Overview of verification activities in the consortium

Flora Gofa

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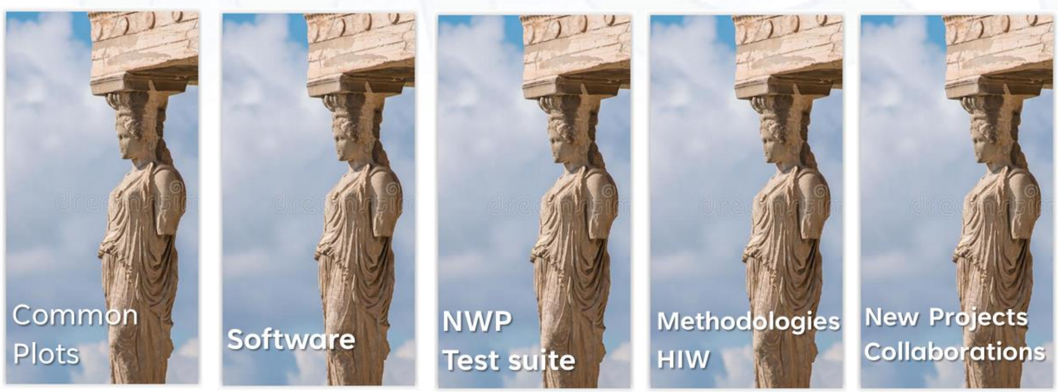
Verification Group Guidelines

https://www.cosmo-model.org/content/consortium/reports/WG5_Guidelines_2021.pdf

- Common Verification framework: developments concerning EPS verification with MEC-Rfdbk and its conditional verification capabilities. *PP-CARMA, PP-CARMENs*
- Exploitation of spatial verification techniques: Analyse how methods relate to one another, how each method works, what information could be gleaned from each method, and whether a given method actually conveys useful information *PP-INSPECT, PP-AWARE*
- Severe and High Impact Weather. Forecast methods and verification are important aspects of any HIW consideration. *PP-AWARE:* addresses issues such the representation in the observations of HIW, importance of observation uncertainty, systematic and stochastic errors of HIW forecasts and their sensitivity to model resolution.
- Utilization of non-conventional observational datasets: obs often do not permit characterization of the phenomenon of interest for objective verification. Discussion on new PT on crowdsource data potential in NWP applications



calculation and representation of verification results *of statistical indices derived using* ***operational ICON-LAM and/or COSMO implemenations*** *in each service.*

Domain (common or not), resolution, statistical scores/methods, frequency and graphical representation, are decided on an ***annual basis*** *http://www.cosmo-model.org/content/tasks/verification.priv/default.htm*

CONSORTIUM FOR SMALL SCALE MODELING

COSMO

COSMO GM 2022

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Work Groups
Priority Projects
Priority Tasks
Model Management
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ICON Transition
Home

Verification tasks

Last updated: 7 Mar 2022

In the framework of WG5 verification activities, statistical scores are produced on a seasonal basis over Common Verification Areas and over national domains. For the station based approach (point verification), a Common Verification Software is used for all operational COSMO deterministic models. On the other hand, the evaluation with fuzzy (neighborhood) spatial methods is performed with VAST software over common areas. The technical details and the specifications of the verification analysis, are available in the guidelines which are prepared on an annual basis by the WG5C (pdf document, last updated in Nov 2021).

Point-wise Verification

The preparation of Common Plots based on Feedback Files is performed with the **MEC/Rfdbk statistical framework** and they can be viewed interactively in the links below:

continuous parameters	domain average, against SYNOP stations
continuous: geographical plots	station average
continuous: time series	domain average
categorical parameters	domain average, against SYNOP stations
categorical: geographical plots	station average
upper air	domain average, against TEMP stations
upper air: geographical plots	station average
upper air: time series	domain average

The verification files (Rdata) that can be viewed through the links above, follow a naming protocol that is described in this document.

Fuzzy (neighborhood method) Verification

Fuzzy verification scores for precipitation forecasts are calculated over ComA-2 for operational deterministic models that cover this area. The comparison is performed against the OPERA network radar composites. For this activity, VAST COSMO software is used that is based on Beth Ebert fuzzy verification IDL code. On the menu, plots of FSS, POD and FAR scores are provided on a seasonal basis

(in testing phase, summer 2021 scores currently available, d0:first, d1:second forecast day)

FAR | 2022 | Autumn | both days | show

Verification documentation

user guide	description of the usage of the web-based tool and the interpretation of the shown scores.
data format	Feedback File Definition (pdf, Harald Anlauf & Andreas Rhodin, 2019)
guidelines	Feedback File Verification Suite at DWD (Felix Fundel, 2022)
training	Feedback File Verification Training Course (Felix Fundel, 2019)

In 2015, WG5 submitted to the Steering Commitee, a recommendation document for COSMO verification tools. The STC considered it and published the Strategy on Verification Tools.

Verification analysis based on point-wise verification prior to **Aug 2021** (VERSUS and MEC-Rfdbk software derived), can be viewed through older-style plots.

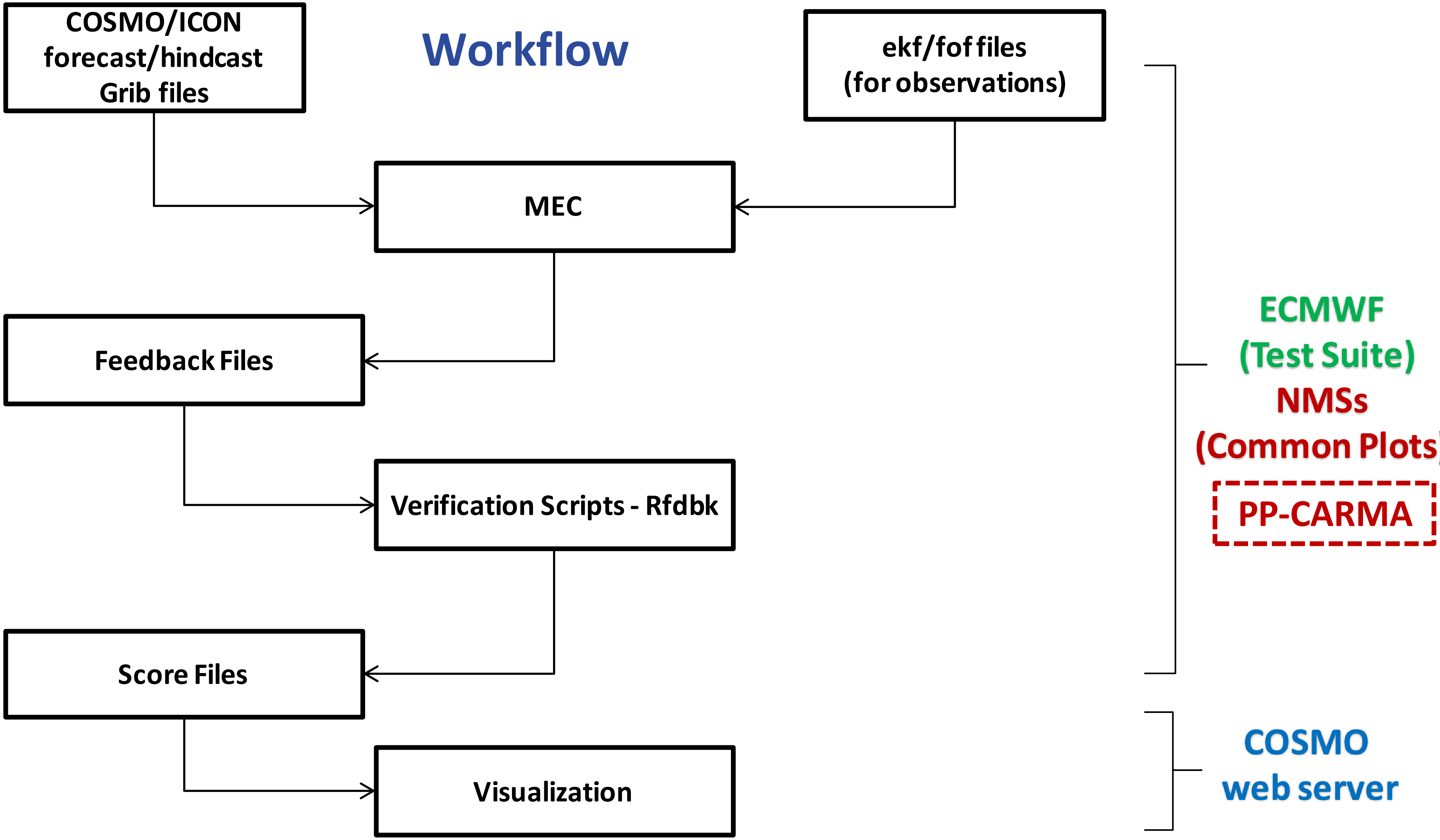
Edit

From 2015 to 2020, findings were summarized in annual reports. Since 2021, the annual scores are submitted through newletter entry.

