

ARSCL (Active Remote Sensing of CLOUDs) Updates and Radar Consolidation

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ARSCL Product Purpose

To transform cloud radar observations into:

- Lowest cloud base
- Cloud layers
- Best-estimate radar reflectivity
- Corrected vertical motions

with input from other ARM sensors.

ARSCL Impact

ARSCL products are widely used at most ARM fixed sites and AMF locations on their own and as input to other ARM products.

Current ARSCL VAP Components

KAZRCOR (IDL)

For each radar mode (ge, md, pr)

- Corrects velocities
- Corrects reflectivity for gaseous attenuation
- Identifies significant detections

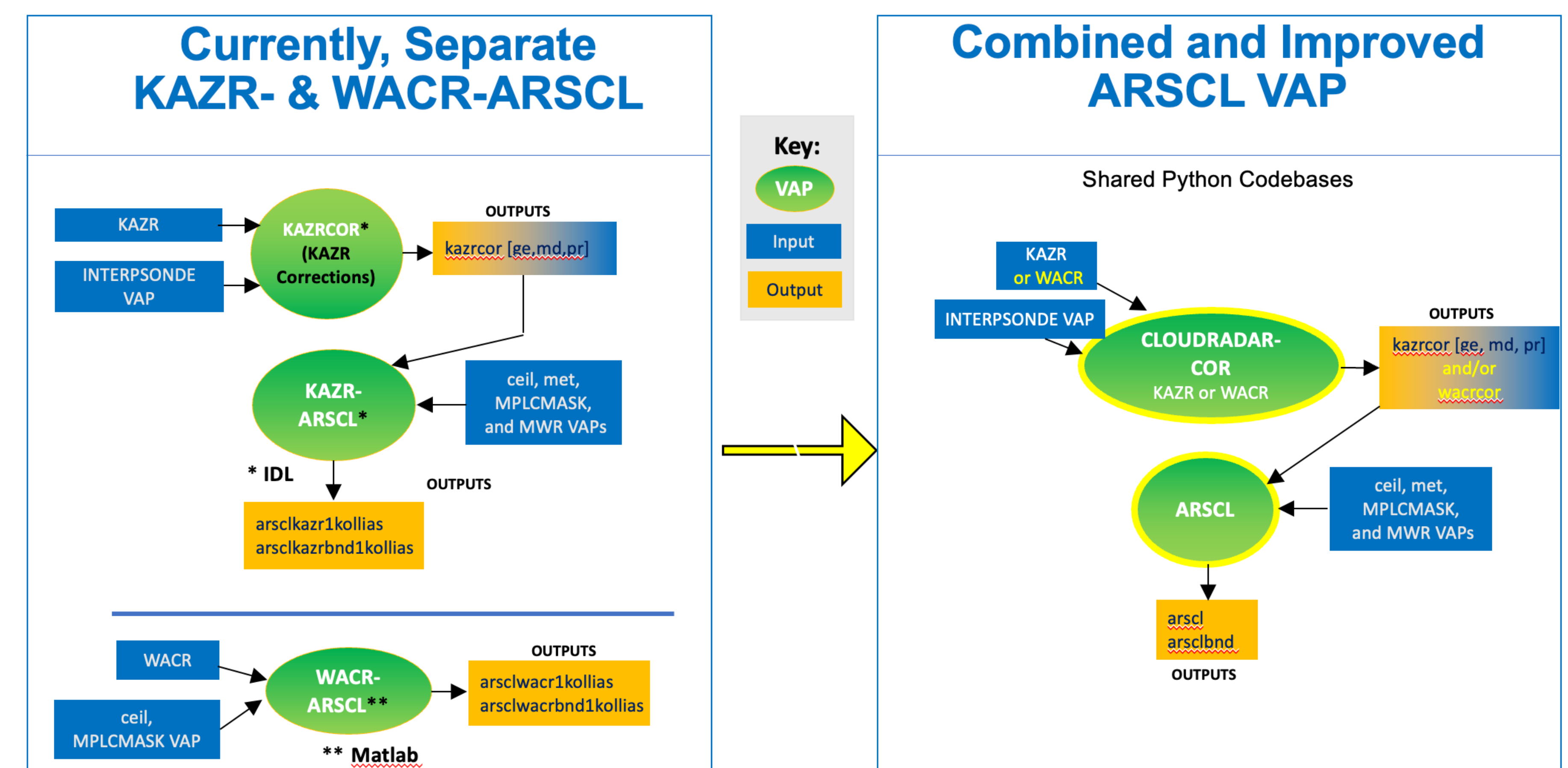
KAZR-ARSCL (IDL)

- Nearfield correction (reflectivity)
- Merges corrected KAZR modes
- Finds best-estimate cloud base
- Flags/removes radar clutter
- Identifies cloud layer boundaries

WACR-ARSCL (Matlab)

Similar to KAZRCOR + KAZR-ARSCL

ARSCL Enhancements, Code Merge / Modernization and Open Source Project Underway



History of ARSCL Product

➤ **Original ARSCL** developed in late 1990's by Clothiaux and Turner (Clothiaux, et al., 2000)

