GRAPHICAL INTERACTION WITH GRIDDED FIELDS
A COOPERATION PROJECT AT KNMI

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1. INTRODUCTION

An overview is given of a project on Graphical Interaction (GI) with gridded fields at KNMI, the Netherlands. First answers are given to the question why to apply graphical interaction on model fields and, if so, where, at what stage, should it be applied. Then some information is given on the current GI project at KNMI. In the fourth and fifth paragraph something is said about synoptic scale and mesoscale GI respectively. Finally some expectations for the next few years are given.

2. GRAPHICAL INTERACTION: WHY AND WHERE ?

2.1 Why GI?

Currently the primary operational production process is highly automated. The forecaster is monitoring the process and interfering when needed. For his monitoring task he can use a powerful presentation workstation, where all observational and model data can be viewed. For his interference task he needs dedicated GI tools. To perform this interference in a most efficient way it should be done on a meteorological level as early as possible in the operational process. The premiss for this interference is always that the forecaster is supposed to add value to the model output. This also means that the forecaster should be very cautious in performing this kind of interference.

2.2 Where GI?

Four levels of GI can be defined:

- interaction with analysis: it has not been established to what extend forecaster interaction with model analysis could contribute to the model result. Modellers are generally not in favour of such kind of human interaction. However, research is going on to find out if manually adjusted potential vorticity (PV) using WV-imagery could succesfully be assimilated in a model analysis.
- synoptic scale: the On Screen Field Modification (OSFM) tool from UK MetOffice is well known in this category. Meteorological consistency is very important when interfering on a synoptic scale.

- mesoscale and short range: on this scale boundary layer parameters are predominant. There is no simple consistency between parameters, however it may be argued that for the very short range this is less relevant. Delta-techniques and the concept of Meteorological Objects (MO) are used.
- interaction on final products: this should be minimized, however in some cases it may be still needed to adjust final products (for instance TAF production).

