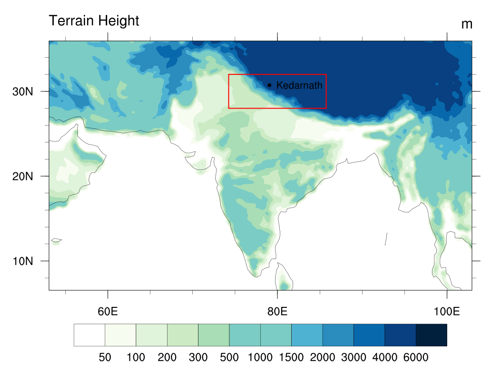
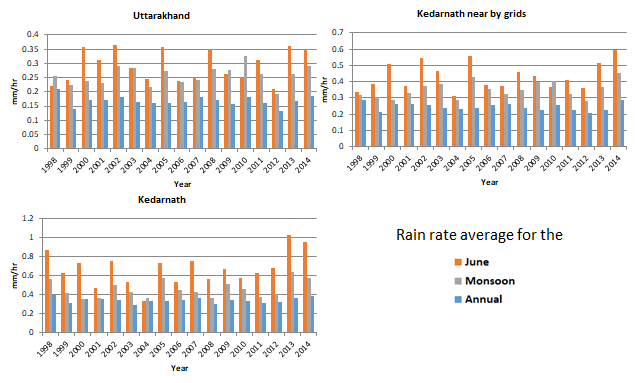
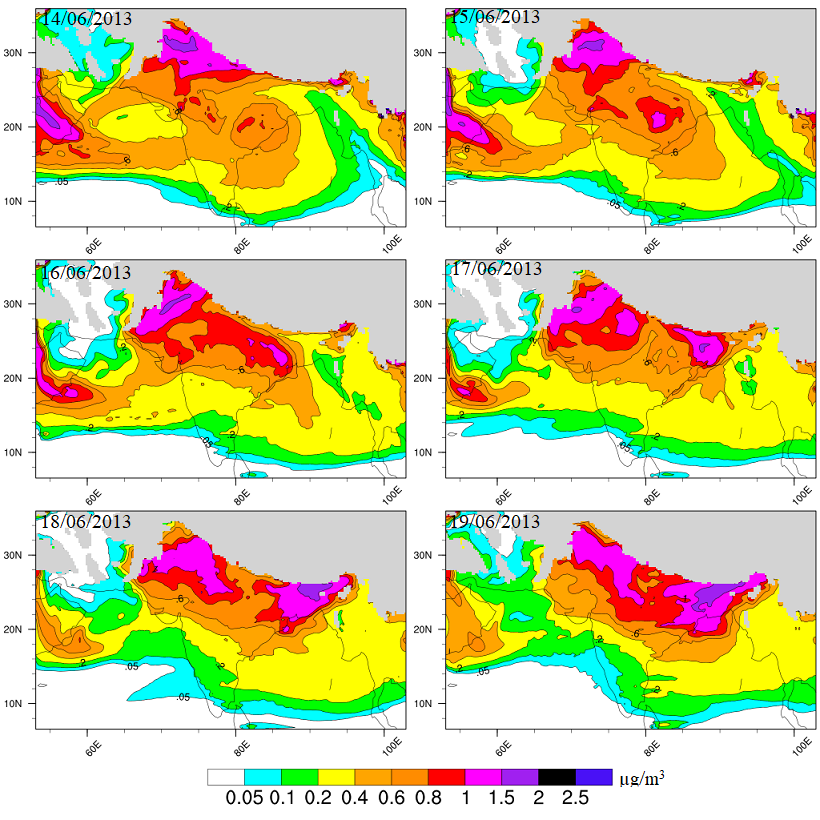
**Supporting Figures**



