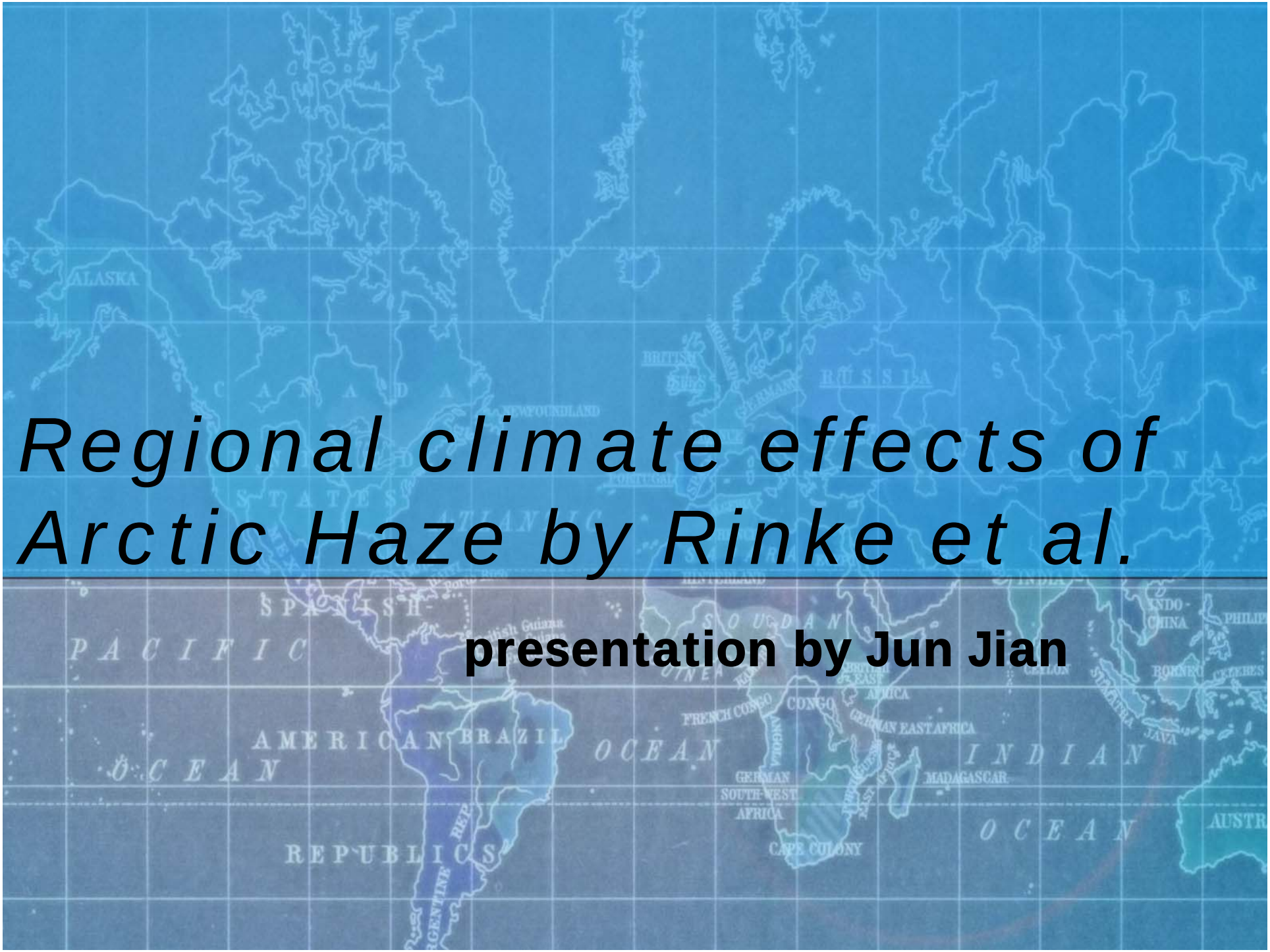
