Asian perspective of the cryosphere-atmosphere feedbacks

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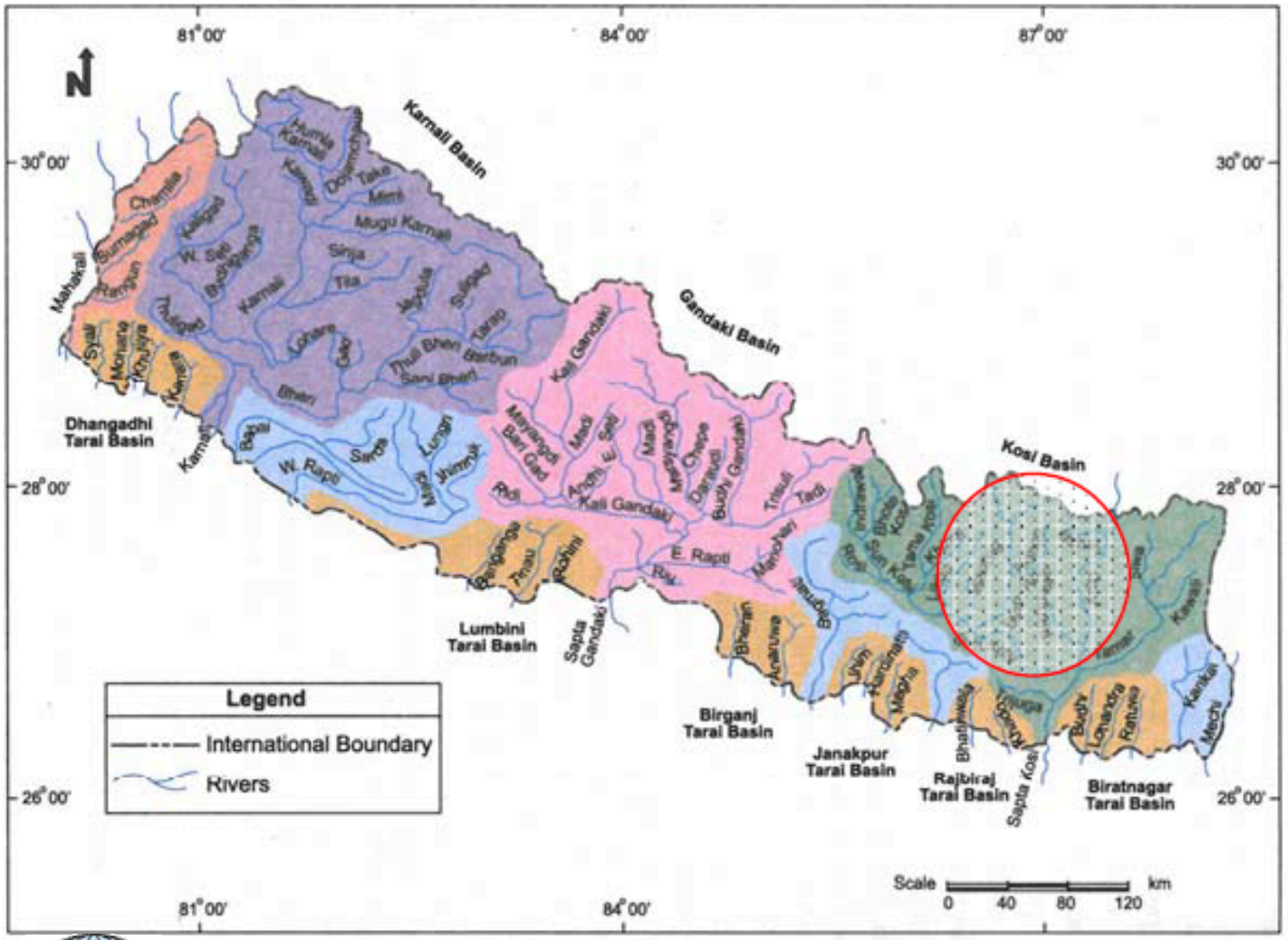
Motivation and main objectives

- The study of the role of the strongly absorbing black carbon and of dust
- How aerosols influence the onset and the position of the monsoon?
- Consequences of changes in snow albedo for the climate in the region

Project PAPRIKA:

Response of the cryosphere to anthropogenic influences in the Hindu-Kush-Himalaya: impact on the water resources and socio-economical adaptation for the region



