27 May 2022 EGU AS1.17

Heavy summer precipitation events in the Sichuan basin and their connection to meso-scale convective systems and Tibetan Plateau vortices

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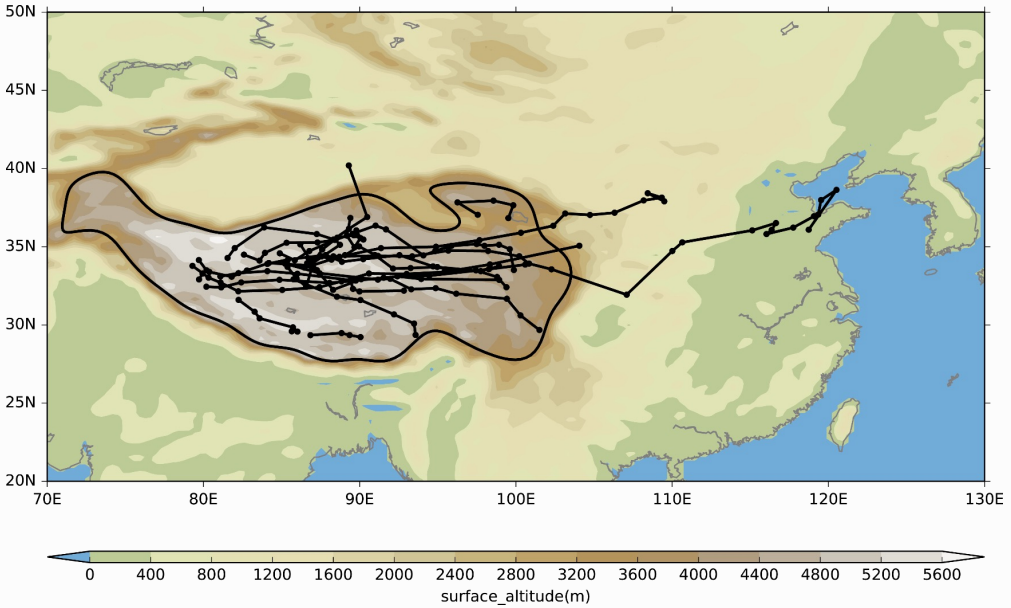
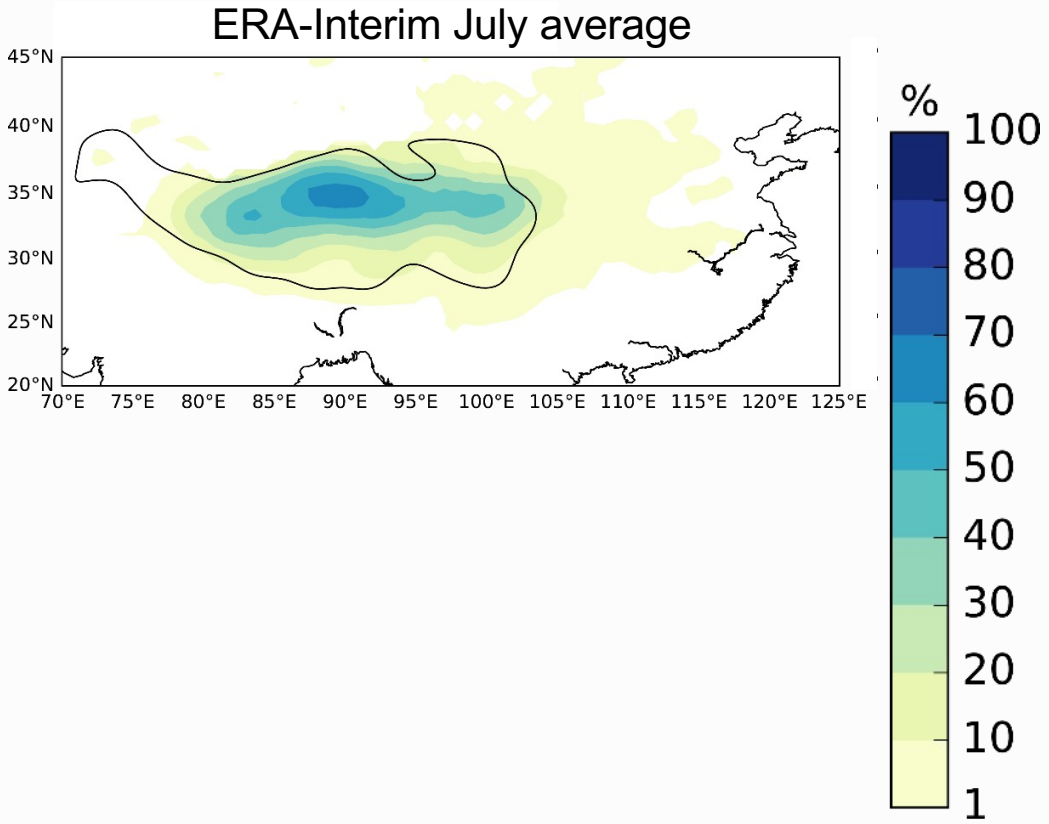
Tibetan Plateau Vortices (TPVs)



- Frequent phenomena
- Mainly present at 500 hPa level
- Spatial scales
  - horizontal: Meso-α-scale, 400-800 km
  - vertical: 2-3 km
- Pronounced annual cycle with maximum occurrence frequency in summer and minimum in winter
- Only a minority of TPVs move off the Tibetan Plateau

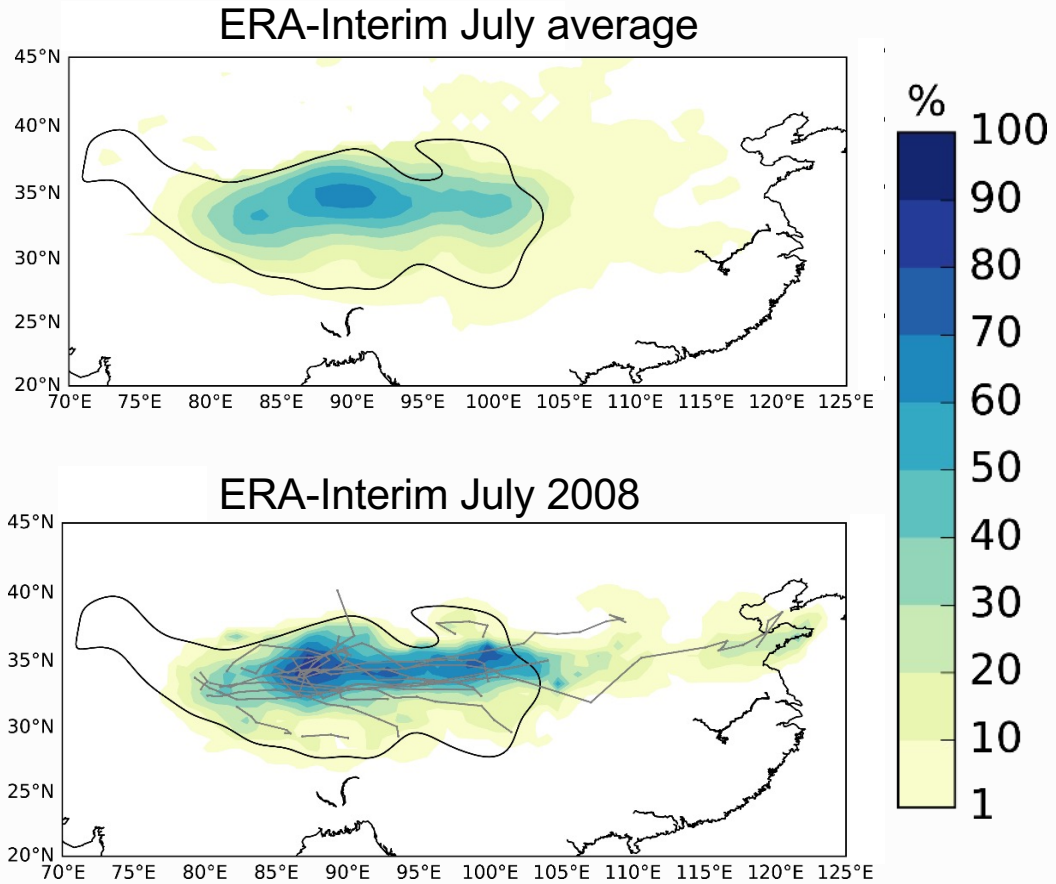
Precipitation contribution



- TPV-associated precipitation accounts for up to 70% of the total monthly precipitation on the TP
- Contribution downstream up to 20%

