Pre-Processing Data for Model Input and Selection of Model Configuration

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World Meteorological Organization's

"Training course on Seamless Prediction of Air Pollution in Africa"

Online webinars, 12-25 September 2024

Outline

- **Types and General Considerations of Air Quality Model Applications**
- **WRF-Chem Testbed over Africa**
  - Model setup and consideration
  - Major Inputs for WRF-Chem
  - Chemistry and Aerosol Options in WRF-Chem
  - Goal of Hands-on Training
- **Preprocessing Inputs for African Testbed**
  - Overview of Specific Inputs for WRF-Chem
  - Initial and boundary conditions
  - Biogenic emissions
  - Fire emissions
  - Anthropogenic emissions
- **Summary**

Major sources: WRF-Chem Users' Guide, Tutorials, Jacobson (2005), Zhang (2024)

Types of Application of Air Quality Models (Zhang, 2024)

- **Retrospective Applications**
  - Reproduce historical pollution episodes to gain insights into factors controlling pollutant concentrations
  - Identify the areas of model improvement to enhance model's capabilities
- **Advanced Probing Applications**
  - Quantify contributions of source area A to receptor B or impact of source sector C on the concentration at B through source appointment
  - Perform process analysis to understand the most influential process for key pollutants
  - Conduct simulations with different emission scenarios to develop cost-effective air pollution control strategies
- **Air Quality/Climate Forecasting**
  - Forecasting future air quality/climate change (short-term or long-term)
  - Evaluate the impact of emission control strategies on future air quality and human life
  - Design, plan, and analyze field experiments
- **Integrated Eco-Environmental-Health Studies or Earth system modeling**
  - Integrated air quality, human health, and climate modeling system
  - Integrated eco-environmental modeling system (e.g., atmosphere, land, ocean, economy, risk/probability analysis, societal impact, etc.)
  - An atmospheric component model in the Earth system models

Steps in 3-D Air Quality Model Applications (Jacobson, 2005)

1. Define purpose of model
2. Determine scales of interest
3. Determine dimension of model
4. Select physical, chemical, dynamical processes treated
5. Select variables
6. Select computer architecture (scalar vs. vector, single vs. parallel, shared vs. distributed memory)
7. Write code for model or choose an existing model
8. Optimize memory and speed of model
9. Select time steps and time intervals
10. Set initial conditions
11. Set boundary conditions
12. Select input data
13. Select ambient data for comparison
14. Interpolate data and model results for inputs and outputs
15. Select or write algorithms for statistics and graphics
16. Run model simulations
17. Run sensitivity tests
18. Improve model based on results

WRF and WRF-Chem

Weather Research and Forecasting (**WRF**) model

- Numerical weather prediction model
- Scalable: from global to local scale
- Flexible: different physics and chemistry options
- Integrates physical processes: radiation, cloud microphysics, planetary boundary layer, …
- Open-source developed by a collaboration of research institutions: scientific challenges
- Applications: severe weather forecasting, climate studies, input for other air quality models, …

WRF coupled with Chemistry (**WRF-Chem**)

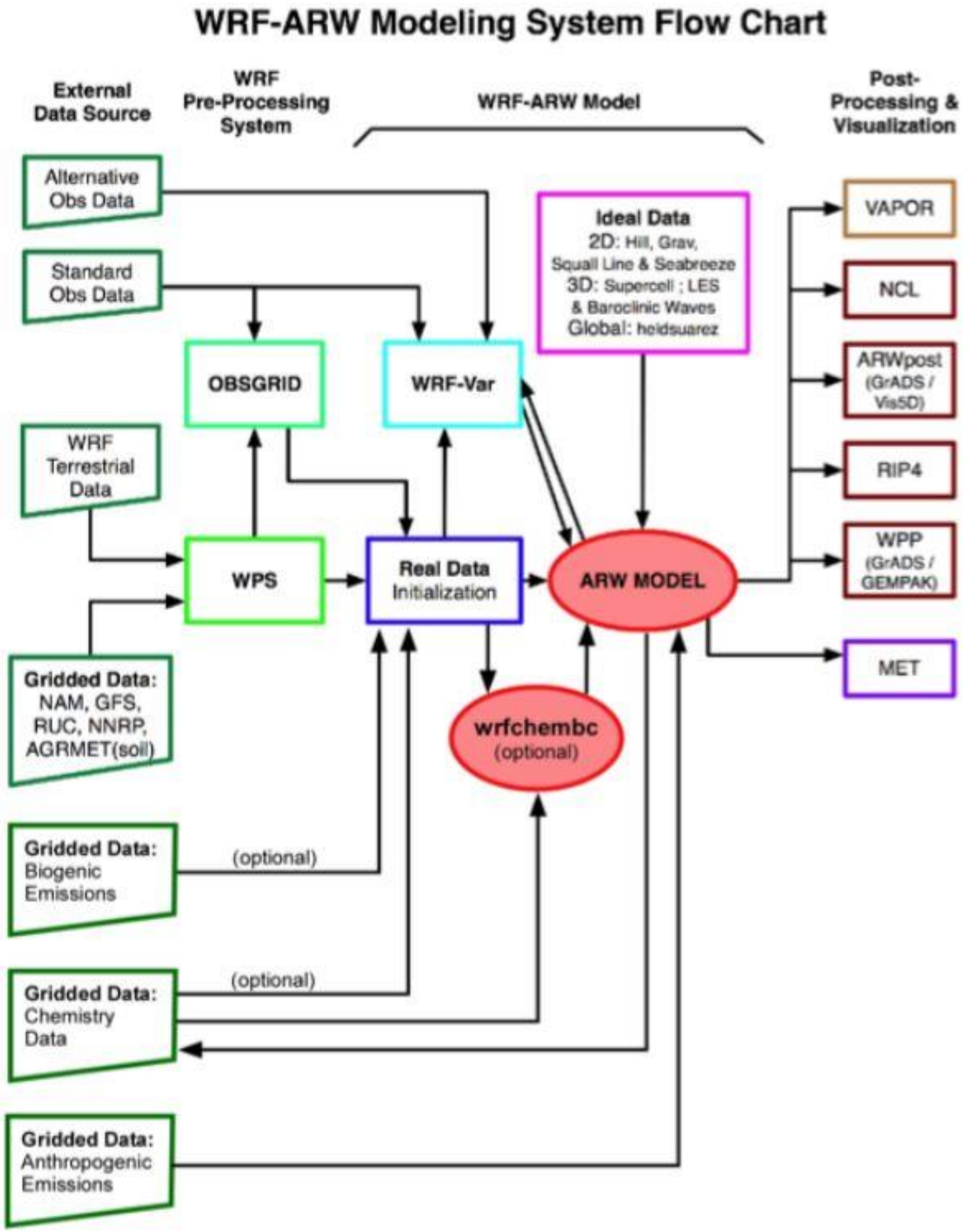
- Simulates gas-phase chemistry, aerosols, and meteorological-chemical interactions
- Key applications:
  - Study air quality and track pollutants
  - Interactions between weather and chemical processes
  - Understanding impacts of climate change
  - Modeling and forecasting urban air pollution
  - Tracking hazardous emissions: wildfires, industrial activity, transportation, …

Emissions

- Anthropogenic emissions
- Biomass emissions
  - 4 options
- Online modules
  - Biogenic emissions (4 options)
  - Dust emissions (4 options)
  - Sea-salt emission

Other inputs

- Topographical data
- Land use
- Soil moisture
- Initial and boundary conditions
- Chemistry data
  - Chemical-rate coefficients
  - Cross-section and quantum yield data
  - Activity-coefficient data



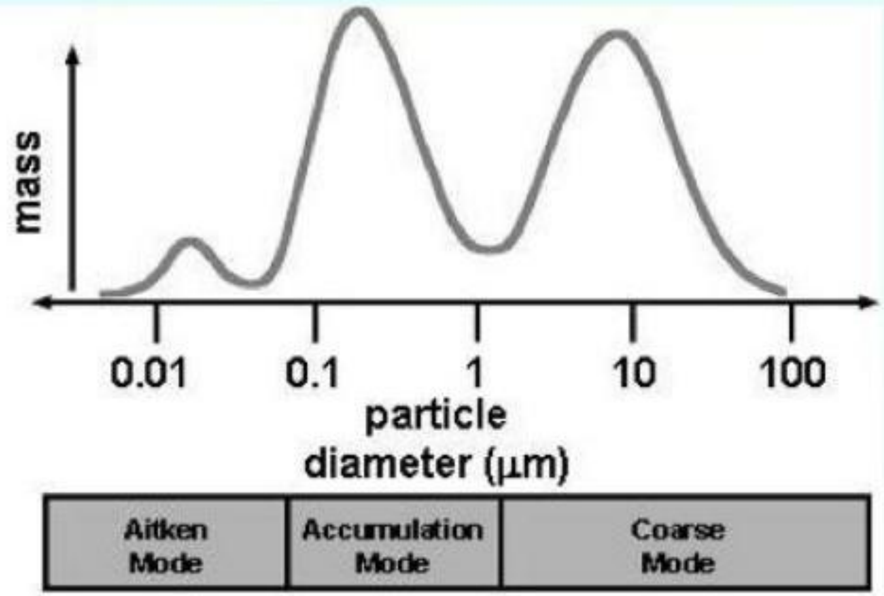
Options for Gas-Phase Chemical Mechanism (Ahmadov et al., 2018)

- ✓ Regional Acid Deposition Model, 2nd generation (RADM2)
- ✓ Regional Atmospheric Chemistry Mechanism (RACM)
- ✓ RACM - Mainz Isoprene Mechanism (RACM-MIM)
- ✓ RACM - Earth System Research Laboratory (RACM-ESRL), *updated RACM-MIM*
- ✓ Carbon-Bond Mechanism version Z (CBM-Z)
- ✓ Carbon-Bond Mechanism (CB05)
- ✓ Model of Ozone and Related Chemical Tracers (MOZART)
- ✓ Statewide Air Pollution Research Center (SAPRC99)
- ✓ Common Reactive Intermediates gas-phase Mechanism (CRIMech)

different implementations, coupled to different aerosol schemes and aqueous chemistry, suitable for different applications ranging from regional air quality to global atmospheric chemistry simulations

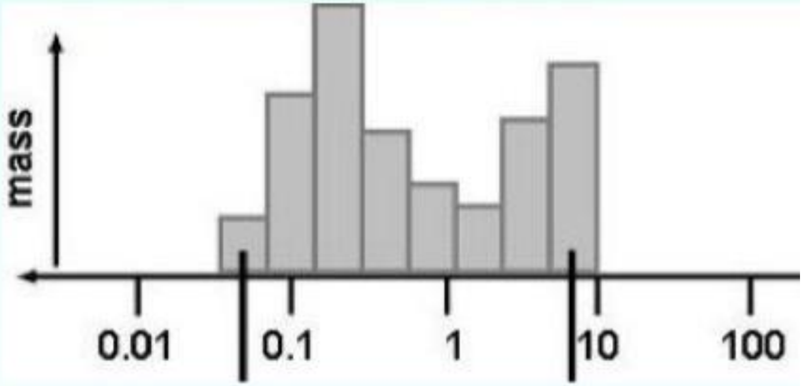
Available Aerosol Modules (Ahmadov et al., 2018)

(3) Modal



composition
sulfate
nitrate
ammonium
chloride
carbonate
sodium
calcium
other inorganics
organic carbon
elemental
carbon

(4) Sectional



Modal and sectional schemes may be too expensive in operational NWP settings – but important in research and for air quality forecasting

Available Chemistry-Aerosol Options (Ahmadov et al., 2018)

Chemical mechanisms	*Fixed versions*	*KPP*	*Coupled aerosol schemes*	*Indirect effect*
RADM2	Yes	Yes	MADE/SORGAM, GOCART	MADE/SORGAM with aqueous phase chemistry
RACM	-	Yes	MADE/SORGAM, GOCART	MADE/SORGAM with aqueous phase chemistry
RACM-MIM	-	Yes	-	-
RACM-ESRL	-	Yes	MADE/SORGAM, MADE/SOA_VBS	-
CBM-Z	Yes	Yes	MADE/SORGAM, MOSAIC, MAM	4bin/8bin with aqueous phase chemistry; CAM5 -MAM and aqueous phase chemistry
CB05	-	Yes	MADE/SORGAM	with aqueous phase chemistry
MOZART	-	Yes	GOCART, MOSAIC	-
SAPRC99	-	Yes	MOSAIC	8bin with aqueous phase chemistry
CRIMech	-	Yes	MOSAIC	4bin/8bin with with aqueous phase chemistry

General Consideration (Ahmadov et al., 2018)

- **Am I following the WRF best practices for my domain?**
- **What chemistry option should I use for my project?**
  - Research or forecasting?
    - What is my computational power?
    - How quickly do I need a solution?
  - What horizontal and vertical resolution may be required to resolve important features?
    - Meteorology and chemistry might be different
  - Do I have appropriate emissions inventory (if necessary)?
    - Speciation for chemical mechanism correct?
    - Adequate spatial and temporal resolution?

