Overview and early intercomparison of ESA/JAXA radiation products

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2nd ESA-JAXA EarthCARE In-Orbit Validation Workshop

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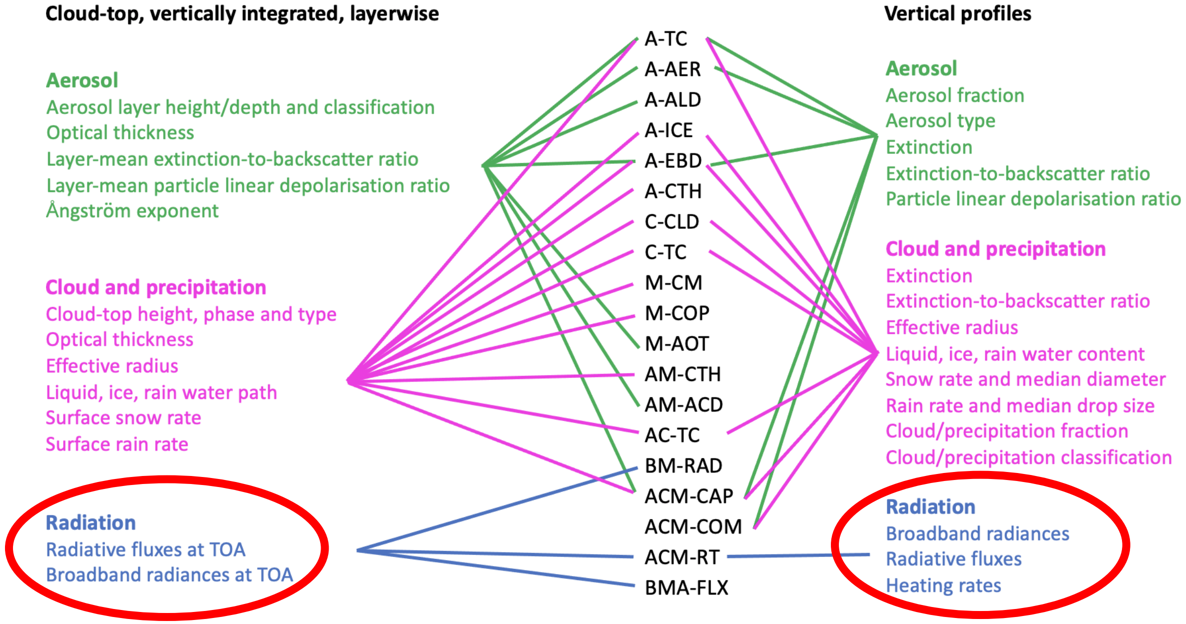
Radiation products in EarthCARE mission

