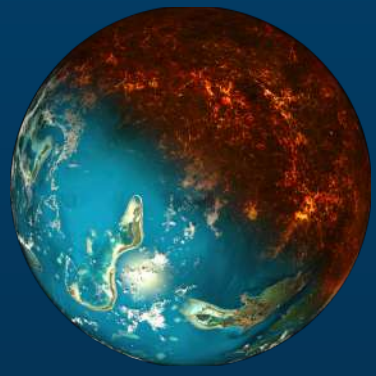


Impact of the atmospheric composition on the Habitable Zone

Guillaume Chaverot
IPAG - University of Grenoble-Alpes

In collaboration with L. Mignon, X. Delfosse, N. Meunier, P. Delorme



Searching for temperate planets



Detection

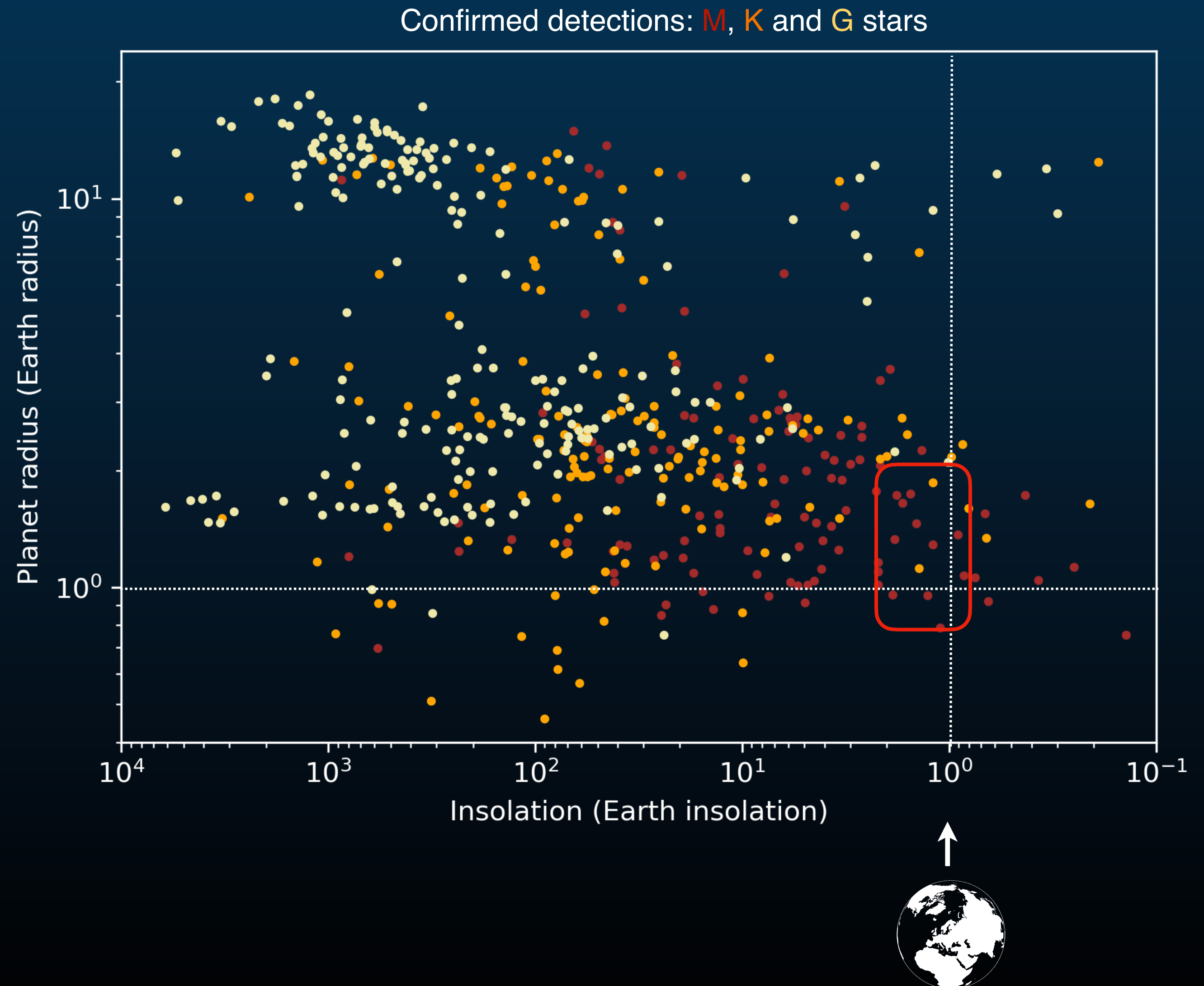
The PLATO mission [2026-2030]

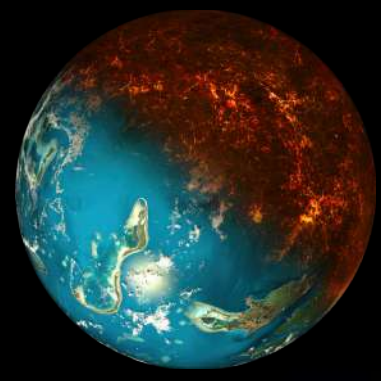
detection goal: 400 planets (Rauer+2025)
< 95 within the habitable zone

RV follow up: ≈ 40 planets with ESPRESSO@VLT
Need to select the most interesting targets

Atmospheric characterisation

1. ANDES@ELT (2033)
2. PCS@ELT, HWO/LIFE (2040+)





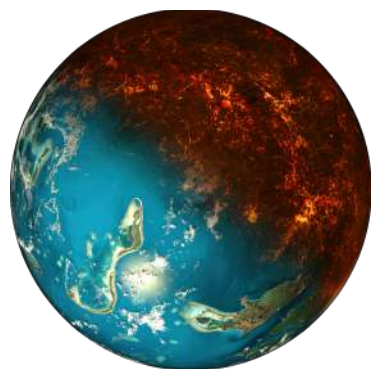
The Habitable Zone

First definition of the Habitable Zone: Huang (1959), Hart (1978)

