WRF-CMAQ group

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Outline

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Acknowledgement

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Stakeholders

AMAZING CMAQ team members 🙂

Introduction

Description WRF and CMAQ

Set up

Description WRF and CMAQ

WRF (Weather Research and Forecasting)

- Model solves fully comprehensive non-hydrostatic Euler equations
- Community model used for both research and operational purposes

CMAQ (Community Monitoring Air Quality): atmosphere modelling system which contains state of science parameterizations of the atmospheric processes which affect the transport, transformation and deposition of pollutants such as particulate matter and ozone, airborne toxic compounds, acidic and nutrients pollutant ozone, as well as estimates of visibility degradation throughout the troposphere.

WRF Processes



Geogrid: To set the domain

Ungrib: gridded binary files for meteorological data such as wind speed, humidity, surface pressure, soil data, snow data, sea-surface temperature, etc.

Metgrid: Support prognostic data

CMAQ Processes



(b) Chemistry transport model and pre-processors

Figure 1: (a) CMAQ main programs and third-party programs (b) CMAQ main programs and third-party programs showing the processes in CCTM

WRF results

WRF Model set up and configuration



Details	Configuration
Dynamical core	WRF - ARW, compressible, non-hydrostatic
Domain size	20°W - 55°E, 40°S - 40°N (416X466)
Resolution	20x20km, 24 vertical levels (100hpa)
Initial and boundary conditions	Global Forecast System, 0.5°
Cloud microphysics	Lin et al.
Long wave radiation	Rapid Radiative Transfer Model (RRTMG)
Short wave radiation	Goddard
Land surface processes	Noah LSM
Cumulus convection	Grell 3D
Boundary layer physics	Mellor Yamada Janjic

WRF Simulations over Africa for PBL height and temperature January 1st-4th 2017, starting from 7UTC (+ 3hrs local time)

 \mathbf{m}







WRF Diurnal Variation

January 3rd 2017, UTC (+ 3hrs local time)



WRF Simulations over Africa for humidity and wind speed January 1st-4th 2017, starting from 7UTC (+ 3hrs local time)



WRF **Diurnal Variation** January 3rd 2017, UTC (+ 3hrs local time)



Interpretation

WRF (On January 1st-4th 2017)

- Relationship between different weather elements
- PBL Height is related to temperature
- When temperature is low in the morning, PBL height is low (Converse is true)
- Dry atmospheric condition can be seen over the desert
- Equatorial Forest to have high humidity values shown in the map
- In Azores (high pressure system) and mascarene area (high pressure) and st. hellena strong winds are observed

CMAQ results

CMAQ Domain September 7th 2019



WPS Domain Configuration

CMAQ Simulation on NO2 and O3 September 7th 2019



CMAQ Diurnal variation of NO2 September 7th 2019

- NO2 Diurnal variation mimics traffic variations
- The increase in temperature leads to higher PBL which dilutes the concentrations in the afternoon due to increased vertical mixing



Layer: 1 NO2[1] [1]=CCTM_e2a.d02.2019-09-07.CONC

CMAQ Diurnal variation of O3

September 7th 2019

- In the morning gradual increase of ozone (O3) due to NOx conversion to ozone (O3)
- In the afternoon there is higher photolysis due to increased solar radiation leading to the higher production of ozone (O3)



Layer: 1 O3[1] [1]=CCTM e2a.d02.2019-09-07.ACONC

Summary

WRF (Weather Research and Forecasting) and CMAQ (Community Monitoring Air Quality)

- WRF is meteorological model and CMAQ is air quality model.
- Two models are interfaced to capture elements of meteorological and air quality transport
- Forecast and monitor air quality by using WRF and CMAQ

Way forward

- Cities in Africa are growing tremendously so air quality monitoring and forecasting is <u>necessary!</u>
- Identify students and officers from Met. Department for short-term training to enhance the capacity of Weather and air quality forecasting
- WMO to facilitate for operation of air quality forecasting in Africa
- Partners and attendees of this workshop should form a regional group to collaborate each other, centralize information sharing and share opportunities for more training
- Highlight challenges and contributions from each country
- Model validation/evaluation over the region
 - Compare Model output and ground-level measurement
- Survey from each country

THANK YOU. Asante