1. Projections using the SRES Scenarios

- The Special Report on Emission Scenarios (SRES) built storylines of possible futures based on factors like population growth, economic integration or isolation, energy choices, technology, and policy.

- Four main families:
  - A1 and A2 emphasize strong economic growth (A1 = globalized, A2 = regional).
  - B1 and B2 emphasize environmental sustainability (B1 = globalized, B2 = regional).

- The A1 family splits into:
  - A1FI - fossil-fuel intensive, “business as usual”,
  - A1T - transition to non-fossil energy,
  - A1B - balanced mix.

- Emissions from these storylines were fed into climate models. By 2100, projected warming varies widely, from modest increases under B1/B2 to high temperatures under A1FI. Also, no probabilities or preferences are assigned: the goal is to span a plausible range, not pick a “most likely” path.

2. Radiative Forcing Approach (RCPs)

- Representative Concentration Pathways (RCPs) reverse the logic:
  - They start with defined endpoints for radiative forcing, extra energy added to the climate system relative to pre-industrial, by 2100,
  - Emission trajectories are then designed to reach these targets, and researchers infer socio-economic futures that could produce those pathways.

- RCP2.6 requires rapid emissions decline, possibly negative emissions (carbon capture). RCP4.5 and RCP6 stabilize later, while RCP8.5 continues rising well past 2100, “business as usual”.

- RCP data include land use, air pollutants, and greenhouse gases at fine spatial resolution, harmonized with historical observations.

- Extended Concentration Pathways (ECPs) carry RCPs out to 2300 to capture long-term effects like sea-level rise and CO_2 residence times.

3. Main Uncertainties in Projecting Future Emissions and Climate Impacts

- Human choices & socio-economic factors: Population growth, energy transitions, economic development, technology adoption,(carbon capture), and policy actions are unpredictable.

- Technological and geopolitical surprises: Events like pandemics, wars, or breakthroughs in renewables can disrupt emission trajectories.

- Integrated Assessment Model (IAM) assumptions: Criticisms include reliance on uncertain technologies (large-scale bioenergy + carbon capture), oversimplified land-use dynamics, and possible political pressures on scenario design.

- Carbon cycle and feedbacks: Uncertainty in how much CO2 oceans and land will absorb, and potential climate-carbon feedbacks.

- Non-CO2 forcings: Aerosols, methane, black carbon, and nitrogen/sulfur deposition are harder to measure and model precisely.

- Long-term projections: Extending scenarios to 2300 compounds errors, climate sensitivity, ice-sheet dynamics, and sea-level rise remain uncertain on century timescales.

- Equity and regional dynamics: Disagreements about which nations bear responsibility or are blamed for emissions, and how mitigation burdens are shared.