

README for iwvcalc.py

Lyuben Kodinov

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1. Description

The aim of this script is to export the data from the WRF model, that is stored in a netCDF format, and data from a troposinex file and compute IWV, ZTD, ZHD, ZWD, temperature and pressure.

2. Basic Information

To run the script:

```
python3 iwvcalc.py --snx-file snx_file --wrf-file wrf_file [--o output_file  
--station station]
```

where the arguments **not** in brackets are mandatory.

```
--snx-file - path to: snx file  
--wrf-file - path to: folder, wrf file or wrf files seperated with comma  
--station  - station name or station names seperated with comma (optional)  
--o        - name of output file (optional)
```

Default value for station argument is all stations.

If no output file name is set, then it prints to stdout a table.

Wrf file option does **NO** pattern matching. It just assumes every file in the folder is a netCDF file.

The script consists of three helper classes **Station**, **Point** and **Result**.

Station - data from the snx file.

Point - data from one wrf (netCDF) file.

Result - the computed results.

There are four helper procedures:

read_met_from_wrf - Calculates indexes. Fetches altitude, temperature and pressure from wrf file.

read_station_latlon - Fetches station names, latitudes and longitudes from the snx file.

read_trop_solution - Reads time and ztd from the snx file.

read_gps_from_snx - Opens snx file and runs read_station_latlon and read_trop_solution.

And the main procedure, where a couple of things happen:

1. We have a list of stations and a list of points. Where the number of points = number of wrf_files * stations.
2. The points and stations are averaged in five minute intervals.
3. Combined into one array based on time.
4. Begin the calculations for pressure, temperature, zhd, zwd, iwv.
5. Then they are either printed to stdout in a table or saved in troposinex (snx2) file format.

3. Manual

Open a terminal and type:

```
pip3 install numpy netcdf4
```

```
git clone https://github.com/lyubenkod/iwv_calc
```

This will create a folder iwv_calc. With a folder structure

```
iwv_calc/iwvcalc.py - main script.
```

```
iwv_calc/iwv_test.py - script using only calculations from wrf file.
```

```
iwv_calc/sample.snx2 - sample snx2 file created by iwvcalc.py.
```

iwvcalc.py can be used as described in the previous section.

iwv_test.py is hardcoded to use a specific wrf file. Its mostly meant as a debugging tool.

