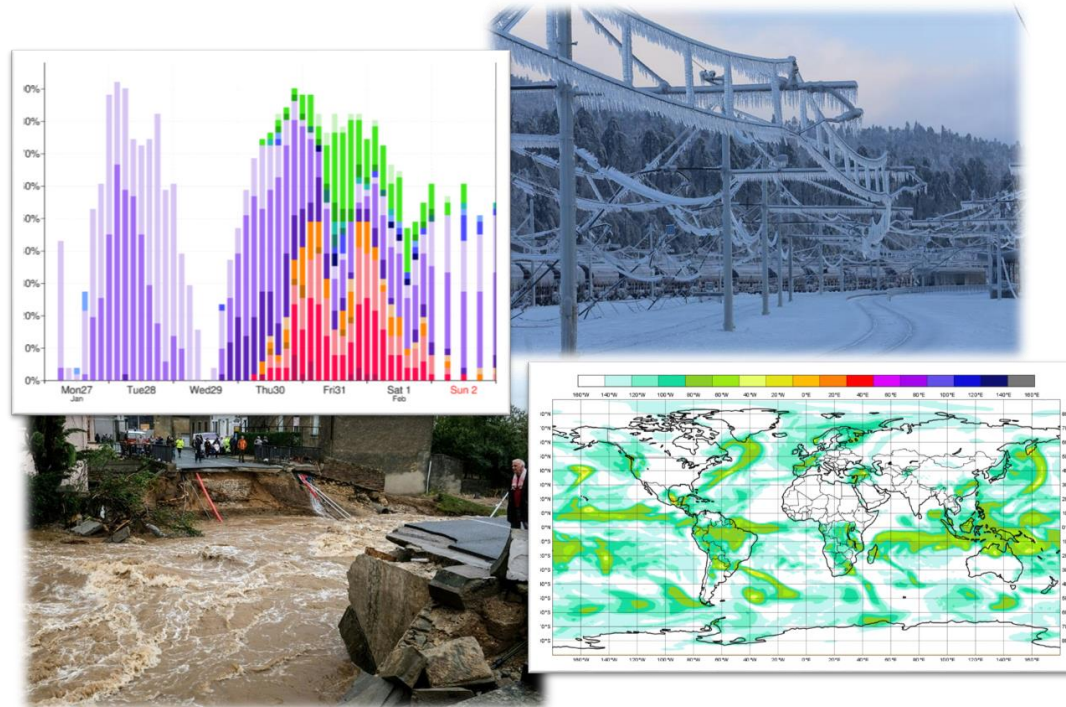# Precipitation type estimation with ECMWF probability products

Road Weather Event Week. EUTMETNET

Estíbaliz Gascón

Forecast Department, ECMWF

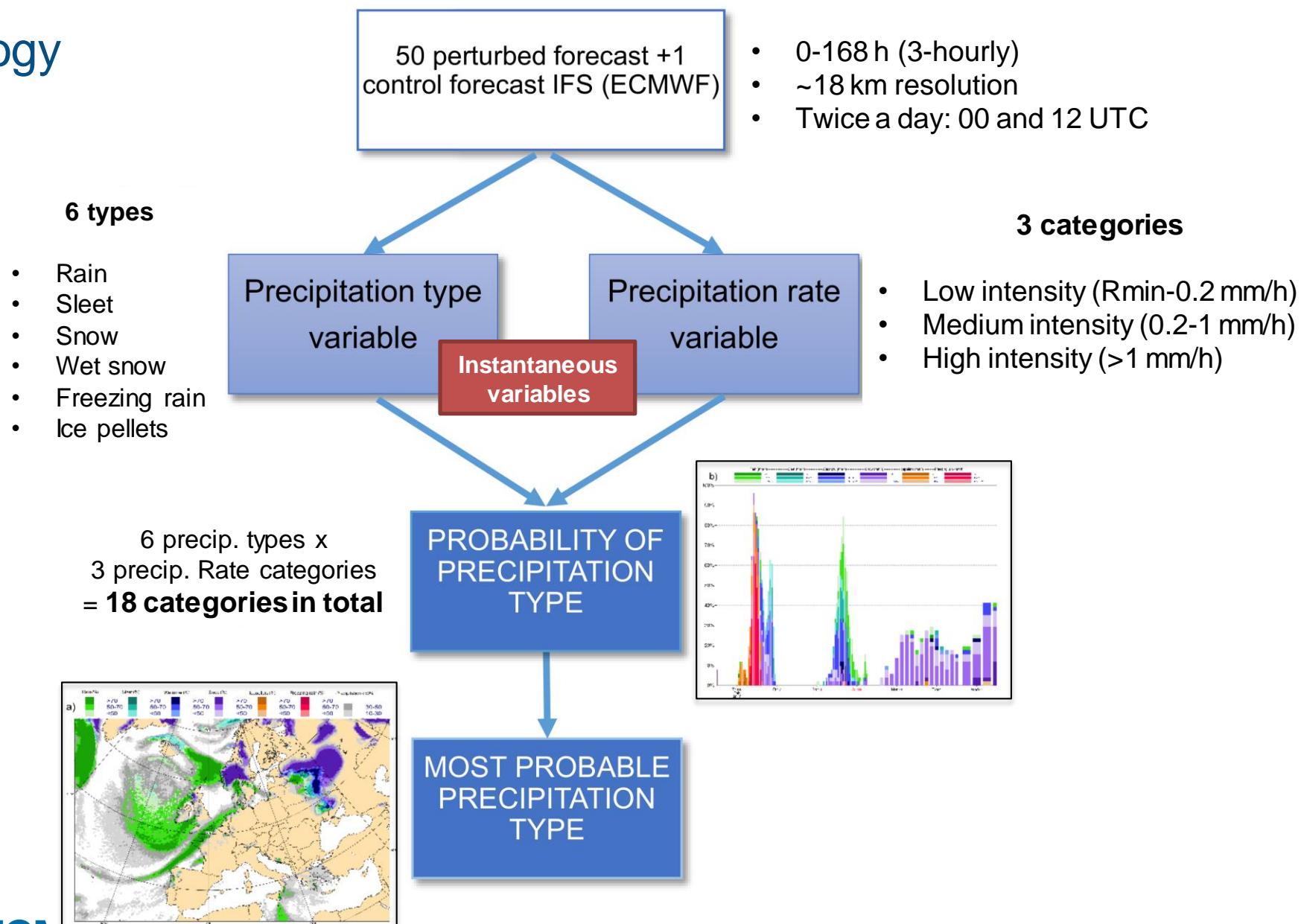estibaliz.gascon@ecmwf.int

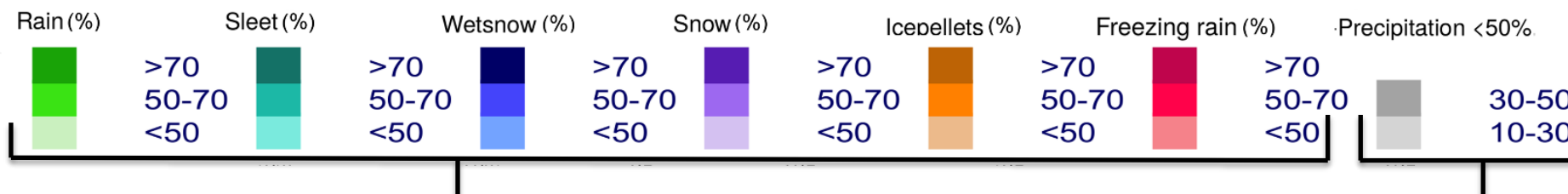© ECMWF   December 19, 2019

Why these new probabilistic products?

- Difficulties of accurate forecasting of precipitation type in winter at ground level, specially mixed (freezing rain).

- **Freezing rain** is particularly hazardous due to its ice-loading effects on power wires and because it can make travel extremely dangerous. But also heavy snowfalls.

- The uncertainty of mixed phases forecasting can be partially reduce using ensemble forecast.

- We also used a technique with precipitation rate variable to classify dry from precipitating in order to try to enforce a zero frequency bias for each precipitation types: reduce misses and false alarms.


ECMWF

2. Methodology

50 perturbed forecast +1 control forecast IFS (ECMWF)

- 0-168 h (3-hourly)
- ~18 km resolution
- Twice a day: 00 and 12 UTC

6 types

- Rain
- Sleet
- Snow
- Wet snow
- Freezing rain
- Ice pellets

Precipitation type variable

Instantaneous variables

Precipitation rate variable

3 categories

- Low intensity (Rmin-0.2 mm/h)
- Medium intensity (0.2-1 mm/h)
- High intensity (>1 mm/h)

6 precip. types x
3 precip. Rate categories
= **18 categories in total**

PROBABILITY OF PRECIPITATION TYPE

MOST PROBABLE PRECIPITATION TYPE

3. Most probable precipitation type product

Rain (%)   Sleet (%)   Wetsnow (%)   Snow (%)   Icepellets (%)   Freezing rain (%)   Precipitation <50%
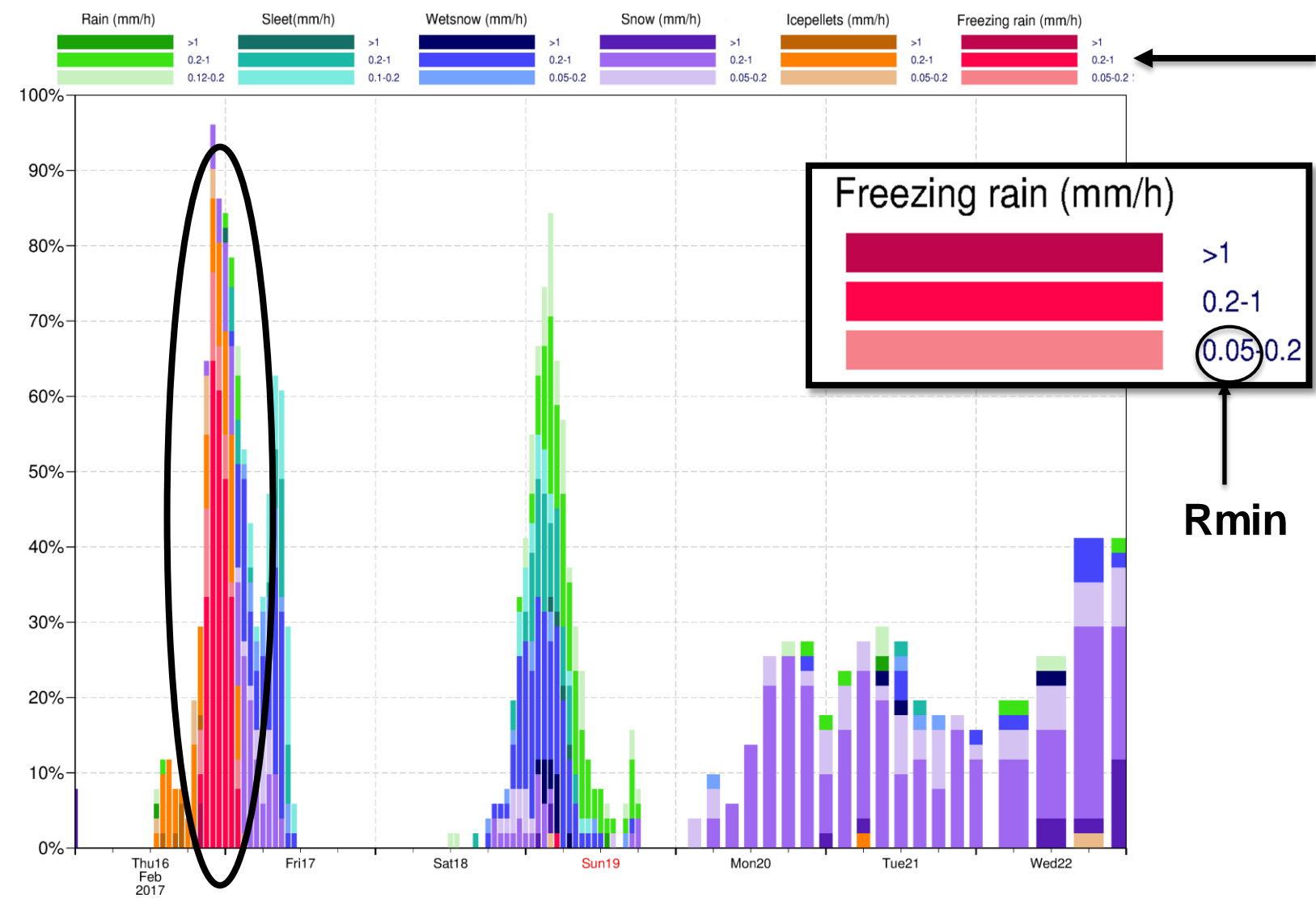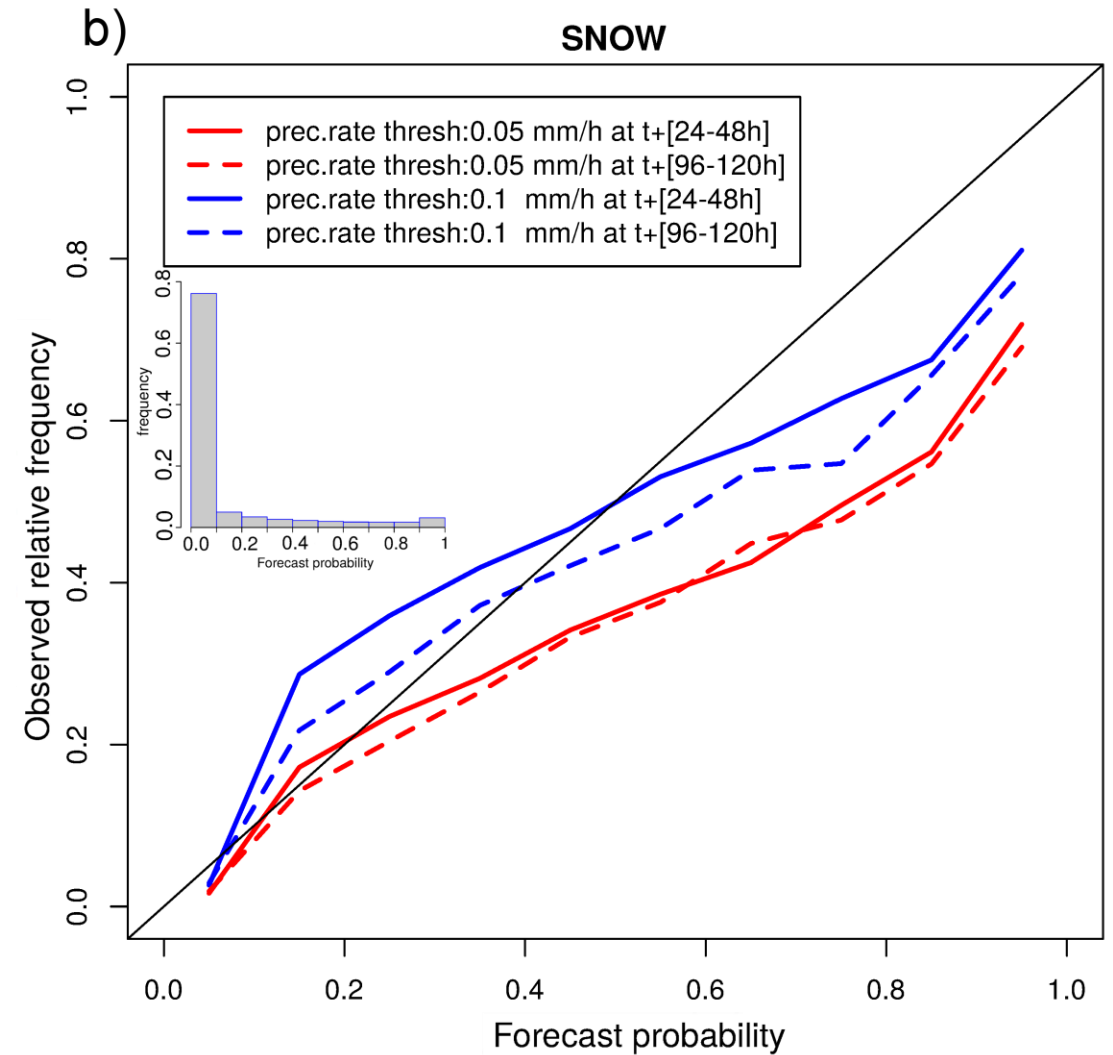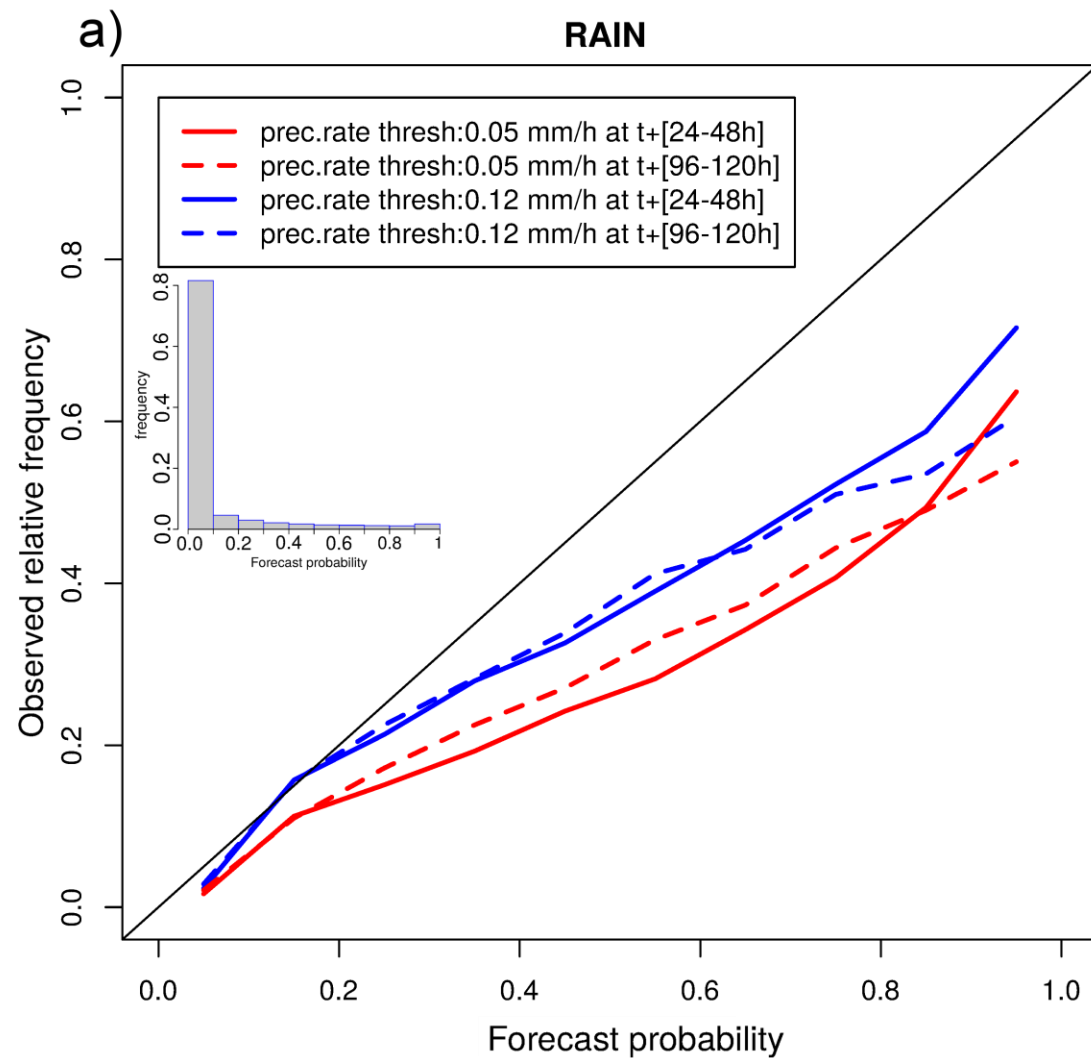
>70 / 50-70 / <50

