Land Surface Impacts from a Plausible Global Forestation Scenario

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Global Tree Planting Commitments

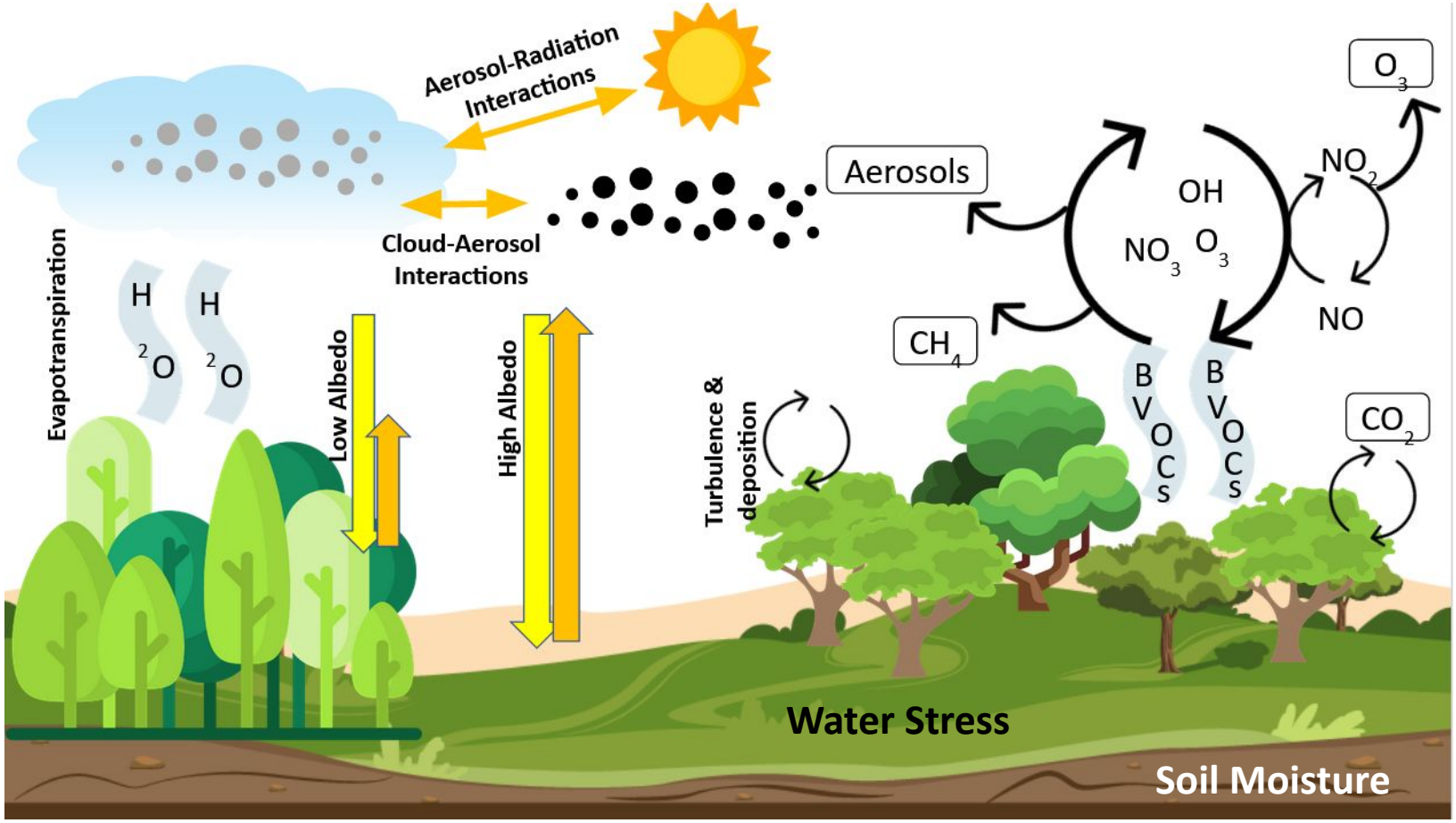
One billion trees to be planted in Ukraine in next three years – program

Press release

Government launches new scheme to boost tree-planting

£50 million Woodland Carbon Guarantee scheme will encourage farmers and landowners to plant more trees and help to tackle climate change

