



# Current progress for improving the skill of 0-6 hours precipitation forecasting at Meteorological Service Singapore

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Acknowledgements: Xiangming Sun, Anurag Dipanka, Jeff Lo, Jerry Liu and Tony Song, CCRS, MSS  
Forecasters from Central Forecast Office, MSS  
All SINGV project team members, UKMO

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# Background

--- Why 0-6 hour nowcasting is important for Singapore

## Public forecasting

2 hour nowcast: it is updated at anytime when necessary  
12 hour short forecast: it is updated every 12 hours



Local water and risk management

## Aviation forecasting

0-6 hour nowcast: it is required to be updated every 3 hours (but if it's necessary, it can be updated at anytime)



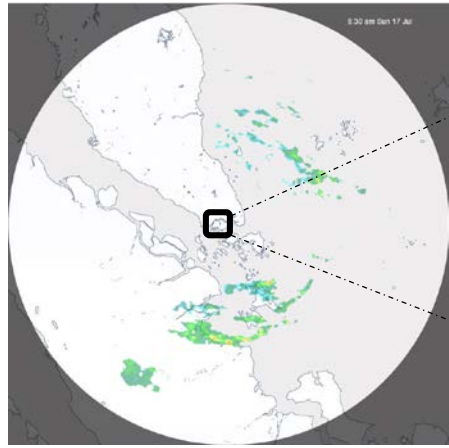
Flight plan/management for Civil Aviation Authority



# Background

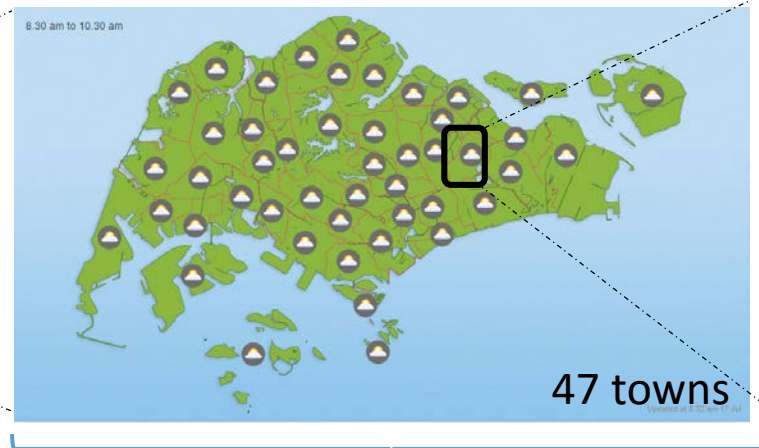
--- Why 0-6 hour nowcasting is difficult in Singapore

