Remote sensing of a coastal wind front over the South China Sea caused by the strengthening of the northeast monsoon

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Bergen, Norway

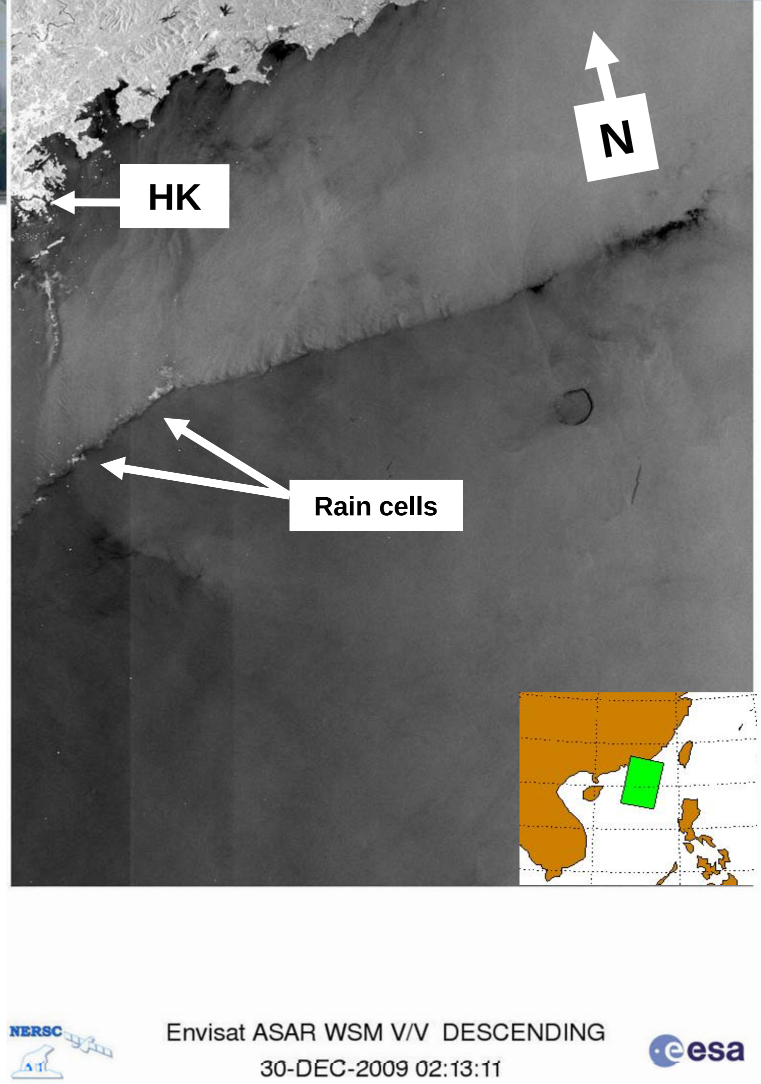
Introduction

Wind fronts over coastal sea areas is an often observed phenomenon .

They can be caused by a different atmospheric processes, like:

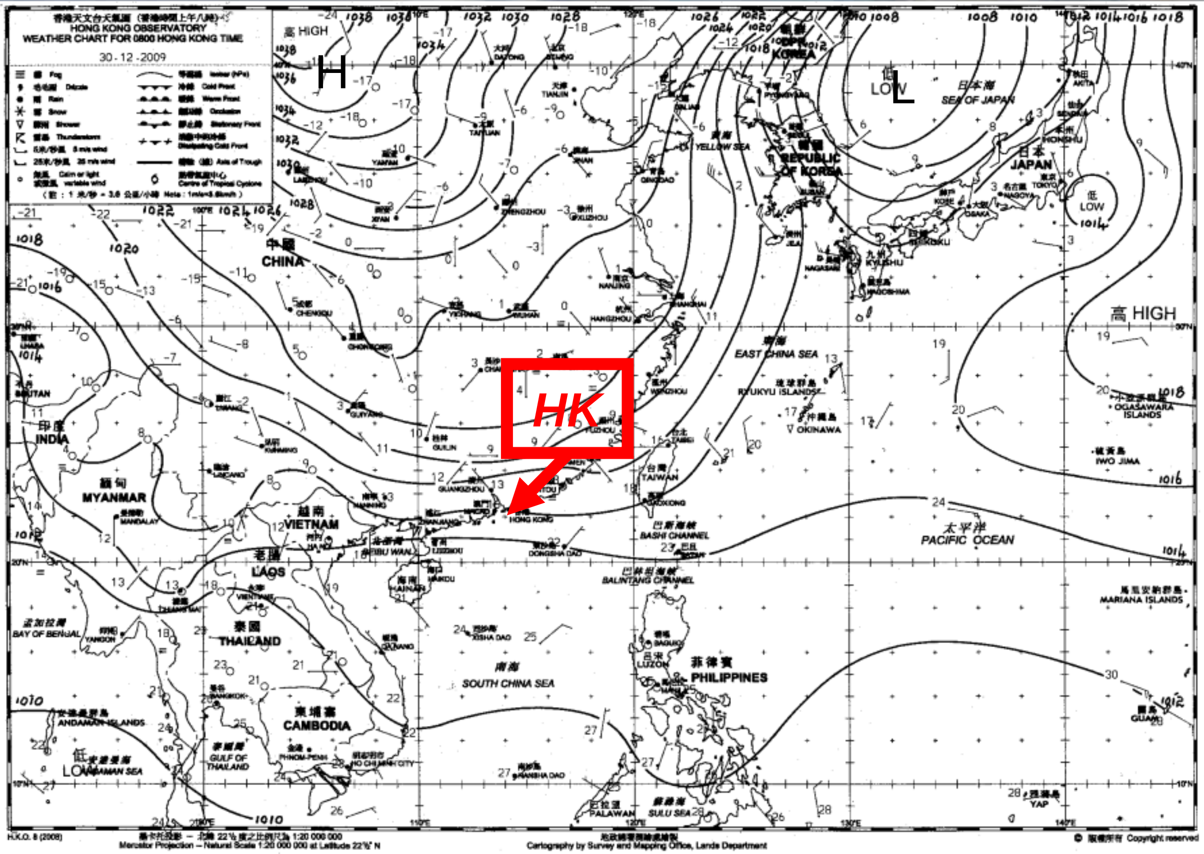
- Katabatic winds
- Recirculation of airflow impinging on a coastal montain range
- Cold air outbreak
- **Strengthening of the northeast monsoon**

which is caused by the replenishment of the northeast monsoon due to the merging of two high pressure areas over the Chinese continent.



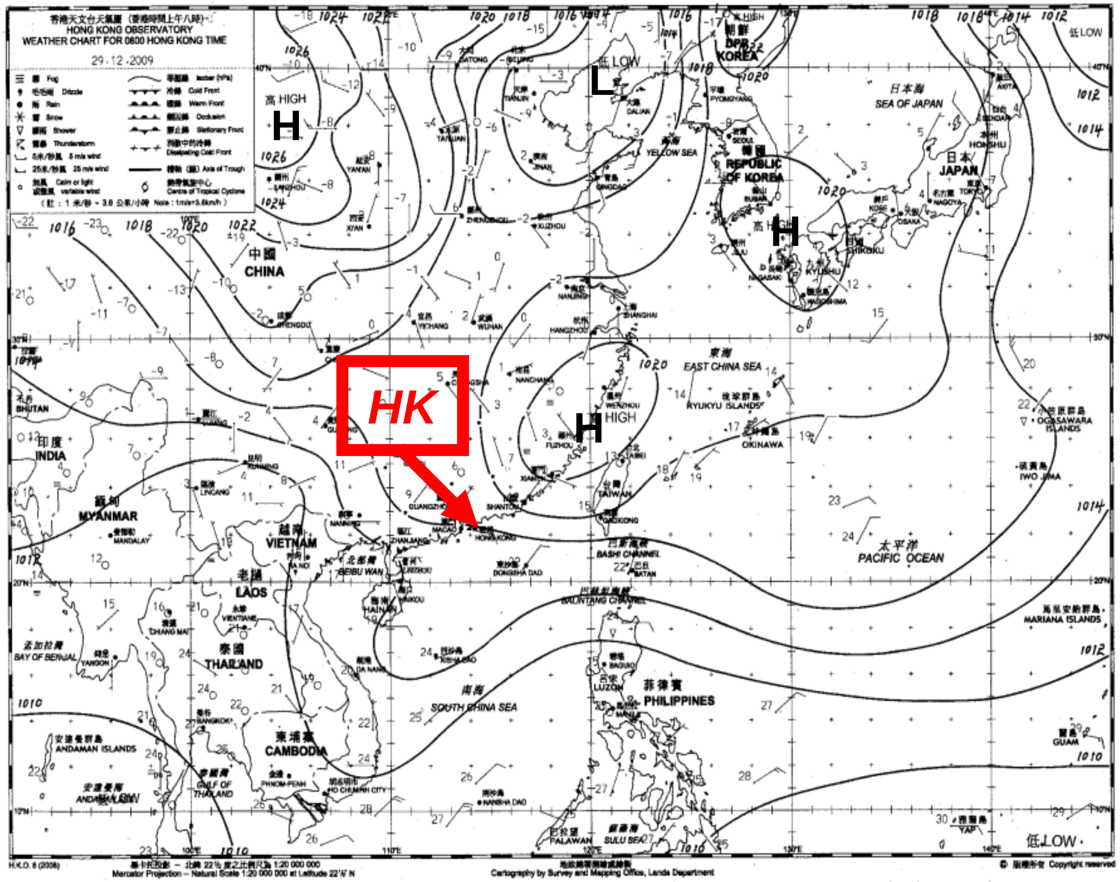
SAR image acquired by Envisat ASAR in the Wide Swath mode (VV polarization) at 0213 UTC (1013 HKT) 30 December 2009 over the Chinese coast of the South China Sea near Hong Kong (HK). The imaged area is 510 km x 660 km. The inset shows the location of the SAR scene in the South China Sea. © ESA

30 Dec 2009, 0000 UTC



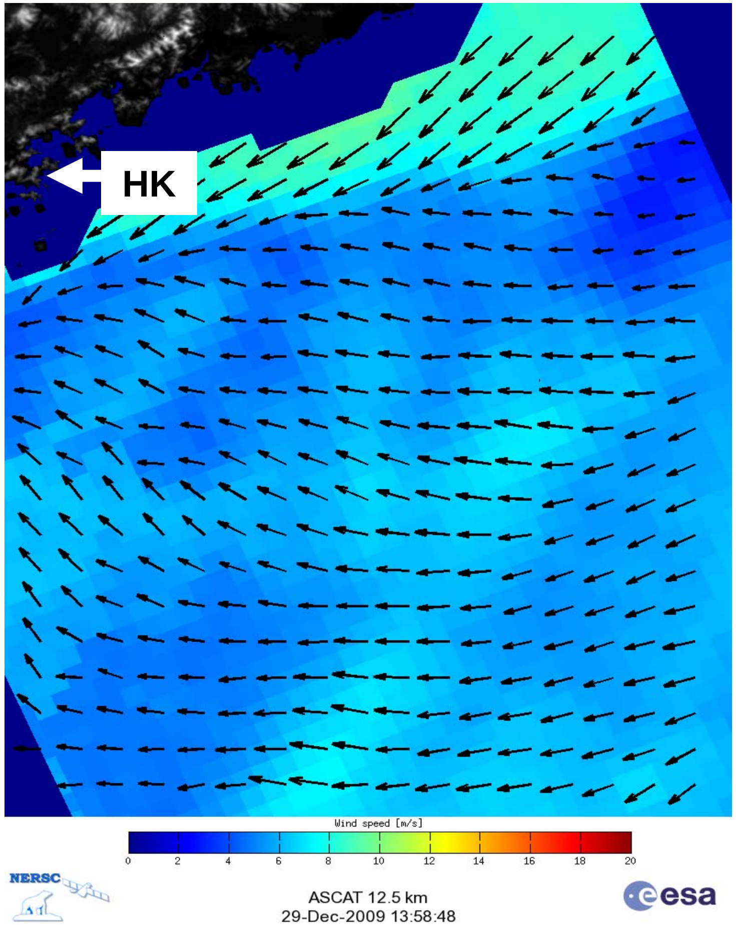
Weather chart (at mean sea level) of South East Asia for **30 December 2009 at 0000 UTC**.

It shows a high pressure region over Mongolia. The direction and spacings of the isobars near Hong Kong indicate strong winds near Hong Kong.

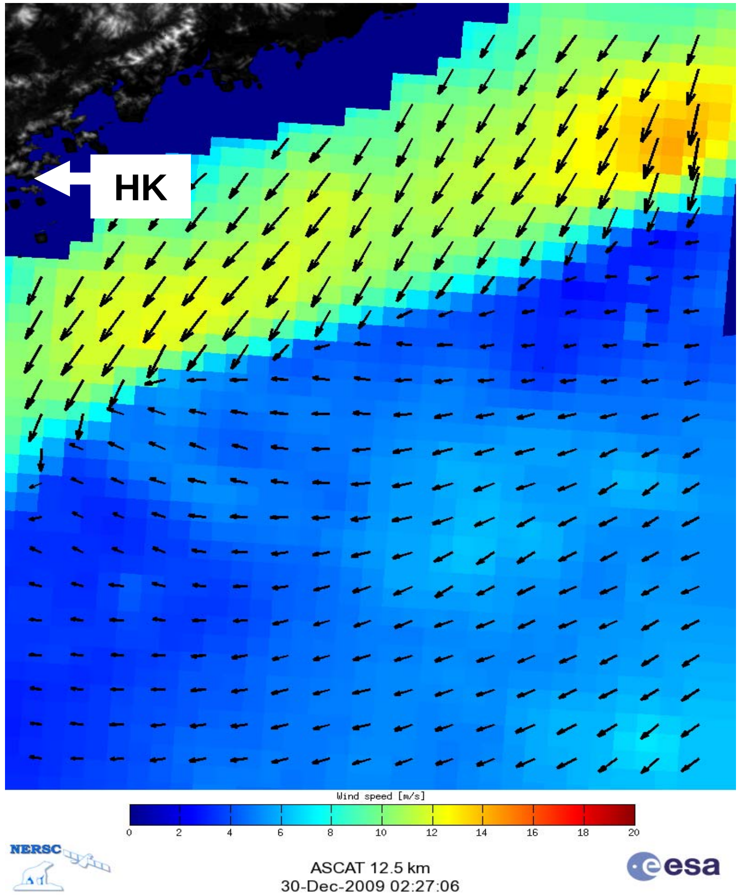


Weather chart (at mean sea level) of South East Asia for **29 December 2009 at 0000 UTC**.

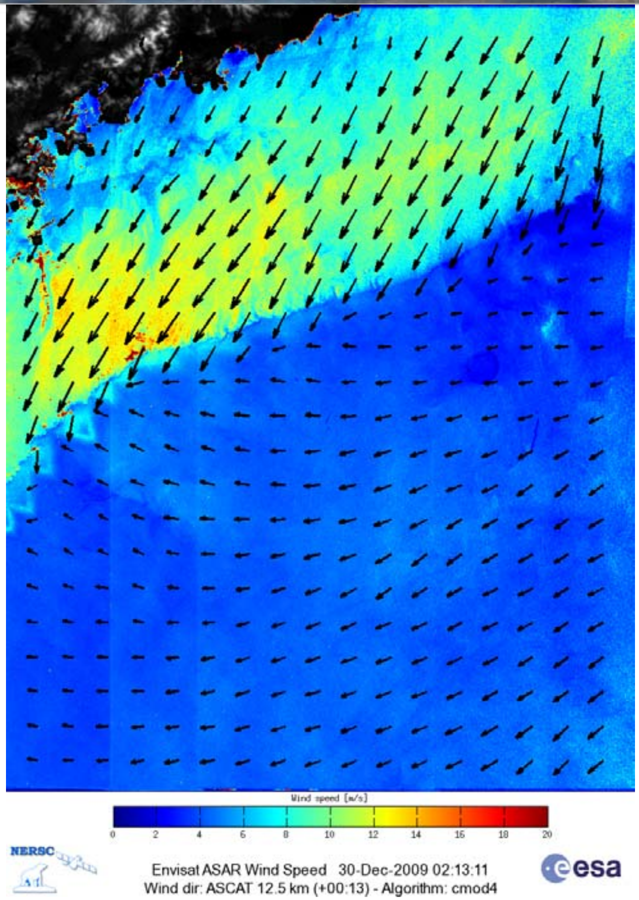
It shows a high pressure region over Mongolia. The direction and spacings of the isobars near Hong Kong indicate strong winds near Hong Kong.



