

Nowcasting in data sparse regions

Estelle de Coning
South African Weather Service
with inputs from Morne Gijben and Bathobile Maseko

Content

- 1. Introduction
- 2. SWFDP
- 3. Current satellite (MSG) based nowcasting tools for Southern Africa:
 - 3.1 Satellite based instability indices
 - 3.2 Satellite based rainfall estimation
 - 3.3 Nowcasting SAF products – RDT and CRR
- 4. Summary and future work

Kofi Annan

former UN Secretary-General (21 July 2016)

- “Climate change will magnify and multiply existing health threats – in many cases - dramatically. The effects will be felt hardest in low and middle-income countries in Africa and South Asia.
- Climate change is complicating the *already enormous challenges* of providing health services around the world – and those complications are felt most keenly in the world’s poorest countries.“

The poor need warnings too!

- The Global Humanitarian Forum states:
 - “Developing countries, which are most likely to suffer the brunt of climate change impacts, have the least number of ground-level weather data observation systems, the critical basis for efficient delivery of weather information.
 - Despite covering a fifth of the world's total land area, Africa has the least developed land-based weather observation system of all continents, and one that is in a deteriorating state.”

Global Humanitarian Forum (2008). *Weather information for all initiatives 2008-12* available at http://info.publicintelligence.net/WIFA_Project_Outline_Executive_Summary.pdf.

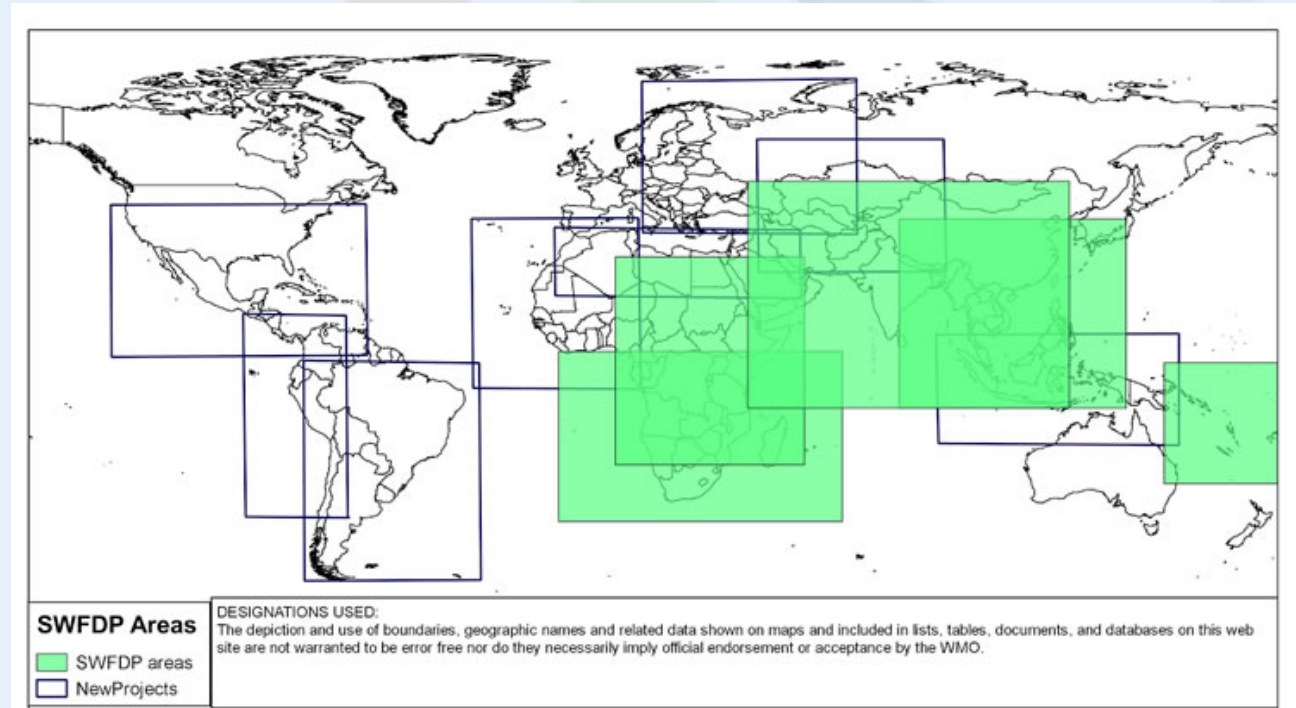
WMO Nowcasting Symposium 2016

1. Introduction

- **Strength of nowcasting** - location-specific forecasts of the initiation, growth, movement and dissipation of weather phenomenon in real time
- **Ideal world - radar systems**
- Reality, however, is that **many developing countries (DC) and even more so Least Developed Countries (LDC) do not have operational radar systems at all**
- The countries which are fortunate enough to have radar systems, are struggling to maintain and sustain these powerful data sources.

2. Severe Weather Forecasting Demonstration Projects (WMO CBS SWFDP)

- The WMO Severe Weather Forecasting Demonstration Project (SWFDP) is aiming to **strengthen capacity** in National Meteorological and Hydrological Services (NMHSs) in developing and least developed countries including Small Island Developing States (SIDSs) to **deliver improved forecasts and warnings of severe weather to save lives, livelihoods and property.**
- **Tools: NWP, ensembles, derived products**



2. Severe Weather Forecasting Demonstration Projects (WMO CBS SWFDP)

- Fourth meeting of the CBS-SWFDP Steering Group in Geneva, February 2012:
 - Challenge for the SWFDP: “the need for very short-range forecasting tools, to address especially the rapid onset of localized severe thunderstorms which can produce heavy precipitation and strong wind, given the absence of adequate real-time observational networks, especially weather radar coverage.”
 - The usefulness of EUMETSAT satellite based instability products, such as the Global Instability Index, for nowcasting purposes was recognized
 - Also agreed that real time satellite rainfall estimates have proven particularly useful in regions where rain gauges and radar coverage is sparse.
- Surface-based measurement systems in DC and LDC are still needed to accurately measure and monitor precipitation amounts on the ground, to be incorporated into application models as well as aid in validation of other (satellite and model based) methodologies.

Southern Africa RSMC website

World Meteorological Organization
Weather • Climate • Water

Regional Specialised Meteorological Center (RSMC) Pretoria

Designated to
South African Weather Service

Guidance Products

NWP & EPS Products

Regional Models

- [UM SA12](#)
- [Aladin La Reunion](#)

Global Products

- [NOAA](#)
- [ECMWF: EPS](#)
- [Met. Officer: EPS](#)
- [SAWS: EPS \(NOAA\)](#)

Short-range (1-2 Days)

- [Map Day 1](#)
- [Map Day 2](#)
- [Risk Tables](#)
- [Discussion](#)

Medium-range (3-5 Days)

- [Map Day 3](#)
- [Map Day 4](#)
- [Map Day 5](#)
- [Prob. Tables](#)
- [Discussion](#)

Flash Flood Guidance

- [SARFCG Portal](#)

Regional and International Centers

- [ECMWF](#)
- [NCEP](#)
- [UK Met Office](#)
- [WMO](#)
- [RSMC - Reunion](#)
- [ACMAD](#)

SADC Countries

- [SADC Countries National Meteorological Services](#)

Other Services and Products

- [Short-range](#)
- [Long-range \(Seasonal\)](#)

Nowcasting Products

Satellite-Based Rainfall

- [Hydro-Estimator Rainfall Totals](#)
- [1hr](#) • [3hr](#) • [6hr](#) • [24hr](#)
- [Hydro-Estimator Rainfall Totals In Days](#)
- [10 Days](#) • [30 Days](#) • [Archive](#)
- [Description of Product](#)

Convective Thunderstorm Forecasts

- [Probability of Convective Thunderstorms](#)
- [CII](#) • [Description of Product](#)
- [Rapidly Developing Thunderstorms](#)
- [RDT SADC](#) • [Description of Product](#)
- [RDT SA](#)
- [Convective Rainfall Rate \(CRR\)](#)
- [CRR](#) • [Description of Product](#)

Hail Forecasts from UM SA12

- [10 UTC](#) • [12 UTC](#) • [14 UTC](#)

Lightning information

- [Forecast Today](#) • [Forecast Tomorrow](#)

Hydro-estimator Storm Tracks

- [SADC](#)
- [SADC NW](#)
- [SADC NE](#)
- [SADC SW](#)
- [SADC SE](#)
- [Madagascar](#)
- [South Africa](#)

SWFDP Training Nov 2012

- [GDPPS](#)
- [PWS](#)

SWFDP Training Nov 2013

- [GDPPS](#)
- [PWS](#)

SWFDP Training Nov 2014

- [GDPPS](#)
- [PWS](#)

[RSMC Guidance Archive](#)

[Contact RSMC](#)

[Logout](#)

RSMC Pretoria / Contact the Webmaster /

Nowcasting Products

Satellite-Based Rainfall

Hydro-Estimator Rainfall Totals

- [1hr](#) • [3hr](#) • [6hr](#) • [24hr](#)