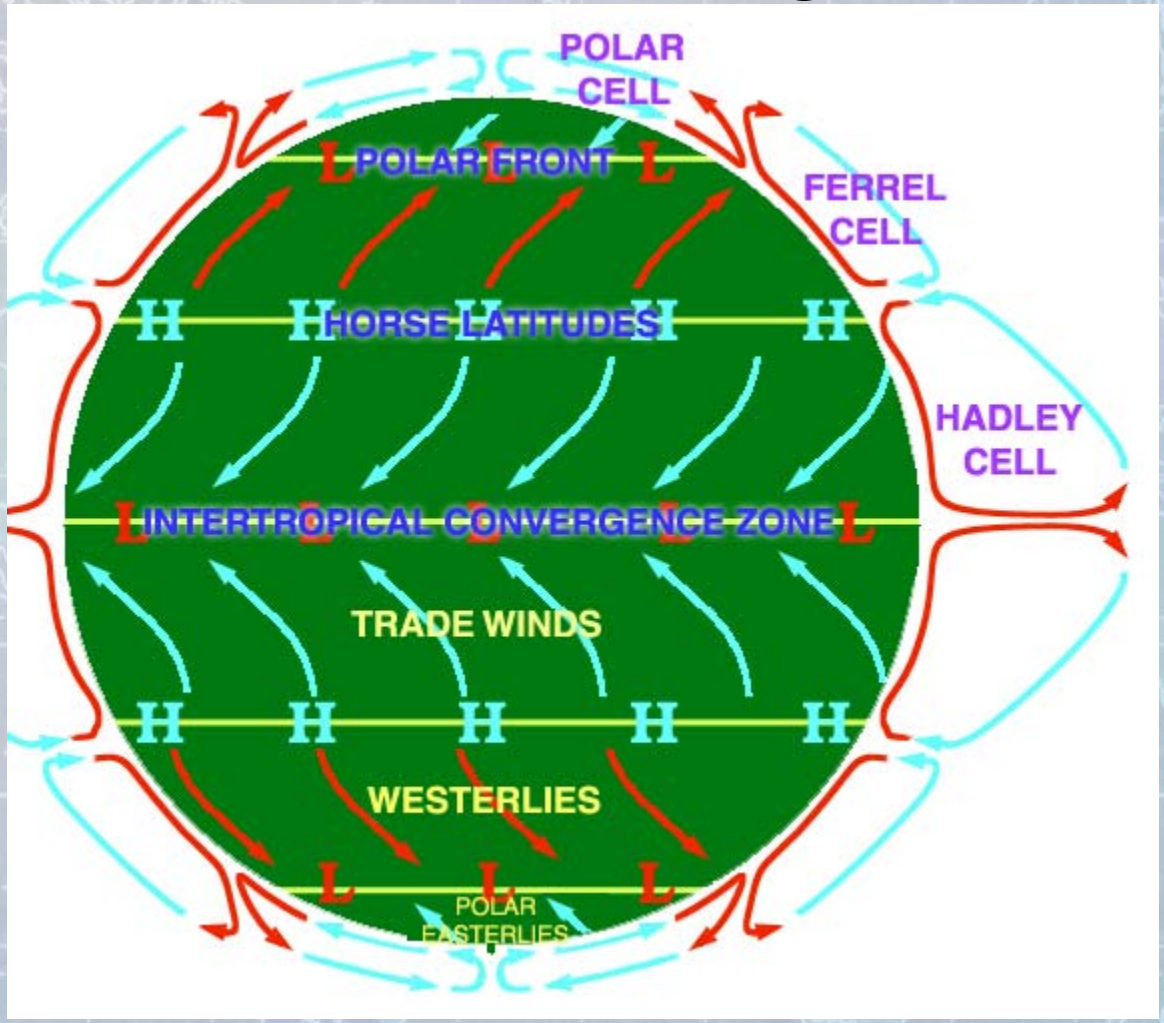


