The Landfall And Inland Penetration Of A Flood-producing Atmospheric River In Arizona.

Part 2: Impacts Of WRF Resolution On Water Vapor Transports And Precipitation

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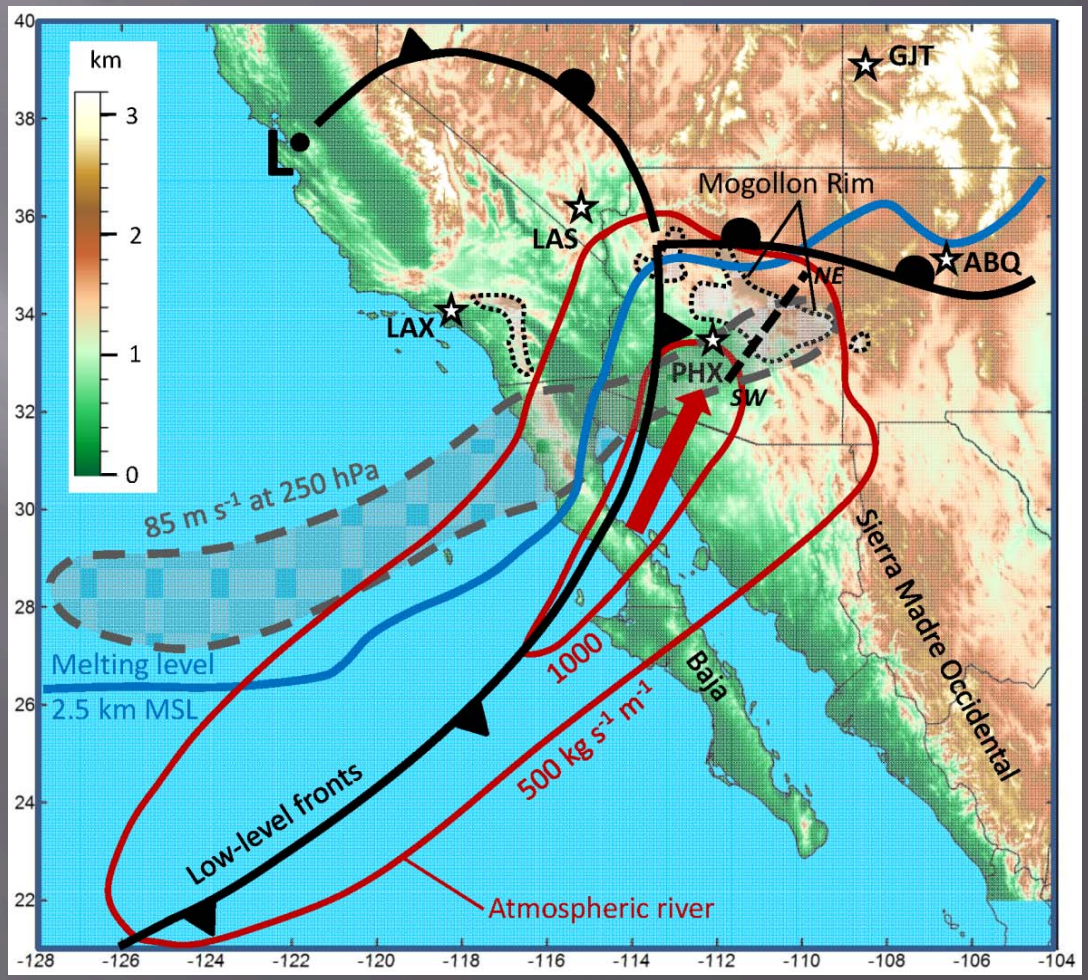
Steamboat Springs, CO

Thanks to coauthors: Paul Neiman, Kelly Mahoney, Ben Moore, Marty Ralph, Mike Alexander

Motivation and questions addressed

To assess the impact numerical weather model resolution has on integrated water vapor transport and resultant precipitation, and to determine the role of key mountain ranges in redirecting, or blocking, the incoming water vapor.



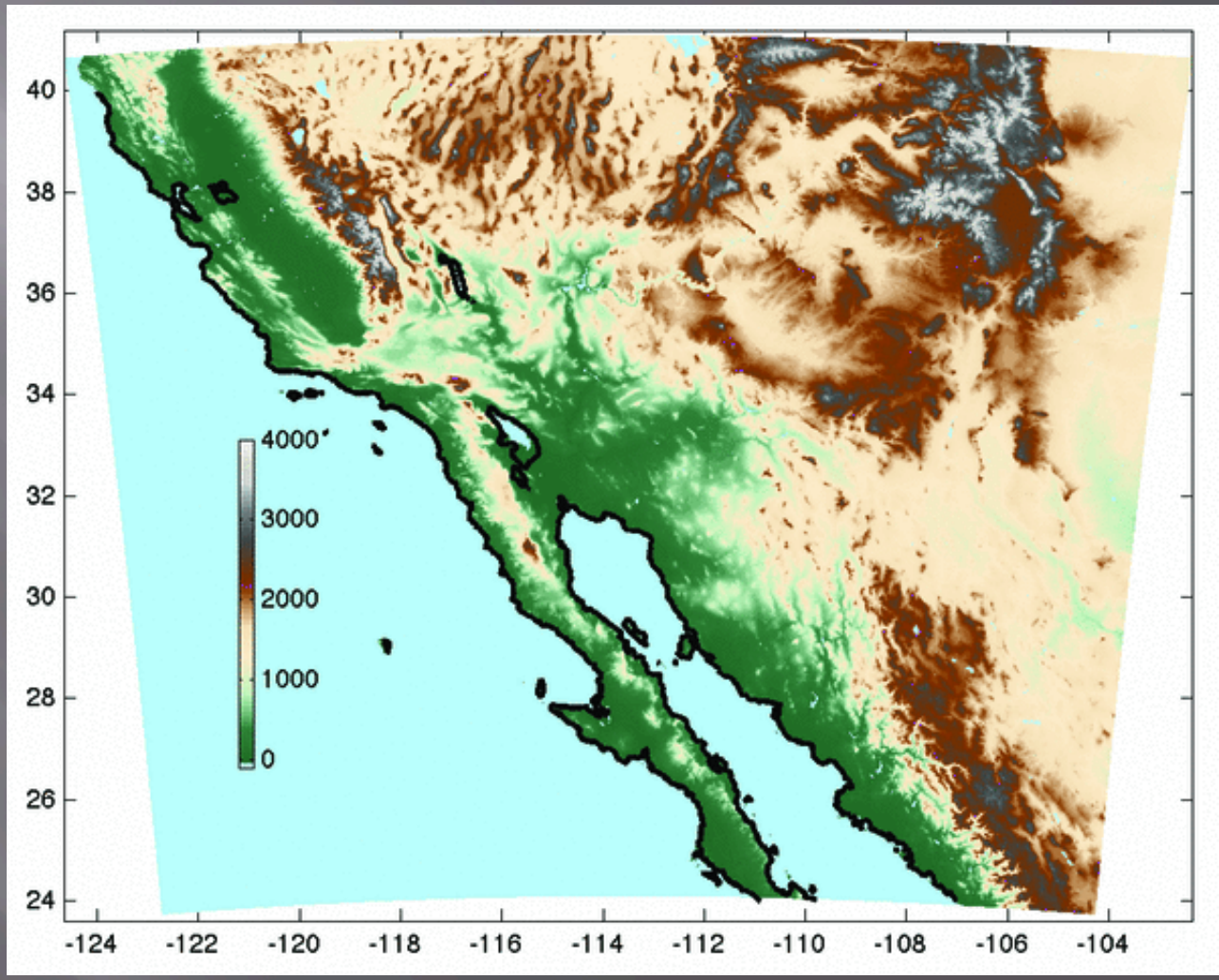
From Neiman et al 2012

To what extent was the extreme precipitation in this case caused by local topography, in-situ synoptic-scale forcing, and/or remote orographic or dynamical enhancement processes?

Model sensitivity experiments

Jan 20, 18Z – Jan 22, 18Z are run at:

1 km, 3 km (CP on/off), 6 km (CP on/off), 9 km (CP on/off), 27 km (CP on/off), and 81 km grid spacing. All runs use Thompson microphysics, Kain Fritsch cumulus parameterization (CP, when turned on), YSU PBL, CFSR as boundary conditions, and 54 vertical levels.



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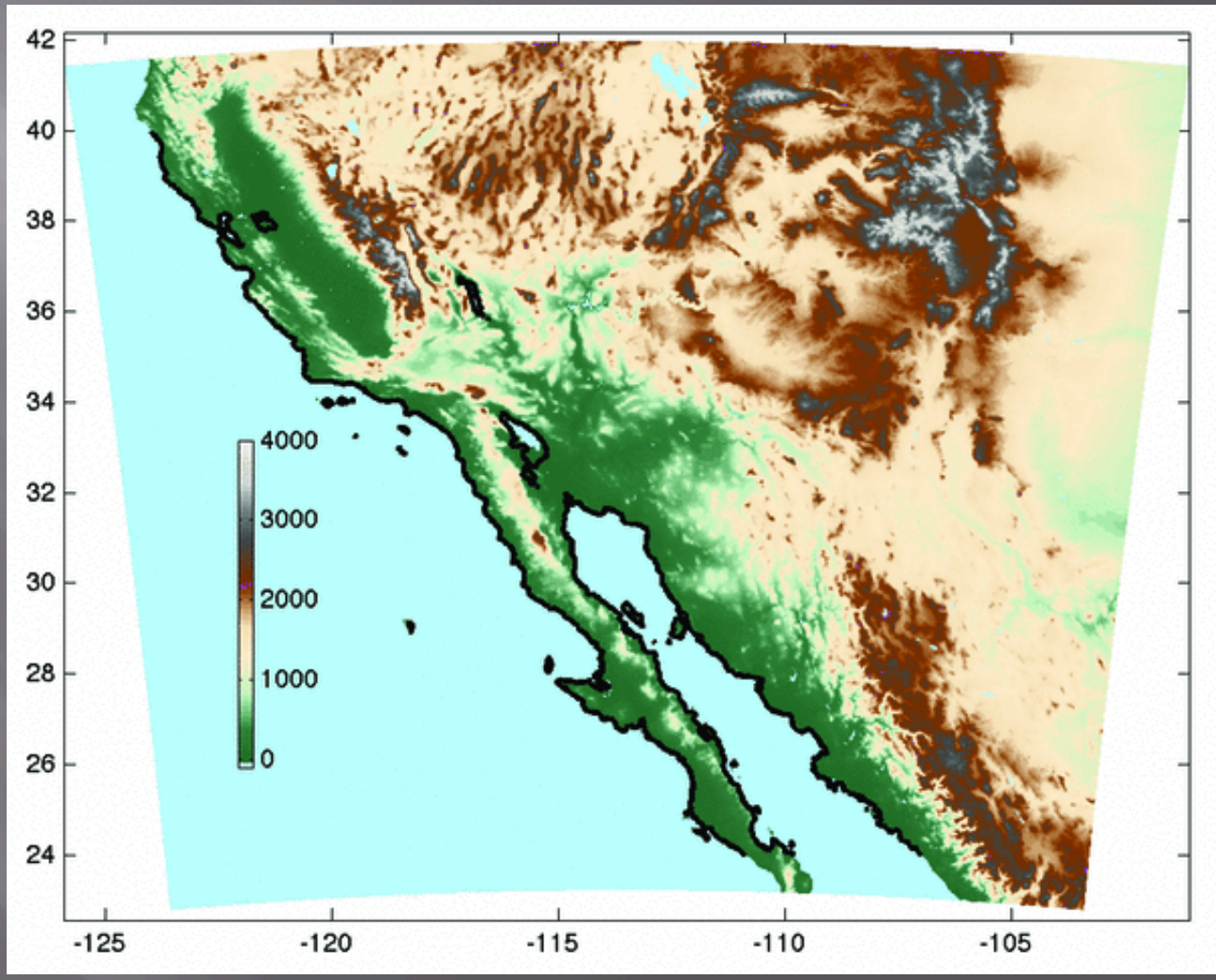

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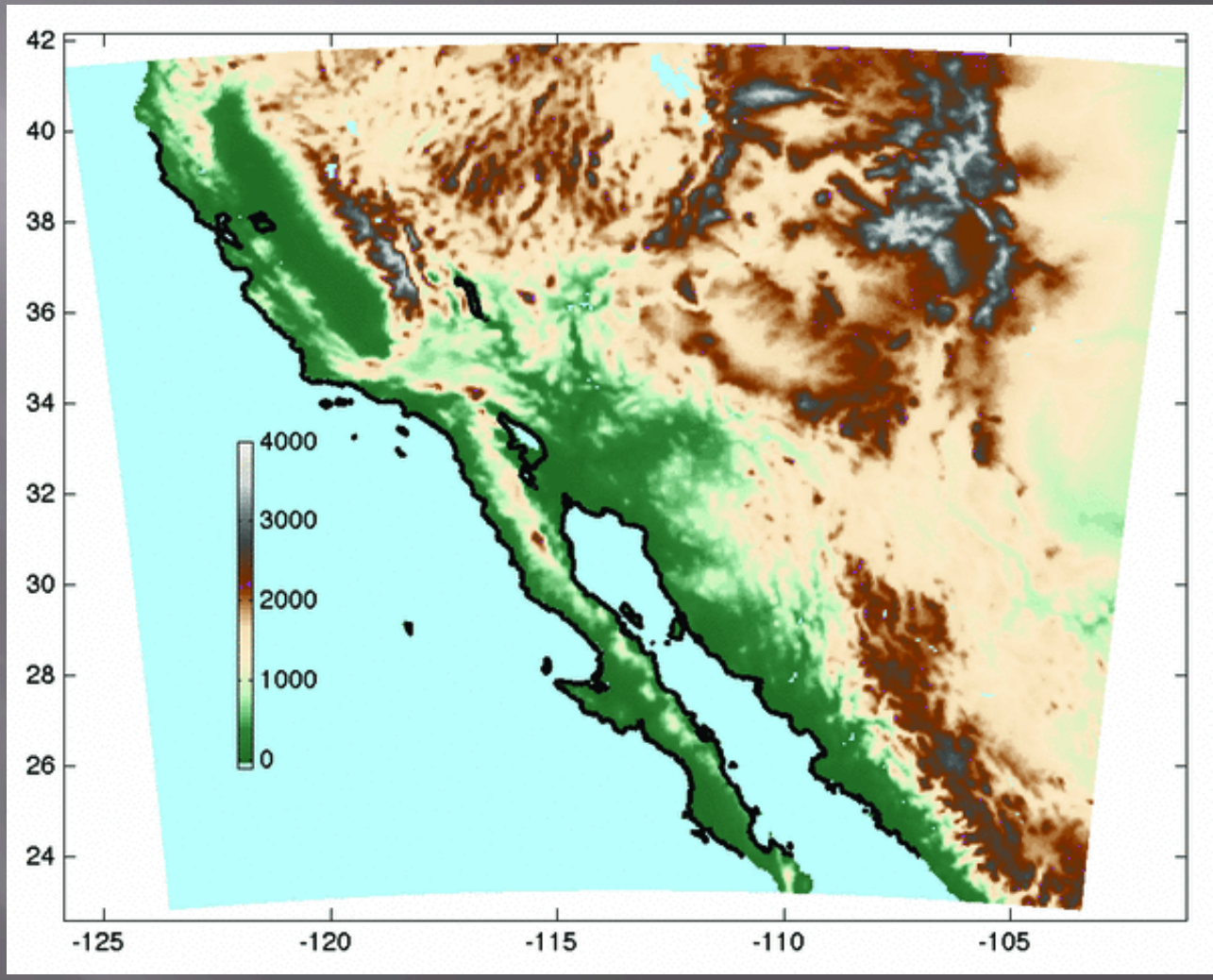

