Tropical-Antarctic Teleconnections and their Impacts on the Antarctic Climate Changes

A Brief Review

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Outline

• Why we are interested in the Tropical–Antarctic teleconnection

• The Mechanisms of Teleconnections between Tropics and Antarctic Atmospheric Circulation

• The impacts of the Tropical–Polar teleconnections on the Antarctic Climate Changes
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1. Importance of Tropical - Antarctic Teleconnections

Antarctic Climate Changes: Glacier Melting
I. Importance of Tropical - Polar Teleconnections

Antarctic Climate Changes: Glacier Melting
I. Importance of Tropical-Polar Teleconnections

Antarctic Climate Changes: Rapid Warming

西南极和南极半岛剧烈增温

幅度可达到全球平均增速的5倍以上
I. Importance of Tropical-Polar Teleconnections

Antarctic Climate Changes: Antarctic Paradox
I. Importance of Tropical - Polar Teleconnections

Antarctic Climate Changes: Sudden Loss
I. Importance of Tropical - Polar Teleconnections

Zonal Asymmetry of the Antarctic Changes
1. Importance of Tropical - Polar Teleconnections

Zonal Asymmetry of the Antarctic Changes

- Near-Surface Air Temperature Reconstruction (1952 - 2006) in Degrees C
- Monthly Carbon Dioxide Concentration
- CO2浓度升高，温室效应
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II. Mechanisms of the Teleconnections

Teleconnections on Interannual Time-scales

Hoskins et al. 1981, 1992
Karoly et al. 1989
Mo et al. 1997
Bromwich et al. 1999
Yuan et al. 2001
Yoo et al. 2012
II. Mechanisms of the Teleconnections

Teleconnections on Interannual Timescales

a El Nino Induced Teleconnection
II. Mechanisms of the Teleconnections

Teleconnections on Interannual Timescales

a El Nino Induced Teleconnection
Pacific impacts on the Antarctic

Pacific

ENSO

Antarctic

Antarctic
II. Mechanisms of the Teleconnections

IPO impacts on the Antarctic

Turner et al. 2014, 2016
Li et al. 2014, 2015, 2016
Ding et al. 2012, 2013
Simpkins et al. 2014
Meehl et al. 2016
II. Mechanisms of the Teleconnection

IPO impacts on the Antarctic

b IPO (-) Induced Teleconnection
Pacific impacts on the Antarctic
AMO impacts on Antarctic SAT and sea ice

Li et al. 2014, 2015
II. Mechanisms of the Teleconnections

Idealized Model of the Rossby Wave Dynamics

- GFDL initial condition simulations show clear Rossby Wave Trains
- Transport to Amundsen Sea within two weeks
II. Mechanisms of the Teleconnections

Teleconnections on Decadal Time-scales

b) IPO (-) Induced Teleconnection

c) AMO (+) Induced Teleconnection
II. Mechanisms of the Teleconnections

Teleconnections on Decadal Time-scales

b) IPO (-) Induced Teleconnection

c) AMO (+) Induced Teleconnection

Decadal

AMO+

Stationary Rossby Wave

Inter-basin Interaction

IPO-

ASL+

LAP
Tropics impacts on the Antarctic

Pacific PDO

Antarctic AMO

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II. Mechanisms of the Teleconnections

**AMO ( + )** vs. **IPO ( - )**

1. **Atlantic Multidecadal Oscillation**
2. **Pacific Decadal Oscillation**
II. Mechanisms of the Teleconnections

**AMO** vs. **IPO**. Different Period

(I980 - 2000)

(I998 - 2015)
11. Mechanisms of the Teleconnections

The Role of Inter-basin Interactions

Pantropical climate interactions

Li et al. 2016

Cai et al. 2019
II. Mechanisms of the Teleconnections

The Role of Inter-basin Interactions

Wu et al. 2020

Meehl et al. 2021
Tropics impacts on the Antarctic

Antarctic

Pacific

PDO

Atlantic

AMO

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II. Mechanisms of the Teleconnections

**AMO+ and IPO- Deepened the ASL in the Past Decades**
Outline

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• The impacts of the Tropical - Polar teleconnections on the Antarctic Climate Changes
III. Teleconnections Impact on Antarctic Climate Changes since 1980s
III. Teleconnections Impact on Antarctic Climate Changes since 1980s

- Rapid Warming over WA
III. Teleconnections Impact on Climate Changes since 1980s

- Rapid Warming over WA
- Increase of OHC
III. Teleconnections Impact on Climate Changes since 1980s

- Rapid Warming over WA
- Increase of OHC
- Sea Ice Paradox & Sudden Loss
III. Teleconnections Impact on Climate Changes since 1980s

- Rapid Warming over WA
- Increase of OHC
- Sea Ice Paradox & Sudden Loss
- Accelerated Glacier Melting
Circulation changes drive surface warming through thermal advection.
III. Teleconnections Impact on Climate Changes

Drive the Ocean-Sea Ice Model with the Atmos Circulation Changes
III. Teleconnections Impact on Climate Changes

Drive the Ocean-Sea Ice Model with the Atmosphere Circulation Changes

Sea Surface Height
Sea Ice (JJA)
Subsurface Temperature
Subsurface Salinity

Observation Changes Since 1990s

Sea Ice Active Simulation
III. Teleconnections Impact on Climate Changes

Drive the Ocean-Sea Ice Model with the Atmosphere Circulation Changes

Sea Surface Height
Sea Ice (JJJA)
Subsurface Temperature
Subsurface Salinity

Observation
Changes Since 1990s

Simulation
Sea Ice Active

Sea Ice Inactive

Legend:
-40 -20 0 20 40 60
-60 -40 -20 0 20 40 60
-1 0 1
-1 0 1 x 10^6

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III. Teleconnections Impact on Climate Changes

Teleconnections impact on Antarctic Changes

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Summary

Tropical - Polar teleconnections impact on the Atmospheric Circulation

Atmospheric-ice-ocean interactions

Contribute to Antarctic Climate Changes
Discussion

The Role of Ocean Dynamics in the Teleconnections

Antarctic Feedback to Lower Latitude
Thank you so much! 😊