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Operational forecast of thunderstorms over Piemonte region: verification and past cases re-forecasts

Paolo A. Bertolotto

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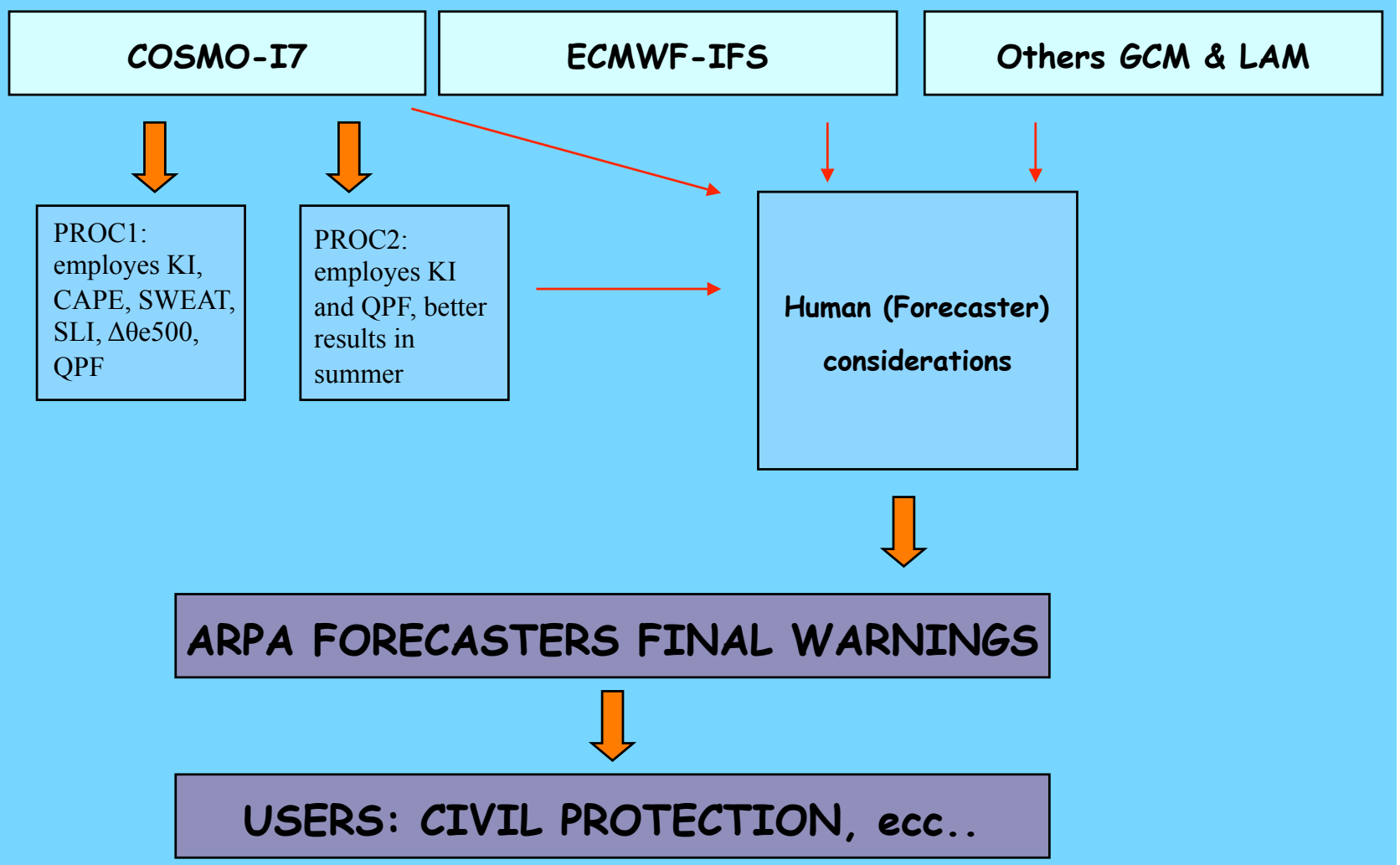
Thunderstorm Forecasting Operational Chain



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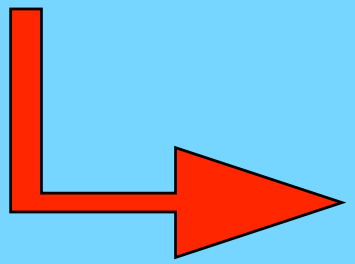
Thunderstorm Forecasting over Piemonte Region

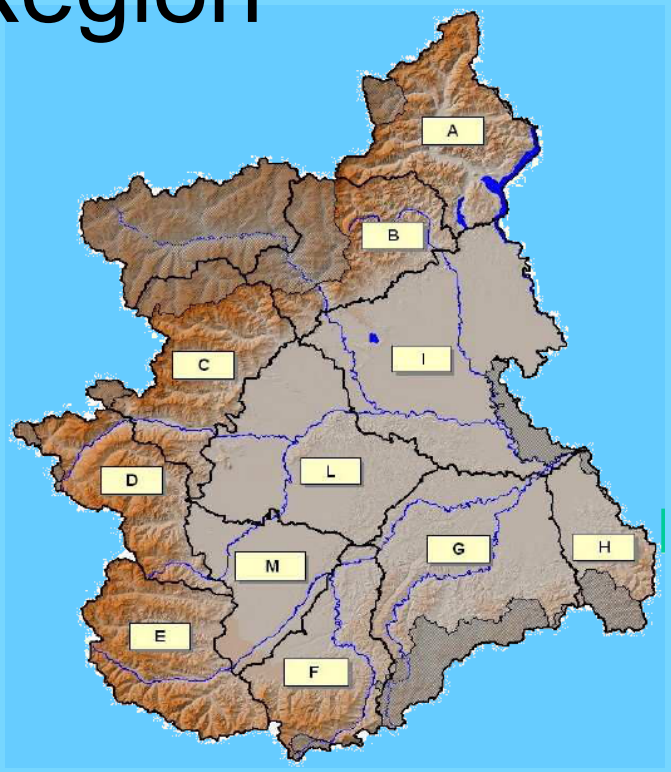
- 11 Alert Areas
- 36 h Warnings

Moderate Probability

High Probability



Warning over the area



- Observed Thunderstorm "yes" if QPF exceeds over an area 25mm/1h or 40 mm/3h with at least 1 lightning over the same area

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How much our methods are reliable in forecasting Thunderstorms? (COSMO-I7 model and Post-Processing Procedures in particular)

How good and how much improvable are our operational forecasts?

