Atmospheric Chemistry & Transport: Estimating SLCF Distributions and Contributions

Greg Carmichael, University of Iowa

<u>Many Current Studies (e.g.)</u>

LRTAP - Hemispheric Transport of Air Pollutants

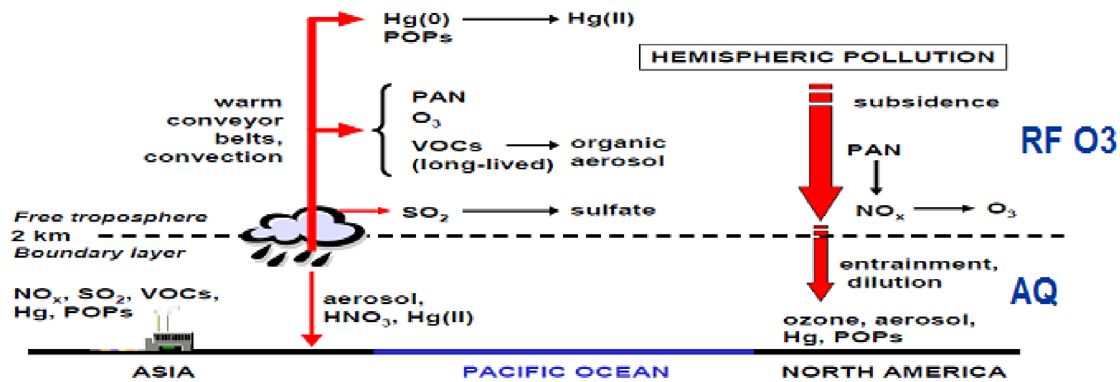
Royal Society - Ground-level ozone in the 21st century: future trends, impacts and policy implications

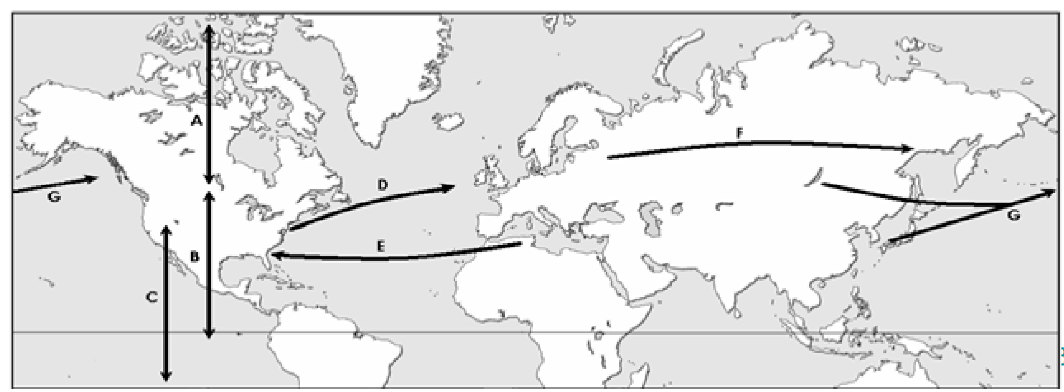
NAS - Global Sources of Local Pollution

UNEP - Opportunities to Limit Near-Term Climate Change

IGAC/SPARC - Bounding the role of black carbon in climate

Major Atmospheric Transport Pathways and Processes Impacting SLCF



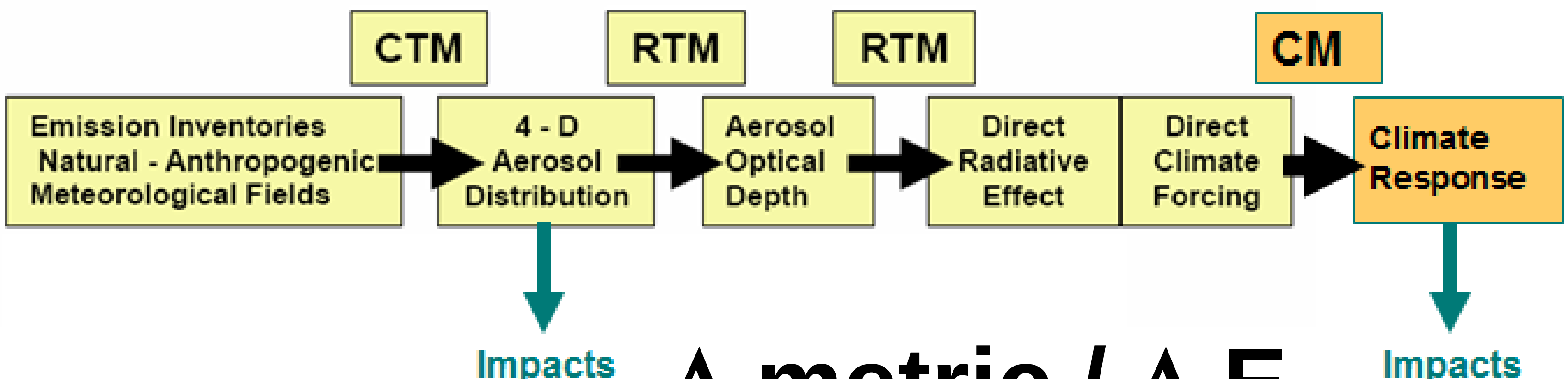


NAS Global Sources of Local Pollution, 2010

Models Play a Critical Role in Linking Emissions to SLCF Distributions and Subsequent Radiative/Climate Effects