Radar



480 km

480 km



≈ 50 km

47 towns

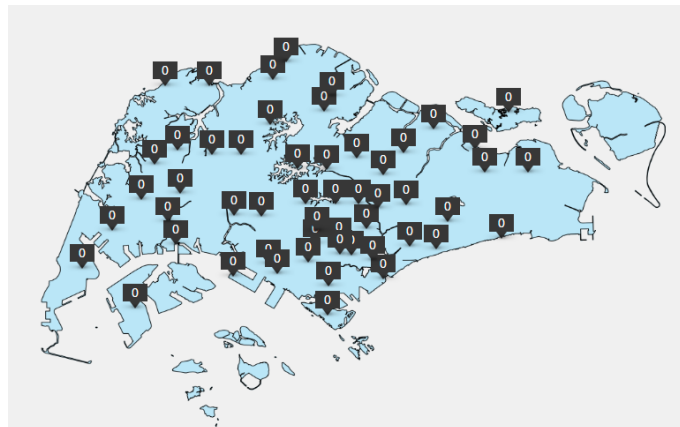
≈ 30 km



< 6.5 km

< 3.5 km

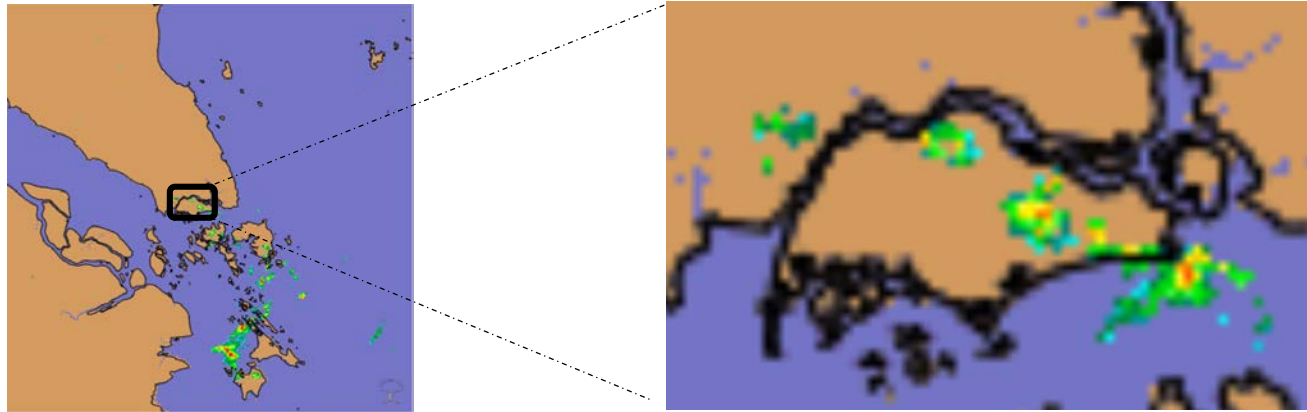
Rain Gauge



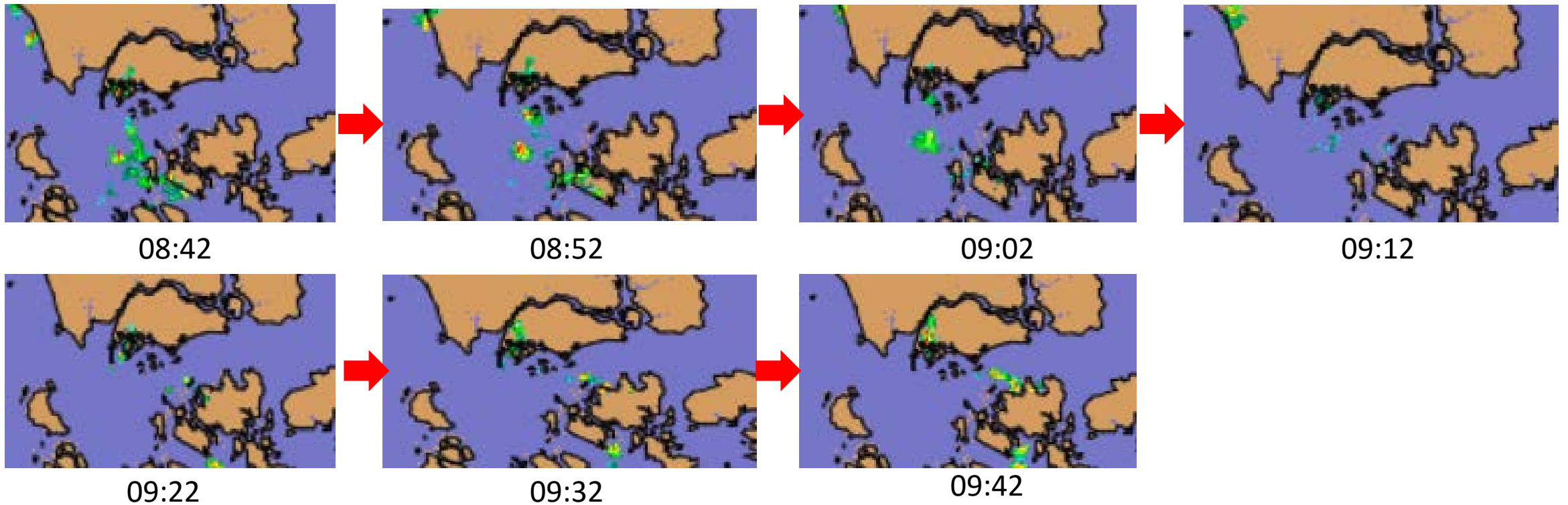
Very high density of observations within SG, but limited observations outside

# Background

--- Why 0-6 hour nowcasting is difficult in Singapore

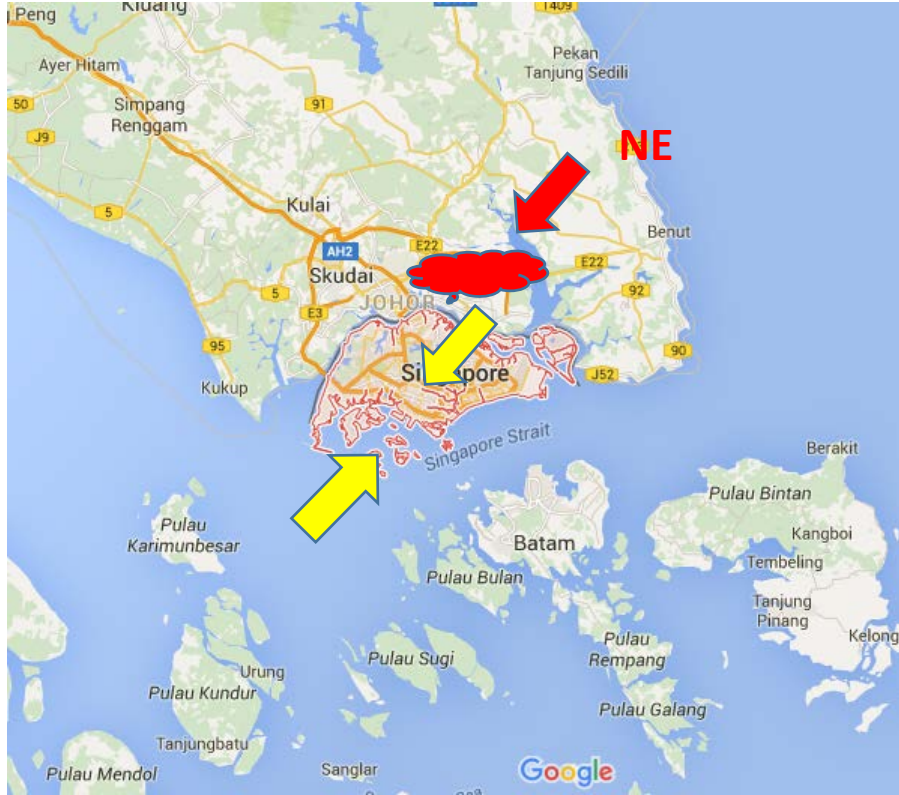


The spatial scale of thunderstorm is very small  
Systems usually develop very fast

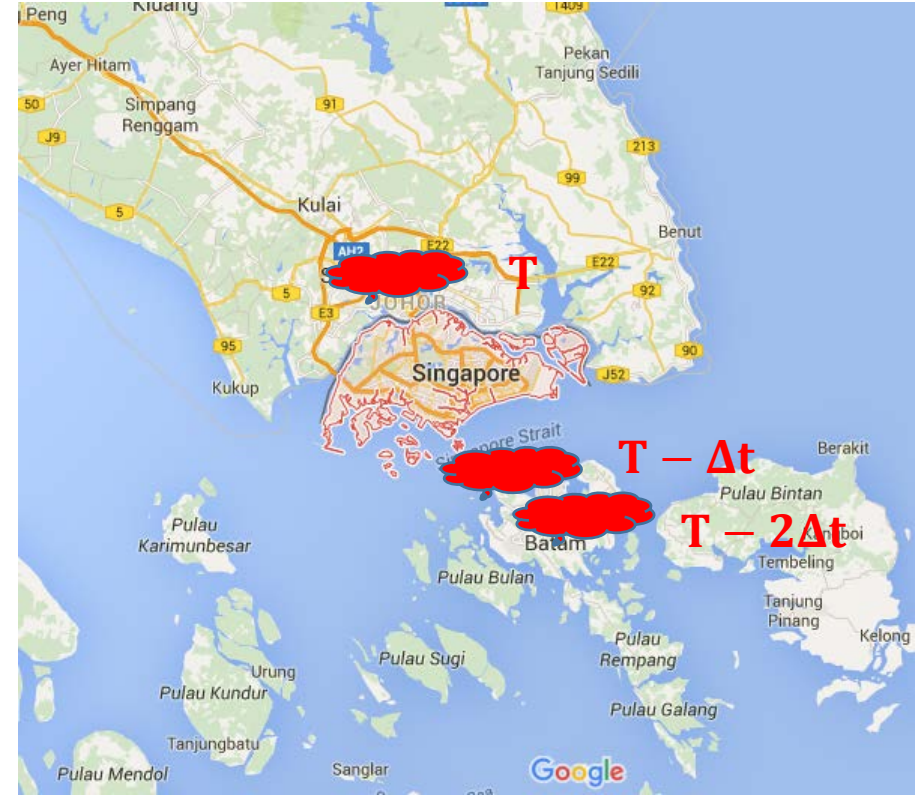


# Current research activities

--- Examples: conceptual model from forecasters



*The strength of the surface wind determines the location of convergence, which is important in determining the number of areas affected*



