Intercomparison of Spatial Verification Methods for COSMO Terrain (INSPECT): First Results

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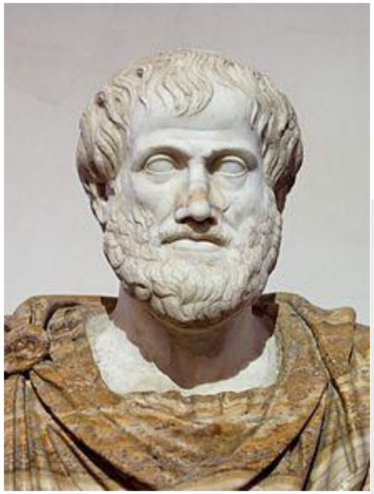
(1) RHM (a.bundel@gmail.com), (2) HNMS, (3) DWD, (4) MCH, (5) IMGW-PIB, (6) ARPA-SIMC, (7) ARPA-PT

WG5

COSMO GM, 08 September 2015, Wrocław, Poland

From Aristotle's Meteorologica
Book II, Chap IV, p. 167-169



Sometimes ***drought or rain*** is ***widespread and covers a large area*** of country, sometimes it is only ***local***; for often in the country at large the seasonal rainfall is normal or even above the normal, while in borne districts of it there is a draught ;
At other times, on the other hand, the rainfall in the country at large is meagre, or there is even a tendency to draught, while in a single district the rainfall is abundant in quantity.
The reason is that as a rule a considerable area may be expected to be similarly affected, because ***neighboring*** places lie in a similar relation to the sun, unless they have some local peculiarity ; …
And the reason for this again is the movement of either of the two exhalations across to join that of the neighboring district; the dry, for instance, may circulate in its own, the moist follow to a neighboring district or ***be driven by winds*** still farther afield.

COSMO Priority Project INSPECT

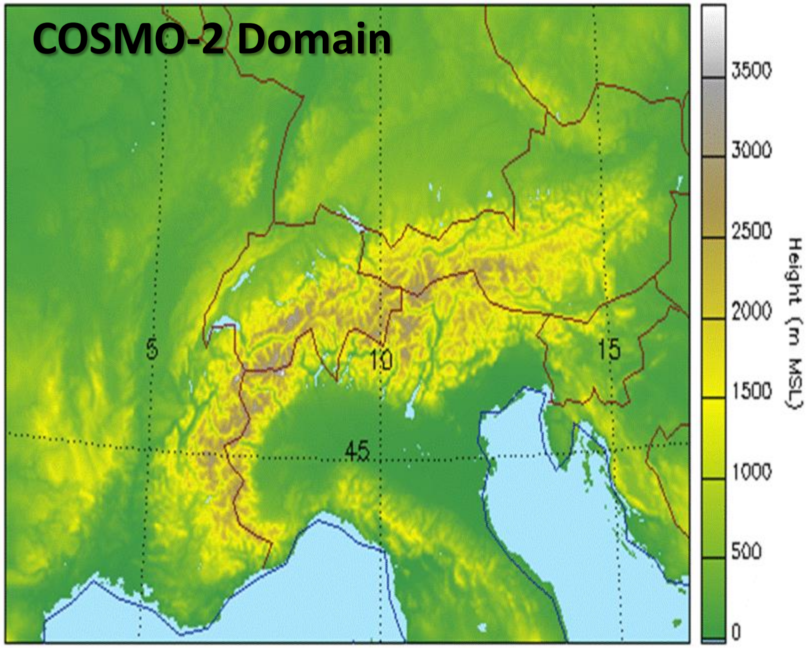
- summarizes the COSMO experience of applying spatial verification methods to forecast systems of high and very-high-resolution (1-3 km)
- runs in parallel to MesoVICT (several INSPECT tasks involve reruns of COSMO high and very-high-resolution models for MesoVICT test cases)
- Same as MesoVICT, INSPECT focuses on the ensembles and variables besides precipitation
- In addition to targeting the goals of MesoVICT, INSPECT provides COSMO users more choice of verification domains and reference data - newer and longer periods, two complex terrains (the Alps and the Caucasus)
- Finally, INSPECT will try to provide criteria for deciding which methods are best suited to particular applications

The software developed within INSPECT can be used as AVS (Strategy)

Tasks involving reruns of MesoVICT test cases

- 1a. MCH: The recalculations with COSMO-1 for the first MesoVICT period (20-22 June 2007
- 1c. ARPA-SIMC: CLEPS (to serve also as IC-BC for COSMO-Ru2) (not all the dates yet)

Task 3f. MesoVICT case (by Flora Gofa using VAST)



CONSORTIUM FOR SMALL SCALE MODELING COSMO

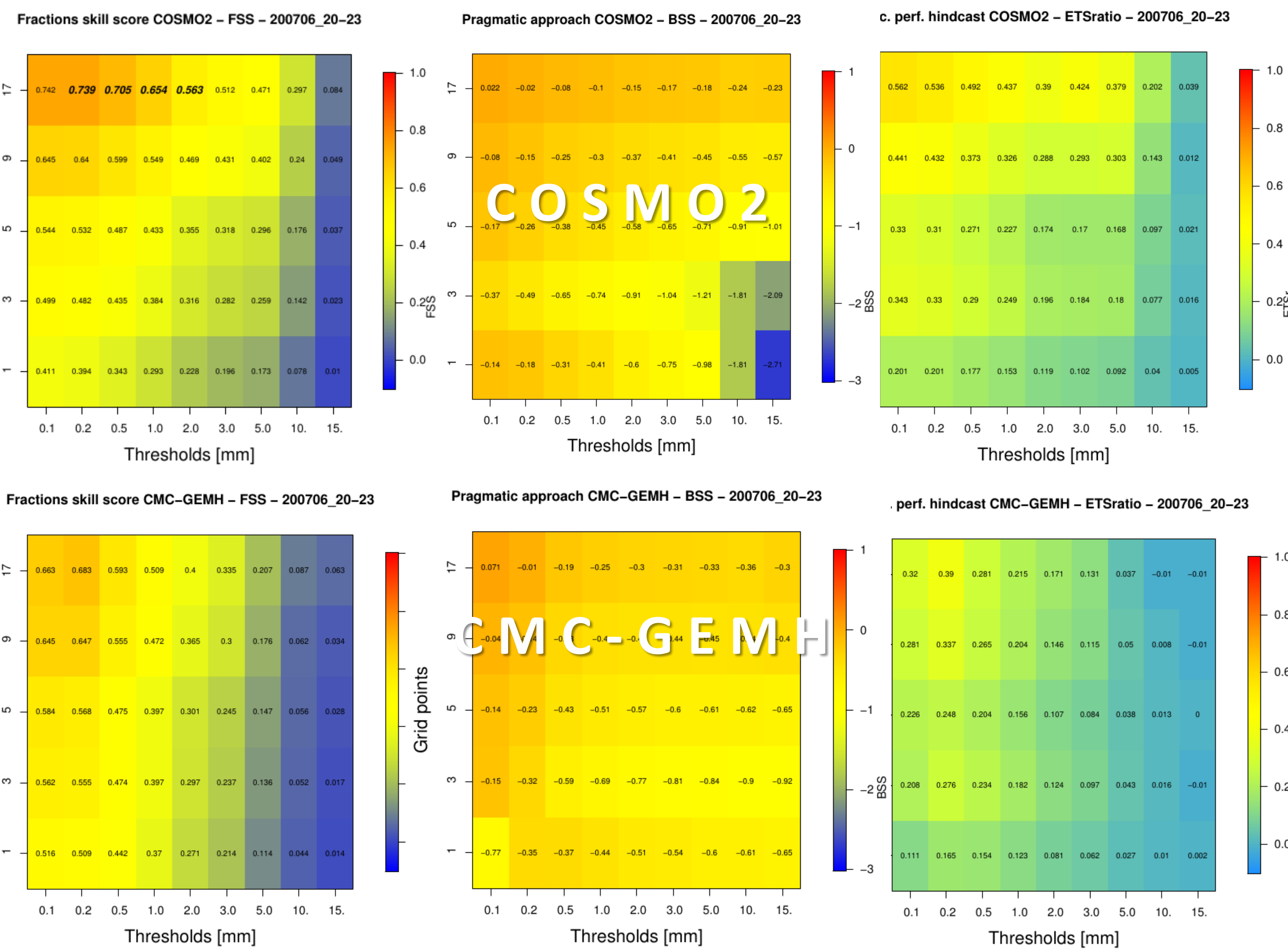
MesoVict Core case

<u>Forecast model used</u>:
1. COSMO-2 extrapolated to ~7km resolution
Data:20, 21,22.06.07:00-24UTC
Precipitation, 1h accumulation

