# Sensitivity of the Regional Climate models; the role of the convection schemes

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**Abstract:** *The objectives of this paper is to study the sensitivity of the regional climate models to the utilized convection schemes when it is used to simulate the rainfall over certain domain, Regional Climate Model (RegCM3), which has the advantages that the interactions at different scales can be well simulated and, has been employed to investigate the autumn 1994 rainfall over Egypt and more emphasis on the flash flood that hit Egypt on the late night of 31 of October to the 2nd of November 1994. The simulation period is the 1st of Aug.1994 to the end of November 1994. Several model runs have been carried out using different convection schemes in an effort to investigate their performance in simulating the rainfall over the entire domain, in general, and more focusing over Egypt. The validation of the simulation output has indicated that the RegCM3 is capable of simulating both the spatial patterns and magnitude of the rainfall over Egypt to some extent, and showed that the results were sensitive to the cumulus parameterization scheme choice. The model with the Grell cumulus parameterization scheme with Fritsch Chappell assumption well simulated the process of the heavy rains case; however, there are still some discrepancies between the simulations and observations. For example, the model cannot completely simulate the intensity, the location and the onset time of the rainfall*

**Keywords:** *Cumulus parameterization scheme, numerical simulation, convection schemes, RegCM3 sensitivity.*

## 1. Introduction

Through the last few decades, the regional climate models (RCMs) have been used to study the climate processes over various regions of the world such as Jenkins (2002); Seth and Rojas, (2003); Pal JS, Giorgi F, Bi X, Elguindi N, Solmon F, Gao X, Ashfaq M, Francisco R, Bell J, Diffenbaugh N, Sloan L, Steiner,A, Winter J, Zakey A (2007); RegCM3 has been used in such studies over many regions as an example, Maisa Rojas and Anji Seth (2003), R. V. Francisco et al (2005), .etc

In this study, a Regional Climate Model, RegCM3, has been utilized to simulate the rainfall over the domain shown in, fig. (1). The principle behind the regional climate model technique is that, given a large-scale atmospheric circulation, a limited-area model with a suitably high-resolution resolving complex topography, land–sea contrast, land use, and detailed description of physical processes can generate realistic high-resolution (both spatial and temporal) information coherent with the driving large-scale circulation supplied by either reanalysis data or a global general circulation model (GCM).

The regional climate modeling has been proven to be able to improve simulation of regional scales with great details, especially in the region where forcing due to complex

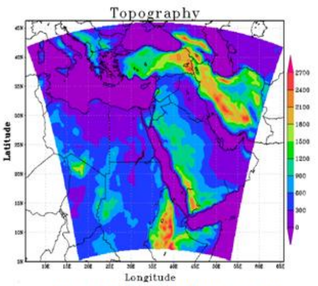


Fig. (1) Terrain height (m)

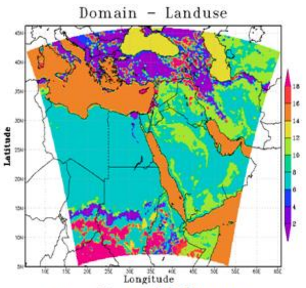


Fig. (2) Model domain

topographical effect or coastlines, or both, regulate the regional distribution of climate variables (Wang et al. 2000). The regional climate modeling approach has also been shown to be useful for improving our understanding of many climate processes, such as cloud–radiation forcing, cumulus convection, and land surface processes, etc. (e.g., Giorgi et al. 1996; Bosilovich and Sun 1999; Pal and Eltahir 2001). Two major factors are responsible for this difficulty: the first is the dominated cumulus convection in the Tropics, which seems not to be represented well by current regional climate models, and the other is the much weaker large-scale forcing in the Tropics than that in the mid- and high latitudes. This latter could produce accumulation of errors in the interior model domain and thus affect the long-term simulation of regional climate in the Tropics. Another major uncertainty of current regional climate models is the treatment of clouds, a critical weakness that needs improvement in. both global and regional climate models (e.g., Giorgi and Mearns 1999). Although the detailed explicit cloud microphysics parameterization for grid resolved moist processes is considered in some of the regional climate models, the complex interaction between subgrid cumulus convection and grid-scale moist processes is very crudely treated. Some studies have indicated the improvements in radiation budgets by using cloud microphysics information either in column models (Petch 1998) or in the GCM (Fowler and Randall 1996), but the cloud amount is treated in a quite simple way and is usually estimated by the relative humidity in most global and regional climate model applications (e.g., Wang et al. 2000). One assumption is Hong et al. (1998), who used the prognostic cloud scheme, the cloud fraction scheme, which accounts into not only the relative humidity but also the cloud condensates, in the National Centers for Environmental Prediction regional spectral model (RSM). The increased resolution of regional climate models can allow simulation of a broader spectrum of weather events to improve simulation of the daily precipitation intensity distributions. Such a skill is extremely important to give confidence of the model simulated climate sensitivity or climate change scenarios. As one of the IPCC recommended is the need to coordinate regional climate modeling efforts and to extend studies to more regions and to perform ensemble simulations with different models.