*Sometimes we may expect a “jump” where a TS may skip the central area of SG and redevelop in the north, as the land heating provides additional energy for the TS*

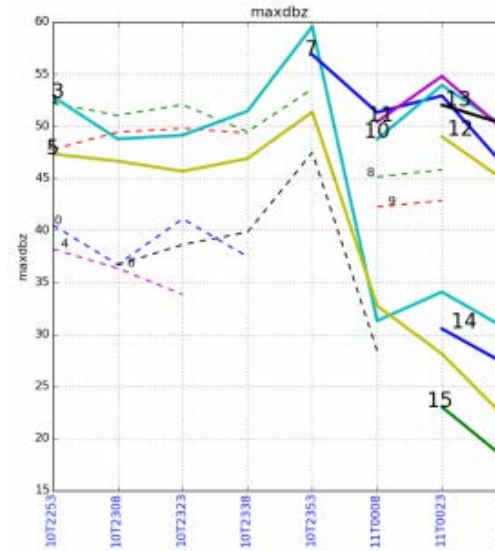
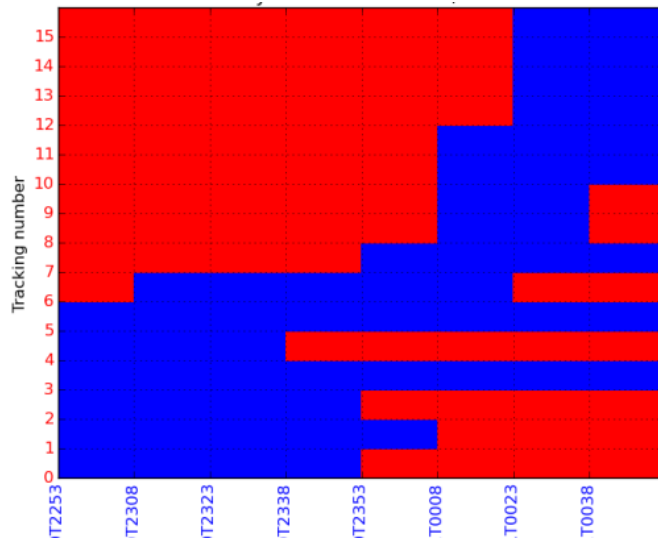
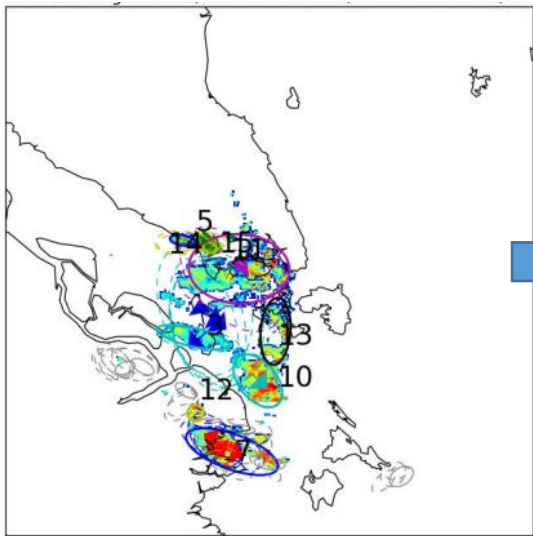
# Current research activities

--- Traditional approaches: extrapolation

Commercial/open source software available: { The Short Term Ensemble Prediction System (STEPS) (Bowler et al., 2006)  
Thunderstorm Identification, Tracking, Analysis and Nowcasting (TITAN)

Local developed system: (Since 2015) { Stracking (under development): tracking everything: from radar, satellite to NWP fields  
OF system (under development): A pure Optical flow based system

Reasons: (1) highly customized system; (2) the capability of ingesting local experiences; (3) Local copyright

