



Overview and early intercomparison of ESA/JAXA radiation products

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Radiation products in EarthCARE mission



ESA L2 products

JAXA L2 products

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

Cloud-top, vertically integrated, layerwise

Aerosol

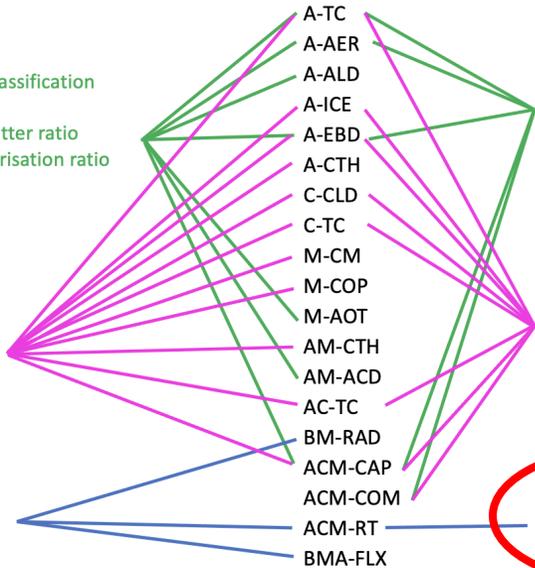
Aerosol layer height/depth and classification
Optical thickness
Layer-mean extinction-to-backscatter ratio
Layer-mean particle linear depolarisation ratio
Ångström exponent

Cloud and precipitation

Cloud-top height, phase and type
Optical thickness
Effective radius
Liquid, ice, rain water path
Surface snow rate
Surface rain rate

Radiation

Radiative fluxes at TOA
Broadband radiances at TOA



Vertical profiles

Aerosol

Aerosol fraction
Aerosol type
Extinction
Extinction-to-backscatter ratio
Particle linear depolarisation ratio

Cloud and precipitation

Extinction
Extinction-to-backscatter ratio
Effective radius
Liquid, ice, rain water content
Snow rate and median diameter
Rain rate and median drop size
Cloud/precipitation fraction
Cloud/precipitation classification

Radiation

Broadband radiances
Radiative fluxes
Heating rates

Overview of JAXA L2 products

Cloud-top, vertically integrated, layerwise

Aerosol

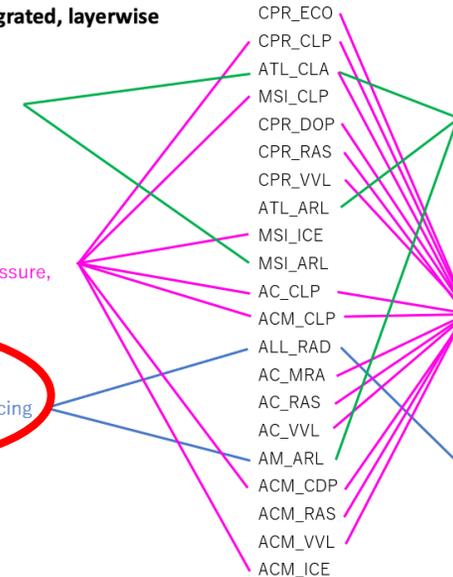
Boundary layer height
Aerosol optical thickness
Ångström exponent

Cloud and precipitation

Cloud phase
Optical thickness
Effective radius
Cloud-top temperature, pressure, and height
Liquid, ice water path

Radiation

Radiative flux at TOA/BOA
Aerosol direct radiative Forcing at TOA/BOA



Vertical profiles

Aerosol

Aerosol species
Extinction, backscatter, lidar ratio
Depolarisation ratio
Mode radius

Cloud and precipitation

Refractivity
Doppler velocity
Extinction
Cloud mask, cloud particle type
Effective radius, optical thickness
Liquid/Ice/rain/snow water content
Rain/snow rate
Vertical air motion
Sedimentation velocity
Mass ratio (2D_ice/IWC)

