Danish Meteorological Institute

NWP news 2012

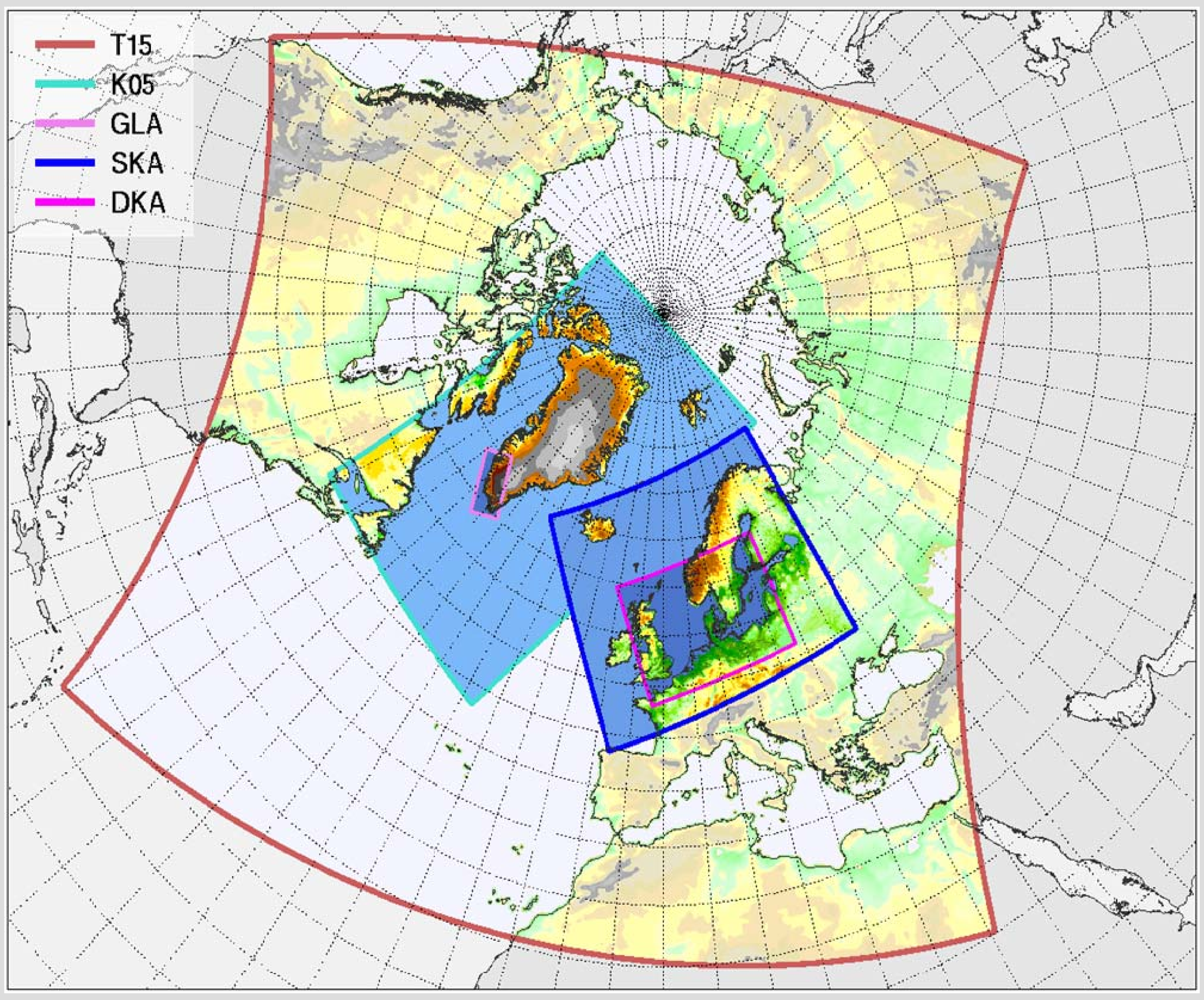

Fig.1

	SKA	K05	T15	GLA	DKA
Model	**Hirlam**	**Hirlam**	**Hirlam**	**Harmonie**	**Harmonie**
Horizontal resol.	**0.03 °**	**0.05 °**	**0.15 °**	**2 km**	**2.5 km**
Vertical levels	**65**	**40**	**40**	**65**	**65**
Boundary fields	**ECMWF**	**ECMWF**	**ECMWF**	**ECMWF**	**ECMWF**
Forecast length	**54 h**	**48 h**	**60 h**	**36 h**	**36 h**
Run interval	**6 h**	**6 h**	**6 h**	**6 h**	**6 h**

Operational models at DMI October 2012

The models dispalyed in Fig.1 are:

DKA : Harmonie model with surface data-assimilation
GLA : High resolution Harmonie for SW Greenland using surface data-assimilation
SKA : Main deterministic model for the Scandinavian-North Sea area using 3D-VAR
K05 : Main forecast model for Greenland based on Hirlam
T15 : Large scale Hirlam model for the purpose of emergency-preparedness.

