Global Atmospheric Moisture Budget

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Aims and Scope

- Investigating the seasonal global circulation patterns of atmospheric moisture and explaining the **moisture sources and changes** in atmospheric moisture conditions.
- For this purpose; we focused on mid-season months (**January-April-July-October**) circulation patterns.
- The atmospheric eddy moisture fluxes and its convergence were also investigated to show the contribution of eddies to the atmospheric moisture budget.

METHODOLOGY

Calculation of the Atmospheric Moisture Budget

$$P - E = -\frac{1}{g}\int_{P_{top}}^{P_{sfc}} q\,dp - \nabla.\left[\left(\frac{1}{g}\int_{P_{top}}^{P_{sfc}} \bar{q}\bar{V}\,dp\right) + \left(\frac{1}{g}\int_{P_{top}}^{P_{sfc}} \overline{q'V'}\,dp\right)\right]$$

Because most water vapour exists below 300 hPa, the atmospheric moisture budget equation was integrated between p_{sfc} and 300 hPa.

P is the precipitation rate (mm)
E is the rate of evaporation (mm) from the surface
q is the atmospheric specific humidity (kg/kg)
p is atmospheric pressure (Pa)
p_{sfc} is the surface air pressure(Pa)
p_{top} is the air pressure at the top of the atmosphere (Pa)
V(*ui* +*vj*) is the horizontal wind velocity (m/s)
g is the gravity constant (m/s^2)

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DATA

List of the NCEP/NCAR reanalysis variables used in the study. Class *A* indicates fields strongly influenced by observations; Class B indicates fields partially influenced by observations, and partially by models

Class	Field Type	Unit
A	u wind at 17 levels	m/s
A	v wind at 17 levels	m/s
A	Precipitation rate	$kg/m^2/s$
B	Specific air humidity at 8 levels	kg/kg
B	Surface air pressure	Pa
B	u wind at 10 m	m/s
B	v wind at 10 m	m/s
B	Specific air humidity at 2 m	kg/kg
B	Precipitable water	mm

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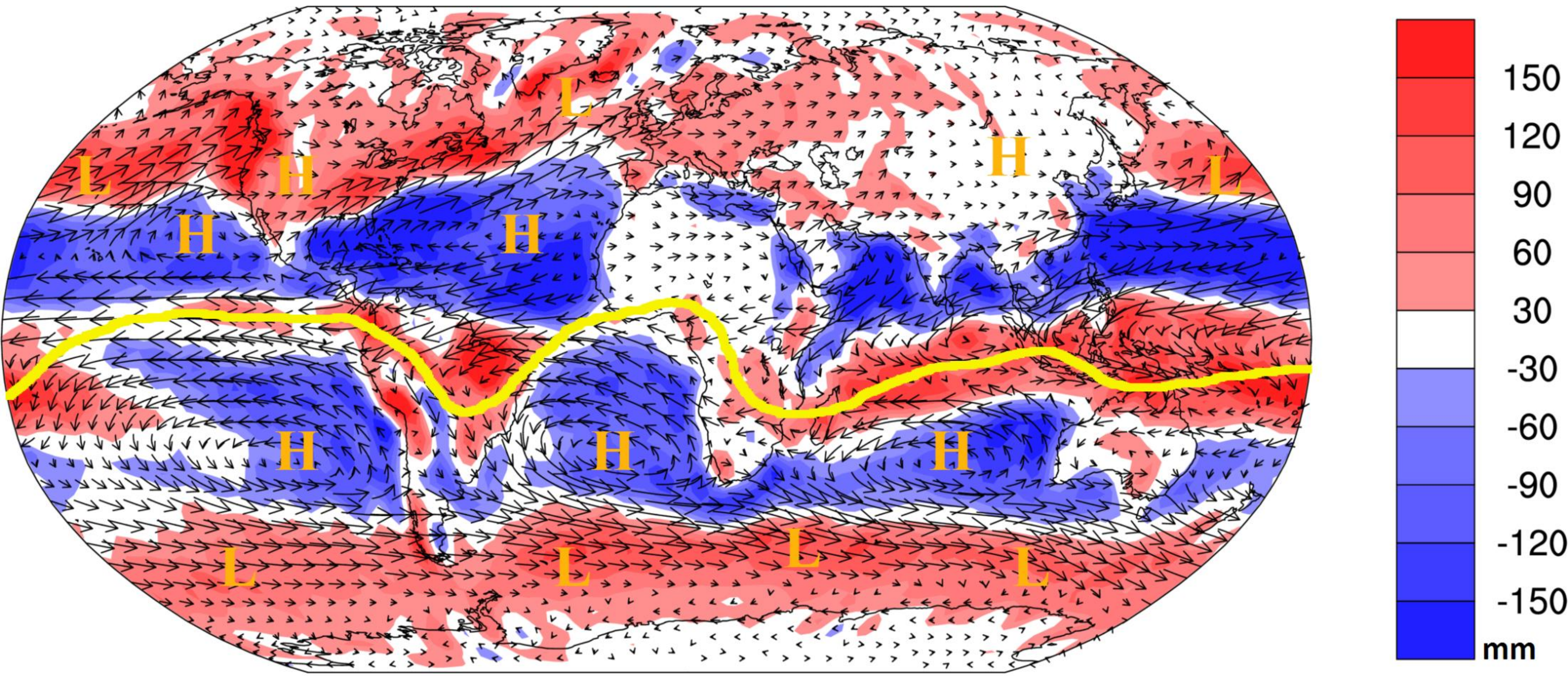
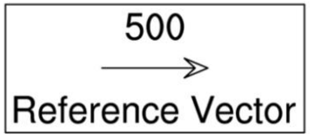
Vertically integrated atmospheric moisture flux (vectors, in kg•(ms)-1) and AMC (shaded and contours, in mm month-1) for January for the period 1949-2014