2. CMC GEMH: in VERA resulution
Originally 2.5 km (0.0225 X 0.0327)
Data:20, 21,22.06.07: 06-18UTC
Precipitation, 6h accumulation

<u>Observation data used</u>: VERA analysis in ~7km resolution resolution

Data adapted by N.Vela and M.S.Tesini


Fractions skill score COSMO2 – FSS – 200706_20–23
17: 0.742 0.739 0.705 0.654 0.563 0.512 0.471 0.297 0.084
9: 0.645 0.64 0.599 0.549 0.469 0.431 0.402 0.24 0.049
5: 0.544 0.532 0.487 0.433 0.355 0.318 0.296 0.176 0.037
3: 0.499 0.482 0.435 0.384 0.316 0.282 0.259 0.142 0.023
1: 0.411 0.394 0.343 0.293 0.228 0.196 0.173 0.078 0.01
0.1 0.2 0.5 1.0 2.0 3.0 5.0 10. 15.
Thresholds [mm]
FSS
1.0 0.8 0.6 0.4 0.2 0.0
Pragmatic approach COSMO2 – BSS – 200706_20–23
COSMO2
17: 0.022 −0.02 −0.08 −0.1 −0.15 −0.17 −0.18 −0.24 −0.23
9: −0.08 −0.15 −0.25 −0.3 −0.37 −0.41 −0.45 −0.55 −0.57
5: −0.17 −0.26 −0.38 −0.45 −0.58 −0.65 −0.71 −0.91 −1.01
3: −0.37 −0.49 −0.65 −0.74 −0.91 −1.04 −1.21 −1.81 −2.09
1: −0.14 −0.18 −0.31 −0.41 −0.6 −0.75 −0.98 −1.81 −2.71
0.1 0.2 0.5 1.0 2.0 3.0 5.0 10. 15.
Thresholds [mm]
BSS
1 0 −1 −2 −3
c. perf. hindcast COSMO2 – ETSratio – 200706_20–23
0.562 0.536 0.492 0.437 0.39 0.424 0.379 0.202 0.039
0.441 0.432 0.373 0.326 0.288 0.293 0.303 0.143 0.012
0.33 0.31 0.271 0.227 0.174 0.17 0.168 0.097 0.021
0.343 0.33 0.29 0.249 0.196 0.184 0.18 0.077 0.016
0.201 0.201 0.177 0.153 0.119 0.102 0.092 0.04 0.005
0.1 0.2 0.5 1.0 2.0 3.0 5.0 10. 15.
Thresholds [mm]
1.0 0.8 0.6 0.4 0.2 0.0
Fractions skill score CMC–GEMH – FSS – 200706_20–23
17: 0.663 0.683 0.593 0.509 0.4 0.335 0.207 0.087 0.063
9: 0.645 0.647 0.555 0.472 0.365 0.3 0.176 0.062 0.034
5: 0.584 0.568 0.475 0.397 0.301 0.245 0.147 0.056 0.028
3: 0.562 0.555 0.474 0.397 0.297 0.237 0.136 0.052 0.017
1: 0.516 0.509 0.442 0.37 0.271 0.214 0.114 0.044 0.014
0.1 0.2 0.5 1.0 2.0 3.0 5.0 10. 15.
Thresholds [mm]
Grid points
Pragmatic approach CMC–GEMH – BSS – 200706_20–23
CMC-GEMH
17: 0.071 −0.01 −0.19 −0.25 −0.3 −0.31 −0.33 −0.36 −0.3
5: −0.14 −0.23 −0.43 −0.51 −0.57 −0.6 −0.61 −0.62 −0.65
3: −0.15 −0.32 −0.59 −0.69 −0.77 −0.81 −0.84 −0.9 −0.92
1: −0.77 −0.35 −0.37 −0.44 −0.51 −0.54 −0.6 −0.61 −0.65
0.1 0.2 0.5 1.0 2.0 3.0 5.0 10. 15.
Thresholds [mm]
BSS
1 0 −1 −2 −3
perf. hindcast CMC–GEMH – ETSratio – 200706_20–23
0.32 0.39 0.281 0.215 0.171 0.131 0.037 −0.01 −0.01
0.281 0.337 0.265 0.204 0.146 0.115 0.05 0.008 −0.01
0.226 0.248 0.204 0.156 0.107 0.084 0.038 0.013 0
0.208 0.276 0.234 0.182 0.124 0.097 0.043 0.016 −0.01
0.111 0.165 0.154 0.123 0.081 0.062 0.027 0.01 0.002
0.1 0.2 0.5 1.0 2.0 3.0 5.0 10. 15.
Thresholds [mm]

Spatial verification activities at ARPA-SIMC: first results on MesoVICT cases

Maria Stefania Tesini

Andrea Montani, Chiara Marsigli, and Tiziana Paccagnella

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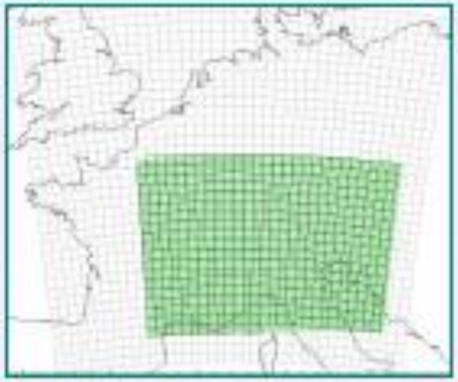
(mstesini@arpa.emr.it)

Application to the Core case 20-22/07/2007

- On the COSMO-2 domain we create a set of boxes of different size:

8x8 Km^2 containing 1 point (as the original VERA grid)

24x24Km^2 containing 9 points



40x40 Km^2 containing 25 points

80x80 Km^2 containing 100 points

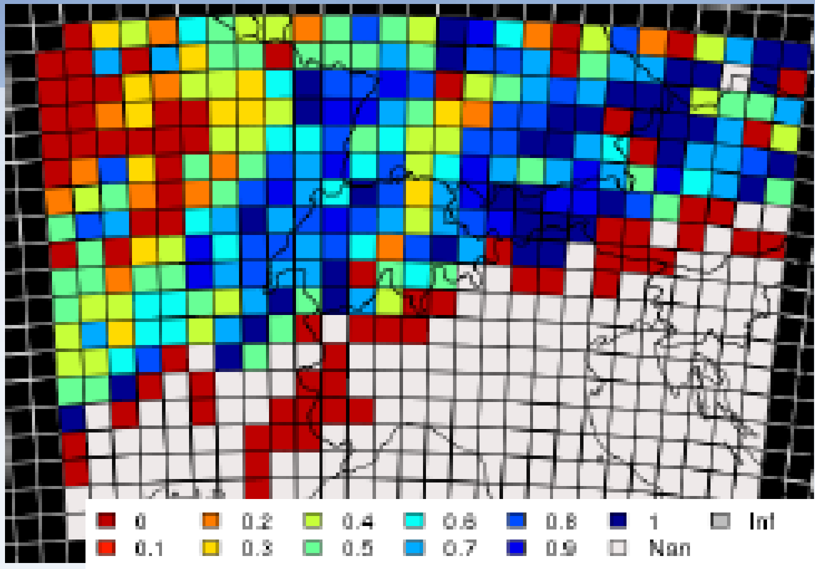
Scores are evaluated for each time step and aggregated over all the period (72 hours)

Max > 1 mm/1hour

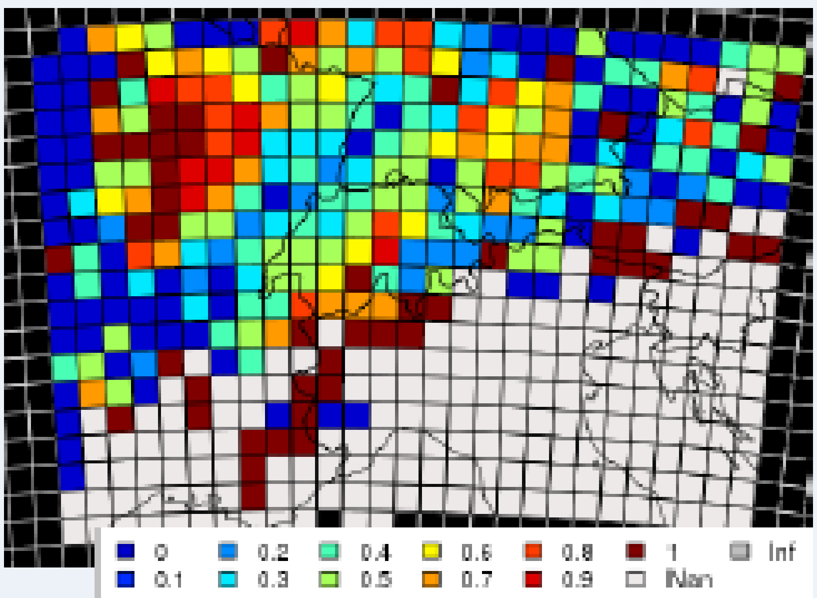
GRID: 25 points

(40x40 Km^2)

