Implementation of a new aging parameterisation scheme in RegCM4

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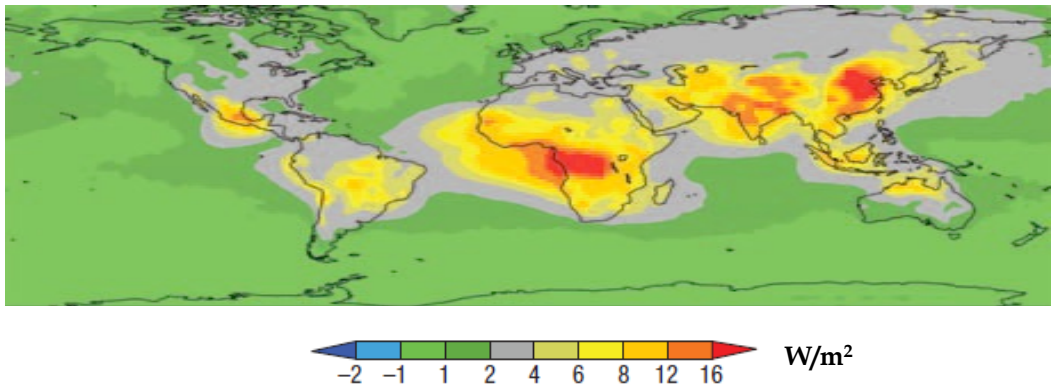
Why black carbon aerosols ?

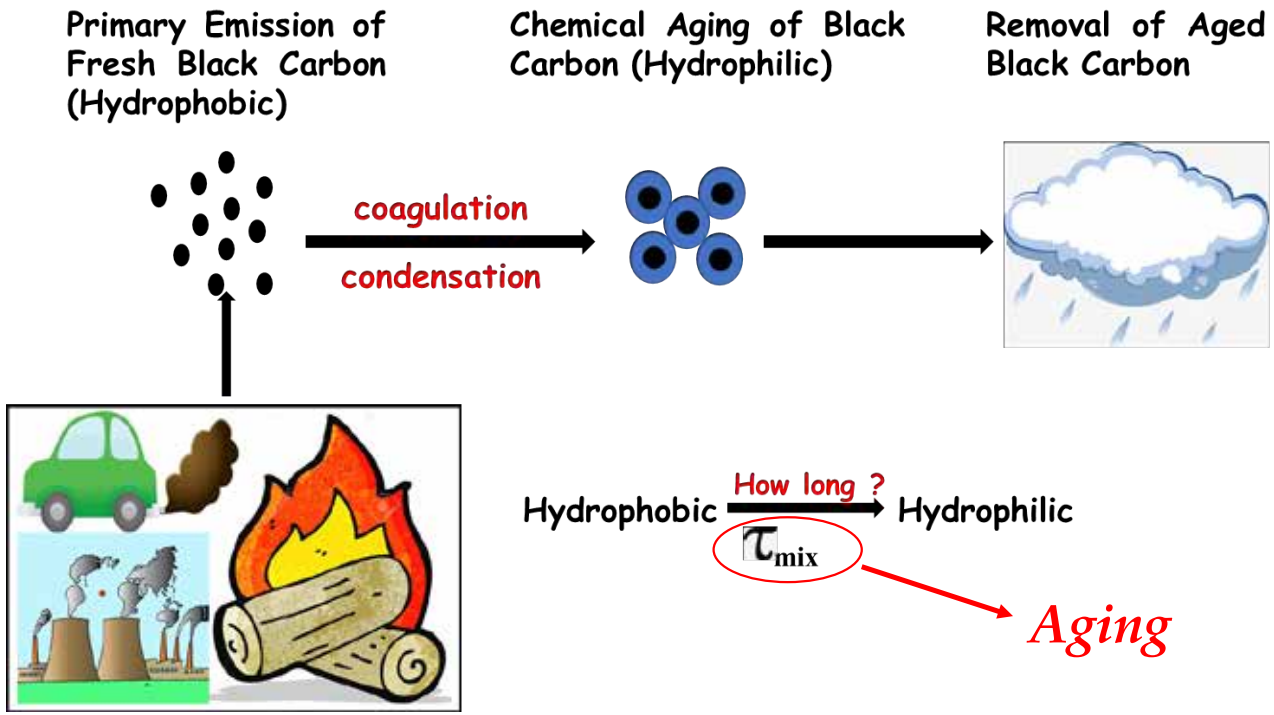
- **Aerosols produces cooling both at TOA and surface but black carbon warms the TOA due to absorption and produces dimming at the surface.**

- **Total radiative forcing of BC aerosols is 1.1 W/m^2 (Bond et al., 2013) which stands second to CO_2 forcing in warming the climate (Ramanathan and Charmichael, 2008).**



Atmospheric solar heating due to black carbon.
[Chung et al. (2005)]

What is aging of black carbon aerosols ?



