STATUS OF KENDA-LETKF DA CYCLE AT CNMCA

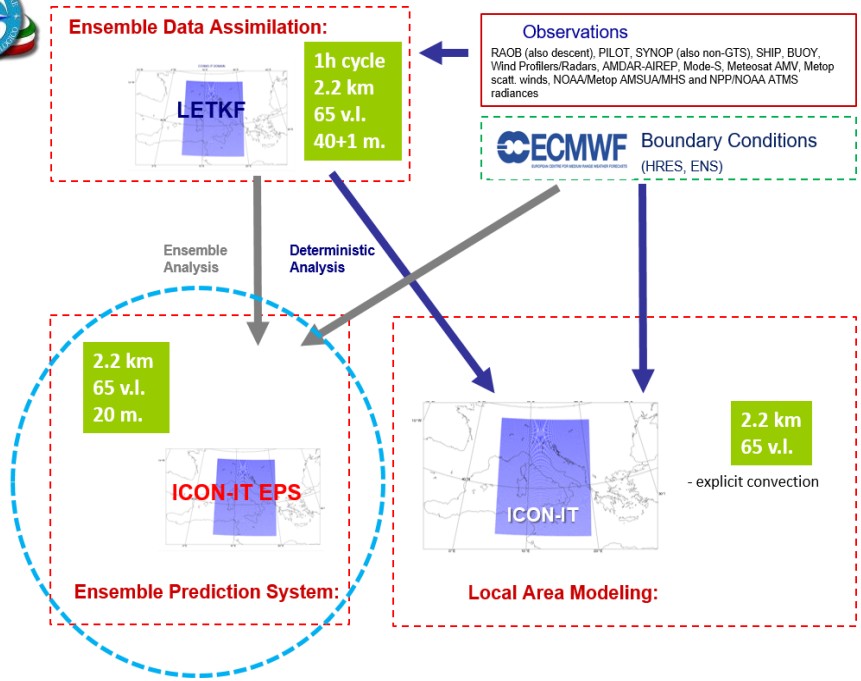
Valerio Cardinali

26° Cosmo GM, 02-05 September 2024, Offenbach

OUTLINE

- Current national operational setup
- Assimilation of RADAR reflectivity in ICON: setup and results
- Assimilation of RADAR radial winds: setup and first results
- Assimilation of non conventional synoptic obs (MeteoMont, MeteoNetwork, Autostrade, DPC)
- Assimilation of GNSS (ZTD only) obs: first setup
- Future developments

Operational ICON-IT @ CNMCA - ITALY



- The ICON model (1h DA cycle + 00/12 UTC model runs) is fully operational at the Italian Met Service since **jul 2020** on ECMWF-HPC and available to forecasters for daily use
- ICON-IT EPS: the implementation process is ongoing (on ECMWF-HPC or on local hpc);
- ICON-MED tests on ECMWF-HPC (2.8 or 5 km resolution).
- KENDA-LETKF provides analyses at a 1-hourly interval

NAMELIST_EMVORADO for ICON (only reflectivity obs)

```
&RADARSIM_PARAMS
  lout_geom=.false.,
  loutradwind=.false.,
  loutdbz=.true.,
  dbz_meta_glob%itype_refl=1,
  dbz_meta_glob%llookup_mie=.true.,
  lvoldata_output=.false.,
  lfdbk_output=.true.,
  lreadmeta_from_netcdf=.true.,
  dom=1,
  icountry=3,
  itype_supobing=1,
  supob_cart_resolution = 10000.0, ! Superobbing at 10 km
  supob_lowthresh_z_obs = 5.0,  ! 5 dBZ threshold on reflectivities
  supob_lowthresh_z_sim = 5.0,

.....

 /END
```

- No simulation and output of radial winds
- Output of NetCDF feedback files enabled
- MIE scattering option activated, assuming spherical particles for all hydrometeors
- Superobbing at 10 km
- 5 dBZ threshold on reflectivities

NAMELIST_KENDA for ICON (only reflectivity obs)

```
&RULES
 comment     = 'specific parameters for RADAR'
 !type        = 1024           ! modtype RADAR
 obstype     = 13
 uv%v_loc    = 0.3
 uv%h_loc    = 16.0
 !o%v_loc    = 0.3
 o%h_loc    = 16.0
 o%sgm_fg(1) = 10 !999
!!  uv%ekf_pass = 1
/

&RULES
   comment     = 'specific parameters for RADAR operator'
   obstype     = 13           ! RADAR
   sat_zenith  = -1. 45.      ! set all elevation angles passive
   o%use       = 7
/

   !Set elevation 1.5 fo reflectivity to active
&RULES
   comment     = 'specific parameters for RADAR operator'
   obstype     = 13           ! RADAR
   sat_zenith  = 1.1 2.1
   o%use       = 11
/
   !Set elevation 3.5 for reflectivity toactive
   &RULES
   comment     = 'specific parameters for RADAR operator'
   obstype     = 13           ! RADAR
   sat_zenith  = 3.1 4.0
   o%use       = 11
   /
   !Set elevations 5.5 for reflectivity to active
&RULES
   comment     = 'specific parameters for RADAR operator'
   obstype     = 13           ! RADAR
   sat_zenith  = 5.0 6.0
   o%use       = 11
/
```

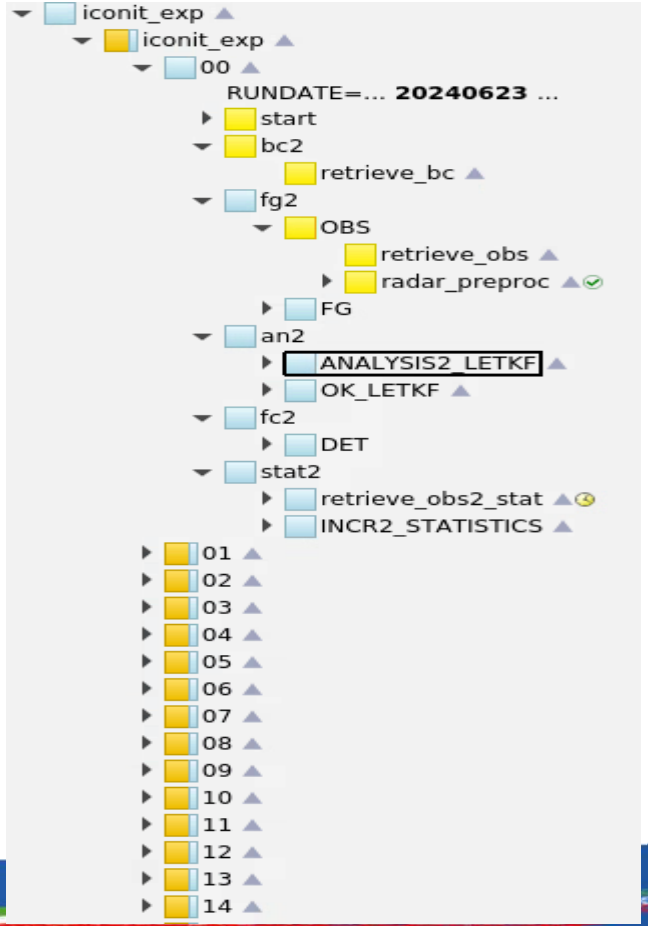
```
   !Set elevation 8.0 for reflectivity to active
&RULES
   comment     = 'specific parameters for RADAR operator'
   obstype     = 13           ! RADAR
   sat_zenith  = 7.0 8.5
   o%use       = 11
/
   !Set elevations for 11 fo reflectivity  to active
&RULES
   comment     = 'specific parameters for RADAR operator'
   obstype     = 13           ! RADAR
   sat_zenith  = 10.6 11.1
   o%use       = 11
/
   !Set reflectivity between 0 and 600 m 'passive'
&RULES
    comment    = 'specific parameters for RADAR operator'
    obstype    = 13           ! RADAR
    zlim       = 0. 600.      ! between 0.0 and 600.0 m
    o%use      = 7
/
   !Set reflectivity above 10000 m to passive
&RULES
   comment     = 'specific parameters for RADAR operator'
   obstype     = 13            ! RADAR
   zlim        = 9000. 99999. ! above 9000 m
   o%use       = 7
/

 &OBSERR obstype='RADAR' quantity='rrefl'  table='extern'  scale=1.0
        err= 10. 10. 10. 10. 10.
             10. 10. 10. 10. 10.
             10. 10. 10. 10. 10.  /
```