Near-surface wind field retrieved from data of the ASCAT scatterometer onboard the MetOp satellite at 1358 UTC (2158 HKT) 29 December 2009. © ESA

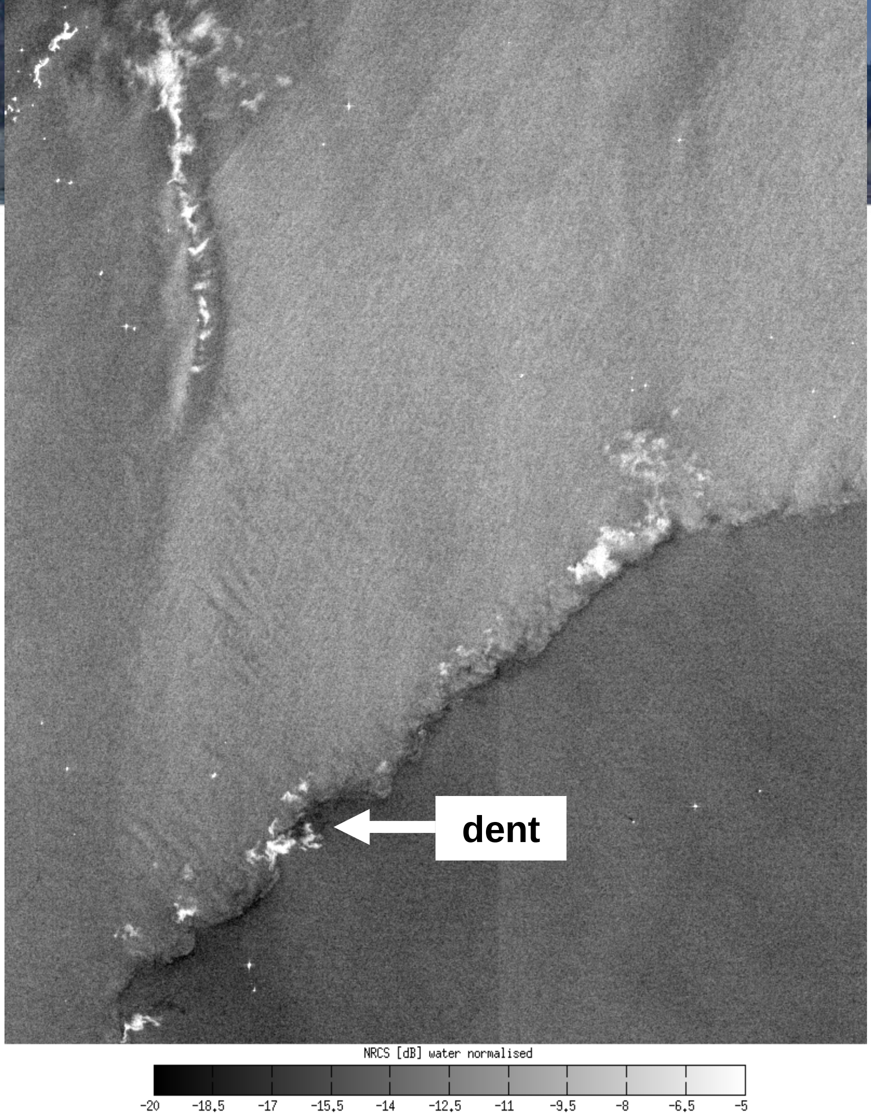


Near-surface wind field retrieved from data of the ASCAT scatterometer onboard the MetOp satellite at 0227 UTC (1027 HKT) 30 December 2009. © ESA

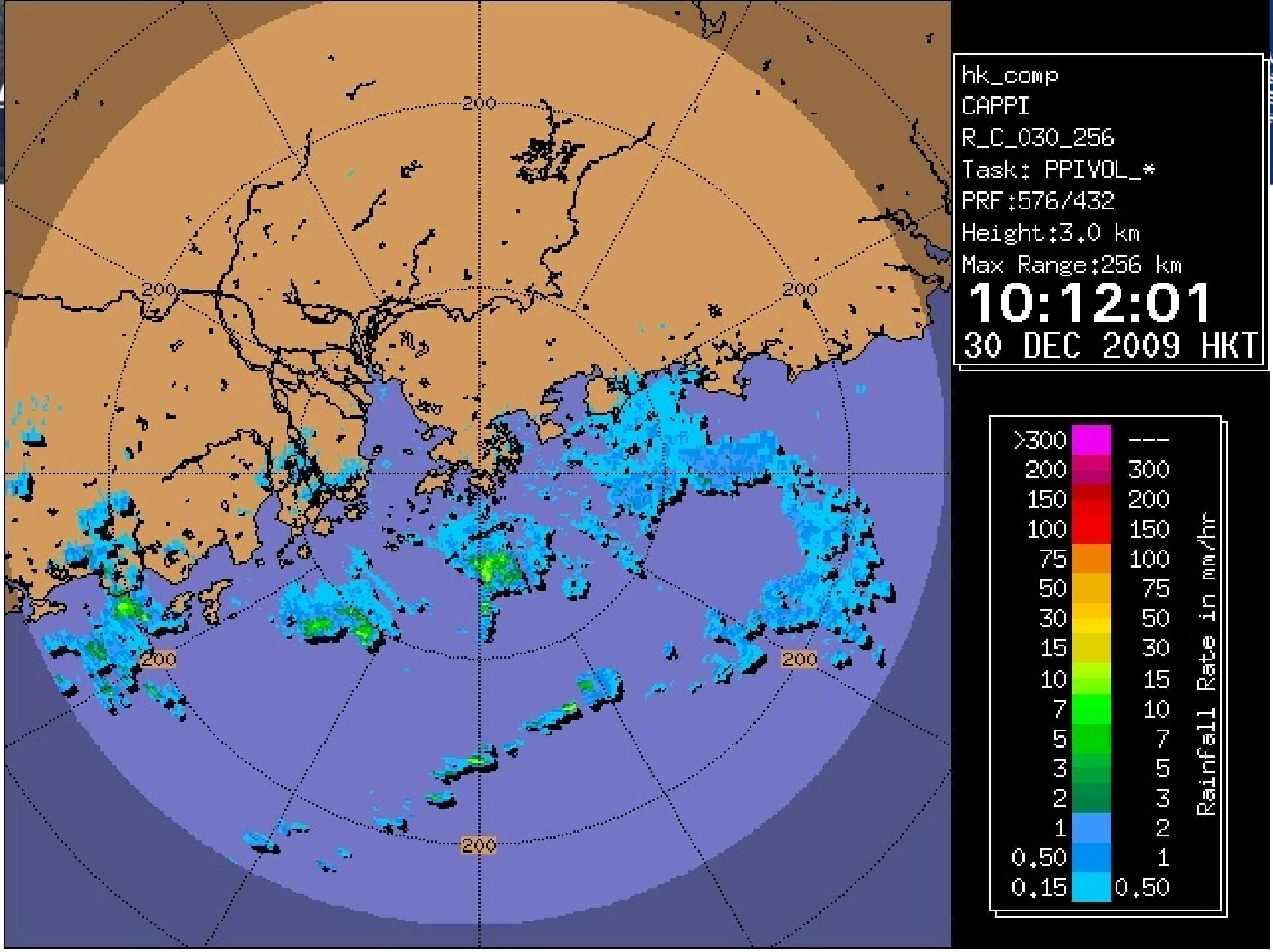


Near-surface wind field retrieved from the ASAR image by using the wind direction measured by ASCAT 13 minutes **after ASAR** data acquisition (see Fig. 4) and, near the coast, provided by the NCEP model.

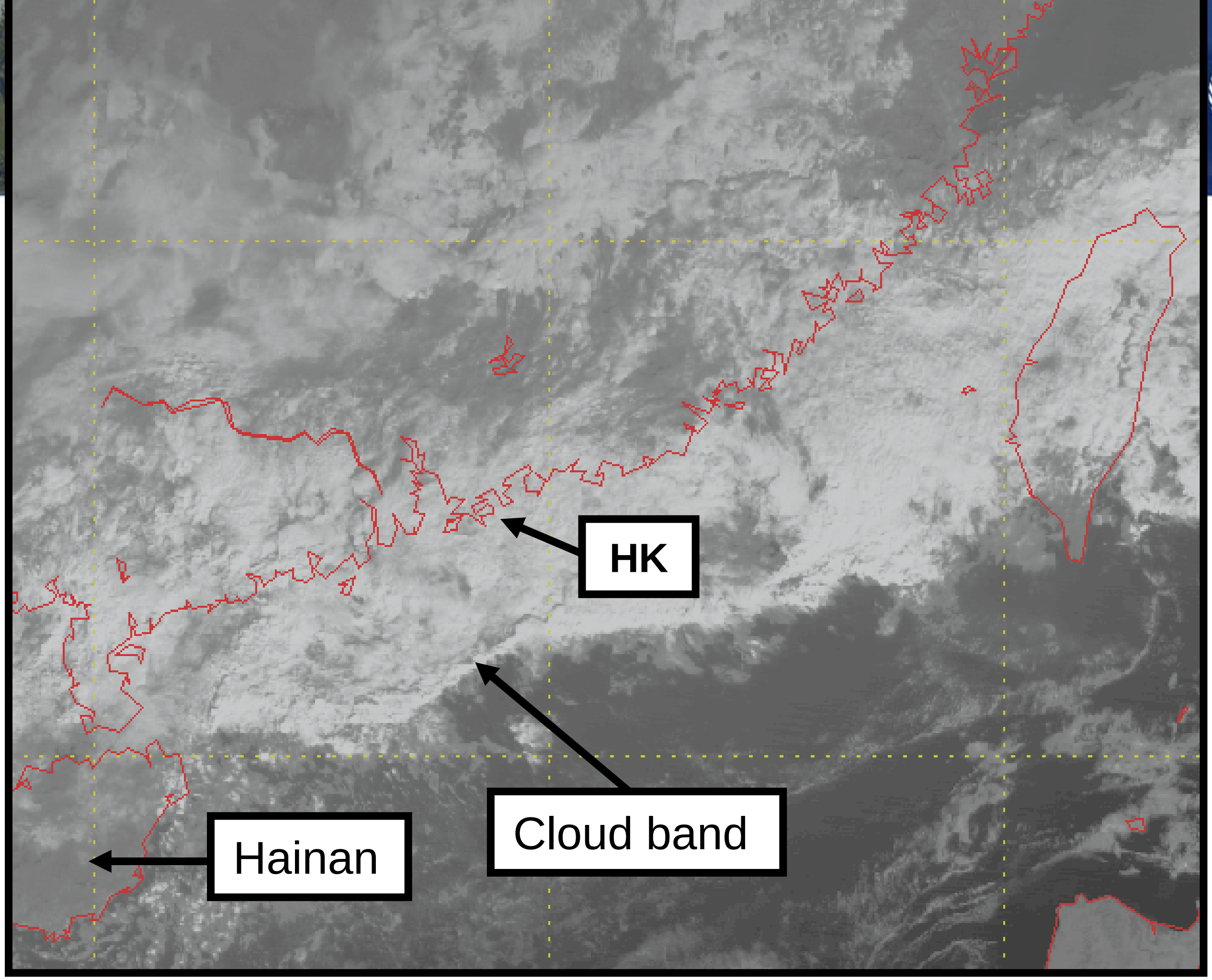
Zoom



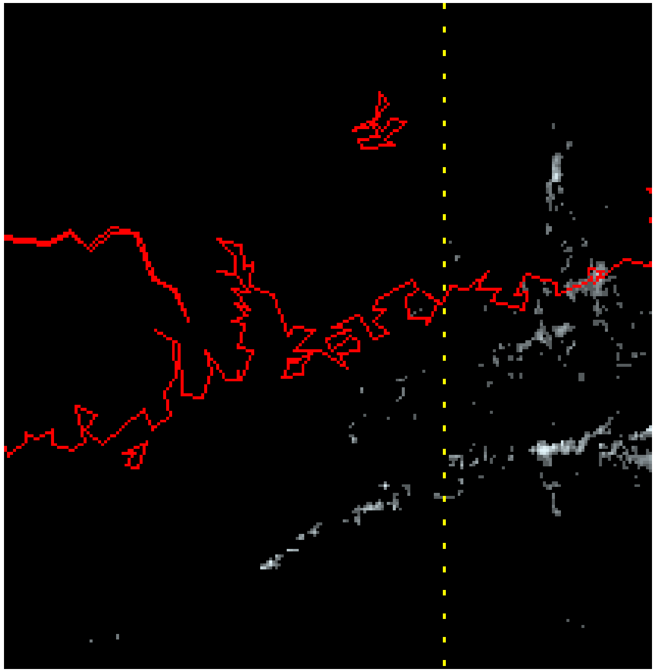
Zoom on the central western section of the SAR image showing details of the frontal line. The white patches are radar signatures of rain cells caused by radar backscattering by rain drops in the atmosphere. Note the dent in the frontal line associated with a rain cell.

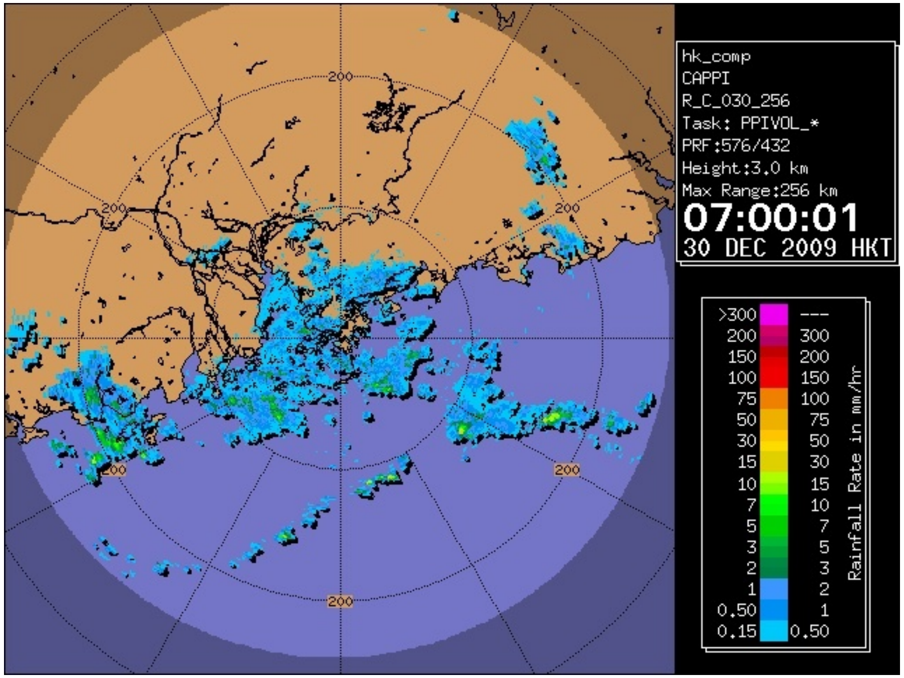


Radar reflectivity image acquired by the Hong Kong weather radar at 0212 UTC (1012 HKT) 30 December 2009 converted into rainfall showing the distribution of rain around Hong Kong. Note that the position of the rain band coincides with the fontal line visible on the ASAR image depicted in Figs. 4 and 5.

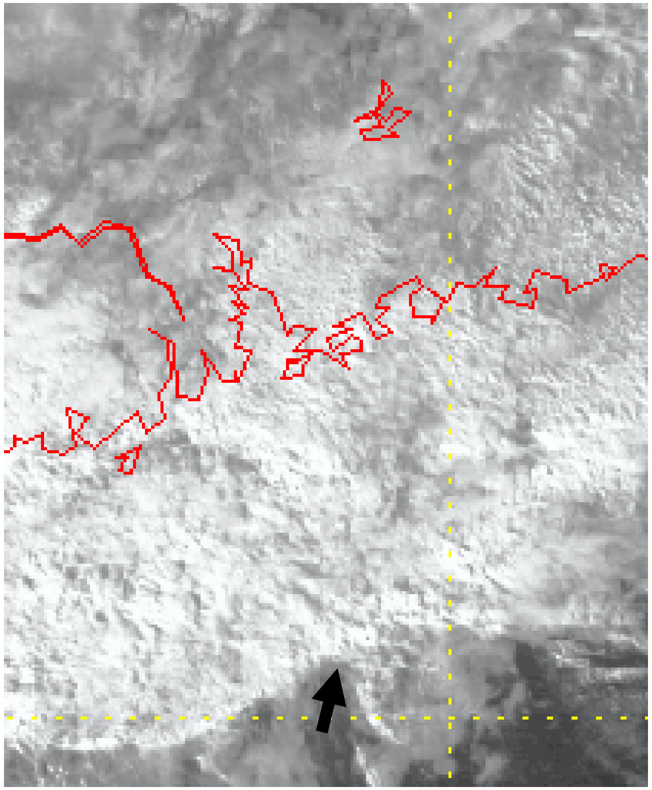


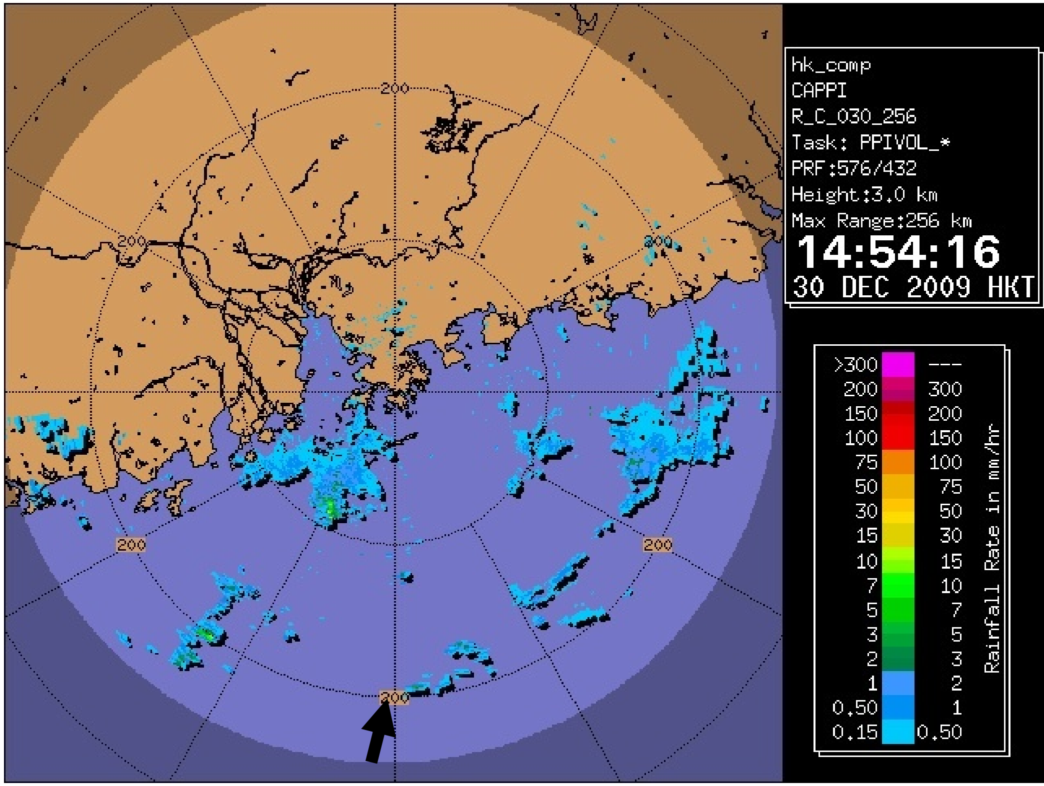
Cloud image acquired in the visible band by the Japanese **geostationary satellite MTSAT-1R at 0157 UTC (0957 HKT) 30 December 2009** over the South China Sea and the Chinese Continent. The narrow band of enhanced cloud density at the southern boundary of the cloud field coincides with the wind front visible on the wind maps depicted in Figs. 3 and 6. © JAXA