Environmental Impacts of Forests

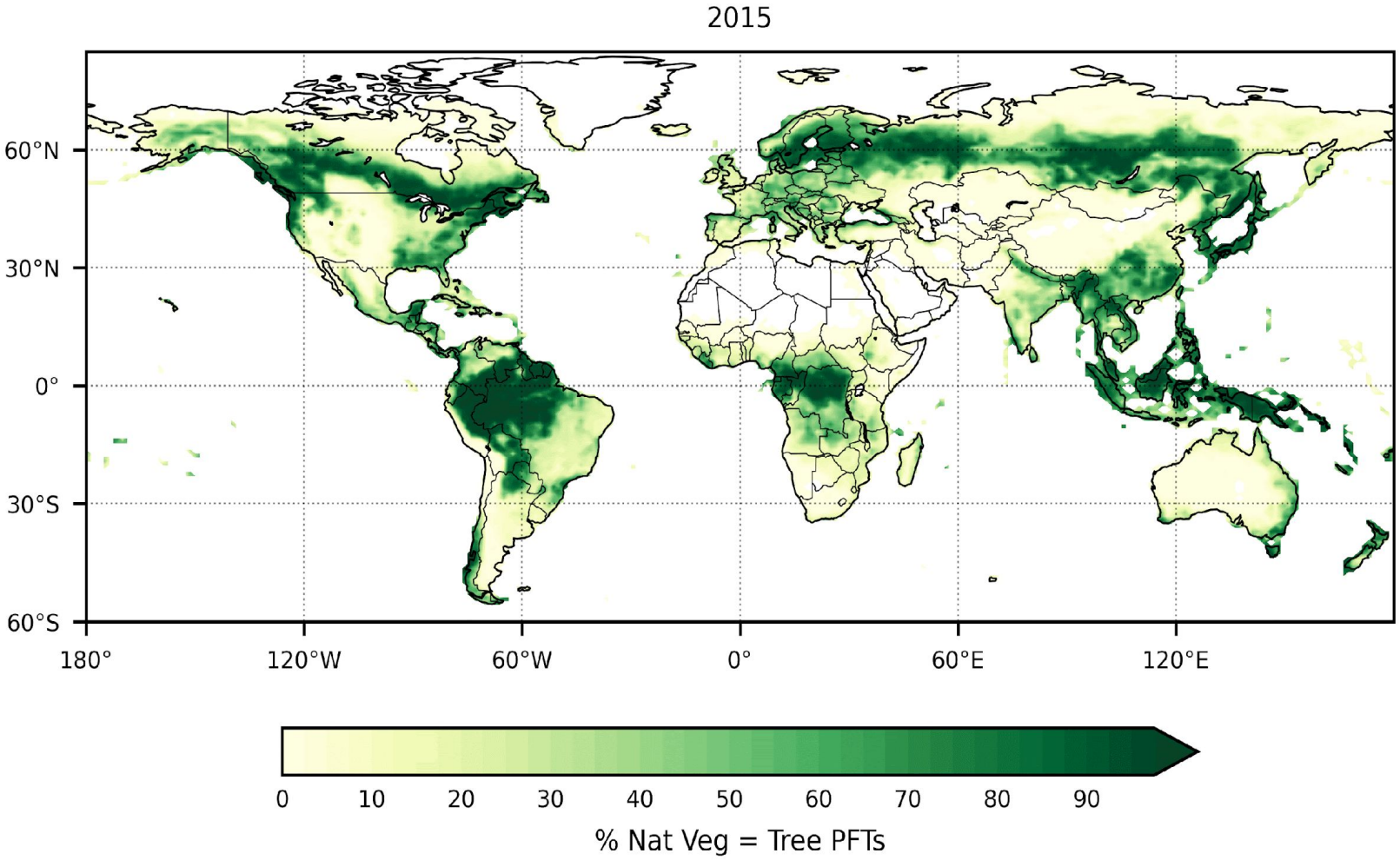


Cartoon courtesy of Maria Val Martin

Experimental Setup

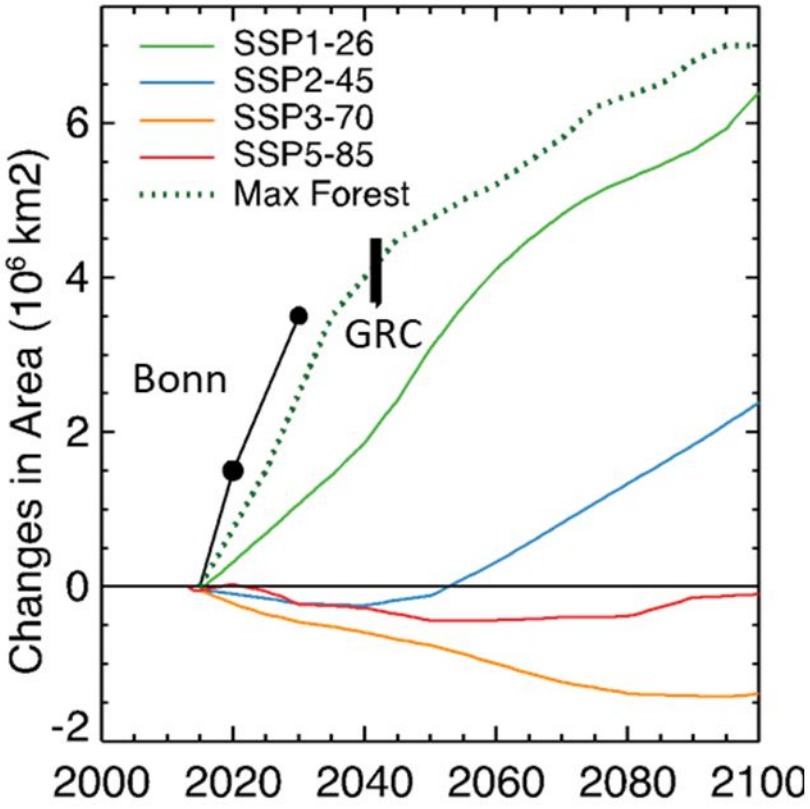
- CESM2.1.3 running on new UK HPC ARCHER2 – 750k cores, 28 Pflop/s (when it works)
- Fully coupled CESM2 runs with active ocean (POP), CLM5 BGC-CROP, TS1 atmospheric chemistry scheme, 0.9° x 1.25°
- SSP1-2.6 GHG concs/emissions
- Land use follows:
  - SSP1-2.6 Base
  - Max Forest
  - No LULCC control (held constant at 2015 levels)
- Transient model integrations over 2015-2100

