NOWCASTING THUNDERSTORM ACTIVITY ACROSS THE MEDITERRANEAN

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I. INTRODUCTION

Flash floods in the Mediterranean are one of the most disastrous and damaging natural phenomena, claiming lives and causing damage to property and agriculture on a large scale. Since flash flood by definition is a flood that hits strong and fast, it is difficult to predict. And therefore, a need exists for an improved alert system.

This research is part of the EU funded FLASH Project whose goal is to improve forecasting and now-casting of flash floods in the Mediterranean region.

Lightning data is immediately available and can be detected over thousands of kilometers and can assist in improving forecasts in areas without radar coverage. Lightning is known to have a strong correlation with rain rate and therefore prediction of lightning storms can eventually assist in prediction of intense rain fall and potential floods.

In this research we attempt to now-cast thunderstorms using lightning data from the Zeus lightning detection network and the WDSS-II analysis and forecasting model (Lakshmanan et al., 2003). Using the WDSS-II model, the motion of storm cells is detected and projected forward in time to give a now-cast of between 30 to 120 minutes of the location and intensity of the storm cells.

II. DATA AND METHODOLOGY

The data used comes from the Zeus VLF Lightning detection network centered at the National Observatory of Athens and which has 6 sensors throughout Europe.

The Warning Decision Support System – Integrated Information (WDSS-II) model from NOAA NSSL is a suite of algorithms and displays for severe weather analysis, warnings and forecasting.

(I) Using a hierarchical k-means clustering method, WDSS-II is able to define storm clusters (lightning data) at different scale sizes. Scale 0 has the smallest clusters and is therefore the most detailed, in scale 1 smaller clusters are combined to form bigger clusters, and scale 2 has the biggest clusters.

(II) The motion of the storm clusters is then estimated by comparing two consecutive frames, objectively matching clusters over time. A wind field is created based on the motion estimates, and the future position of every pixel is then interpolated accordingly.

ZEUS data from the entire year of 2008 was analyzed using WDSS-II, and now-casts we created for 30, 60, 90, 120 minutes. The main model setup includes:

-The area of research: latitude [32 50], longitude [-8 35]

-Average lightning density was calculated for a 0.1x0.1 deg grid

-A 30 minutes lightning density average was calculated every 15 minutes

-The bottom limit of lightning activity: 1 flash per pixel per 15 minutes

-Minimum size of cluster size: scale 0: 100 km^2, scale 1: 1000 km^2, scale 2: 2000 km^2.

III. RESULTS AND CONCLUSIONS

We assessed the success of the now-casts by comparing clusters found in the now-cast with clusters found in the actual observations and determining if it was a hit, miss or false alarm. This was done for different forecast radii around the forecasted cluster, ranging between 0-5 pixels around the cluster.

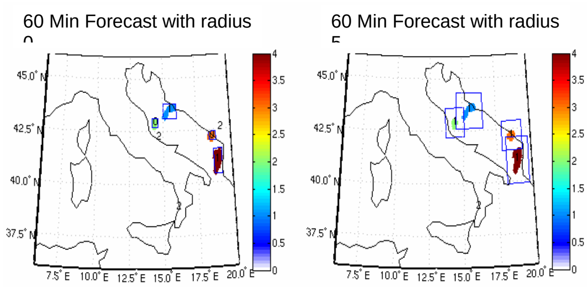

***Figure 1**: Success of thunderstorms nowcast for 60min lead time. The numbers 1 (on the cluster) implies a hit, 2 implies a miss, and 3 implies a false alarm. The boxes represent the uncertainty of the nowcast, with the radius 5 implying adding a 50km uncertainty around the original nowcast region (radius 0). The colors represent the different clusters.*

Figure 2 represents the skill of our nowcast. The top, middle, and lower panels show the percentage of hits, false alarms, and misses, according to forecast times (x-axis) and as a function of the forecast radius (y-axis).

