

## single\_vs\_double\_precision\_output

June 2, 2024

```
[1]: import xarray as xr
import numpy as np
import matplotlib.pyplot as plt
import sys
```

```
[2]: output_dir1 = './output32'
output_dir2 = './output64'
case_output = '/output_twice_SCM_RAP'

f32 = output_dir1 + case_output + '/output.nc'
f64 = output_dir2 + case_output + '/output.nc'

ds32 = xr.open_dataset(f32)
ds64 = xr.open_dataset(f64)
```

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[3]: ds32.identical(ds64)
```

```
[3]: False
```

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[4]: #mean_absolute_error = (abs(ds32[var] - ds64[var])[:, :, 0]) / ds32[var].count()
def print_error(var, max_re, std_err, mean_absolute_error):
    print("-----")
    print(var,
          ": max_re", max_re,
          ", std err =", std_err,
          ", mean absolute error", mean_absolute_error)
def calc_relative_error(ds32, ds64, var):
    if (len(ds32[var].shape) == 2):
        re = (abs(ds32[var] - ds64[var])[:, :]) / abs(ds64[var][:, :])
    else:
        re = (abs(ds32[var] - ds64[var])[:, :, 0]) / abs(ds64[var][:, :, 0])
    return re
def calc_relative_error_t0(ds32, ds64, var):
    if (len(ds32[var].shape) == 2):
        re = (abs(ds32[var] - ds64[var])[0, :]) / abs(ds64[var][0, :])
    else:
```

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        re = (abs(ds32[var] - ds64[var])[0,:,:]) / abs(ds64[var][0,:,:])
    return re
def calc_std_error(re_std, count):
    return re_std / count
def calc_mean_absolute_error(ds32, ds64, var):
    if (len(ds32[var].shape) == 2):
        mean_absolute_error = np.sum(abs(ds32[var] - ds64[var]))[:,:]) /
↳ds32[var].count()
    else:
        mean_absolute_error = np.sum(abs(ds32[var] - ds64[var]))[:,:,0]) /
↳ds32[var].count()
    return mean_absolute_error
def calc_mean_absolute_error_t0(ds32, ds64, var):
    if (len(ds32[var].shape) == 2):
        mean_absolute_error = np.sum(abs(ds32[var] - ds64[var])[0,:]) /
↳ds32[var].count()
    else:
        mean_absolute_error = np.sum(abs(ds32[var] - ds64[var])[0,:,:]) /
↳ds32[var].count()
    return mean_absolute_error
def plot_relative_error(re, len_re):
    if (len_re == 2):
        fig, ax = plt.subplots(nrows=1, ncols=1, figsize=(6, 4))
        re.transpose().plot(ax=ax)
    else:
        fig, axes = plt.subplots(nrows=1, ncols=2, figsize=(12, 4))
        re.transpose().plot(ax=axes[0], vmax=0.05)
        axes[0].set_title('Plot with vmax=0.05')
        re.transpose().plot(ax=axes[1], vmax=1.0)
        axes[1].set_title('Plot with vmax=1.0')
    plt.show()
def plot_relative_error_t0(re):
    fig, ax = plt.subplots(nrows=1, ncols=1, figsize=(4.5, 3))
    re.plot(ax=ax)
    plt.show()

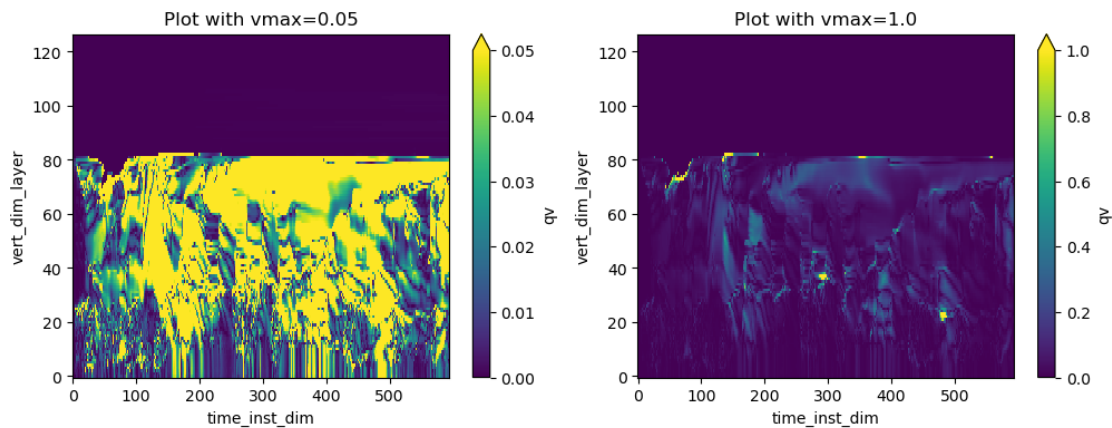
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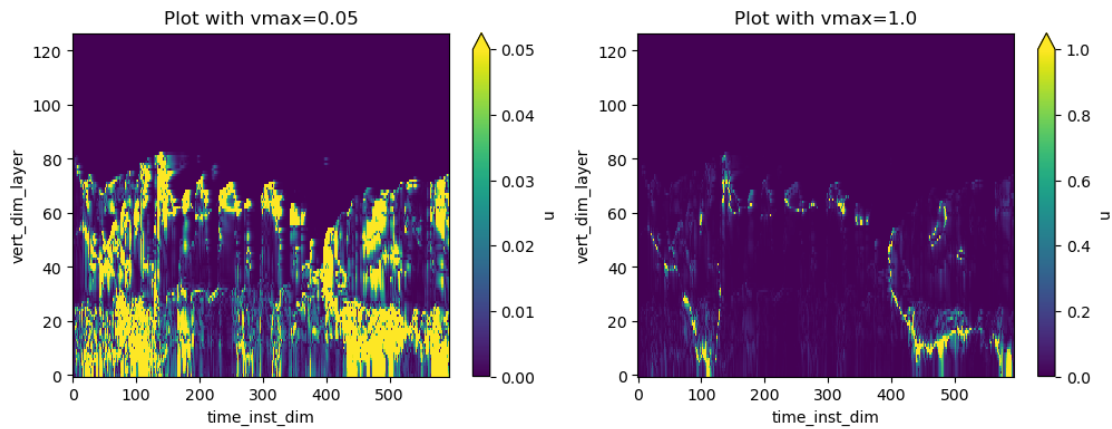
[5]: # compare variables across full run
for var in ds32.variables:
    if (not ds32[var].identical(ds64[var])):
        relative_err = calc_relative_error(ds32, ds64, var)
        max_re = max(abs(relative_err.min().data), relative_err.max().data)
        if (max_re > .05):
            std_err = calc_std_error(relative_err.std(), relative_err.count())
            mean_absolute_err = calc_mean_absolute_error(ds32, ds64, var)
            print_error(var, max_re, std_err.data, mean_absolute_err.data)
            plot_relative_error(relative_err, len(ds32[var].shape))
            #sys.exit()

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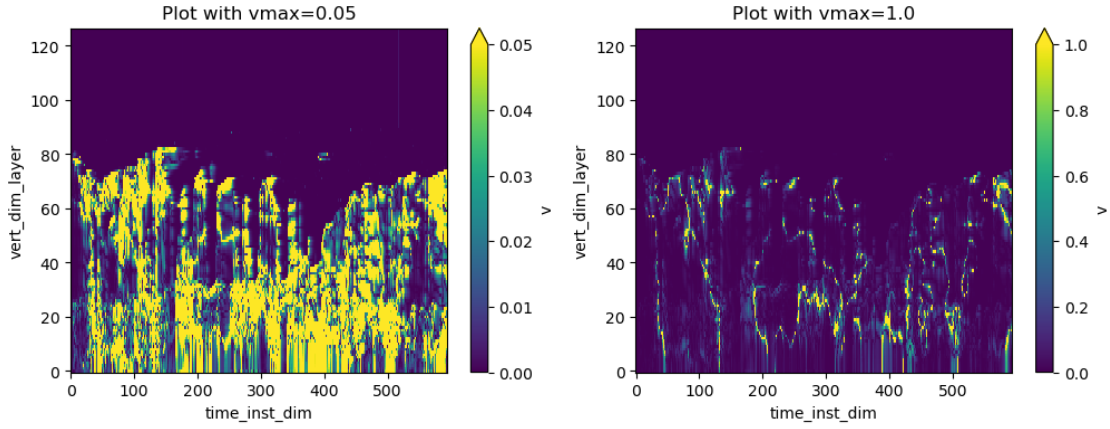
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qv : max\_re 8973305.0 , std err = 0.5705933012968967 , mean absolute error  
0.00016317412356778803



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u : max\_re 1457.572265625 , std err = 8.28164264146619e-05 , mean absolute error  
0.10125452063207173

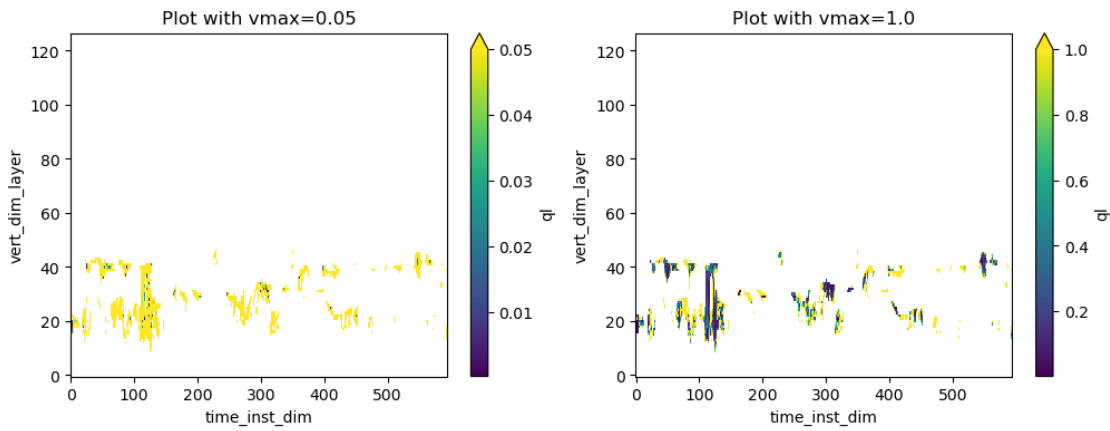


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v : max\_re 2231.651611328125 , std err = 0.00011412449472437843 , mean absolute  
error 0.04327666475054589



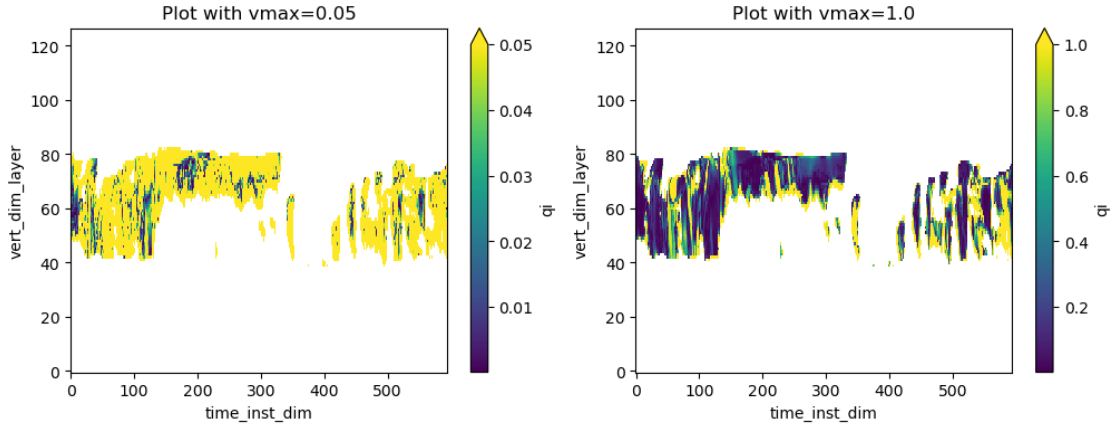

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ql : max\_re inf , std err = nan , mean absolute error 3.354706218696513e-06



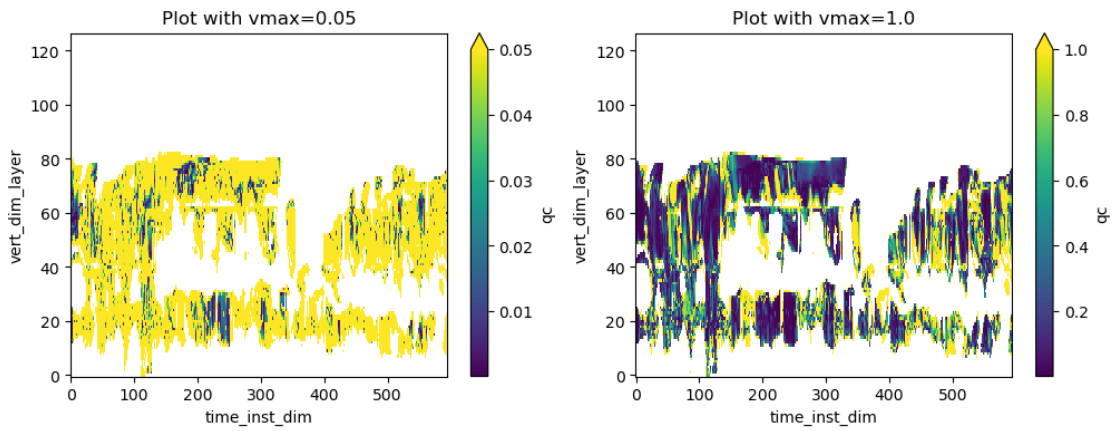

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qi : max\_re inf , std err = nan , mean absolute error 1.1948357030383522e-06



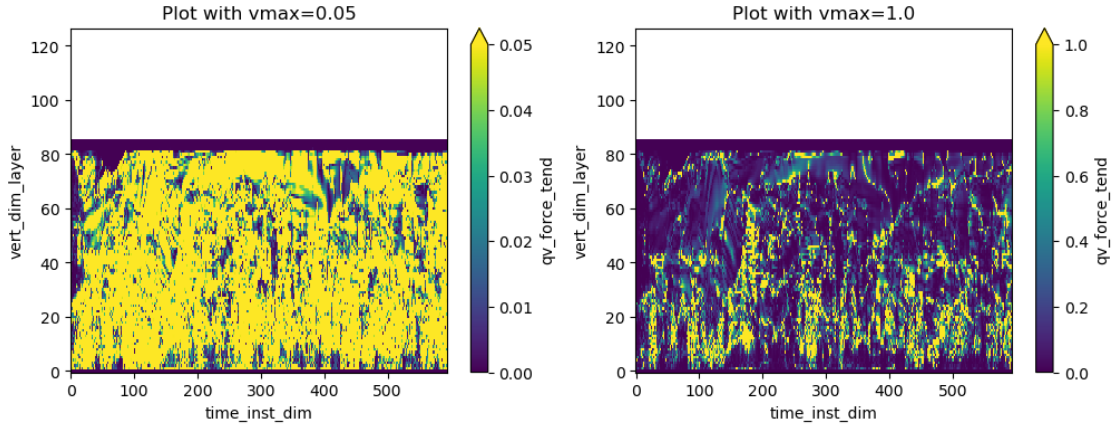
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qc : max\_re inf , std err = nan , mean absolute error 9.156968539486665e-06



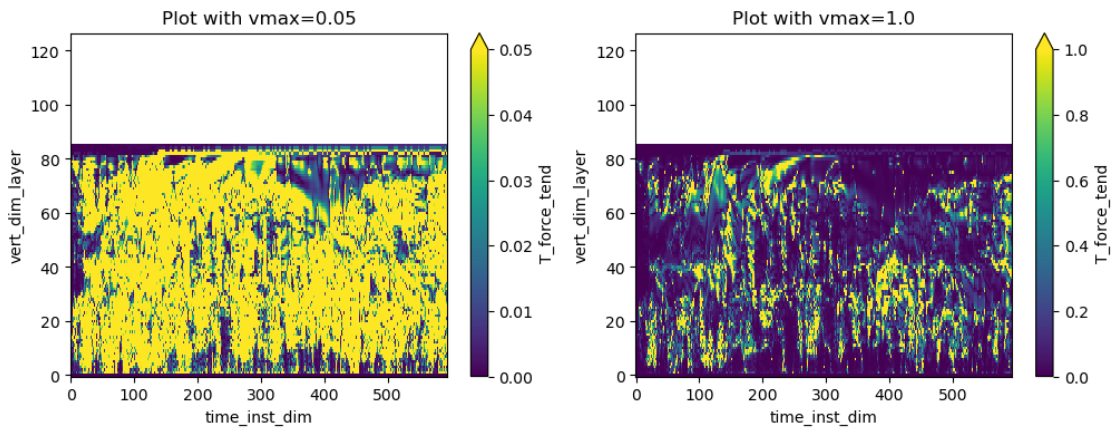
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qv\_force\_tend : max\_re 1910.5413818359375 , std err = 0.0003158394447107414 ,  
 mean absolute error 4.268155981012737e-09



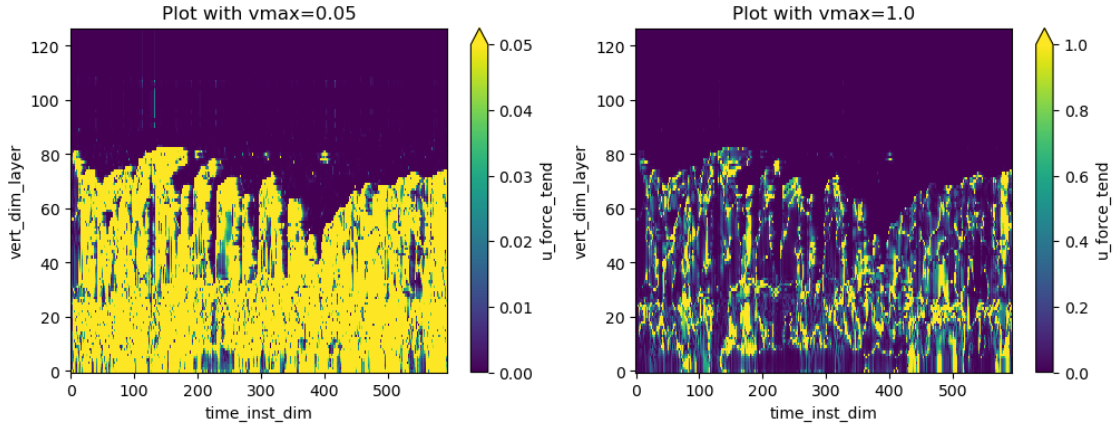
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T\_force\_tend : max\_re 7533.76416015625 , std err = 0.0006987828075554403 , mean absolute error 5.851804022989984e-06



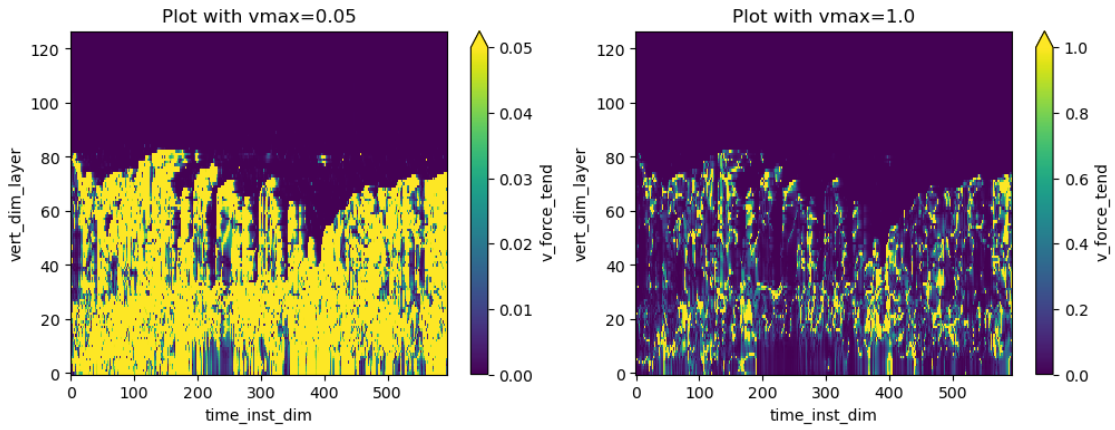
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u\_force\_tend : max\_re 1884.8555908203125 , std err = 0.00015565544313898887 , mean absolute error 1.4104225046620634e-05