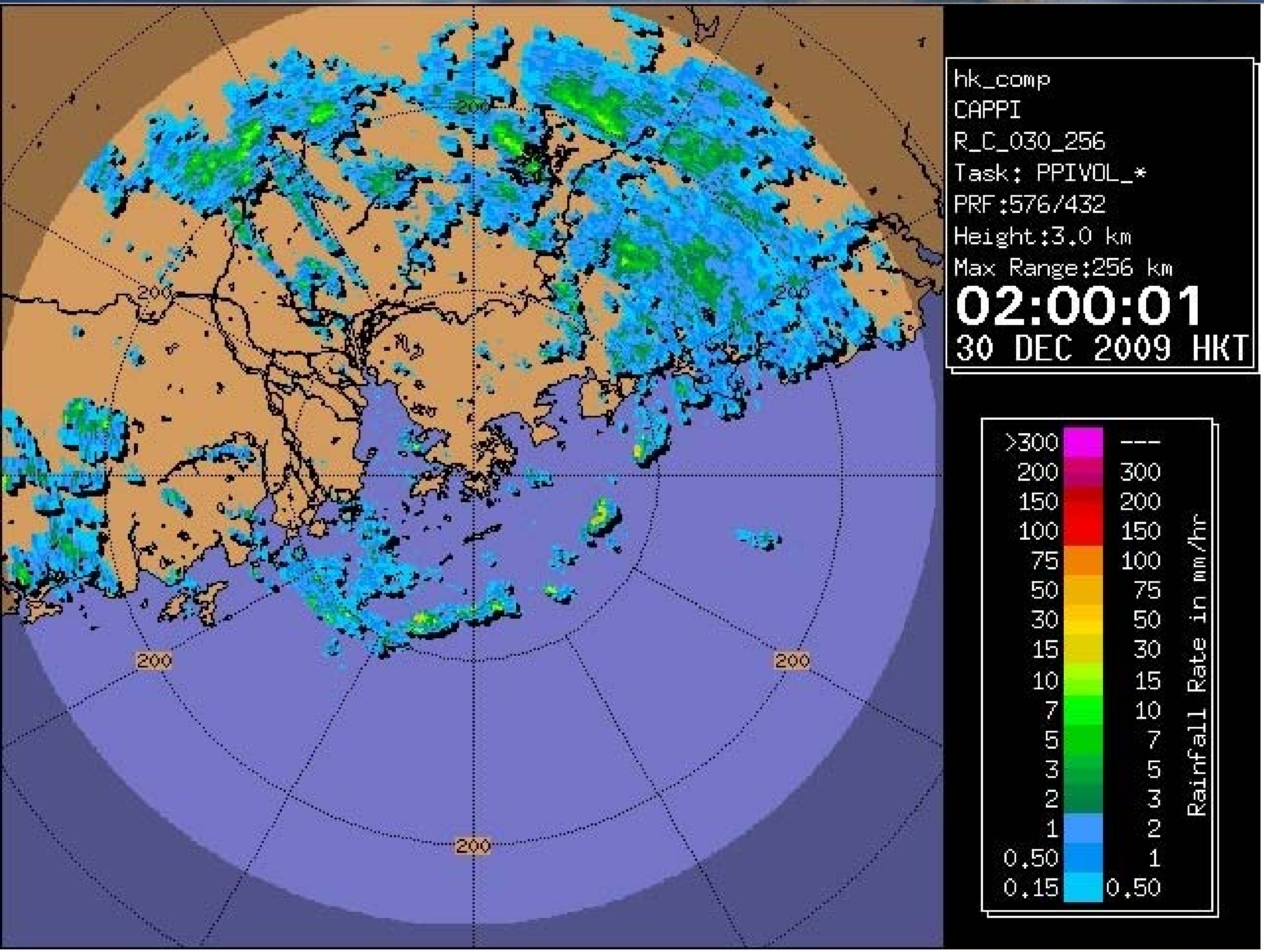


Left: **Cloud image acquired in the visible band by the Japanese geostationary satellite MTSAT-1R at 2257 UTC 29 December 2009 (0657 HKT 30 December) over the South China Sea showing a narrow cloud band south of Hong Kong. Right: Radar reflectivity image acquired by the Hong Kong weather radar at 2300 UTC 29 December 2009 (0700 HKT 30 December) converted into rainfall showing a rain band south of Hong Kong. The position of the rainband coincides with the position of the narrow cloud band visible on the MTSAT-1R image. © JAXA**





