Meteorology of the Pacific Cup

Pacific Cup Offshore Academy – 2014

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Sailor's Energy
Sail Tactics

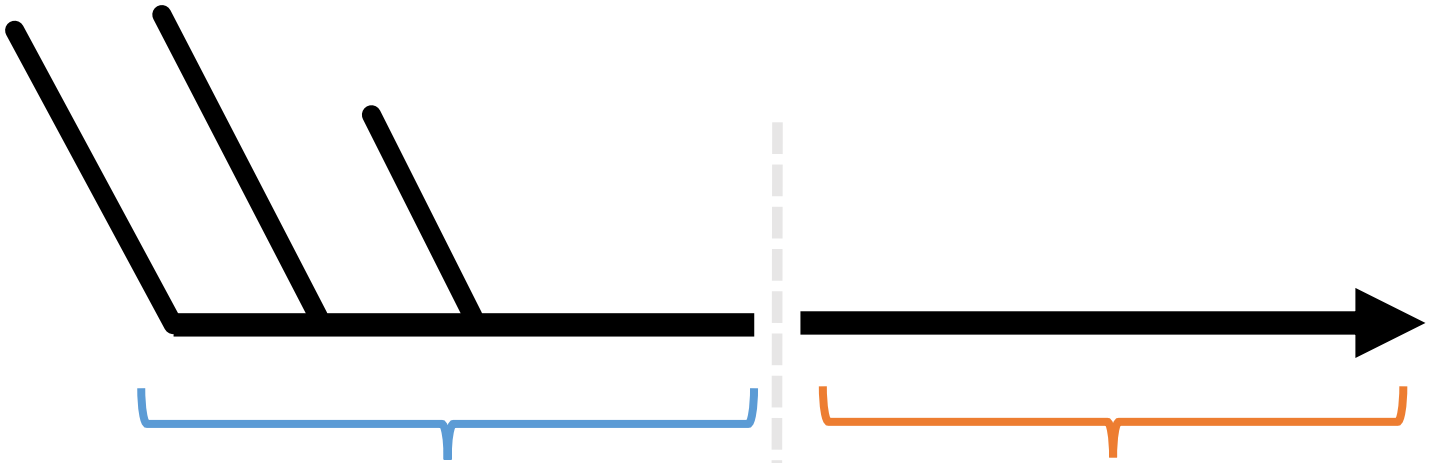
Outline

Meteorology of the Pacific Cup

- "Race to the synoptic wind before nightfall on the first day"
  - Sea breezes and the Golden Gate
- "The windy reach to the ridge (first third)"
  - California coastal winds
- *"Slot cars* through the middle (middle third)"
  - The Pacific High
- "The run (final third)"
  - Trade winds and squalls

Source: Stan Honey's 2012 Pac Cup write-up

Wind Barbs and Vectors

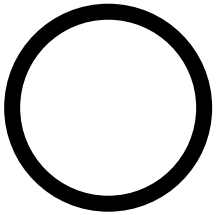


Wind Barb
Preferred by
weather people

Flow Vector
Preferred by
ocean people

Both describe the **same fluid flow**,
moving from **left to right**

Wind Barbs: Magnitude



Light and variable (<2.5 knots)

10 knots from the west

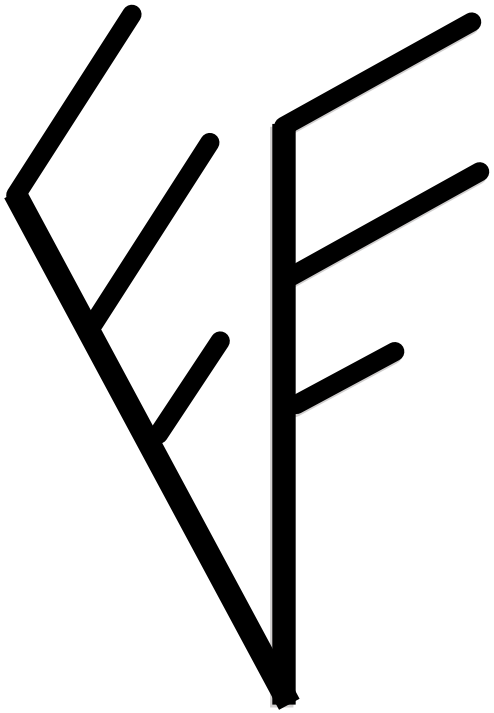
5 knots from the west

25 knots from the west

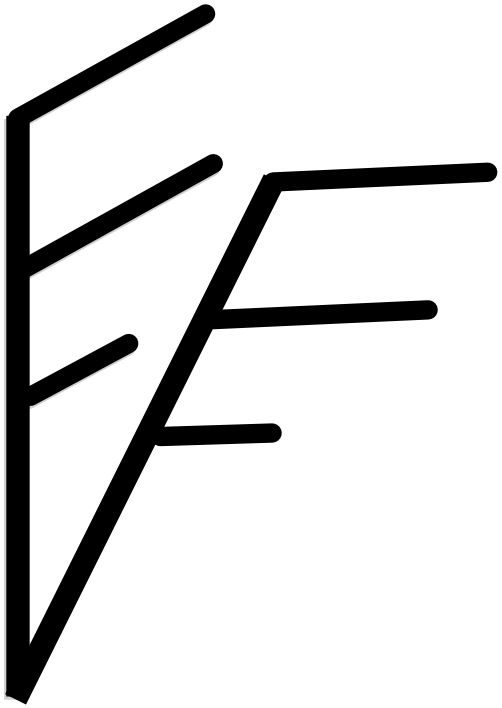
= 10 + 10 + 5

Wind Barbs: Shifts

Left Shift – *Backing*



Right Shift – *Veering*



The bow of the boat goes the same way as the shift

Recipe for Wind

- If you only remember one thing from this talk…

$$\boldsymbol{wind\ speed} \propto \frac{\boldsymbol{presssure\ difference}}{\boldsymbol{distance}}$$