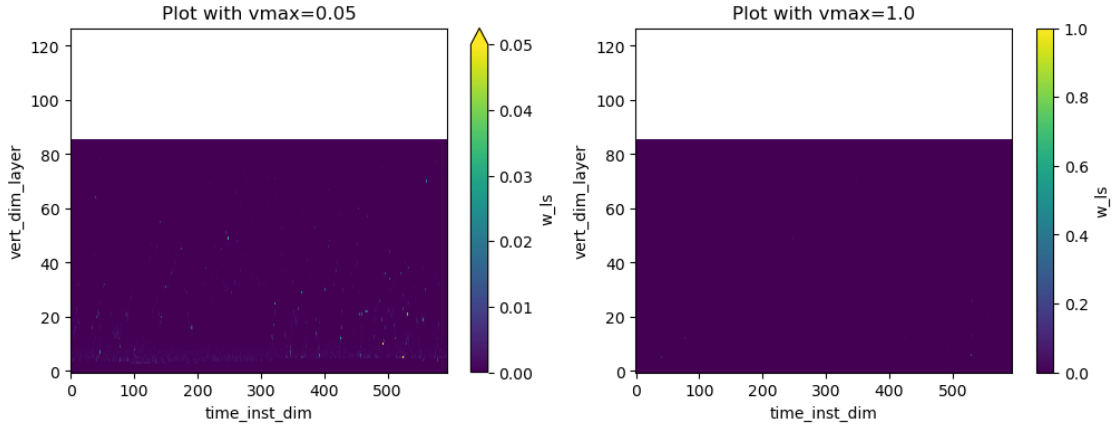

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v\_force\_tend : max\_re 9228.91796875 , std err = 0.0006658069692818161 , mean absolute error 5.993292978973682e-06



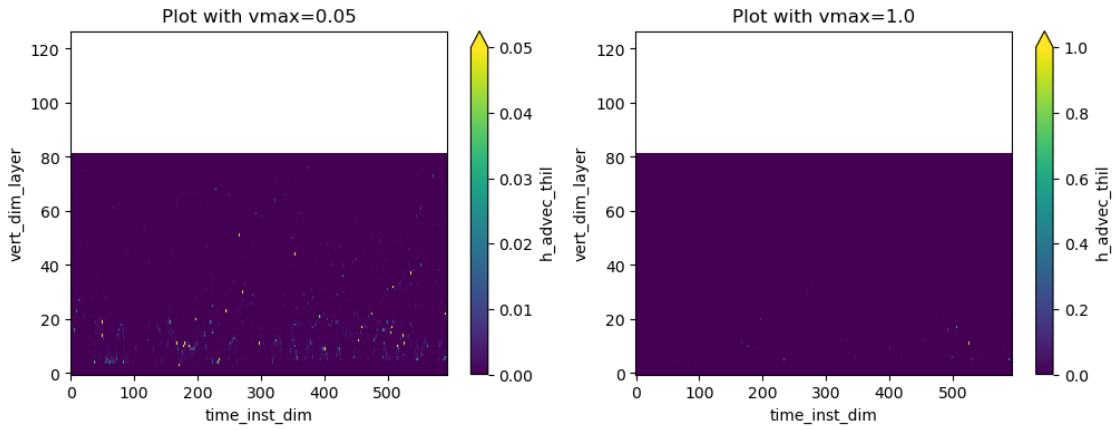

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w\_ls : max\_re 0.24458375573158264 , std err = 2.999571469631166e-08 , mean absolute error 1.6797125173862911e-07



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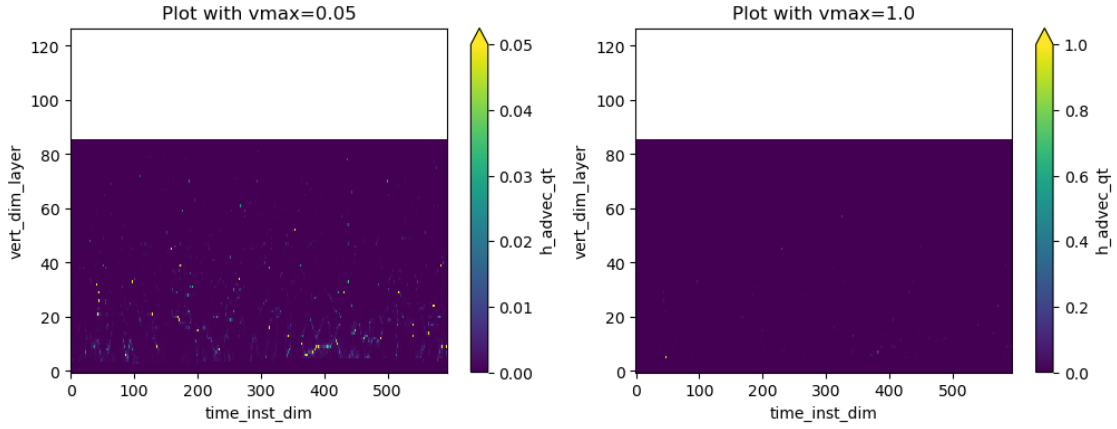
h\_advec\_thil : max\_re 1.429416298866272 , std err = 2.120875568877578e-07 , mean absolute error 8.091836406869106e-10



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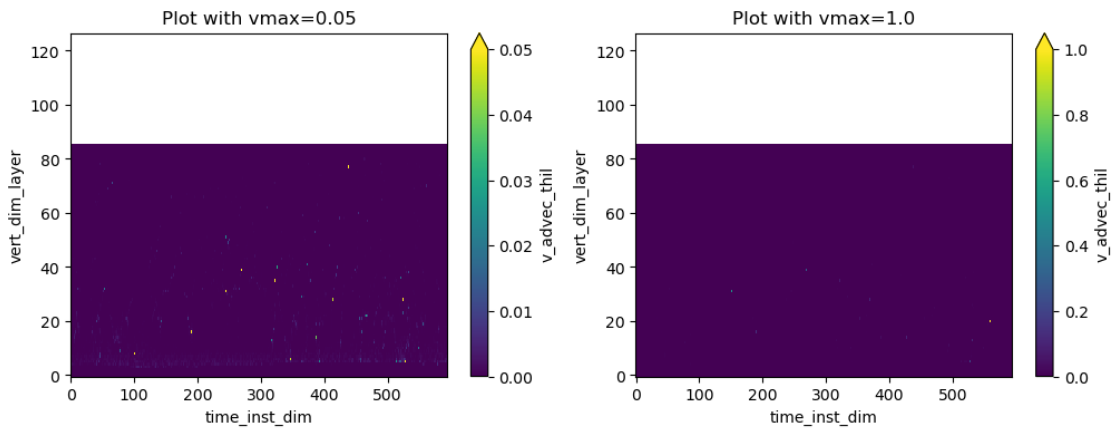
h\_advec\_qt : max\_re 3.0694022178649902 , std err = 2.936804614333592e-07 , mean absolute error 1.0859127826049856e-12





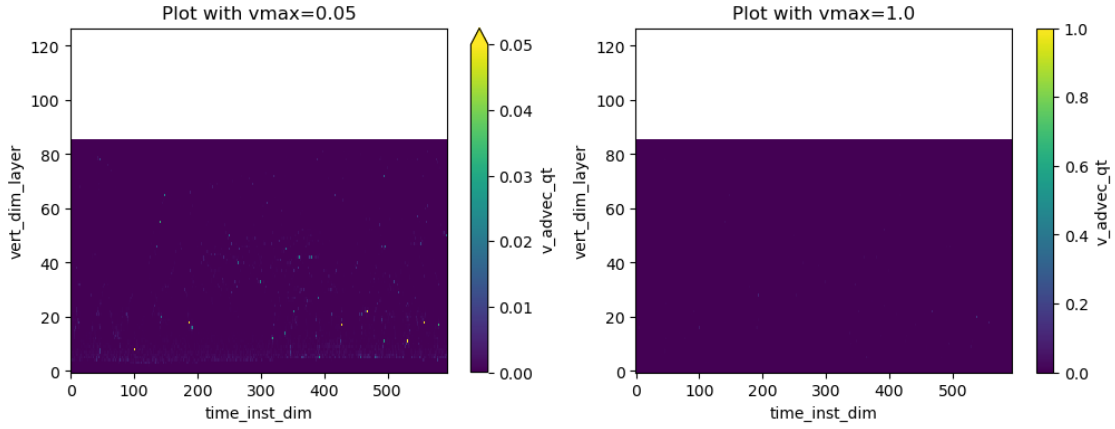

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$v\_advec\_thil$  : max\_re 3.0505452156066895 , std err = 2.898730866163998e-07 ,  
mean absolute error 1.2391986573604409e-09



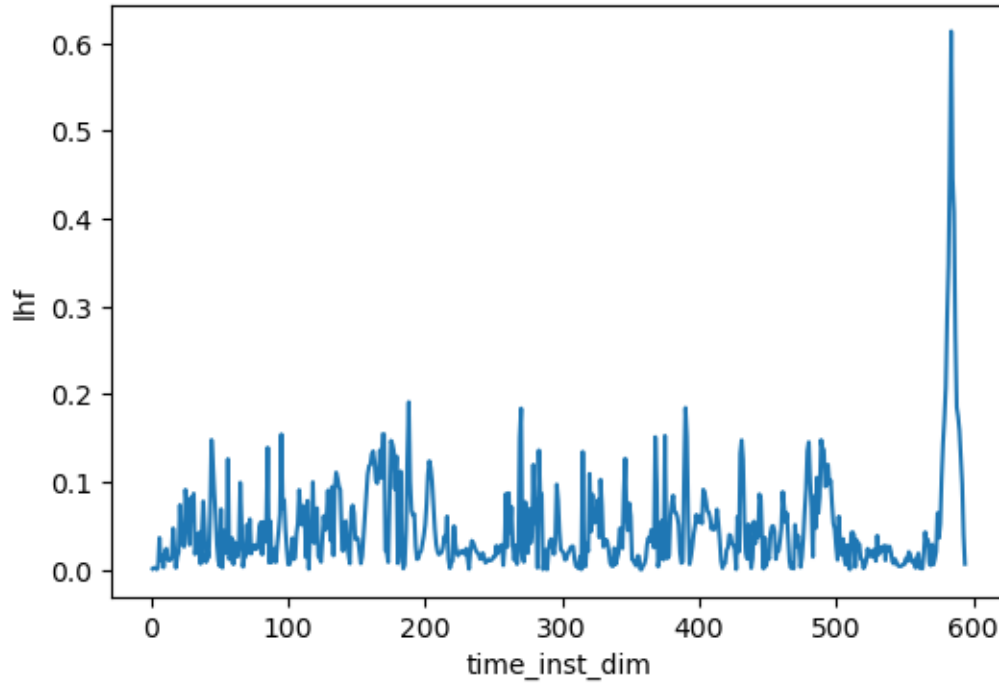

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$v\_advec\_qt$  : max\_re 0.29005974531173706 , std err = 3.8568389296054095e-08 ,  
mean absolute error 7.129938331587713e-13



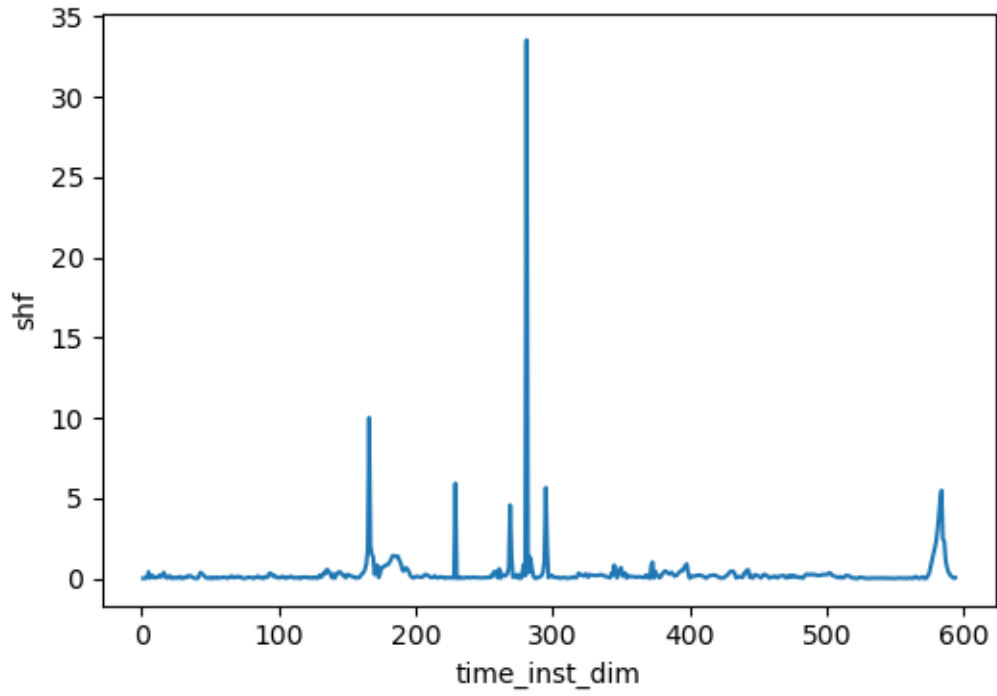
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lhf : max\_re 0.6133176684379578 , std err = 9.622186522692542e-05 , mean absolute error 7.621605829831933



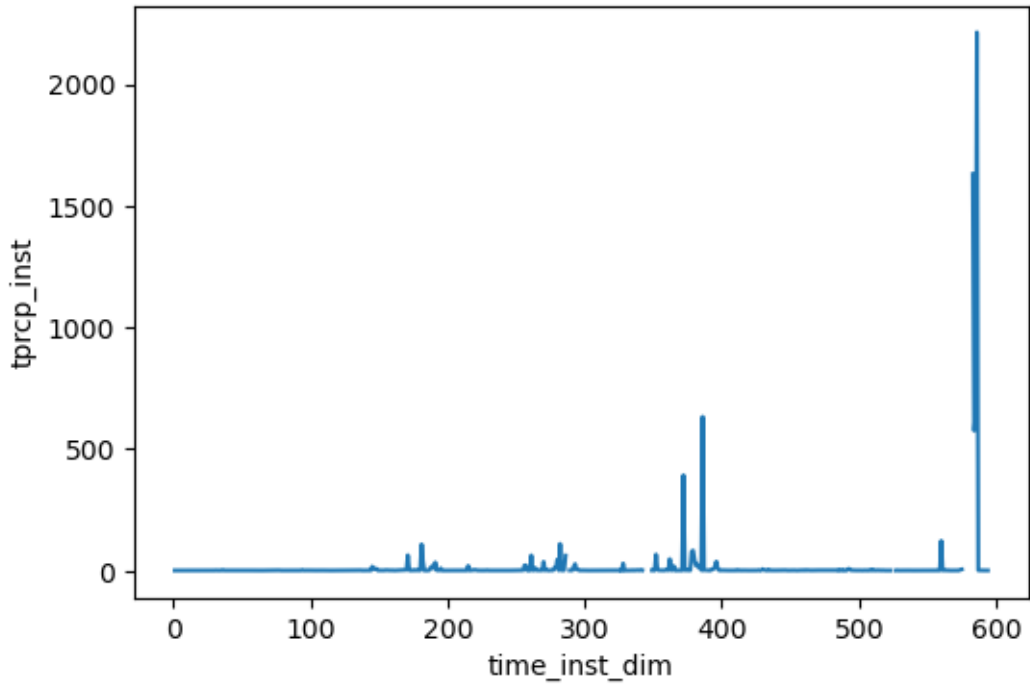
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shf : max\_re 33.54254150390625 , std err = 0.0025967196984724565 , mean absolute error 2.5005215172006303

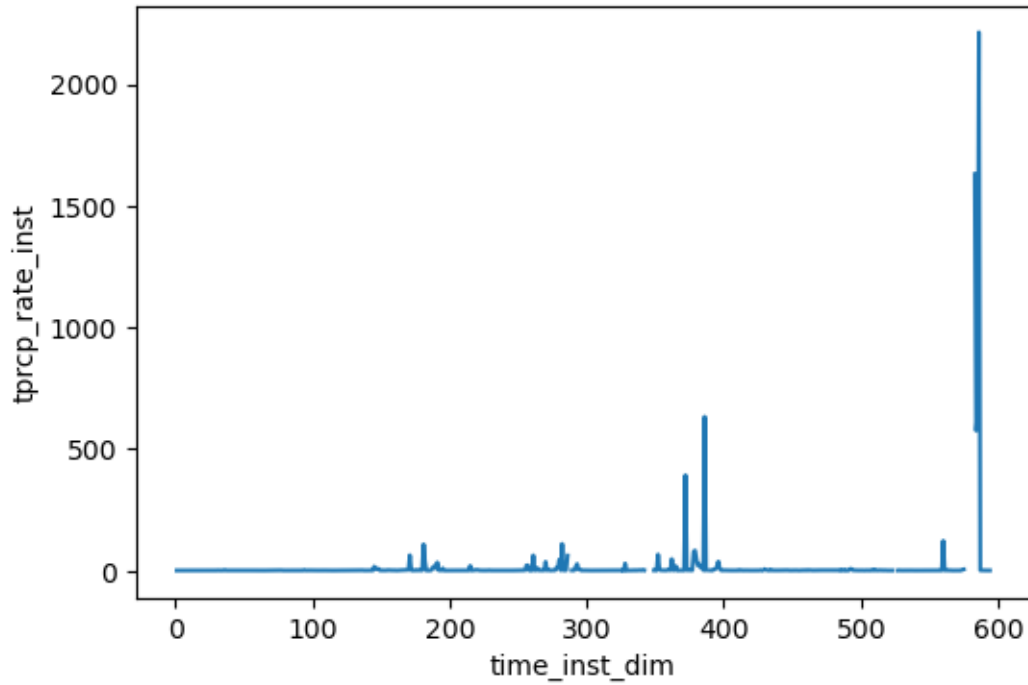


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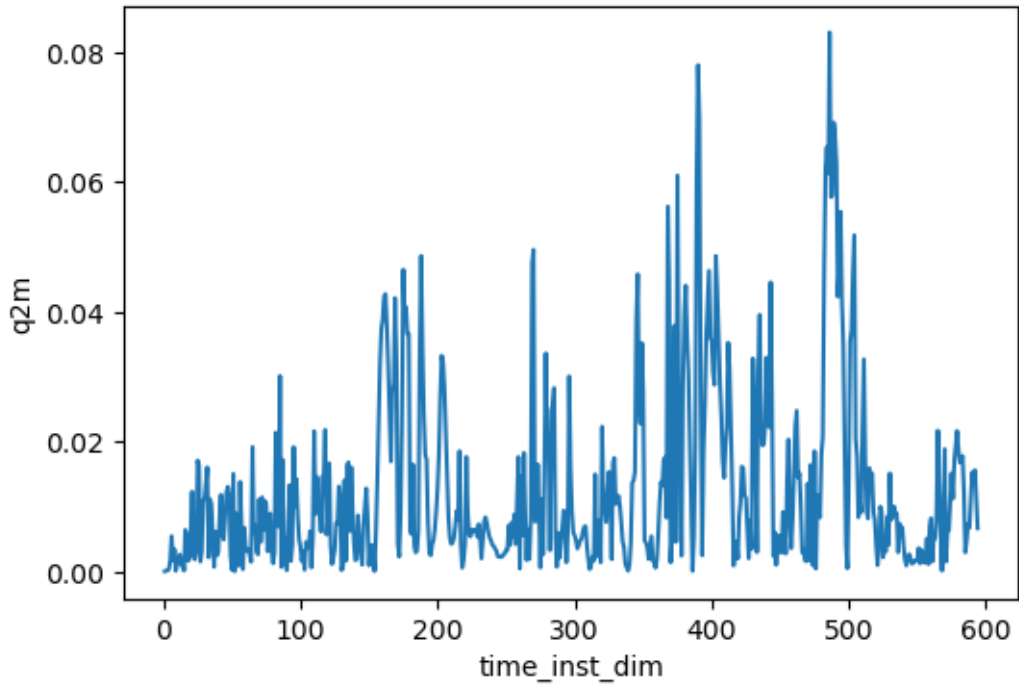
tprcp\_inst : max\_re inf , std err = nan , mean absolute error  
2.3250854691537487e-05



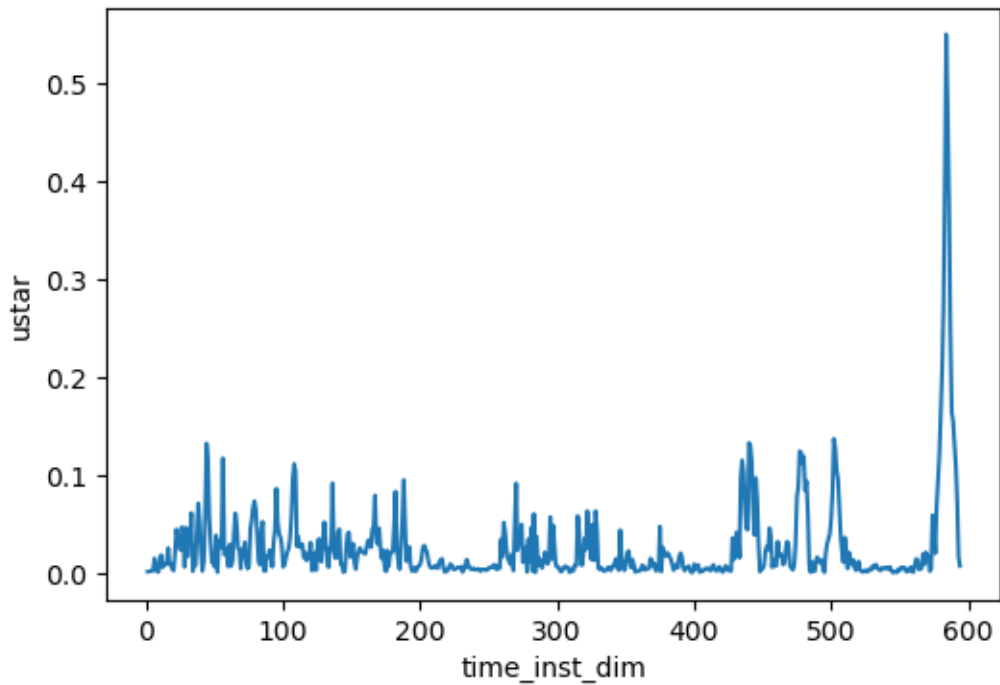
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tprcp\_rate\_inst : max\_re inf , std err = nan , mean absolute error  
3.8751420083635744e-08



