African Centre of Meteorological

Applications for Development

FINAL REPORT

OF ATTACHMENT

IN

THE DEPARTMENT OF WEATHER WACTH AND PREDICTION

UNDER

ISACIP/AFRICLIMSERV Project

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1. Acknowledgements:

At this juncture allow me to convey my compliments to the African Center of Meteorological Applications for Development (**ACMAD**) administration on behalf of South Sudan Meteorological Services, am grateful for your invitation and facilitation offered to me that enable me to travel from South Sudan to Niger – Niamey, Thanks and appreciation to Director General Mr. Alhassane Adam Diallo, also extend wavering thanks to Secretary General Mohammed Kadi for their encouragement and good cooperation with (**SSMS**) and Warming thanks to the chief of weather watch and prediction department Mr. Leon Gay Razafindrakoto for his warm welcoming in the department and good advices during this four months and the chance he give to me under his supervision to know more about forecasting and how to use all the equipment at the center of weather watch and prediction thank so much Sir, I will never forgot to extend specially thanks to the staff of weather watch and prediction for their good teaching to use RETIM/SYNERGIE SYSTEM and to forecast WASA/F and SASA/F and forecasting of flood risk bulletin and good cooperation's. Last thank and appreciations to all staff of (**ACMAD**) for their good cooperation during my four months with them. Thanks to **(ACMAD)** for their big and importance role in Africa to made challenges of climate change and upgrading the skills of those are working in the different field of Meteorology and climatology, I wish good to you and almighty God bless you.

Best Regard,

Edward Andrew Ashiek Okeiyg

South Sudan Meteorological Services

2012/09/28- ACMAD

Niamey – Niger

2. Back ground:

This report is the final work of **four** (**4**) months from **(4th June 2012 to 30th September 2012)**. The training is under the program of ISACIP/AFRICLIMSERV of 013/PROT/ACMAD/2012 between (**ACMAD**) and (**SSMS**), **SSMS** agreed to make me available on secondment to (**ACMAD**) for the period of Four months mention above in the department of Weather Watch and Prediction. This program is the (**ACMAD**) contribution in promoting, enhancing and upgrading the African Meteorologists skills in the field of weather forecasting and climatology, we are appreciate and thankful. My specific target during four months focused on the tools on RETIM/SYNERGIE system for the production of weather forecasting needs, classified into four approaches, the first approach is introduction to the concepts of meteorology and the tools use for the weather forecasting in the west Africa, the second approach is the production of FIT/ITD; CAB; ITCZ on the RETIM/SYNERGIE SYSTEM, the third approach is the production of West Africa Synthetic Analysis/Forecast WASA/F, the fourth approach is the production of Southern African Synthetic Analysis/Forecast SASA/F and the fifth approach is the production of flood risk bulletin. Also during my training I attended course on climate data library presented by IRI and it's was very good and interesting, also I had more knowledge during my movement in the different departments in (**ACMAD**) specially in the department of Climate Prediction and the department of Information and Telecommunication.

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3. Introduction:

The African Center of Meteorological Application for Development (**ACMAD**) is a center of excellence in Meteorology and climatology in the Africa as regional. The center is to address the capacity building needs in the field of training personnel in Meteorology and Climatology over the continent. The task of a forecasters involves the analysis of numerous observations and **NWP** products (both analysis and forecasts) before deciding on the weather forecast for a given location and range. This is a very complex process involving both objective and subjective criteria and where the experience of the forecaster can play an important role on the skill of the final forecast. The difficulty is even stronger for tropical regions where in contrast to mid-latitudes the atmospheric flow is weakly balanced resulting in a weaker predictability, especially for convective events. Also this process needs to be performed as quickly as possible.

4. Data Reception and procession:

The data processing and forecasting systems used at the centre are the synergie and MSG. date is fed into synergie vie the RETIM – Africa system and the forecast production on synergie. The production on the synergie systems consists of weather information analyzed and forecast preparation using the different models for comparison.

5. The Models Available at the Synergie Systems is:

ARPEGE/1.5 METEO-France model at resolution 1.5 by 1.5 degrees latitude and longitude, the forecasts have validity going out to 96 hours, every 6 hours.

ARPEGE-TROPIC/1.5 METEO-France model at resolution 1.5 by degrees latitude and longitude, the forecasts have validity going out to 96 hours.

CEP/2.5 ECMWF model at resolution 2.5 by 2.5 degrees latitude and longitude, the forecasts have validity going out to 168 hours every 24 hours.

CEP/TROPIC UK/1.25 model at resolution 1.25 by degrees latitude and longitude, the forecasts have validity going out to 36 hours.

The synergie system is configured for display of all the above mention models. And the most widely used model is the ARPEGE/1.5 since the production of (**FIT/ITD, CAB, ITCZ, WASA, WASF, and SASA AND SASF**) is configured for using the model. If there is ambiguity the comparison have to be made to the other models.

6. Newsletters and Target Audience:

The bulletins provided by the **ACMAD** are:

- Bulletins for professionals in meteorology and assistance with the positioning of the major parameters that have great influence and impact in weather changing. This is the WASA/F for the area of West Africa and the SASA/F for the area of South Africa. These bulletins are updated regularly on the web site of **ACMAD** and are available for any scientist working in the area of the passage of time by Mail.
- The newsletter of FIT/ITD which is primarily designed to determine the position of the FIT/ITD,CAB (Congo Air Boundary) and Inter-Tropical Convergence Zone (ITCZ), which are often the subject of much controversy for the complexity of the criteria drawn.
- The bulletin of the flood risk forecasting (FRF).

- ➢ The bulletin of the severe weather forecasting (SWF), which is related to National Meteorological and Hydrological Services (NMHSs) and the humanitarian agencies.

7. Daily Production Routine:

A. The analysis and forecast products daily West Africa Synthetic Analysis/Forecast (WASA/F) are summarized in the tables below).

Product	**Forecast Range**
West Africa synthetic analysis 1800Z-WASA	Analysis for 1800Z on Day D-1
West Africa synthetic analysis 0600Z-WASA	Analysis for 0600Z on Day D
West Africa synthetic analysis 1800Z-WASF	Forecast for 1800Zon Day D
West Africa synthetic analysis 0600Z-WASF	Forecast for 0600Zon Day D+1

B. The analysis and forecast products daily South Africa Synthetic analysis / Forecast (SASA/F) are summarized in the table below.

Product	**Forecast Range**
Southern Africa Synthetic Analysis 1800Z - SASA	Analysis for 1800Z on Day D-1
Southern Africa Synthetic Analysis 0600Z - SASA	Analysis for 0600Z on Day D
Southern Africa Synthetic Analysis 1800Z - SASF	Analysis for 1800Z on Day D
Southern Africa Synthetic Analysis 0600Z - SASF	Analysis for 0600Z on Day D+1

The major features of parameters used or taken into consideration during the analysis are plotted according to the procedures at the forecaster’s desk. See the rules of the WASA/F and SASA/F production below (table 1, 2).

WASA and WASF	**The Level**
ITD	at the surface
Heat Low	at the surface
Vortices	at 850hpa level
African Easterly Waves	at 700hpa level
AEJ	at 600hpa level
Trough north of ITD	at 500hpa level
TEJ	at 200hpa level
STJ	at 200hpa level

Table (1).

SASA and SASF	The Level
Front	at the surface
ITD	at the surface
Vortices	at 850hpa level
CAB	at 850hpa level
ITCZ	at 850hpa level
Trough	at 850hpa level
Anticyclone centers	at 850hpa level
STJ	at 200hap level

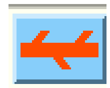
Table (2).

8. List of the 10 key features:

The following 10 features are considered as important and will figure on the WASA/F (Fig. 1) maps in order to capture the main characteristic of the situation and to forecast the occurrence of deep convection and the weather over West Africa.

1. The Inter-tropical Discontinuity ITD
2. The associated Heat-Low HL
3. Subtropical Jet STJ
4. Troughs extending from mid-latitudes
5. The Tropical Easterly Jet TEJ
6. The African Easterly Jet AEJ
7. African Easterly Waves AEW and cyclonic vortices
8. Midlevel dry air
9. The African Easterly Monsoon layer and low level energy
10. Convective activity with the distinction between 3 cases:
A. Suppressed convection areas
B. Unorganized isolated convective cells
C. Mesoscale Convective Systems: MCS hereafter and Squall Lines: SL hereafter

9. *The Inter-tropical Discontinuity ITD:*



The ITD is a discontinuity close to the surface which divides in two parts the Africa from the Atlantic up to Sudan:

- The south to south-west flux of monsoon at the south of ITD with high energy (high θ_w') whose depth is up to approximately 800-850hpa.
- The northern flux of dry air (low T_d) at the north of ITD.

The three criteria needed to draw this line, classified by decreasing degree of importance, are:

- Convergence line at **surface** (10m or 950hPa) between southerly and northerly winds. This criterion is easier to use during the night (0 and 6h).
- Strong **gradient** of humidity at surface. You can use θ_w' (with 0, 5° spacing), T_d (limit near 15°C) or relative humidity (limit near 40%).
- Line of minimum pressure. It's especially useful at the western coast of Africa where the above criteria are difficult to use. There is a thermal depression located in the north of Mali and Mauritania which has a longitudinal orientation and is close by the ITD (see below heat low for explanation).
- All these criteria do not necessarily converge on the same drawing, so the forecaster will have to use his best judgment according more importance to one of the criteria listed above.
- Over the Atlantic Ocean, the ITCZ is drawn by the coincidence of the convergence of the trades, maximum of energy (θ_w'>21°C) at 950hpa, and location of MCS. There is continuity with the convective systems going out of Africa, but not with the ITD. Therefore there is no need to link these two lines.

10.The Heat Low HL or Thermal Depression:

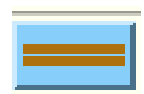
The HL is outlined by the pressure lower than a given threshold. But we need to take into account the strong diurnal cycle with the minimum of pressure obtained around 18h and the weakest depression around 12h.
We propose to draw surface pressure each hector Pascal with the following criteria:

- at 12h lower than 1010hPa
- at 18h lower than 1006hPa
- at 0h lower than 100hPa
- at 6h lower than 1008hPa
- If the thermal depression is weak and not visible with these thresholds, the location and intensity of the minimum of pressure has to be mentioned anyway. Most of the time the HL is located at the north of Mali and Mauritania, but there is also travelling thermal depressions which goes from east to west along ITD.

The diurnal cycle of the heat low is such that:

- The HL reaches its maximum (minimum of pressure) in late afternoon as a result of the intense diurnal heating.

- Nevertheless the wind response is not instantaneous, so that the maximum of wind occurs at the end of the night.
- The ITD in general fits in the position of the HL pressure minimum but there is an extension of the heat low to the north in the afternoon.
- The maximum of convergence occurs between 00 and 06UTC, it is weaker during the day to investigate the structure of the HL, two criteria are useful:
- The temperature at 1500m (if available) keeps the trace of the heat low. The highest temperature (>24°C) are the result of the dry convective activity.
- Cross-section in θ of the HL (or vertical sounding) can also help, since at 18h, the dry convective activity has produced an homogeneous layer between the surface and 700-600hPa (θ ≈ 44-45°C) The thermal depressions are limited to the lowest level of the atmosphere, but on some occasion they have a larger vertical extent. In these cases, we find a vorticity center at 850hPA and even a wave at 700hPa associated with a thermal depression. We can use the easterly wave and the vorticity center symbols (see below) to identify these features located at the north of ITD because they can break the link with the thermal depression below and interact with the African easterly jet, giving birth to a true easterly wave.



11. Subtropical Jet STJ:

The subtropical jet core at 200hPA must be drawn following the streamlines. The difficulty comes from the fact that the threshold may vary for the different seasons. We propose to use 45 knots during the monsoon, since it is less active during this period and 60 knots during the winter. Its climatologically position is over Maghreb during the monsoon, but the STJ can be over Sahel during the transition periods of June and September and is permanent during winter.

The STJ is related to the interaction between tropics and mid-latitudes. Three features are of direct interest for West Africa:

- The zones of acceleration and slowing down of the STJ, named entrance and exit zones can force ageostrophic circulation. The lifting effect occurs at the right of the entrance and the left of the exit and the opposite for the subsidence. These effects are apparent on the vertical velocity field in mid-troposphere (600hPa). In this case the forecaster can use the symbol which identifies an entrance or exit zone.
- Altitude trough or cyclonic cells at 200-300hPa are often associated with PV anomaly, a signature on water vapour imagery (dry air) and cold air below (300-400hPa). There can be a jet at the south or south-east of the vorticity maximum. This feature can be seen over West Africa all along the year, but not during the two months of monsoon (July and august). These cold surges favours convection at the south-east of the vorticity maximum and during the most dramatic event it will change the circulation of all the troposphere and produce strong rains in the middle of dry season even at the coast of golf of Guinea.

