RegCM4-CHEM Dust and Gas Phase (Case Studies)

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Motivations

TO run and bug fix the Regcm4.3 CHEM

Achievements

1-To run Tropical band with a gas-phase chemistry options for the first time, which open the door to study the role of tropical dynamics in global climate chemistry interaction.
2-Fix some bugs related to gas-phase chemistry

Outlines

Testing the RegCM4.3-CHEM for:

- ✓ **The large and heavy dust storm 2006 case over North Africa.**

- ✓ **Tropical-Band Chemistry Simulation**

- ✓ **Heat wave over Europe 2003.**

First Part: Heavy Dust storm simulation

Saharan Dust Storm over North Africa

7&8 March 2006

Synoptic Analysis

- It started on 5 March 2006 over Morocco and Algeria when the cold front of a cyclone over the Balearic Islands reached Northern Africa. During the following days, the cyclone moved from the Western to the Eastern Mediterranean Sea and the cold front crossed Northern Africa from west to east, with the dust storm following it.

- On 9 March the dust storm finally reached the Middle East. With the built-up of a high pressure system in the cold air over north-west Africa, a strong north-easterly flow over the Central and Southern Sahara generated further dust storms in the area of the Bodele depression and Agadez, where huge quantities of dust were picked up and carried towards Niger, Mali, Burkina Faso and Nigeria.

Synoptic Analysis

- The further progress of the dust towards the Gulf of Guinea was stopped by a southerly flow in the area of the Ivory Coast, which led to the formation of a convergence line over Northern Ghana.

- The air mass characteristics are: cold, dry, dusty air to the north and warm, moist air to the south of the boundary. On the following day (9 March), the dust was blown far out over the Atlantic Ocean where it was "sucked" into a cyclone situated between the Canary and the Cape Verde Islands.

Model Setup

iy = 140
jx = 160
kz = 18
ds = 50km
Aertyp=AER00D1
icup = Grell
igcc = Fritsch & Chappell
ssttyp = ERSST
dattyp = EIN15
mdate1 = 20060301
mdate2 = 20060315
Land-surface = BATS

Domain surface elevation

Model Results

Dust Animation 1-14 March 2006

Model Results

Temperature

The cold front of a cyclone over the Balearic Islands reached Northern Africa.

Diurnal Variation of Temperature

The daytime Max. temperature dropped by $10^{\circ}C$ over Niamey, Niger.
(Slingo et. al 2006)

Model Results

Aerosol Optical Depth

Observation(AERONET) vs. RegCM4.3 (Niamey, Niger)

Aerosol Optical Depth animation

Conclusion of the Dust Case

➢RegCM4.3 captures the pattern of the large scale dust.

➢RegCM4.3 capture the pattern of Meteorological conditions.

➢RegCM4.3 overestimates the peak of the aerosol optical depth (AOD),

by approximately 30%. And delay the occurrence of the maximum peak

by 2 days. However, the onset of the storm is captured by the model.

Second Part: Tropical Band Simulation

NO$_x$ - VOC's Reactions

The curved lines represent the a constant ozone concentration with respect to Nox/VOC

Emissions used

NOx

CO biomass burning

ISOPRENE

DMS

Simulation Test for 190 hours

Experiment Setup

iy=100
jx=270
dz=18
ds=55.55 km

Datype = EIN15
sstyp = ERSST
convection scheme = Emanual
diurnal sea surface temperature
Land surface = BATS

chem = CBMZ
chem-ICBC= MOZART
climatology

Ozone at 500 hpa

High production of ozone over central africa

Ozone depelition over northern South America

Ozone depelition over Central Pacific

Comparison with Global Chemistry Model MOZART

Lower panel shows the January simulation of surface ozone using MOZART

RegCM4.3 T-Band-Chem is fairly comparable with Mozart, however it is overestimated.

Third Part:From Semi-global to Regional simulation
Europe Heat Wave 2003

Europe Heat Wave August 2003

Europe have been suffered from a extermly heat wave in August 2003 which accompained with a very high level of surface ozone

Does RegcCM4.3 –CHEM capture this ozone episode??

Two months simulation from July to end of August with one month spinup

Model Setup
iy=50
jx =80
mdate1=20030701
mdeate2=20030901
Grill scheme
BATS
CBMZ

NO2 (ppbv)

O3 (ppbv)

**Cannot reproduce the heat
wave ozone episode
Emission (Bug)**

Isoprene (ppbv)

Summary and Conclusions

1-Regcm4.3 capture the large scale dust storm

2-RegCM4.3 is ready to run with Full gas-chemistry (CBMZ) with band option

Bugs need to Fix
1-emission time match
2-ICBC-chem units

THANKS