# NWP Lecture Day 1

## Introduction to basic NWP Modelling concepts and observational network

South African Weather Service

# Lecturer profile

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**Honours in Meteorology**

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**Certificate in Generic Management**



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# NWP THEORY – LEARNER GUIDE INFO

- Mark Allocation
- Semester Mark = Theory Task : 100% of semester
- Examination Mark – Theoretical Exam : 100%
- Final Mark
- Semester Mark : 50% (Assignment + Semester test + Quiz)
- Examination Mark : 50%

# LEARNING OUTCOMES FOR THE WEEK

- **Day 1:** The learner must be able to understand the basic concepts on NWP modelling. The internal NWP suite used at SAWS will be introduced. The learner will be able to understand the difference between Regional and Global Model Forecasts.
- **Day 2:** The learner will learn about different NWP forecasts. Discuss the process to be followed to determine the quality of NWP forecast. The strength and weaknesses of NWP models will also be discussed.
- **Day 3:** The learner will be introduced to short-range forecasts products used to provide guidance for weather forecasting. Medium-range forecast products are explained. Synoptic scale features will also be discussed.
- **Day 4:** The learner will have good understanding of the flow of NWP to medium-range forecasts. The learner will be able to utilize Ensemble Prediction Systems (EPS) in order to indicate forecast forecast uncertainty and probability of the event.

(NB! Refer to the leaner guide for detailed information)

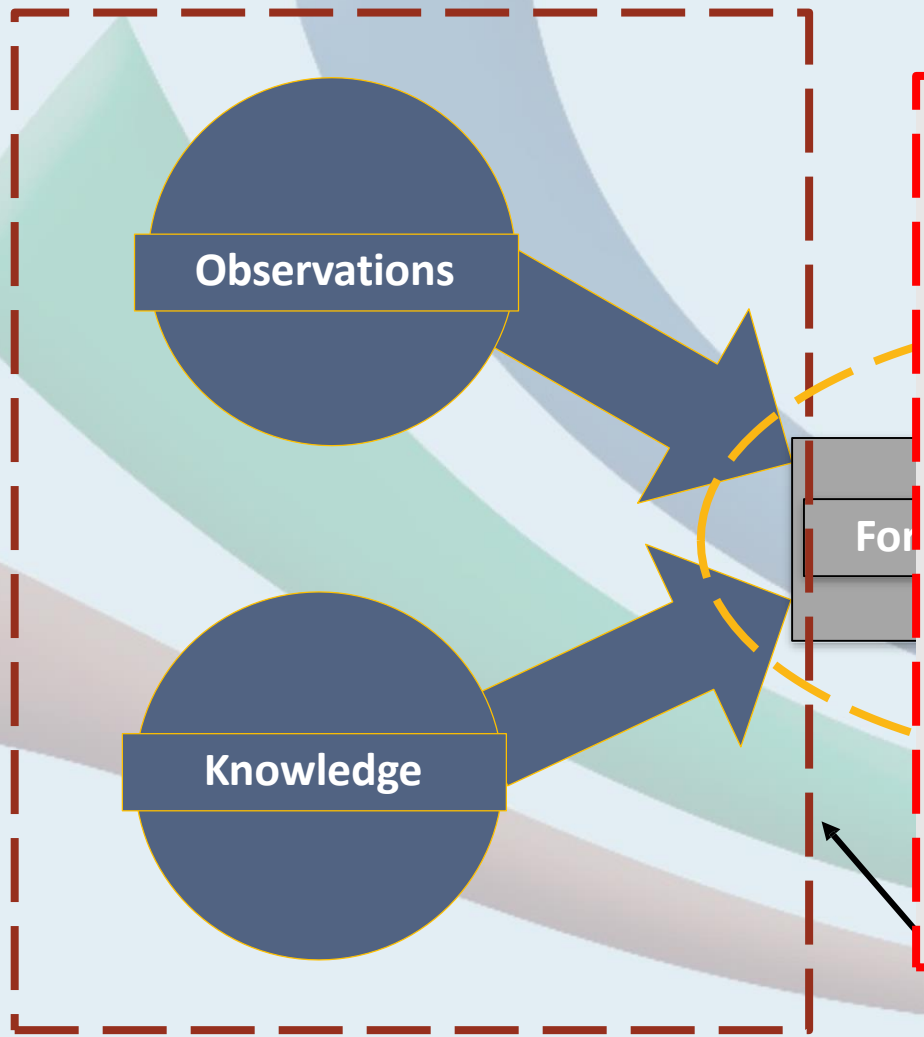
# Learning outcomes for Day 1

- ✓Revision of honours WKD704 course
- ✓Understand the basic components of an NWP Model.
- ✓ Introduction to Numerical Weather Prediction models.
- ✓Seamless forecasting process
- ✓Significance of Numerical Weather Prediction Model to a forecaster.
- ✓Differences between differences between Limited Area vs. Global models?

# WKD 704 Revision

- What is Numerical Weather Prediction model ?
- When  will you use an NWP model
- How will you use an NWP model.
- Can you trust a weather model explicitly.

# Moving from Theory to Operations




The aim of this course is to introduce you to NWP products used in the forecasting process at SAWS.

The **forecast model** is a tool to be used in combination with knowledge and observations. This means that by looking at the observations for the day, i.e. synoptic chart, Radar, Satellite etc. you should already build a picture in your head of what the general circulation is and what weather can be expected from it. NWP products allows you to add details and refine that picture.

