RealPEP Phase 2:
Fine tune QA, QPE and Water Content implementation in POLARA
20.09.2023

Mst. Mahfuja Akter, Kai Mühlbauer

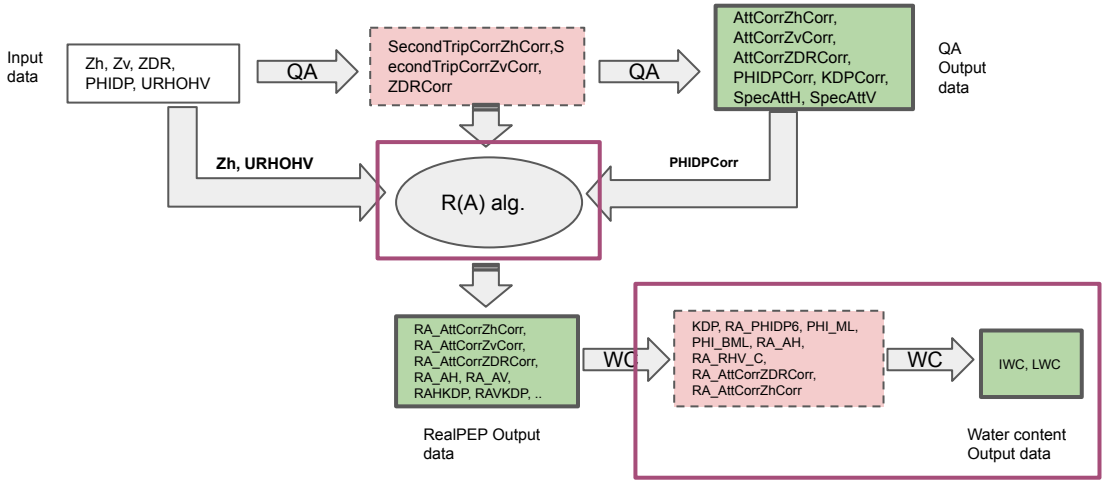
Dr. Silke Trömel

Meteorology Institute, University of Bonn

QA: Corrected Moments (Updated)

1. Signal processor overflow
2. radar status analysis
3. application of threshold filters to reflectivity
4. application of threshold filters to radial velocity
5. smooth parts of phidp filter
6. speckle filter PHIDPCorr — PHIDPCorr
7. manual calculation of KDP
8. spectral width rotation correction
9. spoke detection reflectivity
10. dual prf unfolding
11. spoke detection radial velocity
12. sun spoke marking
13. corrupt image via range normalization
14. ring detection reflectivity
15. ring detection radial velocity
16. RadarQS single sweep algorithms
17. RadarQS volume algorithms
18. dual prf unfolding error correction
19. clutter detection polarimetric — ZhCorr, ZvCorr
20. second trip removal — SecondTripCorrZhCorr, SecondTripCorrZvCorr
21. ZDR filter — ZDRCorr
22. shielding correction
23. polarimetric attenuation correction — AttBiasZDRCorr, AttBiasZhCorr, AttBiasZvCorr, SpecAtth, SpecAttv, DiffAtt
24. single-pol. attenuation correction
25. speckle filter reflectivity — AttCorrZhCorr, AttCorrZvCorr
26. speckle filter differential reflectivity — AttCorrZDRCorr
27. speckle radial velocity — VhCorr, VvCorr
28. speckle KDP — KDPCorr
29. VERIFICATION: counter of moment data, qa bit counter, qa detection monitor

RealPEP: Workflow of Moment data

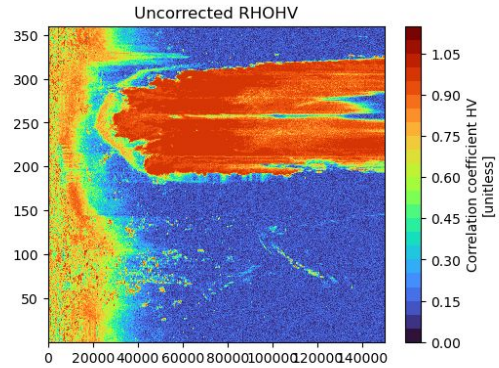


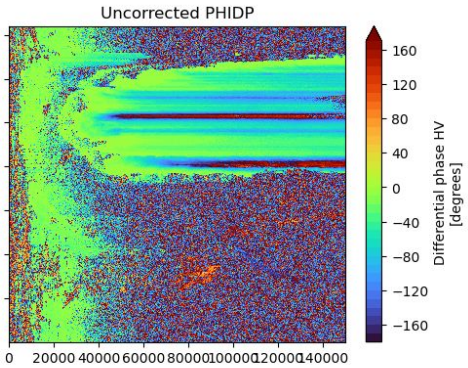
Work Steps:

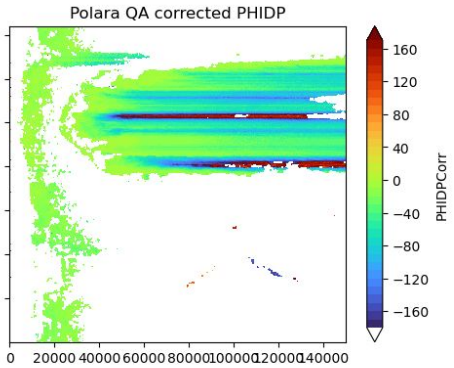
1. Analyse the input data for QA and QPE Alg.
2. Fix Second Trip echo problem.
3. Water Content alg. implementation in POLARA.
4. Melting layer position for all Radars in different times.
5. Plugging Melting Layer into POLARA
6. Deploy QPN Alg. into POLARA.
7. Execute full QPE, QPF, QPN on Benchmark data.
8. Update Nowcasting Alg. with PredRNN.