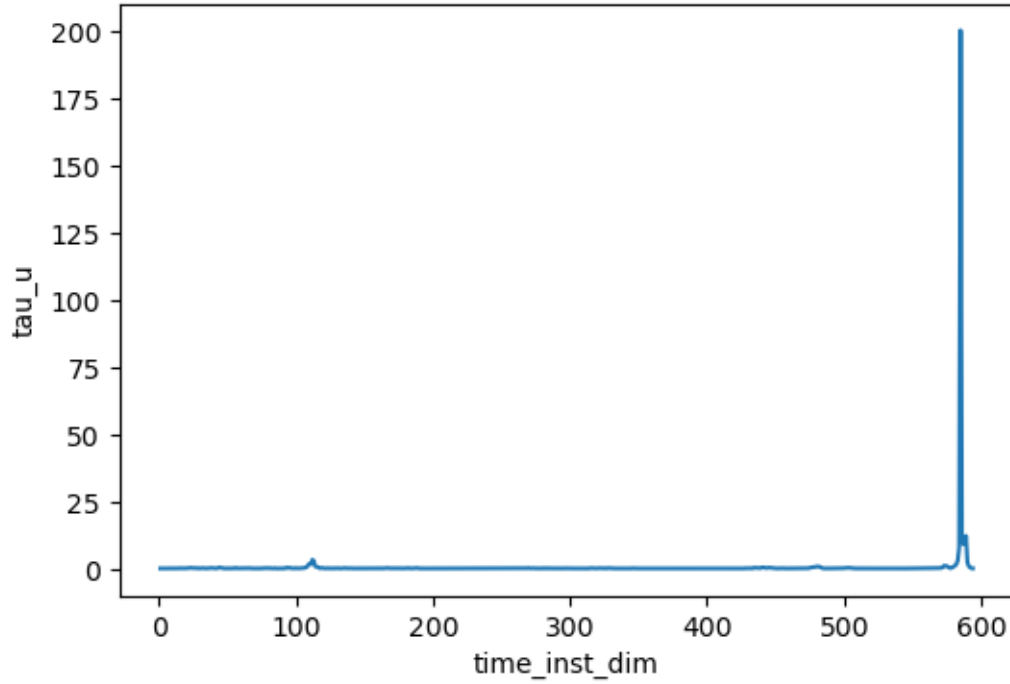
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q2m : max\_re 0.08298105001449585 , std err = 2.3642722642682617e-05 , mean  
absolute error 0.00022946841576520135



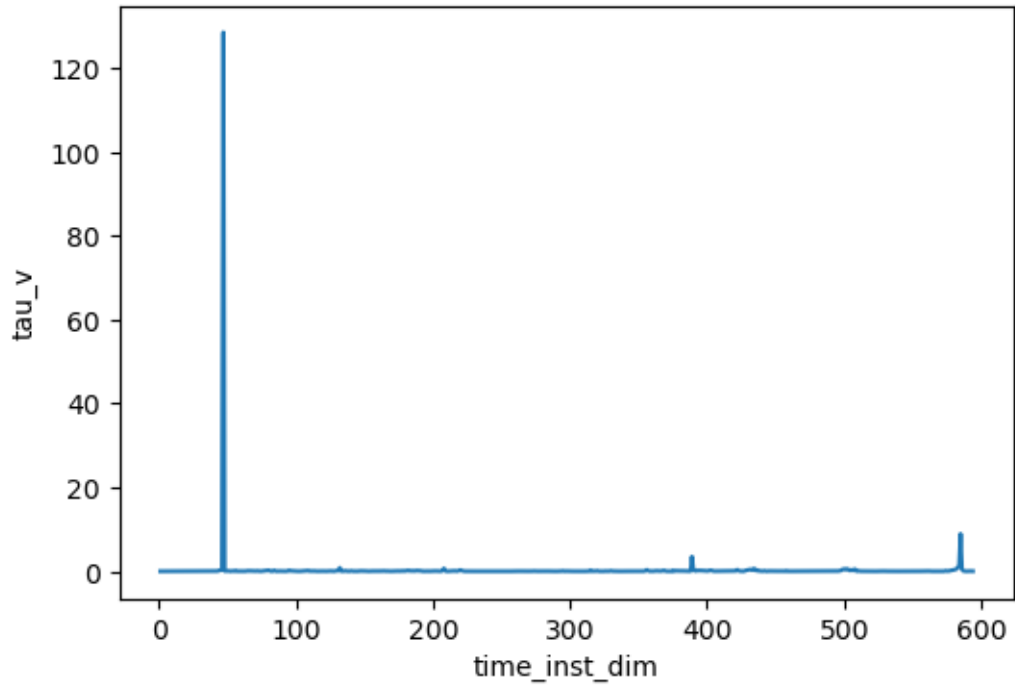
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ustar : max\_re 0.5509912967681885 , std err = 8.131402485097699e-05 , mean  
absolute error 0.004530006697197922



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tau\_u : max\_re 200.050048828125 , std err = 0.013883500789552425 , mean absolute error 0.0030248944498911627

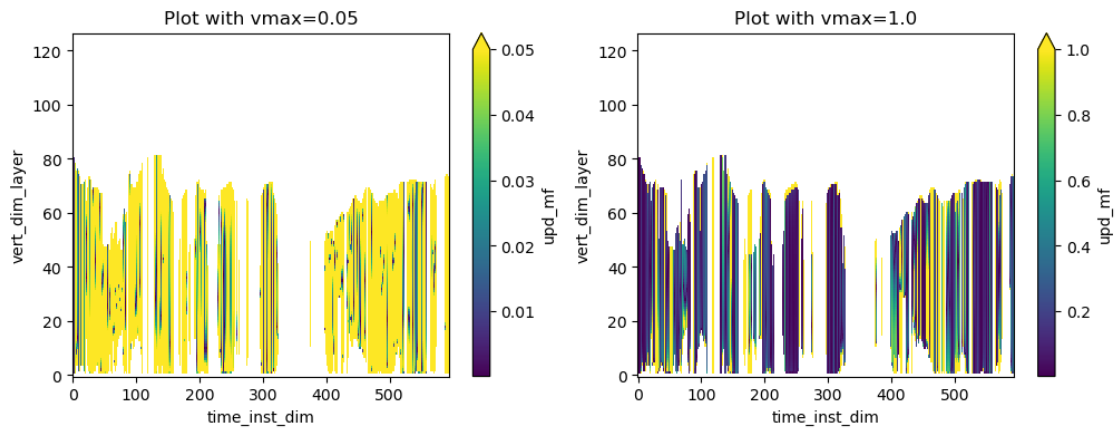


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tau\_v : max\_re 128.5138702392578 , std err = 0.00889016401888144 , mean absolute error 0.000586513160657482



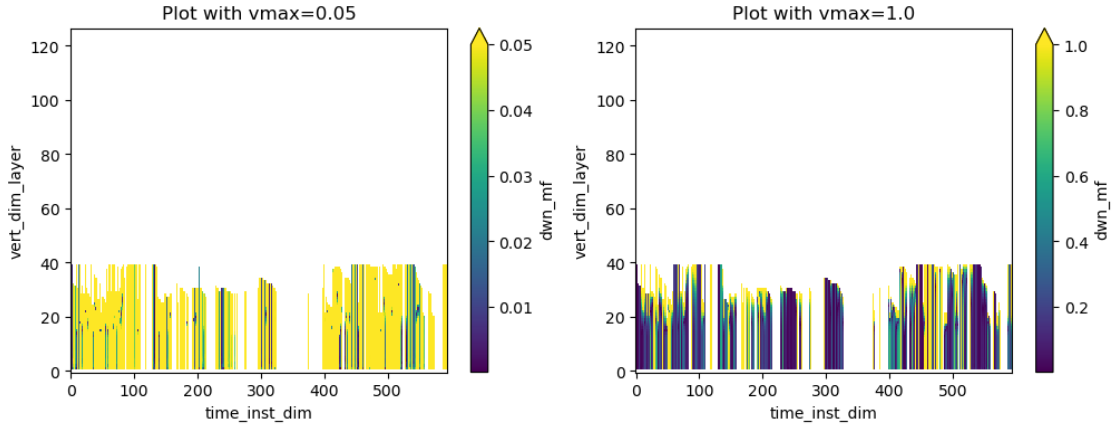

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upd\_mf : max\_re inf , std err = nan , mean absolute error 1.662921201945345



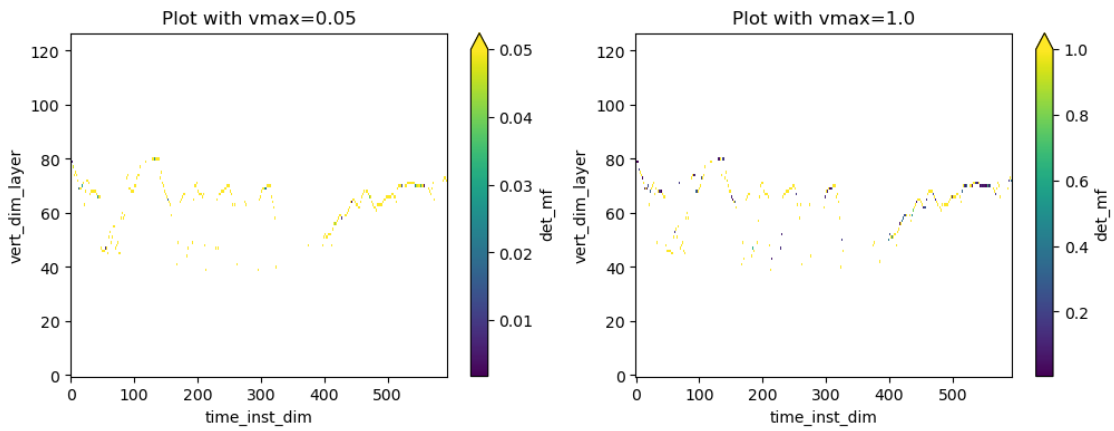

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dwn\_mf : max\_re inf , std err = nan , mean absolute error 0.3757006592006881



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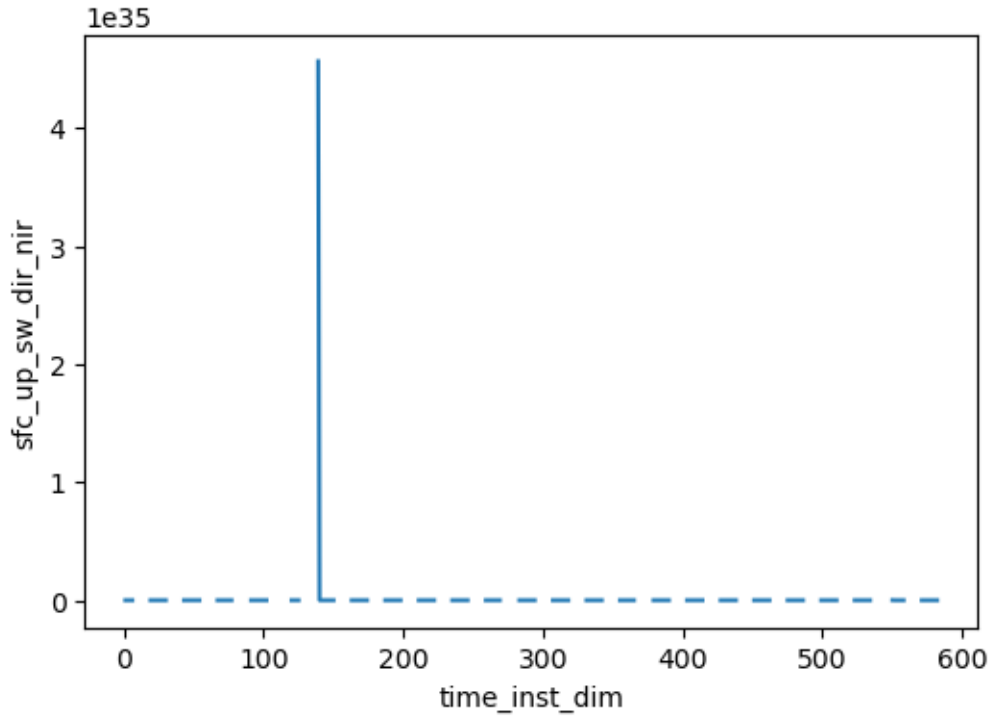
det\_mf : max\_re inf , std err = nan , mean absolute error 0.0706910221642791



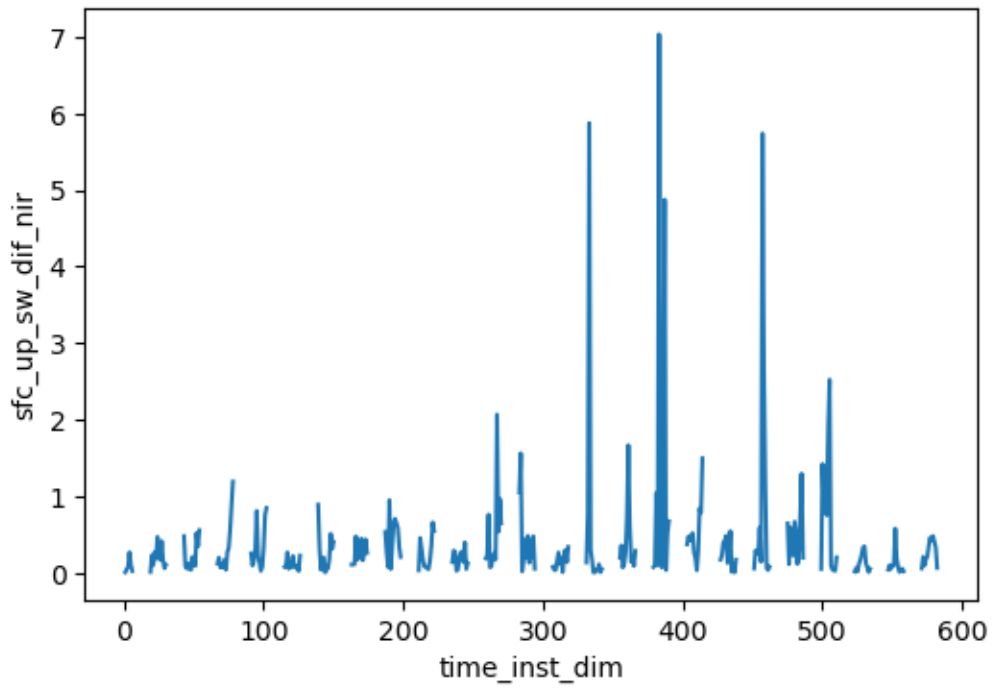
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sfc\_up\_sw\_dir\_nir : max\_re inf , std err = nan , mean absolute error 1.2205876198135504

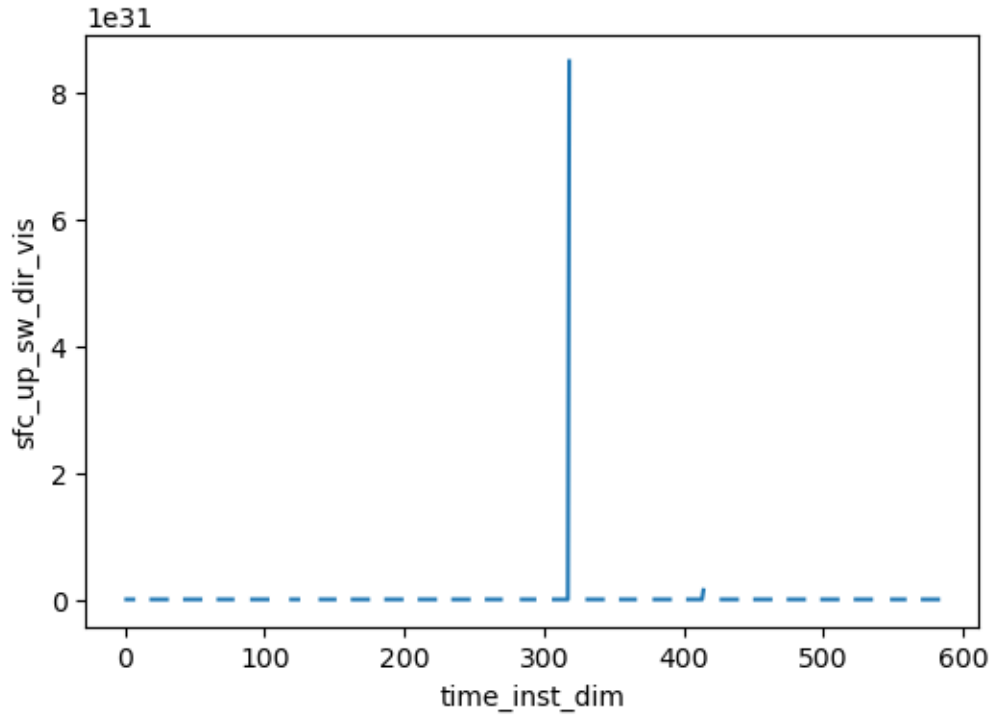




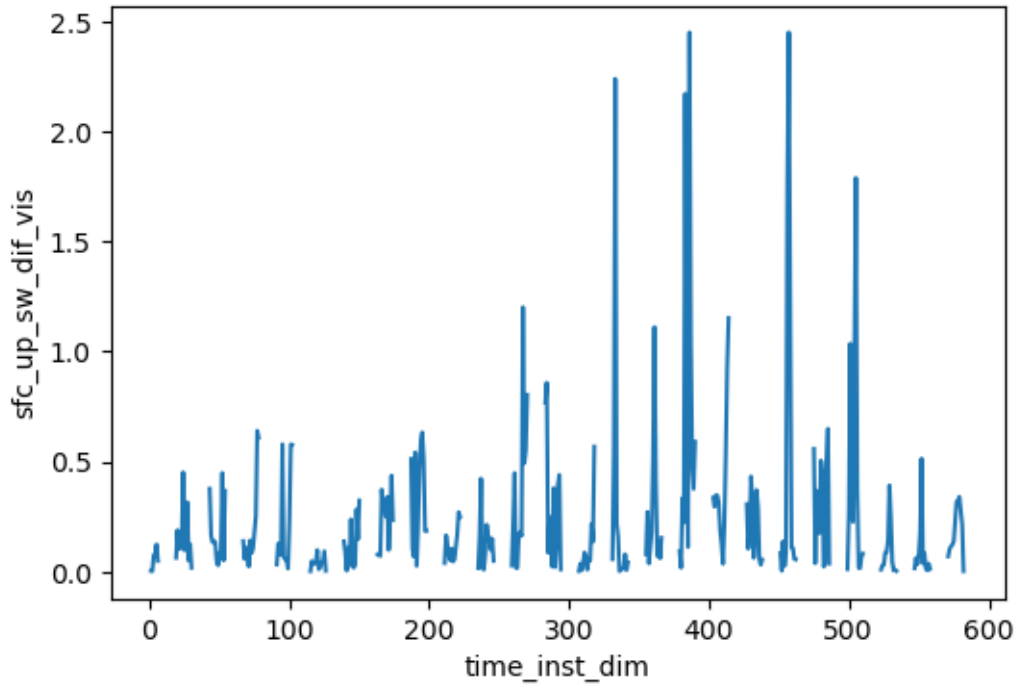
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`sfc_up_sw_dif_nir` : max\_re 7.033625602722168 , std err = 0.0025658812247166016 ,  
 mean absolute error 1.0191279050682773



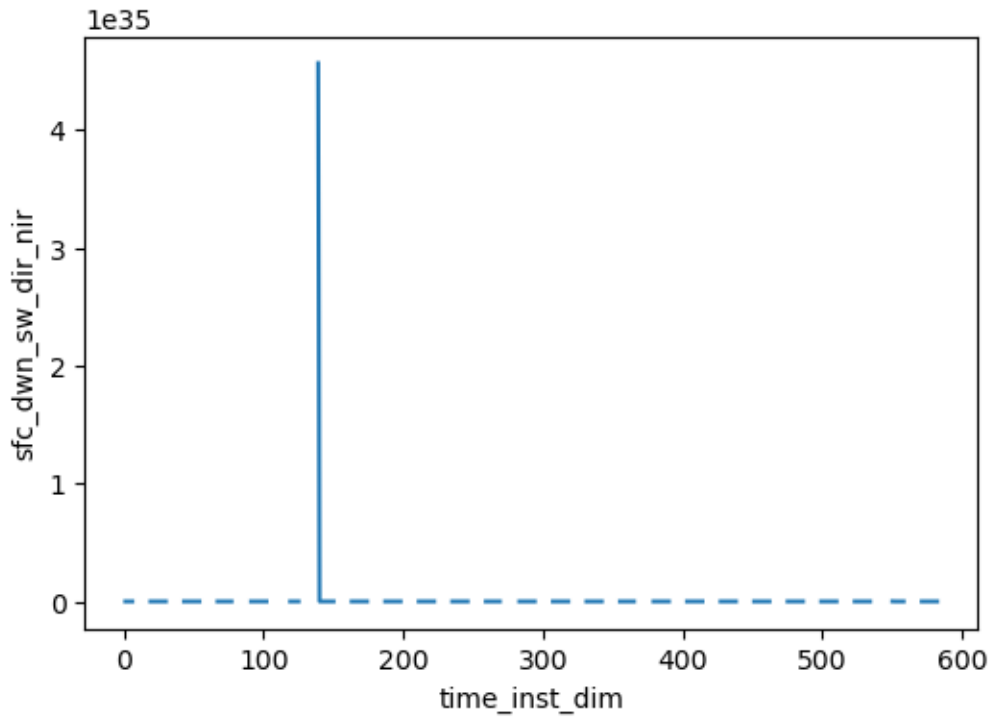
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sfc\_up\_sw\_dir\_vis : max\_re inf , std err = nan , mean absolute error  
1.2118804162289916



