The Impact of Hengduan Mountains Formation on the Regional Monsoon Climate – A Sensitivity Study

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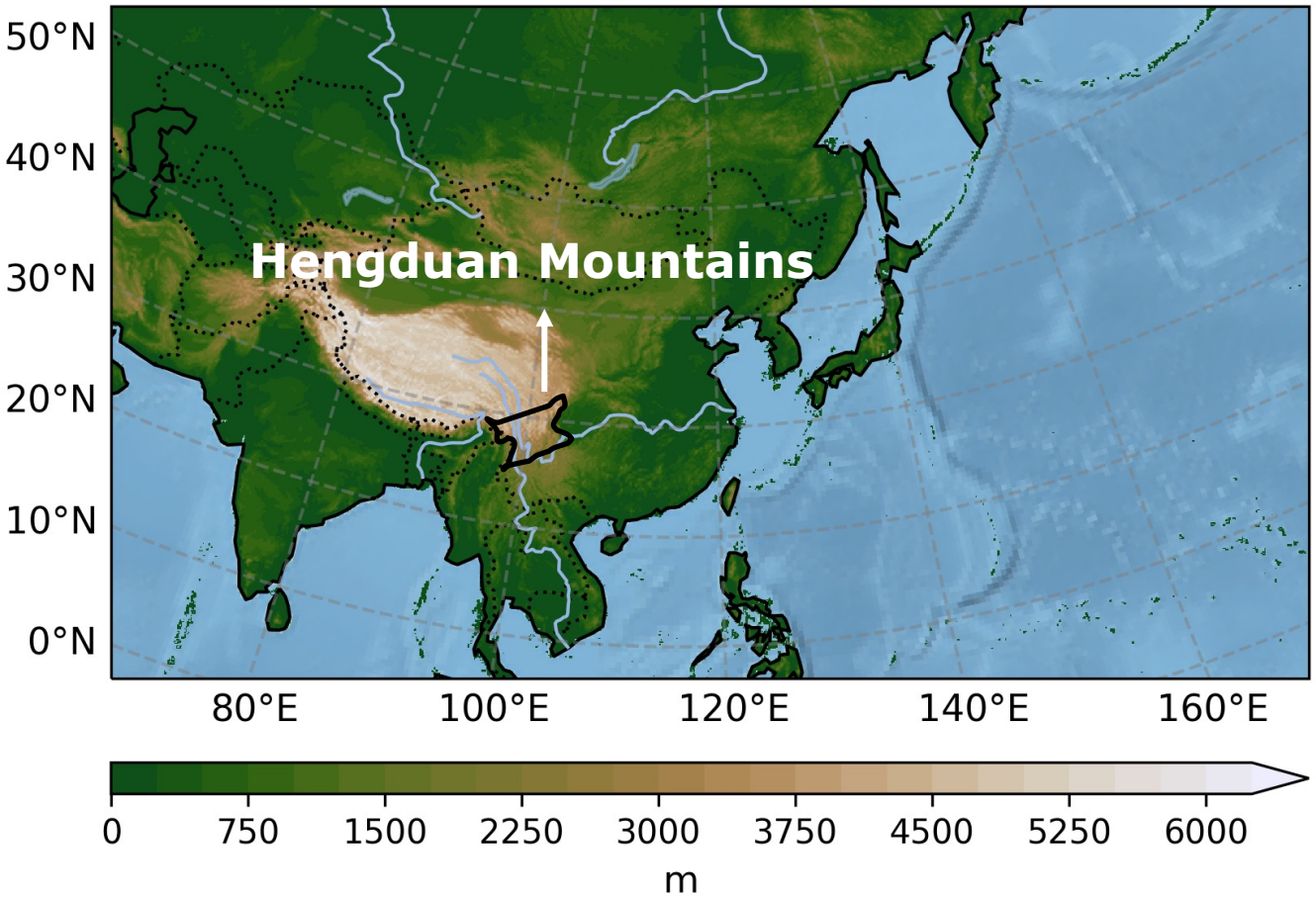
Background



