The HAILCAST Hail Prediction Model

SWFDP Training 2012

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Nowcasting and Very Short Range Forecasting Group

South African Weather Service

Introduction

- SkyWatch developed by Poolman in the early 1990's and was later called HAILCAST by Brimelow
- HAILCAST analyses an atmospheric sounding to predict the maximum hail size on the ground
- Originally used actual soundings as input and was adapted in 2008 to run on model produced soundings
- HAILCAST is a system that consists of two coupled one-dimensional mathematical models
    1. Steady-state cloud model (developed by Poolman)
    2. Time dependent hail growth model (adapted from Dennis & Musil (1972) by Poolman)

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1. Cloud model

- Uses vertical profiles from upper air soundings as input:
  - Ambient temperature, humidity and wind
- Vertical profiles of liquid water content, updraft velocity and in-cloud temperatures are calculated

2. Hail model

- Cloud model output used to simulate hail growth in the updraft
- A drizzle-sized hail embryo is introduced at cloud base and then growths by either wet or dry growth
- Hailstone allowed to melt bellow the freezing level
- During wet growth (melting) excess accreted water on the surface of the stone is shed

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Data & Methods

- Input from the Unified model (12 km resolution)
- Uses 00Z forecast from the model to predict hail size hourly for a 48 hour period
- Include suggested improvements by Brimelow to the HAILCAST system
  1. Precipitation mask
  2. New method to test if an air parcel will reach the Level of free convection (LFC)
- Only a visual comparison with satellite images are made to evaluate the hail model

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1. Precipitation Mask

- Hail is usually accompanied by rain
- The HAILCAST system frequently forecast hail in areas where no rain was forecast or observed
- To solve this dilemma Brimelow proposed masking out hail size where no precipitation was forecasted.
- 15-hour accumulated convective precipitation from the model between 09Z and 24Z was used
- This method is said to reduce the hail area and thus also the false alarm ratio

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2. Vertical Increment

- A New method is used to test if an air parcel lifted from the LCL will reach the LFC
- Previously a coarse vertical increment of 50mb was used when calculating updraft properties in the cloud model
- Thus HAILCAST was unaware of negatively buoyant layers less than 50mb in depth above the LCL
- Changes in the vertical increment affects the amount of entrainment which affects the updraft properties and ultimately the hail size

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2. Vertical Increment (cont.)

- First a non-entraining parcel with initial vertical velocity of 3m/s is allowed to rise (or fall) in response to the buoyancy force with a vertical increment of 15mb
- If the parcel succeeds in overcoming any negative buoyancy between the LCL and LFC and if its maximum vertical velocity is greater than 3m/s then the cloud model is computed again but for an entraining parcel and vertical increment of 50mb
- The resultant updraft properties of this second run is then used as input for the hail model
- If the parcel does not succeed in overcoming negative buoyancy the program is terminated

Case 1: 5 Nov 2010

Hailstorm wreaks havoc in Badplaas

Damages were also reported at the Badplaas Forever Resort a few kilometres down the road

Desireé Rorke

BADPLAAS - For 20 harrowing minutes, hailstones the size of oranges caused total devastation on Friday afternoon, in a storm hailed by many long-time residents as the worst in living memory.

In the eye of the storm, the Travelport and the Cradle of Life Conservation and Tourism Centre suffered the biggest losses, amounting to hundreds of thousands of rand.

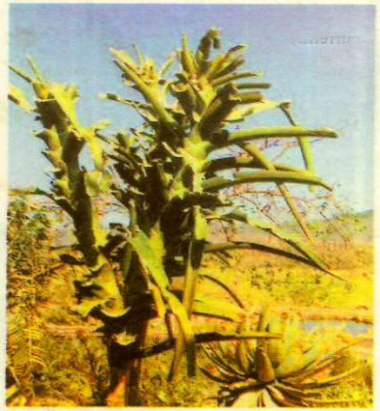
The entire nursery holding a wide variety of indigenous plants were completely destroyed, and hundreds of windows in the main building were shattered by the gigantic hailstones.

Game-viewing vehicles and others parked in the parking area were damaged - in some cases entire windscreens were smashed to smithereens.