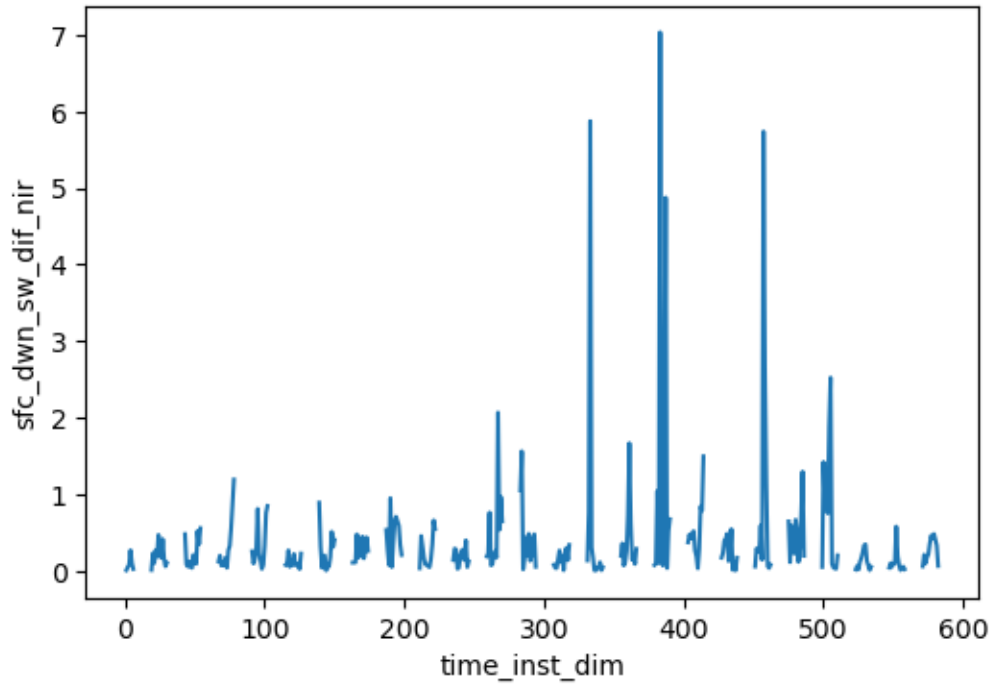
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sfc\_up\_sw\_dif\_vis : max\_re 2.451374053955078 , std err = 0.0012253014003338458 ,  
mean absolute error 1.0580599231880252



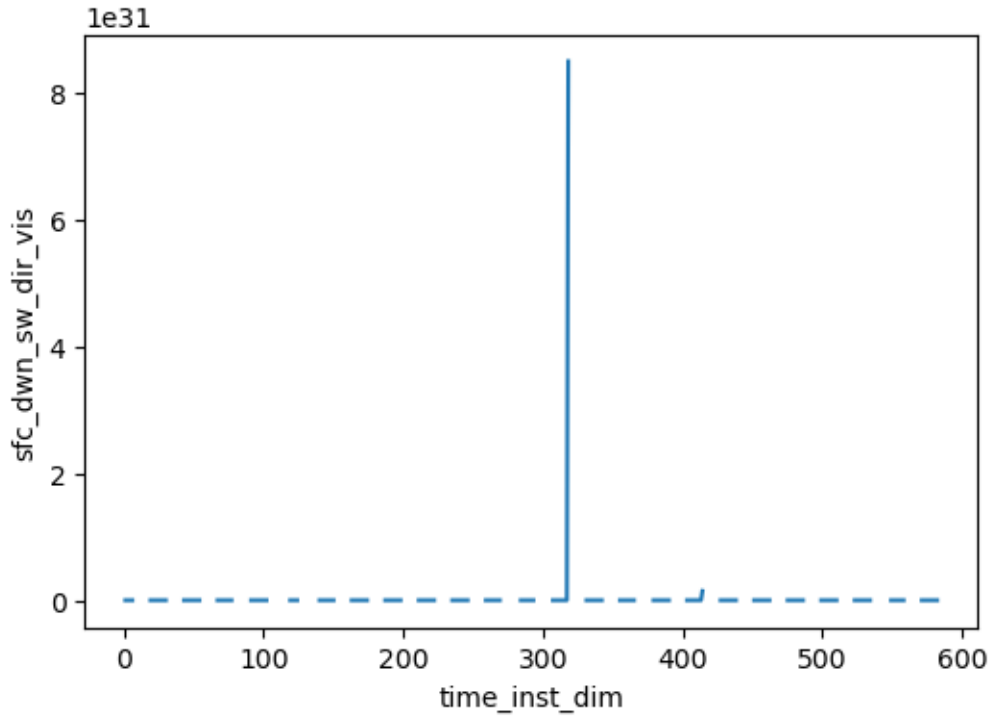
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sfc\_dwn\_sw\_dir\_nir : max\_re inf , std err = nan , mean absolute error  
19.043679424894957



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sfc\_dwn\_sw\_dif\_nir : max\_re 7.033625602722168 , std err = 0.0025658812247166016  
, mean absolute error 16.98546481092437

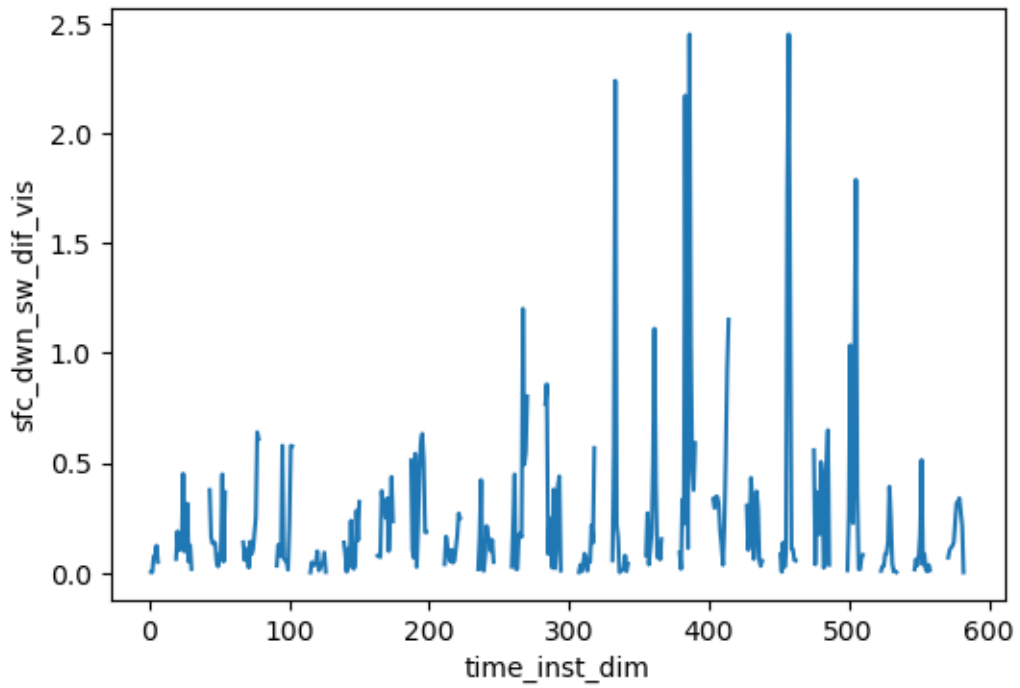


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sfc\_dwn\_sw\_dir\_vis : max\_re inf , std err = nan , mean absolute error  
19.219022452731092

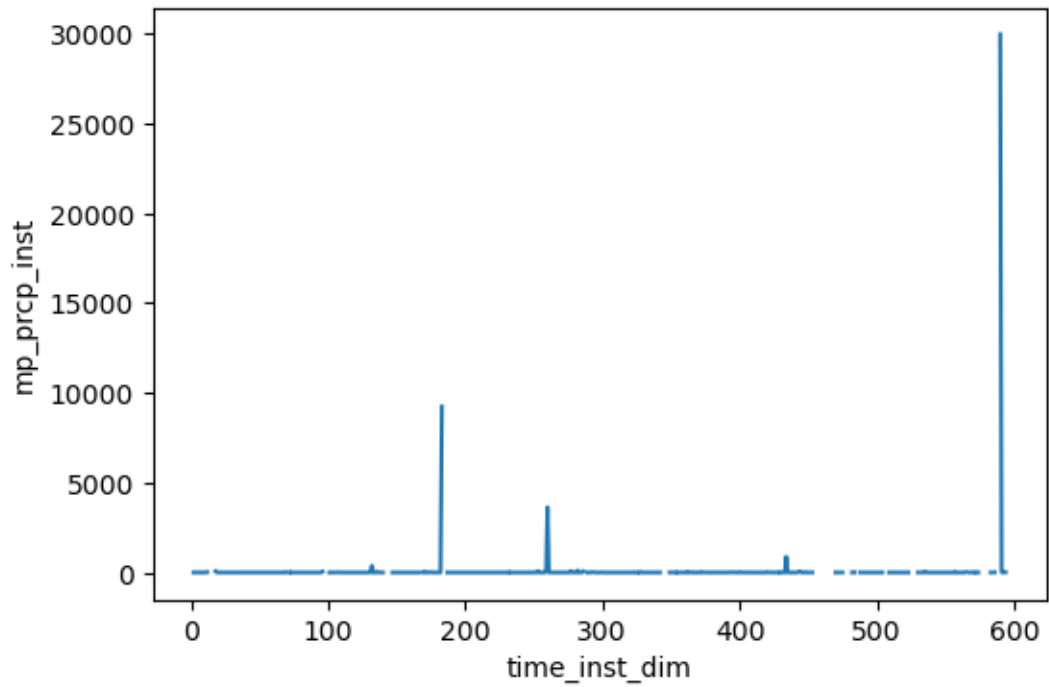


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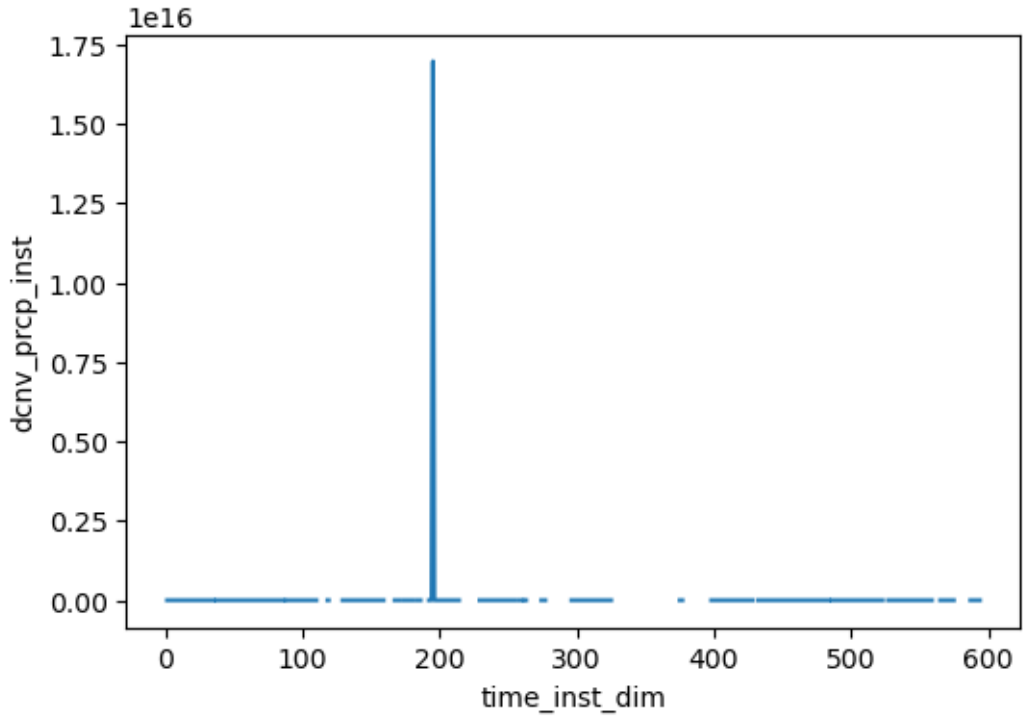
`sfc_dwn_sw_dif_vis` : max\_re 2.4513742923736572 , std err = 0.0012253015017022891 , mean absolute error 17.63433232668067



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mp\_prpcp\_inst : max\_re inf , std err = nan , mean absolute error  
5.644074633341877e-06

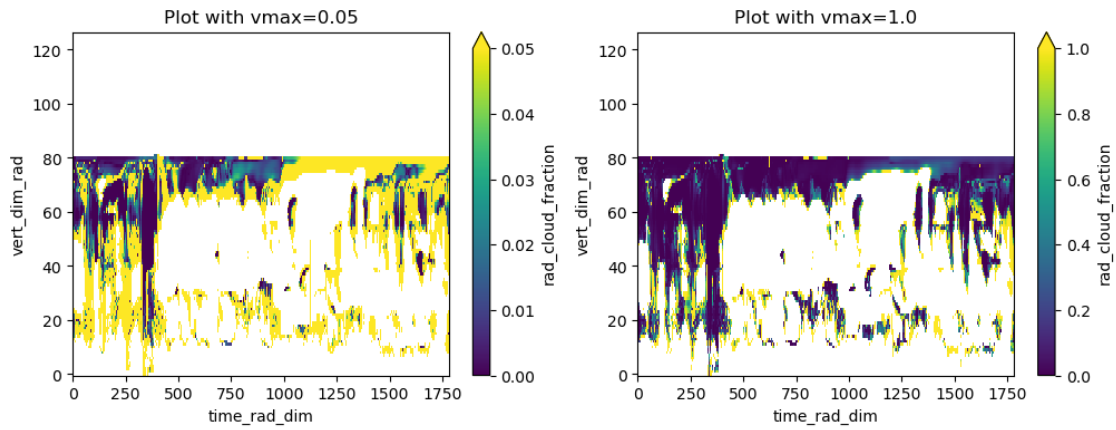


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dcnv\_prpcp\_inst : max\_re inf , std err = nan , mean absolute error  
2.2667885891028814e-05



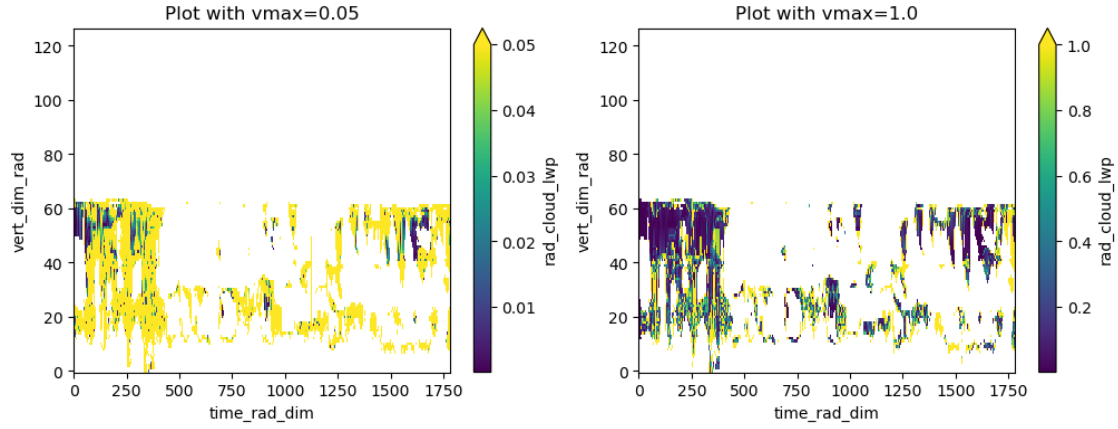

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rad\_cloud\_fraction : max\_re inf , std err = nan , mean absolute error  
0.03350477050828716



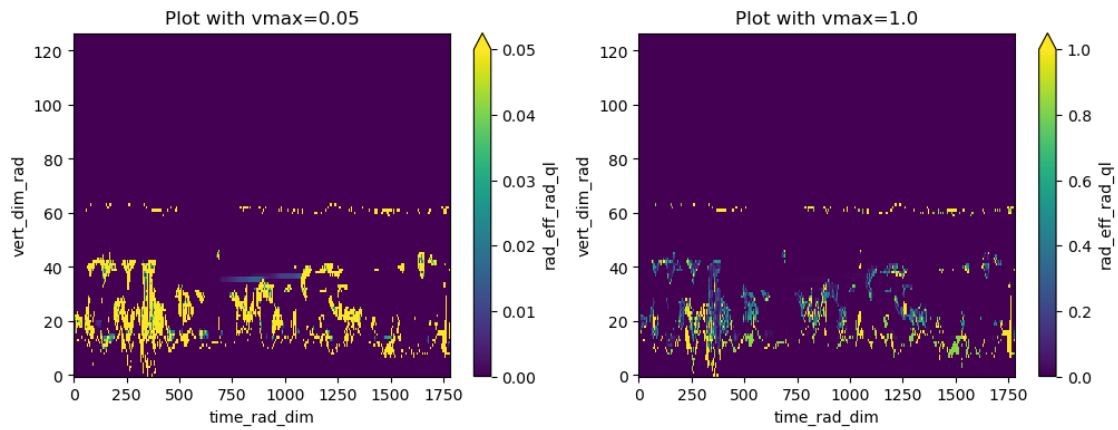

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rad\_cloud\_lwp : max\_re inf , std err = nan , mean absolute error  
0.7124807789177868




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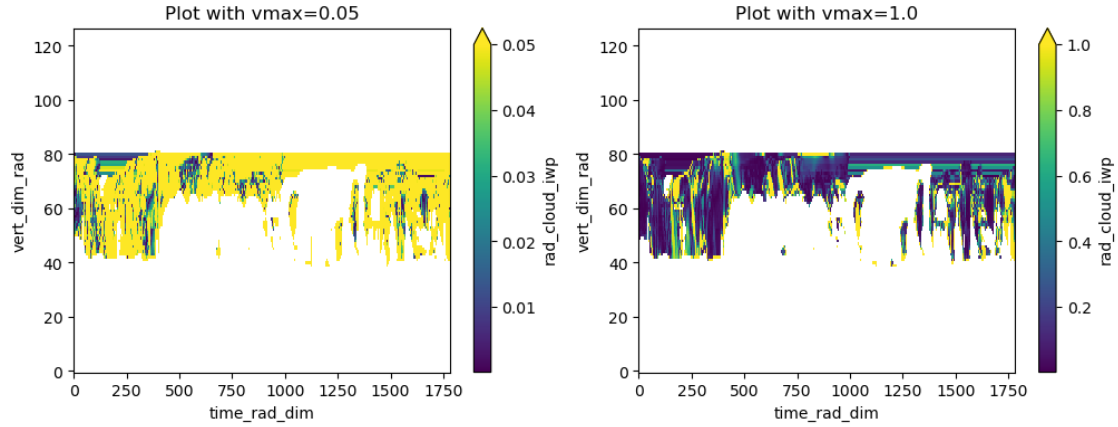
rad\_eff\_rad\_ql : max\_re 19.0 , std err = 2.1014071646943316e-06 , mean absolute error 0.38135735222964556




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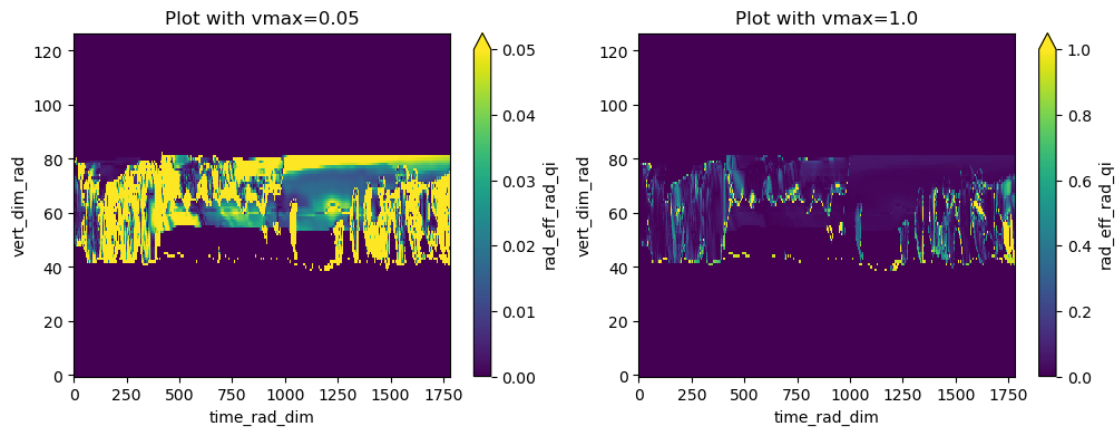
rad\_cloud\_iwp : max\_re inf , std err = nan , mean absolute error 0.16261789827960269





