PRACTICABILITY OF USING WRF-CHEM

Team Members:

1. Oussama DOUBA (Algeria)
2. Bethwel MUTAI (Kenya)
3. TUYISENGE Aminadab (Rwanda)
4. Fitsum Bekele (Ethiopia)
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7. Victor Nthusi (Kenya)
8. David Nganga (Kenya)
9. Mthoni Cindy Kanigi (Kenya)

Instructors:

Prof. & Dr. Yang Zhang (USA)

Prof. & Dr. Aboubakr (Beeker) Abdelrehim (Egypt)

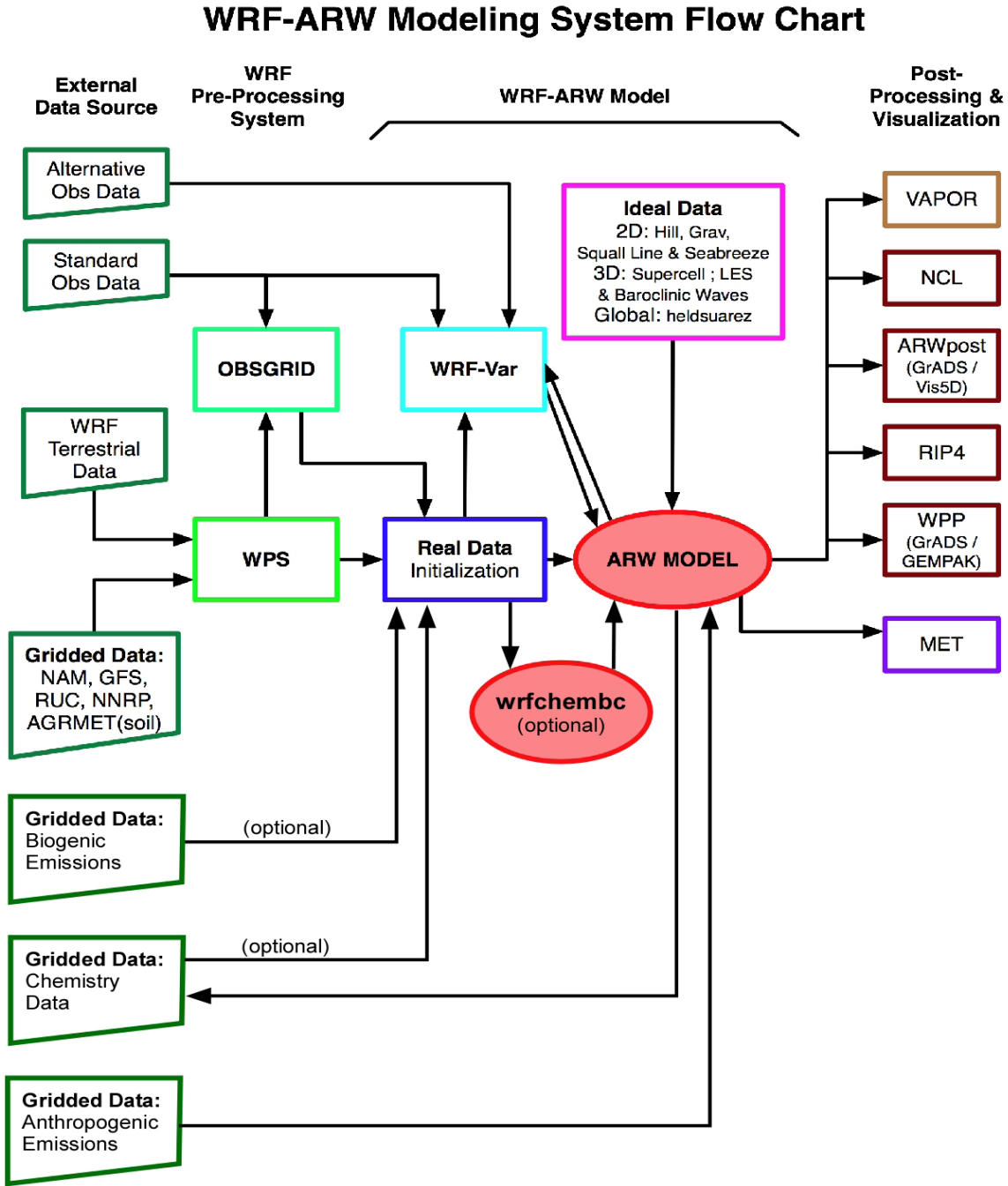
Melaku Yigiletu (South Africa)


INSTITUTE FOR METEOROLOGICAL TRAINING AND RESEARCH
WMO REGIONAL TRAINING CENTRE
(IMTR/WMO-RTC),NAIROBI

Introduction & overarching objective

- WRF/Chem is the state of the science that has been applied for both backcasting and forecasting in air quality and weather
- Objective: to learn how we can apply online coupled meteorology-chemistry model for real time forecasting, retrospective simulation of aerosol direct and indirect effect, and inter-comparison between WRF-Chem and RCM-Chem

WRF-Chem Tutorial Session



- **Simulating Chemistry Feedback and Aerosol Effects over U.S., Jul 1-10, 2010.**
- **RT CW-AQF over Africa, Sep 10-20, 2019**
- **Intercomparison between WRF-Chem and RCM-Chem over Africa**

Tutorial Learning Objectives

In this practice, we performed a set of WRF-Chem simulations and forecasting

The objectives of this practice included:

- Familiarization with WRF/Chem backcasting and forecasting
- Learn how to compile, set up, and run WRF/Chem.
- Learn how to post-process model outputs, visualize, and analyze the results.

WRF-CHEM BASTCASTING FOR USA

- **Team Members:**

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4. Fitsum Bekele (Ethiopia)

- **Instructors:**
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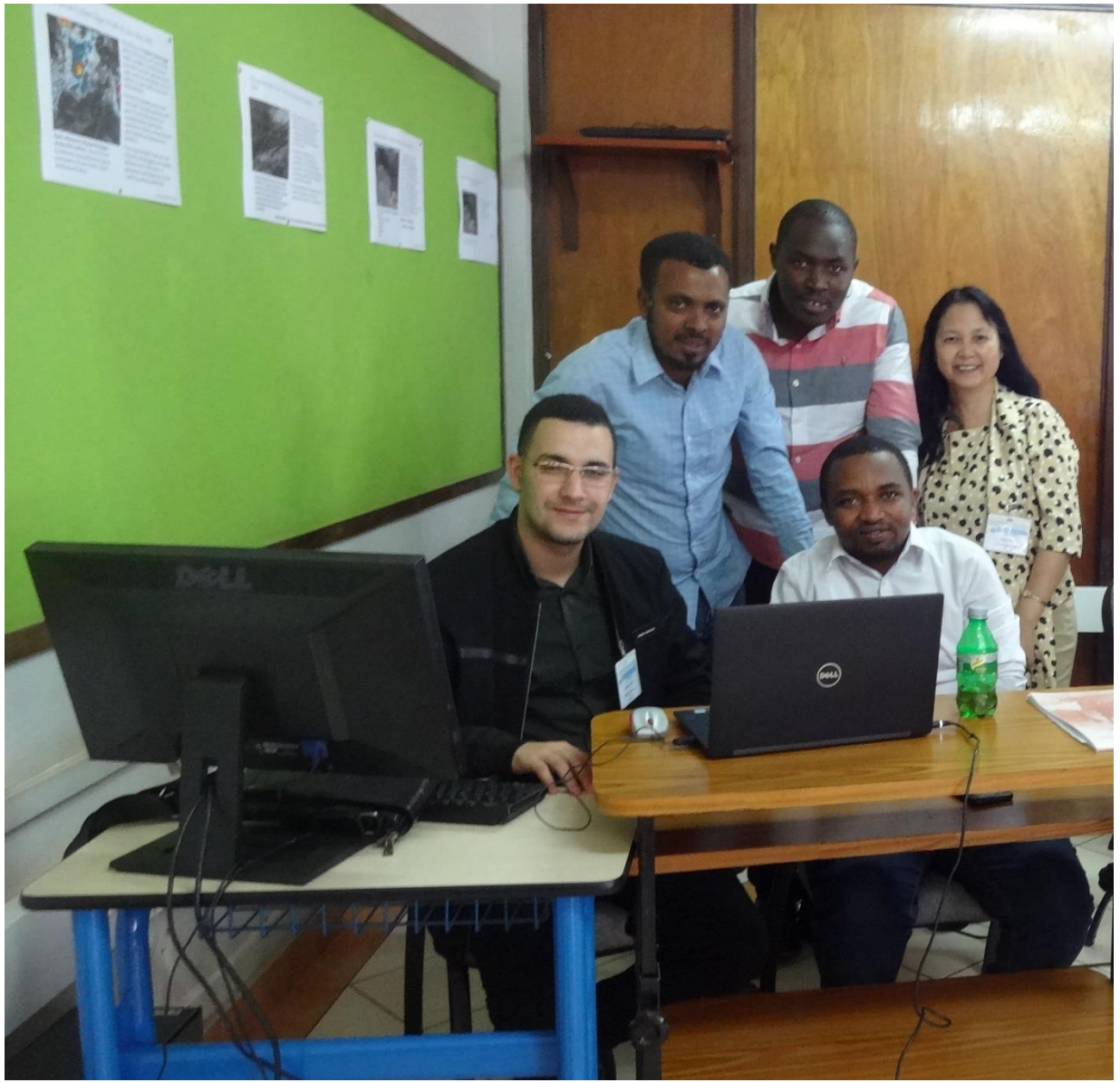