>>> Intersection of three different monsoon regions

>>> Topographic complexity

>>> Unique biodiversity hotspot

Background

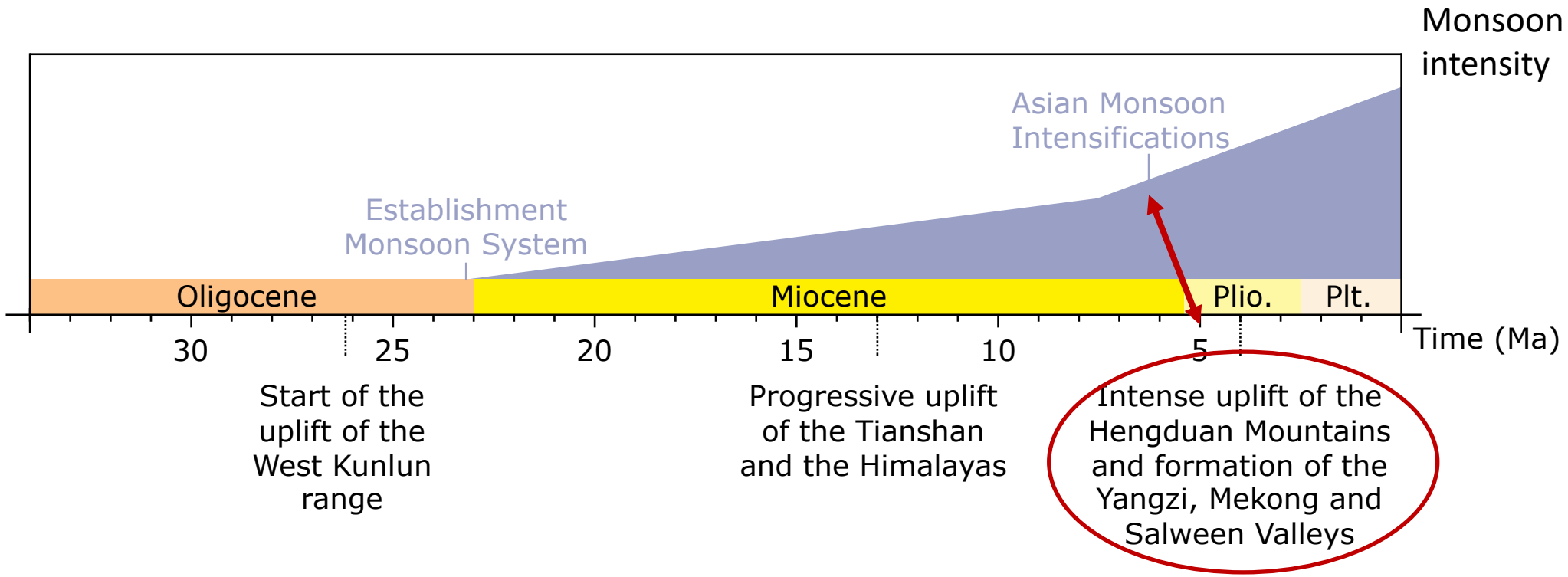
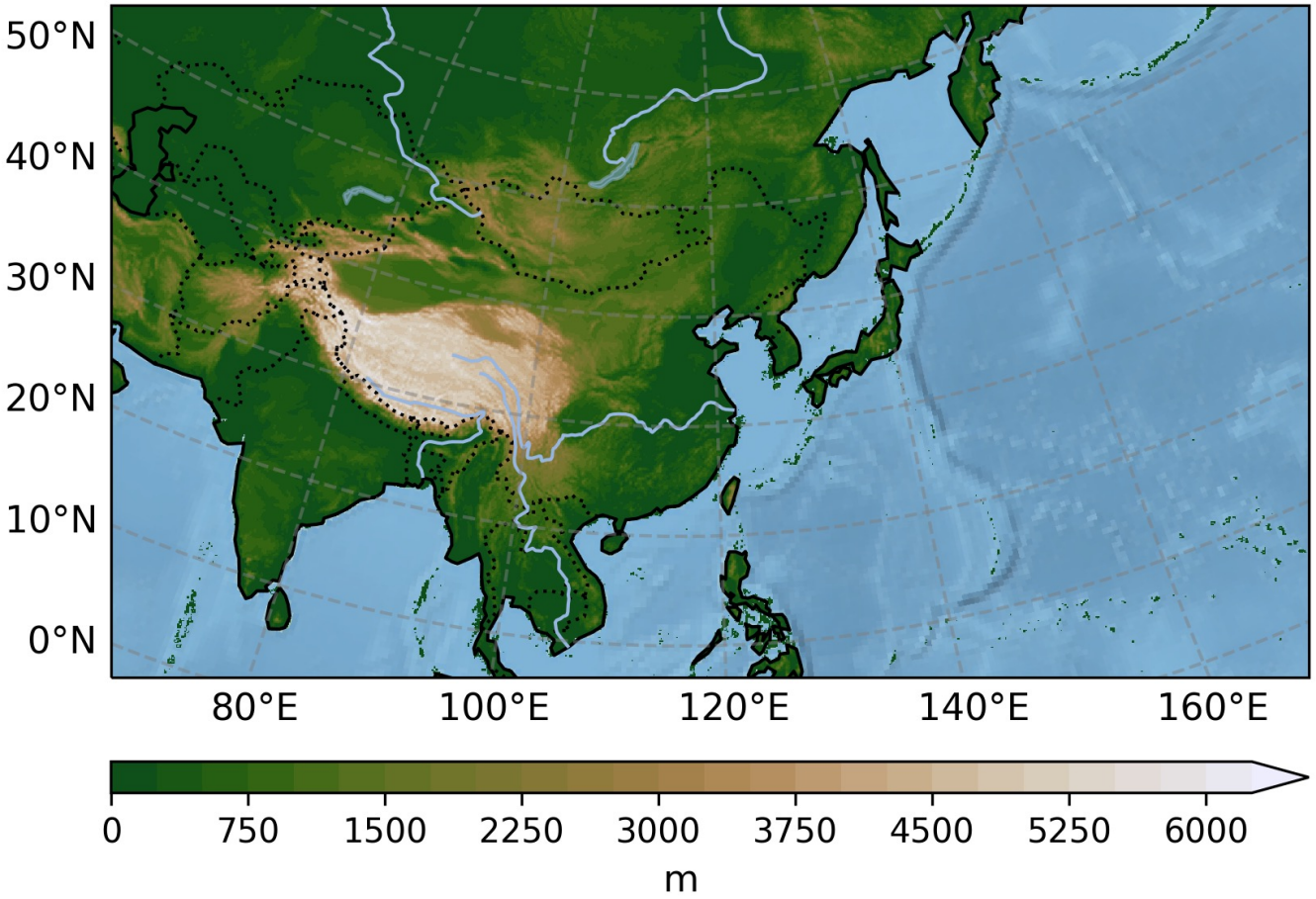


Fig: Favre et al., 2015

What is the role of the topography and uplift history of the Hengduan Mountains for the Asian monsoon system?

Model Setup



RCM: COSMO6

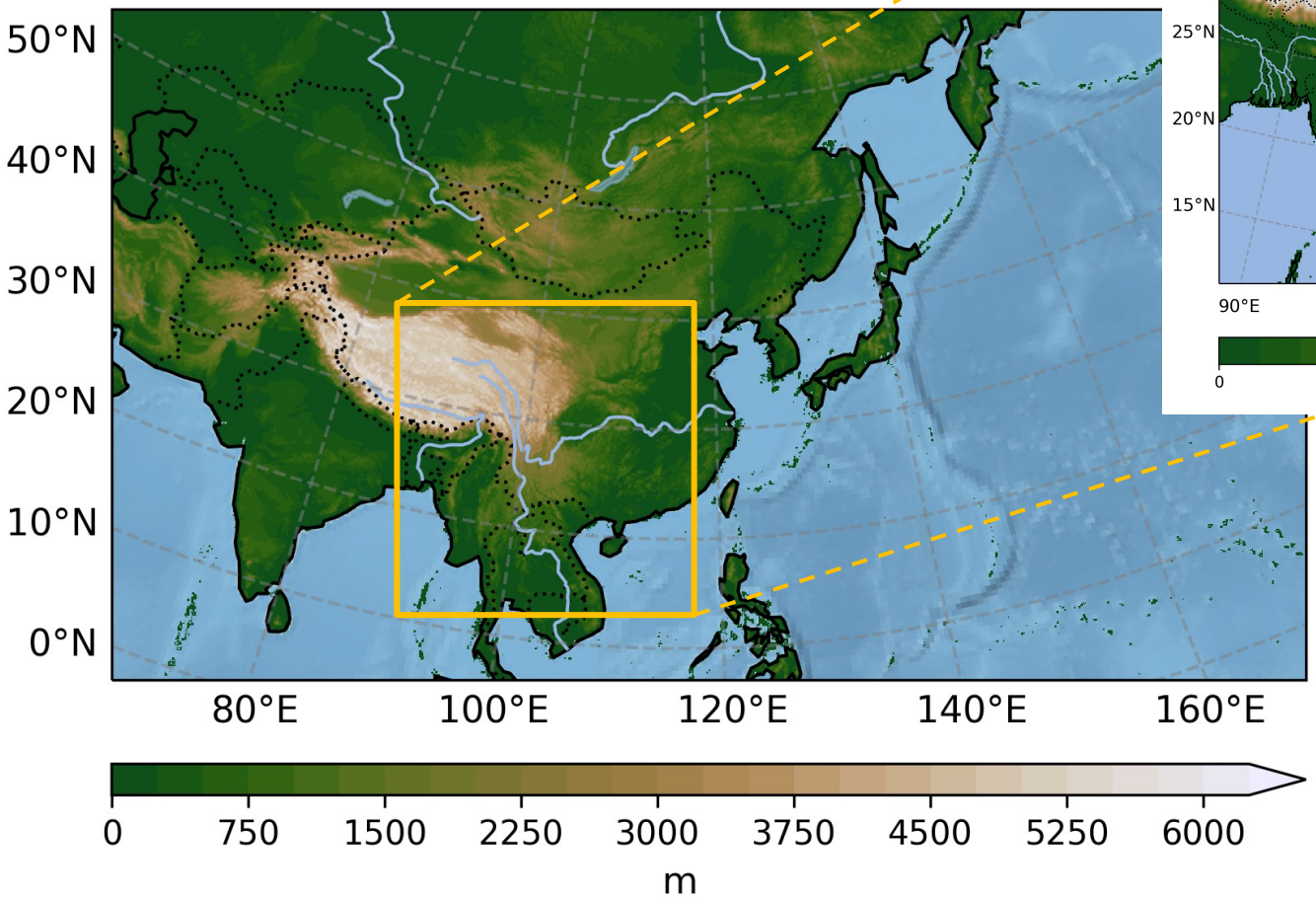
Horizontal resolution:

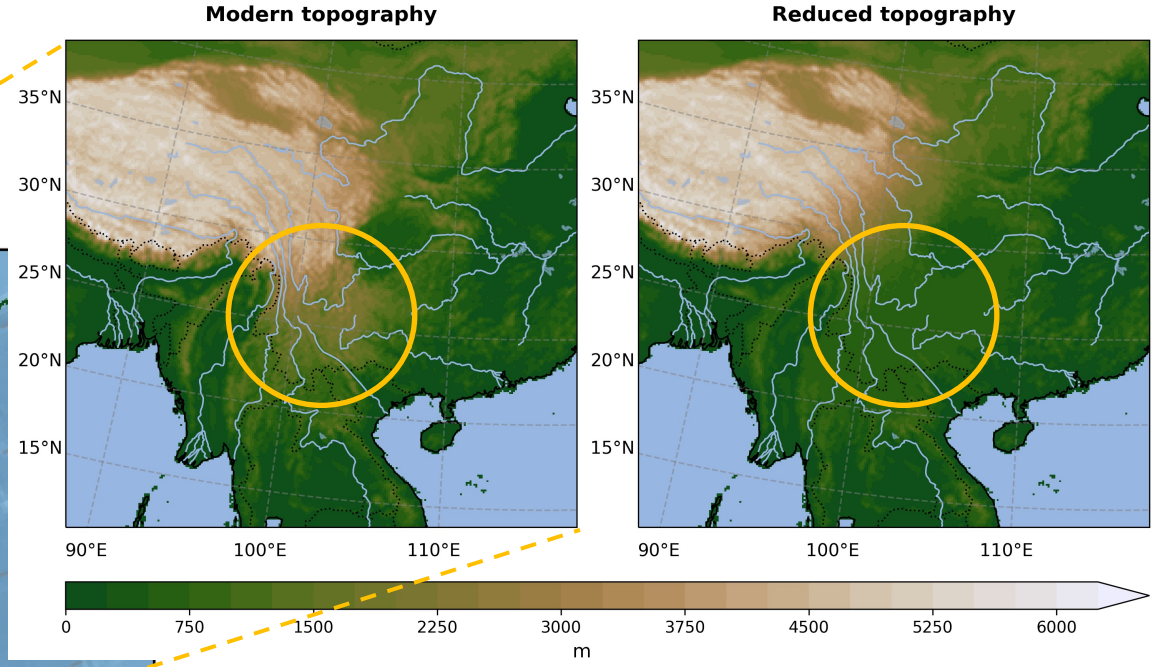
12 km with parametrized deep convection scheme (Tiedtke, 1989)

