The evaluation of the 7 km resolution COSMO model over South Africa

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Introduction

The South African Weather Service (SAWS) has acquired a research license to use the Consortium for Small-scale Modeling (COSMO) numerical weather prediction (NWP) model since 2011. The aim of this study is to evaluate the skill and accuracy of the COSMO in predicting weather over South Africa. SAWS intends to add the COSMO model to its Short-Range Multi-model Ensemble Prediction System (SREPS). This will be done as a means to address uncertainty and increase the skill in S AWS's SREPS forecasts. It is essential for weather forecasts to be accurate and have high skill in order to give good guidance for issuing weather related early warnings, which may in turn be used for mitigation or prevention of weather-related hazards.

Model configuration

Lateral boundary and Initial conditions:

- Extracted from the GME model.
- Horizontal resolution : 20 km.
- 60 vertical layers and 66,7s time steps.
- The data is transferred via ftp server from the DWD (Germany) twice daily (at 02:45 UTC and 14:45UTC)

COSMO model dynamics

- SAWS runs the COSMO model once daily to produce a 72 hour weather forecast.
- Horizontal resolution: 7 km.
- 40 vertical levels and 40s time steps.
- The model domain covers South Africa (Fig. 1).

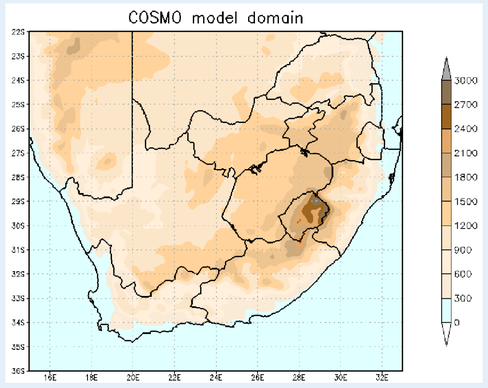

FIGURE 1: The COSMO model domain for SAWS, overlaid with altitude (masl).

Data and methodology

The COSMO model was run and evaluated for selected case studies. The following data was used for evaluation:

Synoptic/observational data

- Extracted from SAWS climate database.
- For categorical, continuous and subjective verification.

Meteosat Second Generation satellite (MSG) images

- Extracted from SAWS database
- For subjective verification and to asses the speed of weather systems.

Case studies were selected from weather events that occurred during October 2011 to March 2013. Monthly verification statistics were also obtained for some months during this period.

Selected weather elements for evaluation:

- Surface temperature
- Dew point temperature
- Wind speed
- Total cloud cover
- Rainfall

Evaluation techniques:

- Categorical methods: Probability of detection (POD), False alarm ratio (FAR), Critical success index (CSI)/Threat skill score (TSS) and Equitable threat score.
- Continuous methods: root mean squared error (RMSE) and bias.
- Subjective evaluation

Results

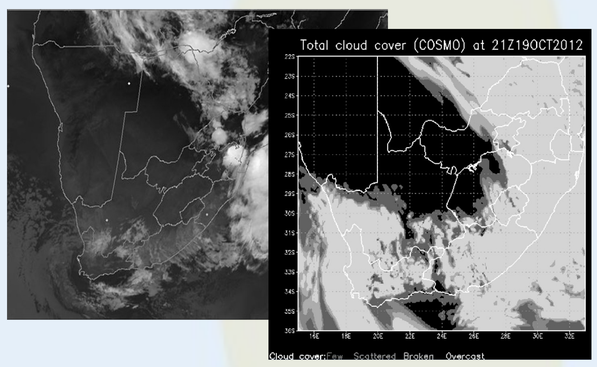

FIGURE 2: Cloud cover forecasts from MSG IR09 (left) and the COSMO model for 21GMT 19012013.

Cloud cover: the COSMO forecast depicts a similar pattern to that of MSG satellite images, though it usually has a larger spatial extent and it extends slightly west of the satellite image (Fig. 2). The COSMO model usually over-forecasts clouds along the north-eastern boundaries of the country. Figure 3 shows that the COSMO has high FAR and POD, and low CSI and ETS throughout all the forecast lead times for cloud cover >2 octas. This is a result of less hits. This may result from the speed at which systems move on the COSMO model.

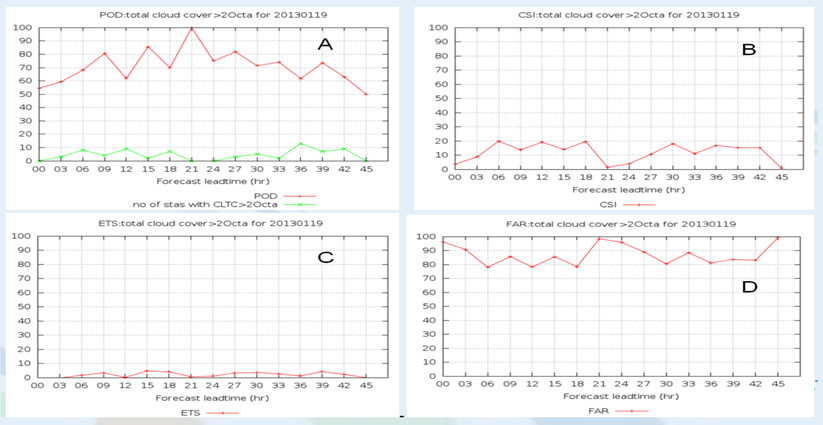

FIGURE 3: Categorical skill scores for cloud cover>2OCT for19012013: COSMO vs OBS.