4. Examples

With one wrf file

```
→ iwv_calc git:(main) python3 iwvcalc.py --snx-file ../../wrf_files_usb/BGR-RT-xxxxx-TEF-FIX-xxxx-IF_240510_1100.snx2 --wrf-file ../../wrf_files_usb/wrfs/wrfout_d03_2024-05-10_11.00.00

dirwxr-xr-x 3 lyubenk lyubenk 4.0K May 20 08:02 .
dirwxr-xr-x 4 lyubenk lyubenk 4.0K May 20 07:53 ..
dirwxr-xr-x 8 lyubenk lyubenk 4.0K May 20 08:02 .git
-rw-r--r-- 1 lyubenk lyubenk 8 Apr 11 22:11 .gitignore
-rw-r--r-- 1 lyubenk lyubenk 16K May 20 07:58 iwvcalc.py
-rw-r--r-- 1 lyubenk lyubenk 7.1K May 20 03:53 iwv_test.py
-rw-r--r-- 1 lyubenk lyubenk 57K May 20 08:01 README
-rw-r--r-- 1 lyubenk lyubenk 3.8K May 20 07:06 sample.snx2
+ iwv_calc git:(main) python3 iwvcalc.py --snx-file ../../wrf_files_usb/BGR-RT-xxxxx-TEF-FIX-xxxx-IF_240510_1100.snx2 --wrf-file ../../wrf_files_usb/wrfs/wrfout_d03_2024-05-10_11.00.00
station,time,ztd,temp,pressure,zhd,zwd,iwv,station_latitude,station_altitude,station_longitude
BGER00BGR 2024-05-10 11:00:00 2.3760750000000006 18.748644540527366 999.1195401682656 2.2752101544113383 0.10086484558866227 15.967163578483959 43.541928 167.788 23.95374
DCER00BGR 2024-05-10 11:00:00 2.3760750000000006 17.531494956359886 999.0859017627316 2.275125301511102 0.10094969848889868 15.931446847651392 43.59053 170.935 23.23428
DDUB00BGR 2024-05-10 11:00:00 2.3760750000000006 18.81627831063845 1002.5931446072253 2.2831268338999147 0.09294816610008594 14.716447406587227 43.41613 136.351 24.411354
GCHA00BGR 2024-05-10 11:00:00 2.3760750000000006 13.839843723999046 991.58708733011669 2.2583520042027256 0.11772299579727497 18.404661435017653 42.300503 223.456 24.63438
GELM00BGR 2024-05-10 11:00:00 2.3760750000000006 12.581758369018578 987.123799367538 2.2482185946648863 0.12785640533511433 19.924536664720005 42.269939 263.842 24.32545
GPGP00CZE 2024-05-10 11:00:00 2.3760750000000006 14.964746640380882 955.3171465500994 2.174416697898751 0.20165830210124946 31.61776694731302 49.913672 554.864 14.785612
GPOE00CZE 2024-05-10 11:00:00 2.3760750000000006 14.964415140380883 955.311369835812 2.1744035734830076 0.201671426516993 31.61979795986932 49.913707 554.915 14.785628
GRAM00BGR 2024-05-10 11:00:00 2.3760750000000006 17.35050474841311 986.89641955500964 2.2473808615459987 0.1286941384540019 20.30063728617011 43.840169 275.137 22.63986
MATE00ITA 2024-05-10 11:00:00 2.3760750000000006 15.399960304199242 956.3261136289306 2.1785420541915648 0.19753294580843583 31.005353786637343 40.649135 495.156 16.704465
ONS100SWE 2024-05-10 11:00:00 2.3760750000000006 18.530120140380888 1019.1055055709713 2.317718466834572 0.05835653316542855 9.232887966620625 57.395336 6.345 11.924547
ONSA00SWE 2024-05-10 11:00:00 2.3760750000000006 18.516554640380882 1018.856435537271 2.317153374341565 0.058921625658435506 9.321974447576544 57.395301 8.432 11.925523
PETR00BGR 2024-05-10 11:00:00 2.3760750000000006 18.880411488708518 994.3106348296398 2.2645352504026763 0.11153974959732427 17.662906913796576 42.287375 188.114 25.635409
POPO00BGR 2024-05-10 11:00:00 2.3760750000000006 13.331334039550804 992.6086145150604 2.2607081041444212 0.11536689585557935 18.012836522488416 42.122762 211.476 25.072149
SBGB00BGR 2024-05-10 11:00:00 2.3760750000000006 15.996715914184593 1013.3502525854879 2.3075657660885804 0.06850923391142016 10.769768292876131 43.405251 43.947 28.147452
SOFI00BGR 2024-05-10 11:00:00 2.3760750000000006 7.357829188476585 894.487748481432 2.037650413666395 0.3384245863336055 52.03083342912854 42.556097 1084.731 23.394738
STAS00BGR 2024-05-10 11:00:00 2.3760750000000006 17.011649204834006 984.8656877953019 2.241201670089887 0.13487332991001377 21.305638438115476 42.561873 277.518 26.142813
STDK00BGR 2024-05-10 11:00:00 2.3760750000000006 14.990639068202995 1008.9983517423801 2.2979221663743132 0.07815283362568737 12.254300105723178 42.232291 70.43 27.772963
SUZF00BGR 2024-05-10 11:00:00 2.3760750000000006 11.318436320556664 943.938785303194 2.1500087795273592 0.22606622047264135 35.114791067855705 42.67381 639.669 23.329108
TLSE00FRA 2024-05-10 11:00:00 2.3760750000000006 20.433719043457053 994.1740289578701 2.2639405198975426 0.11213448010245797 17.82674977870589 43.560698 161.952 1.480895
TLSG00FRA 2024-05-10 11:00:00 2.3760750000000006 20.55405844824221 993.9106462817858 2.263343652145265 0.11273134785473582 17.927063183136816 43.549714 162.904 1.485045
```