The ‘Max Forest’ Scenario

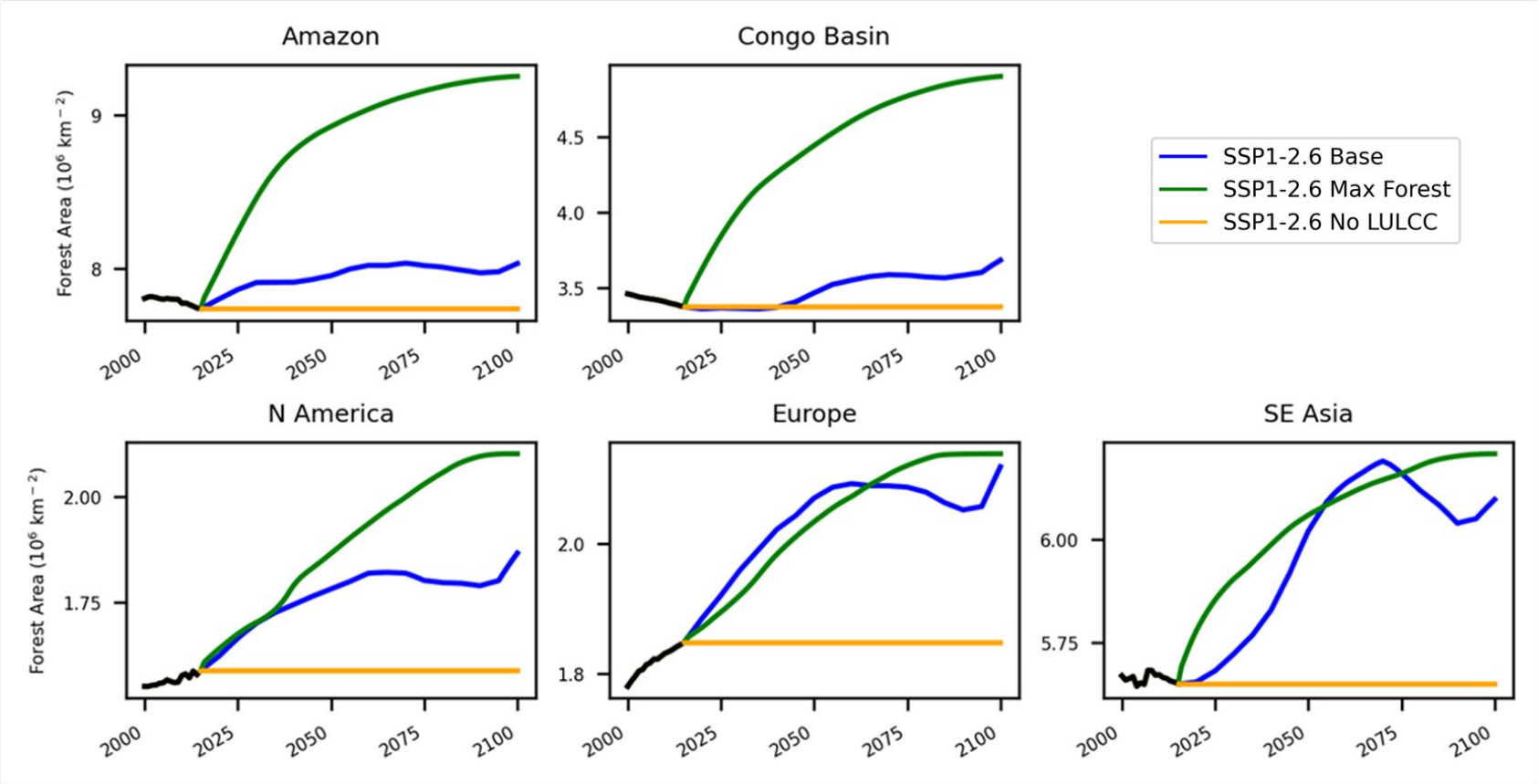


The ‘Max Forest’ Scenario in Context

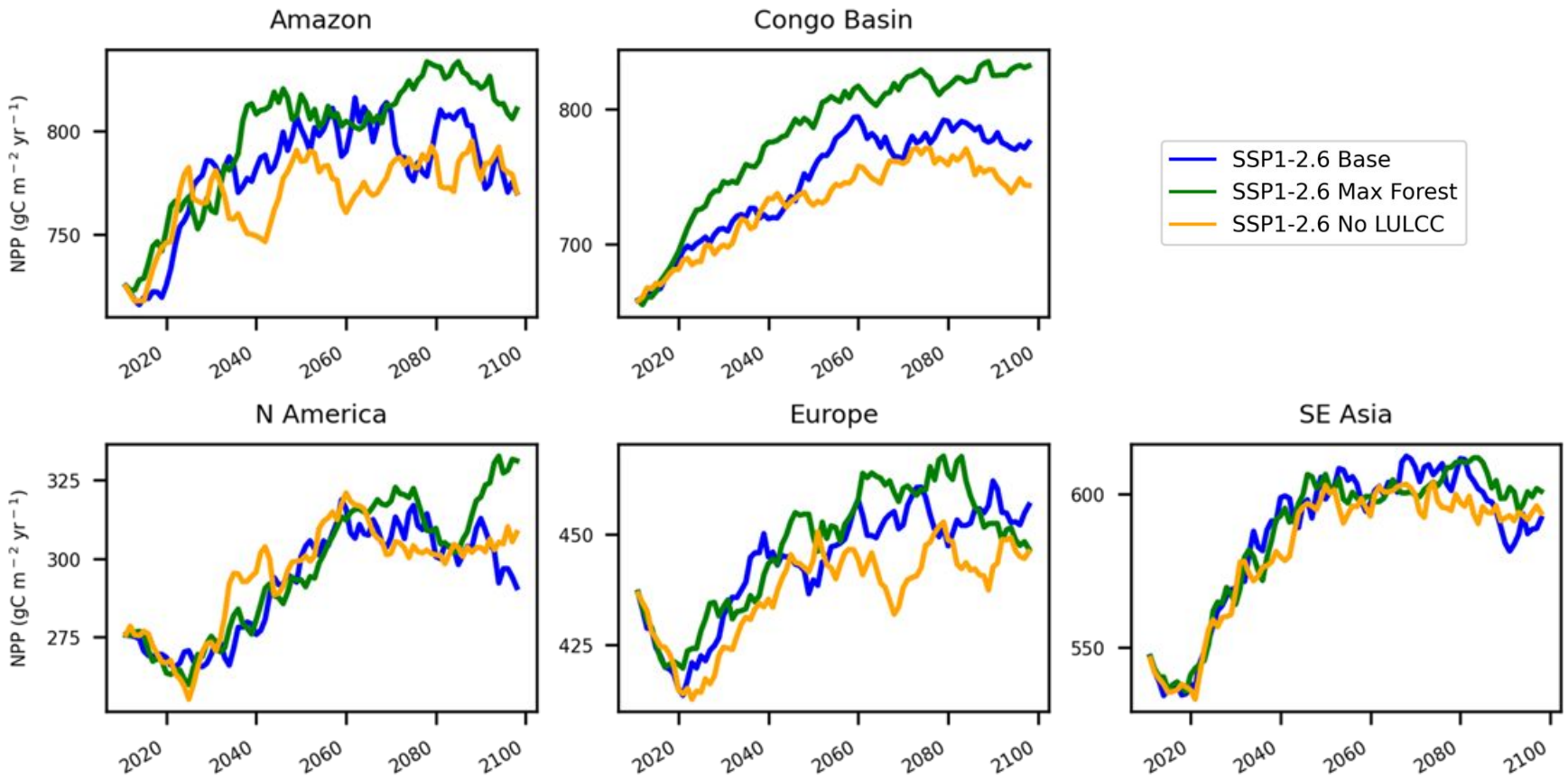
- Transient land use change scenario developed by P. Lawrence (NCAR) as part of study by Roe et al. (under review)
- Includes afforestation, reforestation, and forest restoration
- Forest expansion constrained by climatic suitability (Whittaker bioregions approach)
- Agricultural land held constant at 2015 levels (with some adjustments)
- Peak tree planting in mid-century, asymptotes towards 2100



