

MET SG/19 IP/26

**Verification of
Thunderstorm (TS) SIGMET
with Satellite Pictures**

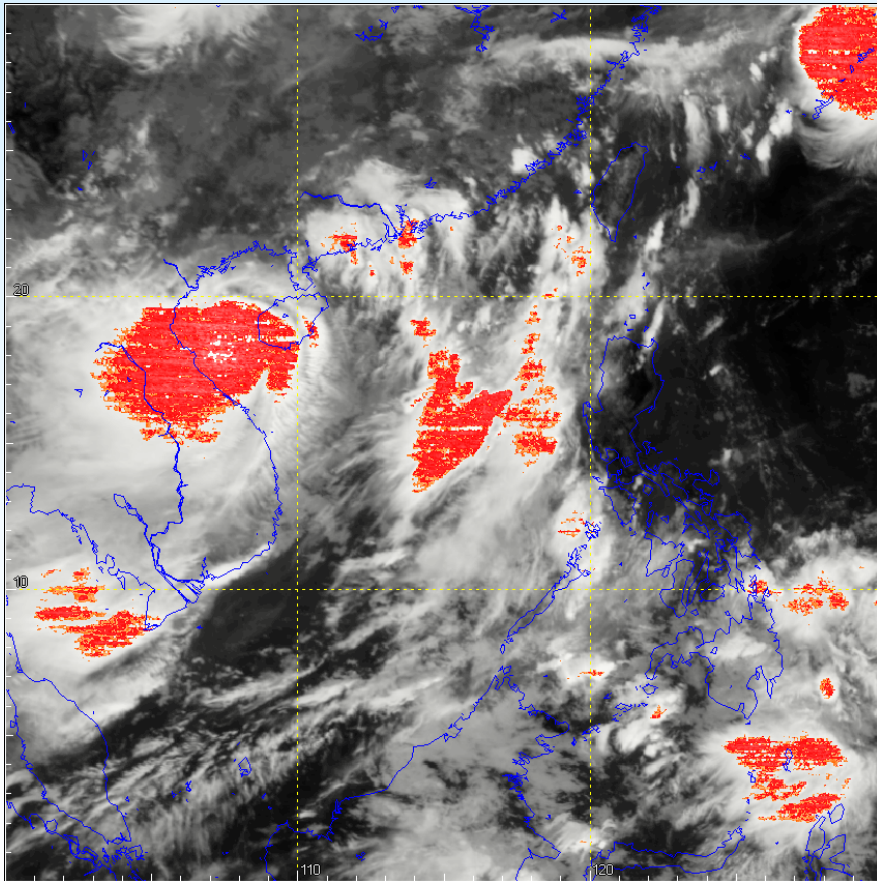
Hong Kong, China

HKO Deep Convection Product

- Emissive radiation from lower clouds is heavily absorbed in IR3 channel (wavelength~6.7 μm) but not much in IR1 channel
- The higher the clouds, the smaller the difference in IR1 and IR3 temperature values
- Deep convection area: difference in temperature values between IR1 and IR3 less than or equal to 1K
- Deep convection area - taken as “ground truth”
- Currently sourced from MTSAT