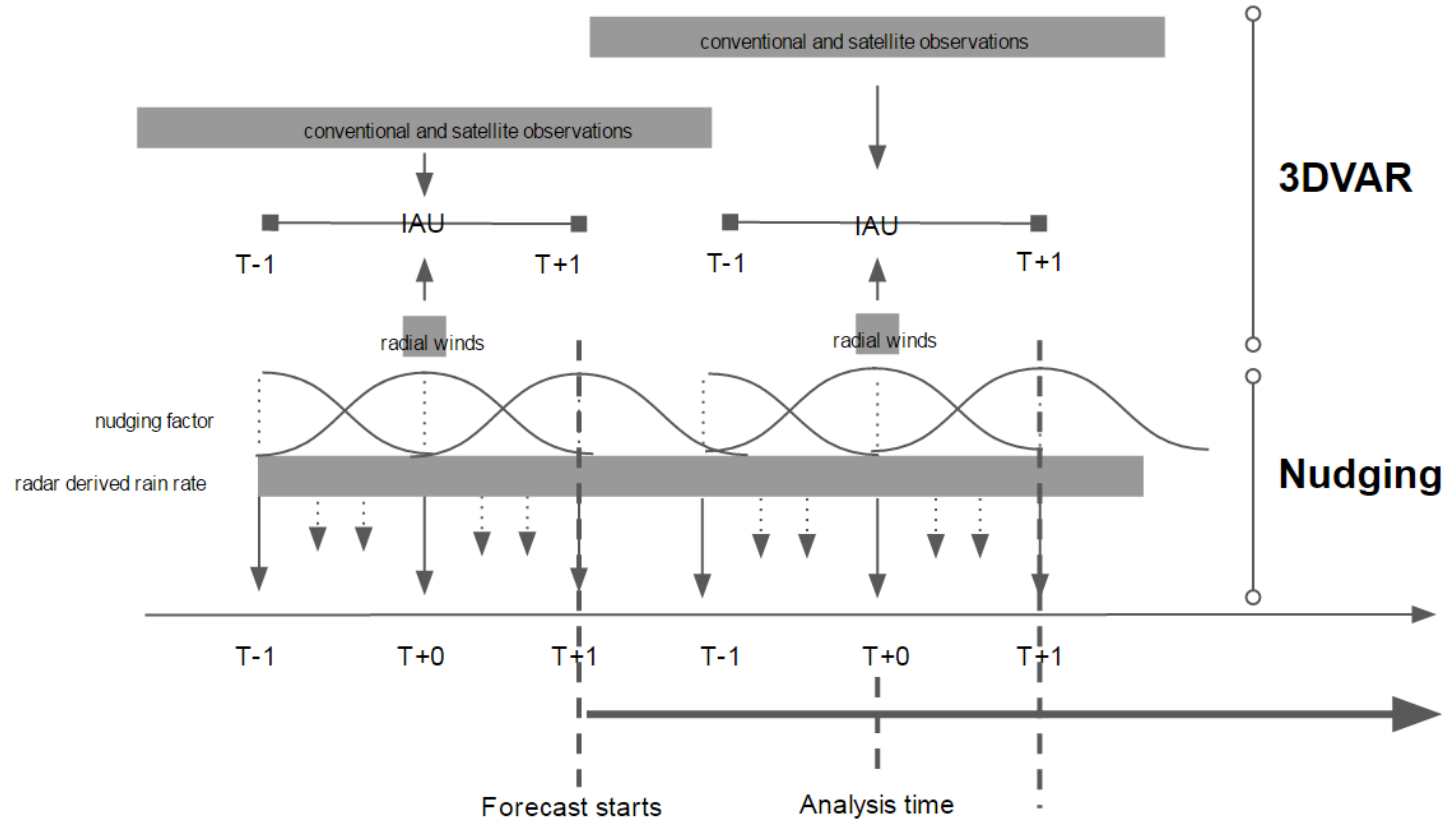


Limited skill for extrapolation alone approach due to the limited skill to represent the phase change of a system

# Current research activities

--- NWP: Numerical Weather Prediction and Data Assimilation

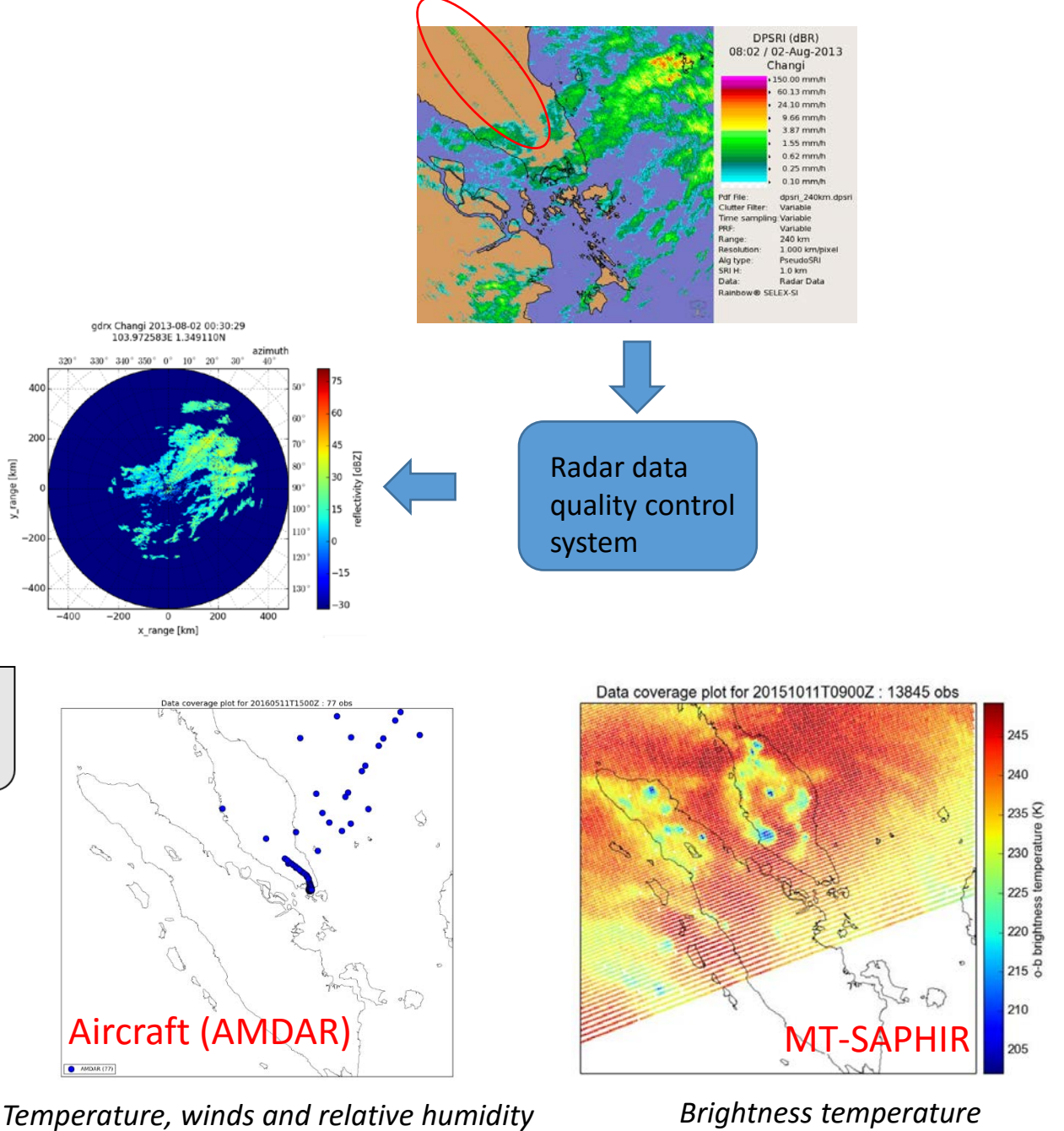
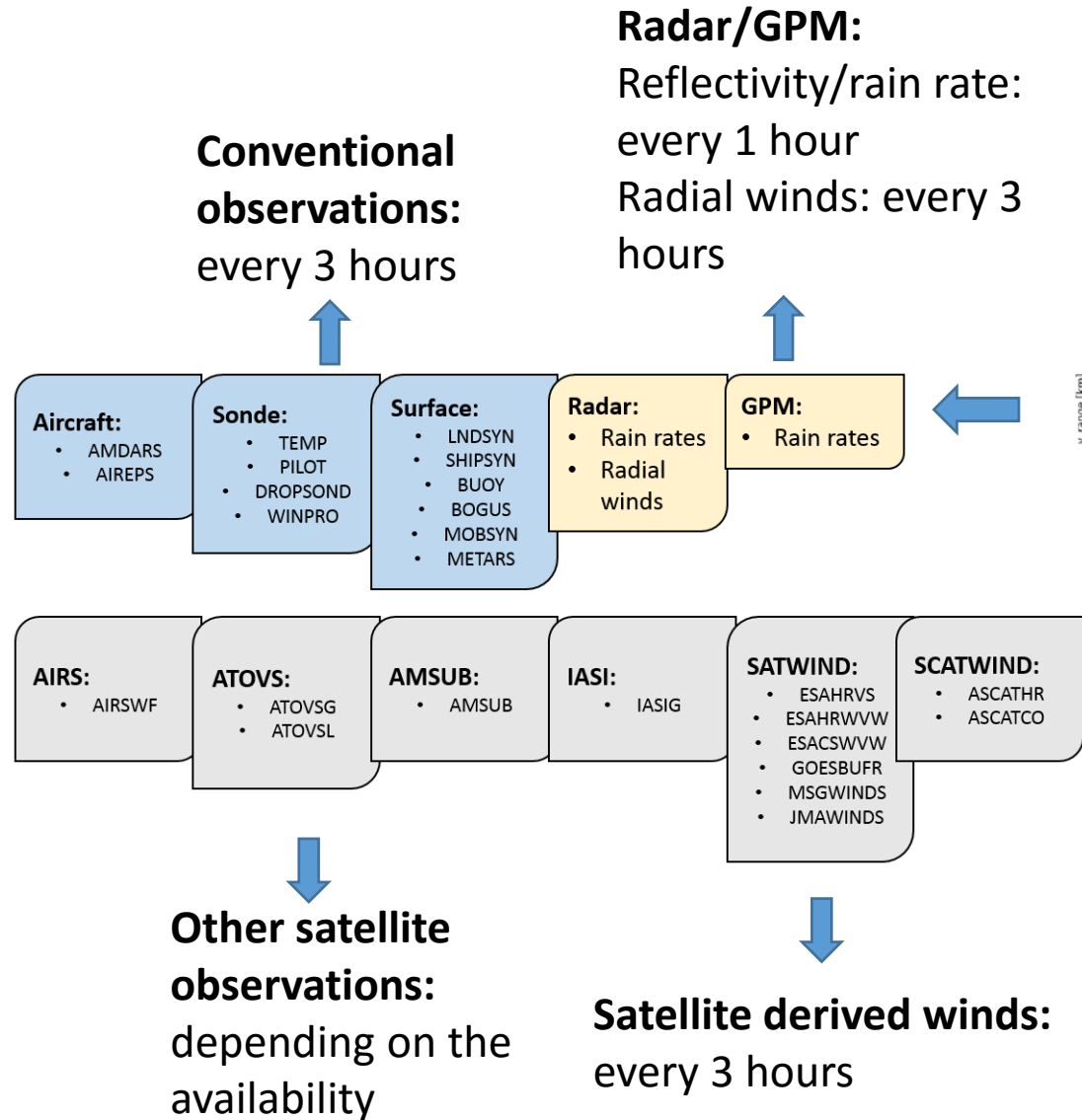
SINGV: a collaboration project between MSS and UKMO



