SOLARIS-HEPPA

Ongoing activities
(…and synergies with SPARC DA)

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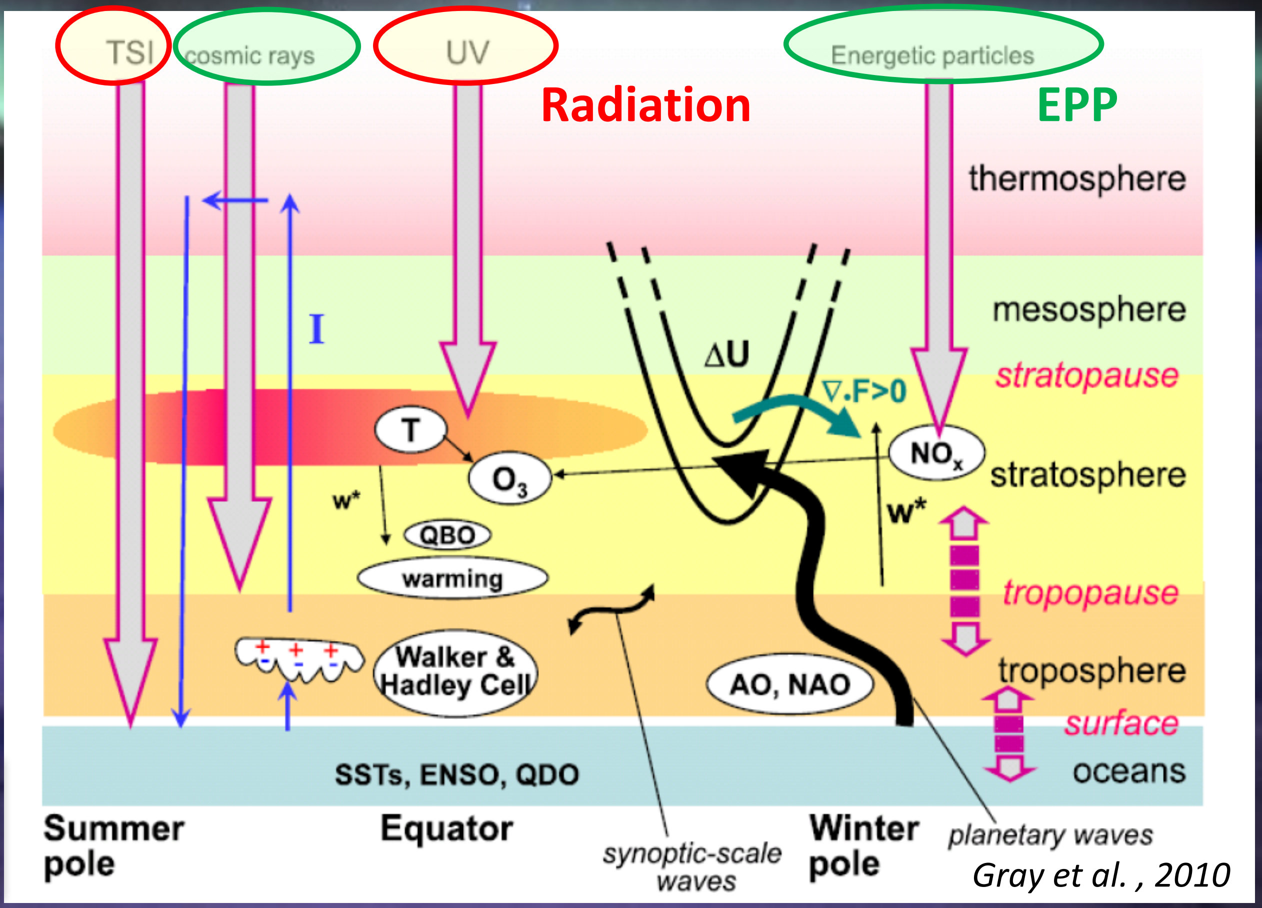
13th SPARC DA Workshop, ECMWF, U.K., 26 October 2017

SOLARIS-HEPPA Research Overview

Solar forcing

Impact on dynamics & chemistry

Impact on climate + decadal prediction



Outline

1. Solar Forcing for CMIP6

2. HEPPA-II model-measurement intercomparison 2008/2009

3. Coordinated analysis of CCMI runs: new working groups

1. Synergies with SPARC DA
    - Model biases in the USM region: need for mesospheric data assimilation?
    - Near term climate predictions

CMIP6 solar forcing

SPARC
Stratosphere-troposphere Processes And their Role in Climate

Geosci. Model Dev., 10, 2247–2302, 2017
https://doi.org/10.5194/gmd-10-2247-2017

Geoscientific Model Development
Open Access
EGU

Special issue

Coupled Model Intercomparison Project Phase 6 (CMIP6) Experimental Design and Organization

Editor(s): GMD topical editors | Coordinator: V. Eyring

Solar forcing for CMIP6 (v3.2)