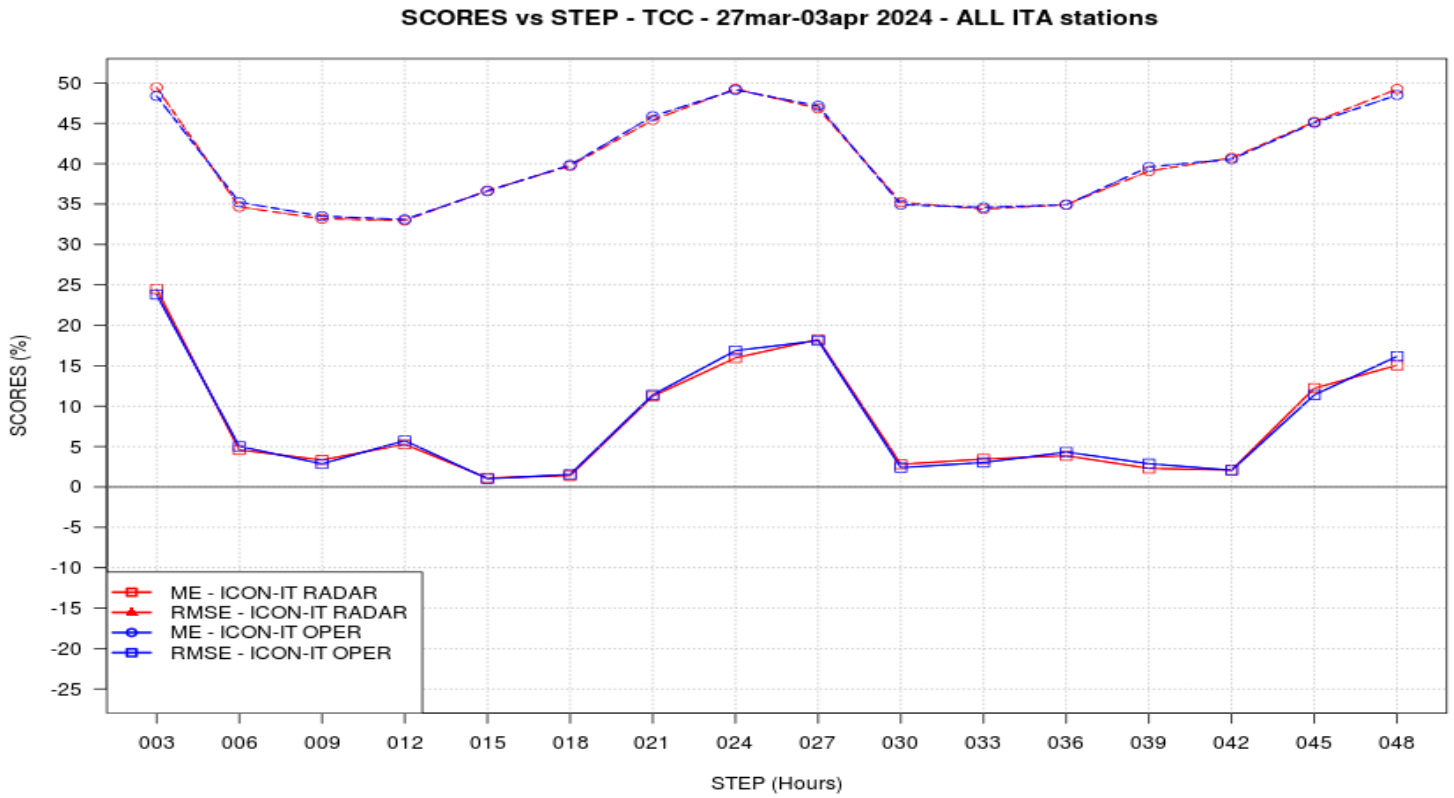
RADAR: exp1

EXP1: 26 March -3 April
Only refl assimilated

Statistics:
TCC, RH2m, T2m, WS, Prec



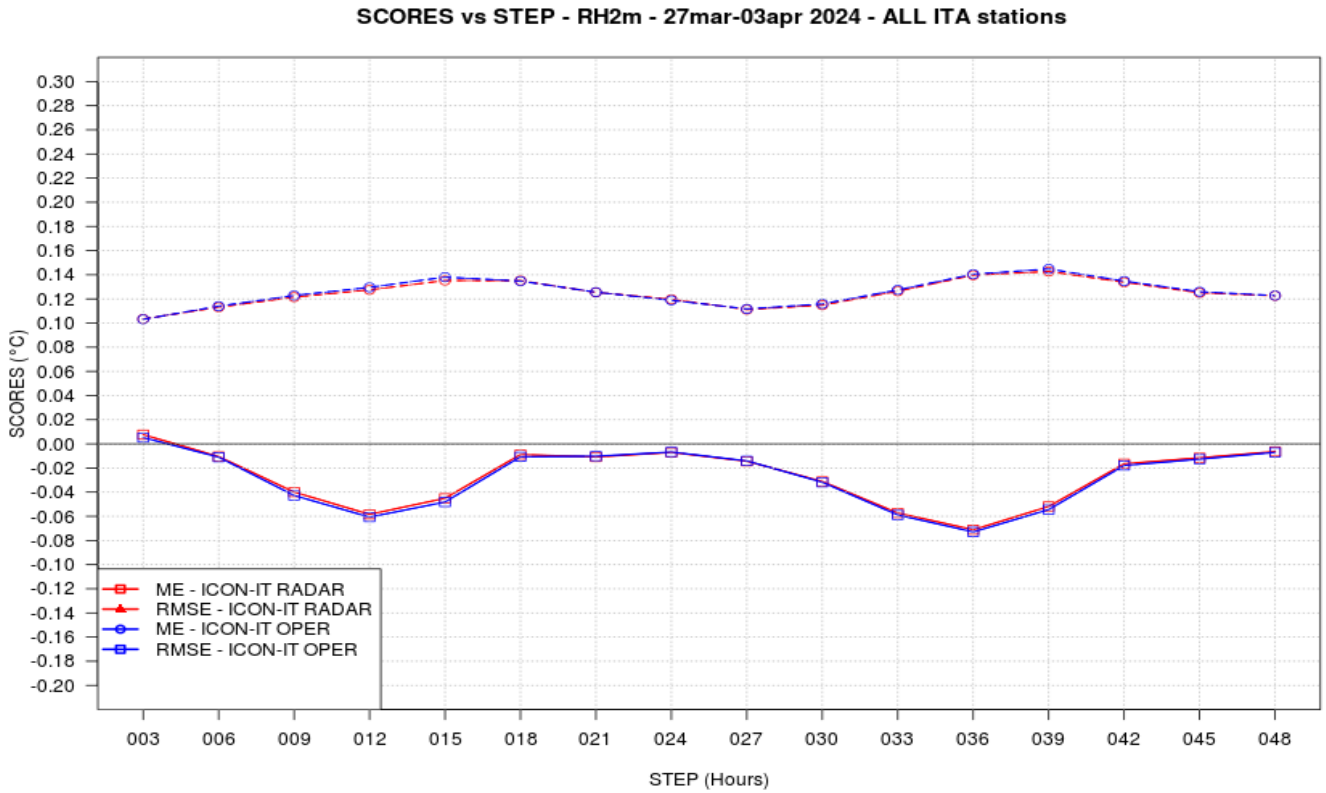
RADAR STATS: 27 March - 4 April 2024 (TCC)