As you will see in the next slides, there are a lot of NWP products and data available. If you are not guided by your knowledge, which will help you filter out irrelevant products, you will get overwhelmed by the amount of NWP information at your disposal



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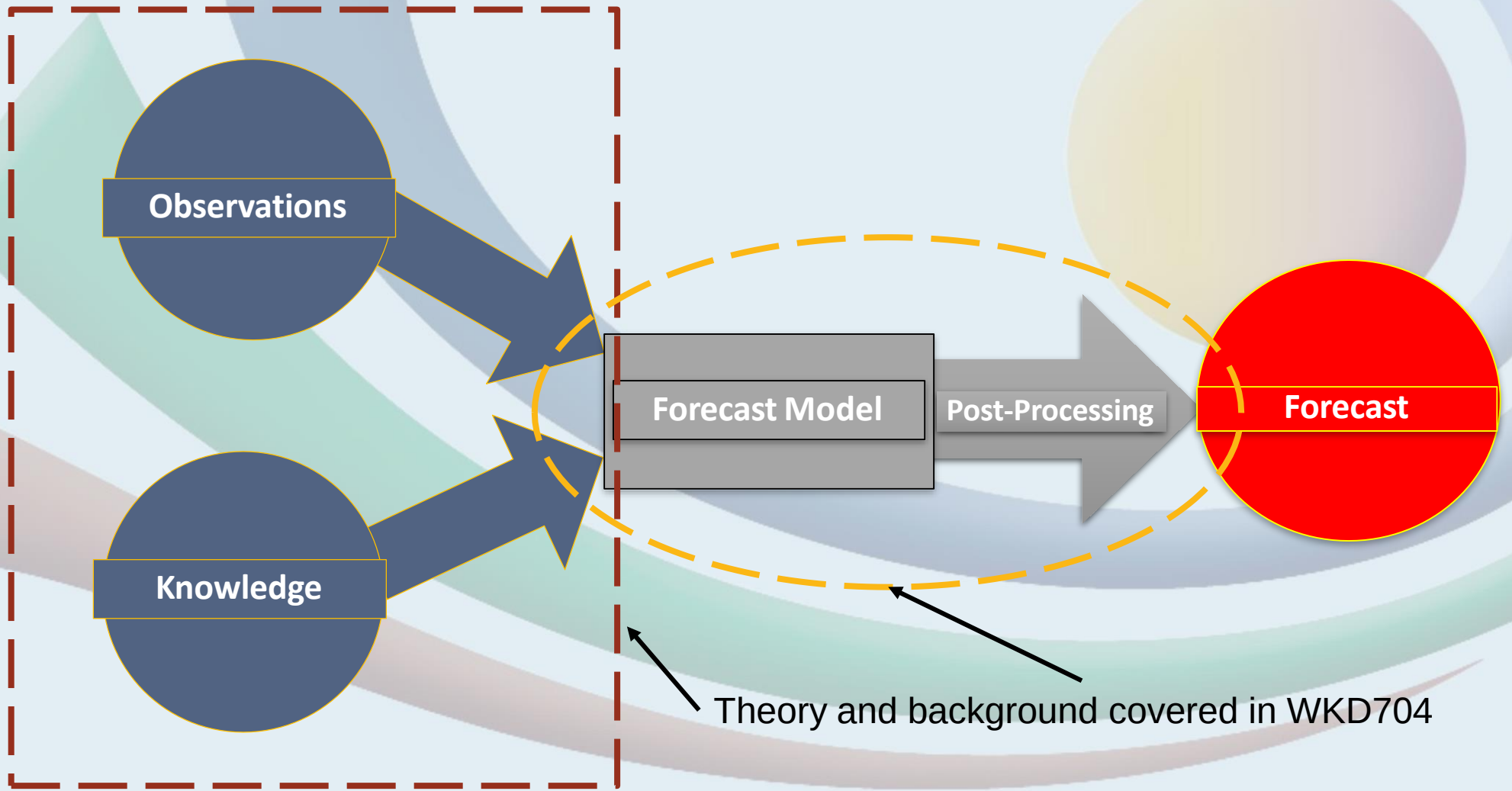
# Moving from Theory to Operations





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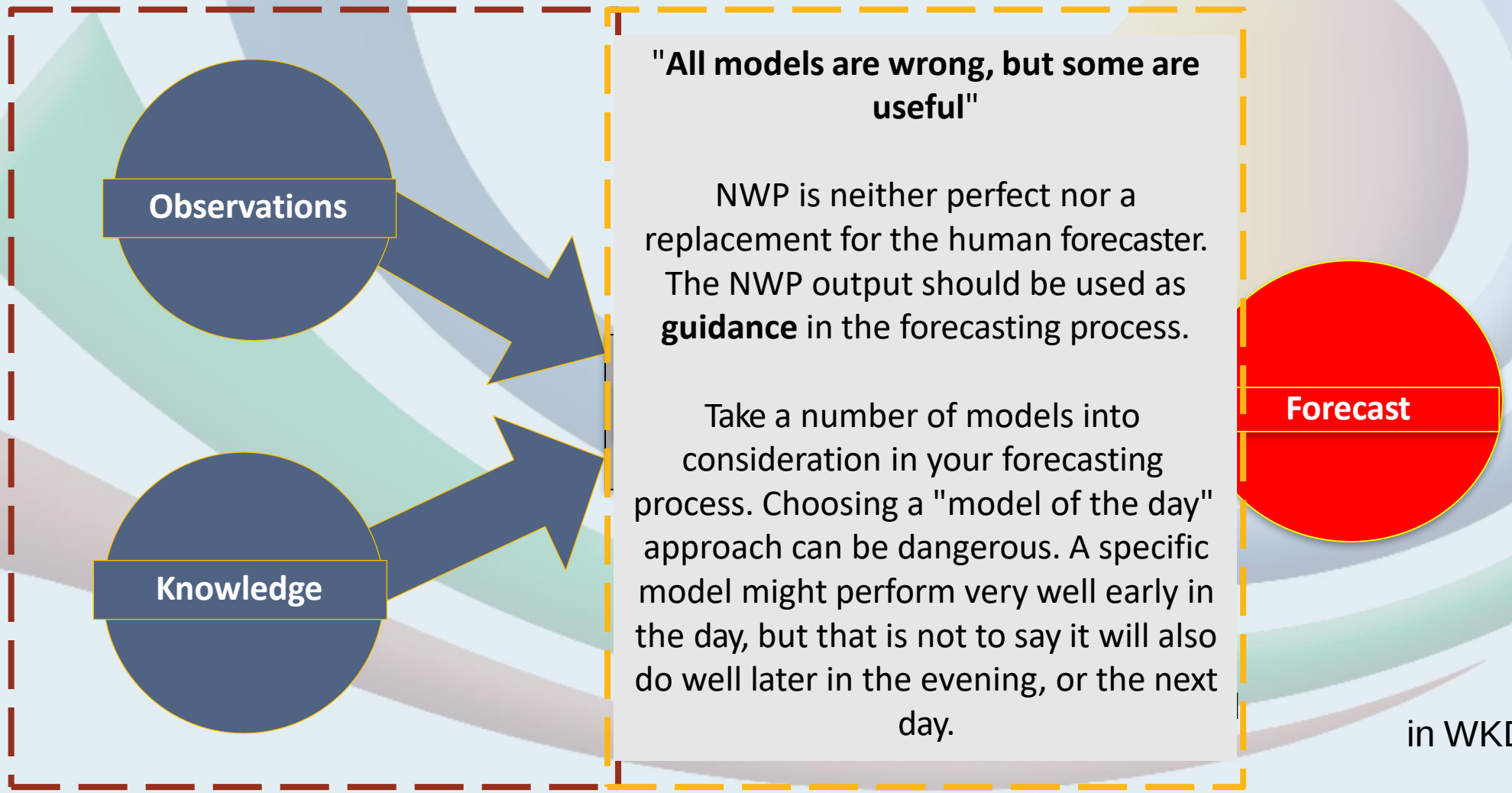
# Moving from Theory to Operations




