Wave energy budget for Pacific island nearshore vironment

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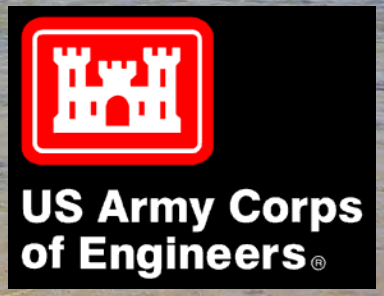
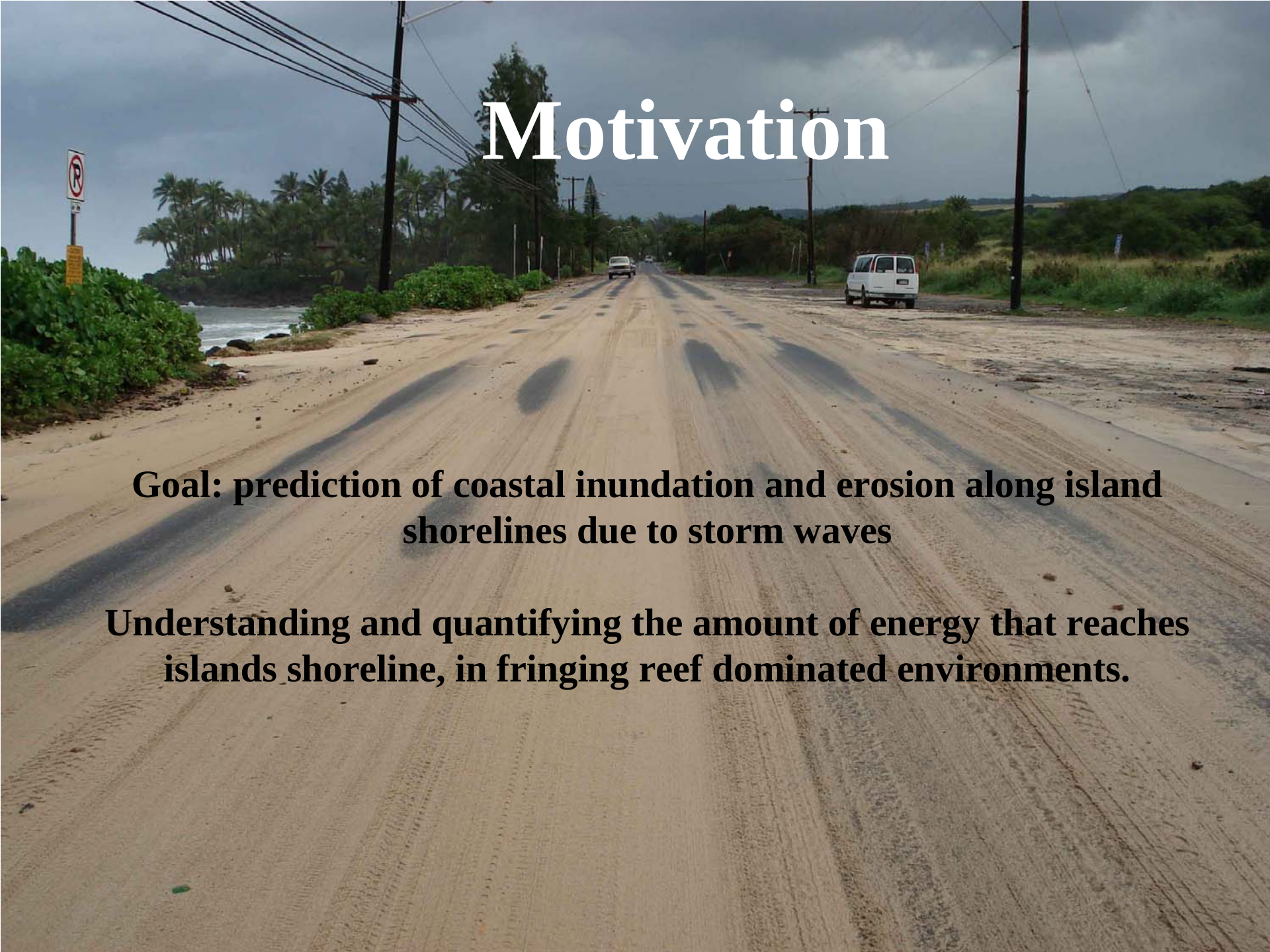




