A climate classification: Mediterranean, monsoon and westerlies climates

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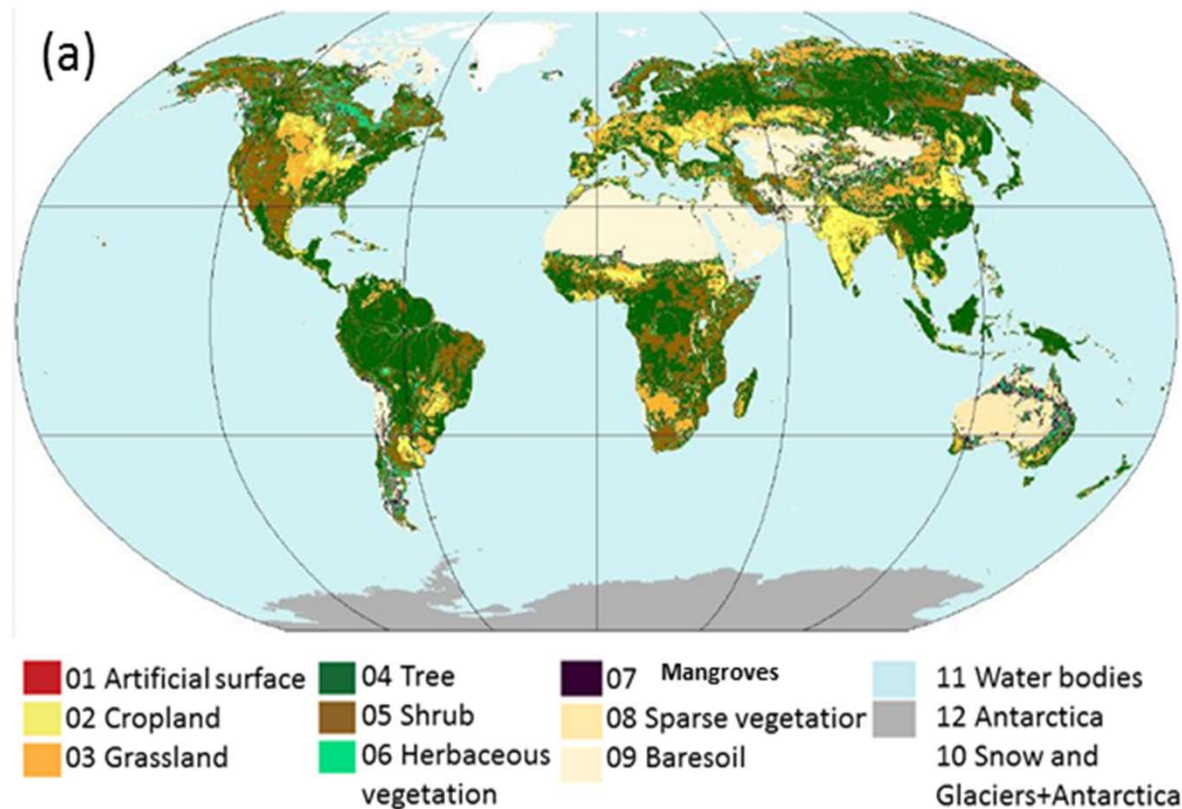
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Outline

- Land cover and Köppen climate classification
- Precipitation and seasonal portion
- Classification around Tibetan plateau
- Seasonal precipitation and temperature
- Minimum in precipitation variance
- Moisture flow and divergence
- Collocation pattern
- Conclusion

Global surface vegetation and Land Cover

.

Note: Mid-latitude deserts in Central Asia, Northwest China,
Others are subtropical deserts

(a)

01 Artificial surface	04 Tree	07 Mangroves	11 Water bodies
02 Cropland	05 Shrub	08 Sparse vegetation	12 Antarctica
03 Grassland	06 Herbaceous vegetation	09 Baresoil	10 Snow and Glaciers+Antarctica

Source: Global Land Cover SHARE database (GLC-SHARE; Beta-Release Version 1.0–
2014), provided by the Food and Agriculture Organization of the United Nations
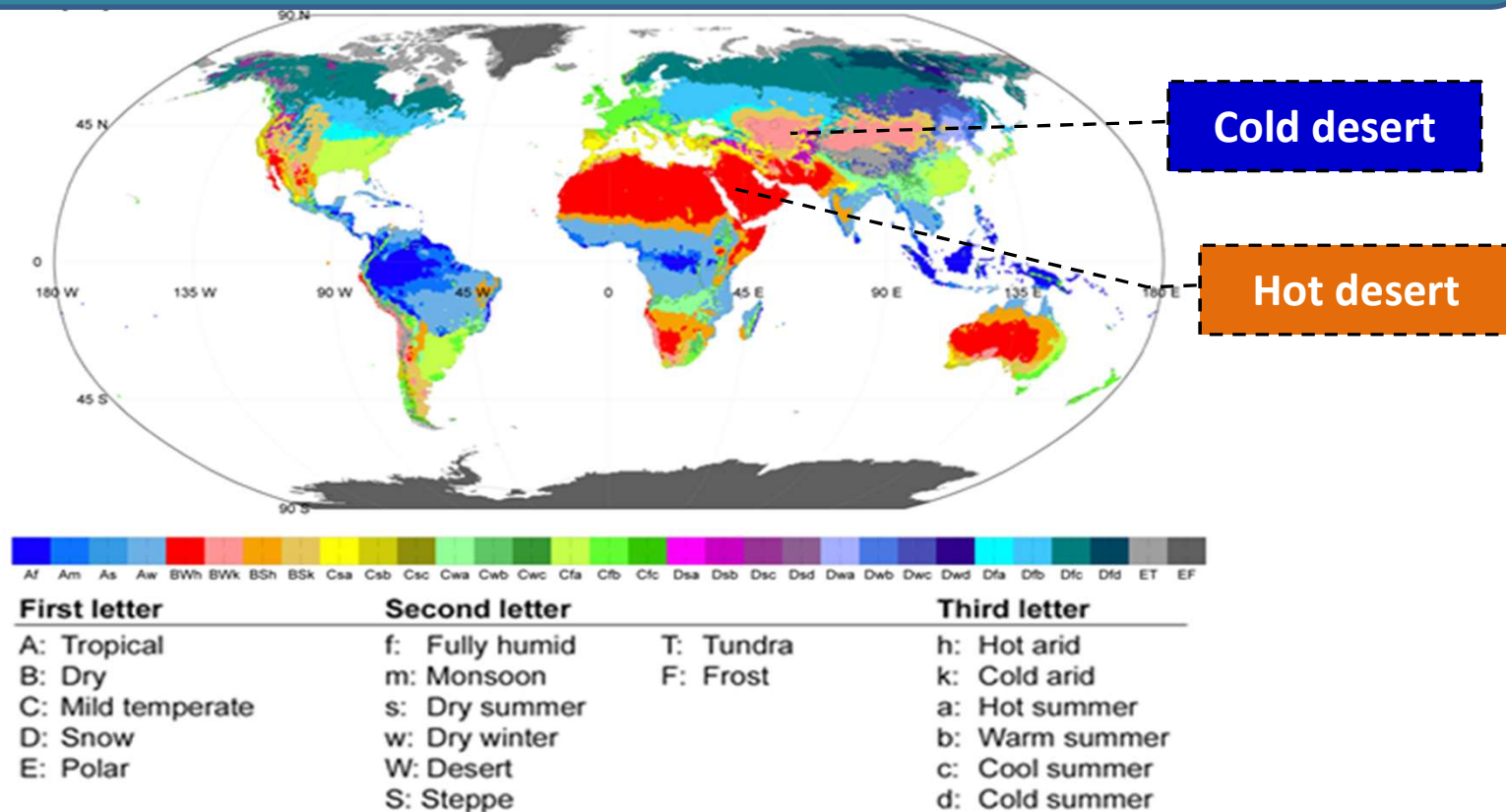(http://www.glcn.org/databases/lc_glcshare_en.jsp)

