

Sequential monitoring of beach litter at multiple sites using webcams

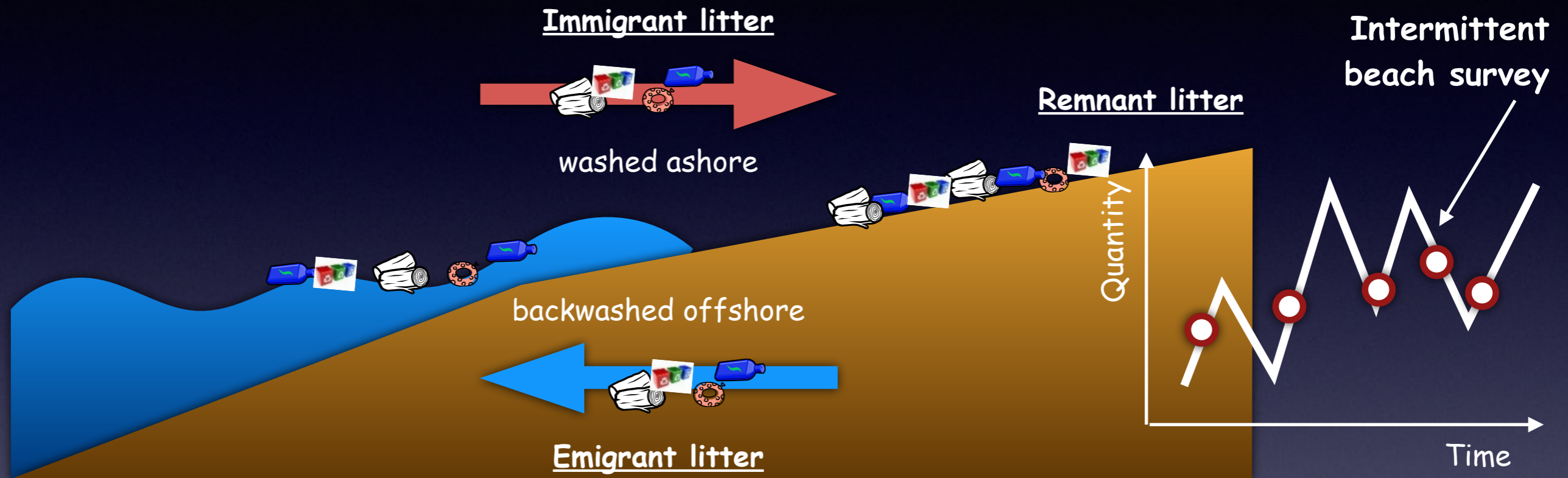
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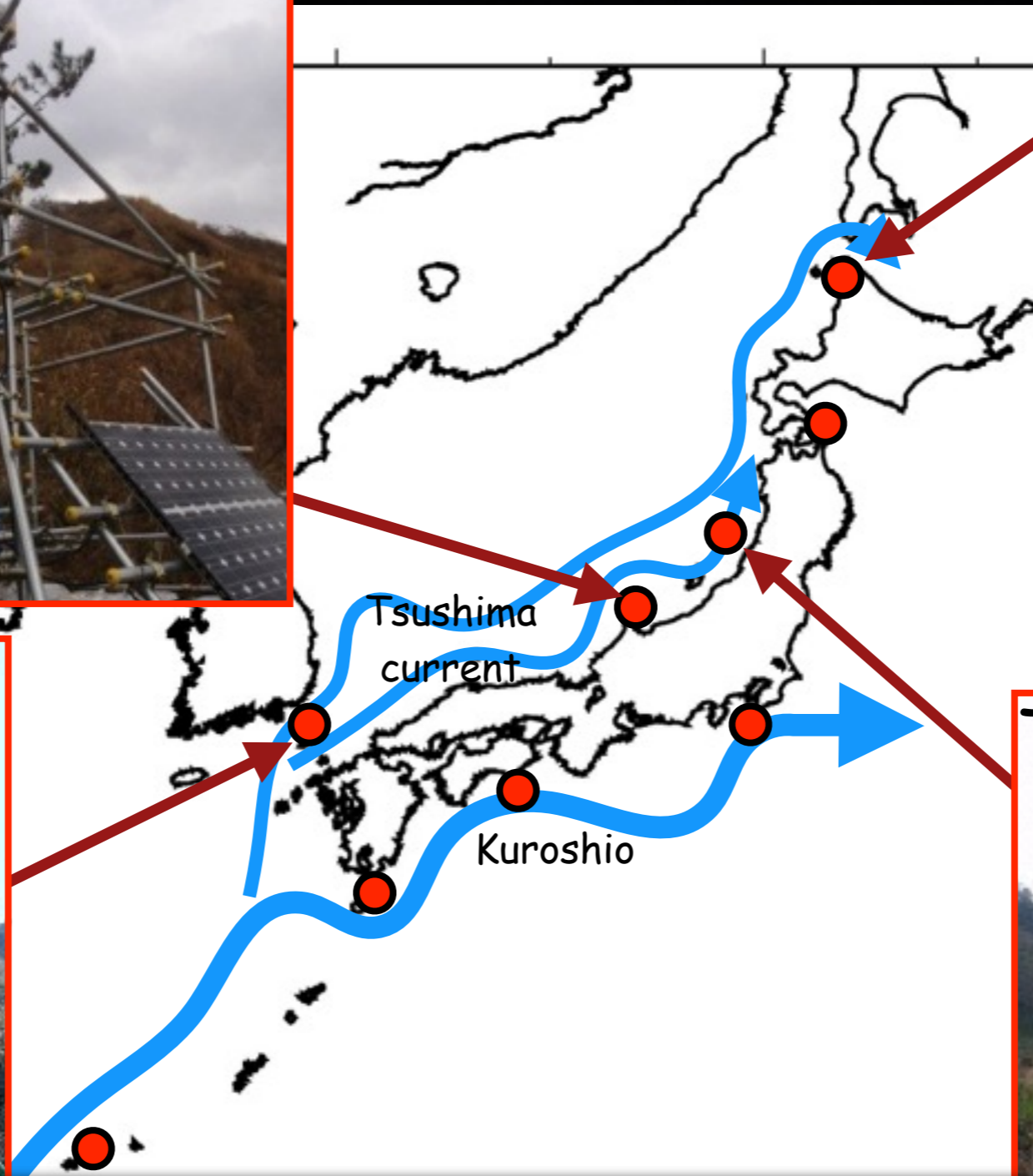
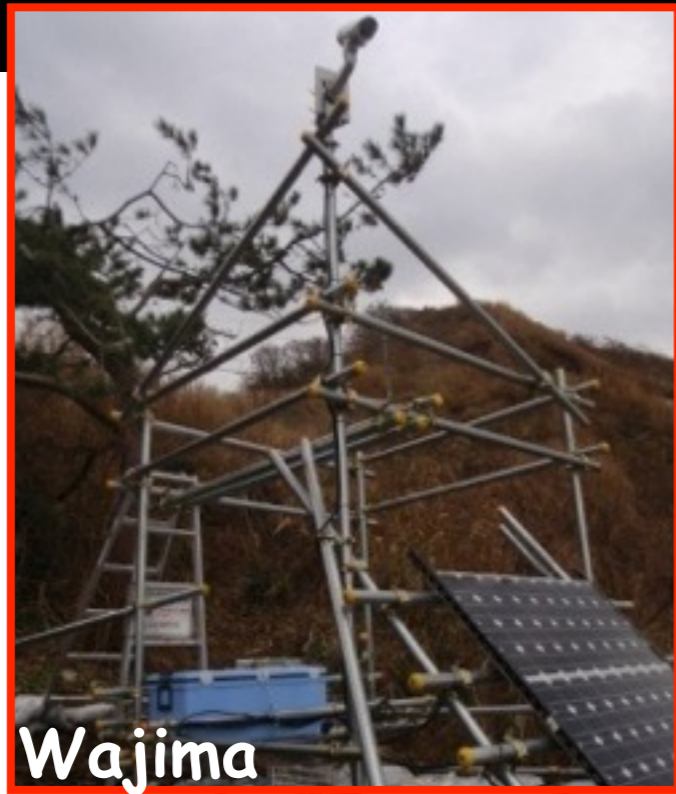
3) Kagoshima University, Japan