- Presence of dry air coming from mid-latitude is discussed below at the item on midlevel dry air and circulation of this dry air over Sahara just below about troughs north of ITD.

12. Troughs north of ITD:

One of the main characteristics of the circulation at the north of ITD is advection of dry air found mainly at 500hPa by the wind at 500-600hPa. There is accumulation of dry air along the axis of the troughs located at 500-600hPa. These troughs, which at first have a link with altitude circulation at 200hPa of mid-latitude, break this link and experiment a strong modification as they extend in the tropics. They take a south-west north-east orientation and a tropical plume-like structure with one of the axis of strong winds having more importance. Therefore we will have plumes advecting dry air to the south-west and plumes advecting dry air to the north-east. The trough itself has to be drawn by streamlines at 500-60hPa and is along the maximum of vorticity. The maximum of wind is often at 600hPa and we propose to use the same symbol as AEJ (see below) to identify on WASA the jet structure with a threshold of 25 knots. Since these jets are at the north of ITD, there is a clear partition with the concept of AEJ even though there can be a connection with AEJ. A vertical cross-section is needed to look at the structure of these jets because it can be either:

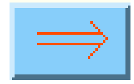
- A structure limited to 500-600hPa with dry air at 500hPa and maximum of wind at 600hPa.
- These two features can also extend to the ground and have an interaction with a thermal depression advecting dry air in the low level vortex. Maghreb trough is a low level steady structure along the Atlantic eastern coast, due to the contrast between Cold Ocean (upwelling zone) and hot continent. The intensity of this trough is an important feature to monitor over that region.

13. The Tropical Easterly Jet TEJ:

The TEJ is an eastward jet at 200hPa found during the monsoon south of ITD. The symbol is drawn along the streamlines with a threshold of 35 knots. The relation with the convective activity is not straight forward, but there is an acceleration of the eastward wind south of big MCS. This is due to the anticyclone circulation generated at 200hPa by the sustained convective activity.

Since this jet is not so strong and may have a large latitudinal extension, it may be difficult sometimes to find the axis of the TEJ. A North-south vertical cross section provides a better view of the structure of the jet. It is possible to find two axis of TEJ for some longitudes.

14. ***The African Easterly Jet AEJ:***



The AEJ is an eastward jet found in the 500-700hPa layer with a climatic maximum at 600hPa. The threshold chosen to draw this feature depends on the model. It goes from approximately 20 knots for UK model to 25 knots for French Arpege model at 600hPa, and for an analysis at the 700hPa level the threshold is lower. The symbol has to be drawn along streamlines. The forecaster will often have to find the location and altitude of the axis by vertical cross sections. The coast of Guinea at the south and the ITD at the north are natural limits for the AEJ. If strong winds at 600hPa over gulf of Guinea are rare during monsoon, we often find strong winds north of ITD for which we can use the same symbol. But as mentioned earlier, they are not of the same nature as AEJ.

15. ***African Easterly Waves AEW:***

C + 

The drawing of easterly waves is one of the most difficult exercises of the African forecaster as it is not easy to avoid a subjective judgment. A necessary criterion to have in mind is the temporal continuity of this structure. We can often follow a wave over several days as it crosses Africa from Chad to the Atlantic.

The axis of the trough is in general oriented north-south and corresponds to the maximum curvature of the winds at 600 or 700hPa. It is easier to find the wave on streamlines and even more on field of vorticity (threshold at 6). If the vorticity signature has a longitudinal extension, it is often related to the horizontal shear at the south of AEJ, but otherwise it may be a wave. At 850hPa, where the wind is weaker just above the monsoon layer, we can find some closed cyclonic circulation and we will mark the center of this circulation by a C if it is associated with a vorticity maximum at the same level (threshold 6). This feature appears in three types of structures which are not totally exclusive:

- Near or north of the ITD, it can be a vertical extension of a thermal depression.
- Near the AEJ, it is often linked to a wave at 700 and 600hPa. The association of a cyclonic vortex with a wave means that the wave has a large vertical extension and is able to favour well organized convective zones. The classical scheme is a C center close at the rear (eastward) of the axis of the trough, but there are many variations from this scheme.
- Away from the AEJ, this feature seems to mark the intrusion of strong advection of dry air over the monsoon layer between 850 and 600hPa.The forecaster has to perform a vertical cross-section to identify the structure associated with the cyclonic center. The 850hpa is during the monsoon an intermediate level where the forecaster can see the consequence of the most significant events of the low levels, monsoon layer and thermal depressions, and of the mid-troposphere events, waves and advection of dry air. The link between convection and structure

of AEWs is still an open area of research but there seems to be at least two types of initiation of waves:

- Waves coming from the north of ITD, (excited probably by strong winds over mountains), and which on their way to the south interacts with AEJ. The models are in general able to forecast these waves.
- Waves created or amplified by MCS. Theses waves appear in the middle of some MCS and the models which does not have a good representation of these MCS will not see theses waves.
- The predictability of these two different types of waves is probably very different.
- The behavior of the MCS in relation with the waves shows two kinds of behaviors:
- The slow moving MCS which are linked to a wave and travels to the west at the same speed.
- The fast moving MCS which speed is twice (10-30 m/s) the speed of the wave (less than 10 m/s) and leave the wave behind.

It is important to make this distinction as the convection in the model does not in general represent the second type of MCS (no treatment of density current) and therefore the forecasted MCS often follows the wave.

16. ***Midlevel dry air:***

Dry air at midlevel is a key feature either in inhibiting or in organizing convection. This contradictory role played by dry air is of primary importance for the understanding of the West African monsoon, as often dry air prevails over the Sahel and Sahara. The origin of this dry air and its interaction with convection is still an issue for research. For example Roca et al (2005) suggested that such dry air intrusions can come from Mid-latitudes. A typical trajectory comes from the anticyclonic southern flank of the polar jet in its exit zone over West Europe. Particles sink below the subtropical jet corresponding to a PV barrier before continuing their path over the Sahara towards the Sahel. This interaction with mid-latitude is one of the hypotheses on the origin of dry air masses over West Africa. The influence of dry air on convection has two extreme possibilities:

- A large area of dry air can stop entirely convection. The barrier due to dry air is visible with a vertical sounding. An MCS going into such a zone can disappear.
- A well-developed MCS evolving at the edge of dry air will be strengthened via the density current. It will change to become a squall line and its speed will grow. We often see convection surrounding the dry air. We propose to outline dry air by the line where the horizontal gradient of Td (around –36°), or of humidity (less than 15%), or of θ_w' (less than 19°) is maximum. Dry air is generally at 500hPa north of ITD, but over monsoon layer altitude may vary from 500 up to 700hPa. Vertical cross sections can help to define the limit and the associated level, which is on rare occasions 400hPa or 800hPa. The limit of dry air should only be drawn if it is near or at the south of the ITD. As mentioned earlier, a look at 600hPa wind show if this dry air id advected to the south or south-west. The term dry intrusion is related to dry air with very low Td or θ_w' as it comes from stratosphere of mid latitudes. A threshold of θ_w'< (cf rémy) at 500hPa at the north of ITD is needed to be sure that this is the case. This air can then mixed with

some humidity and still keep the characteristic of dry air with a horizontal gradient of θ_w’. It is only by tracking back this air that we will be sure of its origin.

To clarify the meaning of these terms, we propose these definitions:

- Mid-latitude dry intrusion: intrusion in the tropics of air coming from mid-latitude stratosphere.
- dry intrusion: advection of dry air (θ_w’ around 18 or 19° with the criterion on gradient used above) near ITD and over the monsoon layer with significant wind at 600-700hPA. On many cases there is a cyclonic centre at 850hPa associated with the intrusion.
- dry air: all the other cases.

17. The African Easterly Monsoon layer:

Drawing the ITD is not enough to characterize the monsoon flux. We need description of the circulation, depth and energy of this flux, but a synthetic representation of these features is not yet available. Fields of perceptible water depth of the monsoon and vertical integration of monsoon flux on the depth of the monsoon are needed.
What is available is the wind and streamlines at 950, 925 and 850hPa to identify the acceleration of the monsoon flux. The forecaster will have to look carefully at the Atlantic coast (Mauritania and Senegal) since there can be three different types of flux in this region with complex interactions:

- Monsoon flux from the south.
- Wind from the north-east coming from the heat low.
- Wind from the north-west coming from subtropical Atlantic with possibly cold air.
- The monsoon depth is available via a vertical cross-section of wind and humidity. The energy of the monsoon is in part visible in the field of θ_w’ at 950hPA. Monsoon surge or rapid displacement of the monsoon to the north is identified by northward movement of the ITD if the second criteria on humidity are preferred locally to draw the ITD. But it is better to have a look at the movement of maximum of θ_w’ at 950hPa near ITD.
-

18. Convection:

Analyzing and forecasting the convection areas, the type and intensity at best, is one of the main objective of the forecaster during the WAM period. Concerning the analysis (WASA), the forecaster must outline the most intense convection area as estimated from the IR imagery (orange corresponding to –65°?) and use the MCS tracking to have an estimation of the speed of the MCS (use the last three or four images to estimate the speed). The drawing must be precise and adjusted with the latest IR image. The MCS will appear as a zone enclosed with the convective symbol inside. For zones with isolated convective cells only the symbol has to be drawn.

Then the forecaster has to look at the convection of the model and verify the conformity with the localization of convection derived from the satellite. It is not such an easy task as there is no simple quantification of the convective activity. But the forecaster can use the following criteria to detect the strongest and long lived MCS in the model:

- The cumulated rain over a short period (3 or 6 hours) shows a maximum. The rain may have low values for the MCS close to ITD because evaporation of rain is so important at the north of the monsoon.
- There is ascending vertical velocity in mid troposphere (600-700 hPa) next to this maximum. The adiabatic heating coming from convection produces this vertical velocity.
- There is relative humidity (>80%) at 600-700hPa.
- For some of the best cases, there is divergence at 200 hPa and convergence at 700hPa nearby.
- This exercise is easier at 6h as we have only MCS at the end of the night. At 18h, the diurnal convection is at its maximum and we cannot make a clear separation with the MCS.
- For the forecast (WASF) of convection, the forecaster must combine different information. It is the most difficult task of the forecasters, as models have weak skill in predicting convection over tropical regions.
- Indeed present parameterizations of convection don't treat correctly all the different convective processes and stages (triggering, inhibition, propagation, evaporation…) that are key features over West Africa. But the model skill is better for some other larger scale structures as listed before (ITD, HL, Jets, dry air intrusion). For each case where one of these structures has an influence on convection, the predictability of convection grows and can be the same as the predictability of the structure. We have four types of factors which can influence convection.

19. Convective updraft:

CAPE: the forecaster has to be very cautious with this parameter as its use depends on the method used to compute this parameter. For example for Arpege model, you cannot compare the value of CAPE with a CAPE derived from a vertical sounding of the model, a zero value of CAPE means that the model is divergent at low levels and nether less a significant CAPE can still exists, and the maximum values are absurd. The main information coming from this field is the fact that for every point with none zero value of CAPE the convective scheme of the model is activated.

20. Low level energy:

Strong convection is likely to occur on zones with high θ_w' near surface and where the depth of monsoon is thick enough to feed convection. The forecaster should also check if there is a confluence of streamlines at 950 or 850 hPa at the same place.

21. Perceptible water (IWV):

For weak quantity (<40g/m2?) there will be no precipitation or they will not reach the ground.

22. CIN:

We will have no initiation of convection in zones with strong CIN, but it does not always have a dissipating effect on an MCS. CIN over monsoon is probably related to presence of a dry and hot layer in mid-troposphere. Since it is not available for Arpege, the forecaster has to look at a vertical sounding.

23. Downdraft and density current:

There is a strong link with dry air at mid level. Nevertheless it favors evaporation of precipitation, allowing the formation of subsidence feeding cold air masses spreading at the surface as density currents that favor the triggering of new convective cells. We can often find convection developing all along a dry air boundary.

24. Shear:

The shear between mid and low levels is often weak in tropical regions, except over the Sahel region due to the AEJ. This low level shear between the AEJ and the monsoon is moderate (15 m/s over 4 km) and easterly. It is linear (no rotation of the shear with altitude) so that it favors cell formation by the density current down shear. It explains the formation of Squall line systems perpendicular to the shear and moving fast at about the AEJ speed.

25. Other forcing:

Well developed **AEW** (with an associated cyclonic center at 850hpa) can force convection; generally it occurs in the axis of the trough or just at the west. An MCS can also amplify or create such a wave.