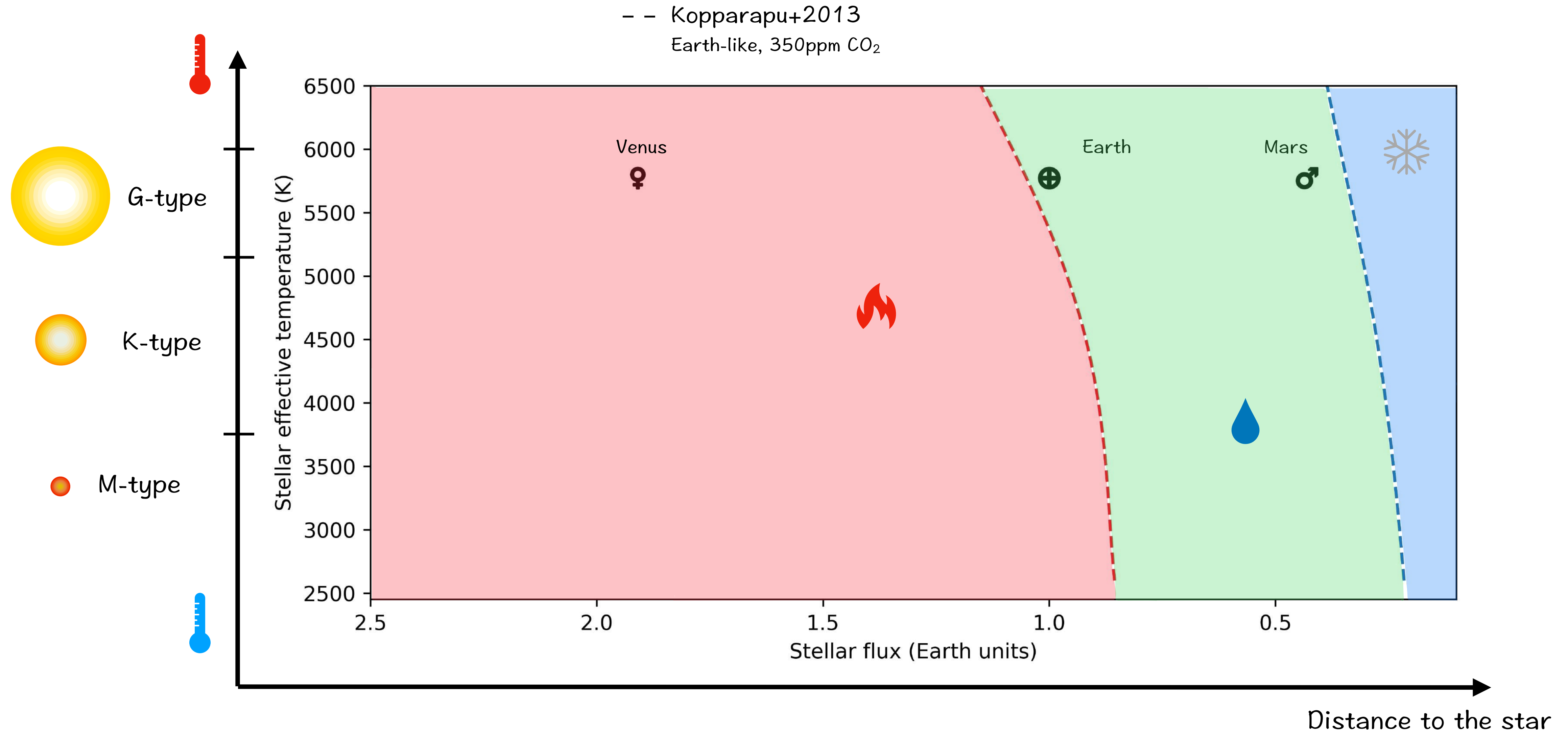
Evaporated water

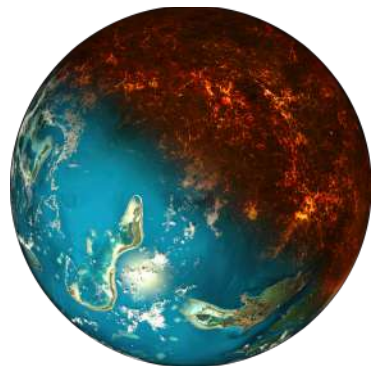
Frozen water

Liquid water

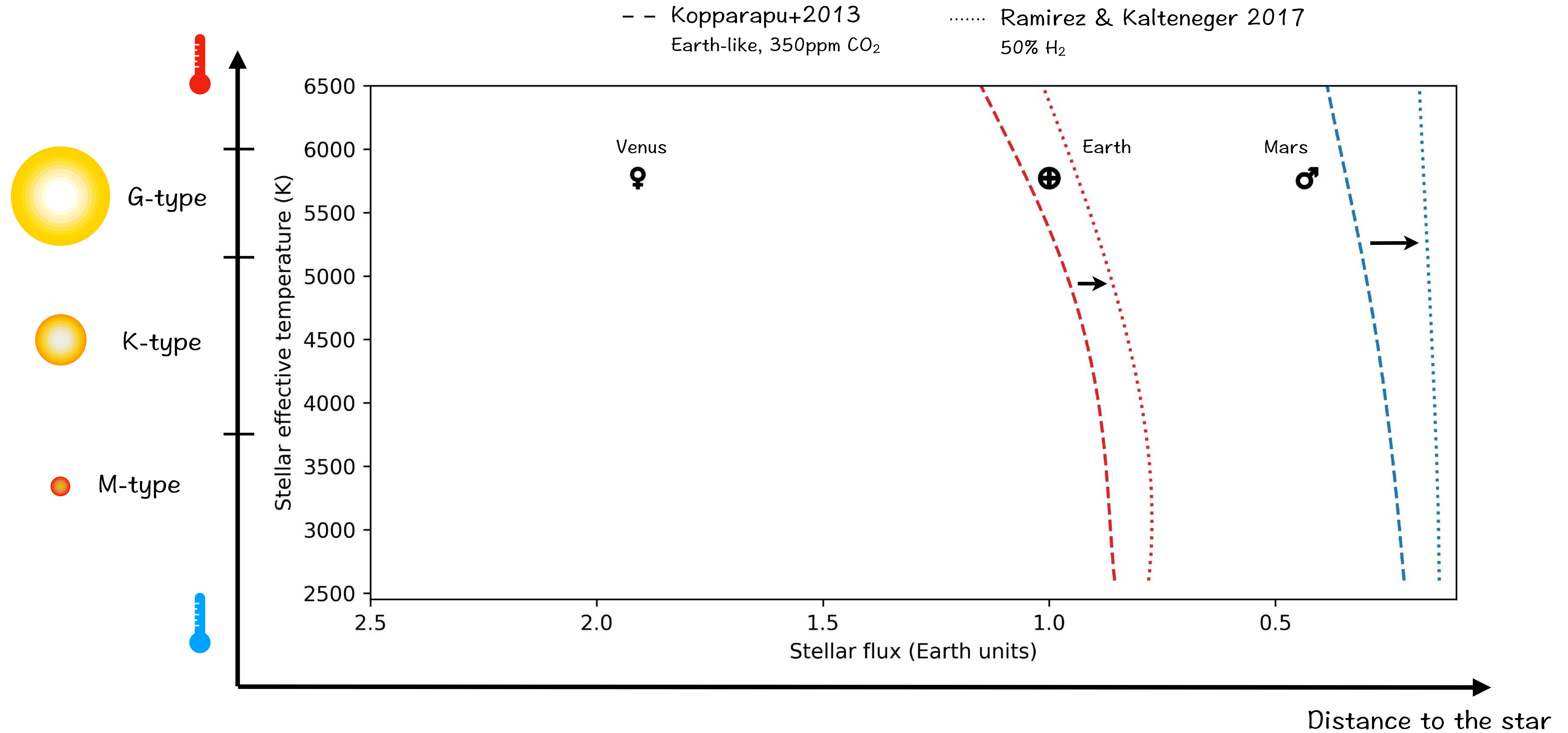


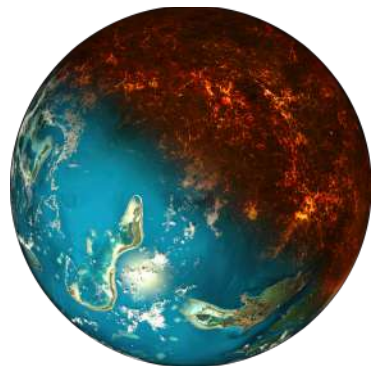
The Habitable Zone



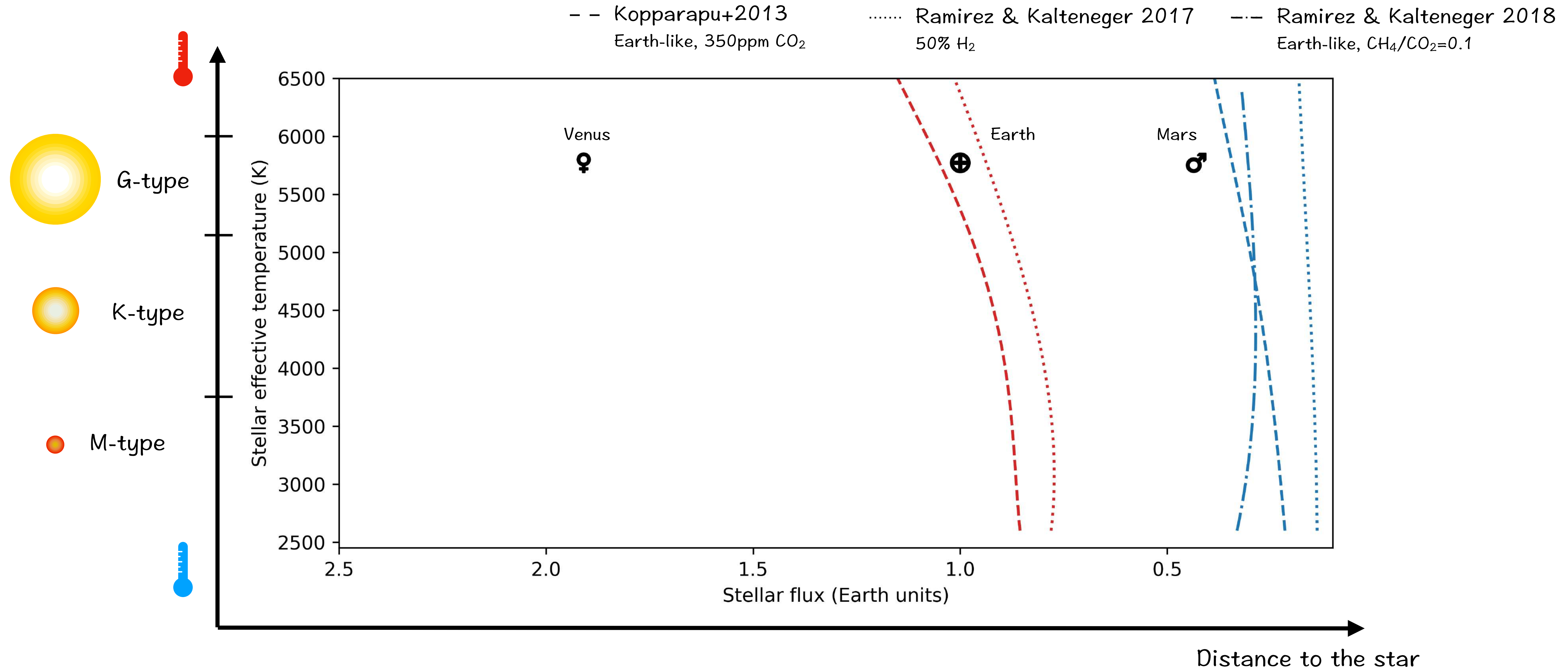


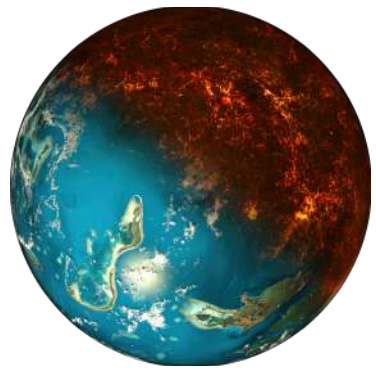
The Habitable Zone



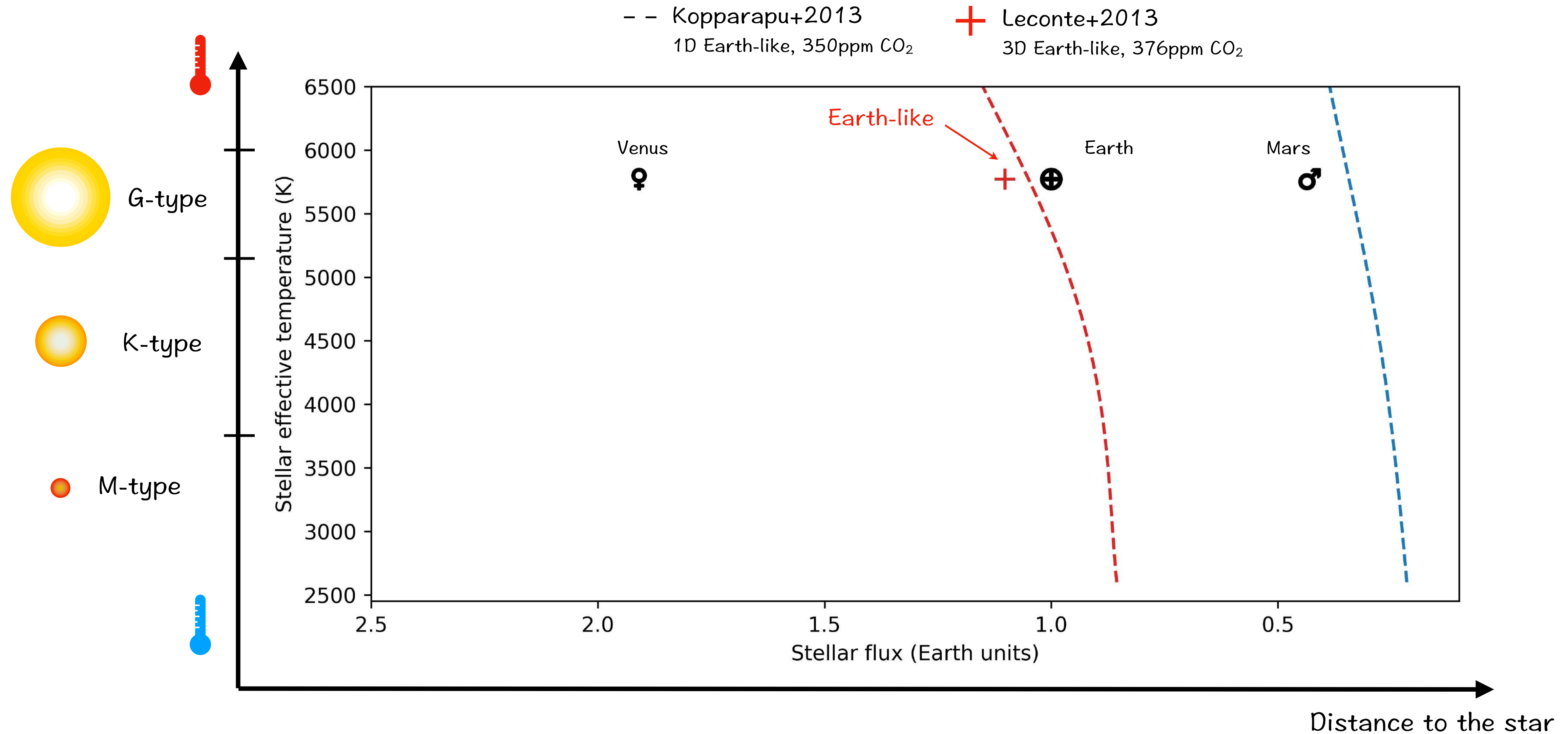


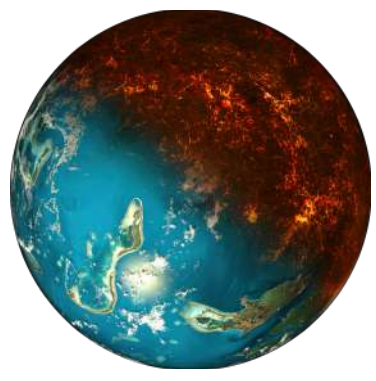