30-50 / 10-30

Colours: most probable precipitation type if **total precip > 50 %**

Grey shading: when the probability of any type of precipitation is **10-30%** or **30-50%**. **THE TYPE OF PRECIPITATION IS NOT SPECIFIED**
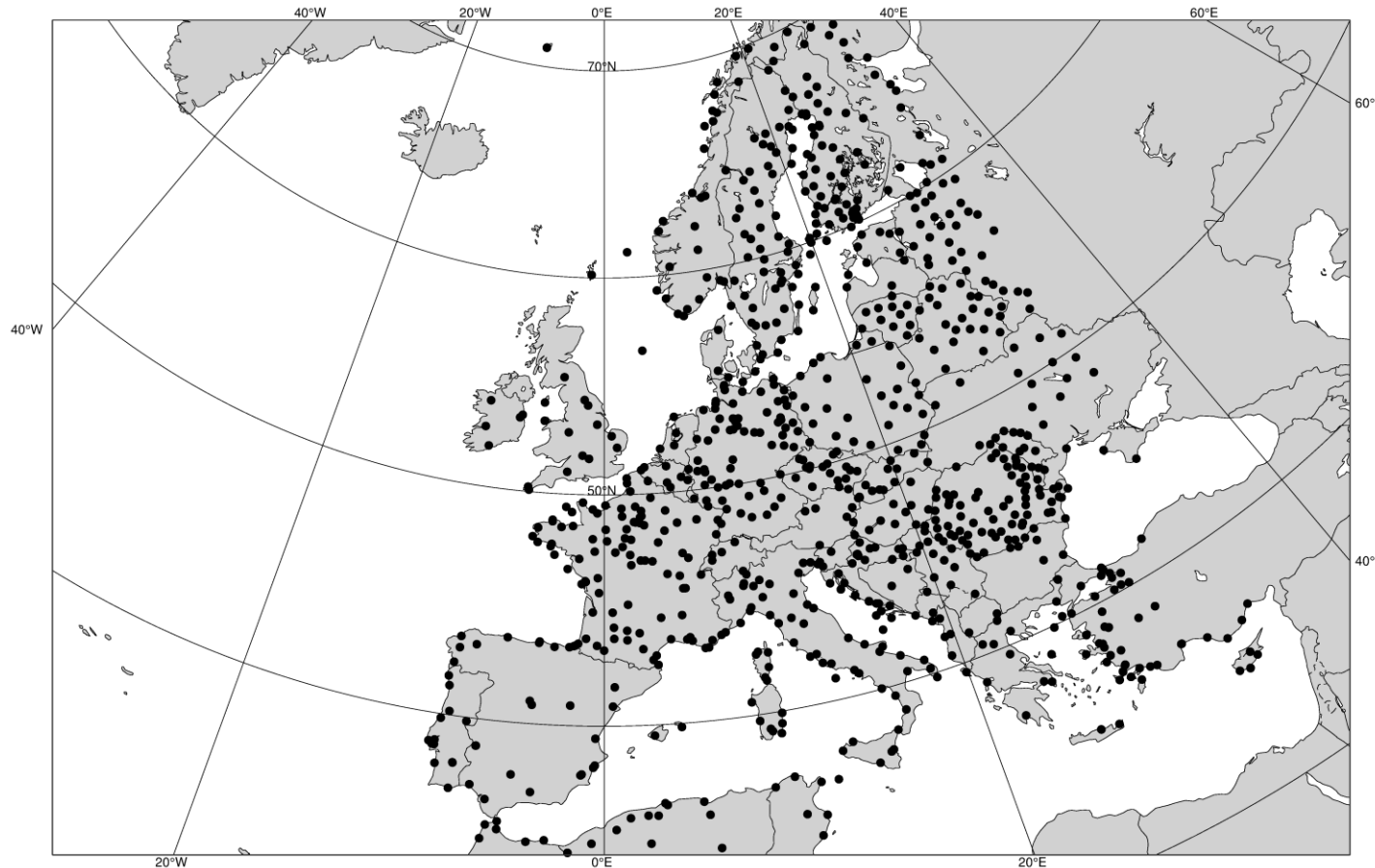

ECMWF
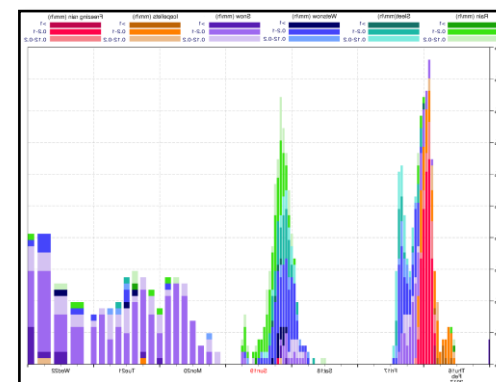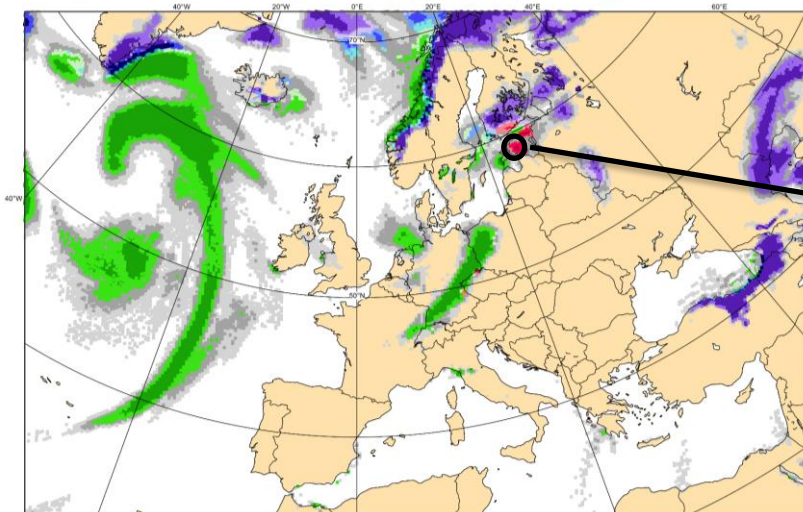
4. Probability of precipitation type meteograms

a) RAIN

b) SNOW

- ENS tends to be over-confident with high probabilities. For snow a net under-prediction bias manifests itself at low probabilities.

ECMWF

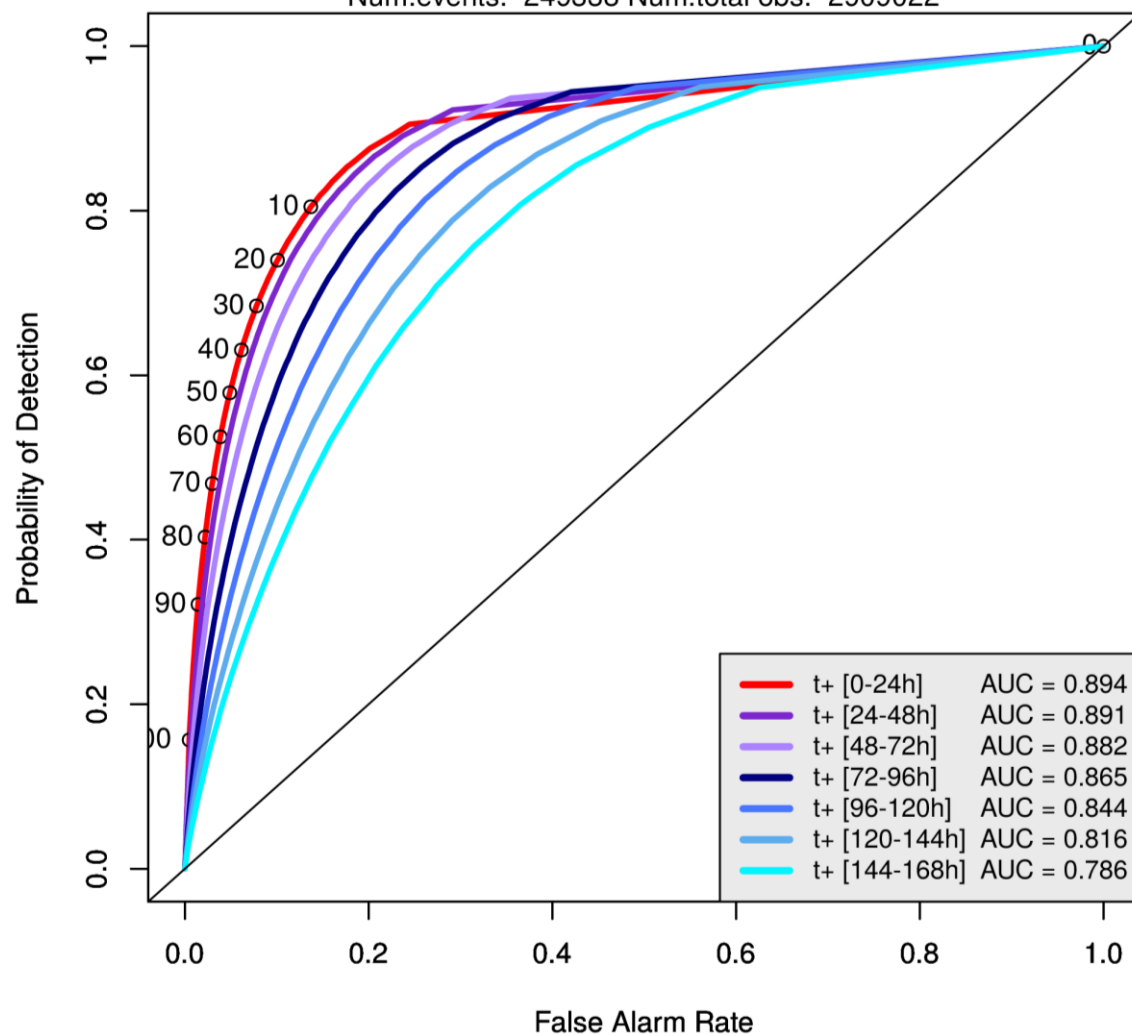6

6. Verification

Manual SYNOP stations available

- The verification has been developed using **3-hourly** observations of present weather from *manual* **SYNOP** in **Europe** in 5 months winter periods 2016-2019 (3 winters).

- SYNOP stations with a 150 m altitude difference with the closest ENS point were removed from the verification.

VERIFICATION: ROC curves of probabilities

ROC diagram for rain probability
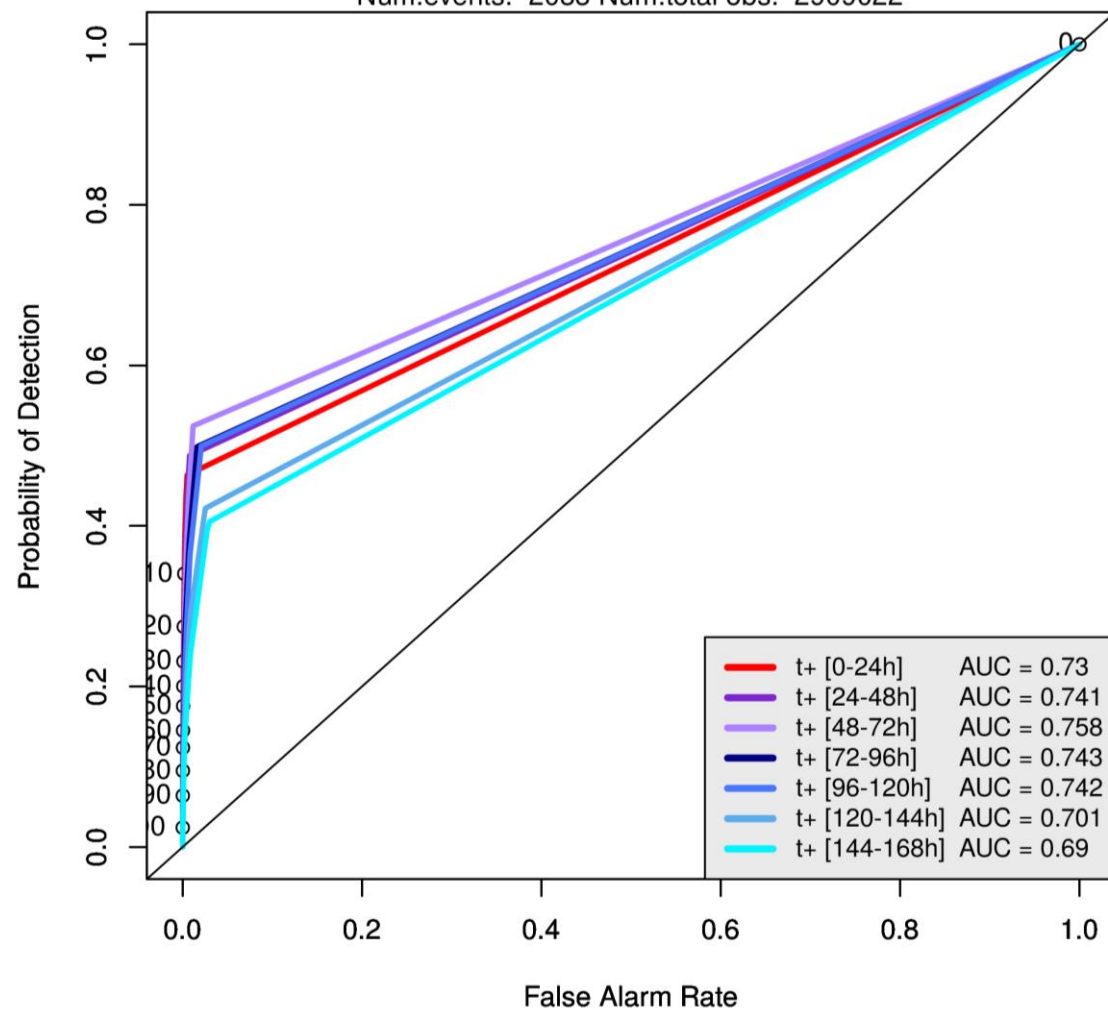
Num.events: 249338 Num.total obs: 2909022

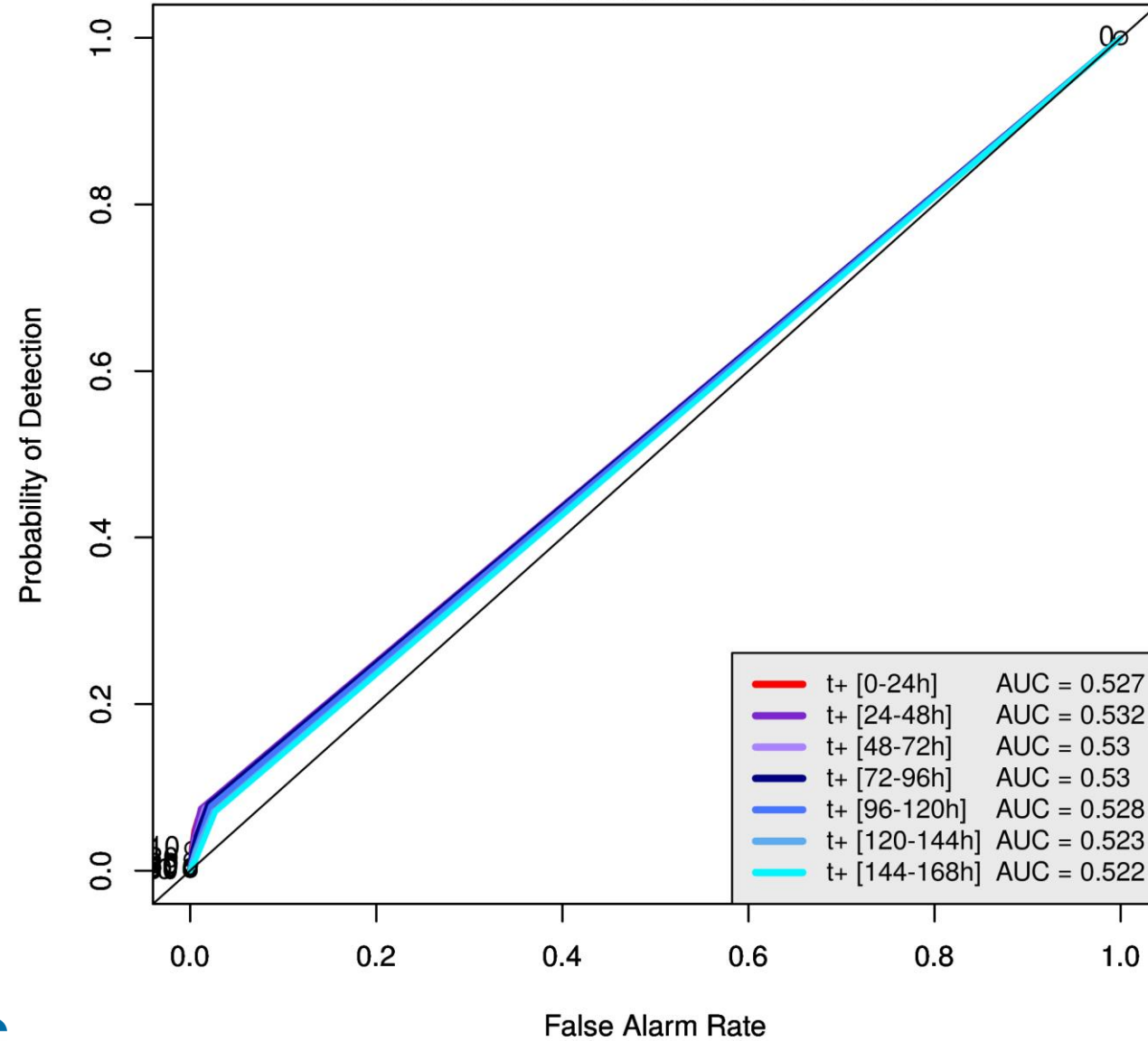|	
t+ [0-24h]	AUC = 0.894
t+ [24-48h]	AUC = 0.891
t+ [48-72h]	AUC = 0.882
t+ [72-96h]	AUC = 0.865
t+ [96-120h]	AUC = 0.844
t+ [120-144h]	AUC = 0.816
t+ [144-168h]	AUC = 0.786