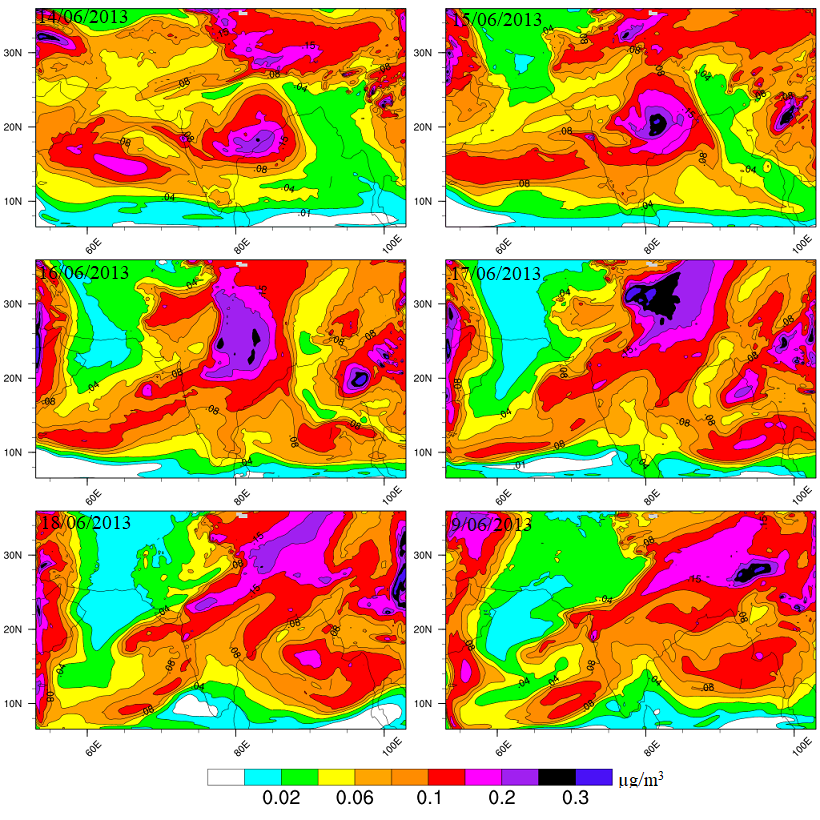
**Figure S1.** Domain of simulation at 25 km resolution, domain of simulation at 4 km resolution (red box) and Kedarnath (black dot).



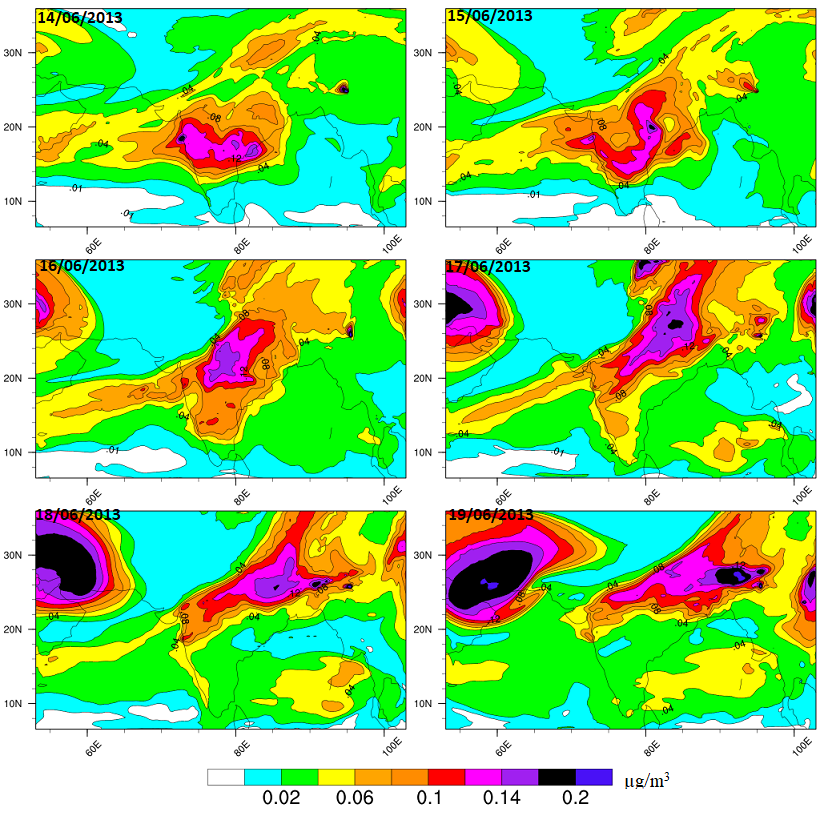
**Figure S2.** Rain rate over Uttarakhand, nearby Kedarnath and over Kedarnath average for annual, monsoon and June month.

