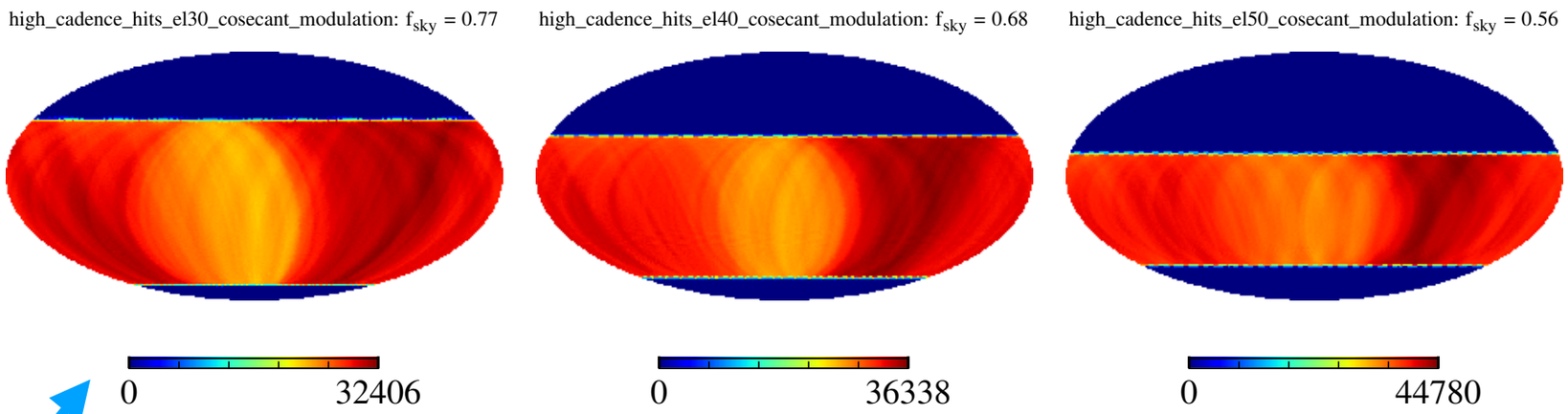
DRAFT tool update: Including galactic emission

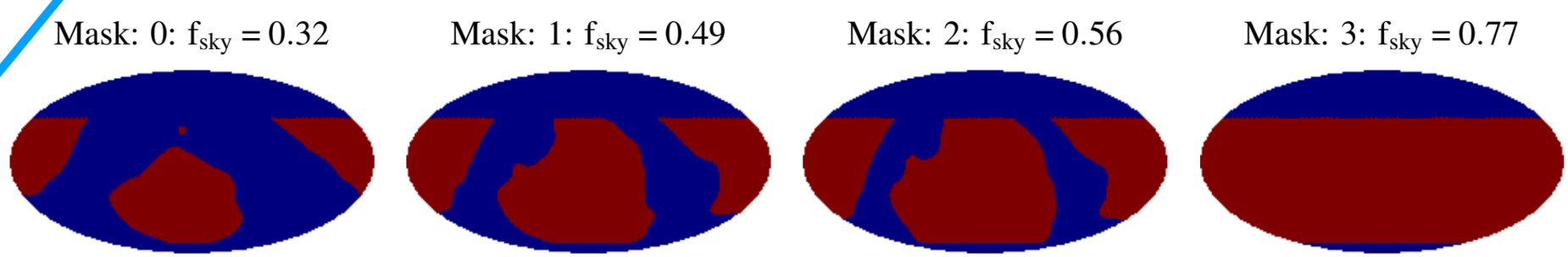
(Srinivasan Raghunathan: 30 April, 2020)

- Plan is to compute and store the covariances for galactic emission for some set of masks and footprints.
- $C_\ell \in [\cancel{C_\ell^{\rm CMB}}, C_\ell^{\rm white}, C_\ell^{\rm 1/f}, C_\ell^{\rm radio}, C_\ell^{\rm CIB}, C_\ell^{\rm tSZ}, C_\ell^{\rm kSZ}, C_\ell^{\rm galdust}, C_\ell^{\rm galsync}]$
- ***To be fixed:*** currently using *Planck* galactic mask.

CMB-S4 footprints:
high cadence cos mod footprints



Masks:
(Modified) Planck galaxy mask



Covariance for galactic emission: 12 set of covariances: 3 footprints * 4 masks

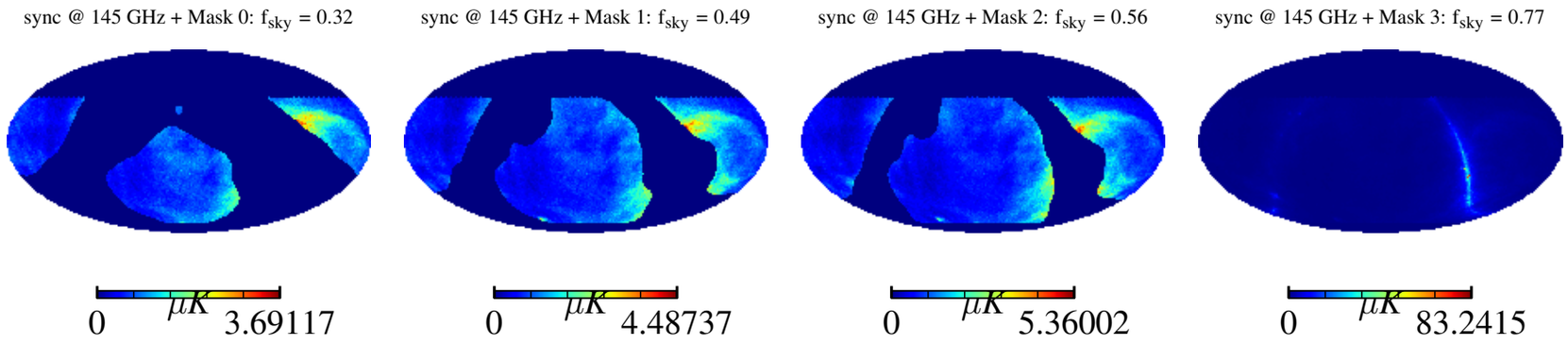
To be fixed: Currently just tried the first footprint ($f_{sky} = 0.77$)

Galactic simulations: pySM3

Link: **https://github.com/CMB-S4/s4mapbasedsims/tree/master/202002_foregrounds_extragalactic_cmb_tophat**