Radiation

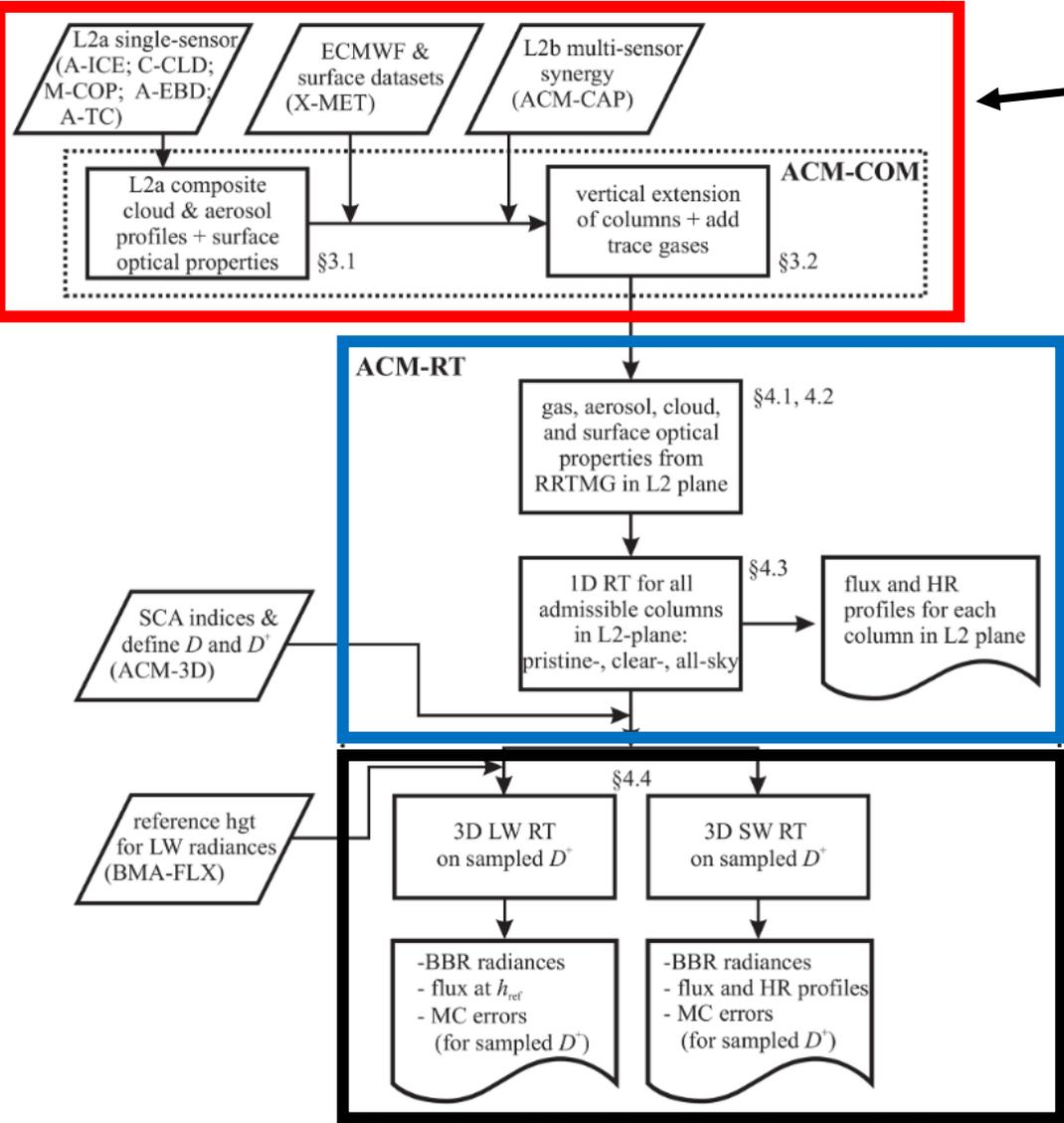
Radiative heating rate

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

Wehr et al. (AMT '23)

