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Overview and Updates of ARM Lidar-related Data Products

August 23, 2023

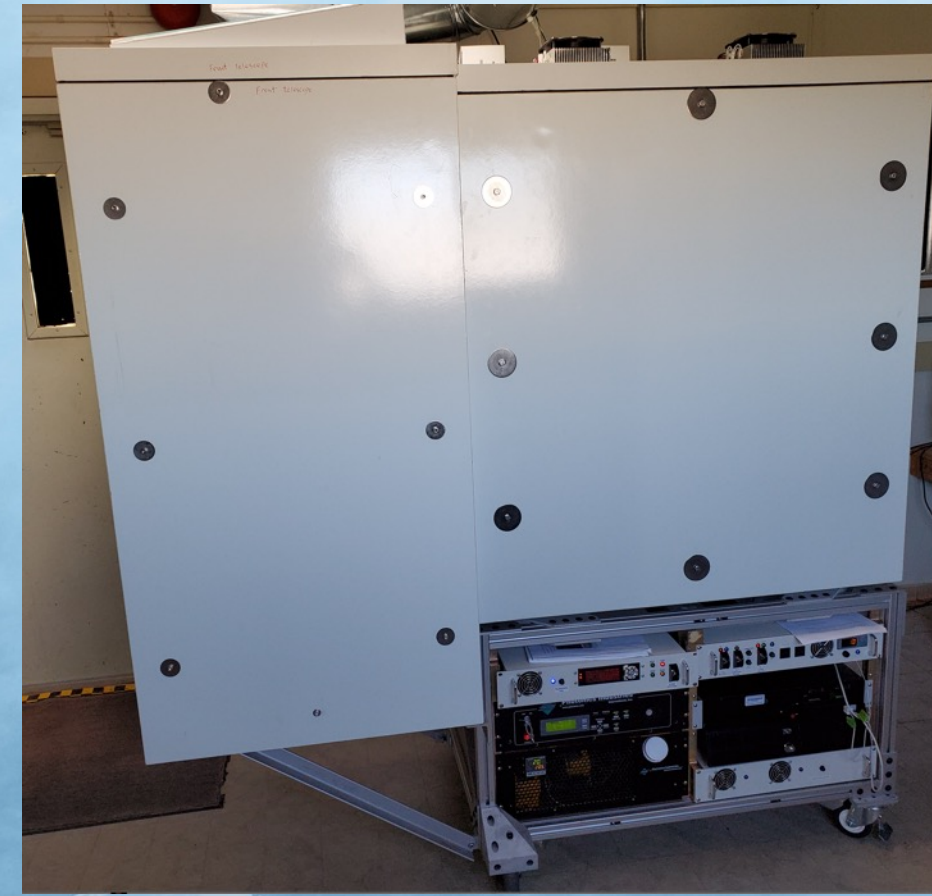
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ARM Translator

U.S. DEPARTMENT OF
ENERGY

ZHANG ARM/ASR PI MEETING 2023



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	Wavelength	Measurements	Data Products
Raman Lidar (RL)	355 nm (elastic), 387 and 408 nm (Raman)	Backscatter and extinction coefficients, depolarization ratio Raman backscatter	rlprofmr2news.c0 : calibrated water vapor mr profiles
			rlproftemp2news.c0 : calibrated temperature profiles
			rlproffex1thor.c0 : extinction (355 nm) and feature mask profiles
High-spectral-resolution Lidar (HSRL)	532 & 1064 nm	Backscatter and extinction coefficients, depolarization ratio	hsrl.a1 : backscatter (532 and 1064 nm) and extinction coefficient (532 nm) profiles
Doppler Lidar (DL)	1.5 μ m	Backscatter coefficient, Doppler velocity	dlfpt.b1 : vertical velocity
			dlprofwind4news.c1 : horizontal wind speed and direction
			dlprofwstats4news.c1 : w variance, skewness, and kurtosis
Micro-pulse Lidar (MPL)	532 nm	Backscatter intensity, depolarization ratio	mplcmask1zwang.c1 : cloud mask profile and boundaries
			mplcmaskml.c1 : cloud mask profile and boundaries
Ceilometer (CEIL)	910 nm	Backscatter coefficient, visibility	ceil.b1 : cloud base height
			ceilpblht.a0 : boundary layer height estimate