Same as previous figure, but at 0657 UTC (1454 HKT) 30 December 2009 (left) and at 0654 UTC (1454 HKT) 30 December 2009 (right). At this time the rain band is very diffuse. The rain cells south of Hong Kong marked by an arrow in the weather radar image is located approximately 10 km behind the southern boundary of the cloud field (also marked by an arrow). Further east, the rain cells are located even further inside the cloud field. © JAXA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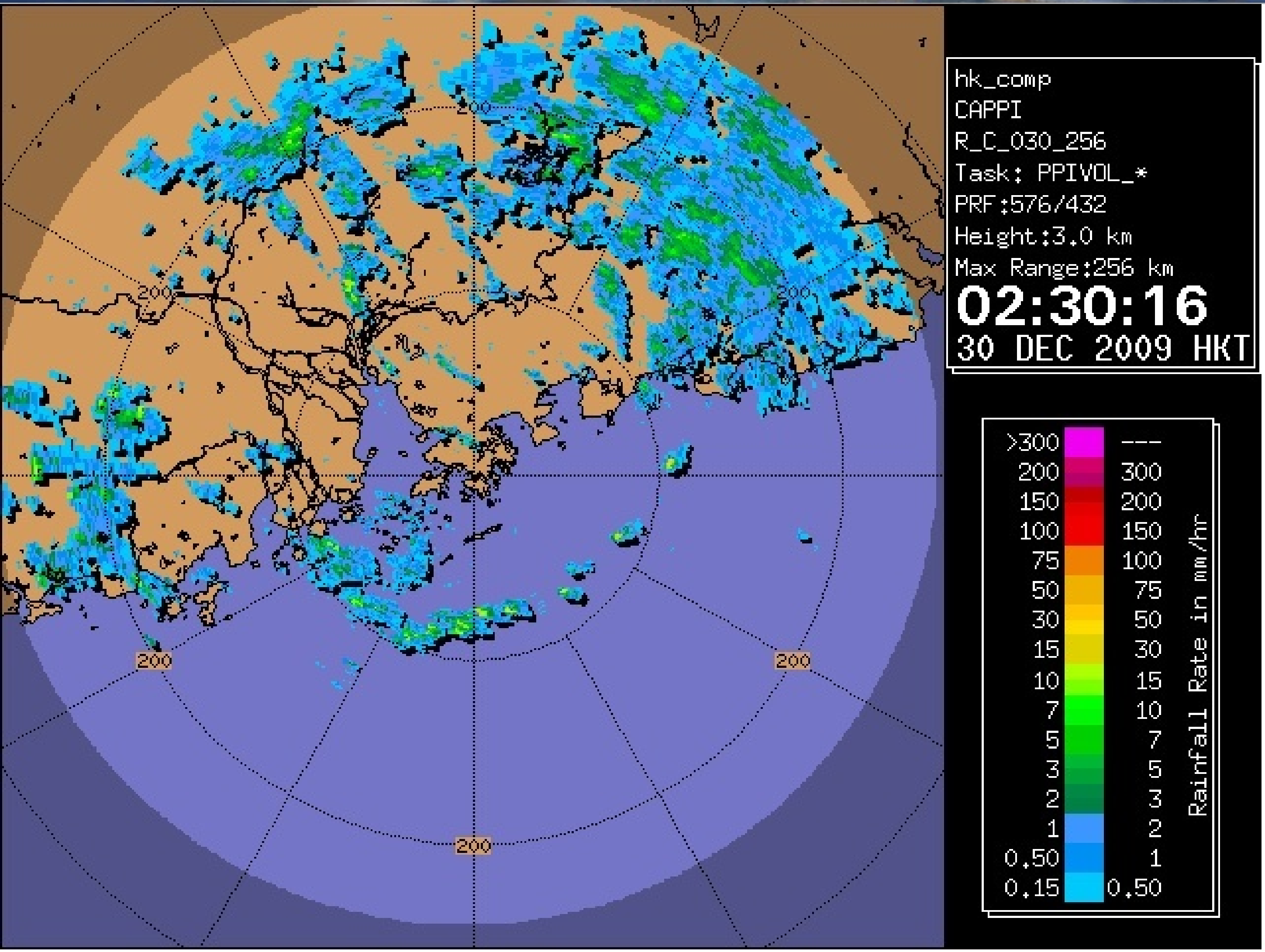
Rainfall Rate in mm/hr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Rainfall Rate in mm/hr
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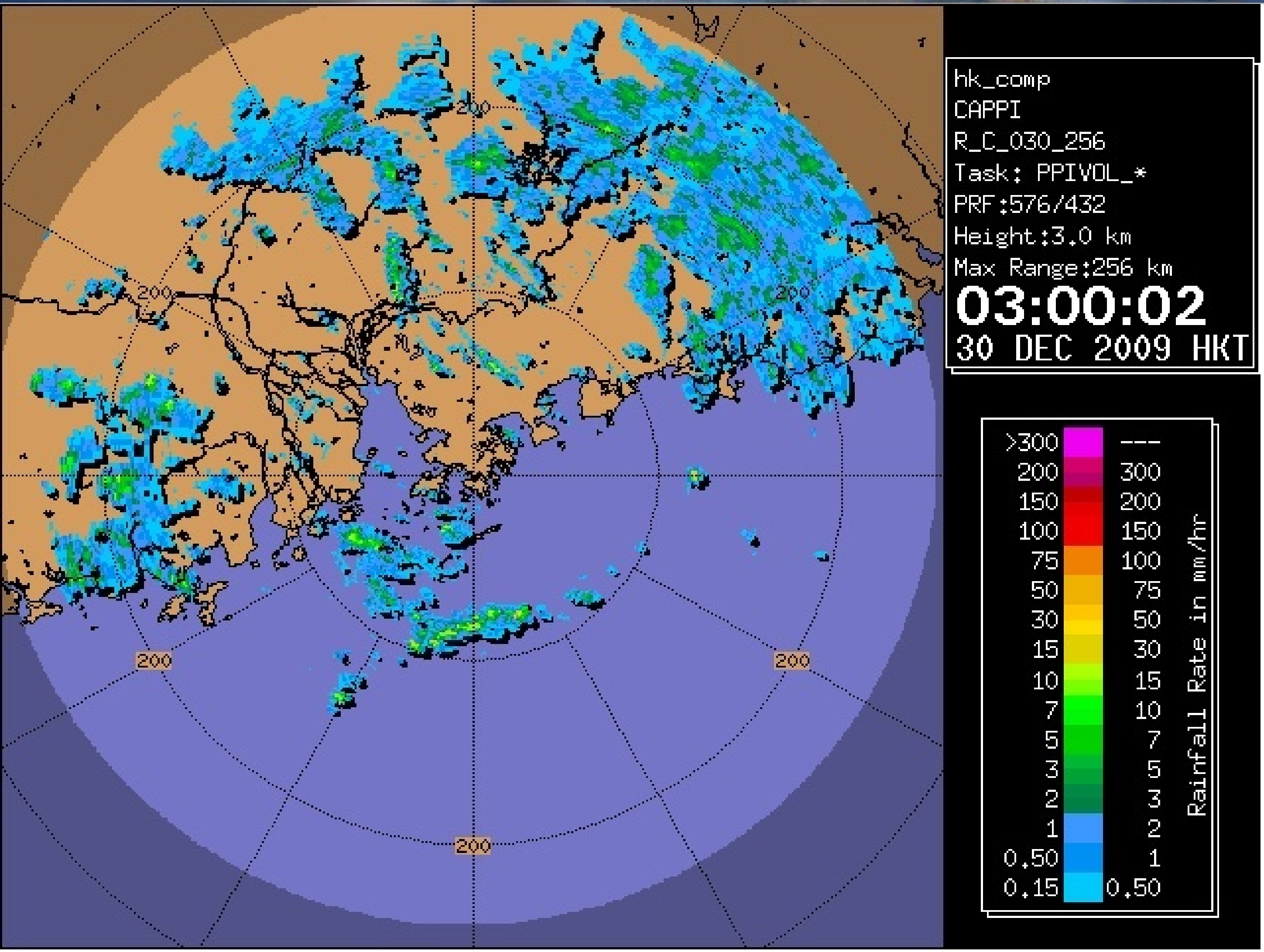
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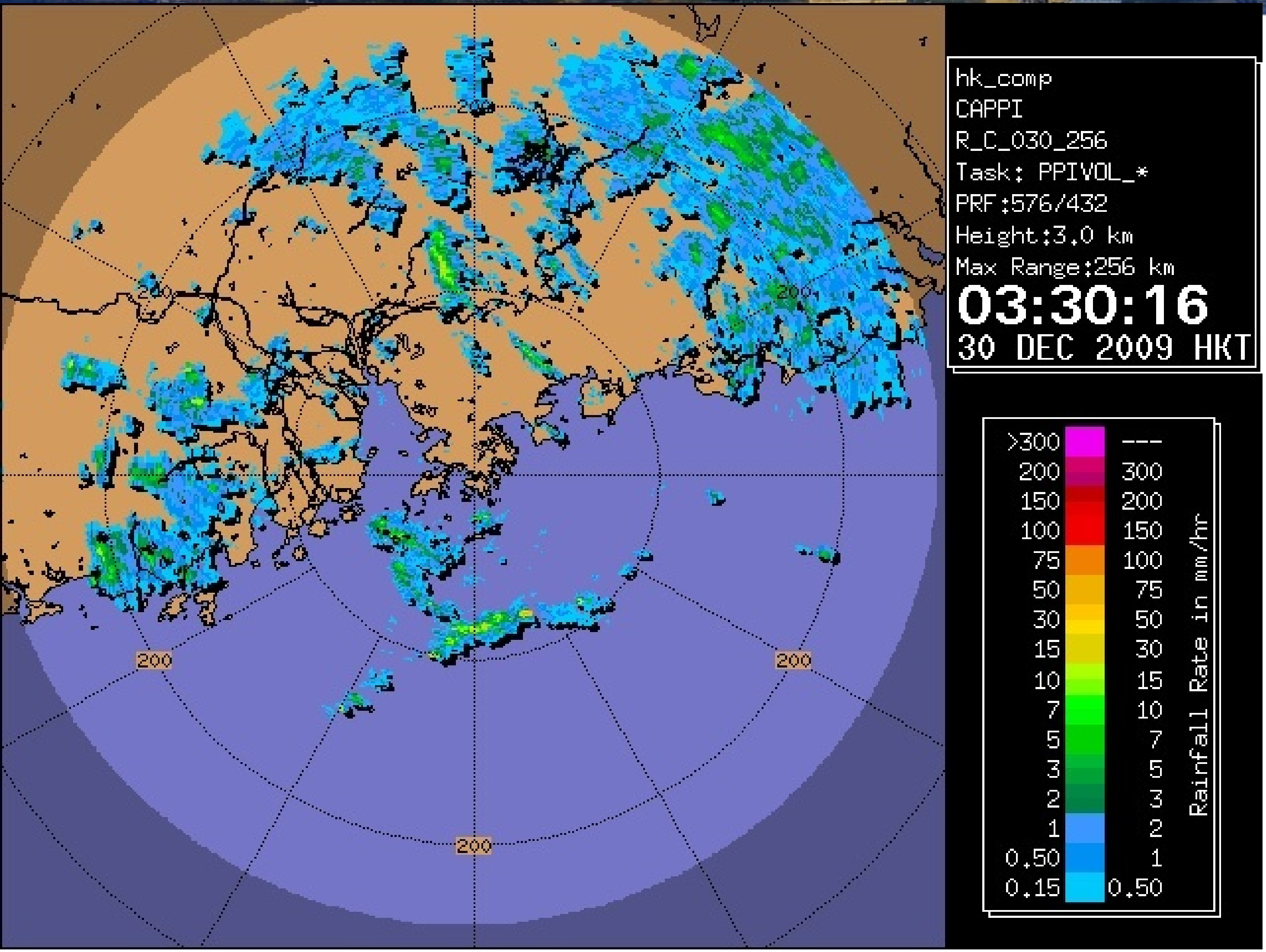
Rainfall Rate in mm/hr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Rainfall Rate in mm/hr
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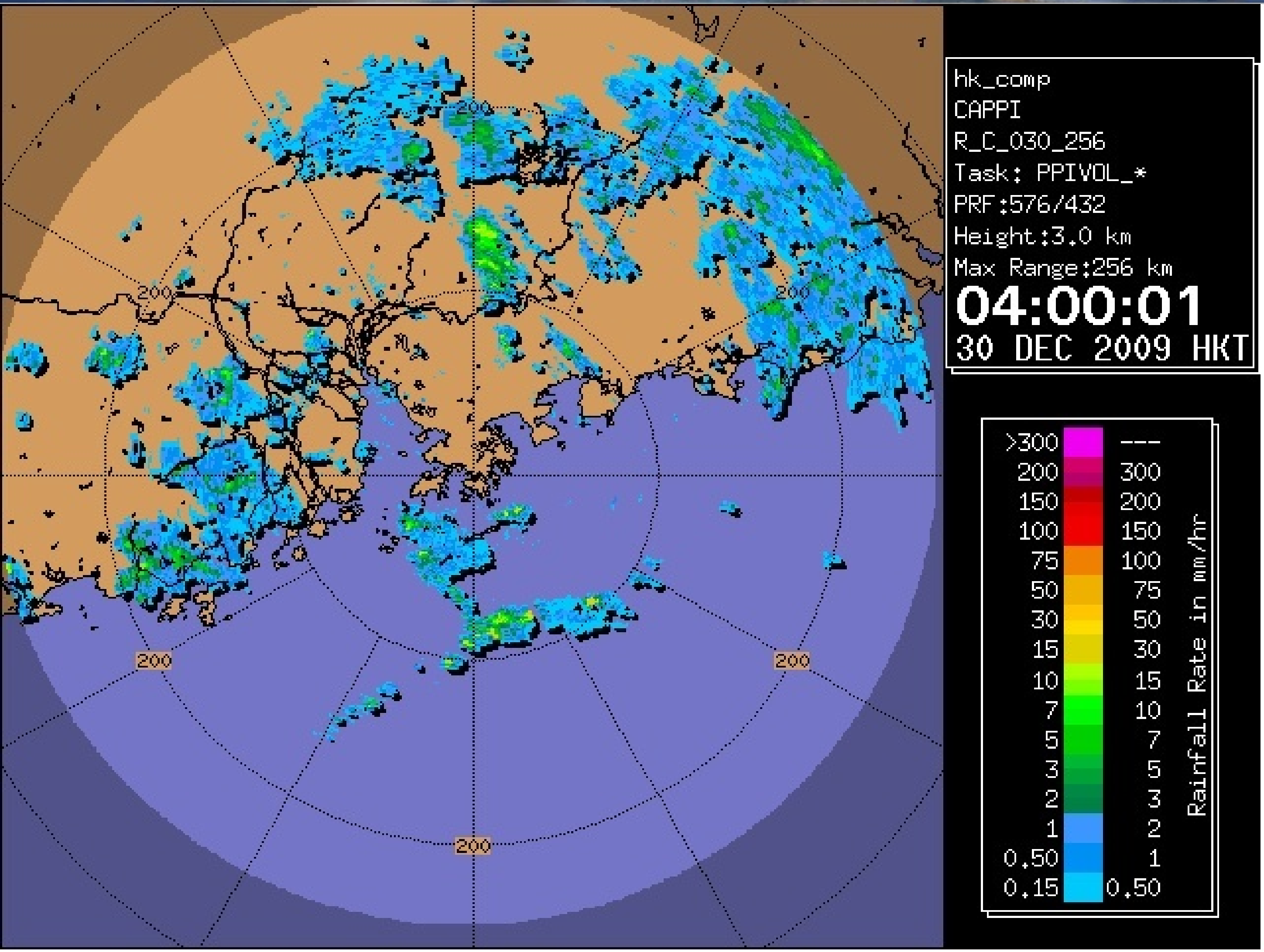
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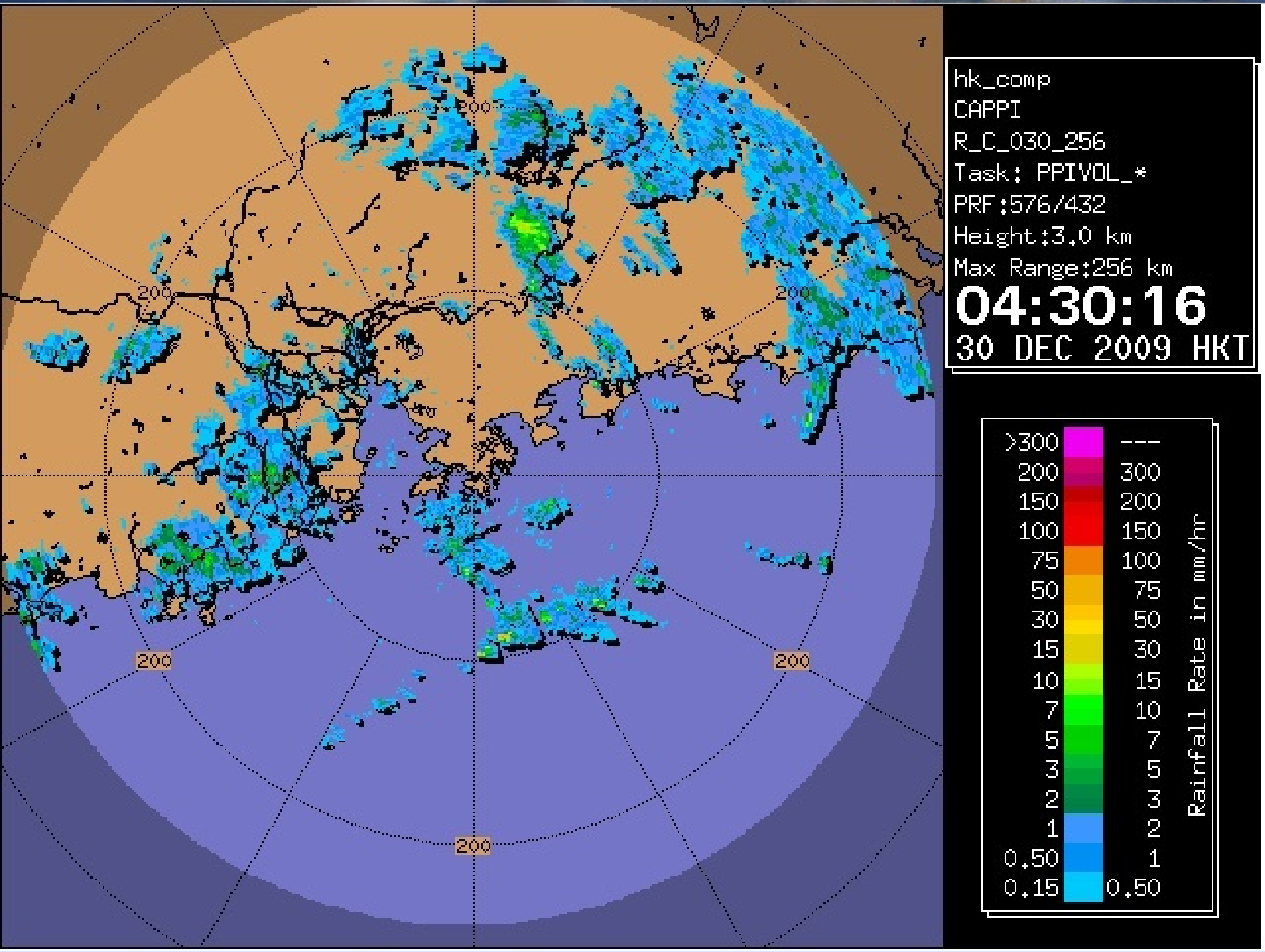
Rainfall Rate in mm/hr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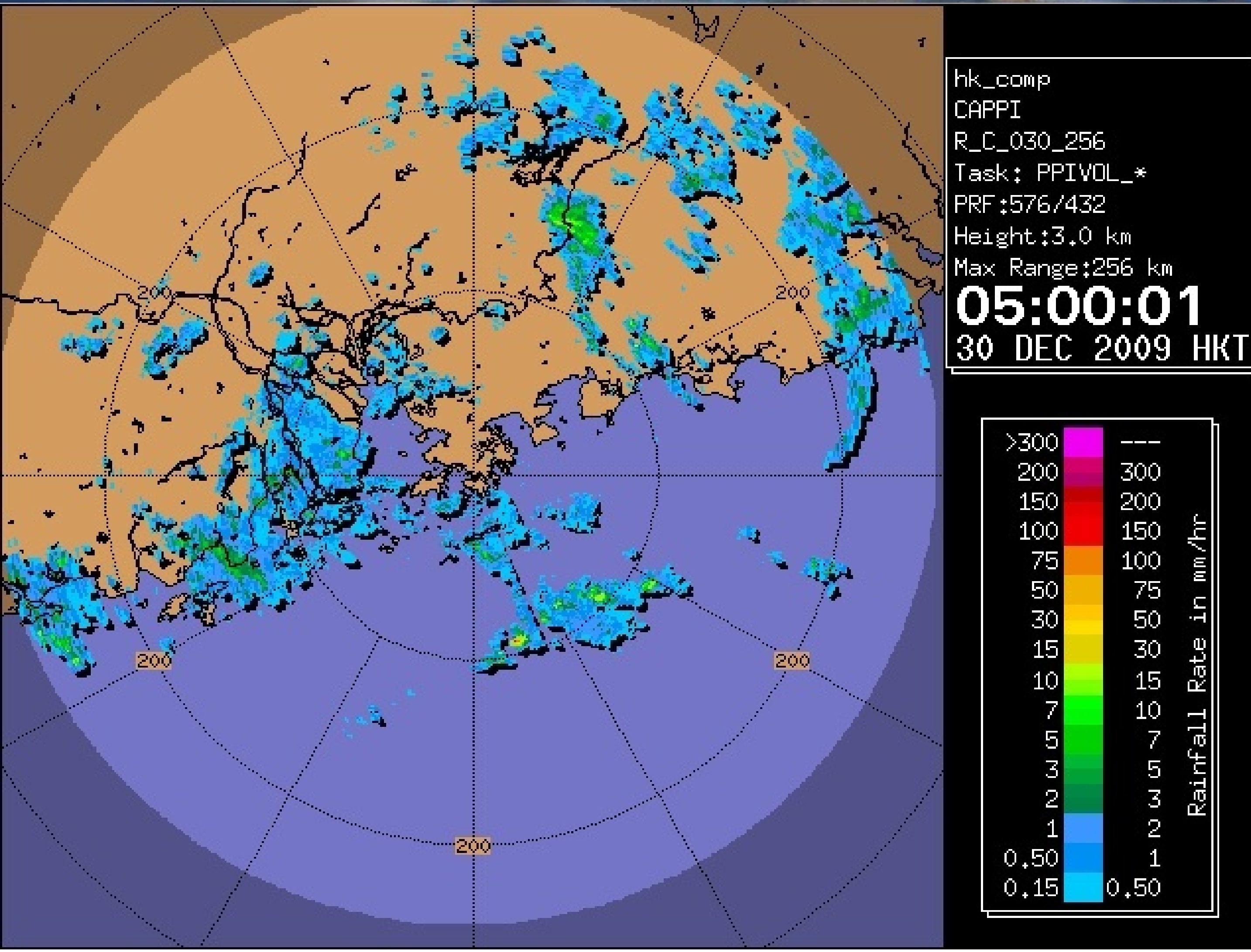
Rainfall Rate in mm/hr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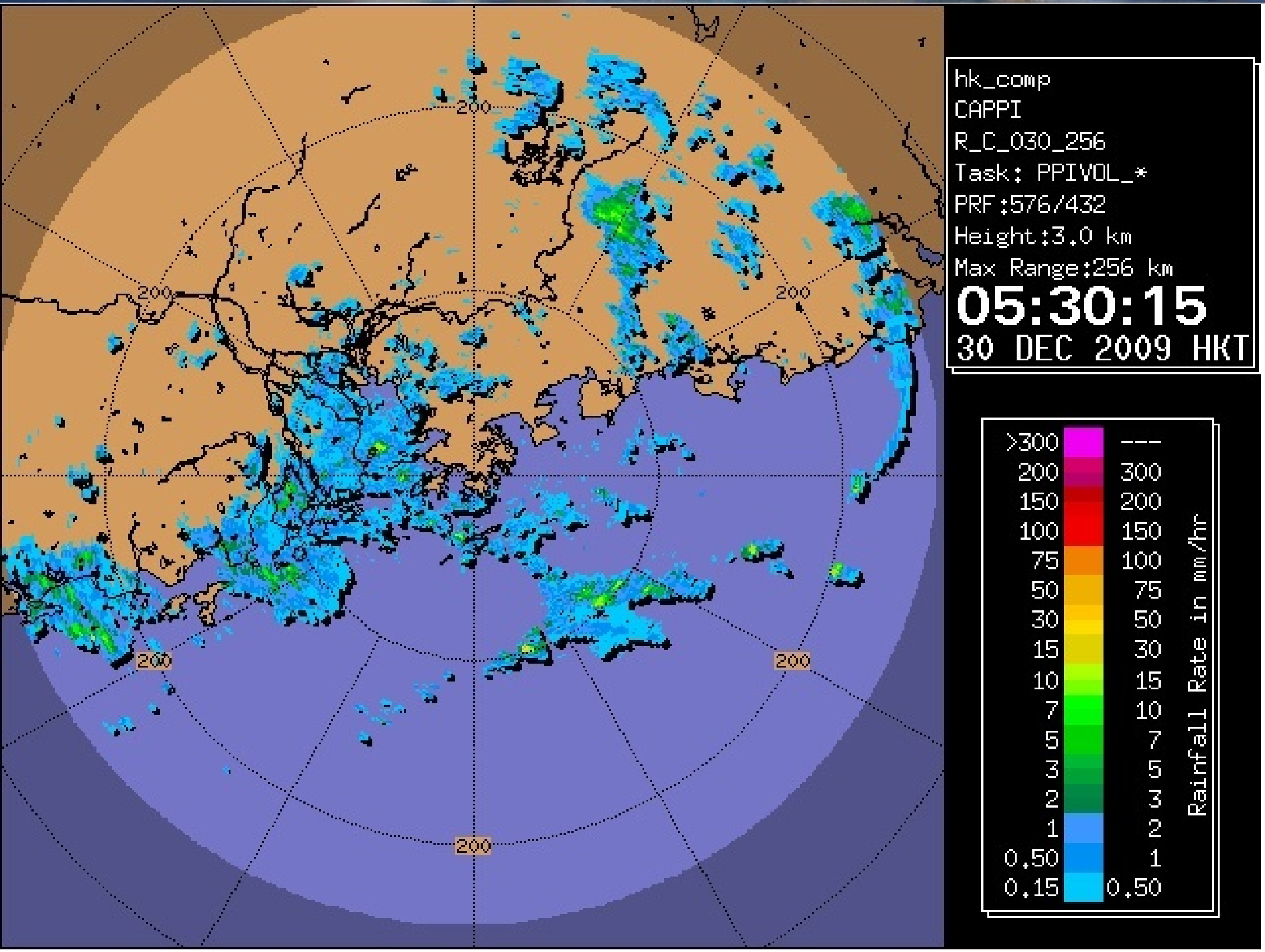
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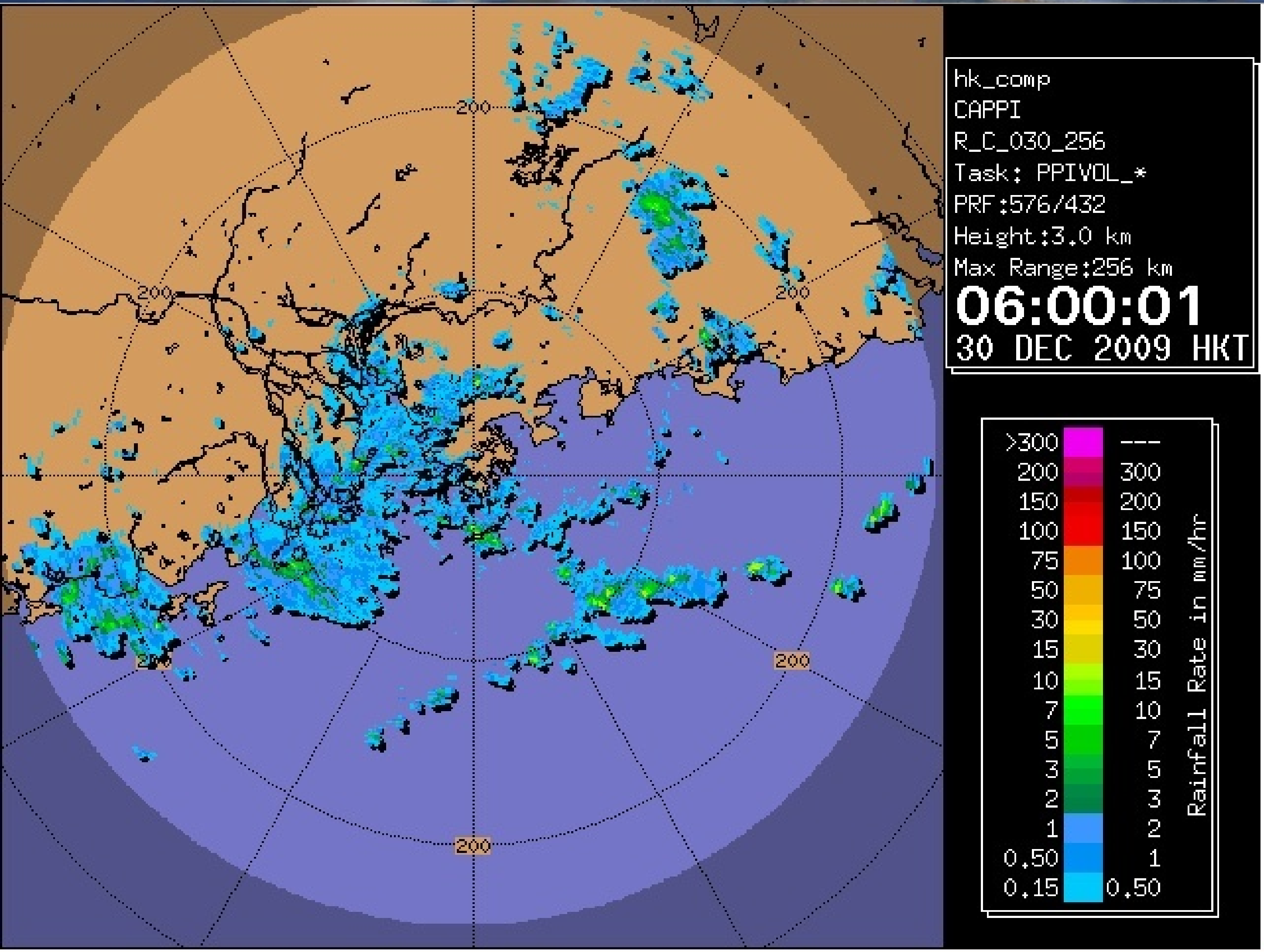
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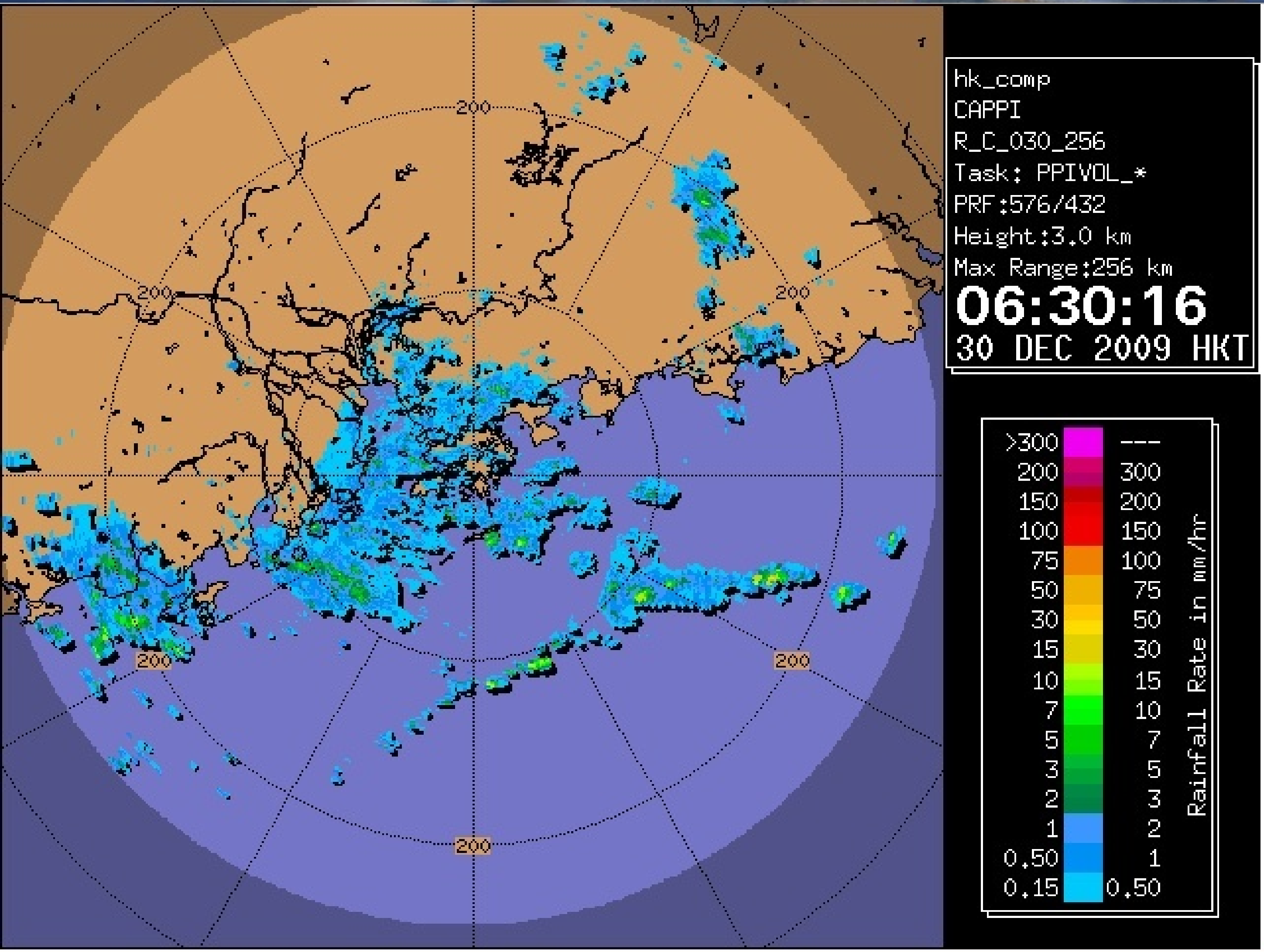