+0.5%

+1%

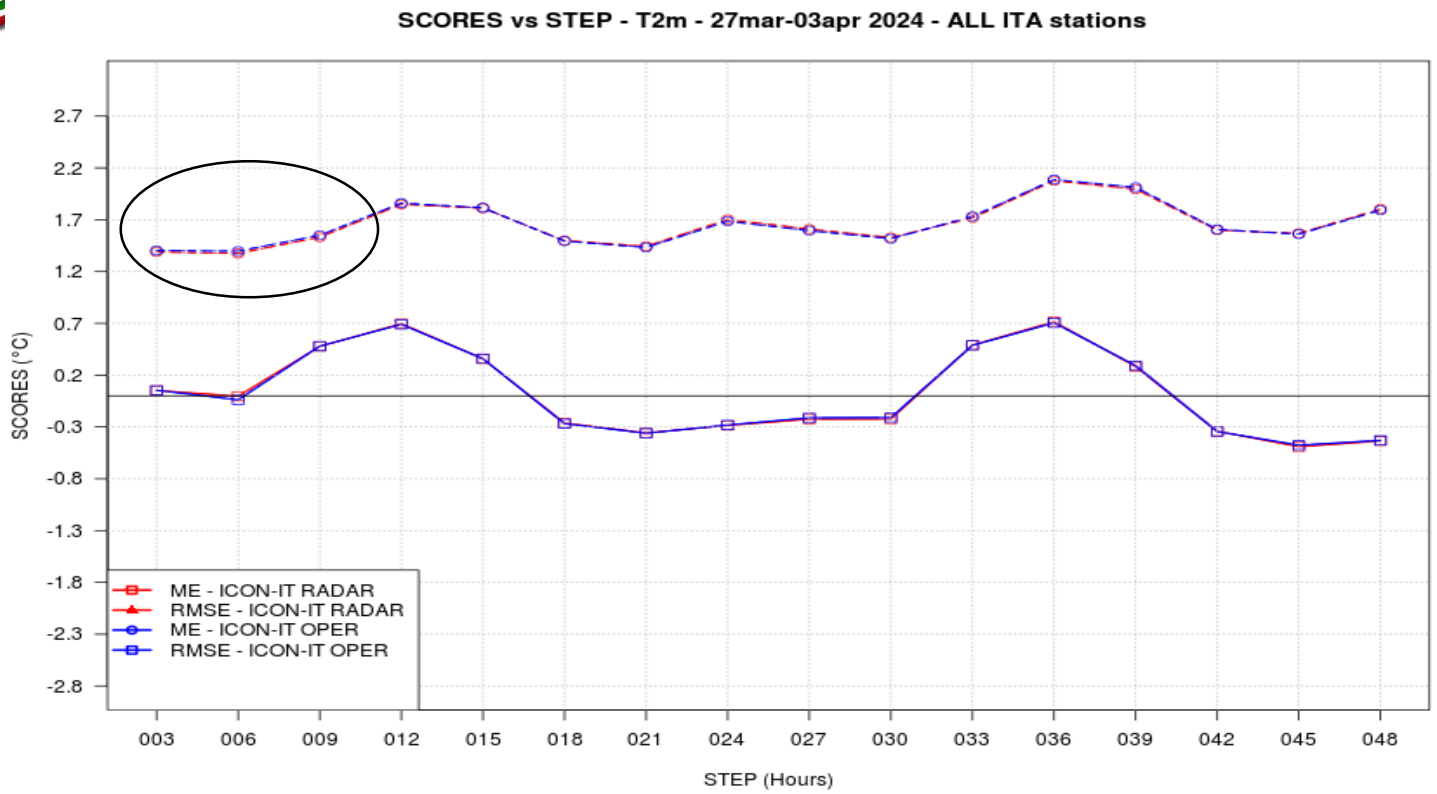
RADAR STATS: 27 March - 4 April 2024 (RH2M)