At the Egyptian Meteorological Authority (EMA), efforts are made to utilize a highly resolved regional climate model; aiming to simulate the variability of the monsoon systems and assessing the impacts of the global change not only over Egypt but also over a bigger domain include Arab countries. Due to its excellent capability, the third version of ICTP regional climate model, RegCM3, has been chosen in simulating the extreme weather case of the first of November 1994 over Egypt. One of the major factors affecting the model simulations is the cumulus parameterization scheme and may mainly define the rainfall output accuracy. So, in this paper, the sensitivity of the rainfall simulations to the utilized cumulus parameterization scheme is examined. The detailed of the operational configuration of the model, the utilized observation data and cumulus parameterization schemes are given in section 2, Results and analysis in sec. 3. Finally, the conclusions are given in sec. 4.

## 2. Model Description and Simulation Design

### *2.1 Model Description*

We employ the third version of the ICTP Regional Climate model, RegCM3, which is a compressible, primitive equation, sigma – vertical coordinates, grid-point limited area model with hydrostatic balance (Giorgi et al., 1993a, b; Giorgi and Mearns, 1999; Dash et al., 2006; Pal e al., 2007). The model dynamical core based on the hydrostatic version of MM5 (Grell et al., 1994). The physical parameterization employed in these simulations include the radiative transfer package of the NCAR Community Climate Model, the non-local boundary layer scheme of Holtslag, and the BATS land surface scheme (Dickinson et al.,1993).

### *2.2 The convective schemes:*

The Precipitation in the RegCM3, is produced in two different forms; resolvable (large scale) precipitation; which is associated with large-scale weather system, and is represented via SUB-grid Explicit moisture scheme (SUBEX; Pal et al., 2000); and convective (subgrid) precipitation; which could be represented through three physical options: the modified Anthes-Kuo scheme (Anthes, 1977; Giorgi, 1991; Giorgi et al., 1993b), the Grell scheme (Grell 1993), and the Emanuel scheme (Emanuel, 1991; Emanuel and Zivkovic-Rothman, 1999). In the modified Anthes –Kuo scheme (Anthes, 1977; Giorgi, 1991; Giorgi et al., 1993b), precipitation is initiated when the rate of moisture convergence in a column exceeds a given threshold and the column is convectively unstable. A fraction of the total moisture convergence precipitates, depending on the mean columnar relative humidity, while the remaining fraction is redistributed thought the column in proportional to the dryness of the column. The latent heat of condensation is redistributed between cloud top and cloud bottom following a specified parabolic vertical heating profile, which gives maximum heating in the upper half of the cloud layer (Anthes, 1977; Giorgi et al., 1993b; Giorgi and Marinucci, 1996).

In the Grell Scheme (Grell, 1993), convection is represented by an updraft and downdraft pair in steady-state circulations with no direct mixing between the environment and convective clouds except at the top and the bottom of the circulations, The mass flux in the updraft and downdraft is assumed constant and originating levels of the updraft and downdraft are given by the levels of maximum and minimum moist stat energy, respectively. The scheme is activated when a lifted parcel becomes buoyant. Owing to the simplistic nature of the Grell scheme, several closure assumptions can be used to relate the mass flux at the bottom of the closure updraft to the large-scale forcing,

*Fig. (3) Stations distribution*

(e.g. Dash et al., 2006) Another stability based assumption available in the RegCM3 and used here is similar to that implemented by Frisch and Chappell (1980) and Giorgi et al., (1993a), and assumes that the clouds remove the available buoyant energy in a given timescale.

The Emanuel scheme (Emanuel, 1991; Emanuel and Zivkovic-Rothman, 1999) is the newest cumulus scheme convection option available in the RegCM3 (Pal et al., 2007). In this scheme; attempts to reproduce the inhomogeneity of convective clouds by considering convective fluxes on the basis of an idealized model of subcloud scale, mixing, and buoyancy sorting (Bony and Emanuel, 2001). Convection is mainly driven by buoyancy (Chow et al., 2006) and is triggered when the first level of neutral buoyancy for undiluted, reversible ascent of near-surface air is higher that the lifting condensation level (Pal et al., 2007). Between these two levels, air is lifted and a predefined fraction of the condensed moisture forms precipitation, while the remaining fraction moistens the environment (Emanuel and Zivkovic-Rothman, 1999). The application to the Egypt domain of each above convection schemes is examined in considerable detail below.

### *2.3 Data*

In our simulations; the NCEP/NCAR reanalysis 2 data (Kistler et al., 2001) is used to provide the initial and lateral boundary conditions. The variables used are three dimensional horizontal wind components (u, v), temperature (T), relative humidity (RH) from 1000 to 70 hPa, and two dimensional surface pressure. The ground temperature interpolated to the model topography. We also used the reanalysis instead of the observation in the analysis of soil moisture, the energy and water budget because of the limitations in obtaining perfect observations. In the verification process, few point observations from the local weather service, fig 3 and table (2), have been used. Although the stations are rather sparse and irregularly distributed and hence could not provide enough information but it will provide some guidance

### *2.4 Experiment Design*

The model has configured during the aforementioned simulations as follows; the entire model domain is divided into 80 X 90 grid points, the central point at latitude 99.39o N and at longitude 35.48 o E to have enough buffer zones around Egypt to have reasonable representations of any coming waves, the Horizontal Resolution is 60 km , eighteen vertical sigma levels with model top at 100 hPa., the model uses the USGS Global Land Cover Characterization (GLCC) dataset (Loveland et al. 2000), which are used to generate the model land surface types that are shown in fig 1, while the NOAA optimum interpolation SST analysis are utilized as the Sea Surface Temperature (SST) for the experiments is from the simulation time is only the autumn season (Sep-Nov.1994) and more focusing on the flash flood period (31st Oct. to 2nd Nov. 1994), while The Spin-up time was One month before the assimilation period (August) used as a spin-up time. The model topography over the domain is shown in fig.2, the Driving force (field), The observational analysis used to drive initial and lateral meteorological boundary conditions are the NCEP-NCAR (NNRP2) (Abdou, 2009). The NCEP-NCAR reanalysis is a retroactive record for more than 50 years of global analysis of atmospheric fields in support of the needs of the research monitoring communities (Kistler et al., 2001). It involves the recovery of land surface, ship, rawinsonde, aircraft, satellite and other data. Although the data assimilation system was kept unchanged over the reanalysis, it is still affected by changes in the observing system, which may cause artificial jumps and trends particularly after the beginning of the assimilation of satellite data (Trenberth et al., 2001)