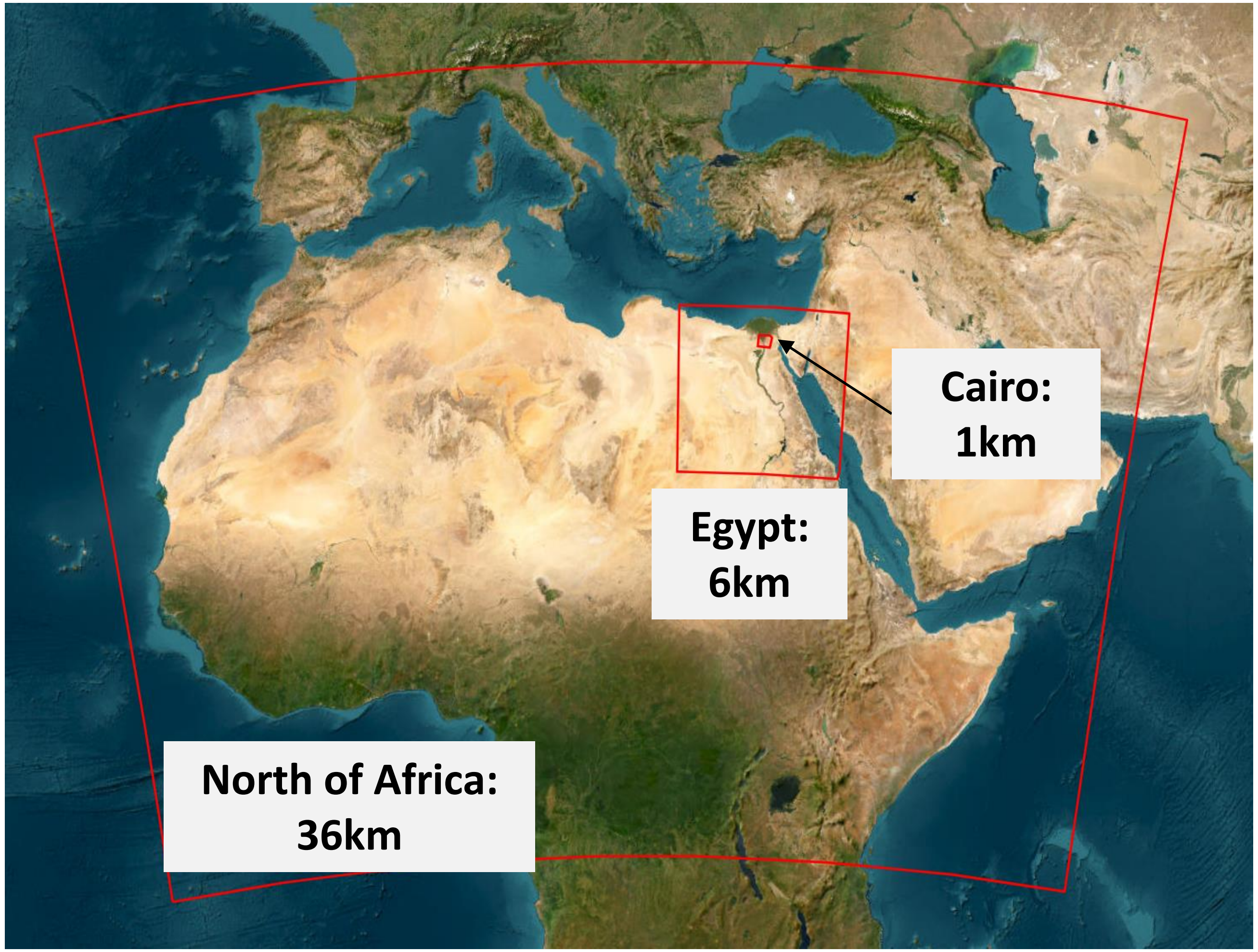
General Consideration (Ahmadov et al., 2018)

- **What chemistry option should I use for my project?**
  - What process do I want to simulate?
    - Dispersion?
      - may include any tracer (dust, smoke, hazardous constituents,...), computing costs from a little more to about 2x plain WRF run
    - Air Quality?
      - usually requires gas-phase chemistry as well as aerosol modules, computing costs more than 5x plain WRF run with little upper limit
    - Fully interactive weather/climate and chemistry/aerosols?
      - Interaction of aerosols with radiation (direct and resulting semi-direct effect) could be anywhere between 2x to more than 100x plain WRF run;
      - indirect effect 10x to more than 100x plain WRF run.
  - Do I have appropriate initial and boundary conditions?
    - Spin-up time for chemistry (enough computational power)?

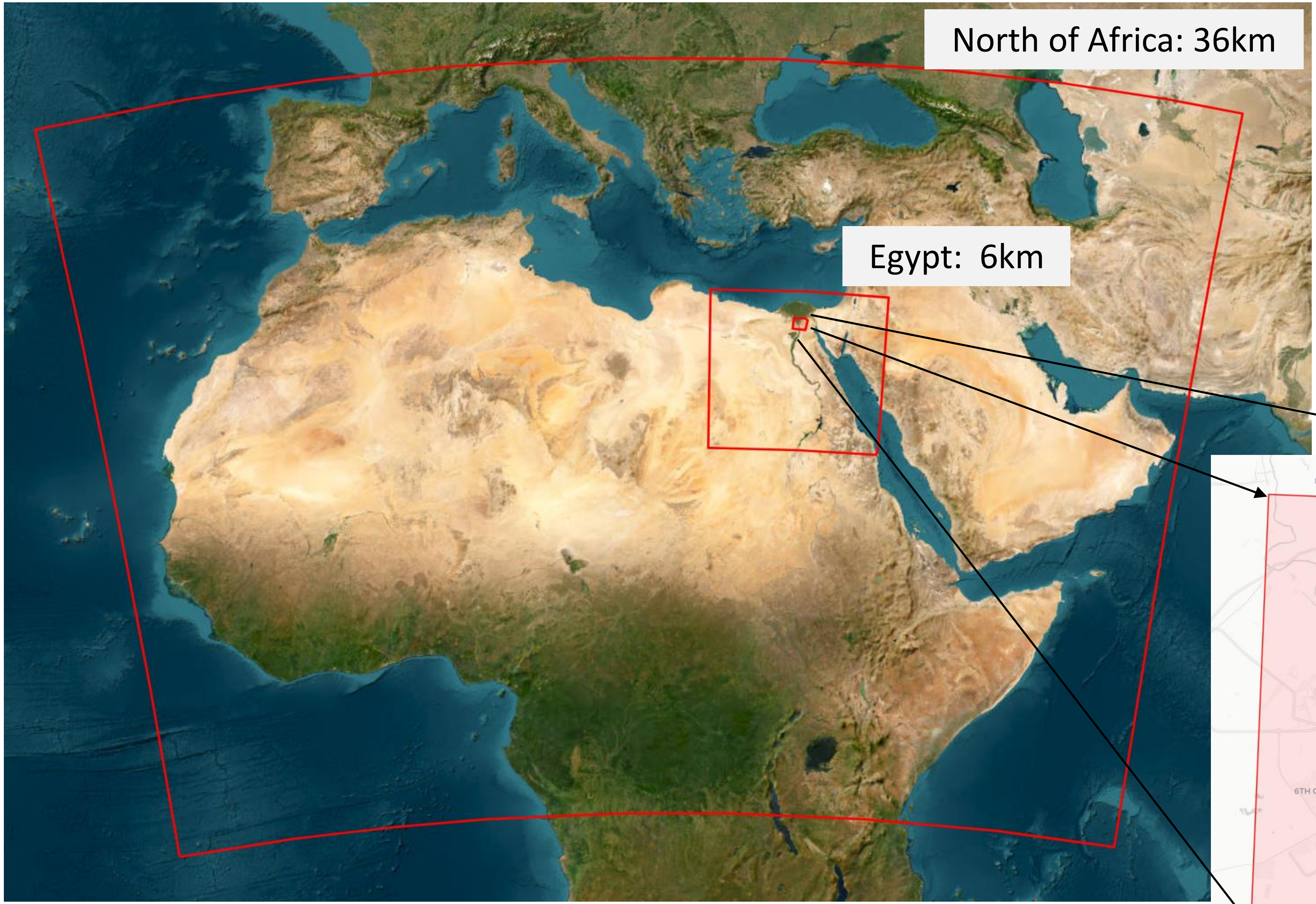
Application of WRF-Chem over Africa (Zhang et al., 2024)

Objectives: Develop model testbed for WMO Training course and demonstrate model performance

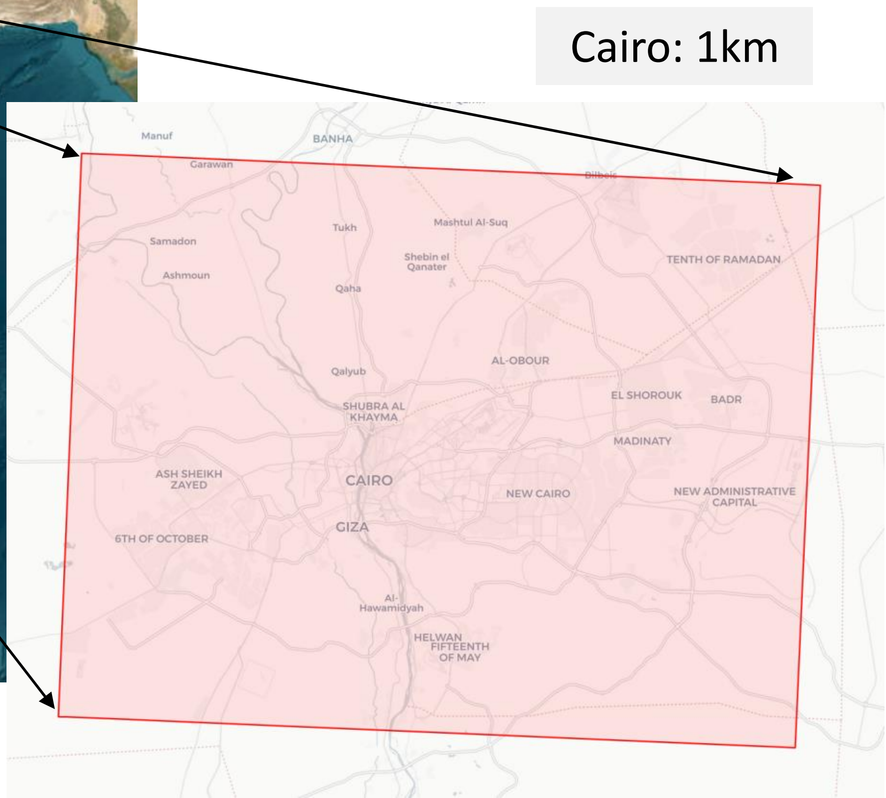
WRF-Chem	version 4.6.0 (released in May 2024)
Simulation Period	January, March, April 2023
Grid Resolution	36-6-1 km
Anthropogenic Emissions	EDGAR version 8.1
Initial/Boundary Cond.	10-day spinup, Whole Atmosphere Community Climate Model (**WACCM**)



Triple-nested Modeling Domains



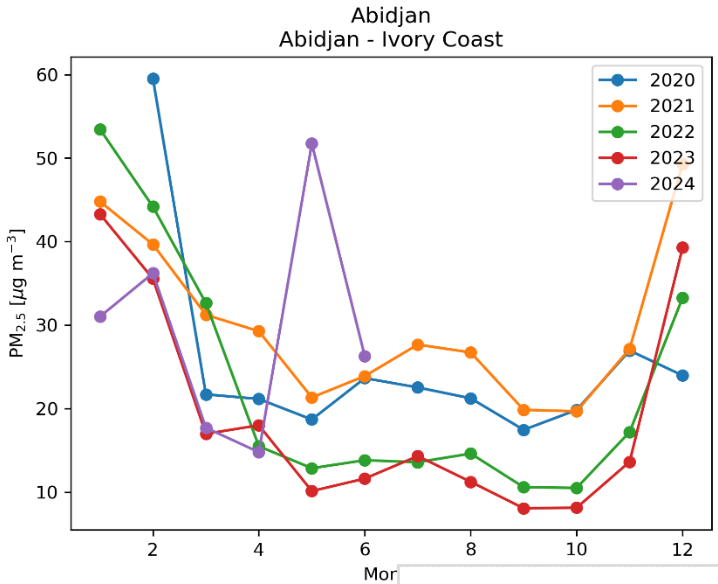
DOMAIN	OPTION
Grid spacing	36-km / 6-km / 1-km
Grid size of d01	229 ×162
Grid size of d02	217 × 199
Grid size of d03	103 × 79
Vertical resolution	35 layers

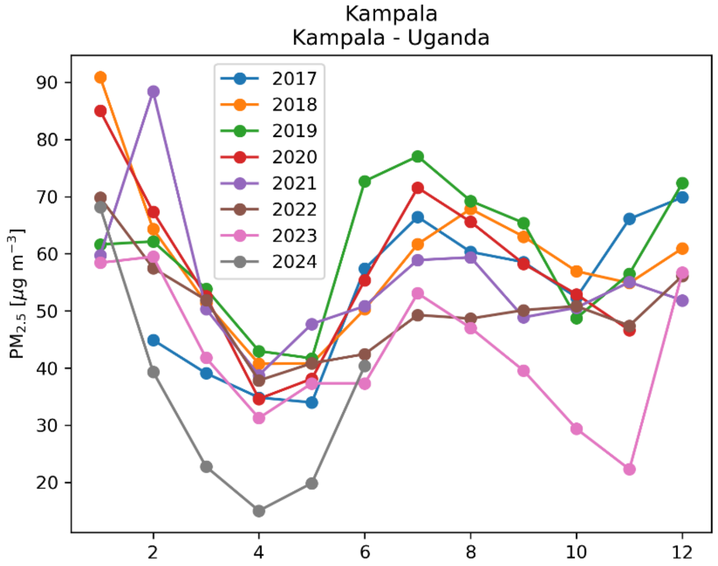


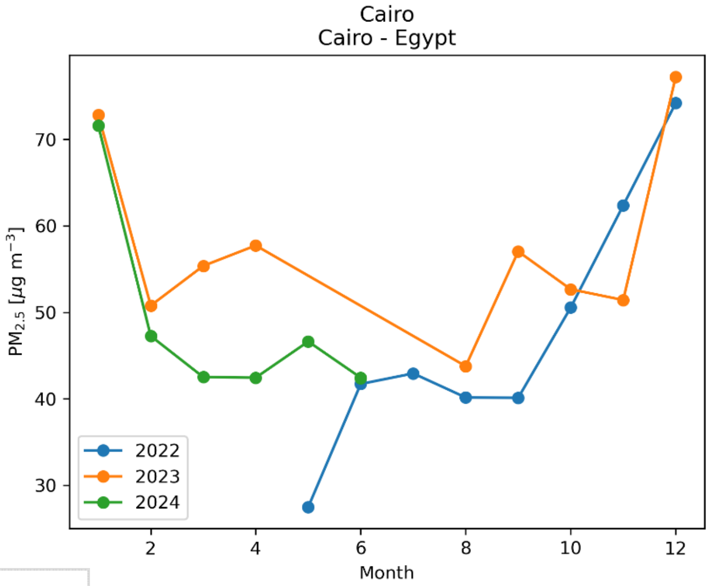
Important Considerations for Testbed Design (Zhang et al., 2024)