26. Altitude trough or cyclonic center:

At 200-300hpa associated with PV anomaly and cold air can force convection at south-east (see upwards at the chapter concerning trough for discussion).

27. Topography:

Convection often starts in some specific spots, related to elevated terrain such as the Aïr, Jos Plateau, Cameroon, and Fouta Djalon…as confirmed by climatology. A good knowledge of a region, allows an experienced forecaster to forecast such on set at midday in some specific spots. Also the MCS tracking allows detection of the first triggering of convection whose location can be cross-checked with terrain properties (topography and surface in homogeneities).

28. *Surface Fluxes and soil characteristic:*

- Soil moisture is a key parameter for convection development. Nevertheless there is a lack of operational observation to monitor surface condition. Accumulated rain in the past days provides information on the soil moisture.
- Also the atmosphere-soil coupling is still a research topic. The basic knowledge is that over dry soil, sensible heat fluxes are stronger and the temperature diurnal cycle is strong. It favours the triggering of first convective cells. On the contrary moist soil favour latent heat flux and deeper and more persistent convection, due to stronger energy in the boundary layer.

29. *Diurnal cycle:*

The diurnal cycle is strong over West Africa. Convection is smallest amount in the late morning. Increase rapidly from noon to reach its maximum in late afternoon to evening. During the night only the biggest and the strongest systems can survive.

30. *Radiation:*

During the night, long wave cooling in clear air allows the reinforcement of the convection in cloudy area we distinguish 3 types of convection:

31. *Squall line type:*

That needs the combination of 3 factors: instability, dry air and shear. The precipitation efficiency of such system is weaker, but their dynamic is strong (intense gusts), and their life time can be important (more than a day).The Sahel region is the preferential track of such system during the mature stage of the monsoon due to the combination of the instability and of the dry AEJ occurrence.

32. *Less organized convective area (or sometimes big MCC):*

When the shear and the dry air are weak, such systems have better precipitation efficiency, especially if IWV is high. They are often less organized (ensemble isolated storms). Their lifetime is shorter and they move slower. They occur more to the south.

33. *Diurnal convection:*

Most of the time convection onset occurs during the afternoon and often over a large area. Most of the convection will disappear in the first half of the night but one or two systems may survive as MCS during the night. It is not easy to forecast which of many convective systems will survive, but the process of selection is often apparent at 18h.

34.Suppressed convection:

Models have difficulties to predict areas of suppressed convection. Nevertheless in some cases the forecaster can identify features that contribute to inhibit convection. In that case he can localize such regions where the probability of convection is weak:

- CIN often associated with large areas of dry air advected over monsoon layer
- A trough at 200hpa associated with a northern TEJ can prevent convection over a large part of West Africa as it goes slowly to the west.
- Subsiding large scale region
- Ridge area (at which level?)
- weak IWV
- Anti-cyclonic circulation between two AEWs
- Anti-cyclonic vortex (streamlines) at 850hPa. There is also sudden dissipation of big MCS. It is often difficult to find an explanation, but some of the causes may be:
- Strong shear due to a strong TEJ
- Drying of low levels for example when an MCS cross ITD
- Some west or north-west circulation near the Atlantic coast seems to dissipate MCS.
- Temporary dissipation during the morning followed by a reactivation during the afternoon.
- To forecast occurrence of MCS in spite of poor behaviour of convective scheme, the forecaster has to follow a simple method:
- Check the errors of localization of MCS in the analysis and try to compensate these errors in the forecast.
- Identify convection in the forecast. If there is some dry air near an MCS, it may behave as a squall line and travel faster to the west. Correct the position of the MCS.
- Look at favorable conditions at the northern part of monsoon. If there is no convection in the model and favorable conditions, you may try to forecast an MCS between a wave and dry air.

Figure 1: FIT/ITD; CAB, ITCZ ON 2012/09/07 at 0600Z

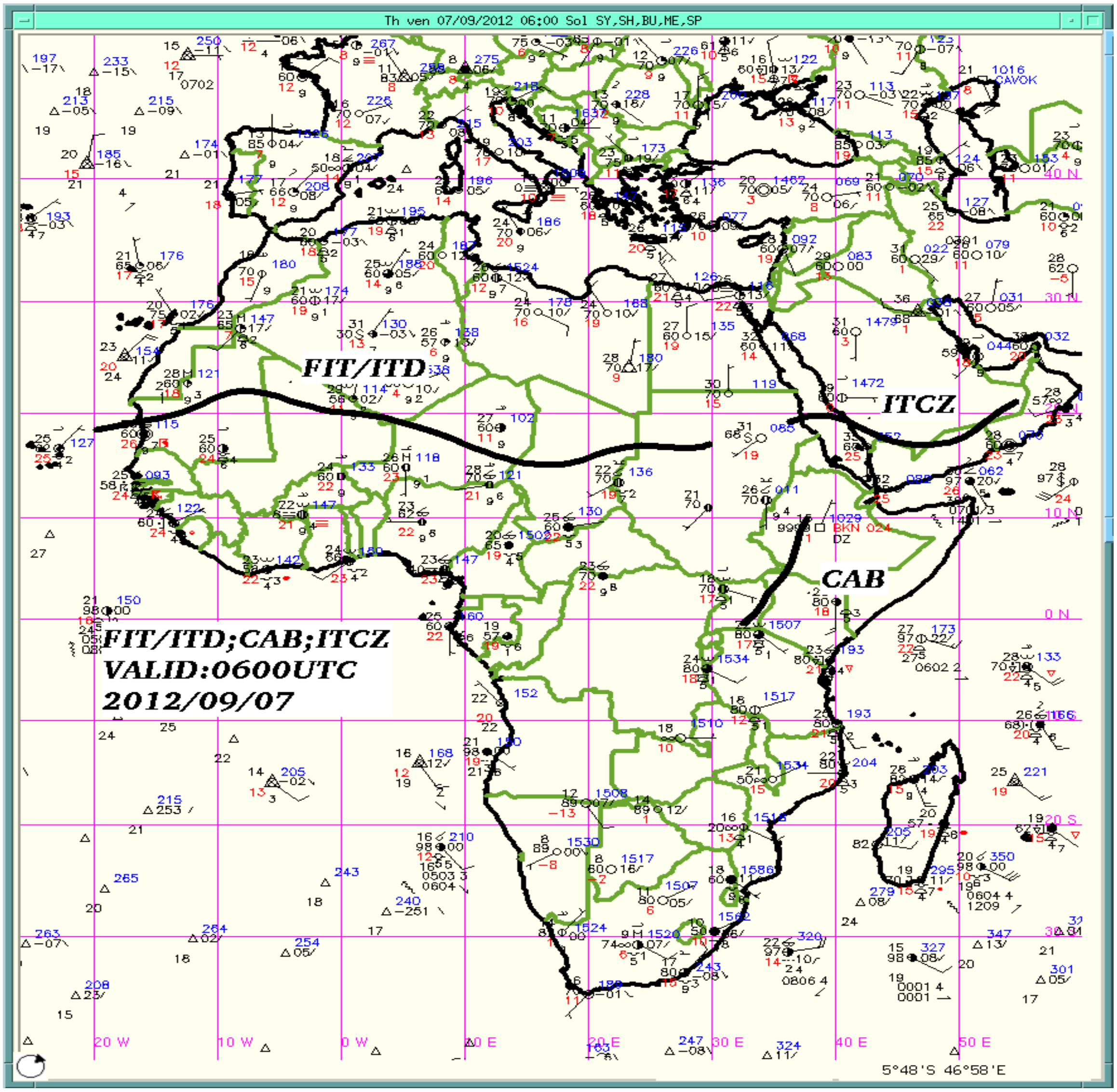
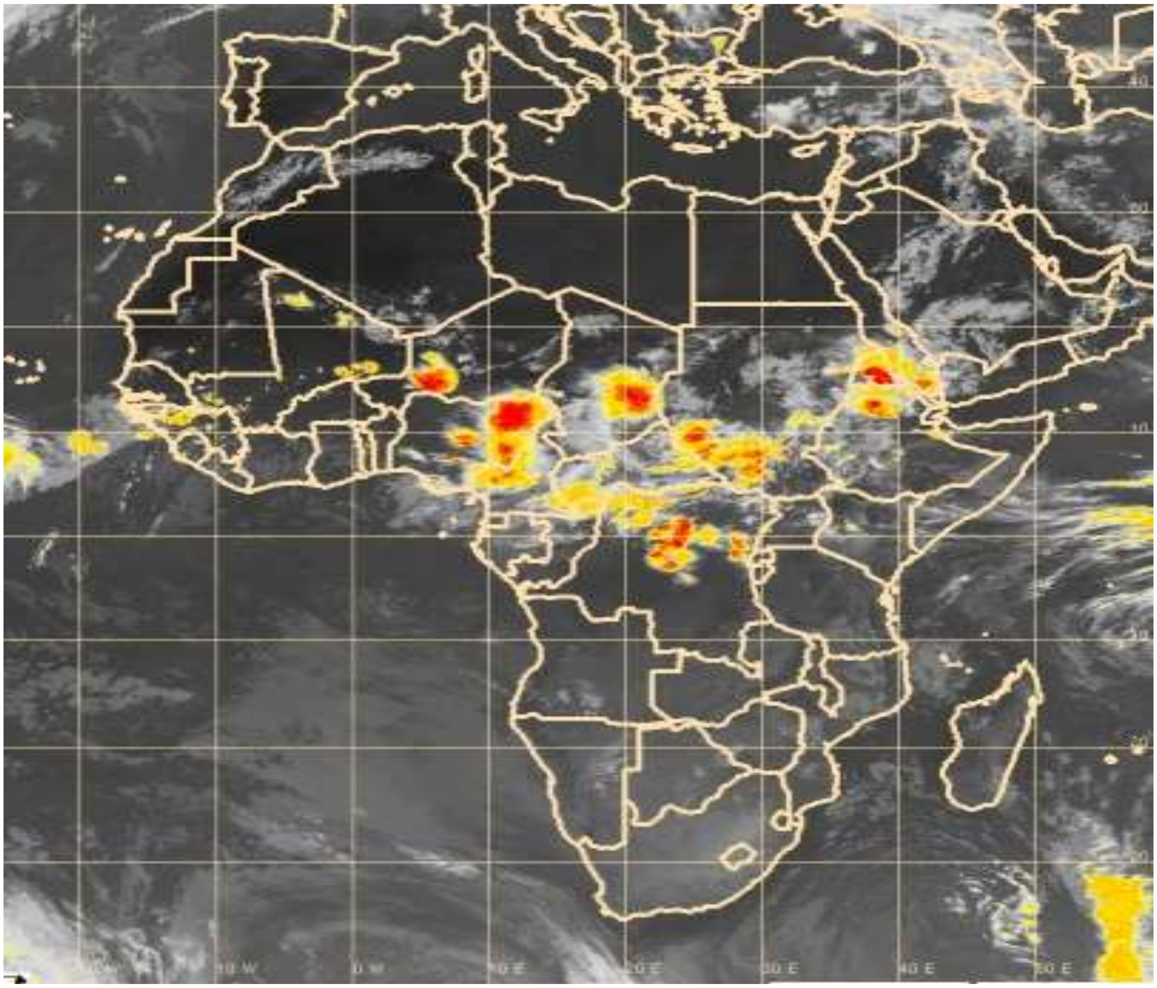


Figure 2: //SAT PIC 1815 UTC ON 30/07/2012.