With folder with wrf files and filter station SUZF00BGR and invalid station

```
→ iwv_calc git:(main) python3 iwvcalc.py --snx-file ../../wrf_files_usb/BGR-RT-xxxxx-TEF-FIX-xxxx-IF_240510_1100.snx2 --wrf-file ../../wrf_files_usb/wrfs --station SUZF00BGR,Hello:~]
Station Hello:~] not found, removing...
station,time,ztd,temp,pressure,zhd,zwd,iwv,station_latitude,station_altitude,station_longitude
SUZF00BGR 2024-05-10 11:00:00 2.2824 11.318436320556664 943.938785303194 2.1500087795273592 0.13239122047264074 20.56428
4378248413 42.67381 639.669 23.329108
SUZF00BGR 2024-05-10 11:05:00 2.28218 11.283829386962914 943.838691127279 2.149780795085627 0.13239920491437296 20.56369
0761392643 42.67381 639.669 23.329108
SUZF00BGR 2024-05-10 11:10:00 2.2816400000000003 11.282761271728539 943.833544857972 2.1497690734312527 0.13187092656874
766 20.481584404048238 42.67381 639.669 23.329108
SUZF00BGR 2024-05-10 11:15:00 2.2809 11.299912150634789 943.826136233656 2.1497521988122927 0.1311478011877072 20.370172
147130546 42.67381 639.669 23.329108
SUZF00BGR 2024-05-10 11:20:00 2.28074 11.318497355712914 943.7343640847115 2.149543169446174 0.13119683055382625 20.3787
63393095014 42.67381 639.669 23.329108
SUZF00BGR 2024-05-10 11:25:00 2.28132 11.343704875244164 943.7139235514858 2.14949661205646 0.1318233879435402 20.477416
305570518 42.67381 639.669 23.329108
SUZF00BGR 2024-05-10 11:30:00 2.28175 11.370316203369164 943.7626880464975 2.1496076829161774 0.13214231708382274 20.528
36609274633 42.67381 639.669 23.329108
SUZF00BGR 2024-05-10 11:35:00 2.2821 11.420517619384789 943.7229666303149 2.1495172094714396 0.13258279052856015 20.5994
5769717339 42.67381 639.669 23.329108
SUZF00BGR 2024-05-10 11:40:00 2.28236 11.484207804931664 943.6622506746206 2.1493789167772177 0.13298108322278246 20.664
73040483955 42.67381 639.669 23.329108
SUZF00BGR 2024-05-10 11:45:00 2.28238 11.544296916259789 943.5742858725846 2.149178559402766 0.13320144059723393 20.7021
76449812026 42.67381 639.669 23.329108
SUZF00BGR 2024-05-10 11:50:00 2.2824400000000002 11.591141398681664 943.4268080570467 2.1488426492747696 0.1335973507252
306 20.766213546804376 42.67381 639.669 23.329108
SUZF00BGR 2024-05-10 11:55:00 2.2828199999999996 11.640488322509789 943.3360578856573 2.1486359476662873 0.1341840523337
1233 20.860059846908552 42.67381 639.669 23.329108
→ iwv_calc git:(main)
```