ROC diagram for snow probability

Num.events: 140867 Num.total obs: 2909022

t+ [0-24h]	AUC = 0.881
t+ [24-48h]	AUC = 0.889
t+ [48-72h]	AUC = 0.891
t+ [72-96h]	AUC = 0.889
t+ [96-120h]	AUC = 0.88
t+ [120-144h]	AUC = 0.869
t+ [144-168h]	AUC = 0.857
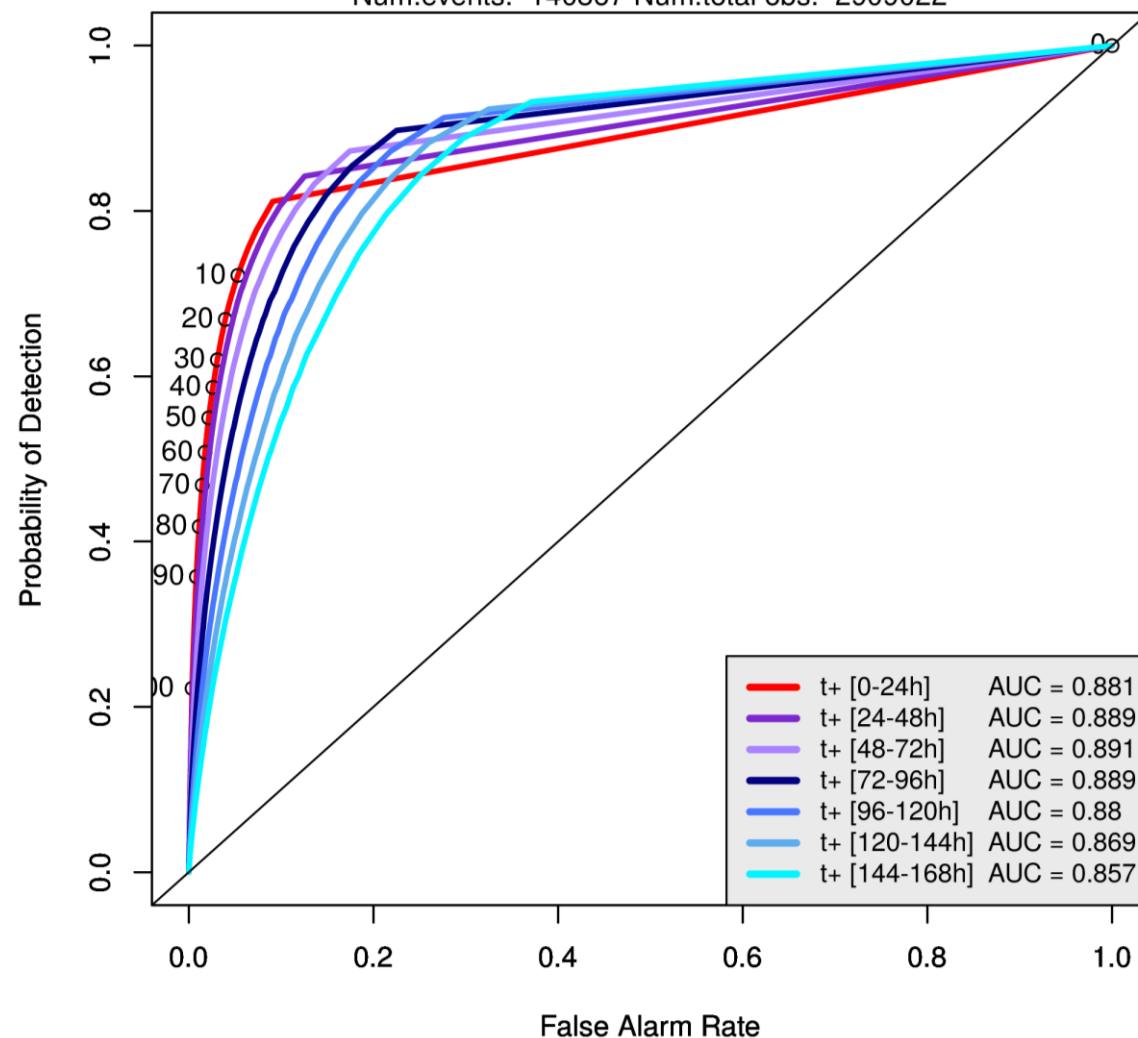
VERIFICATION: ROC curves of probabilities

ROC diagram for freezing rain probability

Num.events: 2033 Num.total obs: 2909022

t+ [0-24h]	AUC = 0.73
t+ [24-48h]	AUC = 0.741
t+ [48-72h]	AUC = 0.758
t+ [72-96h]	AUC = 0.743
t+ [96-120h]	AUC = 0.742
t+ [120-144h]	AUC = 0.701
t+ [144-168h]	AUC = 0.69

ROC diagram for sleet probability

Num.events: 15191 Num.total obs: 2909022

t+ [0-24h]	AUC = 0.681
t+ [24-48h]	AUC = 0.697
t+ [48-72h]	AUC = 0.698
t+ [72-96h]	AUC = 0.687
t+ [96-120h]	AUC = 0.674
t+ [120-144h]	AUC = 0.656
t+ [144-168h]	AUC = 0.638
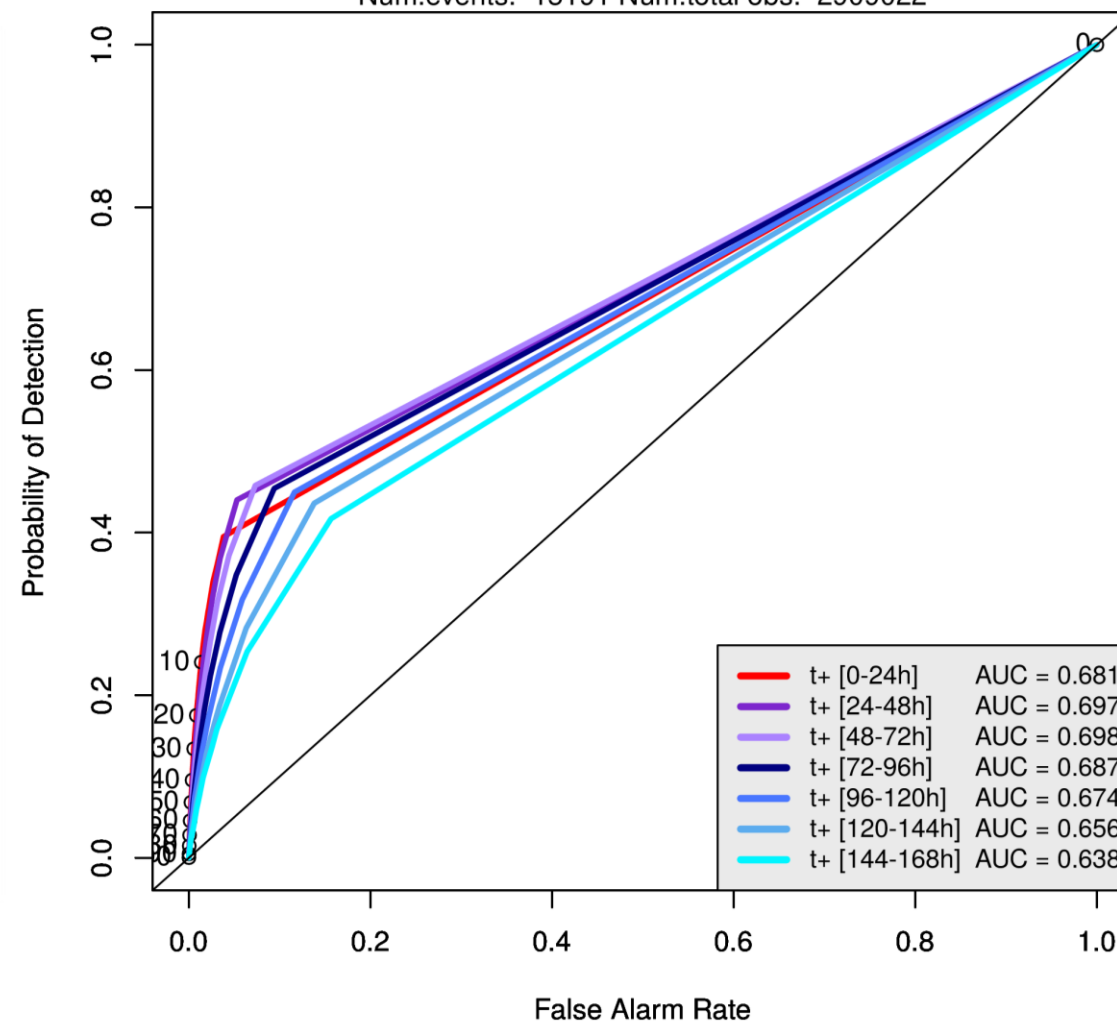
ROC diagram for icepellets probability

Num.events: 3144 Num.total obs: 2909022

Probability of Detection (y-axis): 0.0, 0.2, 0.4, 0.6, 0.8, 1.0

False Alarm Rate (x-axis): 0.0, 0.2, 0.4, 0.6, 0.8, 1.0

Series	AUC
t+ [0-24h]	AUC = 0.527
t+ [24-48h]	AUC = 0.532
t+ [48-72h]	AUC = 0.53
t+ [72-96h]	AUC = 0.53
t+ [96-120h]	AUC = 0.528
t+ [120-144h]	AUC = 0.523
t+ [144-168h]	AUC = 0.522

VERIFICATION: Cost-lost ratio plots
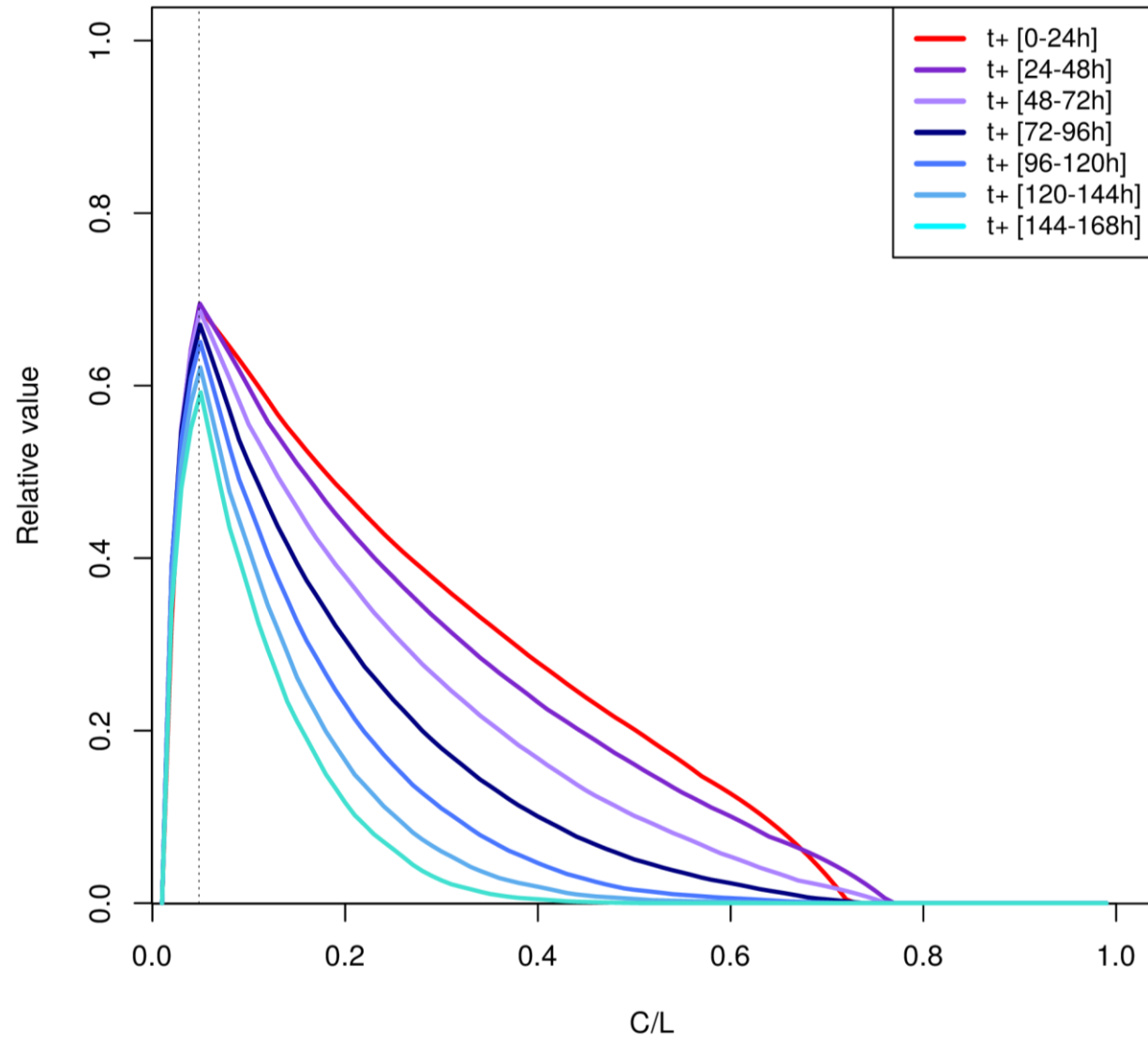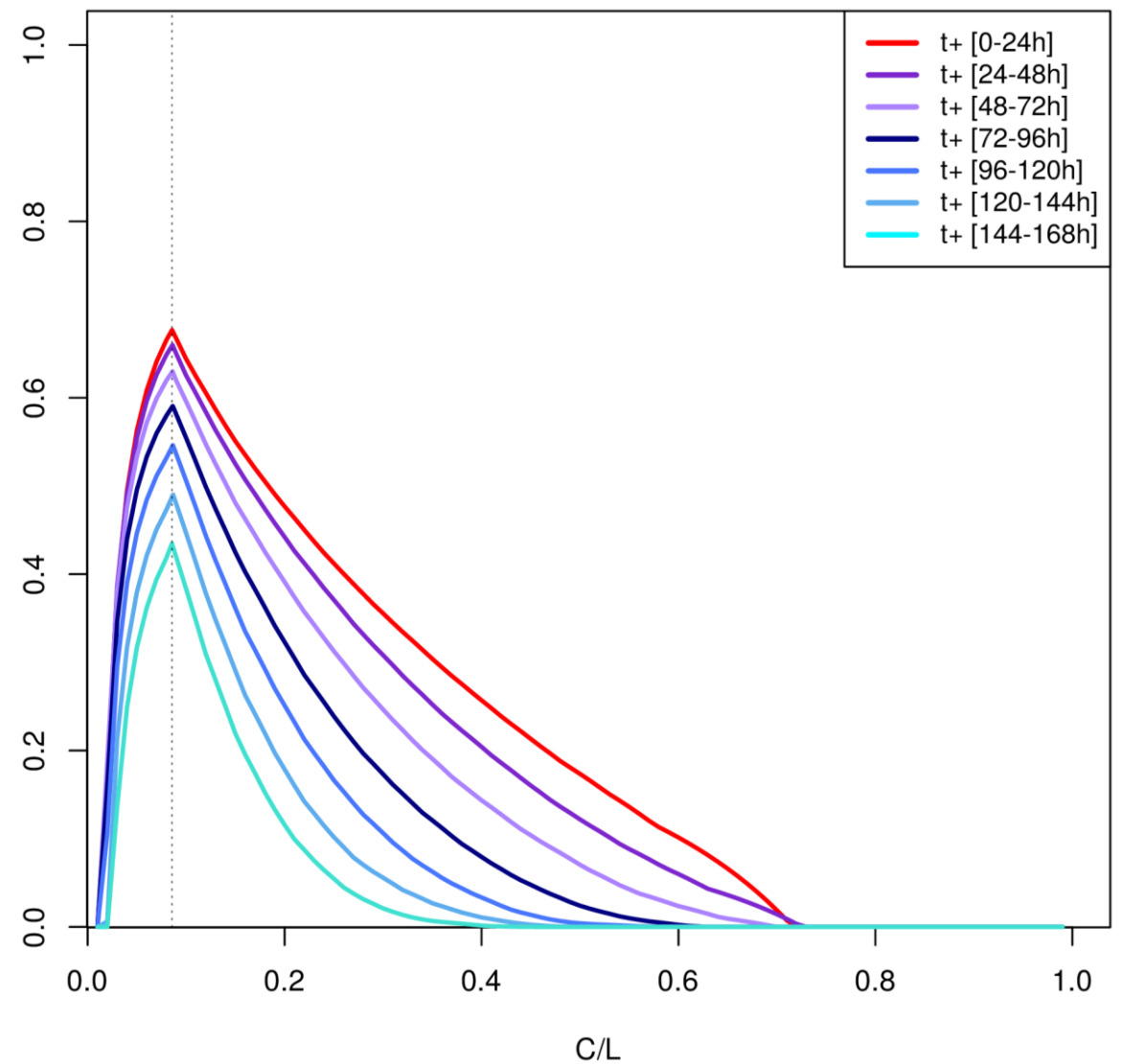
VERIFICATION: Cost-lost ratio plots