ARM VAPs: <https://www.arm.gov/capabilities/science-data-products/vaps>

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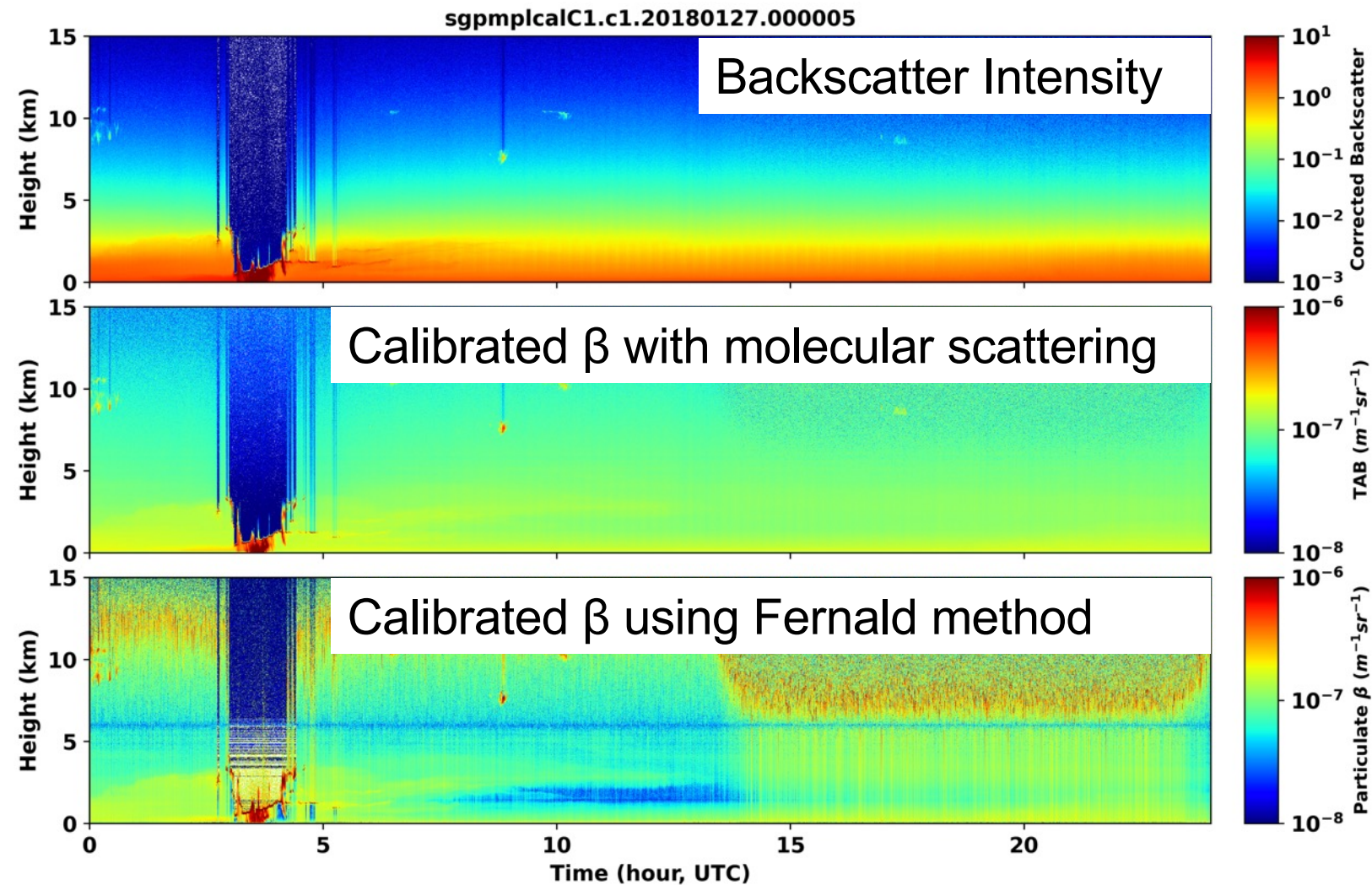
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➤ MPLCAL

- **Inputs:** mplpolC1.b1 and atmospheric temperature and pressure profiles from the INTERPSONDE VAP
- **Outputs:** calibrated lidar backscatter coefficient using 1) molecular backscattering; 2) the Fernald method.
- Comparisons with other lidar measurements, retrievals of aerosol and cloud properties.
- Evaluation data released at **SGP** (01/2016-12/2017)



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➤ MPLCAL

➤ RLPROF-FEX

- Newly available at OLI (02/2015-10/2019)
- Data missing due to the harsh environment at OLI

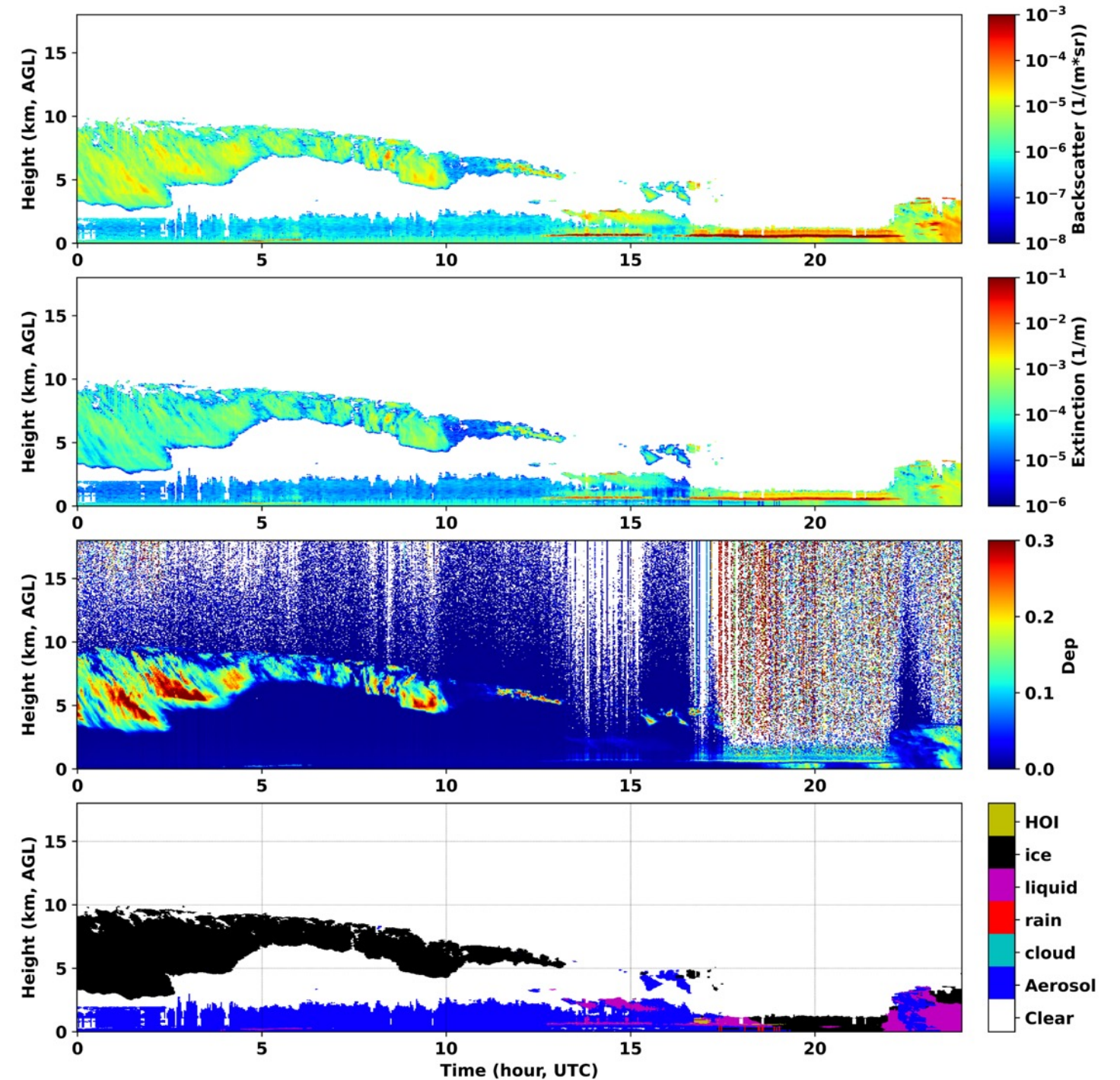
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➤ MPLCAL