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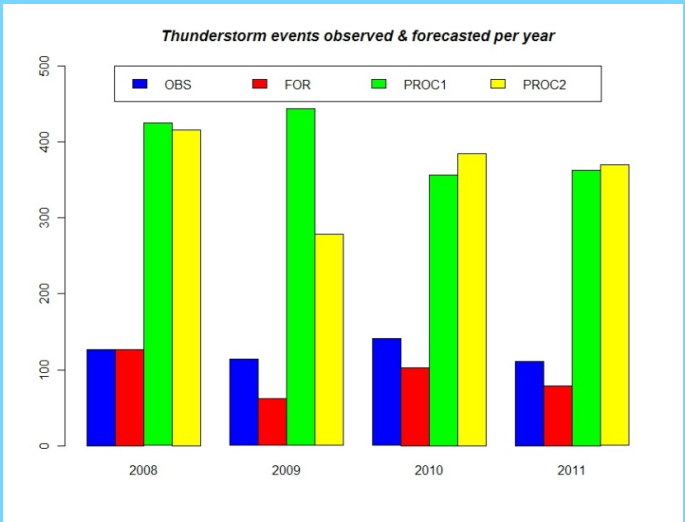
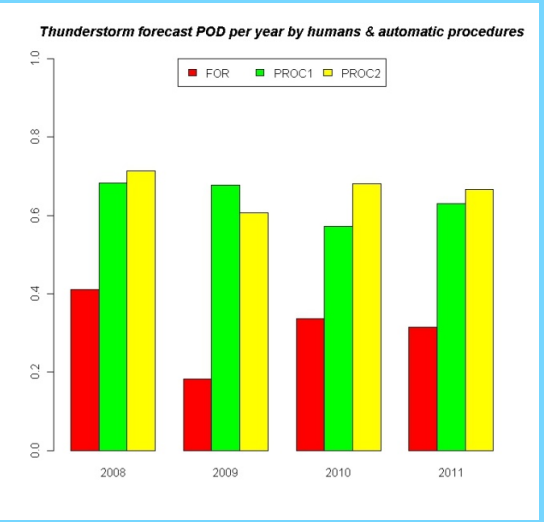
COSMO-I7 derived Post-Proc. Procedures vs. Human Forecasts

Number of events/alerts



POD



- Human Alerts: POD~0.4 , BIAS~0.8
- Automatic Alerts: POD~0.7 , BIAS~3
- Forecasters follow COSMO-I7 and the Post Proc. Procedures, heavily decreasing BIAS (and POD, as direct consequence)
- No significant improvement in the last 4 years
- Human Warnings better over the North

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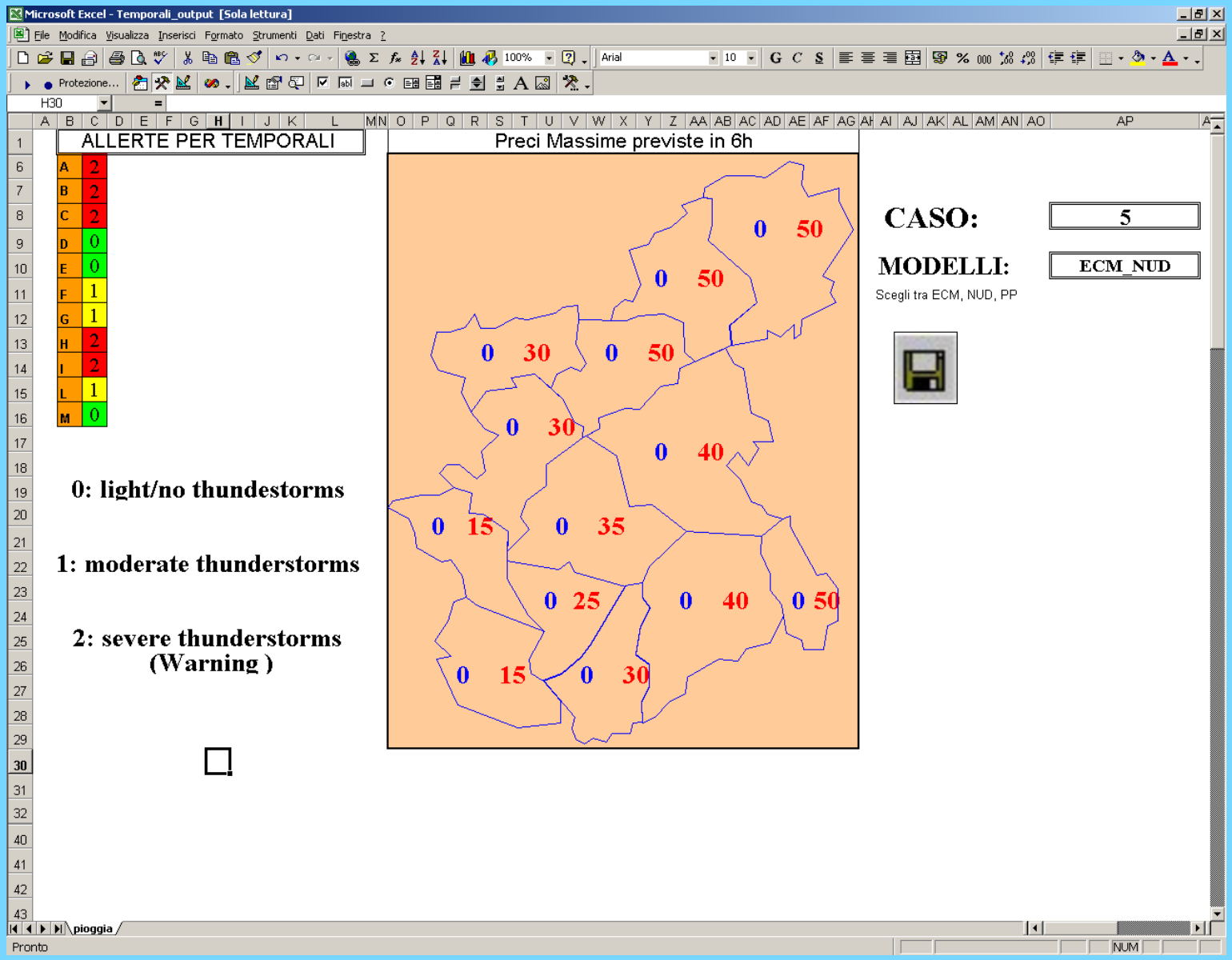
Investigating the problem: Re-Forecasting 10 Significant Cases

1. 13/7/2008 – Heavy Hail and 1 casualty – some MA
2. 13/9/2008 – Hail and small tornado TO-Plains
3. 6/6/2009 – Hail and small tornado E-Plains
4. 5/7/2009 – Heavy Thunderstorms not Forecasted
5. 7/7/2009 – Some Light Thunderstorms, many FA
6. 23/8/2009 – Severe Thund, small tornado – MA
7. 19/6/2010 – Heavy Thund. And heavy hail over Turin
8. 24/7/2010 – Light Showers, many False Alarms
9. 11/8/2010 – Many Missed Alarms
10. 20/8/2010 – False Alarms on the plains, spatial error