Aerosol Direct and Indirect effect

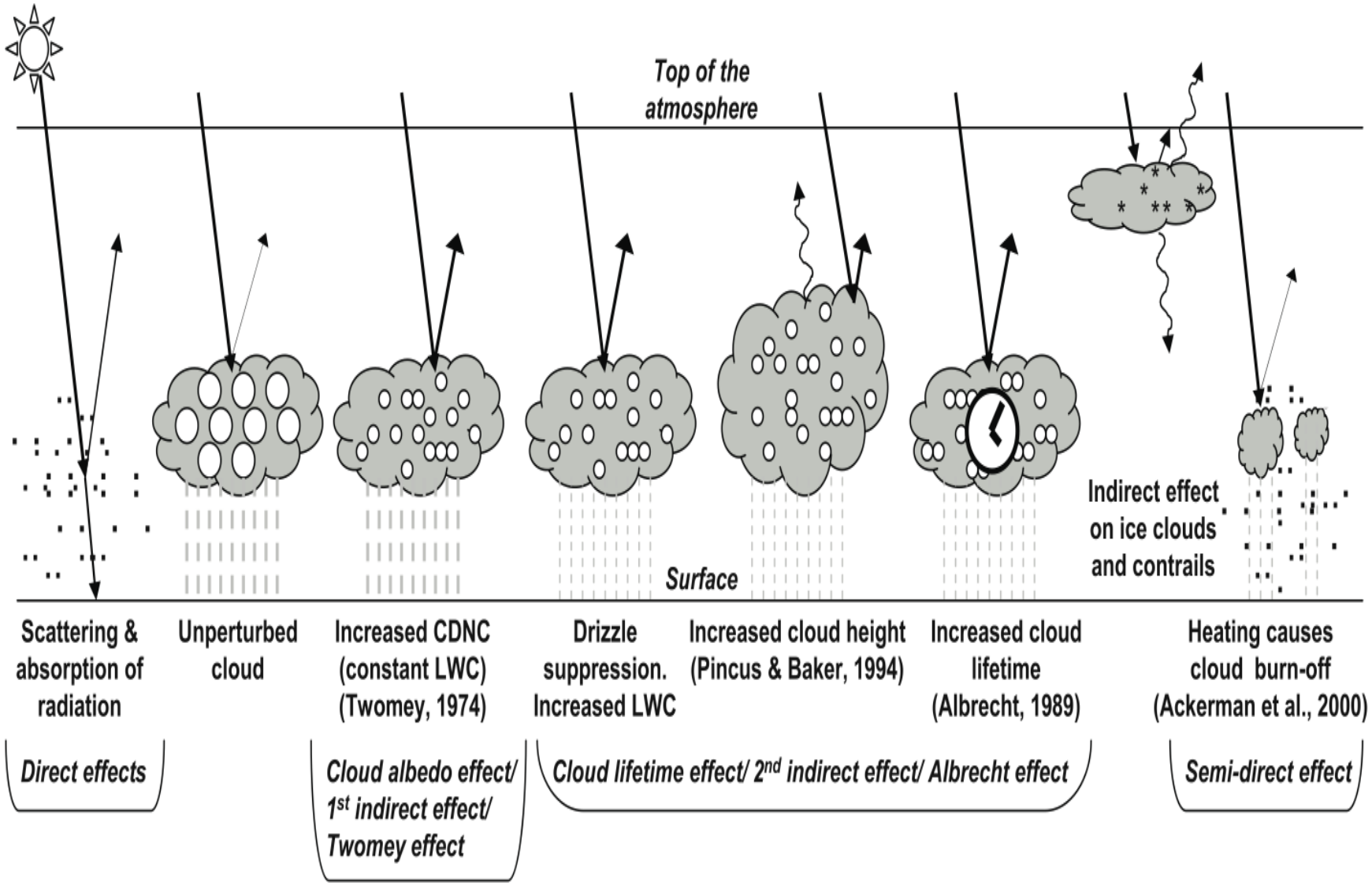
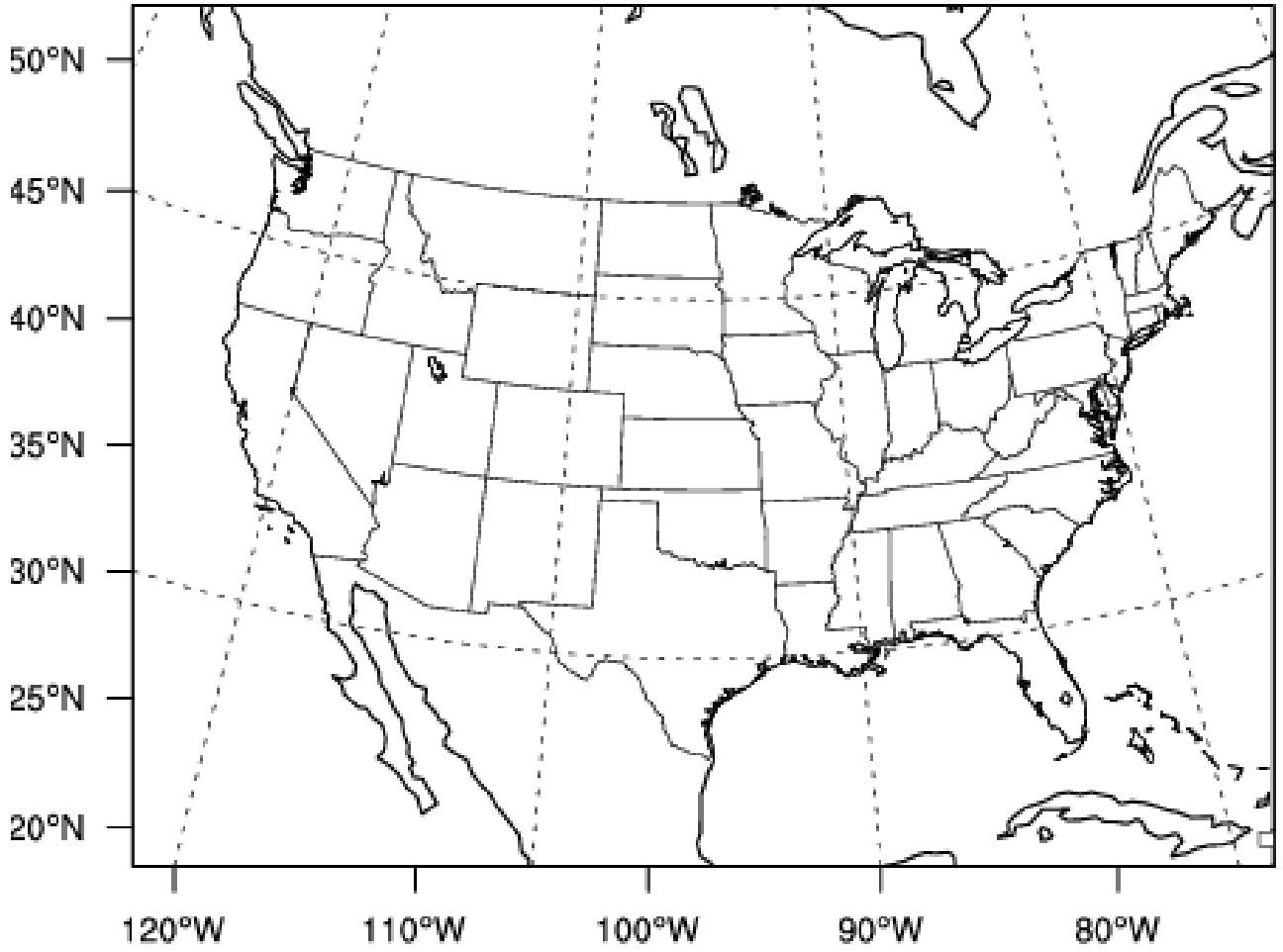


Figure: Schematic diagram showing the various radiative mechanisms associated with cloud effects that have been identified as significant in relation to aerosols (IPCC, 2007)

Simulation Design and Purposes

Index	Model configuration	Purpose
BASE	Baseline simulation with all aerosol feedbacks	Serve as the baseline for SEN1 and SEN2
SEN1	Same as BASE but without aerosol direct feedbacks on shortwave radiation	(BASE - SEN1) show aerosol direct effects
SEN2	Same as BASE but turning off primary aerosol emissions and secondary aerosol formation	(BASE - SEN2) show overall aerosol effects; (SEN1 - SEN2) show aerosol indirect effects (including aqueous-phase chemistry)
SEN3	Simulation running with WRF only	(BASE – SEN3) show impacts of chemistry on meteorological simulation results

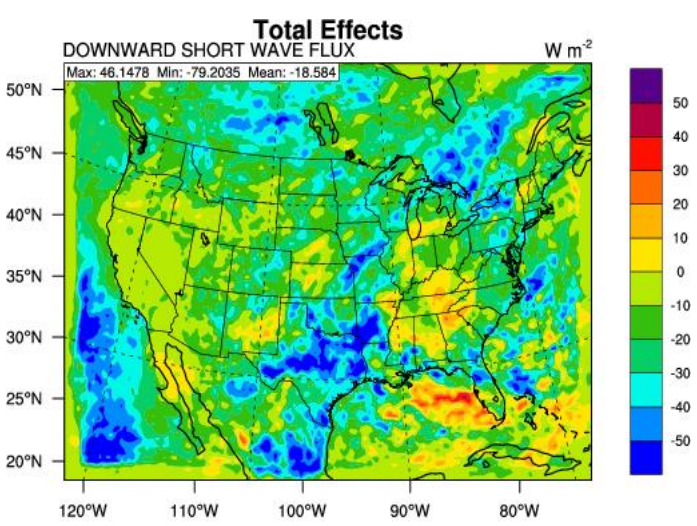
Modelling Domain and Application Time Period



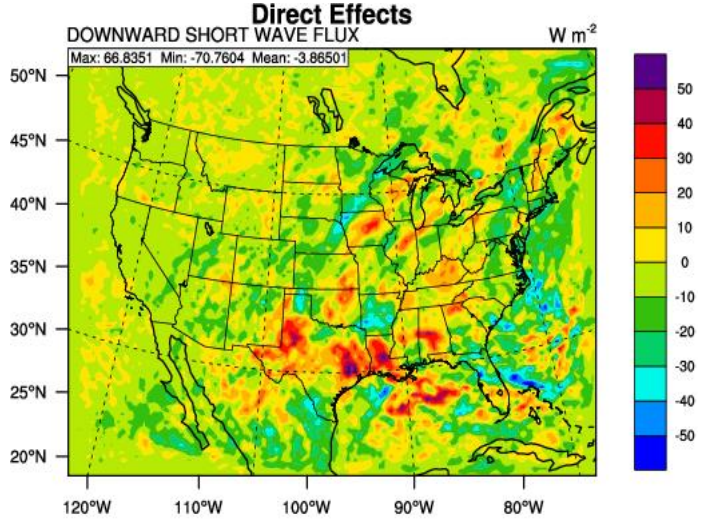
- **The domain: USA**
- **Time period: Jul 1-10, 2010**
- **Resolution: 36-km horizontally and 34 layers vertically**