Hydro-Estimator Rainfall Totals In Days

- [10 Days](#) • [30 Days](#) • [Archive](#)
- [Description of Product](#)

Hail Forecasts from UM SA12

- [10 UTC](#) • [12 UTC](#) • [14 UTC](#)

Lightning information

- [Forecast Today](#) • [Forecast Tomorrow](#)

Convective Thunderstorm Forecasts

Probability of Convective Thunderstorms

- [CII](#) • [Description of Product](#)

Rapidly Developing Thunderstorms

- [RDT SADC](#) • [Description of Product](#)
- [RDT SA](#)

Convective Rainfall Rate (CRR)

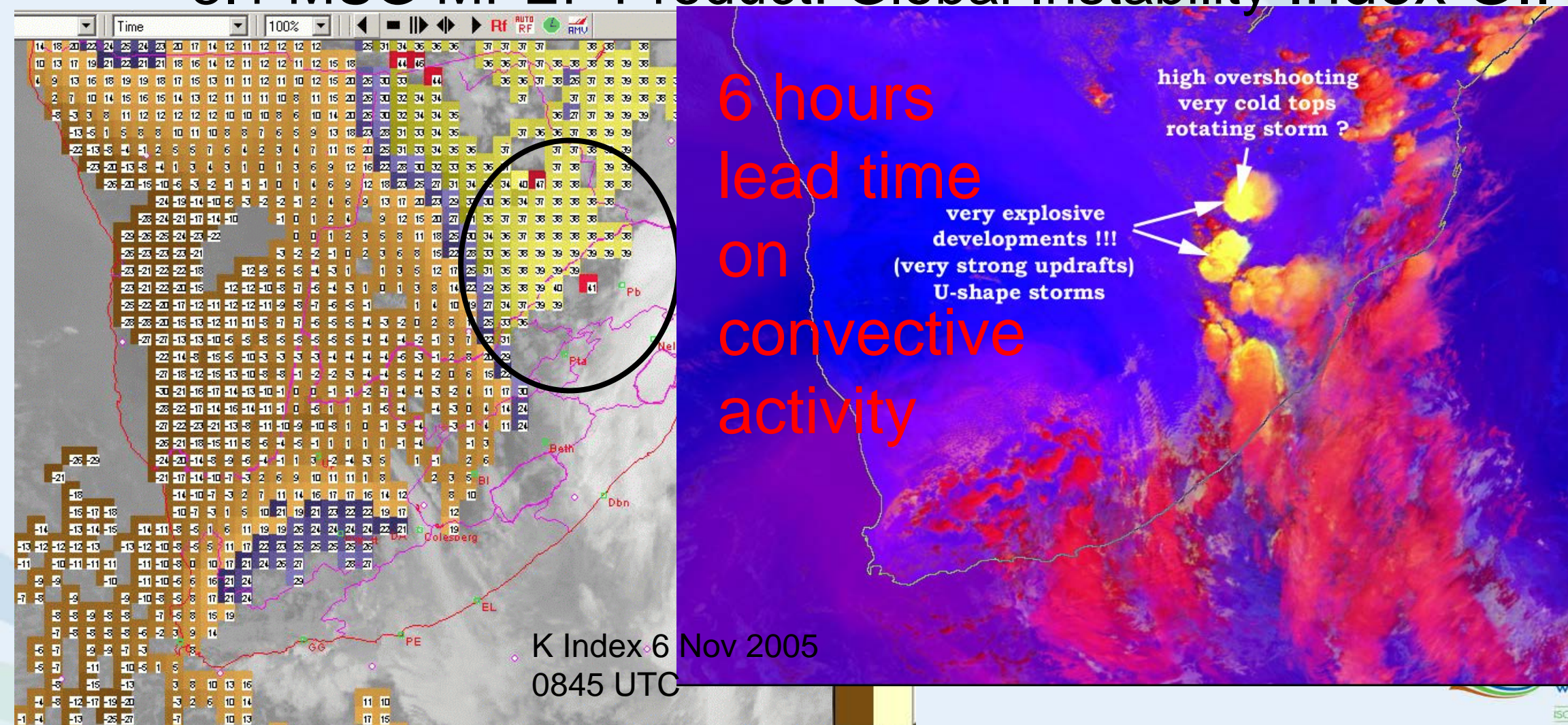
- [CRR](#) • [Description of Product](#)

Hydro-estimator Storm Tracks

- [SADC](#)
- [SADC NW](#)
- [SADC NE](#)
- [SADC SW](#)
- [SADC SE](#)
- [Madagascar](#)
- [South Africa](#)

3. Satellite based nowcasting tools for southern Africa

3.1 MSG MPEF Product: Global Instability Index GII



1430 UTC

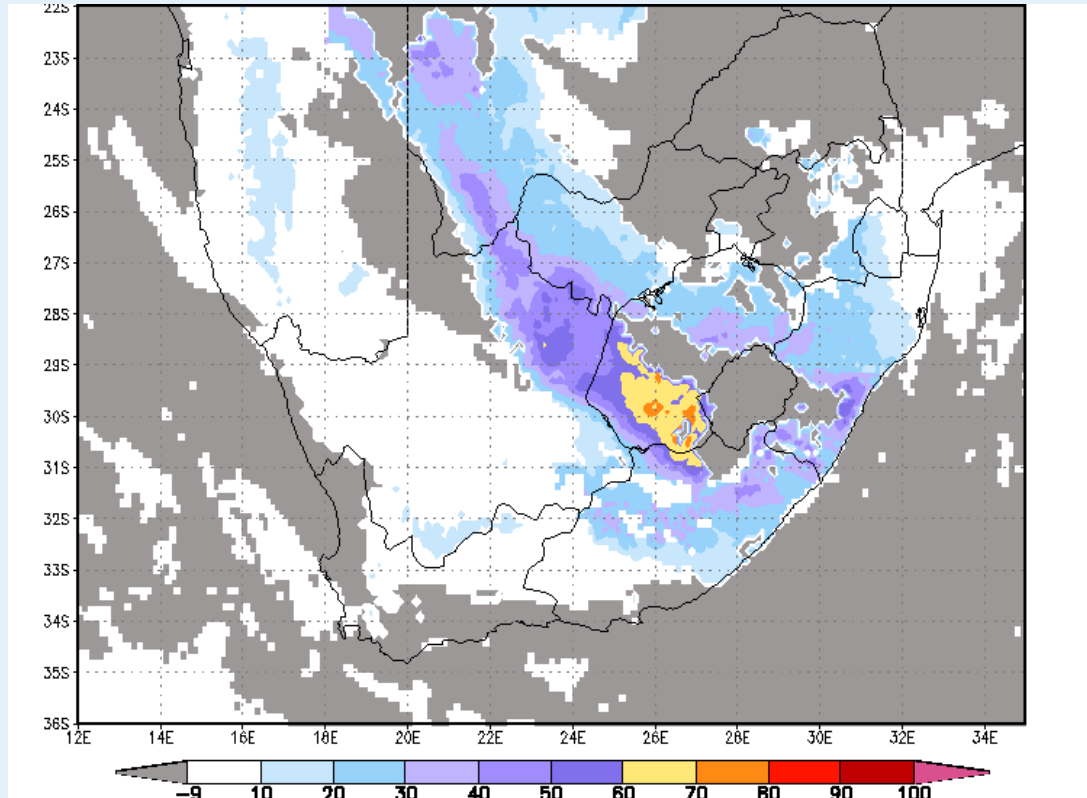
Image courtesy Jochen Kerkmann EUMETSAT

K Index 6 Nov 2005
0845 UTC

3.2 A probability map for convection

- **Combination of satellite based parameters as well as height above sea level was created to give a probability map for seeing lightning/convection later in the day – Combined Instability Index (CII)**
- For a forecaster this is one easy step to get an indication for where to expect convective development later in the day in probabilistic fashion
- Calculation only possible in cloud free areas, thus early morning values are used when it is as cloud free as possible.