- 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

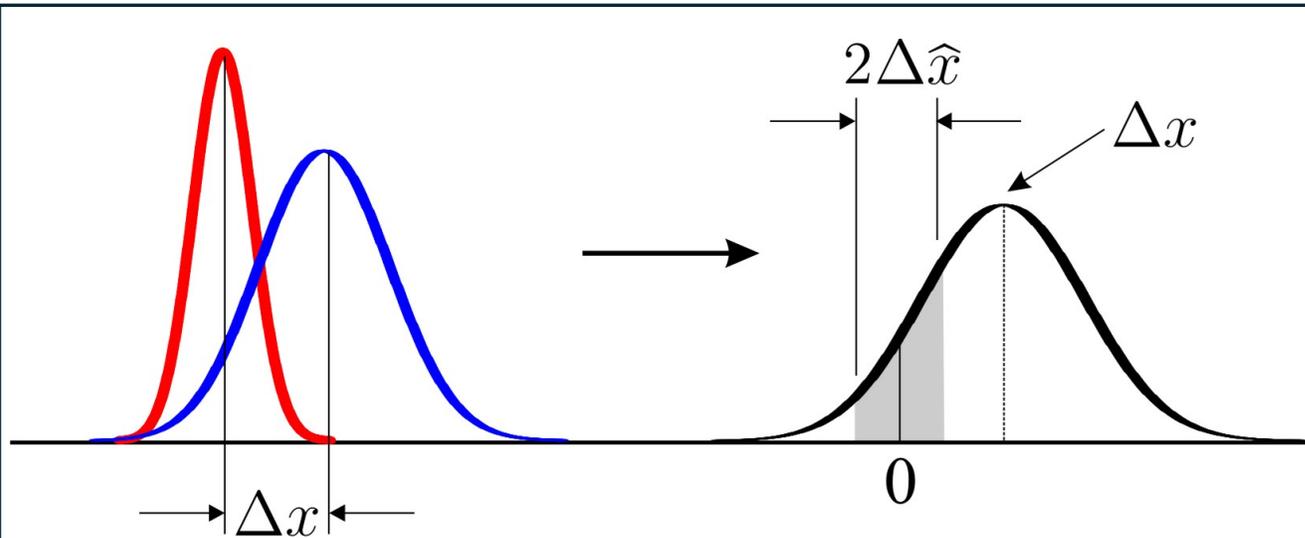
- ACM-COM contains synergy retrieval (ACM-CAP) and composite based on L2 products
- ACMB-3D contains scene construction information

