

Sultanate Of Oman
Public Authority for Civil Aviation
Directorate General of Meteorology and Air Navigation
Operations and Technical Services
Numerical Weather Predictions

Sensitivity study of COSMO model for winter westerly disturbance rain event



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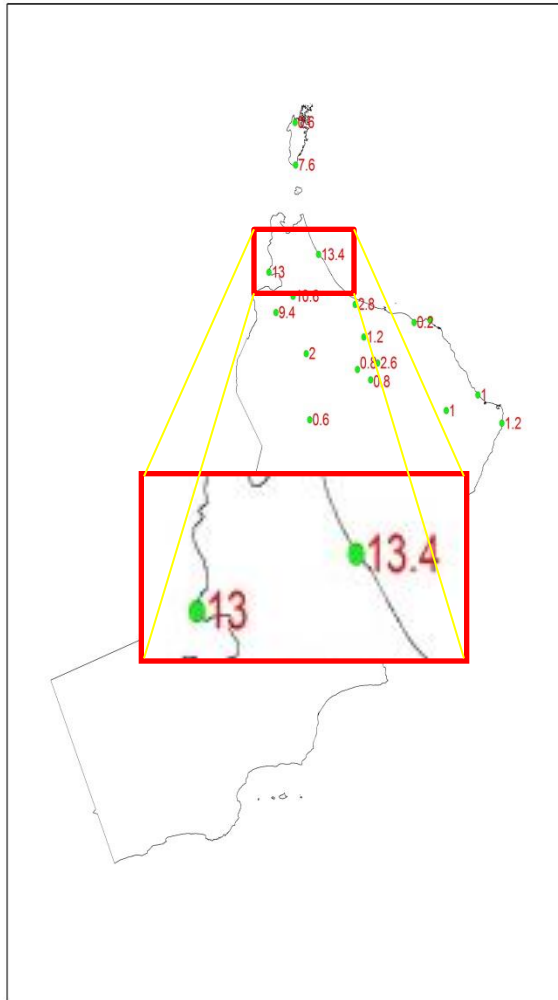
Abstract

Oman is located on the south eastern part of Arabian Peninsula. Oman has three main sources of precipitation, the local activity (topographically enhanced), the monsoon season and the westerly disturbance. In the last winter and during a strong westerly disturbance (24/3/2014- 27/3/2014), the southern parts of Oman had got a good amount of precipitations. During this event, Oman meteorological service was already started to use COSMO 5.0 operationally and on the same time the Hydrostatic model HRM was not phased out yet. It was noticed that COSMO 5.0 strongly underestimated the rainfall amounts and distribution. Unlike COSMO 5.0 , HRM model which was running on 14km resolution was able to give the signal of the rain and it forecasted the spatial distribution very nicely. This case study illustrated comparison of different COSMO 5.0 model configurations trying to understand the reason for the forecast failure. The tested configurations include different vertical layers, different model resolution, and different moment schemes.

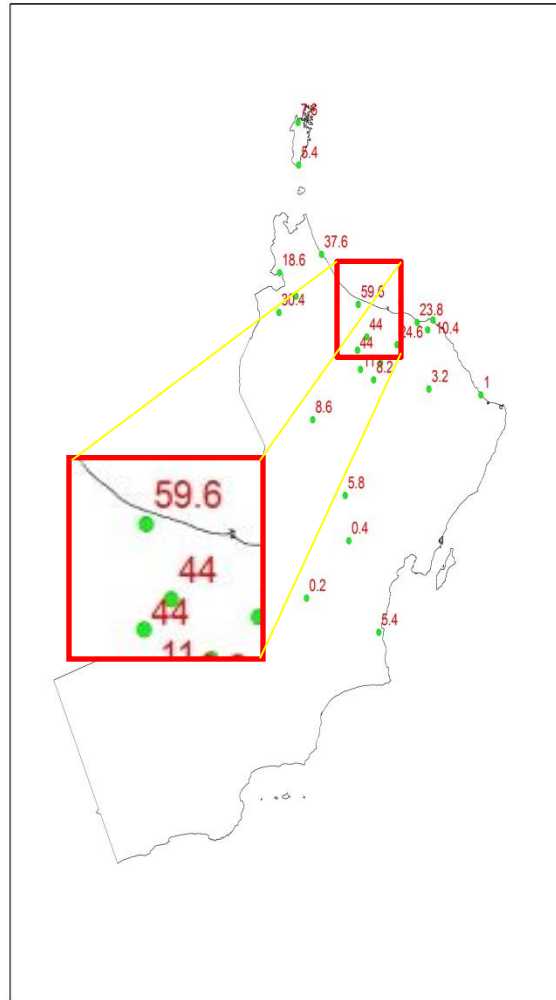
OUTLINE

- Observation data
- Comparison between forecast of COSMO 5.0 and HRM_14
- A list of questions
- Different experiments results
- Summary
- Open discussion