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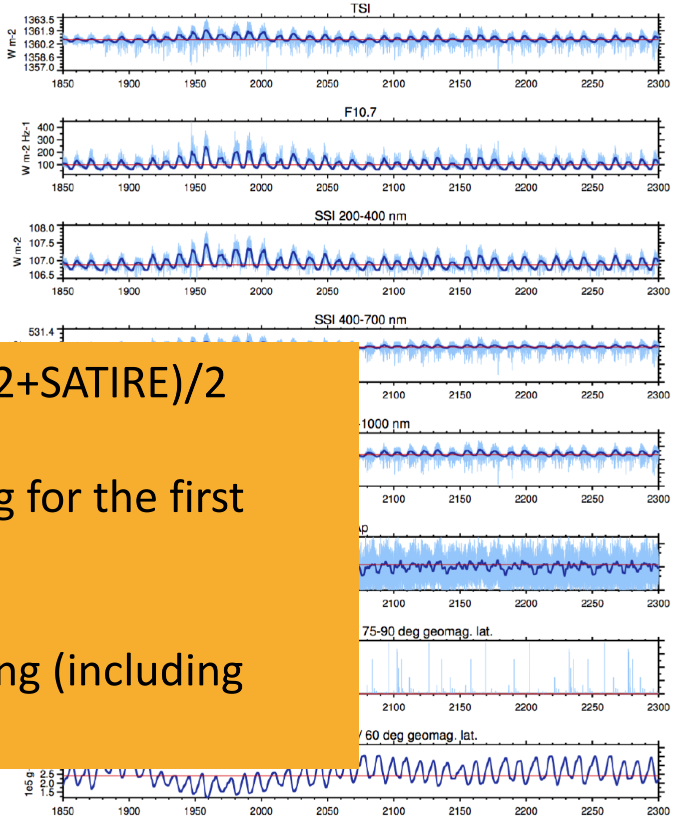

- New SSI/TSI reference: (NRLSSI2+SATIRE)/2
- Consideration of particle forcing for the first time.
- More realistic future solar forcing (including secular variations)

HEPPA II study

Atmos. Chem. Phys., 17, 3573–3604, 2017
www.atmos-chem-phys.net/17/3573/2017/
doi:10.5194/acp-17-3573-2017

Atmospheric Chemistry and Physics
Open Access
EGU

HEPPA-II model–measurement intercomparison project: EPP indirect effects during the dynamically perturbed NH winter 2008–2009

Bernd Funke[1], William Ball[2], Stefan Bender[4], Angela Gardini[1], V. Lynn Harvey[5], Alyn Lambert[6], Manuel López-Puertas[1], Daniel R. Marsh[7], Katharina Meraner[8], Holger Nieder[4], Sanna-Mari Päivärinta[3,9], Kristell Pérot[10], Cora E. Randall[5], Thomas Reddmann[4], ...
Miriam Sinnhuber[4], Timofei Sukhodolov[2], Gabriele ...
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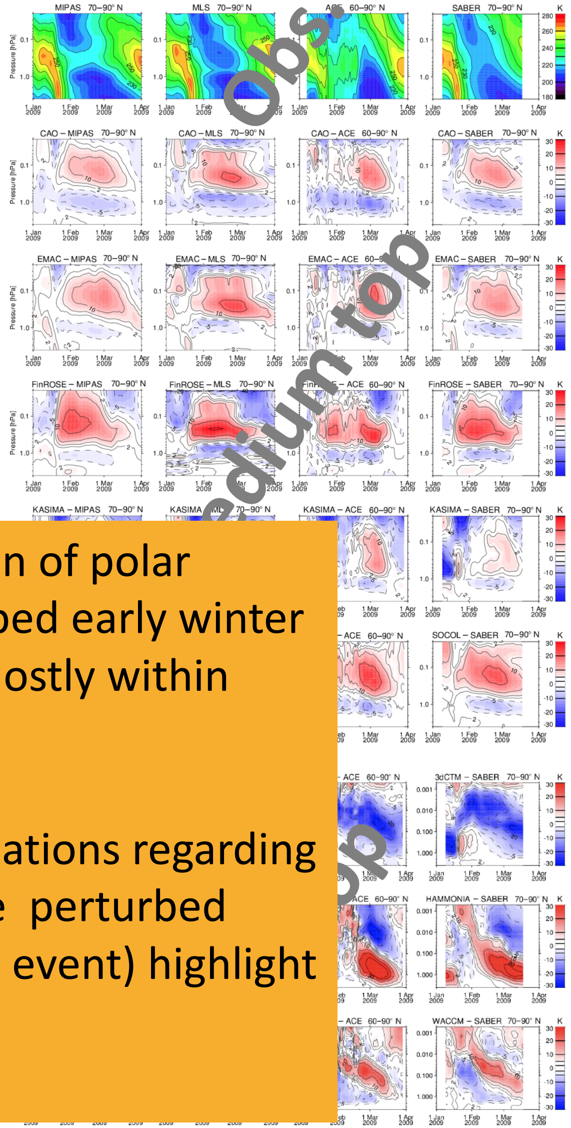
Received: 2 November 2016 – Discussion started: 9 Dec...
Revised: 14 February 2017 – Accepted: 22 February 20...



- Reasonable model representation of polar winter NOx descent in unperturbed early winter (agreement with observations mostly within 20%)
- Large and systematic model deviations regarding temperature and NOx during the perturbed phase of the winter (SSW and ES event) highlight deficiencies in GW schemes.