****

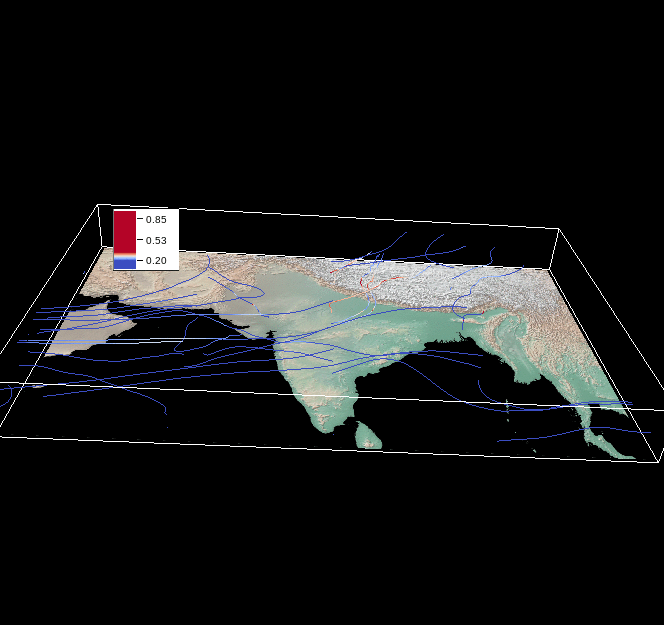
**Figure S3a:** BC1 concentration at 850 hPa from 14th - 19th June 2013.

****

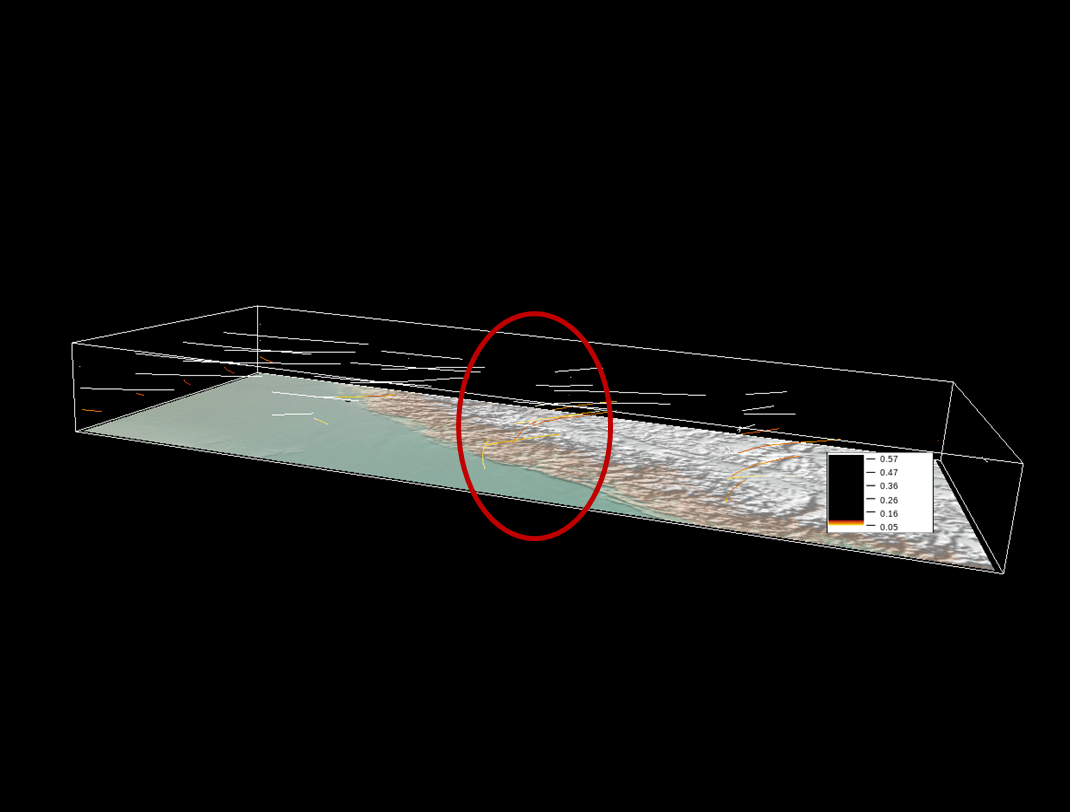
**Figure S3b:** BC1 concentration at 500 hPa from 14th - 19th June 2013.