in WKD704



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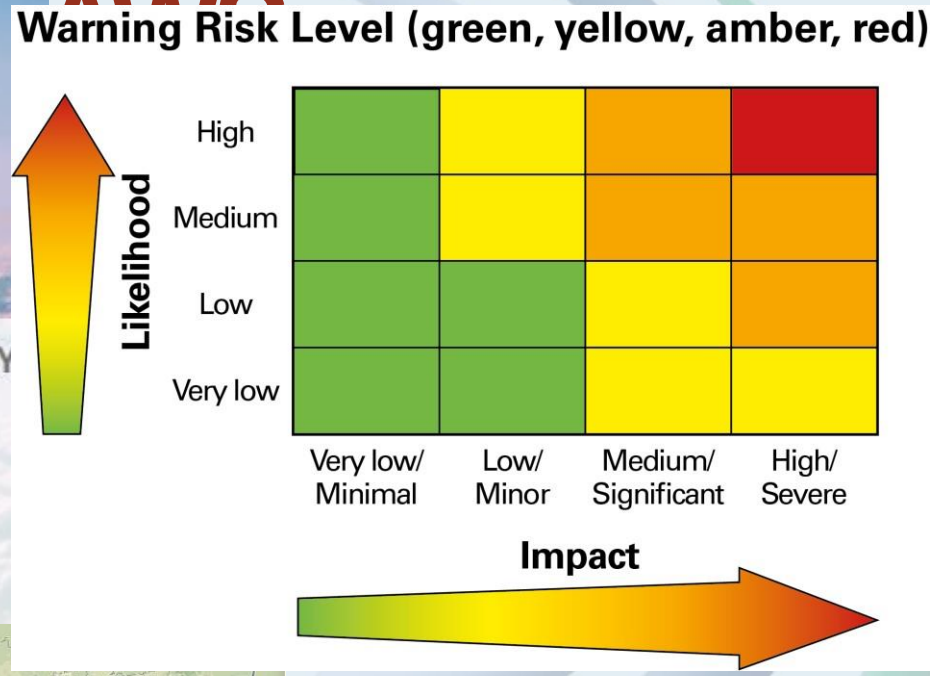


1. GAUTENG:

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Partly cloudy and warm, with isolated showers and thundershowers in the afternoon.

The expected UVB sunburn index:High


**Your final interpretation of al the model output and observations available to you, will result in public weather forecasts and potentially life saving warnings**



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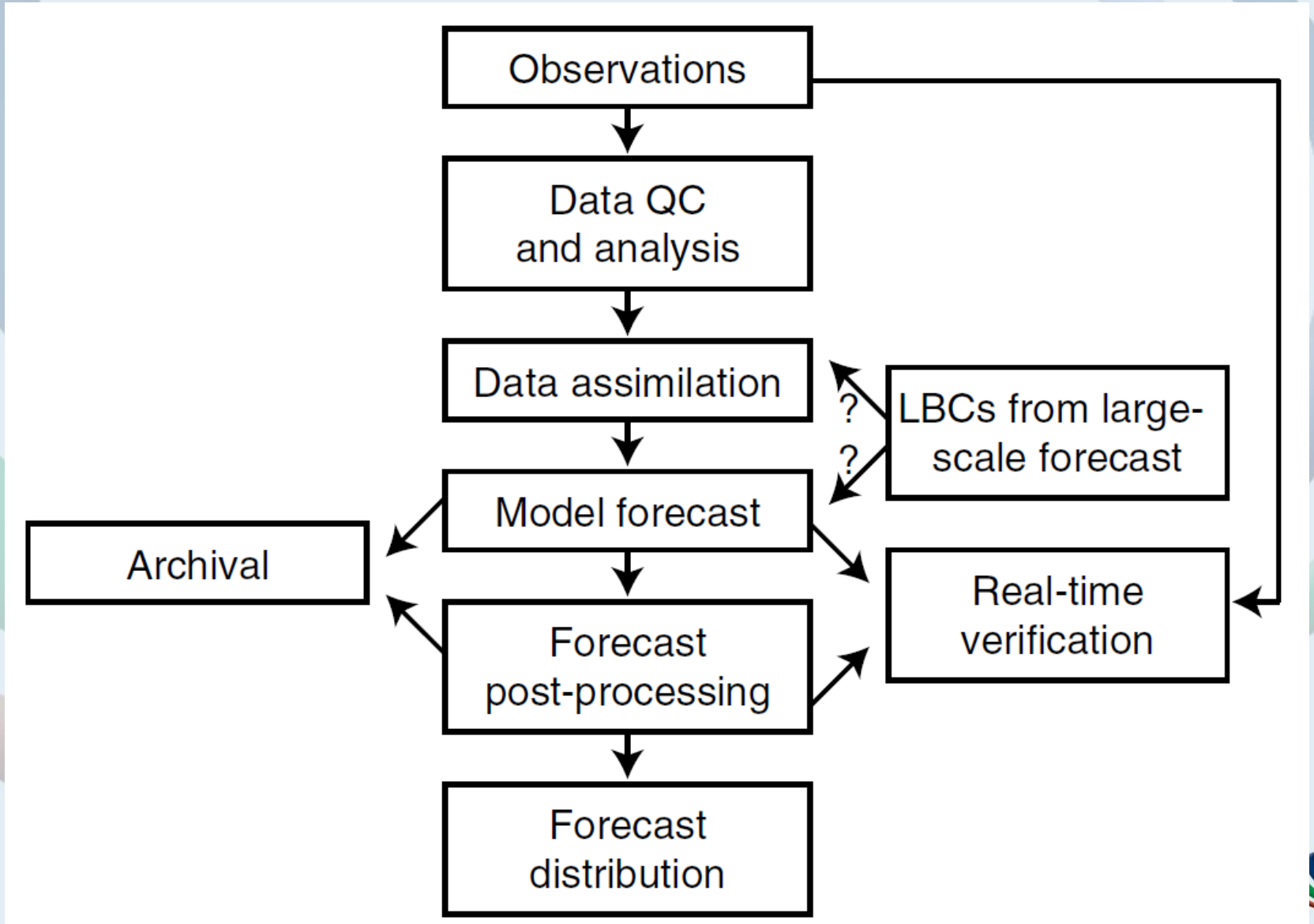
# Basic components of an NWP Model

