



Changes in extreme IVT on the US west coast in NA-CORDEX, and relationship to mountain and inland precipitation

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What has previous work shown? ARs/IVT generally increase by end of century



From Payne et al 2020: "The robust thermodynamic response of atmospheric moisture to climate change means that future atmospheric rivers will contain more moisture, but circulation changes and potential decreases in their precipitation efficiency must be considered in future impact studies."

What has previous work shown? Precipitation also generally increase by end of century (but more uncertain)



From Neelin et al. 2014: Multimodel mean projected change in daily DJF precipitation (mm/day) from CMIP5. Enter Regional Climate Models...

NA-CORDEX == North American COordinated Regional Downscaling EXperiment

	CRCM5 (UQAM)	CRCM5 (OURANOS)	RCA4	RegCM4	WRF	CanRCM4	HIRHAM5		
ERA-Int	0.44° 0.22° 0.11°	0.22°	0.44°	50km 25km	50km 25km	0.44° 0.22°	0.44°	RCP	ECS (°C)
HadGEM2- ES								4.5	4.6
				50km 25km	50km* 25km*			8.5	
CanESM2	0.44°		0.44°			0.44° 0.22°		4.5	3.7
	0.44° 0.22°	0.22°	0.44°			0.44° 0.22°		8.5	
MPI-ESM-LR	0.44°							4.5	3.6
	0.22° 0.44°	0.22°		50km* 25km*	50km 25km			8.5	
MPI-ESM-MR								4.5	3.4
	0.44° 0.22°							8.5	
EC-EARTH†			0.44°					2.6	~3.3
			0.44°				0.44°	4.5	
			0.44°				0.44°	8.5	
GFDL- ESM2M								4.5	2.4
		0.22°		50km 25km	50km* 25km*			8.5	
Access	PoC	PoC	ESGF	PoC	PoC	CCCma	ESGF		
Institution	UQAM	OURANOS	SMHI	lowa State *NCAR	U Arizona *NCAR	CCCma	DMI		
Modeler	K. Winger	S. Biner	G. Nikulin	R. Arritt *M. Bukovsky	H-I Chang *M. Bukovsky	J. Scinocca	O. Christensen	N	Літі



Projected change in cool season (Oct-Mar) mean monthly precipitation for 2070-2100 (future-historical)



NA-CORDEX Ensemble Mean

Projected change in cool season (Oct-Mar) mean monthly precipitation for 2070-2100 (future-historical)

What's happening in the mountains?

 Ultimate question: What are the physical reasons for the NA-CORDEX changes in precipitation?

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 Relate these to IVT event frequency, duration, and intensity in a subset of NA-CORDEX RCMs.

-30

NA-CORDEX Ensemble Mean



100

Projected change in cool season (Oct-Mar) mean monthly precipitation for 2070-2100 (future-historical)



which are hereafter labeled by their parent GCM.

IVT event times – identification and relevance



- Integrated water vapor transport (IVT) is computed at all western US coastal grid points (top) for all times, to construct historical distributions (bottom), for three NA-CORDEX RCMs with 3D, 3-hourly output.
- These distributions are used to calculate IVT percentiles, for each grid point (e.g., 99th percentile is 482.6 kg m-1 s-1 at ~37N)

Time periods with IVT above 90th and 99th percentile thresholds for 24 continuous hours are identified as 'events'.

Define 99th == *extreme* IVT events; 90th == *moderate inclusive* IVT events; 90th where 99th events are excluded == *moderate* IVT events

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IVT event times – identification and relevance



These events are atmospheric river-like but more inclusive (e.g., cutoff lows), and are associated with a large percentage of cool season precipitation.

IVT events in N. CA – Changes in frequency + duration



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time slice, and percent change

IVT event times – Changes in intensity



Composite IVT changes in IVT events at 37-39N (*).

- Positive everywhere indicating IVT events are *intensifying*.
- Some exhibit increases southwest and northeast of historical maximums, indicating changes in IVT event orientation.

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IVT event times – Changes in precipitation



Composite precipitation changes in IVT events at 37-39N (*).

 Extreme IVT events produce more precipitation across much of CA/NV, with some decreases in precipitation *down gradient* of historical precipitation max.

 Moderate IVT events produce less precipitation across Sierra Nevada in HadGEM and MPI; north/south shift in GFDL

IVT event times – Changes in precipitation efficiency?



Despite increased IVT during moderate IVT events, high elevation precipitation is *decreasing*, suggesting other (mesoscale, microscale) factors are playing a role.

Key Takeaways

- Current generation GCMs do not resolve terrain very well: This has physical implications
- NA-CORDEX (GCM 'babies'):
 - Shows projected reductions in cool season precipitation in some of the mountainous regions of the Western US (not seen with GCMs)
 - IVT event changes:
 - *More* extreme IVT events and *fewer* moderate IVT events in future than historical.
 - IVT composites show *intensification* (i.e., more IVT per event)
 - Extreme IVT events generally produce more precipitation
 - Moderate IVT events produce *less* precipitation across Sierra Nevada
 - Fewer moderate IVT events that produce less precip across Sierra Nevada on average ==> drier mountains?





Thanks!

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