## 3. Results and analysis

To examine the model simulations against the observations, the area of Egypt has been divided into 6 zones (sections) as shown in fig.(4) and explained as follows; The first zone, (NE), cover Sinai and part of southern Gulf of Suiz, the second zone, (NM), covers the delta area, the third zone, (NW), coved the north western corner of Egypt, the fourth zone, (SE) covers the south eastern corner, the sixth's zone, (SM), covers the middle of south Egypt and the last zone, (SW), which covers the south western corner of Egypt.

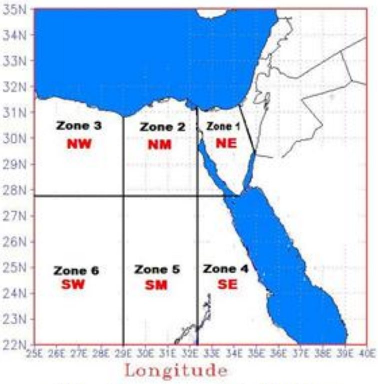


*Fig. 4: zones distribution*

Table 1 and figures 5a-f illustrate the rainfall over observations Egypt during the period 1 – 6 November 1994. A relatively increase in the rainfall of the first day especially over the northern part of SM zone, Assuit (60mm) comparing to the normal, while Cairo (NM zone) has only 30 mm, In the second day the maximum rainfall has moved to the NE zone, over Taba (35mm) and ElArish (24mm). In the third day the maximum rainfall backed to the NW zone, over Sallum (11mm). In the fourth day the maximum rainfall has moved easterly to Alexandria (21mm) and moved to the NE zone again in the fifth day. Regarding the model simulation output; the model simulation using Grell scheme with Fritsch Chappell closure technique, figures 6a-f and with the Anthes Kuo scheme, figures 7a-f, while with the Grell scheme using Arakawa Shubert closure technique, figures 8a-f

***For the first day,***

The maximum rainfall was (60mm) has been observed over the north of the SM section around 27ºN, 31ºE , The NM region (Delta) were lesser in the amounts, while the simulation using Grell Fritsch Chappell shows amounts around (55mm) but far to the south, fig.6a. The model with Anthes Kuo convection scheme shows lowest rainfall amounts (5.5mm) with some difference in distribution and patterns, Fig.7a. The model with Grell & Arakawa Schubert convection scheme (CS) shows underestimated amounts (27mm) near in location to the observed one, Fig.6b.

Also, the model with Grell & Fritsch Chappell CS shows a comparable amount but shifted to the North West comparing to the real location. In north of Egypt but the model with Anthes Kuo and

Grell Arakawa Schubert CS show a good pattern with less very small amount comparing to the observed one.

- ***On the Second day (2 November)***

Fig. 5a 7 and table 1 illustrate that the maximum rainfall amount (35mm) is observed over Taba airport (Zone 1), also, over the same zone there are several peaks of the observed rainfall has recorded over El-Arish (24mm), El-Tor (18.6mm). The maximum amount observed over zone 5 appears in Assuit (13mm) and Sohag (14mm), while over zone 3, appears at Sidi Barrani (11.6mm). Comparing the model simulated rainfall using Grell & Fritsch Chappell CS (Fig.6b) to the observation, fig (5-b), It is clear that the model well simulate the rainfall in terms of the patterns and the distribution while the maximum rainfall appears over the SM zone in terms of the amounts where the observed was (20mm) located to the north of the real location (Taba). Comparing the model simulation using Grell & Arakawa Schubert (Fig.8b) with the observations it is found that the Eastern zones NE and SE were better resolved by the model in terms of amounts and pattern while the other zones were not resolved. Comparing the model simulation using Anthes Kuo convection scheme (Fig.7b) with the observation we found that the maximum simulated rainfall produced over the north of SM-zone, and over-estimated in terms of the rainfall amount with poor pattern distribution

- ***On the third day (3 November)***

Fig.5-c and table 1 show that the maximum rainfall amount (11mm) is observed over Sallum (Zone 3) while there are several small peaks of

the observed rainfall has recorded over the same zone as in Baltim (6.4mm),

Comparing the observation to the model simulation using Grell & Fritsch Chappell CS (Fif.6c) It is clear that the model failed to simulate either the rainfall amount or the rainfall pattern on the observed area while the simulated patterns was shifted to the east except a small amount of rainfall located to the north of NM zone.

Comparing the observations to the model simulation using Grell & Arakawa Schubert (Fig.8c) we found the same behavior of the previous case.

