Air quality modeling with WRF-Chem v3.8.1 over the Sultanate of Oman

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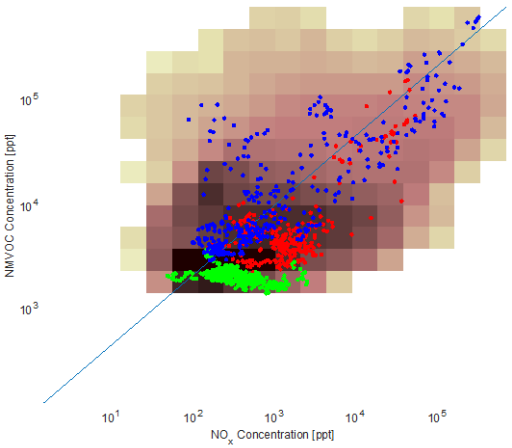

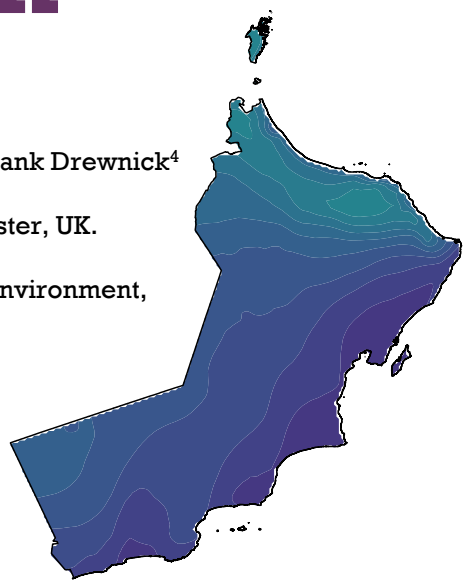

Presented by: Dr Siham Al Hadhrami

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Outline

- Summertime Air Quality over the Arabian Peninsula
- WRF-Chem
- Simulations Validations
- Main Findings
- Conclusion & Recommendations

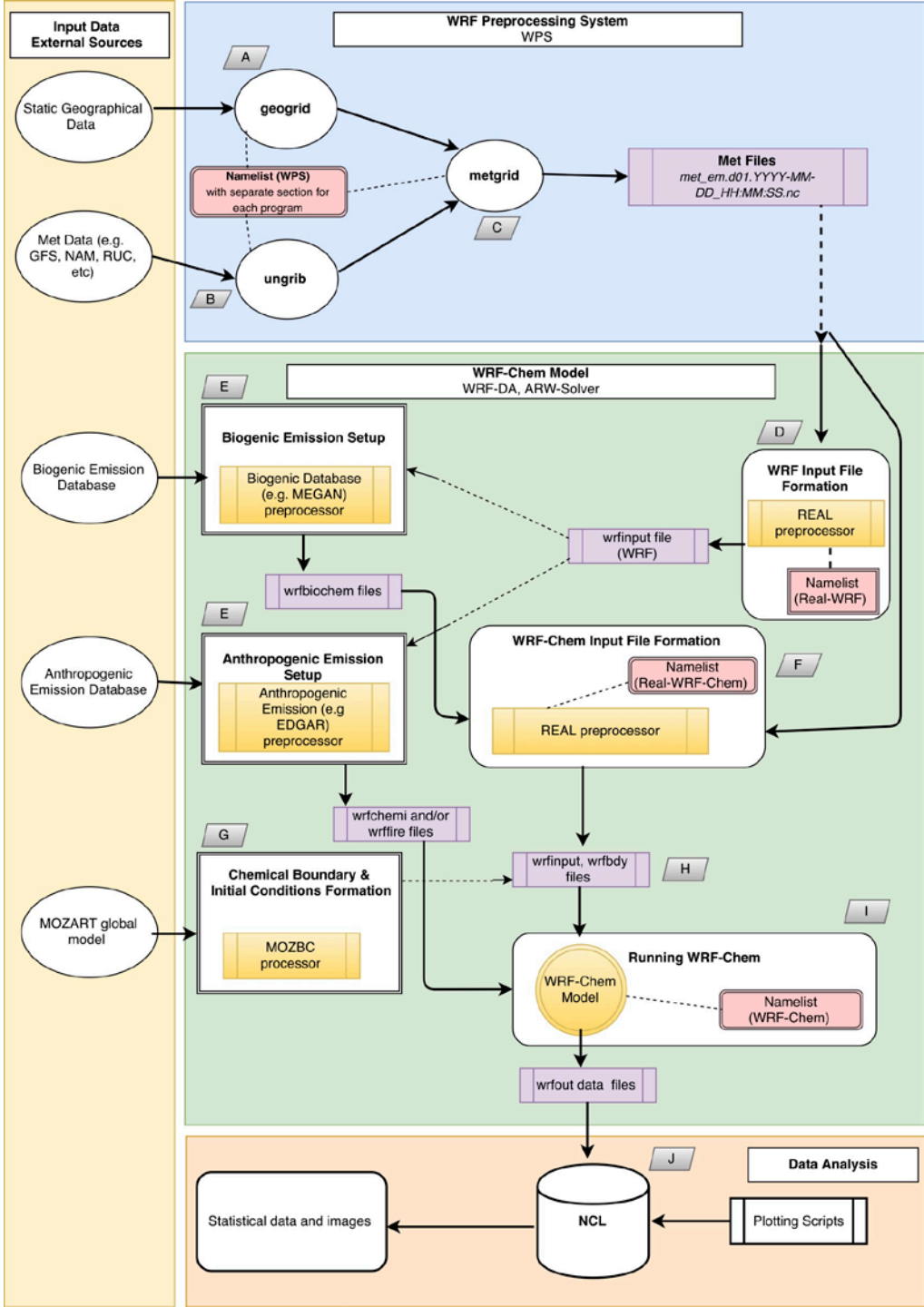
Air Quality

- **Ambient air pollution** is a **major** environmental health risk.
- According to World Health Organization (WHO),
  - In 2019, 99% of the world population was living in places where the WHO air quality guidelines levels were not met.
  - ambient air pollution had been linked to the death of approximately **4.2 million** premature in 2016.
  - Particulate matter (PM), ozone (O_3), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) are the pollutants with the strongest evidence for public health concern.