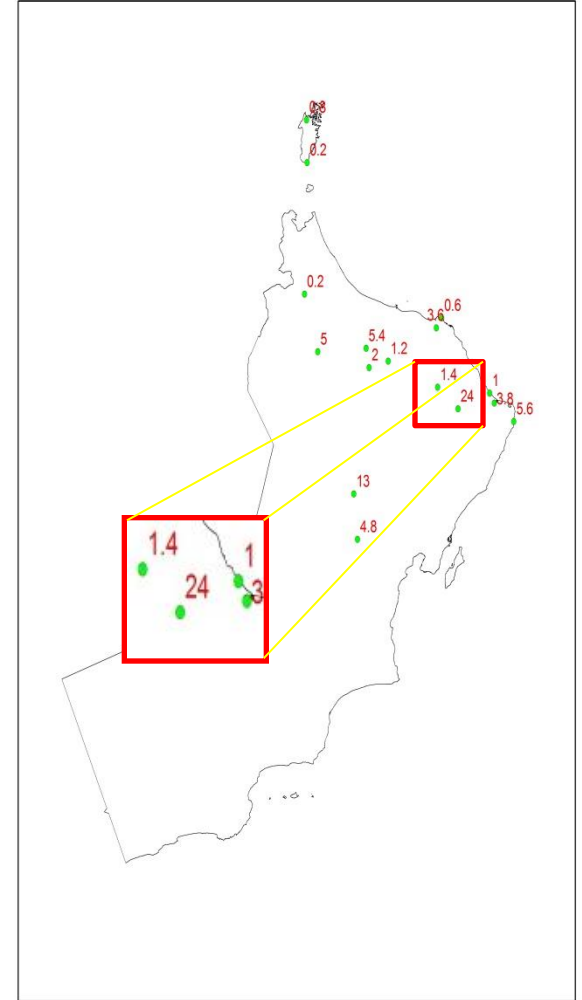
Observation(24 hrs. accumulation rain (mm))



2014032500

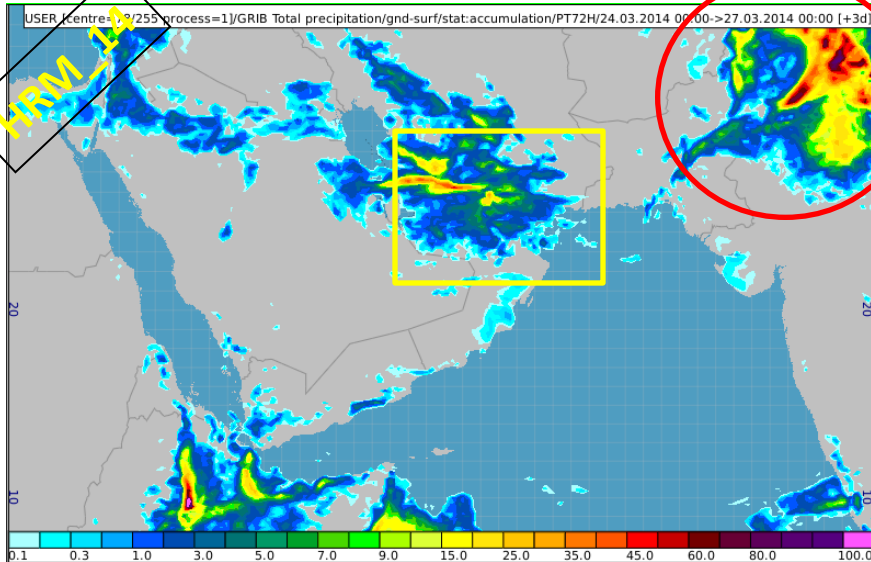
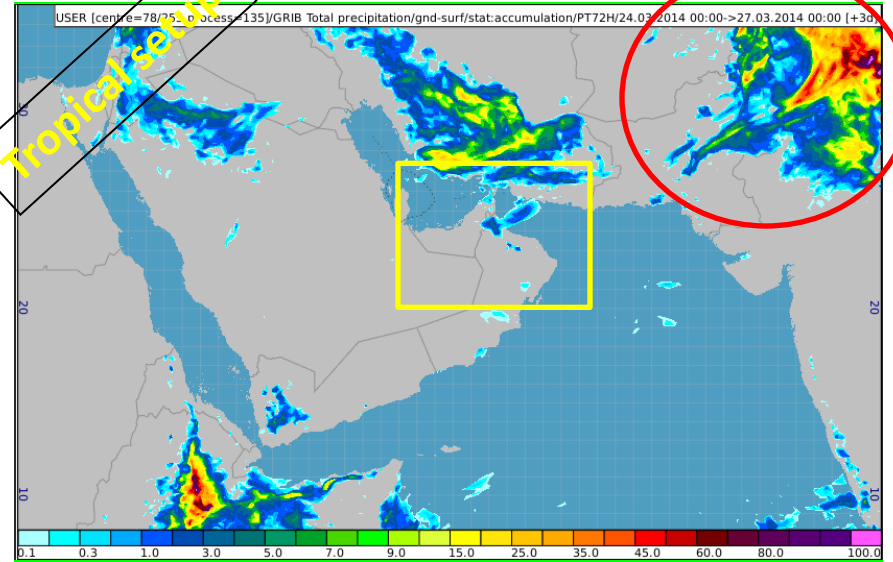
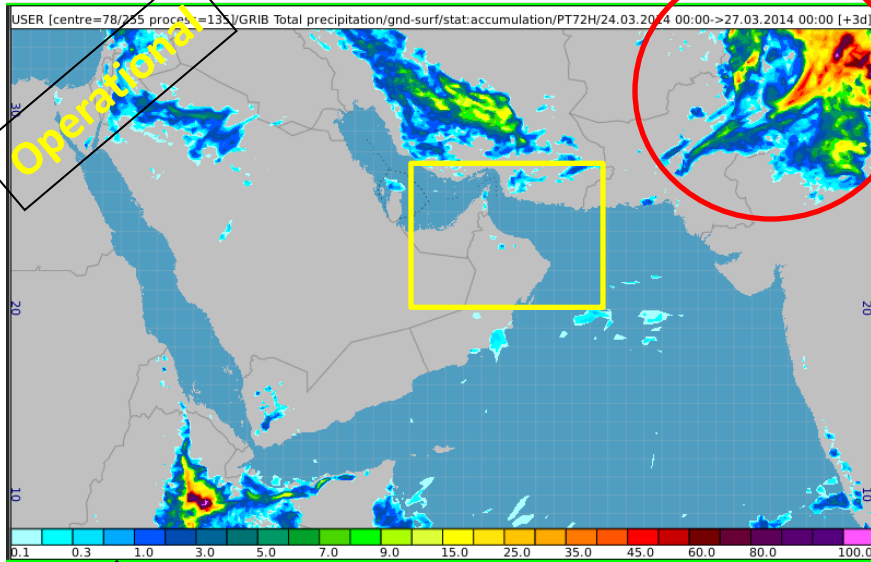


