

# Coastal Wind Observations with HF Radar: Status and Validation

Brian Emery<sup>1</sup> and Anthony Kirincich<sup>2</sup>

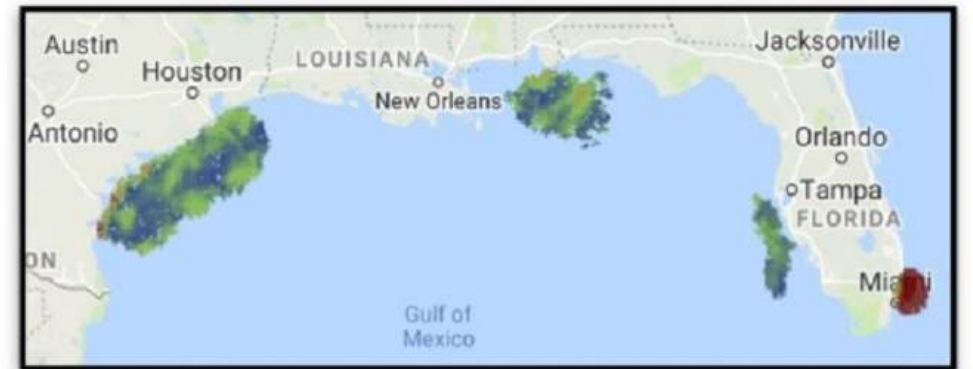
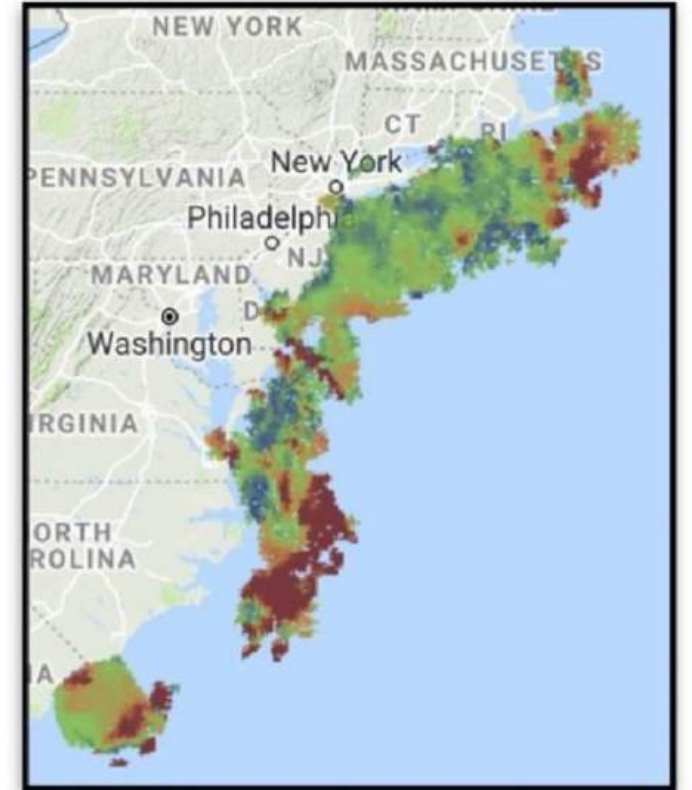
<sup>1</sup>University of California Santa Barbara

<sup>2</sup>Woods Hole Oceanographic Institution



- 165 Radars
- Hourly Currents
- 2 km grid
- 12 m waves

... wind?