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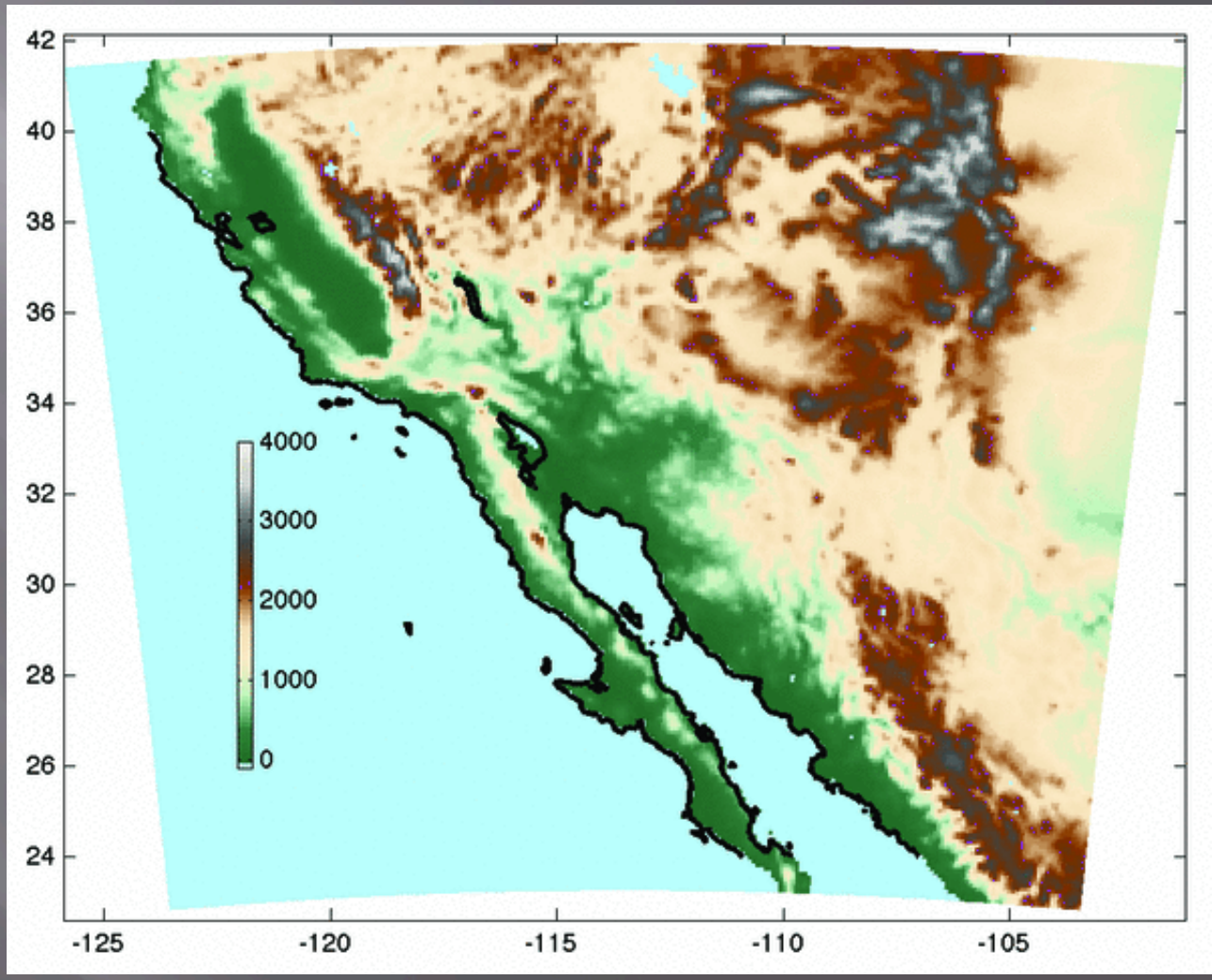

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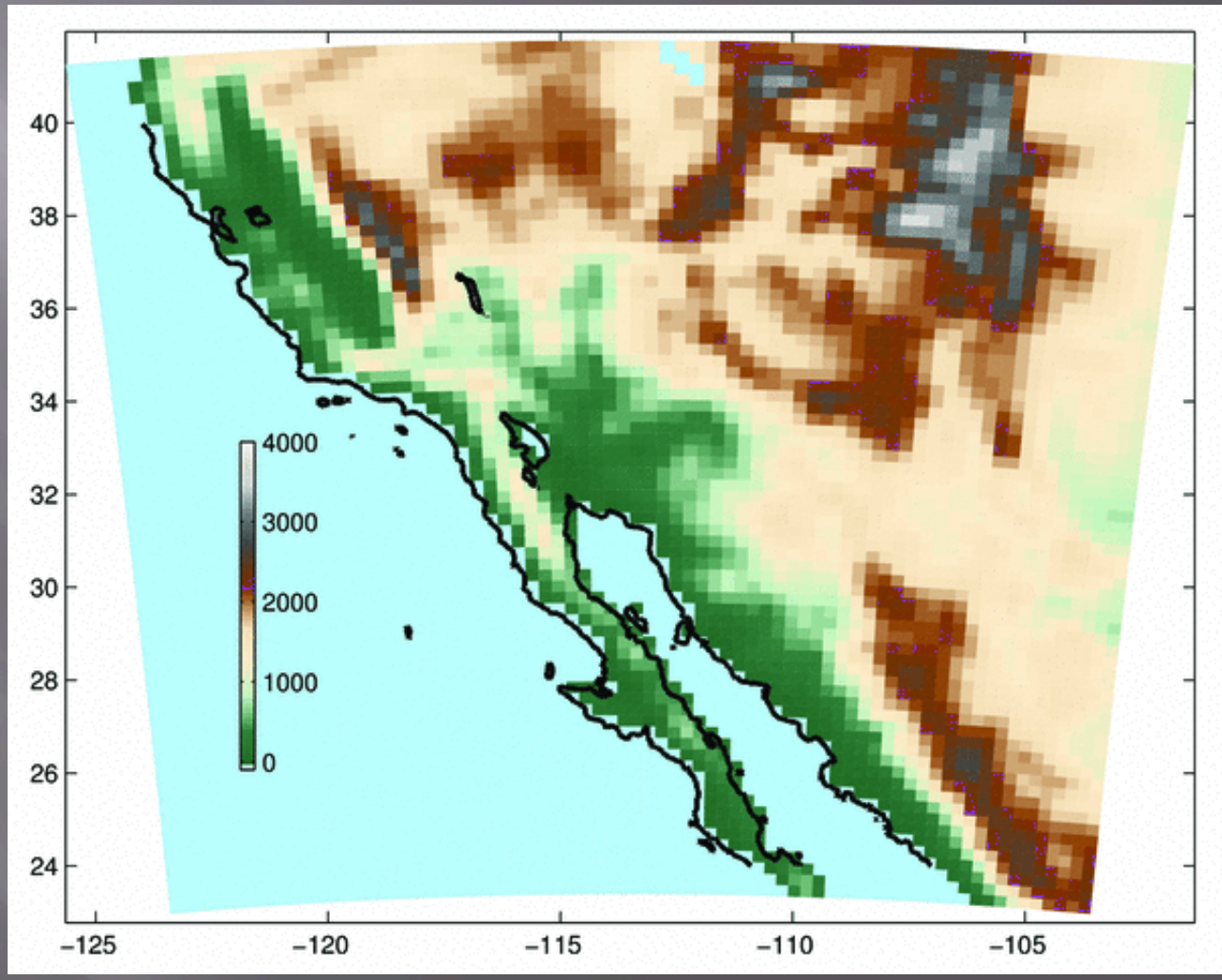

Model sensitivity experiments

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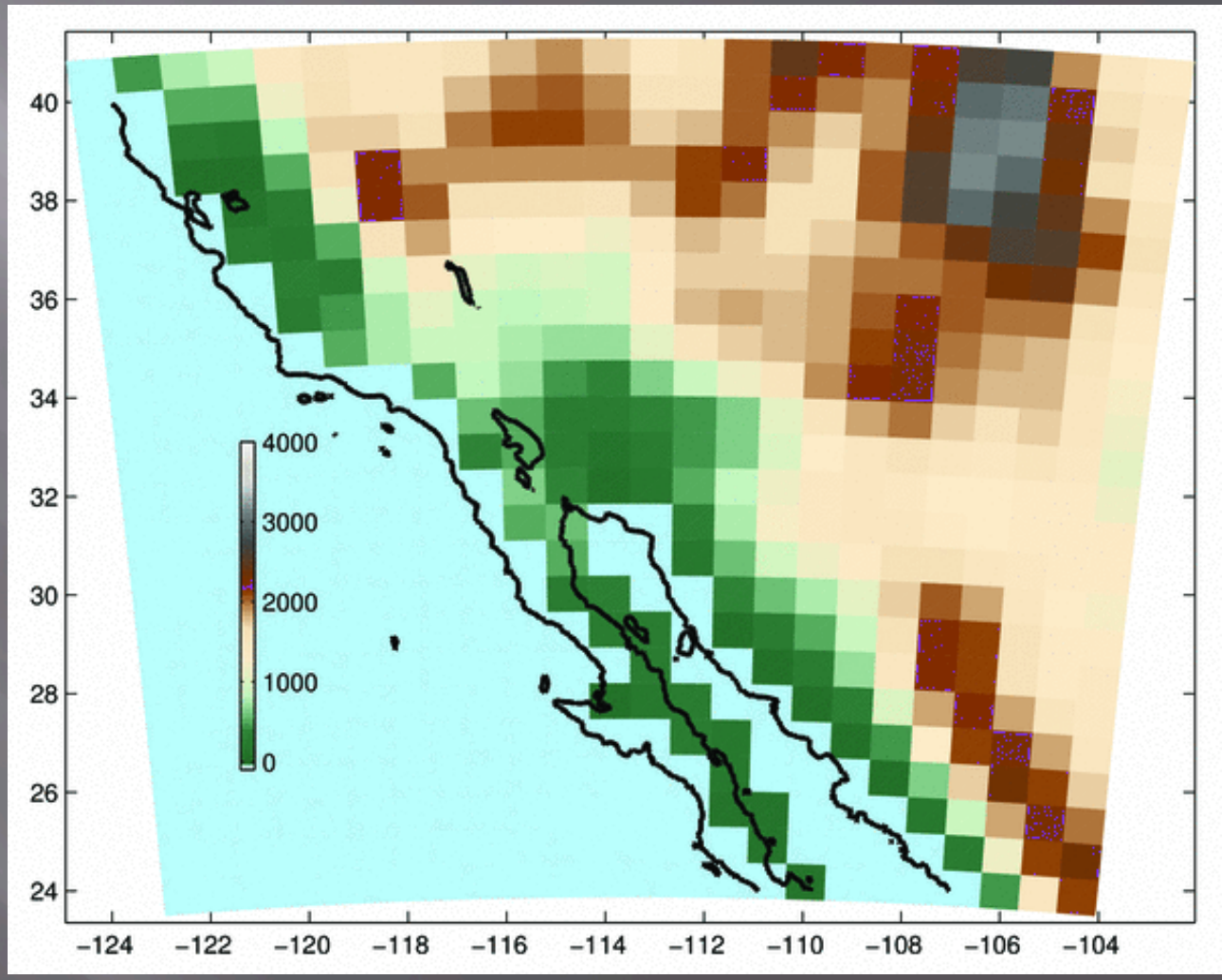