- **Jan:** High $PM_{2.5}$ due to strong inversions and of agriculture waste burning
- **March/Apr:** high PM_{10} from dust storms due to khamaseen depressions
- D01 allows simulations of impacts of long range transport from Europe, D03 captures urban phenomena

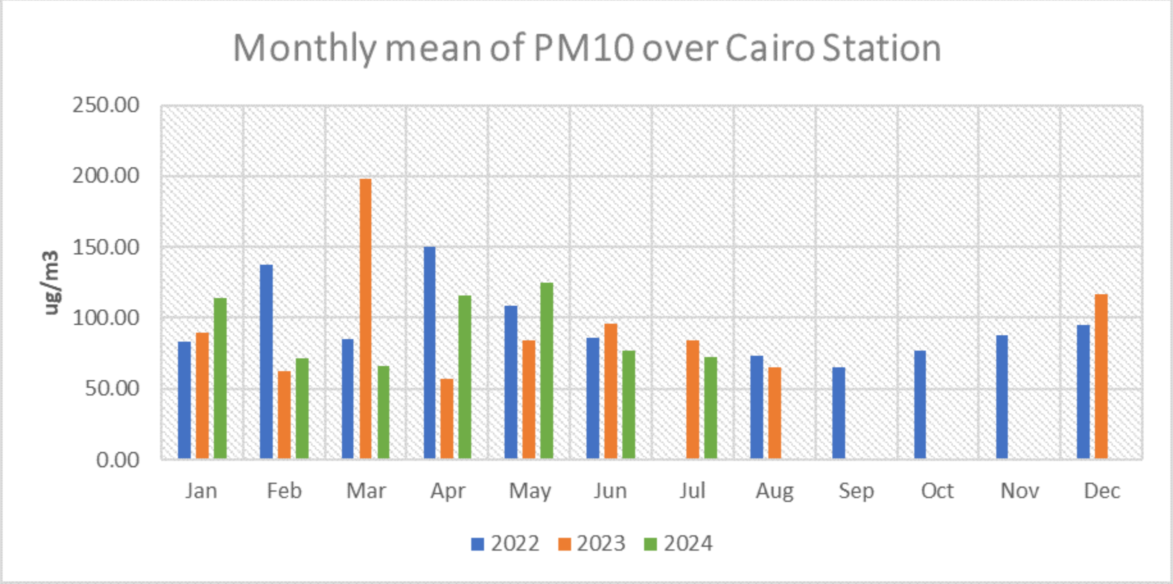
$PM_{2.5}$ data from AirNow processed by Khanh Do, NU







PM_{10} data from Zeinab Salah Mahmoud Abdullah, EMA, 2024



WRF-Chem Version 4.6.0: Model Configuration

PARAMETER	OPTIONS
Shortwave radiation	RRTMG shortwave (Iacono et al., 2008)
Longwave radiation	Updated RRTMG scheme (Iacono et al., 2008)
Cloud microphysics	Lin et al. Scheme
Surface layer	Pleim-Xiu (Pleim, 2006)
Land surface	Pleim-Xiu Land Surface Model (Pleim & Xiu, 1995, 2003; Xiu & Pleim, 2001)
Boundary layer	ACM2 PBL (Pleim, 2007)
Cumulus clouds	Tiedtke scheme (Tiedtke, 1989; Zhang et al., 2011)
FDDA	All domains / all layers outside PBL; grid nudging 6h interval for 109 hours; guv = 0.0003 gt = 0.0003 gq = 0.00001
Gas-phase chemistry	2005 Carbon Bond chemistry mechanism (CB05) (Wang et al., 2015)
Photolysis	Fast-J photolysis (Barnard, 2004; Wild et al., 2000)
Aerosol chemistry	Modal aerosol dynamics model for Europe (MADE) (Ackermann et al., 1998)
Secondary organic aerosol	Volatility Basis Set (VBS) (Ahmadov et al., 2012)
Dust emissions	GOCART[a] dust emissions with AFWA[b] modifications (LeGrand et al., 2019)
Sea salt emissions	GOCART sea salt emission scheme (Gong, 2003)

[a] Global Ozone Chemistry Aeroso; Radiation and Transport; [c] Air Force Weather Agency (U.S.)

Goal of WMO Hands-on Model Training

Objective: **Acquire knowledge on WRF-Chem and hands-on training on its application in Africa**

- Learn considerations of model simulation design and application
- Learn the input choices and namelist options
- Learn all input data need to run the model
  - initial and lateral boundary conditions
  - emission sources
- Learn major steps to compile code and run the model
- Learn how to process observation/reanalysis data for model evaluation
- Learn fundamental on model performance evaluation
- Learn output data post-processing and analysis

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  - Biogenic emissions
  - Fire emissions
  - Anthropogenic emissions
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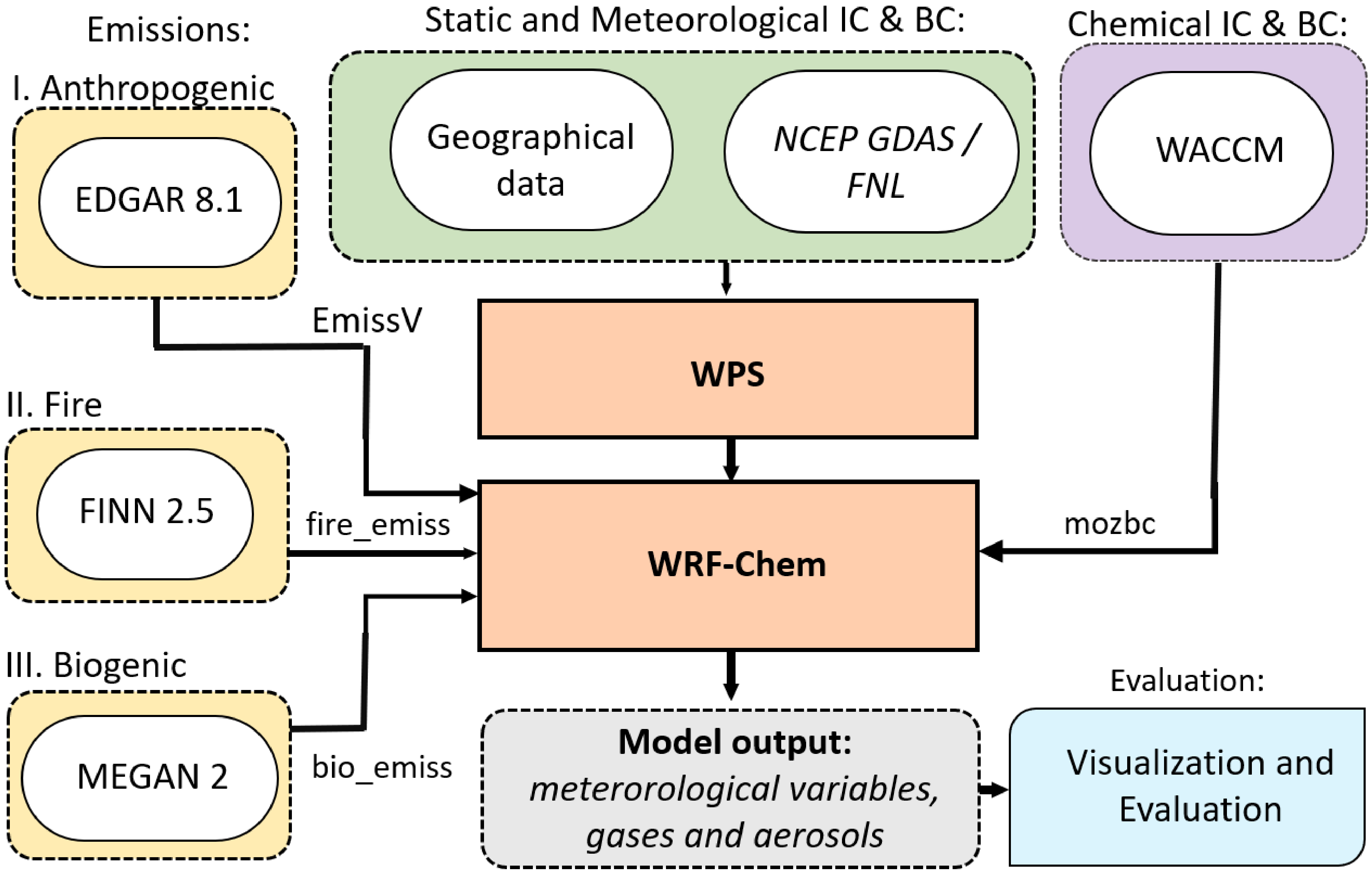
Major sources: WRF-Chem Users' Guide, Tutorials, Jacobson (2005), Zhang (2024)

WRF-Chem Inputs used for the Testbed

INPUTS	SOURCES OF INPUTS
Meteorology IC/BC	NCEP Final analysis 0.25 degree (NCEP-FNL, 2020)
Geographical data	WPS V4 Geographical Static Data
Land use data	MODIS
Gas and aerosol IC/BC	WACCM (Gettelman et al., 2019)
Anthropogenic emissions	EDGAR 8.1 (Crippa et al., 2024)
Biogenic emissions	Model of Emissions of Gases and Aerosols from Nature (MEGAN 2) (Guenther et al., 2006)
Fire emissions	Fire Inventory from NCAR (FINN) (Wiedinmyer et al., 2011)

Diagram of Model Inputs and Outputs & Methods



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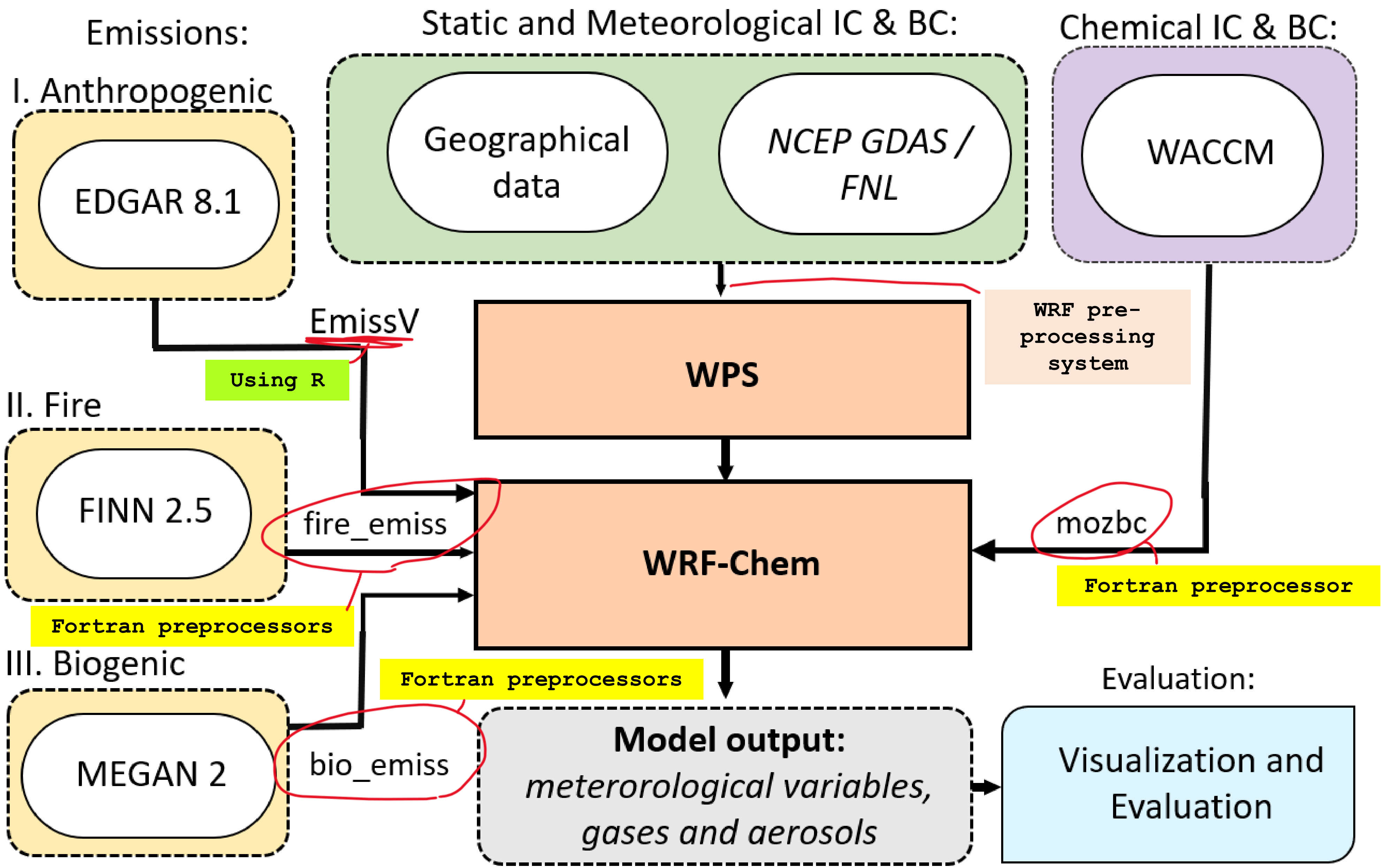