The Game: Internal Web Page for Forecasters



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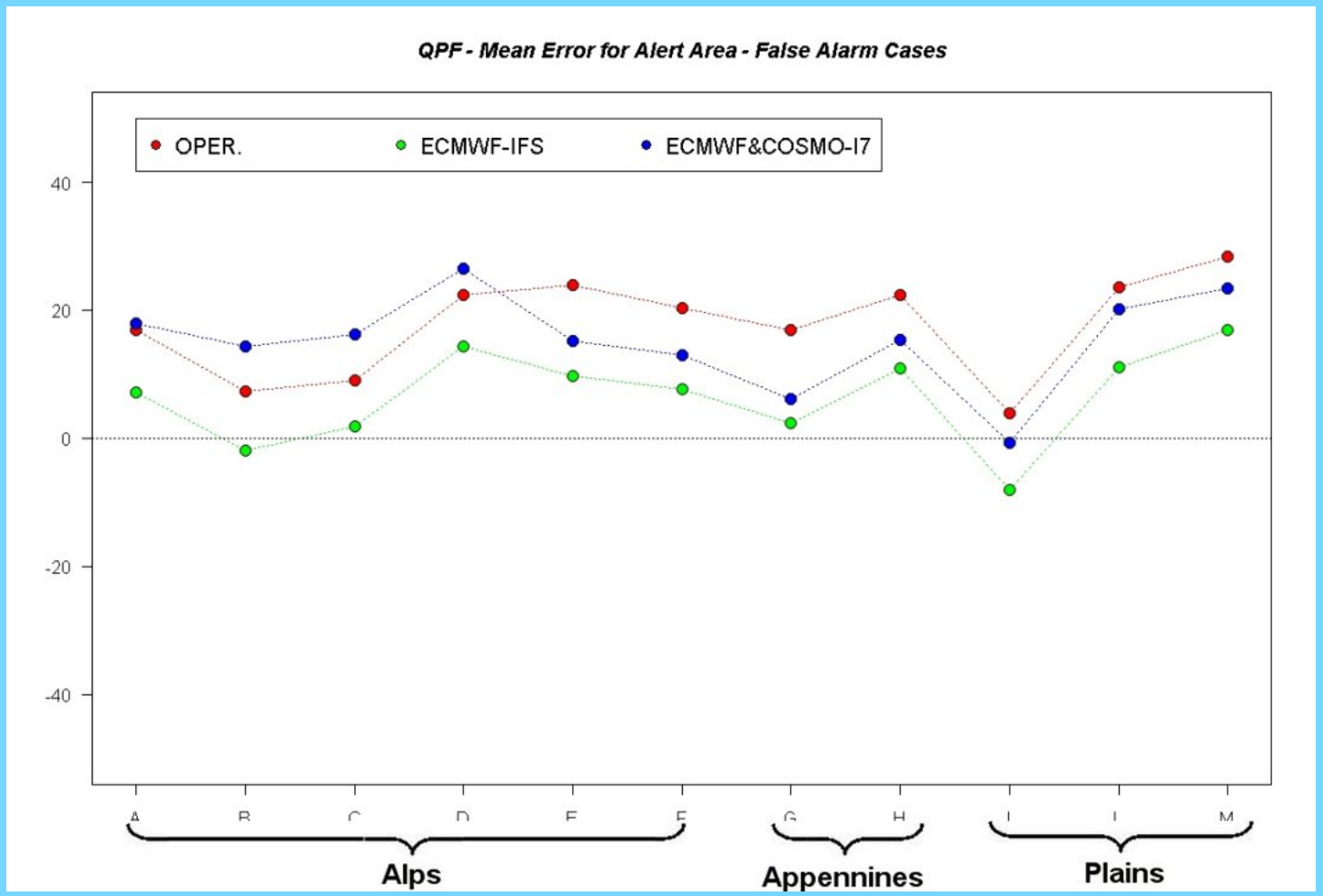
QPF – Mean Error Analysis



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QPF Analysis –Results

- ✓ Generally, QPF underestimation prevailed in re-forecasts (as in operational context)
- ✓ Light improvement of the ECMWF+COSMO re-forecast, and minimal signals of worsening
- ✓ Operational forecasts tend to underestimate the precipitation (cautiously), and forecasters that used ECMWF & COSMO-I7 fields in the game forecasted more rain than usual, showing over most areas slightly better results
- ✓ ECMWF-IFS re-forecasts tended to underestimate the most, and showed improvements only for the “selected” False Alarms cases.

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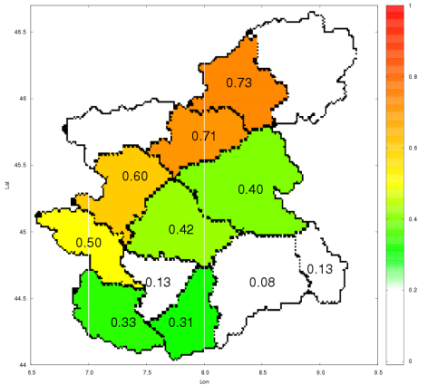
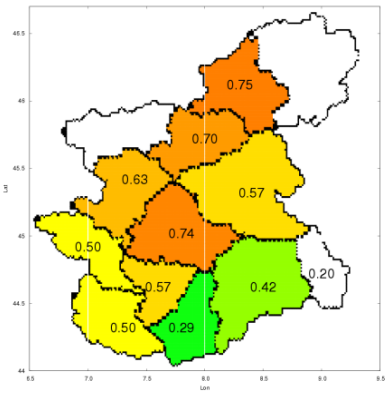
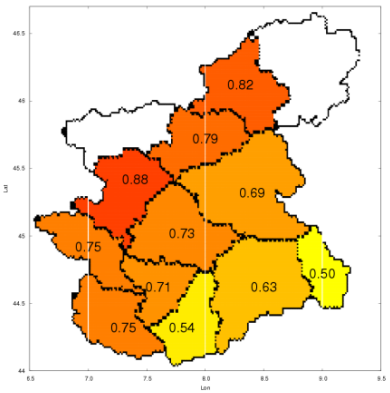
Alerts – Analysis

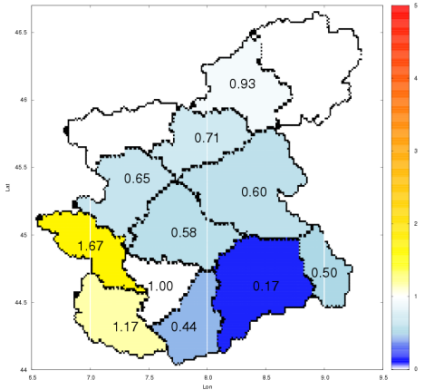
POD

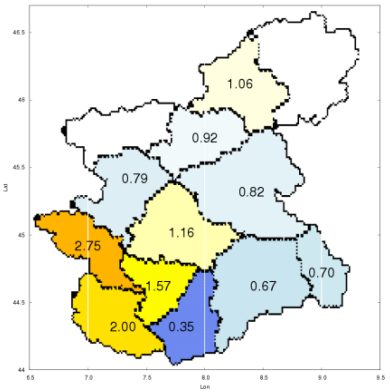


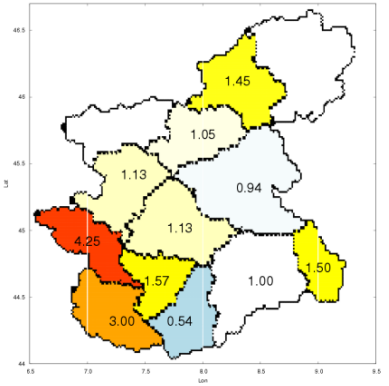




BIAS







Re-Forecasting with:

ECMWF-IFS:
Av. POD= 0.42
Av. BIAS= 0.65

ECM + COSMO-I7:
Av. POD= 0.54
Av. BIAS= 0.92

ECM + C-I7 + Post-Pr.:
Av. POD= 0.71
Av. BIAS= 1.24

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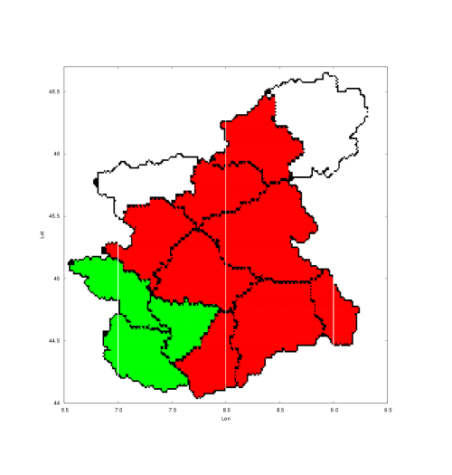
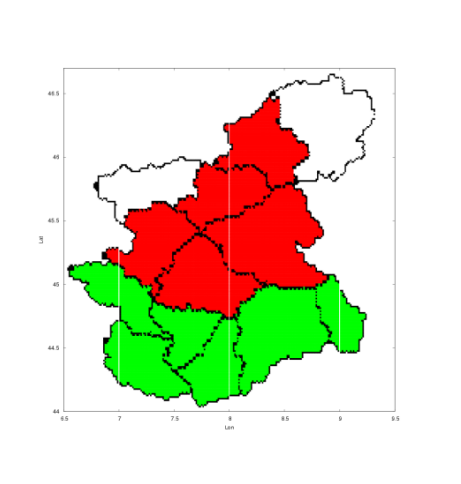
Alerts – Case by Case Analyisis

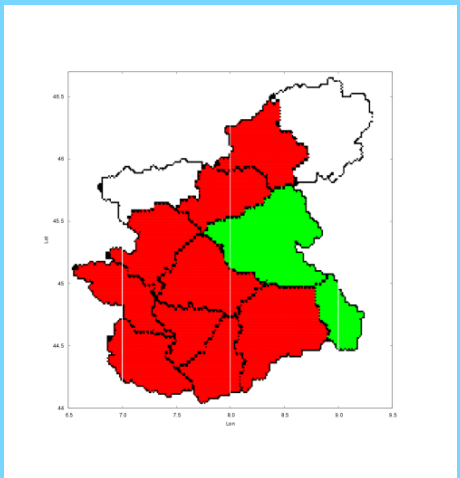
Case 1 – Severe Thunderstorm – Some Missed Alarms

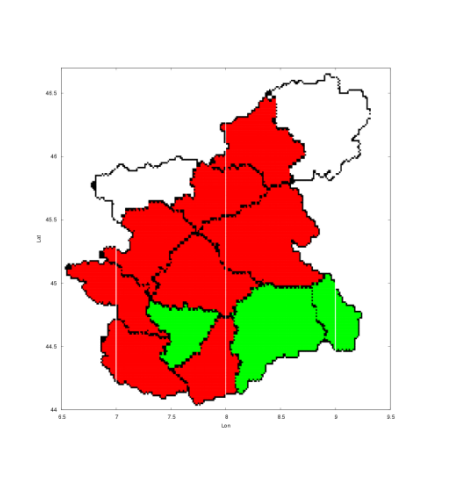




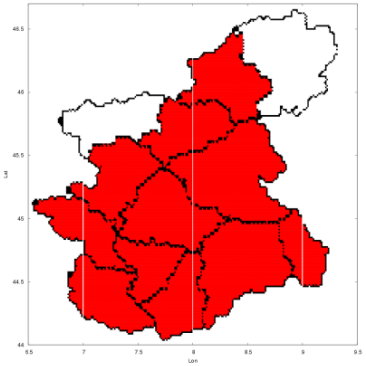
NONE

Case 2 – Severe Thunderstorm





POST-PROCESSING



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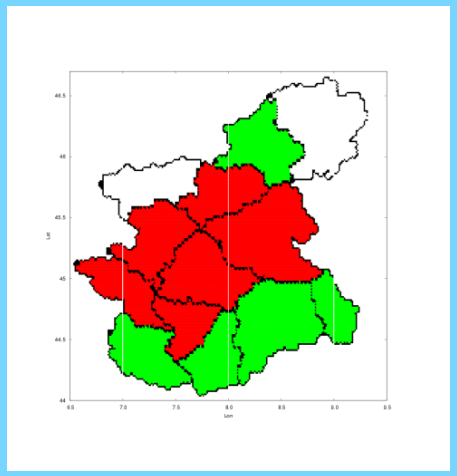
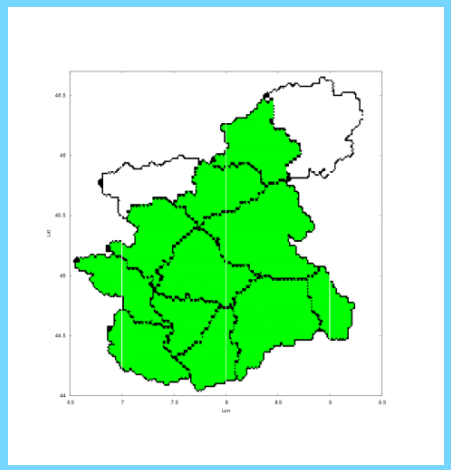
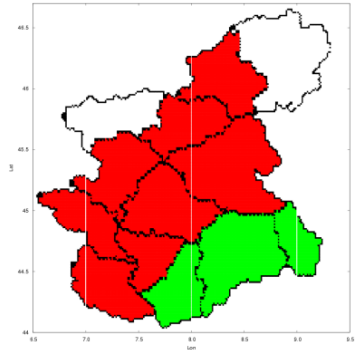
Alerts – Case by Case Analyisis