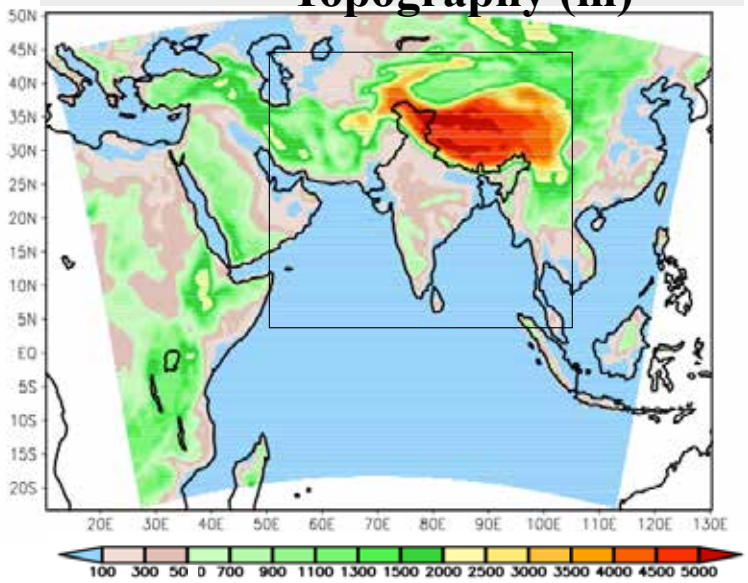
- **Black Carbon radiative forcing can increase at the surface and decrease at the top of atmosphere after aging (Wu, Y. et al., 2016)**

Methodology

Model name	
Domain	Domain
Resolution	
Time period	cember, 2010
Atmospheric data , SST used	rpolated SST data
Anthropogenic aerosol module Anthropogenic Components (BC, hydrophilic and hydrophobic) Emission Inventory	
Cumulus parameterization	oth land and Tiedtke over ocean
Land use	
Planetary Boundary parameteriza	on
Large scale precipitation paramet	

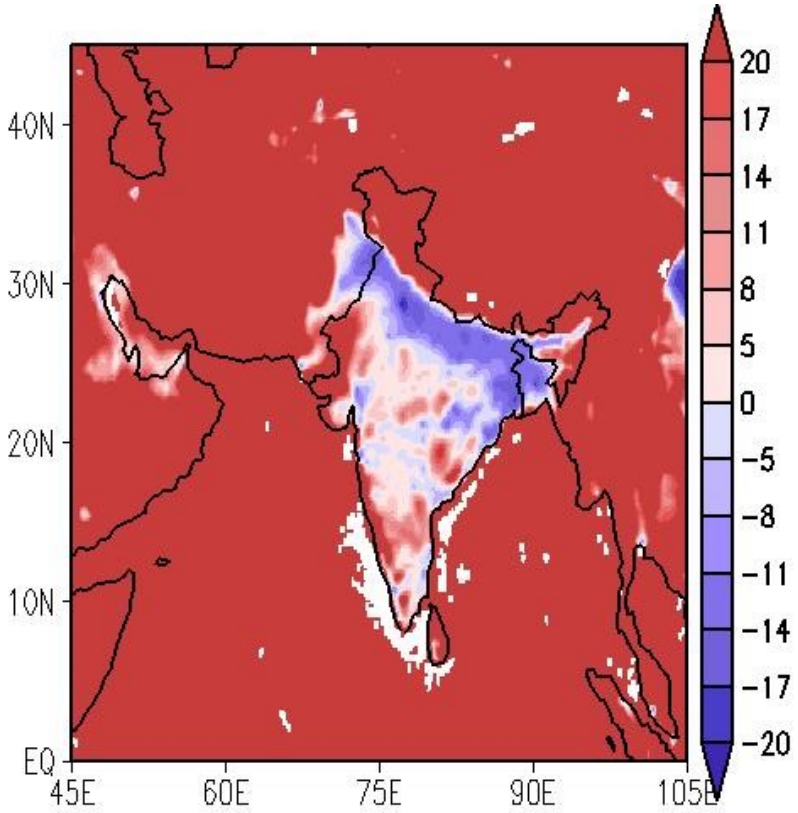
Region of Study

CORDEX South Asian Domain
Topography (m)



