Impact of radar reflectivity assimilation in KENDA:
the italian experience

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KENDA
(Kilometre-scale Ensemble Data Assimilation)

Assimilation of non conventional data through operator

EMVORADO: Efficient Modular Volume RADar Operator

Assimilation of REFLECTIVITY and RADIAL VELOCITY POLAR VOLUMES

EMVORADO application in the italian framework

- Due to its structure, each country can add its own part of the code to read data
- Up to some months ago implementation and test for use of reflectivity and radial wind volumes was concluded only for Germany
- EMVORADO was able to read only radar volumes coded as NetCDF

Implementation of an ODIM HDF5 conventional format reader

This implementation, which at the moment reads reflectivity polar volumes, is now tested for Italy

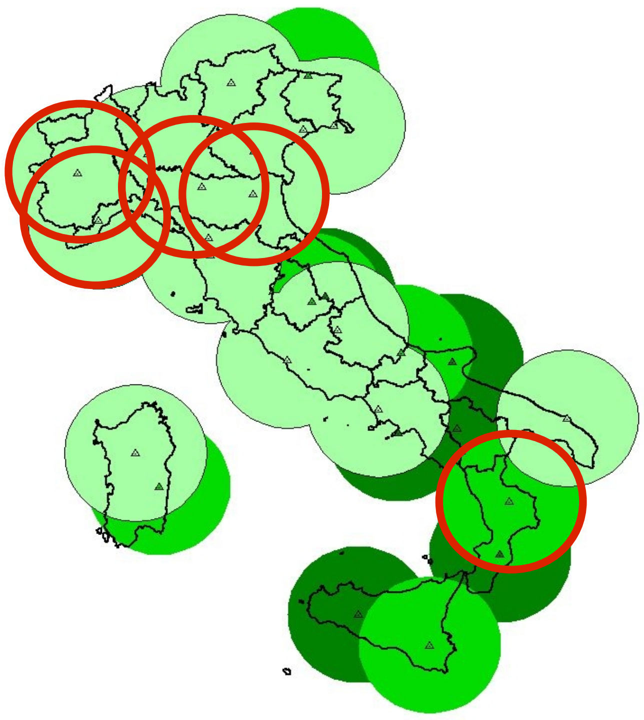
The stand-alone reader works with all OPERA VOLUMES
(so each country can use it)

Use of reflectivity polar volume

- observations denser than grid model resolution can degrade the analysis
- If observations are too much during LETKF step there is a memory request problem that cause a segmentation fault without solution

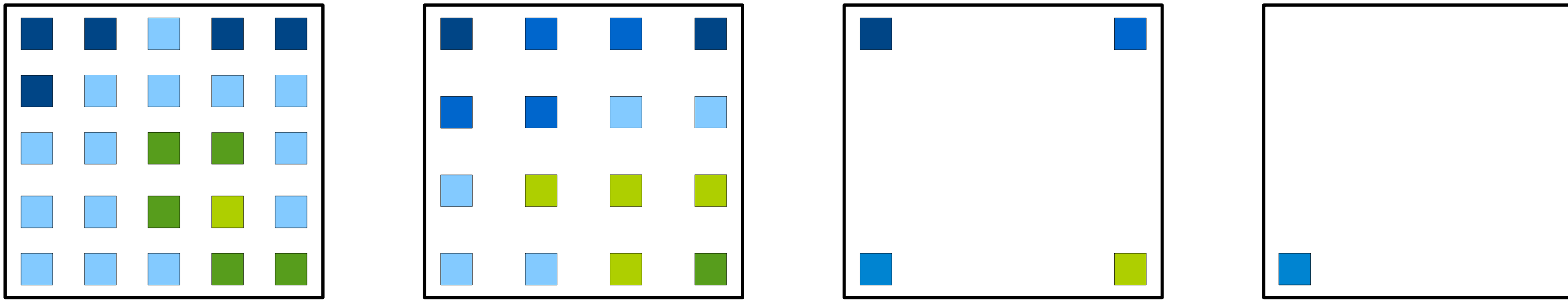
SUPEROBBING

Radars from the italian network used in KENDA
San Pietro Capofiume (BO)
Gattatico (RE)
Bric della Croce (TO)
Settepani (SV)
Monte Pettinascura (CS)



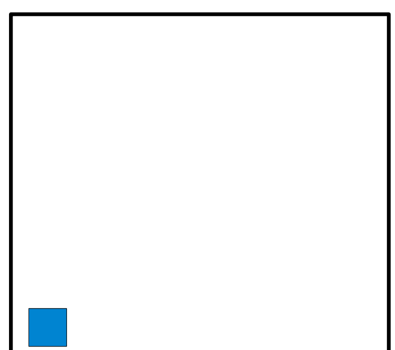
SUPEROBBING

PETTINASCURA CASE STUDY
1 radar: Monte Pettinascura (CS)



5 km   7 km   10 km   20 km

LONG-RUN
4 radars: San Pietro Capofiume (BO), Gattatico (RE), Bric Della Croce (TO), Settepani (SV)



20 km

SUPERORBBING

PETTINASCURA CASE STUDY

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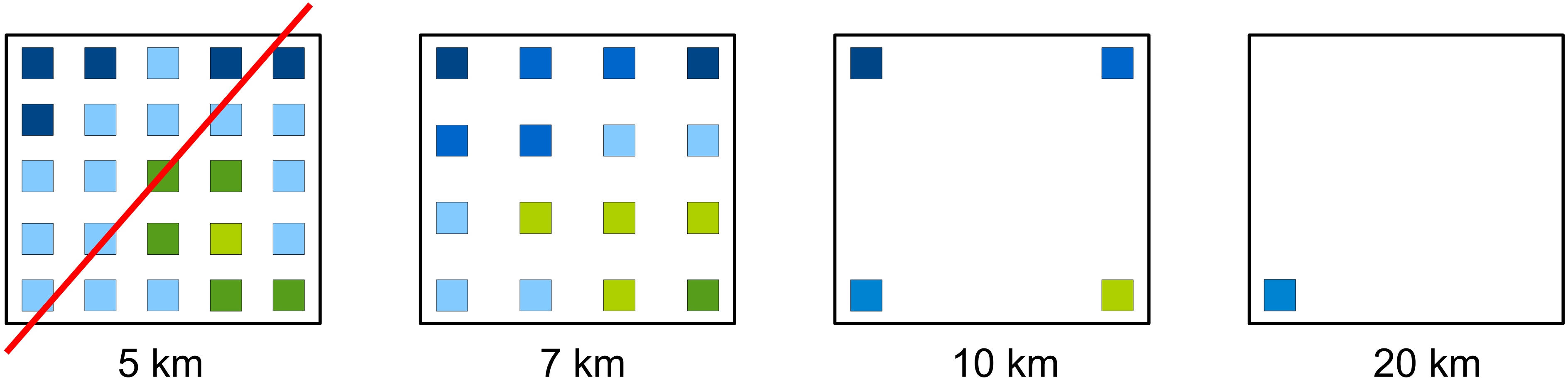


Too much memory requested

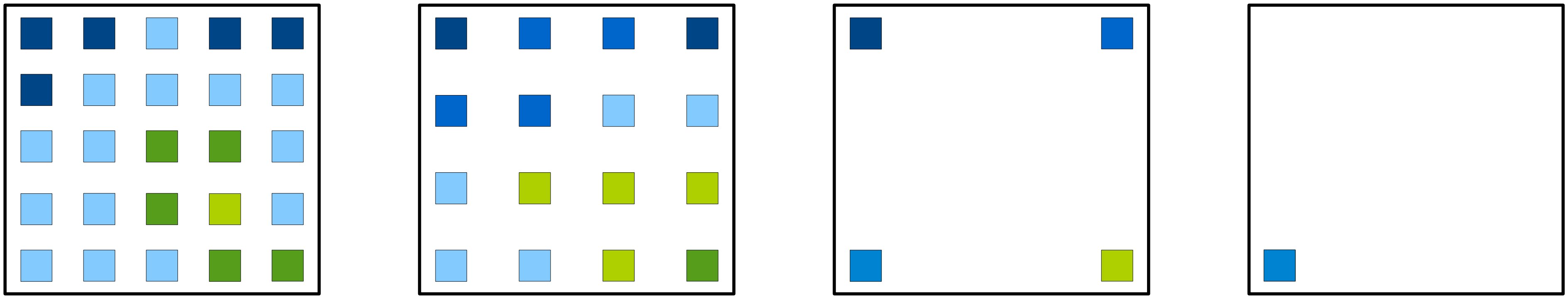
LETKF does not produce OUTPUTS

COSMO run: 4 nodes, 16 processors per node, default memory for each node (32 GB)
LETKF run: 4 nodes, 16 processors per node, maximum memory per node (120 GB)

7 km	10 km	20 km
Mean execution time for COSMO run: 9m9s	Mean execution time for COSMO run: 9m25s	Mean execution time for COSMO run: 9m22s
Mean execution time for LETKF run: 4m47s	Mean execution time for LETKF run: 2m47s	Mean execution time for LETKF run: 1m35s

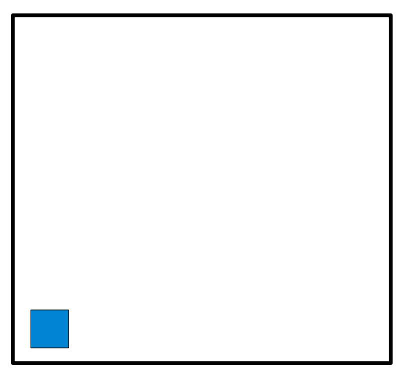
SUPERROBBING

CASO PETTINASCURA
1 solo radar: Monte Pettinascura (CS)



5 km 7 km 10 km 20 km

LONG-RUN
4 radars: San Pietro Capofiume (BO), Gattatico (RE), Bric Della Croce (TO), Settepani (SV)



20 km

Mean execution time for COSMO run:	9m 49s
Mean execution time for LETKF run:	1m 20s

PETTINASCURA CASE STUDY

Run from 11/08/2015 at 00 UTC to 13/08/2015 to 00 UTC

KENDA
- 3 hourly cycle
- BCs from ECMWF ENS (also IC for the cold start), 32 km horizontal resolution
- BC from deterministic run (also IC for the cold start), 16 km horizontal resolution
- 20 members + 1 deterministic run

CONV – COSMO 2.8 km, 50 levels

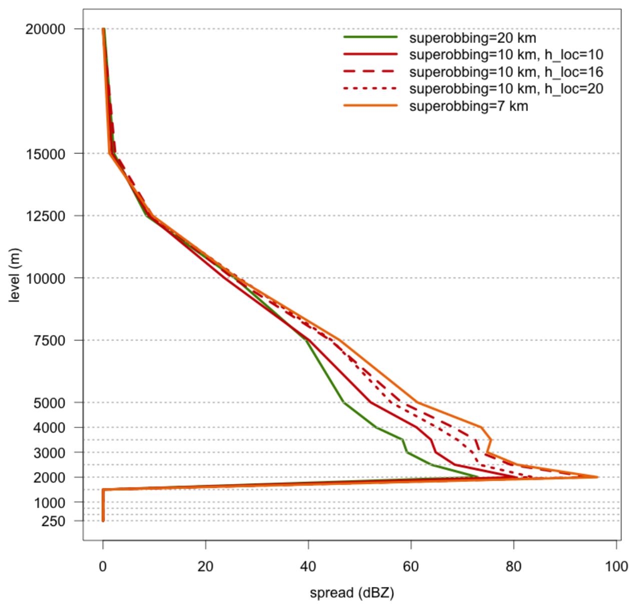
CONV + RADAR –

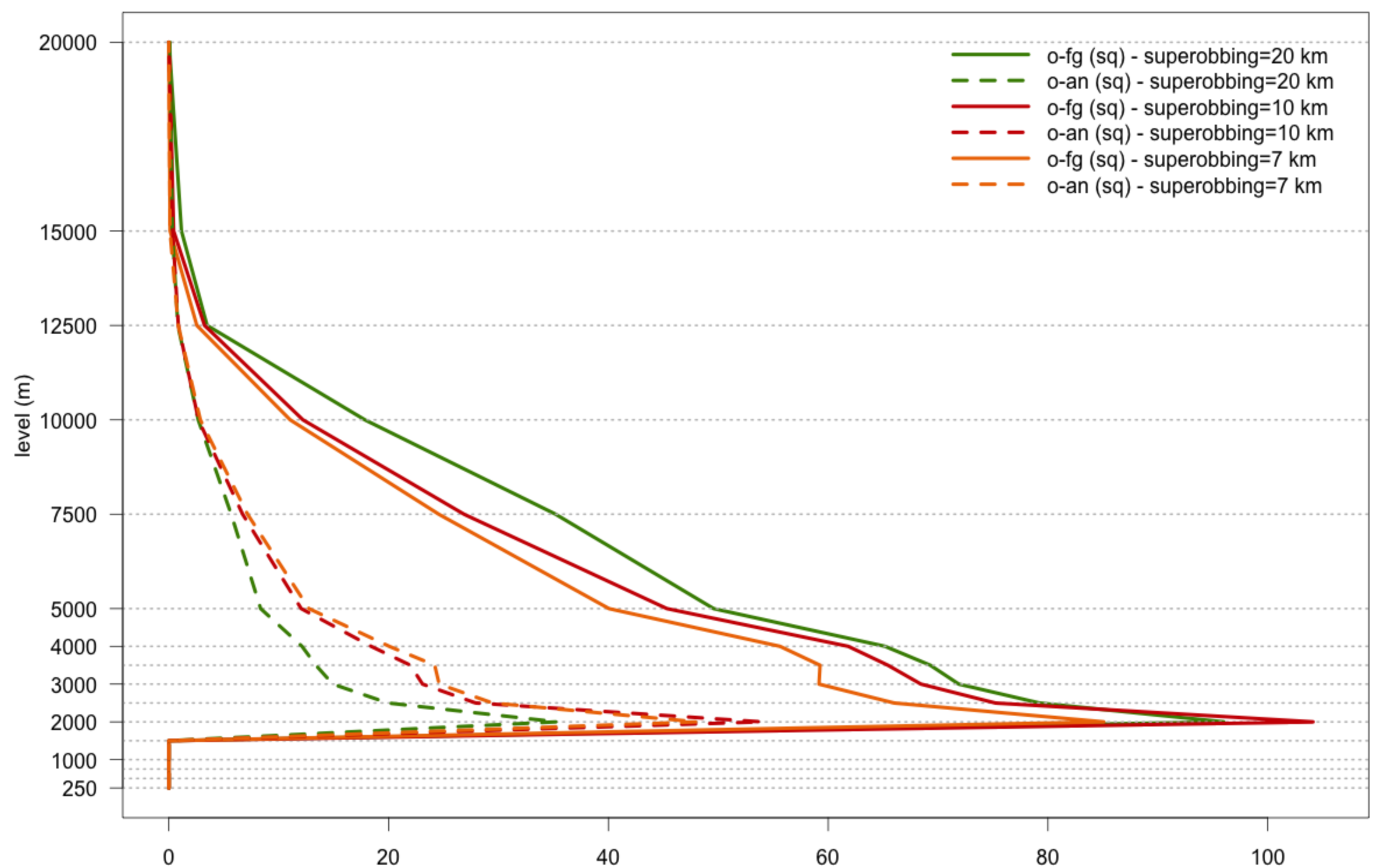
COSMO 2.8 km, 50 levels

Radar forward operator:
- No-reflectivity: values below 5 dBZ set to 5 dBZ

1)Superobbing = 20 km
2)Superobbing = 10 km + horizontal localization=10 km
3)Superobbing = 10 km + horizontal localization=16 km
4)Superobbing = 10 km + horizontal localization=20 km
5)Superobbing = 7 km

