Precipitation type assessment using polarimentric C-band radar and limited area model

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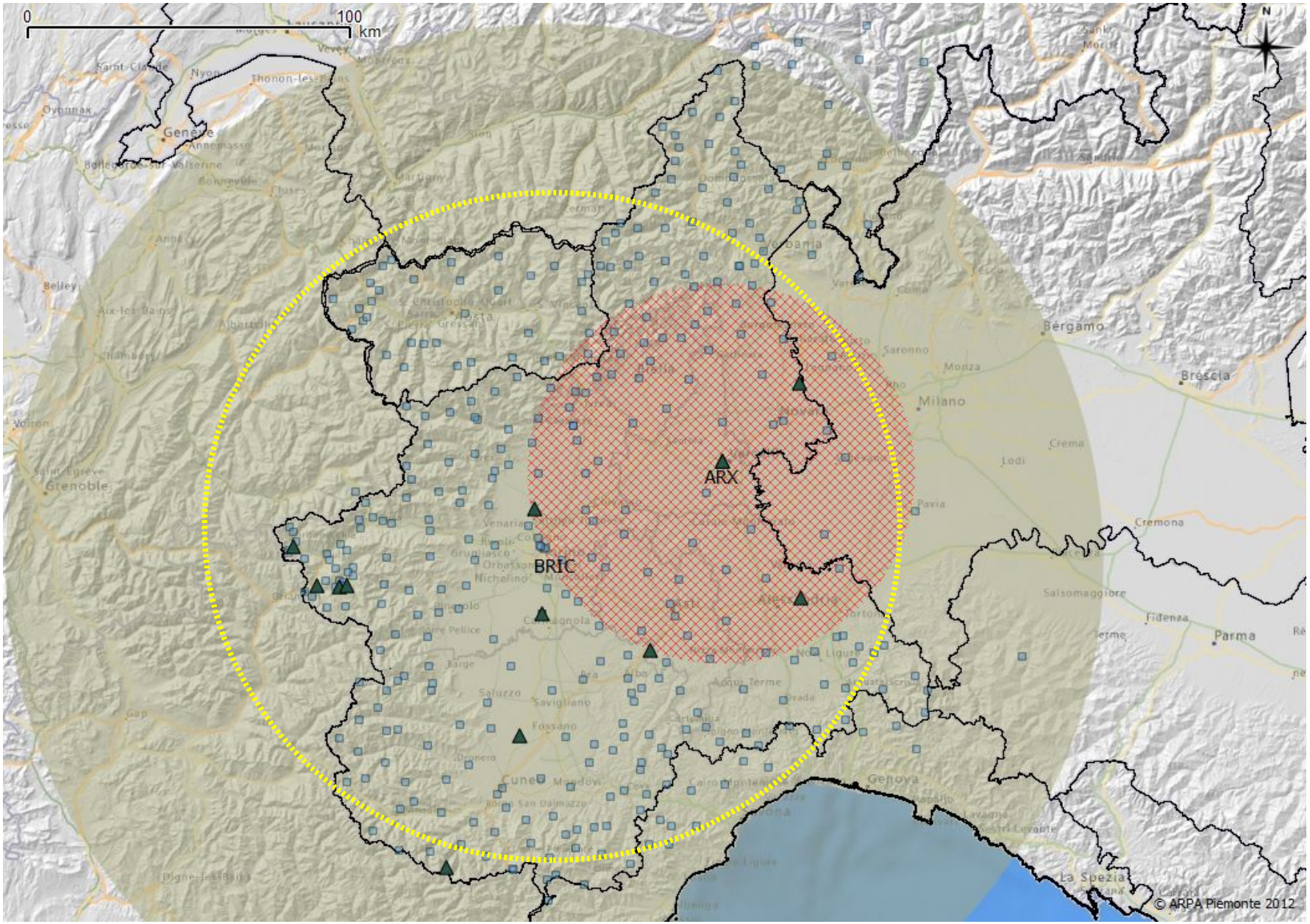
ERAD 2012 Toulouse, June 25th - 29th 2012

Piemonte, Italy test-bed



Algorithm for precipitation type detection

(1) Dry snow (SN)

(2) Wet snow includes wet snow (SW), ice pellets (IP) and freezing rain (FR)

(3) Rain

Simplyfied caterogories are justified by local meteorology of Piemonte and by impacts (FR rare, IP less critical)

Algorithm for precipitation type detection

Developed in 2004

The snowfall, in form of wet snow, extends down for 300 m under freezing level (T_{wb} = 0 °C) for weak precipitations and down for 500 m for heavy ones.

T_{wb} derived by closests to ground first prognostic sigma levels of COSMO-7 LAMI (Cosmo model *Italian version*)

If Z < = 20 dBZ:

wet snow level -> (T_{wb} = 0 °C) – 300m;