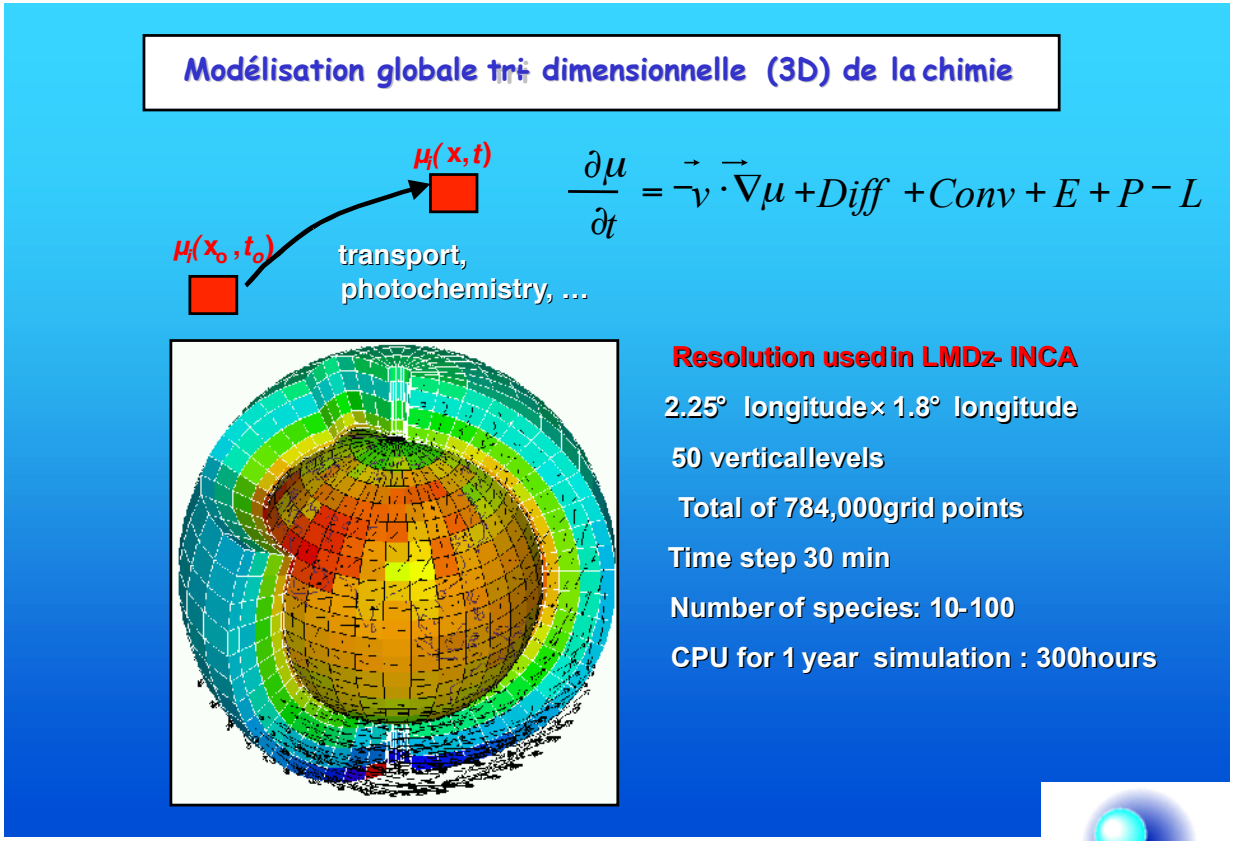
(*Bajracharya et al 2007*)

LMDz General circulation model fully coupled to **INCA** (*INteraction between Chemistry and Aerosols*)

Model resolution: 144x142xL19 or 144x142xL39

CHEMISTRY: Tropospheric chemistry representing methane oxidation (45 tracers et 100 reactions)

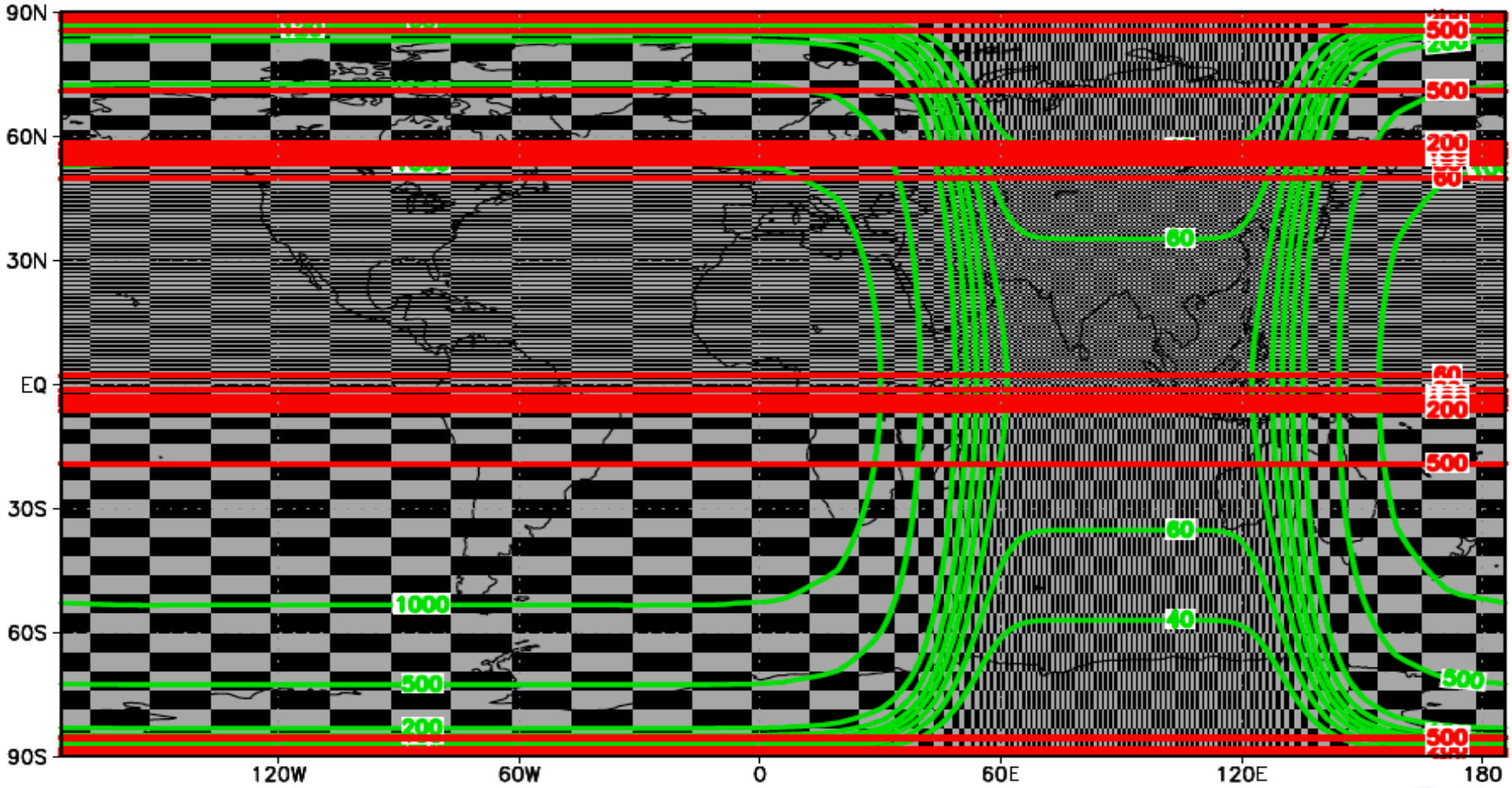
AEROSOLS:
Mineral aerosols,
Seasalt,
sulphates,
black carbon,
primary and
secondary organics



