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ROMIC-2

(Role Of the Middle atmosphere In Climate)

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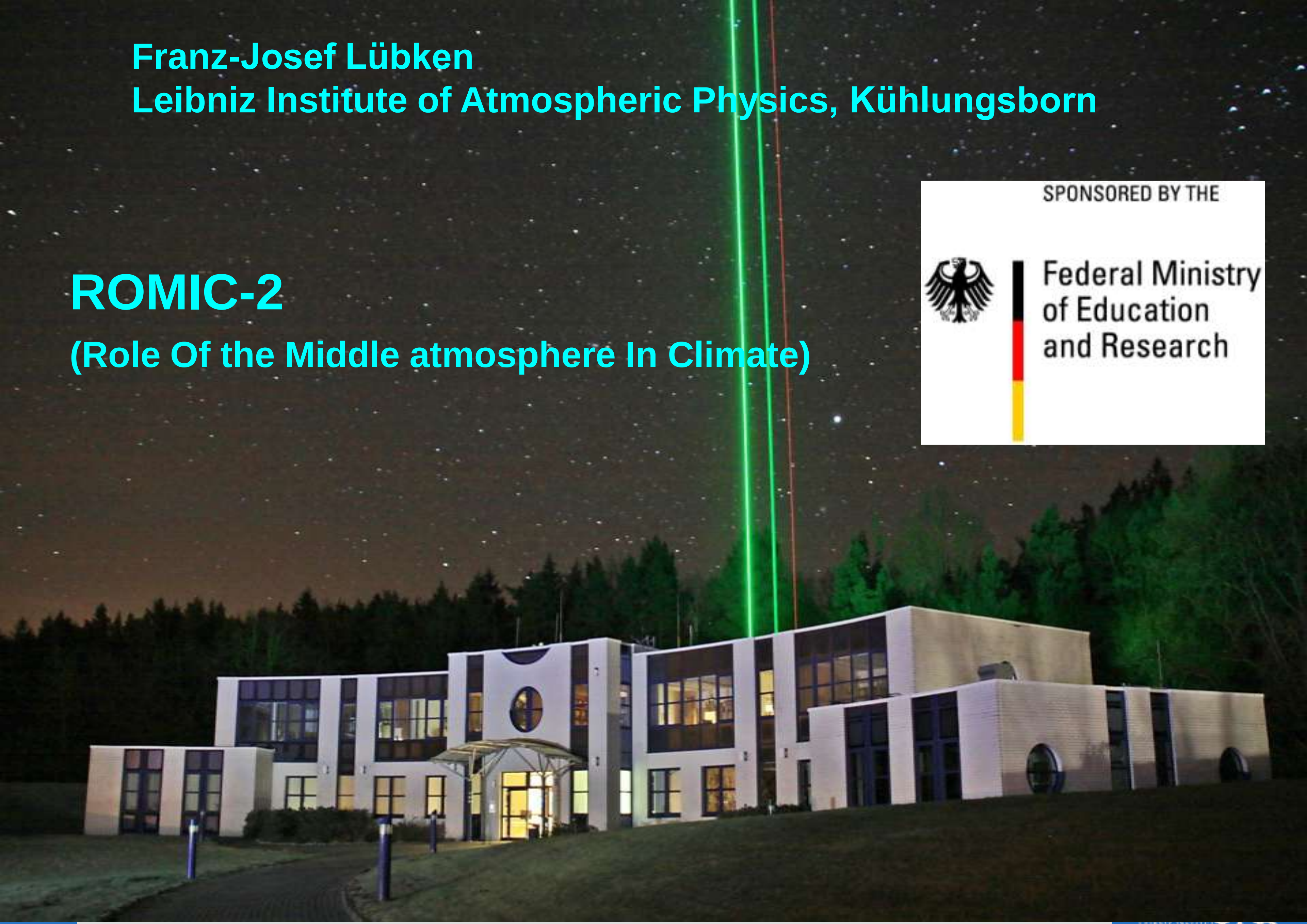

Research program of BMBF

R ole
O f the
M iddle atmosphere
I n
C limate

First phase: 2014-2018

Second phase: 2019-2023

Konzeptpapier zur zweiten Phase von ROMIC

Franz-Josef Lübken (Leibniz-Institut für Atmosphärenphysik, Kühlungsborn)
Katja Matthes (GEOMAR, Kiel), Ralf Koppmann (Univ. Wuppertal),
Ulrich Achatz (Univ. Frankfurt), Andreas Engel (Univ. Frankfurt),
Björn-Martin Sinnhuber (KIT Karlsruhe), Hauke Schmidt (MPI für Meteorologie, Hamburg)

Finale Version, 22. Februar 2016

Concept paper

Zusammenfassung der Begründung für die zweite Phase von ROMIC

von

Franz-Josef Lübken (Leibniz-Institut für Atmosphärenphysik, Kühlungsborn)
Katja Matthes (GEOMAR, Kiel), Ralf Koppmann (Univ. Wuppertal),
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Kühlungsborn, den 8. November 2016

Executive summary

Bundesanzeiger
Herausgegeben vom Bundesministerium der Justiz und für Verbraucherschutz
www.bundesanzeiger.de

Bekanntmachung
Veröffentlicht am Mittwoch, 25. Oktober 2017
BAnz AT 25.10.2017 B5
Seite 1 von 5

Bundesministerium für Bildung und Forschung

Richtlinie
zur Förderung von Forschungsvorhaben zum Thema Role Of the Middle atmosphere In Climate (ROMIC-II)