New SOLARIS-HEPPA WGs for Coordinated CCMI Analysis

- **WG1**: **Stratospheric Signal**
  Co-leads: Markus Kunze and Gabriel Chiodo
- **WG2:** **Surface Signal**
  Co-leads: Kleareti Tourpali and Stergios Misios
- **WG3:** **Comparison with (satellite) observations**
  Co-leads: Eugene Rozanov, Amanda Maycock, and Alessandro Damiani
- **WG4:** **Methodological Analysis**
  Co-leads: Rémi Thiéblemont and Will Ball
- **WG5:** **Medium Energy Electrons (MEE) Model-Measurement intercomparison**
  Co-leads: Miriam Sinnhuber and Hilde Nesse-Tissøy

SPARC Newsletter Article Jan 2017: Matthes, Funke, Randall, Verronen: Update on SOLARIS-HEPPA Activities: New Working Groups.

Working group 2

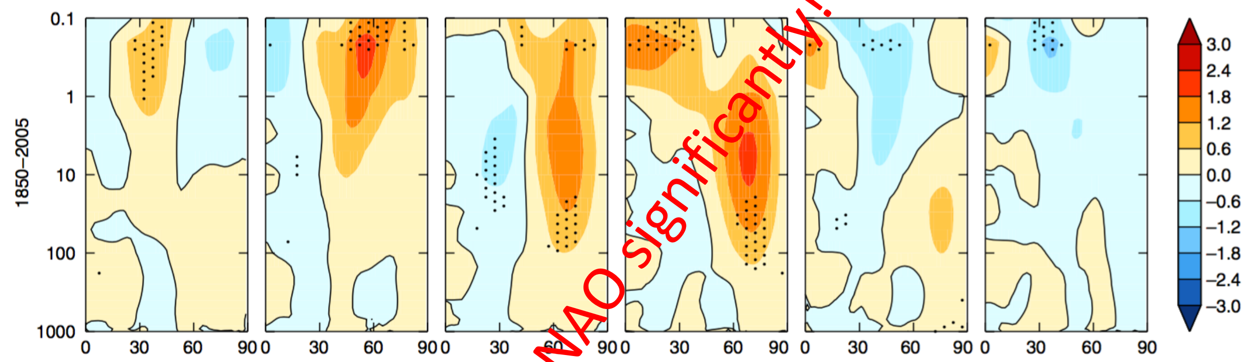
coordinated by Kleareti Tourpali and Stergios Misios

Analysis of the solar irradiance and particle effects on surface climate taking atmosphere ocean coupling processes into account in both historical (1960-2010) and future (2010-2100) simulations, i.e. CCMI REF-C1 and REF-C2. Focus on NAO.

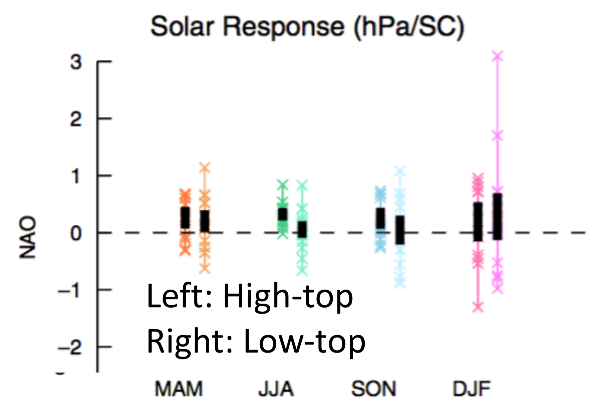
The CMIP5 models **collectively** do not show a strong influence in the NAO region, which has been attributed to the lack of interactive ozone.

Room for opportunities with CCMI…

Zonal winds (m/s) Nov to April



Too weak to influence NAO significantly!



