This paper presents the generation and verification of the numerical situation frames for the EarthCARE L1 data. The simulations have been done with higher resolution than the footprints of the instruments of EarthCARE except the ATLID. And the results are reasonable compared to the observational data. However, I am confused by some sections. I think the authors need to explain the online simulation, offline simulation or just addition of data for the EarthCARE L1 data in section 4, 5 and section 7.

Thanks for the review and the valuable comments. Please find below our answers to your questions (in blue).

Major comments

1. Lack of descriptions of the NWP model setup in Section 3

- For realistic simulation, I would like to know the initial condition and lateral boundary information. And what kind of nesting method is used in this study?

Thanks for this remark which will be useful for the readers. We added the following description in the manuscript:

"The global analysis data used in Environment and Climate Change Canada's Global Deterministic Prediction System (GDPS) (Buehner et al. 2015) were used as the initial conditions for the outermost simulation domain at 10 km grid-spacing. The GDPS predictions are used as the lateral boundary conditions with the nesting method described in Thomas et al. (1998)."

References:

Buehner, M., McTaggart-Cowan, R., Beaulne, A., Charette, C., Garand, L., Heillette, S., Lapalme, E., Laroche, S., Macpherson, S. R., Morneau, J., and Zadra, A., 2015: Implementation of deterministic weather forecast systems based on ensemble-variational data assimilation at Environment Canada. Part I: The global system. Monthly Weather Review, 143, 2532– 2559, DOI: https://doi.org/10.1175/MWR-D-14-00354.1.

Thomas, S. J., Girard, C., Benoit, R., Desgagné, M., and Pellerin, P., 1998: A new adiabatic kernel for the MC2 model, Atmosphere-Ocean, 36:3, 241-270, DOI: 10.1080/07055900.1998.9649613.

- Do you overlap the separated domains at 250m resolution?

No. The innermost domains at 250 m are not overlapping with each other. To clarify this point, we change the phrase in section 3 as:

"It was simplest to align GEM's computational equator approximately along EarthCARE's orbit, and divide 6,200 km long frames into 13 ***non-overlapping*** inner-most domains (Δx=0.25 km) and run them separately"

- I am wondering about handling with the cloud fractions for the low clouds. Did you use the shallow convection scheme for the 250m simulations?

Yes. As mentioned in section 3, the shallow convection and boundary layer schemes are used in all simulation domains.

- What kind of turbulence schemes are used? Have you changed the turbulence scheme for 250m simulations?

The turbulent kinetic energy (TKE) scheme is used for 250 m simulation. Yes, there are some modifications of the turbulent parameterization for the 250 m simulation. We added the following description in the manuscript:

"The atmospheric turbulence is parameterized with a turbulent kinetic energy (TKE) scheme (Benoit et al. 1989, Bélair et al. 2005) named MoisTKE. For the simulations with 250 m horizontal grid-spacing, a modified mixing length with an asymptotic value based on the horizontal grid size [$\lambda_0 = 0.23(\Delta x\, \Delta y)^{1/2}$] is used. The readers are refer to Leroyer et al. (2014) for more details."

References:

Benoit, R., J. Côté, and J. Mailhot, 1989: Inclusion of a TKE boundary layer parameterization in the Canadian regional finite-element model. Mon. Wea. Rev., 117, 1726–1750, doi:10.1175/1520-0493(1989)117<1726:IOATBL>2.0.CO;2.

Bélair, S., J. Mailhot, C. Girard, and P. Vaillancourt, 2005: Boundary layer and shallow cumulus clouds in a medium-range forecast of a large-scale weather system. Mon. Wea. Rev., 133, 1938–1960, doi:10.1175/MWR2958.1.

Leroyer, S., Bélair, S., Husain, S., and Mailhot, J., 2014: Subkilometer numerical weather prediction in an urban coastal area: a case study over the Vancouver metropolitan area, J. Appl. Meteorol. Clim., 53, 1433–1453, https://doi.org/10.1175/JAMC-D-13-0202.

2.Section 4

I understand the shortwave optical properties of the numerical model is not good. I am confused with these data are used in the simulations in the radiation scheme to influence the clouds and precipitation or just added data after the simulation.

The shortwave optical properties of land surface described in the manuscript is not used in the NWP simulations. They are only used as added data for the pre-launch studies of EarthCARE. We modified the manuscript as follow:

"As the additional data for pre-launch studies of EarthCARE, GEM's snow-free surface albedos were replaced by those based on MODIS's MCD43GF 1 km resolution bidirectional reflectance distribution function (BRDF) product for the period 2002 to 2013 (Schaaf et al. 2002)."