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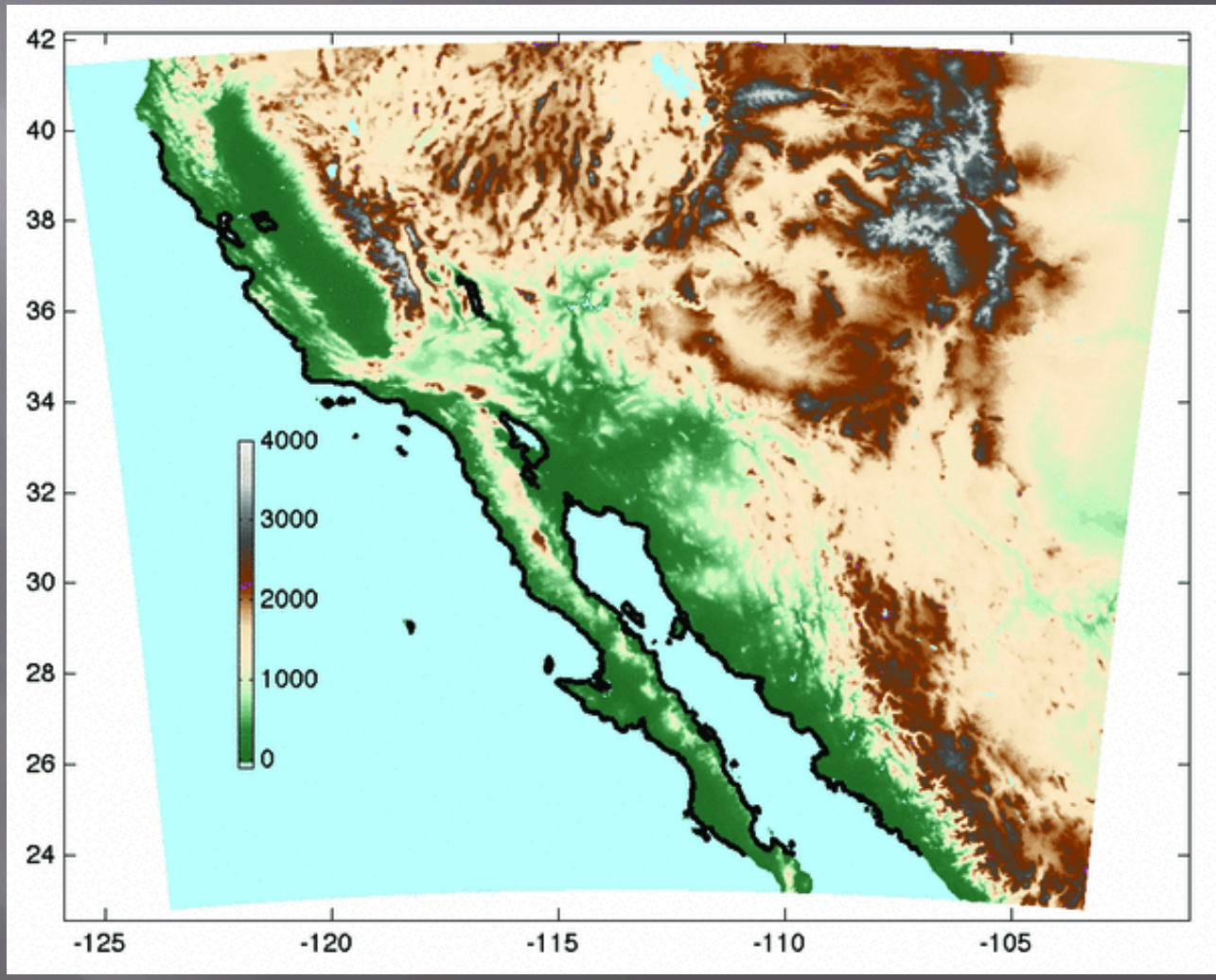
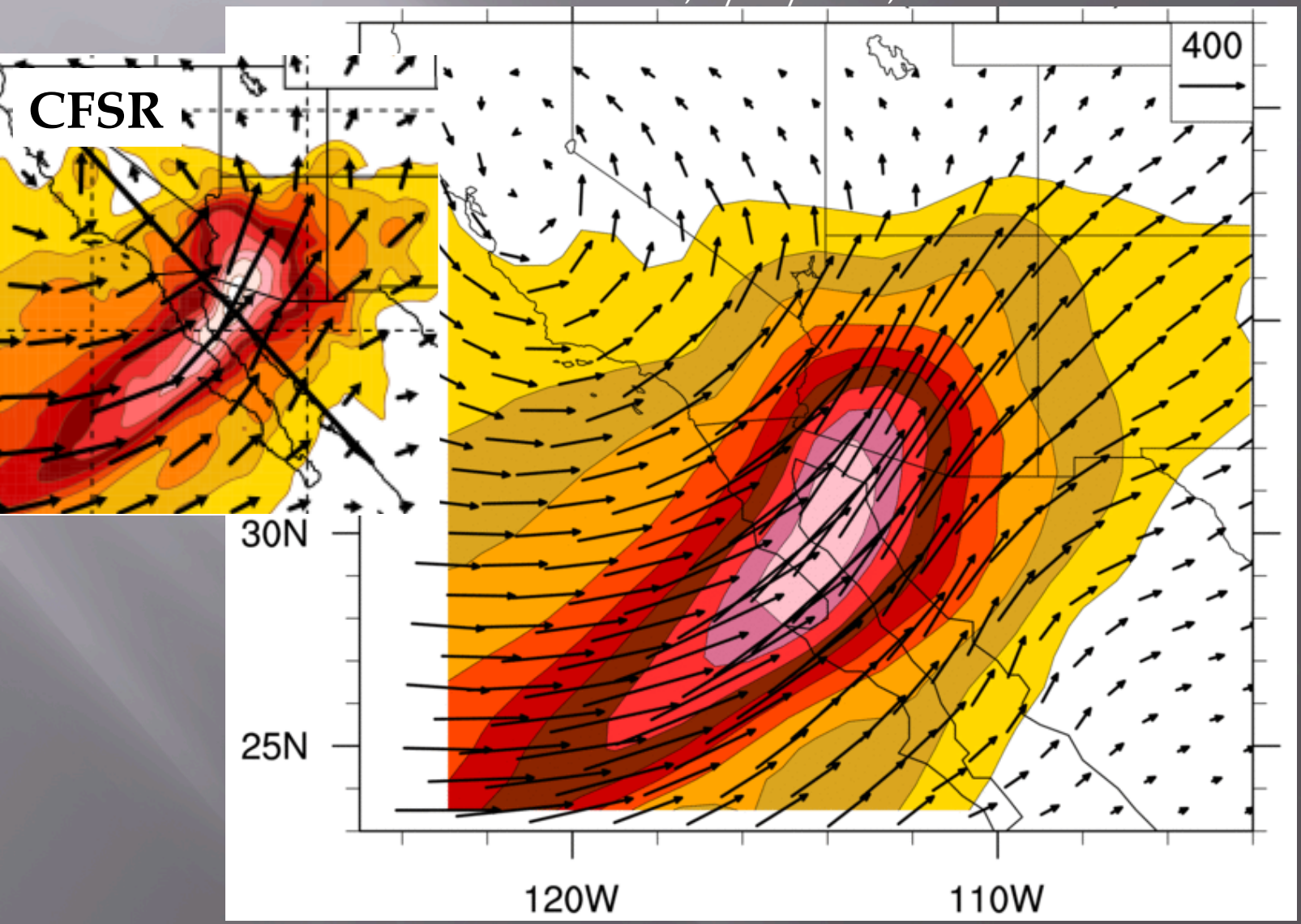
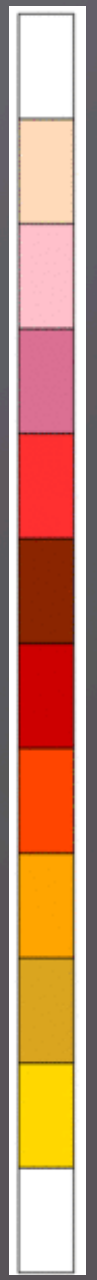