Curio et al. 2019, Journal of Climate

Precipitation contribution



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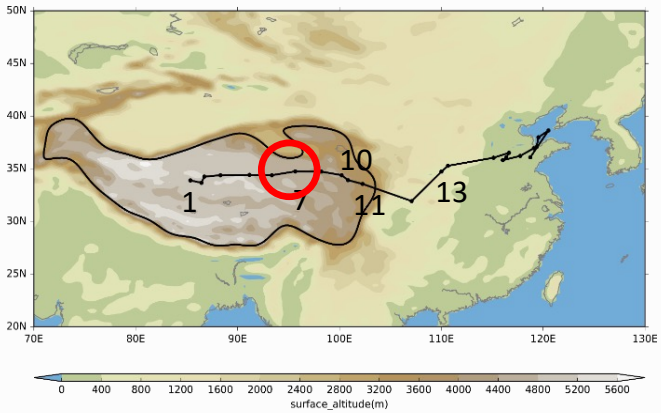
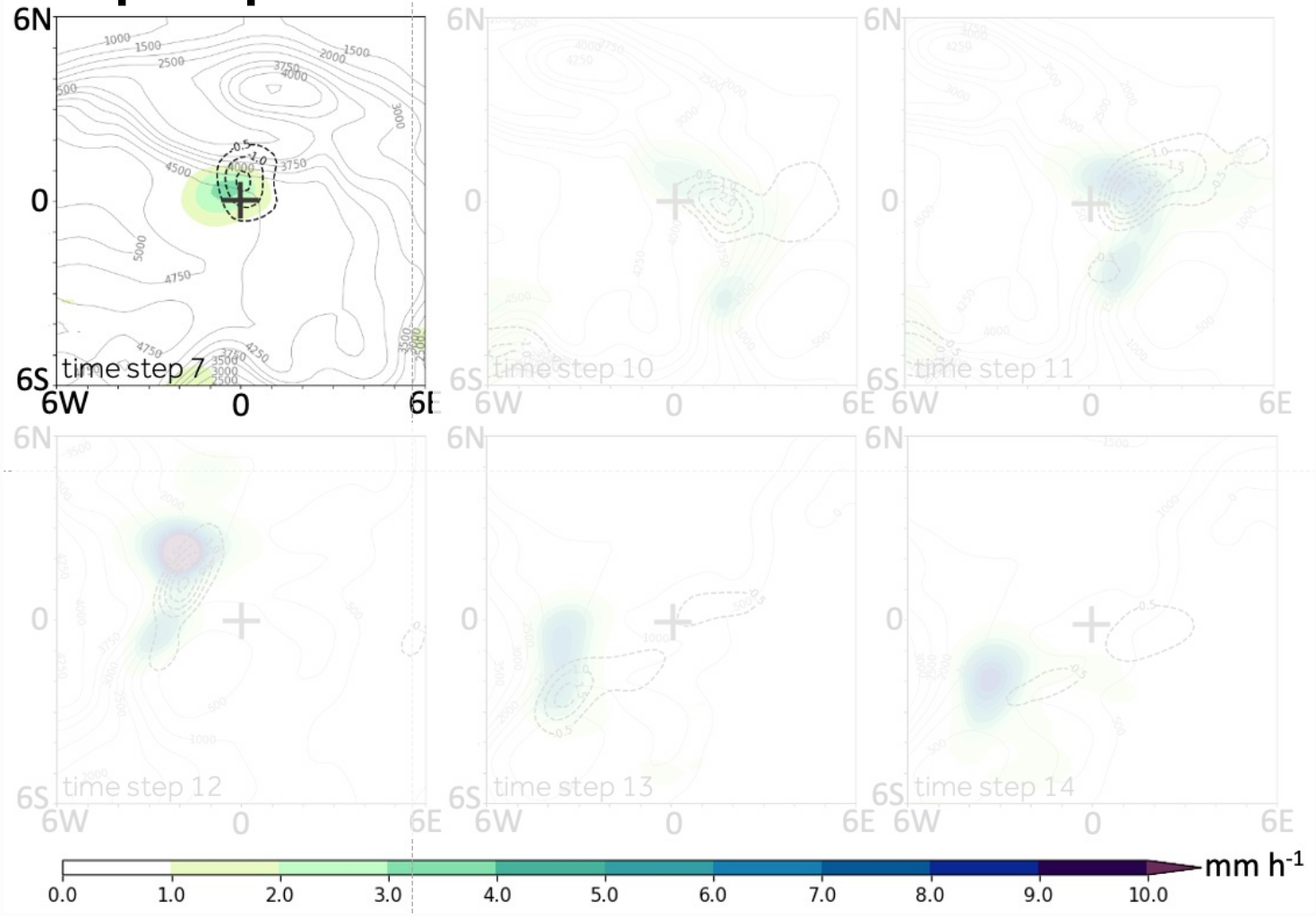
- TPV-associated precipitation accounts for up to 70% of the total monthly precipitation on the TP
- Contribution downstream up to 20%

- For individual months the contribution can be much higher in some downstream regions, mainly due to single TPV events
- These moving-off TPVs can trigger extreme rainfall and severe flooding

July 2008 TPV associated precipitation

Colour shading: precipitation rate
Grey contours: orography
Dotted contours: updraft





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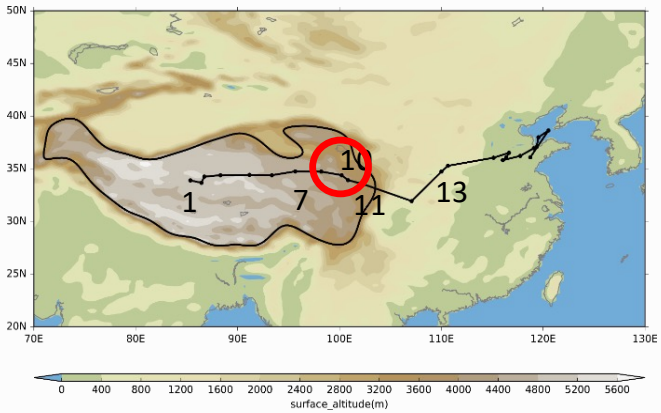

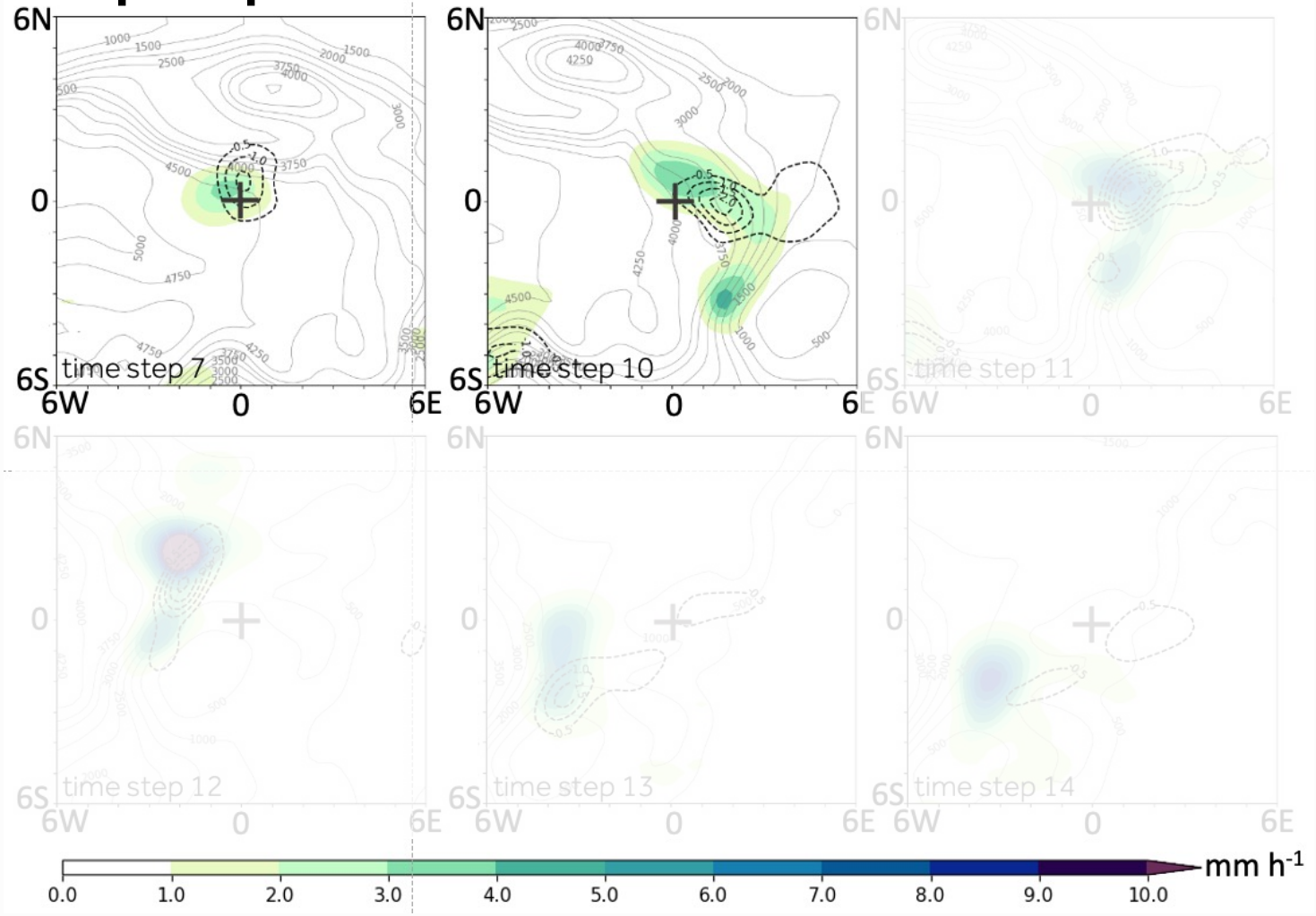

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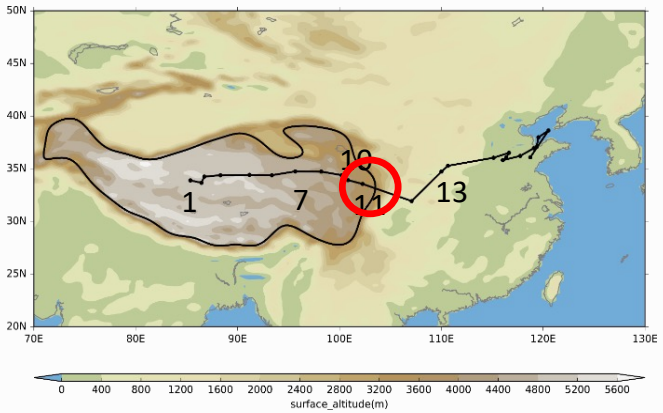

