

The Austrian updateable model output statistic system (A-UMOS): an adaption of the Canadian UMOS design

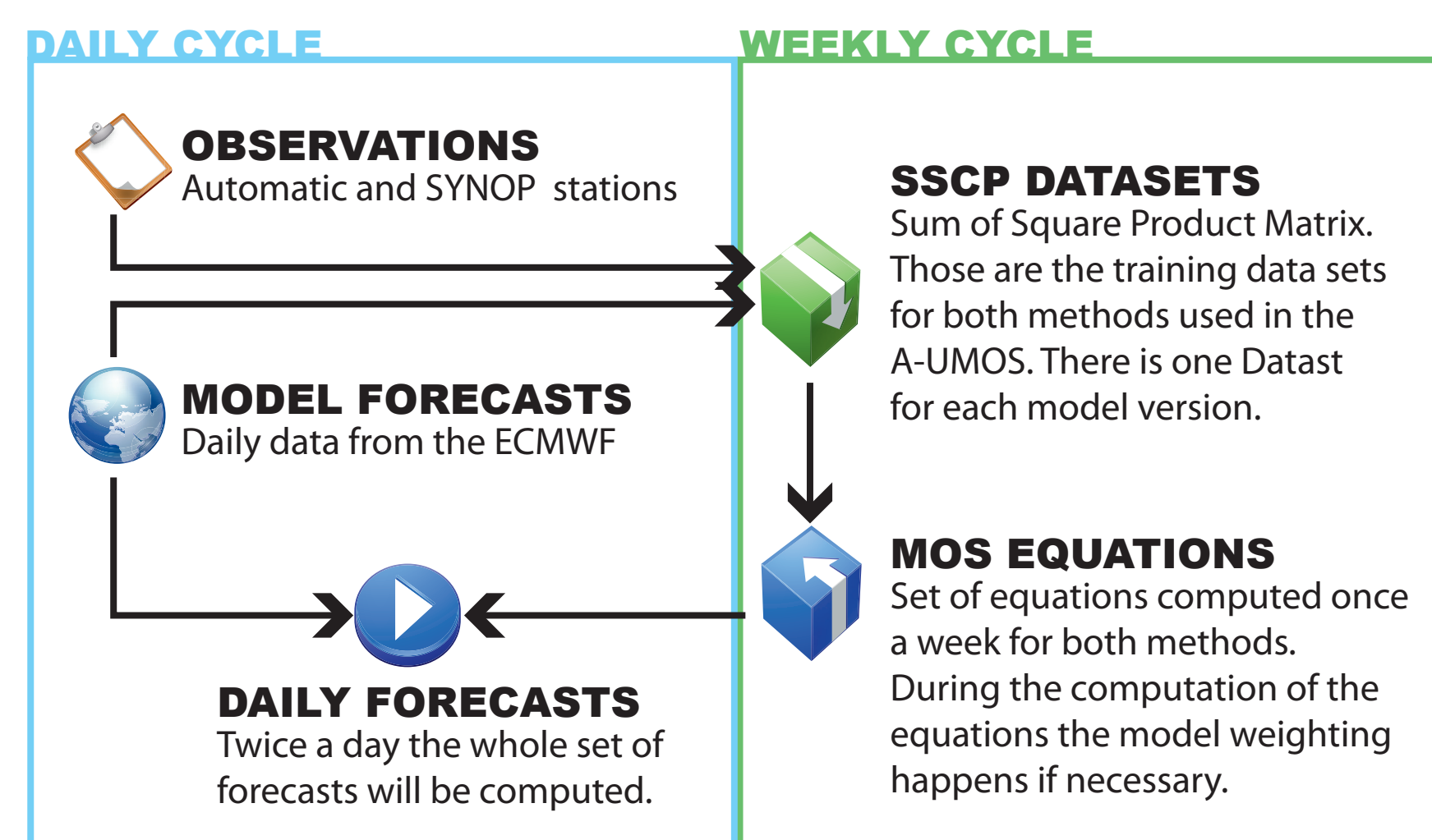
THE REASON FOR THIS PROCEDURE

- ✓ Each (major) change in the numerical model results in a new statistical characteristic of the model output (DMO) and has a big impact on the MOS equations and their quality
- ✓ We need about 300 cases to create stable equations. Because the A-UMOS differs between a cold and a warm season this means that we have to collect 2 years of data to reach the necessary sample size before being able to switch to a stable standalone new model version

