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Research Article

Hidden Synoptic Features That Make Weather over Africa

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Abstract

Certain localized synoptic features can be hidden during weather analysis if viewed on the large-scale weather charts but can produce significant weather events over Africa. Wind speeds do not usually rise so high over West Africa but when they rise to 30 knots and above, they become indications that something quite unusual could happen. Investigation of these winds has been made at the 900 hPa level up in the atmosphere and are seen to coincide with dust on the surface if they track over the Sahara Desert, and then with rain when they track over the Gulf of Guinea. Analysis of atmospheric Pressure distributions over Africa, and those over the Atlantic Ocean have been used in making weather predictions for West Africa by investigating their central values, locations and orientations, including spacing of isobars. Surface pressure values higher than the Standard Pressure are considered as high pressures, and those lower are considered as low pressures when making atmospheric barometric analysis.

Keywords: Weather; Pressure; Knots; Winds; Azores; St. Helena

Abbreviations

PUMA: Permission to Use METEOSAT in Africa; GMet: Ghana Meteorological Agency; hPa: Hectopascal; UTC: Universal Time Coordinate.

Introduction

Meteorologists in Ghana have devised ways of predicting weather conditions for the country through the study of weather elements in the neighborhood using the patterns of synoptic features displayed on charts. Pressure and wind patterns give significant weather results to meteorologists when they try to look into the dynamics of the atmosphere. Winds are seen to originate from high-pressure areas into low-pressure areas, so they define areas as highs, and lows in relation to the Standard Pressure (SP), 1 atm which is approximately 1013 hPa [4].

When there is a trough (an extension of the low-pressure area) extending into the high-pressure area over the sub region, it is an indication that moisture will be accumulated within that trough. An example occurred over Northwestern Nigeria on 17th August 2018 (Figure 1), where rainfall and thundery activities affected that area. Conversely, if a ridge (an extension of the high-pressure area) should extend into a low-pressure area it prevents rain from occurring.

Figure 1: Surface pressure chart for 1200 UTC on 17th August 2018 showing a trough of 1014 hPa isobar extending into Northwestern Nigeria [6].

The geographical location of the West African sub region is such that it is boarded in the South by the Gulf of Guinea, and in the North by the Sahara Desert so weather predictions are mostly based on which airmass will be affecting the region under consideration. The constituents of the airmass depends on its origin and track; if it passes over the sea it will brings moisture, and similarly if it tracks over the Desert it brings dust.

When the equatorial trough (1010 hPa isobar) exhibits a meridional expansion (north to south) over the Sahel, sufficient moisture will be drawn in from the Atlantic Ocean into West African sub region to produce widespread rains and thunderstorms over places (Figure 3).

Figure 2: Winds at 900 hPa level, with thresholds of 30 knots (Low Level Jets) on 17th August 2018 at 0600 UTC over Algeria [6].

Figure 3: Dust RGB satellite imagery at 1200 UTC on 17th August 2018 showing thunderstorms devastating the north-western corner of Nigeria [7].

In this analysis, the high-pressure system over the South Atlantic Ocean has a high central pressure value of 1033 hPa which is quite strong to propel winds to reach the Sahel. However, the high-pressure system over the North Atlantic also has a high value of about 1030 hPa, so these two pressure systems are capable of throwing in lots of moisture into the West African sub region from their respective locations over the Oceans. The 1016 hPa isobar passes over the southwest coast of Ghana which is an indication that pressures are on the high side so, that will not support the tracking of storms along the coast.

Forecasters have also looked into winds at various levels in the atmosphere and decided to study winds at 900 hPa level at dawn times. It has been realized that when winds at this level reach 30 knots and above over the Sahel region, there use to be a corresponding raising of dust at the surface. There used to be a corresponding tightening of pressure gradient at the surface which is responsible to lift dust particles from the ground.

On 17th August 2018 at 0600 UTC winds of 30 knots were predicted by the Meteo France model to occur over Algeria (Figure 2). Even though rain storms raged over West Africa, but spots of dust (magenta colour) were also seen on satellite imageries to have been raised over places in Algeria at where the speeds reached the 30 knots. Winds at this level are used for the prediction of dust hazy conditions. Whenever these winds occur close to Ghana, hazy conditions are experienced, for that matter Forecasters are always on the look-out for these winds, and special emphasis are taken to track them. Ghana is zoomed-in from the Africa map in order to see whether these winds of 30 knots exist or not (Figure 2). Synergie, a special computer programme from PUMA is used in the Meteorological Offices for scrutinizing the atmosphere in this way.