Some statistics on outputs





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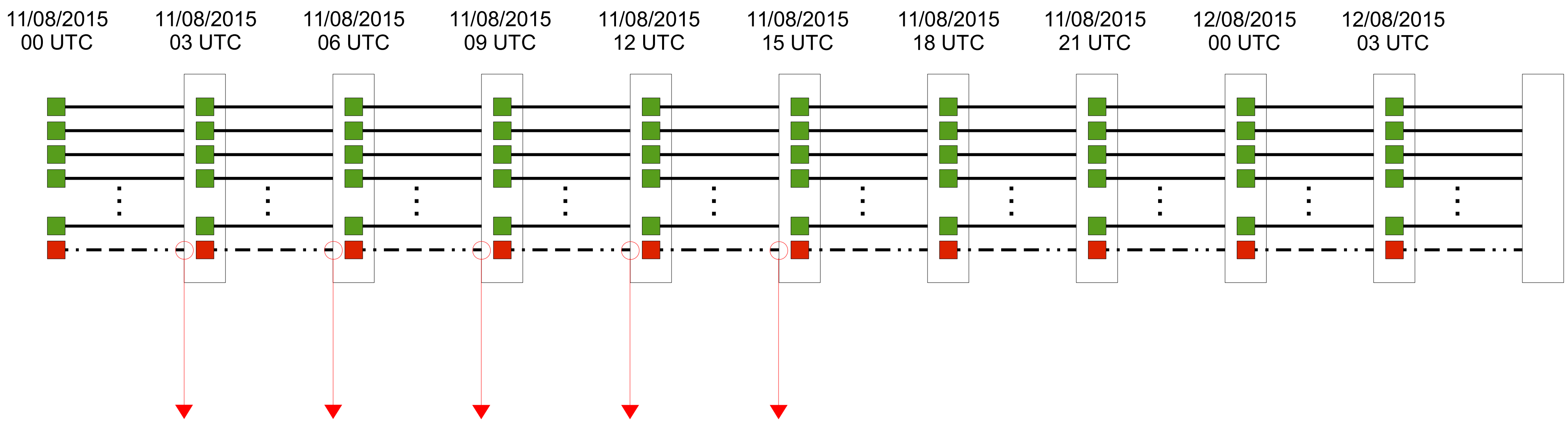
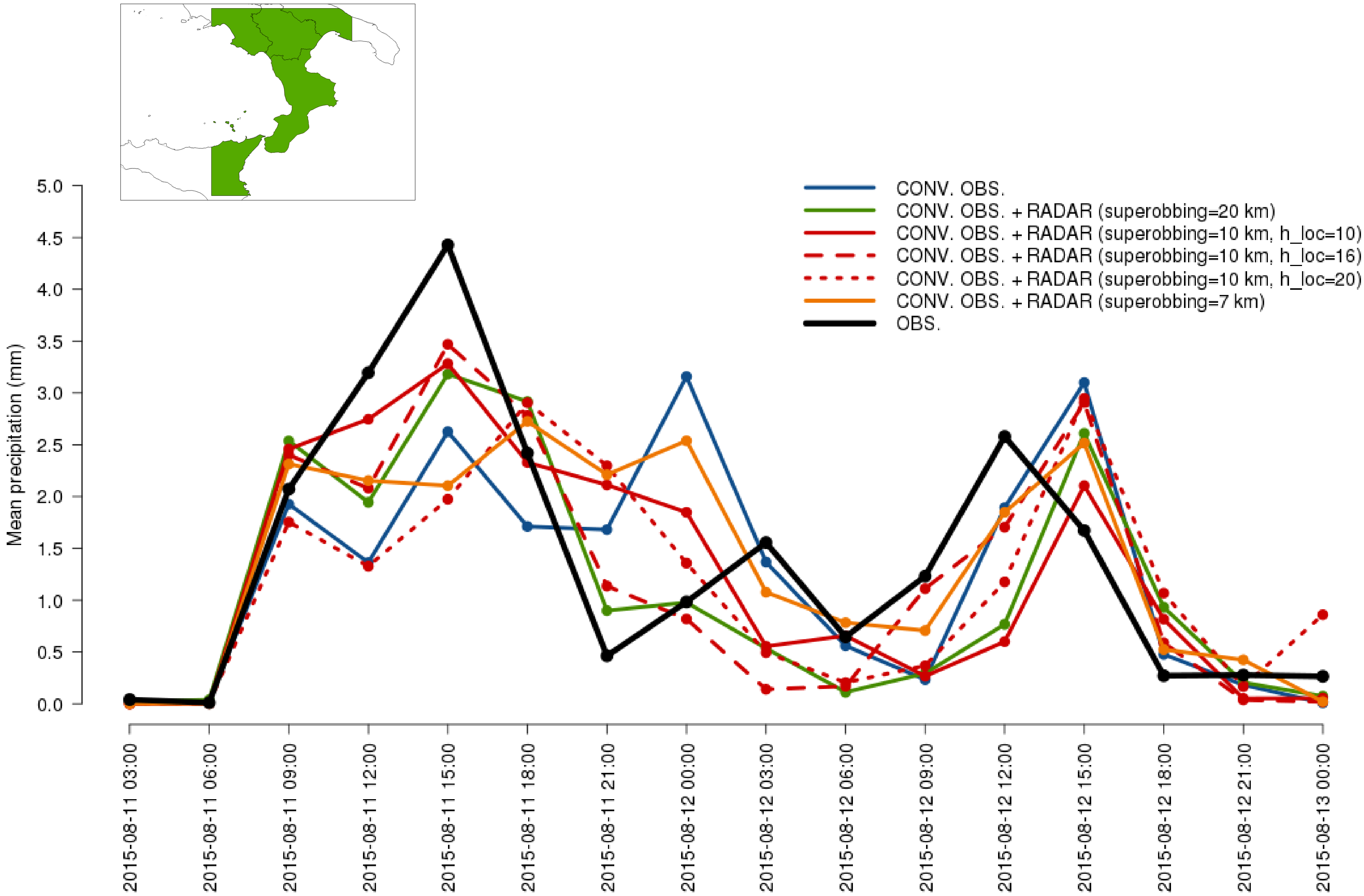
Precipitation analysis

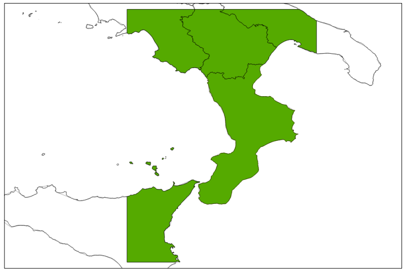


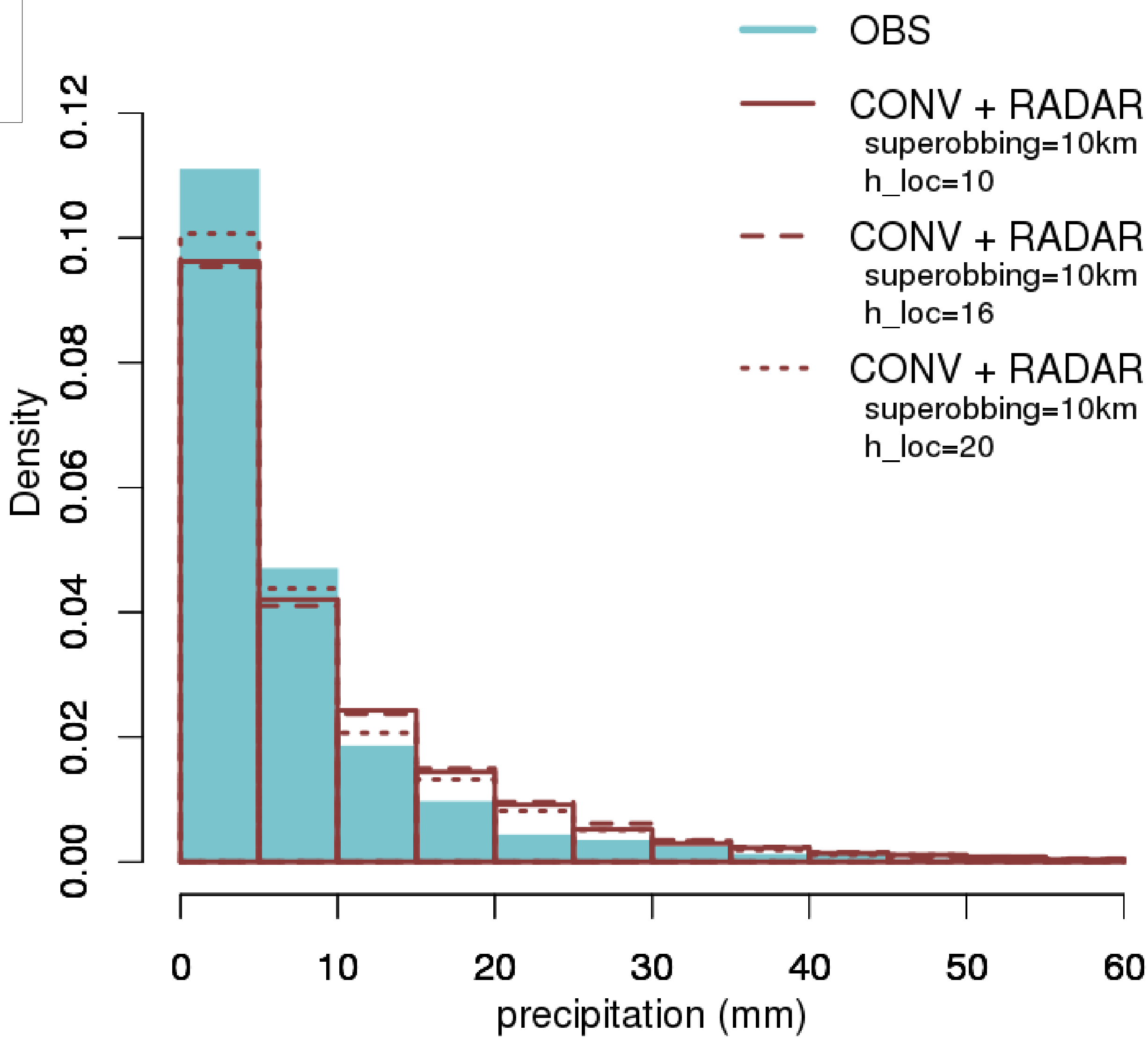
Analysis of COSMO forecasted precipitation at +3h of the deterministic run

Precipitation areal mean over a shapefile



Analysis of precipitation distribution





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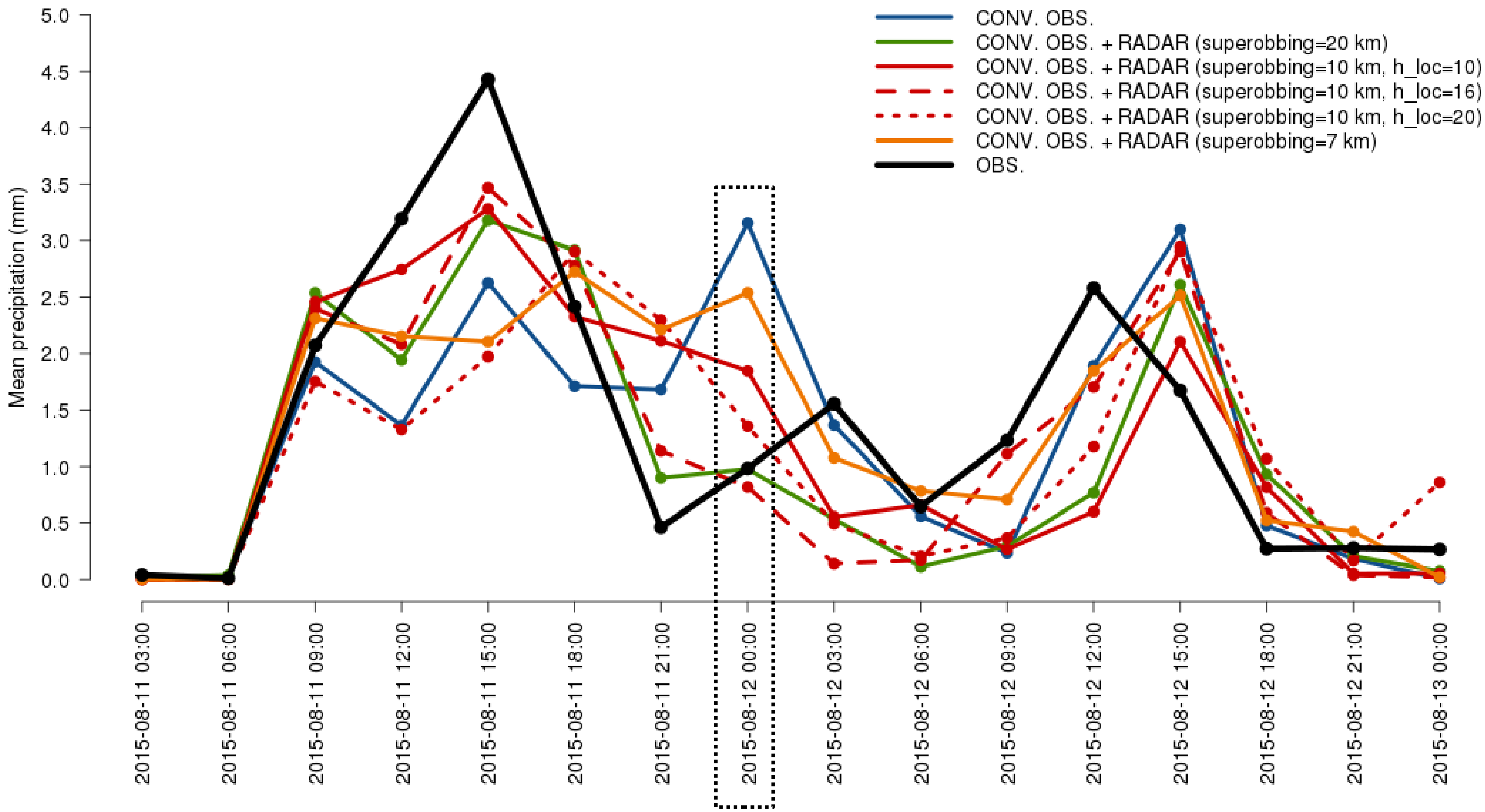
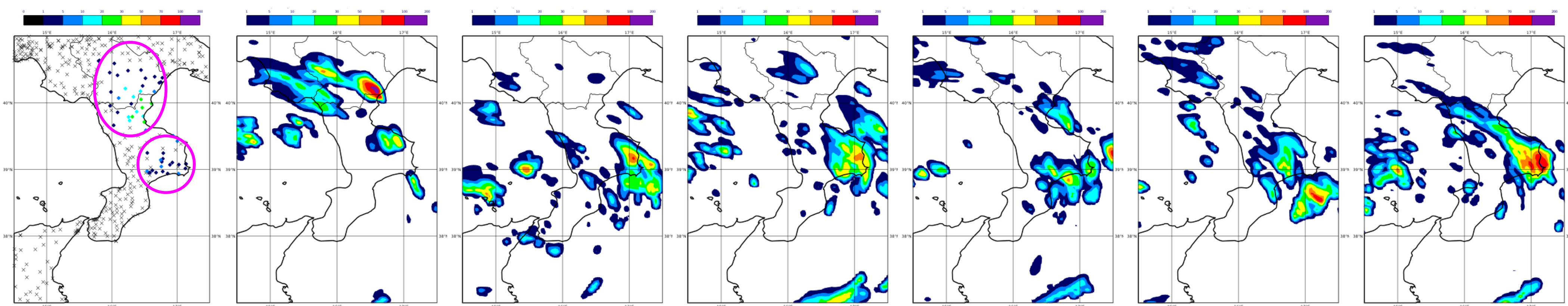




