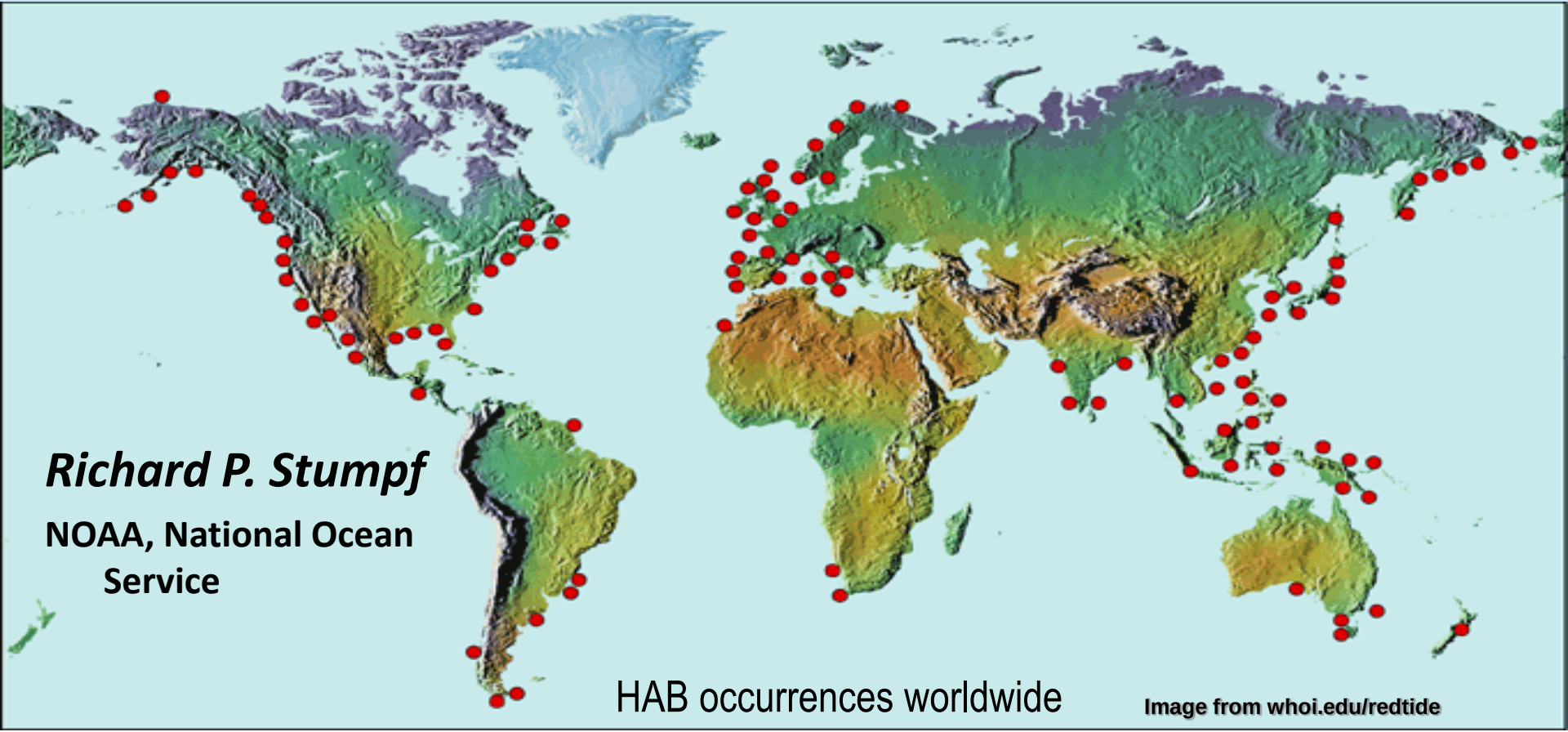
Harmful Algal Blooms (HABs) 4 Validation