Co-ordinates of study region
Lat: 0° - 40° N, Lon: 50° – 105° E

Anomaly of aging timescale (in hours) of carbonaceous aerosols



- **Current aging process from hydrophobic to hydrophilic in RegCM4**

  τ_{mix} = fixed = 27.6 hours [Cook et al., 1999]

- **Parameterization scheme introduced:**

  $\tau_{mix} = (k_{cond}*I_{cond} + k_{coag}*N)^{-1}$ [Fierce et al., 2016]

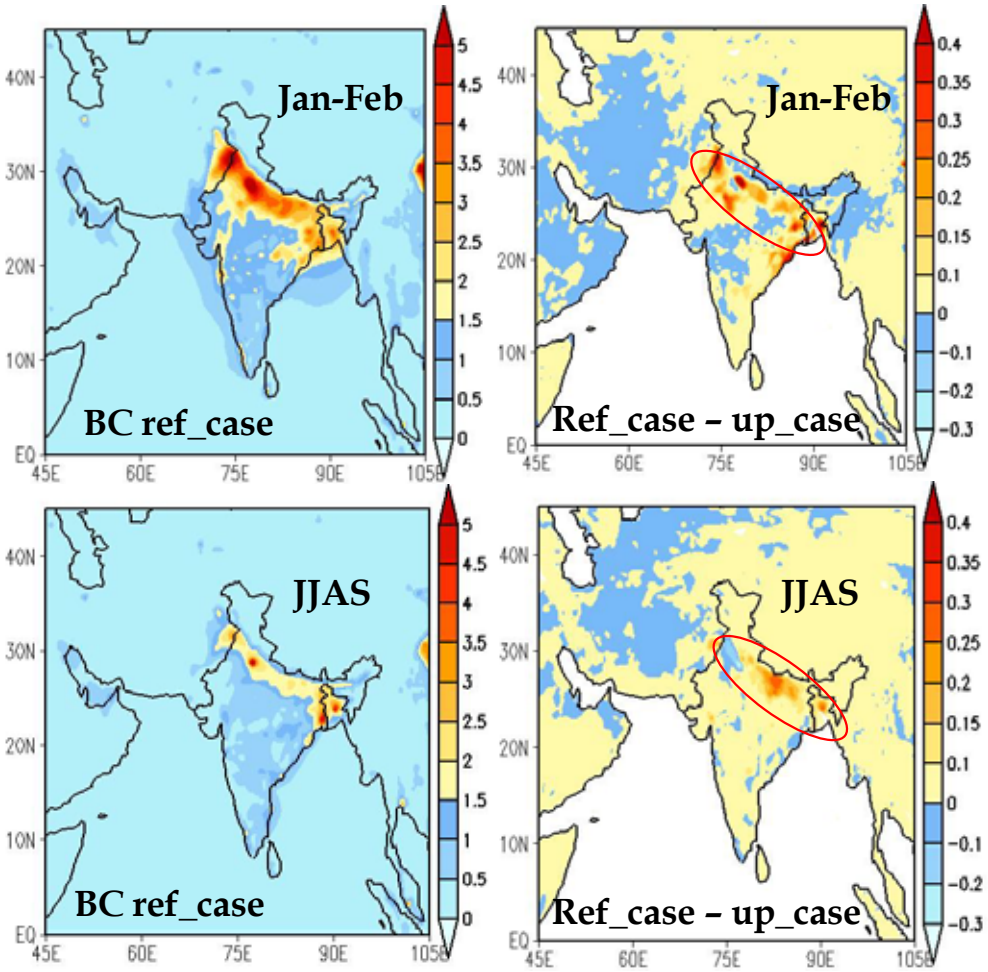
  where N = total number concentration of aerosols
  k_{cond} = 0.01 nm^{-1}
  I_{cond} = condensational flux
  k_{coag} = 6 x 10-6 $cm3h^{-1}$

Results and Discussion

Two set of simulations:

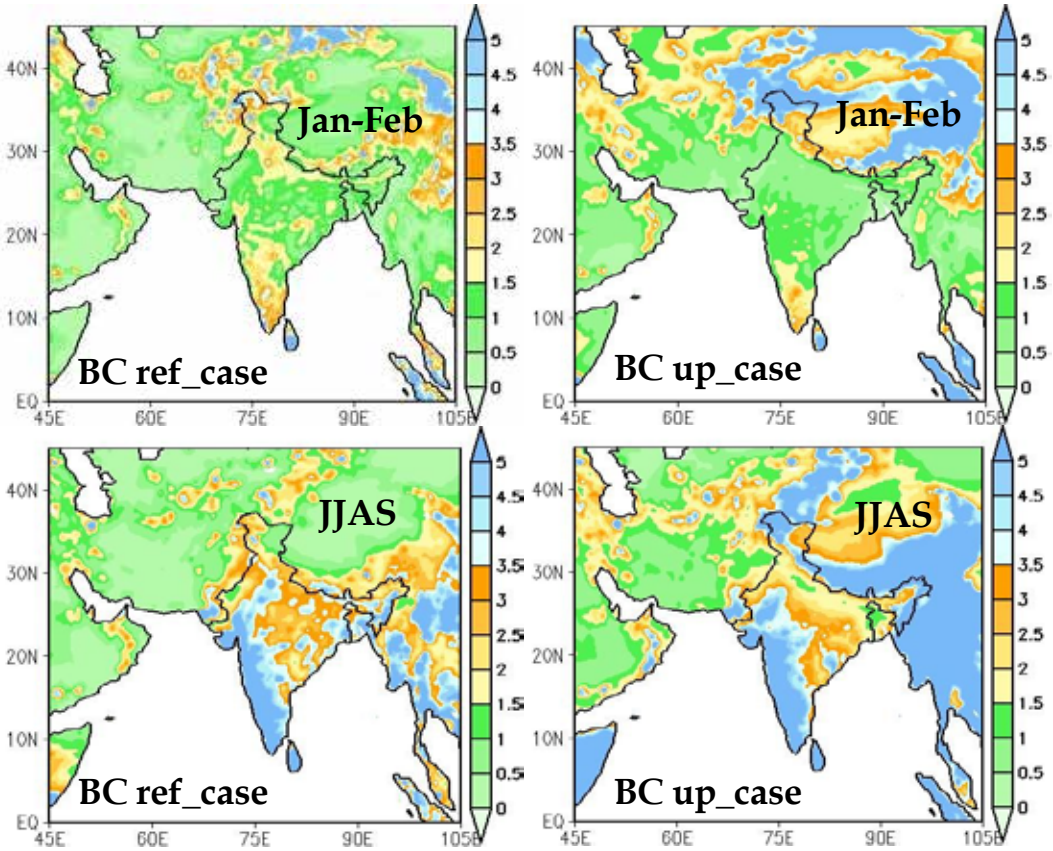
- **Reference_case (henceforth ref_case) with fixed tau value of 27.6 hours**
- **Updated_case (henceforth up_case) with dynamic tau values.**

Change in the surface mass concentration (μg/m^3)



- There is an increase in surface mass concentration across IGB belt in both the seasons but the model estimation increased by only around 6 - 7 % .
- Similar results are observed for organic carbon estimation. However the surface mass concentration simulated by the model in both reference case and updated case is almost 3-times than that for black carbon.

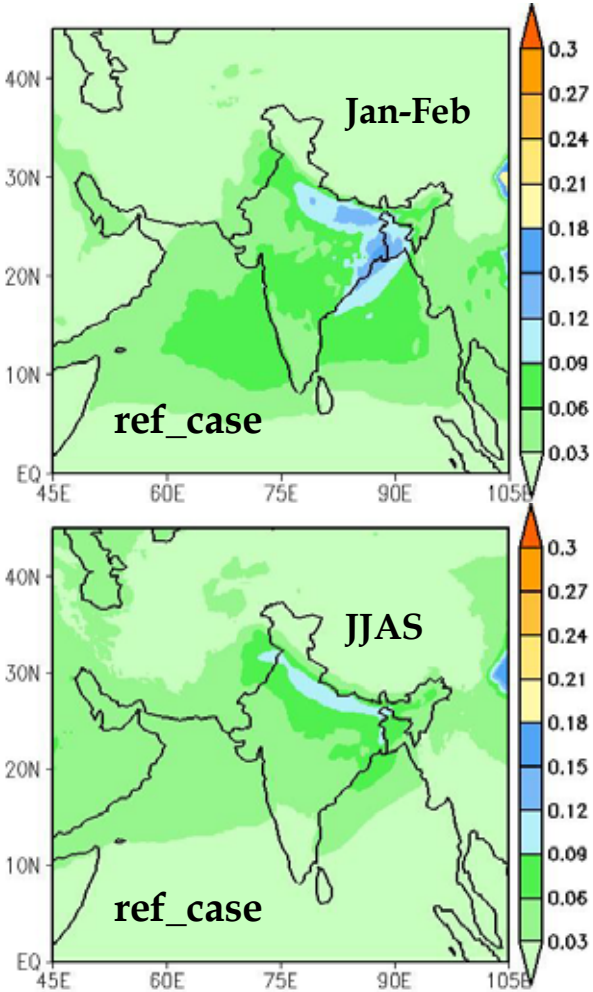
Change in the ratio of surface mass concentration of Hydrophobic to Hydrophilic Tracers