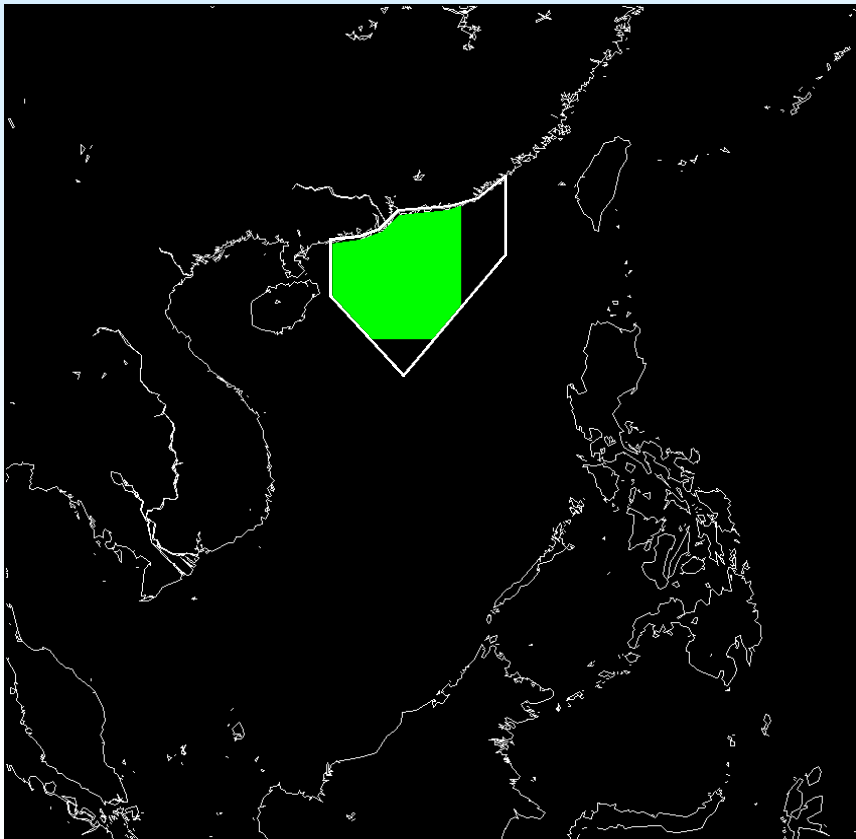
HKO Deep Convection Product

- Deep Convection highlighted in warm color
- Taken as “ground truth” for verification of TS SIGMET



Warning-based verification

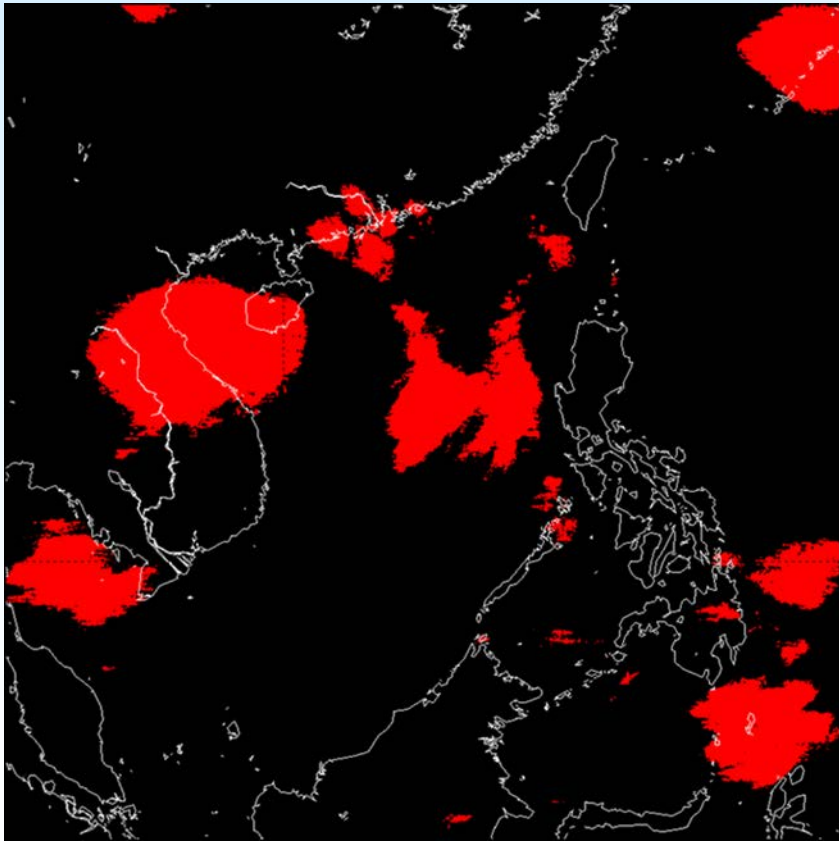
- Decode warning area from TS SIGMET
- Represent area (in green) on digital canvas:



VHHK SIGMET 7 VALID 222200/230200 VHHH-
VHHK HONG KONG FIR EMBD TS
FCST N OF N1800 AND W OF E11600
TOP FL400 MOV N 10KT NC=

Warning-based verification

- Overlay highlighted areas in all deep convection satellite pictures within SIGMET validity period* to form composite (in red):

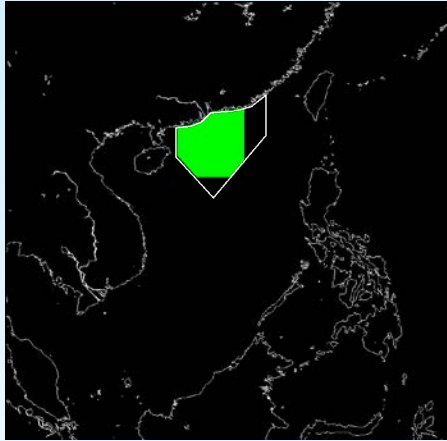


*Strictly speaking, satellite pictures with 15-minutes before start time of TS SIGMET are also used.