The examples charts of WASA/F:

Figure 3: WASA for 06/08/2012 at 0600Z

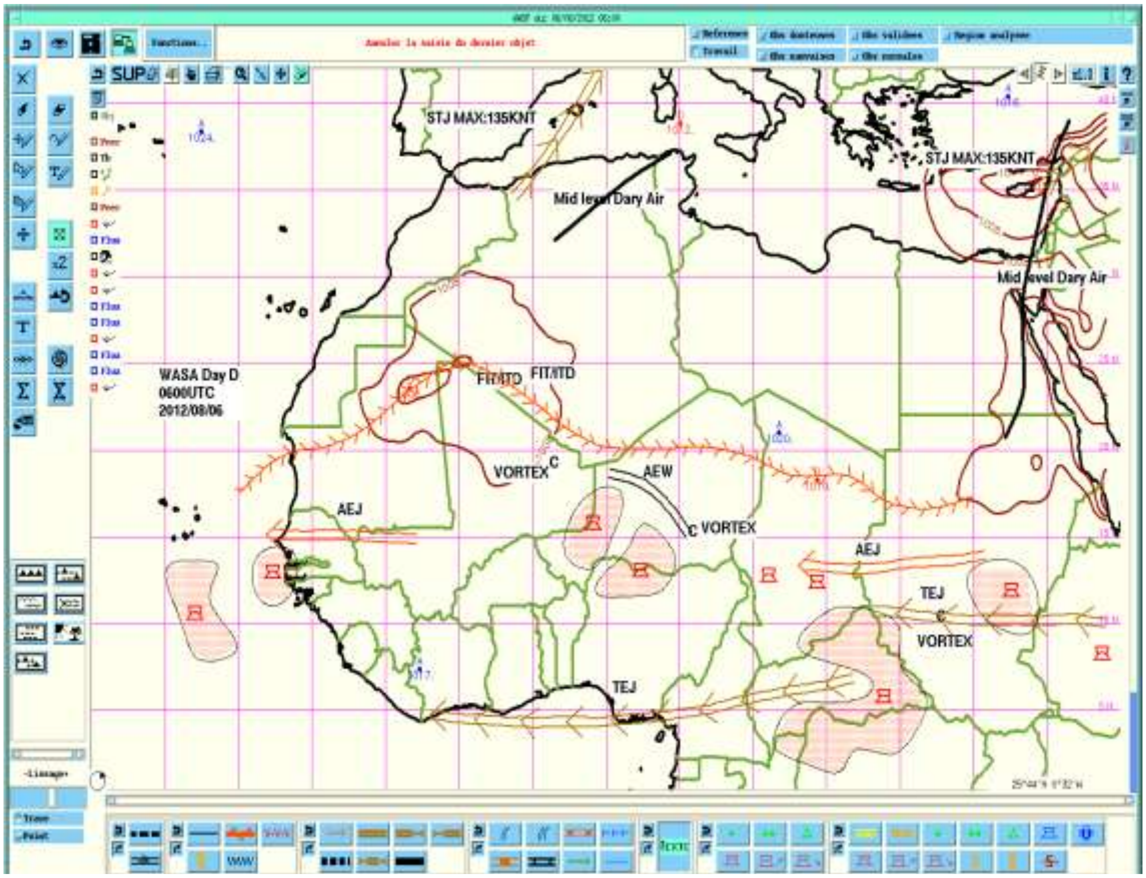


Figure 4: WASA for 2012/08/07 at 1800Z.

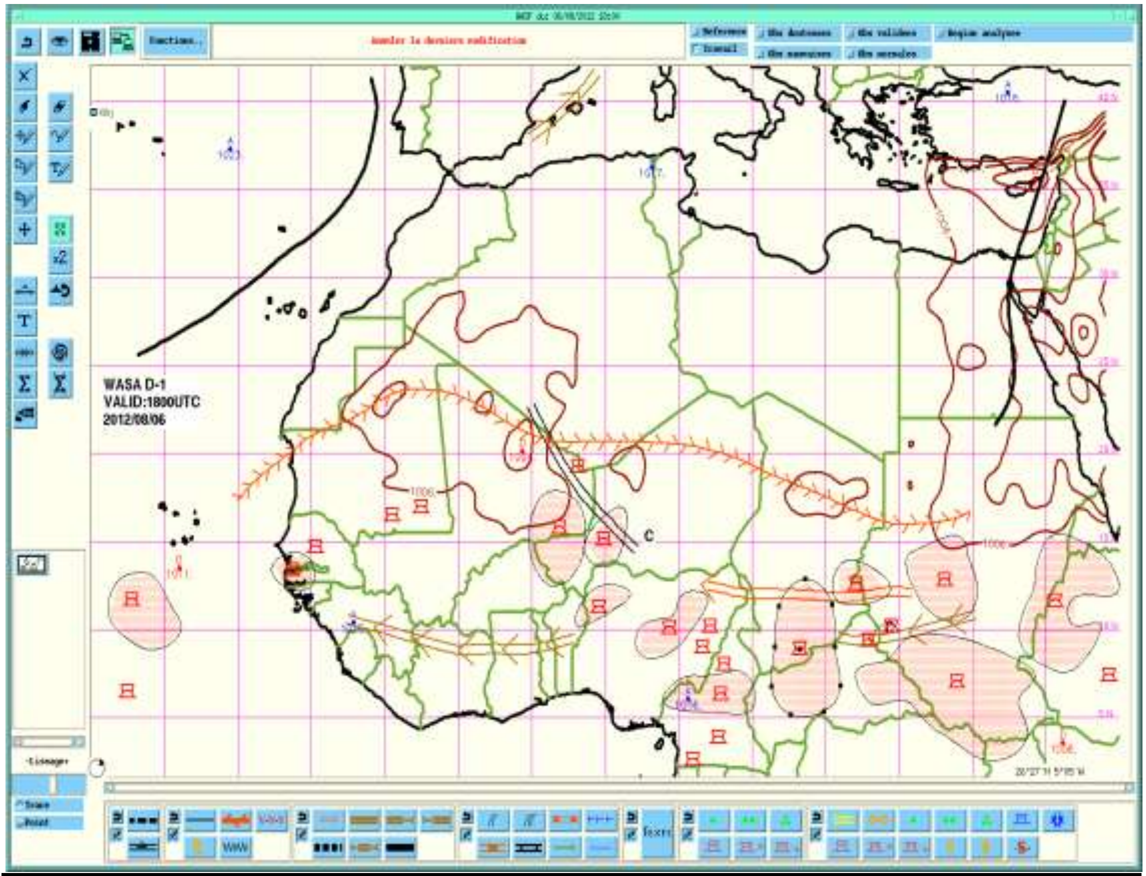


Figure 5: WASF for 2012/08/07 at 1800Z.

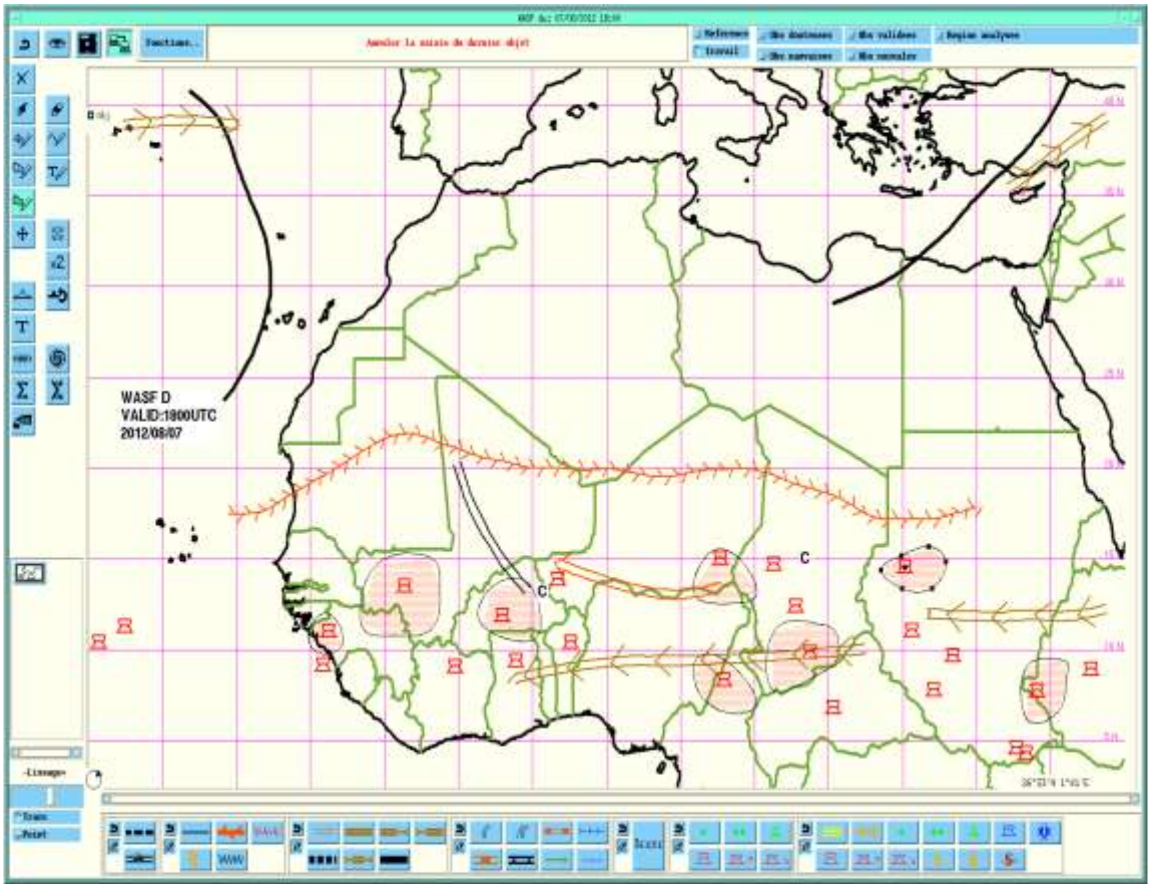


Figure 6: WASA for 2012/08/13 at 1800Z.

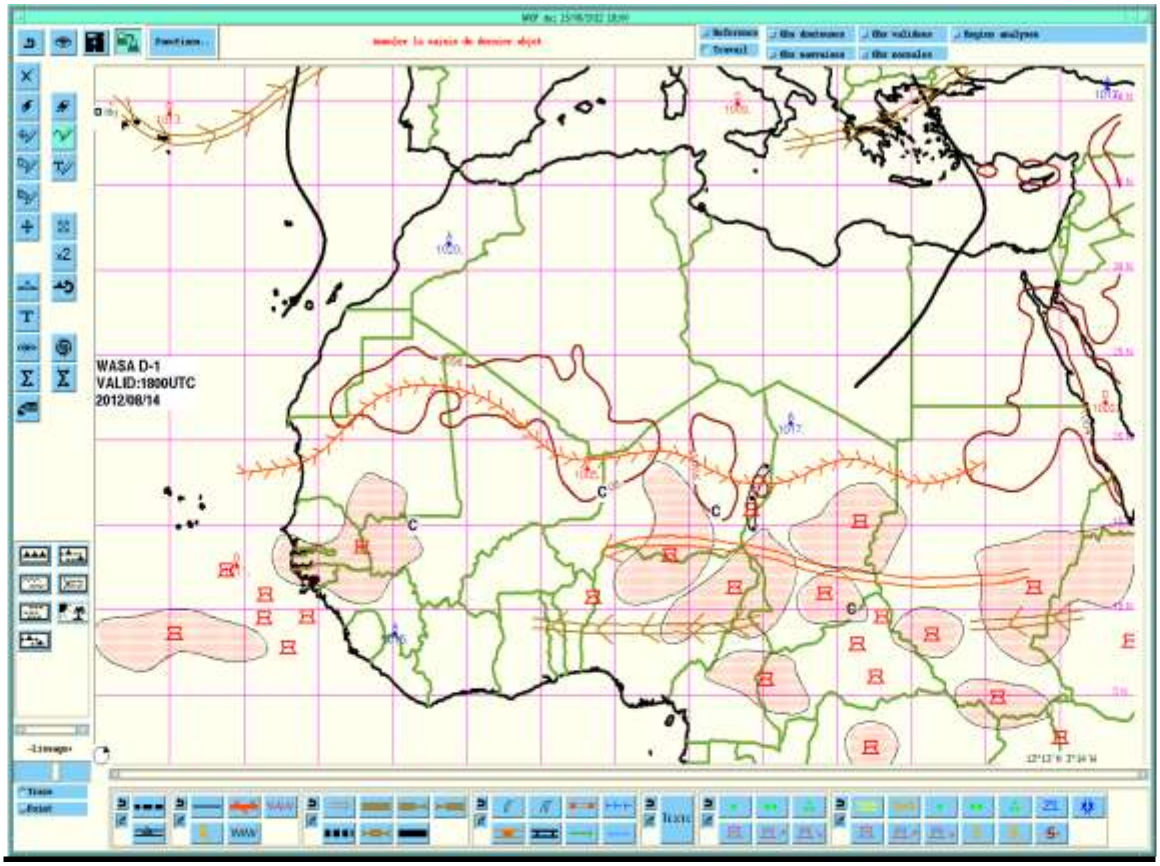


Figure 7: WASF for 2012/08/14 at 1800Z.

