Week 1 (July 6-10) -- Center Green

Monday July 6		
8:30	**Buses leave for Center Green**	
9:00	**Welcome/Introduction**	**Sarah Gibson (NCAR)**
9:15	**Overview of atmosphere:** structure, dynamics, and climate	**Dennis Hartmann, (U. Wash)**
10:15-10:45	**Break**	
10:45	**Overview of sun and geospace:** structure, activity, and long-term variability Generation and role of magnetic field Relation of field to structure, heating and variability of solar atmosphere Solar Wind, solar storms and geospace response Geomagnetic environment and activity Space Weather impacts	**David Alexander (Rice Univ.)**
11:45	**Logistics**	**Scott Briggs (NCAR)**
12:00-1:30	**Lunch**	
1:30-3:30	**Lab 1:** Magnetism and dynamos	**Dibyendu Nandy (IISER)**
3:30-4:00	**Break**	

4:00-5:00	**Lab 1 continued**	**Dibyendu Nandy (IISER)**
5:00- 7:30	**Poster session, ice-breaker activities, and working dinner**	
7:30	**Buses leave for hotels**	
Tuesday July 7		
8:00	**Buses leave for Center Green**	
8:30	**Sun Tutorial:** Dynamo and long-term solar and heliospheric variability Topics to be Covered: Introduction to Solar-Stellar Magnetism, Theoretical Foundations of MHD Dynamos, Long-Term Evolution of the Sun-as-a-Star, Star-Planet Interactions	**Dibyendu Nandy (IISER)**
9:30	**Sun Tutorial:** Solar irradiance variability	**Judith Lean (NRL)**
10:30-11:00	**Break**	
11:00	**Sun Tutorial:** Solar atmosphere and activity Structure, heating and energization of solar atmosphere Energy release processes and consequences Particle acceleration and photon production Spicules, prominences, CMEs and flares	**David Alexander (Rice Univ.)**
12:00-1:30	**Lunch**	

1:30-3:30	**Lab 2:** Sun to Earth	**Rebecca Centeno (NCAR)**
3:30-4:00	**Break**	
4:00-5:30	**Lab 2 continued**	**Rebecca Centeno (NCAR)**
5:30	**Buses leave for hotels**	
Wednesday July 8		
8:00	**Buses leave for Center Green**	
8:30	**Space Tutorial:** Solar wind/magnetosphere dynamic interactions	**Bill Lotko (Dartmouth)**
9:30	**Space Tutorial:** Radiation belt acceleration/loss processes - Trapped particle motion in the magnetosphere - Adiabatic invariants - Basics of wave/particle interactions - Radial transport and associated PSD signatures - Local heating and associated PSD signatures - Loss processes - Radbelt remediation efforts	**Mary Hudson (Dartmouth)/Scot Elkington (LASP)**
10:30-11:00	**Break**	
11:00-12:00	**Space Tutorial:** Thermosphere/ionosphere	**Art Richmond**

	chemistry and dynamics Thermosphere/ionosphere structure and variability Neutral composition and energetics: sources, losses, transport Neutral dynamics: ion drag, tides, gravity waves Ion production, loss, and transport Electrodynamics: fields and currents, plasma irregularities Observables and impacts	**(NCAR)**
12:00 - 1:30	**Lunch**	
2:00 - 4:00ish	**Field trip:** NCAR/RAF **<u>Buses leave for hotels from field trip</u>**	
Thursday July 9		
8:00	**Buses leave for Center Green**	
8:30	**Atmosphere Tutorial:** Dynamics of the Middle Atmosphere –Mean structure and wave motions – Fundamental dynamical concepts –Introduction to transport processes –Examples	**Rolando Garcia (NCAR)**
9:30	**Atmosphere Tutorial:** Radiative processes - Scattering, absorption, and extinction - Equation of transfer - Without sources: Beer's Law - Flux divergence - Heating Rates	**Peter Pilewskie (CU)**
10:30-11:00	**Break**	
11:00-12:00	**Atmosphere Tutorial:** Chemistry	**Arlene Fiore**