# Radar Equation/Radar Cross Section

$$P = \frac{P_t G_t G_r}{R^4} S(2k_o) F^4 \Delta A.$$

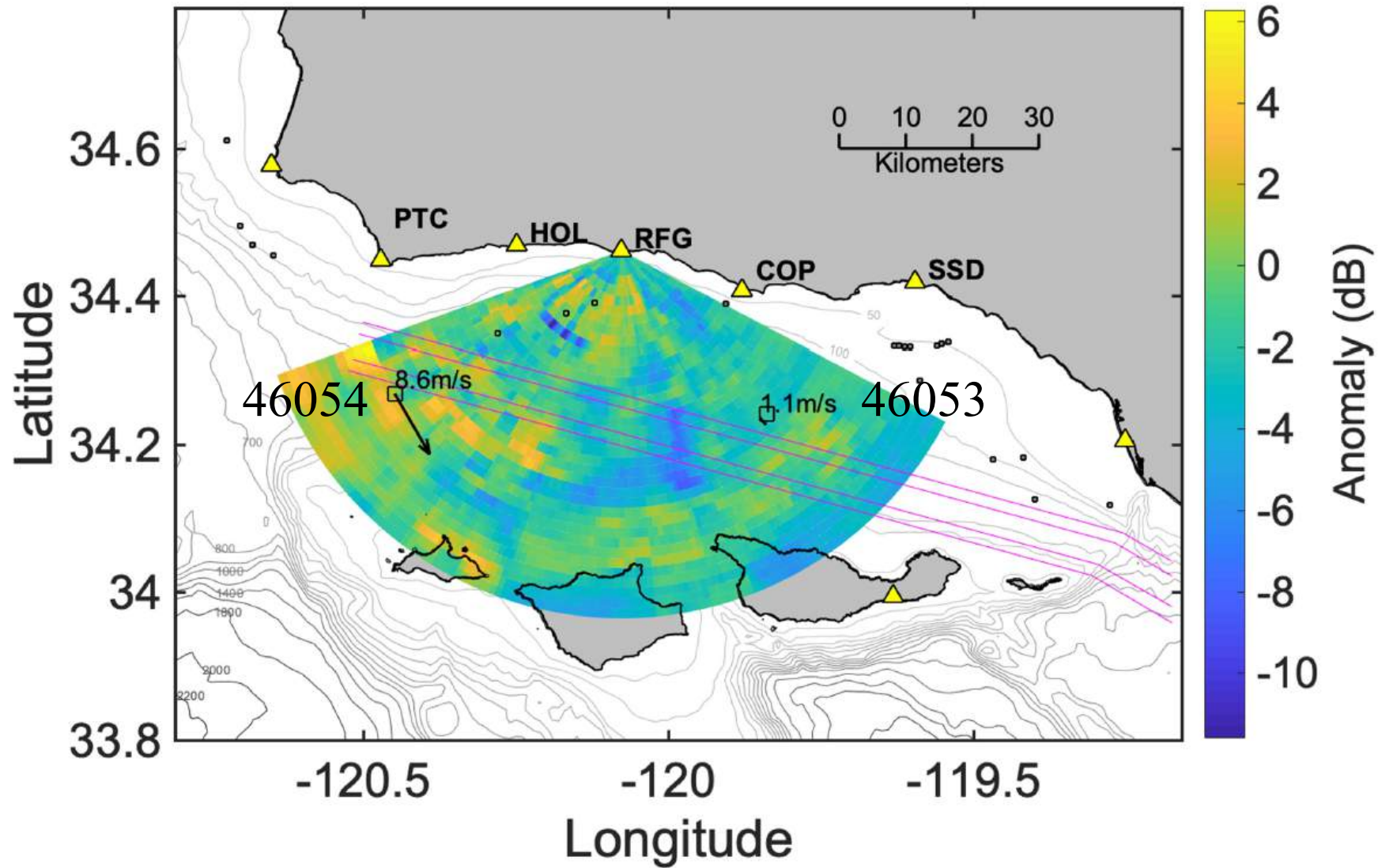
Constants

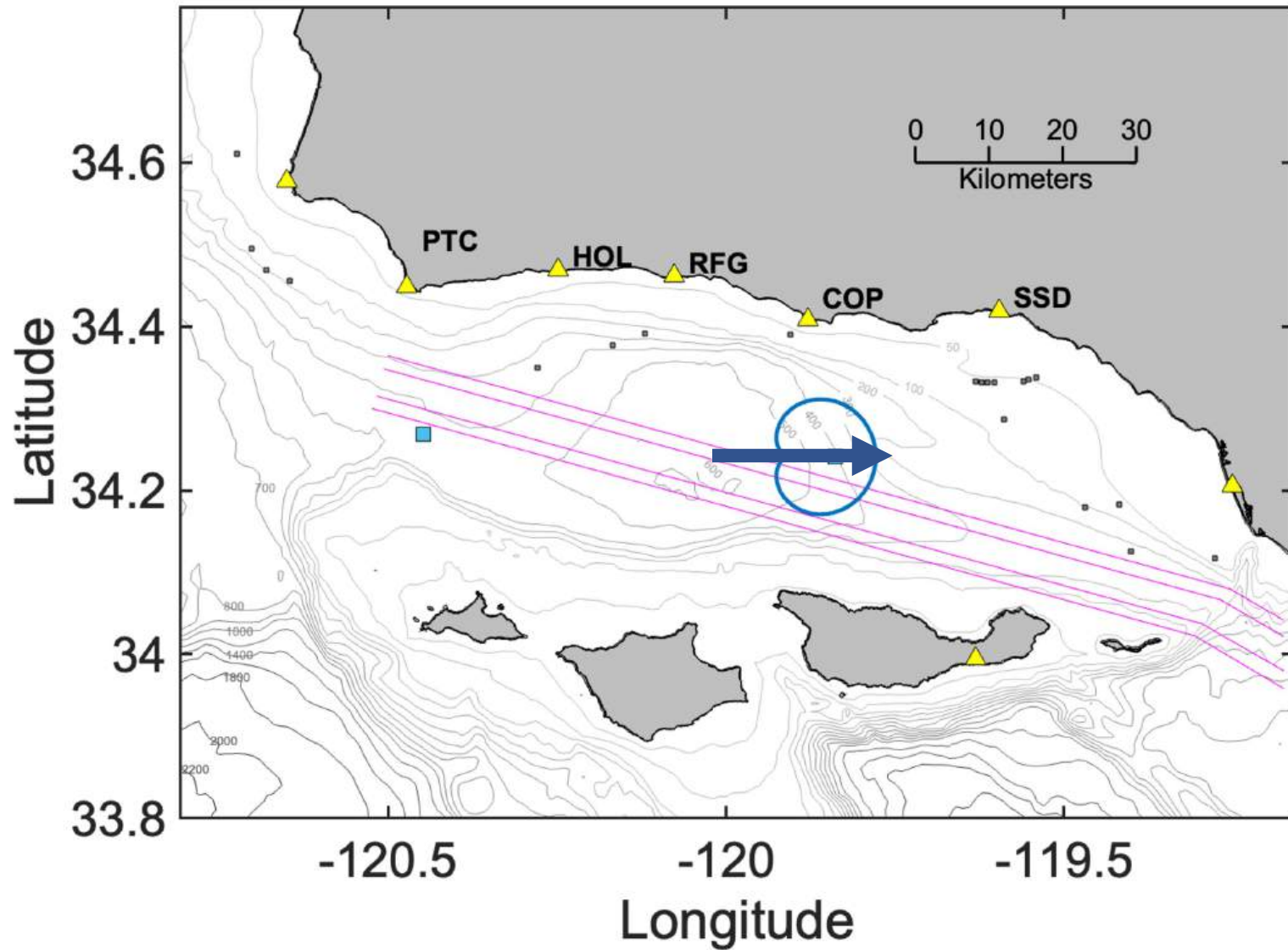
Bragg wave  
spectral power

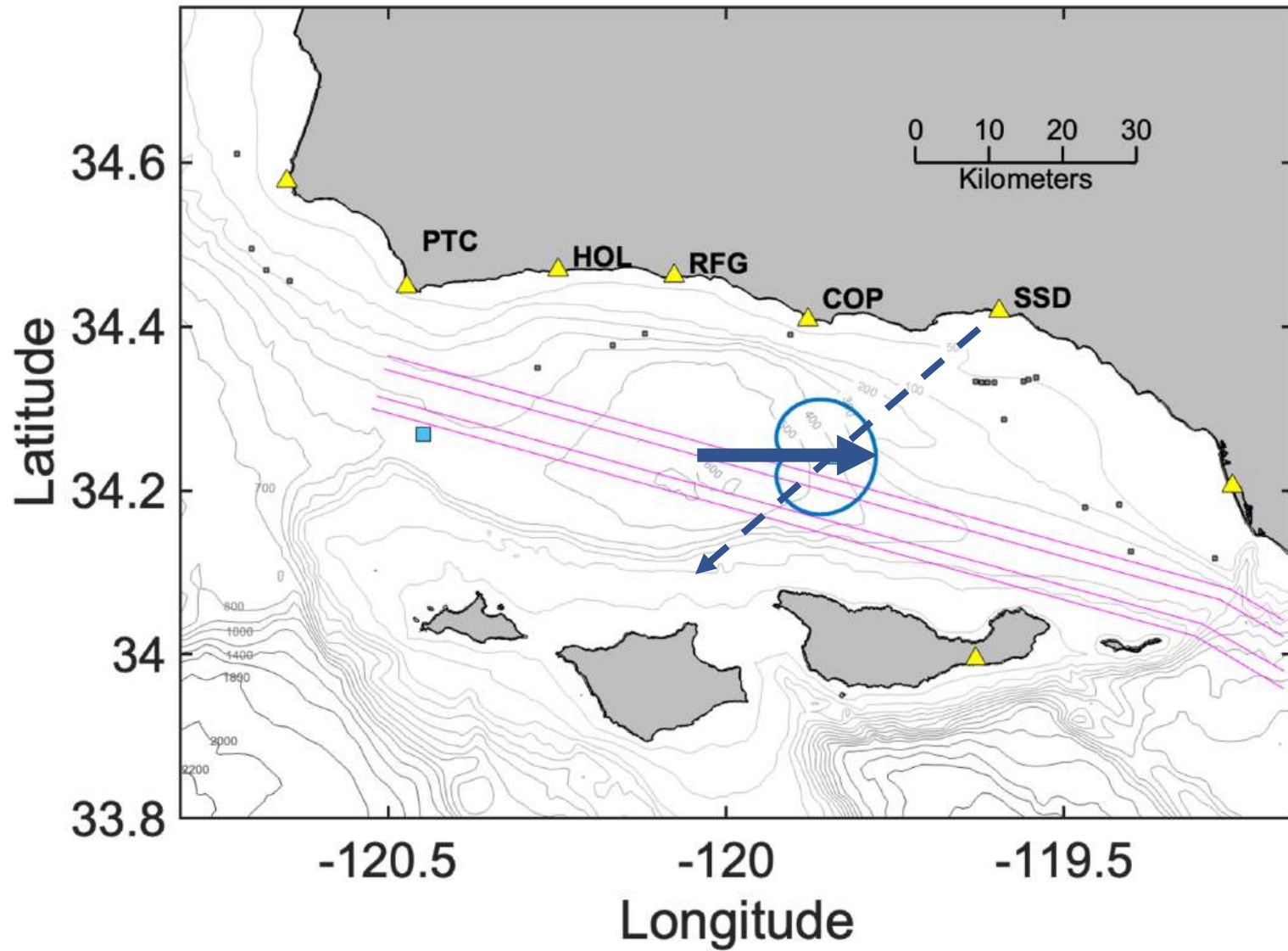