World Map of Köppen Climate Classification for 1901-2010

> **Köppen Climate type:**   **BWk:**   Cold desert in mid-latitude
>   **BWh:**   Hot   desert
>
> **Mechanisms for mid-latitude cold desert:**
>   **1) Less precipitation;   2) seasonal precip. Distribution ?**

Cold desert

Hot desert

First letter	Second letter		Third letter
A: Tropical	f: Fully humid	T: Tundra	h: Hot arid
B: Dry	m: Monsoon	F: Frost	k: Cold arid
C: Mild temperate	s: Dry summer		a: Hot summer
D: Snow	w: Dry winter		b: Warm summer
E: Polar	W: Desert		c: Cool summer
	S: Steppe		d: Cold summer

(Chen and Chen(2013), http://hanschen.org/koppen)

Annual precipitation and cold season portion for 1961-1990

The land cover is determined not only by climate annual precipitation, but also associated with its seasonal distribution. Mediterranean Climate zones leads land degradation in Northern Africa, Mid- and south part of Central Asia, West Asia and the east coast of the North America.
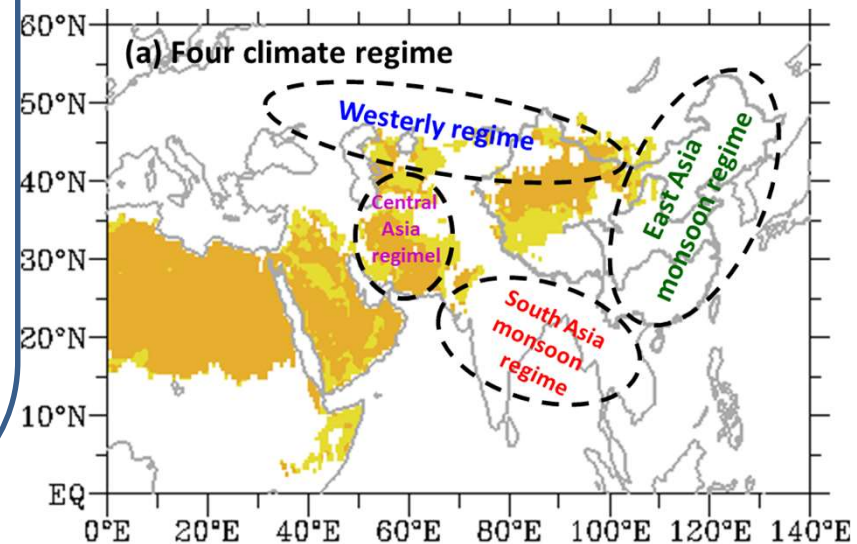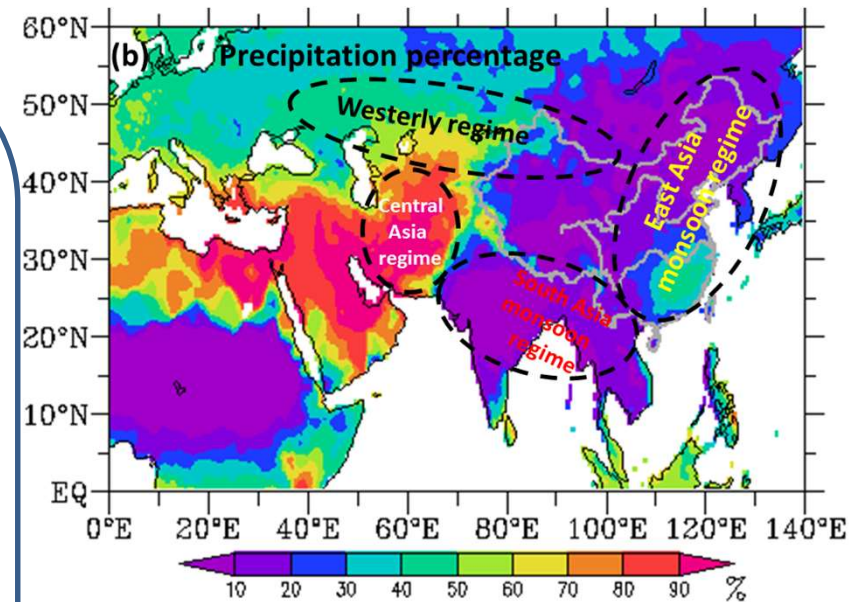
Annual precipitation