- Intertropical convergence zone (ITCZ), subtropical high pressure zone, and the subpolar lows can be observed.
- The formation of yellow band (ITCZ), of low pressure is the result of solar heating and the convergence of the trade winds
- In January, the intertropical convergence zone is found south of the equator, the Southern Hemisphere receives higher inputs of shortwave radiation. Bends in the line occur because of the different heating characteristics of land and water. This phenomenon occurs because land heats up faster then ocean.



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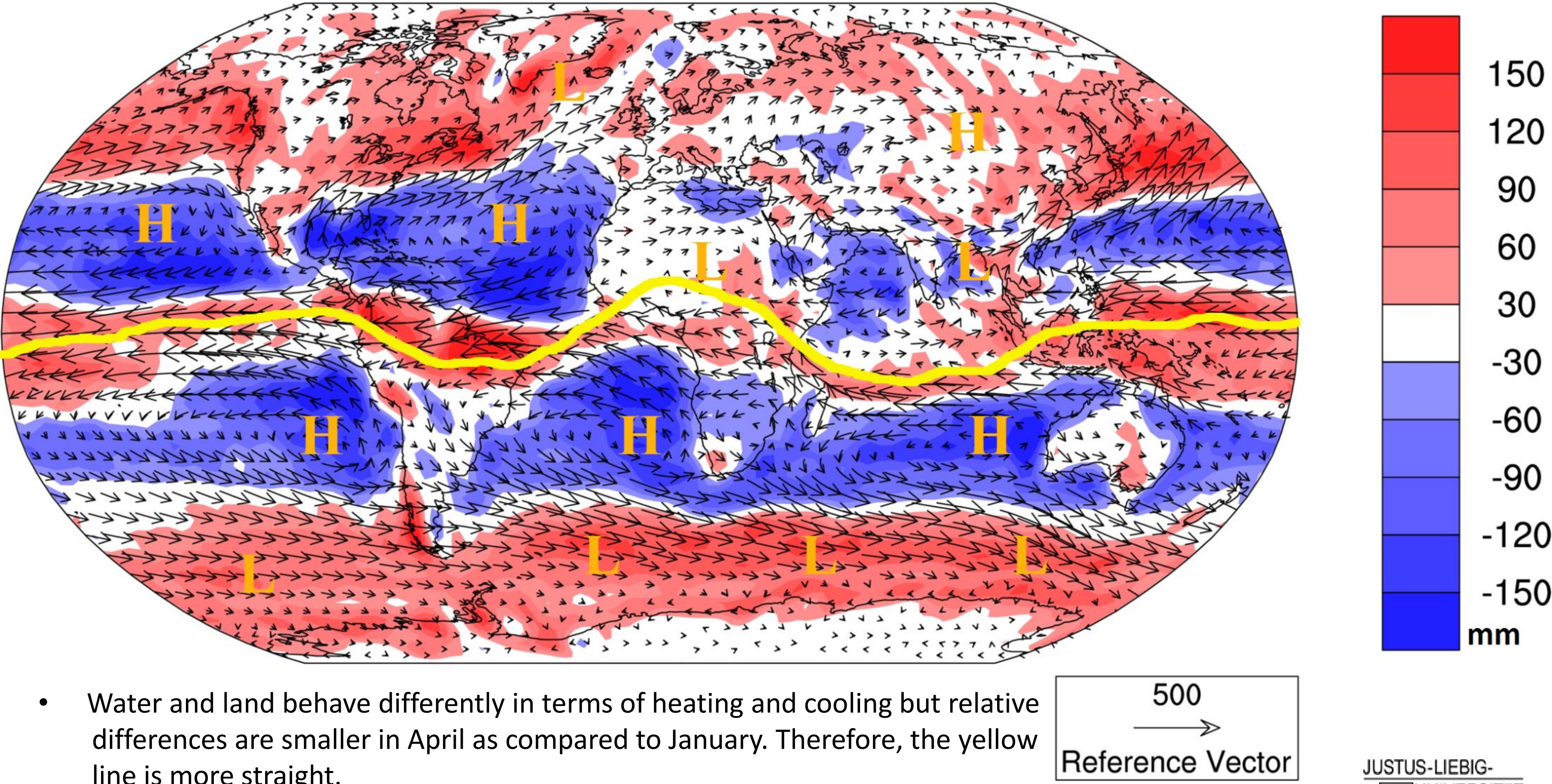
Vertically integrated atmospheric moisture flux (vectors, in kg•(ms)-1) and AMC (shaded and contours, in mm month-1) for April for the period 1949-2014



- Water and land behave differently in terms of heating and cooling but relative differences are smaller in April as compared to January. Therefore, the yellow line is more straight.

