Statistically based calibration/validation control of ATLID L1 data

Artem Feofilov[1], Hélène Chepfer[1], Vincent Noel[2]

1 – Laboratoire de Météorologie Dynamique
Sorbonne Université / Ecole Polytechnique, Paris, France
2 - Laboratoire d'Aérologie, Toulouse, France

ESA-JAXA Pre-Launch EarthCARE Science and Validation Workshop

13-17 November 2023 | ESA-ESRIN, Frascati (Rome), Italy

Formulation of the problem

• Elements of spaceborne lidar, related to calibration:
  - molecular channel
  - aerosol channel
  - cross-polarized channel
  - laser power measurement
  - sending and receiving optics (alignment, coatings, degradation)
  - data acquisition system (noise, electronic cross talk, etc)

• L0→L1 conversion requires knowledge of HSRL cross-talk coefficients (+ cross-talk for cross-polarized channel)

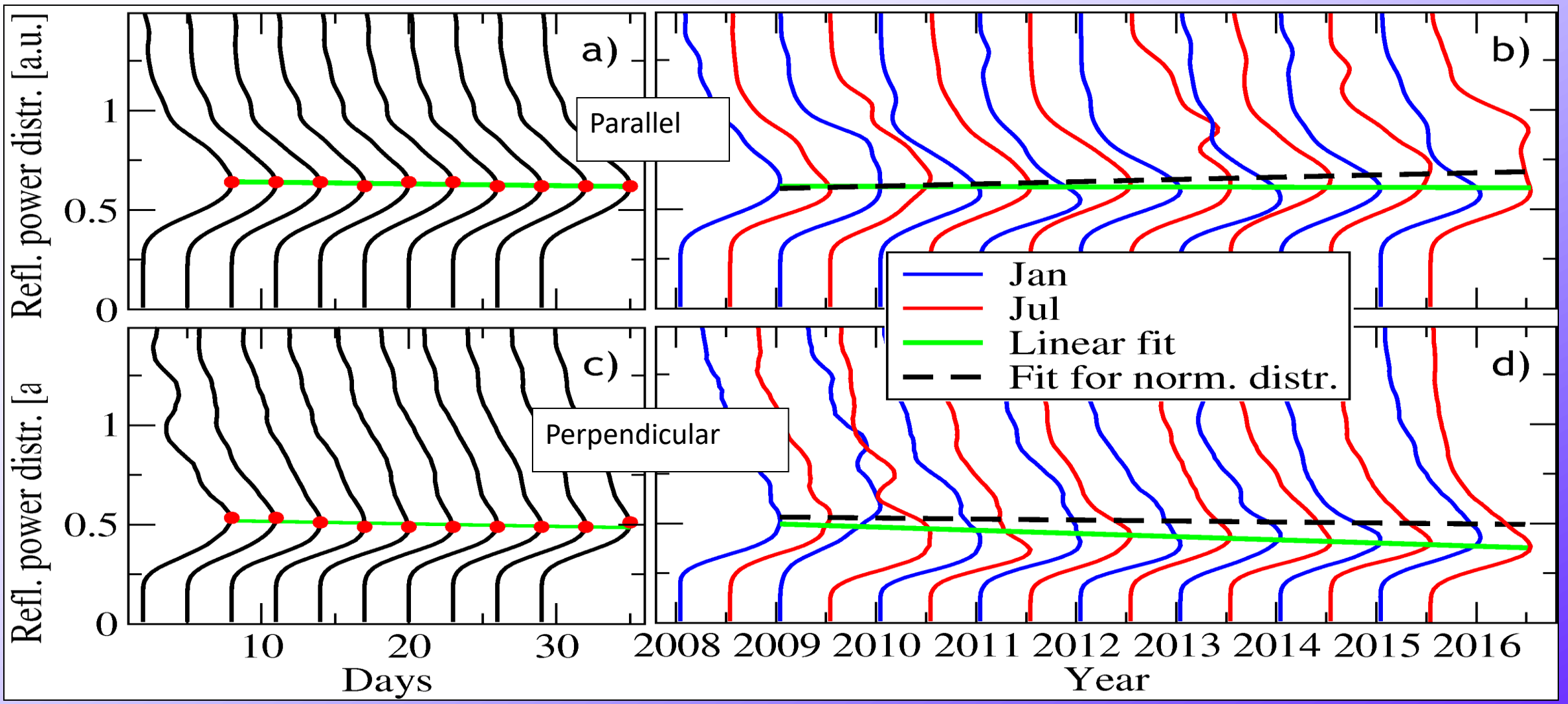
• How to detect drifts and offsets using only a flow of L1 data?

