Snapshot of surface wind speed for June 4, 2017. From https://earth.nullschool.net

The **Surface Wave** Variability in the **California Current Region:** Potential **implications** for **SWOT**

Bia Villas Bôas,
Sarah Gille, Matthew Mazloff, and Bruce Cornuelle

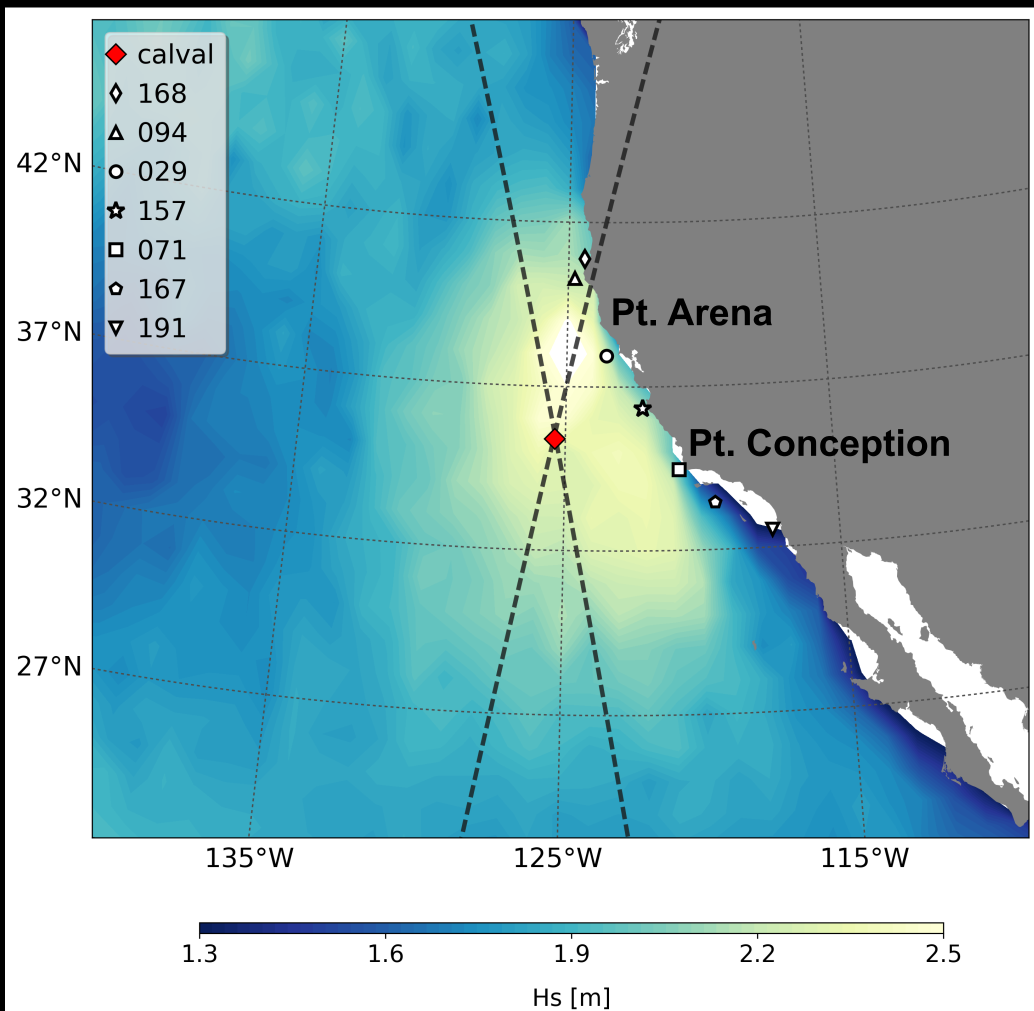
Scripps Institution of Oceanography, UCSD

The surface wave field in a given region results from the combined effect of both **local** and **remote** forcing

Specific goals:

1. Characterize the **seasonal variability** of the deep–water **surface wave field** in the California Current region.
2. Assess the extent to which the variability of the **wave field** is modulated by the **local wind**.
3. How **surface waves** may **impact** the **retrieval of SWOT's SSH** at the cal/val site?

The **California Current** region is historically **well-sampled** and it is a potential site for **SWOT cal/val**



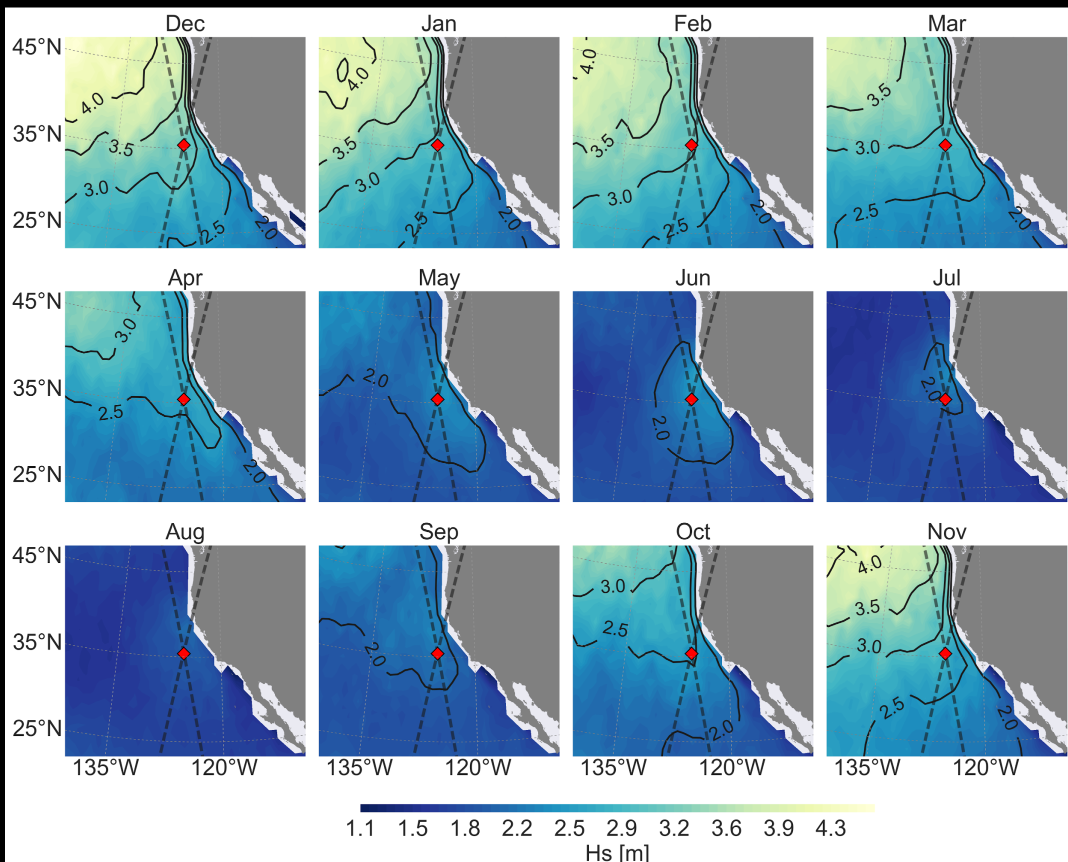
June average significant wave height from altimetry

Satellite altimetry: 23 years of multi-mission significant wave height (Hs) [*Queffeulou, 2004*]

Wave buoys: significant wave height, peak period, peak direction, and spectral moments

Wave model hindcast: WaveWatch III forced by CFSR winds [*Rascle and Ardhuin, 2013*]

