Climatology of Westerly Wind Events in the Lee of the Sierra Nevada

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GEOGRAPHICAL CONTEXT

- Owens Valley is a narrow valley in eastern California, approximately N-S oriented and bounded by the Sierra Nevada (W) and the White-Inyo Range (E, ***Figure 1***).
- The area has been the theatre of major research efforts about windstorms and rotors (***Figure 2***): the Sierra Wave Project (1950's), the Sierra Rotors Project and the Terrain-induced Rotor Experiment (2000's, see Grubišić et al 2008, *BAMS*, **89**, 1513-1533).

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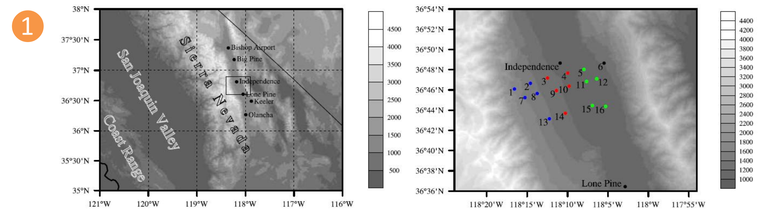

- Existing climatological studies of high wind events in this area reveal hardly any signature of W winds. Strong winds are instead reported to blow preferentially from the N and S as a consequence of synoptic flow channeling (Zhong et al 2008, *MWR*, **136**, 3536-3552).
- We present a climatology of westerly wind events in Owens Valley, built using 5 years of 30-s data (Feb. 2004 – Feb. 2009) from a mesonet of 16 weather stations (***Figure 3***). Differently from previous studies, measurement stations are distributed along cross-valley transects, reaching a significant distance up the western slope.

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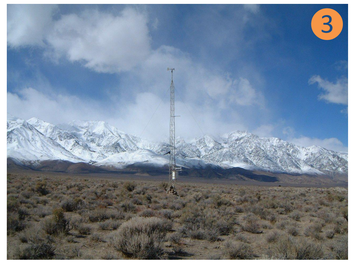

WESTERLY WIND EVENTS AND THEIR DIURNAL AND SPATIAL DISTRIBUTION

- The 16 stations are organized in three groups based on their location (**1**, **2** and **3** in ***Figure 1***). Histograms representing the diurnal cycle of wind direction in stations of each group are in ***Figure 4***. Note that two different wind speed ranges are considered!
- The spatial confinement of strong WWE to the western valley wall suggests that these flows separate from the surface along the lee slope.
- Both thermally forced (katabatic) and dynamically forced downslope winds are known to exhibit this behavior. Given the range of westerly wind speeds observed by the DRI network and the unlikely formation of extreme cold air pools in an unconfined environment like Owens Valley, the most plausible responsible for the occurrence of strong WWE in the area is dynamical forcing conducive to mountain wave activity.

STRONG WESTERLY WIND EVENTS

- We are particularly interested in strong westerly wind events (**WWE**). Strong westerly wind events are determined based on: directionality (from the W slope of the valley), intensity (strong enough to erode any valley inversion and protrude into the valley atmosphere) and spatial coherence (simultaneous detection at more than one measurement point).
- We define a WWE as one with one-hour-average wind direction and speed, respectively, within 255°±45° and > 7 m s^{-1}, simultaneously occurring at any two of Stations 1, 2 and 7 of the network. The W quadrant is centered at 255° to account for the deviation of the valley axis direction from the N.
- ***Figure 5*** refers to IOP6 in T-REX and provides an example illustrating different periods of westerly flow. Only the period between hour 6 and hour 8 is regarded as a strong WWE.

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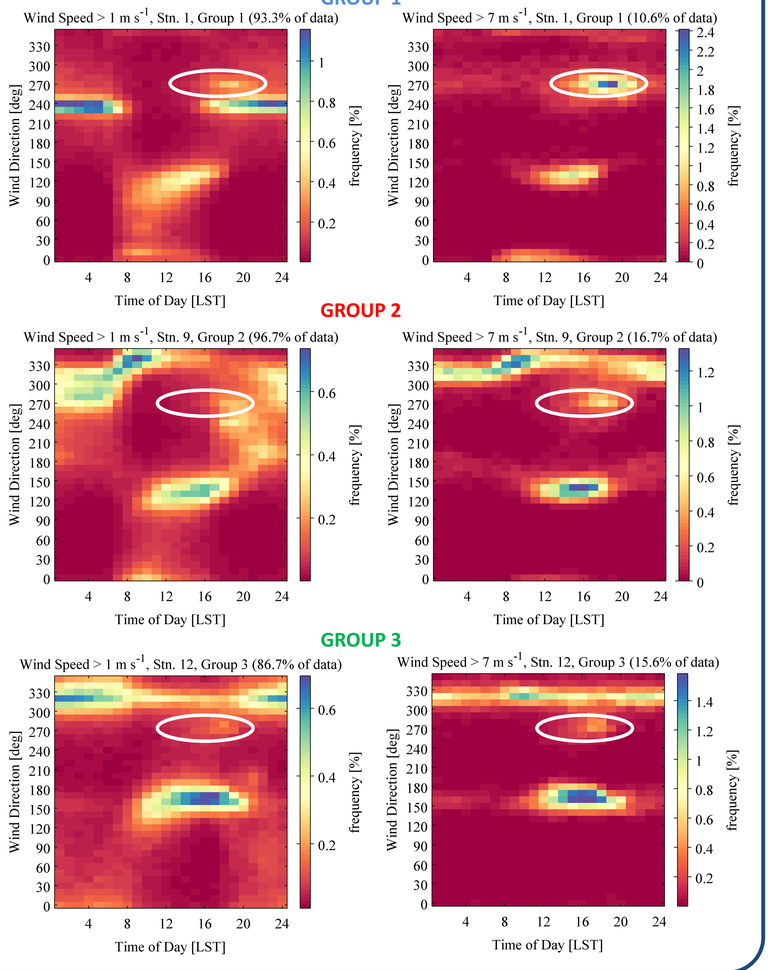