Subsequent predictions by the model predicted the propagation of this trough towards the west, from Nigeria and to be over Ghana by 1800 UTC on 17th August 2018 (Figure 4). The storm took the shape of the trough of the 1012 hPa isobar, covering the northern sector and parts of the middle sector of Ghana, and produced rains over these areas (Figure 5).

When making forecast for Ghana, the value of the central pressure system over the North Atlantic Ocean (the Azores High) and that over the South Atlantic Ocean (the St. Helena High) should be analyzed and compared. These two high pressure systems seem to regulate weather conditions over West Africa, depending on the strength of their central values. When the St. Helena is stronger than the Azores then winds that would be propelled from the center

The oscillatory nature of these two high-pressure systems are used when forecasting for daily and weekly weather conditions in Ghana. Forecasters take into consideration, the mean geographical location of these pressure systems. They are not stationary but hover around in the same location. Their respective mean seasonal central values are also considered when predicting weather events for the seasons in Ghana.

Similarly, when these Low-Level Jets (LLJ) track the Gulf of Guinea, they carry lots of moisture and deposit them on the land as rain. These winds, on the 22nd August 2018 tracked over Southern Ghana (Figure 6), they blew parallel to the coastline, but hit the southwestern coast line almost perpendicularly and produced rainfall over parts of the Western and Central regions of Ghana (Figure 7).

Figure 4: Surface pressure chart for 1800 UTC on 17th August 2018 showing the propagation of the 1012 hPa isobar trough extending over Ghana [6].

Figure 5: Dust RGB satellite imagery at 1800 UTC on 17th August 2018 showing storms over Northern Ghana and the middle sector which takes the shape of the 1012 hPa trough on Figure 4 [7].

Figure 6: Winds at 900 hPa for 22nd August 2018 at 0300 UTC, with thresholds of 30 knots over southern Ghana [6].

Materials and Methods

Wind speeds with thresholds of 30 knots have been earmarked because during analysis it has been realized that where ever these winds occur, they coincide with significant weather like rain or dust over the West African sub region. The Synergie is a computer software that can filter out winds to clearly point out speeds of interest without a hustle. Weather products, both models and satellite imageries are animated on the computer in order to determine the profile of weather conditions. It helps to determine whether a storm is intensifying or weakening, as well as its track, and also to know the trend of weather systems whether troughs and ridges are propagating or stagnating.

Figure 7: Day Microphysics RGB Satellite imagery showing rain clouds observed over southern Ghana on 22nd August 2018 at 1330 UTC due to the occurrence of LLJ along the coast [6].

When troughs and ridges are identified on the surface pressure charts, their central values of the pressure systems are compared, including their shapes, orientations, and tightening of isobars which describes pressure gradient. For clarity, an area on the chart can be zoomed-in for synoptic features that are localized to be revealed. Wind speeds of 30 knots did not appear on the large-scale map of Africa but when zoomed-in to Ghana, speeds of 30 knots were seen to exist over the extreme south of the country (Figure 6).

Results and Discussions

Extensions from low-pressure areas into high-pressure areas usually coincide with rainfall activities over West Africa. LLJs usually become visible on model charts mostly at dawns and early mornings whenever they exist, and then become almost unavailable in the afternoons. Because of that, they are investigated at 0300 or 0600 UTC.

When low-pressure systems form over the West African subregion, countries bordering the Gulf of Guinea experience extensive rainfall activities. This is because winds that originate from the Azores High-Pressure system in the North Atlantic, and the St. Helena High-Pressure systems in the South Atlantic Ocean converge in the low-pressure area over the sub region to replace air that might have risen. Conversely, if High-Pressure forms over the surface in West Africa, with tight isobars, winds at the surface usually raise dust.

Conclusions

Winds and pressure distributions are elements of the weather that are used most extensively over West Africa when making weather forecasts. Wind circulations, curvatures, as well as speeds at different altitudes are very crucial when making weather predictions. Prevailing wind directions over the West African sub region are seasonal. When the apparent position of the sun is in the Northern hemisphere, winds become more southerly and blow into the low pressure that would be created over the sub region. However, when the apparent position of sun moves to the southern Hemisphere winds now become northerly over West Africa and transport dust from the Sahara Desert southward to produce hazy conditions over most coastal areas.

Areas with wind speeds of threshold of 30 knots at the 900 hPa level are subjected to significant weather phenomena at the surface. The phenomena could be dusty or hazy conditions if the winds should track over the Desert or a sandy area. The phenomena could also be cloudy conditions or rains if the winds should track over the Ocean.

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