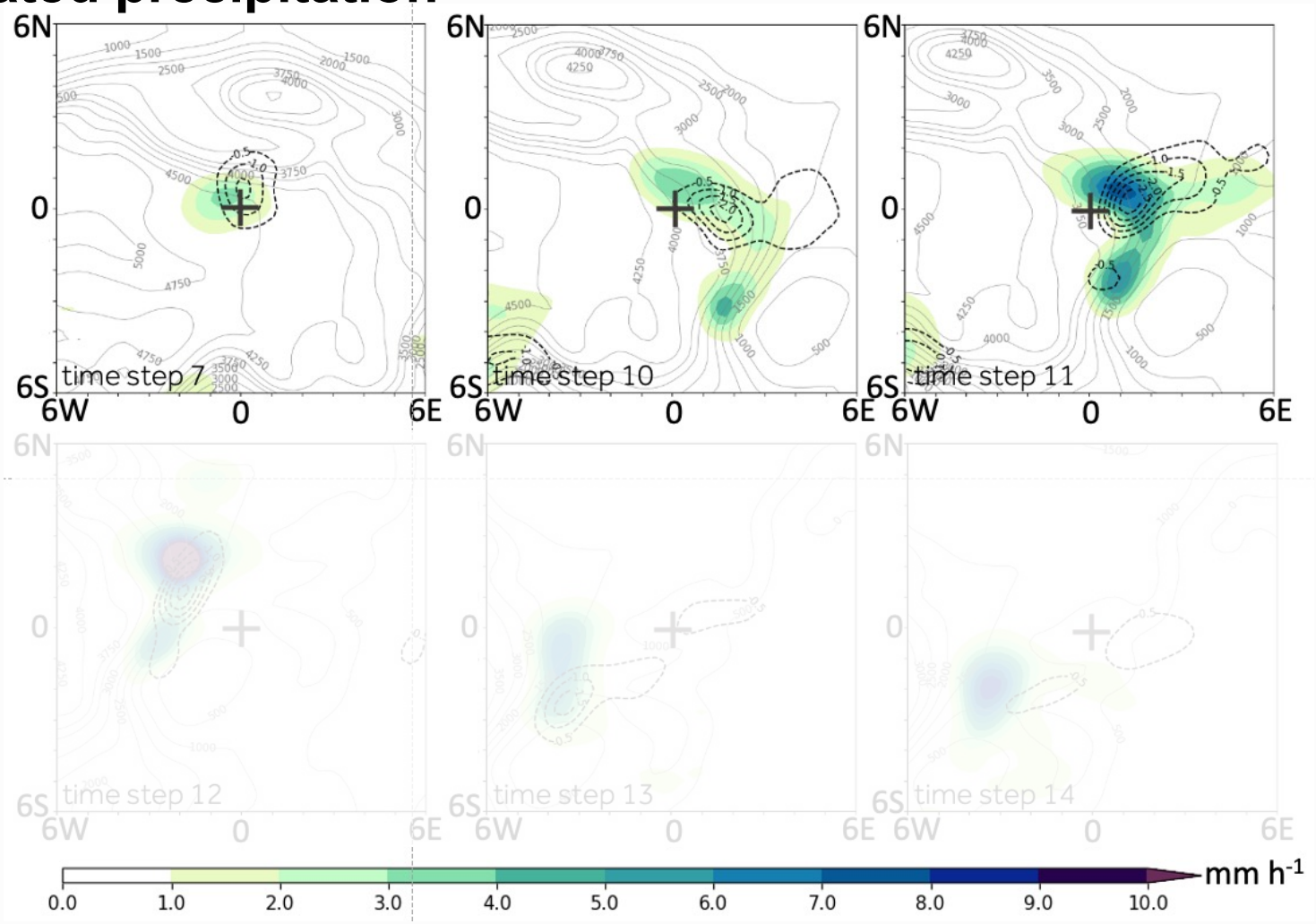

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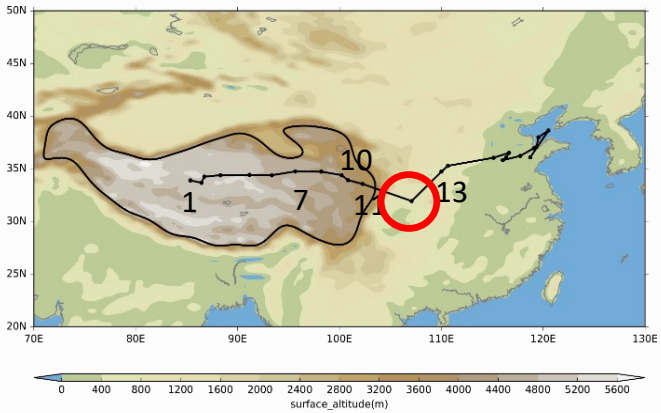

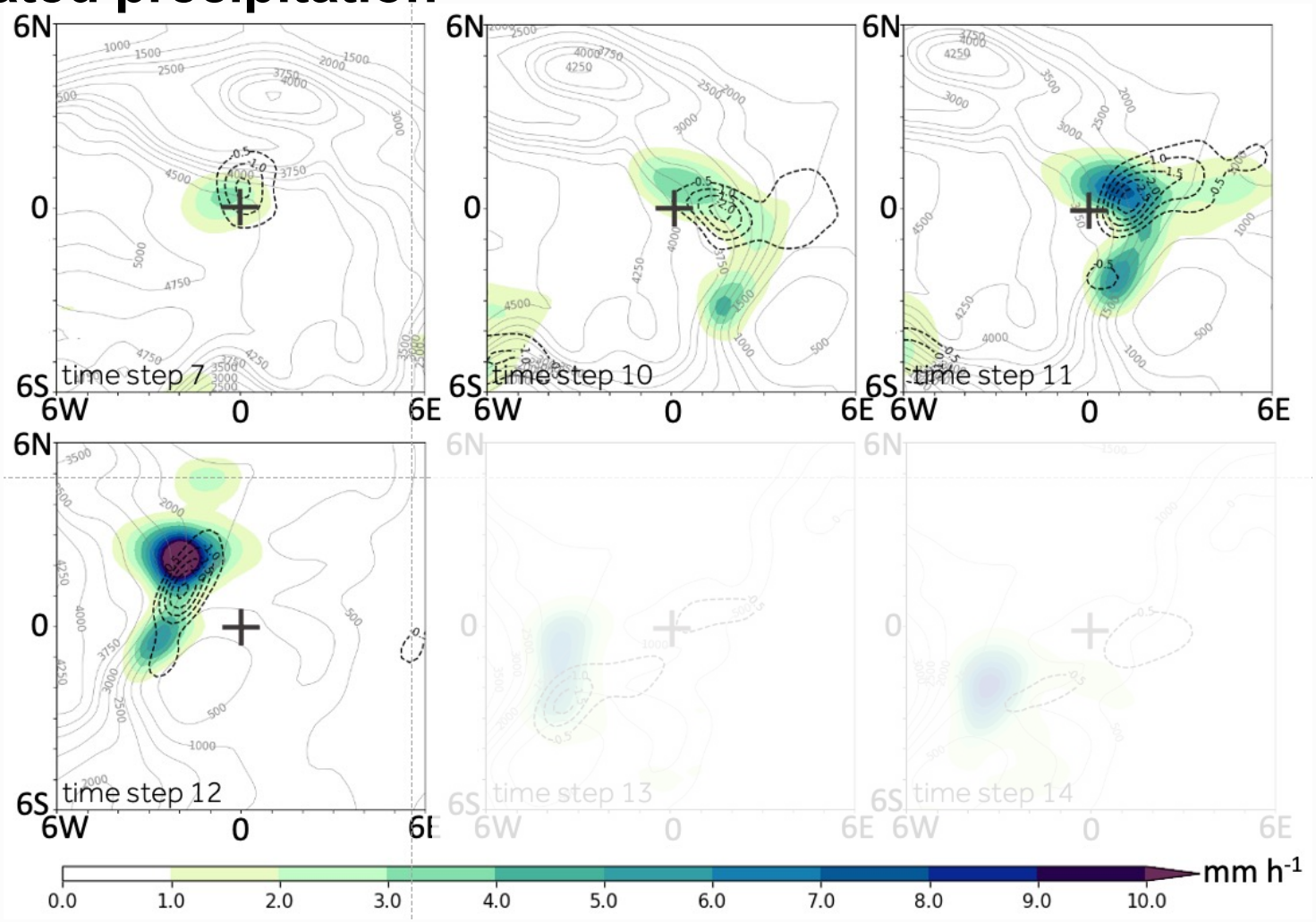

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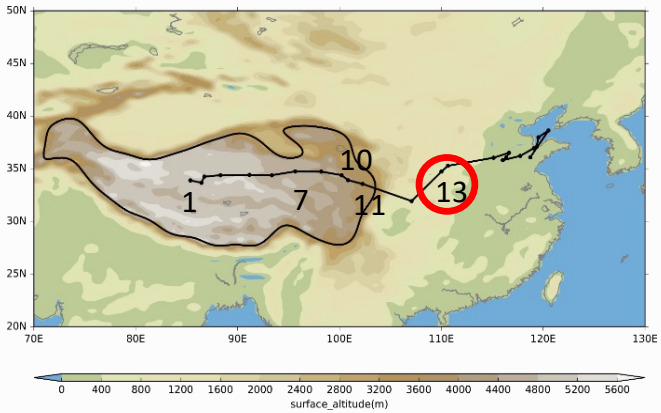