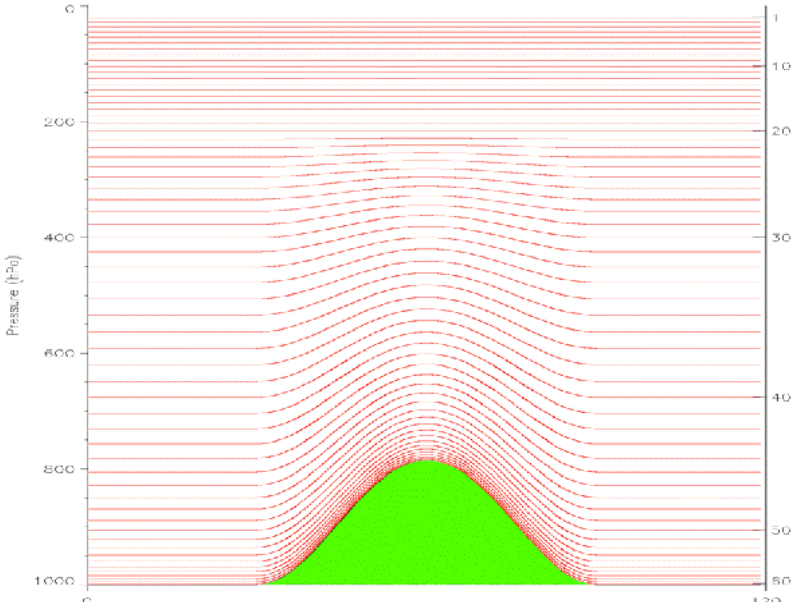
If Z > = 40 dBZ

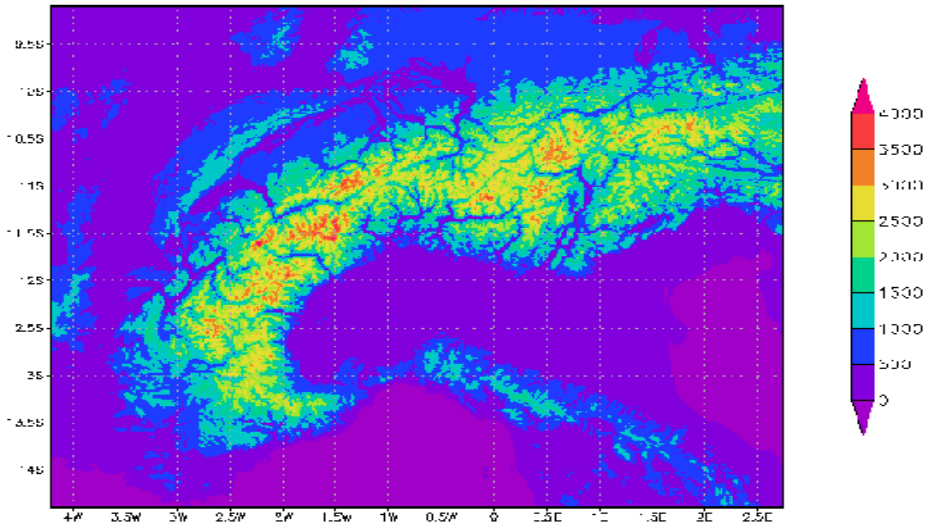
wet snow level -> (T_{wb} = 0 °C) – 500m;

