Moisture Sources, Moisture Transport and Recycling in the East Asian Monsoon

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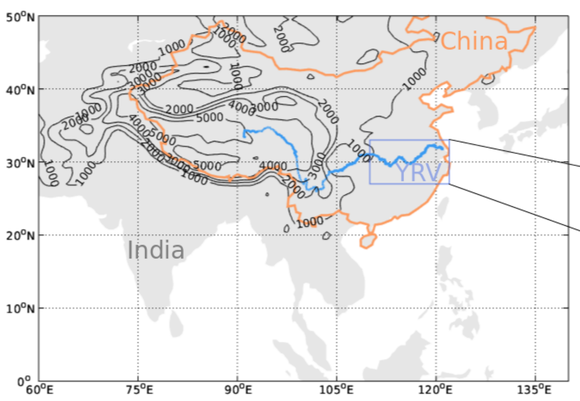
Motivation and Objectives

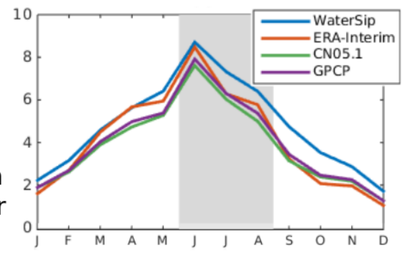
South East China has some of the most important climate proxy records on the past monsoon. Knowledge about moisture sources, transport and recycling is important when interpreting stable isotope concentrations from speleothems as proxy data for past hydroclimate. Even though speleothems usually have annual resolution, the seasonal transition contributes to the annual signal and its variability also needs to be considered in their interpretation.

The region analyzed here covers the lower reaches of the **Yangtze River Valley (YRV)** in China. Here rainfall is controlled by the East Asian Monsoon, with dry winters, wet summers and high variability. The mechanisms controlling the strength and variability of precipitation in the East Asian Monsoon are still poorly understood. We provide new insight into the controlling mechanisms.

Precipitation in the Yangtze River Valley (YRV)

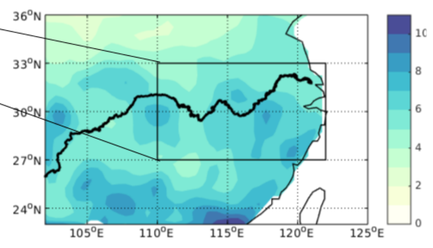


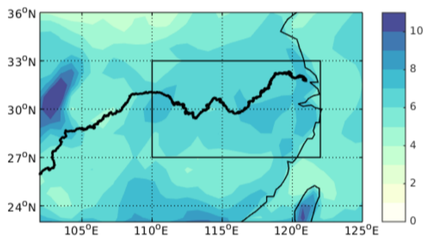
East Asia, with topography [m] and the Yangtze River



Precipitation [mm/day] for each month

Precipitation [mm/day] in South East China according to the observational dataset **CN05.1** (Summer, 1980-2013)



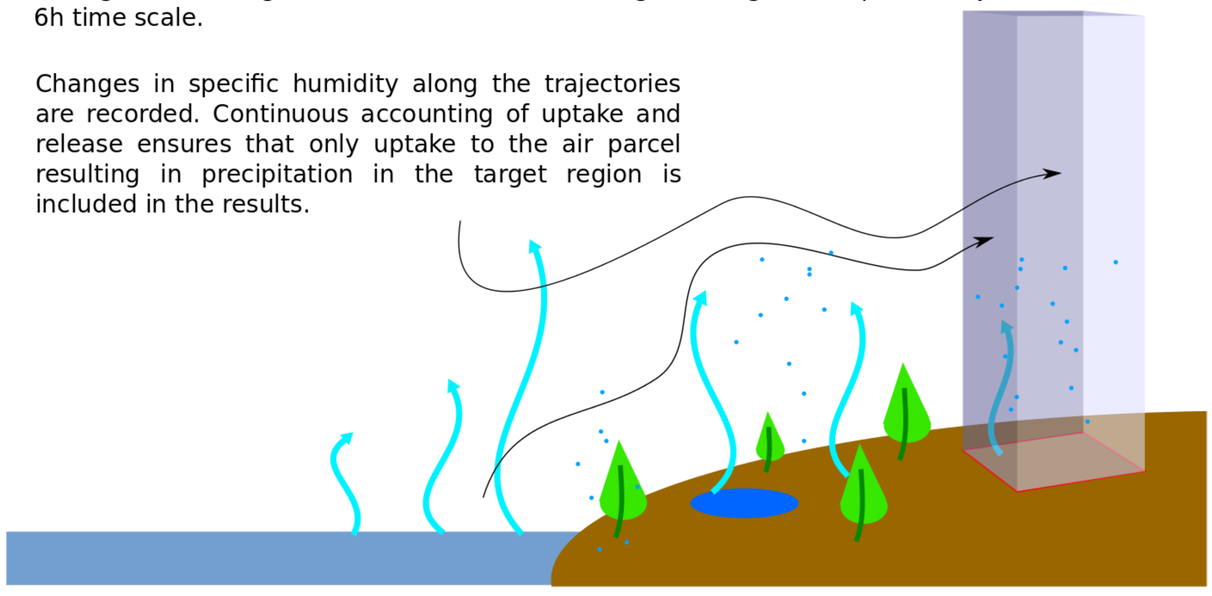


Precipitation in the same region according to **ERA Interim** (Summer, 1980-2013)