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



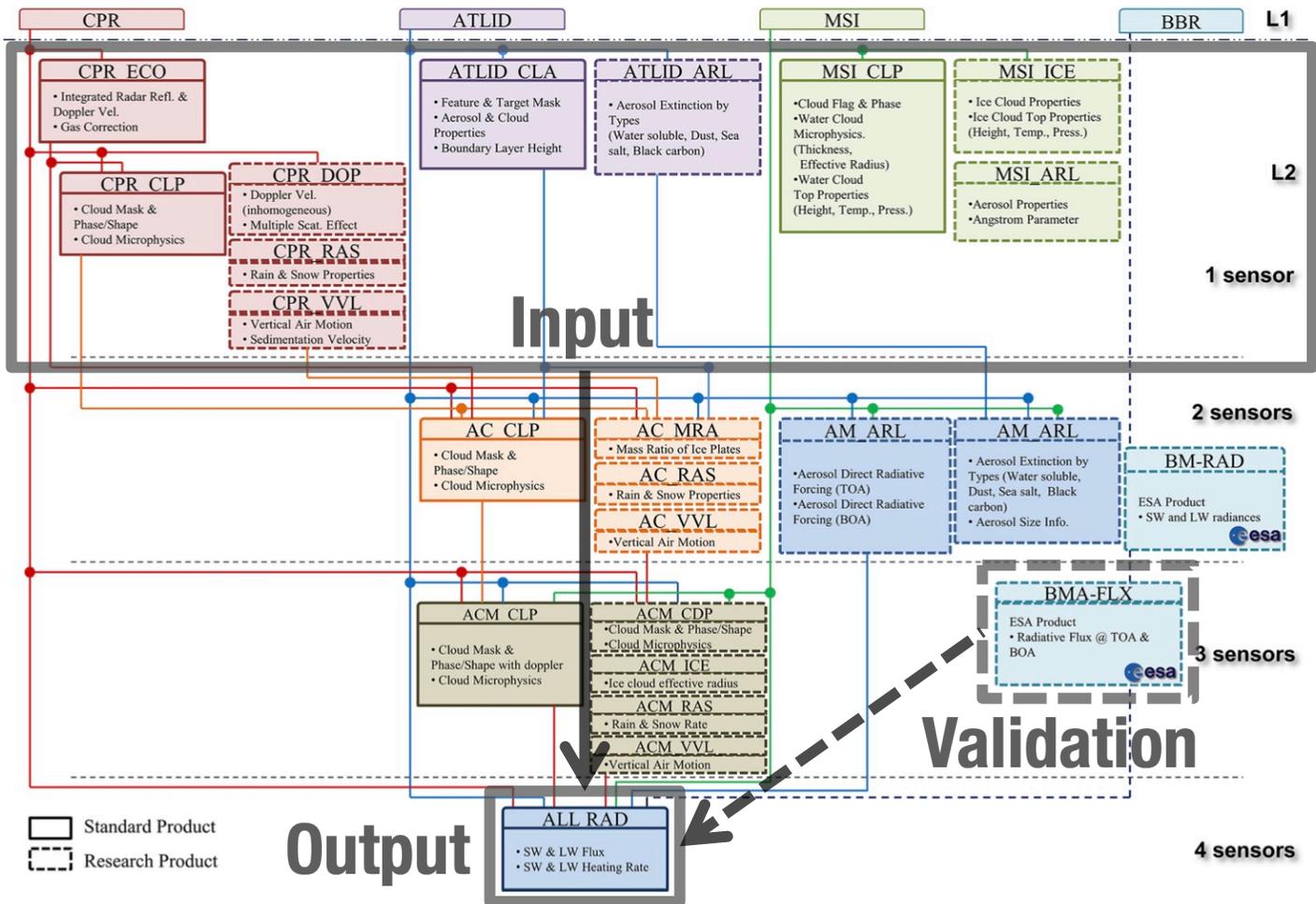
- Simplest assessment is how much BBR and RT fluxes differ relative to threshold
 - E.g., is flux difference greater than 10 W/m^2
- Better to report probability of differences
 - E.g., what is probability flux difference is greater than 10 W/m^2
 - Brings in BBR, RT and retrieval uncertainties

- 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



EarthCARE JAXA L2 Production Model



- 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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Atmospheric Measurement Techniques
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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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Adapted from Eisinger et al. (AMT '24)

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).

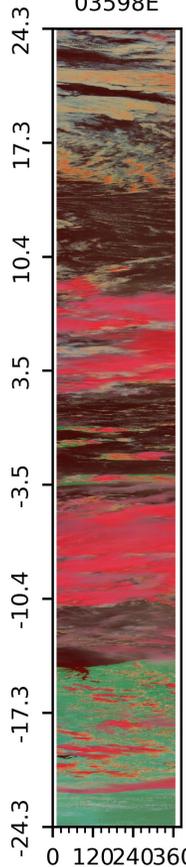
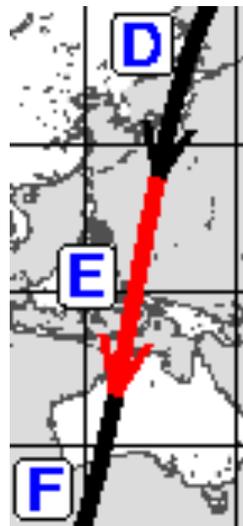
Intercomparison of ACM-RT & ALL_RAD: Example 1