Differences due to resolution in integrated water vapor transport

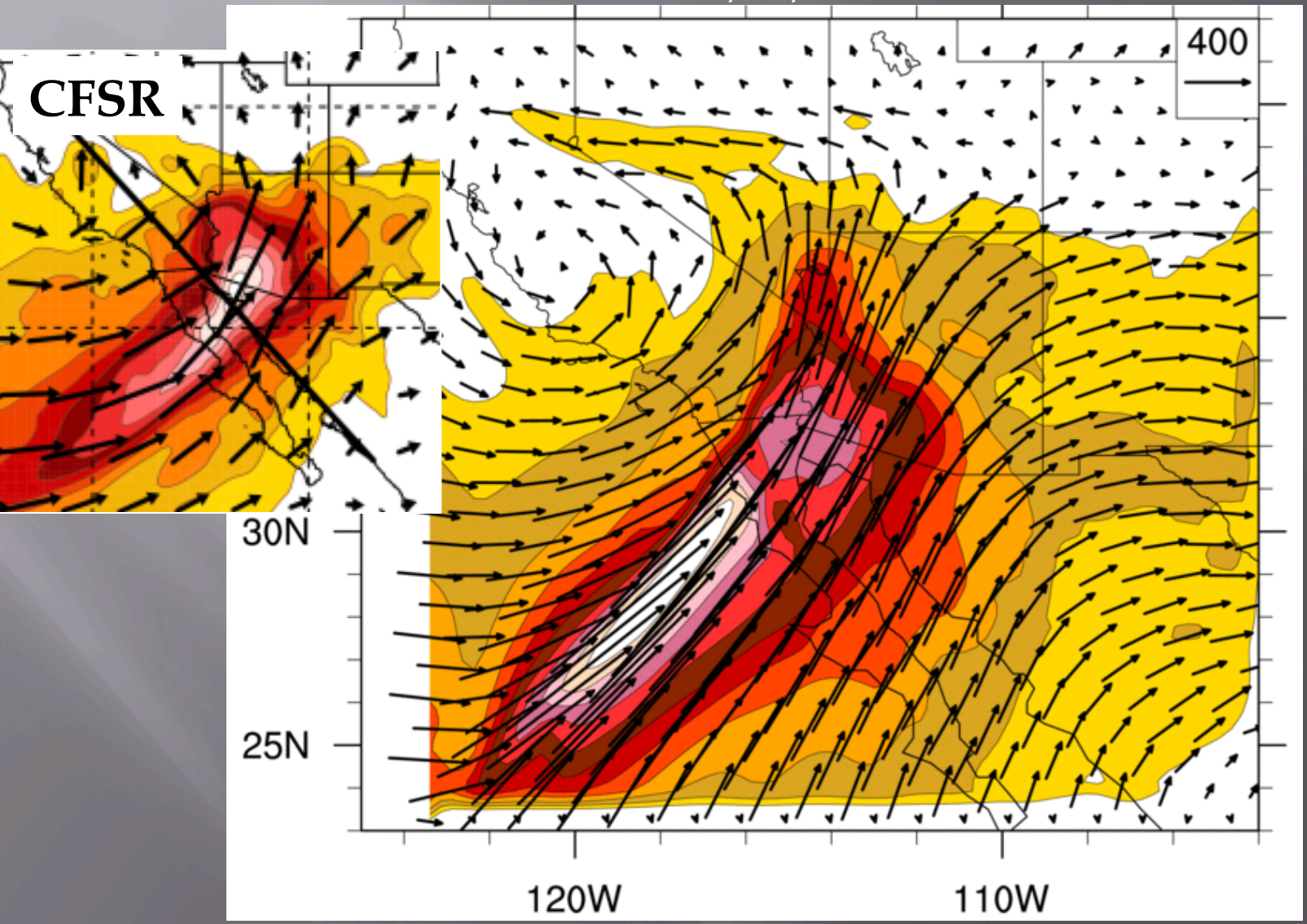
81 km domain IVT, 1/22/2010, 0Z

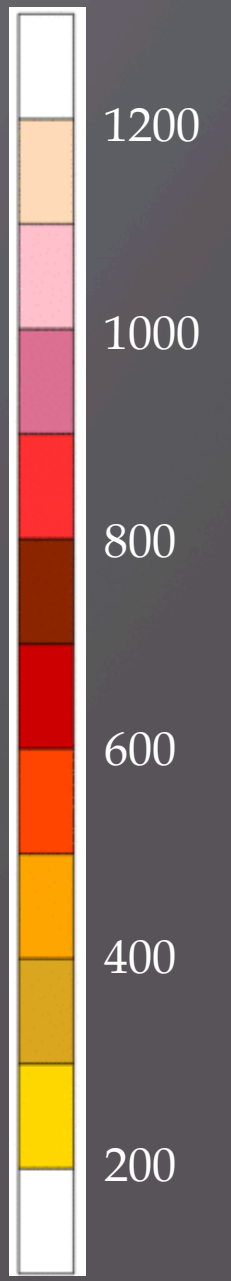




Differences due to resolution in integrated water vapor transport

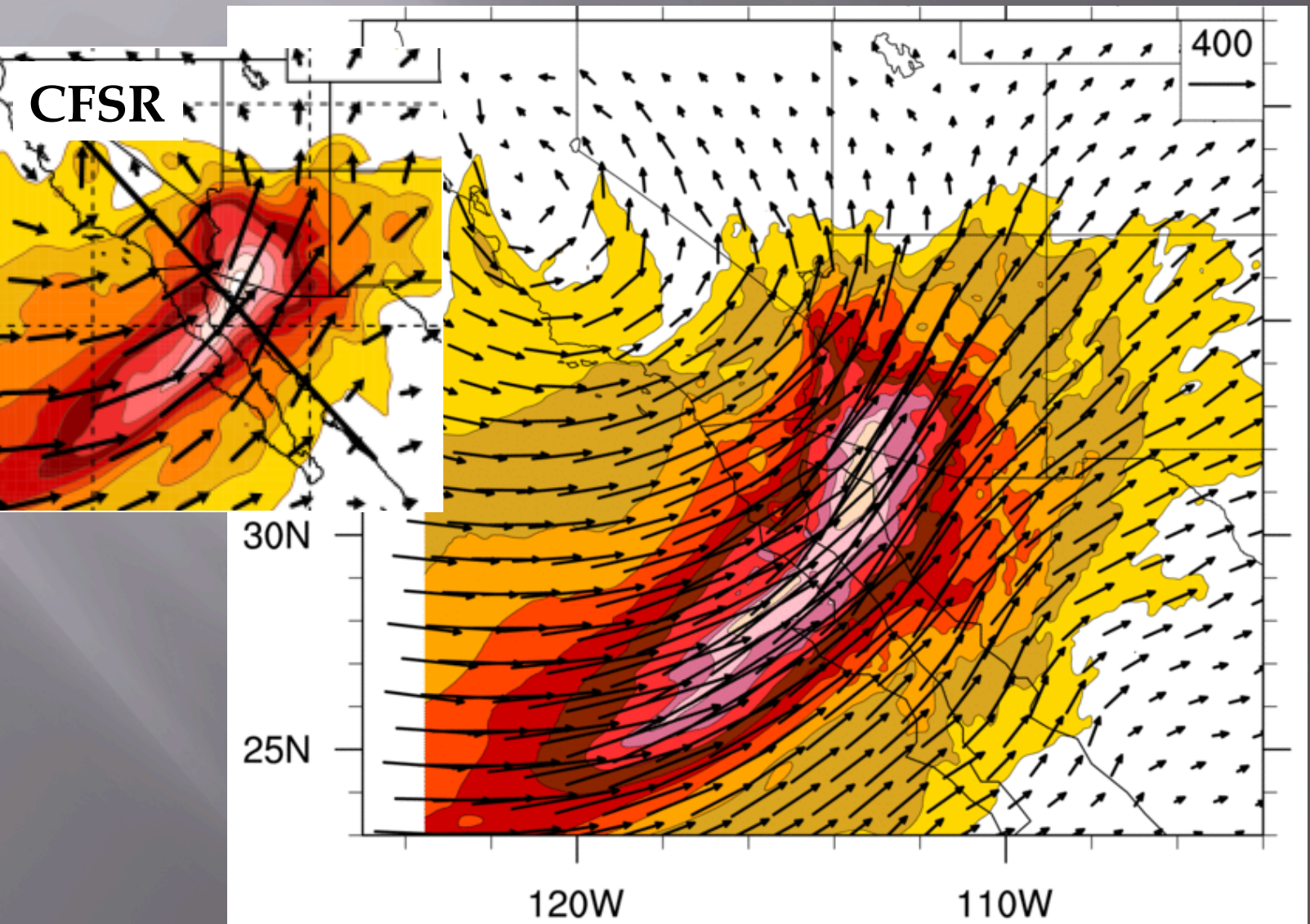
27 km domain IVT, 1/22/2010, 0Z

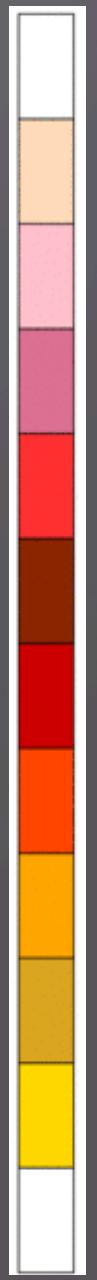




Differences due to resolution in integrated water vapor transport

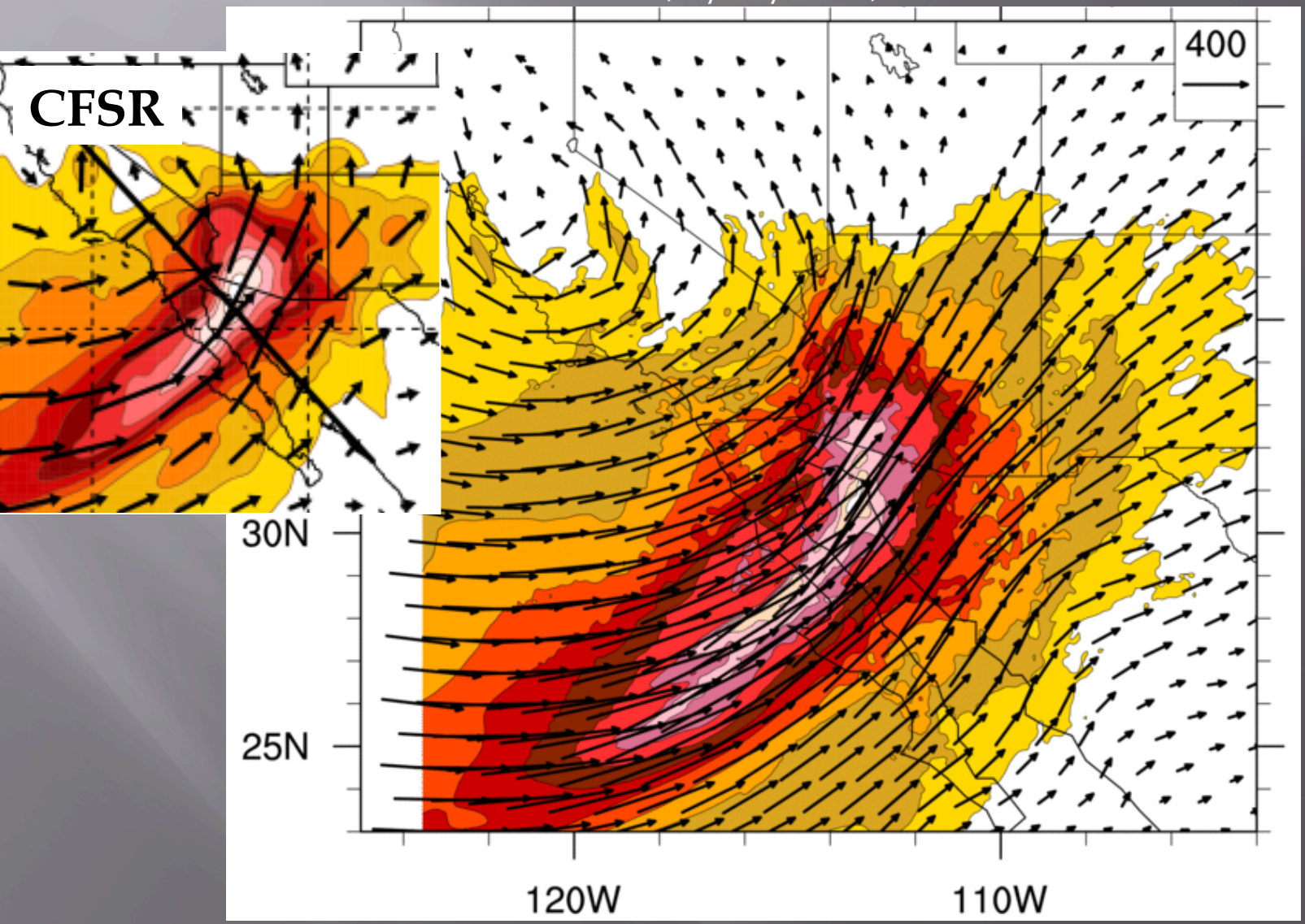
9 km domain IVT, 1/22/2010, 0Z

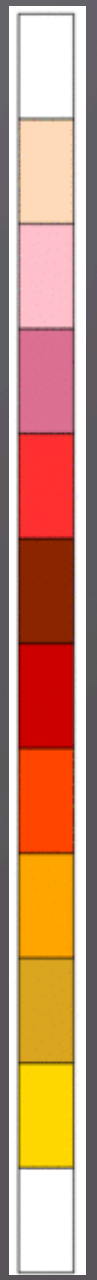




Differences due to resolution in integrated water vapor transport

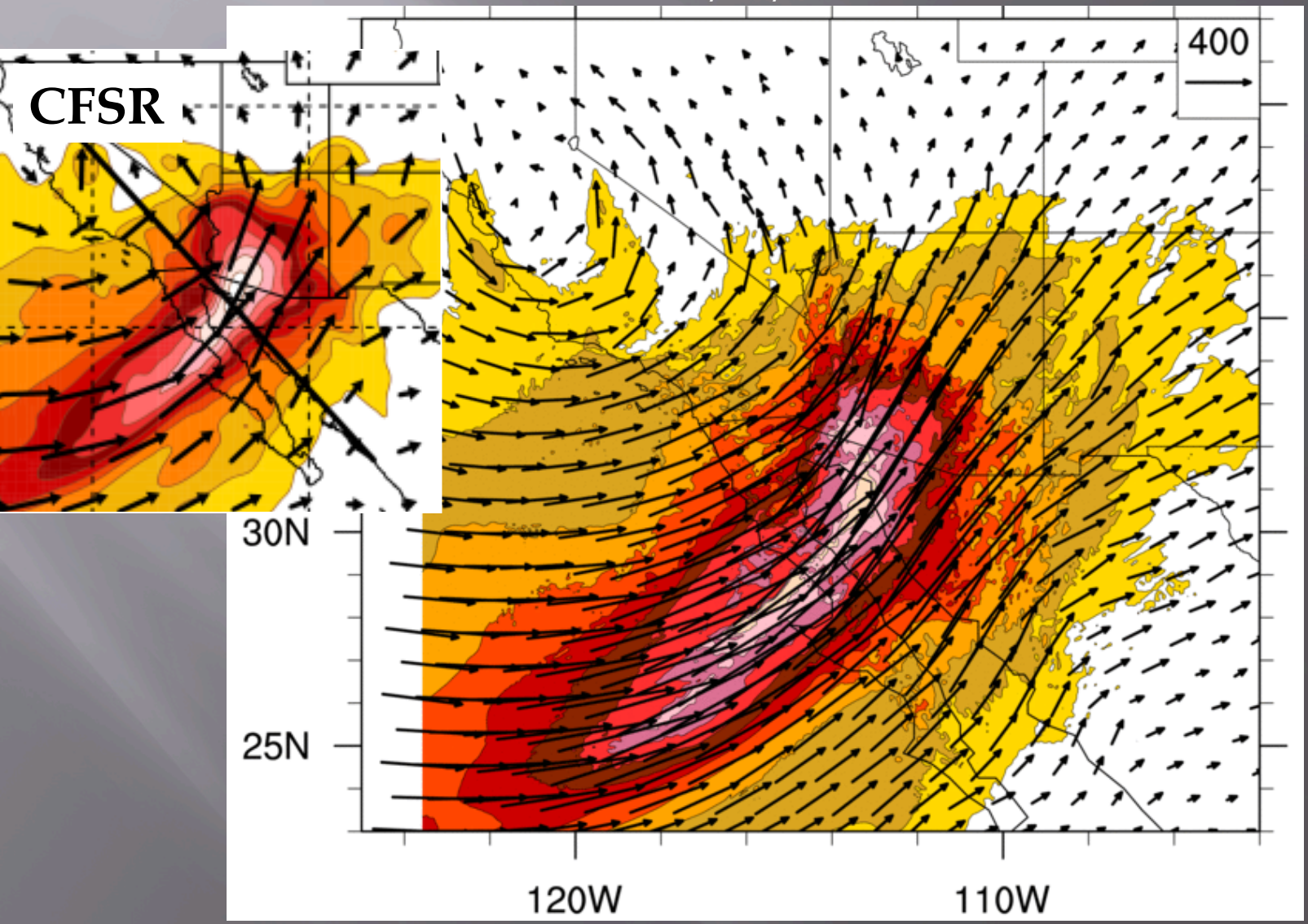
6 km domain IVT, 1/22/2010, 0Z

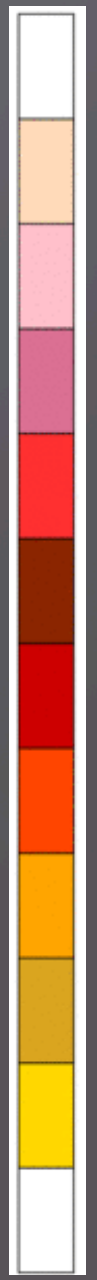




Differences due to resolution in integrated water vapor transport

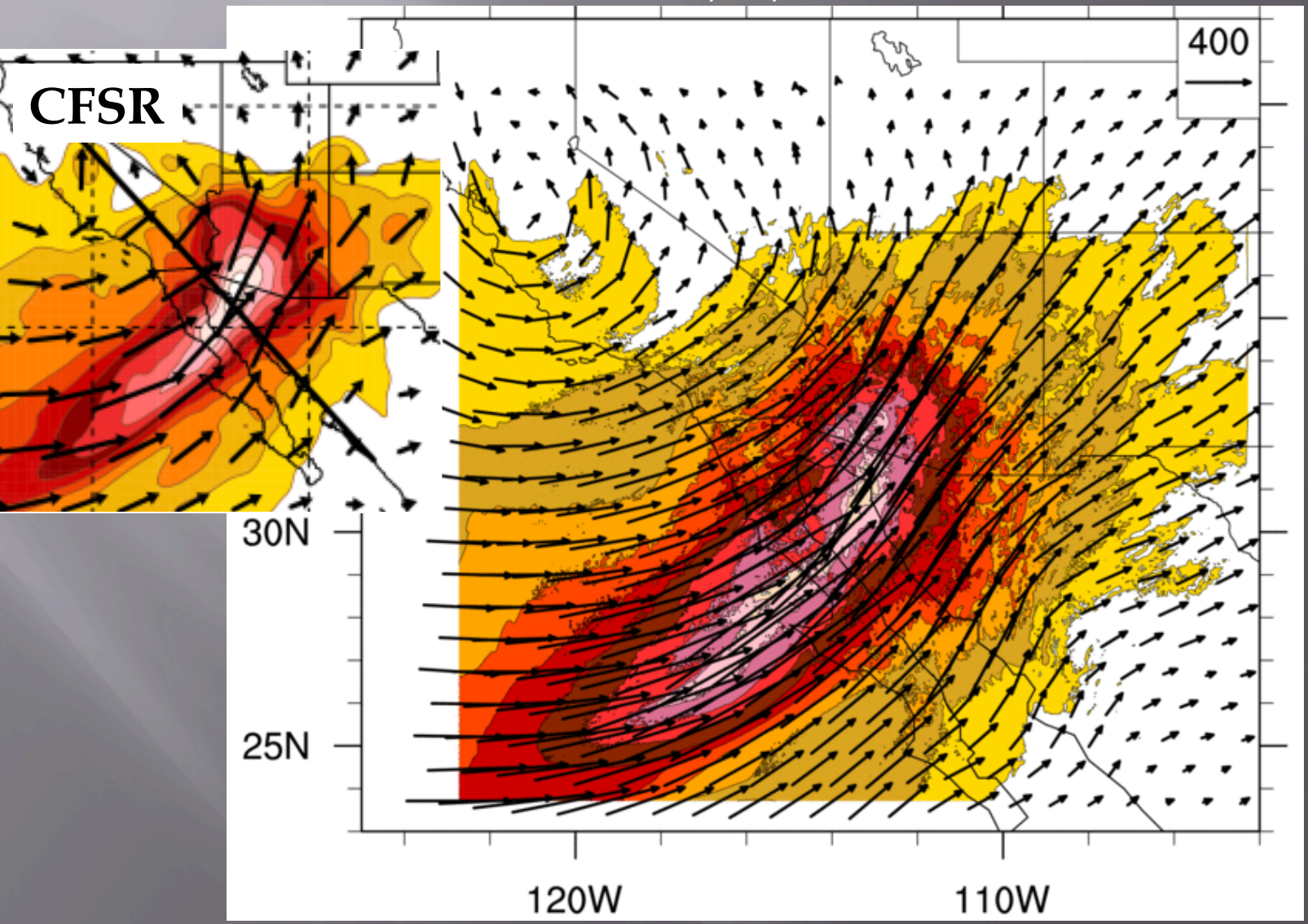
3 km domain IVT, 1/22/2010, 0Z

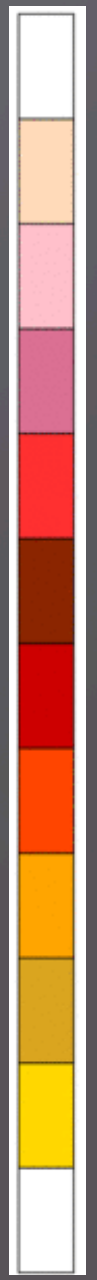




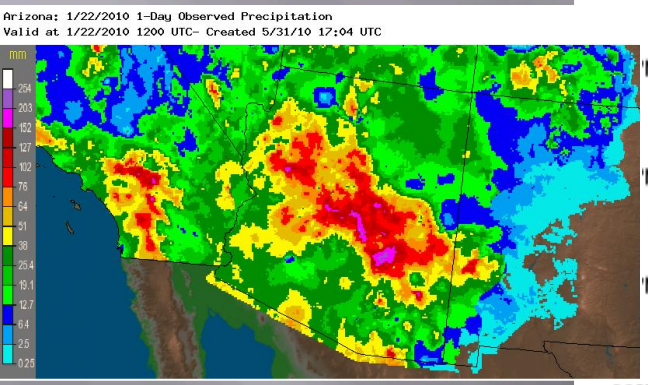
Differences due to resolution in integrated water vapor transport

1 km domain IVT, 1/22/2010, 0Z

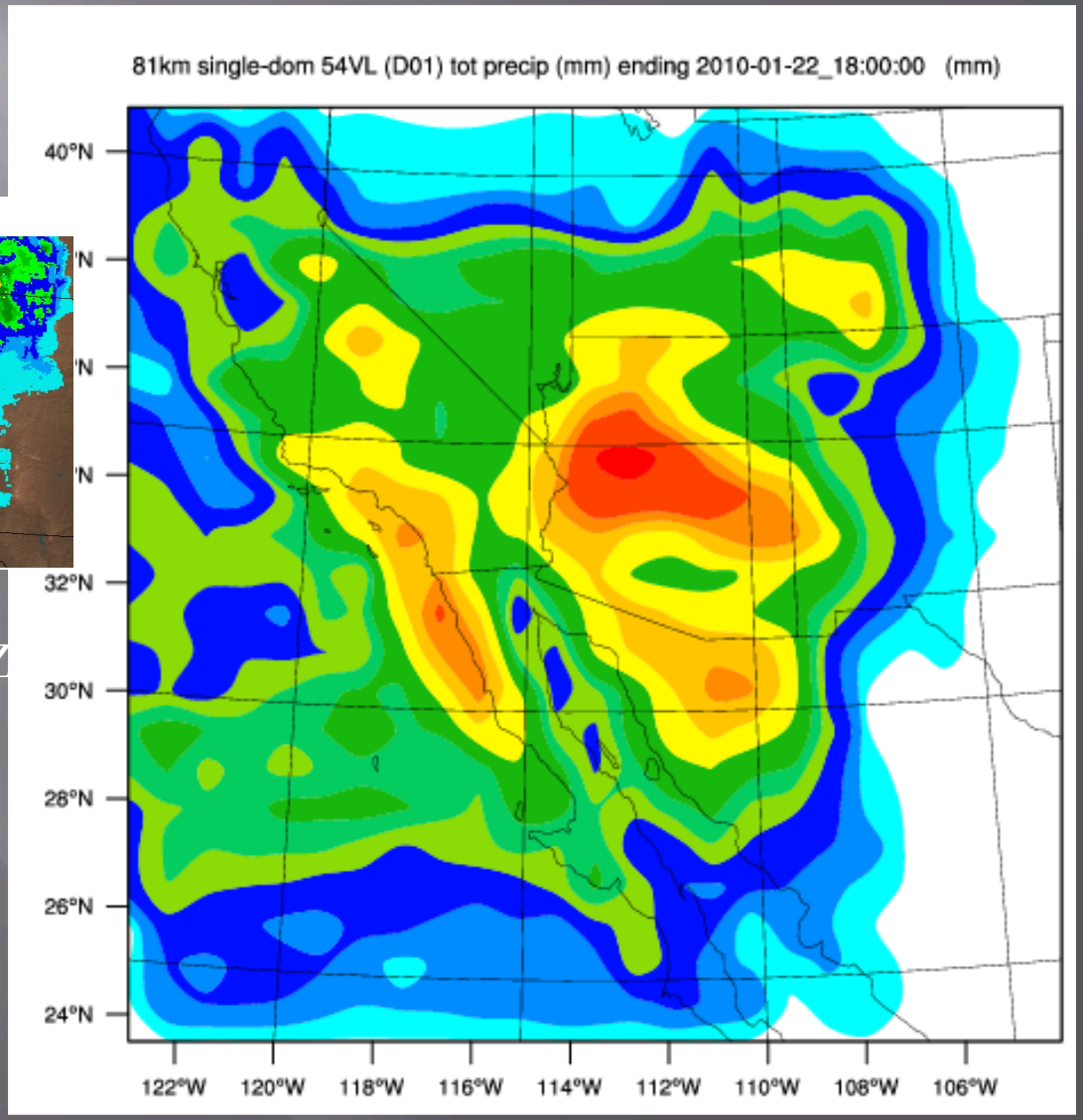




Differences due to resolution in resultant precipitation



NMQ Stage IV QPE
24-hour ending Jan 22 12Z



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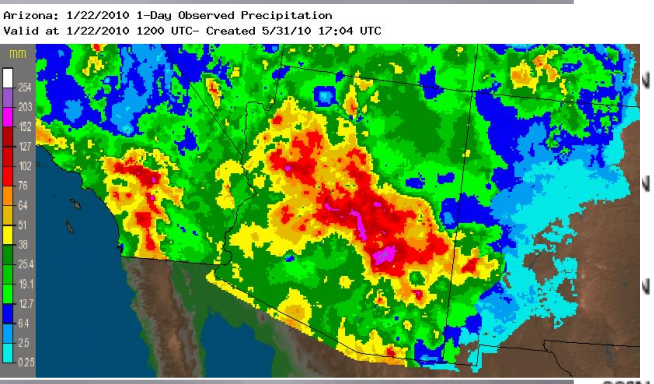