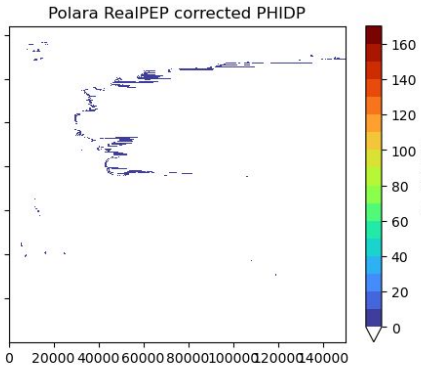
1. Quality Assurance: PHIDP preprocess

Radar: UMD
Time: 20170719 19:00

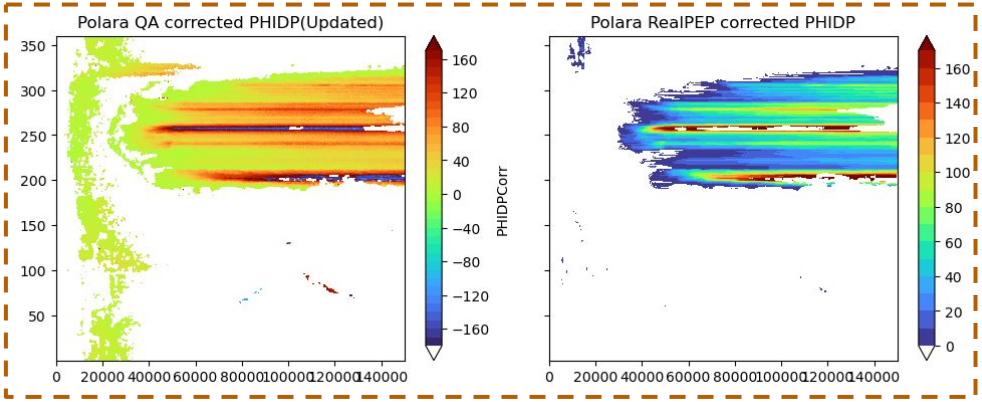






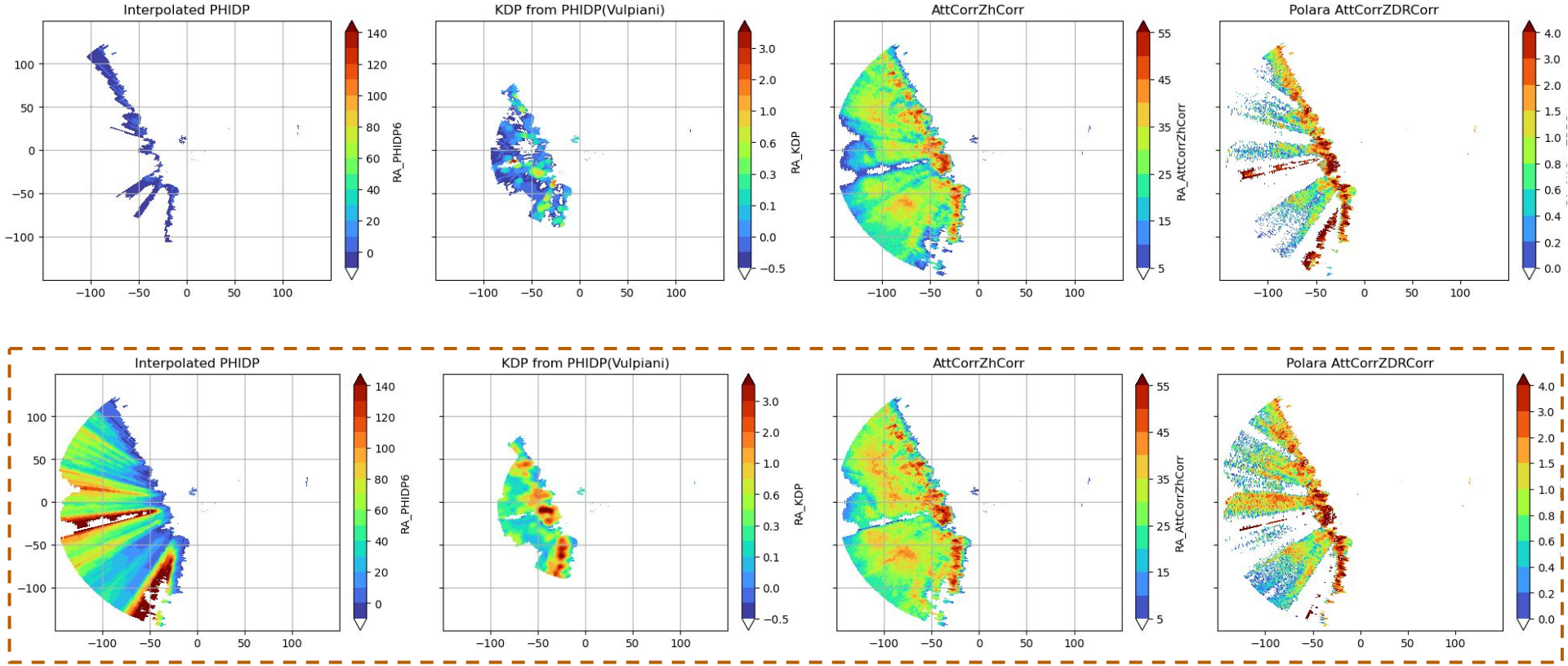


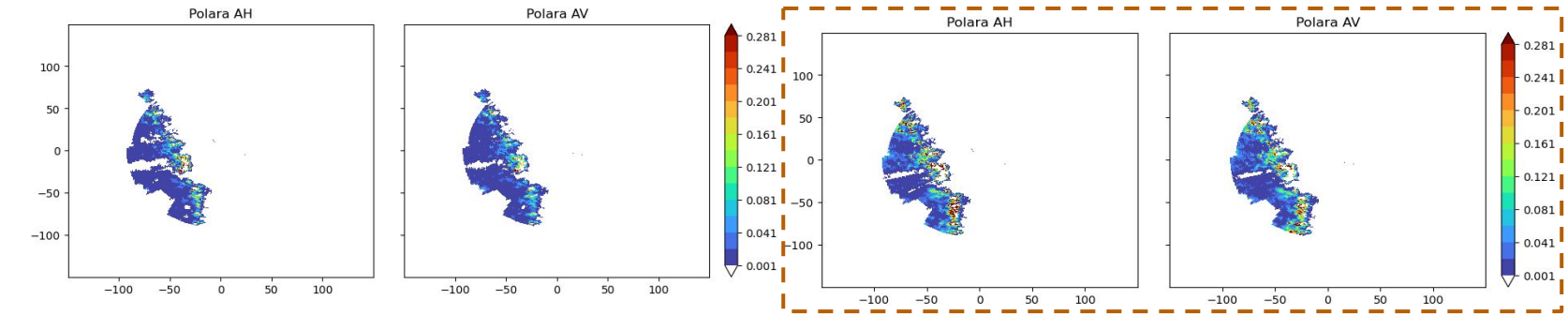
- Total PHIDP count if (RHV>0.7)
- Negative count: if (RHV>0.7) & (Diff_PHIDP <0)
- if (Negative count> Total Count *0.5):
  - Flip the sign of PHIDP



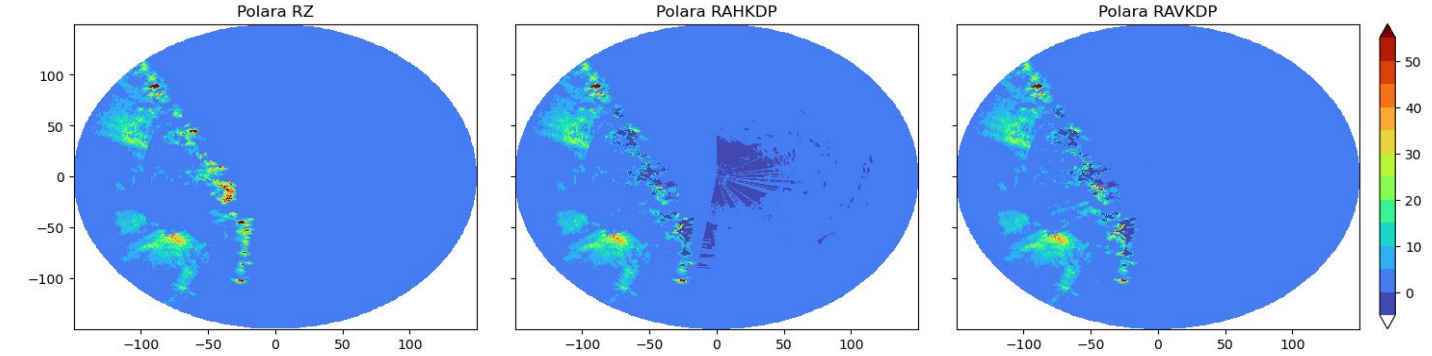
Impact of PHIDP preprocessing on other moments

