



Institute of Meteorology and Water Management National Research Institute



The use of NOAA/ATOVS satellite data for convective storm nowcasting and early warnings

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Goals



To apply NOAA/ATOVS data in IMWM storm forecasting system through atmospheric stability indices;

To define the stability indices threshold values that could be used in recognition of storm highest probability area;



ATOVS (Advanced TIROS Operational Vertical Sounder) on board of NOAA and Metop polar orbiting satellites:

Skanning sensor measuring thermal radiation of the Earth consists of three radiometers:

- HIRS-3 (IR band)
- AMSU-A (MW band)
- MHS (MW band)

Daily skanning of whole globe disc;

Number of available transmissions during 24h depends on satellite number

and varies from 2 to 6.

NOAA/ATOVS products



IAPP software (Wisconsin University) is used for calculation of:

- Temperature at 40 pressure levels from 0.1 to 1000 hPa.
- Mixing ratio of water vapour at 25 pressure levels from 50 to 1000 hPa.
- Total Precipitable Water.
- Total ozone content.

Profile of dew-point temperature is additionally calculated as well as geopotential height (for three pressure levels).

Calculations are made for pixel size of 3x3 pixels HIRS-3 what results in 60 km products resolution.

UK MetOffice weather forecast numerical model fields are used as initial conditions in iterative algorithm as well as parameters describing surface properties.

Satellite atmospheric sounding





Temperature at chosen pressure levels NOAA-18 15.08.2008, 1134 UTC

850 hPa





Satellite atmospheric sounding





Methodology



 Two atmospheric stability indices KI and TTI were chosen as their calculations on a basis of ATOVS data do not require any additional information (for example about ground level pressure). Both can be useful for storm forecasts purposes.

 $KI = (T_{850} - T_{500}) + TD_{850} - (T_{700} - TD_{700})$ (George, 1960)

 $TTI = T_{850} + TD_{850} - 2T_{500}$ (Seemann et al., 2006)

where: T_{850} , T_{700} i T_{500} – temperature at 850hPa,700hPa and 500hPa pressure levels; TD_{850} TD_{700} i TD_{500} – dew-point temperature at 850hPa, 700hPa and 500hPa pressure levels; levels;

Total Precipitable Water (TPW).



- Above mentioned parameters were calculated for all NOAA transmissions of 2007-2010 storm seasons (May-Sept.) on a basis of vertical atmospheric temperature and humidity profiles obtained using IAPP software.
- In the next step, for each satellite transmission pixel center (within Poland) total diurnal lightning number was calculated (PERUN system data). Radial value of 0.2 was applied.
- Only lightning posterior to transmission were taken into account. This way data sets combining lightning activity information, atmospheric stability indices values KI and TTI alongside with TPW were created.

Results: histograms values of investigated indices (2007-2010)



Results





Results: comparison with lightning number (2007-2010)







Proposed threshold values:

•30°C for KI •45 °C for TTI •40 mm for TPW

Case 1: 23rd of August 2011, 0245 UTC



K Index





Case 1: 23rd of August 2011, 1237 UTC







Results: 23rd of August 2011



Total lightning activity map 1300-2400 UTC – calculated on a basis of secondary data files of PERUN system (Vaisala SAFIR 3000).



Case 1: 20th of August 2011



0136 UTC KI





TT Index



TT Index



Results: 20th of August 2011



Total lightning activity map 1300-2400 UTC – calculated on a basis of secondary data files of PERUN system (Vaisala SAFIR 3000).



Conclusions



- Use of NOAA/ATOVS data allows for vertical distribution of atmospheric temperature and humidity assessment, therefore for some stability indices calculations;
- Relations between KI, TTI, TPW and total lightning number proves them to be useful in in-mass storm occurrence probability assessment.
- As a result of investigation, threshold values of in-mass storm occurrence probability were defined (first lightning after 1300 UTC). Values are 30°C, 45°C and 40 mm, for KI, TTI and TPW respectively. When above mentioned are exceeded the probability of storm event occurrence rises considerably.
- The main disadvantage of the NOAA/ATOVS data is their rather small temporal resolution, however if all overpasses are take into account, the information about possible storm threat will be available with long enough lead time.