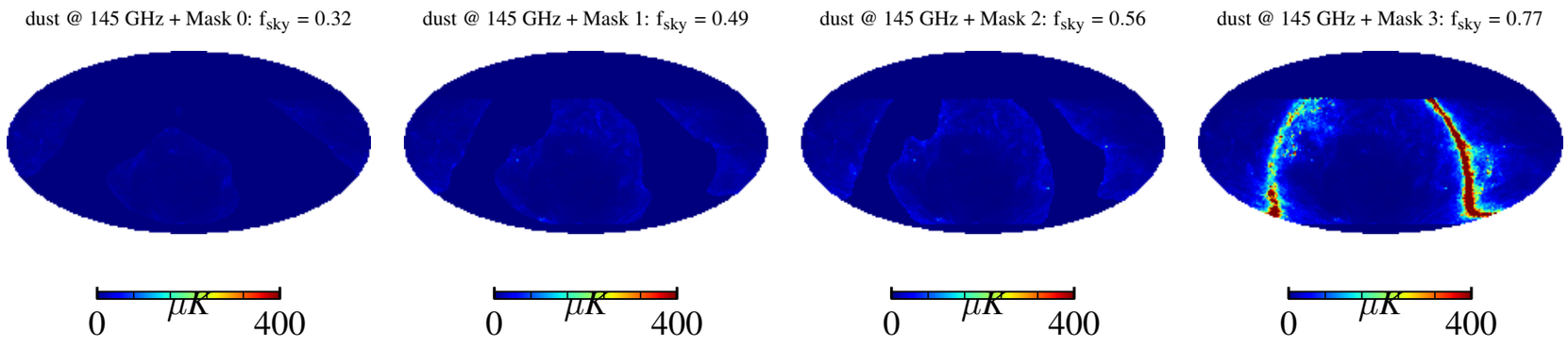
Synchrotron

93 GHz



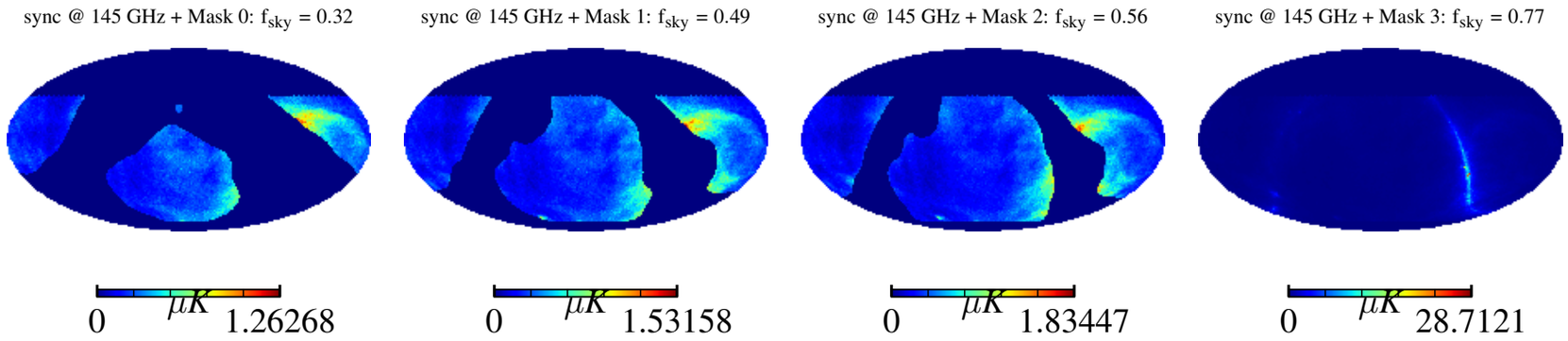
Dust

93 GHz



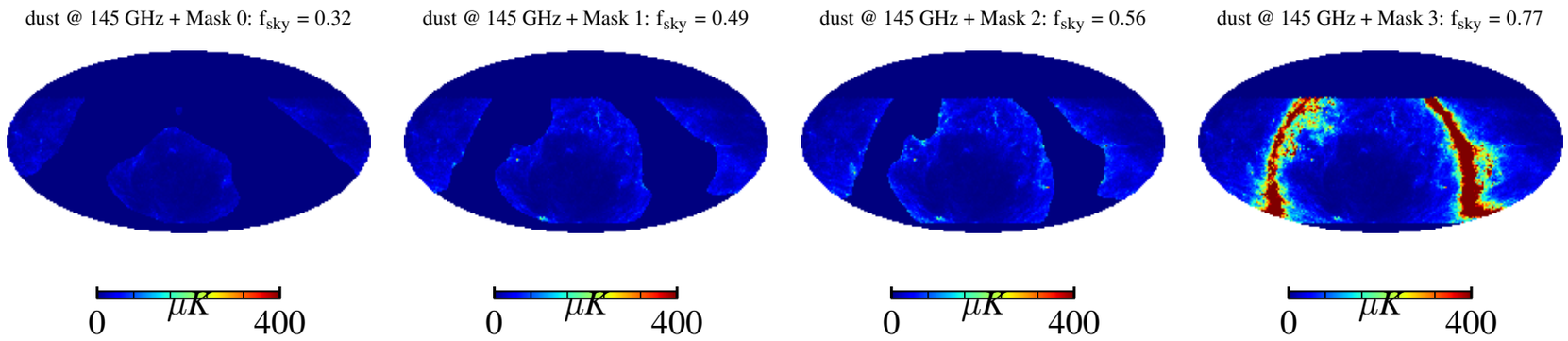
Synchrotron

145 GHz



Dust

145 GHz



Compare to sims by C. Umilta