- 100's of C codes, Unix scripts, and config files
- MPL cloud detection as part of ARSCL
- Slow, manual processing

➤ **Mid 2000's**

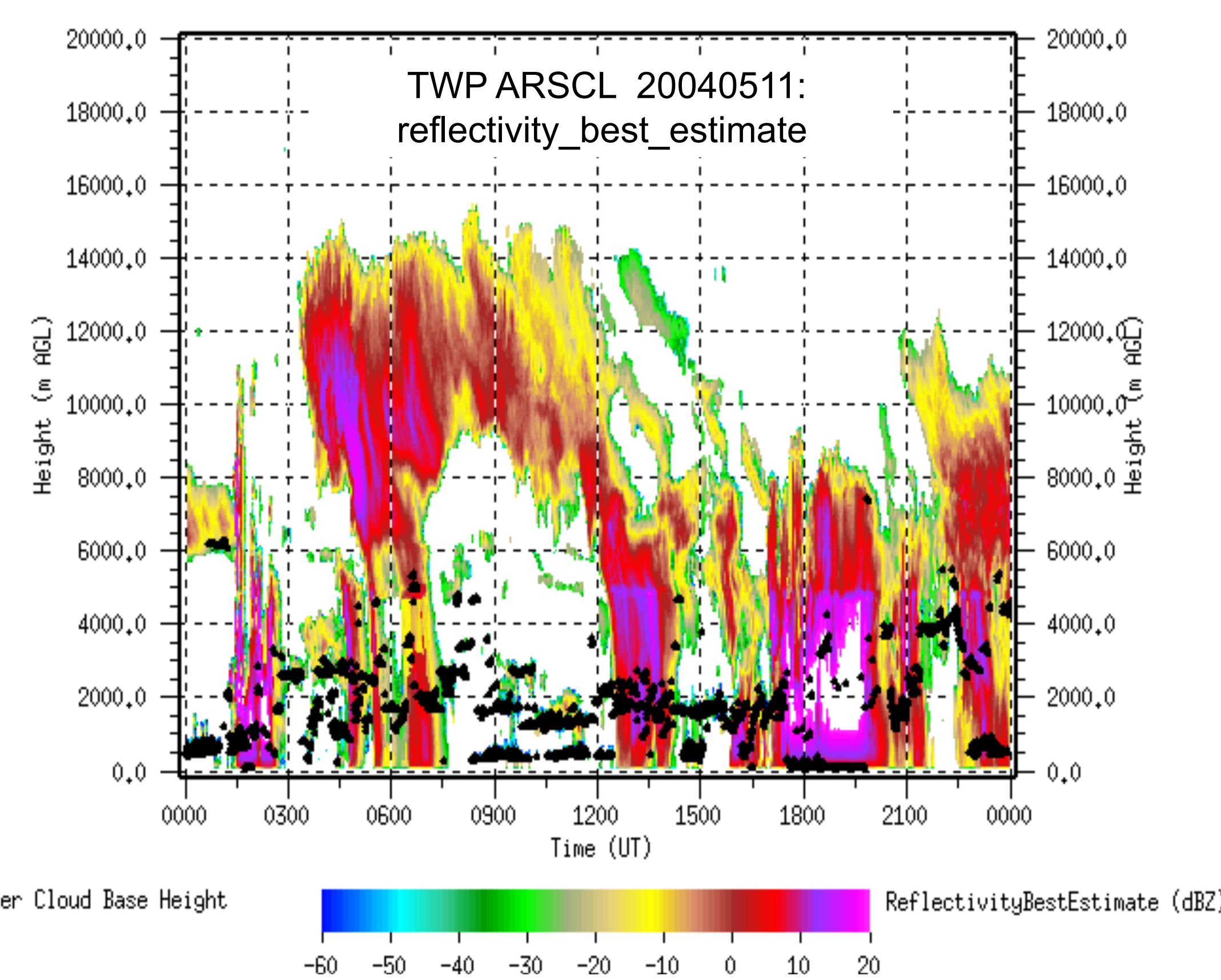
- Updated for MMCR C40 and PIRAQ processors
- WACR-ARSCL developed with Kollias

➤ **2011, KAZR replaces MMCR**

- Recoded in IDL, within ADI framework
- Split into 2 VAPs: **KAZRCOR** and **KAZR-ARSCL**

➤ **2019, KAZR format update to CF/Radial**

- Addition of KAZR Precipitation (PR) mode
- Additional polarization variables



ARSCL Algorithms Change Over Time

Updates as part of MMCR to KAZR transition (2011):