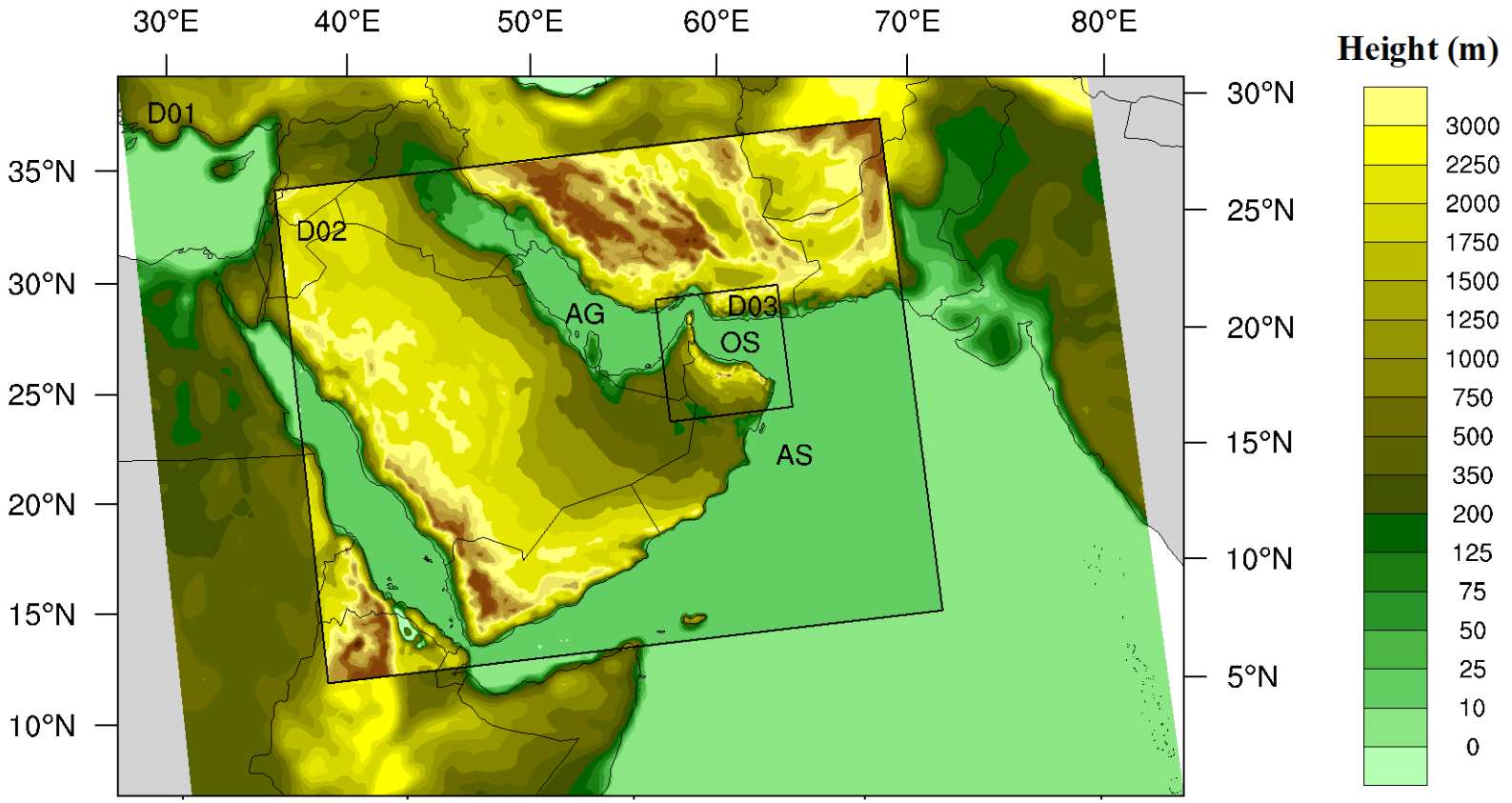
Summertime Air Quality over the Arabian Peninsula

WRF-Chem

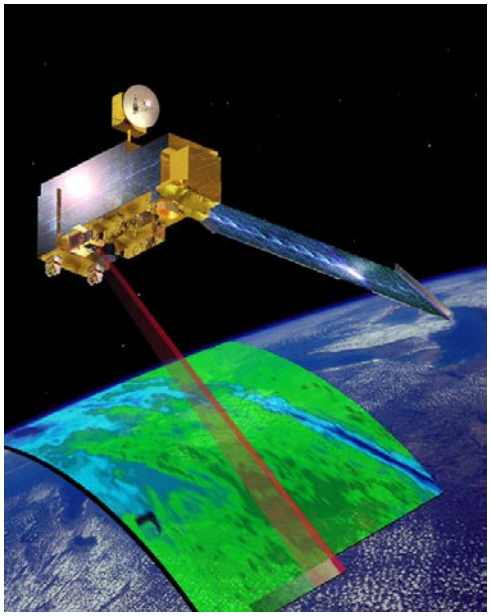
- **WRF-Chem** is the **W**eather **R**esearch and **F**orecasting (WRF) model **coupled** with **Chem**istry.
- The model simulates the **emission, transport, mixing, and chemical transformation** of trace gases and aerosols simultaneously with the meteorology.