THE BENEFITS

- ✓ The updateable process is closing the gap
- ✓ We do not have to wait until the sample size of the new model version is big enough (~300, 2 years) until we can introduce the new characteristic
- ✓ The weighting scheme guarantees the stability of the mixed data
- ✓ The transition between the old and the new model version is smooth
- ✓ Because the initialisation of a new model version is semi-automatic we can reduce the amount of work to a minimum

MAIN PARTS OF THE PROGRAM DESIGN



Some key points of the system: we are computing 16 deterministic predictands (MLR) and 6 probabilistic predictands (LMDA) in 26 different classes for totally 1045 different stations twice a day (ECMWF 00Z and 12Z run). The forecast is running on a dual core 3GHz desktop machine with 8GB RAM and needs about 200GB disk space. The whole process takes about 90 minutes of time.

MULTIPLE LINEAR REGRESSION (MLR)

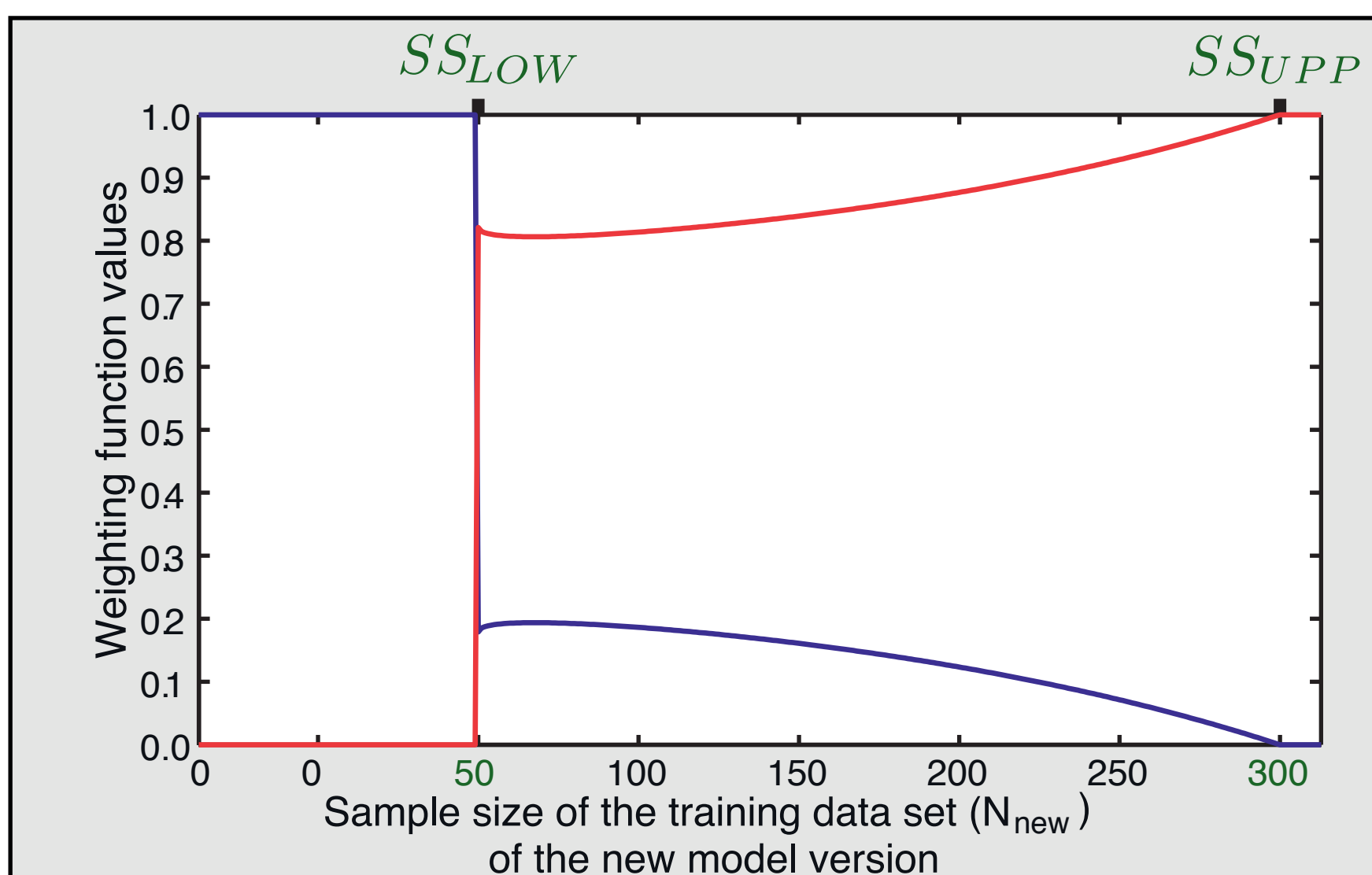
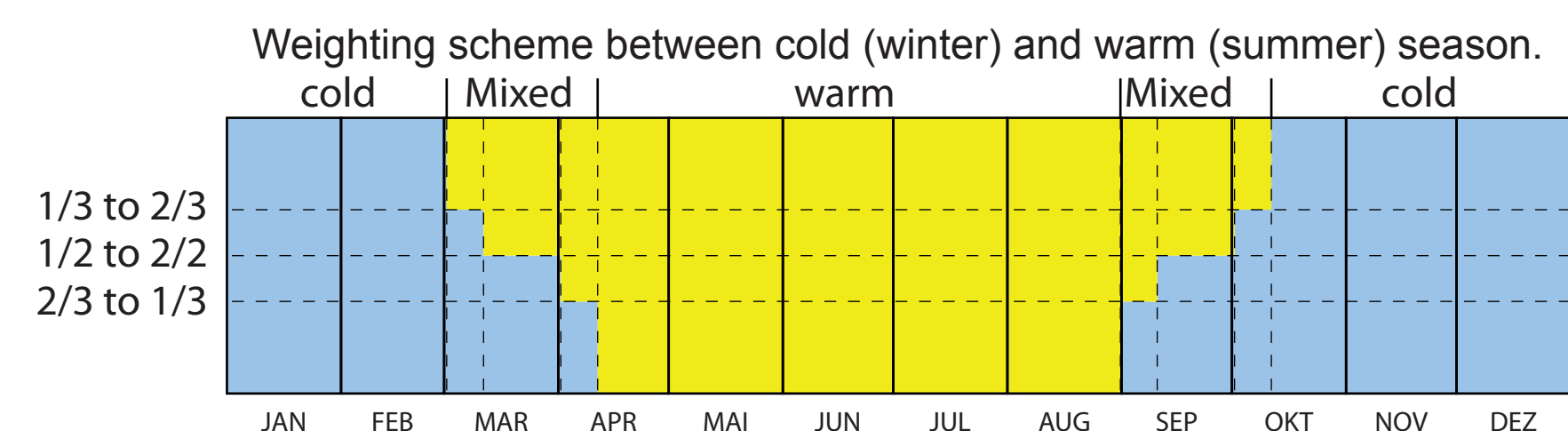
To compute the deterministic predictands we are using a simple multiple linear regression with a forward predictor selection method and an additional backward elimination scheme. The number of predictors is limited by a maximum number and a defined improvement threshold.

LINEAR MULTIPLE DISCRIMINANT ANALYSIS (LMDA)

All probabilistic predictors are based on a Fisher's LMDA. The predictors selection is performed by a pooled Mahalanobis distance test until the improvement of new predictors is less than a defined threshold.

THE SEASON WEIGHTING SCHEME

In order to not mix the winter and summer characteristics of the numerical model (and the nature), a cold and a warm season is implemented with a simple weighting scheme for spring and autumn.