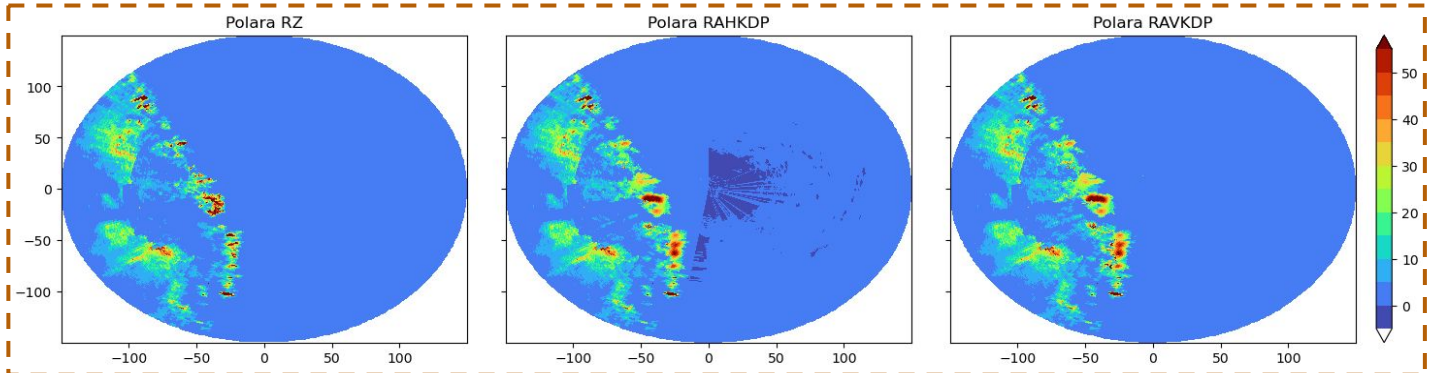
Radar: UMD
Time: 20170719 19:00





Radar: UMD
Time: 20170719 19:00





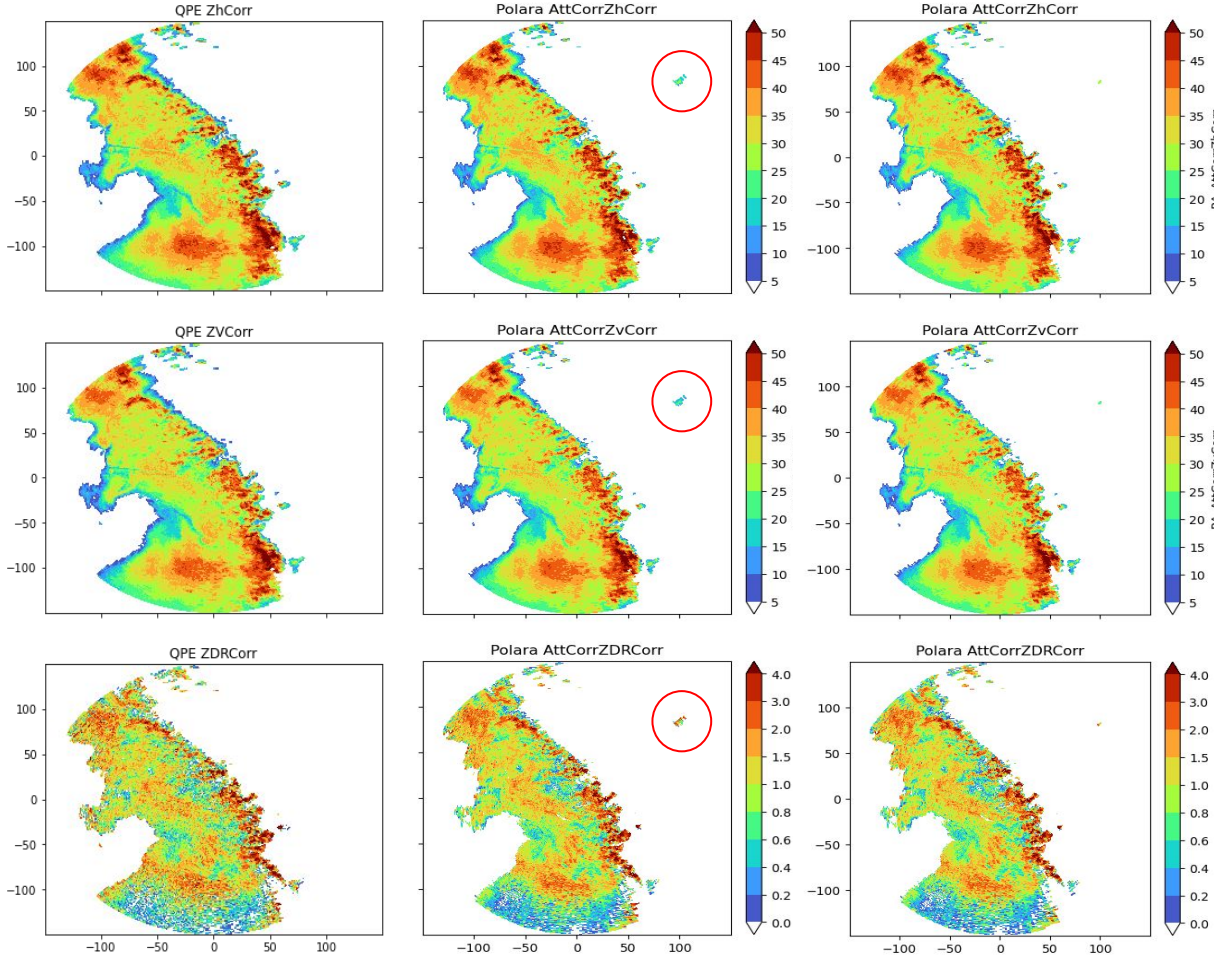
Work Steps:

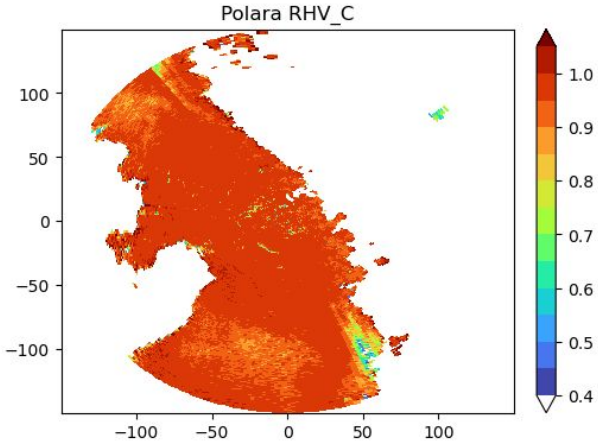
1. Analyse the input data for QA and QPE Alg.
2. Fix Second Trip echo problem.
3. Water Content alg. implementation in POLARA.
4. Melting layer position for all Radars in different times.
5. Plugging Melting Layer into POLARA
6. Deploy QPN Alg. into POLARA.
7. Execute full QPE, QPF, QPN on Benchmark data.
8. Update Nowcasting Alg. with PredRNN.

2. RealPEP: Second Trip Echo removed

Updated

Time: 20170719 18:30
Radar: HNR
Melting layer: 2600 m



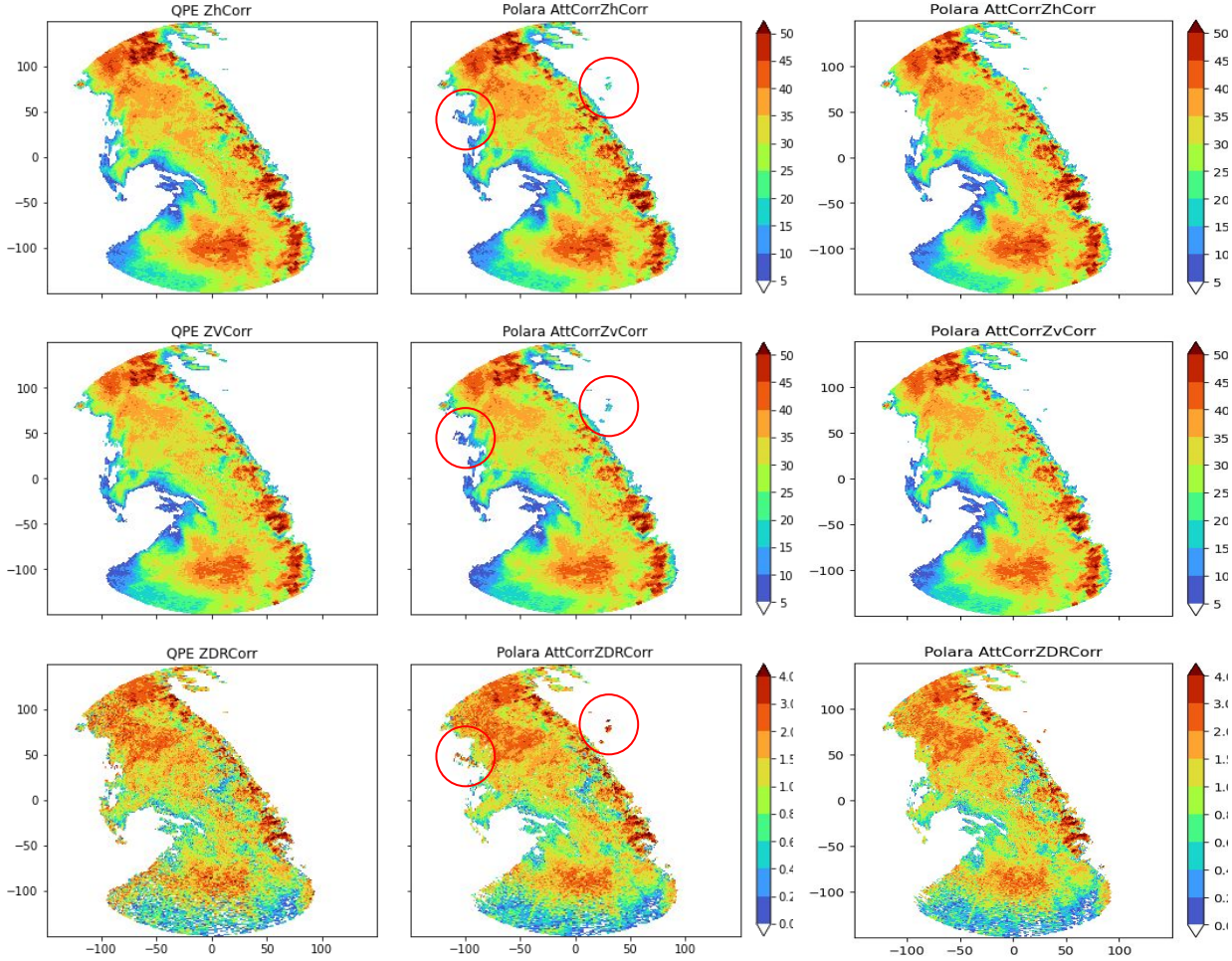


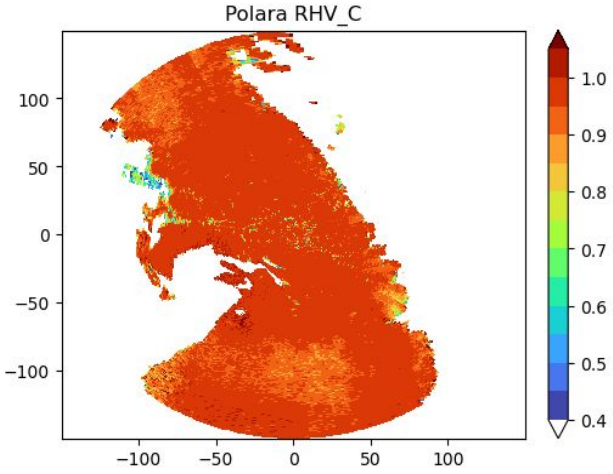
- if (RHV<0.9) & (Radar distance > 15 km) & (Zh <20):
  - Remove Zh
- Apply valid Zh mask on other variables