Cold season precipitation portion (%)
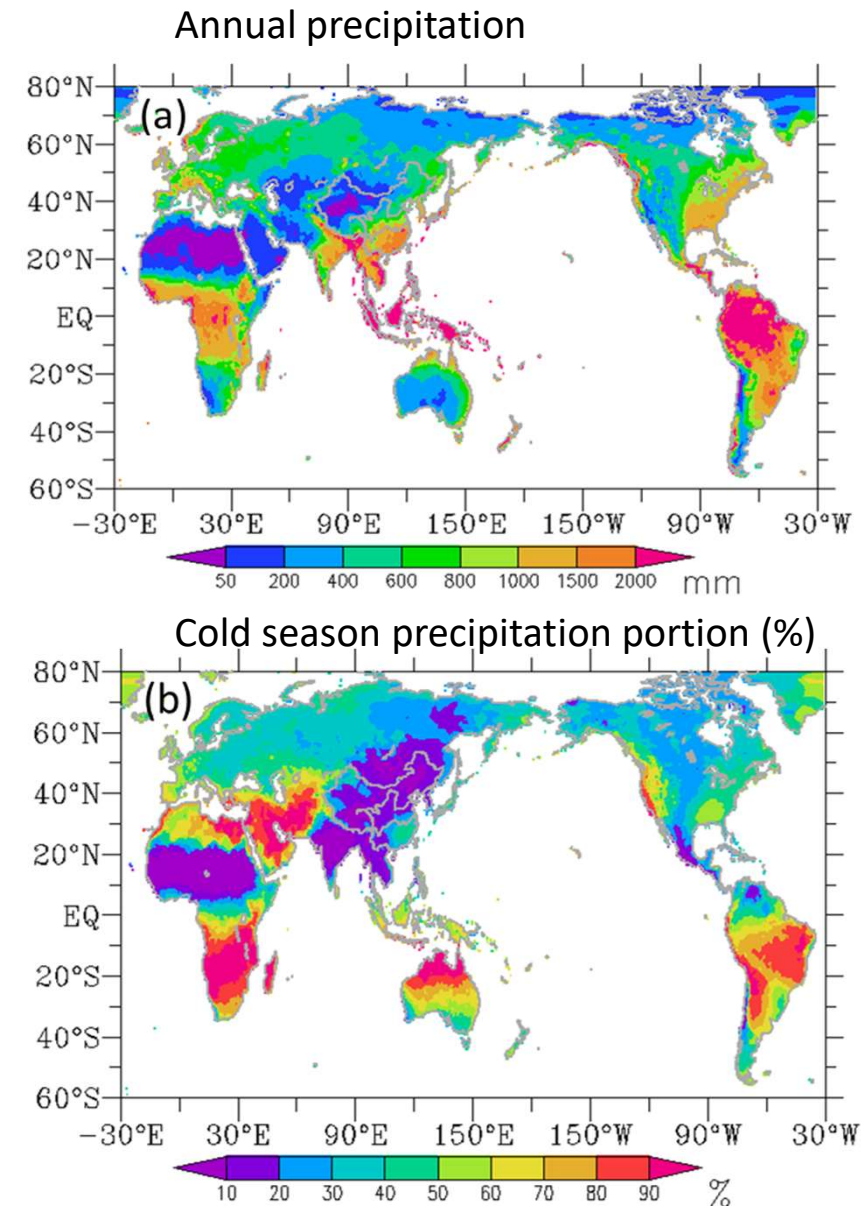
Climate Classification around Tibetan Plateau

Four climate regimes :

1. East Asia Monsoon regime
   (Subtropical monsoon)
2. South Asia monsoon regime
   (Tropical monsoon)
3. Central Asia regime (CAR)

4. Westerly regime (WR)

CAR: Mid-latitude Mediterranean
        Climate

WR: Minimum in seasonal
        precipitation variance

Westerly regime: A zone with minimum in seasonal precipitation variance

Mechanisms for Land Degradation:

Mis-collocation between seasonal precipitation and temperature
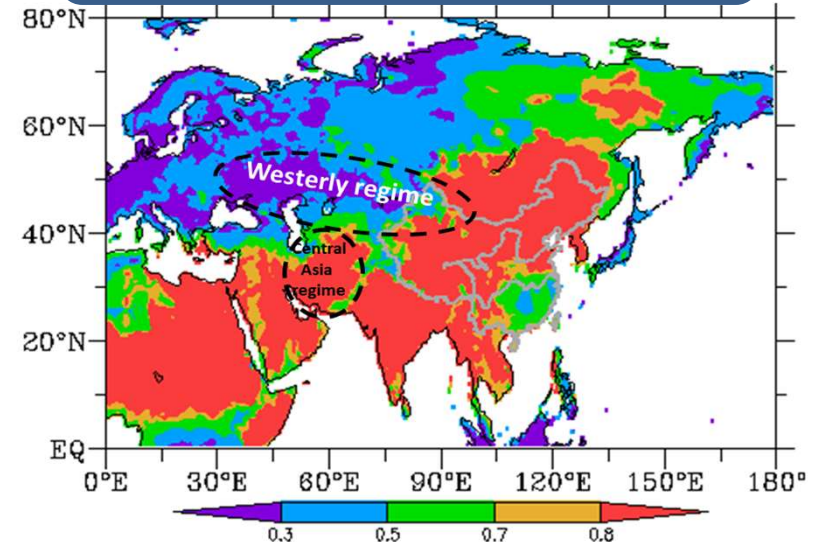
1. Central Asia regime
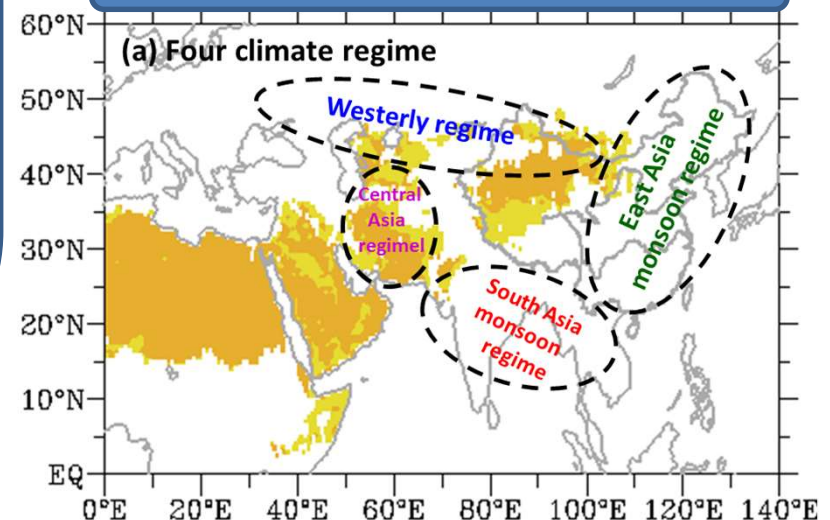   Prep.-Temp. in Anti-phase