Comparing the observation to the model simulation using Grell & Anthes Kuo (Fig.7c) it is clear that the rainfall pattern was slightly shifted to the south of the observed one but in terms of the rainfall amounts it was overestimated

- ***On the Forth day (4 November)***

As shown in (Fig.5d) and table (1); the maximum rainfall amount (21.8mm) is observed over port Alexandrian (Zone 2), Sidi Barrani (14mm) and Sallum (9mm) and most of the coast areas .

Comparing the observation (Fig. 5-d) to the model simulation using Grell &Fritsch Chappell CS (Fig. 6-d). It is clear that the model rainfall simulated pattern shifted to the North West comparing to the observed locations, while the simulated amounts was underestimated.

Comparing the model simulation using Grell & Arakawa Schubert, (Fig. 8-d) with the observations, we found the same behavior of the previous case with more displaced to the north.

Comparing the model simulation using Anthes Kuo (Fig. 7-d) to the observation it is found that the rainfall pattern lies to the far east of the observed pattern while the simulated rainfall amounts it was underestimated.

- ***On the Fifth day (5 November)***

(Fig. 5-e) and table 1 show that the maximum rainfall amount (99mm) is observed over Dabaa (Zone 3), Alexandria (6mm) , Ismailia (10mm) while in Rafah is (21.8mm).

Comparing the observation (Fig. 5-e) to the model simulation using Grell & Fritsch Chappell CS (Fig. 6-d) It is clear that the model rainfall simulated pattern was very close to the observed locations, while the simulated amounts was overestimated. Comparing the observations to the model simulation using Grell & Arakawa Schubert (Fig. 8-e) the same behavior of the previous case and more shifted to the nor-east.

Comparing the observation to the model simulation using Anthes Kuo (Fig. 7-e) the rainfall pattern lies to the north of the observed pattern while the simulated rainfall amounts it was underestimated.

- ***On the sixth day (6 November)***

(Fig. 5-f) and table (1) illustrate that the model with all schemes catches the rainfall distribution especially in the nor-eastern coast but overestimated in terms of the rainfall amounts

**Table (1) Rainfall observations on 1-6 Nov. 1994**

| ***Station Name*** | ***Lon*** | ***Lat*** | ***1 Nov 1994*** | ***2 Nov 1994*** | ***3 Nov 1994*** | ***4 Nov 1994*** | ***5 Nov 1994*** | ***6 Nov 1994*** |
|---|---|---|---|---|---|---|---|---|
| *SIDI_BARRANI* | 31.60 | 26.00 |  | 11.6 | 1 | 14 | 7.4 |  |
| *SALLUM* | 31.57 | 99.13 |  | 2 | 11.2 | 9.4 |  |  |
| *MERSA_MATRUH* | 31.33 | 27.22 | 9.2 | 5.7 | 1.3 | 1.1 |  |  |
| *ALEXAN. NOUZHA* | 30.82 | 29.87 | 4.5 | 0.1 |  | 7.1 | 6.1 |  |
| *ROSETTA* | 31.40 | 30.40 | 1.6 | 1.2 | 3.5 | 5.8 | 1.6 |  |
| *BALTIM* | 31.55 | 31.10 |  | 0.7 | 6.4 |  |  |  |
| *PORT DAMIETTA* | 31.47 | 31.77 |  | 2.6 |  |  |  |  |
| *DAMIETTA* | 31.42 | 31.82 |  | 2.9 |  | 0.1 |  | 0.4 |
| *RAFH* | 31.20 | 34.20 |  | 7.4 |  |  |  |  |
| *ELARISH* | 31.08 | 33.82 |  | 24.4 | 2.3 | 4.4 | 5.3 | 0.9 |
| *ELARISH2* | 31.08 | 33.82 |  | 16.6 | 2.8 | 4.2 | 6.4 | 1 |
| *DAMANHOUR* | 31.03 | 30.47 | 0.3 | 0.4 |  | 0.8 | 7.7 |  |
| *TAHRIR* | 30.65 | 30.70 | 0.4 | 0.2 | 0.3 | 0.8 |  |  |
| *ZAGAZIG* | 30.58 | 31.50 | 4.7 | 1.8 |  |  | 1.4 |  |
| *SHEBIN_EL_KOM* | 30.60 | 31.02 |  | 1.6 | 3.3 | 0.2 | 0.2 |  |
| *CAIRO AirPort* | 30.13 | 31.40 | 30 | 9.2 |  |  |  |  |
| *BAHTIM* | 30.13 | 31.99 | 15.6 | 0.3 |  |  | 2.1 |  |
| *CAIRO_HQ* | 30.08 | 31.28 | 24.6 | 1 |  |  | 0.8 |  |
| *HELWAN* | 29.87 | 31.33 | 8 | 0.6 |  |  |  |  |
| *FAYOUM* | 29.30 | 30.85 | 6.2 | 11.4 | 1.8 |  |  |  |
| *ASYUT* | 27.20 | 31.17 | 60 | 8.7 |  |  |  |  |
| *ASYUT* | 27.05 | 31.02 | 24 | 13 |  |  |  |  |
| *SOHAG AGHMEEM* | 26.60 | 31.78 | 3.8 | 14 |  |  |  |  |
| *QENA* | 26.18 | 32.70 | 1.2 | 0.6 |  |  |  |  |
| *LUXOR* | 99.67 | 32.70 | 1 | 0.5 |  |  |  |  |
| *ISMAILIA* | 30.60 | 32.99 |  | 2.8 | 0.2 |  | 10.2 | 0.7 |
| *EL-SUEZ* | 29.93 | 32.55 |  | 5.9 |  |  |  |  |
| *RAS SEDR* | 29.58 | 32.72 |  | 3.6 | 0.2 |  |  |  |
| *TABA AIRPORT* | 29.60 | 34.78 |  | 35.3 | 0.1 |  |  |  |
| *ELTOR* | 28.23 | 32.62 |  | 18.6 |  |  |  |  |
| *SHARM ELSHEIKH* | 27.97 | 34.38 |  | 2.6 |  |  |  | 0.8 |
| *HURGUADA* | 27.15 | 33.72 |  | 2.7 |  |  |  |  |
| *HURGUADA* | 27.28 | 33.73 |  | 3.2 |  |  |  |  |
| *KOSSEIR* | 26.13 | 34.15 |  | 4.5 |  |  |  |  |
| *BAHARIA* | 28.33 | 28.90 | 5 |  |  |  |  |  |
| *MALWY* | 30.75 | 27.70 | 0.4 |  |  |  |  |  |
| *GIZA* | 30.05 | 31.22 | 14.2 |  |  |  | 0.1 |  |
| *WADI_EL_NATROON* | 30.40 | 30.20 | 16.6 |  |  |  |  |  |
| *DABAA* | 30.93 | 28.47 | 3.2 |  |  | 6.1 | 99.3 |  |
| *RAFH* | 31.20 | 34.20 |  |  | 5 | 3.2 | 21.8 | 1.1 |
| *PORT_ALEXANDRIA* | 30.82 | 29.87 |  |  |  | 21.9 |  |  |