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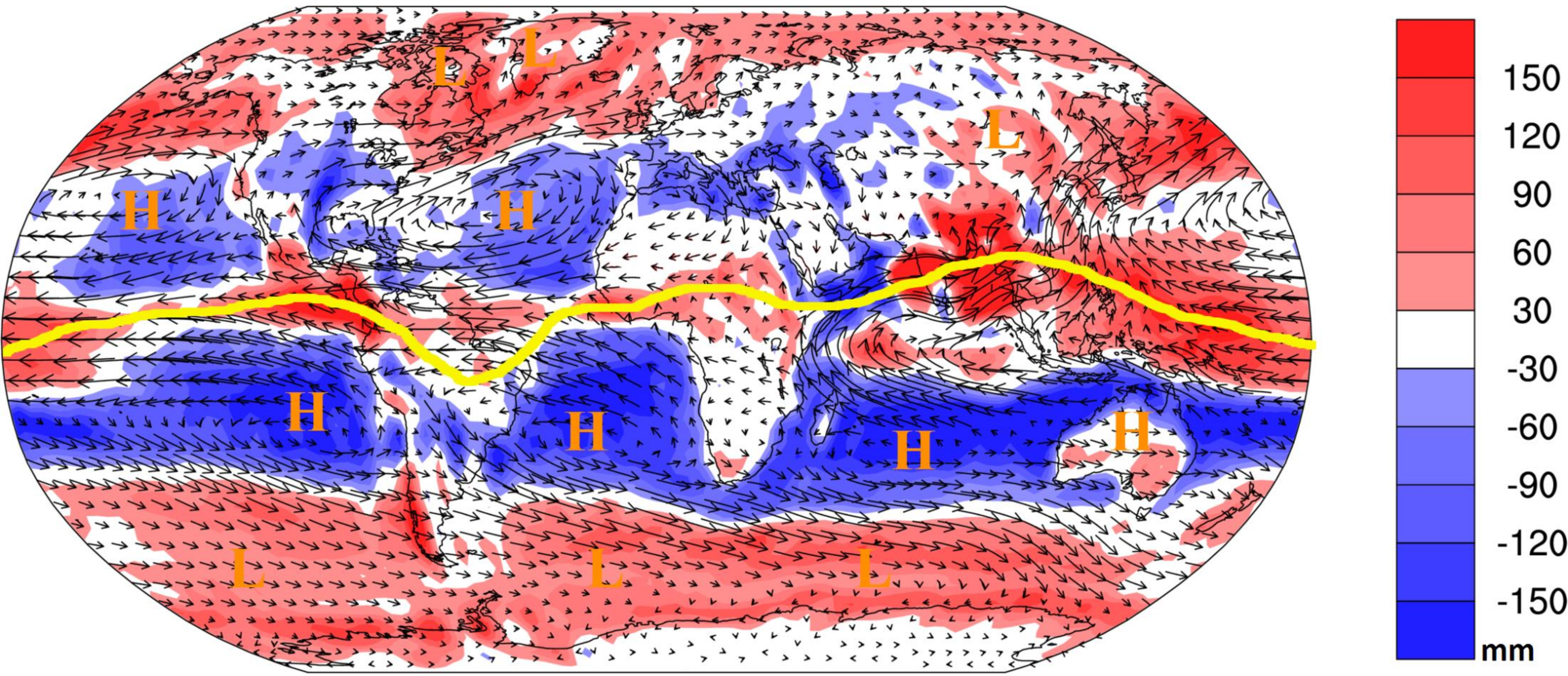
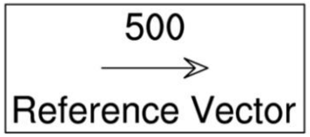
Vertically integrated atmospheric moisture flux (vectors, in kg•(ms)-1) and AMC (shaded and contours, in mm month-1) for July for the period 1949-2014





Shift to North occurs because the altitude of the Sun is now higher in the Northern Hemisphere. The more intense July Sun causes land areas of Northern Africa and Asia rapidly warm creating the ***Asiatic Low*** which becomes part of the ITCZ. In the winter months, the intertropical convergence zone is pushed south by the development of an intense high pressure system over central Asia .The extreme movement of the ITCZ in this part of the world also helps to intensify the development of a regional winds system called the Asian monsoon.

