Verification of fog and low cloud simulations using an object oriented method

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1. Introduction

The forecasting of the onset, development and dissipation of fog remains today as one of the biggest challenges in the field of weather forecasting. We want to know if the use of meso-gamma? scale models in weather forecasting with sophisticated microphysics may improve the representation of fog and low clouds.

Besides, the verification of clouds is a complex issue. Traditional point verification has many limitations due to scarce observations, different meaning of cloud cover from ground observer and model calculation, and limitations of traditional scores (RMS, bias, MAE…).

The aim of this study is to explore the use of an object-based verification method and satellite observations to verify the model performance. We will use the SAL algorithm to see how well is the model able to represent the spatial structure of low clouds. SAL method has been design for precipitation verification and we want to know if it can be applied for cloud verification. Model clouds will be compared with satellite observations using SAF estimates of cloud type.

It seems important to focus the study in a relatively small area to have homogeneous meteorological conditions and for the SAL method to work well. The Spanish Northern Plateau is a fairly homogeneous terrain where radiation fog usually appears during winter. We select two months of data to outline the SAL methodology applied to cloud cover using the quasi-operational HARMONIE/AROME model running at AEMET and satellite observations.

2. SAL method

The SAL method (Wernli et al., 2008) is a *feature-oriented approach* which describes a model forecast skill when verified against gridded observations. Using this method it is possible to estimate the goodness of a model forecast attending not only the quantity of the magnitude but the spatial distribution of the field. SAL stands for *Structure, Amplitude and Location*, the three parameters providing the information of the field in a domain:

S: compares the shape and the size of the objects.
A: compares quantitatively the objects, in this case, cloud fraction.
L: compares the location of the objects in a relative and absolute way

SAL- A Novel Quality Measure for the Verification of Quantitative Precipitation Forecasts. Wernli et al., 2008 2008, Monthly Weather Review, 136, 4470-4487

INTERPRETATION OF THE SAL PLOTS

The SAL plot can help in understanding the distribution and patterns of the field when the model and the observations are compared :

- Every point in the plot describes SAL results for one comparison (e.g., forecast 2010123100+H006 with observation at 2010123106).
- X and Y-axes measure the S and A components respectively, while L is plotted in different colours.
  S = [-2,2] A = [-2,2] L = [0,2]
  The closer to cero at any parameter, the better.
- S > 0 and A > 0 mean that the model overestimate the observations. High values of L means bad location of the structures.
- Large S corresponds to wide structures predicted by the model in a situation of small observed objects. Negative S means forecasting of too small and/or peaked structures.
- The dashed lines show the median of the S and A distributions, while the shadowed rectangle shows the inter-quartile ranges (IQR).

3. Data

MODEL

- HARMONIE v36h1.4
- AROME configuration
- Horizontal resolution 2.5 km, 65 vertical levels.
- 6-hr cycle for surface fields, upper air fields are taken from the ECMWF H+6 forecasts.
- EDMFM scheme for shallow convection
- SLHD scheme for diffusion of hydrometeors.

