Verification of high resolution NWP models:

A verification scheme considering `significant´ or `extreme´ weather and upscaling principles

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Introduction

- **Ever since the beginning of NWP there has been a need to assess the quality of model forecasts.**

- **In the 1980s and 1990s it became popular to compare forecast fields with obervations directly in the observation points (\`obs-verification´, also used widely by the EWGLAM community).**

- **The limitations of simple measures , e.g. BIAS and RMS from \`obs-verification´ have become apparent, especially in recent years where it has been difficult to show added value of meso-scale models compared with coarser mesh models :**

The challenge to assess the added value of high resolution NWP (1)

- In recent years new methods have been developed taking into account the `double penalty issues´, i.e. the scales in space and time that the model can predict :

- The focus here is on how to verify forecasts spatially:
  In Bulletin of the American Met. Soc. , October 2010 ,
  p 1365 – p 1373
  an international intercomparison project is mentioned:
  (www.ral.ucar.edu/projects/icp)

The challenge to assess the added value of high resolution NWP (2)

1) Neighborhood approaches

Investigates spatial skill, e.g. the scales at which the forecast attains a certain skill

Examples: The fractions skill score (FSS) , the new score defined here, i.e. the `significant weather' score SWS.

2) Scale separation approaches

Each field is decomposed using types of band-pass filters, e.g. Fourier, wavelets, …)

3) Features-based approaches

Attempts to identify particular structures using some attributes, e.g. spatial displacements , orientation and sized of observed versus forecasted features.

Example: `SAL´ (Structure , Amplitude, Location)

4) Field-deformation approaches.

Manipulates forecast spatially to better match the observed field in an optimal way (vector displacement)

Example: Hoffman et al., 1995

When verifying high resolution NWP models

it is relevant to, e.g. pay attention to

- significant or extreme weather
- `robustness´ of the verification
- `double penalty´ issue
- which scales in space and time are predictable with a given model resolution

Definition of scheme considering 'significant' or extreme weather and upscaling principles

- **A new NWP score is defined**
- **SWS ~'significant weather score' is constructed to show the virtues of a high resolution model compared with a competing model which will often be run at a lower resolution.**
- **A comparison of the two models is done on a common area.**
- **The potential of high resolution models to better predict extreme weather is considered by identifying sub-areas with the most extreme or significant weather at the verification time.**
- **The size of the sub-areas defines the degree of upscaling used to address the spatial part of the `double penalty issue´ associated with increased model resolution.**

DMI

Computational scheme:

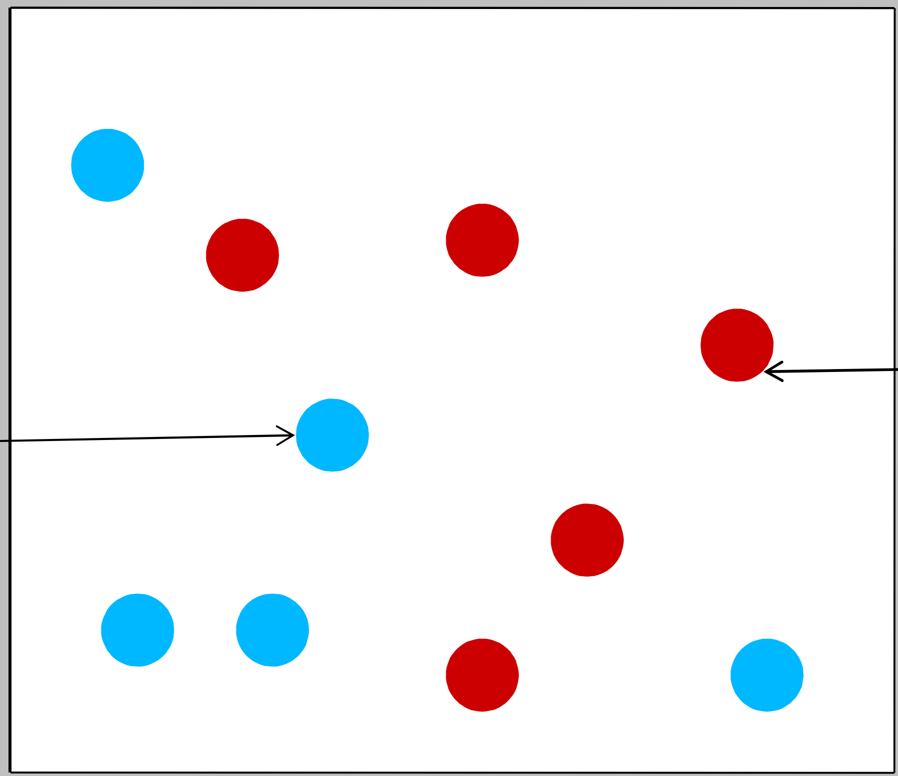
1) Define the total area over which the verification should be done. For models to be compared it has to be a common area.