"I don't often get scared, but for those 20 minutes on Friday afternoon I was frightened," the general manager of the centre, Mr John Baker told *Lowvelder*.

"Through the deafening noise of the downpour, water flooded through the roofs and broken windows, something you cannot imagine if you weren't there," he said.

The storm disappeared as quickly as it came, and in its aftermath it left, apart from the structural damage, numerous dead animals.



The entire indigenous nursery at the Cradle of Life Conservation and Tourism Centre was destroyed.

According to Baker, they found the carcasses of many small animals, such as geese, ducks, various birds and even small buck, including a springbok.

A major clean-up operation was undertaken on Saturday morning, but the exact extent of the damage has not been determined as yet.

Damages were also reported at the Badplaas Forever Resort a few kilometres down the road, and although a staff member informed *Lowvelder* that resort staff is working around the clock to repair the damages before this coming weekend, resort management refrained from commenting at this stage.

One of the giant hailstones that fell in the Badplaas area.

Images courtesy of Badplaas residents

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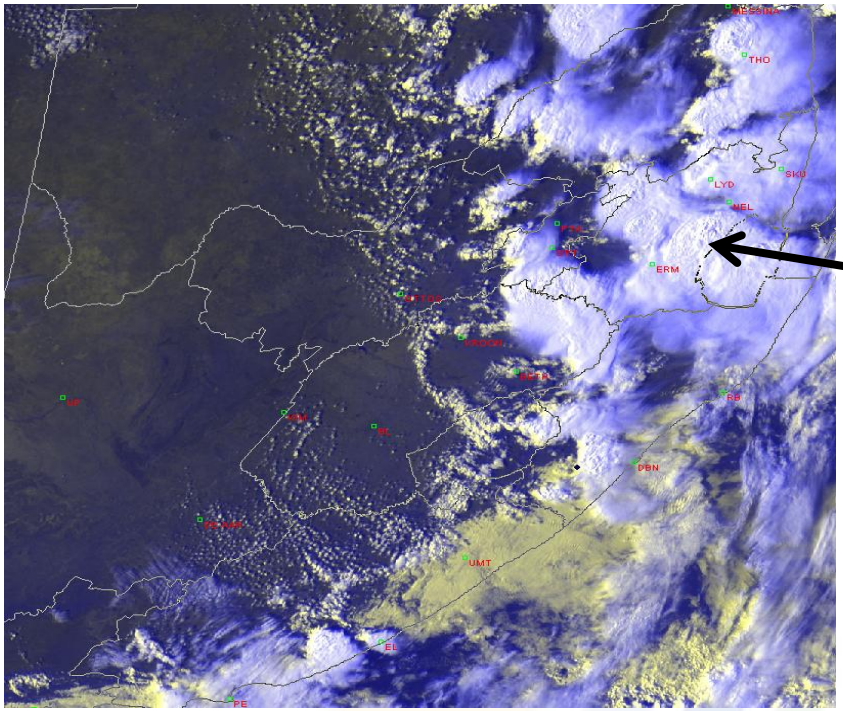
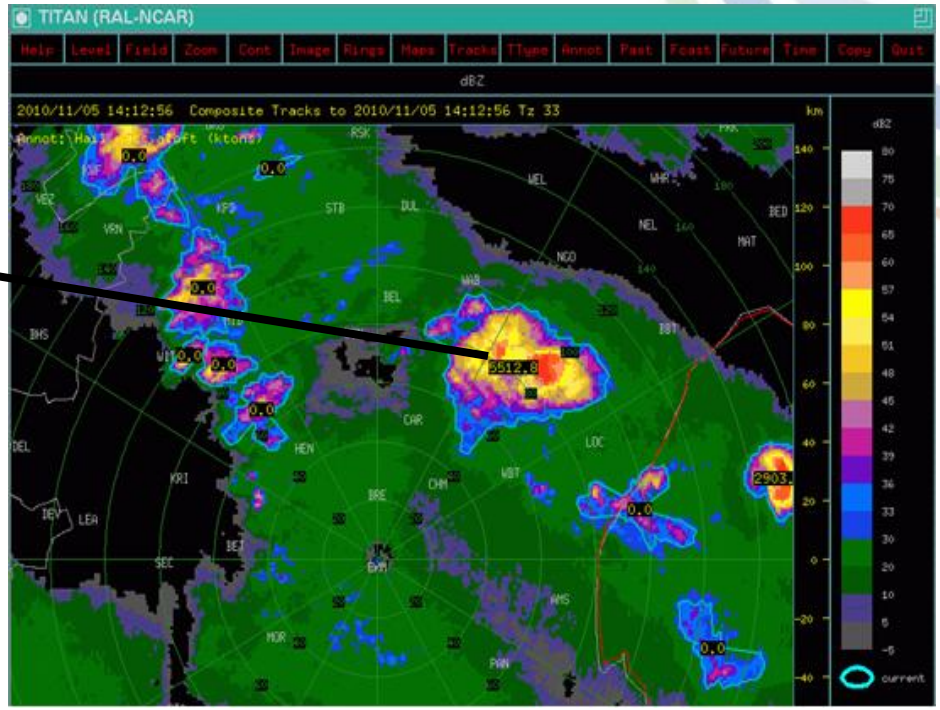
Satellite and Radar

