A Comparative Analysis of Clear-Sky TB Estimation Techniques for Snowfall Retrieval

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1 Summary

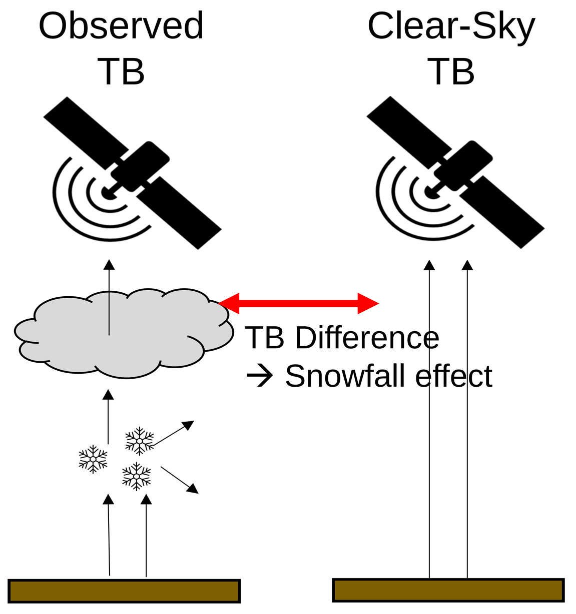
The Global Satellite Mapping of Precipitation (GSMaP) has been developed under the Japan Aerospace Exploration Agency (JAXA) leadership. In an effort to improve snowfall retrieval in GSMaP, utilizing the clear-sky brightness temperature is being considered.

Here, the clear-sky brightness temperatures estimates based on three different approaches, including the combination of the empirical model and dynamic emissivity atlas, are compared.

2 Clear-sky TB

In this study, the clear-sky brightness temperature (TB) for a snowing scene is defined as the expected TB if there were no clouds or snowfall in the scene.

The difference between observed TB and clear-sky TB should contain information about snowfall and clouds. The motivation of this study is to estimate the clear-sky TB for snowing scenes and use it as ancillary information for passive microwave-based snowfall retrieval.



