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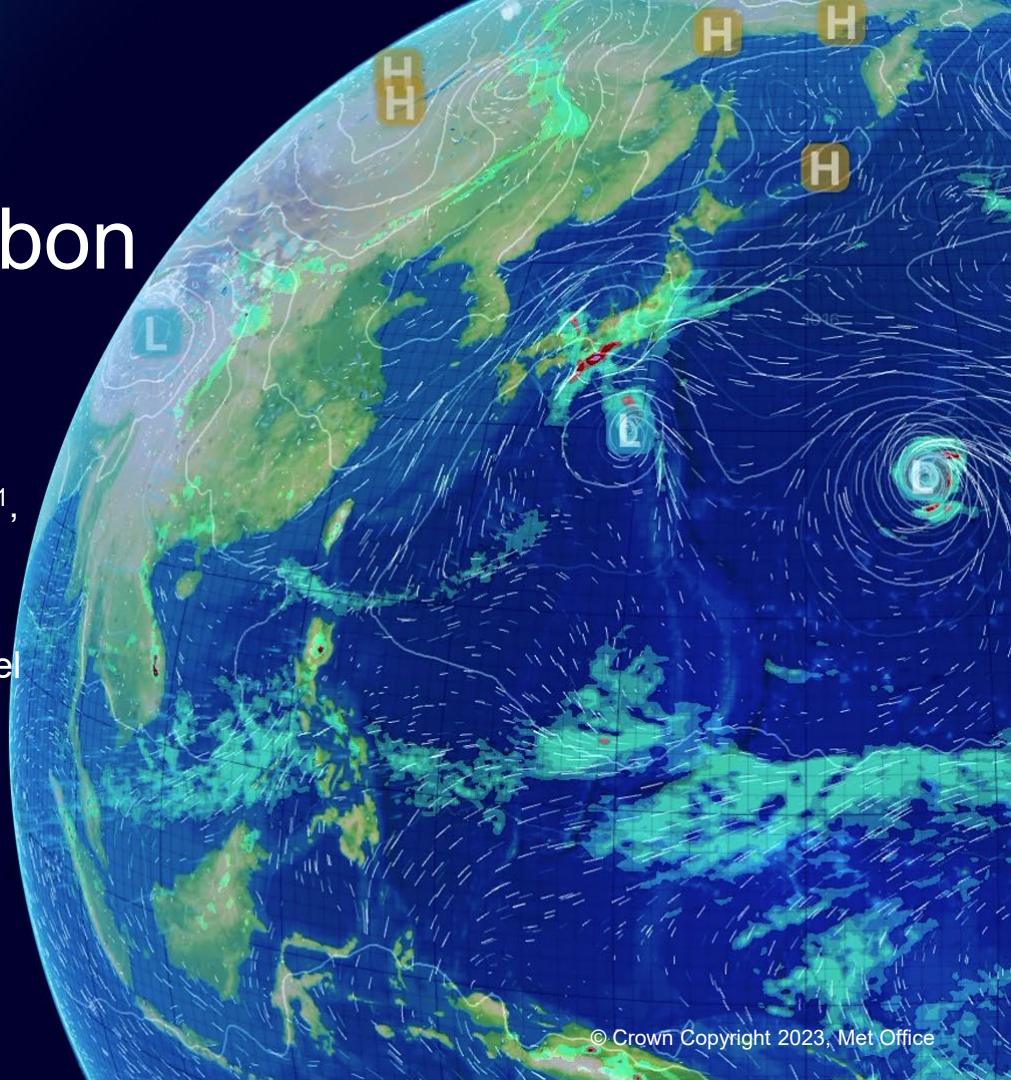
# Fire weakens land carbon sinks before 1.5°C

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# Background

- **Changes to fire regimes** are already occurring due to climate change
- **Fire impacts ecosystems and carbon stores**, and may determine alternate stable states of ecosystems (forest / savanna)
- Fire-vegetation feedbacks may **reduce the capacity of the global sink to store carbon**, as fire regimes change in the future with climate change
- **Many models** used for 1.5℃ (CMIP5) **didn't include fire**
- Is 1.5℃ is still consistent with avoiding **significant ecosystem changes** when considering shifts in fire regimes?

