On the coupled interdecadal variations of the extra-tropical surface air temperature and the isentropic meridional airmass transport in Northern winter

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Motivations

On top of the long-term global warming, the winter surface air temperature (SAT) exhibits significant interdecadal changes. Decadal changes of the winter continental SAT show

(1) What's the coherent interdecadal changes of the winter SAT between the two continents? (2) What's the coupled relationships between the winter SAT and the IMMT in the NH winter at decadal time scale? (3) Possible forcing of this coupled interdecadal variation?

Data and Methods

- ERA5 (1950-2020): daily dataset at 1.5 × 1.5° grids and 37 pressure levels from 10
- Isentropic-level Meridional Mass Transport (IMMT): meridional mass transport be
- PDO index; AMO index.
- Maximum Covariance Analysis (MCA).

first three leading MCA modes explain 90.5% (respectively, 57.7%, 18.9% and 13.8%) of the cumulative squared covariance fraction,

and 0.95 for the MCA1, MCA2 and MCA3.

- MCA1 represents a "out-of-phase" pattern between two continents, while MCA2 represents a coherent "EU-NA" interdecadal pattern.

spectrum peak at the period of 33.1 years and exist significant lead-lag correlation (at -14 year and maximum at 12 year)

00 to 1 hPa.

elow 280K.

Fig.5 The first three leading MCA patterns

inter SAT dominated by changes

Interdecadal variation of the wi

- The decadal SAT variations between two continents are not always in-phase or out of phase at P2 and

explain up to 45.5% of EUA-SAT, while MCA2-reconstructed SAT timeseries can explain up to 43.7% of NA-SAT (not shown).

- MCA1 and MCA2 are coupled modes

- The phase variation against the coupled T-MCA1 and T-MCA2 evolves in a clockwise direction before 1974, but in a counte direction thereafter.

MCA1 before 1974, but a lag of the M

the state vector representing the n of the coupled T-MCA1 and T-

Fig.7 Orbit of phase variation MCA2.

- This coupling basically indicates the dominant role of the dynamical transporting process

overall SAT changes

the coupled interdecadal variations to PDO and AMO

Linking

the PDO/AMO and T-MCA1 for the period of (a) 1950–1974 and (b)

Fig.1 Interdecadal evolutions of the

Fig.2 Longitude-time evolutions of the

PDO/AMO and MCA1 in 1950–21. (d–f) Are the same to (a–c) for the T-MCA2

D and T-MCA1 are positively correlated with each other in general. PDO htly lags the T-MCA1 in

P1(1954–1963)	P2(1964–1984)	P3(1985–1997)	P4(1998–2004)	P5(2005–2016)
EUA Warmer	Colder	Warmer	Warmer	Colder
NA Warmer	Colder	Colder	Warmer	Warmer

relationship between the AMO and PDO after 1975 probably further contributes

- the PDO-regressed patterns

of the SAT and IMMT at a 0-lag resemble that of the MCA1 ('EUA-warmer), while PDO-regressed patterns at a 14yr lag (12yr lead) resemble

Fig.3 Winter climatology of (a) the isentropic mass flux (vectors) and the IMMT (shadings) (units: kg/s),

- The sub-route over explain the not anomalies between European region

accompanied by lo

Summary

- SAT and IMMT are always

- The interdecadal variation of winter SAT is closely coupled with changes of the IMMT, which

- The MCA1 and MCA2 are significantly associated with the PDO which dominates the much-intensified MCA1 and the related 'EUA-warmer/colder' SAT pattern since 1975.

'Warm Arctic - Cold Eurasia' pattern indicated in previous studies

maly fields of (a–e) the decadal SAT and (f–j) the d the IMMT in selected five periods

Fig.4 Composite ano isentropic mass flux an

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