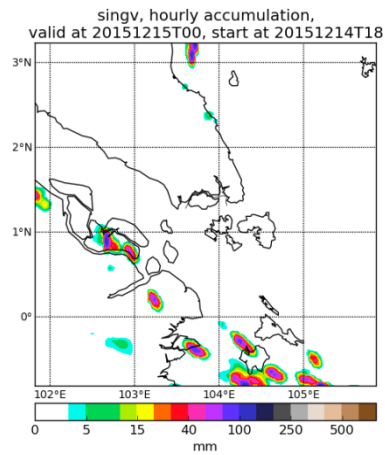
SINGV data assimilation scheme: a. The present cycle is initialized from the 1 hour forecasts of the previous cycle; b. Radar derived rain rate is incorporated into the model using LHN, while all other observations are assimilated using 3D-Var approach



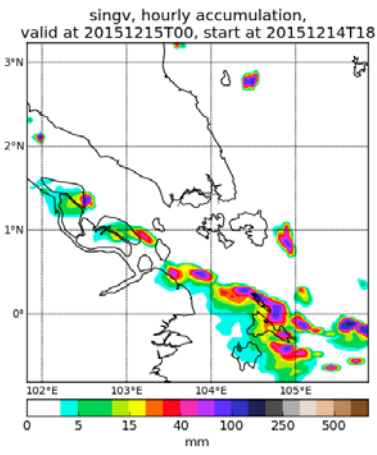
# Observations list used in SINGV



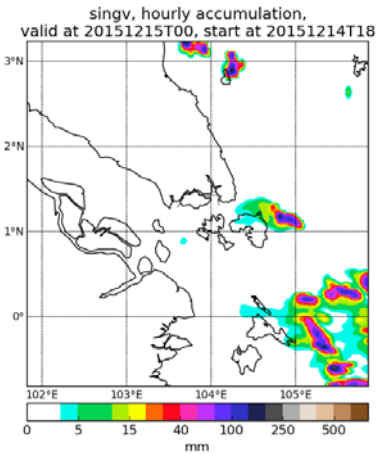
# Case 1: 6 hour forecast, valid at 0000 UTC 15 Dec 2015