• Ideally, a set of L1-based parameters calculated on a day-to-day basis is needed

Quality/stability control parameters

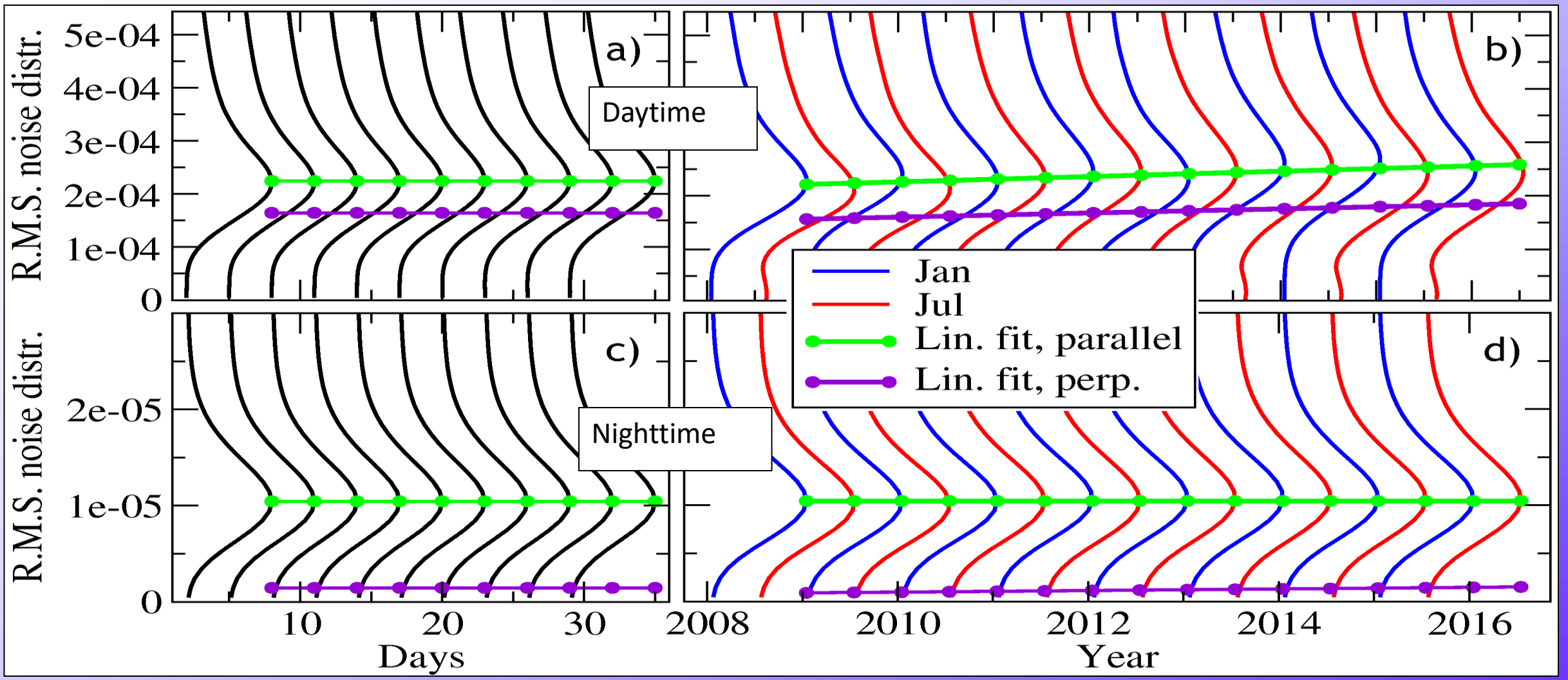
N	Channel/data	Description
1	Mol.	Center values of histograms of radiance reflected from the ocean with T_{surf} = 300±1 K.
2	Part.	
3	Perp.	
4	Mol. day	Center values of histograms of daytime and nighttime stratospheric molecular signal (~35km) or noise (higher altitudes).
5	Part. day	
6	Perp. day	
7	Mol. night	
8	Part. night	
9	Perp. night	
10	K_{corr}, SR histo	Weighted average of the correlation coefficient or deviation for the clustered scattering ratio histograms w.r.t. the reference or the first day
11	R.M.S., SR histo	

