P6.5 BENEFITS AND PROBLEMS OF INTEGRATED OPERATIONAL USE OF RADAR AND OTHER OBSERVATIONAL DATA IN THUNDERSTORM SITUATIONS

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1. INTRODUCTION

The operational suite of the modern nowcaster has changed dramatically in the last 10 years. Besides conventional data diverse remote-sensing observations provide a lot of real time information on actual weather. Radar and satellite data formerly were presented on separated screens and the forecaster had to compare their contents "remotely". Today these data are displayed together on advanced presentation systems. Especially thunderstorm situations can now be closely monitored by several remote-sensing data, highly resolved in space and time. On the presentations systems conventional synoptic data are overlayed to at least three different remote sensing data : Satellite data, radar data and lightning data. But the high potential available in this way to the forecaster provides not only benefits for operational tasks like nowcasting but also problems while fitting the data together and interpreting them. This may be discussed here for thunderstorm situations.

2. DATA CHARACTERISTICS

Satellite data cover the large-scale and mesoscale features of thunderstorms in terms of clouds and cloud parameters. The geostationary satellites have preference on a tight time-scale and give insight from synoptic-scale to mesoscale cloud distributions. Polar-orbiting satellites have their special advantages in the horizontal resolution giving much more mesoscale details than the geostationary satellites.

Radar data are playing the main role in monitoring of thunderstorms in that they are sensing from ground the key parameter precipitation with a very high structural and temporal resolution. Radar images describe internal 3-D structures of the reflectivity in thunderstorms and their wind-fields. Radar images are mostly presented with a spatial resolution of 1-2 km, their time intervals are between 5 and 15 minutes. Radar stations are no longer stand alone systems but are combined to networks of radar stations, being the basis for the production of regional composites. These composites are highly suitable for overlaying to other data.

Lightning data are the only remote sensing data evidencing directly the thunderstorms. They are operationally displayed in horizontal field distributions of lightning flashs. Lightning data are best resolved with a horizontal resolution down to some hundred meters and operational time intervals of some minutes. A color coding indicates their temporal sampling.

3. BENEFITS AND OPERATIONAL USE OF DATA

The potential of the remote sensing data is given by their various characteristics for the identification of thunderstorm situations. For optimized interpretation the nowcaster will make use of conceptual models of thunderstorms and thunderstorm systems comprising typical structures, life-cycles and related weather phenomena. Conceptual models enable the forecaster to discriminate between single cells, multicellular thunderstorms, supercells and mesoscale systems like squall lines or large clusters. The identification is additionally supported by NWP-products, special diagnostic tools and in some services by automatic interpretation. In order to investigate the internal structures and development of thunderstorms most presentation systems offer for instance procedures like overlaying of different data and temporal animations (loops). Loops may show single remote data with the best possible temporal resolution for that data or a combination of different data types with an appropriate selection of time-interval.

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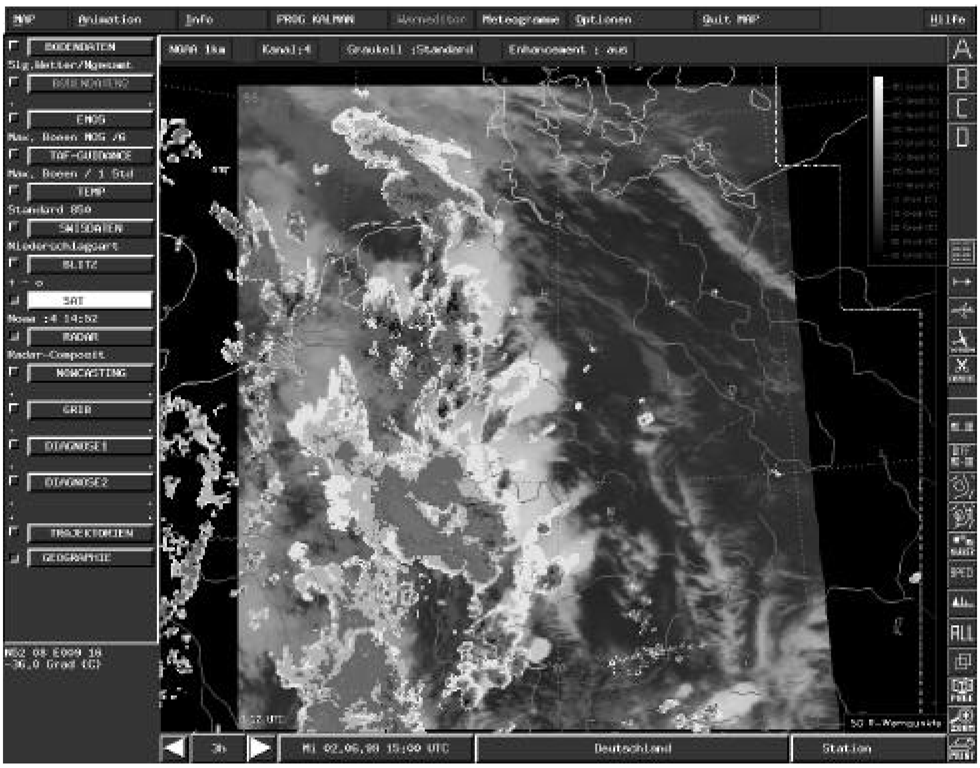
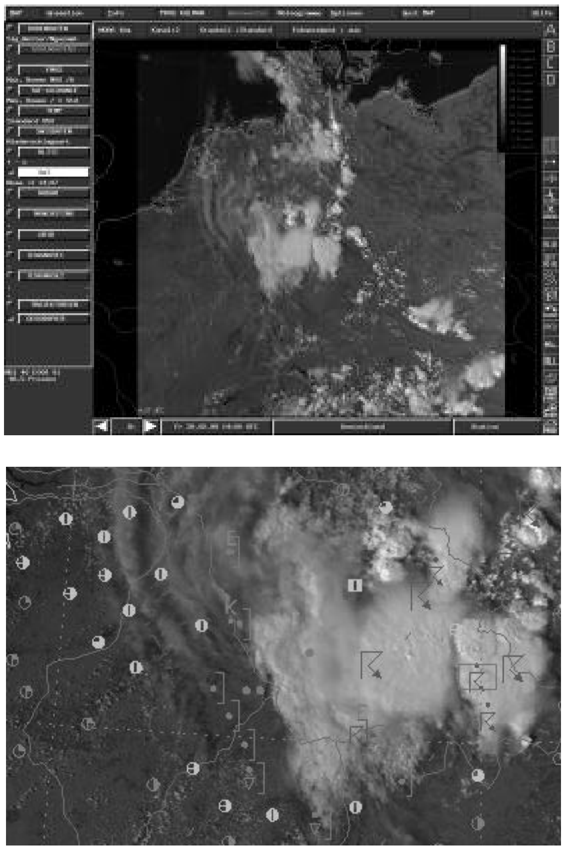