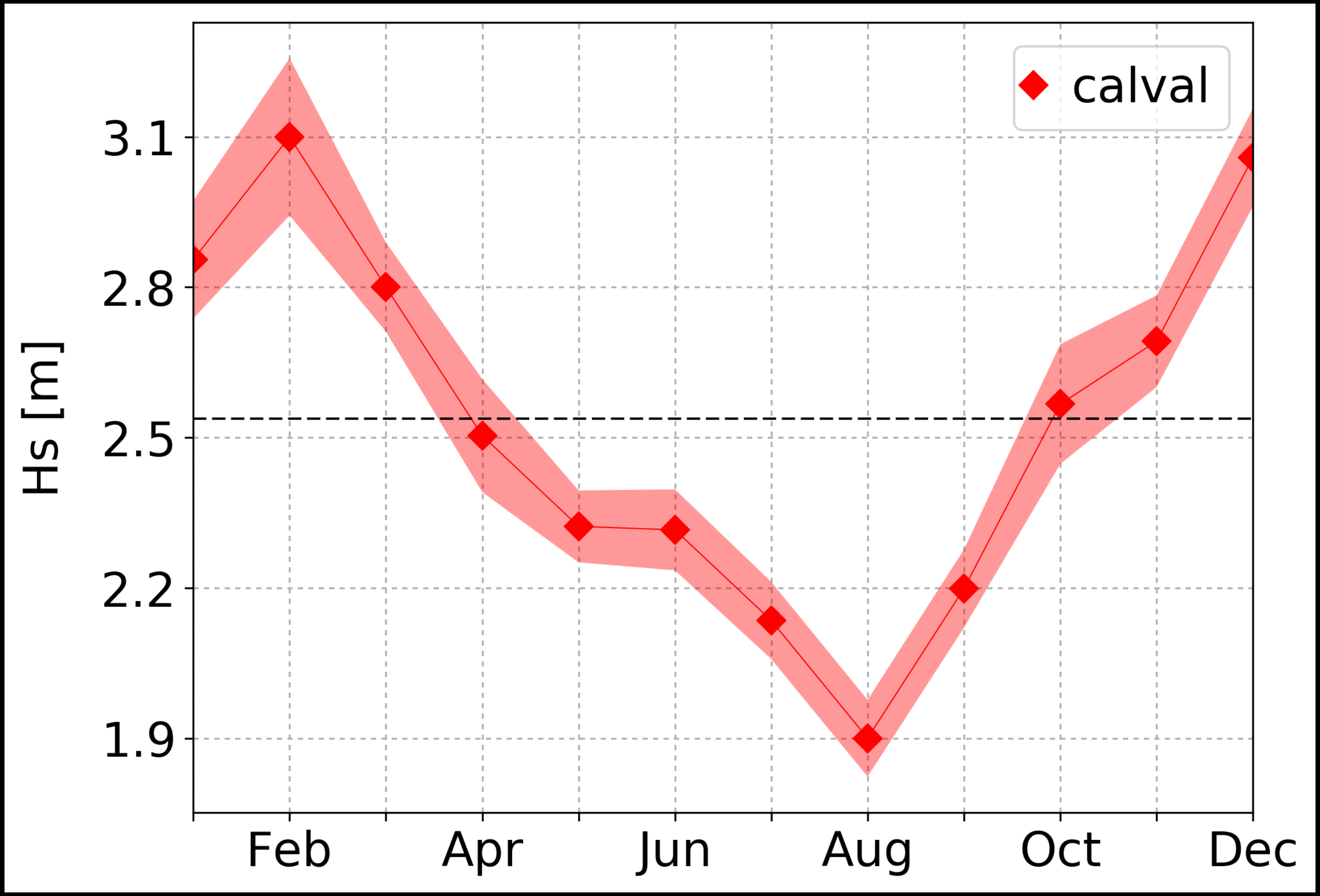
Significant Wave Height Seasonality



Monthly average significant wave height from altimetry

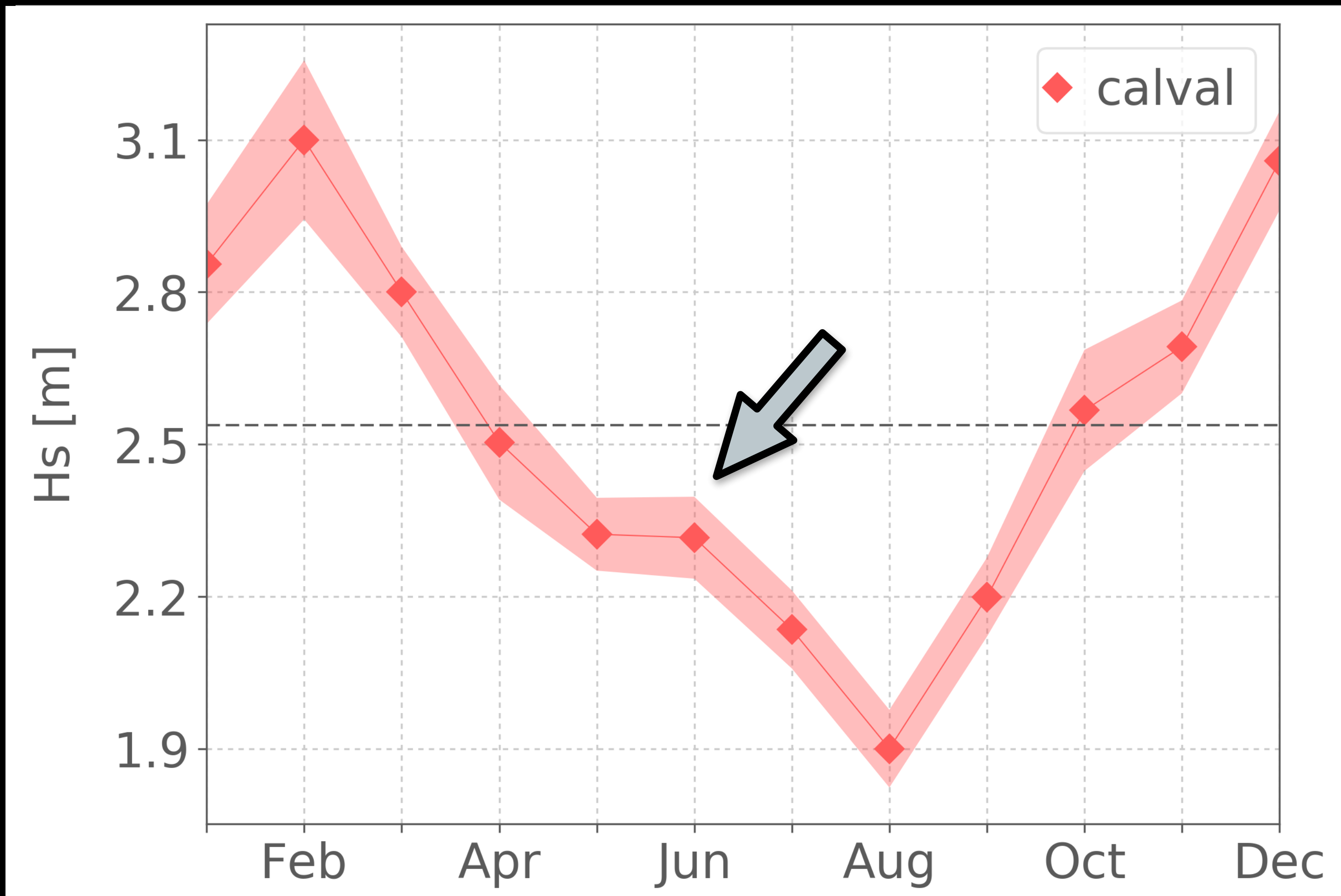
- **Large Hs** during boreal **winter** (4.5 m), **small Hs** during **summer** (1 m).
- Localized region of ***H*s ≥ 2 m** off the California coast in **May–July**.
- Except for August the **average Hs** at the potential **cal/val** site is **greater than 2 m**.

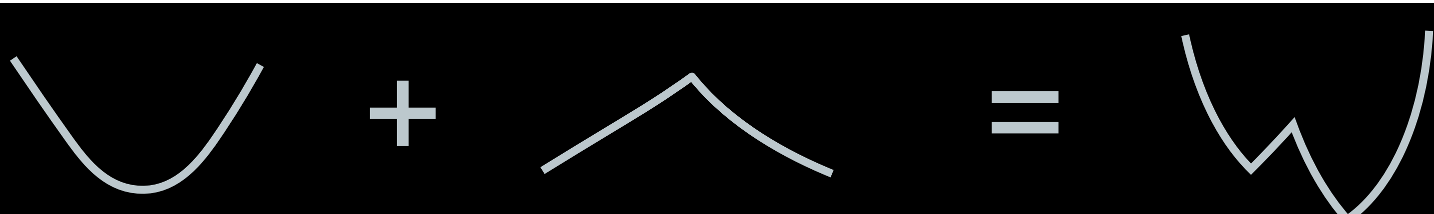
Significant wave height at the cal/val site



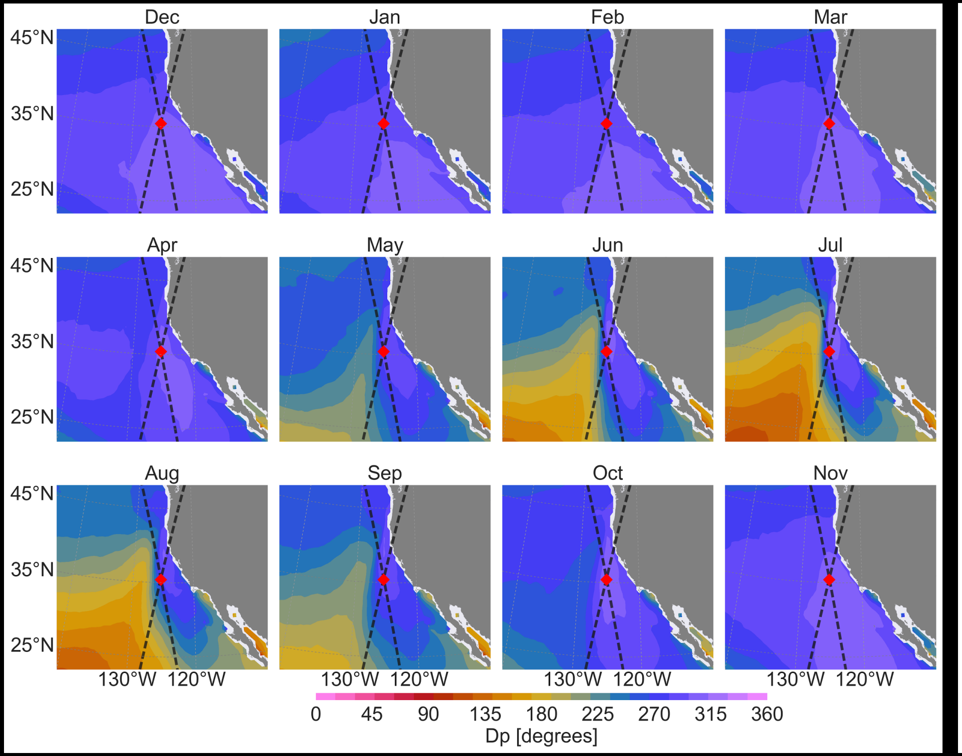
Monthly average significant wave height from altimetry at the cal/val site

What causes the “hump” in the Hs seasonal cycle?