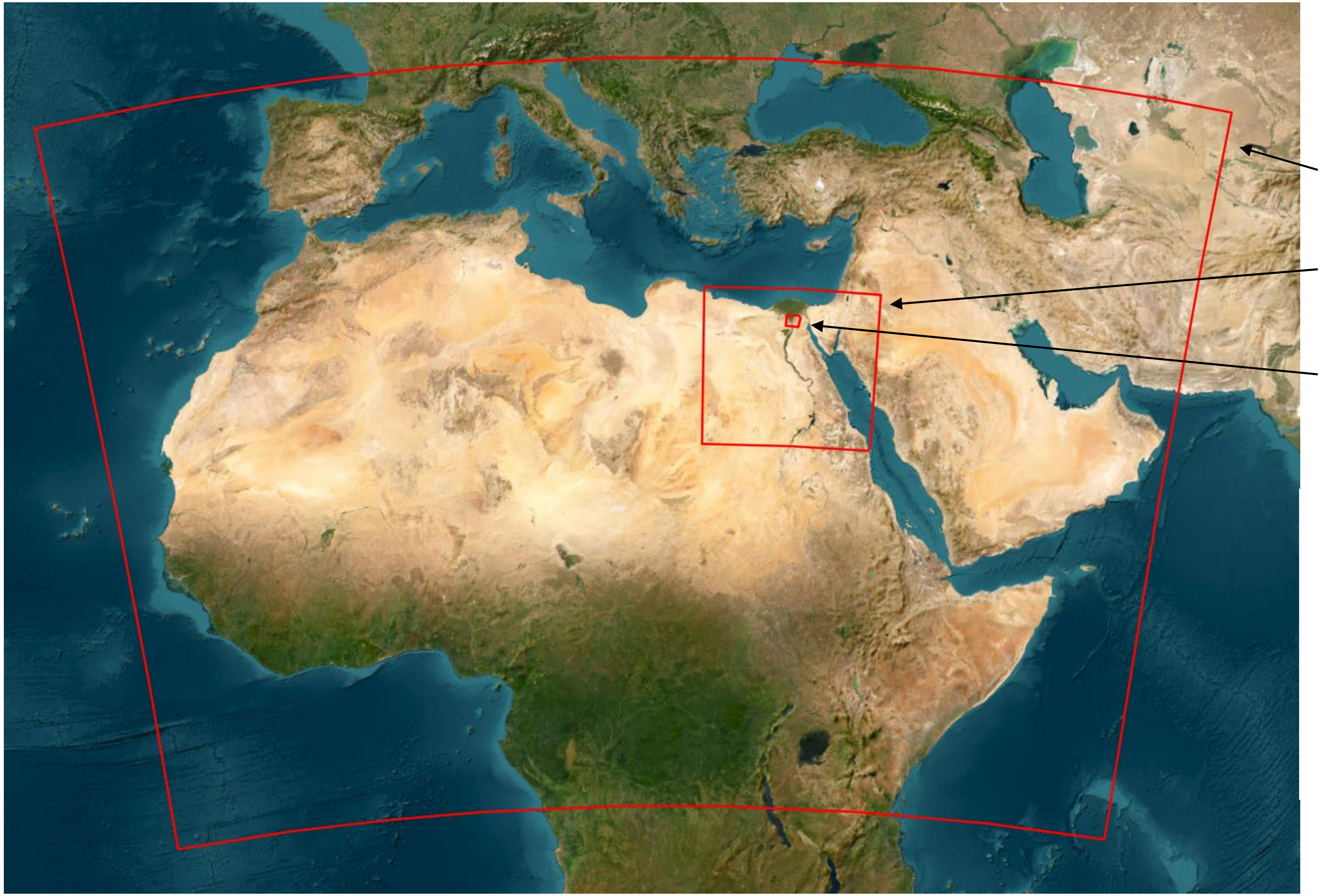
Boundary Conditions

Initial and Boundary Conditions for Gases and Aerosols

Global Chemical Transport Models are often used to drive regional models like Community Multiscale Air Quality Model (CMAQ), Weather Research and Forecasting Model coupled with Chemistry (WRF-Chem), and CHIMERE.
Example Models:

1. **GEOS-Chem** (Goddard Earth Observing System)
2. **GOCART** (Goddard Chemistry Aerosol Radiation and Transport)
3. **CAM-chem** (Community Atmosphere Model with Chemistry)
4. **TM5** (Transport Model 5)
5. **MOZART** (Model for Ozone and Related Chemical Tracers)
6. **CAMS** (Copernicus Atmosphere Monitoring Service) Global Model
7. **UKCA** (United Kingdom Chemistry and Aerosol Model)
8. **EMAC** (ECHAM/MESSy Atmospheric Chemistry Model)
9. **WACCM** (Whole Atmosphere Community Climate Model)

Initial and Boundary Conditions for Gases and Aerosols



North of Africa: 36-km

Egypt: 6km

Cairo: 1km

ICs/BCs

- **North of Africa: 36-km**
  Based on a global CTM
- **Egypt: 6-km**
  Based on 36-km predictions
- **Cario: 1-km**
  Based on 6-km predictions

Initial and Boundary Conditions for Gases and Aerosols
MOZBC preprocessor and WACCM Model Data

(https://www2.acom.ucar.edu/gcm/waccm)

The **Whole Atmosphere Community Climate Model** (WACCM) is a comprehensive numerical model, spanning the range of altitude from the Earth's surface to the thermosphere. The development of WACCM is an inter-divisional collaboration that unifies certain aspects of the upper atmospheric modeling of HAO, the middle atmosphere modeling of ACOM, and the tropospheric modeling of CGD, using the NCAR Community Earth System Model (CESM) as a common numerical framework. The latest version of WACCM is described in Gettelman et al. (2019). WACCM-X extends WACCM to the upper thermosphere, and includes processes important to the ionosphere.

Announcements and support for running WACCM can be found on the DiscussCESM WACCM forum. The CESM Whole Atmosphere Working Group webpage can be found at http://www.cesm.ucar.edu/working_groups/Whole-Atmosphere/.

Subseasonal-to-seasonal forecasts of the Northern Hemisphere polar vortex are available every Monday.

Download WACCM outputs

(https://rda.ucar.edu/datasets/d313006/dataaccess)

Whole Atmosphere Community Climate Model (WACCM) Model Output

d313006 | DOI: 10.5065/G643-Z138

DESCRIPTION | DATA ACCESS | CITATION | DOCUMENTATION | SOFTWARE | METRICS

ASK A QUESTION ›

Mouse over the underlined table headings for detailed descriptions

DATA DESCRIPTION	DATA FILE DOWNLOADS		CUSTOMIZABLE DATA REQUESTS	NCAR-ONLY ACCESS
	Web Server Holdings	Globus Transfer Service (GridFTP)	Subsetting	Central File System (GLADE) Holdings
UNION OF AVAILABLE PRODUCTS	Web File Listing	Globus Transfer	Get a Subset *(login required)*	GLADE File Listing
PRODUCTS: 6-hourly 0.9x1.25 degree global WACCM files for 2019	Web File Listing		Get a Subset *(login required)*	GLADE File Listing
PRODUCTS: 6-hourly 0.9x1.25 degree global WACCM files for 2020	Web File Listing		Get a Subset *(login required)*	GLADE File Listing
PRODUCTS: 6-hourly 0.9x1.25 degree global WACCM files for 2021	Web File Listing		Get a Subset *(login required)*	GLADE File Listing
PRODUCTS: 6-hourly 0.9x1.25 degree global WACCM files for 2022	Web File Listing		Get a Subset *(login required)*	GLADE File Listing
PRODUCTS: 6-hourly 0.9x1.25 degree global WACCM files for 2023	Web File Listing		Get a Subset *(login required)*	GLADE File Listing
PRODUCTS: 6-hourly 0.9x1.25 degree global WACCM files for 2024	Web File Listing		Get a Subset *(login required)*	GLADE File Listing

Download MOZBC Preprocessor:

(https://www.acom.ucar.edu/wrf-chem/download.shtml)

MOZBC source code

Click to download:

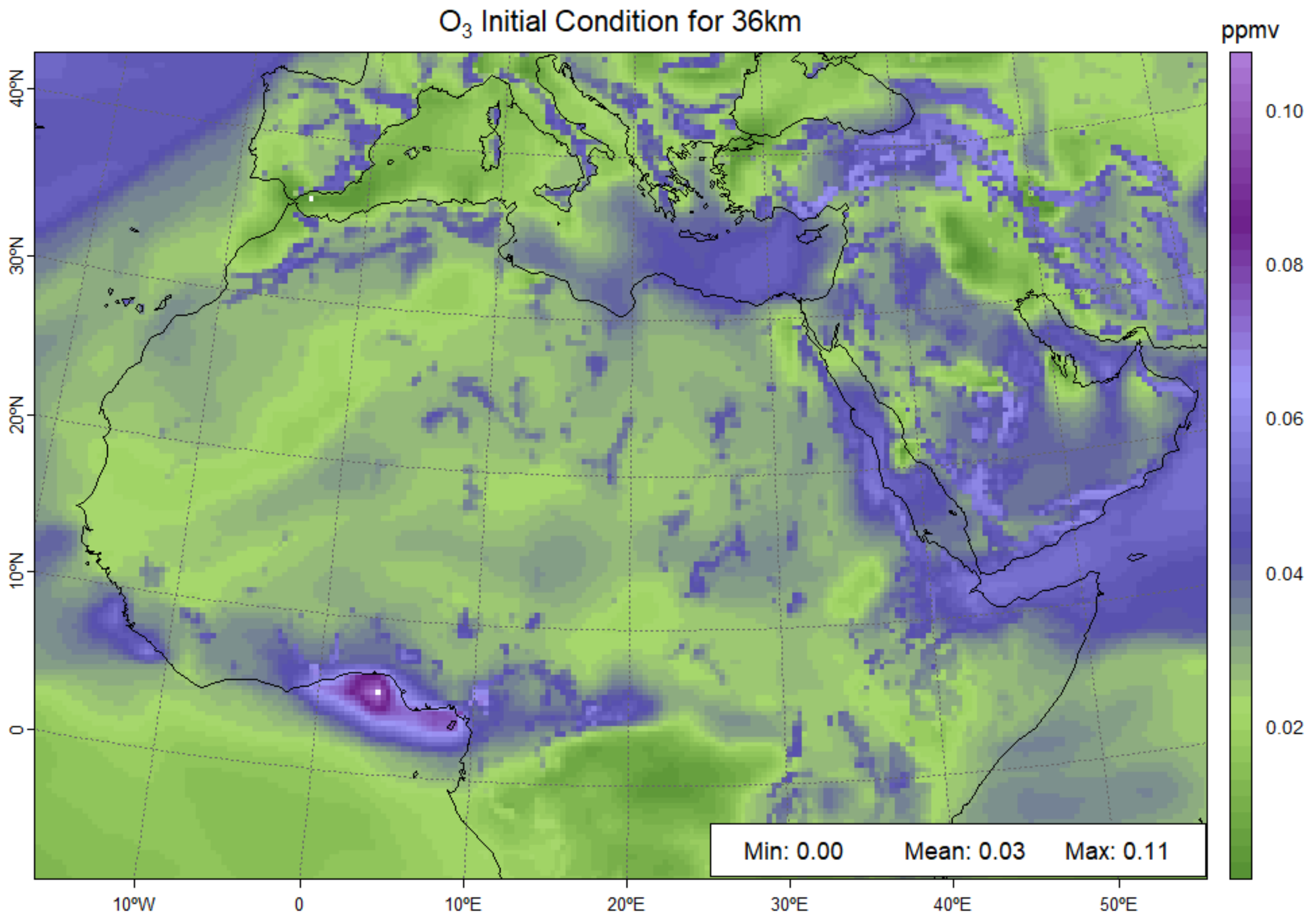
mozbc | bio_emiss | bio_emiss input files | preprocessor | anthro_emiss | EDGAR-HTAP | EPA_ANTHRO_EMIS

You may need to press your browser's 'Back' button to return and download another package.

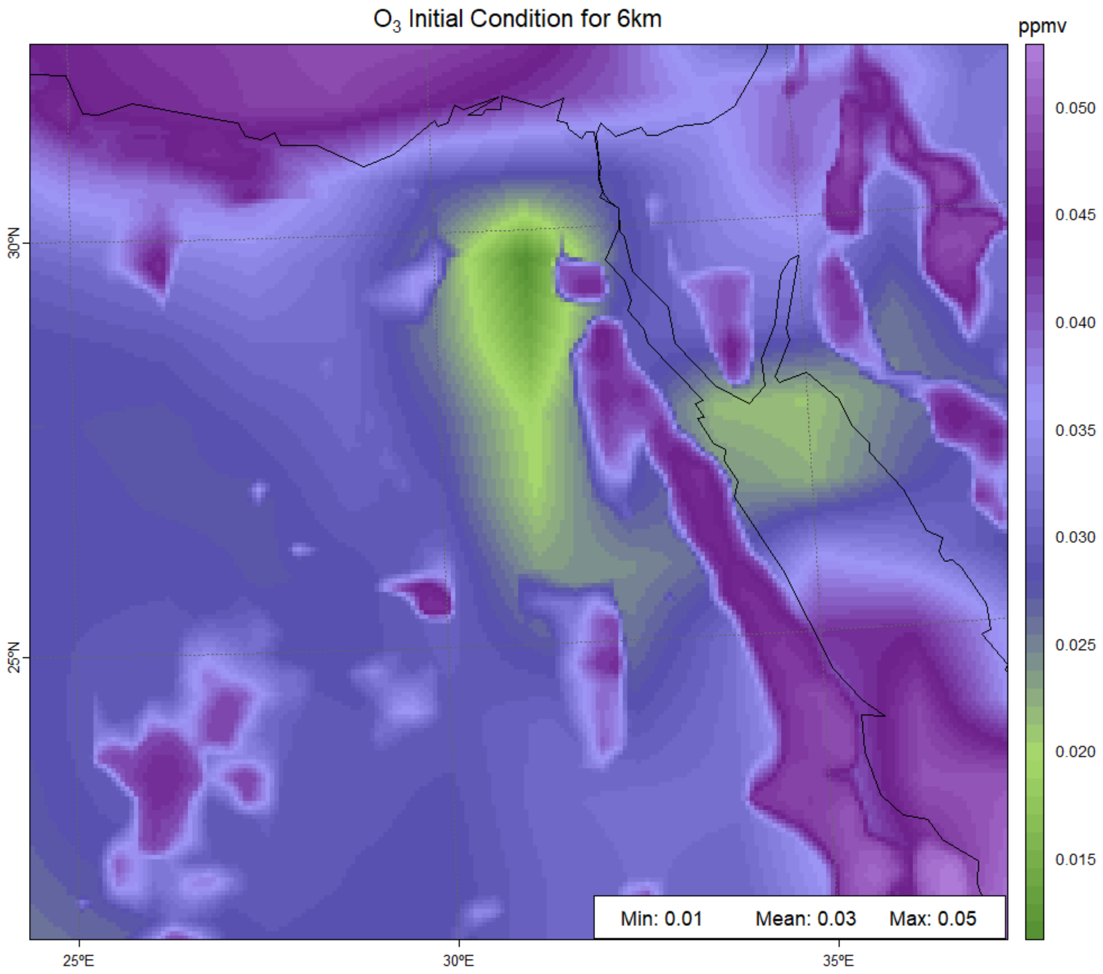
1. Download and compile **mozbc** the pre-processor
2. Link **met_em** files from WPS and copy the **wrfinput** / **wrfobdy** from WRF
3. Download output from the WACCM model (it can be combined using `ncrcat` command)
4. Run `./mozbc < cb05_d01.inp > log.mozbc`