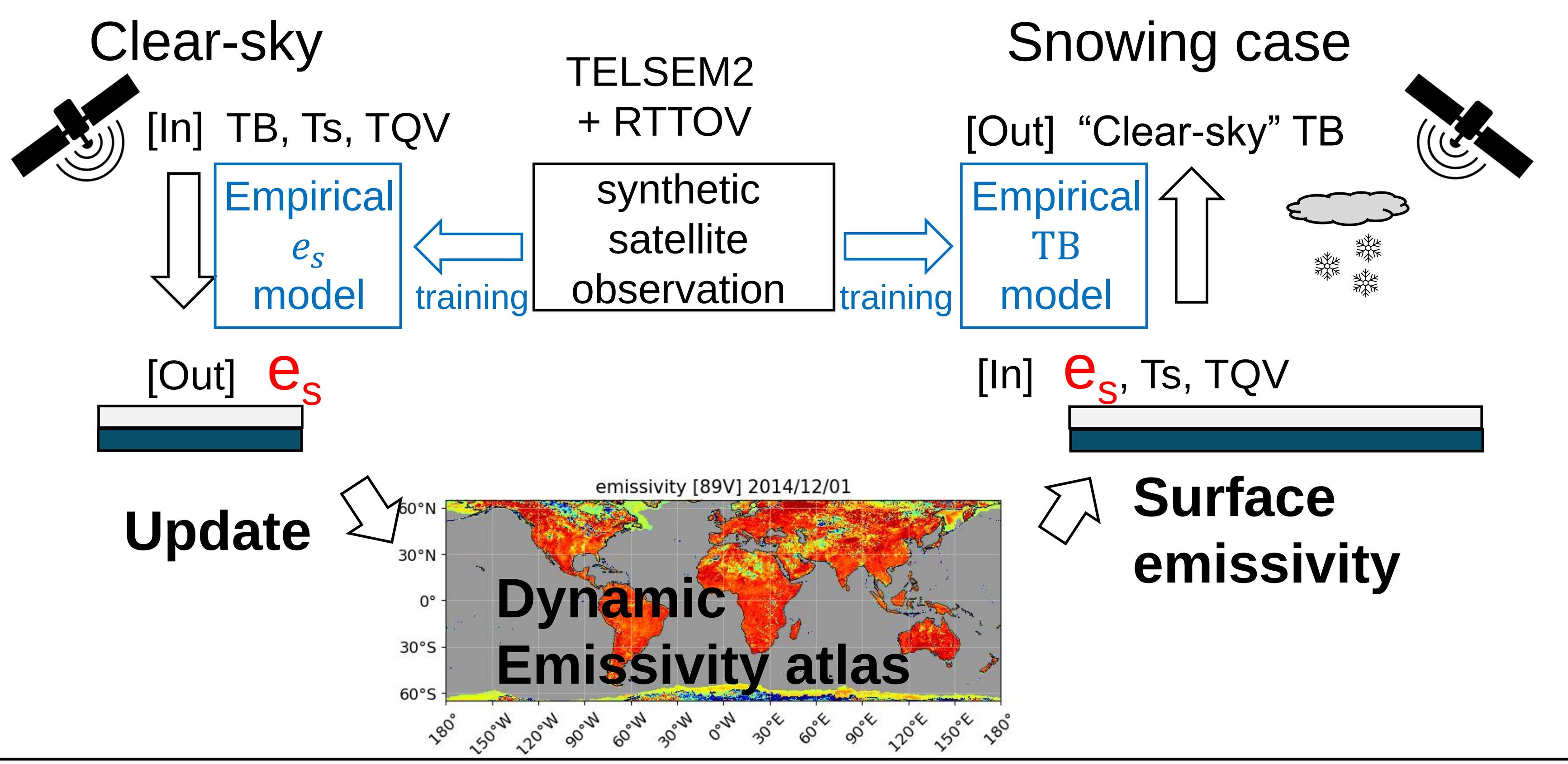
3 Approaches

Three approaches are tested for the clear-TB estimation.

1. Clear-sky TB climatology
2. Emissivity climatology atlas (TESLEM2) + RTM (RTTOV)
3. Dynamic emissivity atlas + empirical TB model

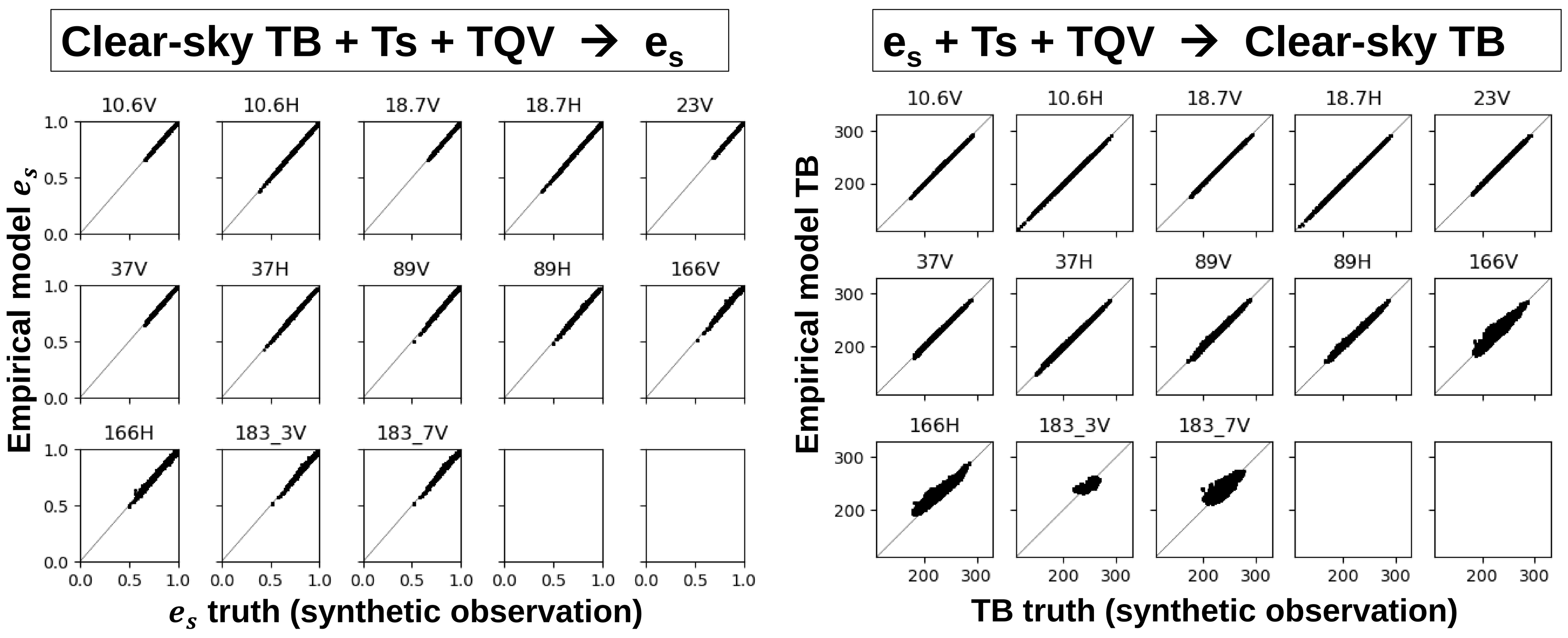
The first approach leverages the surface emissivity climatology provided by TELSEM2, combined with radiative transfer simulations via RTTOV. The second method utilizes a monthly climatology of the observed clear-sky TB, while the third approach employs a dynamically updated surface emissivity map in conjunction with an empirical TB model, catering to real-time applications. These approaches are tested for the GPM Microwave Imager (GMI) channels. The third approach is explained in more detail to the right.