4. Westerly regime
   Prep.-Temp. Out of phase

Square-root variance of climate monthly precipitation
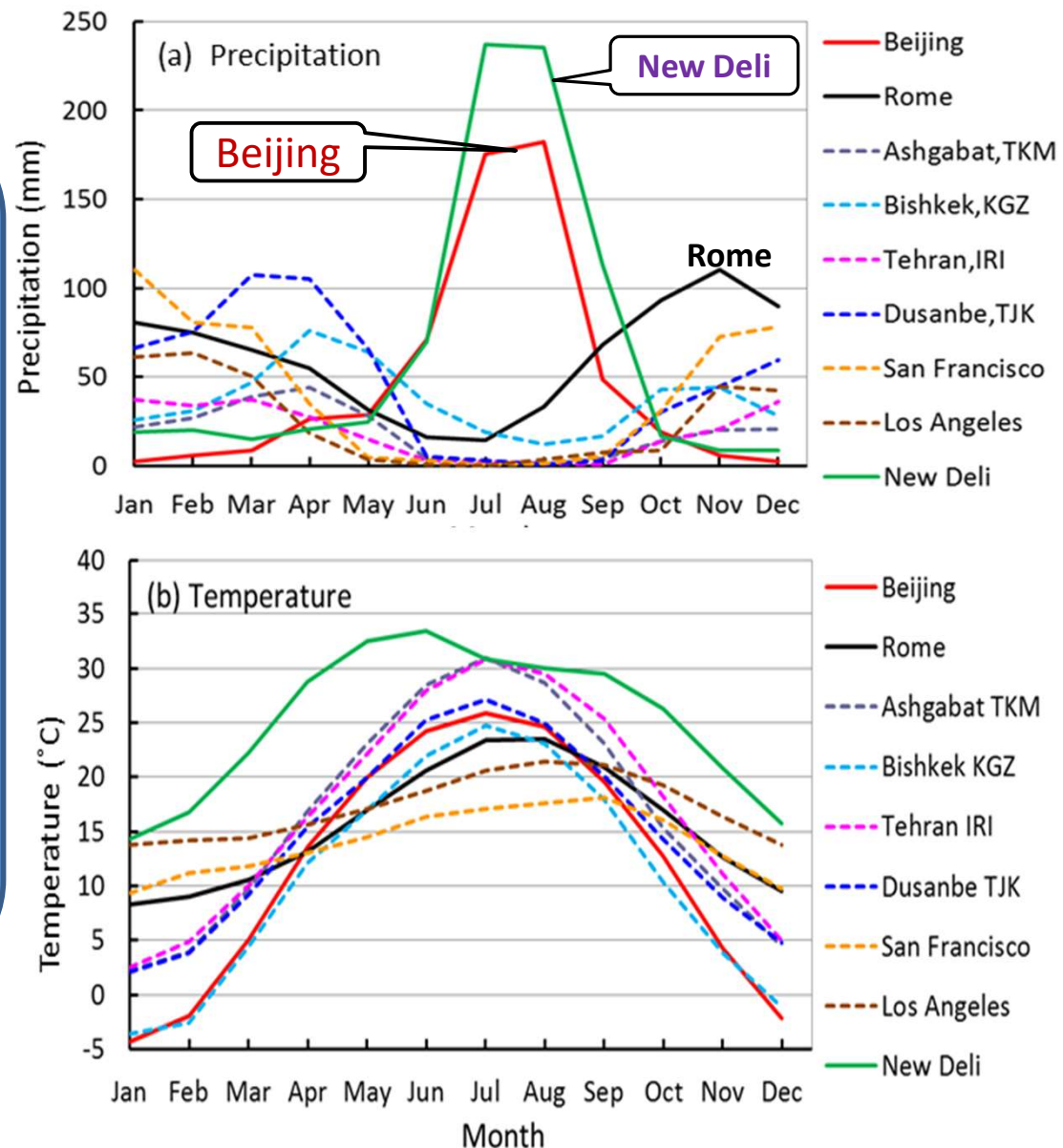

Desert and Sandy land

Seasonal Precipitation and Temperature in Monsoon and Mediterranean Regimes for 1961-1990

Seasonal precipcip. and Temperature

Signal peak

Monsoon area:
in-phase
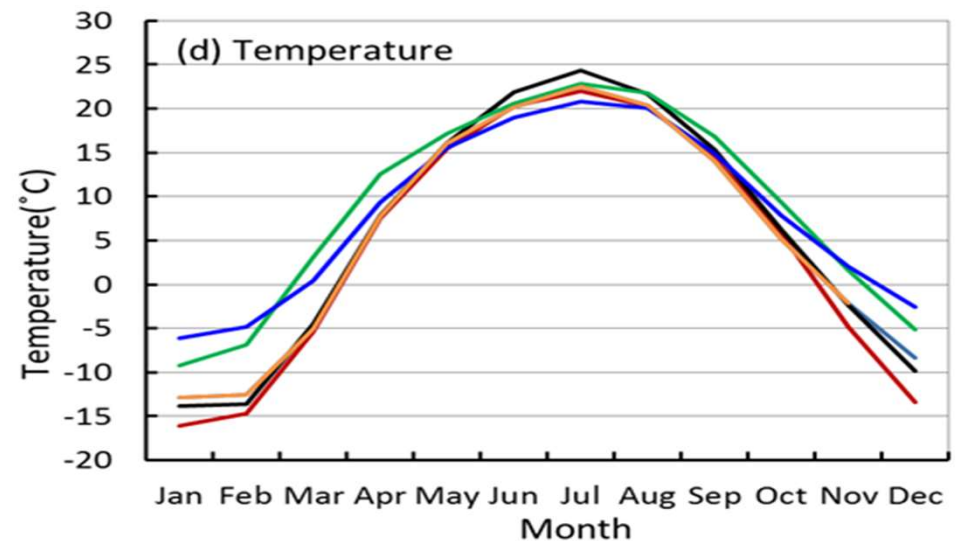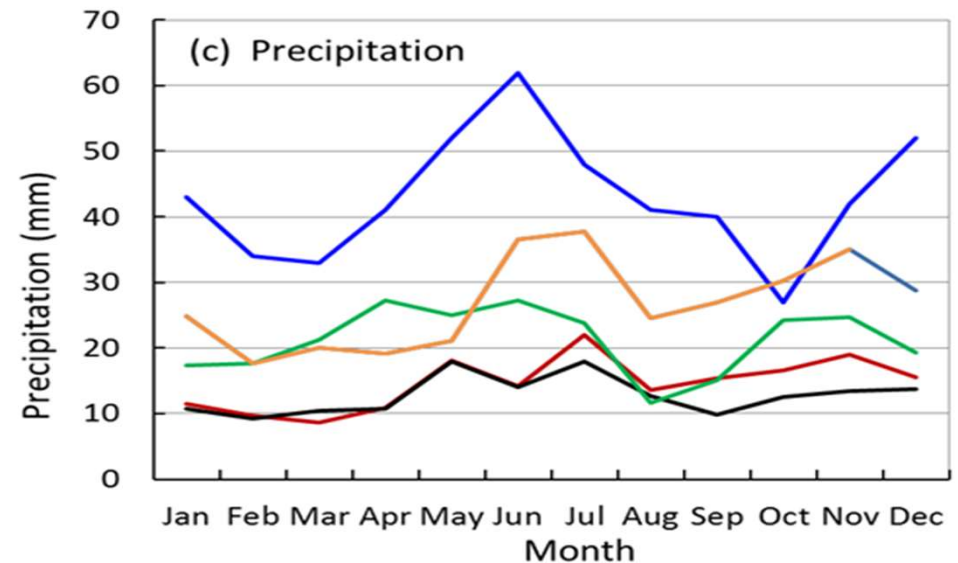
Mediterranean climate:
Anti-phase