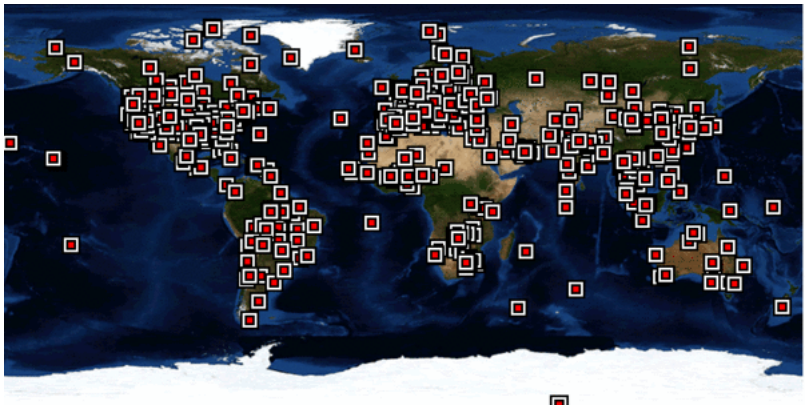


Study Region

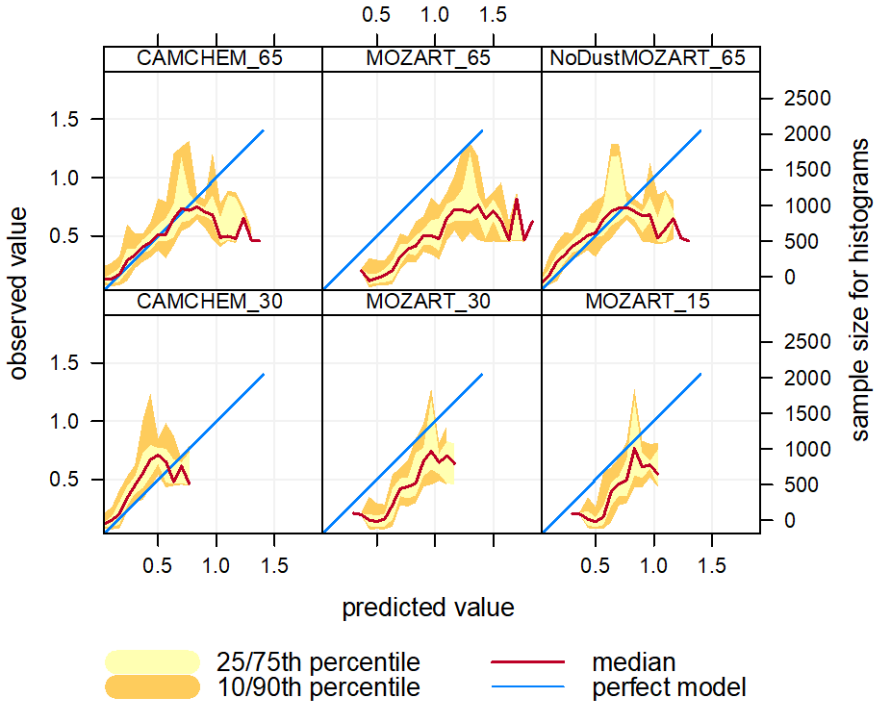


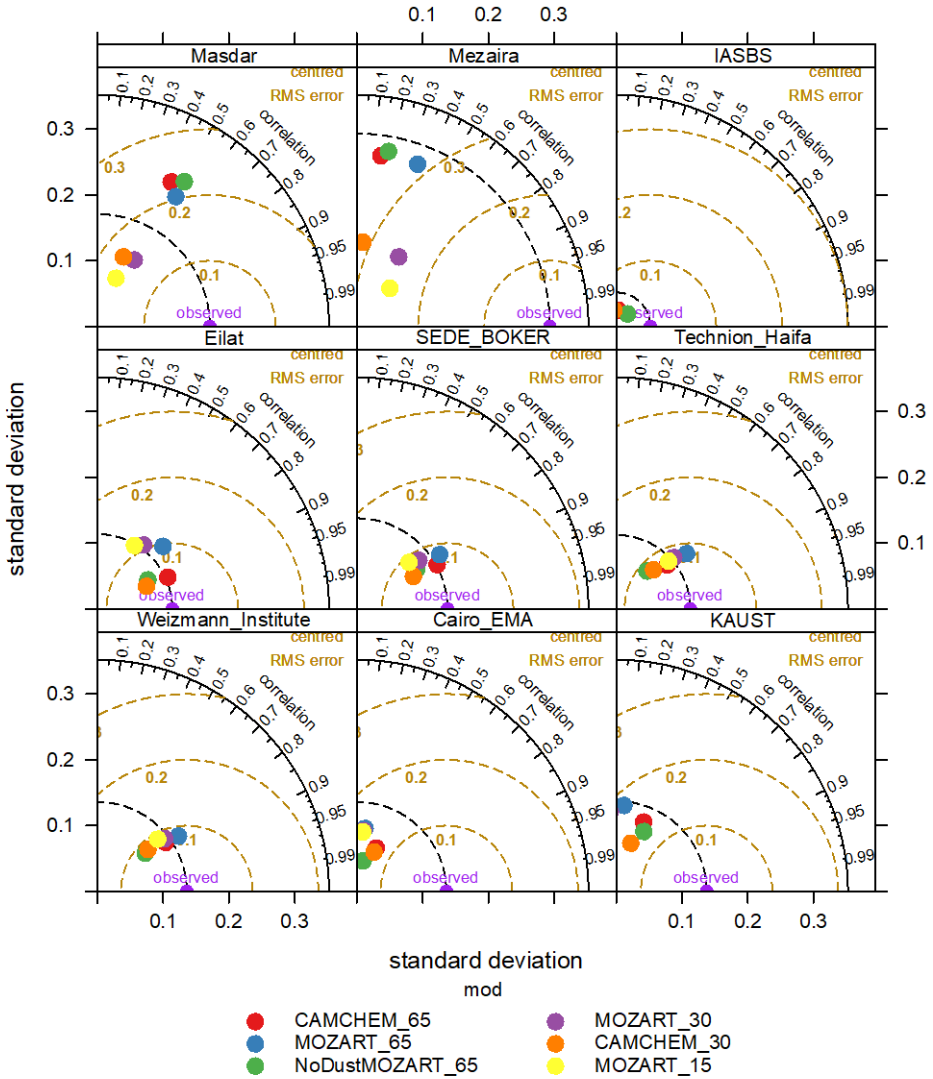
MODEL VALIDATION DATASET



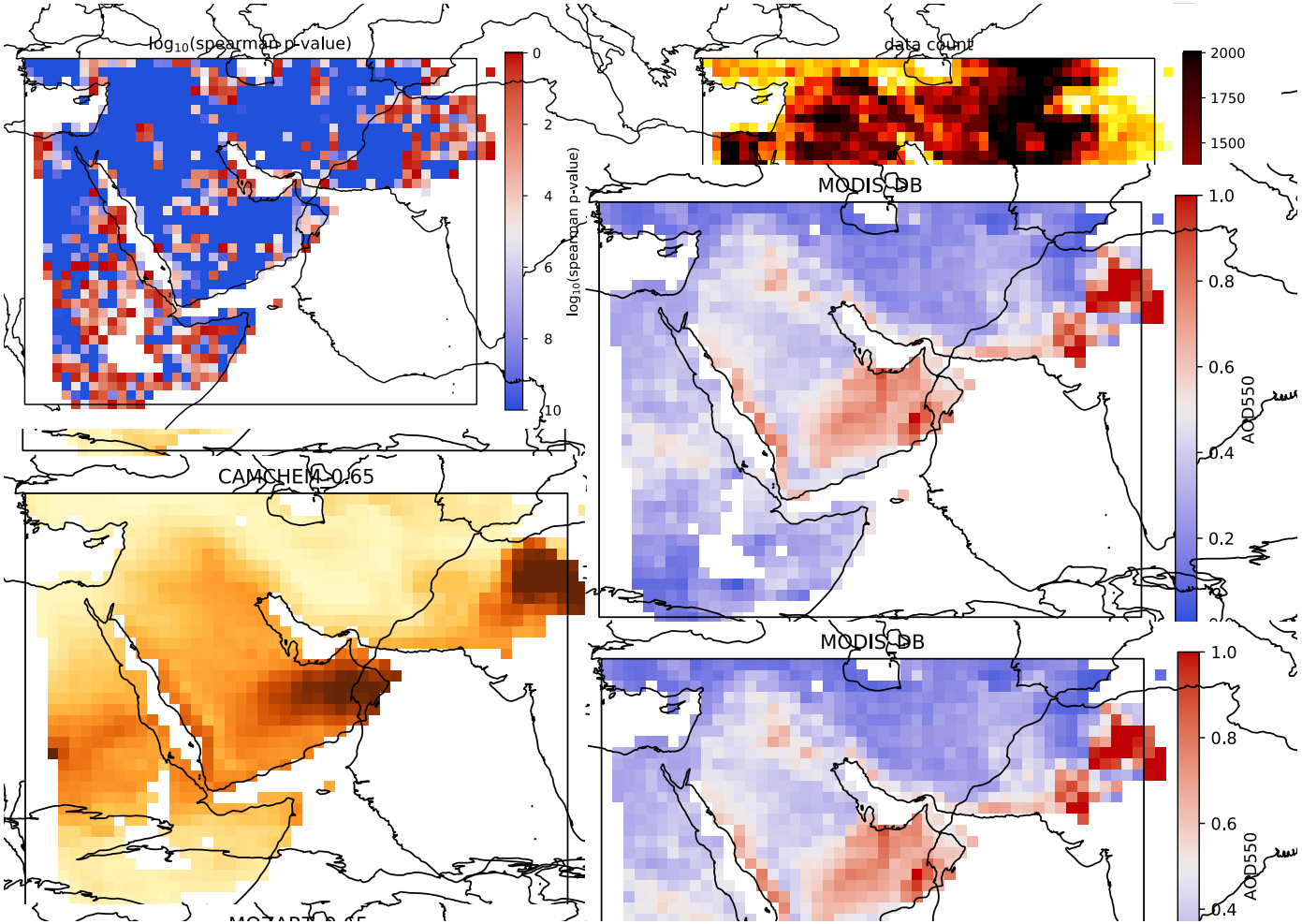