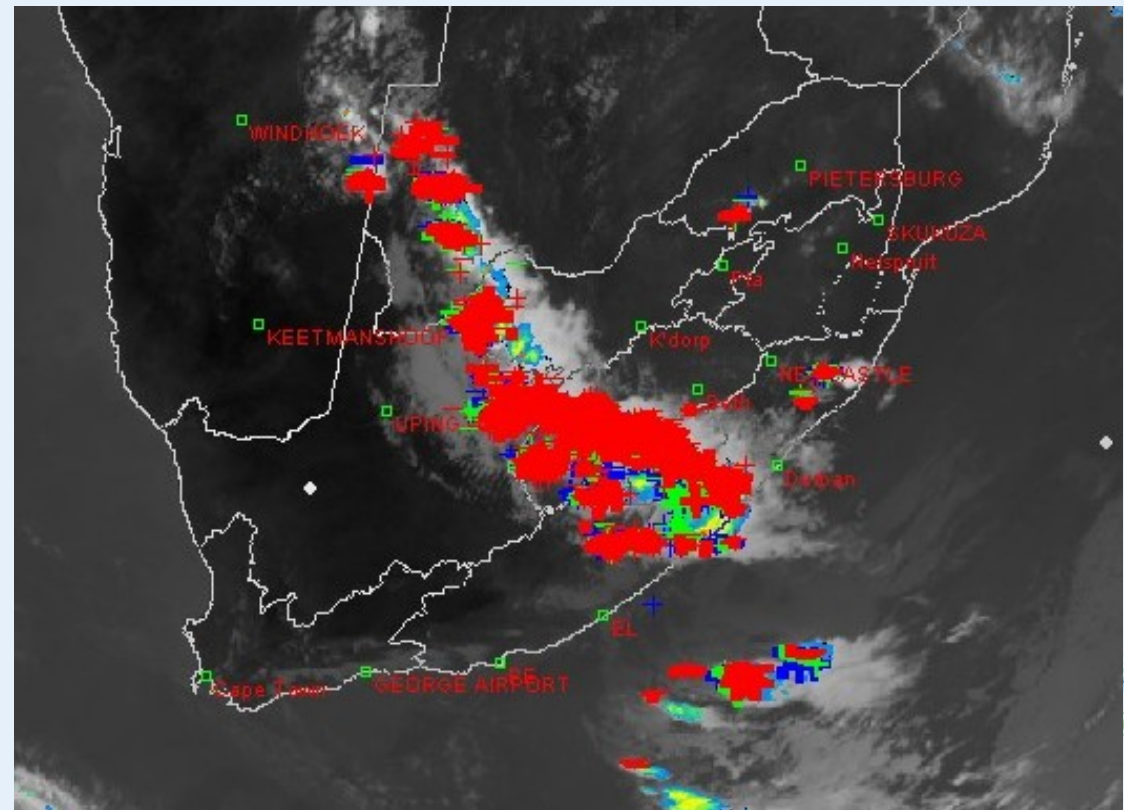
31 Jan 2010



CII 06:00-0900 UTC

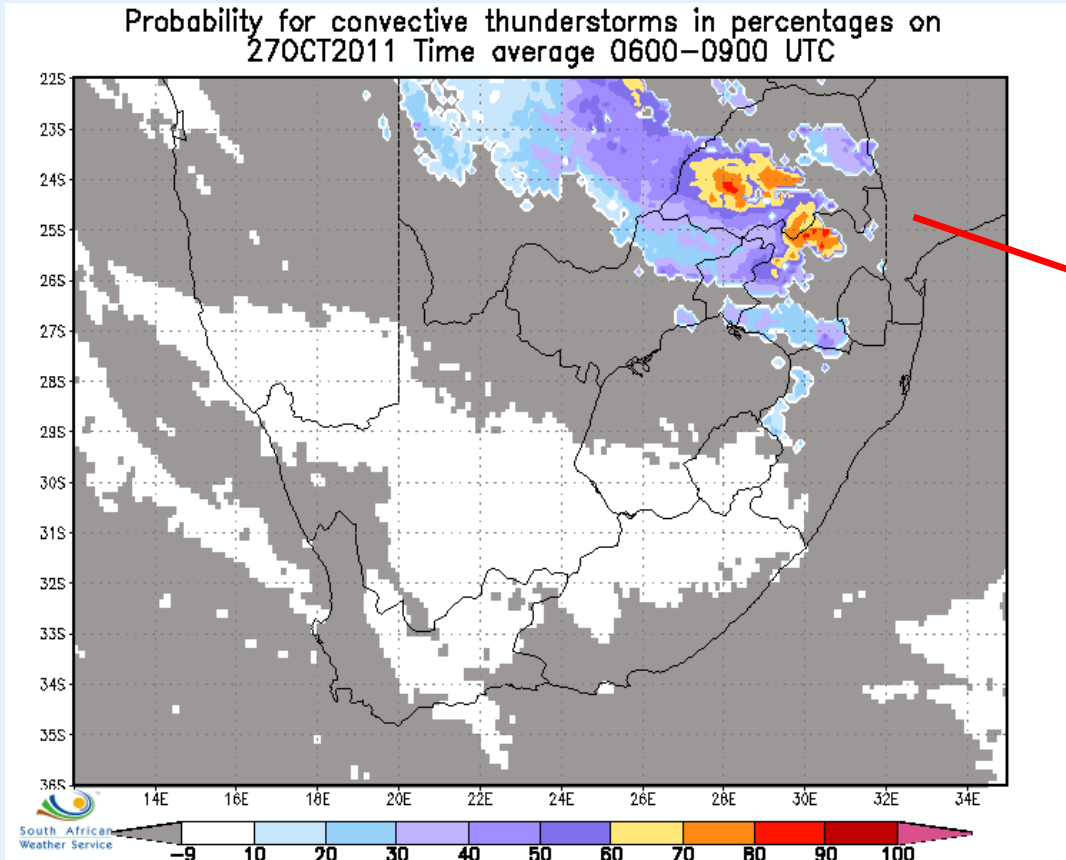
6 hour lead time!