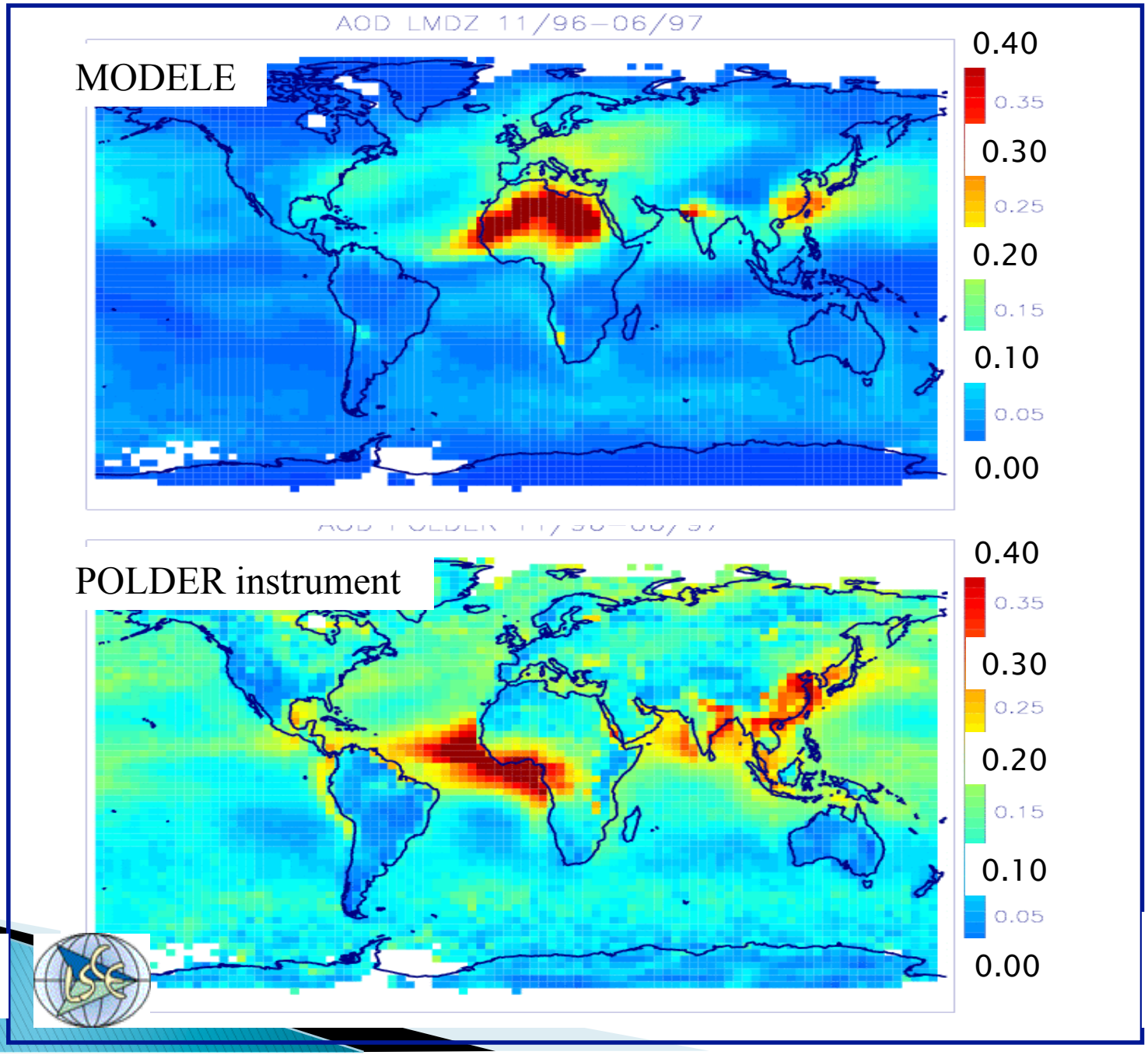
Zoom over most of Asia

Resolution latitudinale (km)