Aerosol impact on Downward Shortwave flux

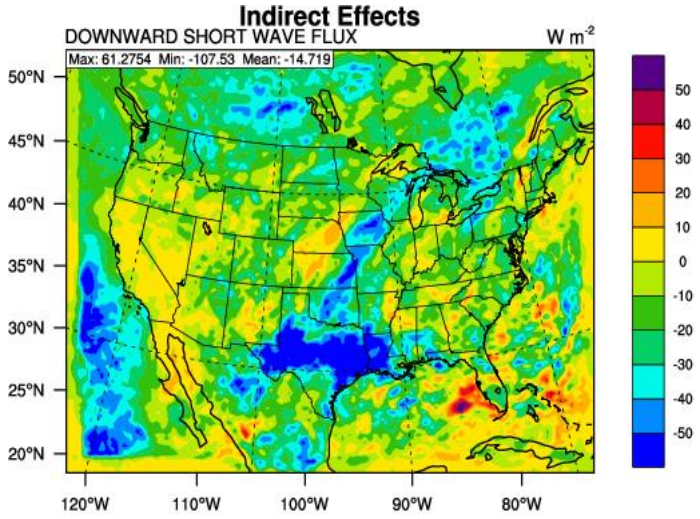
Total



Direct

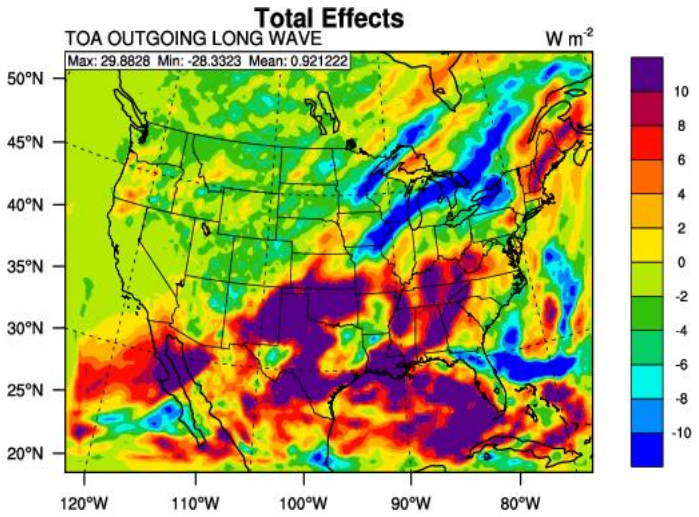


Indirect

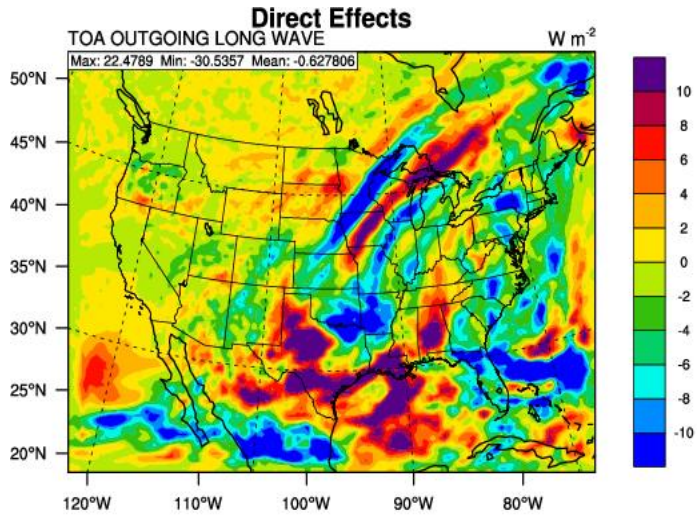


Aerosol impact on Outgoing long wave

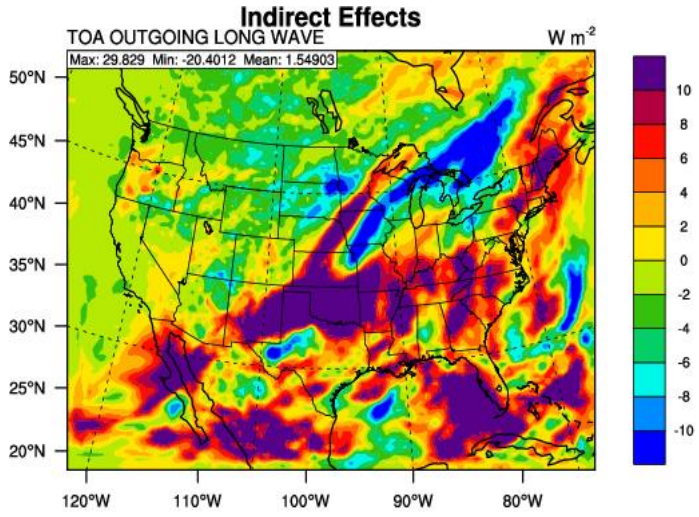
Total



Direct

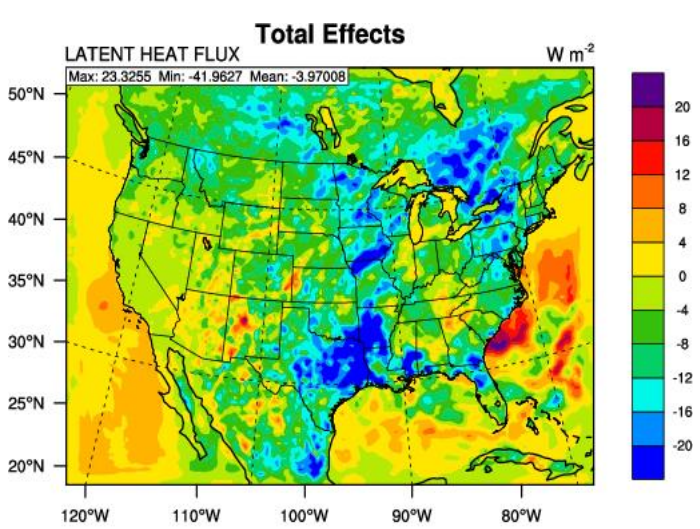


Indirect

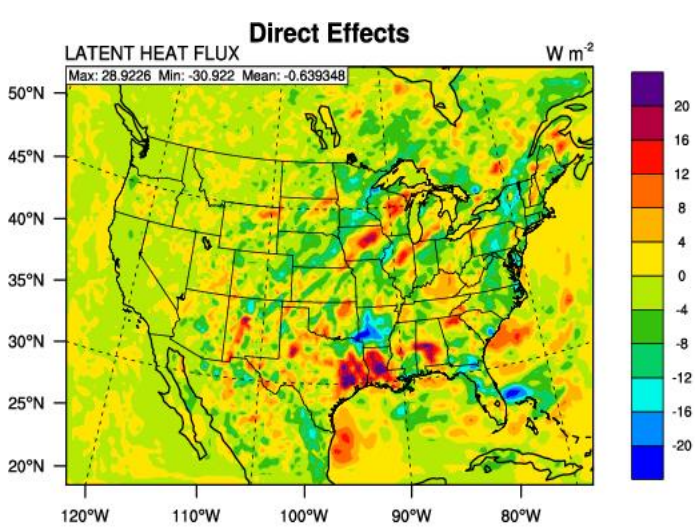


Aerosol impact on latent heat fluxes

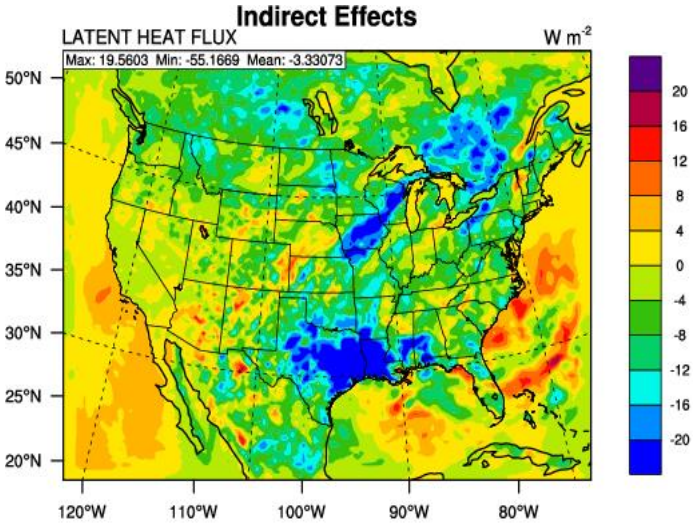
Total



Direct

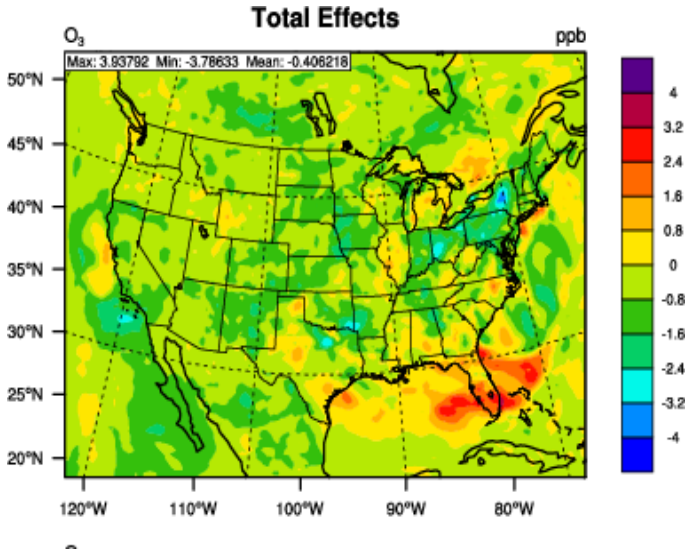


Indirect

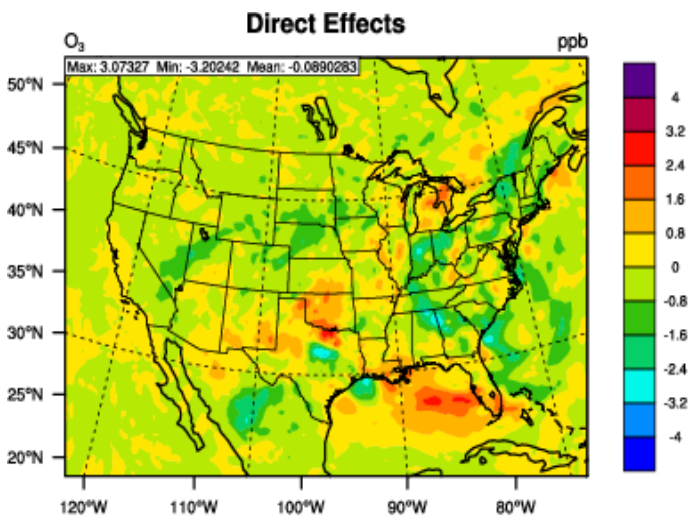