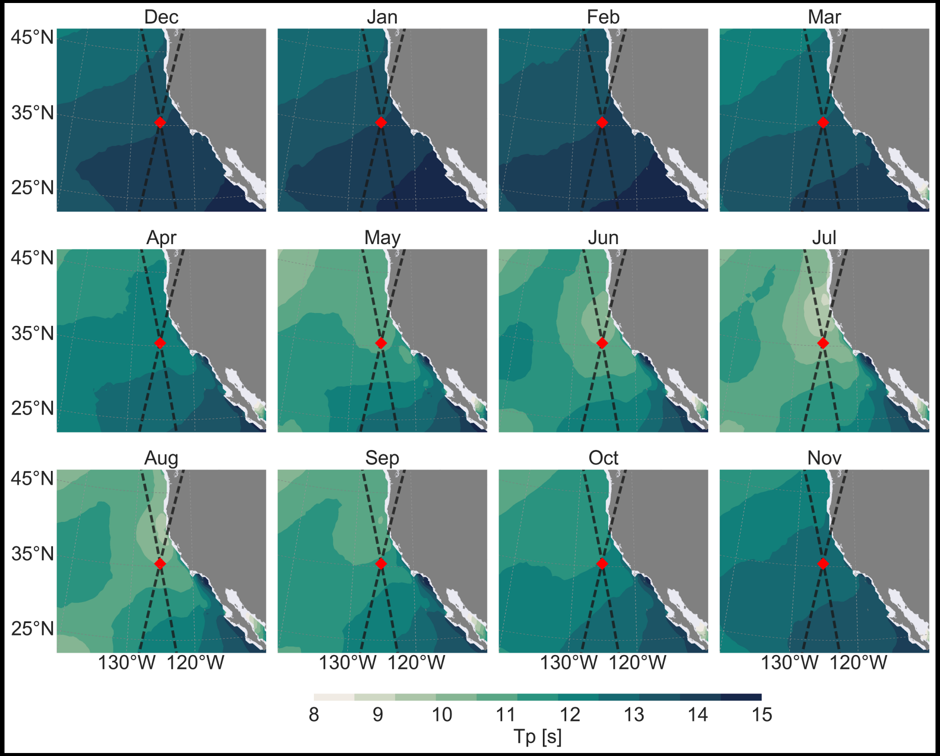




Peak Direction and Period

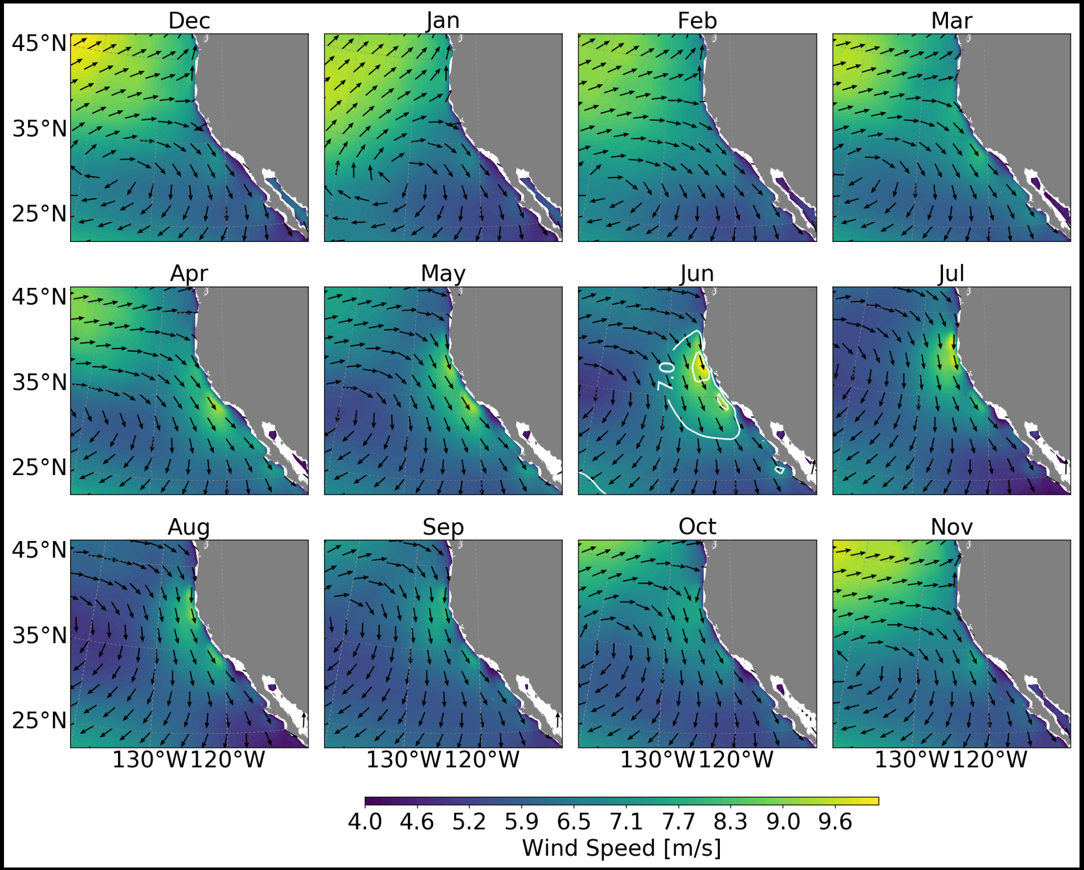


Monthly average peak **direction** from WW3



Monthly average peak **period** from WW3

Surface Wind Speed Seasonality

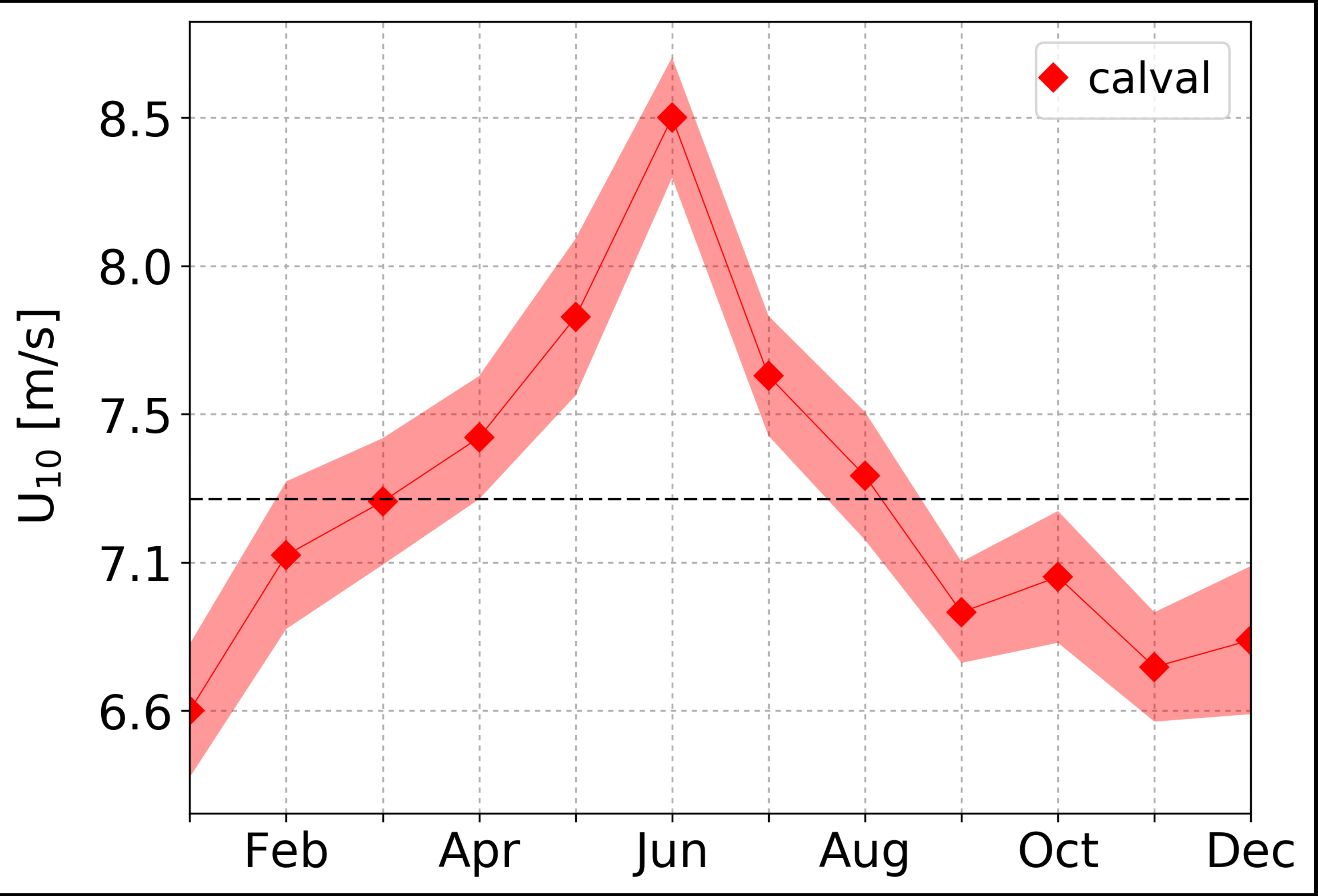


Monthly average surface **wind speed** from CFSR

Expansion fan winds appear as anomalously high (7–10 m/s) **alongshore winds** in central/ northern California during **Spring/Summer [***Winant et al. 1988*; *Taylor et al. 2008***].**

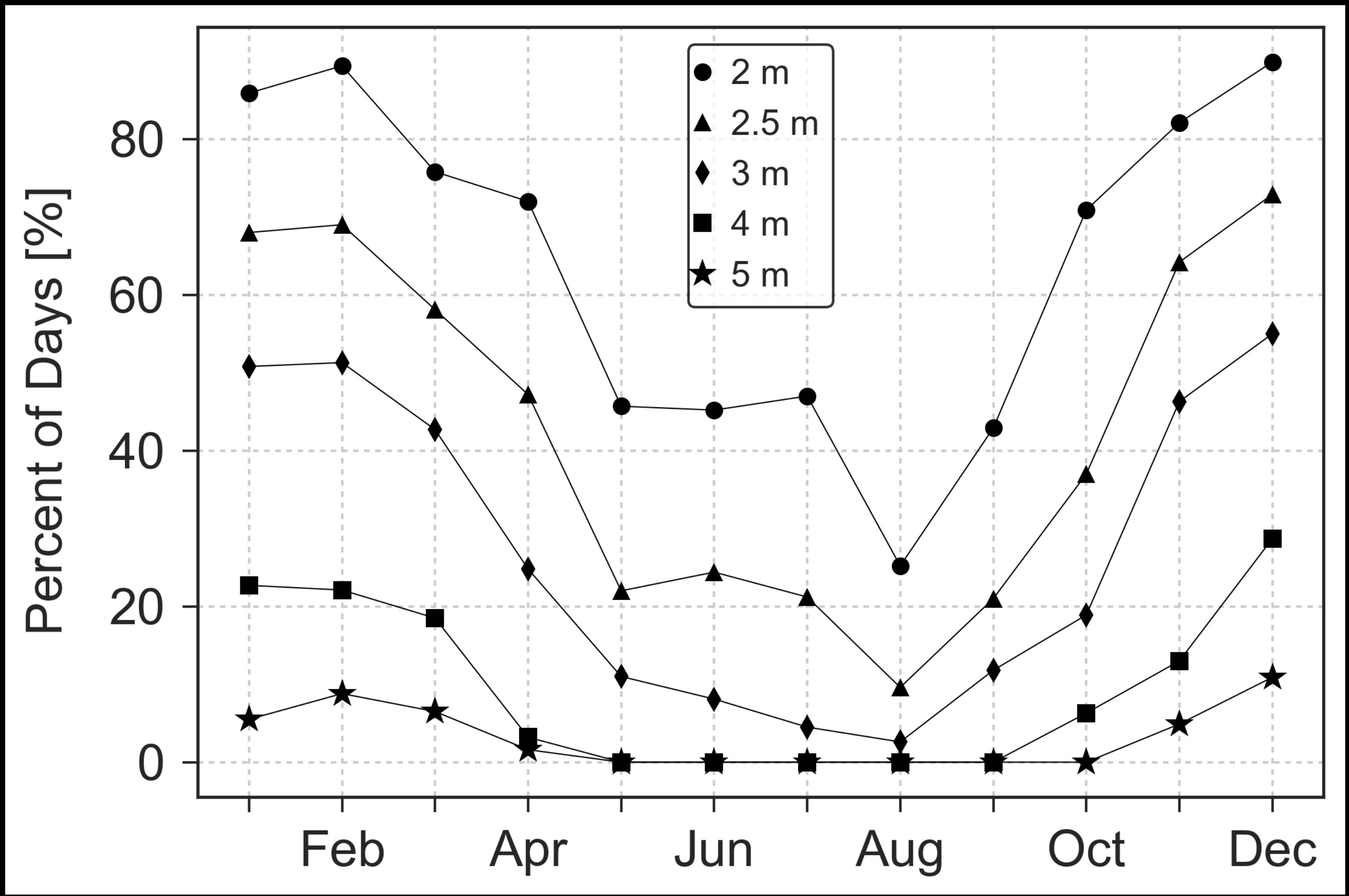
Two cape-scale expansion fans (off Pt. Arena and Pt. Conception), and a California-scale expansion fan (7 m/s contour).