1500 UTC

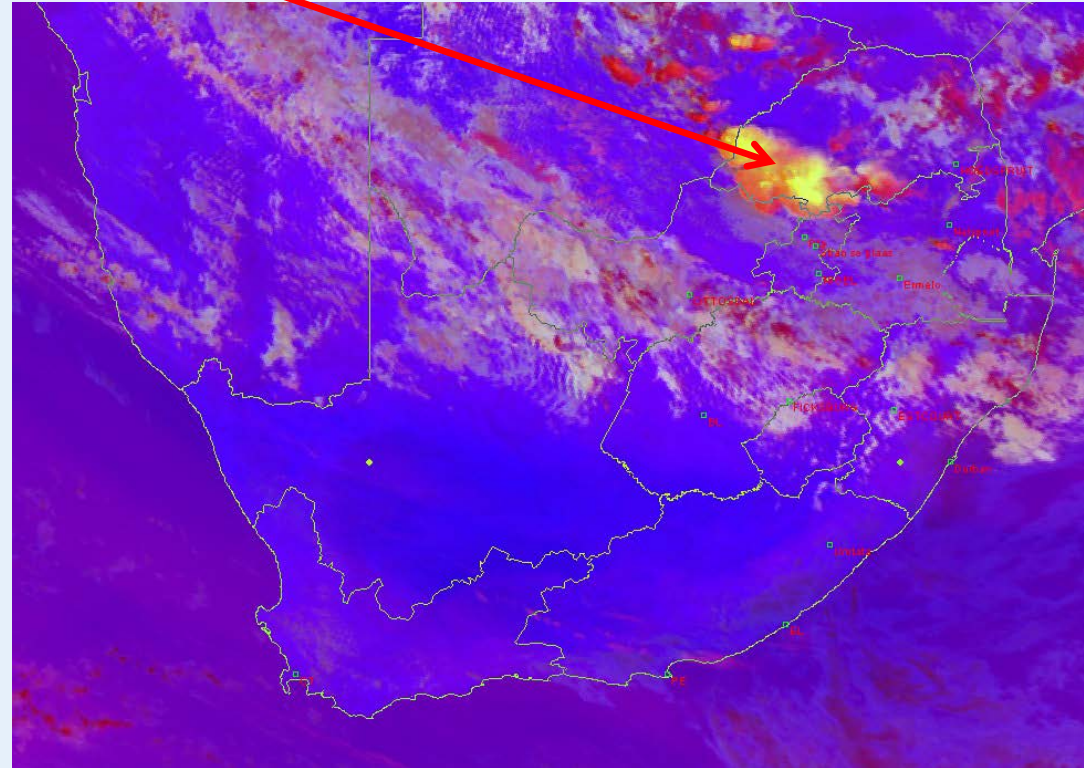


Example 27 Oct 2011

4 hours lead time

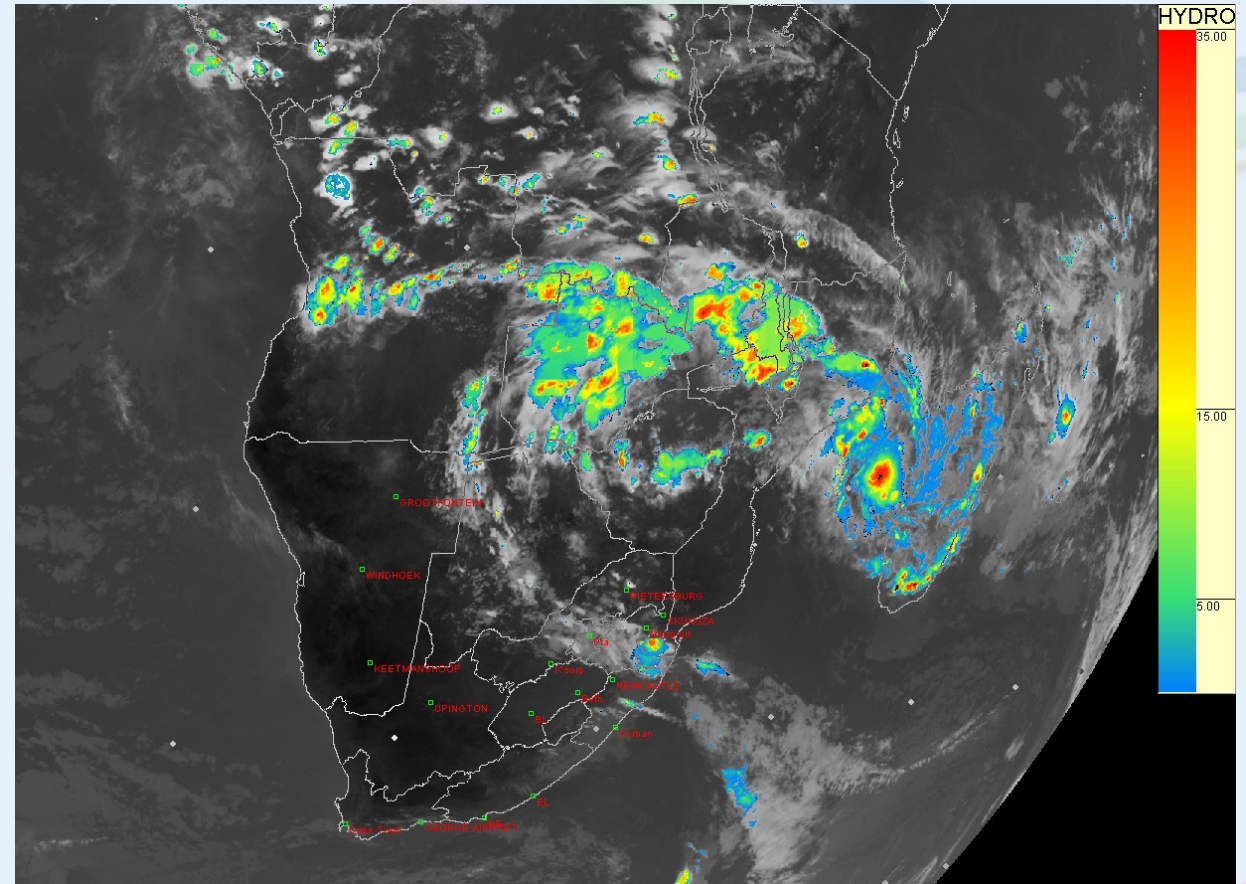


Conv RGB 1330 UTC









3.2. Satellite based precipitation estimation - Hydroestimator

- Hydroestimator (HE) using IR108 and NWP input
- HE is operational in SA since October 2007, available every 15 minutes, using MSG IR108 as well as Unified Model input
- **Real time (15min)** precipitation estimation using 1 MSG channel and NWP



3.3 Nowcasting Satellite Application Facility - Spain

- Satellite Application Facilities (SAFs) are centres of expertise for processing satellite data for various applications
- The **Nowcasting SAF** started in February 1997 aiming to produce the software to *deal with the Nowcasting and Very Short Range Forecasting using the characteristics* of the MSG SEVIRI data and the NOAA and EPS AVHRR data (EUMETSAT Satellites).

 OSI SAF	 H SAF	 O3M SAF	 NWP SAF
OCEAN AND SEA ICE The OSI SAF provides comprehensive information on the ocean-atmosphere interface — requirements of both meteorology and oceanography.	SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT The H SAF generates and archives high-quality datasets and products for operational hydrological applications.	OZONE & ATMOSPHERIC CHEMISTRY MONITORING The O3M SAF processes data on ozone, other trace gases, aerosols and ultraviolet data, obtained from satellite instrumentation.	NUMERICAL WEATHER PREDICTION The NWP SAF aims to improve and support the interface between satellite data/products and European activities in NWP.
 CM SAF	 ROM SAF	 NWC SAF	 LSA SAF
CLIMATE MONITORING The CM SAF generates and archives high-quality climate datasets on a continuous basis.	RADIO OCCULTATION METEOROLOGY The ROM SAF generates and archives high-quality GPS Radio Occultation (RO) datasets for Numerical Weather Prediction (NWP) applications and specific climate application areas.	SUPPORT TO NOWCASTING AND VERY SHORT RANGE FORECASTING Nowcasting is a weather forecast for the next few hours, based on current information.	LAND SURFACE ANALYSIS The LSA SAF develops techniques to retrieve products related with land, land-atmosphere interactions, and biospheric applications.

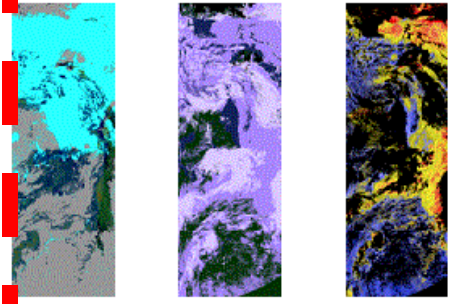
Nowcasting SAF products website

The screenshot shows the NWC SAF website interface. At the top, there is a navigation bar with logos for the EUMETSAT Network of Satellite Application Facilities, NWC SAF, and METEO FRANCE. Below this, the main content area is divided into several sections:

- MSG Cloud Products:** Includes Cloud Mask, Cloud Type, and Cloud Top Temperature and Height.
- MSG Precipitation Products:** Includes Precipitating Clouds, Convective Rainfall Rate, and Prec. Prod. Cloud Physical Properties.
- MSG Clear Air Products Physical Retrieval:** Includes Total Precipitable Water, Layer Precipitable Water, and Stability Analysis Imagery.
- MSG Winds, Conceptual Model and Convection Products:** Includes High Resolution Winds, Automatic Satellite Image Interpretation, and Rapid Development Thunderstorms.

On the left side, there is a 'Help Desk' section with a search bar and a 'Login' form. At the bottom left, there is a 'News' section with a recent article titled 'New PPS v2012 patch in SW Packages & Patches' dated 09/05/2014.

- Cloud Mask
- Cloud type
- Cloud top temperature and height
- Precipitation Clouds
- Convective Rainfall Rate
- Precipitation with microphysics
- TPW
- Layer PW
- RDT
- Stability indices
- High Resolution wind
- Satellite Image interpretation



3.3 Nowcasting SAF products

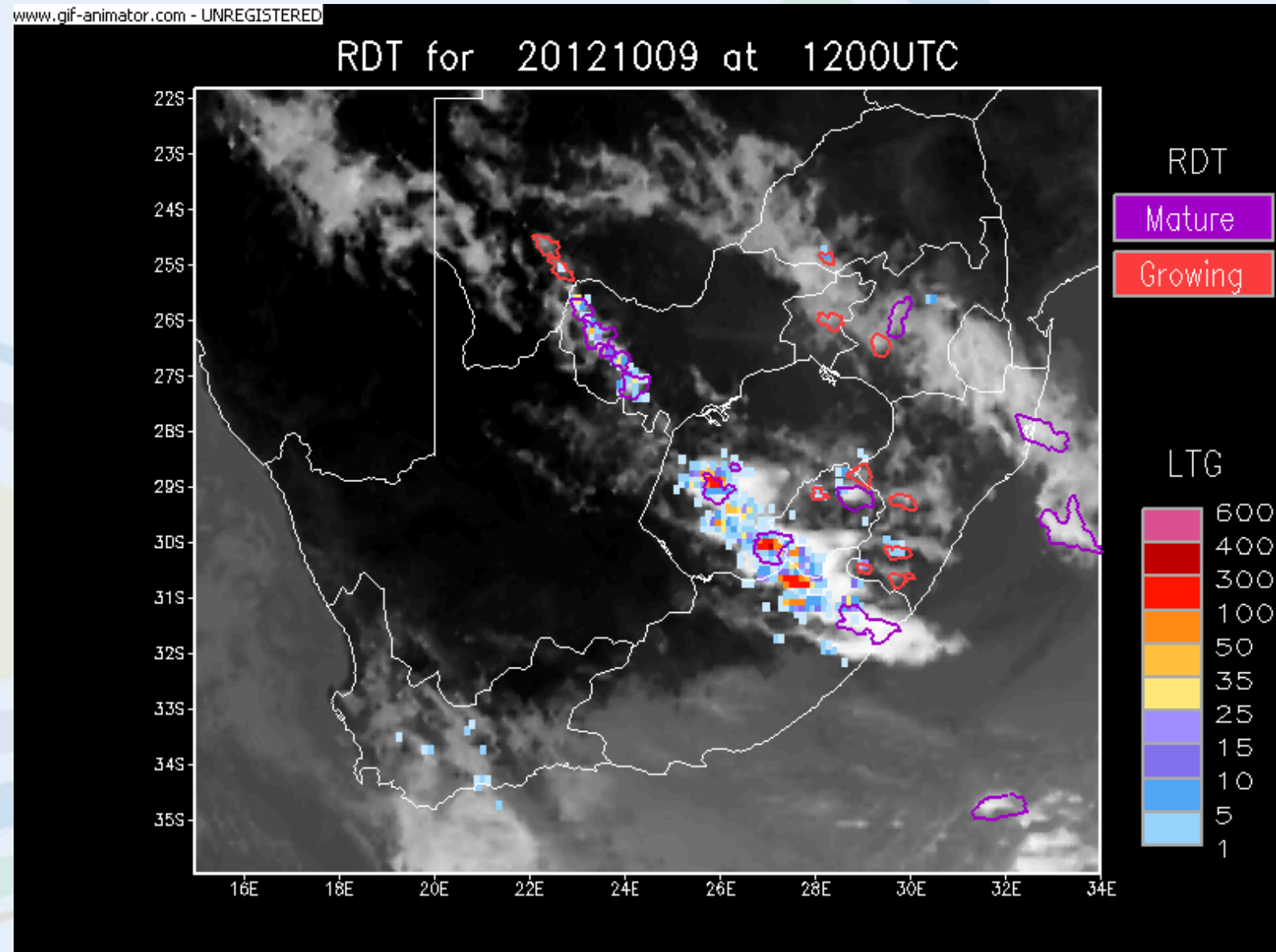
- Amongst the list of products developed by the Nowcasting SAF are:
 - **3.3.1 Rapidly Developing Thunderstorms product (RDT)**
 - **3.3.2 Convective Rainfall Rate (CRR)**
- The RDT and CRR products can be extremely useful for convection and severe convection nowcasting in **data sparse countries**.
- These products are using **MSG** and the local version of the **UKMO Unified Model data as NWP input in southern Africa** to the algorithms