Plans 2013:

The NWP plan may be summarized by the following bullets:

- **Extension of the Harmonie model GLA further to the north**
- **Introduction of 3-hourly data-assimilation cycles for Harmonie DKA**
- **Experiments with Harmonie on larger model domains similar to SKA**
- **Operational use of new verification measures showing the potential of high resolution models**
- **Data-assimilation experiments with both Hirlam and Harmonie: Focus on `moist data´ including data from radar.**
- **Preparations for a new supercomputer installation.**

A note on how empirical global radiation data can improve the parameterization of cloud-radiation interactions in LAMs

We have made a test of a typical NWP algorithm for calculation of global radation – the total downwelling solar irradiance at the surface – against a 5-year data set of measured global radiation and scattered horizontal irradiance (SHI) at the surface.

The measurements [1] have a 2 minute time resolution, which is comparable to the time steps in a high resolution LAM. They have been made 15 kilometers north of Copenhagen. The SHI have been measured by blocking out the direct solar radiation with a solar tracking disk. The data have also been integrated to 1 hour values for comparison of this time scale.

The theorethical calculations have been made with the HIRLAM radiation scheme [2,3,4]. In order to test this with the measured data we have used the known solar zenith angles as an input parameter to the radiation scheme and the cloud transmittance as an optimization parameter. The hypothesis is that this theoretical model should be able to reproduce the measured data.

First the test has been done with integrated 1-hour measurements. The results are shown in Figs. 2a and 2b. In Fig. 2a it can be seen that the model is able to reproduce almost all of the measured 1 hour global radiation values. In Fig. 2b a comparison of the SHI fractions, *i.e.* the fraction of global radiation that does not come directly from the Sun, is shown, as a function of the measured global radiation It can be seen that both the measured and the theoretical values cover approximately the same areas. For a given measured global radiation the minimum value of the SHI fraction occurs in cases of clear sky. The lower minimum values of the SHI fractions in the measurements can be explained by the uncertainty in the measurements.