Vom 9. Oktober 2017

Official announcement

☺

Example

IAP

Trends In the Middle Atmosphere
TIMA: Phase 2
Research Proposal
in response to the BMBF announcement
„ROMIC: Role Of the Middle atmosphere In Climate"
submitted by
Prof. Dr. Franz-Josef Lübken
Dr. Uwe Berger, Dr. Gerd Baumgarten, Prof. Dr. Erich Becker,
Dr. Ralph Latteck, Dr. Fazlul Laskar
Leibniz-Institute of Atmospheric Physics
Kühlungsborn, 28. January 2018

Scetch proposal projects

Example

IAP

Trends In the Middle Atmosphere
TIMA: Phase 2
and
Coordinator of ROMIC-2
Proposal
in response to the BMBF announcement
„ROMIC: Role Of the Middle atmosphere In Climate"
submitted by
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Dr. Ralph Latteck, Dr. Fazlul Laskar

26. January 2019

Full proposal for projects

List of projects in ROMIC-2

Solar/climate variability ; trends:

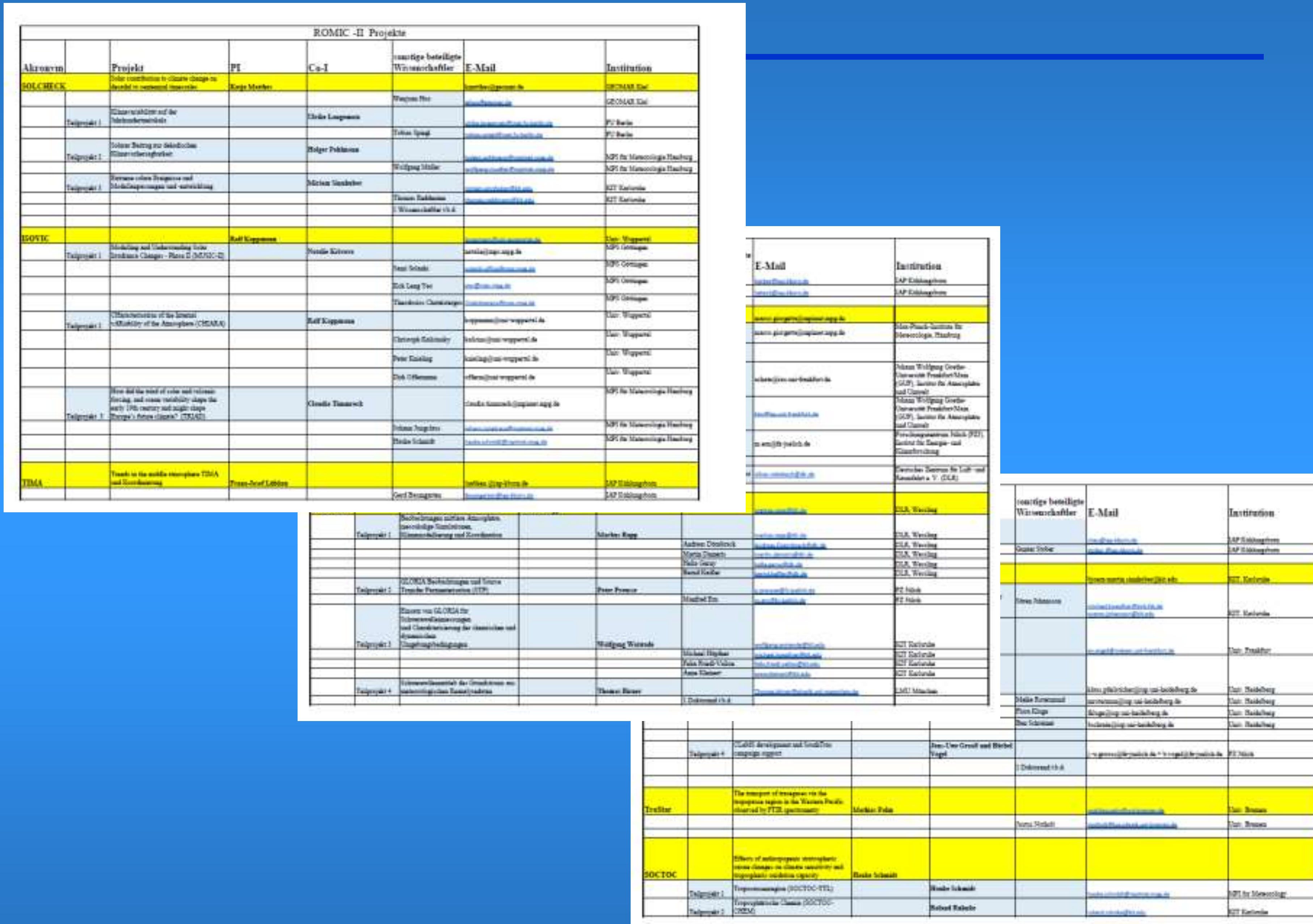
- **SOLCHECK**
  Solar contribution to climate change on decadal to centennial timescales
- **ISOVIC**
  Impact of SOlar, Volcanic and Internal variability on Climate
- **TIMA**
  Trends in the middle atmosphere