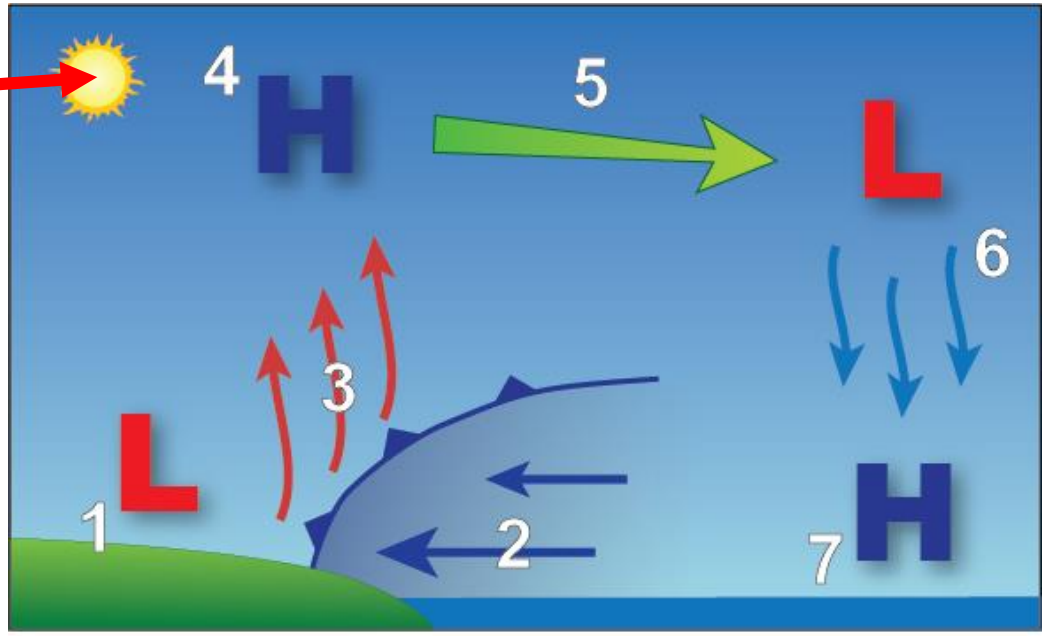
- Pressure difference over a small distance, **more wind**

- Pressure difference over a large distance, **less wind**

Coastal Winds Near the Golden Gate

The **sun drives** this whole process… **don't be stuck** *just offshore* when the **sun goes down**