Case 9 –Missed Alarms

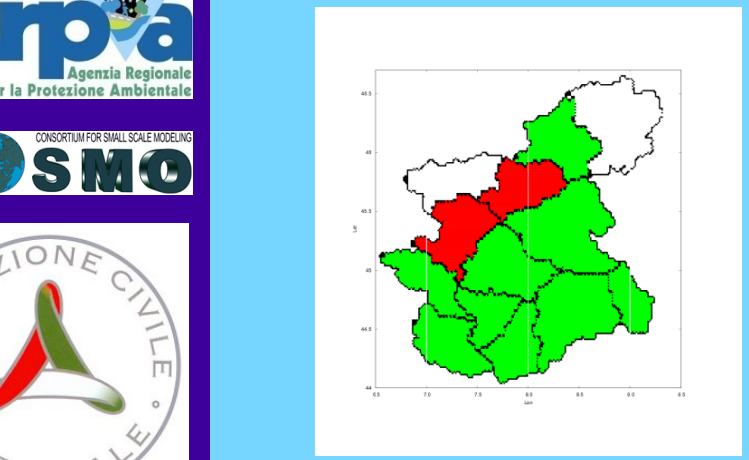


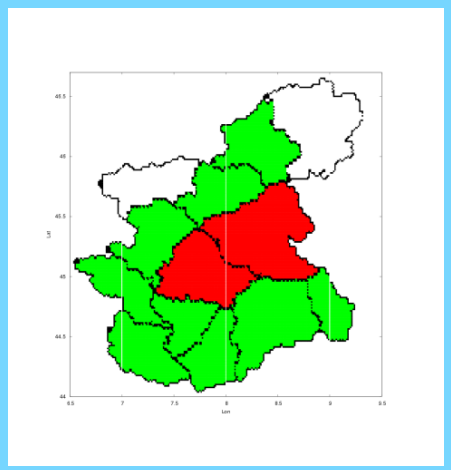


POST-PROCESSING

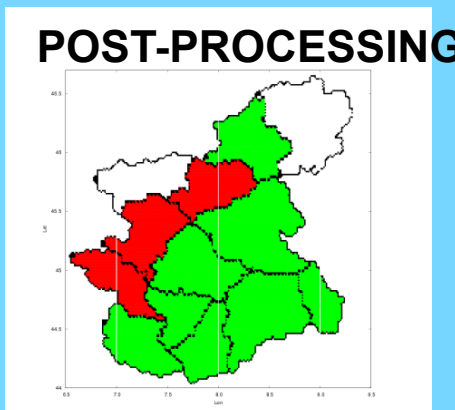


Case 10 – Spatial Error





POST-PROCESSING



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Alerts – Results

- Post processings seemed to help forecasters in improving performances in re-forecasting: the POD went from around 0.5 to around 0.7, with a correlated moderate BIAS increase;
- ECMWF-IFS alone alerts simulation have been unexpectedly good, obviously with low POD (0.4);
- Around 47% of total re-forecasts improved operational ones, while 45% were worser (the rest were equivalent)
- Only 39% Post Processing re-forecasts were worser
- This means that operational forecasts are still improvable with a deeper analysis

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Causes of Error in Operational Forecasts:

1. (Too strong) Correlation with End-Users: interfacing Civil Protection Managers may cause Forecasters to be cautious in issuing alerts and sometimes to change their warning intentions
2. Persistence: “Yesterday” Forecast Errors can bias and cause opposite Errors in “Today” Forecasts – not in the simulation
3. More time dedicated to Thunderstorm Forecasting in the re-forecast with respect to the operational context
4. Warning Areas too small: verification results would be better if we consider to alert or not the whole region; is models spatial accuracy in positioning thunderstorms greater than Warning areas dimension?

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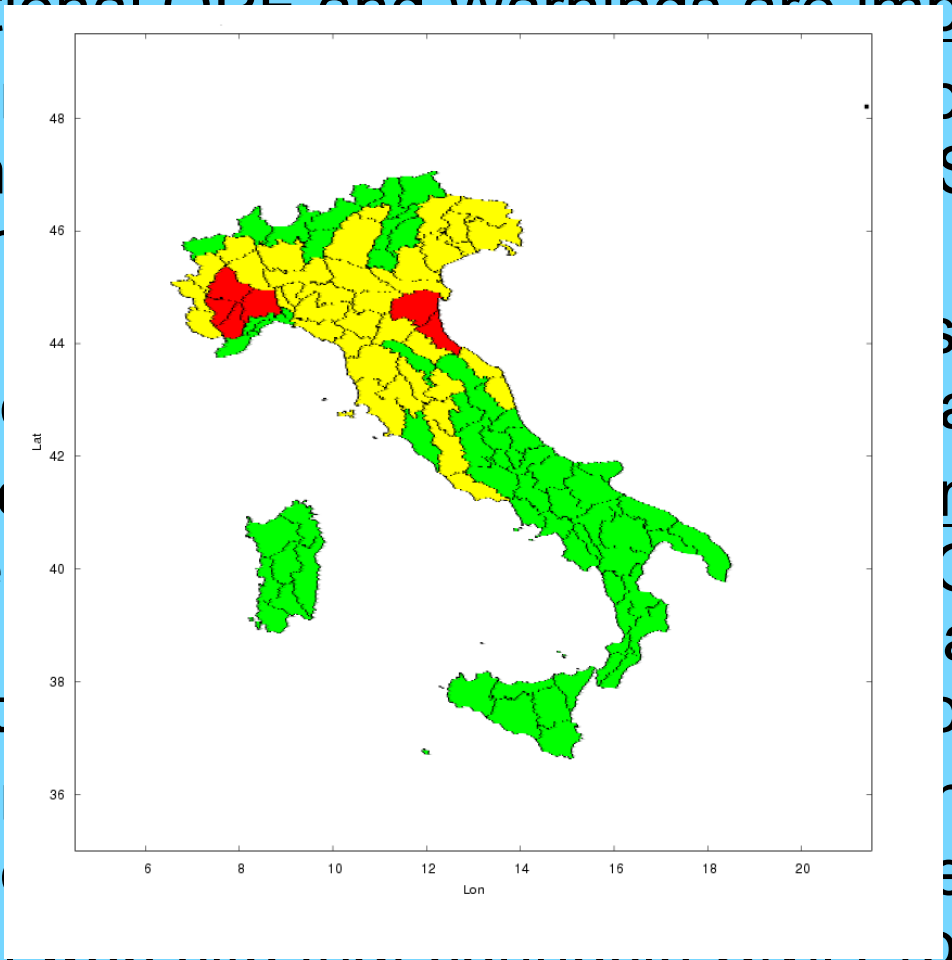
Conclusions and future steps

- Operati… …provable
- Post-P… …out knowin… …S than other ir…
- Future … …ssing trying t… …ables
- Need t… …nalysis to dete… …OD and higher … …alses) is better t… …ow POD
- Post-P… …n extend… …ew interna… …otection Regional Centres --→ Verification



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Thank you
for your attention

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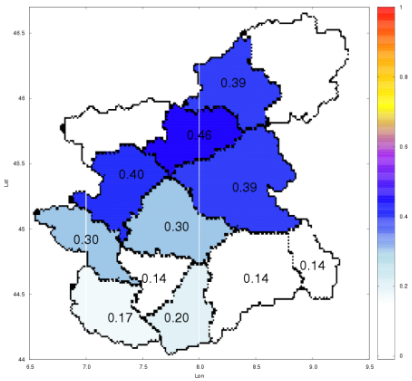
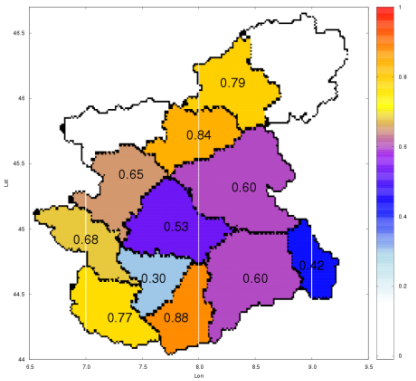
COSMO-I7 derived Post-Proc. Procedures vs. Human Forecasts