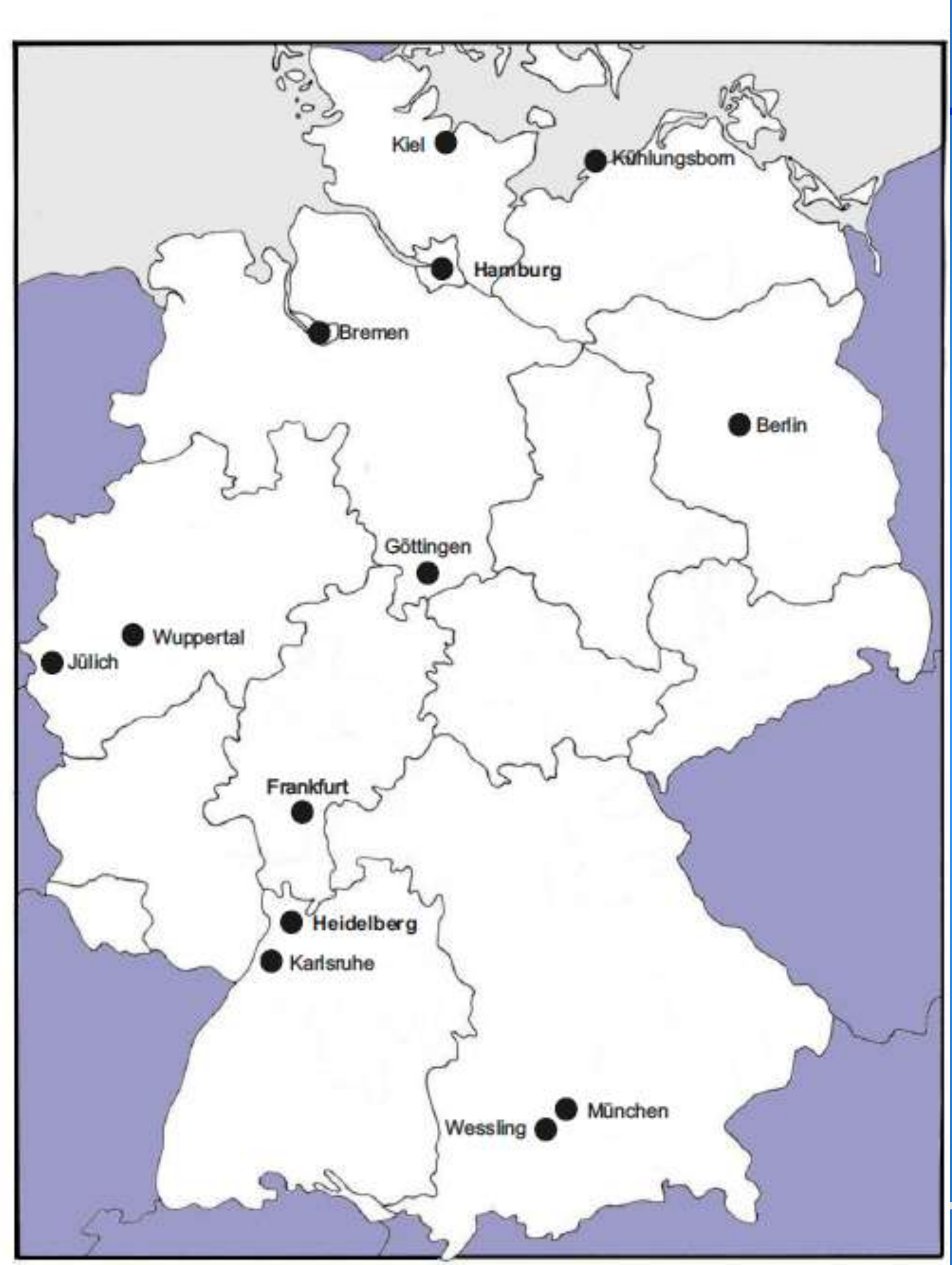
Dynamics:

- **QUBICC**
  The Quasi-Biennial Oscillation in a Changing Climate
- **WASCLIM**
  Role of Gravity Waves in the Southern Hemispheric Circulation and Climate

Chemistry (stratosphere)

- **SCI-HI**
  Surface Climate Impacts of Halogen Induced Stratospheric Ozone Changes
- **TroStar**
  The transport of trace gases via the tropopause region in the Western Pacific observed by FTIR spectrometry
- **SOCTOC**
  Effects of anthropogenic stratospheric ozone changes on climate sensitivity and tropospheric oxidation capacity


ROMIC -II Projekte
Akronym
Projekt
PI
Co-I
sonstige beteiligte Wissenschaftler
E-Mail
Institution
SOLCHECK
ISOVIC
TIMA
TreStar
SOCTOC