Why is sequential monitoring of beach litter needed?



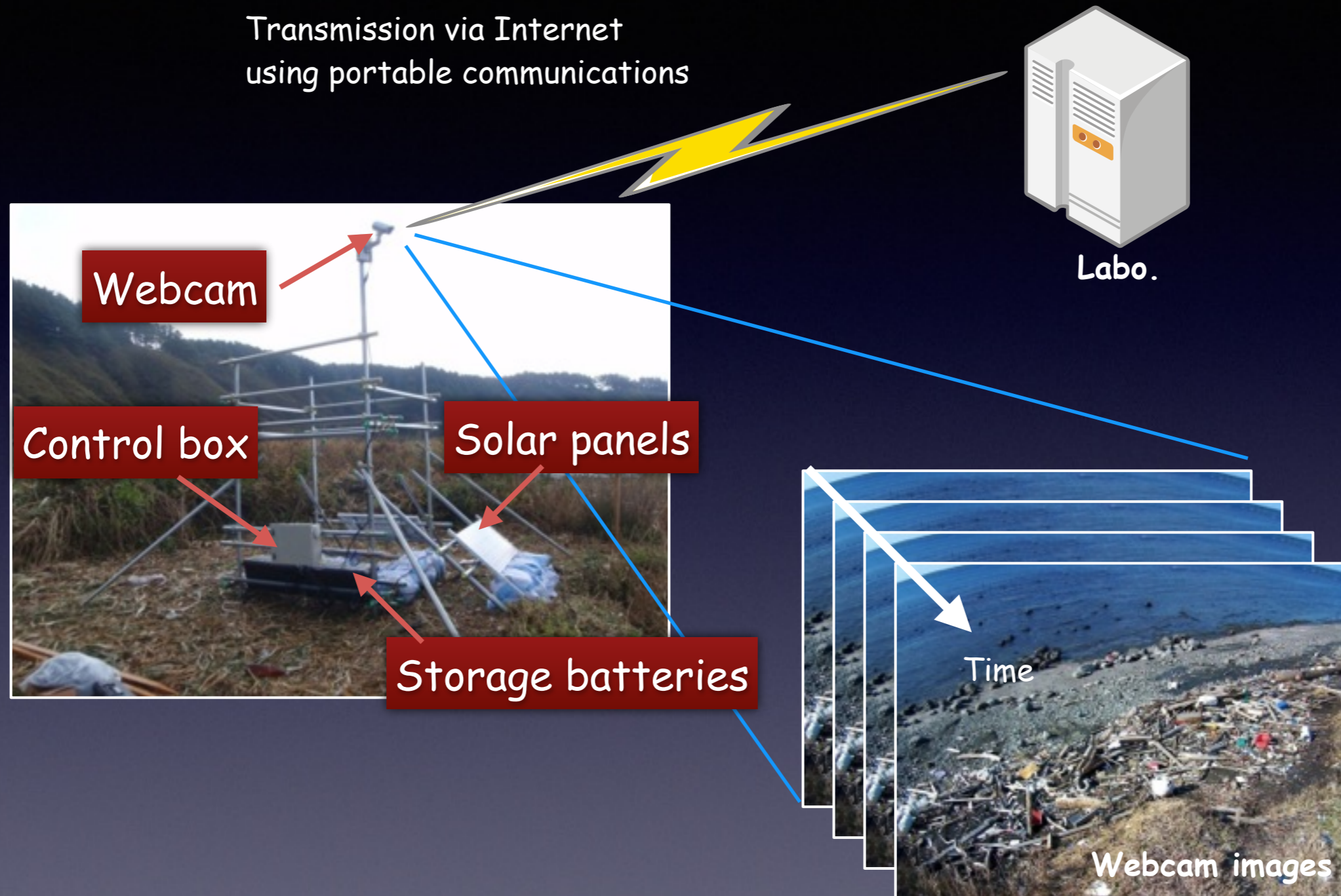
- Quantity of beach litter is determined by the balance between immigrant and emigrant litter
- Sequential variability of litter quantity cannot be obtained by intermittent beach survey.
- It is difficult to monitor temporal variability of litter quantity at multiple sites by beach survey.