Attenuation

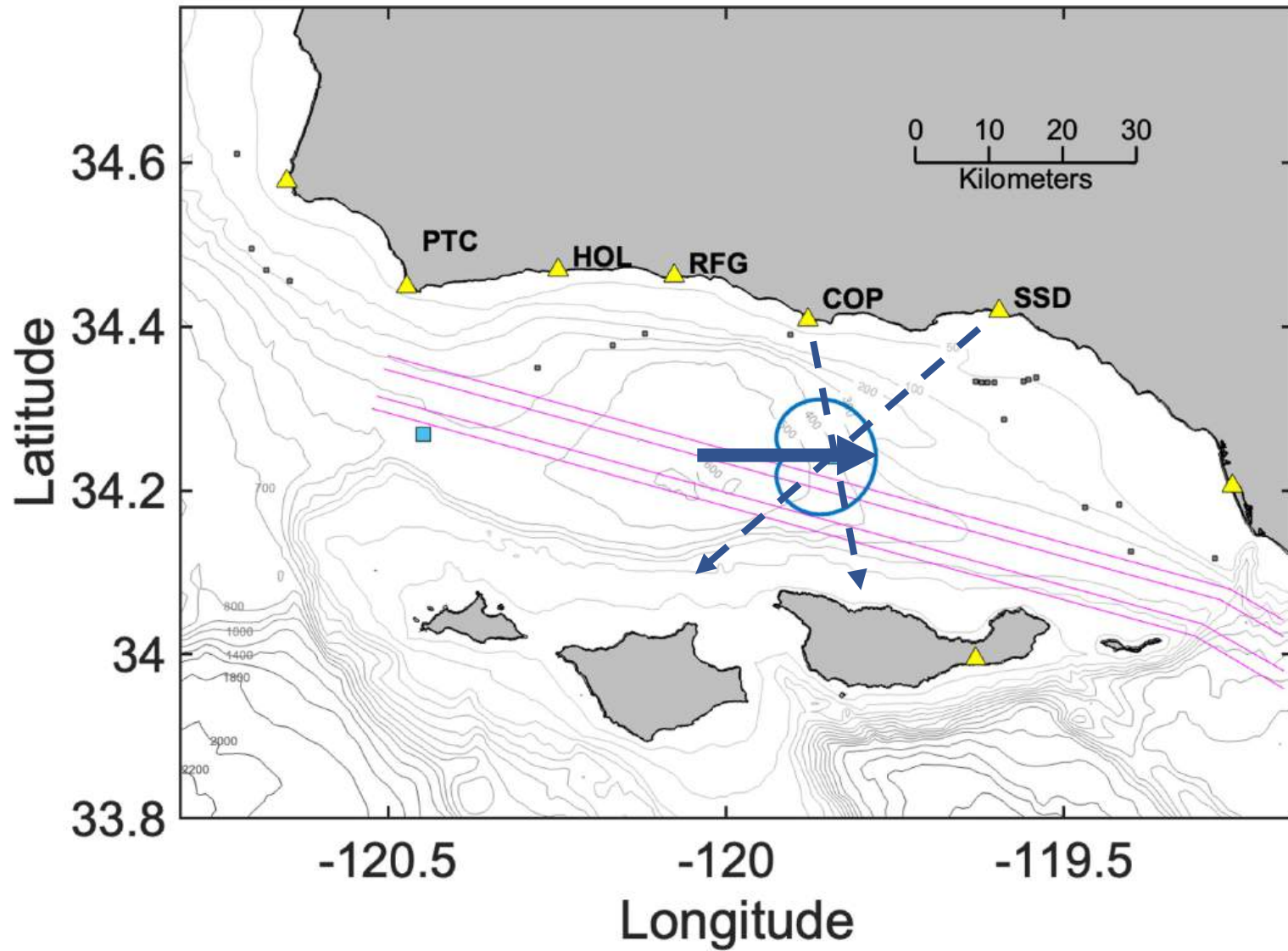
Area of  
scattering  
patch

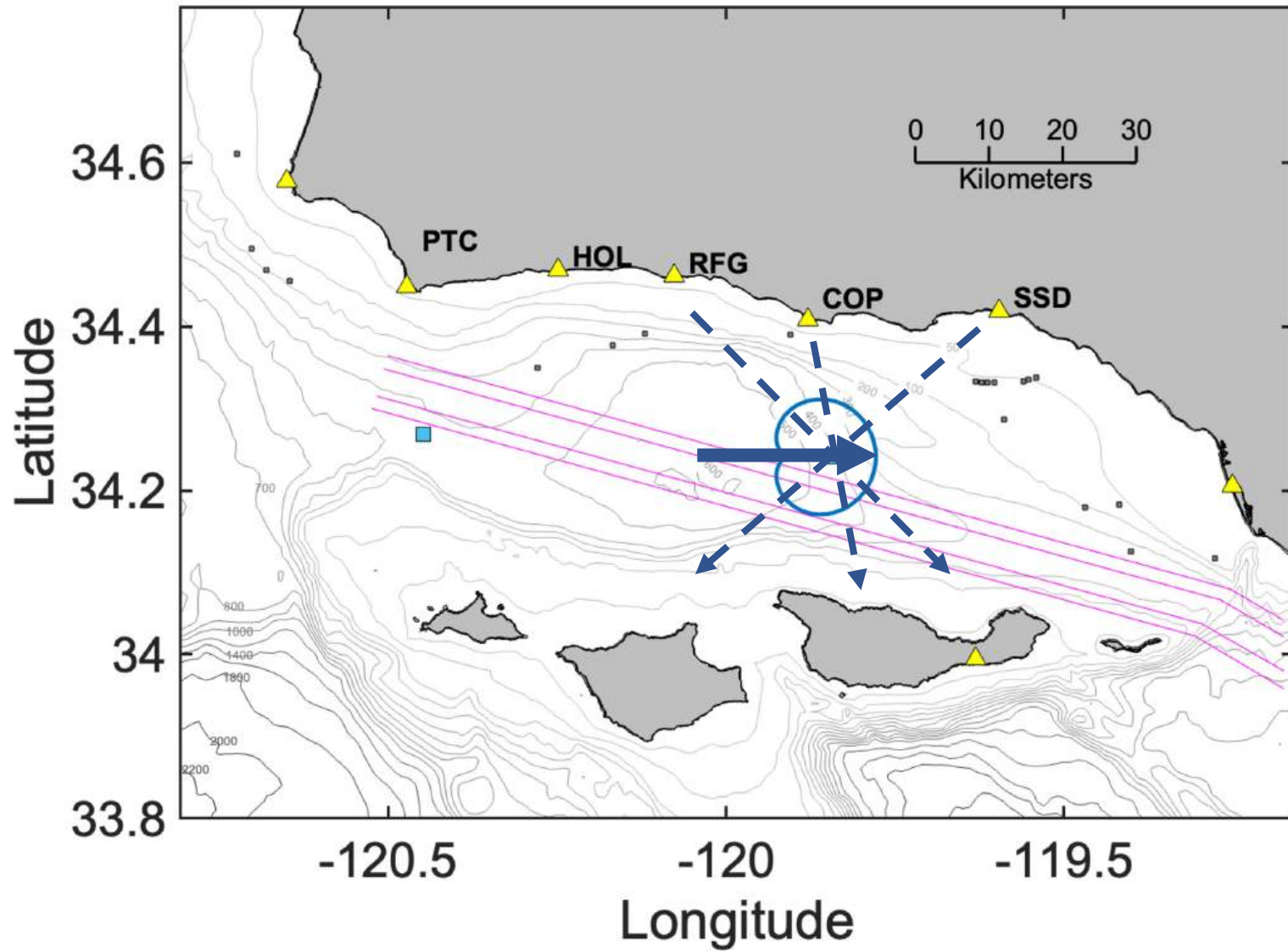
# Signal Power Anomaly

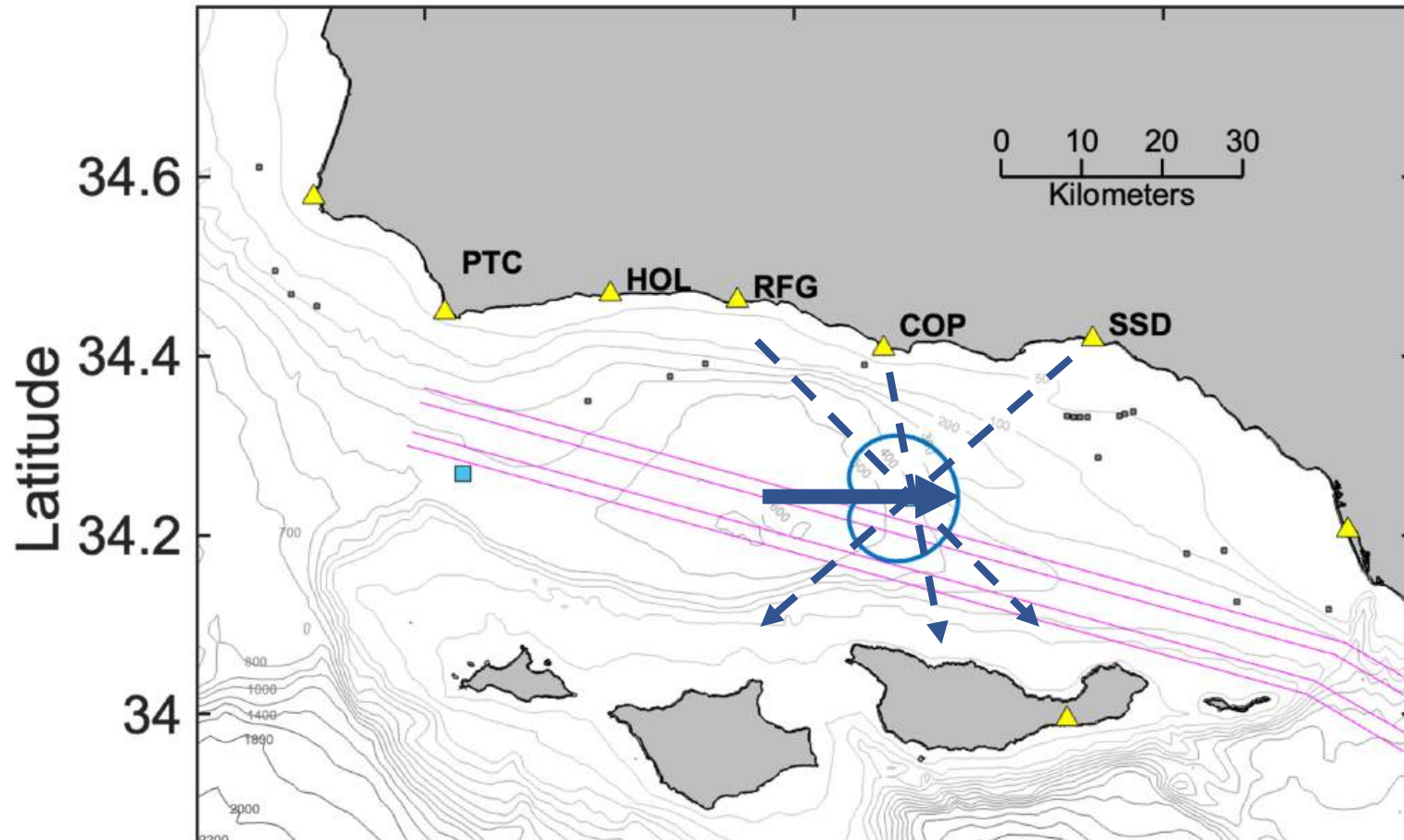












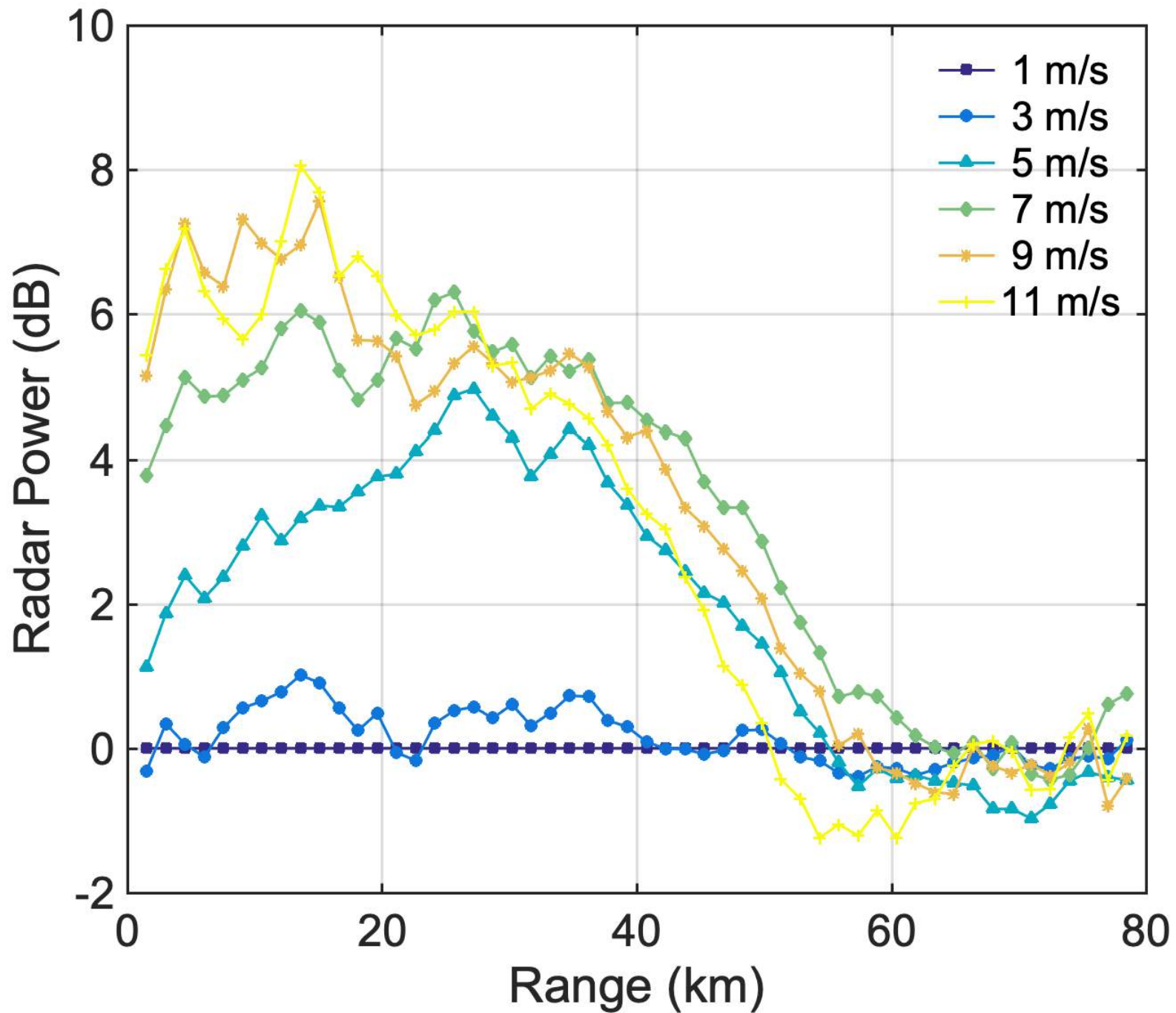
“GMF”