HRV Cloud enhanced – 14:15 UTC



Radar – 14:12 UTC



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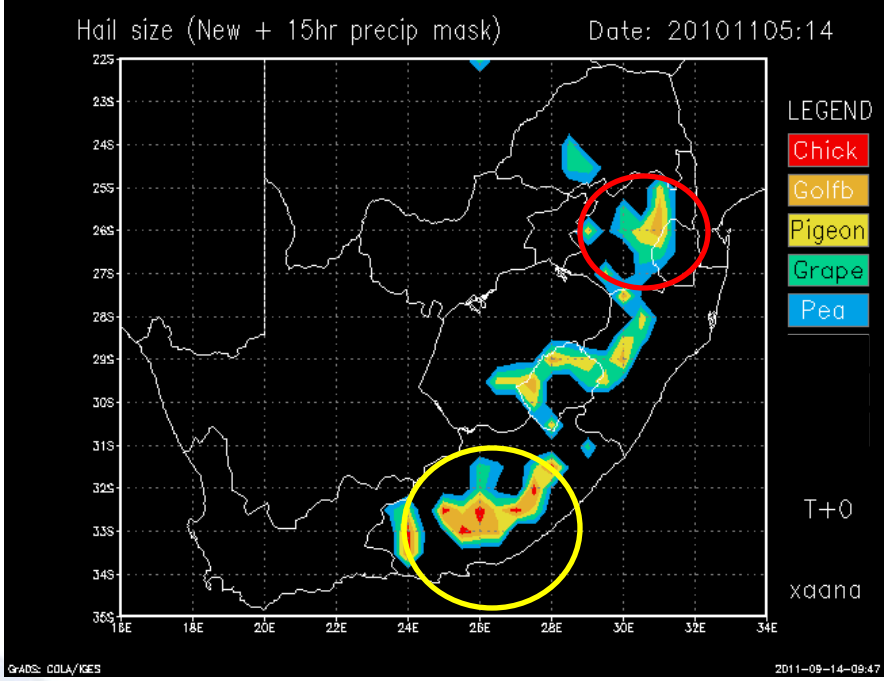
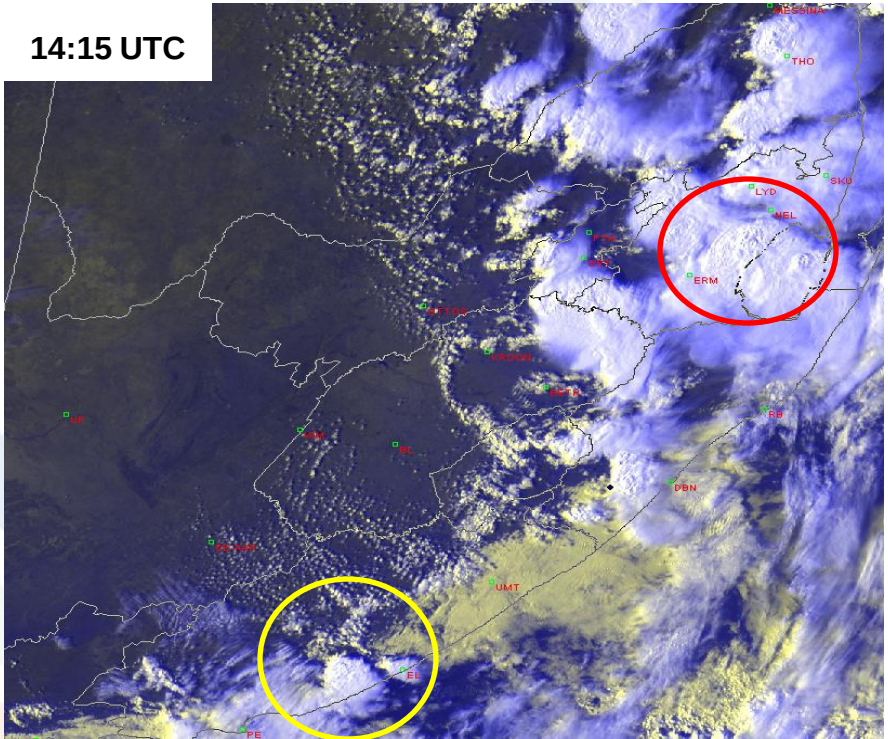


