Atmospheric Chemistry: A revolution helping people mitigate risks of air pollution

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and several more.....
Atmospheric Chemistry: A Revolution

Societal Issues

Los Angeles, 1968

London, 1952

Atmospheric Chemistry Research

Laboratories

Ground-based

Balloons

Ships

Aircrafts

Satellites

Supercomputers

Models

Solutions

Tomorrow’s surface O₃ forecast (09 Z)

Long-term reduction in air pollution

• Air quality alerts help to decrease emergency department (ED) visits by 25% in Canada [Chen et al., 2018]
• Emission regulations in Atlanta avoided 50,000 ED visits in the last 15 years [Russell et al., 2018].
Air Pollution Continues to be a Global Threat

- 7 million premature deaths related to air pollution [WHO, 2018].
- US$5 trillion in economic loss related to air pollution [World Bank, 2015].
- 79-121 million tones of lost crop produce globally [Avnery et al., 2011].
Five Steps to Improve Air Quality Forecasts

1. Monitoring
   (In situ and space observations of weather and atmospheric composition.)

2. Modeling
   (Multi-scale air quality forecasts to protect public health.)

3. Interpretation
   (Develop tools to help air quality managers evaluate the impacts of regulations, policies, and urbanization.)

4. Dissemination
   (Translate technical details into actionable information and disseminate to public.)

5. Training and Education
   (Train local students, scientists and public in developing countries.)

International System for Monitoring, Analysis, and Prediction of Air Quality (MAP-AQ)

Please stop by:
- MAP-AQ Poster
- Side-Meeting (Wednesday, 26 Sep 2018, 7:30-8:30PM, Room 54)

[Kumar et al., Nature, 2018]

https://www2.acom.ucar.edu/map-aq
Improving Air Quality Forecasts over the US

- The assimilation of MODIS AOD in Community Multiscale Air Quality (CMAQ) model improves the correlation coefficient between the model and observed PM$_{2.5}$ by ~67% and reduces the mean bias by ~38% over the CONUS.

[Kumar et al., under review, JGR, 2018]
Forecasting extreme air pollution events in New Delhi

Delhi doctors declare pollution emergency as smog chokes city

Levels of airborne pollutants are off the scale in parts of India’s capital with effects likened to smoking 50 cigarettes a day

The Guardian (07 Nov 2017)

MODIS AOD (07 Nov 2017)
Post-processing: Further Improving AQ forecast

Find set number of analogs based on certain predictors

[Adapted from Delle Monache et al., 2013]
Quantifying uncertainties in AQ forecasts

AnEn generates forecast quantiles that provide uncertainty quantification

Bias Reduction: ~95%

Bias Reduction: ~85%

[Delle Monache et al., ACPD, 2018]
Projection of Future Air Quality in South Asia

South Asian air quality shows no signs of improvement by mid-century under emission scenarios projected by the Representative Concentration Pathways (RCPs)

[Kumar et al., JGR, 2018]
Summary

• Air pollution continues to be a global threat for human health and food security.

• Advances in atmospheric chemistry research has put us in a position to help the public mitigate risks of air pollution.

• Air quality forecasts must be extended to the developing nations with partnerships between the forecasters from the developed and developing nations.

• We must continue to improve our fundamental understanding of atmospheric chemistry (organic atmospheric chemistry, aerosol microphysics, emissions and deposition).

Thank You!