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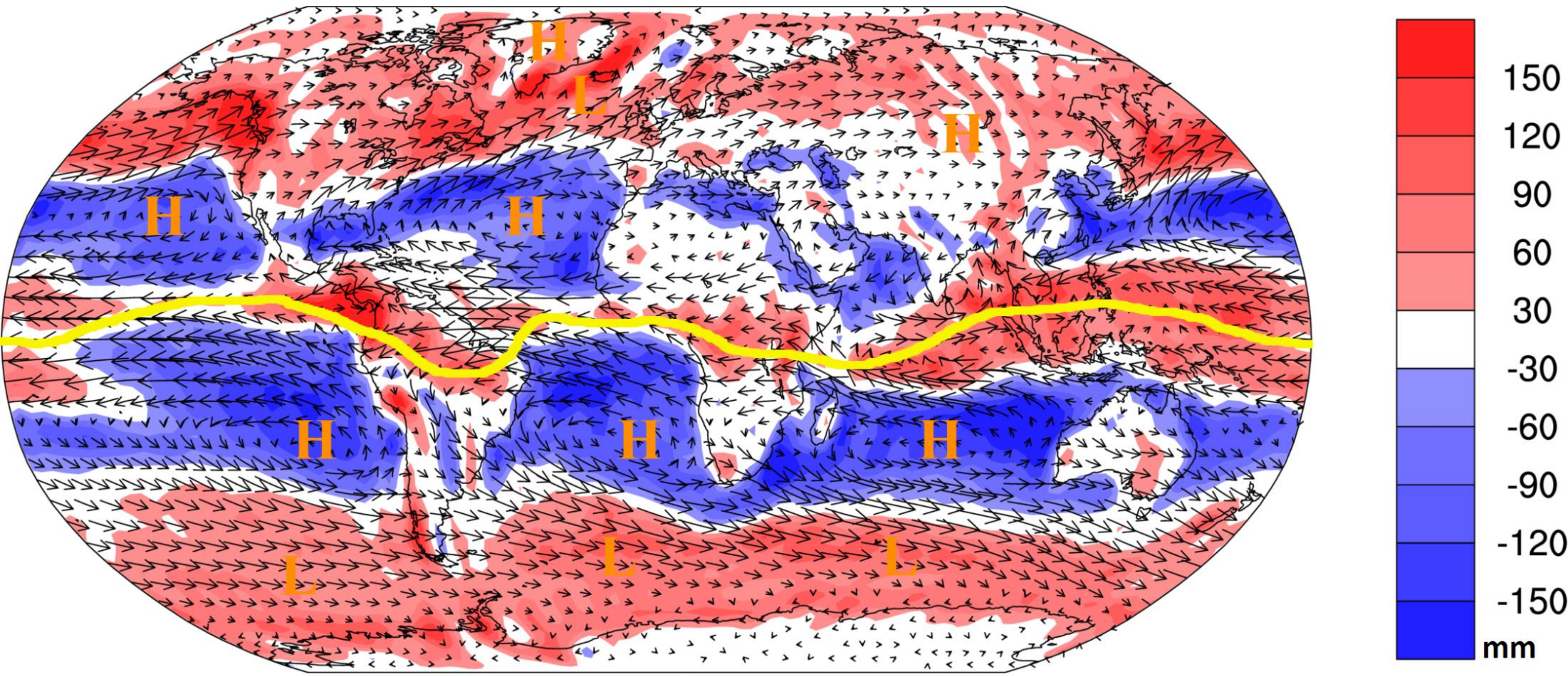
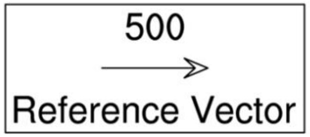
Vertically integrated atmospheric moisture flux (vectors, in kg•(ms)-1) and AMC (shaded and contours, in mm month-1) for October for the period 1949-2014





- More straight ITCZ zone.
- ITCZ zone moves to south.
- The ***Asiatic Low (***Northern Africa and Asia) continues loosing its strength.