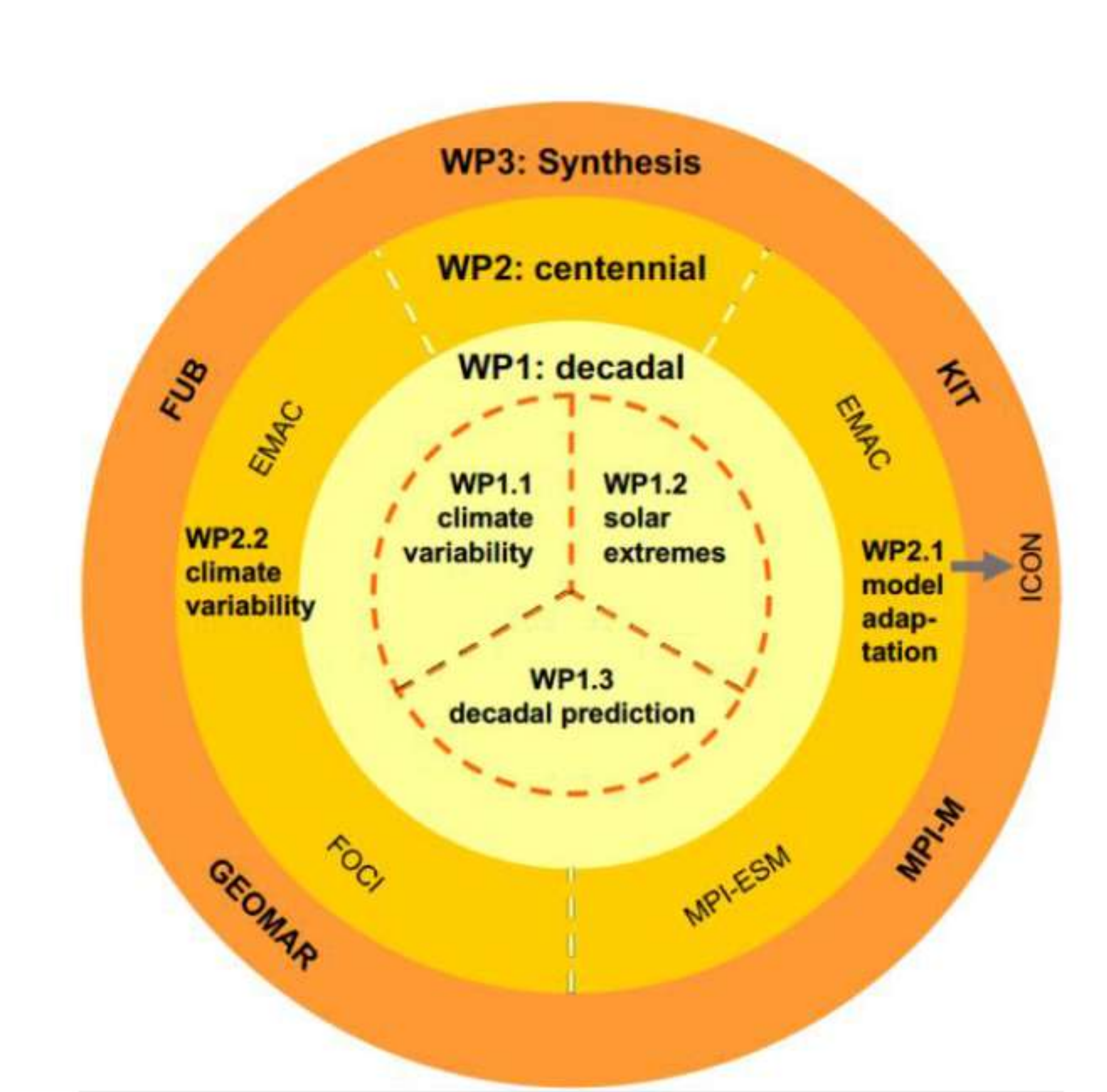

Kiel
Kühlungsborn
Hamburg
Bremen
Berlin
Göttingen
Wuppertal
Jülich
Frankfurt
Heidelberg
Karlsruhe
München
Wessling

Solar and climate variability
and
trends

SOLCHECK

Solar contribution to climate change on decadal to centennial timescales

- **Solar contribution to past, present and future climate evolution in the NH on decadal to centennial timescales.**
- **Role of natural solar variability for global and regional climate change.**
- **Estimate potential impact of extreme solar scenarios (Grand Solar Minimum etc.) on climate evolution.**
- **Contribution of solar forcing climate prediction skill.**

