequently in this anomaly that we have had in the index, where in the last 20 years there has been a persistence of this positivity, of this situation in our Atlantic, the Mediterranean, that you see in the diagram as a large system of great vertical dynamism, that therefore feeds the waters in all its depths, has a conveyor belt of its own where the waters of the Atlantic enter the Mediterranean, enter the eastern region and here form very dense and warm waters, called Levantine, that go to feed a circuit of that motor center of the southern Adriatic and so on (**see page 15**). Here we have a connected anomaly that occurred during this period, between 1987 and 1995 - a period of roughly 10 years. Therefore the Mediterranean Sea's response to this anomaly in the North Atlantic's climatic system led to a larger formation of saltier waters and modified the circulation system with a different conveyor belt. This naturally meant an increase, we can see it here, in the waters of the Mediterranean (**see page 16**). If we look at the last picture summing up the entire depth over the last 50 years, we can see an increase of 0.008°C in the water interstratum also with a rise in salinity of the order of 0.02 (**see page 17**). This does not seem very much, but it is significant also from the standpoint of the biotic system, because the biotic system responds to these local anomalies. If we also want to briefly mention what is defined the tropicalization of the waters of the Mediterranean Sea that is often spoken about, it can be seen that the greatest influence is not due, at least that is what appears to be the case, to these different conditions of temperature and salinity in the Mediterranean Sea, but above all to aspects like Lessepsian migration, namely the migration of the species due to the opening of Suez by Ferdinando Lesseps; only 30 years after its opening it was possible to find species on the coast of Israel coming from the Red Sea. (**see page 19**). Here we have the Suez isthmus, but also due above all to maritime traffic and areas of pollution and so on (**see page 20**). To date there has been the inclusion of 55 species, 40 in terms of biomasses from the Red Sea and 30 species from the Atlantic. These are changing the entire ecosystem and habitat of our Mediterranean, especially along some of the coasts we have heard about the killer seaweed, the caolea and so on that are replacing the notorious posodonia that does us a lot of good. Naturally, maritime traffic is also relevant here. Every year 200,000 ships bound for 35 ports located along our coasts pass through the Mediterranean. This means that bilge water is discharged everywhere. The control of such a situation should be accompanied to a scientific control. I now have to rush because time is running out, and I want to conclude with that great question mark that the moderator presented us with at the beginning. How does the ocean respond? It responds in an extremely diversified manner; it responds in points that are very different among themselves and with highly diverse consequences. We do not have the possibility of keeping such a significant mass under observation. The model certainly helps us but the model cannot solve all the problems; the model needs experimental data. We therefore need to set up a policy of scientific sustainability, need to effectively direct our attention at what the trends of research are, to respond to its crucial points with the necessary methods and criteria to lengthen the historical series so that, with a correct interpretation of a series of data, it will perhaps be possible to give a reply, but at the moment, the question mark is still there. Thank you.