Motivation

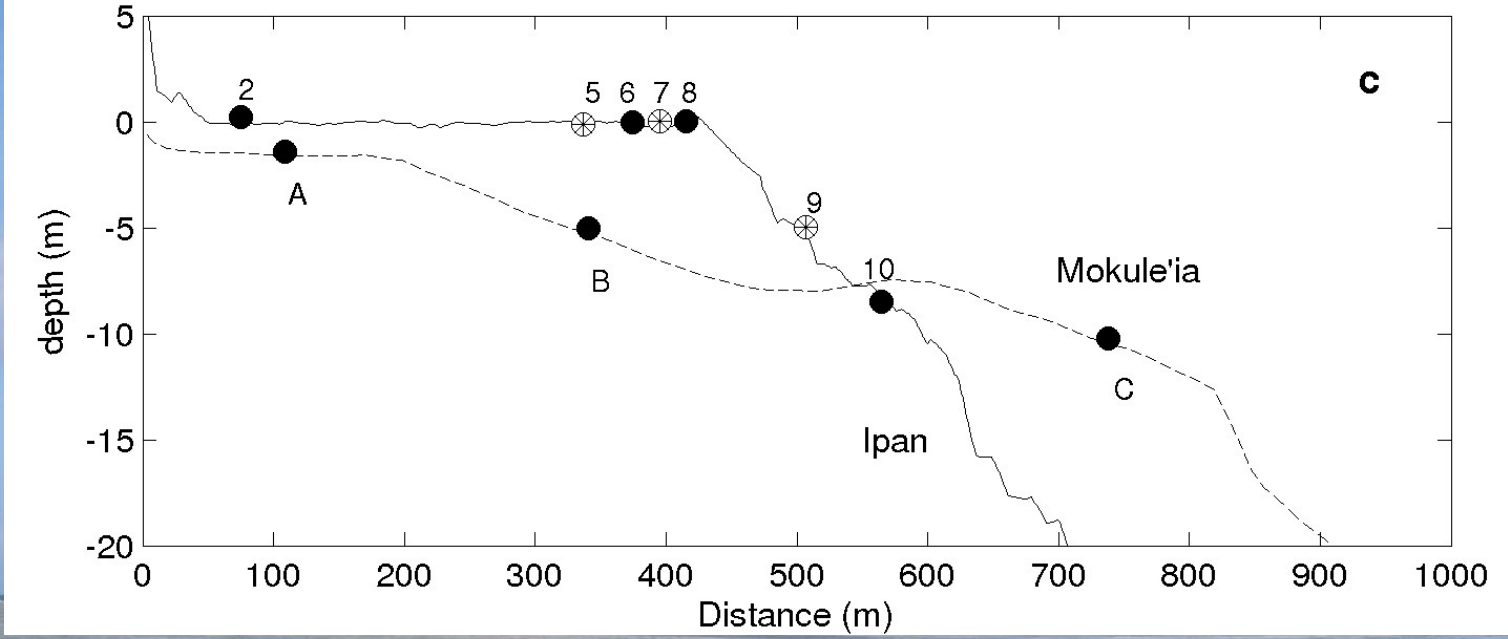
Goal: prediction of coastal inundation and erosion along island shorelines due to storm waves

Understanding and quantifying the amount of energy that reaches islands shoreline, in fringing reef dominated environments.

Main results

- **Infragravity dominates** the spectrum on the reef flat and near the shoreline
- Consequence of **strong dissipation of sea and swell** energy
- Energy at the shore is **strongly dependent on water depth** which is function of offshore wave height through setup