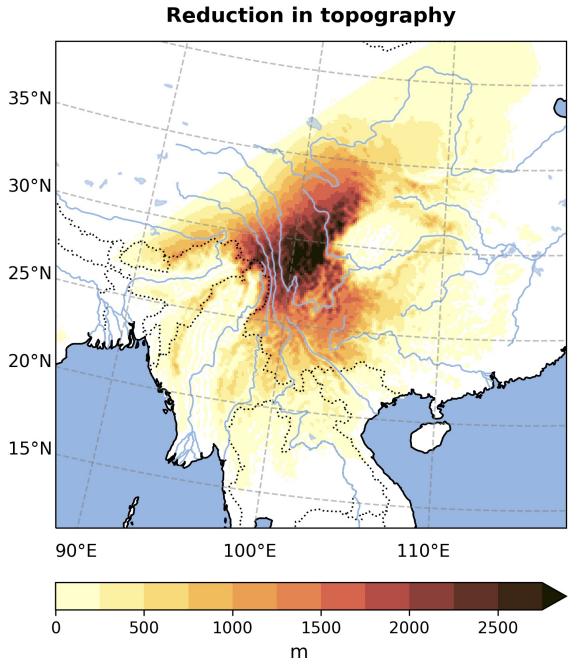
Running period: 2001-2005

Boundary condition: ERA5

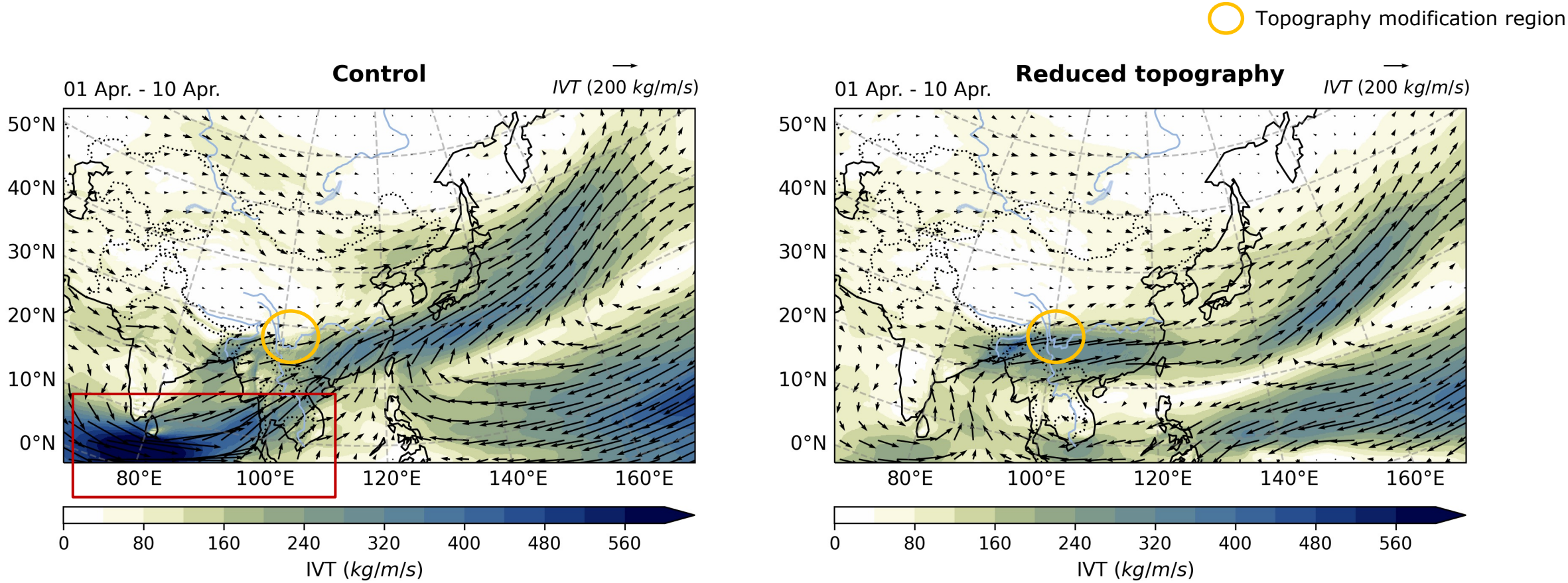
Reduced-elevation Scenario







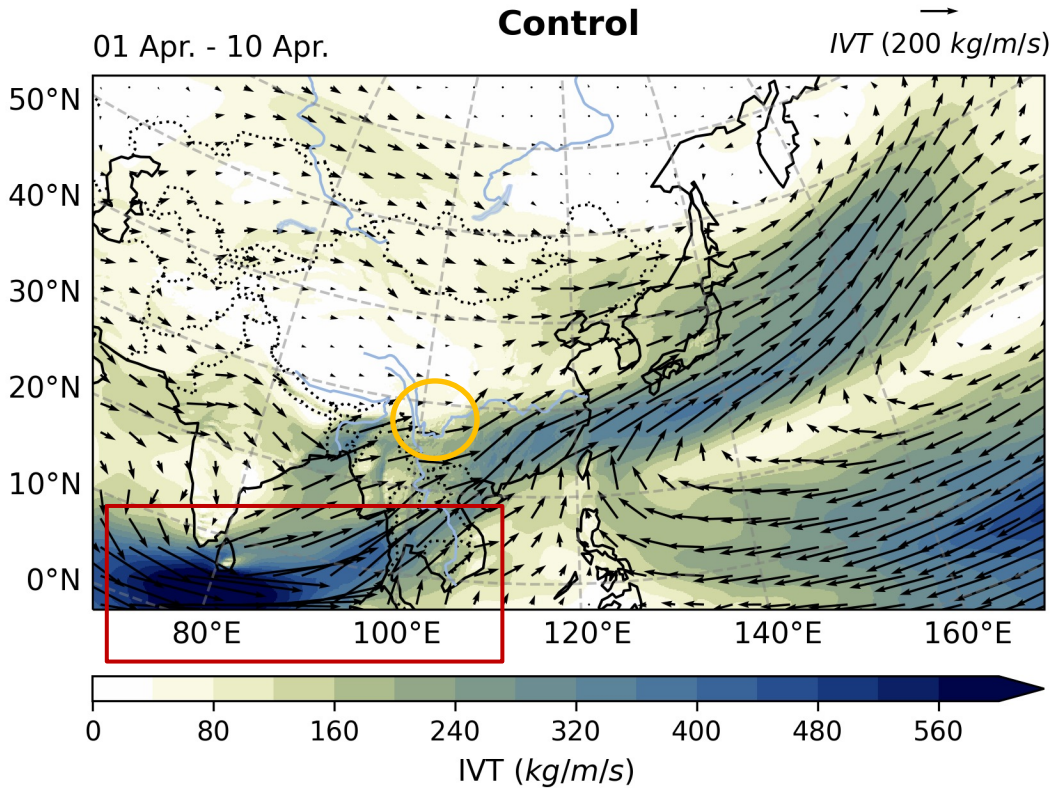
East Asia Atmospheric River (IVT)

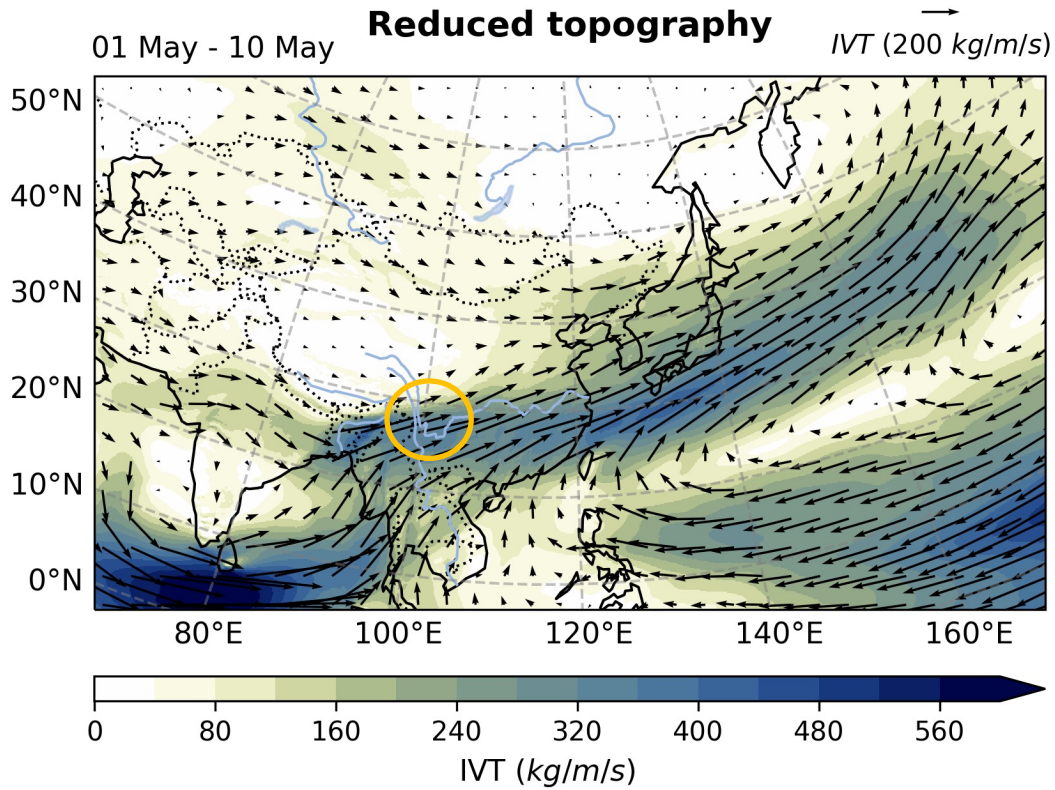


>>> After the uplifts of the Hengduan Mountains, the water vapor transport to the South of India shift by one month.