****

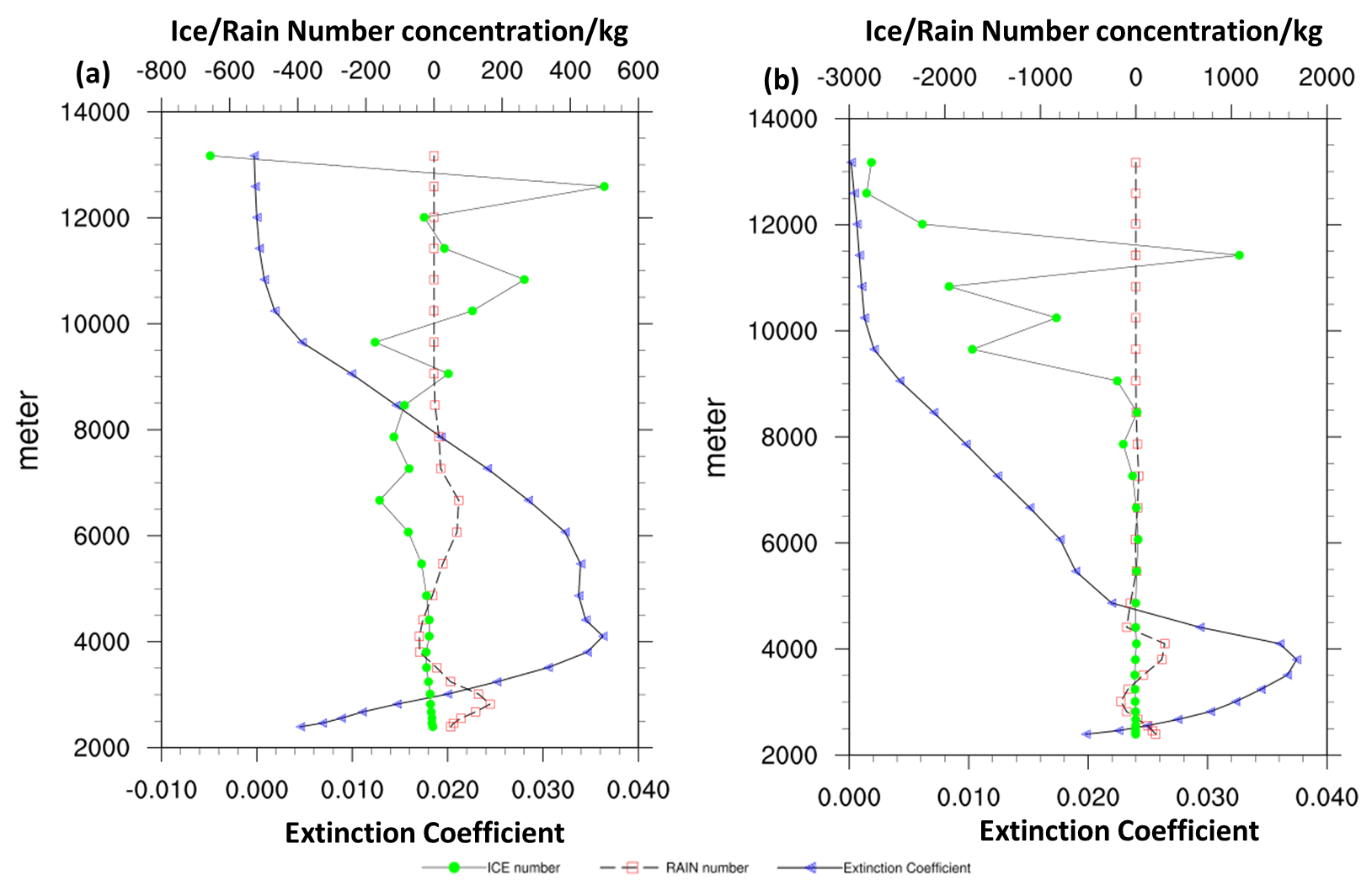
**Figure S3c:** BC1 concentration at 300 hPa from 14th - 19th June 2013.