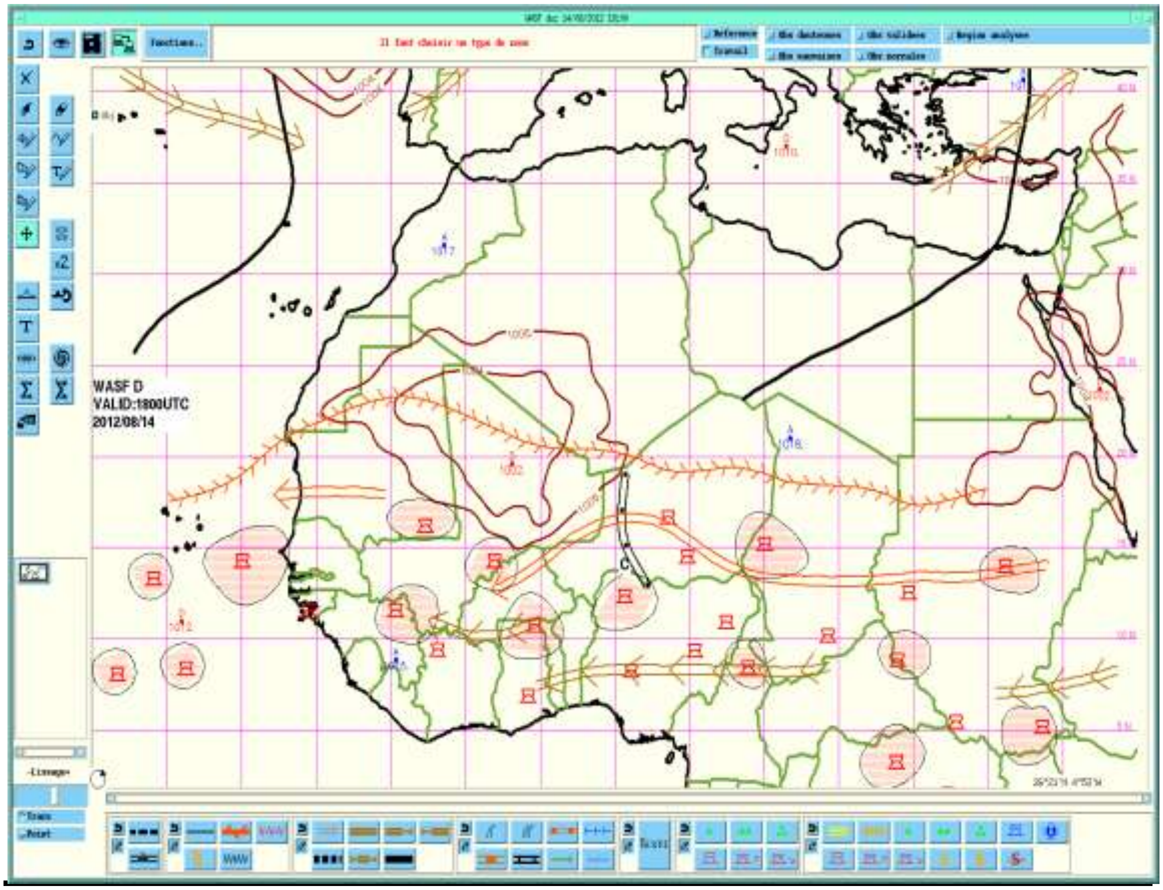


Figure 8: WASA for 2012/09/01 at 1800Z.

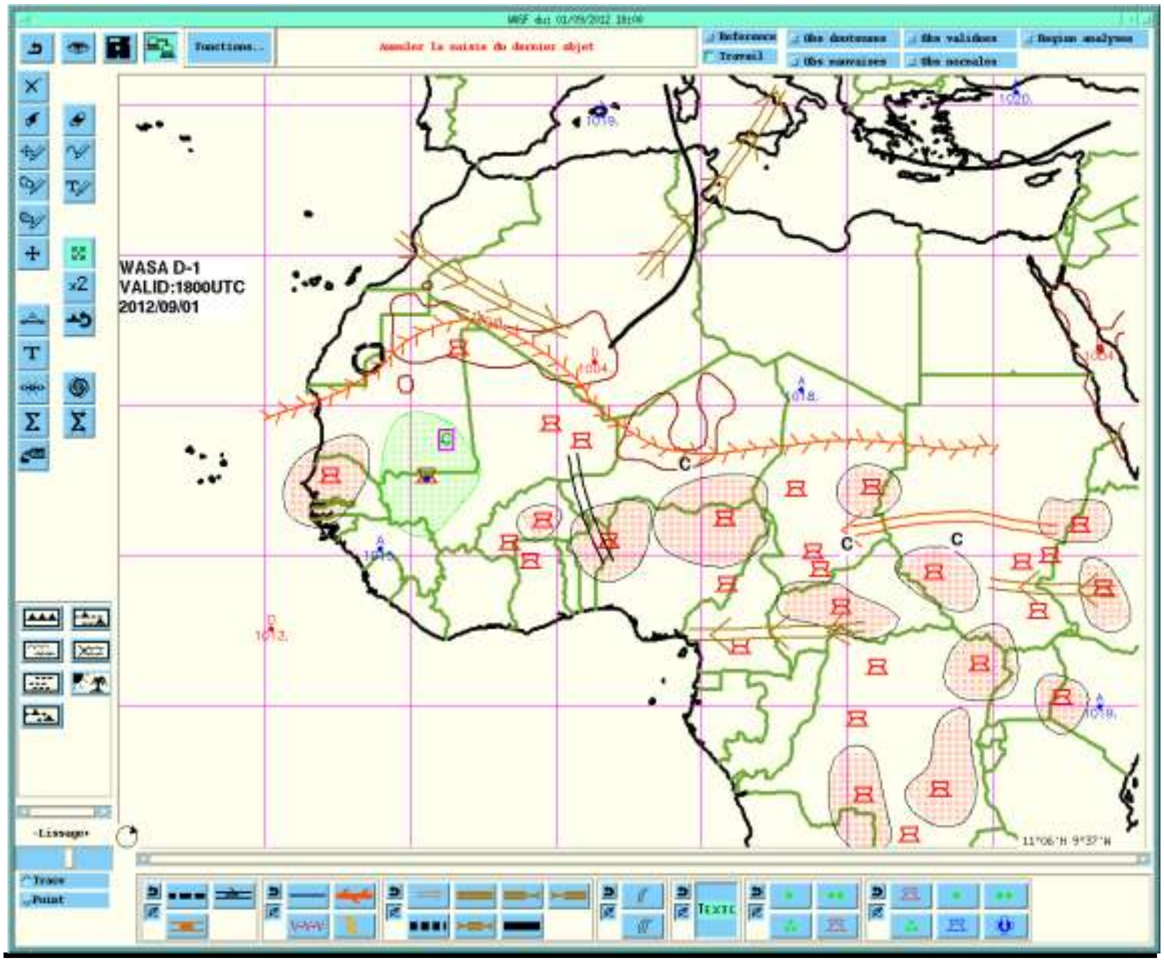


Figure 9: WASA for 2012/09/02 at 0600Z.

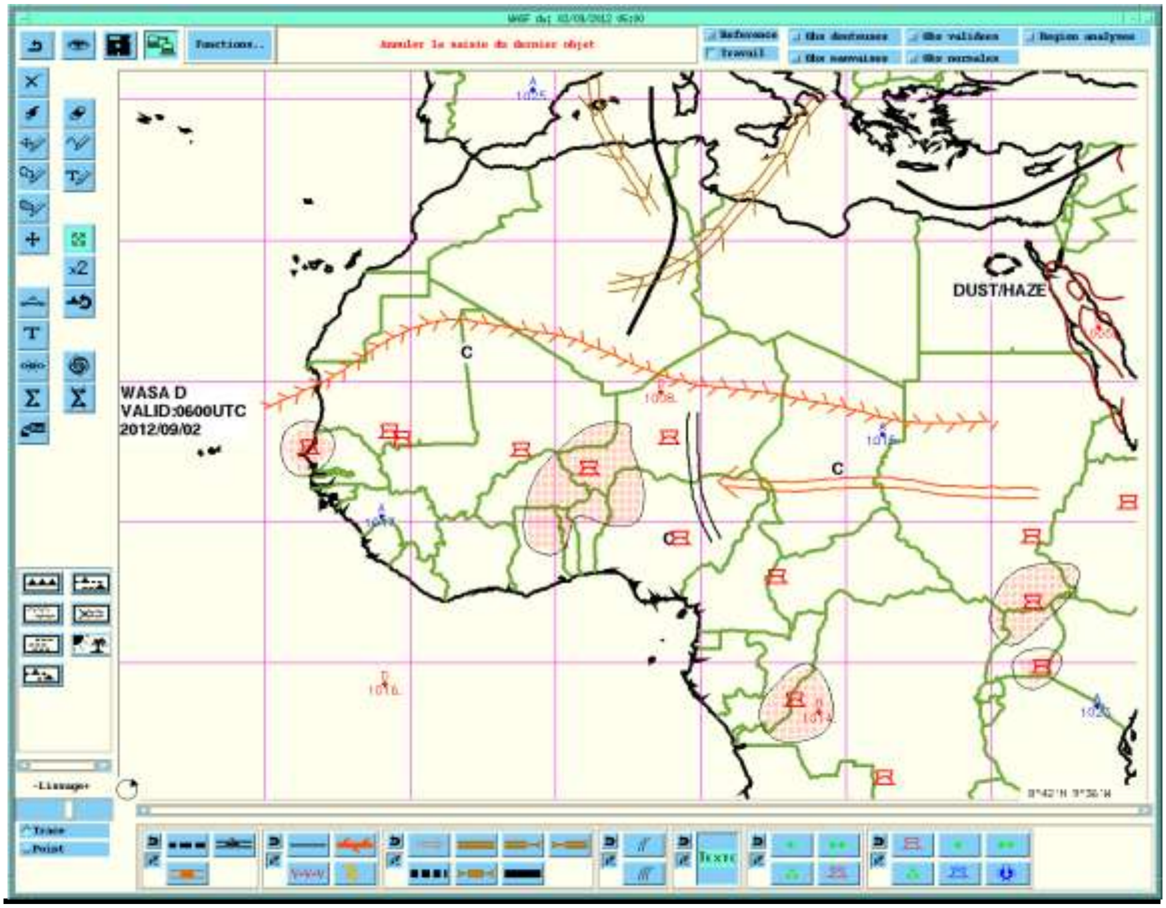


Figure 10: WASF for 2012/09/02 at 1800Z.