Local Aerosol Optical Depth Distribution

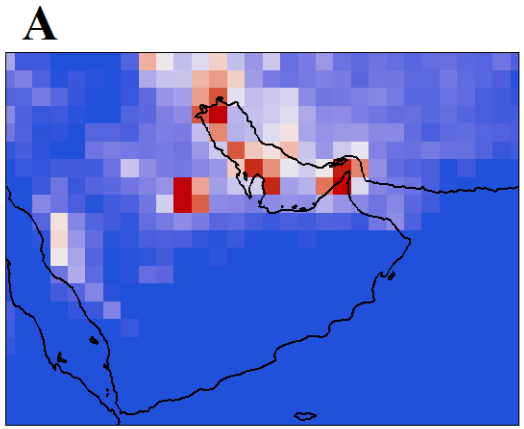


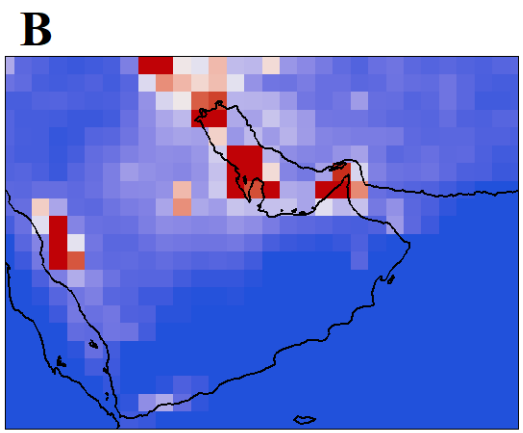


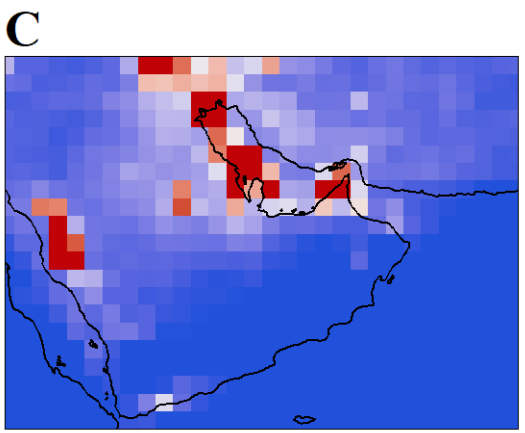
Regional Aerosol Optical Depth Distribution