Aerosol impact on O3

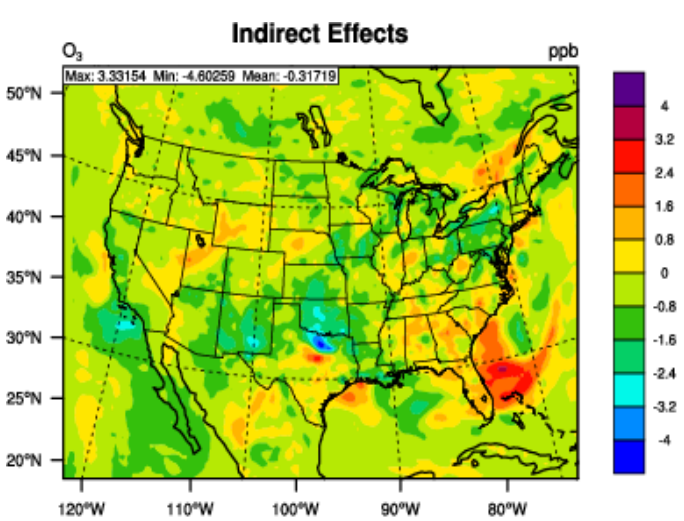
Total



Direct

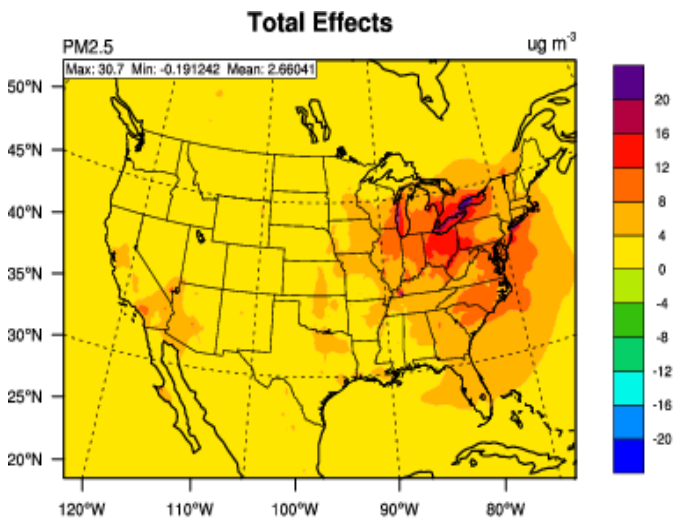


Indirect

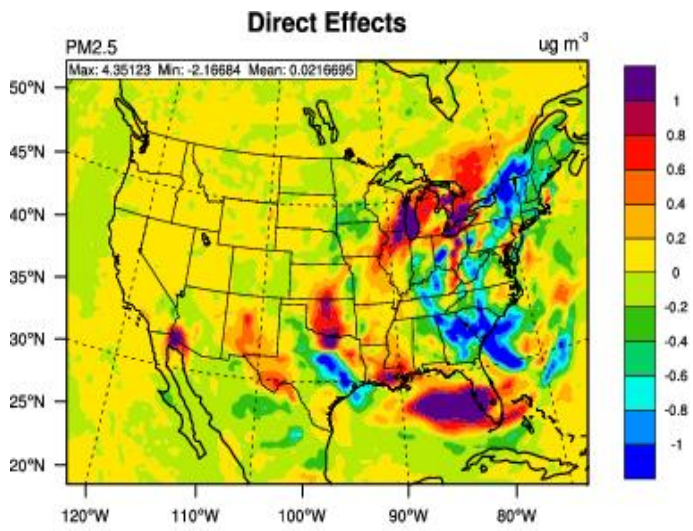


Aerosol impact on PM 2.5

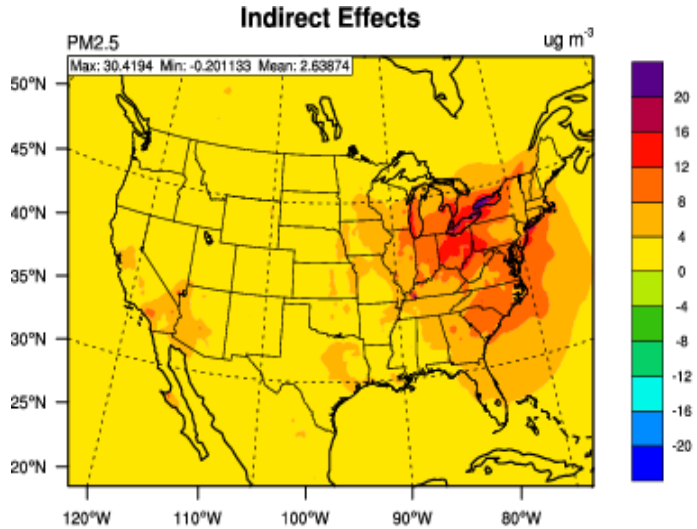
Total



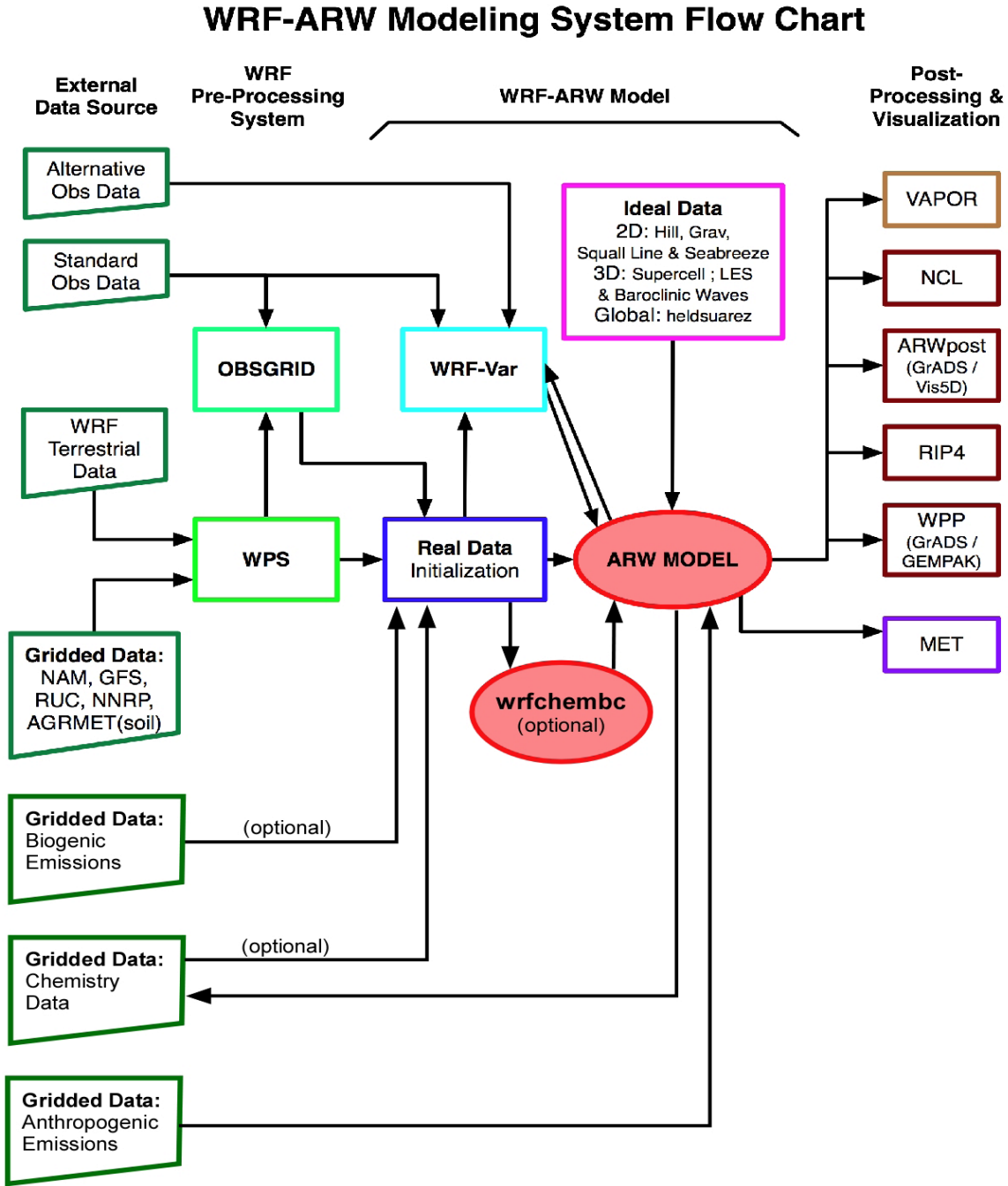
Direct



Indirect



WRF-Chem Tutorial Session



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WRF-CHEM FORECAST FOR AFRICA

Team Members:

1. Sarah Osima
2. Constance Okuku
3. Victor Nthusi
4. David Nganga
5. Mthoni Cindy Kanigi

Instructor:

Prof & Dr. Aboubakar A

INTRODUCTION CONTI...