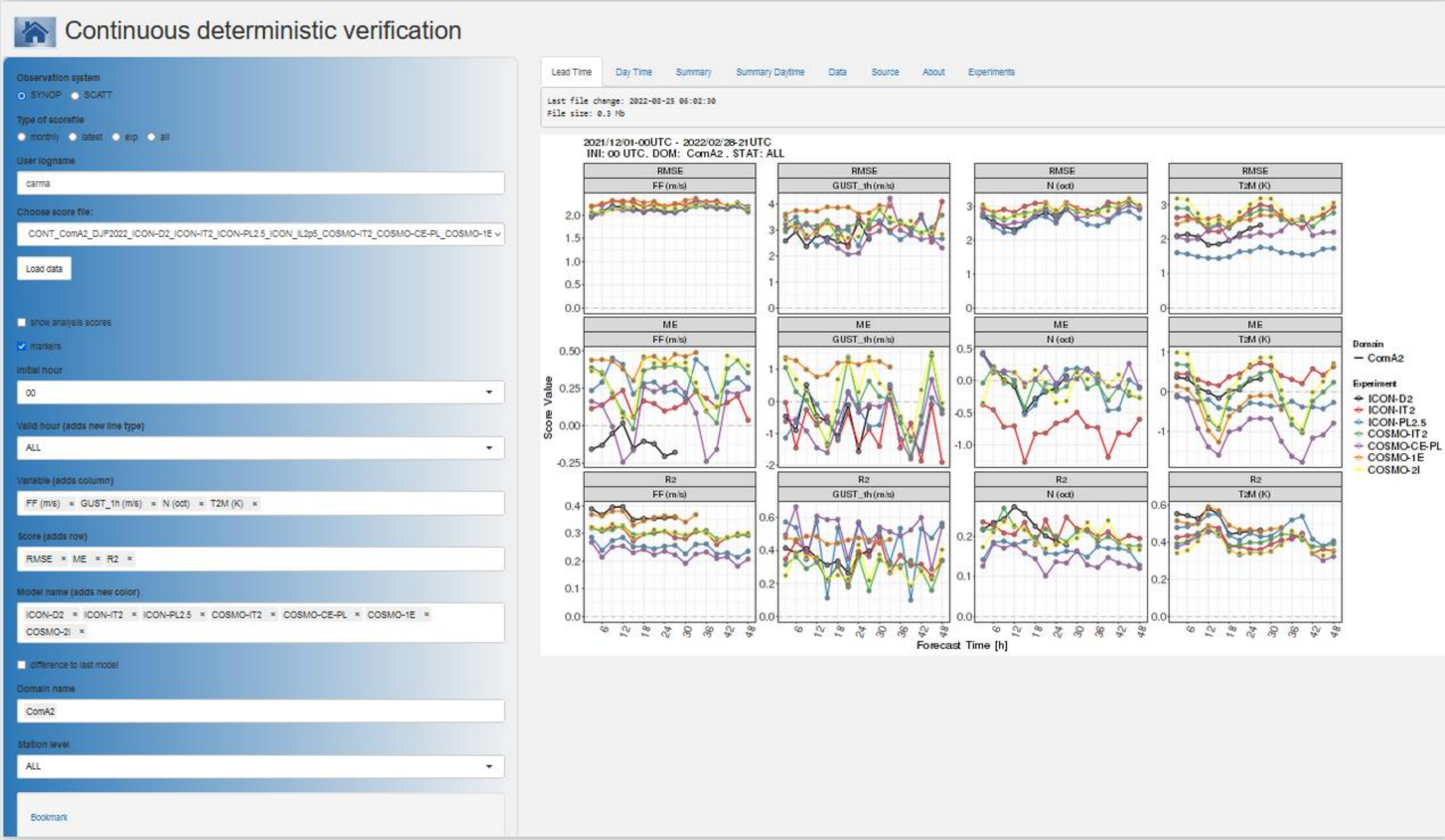
The 2015-to-2020 reports are still **available** to see.

Feedback File based Verification

Felix Fundel
Deutscher Wetterdienst
Wetter und Klima aus einer Hand



COSMO shiny web server



Felix Fundel
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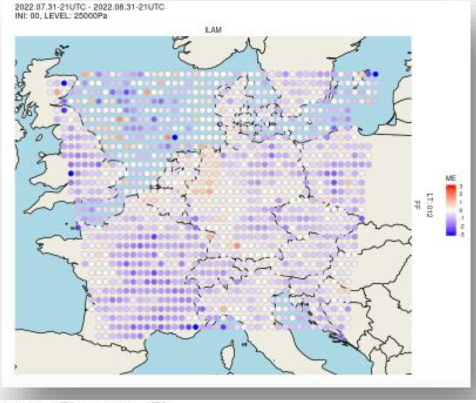
Wetter und Klima aus einer Hand

Advances in Rfdbk and Feedback File Verification at DWD

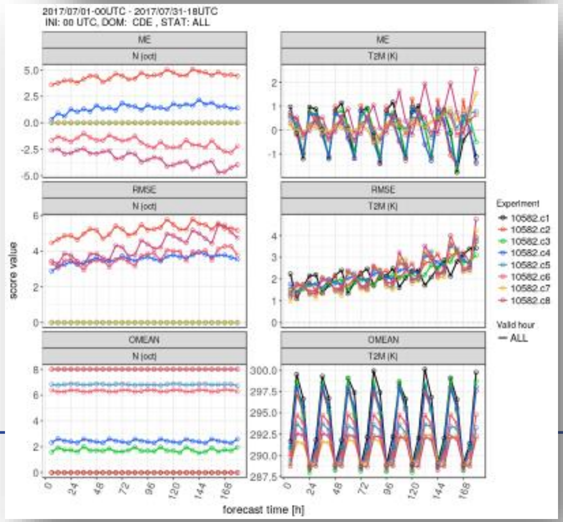
New (FFV2)

- Modular structure
- Functions for each verification task that work with all forecast and observation systems
- Rfdbk package is integrated in FFV2 package so no longer needed
- FFV2 is in many parts more memory efficient and better parallelizable.



New features: Verification of non-local observation systems

- Moving observation systems do not allow for a station based verification.
- Score for one location would be supported by one observation only.
- FFV2 offers option to aggregate scores on a user defined lat-lon grid.



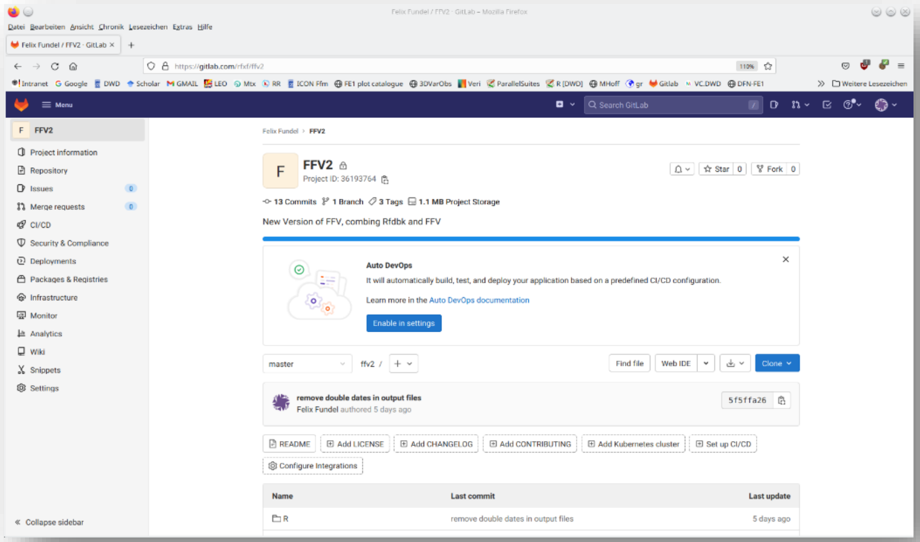
New features: Conditional Verification based on external data

- Using observation properties to define conditions
- Several properties can be combined
- New: Conditional verification required data to make the decision to be contained in the feedback file (e.g. T2M score based on TCC threshold).
- FFV2 allows to read external data on model grid.to be used to make conditions.
- So far it covers data in NetCDF on native ICON grid.

Felix Fundel

Package

https://gitlab.com/rfxf/ffv2



Install

git clone git@gitlab.com:rfxf/FFV2.git
R CMD INSTALL FFV2

Run (example)

Rscript ../Rlib/FFV2/demo/starter_scores_by_date.R namelist.nl SYNOP DET 6
Rscript ../Rlib/FFV2/demo/starter_aggregate.R namelist.nl SYNOP DET 6

PP CARMENs

Cosmo Application of Rfdbk/MEC on ENS

Goal

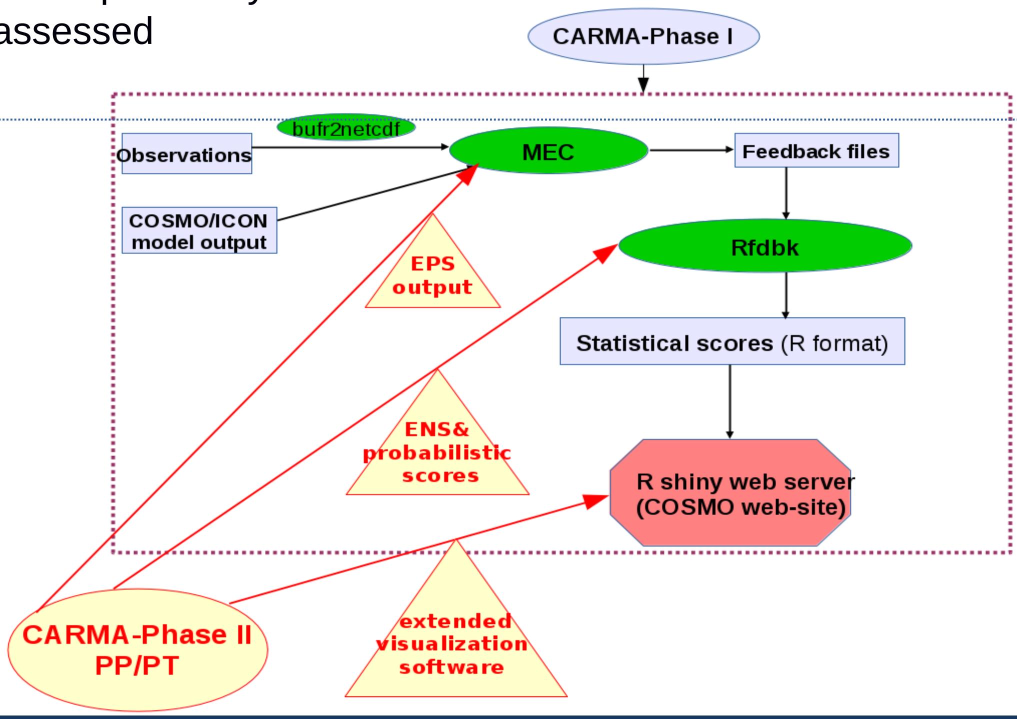
PL: Amalia IRIZA-BURCĂ (NMA)

➔ **extend the implementation and usage of the MEC-Rfdbk system to the evaluation of EPS model outputs**

➔ Minimum basis for the monitoring of performance and homogeneous definition of scores