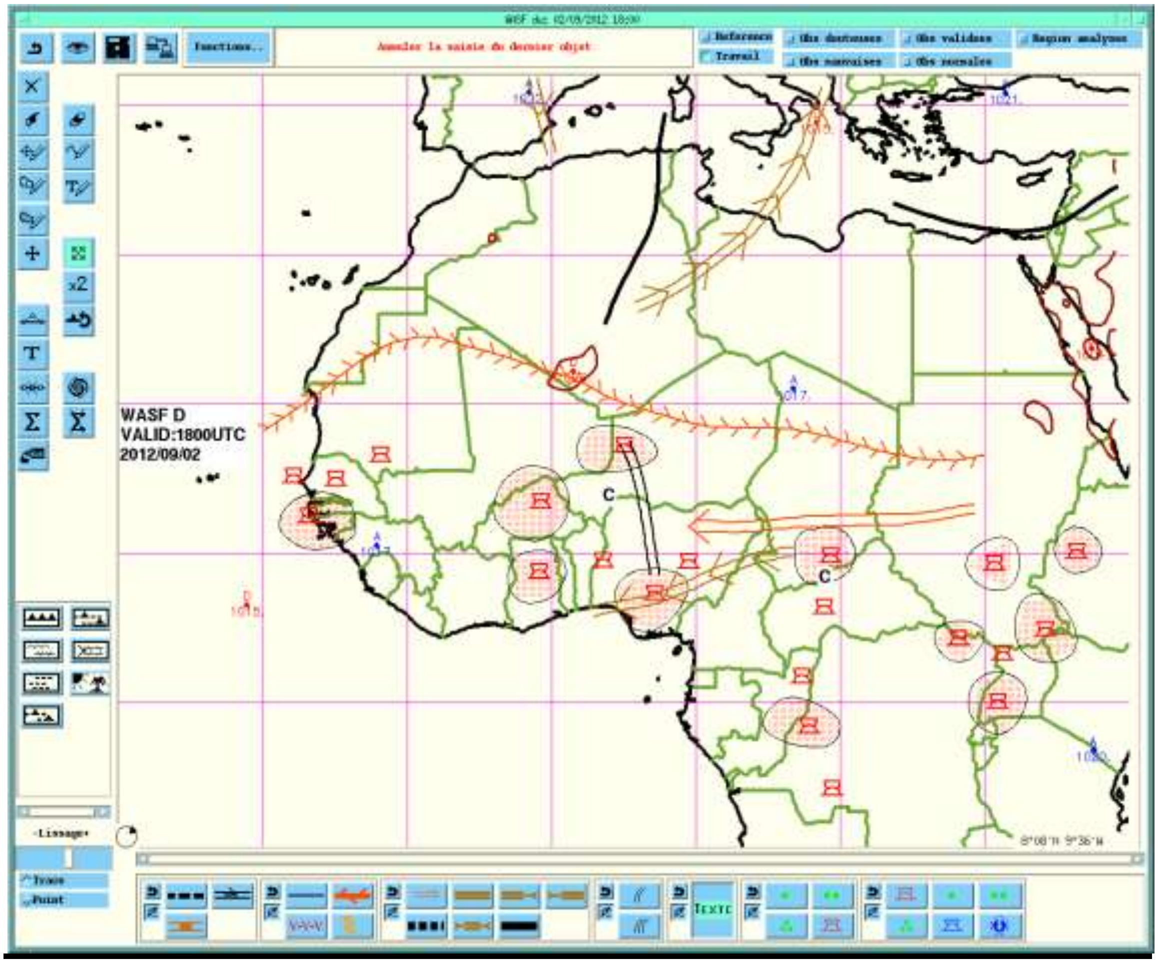
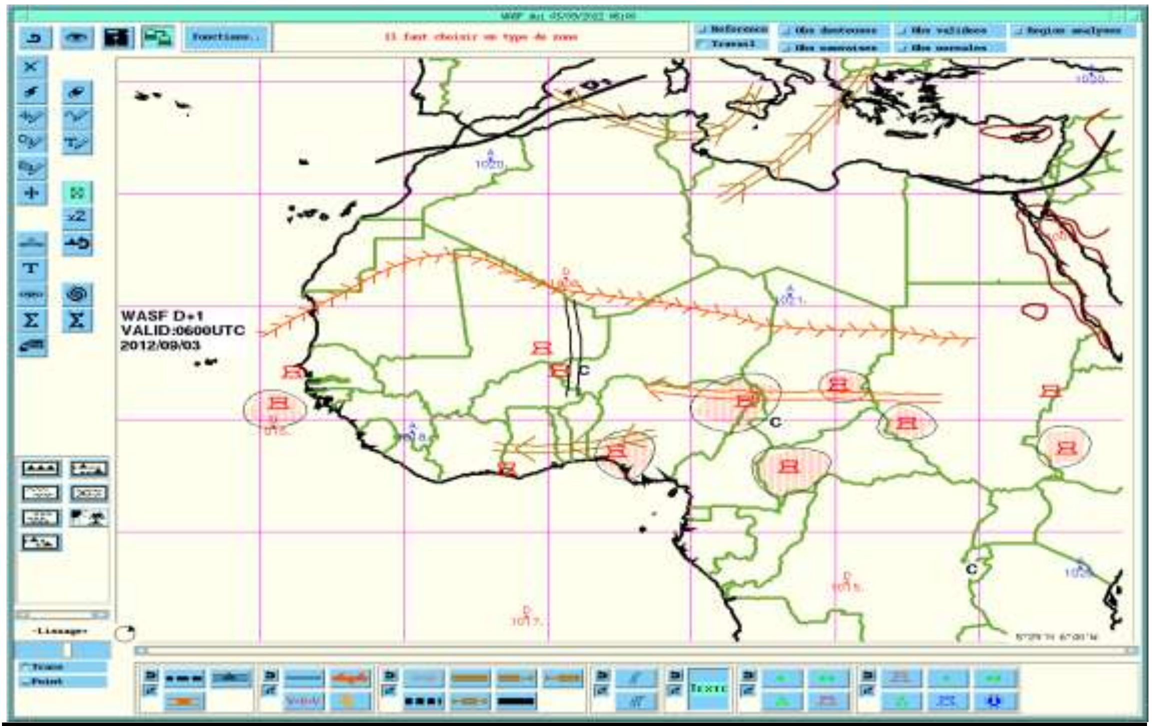


Figure 11: WASF for 2012/09/03 at 0600Z.



WASA/F Legend

The examples charts of SASA/F:

Figure 12: SASA for 2012/08/07 at 1800Z.

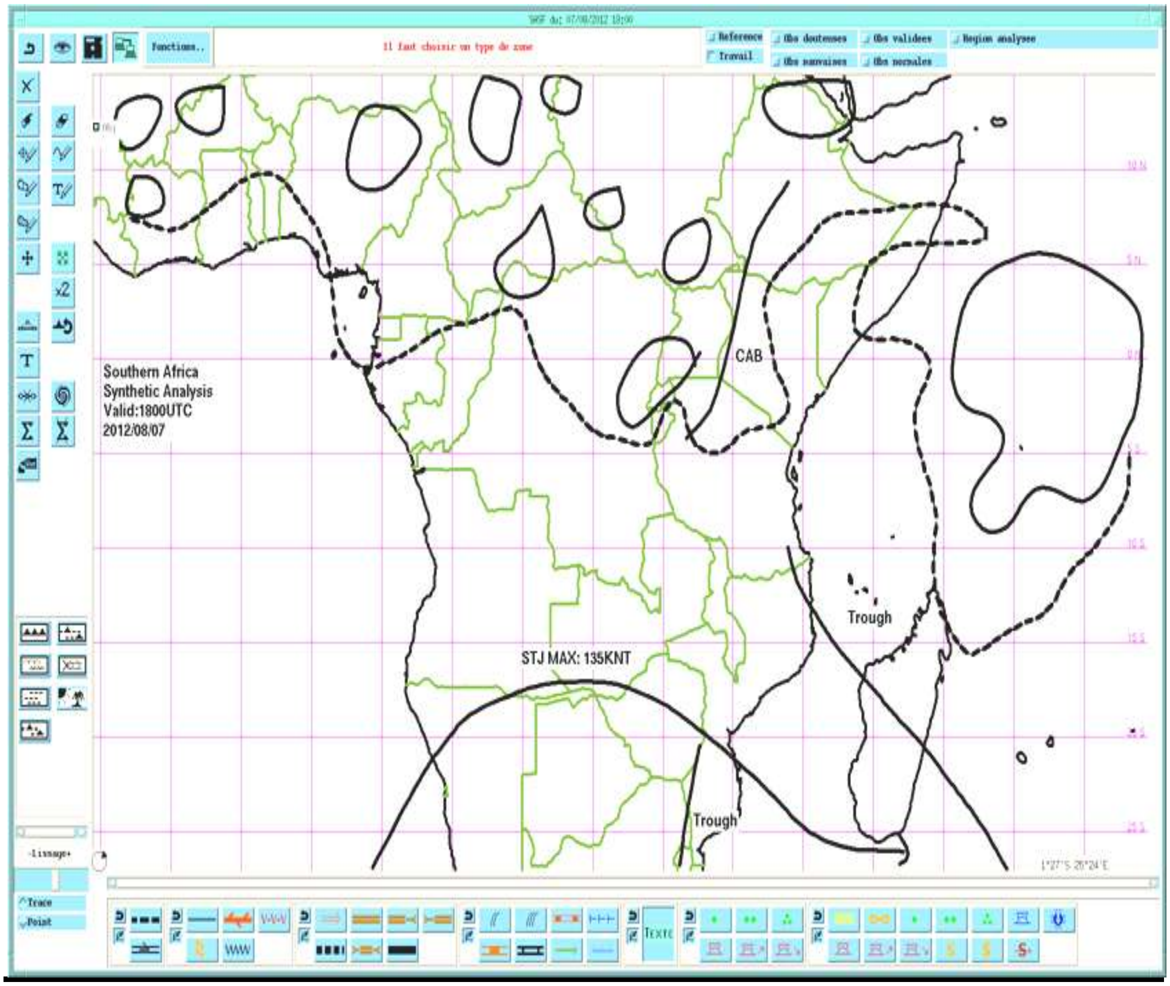


Figure13: SASF for 2012/08/08 at 1800Z.

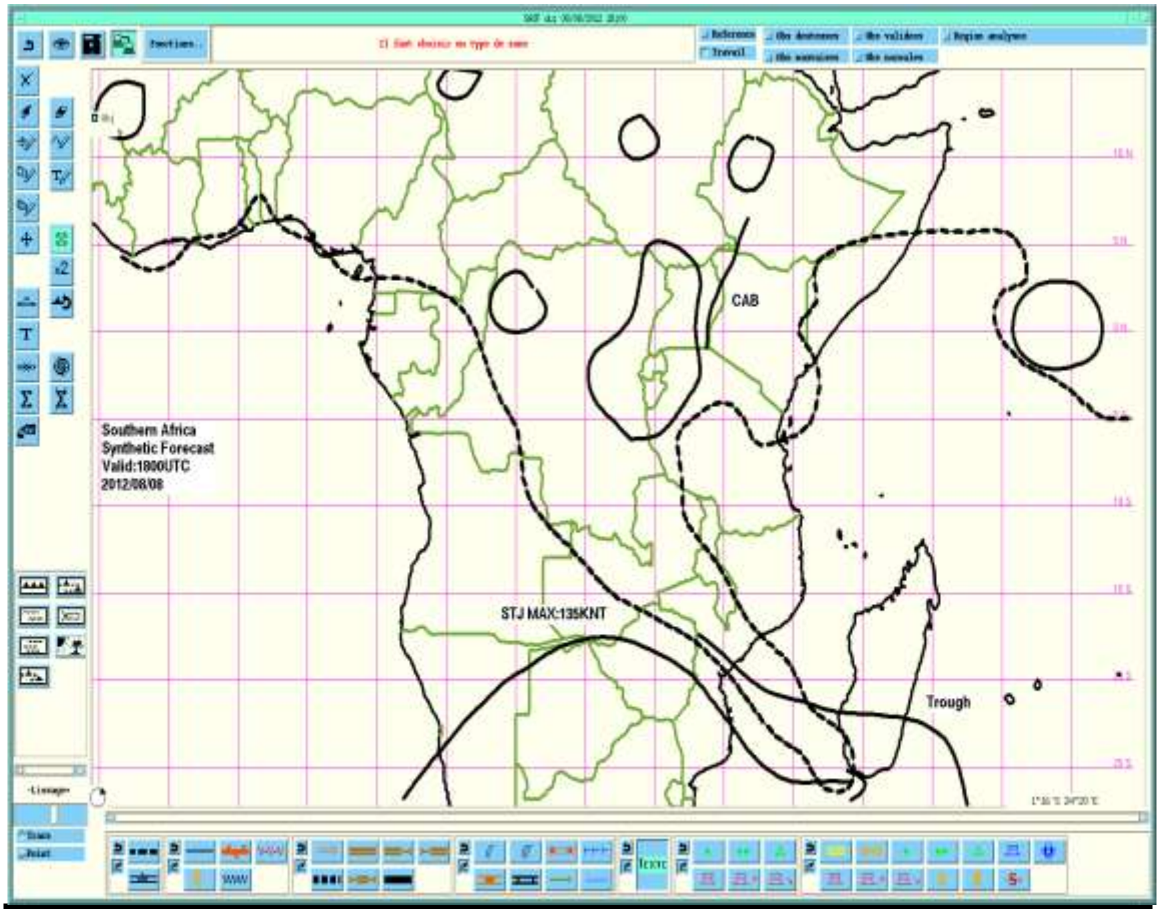


Figure 14: SASF for 2012/08/09 at 0600Z.