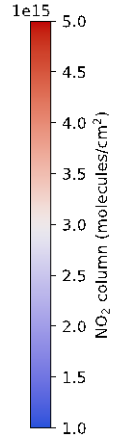


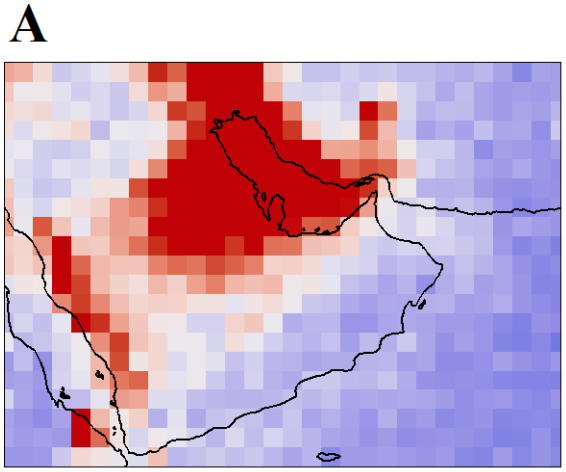
Regional Air Pollutants Distribution

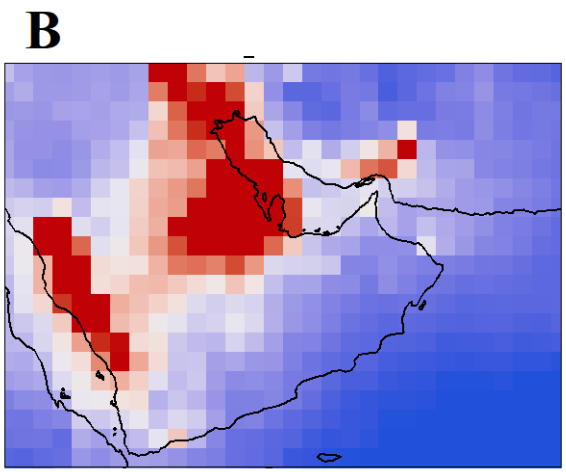


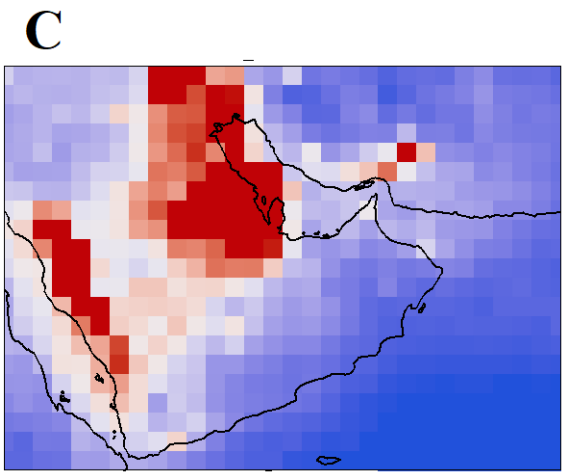


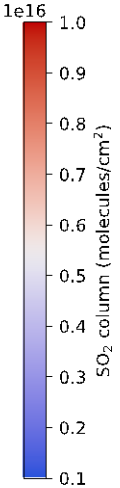




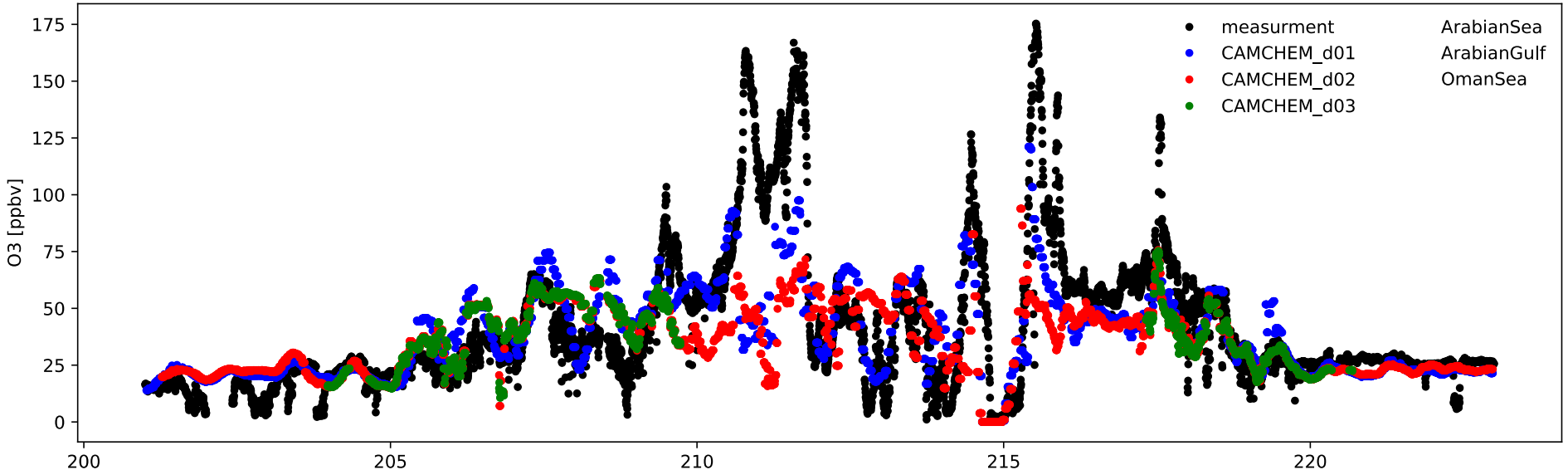


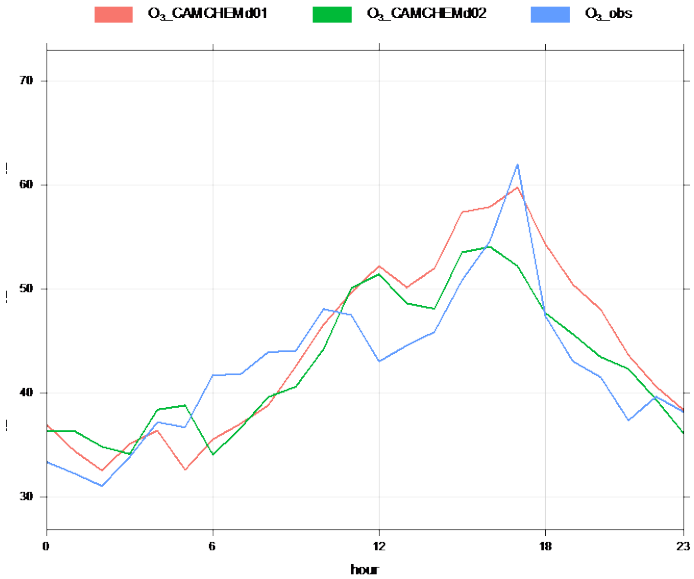






Ozone: AQABA vs Model

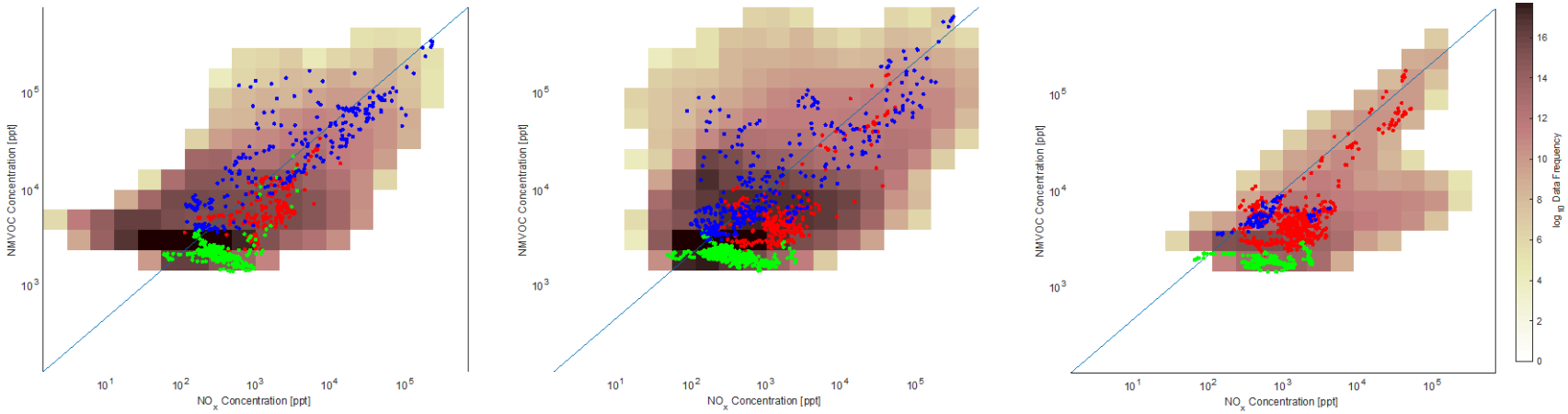




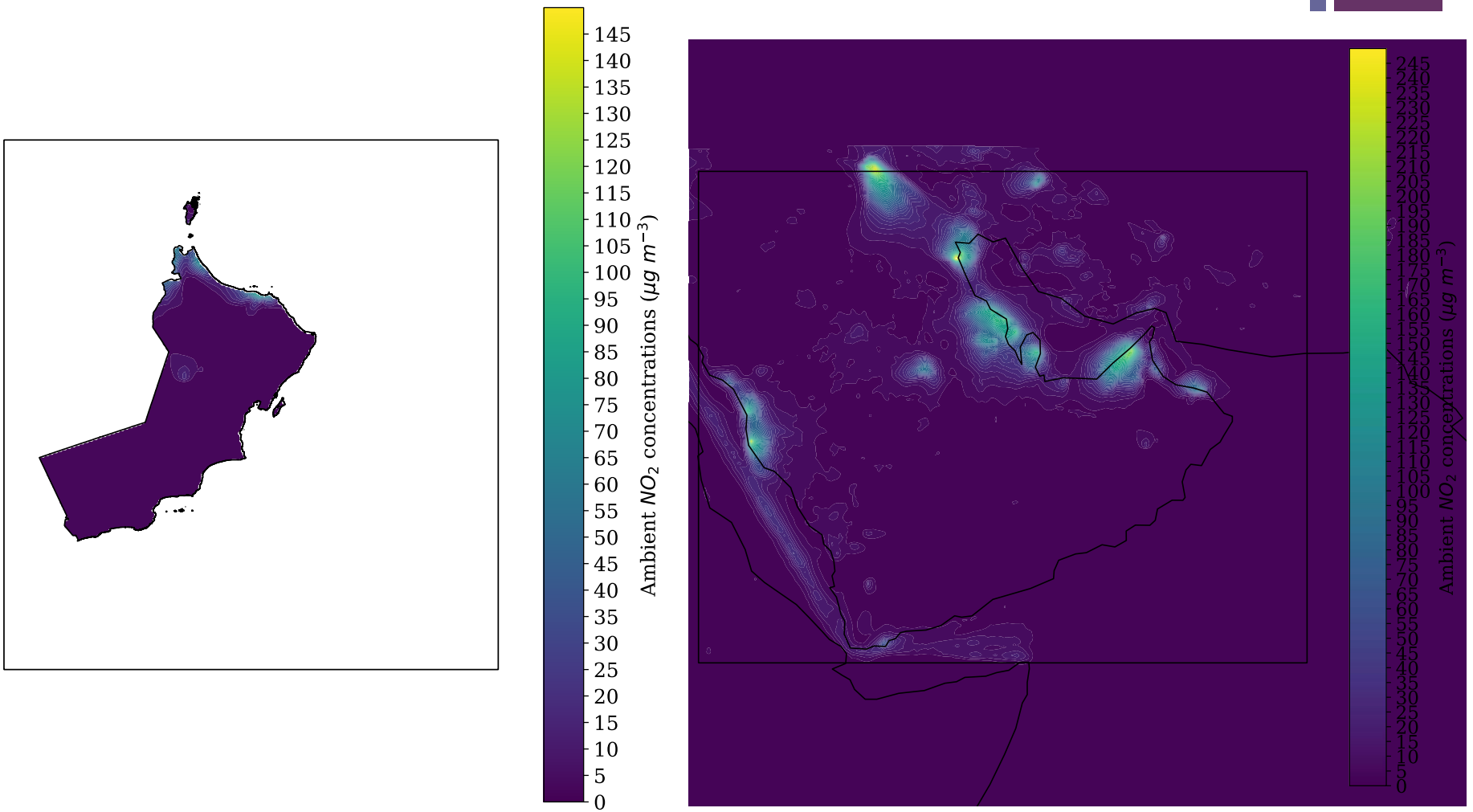
Regional chemistry over the Arabian Peninsula

- The modelled **NO_x** mixing ratio ranged from **100 pptv to several parts per billion by volume.**
  - This can be related to **multiple local anthropogenic** sources such as on- and offshore petrochemical processing, **highly urbanized cities** and **passing ships**

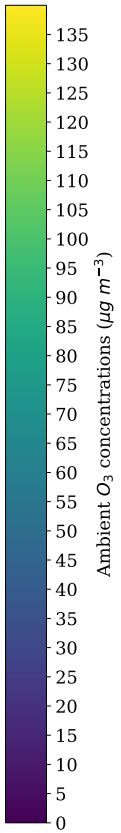
- The modelled **NMVOC** mixing ratio ranged from 1 ppb to several parts per billion by volume.
  - **The Arabian Sea** shows the **lowest** NMVOC mixing ratio; while the **Oman Sea and Arabian Gulf** have the **highest** mixing ratios, due to the **significant presence** of the **oil and gas industries** in these locations.