Seasonal Precipitation and Temperature in Westerly Regime for 1961-1990

Westerly:

Temperature : Signal Peak

Precipitation: Multi peaks

out of phase

(c) Precipitation

(d) Temperature

— Urumqi CHN
— Balhash KSA
— Yining CHN
— Doneck UKR
— Uralsk KSA

Climate moisture transport in warm and cold seasons

Total/mean-wind moisture transport direction

Warm season:
Central Asia regime: Southward
Westerly regime: Eastward
East Asia regime: Northward
South Asia regime:
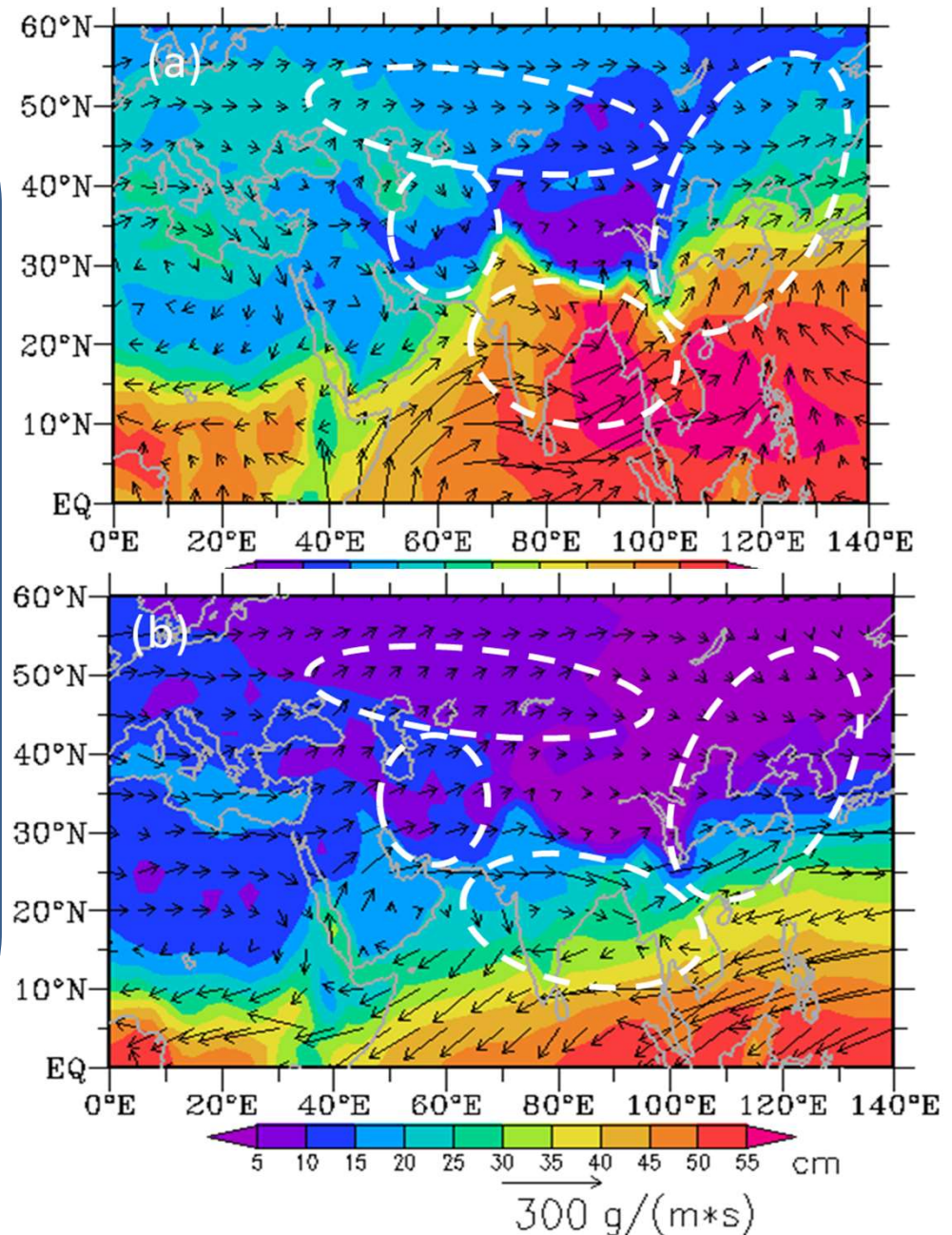Northeastward

Cold season:
Central Asia regime: Northward
Westerly regime: Eastward
East Asia regime: Southward
South Asia regime: Westward