Data and Method: ERA Interim, FLEXPART & WaterSip

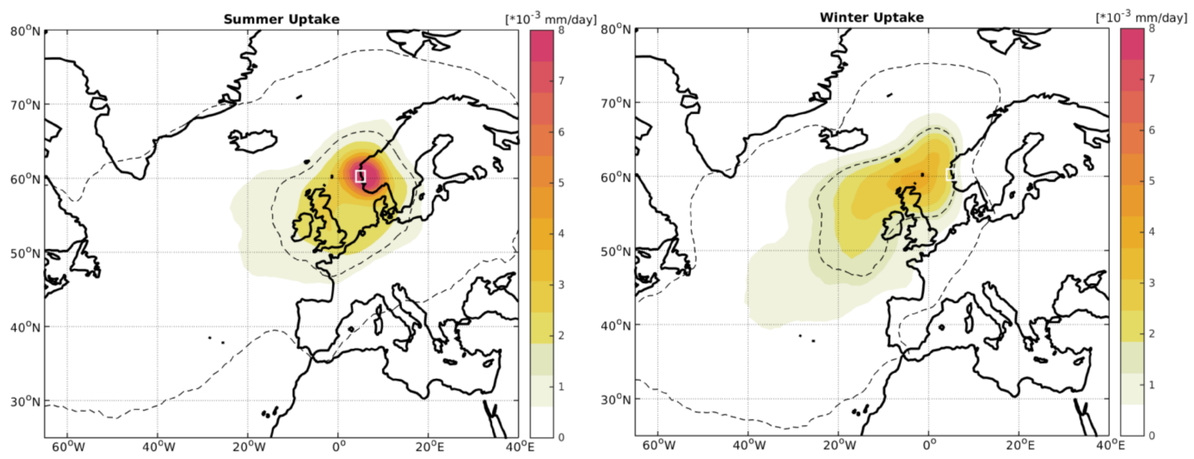
To quantify the origin and transport of moisture in the atmosphere we use the Lagrangian model FLEXPART and the diagnostic tool WaterSip with wind and humidity from the ERA Interim reanalysis dataset as input. First air parcel trajectories are calculated for 1980 - 2013. Then the moisture sources and transport conditions of each rain event in the period is diagnosed through calculation of moisture budgets along the air parcel trajectories on a 6h time scale.

Changes in specific humidity along the trajectories are recorded. Continuous accounting of uptake and release ensures that only uptake to the air parcel resulting in precipitation in the target region is included in the results.

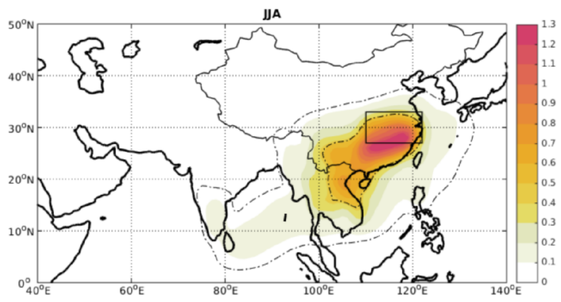


What about seasonal moisture source variability in Norway?

Repeating the analysis for Bergen (1980-2013) we can illustrate moisture transport conditions in Norway.

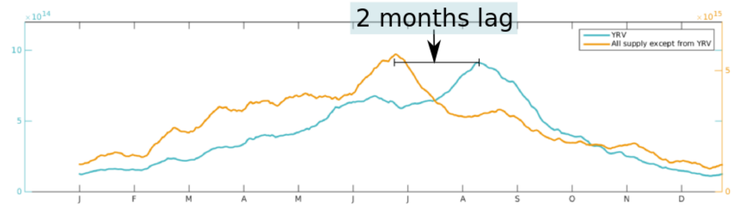


Results: Moisture Sources - Seasonality

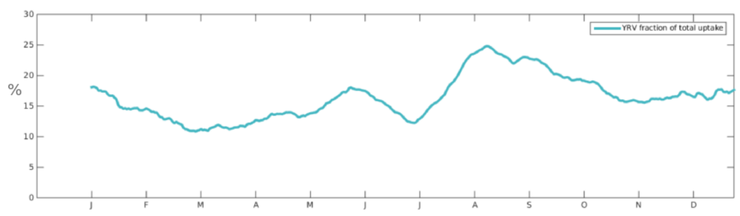


Moisture sources [mm/day] during summer.
The origin of moisture (evaporation) that eventually precipitates in the Yangtze River Valley (box).