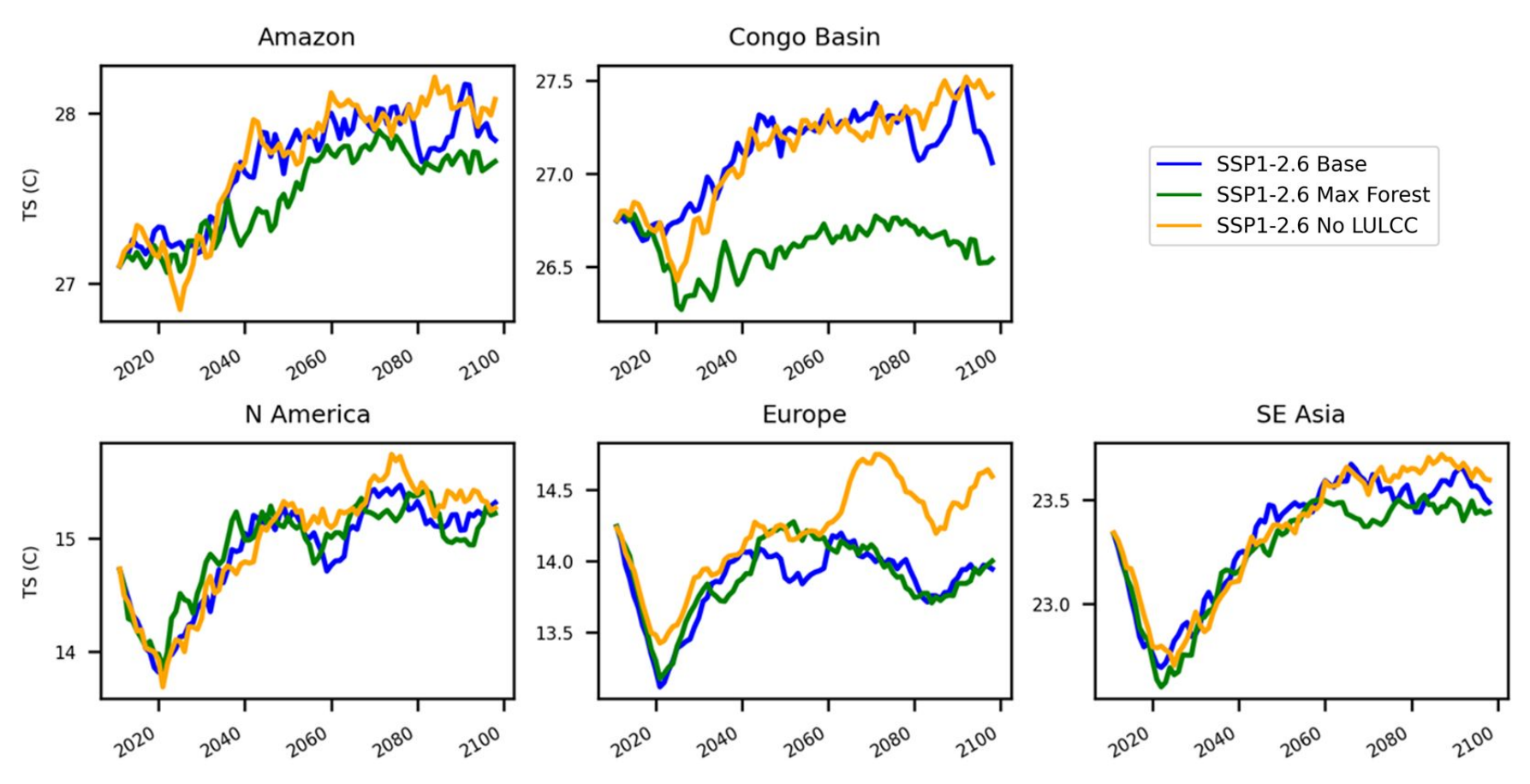
The ‘Max Forest’ Scenario in Context



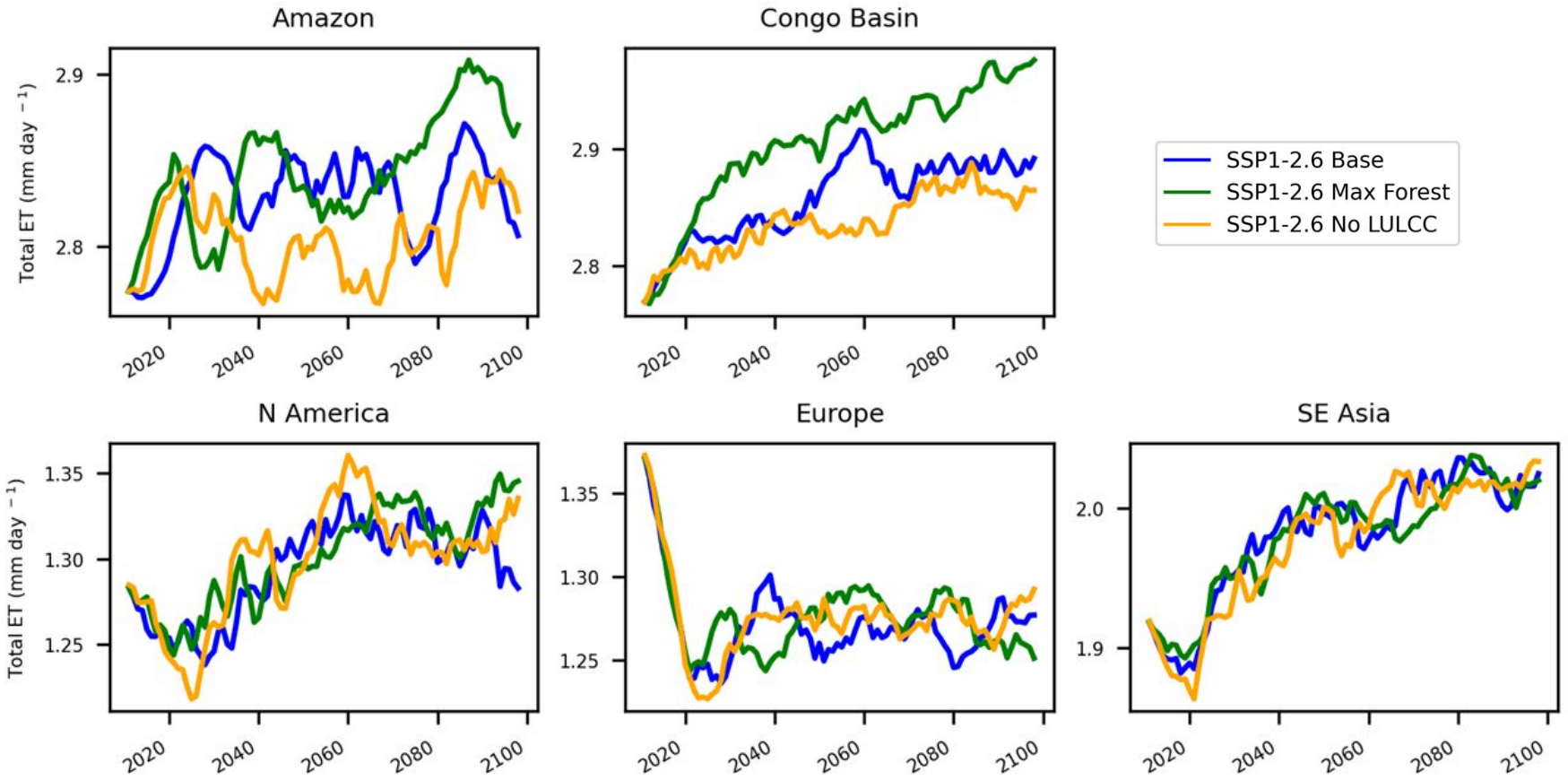
Results - NPP


Amazon
Congo Basin
N America
Europe
SE Asia
NPP (gC m⁻² yr⁻¹)
800
750
700
325
300
275
450
425
600
550
2020
2040
2060
2080
2100
SSP1-2.6 Base
SSP1-2.6 Max Forest
SSP1-2.6 No LULCC