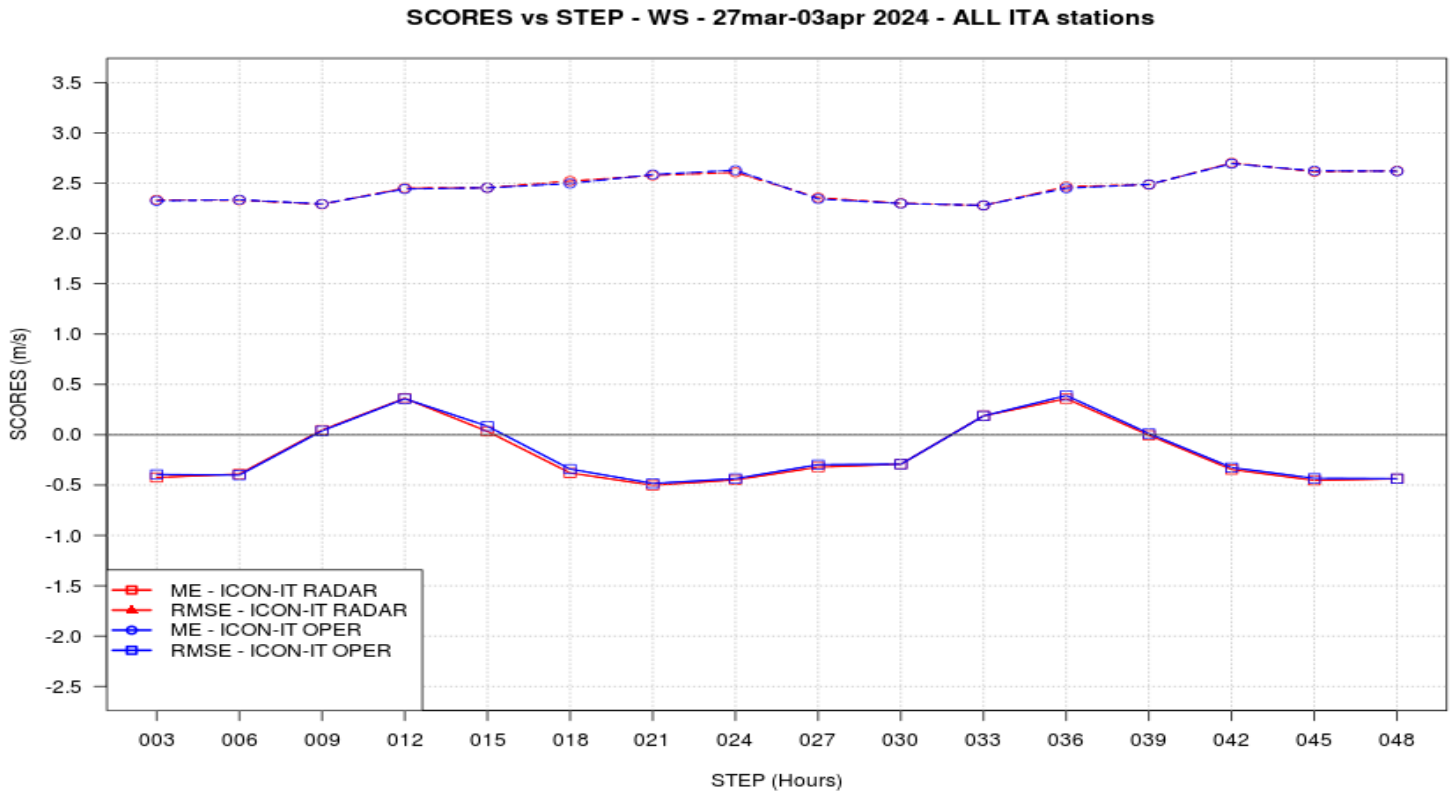
+0.6%

+3.7%

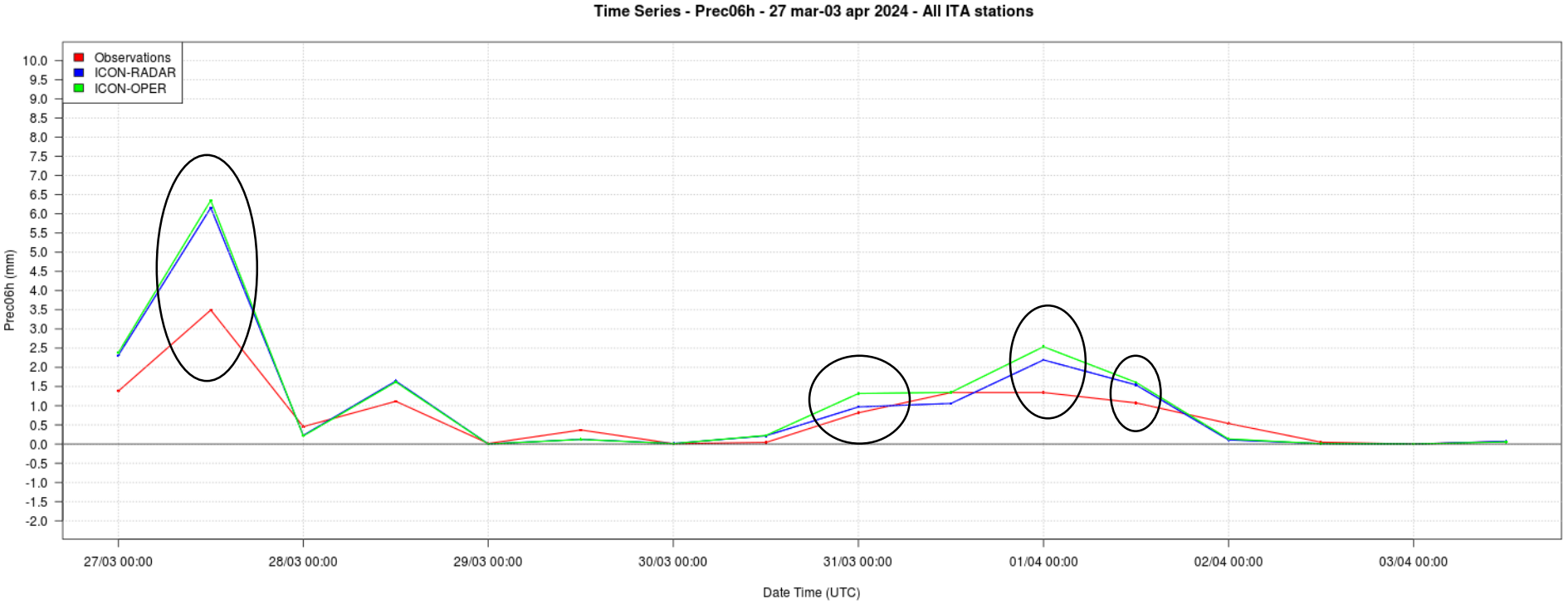
RADAR STATS: 27 March - 3 April 2024 (T2M)



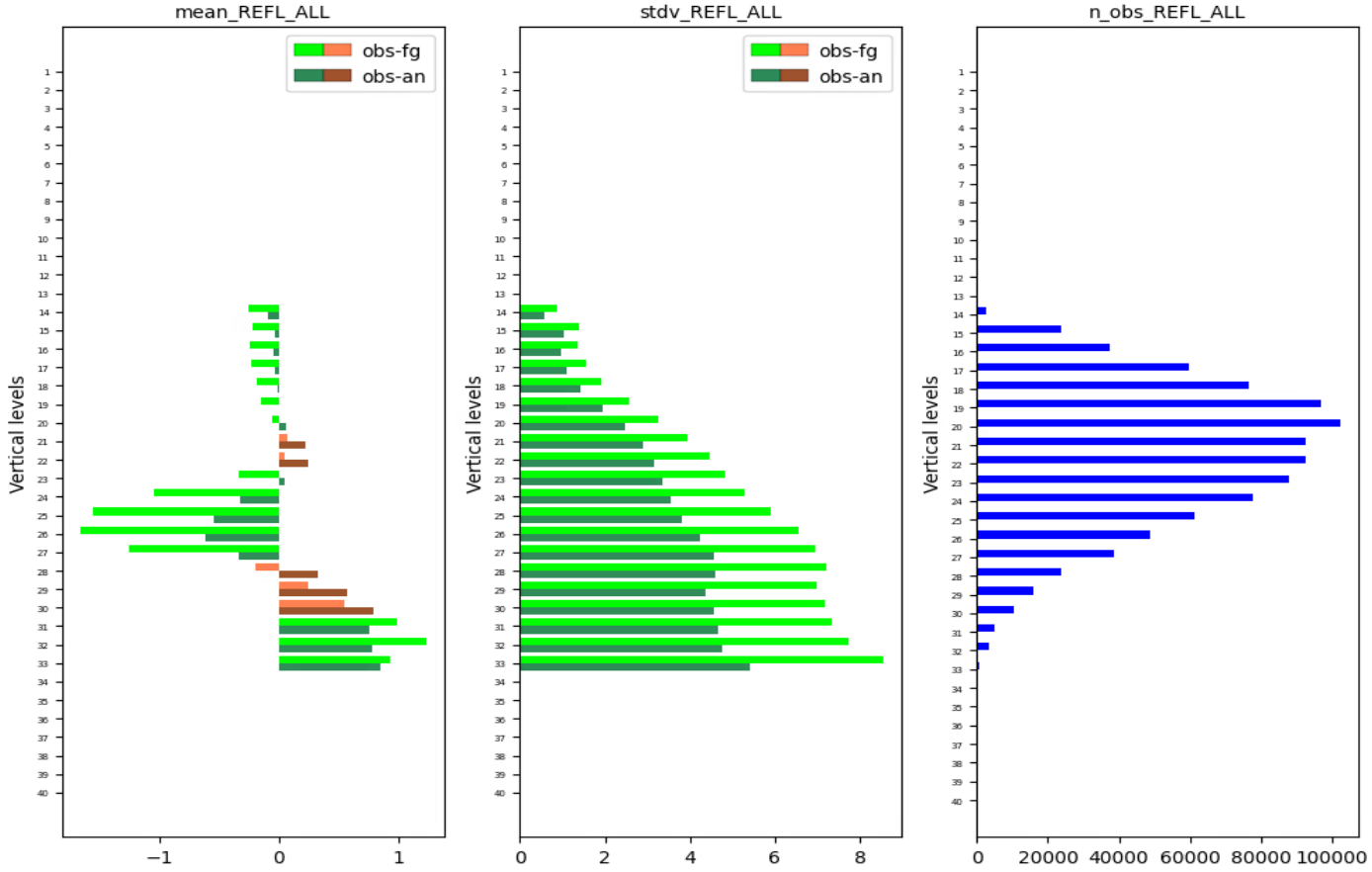
RADAR STATS: 27 March - 3 April 2024 (WS)