2) Define an ’event’ to be verified and choose a number of ’upscaling areas’ associated with the event : The scheme will normally process a certain fraction of the most extreme observations over the verification area considered.

3) Define a method to identify the `significant´ (extreme) observations associated with `upscaling areas´. A natural constraint to impose is that the distance between selected observations should be long enough to imply selection of non-overlapping upscaling areas.

Definition of scheme considering ’significant’ or extreme weather and upscaling principles

Extreme low Values observed to be verified



Extreme high values observed to be verified

Model domaine

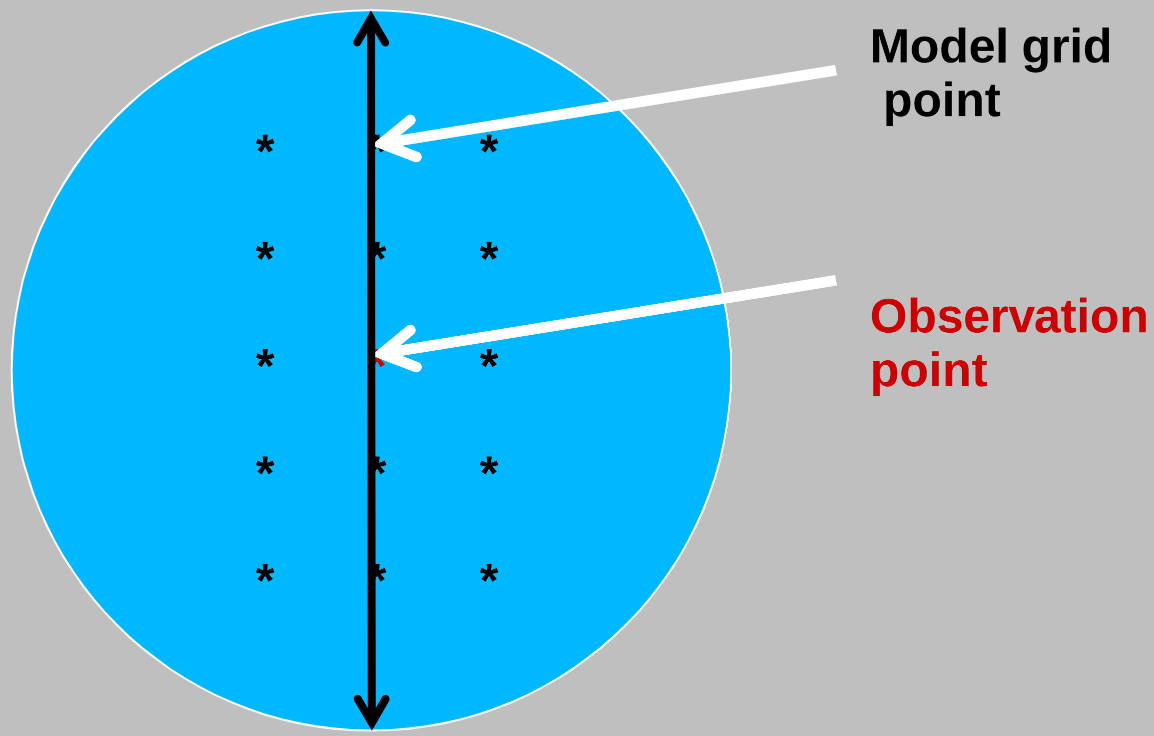
For verification of an event choose ’extreme’ values for circular `upscaling areas´

Computational scheme:

4) Choose a threshold distance between \`observation´ (e.g. observation point) and model grid points used in the verification.