Initial Conditions for O_3

36-km, D01



6-km, D02



Biogenic Emissions

Biogenic Emissions Processing using MEGAN 2

(https://ruc.noaa.gov/wrf/wrf-chem/wrf_tutorial_2012/wrfchem_tutorial_biogenic.pdf)

- **MEGAN**:
  Model of Emissions of Gases and Aerosols from Nature
  - Guenther et. al., *Atmospheric Chemistry and Physics*, 2006
  - 134 emitted chemical species
    - Isoprene
    - Monoterpenes
    - Oxygenated compounds
    - Sesquiterpenes
    - Nitrogen oxide
  - 1 km^2 resolution
  - Input files available at:

MEGAN Framework:
Calculation of emissions

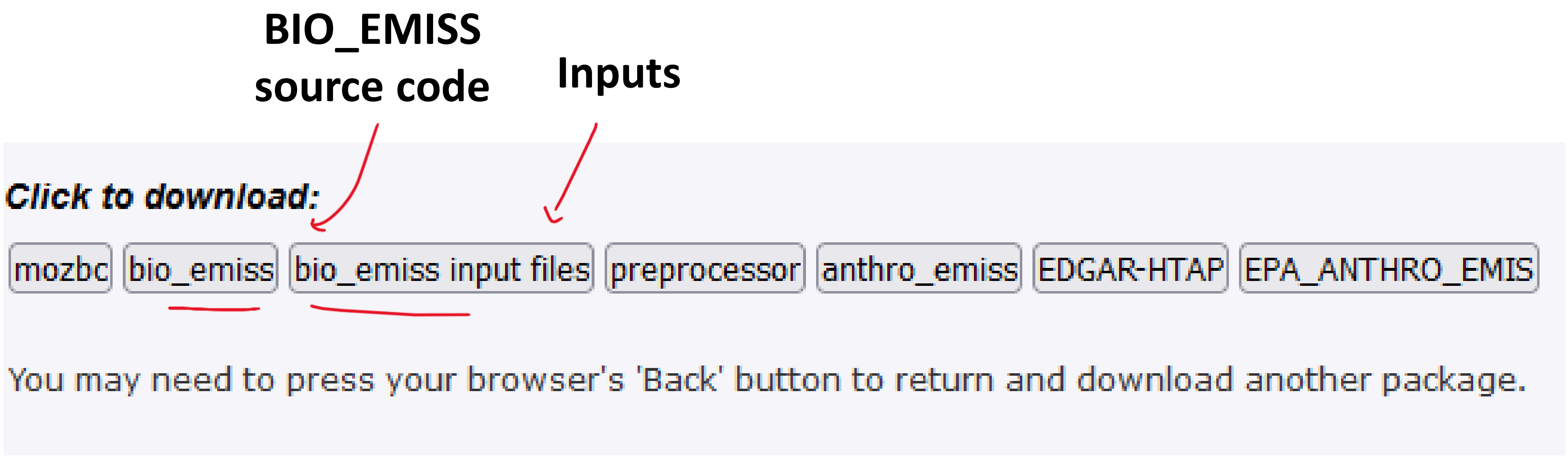
$$EM = \varepsilon \bullet \gamma_{CE} \bullet \gamma_{age} \bullet \gamma_{SM} \bullet \rho$$

$$\gamma_{CE} = \gamma_{LAI} \bullet \gamma_{P} \bullet \gamma_{T}$$

EM: Emission ($\mu g\ m^{-2}\ hr^{-1}$)
ε: Emission Factor ($\mu g\ m^{-2}\ hr^{-1}$)
γ_{CE}: Canopy Factor
γ_{age}: Leaf Age Factor
γ_{SM} : Soil Moisture Factor
ρ: Loss and Production within plant canopy
γ_{LAI} : Leaf Area Index Factor
γ_{P} : PPFD Emission Activity Factor (light-dependence)
γ_{T}: Temperature Response Factor

Download Source Code and Inputs

(https://www.acom.ucar.edu/wrf-chem/download.shtml)



1. Download and compile **megan_bio_emiss** pre-processor and input data:

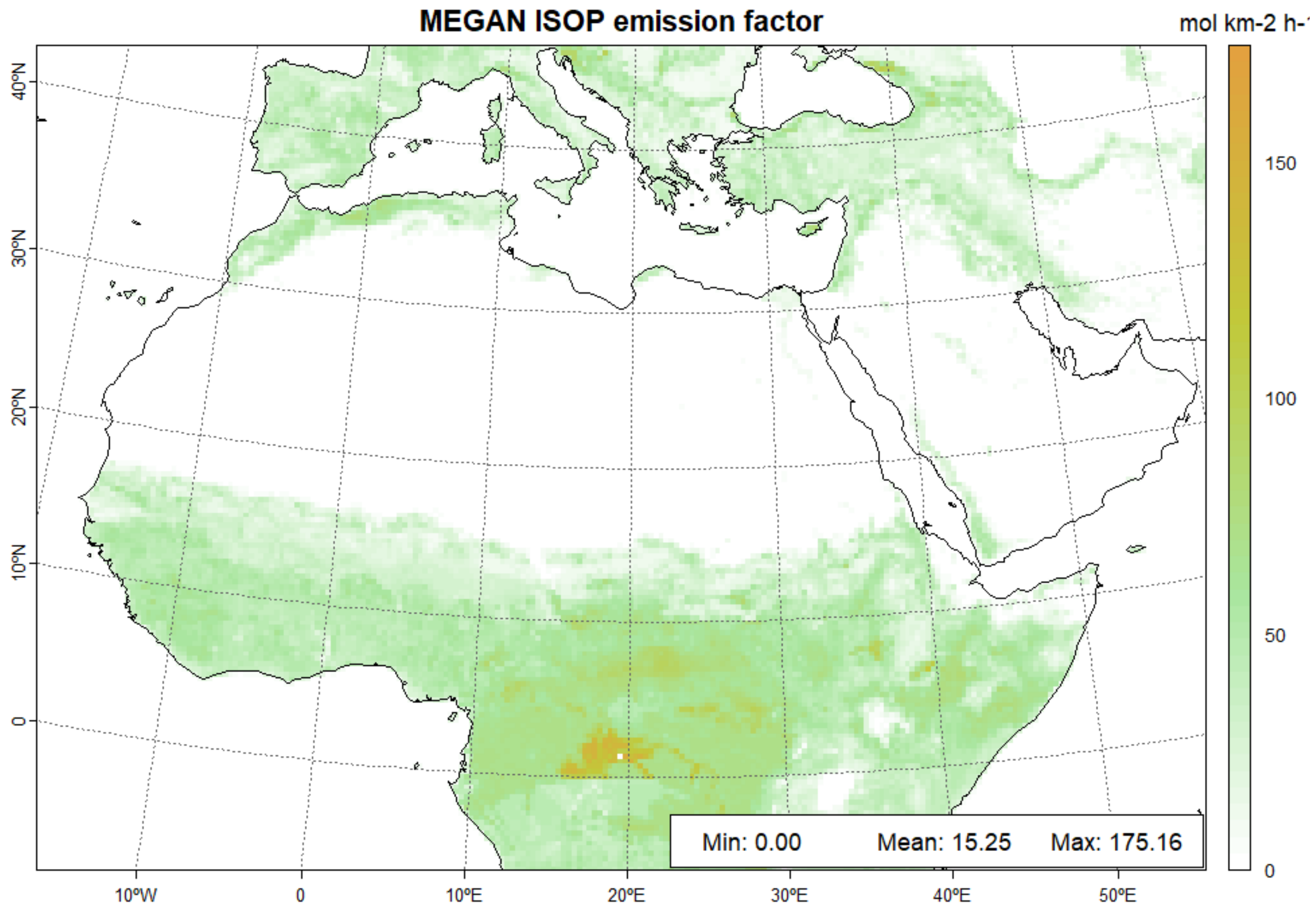
2. Copy the **wrfinput** files from WRF

3. Untar **bio_emiss_input_files** data

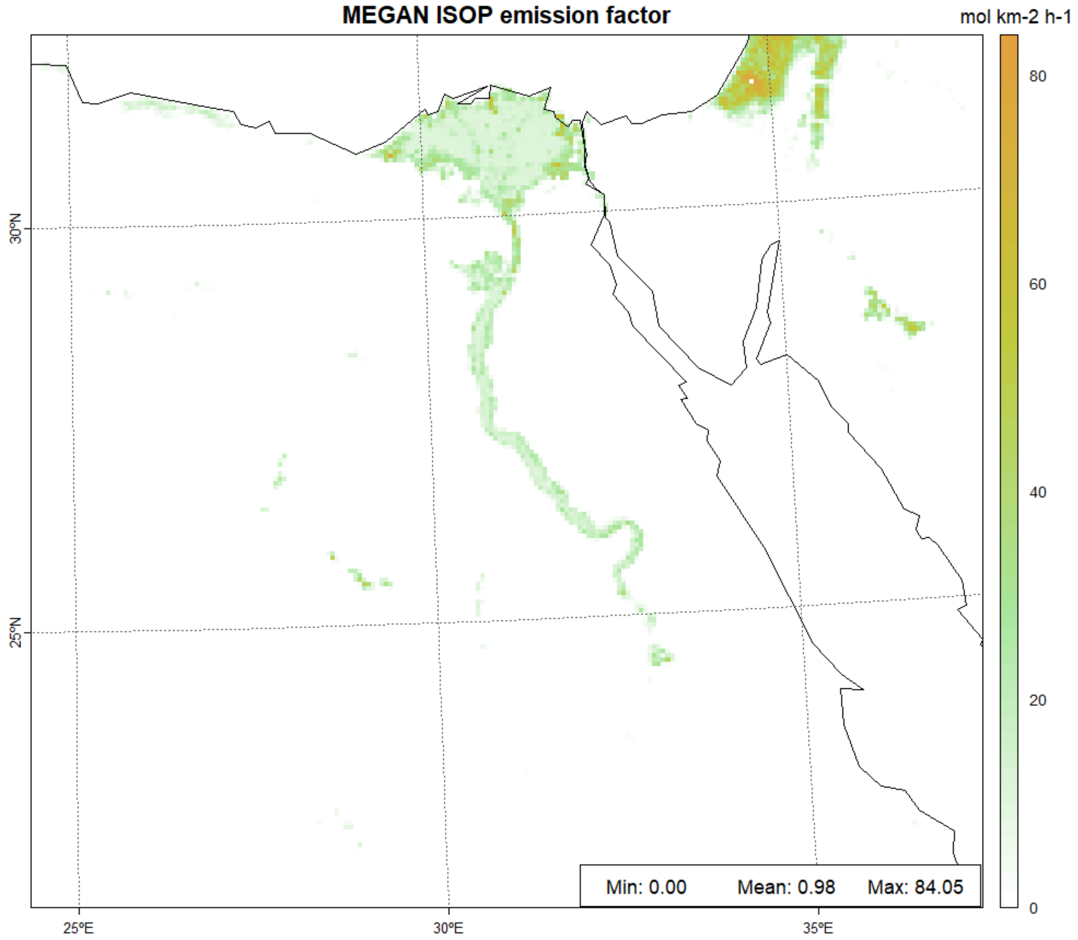
4. Run `./megan_bio_emiss < bioemiss.inp > log.megan`

Isoprene Emissions Generated using MEGAN 2

36-km, D01



6-km, D02



Fire Emissions

Fire Emissions

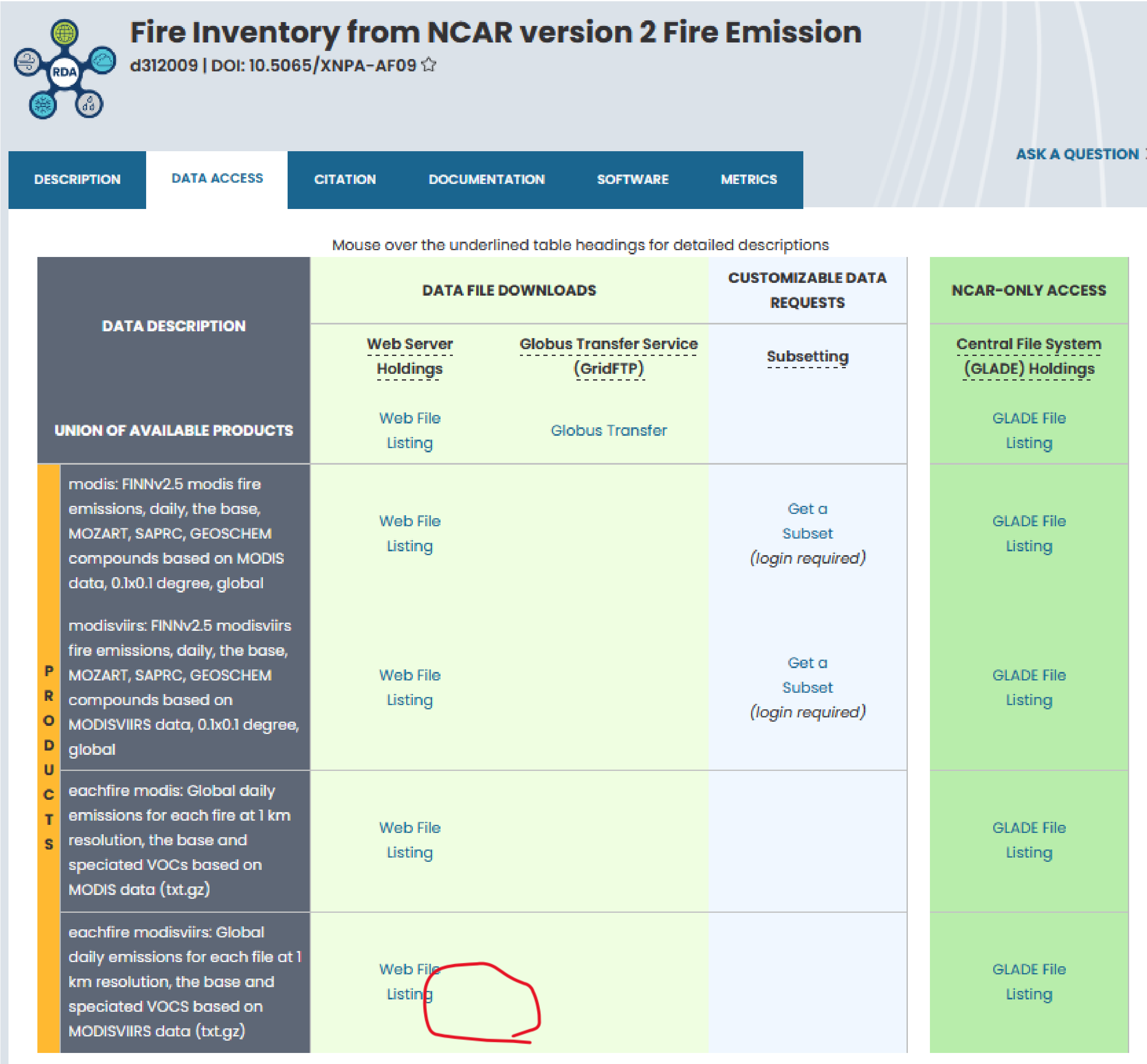
Many fire emission datasets are available in near-real-time, making them valuable for operational air quality forecasting and assessment. Major global fire emission inventories include