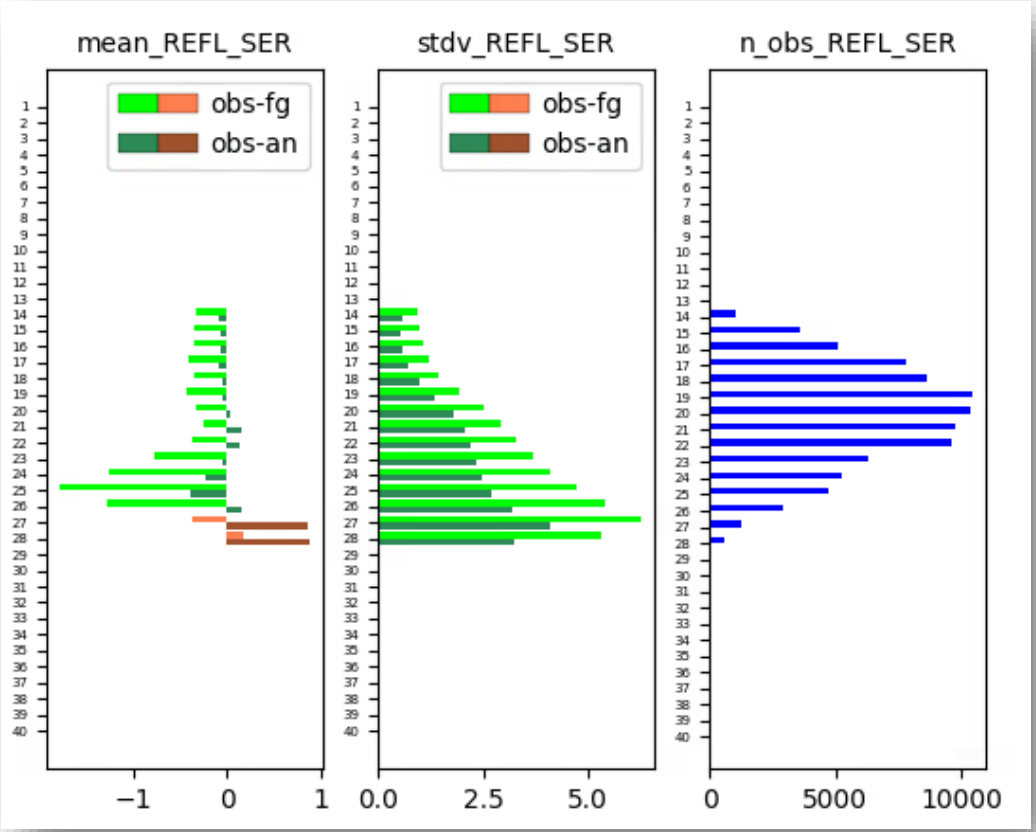
RADAR STATS: 27 March – 3 April 2024



RADAR exp1: obs inc statistics (ALL radars)



RADAR exp1: obs inc statistics



M.SERANO
1428 meters

NAMELIST_EMVORADO for ICON (REFL + RADW obs)

```
&RADARSIM_PARAMS
 lout_geom=.false.,
 loutradwind=.true.,
 loutdbz=.true.,
 …….
 dom=1,
 icountry=3,
 itype_supobing=1,
 supob_cart_resolution = 10000.0, ! Superobbing at 10 km
 supob_lowthresh_z_obs = 5.0,  ! 5 dBZ threshold on reflectivities
 supob_lowthresh_z_sim = 5.0,
 itype_obserr_vr=1,
 ramp_lowdbz_obserr_vr=0.0,
 ramp_highdbz_obserr_vr=10.0,
 maxval_obserr_vr=25.0,
 baseval_obserr_vr=2.5,
……

 /END
```

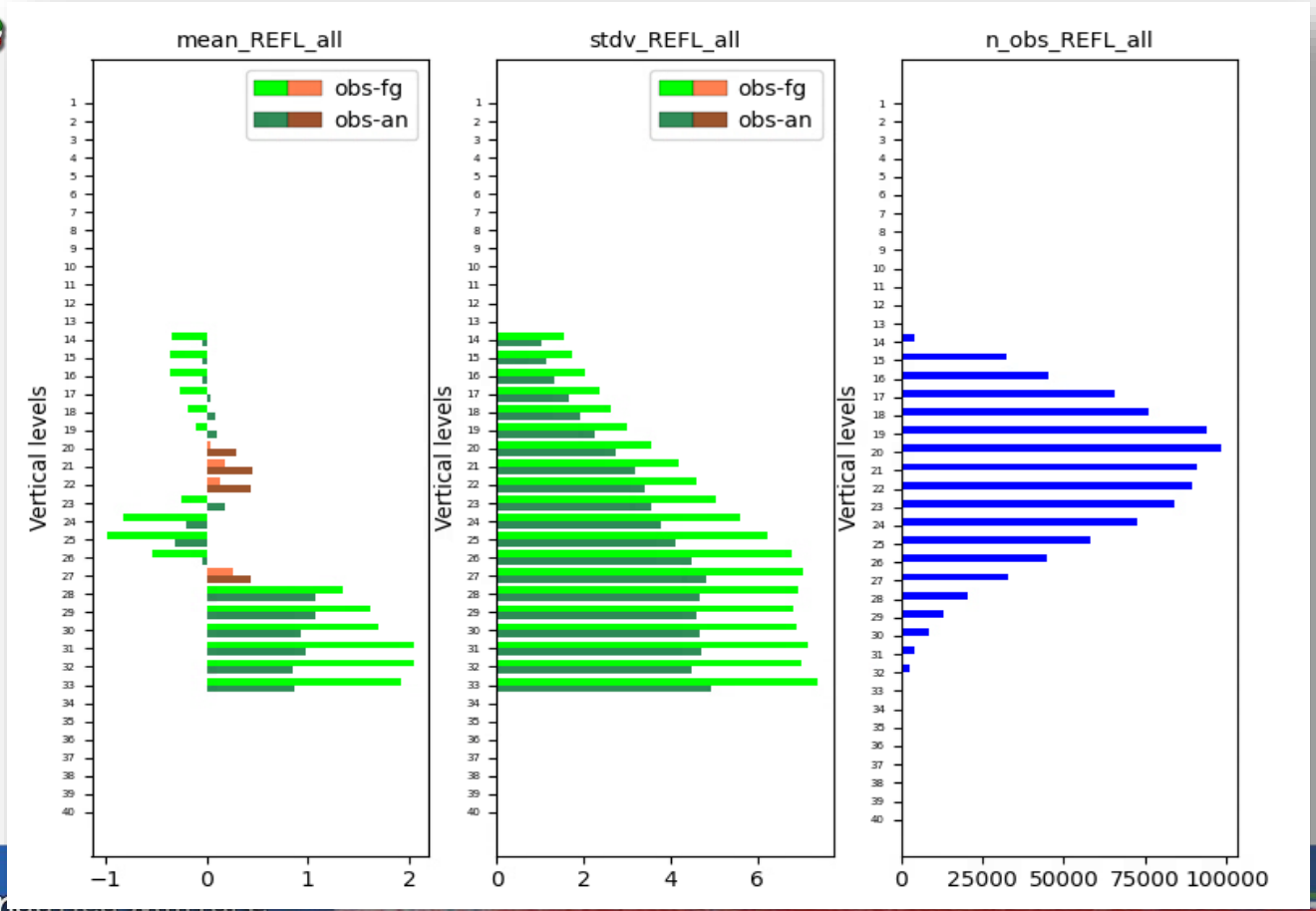
- simulation and output for radial winds and reflectivity activated
- Ramp function for the error of the RADW obs activated (following ARPAE settings)