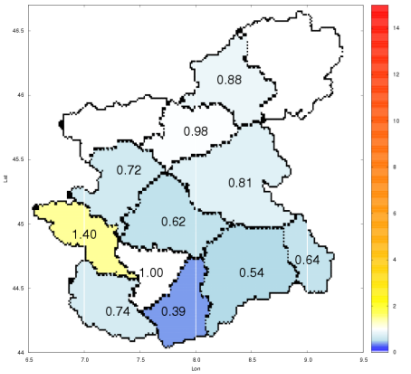
HUMAN - POD



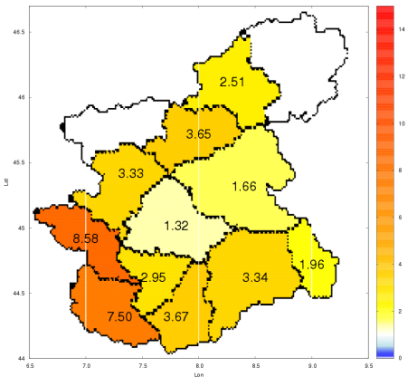
PROC2 - POD



HUMAN - BIAS



PROC2-BIAS



- ✓ Human Warnings better over the North
- ✓ Automatic POD better over the Alps
- ✓ Automatic Procedures Overestimation from 1.5 (plains) to 8 (Western Alps)
- ✓ Forecasters followed COSMO-I7 and the Post Proc. Procedures, but heavily decreasing BIAS (and POD, as direct consequence)

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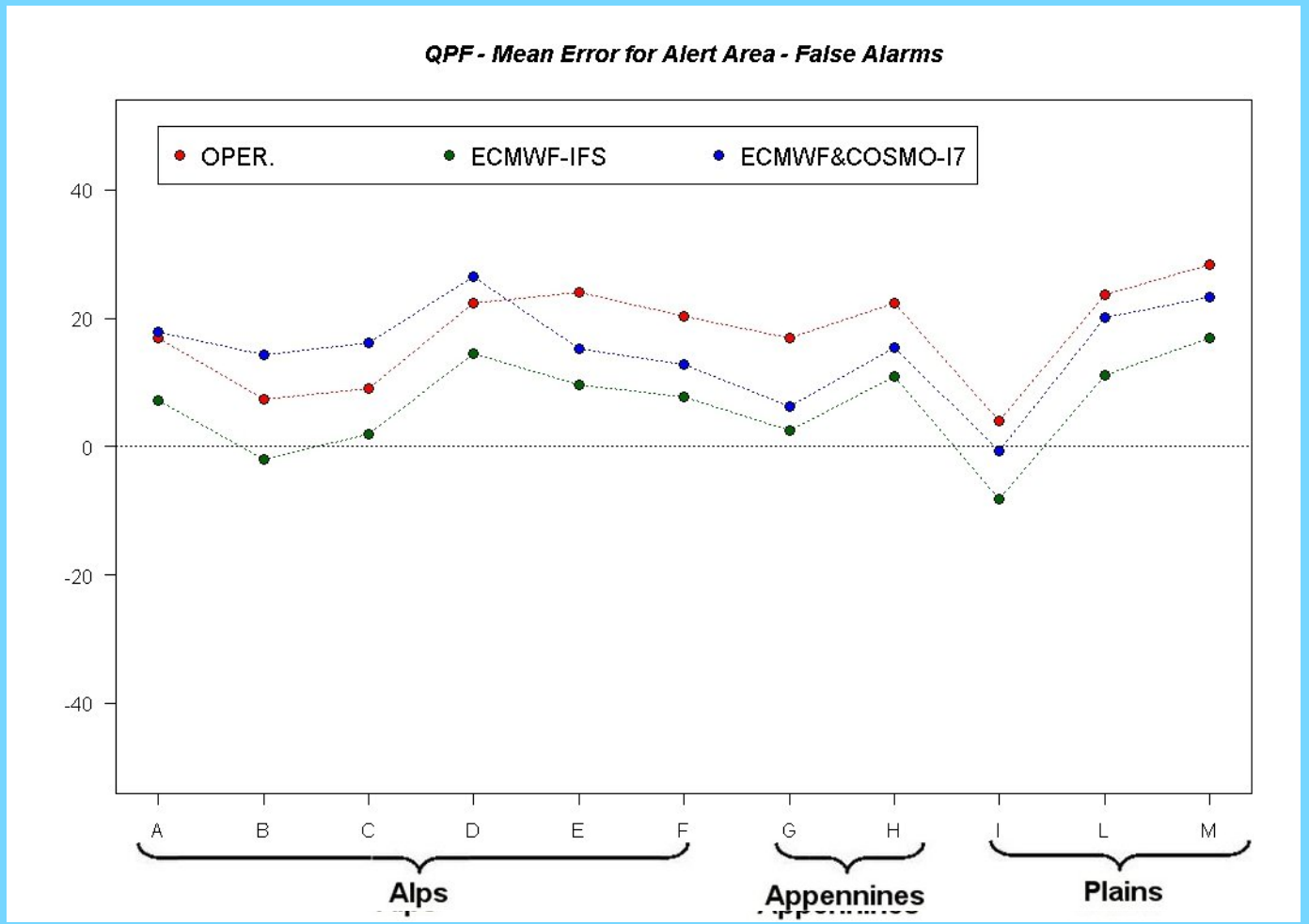
QPF – Mean Error Analysis