Stability control using surface backscatter: CALIOP



Stability control using surface reflection for CALIOP L1 data: (a) parallel component, 3-day statistics for January 2008; (b) same as (a), but for 2008–2015; (c, d) same as (a, b) but for perpendicular component. Dashed lines represent linear fit for laser power-normalized ATB histograms.

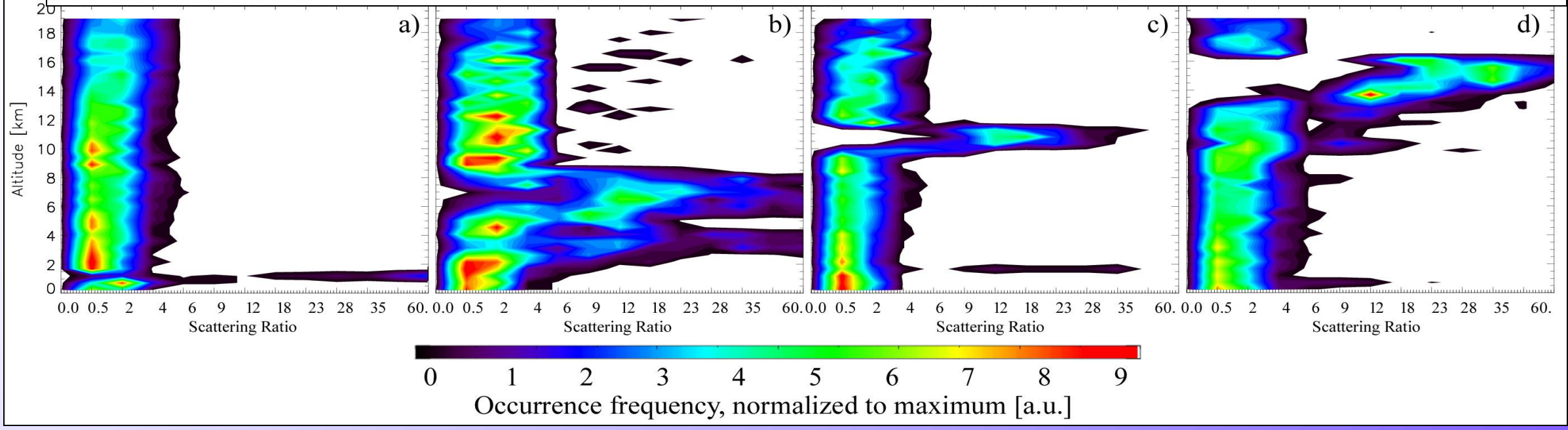
Stratospheric noise analysis: CALIOP

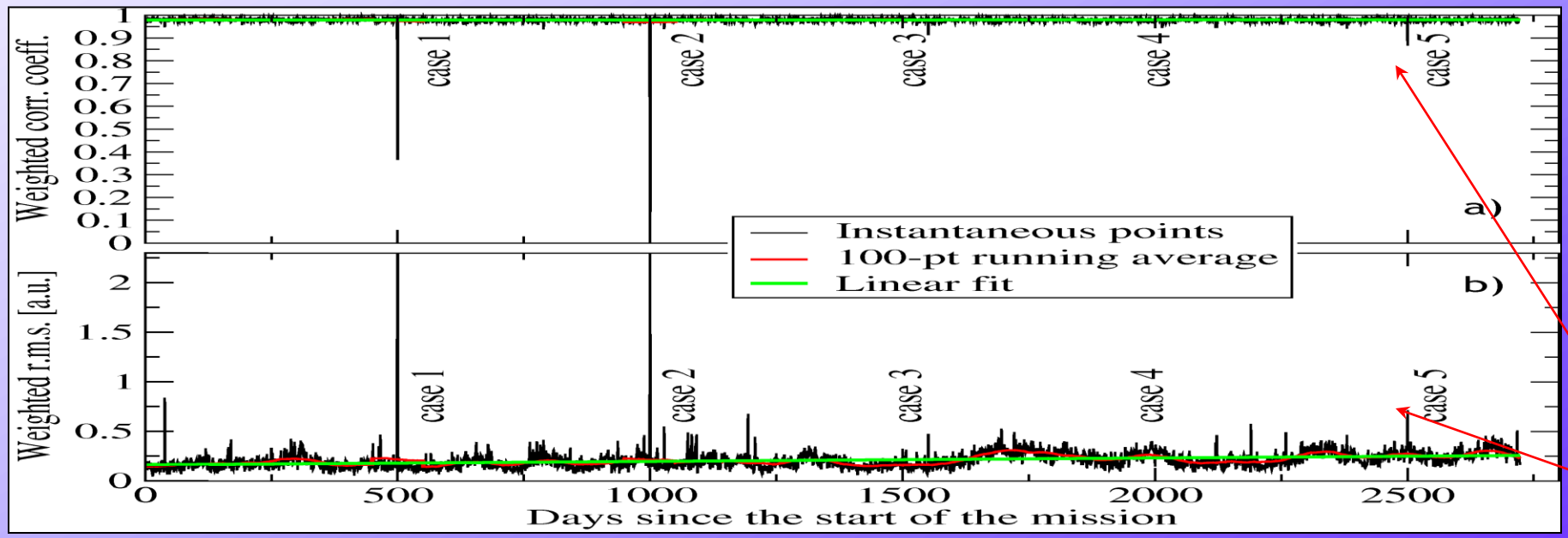


Histograms of stratospheric (35–40 km) signals for parallel component and linear fit of parallel (green line) and perpendicular (violet line) histogram maxima for: (a,b) daytime and (c,d) nighttime; (a, c) are zoomed versions of the first month of (b, d), respectively

Clustering of the scatterring ratio histograms

Examples of height-intensity SR histograms for CALIOP: a) clear sky; b) multi-layer mid-level cloud; c) high semi-transparent cloud; d) thick high cloud.

