On Weather Forecasting techniques over West Africa

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Outline

- Introduction
- Techniques of Weather Forecasting over the West African region
- Forecasting specific high impact weather events
- Problems of Weather Forecasting in West Africa
- Conclusion

Introduction

- Timescales of Forecasts
- High Impact Weather Systems in West Africa

Timescales of Forecasts

- *Very Short-Range (Nowcast) (less than 1 day),*
- *Short-Range (1-2 days),*
- *Extended Range (3-5 days),*
- *Medium-Range (up to 6-10 days) and*
- *Long-Range (monthly or seasonal) outlooks*

❖ ***Predictability of High Impact weather systems in West Africa include:***

- ***Thunderstorms and Squall lines***
- ***High wind waves along the coasts – Storm surges***
- ***Flash floods***
- ***Thick Dust storms - difficult for Aviation Industry***
- ***Dry Spells – Little Dry Season (LSD)***
- ***Onset of rain – important for agriculture and water resources management***

Techniques of Weather Forecasting over the West African region

- ***The subjective approach*** - in which forecasters attempt to predict future changes by taking into account both the general theoretical knowledge and also the practical experience of the evolution of weather situations in the region. Nearly all forecasts in West Africa are produced by this approach.
- ***The objective approach*** - in which the equations expressing the physical changes in the atmosphere are formulated and solved by electronic computers to the greatest degree of accuracy that is at present possible.

The Subjective approach

3 - Stage process of traditional weather forecasting in West Africa

Stage – 1: Observations are taken at set time intervals over a three dimensional (x,y,z) array

Stage – 2: Analyses of the instantaneous fields of meteorological fields (e.g. wind – streamlines) to identify the characteristics of the fields

Stage – 3: Movements, development and interactions of the features are predicted

The Subjective approach cont'd

- **The broad spectrum of this approach involves the use of:**

- **empirical forecasting** (practical, observed, pragmatic method)
  - **typical isobaric patterns (lows, highs, troughs, ridges, etc).**
- **extrapolation**
  - **to predict the movement of existing weather by extrapolating from the trends of the immediate past**
- **forecast by similarity**
  - **to follow a particular situation is to search for similar situations (or analogues) in the past and see what happened then**

The Subjective approach cont'd

- **The broad spectrum of this approach involves the use of:**

- **climatology**
  - idea of the normal value of the element (or ITD) as deduced from climatological charts, together with the departure of the present value of this element (ITD) from this normal value
- **local weather forecasting techniques**
  - example of local weather system that is typical of coastal Lagos is the meso-scale "Bariga" convective system. Others include – fog, thunderstorm etc

    Forecasting of such features require a good knowledge of the local condition setting-up such weather.

The objective approach

Background

- The method involves the use of fast computer to solve a number of non-linear equations in order to predict numerical values at grid points, which is known as numerical weather prediction (NWP).
- NWP activities over West Africa by African scientists from the region could be said to have started in the early 1990s.
- Recent advances in communications and reduced costs of on-site computers, however, are providing operational forecasters the opportunity to improve processing of forecasts through more extensive use of NWP.

The objective approach cont'd

- **Direct Use from Model Output products**

  NMSs in the region have acquired a variety of computer software tools to display and manipulate gridded data, such as RETIM, SYNERGIE, etc.

- **Conceptual Modelling**

  Using MDD and MSG to forms part of the forecast, which provide a mechanism for describing many fine-scale weather features, especially cloud and precipitation patterns.

- ***Forecast from Model Output Statistics***

  An operational statistical forecast product based on NWP model output products (PPM, MOS, etc)

- **Ensemble Prediction**

  Examining multiple NWP forecasts from different modelling centres to help produce a more reliable probabilistic forecast.