**Schematic diagram showing the various components of a simple operational NWP system.**



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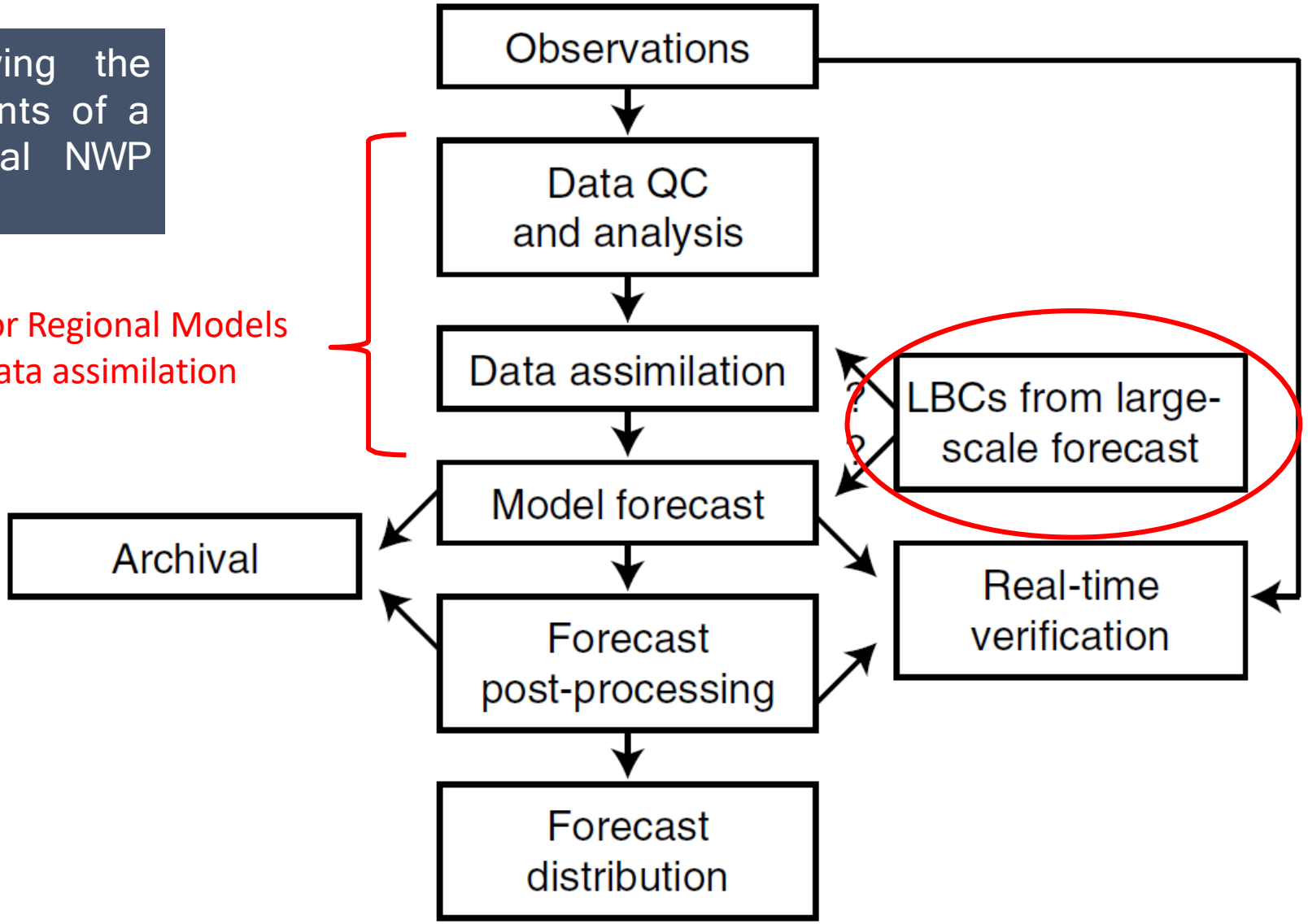
# Schematic Diagram of an NWP system