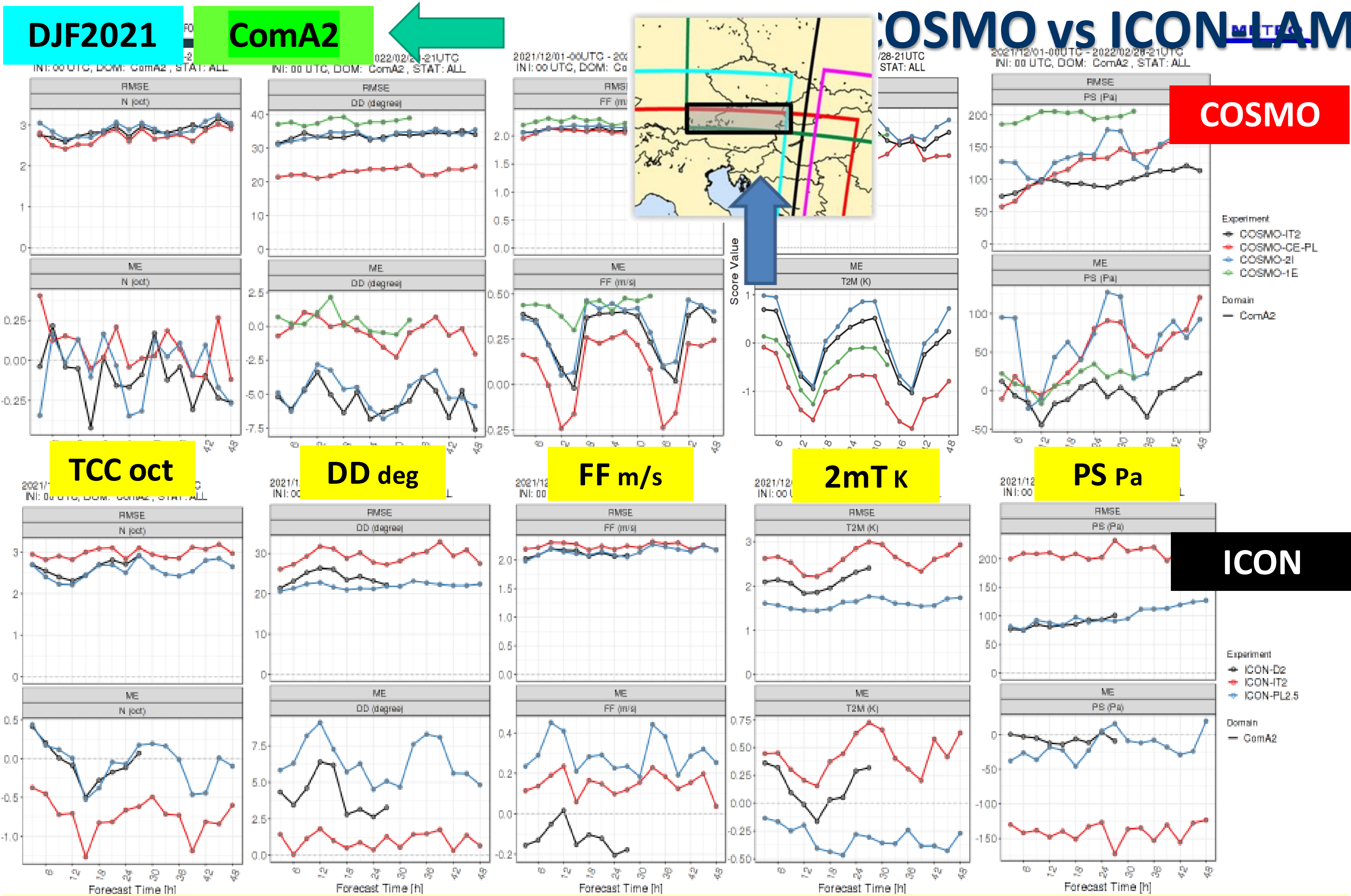
➔ available statistical results for selected time periods of ensemble COSMO and ICON-LAM based systems over national domains to be produced and published on the COSMO Verification web page

➔ the possibility of an extension of Common Plot activities to EPS (selectively over common areas) will be assessed



EPS run operationally by COSMO members are:

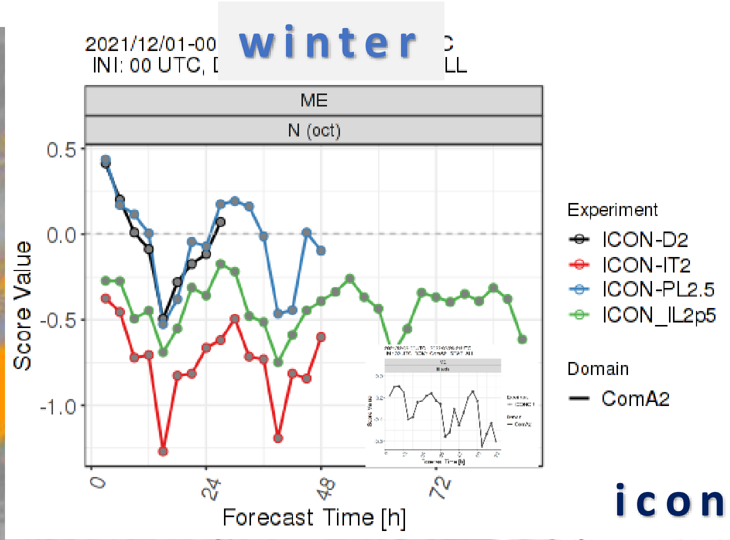
COSMO-LEPS (COSMO)
ICON-D2-EPS (DWD)
COSMO-2E and COSMO-1E (MCH)
TLE-MVE (IMGW)
COSMO-IT-EPS (CNMCA)
COSMO-IL-ENS (IMS)
COSMO-2I-EPS (ArpaE)

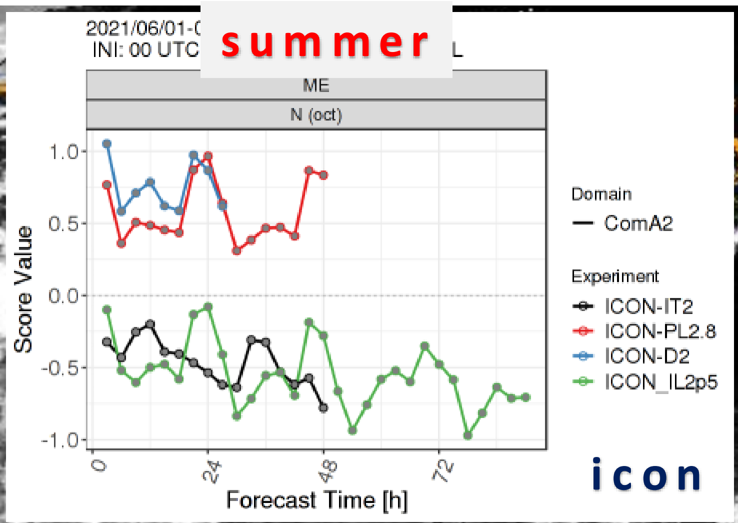


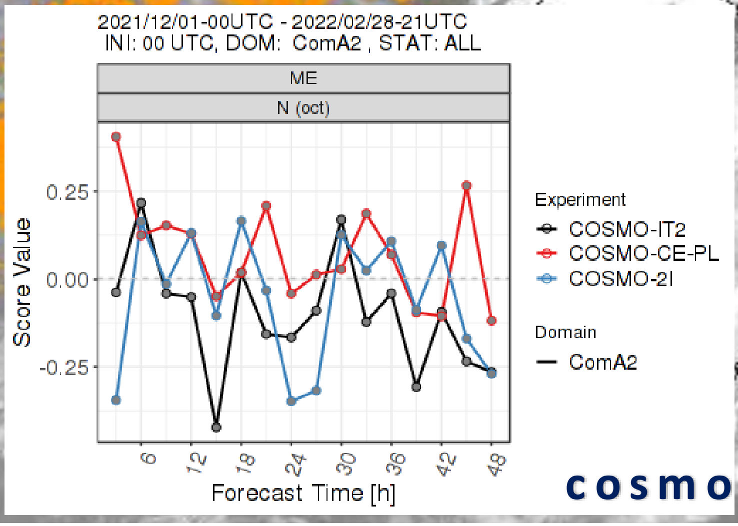
OVERALL: Smaller amplitudes of BIAS diurnal cycle. reduced RMSEs in ICON-LAMs;

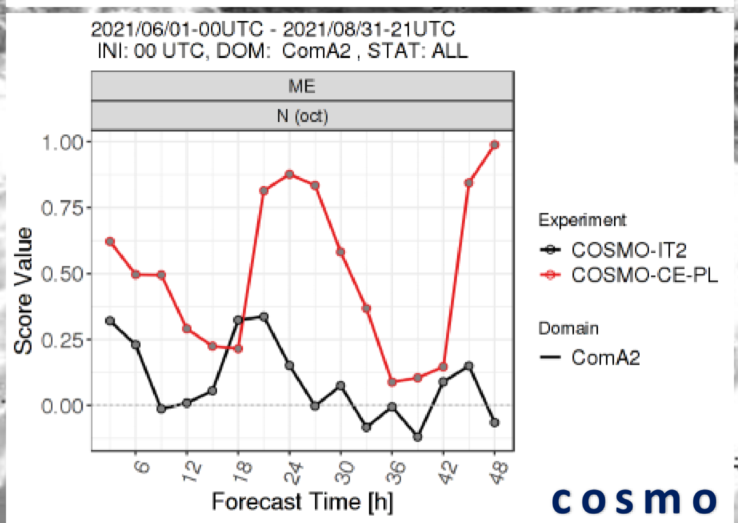
Reduction of **T2m** error, FF with smaller positive impact, reduction in error in DD partially associated with Pa error reduction. TCC performance not clearly improved. Spread among ICON-LAMs in performance