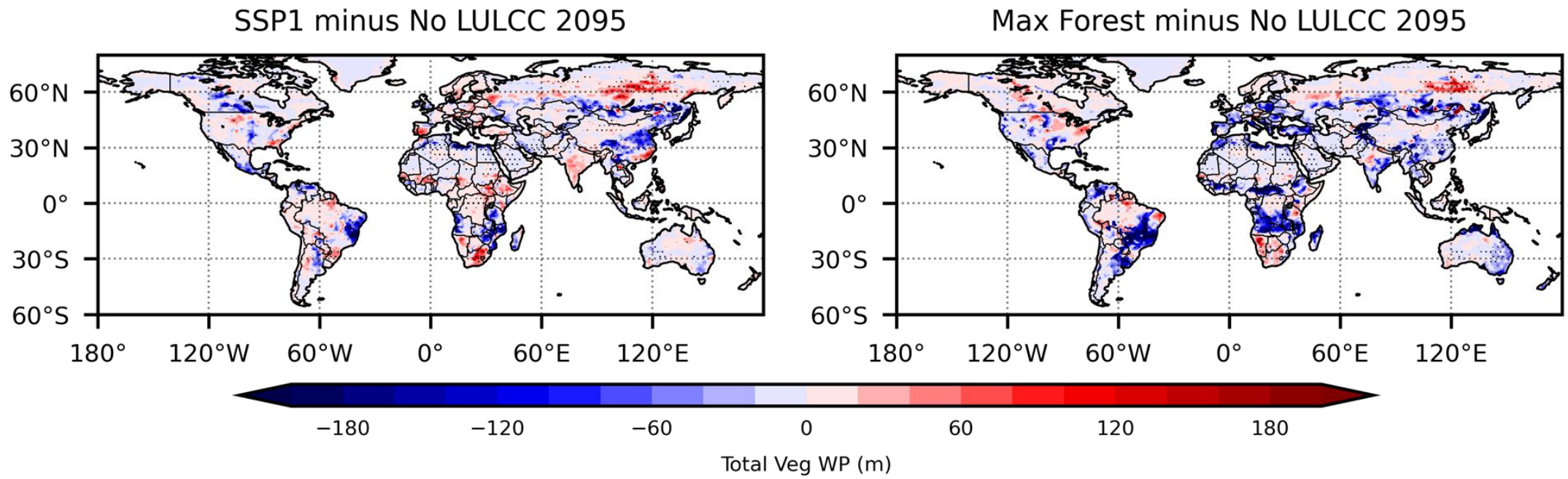
Results – Surface Temperature



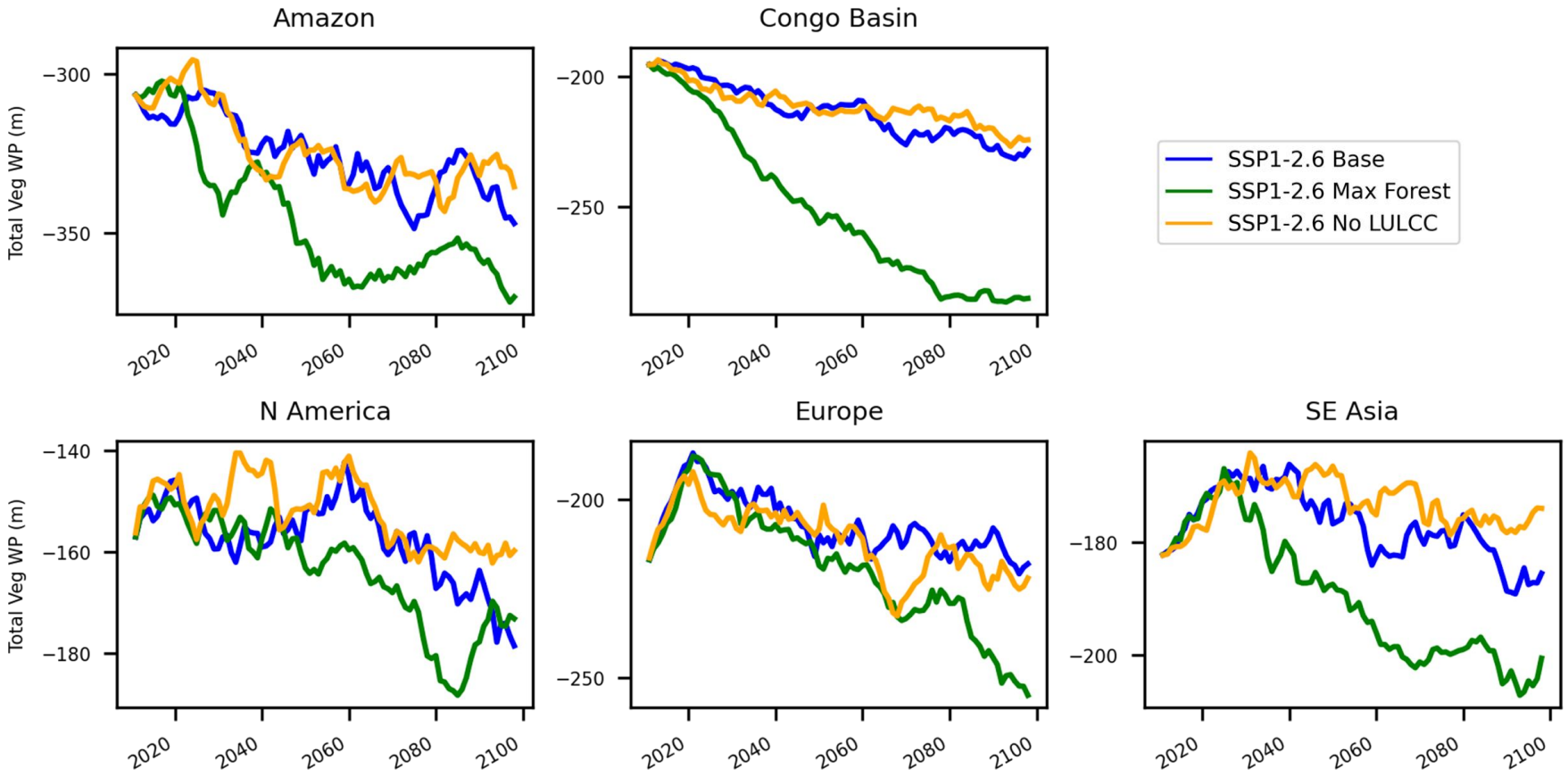
Results - Evapotranspiration



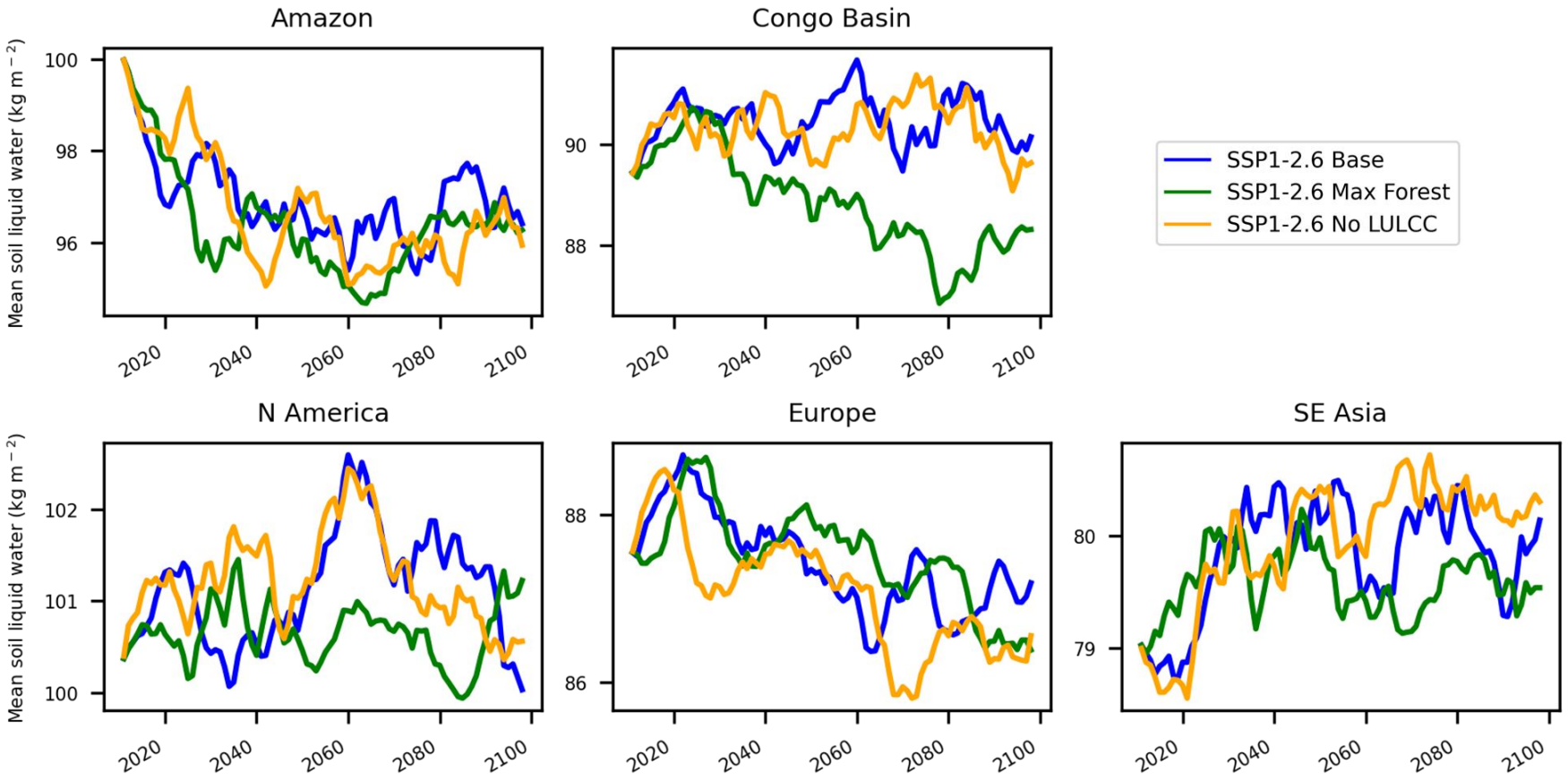
Results – Vegetation Water Potential



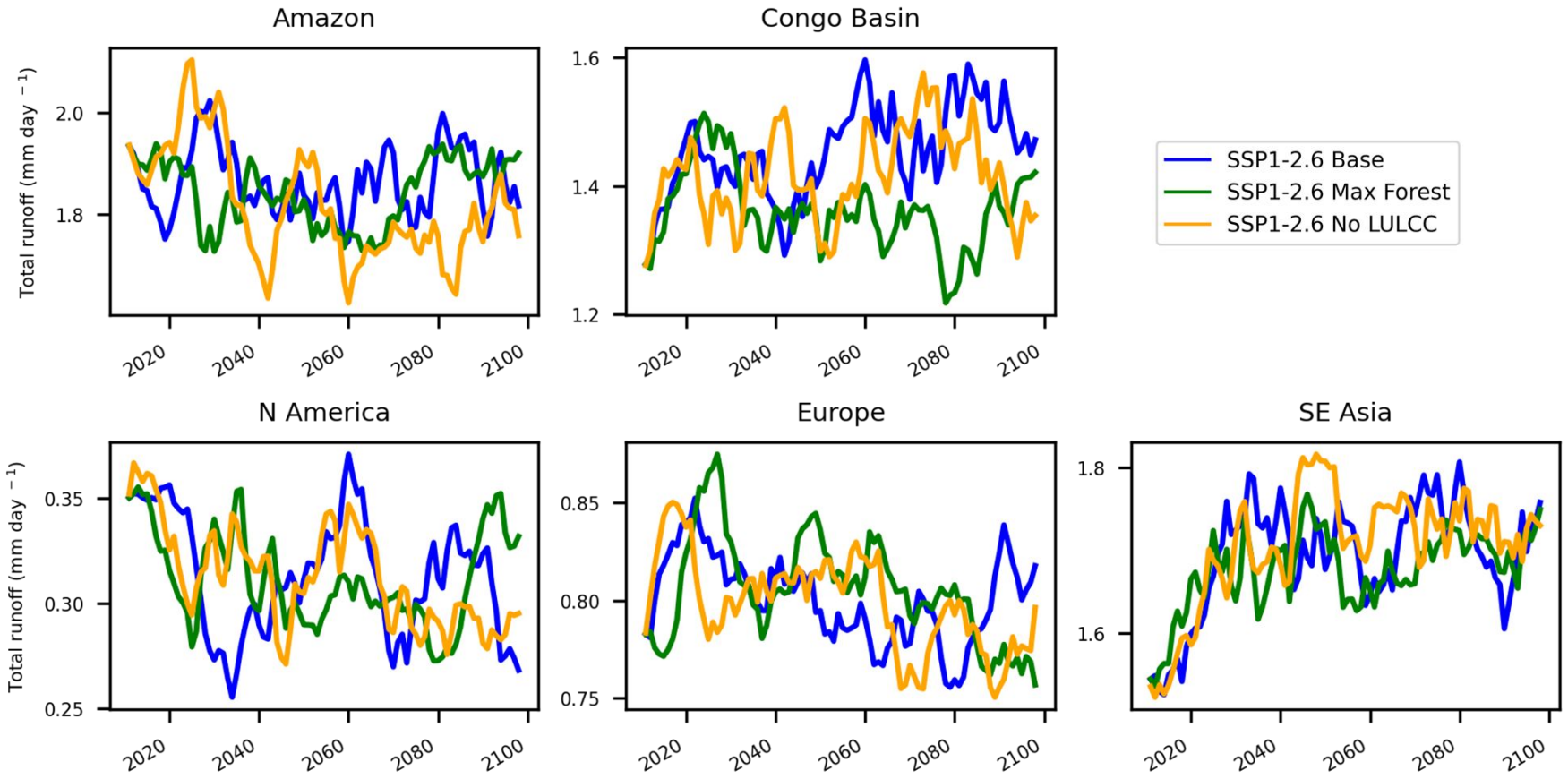
Results – Vegetation Water Potential



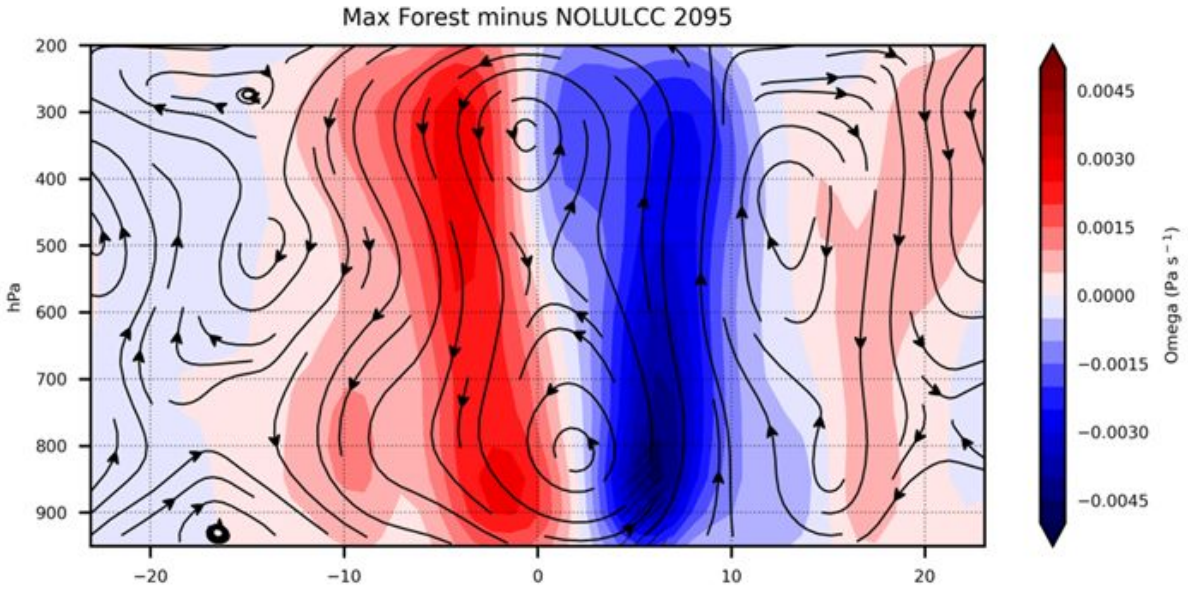
Results – Soil Moisture