East Asia Atmospheric River (IVT)

Topography modification region





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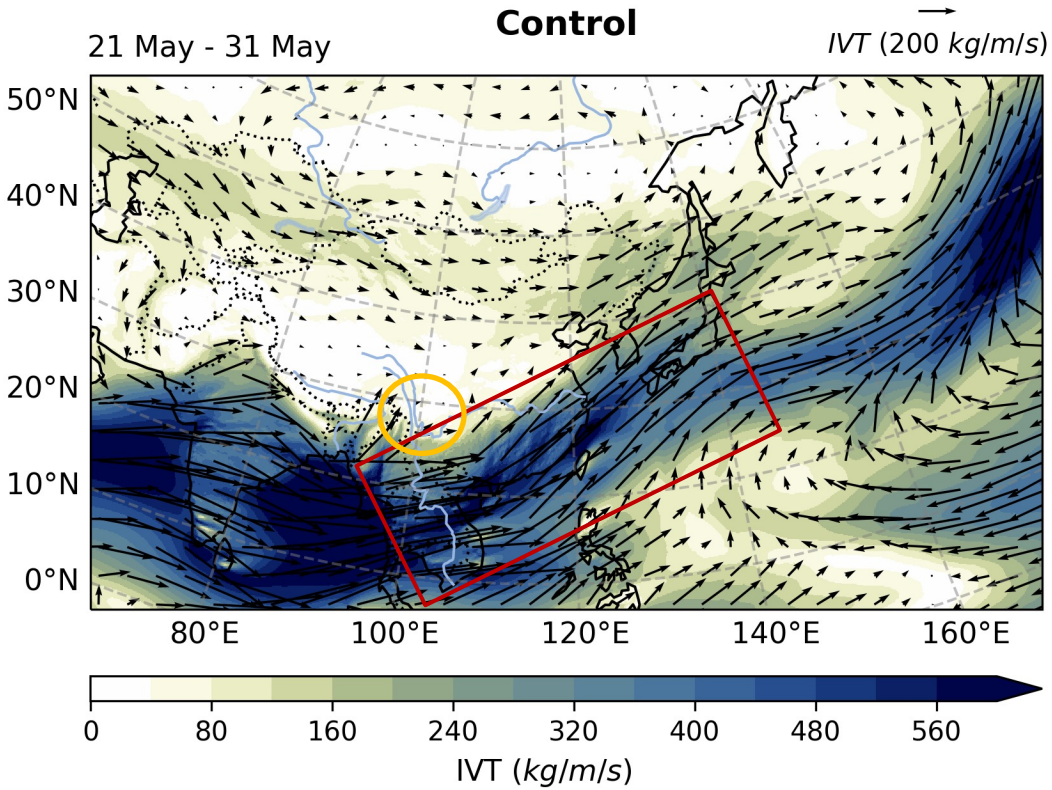
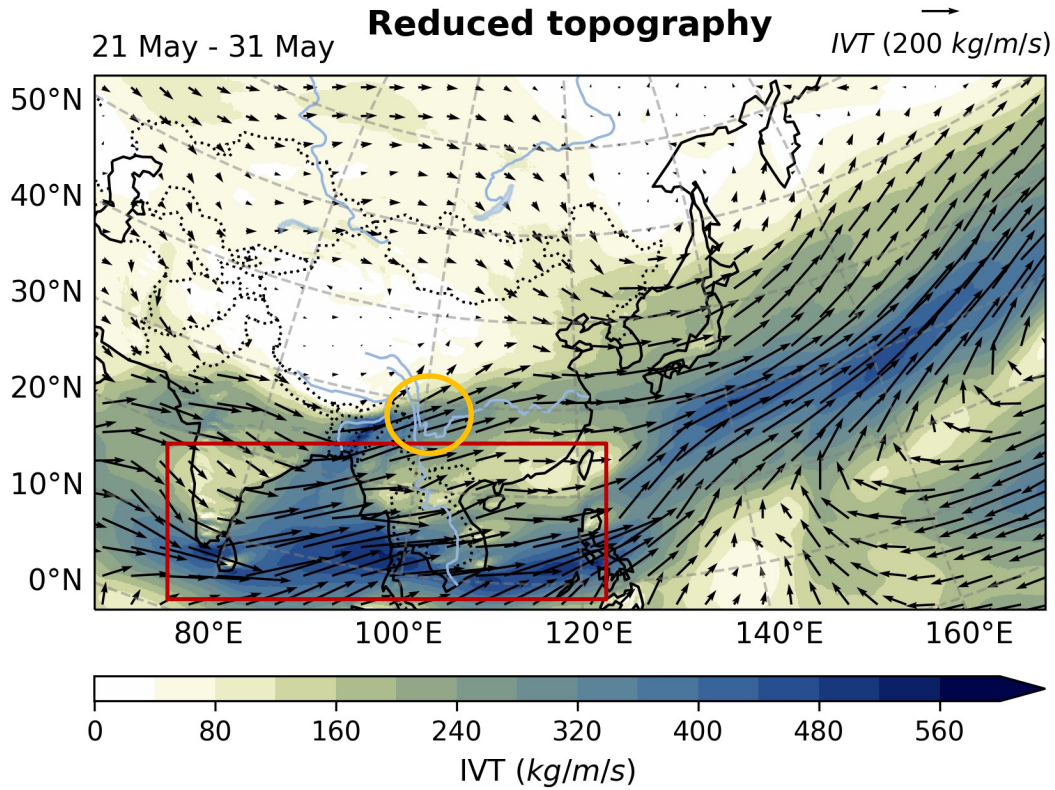
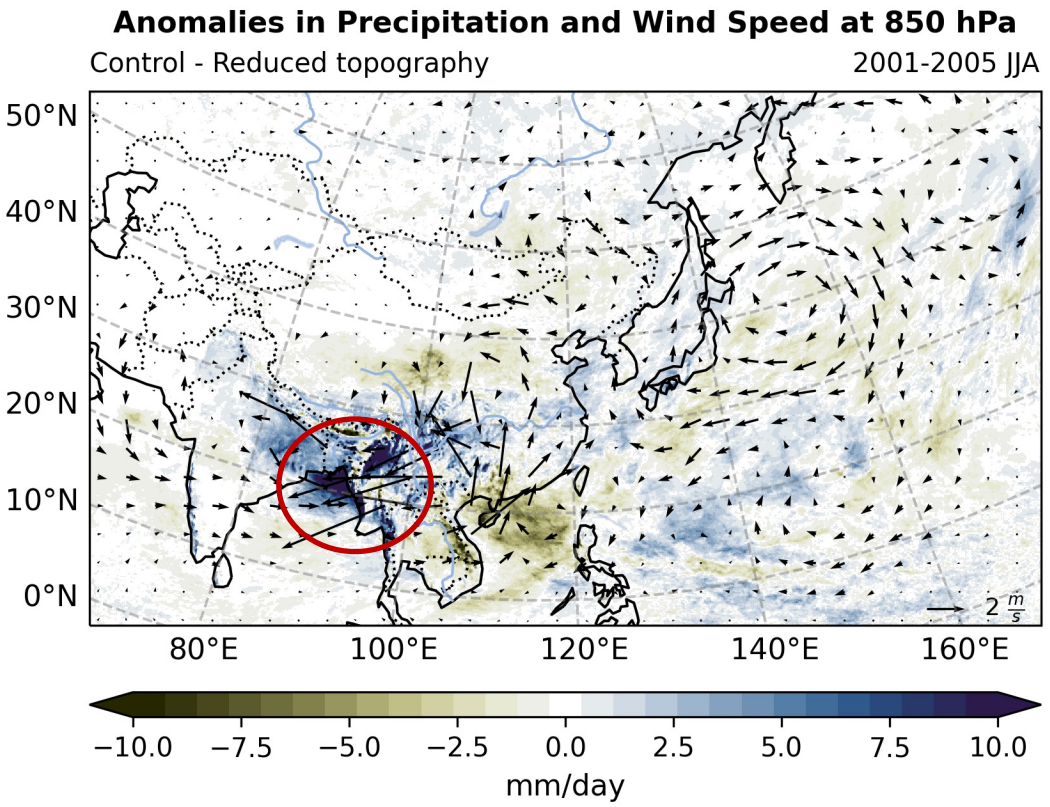
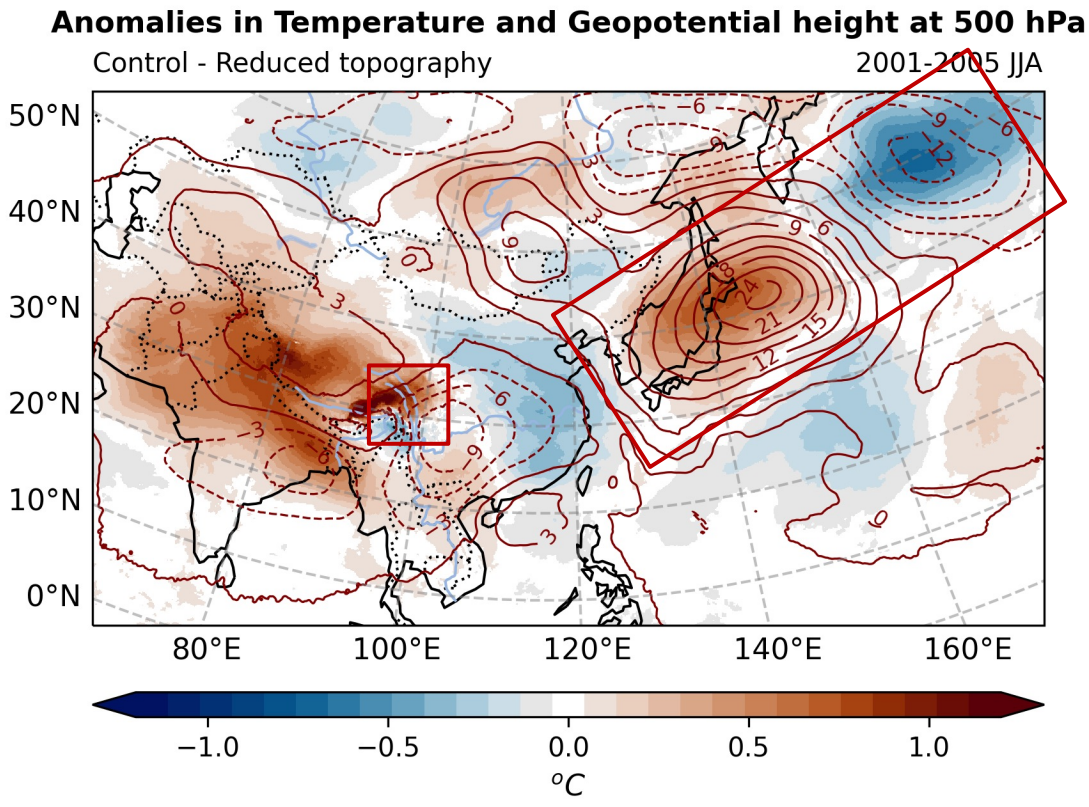