Schematic showing the various components of a simple operational NWP system

Only required for Regional Models applying local data assimilation modelling




Only required for Regional Models



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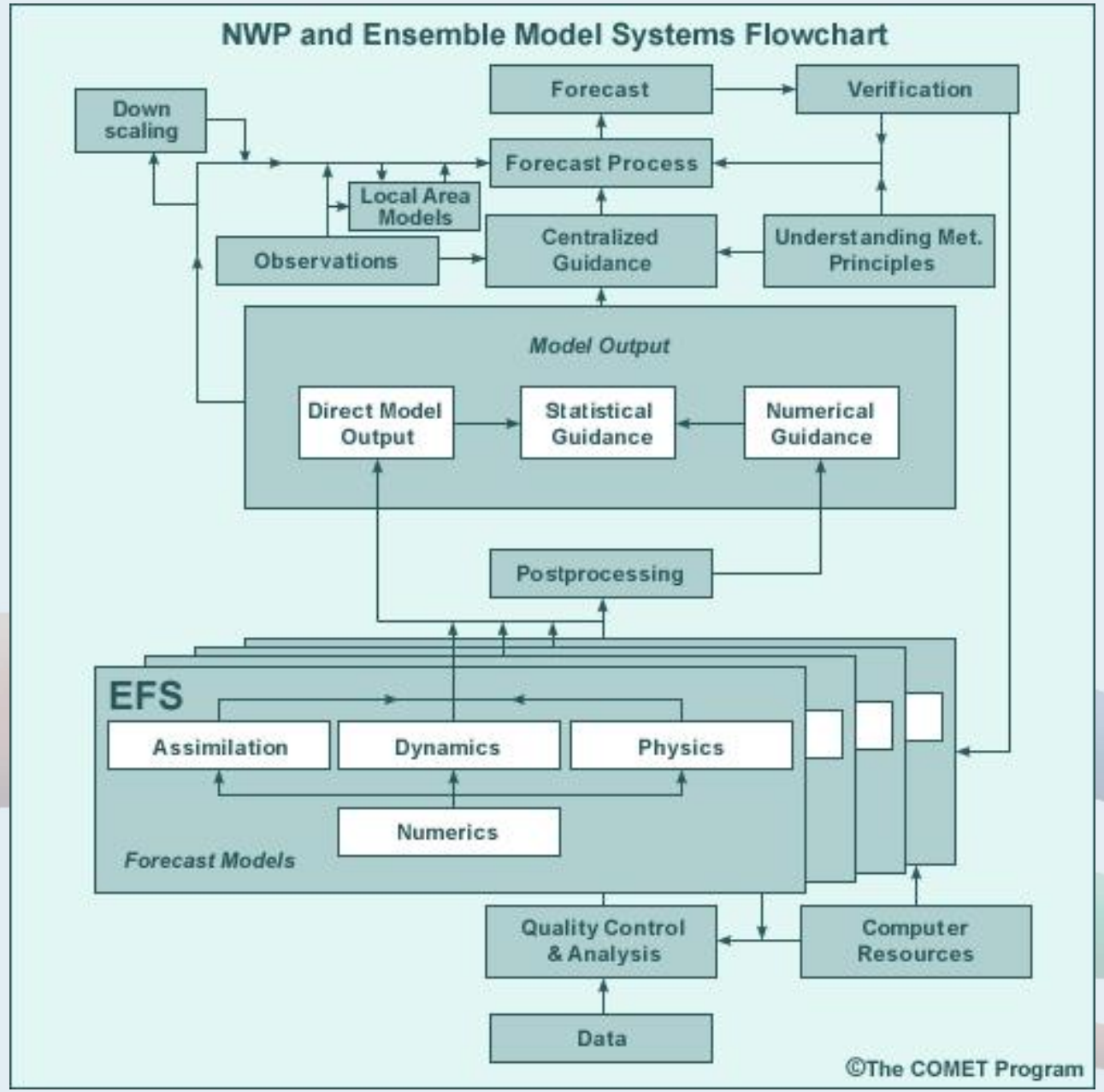


A flow chart of all the inputs, elements, and outputs of numerical weather prediction (NWP) models and Ensemble Prediction systems (EPS), starting from data used to determine the initial condition or starting point for the numerical weather prediction model or ensemble prediction system forecast. The flowchart then moves through the components of an NWP model or EPS, the post-processing of forecast information, and then uses and verification of the post-processed model guidance.

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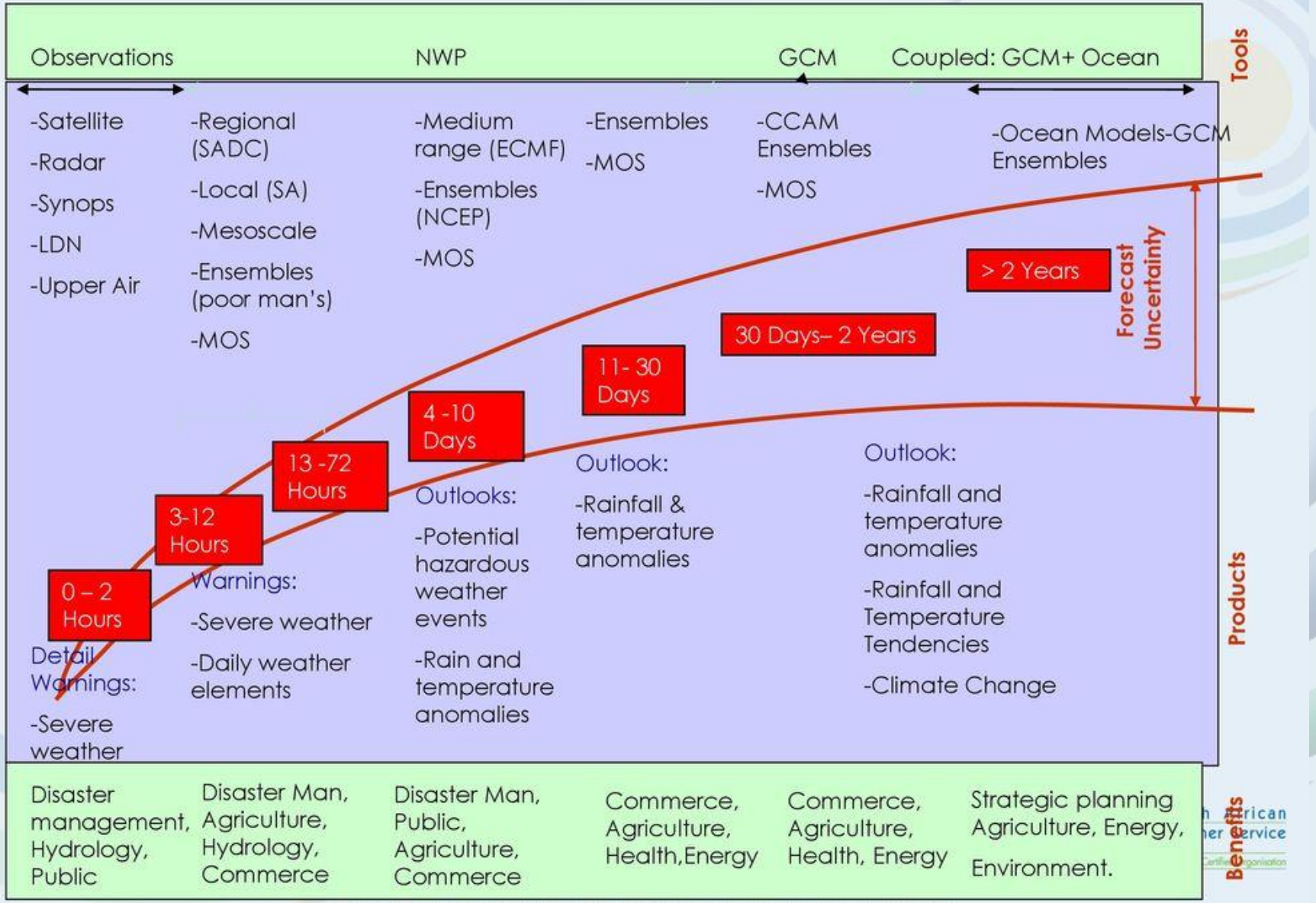
# Seamless Forecasting Process