Purpose



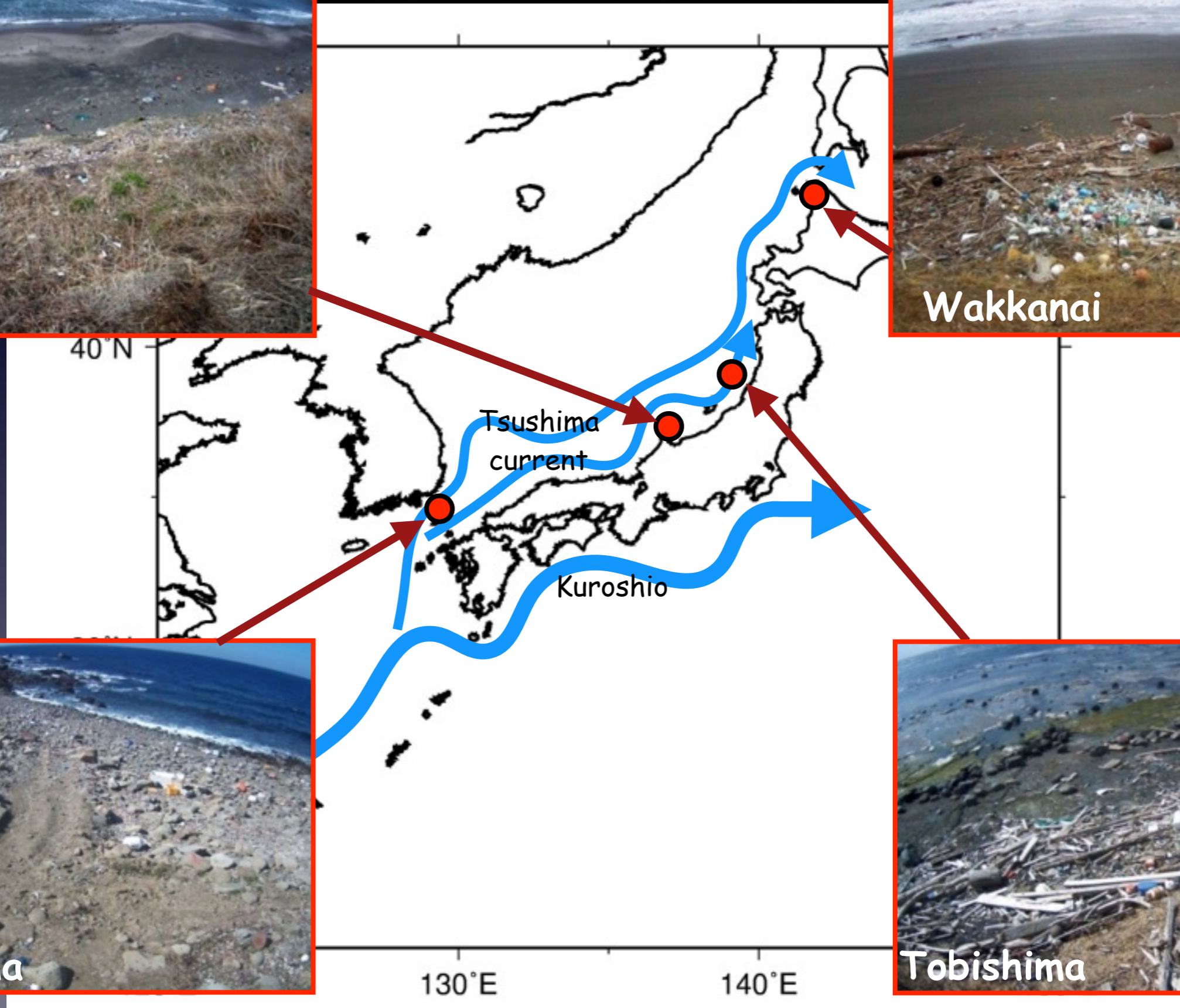
To sequentially measure quantity of beach litter at four sites around the East China and Japan Seas

Webcam monitoring system



- System is operated every two hours from 7:00-15:00 (i.e., five time).
- Five images are taken every time the webcam operates.
- 25 images daily (i.e., 5 times × 5 images each).

Webcam images at four sites



Webcam images at Tobishima (Dec. 2010)



Quantity of macro-plastic litter is calculated using these webcam images.

Flow of image processing

(Kataoka et al., MPB, 2012)

1. Generation of color references (CRs)

To detect plastic pixels from webcam images, CRs are generated in the CIELUV color space.

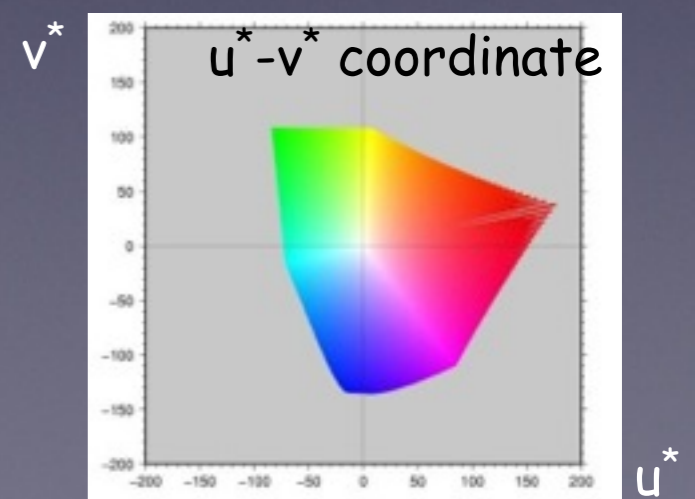
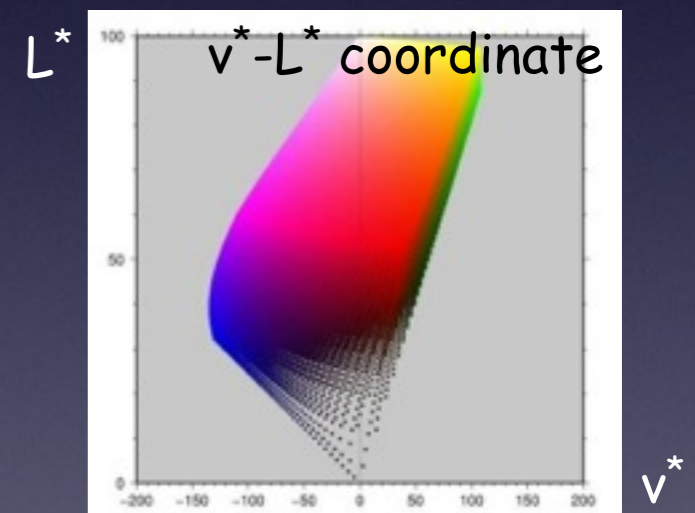
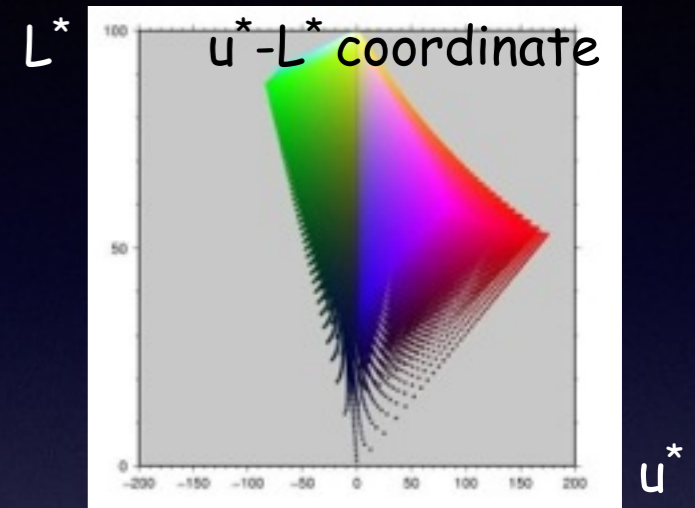
2. Detection of plastic pixels

To remove mis-detection of other litter, a composite image is used in the detection of plastic pixels.