Regional climate effects of Arctic Haze by Rinke et al.

presentation by Jun Jian

- **Changes in the Arctic environment have been highlighted recently.**
  - **Increasing precipitation**
  - **Increasing river runoff**
  - **Declining snow cover/iceberg**
  - **Thawing permafrost**
- **They are associated with increasing temperatures in the region.**
- **How much did variations of aerosols contribute?**

How can anthropogenic activity influence the Polar region?

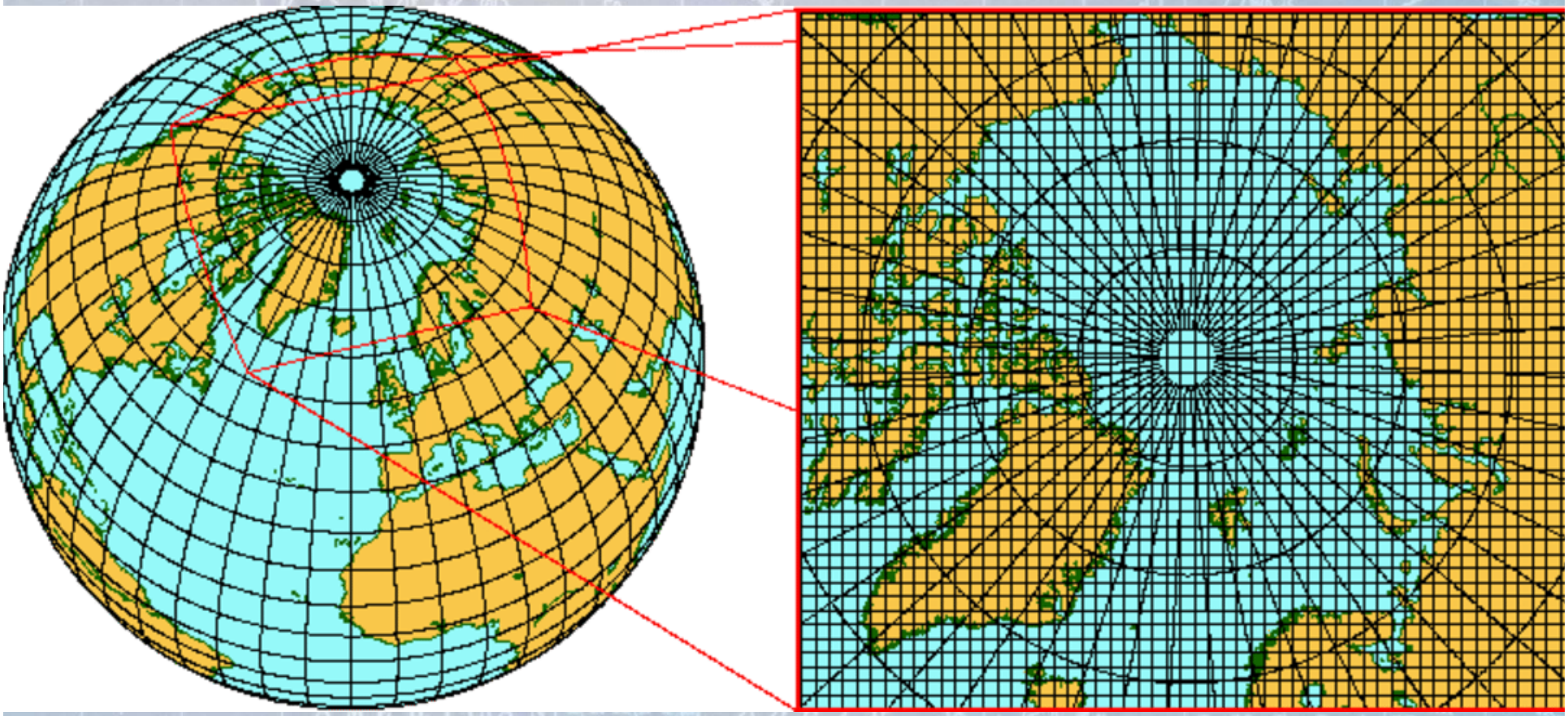


Via global circulations : Polar Cells

Major Arctic Haze aerosols