14:15 UTC



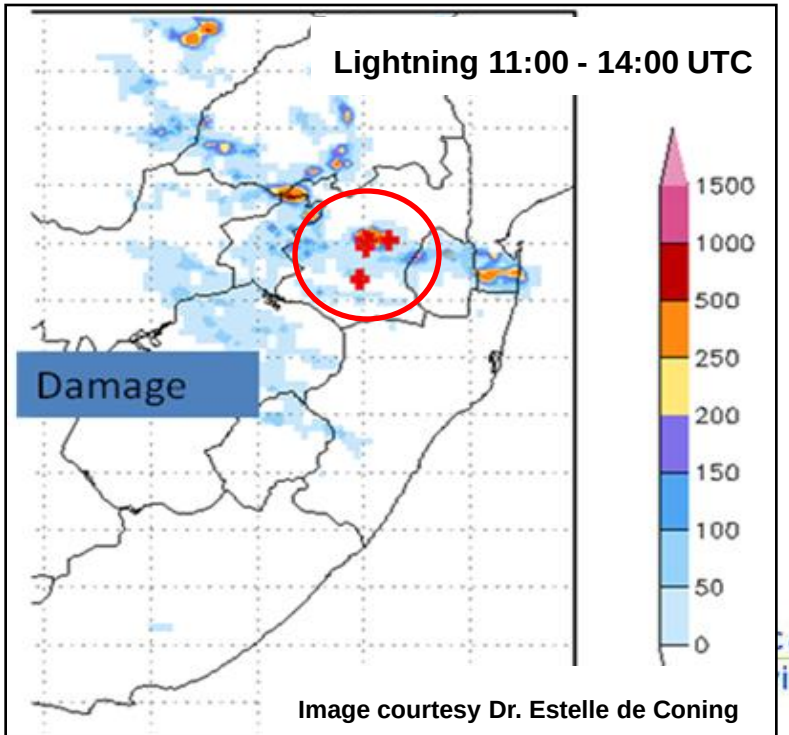


Image courtesy Dr. Estelle de Coning

Case 2: 22 Dec 2010

Images courtesy of Keith Ngesi from the Daily Dispatch and JP Human