FREEZING RAIN
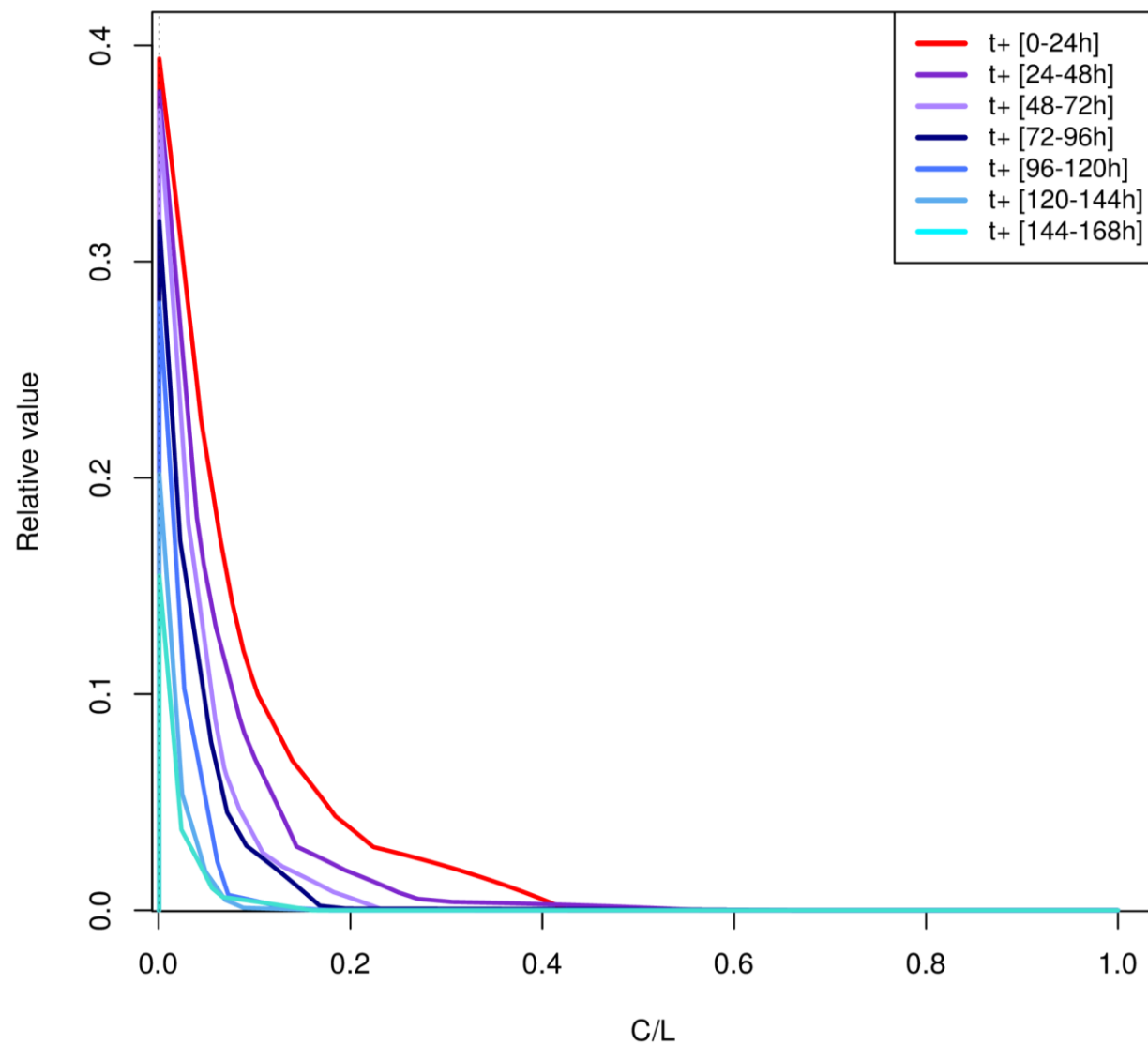
SLEET
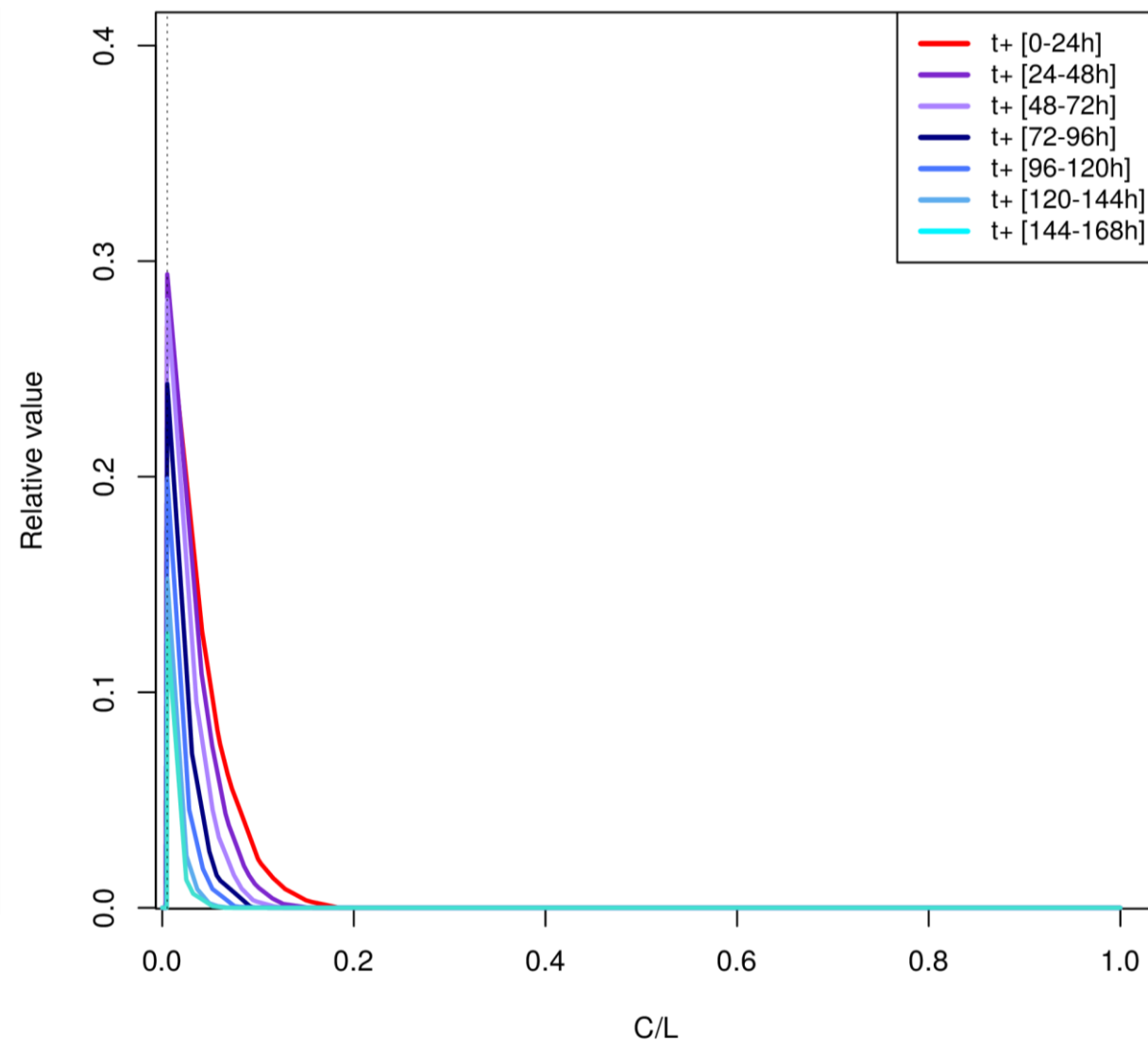
VERIFICATION: Most probable precipitation type
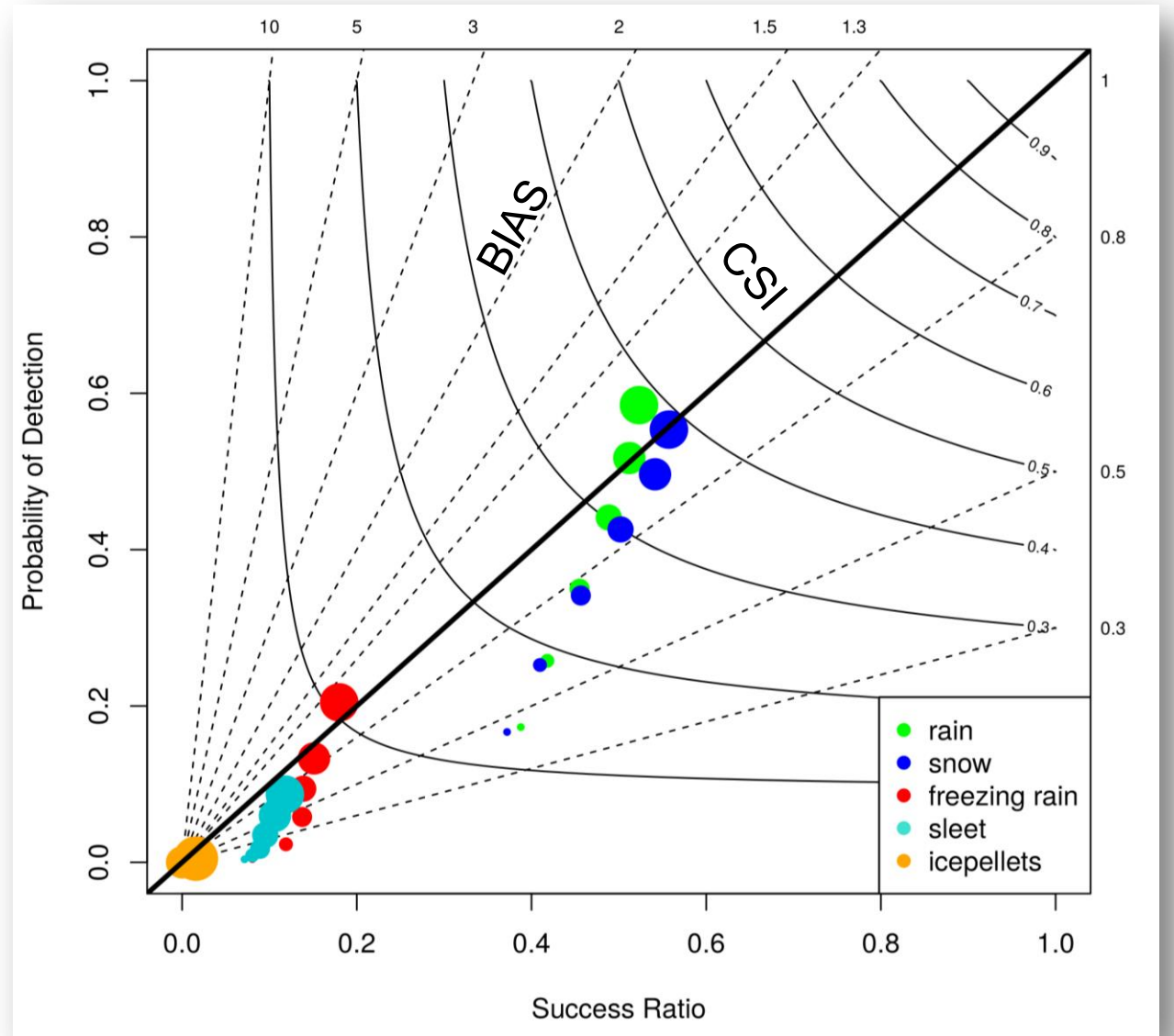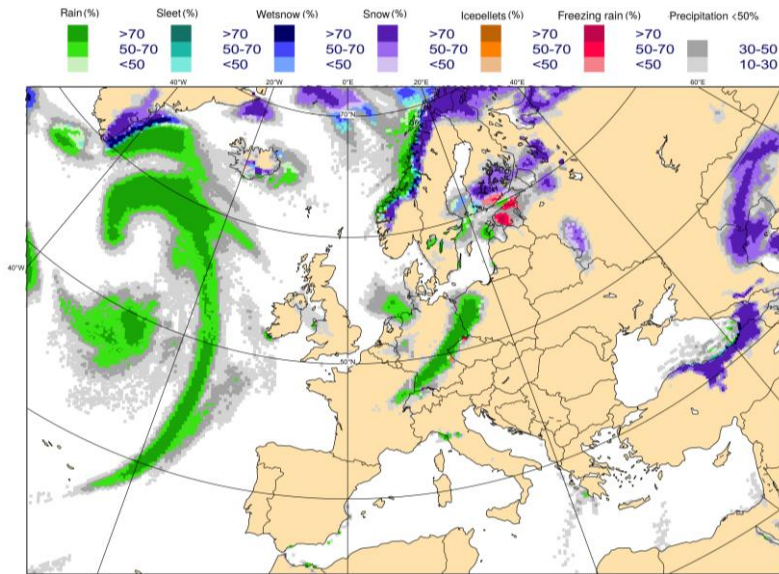
CASE STUDY 1: Freezing rain in Slovenia 2014 (Jan-Feb)