2014032600



2014032700

Accumulation rain _72hrs



- Operational COSMO 5.0 had the worst forecast
- There is a little improvement with tropical setup.
- HRM_14 give a better results comparing to the other
- The three output approximately give the same amount of precipitation over top right corner of the domain, but they are different in north part of Oman !!!
- Comparing to observation all the three model had underestimation.
- HRM_14 catch the distribution very well.



Why models catch the precipitations over North of India, but not over Oman?

COSMO 5 has higher resolution than HRM, so we expect a better forecast, Why it is not?

Even with new vertical levels setting , there is no noticeable difference?

The precipitation during westerly disturbance is almost convective, How model handle it ?

What about the relative humidity on the vertical layers ?

Did COSMO 2.8 give a better results?

If we use 2moment_scheme , can that improve the model efficiency ?

Did this situation of model forecast is continues or just in this event?



Why models catch the precipitations over North of India, but not over Oman?

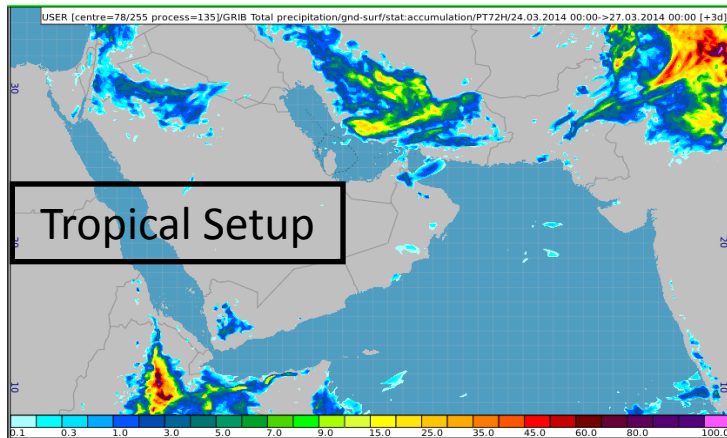
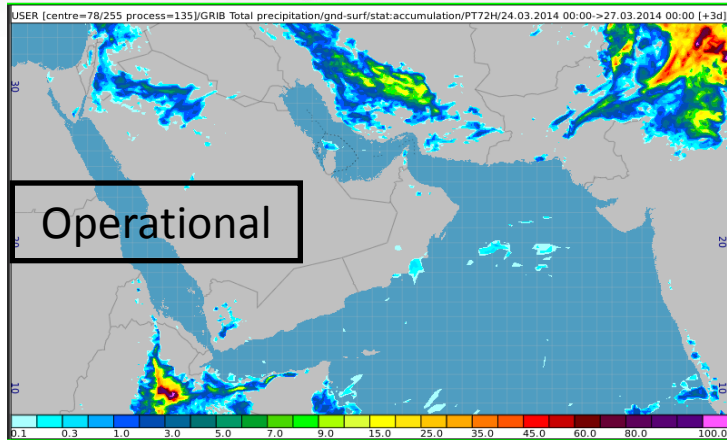
| Date | Station | Country | Observation | forecast | Status |
|-----------|-------------|---------|-------------|---|-----------------|
| 24/3/2014 | Srinagar | India | 7mm | >30mm | Overestimation |
| 24/3/2014 | Amritsar | India | 15mm | >30mm | Overestimation |
| 26/3/2014 | Jask | Iran | 63.5mm | 10-15mm(HRM) <7mm (COSMO TS) <5mm (COSMO OPER) | underestimation |
| 26/3/2014 | Bandarabass | Iran | 55.2mm | 10-15mm (HRM) <15mm (COSMO TS) 0mm (COSMO OPER) | underestimation |
| 26/3/2014 | Suwaiq | Oman | 59.6mm | <6mm (HRM) <5mm (COSMO TS) 0mm (COSMO OPER) | underestimation |

- The overestimation over North of Indian is a normal situation in our case and that due to lateral boundary condition . Since the relaxation zone (Domain boundary) locate over Himalaya mountains , the model predicted heavy rain over that area due to the noisy generated by the differencing in the resolution between global and regional models.



