The Atlantic Multidecadal Variability phase-dependence of teleconnection between the North Atlantic Oscillation in February and the Tibetan Plateau in March

Jingyi Li[1,2], Fei Li[3, 2], Shengping He[3, 2], Huijun Wang[2, 4, 5], and Yvan J Orsolini[6]

1. Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, Nanjing, China
2. Collaborative Innovation Center on Forecast and Evaluation of Meteorological Disasters/Key Laboratory of Meteorological Disaster, Ministry of Education, Nanjing University of Information Science & Technology, Nanjing, China
3. Geophysical Institute, University of Bergen and Bjerknes Centre for Climate Research, Bergen, Norway
4. Climate Change Research Center, Chinese Academy of Sciences, Beijing, China
5. Nansen-Zhu International Research Center, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China
6. NILU-Norwegian Institute for Air Research, Kjeller, Norway

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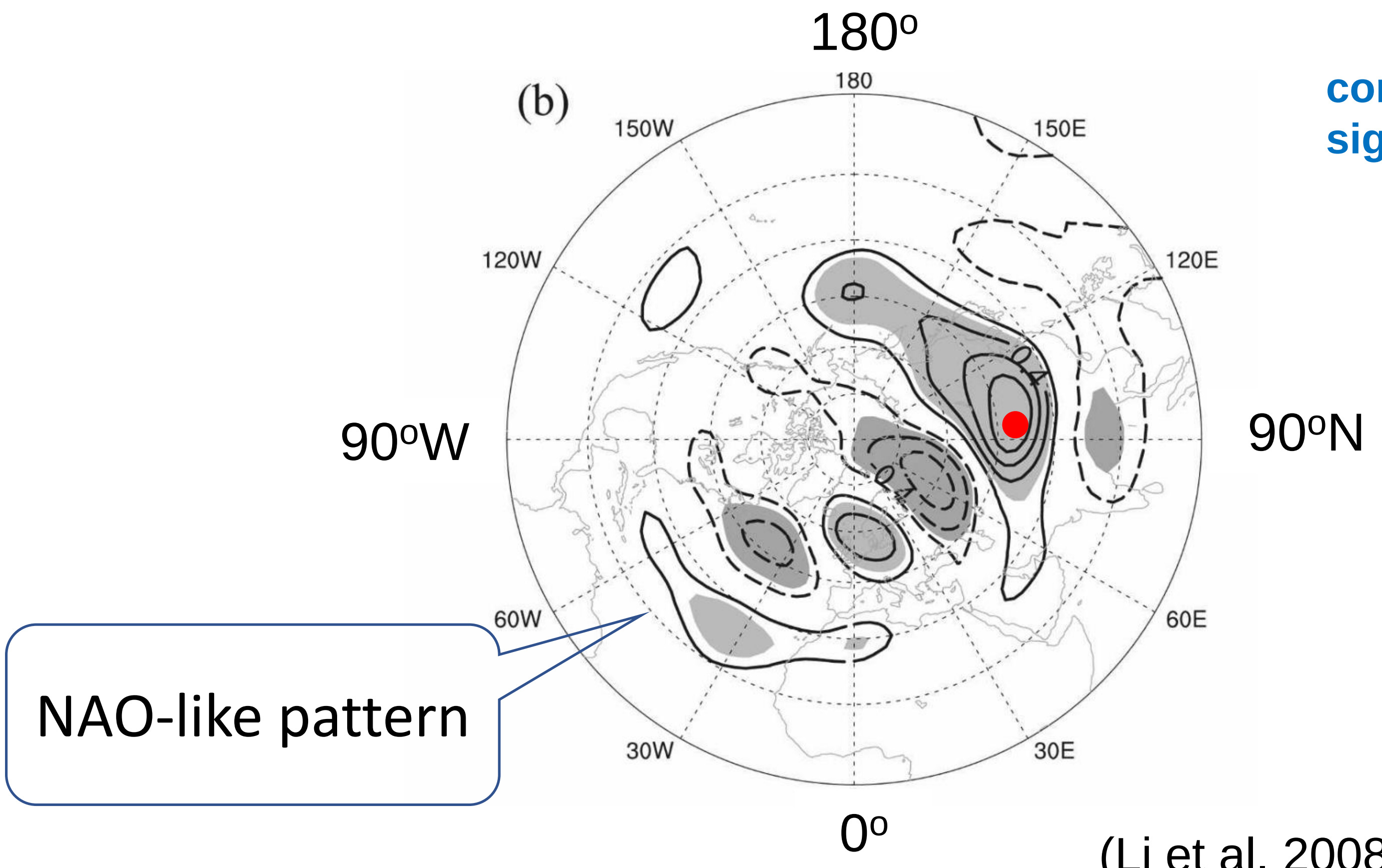
Teleconnection between the North Atlantic and the Tibetan Plateau

One Point Correlation between z250 & basepoint (40ºN 97.5ºE) in March

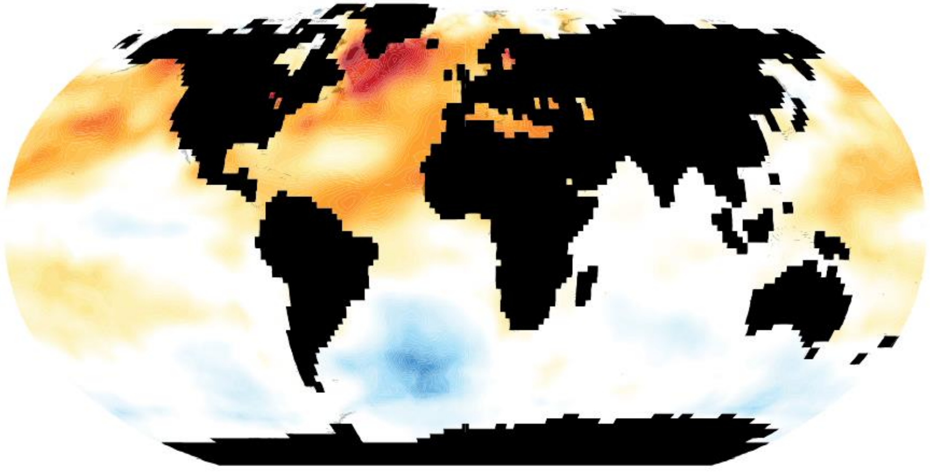


corr.: contours
significance: shading

(Li et al. 2008)

AMV modulating the NAO

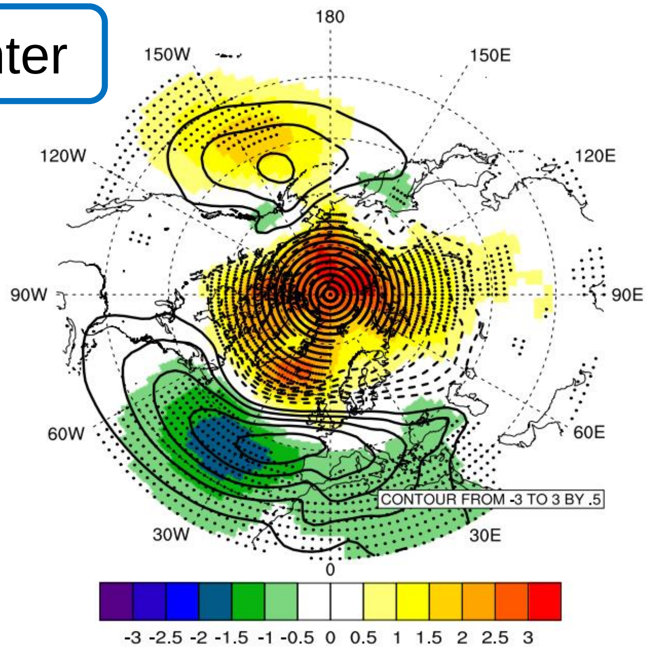
SST (warm phase of Atlantic Multidecadal Variability; AMV+)



Period of the AMV: 60~70 years

SLP (AMV+): shading
SLP (NAO+): contours

winter



Peings and Magnusdottir (2015)

NAO+AMV

Tibetan Plateau (TP)?