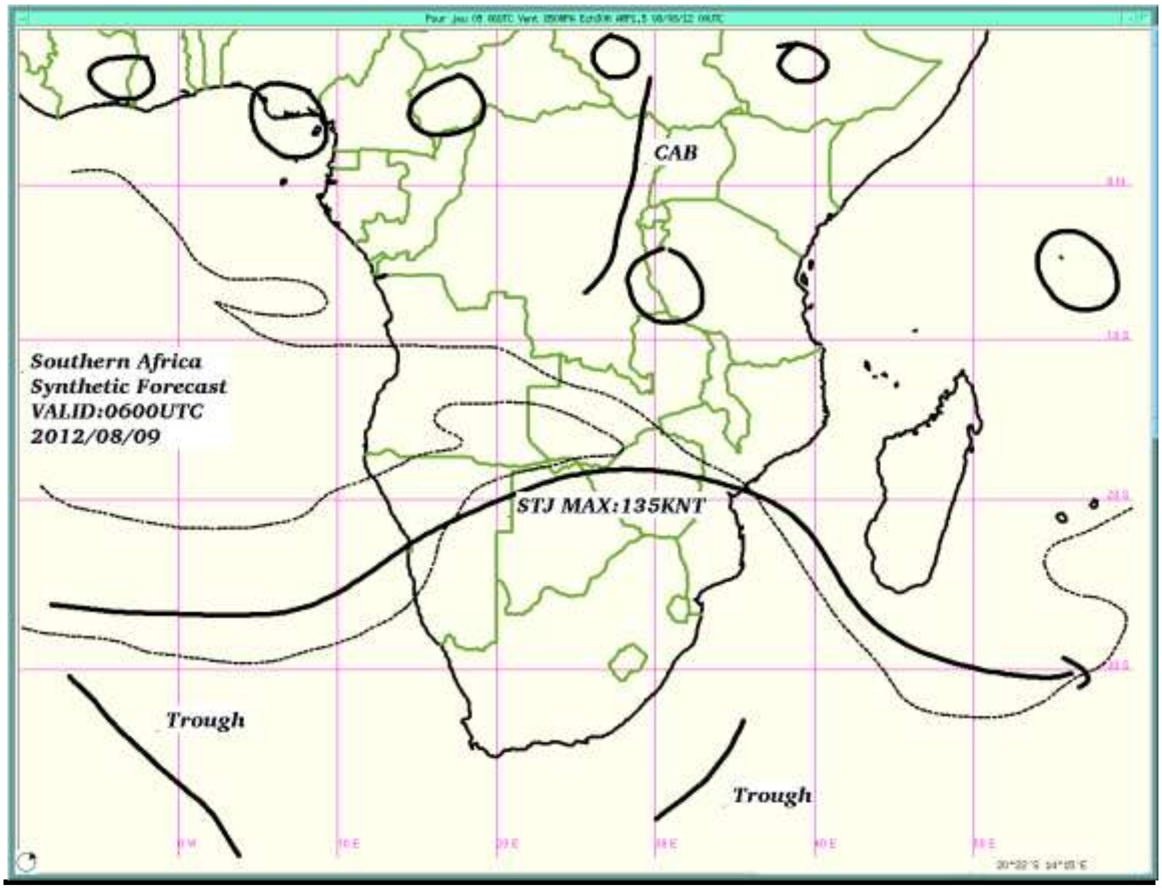


Figure 15: SASA for 2012/09/03 at 1800Z.

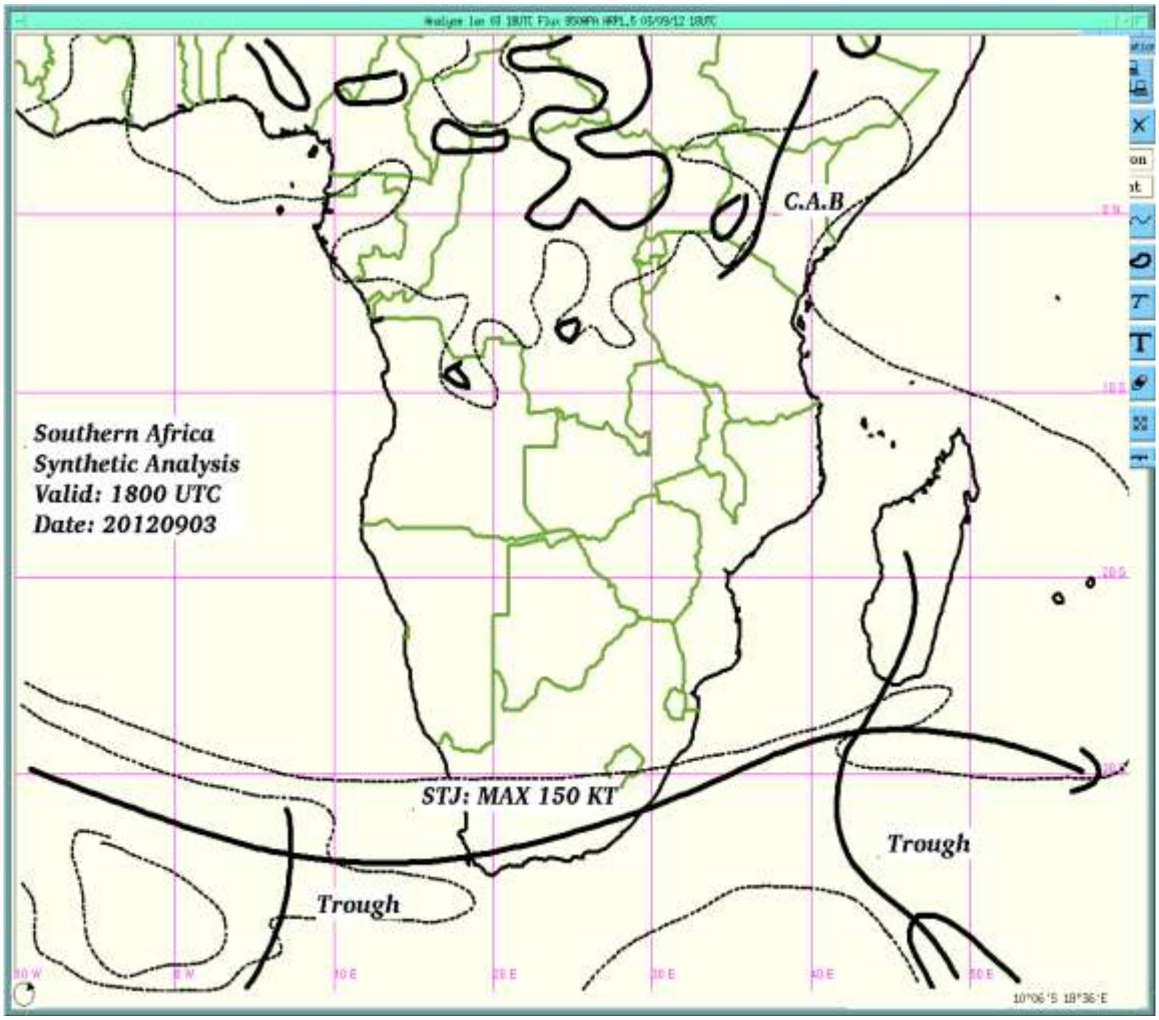


Figure 16: SASF for 2012/09/04 at 0600Z.

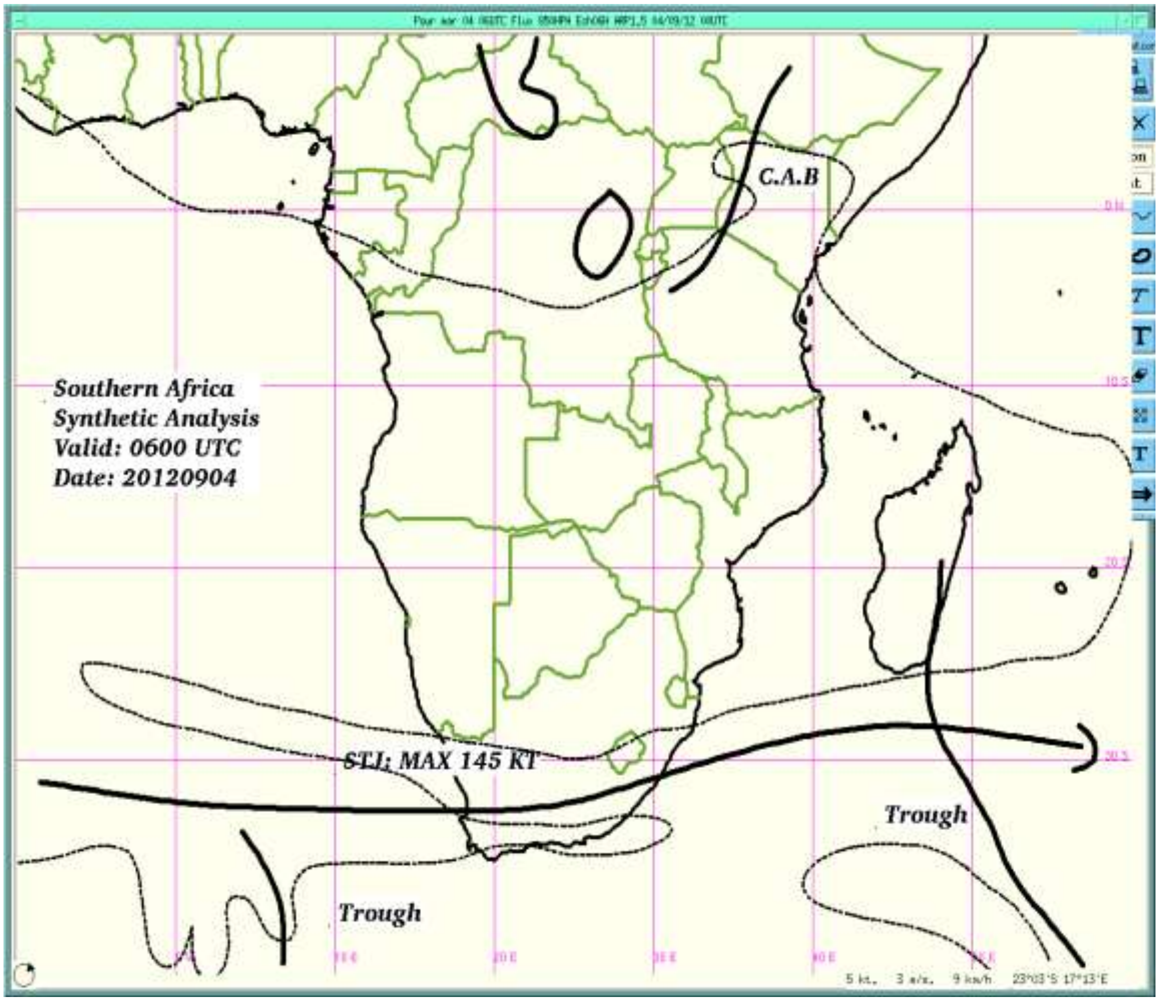
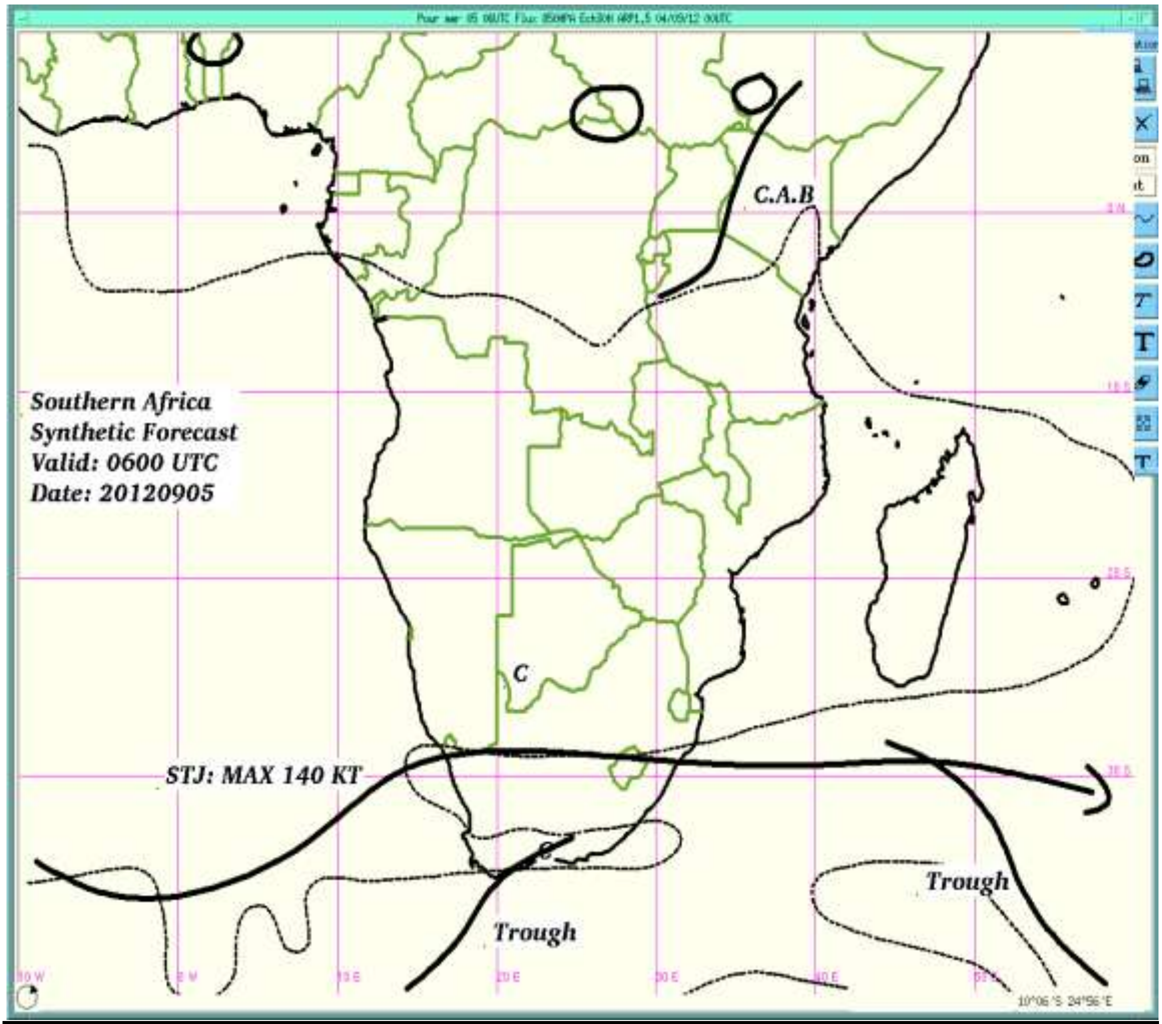


Figure 17: SASF for 2012/09/05 at 0600Z.



