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1. INTRODUCTION

Summer climate over Far East

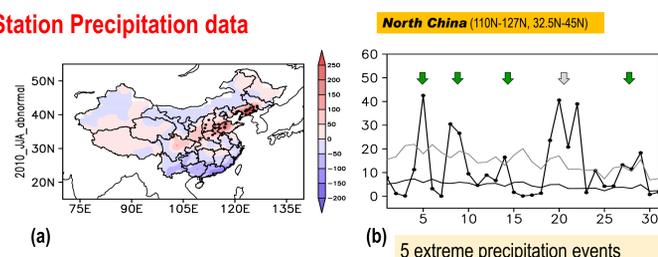
- Over Far East in summer, precipitation is strongly influenced by the East Asian Summer Monsoon and Western Pacific Subtropical High (WPSH)
- The WPSH variability is affected by ENSO, the Pacific-Japan meridional teleconnection and by wave-trains (WTs) propagating eastwards from the Atlantic across Asia. Two prominent WTs propagate along the two westerly jets across Asia: the **Silk-Road** WT along the Asian jet at mid-latitudes, and the polar WT along the sub-polar jet

Unusual summer 2010

- Record-breaking hot summer, pronounced blocking and heat wave over Russia
- Devastating monsoonal floods in Pakistan
- Record-breaking hot summer over Japan
- Devastating floods over Northern and Northeastern China

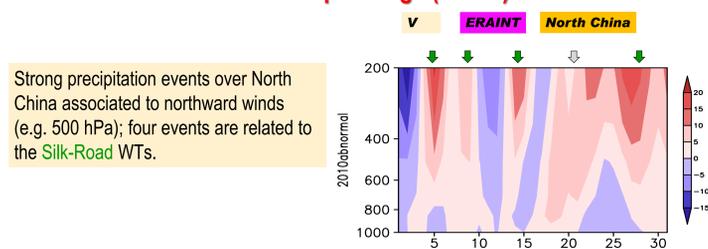
2. EXTREME PRECIPITATION EVENT OVER CHINA IN AUGUST 2010

Station Precipitation data

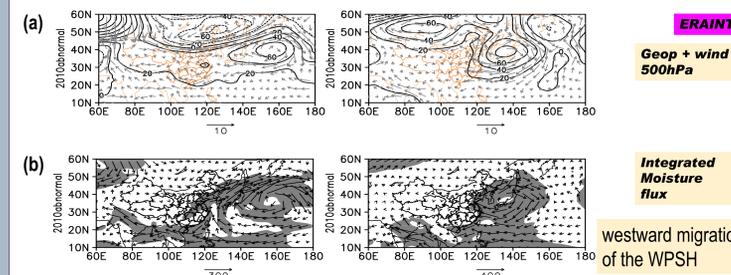


(a) Geographical distribution of precipitation anomalies (mm/month) in August 2010 over China. The extreme wet stations are indicated as black dots. (b) Daily rainfall (mm/day) over North China (black line with dots). Black line is climatology for August, and grey line is climatology plus 2 std. dev.

Link to Western Pacific Subtropical High (WPSH)



Pressure-time section of daily meridional wind (m/s) anomalies in August 2010 over North China



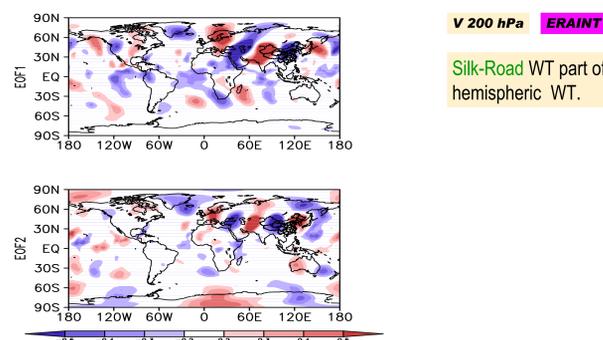
(a) Geopotential height (gpm) and wind fields (m/s) anomalies at 500hPa. (b) Vertical integral of moisture flux vector anomalies (grey area is moisture transport anomalies > 90 kg/m/s). Left: August 1-15, 2010. Right: August 16-31, 2010.

DATA SECTION

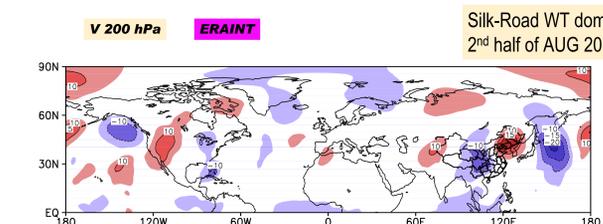
STATION DATA: Observed precipitation from 1961 to 2010 is provided by the National Meteorology Information Center, China Meteorological Administration (573 stations for the entire China). Black dots are extreme wet stations where Standardized Precipitation Index (SPI) > 2.0

RE-ANALYSIS DATA: Geopotential height, wind fields and precipitation data are taken from Era-interim (ERAINT) available since 1979. Anomaly is calculated from the climatology (1979-2009).