The Habitable Zone



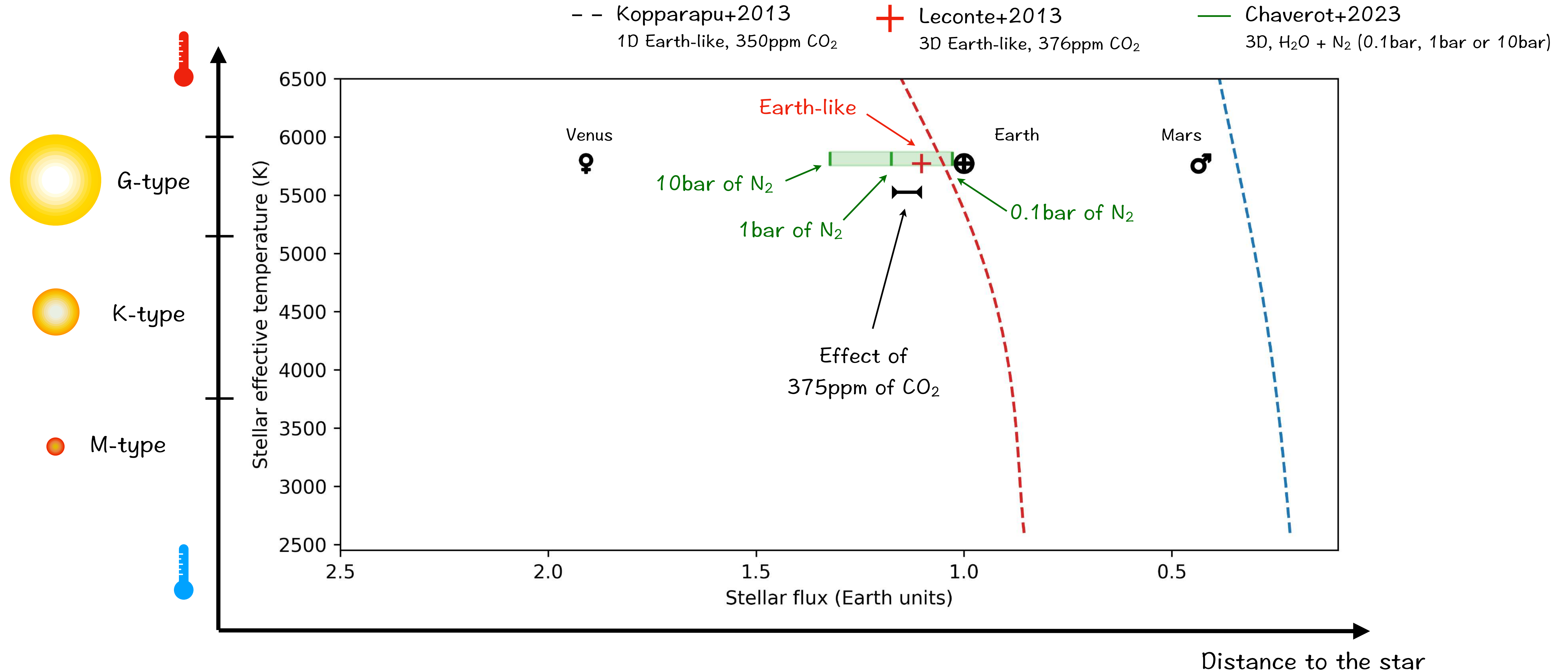


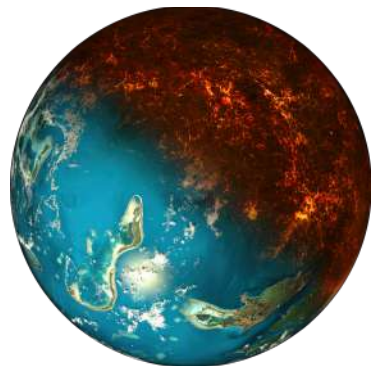
The Habitable Zone



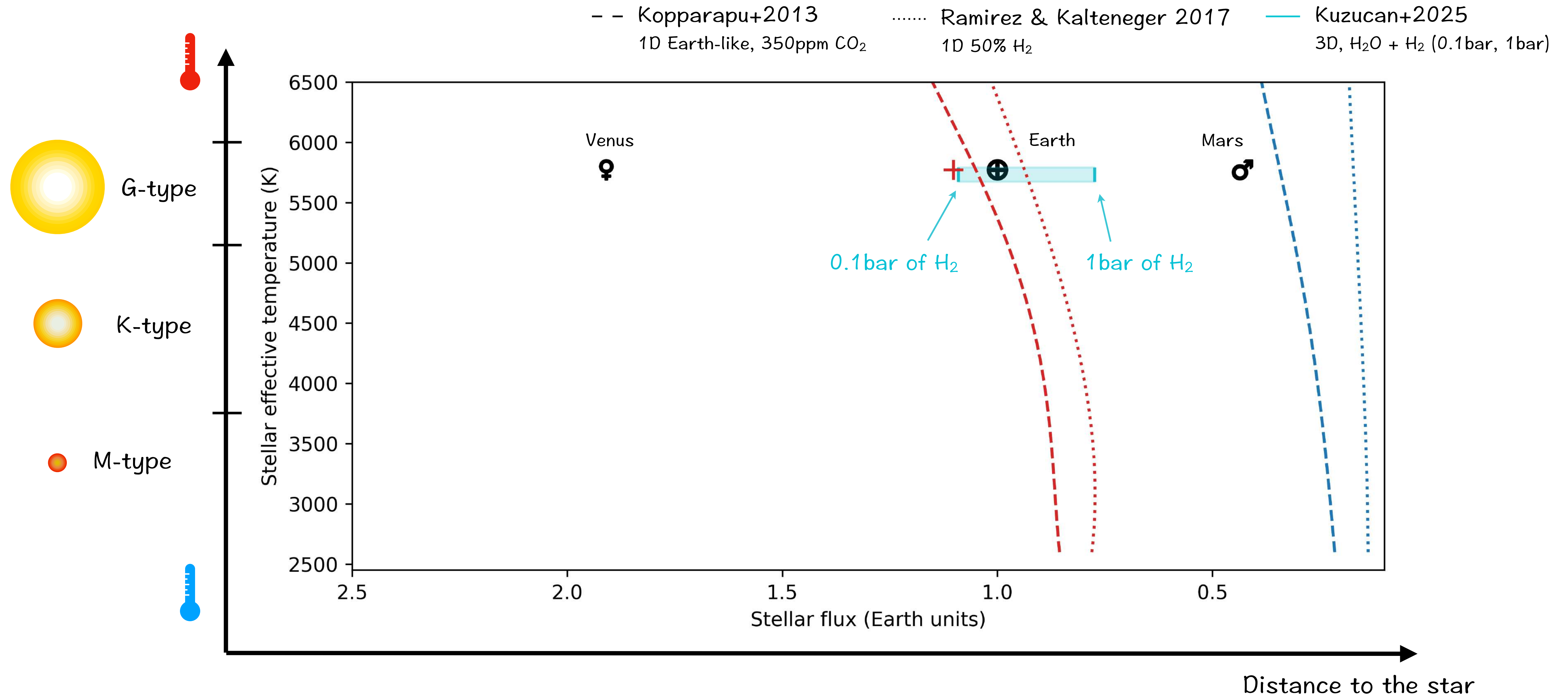


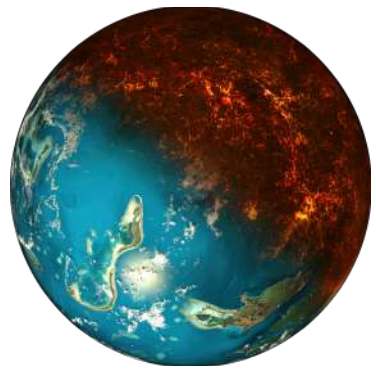
The Habitable Zone



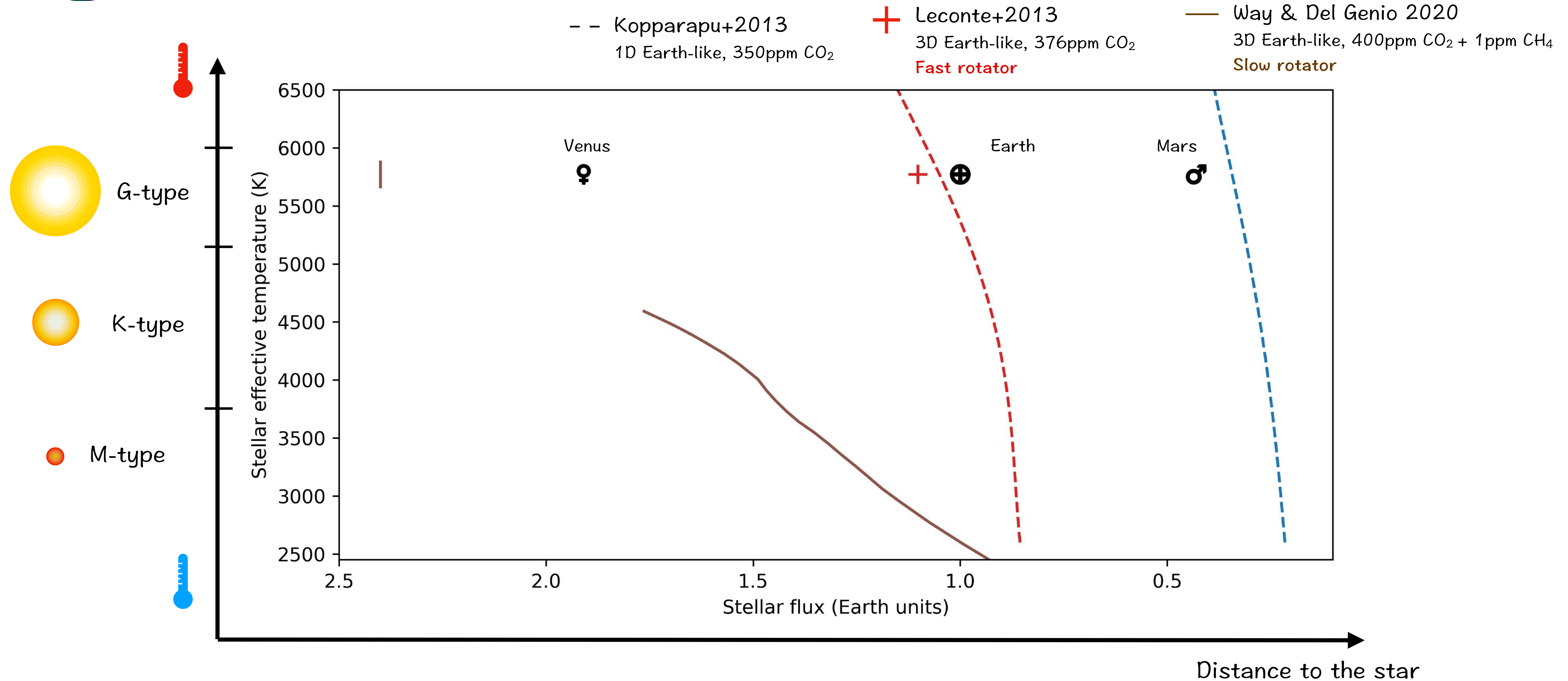


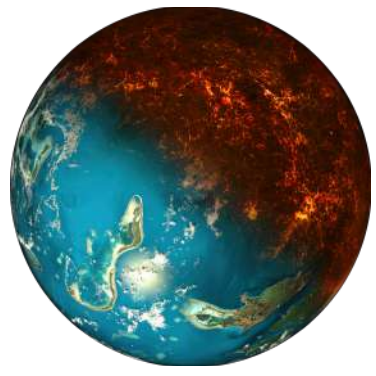
The Habitable Zone



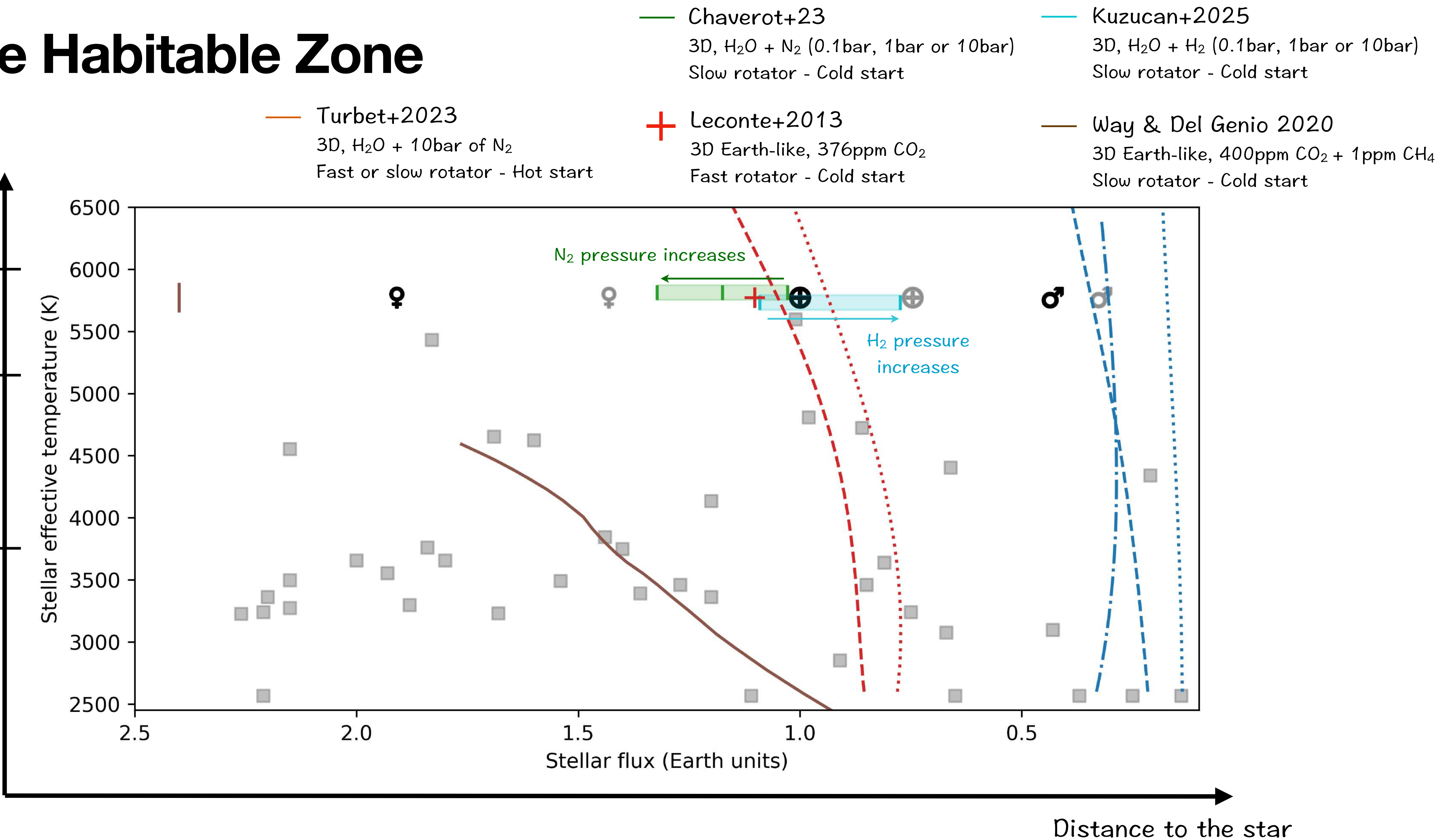
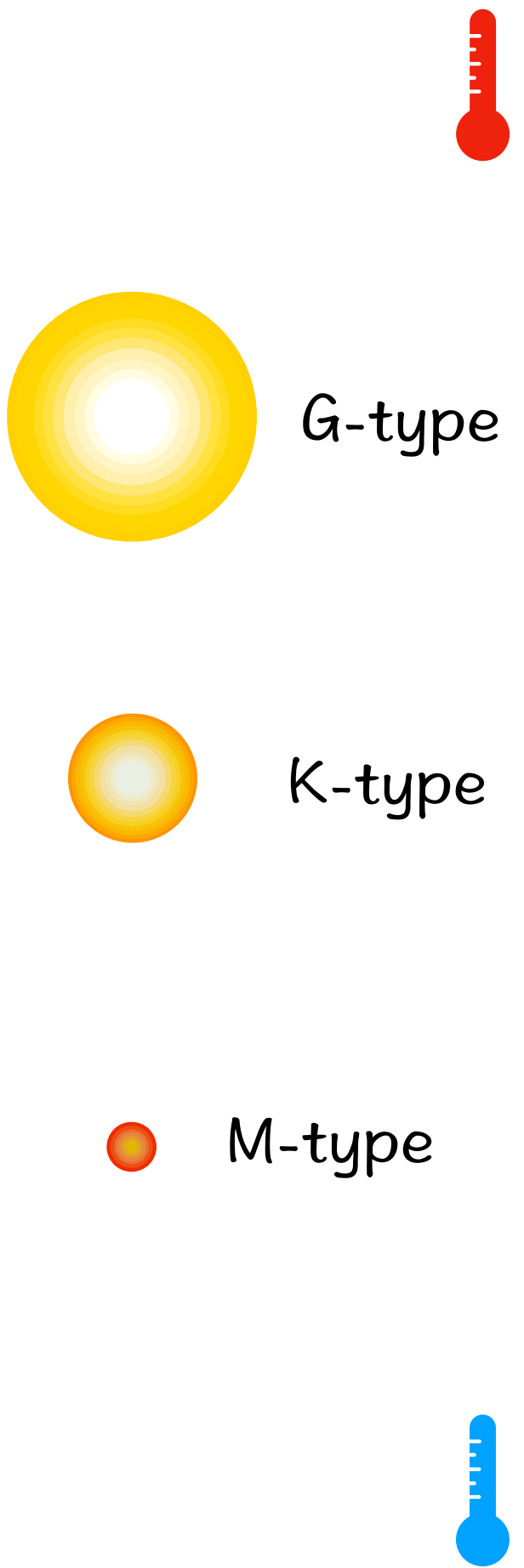