SASA/F Legend

a) **Dynamical systems identified on wind field at 850hPa**

 **Tropical cyclone**

TD ***Tropical depression***

C **Vortices**

A **Anticyclone**

ITCZ/ ITD Inter Tropical Convergence Zone

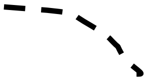
CAB Congo Air Boundary

Extra-tropical trough

 **Ridge**

 **Front**

b) Rainy areas

 Overcast areas / Thundershowers (rainfall < 25mm)

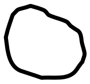
 Convective areas; heavy rains > 25mm

Figure 18: Severe Weather Forecast on 2012/09/05.

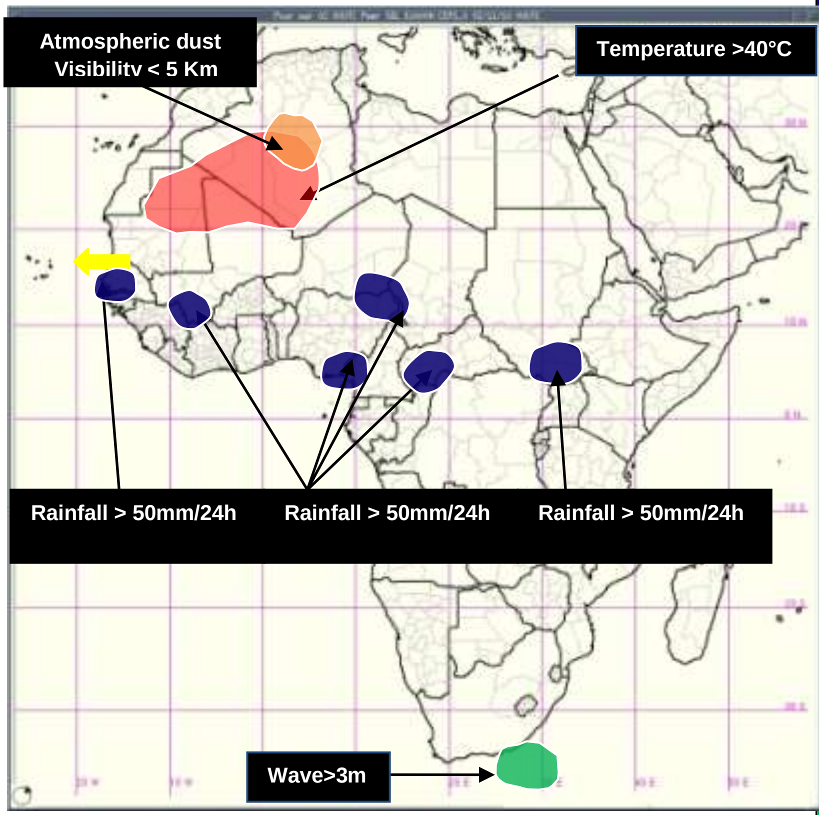
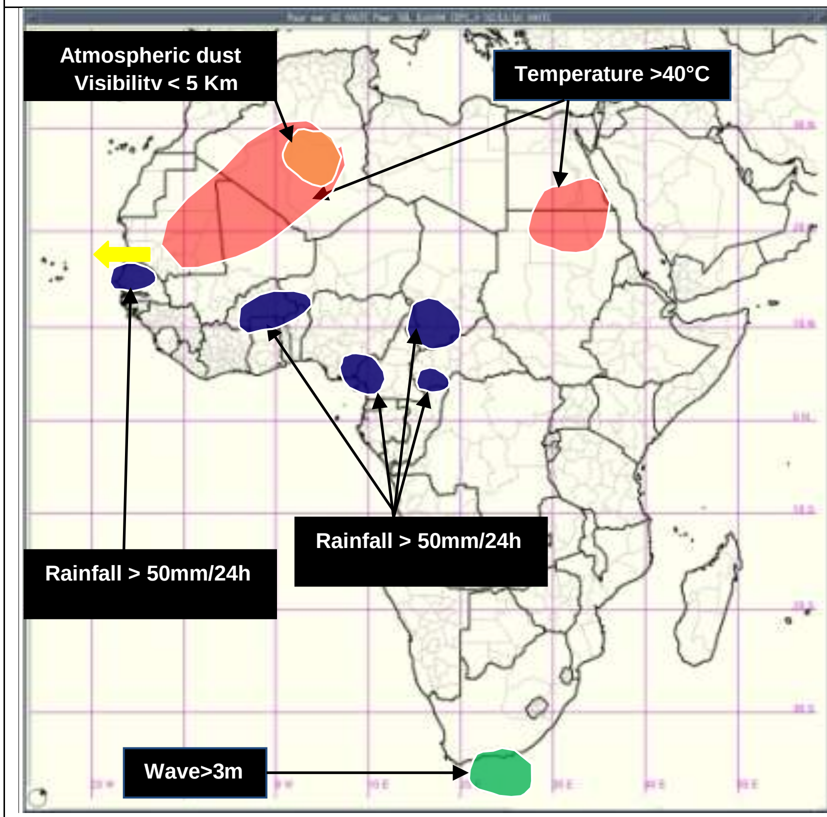
MAP OF SW OCCURRENCE ON September 06th,2012		AFFECTED AREAS
		High Confidence: Senegal, Gambia
		Senegal
		Central/ West Algeria, North Mali, North Mauritania.
		Nil
		Central Algeria
		South East off coast of South Africa

Figure 19: Severe Weather Forecast on 2012/09/05.

MAP OF SW OCCURRENCE ON September 07th ,2012



	AFFECTED AREAS
	High Confidence: Nord Senegal
	South West Mauritania.
	Central/ South West Algeria, North Mali, South east Mauritania.
	Nil.
	Central Algeria
	South off coast of South Africa

Description of Severe Weather Forecast Map:

Symbol map shows severe weather forecasting, heavy rain, strong wind, sand storm or atmospheric dust, extreme temperature, and high waves in sea. This map is developed to address the needs of users whose area of activity is of regional scale and to help forecasters working in Africa. This product falls within the three level cumulative forecast process instituted by global data processing and forecasting system/World Meteorological Organization GPDFS/WMO during the pilot phase of the severe weather predictability project. Global forecasts are developed by global centers like ECMWF, NCEP, Meteo France and UK Met Office, while regional forecasts are made by specialized Regional Meteorological Centers, while national and local scale forecasts are the responsible for:

1. Heavy rain occurrence area-flood
- Area or regions where rainfalls are likely to reach or go over 50 mm in 24 hours.
- 50 mm/24 hours rainfall intensity was chosen generally at the regional level is an expected range of values is given and details are refined at the scale of every country.
- Forecasts are given in three categories: low, medium and high. These categories are influenced by topography, location, soil moisture and previous rainfall amount which may cause floods in some places.
2. Strong wind area: areas where wind velocity or strength is expected to be higher than 20 KT or 45 km/h, velocity from which the wind stars presenting a risk for transport, public works, tourism and agriculture. Strong winds are often accompanied by other severe weather events such as heavy rains, the lifting of sand or dust or strong waves in oceans and over coast.
3. Rising sand or atmosphere dust occurrence area.
- These areas cover surface areas where the quantity of airborne dust in the vicinity of the surface is expected to be higher than 100g/m3, visibility is affected by the expected quantity of sand or dust in the atmosphere.
- It is not always probable that the entire expected area be shrouded by rising sand or dust.
- These areas represent a forecast of rising sand propagation from its source.
- Extreme temperature occurrence area: where a condition of extreme temperature is expected with a probability of excess higher or low than 80% of the entire temperature previously expected over the area.

Figure 20: Flood Risk Forecast on 04/08/2012.

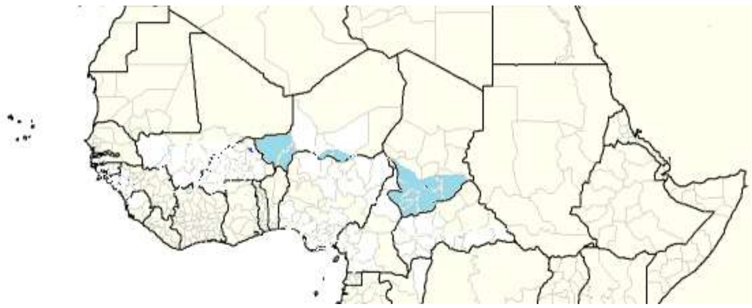
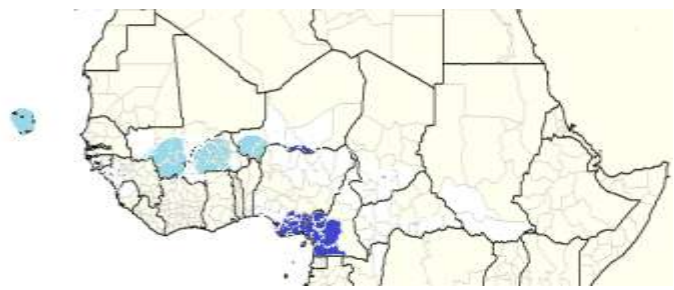


Figure 18: Figure 21: Flood Risk Forecast on 05/08/2012.



Flood Risk Forecast Legend:

Color	Severity of risk
	Low
	Medium
	High

The Description of Flood Risk Forecast:

The bulletin is now operational and disseminated to NMHSs in West Africa and disseminated on a large scale on ACMAD web site.

The bulletin comprises of three parts:

a. Meteorological situation on the previous and current days, brief description of the meteorological situation of the previous and current days is illustrated with two satellite images followed by an explanatory note of rain system. And the areas affected by heavy rains are mentioned with the amount of observed rains.
b. Flood risk forecast.
   - The areas where the expected rainfall in the next 24 hours, 48 hours and 72 hours might cause floods. The determination of flood risk used in this bulletin is solely based on the rainfall and topography of the areas, without taking into consideration hydrological data.
   - Areas likely to be flooded determined by the analysis of rainfall observed during the last 72 hours and the forecast for the next 72 hours. The degree of flood risk is assessed according to observed and expected rain amounts and the uncertainty related to forecasting. A standard threshold of 50 mm/day was picked as low risk of flood threshold.
   - Three levels of risk are thus defined: low risk, medium risk and high risk.
   - Forecasts of strong wind occurrence above 45 km/h following rain systems are also shown by arrows of map.
c. Significant aggregates of rainfall during the past 72 hours.

The conclusions

This report is a presentation of four months On Job Training activities conducted in the Department of Weather Watch and Prediction from 4th June 2012 to 30th September 2012. During these four months, I studied the drawing of FIT/ITD/CAB/ITCZ, the production of WASA/F, SASA/F and flood risk forecast bulletin. Through warmed interactive relations/discussions in the department, I was privileged and precipitated in a short training course and weekly weather forecast briefing. I have been introduced to various ways of data analysis and weather forecasting. The experience and knowledge I have gained during my stayed at ACMAD is refreshing and an added advantage to my forecasting skills. It is my desire to share this knowledge with my colleagues at home as my contribution to the development of the newly born Meteorogical Services of South Sudan.

Recommendations

I wish to make the following recommendations triggered by scenarios unfolded during my training sections:

1. That ACMAD, as a regional institution, recruit some English speaking professional meteorologists forecasters and adapt standing policy for language balance during training and presentation.

2. That the number of forecasters in the Department of Weather Watch and Prediction be increased to curtail constraints faced by the department´s staff on daily duties as well as training sections.

3. That the living quarters (Onersole) be improved to commensurate with the status of ACMAD as well as the health needs of occupants/trainees.

Visit World Bank Delegation to ACMAD

At right of picture director general of ACMAD Mr. Ahassane Adama Diallo

Part of weekly weather forecast presentation at ACMAD

On right Chief of department of WWP Mr. Leon Gay

Part of weekly weather forecast presentation at ACMAD

Edward Andrew Ashiek at ACMAD - Niamey

Colleague’s trainees at ACMAD from difference countries