CONV. OBS

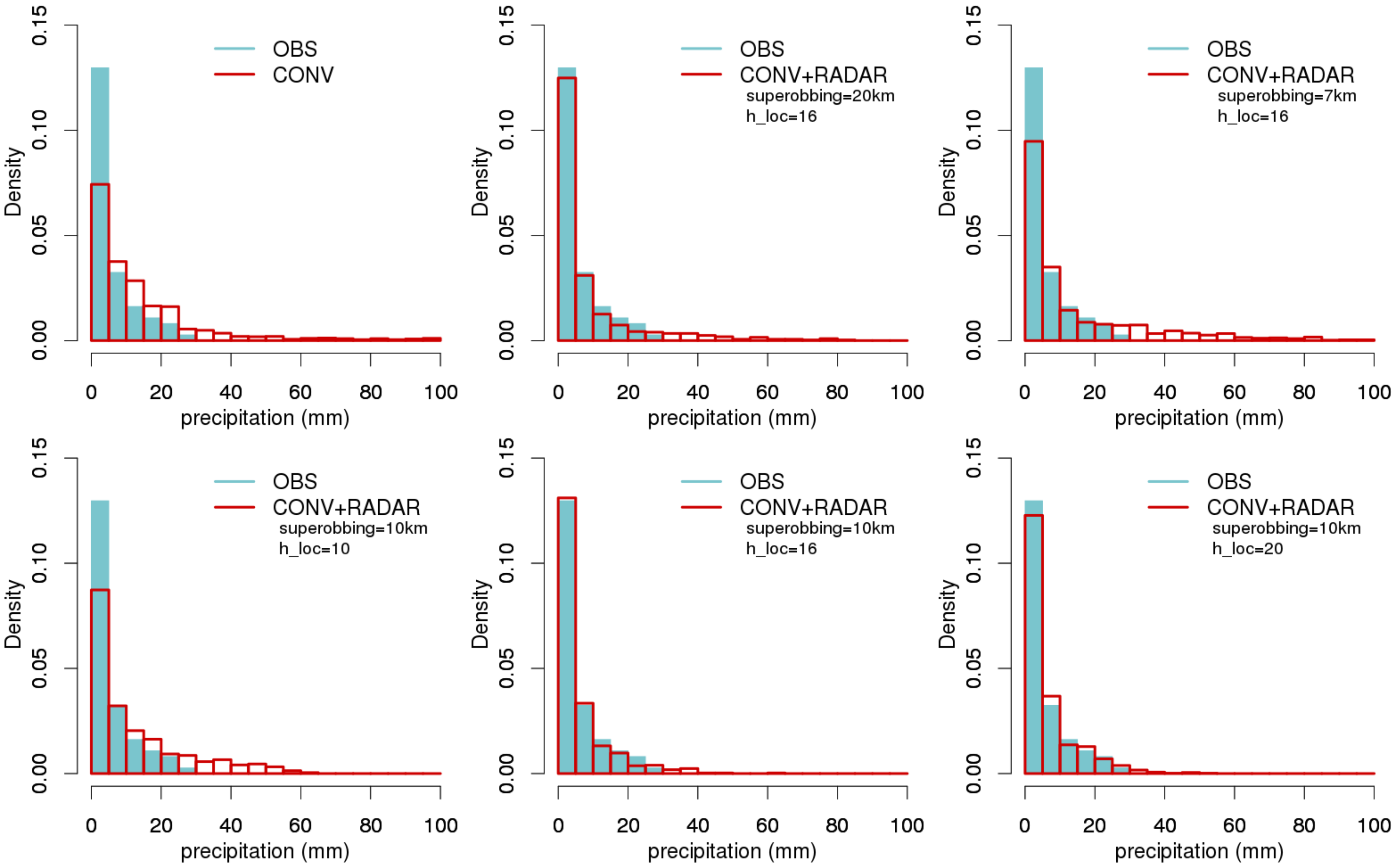
CONV. OBS.+ RADAR (superobbing=20 km)

CONV. OBS.+ RADAR (superobbing=10 km, h_loc=10 km)

CONV. OBS.+ RADAR (superobbing=10 km, h_loc=16 km)

CONV. OBS.+ RADAR (superobbing=10 km, h_loc=20 km)

CONV. OBS.+ RADAR (superobbing=7 km)


OBS
CONV
OBS
CONV+RADAR
superobbing=20km
h_loc=16
OBS
CONV+RADAR
superobbing=7km
h_loc=16
OBS
CONV+RADAR
superobbing=10km
h_loc=10
OBS
CONV+RADAR
superobbing=10km
h_loc=16
OBS
CONV+RADAR
superobbing=10km
h_loc=20
Density
precipitation (mm)
0.00
0.05
0.10
0.15
0
20
40
60
80
100

LONG RUN

Run from 07/10/2014 at 00 UTC to 15/10/2014 at 00 UTC

KENDA
- 3 hourly cycle
- BCs from ECMWF ENS (also IC for the cold start), 32 km horizontal resolution
- BC from deterministic run (also IC for the cold start), 16 km horizontal resolution
- 20 members + 1 deterministic run

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CONV + RADAR – COSMO 2.8 km, 50 levels

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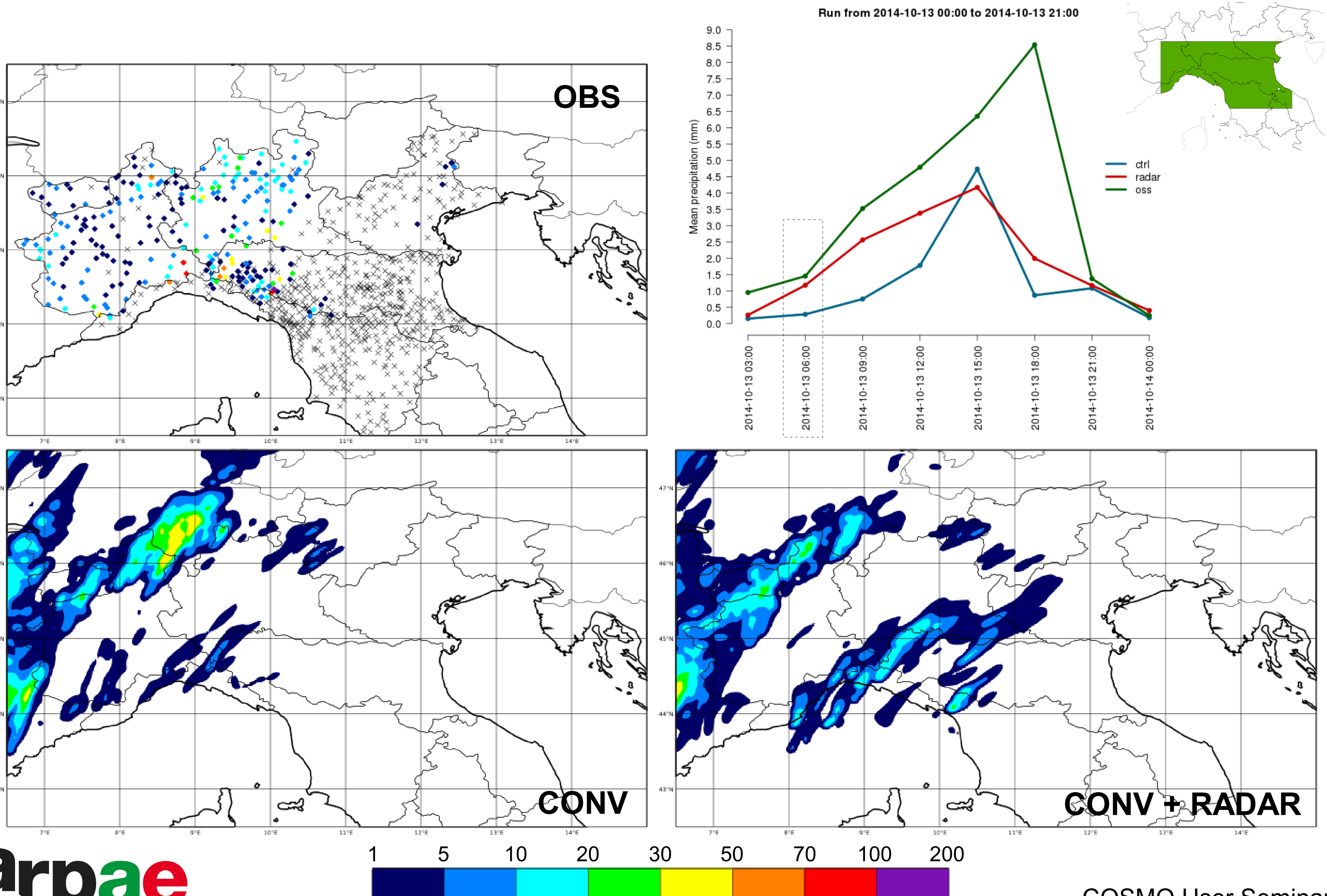
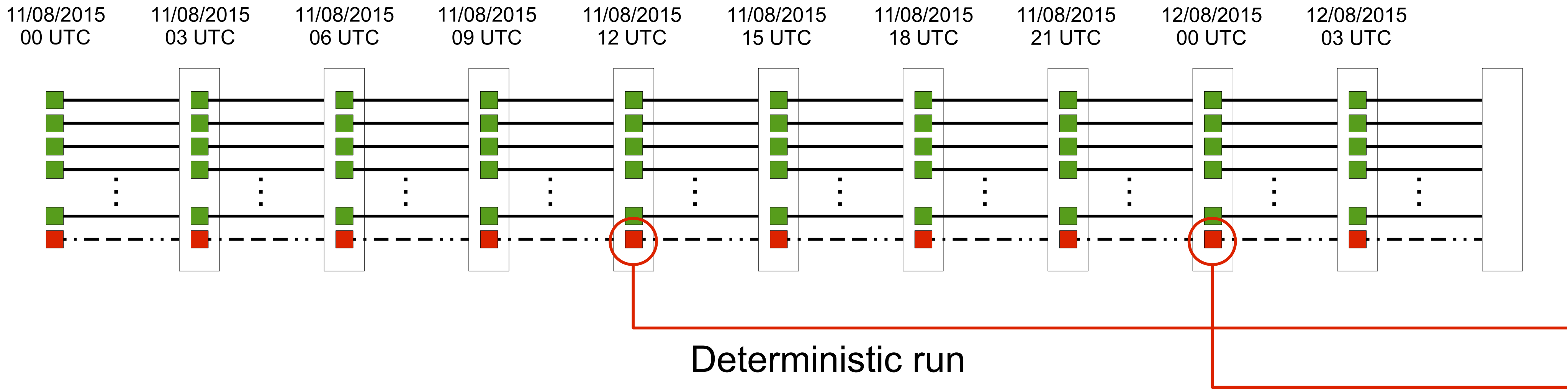
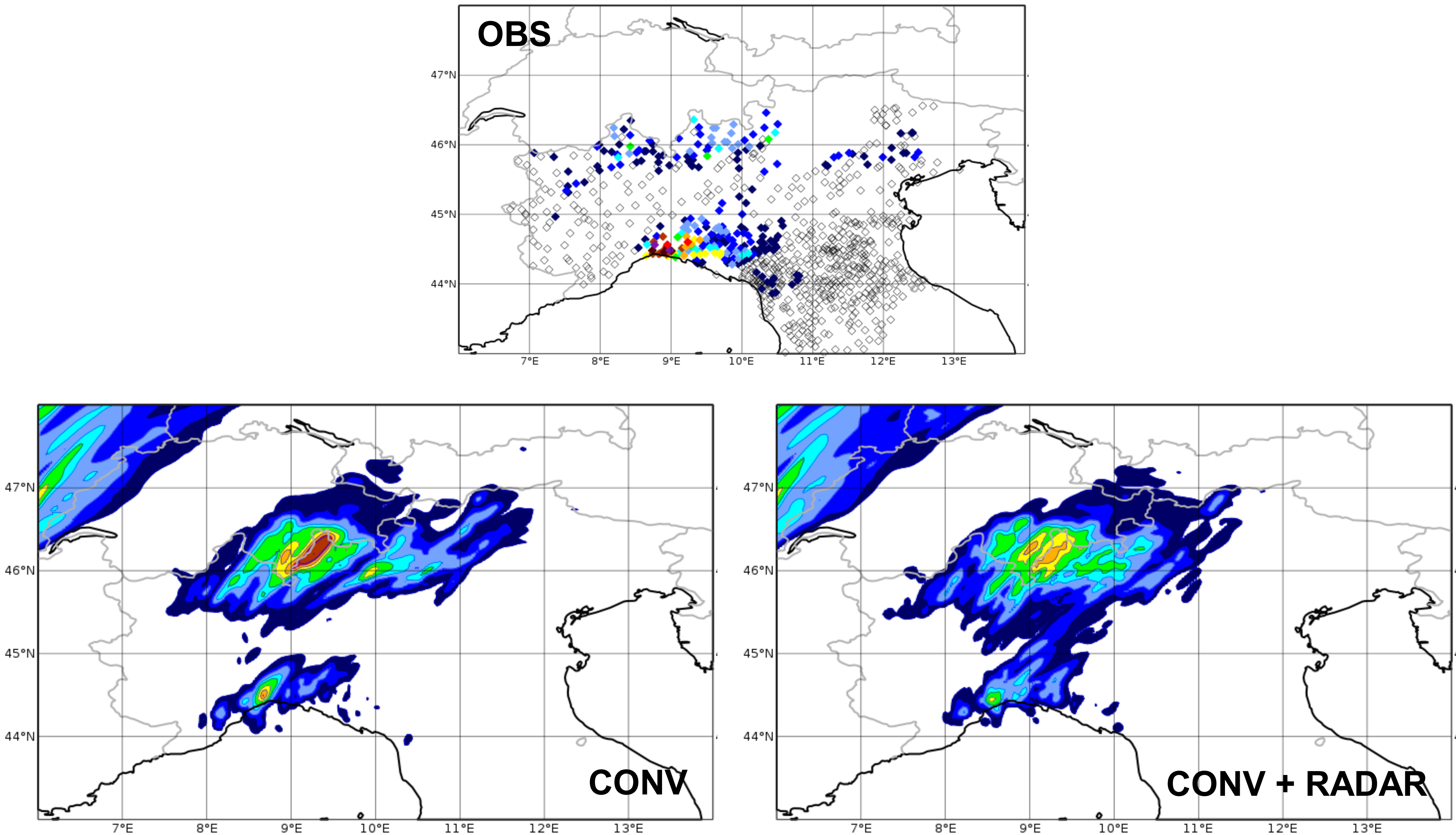
Precipitation areal mean over a shapefile