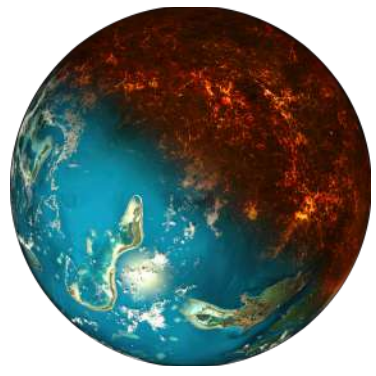
The Habitable Zone



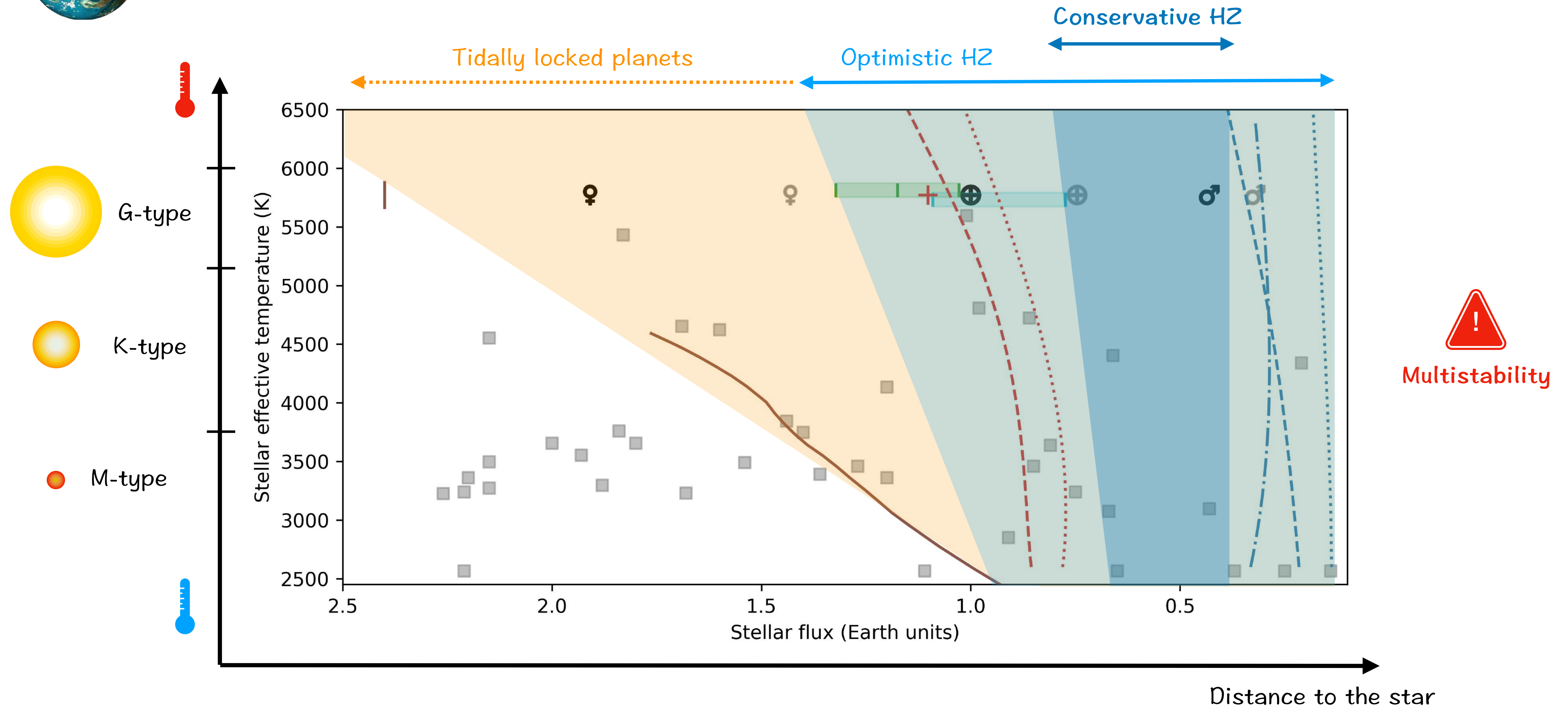


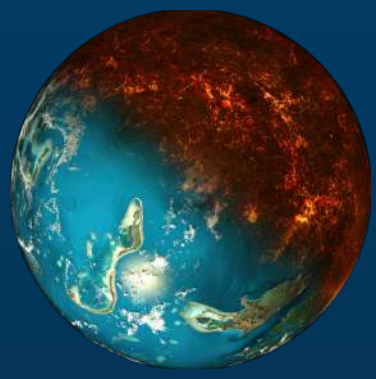
The Habitable Zone





The Habitable Zone





Planetary mass

Preliminary results

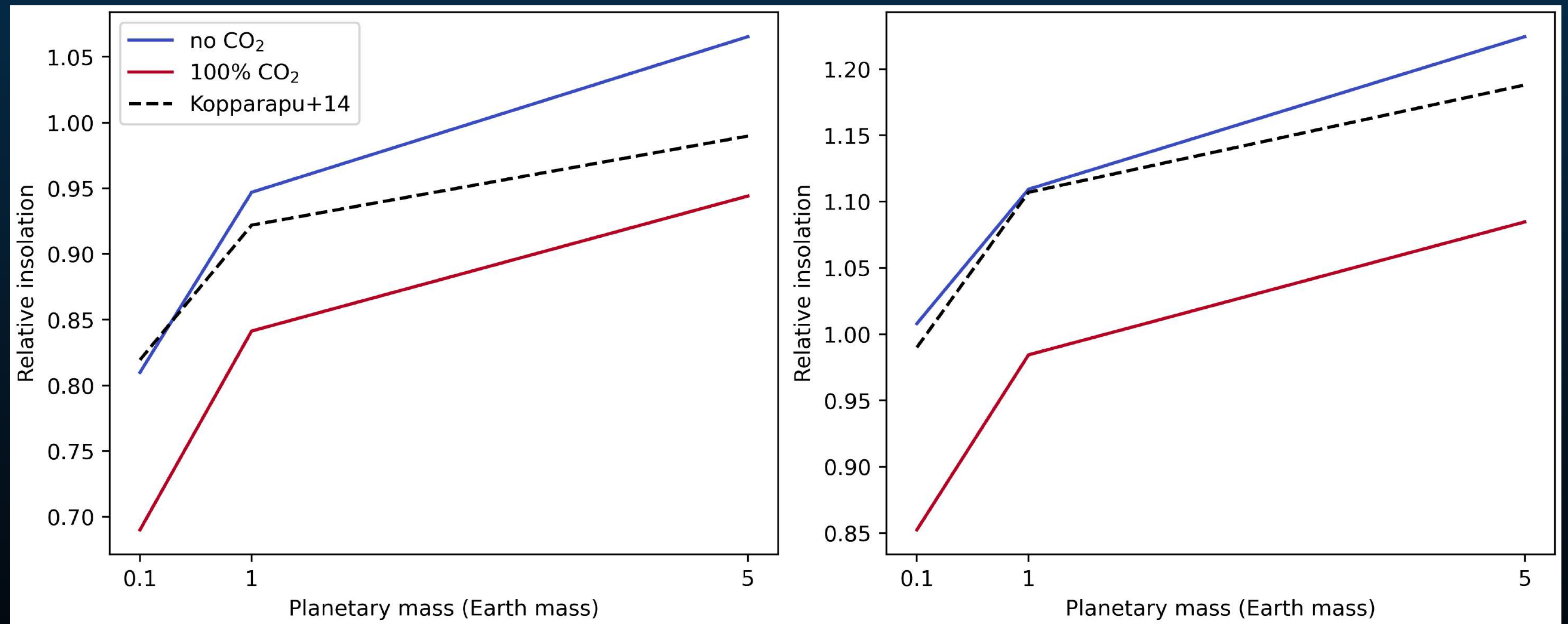
Master student internship
Nariman Al Zaher Noufal
co-supervision with L. Mignon

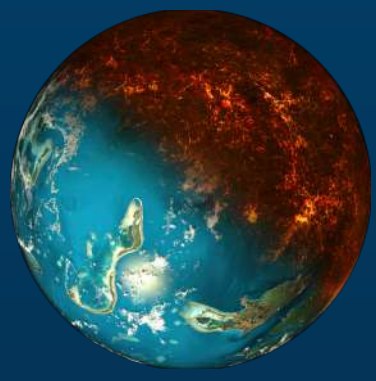


M-dwarf (3000K)