COSMO 5.0 has higher resolution than HRM, so we expect a better forecast, Why it is not?

- The resolution of HRM was 14km while the resolution of COSMO 5.0 is 7KM. Both used Tiedtke (Convection scheme) as GME.
- Since HRM_14 predicted the precipitation over north of Oman ,we can vouch that there is no wrong with initial data.
- COSMO 5.0 operationally used 40 vertical levels , also HRM_14 used 40 vertical levels but with different distributions.
- There is no clear reason for the underestimation with COSMO 5.0.



Even with new vertical levels setting , there is no noticeable difference?

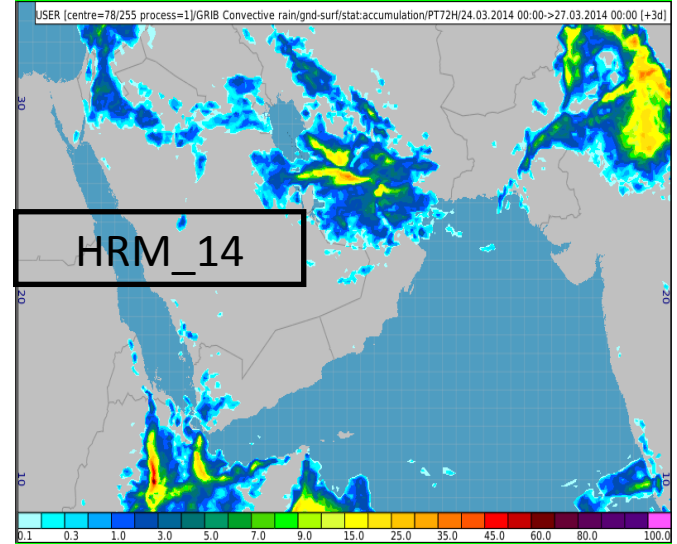
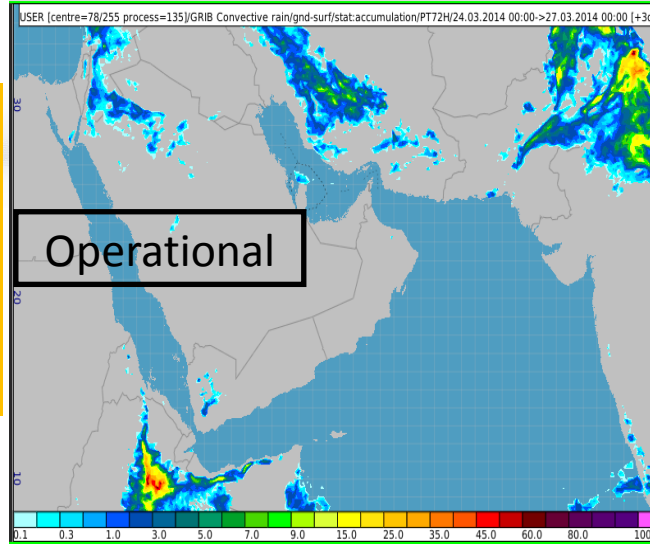
- The vertical levels were modified by increasing the (vcflat) to be 15KM and increase the number of vertical levels to 50 rather than 40.
- There was a little improvement but not acceptable.
- So changing the vertical layers setting dose not help to improve the forecast in this case.



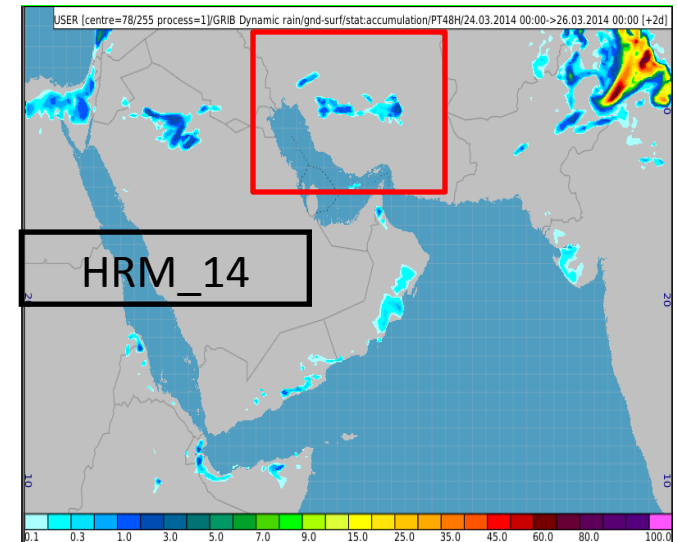
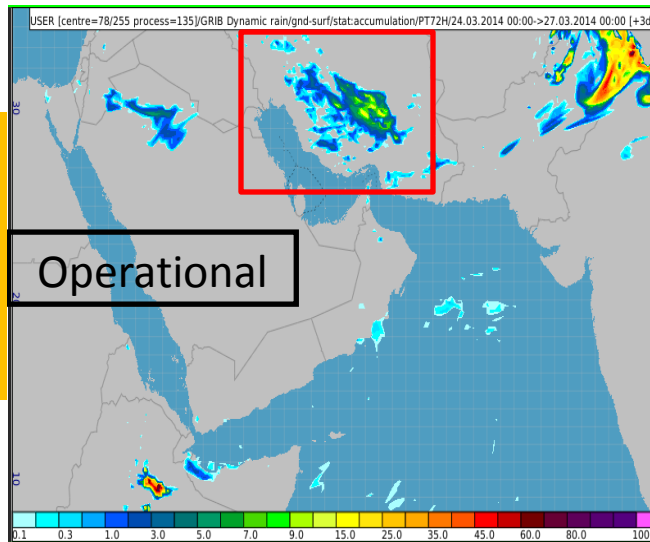
The precipitation during westerly disturbance is almost convective, How model handle it ?