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➤ RLPROF-FEX

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➤ **Aerosol Feature Mask profile**

- Use the similar method as RLPROF-FEX VAP
- Detect aerosol feature using height-dependent scattering ratio
- Evaluation data at SGP will be released soon
- Extend to MPLCAL data in the future

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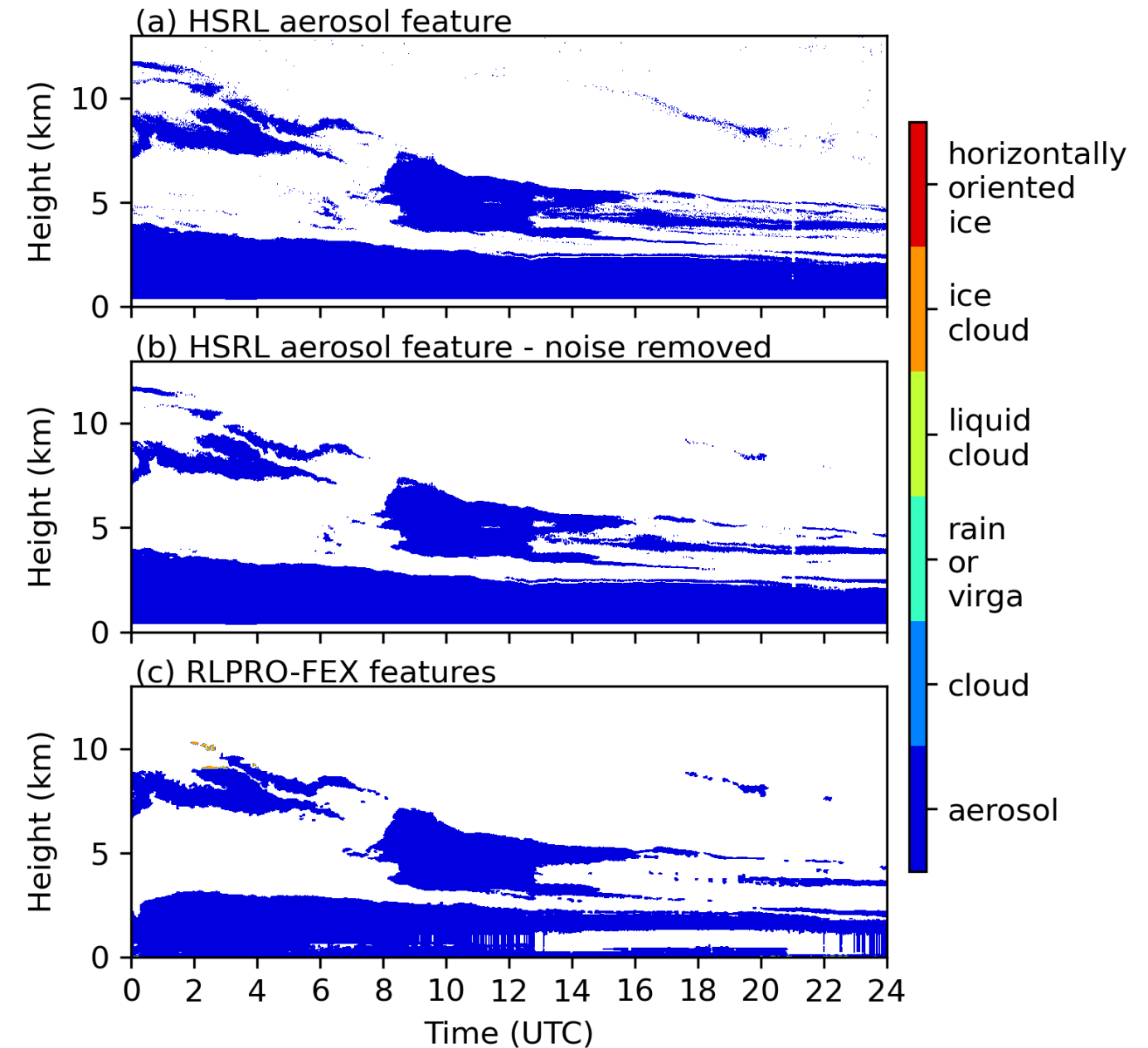


Figure from Peng Wu

Find more in poster #28

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➤ MPLCAL

➤ RLPROF-FEX

➤ Aerosol Feature Mask profile

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➤ **Aerosol microphysical property retrievals**

- 3β (RL 355nm, HSRL 532 and 1064 nm) + 2α (RL 355 nm and HSRL 532 nm) algorithm
- Collaborating with NASA LaRC group to implement the retrieval code

