JAXA Radiation Budget Standard Product (ALL_RAD): Development, Validation and Early Analysis

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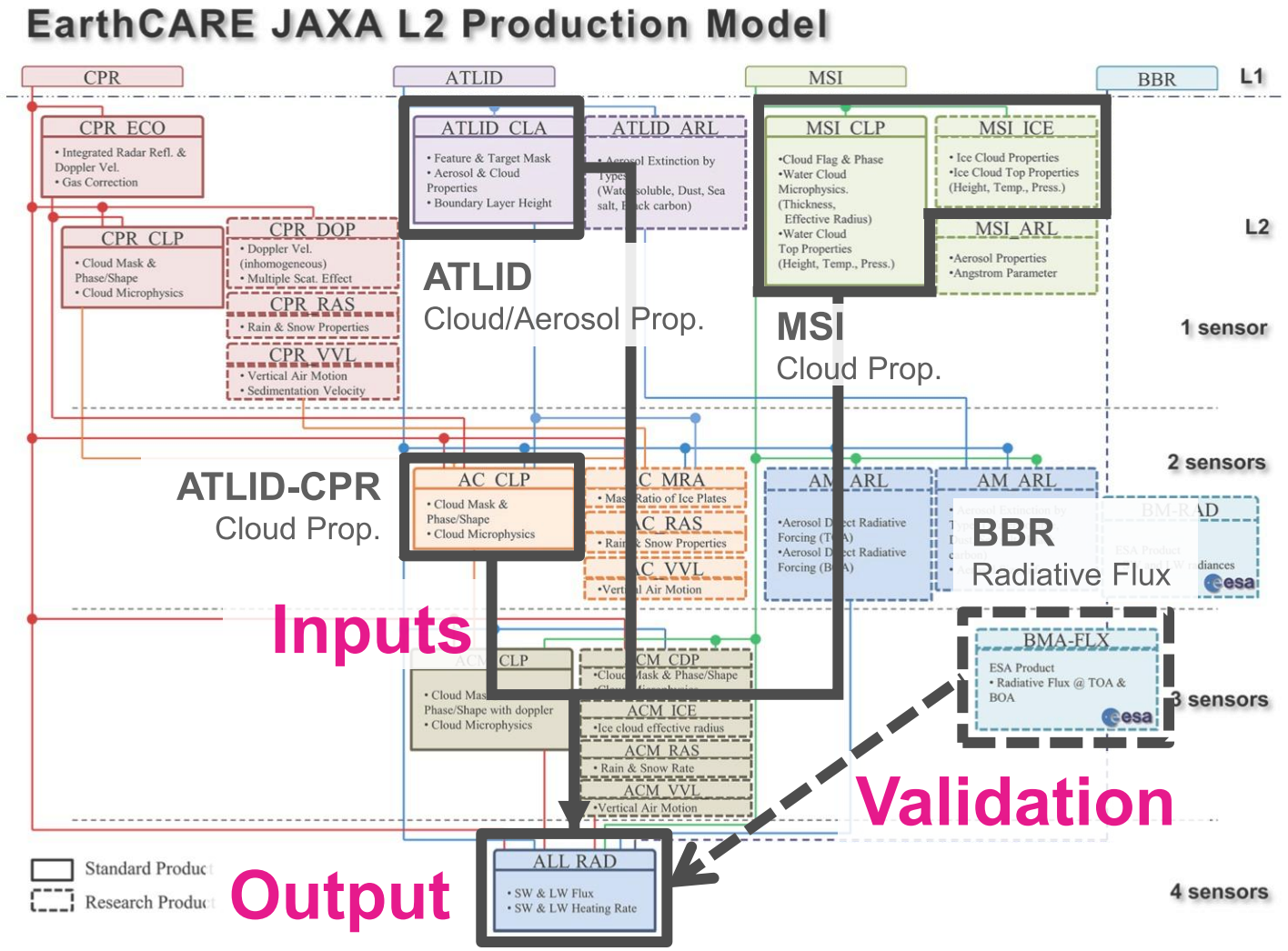
JAXA Radiation Budget Standard Product (ALL_RAD)



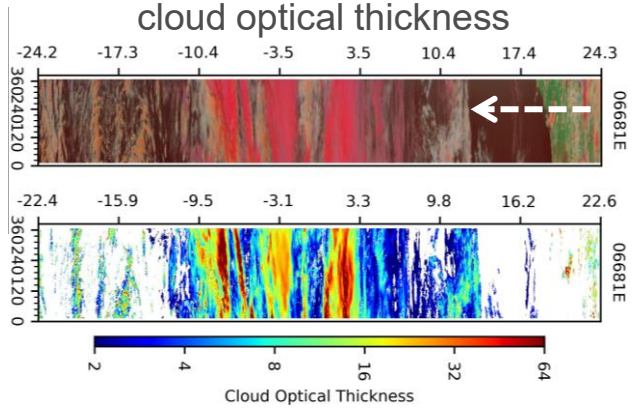
(Adapted from Eisinger et al. 2024)

- JAXA L2b Standard Product
- Generates composite aerosol and cloud profiles by integrating L2 products from CPR, ATLID, and MSI
- Applies 1-D radiative transfer calculations to derive radiative fluxes & heating-rates
- Radiative closure assessment through comparison with BBR observations
- Public Release: Dec. 2025