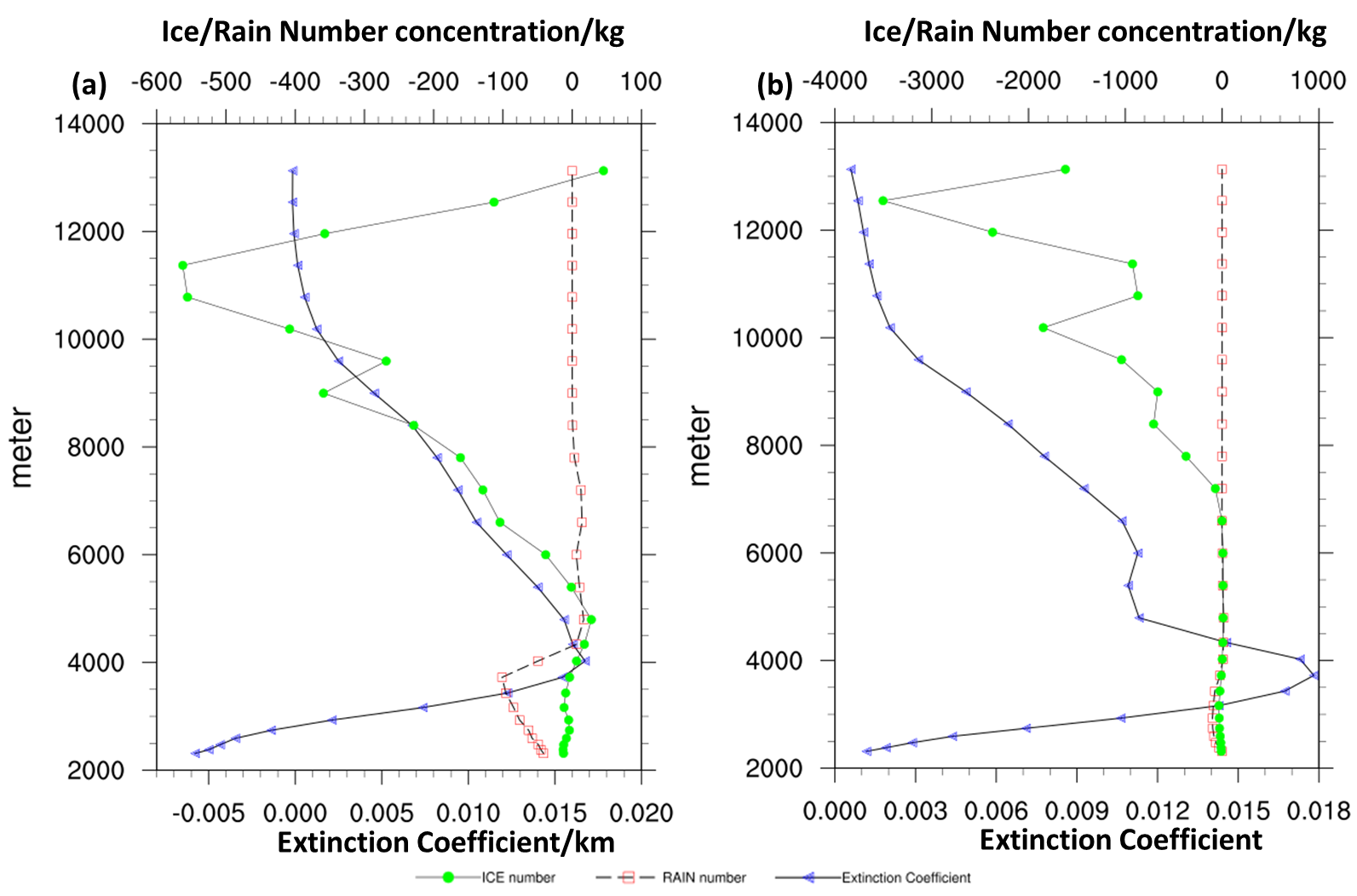
**Figure S4a:** BC1 volume flow on 17th June 2013, 25 km resolution.