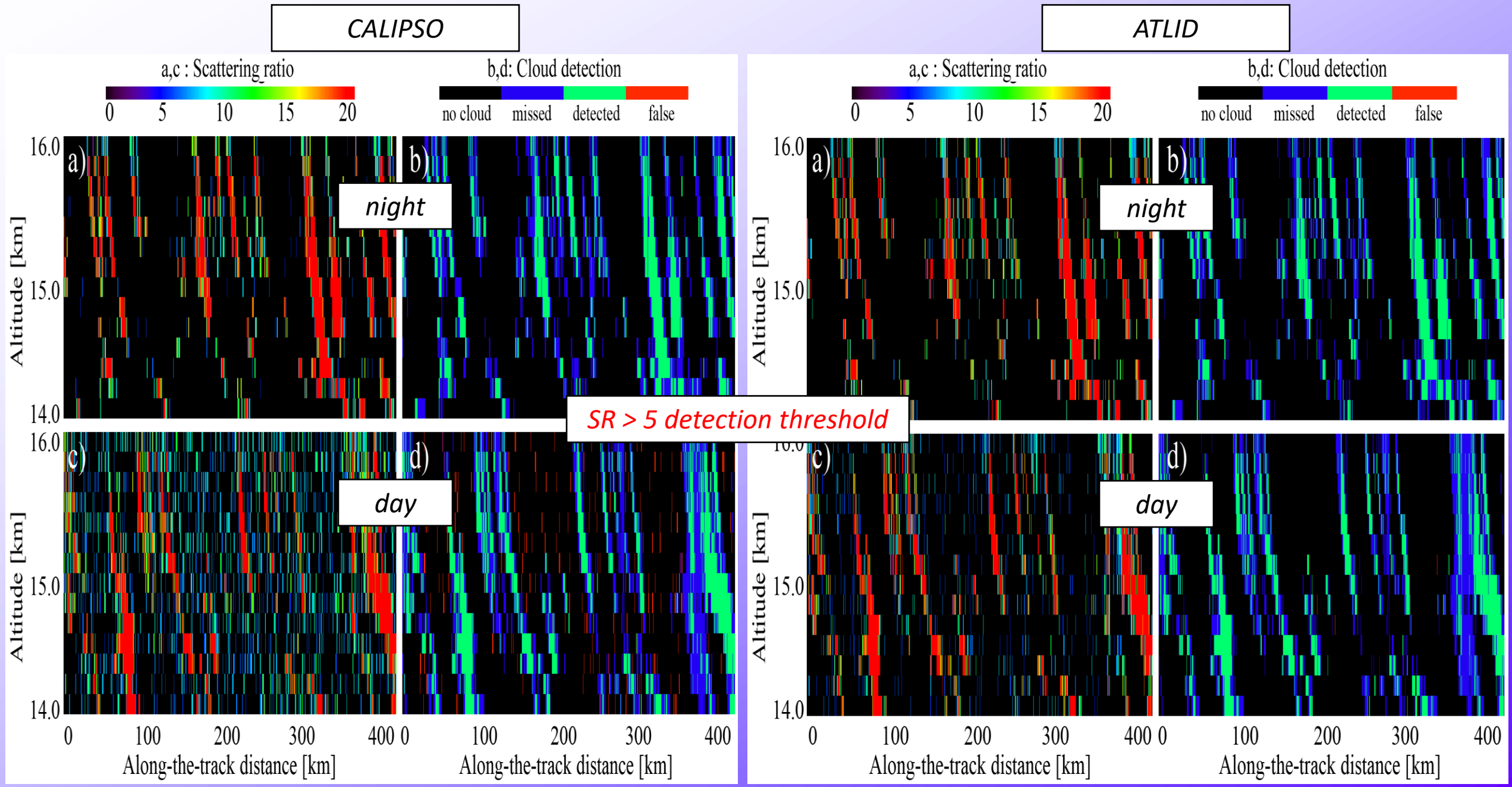




- If everything goes without issues, both lines remain horizontal with small natural variability.
- Offsets in calibration, saturation, increased noise, and so on will reveal themselves in smaller correlation coefficient (upper panel) and/or higher R.M.S. (lower panel)

What to expect from ATLID ?