Definition of scheme considering ’significant’ or extreme weather and upscaling principles

Circular area representing upscaling area of diameter D



Verification concept:

Do not restrict comparison of variable *X* to point of observation but consider the distribution of forecast field and observed values of *X* over the chosen relevant ’upscaling area’

Computational scheme:

5) Compare the `observation´ with all forecast grid points within the threshold distance and compute score of the event. In the simplest form it will be either 0 or 1 (failure or success respectively)

6) Compute the ’significant weather score’ SWS by updating summary statistics of the two models compared and computing the fraction between the sums.

The `significant weather´ score (SWS):

$$SWS = \left(1 + \sum_{j=1}^{K} J_{meso}\right) / \left(1 + \sum_{j=1}^{K} J_{ref}\right)$$

SWS may vary between 0 and $+\infty$

High values which are above 1 favors

the mesoscale model quality

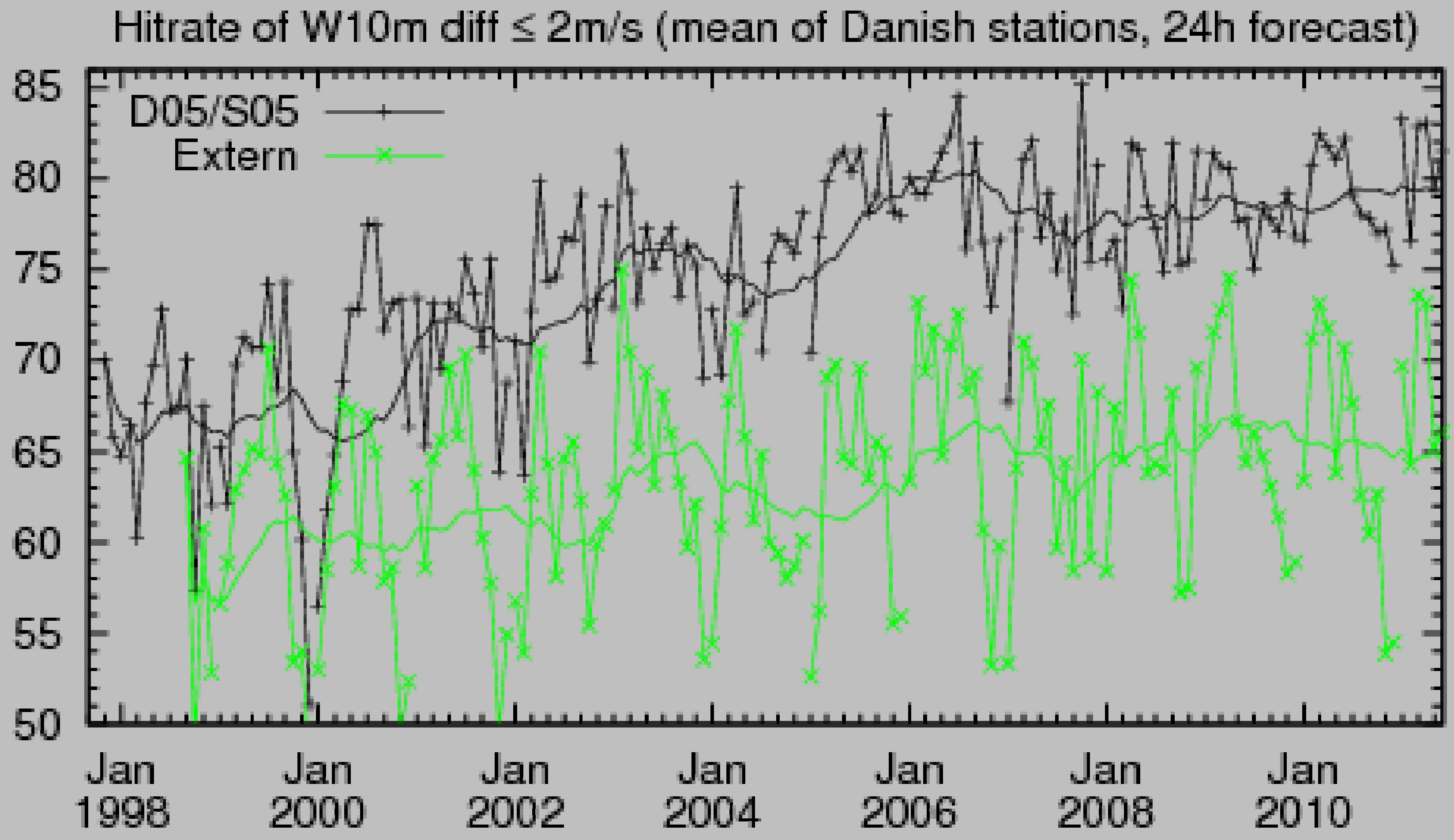
Virtues of new score SWS:

The SWS is expected to be less prone to weather dependent variations on time scales of months than many traditional schemes, because :

A fraction is computed between the success of the models compared, and weather scores of individual models tend to vary in similar ways as a consequence of changing weather conditions considered over scales of months.