If 20 dBZ < Z < 40 dBZ

wet snow level -> (T_{wb} = 0 °C) – linear function of Z

COSMO-7 model

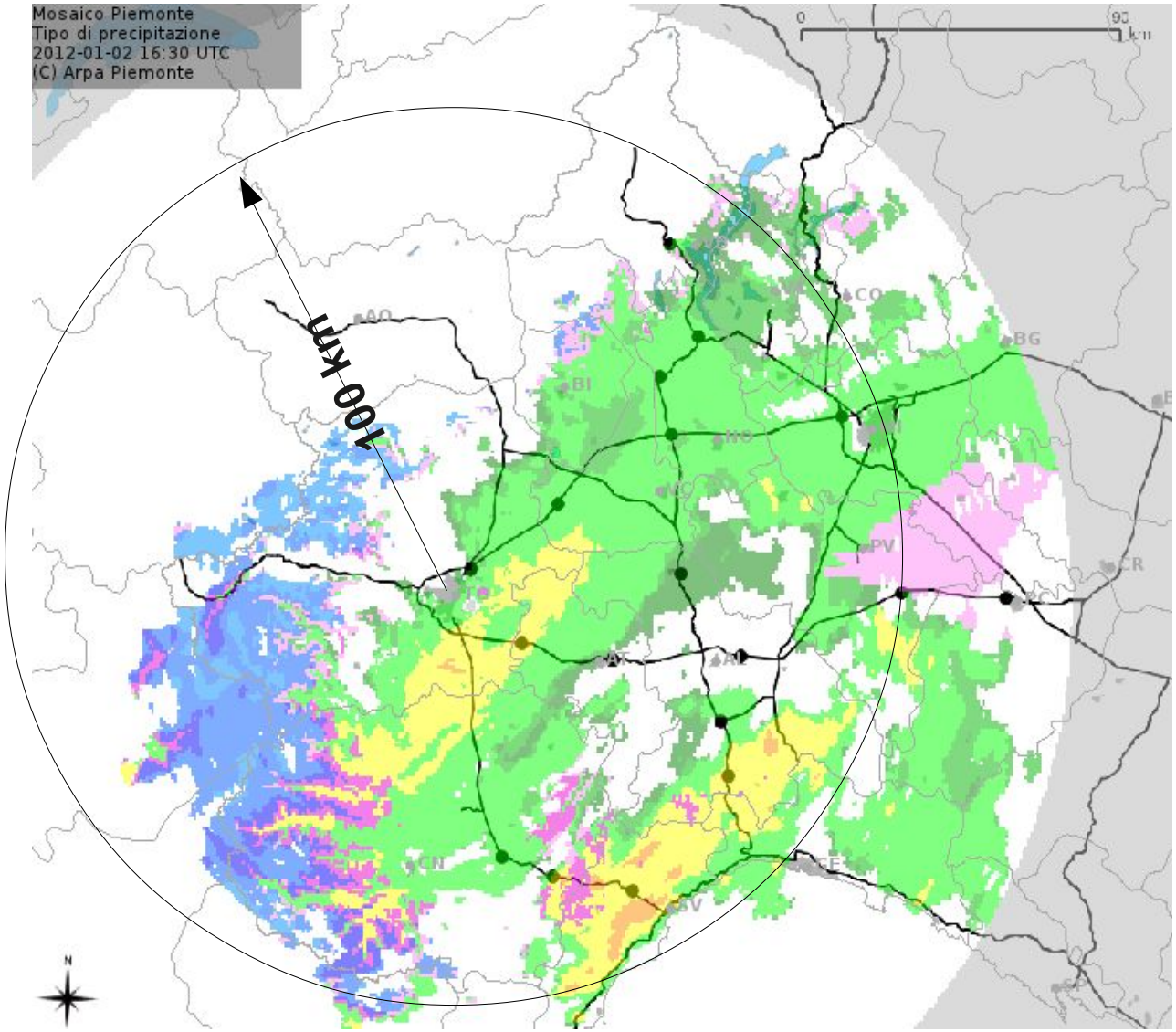




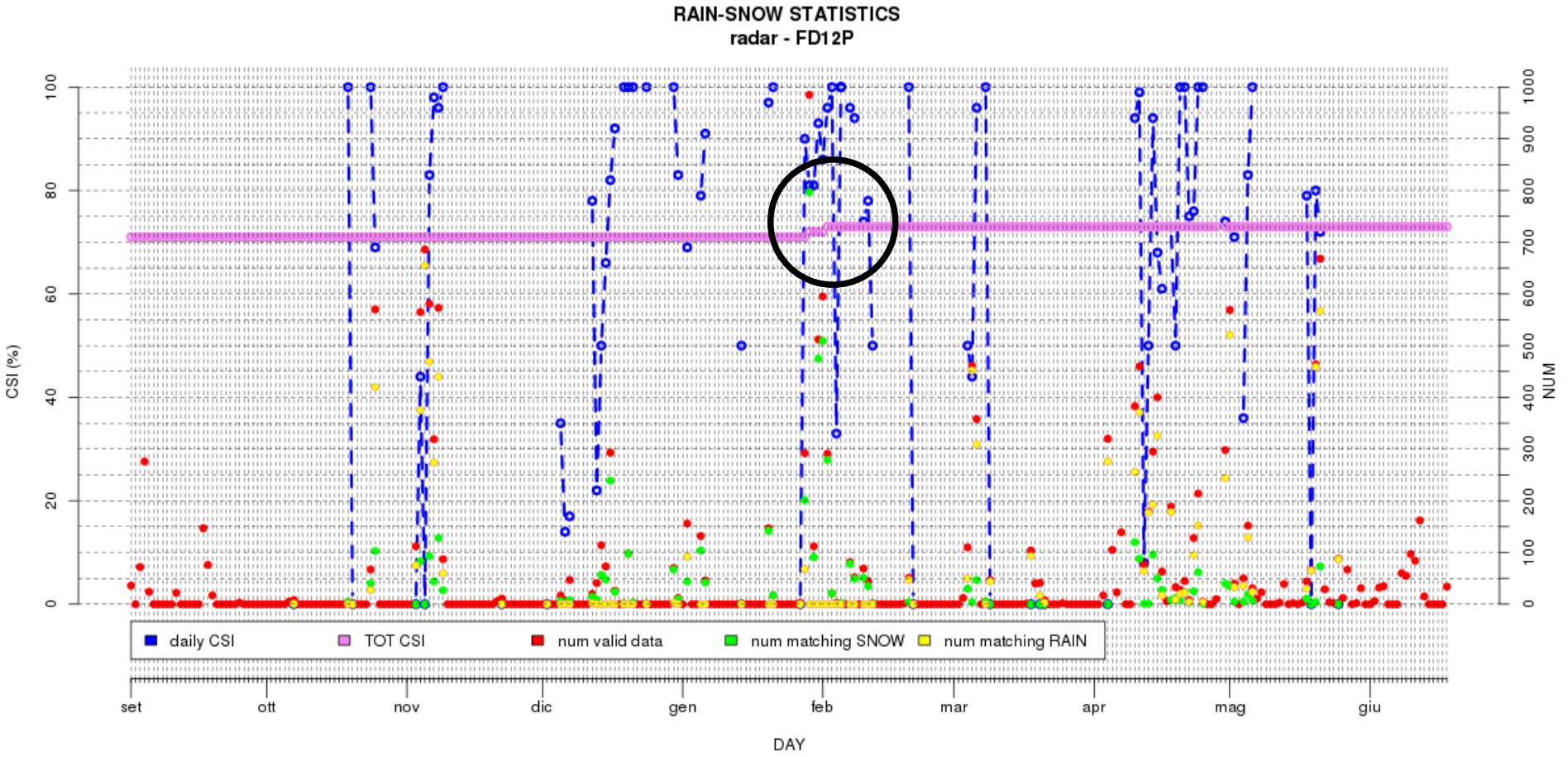
- 6.6 km model resolution
- 41 vertical *sigma*-coordinates
- Daily operational 00, 12 UTC runs
- T_{wb} forecasted up to T_0 +18 hr is used for precipitation type assessement

Operational precipitation type

- Green-yellow colours for rain
- blue and light blue for dry snow
- cyan for wet snow (including IP and FR)

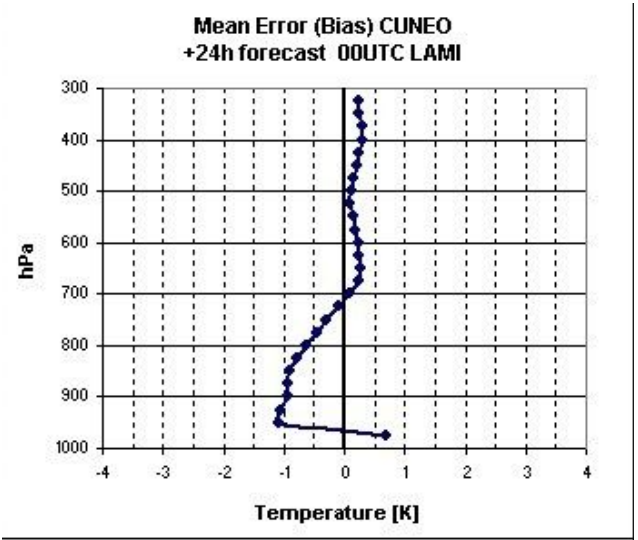


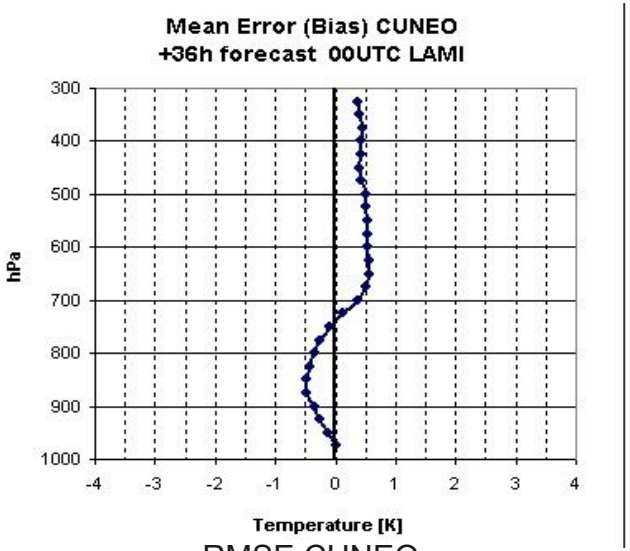
Validation by FD12P sensors from Sept, 1st 2011

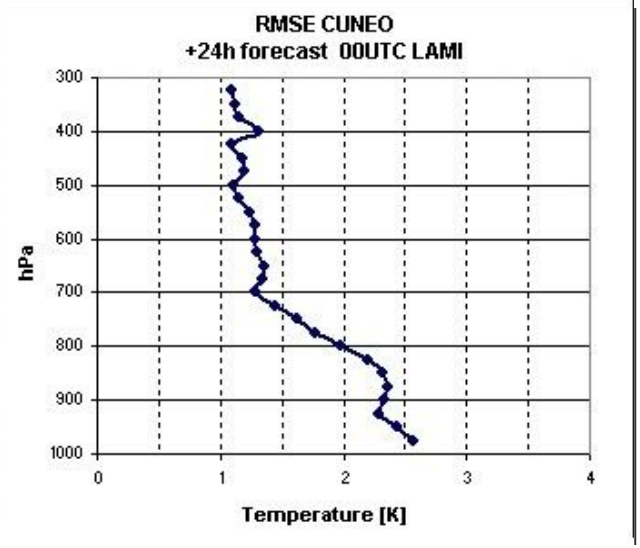


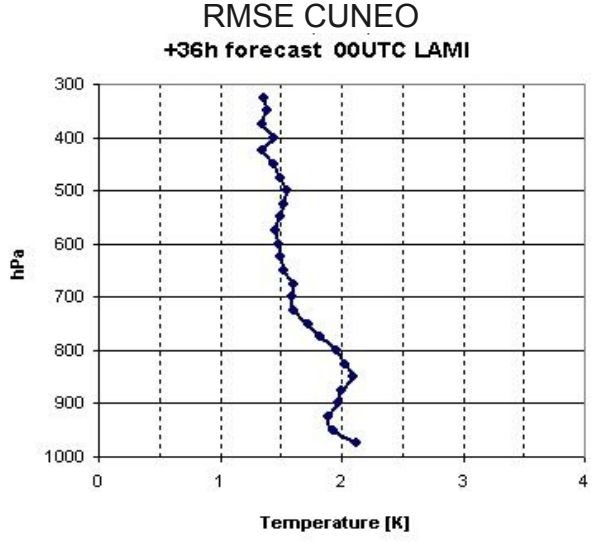
NOTE: only part of verification (running from 2008) is reported!