Verification against SYNOP:COSMO/ICON



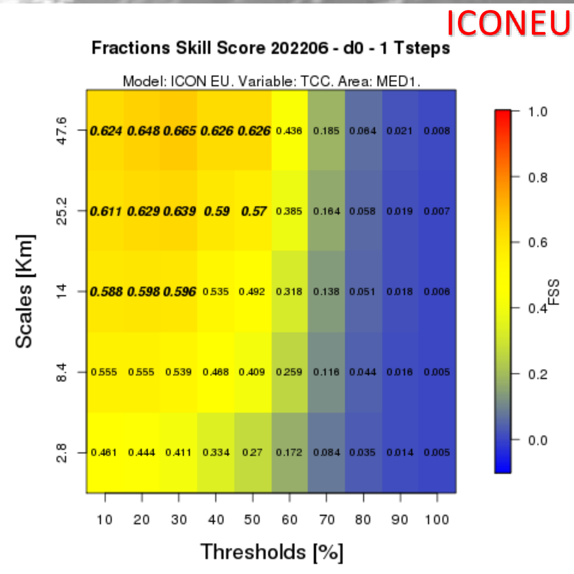


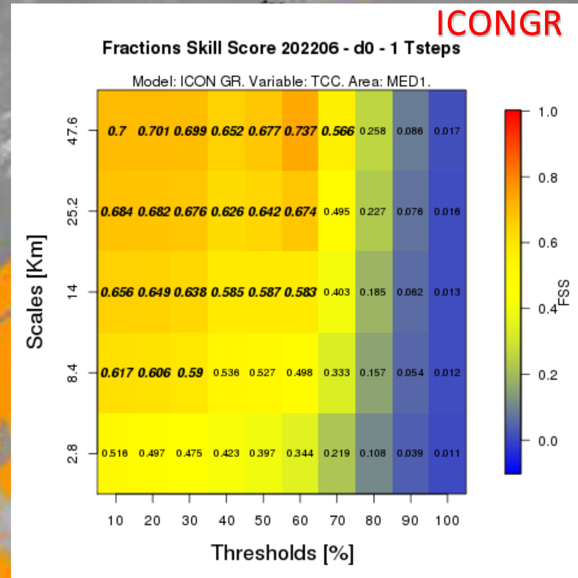


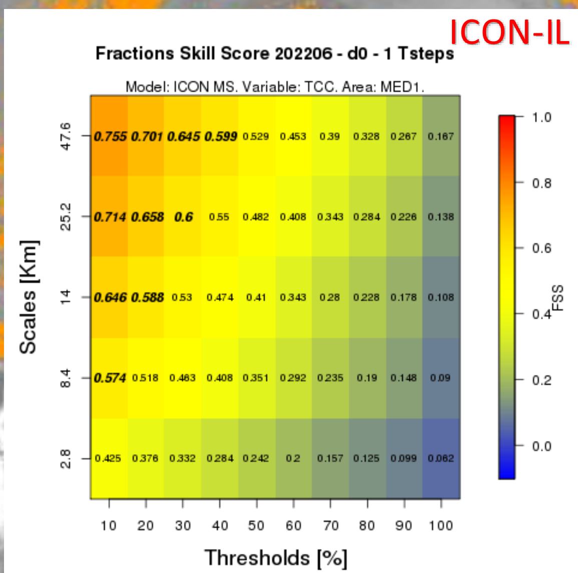


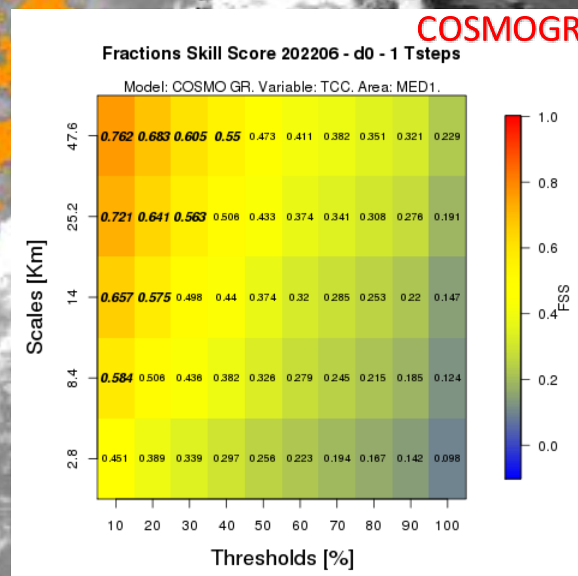
- During winter, great underestimation of ICON models during afternoon
- Strong overestimation in summer by COSMO models mainly during night hours, while for ICON behaviour is ambiguous

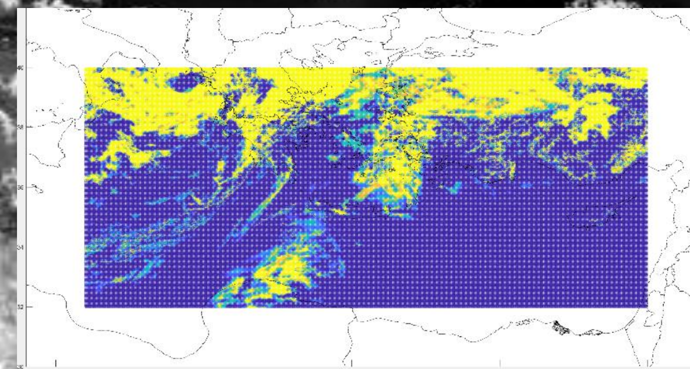
Verification agst NWCSAF
Period: 01-31 Jun 2022
Area: Mediterranean
Sample: 3h timesteps
Index: FSS
Models: ICONGR, COSMOGR, ICONEU, ICON-IL2p5





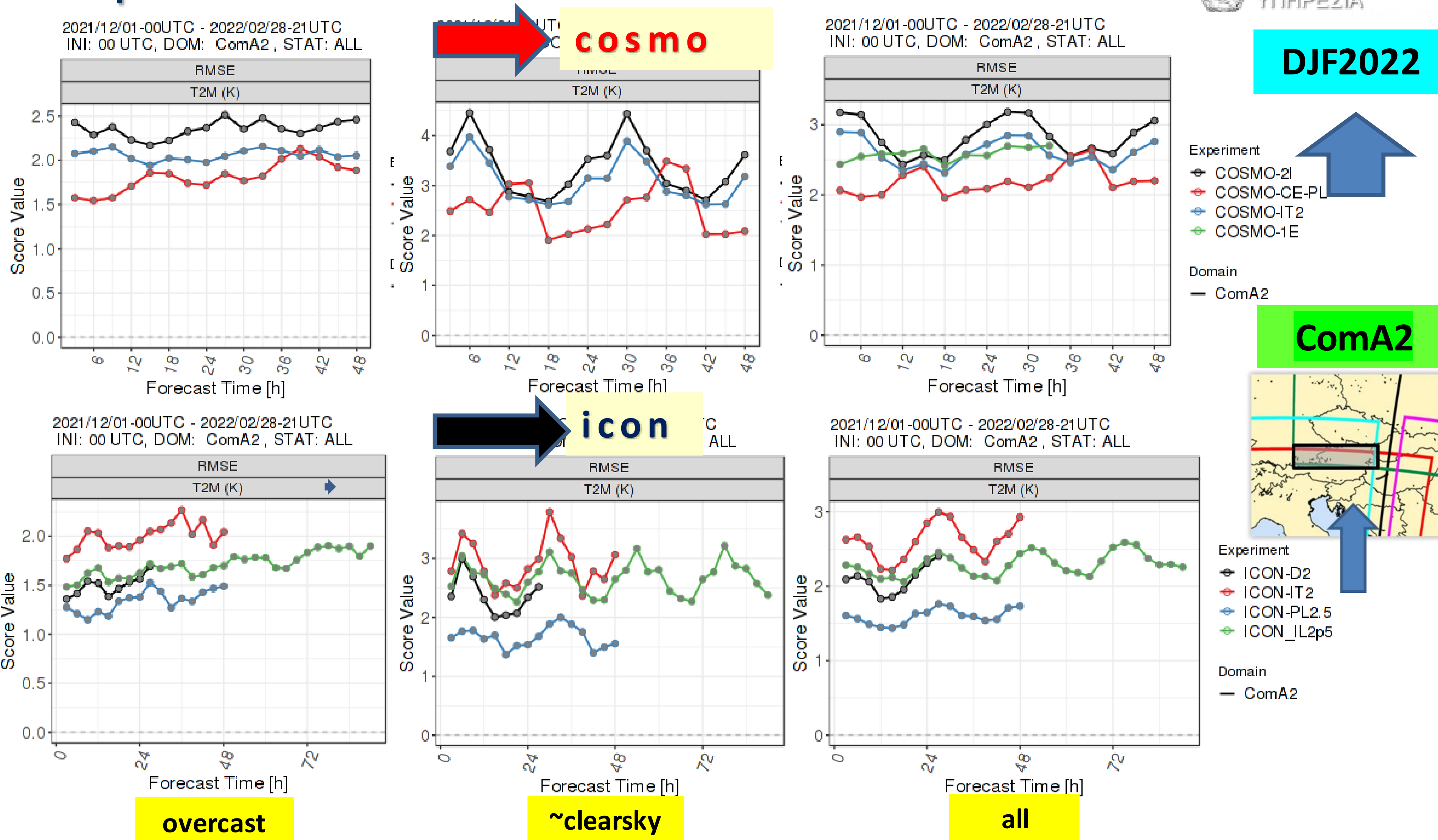






Useful scales for larger spatial windows (>14km) and for less smaller amounts of cloudiness
COSMO at higher TCC% outperforms ICON-LAMs over sea areas.

Temperature w.r.t. Cloudiness - RMSE

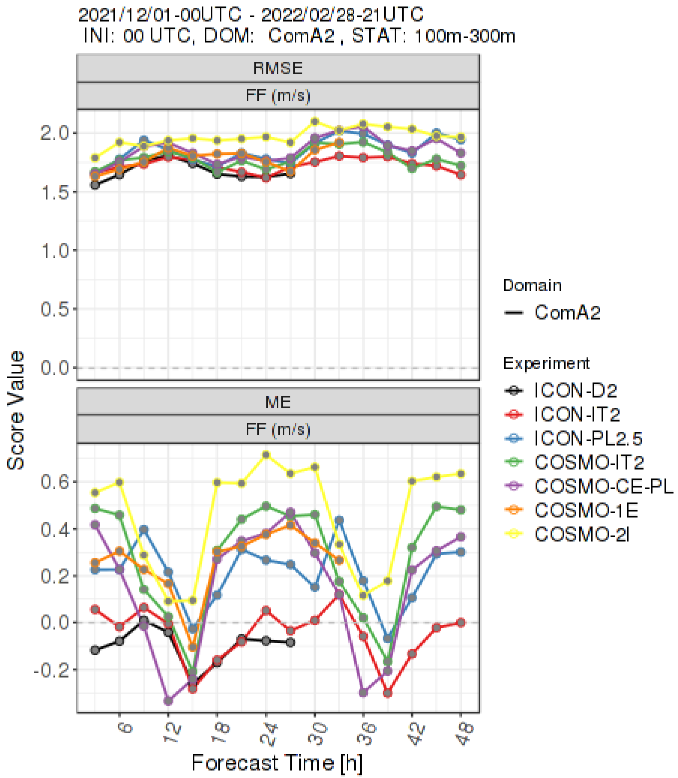


Winter: Higher errors in 2mT in clear sky conditions, and lower errors when overcast conditions only.
Stronger diurnal variability of error with COSMO models in days with few clouds
Significantly improved performance of 2mT with ICON models in the winter in all cases.