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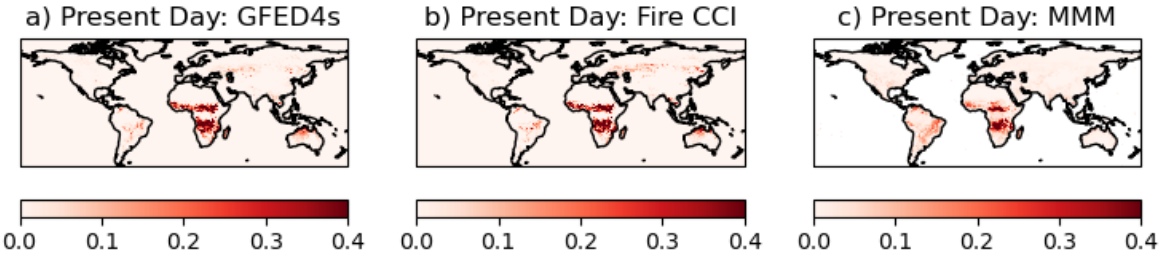
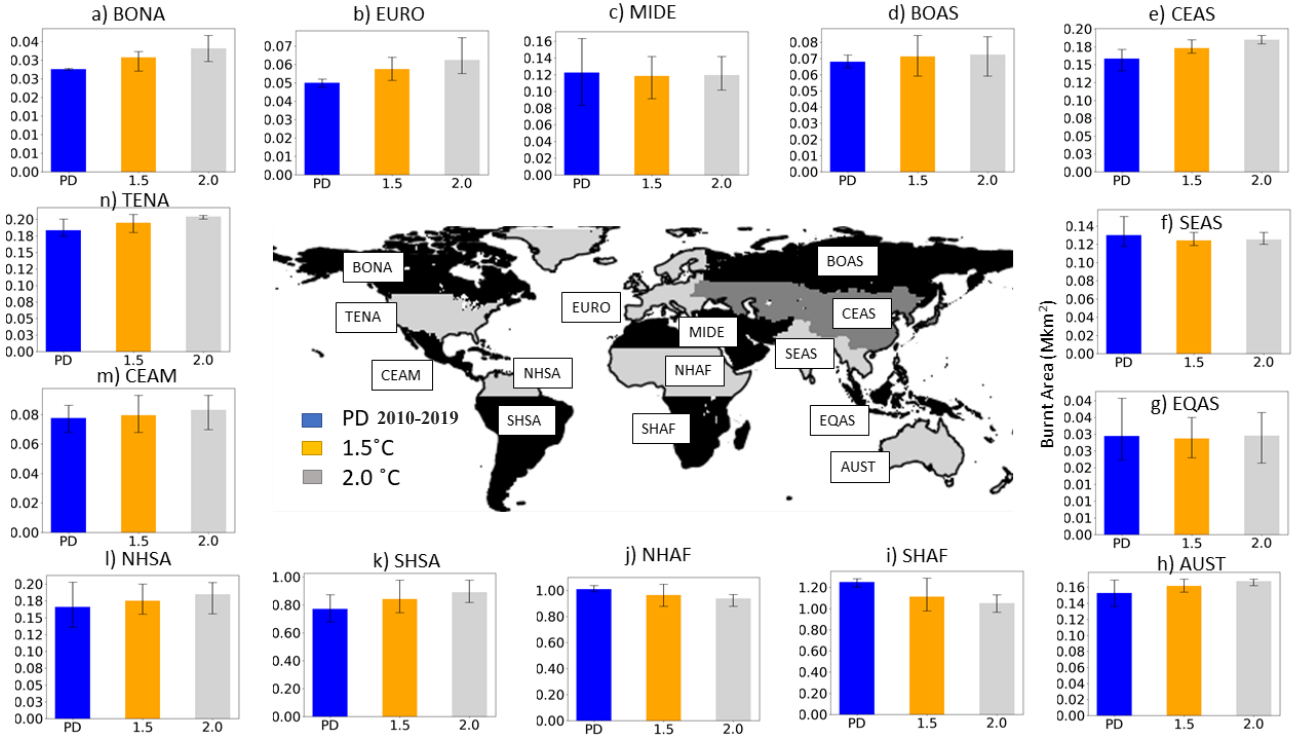
# Methods