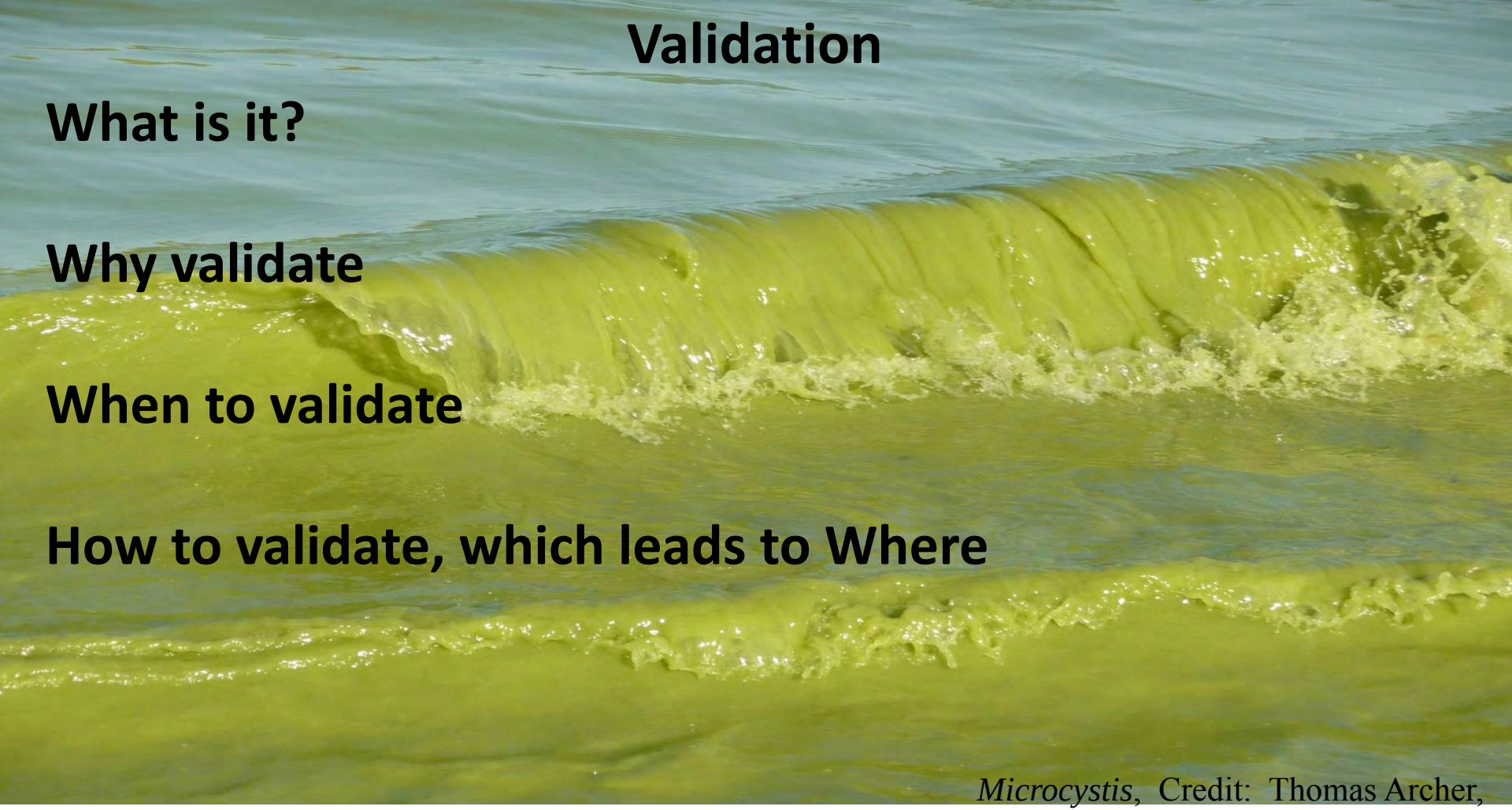
Validation

What is it?

Why validate

When to validate

How to validate, which leads to Where



Microcystis, Credit: Thomas Archer, Columbus Ohio

What is Validation

Quantitative: algorithm gives quantity

how accurate is the quantity?

Qualitative: algorithm indicates presence/absence or type of bloom

is it reliable?

Why Validate

Robustness: does it hold up for various images (atmos. error etc.)
Reproducibility: does it apply over multiple years, regions, satellites
Usability: is it useful enough for the applications

Accuracy in algorithm
Is it useful

- false positives (type 1 error); the HAB actually is there
- false negatives (type 2 error); the HAB is NOT there

When to Validate

Application of field algorithm to satellite

Use by managers

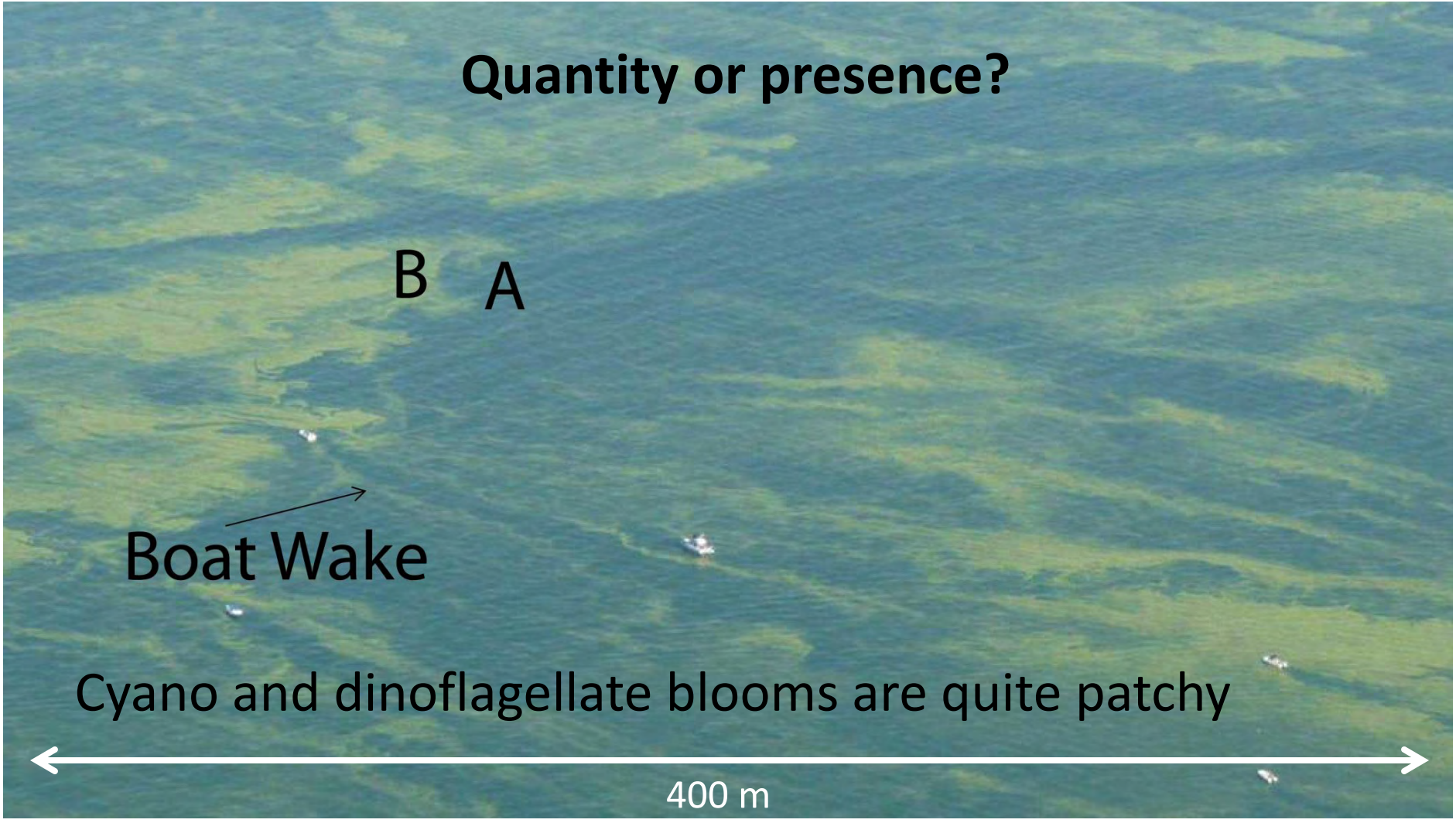
Use in time series or climatological analysis

How to Validate

Determine whether algorithm is quantitative or qualitative

Determine how the algorithm will be used

Finding a bloom for manager is different than mapping extent for ecological study.