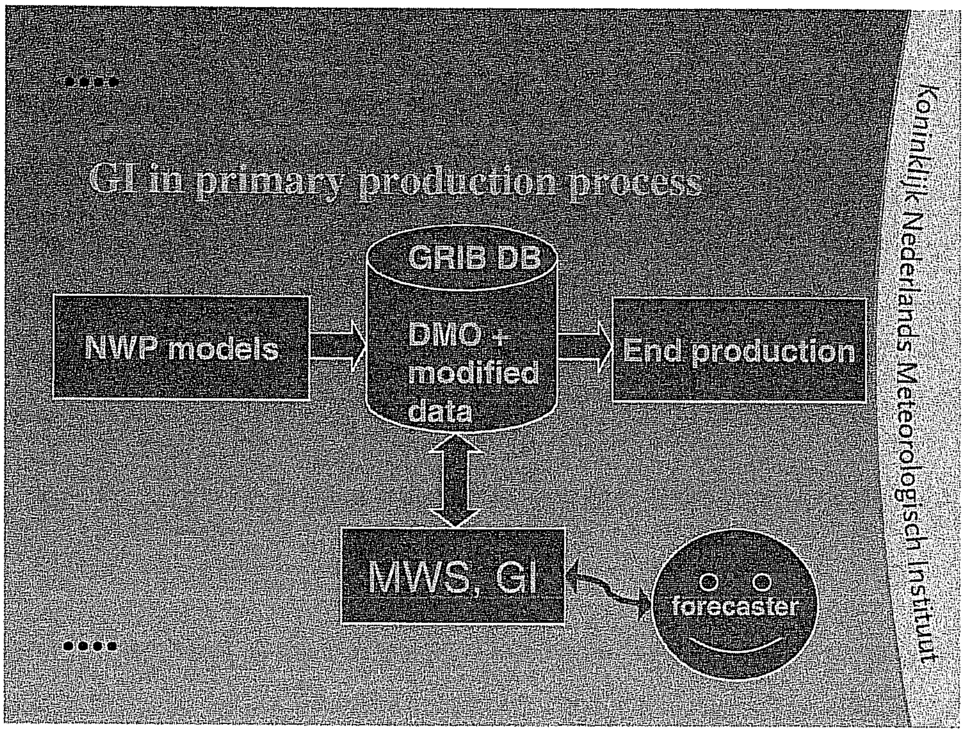

Fig. 1 GI in the primary production process

3. PROJECT GRAPHICAL INTERACTION (GI)

The goal of the current project at KNMI is: the operational implementation of a general tool for interaction on model output of all parameters that are used in operational products. The emphasis is on but not restricted to very short range GI. For efficiency reasons GI tools should be integrated in the current operational Meteorological Workstation Application.

The project GI started in December 1998 and has been scheduled to end in August 2000. The design phase has been concluded during summer 1999. Implementation of phase 1: integration of the OSFM tool from UKMO will be delivered during March 2000. This part of the project is a cooperation between KNMI, UKMO and 3SI, the American vendor of the Duth workstation system. Implementation of phase 2 has been scheduled for summer 2000, though this may run into fall 2000. During 2001 follow-up activities are anticipated based on user feed-back.

4. SYNOPTIC SCALE GI

The most important property of UKMO's On Screen Field Modification (OSFM) tools is the PV inversion principle that has been used to consistently modify gridded fields of MSLP, geopotential height, temperature and, with some assumptions, of horizontal and vertical wind, relative humidity, and precipitation (Carroll, 1997, where a full description of the method can be found). Interaction can be done directly on MSLP/gph (not using PV), acting on MSLP/gph via PV, or by modification of low level temperature (using PV). The OSFM tools are fully integrated with current workstation functionality like pan/zoom, animate, overlay and so on.

5. MESOSCALE GI

5.1 δ-techniques

Tools for mesoscale GI are meant for the modification of mesoscale phenomena (for instance sharpening troughs, small scale adjustments of boundary layer parameters) at lead times up to 6 to 12 hours (nowasting and very short range forecasting). For these smaller scales less emphasis on mutual dependence of parameters (except for some simple rules) can be justified. The techniques currently used in other systems (like FPA from Environment Canada) are known as delta-techniques (referring to the δ-changes imposed on the fields to be modified). Most important are (Proceedings COST-78 Workshop, 1998):

- poke: the forecaster increments or decrements the field value at one location;
- stomp: the forecaster draws an area around a feature, and increments or decrements the field value uniformly inside the area;
- move: the forecaster draws an area around a feature, and moves it horizontally to a new location;
- merge: the forecaster replaces a feature in the existing field with a corresponding feature from another source;
- draw: the forecaster creates a new area in a discrete field, by simply drawing its boundary.

5.2 Structure function

With all these techniques horizontal interpolation plays an important role. It should be defined how a given δ change should be interpolated to the background field. This can be done by defining an influence radius and structure function, for instance: $P_{mod}(r) = P(r) + \delta S_h(r)$, with $P(r)$ and $P_{mod}(r)$ the field before respectively after modification, $S_h(r)$ the horizontal structure function and δ the modification. A simple horizontal structure function can be defined by: $S_h(r)=1$ for $r<=r_s$ and $S_h(r) = r_s^n/r^n$ for $r>r_s$, however, also different interpolation above land vs sea can be defined in this way. Vertical interpolation can be done in a similar way using vertical structure functions. After horizontal and vertical interpolation the time evolution of a "δ-field" should be defined.

5.3 **Meteorological objects (MO)**

In its siplest form a meteorological object is data + a method. In this way a δ-technique defines a special class of objects. In order to describe interaction with objects, one should derive an object from the underlying model fields, interact with the object and translate the result. However the definition problem is not trivial.

The concept of MO allows for a large variety of complexity ranging from symbols to conceptual models with a hierarchy of spatial scales, time scales, dynamics, and relations between them.