Atmospheric response to AMV (NAO):

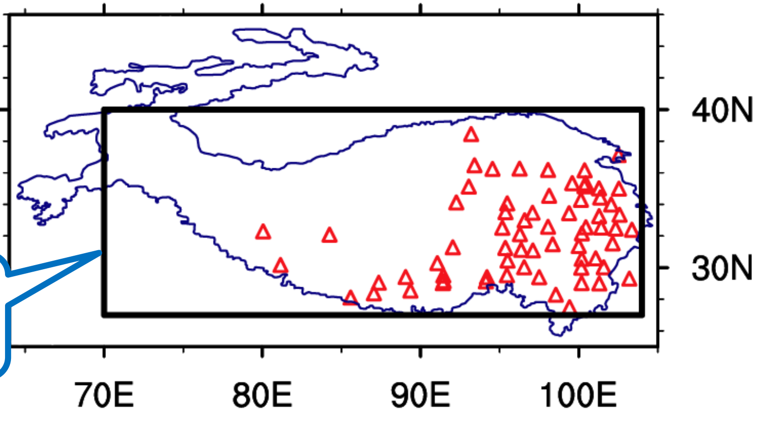
- Dipole pattern in SLP field
- Meridional shift of westerly and storm track

(Msadek et al. 2010; Ruprich-Robert et al. 2017)

Data & Method

- **Study period:** 1920~2017, linear trend removed
- **Atmospheric data:**
  ERA20C (1920-1978) and ERA-Interim (1979-2017) from ECMWF
  HadSLP2r from the Met Office Hadley Centre
- **SST data** is from the Met Office Hadley Centre
- **SAT data:**
  CRU TS 3.26 data (1901–2017, $0.5^{o} \times 0.5^{o}$)
  67-station observation
  (1979–2017, above 2600m)

TPSAT index



Data & Method

- **NAO index:** SLP difference of the stations in Gibraltar and in South-West Iceland (Jones et al. 1997)
- **AMV index:** internal component of SST variability averaged over (0^o–60^oN, 7.5–75^oW) with a low-pass filter of a 10-yr cutoff (Ting et al. 2009).

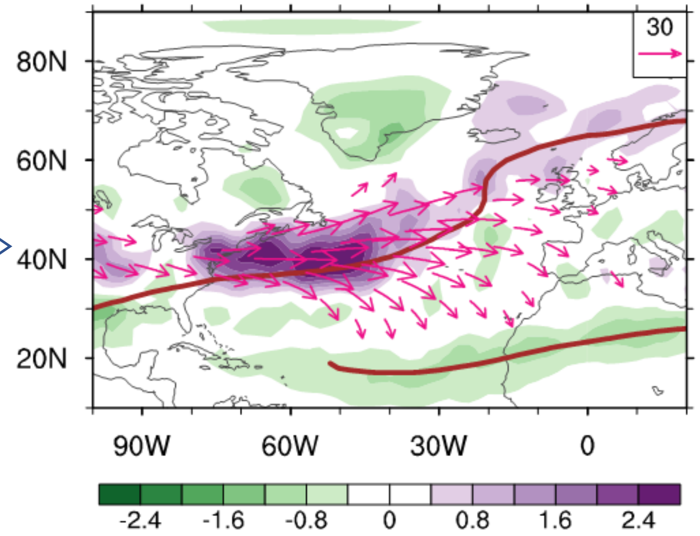
AMV+： AMV index>0
AMV- ： AMV index<0

Data & Method

- **Wave activity flux (WAF):** Takaya and Nakamura (2001)
- **Transient eddies:** root mean square of daily bandpass-filtered geopotential height with periods of 2.5-to 6-days (Lau and Nath, 1991)
- **Localized Eliassen−Palm (E−P) flux:**

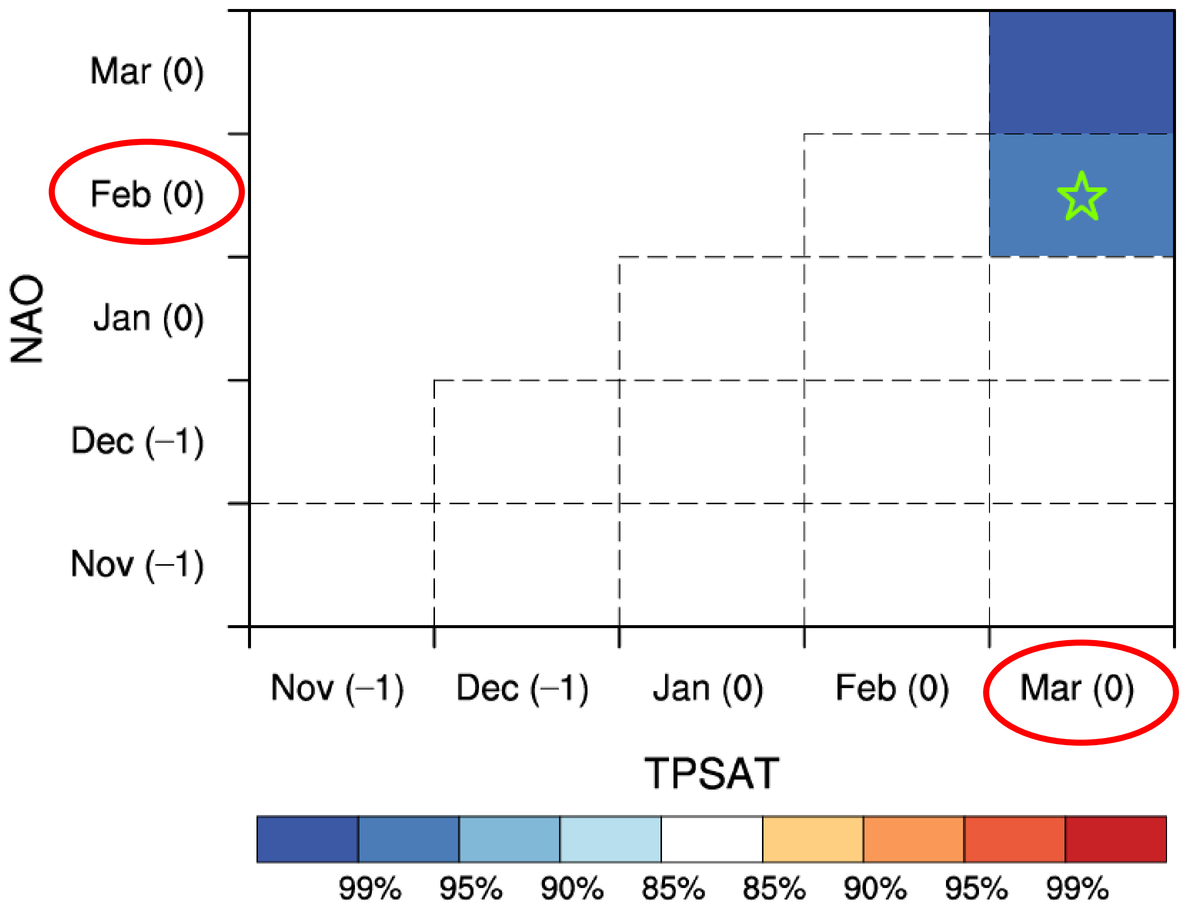
$$\vec{E} = \frac{1}{2}\left(\overline{v'^2} - \overline{u'^2}\right)\vec{i} - \overline{u'v'}\vec{j}$$