Models try to represent our present understanding of the processes at play

E - emissions

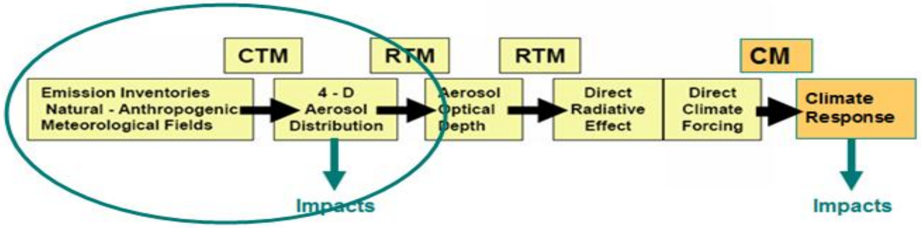


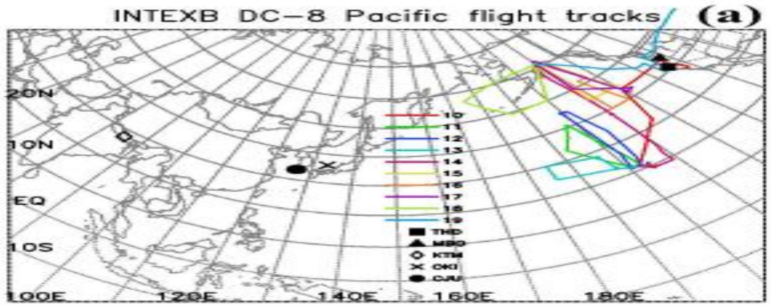
Δ **metric / Δ E**

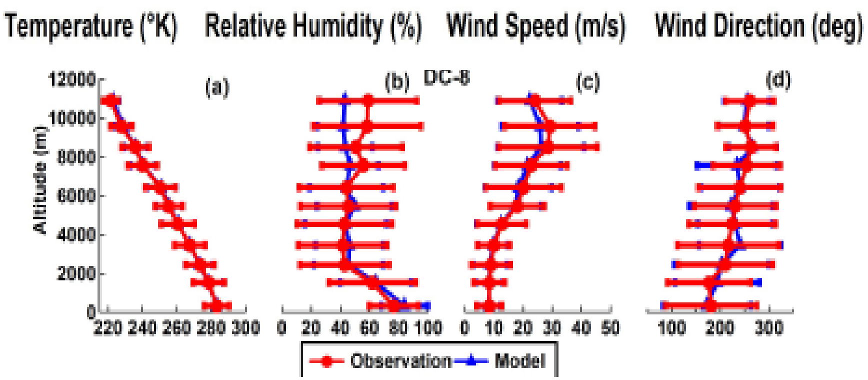
Uncertainties

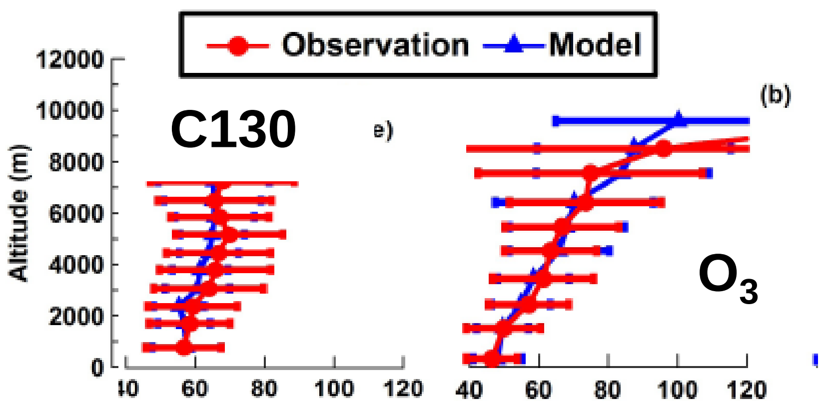
Significant → **Increasing**

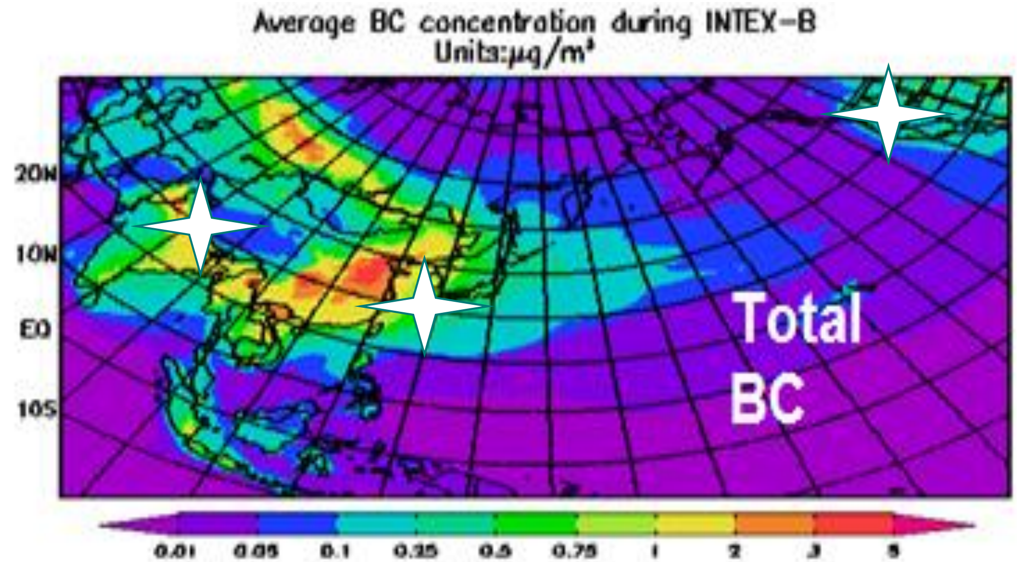
Large Scale Comprehensive Field Experiments Like NASA Intex B Experiment Explore Our Understanding of Atmospheric Processes

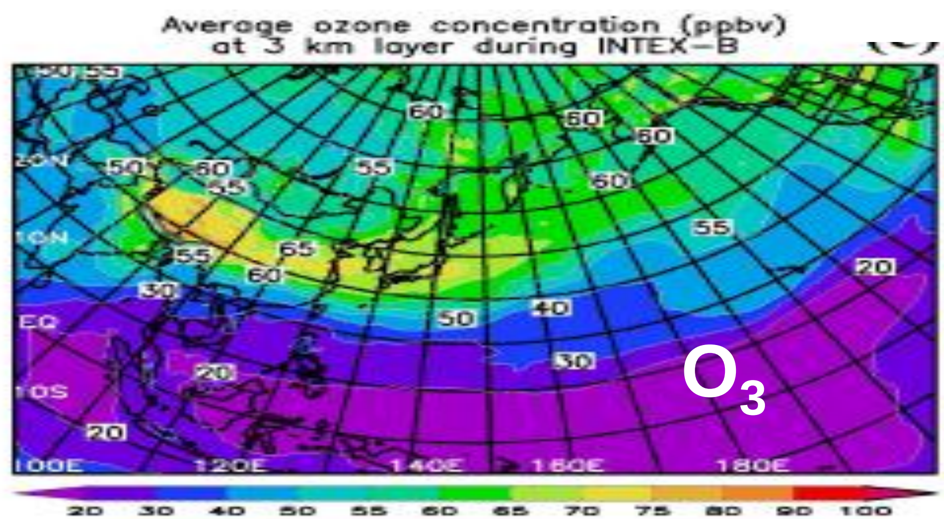




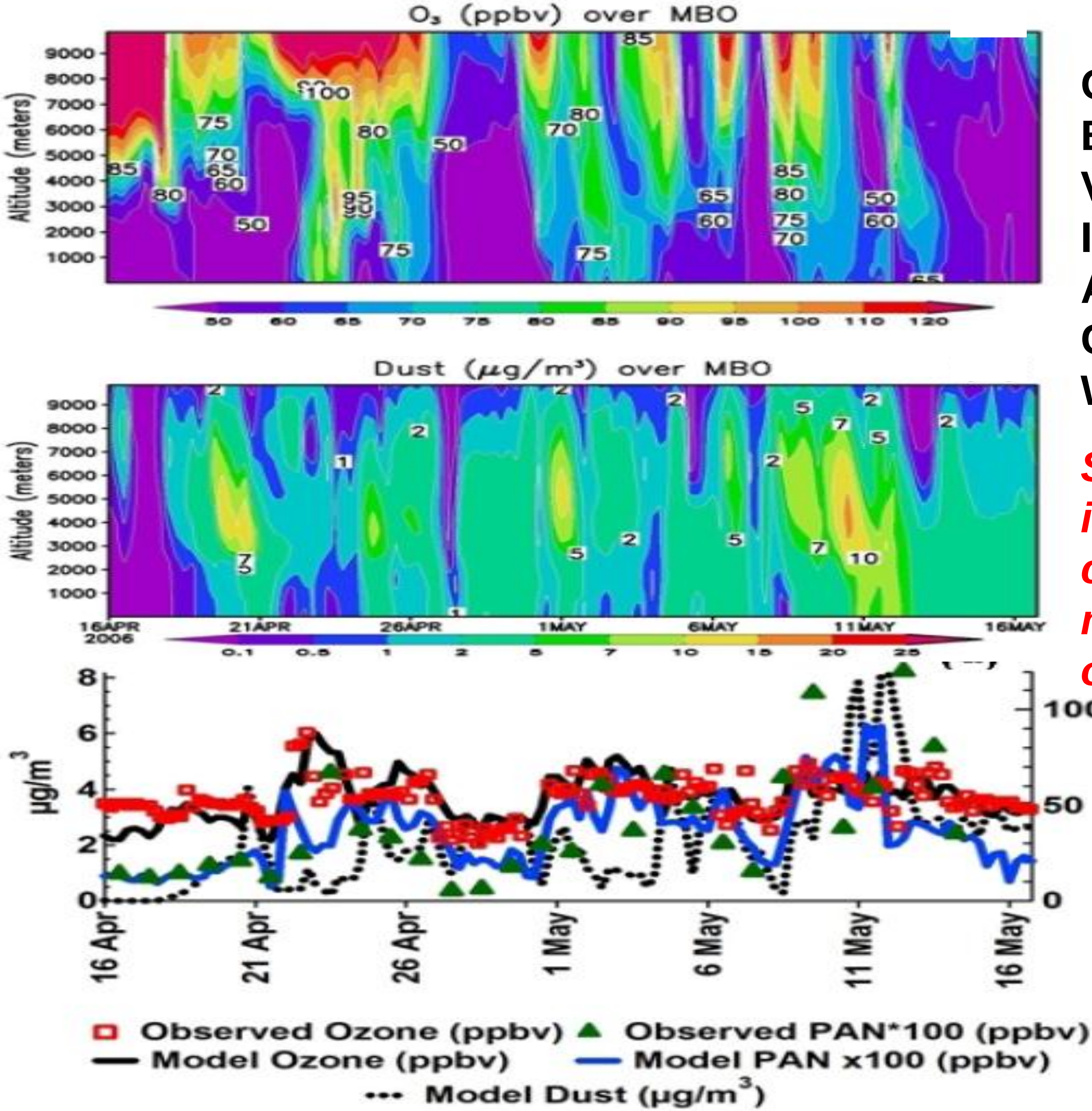








Adhikary et al., ACP, 2010

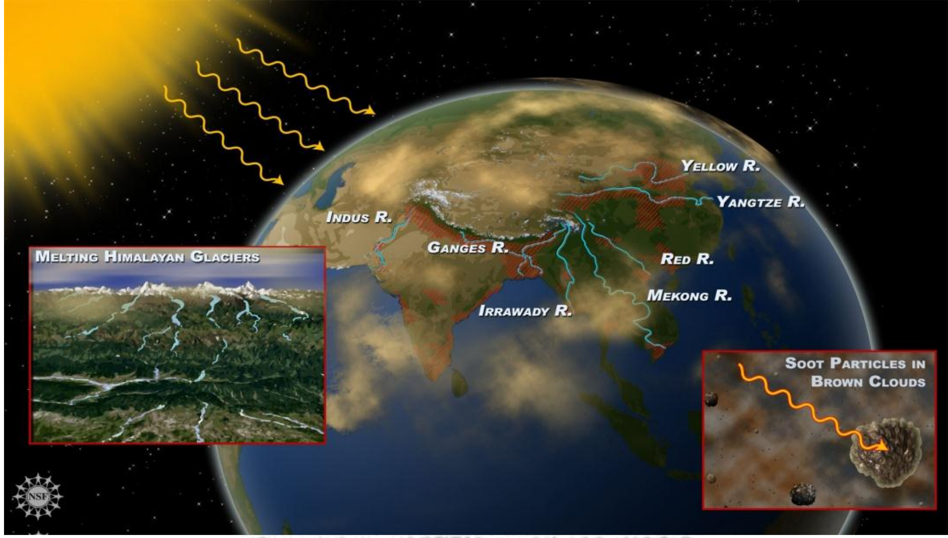


Observations at Mt. Bachelor Provide Valuable Insights Into The Variability In Atmospheric Composition in the Western US.