1. **GFED** (Global Fire Emissions Database)
2. **FINN** (Fire INventory from NCAR)
3. **GFAS** (Global Fire Assimilation System) – Copernicus
4. **QFED** (Quick Fire Emissions Dataset)
5. **BBECS** (Biomass Burning Emissions from Copernicus Services)
6. **FEER** (Fire Energetics and Emissions Research) Dataset
7. **VNP14IMGML** (VIIRS Active Fire Product)
8. **FLAMBE** (Fire Locating and Monitoring of Burning Emissions)

Fire Emissions Processing Based on FINN v2.5

(https://ruc.noaa.gov/wrf/wrf-chem/wrf_tutorial_2012/wrfchem_tutorial_biogenic.pdf)

Download INPUTS:
(https://rda.ucar.edu/datasets/ds312.9/dataaccess/)



Fire Inventory from NCAR version 2 Fire Emission

d312009 | DOI: 10.5065/XNPA-AF09

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PRODUCTS: modis: FINNv2.5 modis fire emissions, daily, the base, MOZART, SAPRC, GEOSCHEM compounds based on MODIS data, 0.1x0.1 degree, global	Web File Listing		Get a Subset *(login required)*	GLADE File Listing
modisviirs: FINNv2.5 modisviirs fire emissions, daily, the base, MOZART, SAPRC, GEOSCHEM compounds based on MODISVIIRS data, 0.1x0.1 degree, global	Web File Listing		Get a Subset *(login required)*	GLADE File Listing
eachfire modis: Global daily emissions for each fire at 1 km resolution, the base and speciated VOCs based on MODIS data (txt.gz)	Web File Listing			GLADE File Listing
eachfire modisviirs: Global daily emissions for each file at 1 km resolution, the base and speciated VOCS based on MODISVIIRS data (txt.gz)	Web File Listing			GLADE File Listing

<u>Daily fire emissions calculated with FINNv1</u>

Wiedinmyer et al., *Geoscientific Model Development*, 2011, http://www.geosci-model-dev.net/4/625/2011/gmd-4-625-2011.html

- Daily global fire emissions
  - GHG, CO, NOx, VOCs, SO2, NH3, Particulate Matter
- Spatial resolution ~ 1km^2
- Available for hindsight and forecast model applications

Download Source-Code (https://www.acom.ucar.edu/Data/fire/)

Source code and static input

Gridding program - updated June 2020

- (selected) fire_emis fortran program to grid the FINN (v1.5 and v2) text files to netcdf files for use in WRF-Chem or global models.
- vegetation data files used in creating WRF-Chem gridded emissions (not needed for global grids).

Security question: What is 3 plus 4 ? 7

Submit download request here: Submit Cancel

13450 downloads since 2013-08-29.

1. Download and compile **fire_emis** pre-processor
2. Untar the static inputs
3. Download and gunzip FINN files on `grid_finn_fire_emis_v2020` folder
4. Run `./fire_emis < finn_wrf.inp > log.fire`

Anthropogenic Emissions

Anthropogenic Emissions

Anthropogenic (human-made) emissions datasets with global coverage vary in resolution, temporal coverage, and species available. Examples include:

1. **EDGAR** (Emissions Database for Global Atmospheric Research)
2. **HTAPv2** (Hemispheric Transport of Air Pollution)
3. **CAMS-GLOB-ANT** (Copernicus Atmosphere Monitoring Service – Global Anthropogenic Emissions)
4. **ECLIPSE** (Evaluating the Climate and Air Quality Impacts of Short-Lived Pollutants)
5. **CAIT** (Climate Data Explorer)
6. **GAINS** (Greenhouse Gas and Air Pollution Interactions and Synergies)
7. **PRTR** (Pollutant Release and Transfer Register)
8. **GAINS** City-Scale Dataset
9. **RETRO**
10. **DACCIWA emission inventories (regional emissions over Africa)**

Anthropogenic Emissions Processing based on EDGARv8.1

Introduction

EDGARv8.1 provides emissions not only for the greenhouse gases per sector and country but also for the air pollutants:

- Ozone precursor gases: Carbon Monoxide (CO), Nitrogen Oxides (NO_X), Non-Methane Volatile Organic Compounds (NMVOC) and Methane (CH_4)
- Acidifying gases: Ammonia (NH_3), Nitrogen oxides (NO_X) and Sulfur Dioxide (SO_2)
- Primary particulates: Fine Particulate Matter (PM_{10} and $PM_{2.5}$) and Carbonaceous speciation (BC, OC)

Emissions from large scale biomass burning with Savannah burning, forest fires, and sources and sinks from land-use, land-use change and forestry (LULUCF) are excluded.

For the energy related sectors the activity data are primarily based on IEA data (2022) World Energy Balances, (www.iea.org), all rights reserved, as modified by Joint Research Centre, European Commission, whereas the activity data for the agricultural sectors originate primarily from FAO (2022) (www.fao.org/faostat).

Novelties of EDGARv8.1 compared to the previous EDGARv6.1 release are:

- updates of all activity data up to 2022
- updates of technology penetration, abatement measures and emission factors for power plant emissions and residential emissions in Europe
- new spatial proxies as described in Crippa et al. (2024)

Download inputs and additional information:
Global air pollutants Emissions (*version 8.1*):
(https://edgar.jrc.ec.europa.eu/dataset_ap81)

Global GHG pollutants (*version 8.0*):
(https://edgar.jrc.ec.europa.eu/dataset_ghg80)

Download EDGARv8.1 monthly sector-specific gridmaps

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Time series

Monthly time series

Annual gridmaps

Annual sector-specific gridmaps

Monthly sector-specific gridmaps

Sources and references

Contacts

Monthly sector-specific gridmaps (2000-2022)

— Click to expand

Monthly emission gridmaps (2000-2022) are provided for all substances and sectors using the temporal distribution profiles described in Crippa et al. (2020).

Sectors definition:

- Power Industry - Power and heat generation plants (public & autoproducers)
- Industrial combustion - Combustion for industrial manufacturing
- Buildings - Small scale non-industrial stationary combustion
- Transport - Mobile combustion (road & rail & ship & aviation)
- Agriculture - Agricultural soils, crop residues burning, enteric fermentation, manure management, indirect N_2O emissions from agriculture
- Fuel exploitation - Production, transformation and refining of fuels
- Processes - Industrial processes (e.g. emissions from the production of cement, iron and steel, aluminum, chemicals, solvents, etc.)
- Waste - Solid waste disposal and waste water treatment

Files format:

- Emissions: Mg/month gridmaps at 0.1x0.1degree resolution, .NetCDF file per year, substance and sector is produced including the emissions for the 12 months.
- Emission fluxes: kg/m2/s at 0.1x0.1degree resolution, .NetCDF file per year, substance and sector is produced including for each sector the emission fluxes for the 12 months.
- Note that OC emission and fluxes are expressed in amount of C.

- **Agriculture**
  IPCC 1996: 4A+4B+4C+4D+4F+4G / IPCC 2006: 3A+3C+5A

  - **EDGAR BC - NETCDF (emi)** (AGRICULTURE_emi_nc.zip) Download
    English (687.89 Mb - ZIP)

  - **EDGAR BC - NETCDFD (fluxes)** (AGRICULTURE_flx_nc.zip) Download
    English (700.96 Mb - ZIP)

Anthropogenic Emissions Processing Using R-package EmissV

Dev: https://github.com/atmoschem/EmissV
Official: https://CRAN.R-project.org/package=EmissV
Doc: https://atmoschem.github.io/EmissV

EmissV 0.665.8.0 Reference Changelog Search for

EmissV

This package provides tools to create emissions (with a focus on vehicular emissions) for use in numeric air quality models such as WRF-Chem.

Installation

System dependencies

EmissV import functions from ncdf4 for reading model information, raster and sf to process grinded/geographic information and units. These packages need some aditional libraries:

To Ubuntu

The following steps are required for installation on Ubuntu:

```
sudo add-apt-repository ppa:ubuntugis/ubuntugis-unstable --yes
sudo apt-get --yes --force-yes update -qq
# netcdf dependencies:
sudo apt-get install --yes libnetcdf-dev netcdf-bin
# units/udunits2 dependency:
sudo apt-get install --yes libudunits2-dev
# sf dependencies (without libudunits2-dev):
sudo apt-get install --yes libgdal-dev libgeos-dev libproj-dev
```

To Fedora

The following steps are required for installation on Fedora:

```
sudo dnf update
# netcdf dependencies:
sudo yum install netcdf-devel
# units/udunits2 dependency:
sudo yum install udunits2-devel
# sf dependencies (without libudunits2-dev):
sudo yum install gdal-devel proj-devel proj-epsg proj-nad geos-devel
```

Links
View on CRAN
Browse source code
Report a bug

License
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Community
Contributing guide

Citation
Citing EmissV

Developers
Daniel Schuch
Author, maintainer
Sergio Ibarra-Espinosa
Author

Dev status
build passing
coverage 100%
R-CMD-check passing
license MIT
CRAN OK
downloads 39K
downloads 466/month
DOI 10.5281/zenodo.1451027
JOSS 10.21105/joss.00662

Atmoschem: is a non-governmental organization of software developers focusing on air quality modeling on Github.
(https://github.com/atmoschem)

Anthropogenic Emissions Processing Using R-package EmissV

eixport 0.6.0 Reference Changelog

eixport

build unknown | build passing | coverage 100% | DOI 10.5281/zenodo.10044992
CRAN 0.6.0 | downloads 34K | JOSS 10.21105/joss.00607 | Github 27

Exporting emissions to atmospheric models, eixport: 0.6.0

Emissions are mass that affects atmosphere in complex ways, not only physical, but also, in the health of humans, ecosystems, economically, etc.

There are several models whose inputs are emissions, such as R-Line or WRF-Chem. This R-Package provide functions to read emissions from VEIN and from other models in different formats and export the emissions into the appropriate format suitable to other models.

Install

To install the CRAN version:

```
install.packages("eixport")
```

To install the development version:

```
devtools::install_github("atmoschem/eixport")
```

Links

View on CRAN

Browse source code

Report a bug

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Community

Contributing guide

Code of conduct

Citation

Citing eixport

Developers

Sergio Ibarra-Espinosa
Author, maintainer

Daniel Schuch
Author

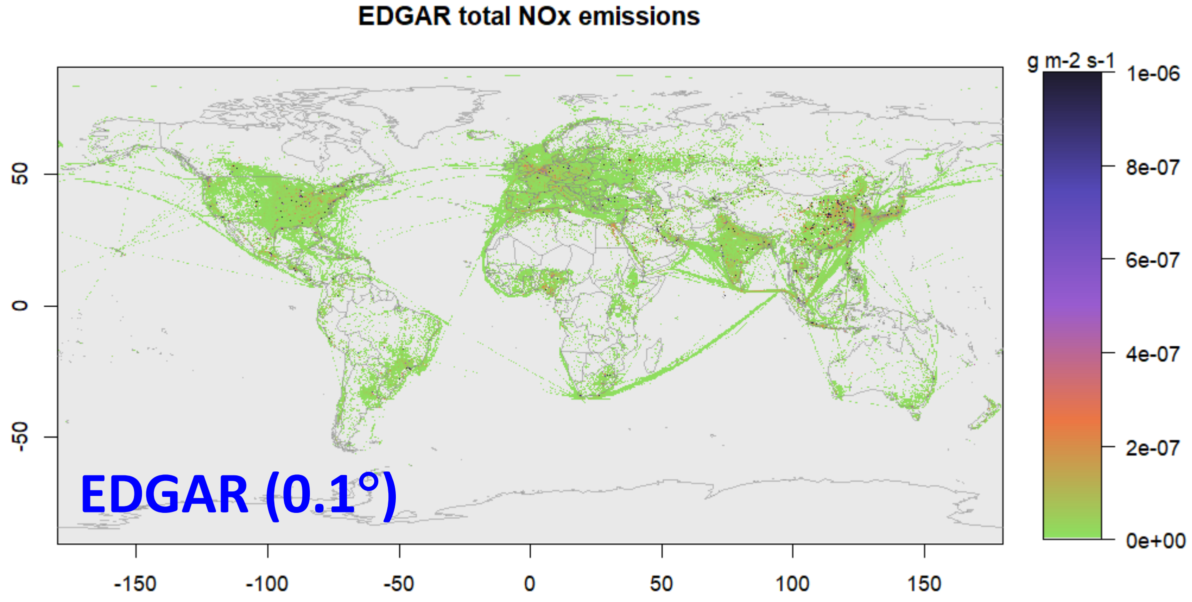
More about authors...

