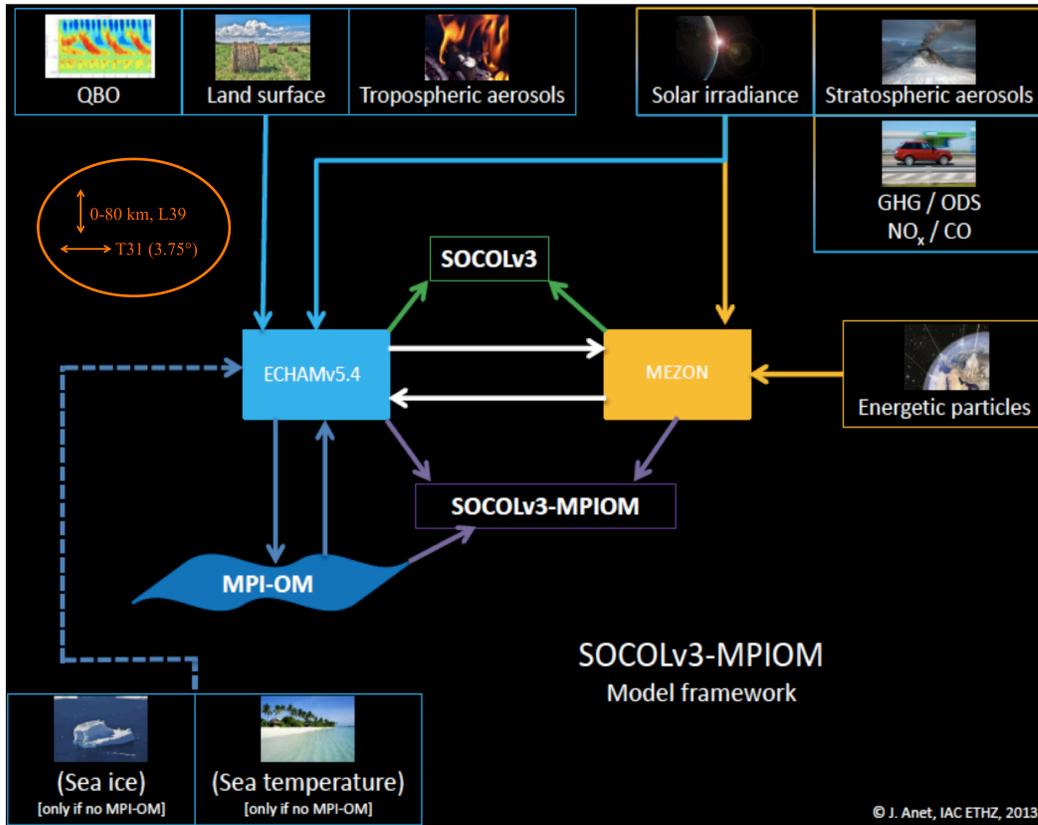


Planned long-term simulations of the future climate with AOCCM-SOCOL

P. Arsenovic¹, A. Stenke¹, T. Peter¹, E. Rozanov^{1,2}
1 - IAC ETH Zürich, 2 - PMOD/WRC Davos

Introduction

Global warming became of the great interest to the mankind. There is growing evidence that anthropogenic greenhouse gases have become the dominant factor of climate change since 1970, although the natural factors such as solar activity and volcanic eruptions cannot be neglected. In the previous IPCC assessment (IPCC, 2007) the understanding level of the solar influence on climate was graded as very low. The results of the FUPSOL project (Future and Past Solar Influence on the Terrestrial Climate) aim to enrich this knowledge.



SOCOL3 model

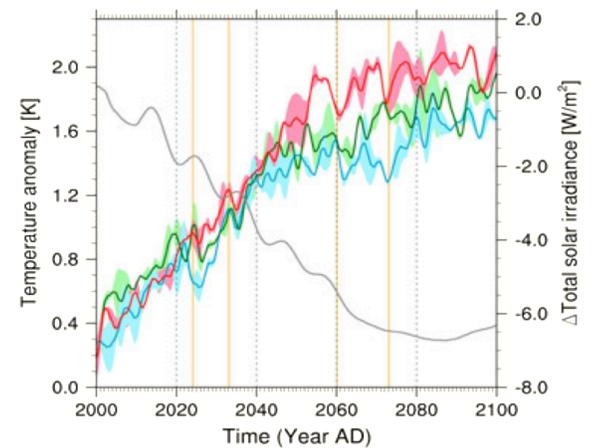
Model description:

- Atmosphere-ocean-chemistry model: SOCOL3-MPIOM
- Atmosphere model – ECHAM5
- Ocean model – MPIOM
- Chemical module – MEZON

Experiment description (Anet et al., GRL, 2013):