Resolution longitudinale (km)

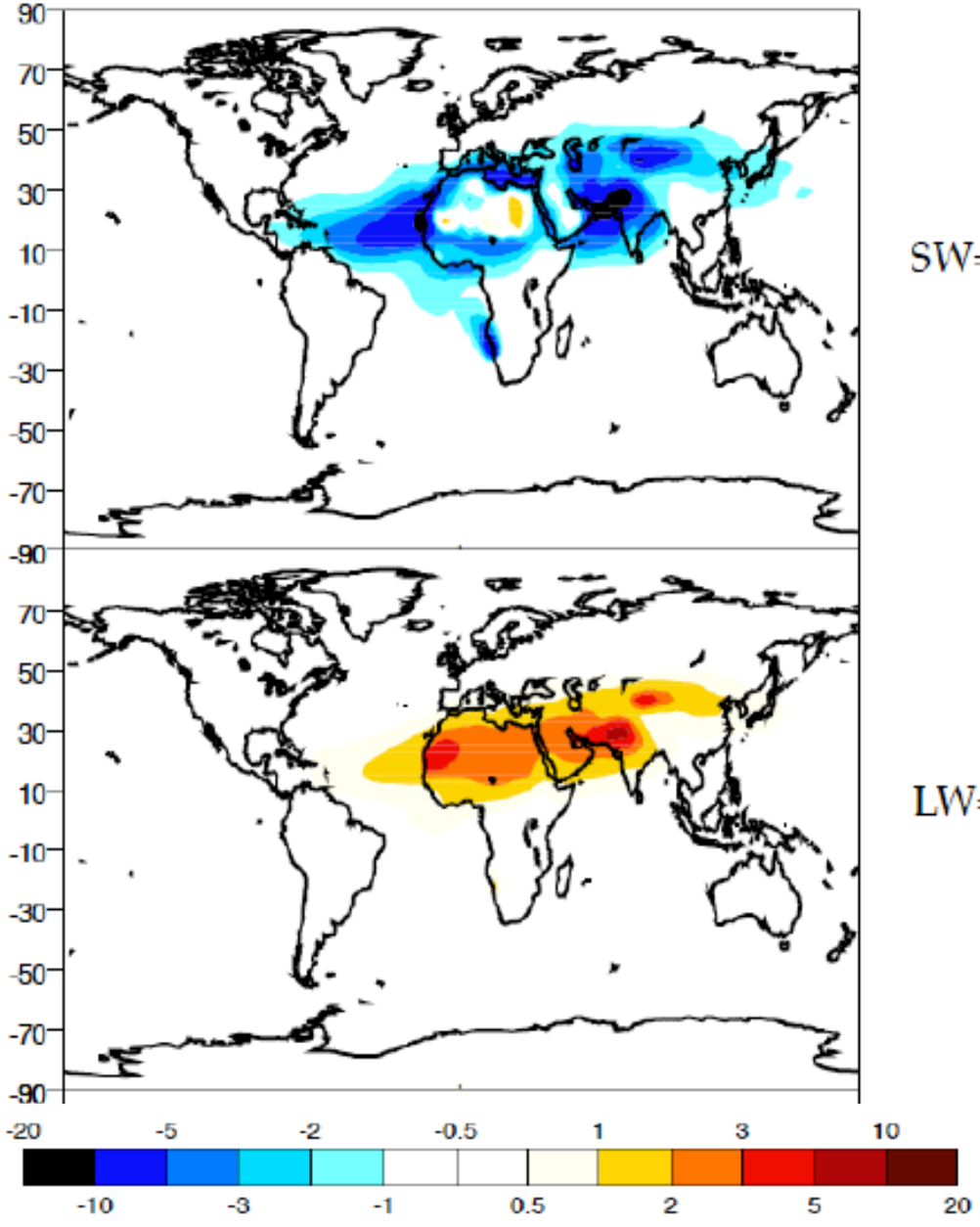


Comparaison with aerosol optical depth



I P S L

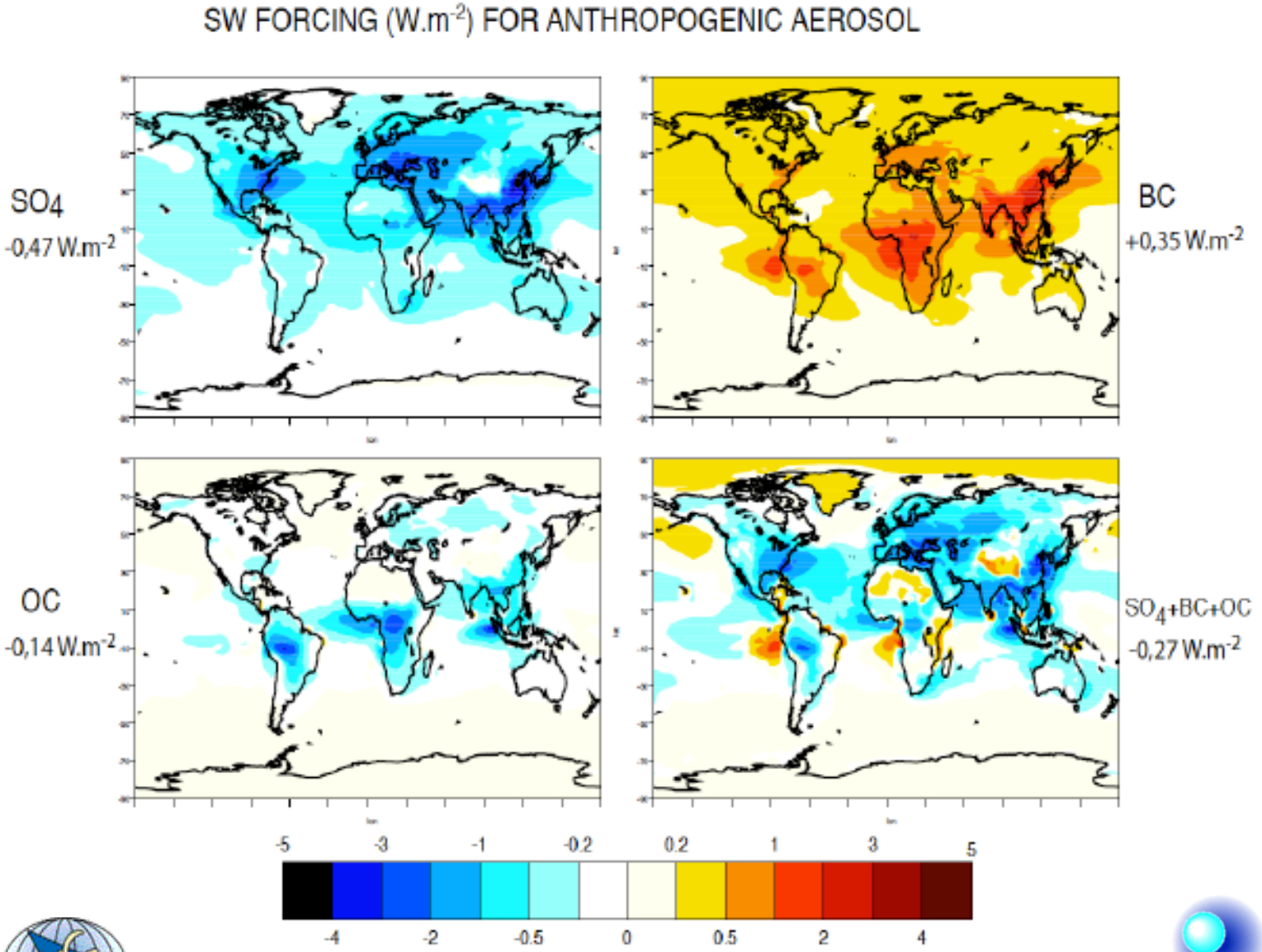