Wind Speed at the cal/val site



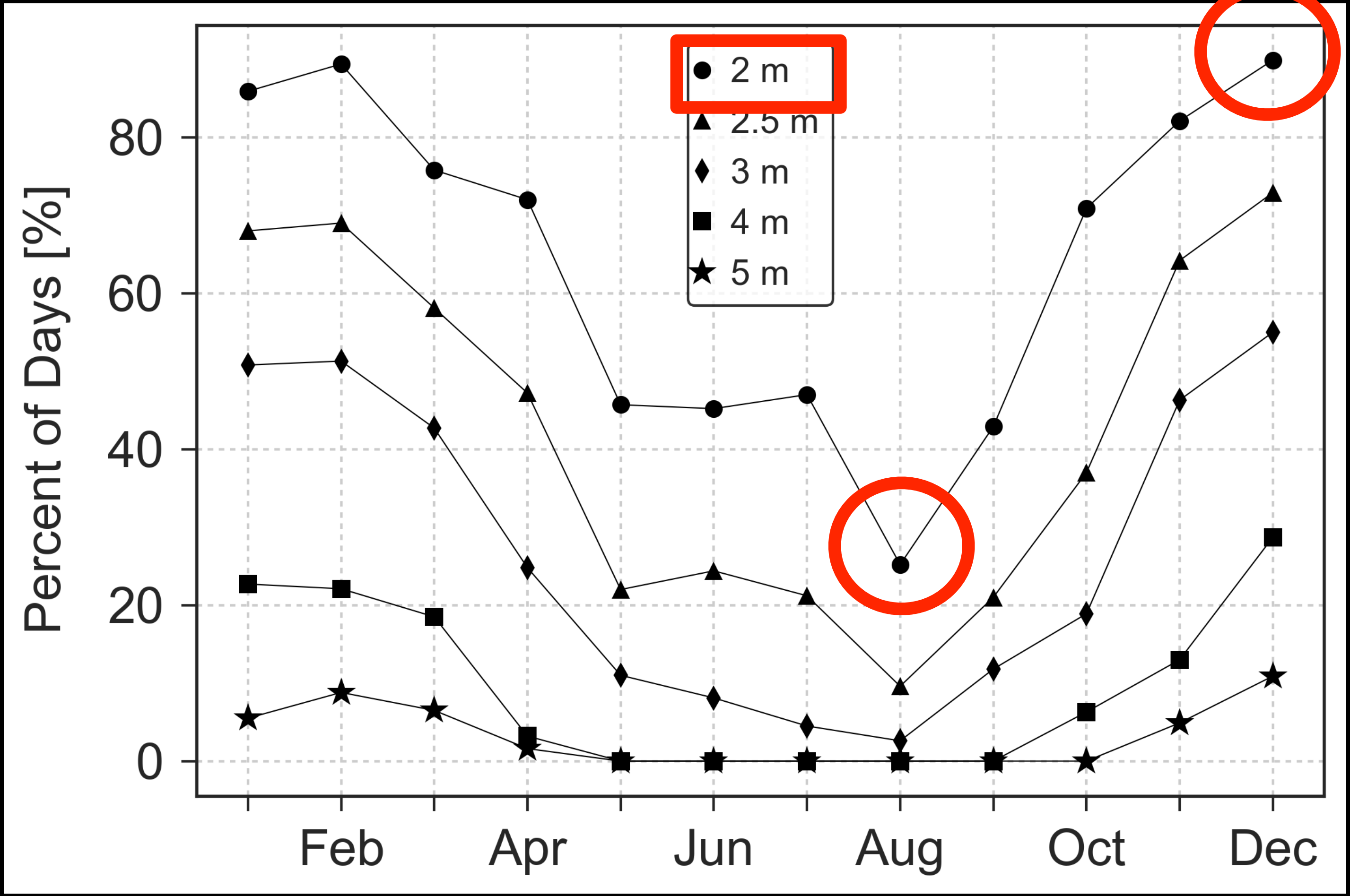
Monthly average surface **wind speed** from CFSR at the cal/val site

Implications for SWOT



Average percentage of days per month on which the significant wave height (from altimetry) at the SWOT cal/val site is above a given threshold.

Implications for SWOT



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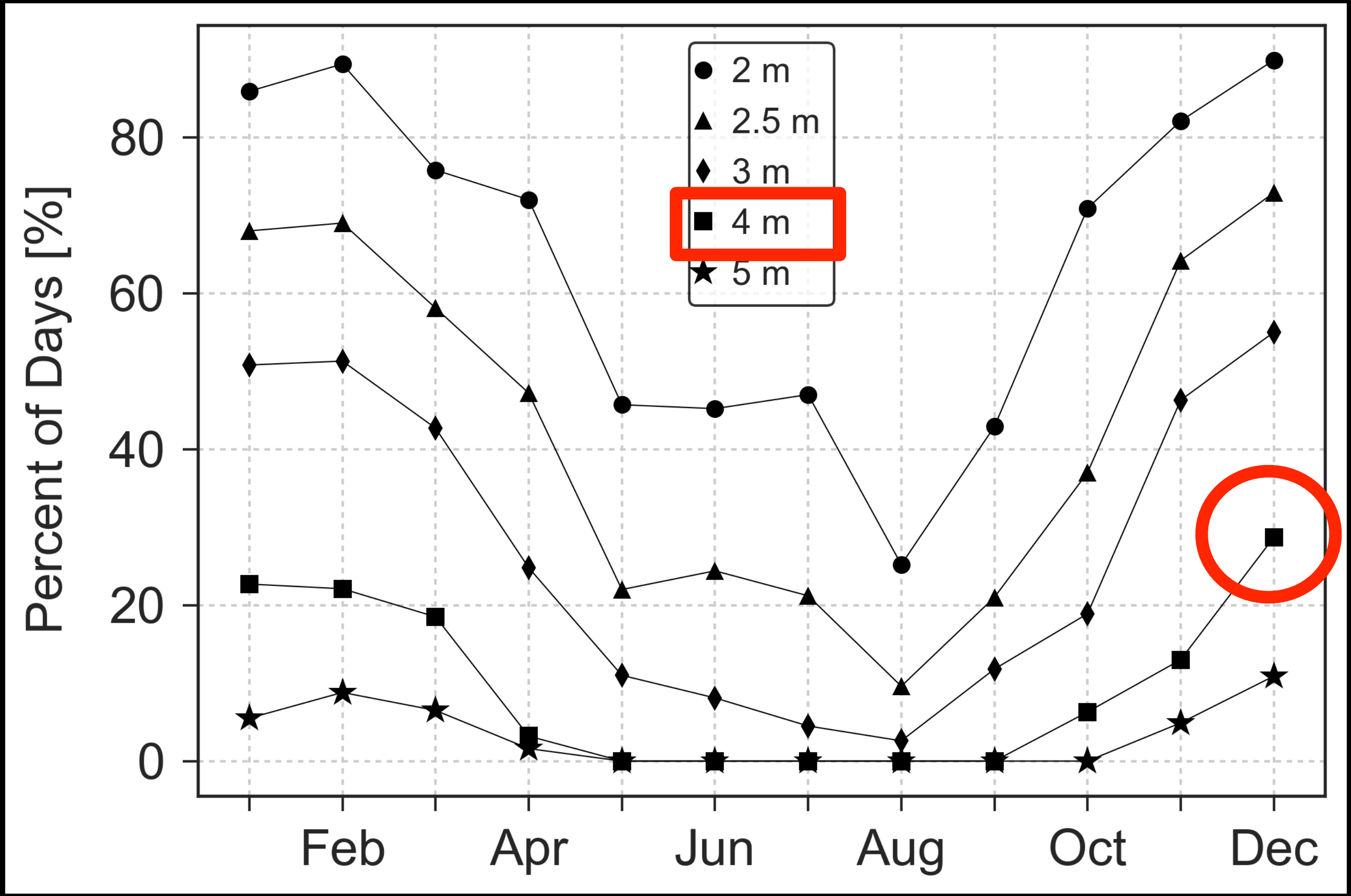
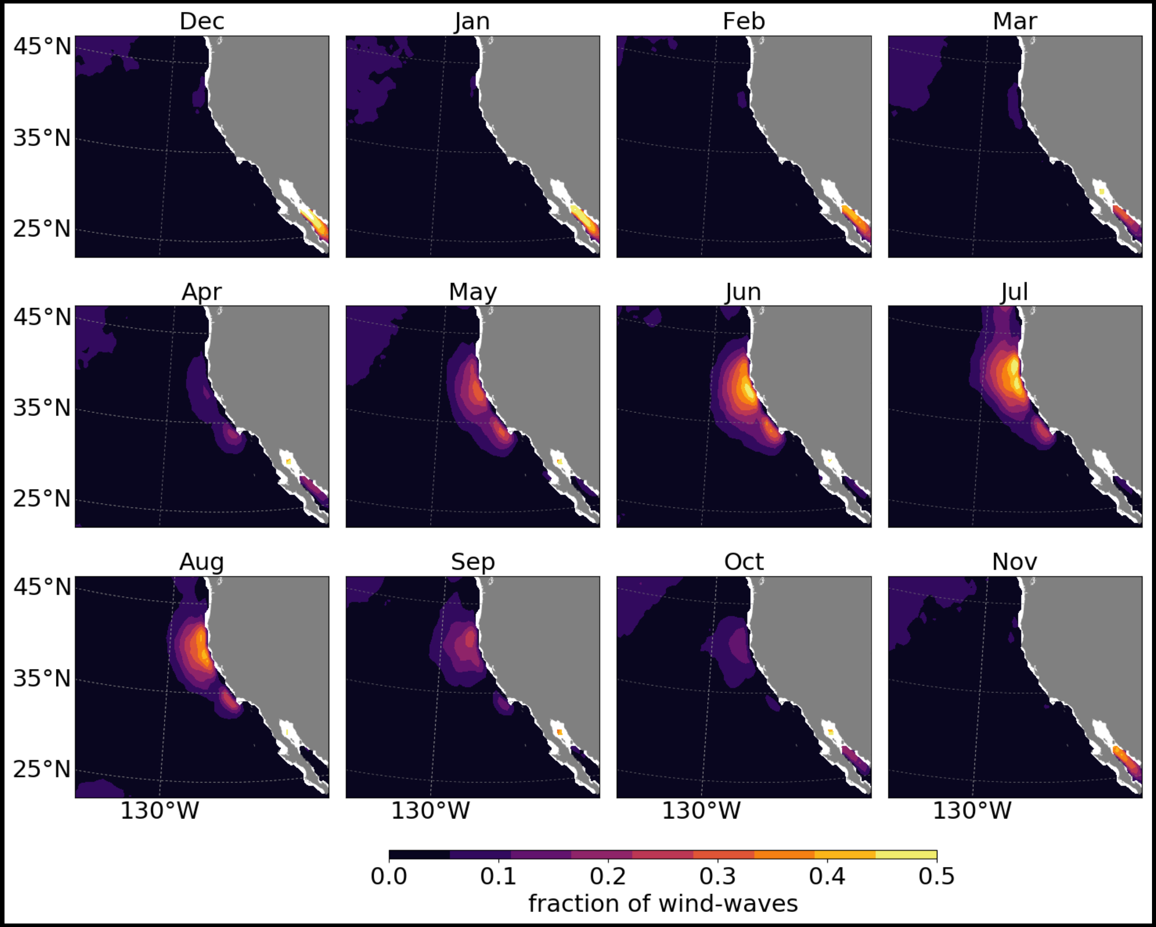
Implications for SWOT



Average percentage of days per month on which the significant wave height (from altimetry) at the SWOT cal/val site is above a given threshold.