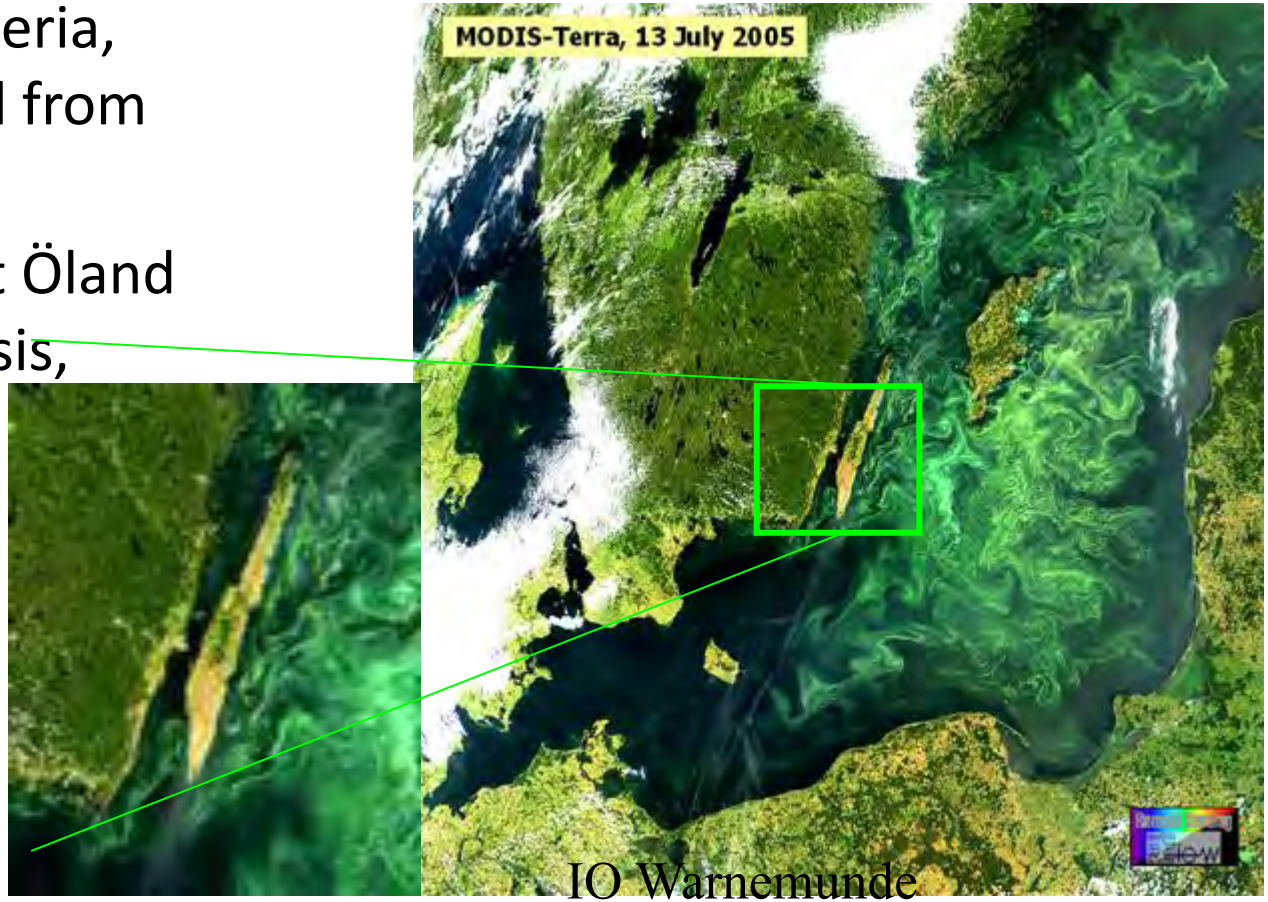

Quantity or presence?
B
A
Boat Wake
Cyano and dinoflagellate blooms are quite patchy
400 m

Why are HABs difficult to map? they are patchy.
An extremely dense patch of *Karenia brevis* (toxic dinoflagellate)

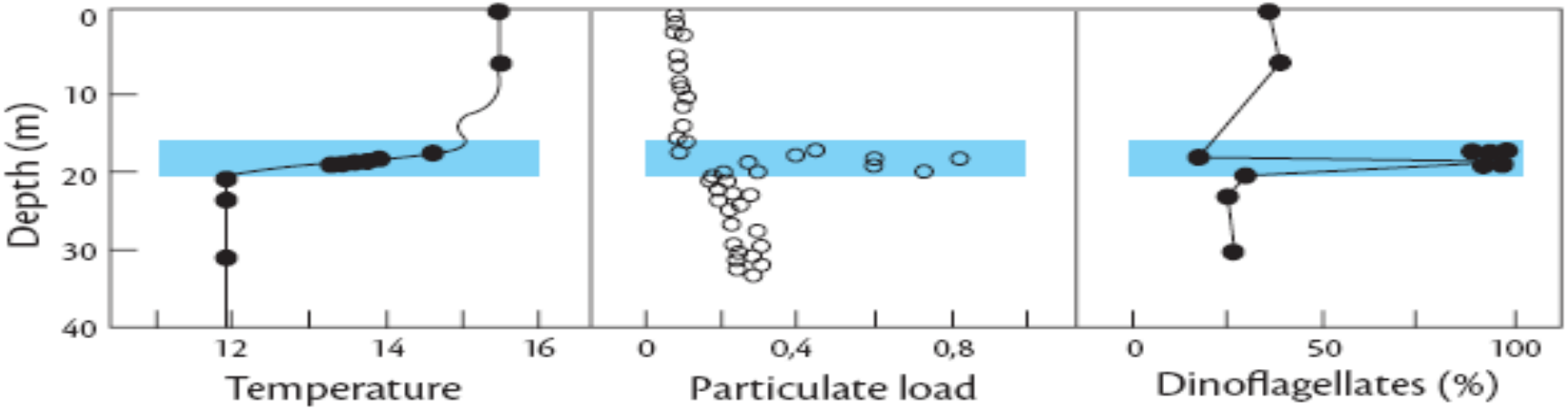
Patchiness even with best observations

Baltic, 2005, cyanobacteria, commonly estimated from satellite.