93 GHz **145 GHz**

Synchrotron **Dust** **Synchrotron** **Dust**

pySM3

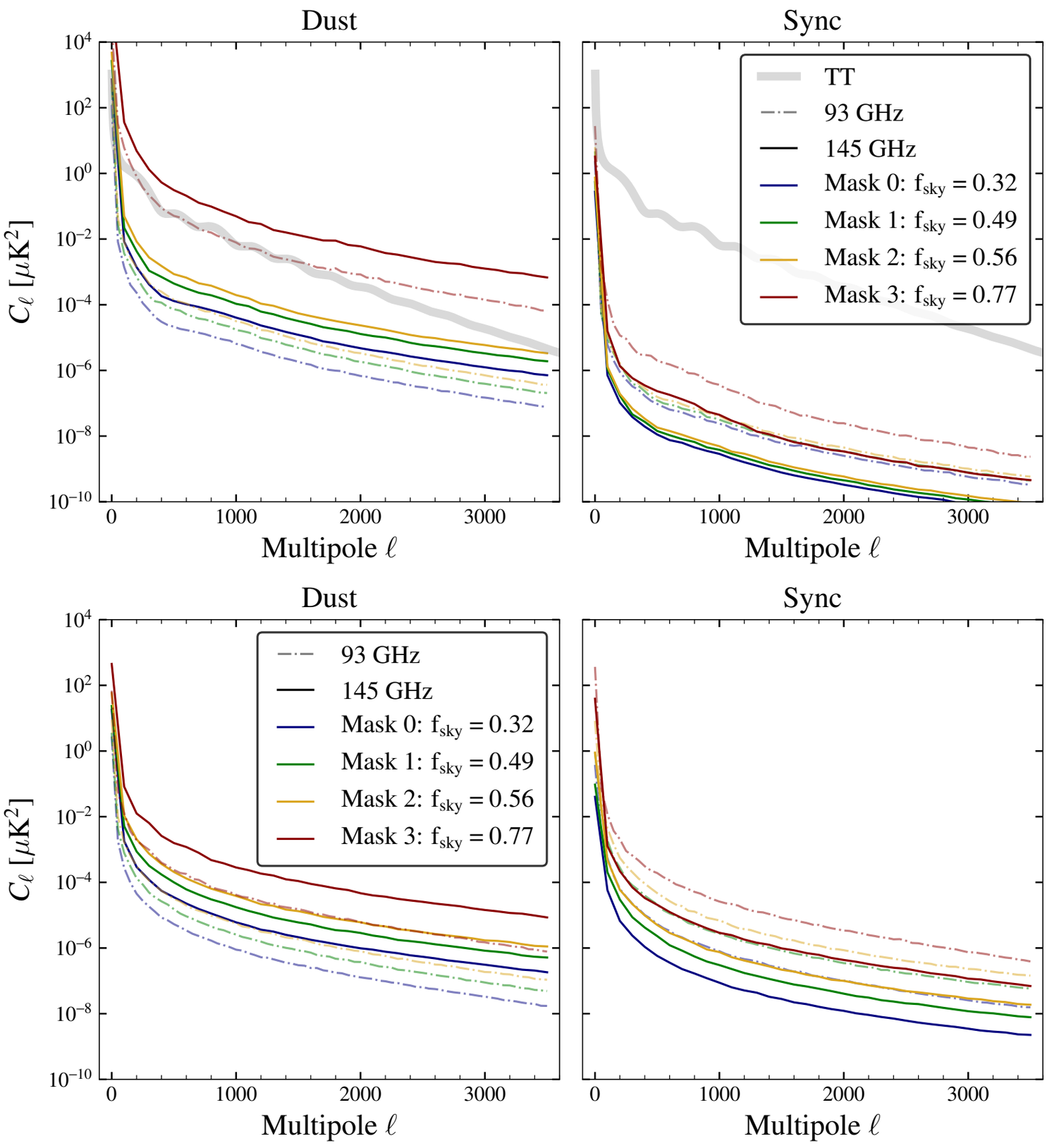
Dust brighter here

Sync. brighter here

C. Umilta

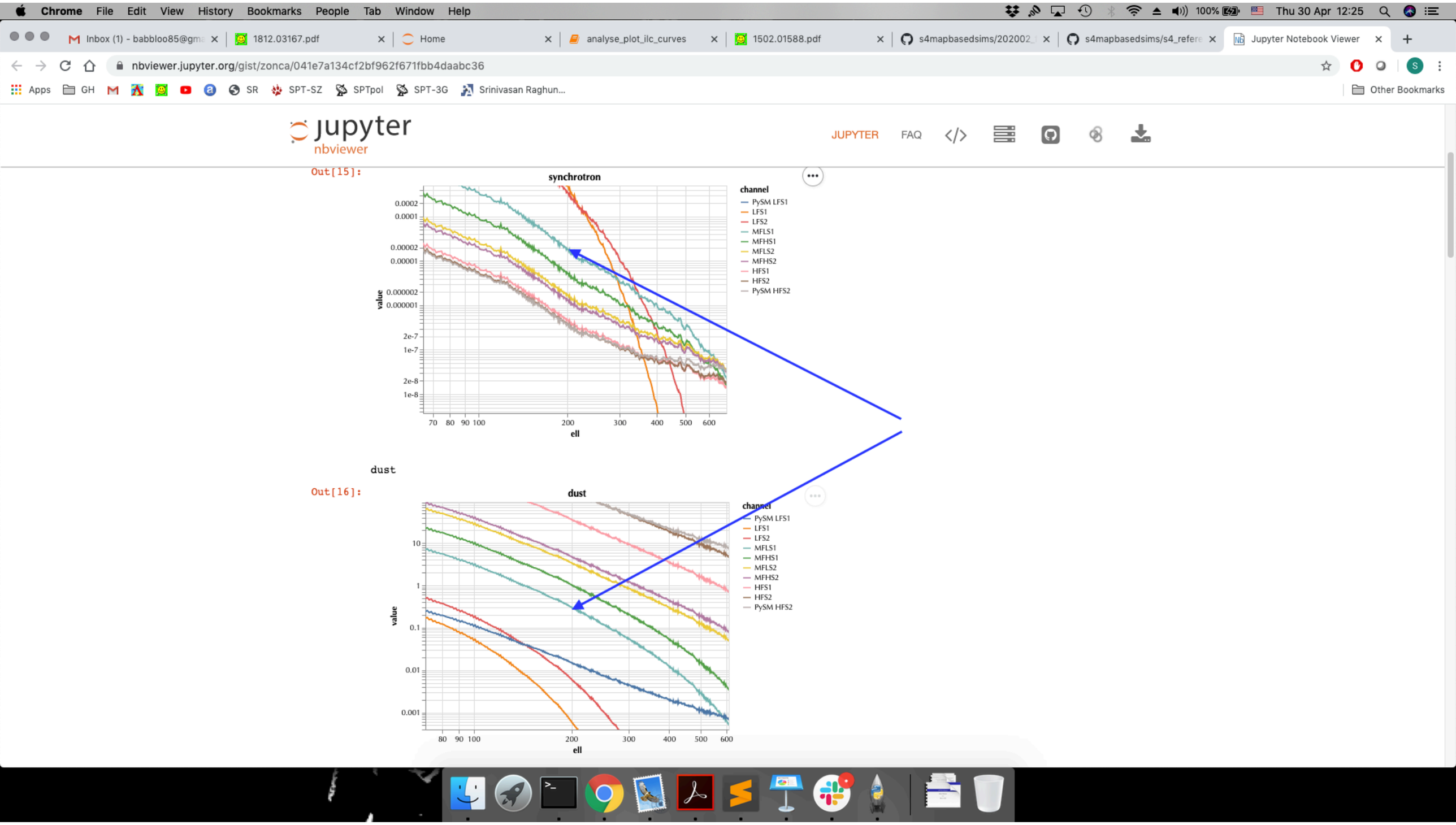
