Lectures of Vincenzo Artale

Enea

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1) Tuesday May 27, Lecture 7:

"The coastal area and marginal sea in the warming world (physical point of view)"

Authoritative assessments of the state of the climate (e.g. IPCC-AR4, 2007) show major changes in its composition, structure or functioning. In particular regarding the ocean, over the period 1961 to 2003, global ocean temperature has risen by 0.10°C from the surface to a depth of 700 m., equivalent to absorbing energy at a rate of 0.21 ± 0.04 W m^{-2} globally averaged over the Earth's surface. Two-thirds of this energy is absorbed between the surface and a depth of 700 m. However global ocean heat content observations show considerable interannual and inter-decadal variability superimposed on the longer-term trend. Regarding the salinity are also observed large-scale, coherent trends, which are characterised by a global freshening in subpolar latitudes and a salinification of shallower parts of the tropical and subtropical oceans. Moreover ocean biogeochemistry is changing. The total inorganic carbon content of the oceans has increased by 118 ± 19 GtC between the end of the pre-industrial period (about 1750) and 1994 and continues to increase. It is more likely than not that the fraction of emitted carbon dioxide that was taken up by the oceans has decreased, from 42 ± 7% during 1750 to 1994 to 37 ± 7% during 1980 to 2005. Accordingly of the above observed changing the global mean sea level has been rising, even if it's accompanied by considerable decadal variability. From 1961 to 2003, the average rate of sea level rise was 1.8 ± 0.5 mm yr^{-1}, but for the period 1993 to 2003, the rate of sea level rise is estimated, from observations with satellite altimetry, as 3.1 ± 0.7 mm yr–1, significantly higher than the average rate.

The North Atlantic Ocean has a special role in long-term climate assessment because it is central to one of the two global-scale MOCs, the other location being the Southern Ocean. The subtropical gyre warmed and the subpolar gyre cooled over that period, consistent with a predominantly positive phase of the NAO during the last several decades. The warming extended down to below 1,000 m, deeper than anywhere else in the World Ocean, and was particularly pronounced under the Gulf Stream and North Atlantic Current near 40°N.

Moreover the Atlantic Ocean is strongly influenced by its adjacent seas, this is particularly true for Artic Sea, which plays a crucial role in Deep Water formation, but also is relevant the role of Mediterranean Sea and the Caribbean and the Gulf of Mexico. In particular, marked changes in thermohaline properties have been observed throughout the Mediterranean

Sea. This basin can be considered an exceptional ocean where a wide range of oceanic processes and interactions of global interest may be placed.

The marginal seas are very susceptible to the climate variability, in this lesson we analyze the relation between the key functioning factor of the thermohaline circulation (e.g. strait) and climate change and their impact on the closure of the hydrological cycle, on the Mediterranean outflow and on the deep convection and.

2) Friday May 30, Lecture 24:

Model improvement and the new numerical tools for the marine process representation on the way of the "Earth System".

There is a fundamentally urgent need to understand the Earth's life support systems to the extent that we are able to model and predict the effects of continued trends of human activity on them, and the consequent effect on the ability of life to be sustained on the planet, including humans.

This requires the development of extremely powerful predictive models (**Integrate Earth System model**) of the complex and interacting factors that determine and influence our ecosystem and environment, and use these models to generate and evaluate strategies to counteract the damage the Earth is being subjected to. Computational simulation and modeling of the dynamic behavior of the climate are possible today, thanks to the efforts of numerous research centre, including the Earth Simulator in Japan, the Hadley Centre for Climate Prediction and Research in the UK and now the CMCC in Italy.

Climate modeling and prediction is an obvious and critical aspect of understanding the Earth, but we should anticipate being able to understand and model other key 'abiotic' systems. Earth System, that incorporates into computational models, the influence and effect of human activities such as production of global warming gases on climate variability. This is already under way and will be possible to model more effectively by the next decade.

The challenges run from providing more powerful hardware and the software infrastructure for new tools and methodologies for the acquisition, management and analysis of enormously complex and voluminous data, to supporting robust new theoretical paradigms and modeling complex system.

On this line and in the framework of European CIRCE Project, we are developing a coupled regional model, a first step for a **Integrated Earth System at Regional scale** (Protheus), which object is to understand and to explain how climate will change in the Mediterranean area and to give some information about economical and social impacts. Moreover in order to give a realistic description of future climate in Mediterranean Region, at first we want to provide a comprehensive assessment of the Mediterranean climate variability and teleconnection for current climate. We applied PROTHEUS, a Mediterranean model, comprehensive of atmospheric and oceanic components, nested in ERA40 meteorological fields, over a domain (-10, 40 °E; 22, 57 °N), with a spatial resolution of about 30km.We investigate how global and Mediterranean climates interact and we describe the properties of the atmosphere and the ocean, as well as the radiative fluxes, the role of cloudiness, the water cycle.