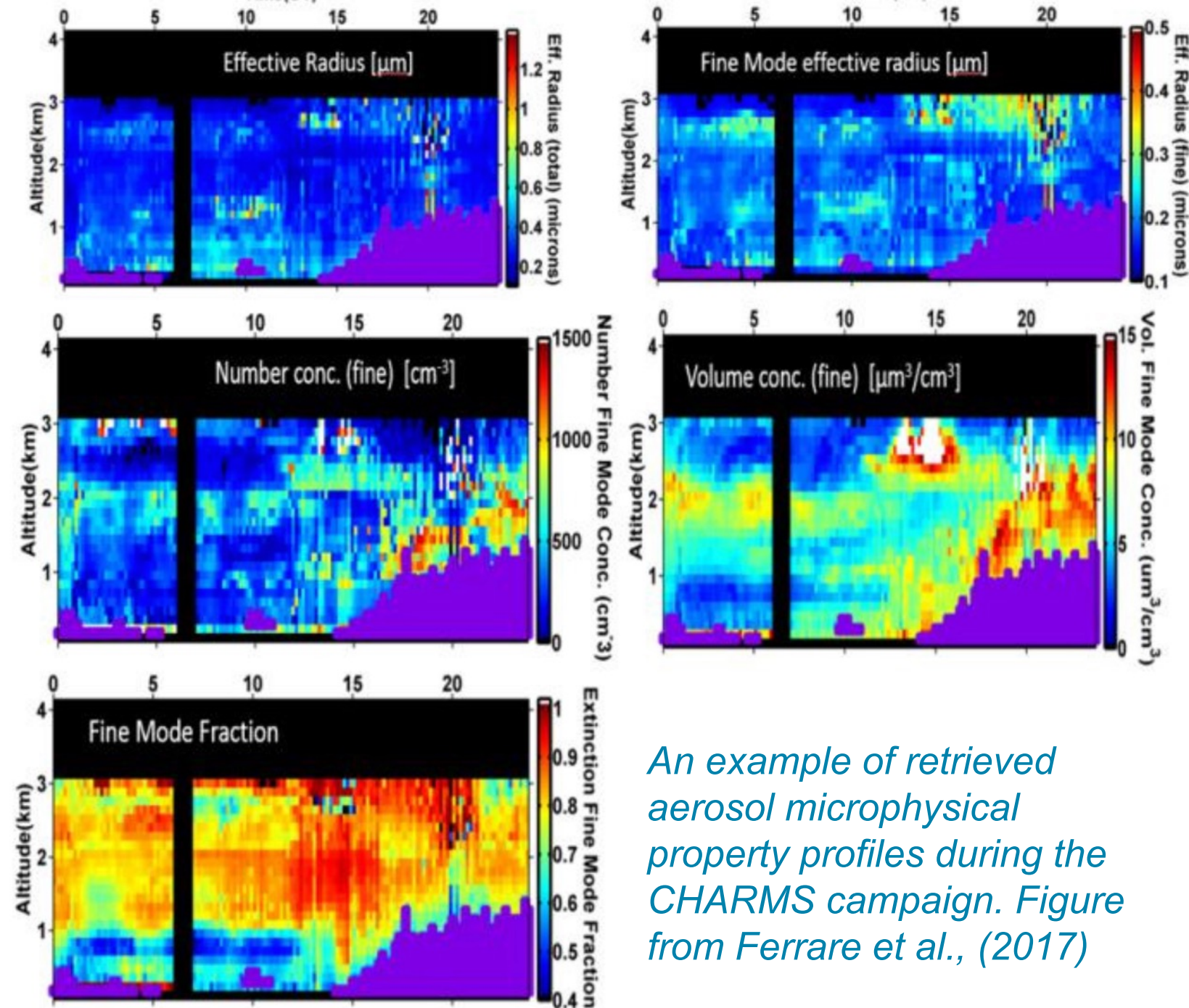
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➤ **CCNPROF**

GK's presentation



An example of retrieved aerosol microphysical property profiles during the CHARMS campaign. Figure from Ferrare et al., (2017)

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➤ MPLCMASKML

- Improved cloud detection with Micropulse lidar measurements and fully convolutional network machine learning model.
- Better cloud boundary detection.
- Available at multiple sites; historical processing is ongoing.