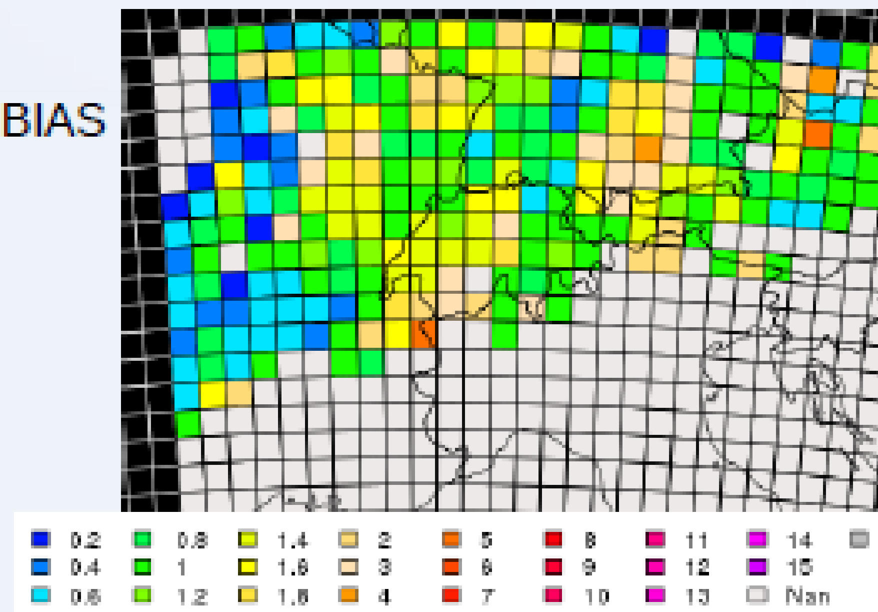
POD



FAR



BIAS



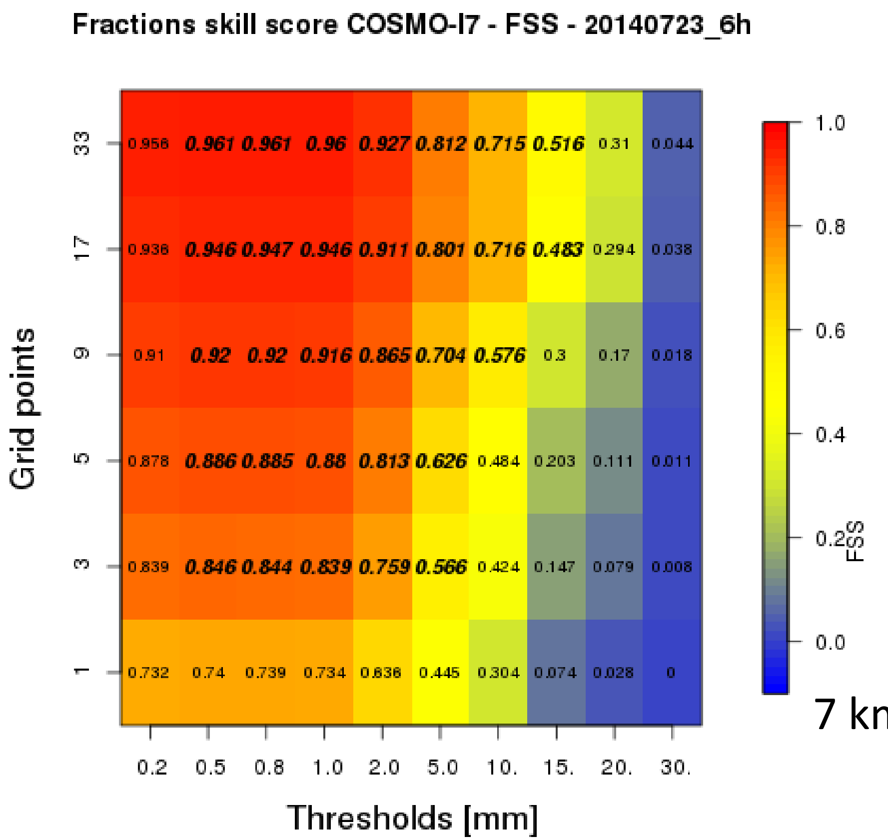
VAST
Application on test cases

Naima Vela, Elena Oberto

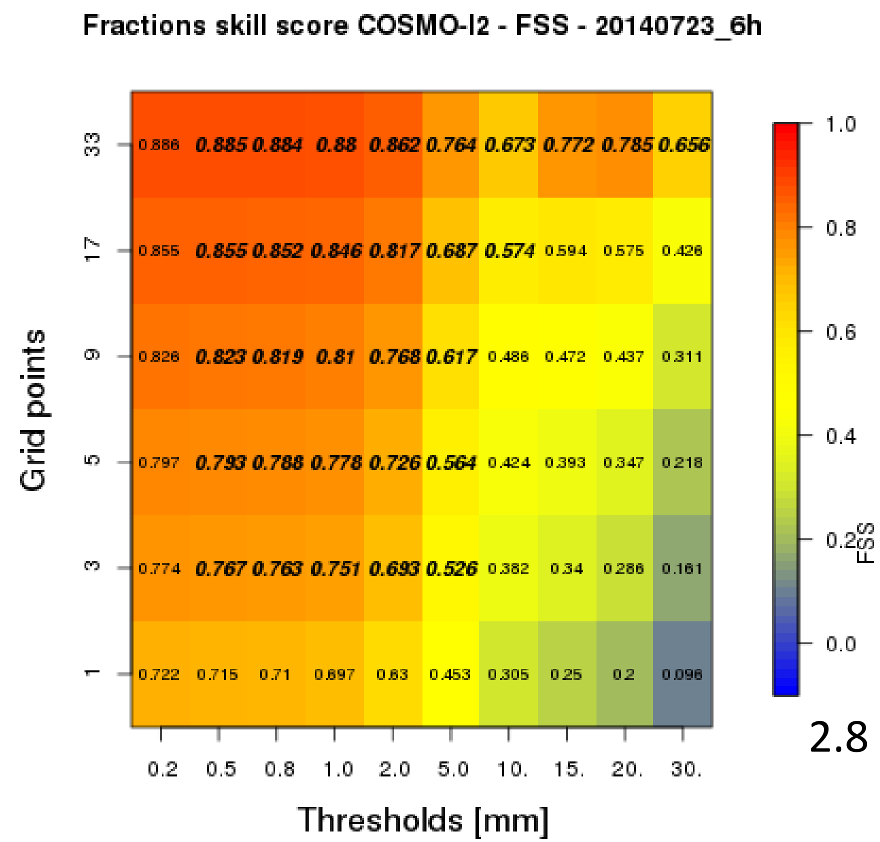
September 7^{th}, 2015

- VAST is able to handle big amounts of data

2014/07/23



7 km



2.8 k

Good results for COSMO I7 up to 15 mm. Better results (also at smaller scales and higher thresholds) for COSMO I2.