COSMO-MODEL verification





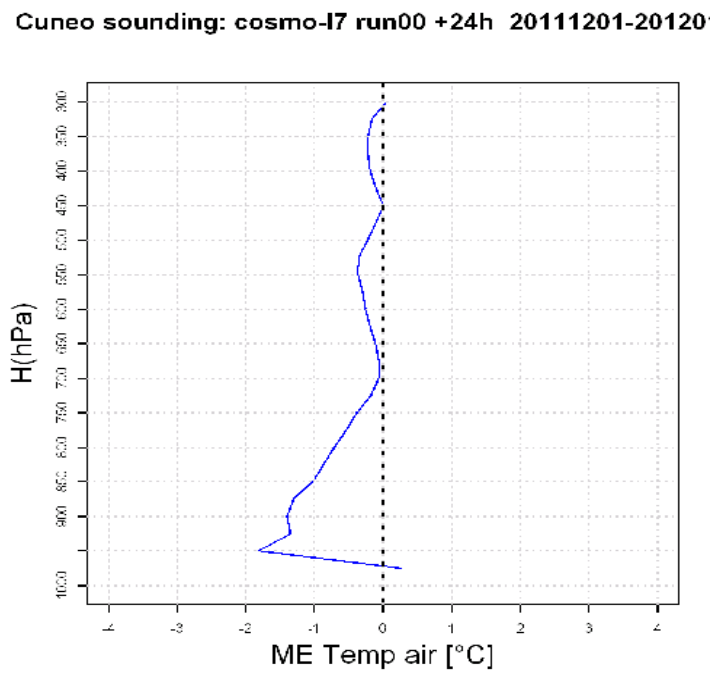


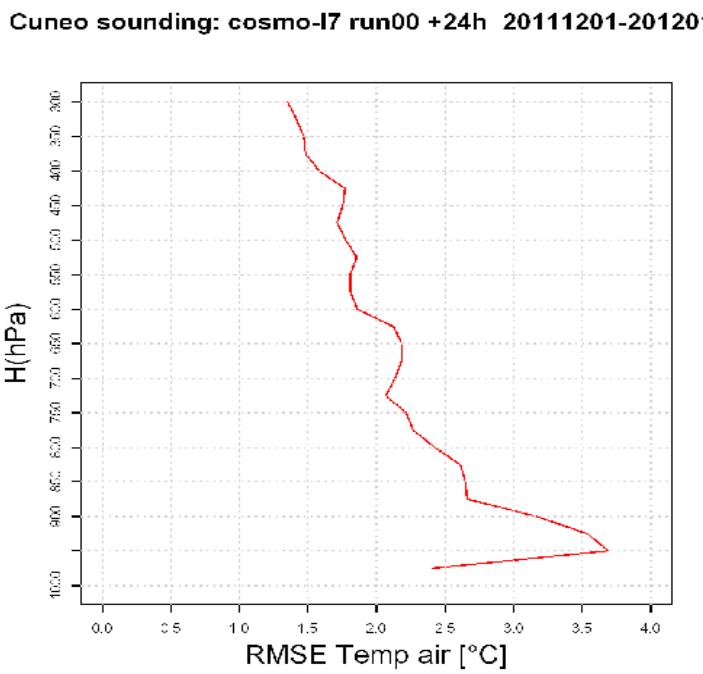


Night **Day**

Thanks to E. Oberto (ARPA Piemonte)

COSMO-MODEL verification





Thanks to E. Oberto (ARPA Piemonte)

Uncertainties in NWP forecast leads to erroneous precipitation type assesment

Polarimetric radar and precipitation type assessment (1/3)

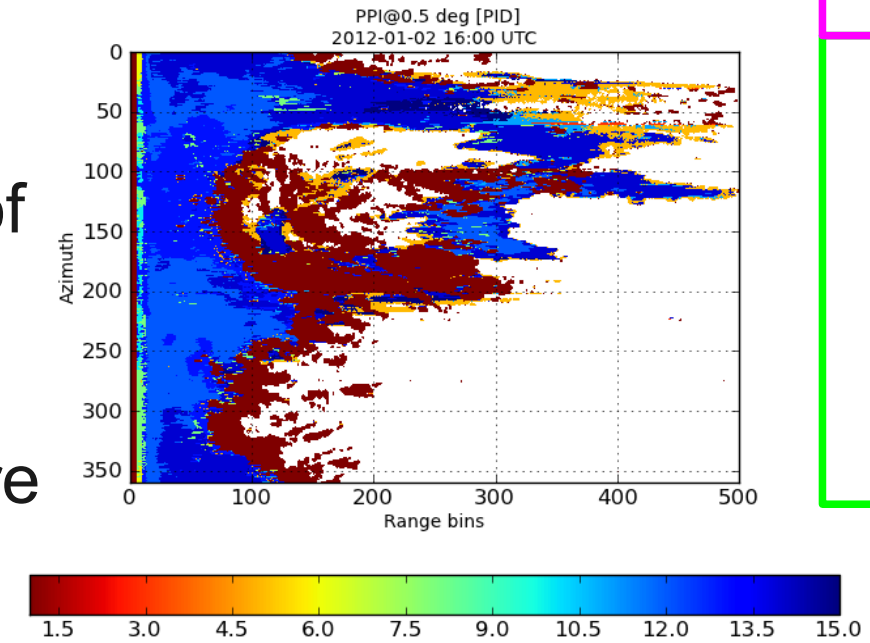
Polarimetric radar observations in good conditions (close to ground without beam-blocking) can be used to assess precipitation type.