Sun

Toward
the star





Planetary mass

Preliminary results

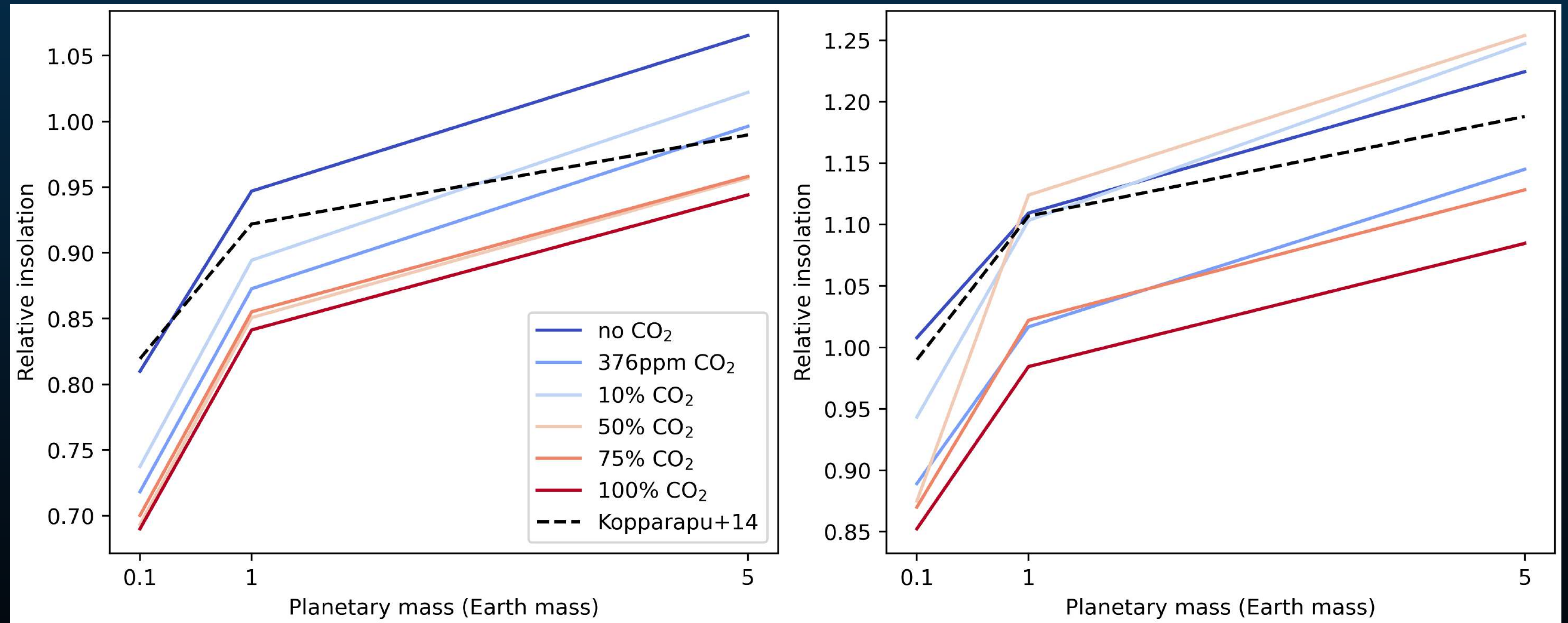
Master student internship
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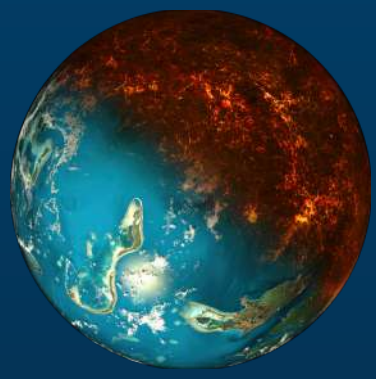


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Planetary mass

Preliminary results

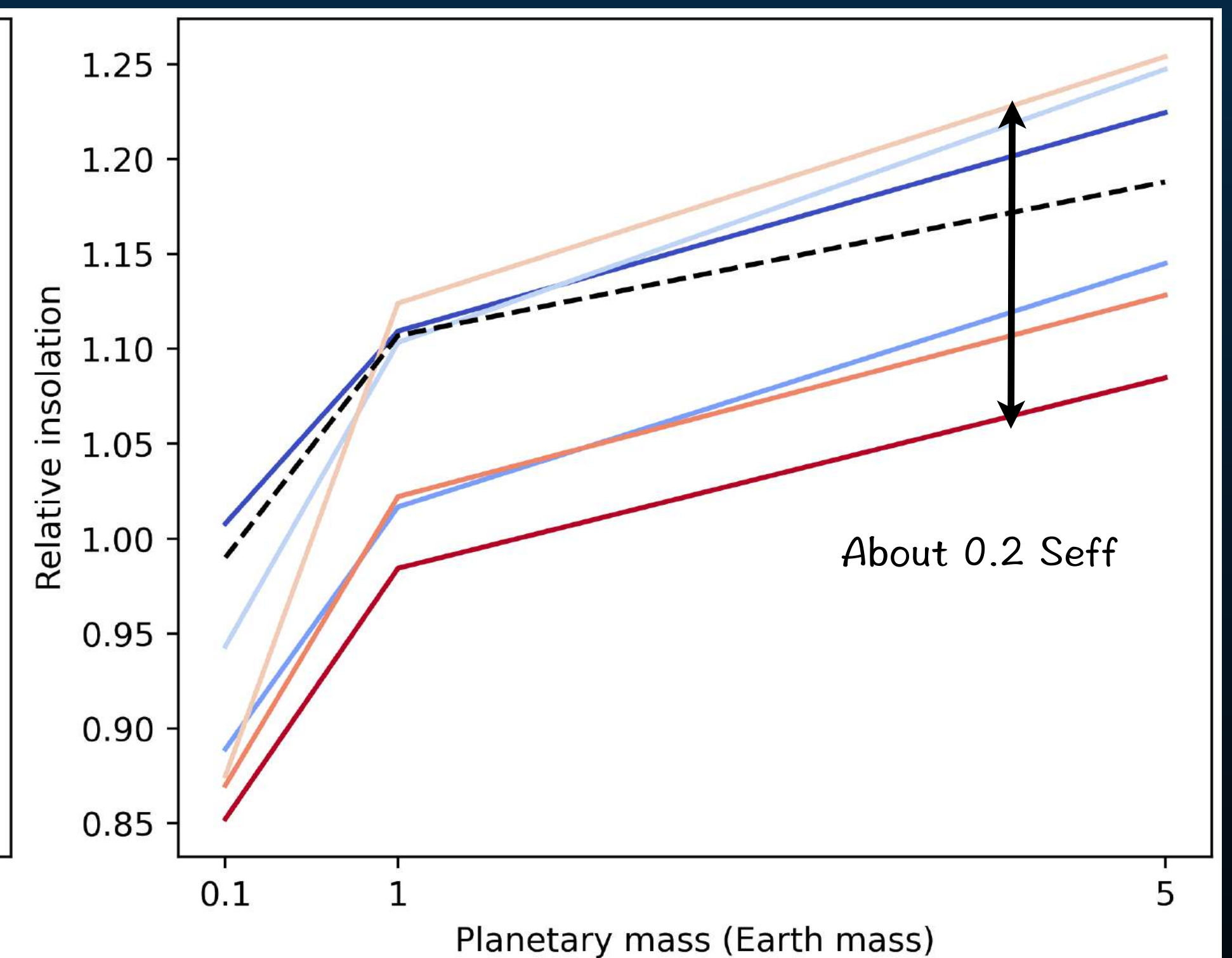
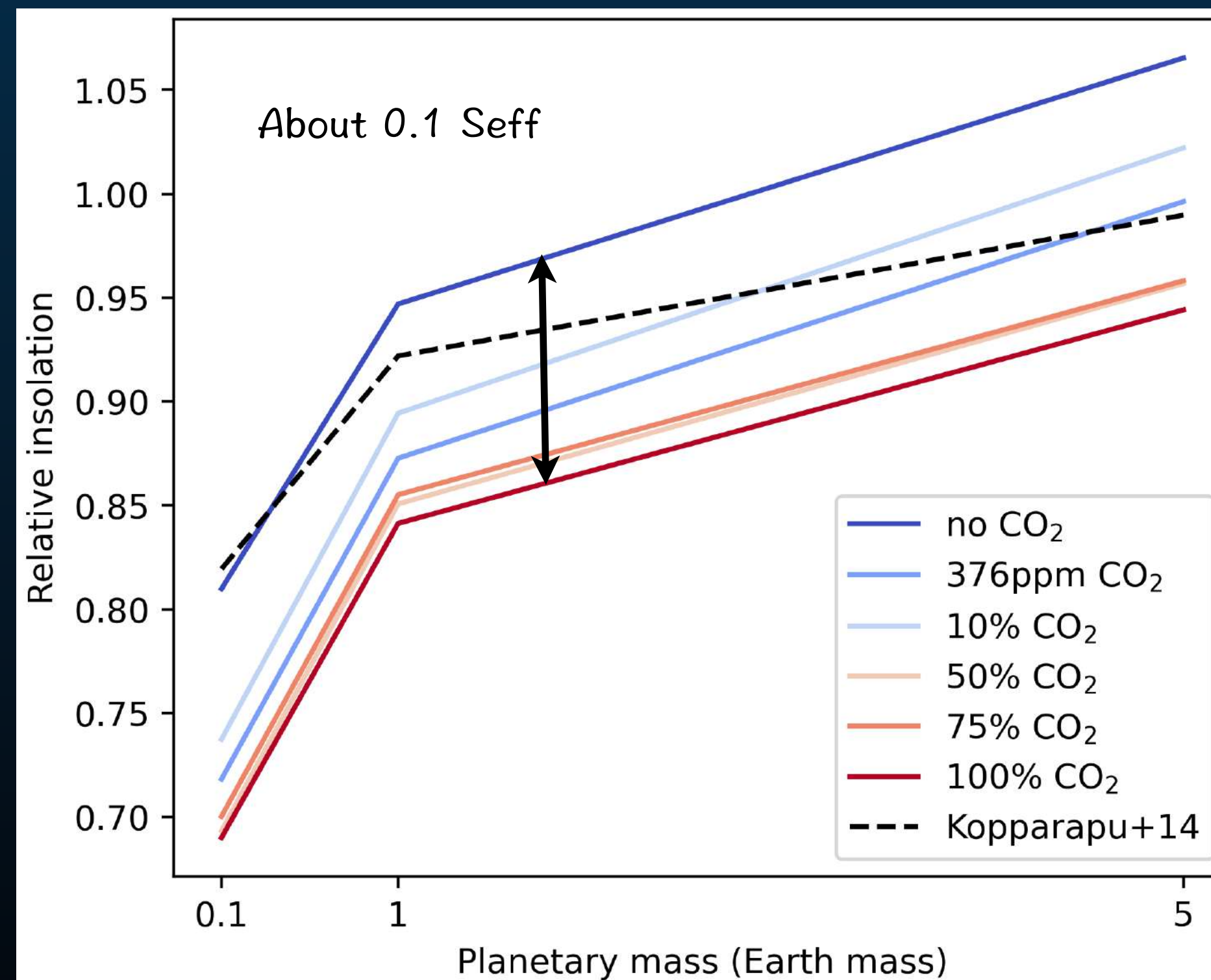
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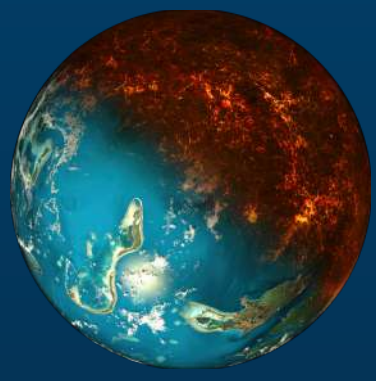


M-dwarf (3000K)