3.3.1 Rapidly Developing Thunderstorms

- The objectives of RDT are:
 - The identification, monitoring and tracking of **intense convective system clouds**
 - The detection of **rapidly developing convective cells**.
- The Rapid Developing Thunderstorm (RDT) combines a cloud tracker and an algorithm to discriminate convective and non-convective cloud objects.
- The major benefit of an automatic tool like the RDT is the *object and tracking approach*
- Uses MSG data mainly, NWP is optional/preferred

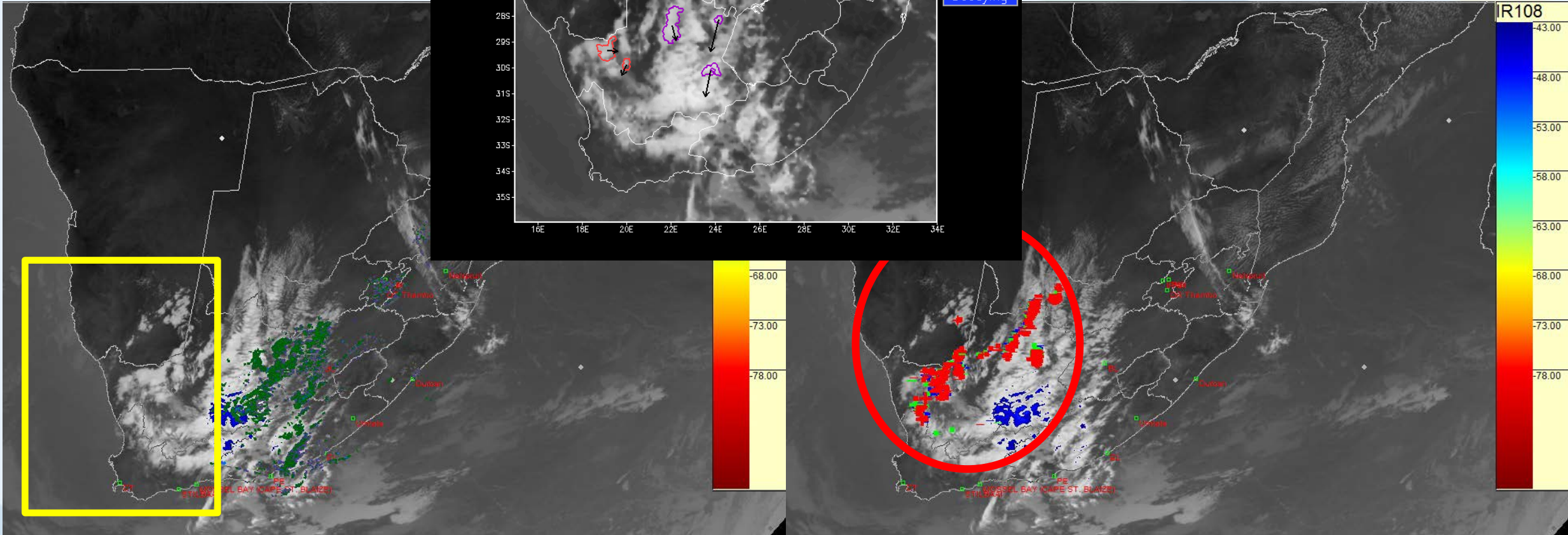
Example: RDT for 9 October 2012 from 1200 to 2000 UTC

Real time (15min)
identification of
intense and rapidly
developing
thunderstorms in
different phases



Advantage

without radar –



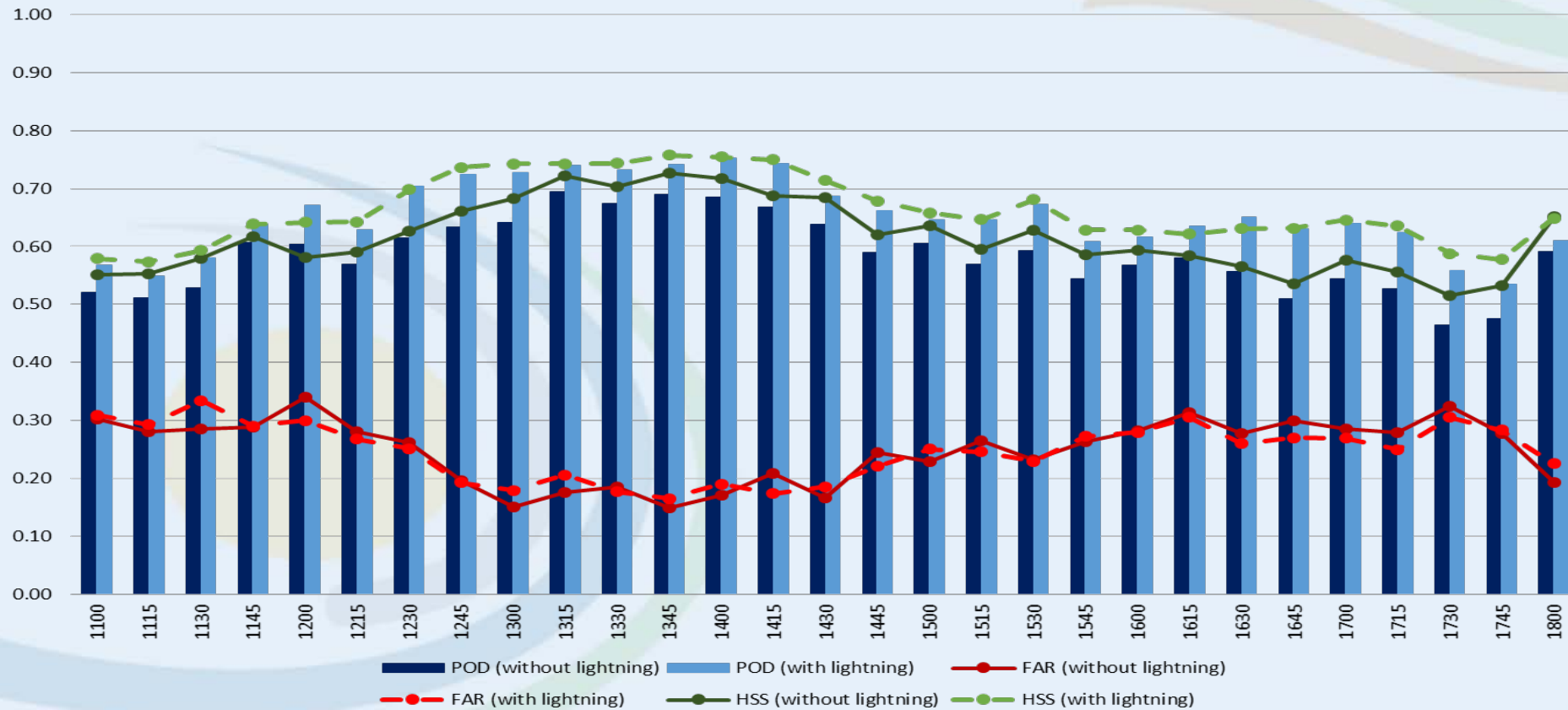
IR108 colour enhanced with Radar

IR108 colour enhanced with lightning

Validation of 25 cases over South Africa in summer season against 35 dBz radar reflectivity

HSS, POD and FARatio with/without lightning data included in the software for 25 cases from Sep to March