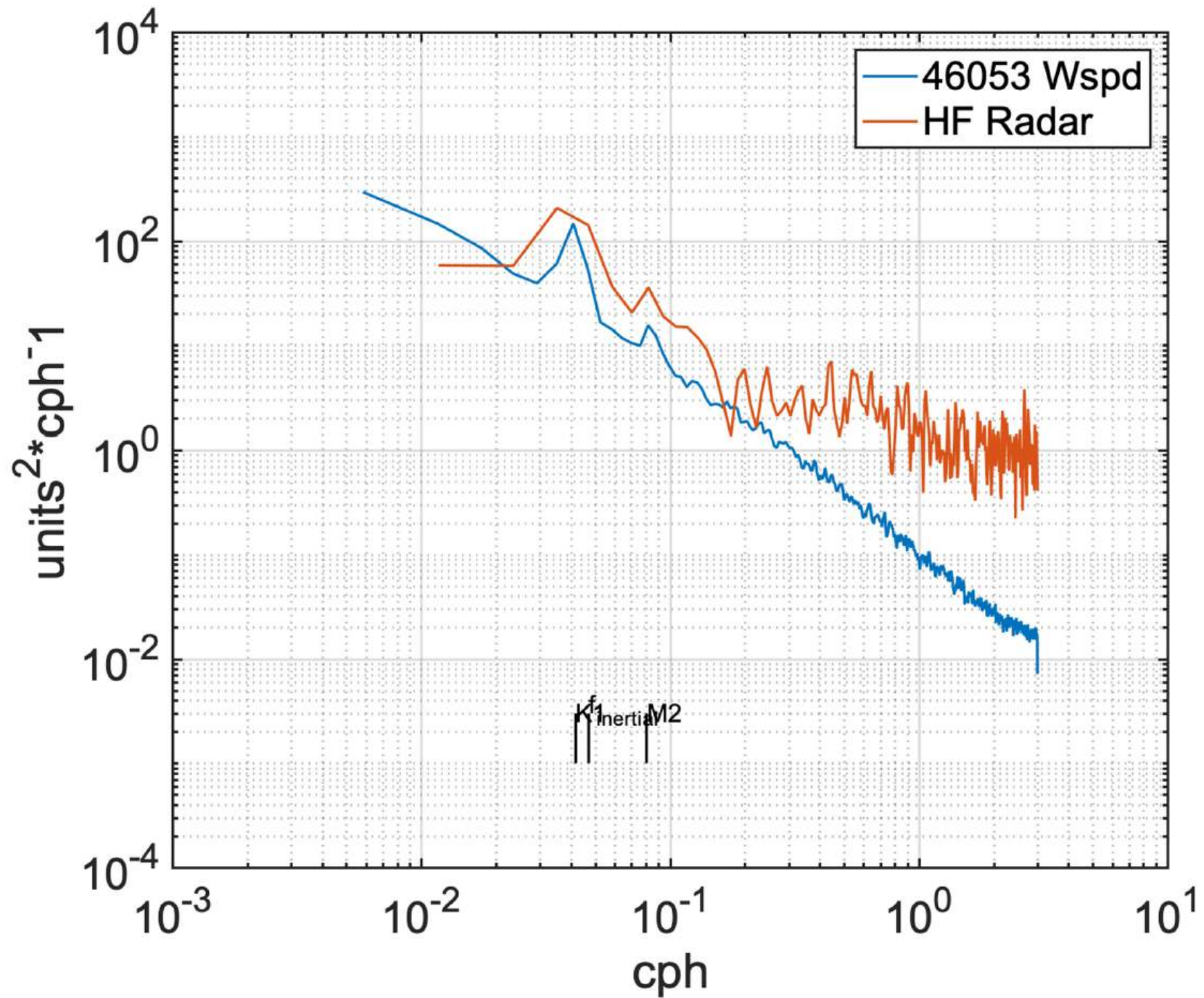
$$P(\pm f_B) = \kappa + \left( \underbrace{W_{fact} \left( \frac{U_{10}}{c} \right)^2}_{\text{Wave Growth}} - \frac{r}{\underbrace{r_{max} \left( \frac{U_{10}}{R_{fact}} \right)^3}_{\text{Decay}}} \right) \text{sech}^2(\beta\theta)$$