NAMELIST_KENDA for ICON (REFL + RADW obs)

```
   !Set elevation 0.5 fo radial wind to active
   &RULES
   comment     = 'specific parameters for RADAR operator'
   obstype     = 13           ! RADAR
   sat_zenith  = 0.4 0.8
   uv%use      = 11
   /
   !Set elevation 1.5 fo reflectivity and radial wind to active
&RULES
   comment     = 'specific parameters for RADAR operator'
   obstype     = 13           ! RADAR
   sat_zenith  = 1.1 2.1
   o%use       = 11
   uv%use      = 11
/
   !Set elevation 3.5 for reflectivity and redial wind to active
   &RULES
   comment     = 'specific parameters for RADAR operator'
   obstype     = 13           ! RADAR
   sat_zenith  = 3.1 4.0
   o%use       = 11
   uv%use      = 11
   /
```

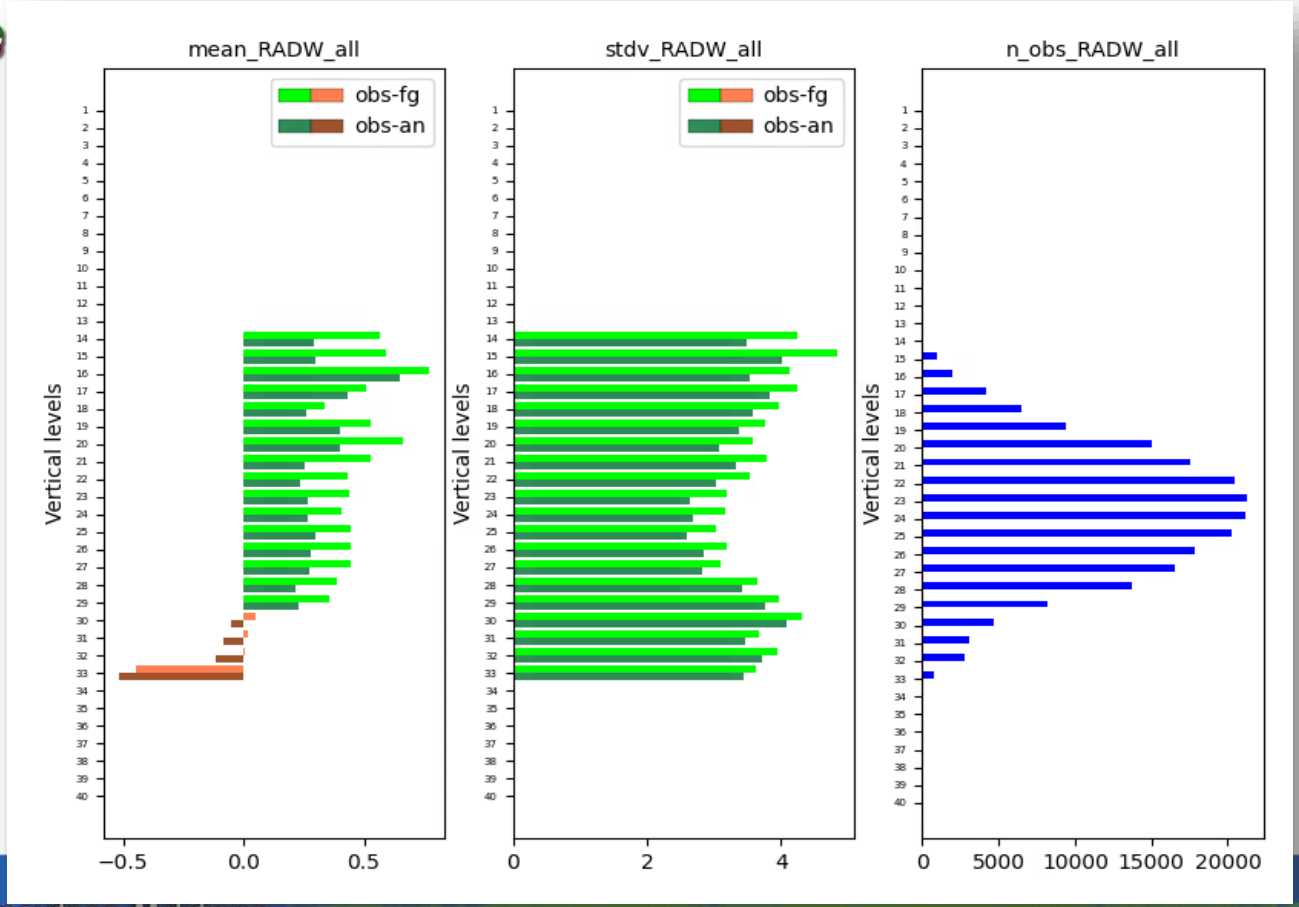
```
   !Set reflectivity between 0 and 600 m 'passive'
&RULES
    comment    = 'specific parameters for RADAR operator'
    obstype    = 13           ! RADAR
    zlim       = 0. 600.      ! between 0.0 and 600.0 m
    o%use      = 7
    uv%use     = 7
/
   !Set radial winds and reflectivity above 10000 m to passive
&RULES
   comment     = 'specific parameters for RADAR operator'
   obstype     = 13            ! RADAR
   zlim        = 9000. 99999. ! above 9000 m
   o%use       = 7
   uv%use      = 7
/
```

RADAR exp2: REFL stats (ALL radars)



29 April – 5 May

RADAR exp2: RADW stats (ALL radars)



29 April – 5 May

Conclusions – RADAR obs assimilation

- EXP 1: only REFL assimilation.
  - Small improvements in terms of TCC, RH2m, precipitation;
  - Obs increments: reduction of stdv for each vertical levels, small increase of bias in some vertical levels;
  - **OPERATIONAL** since 20/08/2024.

- EXP 2: REFL + RADW assimilation.
  - Obs increments for REFL: behiaviour similar to EXP 1;
  - Obs increments for RADW: small reduction of stdv for each vertical levels, small increase of bias in the lowest vert. levels;
  - Number of RADW obs assimilated: around 20% with respect to the number of REFL obs assimilated;
  - Need of further statistical investigation for RADW observations.