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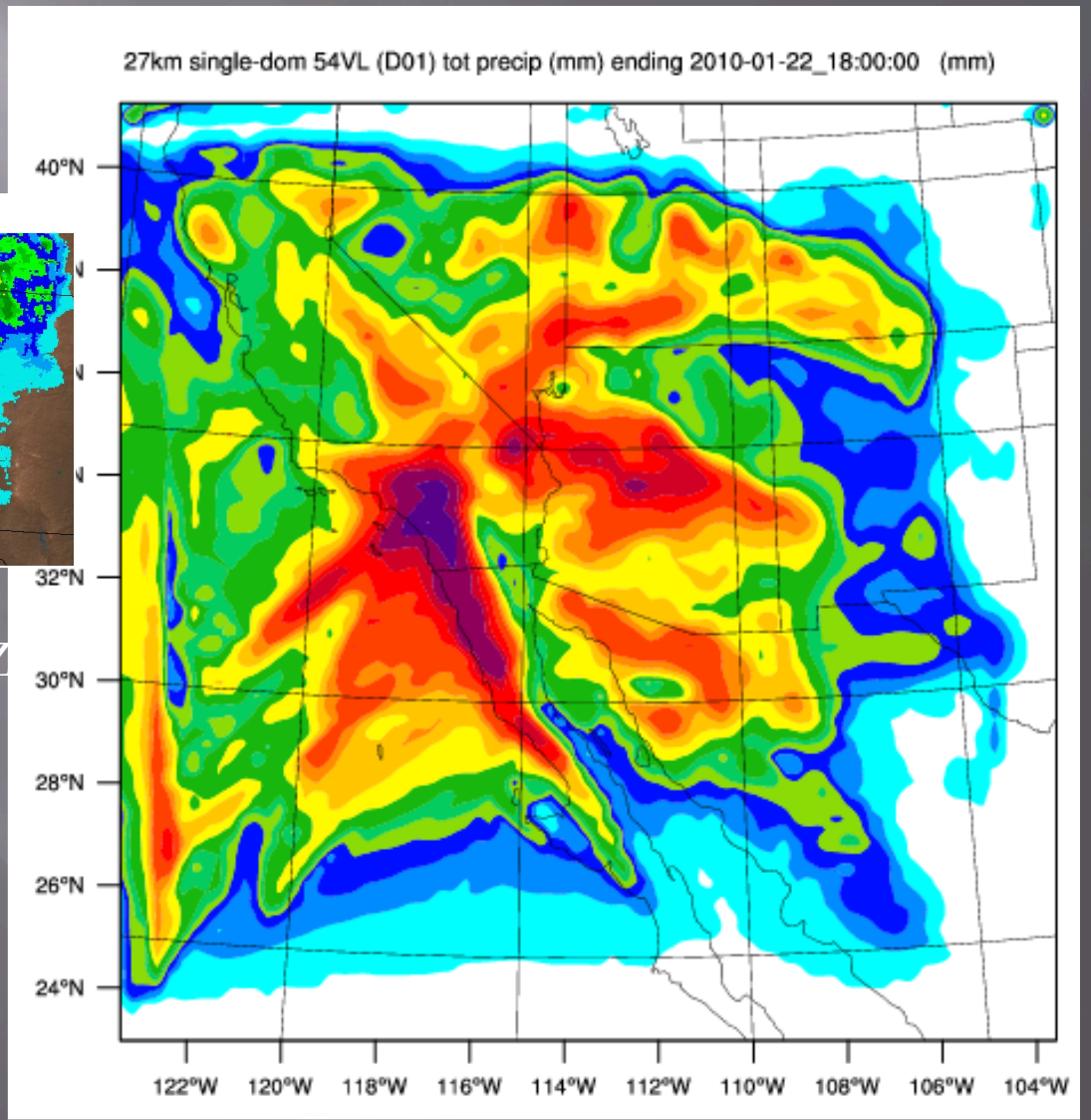

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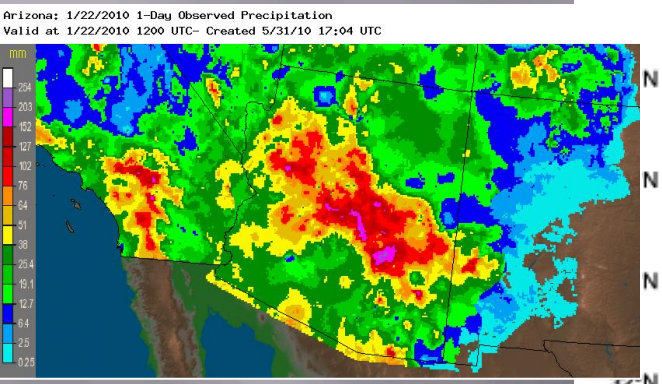

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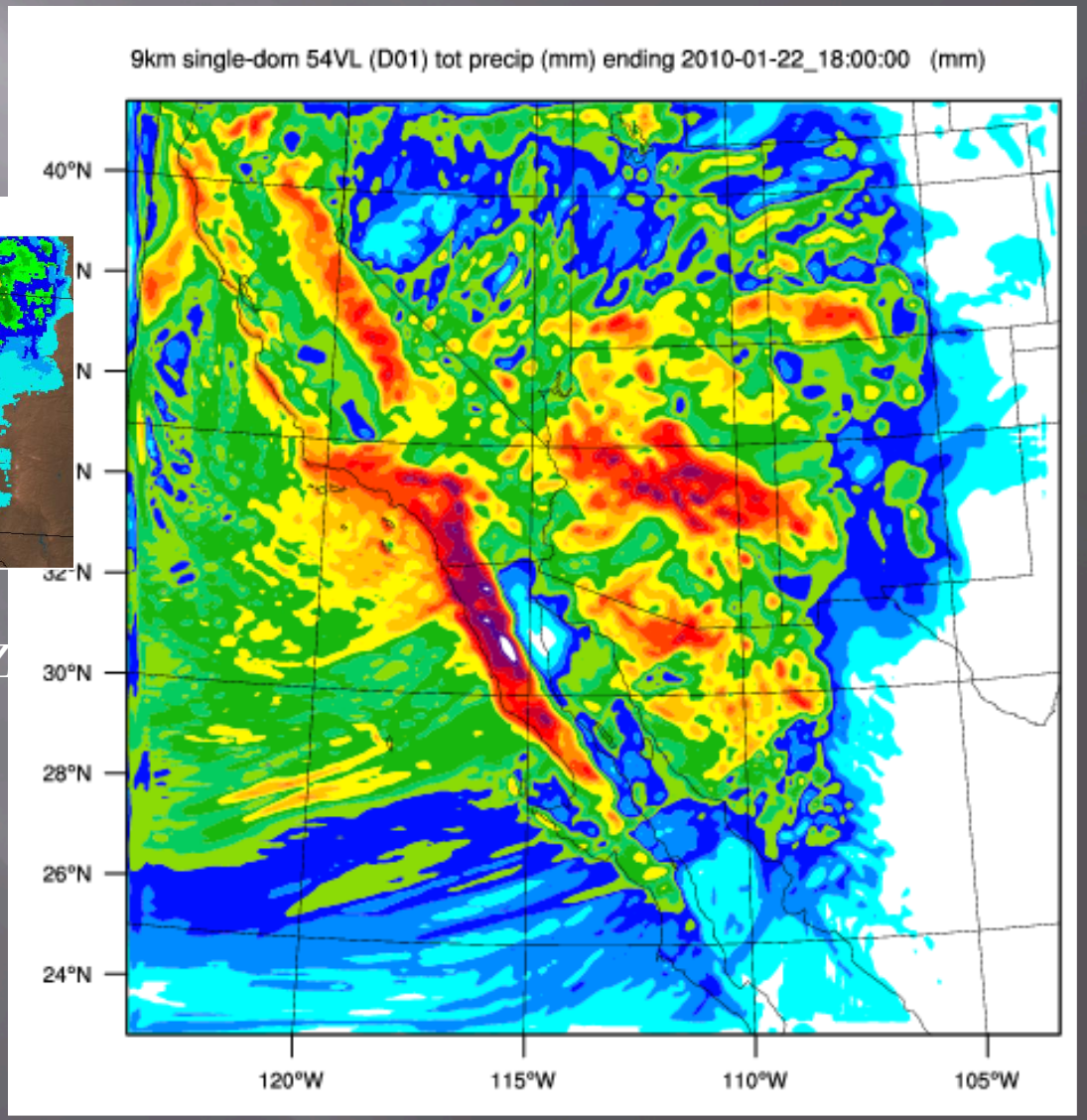

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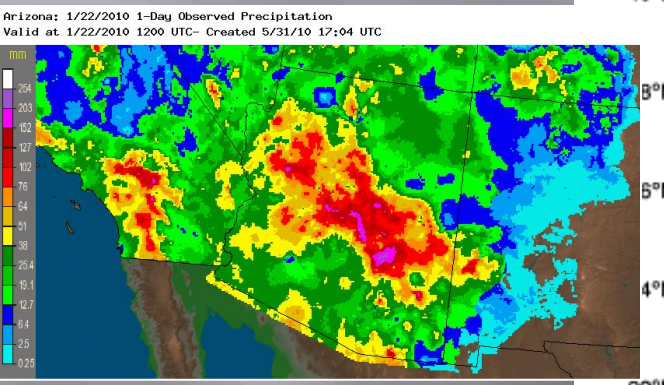

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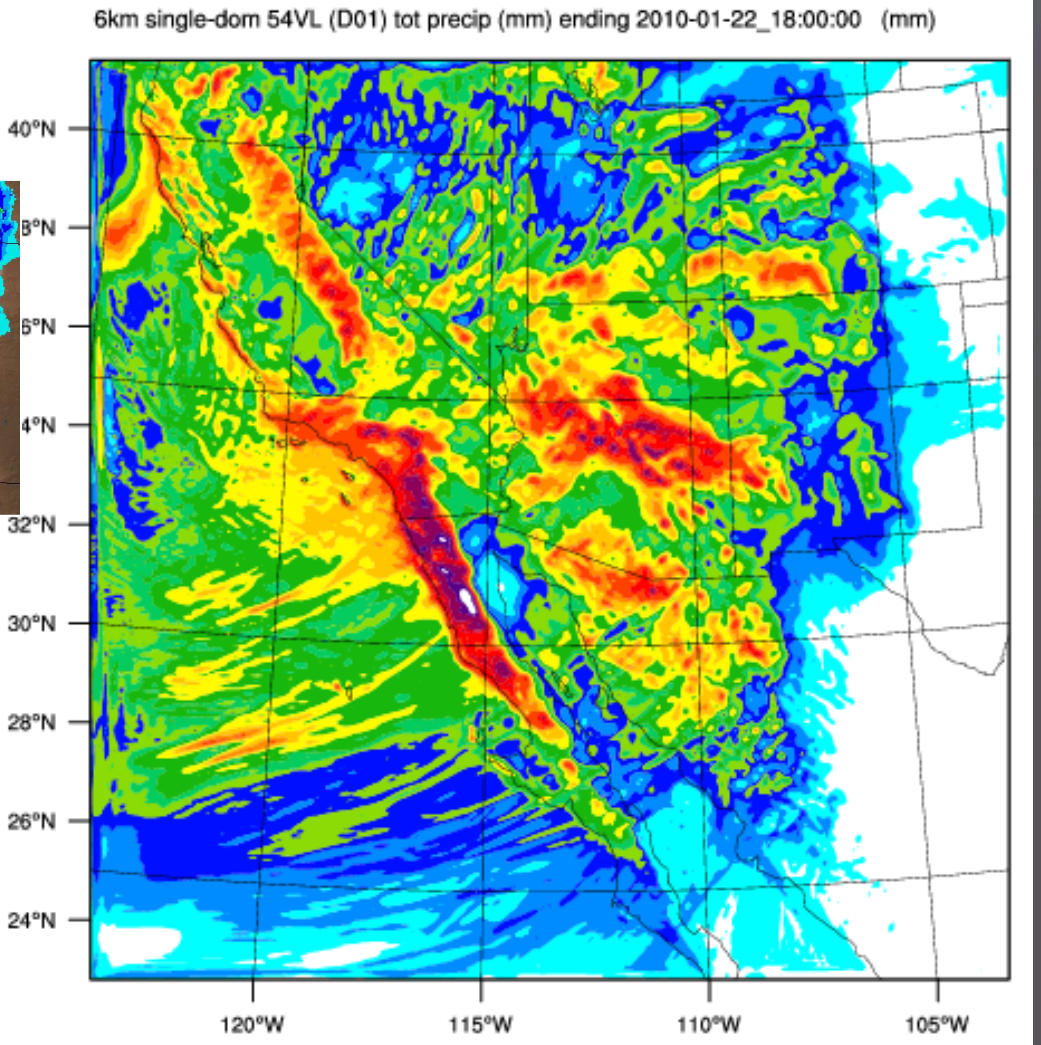

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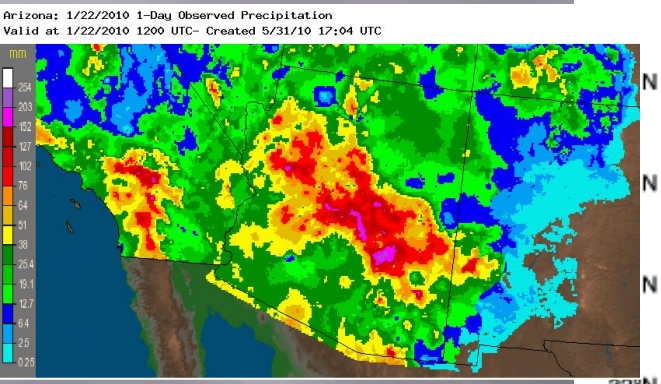