Large-scale **sea breeze** drives winds through the Gate on **most** summer days

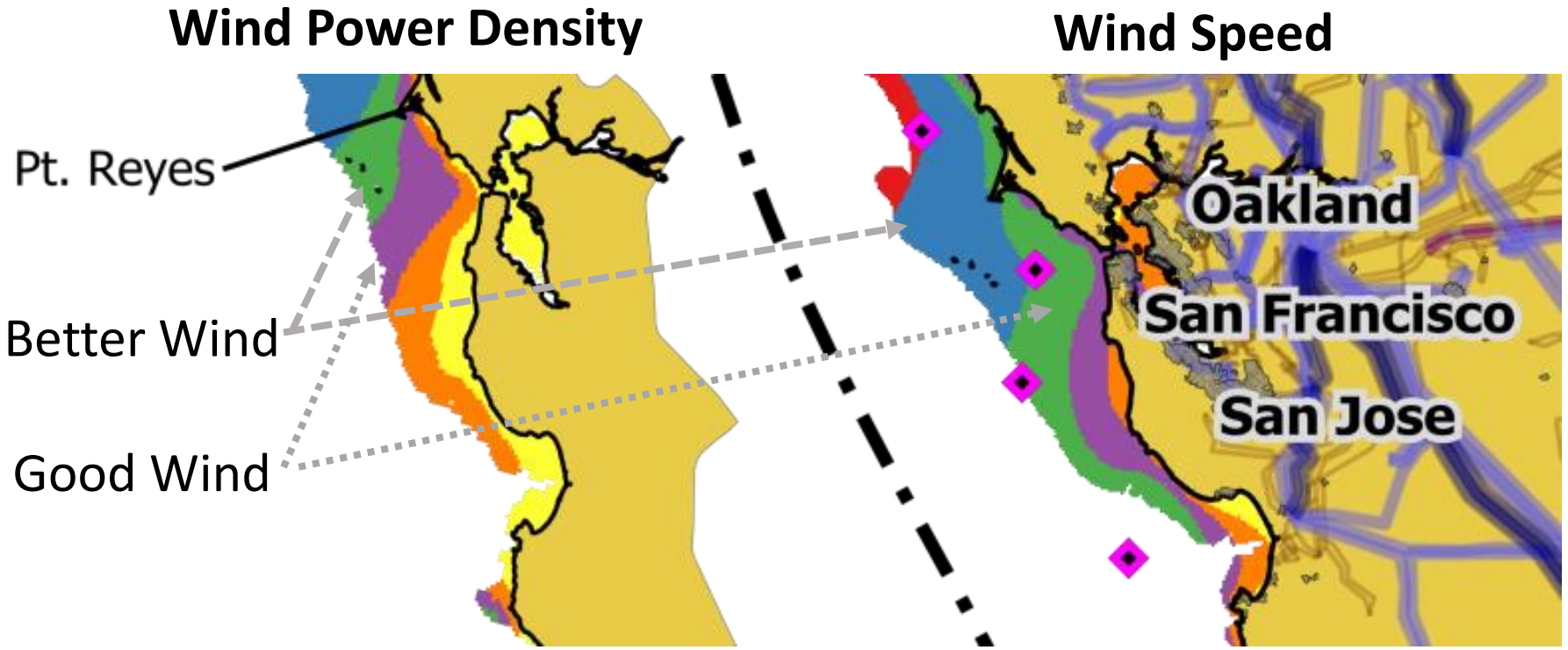


100° F
Central Valley

53° F
Pacific Ocean

Image source: NOAA

North Side Out the Gate Favored



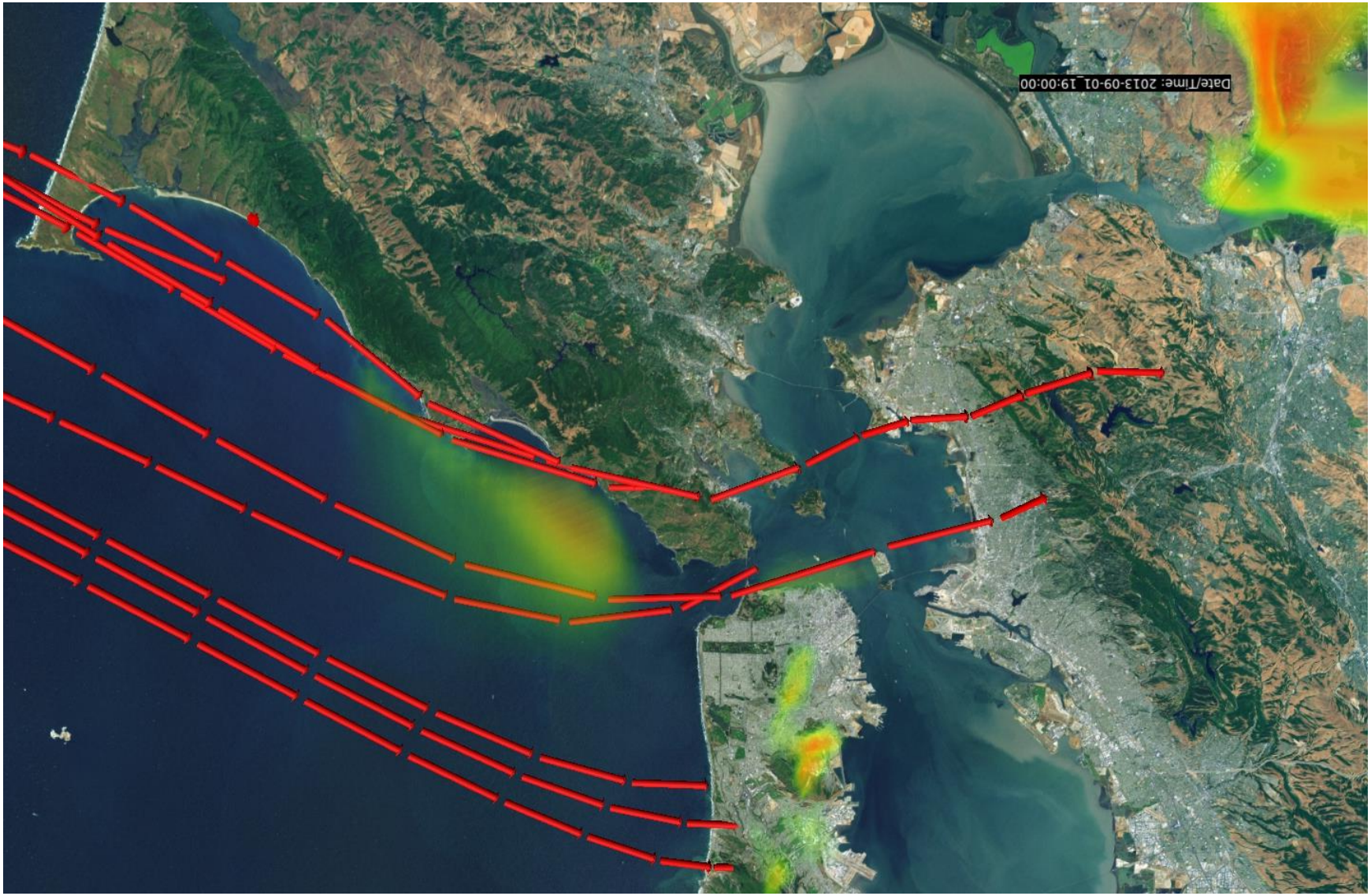
Funnel flow at the GG Bridge:

- Northside flow additive
- Southside flow subtracts

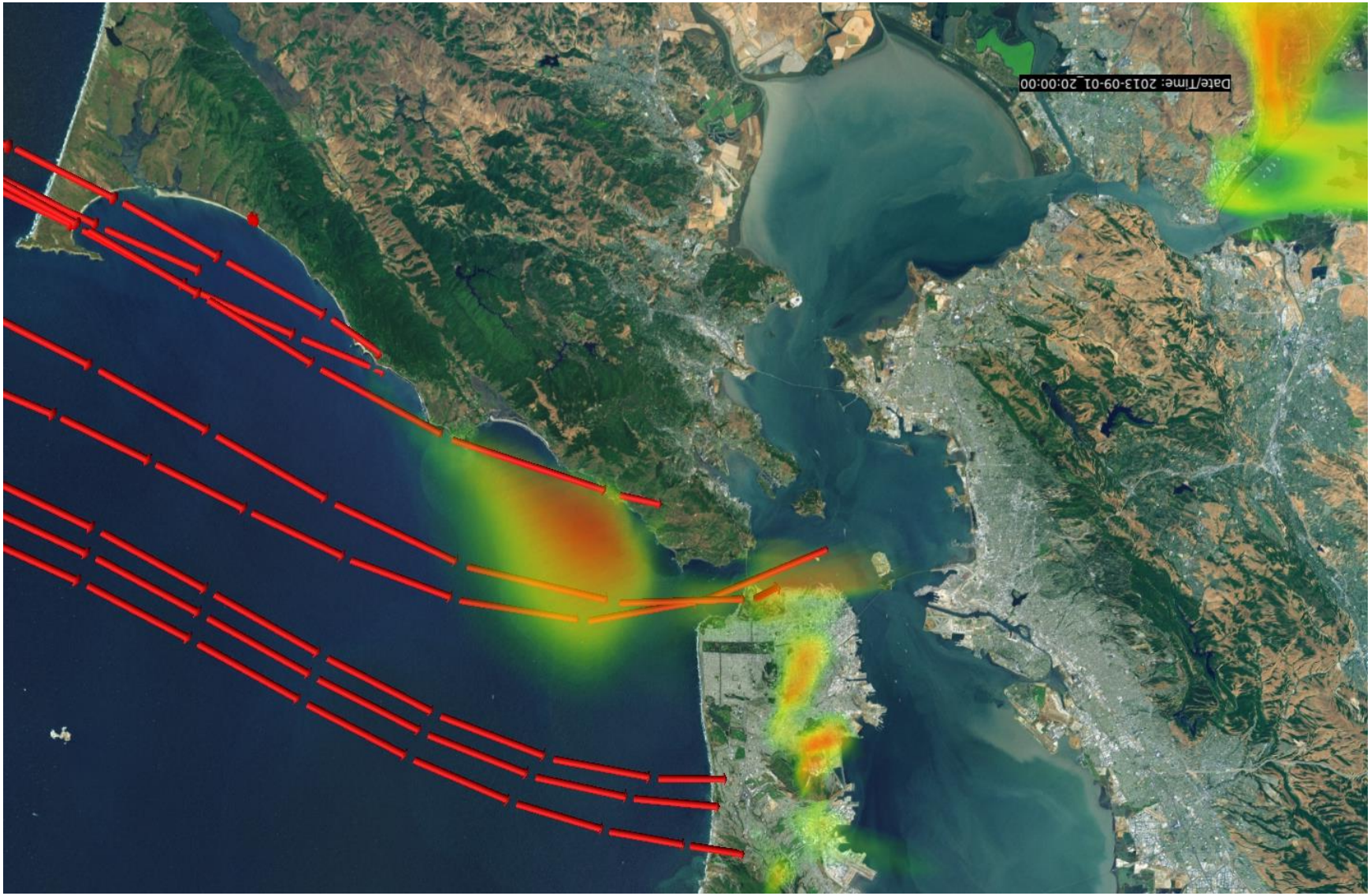
Of course **tidal currents** are also a consideration

Source: Dvorak, M. J., Archer, C. L., and Jacobson, M. Z., (2010). California offshore wind energy potential. *Renewable Energy*.