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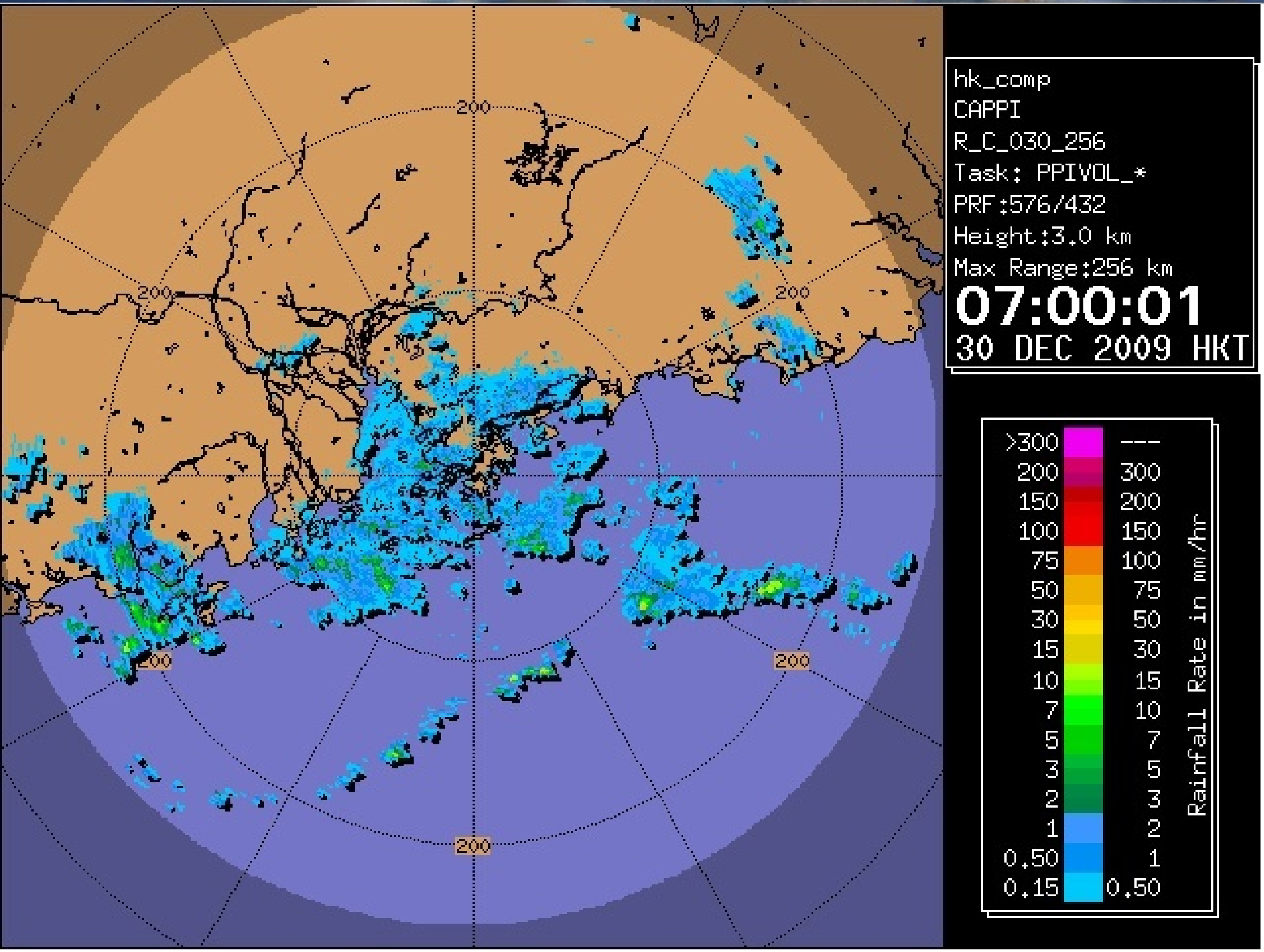
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Rainfall Rate in mm/hr
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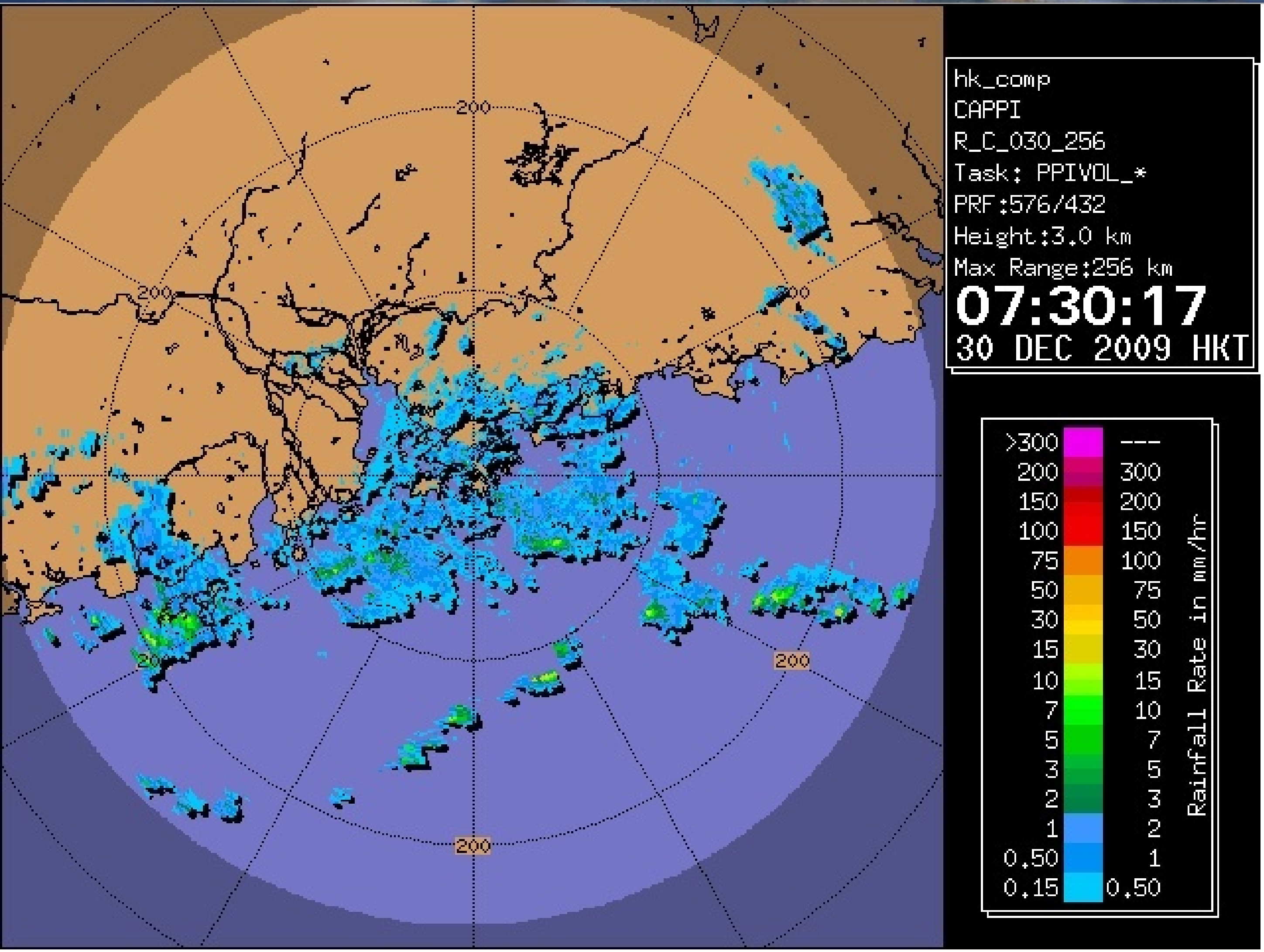
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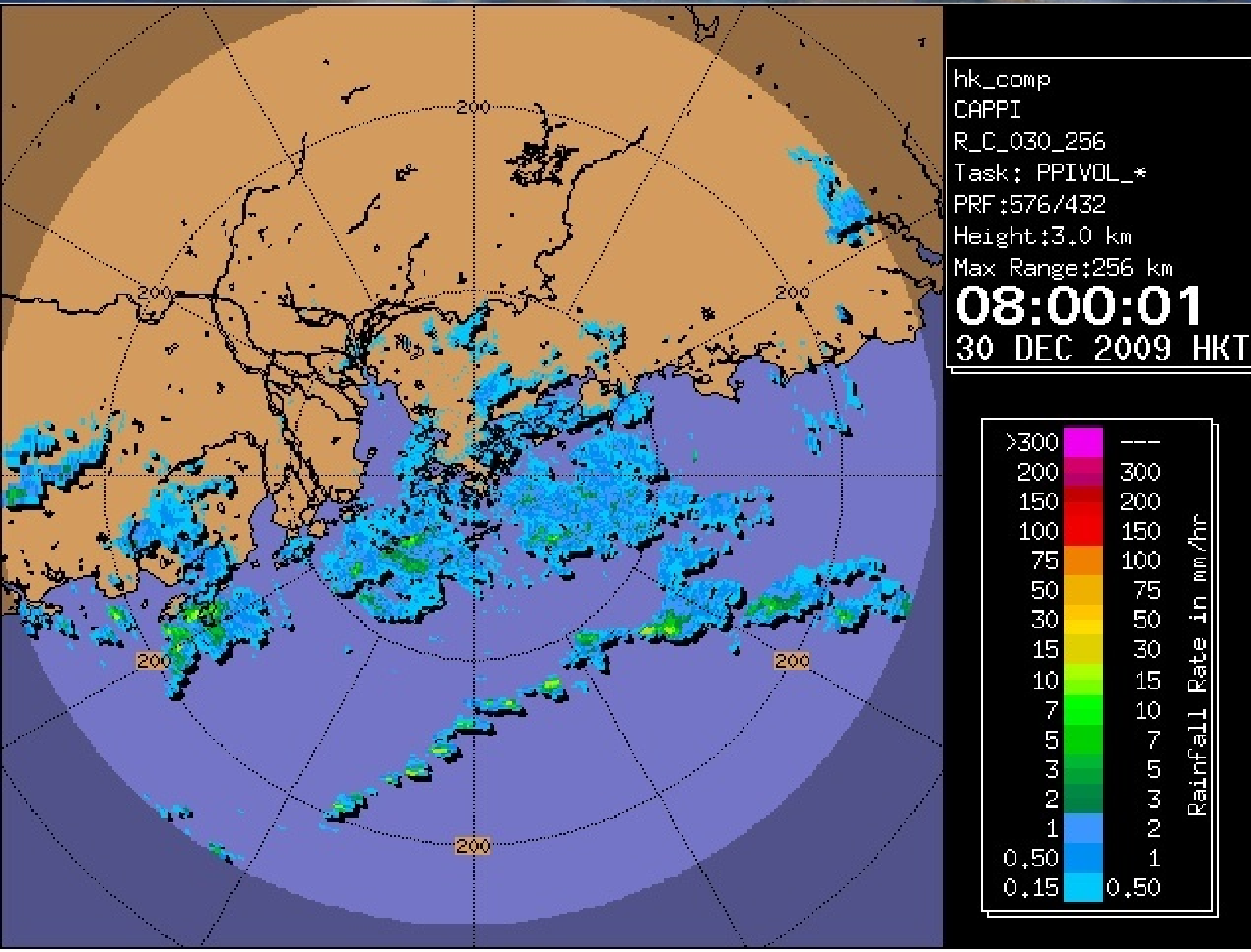
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Rainfall Rate in mm/hr
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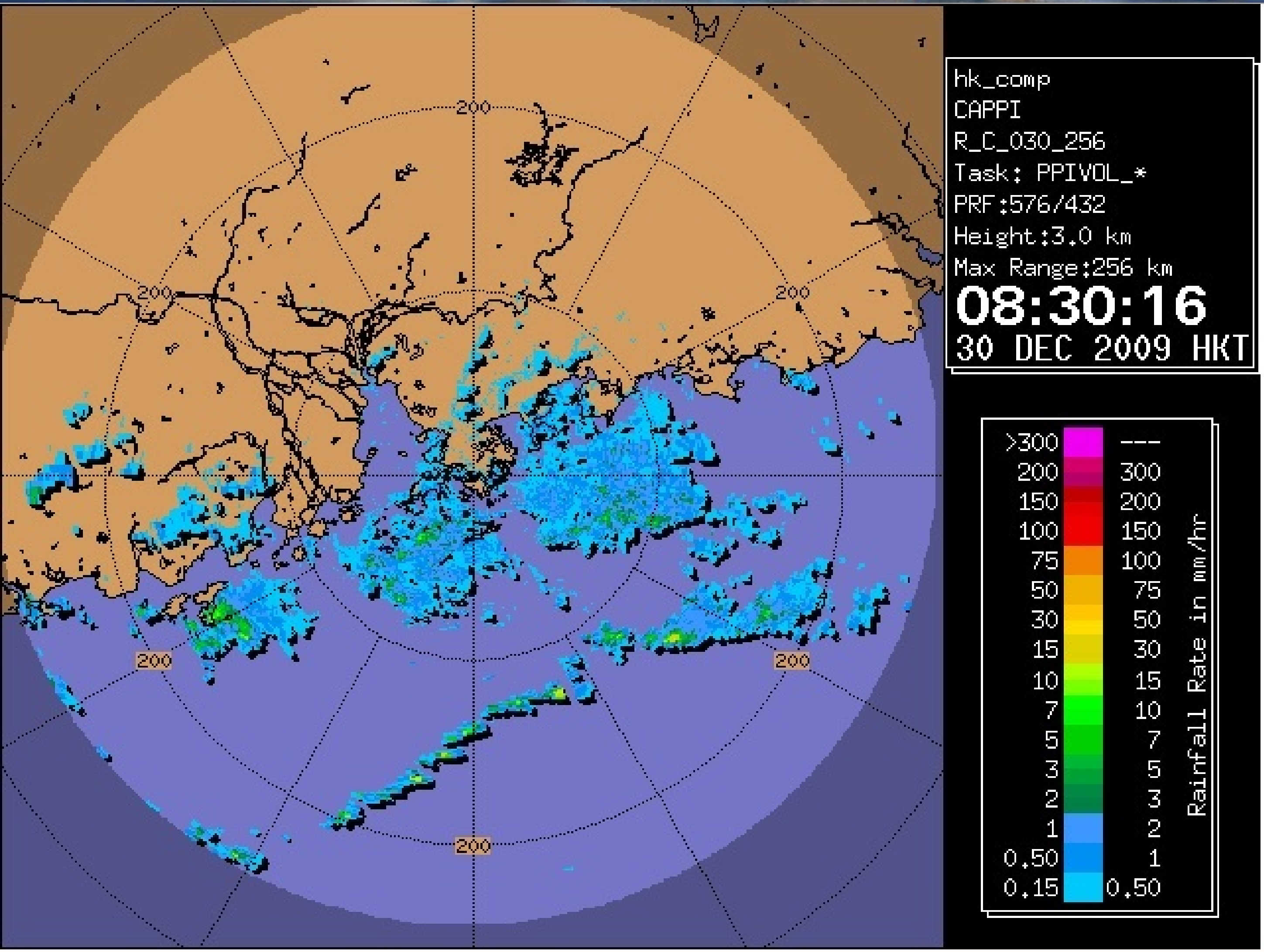
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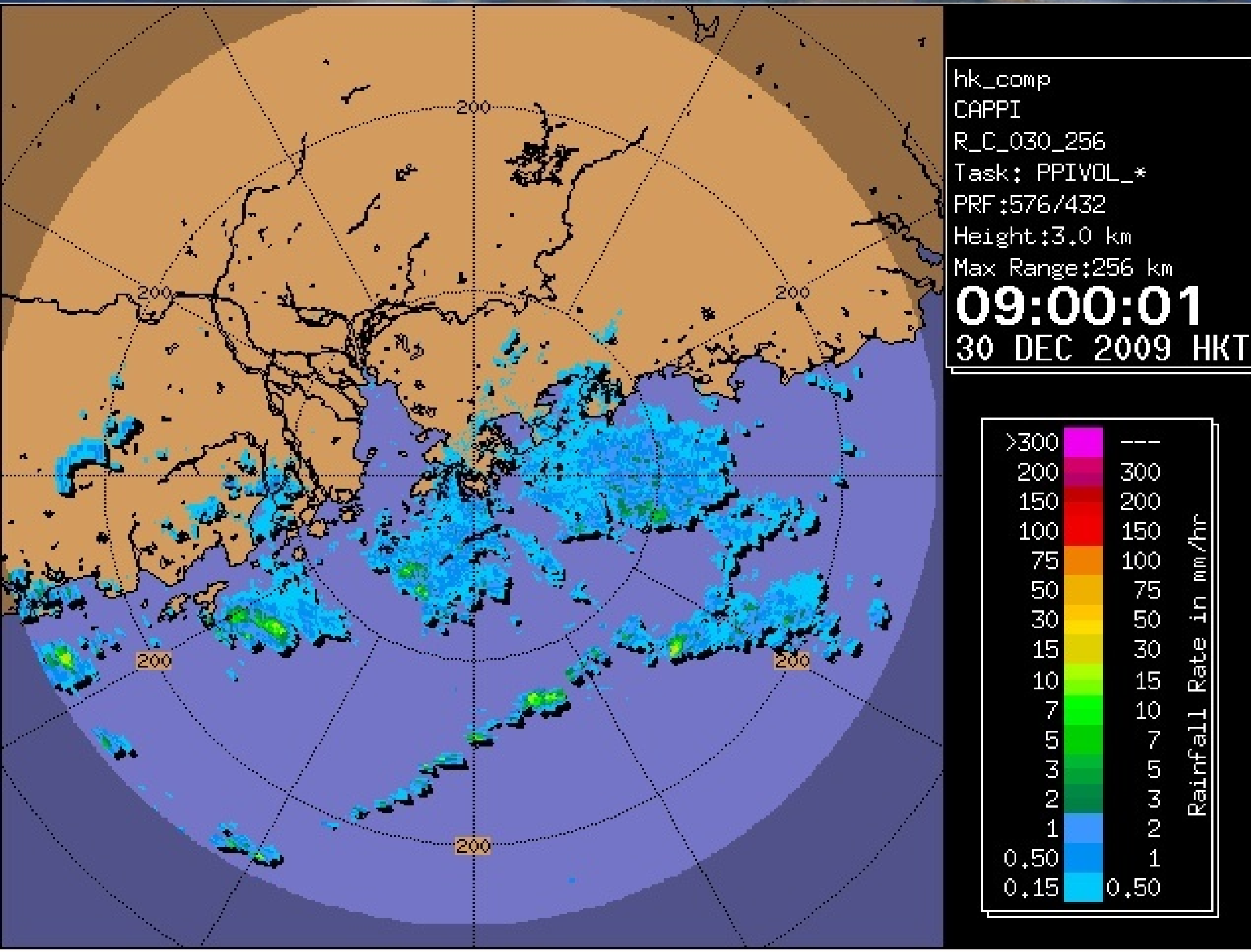
Rainfall Rate in mm/hr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Rainfall Rate in mm/hr
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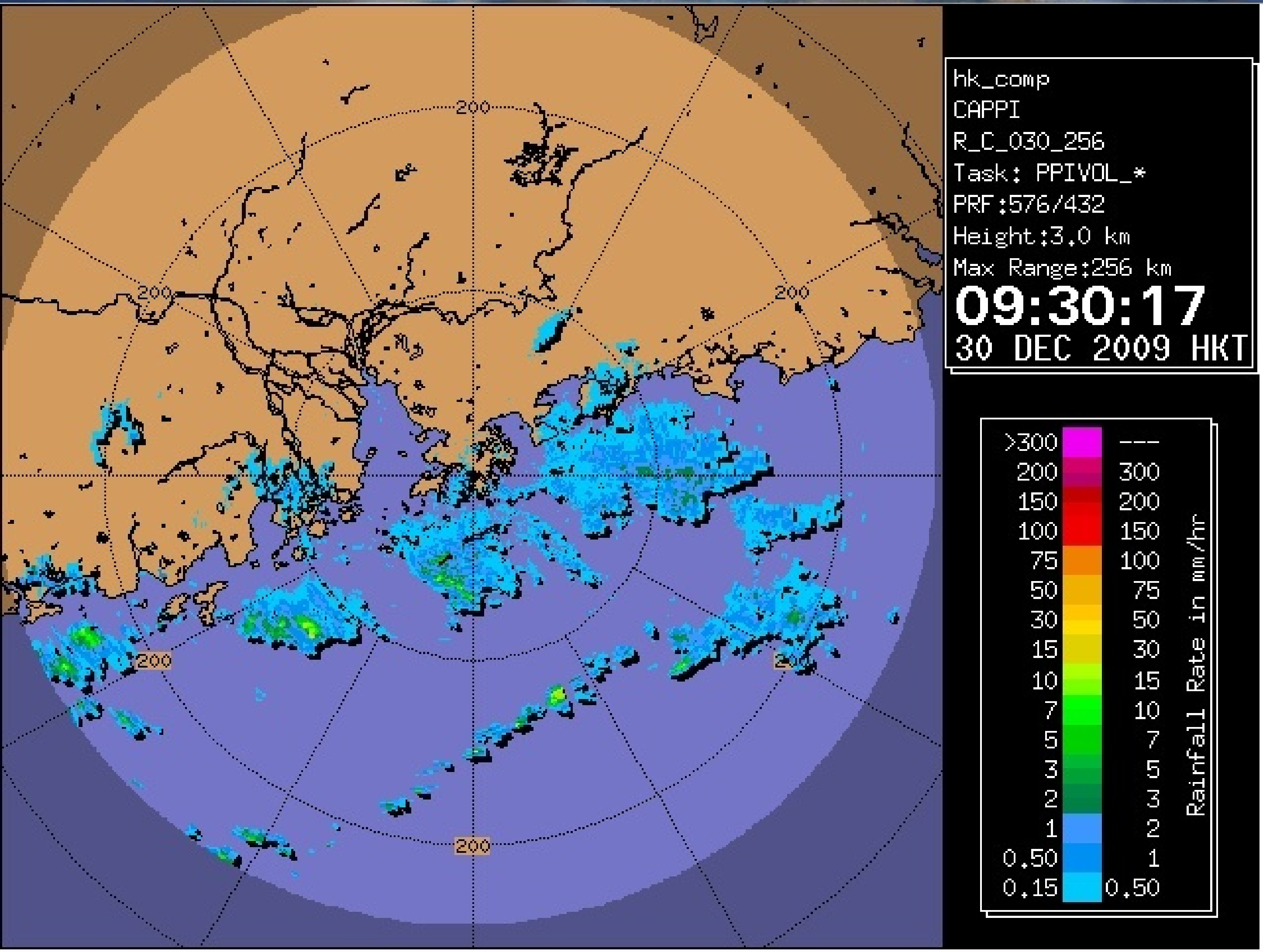
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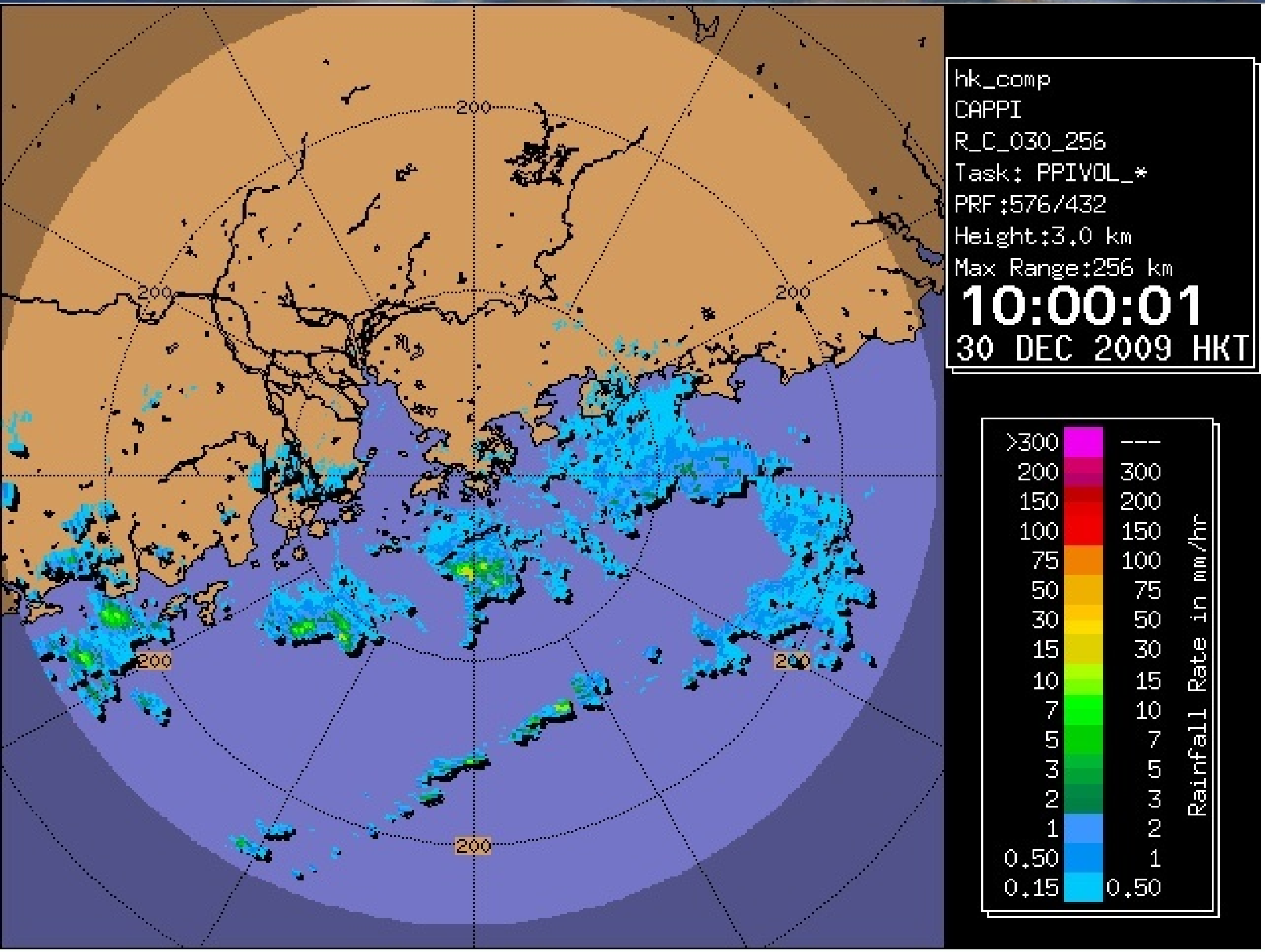
Rainfall Rate in mm/hr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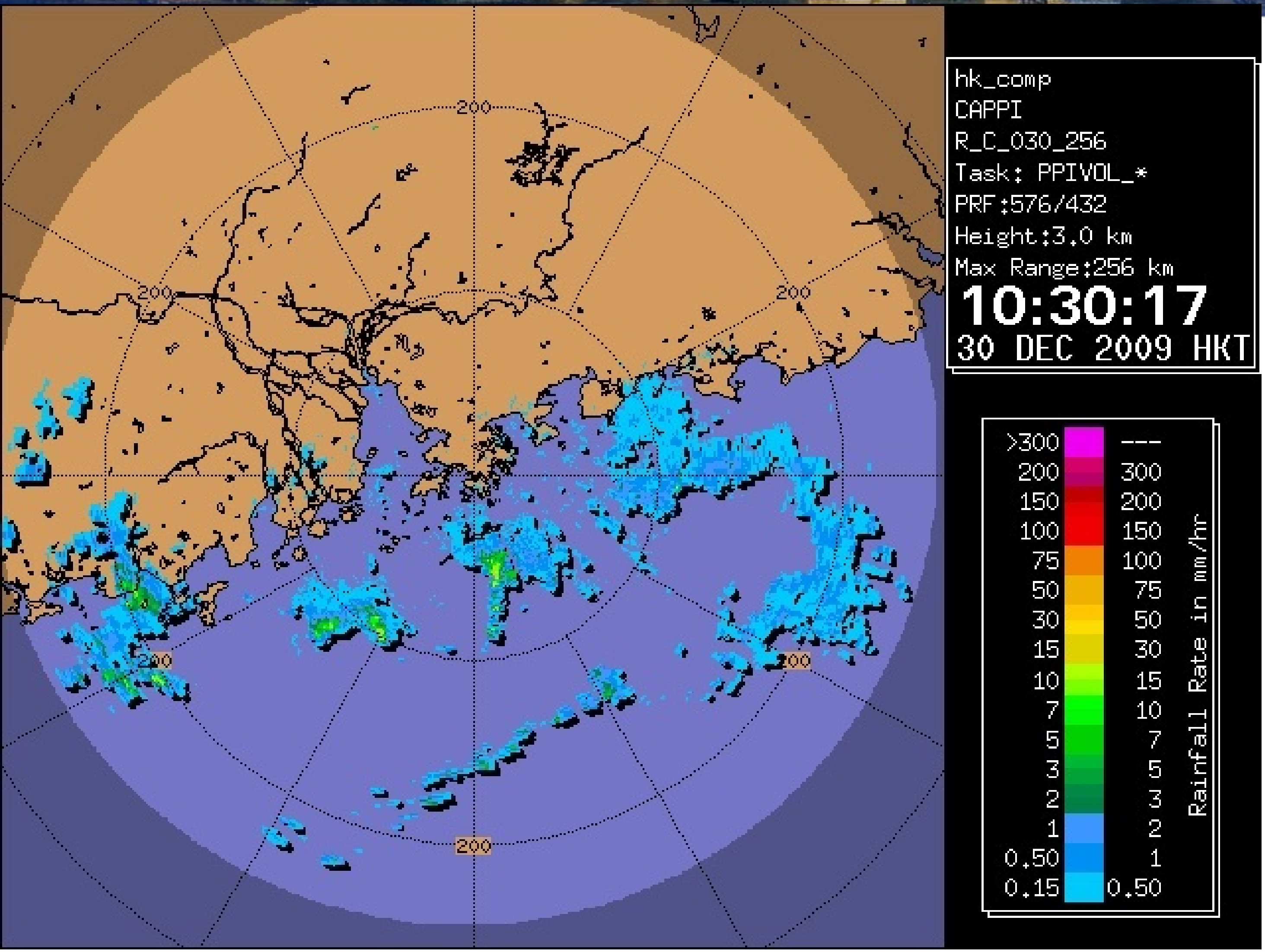
Rainfall Rate in mm/hr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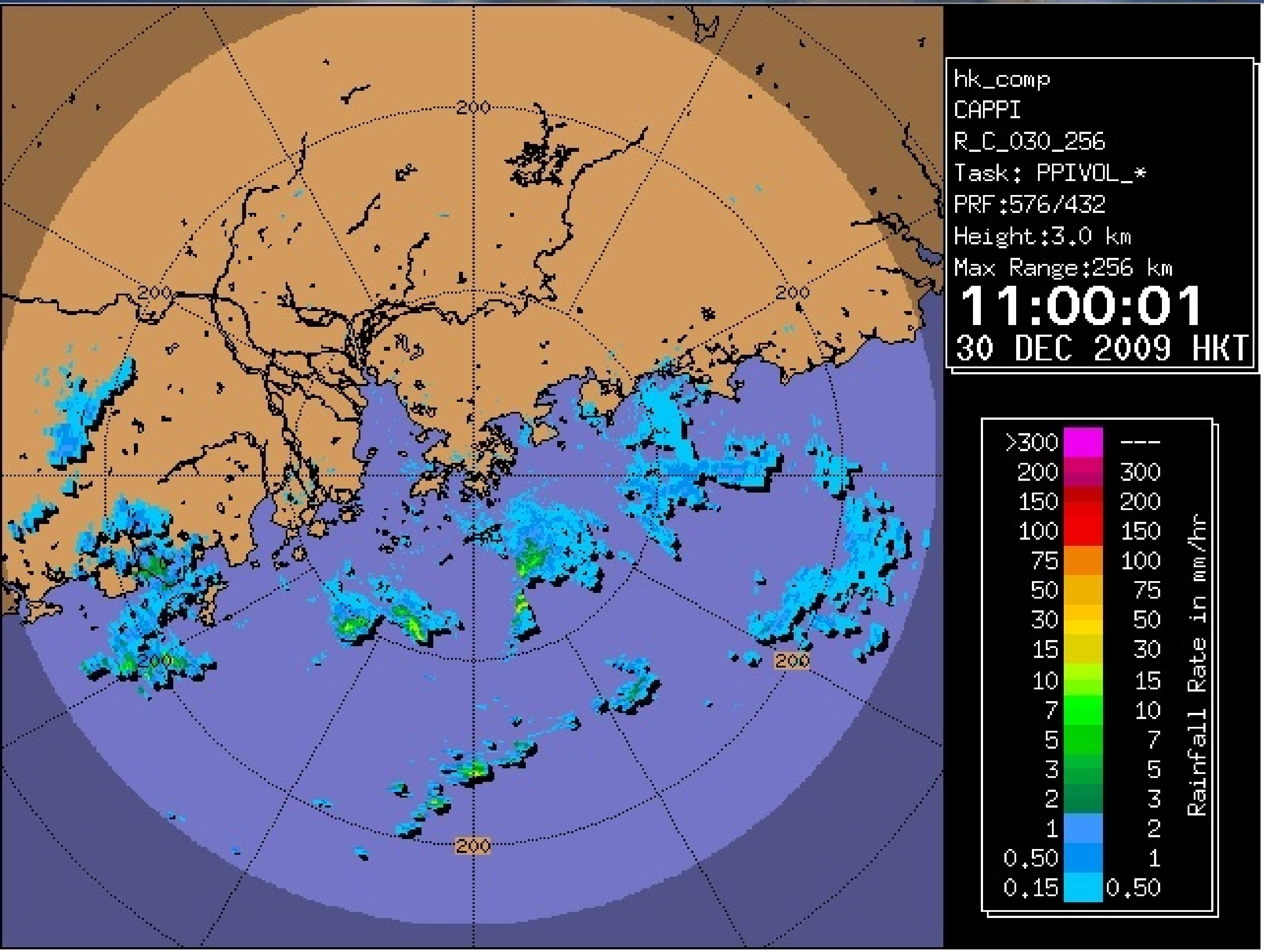
Rainfall Rate in mm/hr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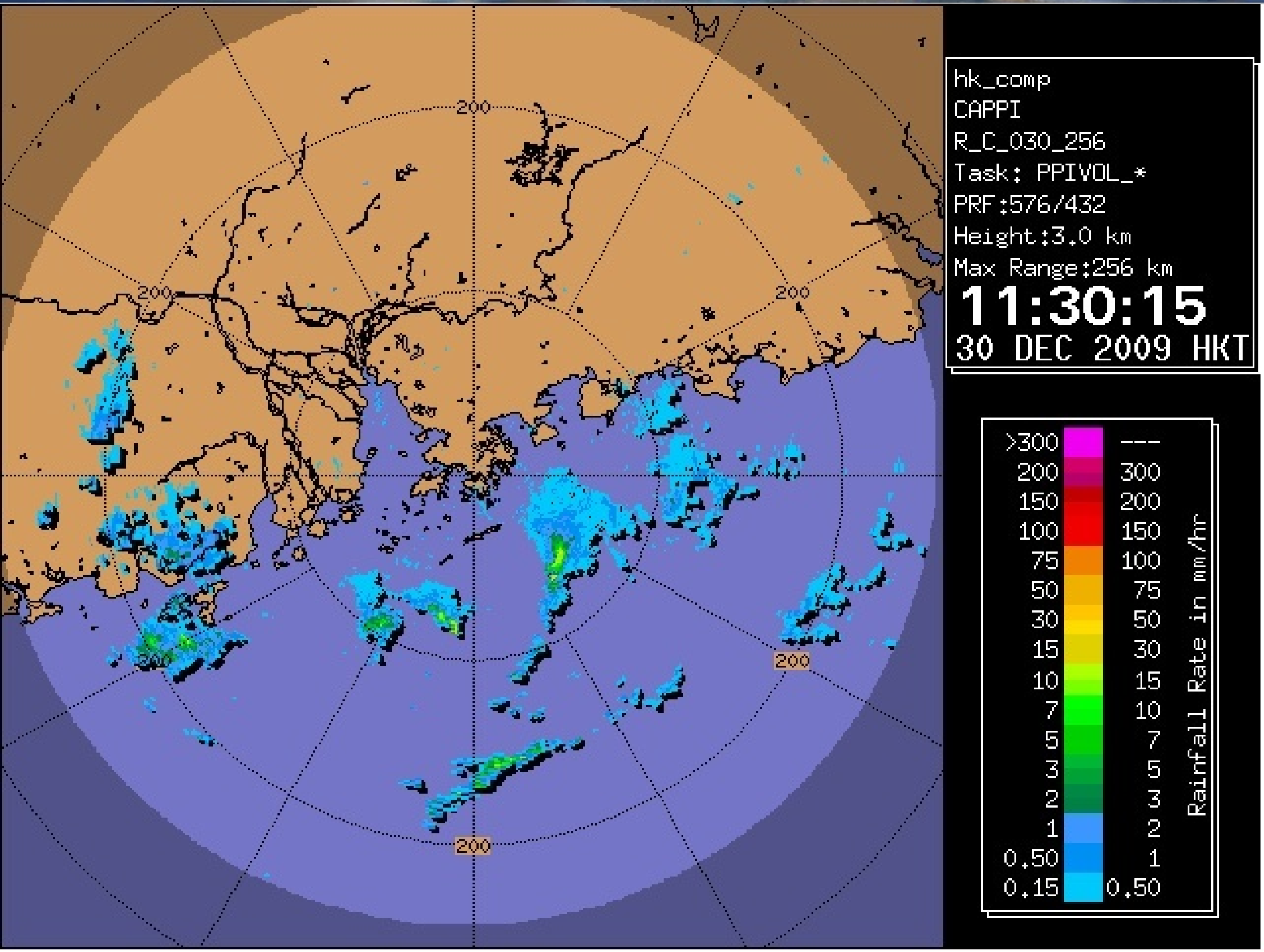
Rainfall Rate in mm/hr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Rainfall Rate in mm/hr
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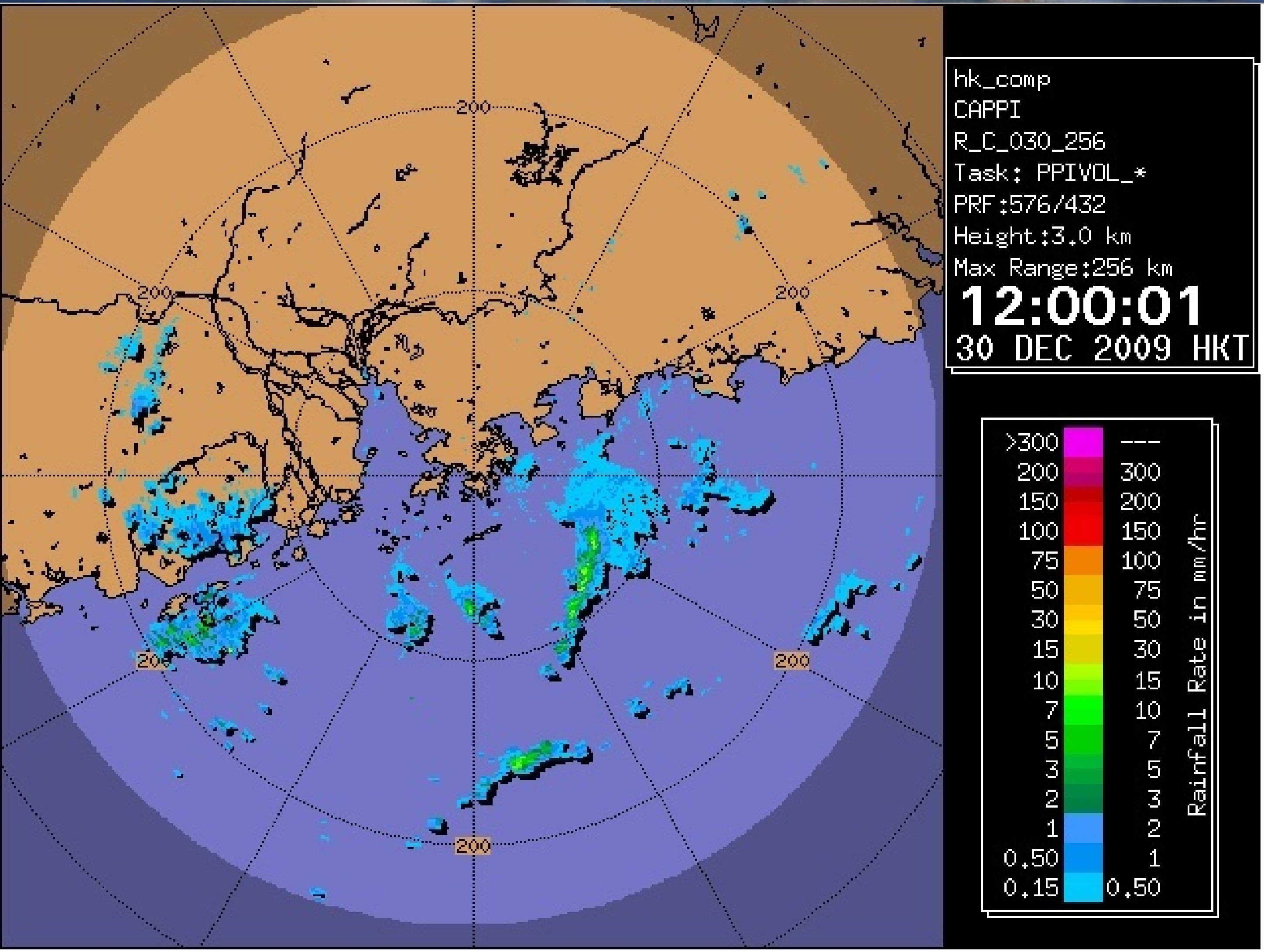