THE MODEL VERSION WEIGHTING FUNCTION

Until the lower sample size limit (SS_{LOW}) is not reached, the new model version will be ignored. Once this first limit is exceeded the new model version with the new characteristic taken into account with a factor of 1.66 (66% stronger than the old model). With increasing sample size, the new characteristic displaces the old dataset until the upper sample size limit is reached. Then the training data set is large enough to build standalone stable equations and forecasts and the old model version is no longer used.

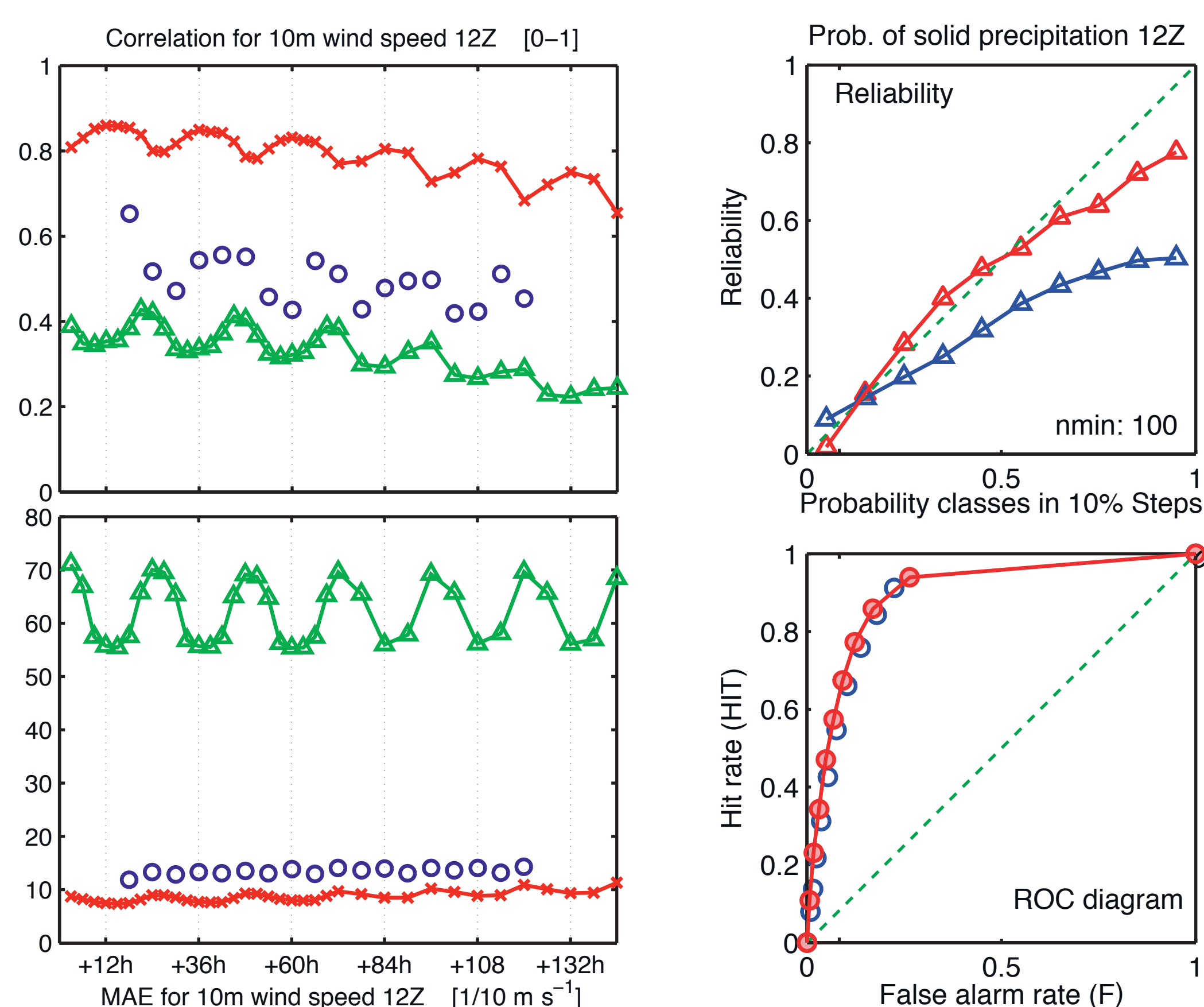
$$N_{new} > SS_{SUPP} \begin{cases} \omega_{old} = 0.0 \\ \omega_{new} = 1.0 \end{cases} \quad \text{If } SS_{LOW} \leq N_{new} \leq SS_{SUPP} \text{ then:}$$