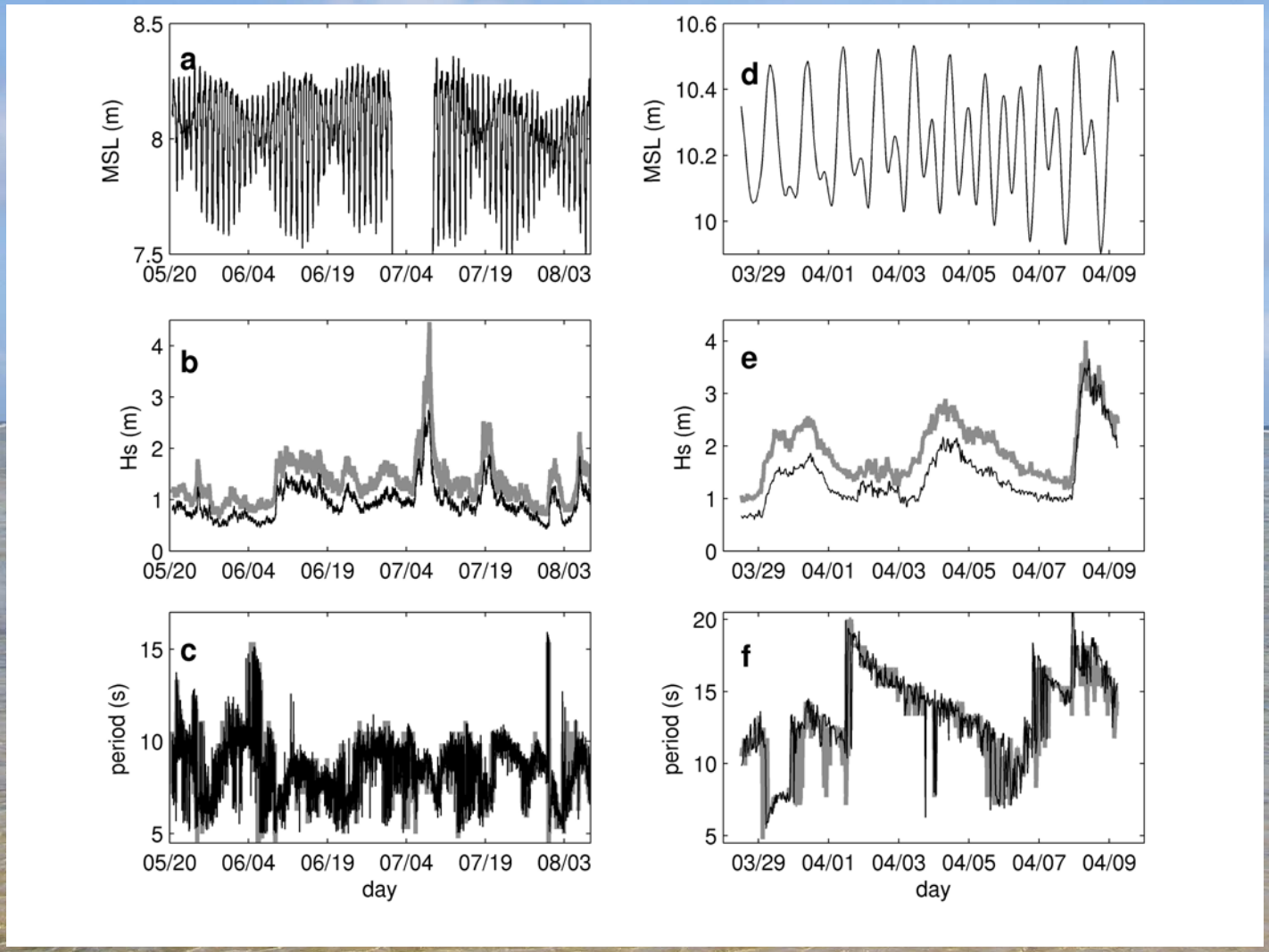
Deployments



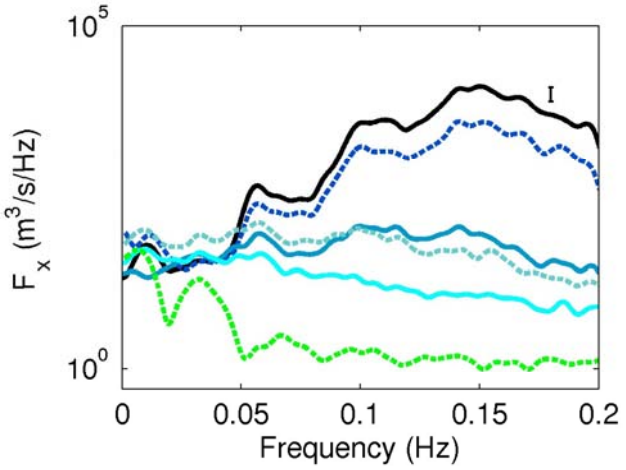
Ipan,Guam
July 2006
tides ~0.5m

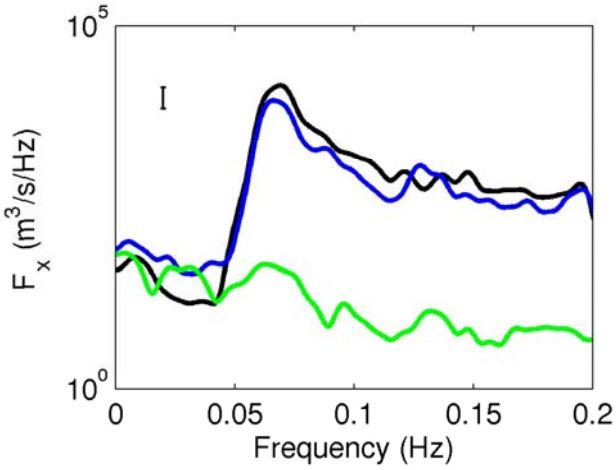
Mokuleia, Oahu
April 2004
tides ~0.3m

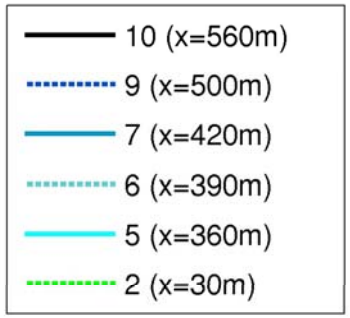