Dust / Sync TT power spectra

Top: pySM3; Bottom: C. Umilta simulations

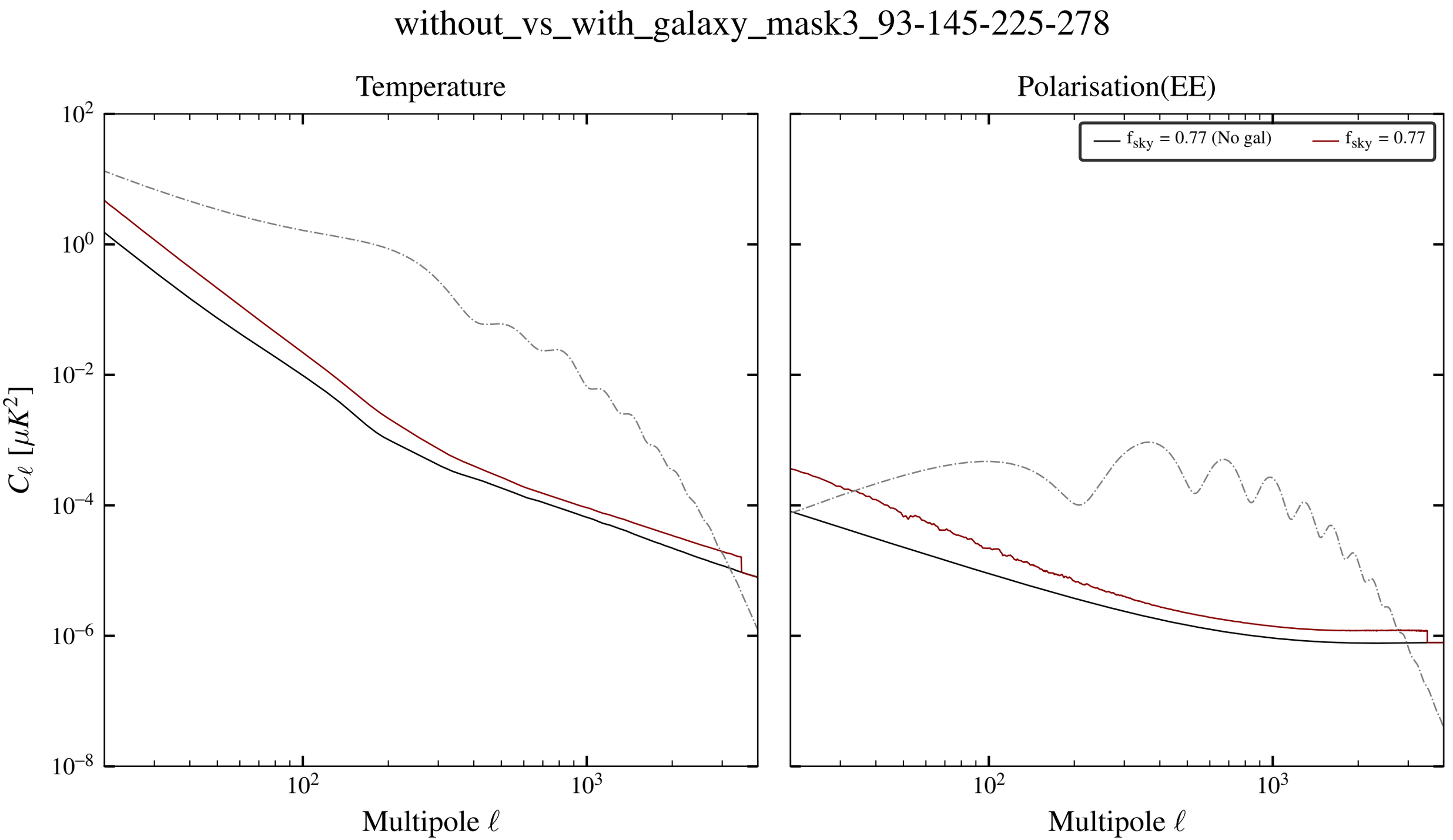


From pySM3 plot viewer tool

Link: **https://nbviewer.jupyter.org/gist/zonca/041e7a134cf2bf962f671fbb4daabc36**