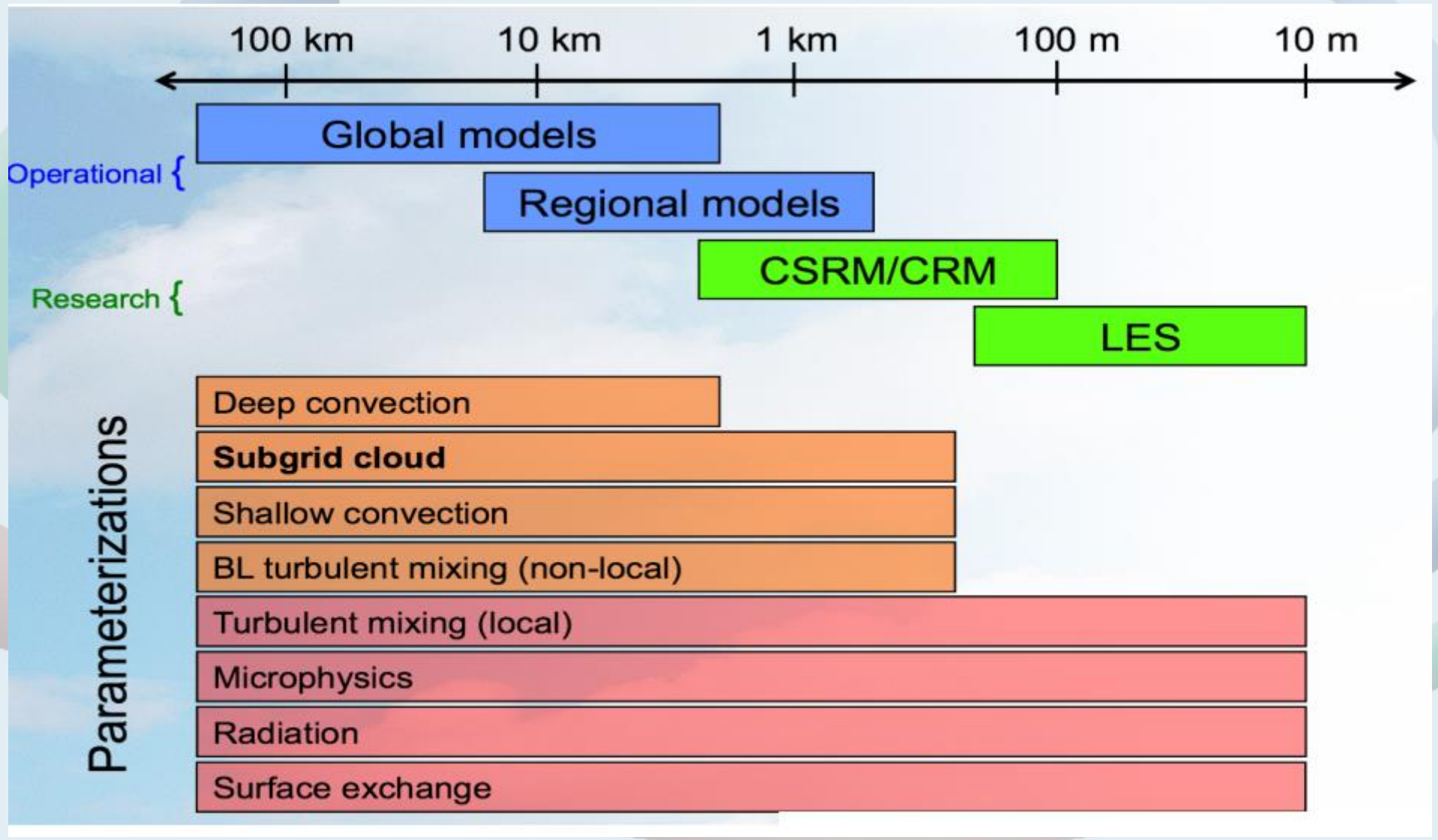
- ✓ Disaster management, Hydrology and Public.
- ✓ Disaster management, Agriculture, Hydrology and Public.
- ✓ Disaster management, Agriculture, Commerce.
- ✓ Commerce, Agriculture, Health and Energy.
- ✓ Commerce, Agriculture, Health and Energy.
- ✓ Strategic planning, Agriculture, Energy and Environment.