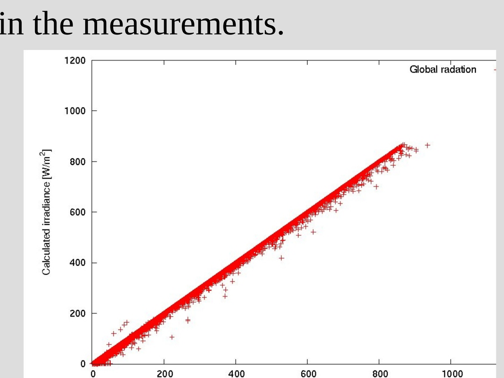

Fig.2a

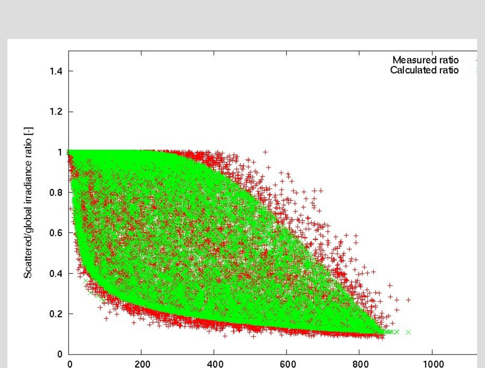

Fig.2b

New results on solar radiation

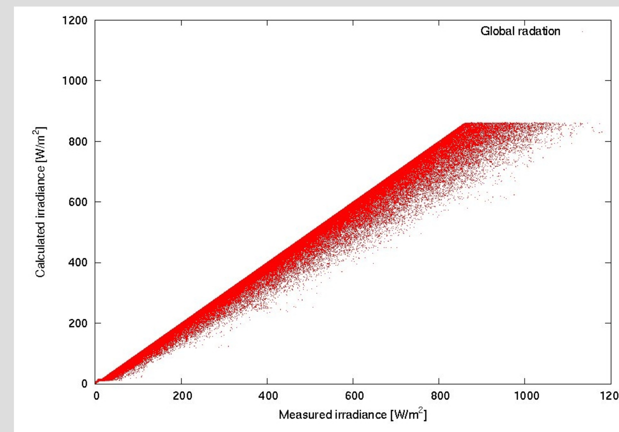

Fig.2c

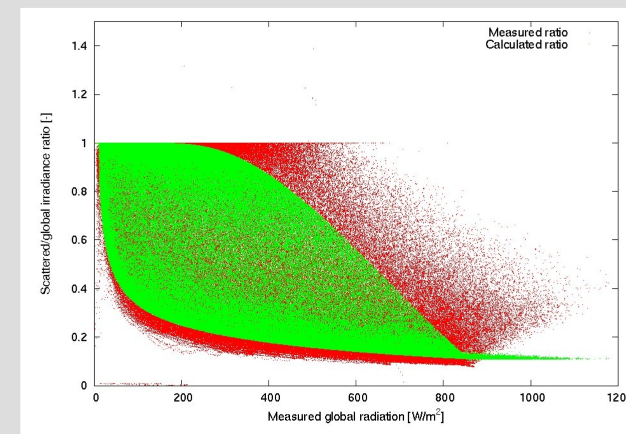

Fig2d

In Figs. 2c and 2d the same types of plots as in Figs. 2a and 2b are shown. However, now for 2 minute time resolution data. At this time resolution there are several measured global radiation values that the theoretical model cannot reproduce as shown in Fig.2c. In all these cases the measurements show higher values than the theoretical model. The theoretically calculated global radiation values reach a maximum value of approximately 850 W/m² corresponding to noon on a cloud free day at midsummer. The highest measured global radiation values often exceeds this value and even exceeds 1100 W/m² in a few cases. This difference is too large to be explained by the uncertainties in the measurements.

From Fig. 2d an explanation for the discrepancy between the highest global radiation values can be deduced. The minimum value of SHI is approximately the same in the measurements as in the theoretically calculated values. In both cases this occurs at a fraction of approximately 10% SHI and a global radiation of approximately 850 W/m², *i.e.* when the sun is highest in the sky and the sky is clear. Beyond this point, it can be seen that the SHI fraction increases for the measured data at values higher than 850 W/m². This can be explained by 3-D cloud effects where additional global radiation is reflected from scattered clouds. The model does not account for these effects, since the cloudy and the cloud-free fractions are treated independently.

The results indicate that for decreasing time steps and increasing resolutions of LAMs, it becomes increasingly important to account for 3-D cloud effects to correctly describe the cloud-radiation interaction.

References

[1] Dragsted, J., S. Furbo: "Solar radiation and thermal performance of solar collectors for Denmark " *DTU Civil Engineering*, report **R-275**, ISBN=9788778773593, 2012.
[2] Savijärvi, H.: "Fast Radiation Parameterization Schemes for Mesoscale and Short-Range Forecast Models," *J. Appl. Meteor.*, **29**, 437–447, 1990.
[3] Wyser, K., L. Rontu, and H. Savijärvi: "Introducing the effective radius into a fast radiation scheme of a mesoscale model," *Contr. Atmos. Phys.*, **72** (3), 205--218, 1999.
[4] Sass, B. H.: Parameterization of clear sky diffuse irradiance in HIRLAM, *pers. comm.*, 2011.

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

Significant **W**eather **S**core (SWS), a new score for use in numerical weather prediction (NWP) verification, has been defined and tested in idealized cases and in preoperational conditions using data from high resolution limited area models run at the Danish Meteorological Institute (DMI), and from the global NWP model run at the European Centre for Medium range Weather Forecasts (ECMWF). The verification with SWS is user oriented and designed for high resolution numerical weather prediction. SWS verifies model results against weather observations considered `significant´ to users. It typically defines, as indicator of significant weather, high values and low values of selected meteorological parameters to be verified over a certain geographical model domain, making use of spatial upscaling principles to take into account effects of phase errors in space and time when comparing model results with point observations from a synoptic network. The scheme has been found easy to implement in an operational NWP environment. The preliminary test results indicate that the SWS score has a good potential to show the added value of high resolution Harmonie and Hirlam against ECMWF model when verifying precipitation forecasts.

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

where the two integers, J_{meso} and J_{ref} measure the success of predicting meteorological events with mesoscale model and with reference model, respectively, and K denotes the number of events in consideration. For a single deterministic forecast a successful prediction of a specific event is assigned a value of 1, and a failure is given a value of 0.