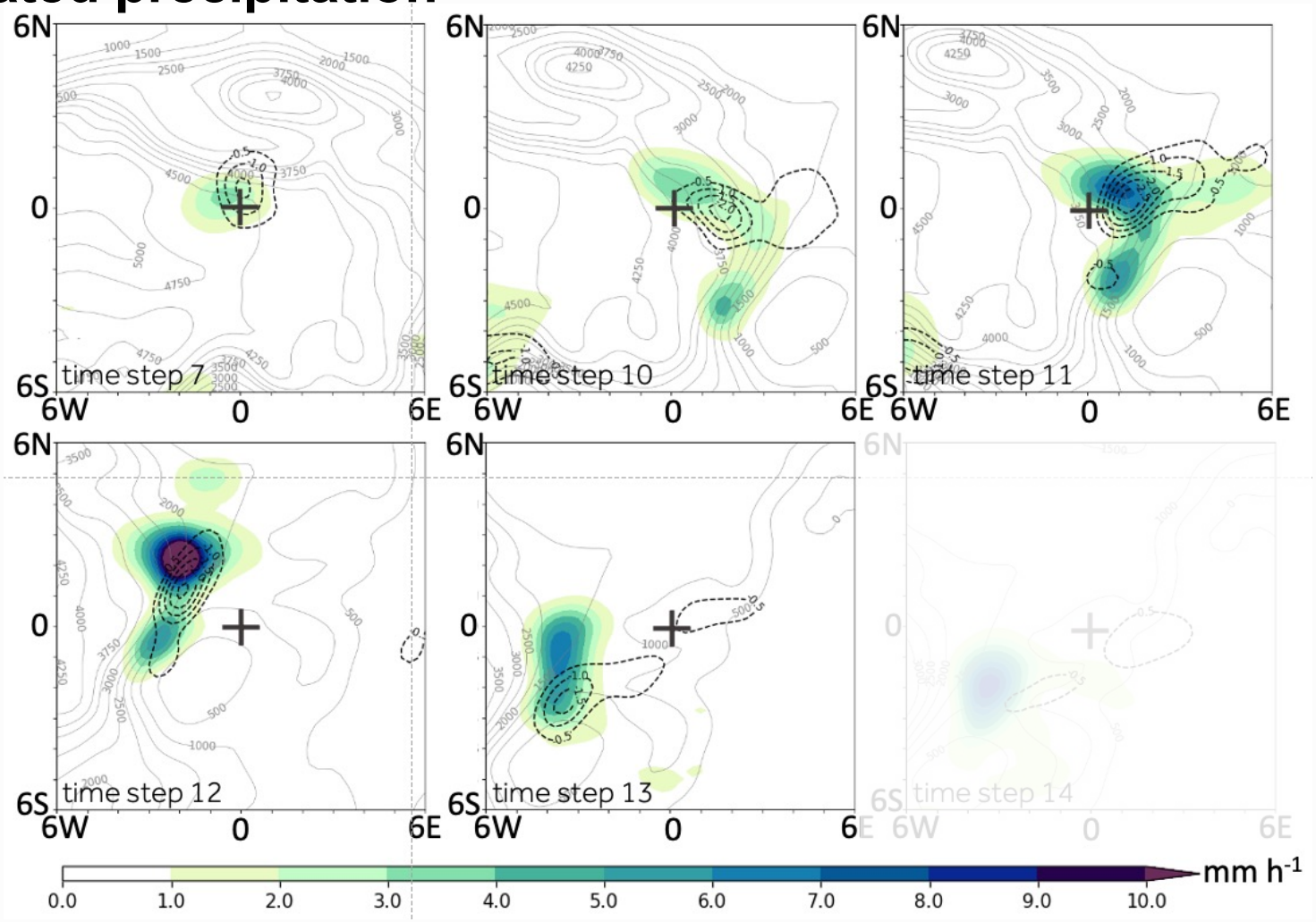

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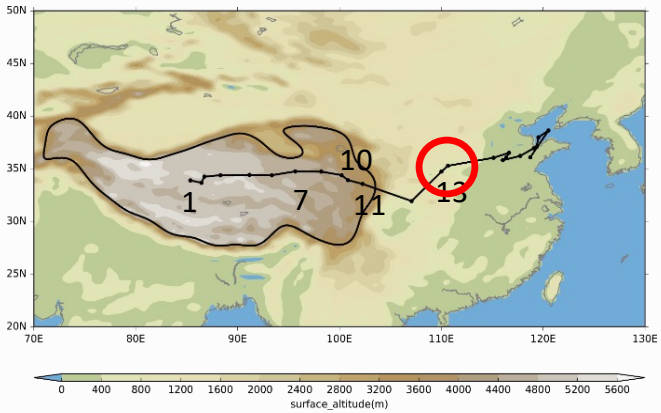
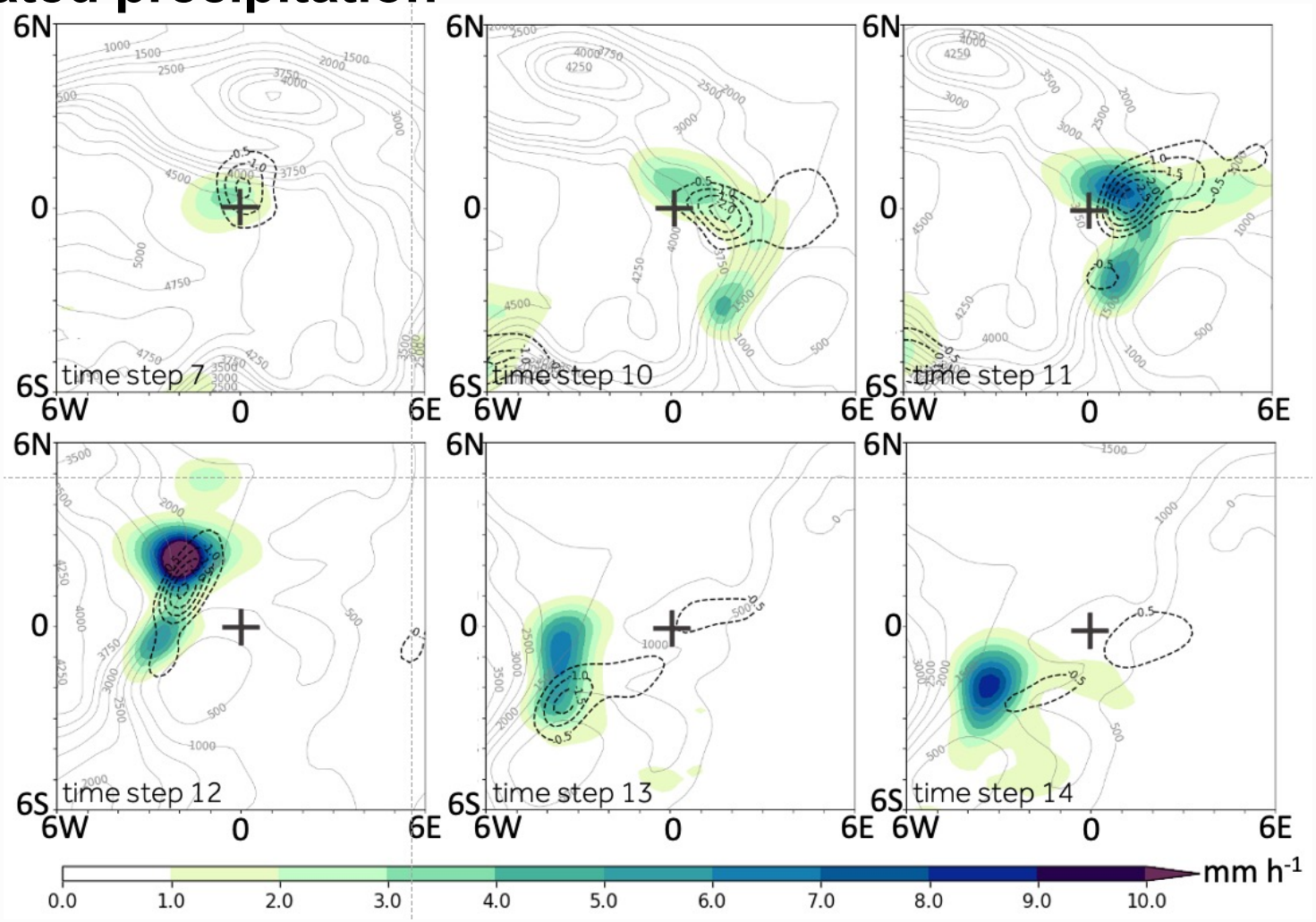
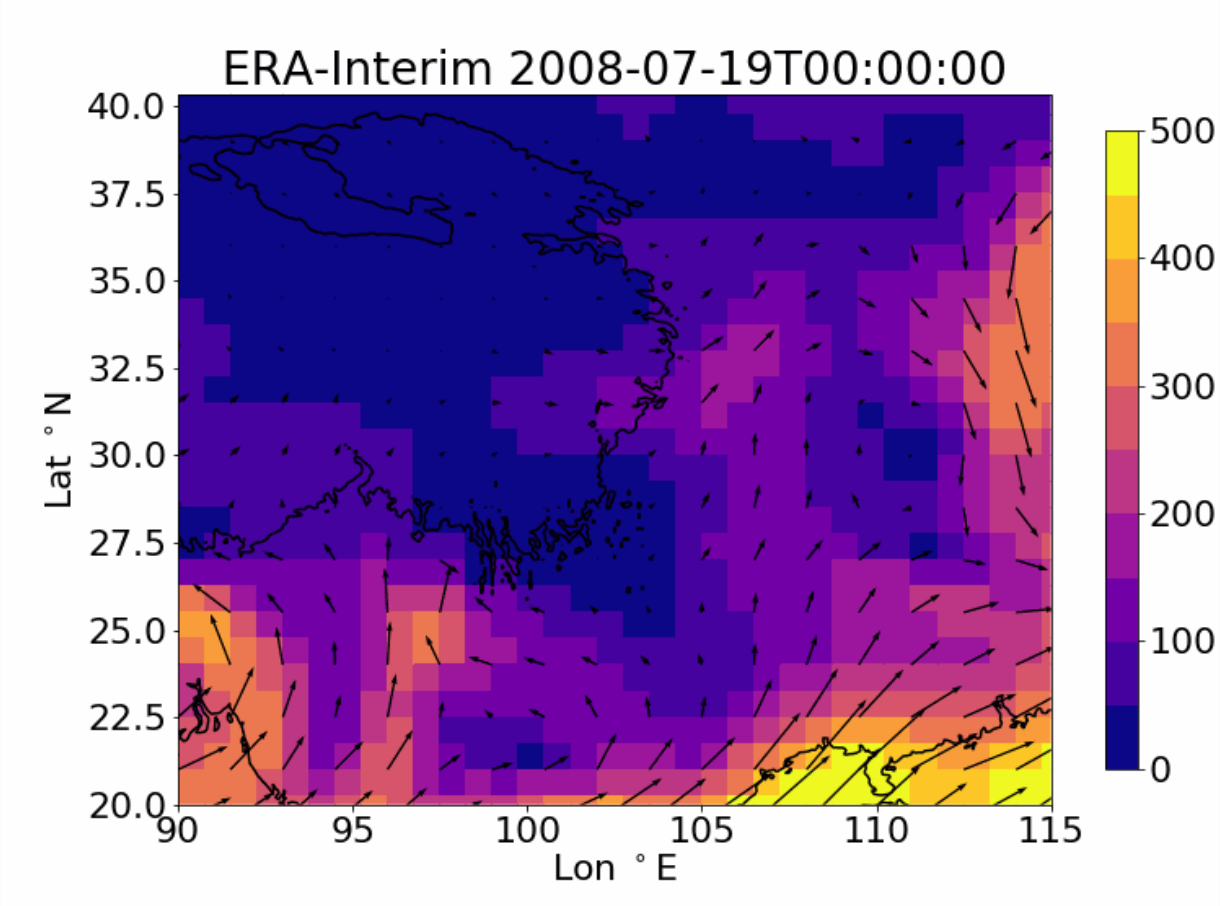