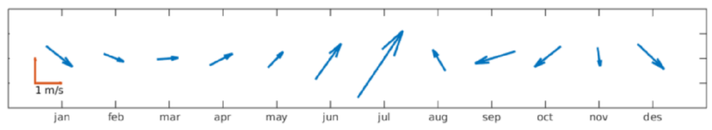
Dotted lines show the limits of the 50th and 90th percentiles of moisture sources.



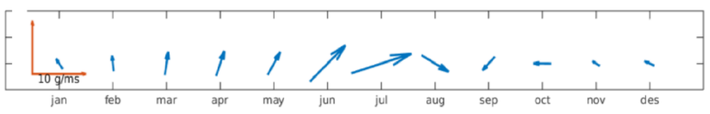
Moisture contribution [kg/day] from **the Yangtze River Valley (YRV) compared to the rest**



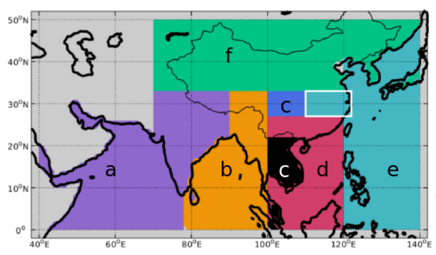
Contribution from the **YRV region** itself



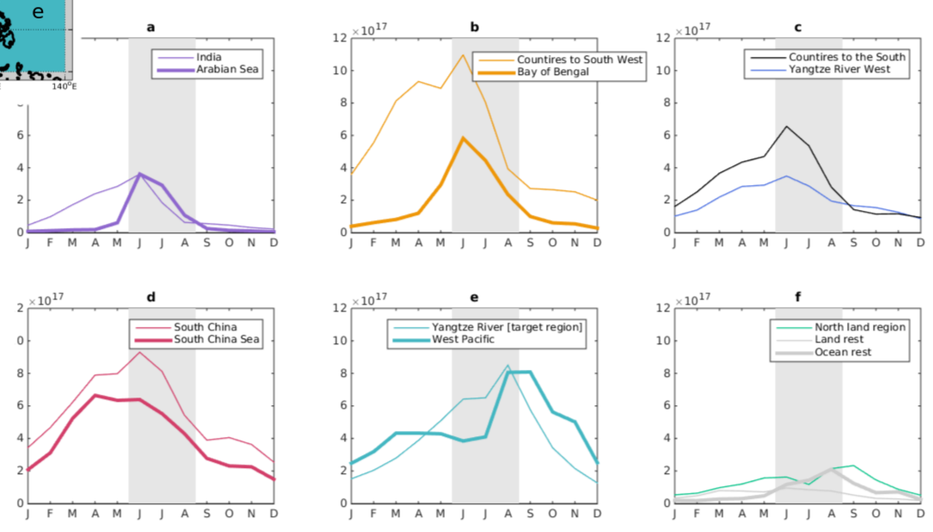
Wind strength and direction 850hPa within YRV (ERA Interim)



Integrated moisture flux within YRV (ERA Interim)



Contribution from different regions YRV [kg/day] from each region on the map (corresponding colours).



Some source regions contribute mainly during specific seasons, eg. 'Countries to South West' (b) contributes in spring and summer, or 'Arabian Sea' (a), contributes only during summer.

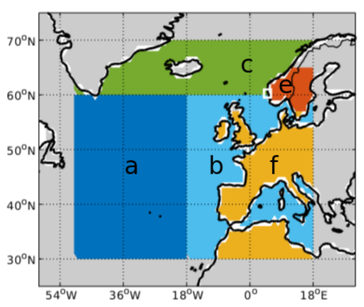
Conclusion

- A large part of the moisture comes from close land regions. 13% comes from within YRV and 12% from South China. 66 % comes from land regions.

- Moisture supply to YRV from the region itself (recycling) peaks 2 months after the monsoon peak and the peak of outside supply. This lag can be due to changing wind regimes or changing local conditions affecting recycling.

- Seasonal changes in contribution from different land and ocean regions show similar developments

References: A Laederach, H Sodemann (2016): A revised picture of the atmospheric moisture residence time.
H Sodemann, C Schwierz, H Wernli (2008): Interannual variability of Greenland winter precipitation sources: Lagrangian moisture diagnostic and North Atlantic Oscillation influence.



Contribution from different regions to BERGEN [kg/day] from each region on the map (corresponding colours).

Some source regions show a clear seasonality, eg. 'Central Atlantic' (a) which contributes more in winter, and 'South Norway' (e), which contributes mainly during summer.