Including lightning data in input

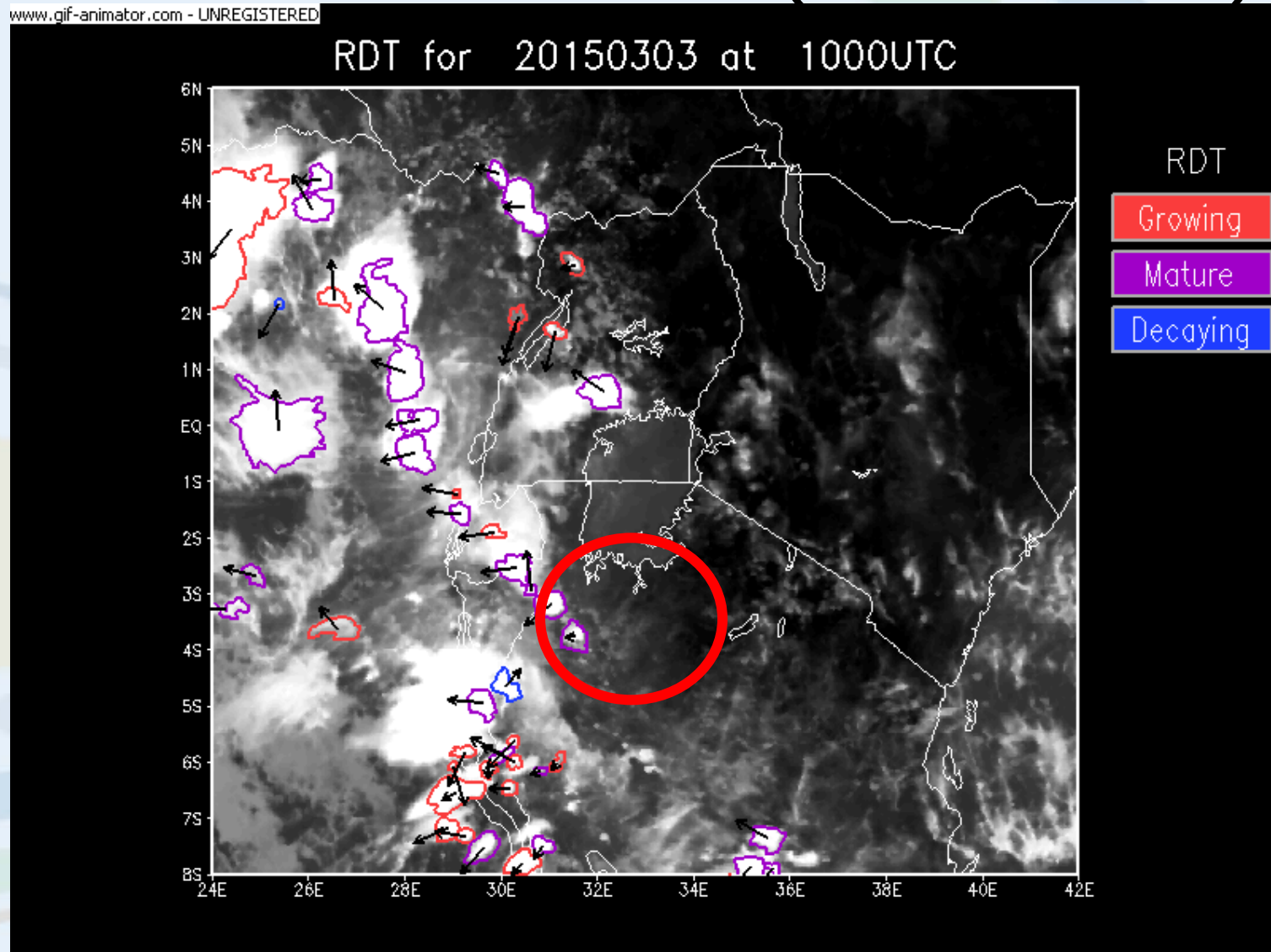


Graph supplied by Morne Gijben

WMO Nowcasting Symposium 2016

Example: RDT for 3 March 2015 from 1000 to 2130 UTC Lake Victoria (East Africa)

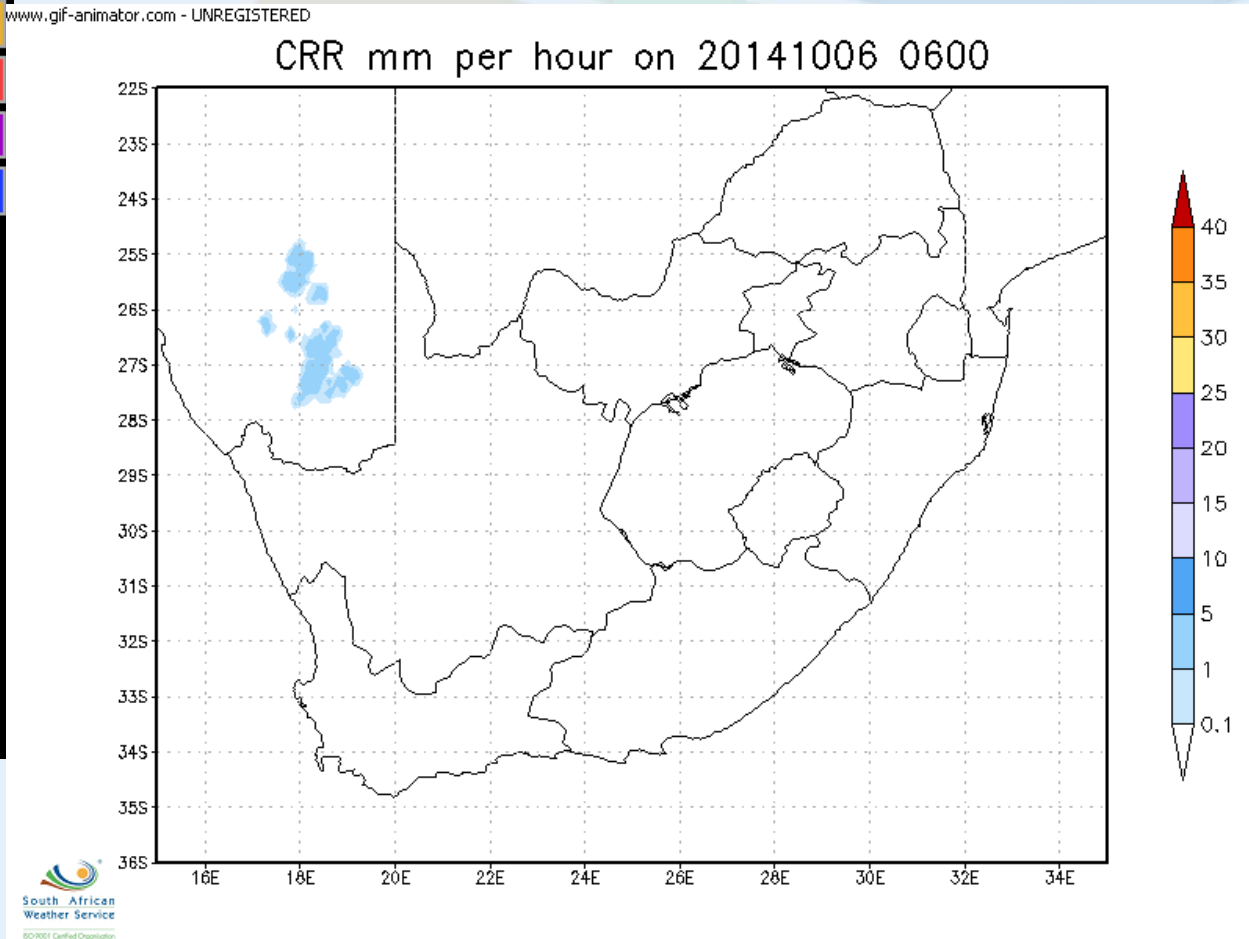
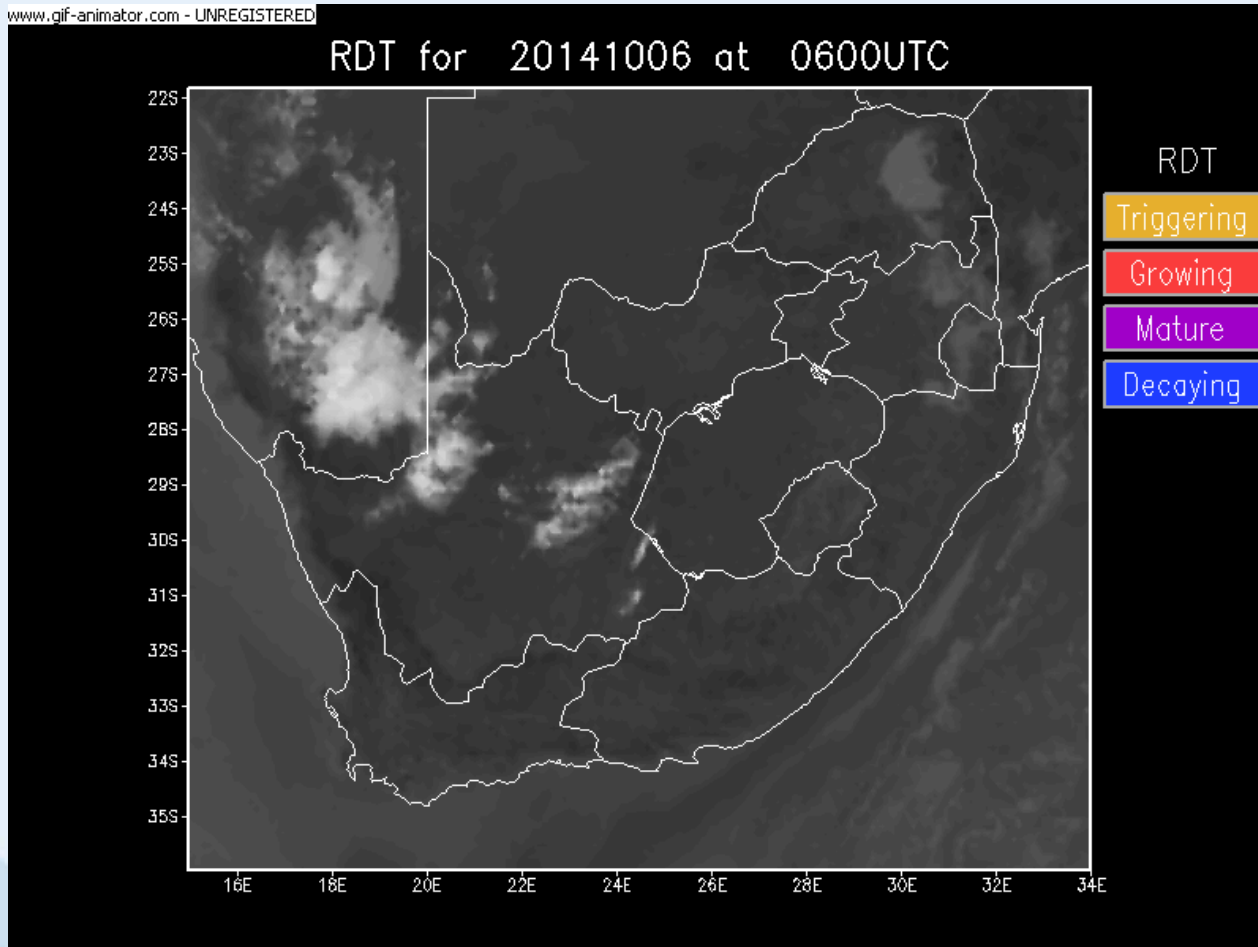
Severe hail storm with lots of damage to infrastructure during evening, from 1900 - 2100 UTC