Sun

Toward
the star





Atmospheric pressure

Preliminary
results

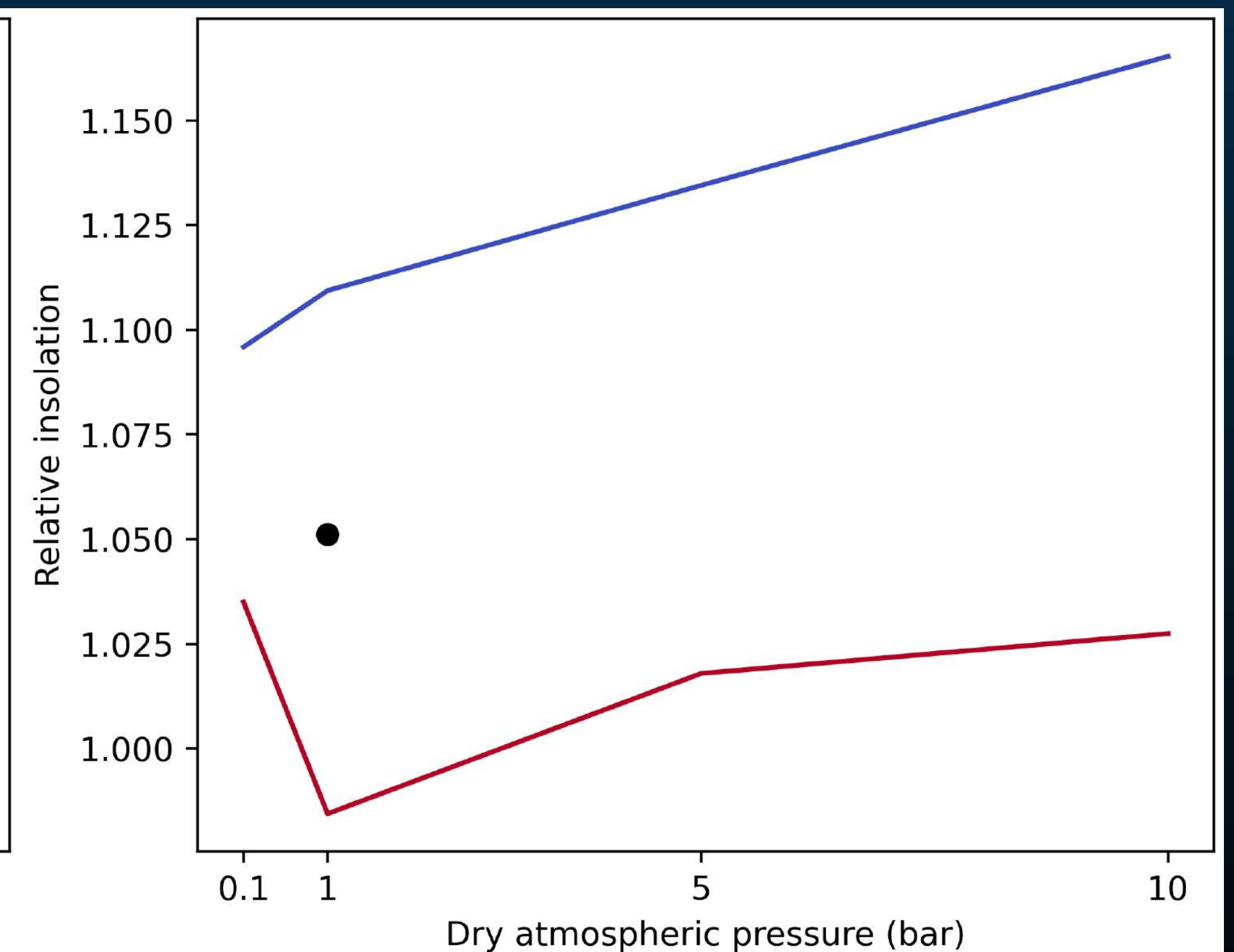
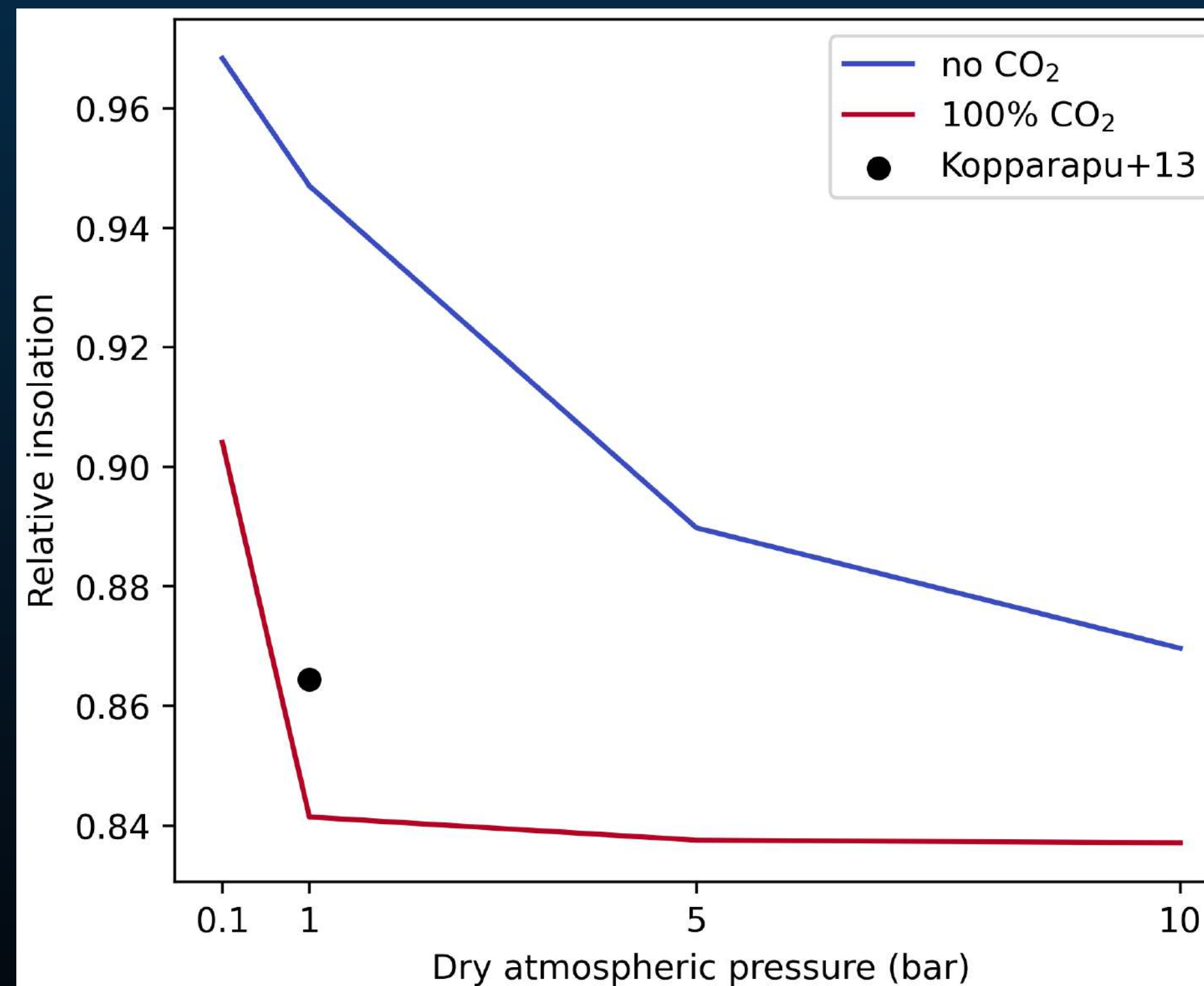
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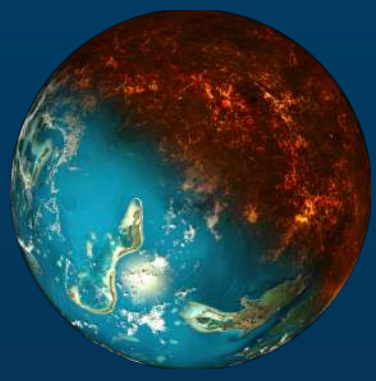


M-dwarf (3000K)

Sun

Toward
the star





Atmospheric pressure

Preliminary results

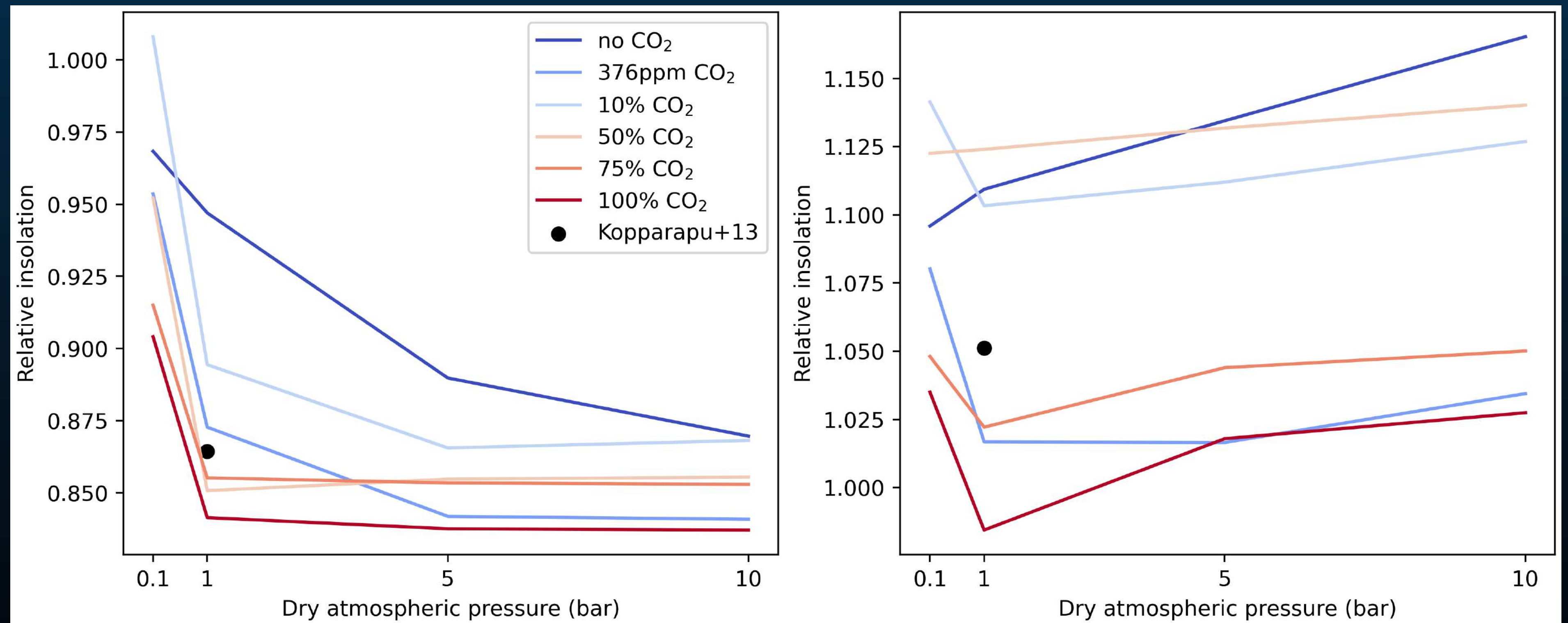
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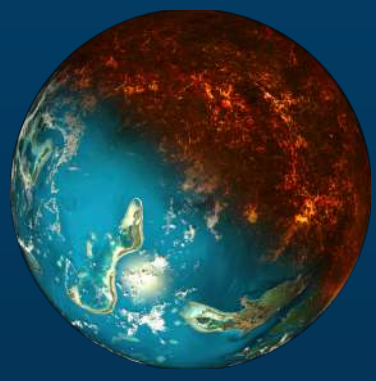


M-dwarf (3000K)