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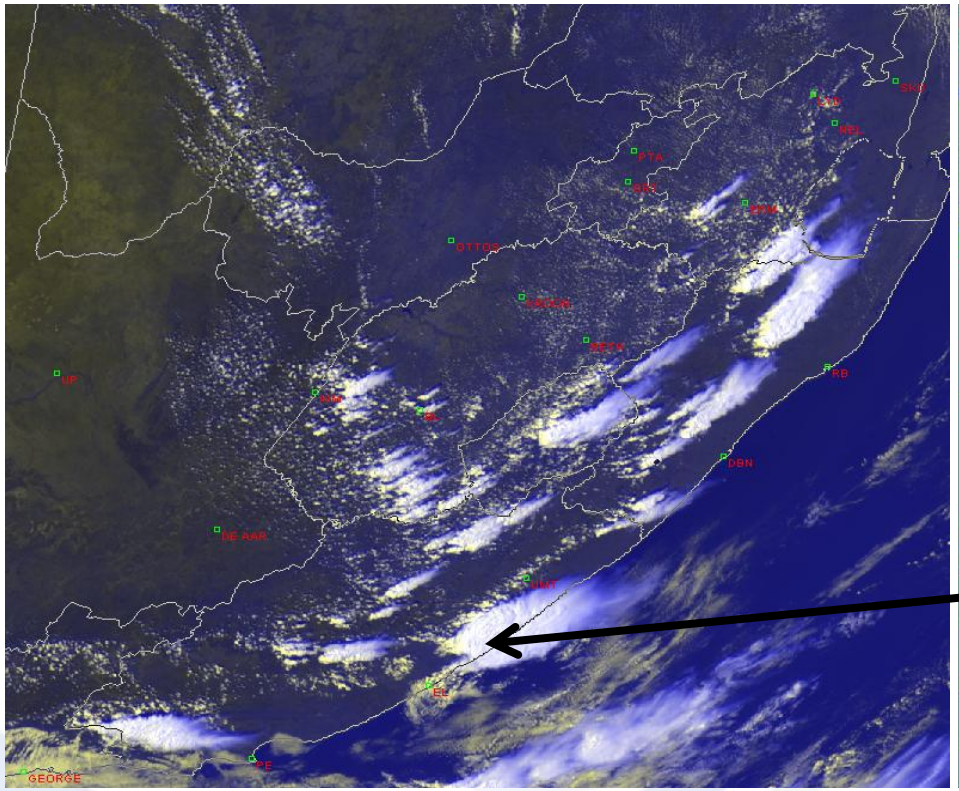
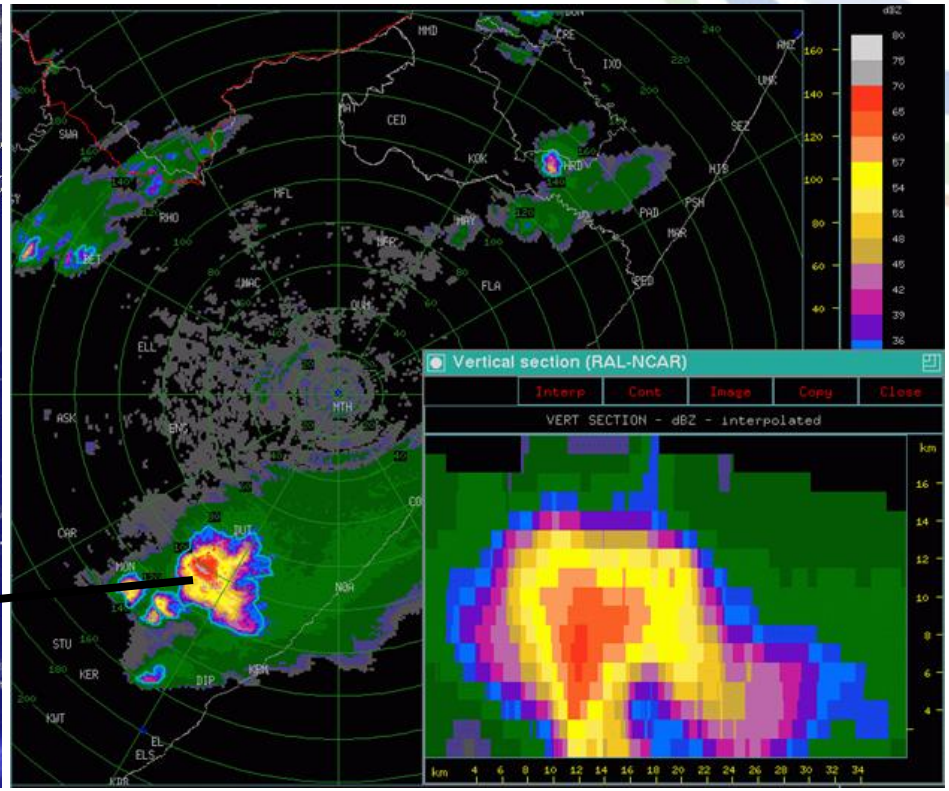
Satellite and Radar