Task 3c. COMPACT REPRESENTATION OF LONG-TIME SERIES OF SCORES

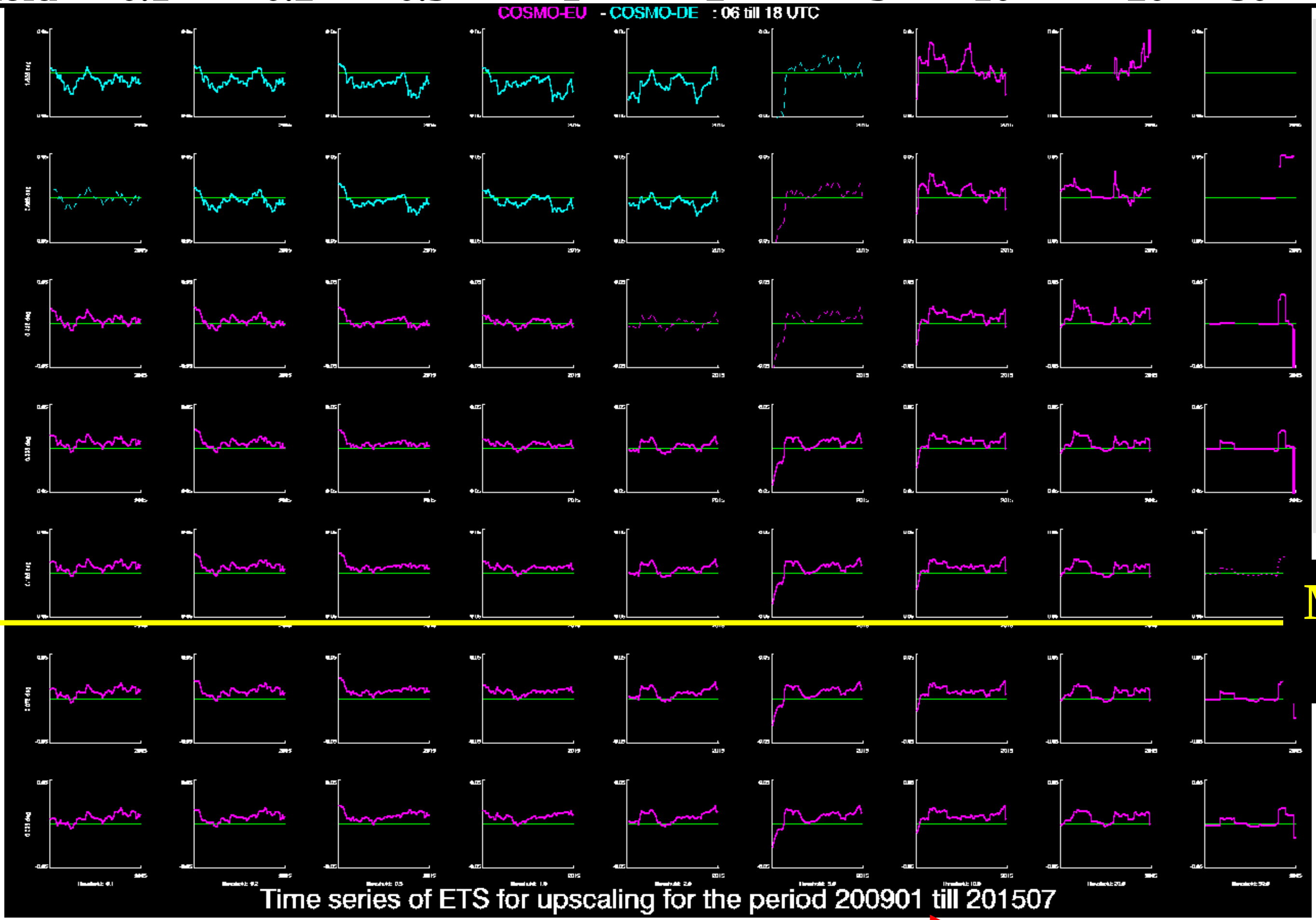
By Uli Damrath,
DWD

Comparison of COSMO-EU to COSMO-DE – upscaling ETS (differences)

DWD Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Threshold 0.1 0.2 0.5 1 2 5 10 20 50

1.625
0.825
0.425
0.225
0.125
0.075
0.025



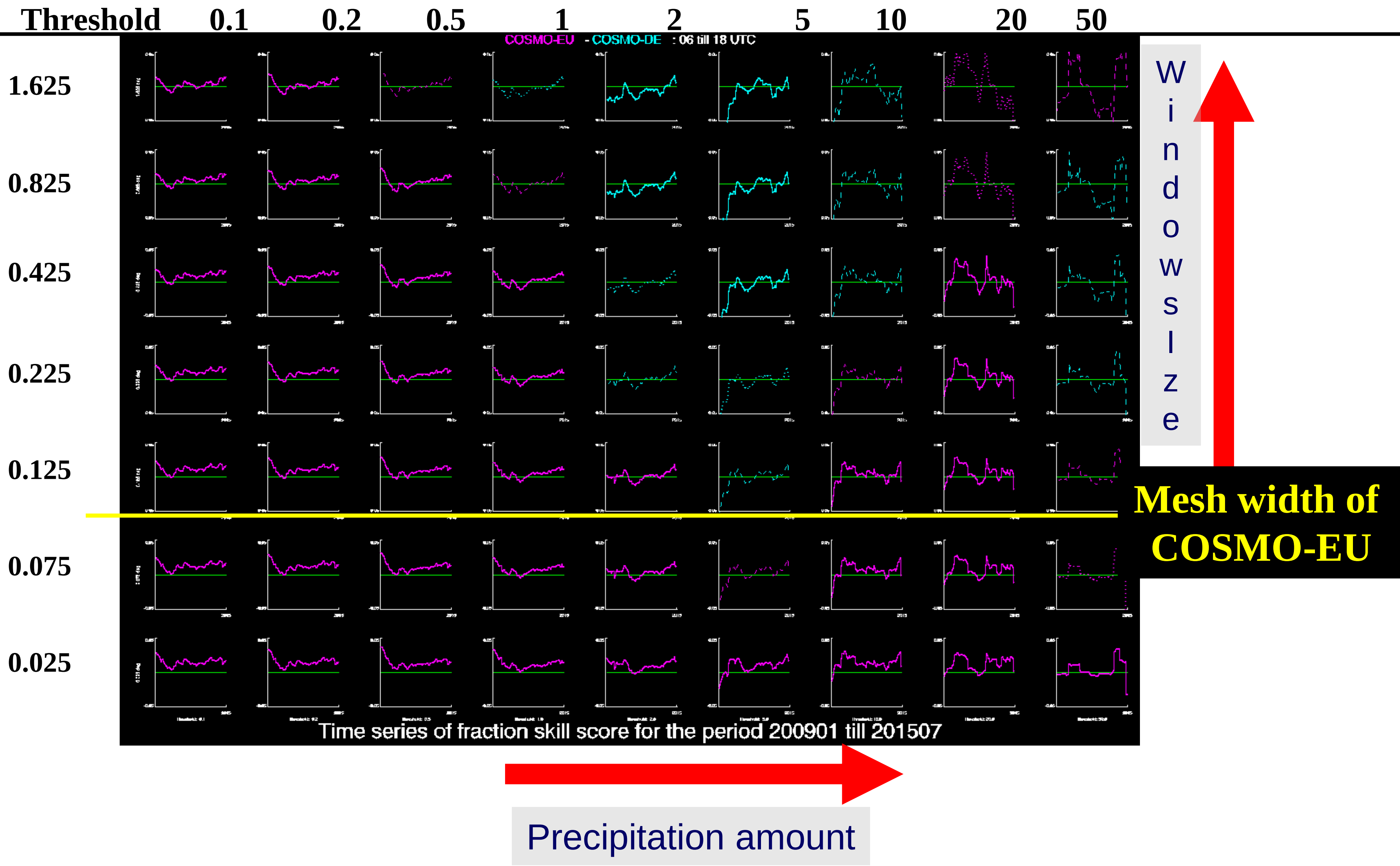
Windowsize

Mesh width of COSMO-EU

Precipitation amount

Comparison of COSMO-EU to COSMO-DE – FSS (differences)

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



Evaluation of model quality using 4d-Verif

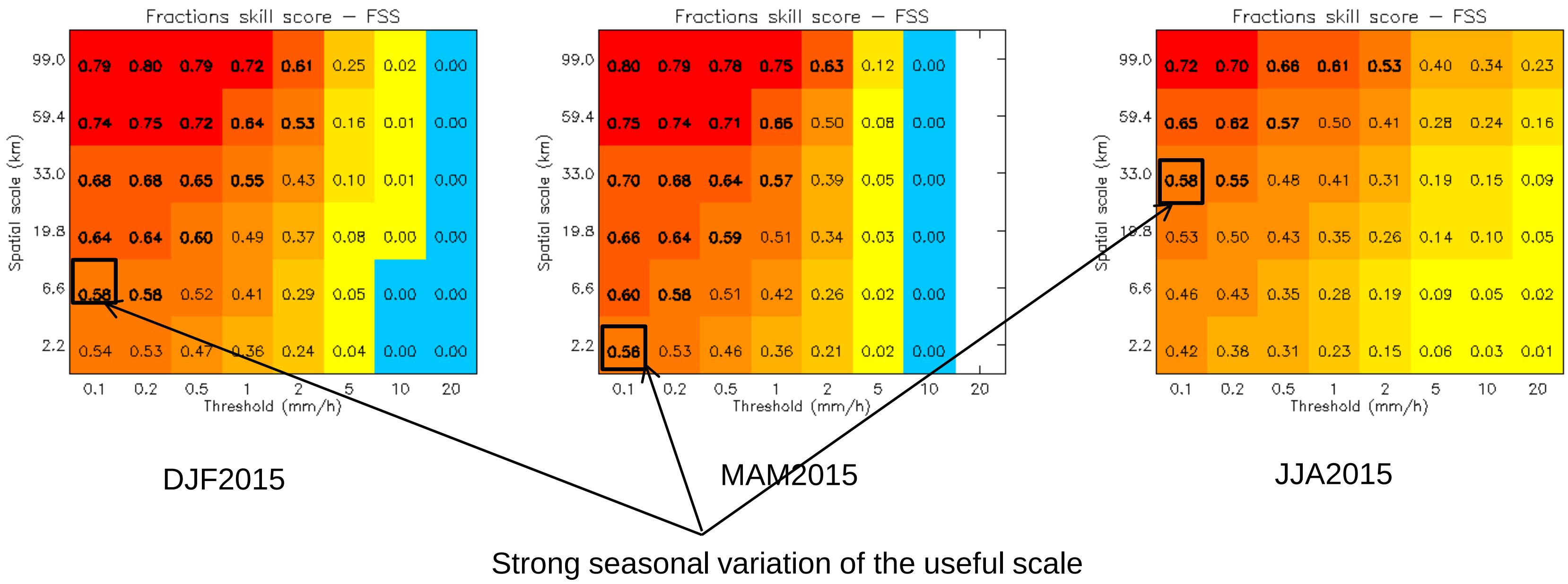
X. Lapillonne, D. Leuenberger, P. Kaufmann