- 3 sets of 2 ensemble simulations, 2000-2100 / 2200
- One set with constant solar activity, the other two with reduced solar activity and different strength of the solar irradiance forcing
- Greenhouse gases emission scenario and CO, NOx emission used: RCP4.5
- QBO nudging
- 4 volcanic eruptions

Model results for the 2000-2100 run



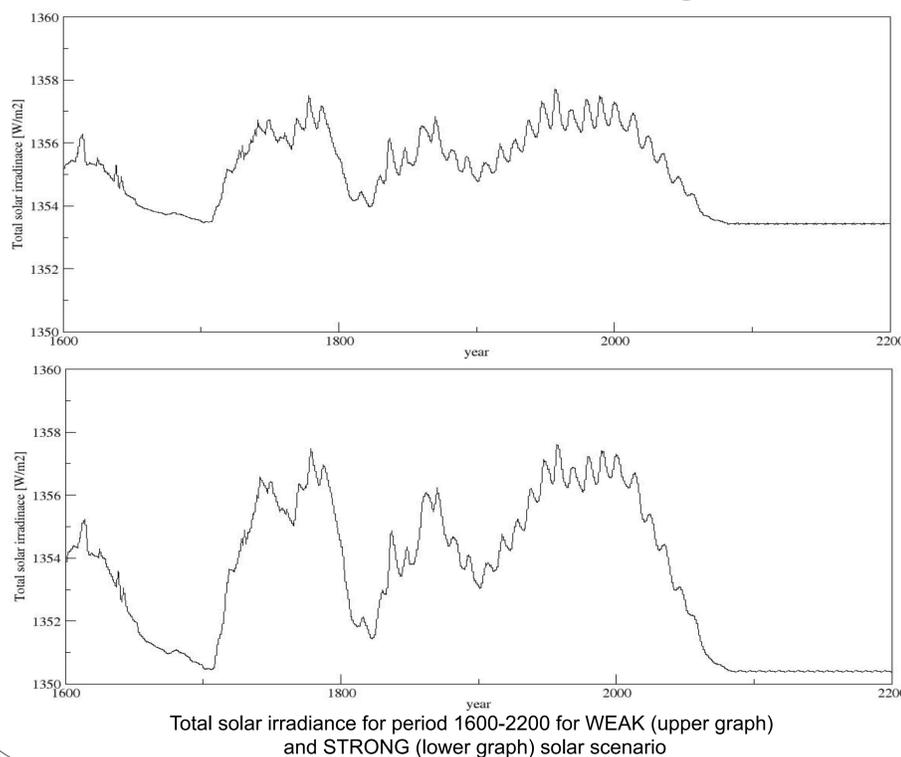
Red – Constant, blue – strong, green – weak solar forcing (Anet et al., 2013)
Grey – total solar irradiance anomaly relative to the average TSI for 1995-2005 period (Shapiro et al., 2011)

All 3 runs follow an apparent warming path:

- CONST - 1.96 ± 0.12 K
- WEAK - 1.75 ± 0.14 K
- STRONG - 1.61 ± 0.12 K

Although by assuming a Dalton minimum type solar minimum for the 2000-2100, it is not enough to compensate the warming caused by anthropogenic impacts. Still, the modeled temperatures averaged over the last 20 years of the 21st century are lower by up to 0.3 K (depending on the solar minimum scenario) than the runs with solar constant forcing. The general warming is due to anthropogenic emissions and that the grand minimum can at best lead to an episodic reduction of the warming.

Past and future solar forcings



Future work

- Extension of the 2000-2100 runs to year 2200
- Improving the parametrization of the gravity waves in model and thus improving the stratospheric-tropospheric coupling
- Include new parametrization scheme for the mid-level energy electrons
- Switch from ECHAM5 to ECHAM6

Extension of the 2000-2100 runs to year 2200

- Solar forcing will be held constant with constant 11-years cycle
- Because of the great heat capacity of the ocean, another 100 years of model simulation with low solar forcing will show the temperature response of the ocean
- Will follow the RCP4.5 emission scenario for greenhouse gases and CO/NOx emission
- QBO cycles will be continued
- 4 volcanic eruptions will be included

References

Anet, J. G., et al. (2013), Impact of a potential 21st century “grand solar minimum” on surface temperatures and stratospheric ozone, Geophys. Res. Lett., 40, 4420–4425, doi:10.1002/grl.50806

Shapiro, A. I., W. Schmutz, E. Rozanov, M. Schoell, M. Haberreiter, A. V. Shapiro, and S. Nyeki (2011), A new approach to the long-term reconstruction of the solar irradiance leads to large historical solar forcing, Astron. Astrophys., 529, A67, 8 pp., doi:10.1051/0004-6361/201016173.