

# The HAILCAST Hail Prediction Model

SWFDP Training  
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# Outline

- Introduction
- Data and Methods
- Case Studies
  - 5 November 2010
  - 22 December 2010
- HAILCAST for SADC
- Conclusions

# Introduction

- Forecasting hail and especially the maximum hail size that can be expected remains a challenge.

## Radar

- Techniques exist to identify and nowcast the movement of hailstorms with Radar.
- Radars are scarce and the lead times of warnings are short.

## Atmospheric Soundings

- Techniques exist to analyse atmospheric soundings in the pre-storm environment to determine if hail might occur.
- These techniques are time consuming and soundings are also not readily available.

# Introduction

- **Multi-dimensional models** have been developed to simulate a hailstorm.
- These models have helped us improve our understanding of the hail growth process.
- Since these models are multi-dimensional, they require **extensive computing resources**.
- Thus they are not feasible as operational tools for weather forecasters.
- More simplified models are needed

# Introduction

- Poolman developed a one-dimensional system called SkyWatch in the early 1990's
- This system analyses an **atmospheric sounding** to predict the **maximum hail size** that can be expected on the ground.
- Originally **actual atmospheric soundings** was used as input to the model
- But soundings are not readily available
- The system was adapted in 2008 to run on **model produced soundings**

# Introduction

- Brimelow also did some work on this system and made some improvements.
- He named this hail prediction model HAILCAST
- 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)

# 1. Cloud model

- Uses vertical profiles from upper air soundings as input:
  - Ambient temperature, humidity and wind
- Uses surface variables as input:
  - Temperature and dew point temperature.
- Vertical profiles of liquid water content, updraft velocity and in-cloud temperatures are calculated.
- Cloud-top and lateral entrainment is taken into account.
- LCL is determined by lifting surface parcel adiabatically until saturation was achieved.

## 2. Hail model

- Cloud model output used to simulate **hail growth**
- A **drizzle-sized hail embryo** is introduced at cloud base within the updraft
- There it **accretes** supercooled cloud water droplets and ice crystals.
- **Rate of accretion** depends on **mass** and **heat budget** of hailstone which depends on the **hailstone's size** and **in-cloud conditions** (determined by cloud model)
- Hailstone allowed to **melt** below the freezing level
- During **wet growth** (melting) excess **accreted water** on the surface of the stone is **shed**



# 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
- More recently suggested improvements by **Brimelow** to the HAILCAST system was introduced:
  1. **Precipitation mask**
  2. **New method** to test if an **air parcel** will reach the **Level of free convection** (LFC)

# 1. Precipitation Mask

- It was found that HAILCAST frequently over-forecasted the hail area.
- 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

## 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
- This is now taken into account when calculating the maximum hail size

# Evaluation

- Evaluation of HAILCAST remains difficult because of the lack of observations for hail.
- Difficult to statistically evaluate the product.
- Thus only visual evaluations were done so far:
  - **Satellite** (intense storms)
  - **Radar** (intense storms)
  - **Damage reports** (Media and insurance reports)

# Case 1: 5 November 2010

## Hailstorm wreaks havoc in Badplaas

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

Desirée 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 *Lowveld*.

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

the structural damage, numerous dead animals.

According to Baker, they found the 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 *Lowveld* 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.

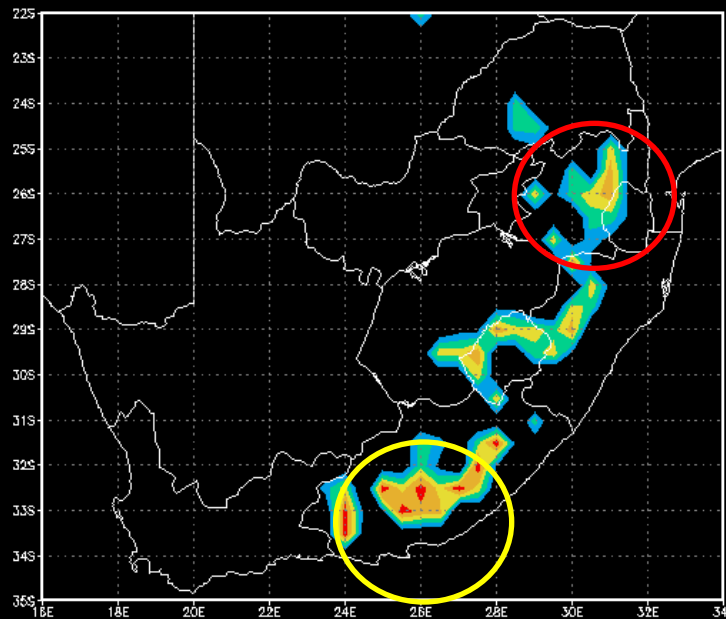


Images courtesy of Badplaas residents



Hail size (New + 15hr precip mask)

