A SATELLITE-BASED LOW-LEVEL STRATUS DETECTION IN SPAIN

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ABSTRACT

Fog and low-level stratus has a significant impact on transportation. 21% of aviation accidents are weather-related. And 19.8% of those accidents occur due to low visibility or dense fog. [1]

In order to improve the short range forecasting of radiation fog, and discriminate high clouds, during night, a satellite-based detection technique was developed using remote sensing.

The study was carried out for 2012th February in Spain. 24 MODerate resolution Imaging Spectro-radiometer (MODIS) night images, 9 from TERRA and 15 AQUA satellites were selected.

Our methodology splits the image analysis in 2 different phases:
(I) Make a distinction between fog/low stratus and other clouds, and
(II) Make a distinction between fog and low stratus.

After using Planck's Function to transform radiance values into brightness temperature,

$$BT = \frac{C_1}{\lambda\left\{\log\left(\left(\frac{C_2\lambda^{-5}}{I_\lambda}\right)+1\right)\right\}} \quad (1)$$

where C_1=14387.7 μmK, C_2 =1.19104 ×10^8 Wμ$m^4$$m^{-2}$$sr^{-1}$, and I_λ is radiance,

two different images corresponding to MODIS channels 31 and 22 were obtained (See Fig.1 and Fig.2). Then the two-IR-band method was applied [2][3].

Fig. 1.- MODIS channel 31 brightness temperature image

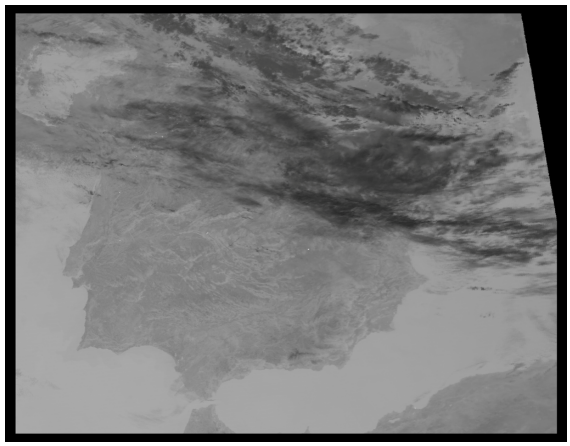

Fig. 2- MODIS channel 22 brightness temperature image

As a result, a temperature difference between 11 μm and 4 μm bands image, with 1 km spatial resolution was obtained (See Fig.3). The characteristic trait of these processed bands allow a visual distinction between fog/low stratus and other clouds after a false color tint.

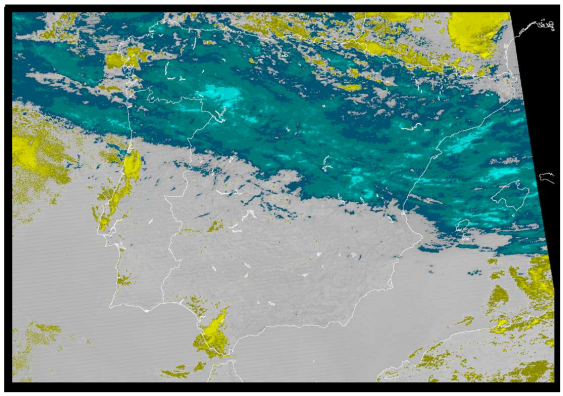

Fig. 3- Brightness temperature difference between 11 µm and 4 µm bands image in false color

A histogram study was carried out, in order to set different temperature thresholds to the 2 main clouds group (See Fig.4).

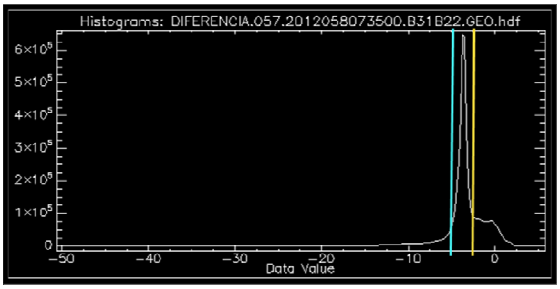

Fig. 4- Medium/high clouds and low stratus threshold determination.

Then, Spanish METAR Network was used as validation of the intermediate results. These coded weather reports broadcasted by Spanish aerodromes every hour, let us check fog presence in over 40 points along the country (See Fig.5).

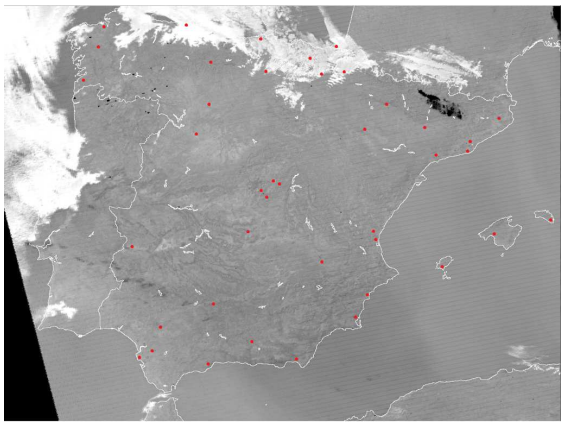

Fig. 5- METAR Spanish network used for step one validation

For the second step, fog and low stratus distinction [4], validation, radiosonde Skew-T charts from University of Wyoming were needed. Showing both, the temperature and dew point curves, they allowed the identification of the different cloud tops (See Fig.6 and 7) [5].

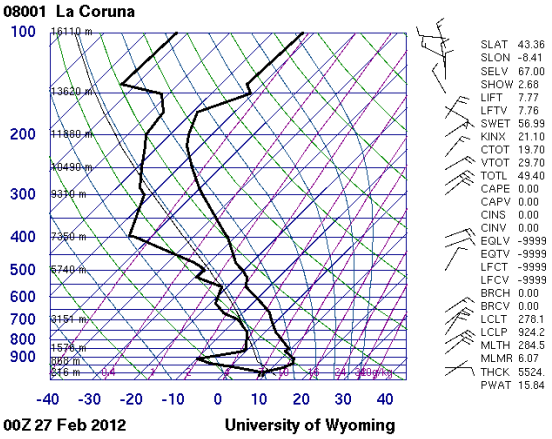

Fig. 6- Fog detection Skew-T, 27th of February 2012

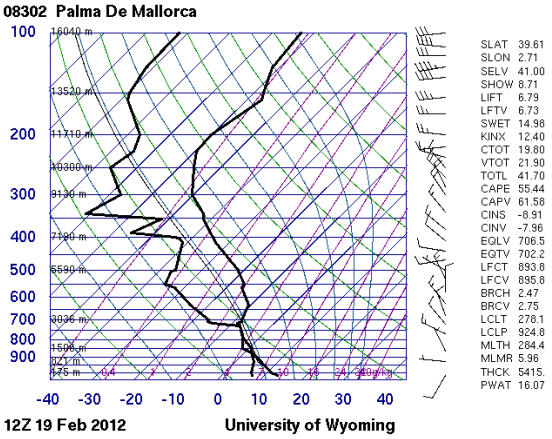

Fig. 7- Fog dismiss low-stratus detection Skew-T, 19th of February 2012

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