Assimilation of Non conventional Synoptic observations

- **MeteoNetwork:** crowd sourced synoptic stations, station number: 667
- **MeteoMont:** Army Alpine Observation department, station number: 46
- **Autostrade:** station number: 207
- **DPC:** Civil Protection Department, station number: 5375

Variables: T, u,v, sp, rh

Period of study: Dec 2023 – June 2024

	mean(obs-fg)		stdv(obs-fg)	num_obs
T	mean 0.011554	stdv	1.323750	1856712
P	mean 0.087984	stdv	0.824691	1812925
u	mean 0.029436	stdv	1.789542	452120
v	mean -0.090808	stdv	1.757326	452120
q	mean 0.013023	stdv	0.101105	1934252

Conventional synop obs assimilated in ICON-IT

Assimilation of Non conventional Synoptic observations

T

stdv\mean	0-0.2	0.2-0.4	> 0.4
0-1.5	G	Y	O
1.5-2.5	Y	Y	R
> 2.5	O	R	R

sp

stdv\mean	0-0.5	0.5-1.5	> 1.5
0-1.0	G	Y	O
1.0-2.0	Y	Y	R
> 2.0	O	R	R

wind

stdv\mean	0-0.4	0.4-0.7	> 0.7
0-2.0	G	Y	O
2.0-3.5	Y	Y	R
> 3.5	O	R	R

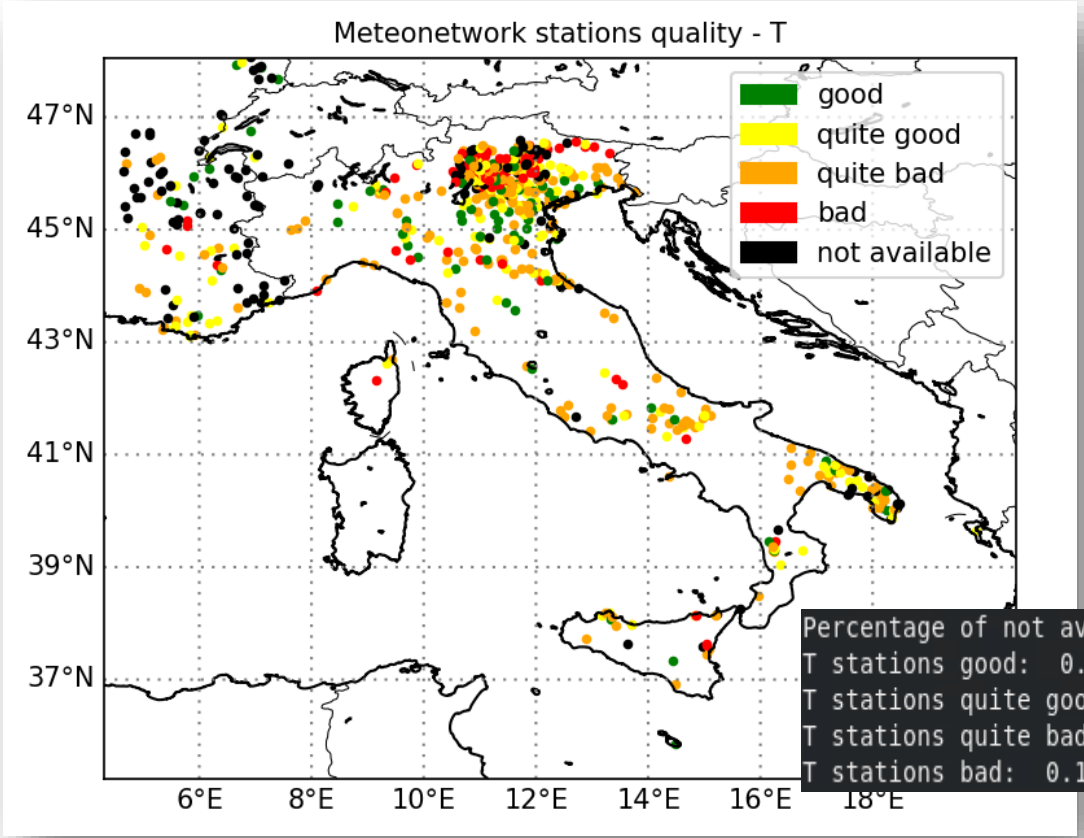
q

stdv\mean	0-0.05	0.05-0.1	> 0.1
0-0.1	G	Y	O
0.1-0.2	Y	Y	R
> 0.2	O	R	R

GREEN-YELLOW
ASSIMILATED

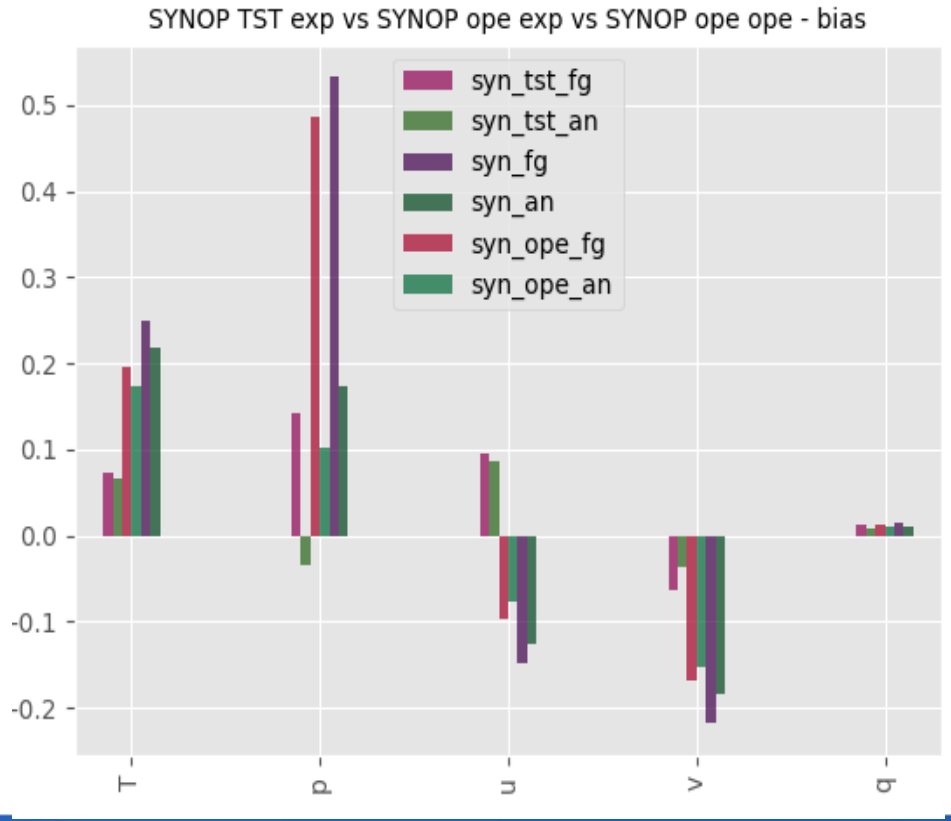
ORANGE-RED
BLACKLISTED

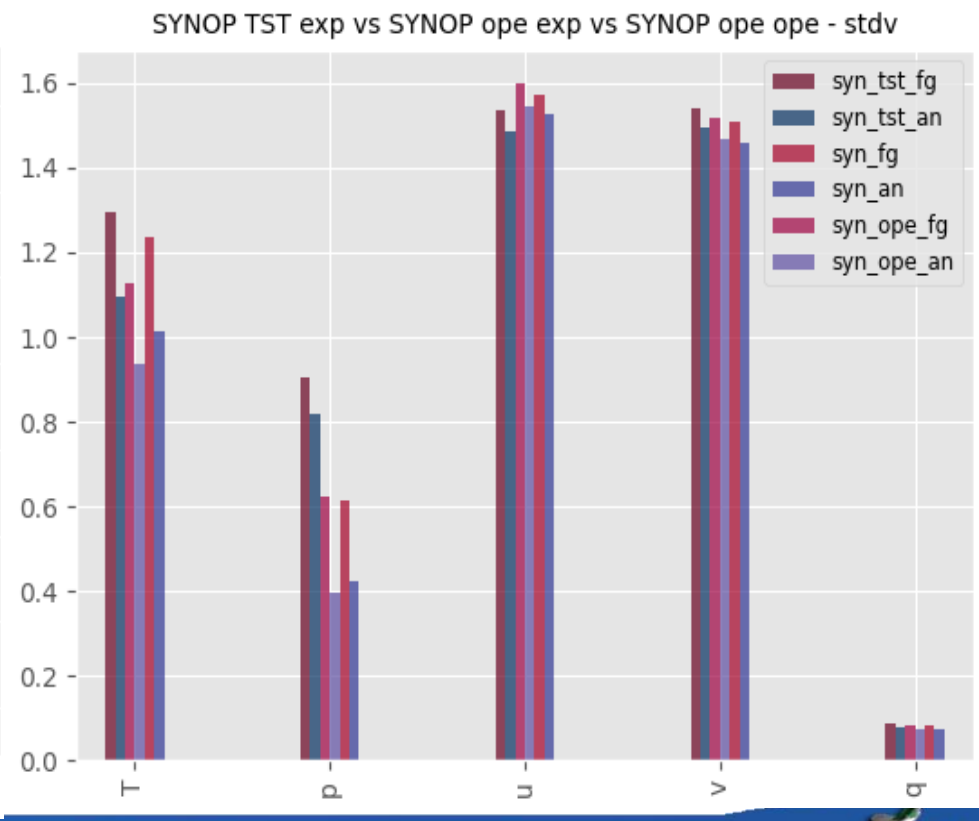
Example – MeteoNetwork (Temperature)



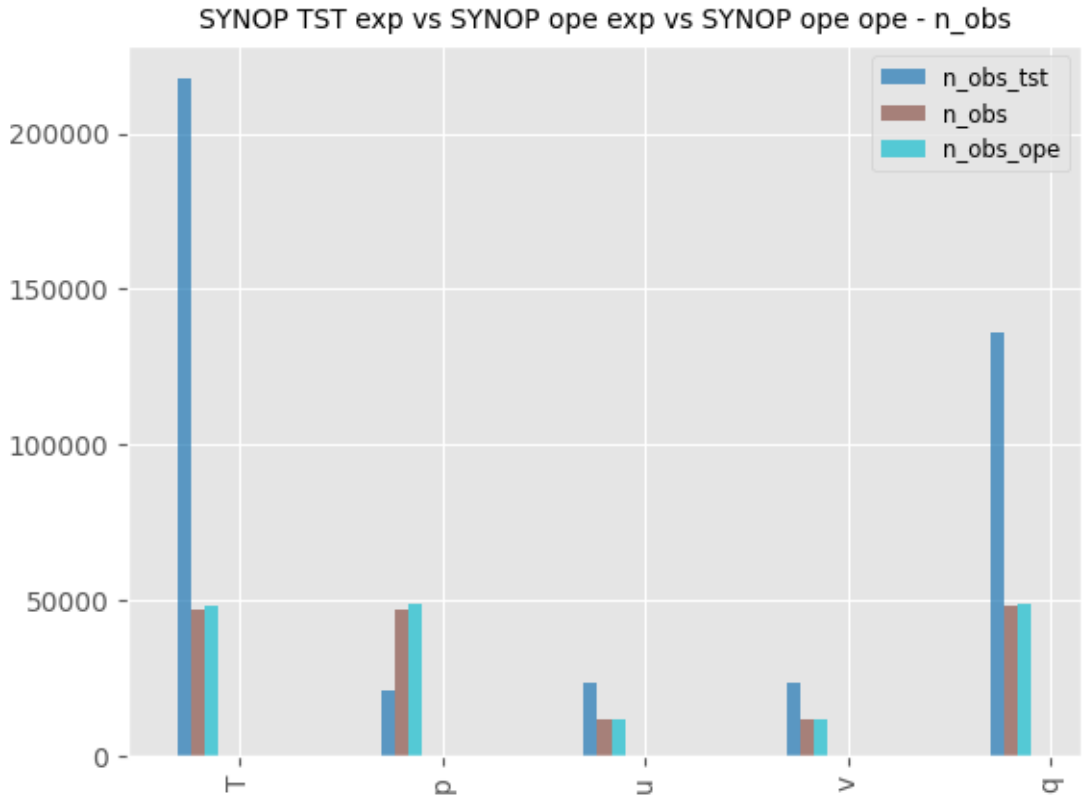

```
Percentage of not available (T) stations:  0.2054794520547945
T stations good:  0.1532567049808429
T stations quite good:  0.2567049808429119
T stations quite bad:  0.44061302681992337
T stations bad:  0.14942528735632185
```

SYNOP TST (codetype 811): test – 3-8 July 2024





SYNOP TST: test – 3-8 July 2024



Assimilation of non conventional synop obs is operational since the end of July 2024 in ICON-IT.

GNSS obs assimilation – ICON namelist

```
&STD_OBS
   read_ascii = .false.
   NStepVertMod = 65
   NStepVertTop = 25
   Hlevel = 15, 15, 15, 10, 10
   Heights = 1077.658, 3434.414, 7370.787, 11584.105, 20700.926
   Hpoints = 12, 12, 12, 11, 11
   Hmax         = 150000