Significant variability in the vertical -- challenges to models and observing systems!

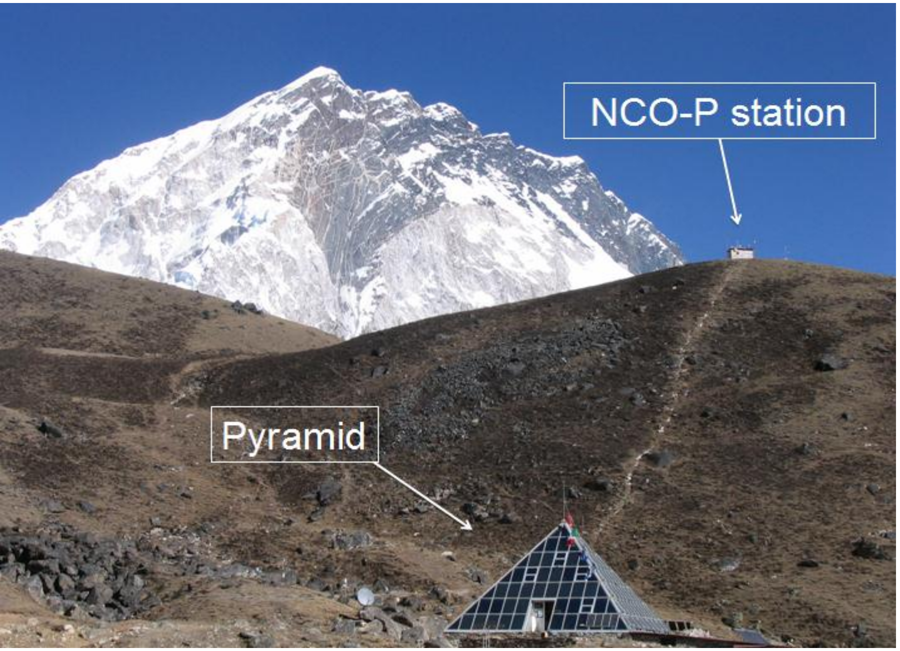
Adhikary et al., ACP 2010

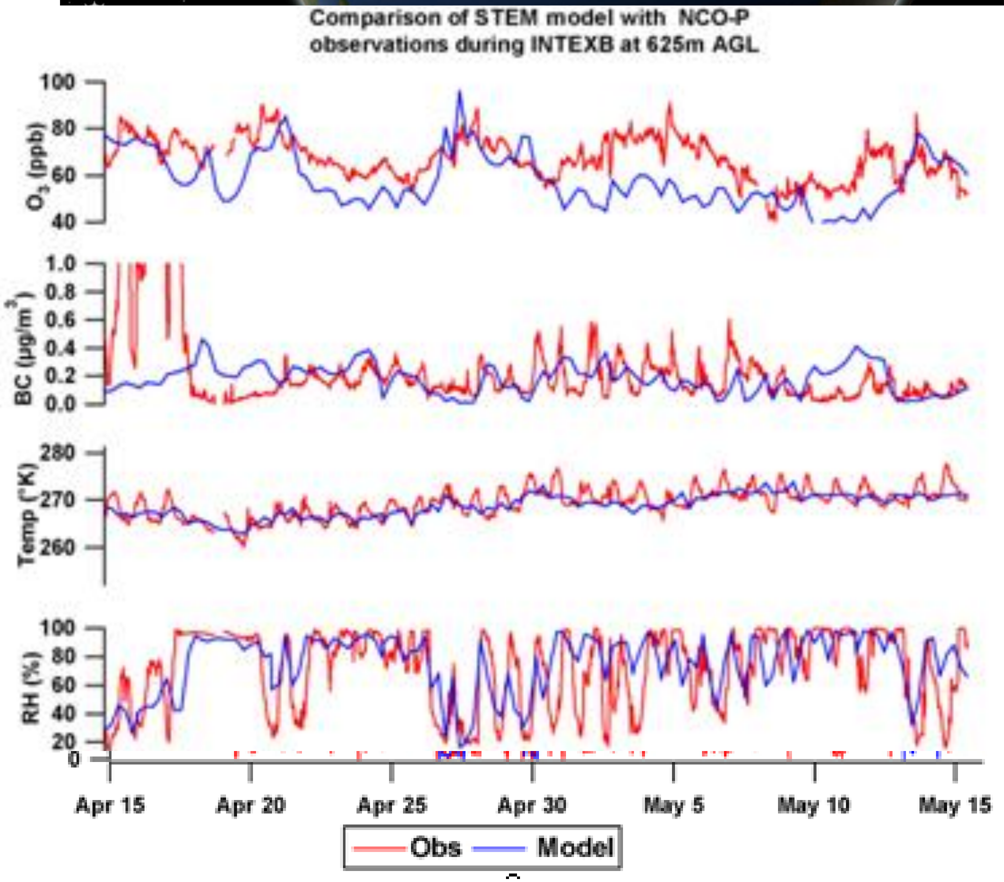
Transport and Deposition Processes in The Himalaya Region Have Important Implications for Water and Food Security



ABC Nepal Climate Observatory (NCO-P)

- **Remote site in Himalayan region**
- **5079 m asl**
- **27.9 N, 86.7 E**
- **Complex topography**

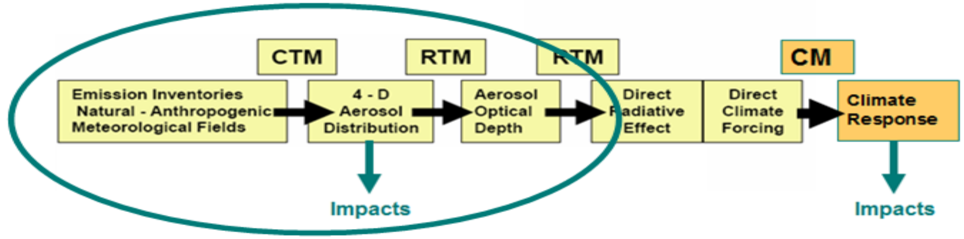


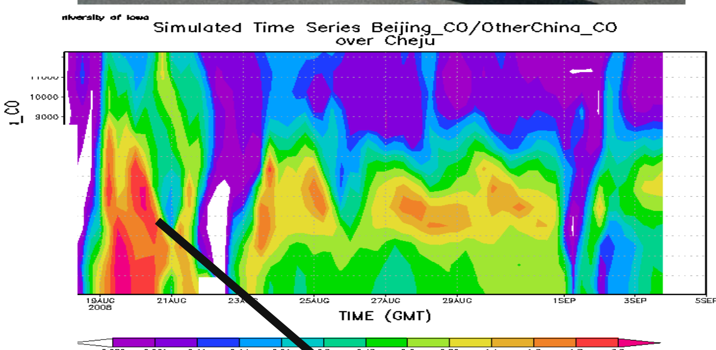


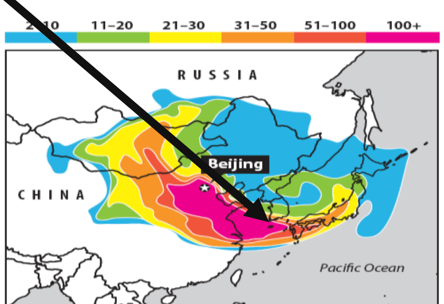
S. Fuzzi and team

Cheju ABC Plume-Asian Monsoon Experiment (CAPMEX) –NSF/KOSEF Providing Insights Into The Impacts of Aerosols