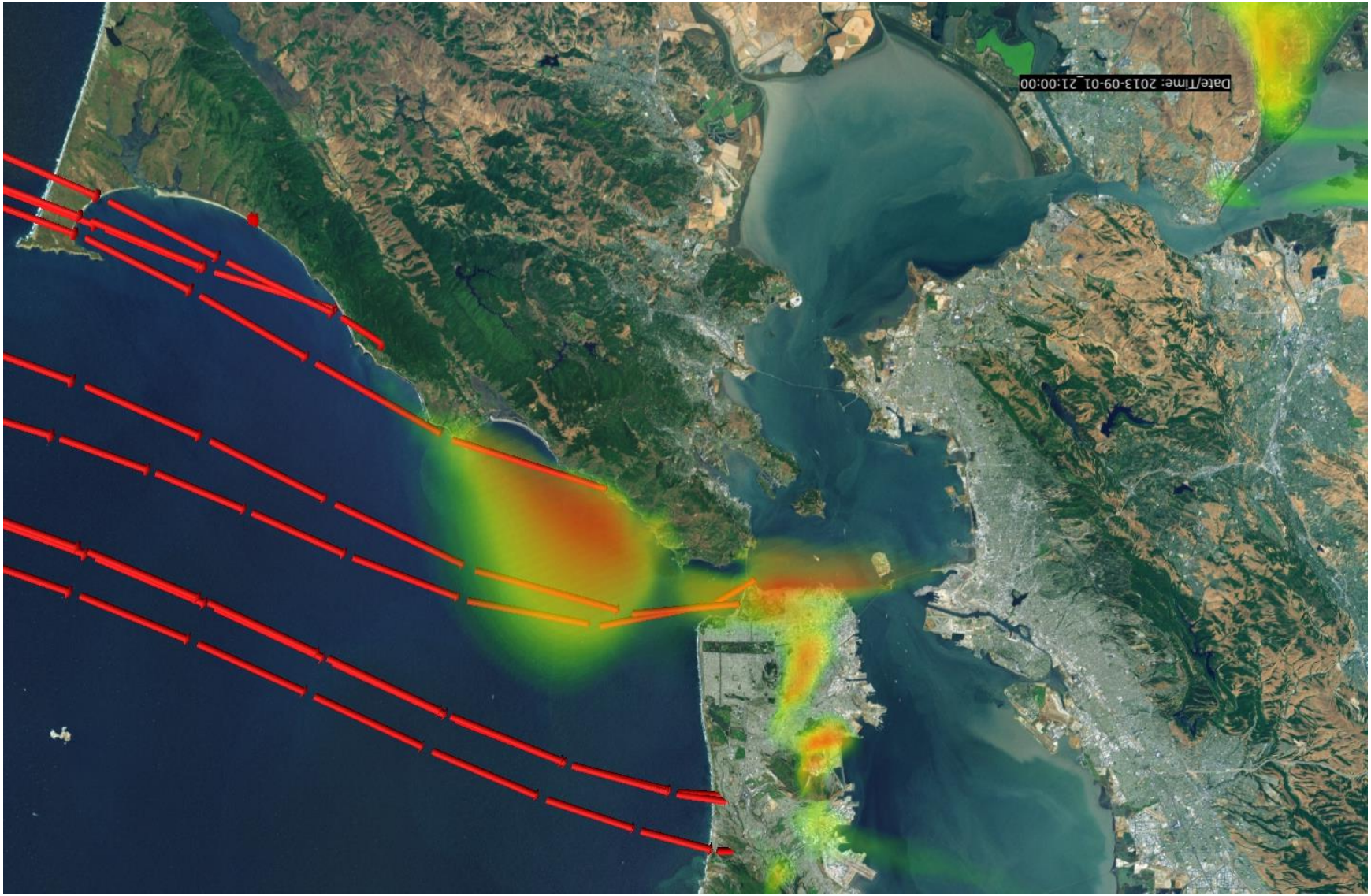
Summertime Flow Just Offshore: 12:00 pm



Summertime Flow Just Offshore: 1:00 pm



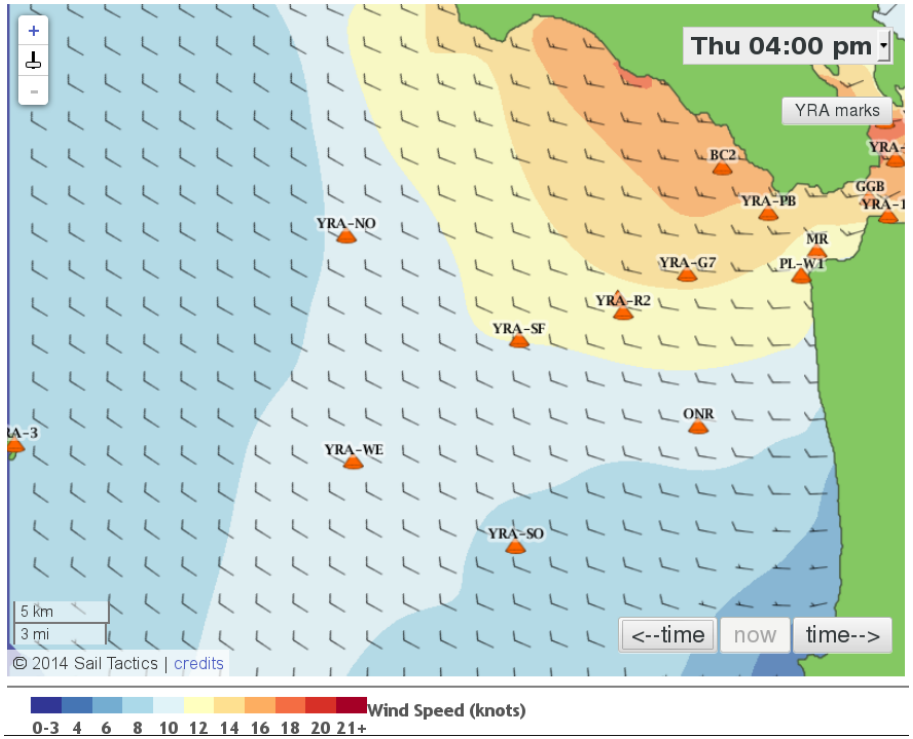
Summertime Flow Just Offshore: 2:00 pm



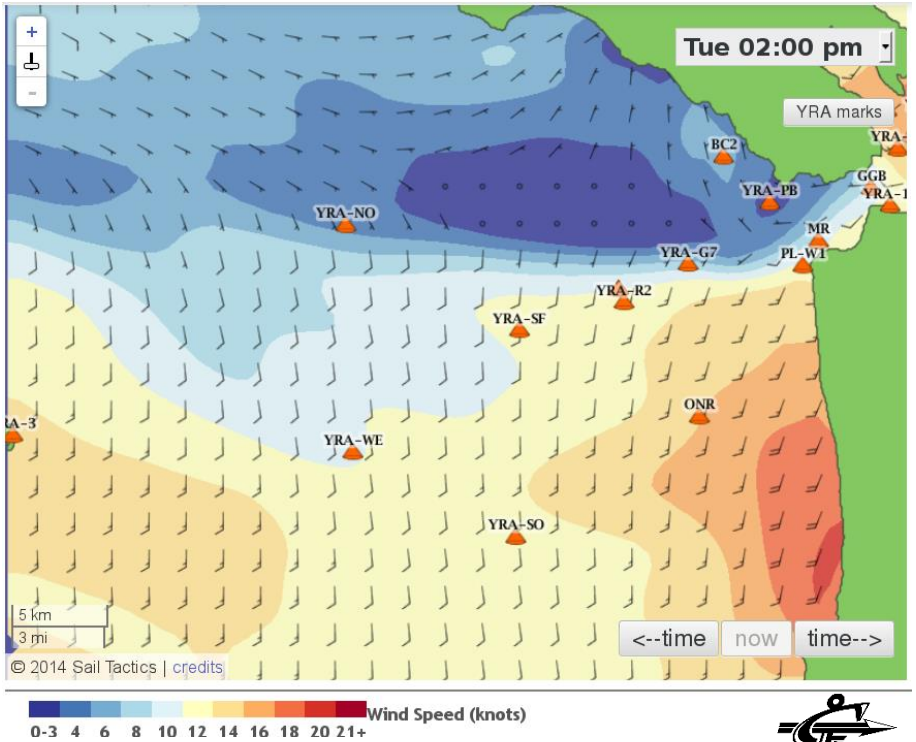