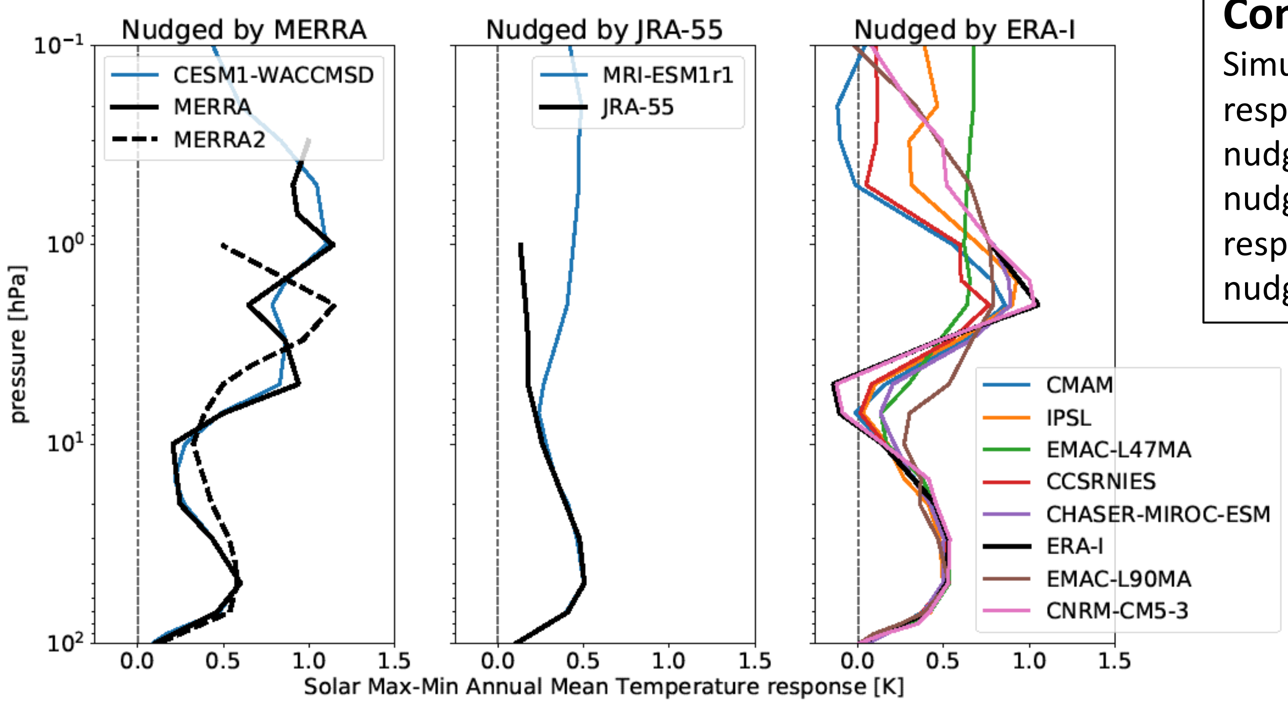
Mitchell et al., 2015

Working group 3

coordinated by Eugene Rozanov, Amanda Maycock, and Alessandro Damiani

Comparison of modeled and observed signals resulting from solar irradiance and particle forcing in the specified dynamics experiments covering the satellite era from 1980-2010 (REF-C1SD).

1. Compare the zonal wind and temperature and evaluate whether they match the respective reanalysis products.



Conclusions

Simulated tropical temperature response depends on source of nudging data and pressure range of nudging. Double-peaked stratospheric response pronounced in models nudged by ERA-I or MERRA.

Kuchar et al., in preparation

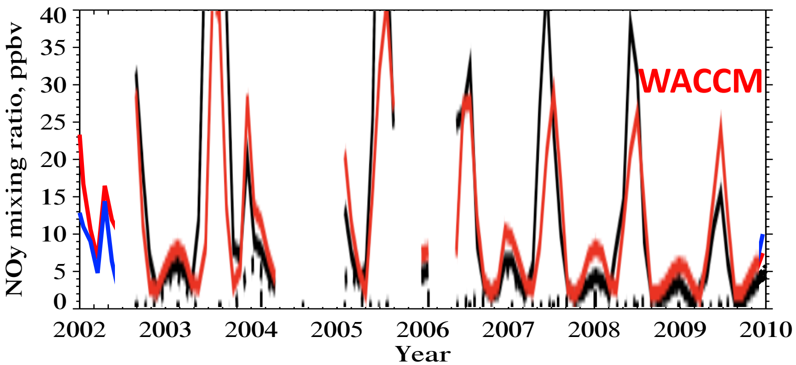
Working group 3

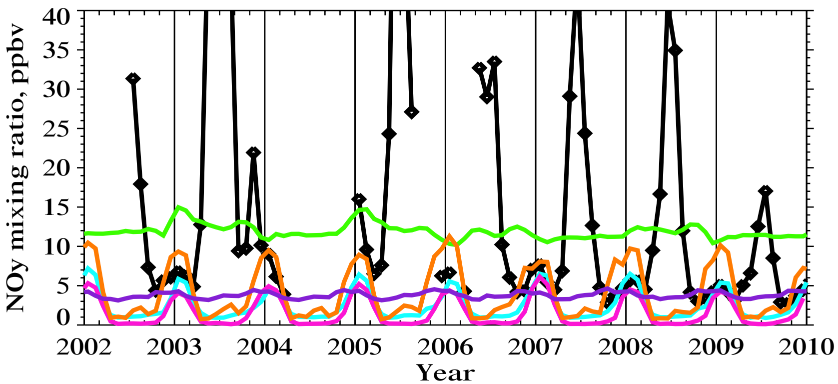
coordinated by Eugene Rozanov, Amanda Maycock, and Alessandro Damiani

Comparison of modeled and observed signals resulting from solar irradiance and particle forcing in the specified dynamics experiments covering the satellite era from 1980-2010 (REF-C1SD).