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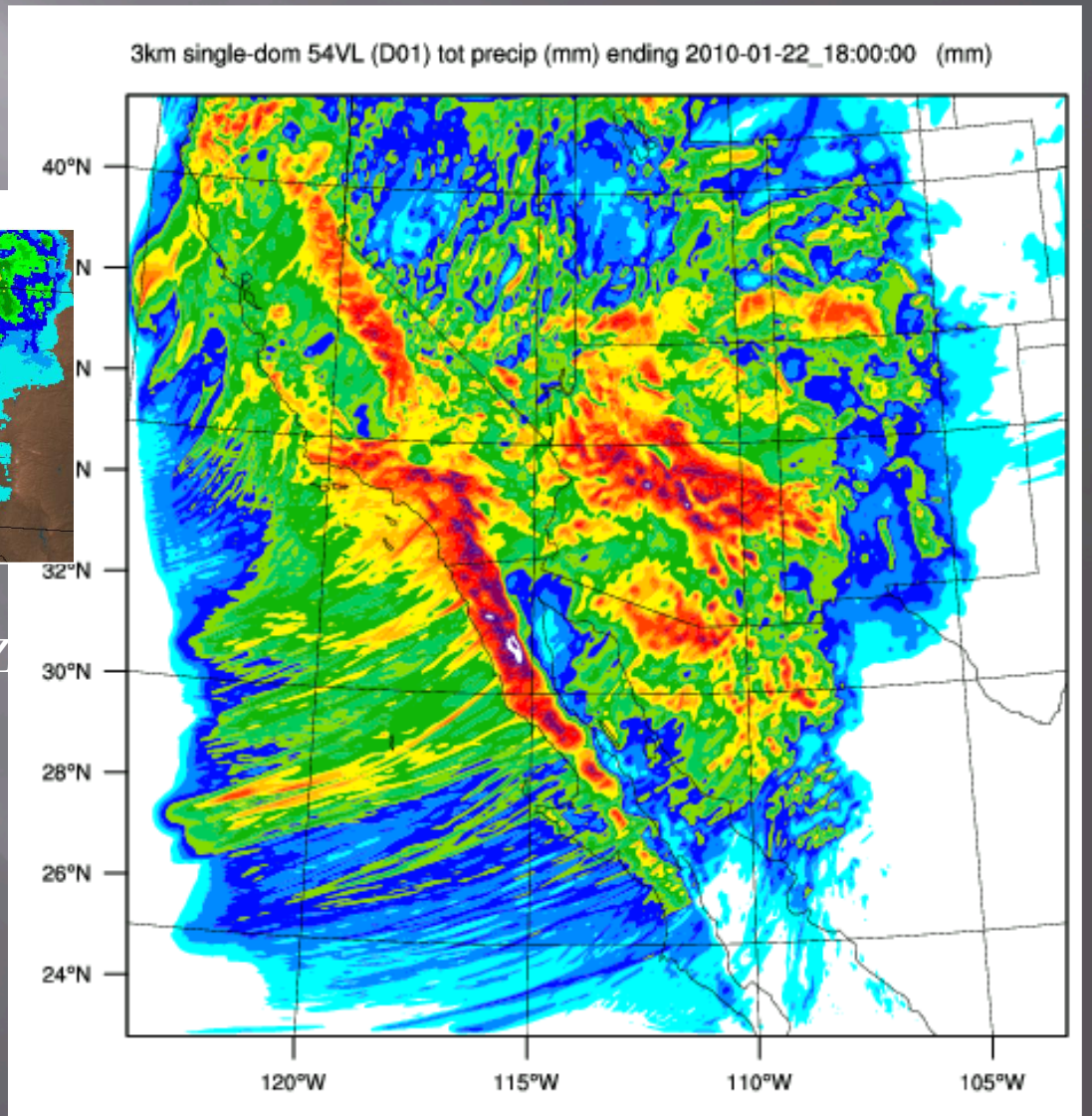

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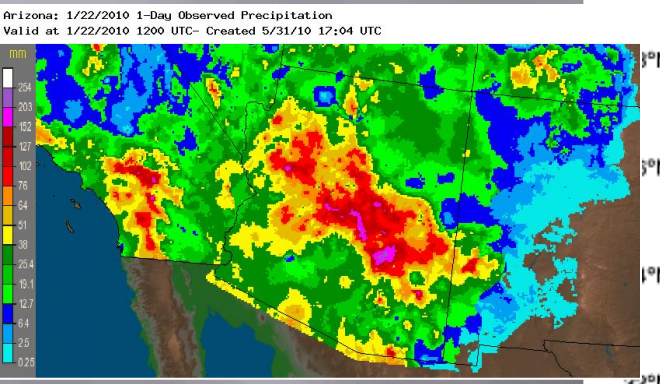

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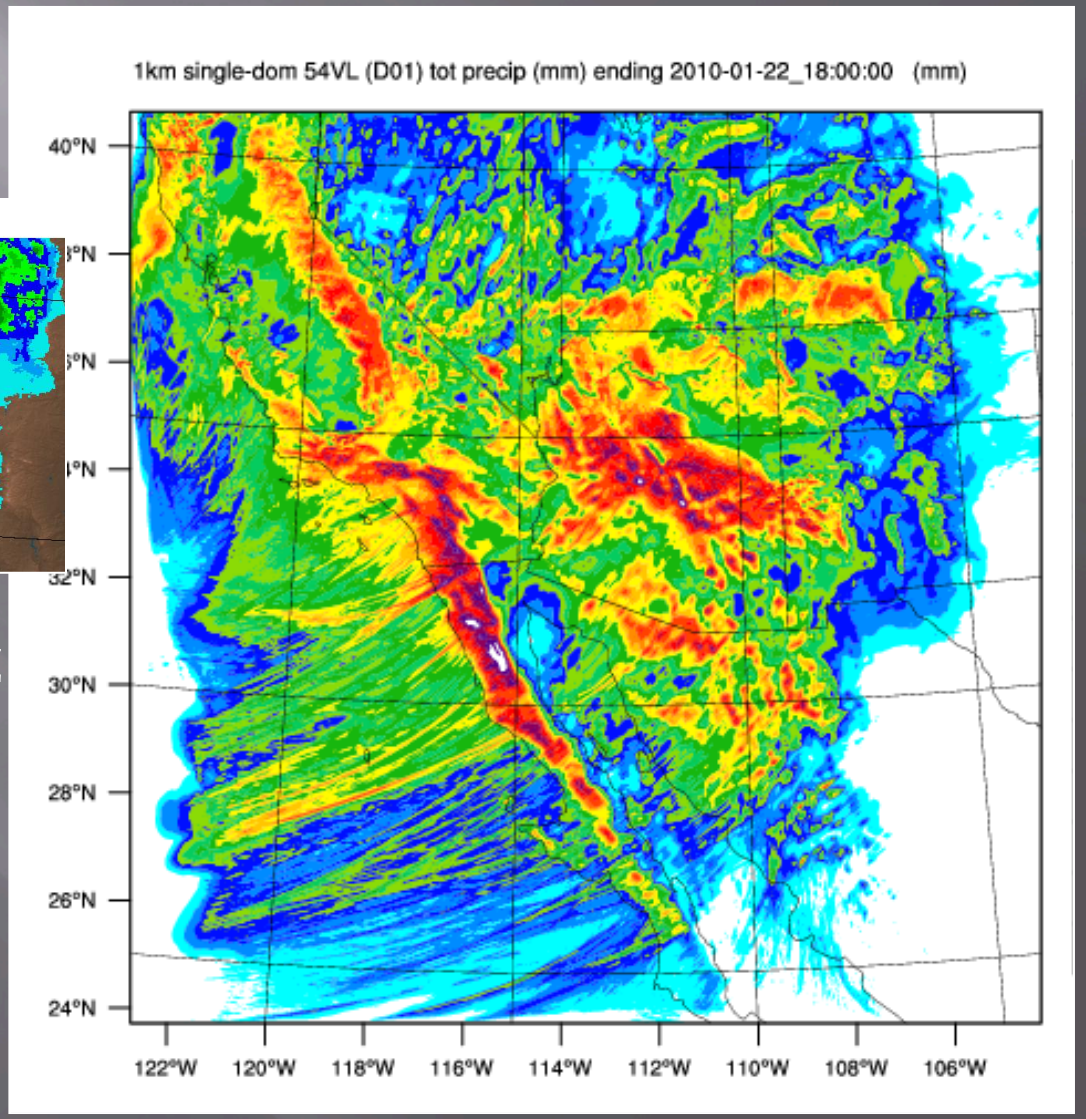
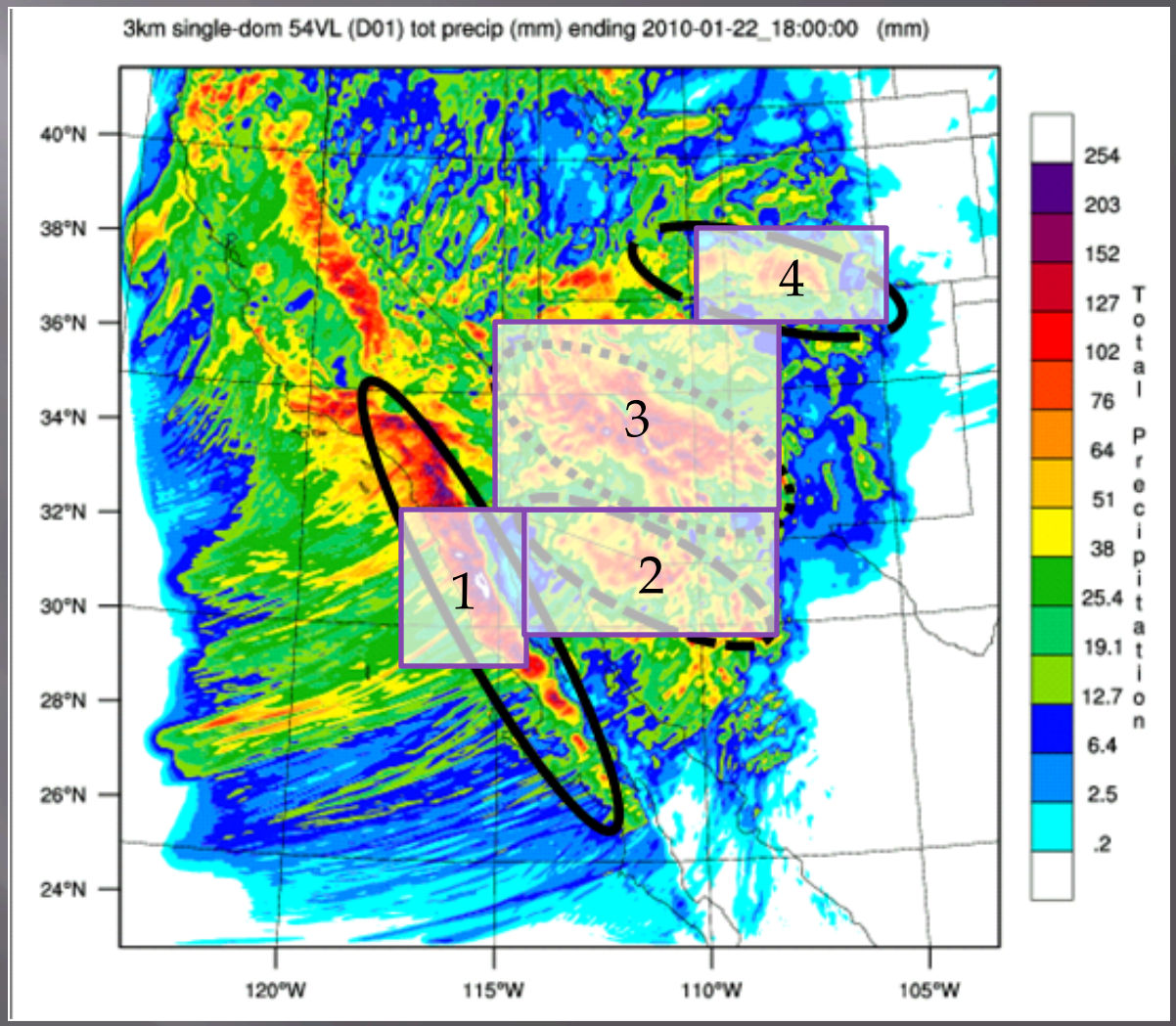


Differences due to resolution in resultant precipitation

We assess the impact the resolution has on precipitation in four regions that received major precip.:

1) Over central Baja
2) AZ/Mexico (skipped)
3) Mogollon rim
4) CO/San Juan mountains



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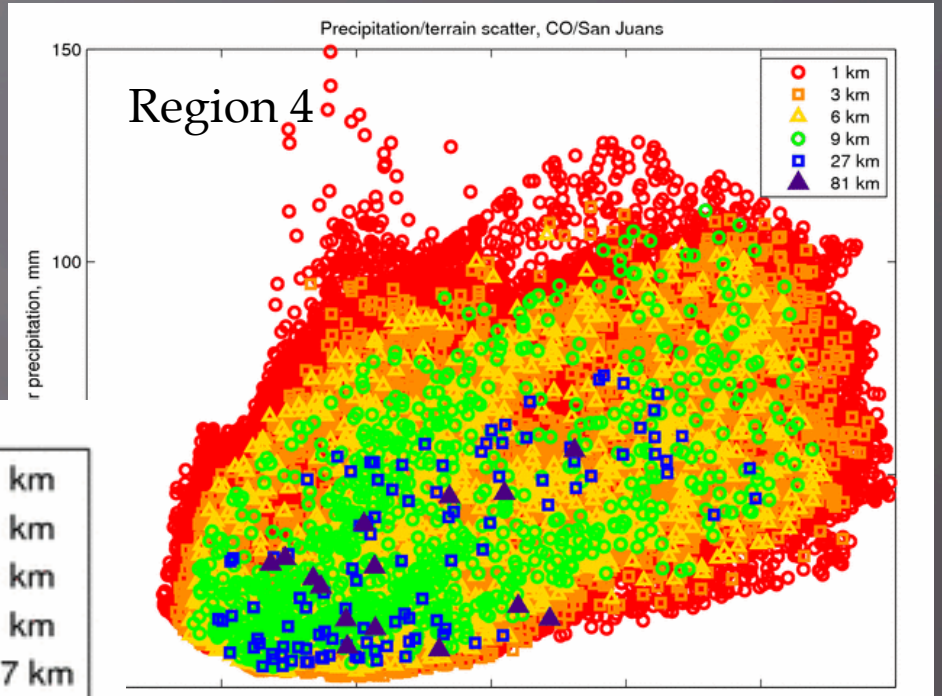