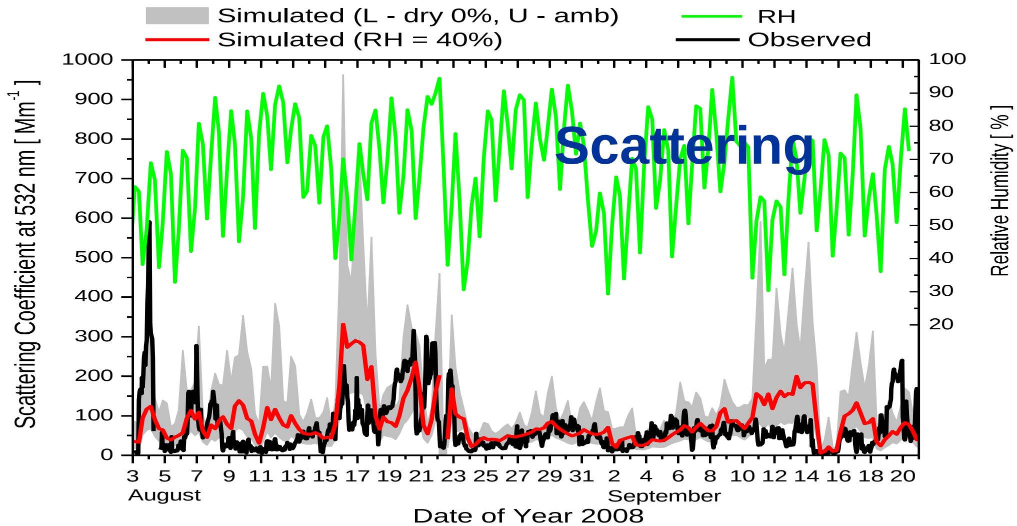
Ramanathan, Yoon, et al.,

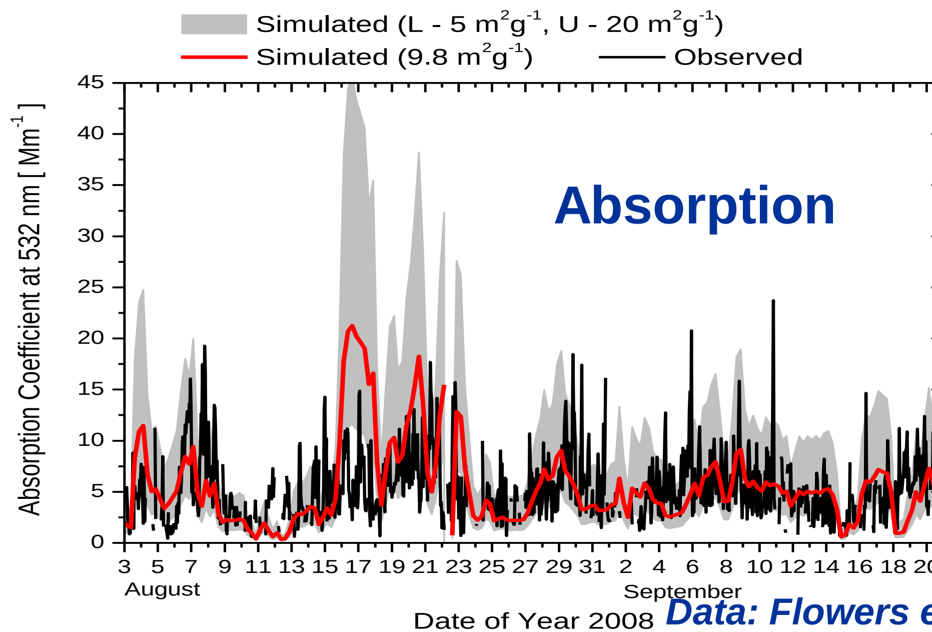






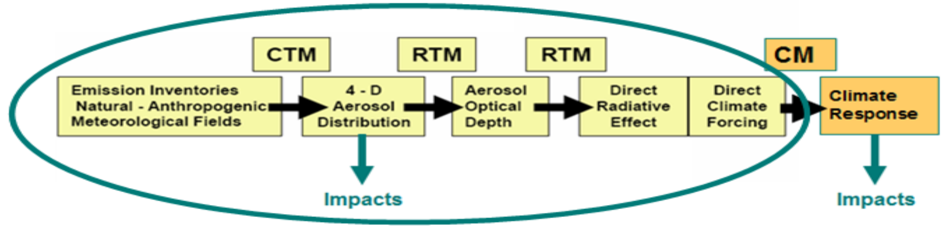
Beijing Plume Influence at Cheju

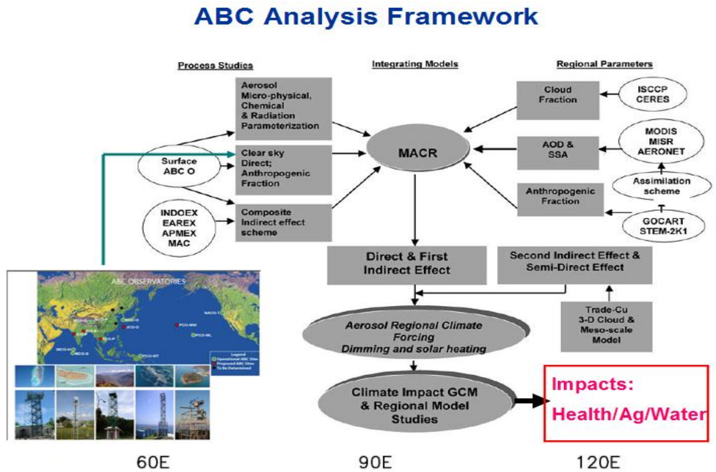


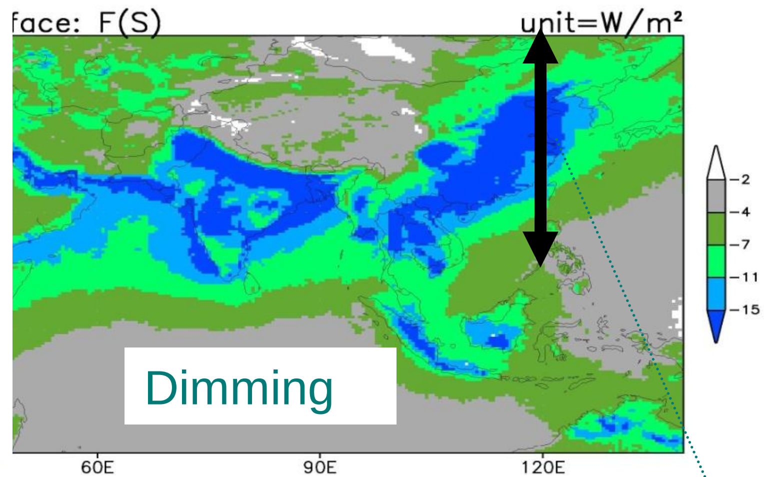


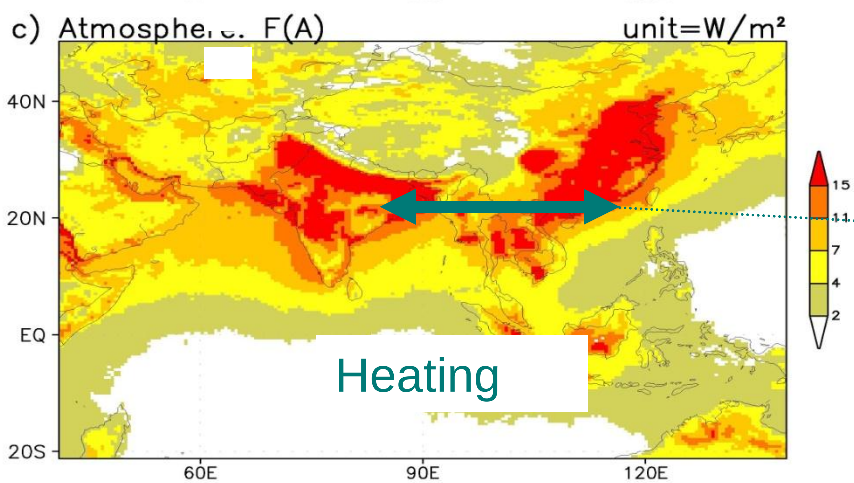
Data: Flowers et al.

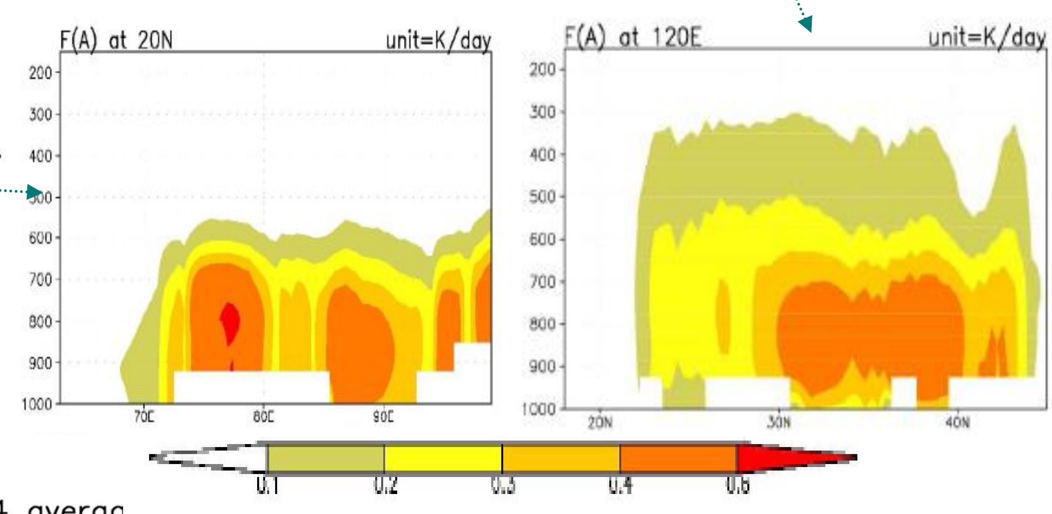
Quantifying Aerosol Radiative Forcing and the Role of Anthropogenic Components Remains a Challenge