Conditions during deployment

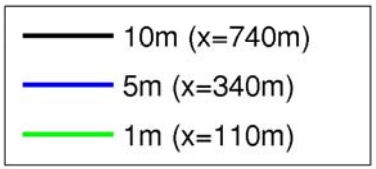


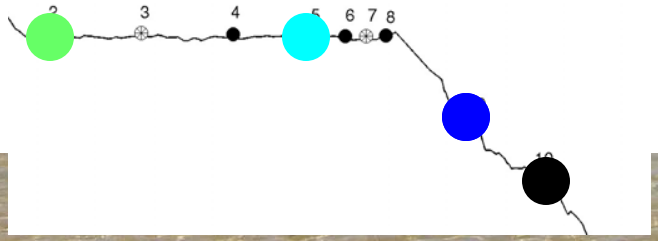
Energy flux spectrum

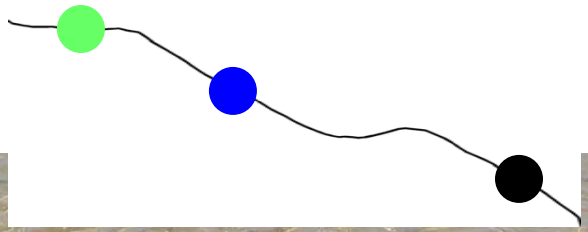




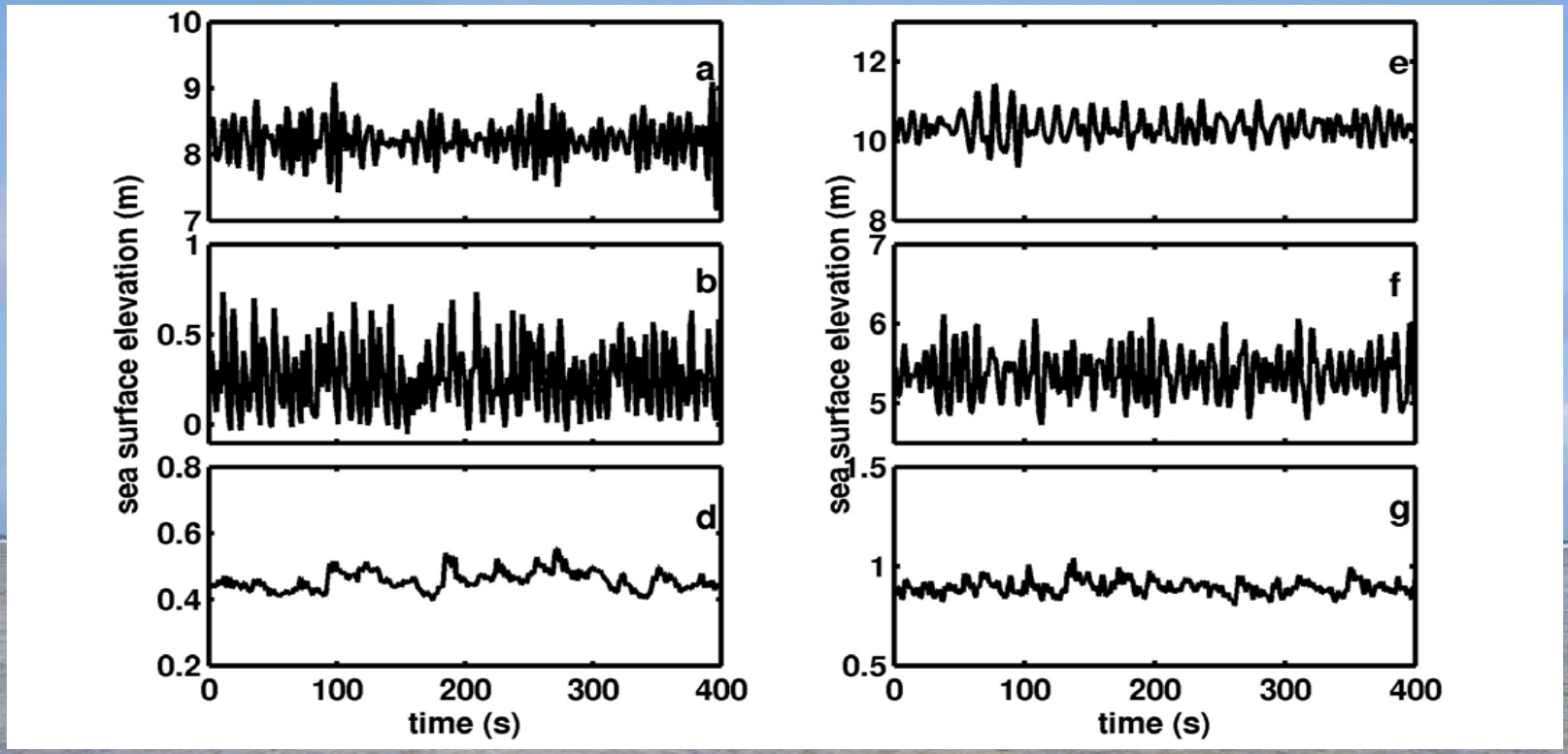