A special working group on meteorological objects and grids in GI has been initiated during a Workshop on GI in Helsinki, Dec. 1998 (chair: Eric Brun, Météo-France, Dick Blaauboer, KNMI).

5.4 **Time evolution**

Time evolution could be described by identifying objects at variable points in time (keyframes) and specifying a time resolution (framerate). Now the time evolution of an object can be defined by editing the keyframes and the time evolution of certain properties of the object. For instance the motion (motion tweening), the evolution of shape (shape tweening) or the evolution of any attribute (attribute tweening) of the object could be prescribed (see fig. 2 next page). The concepts used to describe aspects of time interpolation are modelled on similar concepts used in the vector graphics animation package Flash by Macromedia.

After an interaction session some automatic postprocessing should take place to derive dependent parameters in a consistent way, for interpolation for intermediate timesteps, for vertical interpolations.

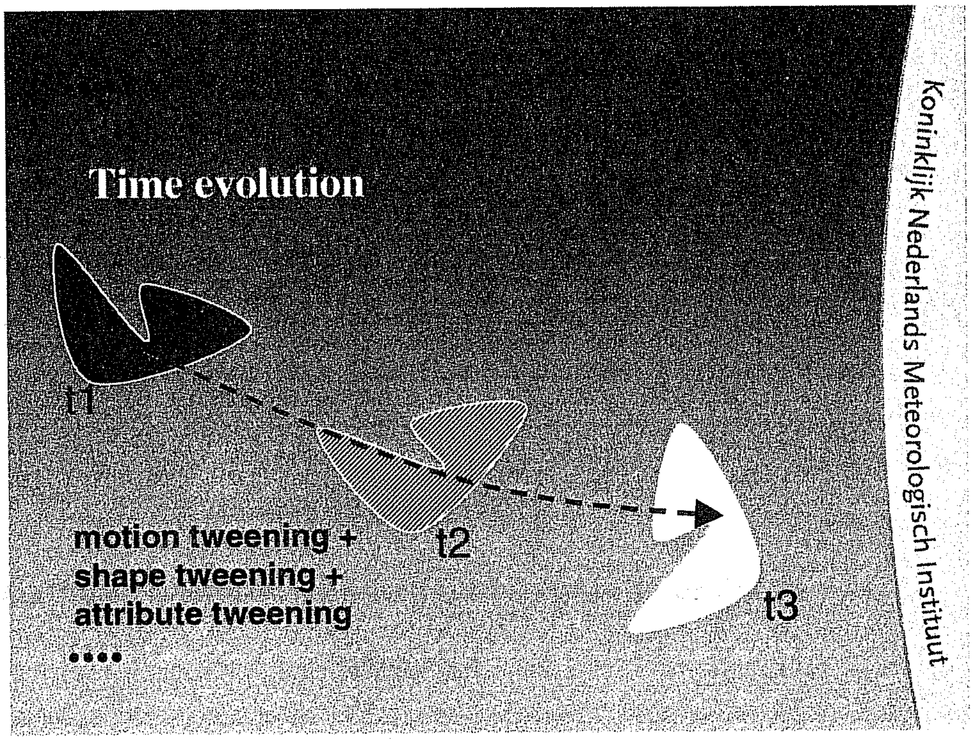

Fig 2. Time evolution of an object

6. EXPECTATIONS

We expect to have the first working GI implementation (OSFM integrated in MWS) available to the forecasters by March 2000. The first complete GI implementation, including tools for short range, should be available by September 2000. Based on feedback from forecasters during 2000 we expect a follow-up project late 2000 to 2001.

7. REFERENCES

Carroll, E., A technique for consistent alteration of NWP output fields, Meteorol. Appl. 4, 171-178 (1997).

COST-78 Proceedings of the International Workshop on Graphical Interaction with Gridded Fields, Helsinki, 10-12 December 1998, ISBN 951-697-500-3

Macromedia Flash, http://www.macromedia.com/support/flash/