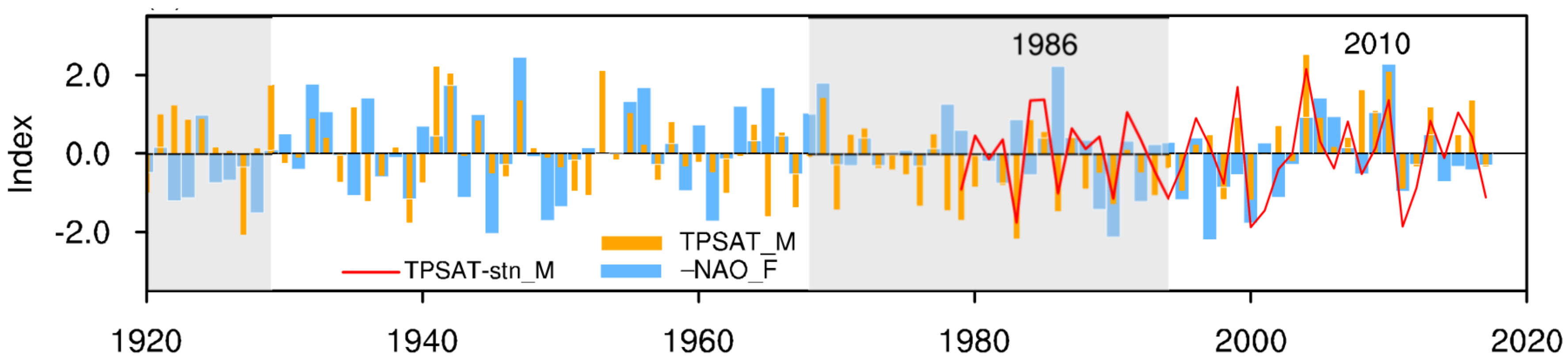
Divergence of ***E***: transient eddies favor zonal wind acceleration through barotropic process (Hoskins et al. 1983; Trenberth 1986).



Climatology of 250-hPa localized E−P flux (vectors) and its divergence (shading) during the AMV+

Significance of lead-lag correlation

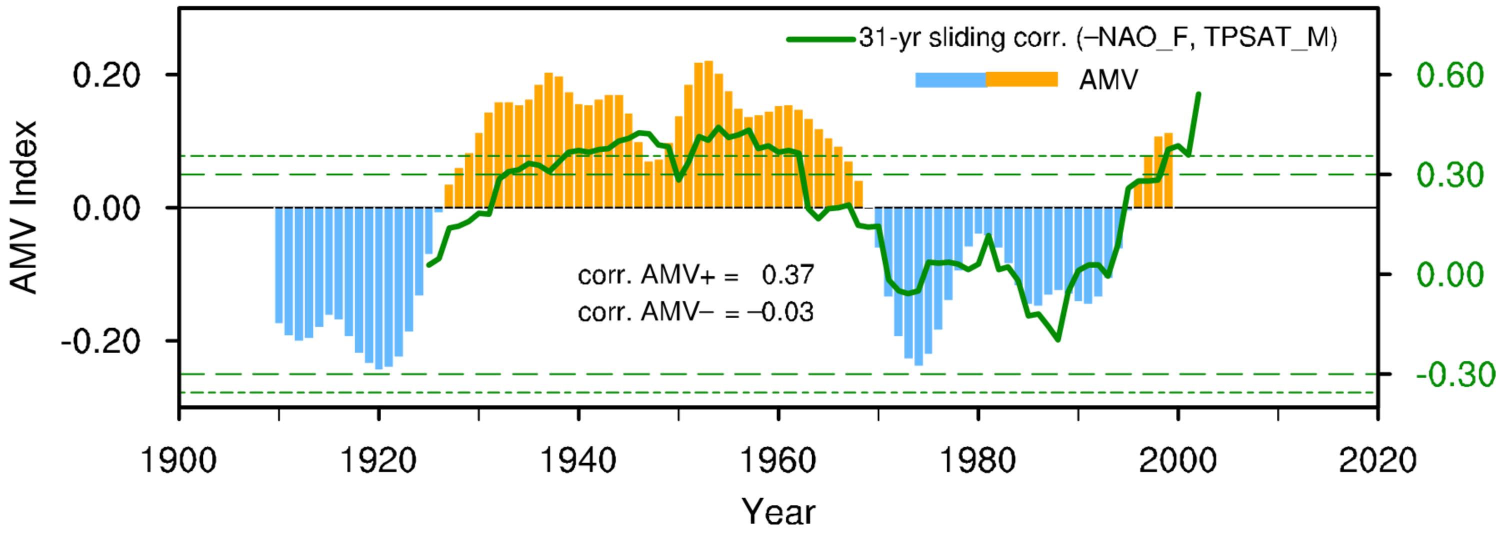




TPSAT index in March (station; red line)

TPSAT index in March (CRU; orange bar)
NAO- index in February (blue bar)

Running correlation (green line)



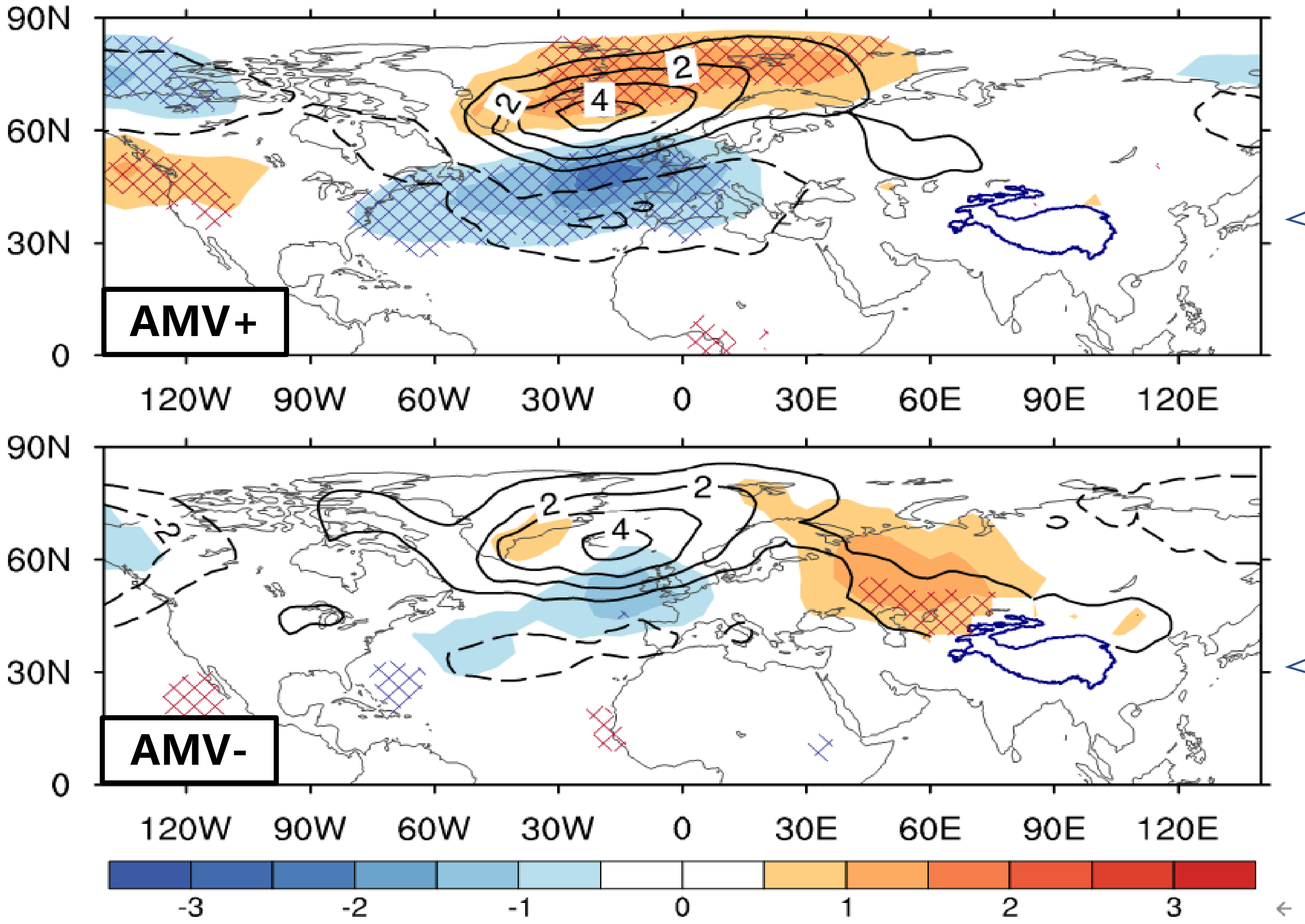
annual-mean AMV index (blue/orange bar)

Only significant during the AMV+

Categorize the entire analysis period into two subperiods based on the AMV phases. Do regressions against the NAO-index in February, respectively.