3. Calculation for quantity of plastic litter

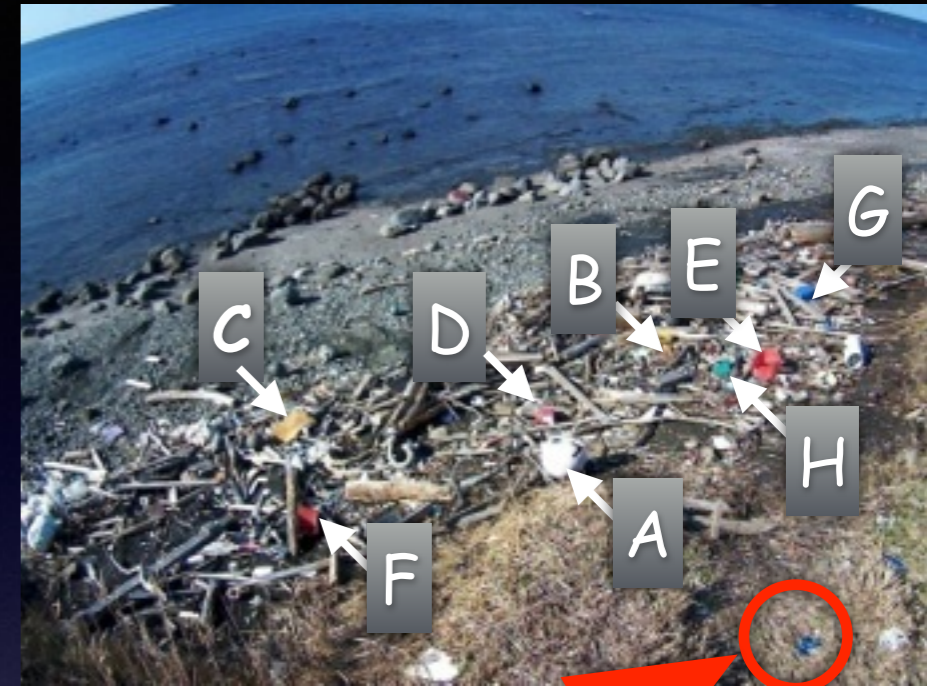
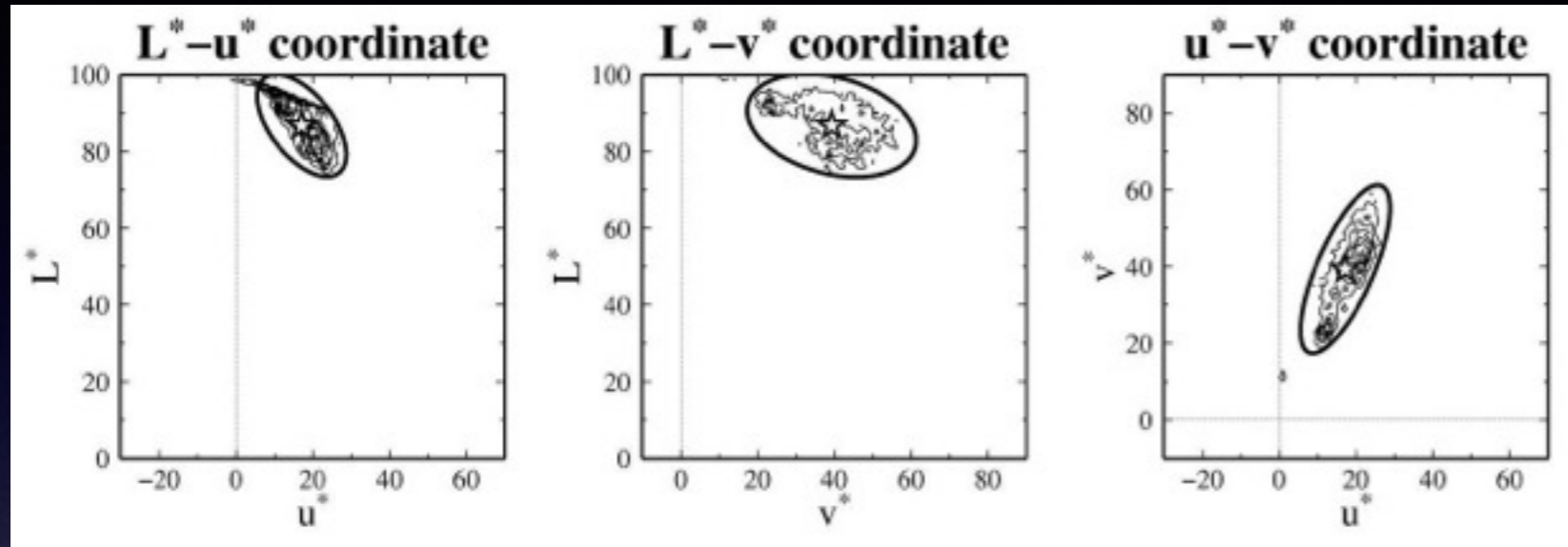
To reduce perspective distortion and convert into a vertical images to the ground plane, projective transformation (Kako et al., MPB, 2012; Magome et al., JO, 2007) is applied to a composite image in the calculation.

CIELUV color space



Step1: Generation of CRs

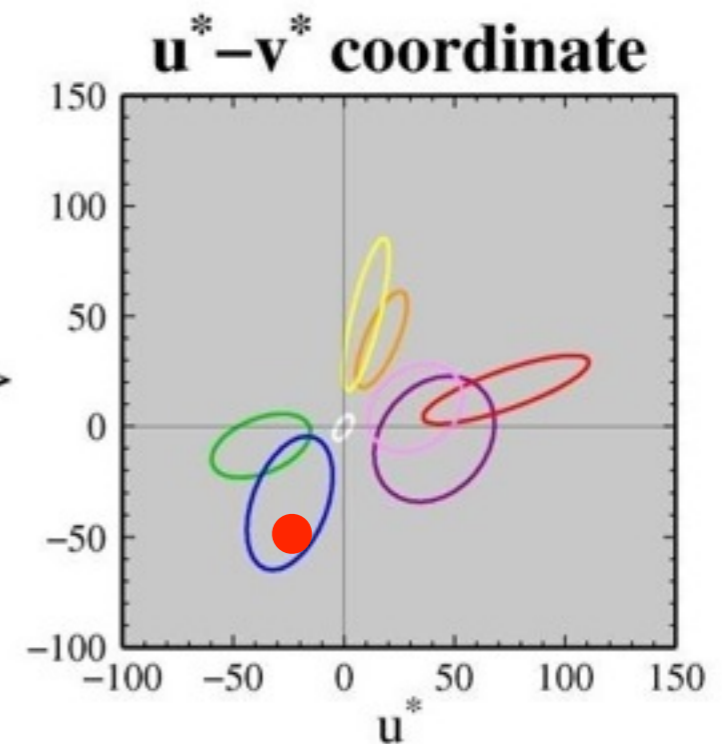
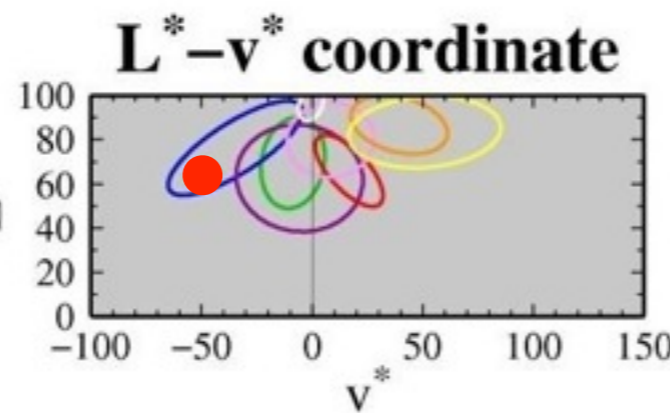
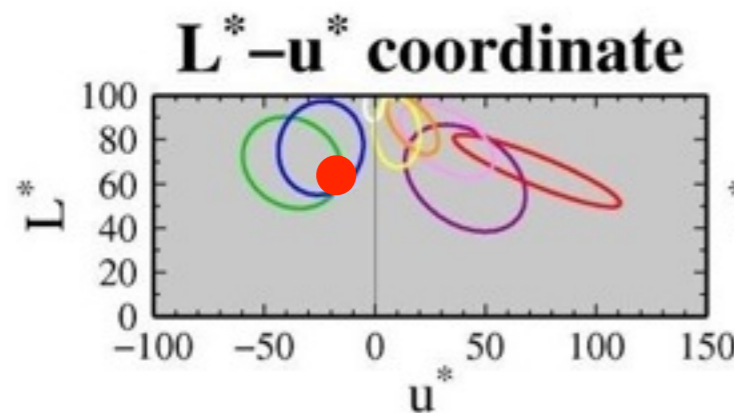
Color distribution of plastic litter "C" in the CIELUV color space