WRF-CHEM

Real-time air quality forecasting (RT-AQF) is a relatively new discipline in atmospheric sciences, which has evolved as a response to societal and economic needs, reflecting the progress in scientific understanding of physical processes and numerical and computational technologies (Zhang et al., 2012a,b). The Weather Research and Forecasting model with the ARW core has been coupled with chemistry (WRF-Chem), as an efficient and flexible system for weather and air quality forecast. W RF-Chem was developed at NOAA/ESRL (National Oceanic and Atmospheric Administration/Earth System Research Laboratory) and community users.

Main Goal

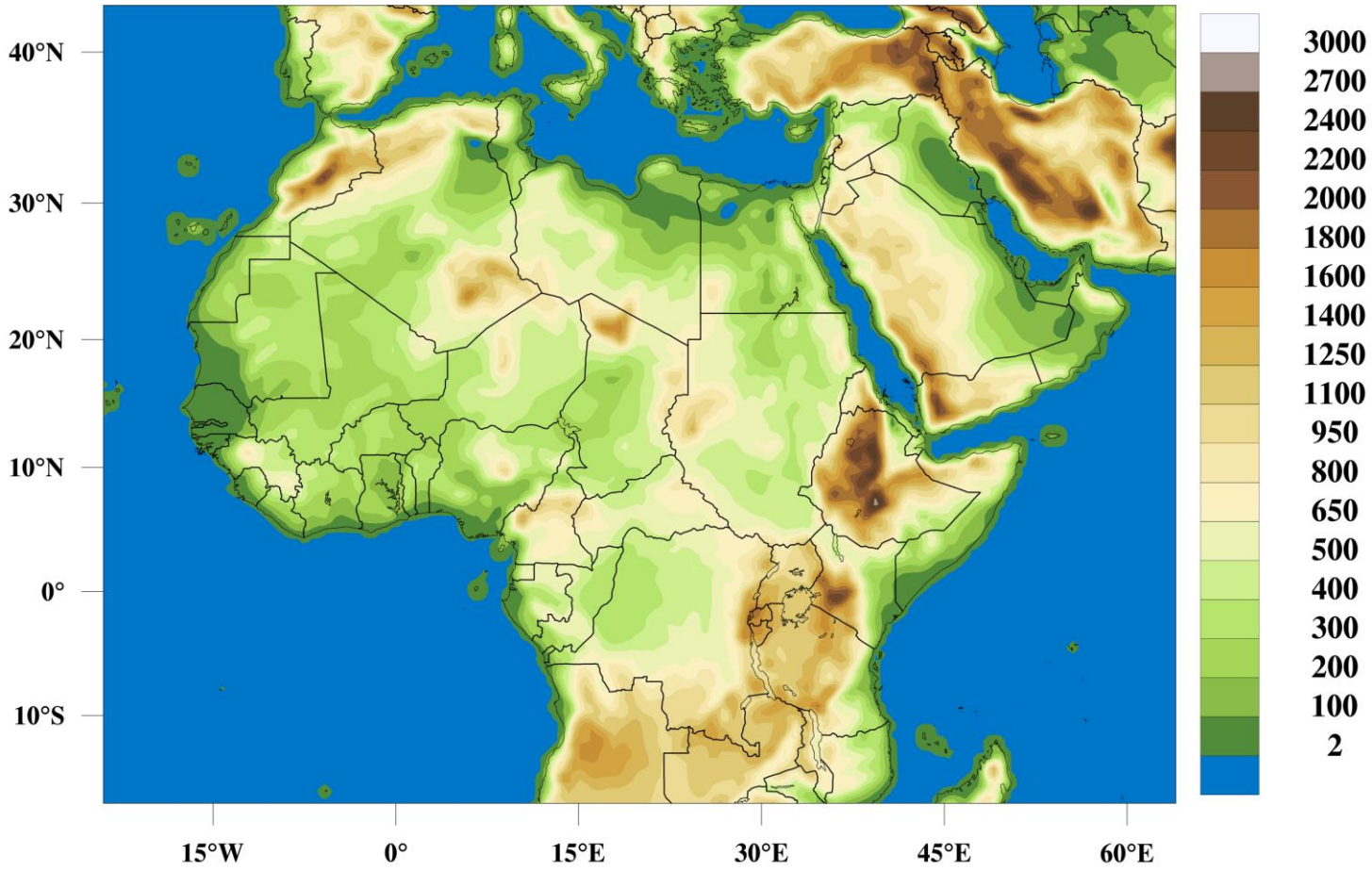
- **Advance African capacity building to improve RT-AQF over Africa using 3-D integrated meteorology-chemistry modeling systems.**
- **Establishing a real time air quality forecasting technique over Africa using 3-D CW-AQF models (WRF-Chem) during the period of 10 – 20 September 2019**

I

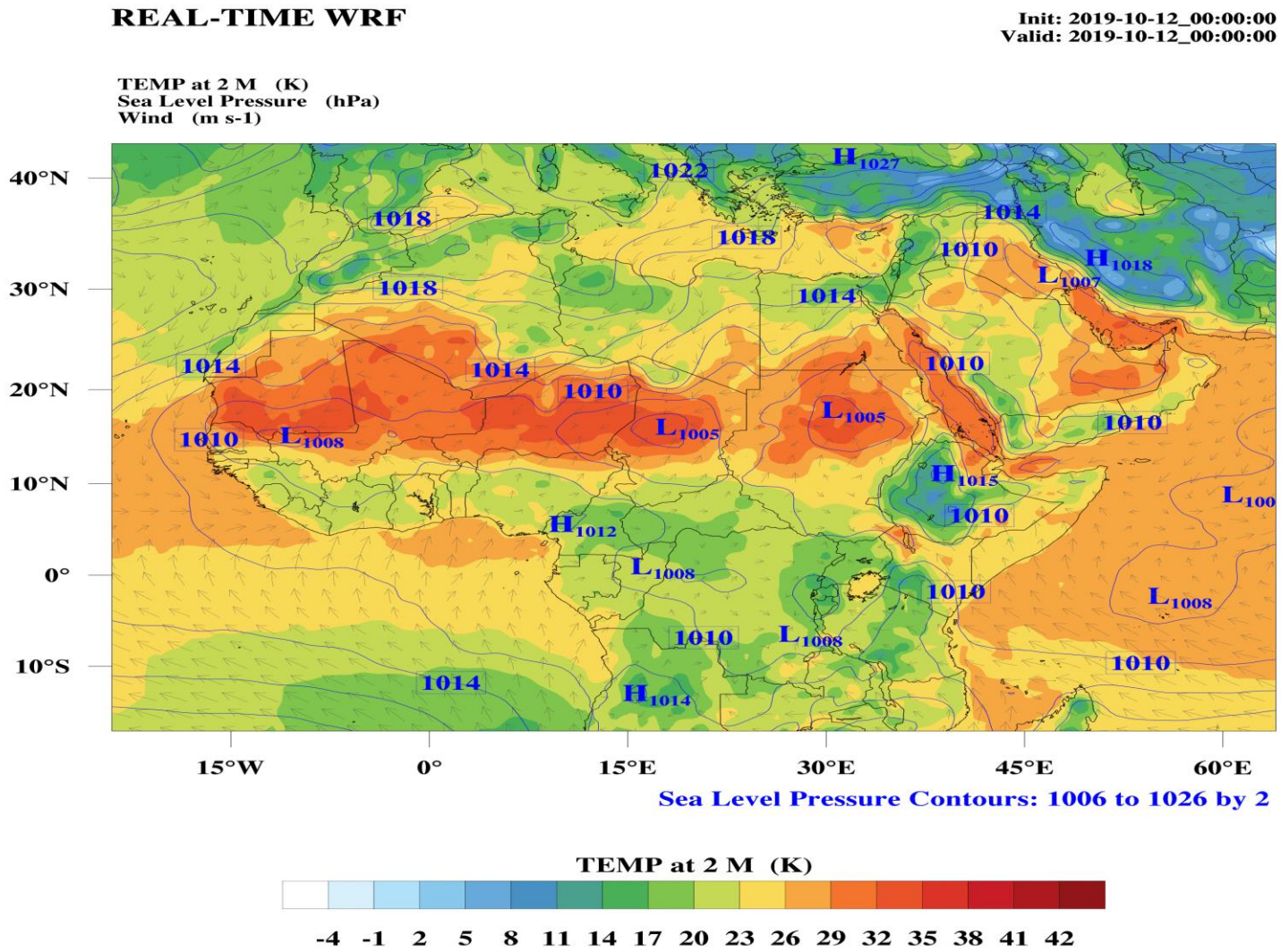
MODEL EXPERIMENT

We present the model experiment results over Africa using 3-D integrated meteorology-chemistry modeling systems.
This is a fover Africa using 3-D integrated meteorology-chemistry modeling systems.

