THE D-EXCESS AS A CHARACTERISTIC OF THE MEDITERRANEAN PRECIPITATION: A CRITICAL REVIEW

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Abstract

A value of the d-excess larger than 15‰ in atmospheric waters of the Mediterranean region has been attributed to the special air-sea interaction mode on the continental leeside and has been utilized as a characteristic identifying moisture originating from the Mediterranean. This review examines additional factors affecting the d-excess parameter and points to the importance of also considering the in-cloud processes and vertical motions and exchange of the air masses over the sea in this context.

Keywords: Air-Sea Interactions, Atmospheric Input

Introduction

Following the recognition of elevated d-excess values in precipitation in the eastern Mediterranean Sea area and in adjacent marginal seas (such as the Adriatic,Black and Aegean seas) ([1], [2], [3]), this was attributed primarily to the large humidity deficit in the atmospheric waters on the leeside of the continent relative to the saturated vapour pressure at the sea surface, based on the Craig-Gordon Evaporation Model. This characteristic has been widely used to identify the contribution of the Mediterranean moisture source to precipitation in the region (e.g.[4]] and its paleoclimatic implications ([5],[6]).

Review of additional data sets of precipitation and atmospheric vapour:

Additional studies throughout the region, many of them as part of the IAEA sponsored CRP on the isotope composition of precipitation in the Mediterranean Basin [7], which included measurements of the isotopic composition of atmospheric vapour, suggested a strong dependence on the air mass trajectory into the area and on the seasonality [8]. These findings were generally in conformity with the basic premise of the Craig-Gordon model, but more detailed meteorological investigations [9], vapour measurements over the sea [10] and collection of orographic precipitation indicate that additional factors have to be taken into consideration before a reliable quantitative assessment can be made. Among them the changing isotope composition of the Mediterranean surface waters, addition of sea-spray and most notably, the non-equilibrium isotope fractionation in accompaniment of in-cloud and below cloud processes that occur en-route throughout the air column.

Model verification

Idealized model calculation of the isotopic composition of the evaporating flux (δ_E) for the range of expected values of the sea-water's isotope composition, of the atmospheric humidity parameters and temperature, all show a relative limited influence on the d-excess value of the resultant atmospheric moisture, beyond that predicted by the classical Craig-Gordon model. However the admixture of vapour that is the residue of non-equilibrium in-cloud and sub-cloud processes, as well as the vertical exchange processes over the ocean, are seen to perturb the isotopic signature of the atmospheric moisture significantly. These model predictions are going to be presented.

Conclusion

Due to the manifold factors contributing to the value of the d-excess in atmospheric waters, it is evident that a more detailed three-dimensional modeling of the air moisture's evolution throughout the region and its seasonal pattern is called for, augmented by appropriate vapour sampling and/or measurements.

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