Date: 20101105:14



LEGEND

- Chick
- Golfb
- Pigeon
- Grape
- Pea

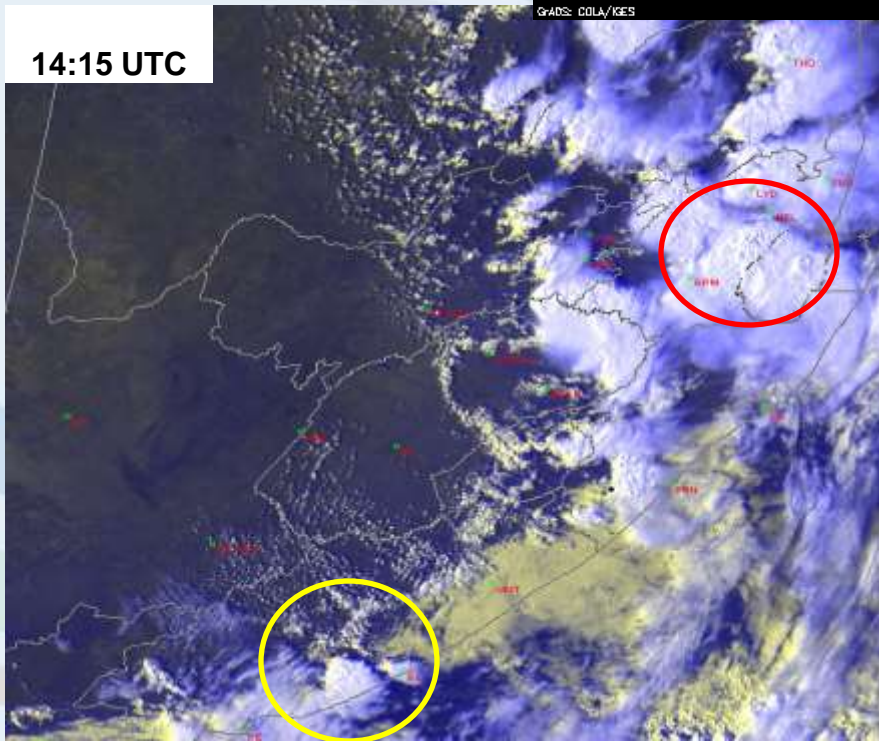
T+0

xdata

GRADS: COLLA/KES

2011-09-14-09:47

14:15 UTC



Lightning 11:00 - 14:00 UTC

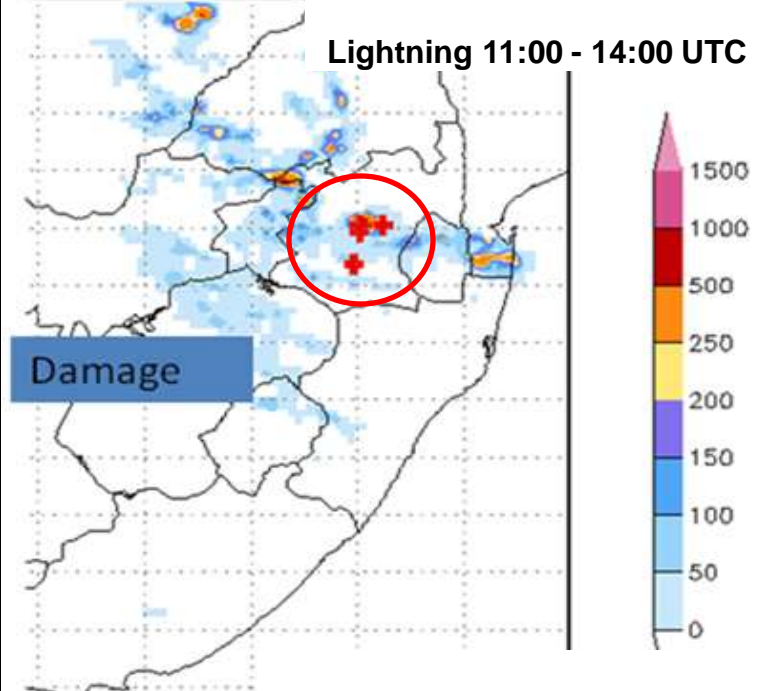