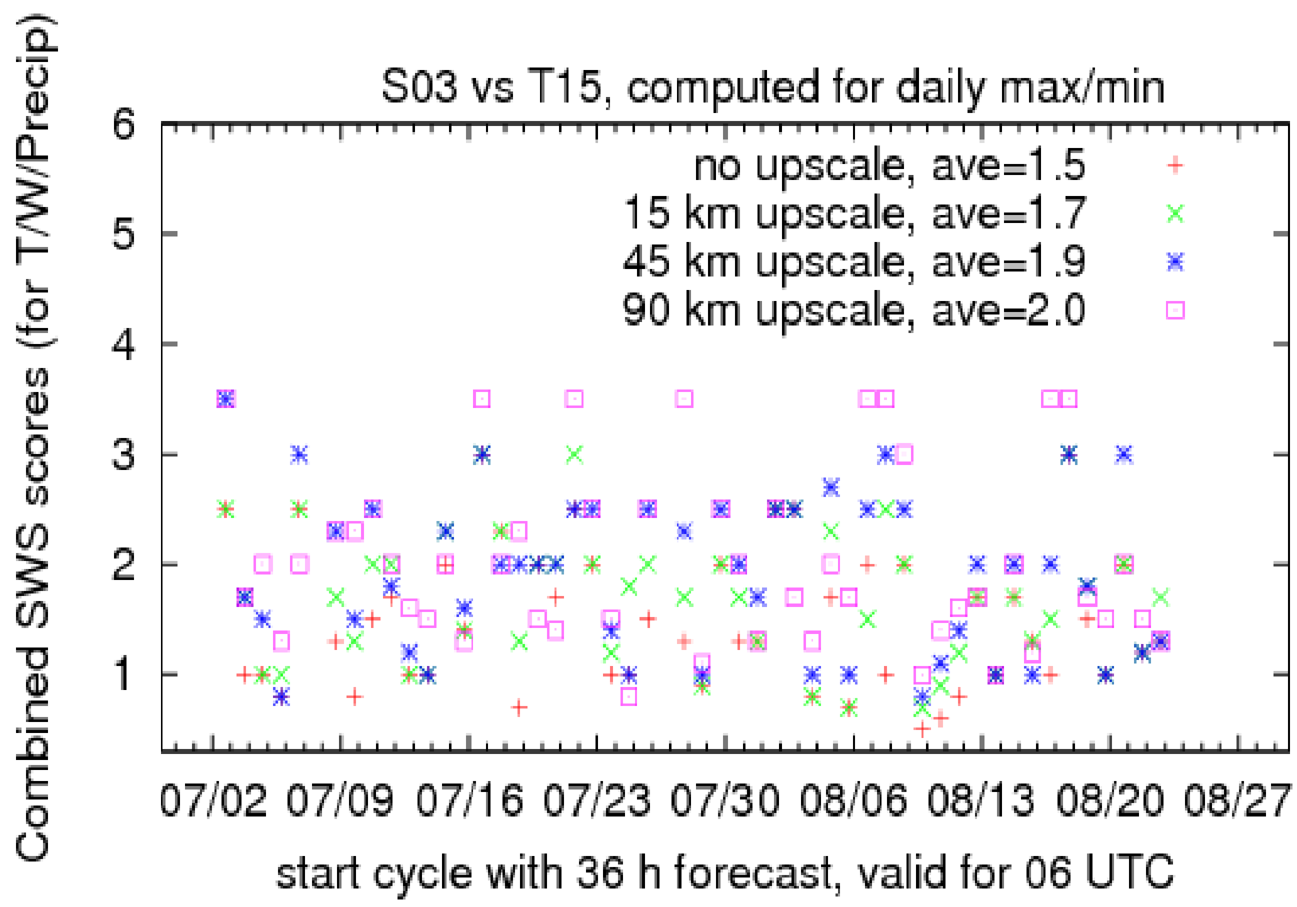
`robustness´:

Hit rate of 10 m wind for two different models (black versus green curves) show `similar´ variations over time.