Moisture transport



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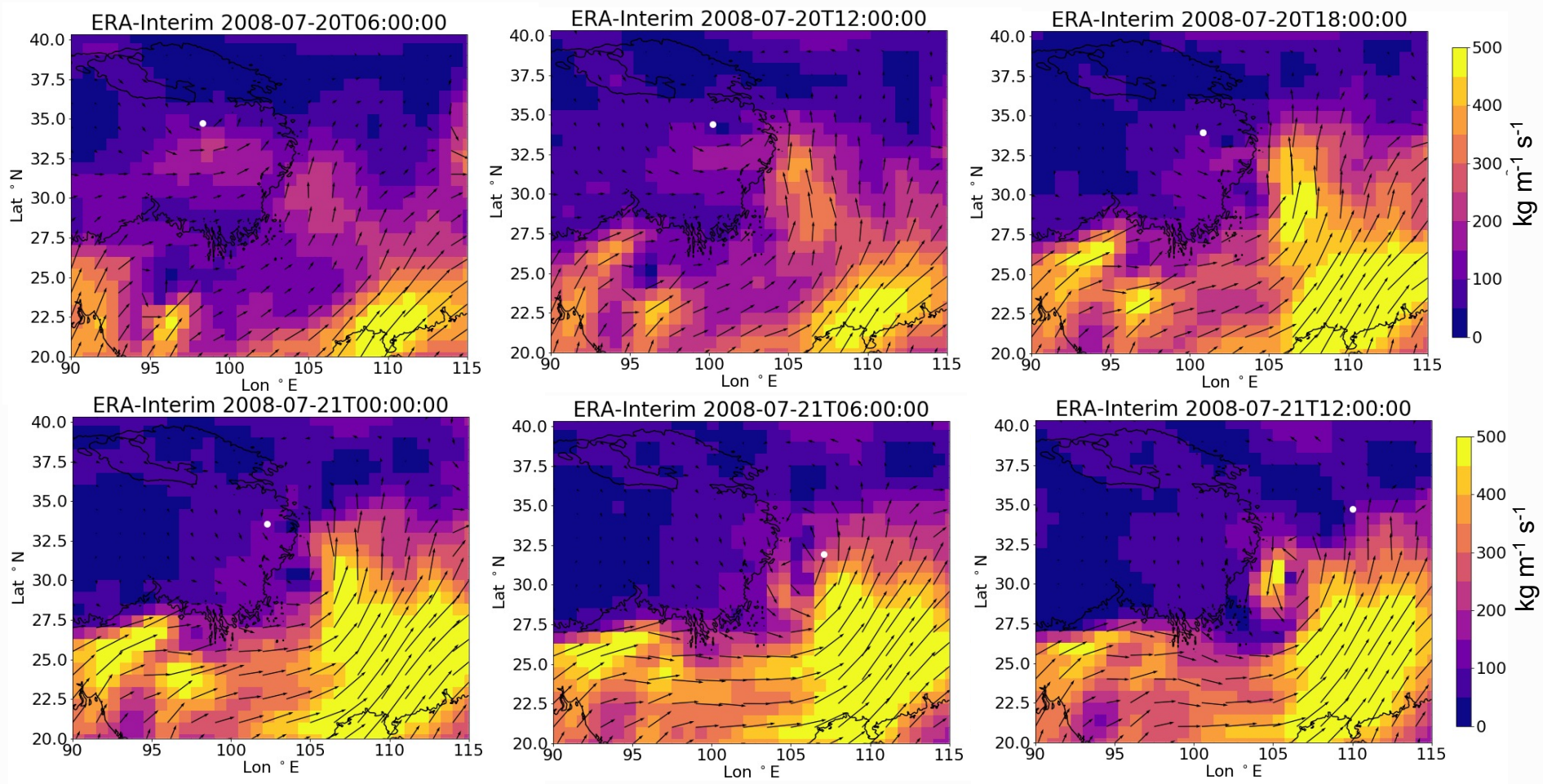
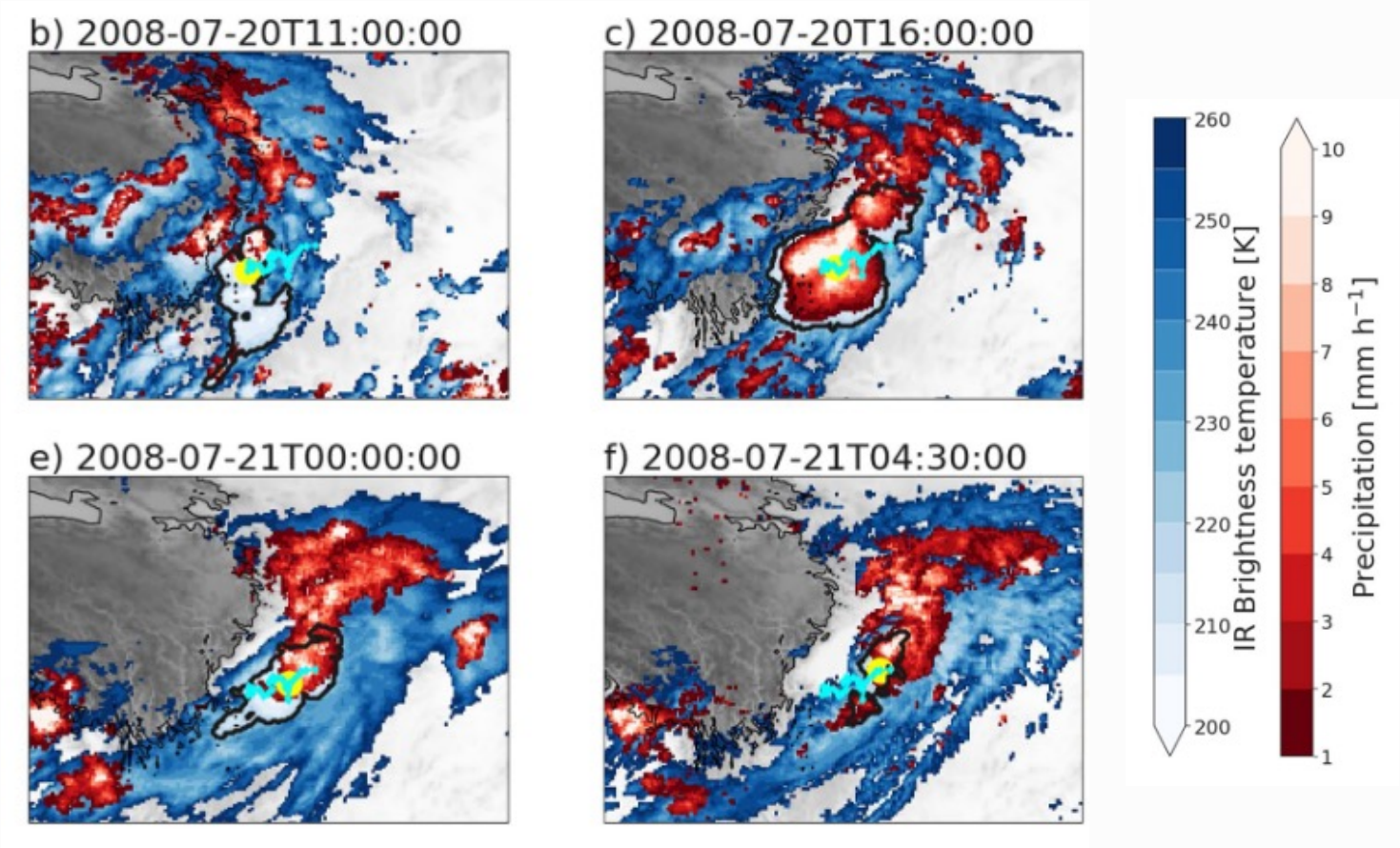
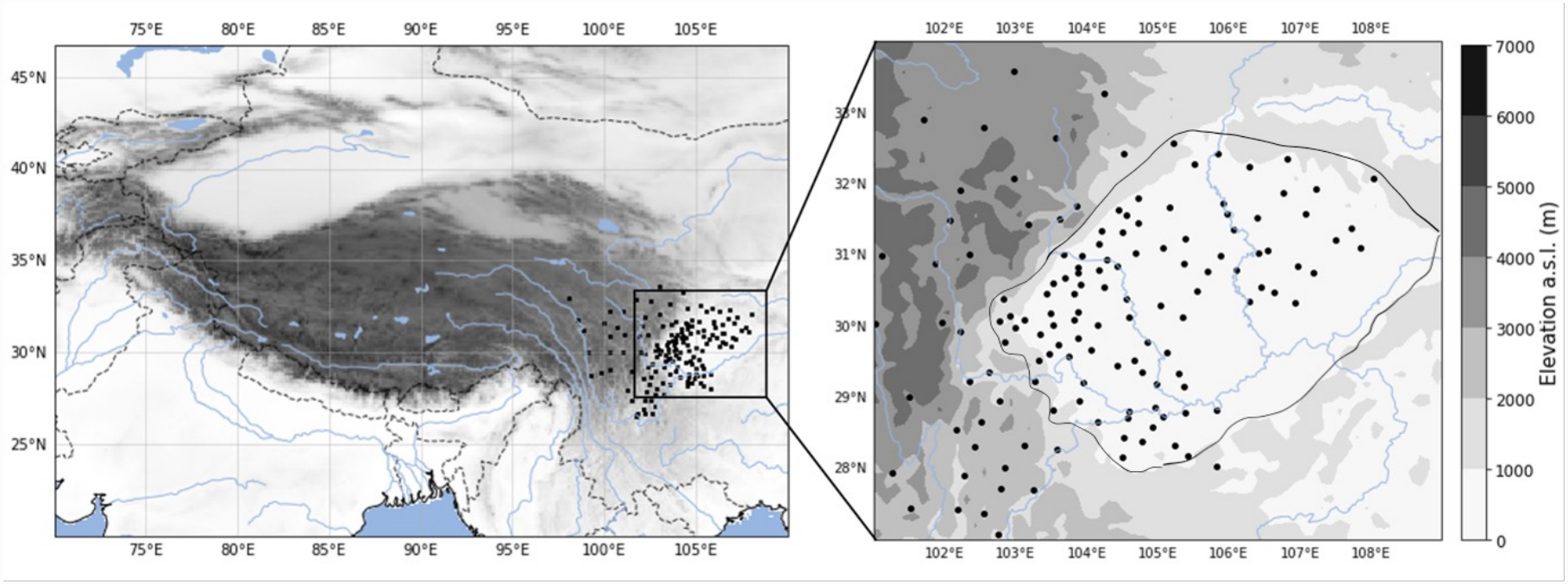


Mesoscale convective system (MCS) triggered by moving-off TPV