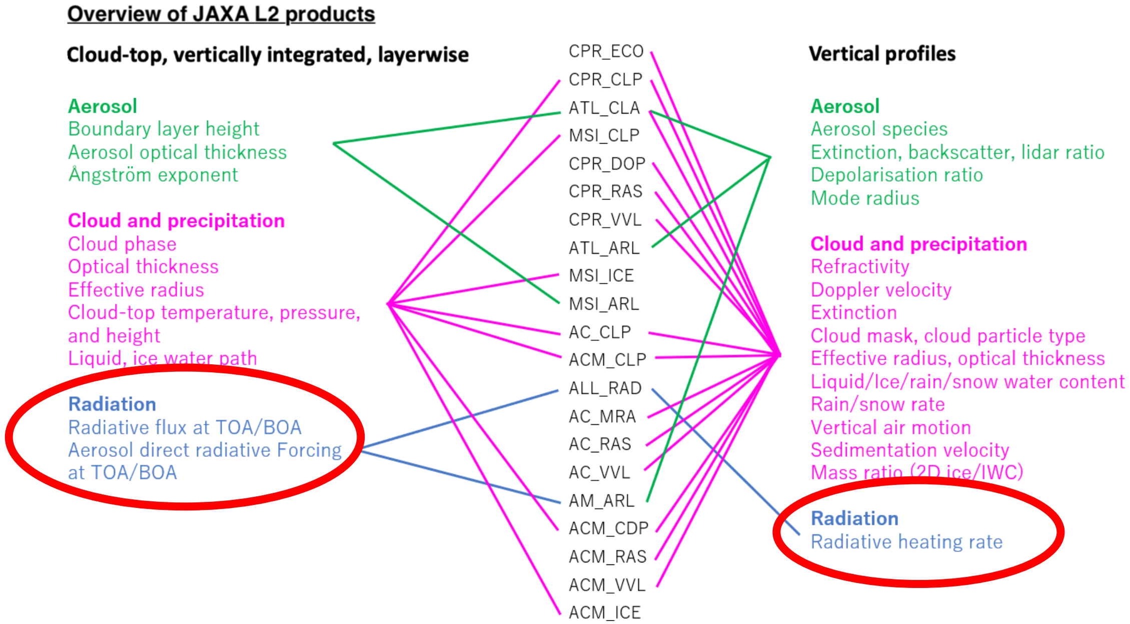
JAXA esa

ESA L2 products

JAXA L2 products

L1: B-NOM (ESA), B-SNG (ESA)



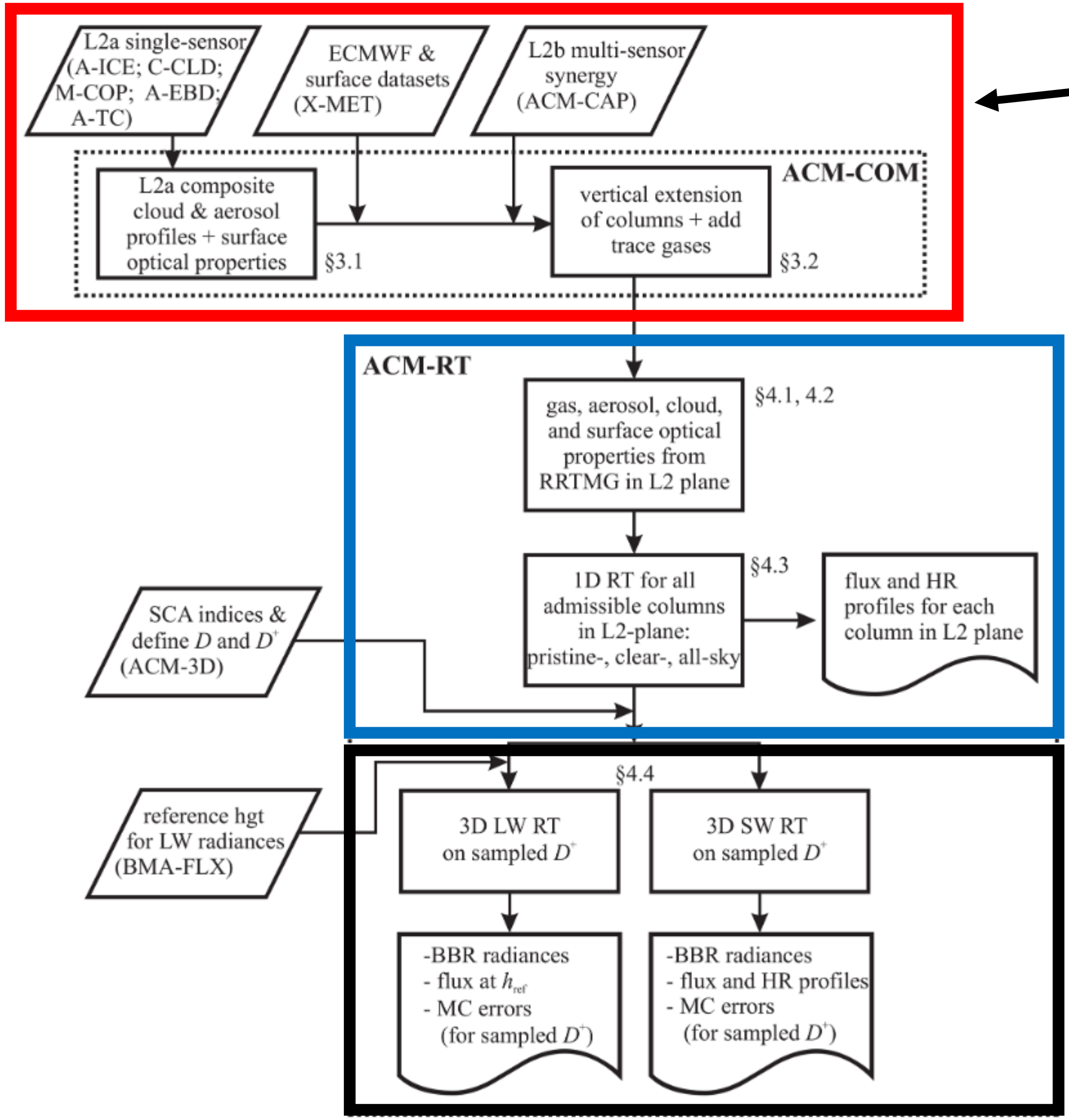


Wehr et al. (AMT '23)