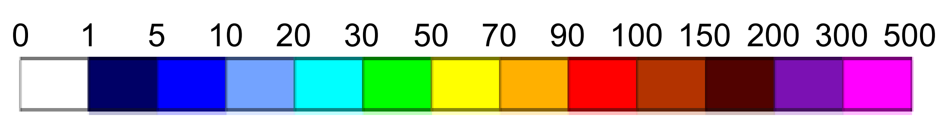


Precipitation analysis

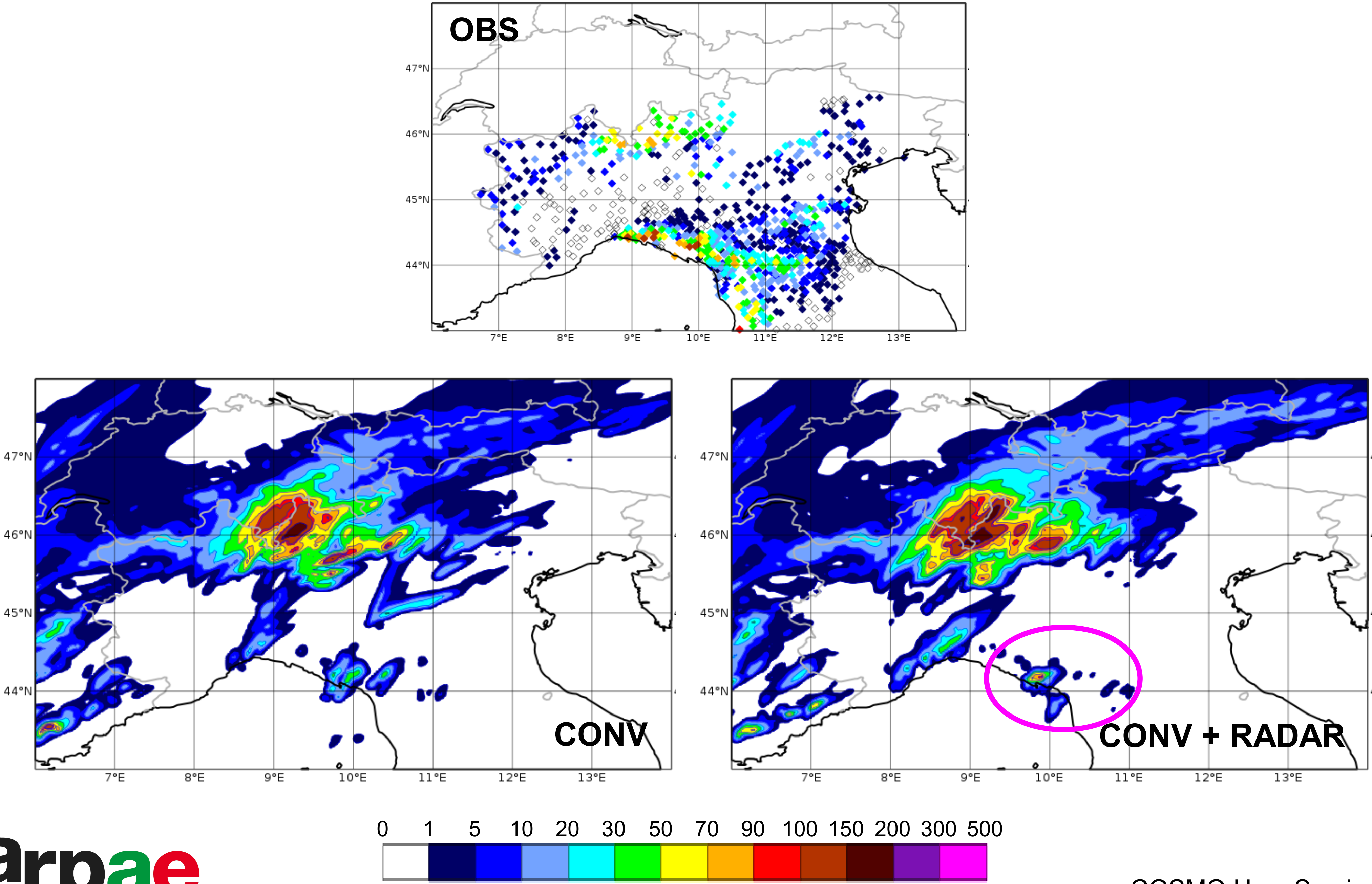


24 h accumulated precipitation: 10/10/2014

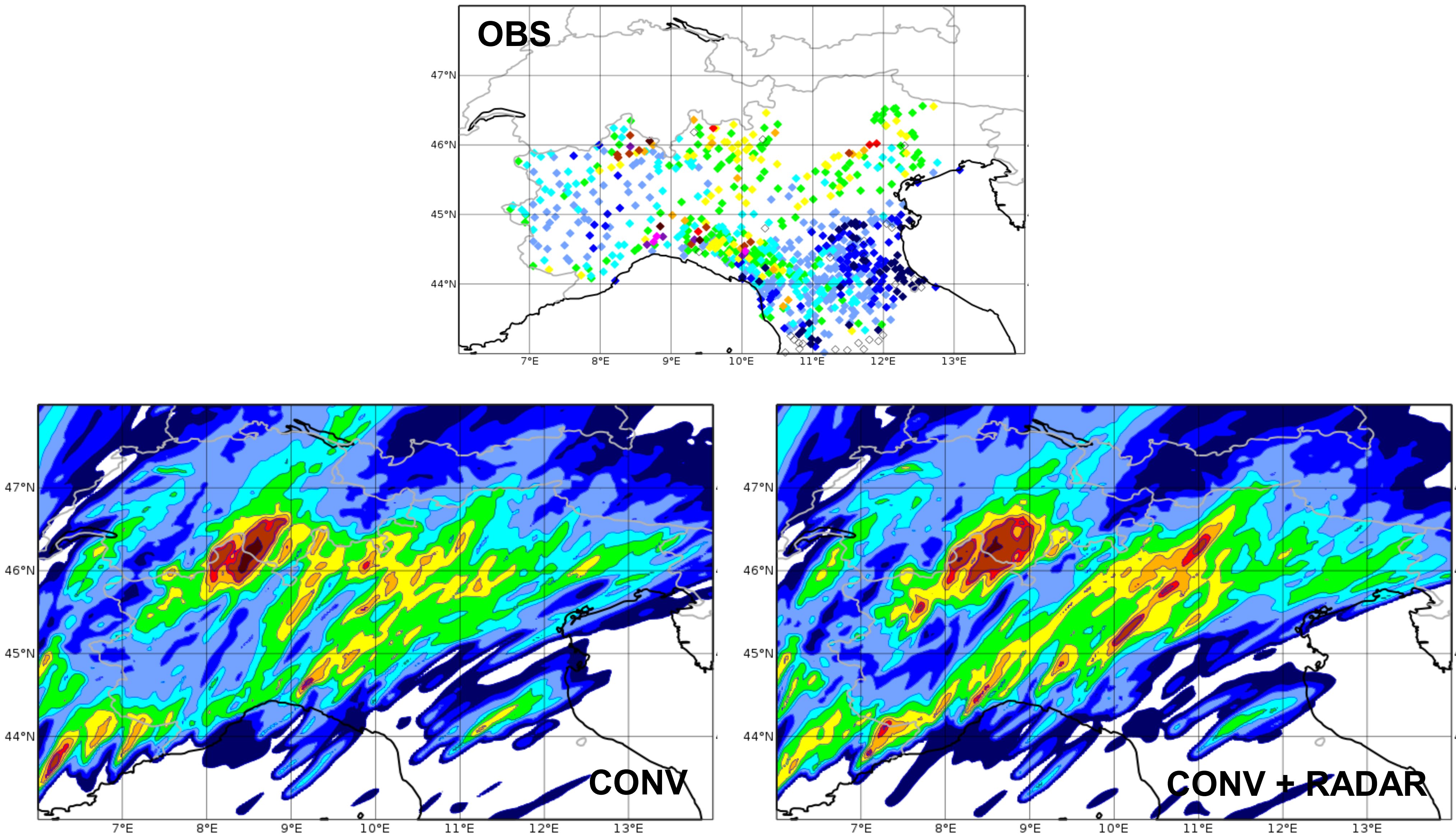


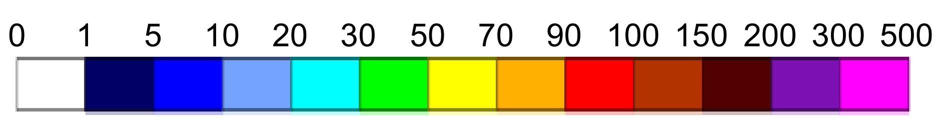


24 h accumulated precipitation: 11/10/2014



24 h accumulated precipitation: 13/10/2014





Limits of the current implementation and conclusions

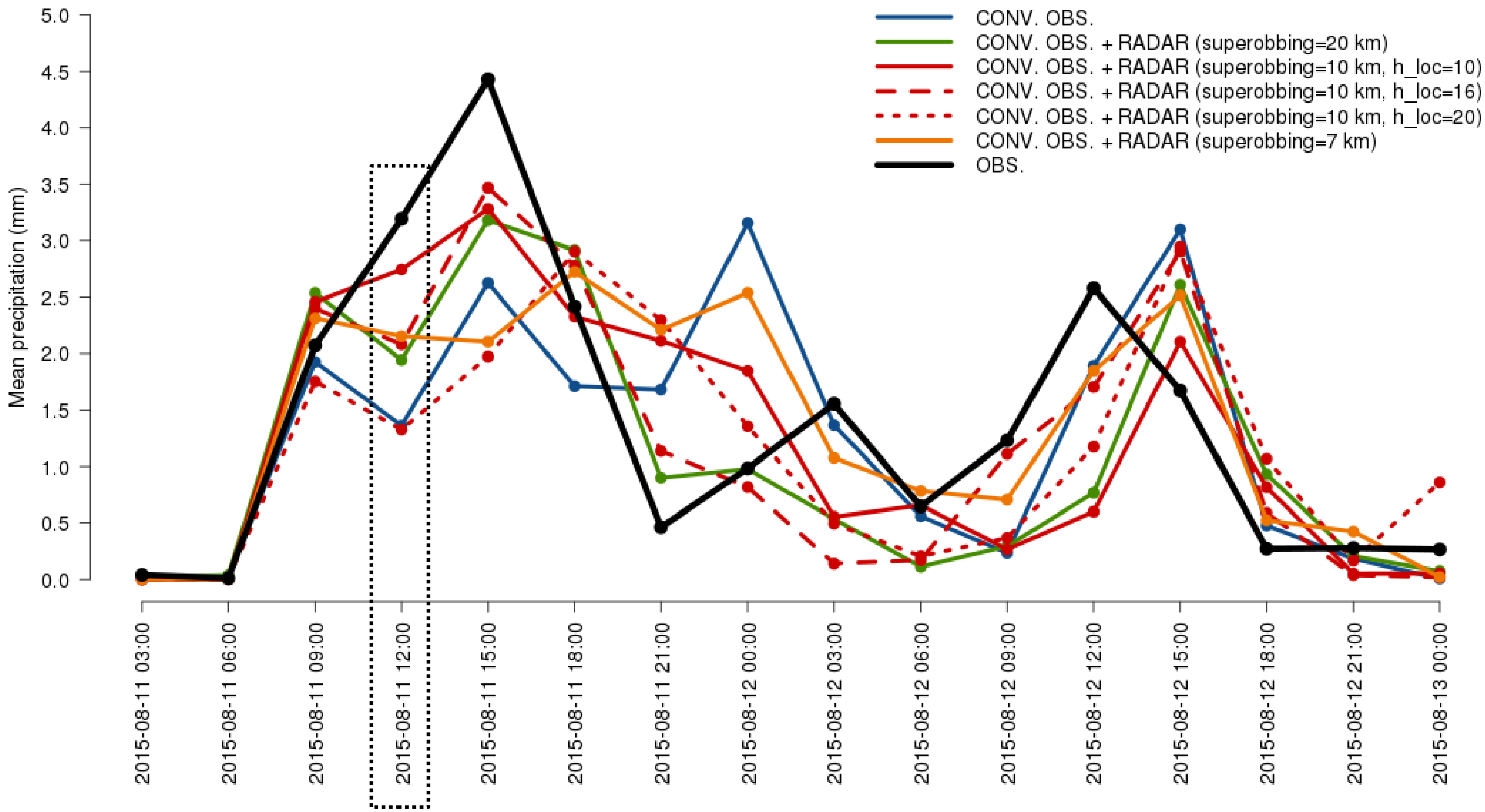
In progress:

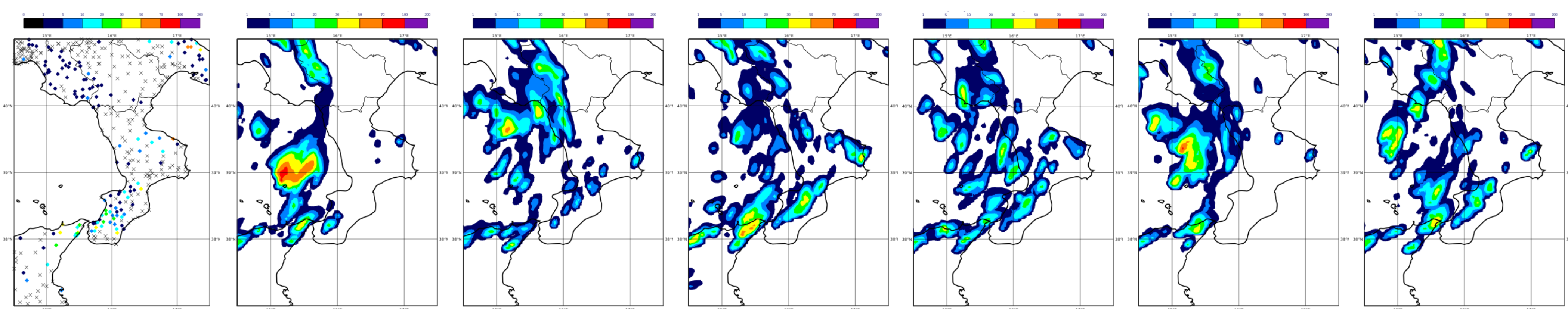
- Polar volumes are read in serial way: parallelization of this step is already provided
- A different management of corrupted/missing data is needed (in our set of data sometimes happens that an elevation is missing)

Conclusions and future works:

- The impact of the use of reflectivity polar volumes is better on the analysis and forecast if the assimilation domain is larger
- The use of more radars will imply further test to combine in the better way superobbing resolution and execution time and resources

- The ODIM HDF5 reader should be extended also to radial wind velocity
- We will need a correct management of data quality. In particular, the Italian radar network is managed by different Regional Services and by the National Department of Civil Protection and a common strategy on the definition of quality should be chosen





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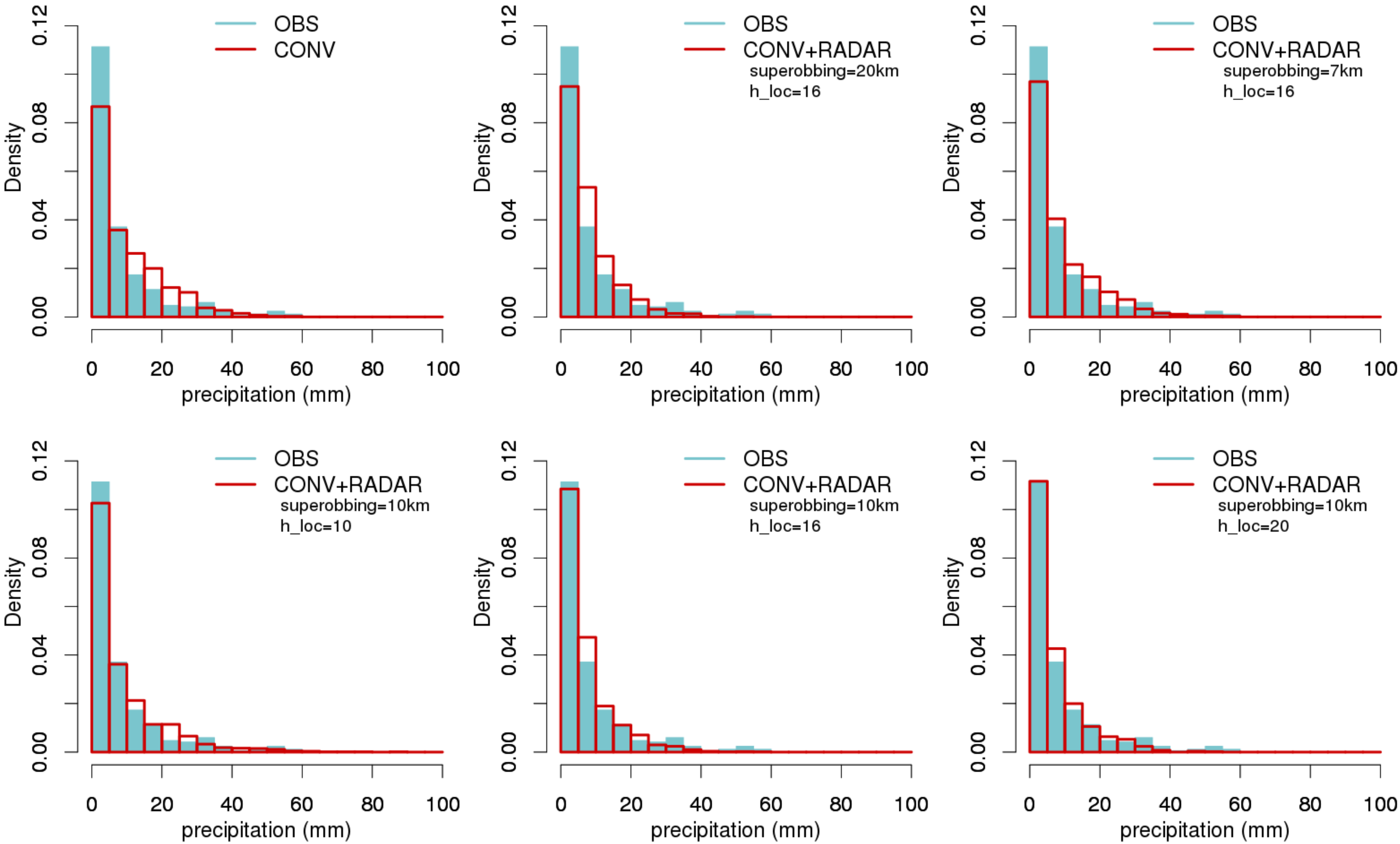
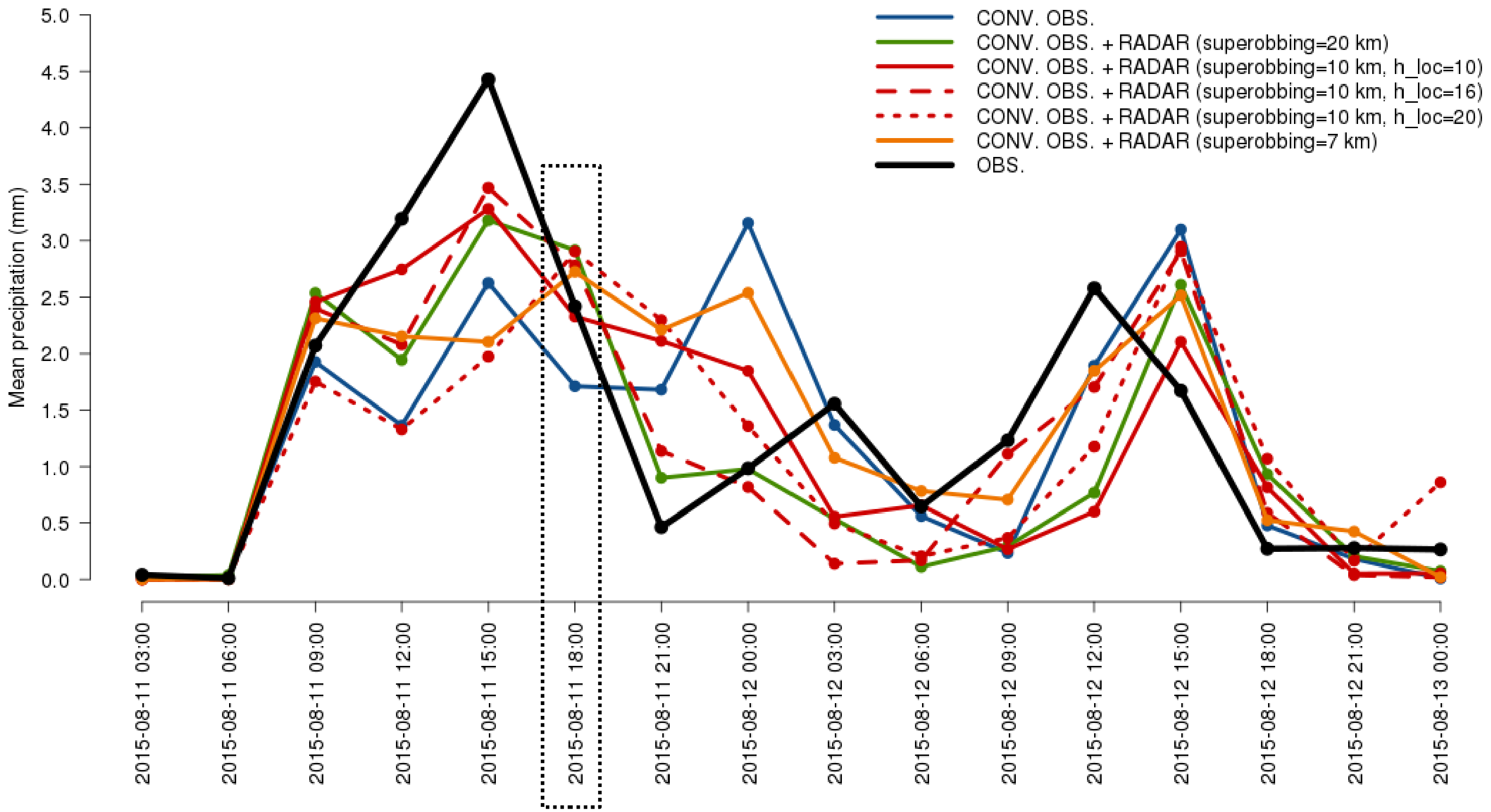
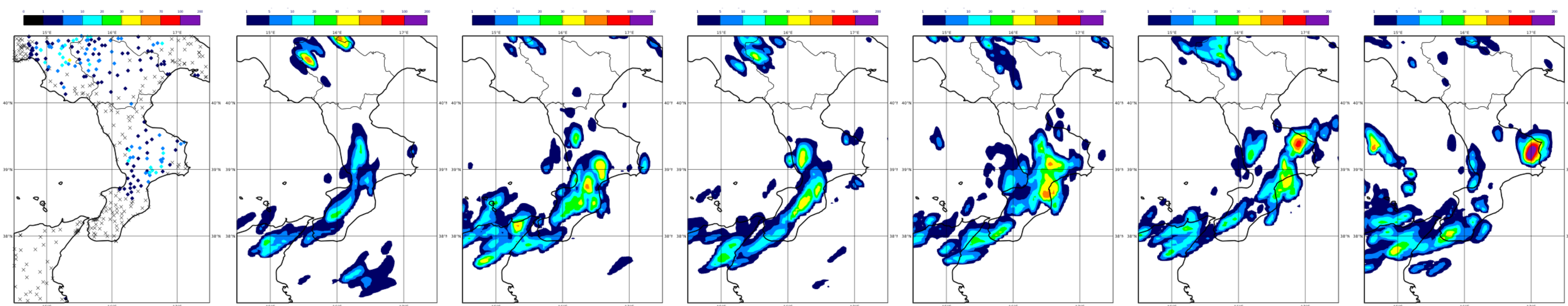