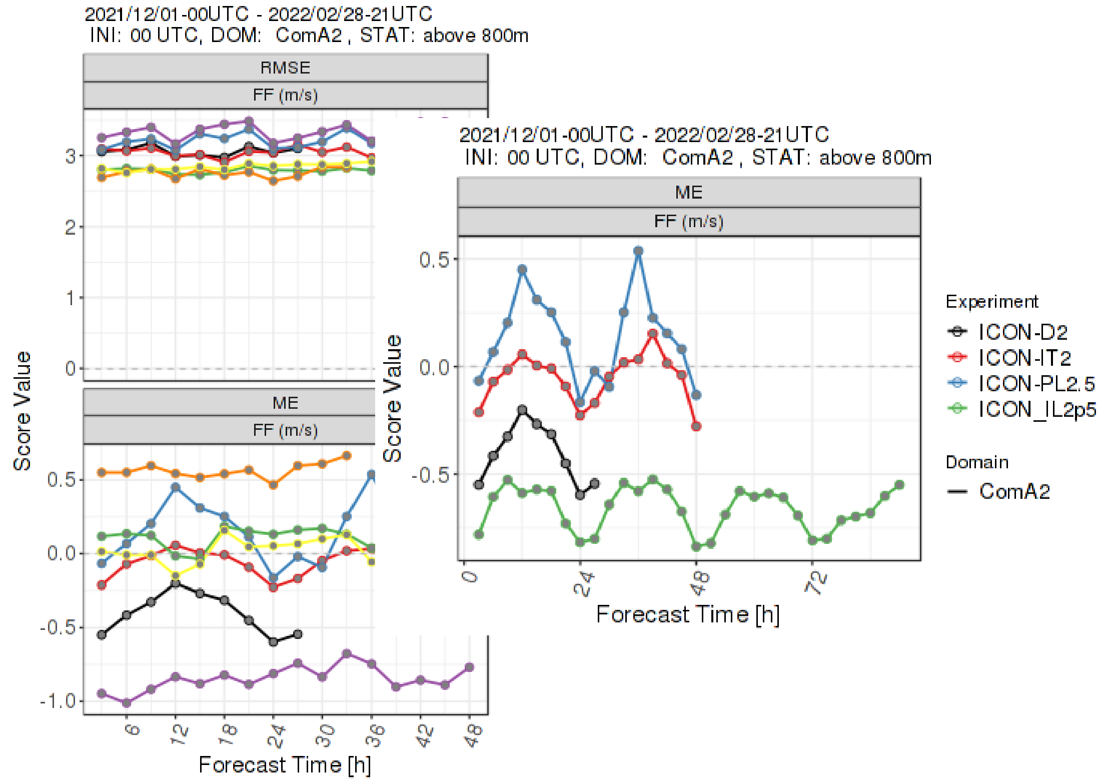
ComA2 MAM2022

Wind Speed wrt Elevation

Lower Elevation



Higher Elevation



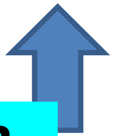
Clear altitude dependence in performance.
Error grows rapidly in higher elevation points, with a general underestimation of windSp.
ICON-LAMs more consistently underestimate WindSp in stations above 800m

6h Precipitation

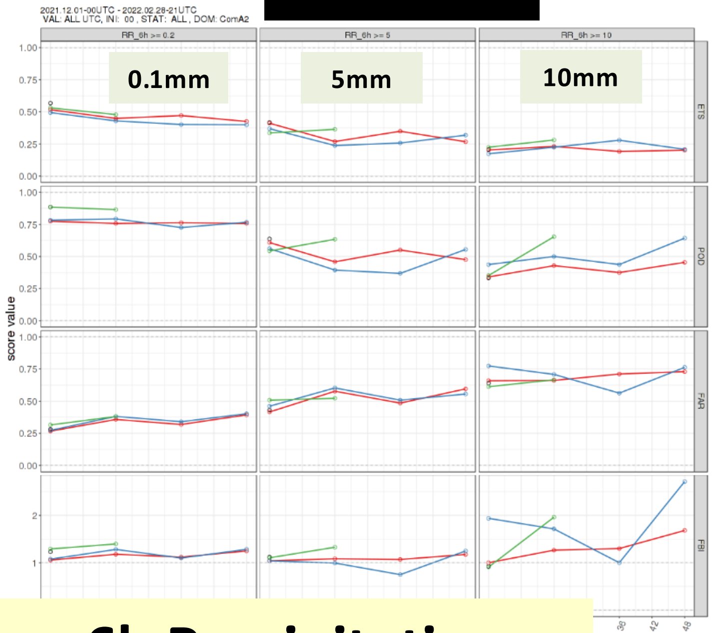
ICON

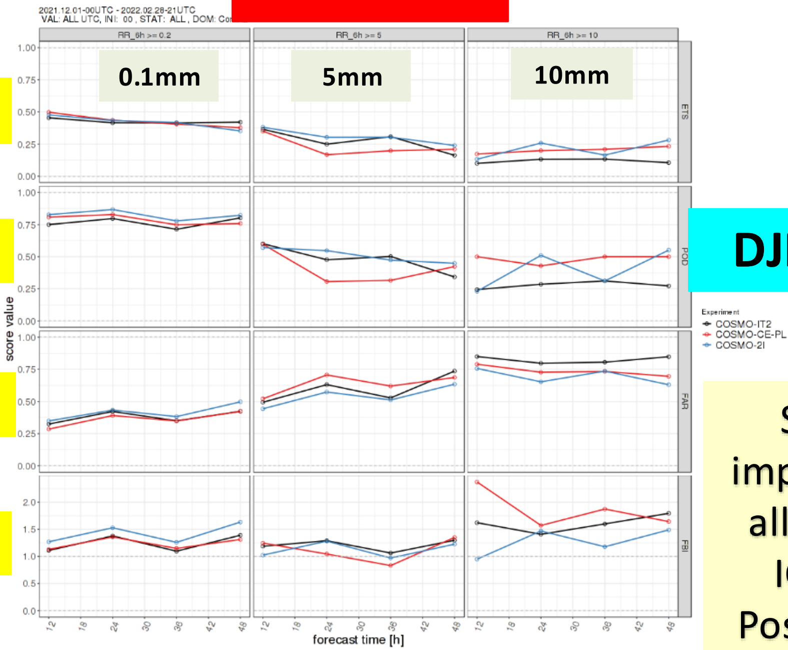
COSMO

ComA2

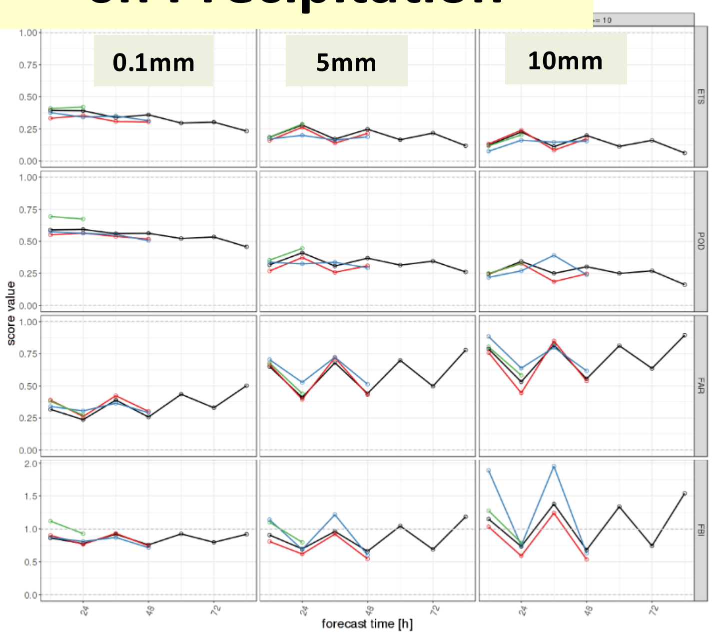


DJF2022

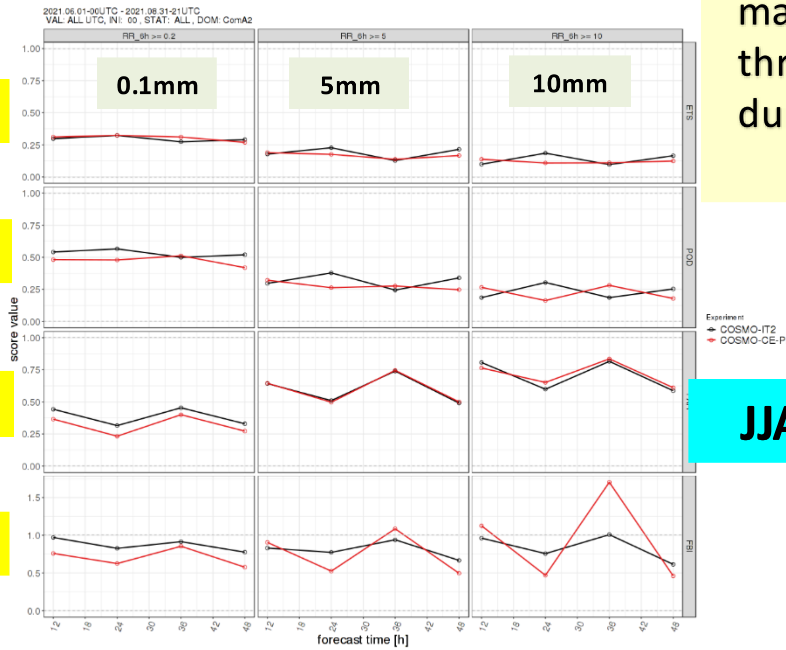




Significant improvement in all scores with ICON-LAMs
Positive change mainly in lower thresholds and during summer period

