

## ARCTIC RECORDS IN 2011: BREAKING THRESHOLDS?

Summer thawing in the Arctic Ocean has been an ever increasing fact, and in September 2011 a new record was established. The extension of the remaining ice cover ( $\sim 4,3 \times 10^6 \text{ km}^2$ ) has decreased in  $\sim 2,4 \times 10^6 \text{ km}^2$  with respect to the 1970-2000 average. The recede since 1972 has been 50%. Even more worrisome that the ice cover surface is the fragility of the new ice formed during winter, which will melt even faster the following summer, thus, accelerating thawing. The temperature increase in the Arctic region is relatively high, twice the global average, mainly propitiated by the disappearance of the marine ice. The reduction of the albedo upon going from the shiny ice to the dark waters constitutes an important positive feedback for warming. The experts predict a total seasonal thawing within the next 20 years. This is being drawn upon to establish new navigation channels that favor commerce between Europe and the Asia-Pacific region. Not long ago, the Russian Prime Minister Vladimir Putin declared that the northern passage through the increasingly thawed Arctic Ocean would soon compete with the Suez Canal.

Rather unexpected was the unprecedented loss of ozone in the Arctic stratosphere, in the spring of 2011. The destruction of the ozone is produced at both poles during their respective spring seasons. Yearly, a drastic reduction takes place in the Antarctic, leading to the formation of the metaphorical 'ozone hole', but in the Arctic the reductions have been very variable and rather small. What happened last year changes the situation, since 'ozone holes' would be produced in both poles. Not all scientists agree that it is already possible to speak of a hole in the Arctic; 'a single swallow doesn't make summer', but the truth is that the 2011 ozone reduction reached levels that are close to those observed in the Antarctic. Normally, over the Arctic there is a total ozone column of 450 Dobson units (DU) and in the spring of 2011, the column was reduced during almost a whole month to less than 250DU, reaching minimal va-

lues, between 220 and 230DU, during one week. What is or what is to be understood by the expression 'ozone hole' has never been defined or codified, but a kind of rule of thumb has been used, requiring a column of less than 220DU, a condition that is observed annually during the Antarctic spring. Whether or not a hole was produced in the Arctic might be a semantic problem, but the important fact is that the reduction reached a record level and it is critical to find out what triggered this situation. Supposedly, thanks to the control of chlorofluorocarbons (CFCs) mandated by the Montreal Protocol, the stratospheric ozone layer is recovering.

The chemical characteristics of the stratosphere of both poles are similar but, different to what is observed in the Arctic, extremely low temperatures are produced during winter in the Antarctic, which activate CFCs with the ensuing massive destruction of ozone ('hole') during the following spring. The 2011 reduction in the Arctic was preceded by a record low temperature period during the winter. It is well established that global warming, on the surface and in the low atmosphere, entails cooling of the stratosphere. This would associated the various records reached in the Arctic: sea defrosting, low stratosphere temperature and ozone destruction.

Environmental systems are non-linear and while the progressive global warming persists, a given threshold can be surpassed at any moment, leading to sudden and unexpected changes. In 2011 an 'ozone hole' was produced in the Arctic, possibly due to surpassing the cooling threshold of the stratosphere, needed to massively activate CFCs. In the case of the Antarctic, in the decade of 1980 the threshold surpassed was that of the CFC concentrations. What other surprises does the future offer if the climate change is not stopped? Are we conscious that some of them can be disastrous? What is the threshold for the recurrent droughts in the Amazonia to turn permanent?

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