OBS
CONV
Density
precipitation (mm)
0.00
0.04
0.08
0.12
0
20
40
60
80
100
OBS
CONV+RADAR
superobbing=20km
h_loc=16
OBS
CONV+RADAR
superobbing=7km
h_loc=16
OBS
CONV+RADAR
superobbing=10km
h_loc=10
OBS
CONV+RADAR
superobbing=10km
h_loc=16
OBS
CONV+RADAR
superobbing=10km
h_loc=20





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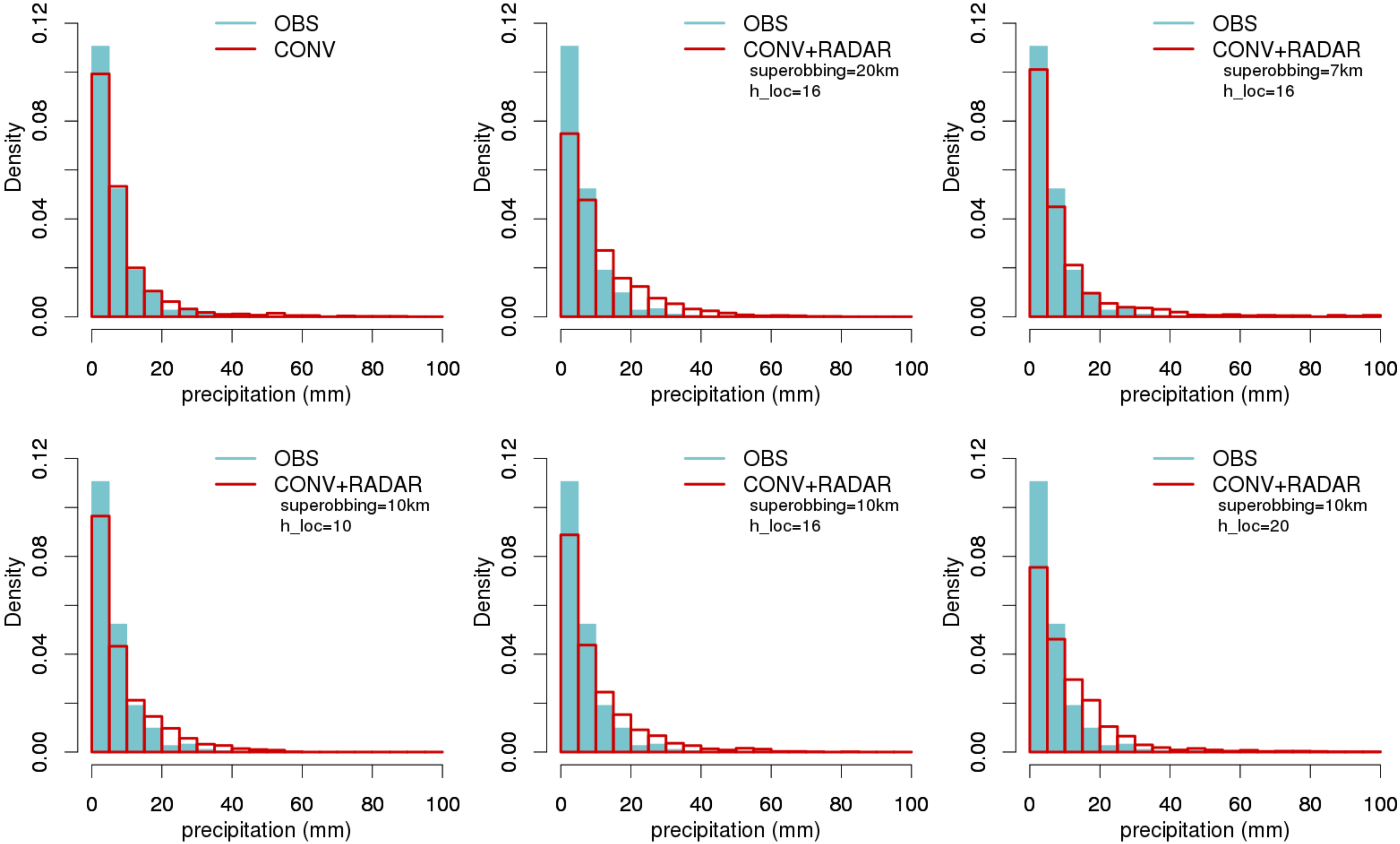

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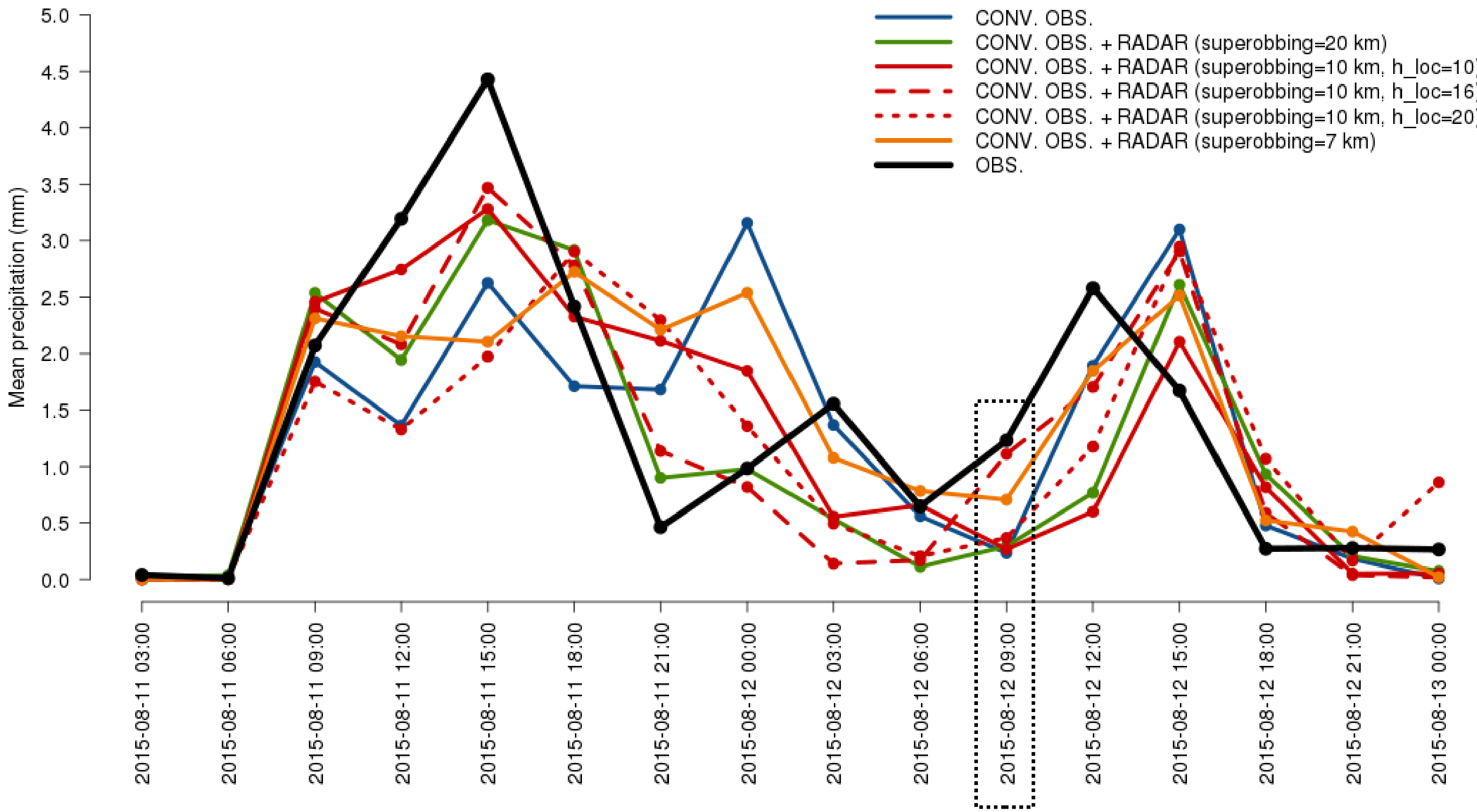