Sun

Toward
the star





Atmospheric composition

Preliminary
results

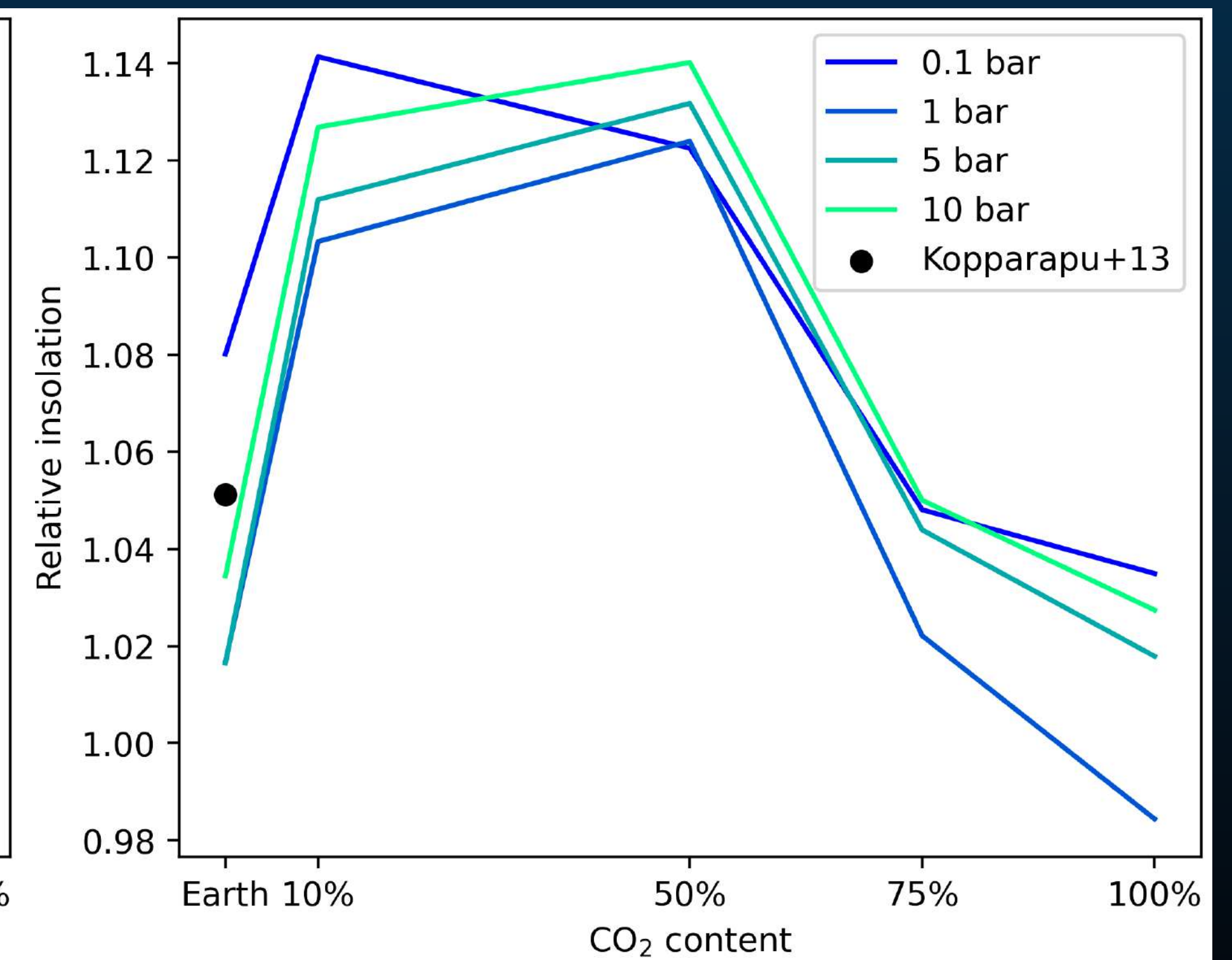
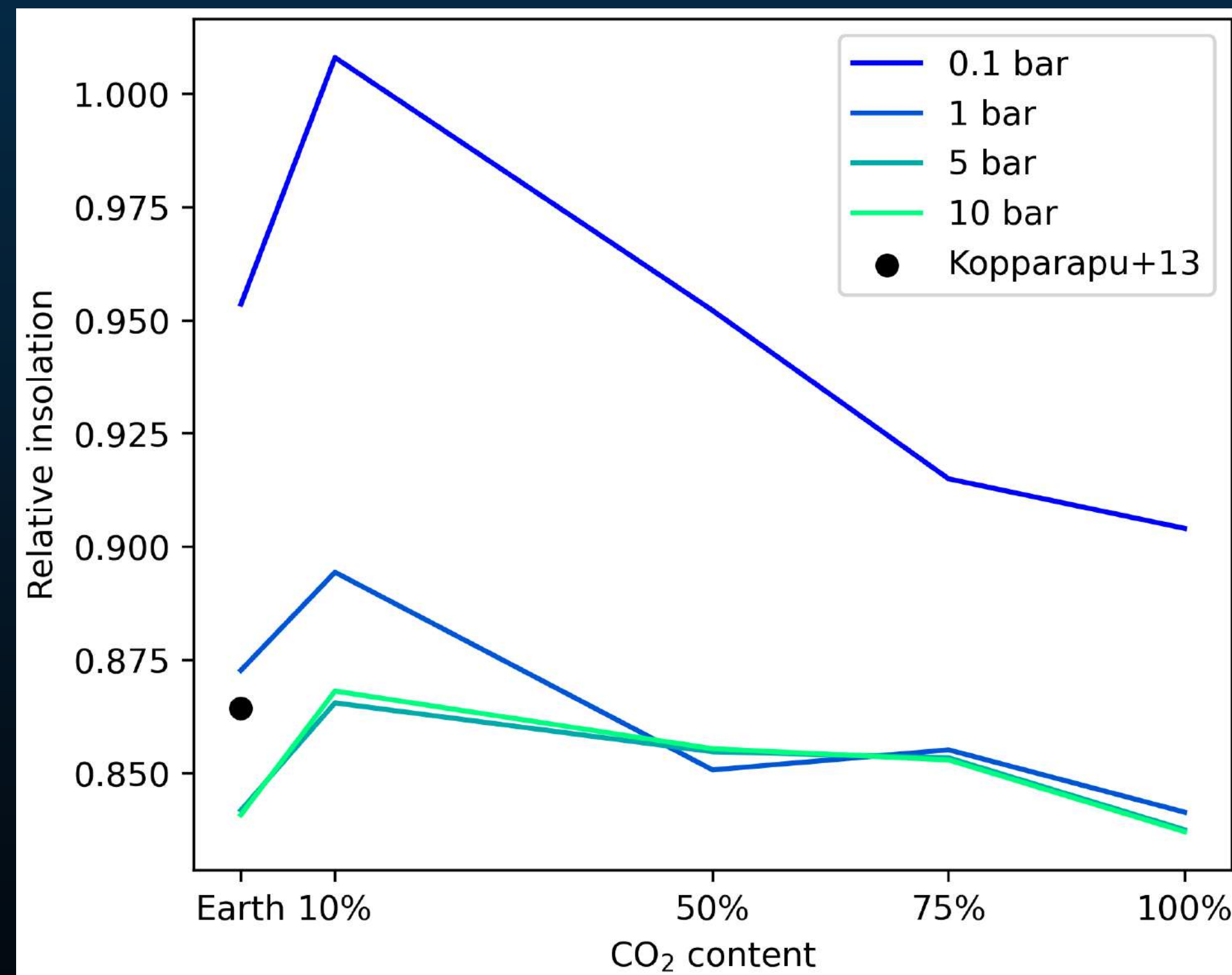
Master student internship
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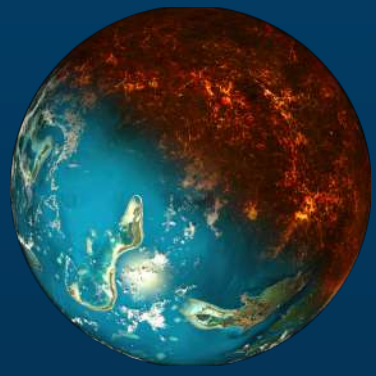


M-dwarf (3000K)