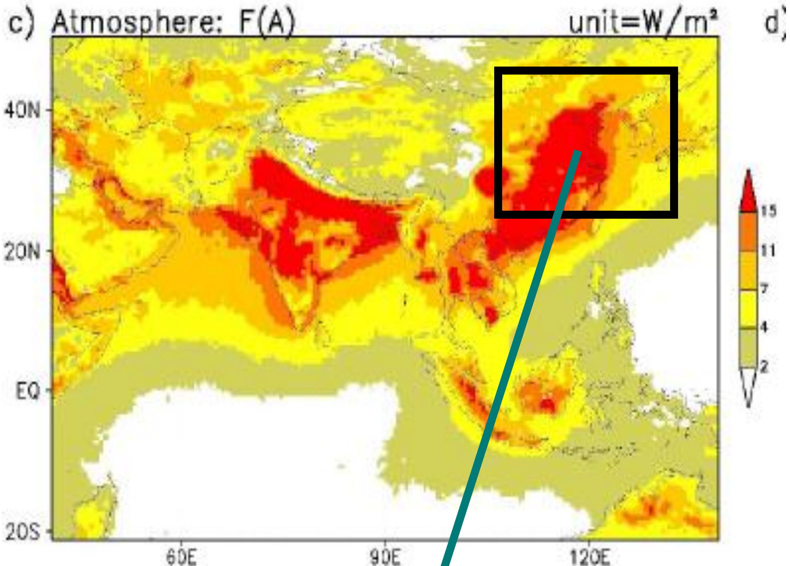




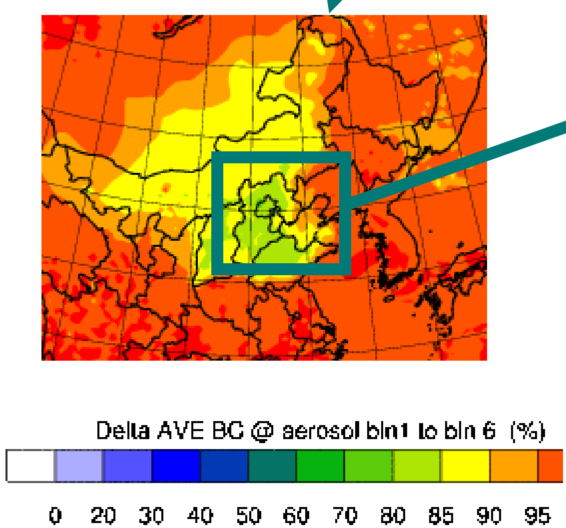
Strong atmospheric heating due to absorbing aerosol implications for processes impacting weather and climate

Chung, C. E., et al., ACPD, 2009

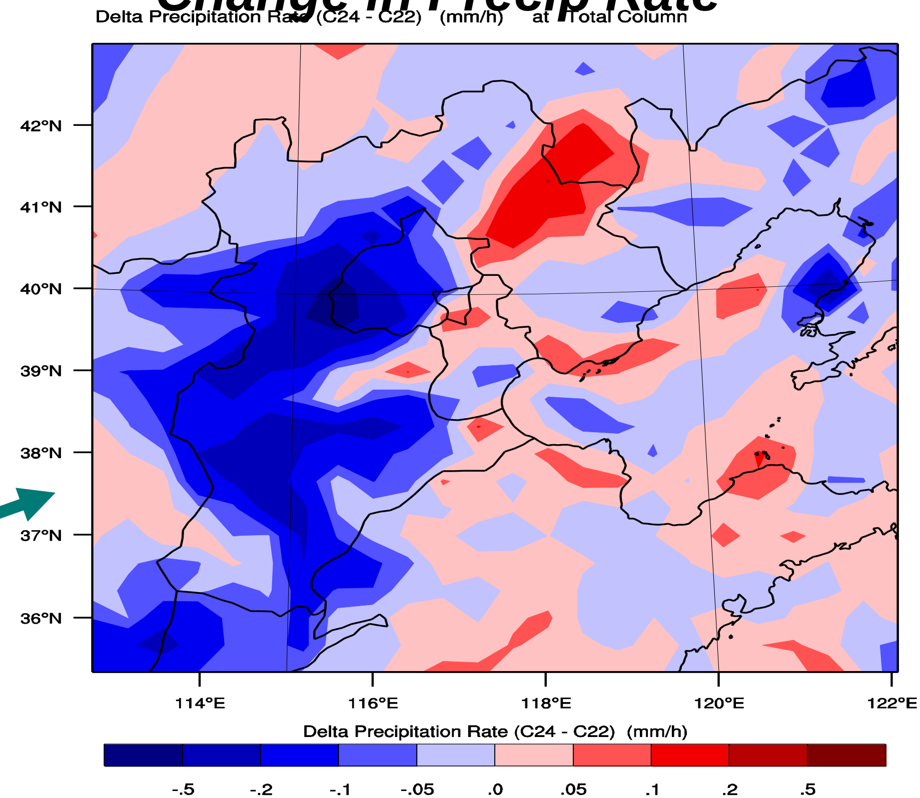
Incorporation of Aerosol Into Weather Prediction Will Provide Further Insights Into Processes



BC



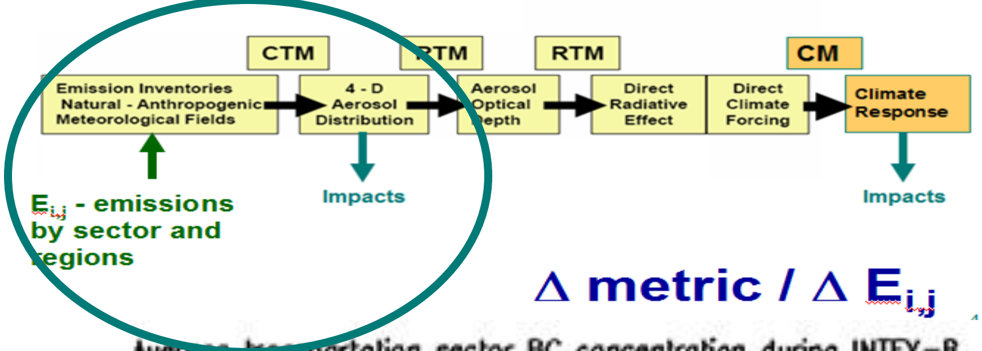
Change in Precip Rate

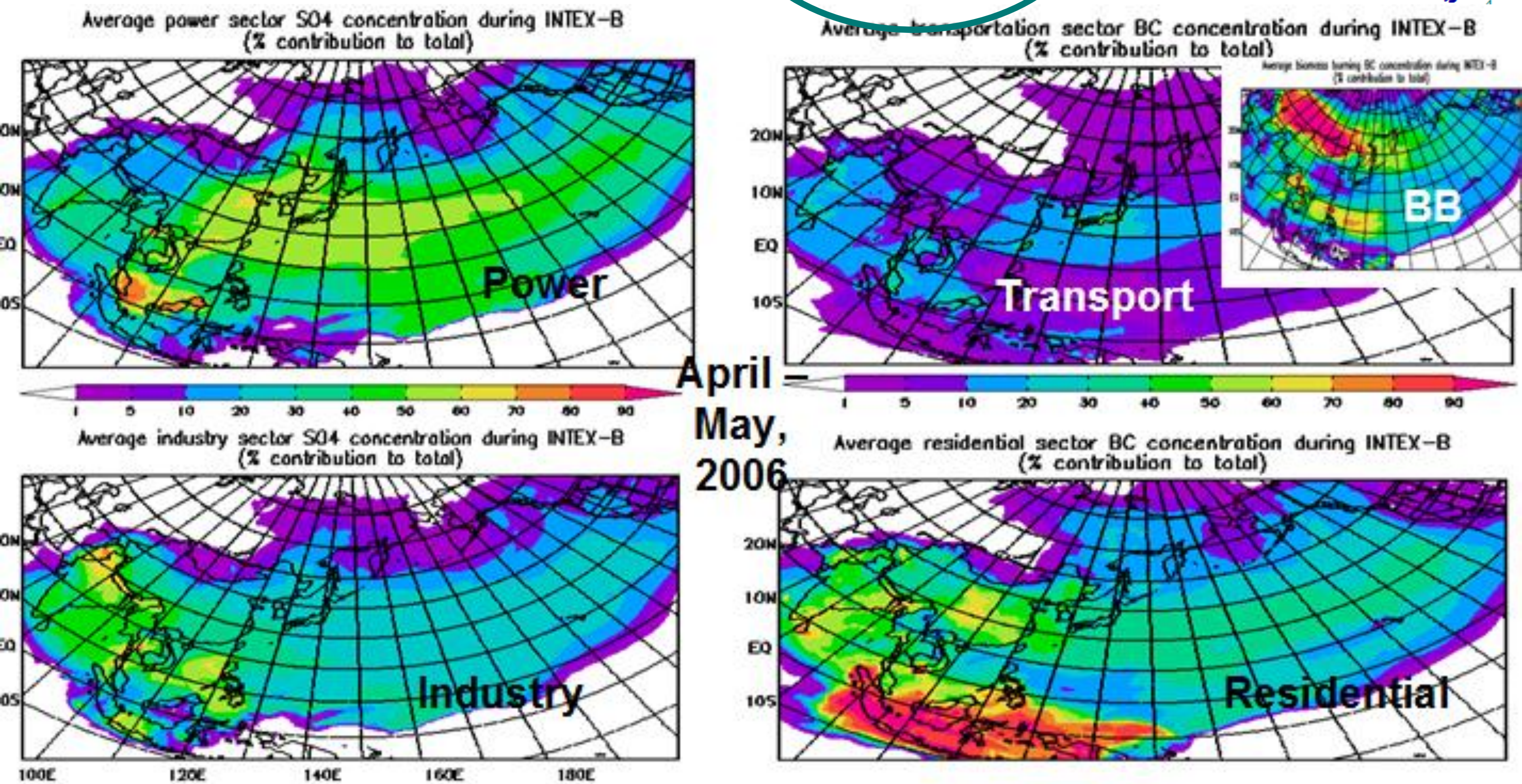


Beijing Olympics WRF-Chem Sensitivities

Case24 = Intex-B emission (2006)
Case22 = reduced Olympic emission (BJ+SD)
Time period Aug 2008