HRV Cloud Enhanced – 13:00 UTC



Radar – 12:53 UTC



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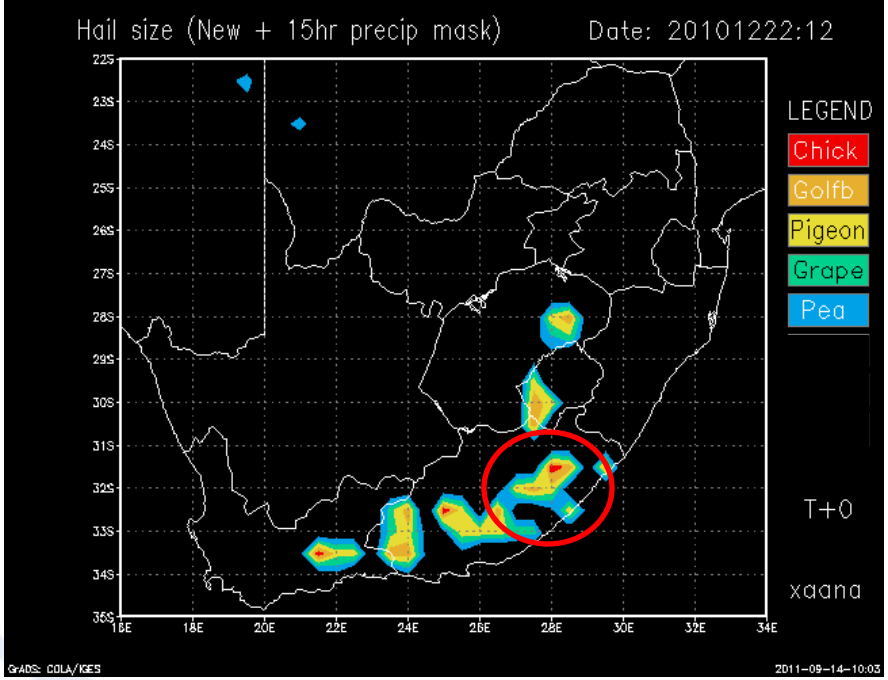
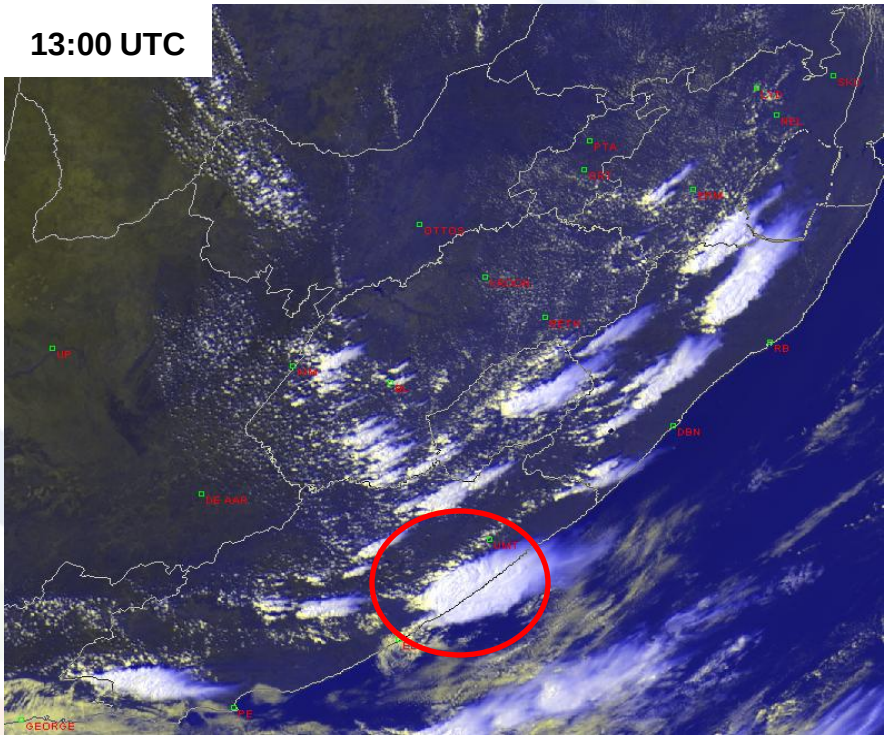