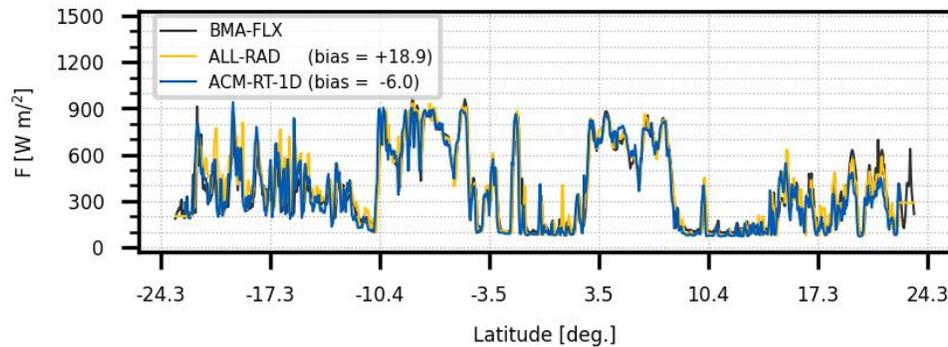
- Intercomparison currently focused on 1D-RT results
- Baseline version used: “AB” for ACM-RT-1D; “vAc” for ALL_RAD
- Shown below is a scene with relatively good agreement but differences in SW@SFC

2025/01/15 05:12, RGB@SW
03598E

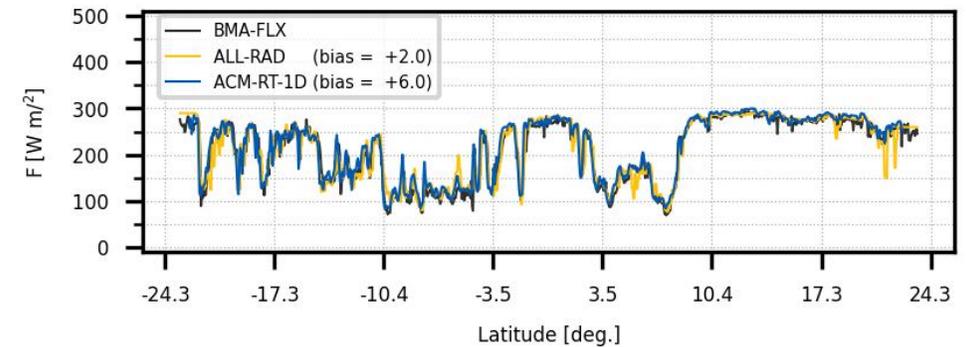
2025/1/15
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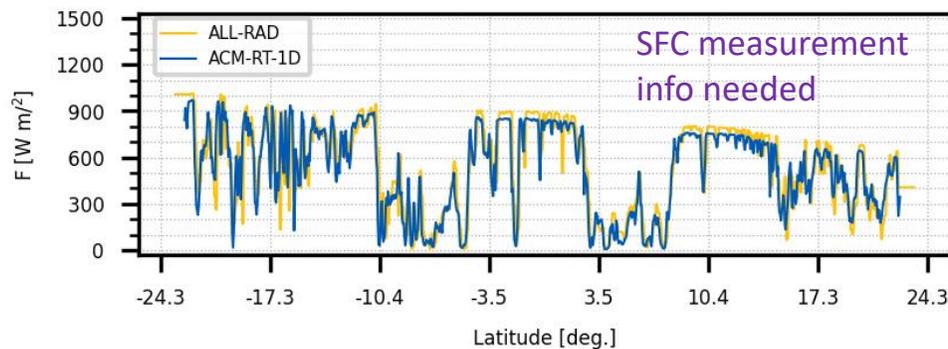
Upward SW Flux at TOA