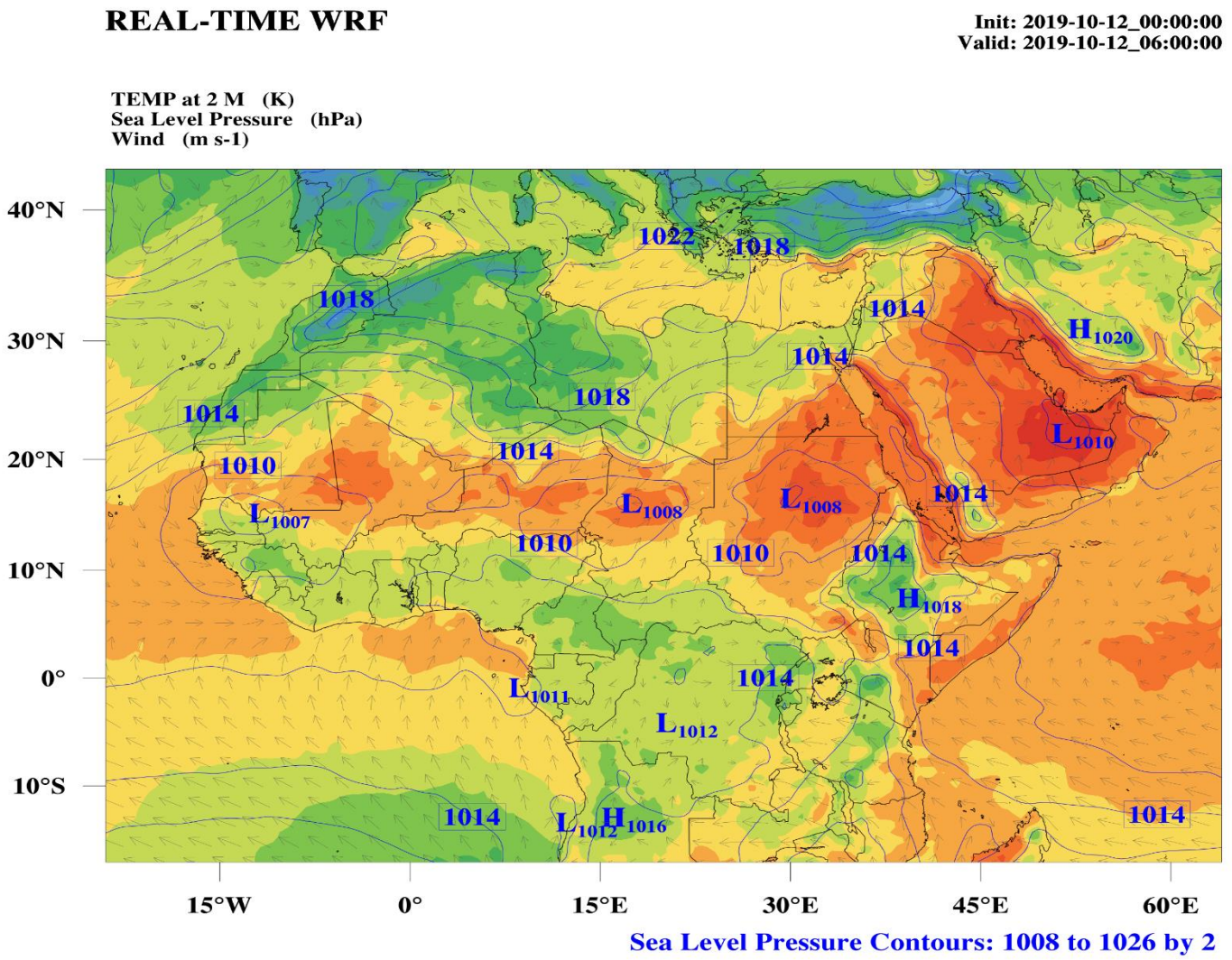
Modelling Domain



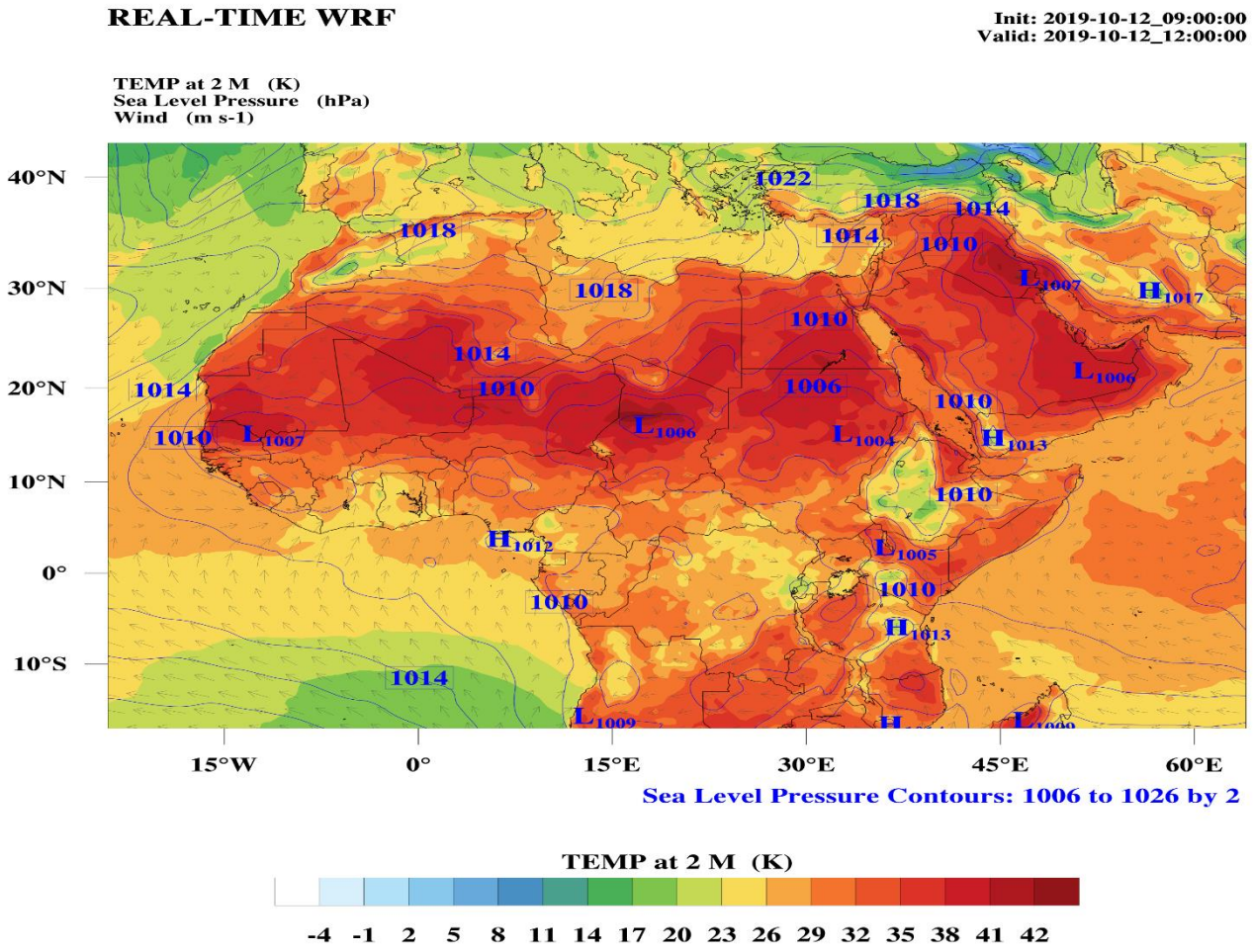
RT TEMP, SLP AND WIND ANIMATION



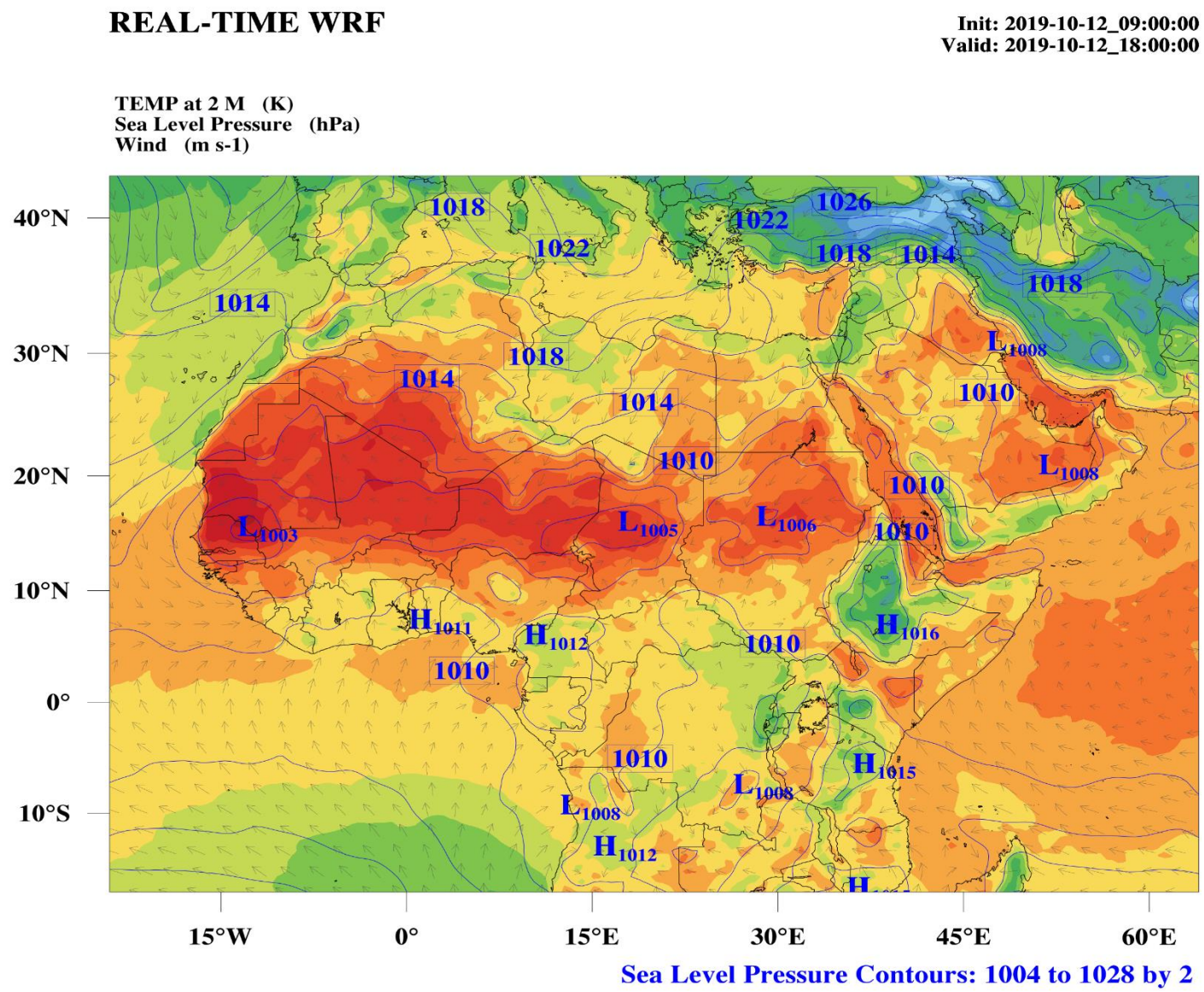
RT FORECAST TEMP, SLP AND WIND AT 6:00



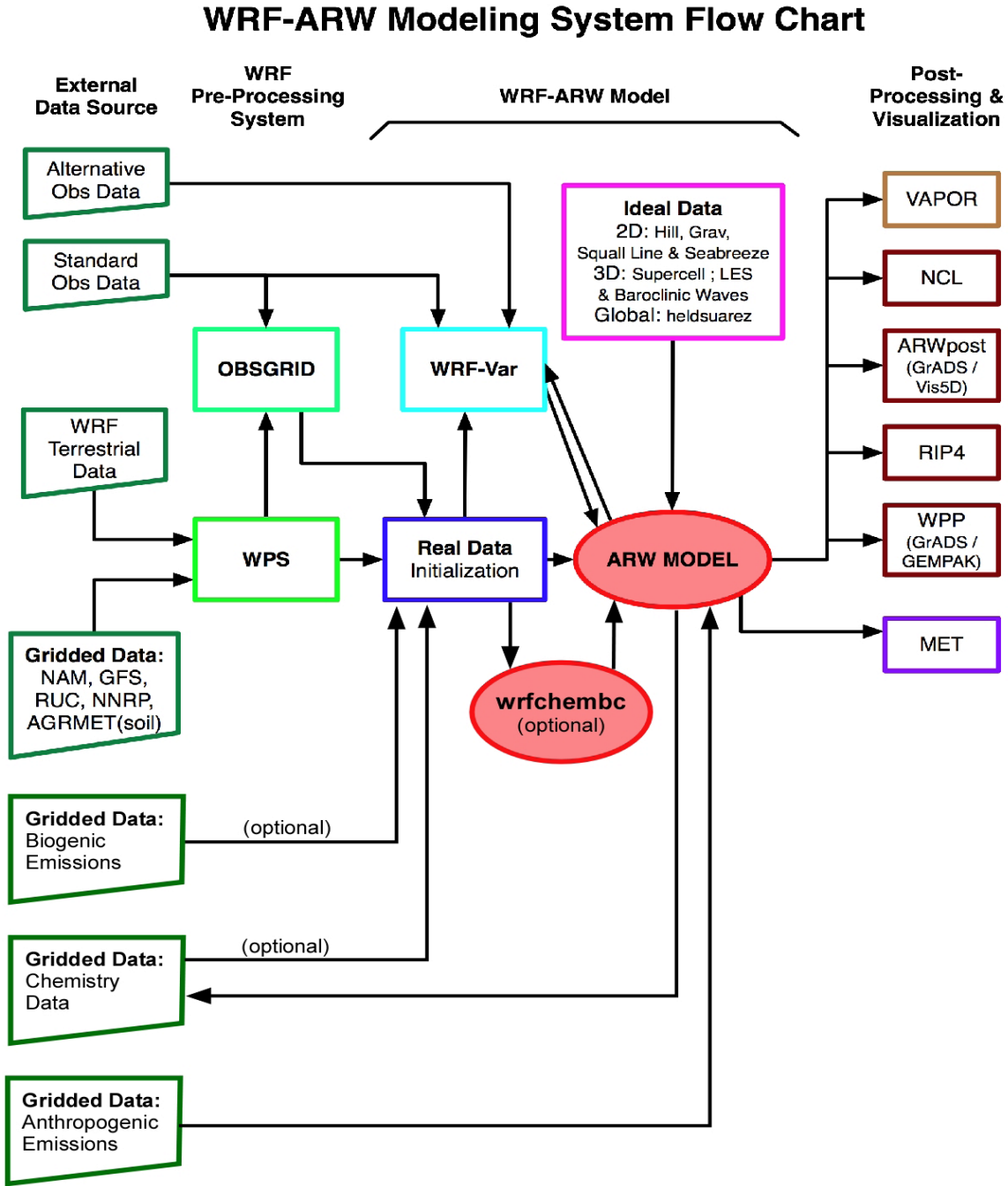
RT FORECAST TEMP, SLP AND WIND AT 1200



RT FORECAST TEMP, SLP AND WIND AT 1800