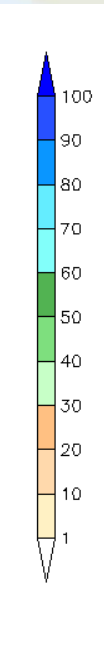
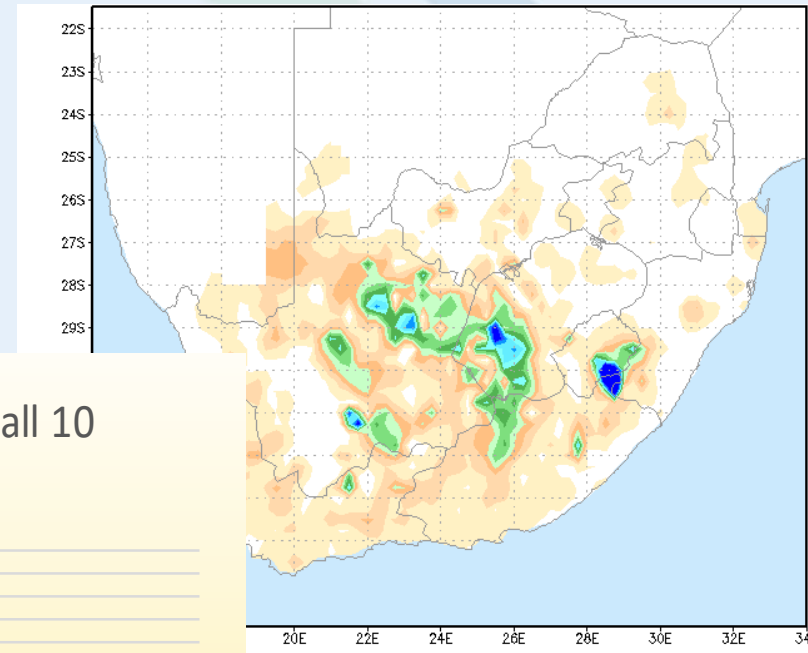
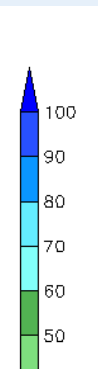
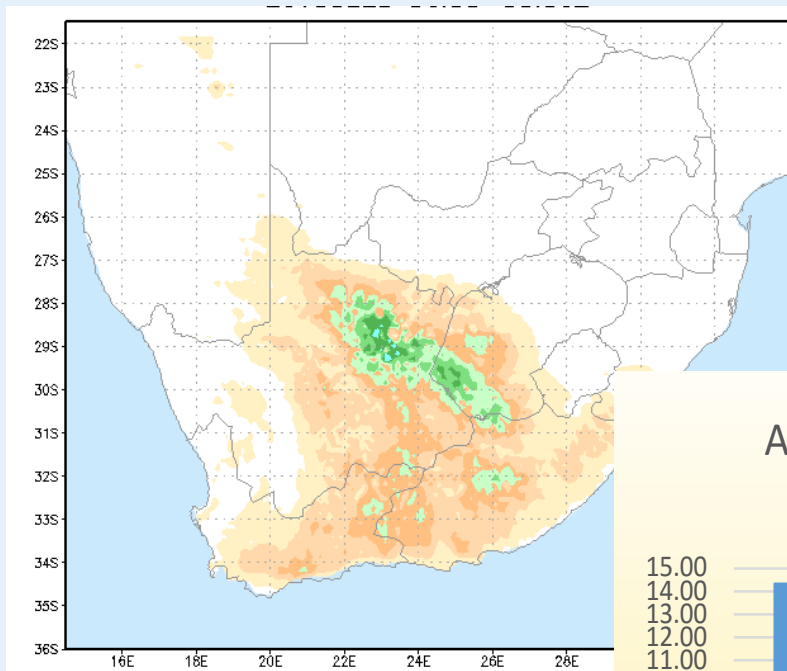
3.3.2 Convective Rainfall Rate

- Convective Rainfall Rate (CRR) product developed in the SAF NWC context, is a Nowcasting tool that provides information on **convective, and stratiform associated to convection precipitation**
- CRR uses either 2 or 3 of the MSG SEVIRI channels:
 - IR108 and (IR108 – WV062) for nighttime
 - IR108, (IR108 – WV062) and VIS006 for daytime
- To take into account the influence of environmental and orographic effects on the precipitation distribution, some corrections can be applied to the basic CRR value, based on input from numerical weather prediction models:
 - the moisture correction, the cloud top growth/decaying rates or evolution correction, the cloud top temperature gradient correction, the parallax correction and the orographic correction

