A climate classification: Mediterranean, monsoon and westerlies climates

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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**

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?

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

Seasonal precipitation and temperature

Signal peak

Monsoon area: in-phase

Mediterranean climate: Anti-phase

(a) Precipitation

(b) Temperature
Seasonal Precipitation and Temperature in Westerly Regime for 1961-1990

Westerly:

Temperature: Signal Peak
Precipitation: Multi peaks out of phase
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 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:**
- **Central Asia:** Cold & dry
  - northward moisture flow
  - moisture convergence
- **Westerly:** Cold & dry
  - eastward moisture flow
  - moisture divergence
- **East Asia:** Cold & dry
  - southward moisture flow
  - moisture divergence
- **South Asia:** Cool & dry
  - westward moisture flow
  - moisture divergence
Collocation pattern of mean-wind and transient eddy moisture flow for warm and cold seasons

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 !