>>> After the uplifts of the Hengduan Mountains, the East Asian monsoon has been intensified.

Summer Precipitation and Temperature





>>> Precipitation markedly increases in the Bay of Bengal.

>>> The uplifts enhance the effect of the Plateau as a heating source in summer.

Conclusion

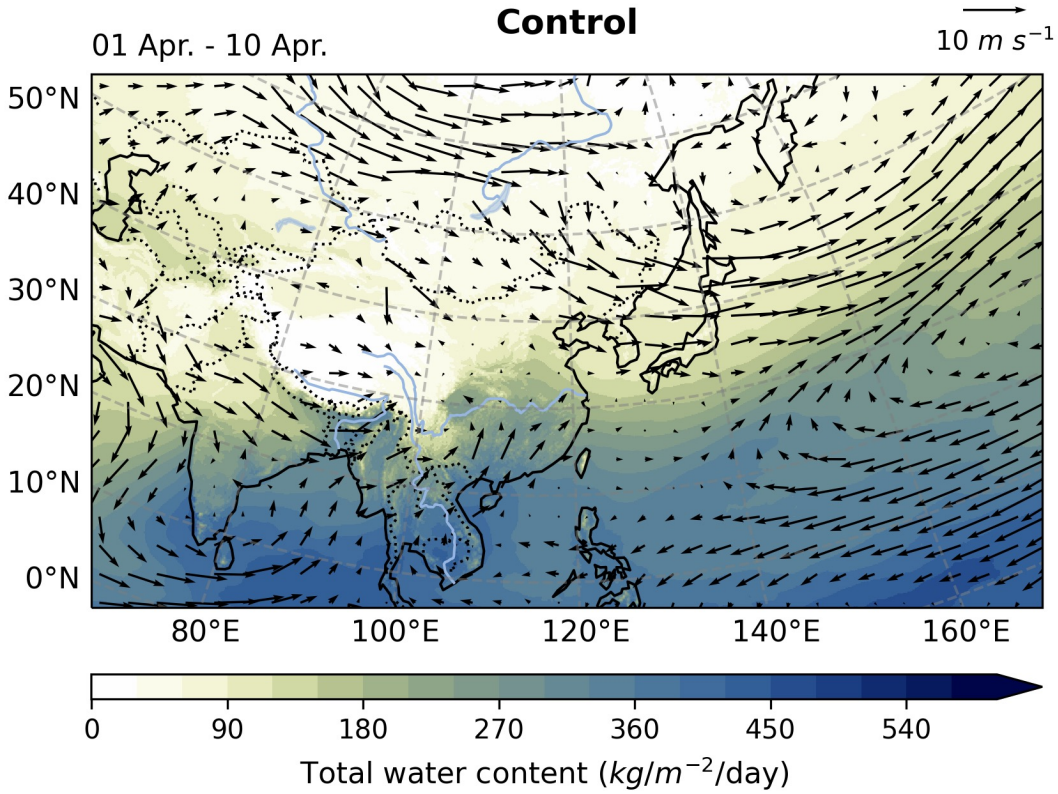
>>> The uplifts of the Hengduan mountains markedly strengthen the monsoon climate in Southeast Asia.

