OPERATIONAL IDENTIFICATION AND VISUALISATION OF CLOUD PROCESSES FOR GENERAL AVIATION USING MULTISPECTRAL DATA

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ABSTRACT

Information about the location of enhanced convective regions and super-cooled water droplet clouds is one major task of aviation meteorology. Deep convective cores are mainly responsible for an increasing amount of delayed flights during the last years leading to enormous economical losses (Evans 2002). Moreover, the majority of aviation accidents is caused by turbulences connected with deep convective regions (Proctor et al. 2002). Super-cooled cloud droplets are on their part responsible for wing glaciation. According to Mingione (1998), wing glaciation was the main cause for about 800 serious incidents and plane crashes between 1975 and 1988. While jet planes produce enough heat to stoke their wings properly, small and medium planes with energy-saving engines and carbon fibre cabins often have no adequate exterior shell heating and moreover are not able to climb above the critical height for wing glaciation of about 5000 meter. Therefore an operational cloud process identification tool (CPI) for retrieving and visualising cloud processes for general aviation using multispectral data is developed. The successive identification of critical areas uses VIS, NIR, WV and IR data from e. g. Meteosat-8, several radiative transfer model based look-up tables and actual atmospheric vertical profiles from radiosonde or analyse data. The poster presents the concept and first results of the CPI algorithm.

1. IDENTIFICATION OF DEEP CONVECTIVE AREAS

The CPI convective module (Figure 1) is based on the concept model that positive TB_WV-TB_IR differences (DWI) can be used in order to discriminate between deep convective, optically thick clouds (DWI>0) and non-convective other clouds like cirrus (DWI<0, Tjemkes et al. 1997). Pixels with positive DWI are subdivided by analysing the frequency distribution of brightness temperatures (TB_IR). Areas with TB_IR<1st quartile of the frequency distribution represent overshooting tops of deep convective cores, those who suit the 1st quartile reveal medium convective systems rising up to tropopause level and pixels with TB_IR<3rd quartile identify moderate convection of high vertical extension. As a result, graded convective regions can be distinguished from adjacent stratiform areas (Figure 2).
2. IDENTIFICATION OF SUPER-COOLED CLOUD REGIONS

The CPI module for the identification of super-cooled water clouds (Figure 3) is based on the retrieval of the effective cloud droplet radius (re) and its variation with cloud-top temperature. The microphysical parameters are retrieved with an adapted version of Nakajimas GTR code (Kawamoto et al. 2001) that is adapted to Terra-MODIS and MSG-SEVIRI spectral bands at about 0.6 and 3.9 and 11 µm. Lensky and Rosenfeld (1997) demonstrated that the variation of re with cloud-top temperature can be used as an indicator for cloud droplet growth processes. In turn, some of these processes are directly linked with cloud phase and therefore mixed-phase growth processes can be used as indicator for super-cooled water cloud regions. An auto-analysing algorithm taking into account the subsequent slope characteristics of the development of re...
with cloud-top temperature is used for the operational differentiation of single cloud phases and the cloud phase is re-allocated in the image area using corresponding cloud-top temperature and re threshold values.

![Figure 3. Cloud droplet growth processes on August 5th 2002, 11:05 UTC (Terra-MODIS).](image3)

3. FOG DETECTION

Fog detection is based on the automated analysis of spatially discrete cloud clusters. In this process both spectral and secondary information (such as a Digital Elevation Model) are used. The high temporal resolution of Meteosat 8 SEVIRI images provides an ideal basis for fog monitoring. More detail on the methodology can be found on the corresponding article within this proceeding from Cermak and Bendix 2004.

![Figure 4. Fog regions over central Europe on May 12th 2004, 22:45 UTC (Meteosat-8).](image4)
4. VISUALISATION FOR NOWCASTING OPERATIONS

In order to visualise the results platform and software independent, the satellite raster data is converted to standard DTP format for flexible access using standard internet web-browsers. Conversion into any other format is possible, too, using a standardized interface. Further research is necessary in order to additionally integrate data of e.g. ground-based radar networks or numerical weather model data in the retrieval technique.

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6. REFERENCES