Anthropogenic Emissions Processing Using R-package EmissV

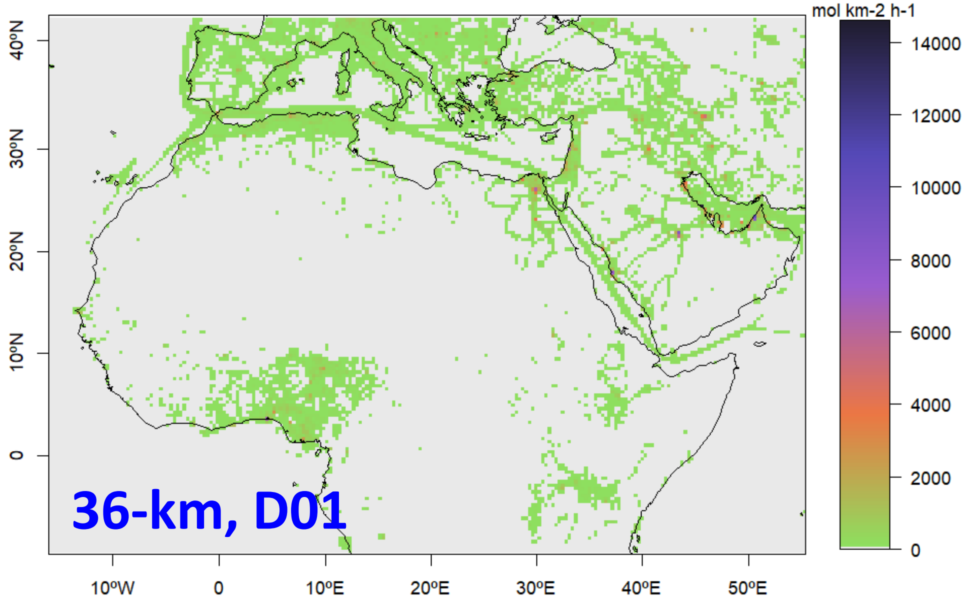
1. Download **EDGAR** and install the R-packages **EmissV** and **eixport**
2. The function `read()` is used read EDGAR 8.1 emission files
3. The function `gridinfo()` Extract the domain information from a **wrfinput** file
4. The function `emission()` interpolates and converts the units for WRF-Chem
5. The functions `wrf_create()` create the emission file
6. The functions `wrf_put()` and `to_wrf()` write the emissions

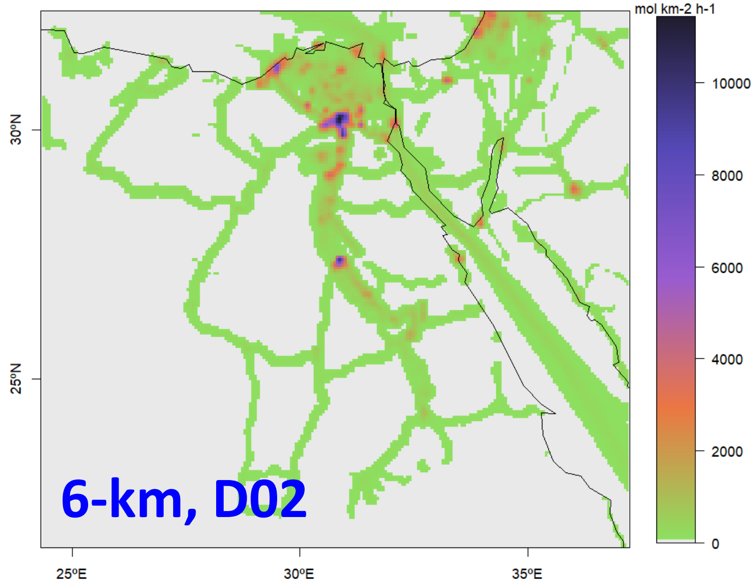
Anthropogenic Emissions Processing Using R-package EmissV

EDGAR 8.1 NO_x emissions using `read()`



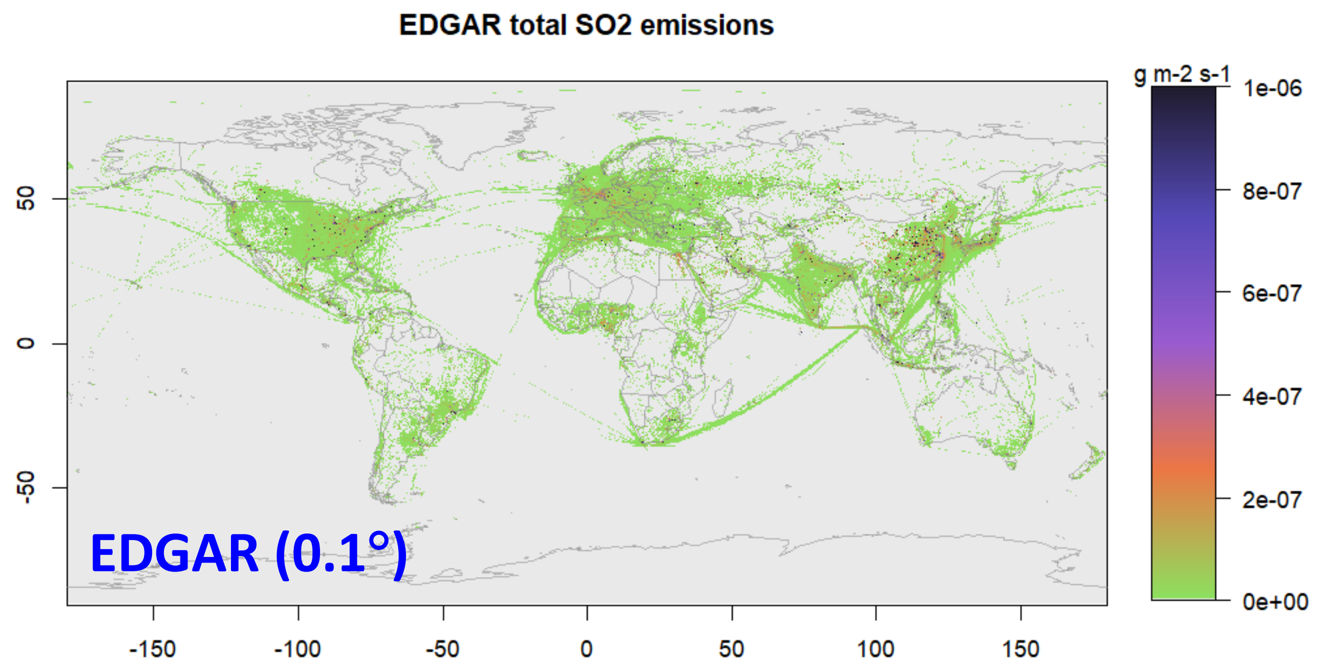
WRF-Chem model ready NO_x emissions using emission()



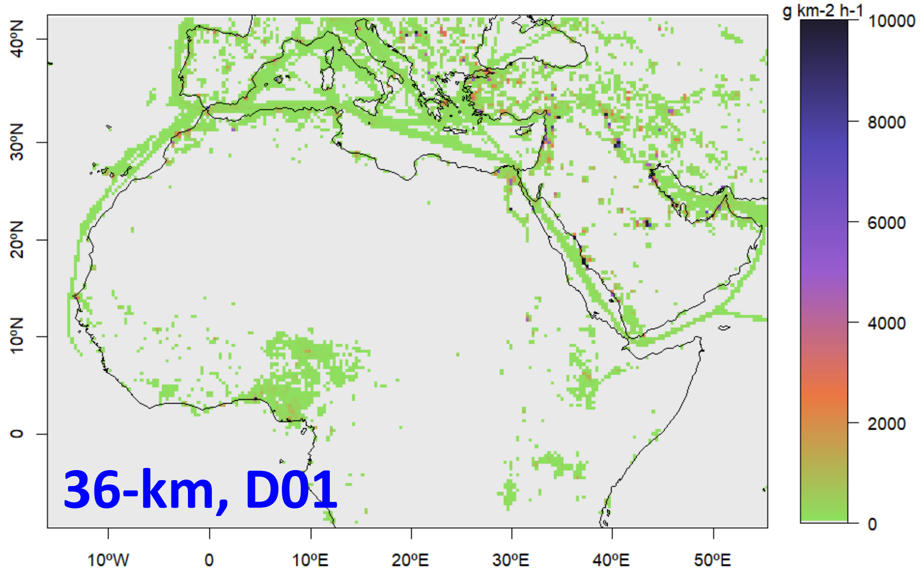


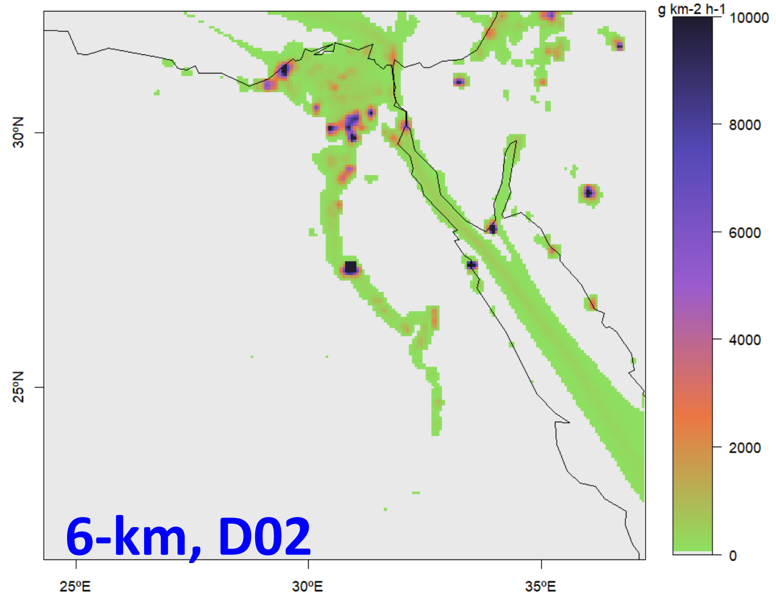
Anthropogenic Emissions Processing Using R-package EmissV

EDGAR 8.1 SO_2 emissions using `read()`



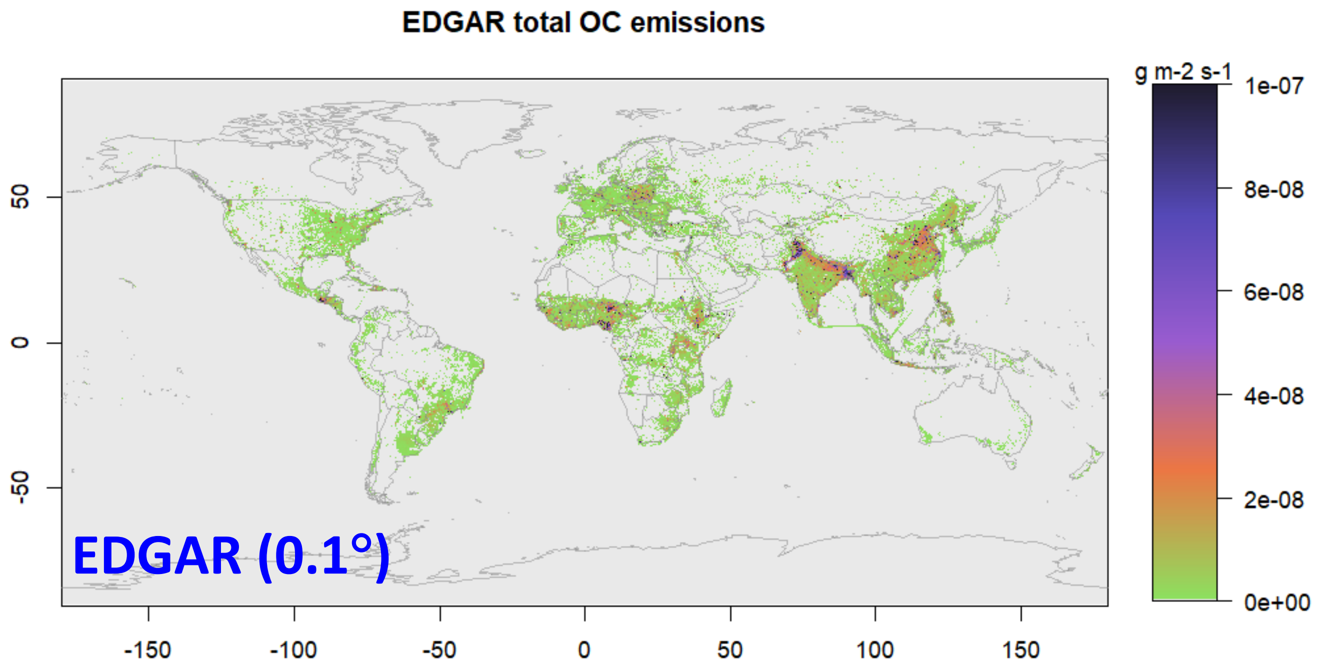
WRF-Chem model ready SO_2 emissions using emission()