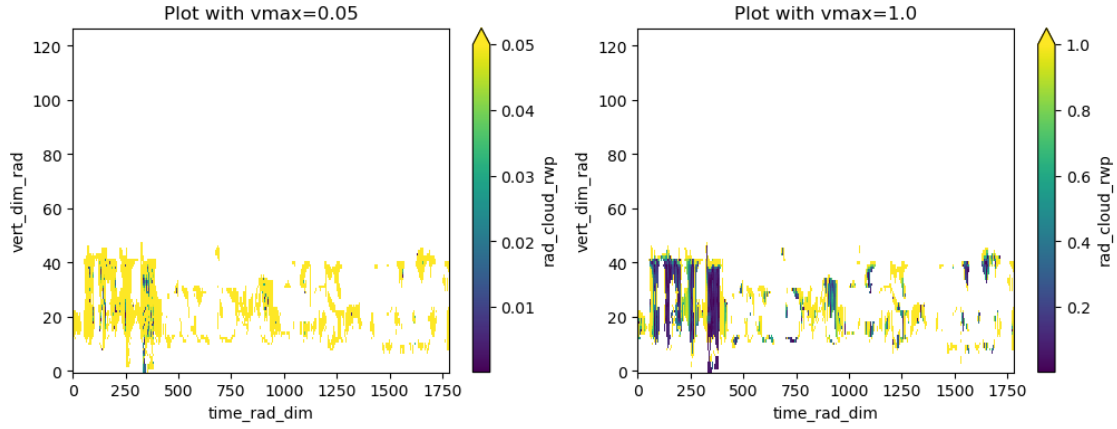

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rad\_eff\_rad\_qi : max\_re 11.500000953674316 , std err = 1.5938132259936902e-06 ,  
 mean absolute error 2.075641724550845



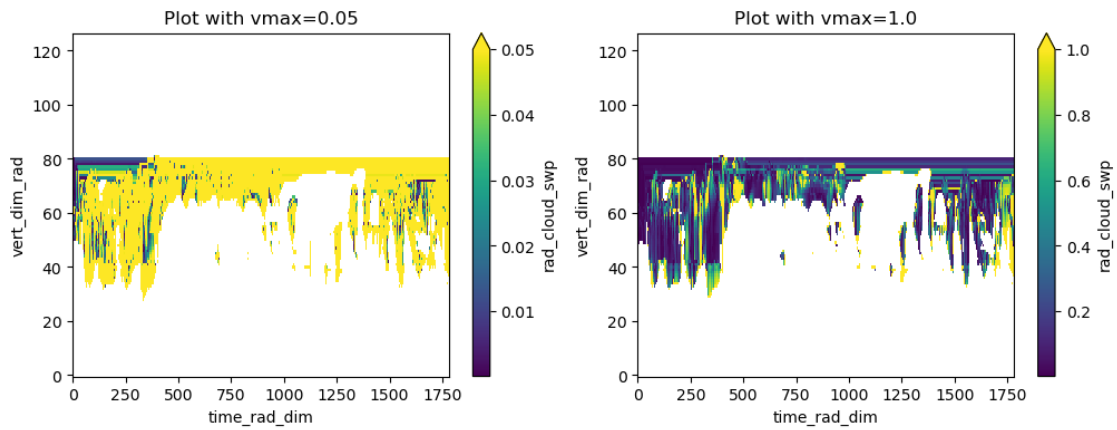

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rad\_cloud\_rwp : max\_re inf , std err = nan , mean absolute error  
 0.08626846646142086



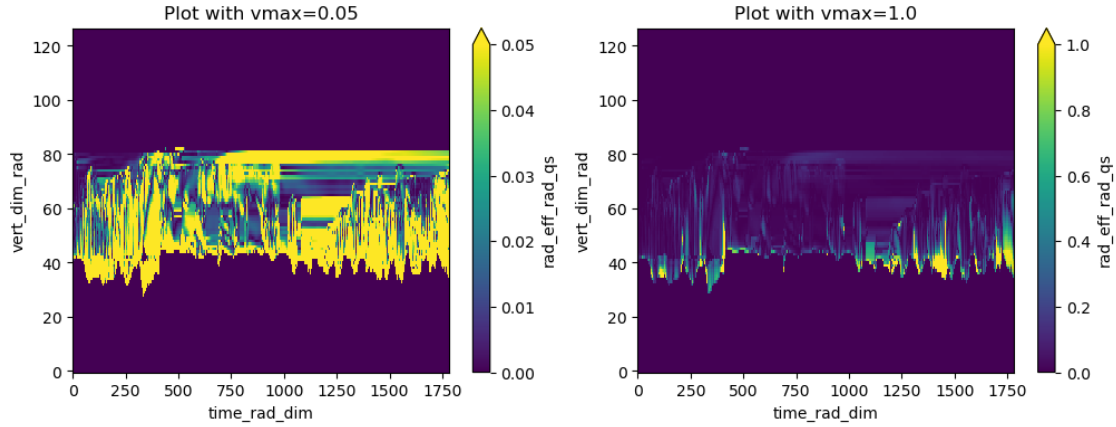

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rad\_cloud\_swp : max\_re inf , std err = nan , mean absolute error  
0.1535569427322216



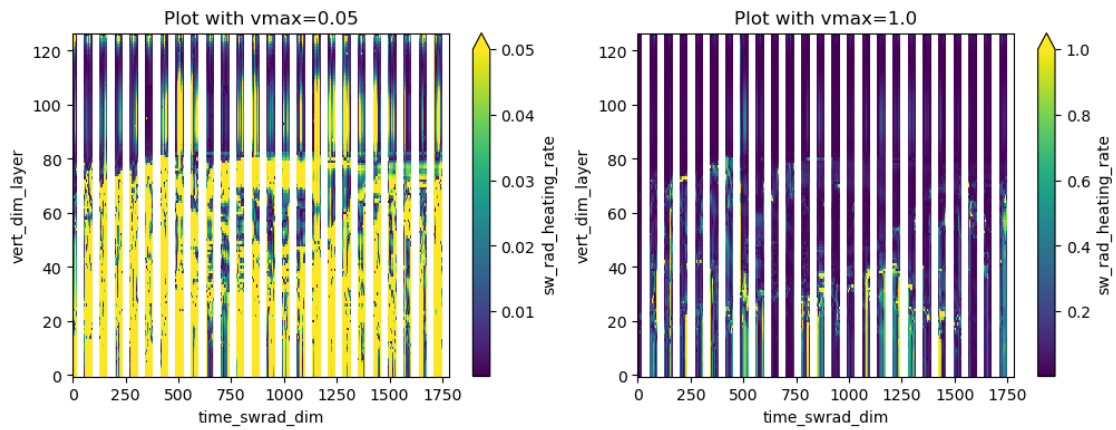

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rad\_eff\_rad\_qs : max\_re 103.2898941040039 , std err = 4.341755934199931e-06 ,  
mean absolute error 4.280255529927446



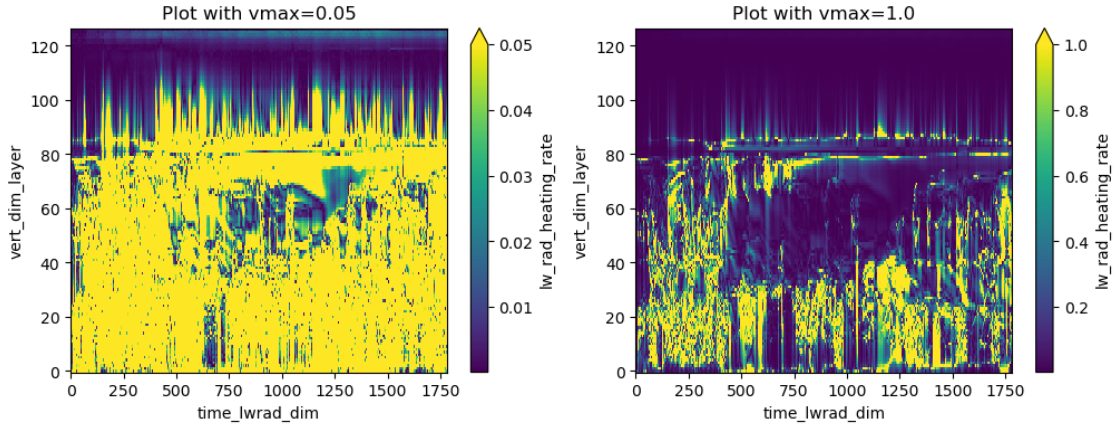
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sw\_rad\_heating\_rate : max\_re 28.009702682495117 , std err =  
 3.5491400575024603e-06 , mean absolute error 1.5837005526926983e-06



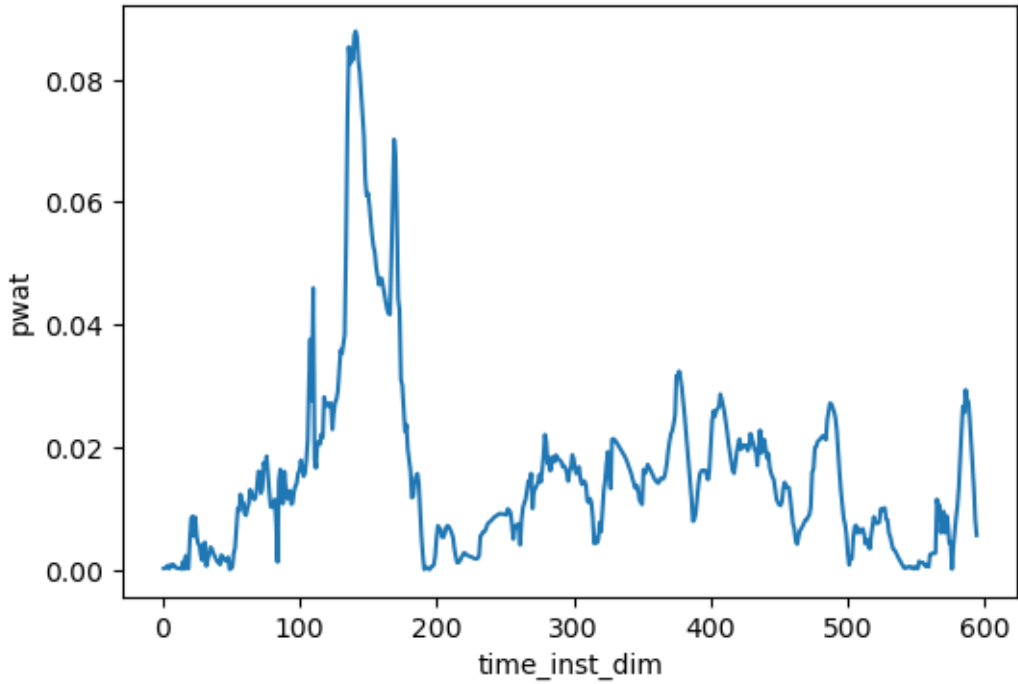
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lw\_rad\_heating\_rate : max\_re 90545.171875 , std err = 0.0014215747126624264 ,  
 mean absolute error 6.6963111210087665e-06



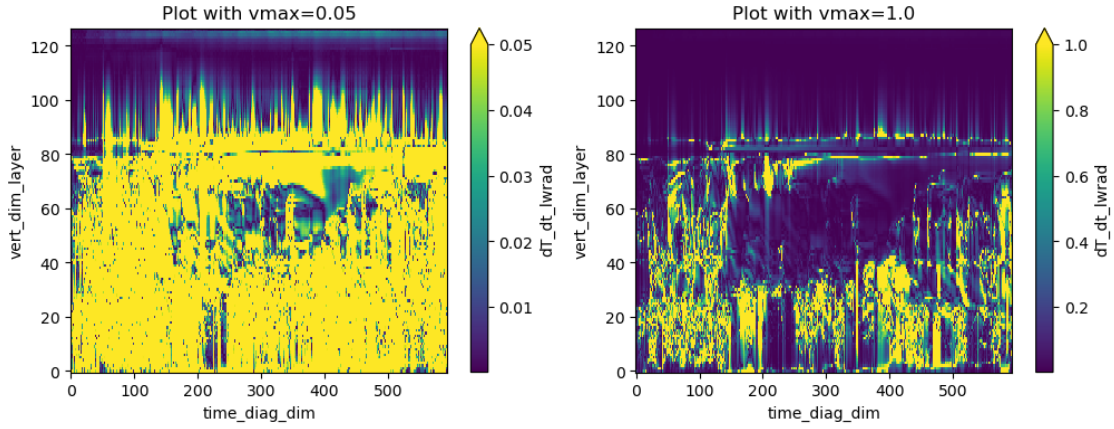
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pwat : max\_re 0.08786547183990479 , std err = 2.5860694008142458e-05 , mean absolute error 0.8552838493795956



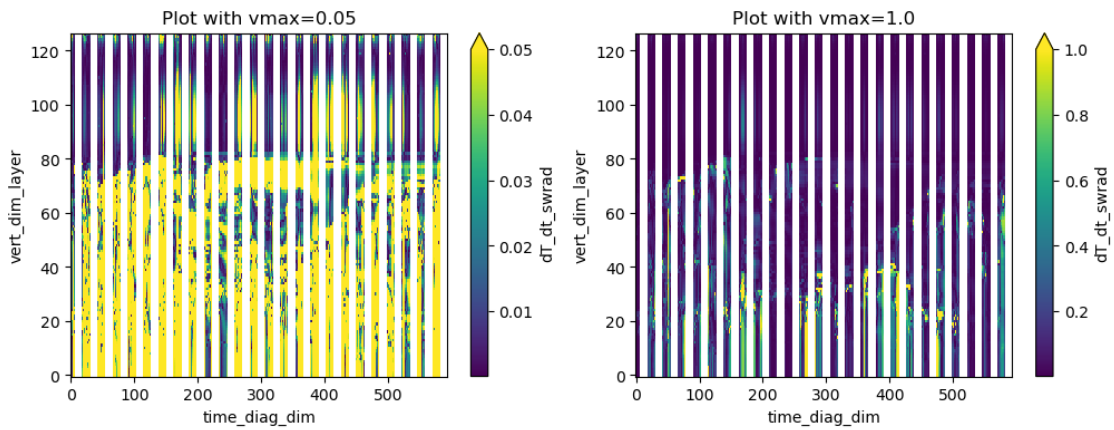
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dT\_dt\_lwrad : max\_re 16655.00390625 , std err = 0.0010409729235302293 , mean absolute error 6.25372212683871e-06



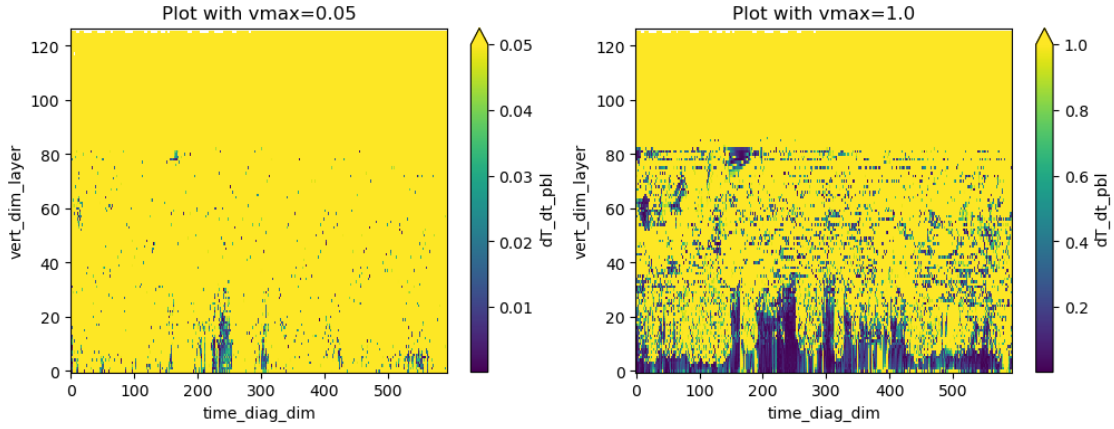
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dT\_dt\_swrad : max\_re 21.518775939941406 , std err = 9.994170891312614e-06 , mean absolute error 1.4865794688824293e-06



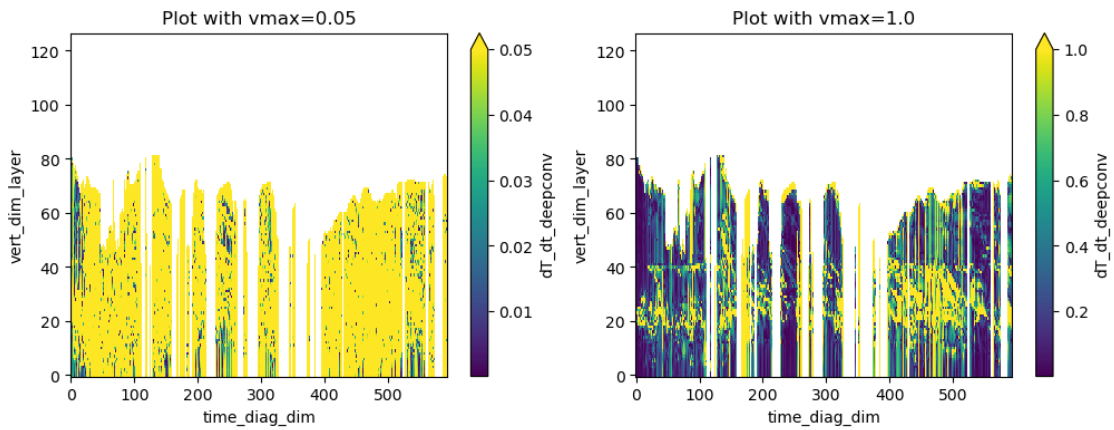
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dT\_dt\_pbl : max\_re 8955309.0 , std err = 0.5998448707611809 , mean absolute error 7.875594156266725e-06



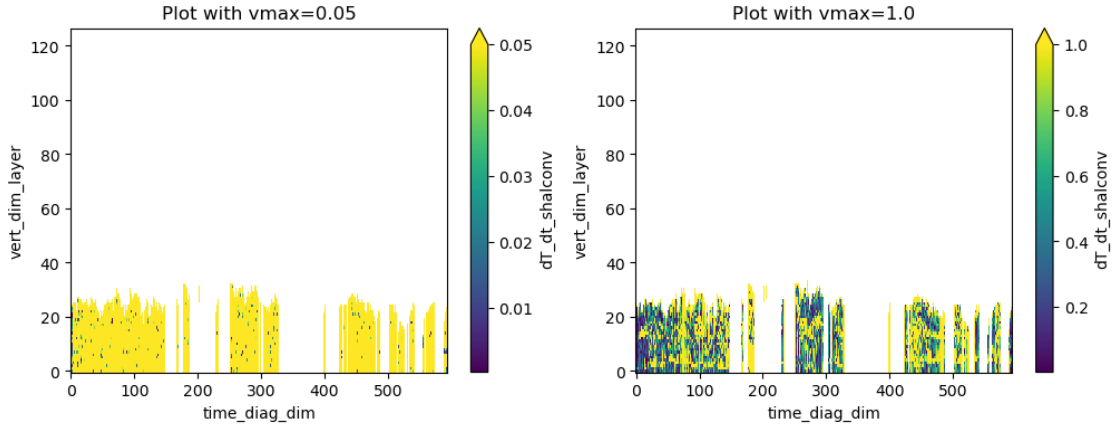

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dt\_dt\_deepconv : max\_re inf , std err = nan , mean absolute error  
 1.610727071755764e-05



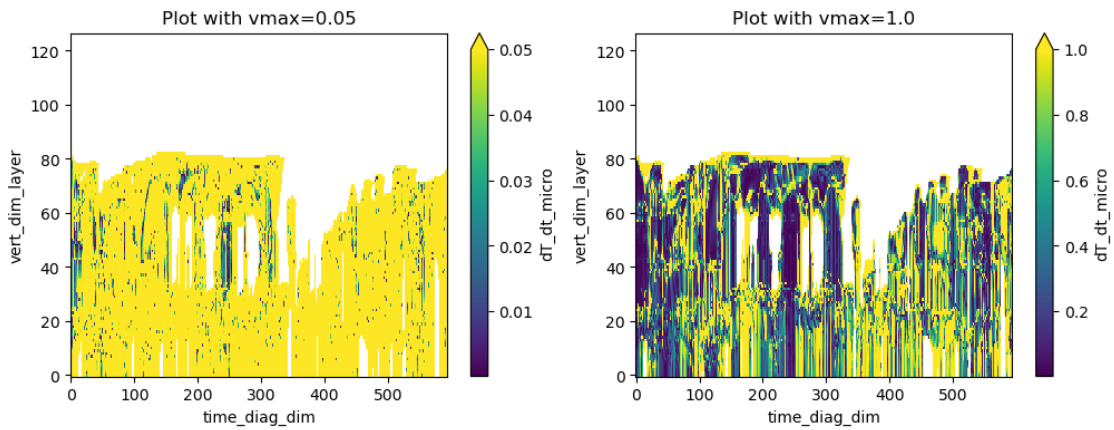

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dt\_dt\_shalconv : max\_re inf , std err = nan , mean absolute error  
 1.0532676745372535e-05