- **JULES-INFERNO** - nitrogen limitation, dynamic vegetation, fire
- ISIMIP2b – 4 driving climate models (**HadGEM2**-ES, **GFDL**-ESM2M, **IPSL**-CM5A-LR, **MIROC**5)
- **Future scenarios** (RCP2.6), RCP6.0
- Fire at **Global Warming Levels** 1.5˚C and 2.0˚C (21 year rolling mean)
- Looking for **GWLs where impacts become significant**
- Lots of **evaluation** of models for burnt area, tree cover, carbon stores

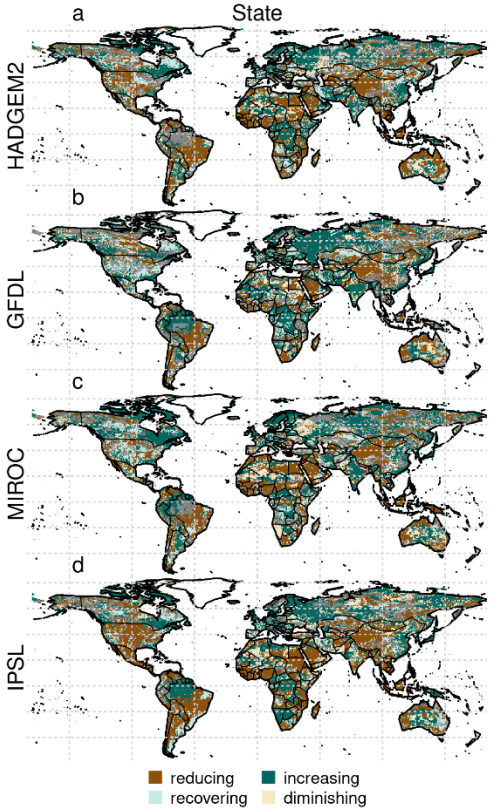
# Results: Change in Burnt Area

- **Burnt area** mostly projected to **increase** from Present Day (PD)
- **Europe: 15%** (1.5℃) and **25%** (2.0℃) increase
- **Boreal North America 12%** (1.5℃) and **20%** (2.0℃) increase
- Decline in Africa
- High model spread in Equatorial Asia