Regression against February NAO-

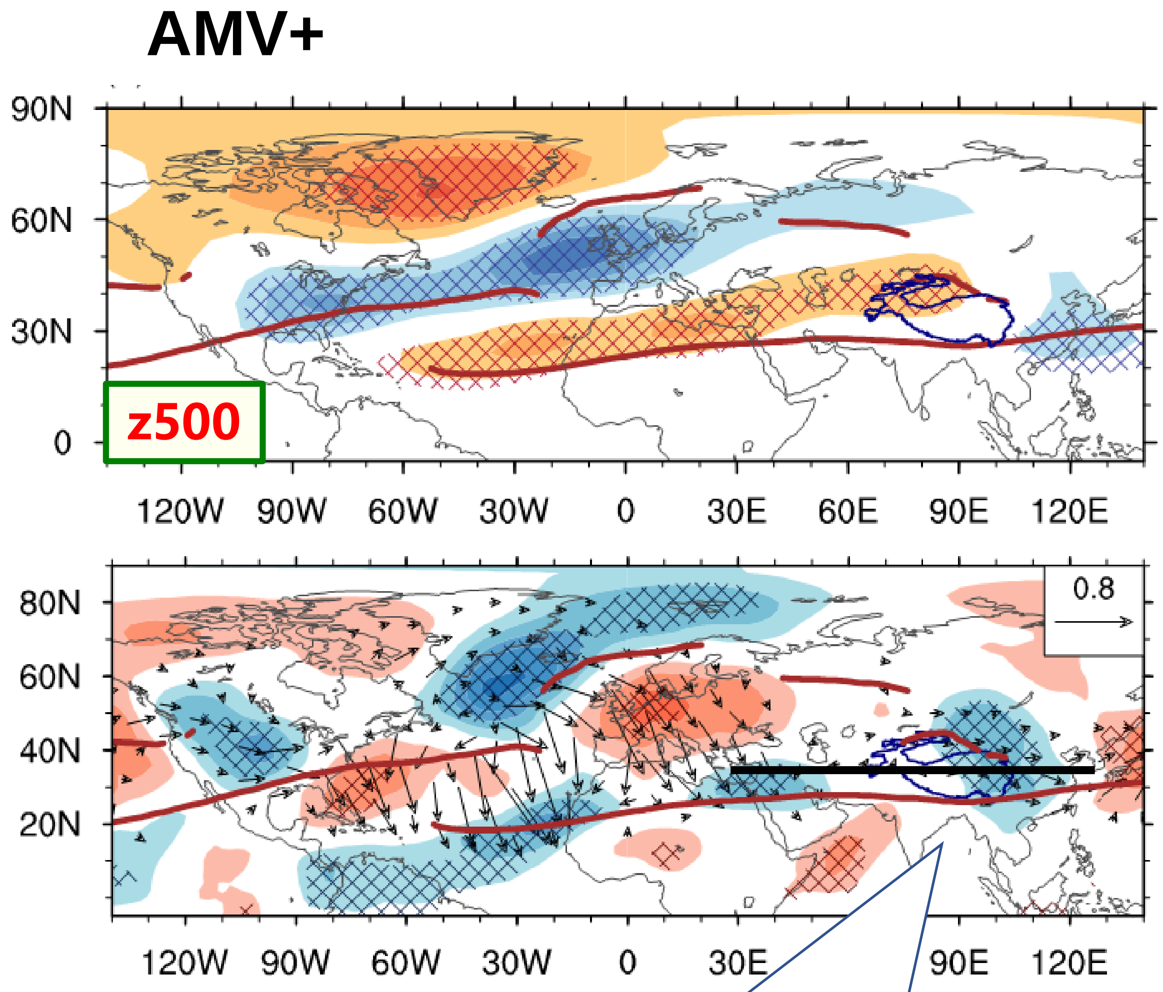
SLP in February (contours) & **in March** (shading)

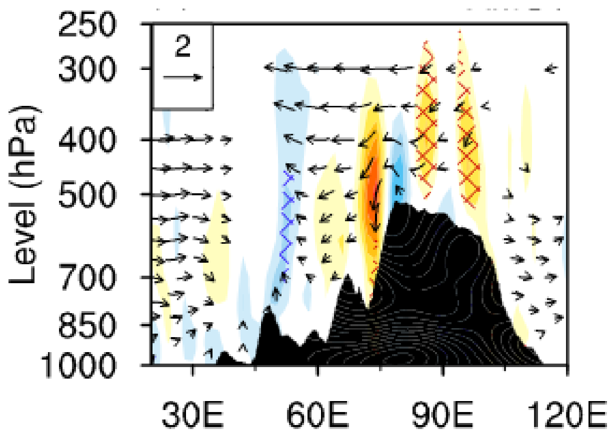


NAO- with 2-month duration

NAO- signals diminish in March

Regression in March against February NAO-





Significant descending motion anomalies

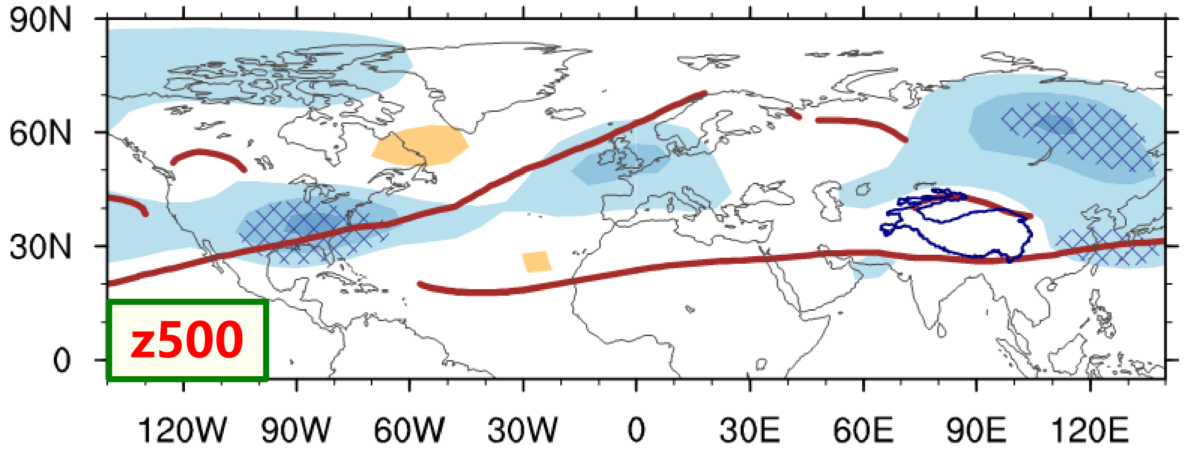
Rossby waves along the subtropical westerly jet