DUST TOA EFFECT ($W.m^{-2}$)



SW=-0,69 Wm^{-2}

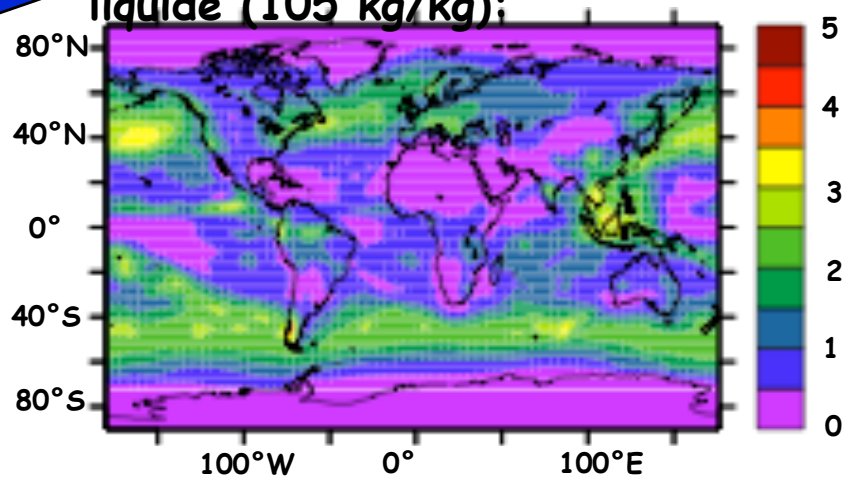
LW=+0,29 Wm^{-2}

Anthropogenic aerosol Direct Forcing (W m^{-2})