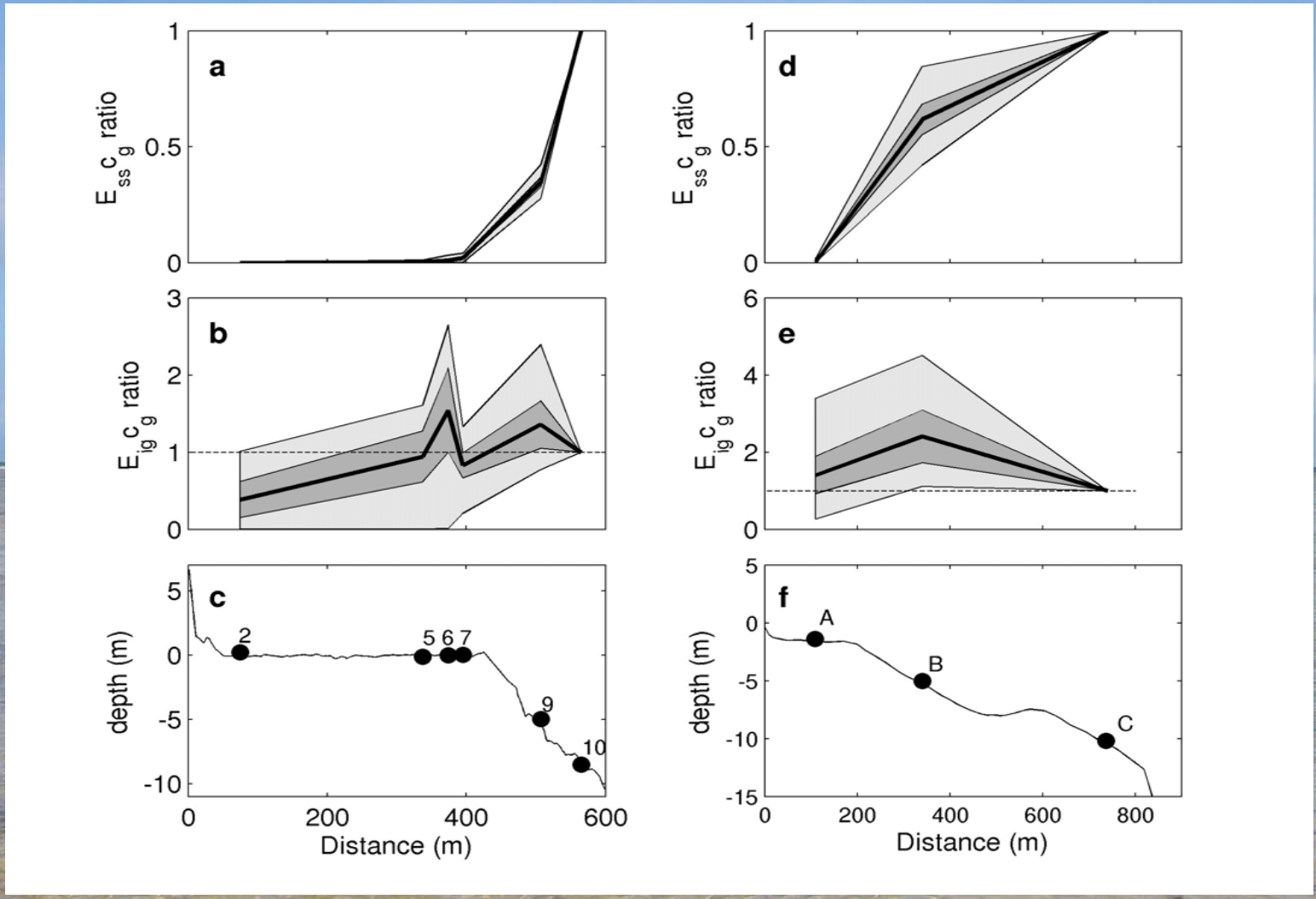


Infragravity signal



- IG energy is proportional to sea/swell energy
- Reefs behave like a dissipative beach:swash infragravity dominated
- Infragravity waves are partially dissipated and partially reflected