With two wrf files

```
➔ iwv_calc git:(main) python3 iwvcalc.py --snx-file ../../wrf_files_usb/BGR-RT-xxxxx-T
EF-FIX-xxxx-IF_240510_1100.snx2 --wrf-file ../../wrf_files_usb/wrfs/wrfout_d03_2024-05-
10_11.00.00,../../wrf_files_usb/wrfs/wrfout_d03_2024-05-10_11.05.00

+ iwv_calc git:(main) python3 iwvcalc.py --snx-file ../../wrf_files_usb/BGR-RT-xxxxx-TEF-FIX-xxxx-IF_240510_1100.snx2 --wrf-file ../../wrf_files_usb/wrfs/wrfout_d03_2024-05-10_11.00.00,.../
wrf_files_usb/wrfs/wrfout_d03_2024-05-10_11.05.00
station,time,ztd,temp,pressure,zhd,zwd,iwv,station_latitude,station_altitude,station_longitude
BGR00BGR 2024-05-10 11:00:00 2.3760750000000006 18.748644540527366 999.1195401682656 2.2752101544113383 0.10086484558866227 15.967163578483959 43.541928 167.788 23.95374
BGR00BGR 2024-05-10 11:05:00 2.3759349999999997 18.804308603027366 999.0312859510168 2.2750091805706902 0.10092581942930945 15.979062989117727 43.541928 167.788 23.95374
DCER00BGR 2024-05-10 11:00:00 2.3760750000000006 17.53149456359886 999.0859017627316 2.275125301511102 0.10094969848889868 15.931446847651392 43.59053 170.935 23.234428
DUBU00BGR 2024-05-10 11:05:00 2.3759349999999997 17.18307576690676 999.0133914087669 2.274960180433289 0.10097481956671084 15.921337581023733 43.59053 170.935 23.234428
DUBU00BGR 2024-05-10 11:00:00 2.3760750000000006 18.81627831063845 1002.5931446072253 2.2831268338999147 0.09294816610008594 14.716447406587227 43.41613 136.351 24.411354
DUBU00BGR 2024-05-10 11:05:00 2.3759349999999997 18.894494863372824 1002.516789087393 2.282952955455619 0.09298204454438075 14.724720337748648 43.41613 136.351 24.411354
GCHA00BGR 2024-05-10 11:00:00 2.3760750000000006 13.89843723999046 991.5870873011669 2.2583520042027256 0.11772299579727497 18.404661435917653 42.300503 223.456 24.63438
GCHA00BGR 2024-05-10 11:05:00 2.3759349999999997 13.788574192749046 991.5828235522902 2.2583422934612845 0.11759270653871523 18.381879710850658 42.300503 223.456 24.63438
GELM00BGR 2024-05-10 11:00:00 2.3760750000000006 12.581758369018578 987.123799367538 2.2482185946648863 0.12785640533511433 19.924536664720805 42.269939 263.842 24.32545
GELM00BGR 2024-05-10 11:05:00 2.3759349999999997 12.689546454956078 987.1065145461225 2.24817922771118 0.12775577228881962 19.914365301955055 42.269939 263.842 24.32545
GOP600CZE 2024-05-10 11:00:00 2.3760750000000006 14.964746640380882 955.3171465500994 2.174416697898751 0.20165830210124946 31.61776694731302 49.913672 554.864 14.785612
GOP600CZE 2024-05-10 11:05:00 2.3759349999999997 15.000116513427757 955.2623881243745 2.174292061137361 0.20164293886263884 31.618211788101174 49.913672 554.864 14.785612
GOPE00CZE 2024-05-10 11:00:00 2.3760750000000006 14.964415140380883 955.311369835812 2.1744035734830076 0.201671426516993 31.61979795986932 49.913707 554.915 14.785628
GOPE00CZE 2024-05-10 11:05:00 2.3759349999999997 14.999785013427758 955.256612450245 2.1742789390877606 0.2016560609122391 31.620242617490376 49.913707 554.915 14.785628
GRAM00BGR 2024-05-10 11:00:00 2.3760750000000006 17.35050474841311 986.8964195500964 2.2473800615459987 0.1286941384540019 20.30063728617011 43.840169 275.137 22.63986
GRAM00BGR 2024-05-10 11:05:00 2.3759349999999997 17.351572863647483 986.8621519483833 2.2473028266572954 0.12863217334270427 20.29091766749452 43.840169 275.137 22.63986
MATE00ITA 2024-05-10 11:00:00 2.3760750000000006 15.399960384199242 956.3261136289306 2.1785420541915648 0.19753294580843583 31.005353786637343 40.649135 495.156 16.704465
MATE00ITA 2024-05-10 11:05:00 2.3759349999999997 14.968930030761742 956.3728283513889 2.1786484718517904 0.19728652814820924 30.932651896587867 40.649135 495.156 16.704465