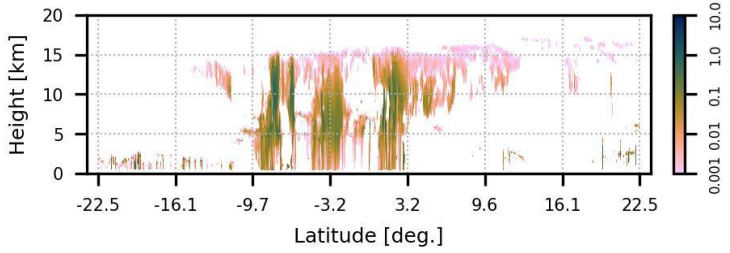
Scene Example of ALL_RAD

- Inputs -

MSI:
cloud optical thickness

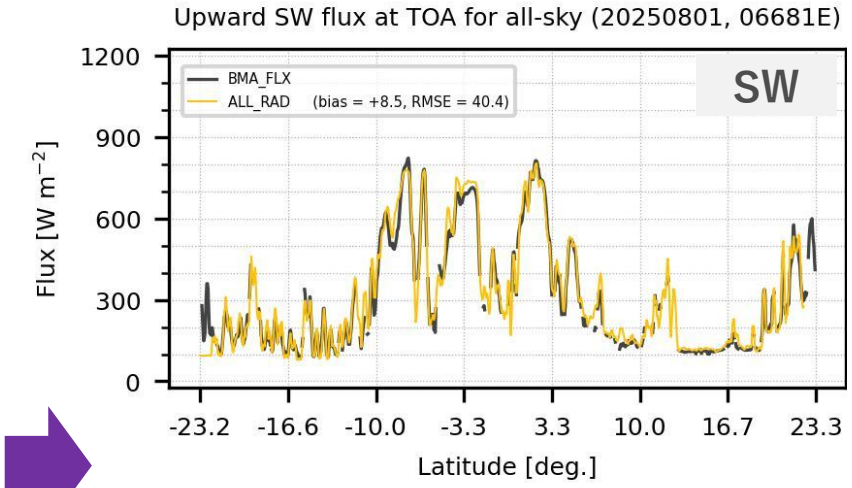


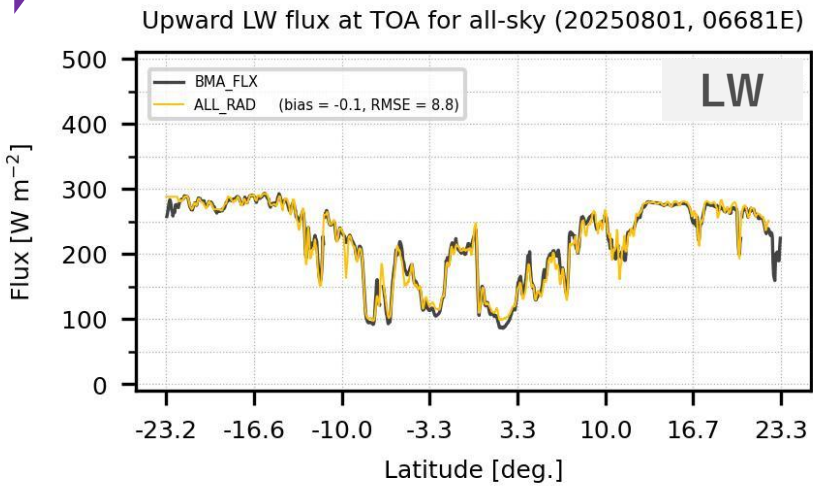
ATLID & CPR:
cloud water content