****

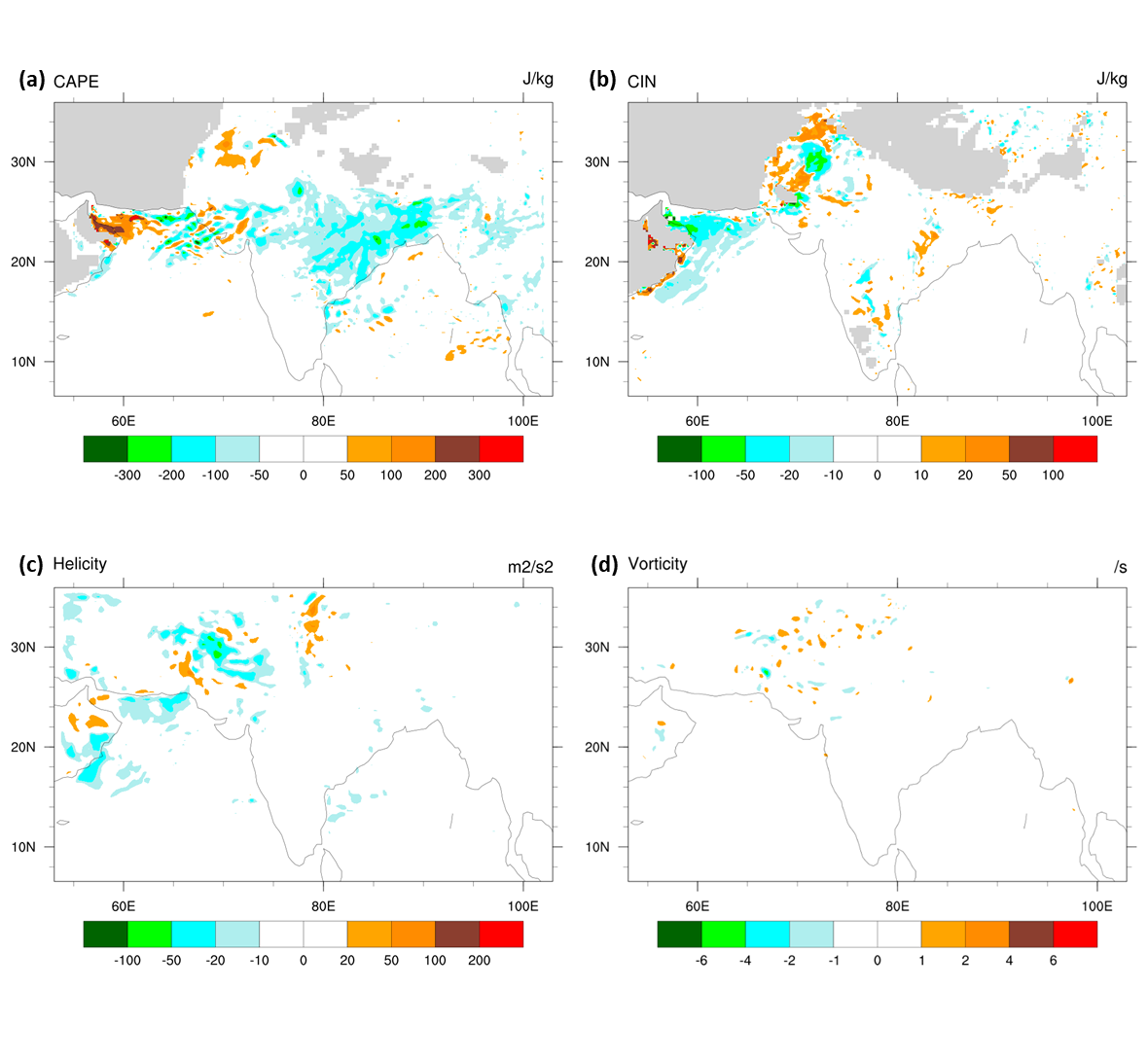
**Figure 4b:** BC1 volume flow on 17th June 2013, 4 km resolution

****

**Figure S5.** Difference of Extinction Coefficient, rain and ice concentration profile over Kedarnath during a) 16th June and b) 17th June from WC25, WRF25 simulations.

****

**Figure S6.** Difference of Extinction Coefficient, rain and ice concentration profiles over Kedarnath during a) 16th June and b) 17th June from WC4, WRF4 simulations (WC4-WRF4).

****

**Figure S7.** Effect of aerosols on a) CAPE, b) CIN, c) helicity and d) vorticity at 25 km resolution (WC25-WRF25) during 17th June.