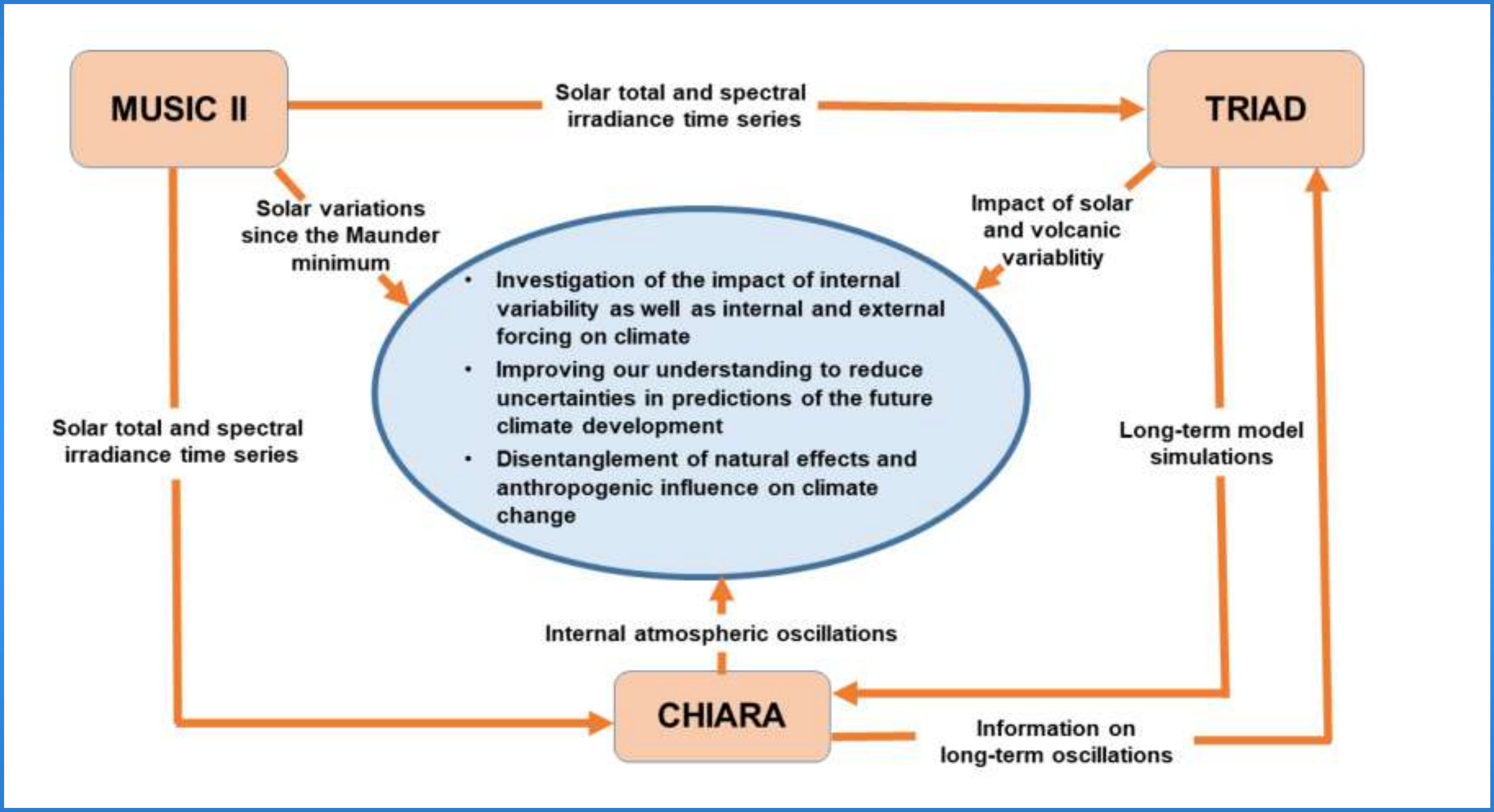

WP3: Synthesis
WP2: centennial
WP1: decadal
FUB
EMAC
KIT
EMAC
WP1.1
climate
variability
WP1.2
solar
extremes
WP2.2
climate
variability
WP2.1
model
adap-
tation
ICON
WP1.3
decadal prediction
FOCI
GEOMAR
MPI-ESM
MPI-M

ISOVIC

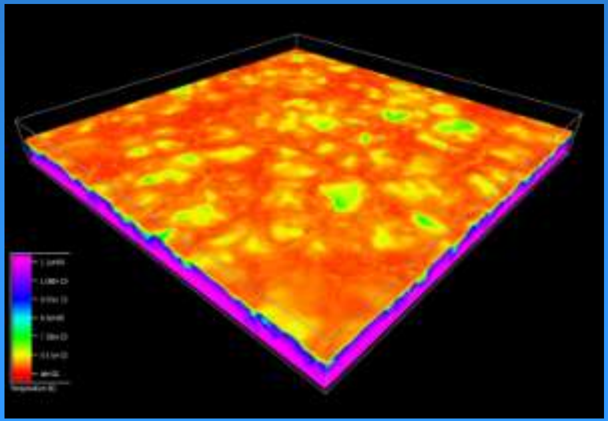
Impact of SOlar, Volcanic and Internal variability on Climate

- **Historical data + simulations of climate: understand internal variability + natural/external forcing.**
- **Improve understanding to reduce uncertainties in future climate predictions.**
- **Disentangle natural effects and anthropogenic influence**

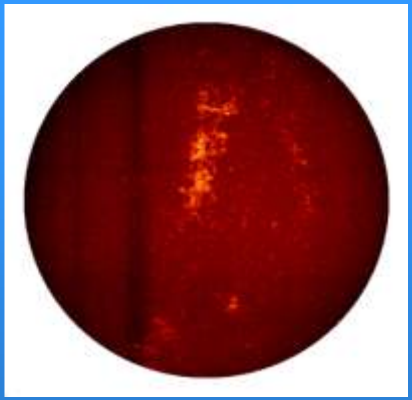
The structure of ISOVIC

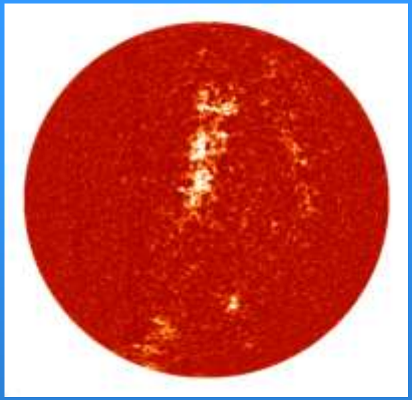


Reduce the existing uncertainty in the amplitude of long-term solar irradiance changes