72hrs accumulation rain

Convective Rain



Dynamic Rain



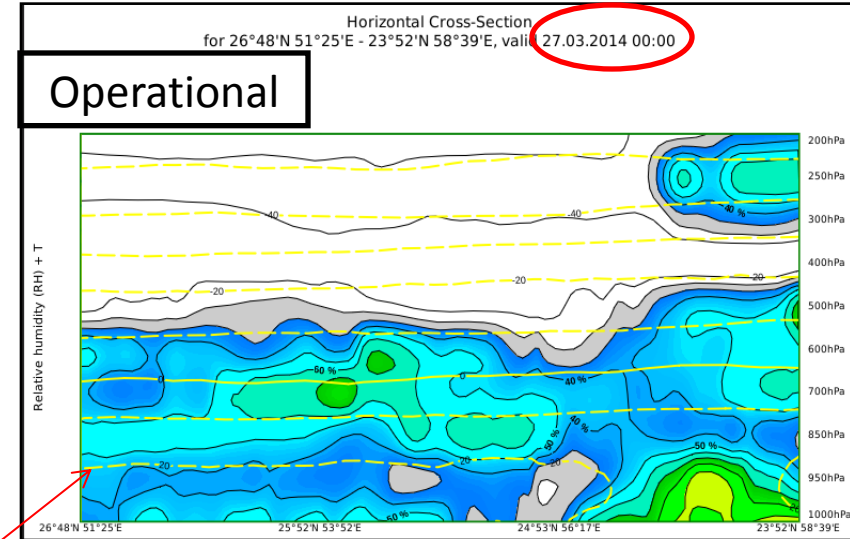


The precipitation during westerly disturbance is almost convective, How model handle it ?

- HRM_14 predicted more convective precipitation than COSMO 5.0
- Almost all the precipitation in HRM_14 are convection.
- In the red square COSMO 5.0 predicted dynamic rain more than HRM_14.
- So its obviously COSMO 5.0 could not handle the convective precipitation.

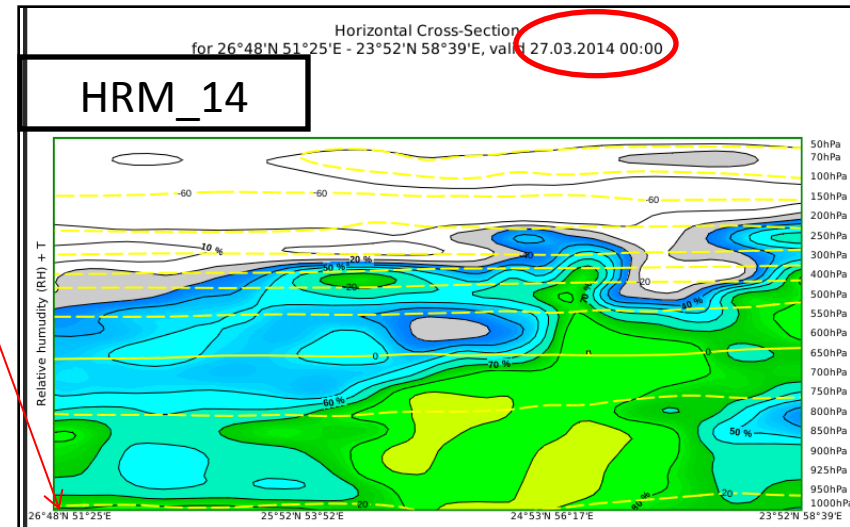


What about the relative humidity on the vertical layers ?