North Side Favored, Not Always

Use good mirco/mesoscale models so you don't get stuck

Typical Summertime Flow

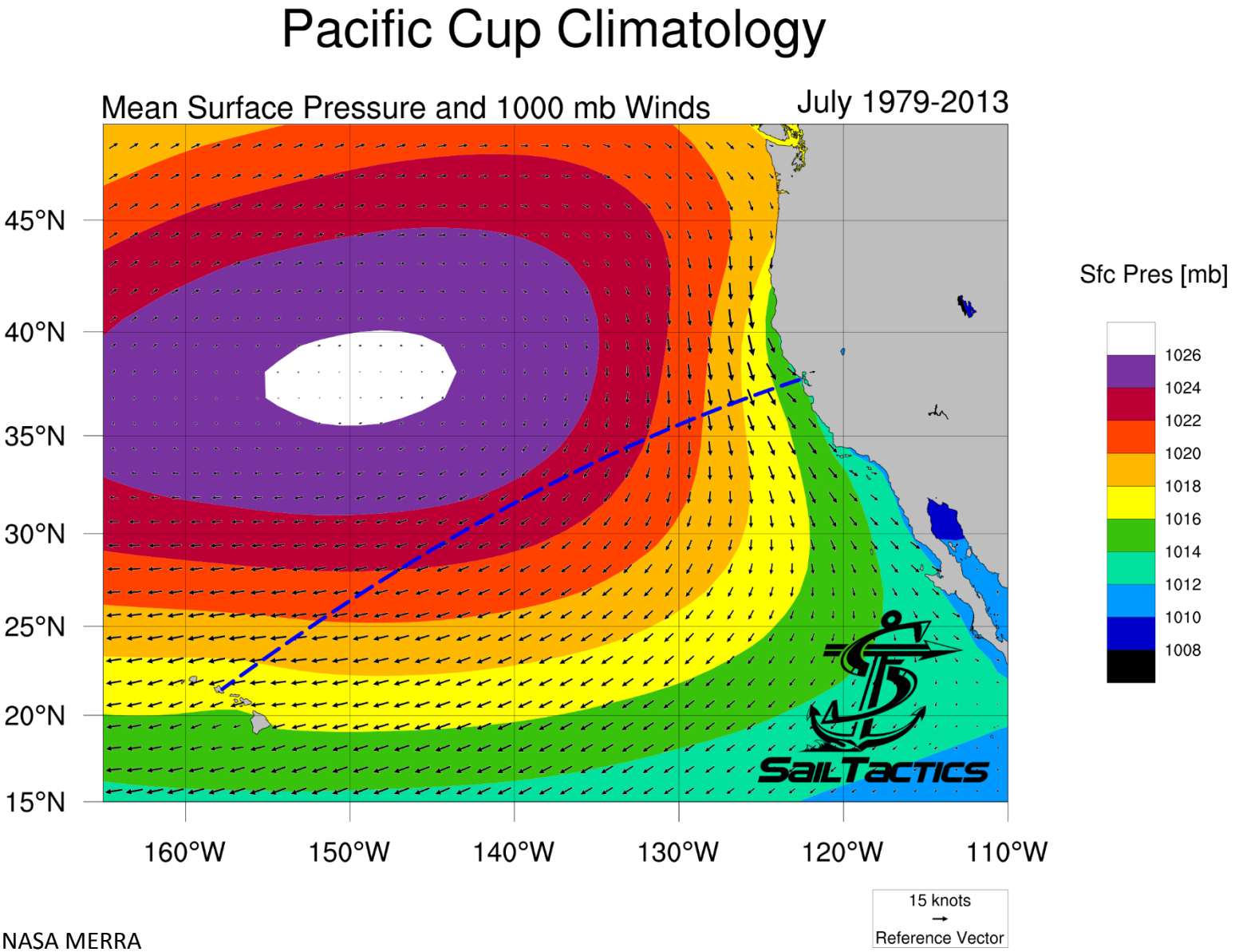


2012 Pac Cup, Day 2 Starts



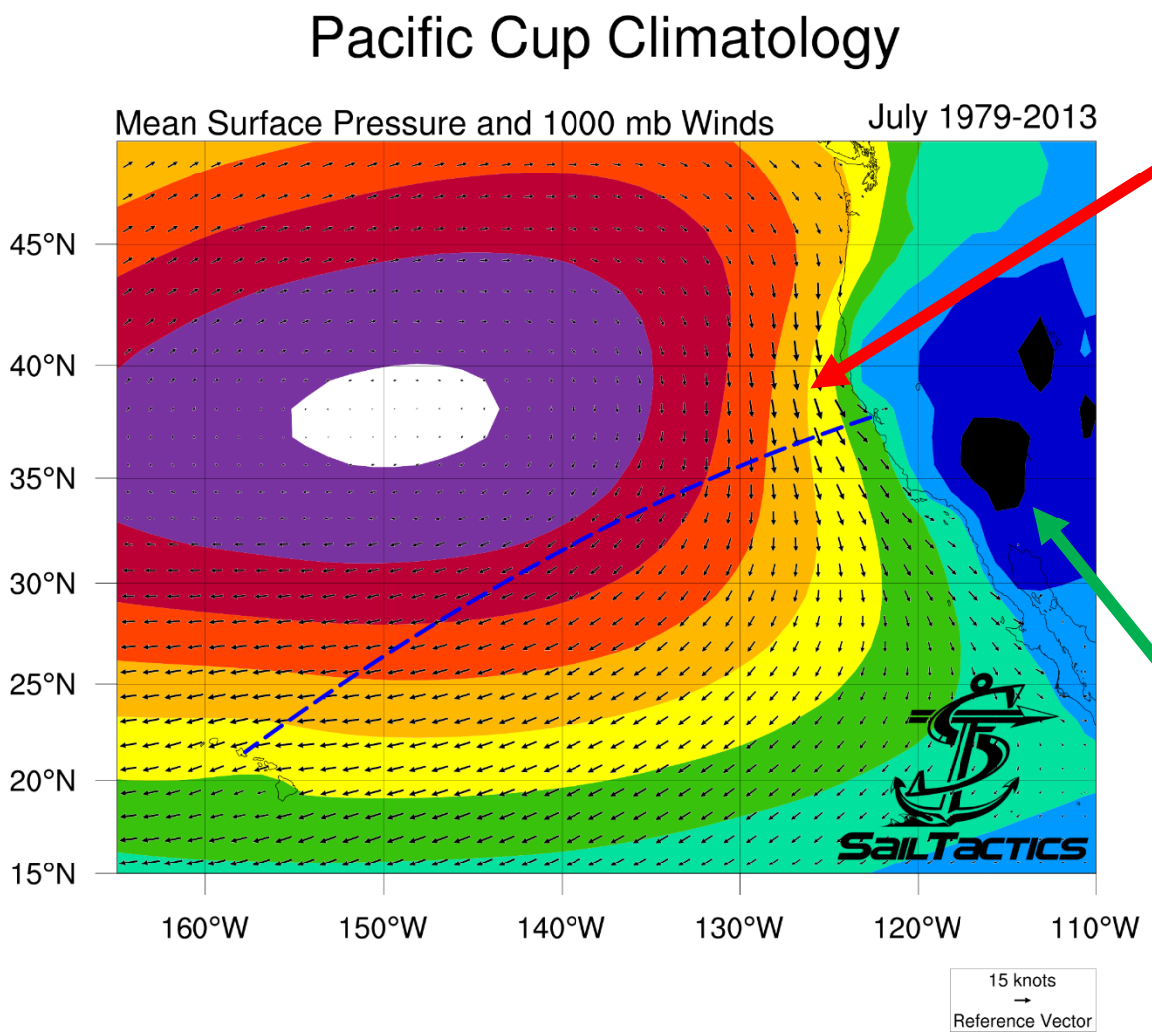
Reanalysis from the 2012 Pac Cup, **SailTactics.com** high-resolution model