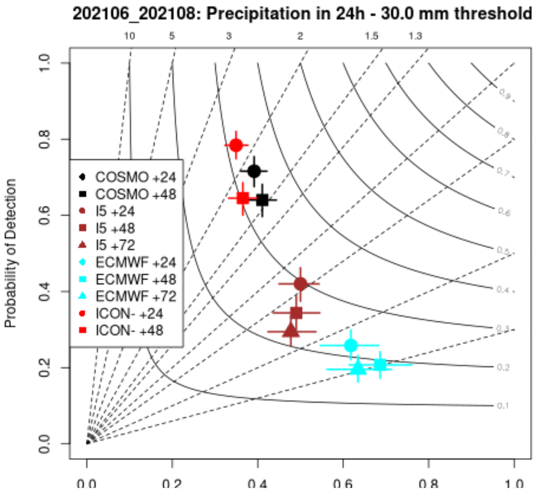


JJA2021

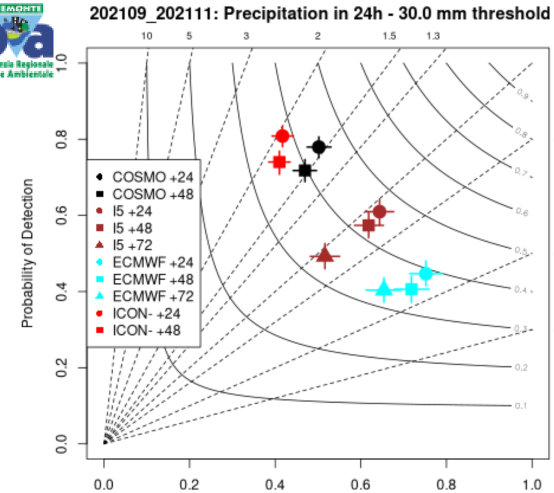


Performance diagram Maximum Values 30mm/24h

JJA 2021

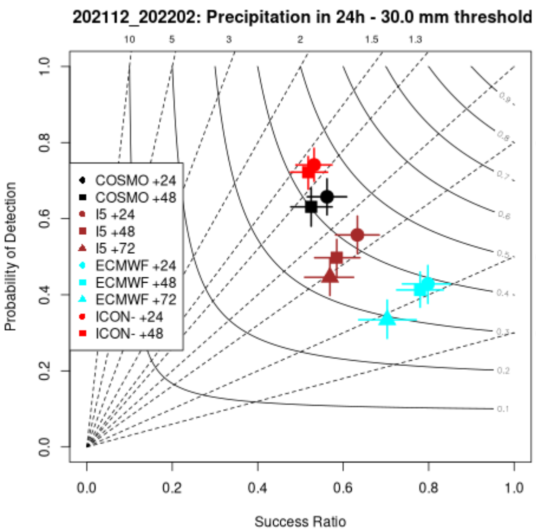


SON 2021

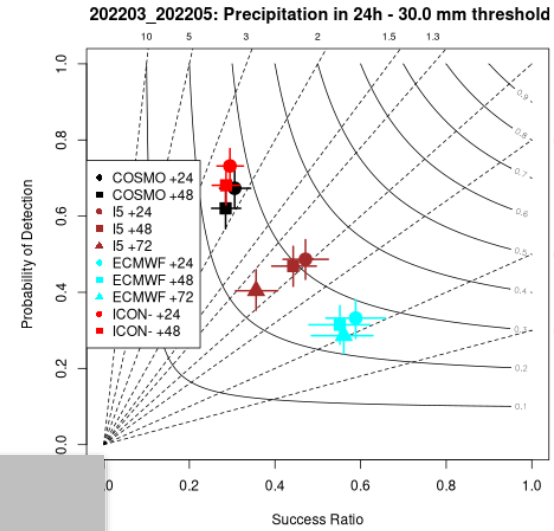


For the issuance of civil protection alerts, information on precipitation maxima is of fundamental importance: the COSMO/ICON models at 2Km resolution, even if at the expense of many false alarms, are able to provide a valid support compared to what IFS does, in particular at the highest thresholds (30mm)

DJF 2022



MAM 2022

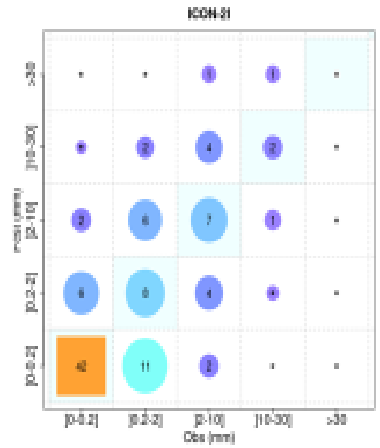


ICON= ICON-IT run from CNMCA
COSMO= COSMO-2I run from Arpae
I5= COSMO-5M run from Arpae
ECMWF= IFS High resolution run from ECMWF

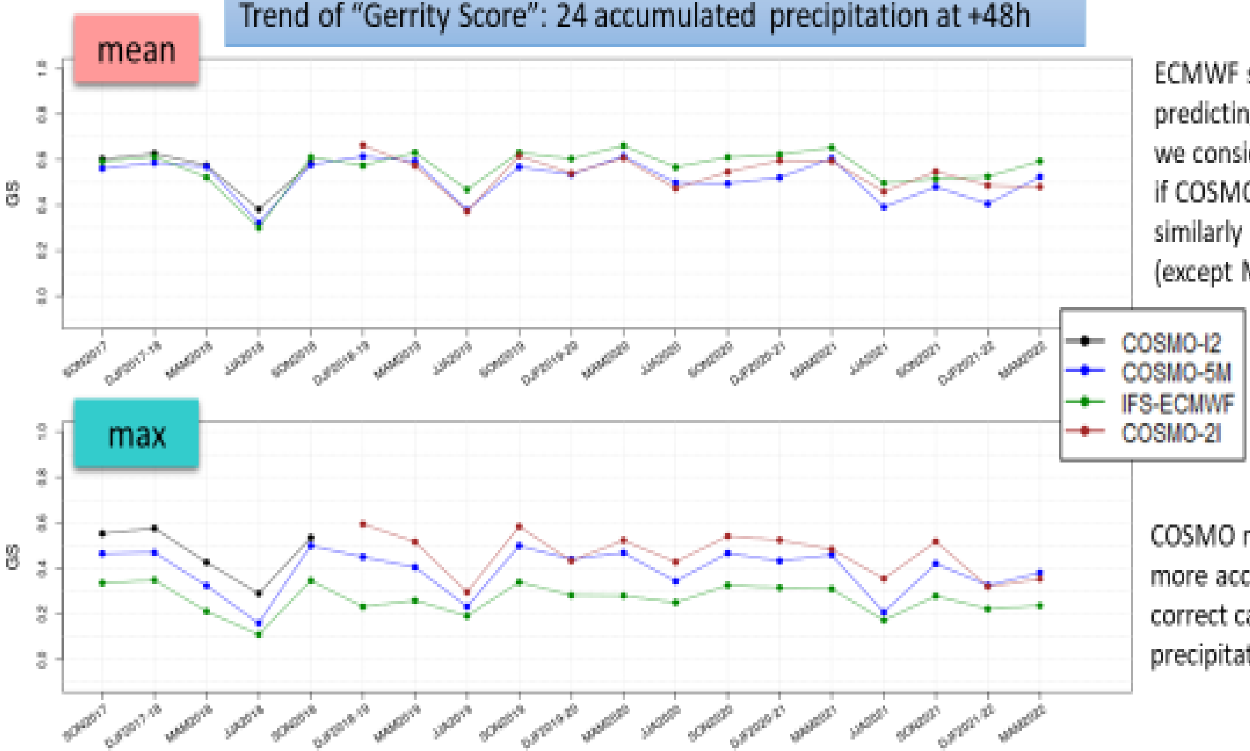
Visual verification with "bubble plots" can be useful to evaluate the behavior of model over a single area

For an objective summary, the use of **Gerrity-Score** allows to evaluate the ability of the model to correctly separate the various classes/category.

Multi-category verification shows that high resolution models (COSMO-2I or ICON-IT/2I) are able to reproduce the precipitation spectrum within the alert areas, distinguishing well especially the precipitation maxima.



Trend of "Gerrity Score": 24 accumulated precipitation at +48h



Range: -1 to 1, 0 indicates no skill. Perfect score:1

ECMWF seems more accurate in predicting the correct category if we consider the mean value, even if COSMO-2I performed very similarly in the last year (except MAM)

COSMO models (in particular2I) are more accurate in representing the correct category for the maximum precipitation

CLASSES FOR MEAN PRECIPITATION	
mm/24h	mm/3h
0-0.2	0-0.2
0.2-5	0.2-1
5-20	1-5
20-45	5-10
>45	>10

CLASSES FOR MAXIMUM PRECIPITATION	
mm/24h	mm/3h
0.2 -5	0-0.2
5-25	0.2-2
25-50	2-10
50-75	10-30
75-100	>30
100-150	
>150	

Overview of forecast methods and evaluation approaches linked to HIW

AWARE

PART A
Challenges in observing CW

PART B
Overview of verification measures

PART C
CW Verification applications based on spatial methods

PART D
Overview of CW forecast methods, representation and user-oriented products

Observation: How well high-impact weather is represented in the observations?

Verification: How well high-impact weather forecast quality is represented with commonly used verification measures? Can spatial verification methods contribute to the proper evaluation of HIW phenomena and in what way?

Forecast methods & representation:
How well is HIW is represented in postprocessing? DMO vs. PostPro with respect to HIW phenomena predictions? User's interpretation of forecast value in high-impact weather situations?