CASE STUDY: Most probable precipitation type
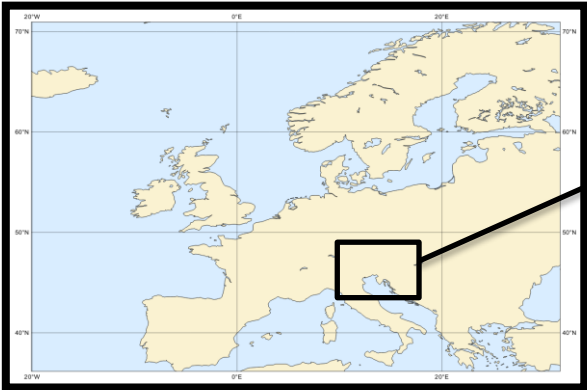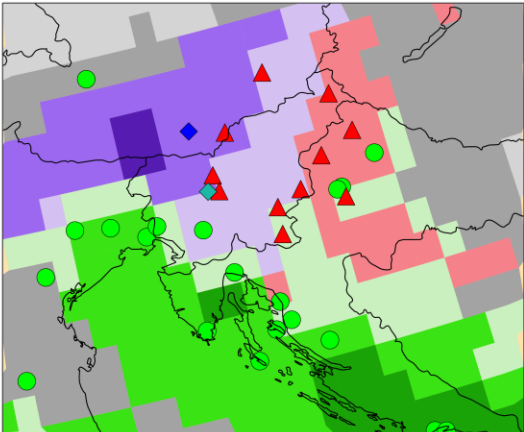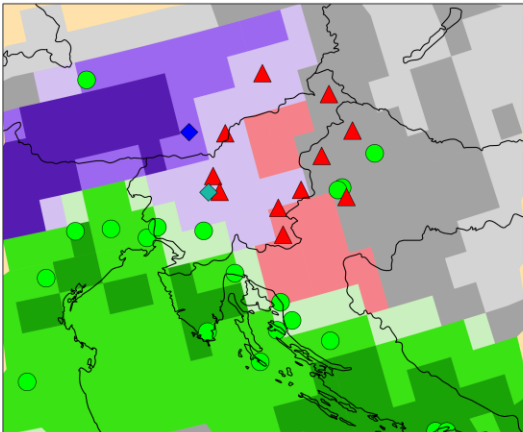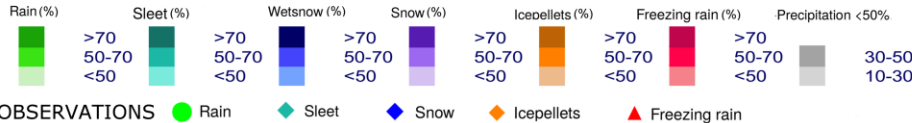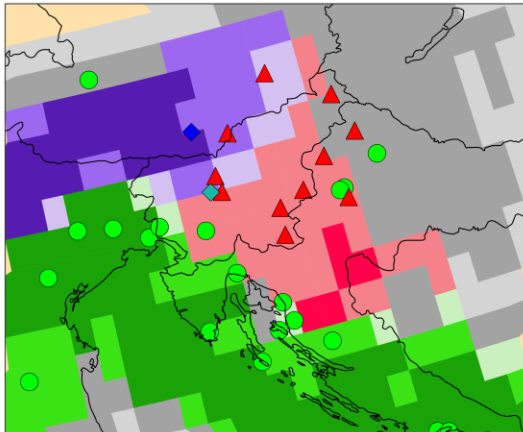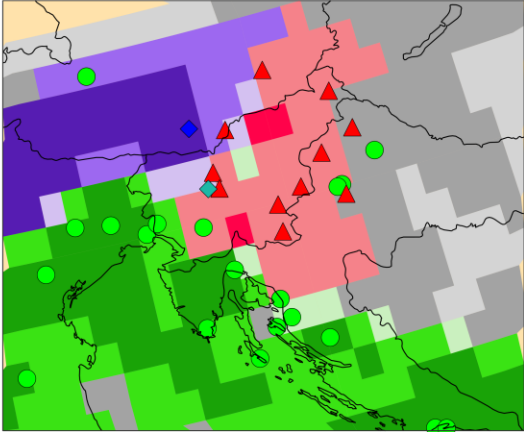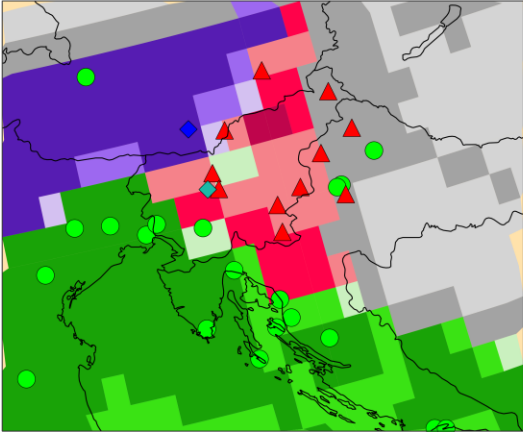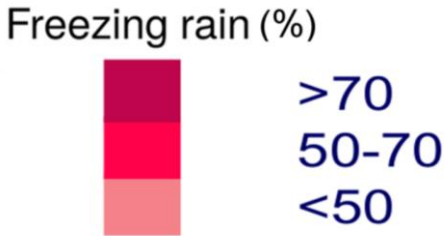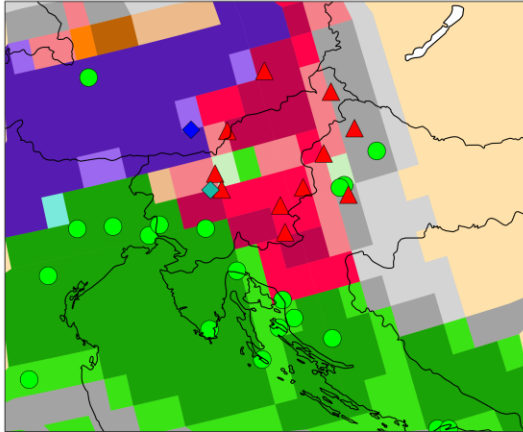
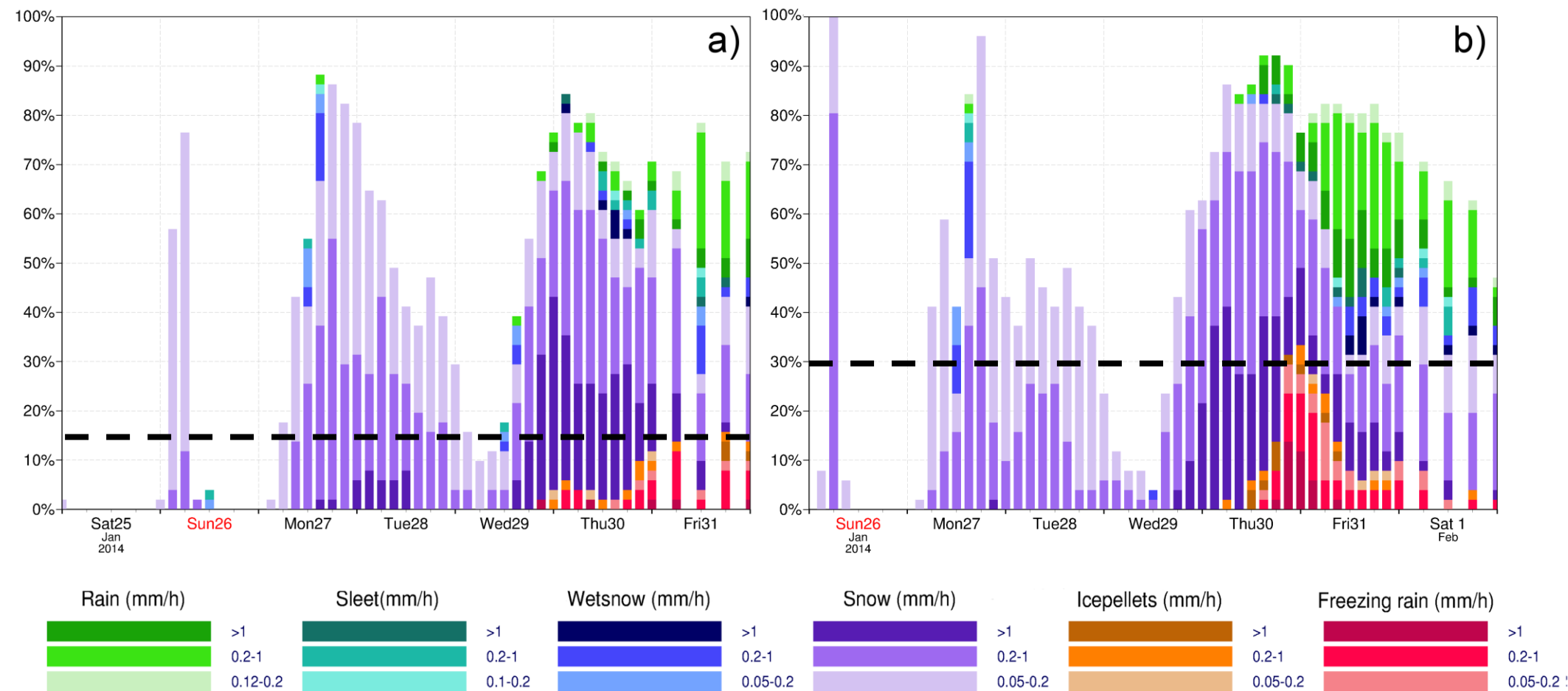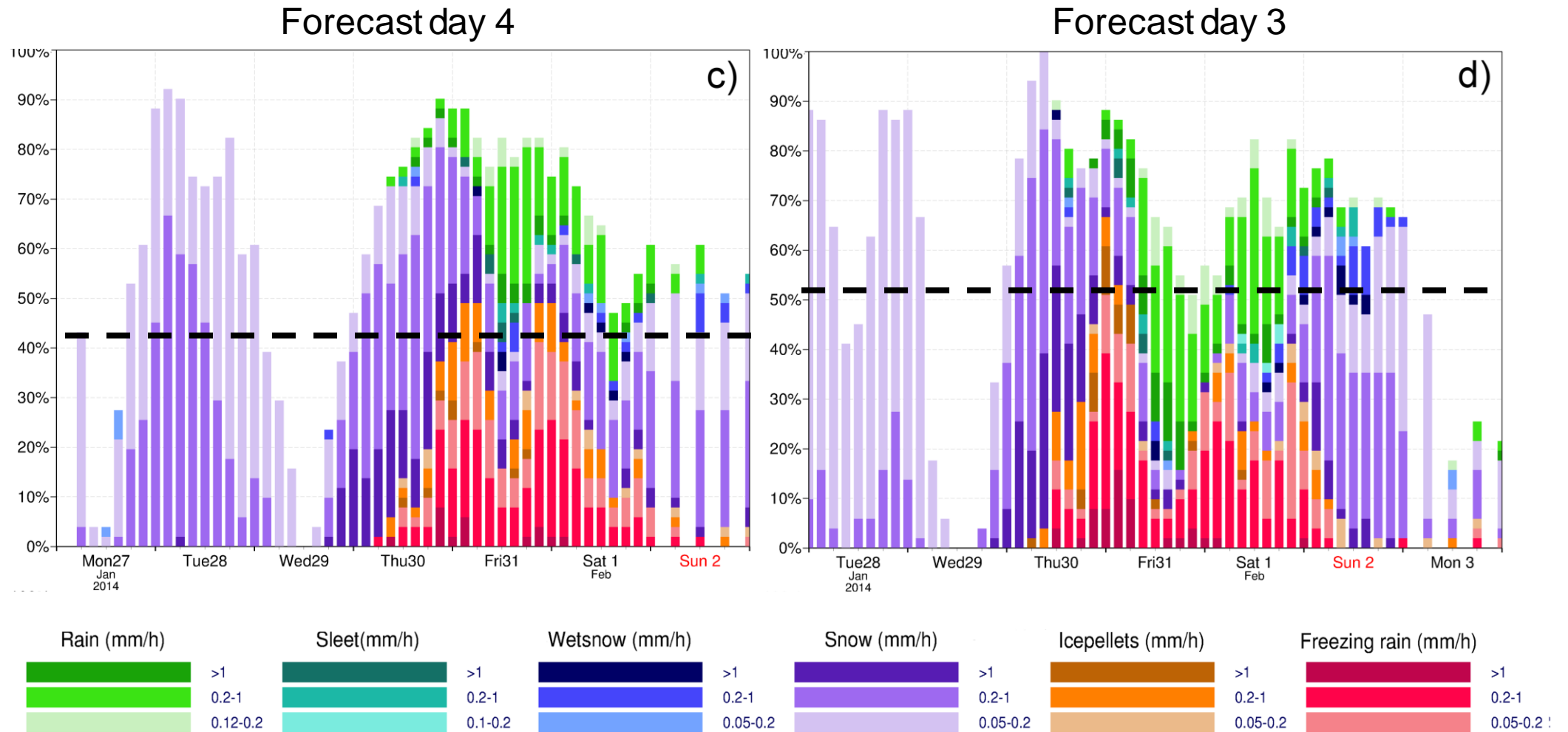# CASE STUDY: Probabilities, meteogram for Postojna

Forecast day 6

Forecast day 5

CASE STUDY: Probabilities, meteogram for Postojna

Forecast day 4

Forecast day 3

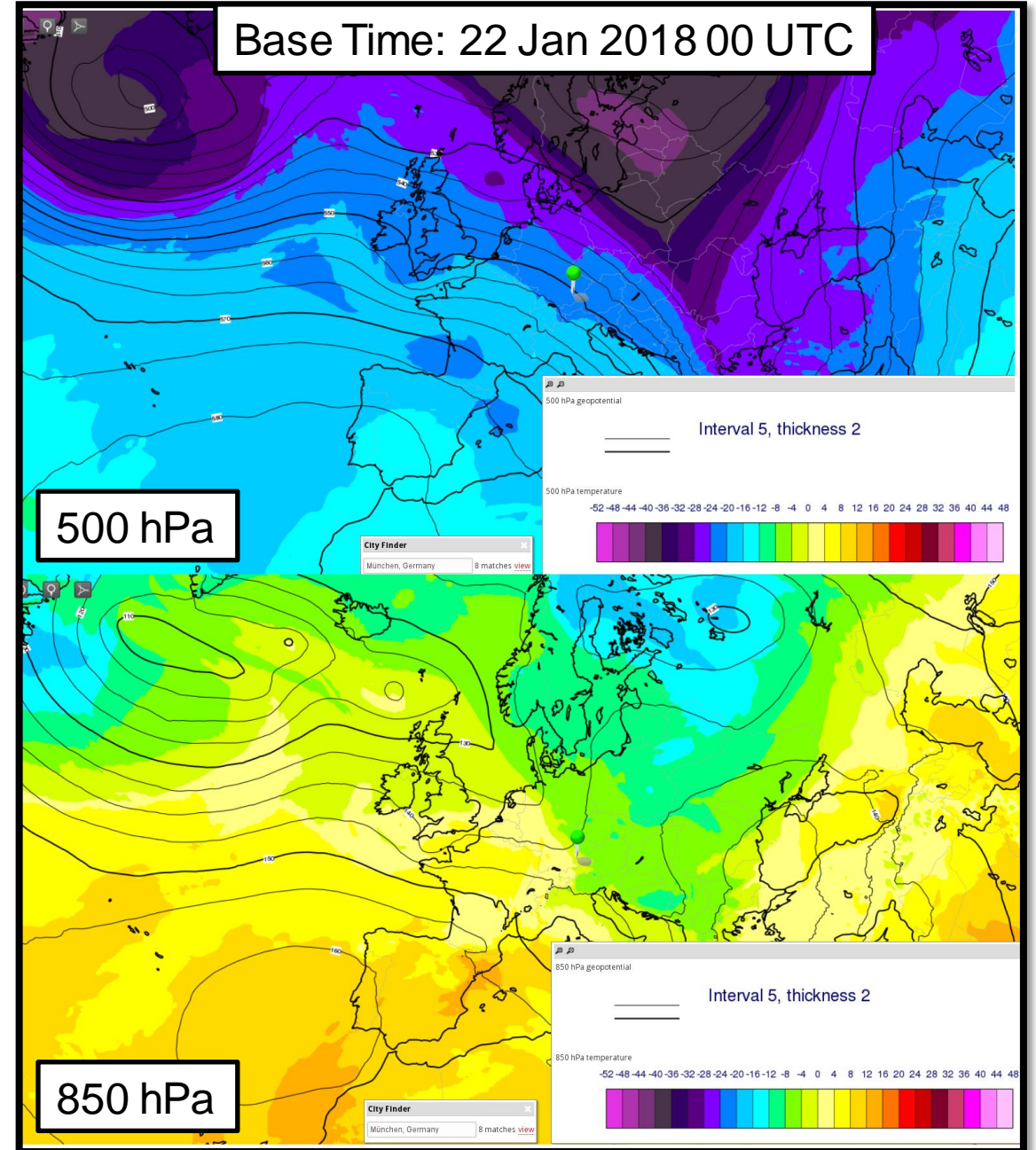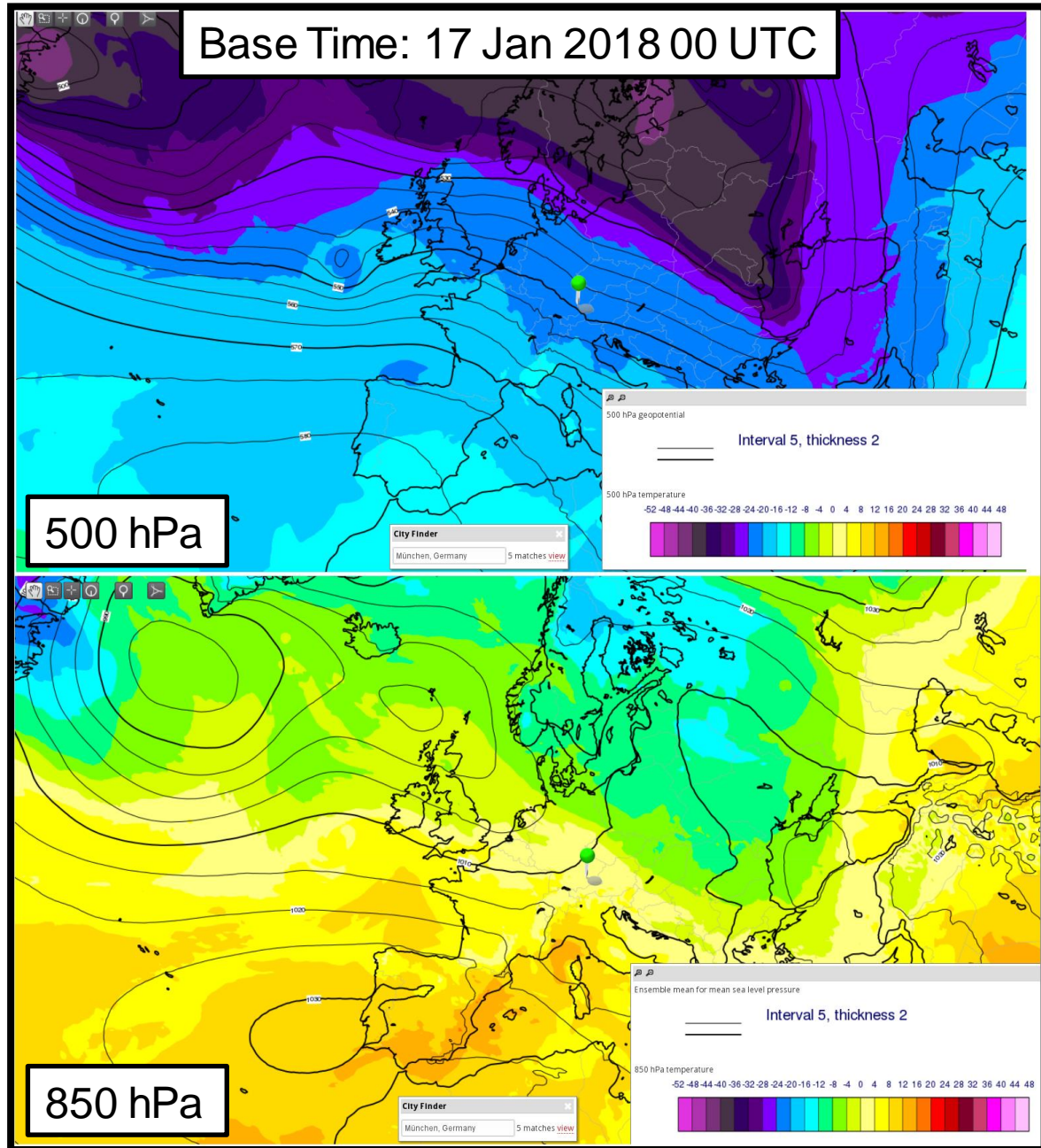# CASE STUDY: Probabilities, meteogram for Postojna
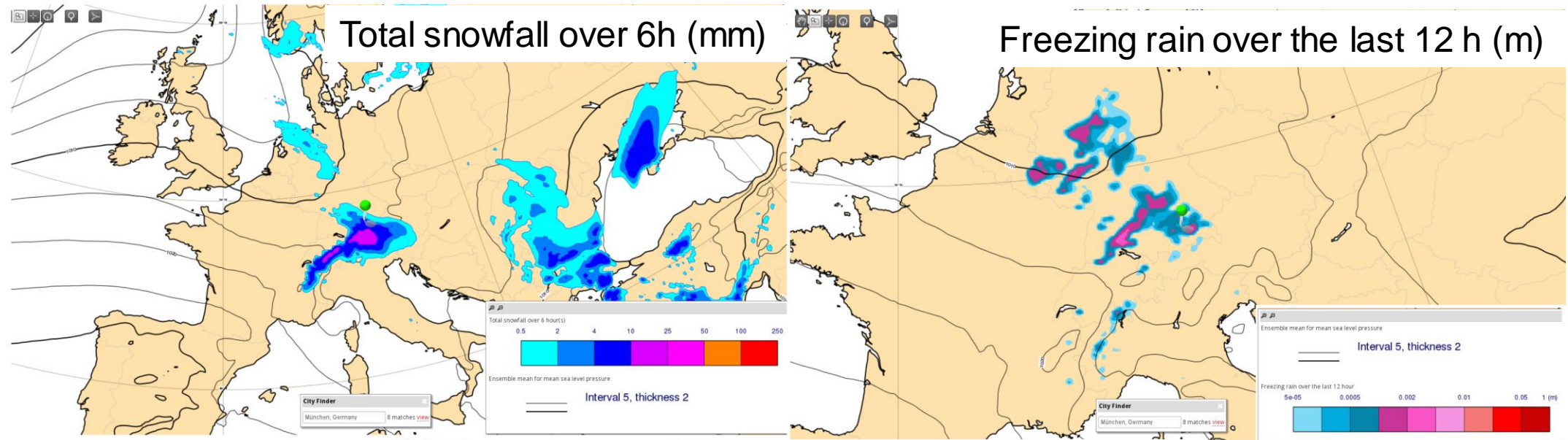

