Using the California Reanalysis Downscaling at 10 km (CaRD10) to Identify the Sierra Barrier Jet and Its Variability since 1950

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Sierra Barrier Jet (SBJ)



Mechanism

- Blocked
- $Fr = u / h_m N < 1$
- Leftward weakened
 Coriolis force



 Maintained by damming of stable air (Kim and Kang 2007)

Observed Sierra-Parallel Wind



(Neiman et al. 2010)

Precipitation



FIG. 4. Composite precipitation rate $[mm (6h)^{-1}]$ from NCEP Stage IV gridded precipitation dataset for the following SBJ cases observed at SHS: (a) the 20 strongest during the cool seasons of 2005/06 through 2010/11 and (b) the remaining 13 strongest during the cool seasons of 2009/10 through 2010/11. The circles and triangles are as in Fig. 1.

(Neiman et al. 2013)

Motivation

- Can CaRD10 reliably identify SBJs?
- If so, what is the multidecadal climatology and variability of SBJs?
- If so, what is the relationship to precipitation and atmospheric rivers

Why CaRD10?

- High horizontal resolution (10 km)
- Hourly instantaneous wind data
- Long record (1950-2012)

Datasets

- CaRD10 winds at 1000, 925, 850, 700, 600 hPa Hourly (Kanamitsu and Kanamaru 2007)
- Observed winds (915-MHz profilers at Chico) Hourly (Carter et al. 1995)
- L13 Precipitation (Gridded to 1/16° based on NOAA Cooperative Observer stations)
 Daily (Livneh et al. 2013)

Observed SBJ Catalogs

- Start and end date and hour for each SBJ event during 2000-2010 October-March from Hughes et al. (2012)
- Start and end date and hour for each SBJ event in April during 2000-2007 from Neiman et al (2010)

Terrain-Relative Coordinates



SBJ Criteria (Neiman et al. 2010)

- The wind profile must have a relative maximum in Sierraparallel component of the flow (V, directed from 160°) of greater than 12 m s⁻¹ below 3 km MSL. If more than one relative maximum exist, the maximum is taken as the SBJ amplitude (Vmax)
- V must decreases by more than 2 m s⁻¹ between the layer of Vmax and 3 km MSL.
- 3. Vmax has to occur at or **above the 200 m** and data should exist above and below Vmax.
- 4. At least **8 consecutive hourly wind profiles** should satisfy the above criteria.

Wind Profiler (Cool Season 2001-2010)



Profiler and CaRD10 (Cool Season 2001-2010)



Matched Obs-CaRD10, Obs only, CaRD10 only, non-SBJ

CaRD10 Vmax threshold = 10.5 m s^{-1} CaRD10 wind shear threshold = 1.2 m s^{-1}

Critical Success Index

CaRD10 Vmax Threshold

	9	9.5	10	10.5	11	11.5	12	12.5
0.5	56.2%	56.9%	57.5%	59.5%	58.5%	58.6%	55.5%	54.2%
0.8	56.3%	57.0%	57.7%	59.2%	57.8%	57.9%	54.6%	53.3%
1.0	56.9%	57.7%	58.3%	59.7%	58.4%	58.4%	55.0%	53.4%
1.2	56.9%	57.9%	58.4%	59.8%	58.3%	57.9%	54.4%	52.7%
1.5	56.9%	57.8%	58.4%	59.2%	57.8%	56.8%	53.3%	51.6%
1.8	56.4%	57.1%	57.6%	58.2%	56.3%	55.1%	52.6%	50.9%
2	55.2%	55.8%	56.5%	57.0%	55.8%	54.7%	52.2%	50.6%
2.5	54.7%	55.3%	55.9%	56.2%	54.7%	54.4%	51.9%	50.0%

CaRD10 Wind Shear Threshold

Daily Precipitation during SBJs



Precipitation-Weighted Critical Success Index

CaRD10 Vmax Threshold

	9	9.5	10	10.5	11	11.5	12	12.5
0.5	73.3%	73.7%	74.0%	74.5%	73.4%	72.8%	70.6%	69.2%
0.8	73.3%	73.7%	74.0%	74.4%	72.8%	72.2%	69.9%	68.4%
1.0	73.6%	74.1%	74.3%	74.6%	73.0%	72.5%	70.2%	68.5%
1.2	73.5%	74.1%	74.0%	74.4%	72.9%	71.6%	69.3%	67.5%
1.5	73.4%	73.9%	73.9%	73.8%	72.0%	71.0%	68.6%	66.6%
1.8	72.0%	72.4%	72.3%	72.0%	70.0%	69.1%	67.7%	65.7%
2	70.8%	71.0%	71.2%	70.9%	69.5%	68.4%	67.0%	65.3%
2.5	70.3%	70.6%	70.7%	70.3%	68.6%	68.2%	66.9%	64.3%

CaRD10 Wind Shear Threshold

SBJ Occurrence in Observations and CaRD10



Matched Obs-CaRD10, Obs only, CaRD10 only

SBJ Climatology in Observations and CaRD10









SBJ Diurnal Cycle in Obs and CaRD10



SBJ Variability in Observations and CaRD10



Now let's look at CaRD10 during cool season 1951-2012

SBJ Climatology



SBJ Variability



SBJ Variability



SBJ Variability



SBJ and ENSO (Jan-Mar only)



SBJ and ENSO+PDO (Jan-Mar only)



SBJ and **Precipitation**



Ratio of SBJ to Seasonal Precipitation



SBJ and **Precipitation**



SBJ and AR



SBJ and AR



Summary

- CaRD10 can identify SBJ events, especially those associated with strong precipitation
- No long-term trend is present in the CaRD10 61-year record of SBJ events.
- SBJs slightly more frequent for El Niño and positive phase of PDO.
- Strong relationship between ARs, SBJs, and precipitation in the northern Central Valley.

Thank you!