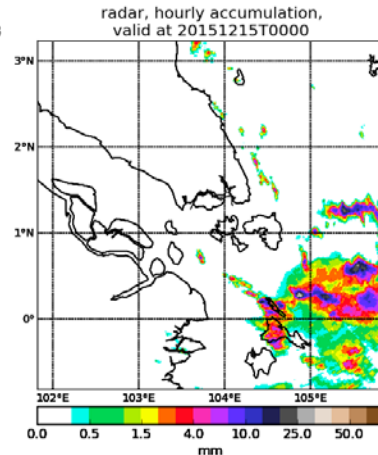
Downscaler



3D-Var



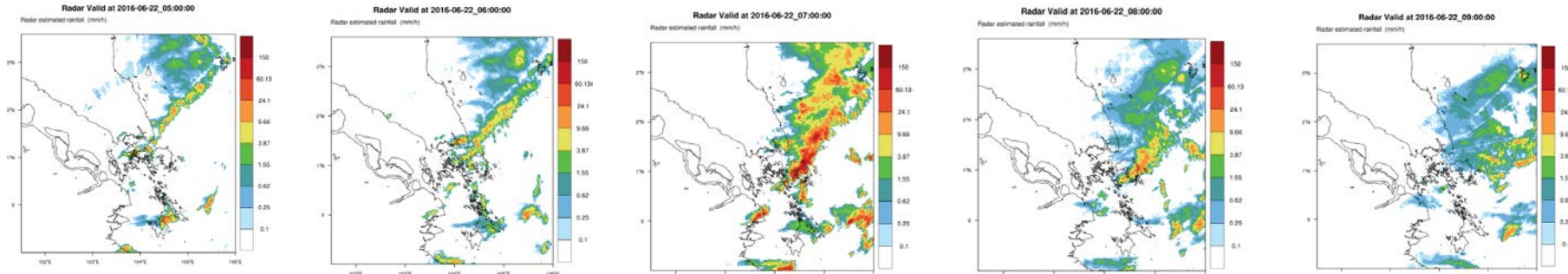
3D-Var+LHN



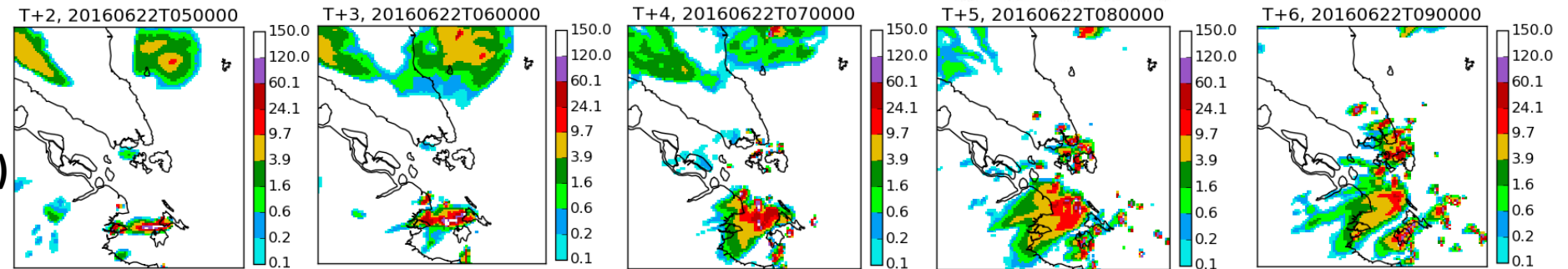
Radar

# Case 2: 2-6 hour forecasts, with an experimental hourly cycling system

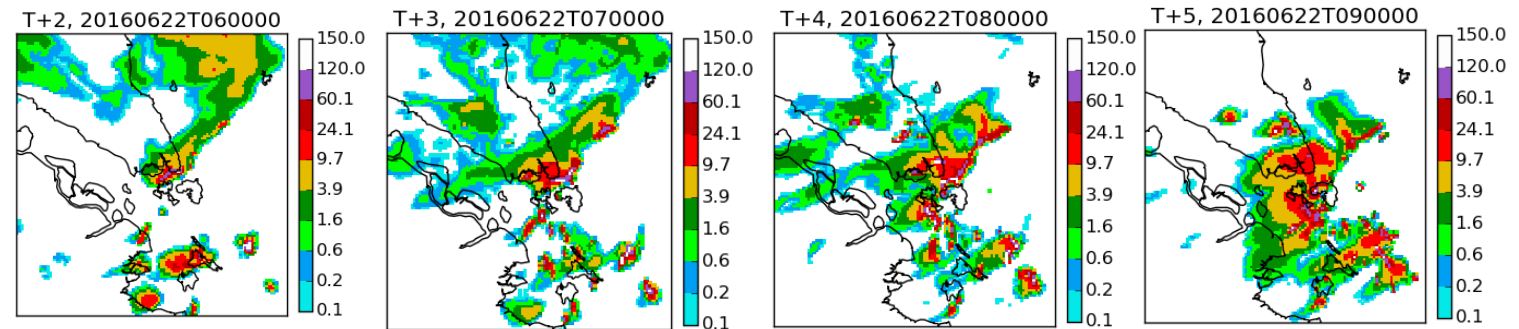
**Observation**



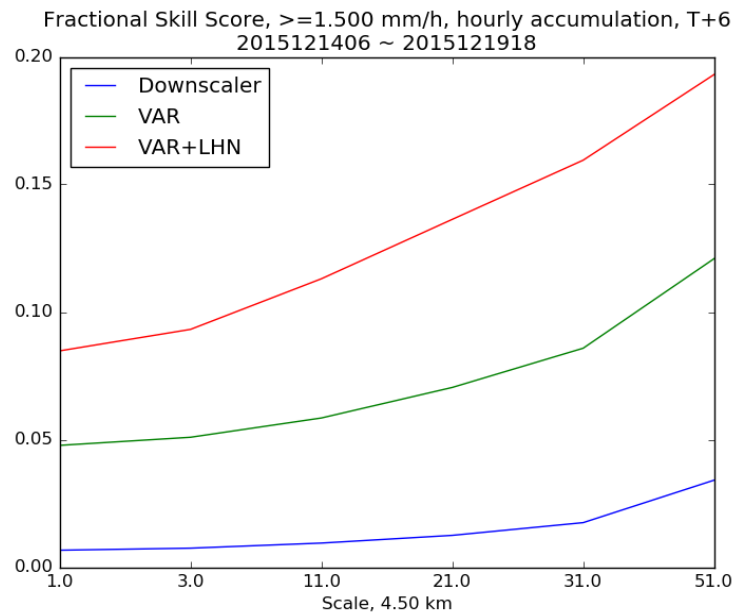
**Forecasts  
(updated at 0300)**



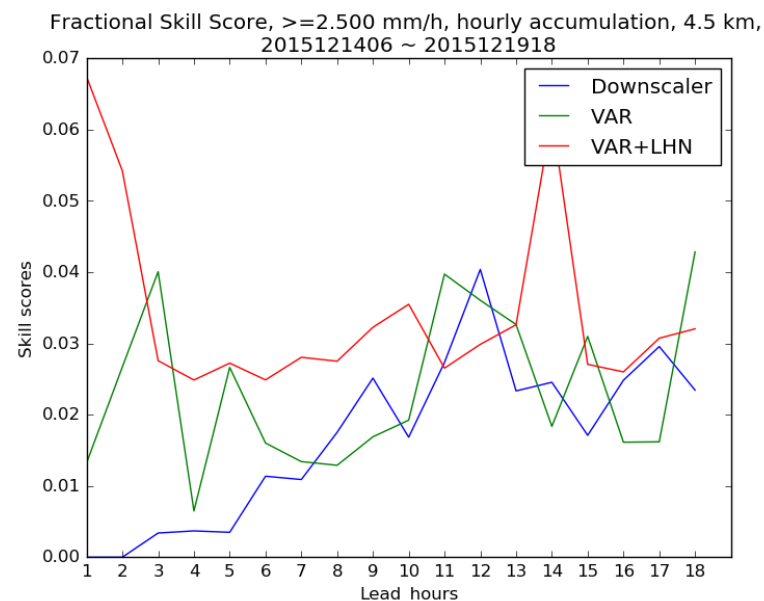
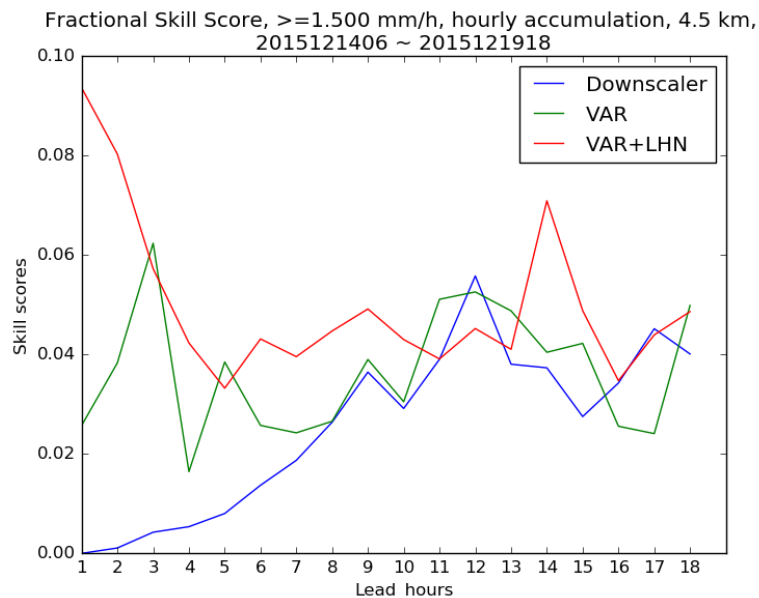
**Forecasts  
(updated at 0400)**