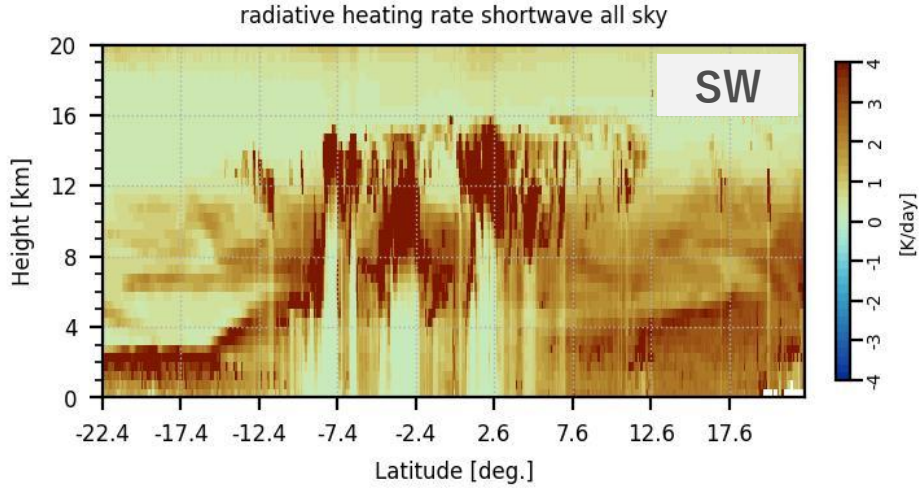
- Outputs -

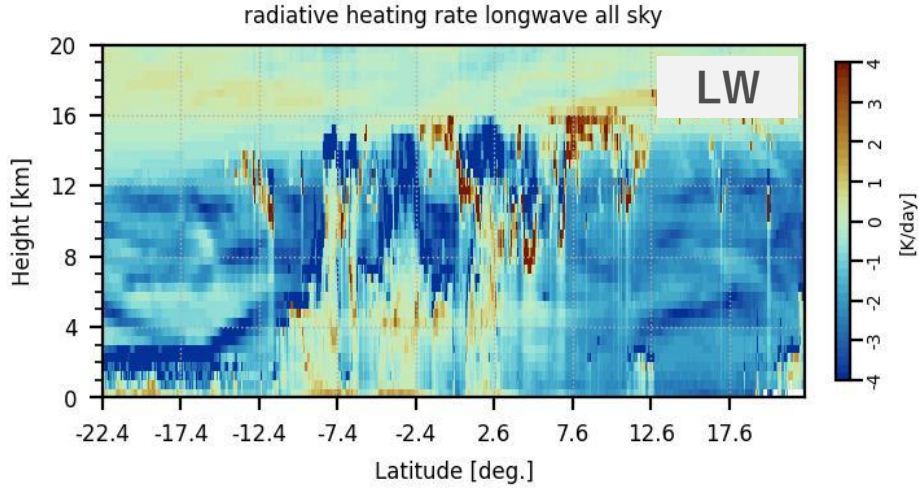
Radiative Fluxes at TOA





Radiative Heating Rate Profiles

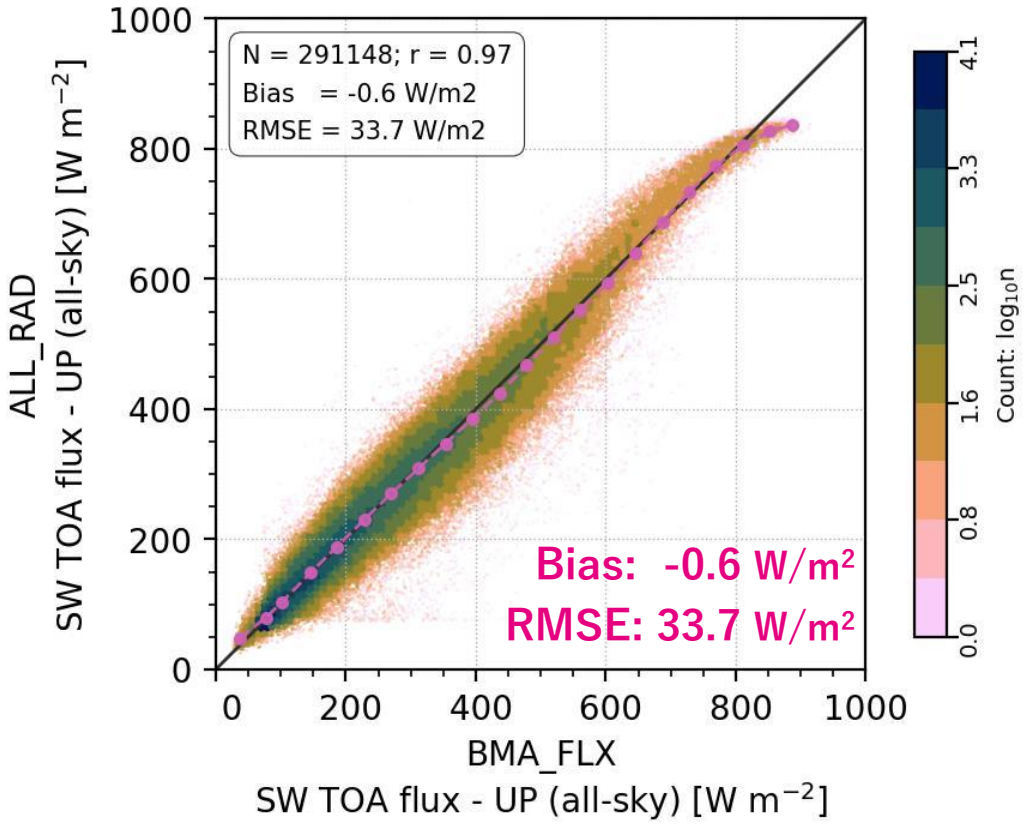




Validation at TOA against BBR (BMA-FLX)