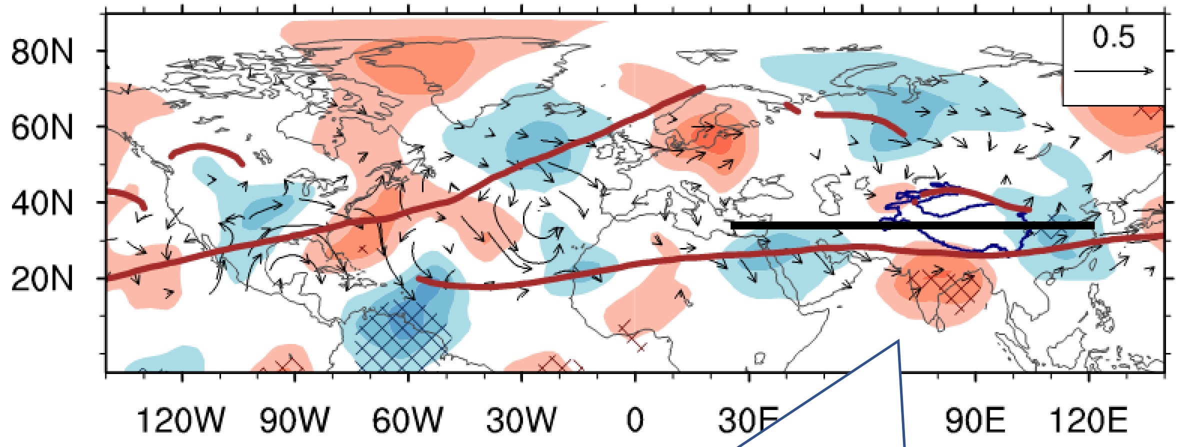
V250: shading
WAF: vectors

Omega: shading
winds: vectors

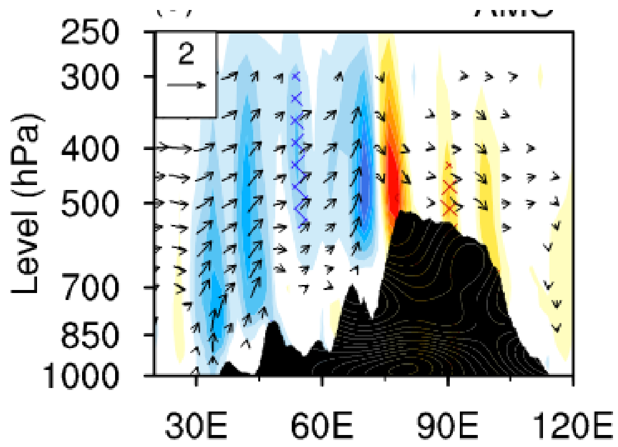
Regression in March against February NAO-