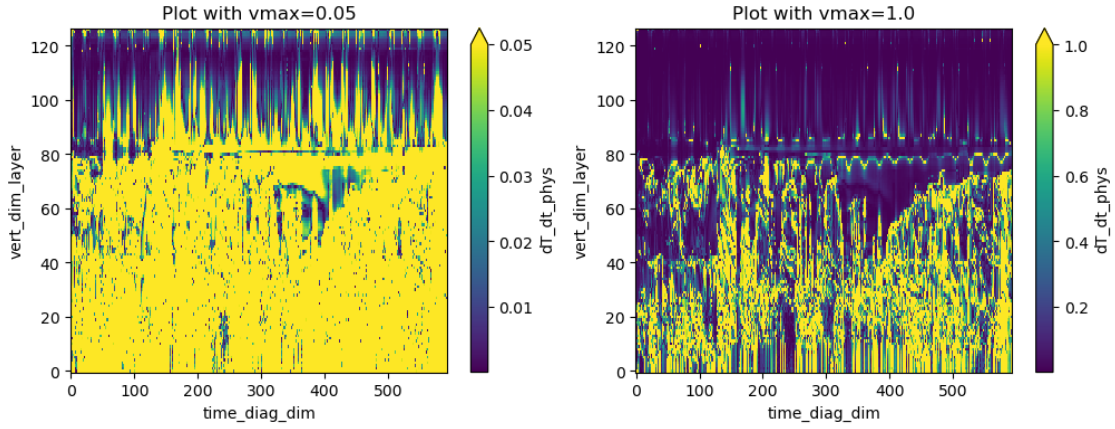

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dT\_dt\_micro : max\_re inf , std err = nan , mean absolute error  
1.577859579838897e-05



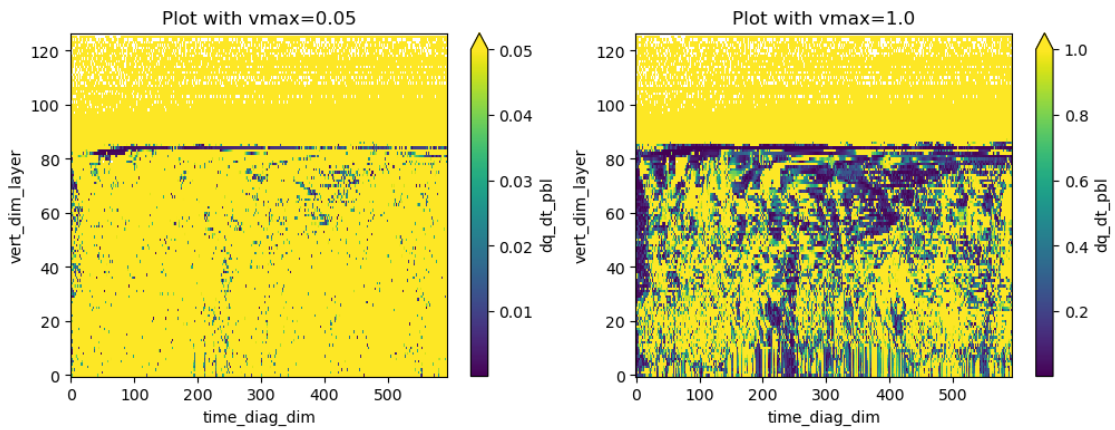

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dT\_dt\_phys : max\_re 179385.28125 , std err = 0.008765806388607201 , mean  
absolute error 2.1859062840265454e-05




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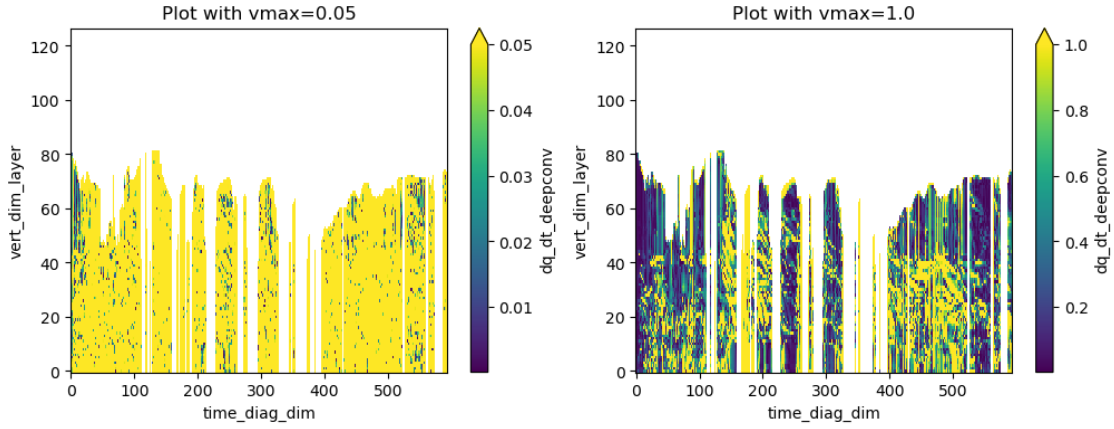
dq\_dt\_pbl : max\_re inf , std err = nan , mean absolute error  
 1.2710485883431829e-08




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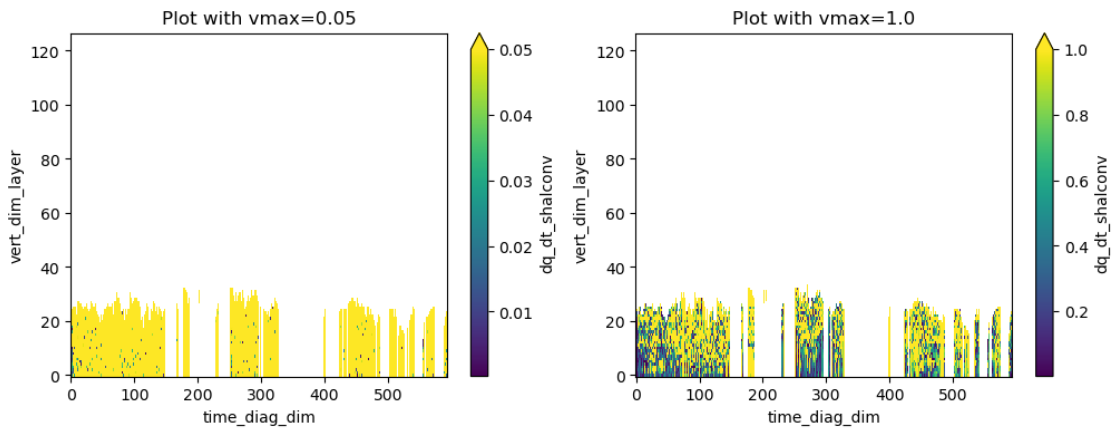
dq\_dt\_deepconv : max\_re inf , std err = nan , mean absolute error  
 8.713803658384214e-09





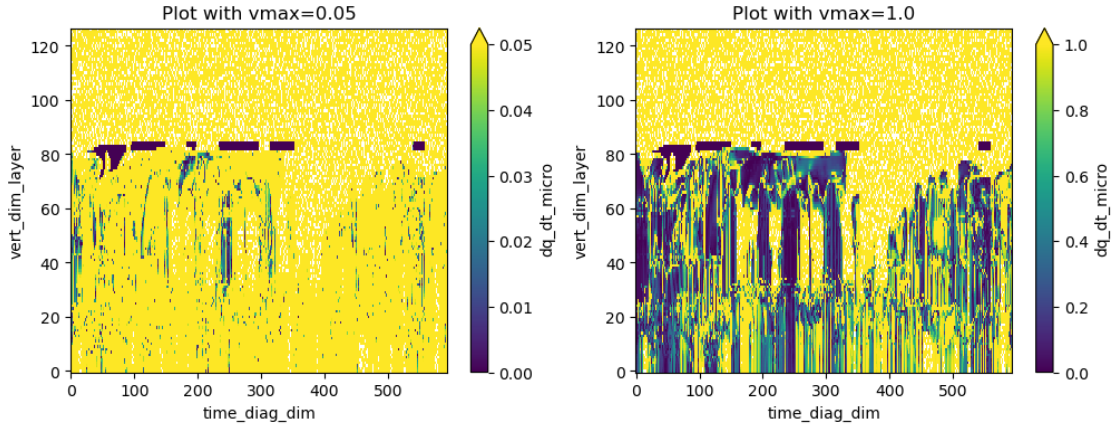

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dq\_dt\_shalconv : max\_re inf , std err = nan , mean absolute error  
1.158518406819961e-08



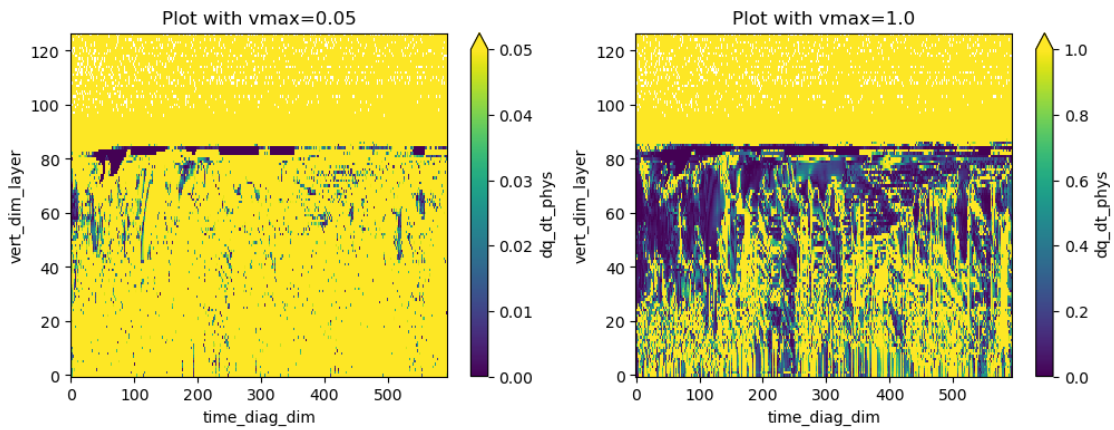

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dq\_dt\_micro : max\_re inf , std err = nan , mean absolute error  
6.196945387666718e-09



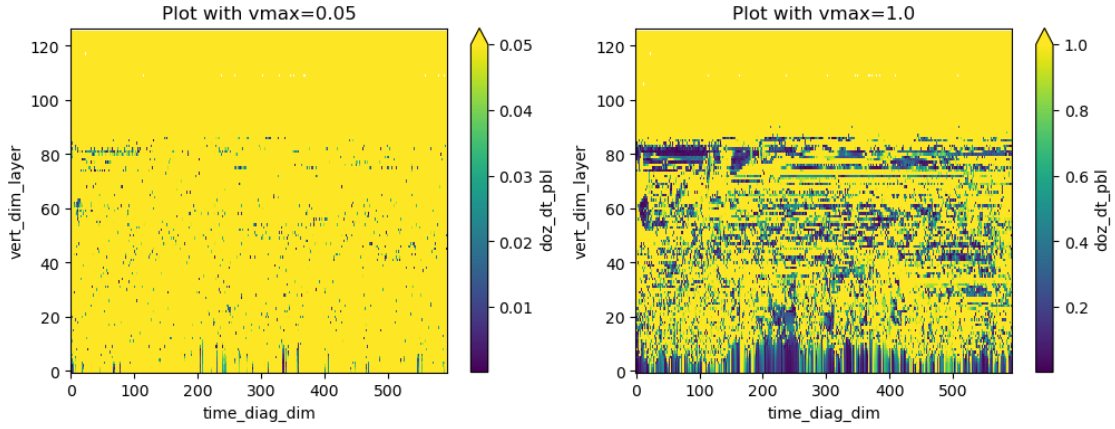
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dq\_dt\_phys : max\_re inf , std err = nan , mean absolute error  
2.116407958482071e-08



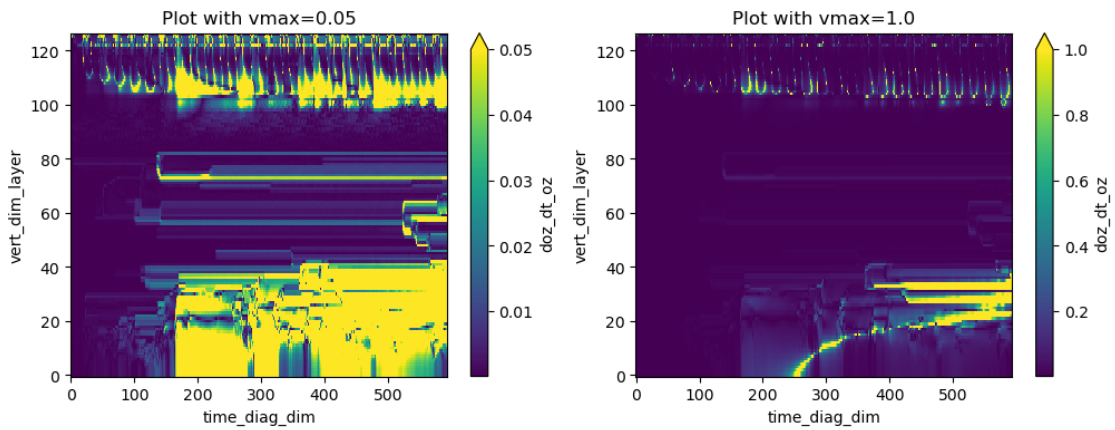
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doz\_dt\_pbl : max\_re 3649143.75 , std err = 0.23331861821660094 , mean absolute  
error 3.1348237190424038e-15



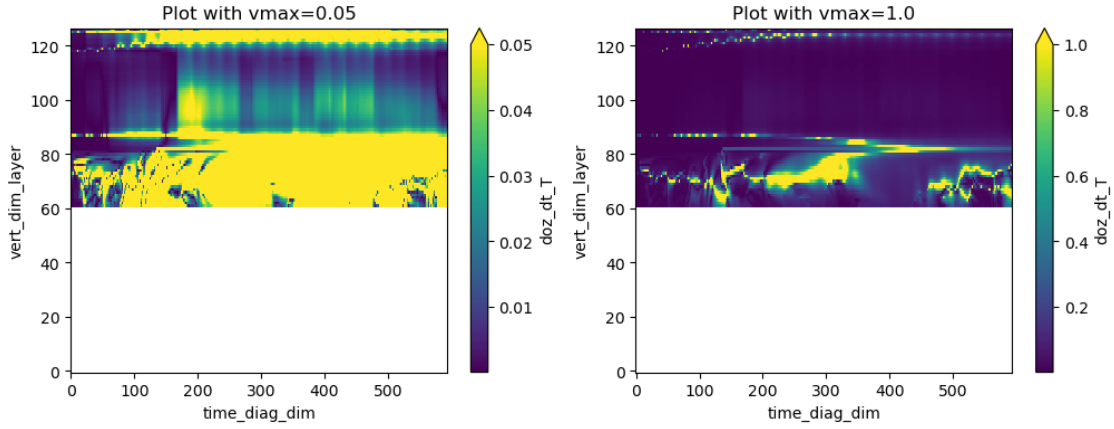

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doz\_dt\_oz : max\_re 3777.971435546875 , std err = 0.00026280330244419467 , mean absolute error 5.24915081104388e-15



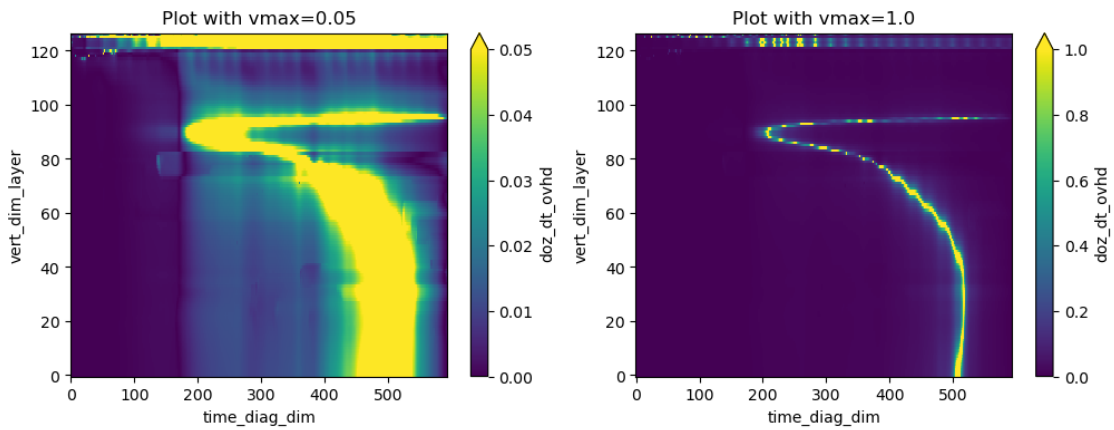

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doz\_dt\_T : max\_re 2958.8671875 , std err = 0.00045490941153826877 , mean absolute error 2.976681619363593e-14



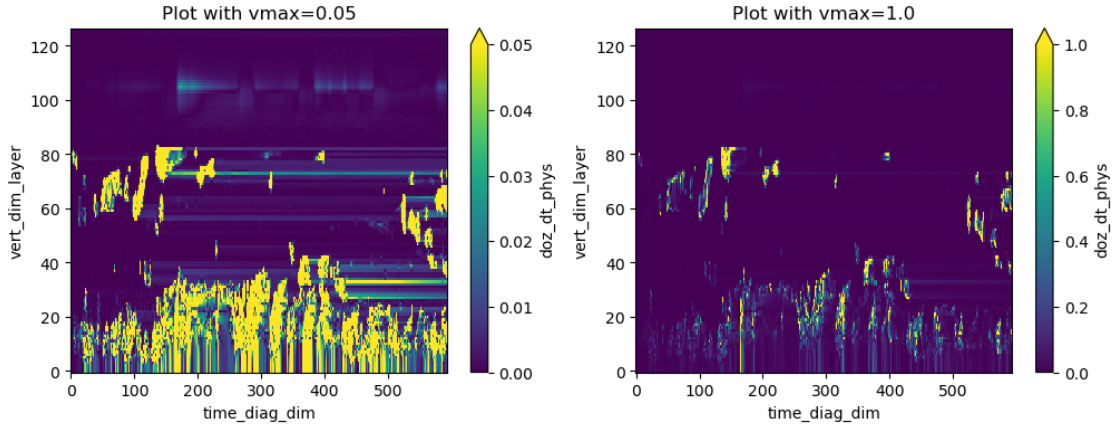
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doz\_dt\_ovhd : max\_re 11826.736328125 , std err = 0.0005711107176407489 , mean absolute error 6.878066226950927e-15



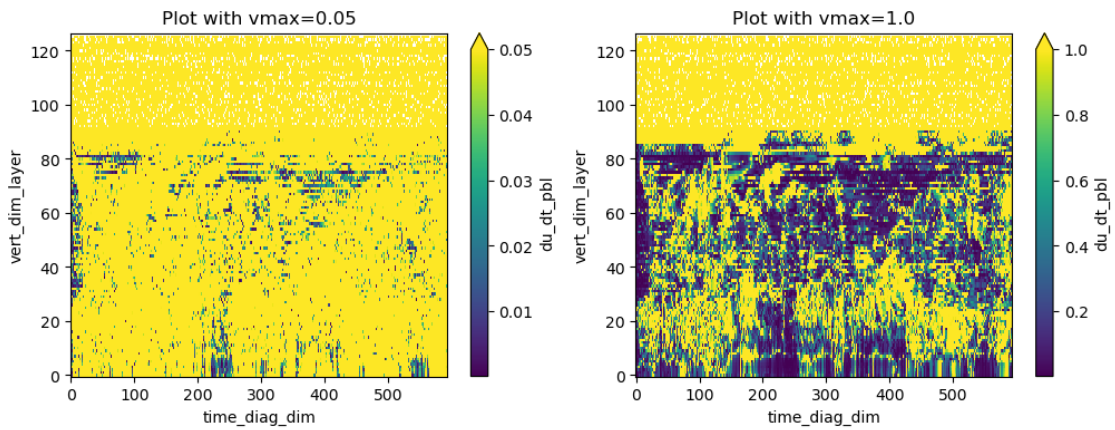
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doz\_dt\_phys : max\_re 16463.7734375 , std err = 0.0007994251377133323 , mean absolute error 2.955132360878783e-14