ONSA00SWE 2024-05-10 11:00:00 2.3760750000000006 18.53012014038088 1019.1055055709713 2.317718466834572 0.05835653316542855 9.232887966620625 57.395336 6.345 11.924547
ONSA00SWE 2024-05-10 11:05:00 2.3759349999999997 18.565490013427755 1019.0390551498928 2.3175673408056956 0.05836765919430409 9.235474041484322 57.395336 6.345 11.924547
ONSA00SWE 2024-05-10 11:00:00 2.3760750000000006 18.516554640380882 1018.856435537271 2.317153374341565 0.058921625658435506 9.321974447576544 57.395301 8.432 11.925523
ONSA00SWE 2024-05-10 11:05:00 2.3759349999999997 18.551924513427757 1018.7900315509653 2.3170023538291837 0.05893264617081595 9.324551762536217 57.395301 8.432 11.925523
PETR00BGR 2024-05-10 11:00:00 2.3760750000000006 18.880411488708518 994.3186348296398 2.2645352504026763 0.11153974959732427 17.662906913796576 42.287375 188.114 25.635409
PETR00BGR 2024-05-10 11:05:00 2.3759349999999997 18.964975697692893 994.2485087148849 2.2643937586274654 0.1115412413725343 17.66691592134815 42.287375 188.114 25.635409
POPO00BGR 2024-05-10 11:00:00 2.3760750000000006 13.331334039550804 992.6086145150604 2.2607081041444212 0.11536689585557935 18.012836522480416 42.122762 211.476 25.072149
POPO00BGR 2024-05-10 11:05:00 2.3759349999999997 13.493351861816429 992.6216570187282 2.2607378089981864 0.115197190100181325 17.9938088253227463 42.122762 211.476 25.072149
SBGB00BGR 2024-05-10 11:00:00 2.3760750000000006 15.966715914184593 1013.3502525854879 2.3075657660885804 0.06850923391142016 10.769768292876131 43.405251 43.947 28.147452
SBGB00BGR 2024-05-10 11:05:00 2.3759349999999997 16.025402437622095 1013.4359231035514 2.307760851997073 0.06817414800292676 10.71874639262895 43.405251 43.947 28.147452
SOFI00BGR 2024-05-10 11:00:00 2.3760750000000006 17.357829188476585 894.487748481432 2.037650413666395 0.3384245863336055 52.03083342912854 42.556097 1084.731 23.394738
SOFI00BGR 2024-05-10 11:05:00 2.3759349999999997 17.22028646386721 894.4035372985102 2.0374585799023137 0.33847642009768597 52.0201635855258 42.556097 1084.731 23.394738
STAS00BGR 2024-05-10 11:00:00 2.3760750000000006 17.911649204834006 984.0656877953019 2.241201670089987 0.13487332991001377 21.305638438115476 42.561873 277.518 26.142813
STAS00BGR 2024-05-10 11:05:00 2.3759349999999997 17.862821079834006 984.0452495298223 2.241155122105137 0.13477987789486257 21.28824351441406 42.561873 277.518 26.142813
STDK00BGR 2024-05-10 11:00:00 2.3760750000000006 14.990639068202995 1008.9983517423801 2.2979221663743132 0.07815283362568737 12.254300105723178 42.233291 70.43 27.772963
STDK00BGR 2024-05-10 11:05:00 2.3759349999999997 14.980629302577995 1008.9980450845327 2.2979214679828206 0.07801353201717909 12.232145282586147 42.233291 70.43 27.772963
SUZF00BGR 2024-05-10 11:00:00 2.3760750000000006 11.318436320556664 943.938785303194 2.1500087795273592 0.22606622047264135 35.114791067855705 42.67381 639.669 23.329108
SUZF00BGR 2024-05-10 11:05:00 2.3759349999999997 11.283829386962914 943.838691127279 2.149780795085627 0.22615420491437277 35.1253252488537 42.67381 639.669 23.329108
TLSE00FRA 2024-05-10 11:00:00 2.3760750000000006 20.433719043457053 994.1740289578701 2.2639405198975426 0.11213448010245797 17.82674977870589 43.560698 161.952 1.480895
TLSE00FRA 2024-05-10 11:05:00 2.3759349999999997 20.486728076660178 994.0781582613668 2.263722024318246 0.11221279756817504 17.841579317380415 43.560698 161.952 1.480895
TLSE00FRA 2024-05-10 11:00:00 2.3760750000000006 20.55405844824221 993.9106462817858 2.263343652145265 0.11273134785473582 17.927063183136816 43.549714 162.904 1.485045
TLSE00FRA 2024-05-10 11:05:00 2.3759349999999997 20.610668555664084 993.8117140830193 2.263118362714159 0.11281663728584057 17.94318045694947 43.549714 162.904 1.485045
+ iwv_calc git:(main)
```