	Topics covered include ozone as a tropospheric pollutant vs. ozone in the stratosphere. Catalytic cycles (ClOx, HOx, NOx). PSCs and the cause of the ozone hole. GHGs and their relative GW potentials and projections for emissions (RCPs) used in climate simulations.	**(Columbia U.)**
12:00-1:30	**Lunch**	
1:30-3:30	**Lab 3:** Calculating the solar energy deposition in Earth's middle and upper atmosphere Using software tools of your choice, you will calculate and plot the altitude at which solar radiation is attenuated to 1/e of its exoatmospheric value, the energy deposition rate and the atmospheric heating rate.	**Dan Marsh (NCAR)**
3:30-4:00	**Break**	
4:00 - 5:30	**Lab 3 Continued -- initial discussion of next week's projects; Example - developing statistical models for solar and geomagnetic forcing for climate models.**	**Dan Marsh (NCAR)**
5:30	**Buses leave for hotels**	
Friday July 10		
8:00	**Buses leave for Center Green**	
8:30	**Climate Tutorial:** Global change - recent developments	**Jerry Meehl (NCAR)**
9:30	**Applied Tutorial Part 1:** Climate Variability Diagnostics Package (CVDP) - physical underpinnings	**Clara Deser (NCAR)**

10:30-11:00	**Break**	
11:00-12:00	**Applied Tutorial Part 2:** How to run the CVDP	**Adam Phillips (NCAR)**
12:00-1:30	**Lunch**	
1:30-2:30	**Climate Tutorial:** Energy balance in the earth's atmosphere	**Guy Brasseur**
2:30-3:30	**Climate Tutorial:** Earth System Modeling Topics to be covered include defining what we mean by the Earth system and a brief history of the development of Earth system models, and possible future directions. We will look at examples of their use and think about where they are successful, and where they are less successful.	**Jean-Francois Lamarque (NCAR)**
3:30-4:00	**Break**	
4:00-5:00	**Research lecture:** Paleoclimate modeling and last millennium model Topics include ● CMIP5: protocols for past1000 simulations, implementations of forcings, and results; ● CESM(CAM5) Last Millennium Ensemble, roles of various forcings and importance of internal variabilities	**Bette Otto-Bliesner (NCAR)**
5:00-5:30	**Continuation of discussion of next week's projects; Example: extracting solar signatures from Last Millennium simulation**	
5:30	**Buses leave for hotels**	

Saturday July 11 field trip - Colorado Research Station/Nederland

Week 2 (July 13-17) Mesa Lab		

Monday July 13		
8:00	**Buses leave for Mesa Lab**	
8:30	**Synthesis lecture:** Solar radiation drivers of the Earth system Solar signals in surface climate Earth radiation balance. Radiative forcing of climate change. Regional impacts. Solar influence through the atmosphere Middle atmosphere structure & composition. Stratospheric winter polar vortex. Lower atmosphere temperature, wind & circulation. Understanding the signals.	**Joanna Haigh (Imperial)**
9:30	**Research lecture:** Variability and Predictability of Space Environment as Related to Lower Atmosphere Forcing (WACCM-X)	**Hanli Liu (NCAR)**
10:30-11:00	**Break**	
11:00-12:00	Team planning discussion -- formation of teams, team objectives	
12:00-1:30	**Lunch**	
1:30-5:30	**Work on projects**	
5:30	**Buses leave for hotels**	
Tuesday July 14		
8:00	**Buses leave for Mesa Lab**	

8:30	**Synthesis lecture:** Geospace and upper atmosphere response to long term solar variability Topics to be Covered: In this context, “geospace” means ~100~600 km In this context, “long term” means 3-4 cycles Basic review of thermosphere-ionosphere Upper atmosphere variability Atmospheric drag on satellite orbits Anthropogenic change in the thermosphere Changes in solar cycle amplitude and minima	**Stan Solomon (NCAR)**
9:30	**Research lecture:** Solar spectral irradiance variability Topics: ● Solar causes of irradiance variability ● Solar variability relevance for Earth’s climate ● Causes of solar spectral irradiance variability and resulting effects on Earth’s atmosphere ● Solar irradiance measurement requirements ● Past, present, and future solar irradiance measurements	**Greg Kopp (CU)**
10:30-11:00	**Break**	
11:00-12:00	**Applied tutorial:** Attributions of climate change causes: how to determine who did it - - Topics to be covered: - - Climate of the last millennium and the 20th century: multiple forcers, climate response and their correlation (volcanoes, the sun, greenhouse gases..) - can attribution tell us about the magnitude of low-frequency solar forcing - possible regional solar signals?	**Gabi Hegerl (U. Edinburgh)**
12:00-1:30	**Lunch**	
1:30-2:30	**Applied tutorial:** Statistical methods	**Doug Nychka (NCAR)**
2:30-5:30	**Work on projects**	

5:30	**Buses leave for hotels**	
Wednesday July 15		
8:00	**Buses leave for Mesa Lab**	