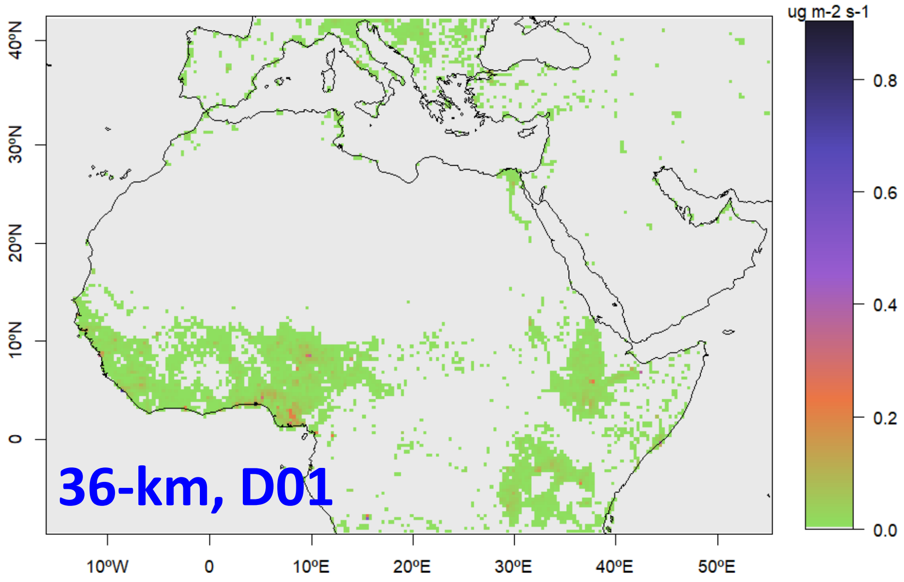


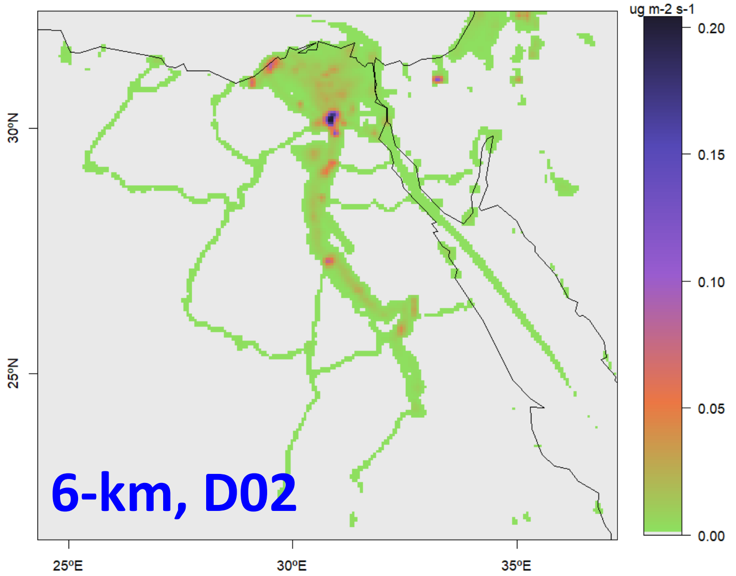
Anthropogenic Emissions Processing Using R-package EmissV

EDGAR 8.1 OC emissions using `read()`



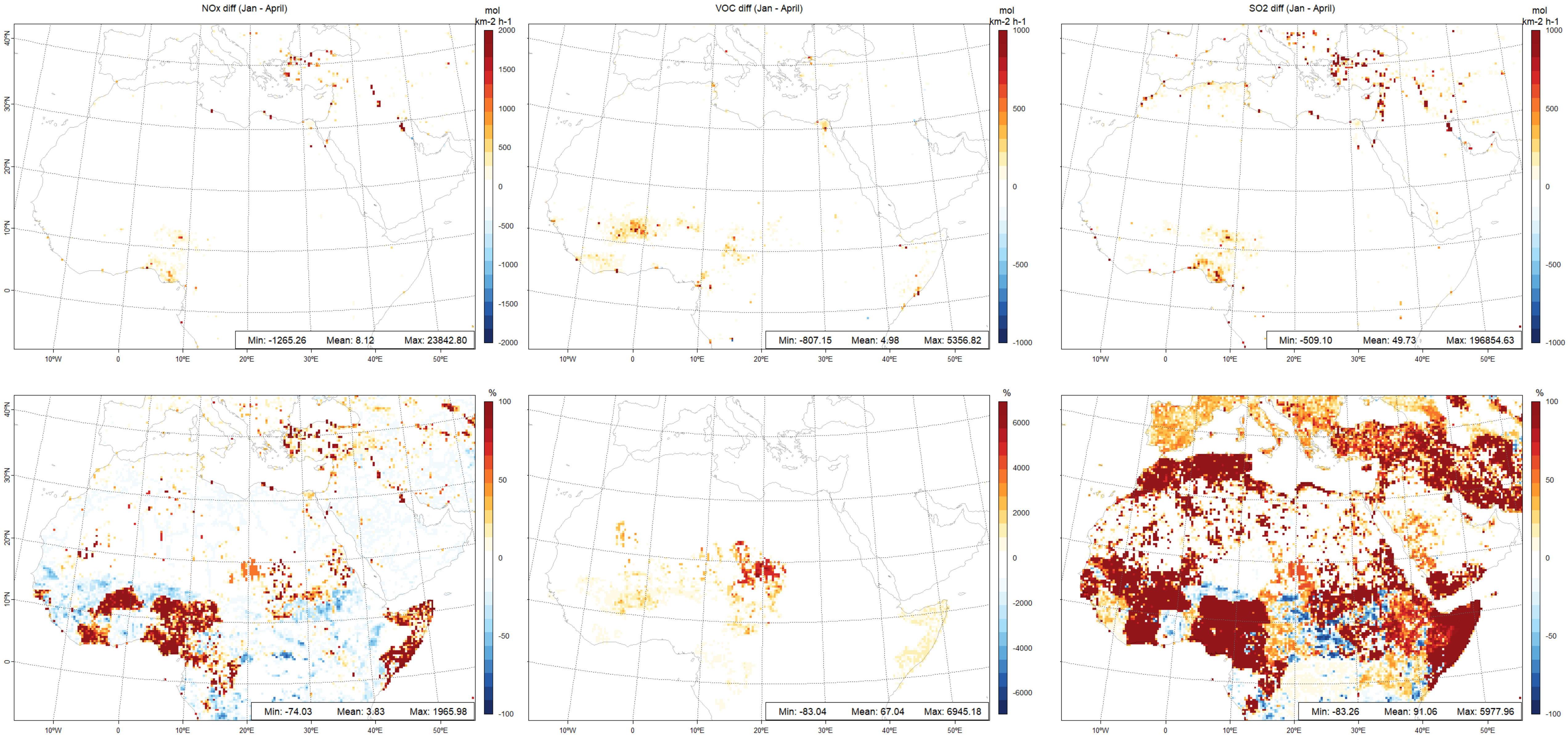
WRF-Chem model ready OC emissions using emission()





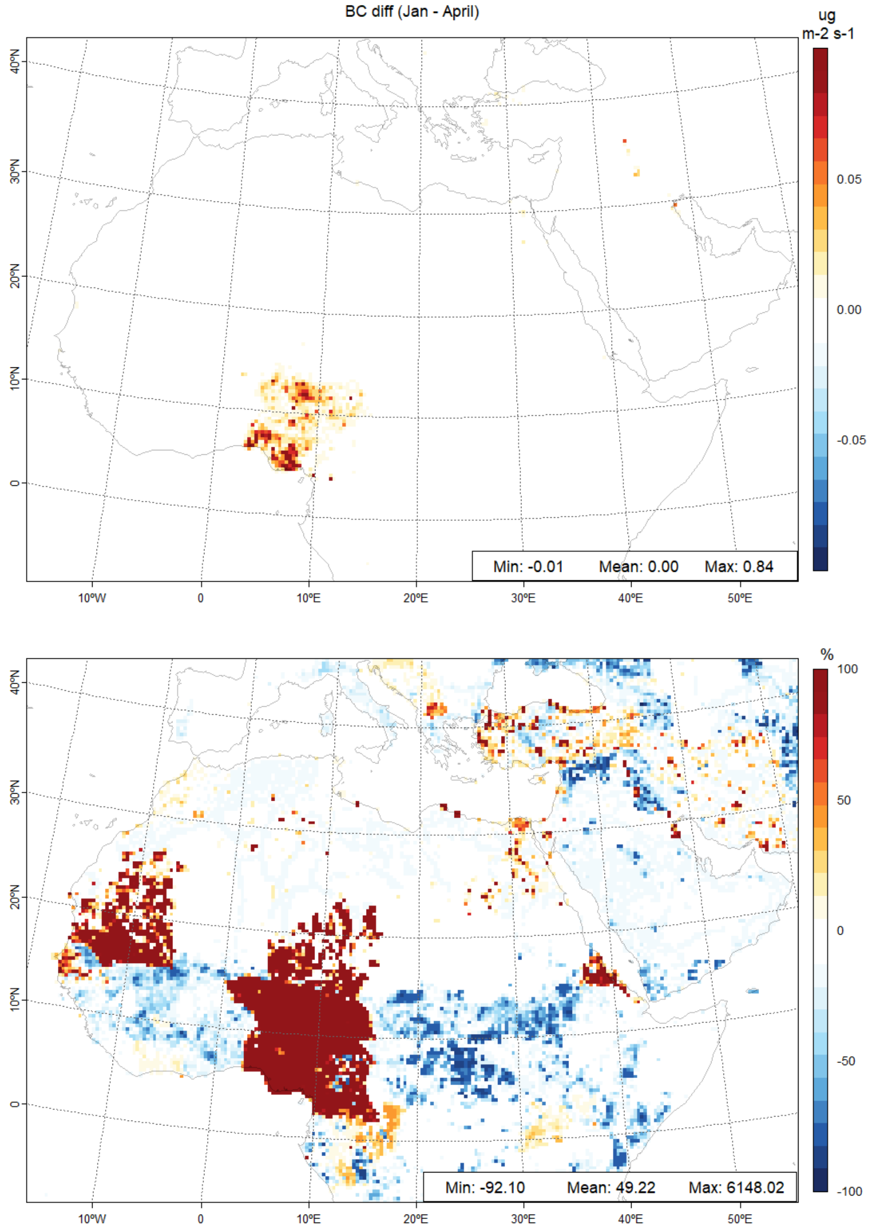
Anthropogenic Emissions: Differences (Jan – Apr, 2023)

NO_x | VOCs | SO_2

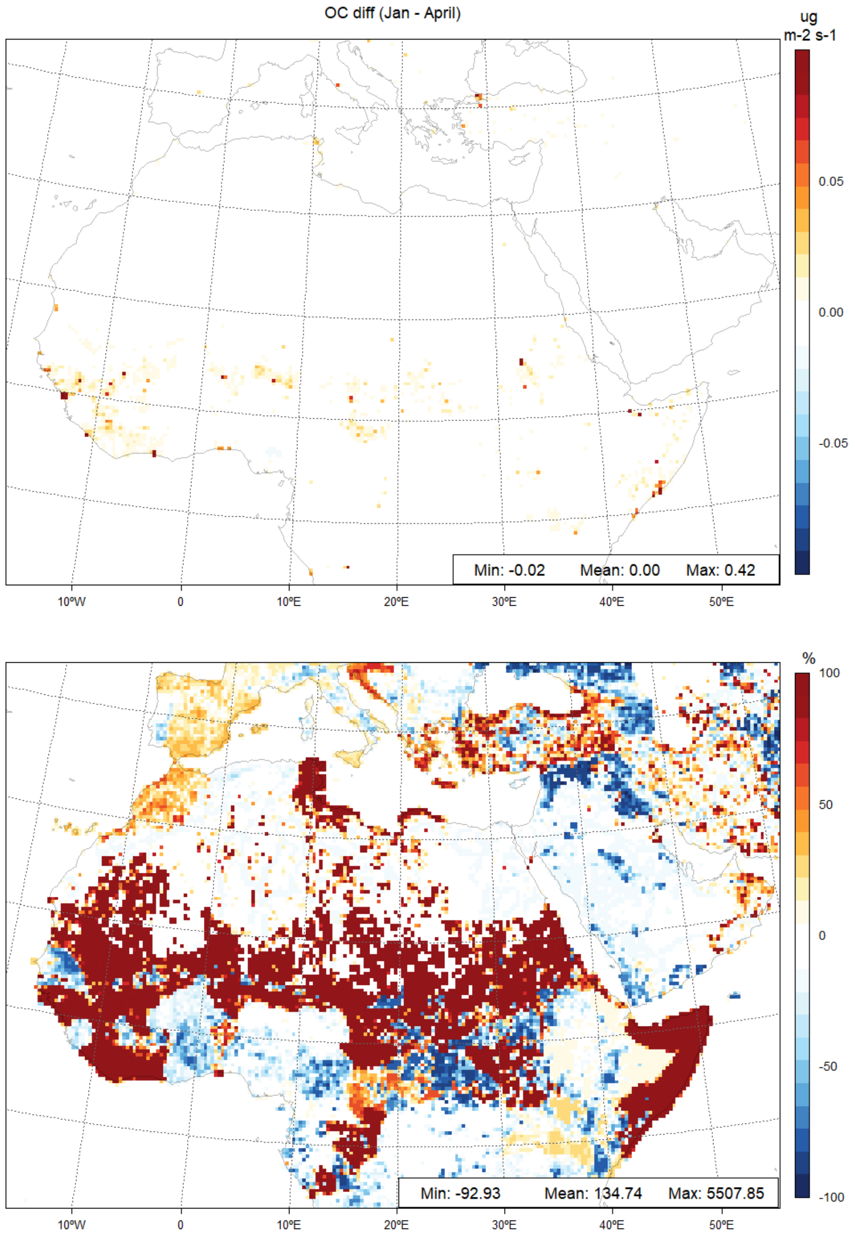


Anthropogenic Emissions: Differences (Jan – Apr, 2023)

OC



BC



Summary

- The choice and configuration of the air quality models depend on the purpose of model applications. It takes 18 major steps and involve several important considerations in applying a 3-D air quality model for domains and time periods of interest
- WRF-Chem is a widely-used online-coupled model that accounts for important feedbacks of meteorology and chemistry. It offers multiple physics, chemistry, and aerosol options
- Major inputs for WRF-Chem include topographical and land use data, soil moisture, initial and boundary conditions, emissions, and chemistry data
- Preparation of model inputs for applications requires careful pre-processing steps of many relevant types of data and mapping them into the grids used for model applications.

References

- WRF-Chem tutorials and presentations: https://ruc.noaa.gov/wrf/wrf-chem/tutorial2018.htm
- WRF-Chem Version 4.4 User's Guide:https://ruc.noaa.gov/wrf/wrf-chem/Users_guide.pdf
- https://ruc.noaa.gov/wrf/wrf-chem/References/WRF- Chem.references.htm
- Jacobson, M.Z., 2005, Fundamentals of Atmospheric Modeling, Cambridge University Press, New York, 813 pp., ISBN 9780521548656
- Zhang, Y., 2024, Air Quality in a Changing Climate: Science and Modeling, Cambridge University Press, in preparation.