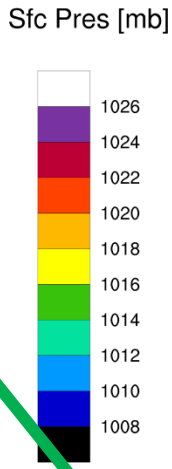
Pacific Cup “Brochure” Chart



Data source: NASA MERRA

Windy Reach, California Coastal Winds





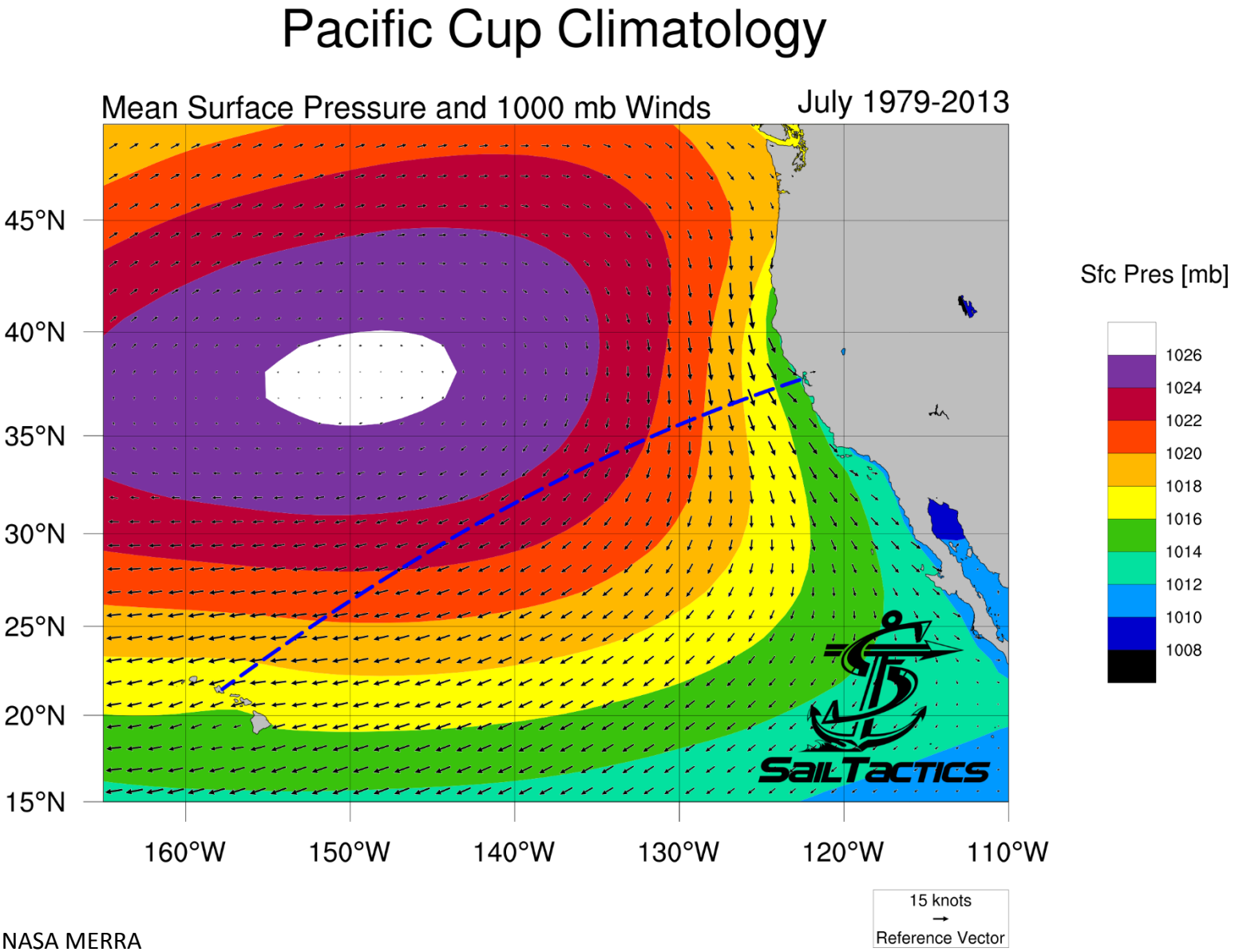
Driven by:
Steep Pacific High pressure gradient