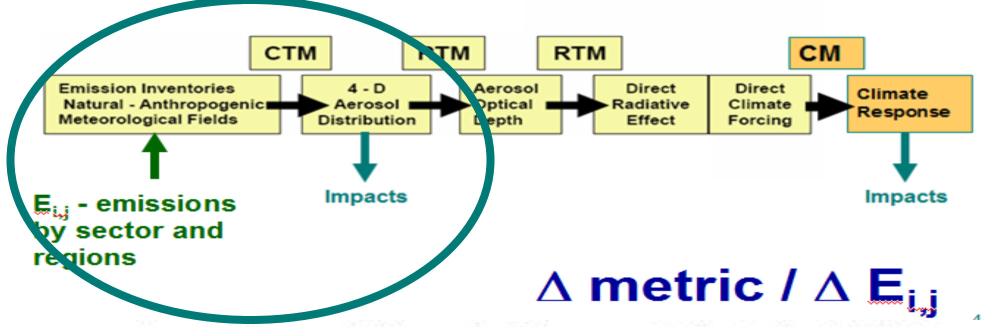
Moving Forward We Need More Analysis Related to Source Sectors & Fuels and Policy Relevant Scenarios

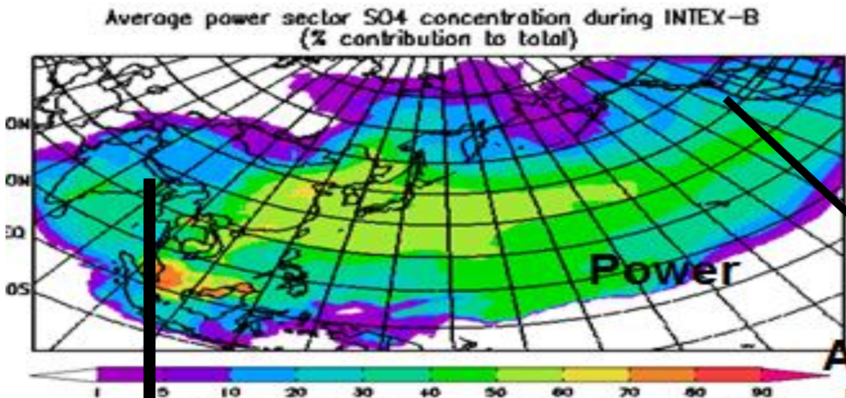




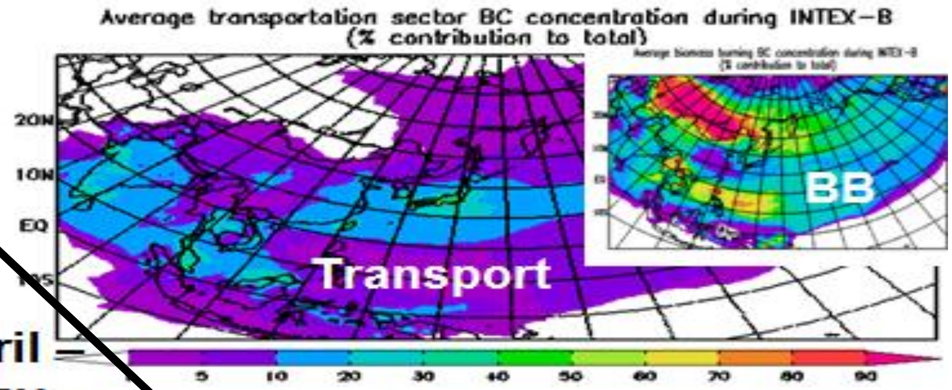
Asia emissions analyzed by sector

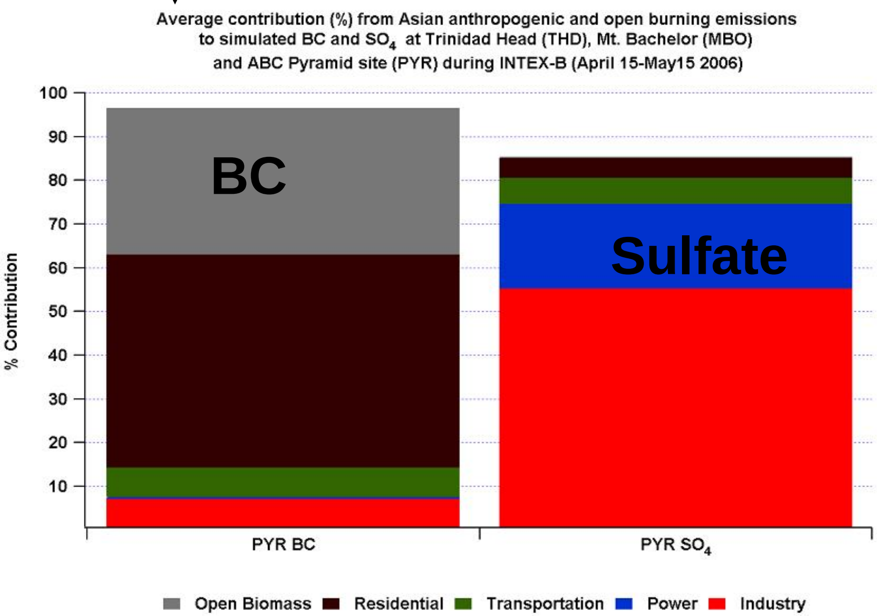
Sector Focus Places Greater Demand on Emissions, Models and Observing Systems