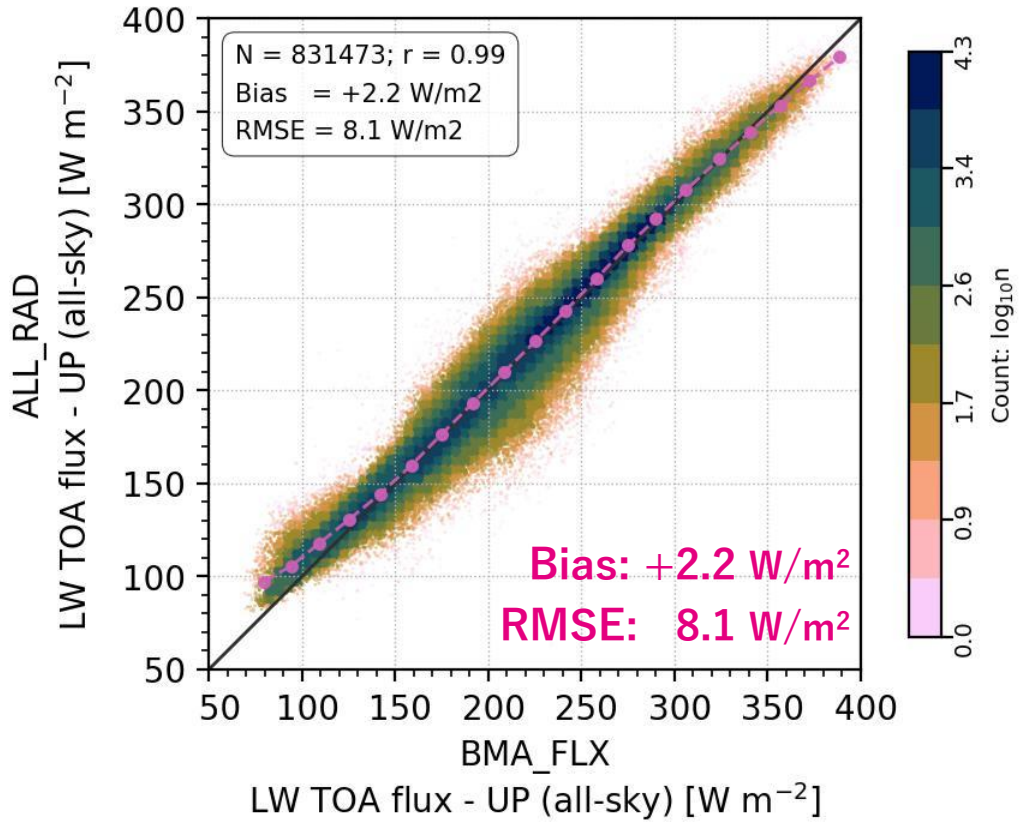
SW TOA flux (all-sky)

Land & Ocean, Daytime only



LW TOA flux (all-sky)

Land & Ocean, Daytime & Nighttime



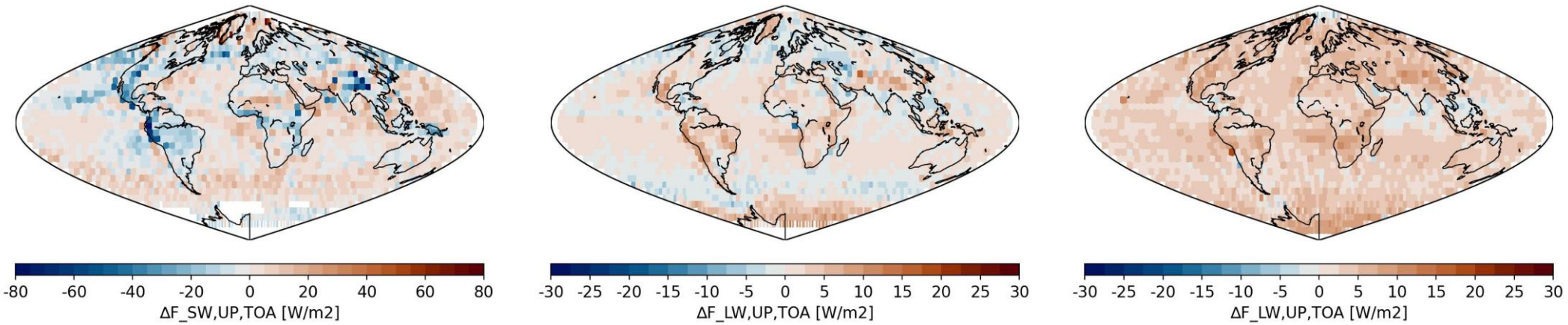
- SW approaching the standard accuracy (25Wm^{-2}), LW meeting the target accuracy (10Wm^{-2})
- Instantaneous comparisons over 21x5km (assessment domain) for August 2025
- Version: ALL_RAD – v1.0, BMA_FLX – vBa, MSI with new vicarious calibration

Error characteristics: Spatial distribution

$RMSE^2 = Bias^2 + Error\_SD^2$

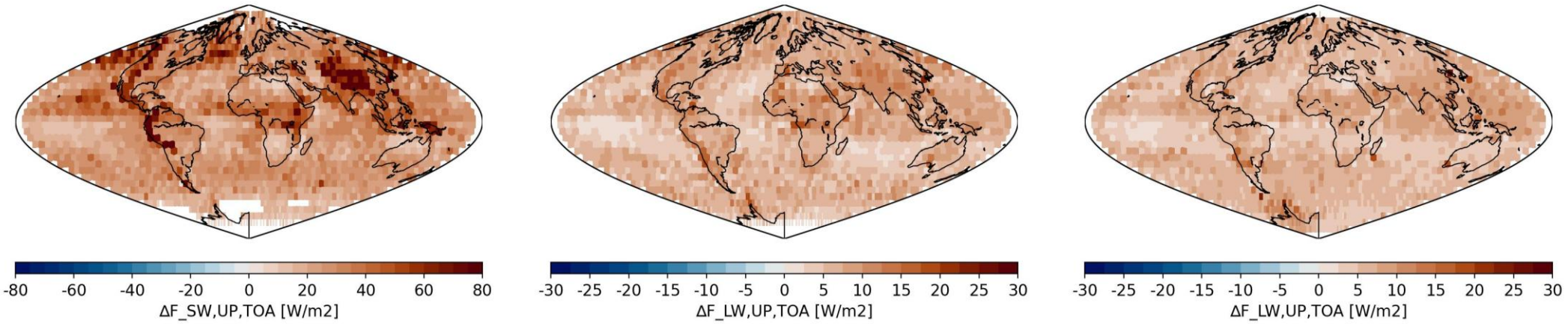
(a) SW, Daytime | (b) LW, Daytime | (c) LW, Nighttime