Fraction of days dominated by locally generated waves ⇨ $\frac{C_p}{u_{10}} \leq 1.2$



The overall average fraction of wind–waves is lower than 5%, consistent with the global estimates of *Hanley et al.* [2010].

During Spring/Summer the fraction of locally generated waves can be as high as 50% in the expansion fans region.

Take Home

Regional–scale **expansion fan winds** between April and July play a crucial role in determining the **surface wave variability** off the California coast.

- In **spring/summer** the sea state off the California coast is dominated by **short–period, short-wavelength, locally generated** waves up to 50% of the time (young waves).
  - Potential implications for the SSB, layover? *[e.g Fu and Glazman, 1991; Melville et al., 2004; Tran et al 2010]*
- The Hs at the c**alval** site is **below the 2 m threshold** specified for the projected SWOT performance about **40% of the time** *[e.g. Peral et al. 2015]*.
  - This probability increases to **75% in August**.
- Trade off between high Hs in the winter and steep, young waves in the summer.

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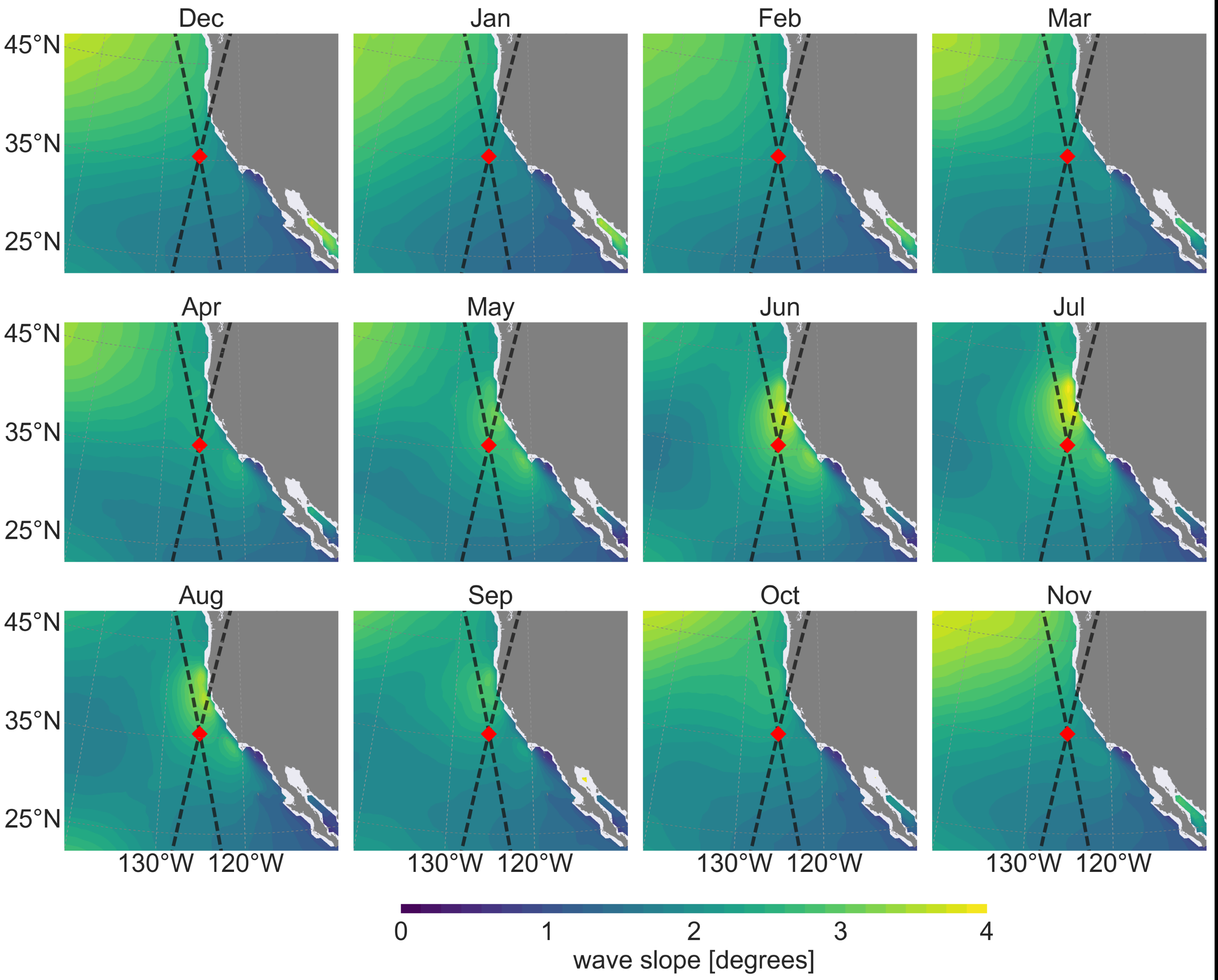
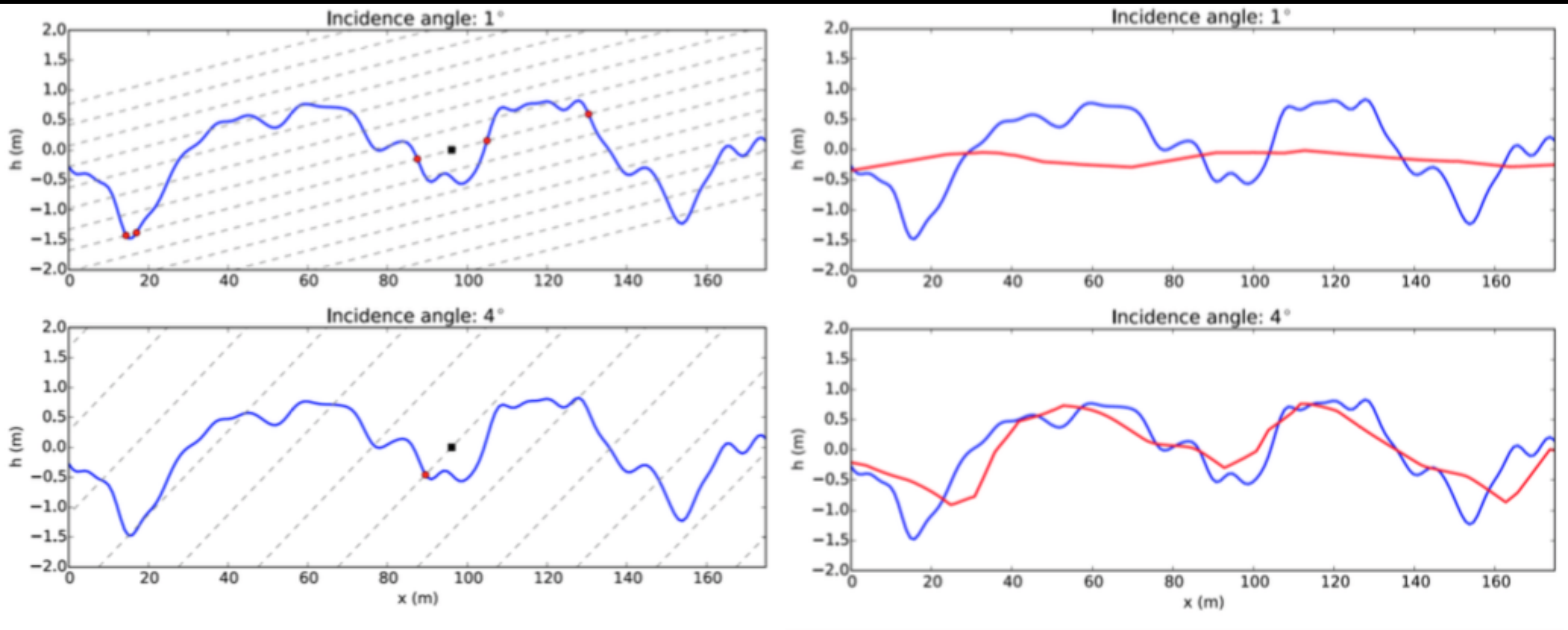
avillasboas@ucsd.edu