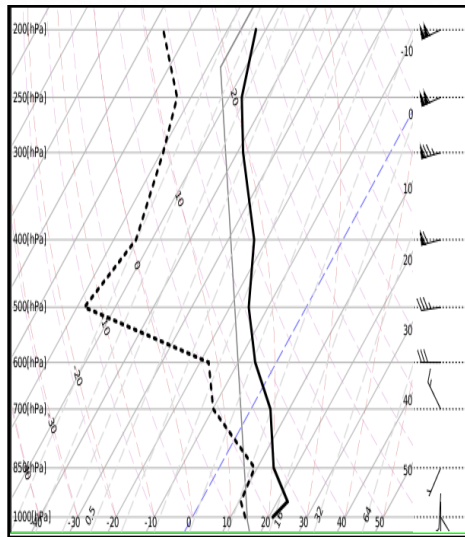
T=20 C

- Cross section go through the area of maximum precipitation during the event in HRM_14.
- HRM_14 had good amount of humidity in the vertical layers , while the dryness in COSMO 5.0 is clear.
- The temperature near the surface in HRM_14 is cooler than in COSMO 5.0

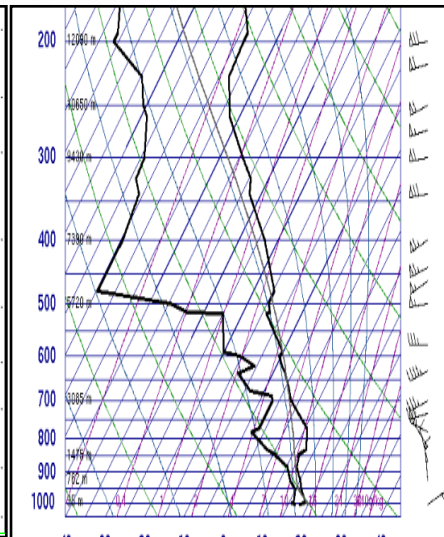




(Sounding data)

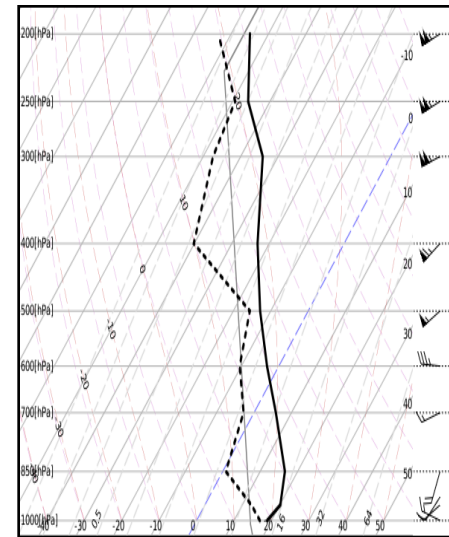


COSMO 5.0 (Operational)

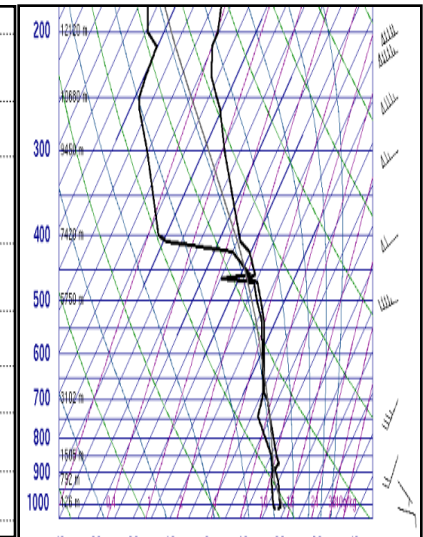


00Z 27 Mar 2014

Observation



COSMO 5.0 (Operational)



00Z 27 Mar 2014

Observation

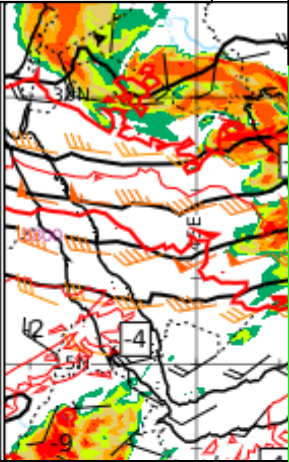
Abu Dhabi international airport

Muscat international airport

- The dryness is clear in model output over Muscat station.
- The surface temperature is in match with observation in both stations
- There is mismatch in wind direction at surface .
- The wind speed and direction at upper level agree with observation

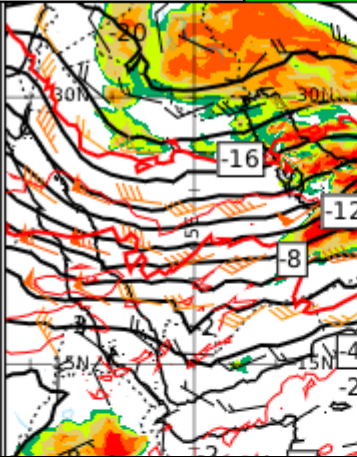
Geopotential height(500hpa), Temperature (500hpa) and wind (500hpa)