**Table S1**: Average rain rate (mm/hr) over Uttarakhand, Kedarnath and nearby area for the period of 1998-2014 from TRMM.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Uttarakhand** | | | **Kedarnath nearby area** | | | **Kedarnath** | | |
| **June** | **Monsoon** | **Annual** | **June** | **Monsoon** | **Annual** | **June** | **Monsoon** | **Annual** |
| **1998** | 0.22 | 0.26 | 0.21 | 0.34 | 0.32 | 0.28 | 0.87 | 0.57 | 0.39 |
| **1999** | 0.24 | 0.22 | 0.14 | 0.39 | 0.31 | 0.21 | 0.63 | 0.42 | 0.31 |
| **2000** | 0.36 | 0.24 | 0.17 | 0.51 | 0.29 | 0.26 | 0.73 | 0.36 | 0.35 |
| **2001** | 0.31 | 0.23 | 0.17 | 0.37 | 0.33 | 0.26 | 0.48 | 0.36 | 0.35 |
| **2002** | 0.36 | 0.29 | 0.18 | 0.55 | 0.38 | 0.26 | 0.76 | 0.50 | 0.35 |
| **2003** | 0.28 | 0.28 | 0.17 | 0.46 | 0.38 | 0.24 | 0.54 | 0.43 | 0.29 |
| **2004** | 0.24 | 0.22 | 0.16 | 0.31 | 0.29 | 0.23 | 0.34 | 0.37 | 0.34 |
| **2005** | 0.36 | 0.27 | 0.16 | 0.56 | 0.43 | 0.24 | 0.73 | 0.58 | 0.34 |
| **2006** | 0.24 | 0.23 | 0.16 | 0.38 | 0.36 | 0.26 | 0.54 | 0.45 | 0.35 |
| **2007** | 0.25 | 0.24 | 0.18 | 0.37 | 0.33 | 0.27 | 0.75 | 0.43 | 0.37 |
| **2008** | 0.35 | 0.28 | 0.17 | 0.46 | 0.35 | 0.24 | 0.57 | 0.36 | 0.30 |
| **2009** | 0.26 | 0.28 | 0.16 | 0.44 | 0.40 | 0.23 | 0.67 | 0.52 | 0.34 |
| **2010** | 0.25 | 0.33 | 0.18 | 0.37 | 0.40 | 0.26 | 0.58 | 0.46 | 0.34 |
| **2011** | 0.31 | 0.26 | 0.16 | 0.41 | 0.32 | 0.23 | 0.63 | 0.38 | 0.31 |
| **2012** | 0.21 | 0.19 | 0.13 | 0.36 | 0.28 | 0.21 | 0.68 | 0.41 | 0.33 |
| **2013** | 0.36 | 0.26 | 0.17 | 0.51 | 0.37 | 0.23 | 1.03 | 0.64 | 0.36 |
| **2014** | 0.35 | 0.29 | 0.19 | 0.59 | 0.45 | 0.28 | 0.96 | 0.57 | 0.39 |

**Table S2.** R2 of precipitation from different simulation with observed precipitation from in situ and satellite observation.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Simulation | TRMM | WC25 | | WRF25 | | WC4 | | WRF4 | |
| Stations | **Obs.** | **Obs.** | **Sat.** | **Obs.** | **Sat.** | **Obs.** | **Sat.** | **Obs.** | **Sat.** |
| Kedarnath | **NA** | **NA** | **0.36** | **NA** | **0.36** | **NA** | **0.40** | **NA** | **0.41** |
| Champawat | **0.52** | **0.40** | **0.95** | **0.63** | **0.70** | **0.60** | **0.74** | **0.60** | **0.74** |
| Nainital | **0.56** | **0.53** | **0.41** | **0.93** | **0.45** | **0.78** | **0.62** | **0.76** | **0.60** |
| Jolly grant | **0.60** | **0.31** | **0.32** | **0.02** | **0.01** | **0.28** | **0.06** | **0.21** | **0.04** |
| Dehradun | **0.32** | **0.28** | **0.27** | **0.14** | **0.02** | **0.41** | **0.06** | **0.36** | **0.03** |
| Lambagrh | **0.58** | **0.63** | **0.74** | **0.66** | **0.56** | **0.65** | **0.54** | **0.39** | **0.54** |
| Pandukeshwar | **0.49** | **0.23** | **0.74** | **0.41** | **0.56** | **0.36** | **0.56** | **0.36** | **0.56** |
| Pipalkoti | **0.40** | **0.23** | **0.57** | **0.67** | **0.45** | **0.42** | **0.44** | **0.40** | **0.43** |