- ✓ "Measured" L2 radiances/fluxes: BM-RAD (ESA), BMA-FLX (ESA)
- ✓ "Computed" L2 radiances/fluxes: ACM-RT (ESA), ALL_RAD (JAXA)

- ■ Radiation products developed independently in ESA & JAXA
- ■ Conducting "radiative closure study" with 1D/3D-RT validated against BBR fluxes
- ■ Intercomparison of ESA & JAXA radiation products (ACM-RT & ALL_RAD) ongoing

Forward radiative transfer and products (ACM-RT)



Inputs

- ACM-COM contains synergy retrieval (ACM-CAP) and composite based on L2 products
- ACMB-3D contains scene construction information

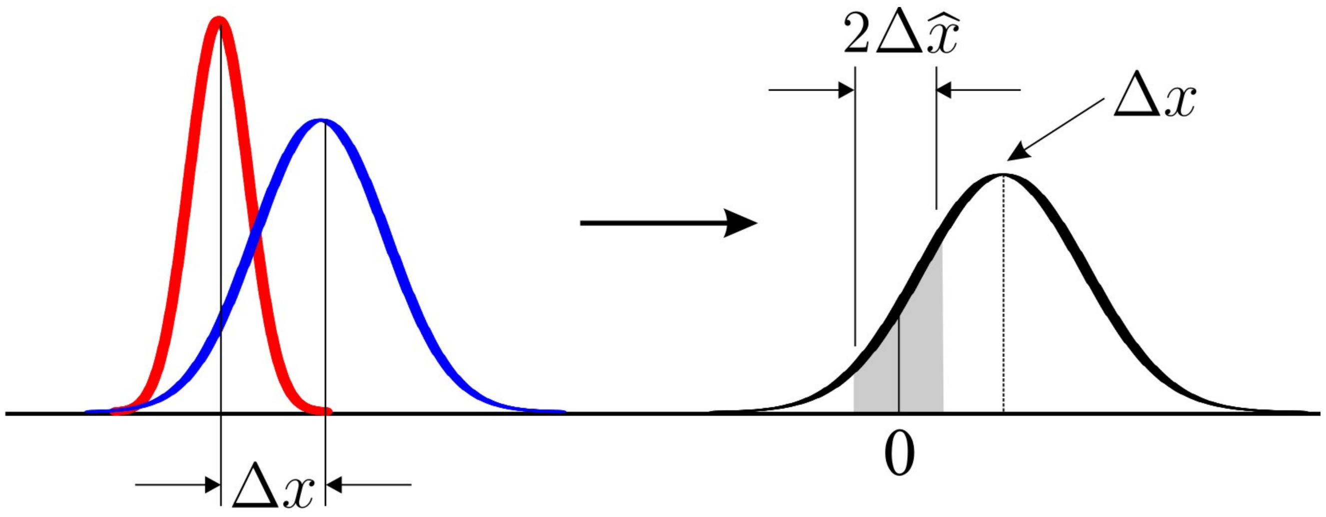
1D broadband radiative outputs

- Radiative fluxes and heating rates profiles (LW, SW)
  - All-sky, clear-sky and pristine
  - Only on the retrieval "curtain"
- Direct and diffuse downwelling SW surface fluxes

3D broadband radiative outputs

- Quantities averaged to "assessment domain"
  - Currently 21 km along track and 5 km across track
- SW radiative profiles and heating rate profiles
- Direct and diffuse downwelling SW surface fluxes
- Upwelling LW fluxes at coregistration height
- LW and SW radiances for each view
- Currently computed every 21 km along track

Radiative transfer closure and products (ACMB-DF)



- Simplest assessment is how much BBR and RT fluxes differ relative to threshold
  - E.g., is flux difference greater than 10 W/m^2
- Better to report probability of differences
  - E.g., what is probability flux difference is greater than 10 W/m^2
  - Brings in BBR, RT and retrieval uncertainties

- Flux computed by radiative transfer models is not computed in same way as from satellites
- For 1D closure "*x*" are fluxes directly from radiative transfer model averaged to assessment domain.
- For 3D closure "*x*" are fluxes created by transforming assessment domain mean radiances to fluxes the same way for BBR observations and RT calculations
  - We also provide upwelling fluxes directly from 3D RT models
- The L1 BBR products (B-NOM, B-SNG) are described in the presentation on Monday by Clerbaux and the L2 BBR products (BM-RAD, BMA-FLX) are described in the next talk by Velazquez Blazquez