AMV-





less circulation anomalies over the TP



V250: shading
WAF: vectors

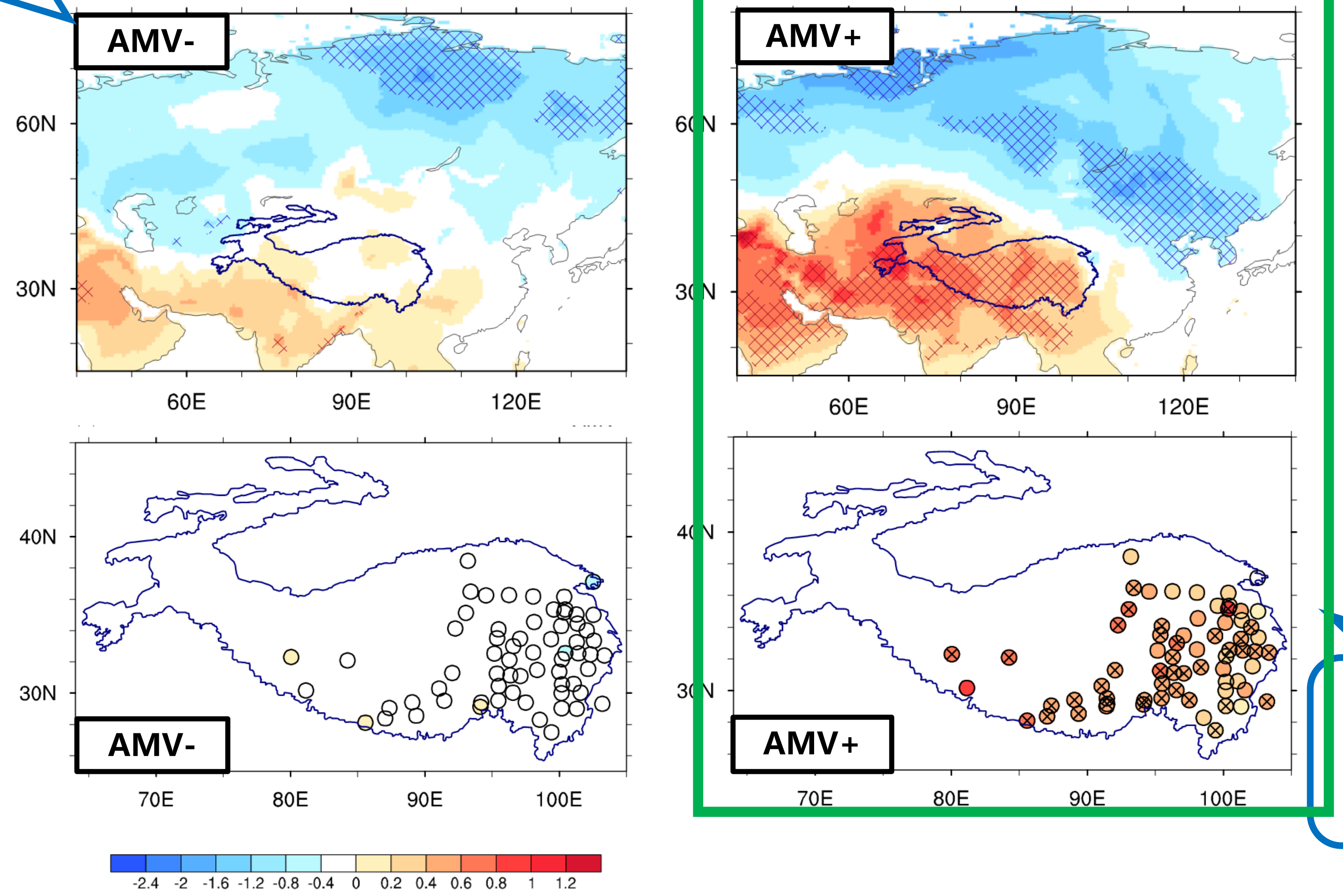
Rossby waves well south to the TP

Omega: shading
winds: vectors

Regression **in March** against February NAO-

CRU

SAT



During the AMV+, anomalous adiabatic descent warms the TP

Station observation

synoptic eddy and low-frequency flow (SELF) interaction: positive feedback

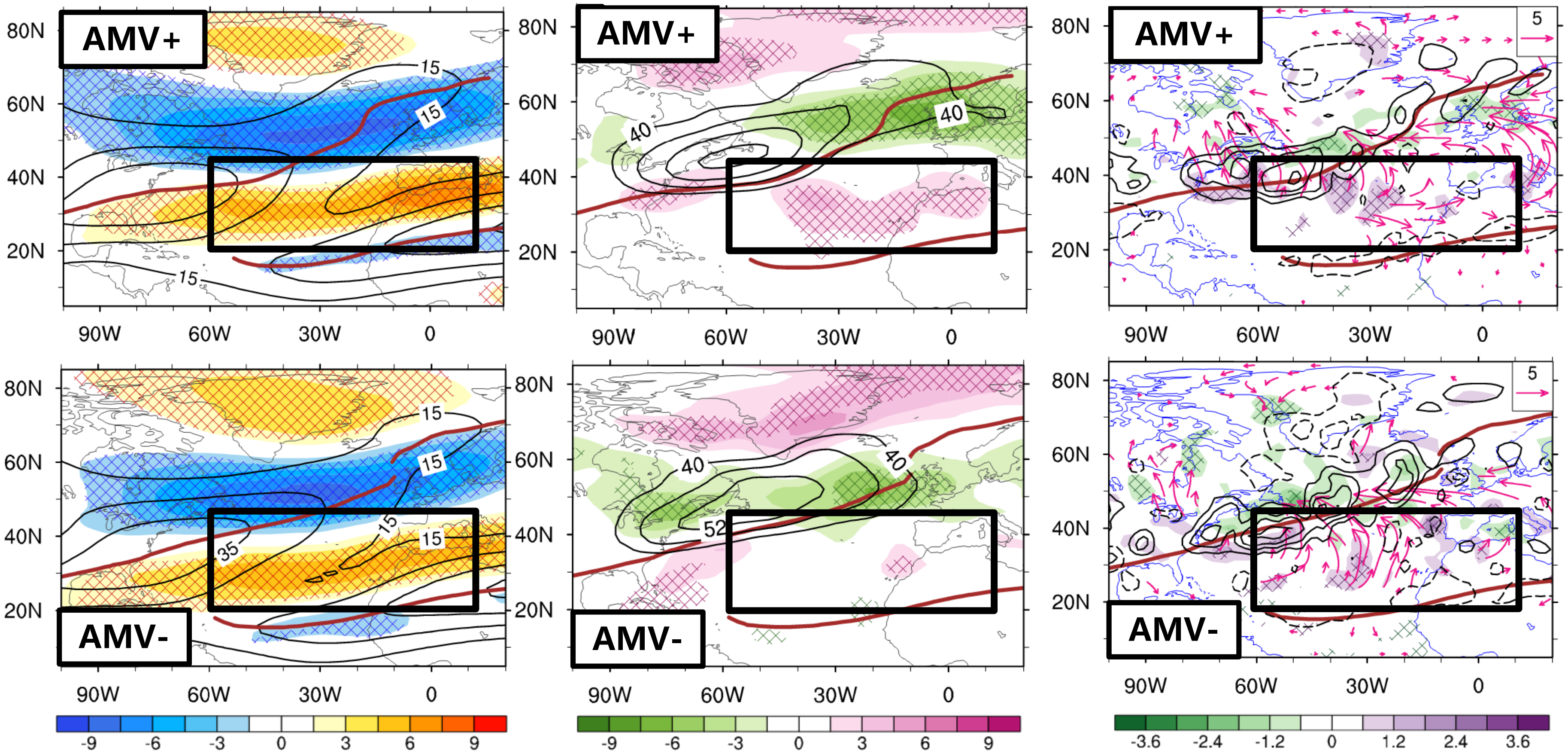
February

regression in against February NAO-: shading
Climatology: contours

u250

500-hPa transient eddies

250-hPa localized E−P flux (vectors) and its divergence (contours/shading)

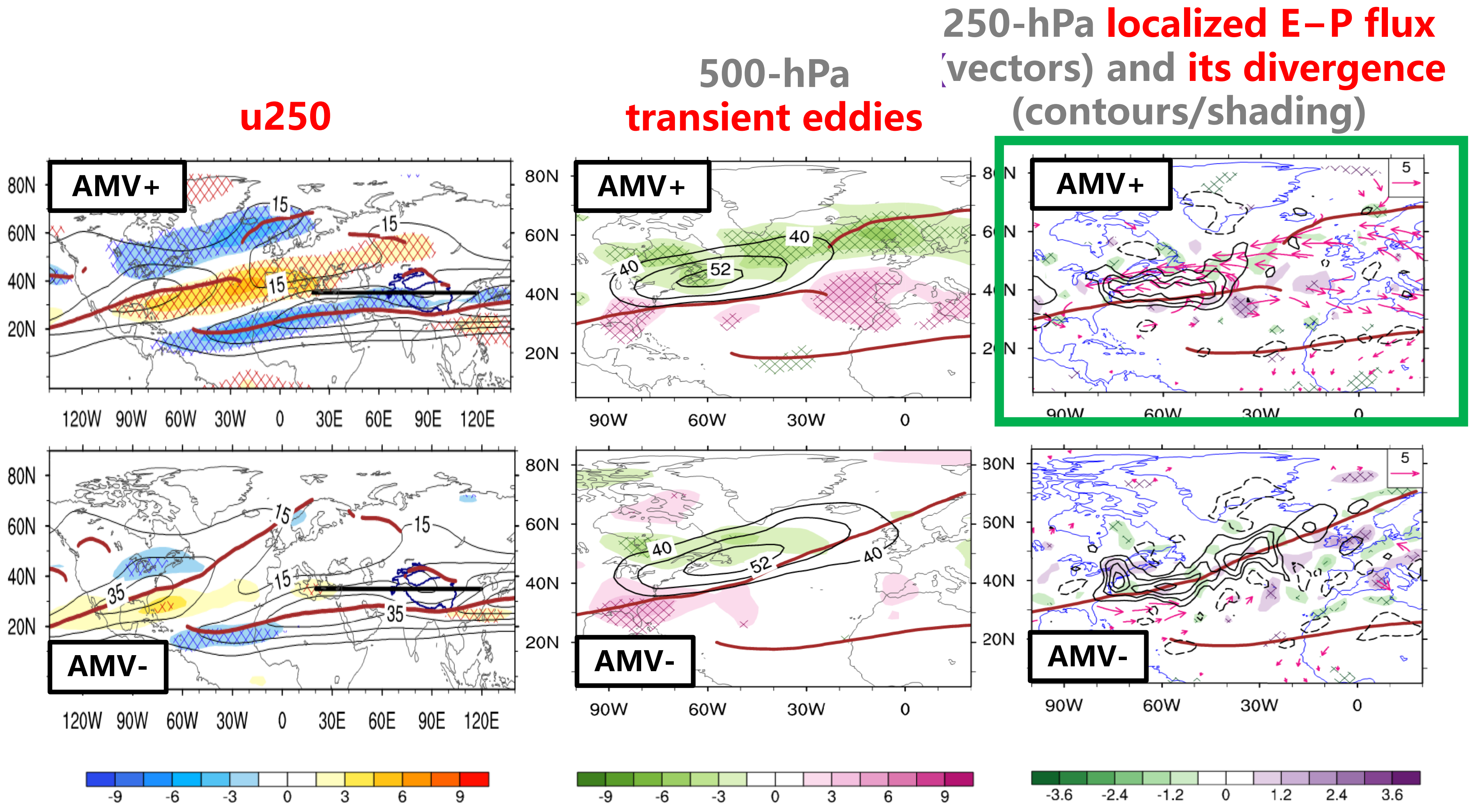


Stronger transient eddy anomalies and SELF interaction during the AMV+

Stronger SELF interaction during AMV+

March

regression in against February NAO-: shading
Climatology: contours



SELF interaction only persists during the AMV+

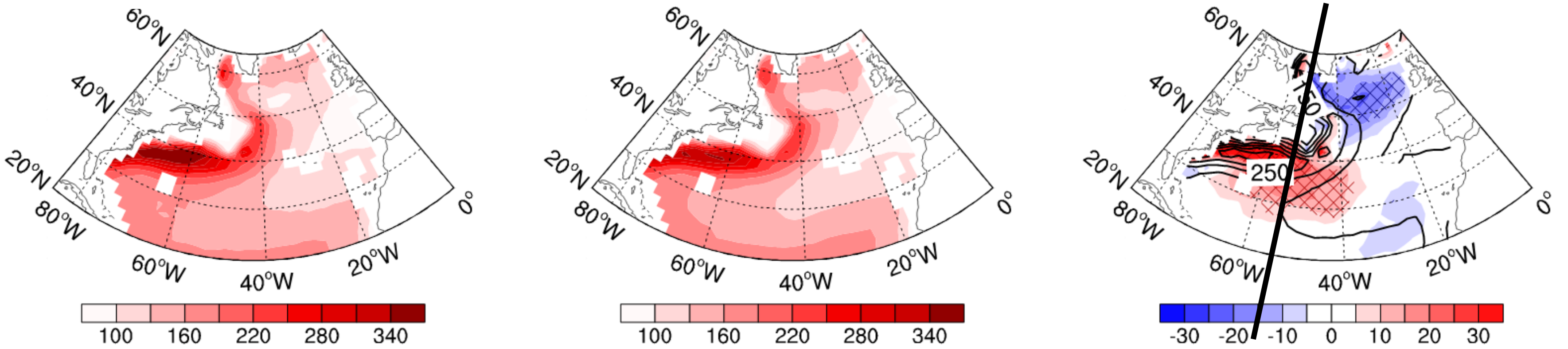
Composite difference between the AMV phases