Energy Flux ratio



Energy flux equation

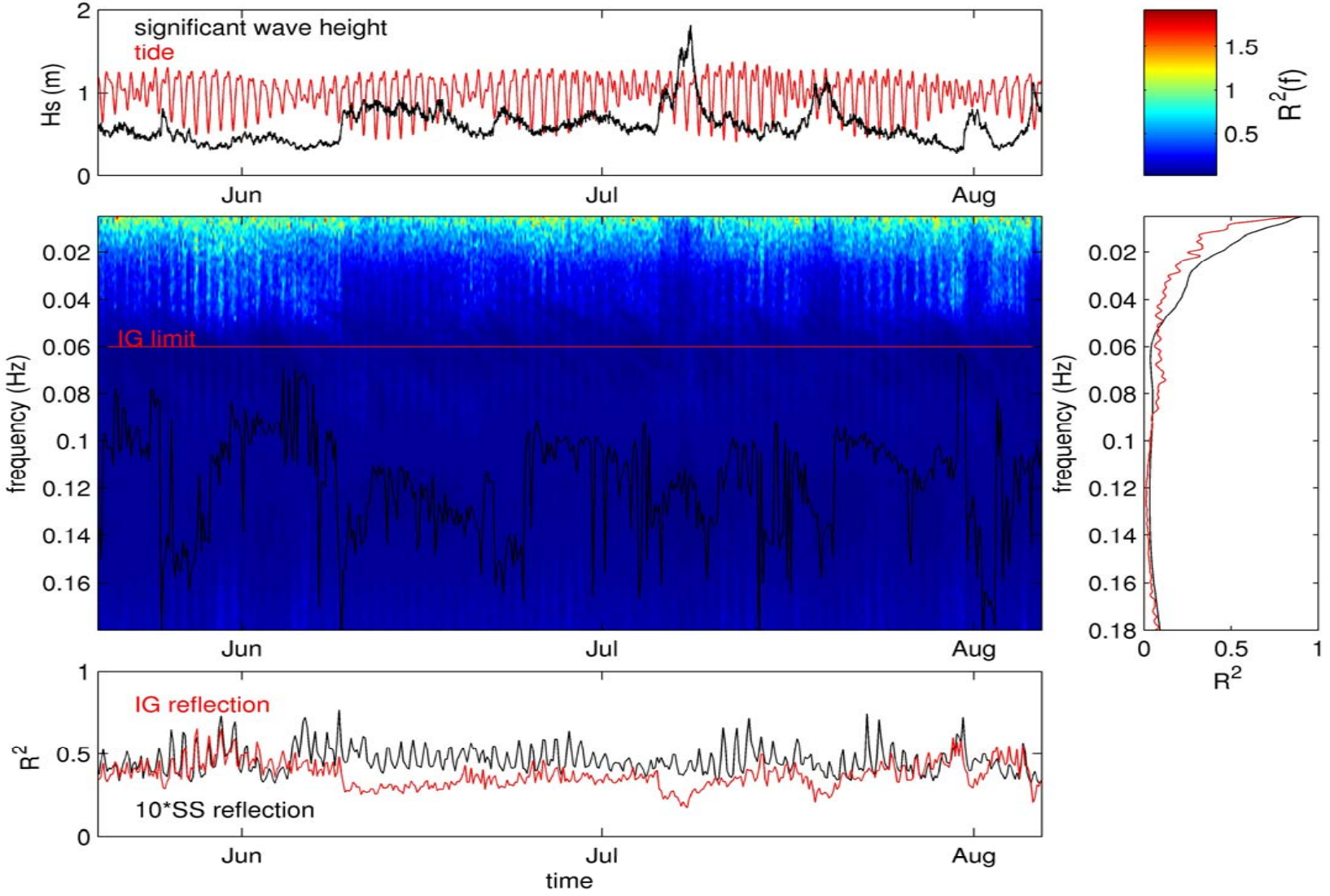
$$dF/dx(f) = D(f) + R(f) + N(f)$$

- D(f) dissipation (friction $\varepsilon_f(f)$ + breaking $\varepsilon_d(f)$)
- R(f) Reflection
- N(f) Non-linear transfer of energy (accounts for <2% of dissipation)