RealPEP: Second Trip Echo removed

Updated

Time: 20170719 19:00
Radar: HNR
Melting layer: 2600 m



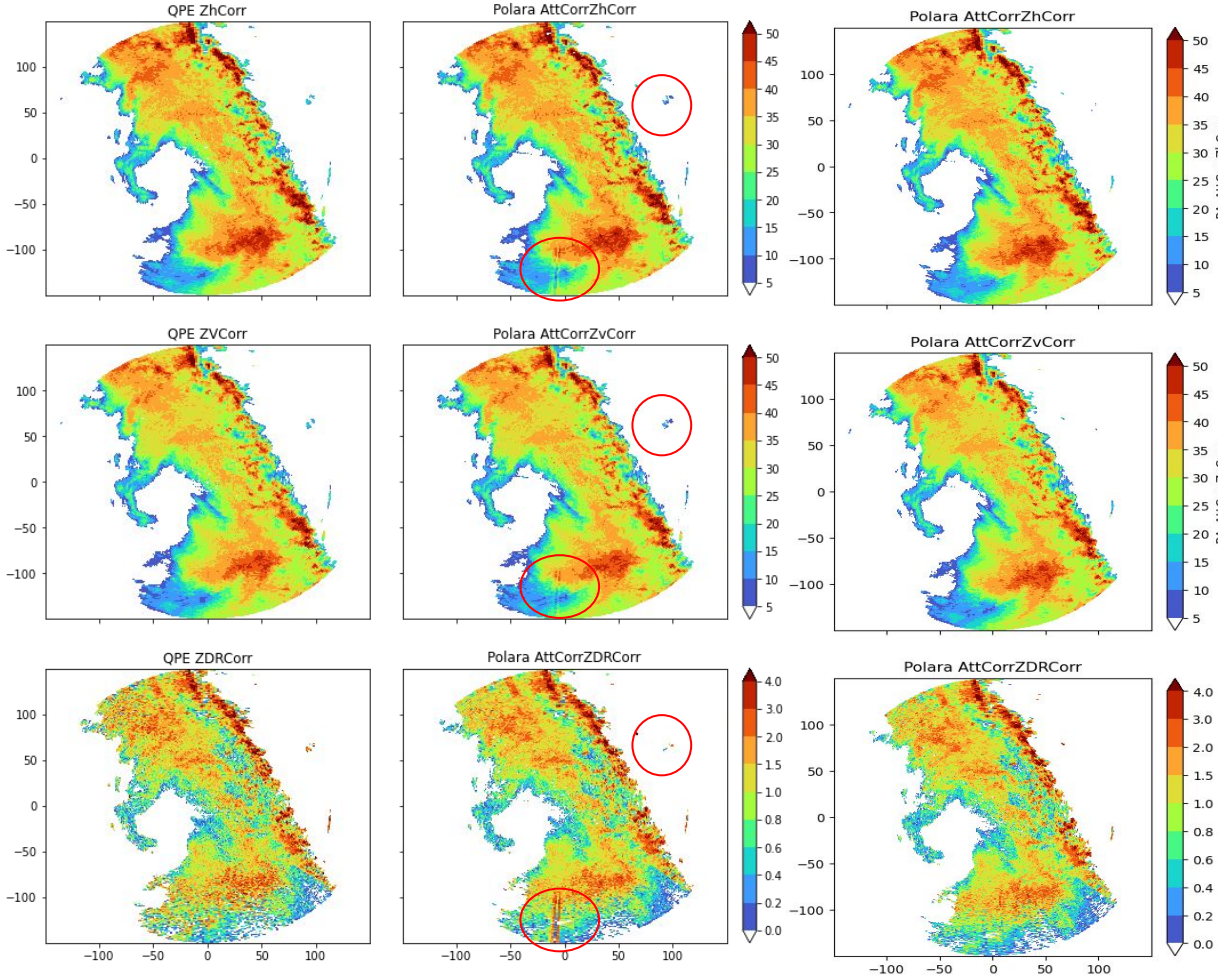


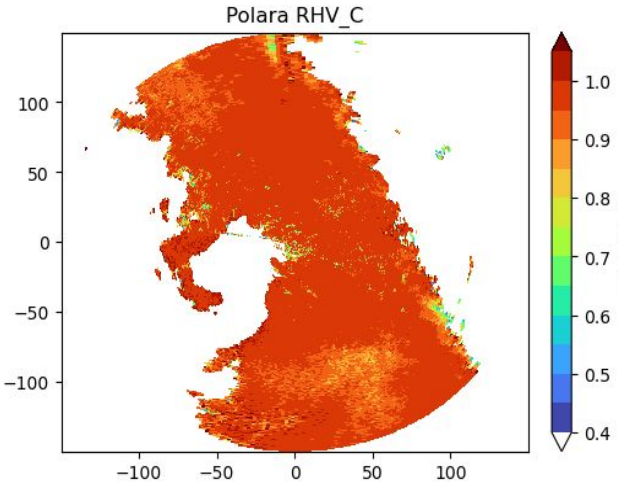
- if (RHV<0.9) & (Radar distance > 15 km) & (Zh <20):
  - Remove Zh
- Apply valid Zh mask on other variables

RealPEP: Second Trip Echo removed

Updated

Time: 20170719 19:30
Radar: HNR
Melting layer: 2600 m

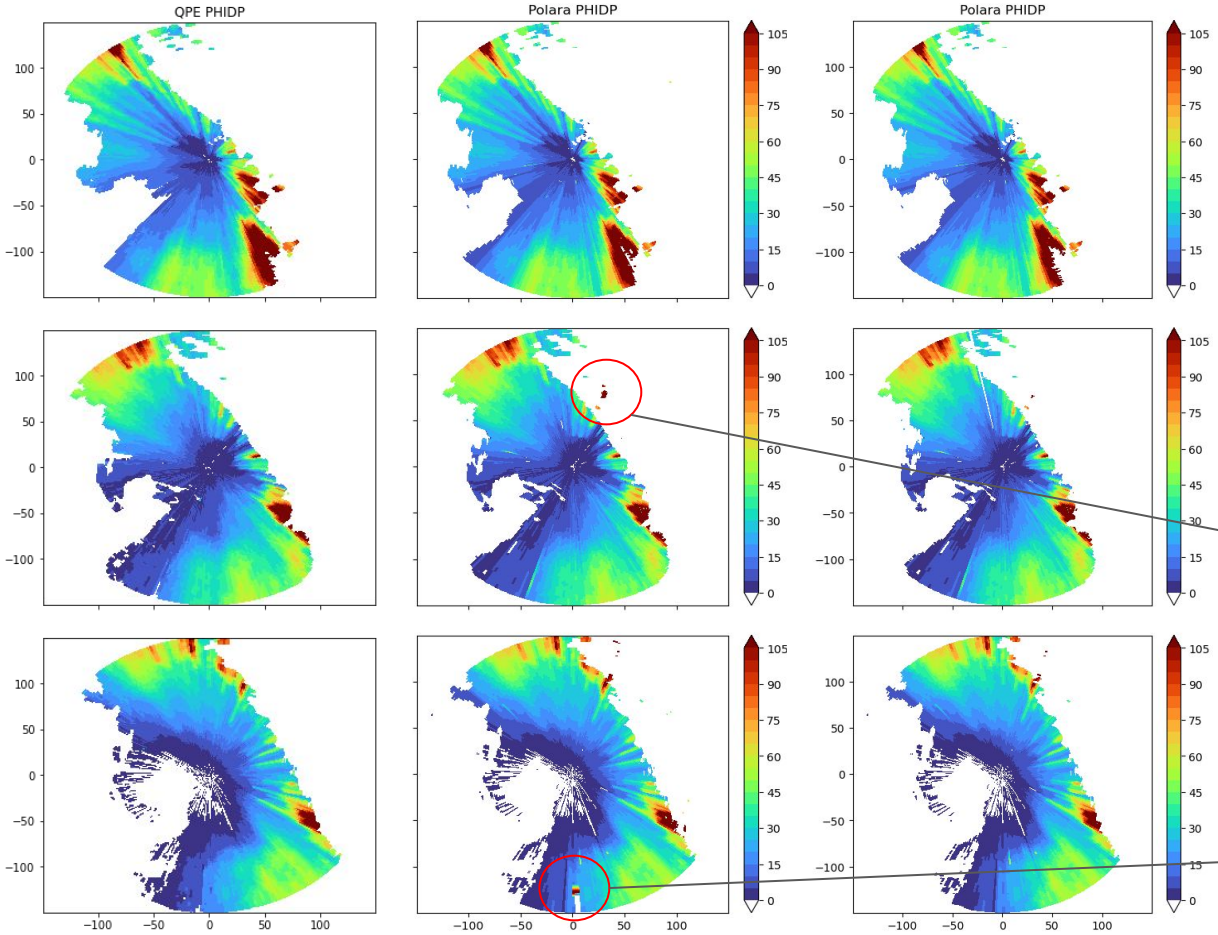




- if (RHV<0.9) & (Radar distance > 15 km) & (Zh <20):
  - Remove Zh
- Apply valid Zh mask on other variables

PHIDP: QPE Vs Polara

Radar: HNR
Melting layer: 2600 m



Time: 20170719 18:30

Time: 20170719 19:00

- Echo's are removed in Polara

Time: 20170719 19:30

- During interpolation:
if(last_valid_val - new_valid_val >90):
update phidp with last_valid_val.