13:00 UTC



Lightning 11:00 - 14:00 UTC

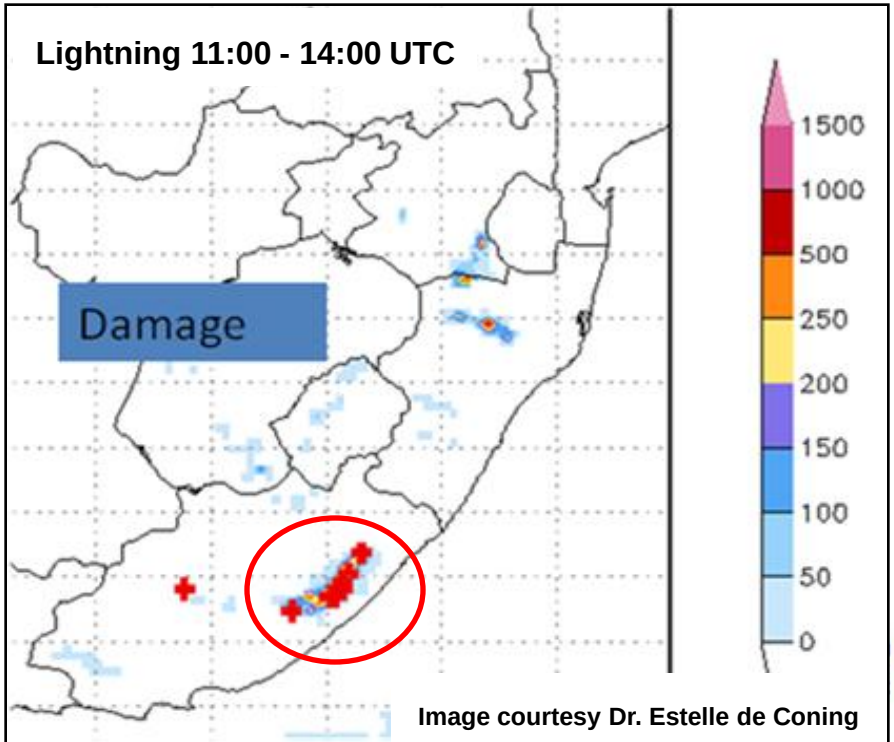
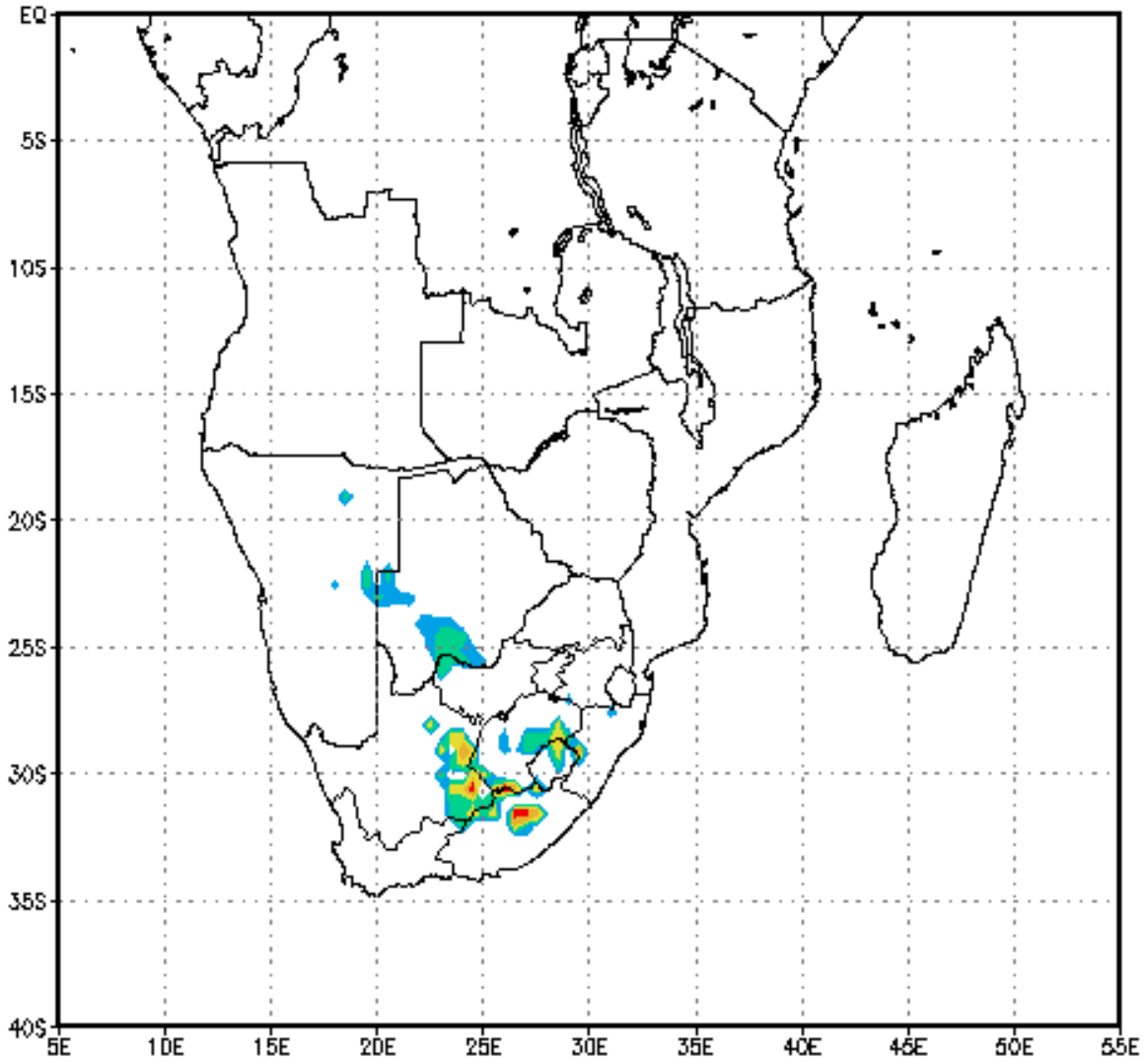