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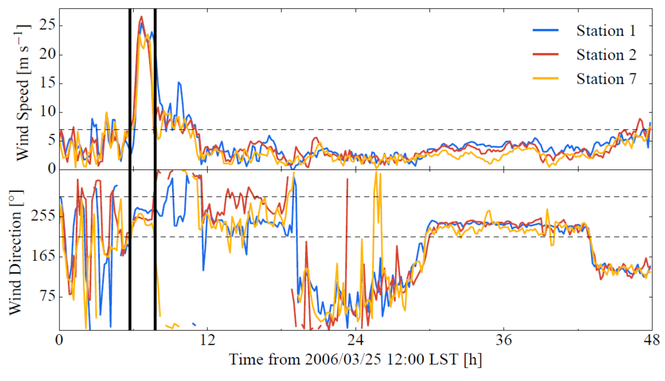

STRONG WESTERLY WIND EVENTS: DURATION AND INTENSITY

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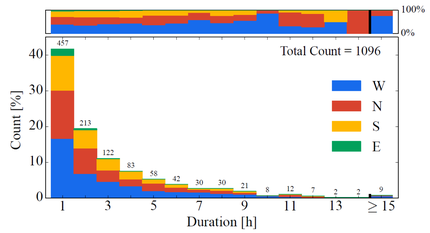

- Using the criterion introduced in ***Figure 5***, strong WWE can be detected in the 5-year period. The frequency distribution of their duration (***Figure 6***), and mean/maximum wind speed (***Figure 7***) can therefore be evaluated.
- Data referring to N, E and S strong wind events are also reported in ***Figures 6-7***. Westerly winds dominate the sample for long durations and strong intensities.

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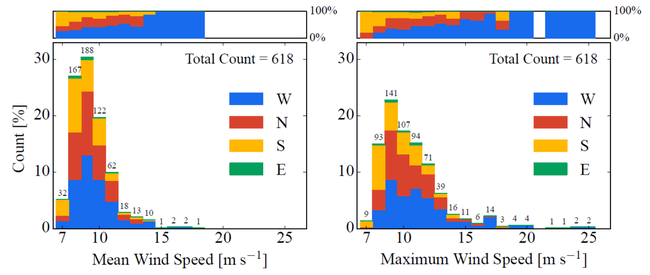

WWE: SEASONAL DISTRIBUTION

- The distribution of WWE throughout the day and through the year (***Figure 8***) shows that they can occur in any season but most frequently from April through September.
- In cold winter months, the frequency of these events is significantly lower than at other times of the year.
- WWE during summer months occur preferentially in the afternoon hours, which points to the role of thermal forcing as a major driver.

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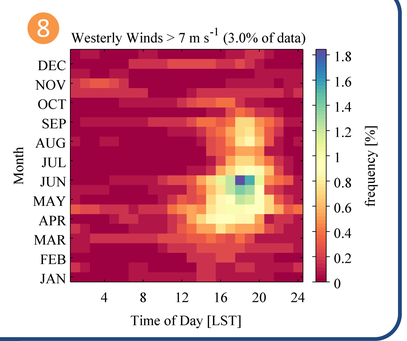

EXTREME WWE

- However, a significant fraction of the most severe WWE actually occurs in winter months.
- Less than half of the extreme WWE in 2004-2009 occur between April and September!
- **Why?** Stay tuned…

Date (LST)	Duration (h)	$\overline{U}(1)$	$U_{max}(1)$	$\overline{U}(2)$	$U_{max}(2)$	$\overline{U}(7)$	$U_{max}(7)$
2005-12-02 13:00	7	17.1	20.8	13.4	16.9	14.7	17.6
2006-03-25 18:00	2	19.8	22.3	17.3	20.4	15.6	16.3
2006-09-15 08:00	11	16.5	21.3	17.6	24.8	13.4	19.7
2006-10-16 12:00	10	13.8	19.8	12.7	19.3	13.1	21.2
2007-01-10 16:00	5	17.0	24.3	16.1	24.9	16.5	27.9
2007-02-25 10:00	16	15.6	21.6	10.6	23.4	14.0	21.3
2007-02-26 09:00	9	15.3	19.8	16.7	24.0	15.6	23.2
2007-06-05 13:00	11	11.7	19.6	14.0	21.8	11.2	22.8
2008-04-19 11:00	30	16.0	26.2	11.3	23.5	12.9	24.3
2008-04-29 17:00	13	19.9	25.5	13.2	20.3	17.2	23.1
2008-08-31 10:00	9	19.2	25.0	14.3	20.2	13.0	20.5
2009-02-13 16:00	3	17.8	20.0	13.6	16.6	15.5	18.0

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