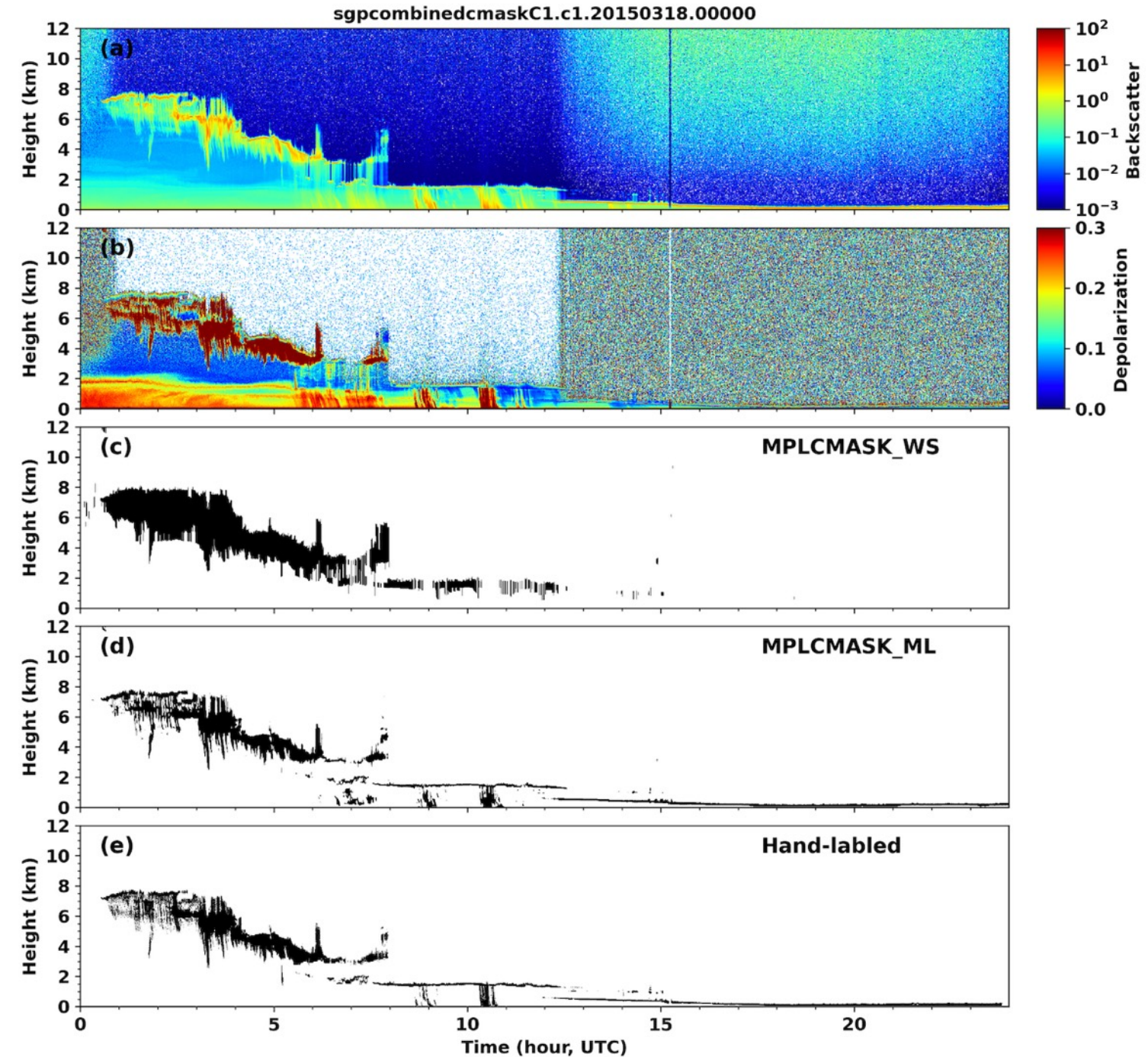
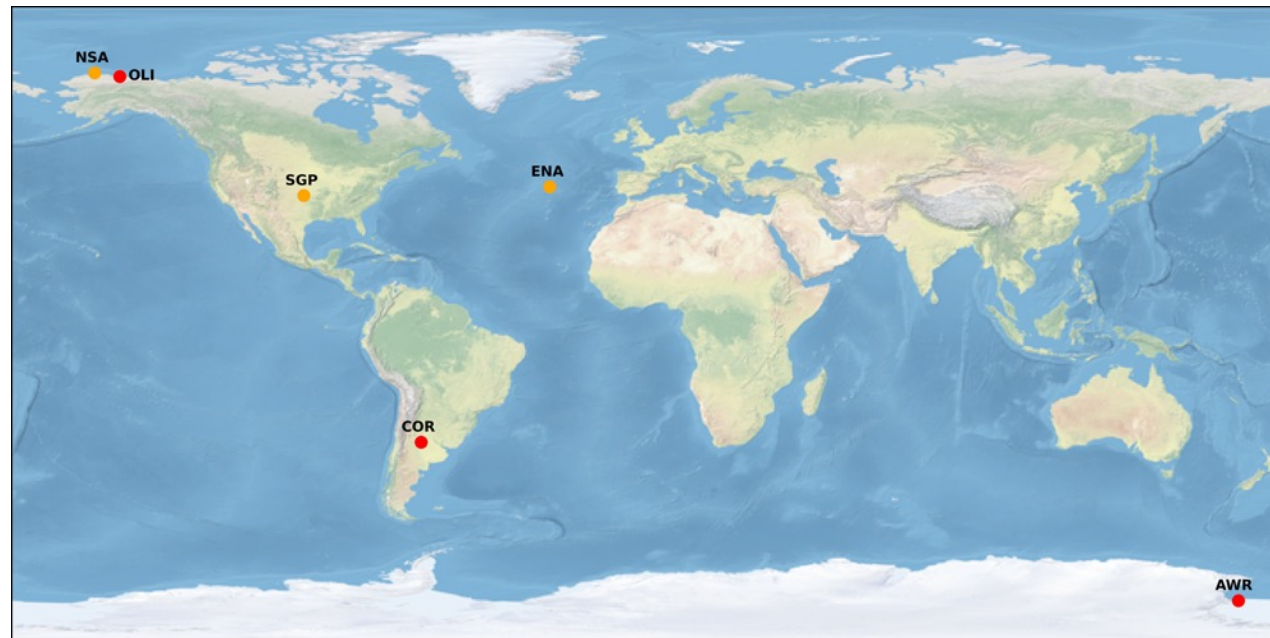
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➤ MPLCMASKML

➤ **Cloud Droplet Concentration (N_d) Retrieval**

Lidar-based N_d retrievals (Snider et al., 2017; Zhang et al., 2023):

$$N_{d,z} = \frac{2\rho_w^2}{9\pi k} \frac{\beta_{e,z}^3}{LWC_z^2}$$

- $\beta_{e,z}$ from MPL or RL

- Will be added in the NDROP VAP
- The ensemble of retrievals help to quantify N_d retrieval uncertainties.