JAXA “4-sensor” product (ALL_RAD) processing

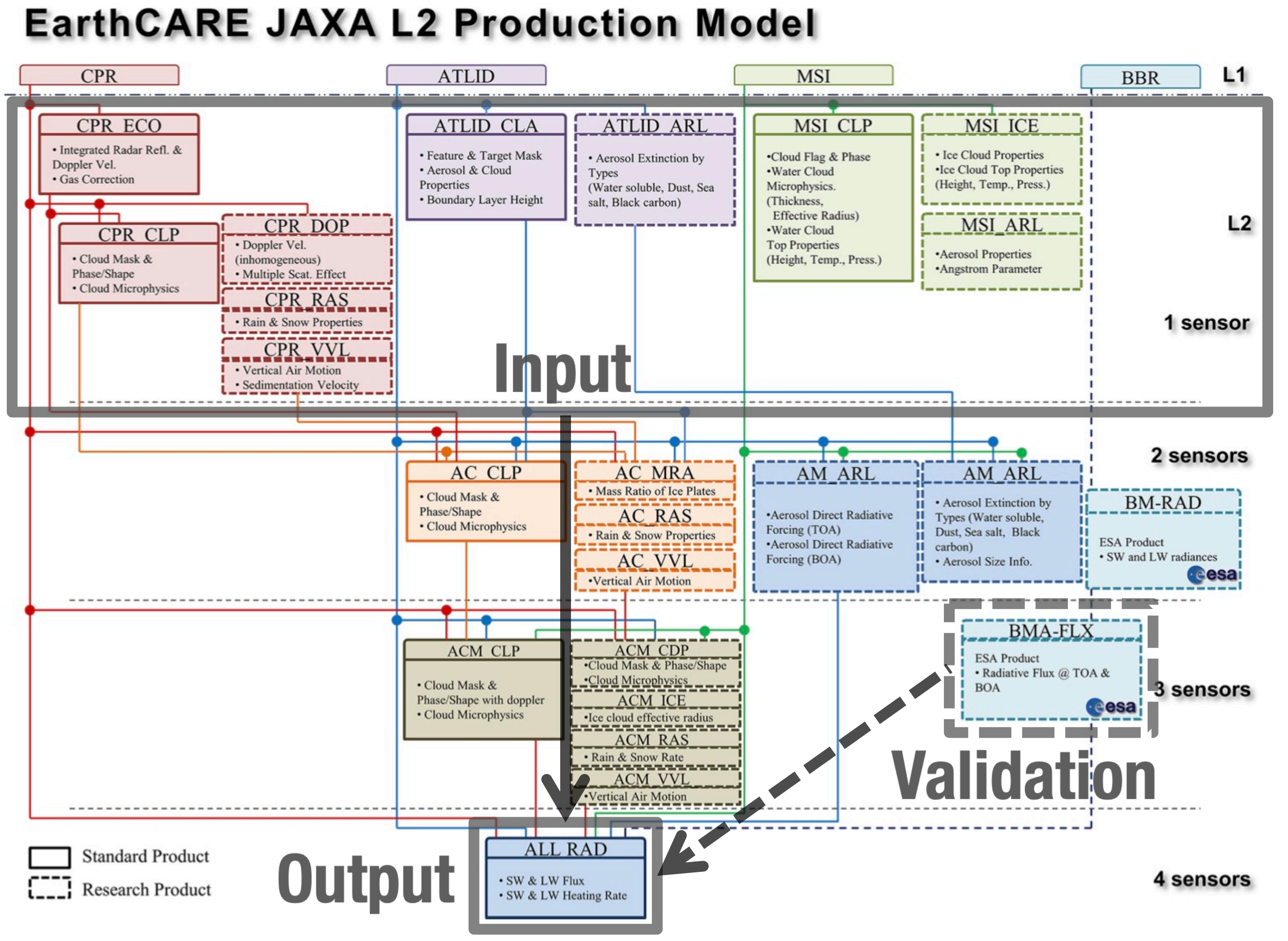


Figure 3. The JAXA EarthCARE Production Model shows all JAXA data products and ESA’s level 1 and BBR level 2b products. Level 2 products and their retrieval algorithms (L2a, L2b) are described in this *AMT* special issue according to Table 2 (L2a) and Table 4 (L2b).