Image courtesy Dr. Estelle de Coning

# Case 2: 22 December 2010



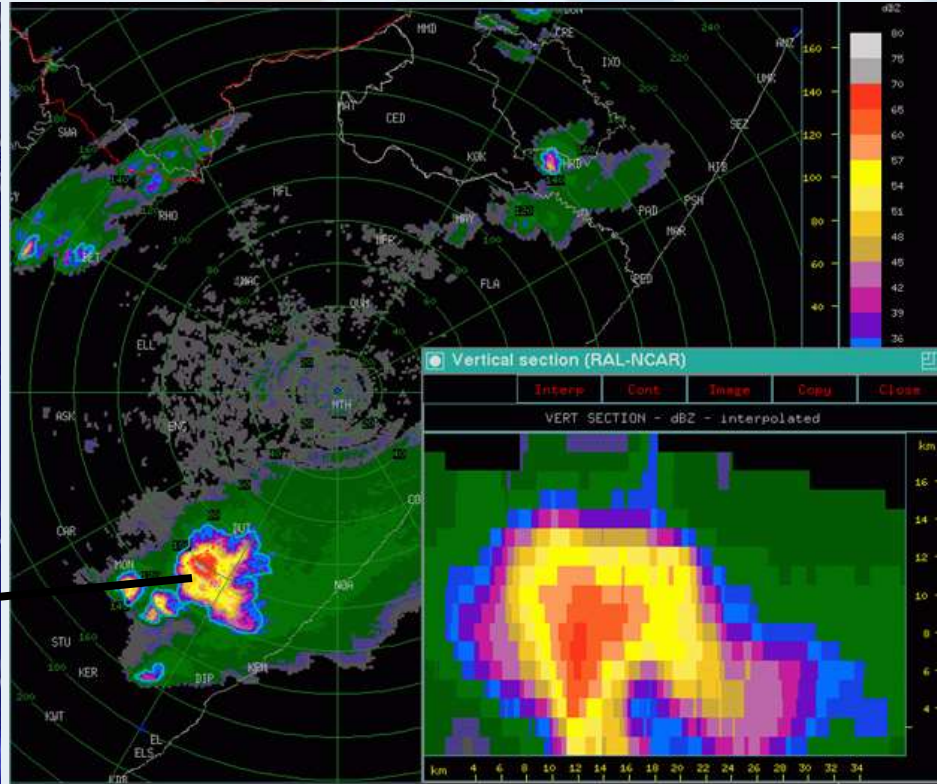
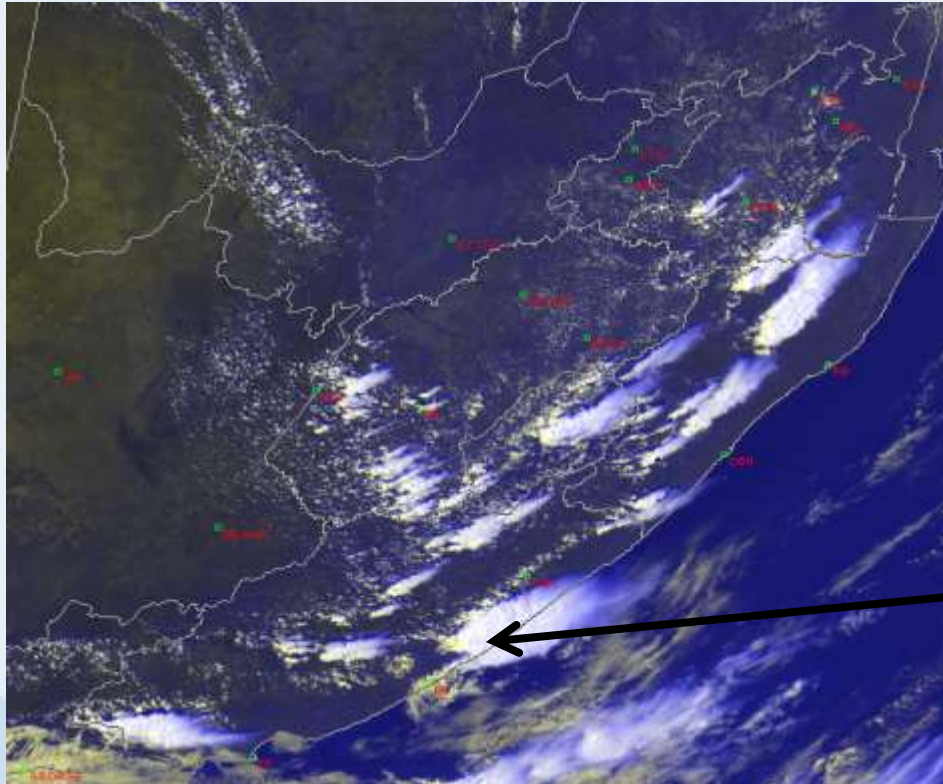
Images courtesy of Keith Ngesi from the Daily Dispatch and JP Human

