Asian Monsoon and Elevated Heat Pump mechanism in the CMCC coupled aerosol-climate model simulations

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OBJECTIVES:
A coupled aerosol-atmosphere-ocean-sea ice model is used to analyze the relationship between aerosol and the Asian summer monsoon.

In this analysis the elevated heat pump (EHP) hypothesis and the solar dimming effect associated with aerosol loading are verified and are found to be consistent with our simulations.

As these results reproduce a reasonably realistic pattern, it is possible to consider absorbing aerosols as a possible source of seasonal predictability of the Asian summer monsoon over the Indian subcontinent.

BACKGROUND
Observational evidences of the aerosols-Asian monsoon relationship are presented by [1] and these are consistent with the EHP mechanism which posits that accumulation of dust and black carbon [2] over the Indo-Gangetic Plain during the pre-monsoon season may induce to increased warming in the upper troposphere during the late spring and early summer and lead enhanced monsoon rainfall over northern India in June-July [3].

METHODOLOGY:
We have realized a control simulation representing the present climate. The simulation is 80-yr long after spin up. Estimated conditions at 2000 determine the external forcings of the Control run. Estimated conditions at 2000 determine the external forcings of the Control run. Estimated conditions at 2000 determine the external forcings of the Control run. Estimated conditions at 2000 determine the external forcings of the Control run. Estimated conditions at 2000 determine the external forcings of the Control run. Estimated conditions at 2000 determine the external forcings of the Control run.

The anomalies of westerly monsoon winds:
- bring more dust from the Middle East deserts toward the Indian subcontinent
- this together with enhanced precipitation
- generates a surface cooling of about 1.5K over the Indian continent, (solar dimming effect).

RESULTS

Figure 1: The observations are from GCPF 1966-2007 and the simulations are over 85-years present climate 2000-landed.

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The monsoon season

Time-latitude cross-sections showing composite seasonal evolution of (a) the A1 anomaly and (b) the rainfall anomaly (mm/day) over 75°-90°E sector; (c) composite of rainfall (mm/day) in August.

In August:
- The global dimming effect increases the atmospheric stability over west-central and south of India subcontinent which weakens the Asian monsoon (not shown) by reducing temperature gradient between land mass and Indian ocean [3].
- A diminution of precipitation is found over northwest and central-north-east of the sub-continent especially over west central and peninsular region.

CONCLUSIONS

When increased aerosol loading is found on the Himalayas slopes in the pre-monsoon period (April-May), an intensification in early monsoon rainfall over India is obtained.

An increase in rainfall during the early monsoon has a cooling effect on the land surface produced also through the solar dimming effect by the presence of more dust from the deserts brought by an increased westerly flow in early monsoon season.

A subsequent reduction in monsoon rainfall over India is found, with a beginning of this decrease in northern India.

It can be deduced that the amount of aerosol loading before the monsoon onset is a source of predictability of the seasonal mean climate in the Indian subcontinent. It should therefore be estimated if a correct representation of the amount of absorbing aerosols in April-May could improve model prediction skills for the extended summer season.

REFERENCES