COSMO GM 2015

Operational since 2015 at MCH

- Computed scores : Fraction Skill Score (FSS), Bias, equitable threat score (ETS)
- Currently only using radar data for precipitation

Lead Time 13-24 FSS (1-h sums), COSMO2



RHM: Tasks 1b, 1d, 2a, 2b, 3e.
A study on verification of FROST-2014 precipitation forecast fields using neighborhood and CRA methods

Anatoly Muraviev (1), Anastasia Bundel (1), Dmitry Kiktev (1),
Nikolay Bocharnikov (2), and Tatiana Bazlova (2)
(1) Hydrometcentre of Russia/Roshydromet, Moscow,
(2) Institute of Radar Meteorology, Saint-Petersburg, Russia

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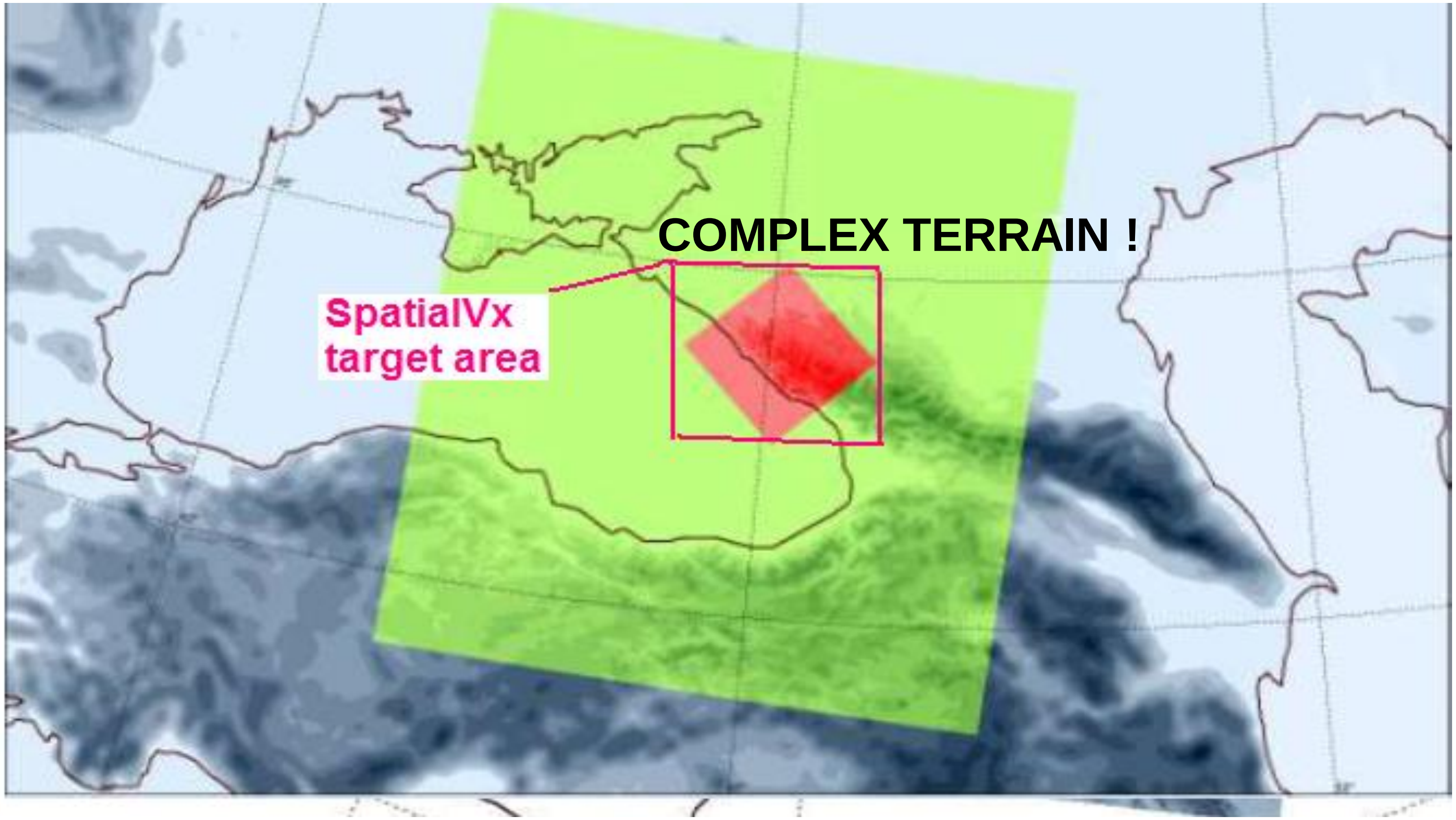
Area of the study

349 lon points * 481 lat points with **0.00833** lat-lon increments.
1 grid size by **longitude** = 111*0.00833 = **930 m**,
1 grid size by **latitude** = cos(43°35')*930 m = 0.72*930 = **~ 670 m**



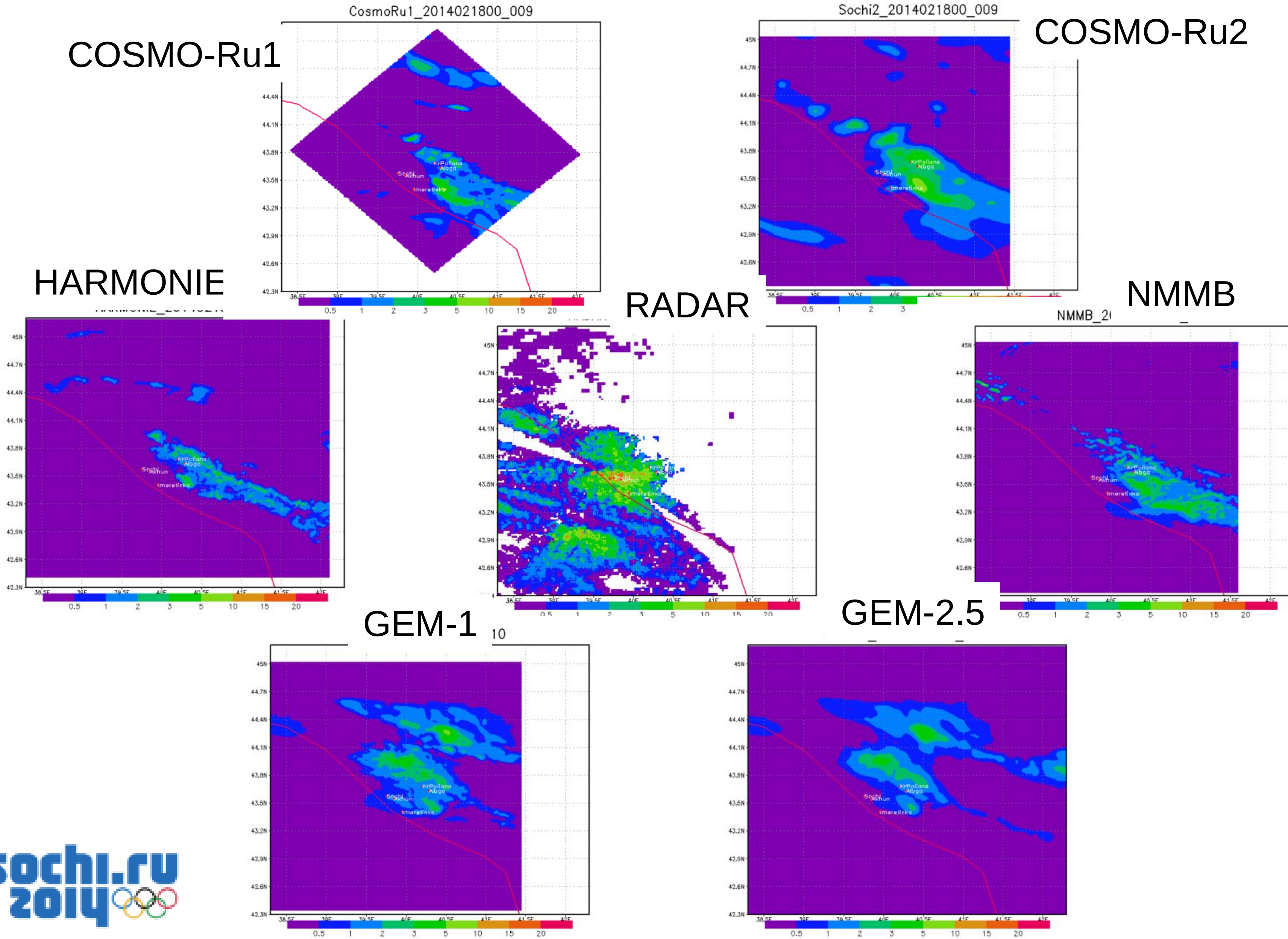
COSMO-Ru2 domain

COSMO-Ru1 domain

All the models were interpolated into the radar grid using GRADS (function *lterp*)