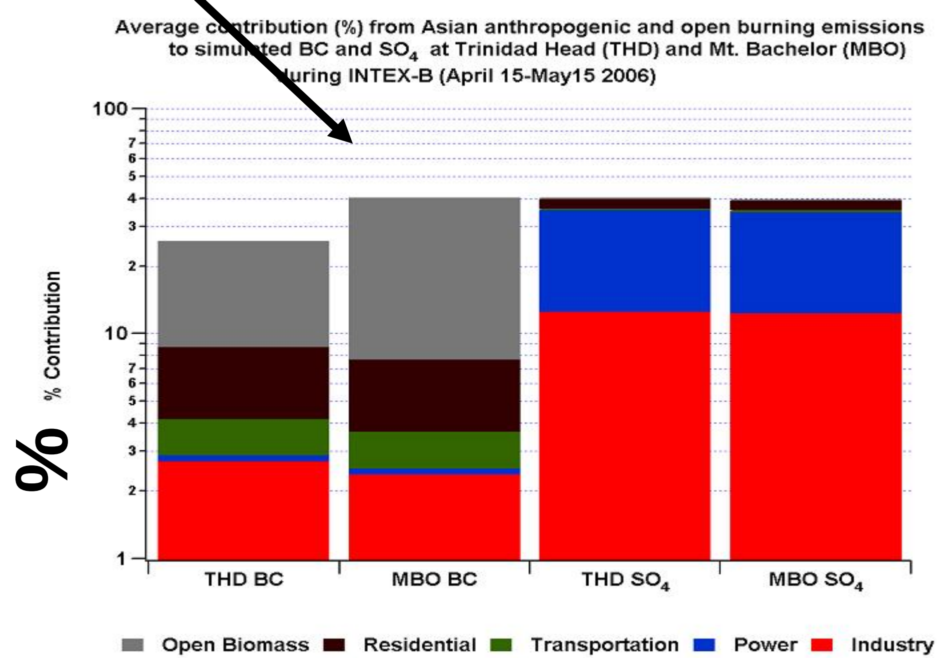




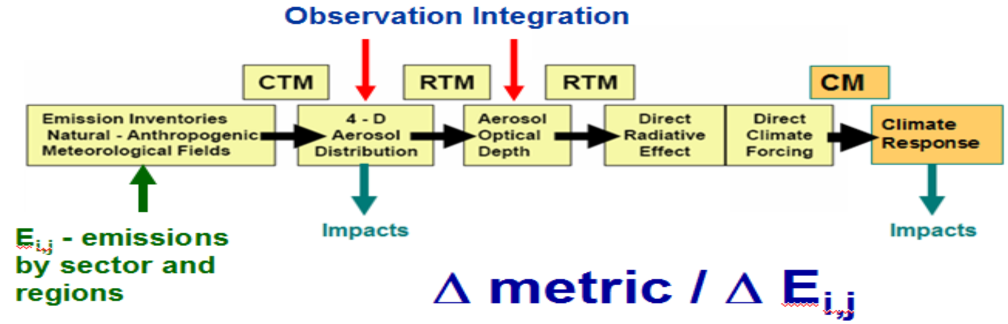
April – May

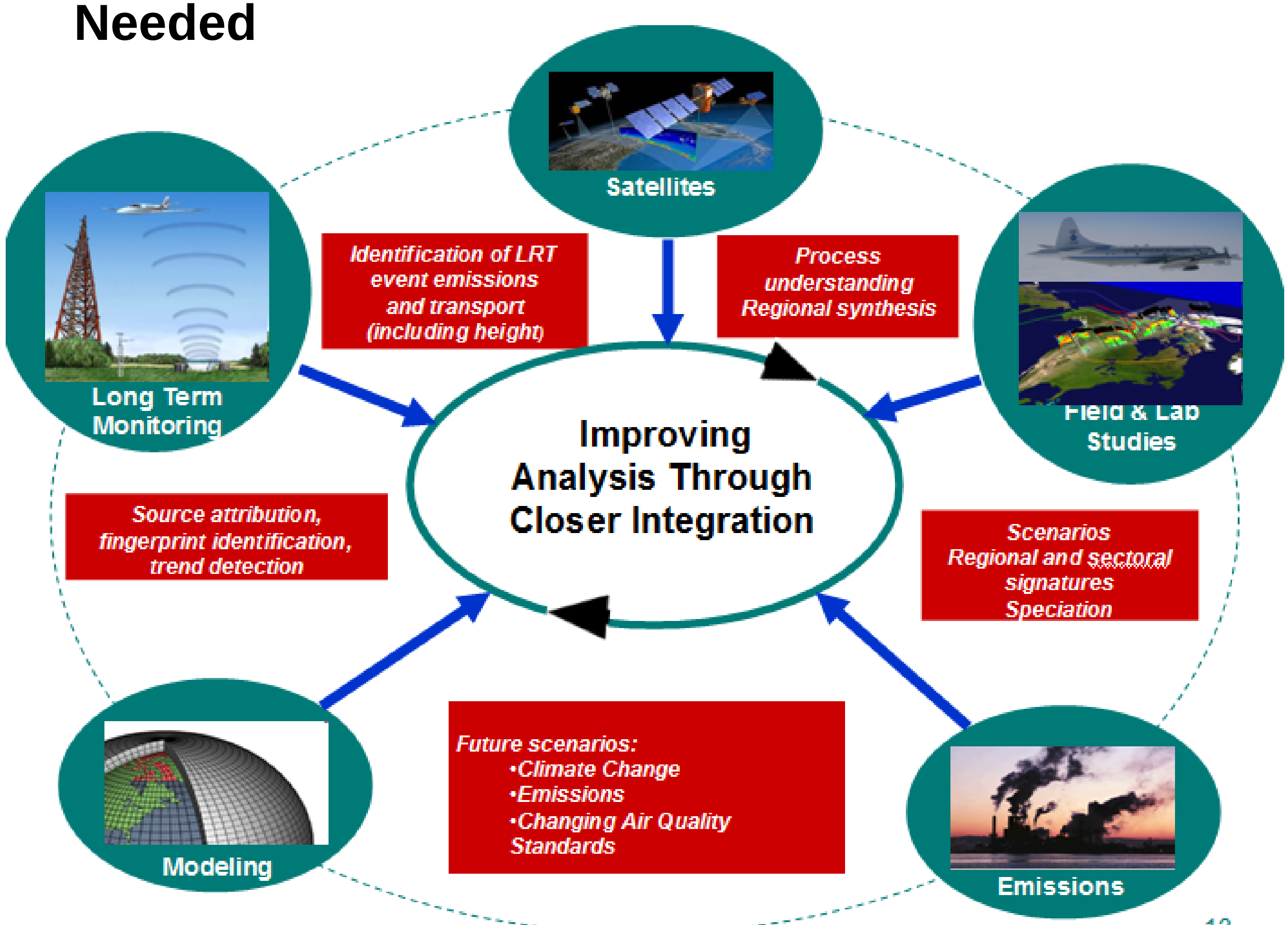






Due to the Complexity and Uncertainties in Calculating the Sources, Formation, Transport and Removal of Aerosols in the Atmosphere, a Closer Integration of Observations and Models is Needed





New US NAS Report 2010 Global Sources of Local Pollution

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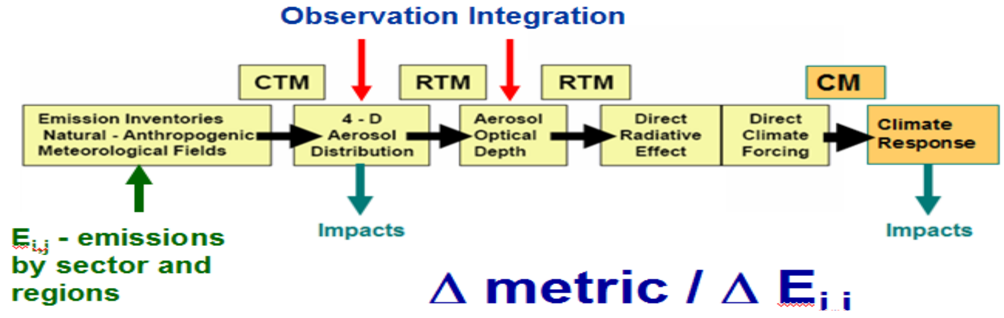
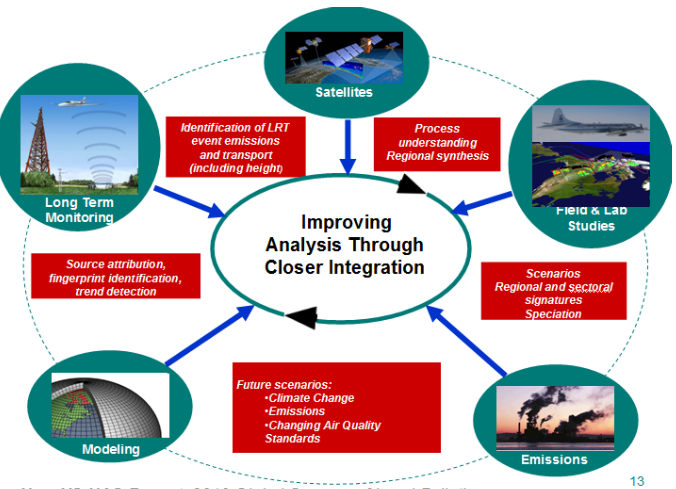
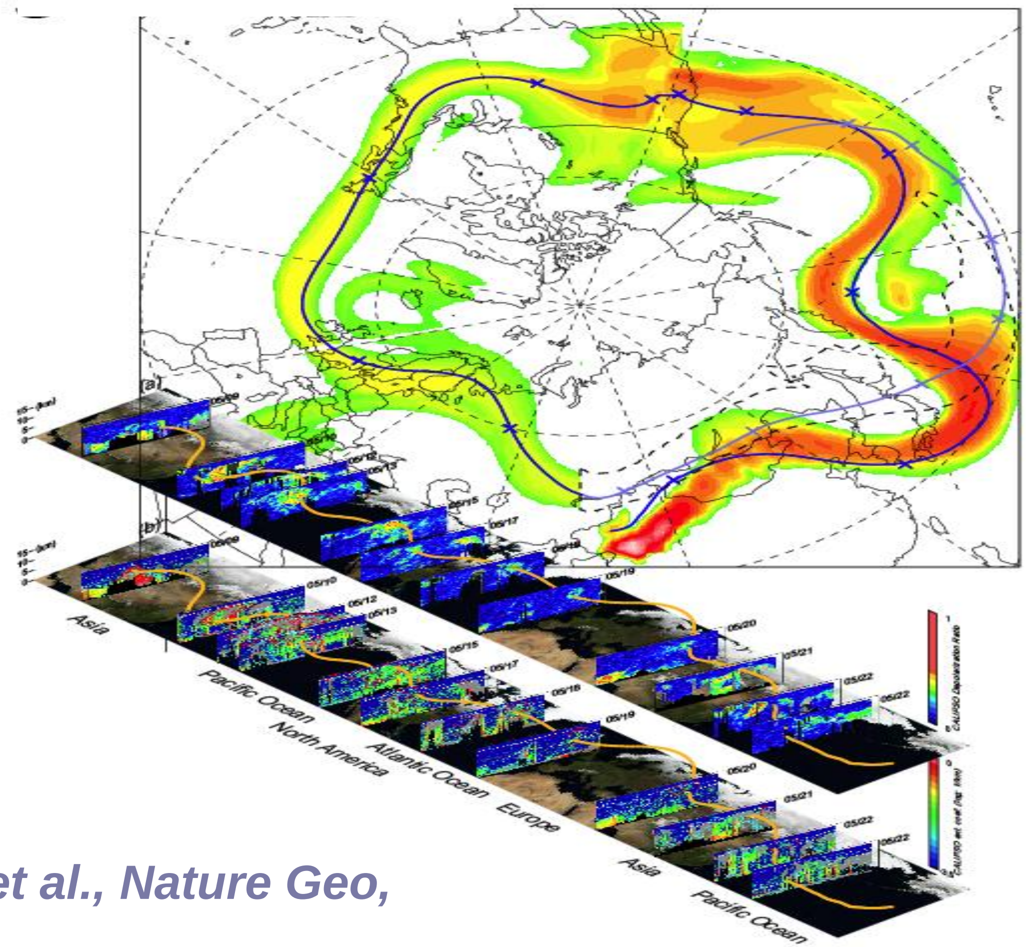