Three ellipses form the ellipsoid body
CR: Ellipsoid body in the CIELUV color space

Blue plastic

CRs for webcam images at Tobishima



Step 2: Detection of plastic pixels

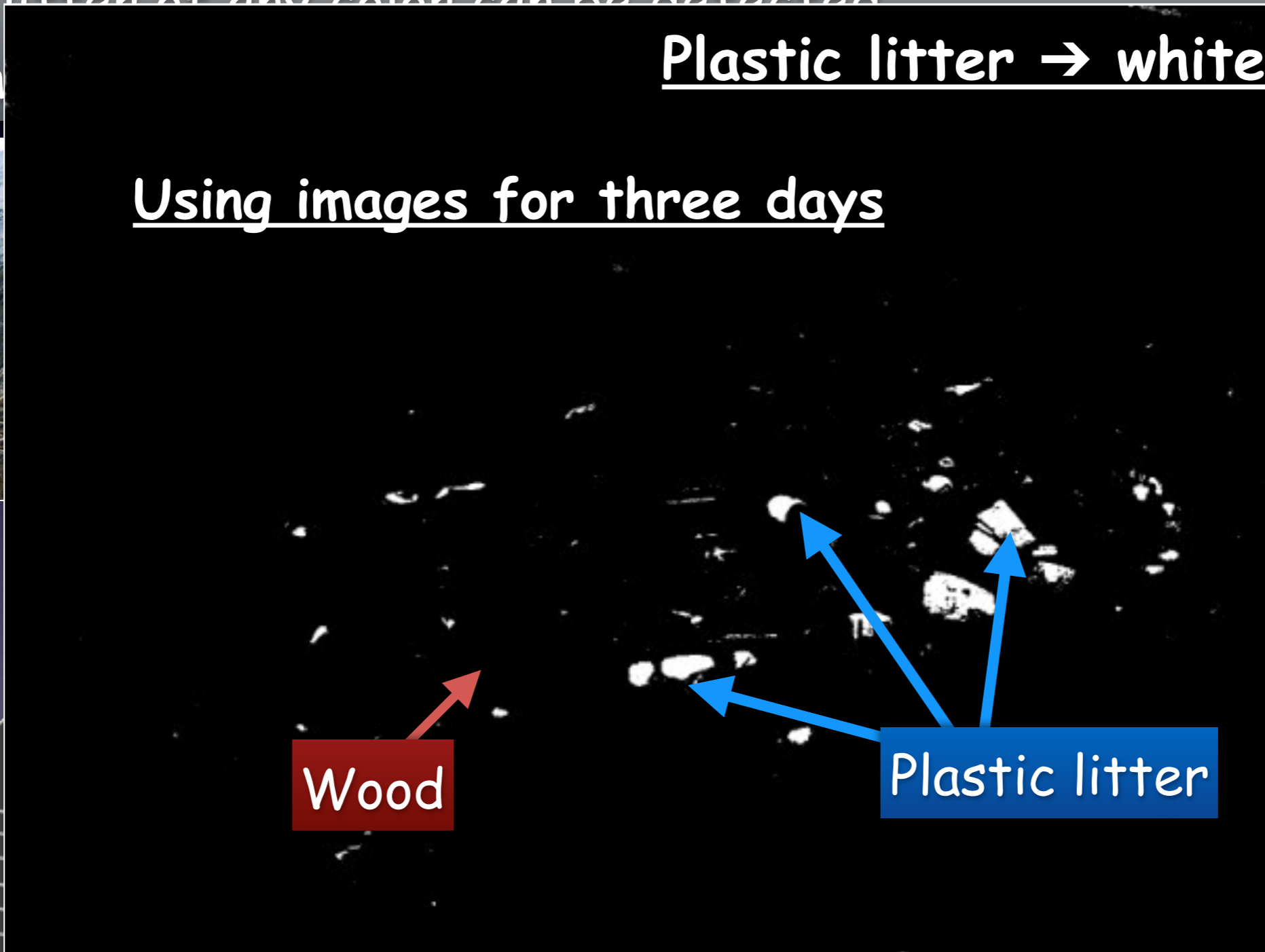
Detection of plastic litter using a single image:

Plastic litter of any color can be detected

but oth

Plastic litter → white

Using images for three days



75 images
(3 days)

Wood

Plastic litter

detected

plastic pixel

xel

Step 3: Calc. of quantity of beach litter

Quantity of plastic litter



Covered area of plastic litter

Projective transformation

(Kako et al., MPB, 2012; Magome et al., JO, 2007)