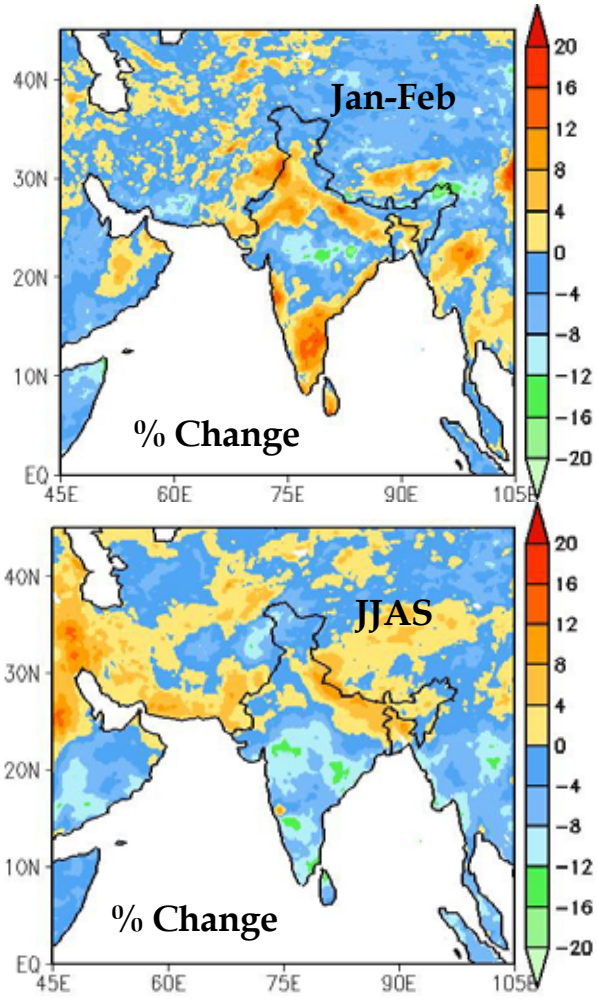


- Although the surface mass concentration did not show some drastic differences in two simulations but the ratio from hydrophobic to hydrophilic tracers are changing.

- With the new aging scheme more amount of hydrophilic tracer is getting generated due to the presence of more condensing particles.