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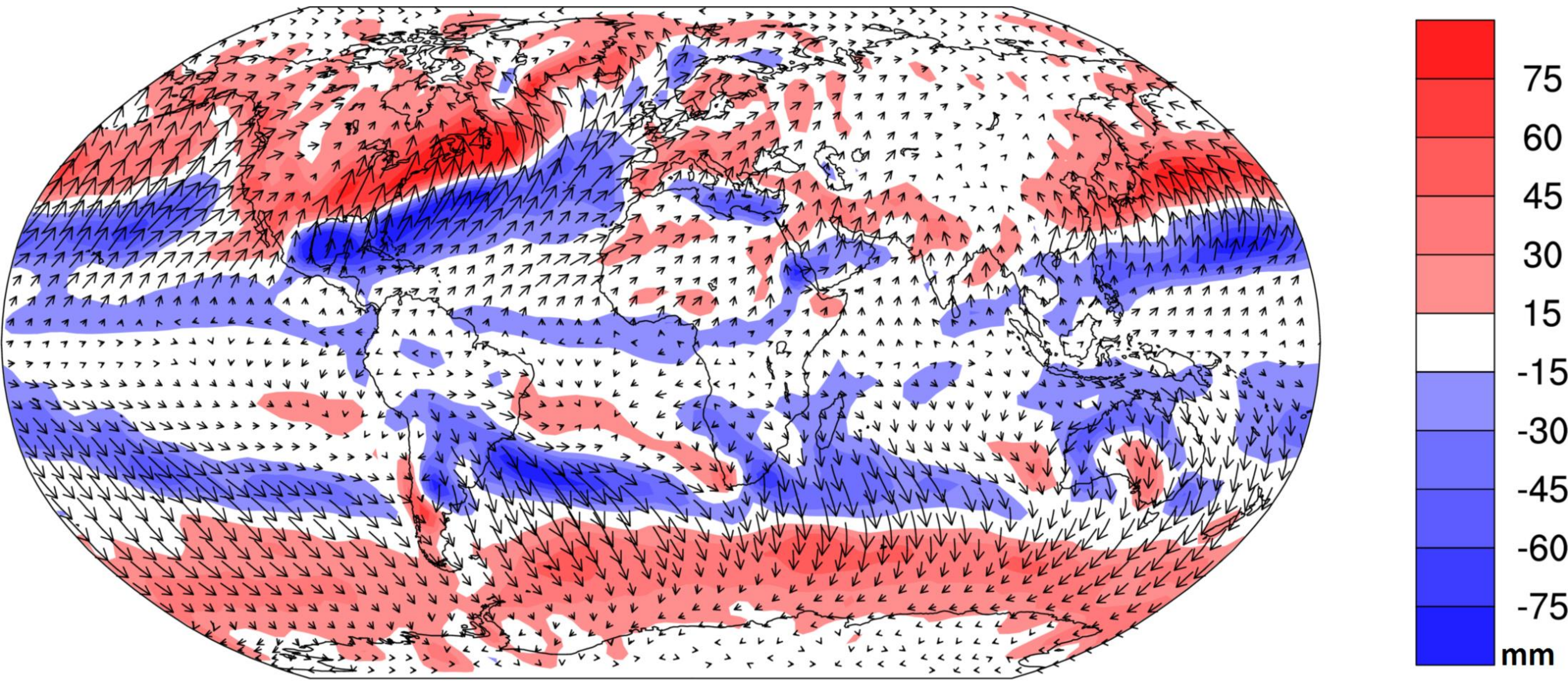
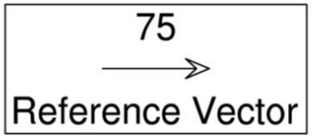
Vertically integrated eddy atmospheric moisture flux (vectors, in kg•(ms)-1) and AMC (shaded and contours, in mm month-1) for January for the period 1949-2014





- Transient eddy fluxes can be defined as the covariance between specific humidity and wind, and therefore may be responsible for the circulation anomalies associated with extreme events.
- Eddies are important for anomalous divergence during dry and wet conditions.
- Eddy activities are stronger in winter months because of stronger and more frequent frontal activities in general