- COSMO-Ru1 (1 km)
- COSMO-Ru2 (2 km)
- NMMB (1 km)
- HARMONIE (1 km)
- GEM-1 (1 km)
- GEM-2.5 (2.5 km)

18 Feb 2014, 09 UTC, cold front: All models underestimated max precip and didn't give precip over the sea.



CRA – Contiguous Rain Area (E.E. Ebert, J.L. McBride 2000)

http://www.cawcr.gov.au/projects/verification/CRA/CRA_verification.html

MSEtotal = MSEdisplacement + MSEvolume + MSEpattern

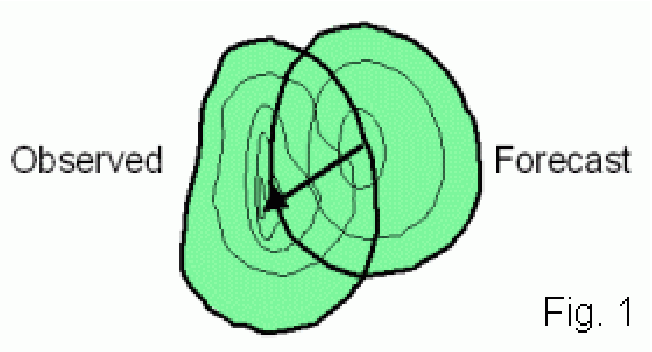


Fig. 1

MSEdisplacement = MSEtotal – MSEshifted

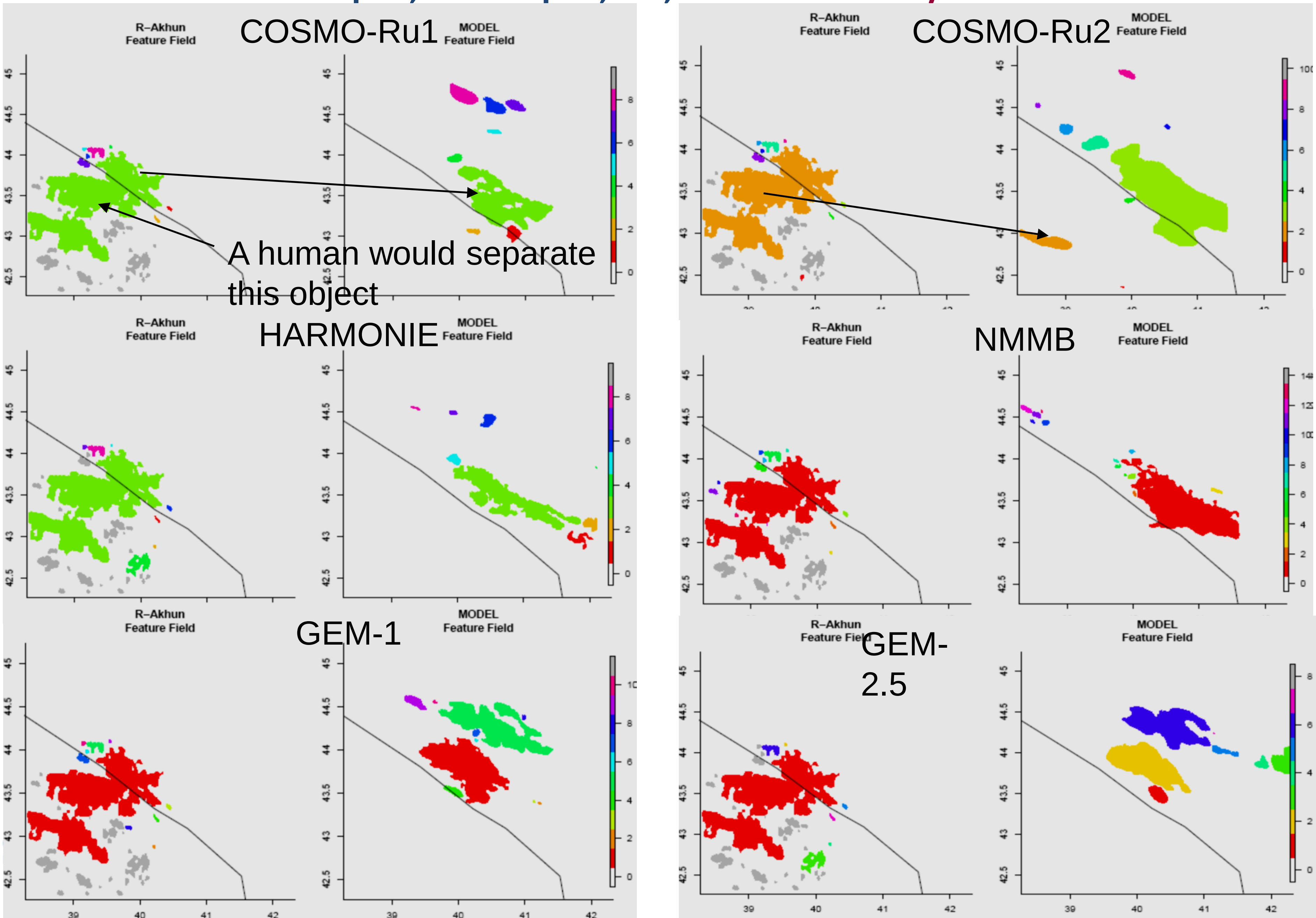
MSEvolume = (***F*** - ***X***)2
where ***F*** and ***X*** are the CRA mean forecast and observed values after the shift.

MSEpattern = MSEshift – MSEvolume

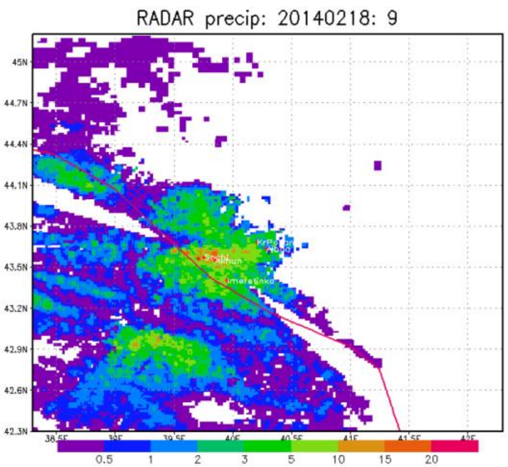
The CRA concept is easy to understand,
but there are many important issues and nuances in application of the CRA

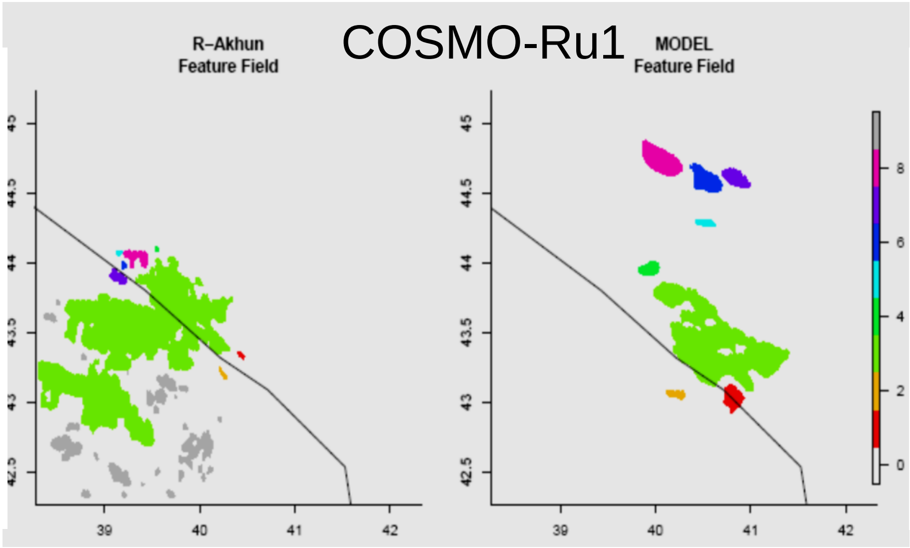
Pairs of matched objects from *craer*, 18 Feb 2014, 09 UTC