BIG PRESSURE DIFFERENCE
=
BIG WINDS

Southwest Thermal Low

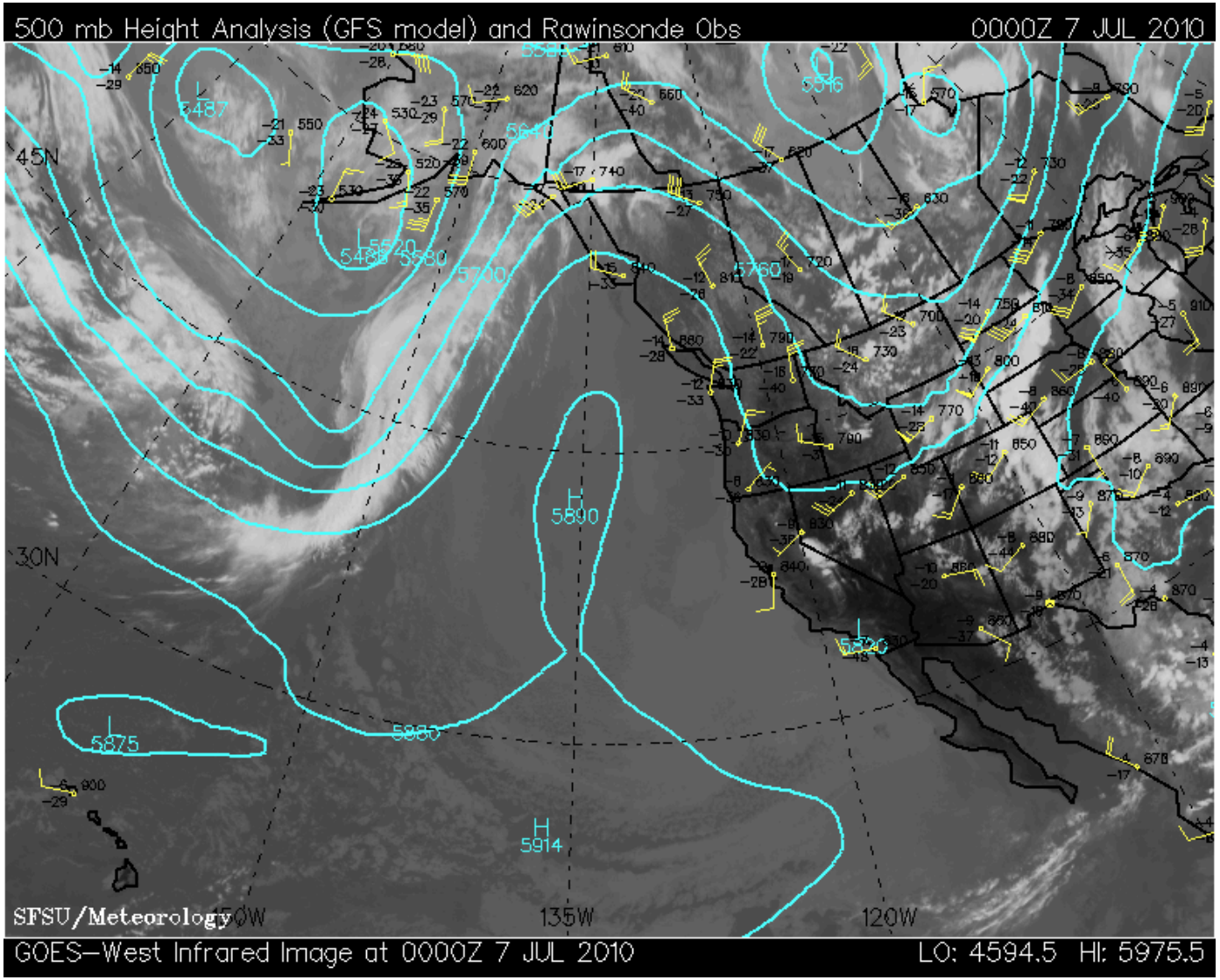
Data source: NASA MERRA

Slot Cars – Middle of the Race

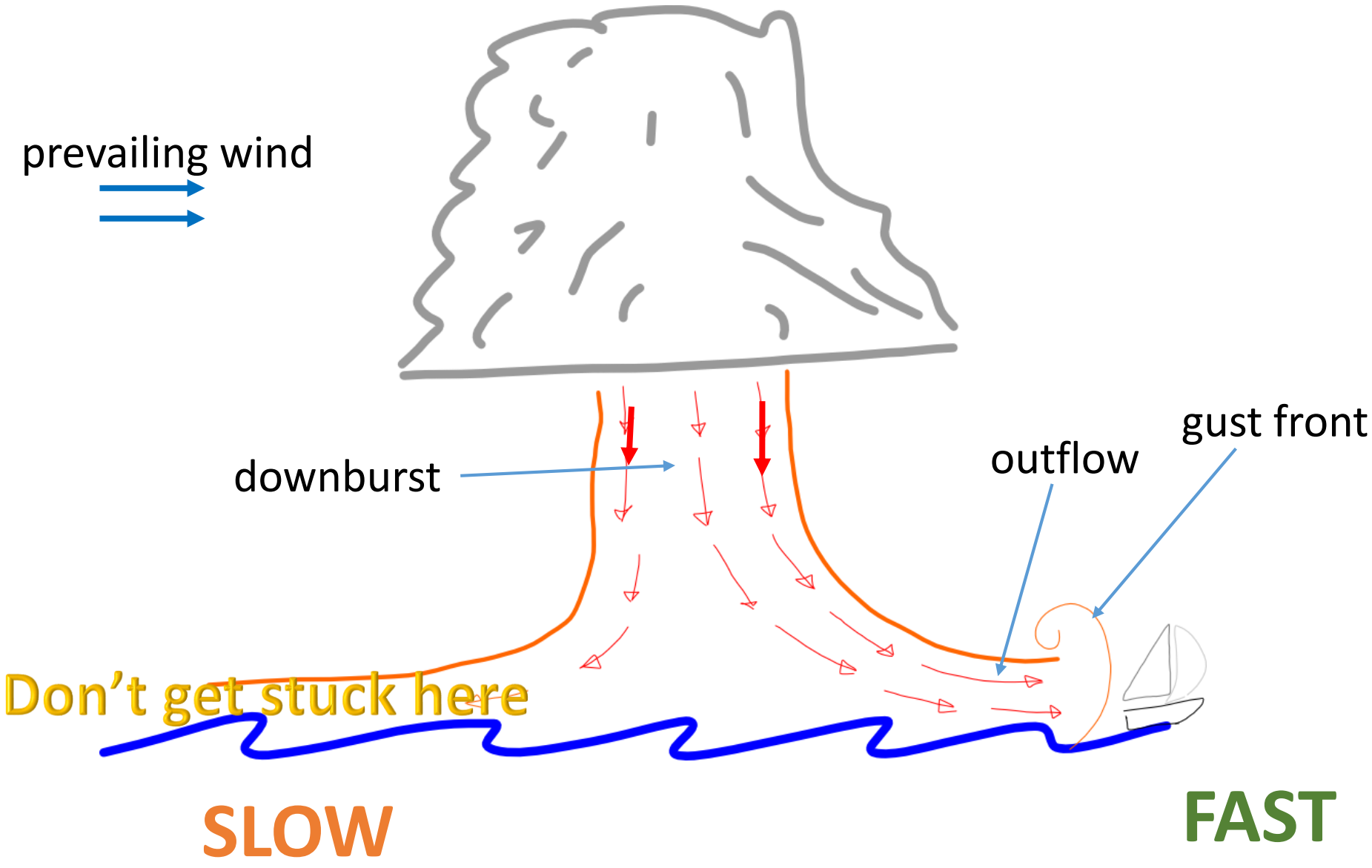


Data source: NASA MERRA

Support for the Pacific High 500 mb Chart



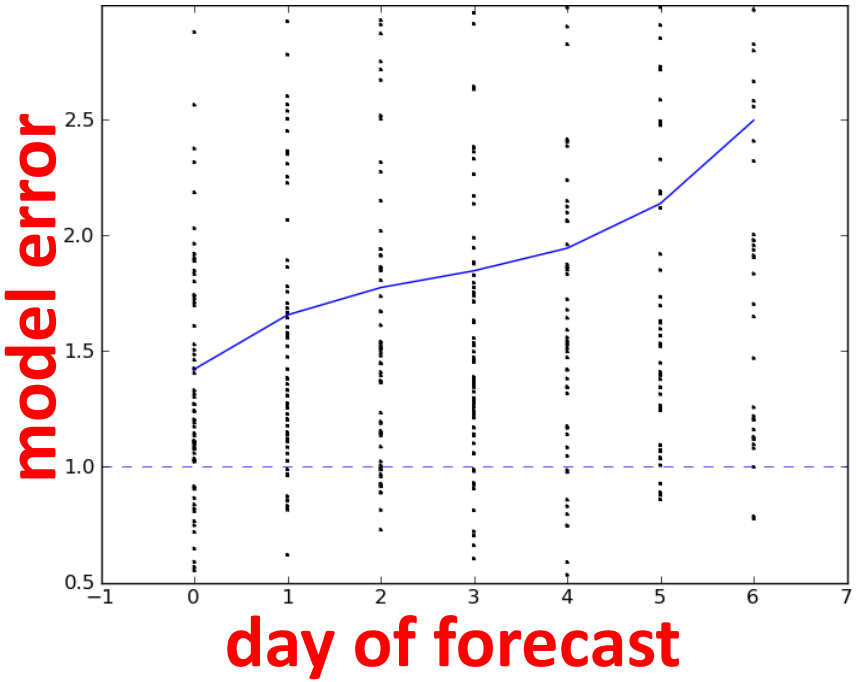
Wind Flow in a Squall



Forecasting the Weather

- Atmosphere is a chaotic system - “Butterfly Effect”
- *Accurately* forecasting >10-days in advance... will be impossible until the end of time

- What this means to you
  - The **weather** you download in San Francisco will ***expire*** at **some point** during the trip
  - You need **new weather continually** along the way



Weather Observations Offshore

- Vast majority of weather stations ***onshore***
- Offshore weather data