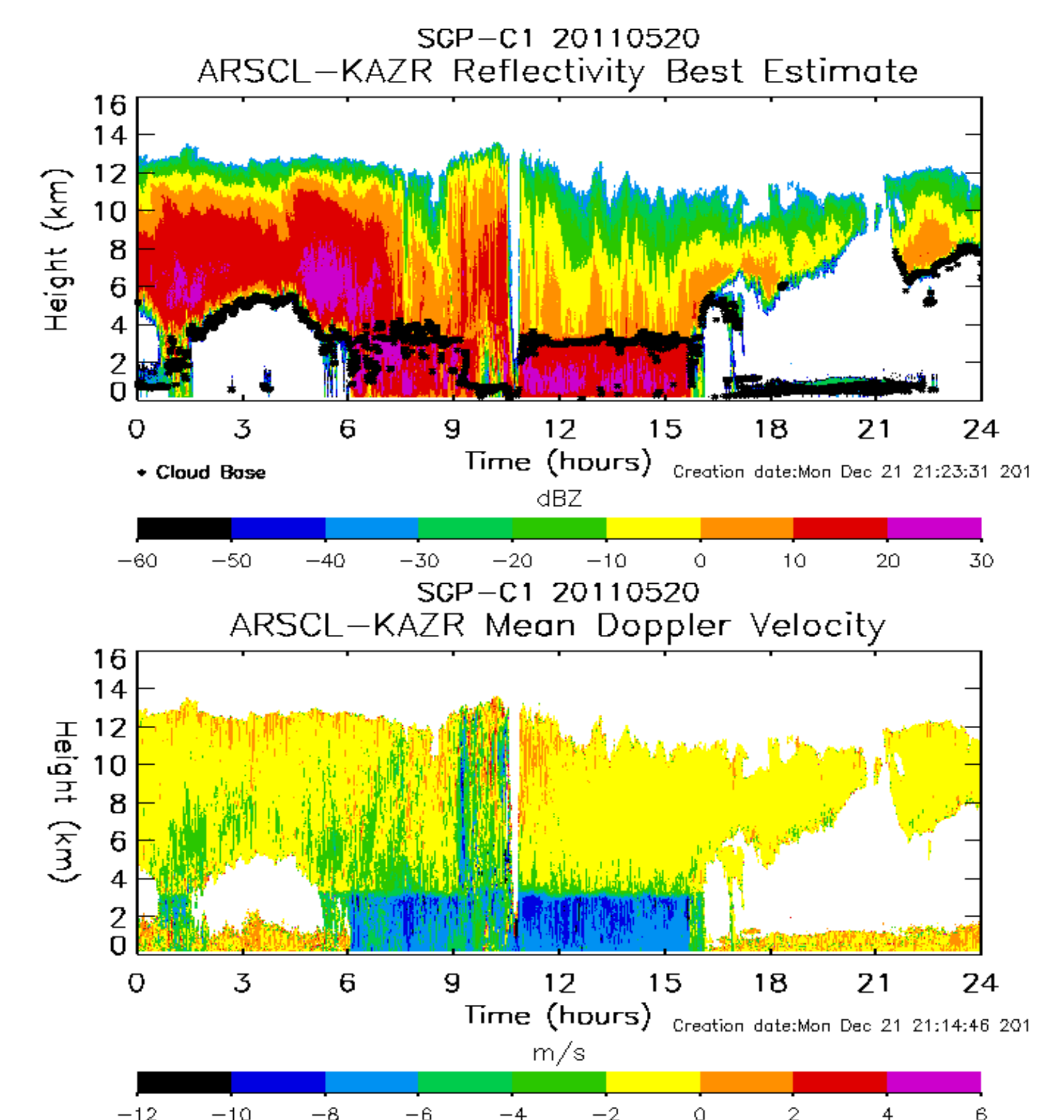
- Gaseous attenuation correction added (KAZRCOR)
- New significant detection algorithm (Kollias)
- MPL cloud masks now from MPLCMASK VAP
- For cloud base, the improved Ceilometer is preferred over MPL up to 7.7 km (vs. original 3 km)
- Less data review needed, faster processing

Updates to support KAZR2 (ENA, OLI, 2015):

- Attenuated KAZR precipitation (PR) mode added
- Additional polarization fields added

Calibrated, 'c1' processing added (2018)

- Additional outputs: Minimum Detectable Reflectivity, Reflectivity Saturation flag



ARSCL VAP Updates, in Progress

KAZRCOR VAP → CLOUD RADAR COR

Green = completed

- Convert IDL to Python
- Inputs from KAZR or WACR (gaseous attenuation correction).
- Add configuration file to specify constants at run time
- Open source availability of algorithms, where appropriate
- Ship corrections module?
- Output datastreams include radar name (e.g., 'kazzcorge', 'mwacrcor')

References

Clothiaux EE, TP Ackerman, GG Mace, KP Moran, RT Marchand, M Miller, and BE Martner. 2000. "Objective Determination of Cloud Heights and Radar Reflectivities Using a Combination of Active Remote Sensors at the ARM CART Sites." *Journal of Applied Meteorology*, 39(5)

KAZR- & WACR-ARSCL → ARSCL

- Convert IDL to Python
- Corrected KAZR + WACR can be inputs, with 'best' source used
- New input sources:
 - MPLCMASKMML – SGP, NSA, ENA
 - RWP observations → better cloud tops in precipitation
- Improve clutter detection using spectra-based techniques
- Address known issues, e.g. KAZR MD mode signal leakage below ~ 3 km, by merging at higher level, use of algorithm to mitigate artifact
- Open source availability of algorithms, where appropriate