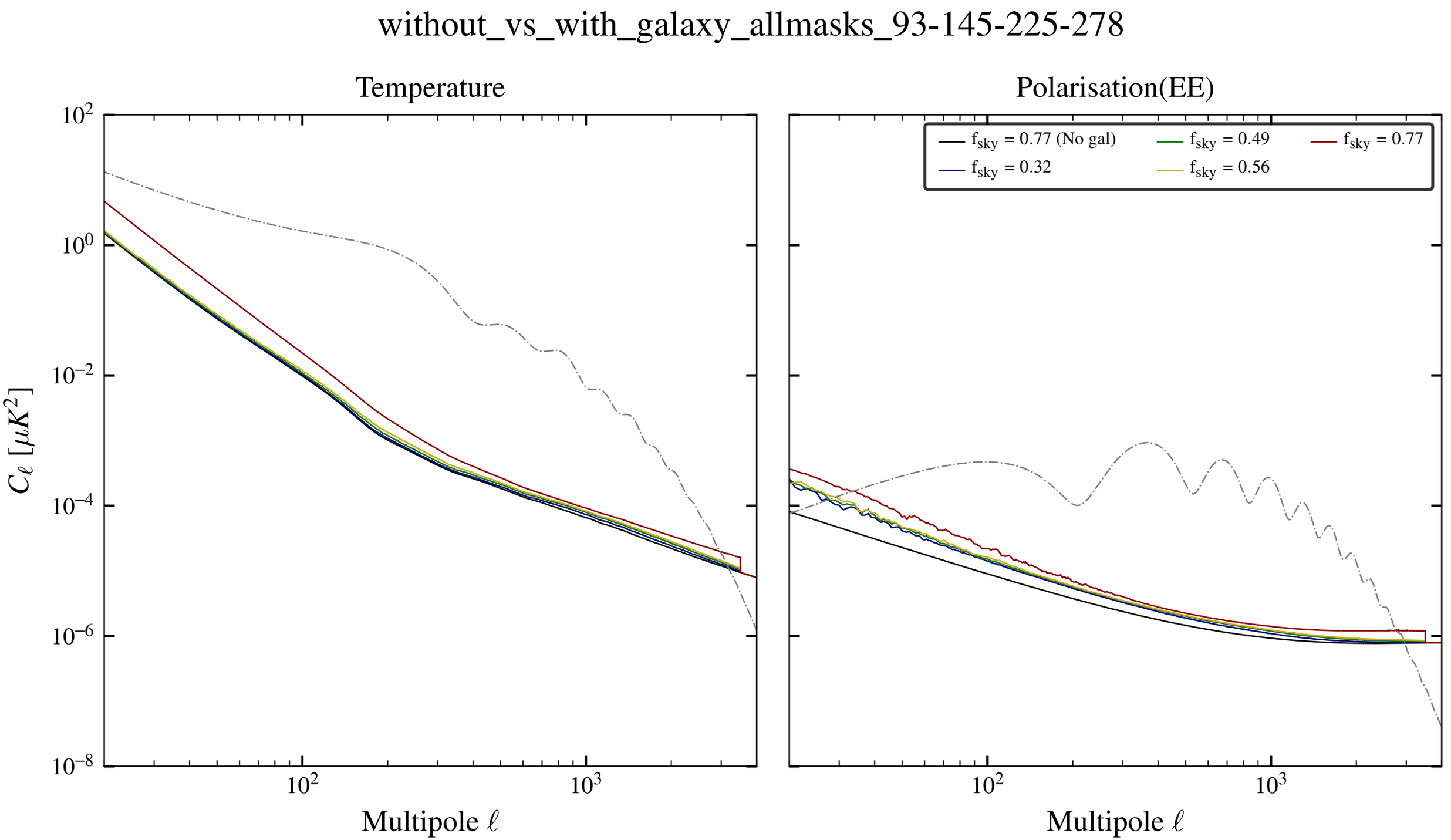


ILC curves - W/o vs w/ galaxy (4 bands)



Residual power increases when galactic emission is added (black vs red)

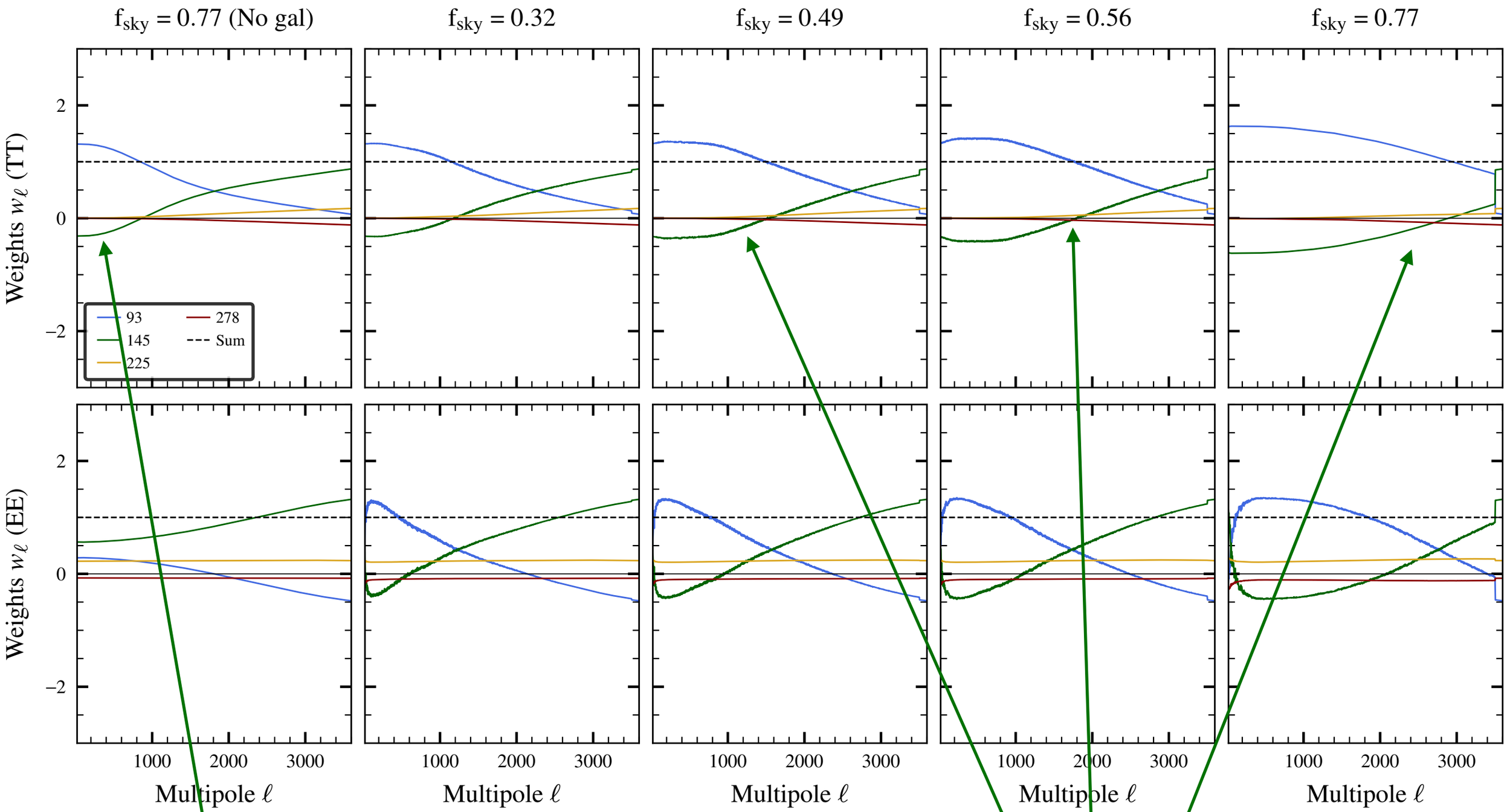
ILC curves - W/o vs w/ galaxy (4 bands, 4 masks)



Residual power increases with more f_{sky} (blue to red)

Weights (4 bands, 4 masks)