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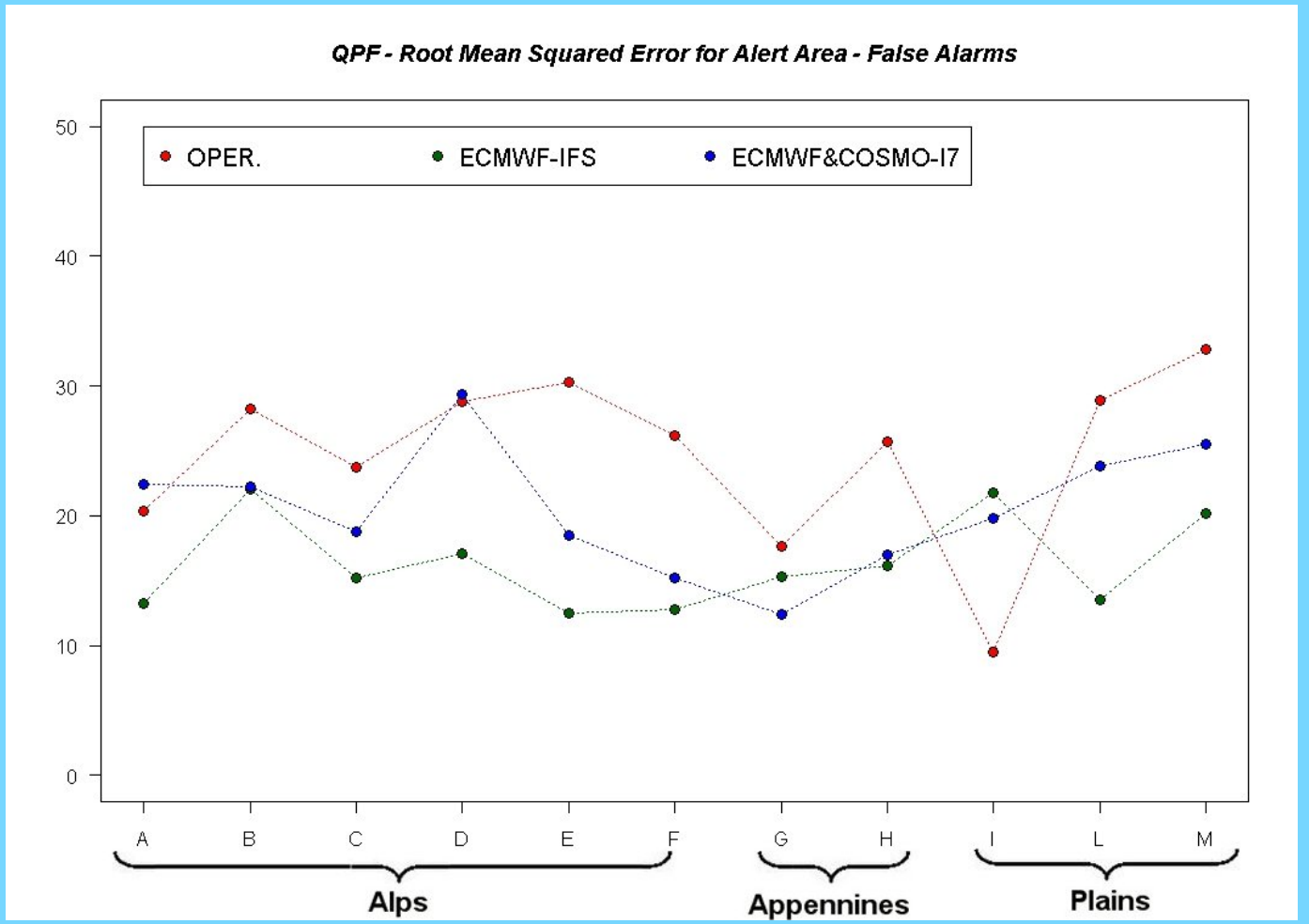
QPF – RMSE Analysis



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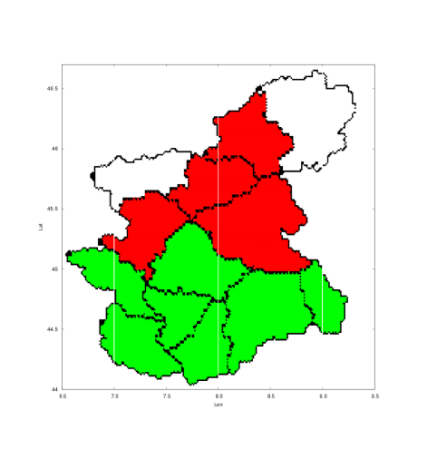
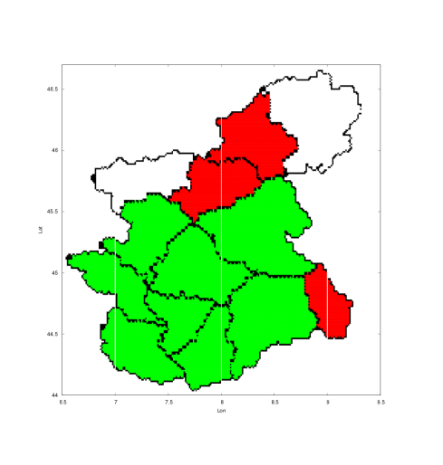
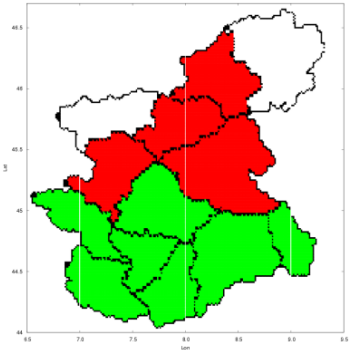
Alerts – Case by Case Analyisis

Case 3 – Severe Thunderstorms

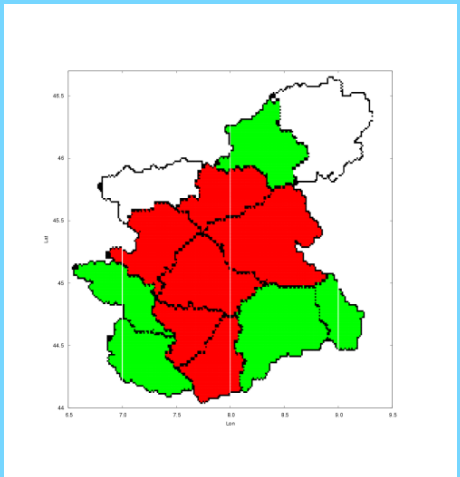


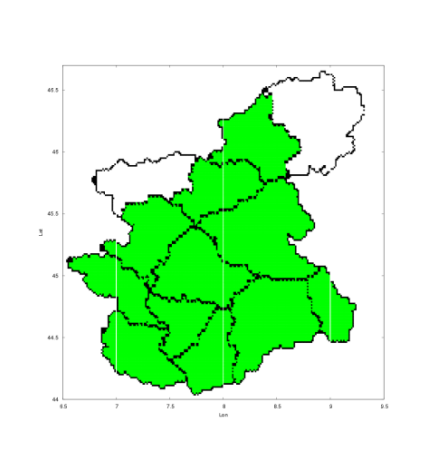


ECMWF-IFS

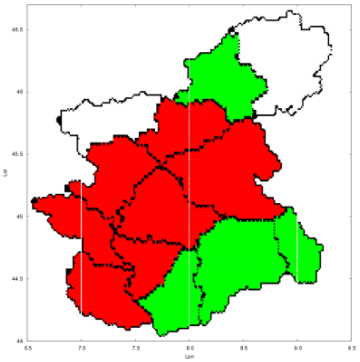


Case 4 – Missed Alarms





POST-PROCESSING



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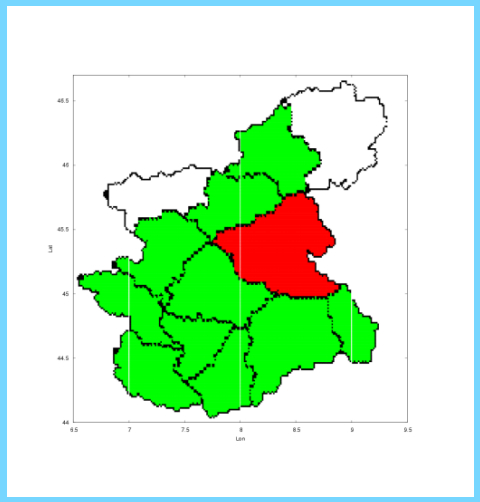
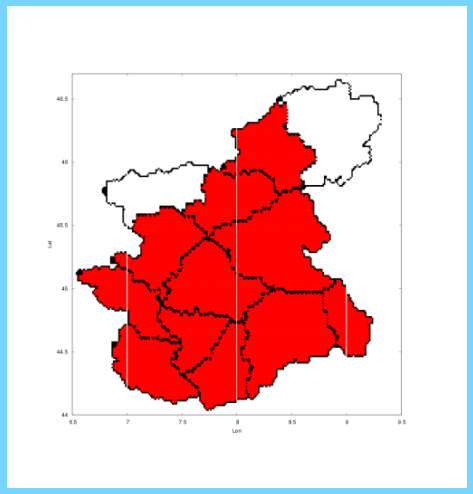
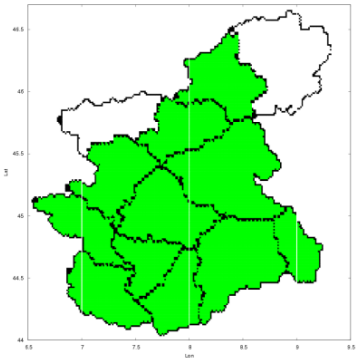
Alerts – Case by Case Analyisis