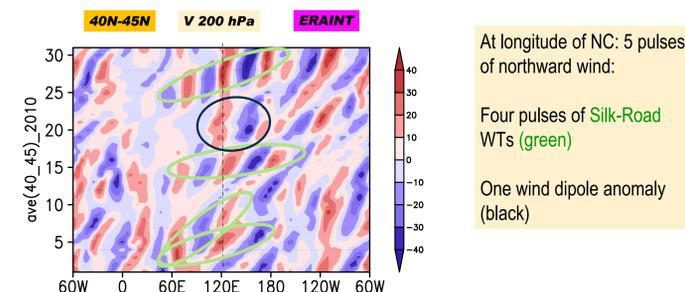
3. WAVE-TRAINS ACROSS EURASIA



Regressed meridional winds onto the two principal EOFs
EOFs: August monthly-mean 200hPa-meridional wind in the latitude band (30N-50N) and longitude band (30E-130E)

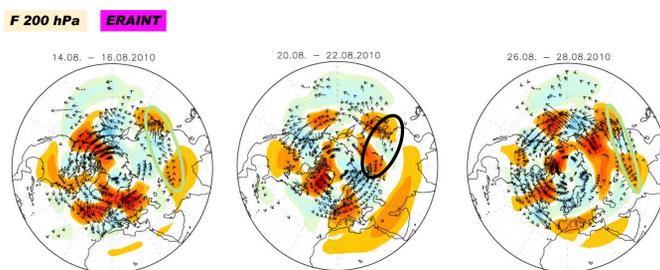


Meridional wind anomaly at 200 hPa for AUG 16-31.



Hovmöller plots of meridional wind anomaly at 200 hPa throughout August 2010

Wave activity propagation (Plumb vector) further distinguishes the near-zonally propagating **Silk-Road** WT pulses from the dipole anomaly, which is related to flux from higher latitudes. The latter may arise from the break-up of the Russian blocking, which lasted until AUG 12 at 60E.



Plumb vector at 200 hPa for three-day periods centered on AUG 15, AUG 21 and AUG 27. Horizontal component as vector and vertical component as shading.

MORE INFO ON CHINA 2010 FLOODINGS

- SUMMER**: China's worst seasonal flooding for a decade: thousands of people dead or missing country-wide, evacuation of a million, and caused tens of billions of dollars in damage.
- AUGUST**: North and Northeast China and the Korean Peninsula were affected by extreme precipitation and flooding. In Liaoning Province, the precipitation in August was the highest since 1961. The Yalu River, which is the national boundary between China and North Korea, experienced severe flooding on 23 August, 2010, ranking fourth among all the historical records. 250,000 people were forced to leave their homes.

4. ECMWF Forecasts

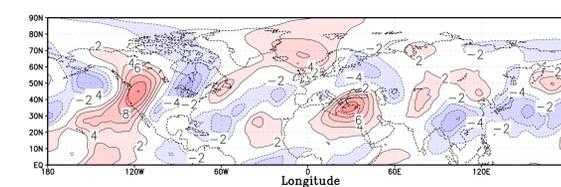
Previous studies⁽³⁾ indicate that lack of predictability of Silk-Road WT limits seasonal prediction of summer climate over the Far East: failed seasonal predictions of a cool summer 2010 in developing La Nina conditions due to interference of **Silk-Road** pattern.

We further show a lack of predictability on the monthly time scale.

Forecast Model

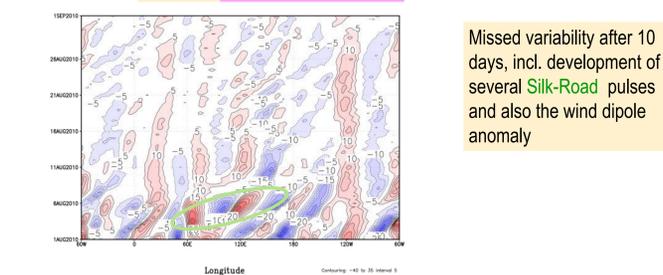
- Atmosphere-only retrospective forecasts carried out by the KNMI (GLACE2)
- recent version of IFS atmospheric model (Cy36R4)
- 10-member ensemble
- 2000-2010 period
- land surface module is HTESSEL
- AUG 1 realistic initialisation, incl. atm., land and soil moisture (off-line)
- SST observed on AUG 1, then relaxed to clim
- Anomaly is calculated from the 10-year climatology (2000-2010)

V 200 hPa FORECAST FROM AUG 1 200 hPa



Meridional wind anomaly at 200 hPa for AUG 16-31 (ensemble-mean forecasts).

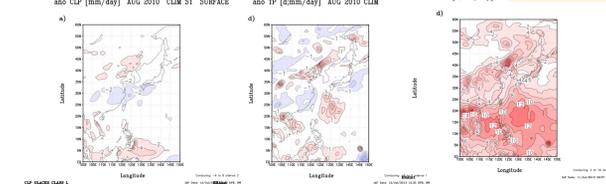
40N-45N V 200 hPa FORECAST FROM AUG 1



Hovmöller plots of meridional wind anomaly at 200 hPa in August 2010.

Forecasted Precipitation (August-mean)

Missed precipitation pattern and intensity over land, but also over maritime areas to the south, linked to WPSH westward migration.



August-mean precipitation (in mm) as ensemble-mean normalized anomalies for forecasts. Corresponding anomalies for ERAINT and ERAINT the total precipitation

CONCLUSIONS

- We characterized the extreme precipitation events of August 2010 over North China using a rain data set from China Meteorological Administration
- Precipitation events linked to northward wind and WPSH shift to the west
- Lack of predictability of the precipitation events is linked to failure to predict intra-monthly variability of the **Silk-Road** and polar WTs, and of the WPSH, esp. during the break-up phase of the Russian blocking.
- There is a need to identify how forecasts of such WTs could be improved. Land-atmosphere coupling could be thought of a factor but the accurate soil moisture initialization in these dedicated forecasts had little impact on improving forecast of WTs or of precipitation. (not shown)

REFERENCES

- 1.Bothe O., et al., Int. J. Clim., 30, 844-855, 2011. 2.Kosaka Y. et al., J. Meteorol. Soc. Japan, 87, 561-580, 2009. 3.Kosaka Y. et al., J. Clim., 25, 7574-7589, 2012. 4. Schneidereit A., MWR, 140, 2967-2981, 2012.

Acknowledgements

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