Forecasting specific high impact weather events

- Intense Precipitation and West African Disturbance Lines
- Thick Dust Haze
- Orographically induced mesoscale convective systems
- Easterly Jet Stream
- Monsoon rainfall
- Mid-Summer Dry Spell

Forecasting specific high impact weather events

- **Intense Precipitation and West African Disturbance Lines**

Widespread precipitation – well-marked upper level (200hPa)divergence/lower level (925hPa) convergence fields with adequate availability of moisture

Disturbance / Squall Line – (i) large lateral and vertical wind shears,
(ii) well marked trough or vortex in the lowest level
(iii) adequate moisture supply (SW monsoon winds)
(iv) Convection indices (LFC, CIN, CAPE etc)

Detection and tracing of movement of a disturbance – kinematical and climatological techniques help to indicate which areas are likely to be affected by the movement and intensification of the system. In this technique, satellite cloud pictures are extremely valuable

Forecasting specific high impact weather events cont'd

- **Thick Dust Haze – a period of 4 - 5 days or more when visibility will be less than 1000m**

Old School 1: West Africa

(a) tracing the cold front associated with an extratropical system, with strong winds in its rear to the raising of the dust in the Sahara at the surface

(b) Strong Northeasterly winds on the eastern side of the semi-permanent anticyclone over North Africa to transport the dust southward, particularly at 925hPa.

Old School 2: Case for Nigeria

(a) Dust haze first reported in Faya Largeau, Chad

(b) Strong surface and low-level northeasterly wind resulting from a pressure gradient of more than 10hPa between Sebha (Libya) and Abeche (Chad)

(c) In 24 hours, it is forecast at Kano, Nigeria

This technique can be applied in other areas of West African on the same basis.

Drawback – with deteriorating data coverage, it will breakdown if no report is received from Faya Largeau or any other signal station.

Contemporary School: Using model Output products –

(a) On the surface chart, the 1015hPa isobar from the semi-permanent highs over North Africa must extend southward to about 10°N with tighter pressure gradient towards the centre of the high. This will be appropriate to raise the dust.

(b) Northeasterly winds between 20 – 30kts at 900/925hPa for the advection of the dust southwards to affect West African countries.

The deterioration/improvement of visibility associated with the dust is dependent on velocity convergent/divergent respectively of the flow downstream at this level

Forecasting specific high impact weather events cont'd

Orographically induced mesoscale convective systems (MCSs)

In situ developments over mountain ranges at late morning and afternoon hours in summer. Satellites track the MCSs.

Easterly Jet Stream

The AEJ is a major dynamical feature of the West Africa weather systems. It has a crucial role in organising the long-lived meso-scale convective systems and through barotropic and baroclinic instability, the generation of the synoptic-scale easterly waves (CISK). The strength and position of the jet determines the squally (convective) activities of West Africa

Monsoon rainfall

The northward extension of the southwest monsoon and the location of the station relative to Zone D in the West African weather classification

Mid-Summer Dry Spells

Guinean Coast SSTs, Lower level subsidence, intrusion of South Hemispheric winter

Problems of Weather Forecasting in West Africa

Subjective approach

- the use of synoptic-scale charts
- the paucity of data on the charts
- weather predictions based on teleconnections and other empirically determined relationships

Problems of Weather Forecasting in West Africa

Objective approach

- limited accuracy of the initial analyses
- Problem of horizontal and vertical resolution of models and parameterised subgrid processes
- Inadequate representation of orographic and other local information

Conclusion

- Weather Forecaster in the region must study weather charts to obtain an understanding of the weather from the geometrical, kinematical, statistical, dynamical and physical viewpoints

- Successful Weather Forecaster must possess a complex combination of a good theoretical understanding of atmospheric processes, a wide synoptic climatological knowledge, long experience and sound judgement.

Conclusion

- The forecaster in either the deterministic or the ensemble forecasts must consider the constraints in producing the forecast.

- With the problems associated with weather forecasting in West Africa and the present activities of AMMA in the region, it is important to encourage and support the current efforts to develop dynamical modelling activities. Such activities require building capacities for example, in terms of human and material resources and development of infrastructure as is done presently in the African Multidisciplinary Analyses (AMMA) project.

Thank You

For Listening