Forecast day 2

Forecast day 1
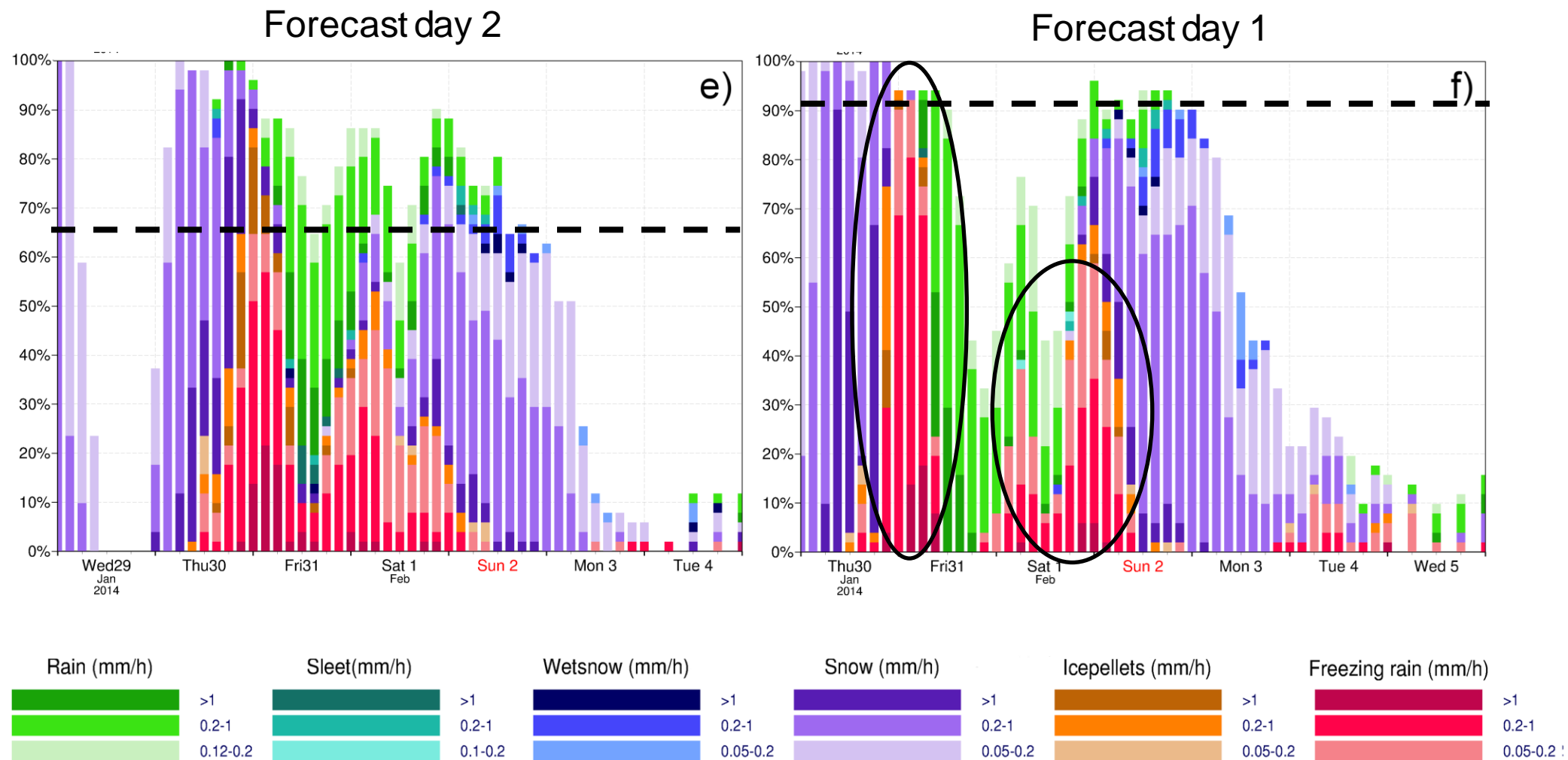
CASE STUDY 2: Freezing rain 22nd January, Munich (Germany)

USE OF DIFFERENT PRODUCTS

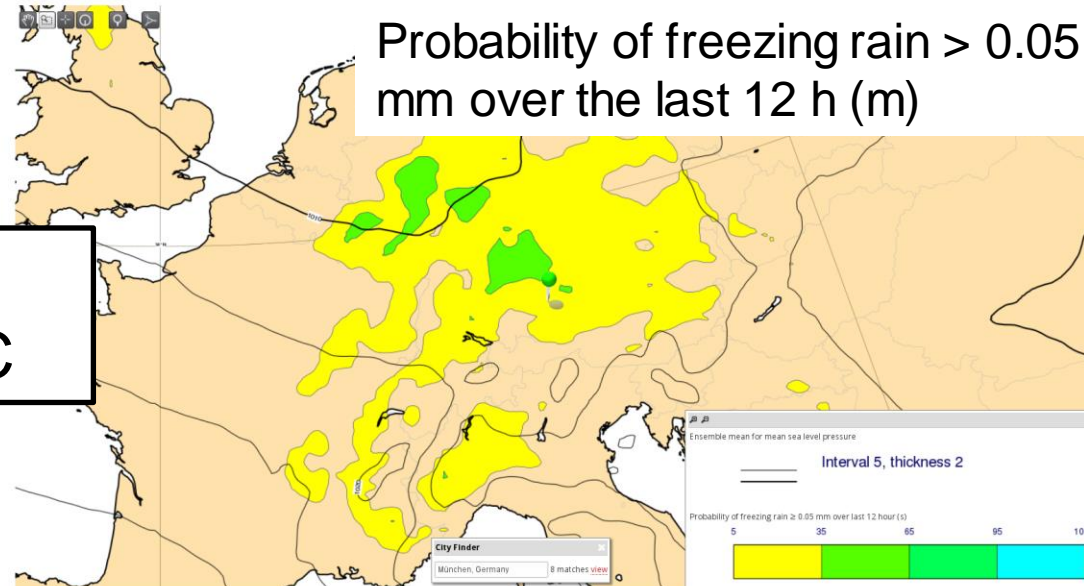# Temperature and geopotential. Valid time 22 Jan 2018 09 UTC

Base Time: 17 Jan 2018 00 UTC

500 hPa

850 hPa

Base Time: 22 Jan 2018 00 UTC

500 hPa

850 hPa

Freezing rain and snow map products. Valid time 22 Jan 2018 09 UTC

Total snowfall over 6h (mm)
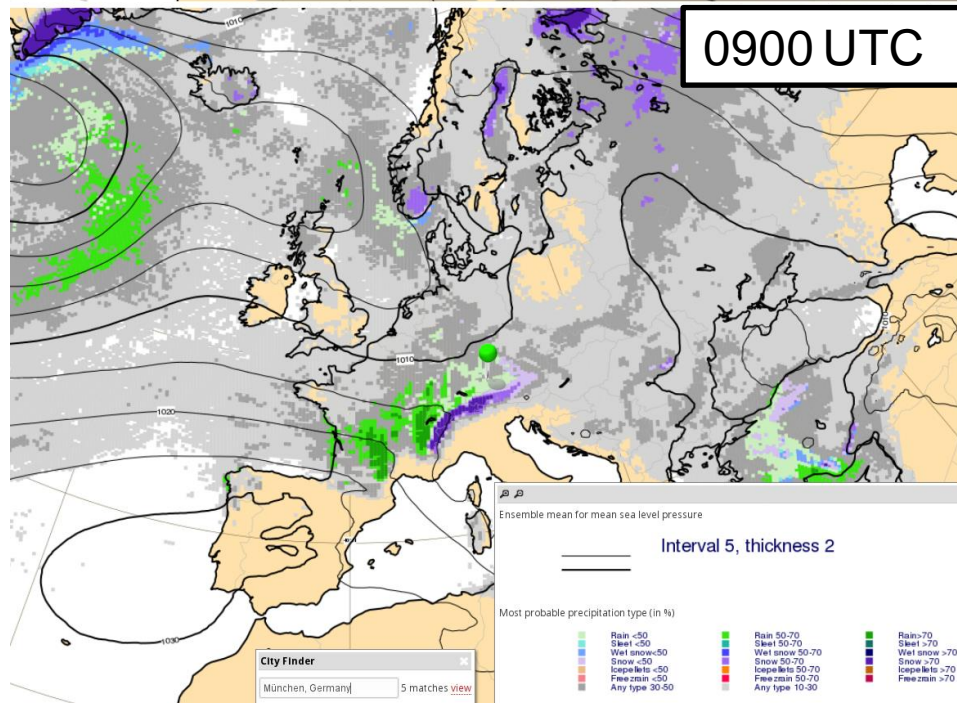
Freezing rain over the last 12 h (m)
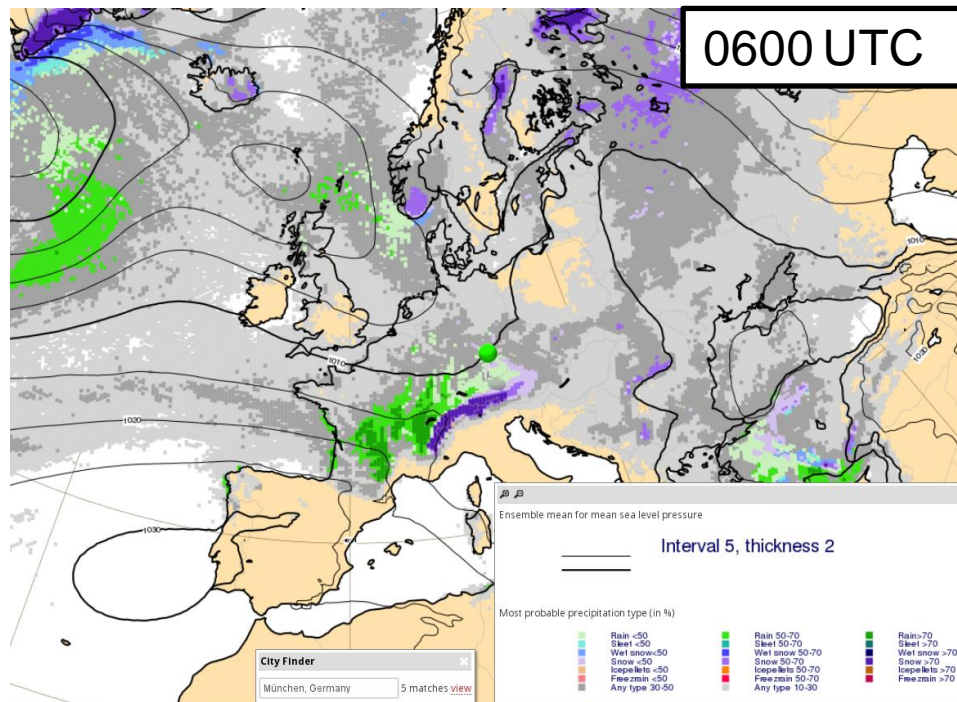
Probability of freezing rain > 0.05 mm over the last 12 h (m)
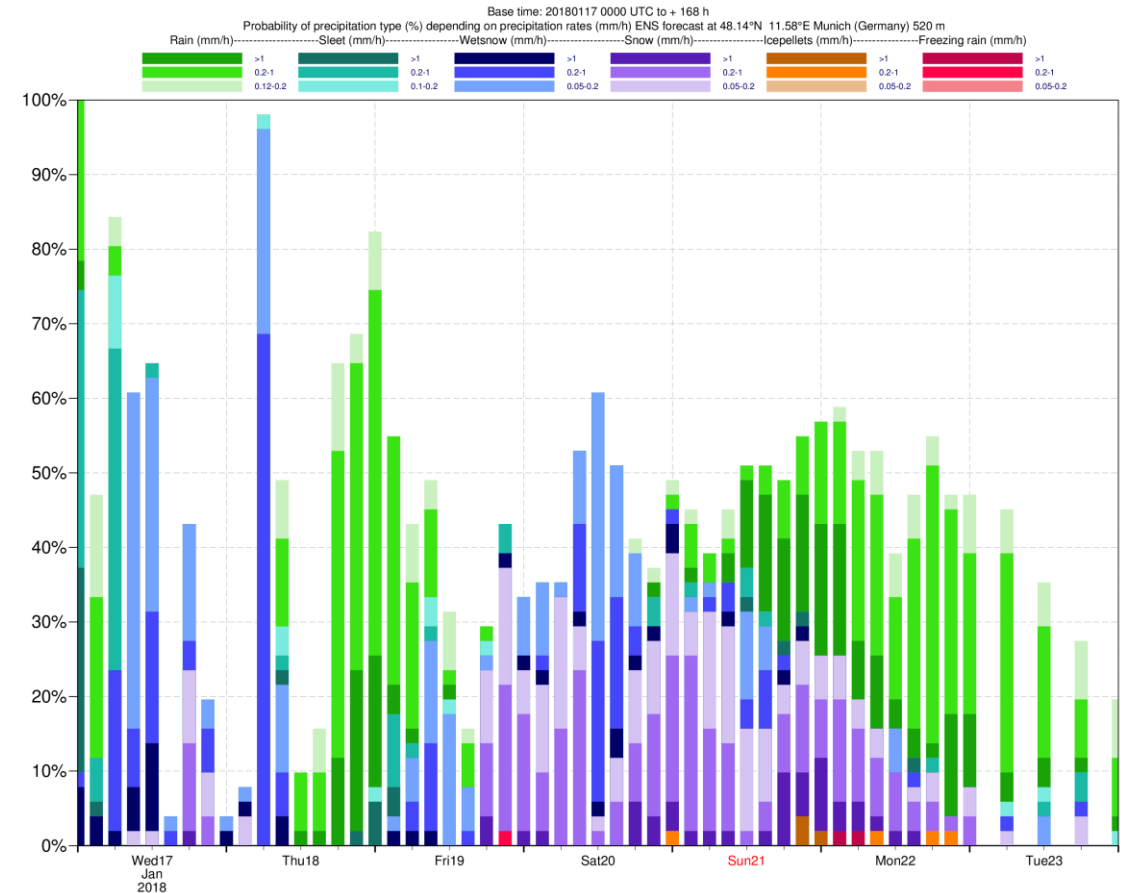
Base Time:
17 Jan 2018 00 UTC

Probabilistic precipitation type products.

Base Time: 17 Jan 2018 00 UTC

Freezing rain and snow map products. Valid time 22 Jan 2018 09 UTC

Total snowfall over 6h (mm)

Freezing rain over the last 12 h (m)

Probability of freezing rain > 0.05 mm over the last 12 h (m)

Base Time:
 19 Jan 2018 00 UTC

Probabilistic precipitation type products.