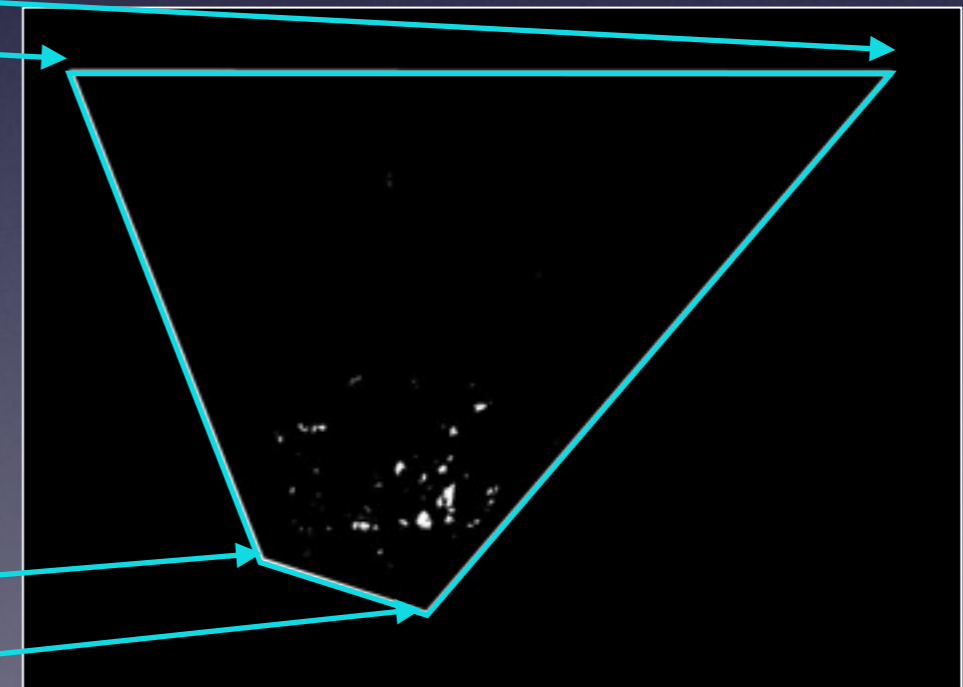
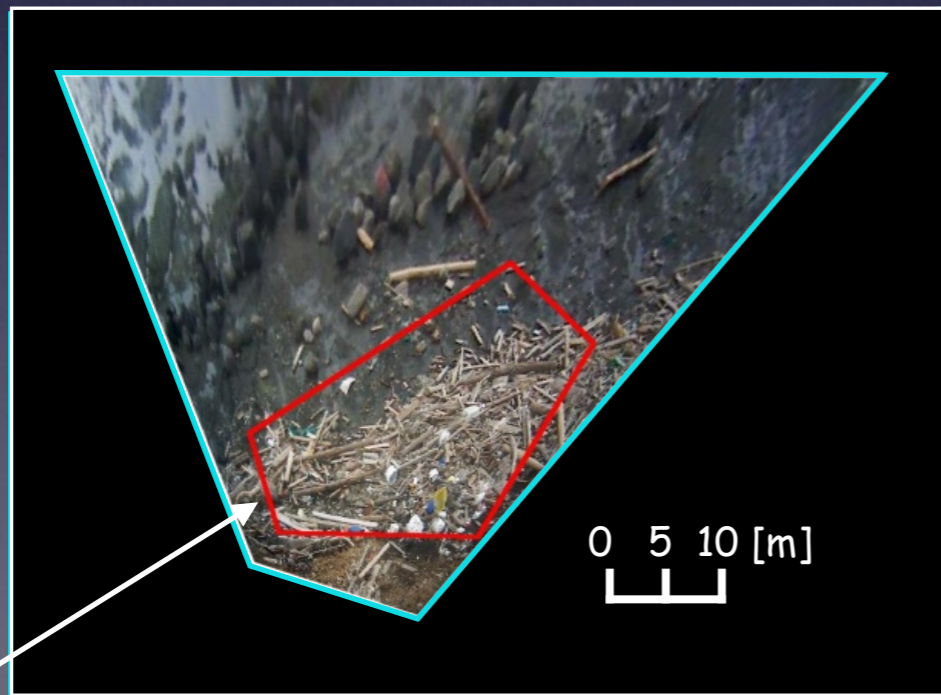
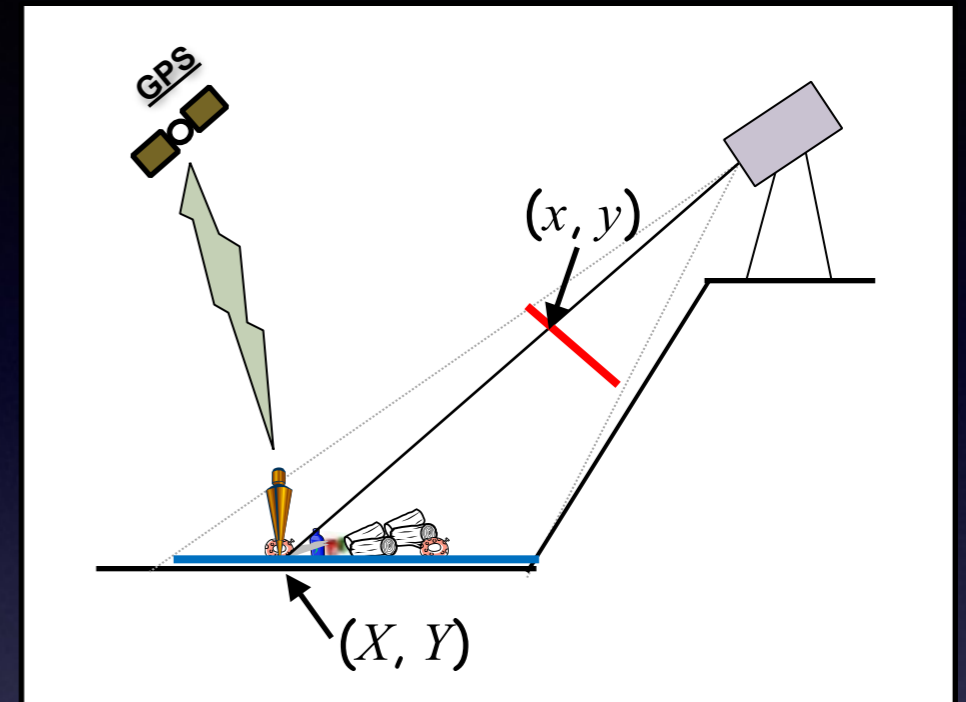
$$X = \frac{b_1x + b_2y + b_3}{b_4x + b_5y + 1}$$

$$Y = \frac{c_1x + c_2y + c_3}{c_4x + c_5y + 1}$$

(X, Y) : Geographic coordinate

(x, y) : Photographic coordinate

$b_i, c_i (i = 1, 2, \dots, 5)$: Coefficients



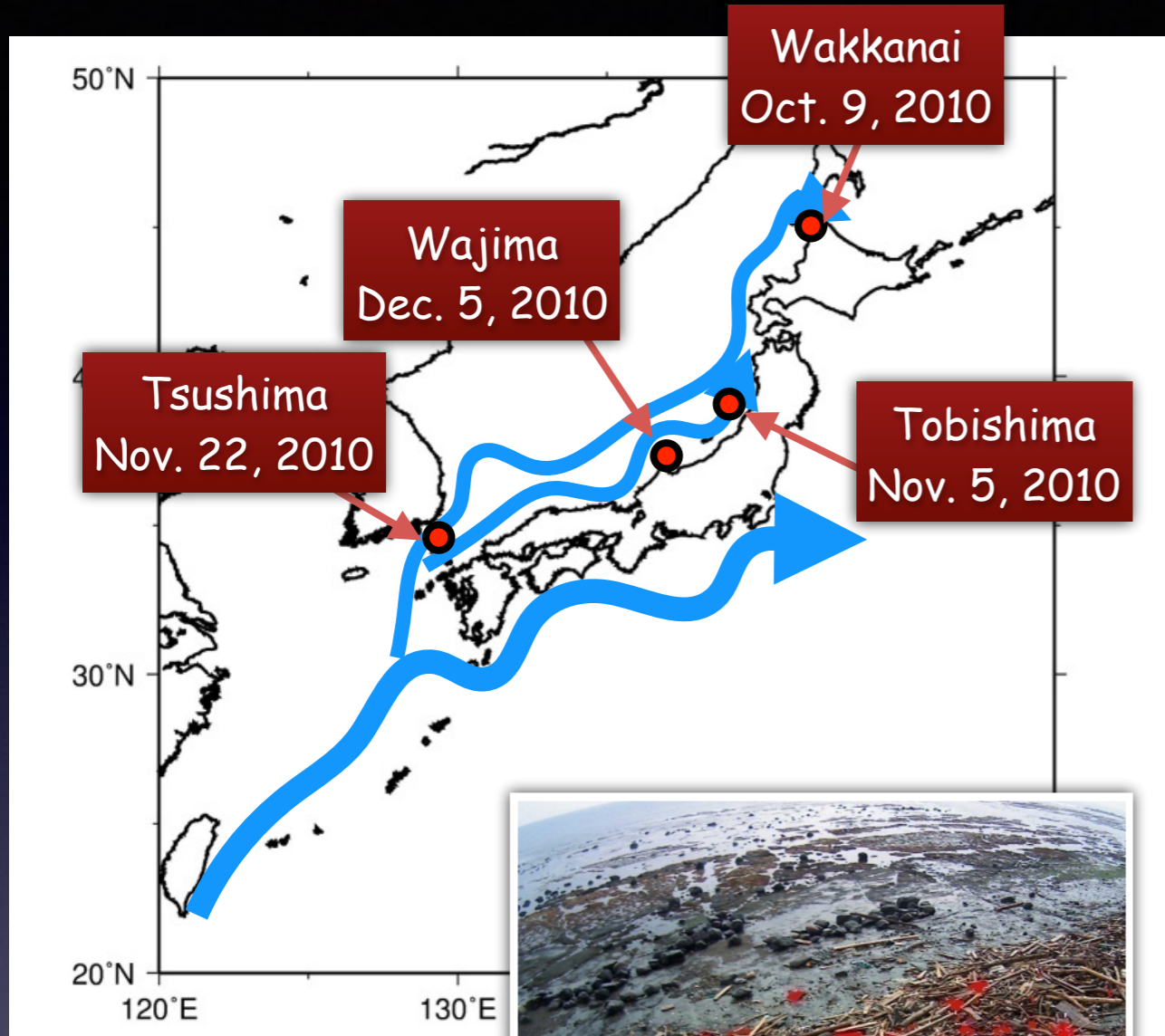
Verification area for
projective transformation