*Note that there are two hours waiting time for forecasters to receive the latest updates*



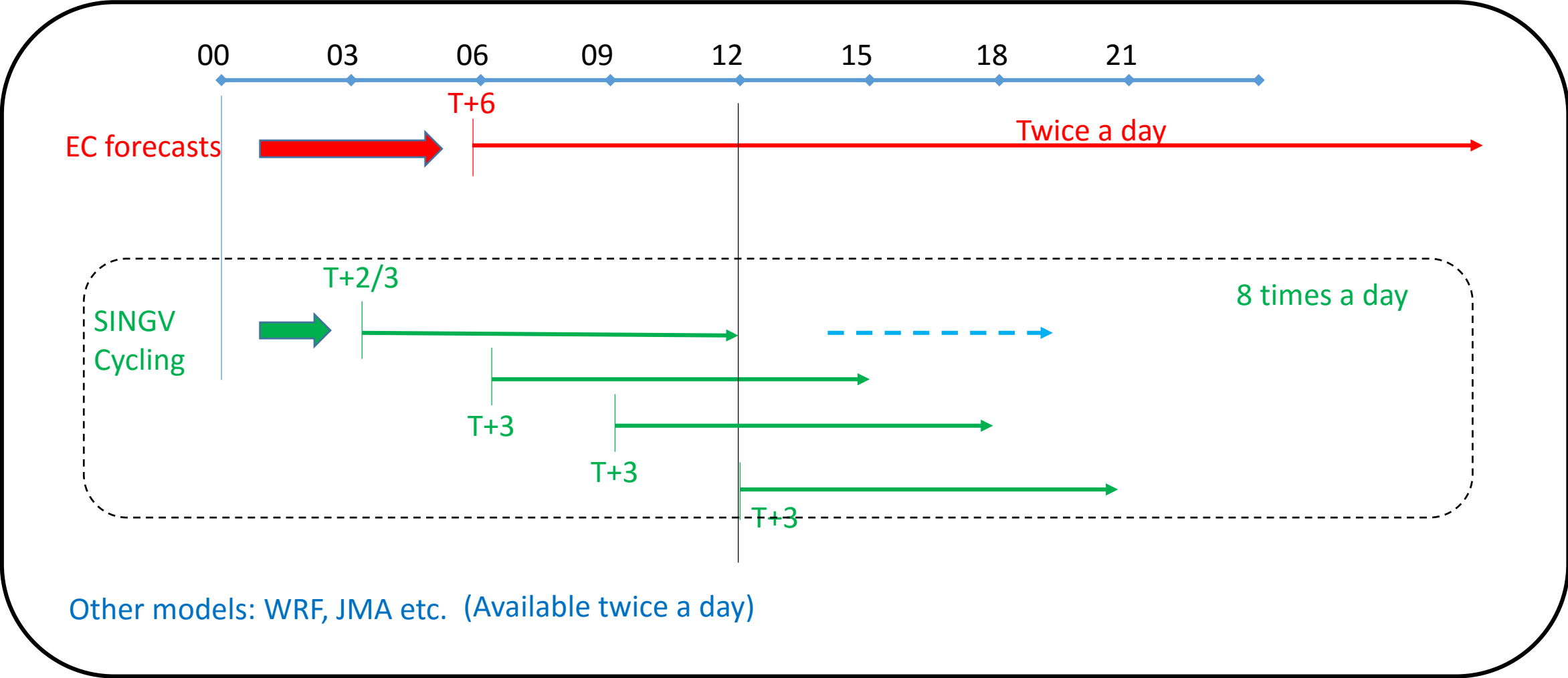
Average FSS at different scales for T+6h from 600 UTC 14 December 2015 to UTC 1800 UTC 18 December 2015



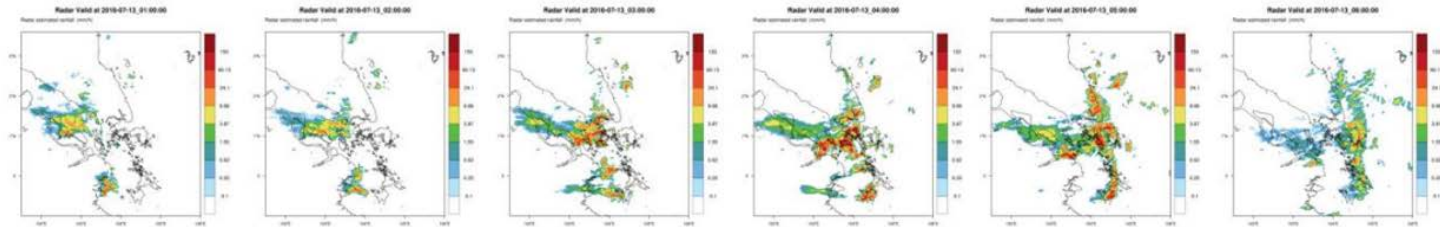
Fractional Skill Score (FSS) for different thresholds (1.5 mm/h and 2.5 mm/h) over 18 hours forecasts at 4.5 km. All cases from 0600 UTC 14 December 2015 to UTC 1800 UTC 18 December 2015 were included.