4. Polar NOy: response to EPP

Comparison of the simulated 60°-90°S mean NO_y (ppbv) with MIPAS data at 60 km





MIPAS SOCOL3 MRI SLIMCAT GEOSCCM HADGEM3 IPSL CCSRNIES

Conclusion:
NO_y VMR is underestimated in all models (slightly better in SOCOL and MRI) because of absence or not accurate treatment of the energetic particles

Rozanov et al., in preparation

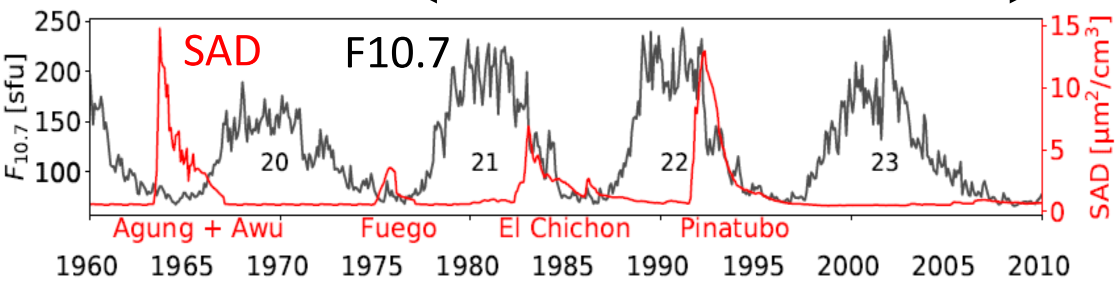
Working group 4

coordinated by Rémi Thiéblemont and Will Ball

Assessing statistical approaches to analyse solar signals in model and observational data.

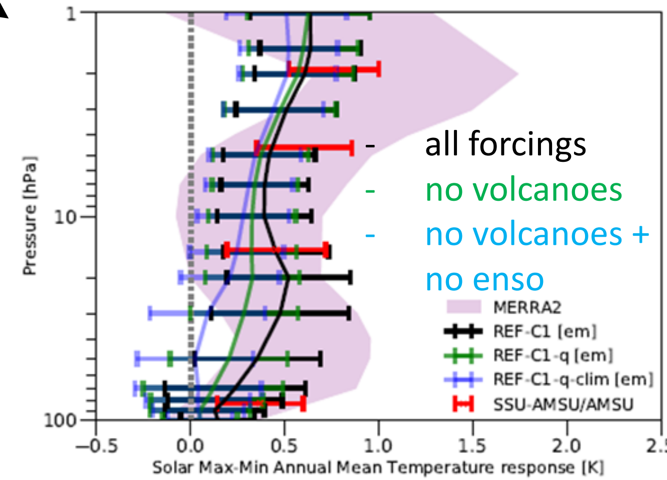
Motivation:

- Aliasing with volcanic signal (Chiodo et al., 2014; Kuchar et al., 2017)



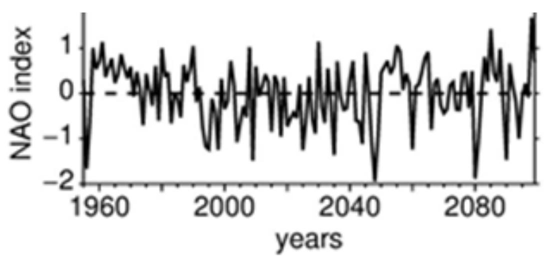
(Kuchar et al., *JGR*, 2017)

T response to solar cycle (SOCOL)
1979 - present

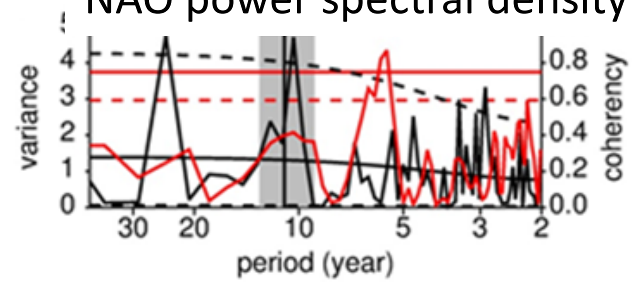


- Role of internal variability (Thiéblemont et al., 2015)

NAO (DJF) in CESM(WACCM)



NAO power spectral density



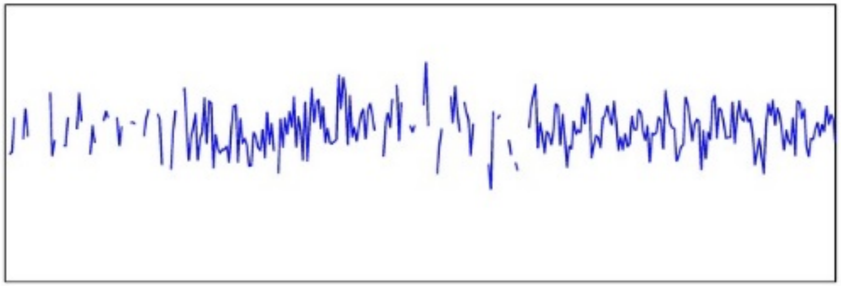
Working group 4

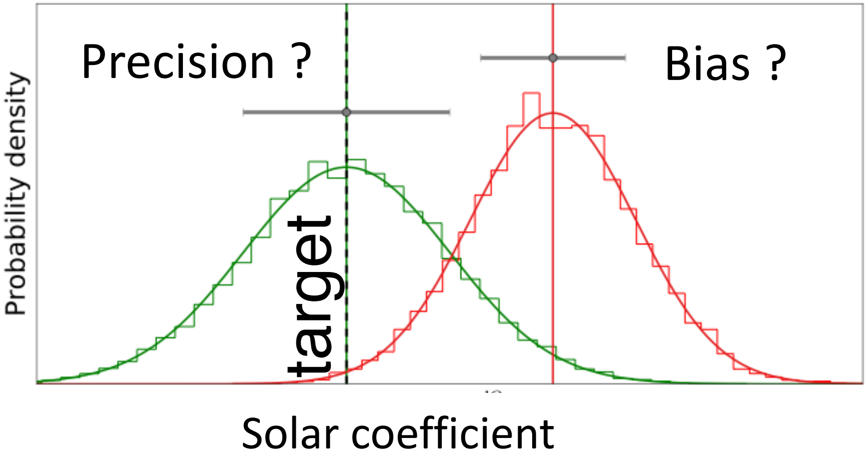
coordinated by Rémi Thiéblemont and Will Ball

Assessing statistical approaches to analyse solar signals in model and observational data.