Adapted from Eisinger et al. (AMT ’24)

- JAXA 1-sensor L2 products from CPR/ATLID/MSI are jointly used as input to 1D-RT computation
- The computed fluxes are validated against BMA-FLX
- See Takashi Nagao’s talk later for details of algorithm & validation

Pre-launch version of algorithm (Yamauchi et al. AMT ’24)

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Description and validation of the Japanese algorithm for radiative flux and heating rate products with all four EarthCARE instruments: pre-launch test with A-Train

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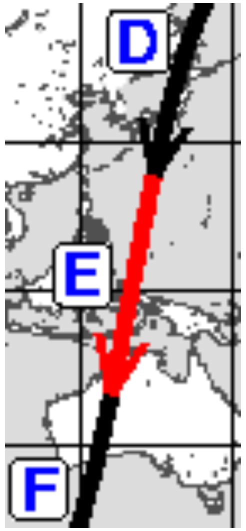
Intercomparison of ACM-RT & ALL_RAD: Example 1

- Intercomparison currently focused on 1D-RT results
- Baseline version used: “AB” for ACM-RT-1D; “vAc” for ALL_RAD
- Shown below is a scene with relatively good agreement but differences in SW@SFC

2025/1/15
(03598E)



2025/01/15 05:12, RGB@SW
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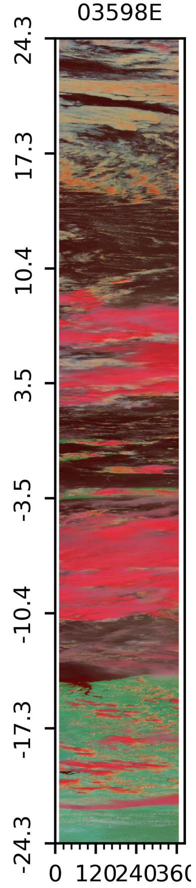
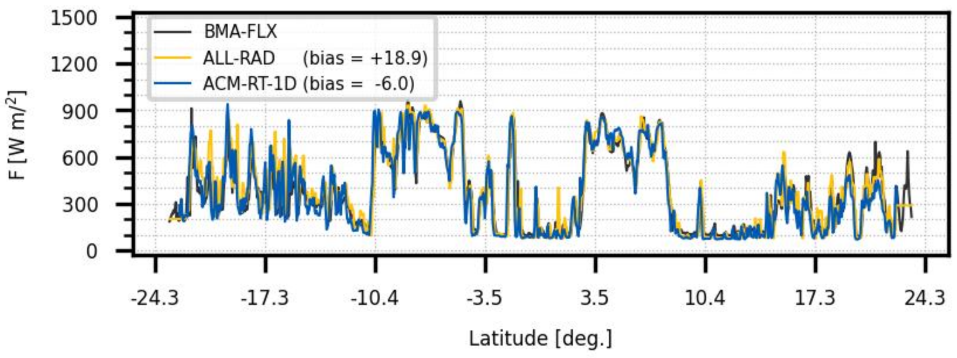
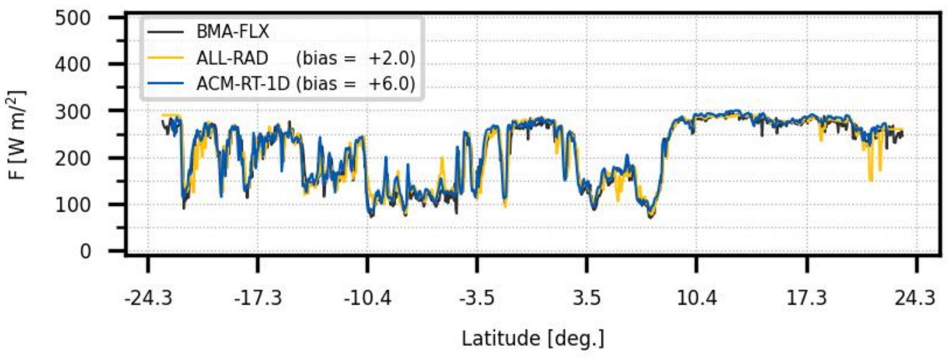