Main ingredients:

- Particle identification by fuzzy logic
- Lowest beam product derived by particle id
- Beam height above ground by standard propagation model
- 2-meter temperature derived by network

Polarimetric radar and precipitation type assessment (2/3)

- Fuzzy logic for particle id (Liu et al., 2000)
- Lowest beam product
- Height above ground of beam centre
- Only cells within 1 km altitude from ground are considered
- Particle id classes are mapped on precipitation type ones



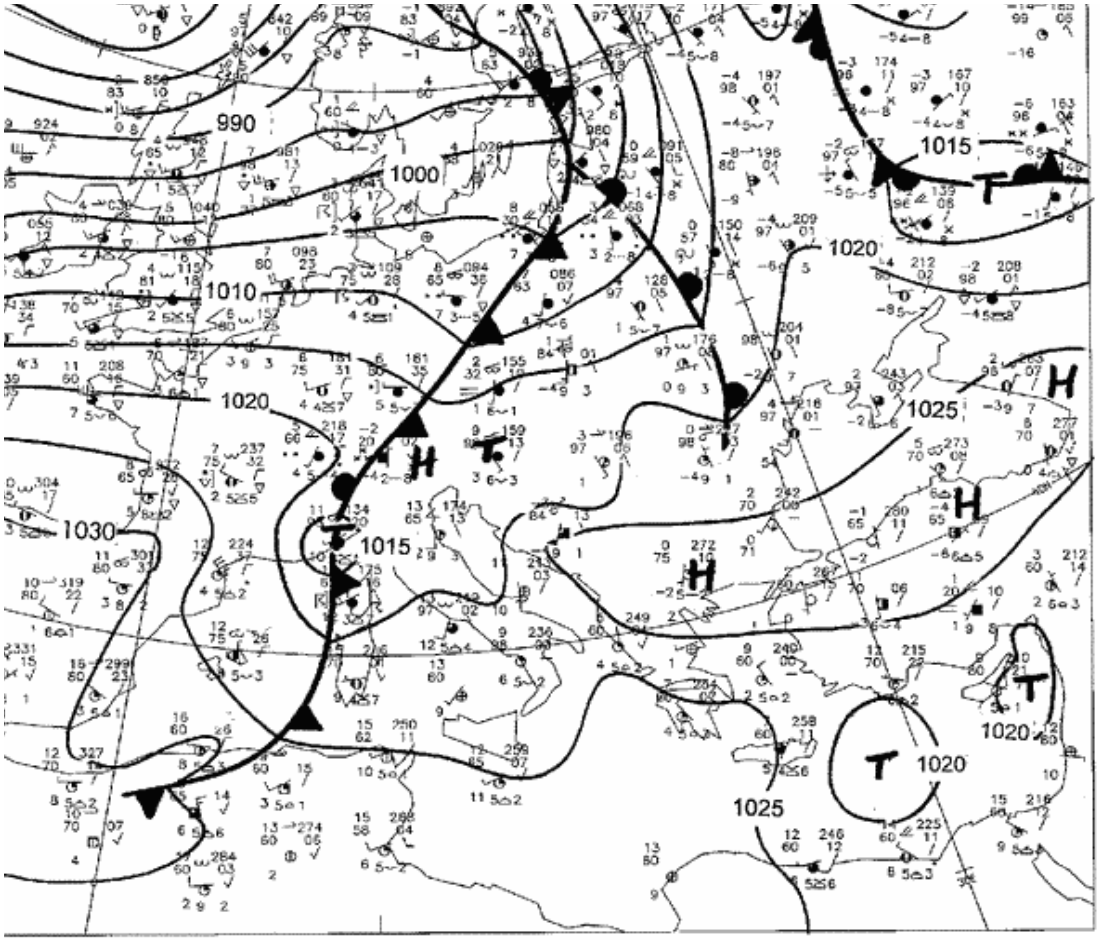
15	CRYSTALS
14	DRY SNOW
13	WET SNOW
12	GRAUPEL
11	HAIL
10	RAIN + HAIL
9	HEAVY RAIN
8	RAIN
7	DRIZZLE
6	LARGE DROPS
5	NOT CLASS
4	ATTEN
3	2ND TRIP
2	CLEAR AIR
1	CLUTTER/AP

Polarimetric radar and precipitation type assessment (3/3)

Radar Obs (H_{gnd} < 1 km)	Ground Temp.	PTYPE
SN	T_{gnd} > 5 °C	RA
SN	0 °C< T_{gnd}< 5° C	WS
SN	T_{gnd} < 0 °C	SN
WS	T_{gnd} > 5 °C	RA
WS	T_{gnd} < 5 °C	WS
RA	-	RA

Case study Jan 2nd, 2012

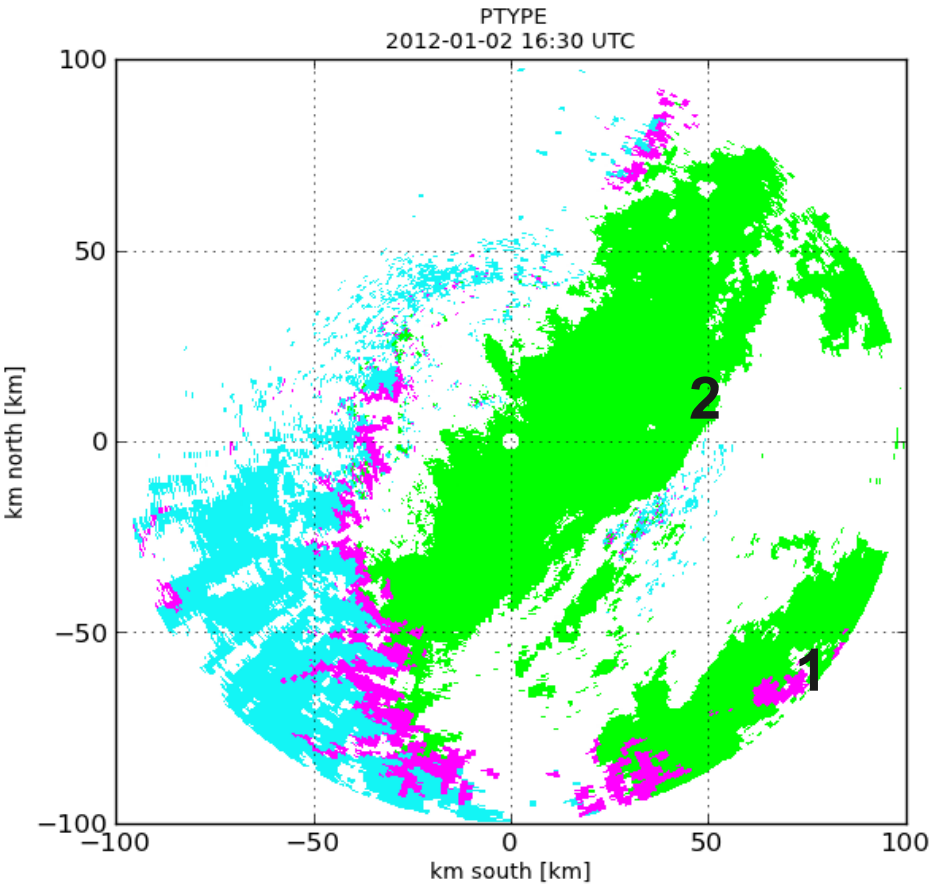
- An Atlantic cold front reaches NW-Italy
- Trapped cold air over Po valley
- Local low pressure developped on Ligurian Gulf