$$\omega_{new} = \omega_{max} + (1 - \omega_{max}) \sqrt{1 - \frac{(N_{new} - SS_{SUPP})^2}{(SS_{LOW} - SS_{SUPP})^2}}$$

$$N_{new} < SS_{LOW} \begin{cases} \omega_{old} = 1.0 \\ \omega_{new} = 0.0 \end{cases} \quad \omega_{old} = \frac{SS_{SUPP} - \omega_{new} N_{new}}{N_{old}}$$

Weighting function developed by Wilson and Vallée, (2002). In this example, the old model version has a sample size $N_{old}=600$ and we are weighting between $SS_{LOW}=50$ and $SS_{SUPP}=300$, ω_{max} is 1.66.

SOME SAMPLE RESULTS 20100201 to 20110731



On the left side a sample result for the MLR routine is shown, on the right side one for the LMDA. In green the ECMWF DMO is shown, blue represents the scores of the existing AUSTROMOS2 (ZAMG) and red those of the new A-UMOS. Results for the 12UTC run, 1 February 2010 to 31 July 2011.

THE BIG ADVANTAGES

- ✓ The results and equations stay stable during the transition periode between two model versions (ECMWF T799/T1279).
- ✓ The MLR and MDA* results shows a positive impact of the early introduction of the new model version characteristics
- ✓ The initialisation of a new model version needs just a few hours. Afterwards the MOS-system upgrades itself to a MOS based on the current numerical model statistics.

PLEASE NOTE THAT

- ✓ *) The impact on the LMDA is different. As the weight of the new model version is increased, the old training data set loses its impact. That means that we are losing infrequent events in the past. The quality for more frequent events is better than if we are mixing both (old and new) model versions together without any weighting.
- ✓ Depending on the predictand and the the chosen predictors, the thresholds for the weighting scheme could be different because of different statistical stability - it is difficult to find the perfect set for all forecasts.



The Austrian updateable model output statistics system (A-UMOS) an adaption of the Canadian UMOS design



Reto Stauffer
Johannes Vergeiner &
Georg J. Mayr

Institute of Meteorology and Geophysics
University of Innsbruck (A)

13 September 2011

Some key words about the A-UMOS

- 1045 sites with ECMWF 00Z and 12Z DMO
- 16 deterministic predictands (MLR)
(e.g. 2m temperature and dewpoint, cloud amount, 10m wind, ...)
- 6 probabilistic predictands in a total of 26 classes (LMDA)
(e.g. probability of: precipitation, solid precipitation, thunderstorms, ...)



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- 6 probabilistic predictands in a total of 26 classes (LMDA)
(e.g. probability of: precipitation, solid precipitation, thunderstorms, ...)
- cold and warm season separate (winter and summer)
- 37 lead times [3, 6, 9, ..., 69, 72, 78, ..., 138, 144]



The program design

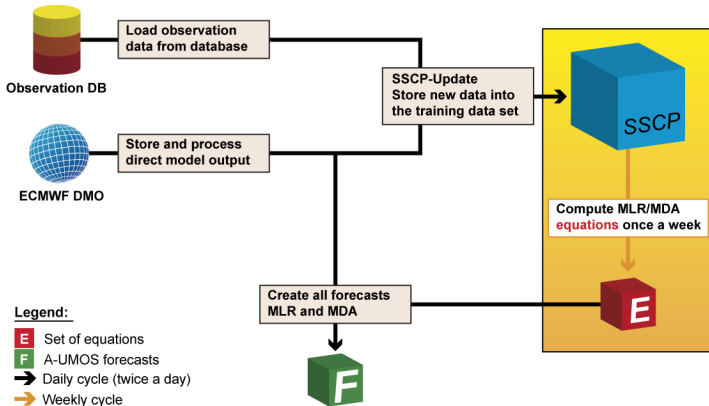
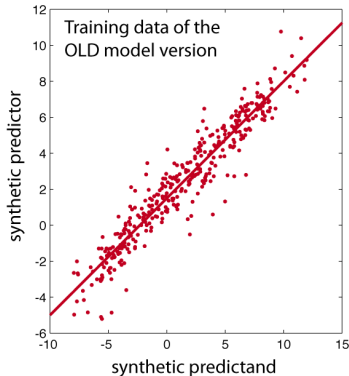