4 Strategy (Dynamic e_s atlas + empirical TB model)



5 Empirical models

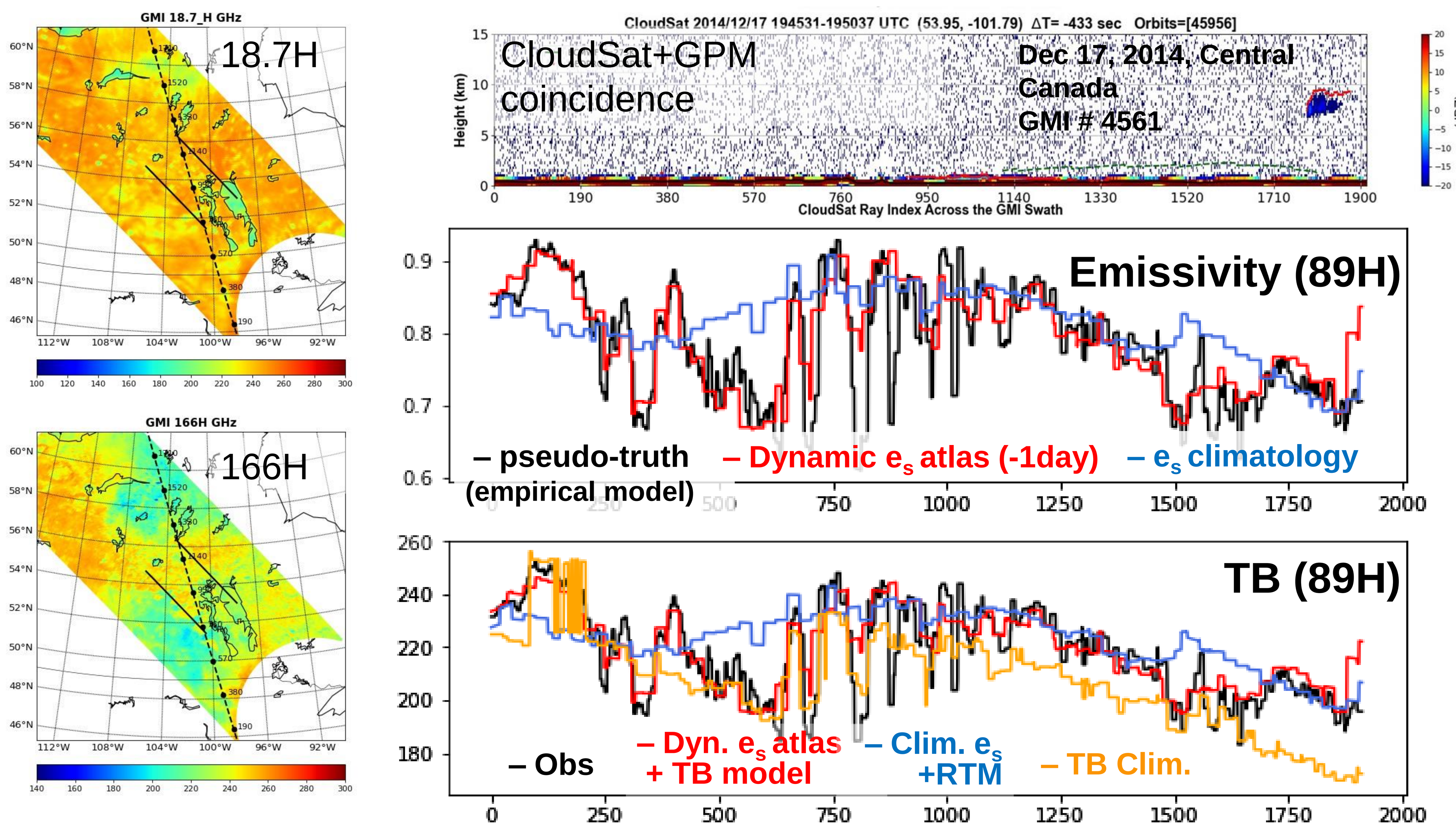
Empirical models were trained and validated using a synthetic satellite observation dataset.