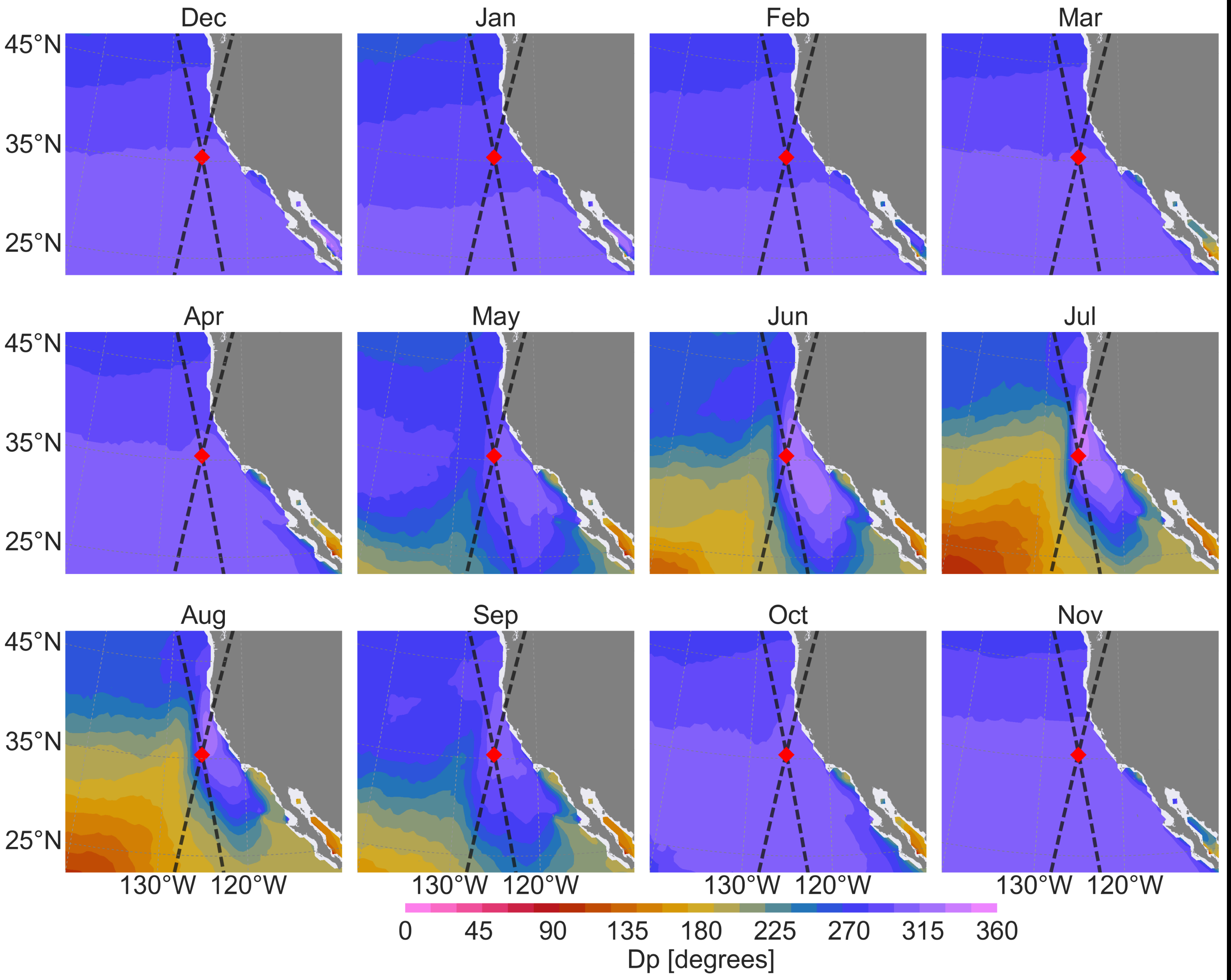
Extras

avillasboas@ucsd.edu

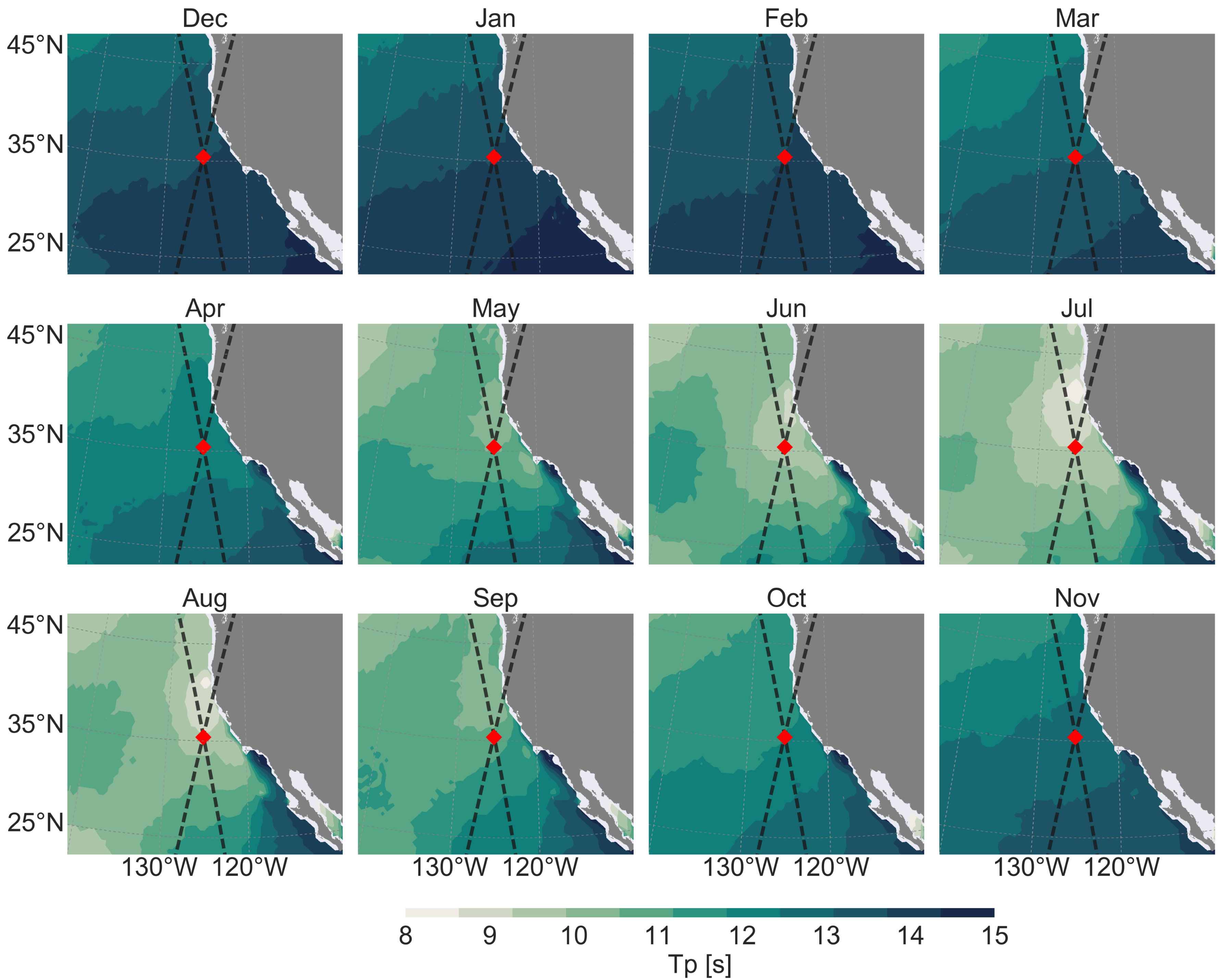

Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
45°N
35°N
25°N
130°W
120°W
0
1
2
3
4
wave slope [degrees]



Peral et al. (2015)

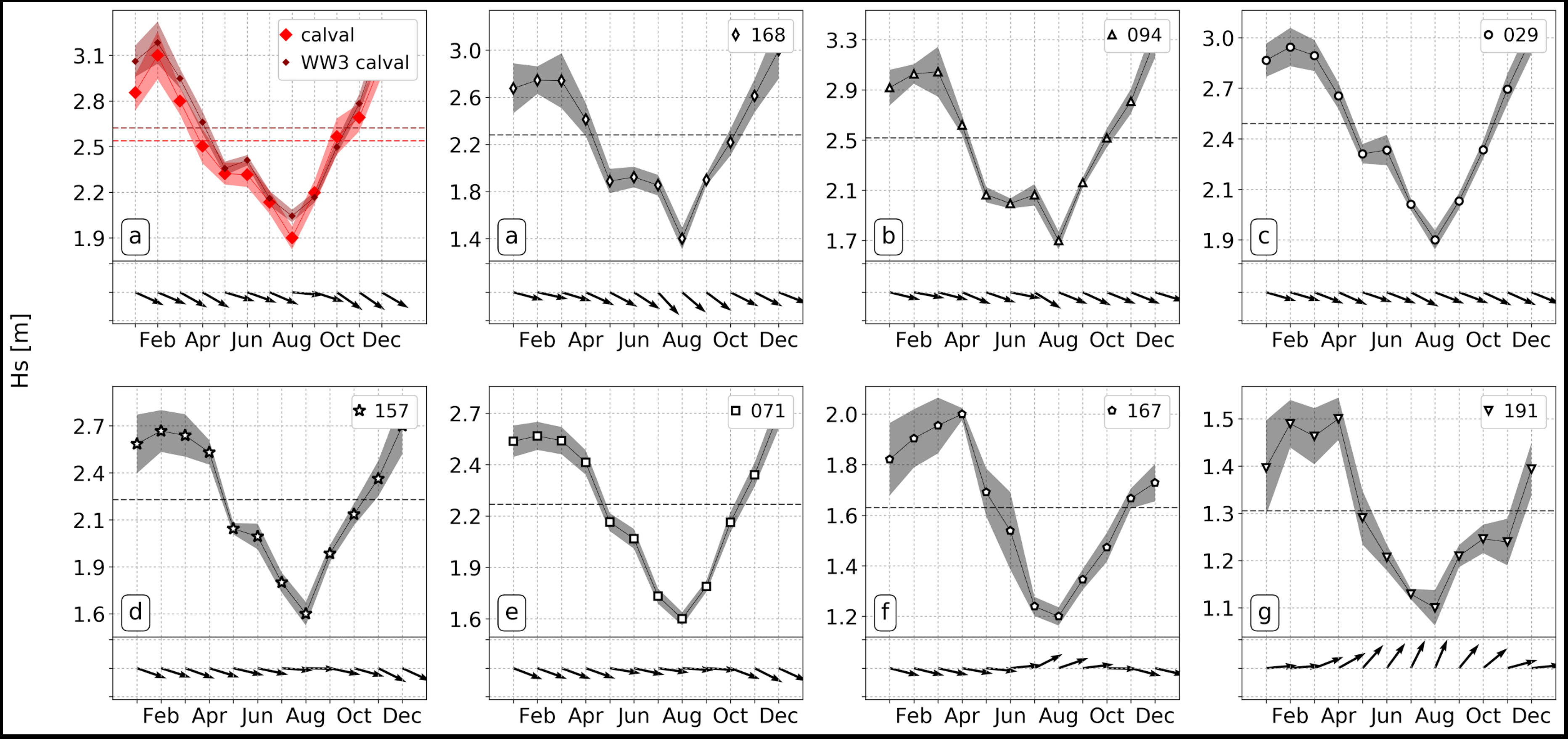


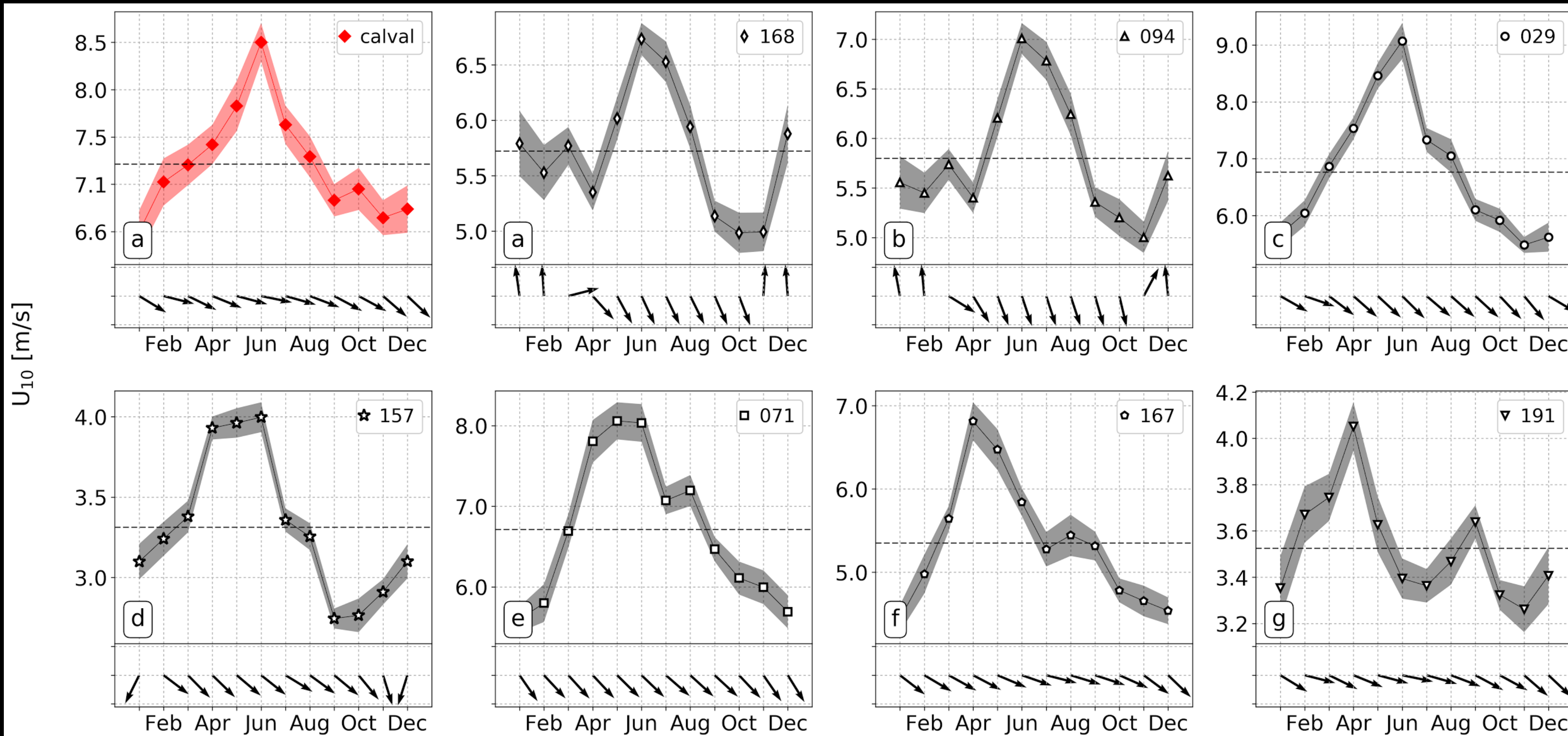
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
45°N
35°N
25°N
130°W
120°W
0
45
90
135
180
225
270
315
360
Dp [degrees]



Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
45°N
35°N
25°N
130°W
120°W
8
9
10
11
12
13
14
15
Tp [s]

Significant wave height and and peak direction at the CDIP buoys





North of Point Conception:

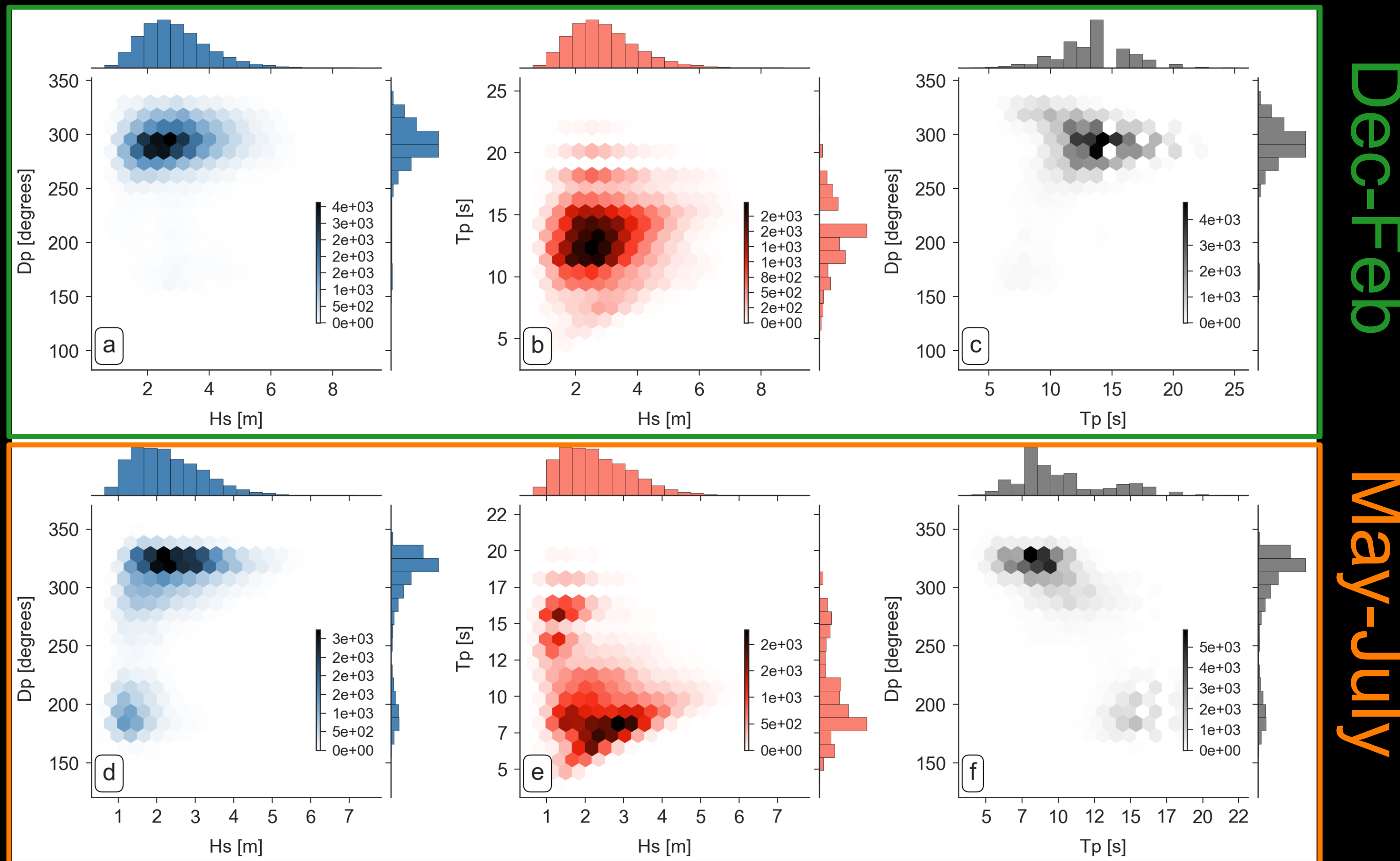
As the North Pacific High migrates, winds become predominantly **northwesterly**.

Wind speed peaks in **May-July**

South of Point Conception:

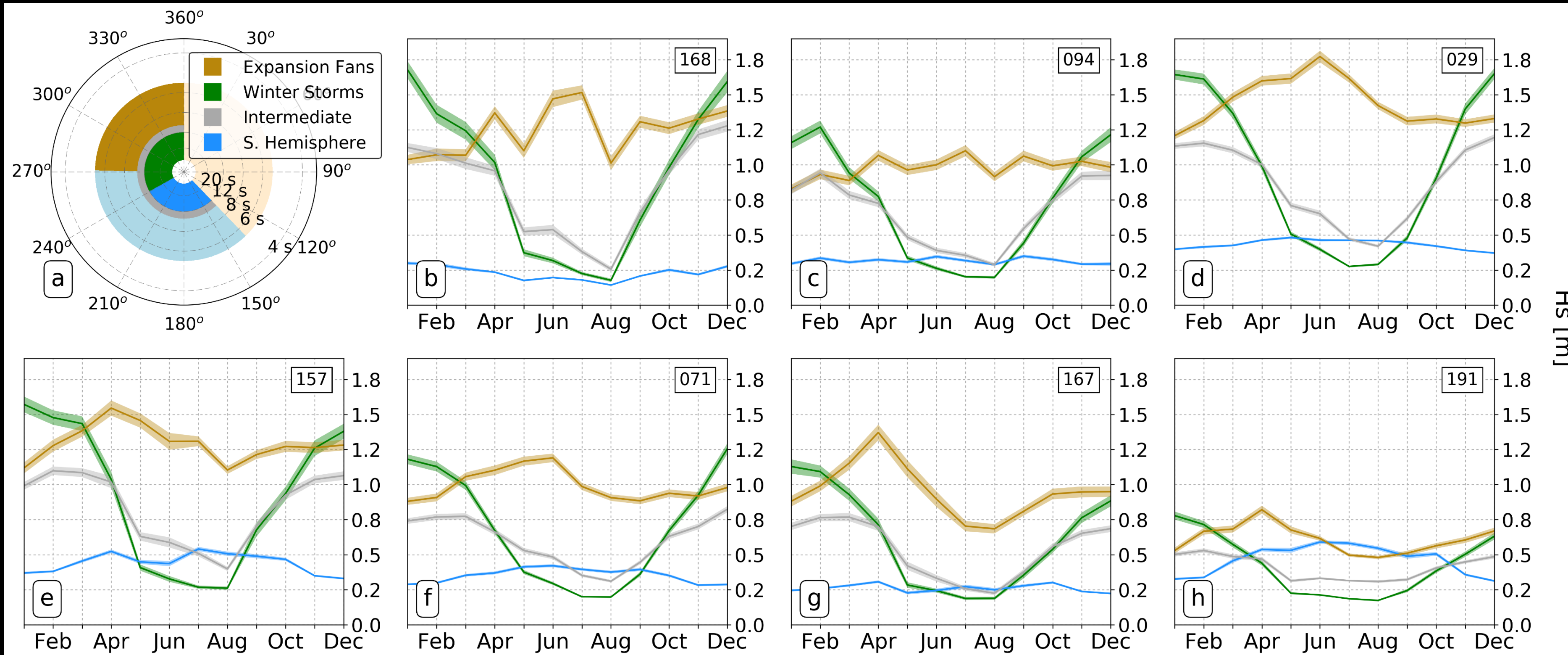
As the North Pacific High migrates, winds become predominantly **westerly** (separation).

Wind speed peaks in **April**



Winter: unimodal distributions with most waves coming from W/NW directions (270° ≤ D_p ≥ 315°), with significant wave heights between 2 m and 4 m, and peak period between 12 s and 15 s.