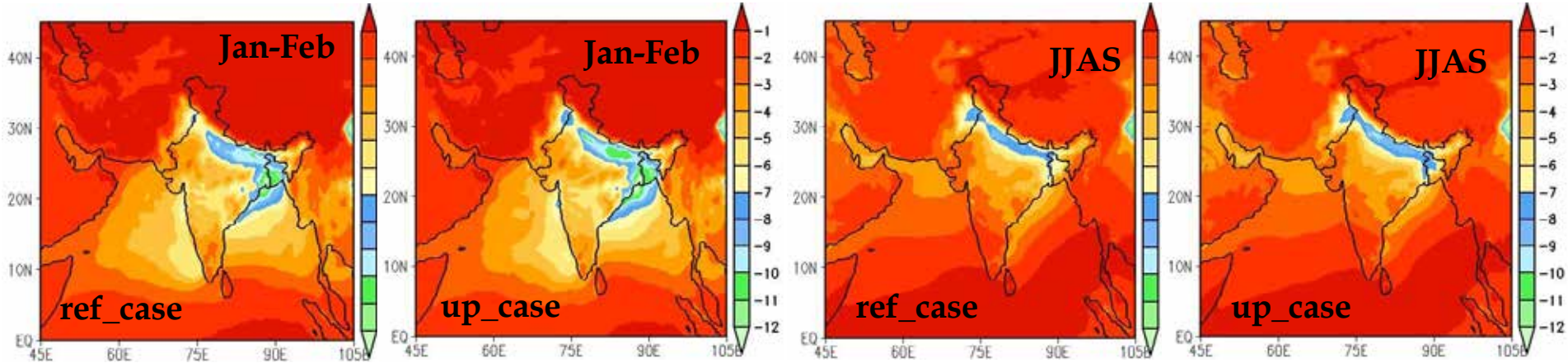
Anthropogenic AOD



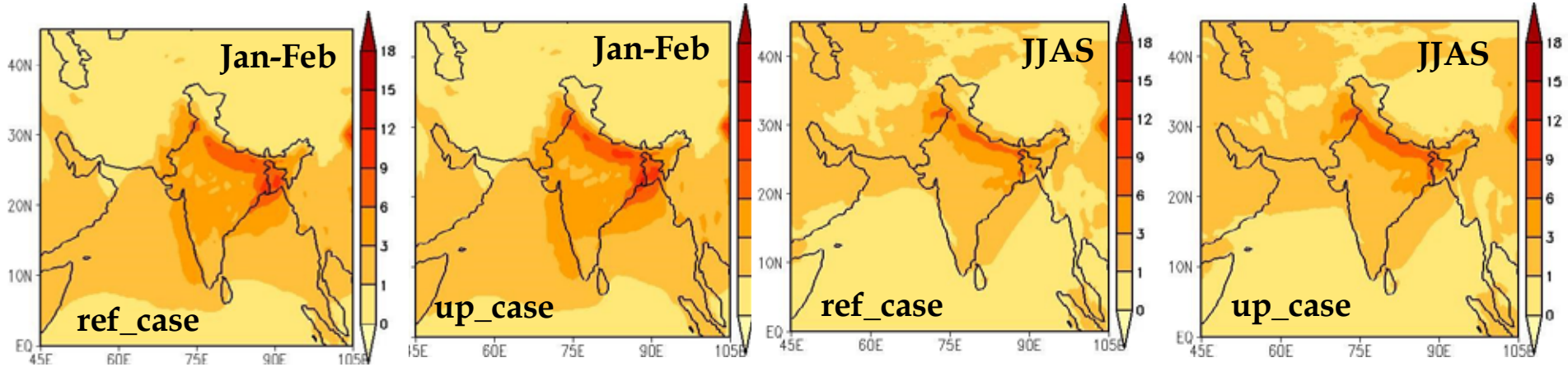


- Generation of more hydrophilic tracers are impacting the optical properties. An increase in total anthropogenic AOD over Indo Gangetic Basin is observed in two contrasting seasons.
- In contrast Peninsular India, which is not a source region is comparatively less polluted during monsoon due to washout but showing an increased AOD value during winter.

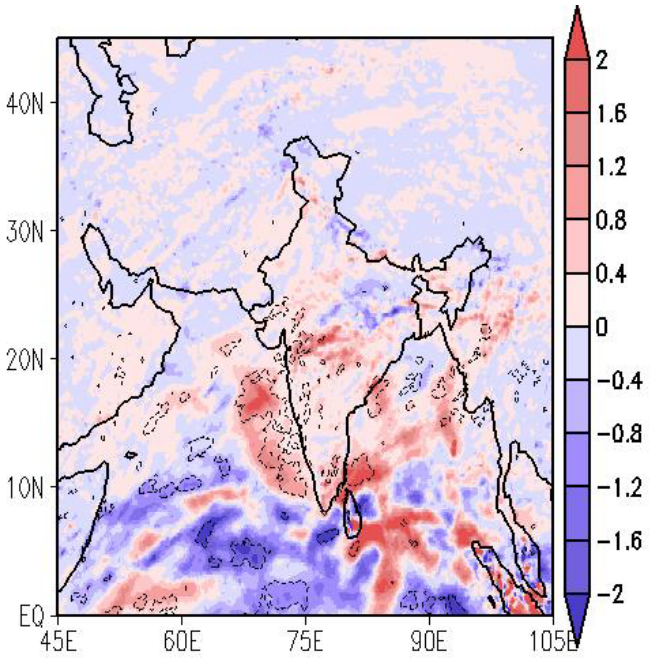
Change in the surface shortwave forcing (W/m^2)