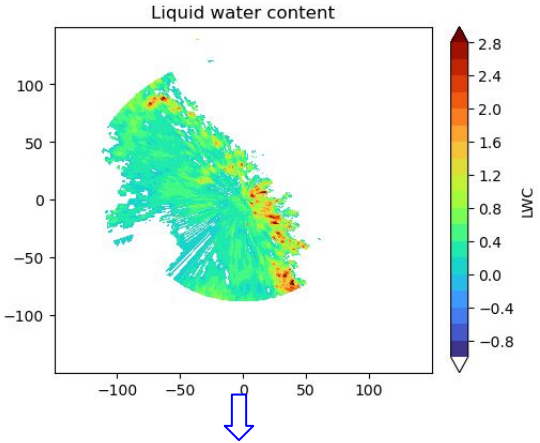
Work Steps:

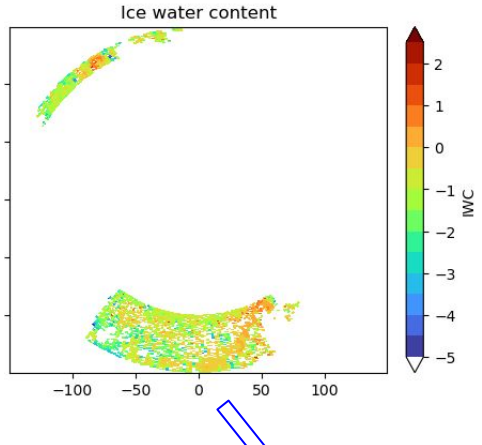
1. Analyse the input data for QA and QPE Alg.
2. Fix Second Trip echo problem.
3. Water Content alg. implementation in POLARA.
4. Melting layer position for all Radars in different times.
5. Plugging Melting Layer into POLARA
6. Deploy QPN Alg. into POLARA.
7. Execute full QPE, QPF, QPN on Benchmark data.
8. Update Nowcasting Alg. with PredRNN.

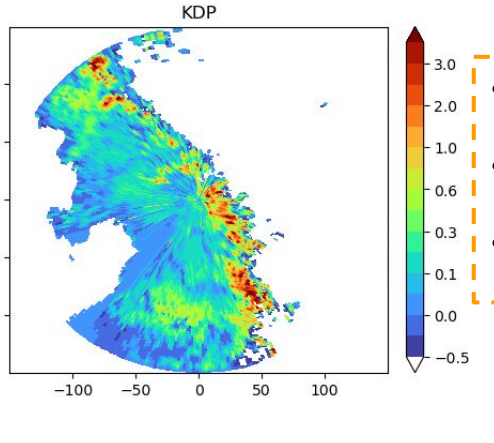
3. Water Content Implementation

Time: 20170719 18:30

Radar: HNR
Melting layer: 2600 m







KDP

- Estimate KDP_L(win=9) by using phidp_vulpiani()
- Estimate KDP_H(win=25) by using phidp_vulpiani()
- If AttCorrZh<40: KDP_L = KDP_H

DPHI = PHIDP max - min

- if (DPHI < 5):

$$LWC = 10^{0.058*Zh-0.115*ZDR-2.36}$$

- if (DPHI >= 5) & (Zh < 45):

$$LWC = 10^{-0.1415*log10(Ah)^2+0.209*log10(Ah)+0.46}$$

- if (DPHI >= 5) & (Zh >= 45):

$$LWC = KDP^{0.568} * 10^{0.06}$$

- Mask below ml and if RHV>= 0.9

- if (ZDR>0.4): @Ryzhkov and Zrnic (2019)

$$IWC = log10(\frac{4.46*(10^{-3})*32.0*KDP)}{1-ZDR^{-1}})$$

- Else: @Bukovcic et al. (2020)

$$IWC = log10(0.71 * (KDP^{0.66} * (Zh^{0.28})$$

- Mask out below ml

Work Steps:

1. Analyse the input data for QA and QPE Alg.
2. Fix Second Trip echo problem.
3. Water Content alg. implementation in POLARA.
4. Melting layer position for all Radars in different times.
5. Plugging Melting Layer into POLARA
6. Deploy QPN Alg. into POLARA.
7. Execute full QPE, QPF, QPN on Benchmark data.
8. Update Nowcasting Alg. with PredRNN.

RealPEP Execution time

- Execution time mostly depends on KDP area (3km) smoothening.
- As much precipitation data the algorithm takes longer.

Next: How do we get runtime melting layer top and bottom height information?

4. Melting Layer detection by QVP

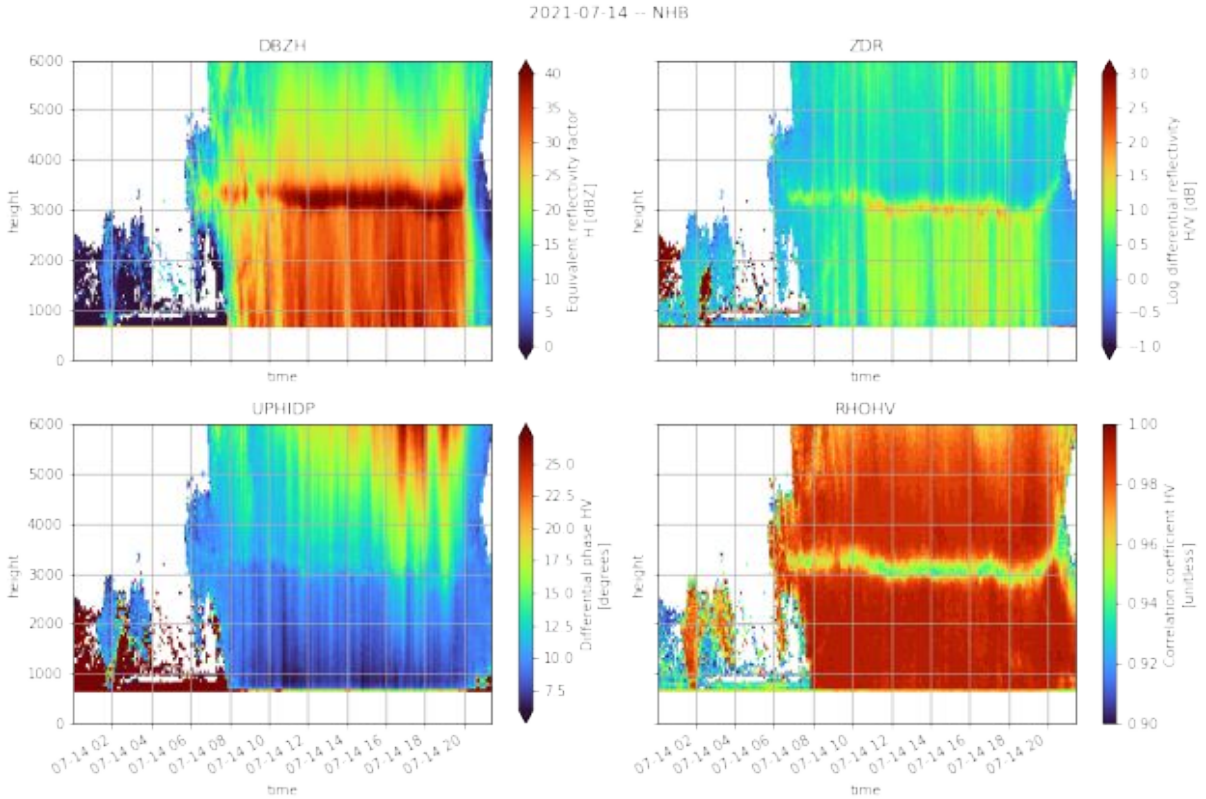
- Adapted from Wolfensberger et. al.
- Using DBZH, RHOHV and PHIDP
- 12 deg sweep volume scan data