Spring/Summer: bimodal distributions. Waves with H_s ≥ 2 m come from NW (315° ≤ D_p ≥ 330°) and have short period. Smaller waves come from S/SW and have long period (Tp > 12 s)



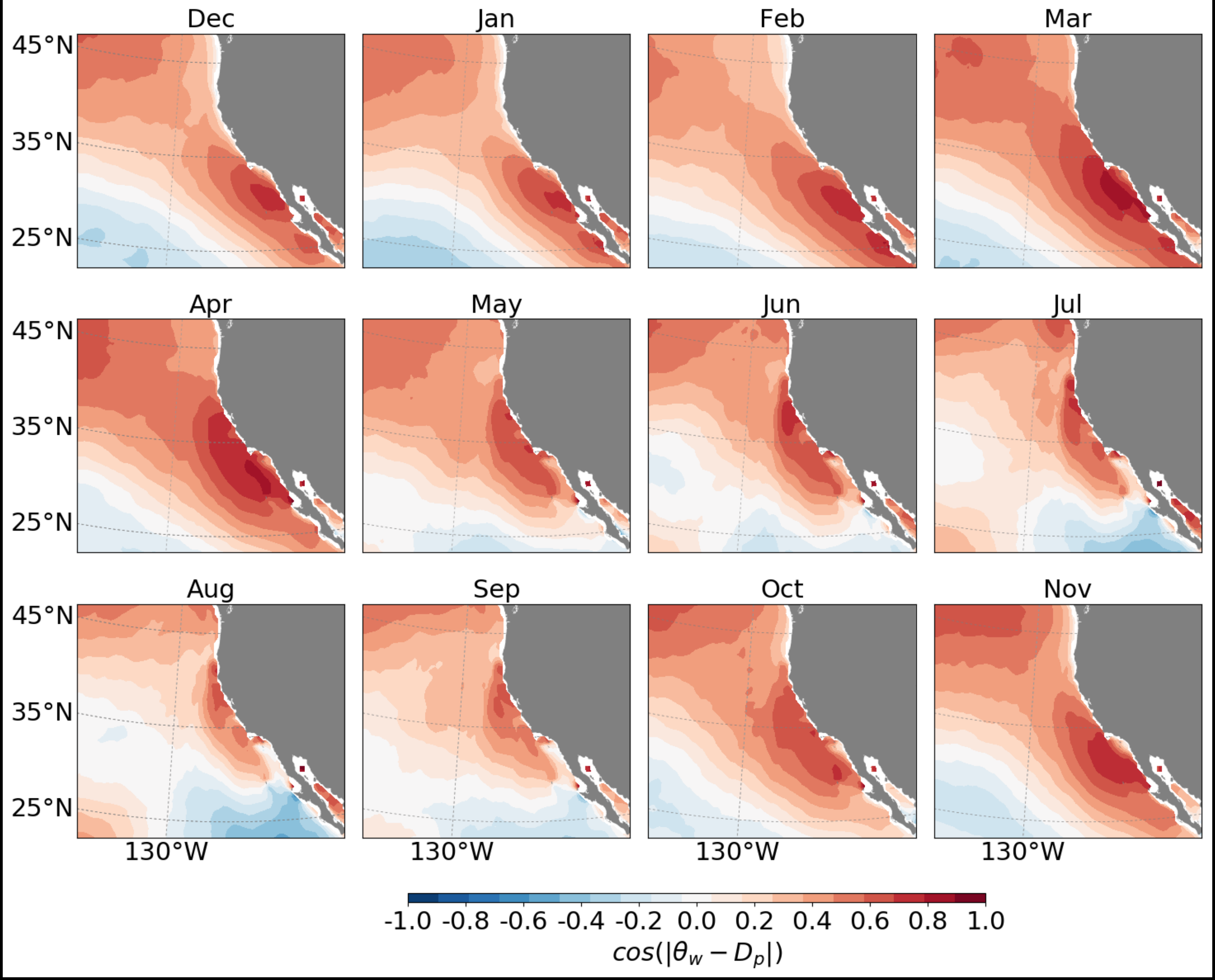
Winter Storms: long-period waves (T>12 s) coming from W/N

Well– defined annual cycle; maximum Hs during winter and minimum during summer; dominates the Hs variability from November to March.

Expansion Fans: short-period waves (T<10 s) coming from NW

Contribute the most to the total Hs between April and October. Also peak earlier (April) at buoys south of Pt. Conception

Station ID	Station Name	latitude	longitude	depth [m]	time span
calval	calval	35.4 N	125.4 W	4561	1992–2016
168	Humboldt Bay	40.896 N	124.357 W	120	2010–2017
094	Cape Mendocino	40.294 N	124.731 W	333	2004–2017
029	Pt. Reyes	37.948 N	123.467 W	550	1997–2017
157	Pt. Sur	36.341 N	122.101 W	366	2009–2017
071	Harvest	34.454 N	120.783 W	548	1998–2017
167	S. Nicolas Isl.	33.499 N	119.489 W	1571	2008–2013
191	Pt. Loma South	32.529 N	117.421 W	1143	2008–2017


Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
45°N
35°N
25°N
130°W
-1.0 -0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8 1.0
$cos(|\theta_w - D_p|)$

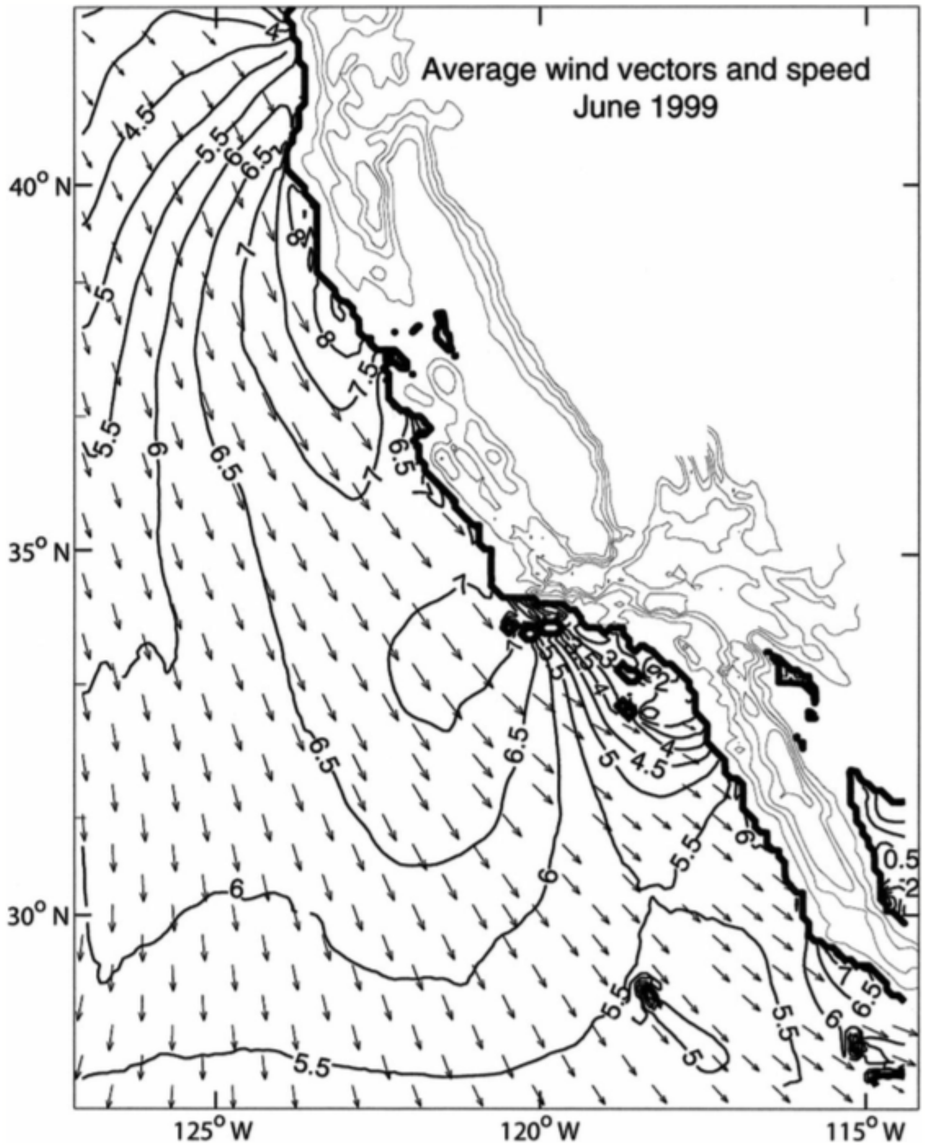


FIG. 6. Simulated wind vectors and contours of surface wind speed (m s^{-1}) averaged for all of Jun 1999. Contour interval is 0.5 m s^{-1}. Expansion fans form high-speed areas on the California scale (enclosed by 6.5 m s^{-1}) and in the lees of every major cape.

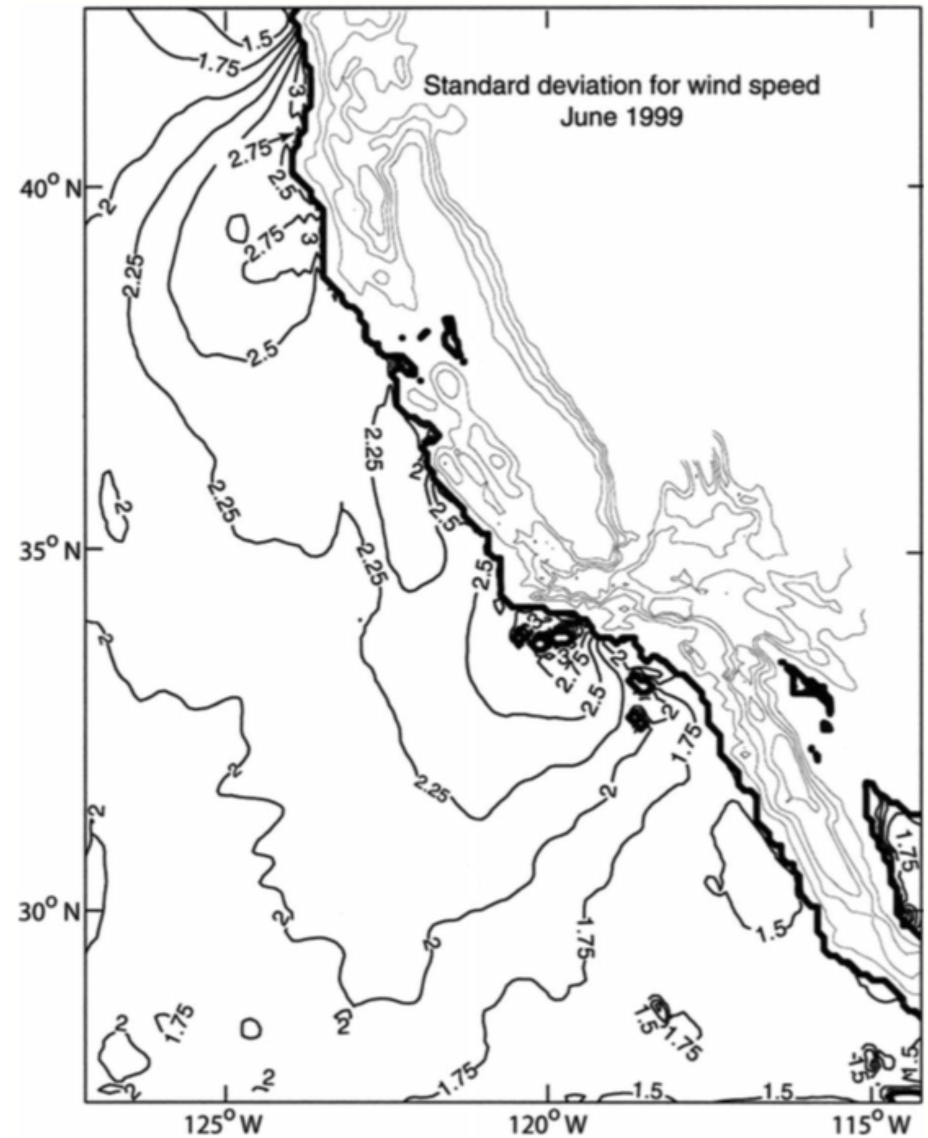


FIG. 7. Standard deviation of the simulated surface wind speed (m s^{-1}) as determined from MM5 simulations for all of Jun 1999. Contour interval is 0.25 m s^{-1}. Maxima are in the lees of major capes. The 2.25 m s^{-1} isoline is coincident with the California-scale expansion fan.