Find more in poster #90

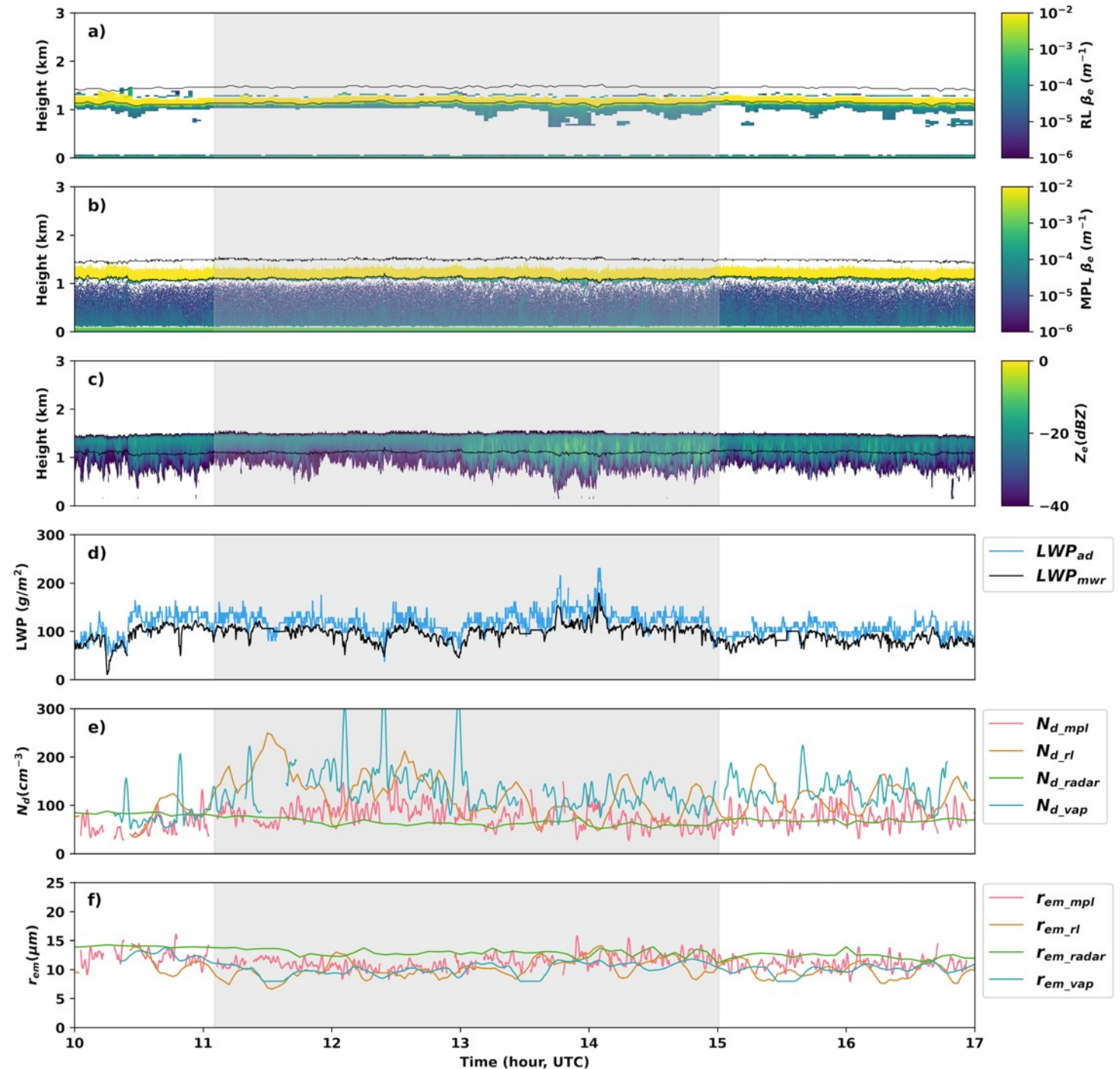
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➤ MPLCMASKML