0600 UTC
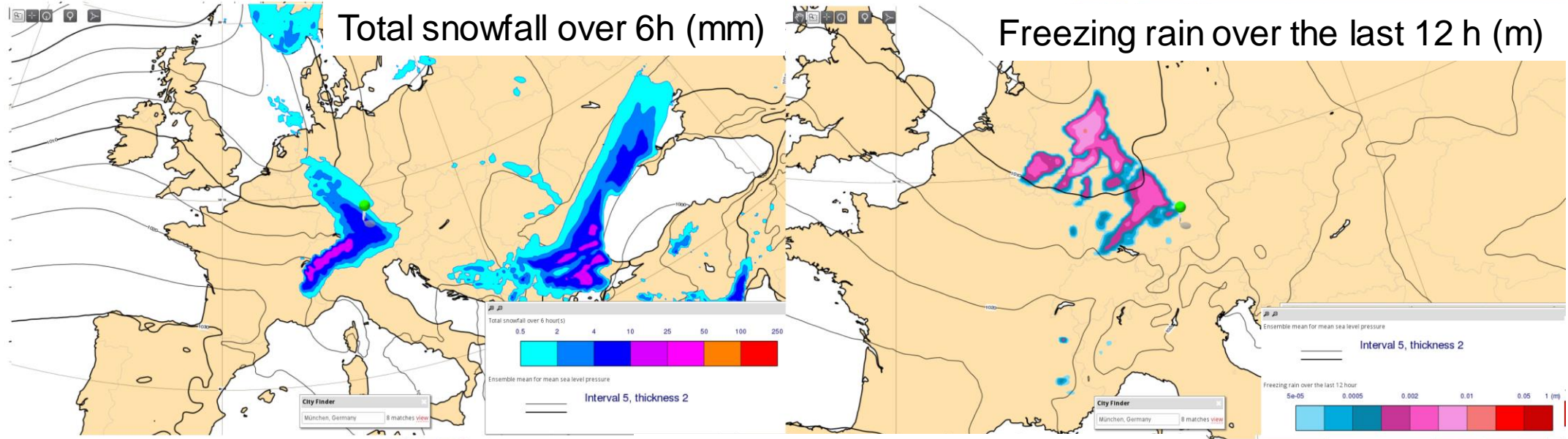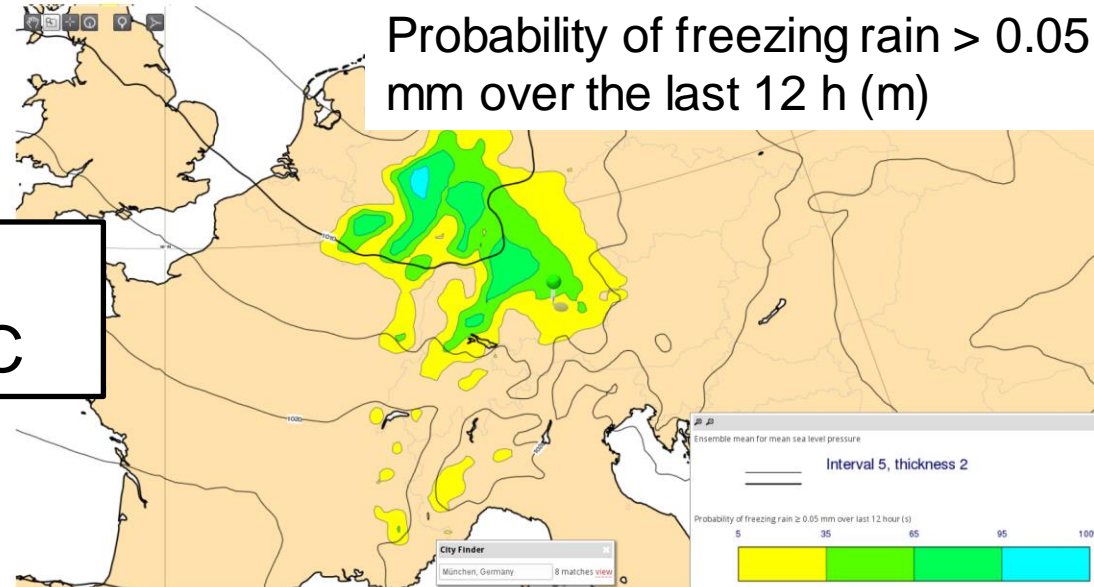
0900 UTC

Munich

Base Time: 19 Jan 2018 00 UTC

Freezing rain and snow map products. Valid time 22 Jan 2018 09 UTC

Total snowfall over 6h (mm)
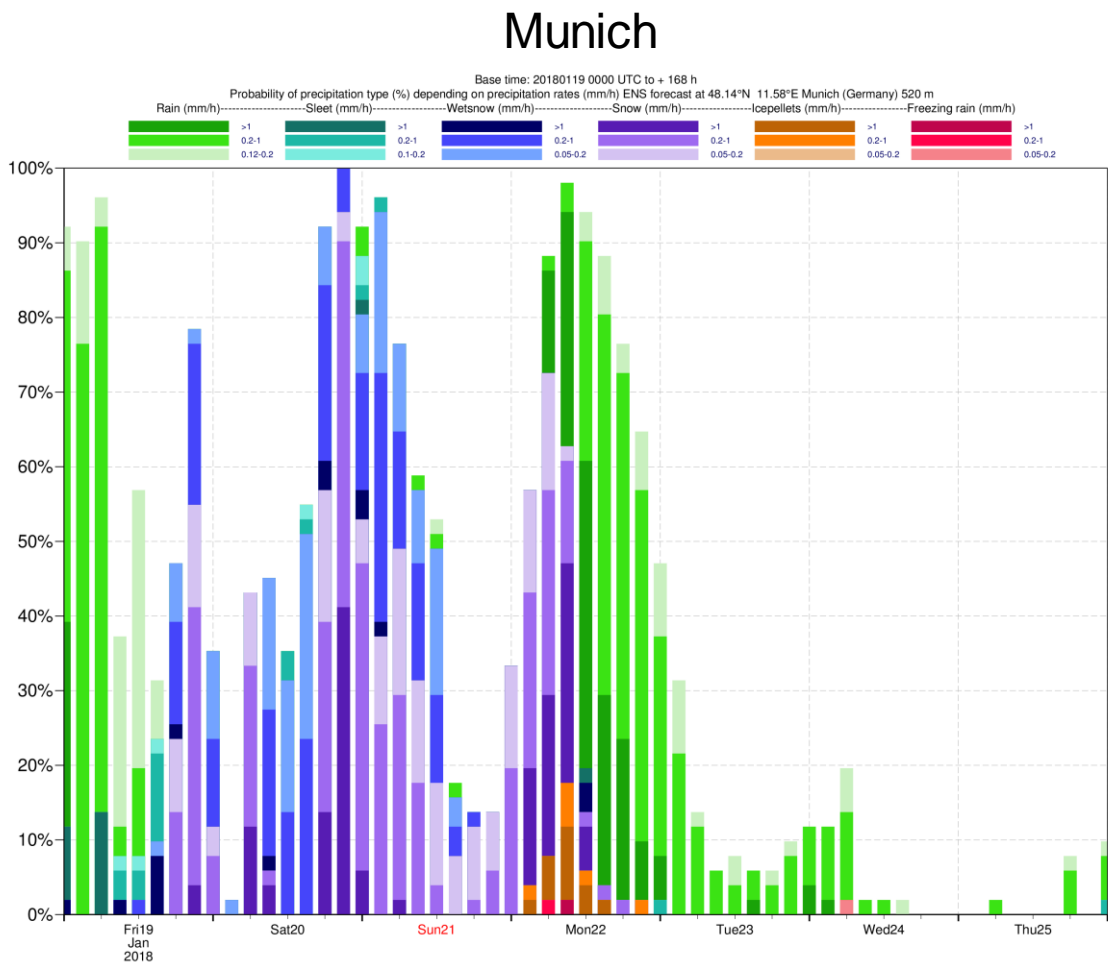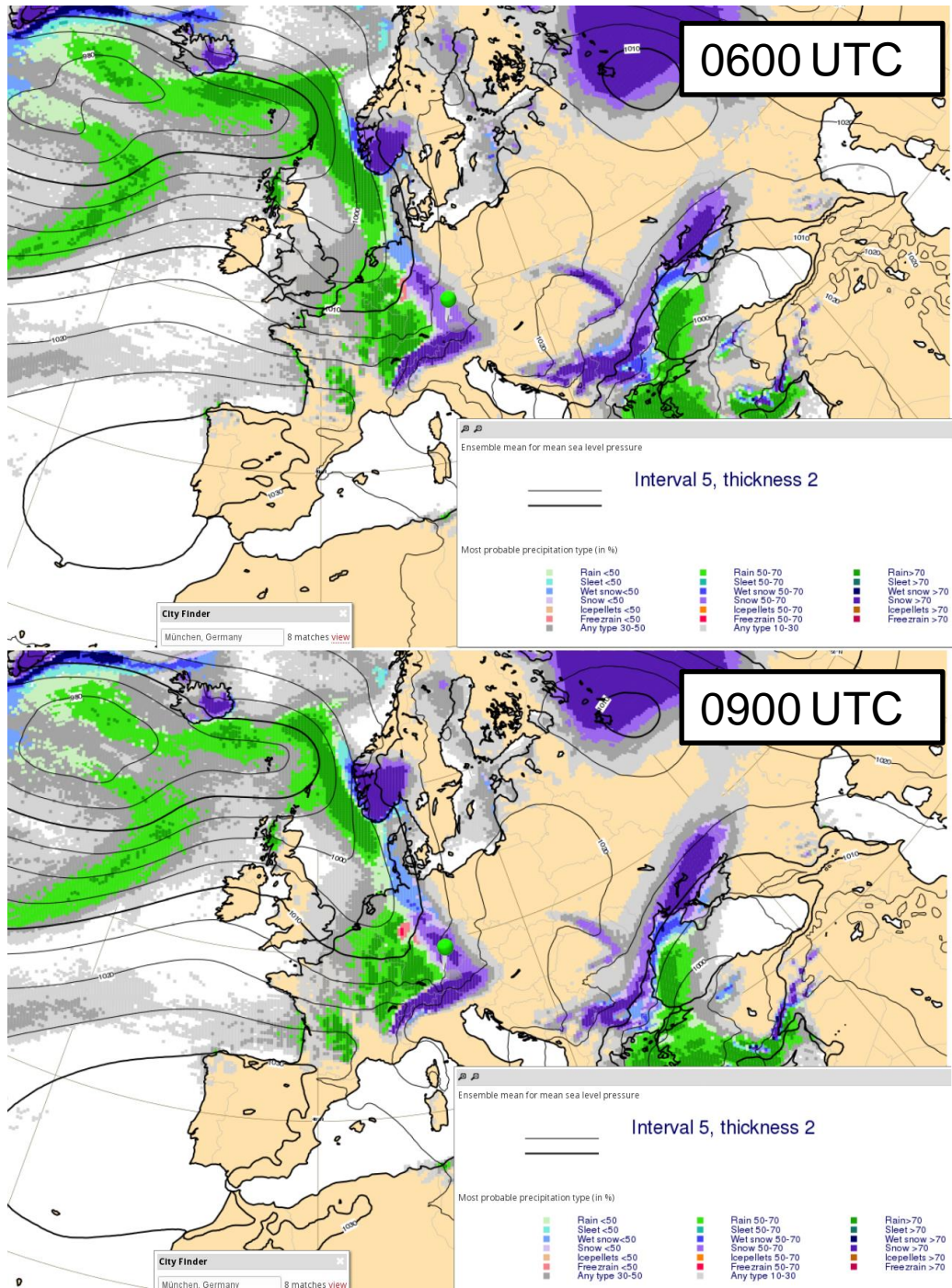
Freezing rain over the last 12 h (m)
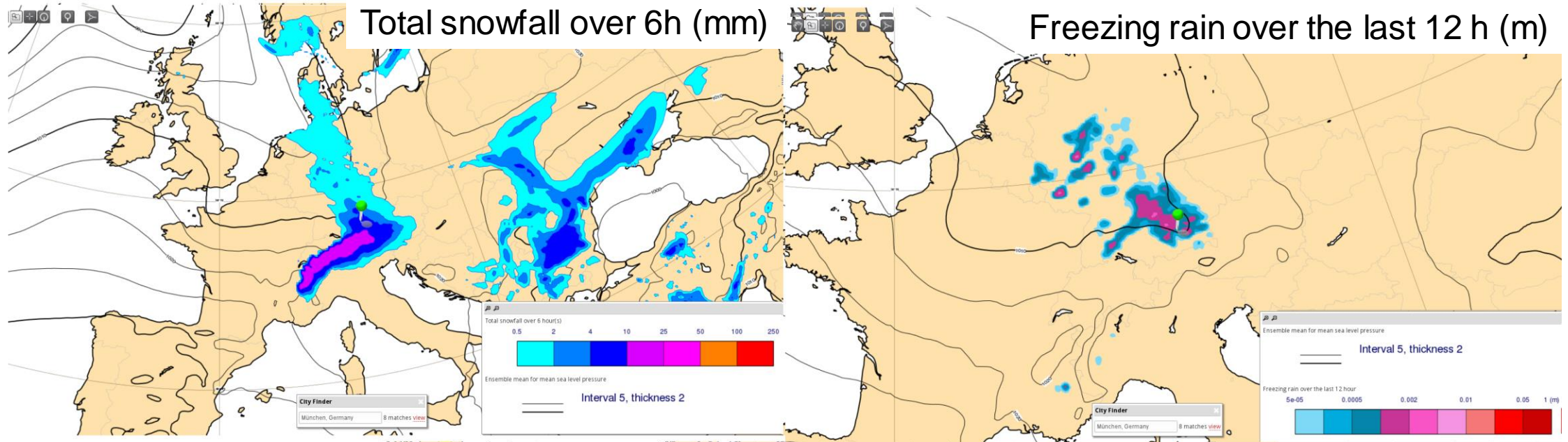
Probability of freezing rain > 0.05 mm over the last 12 h (m)

Base Time:
21 Jan 2018 00 UTC
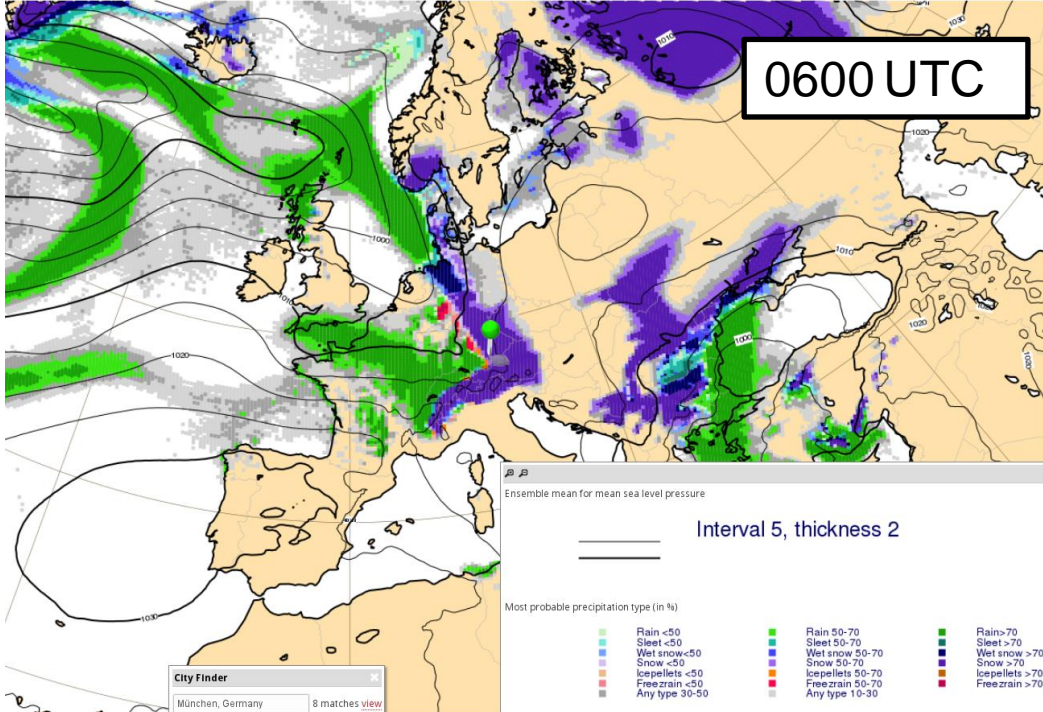
Probabilistic precipitation type products.