without_vs_with_galaxy_allmasks_93-145-225-278

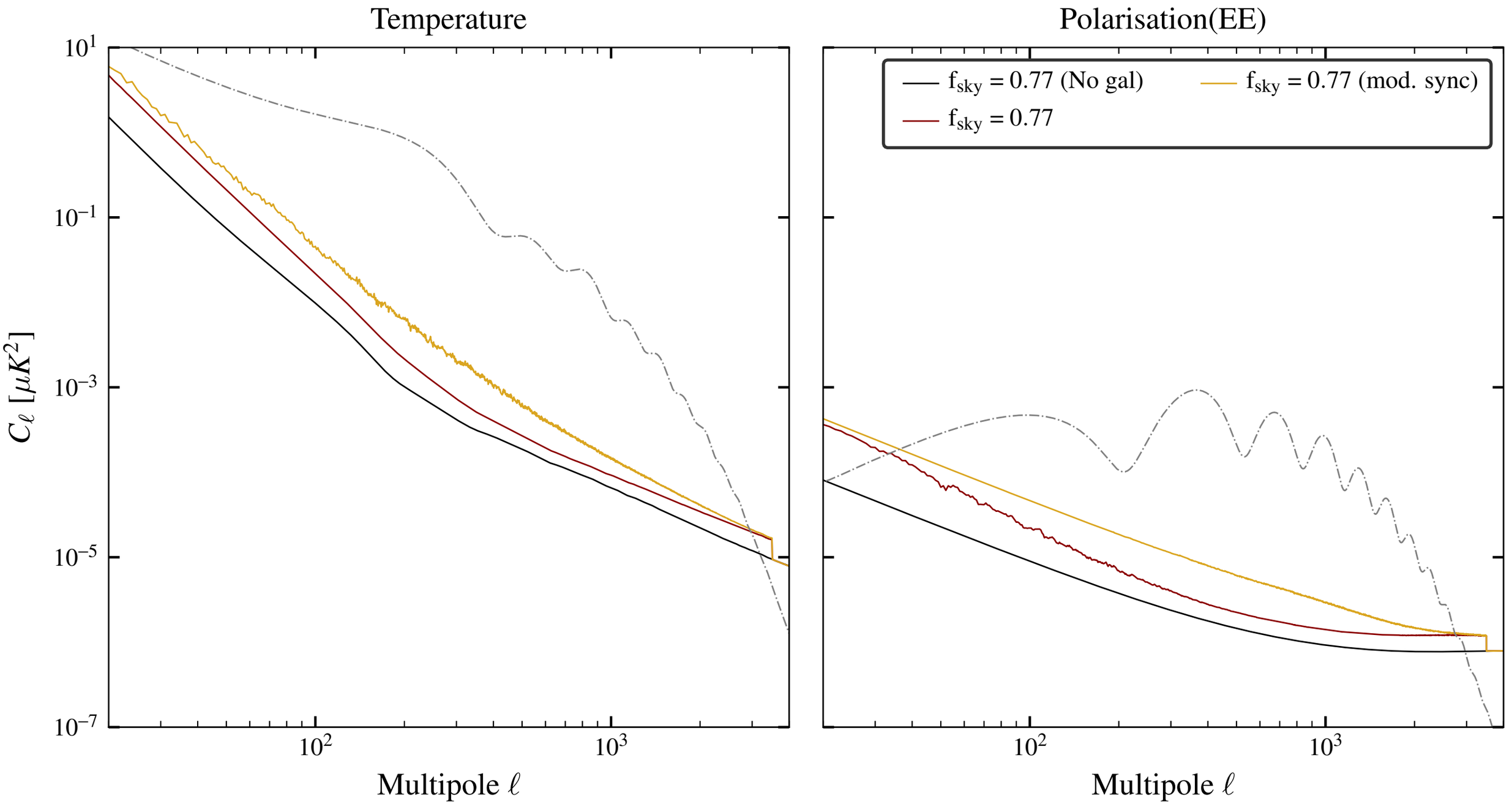


- 90 gets most of the low-\ell weights as it has very low 1/f in T. P looks different.
- **Negative weights for 150 at low-\ell** to cancel the correlated 1/f. The **\ell range with negative weights increases** when gal. dust is added.

ILC curves - W/o vs w/ galaxy (4 bands)

(Synchrotron from C. Umilta simulations)

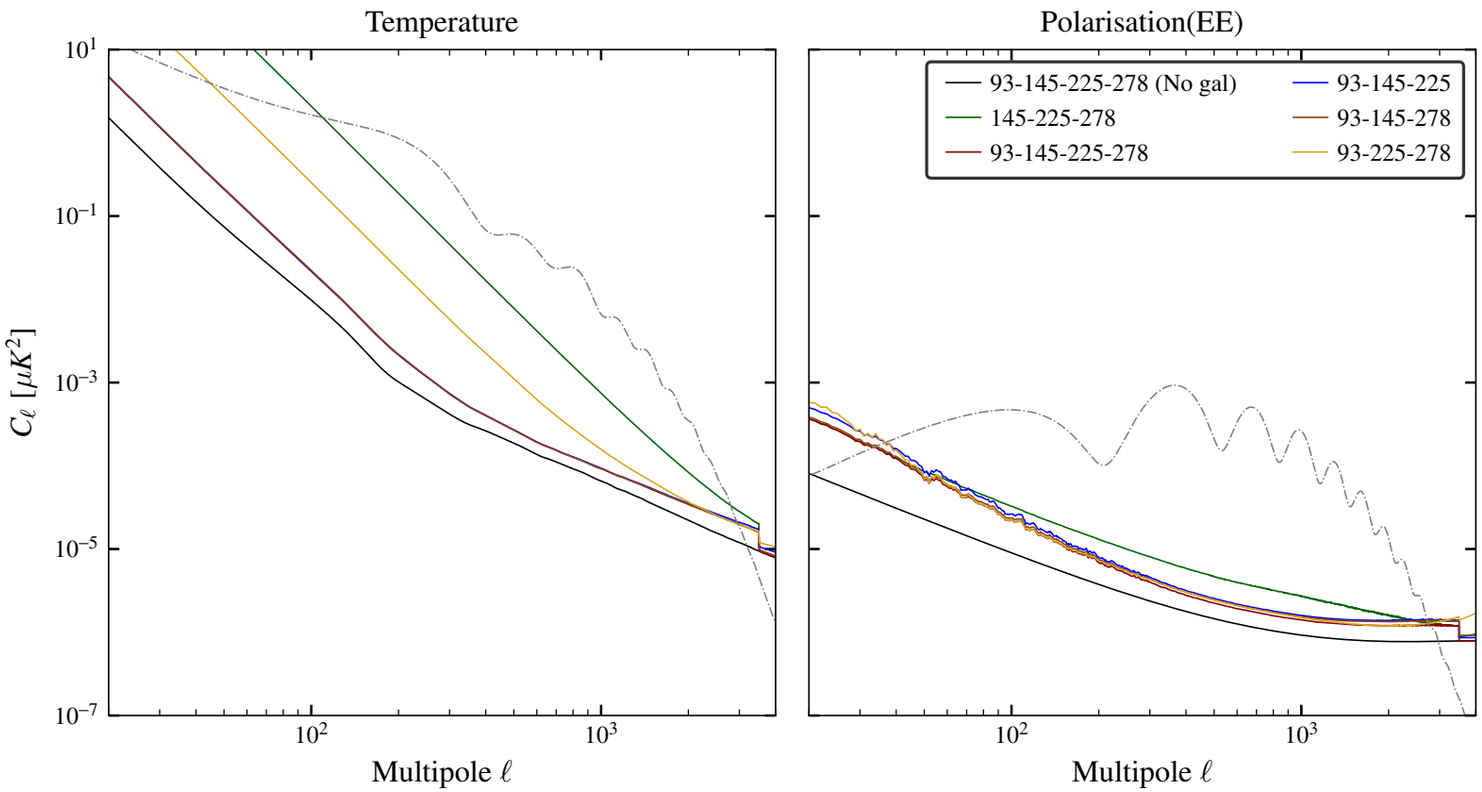
without_vs_with_galaxy_mask3_93-145-225-278_modsync



Synchrotron power is increased using simulations from C. Umilta. Results in a slightly higher residual noise.