Transient eddy moisture transportation in warm and cold seasons

Transient eddy moisture transport direction

Warm season:
Central Asia regime: Northward
Westerly regime: Northward
East Asia regime: Northward
South Asia regime: Northward
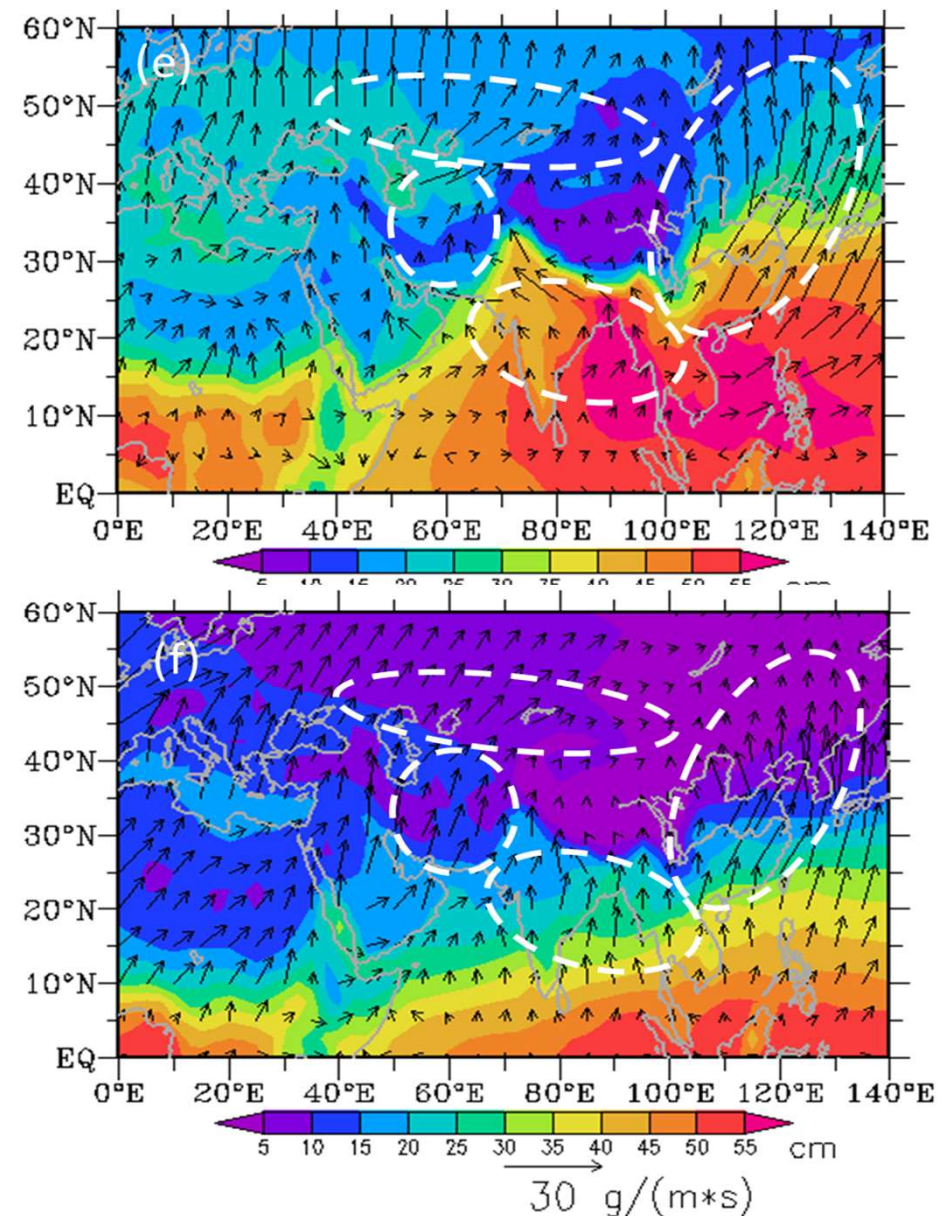
Cold season:
Central Asia regime: Northward
Westerly regime: Northward
East Asia regime: Northward
South Asia regime: Northward

Mean-wind moisture divergence in warm and cold seasons

Mean-wind moisture divergence

Warm season:

Central Asia :	divergence
Westerly regime:	divergence
East Asia regime:	convergence
South Asia:	convergence

Cold season:

Central Asia:	convergence
Westerly regime:	convergence
East Asia regime:	divergence
South Asia :	divergence

Transient eddy moisture divergence in warm and cold seasons

Transient eddy moisture divergence

Warm season:

Central Asia :   convergence
Westerly regime: divergence
East Asia regime: North-convergence
                                    South-divergence
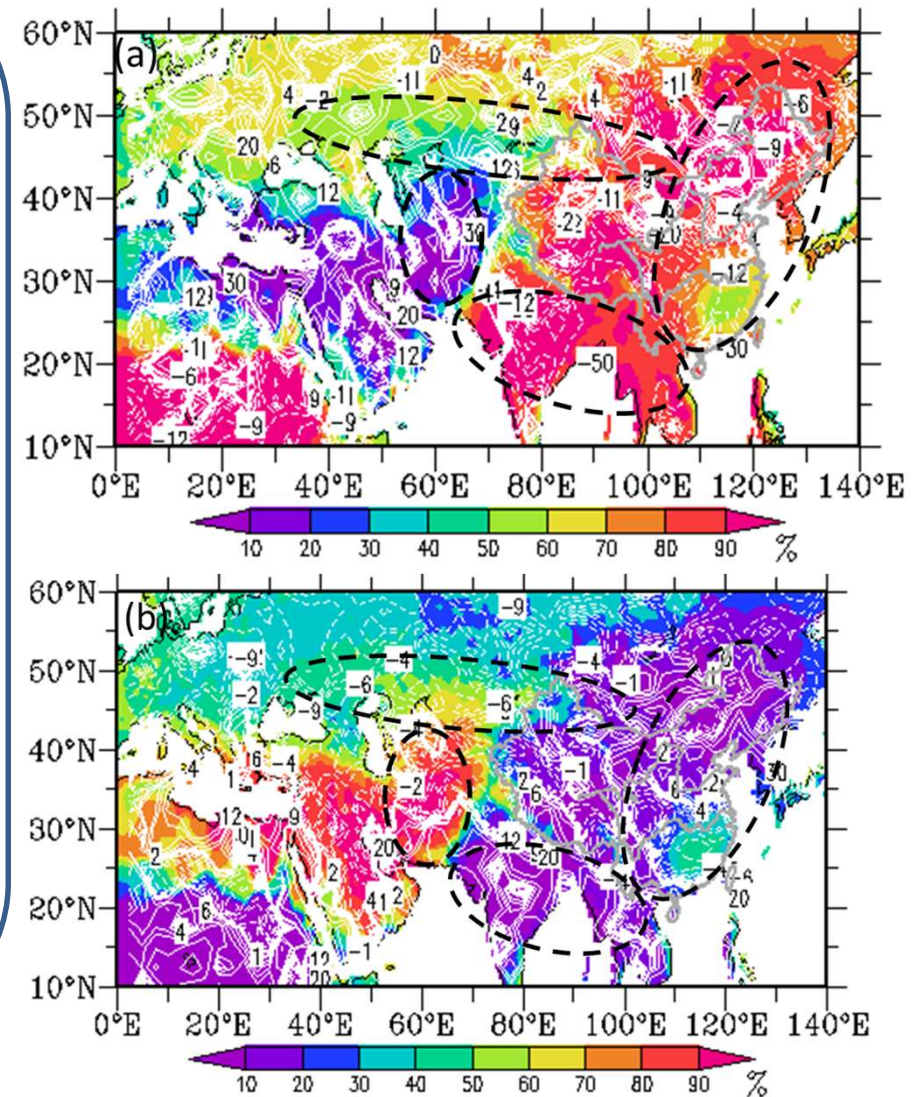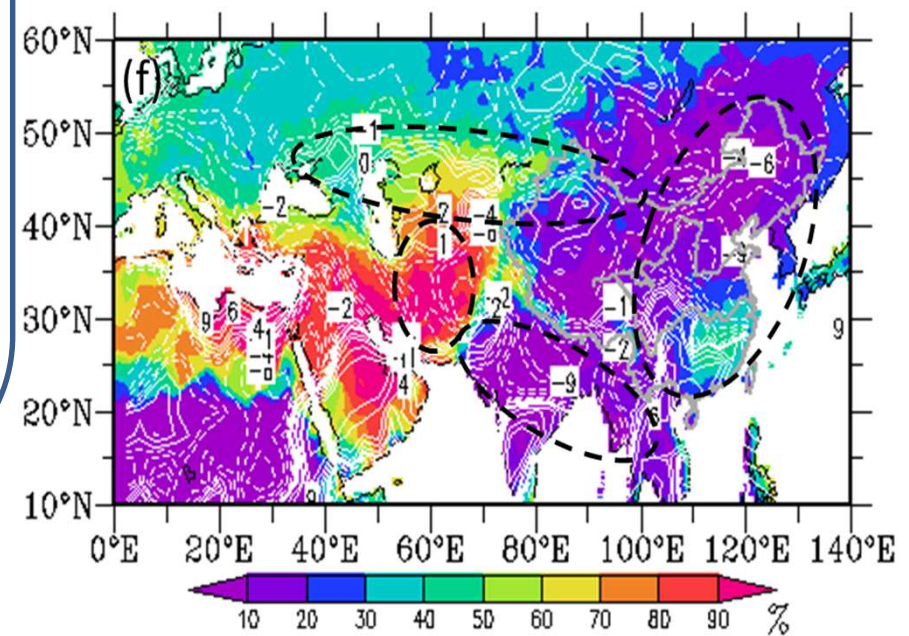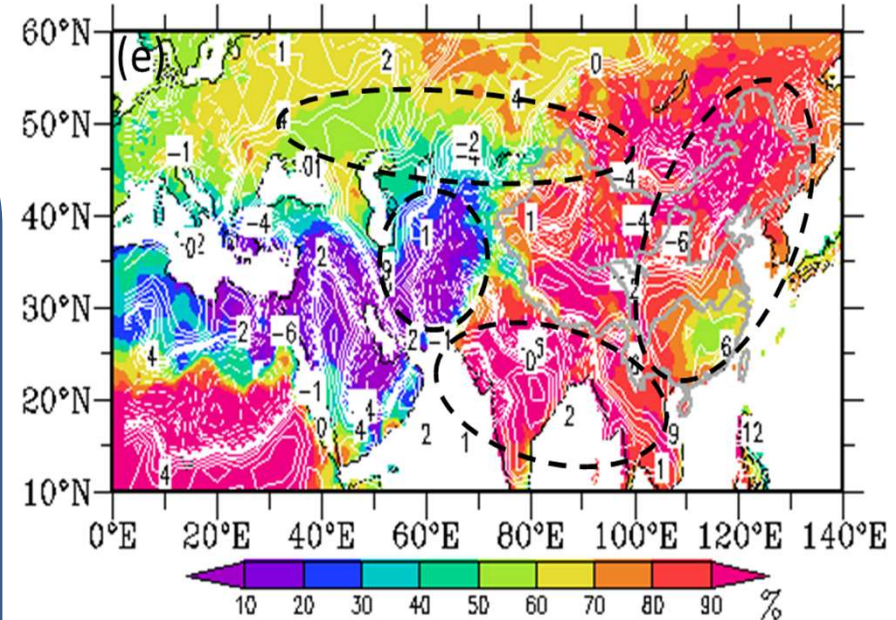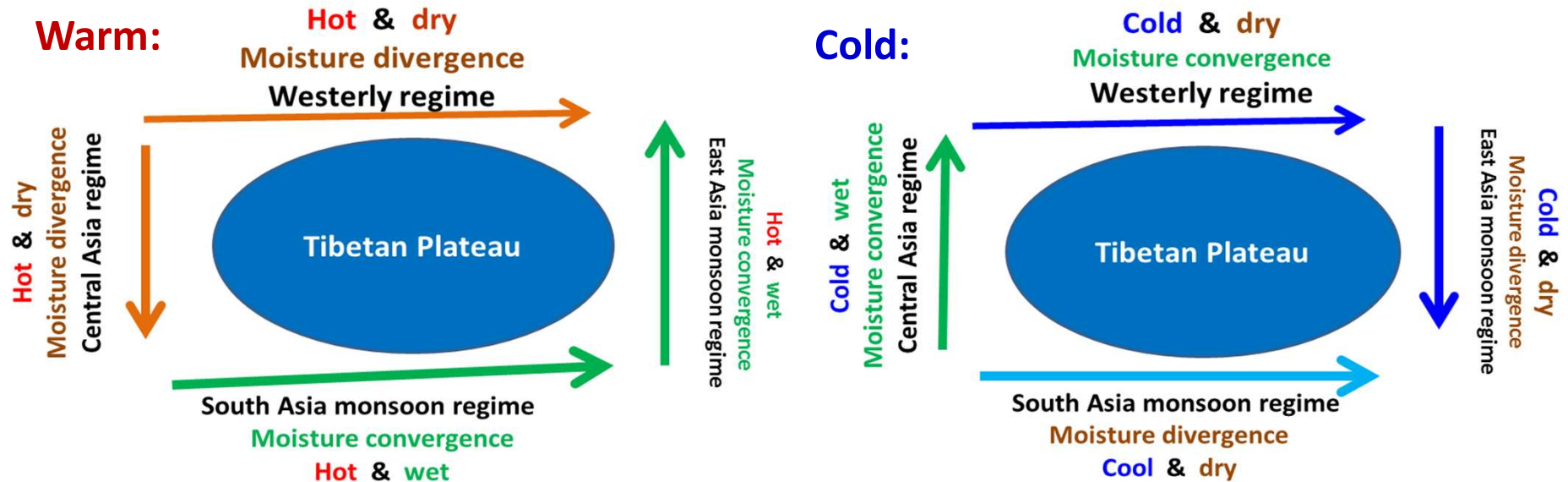South Asia: divergence