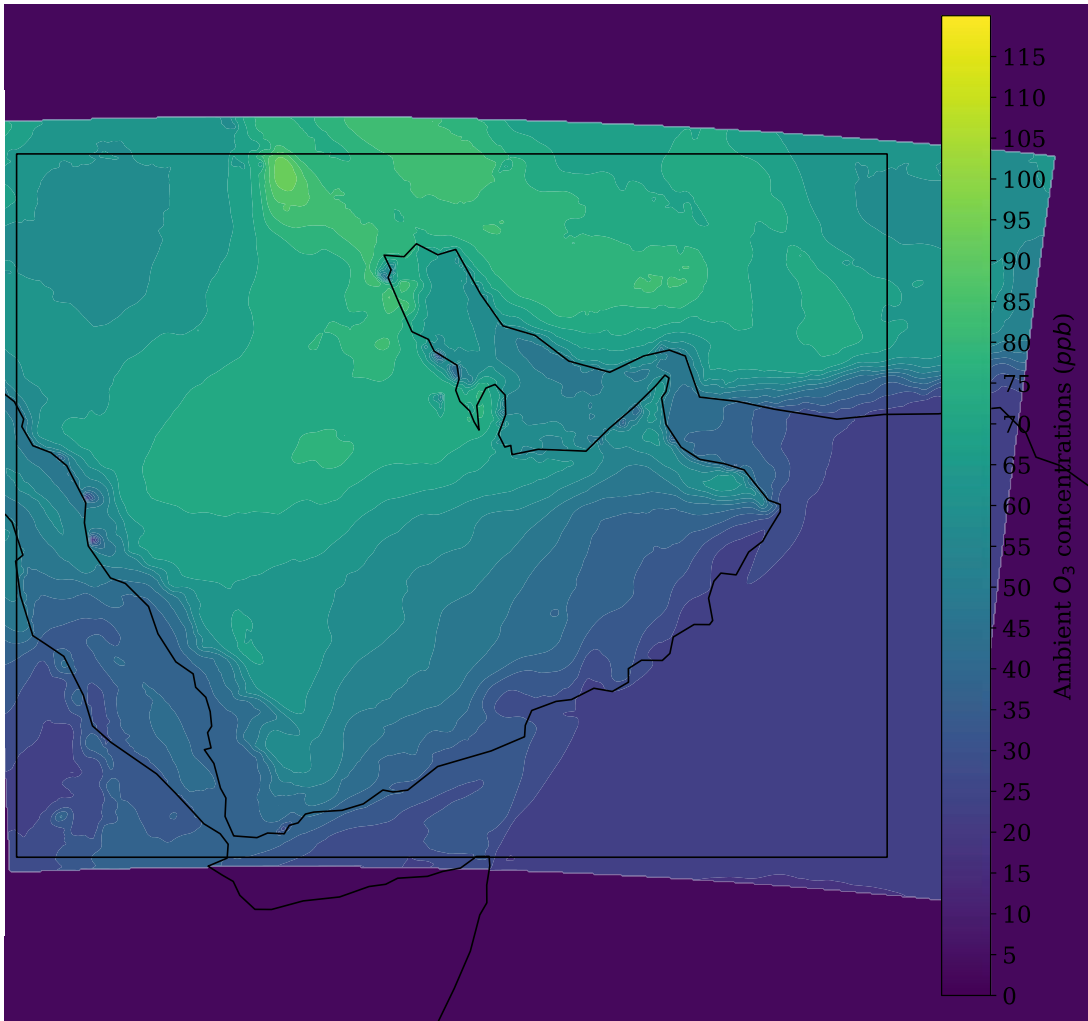


The average simulated maximum daily 1-hour mean NO_2

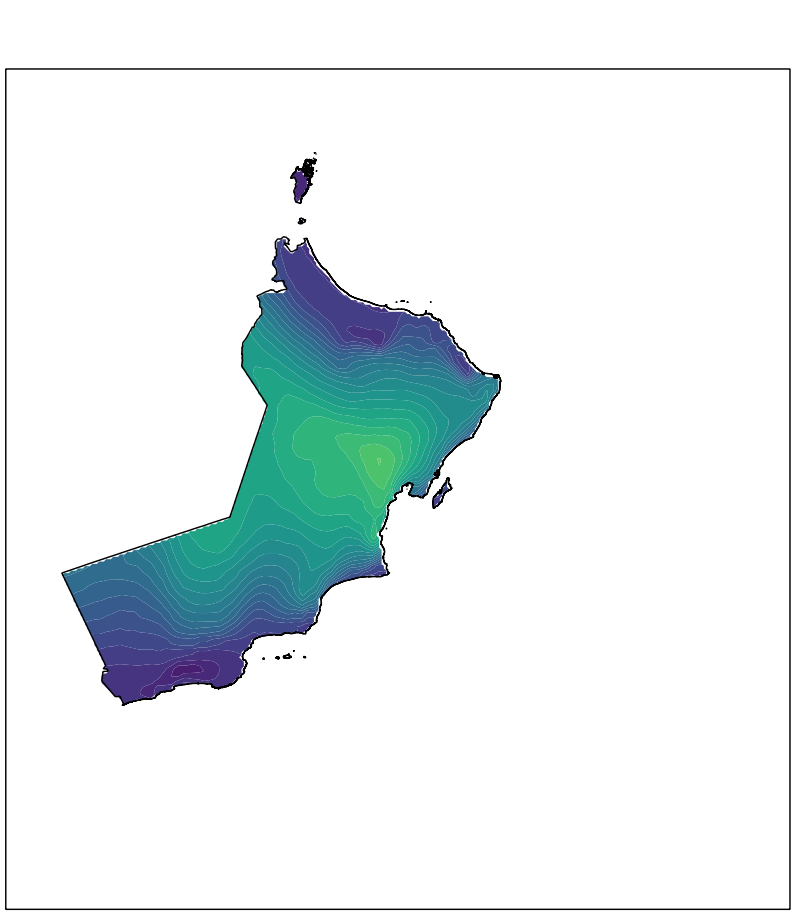


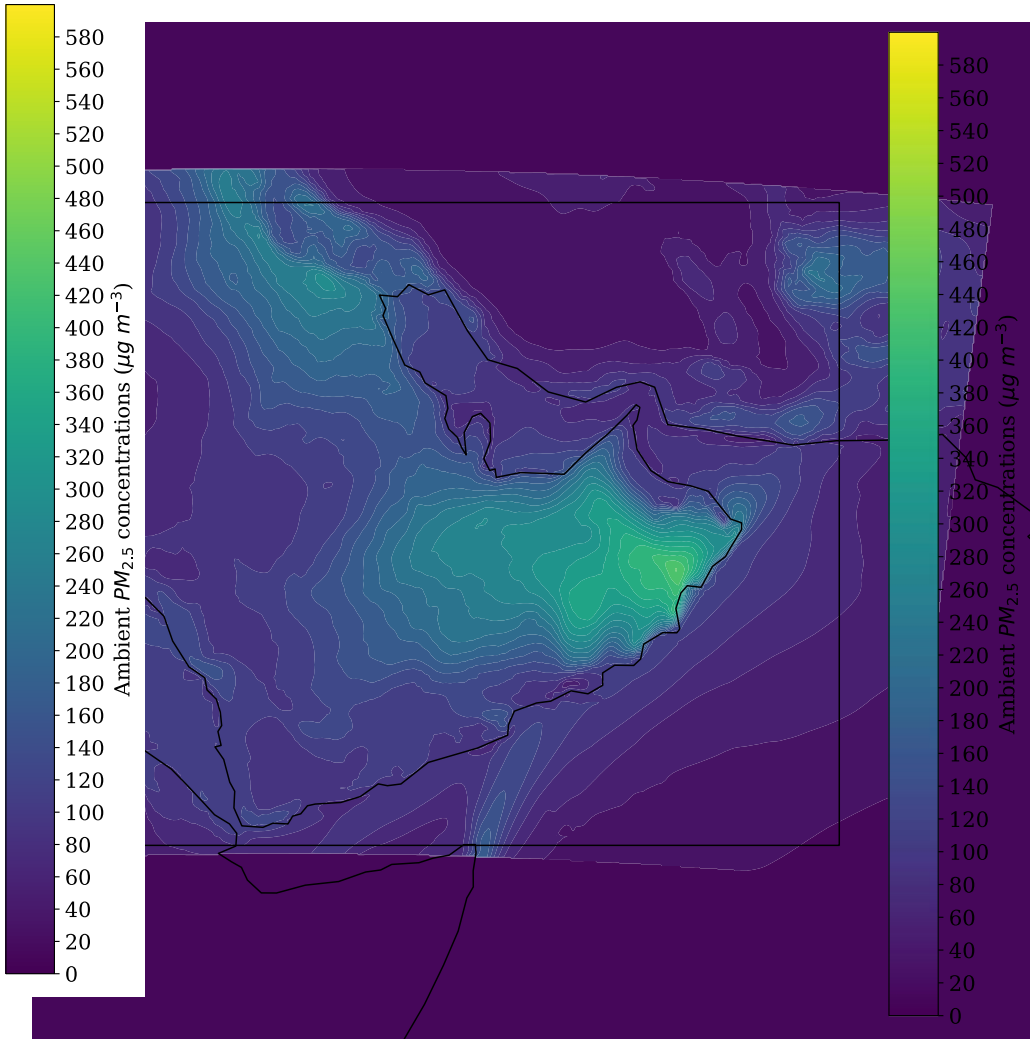
The average simulated maximum daily 8-hour mean O_3



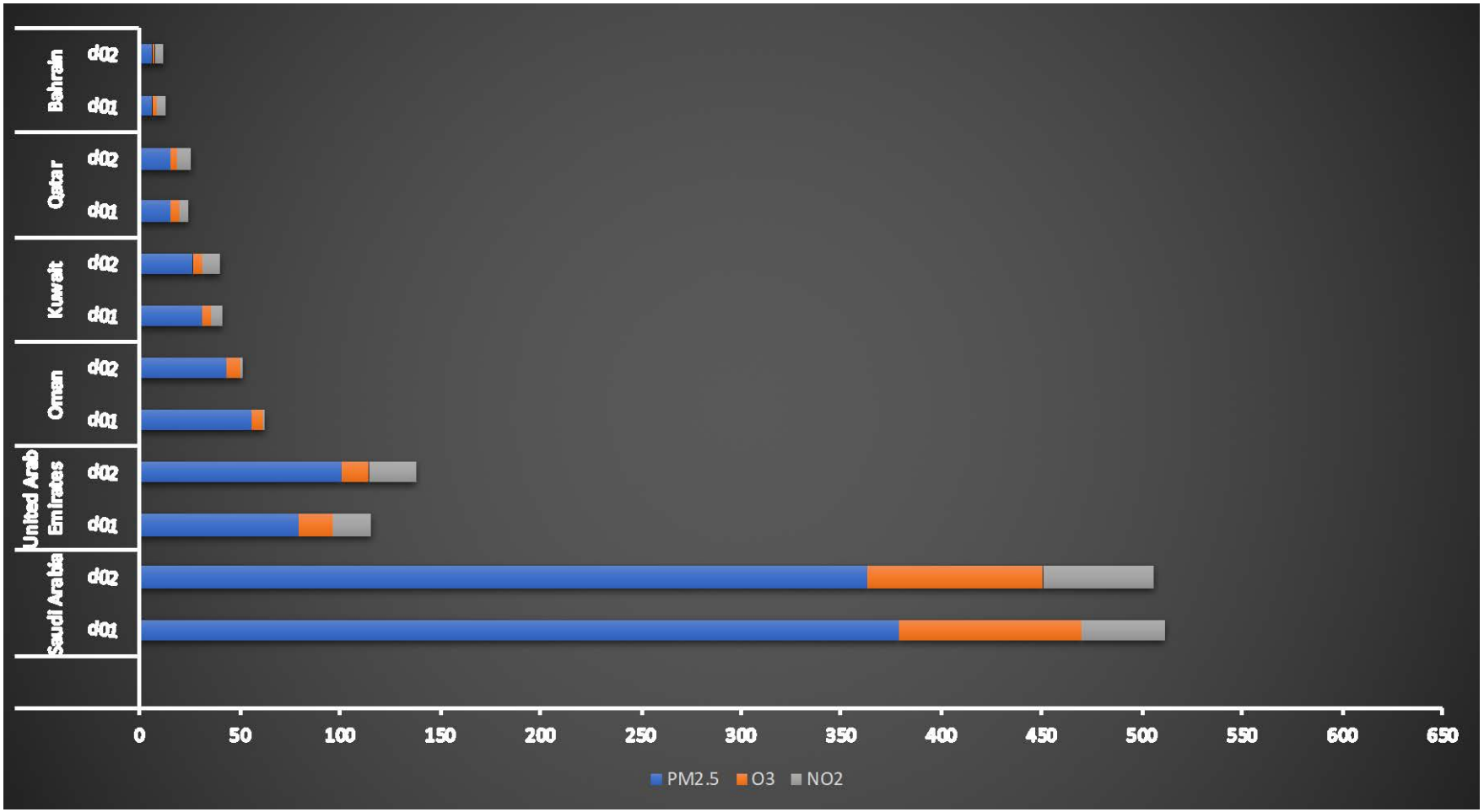


The average simulated daily mean $PM_{2.5}$





The estimated short-term premature mortality



Conclusion & Recommendations

- WRF-Chem simulations were **significantly influenced** by the **global model data used as boundary conditions**
  - data taken from Community Atmosphere Model with Chemistry (CAM-chem) simulations showed the highest fidelity.
- **Discrepancies** in the results between **WRF-Chem and the AQABA-ship** campaign data are likely most **strongly influenced** by **biases in the anthropogenic emission inventory** rather than model boundary conditions.
- The **model-measurement uncertainty** leads to **uncertainties** in **health impacts**, which will also be affected to some degree by model resolution.
- **Improved evaluation** of air quality and its impacts on health would strongly benefit from the **development of a national emission inventory** and provision of **access to available ambient air quality data from monitoring stations.**