Kukulies et al. 2021, JGR Atmospheres

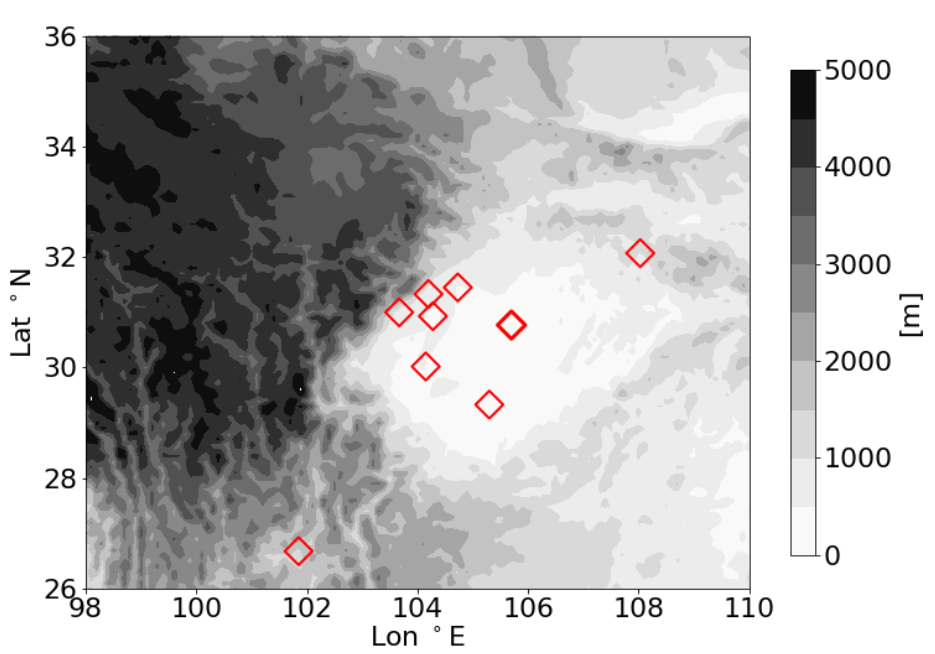
Extreme precipitation events based on in-situ observations (2000-2018)



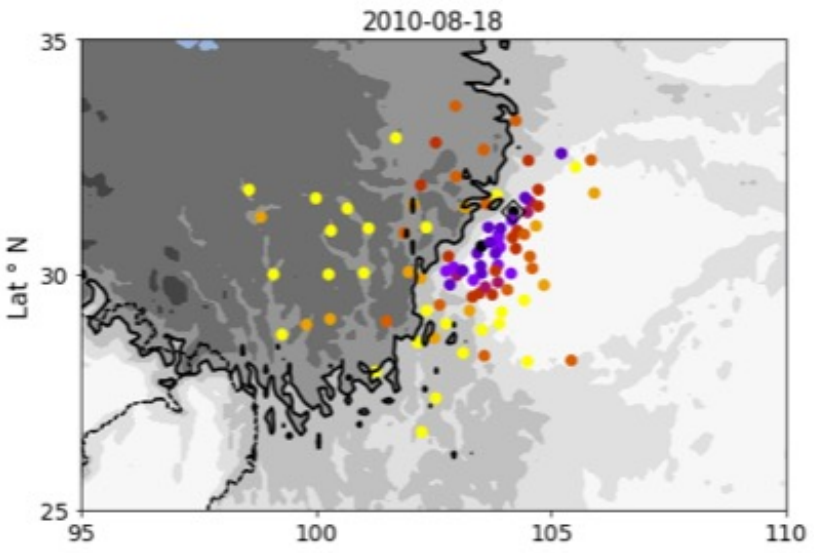
How often do extreme precipitation events in this region occur in connection to mesoscale weather systems?