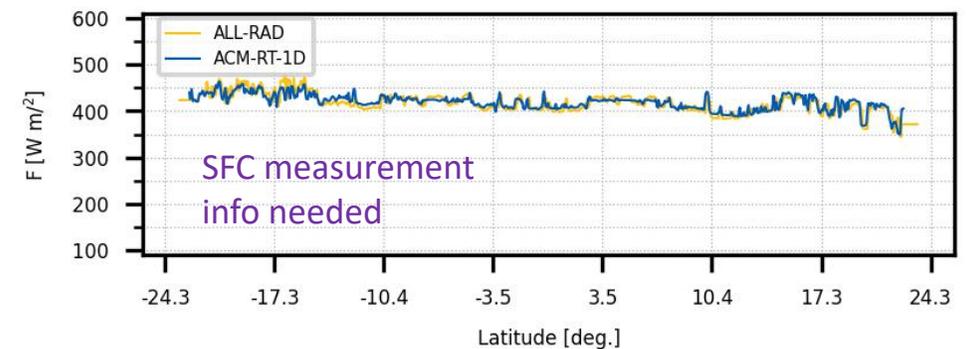
Upward LW Flux at TOA



Downward SW Flux at SFC



Downward LW Flux at SFC



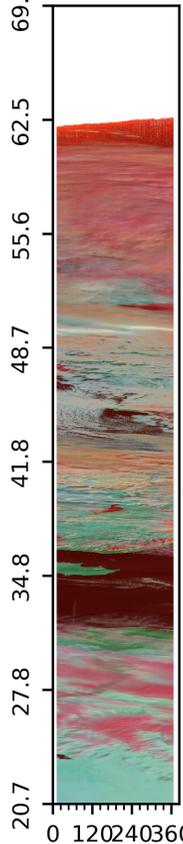
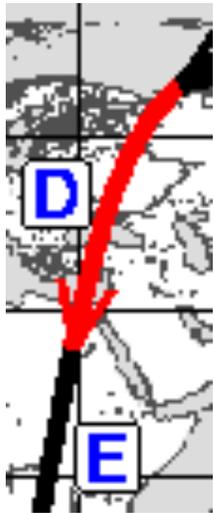
Intercomparison of ACM-RT & ALL_RAD: Example 2



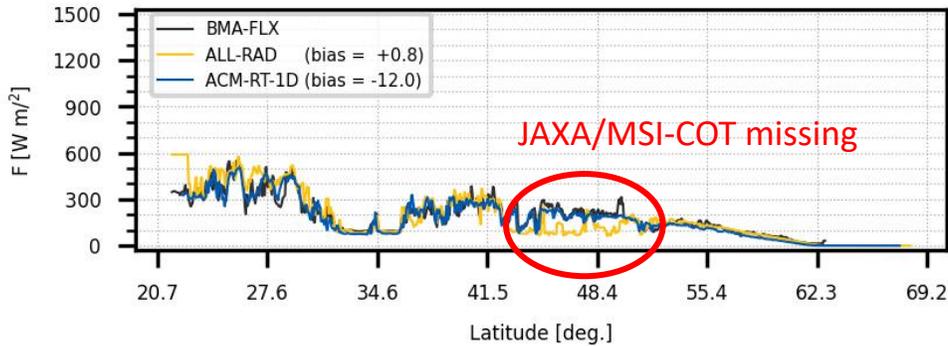
- Shown below is a scene with some differences between the two products at TOA/SFC
 - Partly due to differences in cloud/aerosol properties retrieved from CPR/ATLID/MSI
 - Possible feedback onto the aerosol/cloud retrievals -> Better radiative closure!