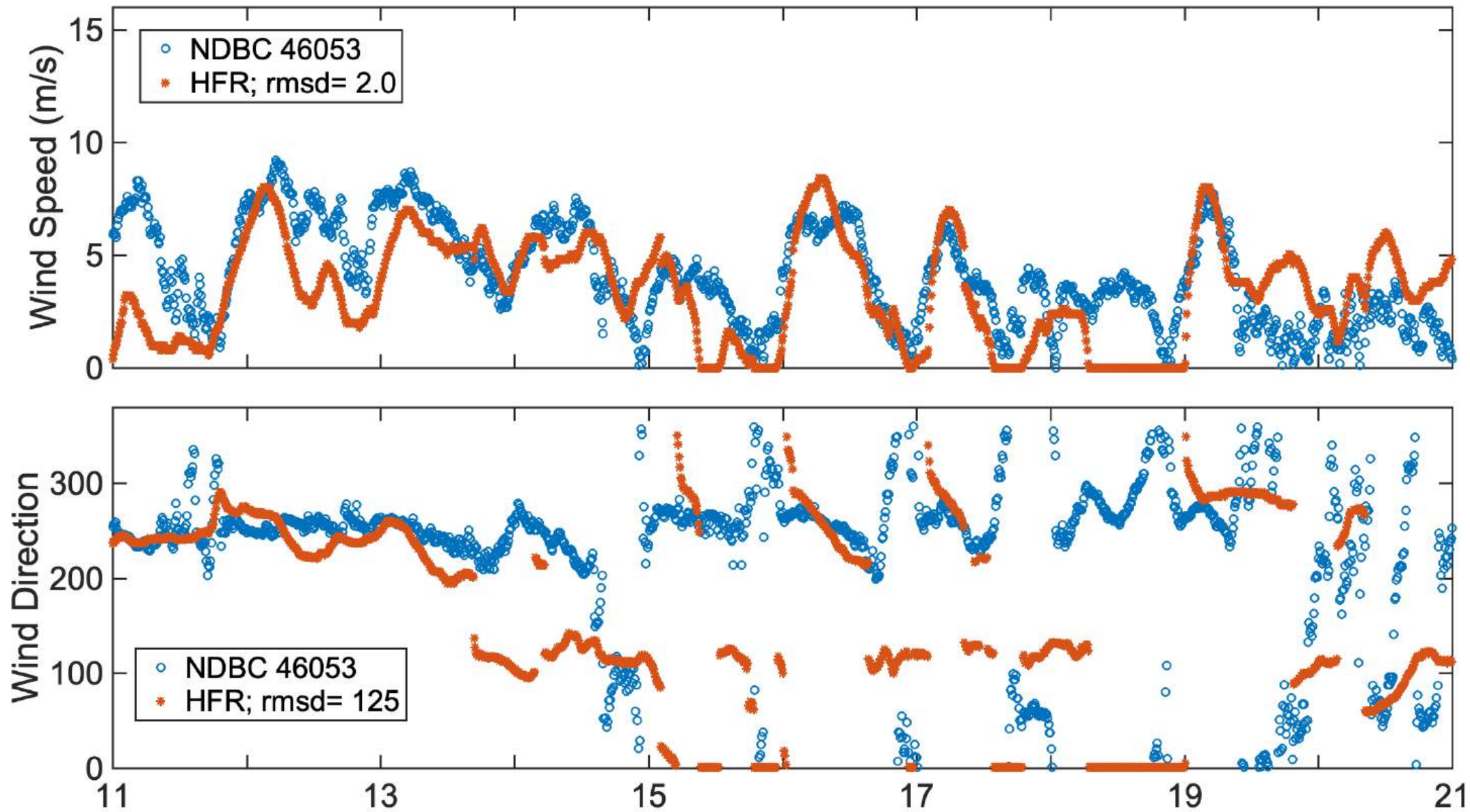
Wave Growth

Decay

Kirincich, 2016







September 2021

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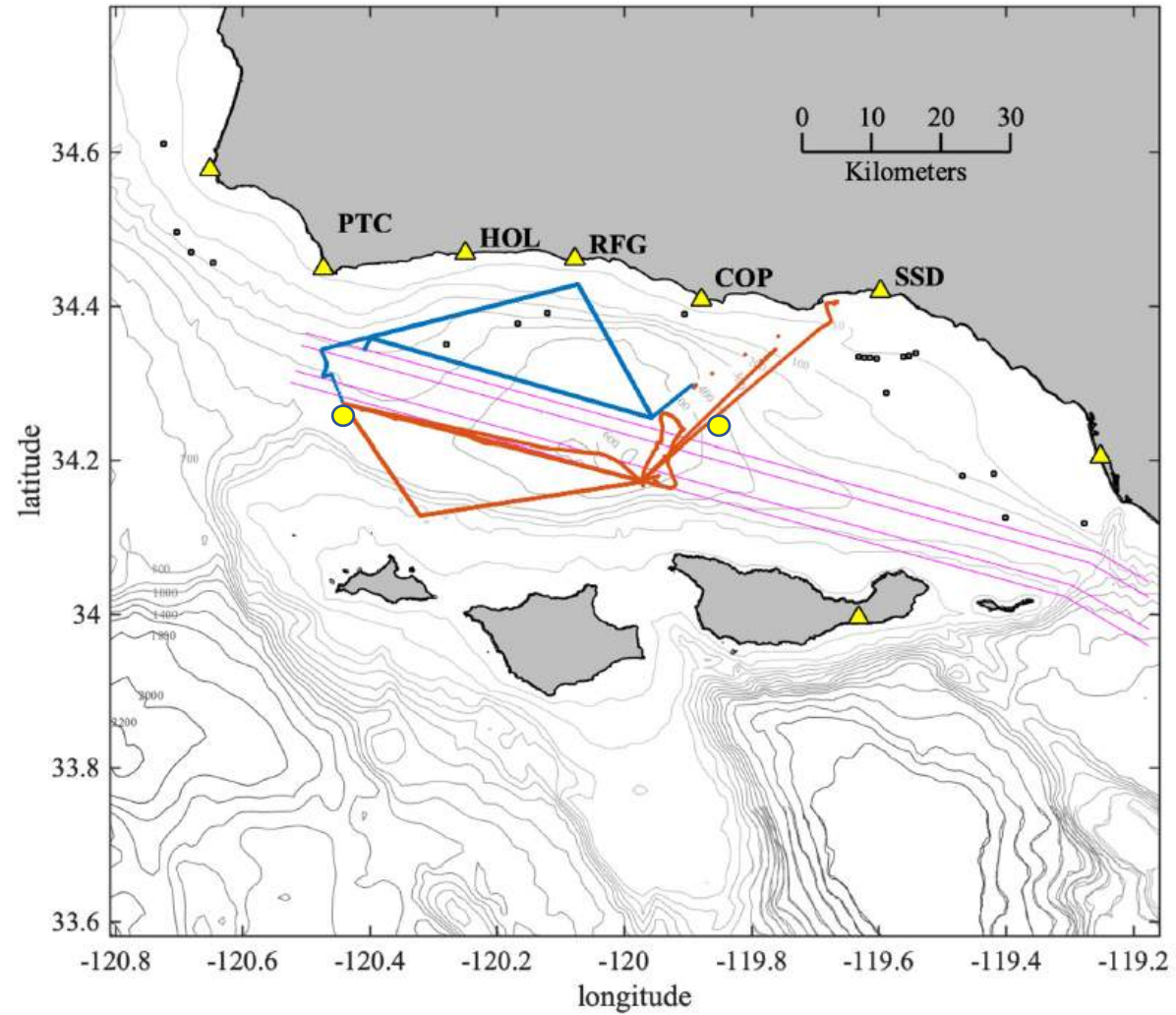
Status:

- 2 m/s RMSD; comparable with others

Ongoing:

- wave glider data
- Better UKF model
- Use of variational methods
- Better attenuation accounting

# Spatial Wind Observations



... off Martha's Vineyard too

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Status:

- 2 m/s RMSD; comparable with others

Ongoing:

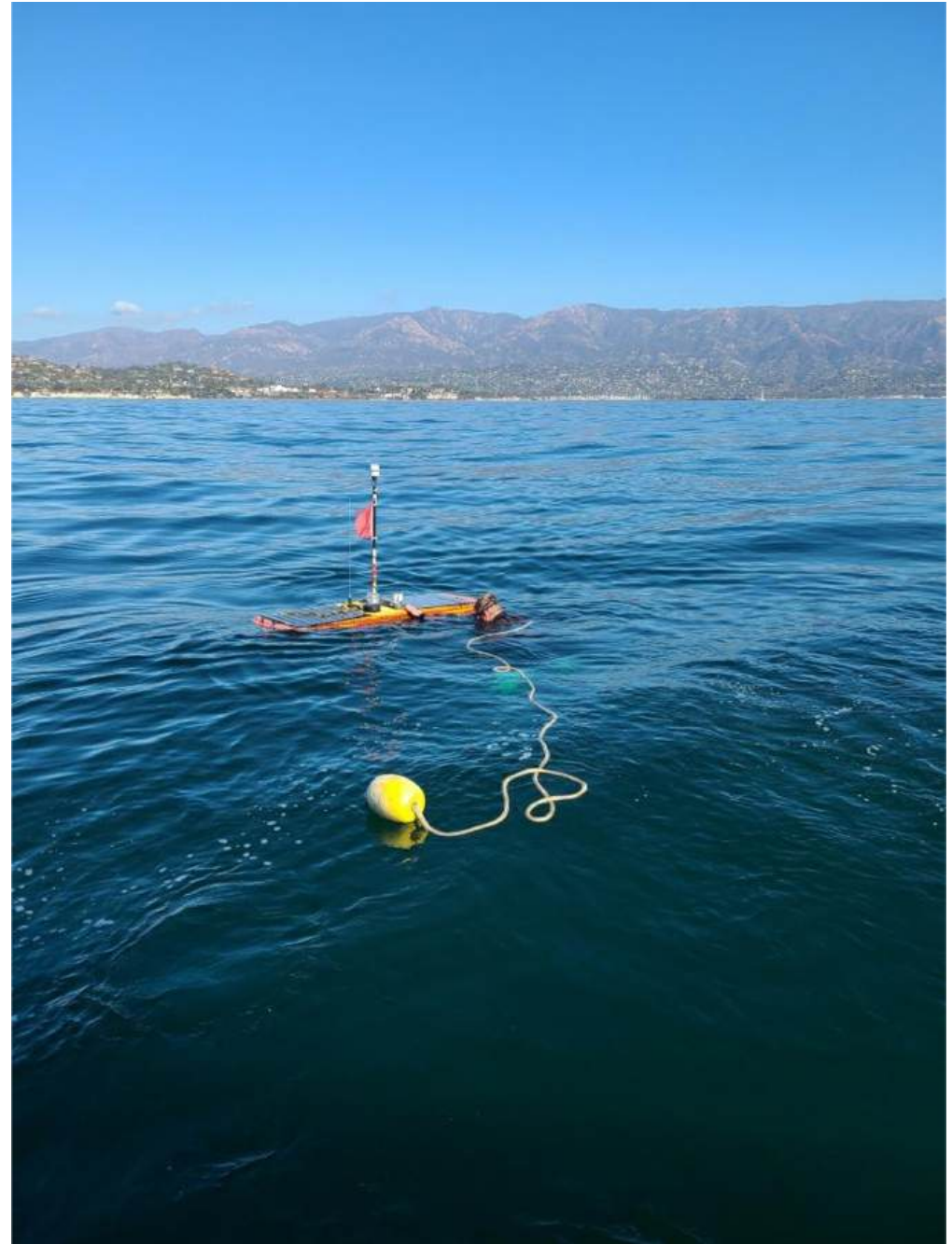
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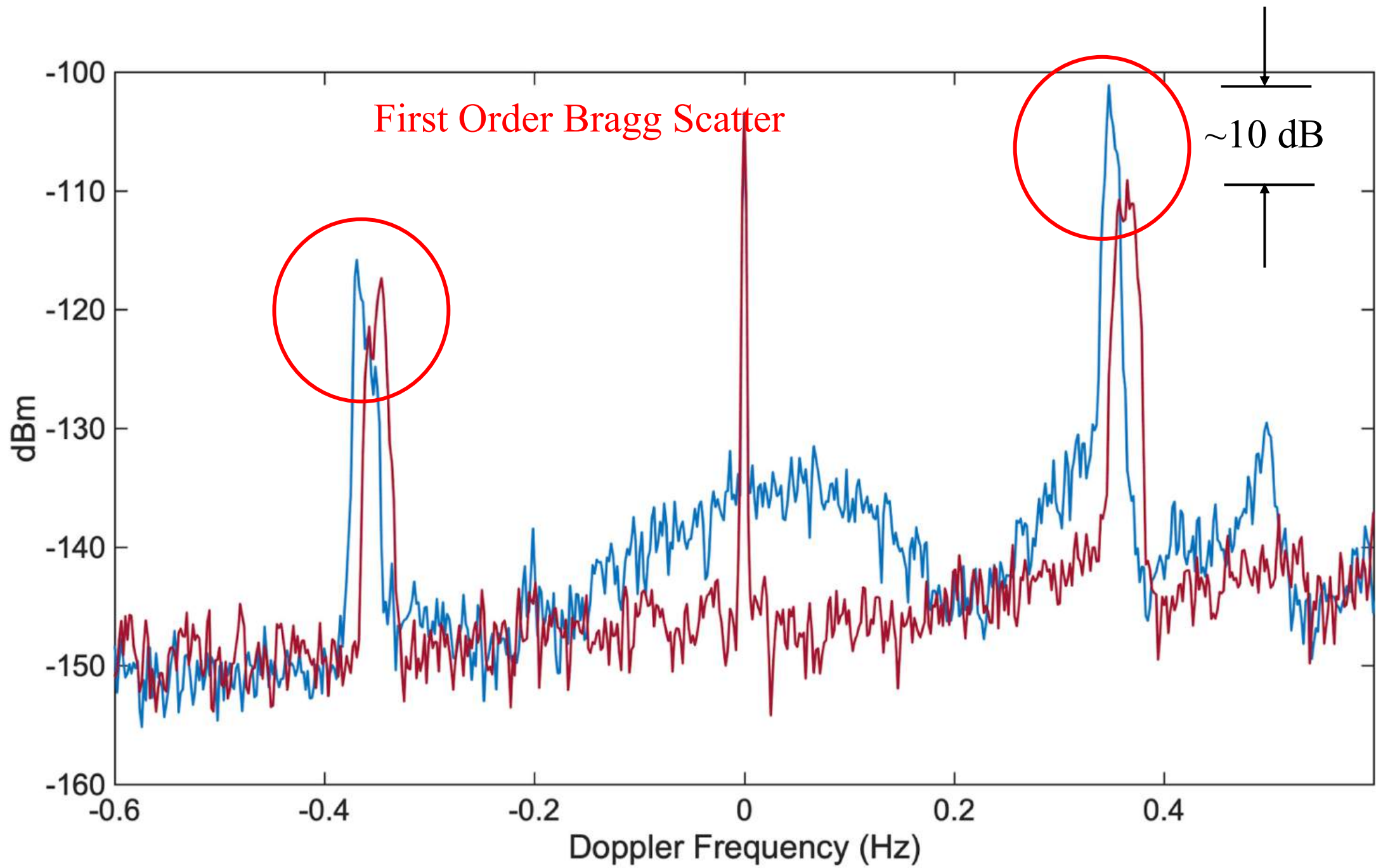
Thanks