# Results:

## Change in Tree Cover

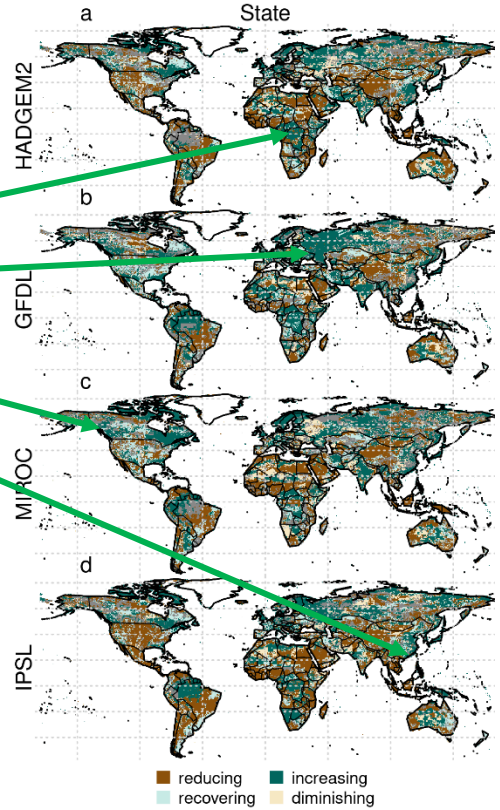



**Change in tree cover at 1.5°C above PI**

# Results:

## Change in Tree Cover

Increasing tree cover



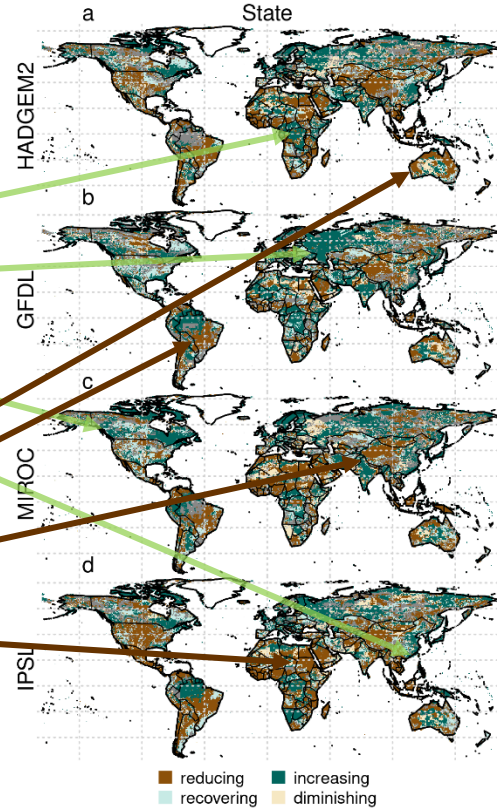

**Change in tree cover at 1.5°C above PI**

# Results:

## Change in Tree Cover

Increasing tree cover

Decreasing tree cover

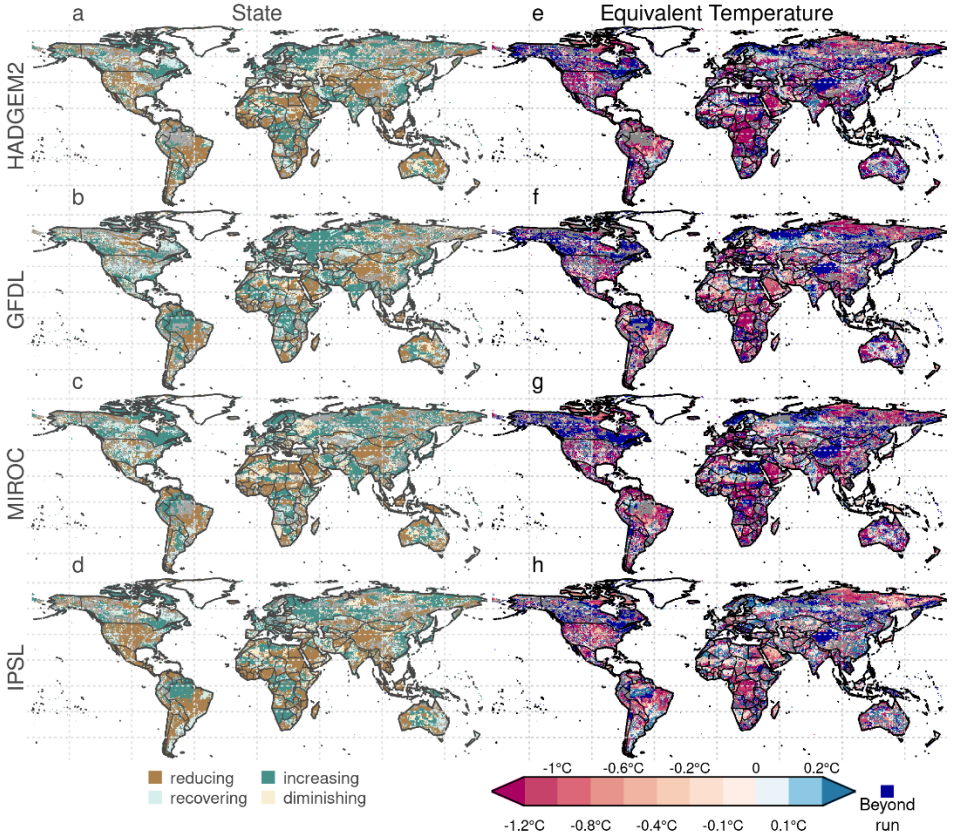



**Change in tree cover at 1.5°C above PI**

# Results:

# Change in Tree Cover

- '**Equivalent impact of change in tree cover**' = the point at which tree cover is at the same level with fire as without fire at 1.5℃ above PI
- Equivalent change in tree cover happens at **lower temperatures (red)** with fire
- **Impacts may happen earlier** than we thought