202025/01/14 12:02, RG
03587D

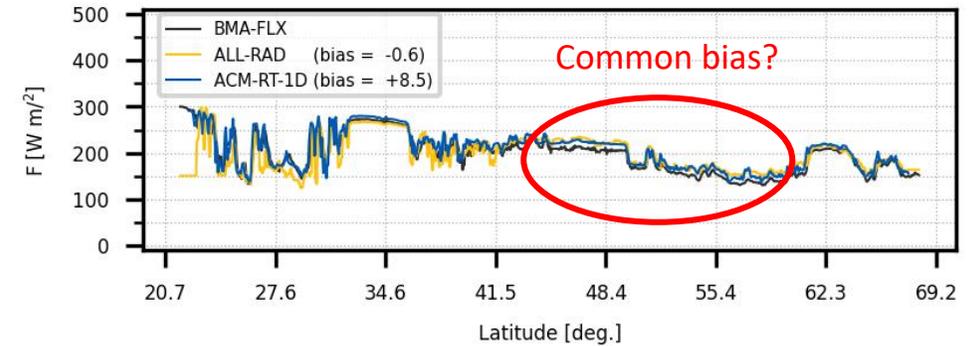
2025/1/14
(03587D)



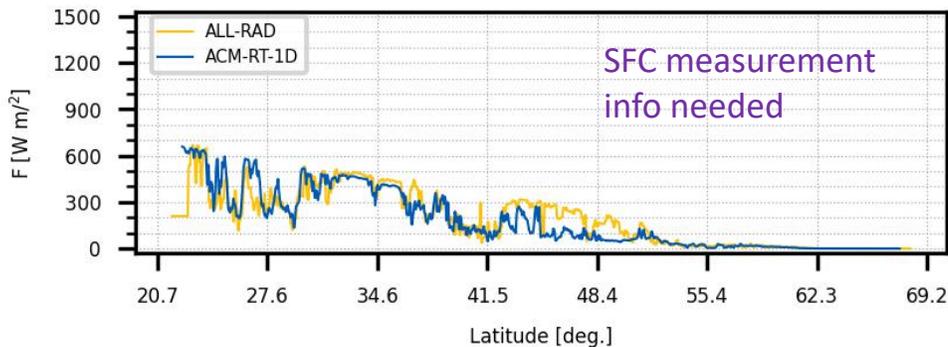
Upward SW Flux at TOA



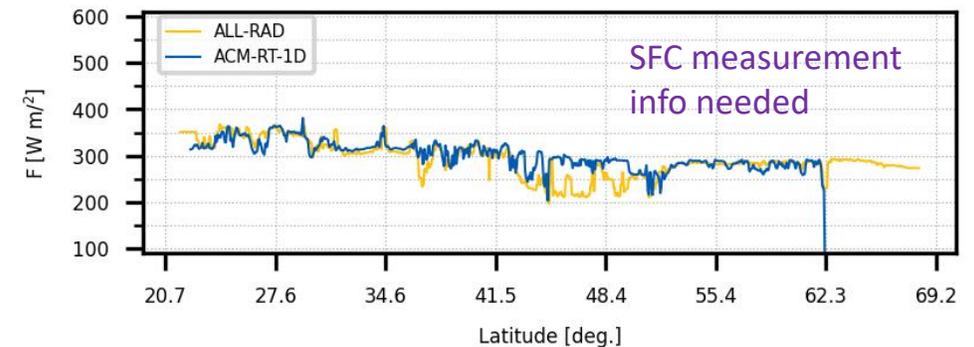
Upward LW Flux at TOA



Downward SW Flux at SFC



Downward LW Flux at SFC



Global statistical comparison: ACM-RT & ALL_RAD