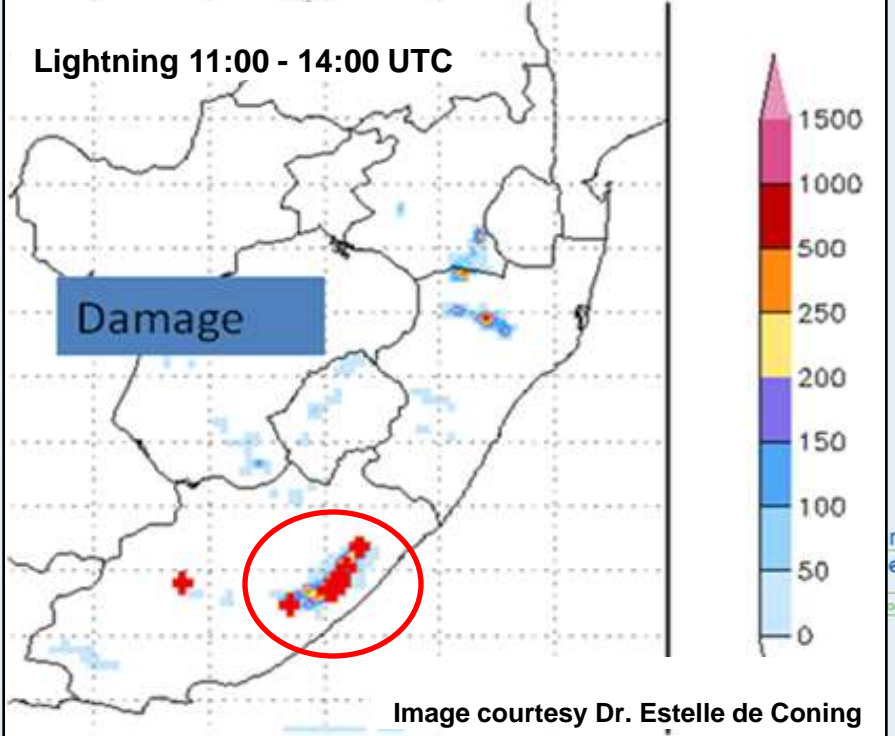
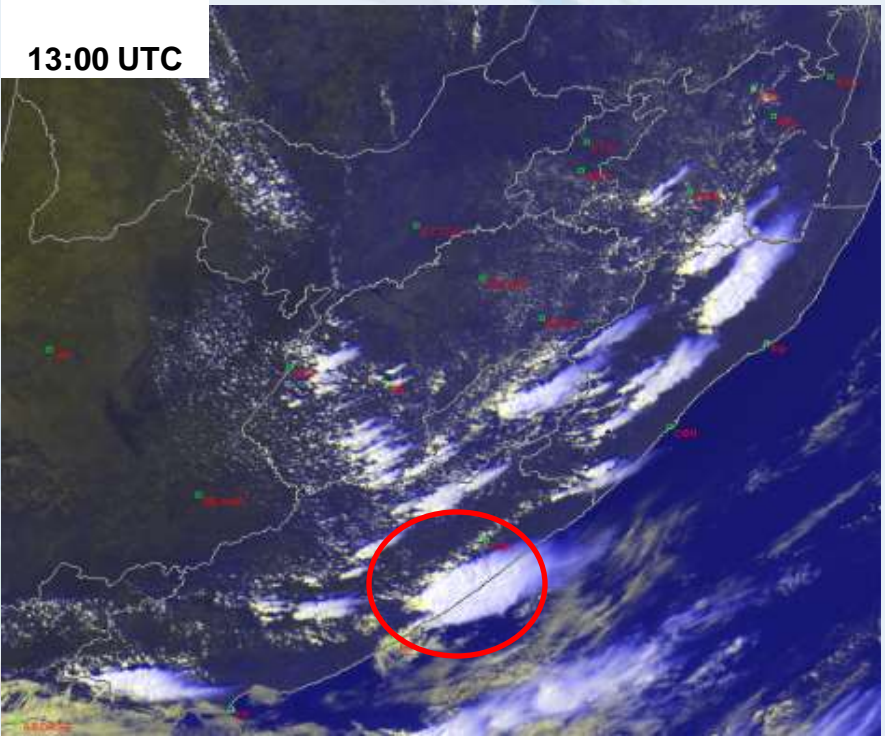