With two wrf files and filter station SUZF00BGR

```
➔ iwv_calc git:(main) python3 iwvcalc.py --snx-file ../../wrf_files_usb/BGR-RT-xxxxx-T
EF-FIX-xxxx-IF_240510_1100.snx2 --wrf-file ../../wrf_files_usb/wrfs/wrfout_d03_2024-05-
10_11.00.00,../../wrf_files_usb/wrfs/wrfout_d03_2024-05-10_11.05.00 --station SUZF00BGR
station,time,ztd,temp,pressure,zhd,zwd,iwv,station_latitude,station_altitude,station_longitude
SUZF00BGR 2024-05-10 11:00:00 2.2824 11.318436320556664 943.938785303194 2.150008779527
3592 0.13239122047264074 20.564284378248413 42.67381 639.669 23.329108
SUZF00BGR 2024-05-10 11:05:00 2.28218 11.283829386962914 943.838691127279 2.14978079508
5627 0.13239920491437296 20.563690761392643 42.67381 639.669 23.329108
➔ iwv_calc git:(main)
```

With wrf folder, filter station SUZF00BGR and output troposinex

```
* iwv_calc git:(main) x python3 iwvcalc.py --snx-file ../../wrf_files_usb/BGR-RT-xxxxx-TEF-FIX-xxxx-IF_240510_1100.snx2
--wrf-file ../../wrf_files_usb/wrfs --station SUZF00BGR --o test.snx2
```

```
1  %=TRO
2  *-----
3  +FILE/REFERENCE
4  *INFO_TYPE_____ INFO_____
5  DESCRIPTION      SUGAC
6  OUTPUT           SUGAC
7  CONTACT          GUEROVA
8  SOFTWARE          WRFv3.7.1
9  INPUT            NWM
10 VERSION NUMBER 001
11 -FILE/REFERENCE
12 *-----
13 +TROP/DESCRIPTION
14 *_____KEYWORD_____ VALUE(S)_____
15 REFRACTIVITY COEFFICIENTS 77.60 70.40 373900.0
16 TROPO SAMPLING INTERVAL 3600
17 TIME SYSTEM             UTC
18 TROPO PARAMETER NAMES   IWV PRESS TEMDRY TRODRY TROTOT TROWET
19 TROPO PARAMETER UNITS   1      1      1 1e+03 1e+03 1e+03
20 TROPO PARAMETER WIDTH   6      6      6      6      6      6
21 -TROP/DESCRIPTION
22 *-----
23 +SITE/ID
24 *STATION__ _LONGITUDE_ _LATITUDE_ _HGT_MSL_
25 SUZF00BGR 23.329108 42.673810 639.669
26 -SITE/ID
27 *-----
28 +SITE/COORDINATES
29 -SITE/COORDINATES
30 *-----
31 +TROP/SOLUTION
32 *STATION__ _EPOCH_____ _IWV_ _PRESS_ TEMPDRY TRODRY TROTOT TROWET
33 SUZF00BGR 2024:131:39600 20.56 943.94 284.5 2.2 2.3 0.1
34 SUZF00BGR 2024:131:39900 20.56 943.84 284.4 2.1 2.3 0.1
35 SUZF00BGR 2024:131:40200 20.48 943.83 284.4 2.1 2.3 0.1
36 SUZF00BGR 2024:131:40500 20.37 943.83 284.4 2.1 2.3 0.1
37 SUZF00BGR 2024:131:40800 20.38 943.73 284.5 2.1 2.3 0.1
38 SUZF00BGR 2024:131:41100 20.48 943.71 284.5 2.1 2.3 0.1
39 SUZF00BGR 2024:131:41400 20.53 943.76 284.5 2.1 2.3 0.1
40 SUZF00BGR 2024:131:41700 20.60 943.72 284.6 2.1 2.3 0.1
41 SUZF00BGR 2024:131:42000 20.66 943.66 284.6 2.1 2.3 0.1
42 SUZF00BGR 2024:131:42300 20.70 943.57 284.7 2.1 2.3 0.1
43 SUZF00BGR 2024:131:42600 20.77 943.43 284.7 2.1 2.3 0.1
44 SUZF00BGR 2024:131:42900 20.86 943.34 284.8 2.1 2.3 0.1
45 -TROP/SOLUTION
46 %=ENDTRO
```