8:30	**Synthesis lecture:** Global Electrical Circuit (GEC)
	Topics covered include:
	- History/Review of GEC
	- Variations of the GEC
	- Conductivity of the Atmosphere
	- Internal sources in the GEC
	  - Electrified clouds, Lightning and TLE's
	- External sources in the GEC
	  - Space weather
		Wiebke Deierling (CU/NCAR)

9:30	**Research lecture:** Historical records of solar and geomagnetic activity It is useful for us? Naked-eye observation of sunspots Auroras during the last millennium Solar eclipse observations Geomagnetic records (16th-19th centuries) Sunspot number(s) Historical Archive of Sunspot Observations	**Jose Vaquero (Central Univ. Merida**)
10:30-11:00	**Break**	

11:00-12:00	**Research lecture: `Reconstructions of solar variability from cosmogenic isotopes`**
	
	`Topics to be covered:`
	`- Galactic cosmic rays as an index of solar activity (heliospheric modulation and geomagnetic sheilding);`
	`- Cosmogenic isotopes 14C and 10Be (production, transport, deposition, archiving);`
	`- Long-term solar activity reconstruction;`
	`- Different modes of solar actiivty (Grand minima, grand maxima, moderate activity);`
	`- The status of the modern solar activity, including the recent minimum 2008-2010 in the view of long-term evolution.`
		Ilia Usoskin (Univ. Oulu)

12:00-1:00	**Lunch**	

1:00-4:00?	**Field trip:** (Mesa trail hike)	**Scott Briggs and Rebecca Centeno-Eliot**
5:30	**Buses leave for hotels**	
Thursday July 16		
8:00	**Buses leave for Mesa Lab**	
8:30	**Synthesis lecture:** Lower atmosphere drivers of space climate Topics to be covered: Greenhouse cooling of the ionosphere-thermosphere (IT); highlight Solomon synthesis lecture content Trends in polar mesospheric cloud signatures Sources of longitudinal variations in the IT - atmospheric tides and planetary waves IT impacts of stratospheric sudden warmings	**Maura Hagan (NCAR)**
9:30	**Synthesis lecture:** Upper atmosphere drivers of climate (energetic particles and particle precipitation) Topics to be covered: Energetic Particle Precipitation (EPP) Direct and Indirect Effect Observations of EPP effects on atmospheric NOx, HOx, and Ozone Sensitivity of EPP Indirect Effect to middle atmosphere meteorology Model simulations of EPP effects	**Cora Randall (CU)**
10:30-11:00	**Break**	
11:00-12:00	**Research lecture:** Connections between solar magnetism and irradiance Topics covered: - Convective and radiative energy transport in convection zone and photosphere - Photospheric magnetoconvection, characterization of photospheric magnetic field from quiet sun to sunspots - Deep seated vs. surface origin of irradiance modulation	**Matthias Rempel (NCAR)**
12:00-1:30	**Lunch**	

1:30-2:00	**CMIP6 overview** The Coupled Model Intercomparison Project, now gearing up for its Phase 6 (CMIP6) has been organizing coordinated experiments across the international climate model community since the 90's under the scientific guidance of the World Climate Research Program's Working Group on Coupled Modeling. Many aspects of climate modeling benefit from standardized comparisons between different models in order to get at the sources of structural uncertainty affecting model simulations. Some experiments also provide input to further research efforts by communities outside of the physical climate sciences, as is the case for the results of future scenario simulations used by climate impact researchers. We will talk about the scientific and organizing principles of CMIP, and describe the CMIP6 structure. In particular we will describe the experiments proposed under some of the sub-projects (individual MIPs) of CMIP6: LUMIP (looking at the effects of Land Use change on climate and vice-versa), ScenarioMIP (organizing te next set of simulations of future climate), and some of the experiments related to Solar Forcing in DAMIP (Detection and Attribution MIP).	**David Lawrence/Claudia Tebaldi (NCAR)**
2:00-5:30	**Work on projects**	
5:30	**Buses leave for hotel**	
Friday July 17		
8:00	**Buses leave for Mesa Lab**	
8:30	**Synthesis lecture:** Characterization and attribution of solar + terrestrial drivers of space climate	**Hugh Lewis (U. Southampton)**
9:30-12:00	**Finalize projects and presentations**	
12:00-1:30	**Lunch**	
1:30-3:30	**Project presentations and discussion**	
3:30-4:00	**Break**	

4:00-5:00	**Wrap-up discussion; lessons learned**	Dan Marsh
5:30	**Buses leave for hotels**	