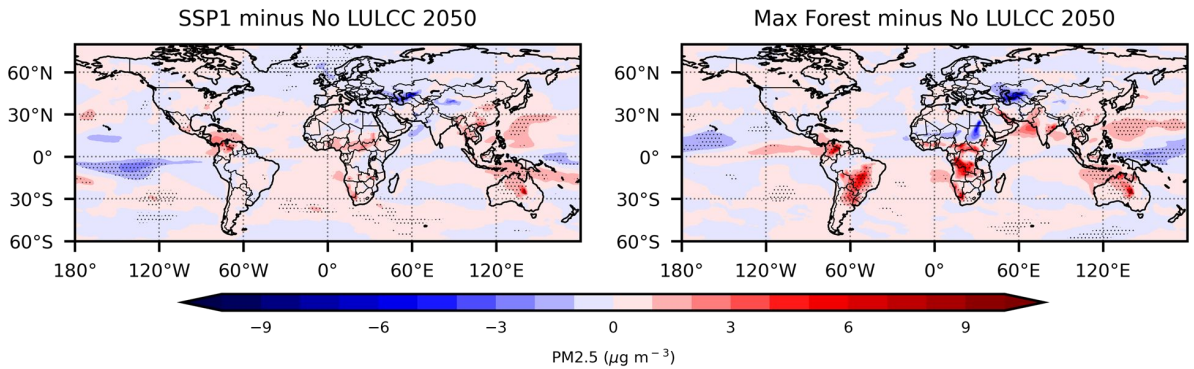


Results – Runoff



Other Work – Air Quality, Chemistry, Dynamics…





Conclusions

- In a plausible global reforestation scenario:
  - Increasing forest cover increases NPP, enhancing CDR potential
  - Surface warming is mitigated, especially in tropical forests
  - Evapotranspiration and latent heat flux is enhanced
  - This results from increased water demand from trees vs. other PFTs
  - Consequently, water stress on plants increases and soil moisture is affected, but we don’t see a clear signal from runoff (possibly because no clear precip trends)
  - Comments and feedback from the community are welcome – what should we look at? What have we missed?

Results - CDR Potential