# The SAWS "Seamless" Forecasting Systems

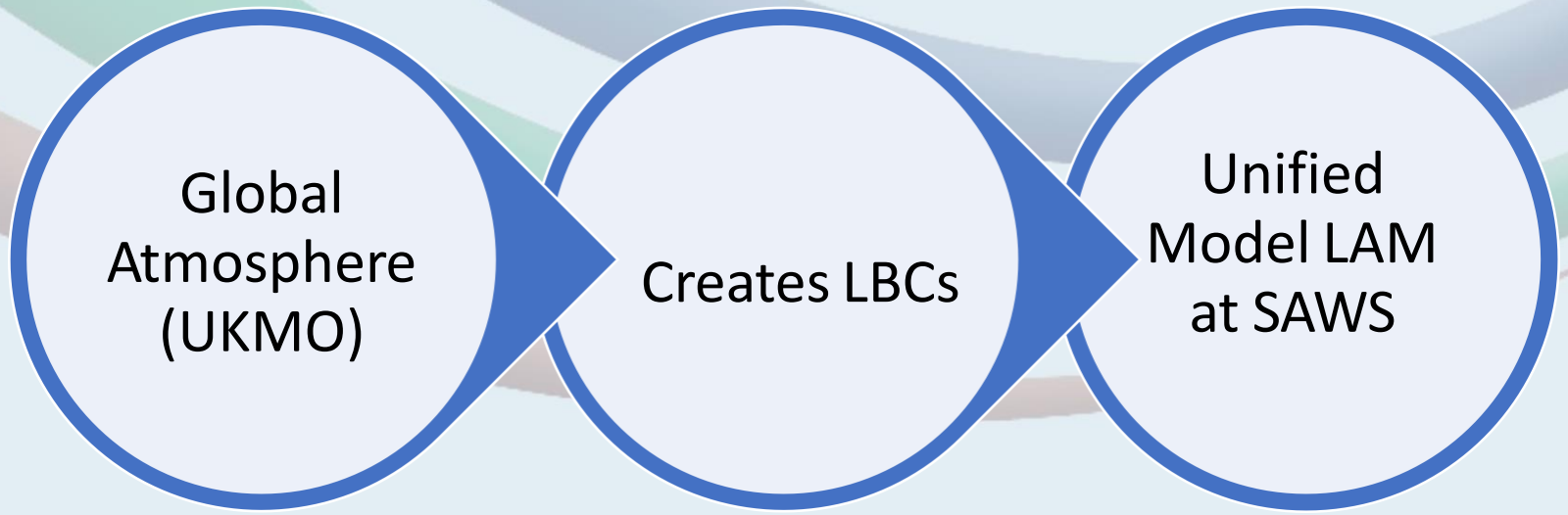



Doc Ref no: SAWS-RES-Rand-Water-Forum.001.01

# Model Resolution



- Lateral Boundary Conditions (LBCs) must be provided to the Limited Area Model (LAM) from a global-model forecast. The gridded forecast fields from the global model must be acquired from a data providing center, unless the global model is run at the same facility as the LAM.
- SAWS gets driving data from the global model run at the Met Office (UK)
- Obviously, the global-model forecast must be completed prior to the
- integration of the LAM.

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# Differences between differences between Limited Area vs. Global models?

- **LAM**

- Limited area models have horizontal and top bottom or vertical boundaries.

- Smaller domain.

- **Global models**

- Covers the entire earth or global and has only vertical boundaries.

- Larger or global domain.

# Limited Area vs. Global models

## Global versions

- Some of the better known global numerical models are:
- **GFS** Global Forecast System (previously AVN) – developed by NOAA
- **NOGAPS** – developed by the US Navy to compare with the GFS
- **GEM** Global Environmental Multiscale Model – developed by the Meteorological Service of Canada (MSC)
- **IFS** developed by the European Centre for Medium-Range Weather Forecasts
- **UM** Unified Model developed by the UK Met Office
- **ICON** developed by the German Weather Service, DWD, jointly with the Max-Planck-Institute (MPI) for Meteorology, Hamburg, NWP Global model of DWD
- **ARPEGE** developed by the French Weather Service, Météo-France
- **IGCM** Intermediate General Circulation Model

# Regional versions

- **WRF** The Weather Research and Forecasting model **WRF-NMM** , **WRF-ARW**
- **HARMONIE-Climate (HCLIM)**
- **RACMO**
- **RACMO2.3p2.**
- **MAR** (Modele Atmospherique Regionale).
- **HIRHAM5**
- **NAM**
- **RAMS**
- **MM5** The Fifth Generation Penn State/NCAR Mesoscale Model
- **ARPS**
- **HIRLAM** High Resolution Limited Area Model
- **GEM-LAM** Global Environmental Multiscale
- **ALADIN**
- **COSMO Meso-NH**
- **CCAM**

# NWP output on SAWS intranet

http://cyclone-web.saws.co.za




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# SAWS INTERNAL NWP SUITE

## Unified Model Forecasts

| Cyclone Home | NWP Products | Research Projects | In-House Training | Publications | Presentations | University Notes | Verification |

**SA4 Temperature list**

Available from early morning hours

**GA10 - 00UTC - SADC Region**

Available from about 07:00 local time

**GA10 - 12UTC - SADC Region**

Available from about 19:00 local time

**SA4 00UTC Analysis SADC**

- Normal Update Time: ~10:30 SAST
- 72-hour lead time
- Forecast: **24 Apr 00:00z** to **27 Apr 00:00z**
- Last updated on: **24 Apr 08:31**
- Update time is still variable

**SA4 06UTC Analysis SADC**

- Normal Update Time: 15:30 SAST
- 48-hour lead time
- Forecast: **23 Apr 06:00z** to **25 Apr 06:00z**
- Last updated on: **23 Apr 14:04**
- Update time is still variable

**SA4 12UTC Analysis SADC**

- Normal Update Time: ~22:30 SAST
- 72-hour lead time
- Forecast: **23 Apr 12:00z** to **26 Apr 12:00z**
- Last updated on: **23 Apr 20:28**
- Update time is still variable

**SA4 18UTC Analysis SADC**

- Normal Update Time: 04:30 SAST
- 60-hour lead time
- Forecast: **23 Apr 18:00z** to **26 Apr 06:00z**
- Last updated on: **23 Apr 03:10**
- Update time is still variable

**SA1p5 00UTC Analysis SA**

- Update: 10:40 SAST
- 36-hour lead time
- Update time is still variable

**SA1p5 06UTC Analysis SA**

- Update: 18:40 SAST
- 36-hour lead time
- Update time is still variable

**SA1p5 12UTC Analysis SA**

- Update: 22:40 SAST
- 36-hour lead time
- Update time is still variable

**SA1p5 18UTC Analysis SA**

- Update: 04:40 SAST
- 36-hour lead time
- Update time is still variable



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| Surface Variables | | | |
|---|---|---|---|
| Daily 1.5m Maximum Temperature |  | Daily 1.5m Minimum Temperature |  |
| 24hr Maximum Temperature Change |  | 24hr Minimum Temperature Change |  |
| 1.5m Temperature |  | 1.5m Fog and Visibility |  |
| **NEW Station Temperature List** |  | 1.5m Relative Humidity |  |
| Sea-level Pressure |  | 1.5m Dewpoint Temperature |  |
| Hourly Total Precipitation |  | Hourly Total Precipitation over South Africa |  |
| 3-hourly Total Precipitation |  | 3-hourly Total Precipitation over South Africa |  |
| Accumulating Total Precipitation |  | Accumulating Total Precipitation over South Africa |  |
| Surface Wind (10m) |  | Surface Wind (10m) over South Africa |  |