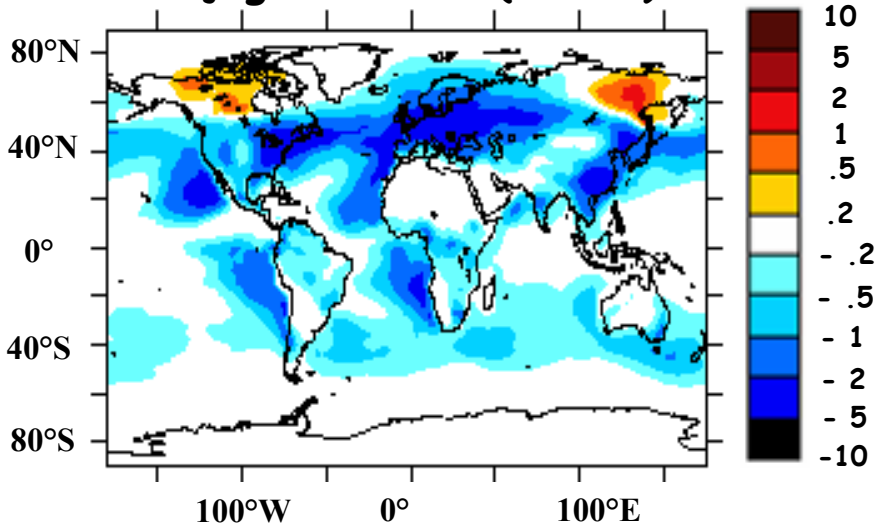


1st Indirect Forcing from aerosols

Différence du contenu en eau liquide (105 kg/kg):

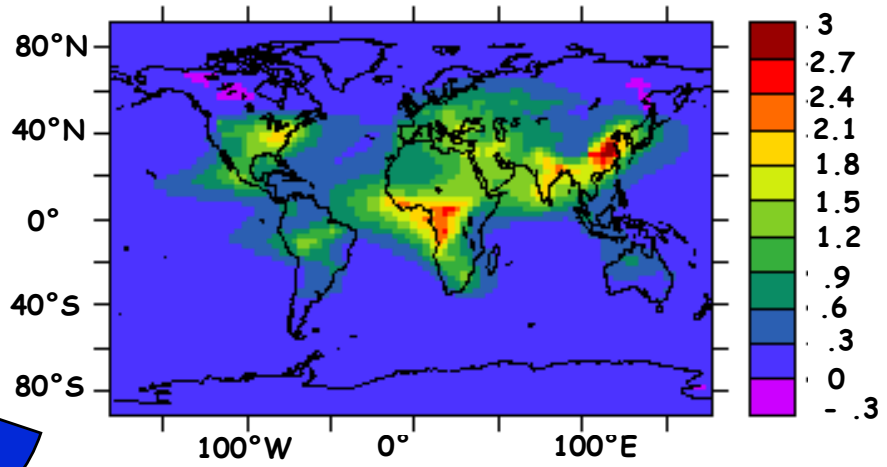


Forçage radiatif (W/m²)