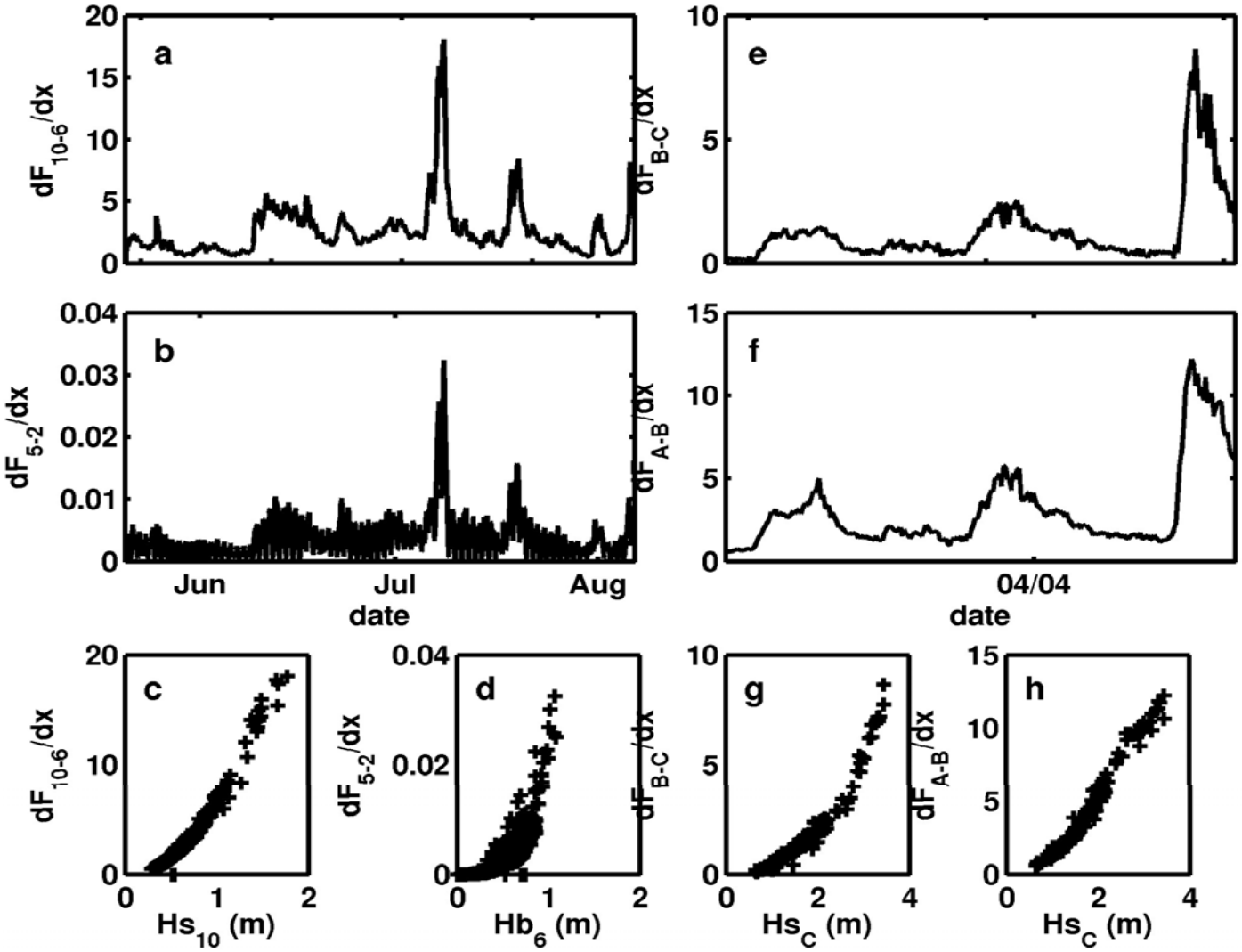
$$\varepsilon_f(f) = (3\sqrt{\pi}/16)\,\rho g\,(B^3 f/\gamma^4 h^5)\,H_{rms}^{\ 7}$$

$$\varepsilon_d(f) = \rho\, C_f\,(1/6\pi)\,(2\pi f/\sinh kh)^3\,H_{rms}^{\ 3}$$

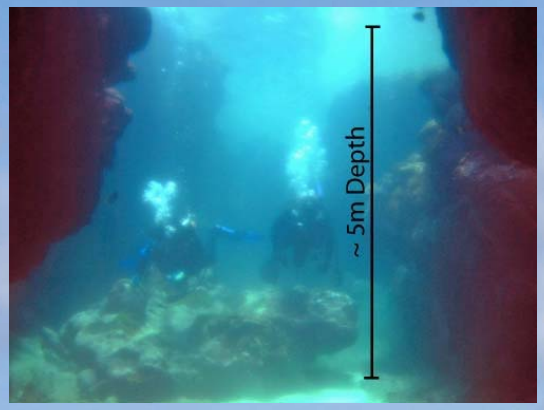
Reflection


significant wave height
tide
Hs (m)
2
1
0
Jun
Jul
Aug
1.5
1
0.5
R2(f)
IG limit
frequency (Hz)
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
R2
IG reflection
10*SS reflection
time