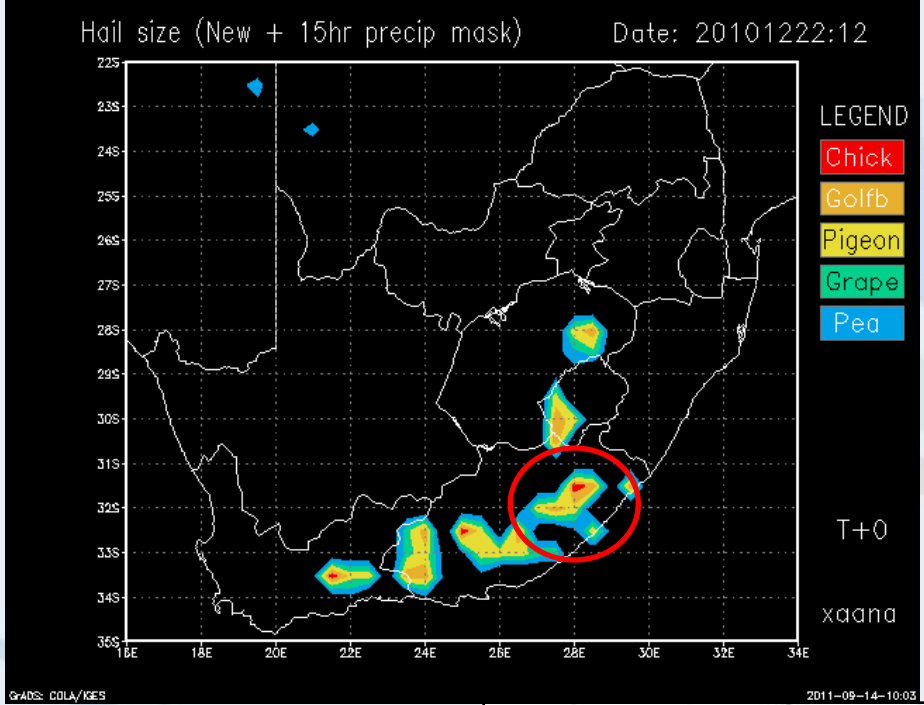