brian.emery@ucsb.edu

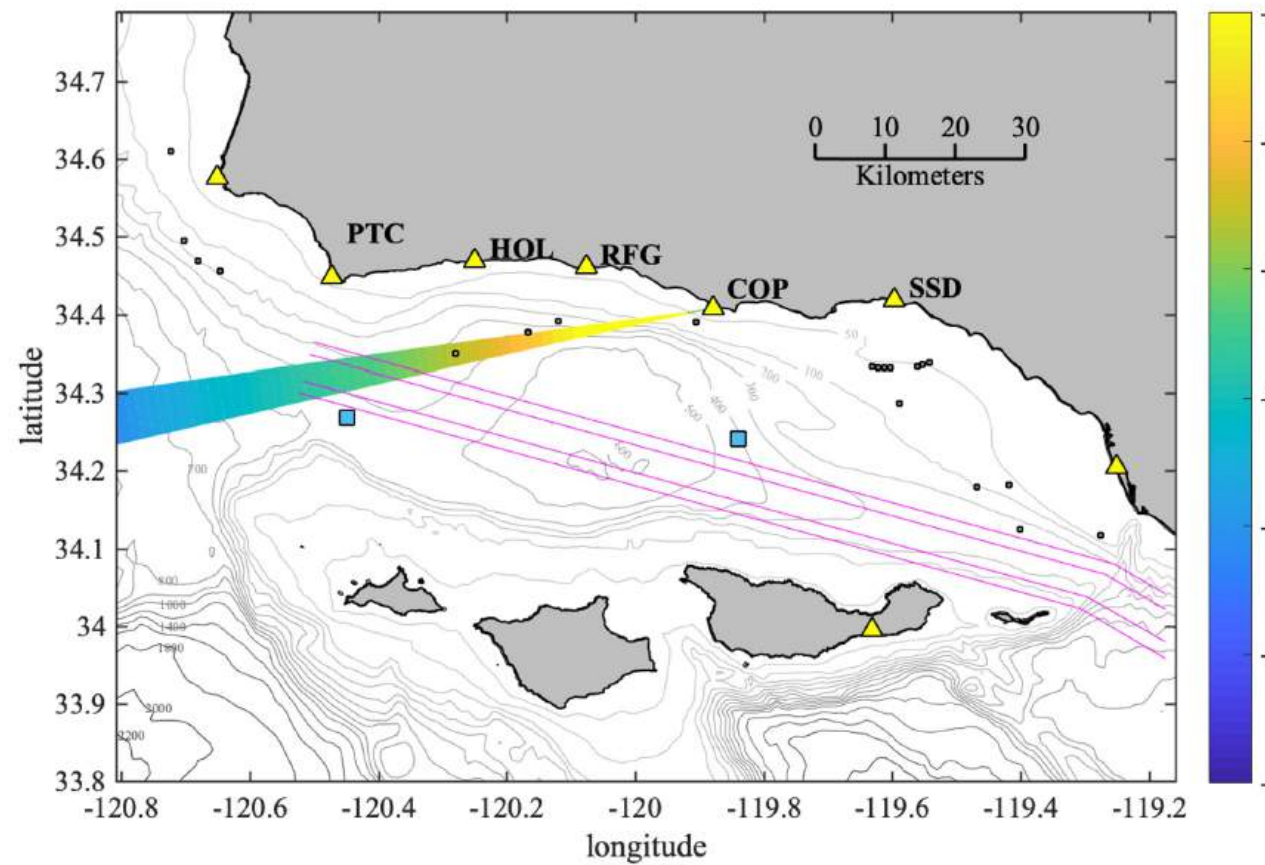
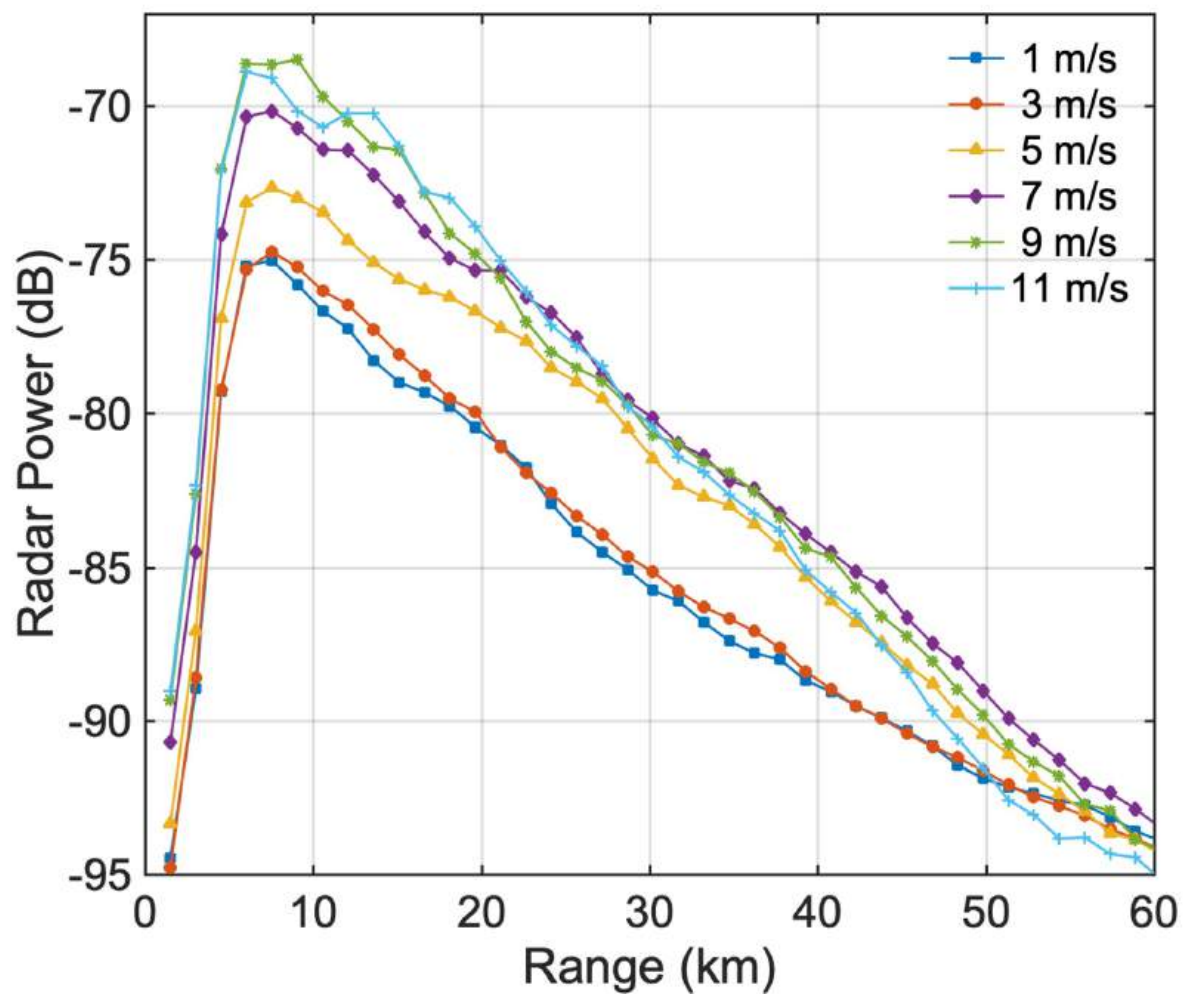
# Thanks