WRF-Chem Tutorial Session



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WRF-CHEM vs. RCM-Chem Forecasting Intercomparions over AFRICA

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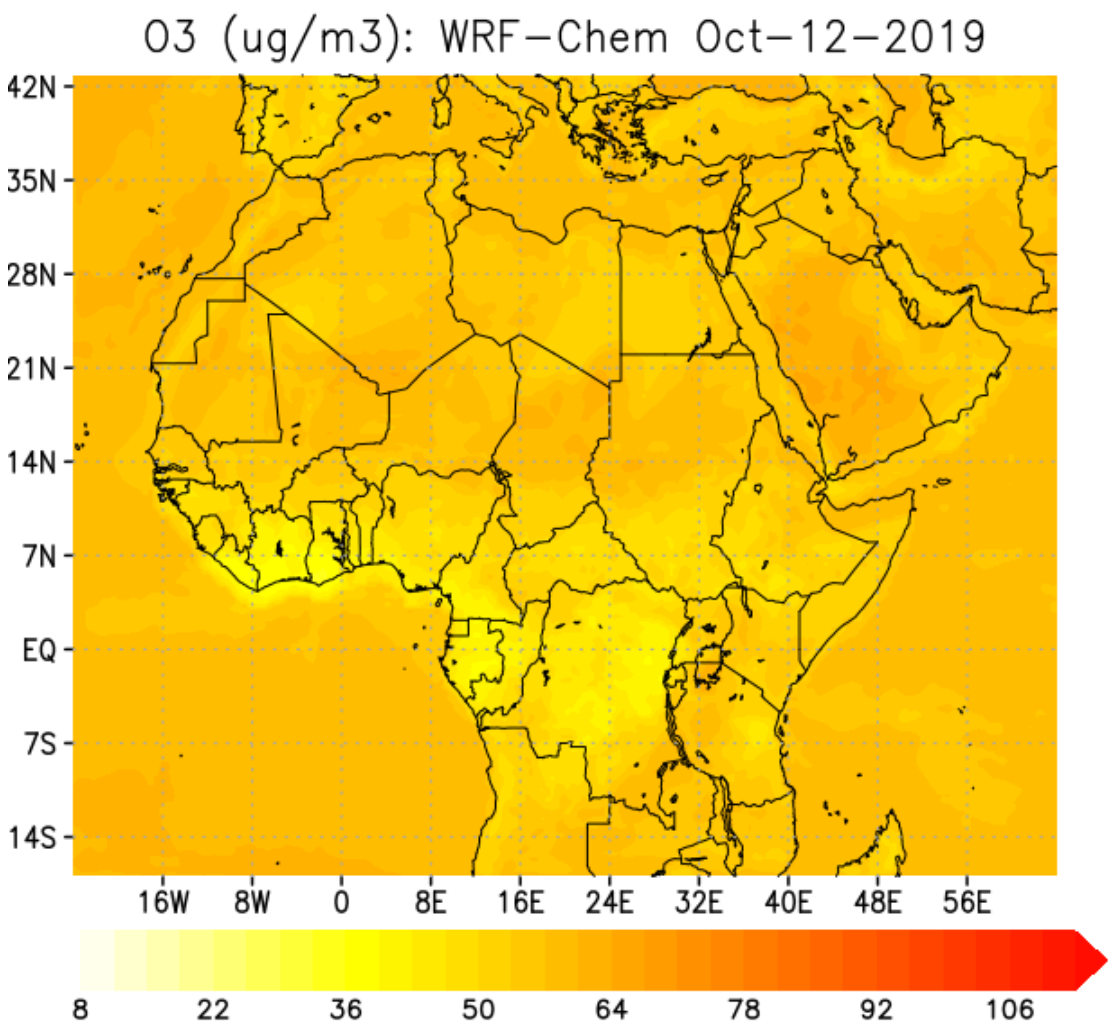
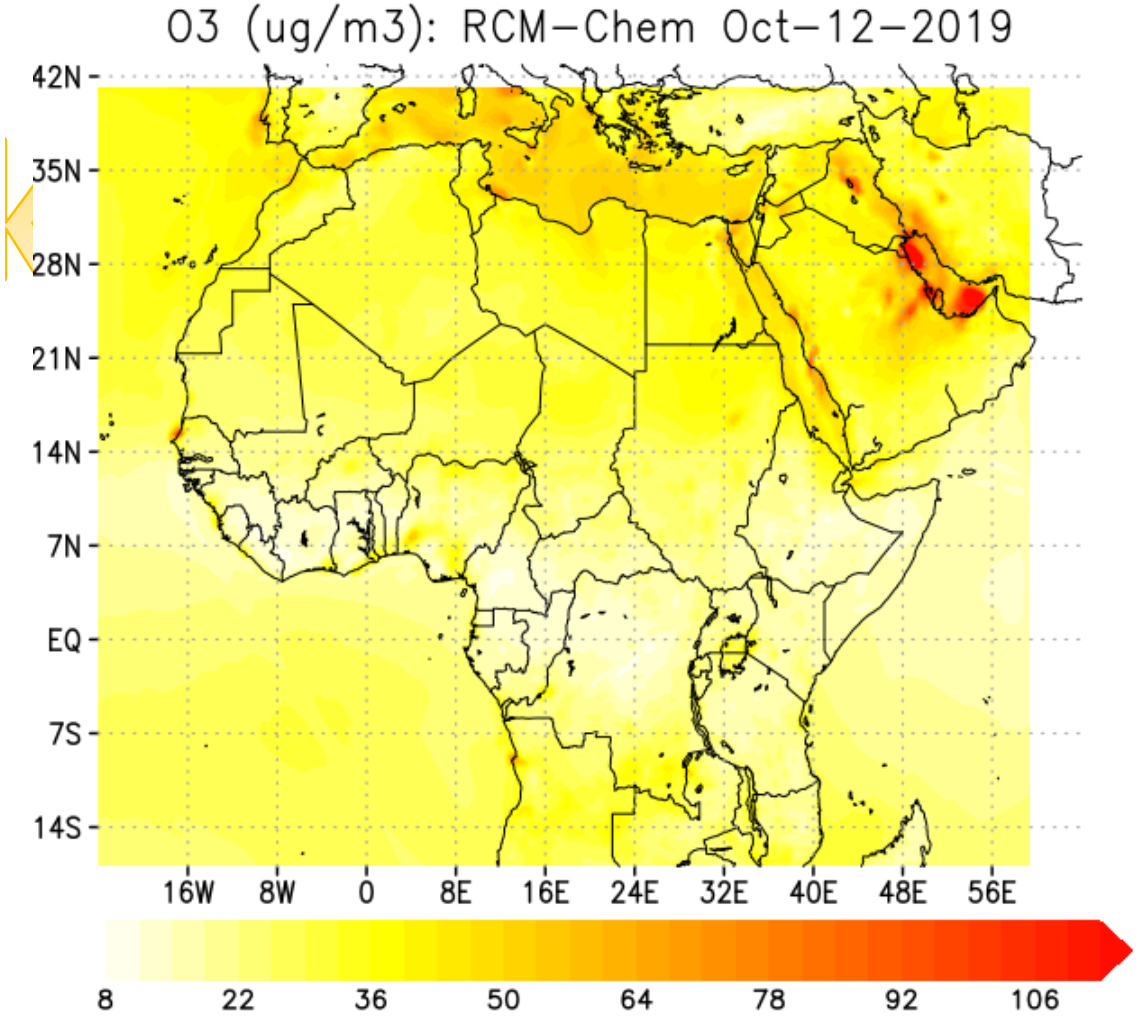
- Dr. Melaku Yigiletu (South Africa)
- Prof. & Dr. Yang Zhang