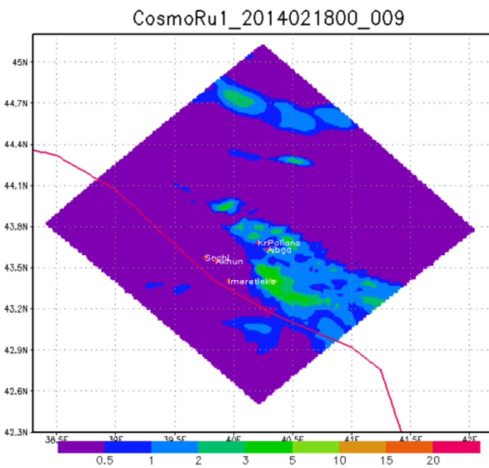
Colors indicate the 1st pair, the 2^{nd} pair, etc, threshold: 1mm/h



COSMO-Ru1







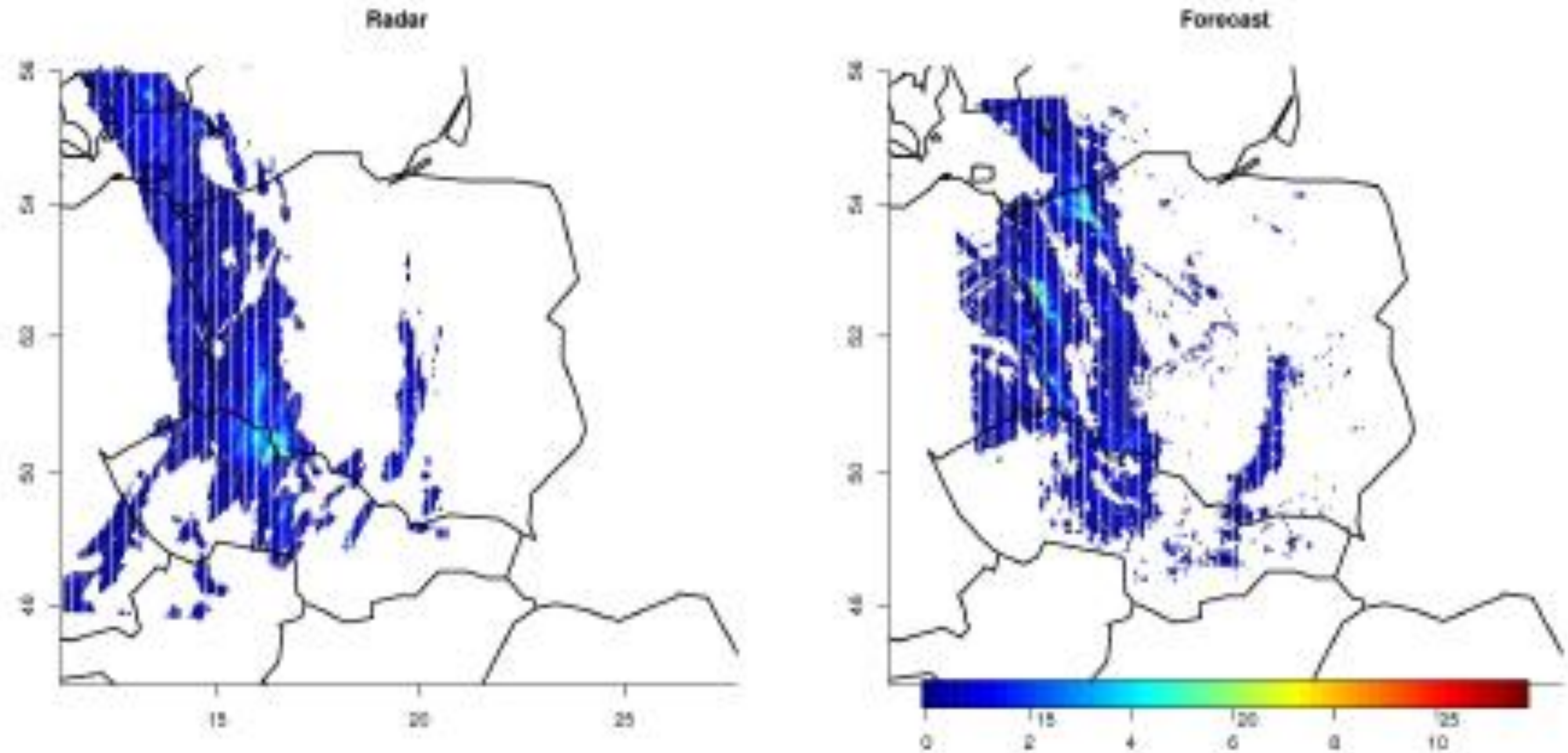
ir	x	y	MSE.total	MSE.shift	MSE.displace	MSE.volume	MSE.pattern
1	45.4021	-36.5179	0.0028	0.0023	0.0005	0.0000	0.0022
2	-2.7630	-17.8333	0.0011	0.0007	0.0004	0.0000	0.0007
3	159.7069	2.3035	0.1246	0.0820	0.0426	0.0027	0.0793
4	45.9893	-16.9170	0.0014	0.0012	0.0002	0.0000	0.0012
5	164.7442	25.5963	0.0011	0.0006	0.0005	0.0000	0.0006
6	159.3112	74.1525	0.0037	0.0033	0.0004	0.0000	0.0033
7	204.6084	85.0732	0.0032	0.0013	0.0019	0.0000	0.0013
8	85.7776	83.9482	0.0068	0.0036	0.0031	0.0000	0.0036

According to these scores, most of the total MSE error comes from the small-scale pattern errors for most object pairs

MODE application to COSMO PL

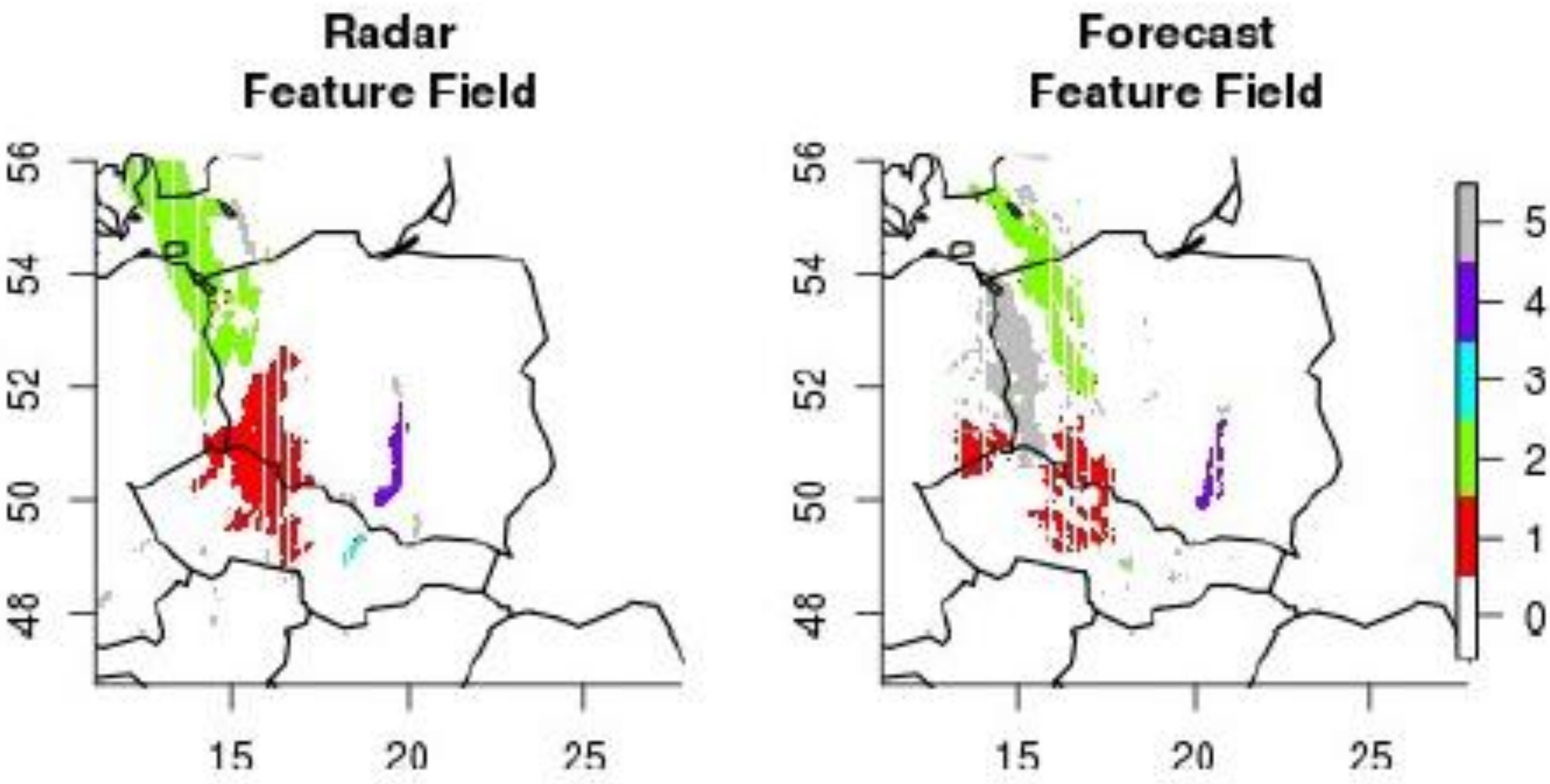
Joanna Linkowska
Andrzej Wyszogrodzki
IMGW-PIB