Task 1: Using artificial time series (MOCKS) to assess MLR attribution methods

- Solar
- ENSO
- QBO30
- QBO50
- SAOD
- AR
- Data gaps
- Noise





WG Leaders: R. Thiéblemont, W. Ball

Working group 5

coordinated by Miriam Sinnhuber and Hilde Nesse-Tissøy

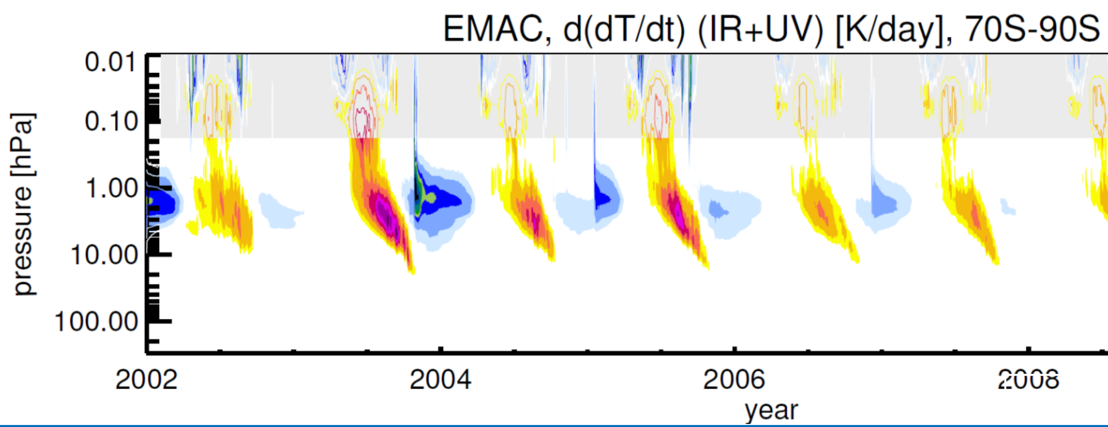
Comparison of observed chemical (NO, OH, O3) responses to ME
available model simulations that account for MEE

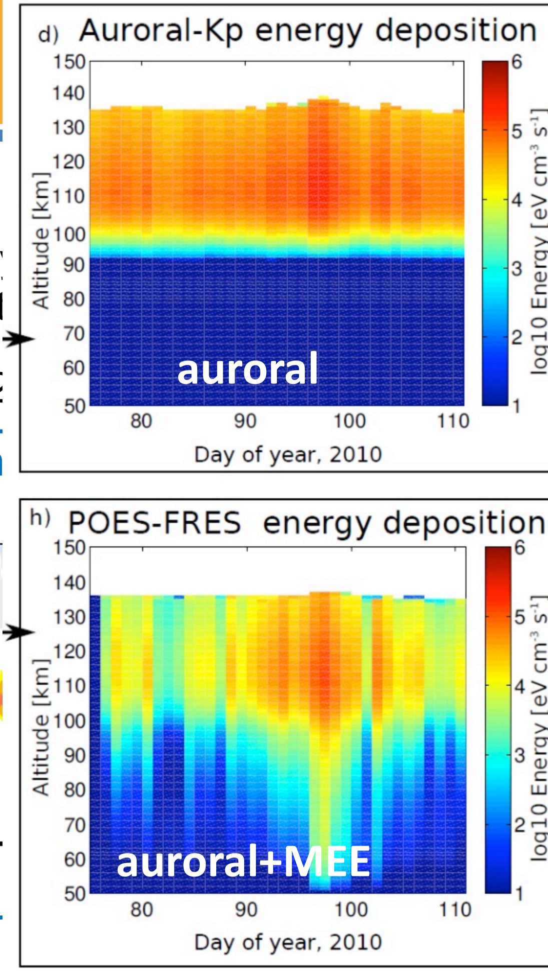
Geomagnetic forcing:

Downwelling of NOx produced in the auroral region and by medium–energ
winter leads to ozone loss and net radiative heating rates at least down to t