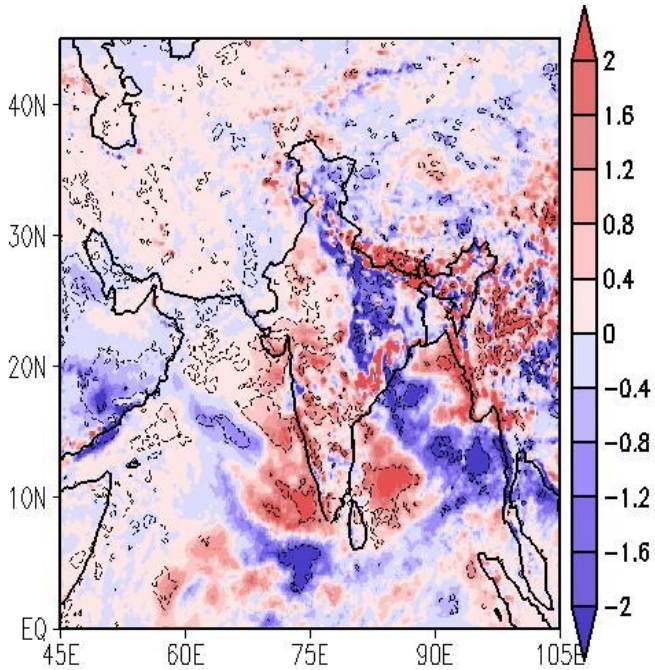
Change in the atmospheric heating (W/m^2)



Change in Precipitation Rate (mm/day) with black dotted contour lines showing regions with 90% significance level



Jan - Feb



Jun-Jul-Aug-Sep

- Due to the implementation of the new aging scheme peninsular India is becoming wetter while the IGB region is showing dry bias.
- Analysis of other meteorological fields is under process.

Understanding and Future Work

- The actual e-folding time for aging of carbonaceous aerosols is less than the fixed 27.6 hours across most parts of a polluted country like India. Aging occurs more rapidly near the source regions like Indo-Gangetic basin than in the remote regions like the peninsular India.

- Formation of more hydrophilic tracer are impacting the optical properties although the actual surface mass concentration of the tracers are not changing dramatically.

- Model estimations are expected to improve with improved emissions, representation of mixing state and size distribution of carbonaceous aerosols.