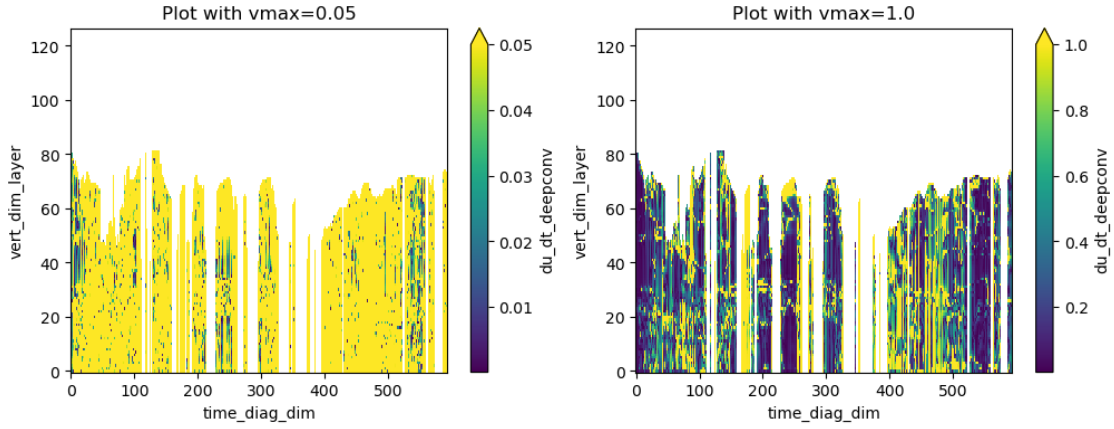

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du\_dt\_pbl : max\_re inf , std err = nan , mean absolute error  
 9.89542267488717e-06



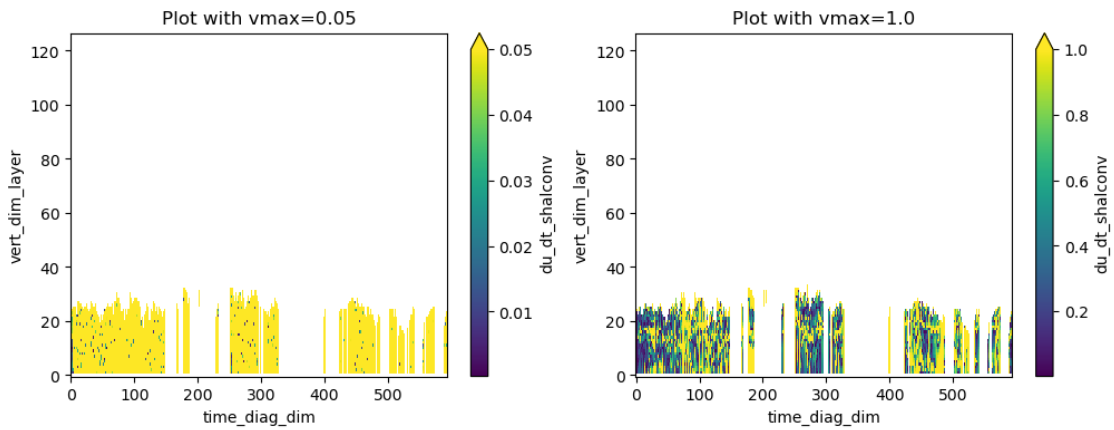

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du\_dt\_deepconv : max\_re inf , std err = nan , mean absolute error  
 1.1288567272519922e-05



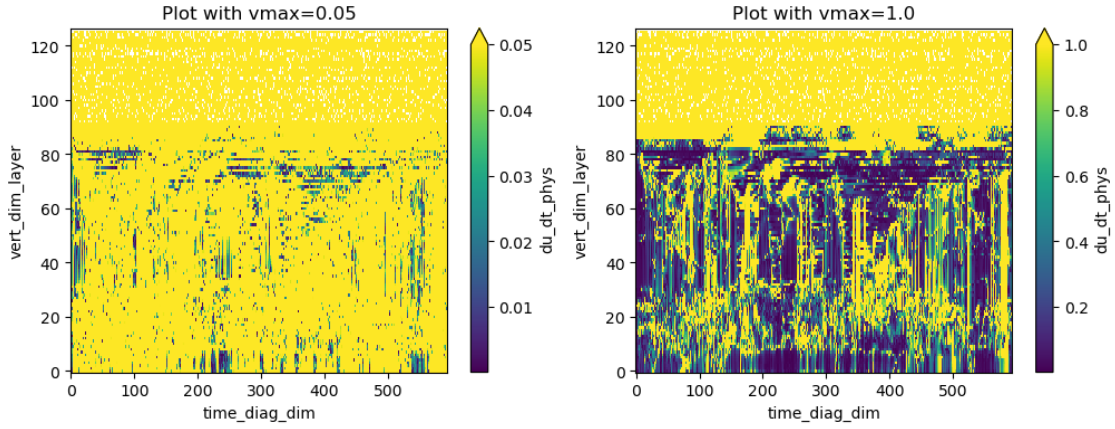

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du\_dt\_shalconv : max\_re inf , std err = nan , mean absolute error  
1.2377573951481098e-05



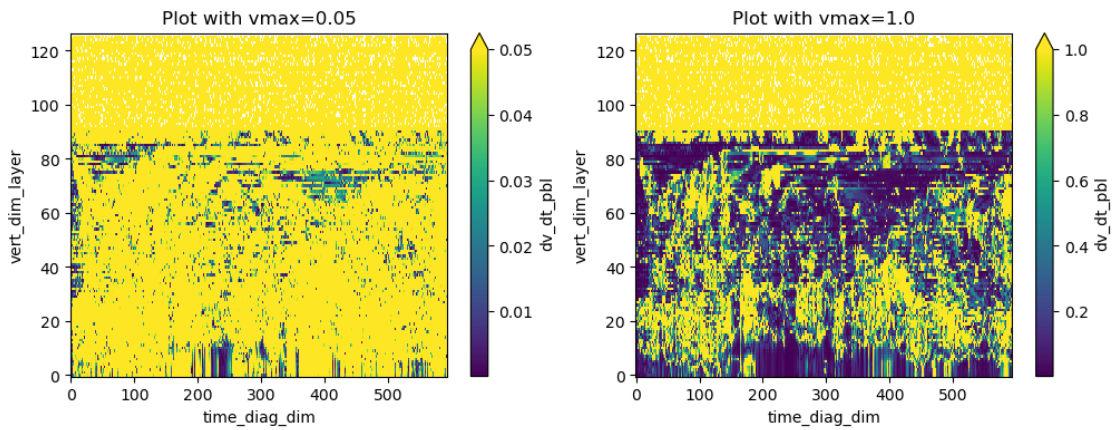

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du\_dt\_phys : max\_re inf , std err = nan , mean absolute error  
2.3970208822497288e-05



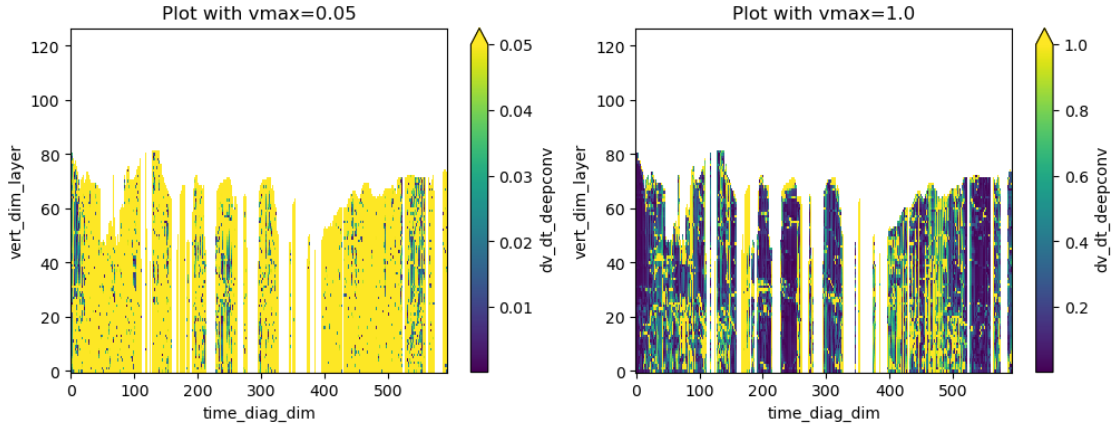

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dv\_dt\_pbl : max\_re inf , std err = nan , mean absolute error  
4.160723490522745e-06



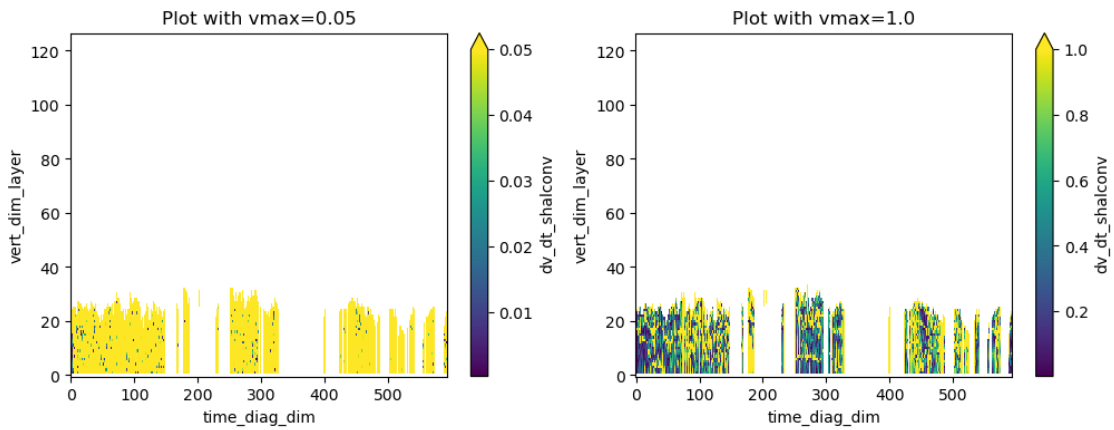

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dv\_dt\_deepconv : max\_re inf , std err = nan , mean absolute error  
5.594073450860209e-06




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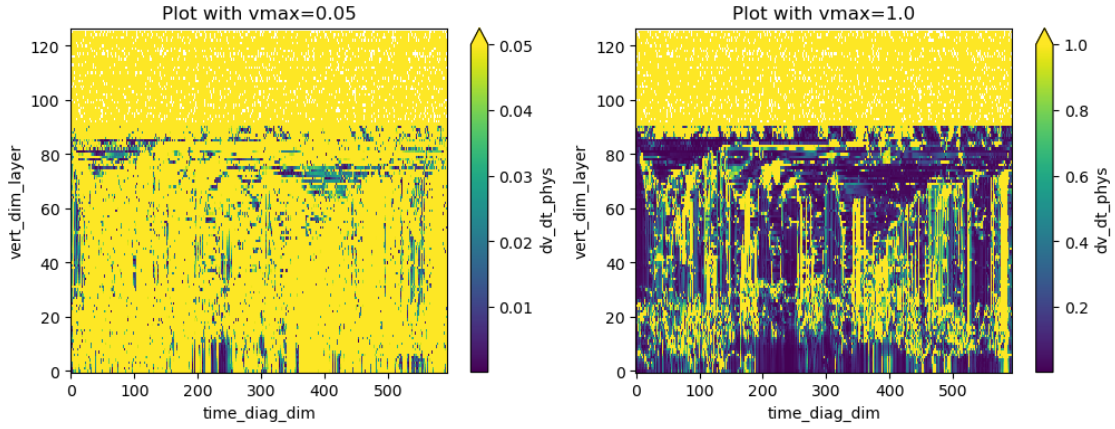
dv\_dt\_shalconv : max\_re inf , std err = nan , mean absolute error  
3.443534343454206e-06




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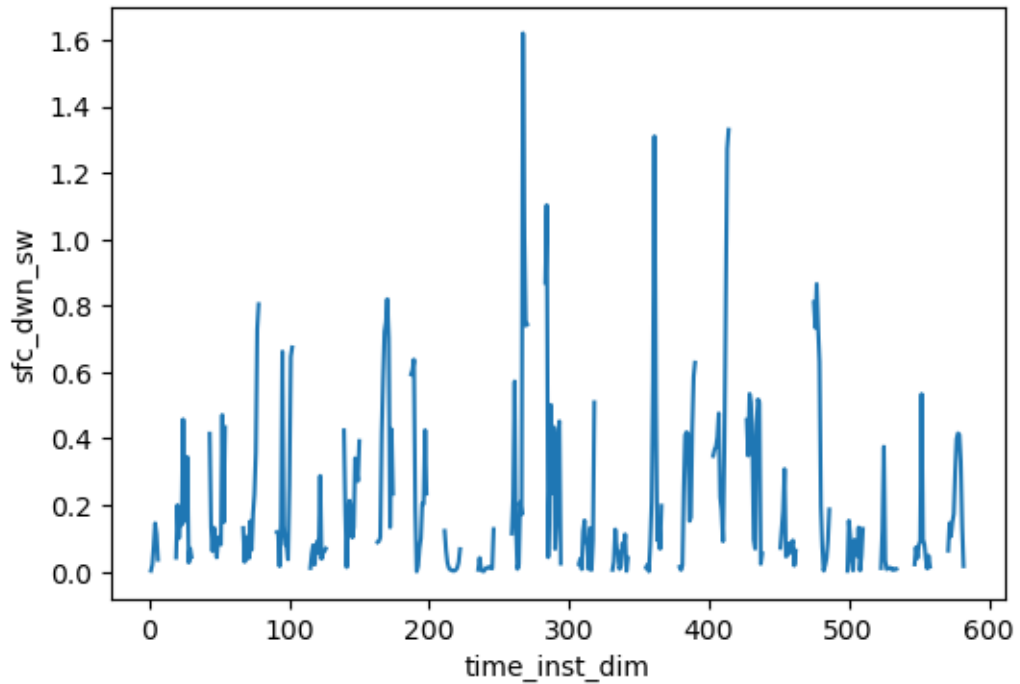
dv\_dt\_phys : max\_re inf , std err = nan , mean absolute error  
1.0042063943837682e-05





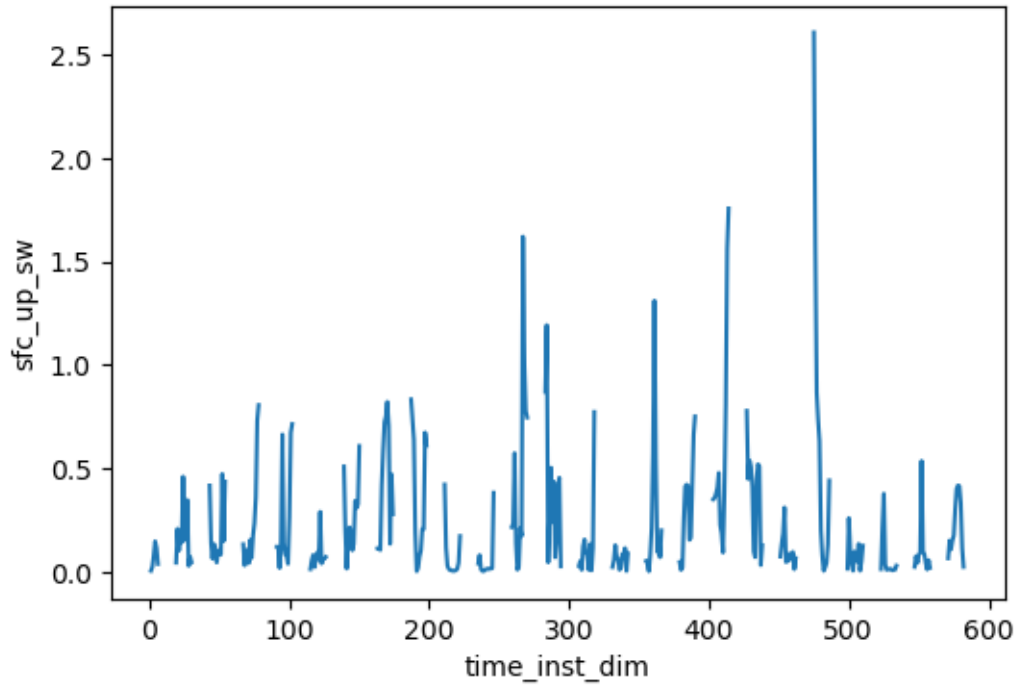
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sfc\_dwn\_sw : max\_re 1.6196235418319702 , std err = 0.0008910228403247132 , mean absolute error 36.95459558823529

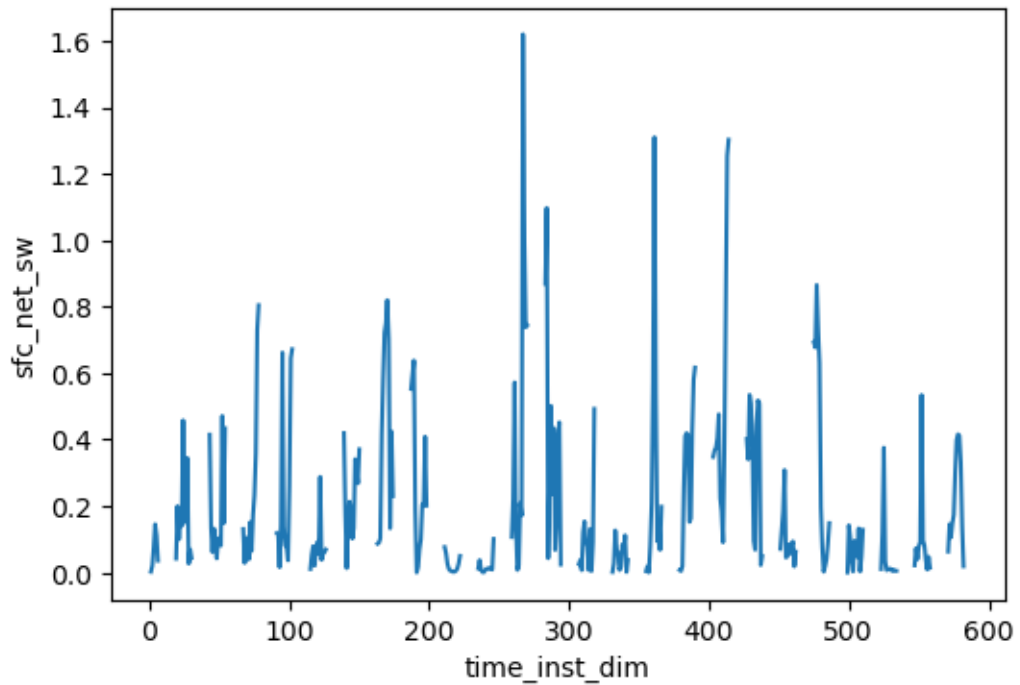


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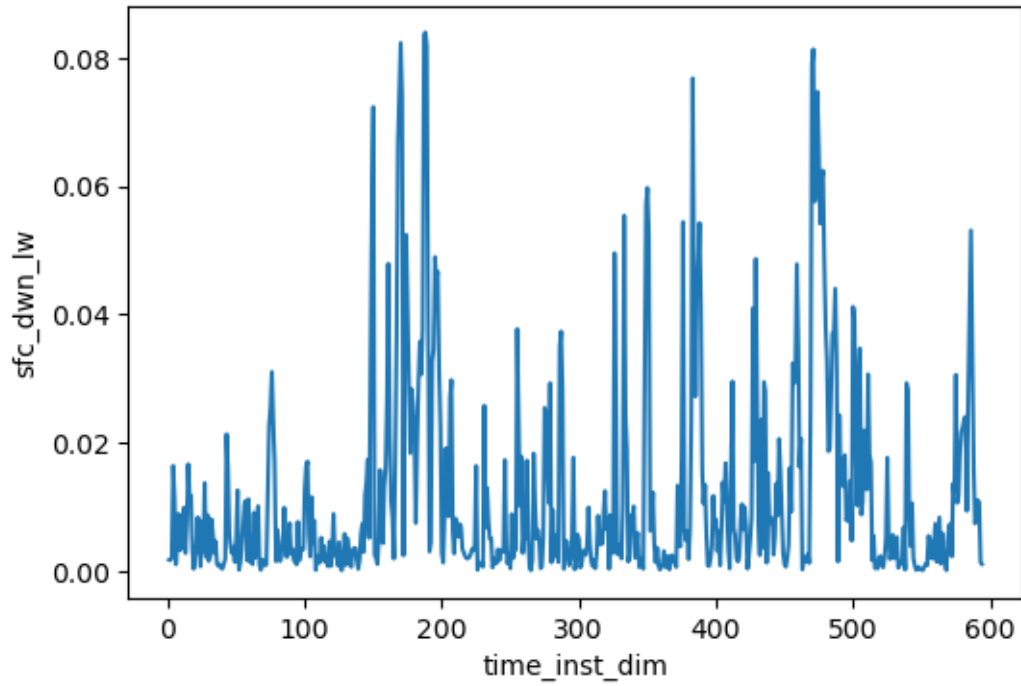
sfc\_up\_sw : max\_re 2.6082804203033447 , std err = 0.001096392569898748 , mean absolute error 2.4128058938419117