→ Recommended as part of solar forcing for CMIP-6 (*Matthes et al., 2*

Change in net radiative heating rates due to geomagnetic forcin



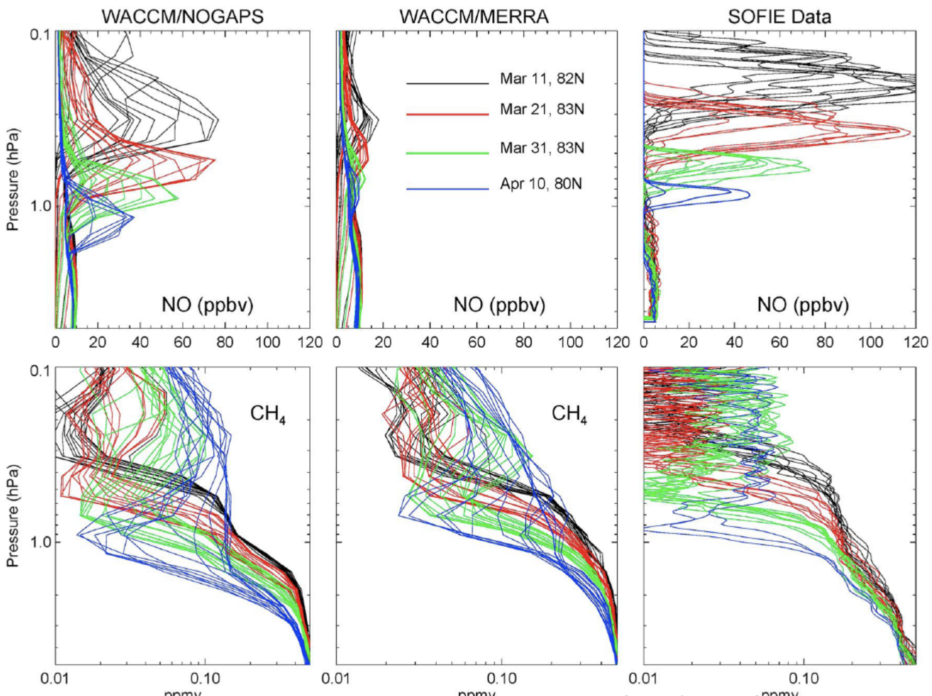


Smith-Johnsen et al, in preparation

- Intercompare available forcing data for auroral / MEE forcing
- Compare model results with available observations (NO, OH, O_3) in the source region (mesosphere / lower thermosphere)

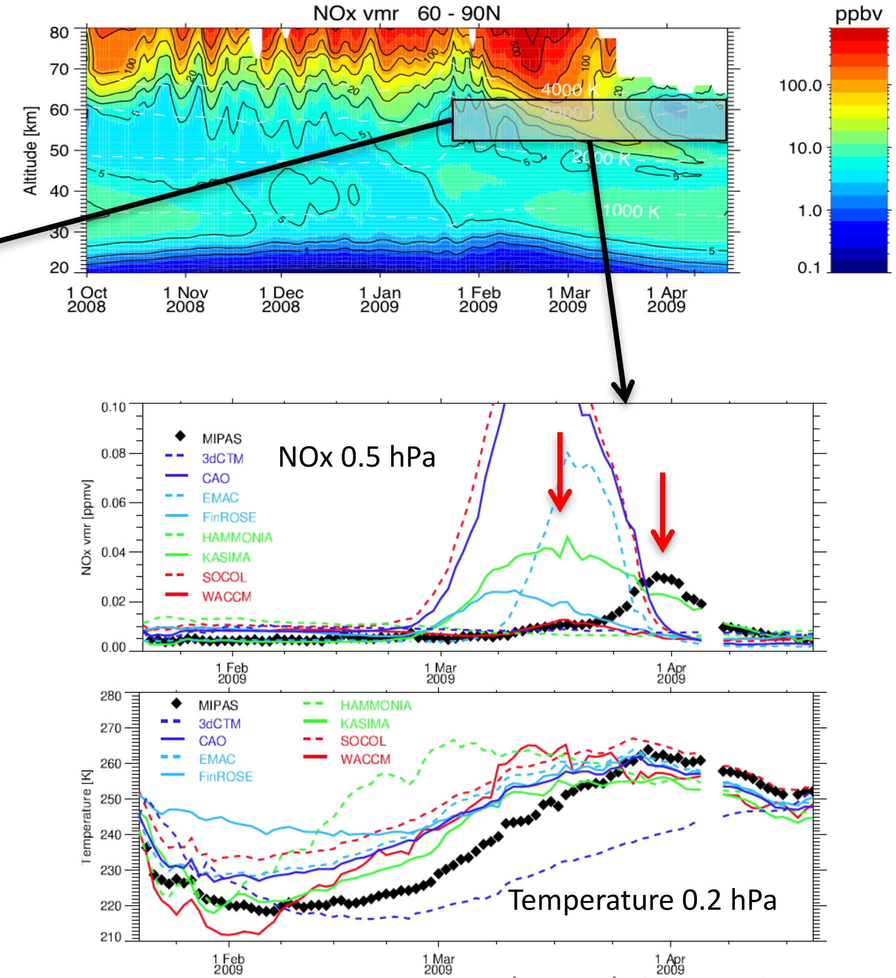
SOLARIS-HEPPA and DA

1) Need for mesospheric DA?