- **Mixture of three aerosol components**
  - **WASO (water soluble sulphate, nitrate) from fuel burning and biogenic activity**
  - **SOOT (organic and black carbon) from volcanoes, biomass burning, fossil fuel burning**
  - **SSAM (sea salt particle with radii between 0.1-1 μm) from ocean wave motions**
- **Their impact to climate are uncertain and complicated.**

Model and dataset

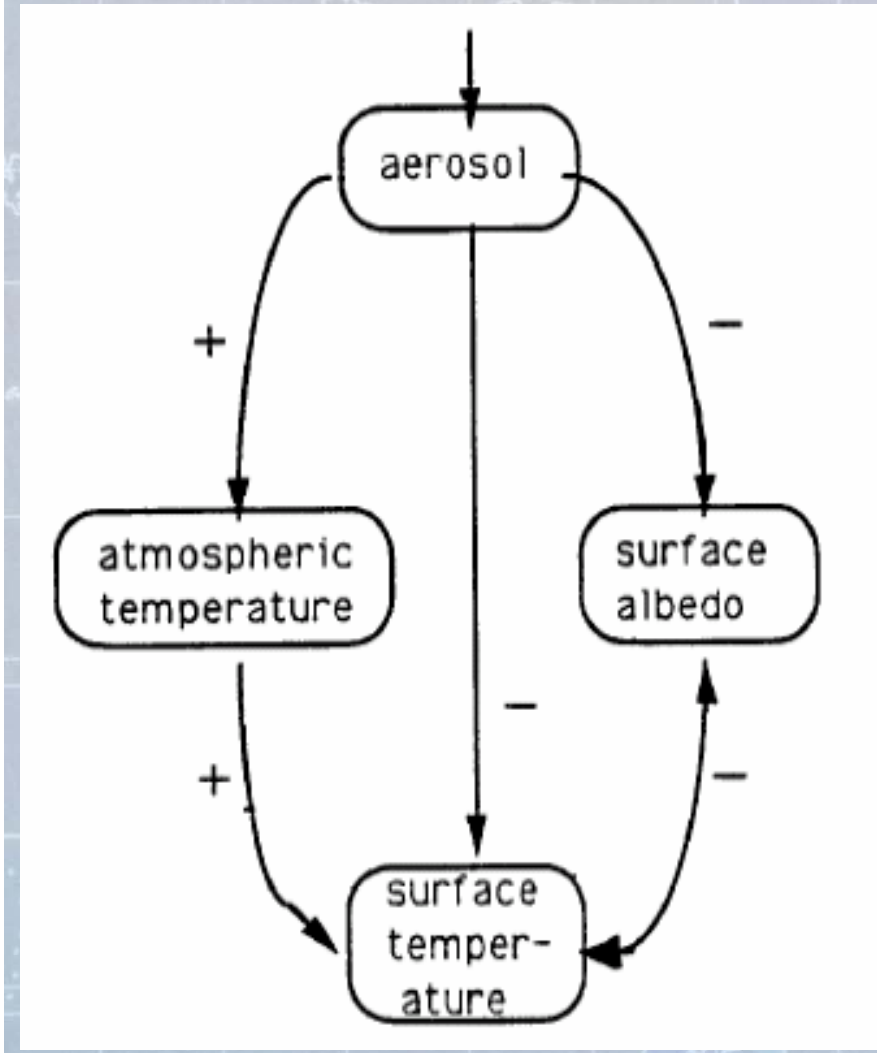


- **HIRHAM=HIRLAM + ECHAM**
  limited area model + general circulation model
  adiabatic formulation + physical parameterization

