Increase in CO2

A climate forcing leads to a change in the energy balance of earth.

Earth responds by changing its characteristics.

Largest method of doing this is a change in temperature.
Surface Air Temperature

White is not significant
Surface Air Temp.

- Significant increase in temp everywhere.
- Maximum in Arctic (Arctic Amplification)
- Land warms more than ocean (c.f. COWL pattern)
- Smallest warming in Southern Ocean/North Atlantic - both areas of strong vertical heat transports in the ocean.
- Large warming in Amazon Basin (not found in all models).
Sea Surface Temps
Sea Surf. Temps

- Similar structure to SAT pattern.
- Don’t see same size warming in Arctic, because sea-ice forms a barrier in winter (Barents Sea has little sea-ice in winter).
- Preferential warming to eastern side of equatorial Pacific and western side of Indian.
- Shallowing of equatorial thermocline.
Precipitation

Change as a fraction of initial rainfall
Precipitation

- Increase in extra-tropics and decrease in tropics
- Relating to enhanced moisture transport of warmer air.
- Northward shift of ITCZ (Northern hemisphere warms more than Southern).
- Increase in rainfall in equatorial Pacific, and decrease over Amazon (similar to El Nino).
- Due to warmer SSTs in E Eq. Pacific.
SSS

- Echoes parts of precipitation pattern.
- Salinification of equatorial Atlantic.
- Freshening of North Atlantic - effects on Thermohaline circulation.
- Strong salinity changes in East Siberian Sea (which I don’t understand)
Tropical Thermocline

Before

No Significance testing

After
Eq. Pacific Response

- Same amount of heat flux goes into mixed layer; so the thin bit heats more.
- Warm pool *expands* eastwards (rather than *shifting* eastwards as in El Nino)
- Sends Kelvin waves east - causing anomalous descent over Amazon.
- Suppresses convection there, allowing more solar radiation onto surface
- Hence Amazon preferentially warms. (carbon feedbacks enhance this)
Thermohaline Circ.

Colour = Temp change (K), white is “no change”,
Contours = circulation change in Sv
THC

~ Temperature increase doesn’t percolate to depths of ocean in 70 yrs.

~ Circulation partly driven by sinking in North Atlantic.

~ Warming and freshening of surface increases stratification - capping convection.

~ Reduction of ~4 Sv (20-30%), but exact value uncertain due to high natural variability.
HadCM3 References

~ Climate Change


~ Plus, of course, the IPCC.

~ Model Description