This bloom missed west Öland beaches, Tourism crisis,
source E. Graneli



Vertical patchiness:
Thin Layer issue, especially *Dinophysis,*
Resolvable with absorption measurements, provided the layer can be found. Major issue in European coastal waters



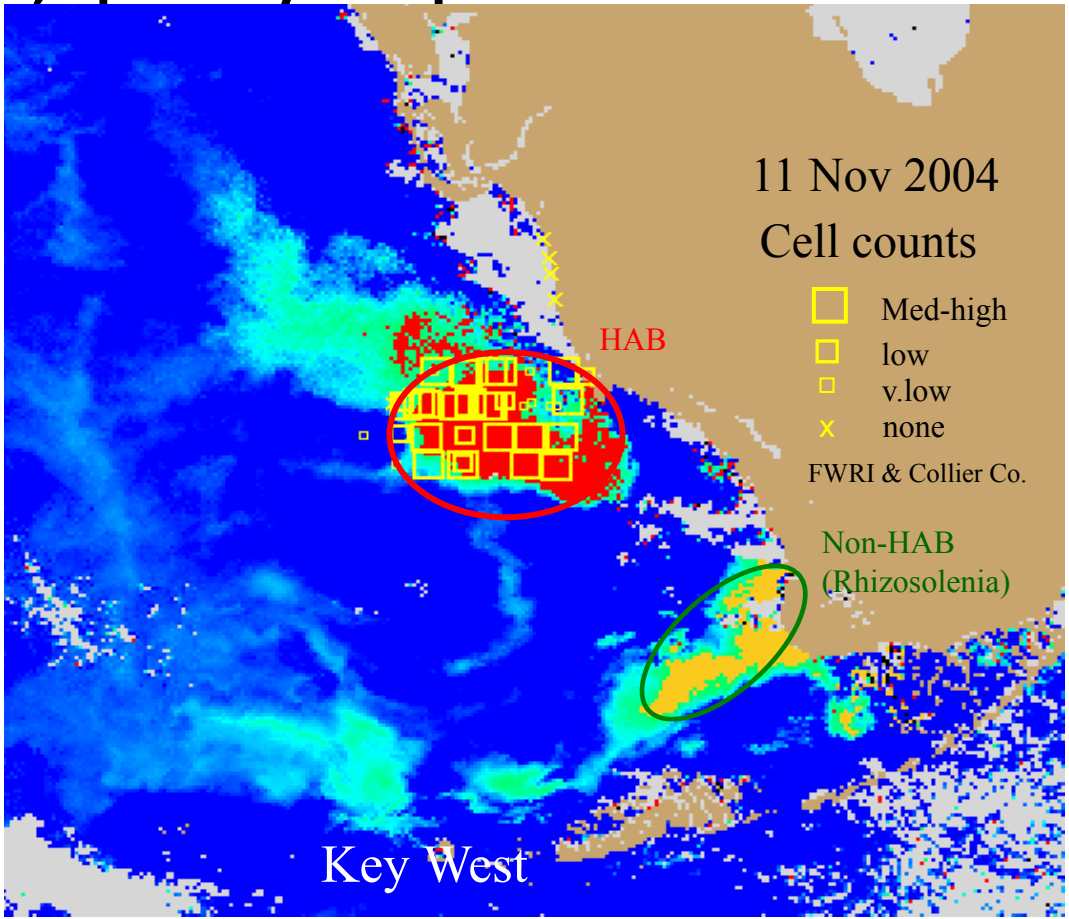
Gentien et al., 2005

One validation, quantity and presence

Bloom found and confirmed with data provides quantity.

This bloom is a problem for qualitative validation.

Why?



Validation

99 samples in one bloom. All correct

One sample outside bloom. Incorrect.

Pixel math says 99% accuracy

Reality: 50% accuracy (one bloom right, one wrong)

Validation concept

Quantitative is for quantity, typically pixel based, e.g., chlorophyll validation.

Qualitative is for classification, draw on land-cover techniques

This may be pixel based (e.g. bloom types).

However, HAB application is usually “bloom presence” (where is the bloom?) so “feature” based.