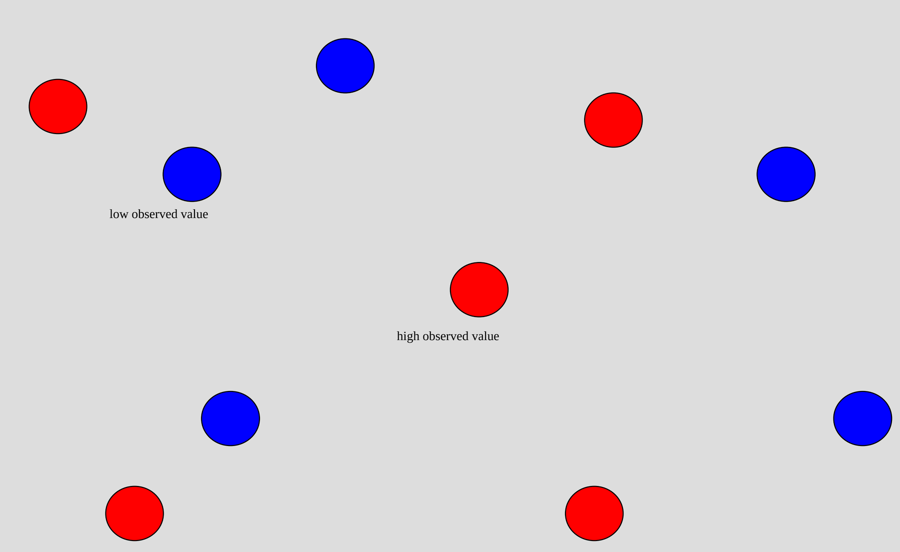

Fig 3a

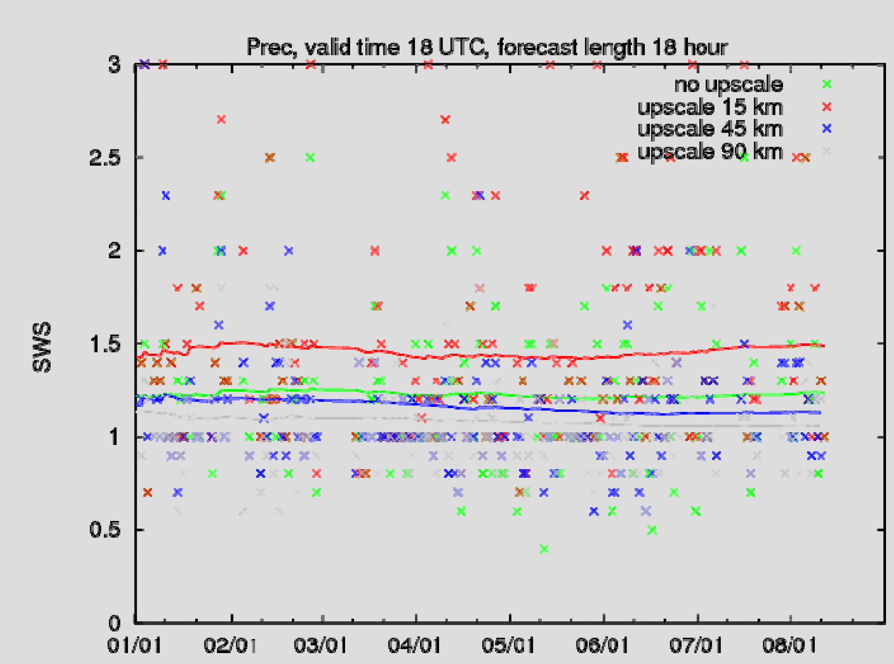

Fig.3b

SWS is considering observed maxima and minima in the forecast area to be verified, allowing the forecast to agree with observations within certain tolerance limits, e.g. the event may be forecast up to a certain distance from the observation. In (3a) circular areas around high and low observed values are shown in red and blue respectively. SWS is rewarding a forecast fully, only if it can forecast correctly the spatial distribution of maxima and minima.

Fig. 3b shows the results of SWS for 12 hour accumulated precipitation validated at +18 hours, using Harmonie at a 2.5 km model grid over Danish domain and corresponding data from the operational ECMWF model.The results apply to the period January-July 2012. The different curves apply to different sizes of upscaling radius, up to 90 km. The lines represent running averages over 30 days. SWS values above 1 indicate benefit of high resolution Harmonie compared with lower resolution ECMWF data.

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