Bias



Major bias sources and situations have been identified

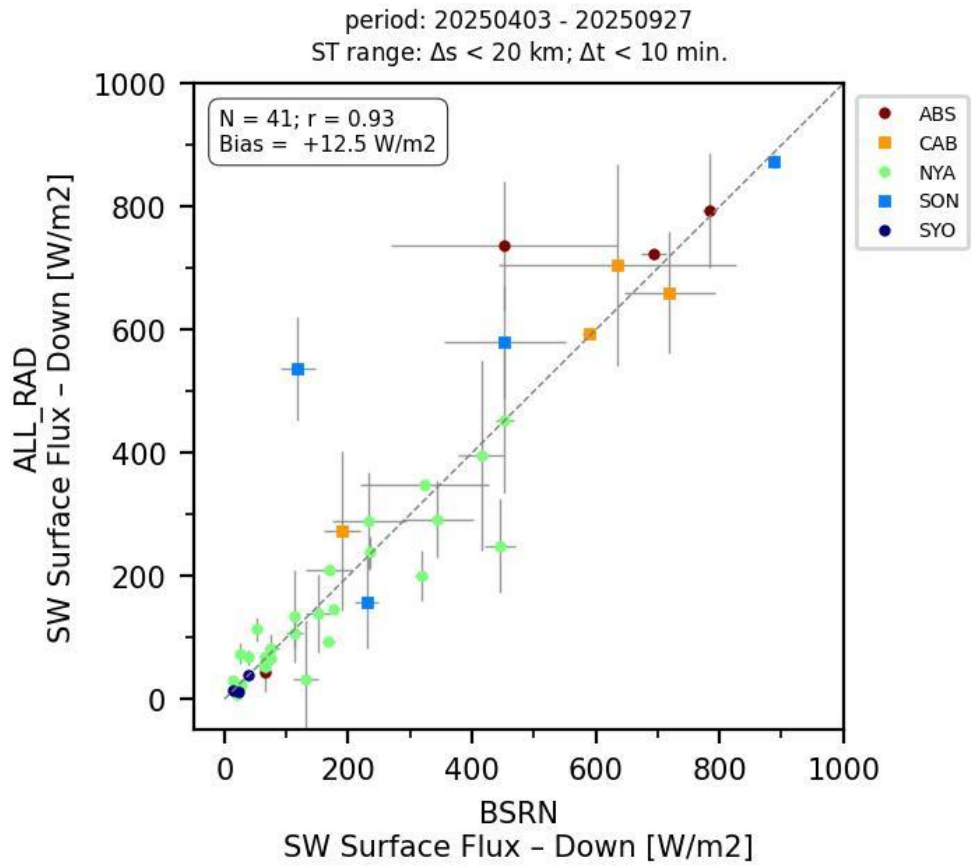
Error SD



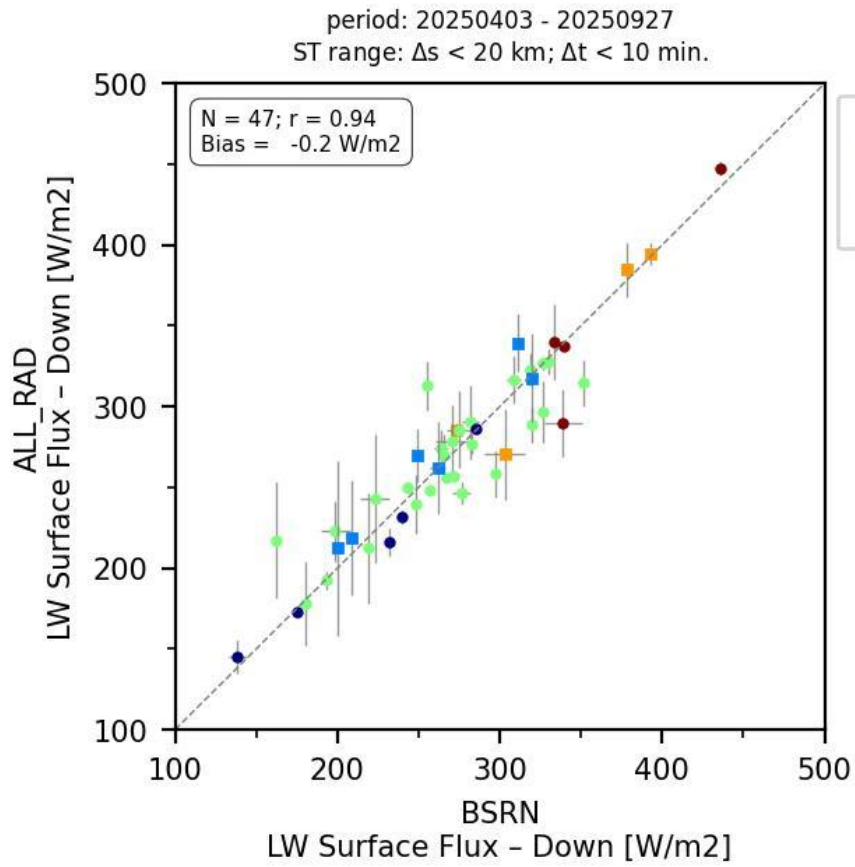
Next task: Identifying error sources – ALL_RAD internal issues, IFOV mismatch, 3-D RT effect etc.