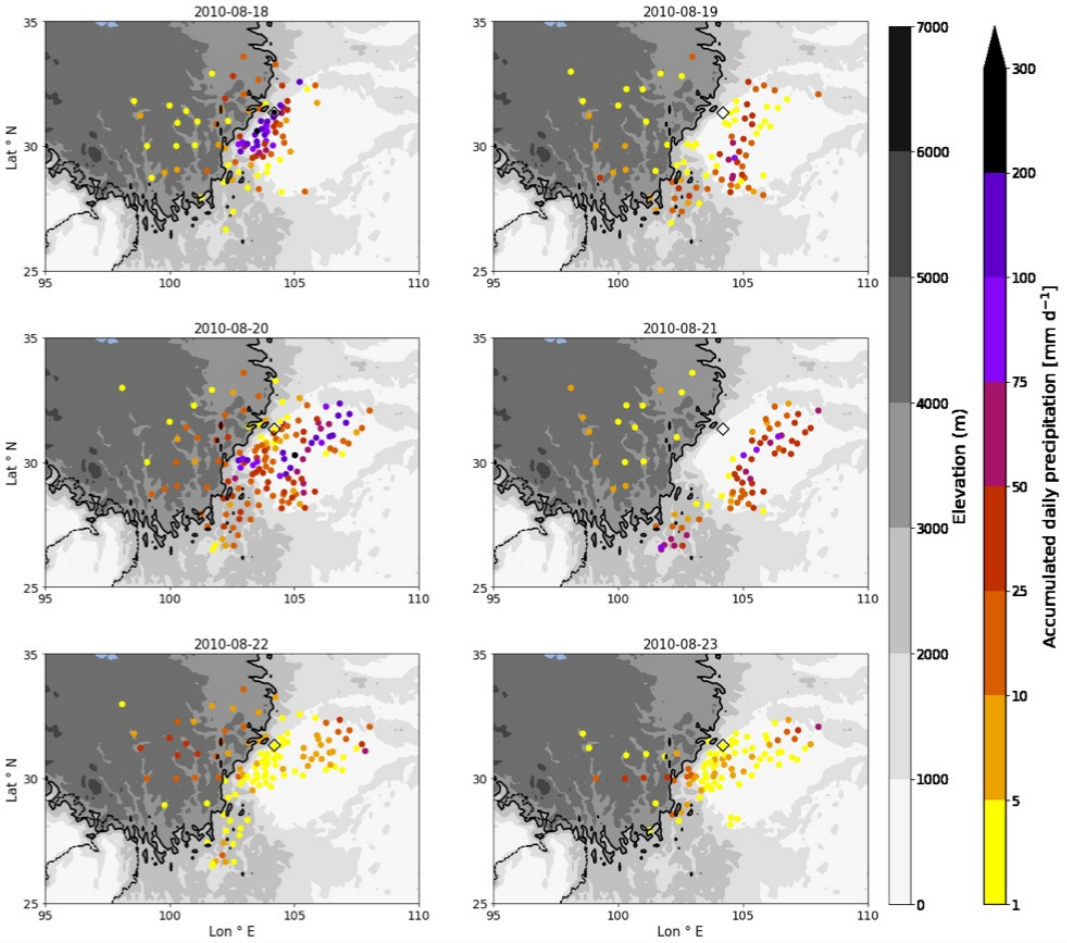
Extreme precipitation events based on in-situ observations (2000-2018)

N°	Station	Coordinates (long., lat.)	Date	Precipitation (mm d^{-1})	Elevation (m)
1	56188	103.67, 31.0	08-07-2013	423.8	698.5
2	56291	104.28, 30.93	10-07-2018	321.9	469.0
3	57507	105.3, 29.33	08-07-2007	298.7	373.4
4	56186	104.2, 31.33	18-08-2010	292.5	589.0
5	56297	104.15, 30.02	24-07-2010	284.5	436.5
6	57402	105.7, 30.77	07-06-2002	278.0	394.5
7	56196	104.73, 31.45	04-07-2017	266.7	522.7
8	57402	105.7, 30.77	08-08-2014	261.8	394.5
9	56665	101.85, 26.68	22-07-2007	261.7	1140.3
10	57237	108.03, 32.07	16-07-2010	255.8	674.0