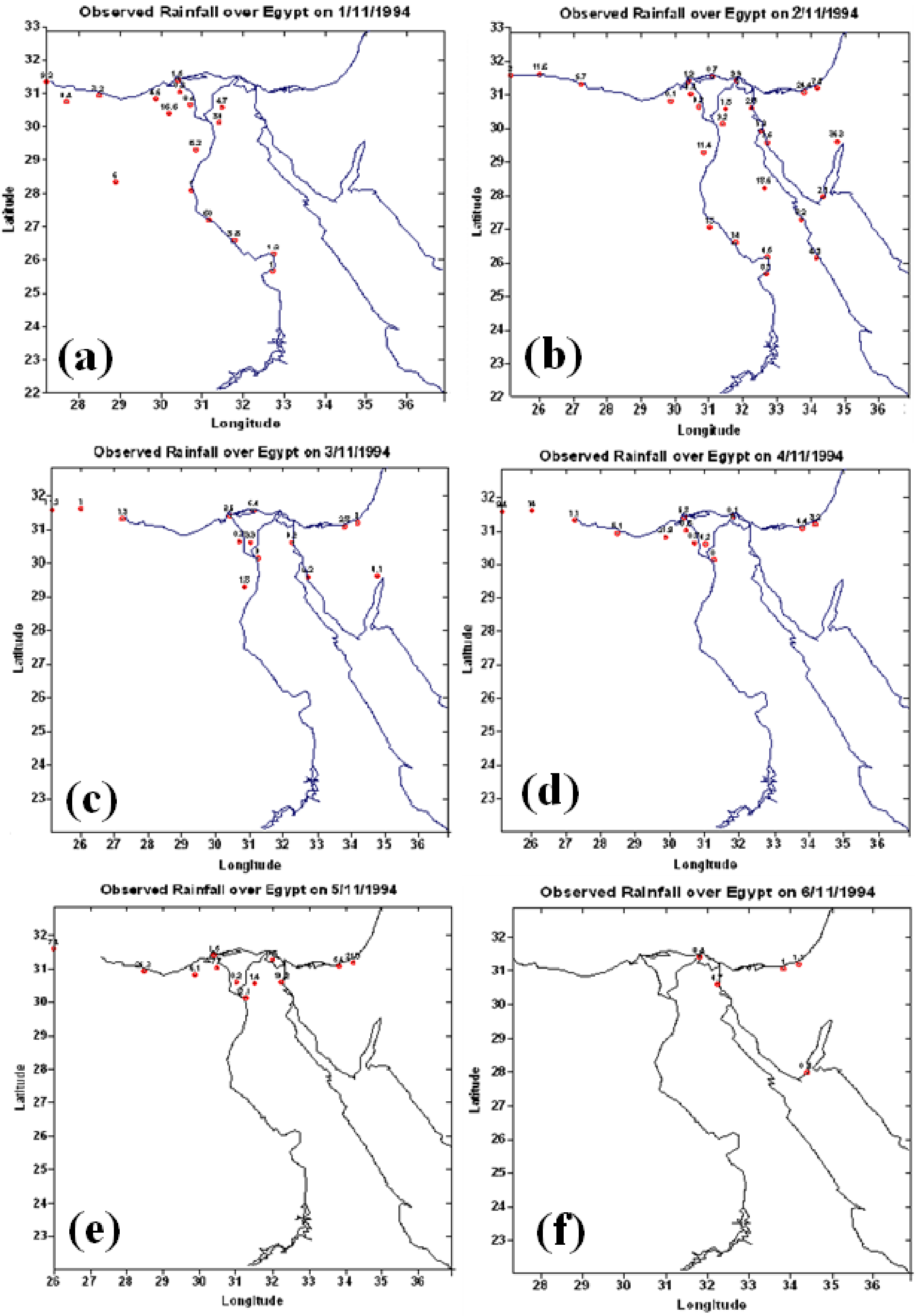
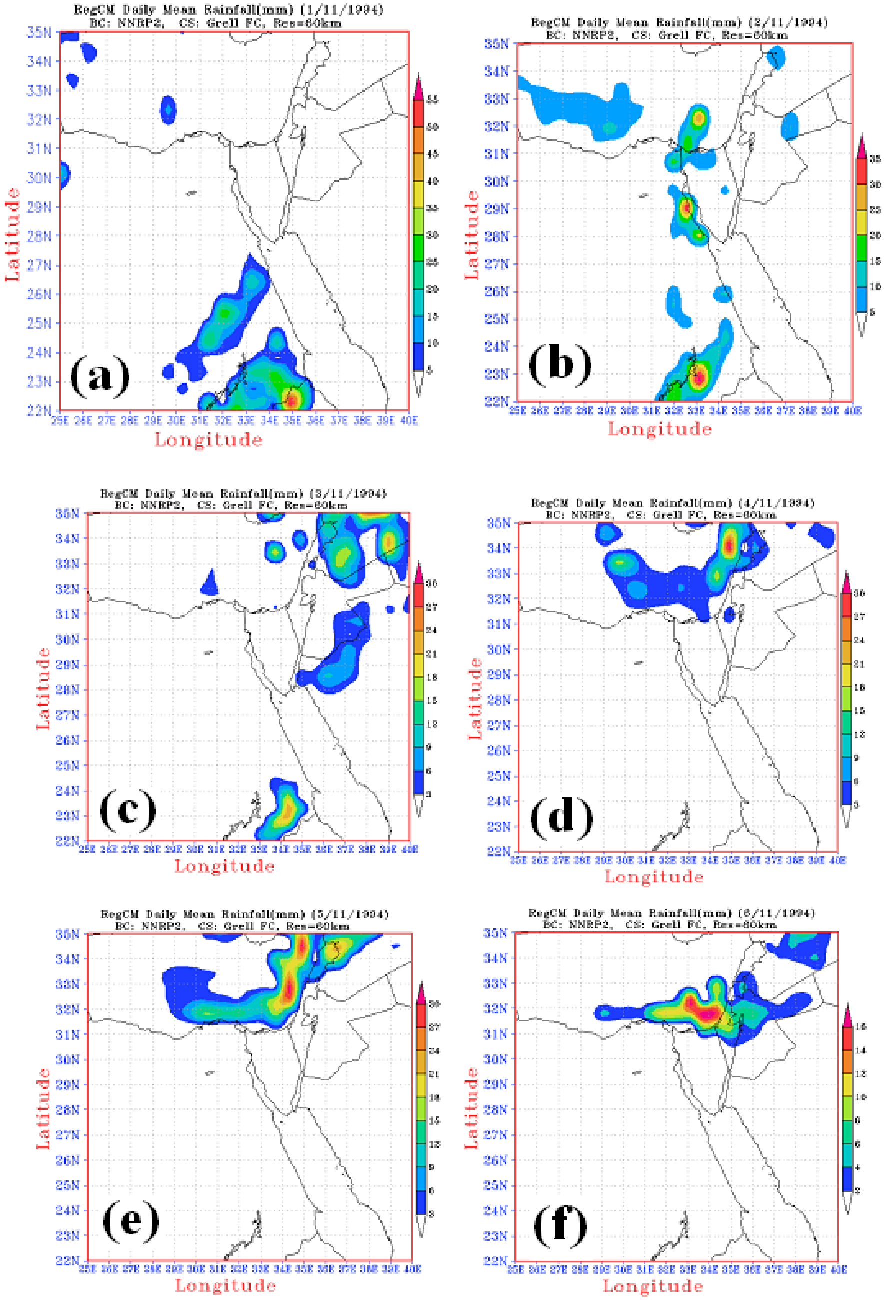