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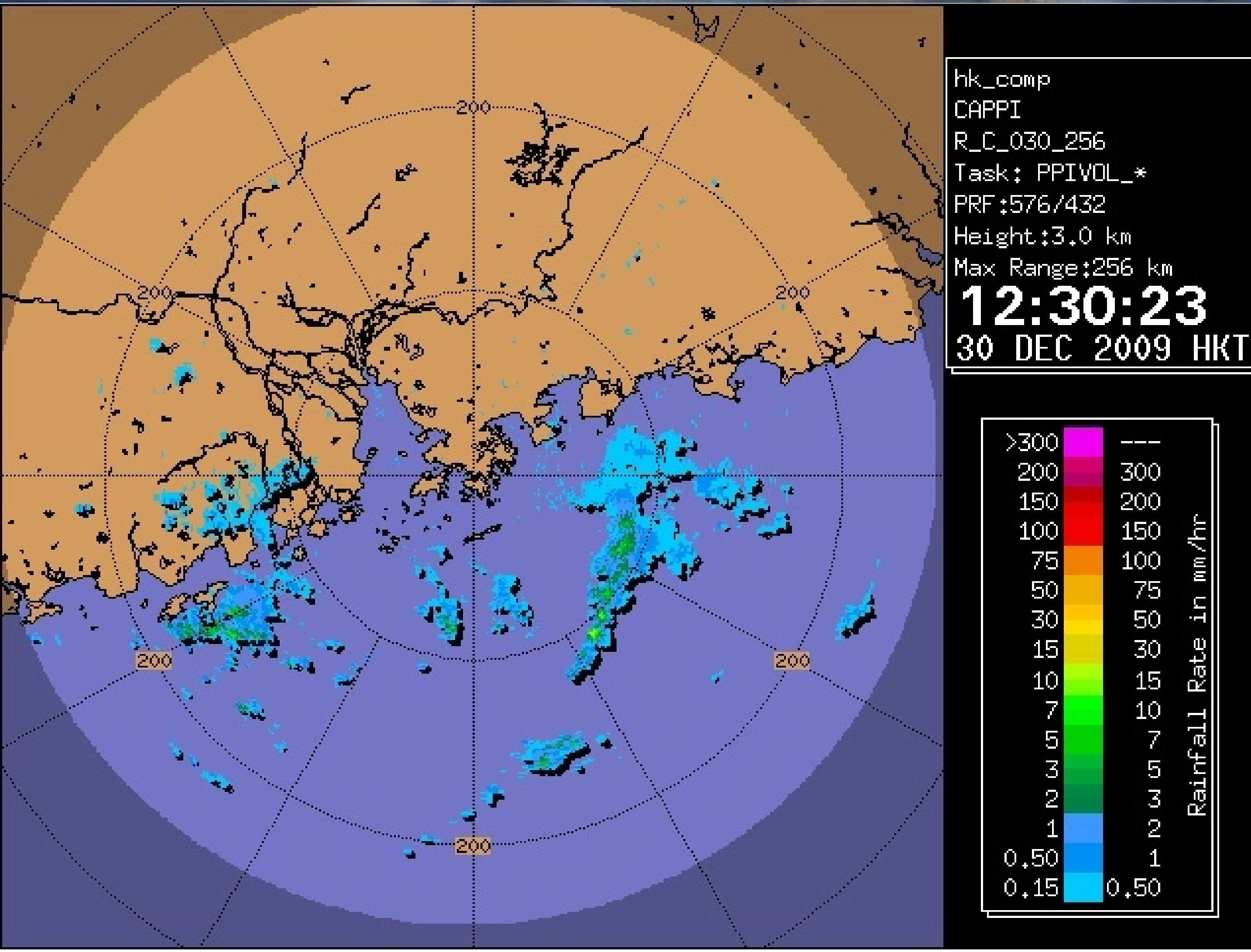
Rainfall Rate in mm/hr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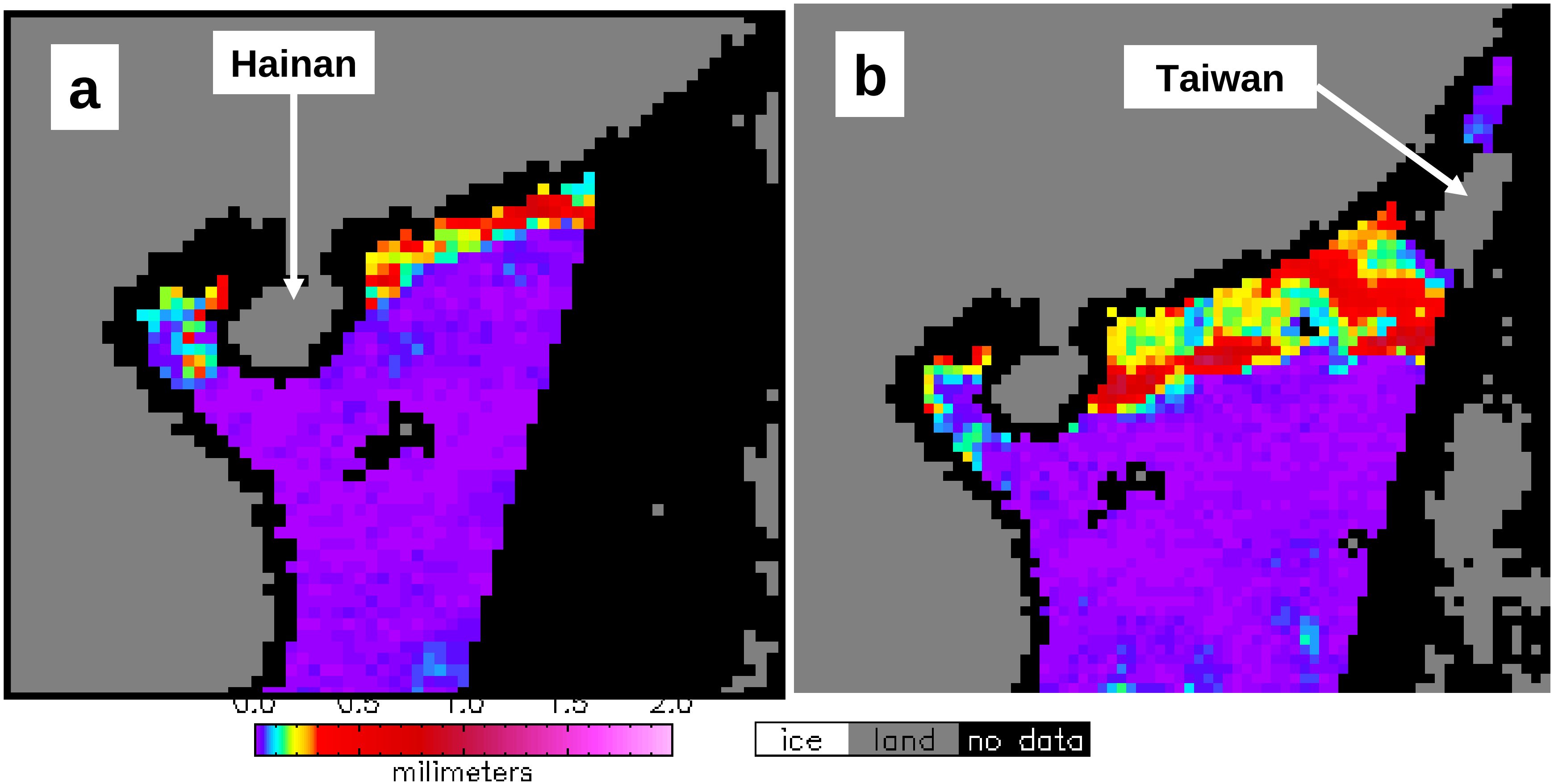
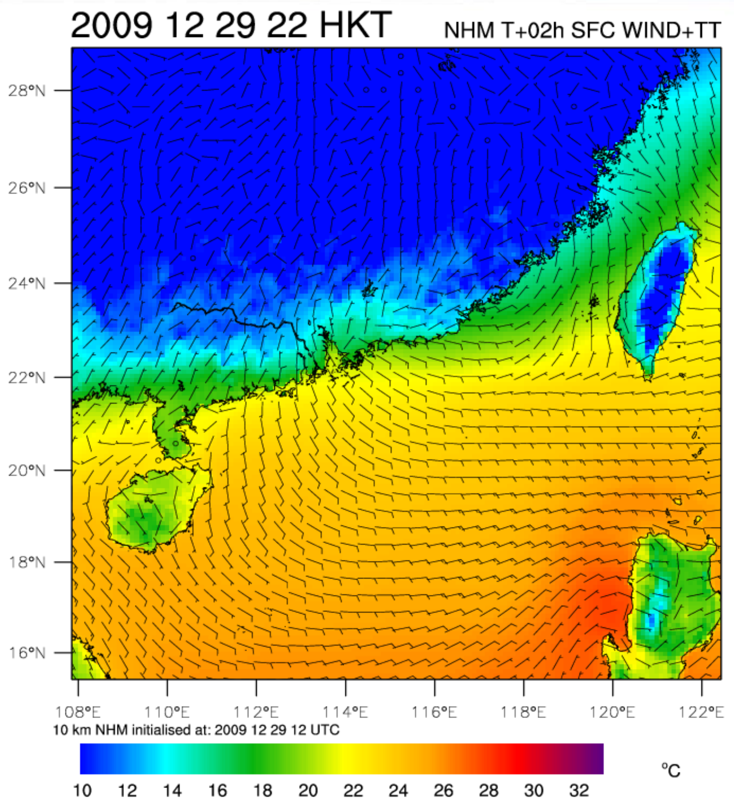
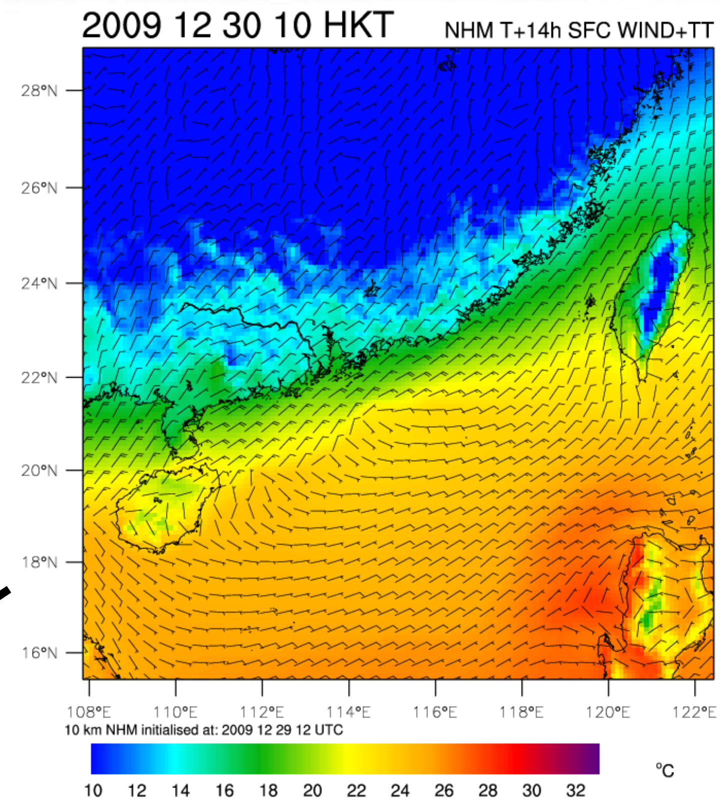