Rainfall: Figure 4(a-c) and 5(f-h) show that for both the daily and monthly average forecasts the COSMO has higher skill for lower thresholds, for 3-hourly rainfall totals (Fig 4d) and 3-houly monthly average rainfall (Fig 5i). and that the skill scores fluctuate throughout the forecast period. On spatial maps (not shown), the COSMO forecasts for rainfall are similar to the observations, though they extend further west of the observations.

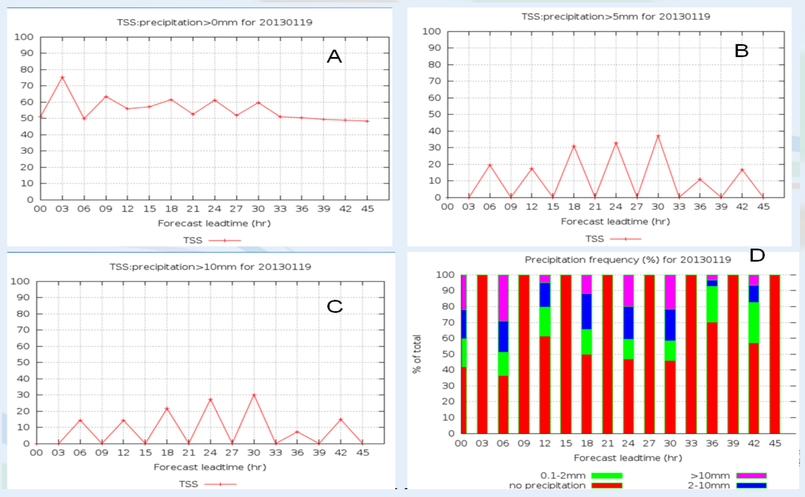

FIGURE 4: Categorical skill scores for surface rainfall for19012013: COSMO vs OBS..

Wind speed: the COSMO generally under-forecasts surface wind speed throughout the forecast period (Fig 5e). Figure 5d-e depict that the COSMO is accurate in predicting wind speed (-1<bias<-3m/s and RMSE<5m/s).

Surface temperature and dew point temperature: the COSMO model is accurate in forecasting surface temperature and dew point temperature: temperature bias ranges between 1 and –1 ^{0}C, and RMSE for both temperature and dew point is less than 6 ^{0}C throughout the forecast period. These scores are within the same range even for daily forecasts.

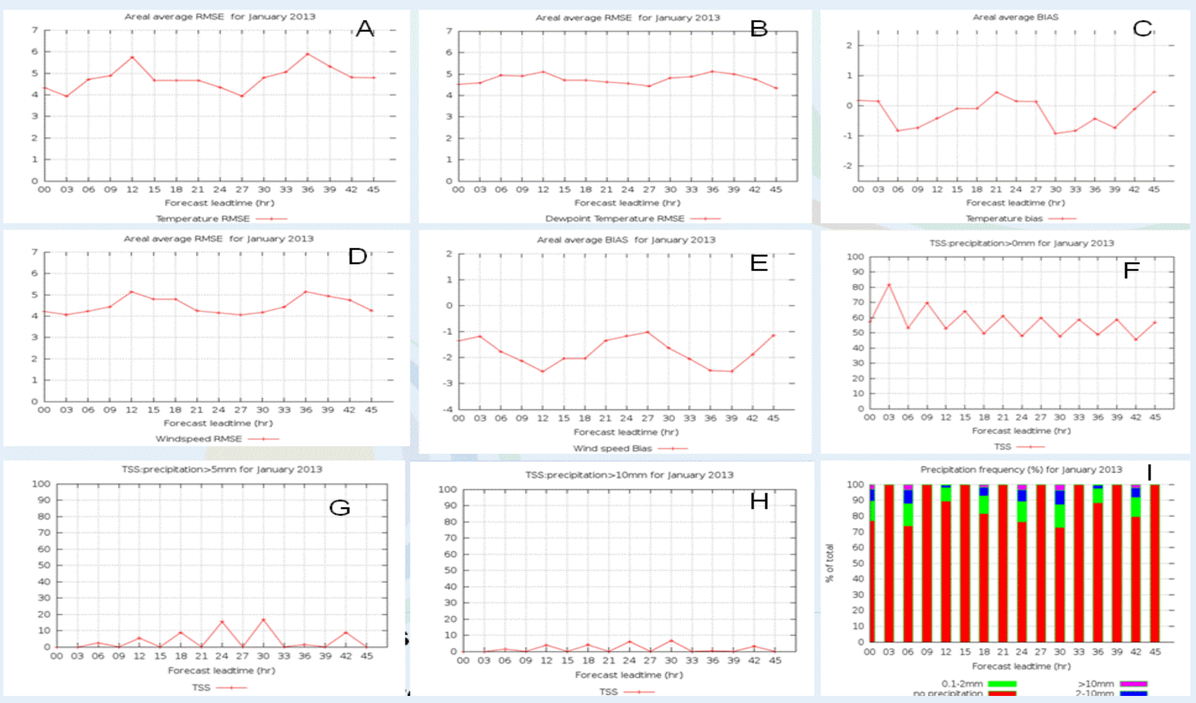

FIGURE 5: Monthly statistics for January 2013: COSMO vs OBS..

Discussions and conclusions

The COSMO model is accurate and skilful in predicting surface temperature, dew point temperature and wind speed when areal averages are taken into consideration. On the spatial scale (for cloud cover and rainfall), the COSMO covers a slightly larger area than the observations and the MSG satellite image forecasts. The model has low skill in forecasting cloud cover and rainfall. This might however be attributed to the sparse observational rainfall network over South Africa.

The skill scores fluctuate throughout the forecast period, not showing the dependence of the model performance on lead time. These results show the need to further evaluate the COSMO model.

Way forward

The COSMO model over South Africa will be investigated further: more weather elements will be evaluated and evaluation methods will be used..

REFERENCES

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