Validation at SFC against BSRN: Early results

SW



LW

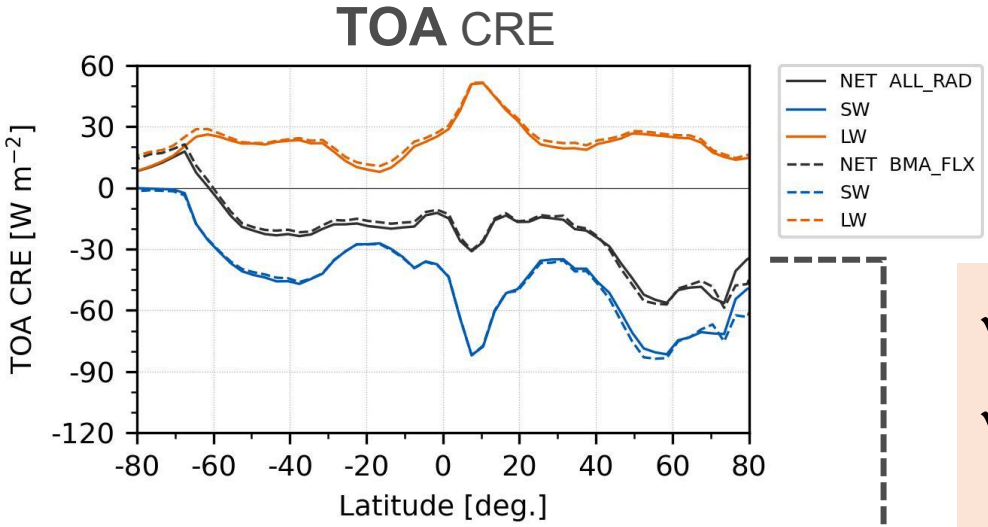


Abashiri (Japan)
Cabauw (Netherlands)
Ny-Alesund
Sonnblick (Austria)
Syowa station

- Good agreement with SFC measurements at locations across the globe
- Better agreement in LW than in SW
- Basis for radiative closure assessment at SFC (in addition to TOA w/ BBR)

Cloud radiative effect (CRE)