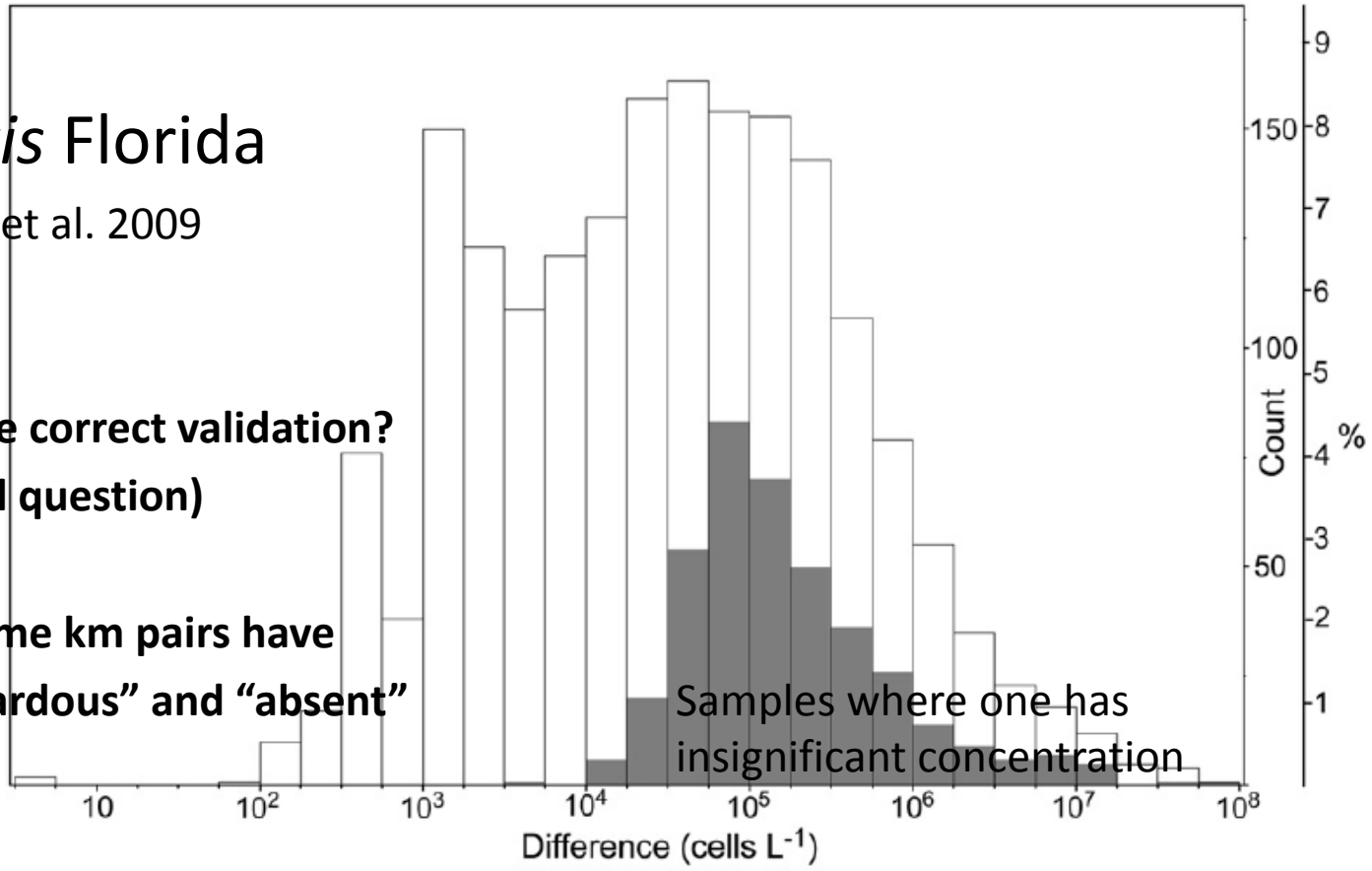
Difference of same day samples < 1 km apart,

K. Brevis Florida

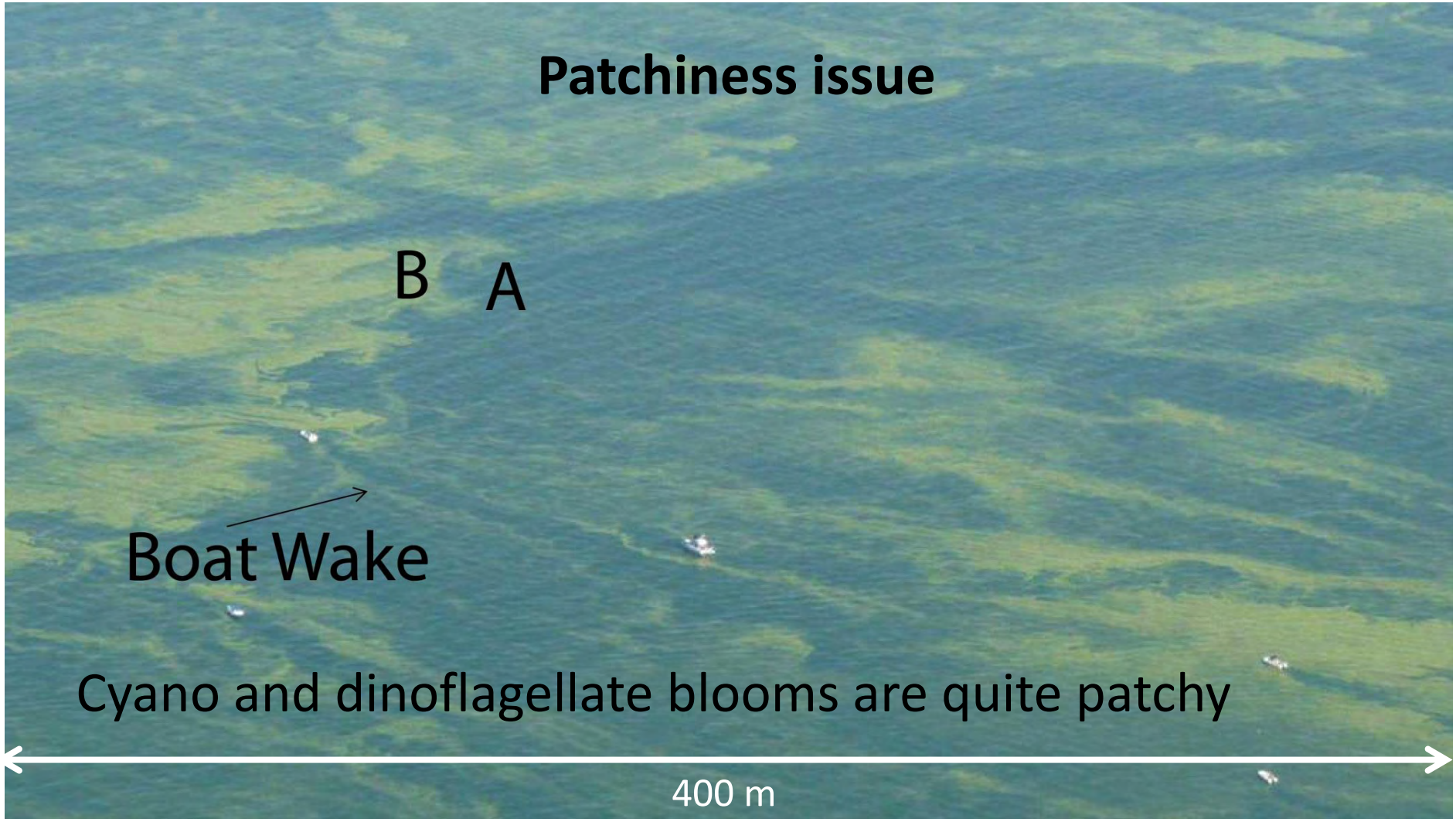
Tomlinson et al. 2009

What is the correct validation?
(Rhetorical question)