Image courtesy Dr. Estelle de Coning

Hail size (With Rainfall Filter)

Date: 20121112:12



LEGEND

Chick

Golfb

Pigeon

Grape

Pea

xaant

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World Meteorological Organization

Regional Specialised Meteorological Center (RSMC) Pretoria

Designated to South African Weather Service

Guidance Products

NWP & EPS Products

Regional Models

- UM SA12
- UM Africa LAM
- Aladin La Reunion

Global Products

- NOAA: GFS
- ECMWF: EPS
- Met Office: EPS
- NOAA: EPS
- SAWS: EPS (SAWS)

Training Website

- Met-eLearning

SWFDP Training Nov 2012

- GDPFS
- PWS

RSMC Guidance Archive

Contact RSMC

Logout

Guidance Products

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

SWFDP Evaluation Form

- Click Here

Nowcasting Products

Satellite-Based Rainfall

Hydro-Estimator Rainfall Totals

• 1hr • 3hr • 6hr • 24hr

Hydro-Estimator Rainfall Totals In Days

• 10 Days • 30 Days
• Description of Product

Hail Forecasts from UM SA12

• 10 UTC • 12 UTC • 14 UTC

Convective Thunderstorm Forecasts

Probability of Convective Thunderstorms

• CII

• Description of Product

Hydro-estimator Storm Tracks

SADC
SADC NW
SADC NE
SADC SW
SADC SE
Madagascar
South Africa

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)

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Conclusions

- The HAILCAST system can be helpful tool to aid forecasters to identify areas where hail can be expected
- It was found that the old hail model frequently over predicts the hail area and size of the hail
- The precipitation mask seems to reduce the total hail area
- HAILCAST has been extended over SADC
- Available RSMC website

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Thank you

Questions?

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