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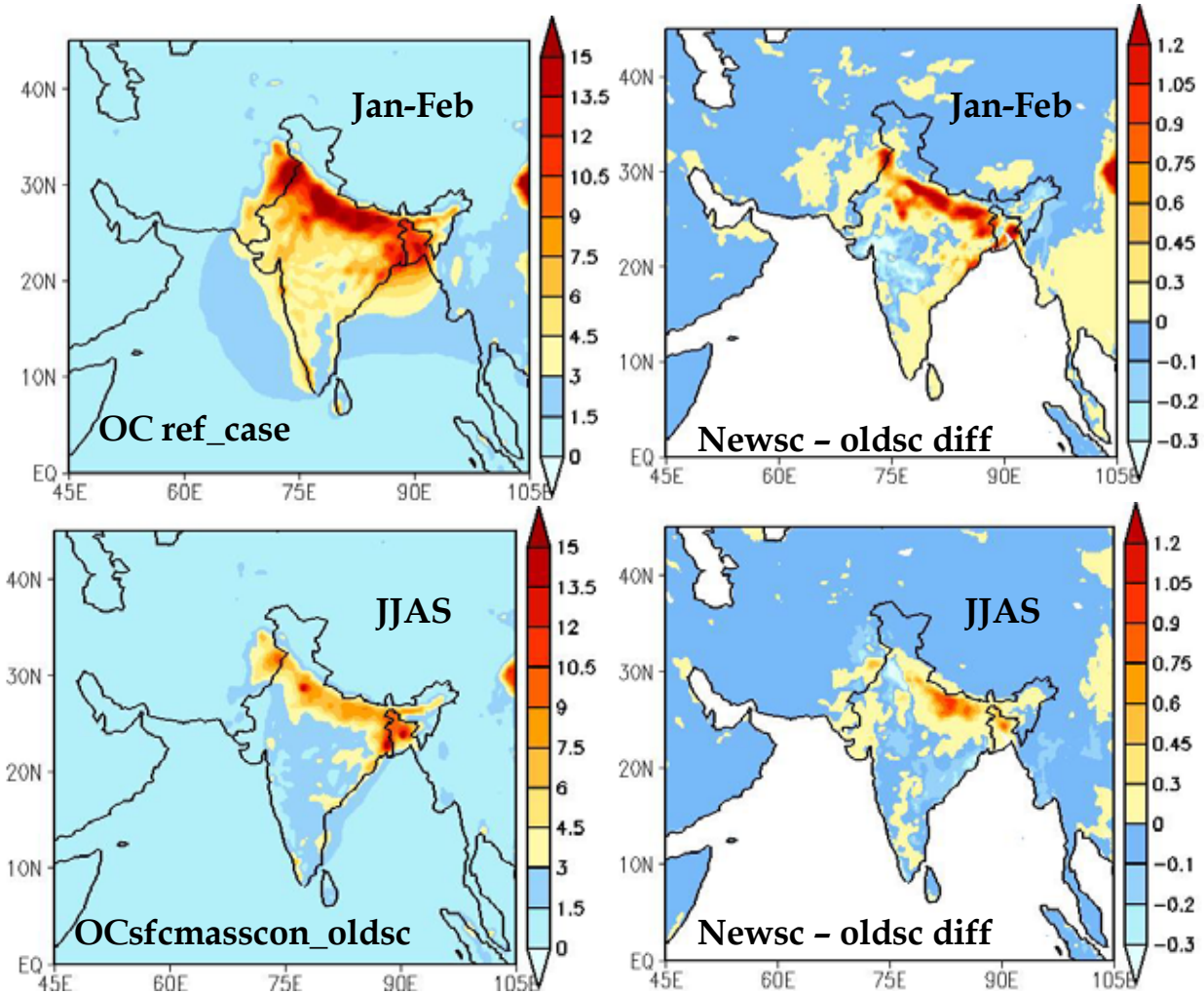
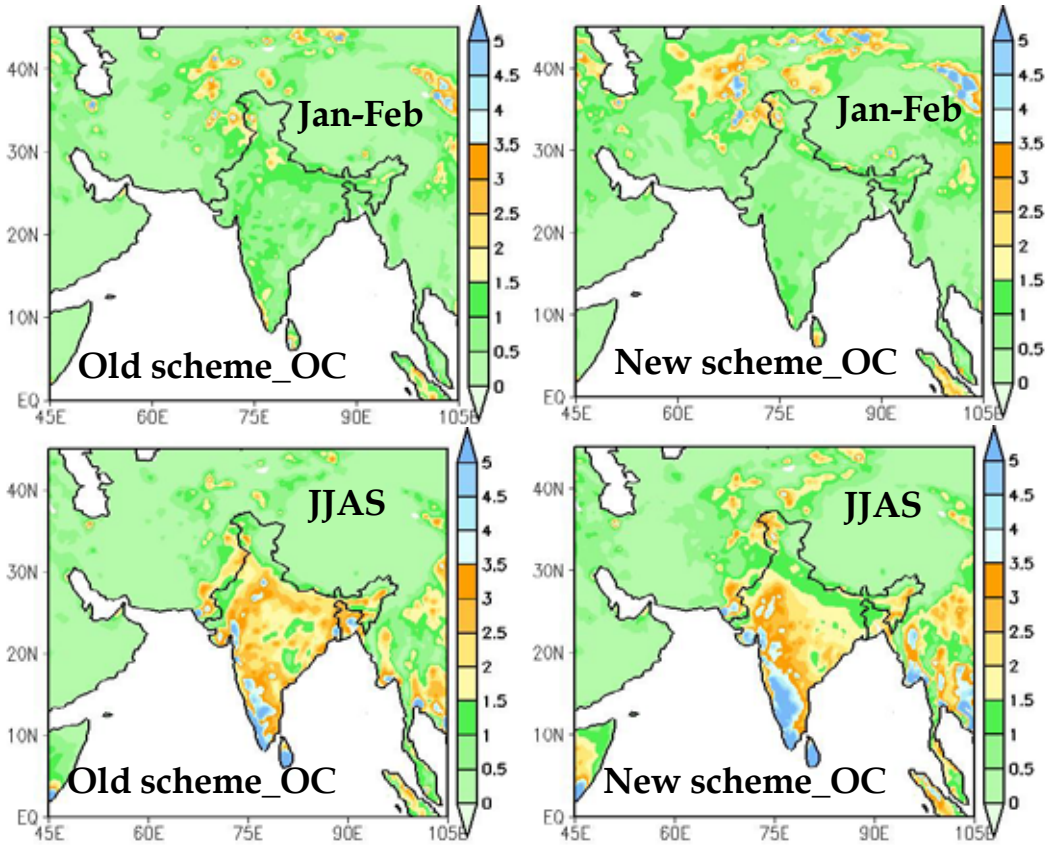
Thank you

Supplementary materials




Jan-Feb
Old scheme_OC
Jan-Feb
New scheme_OC
JJAS
Old scheme_OC
JJAS
New scheme_OC
40N
30N
20N
10N
EQ
45E
60E
75E
90E
105E
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0