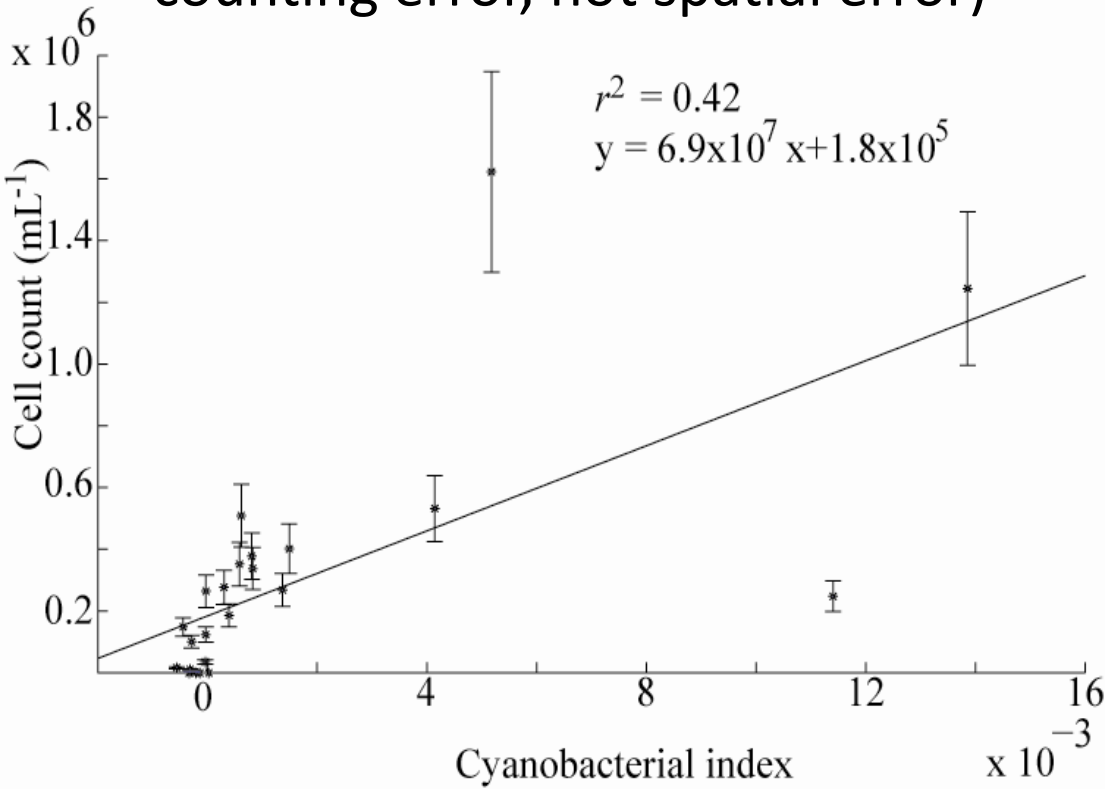
19% of same km pairs have
Both "hazardous" and "absent"



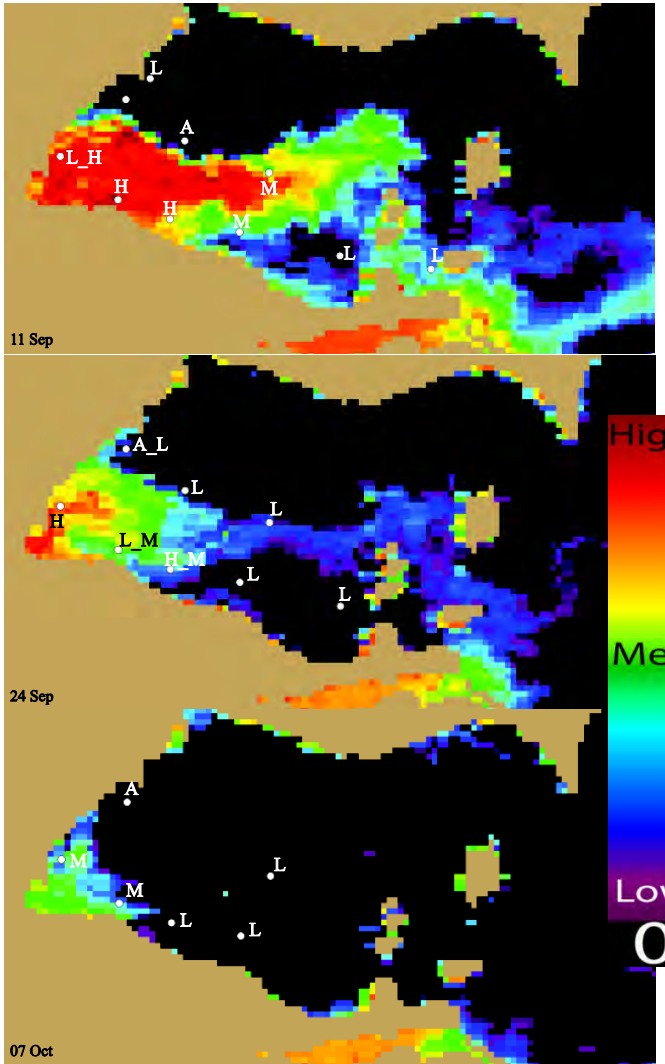
Samples where one has insignificant concentration


Patchiness issue
B
A
Boat Wake
Cyano and dinoflagellate blooms are quite patchy
400 m

Uncertainty is not error. (vertical bar is counting error, not spatial error)



Satellite against field cell counts



Qualitative sampling

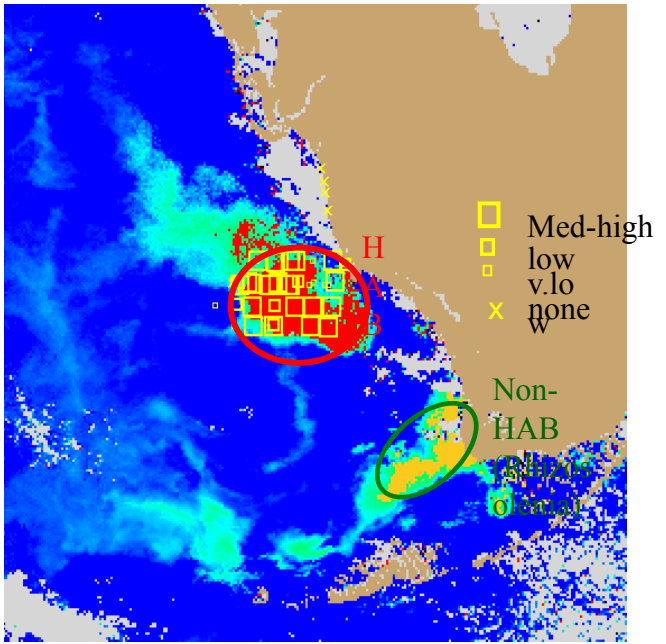
Blooms are spatially and temporally autocorrelated.