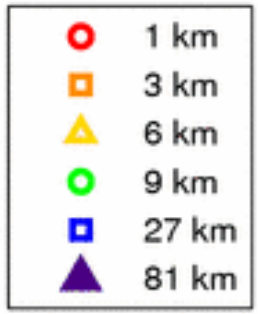

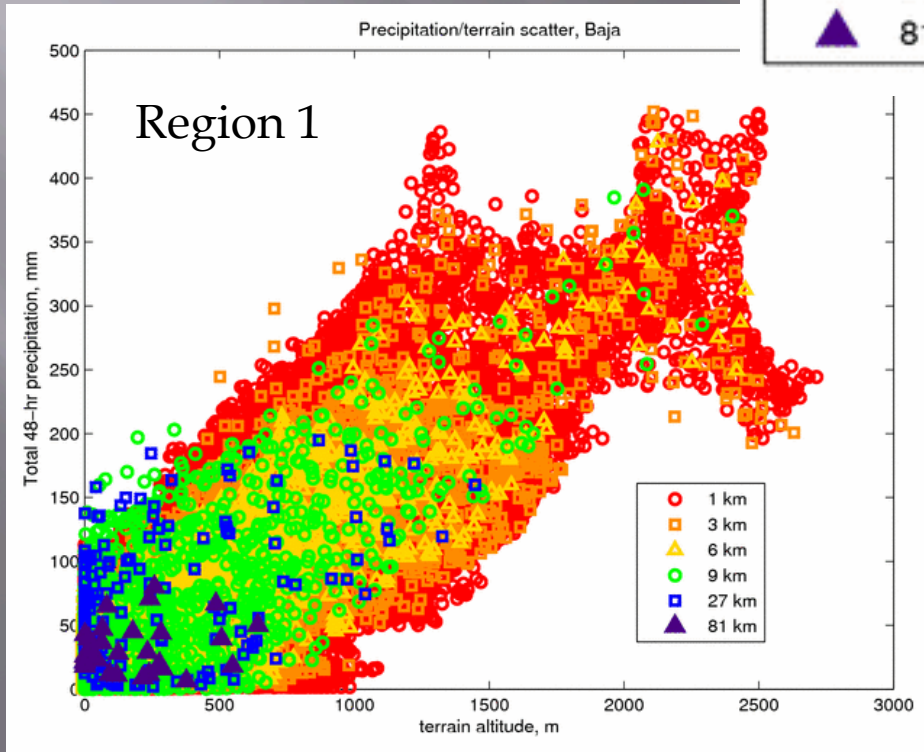

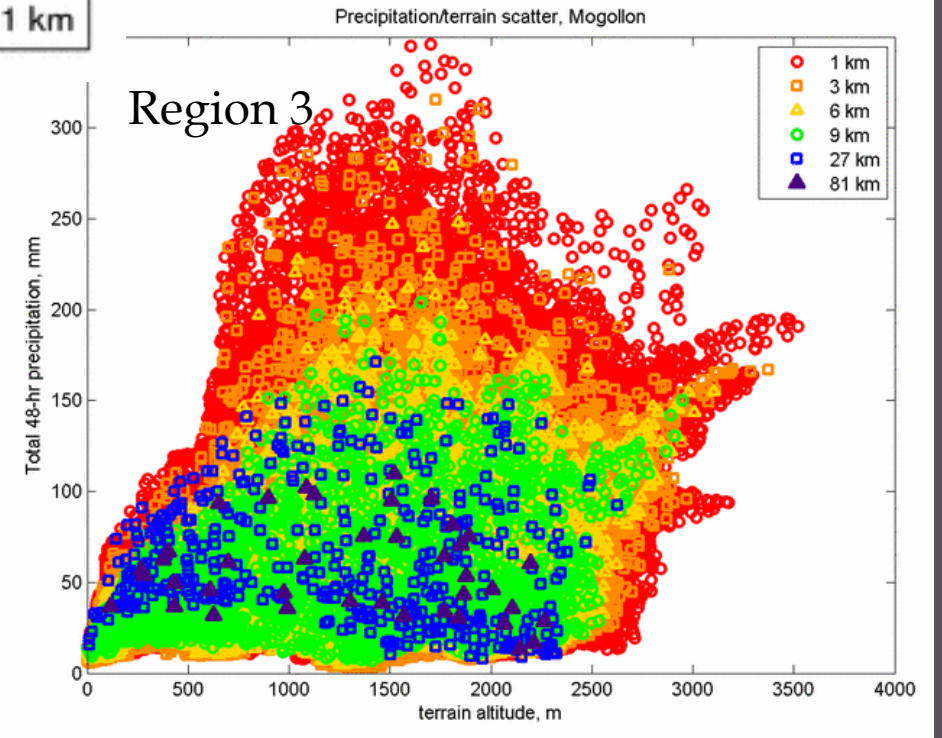

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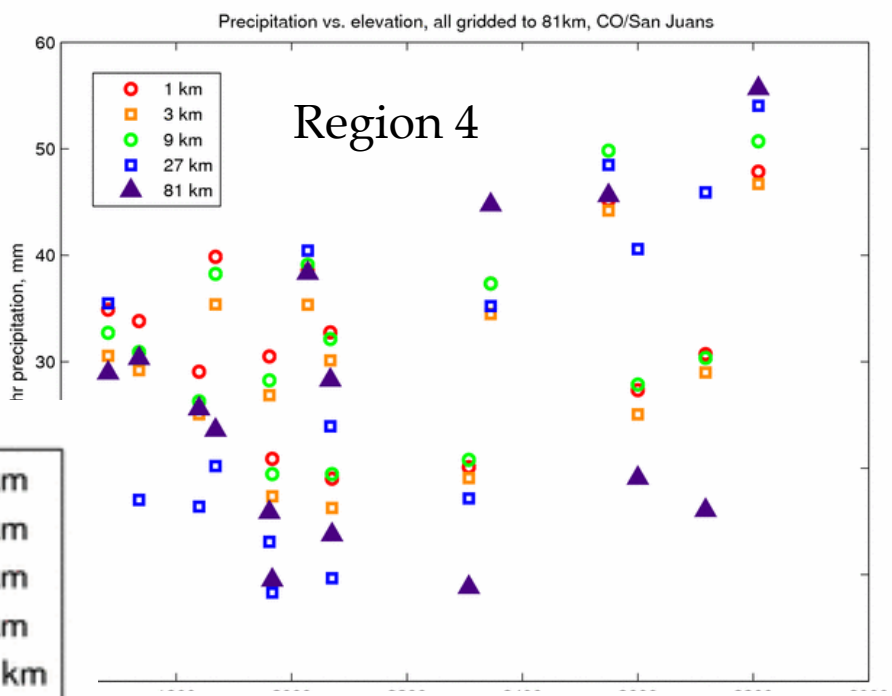
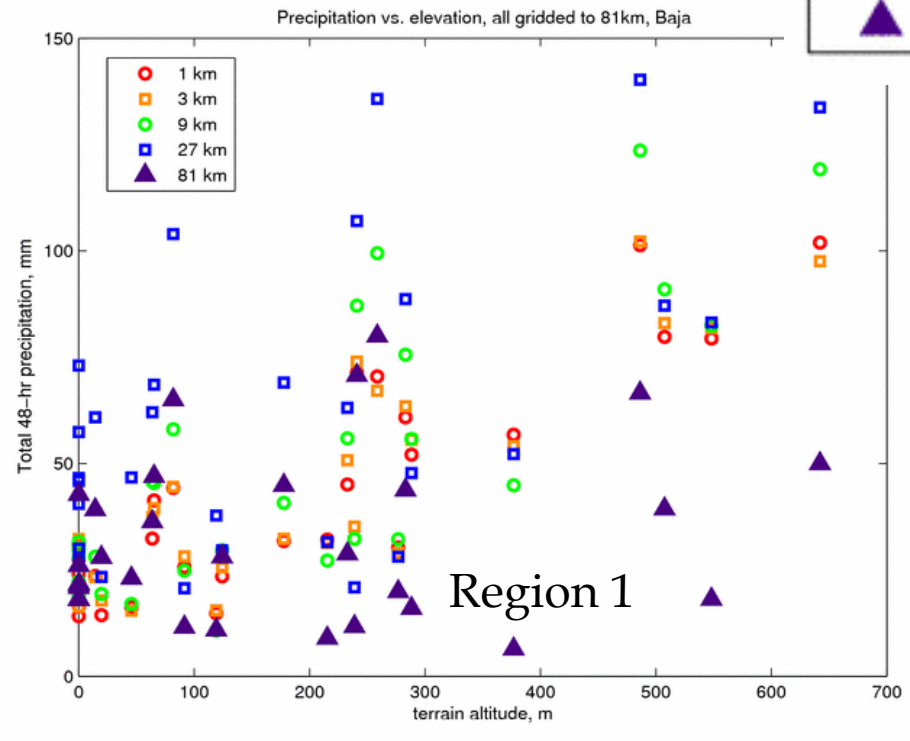
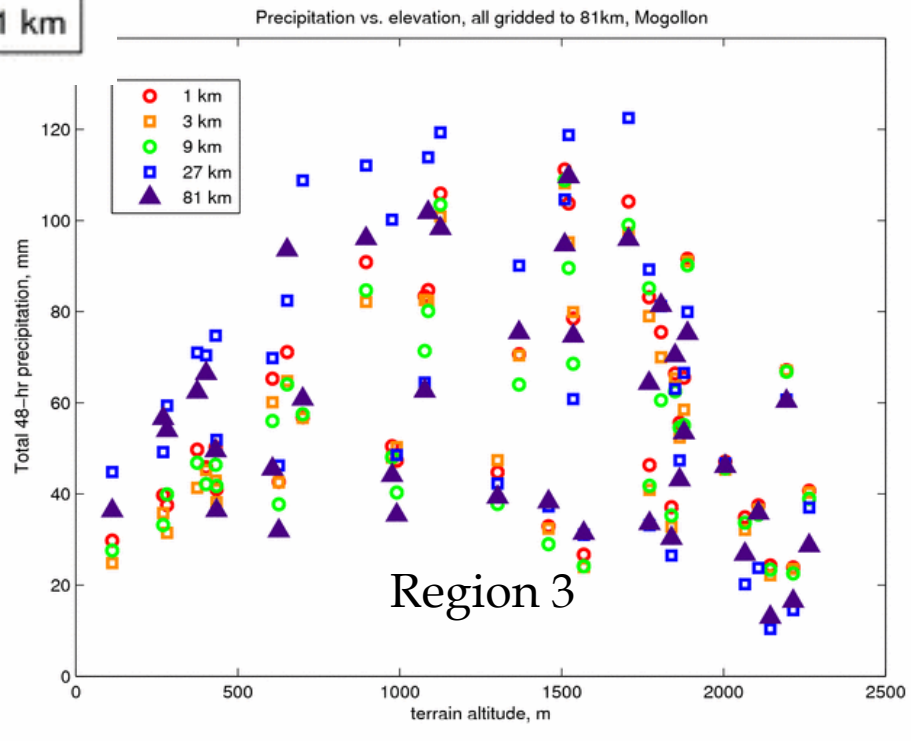
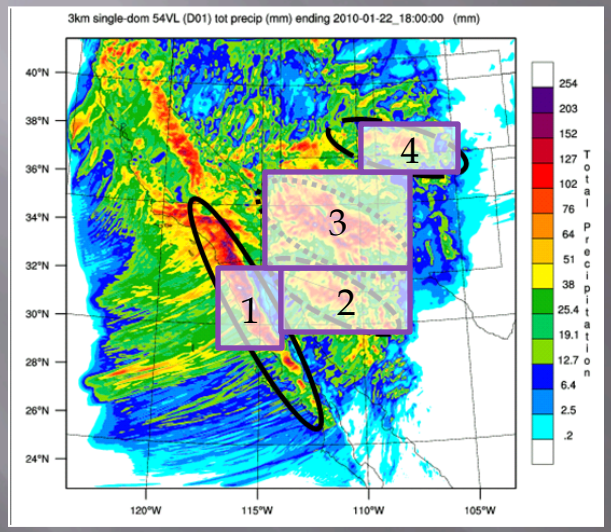