**Table S3:** ∆concentration for different aerosols and ∆ in absolute percentage in model column and at 850 hPa, 500 hPa, 300 hPa for 16th and 17th June 2013 over Kedarnath at 4km resolution.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Aerosols** | **16th June 2013** | | | | | | | |
| **Δ Column** | | **Δ 850 hPa** | | **Δ 500 hPa** | | **Δ 300 hPa** | |
| **ug/m3** | **%** | **ug/m3** | **%** | **ug/m3** | **%** | **ug/m3** | **%** |
| **BC** | 0.069 | 62.69 | 0.318 | 71.64 | 0.056 | 69.01 | 0.019 | 123.85 |
| **OC** | 0.267 | 49.22 | 1.321 | 58.75 | 0.173 | 51.07 | 0.059 | 119.12 |
| **DUST1** | 4.135 | 106 | 15.66 | 103.9 | 4.911 | 119 | 0.842 | 163.13 |
| **DUST2** | 9.283 | 107.1 | 35.49 | 104.3 | 10.94 | 123.1 | 1.831 | 168.1 |
| **DUST3** | 6.174 | 110.1 | 23.76 | 105.8 | 7.243 | 132.1 | 1.161 | 178.9 |
| **DUST4** | 1.829 | 124.1 | 7.276 | 112.3 | 2.063 | 169.8 | 0.307 | 204.4 |
| **DUST5** | 0.842 | 179.1 | 3.613 | 142.5 | 0.861 | 263.9 | 0.121 | 245.8 |
| **SEA SALT1** | 0.002 | 113.5 | 0.004 | 326.1 | 0.003 | 79.99 | 0.004 | 72.56 |
| **SEA SALT2** | 0.015 | 320.5 | 0.039 | 412.5 | 0.029 | 219.4 | 0.005 | 245.5 |
| **SEA SALT3** | 0.021 | 345.2 | 0.06 | 359.4 | 0.038 | 268.6 | 0.004 | 1001 |
| **SEA SALT4** | 0.0002 | 139.7 | 0.001 | 147.7 | 9E-05 | 188.6 | 5E-06 | 4185 |
| **sulf** | -0.012 | -1.28 | -1.49 | -30.99 | 0.321 | 64.39 | 0.161 | 69.71 |
|  | **17th June 2013** | | | | | | | |
| **Δ Column** | | **Δ 850 hPa** | | **Δ 500 hPa** | | **Δ 300 hPa** | |
| **ug/m3** | **%** | **ug/m3** | **%** | **ug/m3** | **%** | **ug/m3** | **%** |
| **BC** | 0.068 | 62.25 | 0.287 | 64.70 | 0.065 | 79.78 | 0.024 | 154.91 |
| **OC** | 0.242 | 44.57 | 1.082 | 48.12 | 0.203 | 59.73 | 0.072 | 146.51 |
| **DUST1** | 4.449 | 114 | 16.99 | 112.8 | 6.059 | 146.8 | 0.947 | 183.51 |
| **DUST2** | 9.998 | 115.4 | 38.55 | 113.3 | 13.52 | 152.2 | 2.078 | 190.90 |
| **DUST3** | 6.687 | 119.3 | 26.04 | 115.9 | 9.0213 | 164.6 | 1.339 | 206.4 |
| **DUST4** | 2.003 | 135.9 | 8.062 | 124.1 | 2.614 | 215.2 | 0.371 | 246.2 |
| **DUST5** | 0.923 | 196.9 | 3.857 | 152.1 | 1.119 | 343.1 | 0.155 | 315.1 |
| **SEA SALT1** | 0.002 | 97.29 | 0.004 | 353.4 | 0.002 | 51.76 | 0.003 | 58.84 |
| **SEA SALT2** | 0.011 | 234.4 | 0.042 | 436.6 | 0.01 | 79.35 | 0.004 | 198.68 |
| **SEA SALT3** | 0.012 | 204.2 | 0.053 | 315.7 | 0.01 | 76.25 | 0.002 | 595.5 |
| **SEA SALT4** | 2E-05 | 13.39 | 1E-04 | 9.75 | 1E-05 | 188.7 | 1E-06 | 1533 |
| **sulf** | -0.026 | -2.61 | -1.157 | -23.57 | 0.205 | 27.56 | 0.023 | 21.25 |