6 Oct 2014 0600-1100 UTC: T/S over southern Namibia

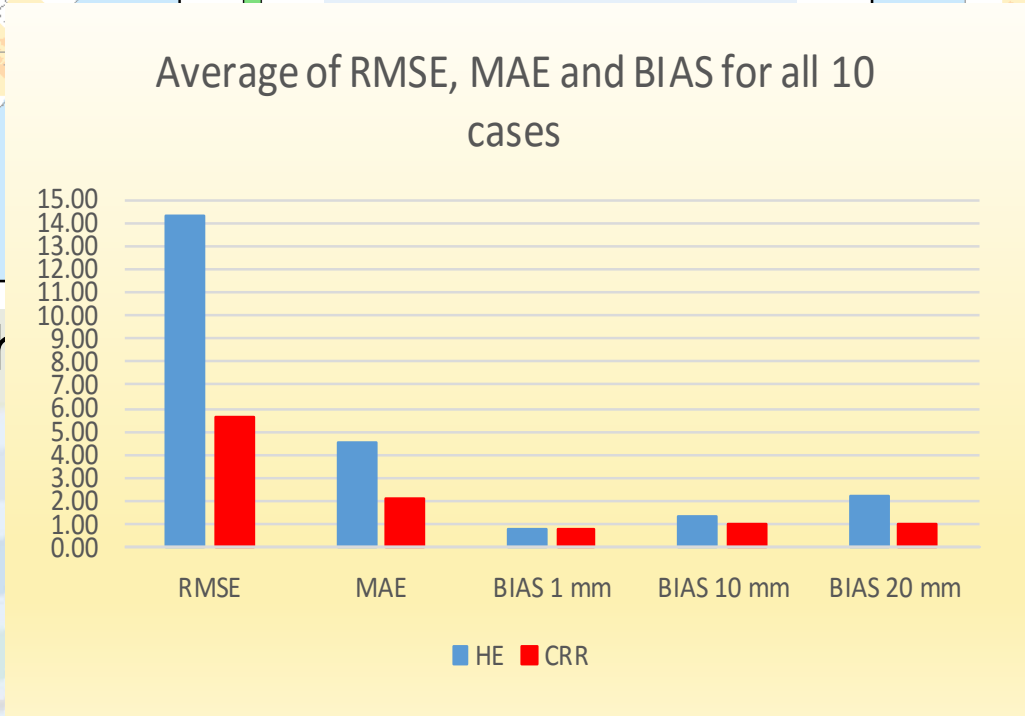


Example: Daily rainfall: CRR vs rain gauges for 23 Feb 2010

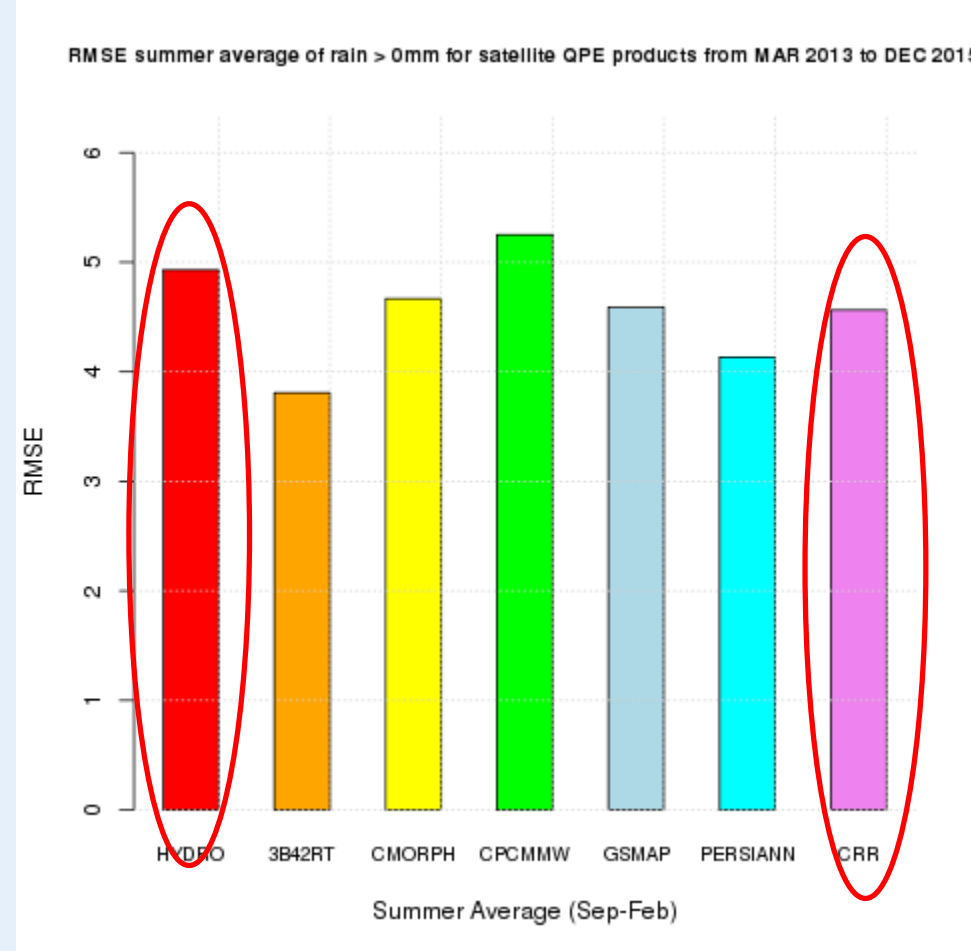
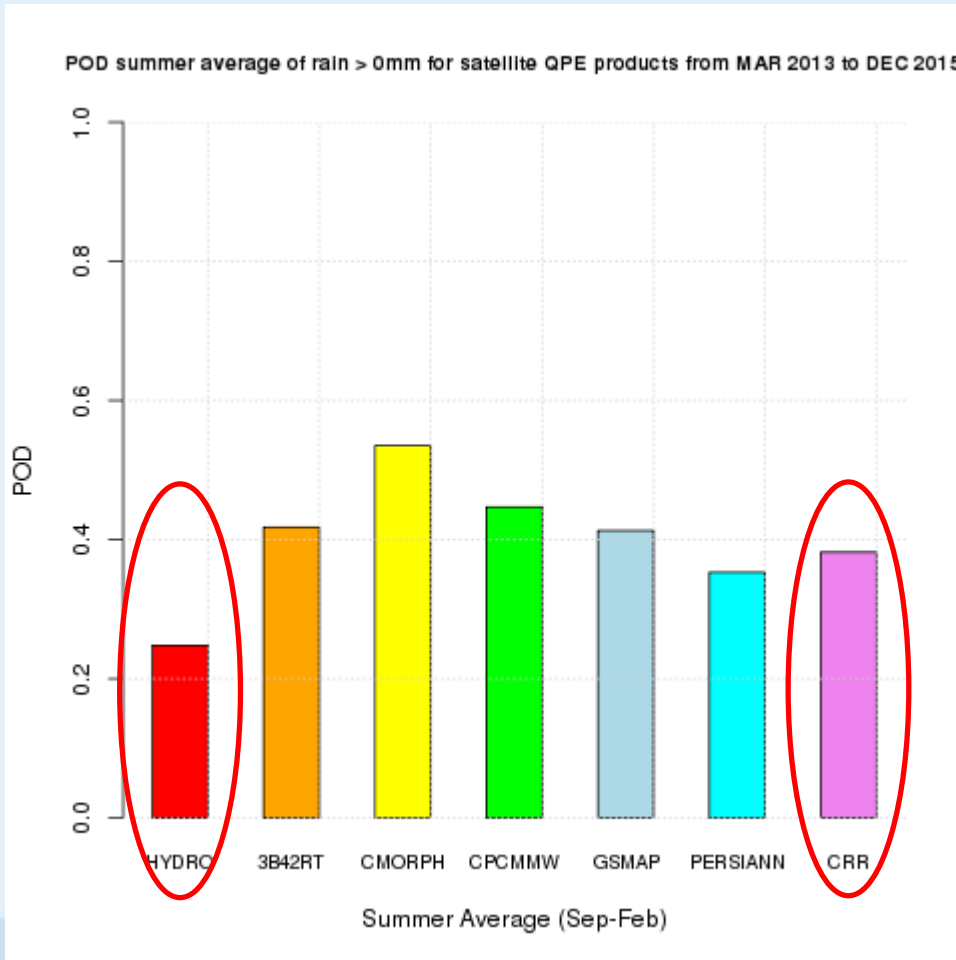


CRR using 3 MSG ch

Rain gauges



SUMMER: POD and RMSE of satellite QPE



Graphs supplied by Bathobile Maseko

Southern Africa RSMC website

Nowcasting Products

Satellite-Based Rainfall

Hydro-Estimator Rainfall Totals

- [1hr](#) • [3hr](#) • [6hr](#) • [24hr](#)

Hydro-Estimator Rainfall Totals 1 Days

- [10 Days](#) • [30 Days](#) • [Archive](#)
- [Description of Product](#)

Hail Forecasts from UM SA12

- [10 UTC](#) • [12 UTC](#) • [14 UTC](#)

Lightning information

- [Forecast Today](#) • [Forecast Tomorrow](#)

Convective Thunderstorm Forecasts

Probability of Convective Thunderstorms

- [CII](#) • [Description of Product](#)

Rapidly Developing Thunderstorms

- [RDT SADC](#) • [Description of Product](#)
- [RDT SA](#)

Convective Rainfall Rate (CRR)

- [CRR](#) • [Description of Product](#)

Hydro-Estimator Storm Tracks

- [SADC](#)
- [SADC NW](#)
- [SADC NE](#)
- [SADC SW](#)
- [SADC SE](#)
- [Madagascar](#)
- [South Africa](#)

4. Summary

- In regions without radar systems and/or lightning detection networks, **satellite and NWP products will certainly benefit nowcasting procedures.**
 - Satellite based instability indices – lead time of 6-9 hours (RII and CII)
 - Satellite based precipitation – near real time (Hydroe and CRR)
 - Satellite based identification/tracking of more intense thunderstorms – near real time (RDT)
- **SWFDP websites (RSMC)** provide easy access by forecasters in NMHSs to use the information received from the global and regional centers to issue nowcasting information on probability of convection and/or severe convection (RDT) and heavier rainfall events (CRR).
- **Walking the last mile:** The importance of developing and maintaining **collaboration and communication** between weather forecasters and disaster managers (end users), in each country for the successful use of nowcasting tools is, of course, fundamental.

Future work

- Enhancing satellite based products for other SWFDP regions
- NWC SAF products for other GEO satellites (GOES-R/Himawari) – 2018
- MTG in 2019 – Lightning imager on board – can enhance NWC SAF RDT products for entire African continent

Kofi Annan

former UN Secretary-General (21 July 2016)

- “We need to *support weather and climate services in developing countries* so that rather just collecting and providing data, they can become trusted suppliers of information and knowledge to the public.
- We need to place greater emphasis on providing people with the timely information they need to protect themselves from extreme weather.
- Early warnings of hazards can not only help communities respond and adapt.. but also raise awareness of the causes and effects of climate change — and hence *build public support for policies that strengthen resilience and mitigate against the impact of climate change*.
- I am confident that the growing awareness of the links between health and climate change will encourage health professionals, UN and government agencies, policy makers and the scientific community to come together to tackle these problems.”