Figure: Program design



Why we need the updateable process

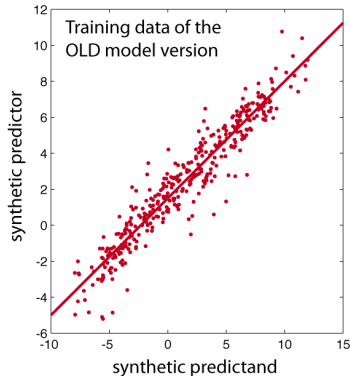


- for stable equations we need about 300 – 350 cases in the training data set

Simple synthetical example for a linear regression.

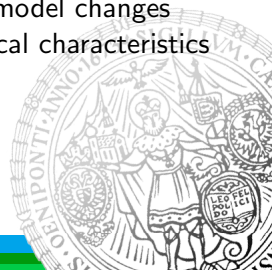


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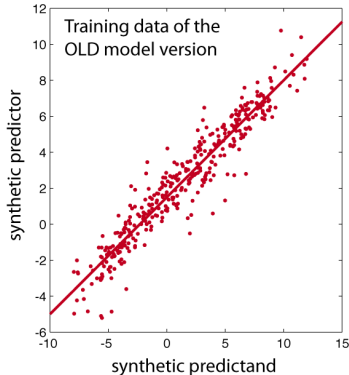


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- frequent NWP model improvements
- each update in the numerical model changes the statistical characteristics

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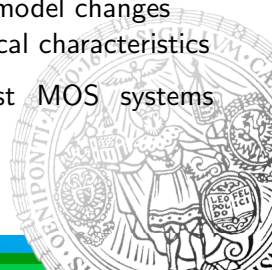
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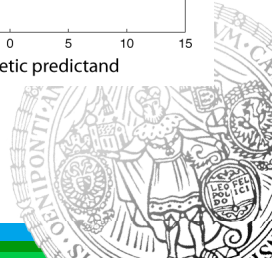
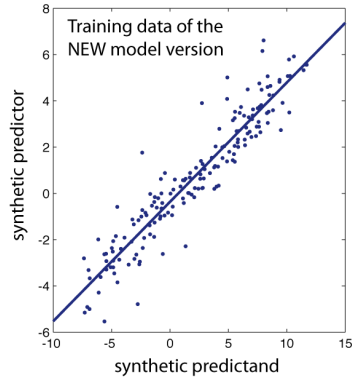
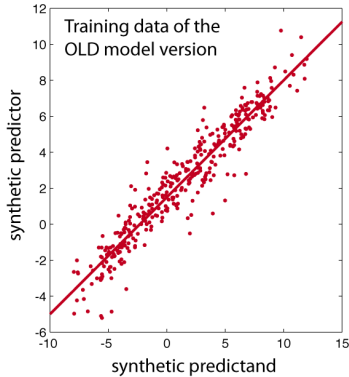
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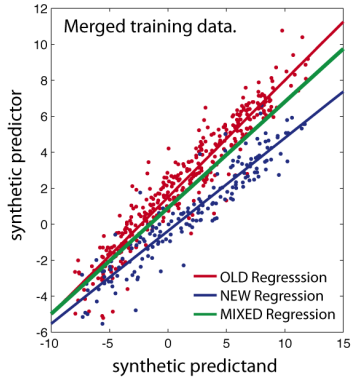
How do most MOS systems handle this?