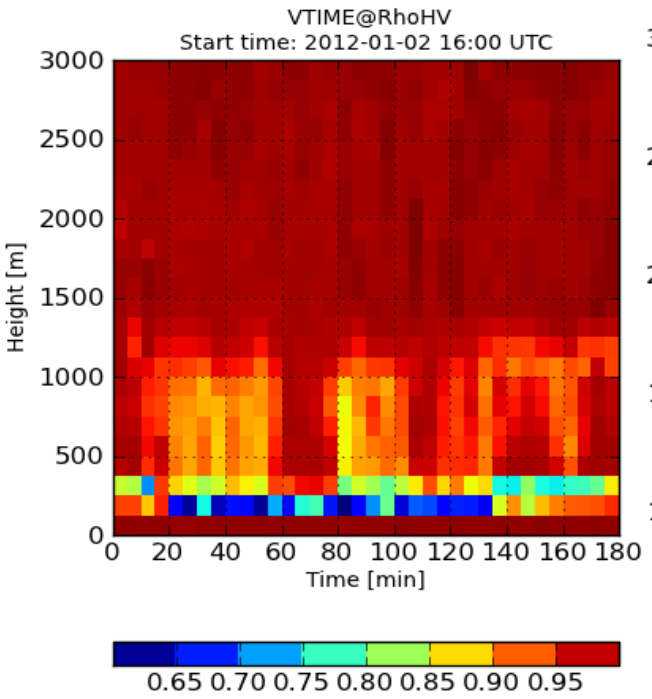
2012.01.02 12 UTC

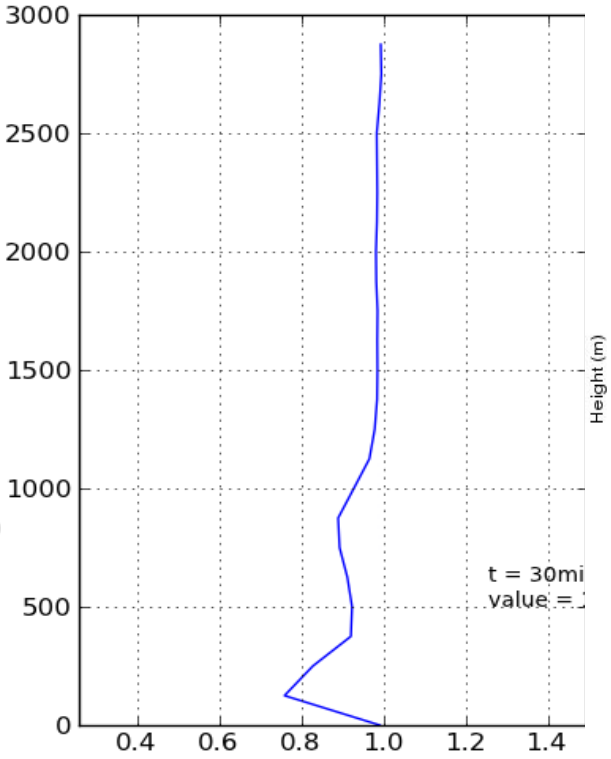
Operational precipitation type

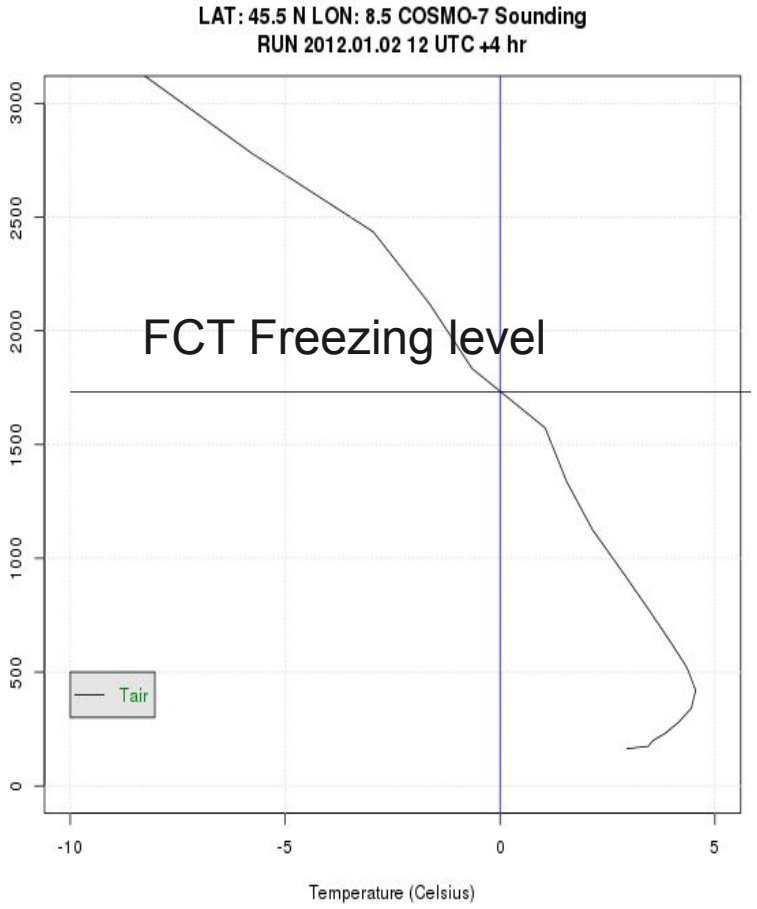
- Light-moderate rain over Piemonte
- Several reports of short-time and localized episodes of ice pellets in Po valley
- IP reports correctly detected close to Appennines (see 1)
- IP reports close to Vercelli (see 2) were missed and classified as rain



