

**Table 2.11.** Uncertainty assessment of forcing agents discussed in this chapter. Evidence for the forcing is given a grade (A to C), with A implying strong evidence and C insufficient evidence. The degree of consensus among forcing estimates is given a 1, 2 or 3 grade, where grade 1 implies a good deal of consensus and grade 3 implies an insufficient consensus. From these two factors, a level of scientific understanding is determined (LOSU). Uncertainties are in approximate order of importance with first-order uncertainties listed first.

	Evidence	Consensus	LOSU	Certainties	Uncertainties	Basis of RF range
LLGHGs	A	1	High	Past and present concentrations; spectroscopy	Pre-industrial concentrations of some species; vertical profile in stratosphere; spectroscopic strength of minor gases	Uncertainty assessment of measured trends from different observed data sets and differences between radiative transfer models
Stratospheric ozone	A	2	Medium	Measured trends and its vertical profile since 1980; cooling of stratosphere; spectroscopy	Changes prior to 1970; trends near tropopause; effect of recent trends	Range of model results weighted to calculations employing trustworthy observed ozone trend data
Tropospheric ozone	A	2	Medium	Present-day concentration at surface and some knowledge of vertical and spatial structure of concentrations and emissions; spectroscopy	Pre-industrial values and role of changes in lightning; vertical structure of trends near tropopause; aspects of emissions and chemistry	Range of published model results, upper bound increased to account for anthropogenic trend in lightning
Stratospheric water vapour from CH <sub>4</sub>	A	3	Low	Global trends since 1990; CH <sub>4</sub> contribution to trend; spectroscopy	Global trends prior to 1990; radiative transfer in climate models; CTM models of CH <sub>4</sub> oxidation	Range based on uncertainties in CH <sub>4</sub> contribution to trend and published RF estimates
Direct aerosol	A	2 to 3	Medium to Low	Ground-based and satellite observations; some source regions and modelling	Emission sources and their history vertical structure of aerosol, optical properties, mixing and separation from natural background aerosol	Range of published model results with allowances made for comparisons with satellite data
Cloud albedo effect (all aerosols)	B	3	Low	Observed in case studies – e.g., ship tracks; GCMs model an effect	Lack of direct observational evidence of a global forcing	Range of published model results and published results where models have been constrained by satellite data
Surface albedo (land use)	A	2 to 3	Medium to Low	Some quantification of deforestation and desertification	Separation of anthropogenic changes from natural	Based on range of published estimates and published uncertainty analyses
Surface albedo (BC aerosol on snow)	B	3	Low	Estimates of BC aerosol on snow; some model studies suggest link	Separation of anthropogenic changes from natural; mixing of snow and BC aerosol; quantification of RF	Estimates based on a few published model studies
Persistent linear Contrails	A	3	Low	Cirrus radiative and microphysical properties; aviation emissions; contrail coverage in certain regions	Global contrail coverage and optical properties	Best estimate based on recent work and range from published model results

Table 2.11 (continued)

	Evidence	Consensus	LOSU	Certainties	Uncertainties	Basis of RF range
Solar irradiance	B	3	Low	Measurements over last 25 years; proxy indicators of solar activity	Relationship between proxy data and total solar irradiance; indirect ozone effects	Range from available reconstructions of solar irradiance and their qualitative assessment
Volcanic aerosol	A	3	Low	Observed aerosol changes from Mt. Pinatubo and El Chichón; proxy data for past eruptions; radiative effect of volcanic aerosol	Stratospheric aerosol concentrations from pre-1980 eruptions; atmospheric feedbacks	Past reconstructions/estimates of explosive volcanoes and observations of Mt. Pinatubo aerosol
Stratospheric water vapour from causes other than CH <sub>4</sub> oxidation	C	3	Very Low	Empirical and simple model studies suggest link; spectroscopy	Other causes of water vapour trends poorly understood	Not given
Tropospheric water vapour from irrigation	C	3	Very Low	Process understood; spectroscopy; some regional information	Global injection poorly quantified	Not given
Aviation-induced cirrus	C	3	Very Low	Cirrus radiative and microphysical properties; aviation emissions; contrail coverage in certain regions	Transformation of contrails to cirrus; aviation's effect on cirrus clouds	Not given
Cosmic rays	C	3	Very Low	Some empirical evidence and some observations as well as microphysical models suggest link to clouds	General lack/doubt regarding physical mechanism; dependence on correlation studies	Not given
Other surface effects	C	3	Very Low	Some model studies suggest link and some evidence of relevant processes	Quantification of RF and interpretation of results in forcing feedback context difficult	Not given