Why we need the updateable process



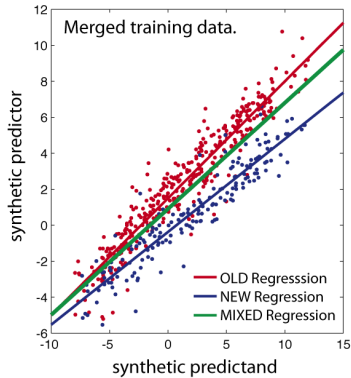
Why we need the updateable process



- out of this data pool the green regression results



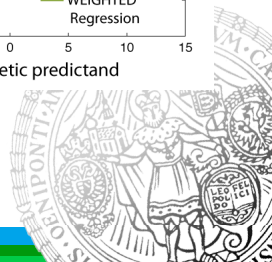
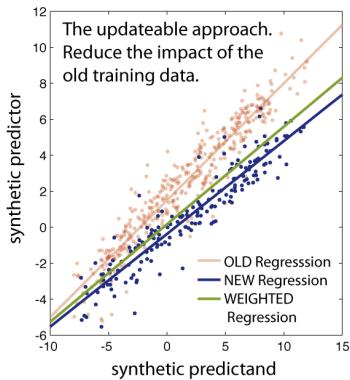
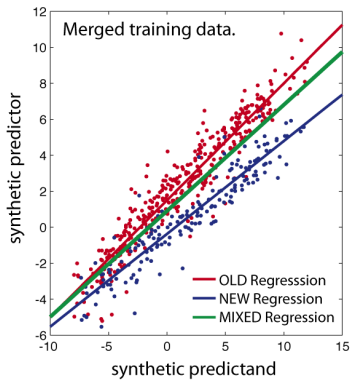
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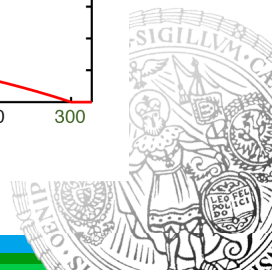
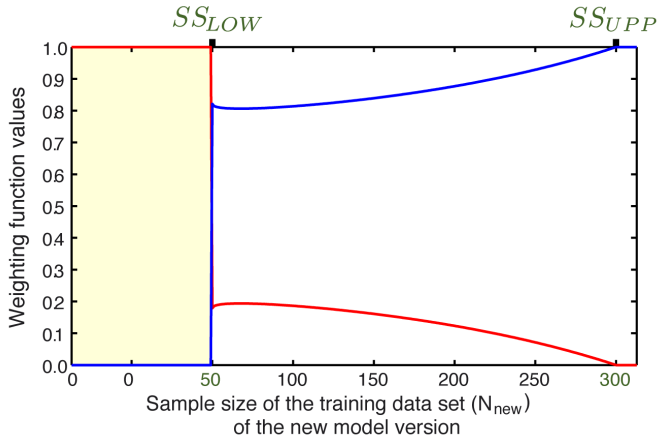
- out of this data pool the green regression results
- it is not hard to see that the quality of the green regression is not satisfying.



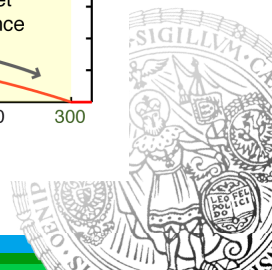
Updateable approach



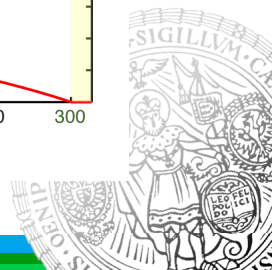
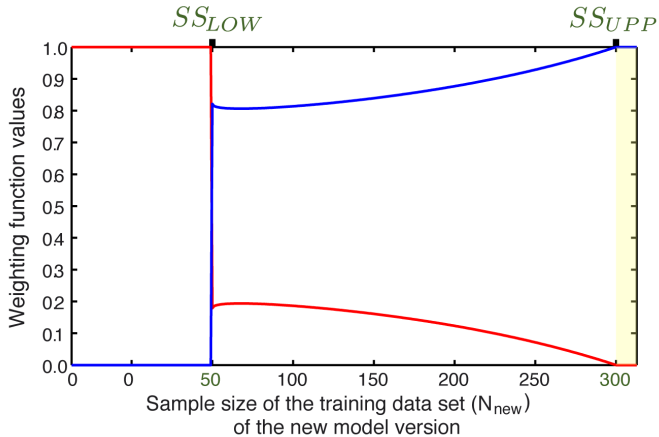
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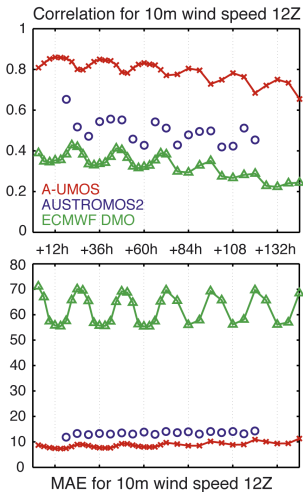
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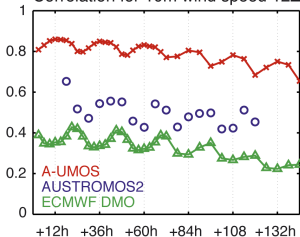