Divergence of energy flux



Estimation of friction coefficients

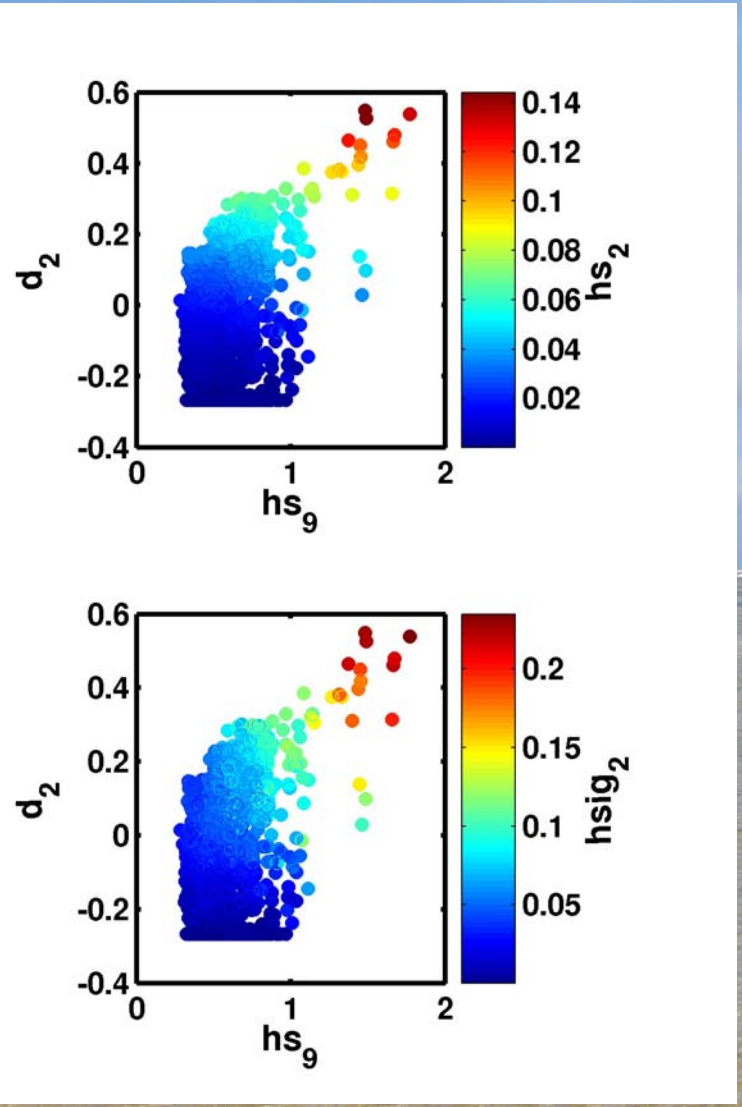


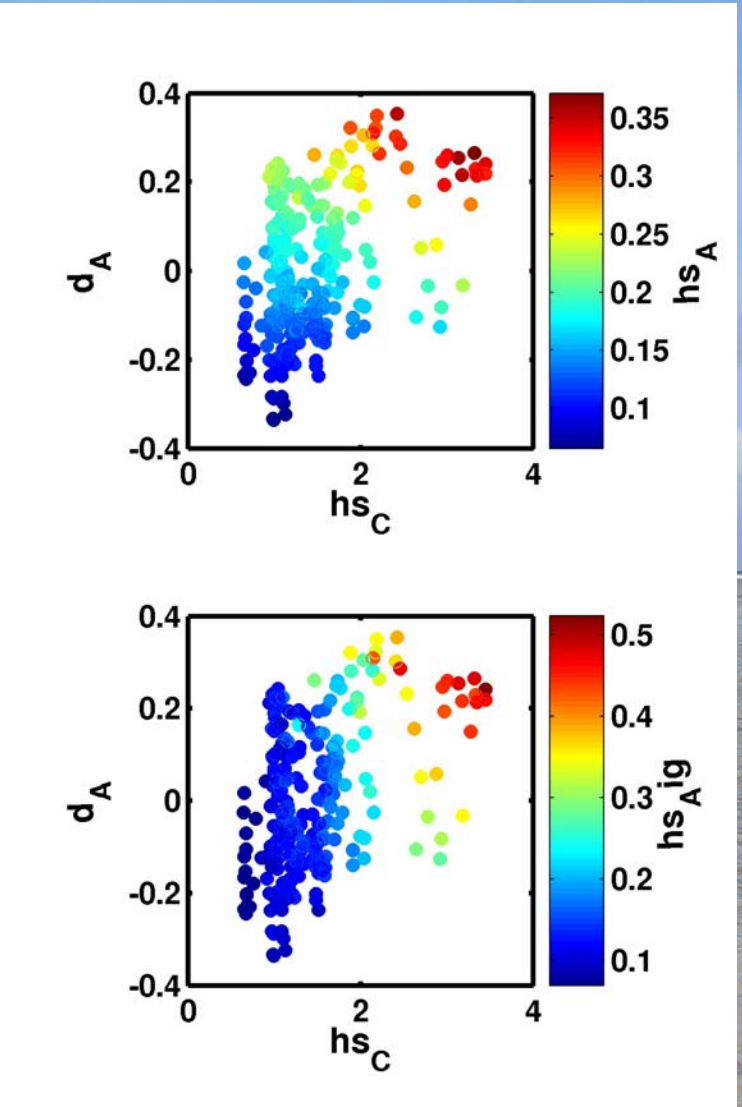
Guam forereef Cf<0.83
Breaking model inadequate

Mokuleia reef Cf~ 0.052
Breaking is reasonable

Guam reef flat Cf~ 0.03

Consequence for shoreline energy





Conclusion

- **Infragravity dominates** the spectrum on the reef and near the shoreline
- Consequences of **strong dissipation of sea and swell** energy
- Energy at the shore is **strongly dependent on water depth** which is function of offshore wave height through setup

Future work

- Estimation of non-linear term N(f)
- Swash measurements using video images
- Assessment of role of porosity using reflection coefficient
- Assessment of 3D topography effect using numerical models

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