First results(1)

combined SWS result (T2m, W10m, Precip)
DMI opr models S03 / T15 in July 2011



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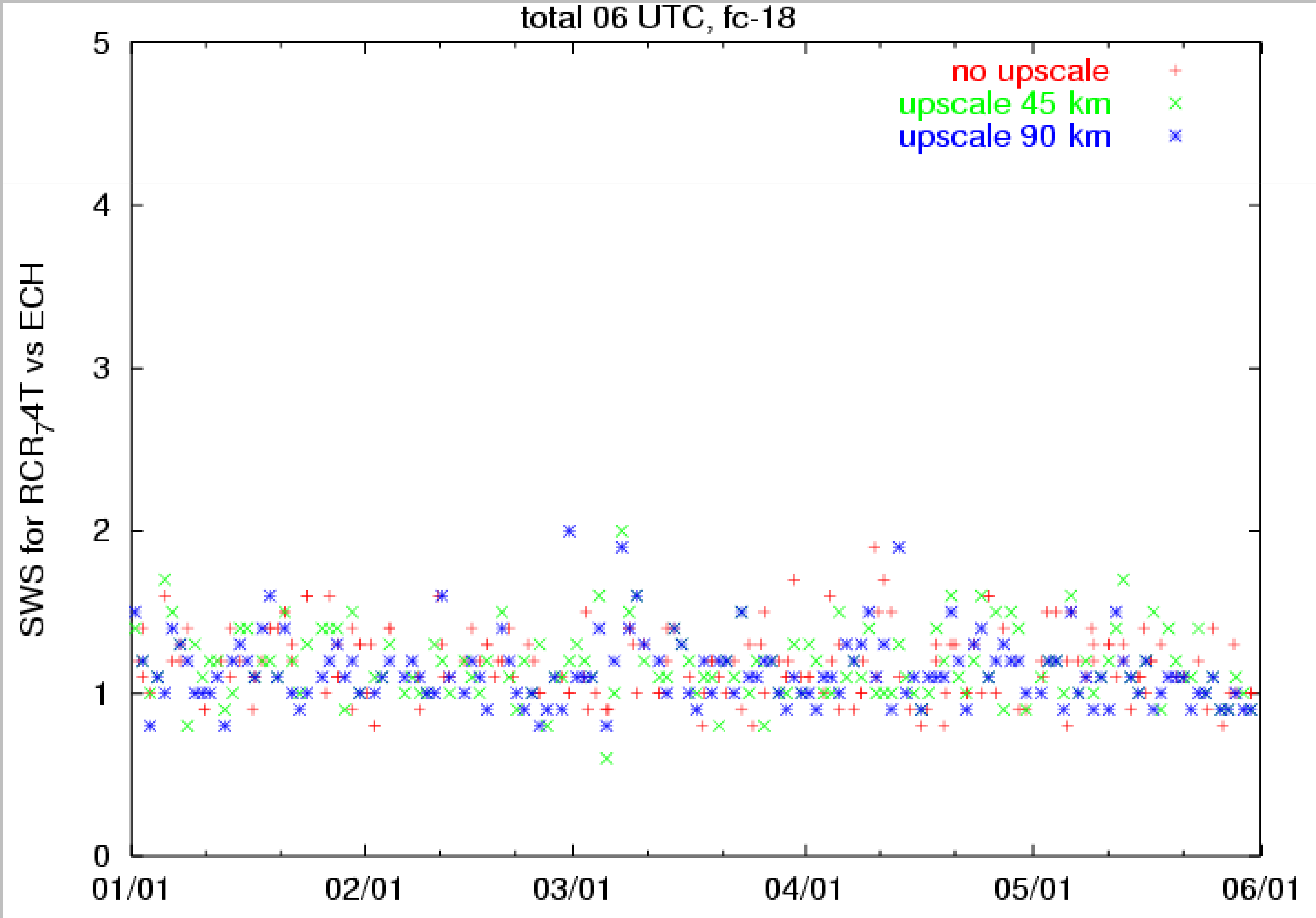
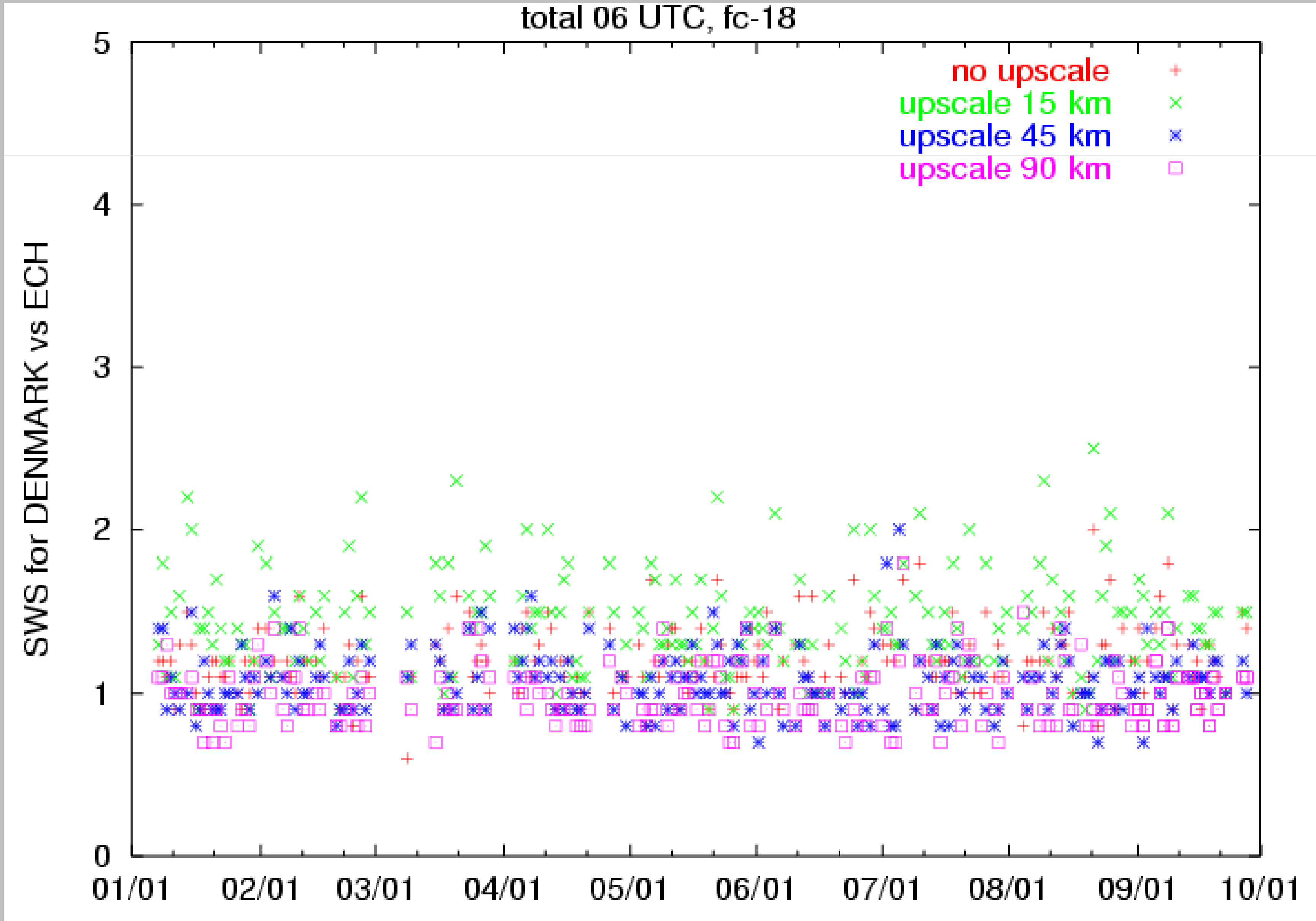
First results(2)