Siskind et al, 2015, GRL

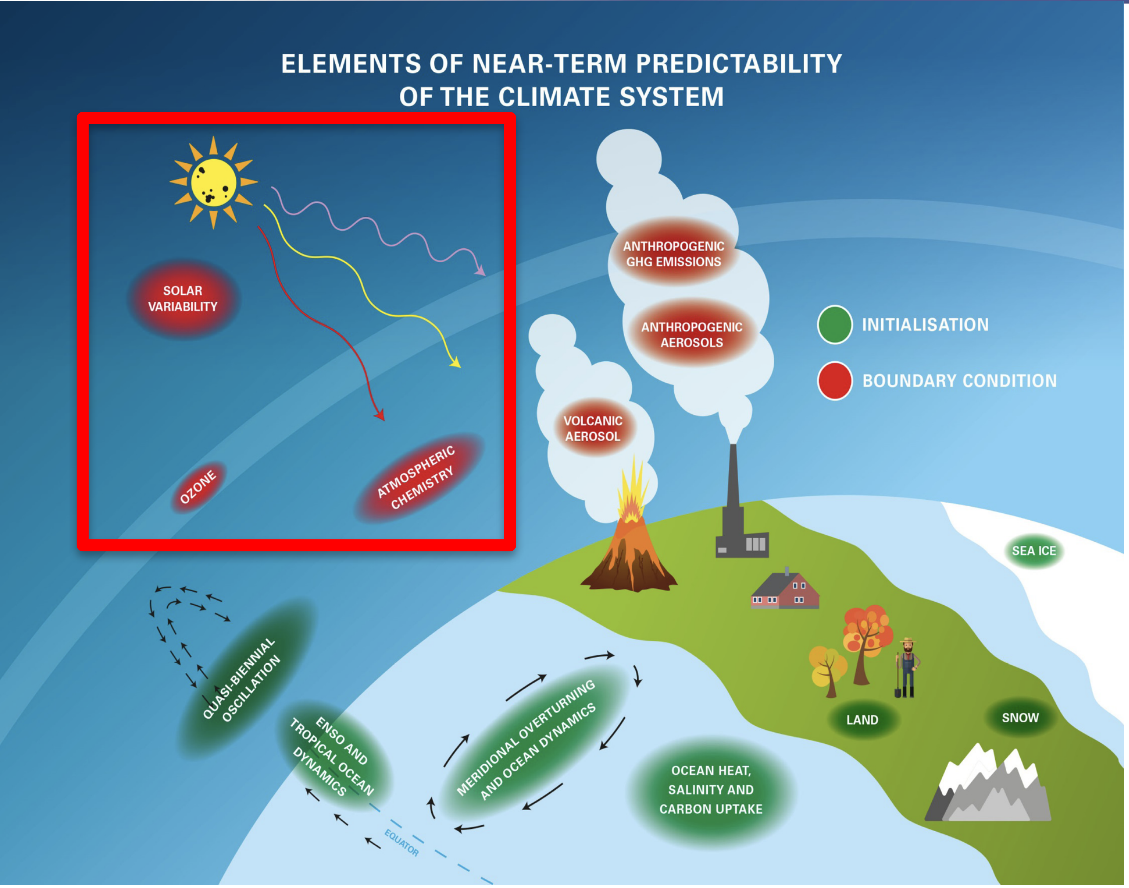
HEPPA-II study: 2008/09 NH winter



Funke et al, 2017, ACP

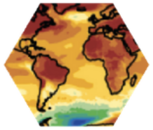
- HEPPA-II: Significant biases of upper stratospheric T and NOx in SD models during 2009 ES event (with nudging up to ~1hPa)
- NOx (and CH4) model biases can be reduced by nudging to reanalysis (NOGAPS) obtained from mesospheric DA (MLS temperatures).

2) Near Term Climate Prediction



WCRP World Climate Research Programme

Near-term Climate Prediction



Summary

The Grand Challenge on Near-Term Climate Prediction will support research and development to improve multi-year to decadal climate predictions and their utility to decision makers. It will furthermore support the development of organizational and technical processes for future routine provision of decadal prediction services that can assist stakeholders and decision-makers.

nature geoscience LETTERS
PUBLISHED ONLINE: 17 OCTOBER 2016 | DOI: 10.1038/NGEO2824

Skilful predictions of the winter North Atlantic Oscillation one year ahead

Nick Dunstone*, Doug Smith, Adam Scaife, Leon Hermanson, Rosie Eade, Niall Robinson, Martin Andrews and Jeff Knight

The winter North Atlantic Oscillation is the primary mode of atmospheric variability in the North Atlantic region and has a profound influence on European and North American winter climate. ...

DePreSys3 hindcasts of the first winter (Fig. 1a) skilfully predict the year-to-year variability in the observed winter NAO index with a highly significant correlation skill of $r = 0.62$ ($p = 0.001$ using a ...

We identify two sources of skill for second-winter forecasts of the North Atlantic Oscillation: climate variability in the tropical Pacific region and predictable effects of solar forcing on the stratospheric polar vortex strength. We also identify model biases in Arctic sea ice that, if reduced, may further increase skill.

Completed a draft white paper, led by co-chairs with active contributions from the 17 members of the international team (incl. K. Matthes) – to be submitted shortly

Thank you for your attention!

Meeting announcement

SPARC SOLARIS-HEPPA working group meeting Paris

6-9 November 2017

http://solarisheppa.geomar.de/paris2017

Venue: University Pierre & Marie Curie (UPMC), Host: Rémi Thiéblemont

Aim: present and discuss preliminary results of the five new working groups

Format: solicited and invited oral contributions, no poster session, plenty of time for discussions