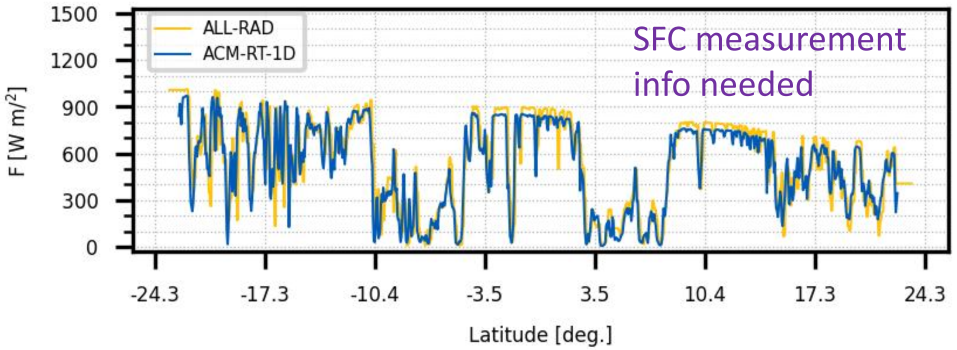
Upward **SW** Flux at **TOA**



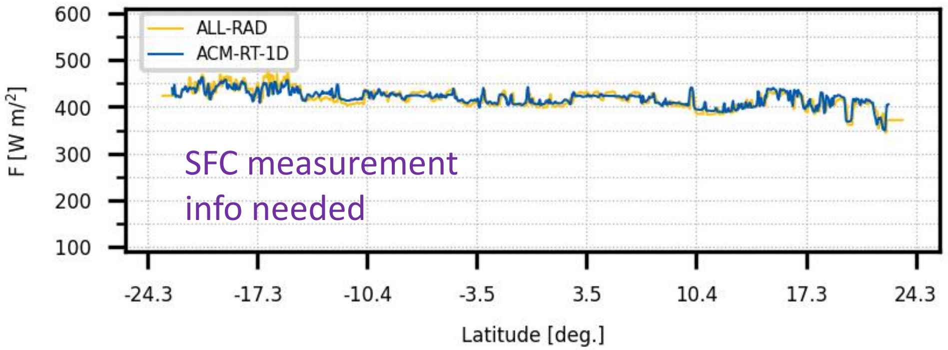
Upward **LW** Flux at **TOA**



Downward **SW** Flux at **SFC**



Downward **LW** Flux at **SFC**



Intercomparison of ACM-RT & ALL_RAD: Example 2

- Shown below is a scene with some differences between the two products at TOA/SFC
  - Partly due to differences in cloud/aerosol properties retrieved from CPR/ATLID/MSI
  - Possible feedback onto the aerosol/cloud retrievals -> Better radiative closure!

2025/1/14
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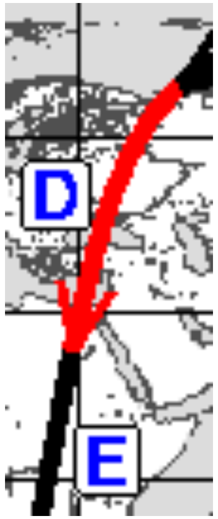
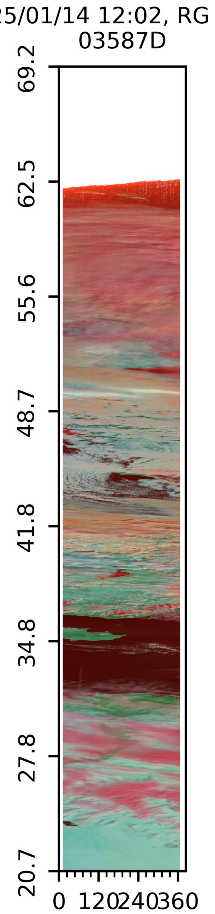
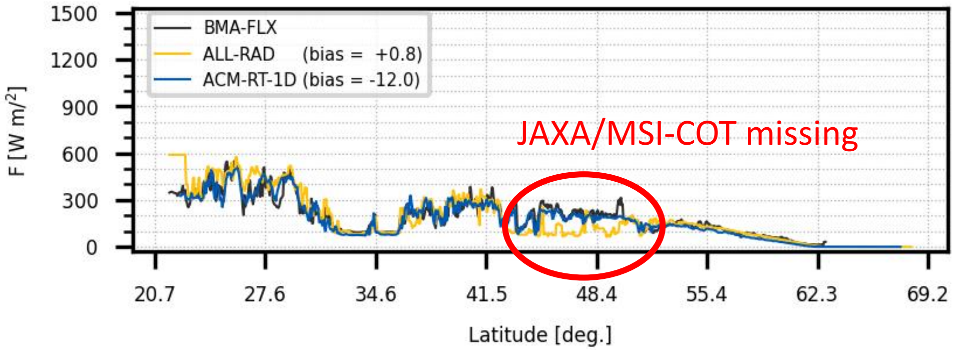
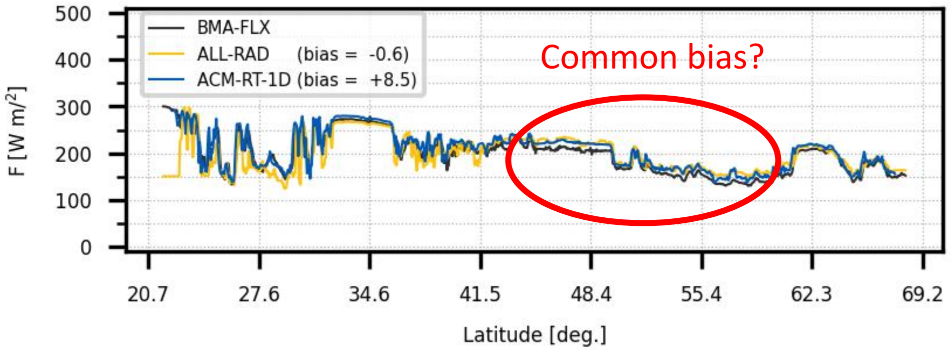