Cold season:

Central Asia: convergence
Westerly regime: divergence
East Asia regime: convergence
South Asia :   convergence

Collocation pattern of moisture flow for warm and cold seasons

Warm:

Hot & dry
Moisture divergence
Westerly regime

Hot & dry
Moisture divergence
Central Asia regime

Tibetan Plateau

Hot & wet
Moisture convergence
East Asia monsoon regime

South Asia monsoon regime
Moisture convergence
Hot & wet

Cold:

Cold & dry
Moisture convergence
Westerly regime

Cold & wet
Moisture convergence
Central Asia regime

Tibetan Plateau

Cold & dry
Moisture divergence
East Asia monsoon regime

South Asia monsoon regime
Moisture divergence
Cool & dry

Warm season:
Central Asia: hot & dry
            southward moisture flow
            moisture divergence
 Westerly : hot & dry
            eastward moisture flow
            moisture divergence
East Asia : hot and wet
            northward moisture flow
            moisture convergence
South Asia: hot and wet
            northeastward moisture flow
            moisture convergence

Cold season:
 cold & wet
 northward moisture flow
 moisture convergence
 cold & dry
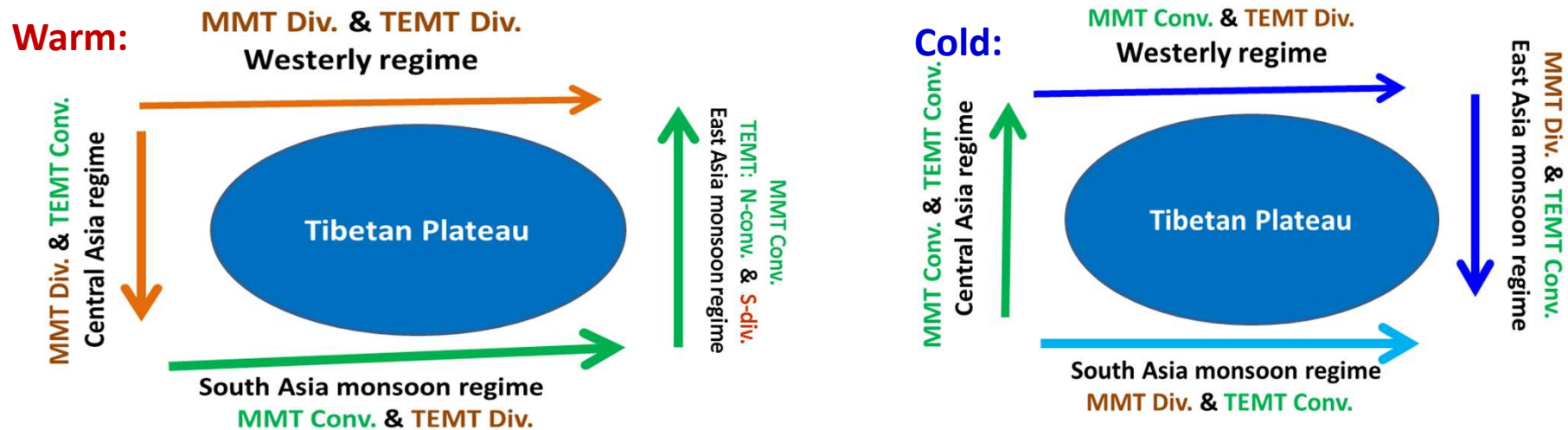 eastward moisture flow
 moisture divergence
 cold & dry
 southward moisture flow
 moisture divergence
 cool & dry
westward moisture flow
 moisture divergence

Collocation pattern of mean-wind and transient eddy moisture flow for warm and cold seasons

Warm:

MMT Div. & TEMT Div.
Westerly regime

MMT Div. & TEMT Conv.
Central Asia regime

Tibetan Plateau

MMT Conv.
TEMT: N-conv. & S-div.
East Asia monsoon regime

South Asia monsoon regime
MMT Conv. & TEMT Div.

Cold:

MMT Conv. & TEMT Div.
Westerly regime

MMT Conv. & TEMT Conv.
Central Asia regime

Tibetan Plateau

MMT Div. & TEMT Conv.
East Asia monsoon regime

South Asia monsoon regime
MMT Div. & TEMT Conv.

MMT: mean-wind moisture transport;   **TEMT:** transient eddy moisture transport

Warm/cold season:

Central Asia: MMT divergence / convergence;   TEMT convergence/ convergence

Westerly :   MMT divergence/ convergence;   TEMT divergence/ divergence

East Asia :   MMT convergence /divergence;   TEMT divergence / convergence

South Asia: MMT convergence/divergence;   TEMT divergence/convergence

Conclusion

1. Four climate regimes around Tibetan Plateau are of different characteristics in seasonal precipitation, moisture transport and divergence;

2. Central Asia regime (CAR) can be regarded as extended Mediterranean climate in mid-latitude;

3. Westerly regime (WR) characterized as minimum in seasonal precipitation variance;

4. CAR or WR leads desertification or land degradation due to less precipitation and the mismatching between seasonal precipitation and temperature as well;

5. Mediterranean climate caused dry climate in warm season of CAR leading to land degradation;

6. Land degradation in WR results from the moisture divergence of the transient eddy and the mean-wind in warm season;

7. Climate north-south moisture transport is almost determined by the stationary waves on mid-latitude westerly, which is associated with the uplift of topography and plate motion in remote past.

Thank you and Merci bien !