WRF-Chem vs. RCM-Chem: O_3 Forecast

WRF-Chem

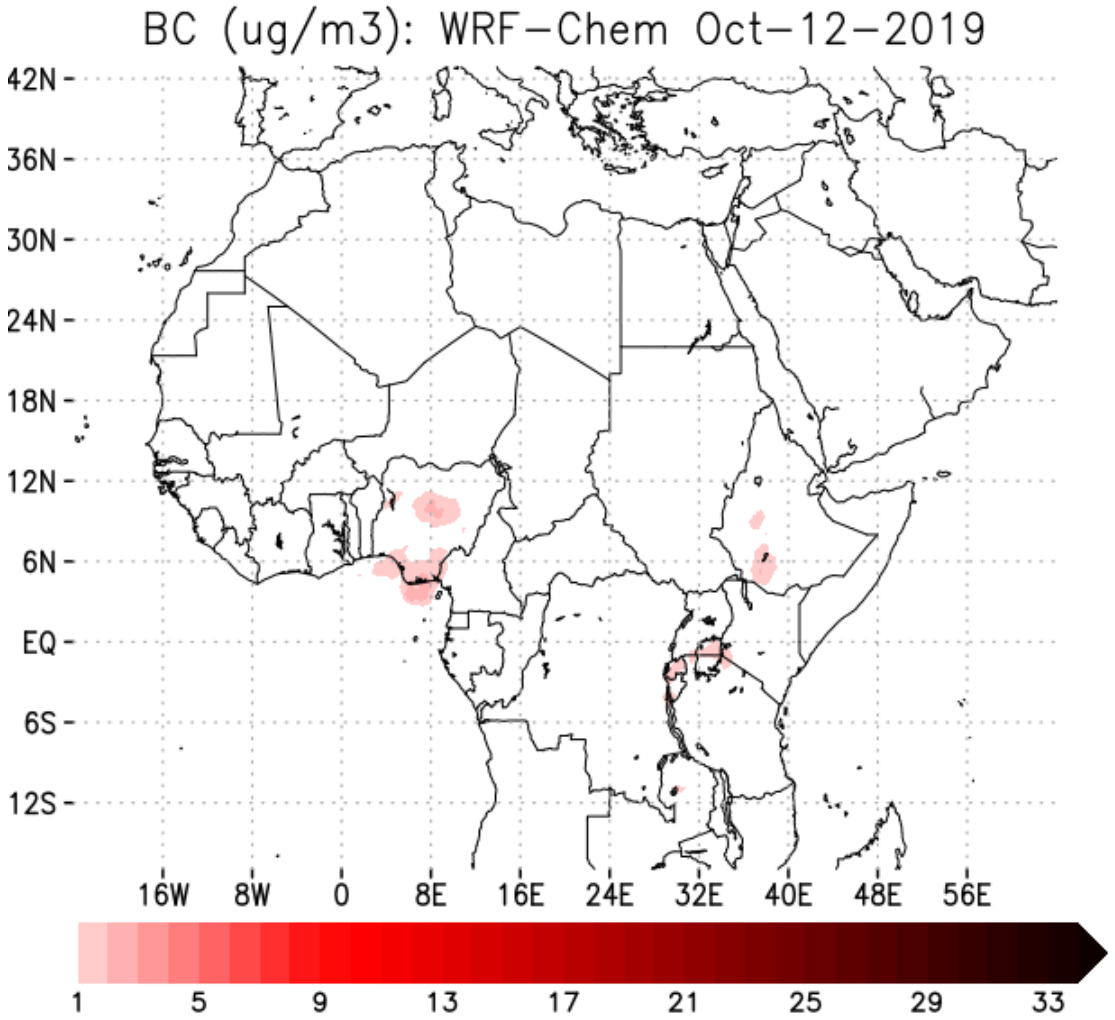


RCM-Chem

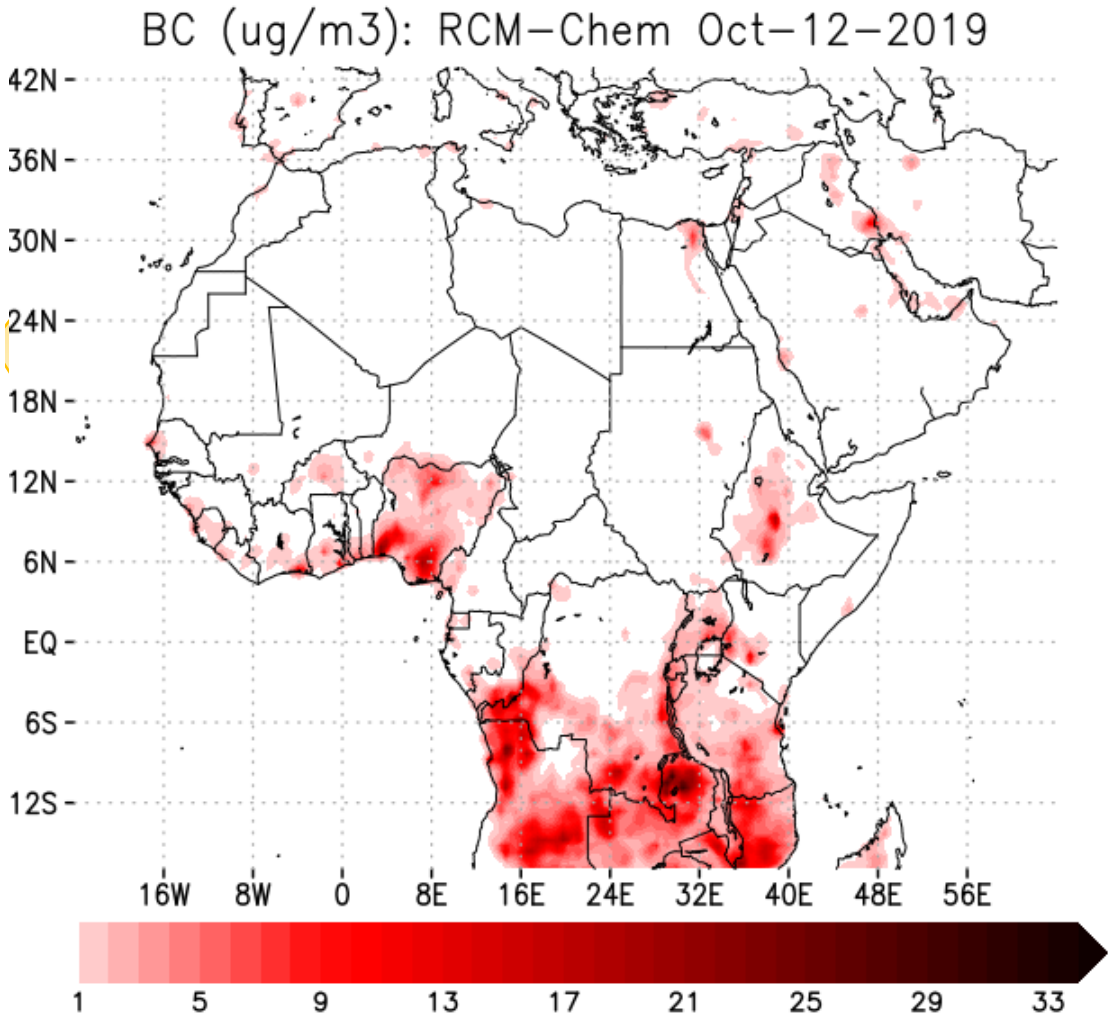


WRF-Chem vs. RCM-Chem: BC Forecast

WRF-Chem



RCM-Chem



Summary & Conclusions

- Aerosol play an important role in forecasting: by inducing radiative forcing and cloud property modification; this affects meteorology, gases and particulate matter
- WRF-Chem is important for forecasting both meteorology and atmospheric composition
- There are significant differences in forecasting O3 and BC using two different models (i.e., WRF-Chem and RCM-Chem). This is mainly because of model configuration, optimization and fire emission formulation
- Overall, the practical's undertaken during the workshop has enhanced the hands-on experience and understanding of the advanced models for air quality forecasting

Acknowledgement

We would like to thank the following:

- **Sponsor: WMO**
- **Organizer: WMO and KMD**
- **PR of each participating country**
- **Instructors:**
  - **Prof. & Dr. Yang Zhang (USA)**
  - **Prof. & Dr. Aboubakr (Beeker) Abdelrehim (Egypt)**
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