combined SWS result (T2m, W10m, Precip)
RCR-v7.4T / ECH, 1 January 2011- 1 June 2011



First results

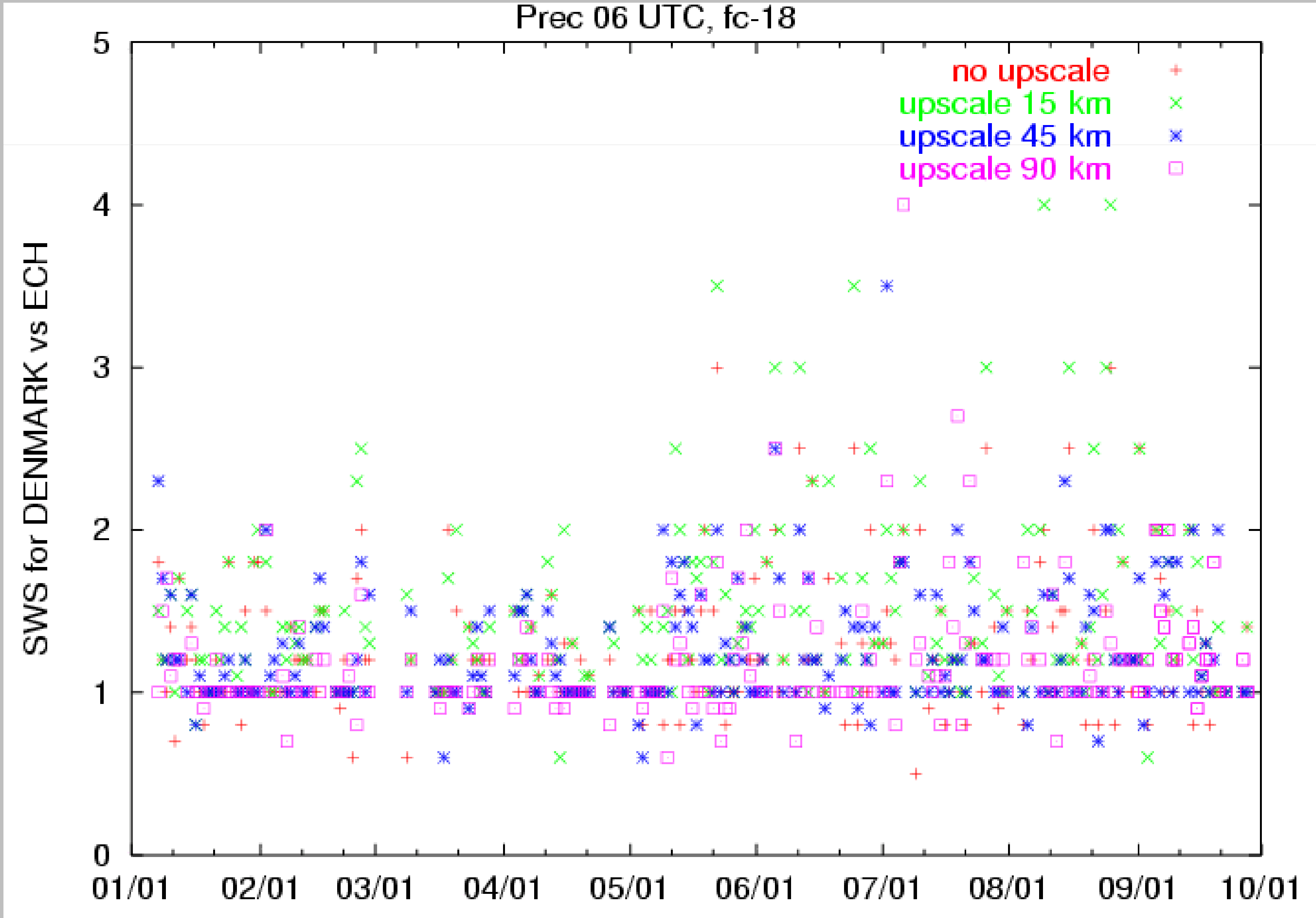
combined SWS result (T2m,W10m,Precip)
Harmonie 2.5 km / ECH, 1 Jan. 2011- 1 Oct. 2011



First results

SWS result (Precip)

Harmonie 2.5 km / ECH, 1 Jan. 2011- 1 Oct. 2011



Conclusions and outlook

- **The preliminary verification results based on the \`significant weather score´ SWS show a positive impact of high resolution models compared with lower resolution models !**
- **The introduced upscaling concept seems to provide some additional potential for showing added value of increased model resolution.**
- **Some results indicate that upscaling is less desirable for 10 m wind and 2 m temperature as compared with precipitation !**
- **The SWS scheme with ingredients of both \`significant weather´, definition of \`events´ and \`upscaling´ provides room for considerable experimentation and optimization !**