  - Satellite scatterometers (surfaces winds)
  - Satellite radiometers (temperatures)
  - Ship observations
  - Sparse buoys
- Large gaps offshore make forecasting error prone

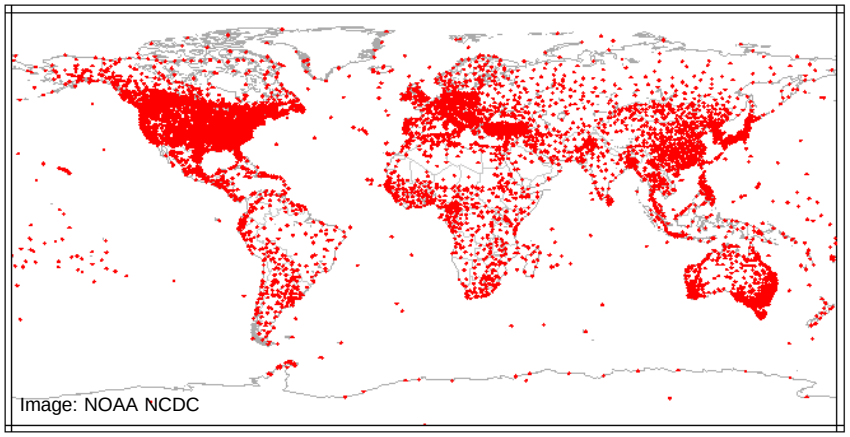


Image: NOAA NCDC

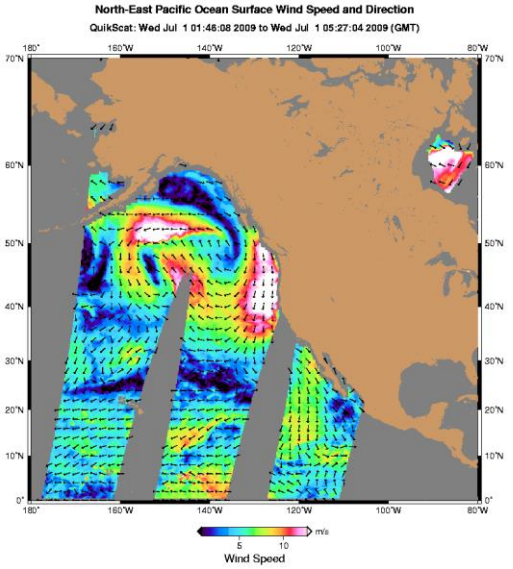


Image: Scott Capps, UC Irvine


Image: NOAA NDBC

Image: NOAA NCDC

Ground Truth Your Weather Model

- Check weather models against reality!
- Use a *calibrated* barometer
  - Ground truth forecasts
  - Watch for trends
- Calibrate using Oakland airport station morning of the race
- My $400 instrument was off 5 mb

Thanks!

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SailTactics.com

SailorsEnergy.com

Coming soon:

Analysis of the
2012 Pac Cup starts at
SailTactics.com

Enjoy the ride!