New US NAS Report *2010 Global Sources of Local Pollution*



Uno et al., Nature Geo, 2009

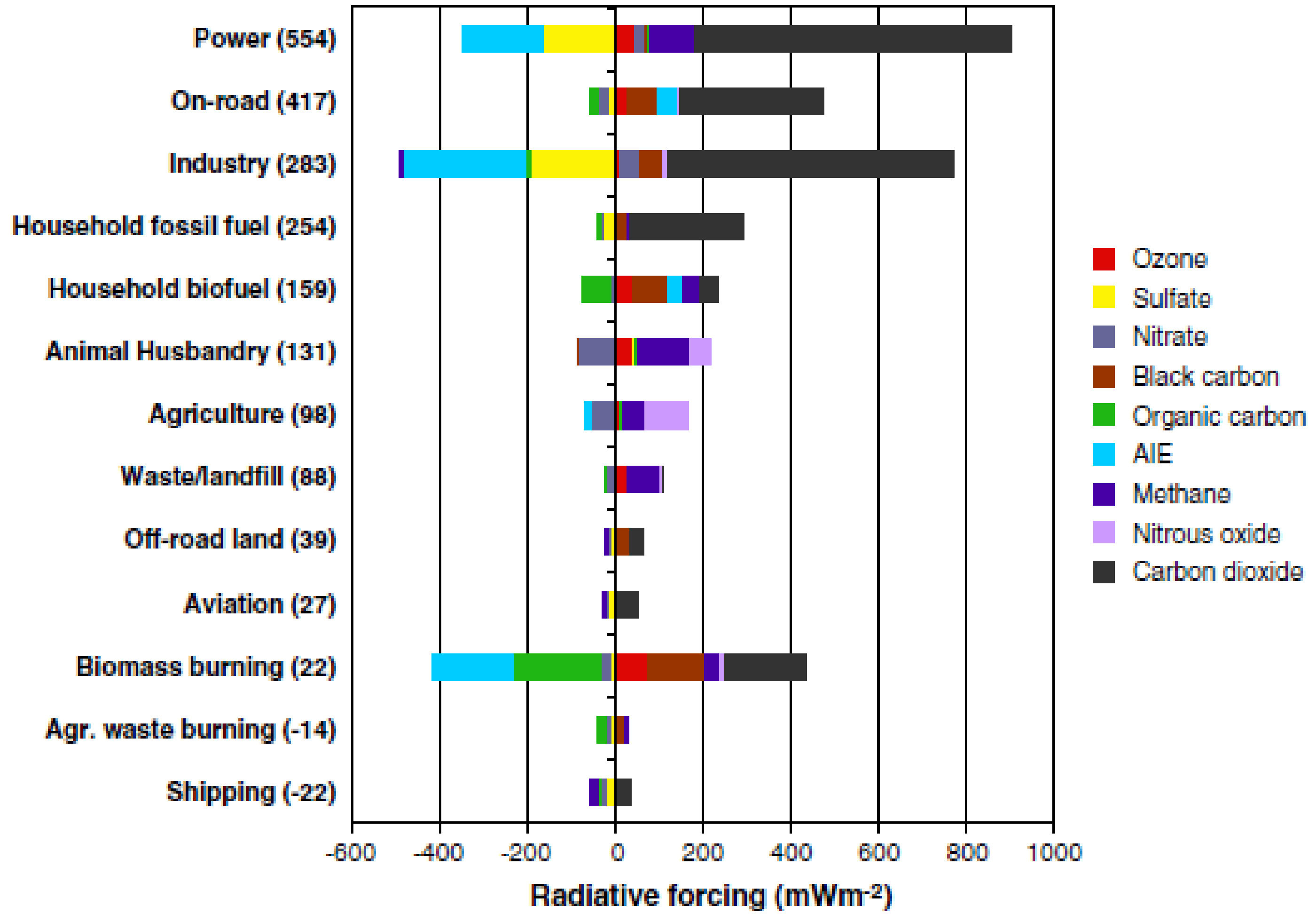
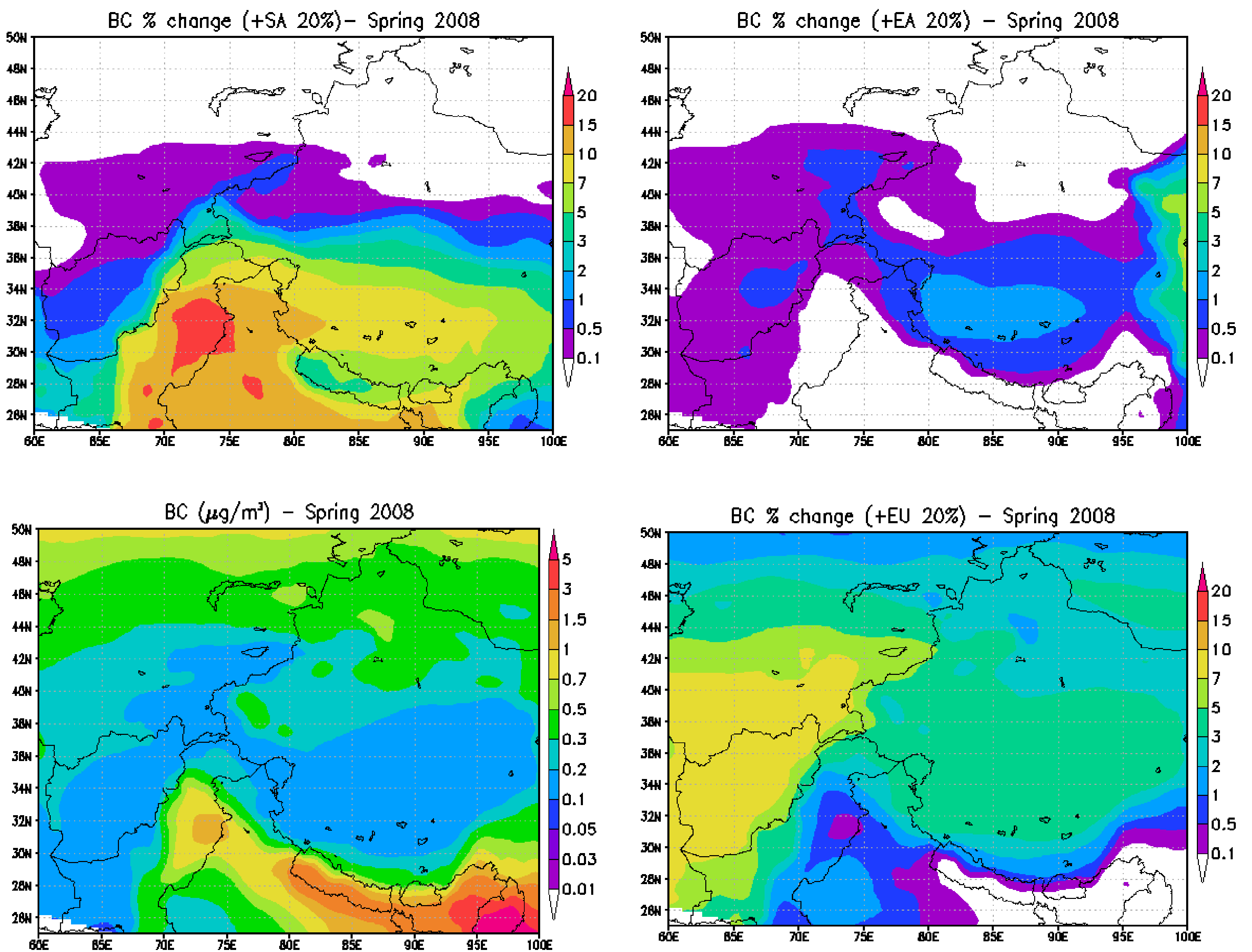


Fig. 1. Radiative forcing due to perpetual constant year 2000 emissions grouped by sector at (*a*) 2020 (*b*) 2100 showing the contribution from each species. The net sum of total radiative forcing is indicated by the title of each bar. A positive RF means that removal will result in climate cooling and vice versa.

2020 **Unger et al., PNAS 2020**



BC % change (+SA 20%)- Spring 2008
20
15
10
7
5
3
2
1
0.5
0.1
50N
48N
46N
44N
42N
40N
38N
36N
34N
32N
30N
28N
26N
60E
65E
70E
75E
80E
85E
90E
95E
100E
BC % change (+EA 20%) - Spring 2008
20
15
10
7
5
3
2
1
0.5
0.1
BC (μg/m³) - Spring 2008
5
3
1.5
1
0.7
0.5
0.3
0.2
0.1
0.05
0.03
0.01
BC % change (+EU 20%) - Spring 2008
20
15
10
7
5
3
2
1
0.5
0.1

Summary of Major Sources of Uncertainty in the Calculations

Multiplicative Uncertainties

Indoex					
	Emissions	Wet removal	Vertical Transport	Chemical Formation	Total Uncertainty
nss SO4	1.3	1.3	1.5	1.3	1.8
BC	3	2	1.5	--	3.9
OC	3.5	2	1.5	3	6.4
Dust	5	2	1.5	--	6.0
Sea Salt	5	1.3	1.5	--	5.4

sub

Super

micron

Note: for analysis of specific points some of these terms are larger…