Spatial autocorrelation:

adjacent cells are likely same

Temporal autocorrelation:

blooms last for weeks

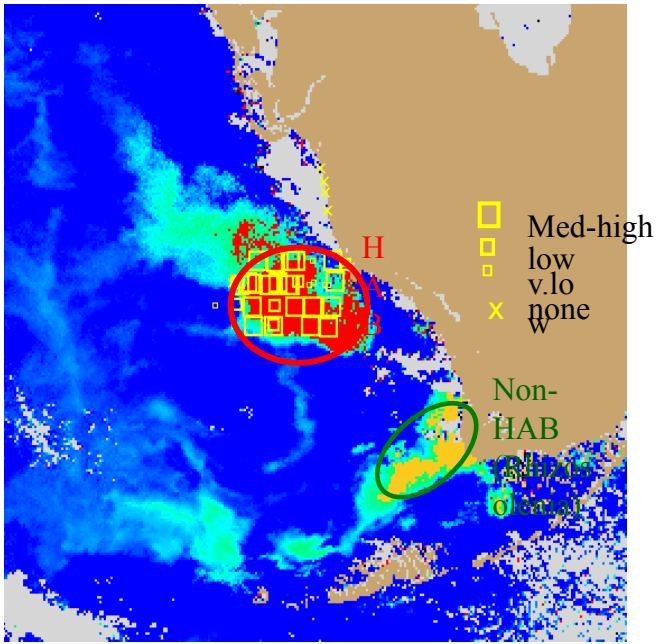


What to do about spatial autocorrelation

Land cover community uses “stratified random sampling”
Stratify by cover type, and randomly select.

This image does NOT show stratified Random sampling.

Problem in marine environment:
Logistics, our study areas are remote and don’t stay around for months or years.



What to do about temporal autocorrelation

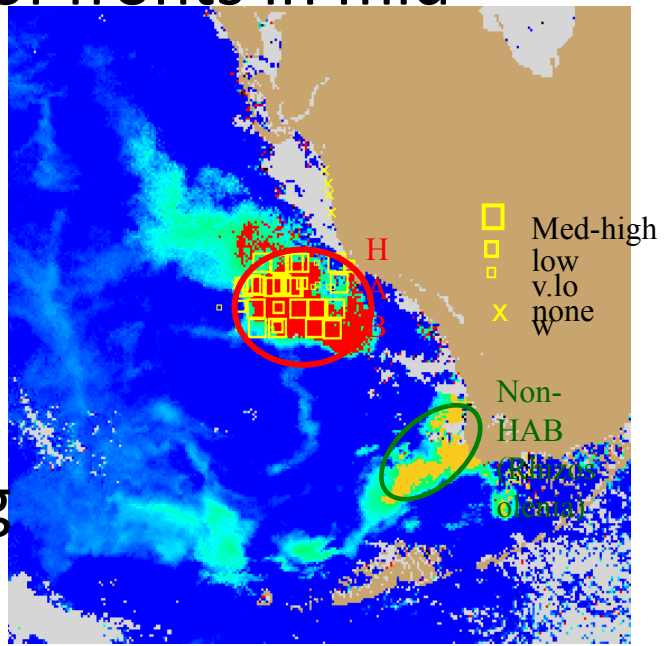
Must sample at the scale of “non-correlation”.

No more frequent than weekly. (Scale of fronts in mid-latitudes)

What difference does it make?

If you are right, you are always right

If you are wrong, you are always wrong

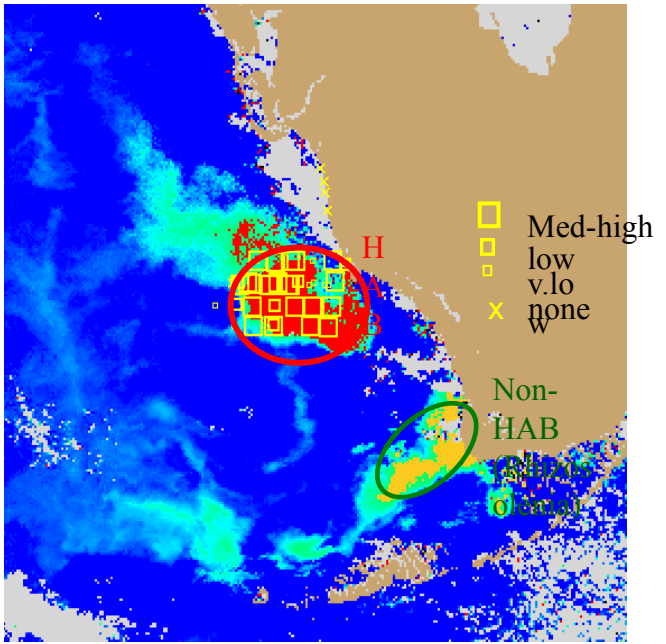


What to do about temporal autocorrelation

This image could have 94% accuracy. 31 of 34 samples correctly identified the bloom.

What is wrong with this accuracy?

The satellite found 1 bloom, not 31 blooms.