Error: 5%

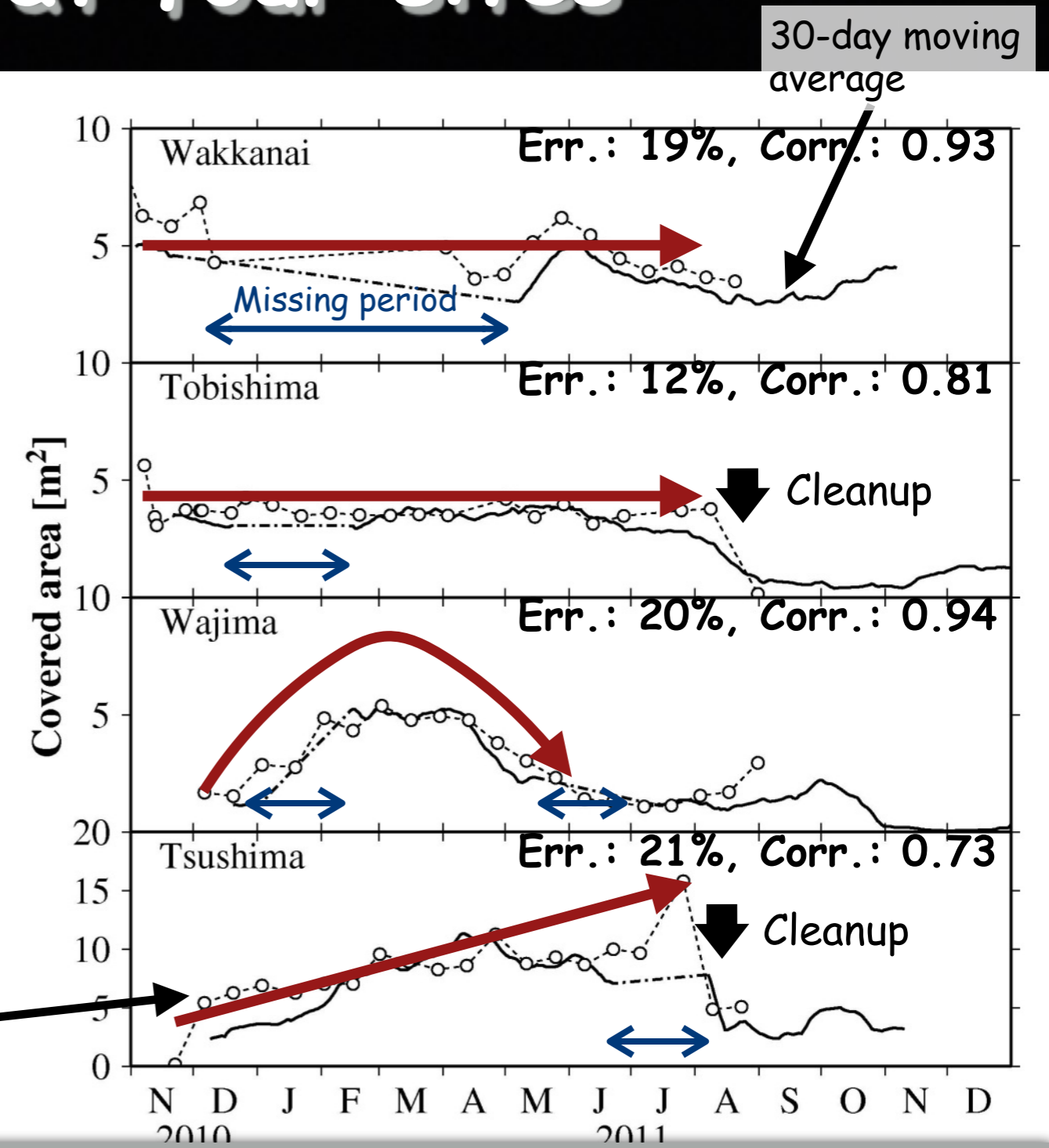
Covered area $A = N \times a$

N : Number of plastic pixels, a : Area of a single pixel

Time series at four sites



Visual detection:
Detecting visually plastic pixels from
webcam images every two weeks



- Wakkanai, Tobishima: low variability.
- Wajima: increased in winter, decreased in spring.
- Tsushima: increased until July 2011.