# Future plan

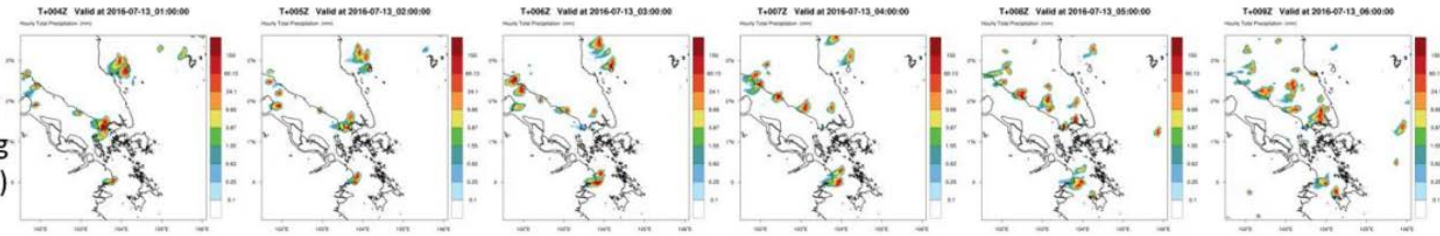
All available models at MSS



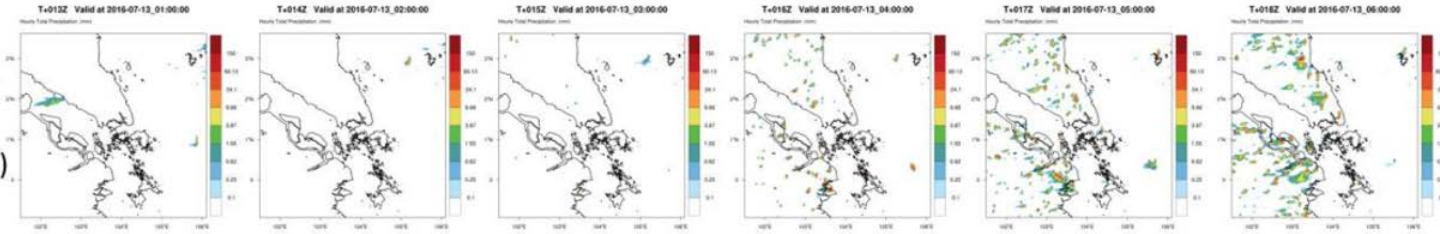
obs



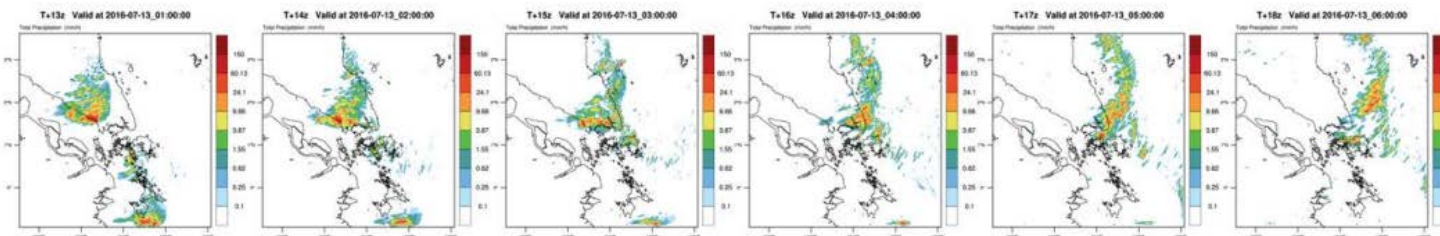
SINGV  
Cycling  
(latest)



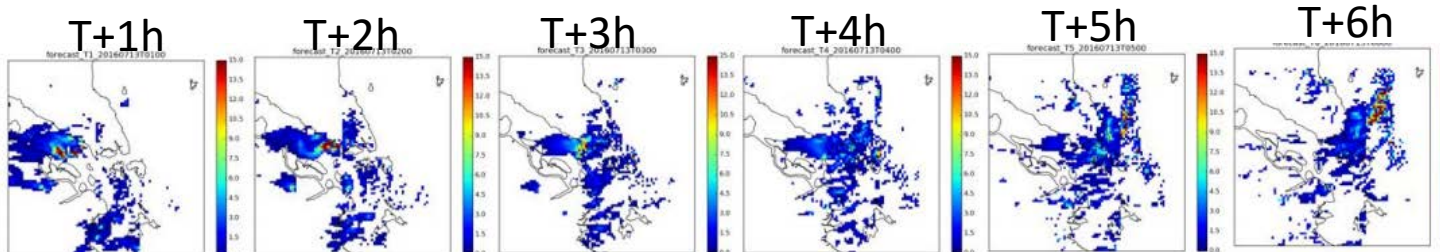
SINGV  
DS  
(latest)



WRF



Hybrid



### What we should do ?

- Optimal Interpolation ?
- Particle Filter ?
- Multiple regression ?
- ....

At very initial stage:  
Statistical Nowcasting Model (SNM)

# Conclusion

1. Approaches and skills of nowcasting in tropics can be very different from the one in mid-high latitude
2. The traditional extrapolation based nowcasting scheme has very limited skill
3. NWP based nowcasting has the potential to improve the skill, although currently it has almost no skill on localized thunderstorm forecasting
4. Some conceptual models would still play important roles
5. A statistical model may be required to take advantages of all available approaches (models)

Thanks for your time

Any suggestions on nowcasting in tropics are appreciated

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