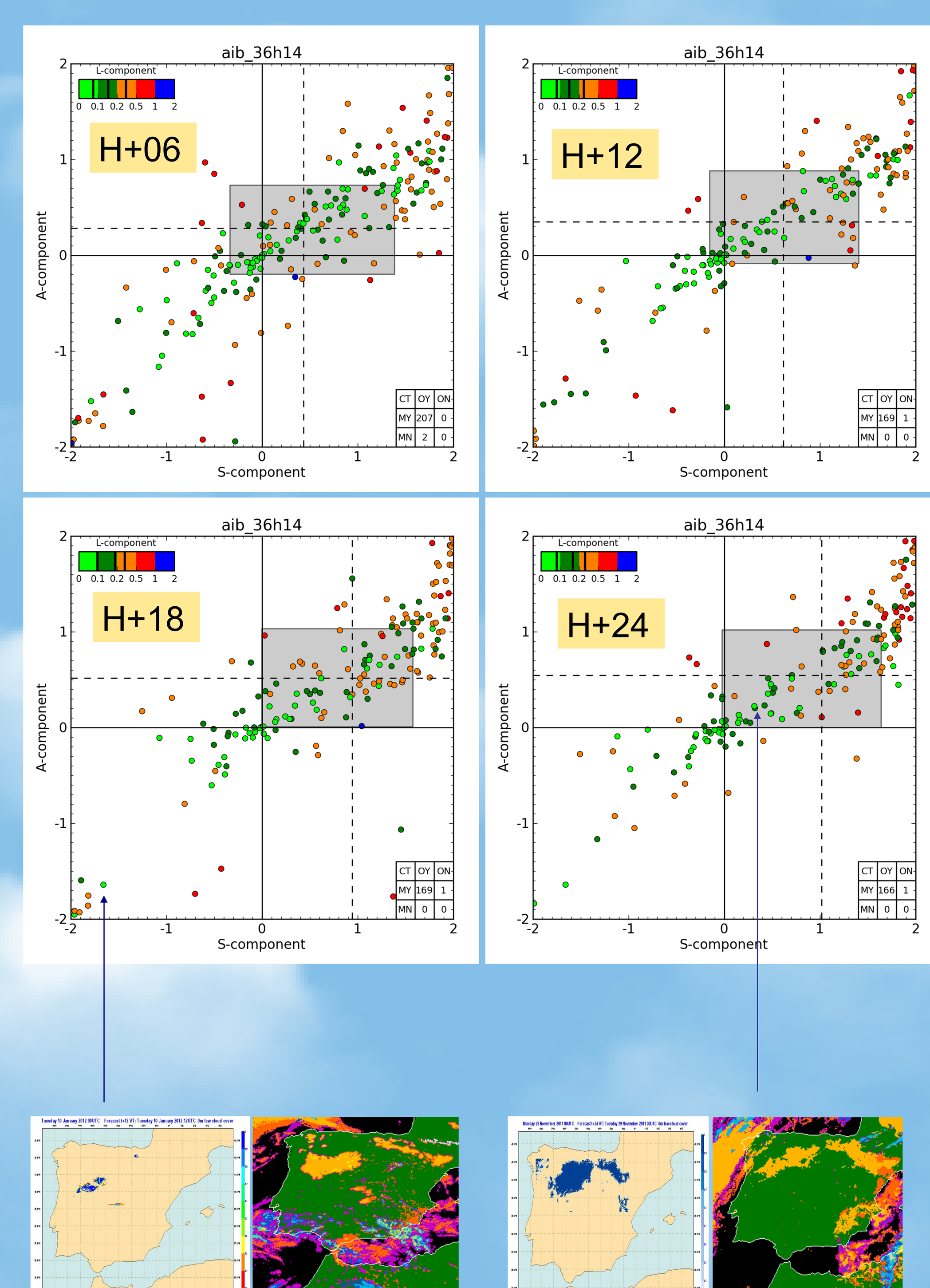
OBSERVATIONS

- MSG v2012.2 images
- Satellite Application Facility product of cloud type
- Native satellite files converted to grib files, filtered low clouds.
- Horizontal resolution ~ 3 km