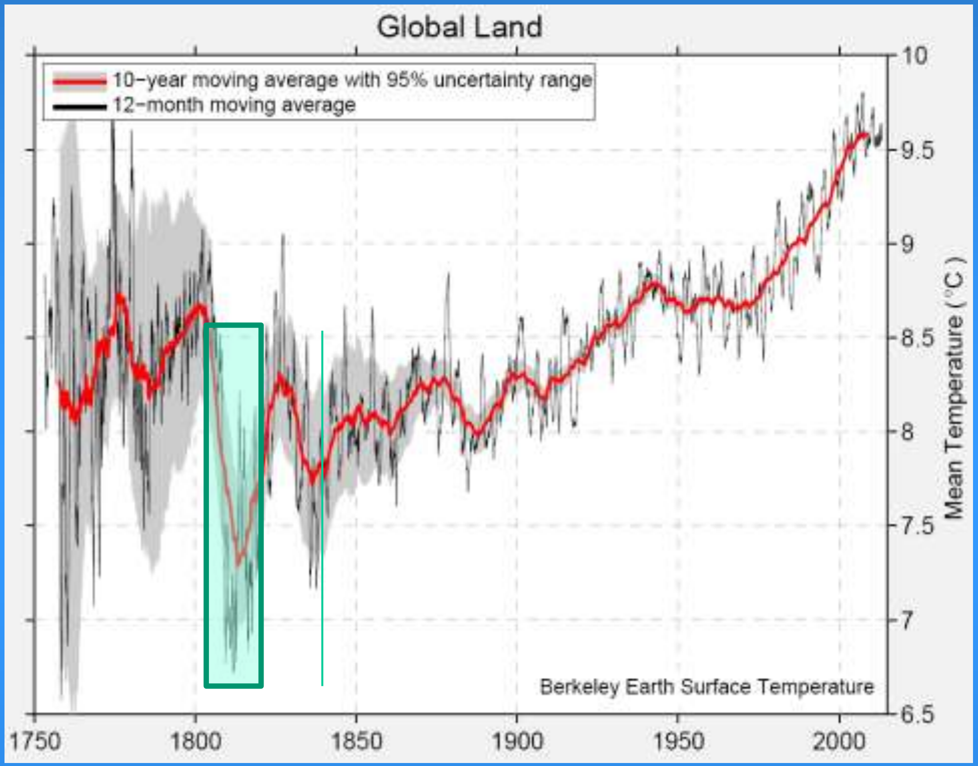
Newest 3D magnetohydrodynamic simulations (including small-scale dynamo) to calculate the brightness of the solar surface.





Study historical archives of daily full-disc photographs of the Sun in the Ca II K line over the last century (faculae and plage)

Understand the triad of solar, volcanic and ocean variability under pre-industrial and anthropogenic forced conditions by using early 19th century natural forcing reconstructions



Evolution of global-average surface temperature over land estimated from the Berkley Earth Surface Temperature (BEST) data (Rohde et al., 2012)

Importance of preconditioning of the ocean ?

Future (high CO2): role of strong natural forcing ?

Can Earth System Model (ESM) reproduce atmospheric response to natural forcing ?

