Draft Specification for "Pinatubo Emulation in Multiple models" (PoEMs)

1. Overall objective: Intercompare & evaluate Pinatubo perturbation to stratospheric aerosol properties and radiative forcings across A-GCMs with prognostic stratospheric aerosol modules.
2. Aims : i) compare & evaluate model perturbations to radiative fluxes and AOD, effective radius
   ii) use new statistical techniques to robustly quantify uncertainty for predicted quantities
   iii) identify where improved knowledge would give greatest improvement in aerosol simulation
   iv) model ensemble data to enable studies on different effects of 1991 Pinatubo eruption
3. Specific Plan for SSiRC Pinatubo ensemble study.
   a. Each model to do perturbed-physics-ensemble (PPE) of runs for several uncertain parameters
   b. 3, 5 or 7 of 8 parameters to vary (7 values-per-parameter: all at 21, 35 or 49 different values)
      P1) Mass of sulphur emitted (range)
      P2) Vertical height-range assumed for injected SO2 (lower-level fixed)
      P3) Latitudinal extent of model injection (single-box at 15N → spread equator to 15N)
      P4) Sedimentation velocity scaling (represent uncertainty in size distribution)
      P5) Reaction rate or conversion-timescale for SO_2 (represent uncertainty in oxidants)
      P6) Nucleation rate scaling (represent uncertainty in nucleation rate in stratosphere)
      P7) Fraction of emitted SO_2 as particles at emission (i.e sub-grid nucleation & growth)
      P8) Coagulation rate scaling (represent van der Waals attraction or Born repulsion)
   c. Choose standard (7), reduced (5) or minimum (3) set of parameters to vary (considering available resources & scheme type) --- 7 runs per parameter = 49, 35 or 21 5-year runs.
   d. Leeds will provide settings for uncertain parameters set at values specified to optimise sampling of multi-dimensional parameter space (maximin Latin hypercube)
   e. Output agreed set of diagnostics matching AeroCom phase 2 protocol (CMOR to CF-netCDF)
   f. Submit files to AeroCom data archive at German data archive (mirror to BADC) **to confirm**.
   g. Leeds gather the data from each model & check results (liaise with SSiRC model contact)
   h. Leeds run software to "train" fast statistical emulator on each model's ensemble and run full Monte Carlo across parameter space for several different metrics (e.g. TOA forcing, AOD, reff).
   i. Derive pdf for each model (in each space/time point) for comparisons to key observations
4. Experimental specification for modellers to follow when setting up Pinatubo ensemble of runs
   a. Free-running simulations where possible matching easterly QBO phase in 1991.
   b. 5-yr runs with AMIP2 time-varying SSTs etc. & time-varying anthop ems as CCMI (1991-5)
   c. First do reference Pinatubo & no-Pinatubo 5-year runs for initial model intercomparison.
   d. Then set up Pinatubo PPE (total yrs= 255 for 7-param, 185 for 5-param or 115 for 3-param).
5. Diagnostics requested to output (a to d to be considered core, e to h where possible)
   a. Monthly-mean 3D temperature, wind components, specific humidity & pressure
   b. Monthly-mean 3D mmr SO_2, H_2SO_4(g), aerosol-sulphur, surface area density & effective radius.
   c. Daily-mean 2D Aerosol Optical Depth & monthly-mean 3D extinction at 550nm and 1020nm
   d. Daily-mean 2D TOA & surface SW & LW all-sky & clear-sky radiative fluxes
   e. Daily-mean 2D tropopause height & 2D strat-trop exchange of SO_2 & aerosol-sulphur
   f. Monthly-mean 3D size-resolved particle conc'ns -- N(r>5,150,250,550,750,1000 nm)
   g. Monthly-mean 2D surface dry and wet deposition fluxes of aerosol-sulphur
   h. Monthly-mean 3D O_3, HNO_3, NO, NO_2, N_2O_5 (for models with interactive chemistry)
6. Timeline
   a. Circulate questionnaire confirming which models intend to participate and asking each group to vote on which parameters to vary and provide uncertainty ranges (end-July 2014)
   b. Send final draft of parameter list & uncertainty range to 3 independent experts (end-Aug 2014)
   c. Leeds provide parameter values for models to use for their chosen PPE runs (end-Sep 2014)
   d. Modellers run reference Pinatubo & no-Pinatubo simulation (from Oct 14, submit by Dec 14)
   e. Modellers run their Pinatubo perturbed-physics ensemble (from Oct14 submit by Jun2015)
   f. Leeds carry out analysis of reference runs & PPEs as data is submitted (~Nov 2014 to Oct 2015)