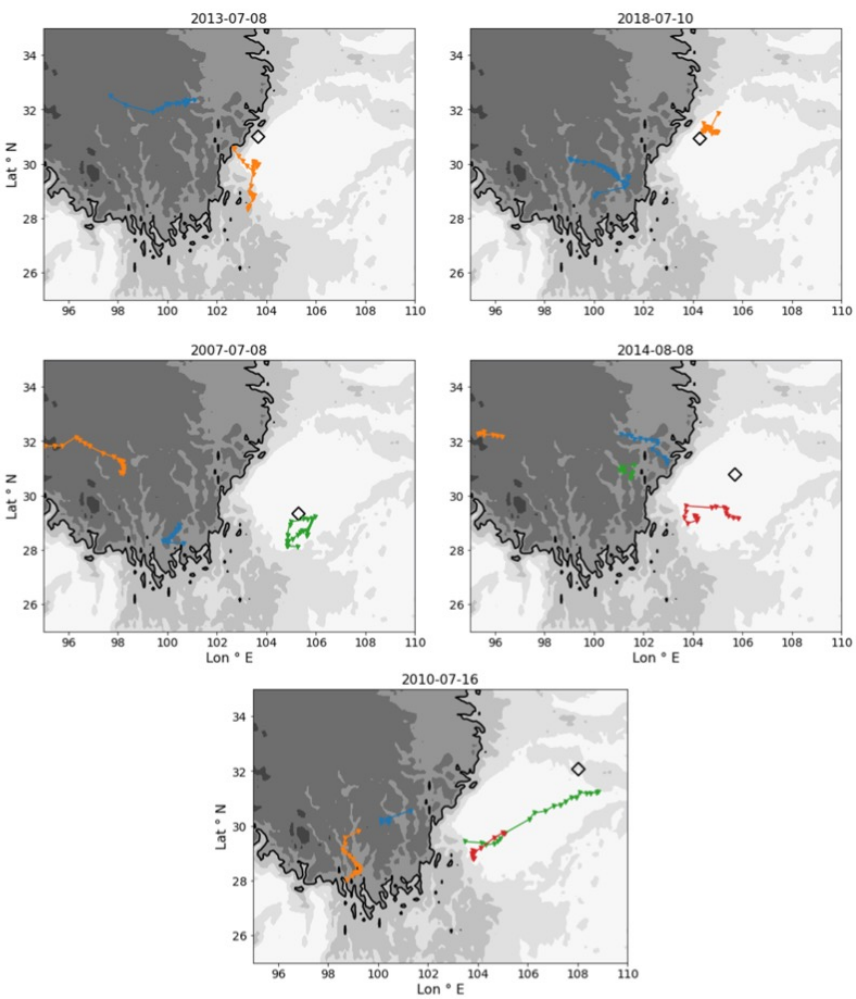


Extreme precipitation event example





MCSs and TPVs associated with extreme precipitation events



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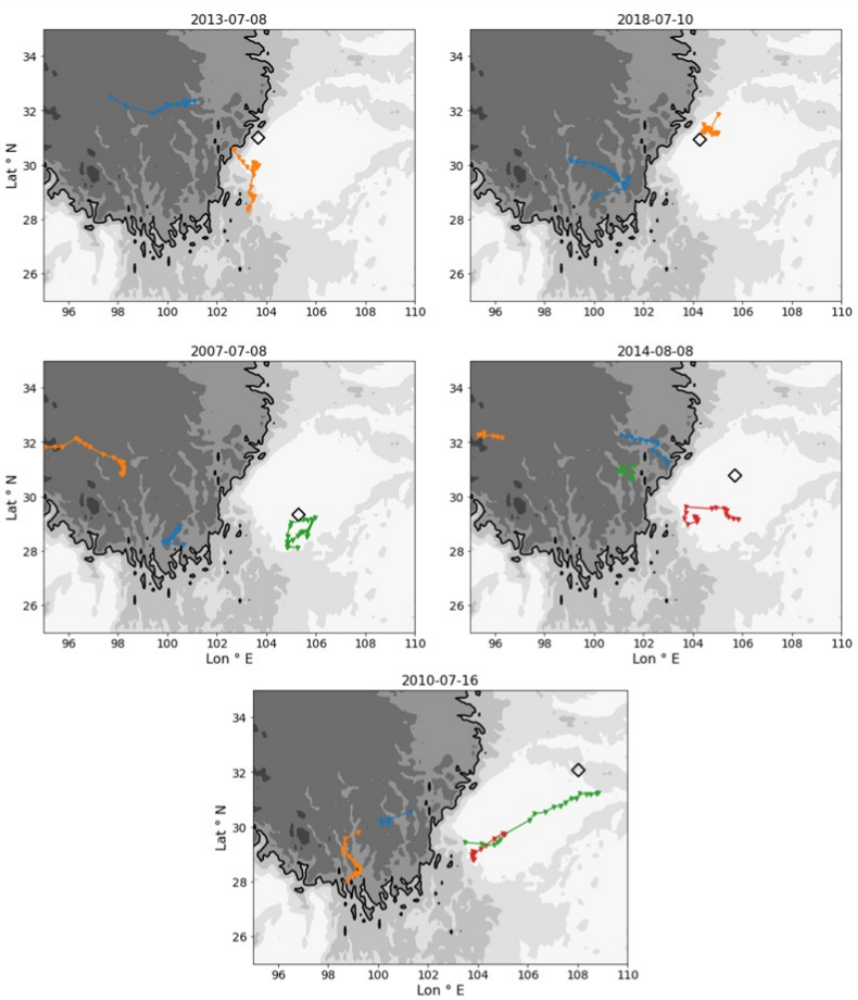
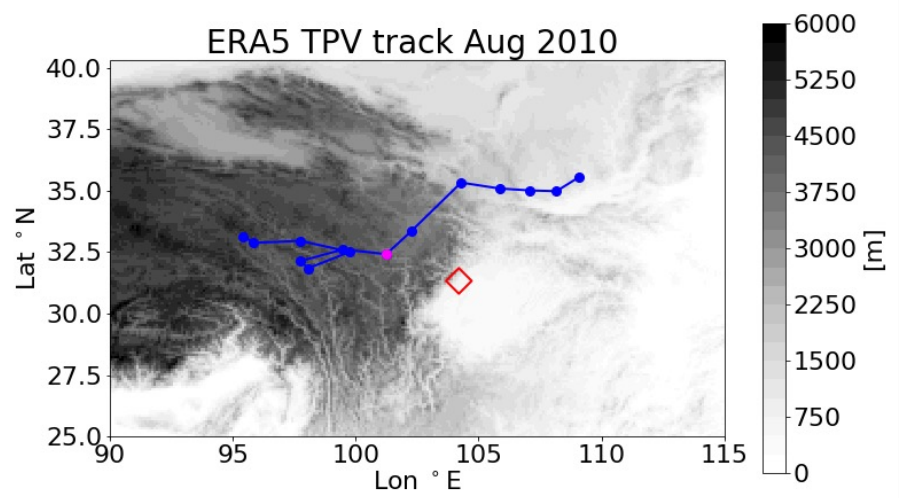
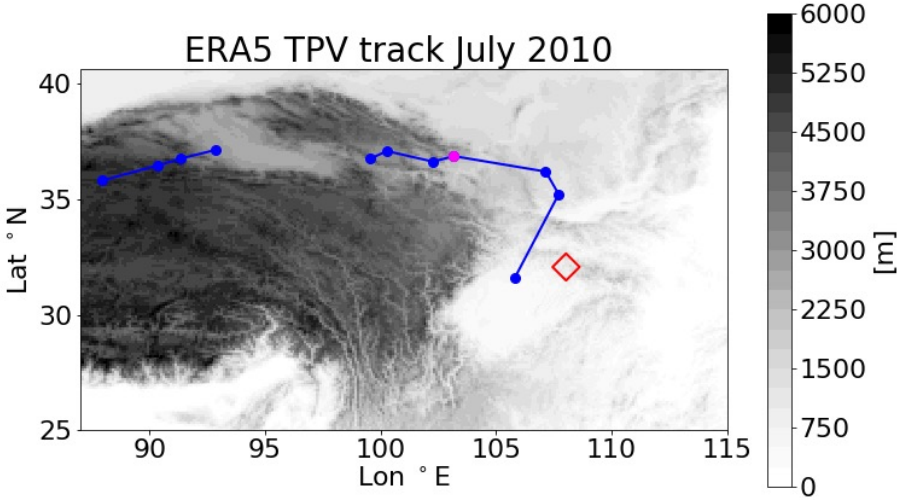
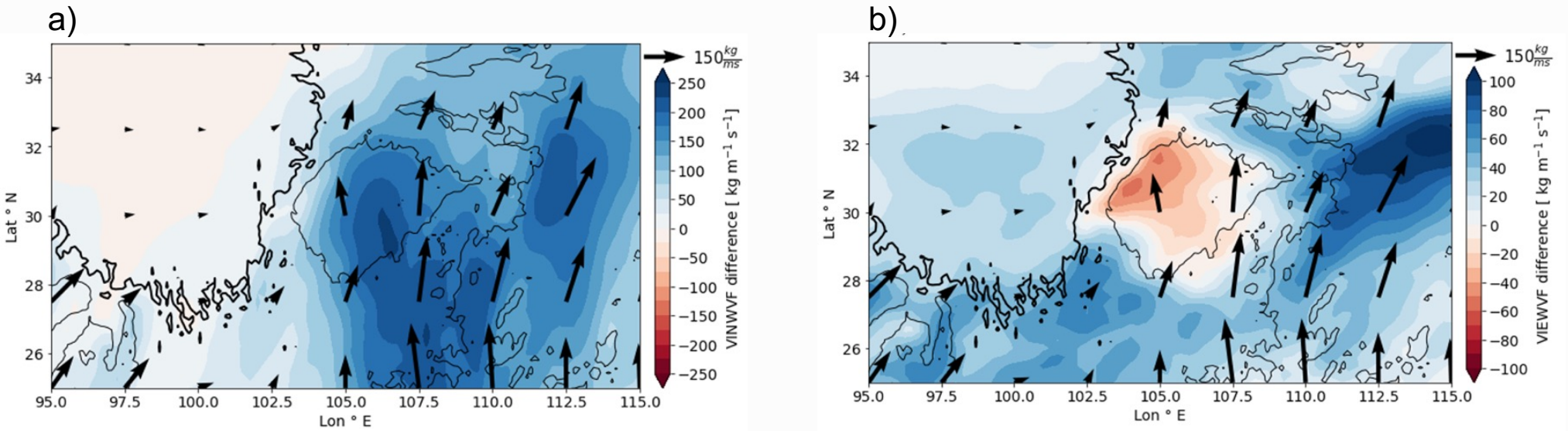






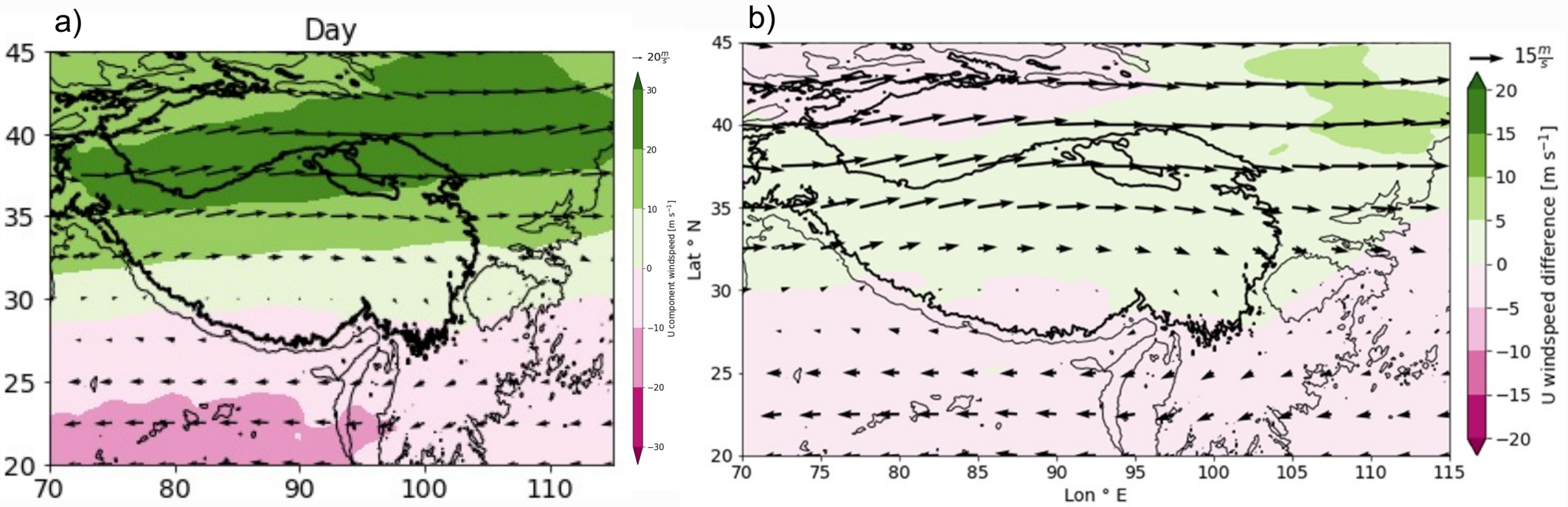
Moisture transport July/August events



Anomaly of vertically integrated northward (a) and eastward (b) water vapour flux (composite – climatology)

Stronger moisture transport into the Sichuan basin and towards the edge of the Tibetan Plateau during the extreme events than for the July/August climatology

Connection to the jet stream



a) Composite U300 wind speed for July/August events and b) anomaly (composite – climatology)

Jet stream further south during the extreme events than for the climatology

Key points

- 6 out of the 9 **extreme precipitation events** classified as organized can be attributed to the occurrence of a **mesoscale weather system** (MCS, TPV, both)
- **Moisture transport** into the Sichuan facilitated by TPVs / mesoscale disturbances → environment favorable for strong convection
- **Subtropical westerly jet** further south during extreme events
- Position and strength of **jet** essential for **moving-off TPVs**