TIMA

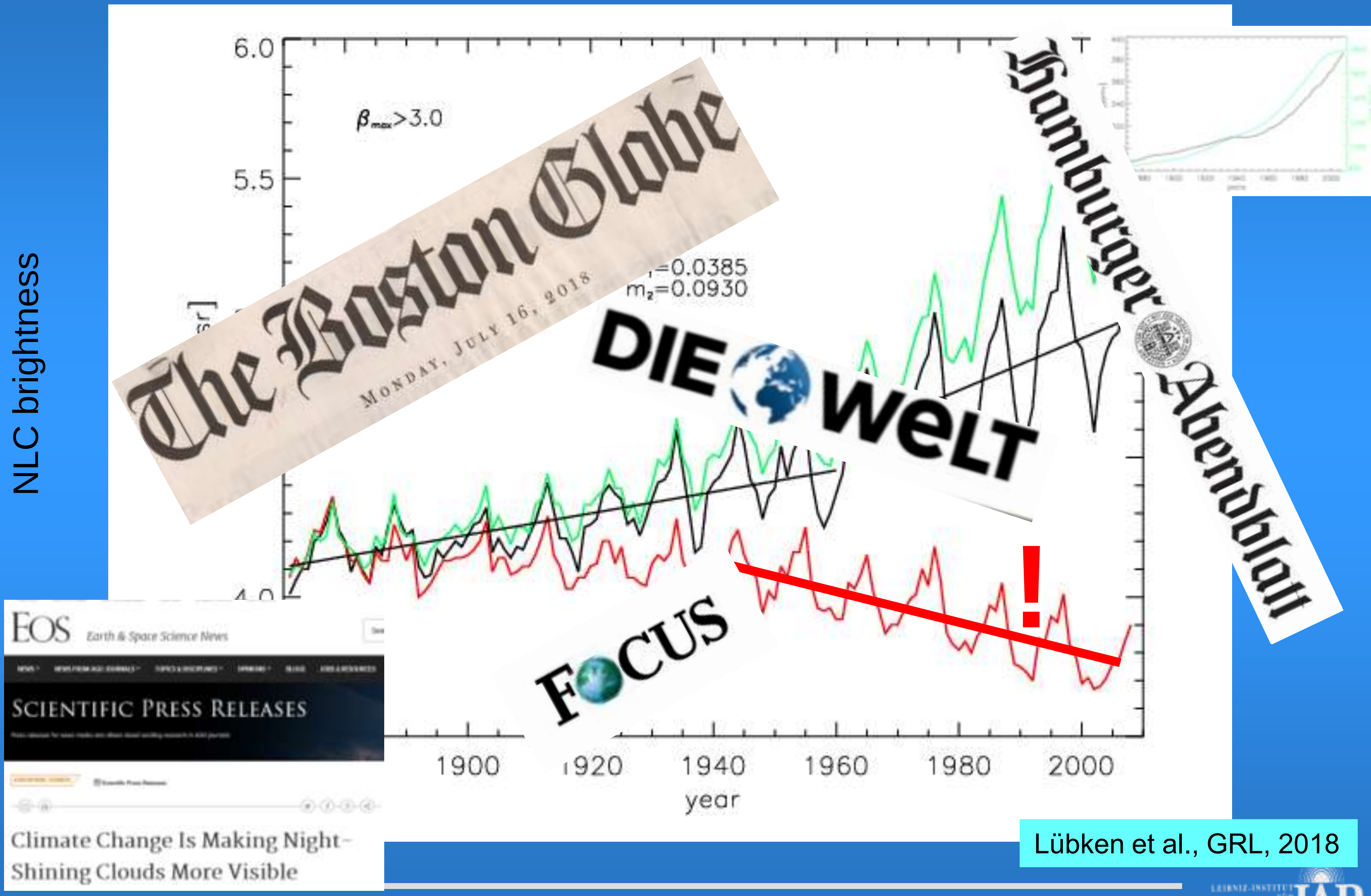
Trends In the MIiddle Atmosphere

- **Study trends in the MLT (observations, modeling)**
- **Trends in NLC, incl. future scenarios**
- **Solar cycle variations in the MLT**
- **Coupling from MLT to troposphere**

reference to IAP paper

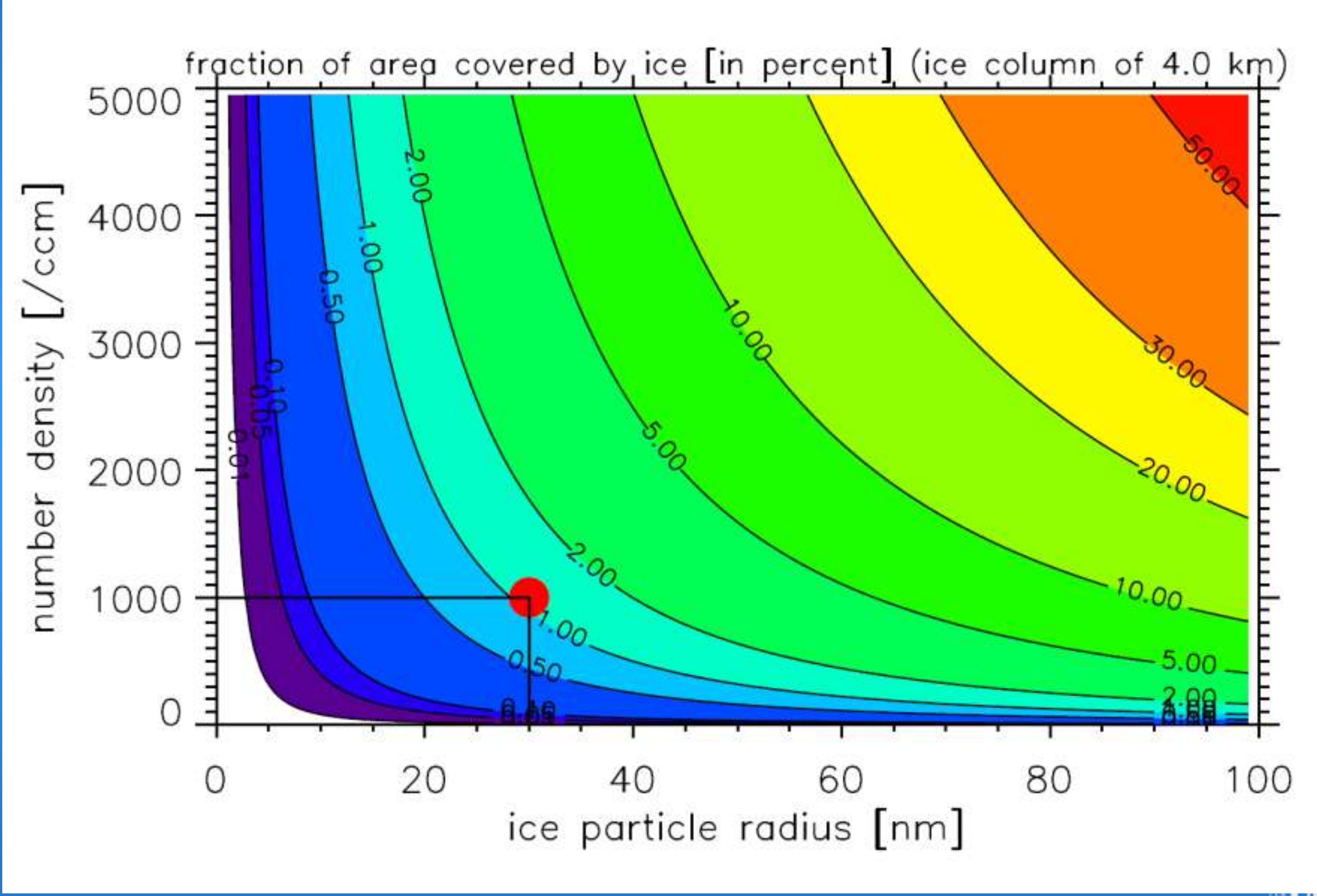
NLC trends on centennial time scales

NLC brightness



Lübken et al., GRL, 2018

fractional area covered by ice particles



Dynamics:
QBO, waves etc.

