Modelización de la formación de estelas producida por tráfico aéreo

Modeling the formation of contrails produced by air traffic

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RESUMEN

The formation of contrails from aircraft has generated controversy over the years and an interesting scientific debate surrounding two very different types of impact: their effect on military flights and their contribution to global warming. The relative humidity near the tropopause rarely exceeds 40% or 50% in most cases. This means that at the low temperatures found in these regions, the amount of available ambient water vapor is very low. Under these atmospheric conditions, when an aircraft crosses these levels with its engines running, a considerable and significant amount of water vapor is emitted due to the combustion process in the engines. Therefore, the mass of ambient water vapor is added to that produced at the engine nozzles. If the temperature of this vapor is below -41°C and the surrounding environment is saturated, spontaneous nucleation occurs, forming ice crystals. This work shows the meteorological conditions necessary for the formation of these contrails, differentiating between persistent and non-persistent ones. The Schmidt-Appleman model, to account for the increase in water vapor per unit mass due to fuel consumed, defines the parameter EI, which is a vapor emission index. Considering the heat capacity of air, the calorific value of the fuel and the propulsive efficiency of the engine, the parameter G is calculated, which represents the relationship between the increase in the partial pressure of the vapor added by the combustion of the fuel and the increase in the temperature produced. To do this, the Schmidt-Appleman model was refined and applied to a sample of 50 cases, half without contrails and the other half with them. The characteristics of the engine type and fuel most used in commercial air transport flights were used. The results show high reliability of the model in detecting the altitudes at which contrails can appear, depending on the meteorological conditions, distinguishing between persistent and more ephemeral ones. Based on these results from the application of the model, it is possible to establish, among other things, a climatology of this type of cloud artificially created by air traffic. The results show that for a given flight level, such as that corresponding to 39 kft, in the months when the temperature is lower, i.e., in winter, it is more likely that condensation trails formed by the exhaust gases from aircraft engines will form, than in those other months when the temperature is higher and therefore it is a little more difficult to reach vapor saturation.

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