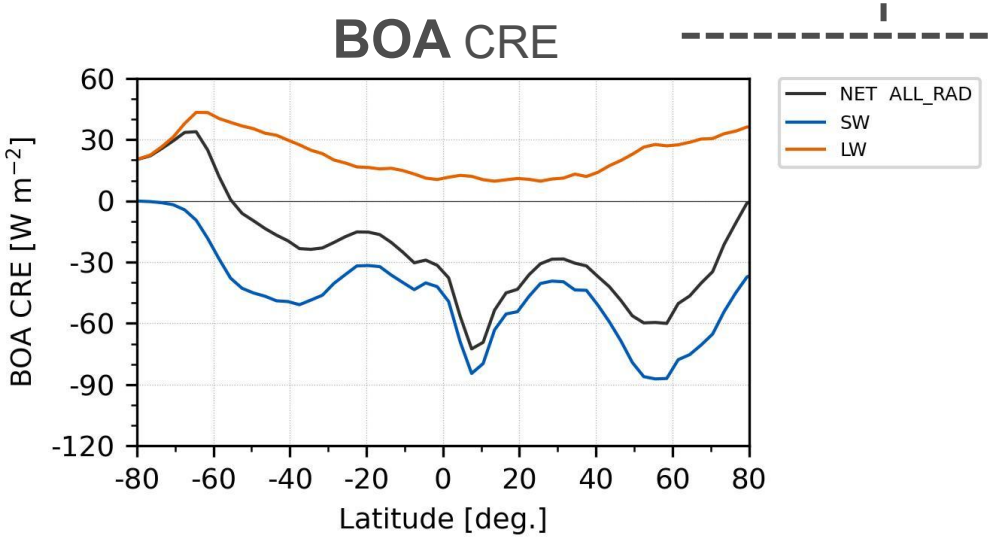
August 2025

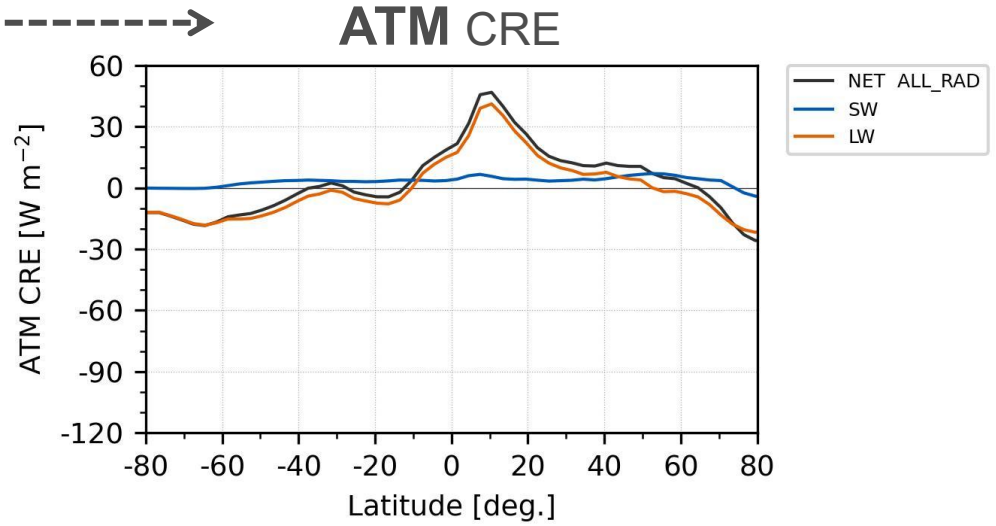


$$CRE = \left(F^{\downarrow} - F^{\uparrow}\right)_{all} - \left(F^{\downarrow} - F^{\uparrow}\right)_{clear}$$

$$CRE_{ATM} = CRE_{TOA} - CRE_{BOA}$$

- ✓ Validated flux estimates lead to reliable CRE
- ✓ CRE distributions are broadly consistent with A-Train (e.g. L'Ecuyer et al. '08)

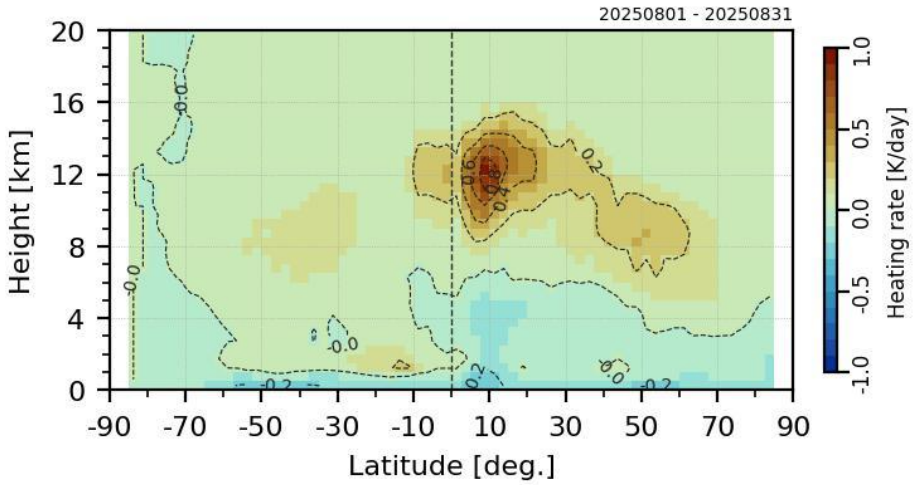




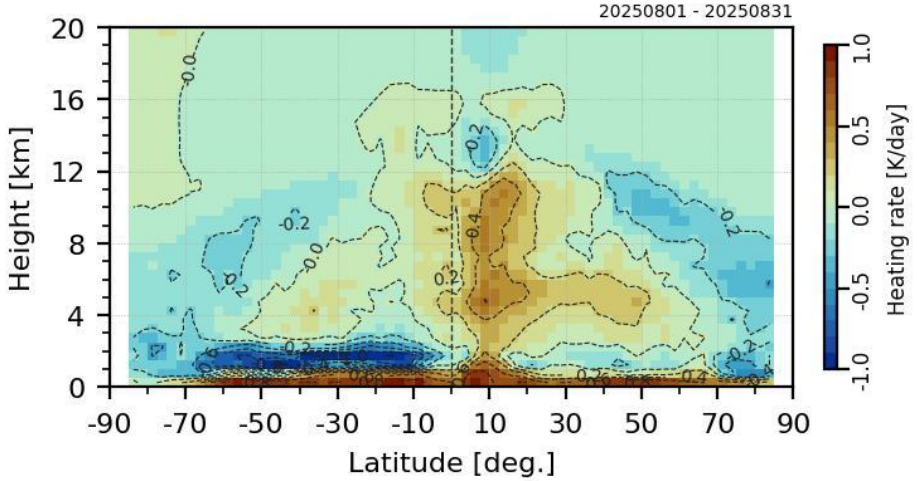
Inferred profiles of cloud radiative heating