Fig. (5a-c): The daily rainfall observations over Egypt during the period 1-6 nov.1994


RegCM Daily Mean Rainfall(mm) (1/11/1994)
BC: NNRP2, CS: Grell FC, Res=60km

RegCM Daily Mean Rainfall(mm) (2/11/1994)
BC: NNRP2, CS: Grell FC, Res=60km

RegCM Daily Mean Rainfall(mm) (3/11/1994)
BC: NNRP2, CS: Grell FC, Res=60km

RegCM Daily Mean Rainfall(mm) (4/11/1994)
BC: NNRP2, CS: Grell FC, Res=60km

RegCM Daily Mean Rainfall(mm) (5/11/1994)
BC: NNRP2, CS: Grell FC, Res=60km

RegCM Daily Mean Rainfall(mm) (6/11/1994)
BC: NNRP2, CS: Grell FC, Res=60km

Fig. (6a-c): The Model rainfall using the Grell-Frisch Scheme during the period 1-6 nov.1994

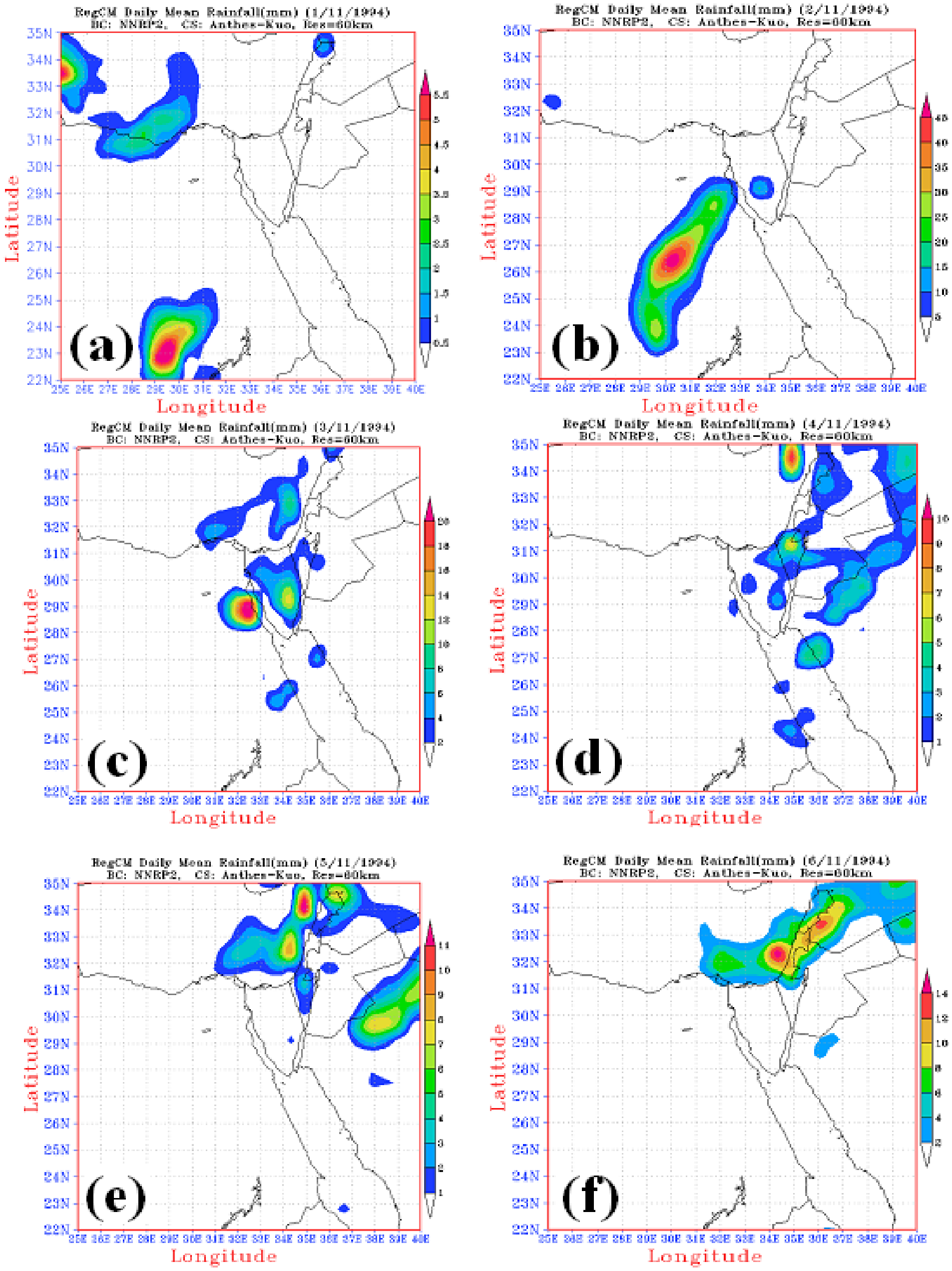
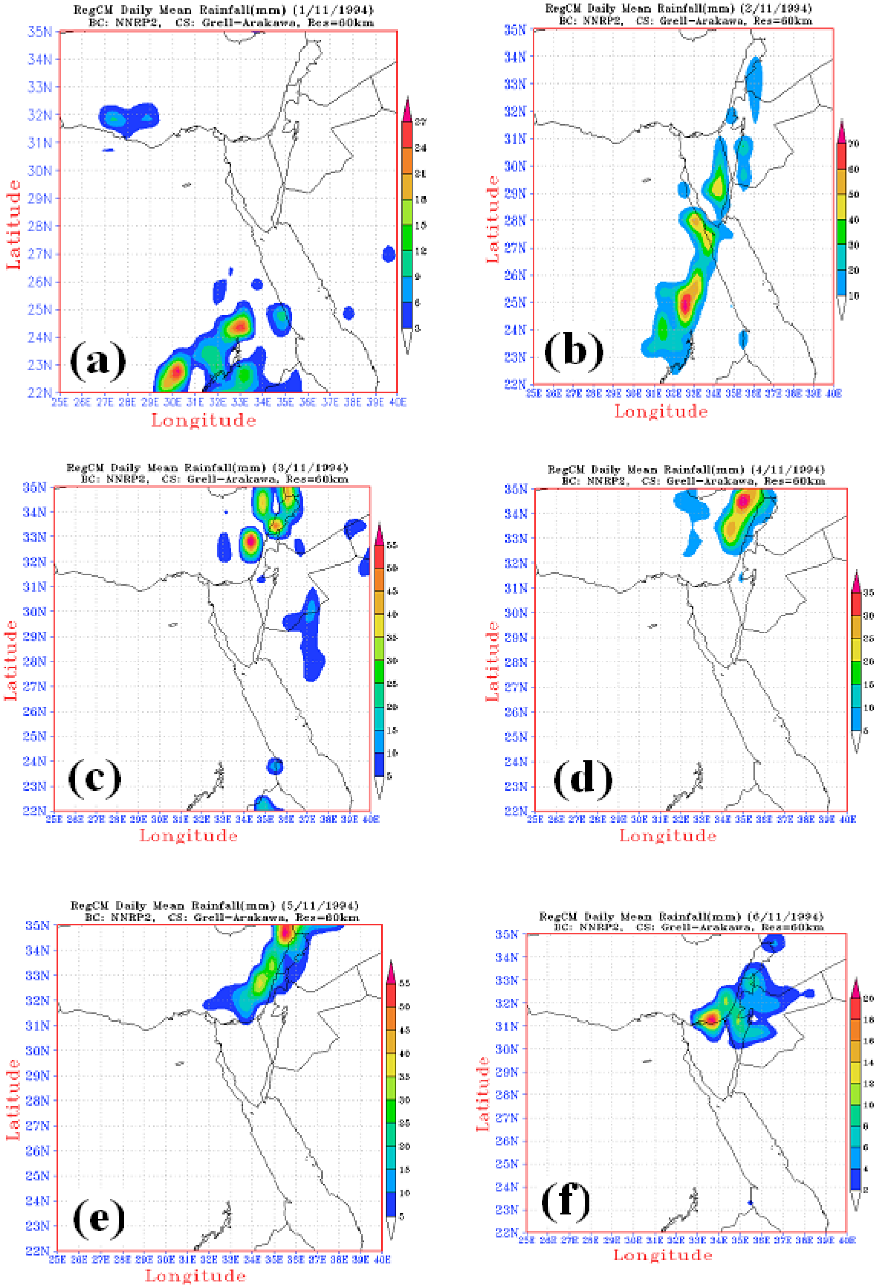