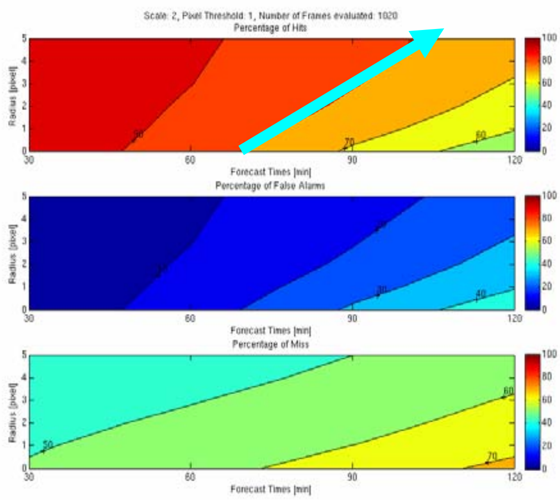

***Figure 2**: Statistics of nowcasts over entire year of 2008*

The blue arrow marks an 80% possibility of a thunderstorm in a radius of 0-5 pixels around the nowcasted storm as a function of forecast time. This can be useful when issuing warnings for potential severe weather.

IV. EXPERIMENTAL NOWCASTS

Using the statistics shown in Figure 2, we have attempted to produce real time experimental nowcasts on our FLASH project website (www.flashproject.org). These experimental nowcasts determine the center location of the thunderstorm in the next 30 min to 120 min. Depending on the initial size of the thunderstorm nowcast (mean radius of cluster), we forecast a circular region of activity in the next 30 minutes. As we progress in time, we increase the size of the region (circle) to allow us to have a 80% probability that thunderstorms will occur in this region, in the next few hours (Figure 3).

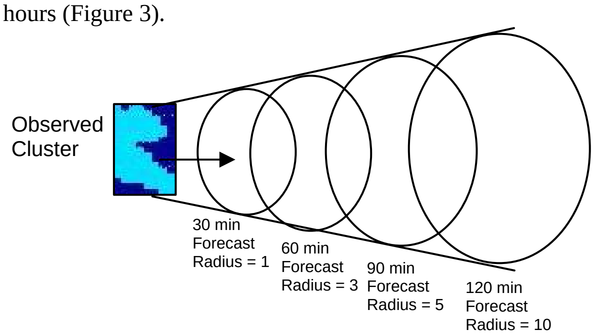

***Figure 3**: Procedure to produce realtime nowcasts.*

V. CLUSTER STATISTICS

Information from the WDSS-II can also be used to obtain statistics of storm characteristics, such as size, velocity and intensity. The figures below (Figure 4) show the annual variation of number of thunderstorms, average storm size, average storm speed, and the maximum lightning density in these storms. A dramatic difference can be seen in most cases between summer storms and winter storms.

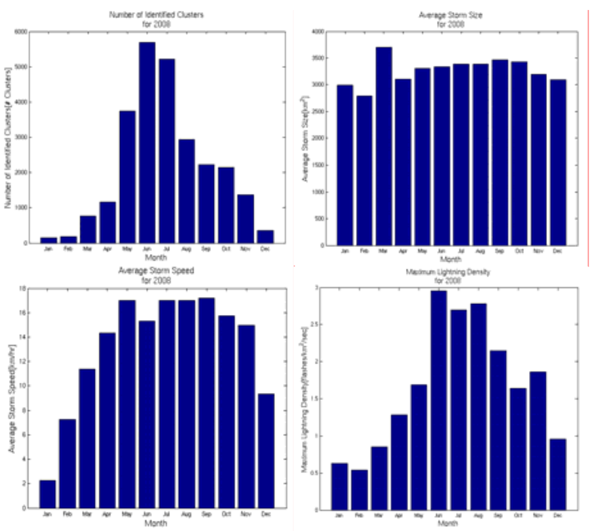

***Figure 3**: Monthly statistics on thunderstorm clusters derived from ZEUS data from the year of 2008. Number of identified storms (top left), average size (top right), average speed of storm (bottom left), and maximum lightning density (bottom right).*

VI. SUMMARY AND CONCLUSIONS

Now-casting of lightning location and intensity is studied using the Zeus observing system and the WDSS-II model. Location of the lightning clusters is automatically detected by the system on several spatial scales, and now-casting is performed for time lags of 30 to 120 minutes.

Results show the system is able to effectively detect lightning regions of relevance to strong precipitation and advect them forward in time. With a good hit percentage up to 120 minutes.

The movement vector, forecast radius and the slope created by the percentage of hits, can assist in defining an area of warning according to forecast time.

The clustering analysis is also useful to derive statistics on the location and intensity of lightning density.

VII. AKNOWLEDGMENTS

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VIII. REFERENCES

Lakshmanan, V., R. Rabin and V. DeBrunner: 2003. Multiscale Storm Identification and Forecast, *Atmospheric Research*, Vol. 67-68, pp. 367-380.