February−March

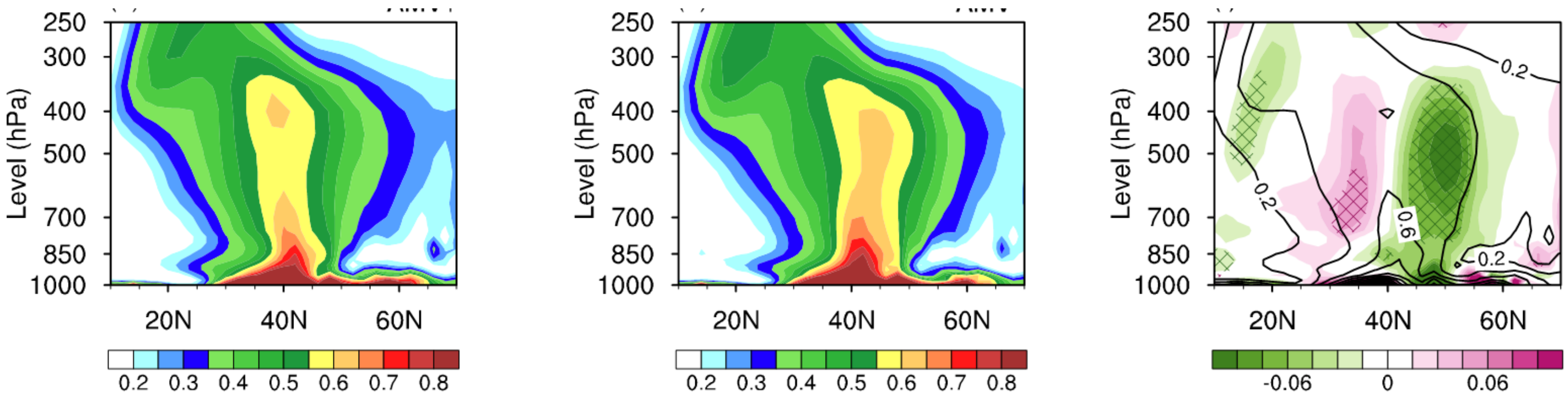
Climatology (AMV+)

Climatology (AMV-)

Climatology: contours
Difference: shading
(AMV+ minus AMV-)



Upward Turbulent heat flux

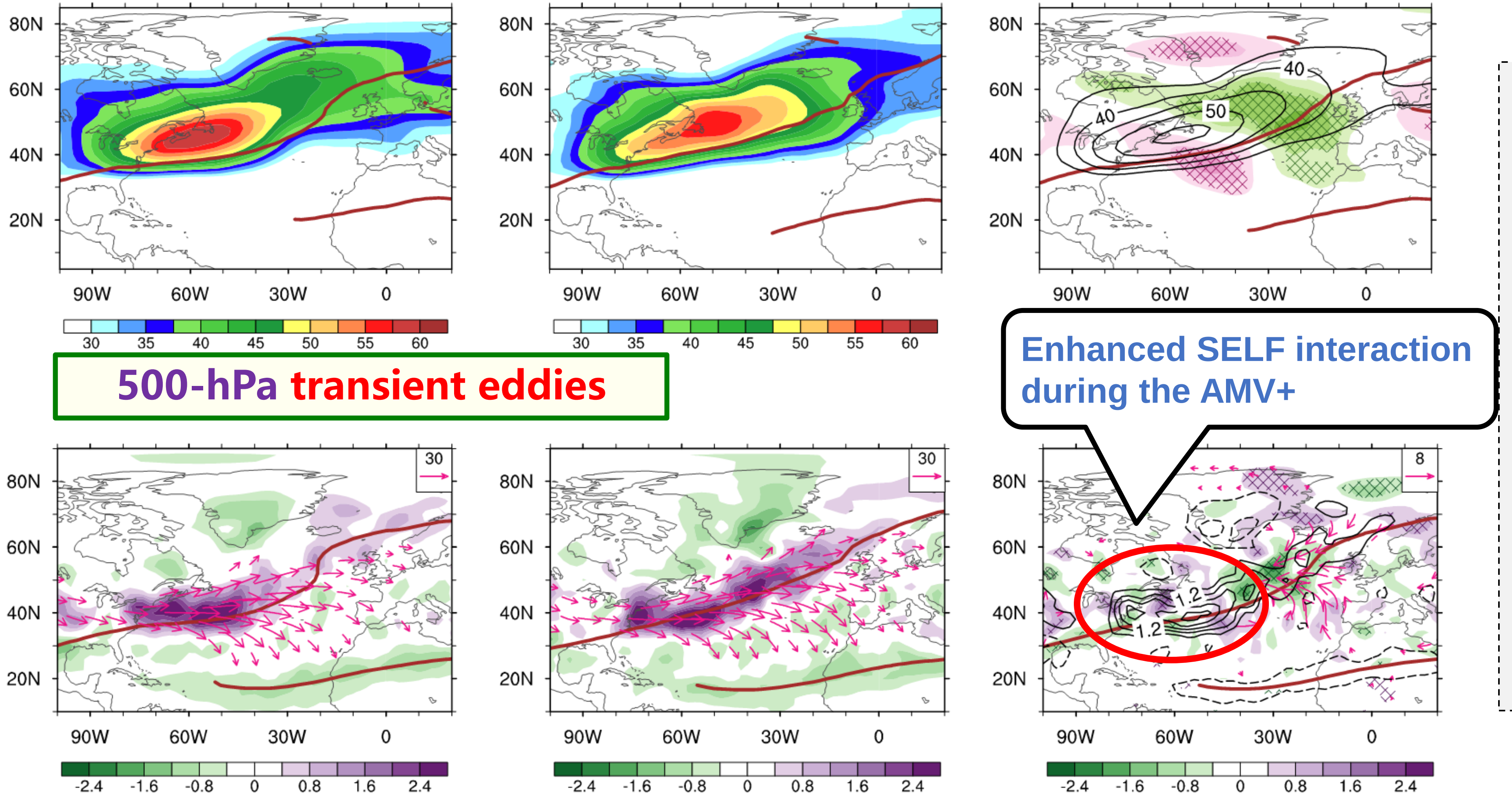


Eady growth rate

During the AMV+, anomalous heating over the Gulf Stream favors southward shift of the atmospheric baroclinicity maximum

February−March

Climatology (AMV+) | **Climatology (AMV-)** | **Climatology: contours Difference: shading (AMV+ minus AMV-)**

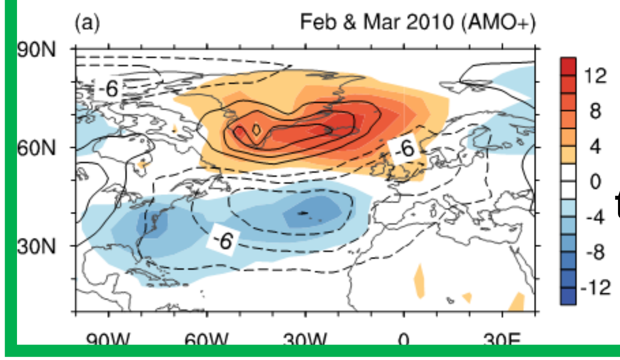


250-hPa localized E−P flux (vectors) and its divergence (shading)

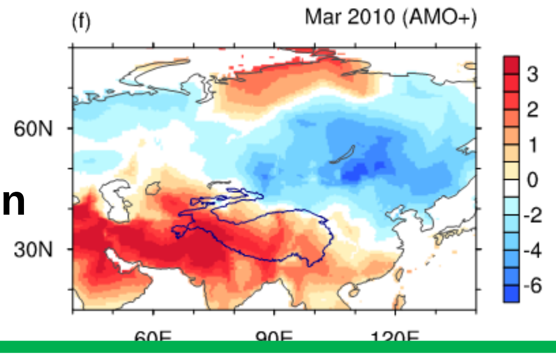
During the AMV+, the storm track shifts southward and favors the enhancement of SELF interaction. The enhanced SELF interaction help maintain the NAO pattern via positive eddy feedback.