Steps:

- ❖ Reading daily data
- ❖ Apply thresholds (e.g. remove artifacts, clean data)
- ❖ Calculate median over azimuth (QVP)
- ❖ Apply ML-detection algorithm

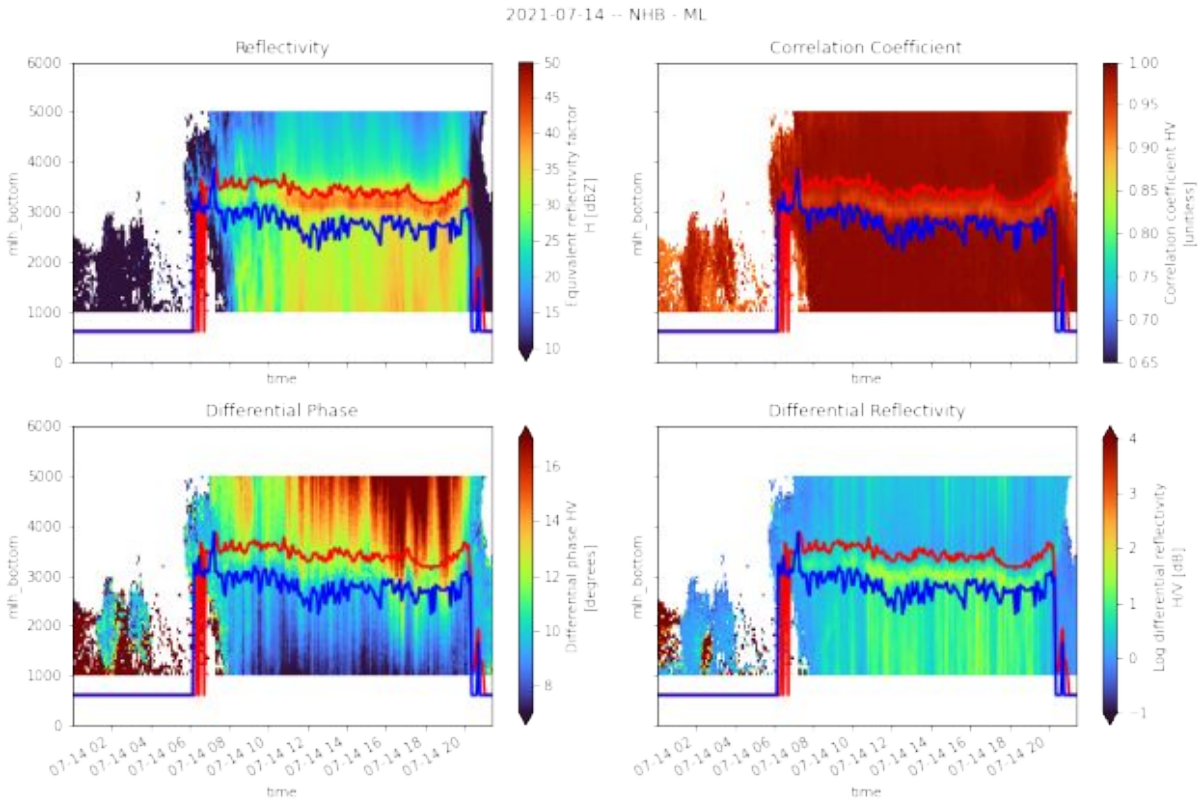
Melting Layer detection by QVP

Daily QVP timeseries



Melting Layer detection by QVP

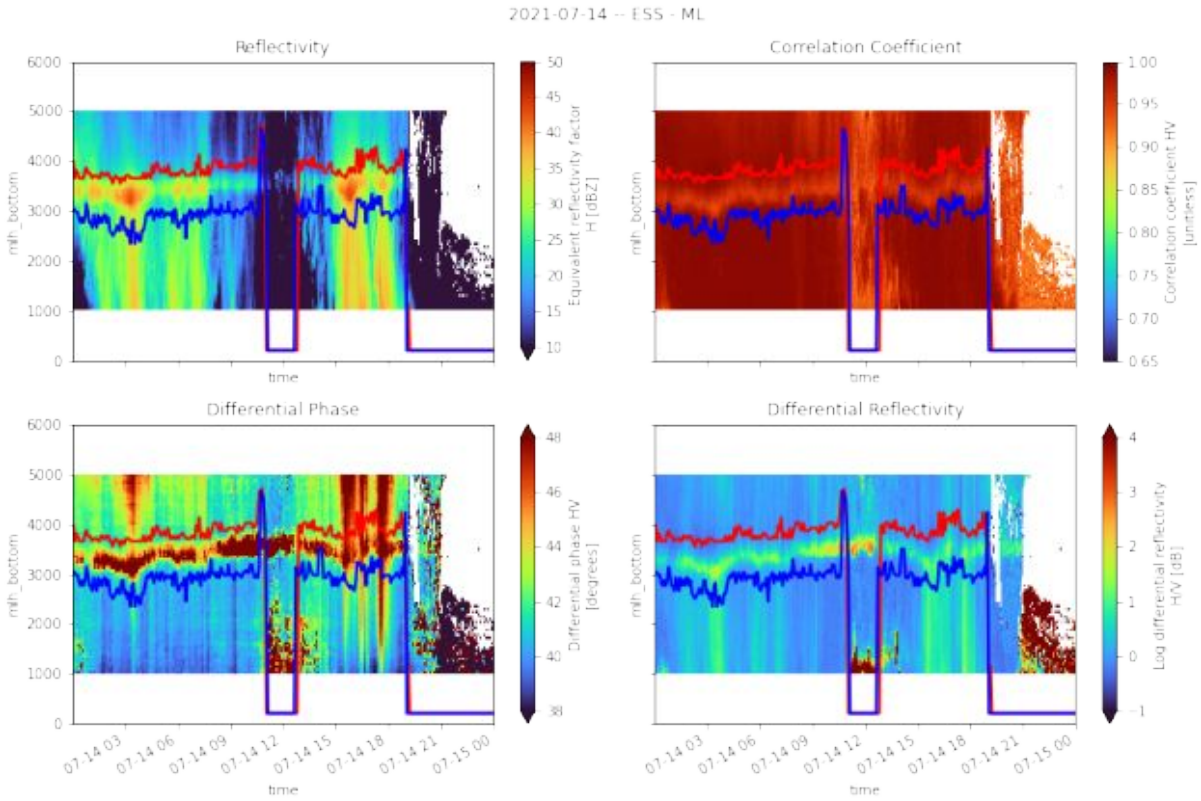
Daily QVP timeseries with applied ML top and bottom



Melting Layer detection by QVP

Daily QVP timeseries with applied ML top and bottom

Problems and issues



Is Melting Layer detection by QVP worth to implement in POLARA?

Factors to consider:

- Implementation time
- Are Input data for QVP and QPE compatible? (e.g volume scan, precipitation)
- Execution time
- How robust is this algorithm to work with each time step data?
- Do we have any alternate but more feasible solution to feed into POLARA system?