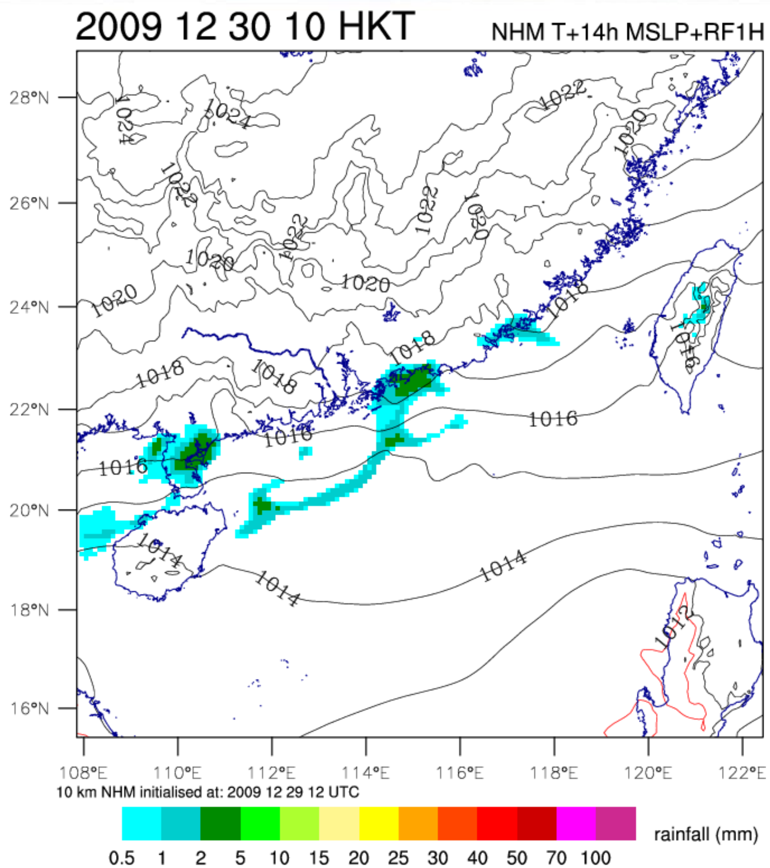
Cloud liquid water content inferred from SSM/I data acquired at (a) 2248 UTC 29 December 2009 (left plot) and (b) 2224 UTC 30 December 2009 (right plot) showing the propagation of the frontal line southeastwards.