25.08.2015, 07 UTC
COSMO PL 2.8, 24.08.2015 18 UTC + T13



make.SpatialVx

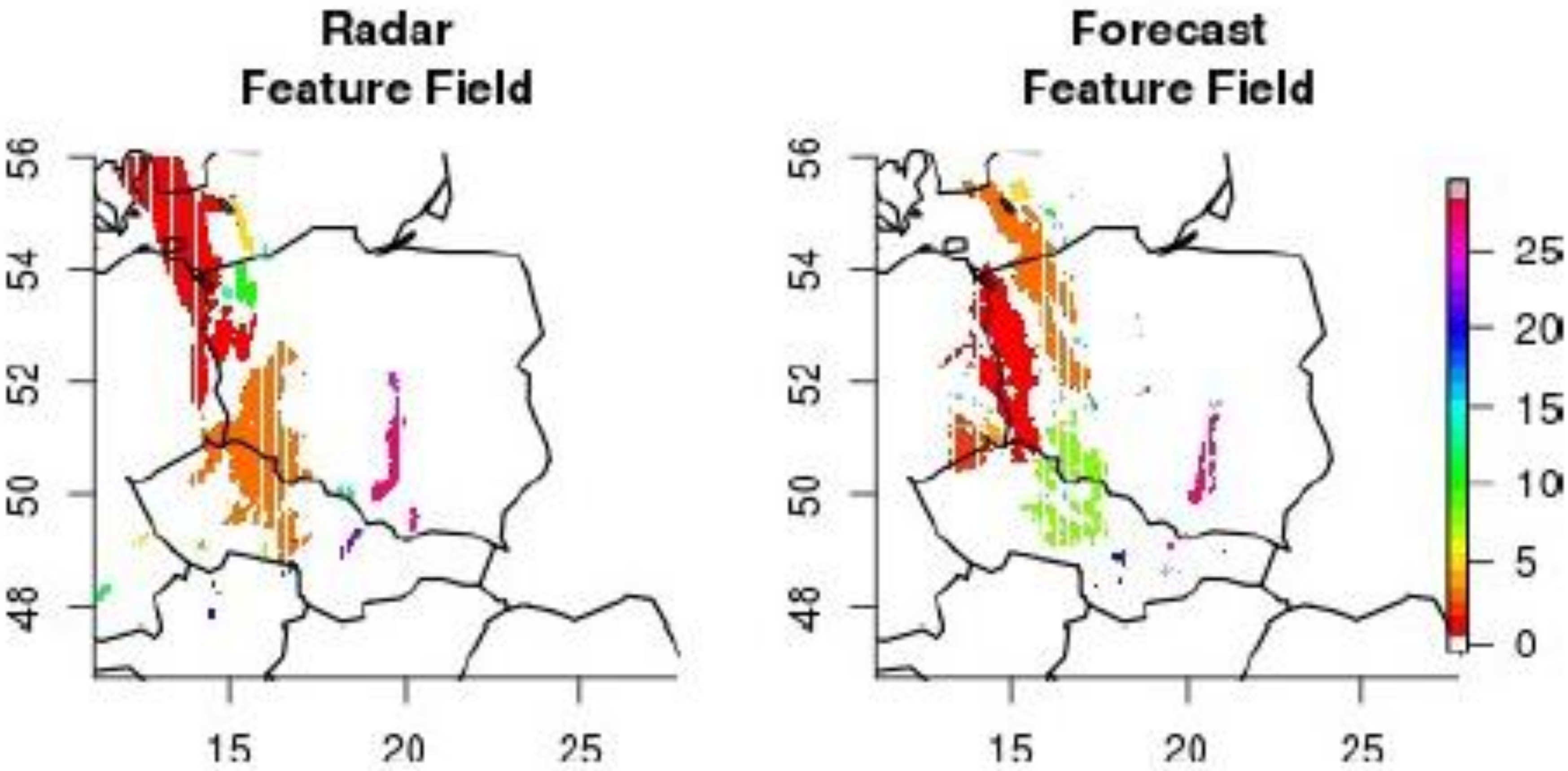
Centmatch = 2, smoothpar = 1.5, thresh = 0.15
25.08.2015, 17 UTC
COSMO PL 2.8, 24.08.2015 18 UTC +T13



White - Zero values, Grey - Unmatched features

D < **average size of the two features**

Minboundmatch, smoothpar = 1.5, thresh = 0.15
25.08.2015, 07 UTC
COSMO PL 2.8, 24.08.2015 18 UTC +T13



Tasks under question:

- 3d: Application of SAL verification methods (over Italy, and for the core MesoVICT case) (ARPA-PT)
- Participation of MCH in task 1c (Perform reruns of COSMO-E for MesoVICT test cases) and 4b (Verification study of, possibly, COSMO-E ensemble for MesoVICT cases)

Delayed tasks

- 3f: Application of traditional categorical scores and spatial verification methods to analyze extreme precipitation events based on MesoVICT cases (RHM, IMGW-PIB)

- 5a. Follow-up of the outcomes from the Tasks of INSPECT and the work accomplished in MesoVICT test cases by the international community: classification of the analysis into categories (e.g. filtering, displacement methods) followed by an intercomparison of the outcomes for each category (assessment of differences/resemblances to the MesoVICT cases applications). (MCH, HNMS, RHM)

  The overview of MesoVICT activities will be given after the MesoVICT session at the EMS-ECAM meeting in Sofia in September 2015.

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Intercomparison of Spatial Verification Methods for COSMO Terrain (INSPECT): Preliminary Results

Dmitry Alferov (1), Elena Astakhova (1), Dimitra Boukouvala (2), Anastasia Bundel (1), Ulrich Damrath (3), Pierre Eckert (4), Flora Gofa (2), Alexander Kirsanov (1), Xavier Lapillonne (4), Joanna Linkowska (5), Chiara Marsigli (6), Andrea Montani (6), Anatoly Muraviev (1), Elena Oberto (7), Maria Stefania Tesini (6), Naima Vela (7), Andrzej Wyszogrodzki (5), and Mikhail Zaichenko (1)

(1) RHM (a.bundel@gmail.com), (2) HNMS, (3) DWD, (4) MCH, (5) IMGW-PIB, (6) ARPA-SIMC, (7) ARPA-PT

A COSMO consortium project devoted to spatial verification methods (INSPECT) has been created to follow MesoVICT activities and to summarize the experience of applying spatial verification methods to high and very high resolution models (deterministic and EPS) comprising COSMO forecast systems. In addition to targeting the objectives of MesoVICT, INSPECT has been designed with the aim of providing COSMO users with more choice of verification domains and reference data, and encouraging the participation of the COSMO community in the development and improvement of spatial verification methods. It is planned to propose a set of Guidelines by the end of the project to facilitate decision-making about which methods are best suited to particular applications.
Some first results concern applications at DWD, where the FSS and ETS for the upscaling method are calculated for 6-hr precipitation data over the entire German territory since 2007, providing plots of long-term trend of these indices. It is shown that a lower threshold and larger window give the highest skill in all cases. Such plots allow compact representation of the neighborhood scores.
Application of neighborhood (FSS, ETS) and possibly features-based (CRA) methods for deterministic models of different resolution for the Sochi region (COSMO-Ru with grid spacing 1km, 2.2 km, 7km; GEM with grid spacing 2.5 km, 1 km, 0.25 km; NMMB – 1 km; HARMONIE – 1 km; INCA – 1 km) will provide some indication of the ability to compare high and very high resolution models in complex terrain.

Thank you for your attention!