Sun

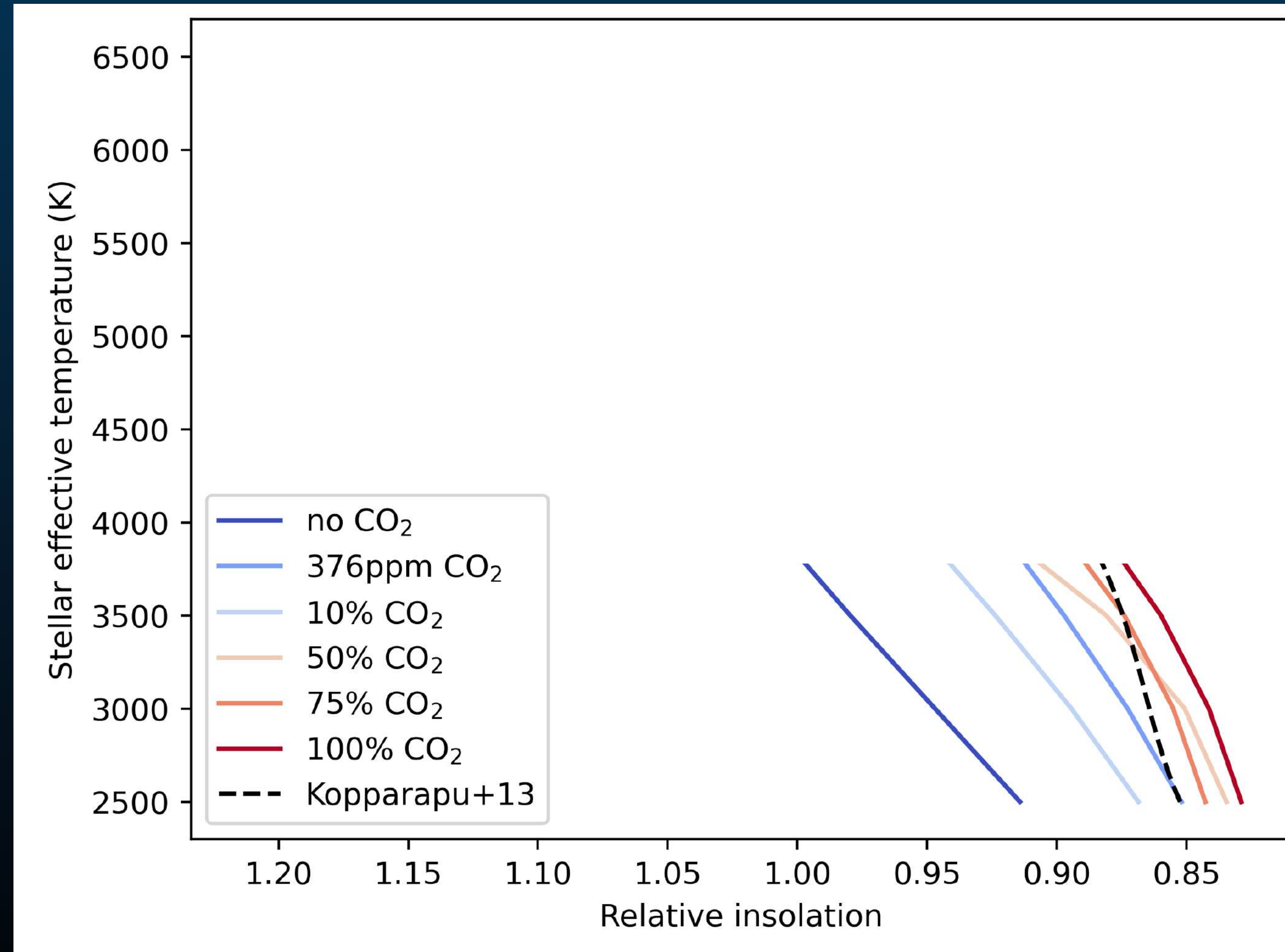
Toward
the star

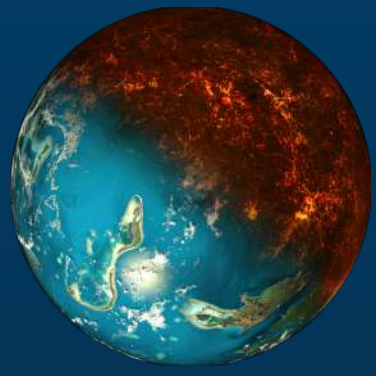




Various stellar types

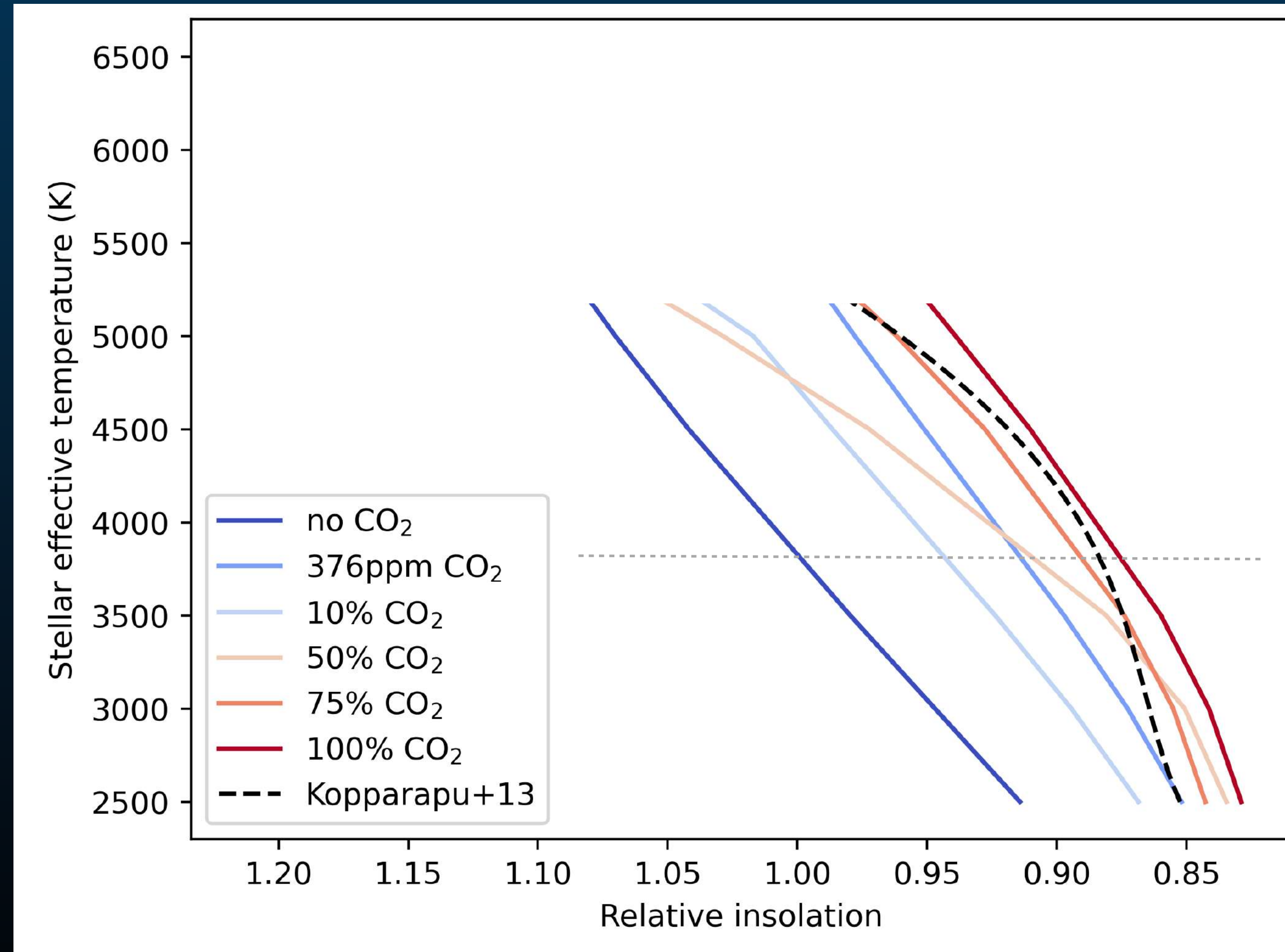
Preliminary
results

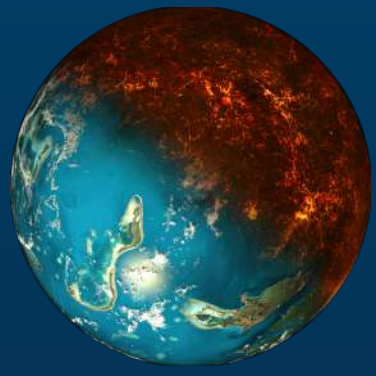




Various stellar types

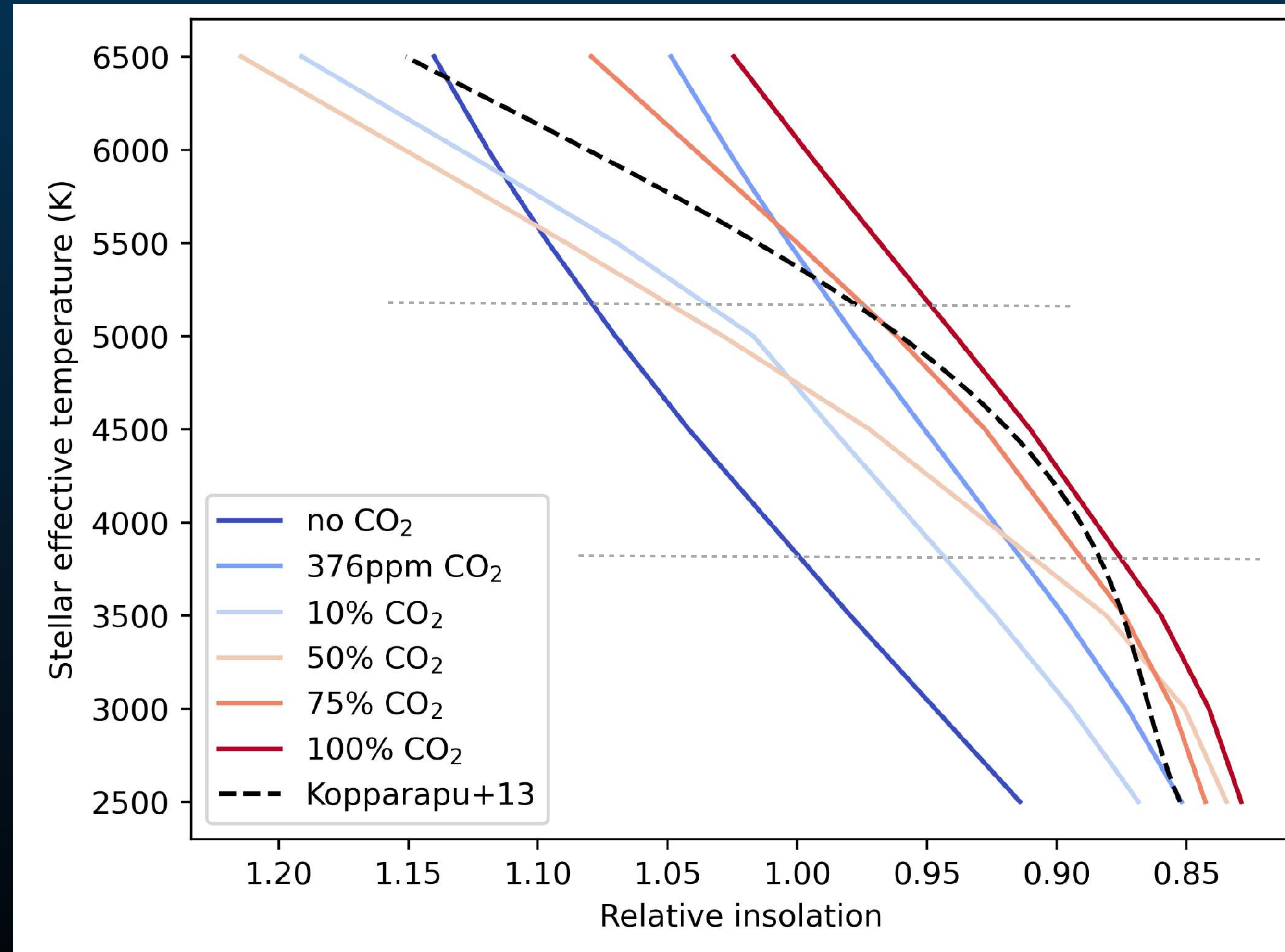
Preliminary
results

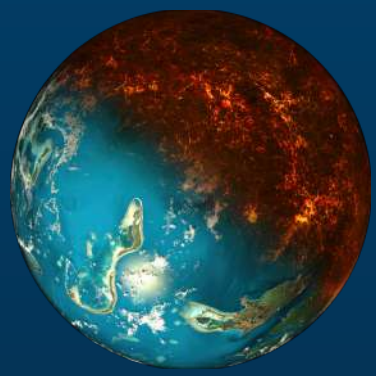




Various stellar types

Preliminary
results





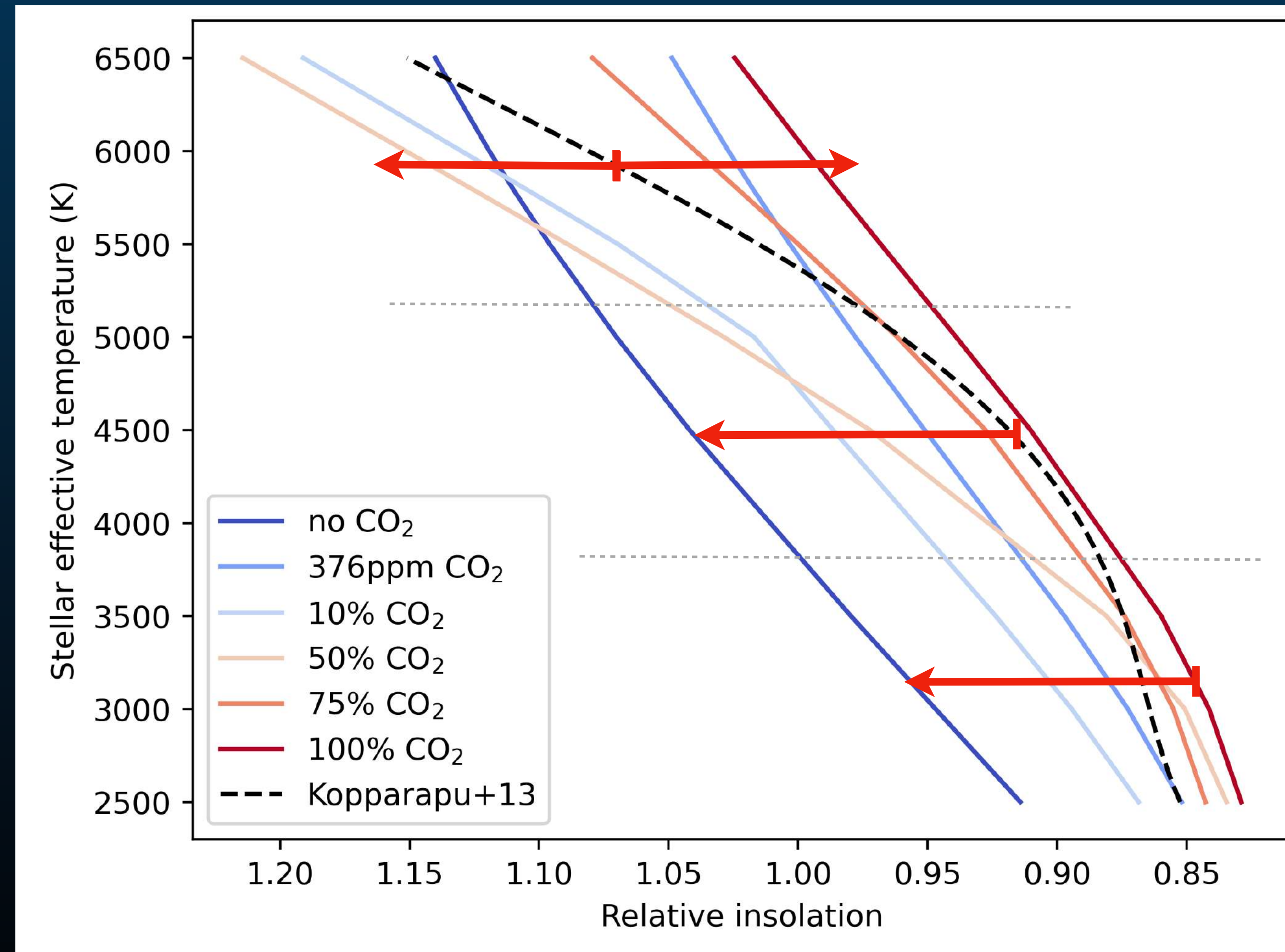
Various stellar types

Preliminary
results

G-type: uncertainty on
the inner edge

M-type: extends the HZ

M-dwarf: extends the HZ



Conclusions



1. Higher planetary mass = larger HZ
2. Non-linear effect of CO₂ -> greenhouse effect vs Rayleigh scattering
3. Impact of unknown atmospheric composition
 - extends the HZ for M and K type stars
 - add uncertainty for solar type stars

Bonus slides