DATA

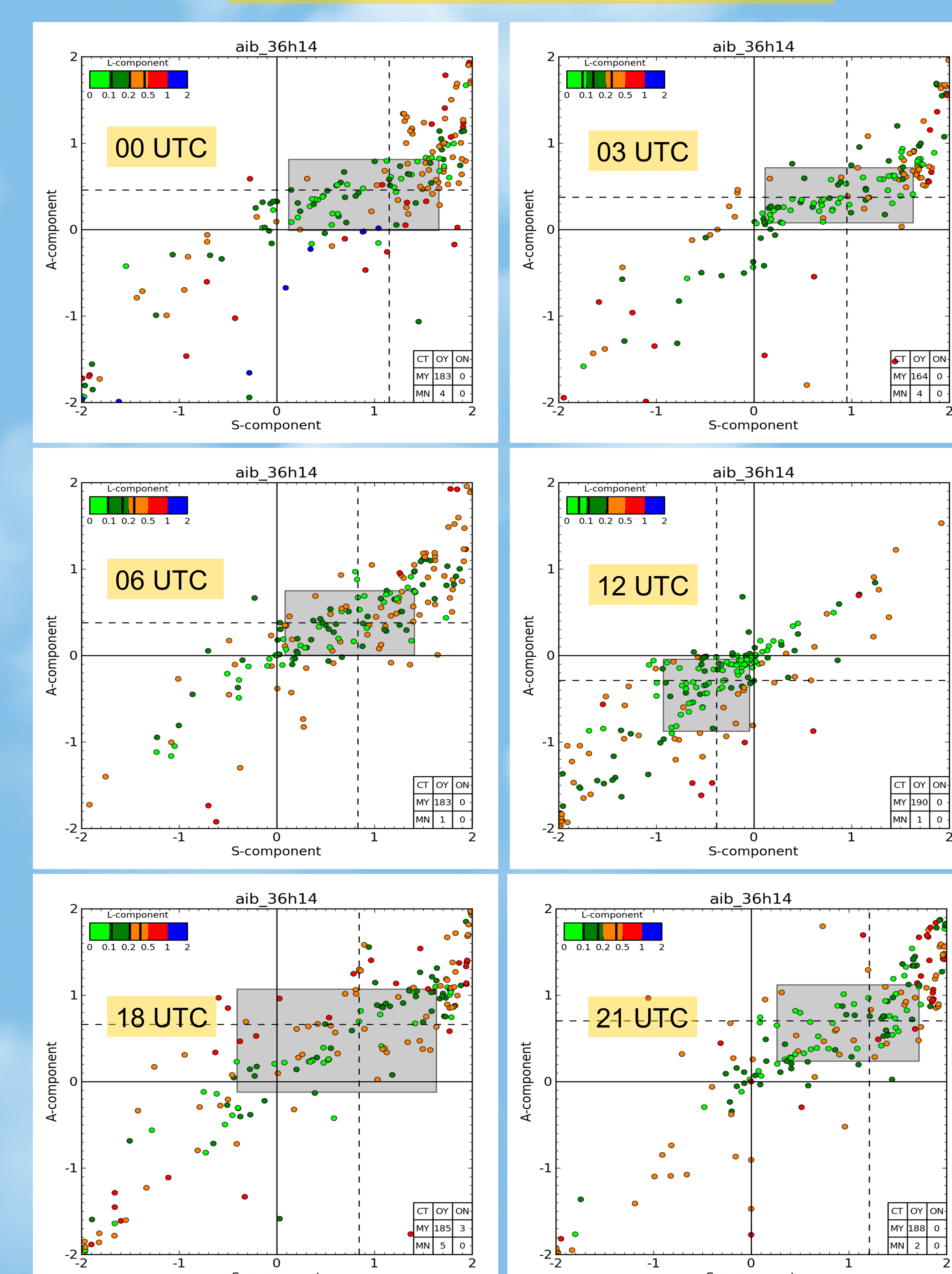
- North Spanish plateau
- 320x120 points ~ 800x300 km
- Jan 2012 and Jan 2013
- Model runs at 00,06,12,18
- Low and Very low cloud cover every hour up to t+24

SAL results at different forecast ranges



SAL method is applied to every pair model-obs verifying at the same hour: it correspons to one coloured point.

SAL results at different verification times



4. Conclusions and future work

Cloud field is complex to verify. In this work the proposal is to compare satellite products and model output to validate results for fog and low clouds from a more objective and quantitative point of view.

- Structure-Amplitude-Location (SAL) gives information that can be used to assess model performance from a different perspective, complementing the classical verifications.
- SAL method applied to two months of data shows that HARMONIE overestimate the fog/low-clouds events at any forecast range. However, it is interesting the underestimation of the model at 12 UTC: during the daylight fog and low clouds are dissipated more than expected compared to observations.
- In the light of these results and despite its limitations, HARMONIE has proved to be a better model than HIRLAM in predicting fog and low clouds (the comparison between the models is not shown here).
- It is planned to extend the study to a longer period to derive conclusions about the model performance regarding fog and low clouds. Different regions over the Iberian peninsula are being selected where fog develops and behaves different. In particular, model seems to have quite different behavior for low clouds over land and sea.
- It is expected that these results will help in identifying the weakness of the model regarding clouds performance as well as further help in forecasting guidance.
- This study opens the possibility to extend it to verify other variables as the liquid water content or the brightness