0600 UTC
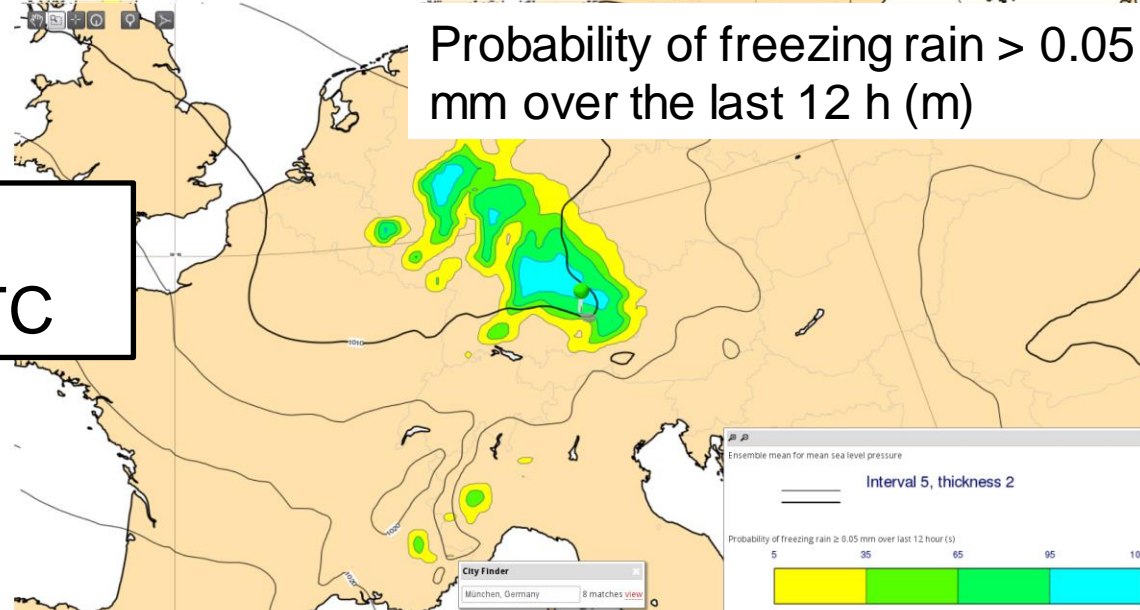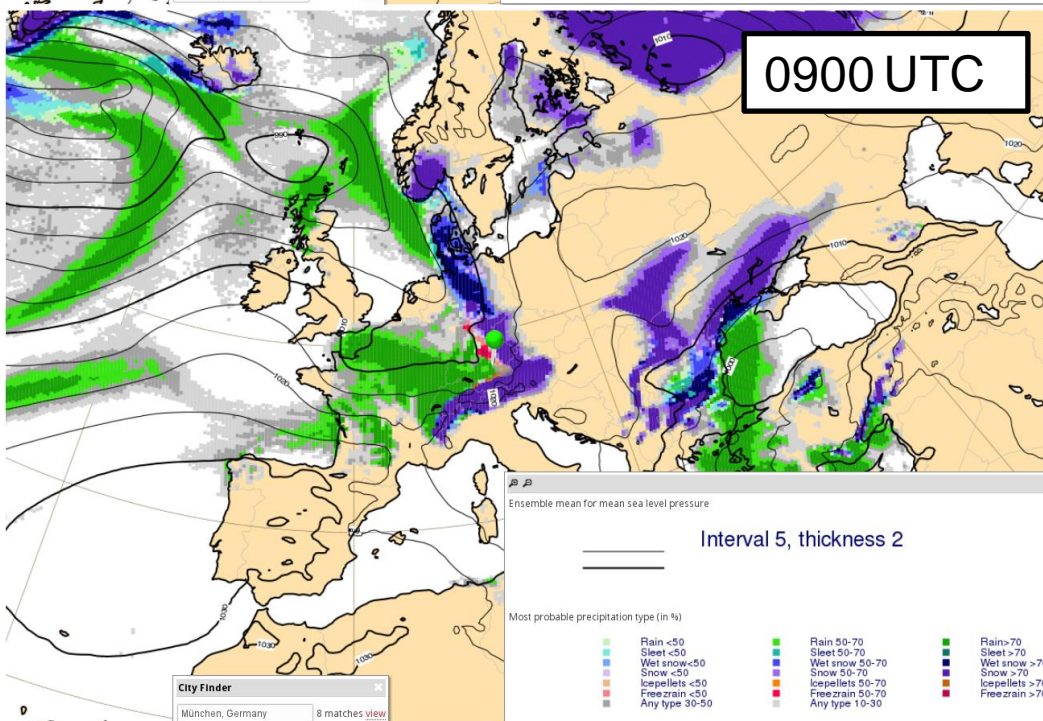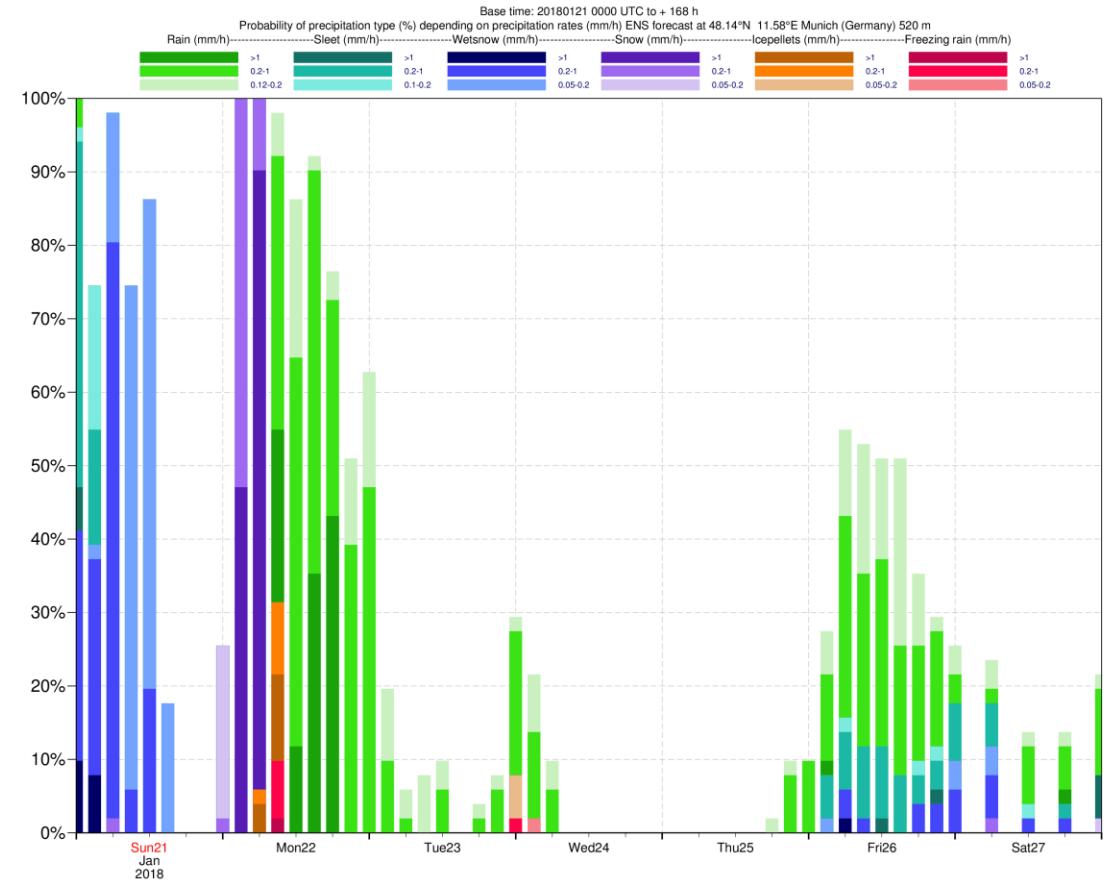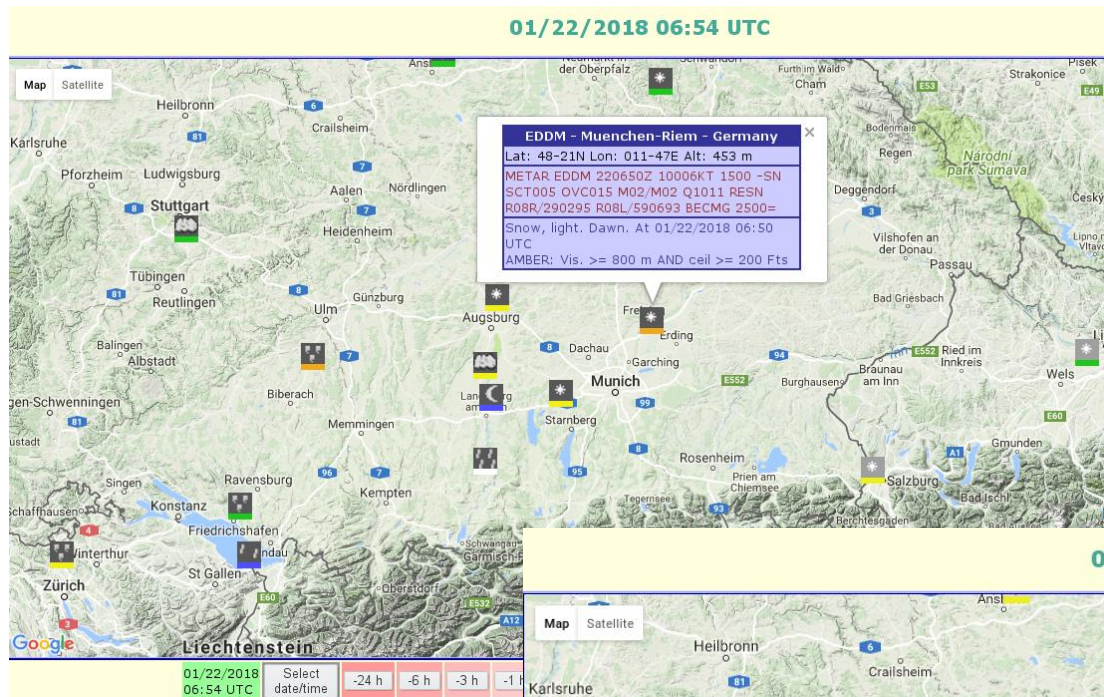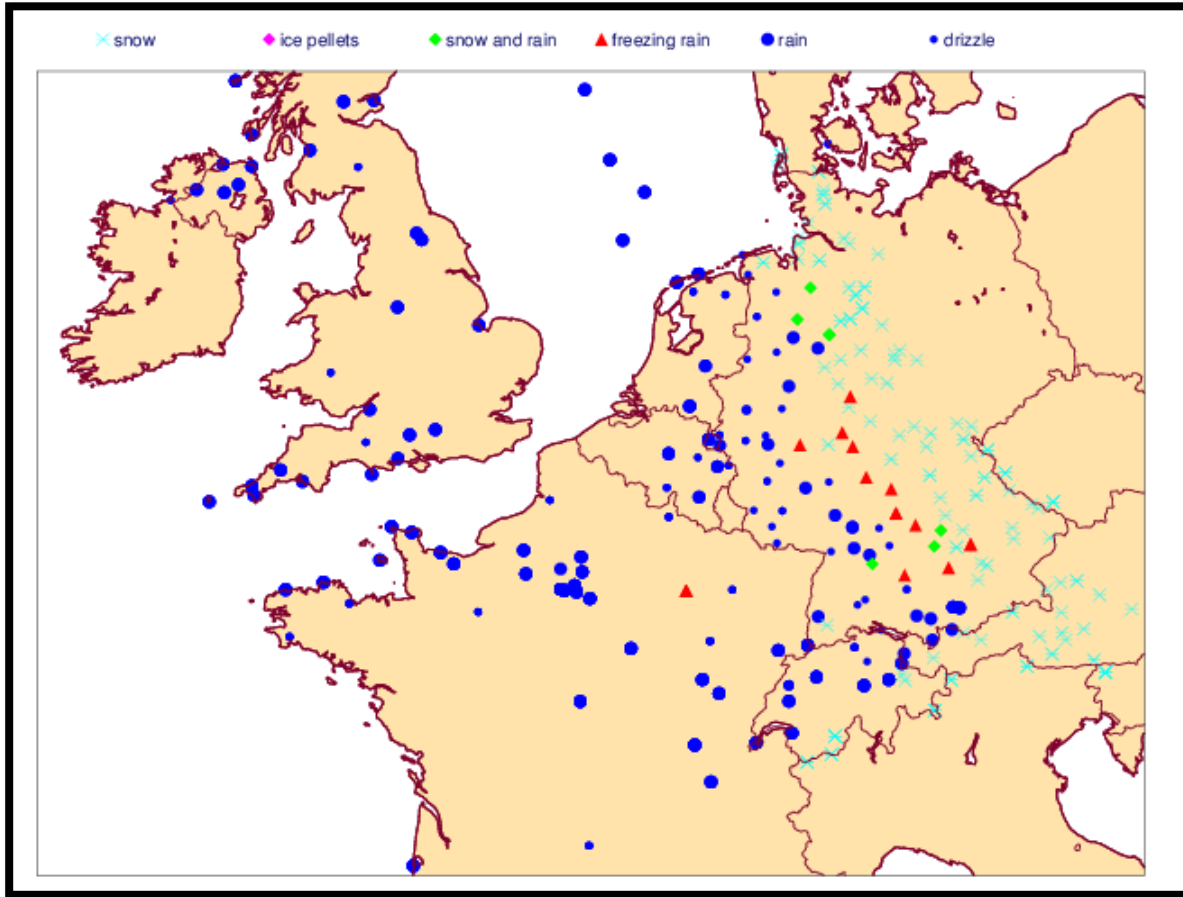
0900 UTC

Munich

Base Time: 21 Jan 2018 00 UTC

Observations
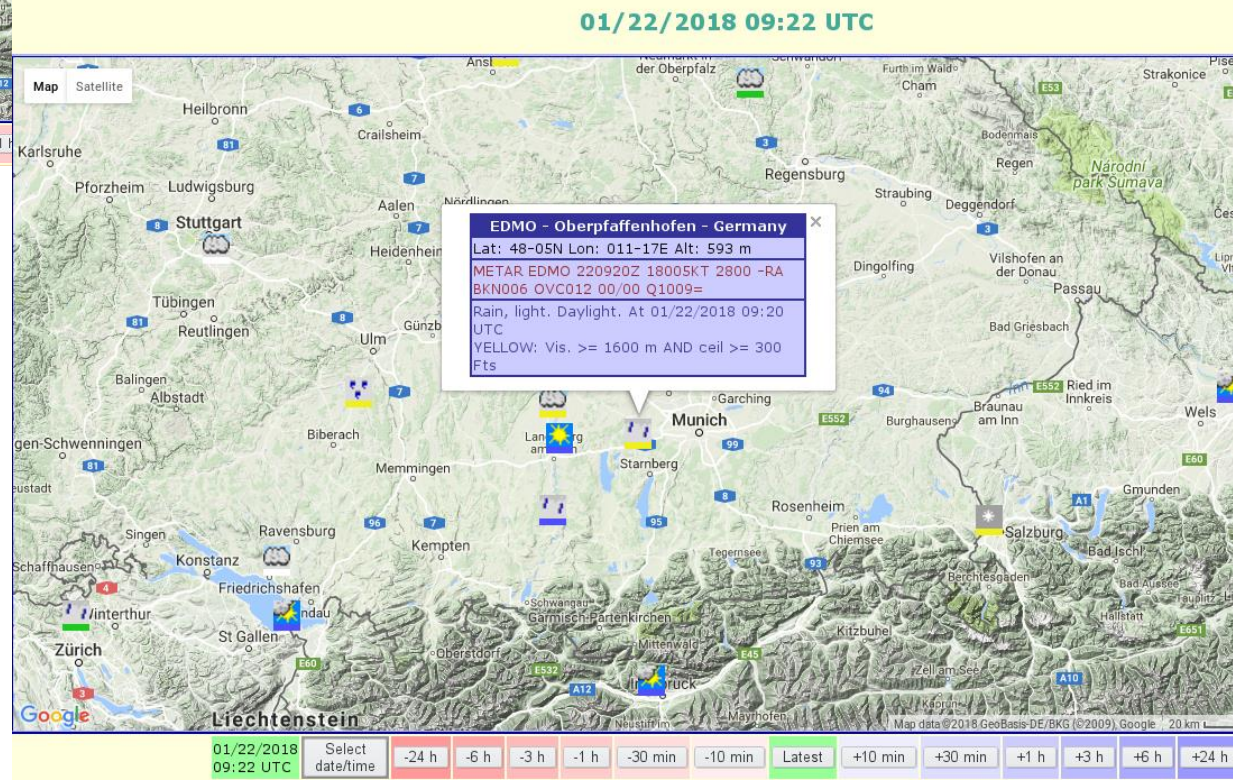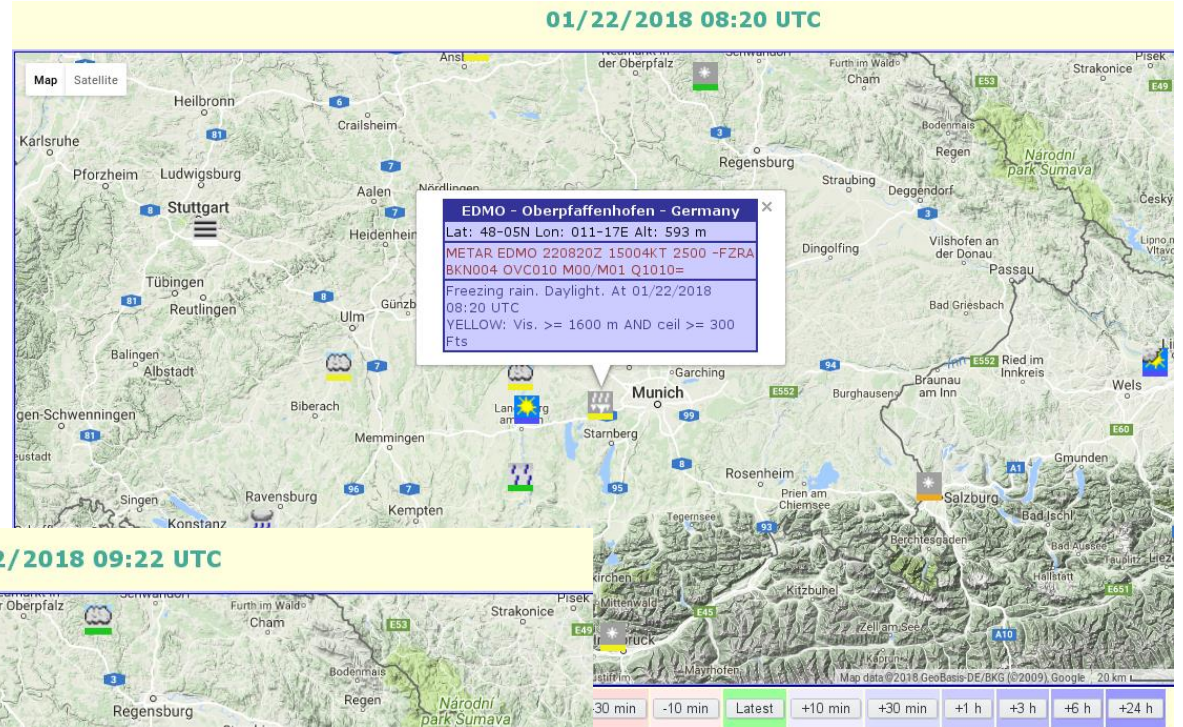
Observations

0600 UTC

0900 UTC
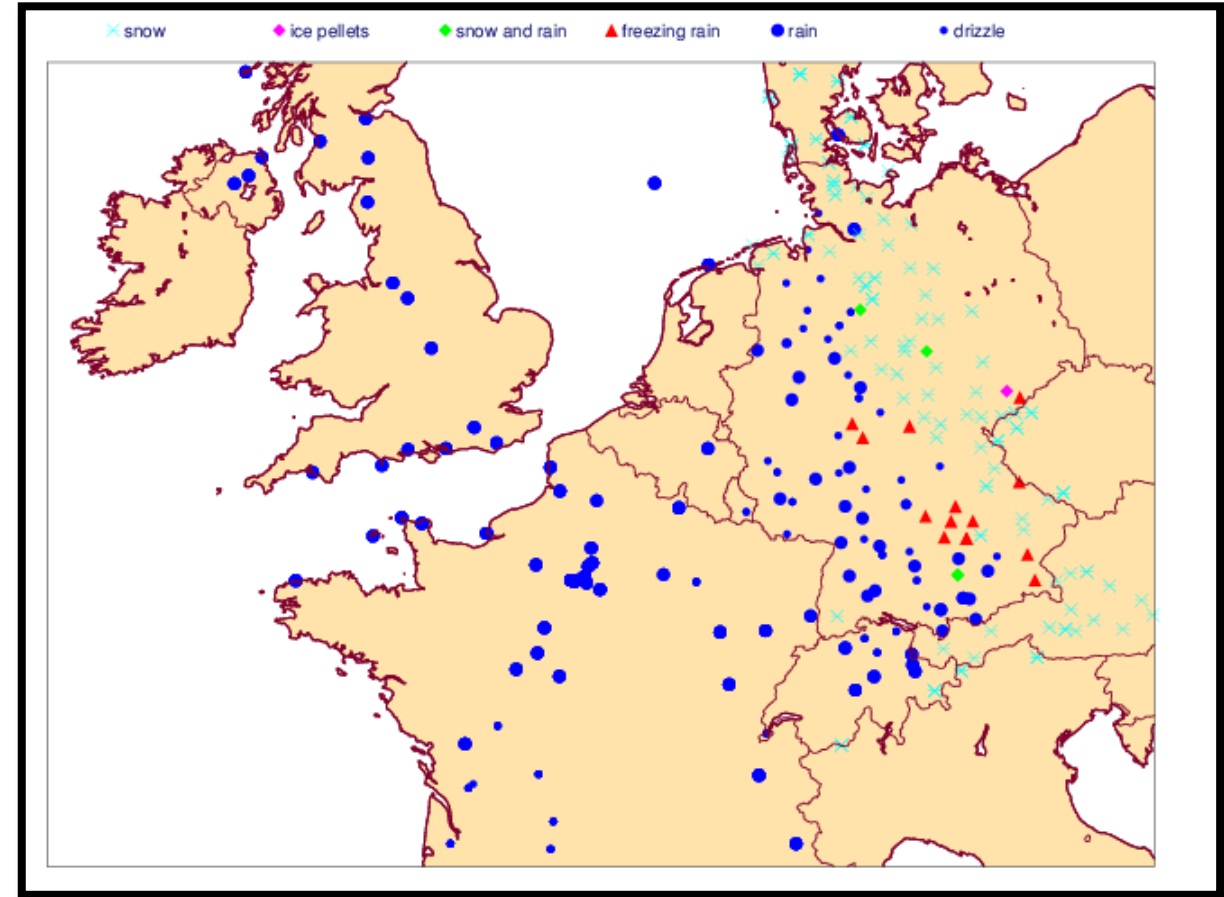
FINAL TIPS to use the products

• Take into account the **height of the ENS in your meteogram location** (in the title of precipitation type meteogram), because the observation height can be very different, specially in mountainous areas.

• In the **meteogram, the bars are stacked** in such a way that the nominally **most hazardous** type (freezing rain in the high intensity category) is shown at **the bottom**, and the least hazardous (low intensity rain) at the top.

• Whenever the **lightest shade**, of a given colour (except grey) appears on **the map**, the user immediately knows that more than one precipitation type has been predicted at that time, which can serve as **an initial alarm bell for "uncertainty"**

ECMWF

CONCLUSIONS

- **Two new ECMWF** products have been performed, the probability of precipitation type and the most probable precipitation type. The second provides a first guess of the precipitation type while the first one analyse all the probabilities in a specific location and help to make better decisions about a particular event.

- Different **precipitation rates thresholds** have been applied to each precipitation type enforce bias=1.

- Both products are very skilful in forecasting **rain** and **snow** but it is only moderately skilful for **freezing rain** and **sleet** and unskilful for icepellets.

- The advantage of use **ENS forecast** is that it consistently produces a better spread of its (FAR, POD) pairs. This provides information for a wider range of FAR scores and thus may be useful for users with different levels of false alarm tolerance.

ECMWF

ECMWF

Thanks!

Any question?

estibaliz.gascon@ecmwf.int

For further reading:

- Gascón, E., T. Hewson, and T. Haiden, 2018: Improving Predictions of Precipitation Type at the Surface: Description and Verification of Two New Products from the ECMWF Ensemble. Wea. Forecasting, 33, 89–108

- ECMWF 2017-2018 winter Newsletter article: "New products for precipitation type probabilities"

ECMWF