Model and dataset

- **ECMWF reanalysis dataset provide**
  - **lateral boundary forcing – 6 hourly**
    - **Wind field**
    - **Specific humidity**
    - **Geopotential height**
    - **Temperature**
  - **lower boundary forcing – daily**
    - **sea surface temperature**
    - **sea ice fraction.**
- **GADS (global aerosol data set)**
  - **10 components**
  - **8 relative humidities**
  - **61 wavelengths**
  - **Globally distributed (5 º × 5 º)**

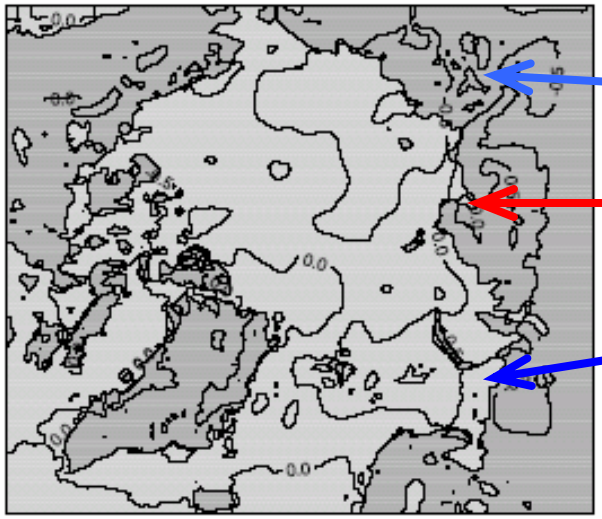
Motivation of the model



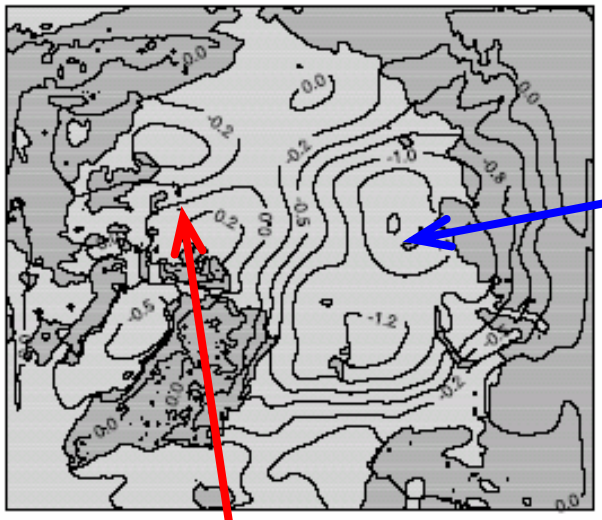
- **Curry (1995) stated that the direct impact from Arctic aerosols on surface air temperature consists of both positive and negative feedback, but the net balance is likely to be a small positive warming.**