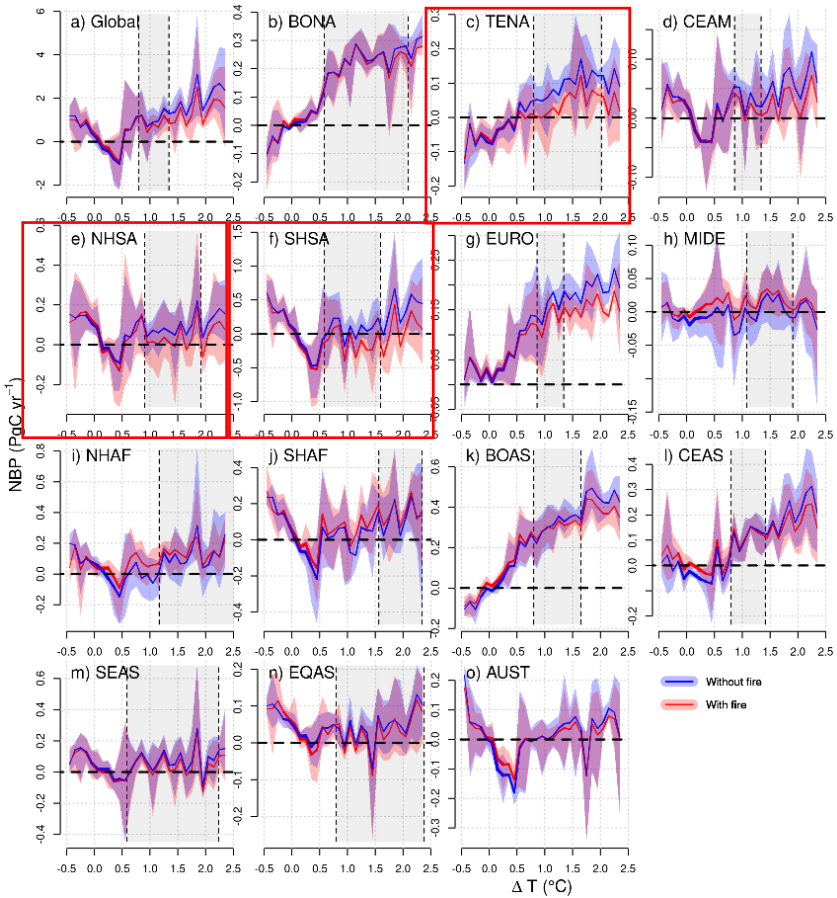



**Temperature of equivalent impact**

# Results:

# Impact on Net Biome Productivity

- NBP **increases globally and in boreal regions** with temperature
- NBP mostly **decreased with fire** (red vs blue)
- Some regions are **close to a sink/source** threshold
- **Fire can shift** some regions from a net sink -> net source