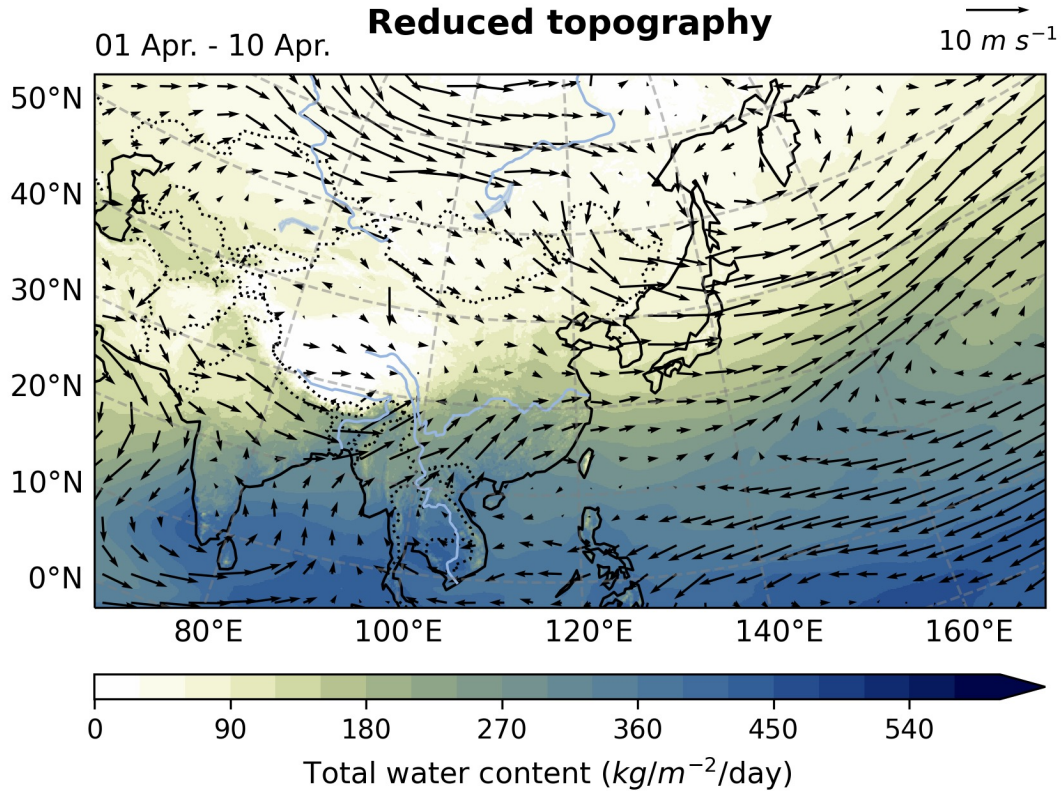
>>> After the uplifts, the water transport to the South of India shift by one month.

>>> The uplifts enhance the effect of the Plateau as a heating source in summer.

Thank you for your attention!

Appendix


Control
01 Apr. - 10 Apr.
10 m s^{-1}
50°N
40°N
30°N
20°N
10°N
0°N
80°E
100°E
120°E
140°E
160°E
0
90
180
270
360
450
540
Total water content (kg/m^{-2}/day)