Results from the model

(a) mean effect on 2-m air temperature

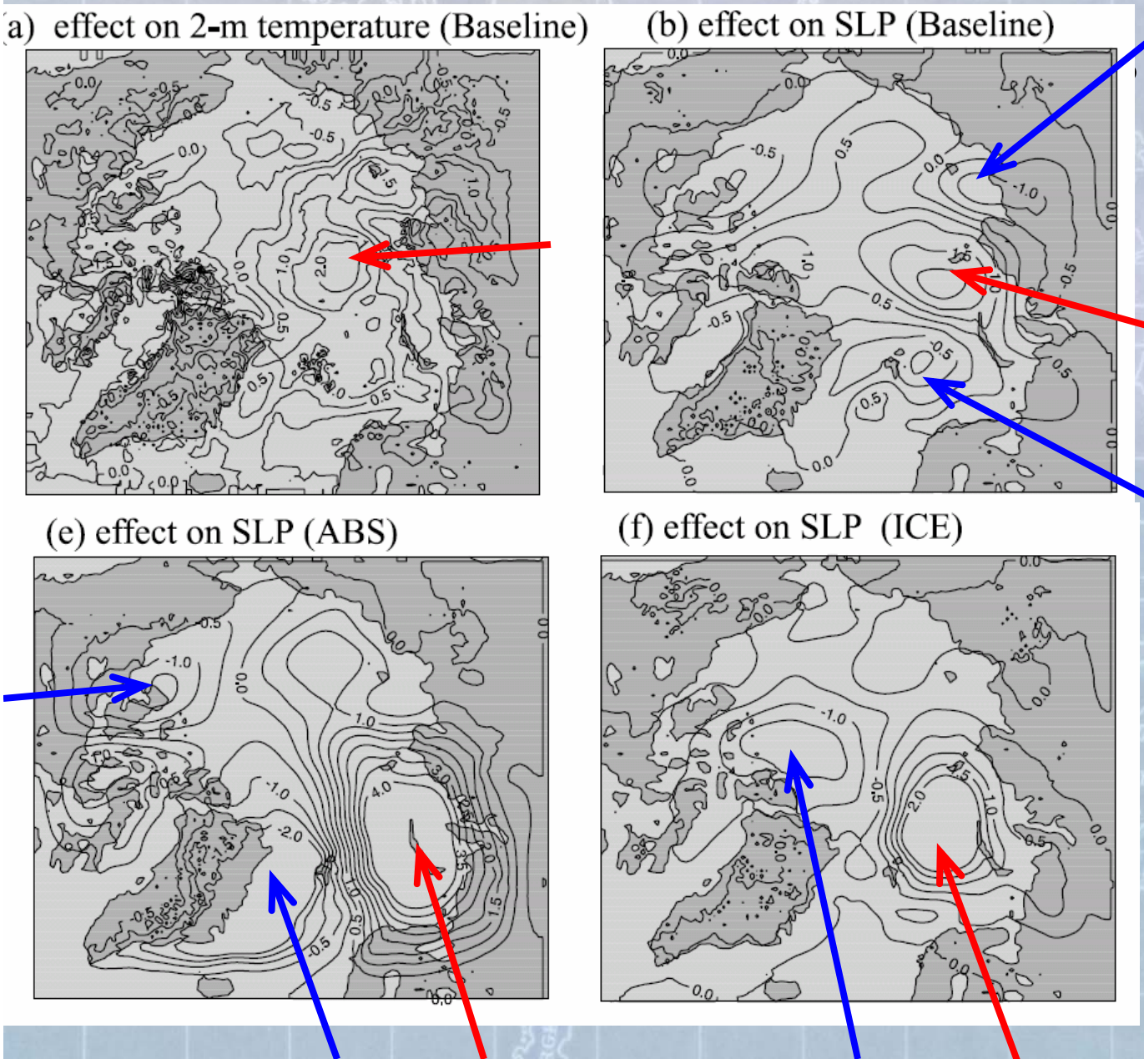


(b) mean effect on mean sea level pressure



- **Mean ensemble effect**
- **Temperature: + / - 1K**
- **Sea level pressure: up to -2hPa**