Feofilov et al., AMT, 2023

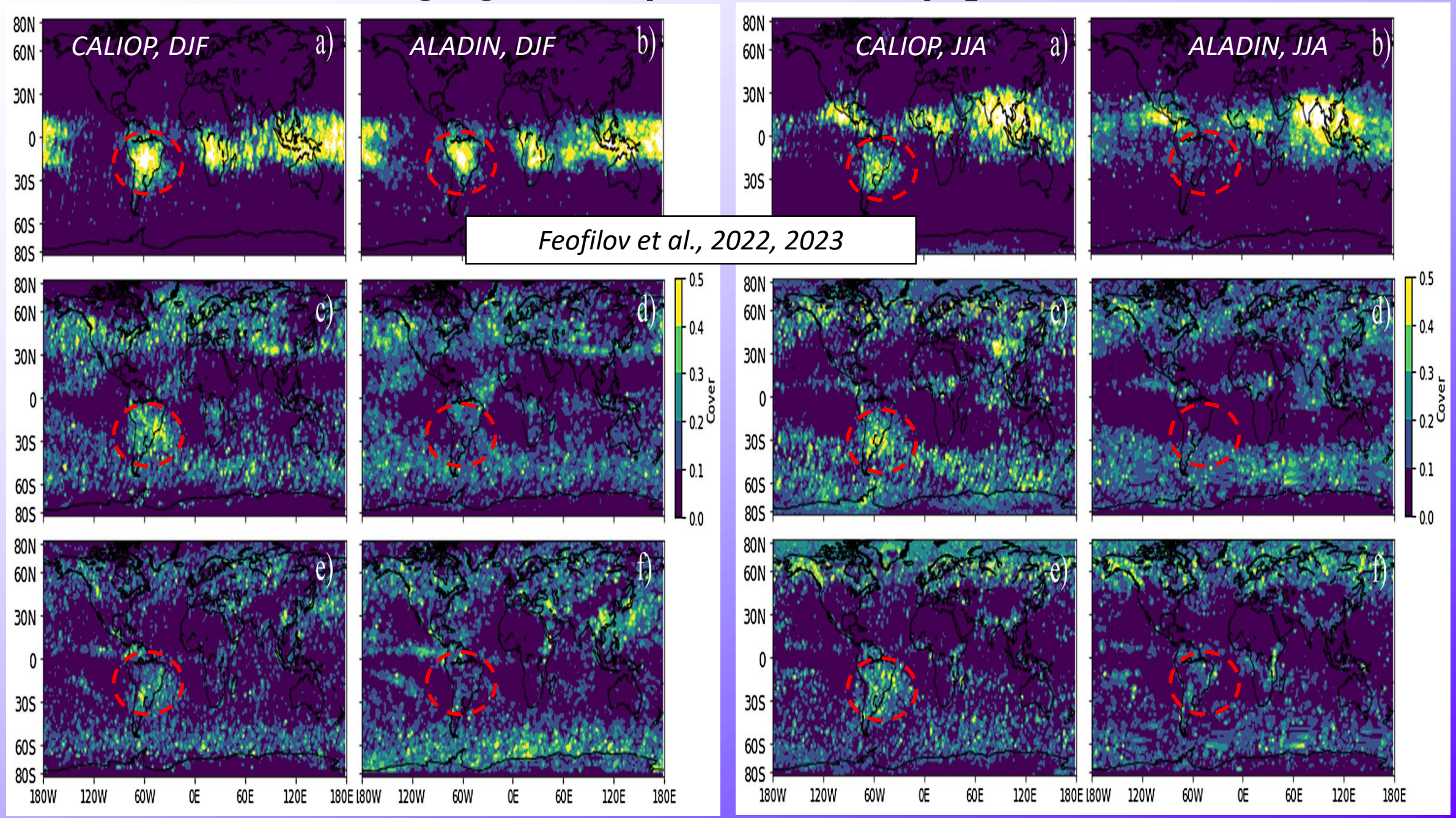


Outlook: merging clouds from a series of space-borne lidars

15km

8km

3km



Feofilov et al., 2022, 2023

Take home messages

• We propose a set of 11 quality control parameters for L1 data flow:

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• We demonstrate the feasibility using a flow of CALIOP data.

• The deliverables are:

(1) an operational quality control algorithm adapted to ATLID L1;

(2) the results of day-to-day quality control using 11 parameters;

(3) a set of daily SR histograms;

(4) a Web-interface dynamically updating quality control results.

In addition, we plan to extend our cloud merging technique tested for a combination of CALIPSO+Aeolus to ATLID