Fig. (7a-c): The Model rainfall using the Anthes-Kue Scheme during the period 1-6 nov.1994



RegCM Daily Mean Rainfall(mm) (1/11/1994)
BC: NNRP2, CS: Grell–Arakawa, Res=60km

RegCM Daily Mean Rainfall(mm) (2/11/1994)
BC: NNRP2, CS: Grell–Arakawa, Res=60km

RegCM Daily Mean Rainfall(mm) (3/11/1994)
BC: NNRP2, CS: Grell–Arakawa, Res=60km

RegCM Daily Mean Rainfall(mm) (4/11/1994)
BC: NNRP2, CS: Grell–Arakawa, Res=60km

RegCM Daily Mean Rainfall(mm) (5/11/1994)
BC: NNRP2, CS: Grell–Arakawa, Res=60km

RegCM Daily Mean Rainfall(mm) (6/11/1994)
BC: NNRP2, CS: Grell–Arakawa, Res=60km

Fig. (8a-c): The Model rainfall using the Grell-Arakawa Scheme during the period 1-6 nov.1994

## 4. Conclusions

The investigation of the simulation output against the available observations has indicated that the model is capable of simulating both the spatial patterns and magnitude of the rainfall over Egypt to some extent, and that the results were very sensitive to the choice of cumulus parameterization schemes.

And the Grell cumulus parameterization scheme with Fritsch Chappell assumption simulates the process of the severe case and the onset reasonably well, which can reproduce the onset timing and dramatic changes before and after the onset, however, there are still some discrepancies between the simulations and observations. For example, the model cannot completely simulate the intensity, the location and the onset time of the rainfall

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# حساسية النماذج المناخية: دور مخططات الحمل

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## الملخص العربى:

يهدف هذا البحث إلى دراسة حساسية النماذج الإقليمية المناخية لمخطط الحمل المستخدم عند تمثيلها للأمطار لإختيار أقربها تمثيلا لكميات وطريقة توزيع الأمطار المقاسة على نطاق الدراسة للتعرف على السمات الداخلية التى تمكن من إستخدامها فى التنبؤ

ولتحقيق هذا الهدف تم إستخدام الإصدار الثالث للنموذج الإقليمى المناخى لمركز الفيزياء النظرية (RegCM3) و إختبار العديد من مخططات الحمل المختلفة المتوفرة بالنموذج مثل جريل يتقريب اراكاوا وجريل بتقريب فريتش تشابل و اخيرا مخطط الحمل انثس كو من خلال عمل محاكاة مناخية لفترة 5 أشهر تبدأ من أول أغسطس و تنتهى بنهاية ديسمبرلعام 1994 وتتميز هذه الفترة استقبالها أمطارا عنيفة على جمهورة مصر العربية وتحديدا ابتداءا من الساعات الأخيرة من يوم 31 اكتوبر 1994 وحتى اليوم الثانى من نوفمبر 1994 وعلى نطاق واسع هذه الأمطار كان لها الأثر الضخم فى الإضرار بالإقتصاد القومى من خلال تدمير البنية التحتية وإزهاق العديد من الأرواح فى أماكن متفرقة من البلاد

وبمقارنة مخرجات النموذج بقياسات الأمطارالمسجلة على مصر تبين ان النموذج قادر على محاكاة الأمطار من حيث القيم والتوزيع وأن هذه النتائج تتأثر بمخطط الحمل المستخدم. وقد أظهرت النتائج أن النموذج باستخدام مخطط جريل للحمل بتقريب فريتش تشابل نتائجه افضل خصوصا فى موعد بداية الهطول.

ونظرا لانه لا تزال توجد فروق بين مخرجات النموذج وقياسات الأمطار من حيث الكمية والتوزيع وبداية الهطول بصورة كاملة فانه ينصح بالاستمرار فى عمليات التطويرلفيزياء النماذج خصوصا نظم الحمل والاشعاع بها للحصول على دقة أعلى.