Overlay of IR-satellite image and radar composite in a situation of developing severe thunderstorms

4. PROBLEMS BY TEMPORAL AND SPATIAL SHIFTS OF DATA

Precise localization of single thunderstorms and mesoscale convective systems and the application of conceptual knowledge of thunderstorms requires accurate mutual spacing and timing of the data displayed on the screen. This is not the case when looking to the observational data in a tight time and spatial scale which is sometimes important in connection with thunderstorms.

Differences exist between the real data time and nominal data time in synoptic, satellite and radar data. These data are not point data in a temporal sense and they will be allocated to nominal time due to agreed operational regulations. Such dependencies may lead to time discrepancies from minutes to nearly half an hour, which is critical especially in situations of rapid thunderstorm development. Synoptic reports of severe thunderstorms or heavy convective rain may occur a quarter or half an hour before the allocated nominal time. The time discrepancy is on the other hand comparatively small in case of geostationary Meteosat data, amounting to only about 5 minutes for regions like Central Europe. Radar scans are lasting about 5-7 minutes, creating time differences



Coast and lake line shift in a Vis-NOAA-Image
In the lower image zoom : Time shift of weather observation

within the radar images in the same scale.

More severe problems may exist with spatial allocation. Difficulties in exact navigation of satellite images can easily result in horizontal displacements of 20 or more kilometers. Displacements by incorrect navigation is most often observed in images of polar orbiting satellites. In such cases plotted coast or lake lines may show a remarkable shift compared with the visible coast and lake lines. Another shift occurs by the parallax of high cloud tops in satellite data, which are not yet corrected in operational images. Horizontal shift of the high cloud tops away from the subsatellite point can be observed both in geostationary and polar orbiting satellites. The shift in geostationary images grows in midlatitudes to more than the height of the clouds themselves, that means in towering Cbs to more than 10 km. The elevation angle of the geostationary satellites in 50 degree latitude is only 32 degree and decreases rapidly further to the north, creating beyond 60 degree a severe shift. Also radar data may sometimes reveal systematic problems in the exact spacing of structures due to refraction of the radar beam. The main spatial problem with radar data is the overshooting of the radar beam over the earth surface and lower clouds, hiding lower precipitations areas.

5. CONCLUSIONS

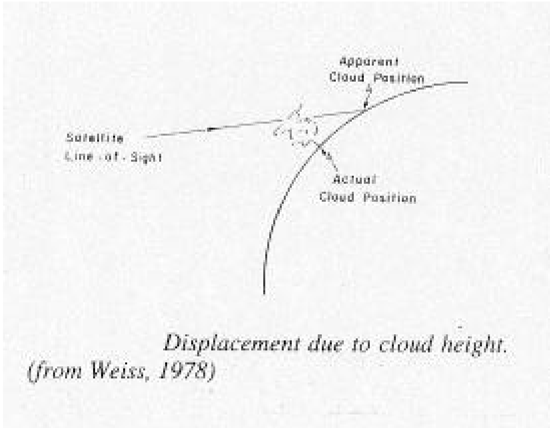
Due to the specific situation in conventional and remote sensing observation data don't fit always precisely together in time and space. Integrated and synergistic fine-scale use of observational data is increasingly important in actual monitoring, diagnosing and nowcasting especially of thunderstorms. This problem is negligible within synoptical scale, but has growing relevance in the mesoscale with special importance when zooming to small scale thunderstorm features. With further progress in conceptual applications to thunderstorm diagnostics and nowcasting these problems have to be tackled more deeply.

6. REFERENCES

Karlsson,K.G., 1997: Remote sensing in meteorology, SMHI

Bader,M.J.,G.S.Forbes,J.R.Grant,R.B.E.Lilley and A.J.Waters 1995: Images in weather forecasting , Cambridge University Press

Weiss,C.E. , 1978: Clopud-location corrections near the horizon of an SMS image, Satellite Applications Information Note 78/8, NOAA-NESDIS



Horizontal Cloud top shift by parallax in satellite images