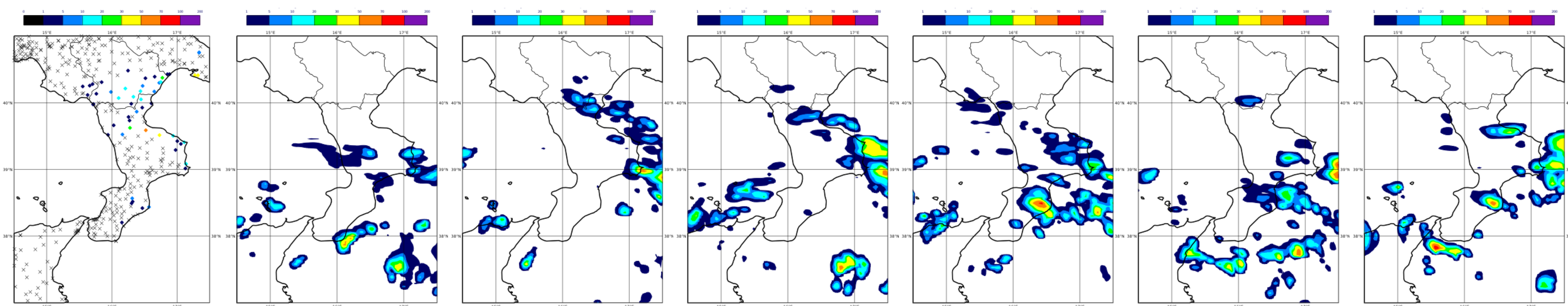

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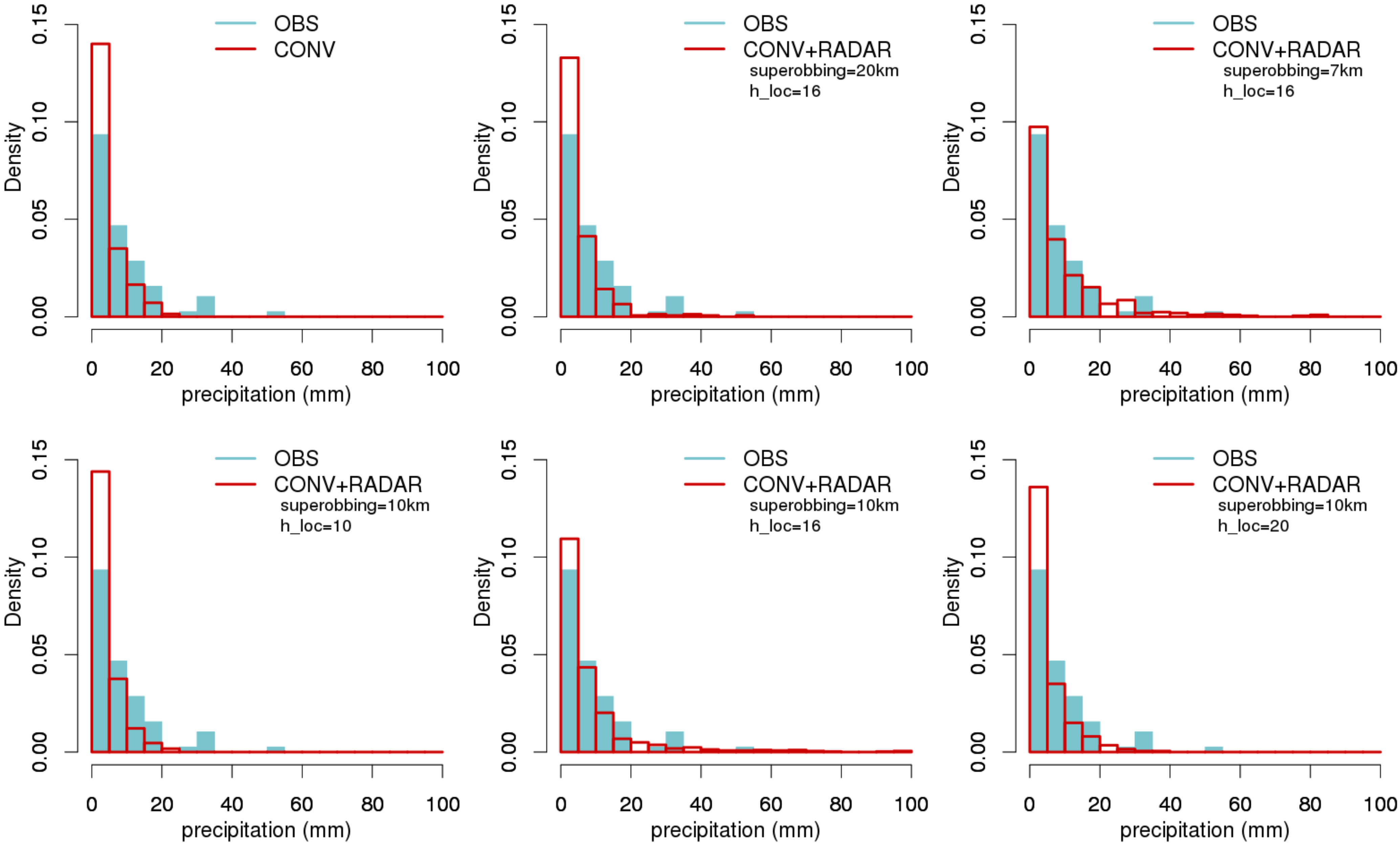
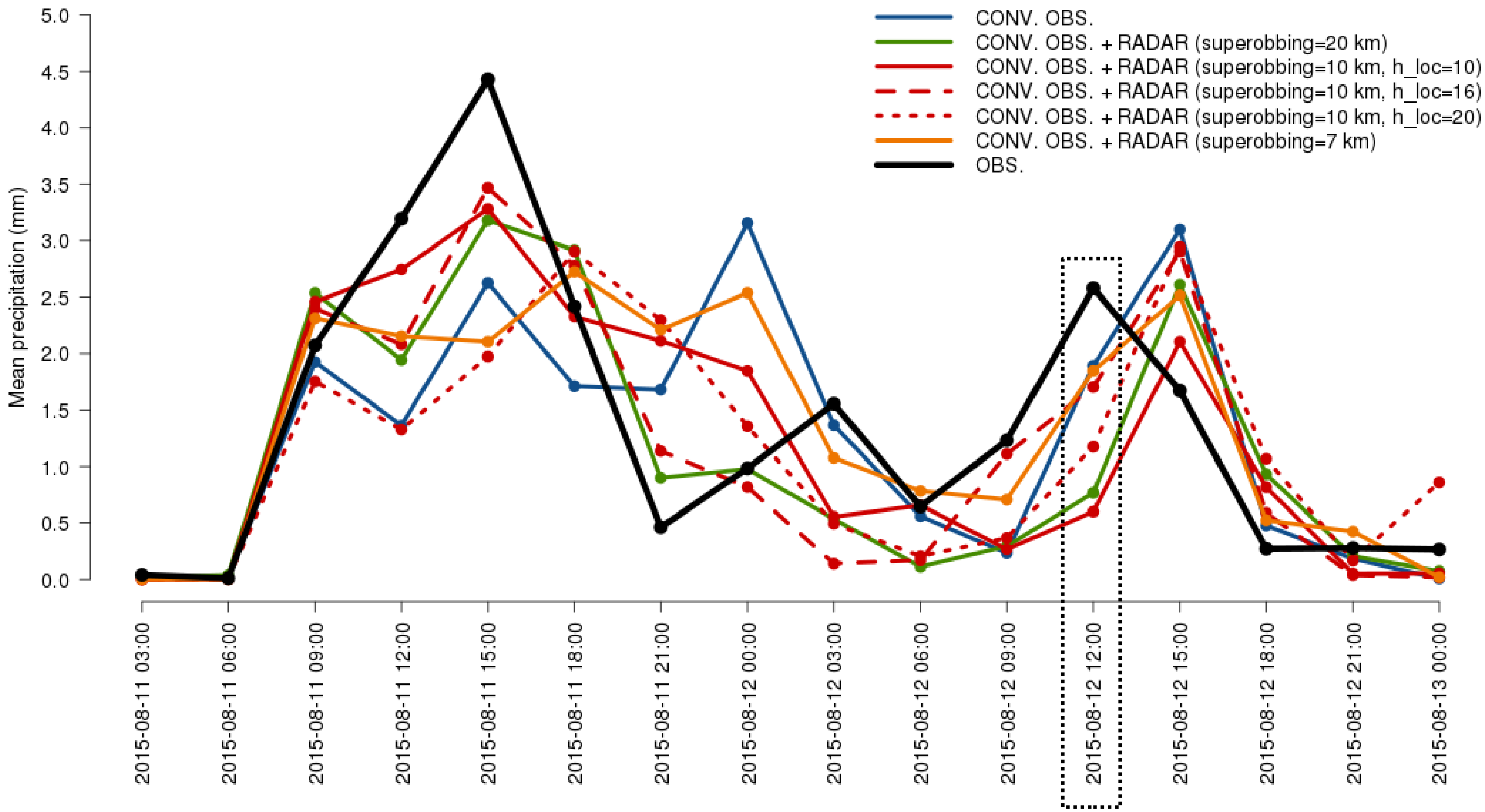
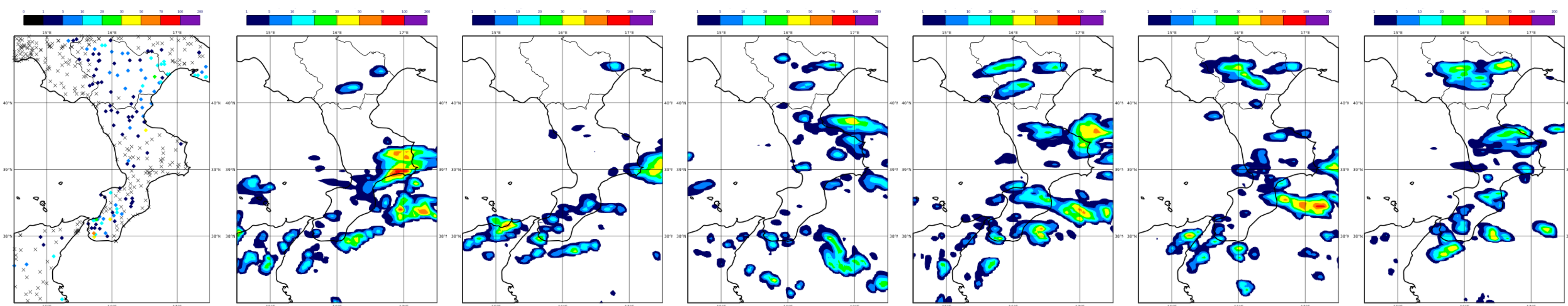

OBS
CONV
Density
precipitation (mm)
OBS
CONV+RADAR
superobbing=20km
h_loc=16
Density
precipitation (mm)
OBS
CONV+RADAR
superobbing=7km
h_loc=16
Density
precipitation (mm)
OBS
CONV+RADAR
superobbing=10km
h_loc=10
Density
precipitation (mm)
OBS
CONV+RADAR
superobbing=10km
h_loc=16
Density
precipitation (mm)
OBS
CONV+RADAR
superobbing=10km
h_loc=20
Density
precipitation (mm)





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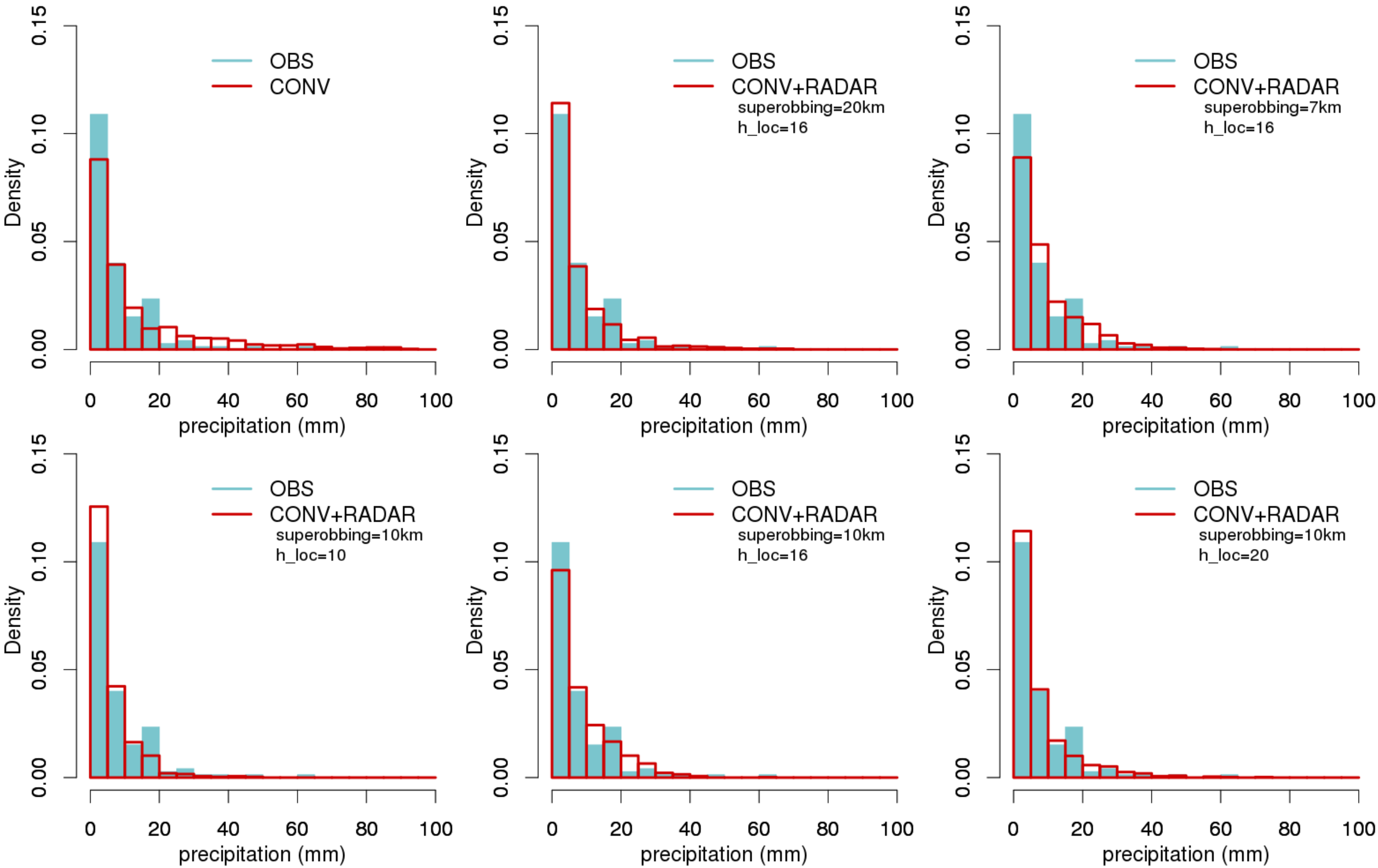
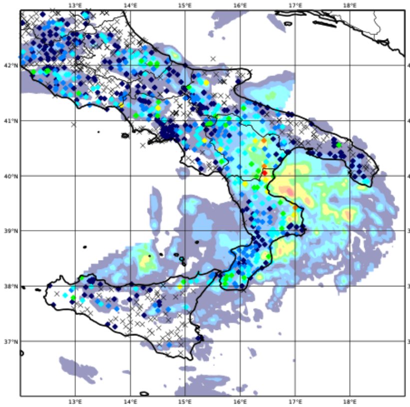
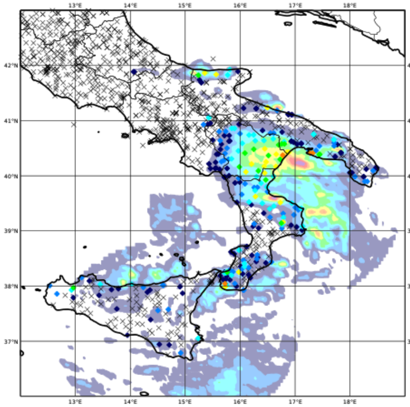
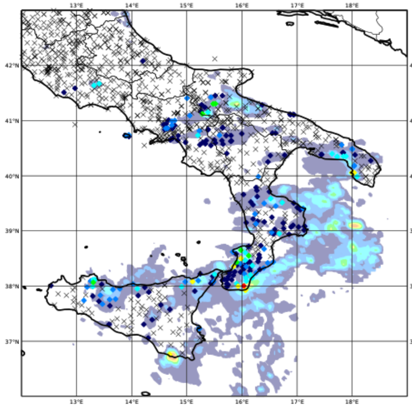

OBS
CONV
Density
precipitation (mm)
0.00
0.05
0.10
0.15
0
20
40
60
80
100
OBS
CONV+RADAR
superobbing=20km
h_loc=16
OBS
CONV+RADAR
superobbing=7km
h_loc=16
OBS
CONV+RADAR
superobbing=10km
h_loc=10
OBS
CONV+RADAR
superobbing=10km
h_loc=16
OBS
CONV+RADAR
superobbing=10km
h_loc=20

OSSERVAZIONI (RADAR + PLUVIOMETRI)

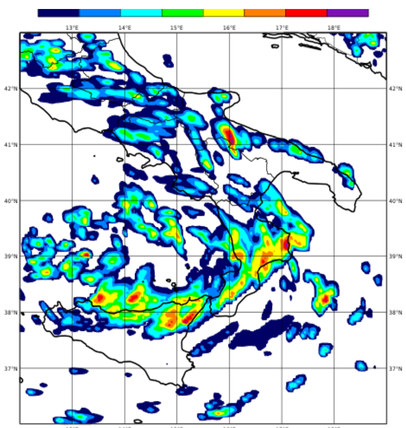




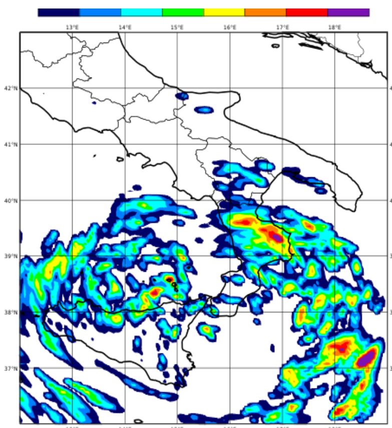


Inizio run: 11/08/2015 12 UTC

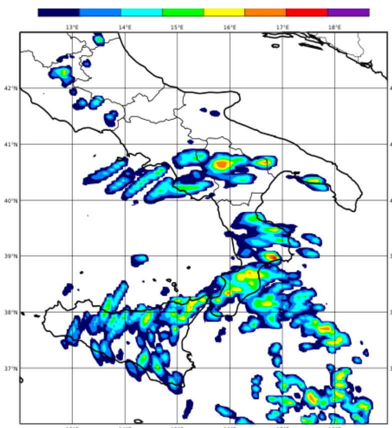
12/08/2015 00 UTC



12/08/2015 12 UTC

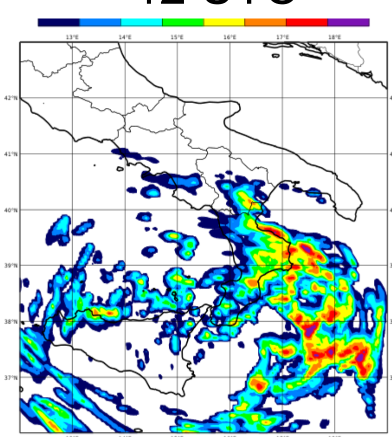


13/08/2015 00 UTC

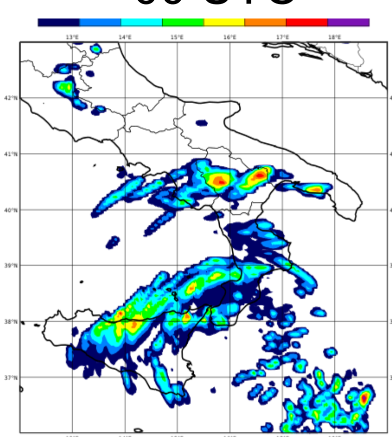


Inizio run: 12/08/2015 00 UTC

12/08/2015 12 UTC

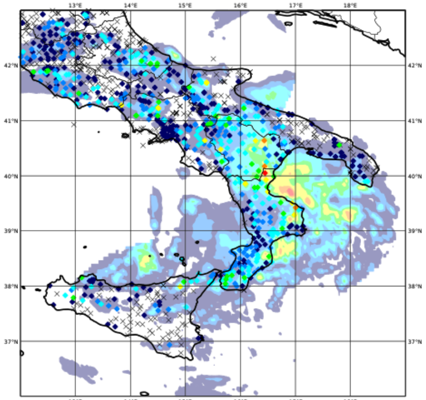


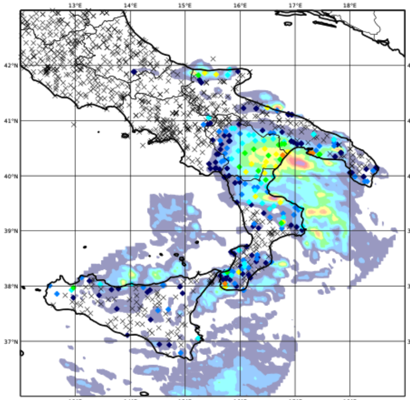
13/08/2015 00 UTC

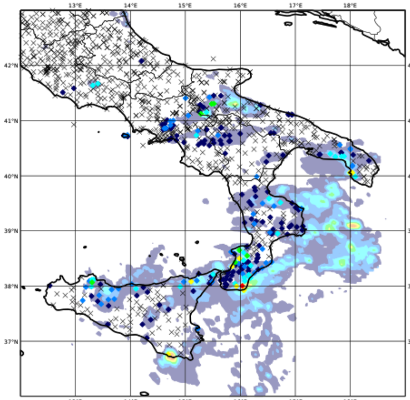


Previsioni effettuate partendo dalle analisi del run deterministico con assimilazione di sole osservazioni convenzionali