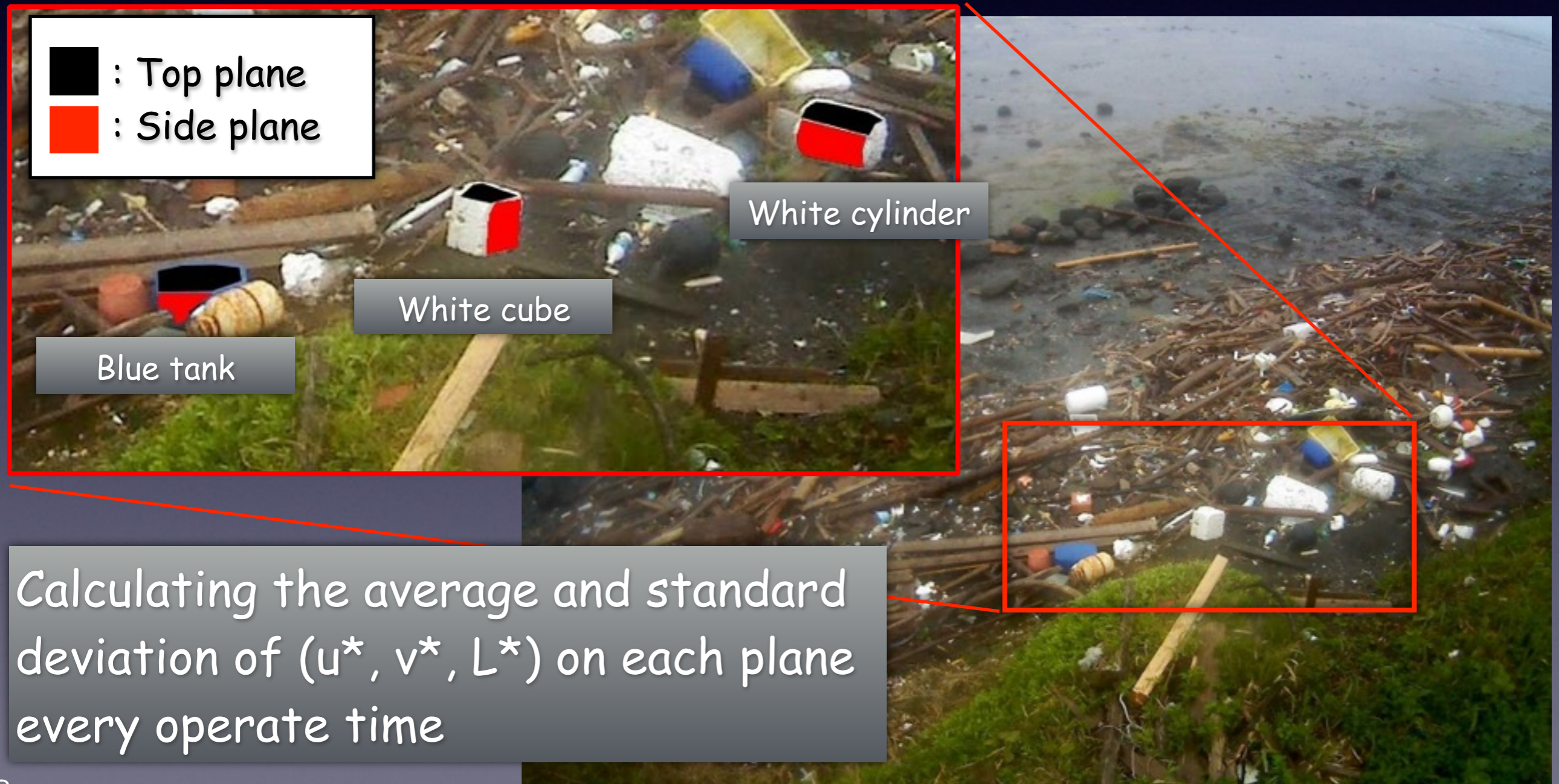
What are the error factors?

Site: Tobishima

Period: 1 month (April, 2011)

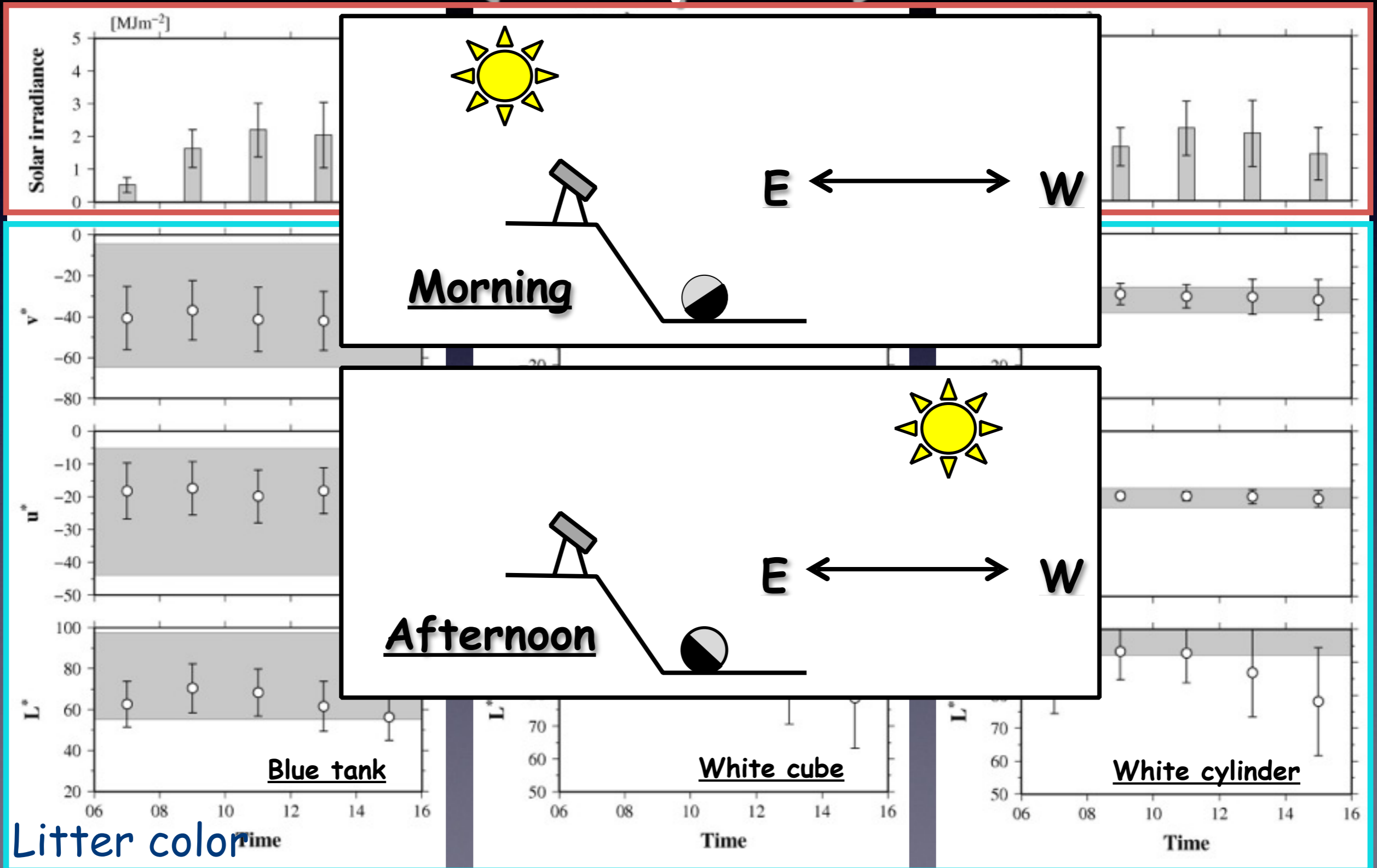
Time: 7:00, 9:00, 11:00, 13:00, 15:00

Plastic litter: Three types (Blue tank, White cube, White cylinder)



Monthly variability of litter color (side plane)

Solar irradiance



Litter color

Summary

- We developed a technique for detecting plastic pixels from webcam images.
- We successfully measured the quantity of plastic litter at four sites around the East China and Japan Seas.
- Measurement error depends strongly on sunlight angle.
- Measurement error can be minimized using only webcam images at a certain time when variability of litter color is the lowest.

Thank you for your attention

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