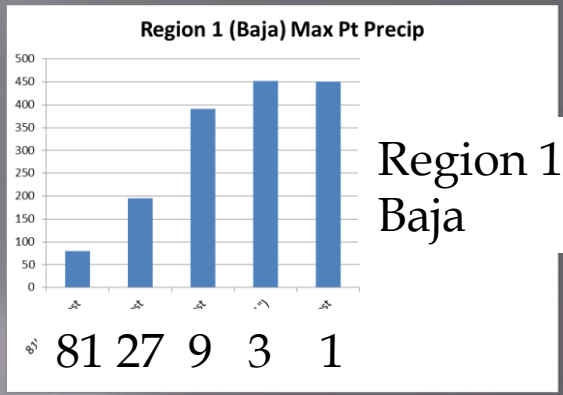


Differences due to resolution in resultant precipitation

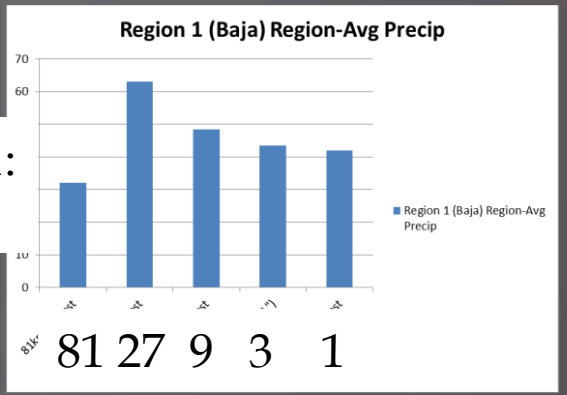


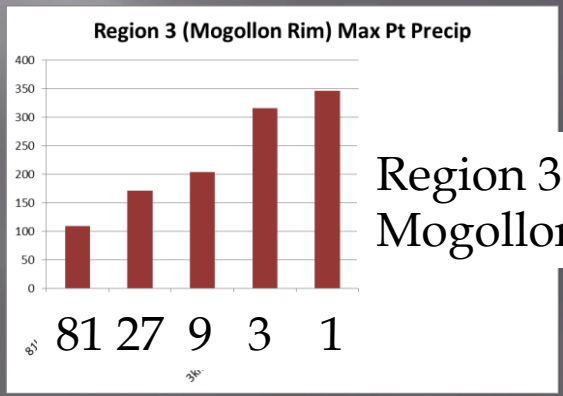
Region maximum precip

Region average precip

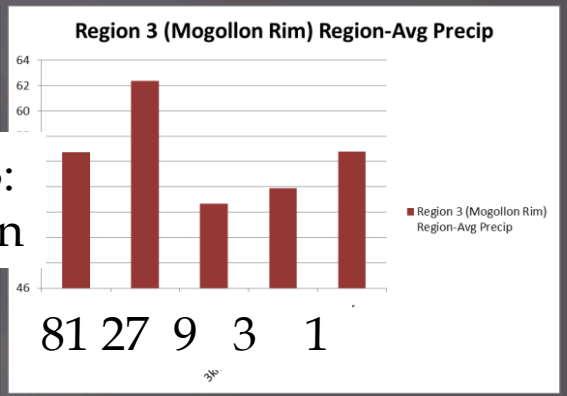


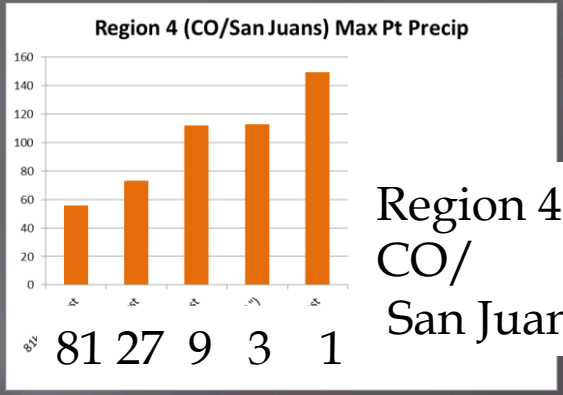
Region 1: Baja



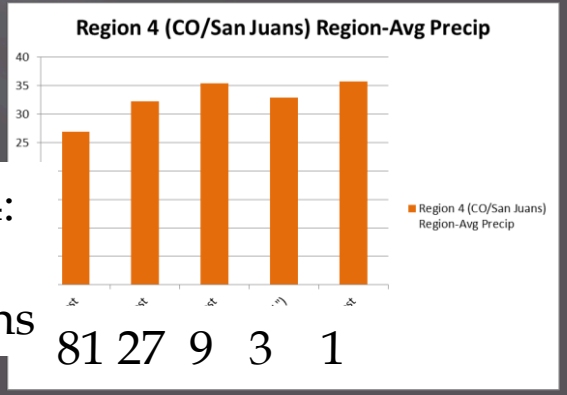


Region 3: Mogollon

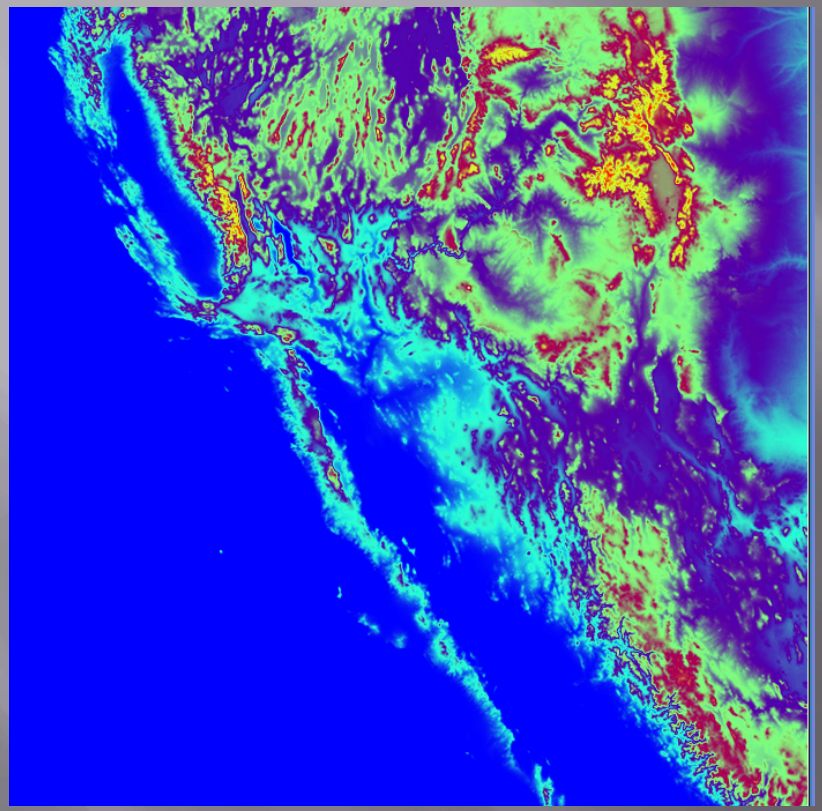


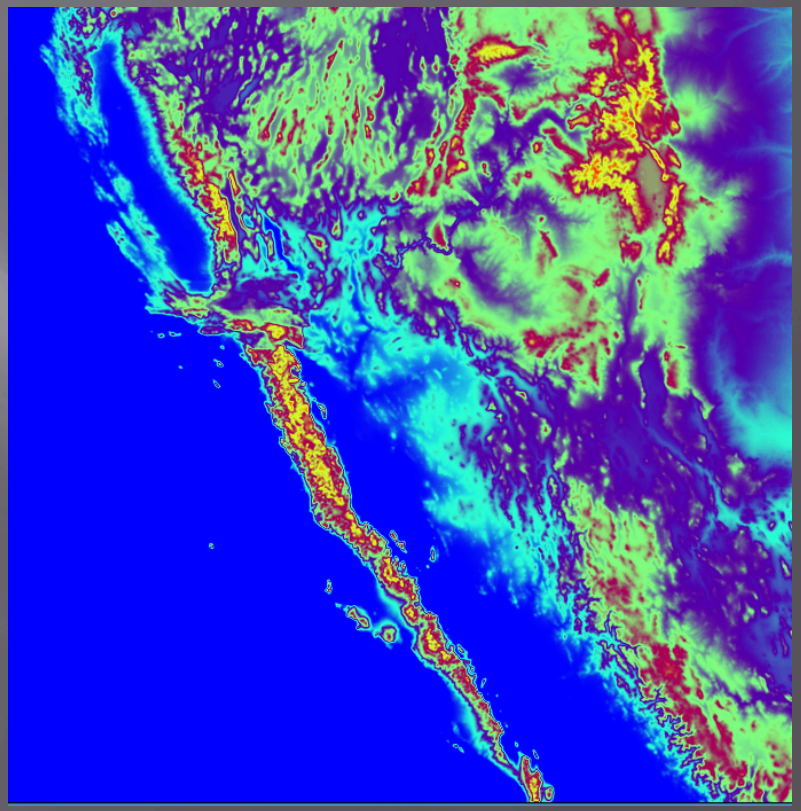


Region 4: CO/ San Juans



To what extent does Baja's terrain 'channel' water to AZ/ CO?





3 km CTRL terrain height

Tall Baja terrain height

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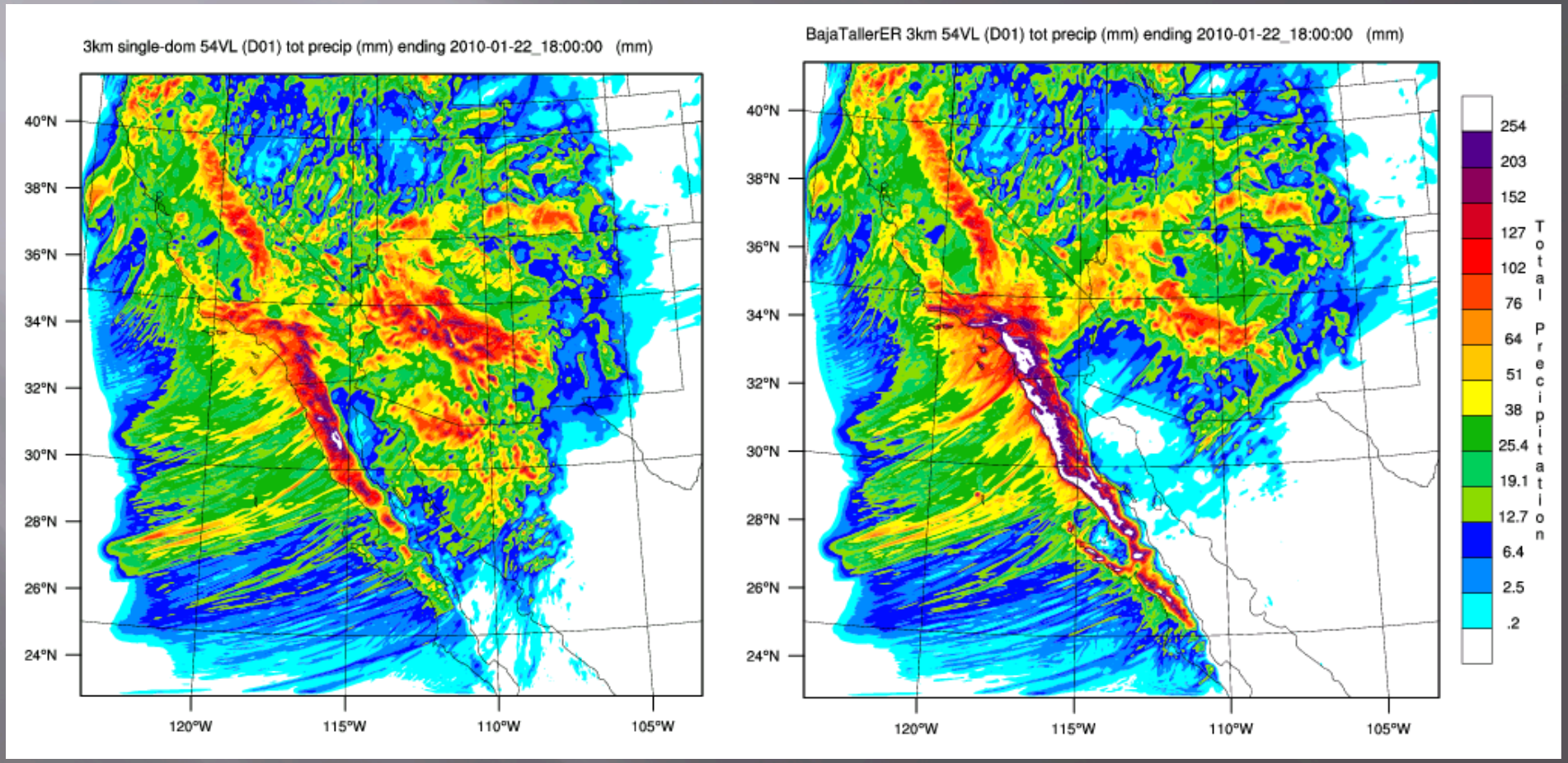
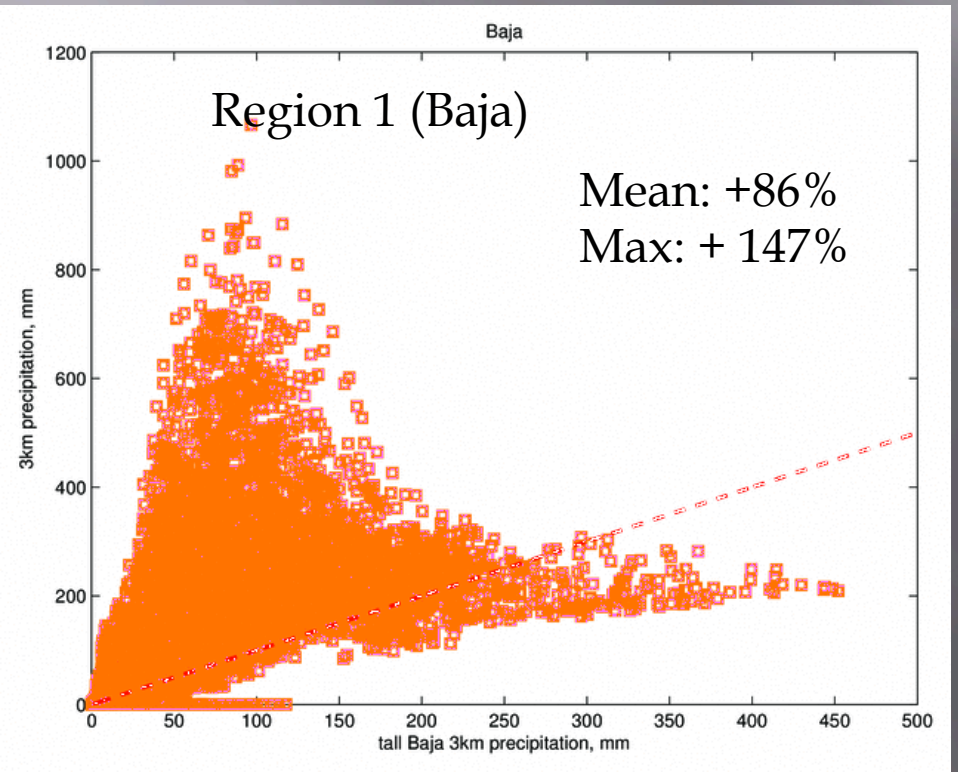
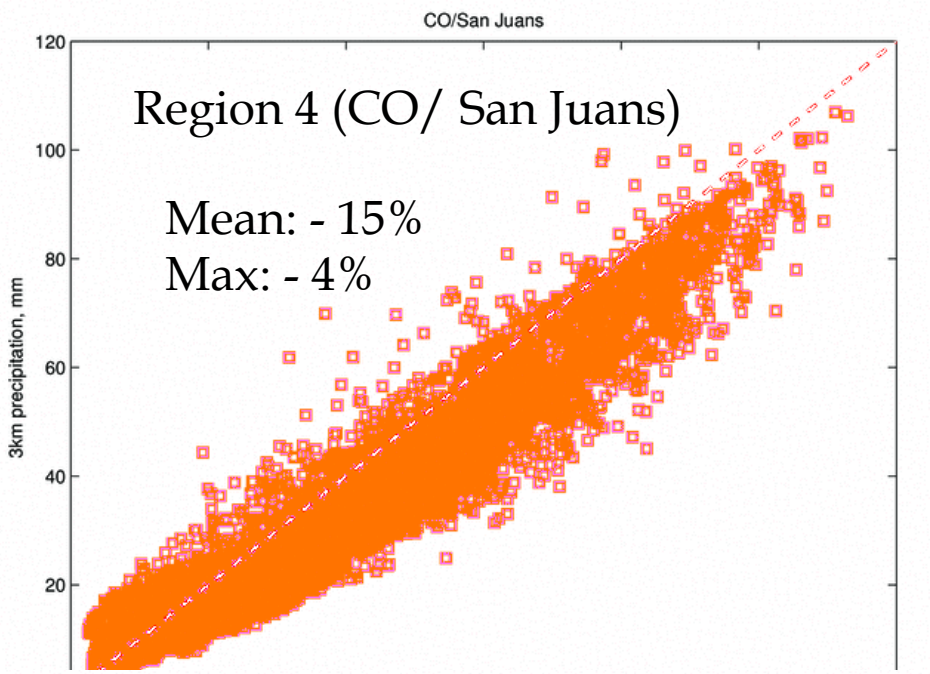


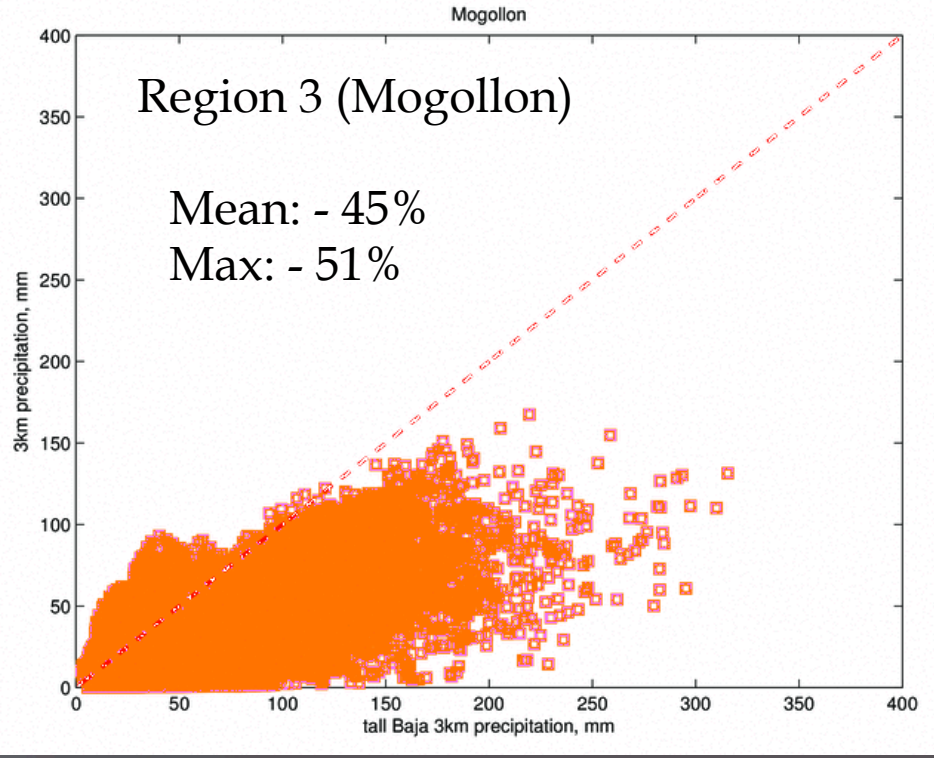
3 km CTRL precipitation

Tall Baja precipitation

Tall Baja resultant precipitation, compared against CTRL







Preliminary Conclusions

- Better-resolved terrain makes little difference in integrated vapor transport (IVT) and resultant, area-averaged precipitation beyond about 9 km grid spacing
- Maximum precipitation amounts generally increase with finer grid spacing up to 1 km
- Preliminary results with a ‘tall Baja’ experiment support the assertion that the atmospheric river’s crossing location – south of Baja’s higher terrain – contributed to the large precipitation over the Mogollon rim

Future directions

- Investigation of the impact of cumulus parameterization (i.e., having it on or off at varying resolutions), vertical resolution, the impact of the Gulf of California, and full terrain removal to quantify synoptic contribution
- Further quantitative investigation of IVT and precipitation at different resolutions, including quantitative comparison to observations, and possibly pseudo moisture budgets

Thanks!