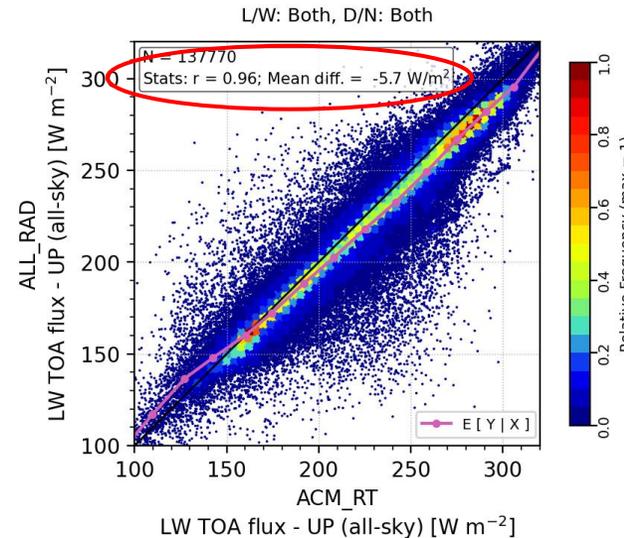
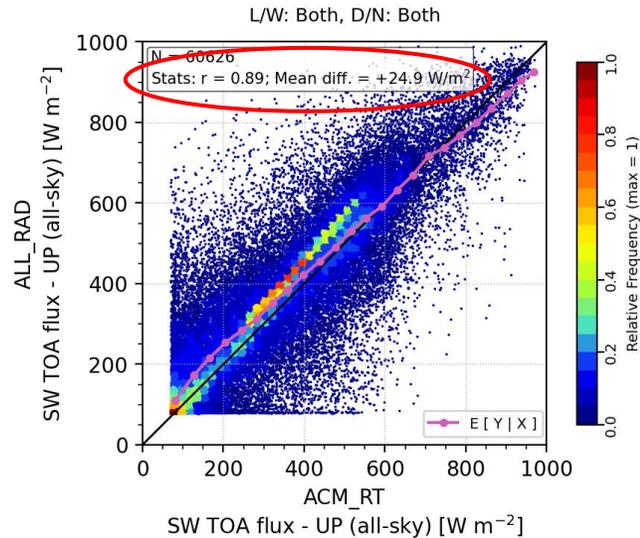
[all-sky]

SW

LW

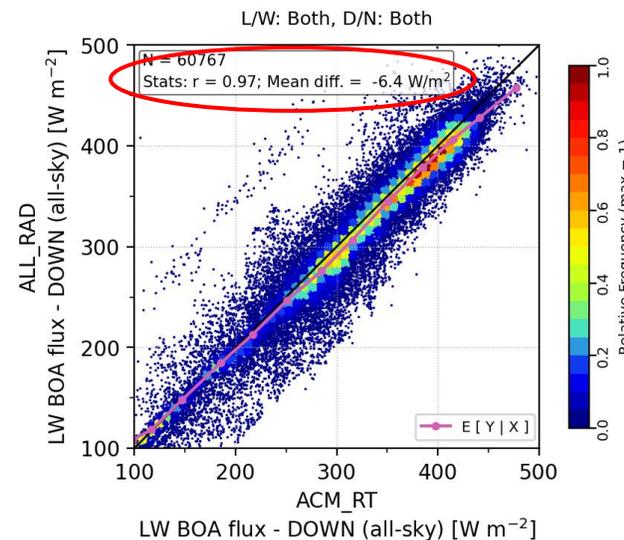
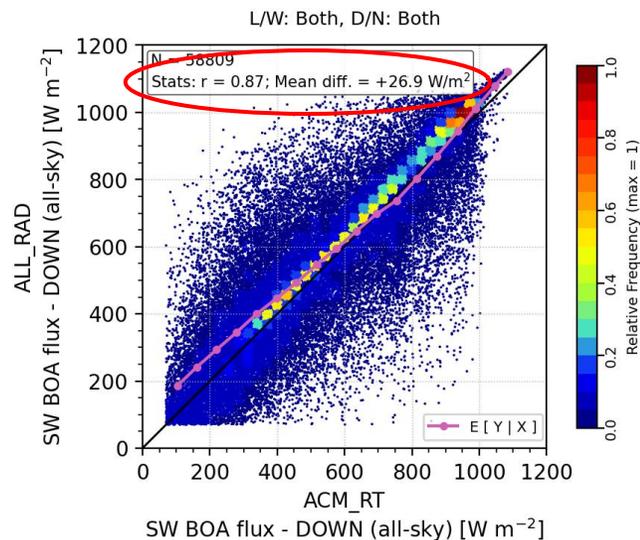
Period: Jan. 14–16, 2025

Upward
TOA



- 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

Downward
SFC



- 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