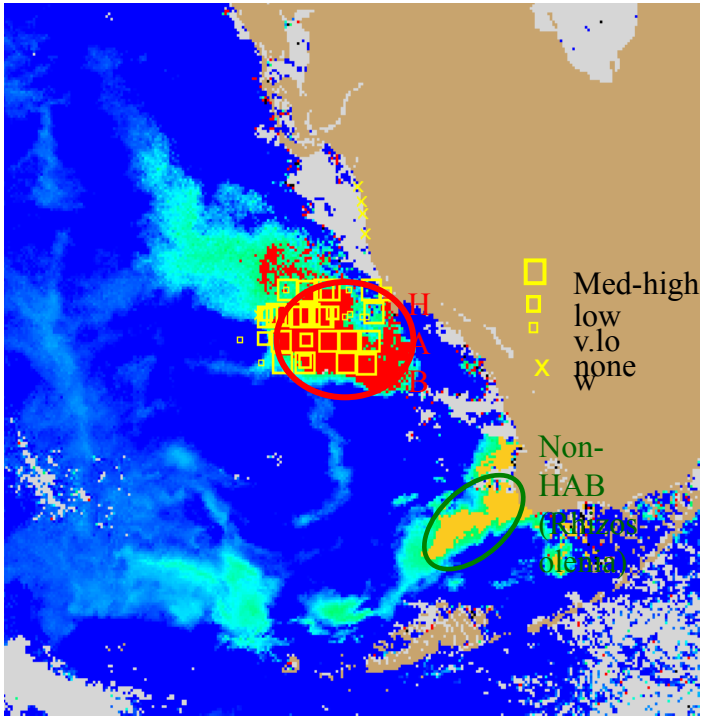
When used to support users, manual evaluation of imagery is common.

In this image, both red and yellow areas passed the anomaly test.

However, the red area was identified from previous imagery.

The yellow area was interpreted as non-bloom from knowledge of the region. (Validated later)

Automated analysis would say that both are *Karenia*.



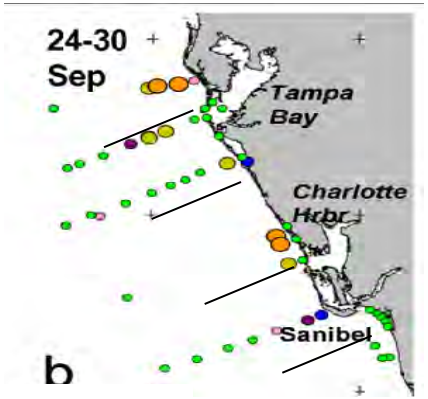
Patchiness causes changes in accuracy with change in resolution

Patchiness, and lack of resolution (clouds, satellite resolution). Stumpf et al.,JMS, 2008

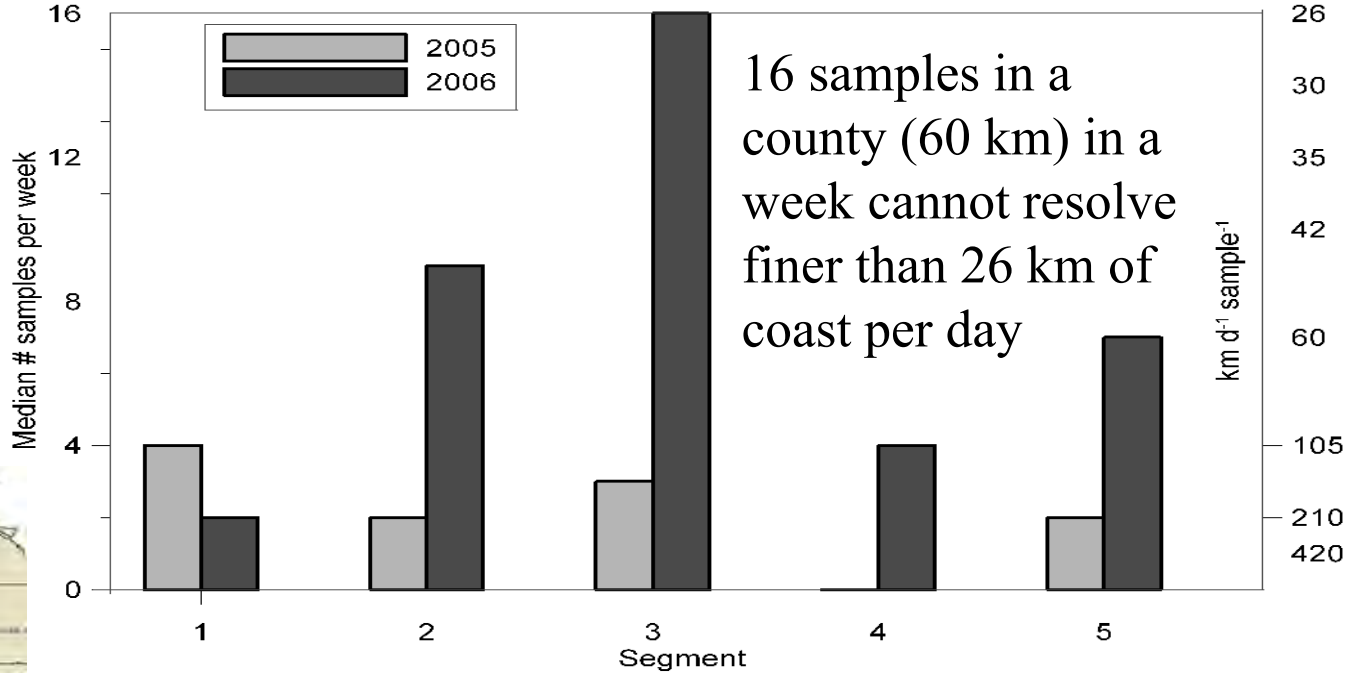
County-wide Forecast of moderate/high respiratory impact	
Correct County-wide (at least one beach)	**73%**
Correct against individual reports from 6 beaches	**21%**

Locating a HAB, sampling problem (Florida)

Even an excellent program has limited resolution



A week of sampling in FL, source: FWRI database, research.myfwc.com



16 samples in a county (60 km) in a week cannot resolve finer than 26 km of coast per day

Oversimplified: If you need data every day at every 1 km, then you will need to sample at least 1 day at every 1 km. Stumpf et al., JMS, 2009

Other methods can be used for validation

Toxin measurements in water or shellfish.

Sometimes fishkills

Not discolored water.

Here are images, design a sampling plan