ILC curves - Eliminating bands

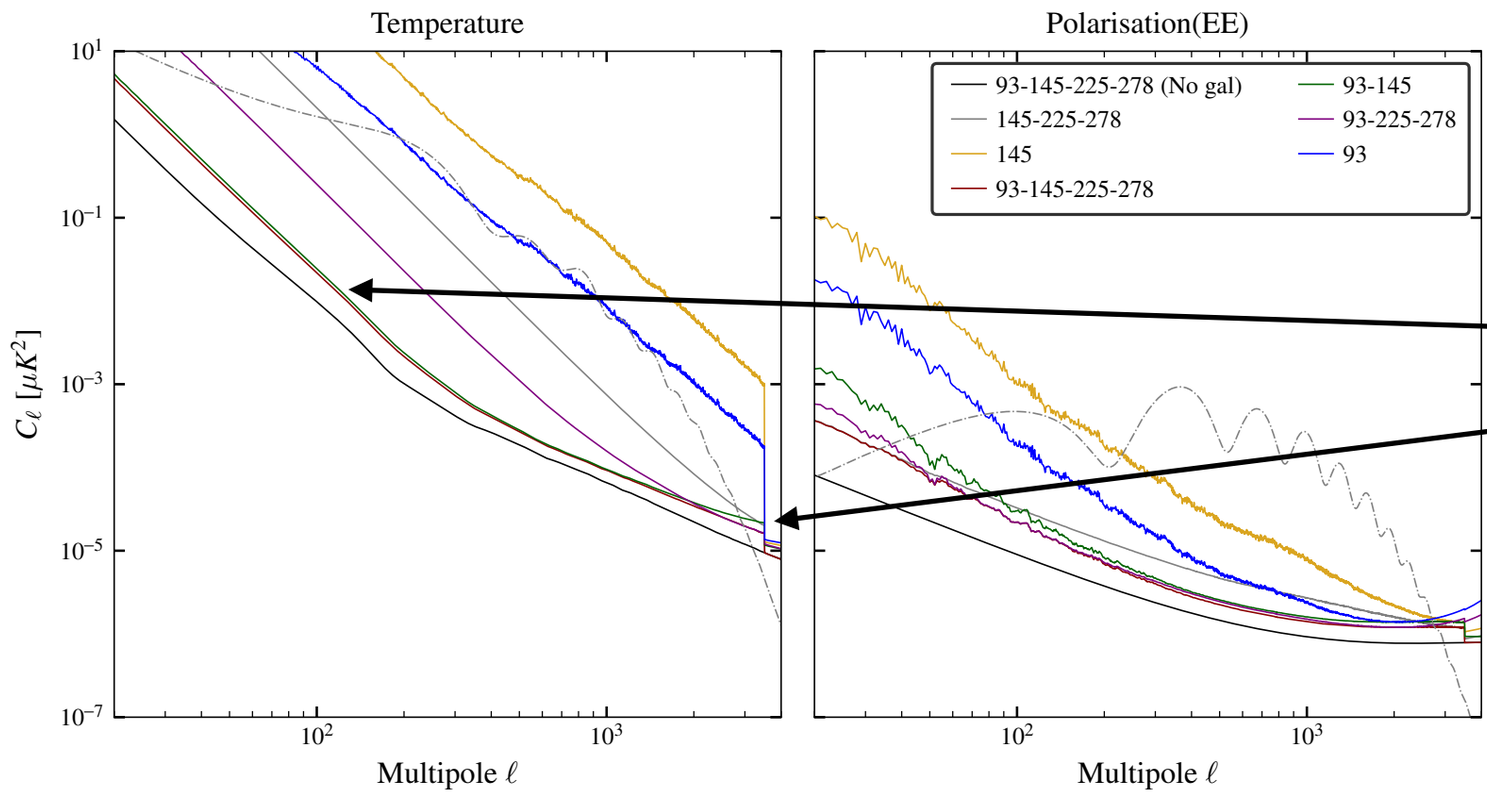
mask3_differentbands



Top: Eliminating one band

- Removing 90 hurts us the most. But this is mostly due to 1/f and not due to galaxy.
- 225/278 roughly add equal contribution. Not clear which is more important.

