WATER RESEARCH COMMISSION

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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

TECHNICAL BRIEF

Climate

Using satellite to track convection over southern Africa

A newly-completed Water Research Commission (WRC) study tested a new nowcasting tool specifically for data-sparse regions.

Background

Nowcasting is the science of anticipating the ordinary and severe weather events in the next few hours. Severe weather events can include heavy rainfall, strong wind, hail and/or tornadoes.

Various sectors of society need to be able to prepare for these events when they occur and the issuing of weather-related warnings for such events in South Africa is the mandate of the South African Weather Service (SAWS).

In an ideal world, radar systems provide the most useful information about the intensity, movement and characteristics of severe weather events, but these data sources are expensive to obtain and require extensive maintenance. Even in South Africa, radar systems do not provide coverage of the entire country and this leaves gaps between radars.

In other southern African countries, very few operational radar systems exist. Despite the shortcomings in data resources, all meteorological centres still have to warn the public of pending severe weather events.

Potential of satellite for nowcasting

The geostationary Meteosat Second Generation (MSG) satellite provides data coverage over all African countries and the operational use of satellite data as a possible solution for nowcasting of severe weather events in data-sparse regions is increasingly being considered by satellite users.

In order to optimise the use of satellite data, different centres were established in the European region to develop derived products for different purposes, including nowcasting. The Nowcasting Satellite Application Facility (NWC SAF) developed various tools, which can be very useful for the nowcasting of severe weather events.

One of the products, developed within the NWC SAF framework by Meteo-France, is called the Rapid Development Thunderstorms (RDT) product. The aim of this product is to use data from satellite and a numerical weather prediction model to identify and track the more intense parts of thunderstorms. The software to generate this product can be downloaded from the NWC SAF website by any user.

This WRC-funded project implemented and tested the RDT product over the South African as well as southern African domain to show the possible benefit of this product in data-sparse regions.

Methodology

European countries that make use of the RDT product mostly use data from the European Centre for Medium-Range Weather Forecasts (ECMWF) model as input to the product. In South Africa, the software had to be adjusted to use the local version of the UK Meteorological Office (UKMO) Unified Model (UM).

This model is run once a day in South Africa, using a 12 km horizontal resolution and 38 vertical levels. The UM has an hourly output for up to 48 hours ahead. Satellite data from the MSG are readily available every 15 minutes.

The 2012 version of the NWC SAF software was installed on a server at the SAWS and several case studies were conducted, ten of which over the South African domain and ten over the southern African domain.

Quantitative validation of the RDT product over the South African region was done using lightning data from the South African Lightning Detection Network (SALDN), while visual comparisons were also done using radar images (where available) and images from the MSG satellite.

Over the southern African domain, the visual validation was performed using MSG images as well as rainfall data derived from the Tropical Rainfall Measuring Mission (TRMM), while quantitative validation was done using lightning data from the World Wide Lightning Location Network (WWLLN).

Results

The results of ten case studies over the South African domain were used to determine whether the 2012 version of the RDT software could identify the more intense part of thunderstorms.

The results indicated that the RDT product compared well with the radar data in most cases and sometimes complemented the radar data in areas where no radar systems were available. Visual comparisons with MSG data showed that the intense parts of rapidly developing thunderstorms could be distinguished from the non-intense parts.

When comparing the occurrence of lightning in the 10 minutes before until 10 minutes after each RDT time step, a large percentage of the moderate to intense lightning occurred inside the RDT polygons. The Hanssen-Kuiper discriminant (HK) showed that there was a good correlation between the moderate to intense lightning and the RDT polygons.

The results of the case studies over the southern African domain were visually compared to MSG images as well as the occurrence of rainfall (using the TRMM data set). Growing and mature RDT polygons coincided well with the more intense parts of thunderstorms as identified by the satellite images, while highlighting the more intense cores of the storms.

The RDT polygons also showed good correlation with the occurrence of more intense rainfall, as estimated by the TRMM. The lightning data from the WWLLN has a very low detection efficiency (DE) – almost a tenth of the lightning data recorded by the SALDN. Despite this shortcoming, large percentages of the lightning still occurred inside the RDT polygons and good contingency table scores were recorded.

Conclusion

The implementation of the 2012 version of the NWC SAF software to test whether the RDT product can be used over the South African and southern African regions proved to be successful. The results of the cases that were considered show promising results that this product could provide additional information on possible severe storms in regions that are not covered by radar systems.

This product may be useful particularly for aviation purposes in regions of Africa and could assist in navigating air traffic around the more intense storms, which could contain hail and/or heavy rainfall.

Several occasions were utilised to demonstrate the RDT product to operational forecasters in South Africa as well as in the southern African region through workshops as well as the annual Severe Weather Forecasting Demonstration Project (SWFDP) training events. Positive feedback has already been received about this new nowcasting tool.

The results of the research were also presented at several national as well as international forums and, in general, the response to the fact that South Africa has succeeded in running the RDT software operationally has been very positive.

Other African countries have expressed the need to share in the output of the RDT product. The 2013 version of the NWC software was made operational at SAWS during the second half of 2014. The RDT images are available on the FCAST website to forecasters in South Africa, but also on the Regional Specialised Meteorological Centre (RSMC) website for forecasters from our neighbouring countries.

This version already contains updates and improvements on the 2012 version. Several new options are available in the 2013 version of the software, which have not all been implemented yet. This will form part of future research on this topic.

The results of the RDT case studies conducted to date are thus very encouraging and several options exist for future work.

Further reading:
To order the report, *Using satellite data to identify and track convection over southern Africa* (**WRC Report No. 2235/1/15**), contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.