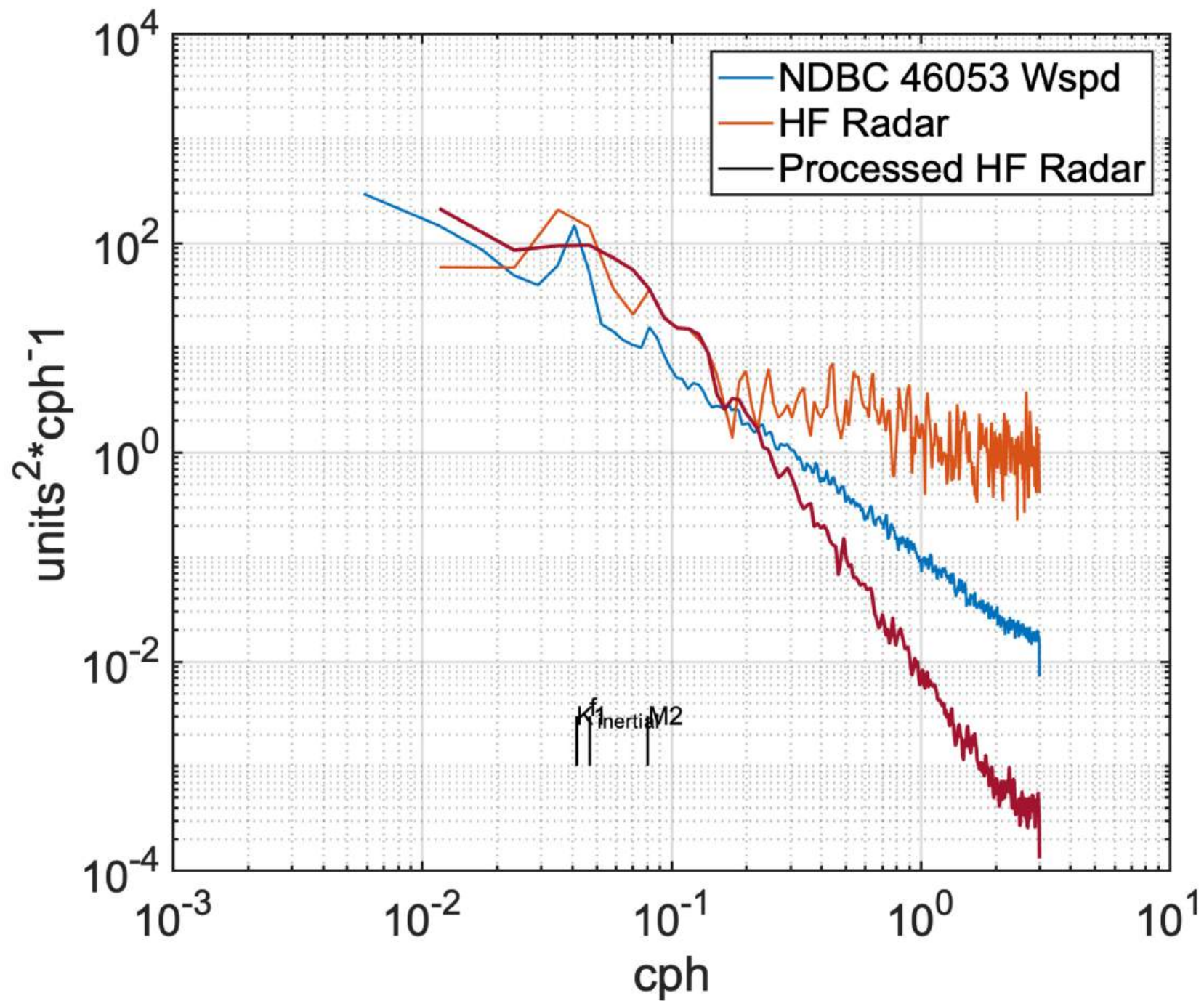
[brian.emery@ucsb.edu](mailto:brian.emery@ucsb.edu)



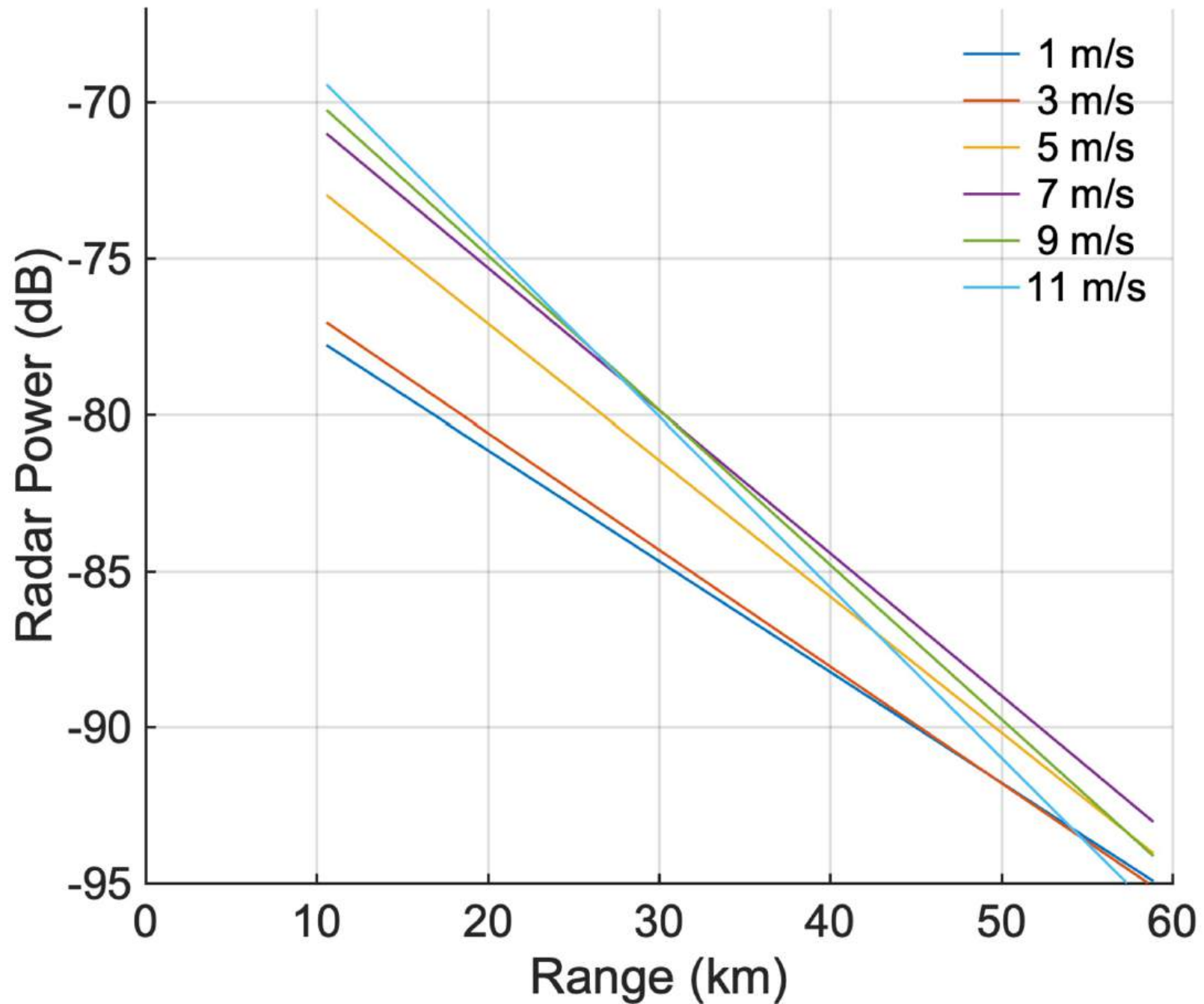


# conditional average by wind speed





conditional average by wind speed



# “GMF”

$$P(\pm f_B) = \kappa + \left( W_{fact} \left( \frac{U_{10}}{c} \right)^2 - \frac{r}{r_{max}} \left( \frac{U_{10}}{R_{fact}} \right)^3 \right) \text{sech}^2(\beta\theta)$$

Observed Power

Wave Growth

Attenuation at  
high wind speeds

Directionality

# SeaSonde (3 receive antennas)



# Univ. of Hawaii (8 receive antennas)

*UH HFR receive antenna installed on Nantucket Island, MA.*

HFR: 09 Apr 2015 0700 GMT