X-band observations

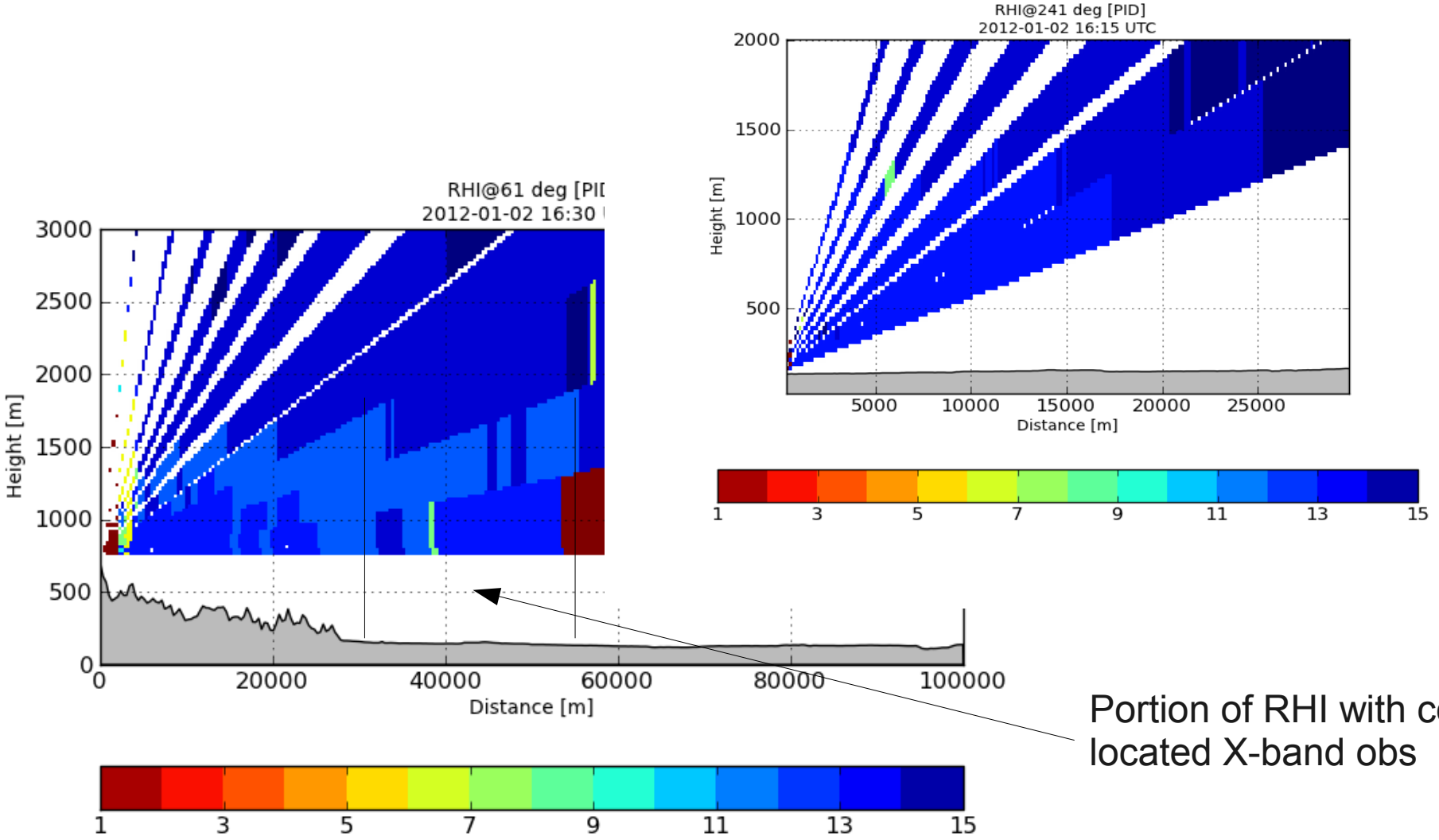




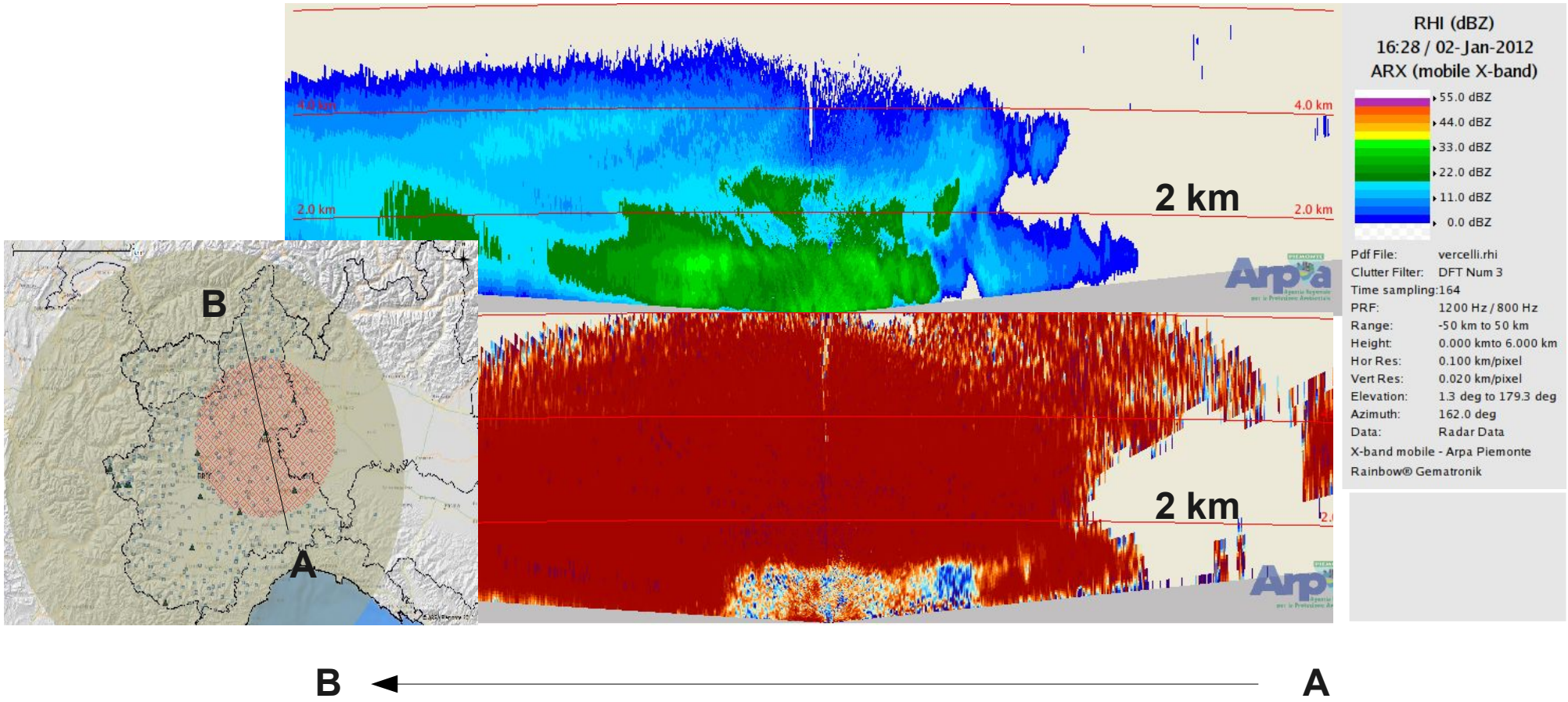


Errors in freezing level forecast and low level temperature profile (warmer than actual).
FL (derived by ARX) = 1,200 m a.s.l.