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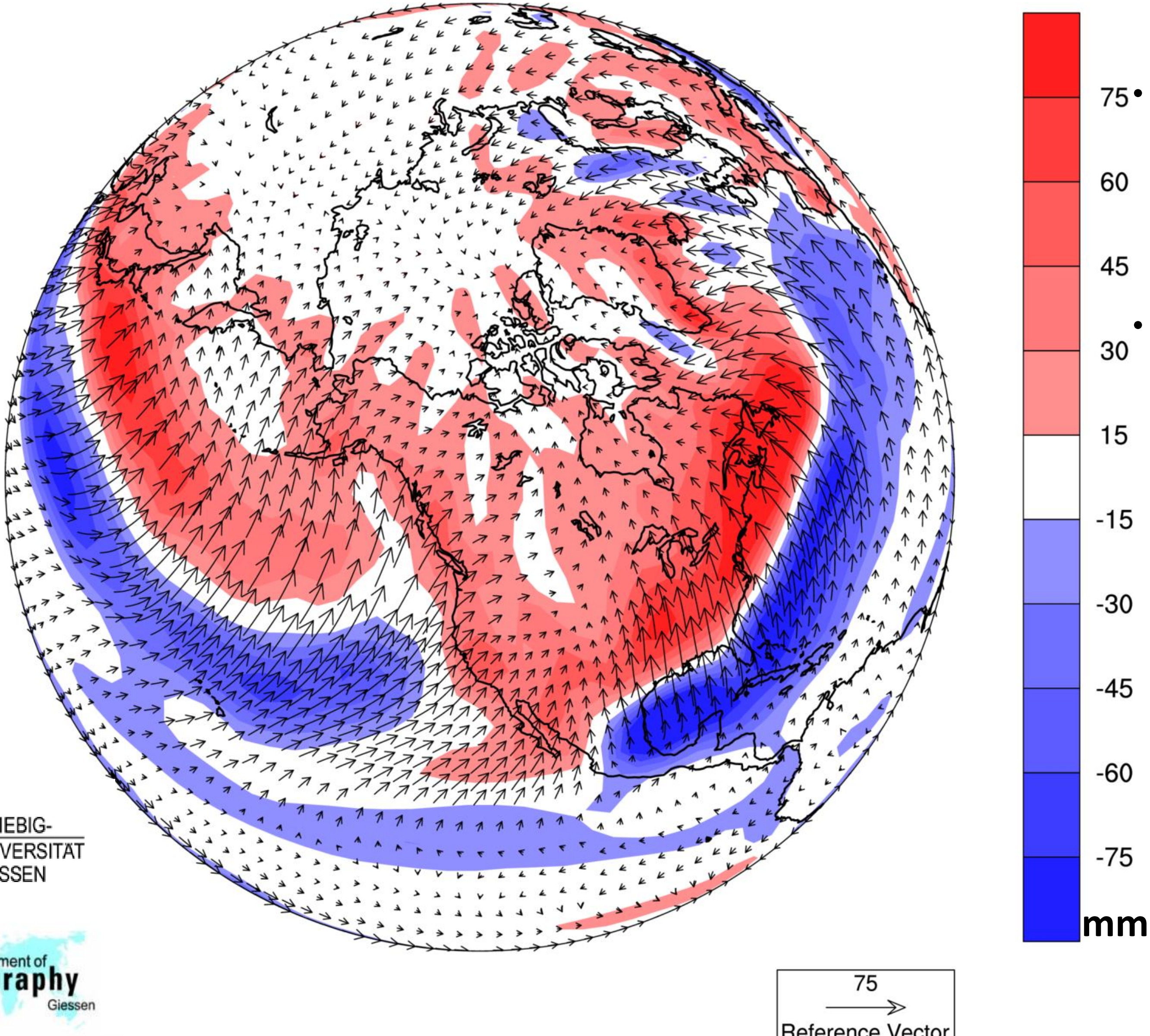
Vertically integrated eddy atmospheric moisture flux (vectors, in kg•(ms)-1) and AMC (shaded and contours, in mm month-1) for January for the period 1949-2014



- On the Earth's surface at 60° North latitude, the subtropical Westerlies collide with cold air traveling from the poles.
- This collision results in frontal uplift and the creation of the subpolar lows and mid-latitude cyclones.