OSSERVAZIONI (RADAR + PLUVIOMETRI)

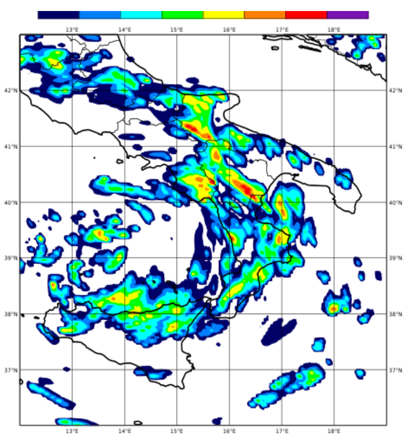


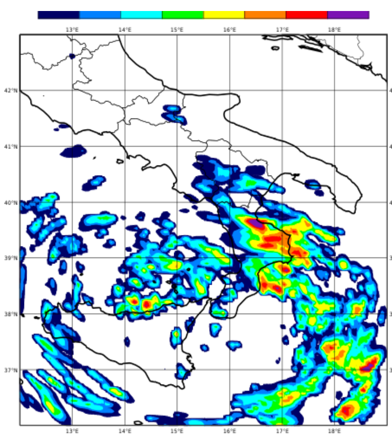


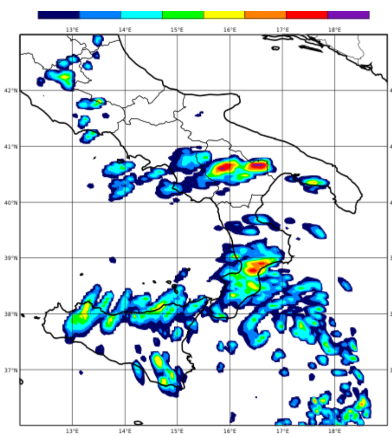


	12/08/2015 00 UTC	12/08/2015 12 UTC	13/08/2015 00 UTC

Inizio run: 11/08/2015 12 UTC

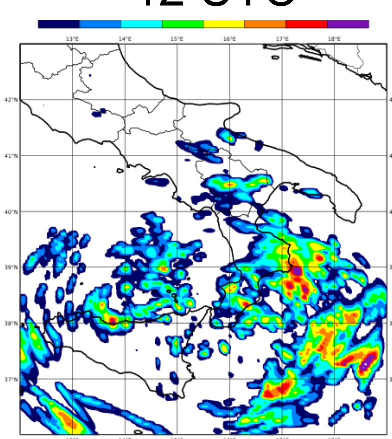


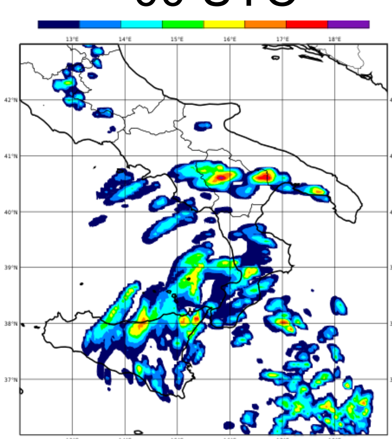




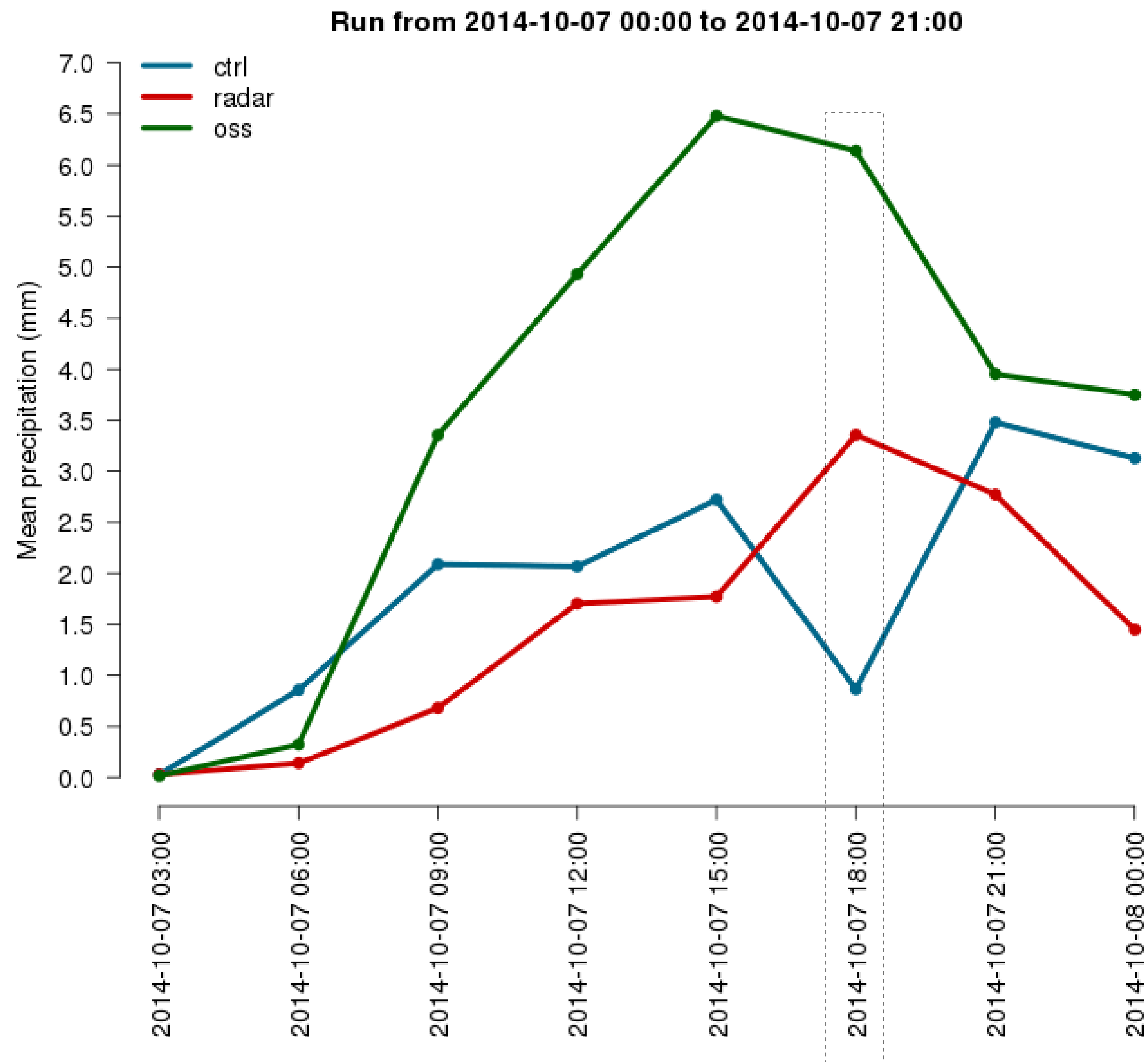
Inizio run: 12/08/2015 00 UTC

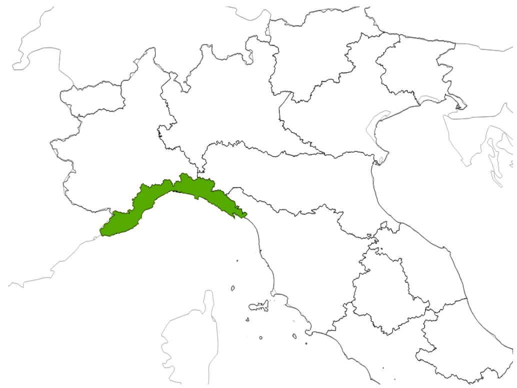
12/08/2015 12 UTC	13/08/2015 00 UTC

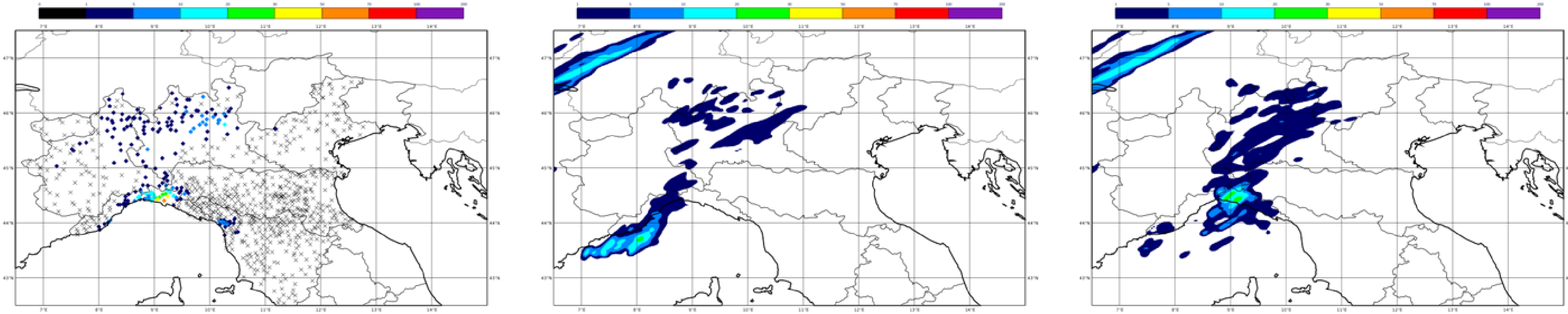


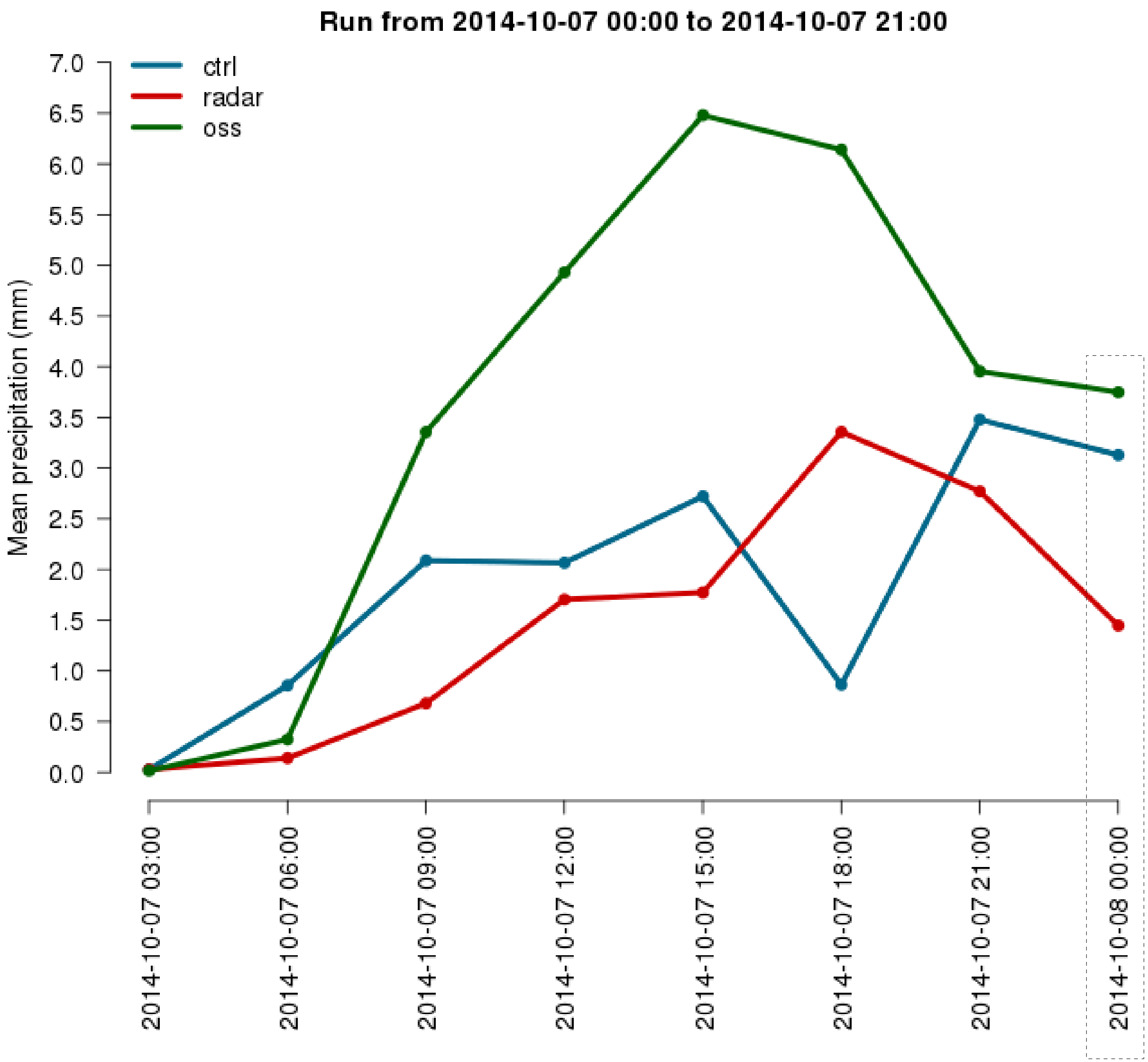


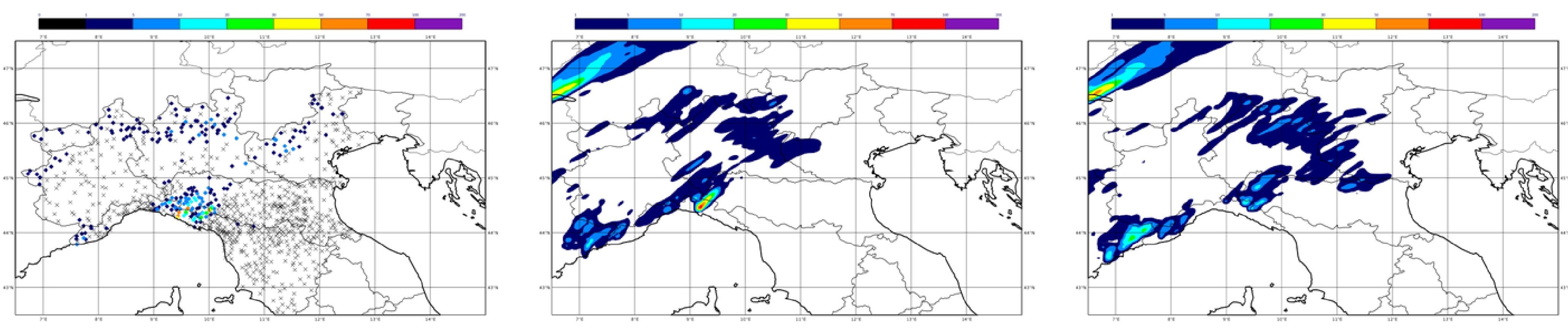
CONV + RADAR
superobbing= 10 km
localizzazione orizzontale = 20 km