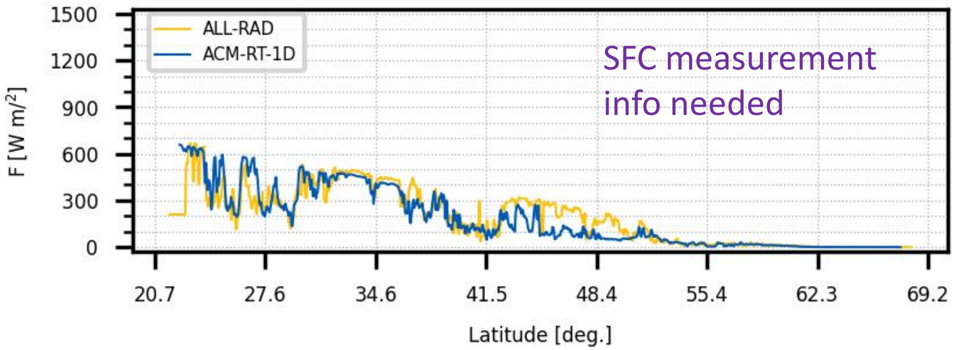
Upward **SW** Flux at **TOA**



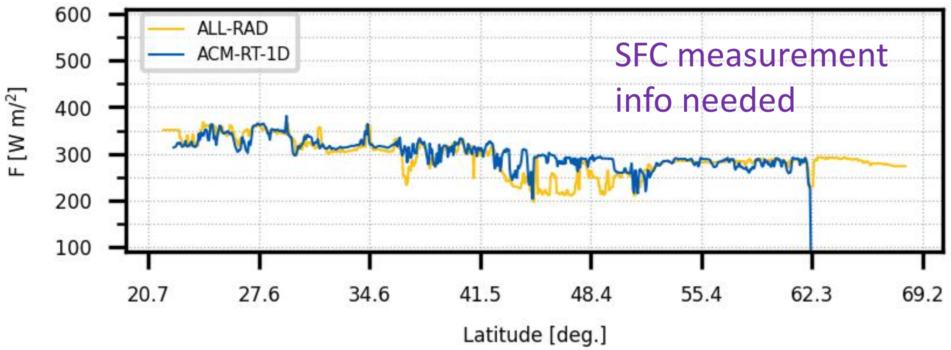
Upward **LW** Flux at **TOA**



Downward **SW** Flux at **SFC**



Downward **LW** Flux at **SFC**



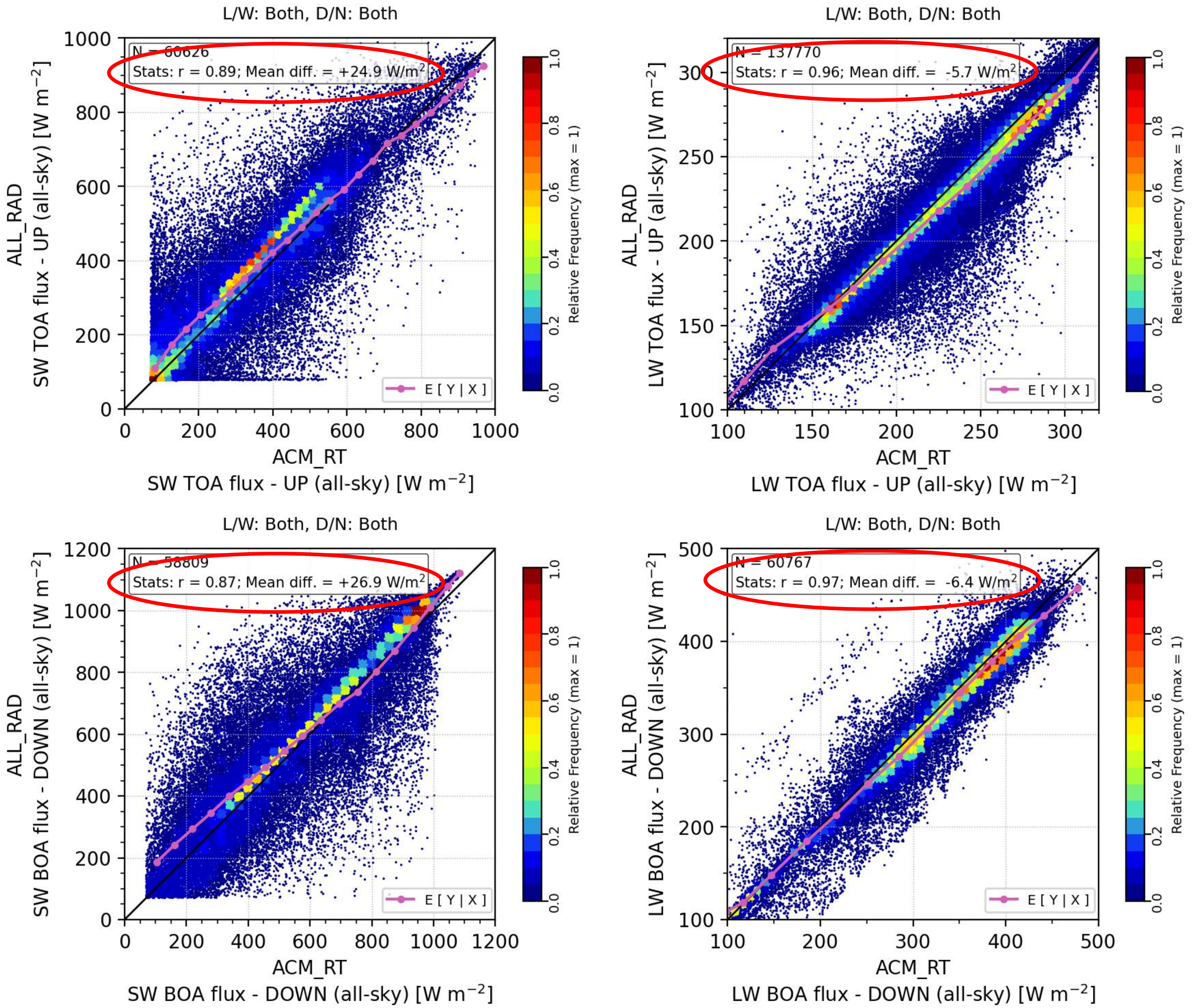
Global statistical comparison: ACM-RT & ALL_RAD

[all-sky]

SW | LW

Upward TOA

Downward SFC



Period: Jan. 14–16, 2025

- Overall good agreement for both SW/LW at TOA/SFC
- Better agreement in LW than in SW
- Need detailed comparisons
  - Clear/cloudy scenes
  - Polluted/pristine scenes
- Need to trace back to aerosol/cloud properties
  - Feedback on retrievals
  - Better radiative closure

Summary & Outlook

- Radiation products are developed independently in ESA & JAXA through radiative transfer (RT) simulations and BBR measurements
- The computed fluxes with 1D/3D-RT are validated against BBR fluxes to serve as radiative closure study at TOA
- Intercomparison of ESA & JAXA radiation products is now ongoing
  - Currently focused on 1D-RT results
  - Early results show good agreement with its degree dependent on scene
- Need to trace back to aerosol/cloud properties in ESA/JAXA sides
  - Feedback onto the CPR/ATLID/MSI retrievals of aerosol/cloud properties
  - Towards higher degree of radiative closure
- Validations at SFC against ground-based flux measurement (e.g. BSRN) would also be useful/necessary for radiative closure at SFC
  - For better constraint on atmospheric radiation budget