➤ NDROP

➤ **THERMOCLDPHASE**

- HSRL (or MPL) β and depolarization ratio are used to identify liquid clouds

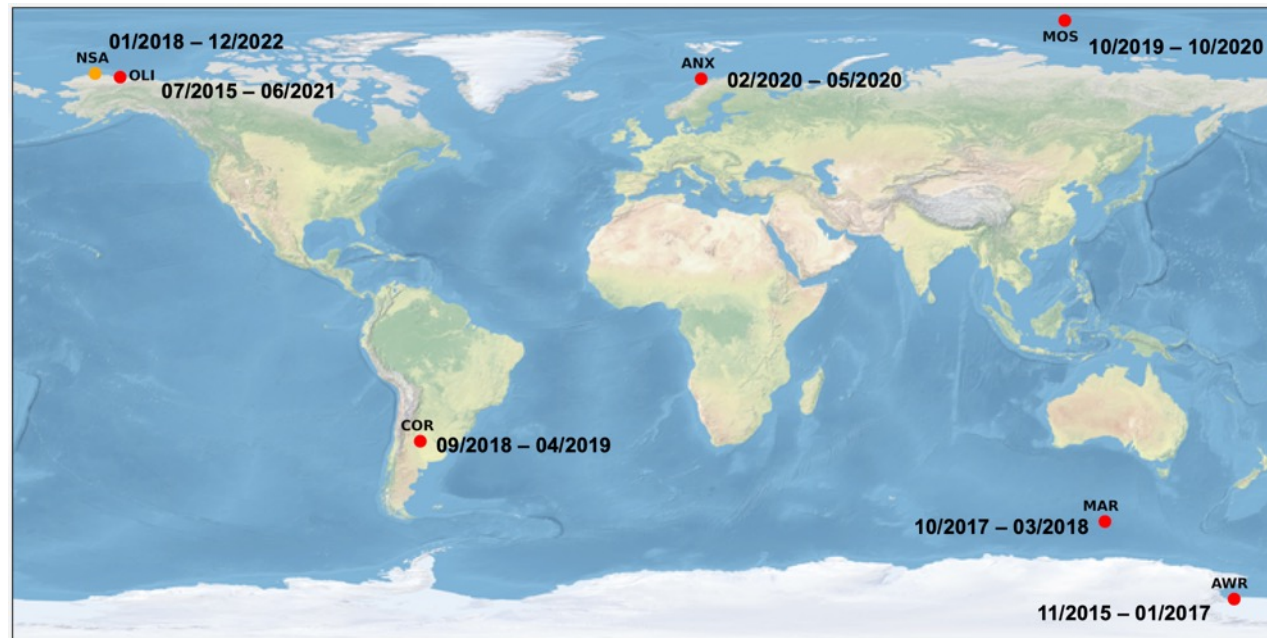
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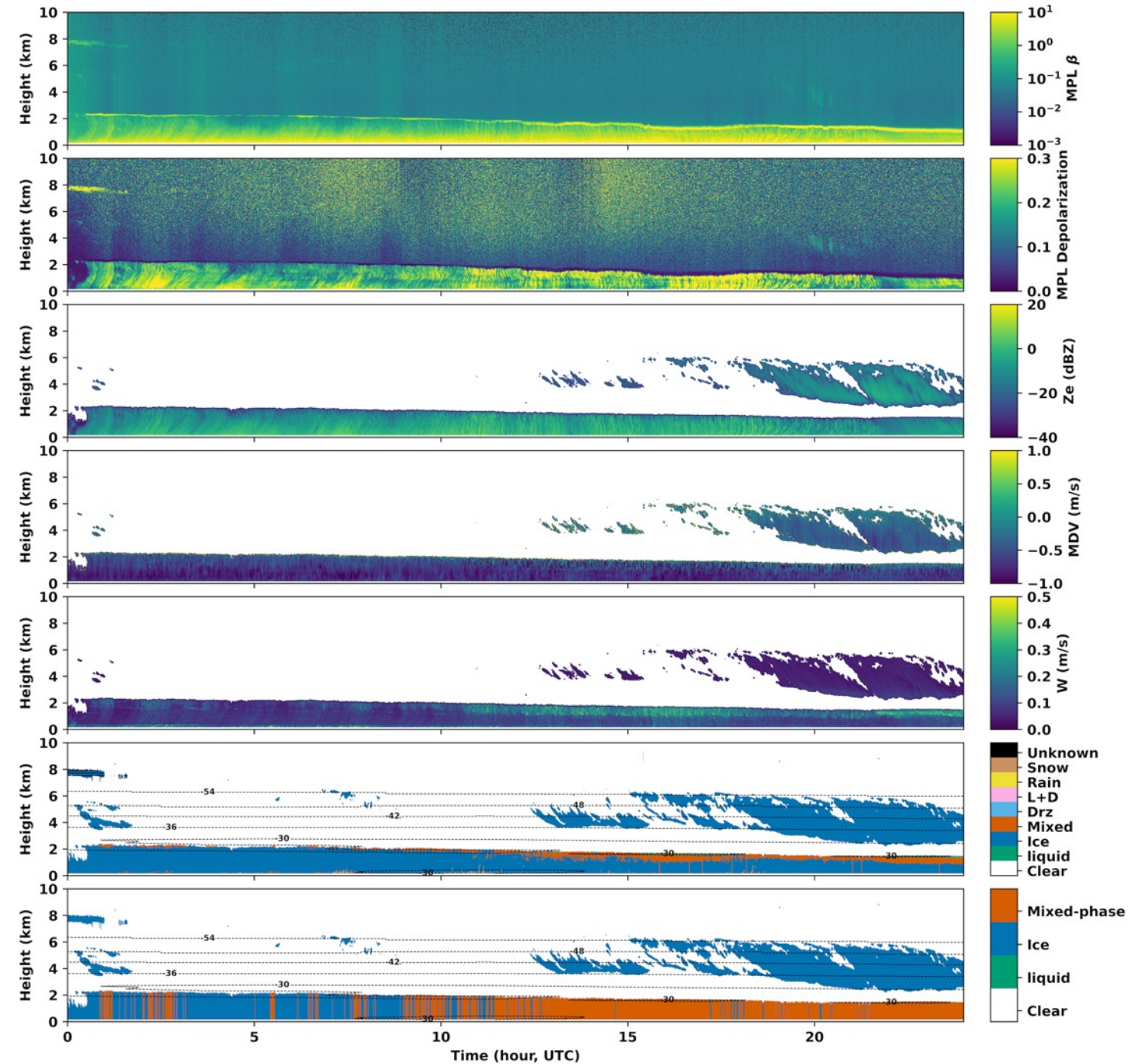
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Find more in poster #73



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- PBLHT_MPL (aerosol backscatter)
 - Gradient method (Harr wavelet covariance) by *Sawyer and Li (2013)*; available at **SGP and COR**.
- PBLHT_CEIL (aerosol backscatter)
 - Enhanced gradient method; real-time display; available at **most sites**.
- PBLHT_DL (dynamics)
 - Vertical wind variance threshold; available at **SGP**.
- PBLHT_RL (thermodynamics)
 - Heffter method using RLPROF+AERloe potential temperature profiles.
 - Good performance under both unstable and stable boundary layer conditions.
 - Evaluation data will be released soon.