August 2025

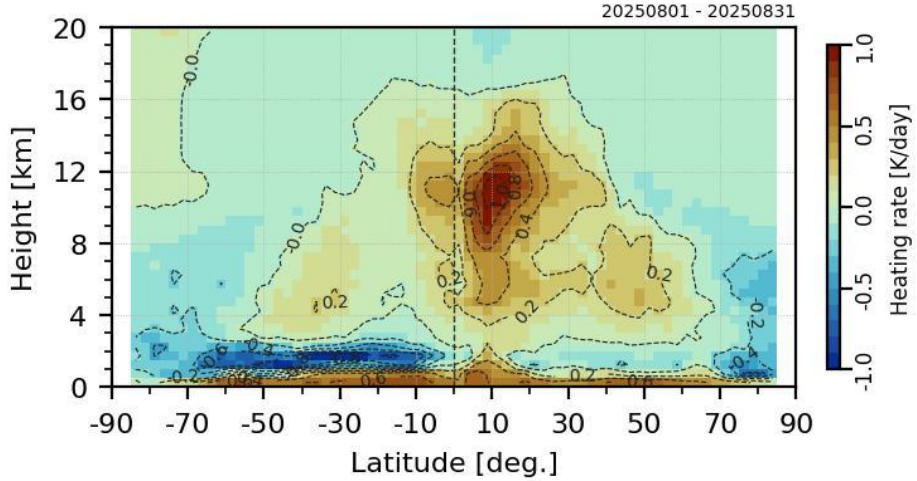
SW CRE heating rate



LW CRE heating rate



NET CRE heating rate



$$\textbf{Heating rate: } Q(p) = \frac{dT}{dt} = \frac{g}{c_p}\frac{\partial F}{\partial p}$$

$$\textbf{CRE on heating rate: } Q_{cre} = Q_{all} - Q_{clear}$$

- ✓ Validated flux estimates lead to reliable CRE
- ✓ CRE distributions are broadly consistent with previous studies (e.g. Kato et al. ’18)

Summary & Outlook

- **Development**
  - Using JAXA L2 standard aerosol/cloud products derived from ATLID, CPR, and MSI
  - Delivering radiative fluxes and heating-rate profiles using 1-D RT
  - Radiative closure assessment through comparisons with BBR measurements
- **Validation**
  - Validated against BMA-FLX (TOA) and BSRN (SFC)
  - LW accuracy already meets the mission's target requirements
  - SW accuracy meets release requirements, with analysis of remaining uncertainties as a follow-up task (e.g. IFOV mismatch, 3-D RT effects etc.)
  - Public release: December 2025 (feedback and user requests are welcome)
- **Future work**
  - Validation of aerosol radiative effects under clear-sky conditions
  - Use of L2 synergy products (aerosols: AM_ALR; clouds: ACM_CLP)
  - Quantitative evaluation of 3-D radiative transfer effects
  - Continued effort of inter-comparison with ESA radiation products (ongoing)

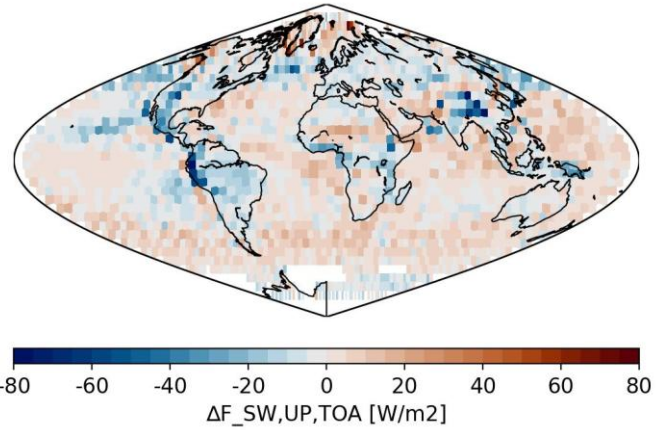
Uncertainty characteristics: Spatial distribution (all-sky)

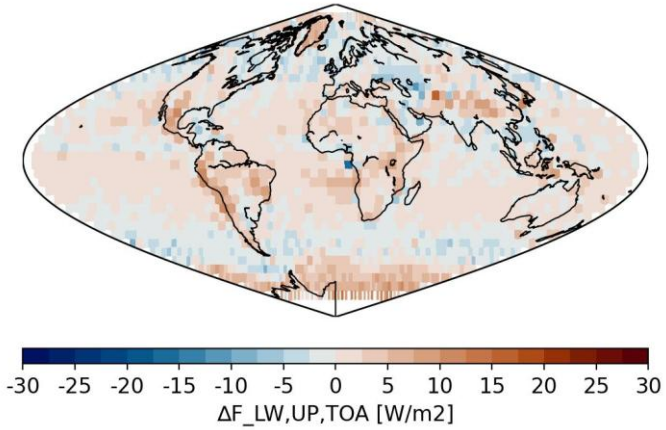
(a) SW, Daytime

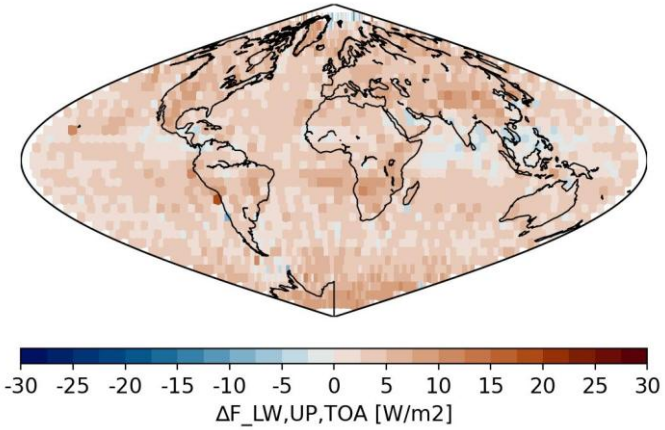
(b) LW, Daytime

(c) LW, Nighttime

Latest (v1.0)
Data: 2025/08







Significant improvement!

(Results of improvements to L2 cloud/aerosol properties)

Previous (v0.8)
Data: 2025/06