Reduced topography
01 Apr. - 10 Apr.
10 m s^{-1}
50°N
40°N
30°N
20°N
10°N
0°N
80°E
100°E
120°E
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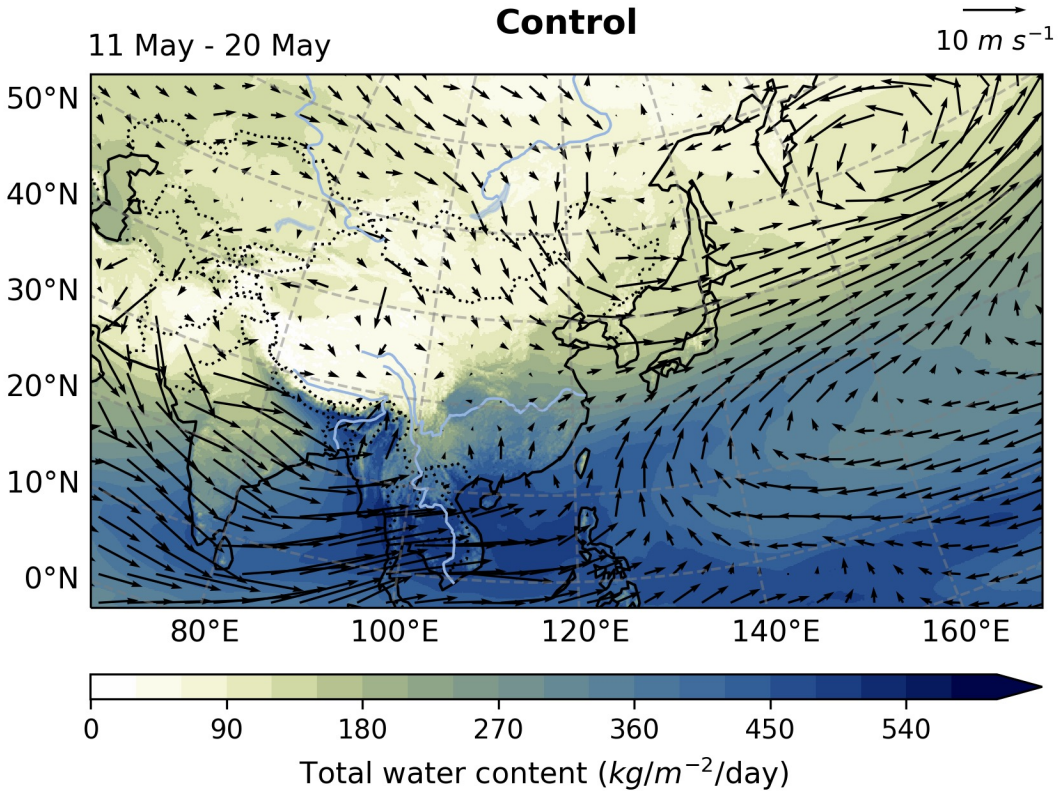
Control
11 May - 20 May
10 m s^{-1}
50°N
40°N
30°N
20°N
10°N
0°N
80°E
100°E
120°E
140°E
160°E
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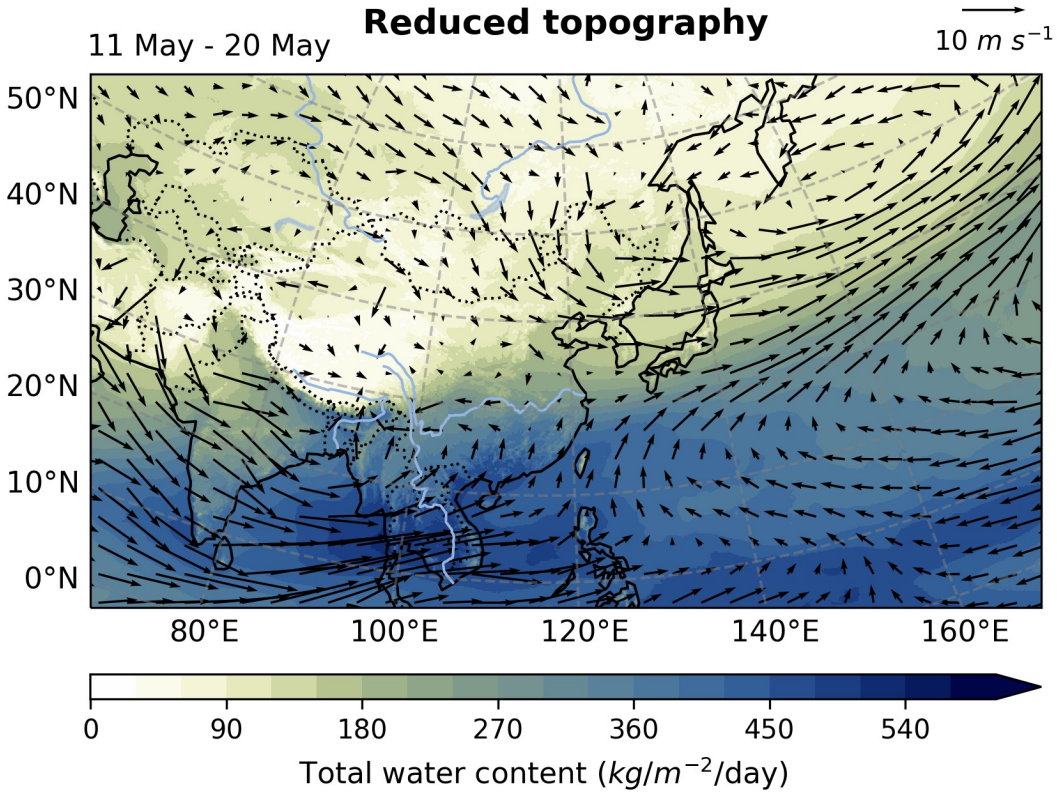
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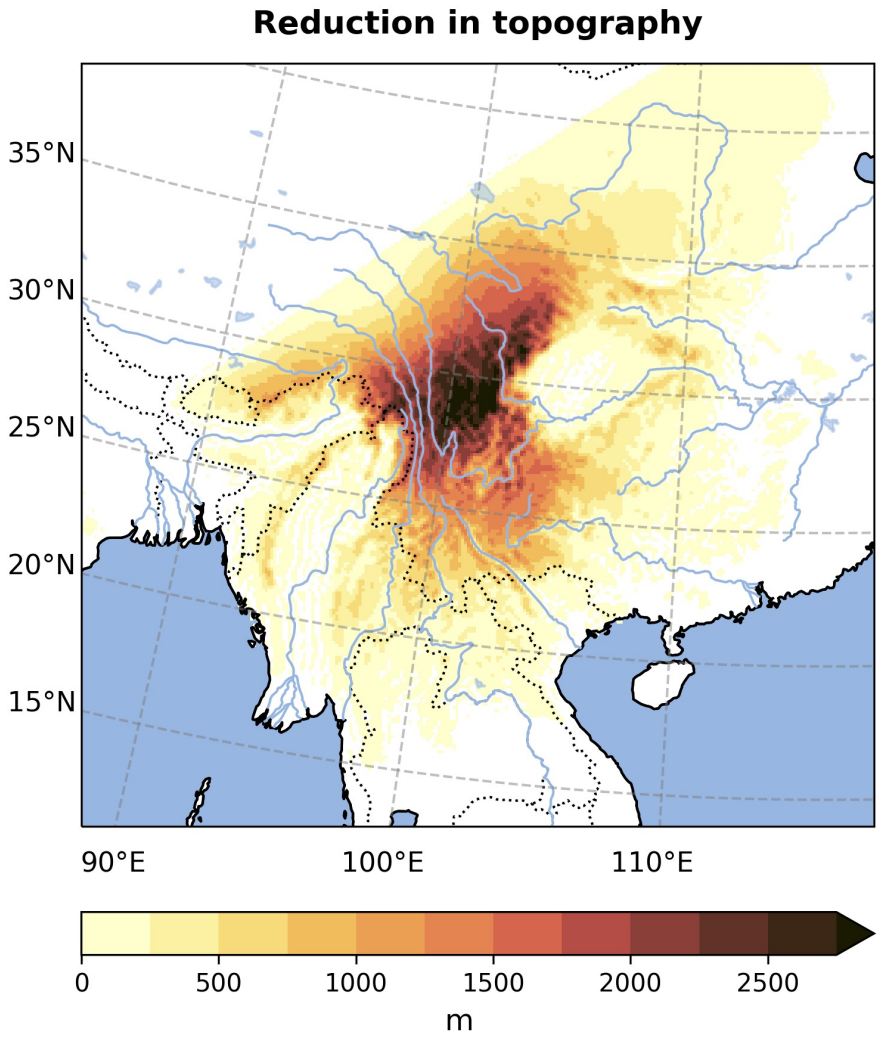

$$f_r = \begin{cases} 0, if\ r > r_o + r_{ext} \\ sin^2\left(\frac{r}{r_0}\times\pi\right), if\ r \le \frac{r_0}{2} \\ sin^2\left(\frac{r - r_{ext}}{r_0}\times\pi\right), if\ \frac{r_0}{2} + r_{ext} \le r \le r_0 + r_{ext} \\ 1, else \end{cases}$$

where r is the distance to the NW point (33.23°N, 95.10°E), r_0 =1800 km and r_{ext}=300 km.

$$f_\alpha = \begin{cases} sin^2\left(\frac{\alpha - \alpha_1}{\alpha_2 - \alpha_1}\times\pi\right), if\ \alpha_1 \ll \alpha \ll \alpha_2 \\ 0, else \end{cases}$$

where α is the angel between the east and the ray to the grid cell. α_1=45° and α_2= − 135°

$$Total\ reduce\ factor:\ f_{tot} = 0.75\times f_r \times f_\alpha$$

$$z_r = z_o\ - \max(z - z_s, 0)\times f_{tot}$$

where z_r is the reduced topography, z_o is the original topography and z_s (500 m) is the spared topography