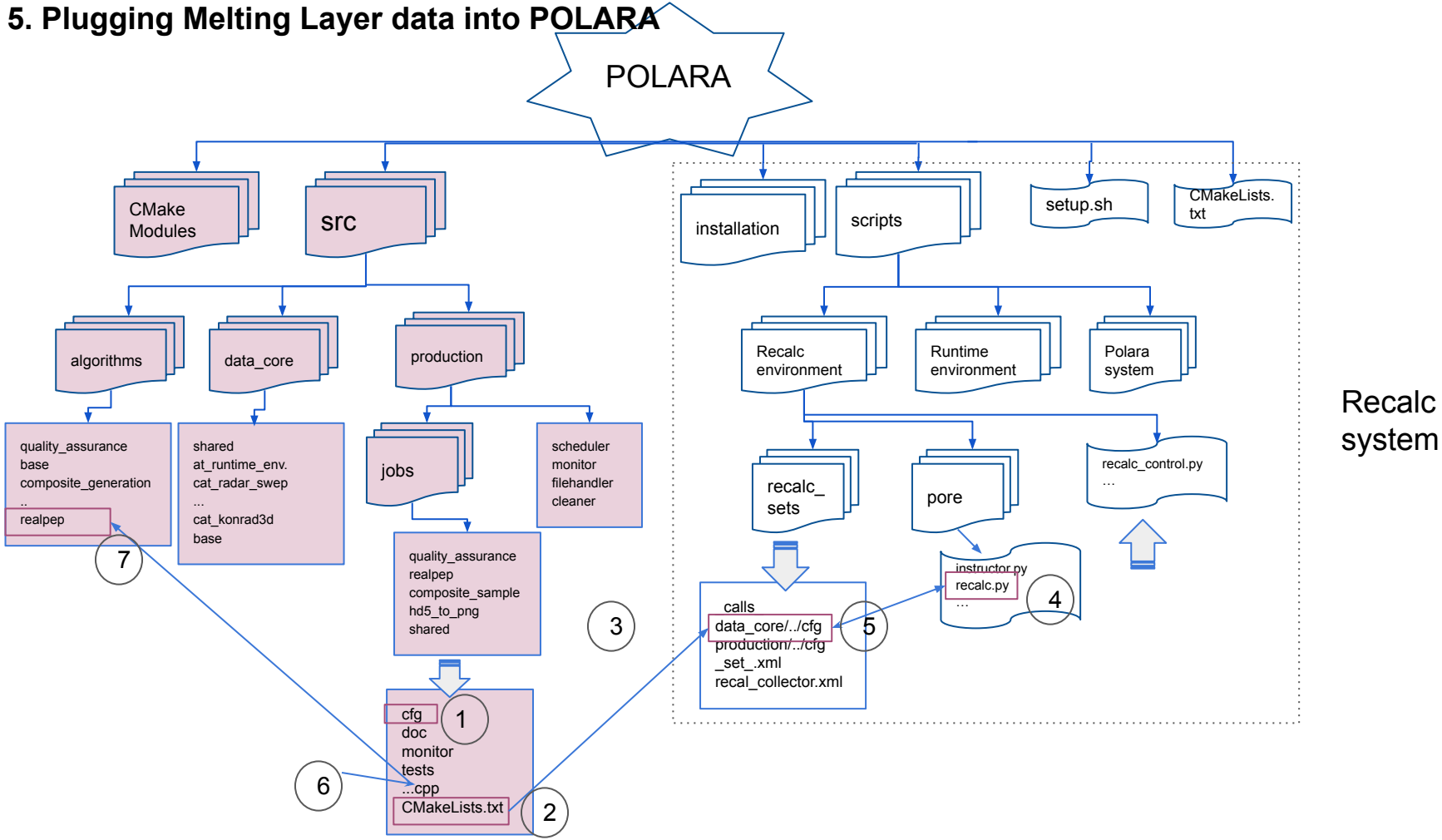
height_ml.txt

```
isn 2017-07-25T00:46:07.000000000 1165.8449875861406 1413.4597511328757
hnr 2017-07-25T00:51:07.000000000 1073.172953756526 1351.6802104786038
umd 2017-07-25T00:56:07.000000000 980.4998336099088 1320.7903460748494
hnr 2017-07-25T01:01:07.000000000 887.8257761914283 1259.0102055016905
ess 2017-07-25T01:06:07.000000000 856.9341491702944 1134.9544469080865
isn 2017-07-25T01:11:07.000000000 856.9341491702944 1134.9544469080865
hnr 2017-07-25T01:16:07.000000000 856.9341491702944 1104.0637192707509
umd 2017-07-25T01:21:07.000000000 856.9341491702944 1104.0637192707509
ess 2017-07-25T19:41:07.000000000 423.9459545239806 701.9803975522518
isn 2017-07-25T19:46:07.000000000 331.26576423458755 671.0881314147264
hnr 2017-07-25T20:01:07.000000000 423.9459545239806 640.1957528423518
isn 2017-07-25T20:06:07.000000000 454.83912018314004 640.1957528423518
boo 2017-07-25T20:36:07.000000000 362.159267231822 640.1957528423518
hnr 2017-07-25T21:11:07.000000000 300.37214878574014 578.410658383742
isn 2017-07-25T21:16:07.000000000 331.26576423458755 nan
hnr 2017-07-25T22:41:08.000000000 nan 609.3032618314028
ess 2017-07-25T22:46:07.000000000 300.37214878574014 547.5179424956441
mem 2017-07-25T22:46:07.000000000 300.37214878574014 547.5179424956441
....
....
```

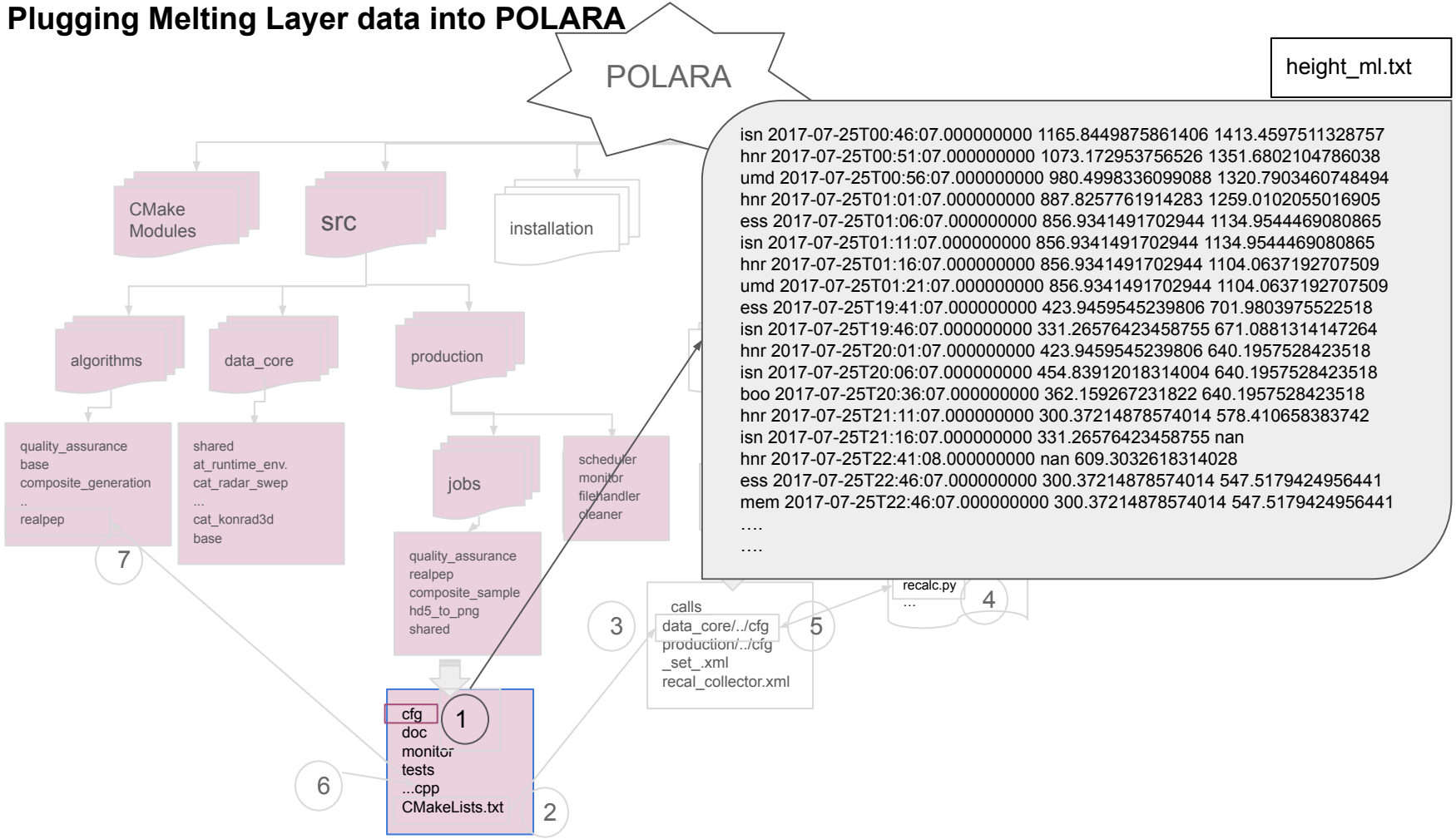
Work Steps:

1. Analyse the input data for QA and QPE Alg.
2. Fix Second Trip echo problem.
3. Water Content alg. implementation in POLARA.
4. Melting layer position for all Radars in different times.
5. Plugging Melting Layer data into POLARA
6. Deploy QPN Alg. into POLARA.
7. Execute full QPE, QPF, QPN on Benchmark data.
8. Update Nowcasting Alg. with PredRNN.