| Namibia and Botswana: Surface Variables | | | |
|---|---|---|---|
| Daily 1.5m Maximum Temperature |  | Daily 1.5m Minimum Temperature |  |
| 24hr Maximum Temperature Change |  | 24hr Minimum Temperature Change |  |
| 1.5m Temperature |  | 1.5m Fog and Visibility |  |

| Upper Air Variables | | | | | | |
|---|---|---|---|---|---|---|
| Level: | 850hPa | 700hPa | 600hPa | 500hPa | 300hPa | 200hPa |
| Temperature |  |  |  |  |  |  |
| Geopotential height |  |  |  |  |  |  |
| Wind |  |  |  |  |  |  |
| Wind over South Africa |  |  |  |  |  |  |
| Wind and Geopotential height over South Africa |  |  |  |  |  |  |
| Relative Humidity |  |  |  |  |  |  |

| Other Variables | | | |
|---|---|---|---|
| 500hPa to 300hPa Temperature Average |  | Wet Bulb Potential Temperature at 850hPa |  |
| Fire Danger index |  | Discomfort index |  |
| Low Cloud cover |  | Low Cloud over South Africa |  |
| Middle Cloud cover |  | Middle Cloud over South Africa |  |
| High Cloud cover |  | High Cloud over South Africa |  |
| Total Cloud cover |  | Total Cloud over South Africa |  |
| 850hPa to 500hPa Thickness |  | Freezing Level Height |  |
| Snow |  | Daily Accumulated Snow |  |
| Frost |  | Airport Specific Aviation Forecasts | |

| Thunderstorm Indices | | | |
|---|---|---|---|
| Total totals index |  | K-Index |  |
| High-level Total totals index |  | Surface to 1km Wind speed shear |  |
| Surface to 600hPa Wind speed shear |  | Surface to 500hPa Wind speed shear |  |
| 700-500hPa Lapse rate |  | Storm Motion Vector |  |
| Surface Cape |  | Surface Lifted Index |  |
| Storm Relative Helicity |  | Energy Helicity Index |  |
| Storm Location Indicator |  | Storm Location Indicator over South Africa |  |
| Severe Storm Index |  | WINDEX |  |
| Flash Rate |  | Flash Rate over South Africa |  |

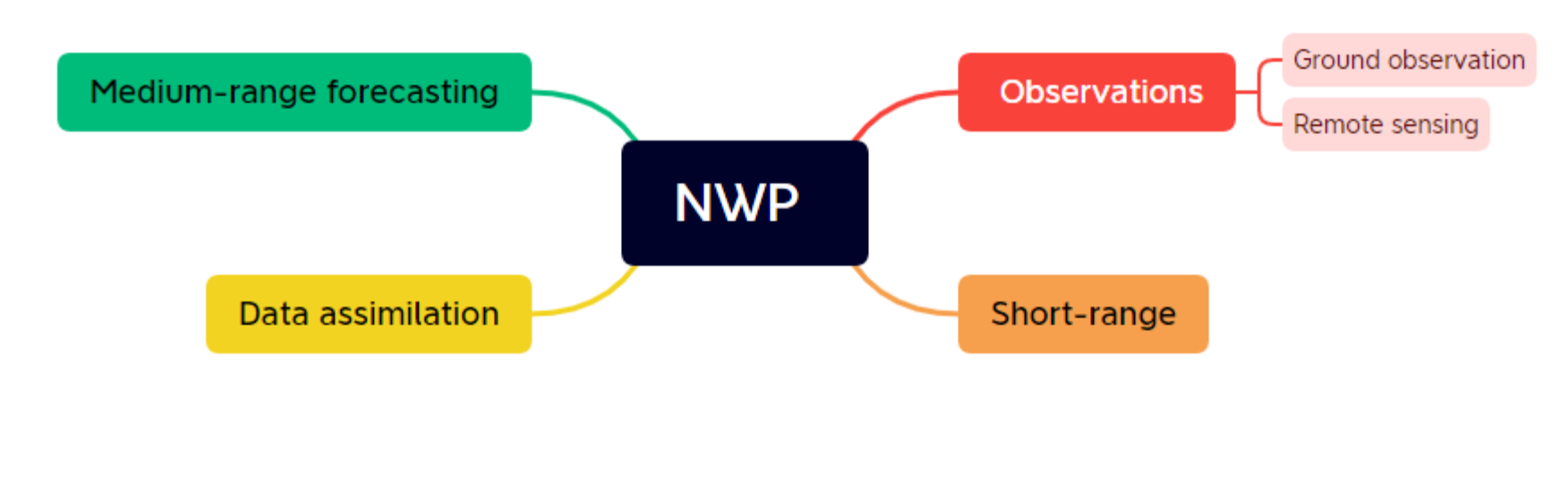
| SkewT - LogP plots | | |
|---|---|---|
| Bethlehem | Bloemfontein | Cape Town Int Airport |
| Cradock | De Aar | Durban |
| East London | Ermelo | Johannesburg Int Airport |
| Kimberley | Klerksdorp | Lephalale |
| Nelspruit | Pietermaritzburg | Polokwane |
| Port Elizabeth | Pretoria, Irene | Rustenburg |
| Umtata | Upington | Vryheid |
| Beaufort West | Springbok | Calvinia |
| George | | |

# Outcomes of Day 1

- ✓ Revision of honours WKD704 course.
- ✓ Understand the basic components of an NWP Model.
- ✓ Introduction to Numerical Weather Prediction models.
- ✓ Seamless forecasting process
- ✓ Significance of Numerical Weather Prediction Model to a forecaster.
- ✓ Differences between differences between Limited Area vs. Global models?.
- ✓ The internal NWP suite used at SAWS will be introduced

# Assignment (count 25%)

**Download …….**
**https://www.xmind.net/**




- **Observational Networks used at SAWS.**
- **NWP forecasting models (i.e UM, CCAM, ECMWF,WRF)**
- **What are the observations used for ? i.e. Data assimilation, Agriculture, Research**

# Questions ???? Comments

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