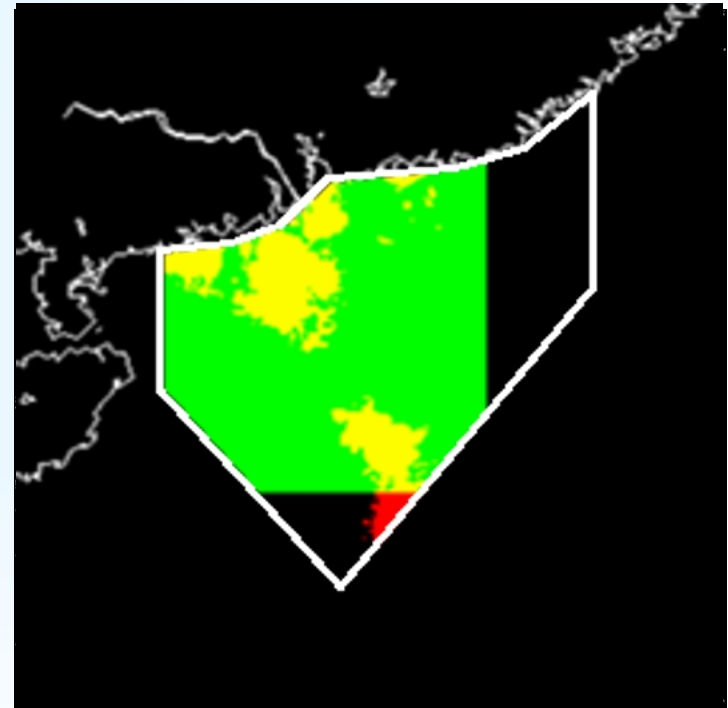
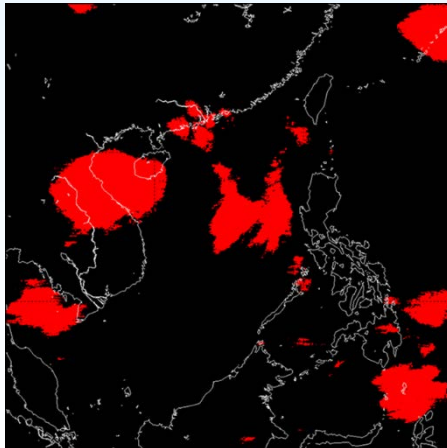
Warning-based verification

- Overlay composite onto warning area

area
warned by
SIGMET



ground
truth
during the
period



- Hit: yellow
- False alarm: green
- Miss: red

Criteria for hit, miss, false alarm

- Minimum deep convection area to be recognized as hit or miss: 50 pixels on digital canvas ($\sim 800 \text{ km}^2$)
- A TS SIGMET is recognized as hit if:
 - area of hit (yellow) $>$ area of miss (red);
 - if the contrary holds, then recognized as miss
- A TS SIGMET is recognized as false alarm if:
 - area of false area (green) $\geq 5 \times$ area of deep convection (red plus yellow pixels)

Criteria for hit, miss, false alarm

A TS SIGMET can be classified as

- a hit
- a miss
- a false alarm
- a hit with false alarm (over-warning)
- both miss and false alarm

Observation-based verification

- Check deep convection satellite pictures outside SIGMET validity period for miss

Exclusion

- Need to exclude validity periods of TC SIGMET in both warning-based and observation-based verifications
- Because CB clouds associated with TC reaching tropical storm intensity are normally warned in TC SIGMET instead of TS SIGMET
- There is no easy algorithm that can automatically identify which cloud mass is associated with a TC and hence should be covered by a TC SIGMET and which is not

Performance measures

Commonly used performance measures

- Probability of detection (POD, also known as “hit rate”)
- False alarm ratio (FAR)
- Critical success index (CSI)

For TS SIGMET verification, consider

- The hit-&-false-SIGMET cases
- The miss-&-false-SIGMET cases

Two separate sets of performance measures

- Strict – a hit-&-false-SIGMET is counted as a false alarm and a miss-&-false-SIGMET is also counted as a false alarm
- Generous – a hit-&-false-SIGMET is counted as hit

Performance measures

- **Set A (strict):**

- $POD_a: [EH] / ([EH]+[EM]+[DH]+[DM]+[MM])$
- $FAR_a: ([FA]+[DH]+[DM]) / ([EH]+[EM]+[FA]+[DH]+[DM])$
- $CSI_a: 1/(1/(1-FAR_a)+1/POD_a-1)$

- **Set B (generous):**

- $POD_b: ([EH]+[DH]) / ([EH]+[EM]+[DH]+[DM]+[MM])$
- $FAR_b: [FA] / ([EH]+[EM]+[FA]+[DH]+[DM])$
- $CSI_b: 1/(1/(1-FAR_b)+1/POD_b-1)$

where,

Result status from warning-based processing:-

[EH]: exclusive hit

[EM]: exclusive miss

[FA]: false alarm

[DH]: dual hit-&-false-SIGMET (over warning)

[DM]: dual miss-&-false-SIGMET (unmatched areas of warning and actual occurrence)

Result status from observation-based:-

[MM]: miss

Preliminary result

- HKO TS SIGMET

Year	Set A (strict)			Set B (generous)		
	POD _a	FAR _a	CSI _a	POD _b	FAR _b	CSI _b
2013	0.37	0.74	0.18	0.93	0.35	0.62
2014	0.39	0.75	0.18	0.93	0.42	0.56