Bric della Croce pseudo-RHI

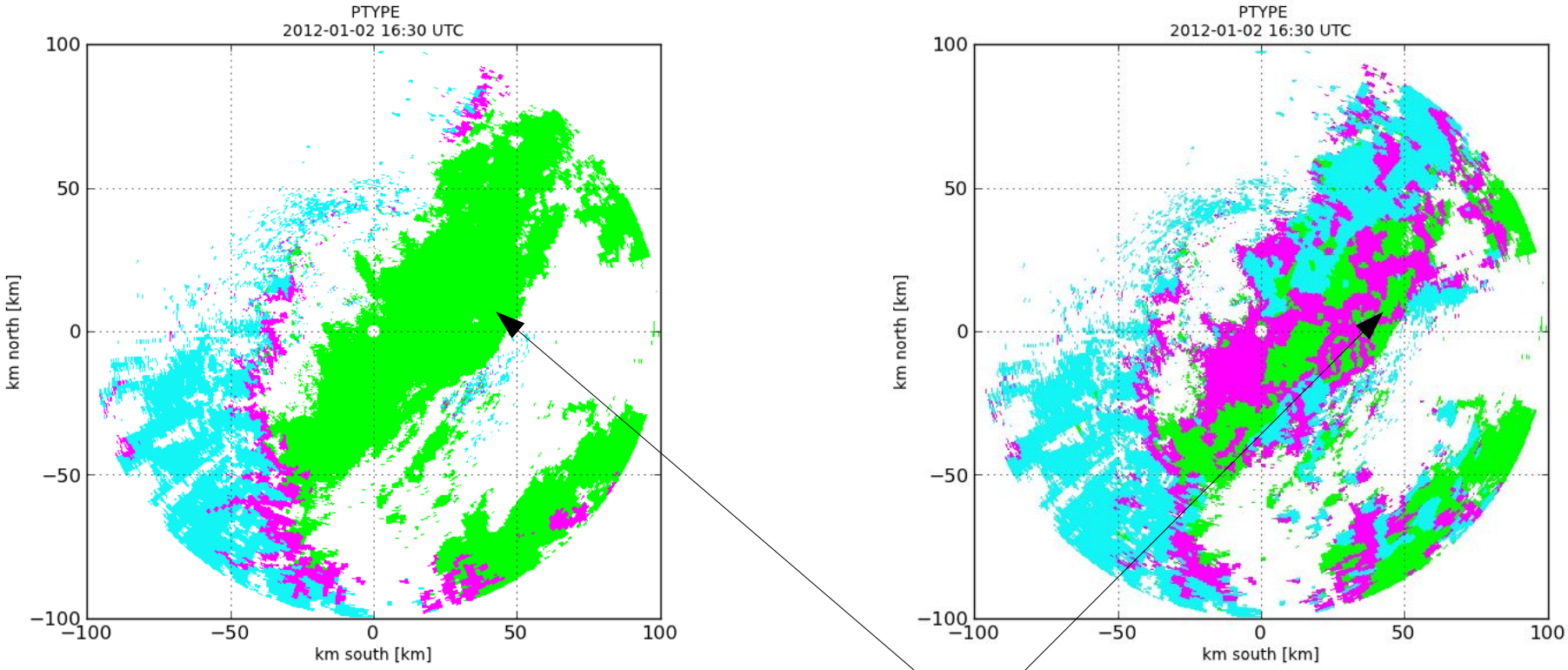


X-band RHI scan



RHI scan reveals mixed particles close to ARX and precipitation microstructure

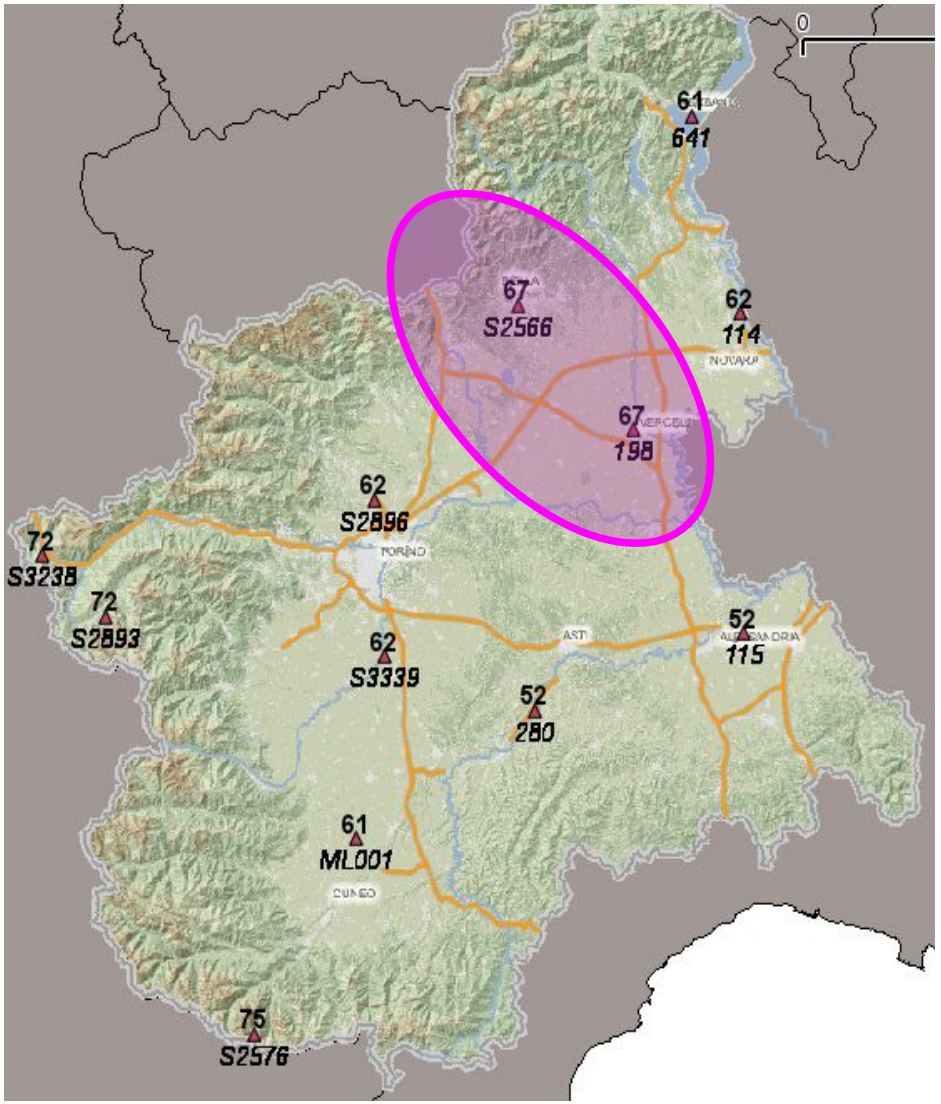
New algorithm results



Left: operational algorithm
Right: precipitation assessment with particle ID

FD12P position

FD12P reports 16:40 UTC



- Drizzle reported over South-East areas
- Rain/Snow light in Vercelli
- Rain in Western areas
- Snow over the Alps

Conclusions

- High variable and local thermodinamic processes on precipitation cannot be properly described by NWP
- First attempt to merge polarimetric data and COSMO-7 derived data
- Polarimetric data in “good” conditions can improve operational products
- Better result when observations are used to “drive” forecast
- Beam broadening impact have to be addressed
- Extensive verification is started
- Extention to hail cases