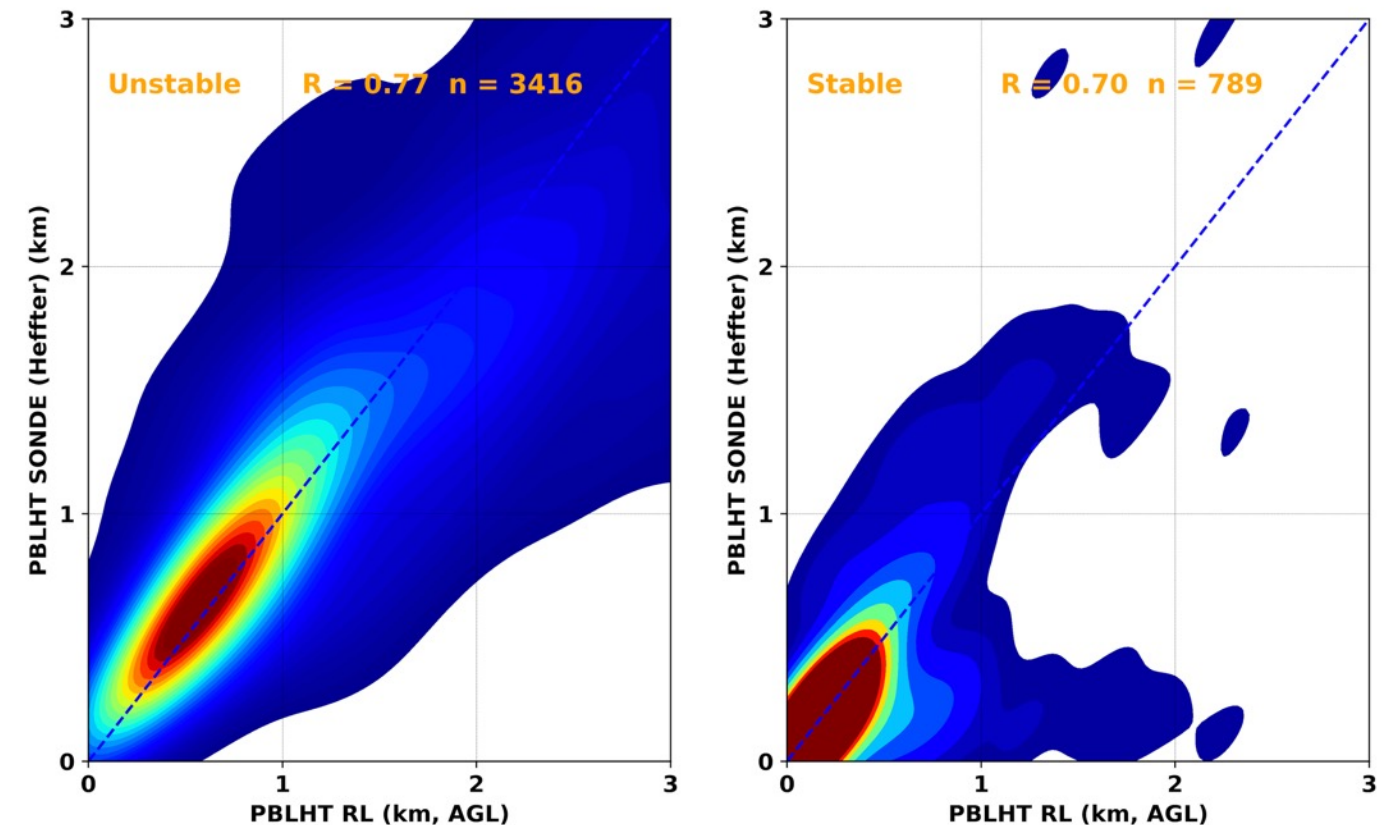
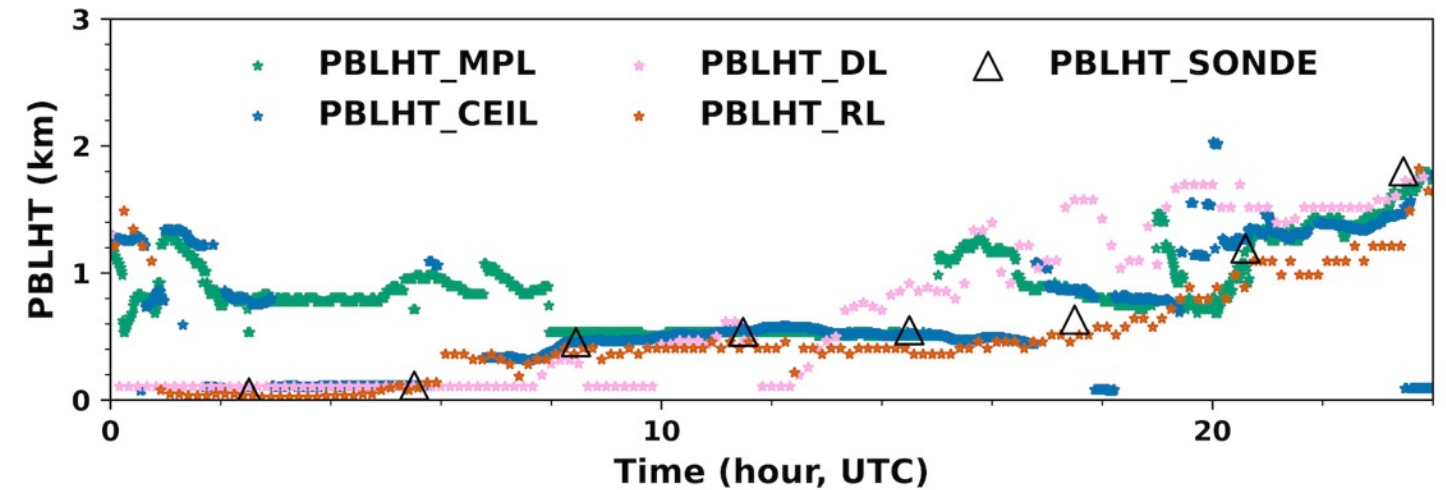
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2016-2022 at SGP with RLPROF+AERloe data

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- For additional questions on VAPs and/or VAP availability, please contact the Translators.
- Prioritize VAP development and processing according to community **feedbacks and requests**.

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