# Satellite and Radar

HRV Cloud Enhanced – 13:00 UTC

Radar – 12:53 UTC





# HAILCAST for SADC

- HAILCAST was extended over the SADC region
- The same methodology is used
- Images available for 10, 12 and 14 UTC everyday
- Available on the RSMC webpage:

<http://rsmc.weathersa.co.za/RSMC/>

- Images available on RSMC webpage at about 06:45 UTC



**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](#)

**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](#)
- [Description of Product](#)

**Hail Forecasts from UM SA12**

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

**Convective  
Thunderstorm  
Forecasts**

**Probability of Convective  
Thunderstorms**

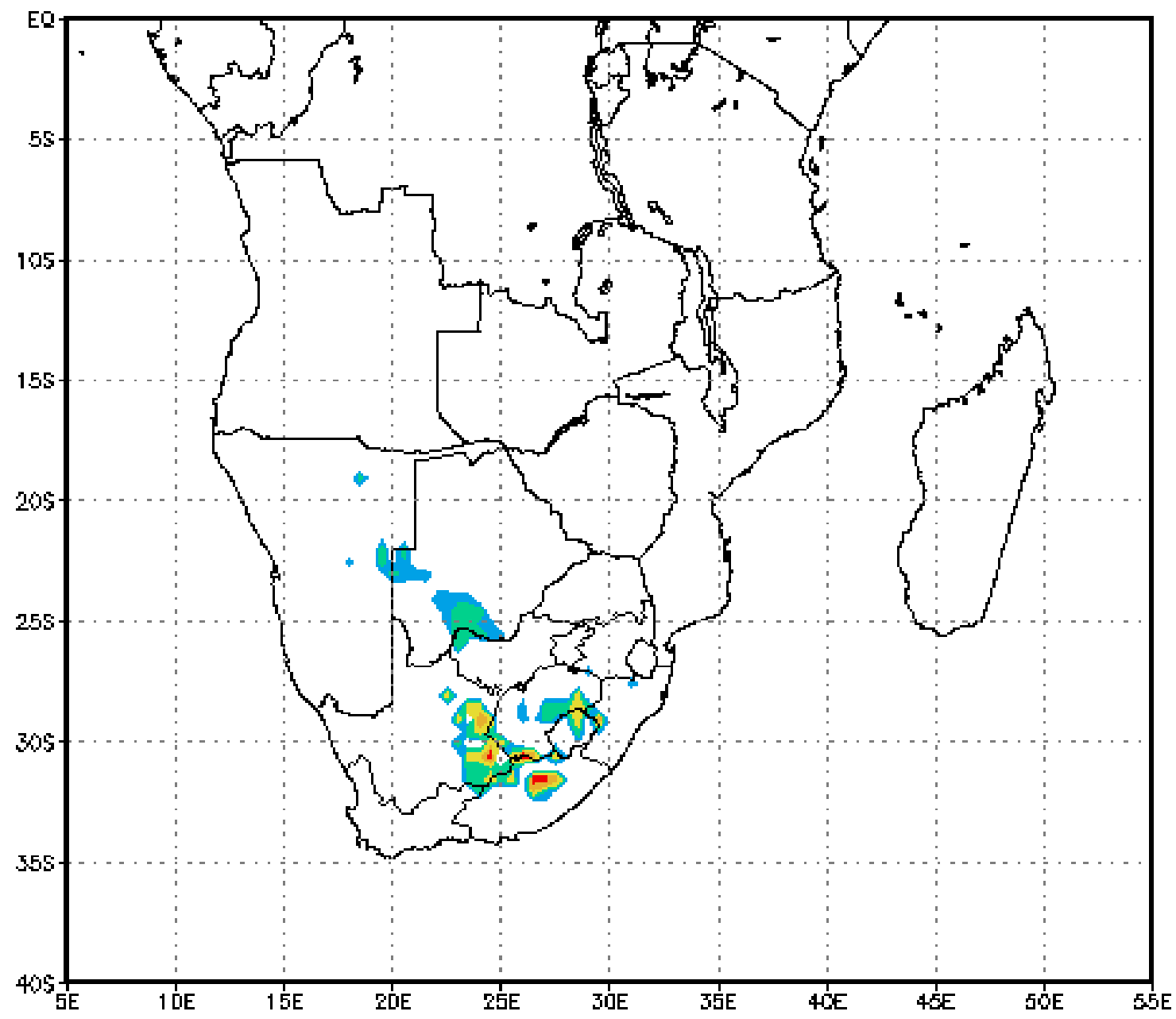
- [CII](#)
- [Description of Product](#)

**Hydro-estimator Storm Tracks**

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

Hail size (With Rainfall Filter)

Date: 20121112:12



LEGEND

Chick

Golfb

Pigeon

Grape

Pea

xaant

# Conclusion

- The HAILCAST system can be a helpful additional tool to aid forecasters to identify areas where hail can be expected.
- HAILCAST has been extended over SADC.
- Available on RSMC website.
- Please let us know if you report hail, so that we can determine if the model predicted the hail.



Thank you



Questions?