Case 5 – False Alarms

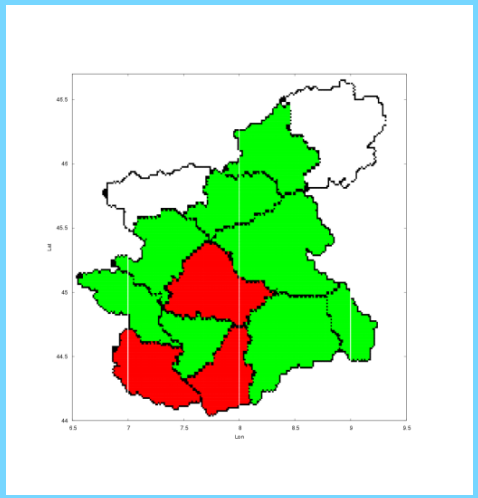


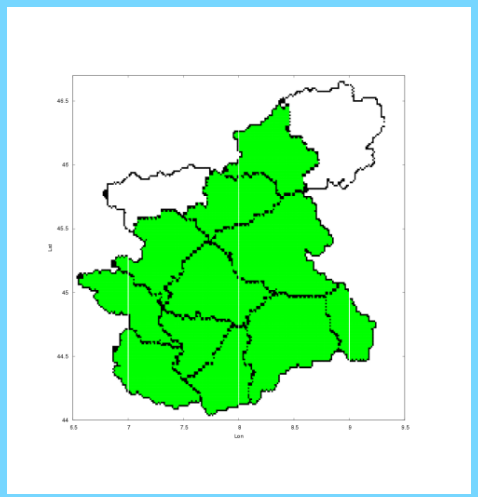


COSMO-I7 & ECMWF-IFS



Case 6 – Missed Alarms





NONE

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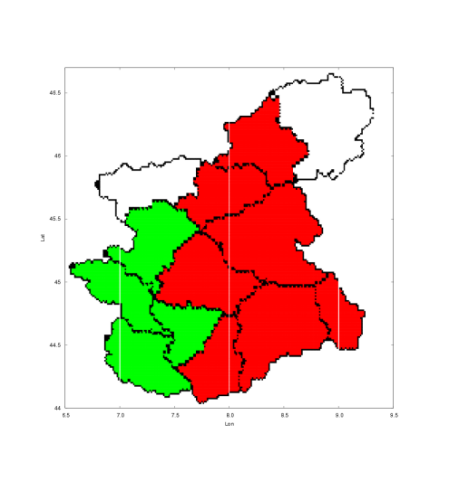
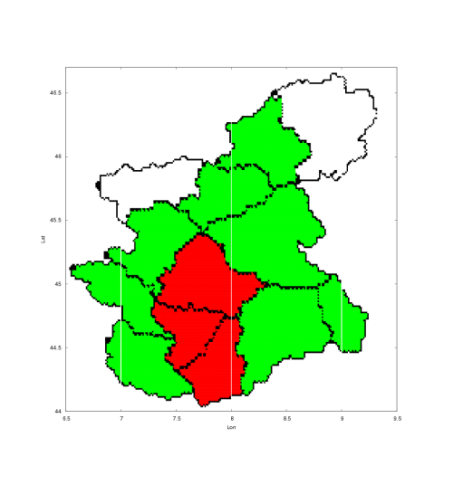
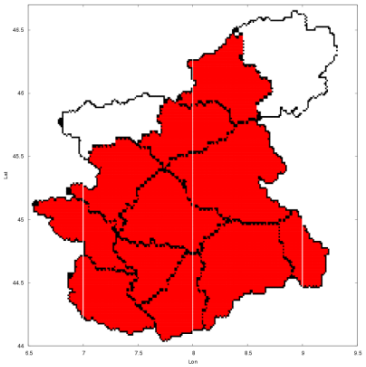
Alerts – Case by Case Analyisis

Case 7 – Severe Thunderstorm – Missed Alarm

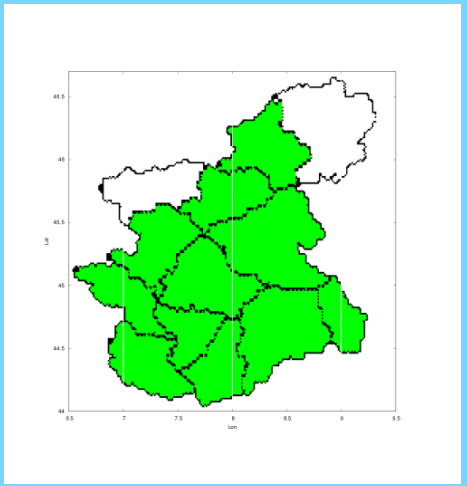


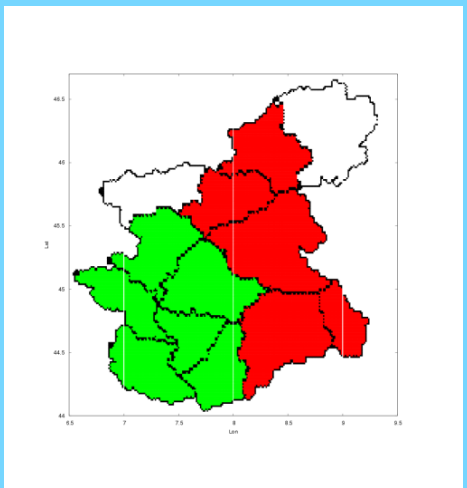


COSMO-I7

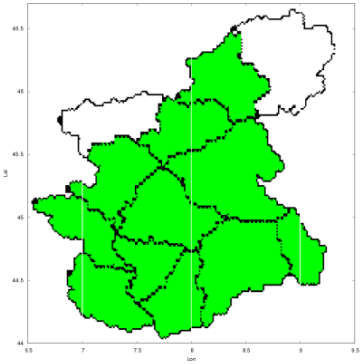


Case 8 – False Alarms





ALL CONFIGURATIONS



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CONSORTIUM FOR SMALL SCALE MODELING COSMO

PROTEZIONE CIVILE NAZIONALE