   UseRaytracer = 70
   verbose      = 0
   ZTDerror     = 0.012
   pl_method = 20     ! Required for LETKF
   Href         = 2000.0
   MaxSTDobs    = 9999999
   MaxZTDobs    = 9999999
   k1           = 77.60E0
   k2           = 70.40E0
   k3           = 3.739E5
   biascor_mode = -2          ! bias correction: 0=no, 1=update-only, 2=fg, 3=ana, 4=VarBC
   bc_fallback = .false.      ! T for coldstart, F otherwise
   StatBelowSurface = 100.0   ! reject stations more than "StatBelowSurface" meter below model surface
   StatAboveSurface = 200.0   ! reject stations more than "StatAboveSurface" meter above model surface
   StatBelowColumn  = 300.0   ! reject stations more than "StatBelowColumn" below max. model column
   ZTDminUse        = 0.1      ! reject ZTDs < 0.1 m (and mapped STDs)
   ZTDmaxUse        = 2.9      ! reject ZTDs > 2.9 m (and mapped STDs)
   ztd_col          = 0        ! ZTDs: Interpolate between model columns
/
```

GNSS obs assimilation – KENDA namelist

```
! Select ZTDs within the last 15 minutes of each hour
&REPORT
 type='GPSGB'
 time_b=-0015
 time_e=0000
 use='active'
/

! Localization for LETKF
&RULES
 comment     = 'specific parameters for GPS ground based'
 obstype     = 12          ! GPSGB
 o%h_loc     = 20          ! specific horizontal localisation scale
 o%v_loc     = 0.17        ! specific vertical localisation scale
/

&THINNING
    comment  = 'GNSS ZTD settings'
    obstype  = 'GPSGB'
    codetype = 110                    ! ZTDs
    ni       = 256                    ! ca 40 km  horizontal distance
    state    = 'passive'              ! set to passive
    pass = -1                         ! apply thinning before splitting reports
    rule1 = 'data'
    rule2 = 'time'
/
```

Future developments

- Operational assimilation of RADW from Italian Radar Network
- LHN + RADAR obs assimilation within ICON
- Assimilation of the GNSS ZTDs obs within ICON (and STD)