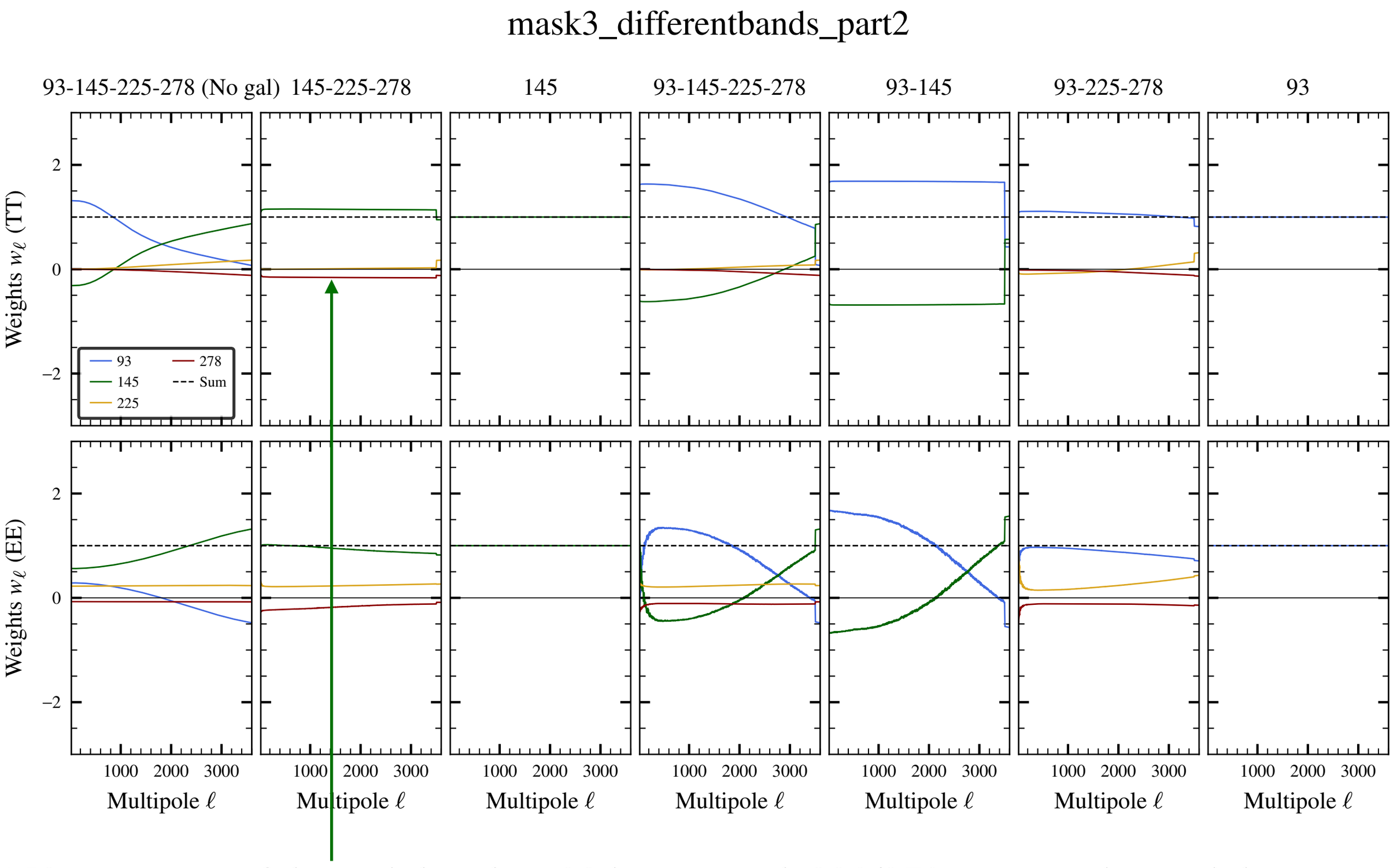
mask3_differentbands_part2



Bottom: Eliminating multiple bands

- Removing both 225/278 increases the noise only slightly on large-scales. (Green vs red). But on small-scales the higher frequency bands might become important (to remove CIB).

Weights (after eliminating bands)

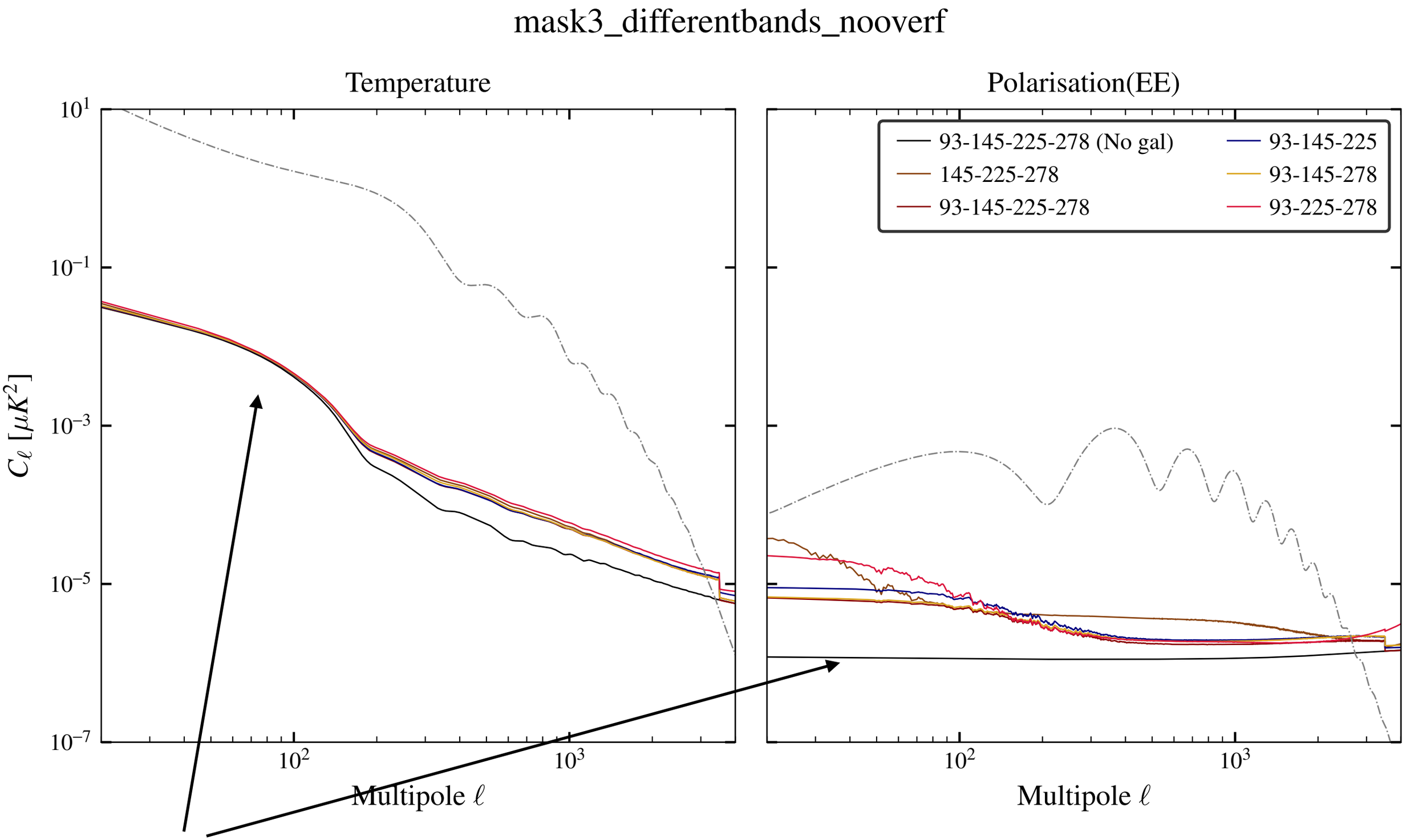


- 150 gets most of the weight when 90 is removed. 220/270 get negative weights now.

Next steps

- Find out the correct set of galactic simulations.
- Galactic mask: Currently using *Planck.*
- S4 footprints: Currently using fsky = 0.77. Other two footprints to be included.
- Power spectra: Currently only has TT and EE. TE to be included.
- ℓ_{max}: Current limiting it to 3500. To be increased to 6000 or higher.

ILC curves - Eliminating bands and no 1/f



The low-\ell increase for black (despite removing galaxy and 1/f) is because extragalactic foregrounds are not white. This trend is absent for polarisation, as expected.