2014032500



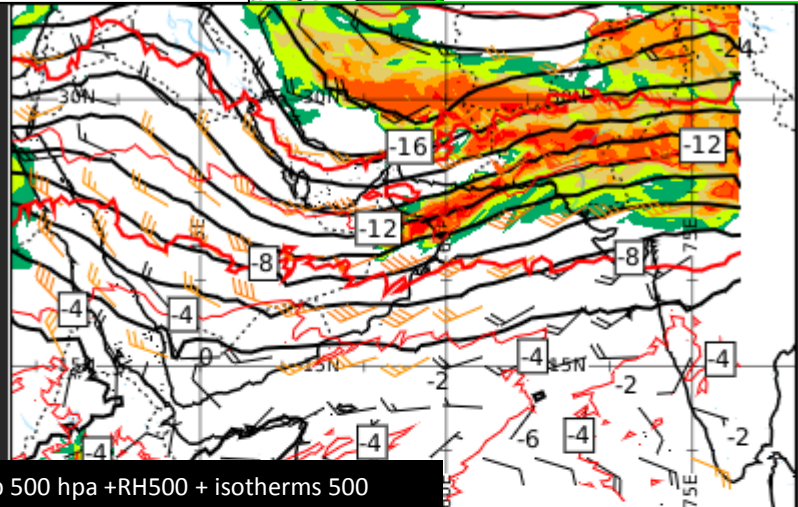
Geop 500 hpa +RH500 + isother

2014032600

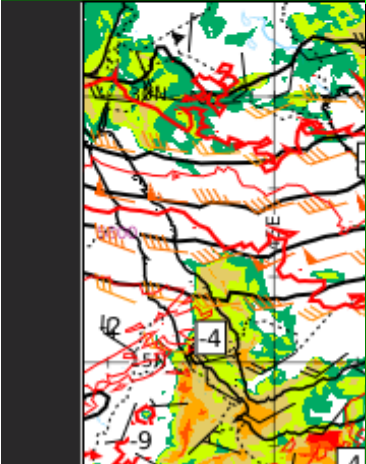


Geop 500 hpa +RH500 + isotherms 500

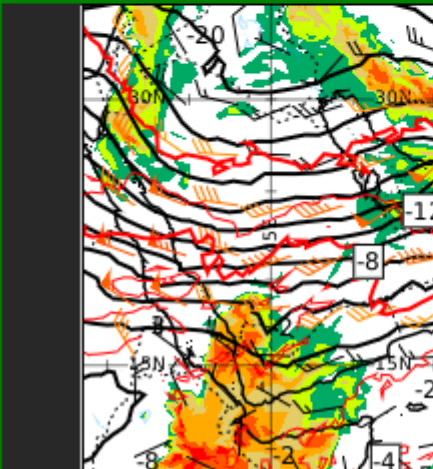
2014032700



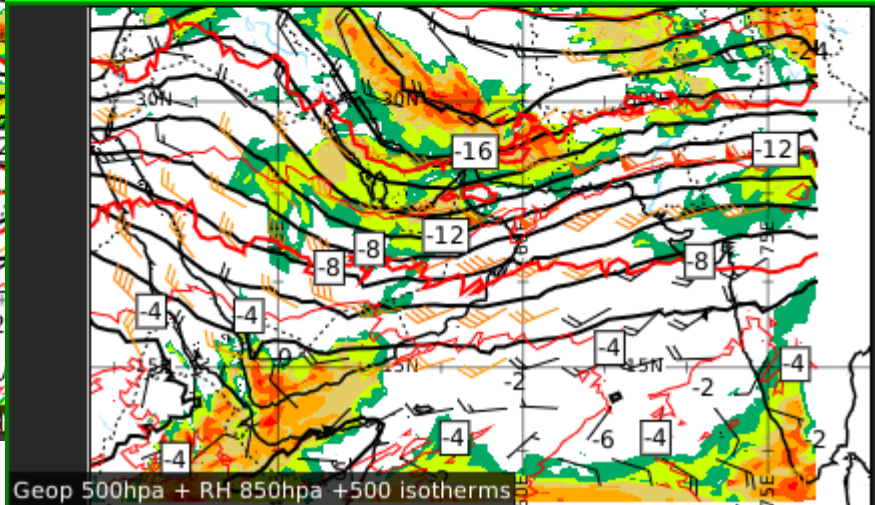
Geop 500 hpa +RH500 + isotherms 500



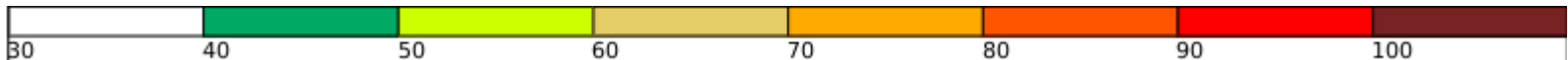
Geop 500hpa + RH 850hpa +500



Geop 500hpa + RH 850hpa +500 isot



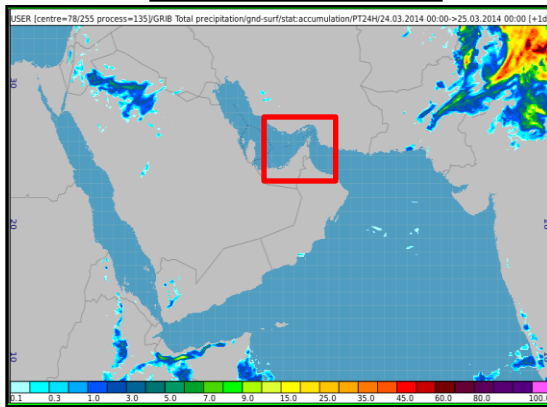
Geop 500hpa + RH 850hpa +500 isotherms



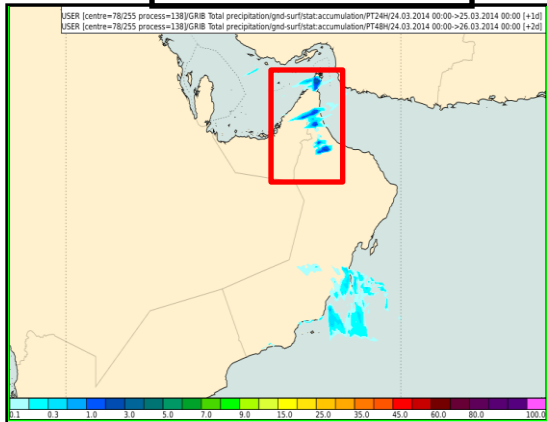


Did COSMO 2.8 give a better results?