Moyenne globale = - 0.46 W/m²

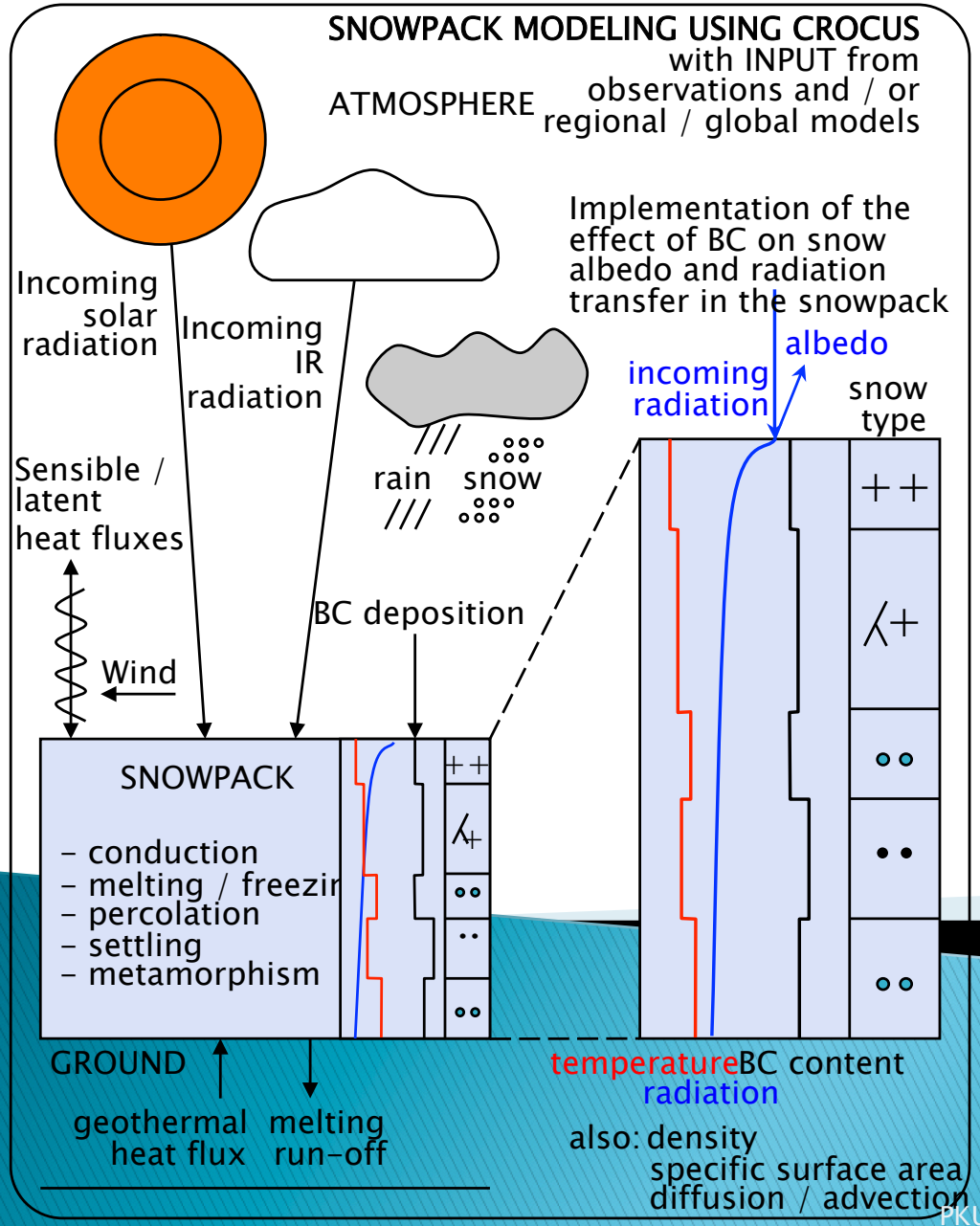
IPCC AR4: - 0.7 [-1.8 to -0.3] W/m²



Différence de concentration d'aérosols 2000 -1750 (µg/m3)

I P S L

Work package 4: MODELLING THE INTERACTION BETWEEN SNOWPACK, RADIATION, AND THE ABSORBING MATERIAL DEPOSITED IN THE SNOW



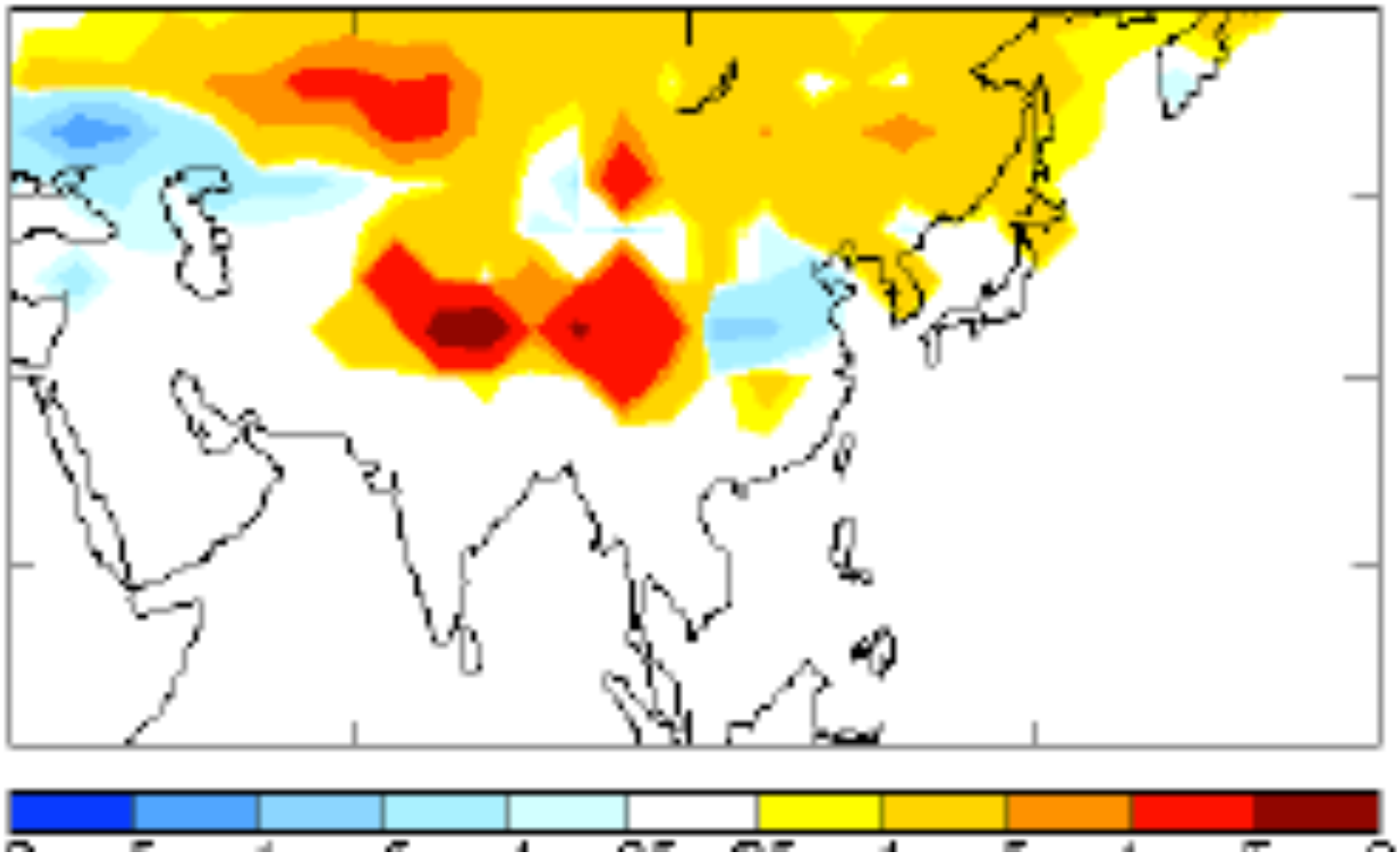
Local 1D modeling of optical snowpack properties for different conditions / altitudes:

- glaciers
- seasonal snowpack

Quantification of BC impact in snow on

- melting rates and days
- contribution of the snow melting to the total run-off
- sensitivities to future changes in temperature and atmospheric BC

Difference in annual mean forcing (W.m-2) due to snow/albedo feedback

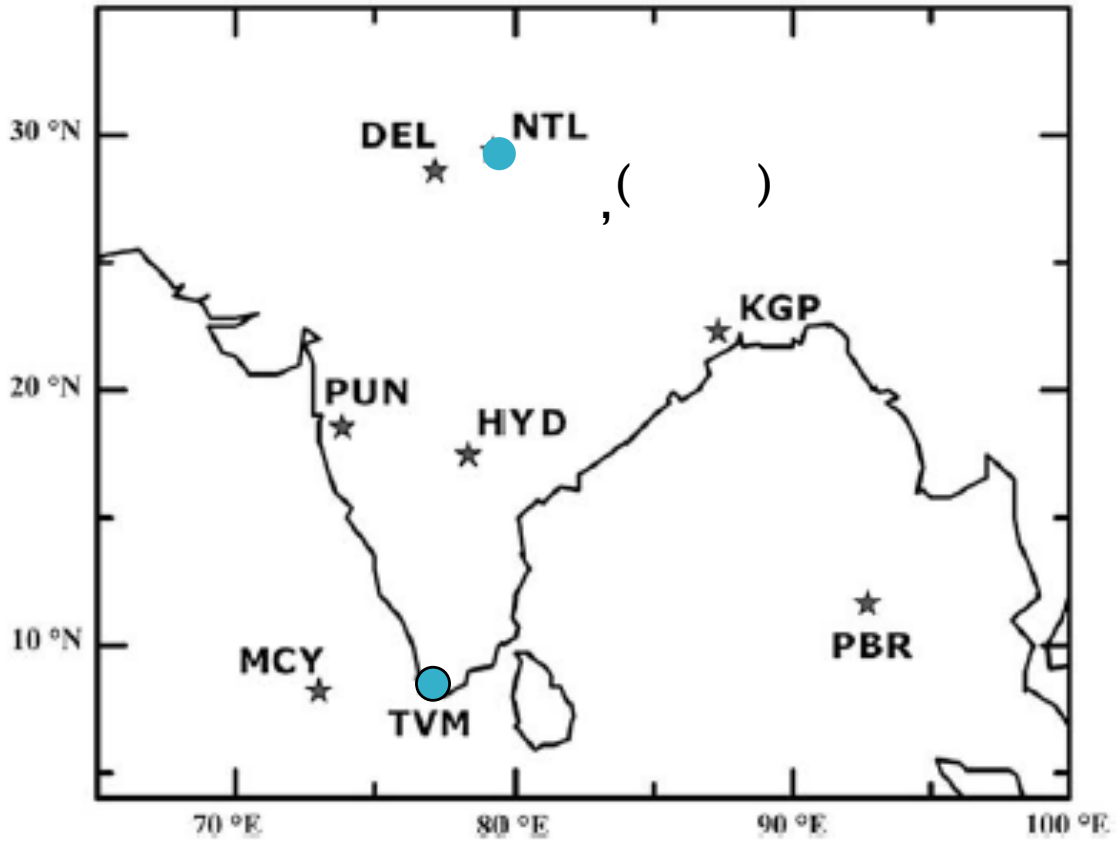


Menon et al., ACPD (2009)

Perspectives and conclusions

- We have coupled a chemistry-aerosol module to the Earth System Model from IPSL
- It allows to study large regions with a zoom and consider how chemically driven processes affect climate (and vice-versa)
- A study to understand the effects of aerosols on the monsoon and on the hydrological cycle is underway
- We will specifically address the effect of a change in albedo due to black carbon and dust deposition

Foreseen challenges (1/2)



Nainital
NTL, 1950m

Trivandrum
TVM 3m asl

Beguum et al (2009)

Foreseen challenges (2/2)

BC concentrations ($\mu g.m^{-3}$)

Location	Observation Jan–Feb	Beig	Bond	Observation Mar–May	Beig	Bond
Minicoy	0.47	0.13	0.08	0.06–0.22	0.03	0.02
Trivandrum	5.2–5.7	0.12	0.09	1.8-3.0	0.05	0.04
Port Blair	2.6	0.22	0.22	2.7–6.9	0.15	0.14
Hyderabad	21–25	6.3	2.6	12–15	2.4	0.85
Pune	6.4–7.3	2.4	0.64	2.2–4.5	1.2	0.30
Kharagpur	7.5–8.3	7.27	3.2	2.7–6.9	1.6	0.74
Delhi	19–27	2.1	0.47	8–12	2.2	0.57
Nainital	0.67–1.87	0.34	0.10	1.3–1.6	0.52	0.17

Menon et al., 2009

What can we do to increase our understanding?

Need to resolve BC concentration in the region

Improve the representation of snow/ albedo in the models

Diagnose the monsoon (see Marzin and Braconnot 2009) to better represent the general flow, onset and precipitation in the model

The model(s) used

- *LMDz-ORCHIDEE-INCA (SST fixed)*

→ Computes the aerosol concentrations and deposition: BC, POM, SO_4, dust and seasalts

→ Represents the change in albedo

- *Coupled IPSL model*

➞ Simulates changes in the intensity, onset phases and extent of the monsoon