3. Section 5

-Describe more detailed information about the data for CAM, such as horizontal resolution and vertical resolution.

- What types of aerosol optical properties are used in this study?

The text around at the beginning of section 5 has now been changed to:

"The ECSIM scene creation process requires 3D distributions of aerosol size distributions. As GEM lacks interactive aerosol tracers and chemistry, aerosol fields were added to the test scenes using information from the Copernicus Atmosphere Monitoring Service (CAMS) (Flemming et al. 2017). The CAMS data was at a resolution of 0.5 by 0.5 Lat-Lon degrees and 60 hybrid sigma model levels. The aerosol scheme implemented within ECSIM follows the *Hybrid End-To-End Aerosol Classification* (HETEAC) approach of defining a certain set of basic aerosol types with associated e.g. size distributions, refractive indices and optical properties that, when weighted and summed, yield adequate representations of a wide range of observed aerosol optical properties (Wandinger et al. 2016; Wandinger et al. 2023). Table 4 lists the CAMS aerosol fields, and the *Supplementary Material* section provides a detailed description of the mapping between CAMS fields and ECSIM/HETEAC scattering types. It also provides more details regarding aerosol representation."

-Have you used these data in your simulation (off-line simulation)?

If so, could you explain how to interact with radiation or microphysics shorty?

The added aerosols are not used in NWP (on-line or off-line) simulations.

4. Section 7

- Have you applied these changes to the previous results?

The results presented before the section 7 didn't include the changes.

Are they only for the EarthCARE L1 data or are they just an introduction to an update plan?

The modifications are applied to the original GEM data. These modified data then are used in the EarthCARE simulations to produce L1 and L2 products.

If you used these modifications for the previous results. Please go to the upper parts after section 3.

As previously answered, the modifications are not included in the results before the section 7.

- How about the effect of the changes on the thin cirrus? I think your simulations reproduced the thin cirrus more than the observation (Fig. 10, 13, 15). However, your improvement increases the thin cirrus in Fig. 18. Please explain this.

The panels (b) of Fig. 10, 13 and 16 show CloudSat's 94 GHz radar retrievals of IWC which are not suitable to detect thin cirrus cloud. This might partly explain the lower amount of thin cirrus cloud from the CloudSat data. However, in Fig. 15, we do see the missing high ice clouds between -2° and -6°S. But it is more likely to be caused by the harsh discontinuity in GEM's string of innermost domains as explained in the subsection 6.3.

The perceived changes the thin cirrus noted by the reviewer are spurious. The figure caption has been updated to make this clear.

"Nadir cross-sections of R_{eff} and 355 nm extinction before and after making adjustments described in the text. Note that the changes in the aerosol regions e.g. the elevated layer north of 50 Degrees at around 7.km are due to technical updates to the aerosol processing between the "Before" and "After" data not related to the ice-cloud adjustments."

Specific comments

L47: Six or eight frames per orbit? I think eight frames per orbit.

Thanks for the remark. Indeed, we changed the text accordingly.

L77: please check the number of frames per orbit.

Agreed. We changed the text accordingly.

L77-79: I think the name of frames are depending on the latitude. Please check the criterion of the frames.

Thanks very much for this comment. We modified the description in the section 2.

"Figure 1 shows several EarthCARE orbits, numbered 39316 through 39320. An orbit consists of eight frames; each frame's number having an appending letter from A to H which is defined by given ranges of altitude (JAXA, 2017). Frames are colour-coded and measure ~5,000 km along-track and 150 km across-track."

L85: I think the main reason for the choice of orbit is the availability of A-train data (CloudSat and CALIPSO). The swath of CloudSat and CALIPSO is very narrow compared to the other satellite. Please move it to the upper part.

We considered that both the various surface/atmospheric conditions and the interception with A-Train satellites are equally important. Hence we prefer to keep the statement as is.

L249: There is a difference between observation and simulation of ice precipitation between 42N and 43N in Fig. 10. GEM produced the ice precipitation as snow or graupel. Has GEM underestimated the surface temperature in these areas? I suggest some comments on this.

The near surface areas between 42°N and 43°N are indicated as "Significant return power but likely surface clutter"in CloudSat's CPR_Cloud_mask data (mask=5). This means that the retrievals are not reliable. We excluded these data in the results presented in Fig. 10. Therefore, it doesn't mean that there is not ice

precipitation in the area. Unfortunately, there is not surface data available for the verification. We added a short comment in subsection 6.1:

“Between 42°N and 43°N, GEM produces a large amount of solid precipitation whereas in CloudSat data, due to the ground clutter, there is no reliable retrieval available.”

L412: six or eight frames per orbit? I have commented on this part in the comments above.

It should be eight frames. We changed the text.