The PNA Teleconnection in Different Climate States

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The Pacific-North America Teleconnection (PNA)

Horel and Wallace (1981)
1. About PNA: 3 papers in 1981


Question

• What cause the PNA differences for the different climate states?
  1. LGM (cold)
  2. Present
  3. RCP8.5 (warm)
2. Data

CCSM4 simulations

1. Pre-industry (modest)
2. 4xCO$_2$ (warm)
3. PMIP3: LGM (21 ka) (cold)
The Last Glacier Maximum (LGM)

21000 years ago (21 ka)
Annual-mean surface temperatures

piControl

21k (LGM)

abrupt4xCO2
Annual-mean geopotential height at 500 hPa
DJF Geopotential heights at 500 hPa

Present

LGM

4×CO₂
One-point correlation of DJF geopotential heights at 500 hPa, with the base-point at 20° N and 160° W

The PNA Teleconnection is lost in LGM.
One-point correlation of DJF geopotential heights at 500 hPa, with the base-point at 45° N and 165° W.
DJF SATs regressed on Nino3.4

piControl

21k (LGM)

abrupt4xCO2
DJF precipitation regressed on Nino3.4

piControl

21k (LGM)

abrupt4xCO2

Temperature

-1.5 -1.2 -1 -0.8 -0.6 -0.4 -0.2 0.2 0.3 0.4 0.6 0.8 1 1.2 1.5
DJF zonal wind at 500 hPa

- piControl
- 21k (LGM)
- abrupt4xCO2
Vertical cross-section of DJF zonal-wind at 100° W
Vertical cross-section of DIF temperature at 100° W
The wave guide

\[ K_s = \sqrt{\beta / U} \]

\( K_s \): stationary wavenumber

\( U \): zonal – mean wind
$K_s$ differences

Present

LGM

4xCO2

Unit: $10^3 \text{ km}^{-1}$
Conclusions

1. The PNA is almost completely lost in LGM.
2. The PNA has not significant changes for 4xCO2 and RCP8.5, with stronger correlation at Alberta and weaker correlation at Gulf.
3. The different PNAs are caused by mid-latitude wave guides.

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1. Any paleo-records for PNA in LGM?
PNAs for different RCPs

piControl

RCP2.6

RCP4.5

RCP8.5
DJF SATs regressed on Nino3.4

- piControl
- abrupt4xCO2
- RCP4.5
- RCP8.5