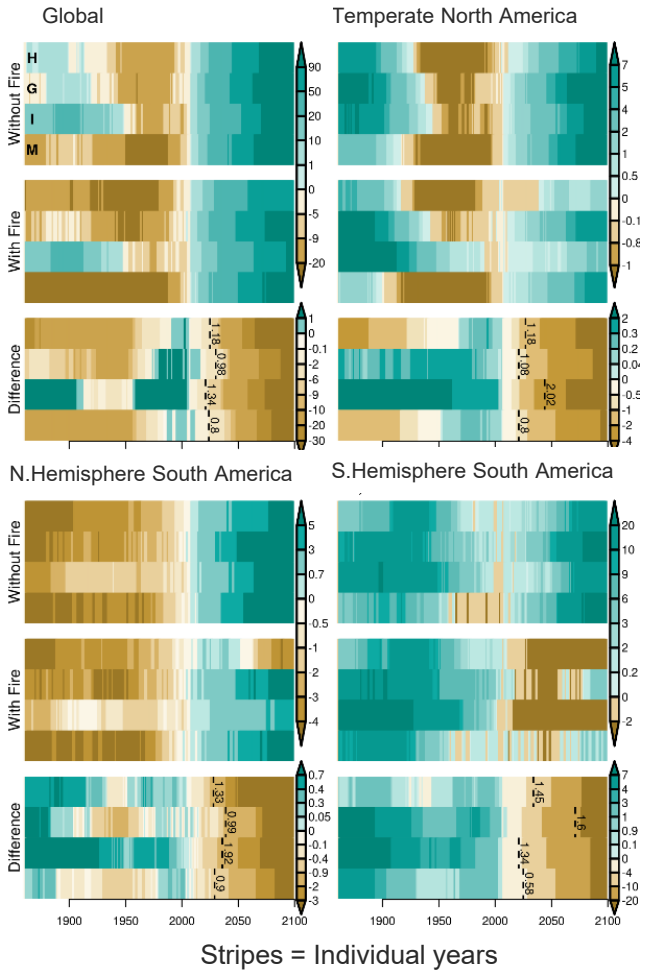



**NBP with and without fire by temperature**

# Results:

# Impact on Net Biome Productivity

- More shifts from **sink to source** (brown stripes) 'with fire'
- Fire has a **negative impact by the end of the century**, offsetting $CO_2$ fertilisation
- We find that the global warming level at which **<u>fire significantly impacts global carbon storage is 1.07℃</u>** (0.8-1.34℃) above pre-industrial
  (with fire vs without fire, anomaly from PD, Wilcoxon signed-rank test)



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# Conclusion

- **Impacts happen earlier** when we account for fire
- Fire s**ignificantly impacts global carbon storage** at **1.07℃** above PI
- Therefore, regions which were previously projected to continue as a net sink of carbon into the future may be closer to a threshold than previously understood, and those **impacts could be starting now**.
- We estimate the reduction in the **remaining carbon budget** due to fire is 15 $GtCO_2$ for limiting temperature rise to 1.3℃, **25 $GtCO_2$ for 1.5℃**, and 64 $GtCO_2$ for 2.0℃ compared to IPCC AR6

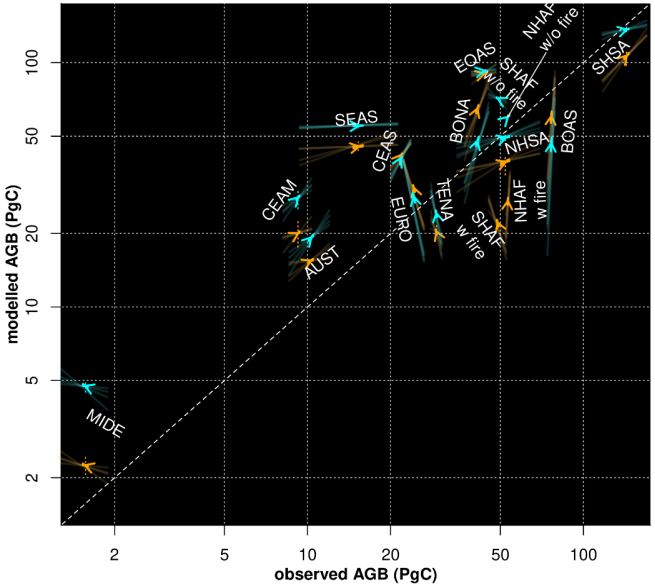
# Model evaluation:

Criteria tested to ensure framework can find how **considering fire** affects significant impacts:

- Capture's **spatial patterns** and **trends** in:
  - Burnt Area
  - Tree cover
  - Vegetation carbon

- **Without fire simulation performs as well** as with fire for present **day spatial patterns in tree cover and vegetation carbon**

- **With fire outperforms** without fire in changes/**trends in tree cover and vegetation carbon**




| | GFDL | HADGEM | IPSL | MIROC |
|---|---|---|---|---|
| BONA | 96.61 | 99.94 | 99.9 | 96.74 |
| TENA | 92.4 | 99.53 | 95.54 | 99.1 |
| CEAM | 82.98 | 77.46 | 92.16 | 71.47 |
| NHSA | 81.59 | 89.77 | 87.31 | 100 |
| SHSA | 69.33 | 64.33 | 55.18 | 65.05 |
| EURO | 50.3 | 43.15 | 44.42 | 42.55 |
| MIDE | 98.84 | 94.94 | 96.78 | 97.15 |
| NHAF | 49.11 | 27.44 | 41.65 | 36.4 |
| SHAF | 97.13 | 97.31 | 97.23 | 97.15 |
| BOAS | 89.4 | 92.02 | 94.92 | 92.13 |
| CEAS | 40.2 | 33.48 | 39.64 | 42.72 |
| SEAS | 71.68 | 71.64 | 71.37 | 65.78 |
| EQAS | 83.84 | 87.16 | 86.45 | 87.44 |
| AUST | 65.46 | 72.66 | 62.94 | 67.89 |

See qr code for more detail