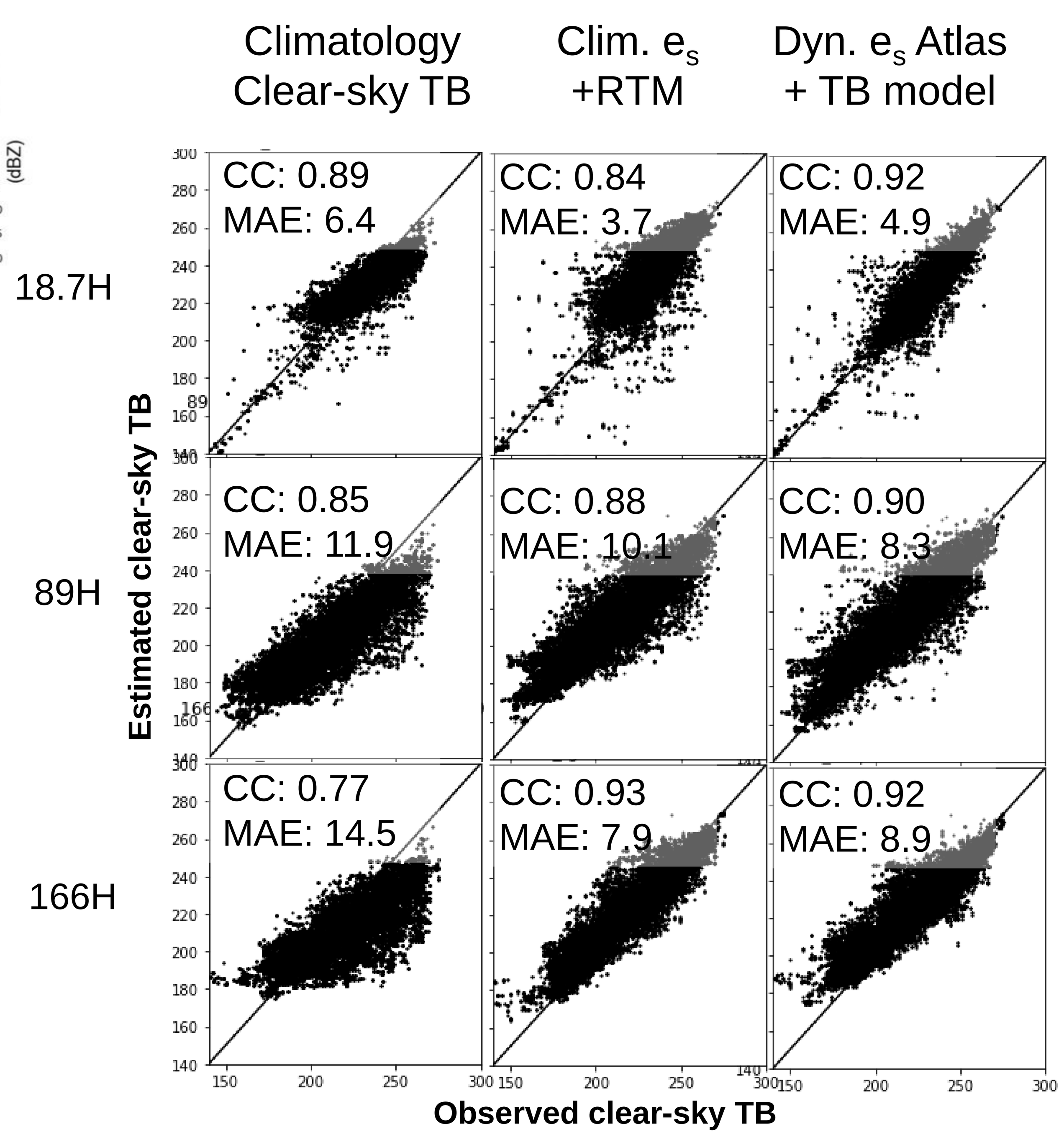
6 Results and conclusions

The estimated TBs are validated against the observed TB (by GMI) for clear-sky cases. Since the approaches tested here do not rely on variables directly affected by clouds and snowfall at the scene, similar estimation performance is expected for snowfall scenes.

The third approach, with its dynamic surface emissivity atlas and empirical TB model, exhibited superior performance in estimating clear-sky TB up to 89 GHz over snow-covered surfaces. For higher frequencies, both the second approach (employing TELSEM2 and RTTOV) and the third approach demonstrated comparable performance. These results underscore the potential of the dynamic emissivity atlas and the empirical TB model in improving clear-sky TB estimation.



Radar reflectivity factor (CloudSat-CPR), emissivity, and TB for a clear-sky scene. A CloudSat + GPM coincidence case on Dec 17, 2014, central Canada.



Validation of the estimated clear-sky TB.