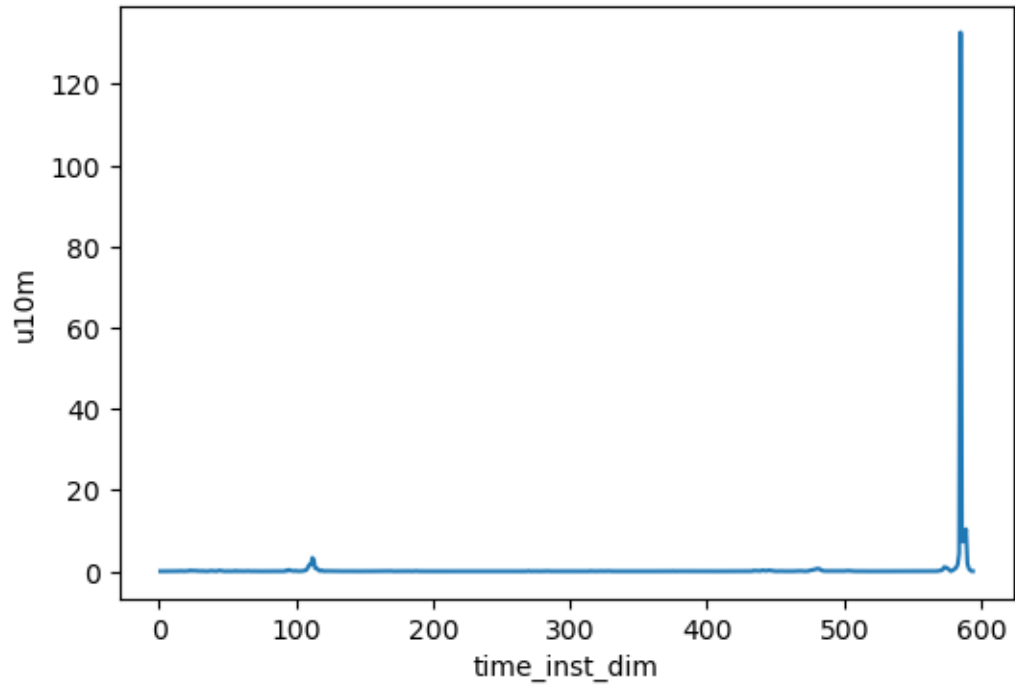
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sfc\_net\_sw : max\_re 1.6196236610412598 , std err = 0.0008829722599107392 , mean  
absolute error 34.54429162289916



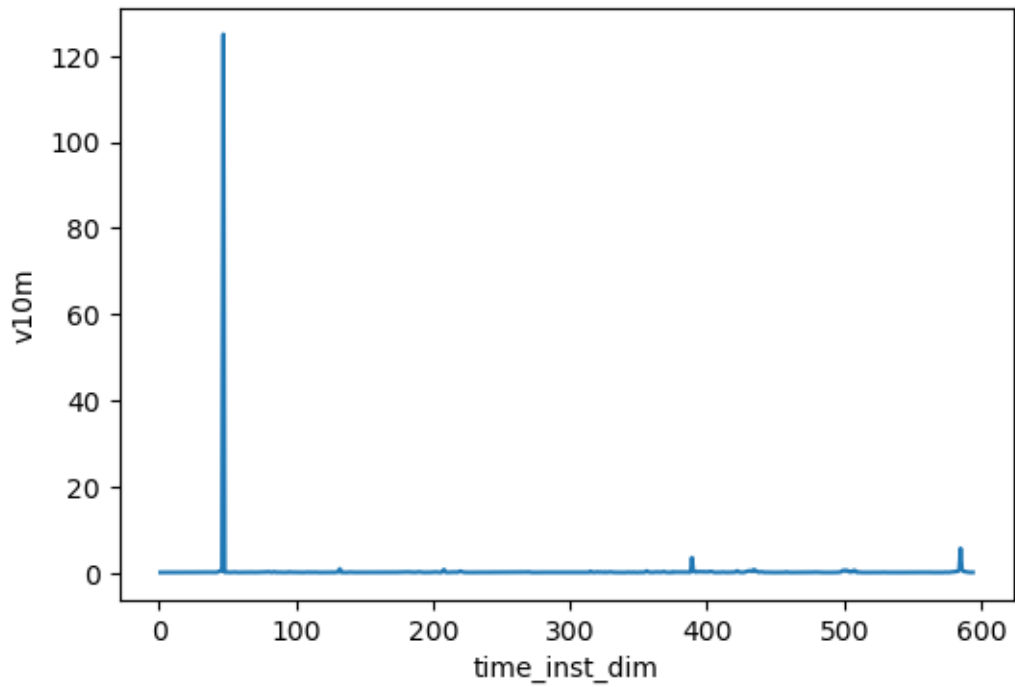
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sfc\_dwn\_lw : max\_re 0.08399560302495956 , std err = 2.7438127106488353e-05 ,  
mean absolute error 5.19552996980042



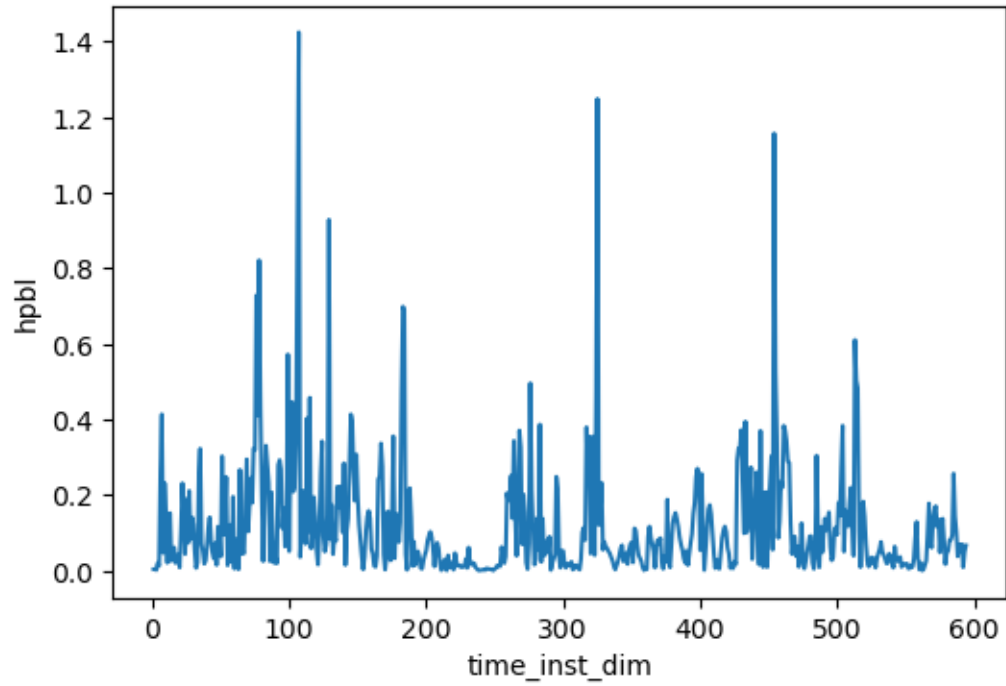
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u10m : max\_re 132.7131805419922 , std err = 0.009236599058414549 , mean absolute  
error 0.13741129386324843



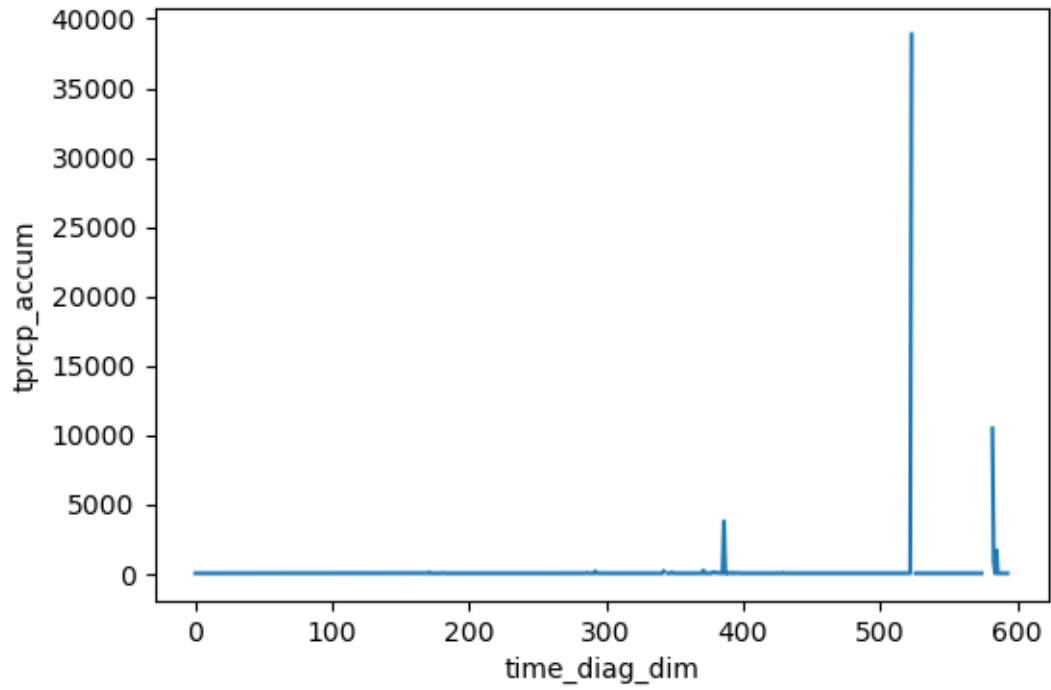
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v10m : max\_re 124.98046112060547 , std err = 0.008634175515736794 , mean  
absolute error 0.041491641517446824



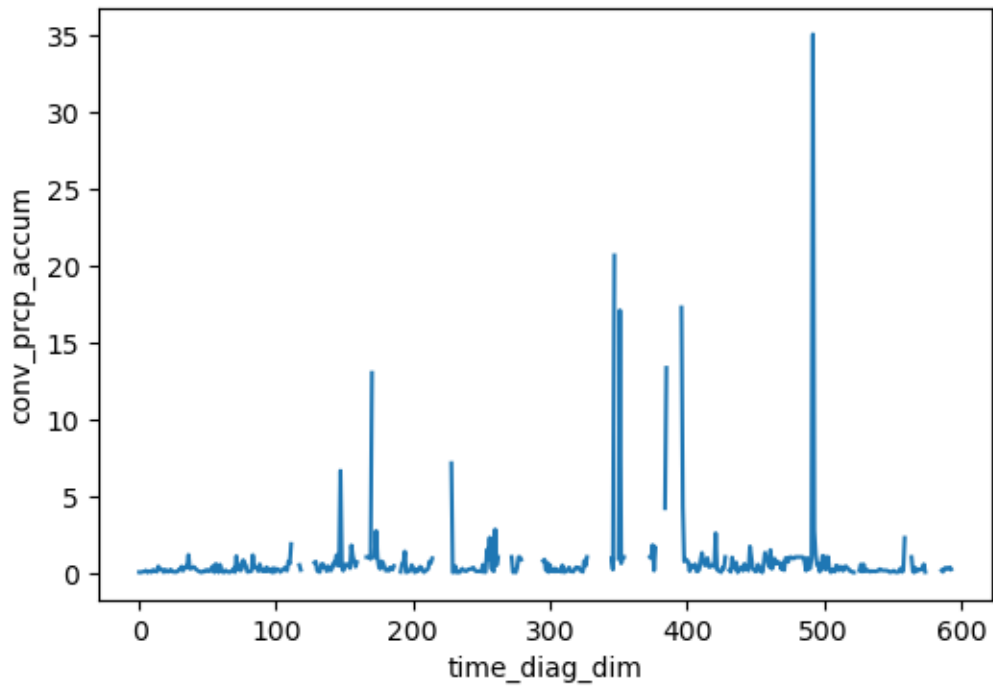
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hpbl : max\_re 1.4246442317962646 , std err = 0.0002597590237354189 , mean  
absolute error 75.47162552521009



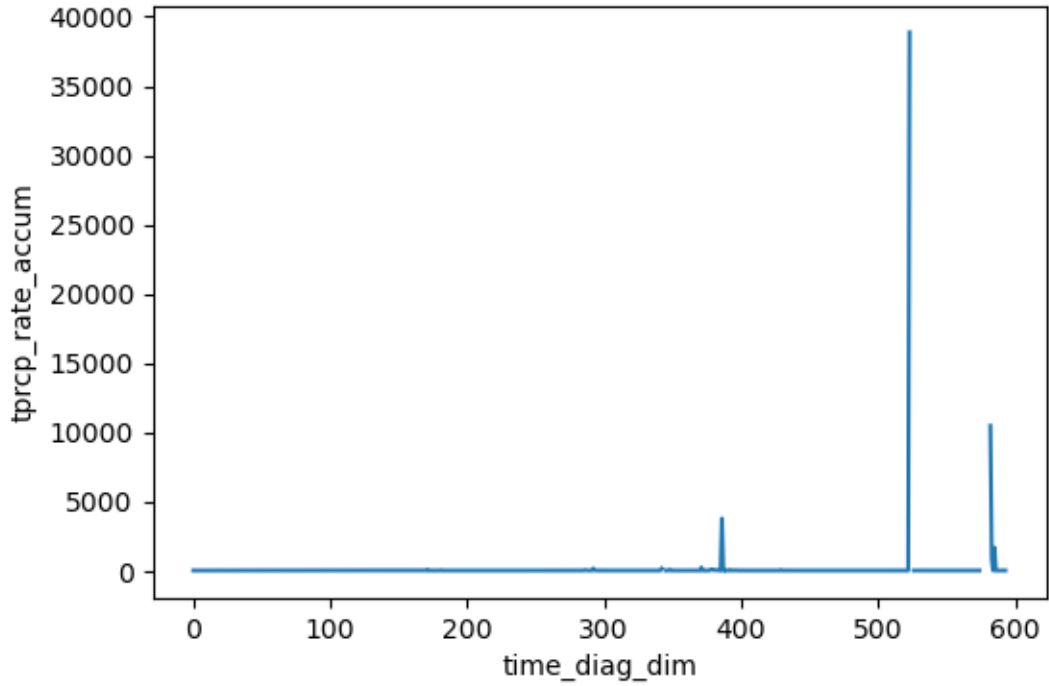
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tprcp\_accum : max\_re inf , std err = nan , mean absolute error  
1.5643406471218726e-05



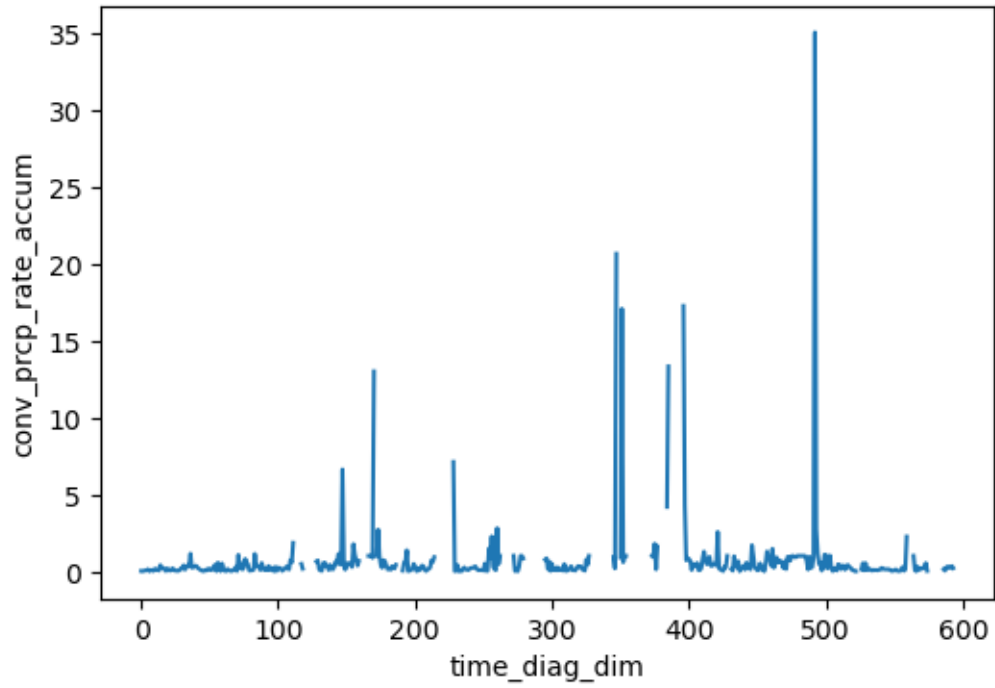
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conv\_prcp\_accum : max\_re inf , std err = nan , mean absolute error  
1.530922315889336e-05



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tprcp\_rate\_accum : max\_re inf , std err = nan , mean absolute error  
2.607234375122527e-08

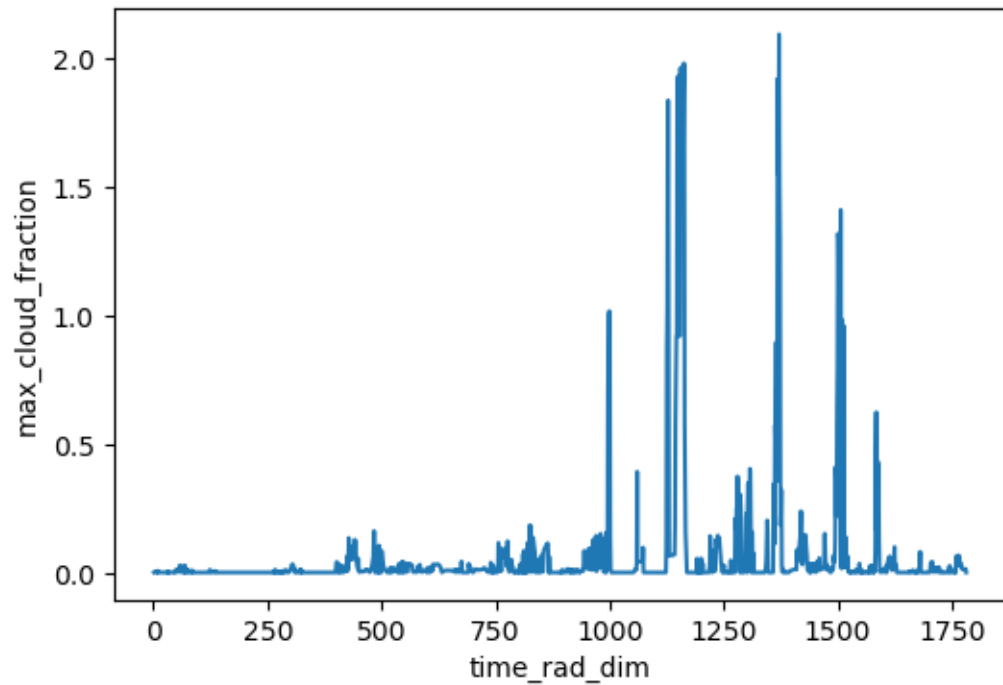


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conv\_prcp\_rate\_accum : max\_re inf , std err = nan , mean absolute error  
2.5515371645676907e-08



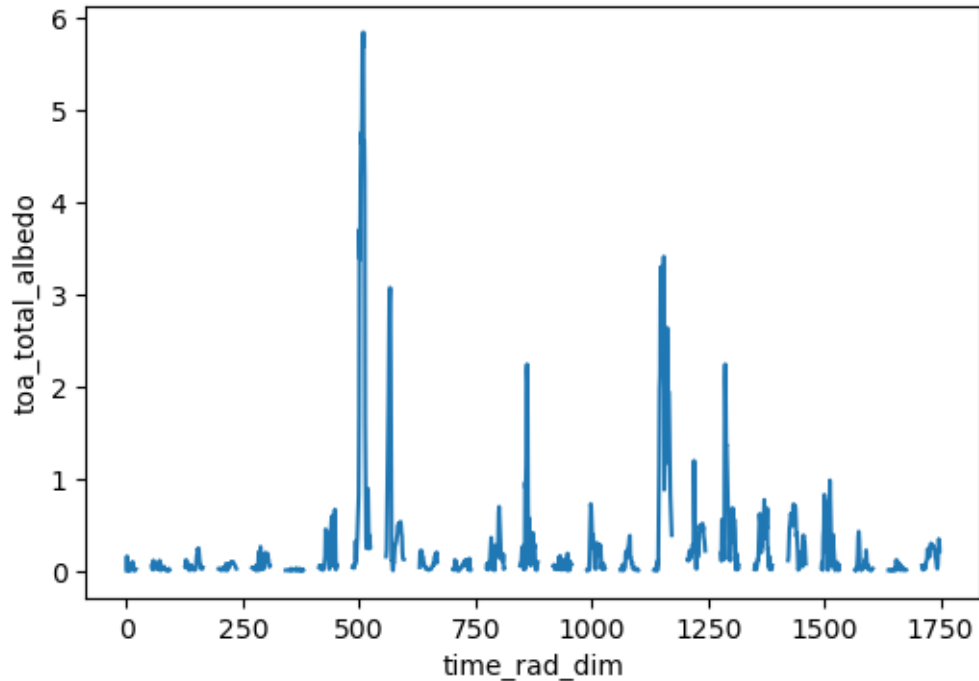
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max\_cloud\_fraction : max\_re 2.0907955169677734 , std err =  
0.00012703958620588677 , mean absolute error 0.03309135993589322





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toa\_total\_albedo : max\_re 5.836828708648682 , std err = 0.0007093815345126384 ,  
mean absolute error 0.033918706121134304



```
[ ]: # compare variables at initial timestep
for var in ds32.variables:
    if (not ds32[var].identical(ds64[var])):
        relative_err = calc_relative_error_t0(ds32, ds64, var)
        max_re = max(abs(relative_err.min().data), relative_err.max().data)
        if (max_re > .05):
            std_err = calc_std_error(relative_err.std(), relative_err.count())
            mean_absolute_err = calc_mean_absolute_error_t0(ds32, ds64, var)
            print_error(var, max_re, std_err.data, mean_absolute_err.data)
            plot_relative_error_t0(relative_err)
            #sys.exit()
```