AWARE: Appraisal of "Challenging WeAther" FoREcasts

AWARE: Appraisal of "Challenging WeAther" FoREcasts

http://www.cosmo-model.org/content/tasks/priorityProjects/aware/default.htm

Task 1. Challenges in observing HIW

- Overview of CW/HIW observational data sources characteristics Approaches to introduce observation uncertainty (RHM, IMGW-PIB)

Task 2: Overview of appropriate verification measures for HIW (precipitation)

- Continuous vs. discrete verification (IMGW-PIB)
- Role of SEEPS and EDI-SEDI for the evaluation of extreme precipitation forecasts (HNMS)
- Extreme Value Theory (EVT) approach- Fitting precipitation object characteristics to different distributions (RHM)

Task 3: Spatial Verification applications to HIW (precipitation, flash floods, reflectivities, LPI)

- Verification of forecasts of intense convective phenomena (IMGW-PIB)
- Lightning potential index (LPI) in mountain regions (MCH)
- LPI verification and correlation of convective events with microphysical and thermodynamical indices (HNMS)
- CRA and MODE analysis on intense precipitation (RHM)
- DIST methodology tuned on high-threshold events for flash floods forecast evaluation (ARPAE)
- Comparative verification of NWC and NWP results using spatial verification methods as part of the SINFONY project (DWD)

Task 4. Overview of forecast methods, representation and user-oriented products linked to HIW

Spatial Verification Efforts - PPAWARE

SINFONY project

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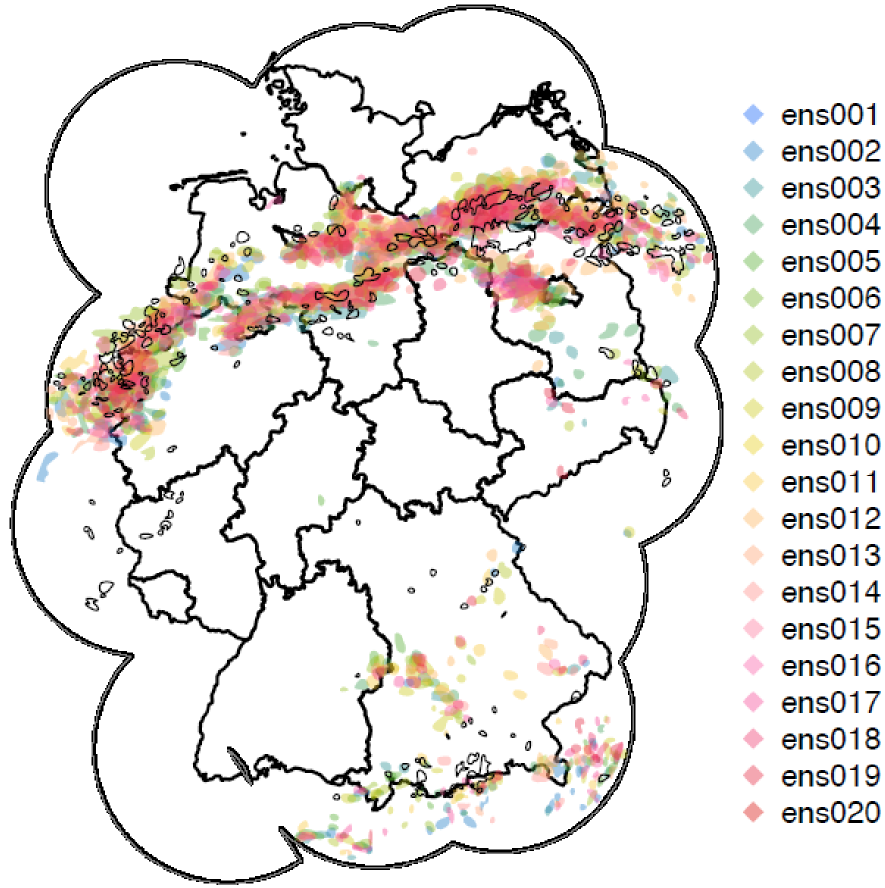
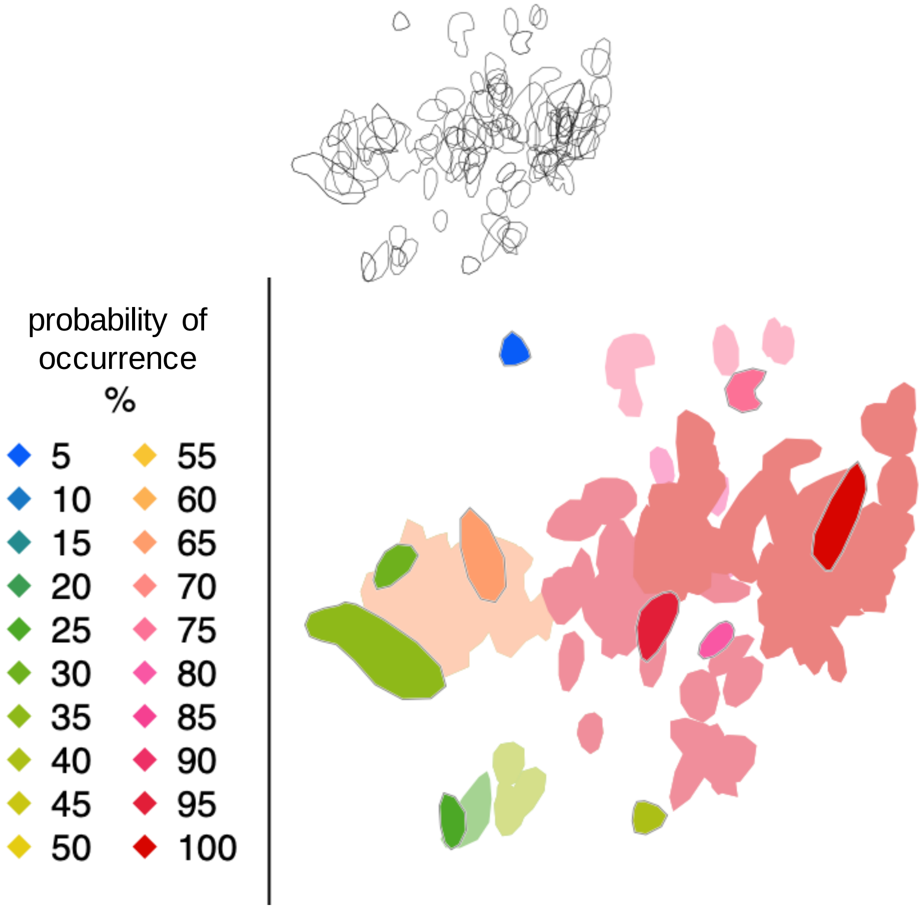
- Seamless INtegrated FOrecastiNg sYstem
- Here: „seamless“ = „from minutes to hours“
- Aim: Development of a coupled probabilistic system consisting of precipitation nowcasting and short-range numerical weather prediction (+12 h) on the convective scale
- SINFONY-RUC (Rapid Update Cycle)
  - Hourly initialization of ICON-D2-EPS (20+1 members) + 8 hours lead time
  - 2-moment microphysics
  - Running since June 2021
- Object-based verification of features from KONRAD3D cell detection tool of observed radar reflectivities and from model equivalents (EMVORADO forward operator)
  - Reflectivity objects as polygons with several properties, e.g., position, size, intensity, …



Pseudomember (Johnson et al., WAF, 2020)

- ➔ Selection of the locally most representative objects from the ensemble
- ➔ Each pseudomember object has a probability of occurrence, i.e., the percentage of ensemble members with similar objects
- ➔ Use unified area of „matching“ objects from other members to define uncertainty regions



Local beats global

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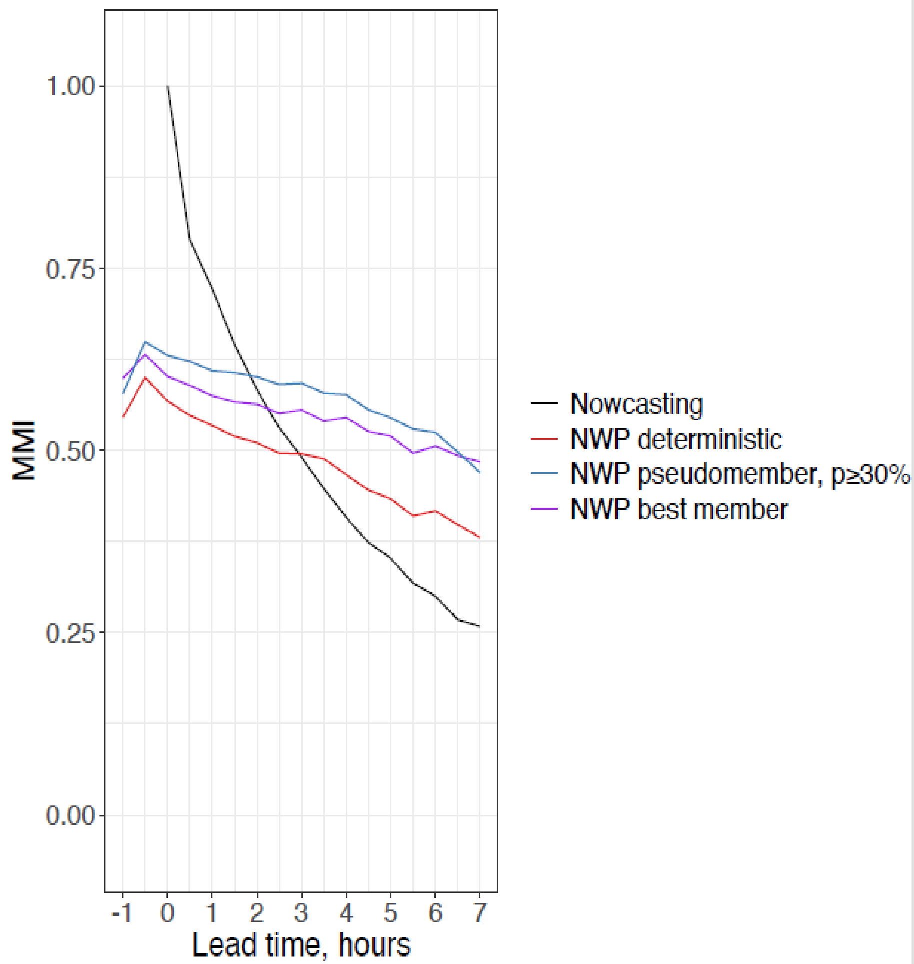
- Pseudomember: a-priori selection of locally most representative objects only based on ensemble forecasts
- „Best member“: a-posteriori selection; use observations to evaluate which member is globally the best at each time step
- Pseudomember has higher MMI than the best member selection!