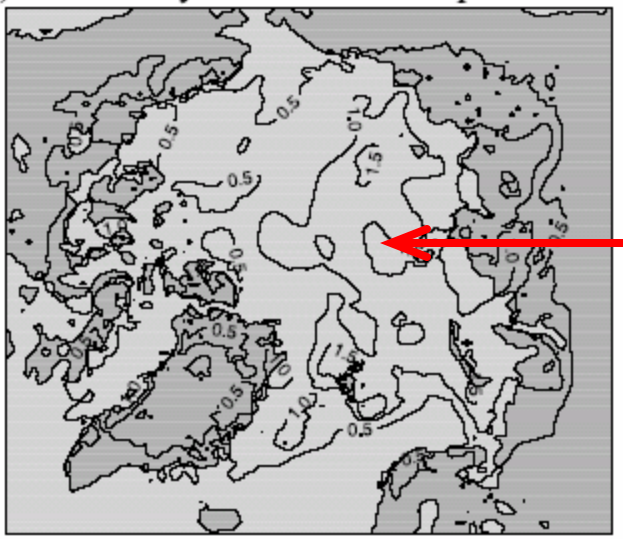
Results from the model



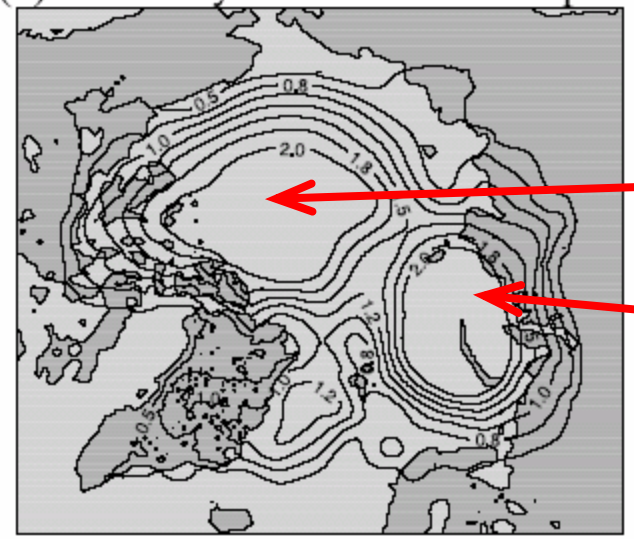
Aerosol effect on a specific period (mar 1990)

Results from the model

(a) variability of 2-m air temperature effect



(b) variability of mean sea level pressure effect



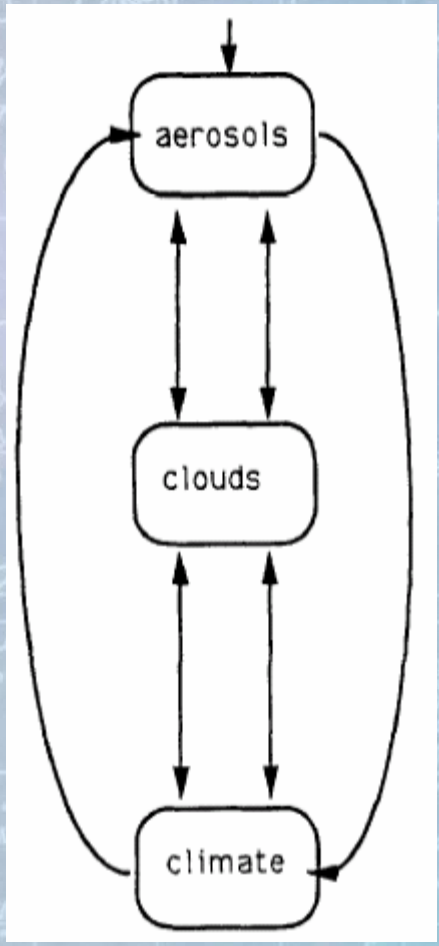
- **Ensemble year-to-year variability:**
- **Bigger value indicates disagreement in the simulations of aerosol effect among different years and high variability.**

Conclusions

- **Arctic aerosols exert a not negligible climate effect.**
- **Magnitude and regional distribution depend on radiative absorption and ice cloud optical properties.**
- **Direct aerosol effect is strong enough to modify the regional circulations and cloud structures.**
- **Future investigation needed.**

Limitations of the model

- **Only direct climate effects are considered.**
  - **The cloud's impact on climate due to aerosols are ignored.**
    - **Water soluble aerosols (e.g. NaCl, sulfate) act as CCN or IN in cloud formations.**
    - **Clouds observed in Arctic are observed in each level, each season.**



Uncertainty of the model

- **Surface boundary are forced by ECMWF reanalysis data.**
  - **Is the pollution of snow and permafrost by SOOT counted?**
- **The results have not been verified by observations or other numerical simulations.**
  - **No compelling explanations given for the dipoles of temperature and SLP field**
  - **To me, the 2˚C of interannual air temperature variability seems too big.**