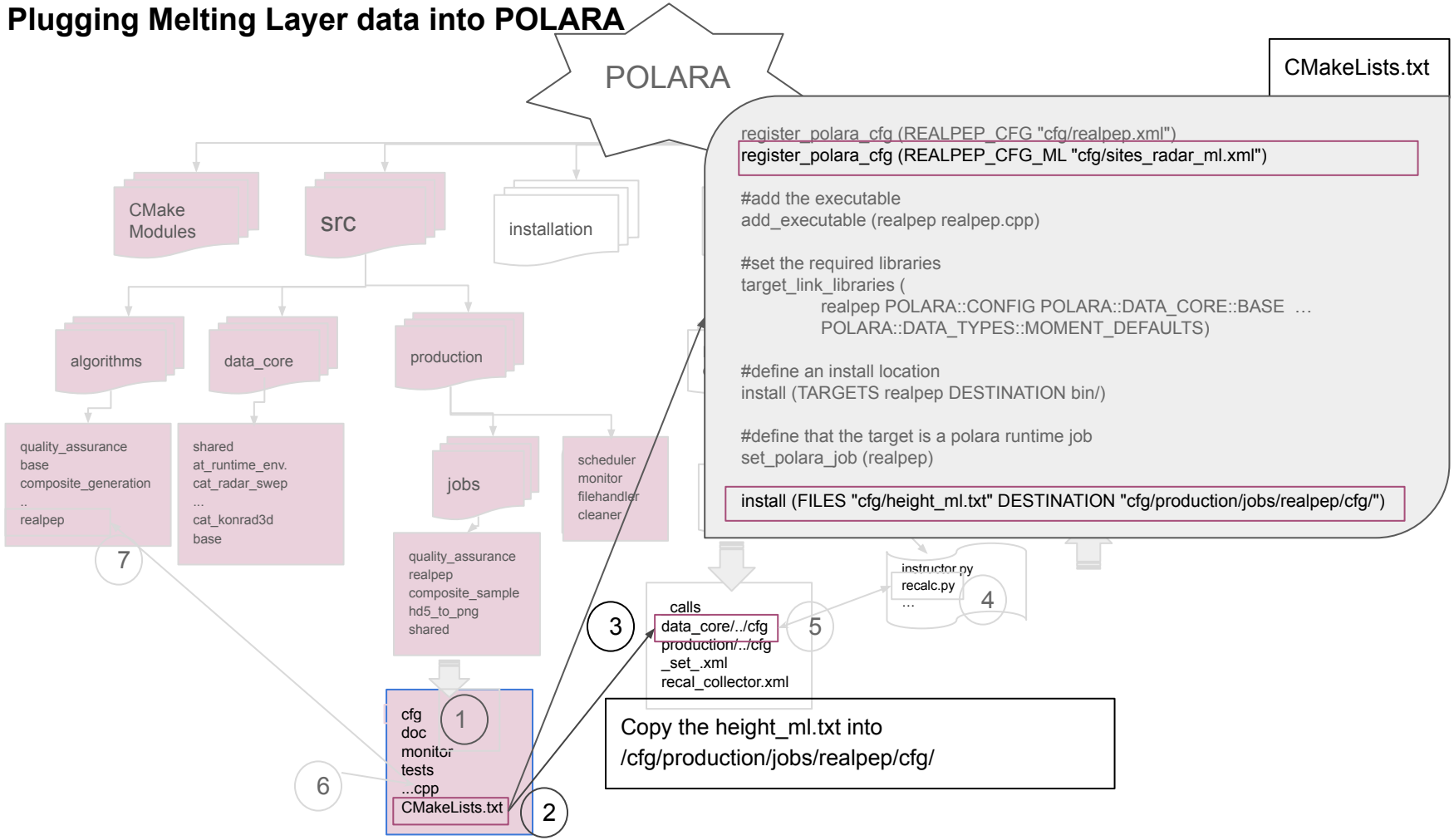
5. Plugging Melting Layer data into POLARA



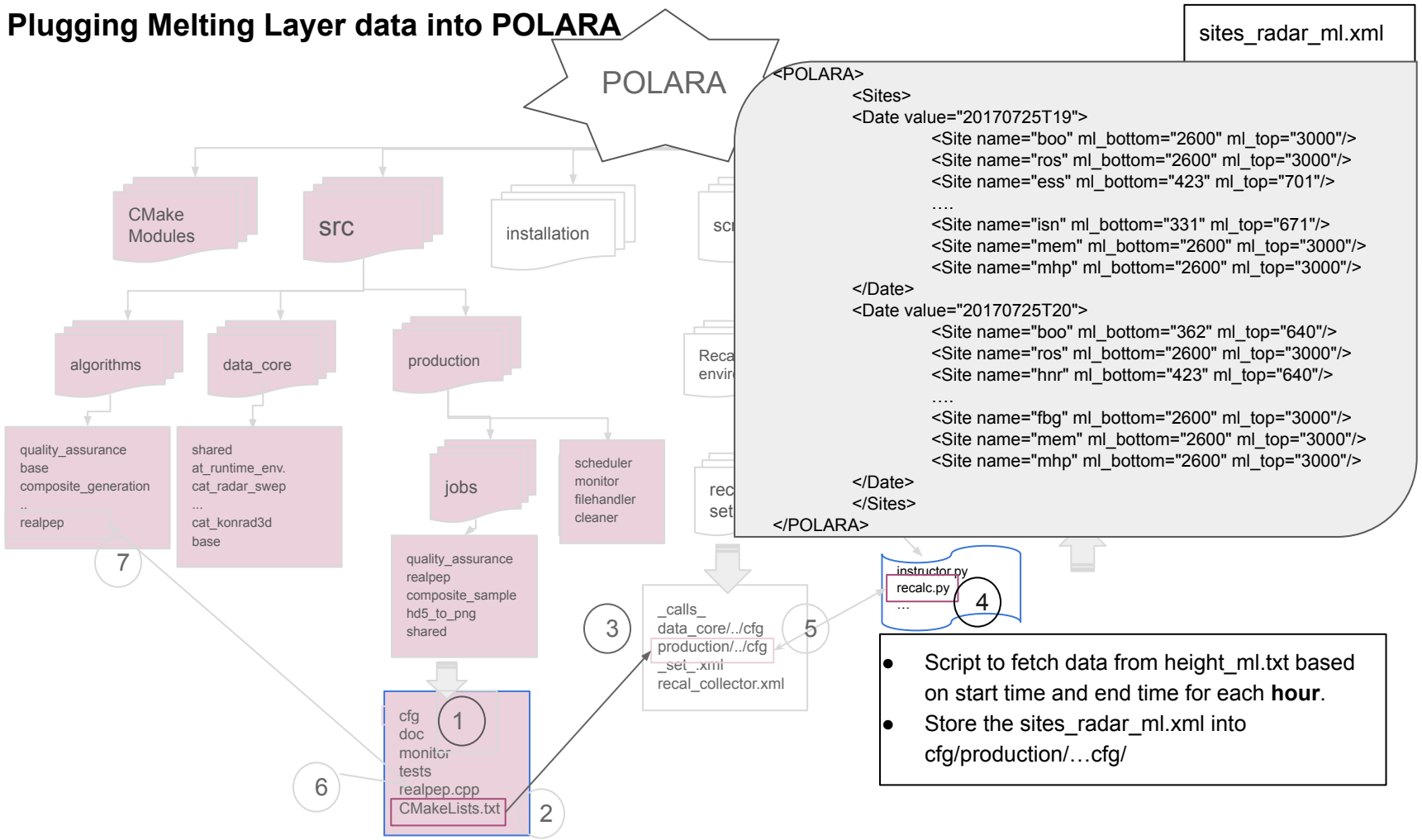
Plugging Melting Layer data into POLARA



Plugging Melting Layer data into POLARA



Plugging Melting Layer data into POLARA



sites_radar_ml.xml

```
<POLARA>
        <Sites>
        <Date value="20170725T19">
                <Site name="boo" ml_bottom="2600" ml_top="3000"/>
                <Site name="ros" ml_bottom="2600" ml_top="3000"/>
                <Site name="ess" ml_bottom="423" ml_top="701"/>
                ….
                <Site name="isn" ml_bottom="331" ml_top="671"/>
                <Site name="mem" ml_bottom="2600" ml_top="3000"/>
                <Site name="mhp" ml_bottom="2600" ml_top="3000"/>
        </Date>
        <Date value="20170725T20">
                <Site name="boo" ml_bottom="362" ml_top="640"/>
                <Site name="ros" ml_bottom="2600" ml_top="3000"/>
                <Site name="hnr" ml_bottom="423" ml_top="640"/>
                ….
                <Site name="fbg" ml_bottom="2600" ml_top="3000"/>
                <Site name="mem" ml_bottom="2600" ml_top="3000"/>
                <Site name="mhp" ml_bottom="2600" ml_top="3000"/>
        </Date>
        </Sites>
</POLARA>
```

- Script to fetch data from height_ml.txt based on start time and end time for each **hour**.
- Store the sites_radar_ml.xml into cfg/production/…cfg/

Work Steps:

1. Analyse the input data for QA and QPE Alg.
2. Fix Second Trip echo problem.
3. Water Content alg. implementation in POLARA.
4. Melting layer position for all Radars in different times.
5. Plugging Melting Layer into POLARA
6. Deploy QPN Alg. into POLARA.
7. Execute full QPE, QPF, QPN on Benchmark data.
8. Update Nowcasting Alg. with PredRNN.

Thank you for listening …

RealPEP: R(A) Alg. steps