Sample result: 10m wind speed [1/10 $m s^{-1}$]

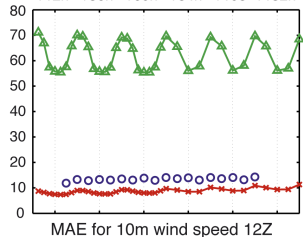


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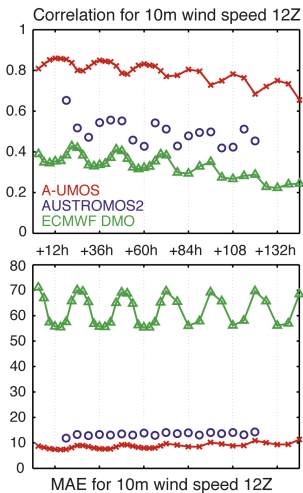
Correlation for 10m wind speed 12Z



- improvement over previous system and stable results for all lead times
- improvements partly due to higher ECMWF model resolution



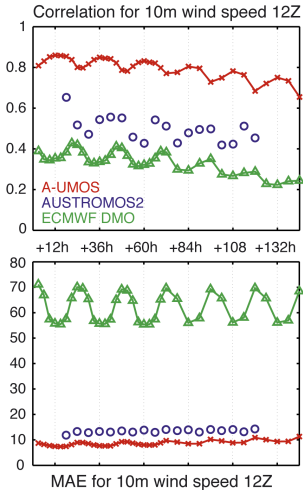
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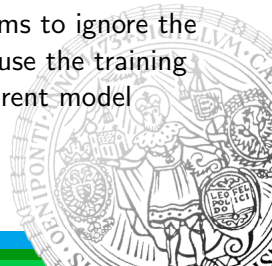
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- *BUT* only the updateable process makes it possible to use this improvement!



Sample result: 10m wind speed [$1/10 m s^{-1}$]



- improvement over previous system and stable results for all lead times
- improvements partly due to higher ECMWF model resolution
- *BUT* only the updateable process makes it possible to use this improvement!
- the existing MOS seems to ignore the new characteristic because the training set spans several different model versions



Be aware

- you cannot introduce a new model version each year
- using the updateable for the LMDA classifier is a little bit tricky; lower weight for the old training data set means that some infrequent events will be “ignored” after a while.



The benefits

- fast and automatic introduction of the new characteristics
- semi-automatic update to a MOS based on the new model version/resolution (low cost)
- smooth transition period
- stable results in the transition period



Further work

- testing the stability of the model version transition period (the *updateable* periode) for special sites
- try to combine predominant time of days (9UTC yesterday, today and tomorrow) for a faster increase of the size of the training data set until the sample size is big enough for a standalone new model version MOS
- checking the improvement for the MOS between the current model and the 30yr GFS reforecast with lower resolution
- adapt the method for more complex regression models
- adapt for other predictands



The End

Wilson. . . , L., 2002: The canadian updateable model output statistics (umos) system: Design and development tests. *Weather and forecasting*.

Wilson. . . , L., 2003: The canadian updateable model output statistics (umos) system: Validation against perfect prog. *Weather and forecasting*.