SINFONY ref.: 27 May - 25 Jun 2016, hourly init. 12-16 UTC



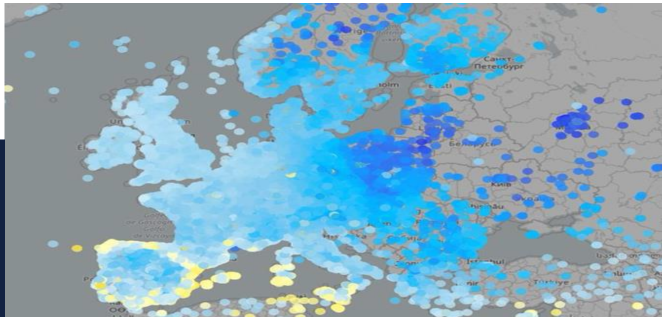
Priority Task Idea: EPOCS (Evaluate Personal Weather Station and Opportunistic Sensor Data CrowdSourcing)

Motivation

CONSORTIUM FOR SMALL SCALE MODELING
COSMO

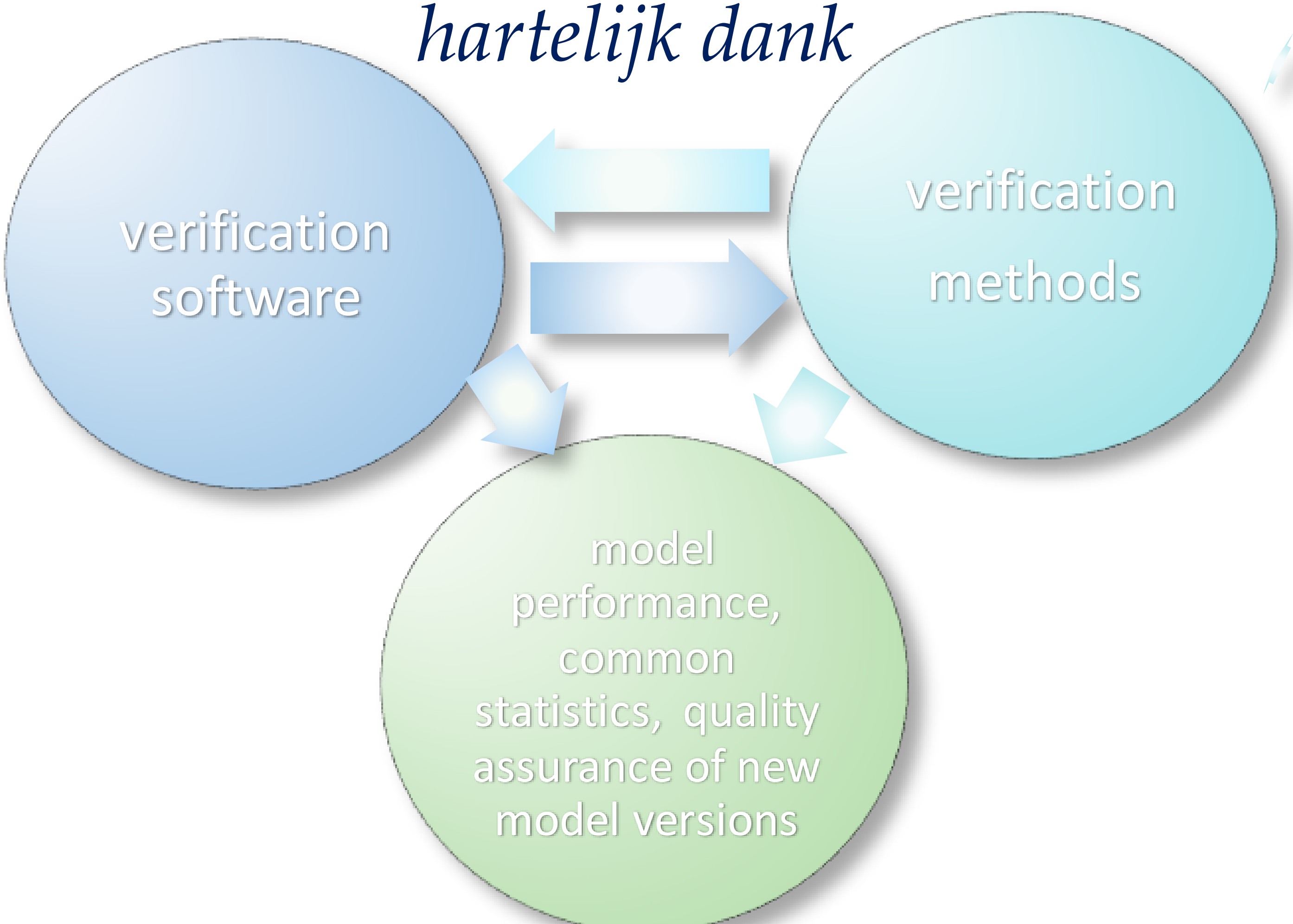
PWS: weather measuring instruments that you can install at your own home or business
Dense network of observations possess a potential to capture high-resolution meteorological information

1. **Survey on PWS data availability within different networks**
2. **Data quality control (QC) of PWS**
   - ❑ development/tuning/testing of RainGaugeQC and TITANLIB algorithms
3. **QC of rainfall estimates (RainGRS+)**
   - ❑ processing various rainfall data sources (private rain gauges, commercial microwave links, sewer/water service stations, etc.) combined with radar, satellite derived fields into an **enhanced rainfall estimates** (RainGRS+)
4. **Local variability of precipitation based on the testing PWS stations**
   - ❑ potential of using PWS to monitor extreme events



IMGW-PIB: Joanna Linkowska, Jan Szturc, Anna Jurczyk, katarzyna Ośródka, Marcin Grzelczyk, Radosław Doździoł
CIMA: Massimo Milelli, Umberto Pellegrini
CNMCA: Francesco Sudati

thank you
merci beaucoup
hartelijk dank



Additional Slides

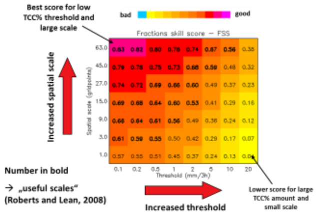
CP activity: operational models

COARSE | FINE | S

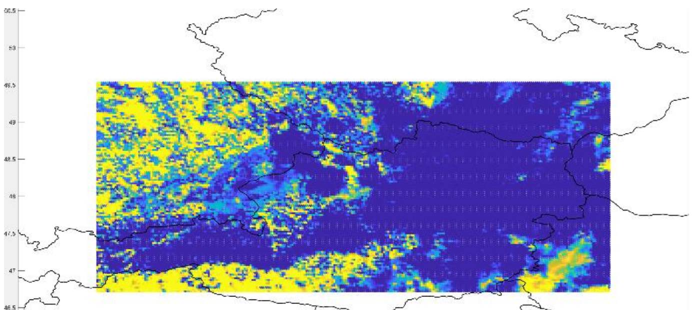
- **DWD:** ICON-EU (0.0625), ICON-D2 (0.02), ICON-D2-EPS (0.02)
- **COMET:** COSMO-ME (0.045), COSMO-IT (0.02), ICON-IT (0.02), COSMO-ME-EPS (0.0625), COSMOIT-EPS (0.02)
- **IMGW-PIB:** COSMO-PL7 (0.0625), COSMO-CE-PL2k8 (0.025), ICON-PL (0.025), COSMO-PL2.8-eps (0.025)
- **HNMS:** COSMO-GR4 (0.04), ICON-GR (0.025)
- **MCH:** COSMO-1E (0.01), COSMO-2E (0.02), ICON-1, ICON-2 in preoperational phase
- **IMS:** ICON-IL (0.025), ICON-IL-EPS (0.025)
- **NMA:** COSMO-RO7 (0.0625), COSMO-RO3 (0.025), ICON-RO2p8 (0.025)
- **ARPAE-SIMC:** COSMO-5M (0.045), COSMO-2I (0.02), COSMO-2I-EPS (0.02), ICON-2I, in preoperational phase

- RHM: COSMO-Ru7 (0.0625), COSMO-Ru2 (0.02) (over the same area, soon to gain operational status. ICON configuration is something I can not say much about. ICON-Ru7 (with some nested LAM).

ComPlot: FSS for cloudiness

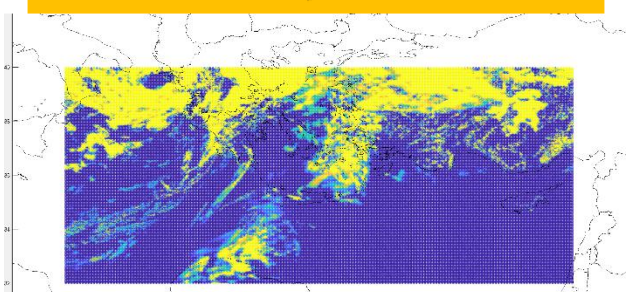


- **Reasoning:** Investigate Cloudiness performance over certain areas
- **Models:**
  - COSMO2I, COSMO I2, ICON-PL2.5, ICON-IL-2p5, ICOND2, ICONEU, ICONGR2.5, COSMOGR4
- **Period:** more organized from Feb-Jun 2022
- **Scores:** FSS (more scores could follow in next phase)
- **Cumulation:** 3h
- **Areas:** ComA2, Mediterranea (large, mainly over sea)

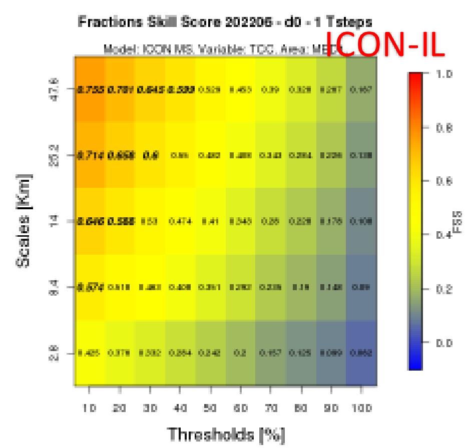


ComA2: *restricted, mountainous*
Lon: 16.000-17.424, Lat: 46.725-49.550

Domain: lon1=-12; lon2=39; lat1=26; lat2=55;
Interpolated resolution: 0.025 degrees.
Adaptation Method: *4km 15min CMA fields average 3 time steps: -15min, 0, +15min multiply by 8 to get an estimation to the cloud cover in octas. Calculated TCC fields provided by P.Khain (thanks)*



Med1: *Extended, over water*
Lon: 16.00-35.00, Lat: 32.00-40.00



CONSORTIUM FOR SMALL SCALE MODELING
COSMO

NWP Meteorological Test Suite @ ECMWF

Hindcast mode experiments
Winter and summer period
Coarse and high resolution model implementations

http://www.cosmo-model.org/shiny/users/fdbk/