Simulations carried out with the AIR model of the Hong Kong Observatory

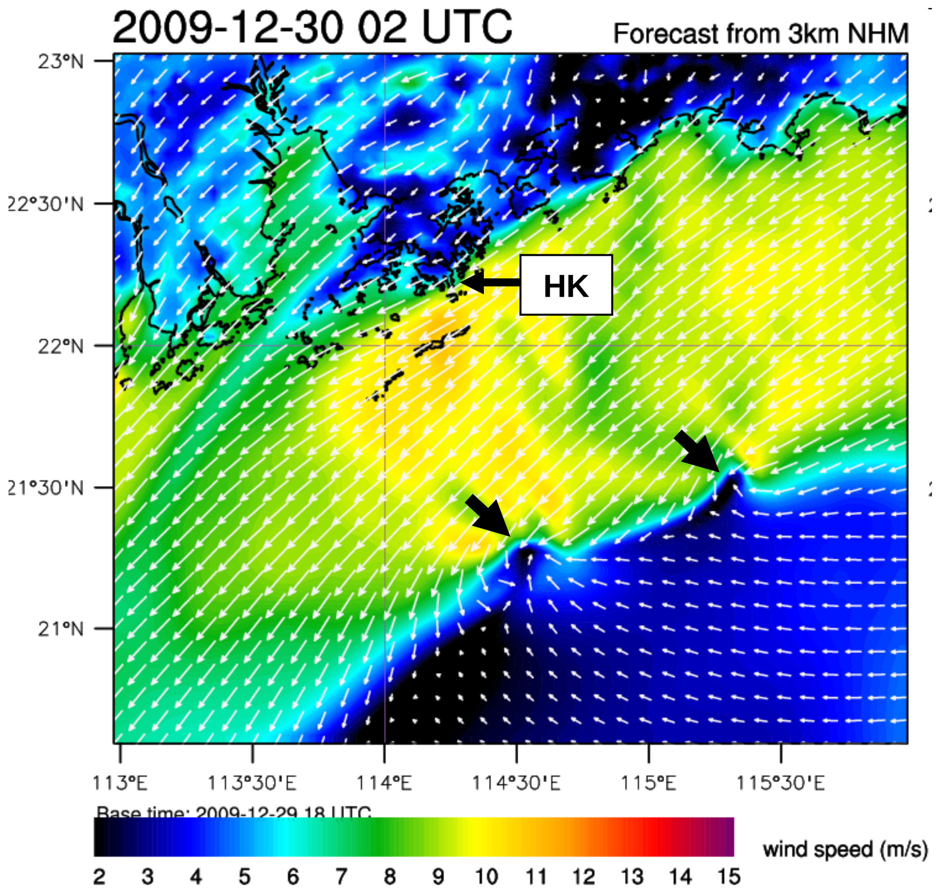




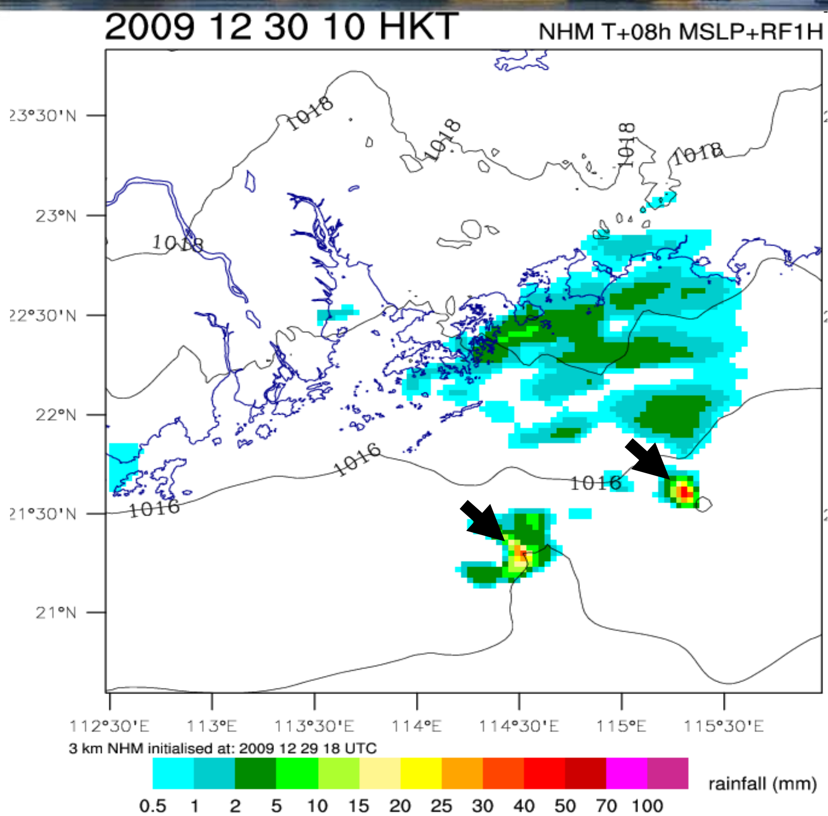
Surface wind (10 m level) and air temperature (2 m level) fields calculated by the AIR model with 10 km resolution for 1400 UTC on 29 December 2009 (left plot) and 0200 UTC (1000 HKT) 30 December 2009. The air temperature is shown by the color shading and the wind vector by conventional wind barbs.



Mean-sea-level pressure (contours) and 1-hour accumulated rainfall (color shading) calculated by the AIR model with 10 km resolution for 0200 UTC (1000 HKT) 30 December 2009.



Surface wind vectors (white arrows) and wind speed (color shading) calculated by the AIR model with 3 km resolution for 0200 UTC (1000 HKT) 30 December 2009. Note the two dents (embayments) in the frontal line marked by arrows which coincide with strong rain cells.



Mean-sea-level pressure (contours) and 1-hour accumulated rainfall (color shading) calculated by the AIR model with 3 resolution for 0200 UTC (1000 HKT) 30 December 2009.The contour lines denote isobars in hPa and the color shading rainfall in mm. Note the two distinct rain cells marked by arrows which are located at the positions where the frontal line has dents (Fig. 14).

Conclusions

•For the first time, a coastal wind front over the South China Sea caused by the strengthening of the northeast monsoon has been investigated using multi-sensor satellite data, weather radar data, and a meso-scale atmospheric model.

•The remote sensing data show quite good agreement with the model data.

•. However, some differences are observed, which can be used to improve the model.

•High resolution SAR images are an excellent means to validate and improve high-resolution mes-scale atmospheric models.

Thank for your attention