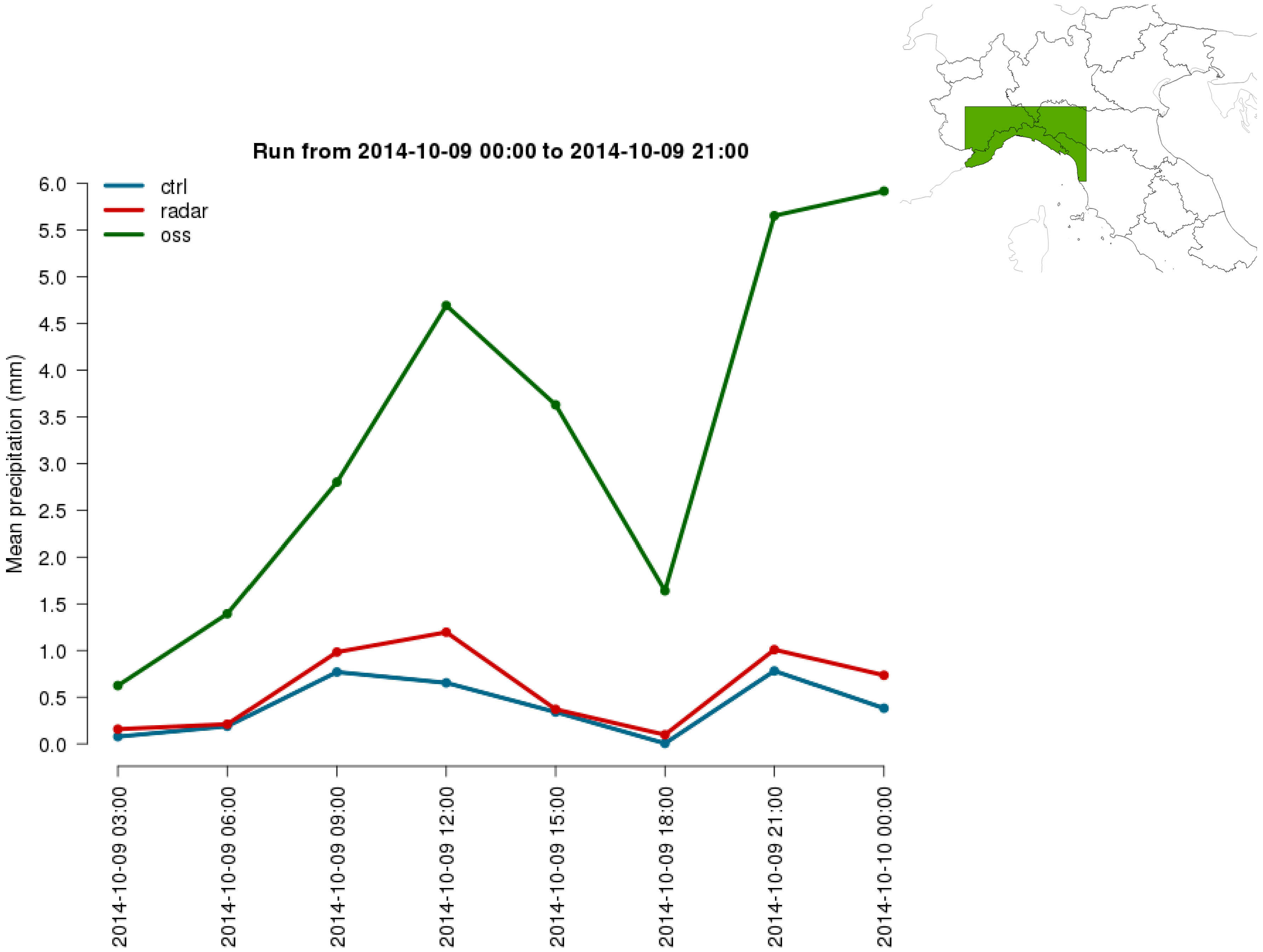

Run from 2014-10-07 00:00 to 2014-10-07 21:00
ctrl
radar
oss
Mean precipitation (mm)
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2014-10-07 03:00
2014-10-07 06:00
2014-10-07 09:00
2014-10-07 12:00
2014-10-07 15:00
2014-10-07 18:00
2014-10-07 21:00
2014-10-08 00:00



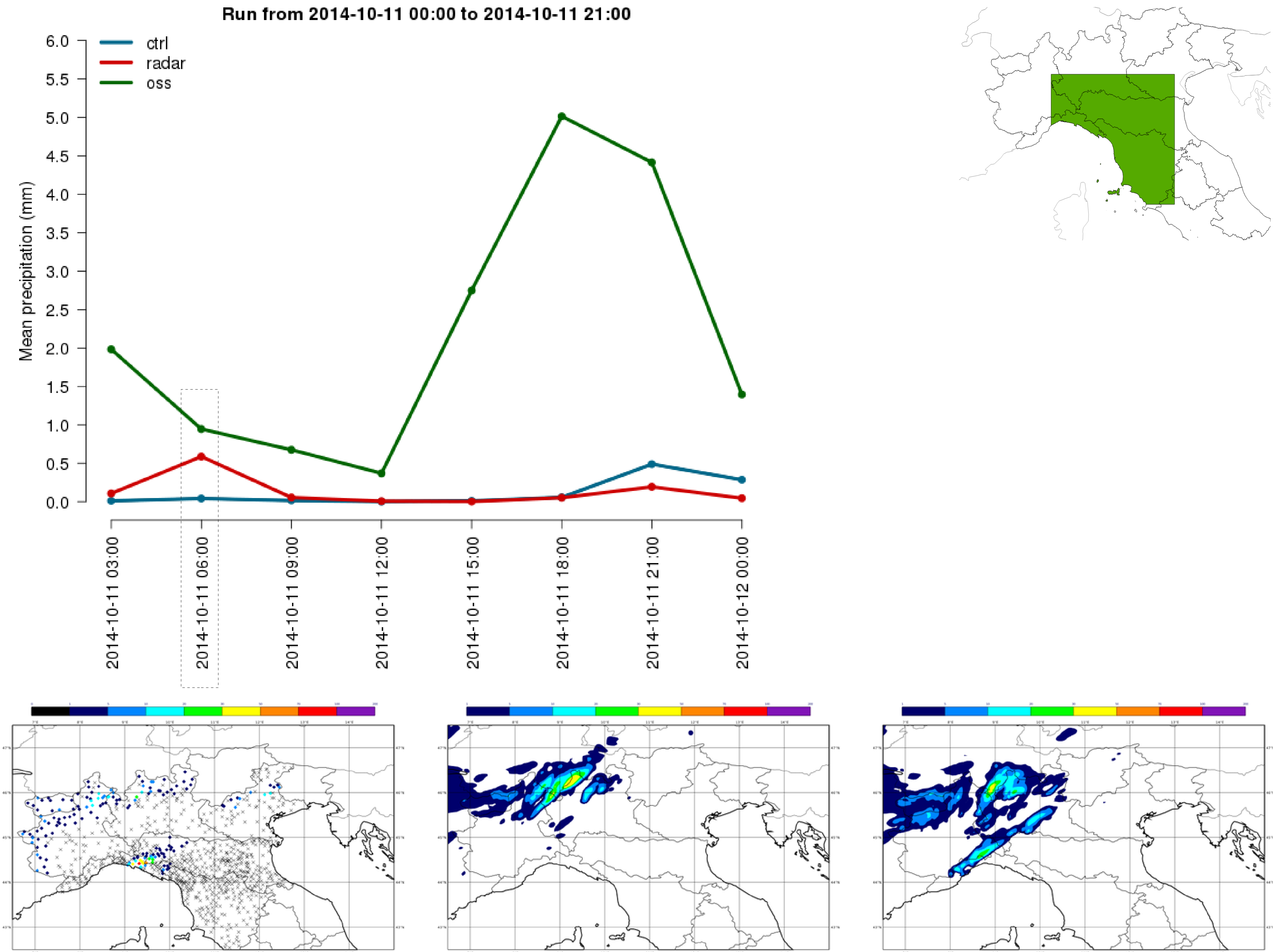


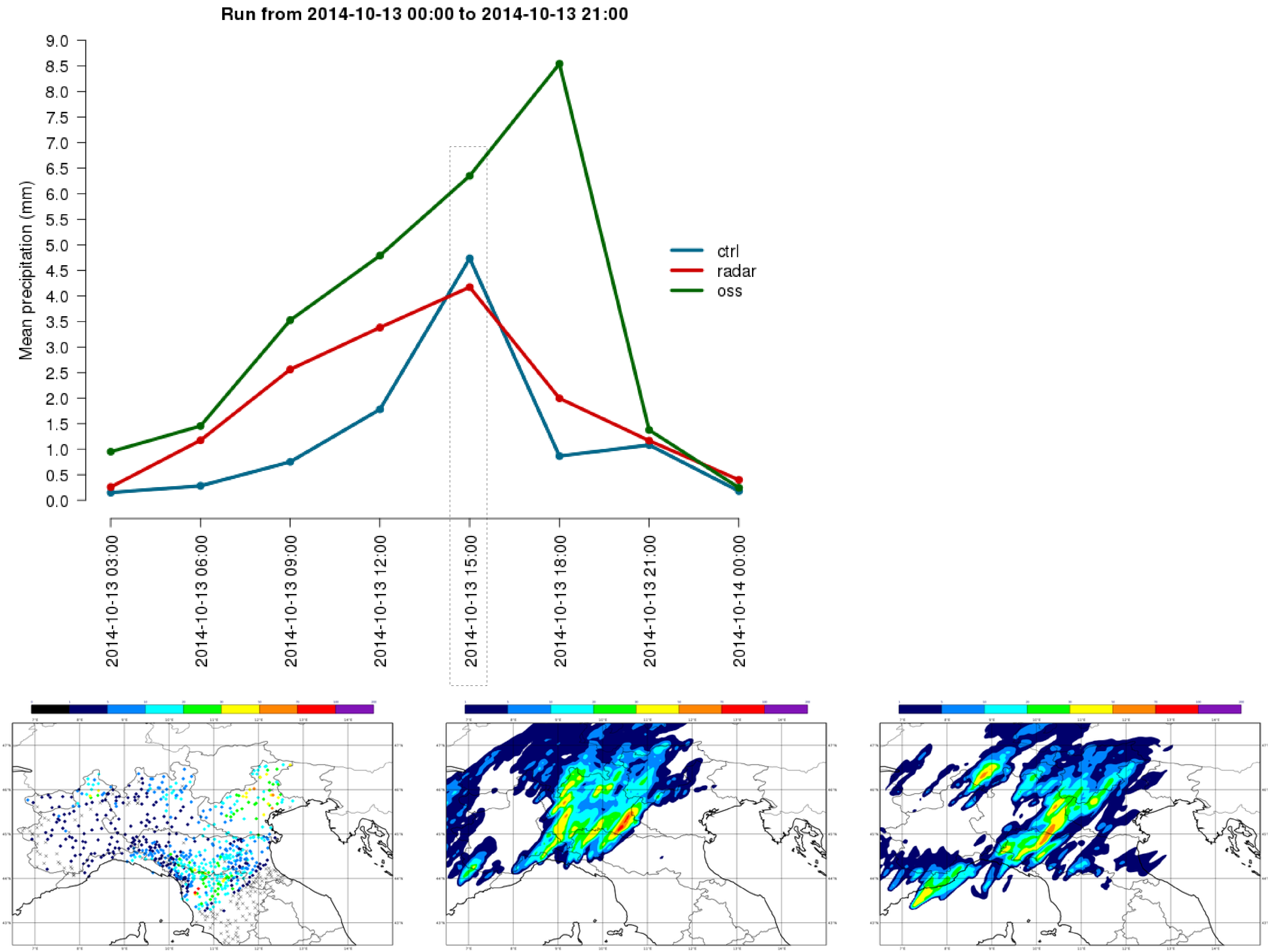

Run from 2014-10-07 00:00 to 2014-10-07 21:00
ctrl
radar
oss
Mean precipitation (mm)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
2014-10-07 03:00
2014-10-07 06:00
2014-10-07 09:00
2014-10-07 12:00
2014-10-07 15:00
2014-10-07 18:00
2014-10-07 21:00
2014-10-08 00:00



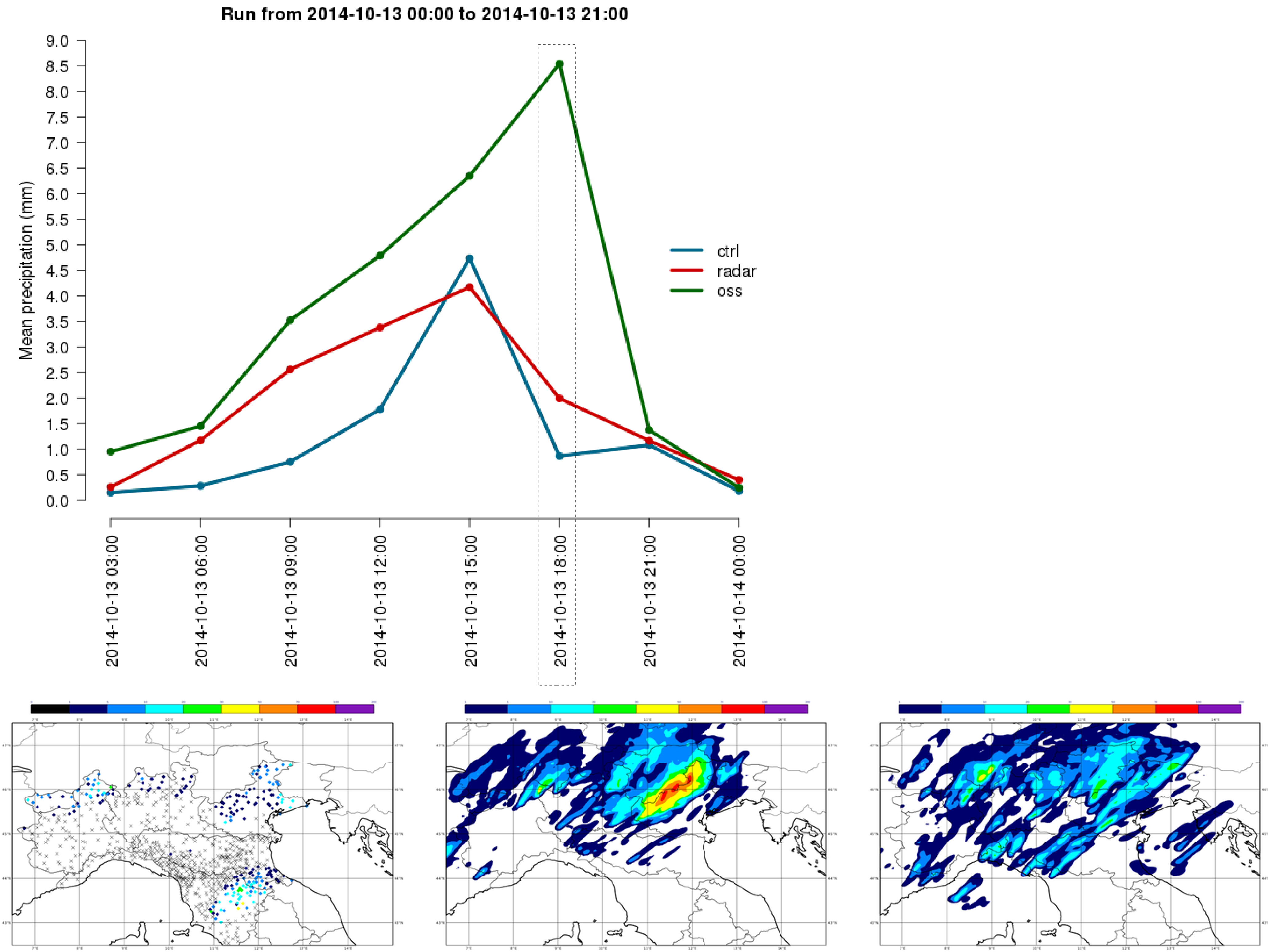


Run from 2014-10-09 00:00 to 2014-10-09 21:00
ctrl
radar
oss
Mean precipitation (mm)
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2014-10-09 03:00
2014-10-09 06:00
2014-10-09 09:00
2014-10-09 12:00
2014-10-09 15:00
2014-10-09 18:00
2014-10-09 21:00
2014-10-10 00:00


Run from 2014-10-11 00:00 to 2014-10-11 21:00
ctrl
radar
oss
Mean precipitation (mm)
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2014-10-11 03:00
2014-10-11 06:00
2014-10-11 09:00
2014-10-11 12:00
2014-10-11 15:00
2014-10-11 18:00
2014-10-11 21:00
2014-10-12 00:00



Run from 2014-10-13 00:00 to 2014-10-13 21:00
Mean precipitation (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ctrl
radar
oss
2014-10-13 03:00
2014-10-13 06:00
2014-10-13 09:00
2014-10-13 12:00
2014-10-13 15:00
2014-10-13 18:00
2014-10-13 21:00
2014-10-14 00:00


Run from 2014-10-13 00:00 to 2014-10-13 21:00
Mean precipitation (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ctrl
radar
oss
2014-10-13 03:00
2014-10-13 06:00
2014-10-13 09:00
2014-10-13 12:00
2014-10-13 15:00
2014-10-13 18:00
2014-10-13 21:00
2014-10-14 00:00