Extreme NAO- in February 2010 (AMV+)

SLP
(Feb: contours, Mar: shading)



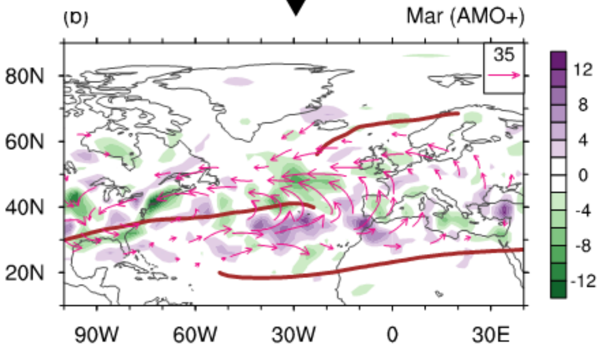
NAO-TP teleconncetion



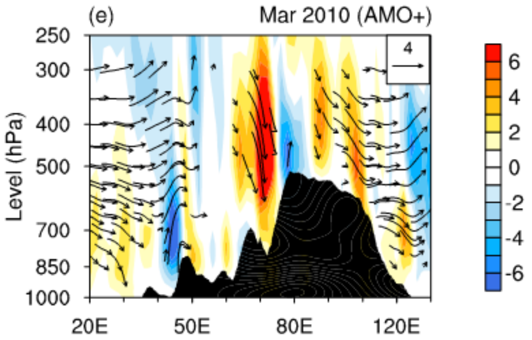
SAT (Mar)

Enhanced SELF interaction during the AMV+

Localized E-P flux (Mar)



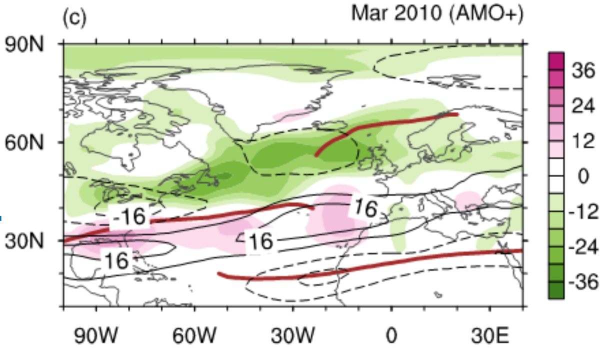
Enhanced descent adiabatic heating over the TP



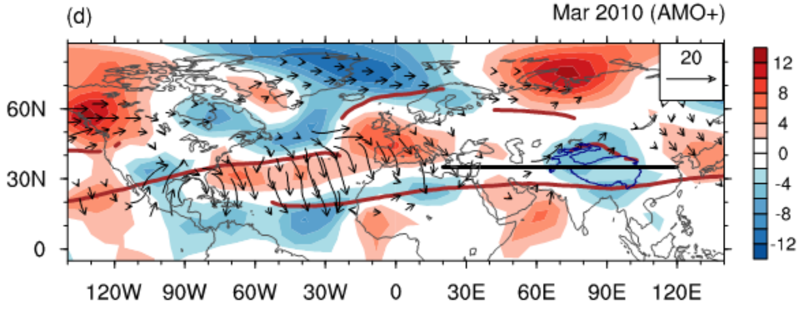
omega (shading) & wind field (vectors) in Mar

Positive eddy feedback

u300 (contours) & 500-hPa transient eddies (shading) in Mar



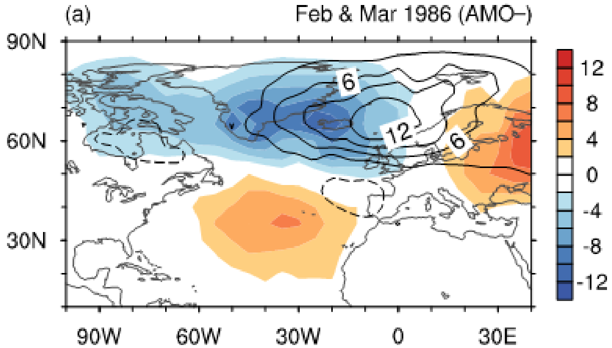
Disturb circulation over the TP



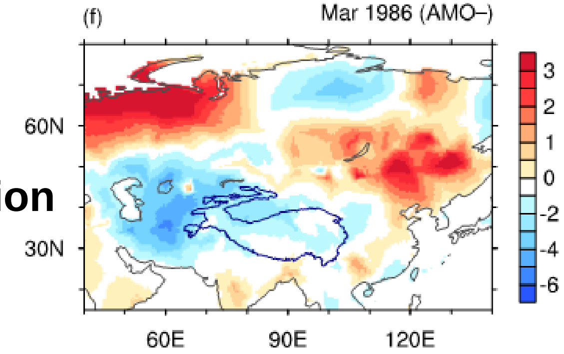
v250 (shading) & WAF (vectors) in Mar

Extreme NAO- in February 1986 (AMV-)

SLP (Feb: contours, Mar: shading)



No NAO-TP teleconncetion

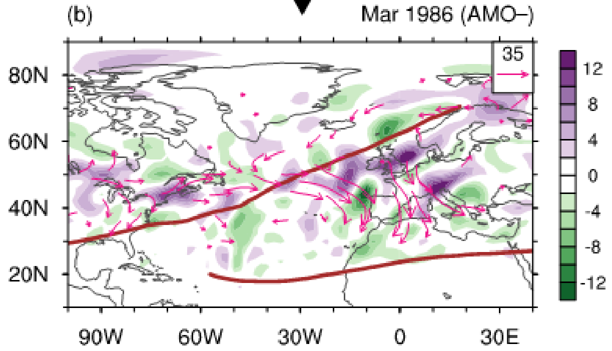


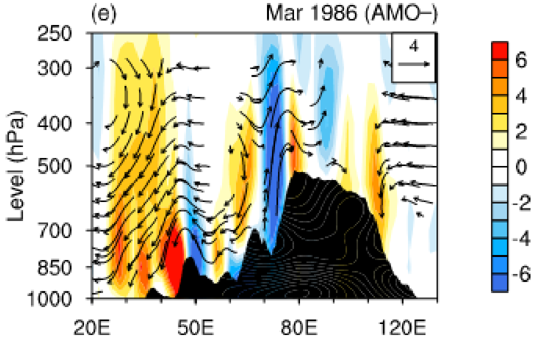
SAT (Mar)

Weakened SELF interaction during the AMV-

Limited circulation anomaly over the TP

Localized E-P flux (Mar)

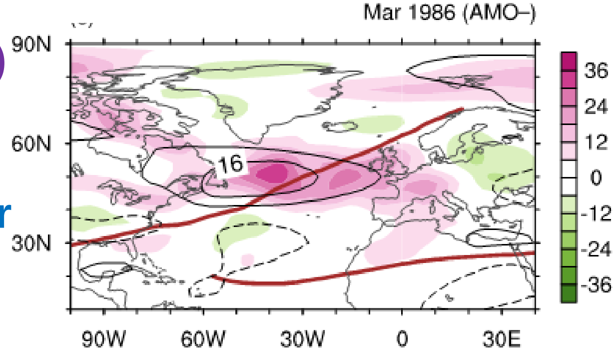


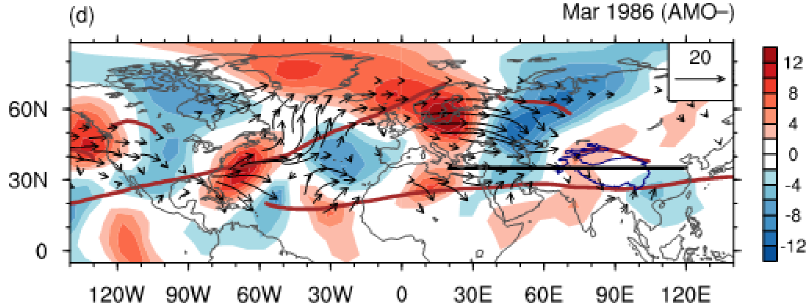


omega (shading) & wind field (vectors) in Mar

Unfavorable for NAO- maintenance

u300 (contours) & 500-hPa transient eddy (shading) in Mar





v250 (shading) & WAF (vectors) in Mar

Conclusion

- The NAO signals in February could persist into March and disturb circulation over the TP during the AMV+, but diminish during the AMV-.

- The southward shift of storm track during the AMV+ enhanced the SELF interaction, which help maintain the NAO pattern via positive eddy feedback and plays a key role in the NAO-TP teleconnection.

Citation: Jingyi Li; Fei Li; Shengping He; Huijun Wang; Yvan. J. Orsolini; The Atlantic Multidecadal Variability phase-dependence of teleconnection between the North Atlantic Oscillation in February and the Tibetan Plateau in March, *Journal of Climate*. 2021, 34(11): 4227-4242.