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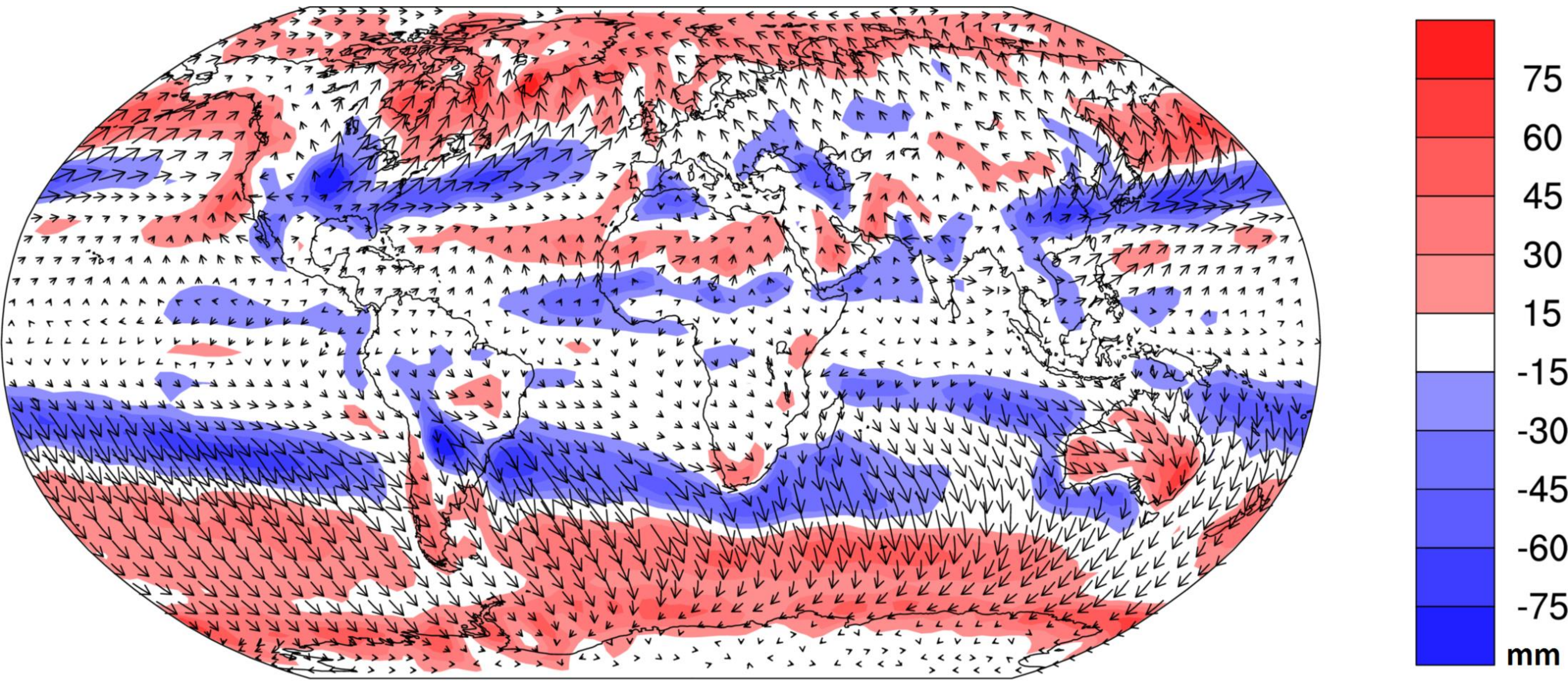
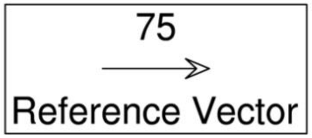
Vertically integrated eddy atmospheric moisture flux (vectors, in kg•(ms)-1) and AMC (shaded and contours, in mm month-1) for July for the period 1949-2014





- The contribution of eddies to the moisture budget weaken in summer because of weaker and less frequent frontal activities in general.

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CONCLUSIONS

- Westerlies and trade winds carry high amount of moisture
- Intertropical convergence zone (ITCZ), subtropical high pressure zone, and the subpolar lows can be observed with global moisture flux pattern
- Also, major teleconnecition patterns such as NAO phases can be observed ,and especially, that shows the importance of moisture fluxes for dry and wet conditions.
- Eddy activities are stronger in winter months and contribution of eddy moisture convergence to global moisture budget is about 10%
- Eddy moisture flux and its convergence is more stronger in Northern Hemisphere because of stronger frontal activities.

THANK YOU

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