Operational (7 KM)



Operational (2.8 KM)

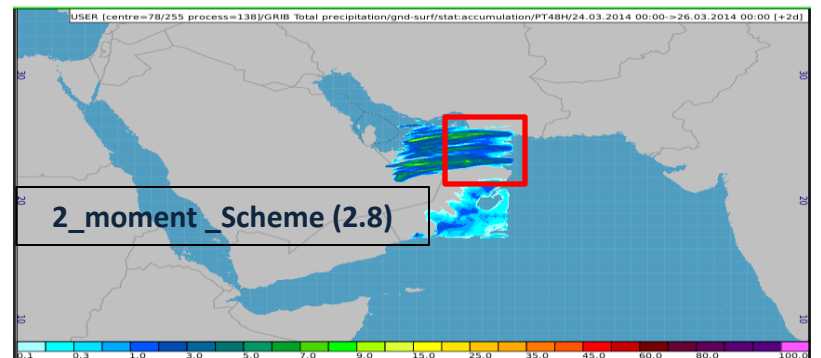
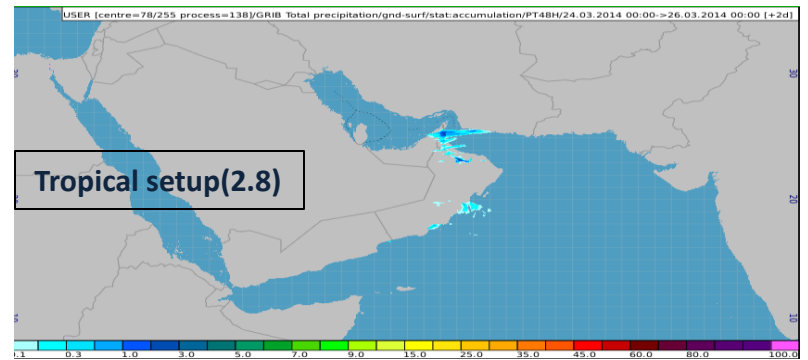
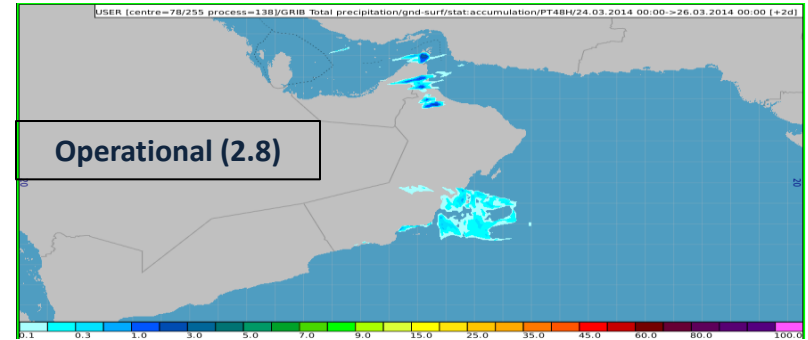


- There is some improvement in the 2.8 resolution .
- Still there is an underestimation .
- The distribution of rain is not acceptable comparing to observation data .



If we use 2_moment_scheme , can that improve the model efficiency ?
(48hrs accumulation rain (2014032400 -2014032600))

- Increasing the vertical levels can not improve the model efficiency.
- In contrast there is a big improvement by using 2_moment_scheme.
- The amount of precipitation (2_moment_scheme) is within the range of observation in the area of interest.
- Sohar record 13.4 mm for 20140325 and the model give around 7mm.





Did this situation of model forecast is continues or just in this event?

Yes, it is continues in every westerly disturbance with difference in degree of underestimation .

Summary

- HRM_14 and operation COSMO 5.0 (7KM) have underestimation in precipitation forecast over Oman.
- Both Model have overestimation over North of India.
- HRM_14 is better than COSMO 5.0 in the prediction of the amount and the distribution of precipitation.
- COSMO 5.0(2.8 KM) is quit better than COSMO 5.0 (7 KM) , but the forecast is still not acceptable.
- Using 2_moment _scheme with COSMO 5.0 (2.8 KM) improve the forecast in both the amount and distribution.

Open Discussion

- In our meteorology department COSMO 5.0 is an important source of information for the forecaster.
- So we need to improve the model forecast.
- Even the 2.8 with 2_moment_scheme give a nice results but we can not depend on that only.
- This Seminar is precious and it good chance to share the experience.
- Your comments and recommendations are important to us to achieve our target.



**THANK YOU FOR YOUR
ATTENTION**