nature geoscience

PERSPECTIVE

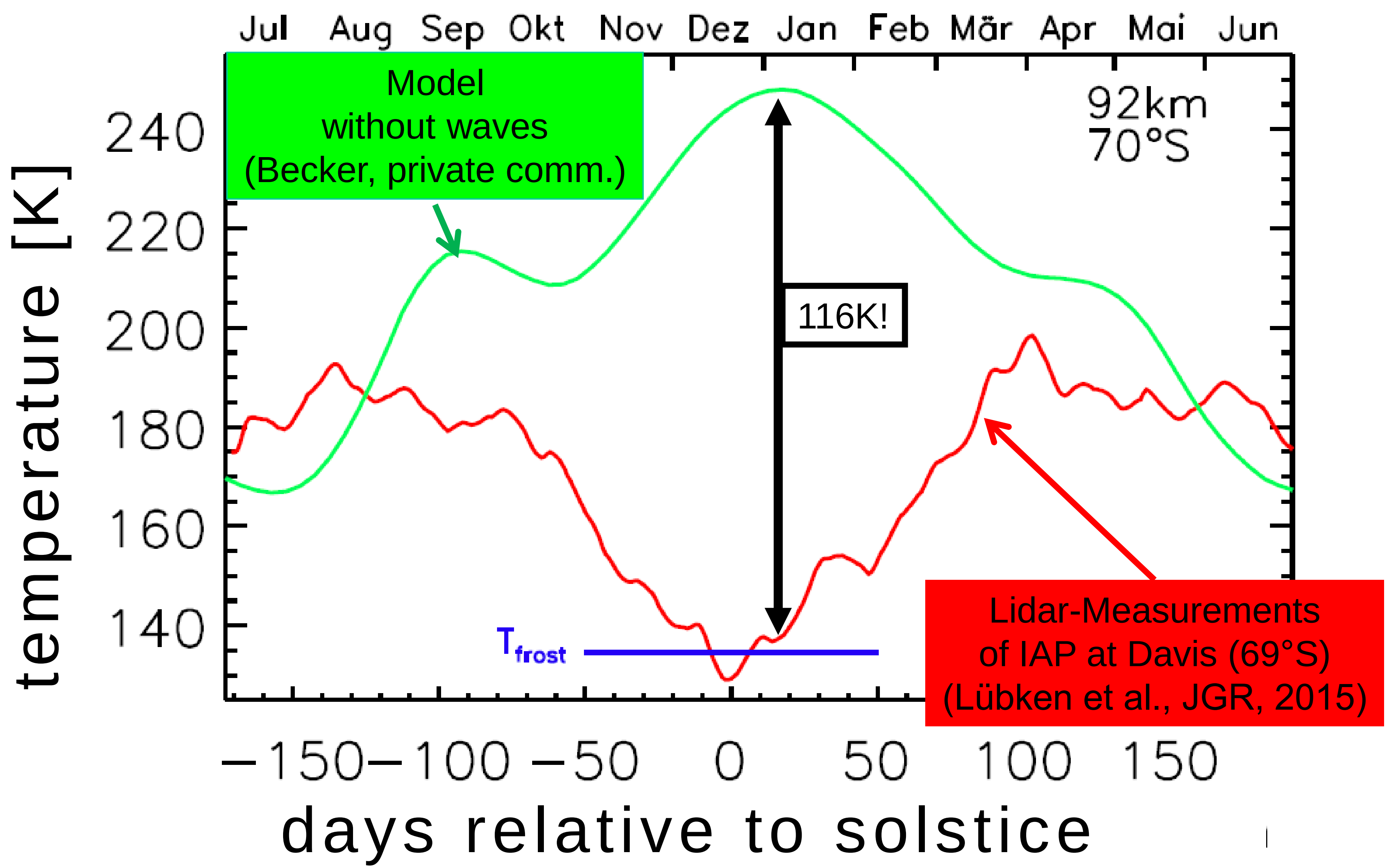
PUBLISHED ONLINE: 21 SEPTEMBER 2014 | DOI: 10.1038/NGEO2253

Atmospheric circulation as a source of uncertainty in climate change projections

Theodore G. Shepherd

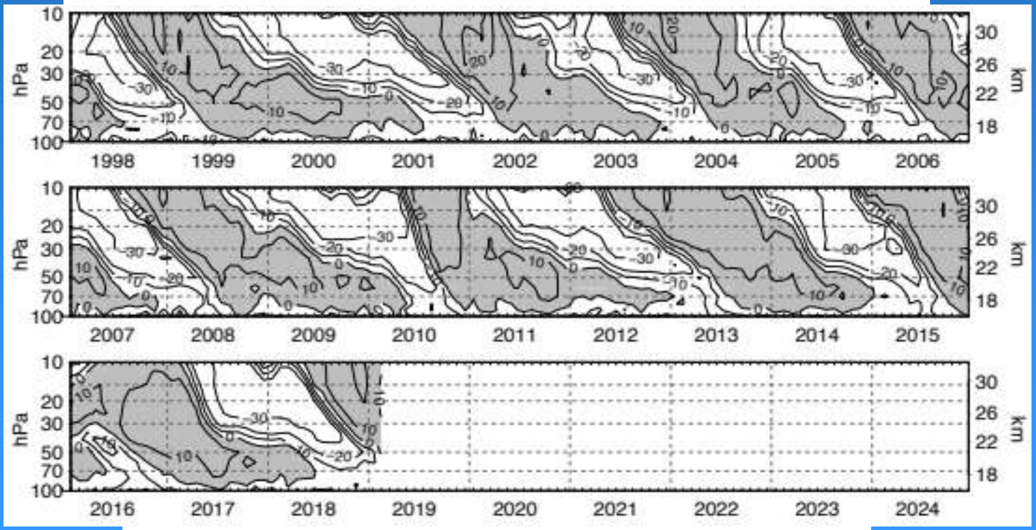
"The most uncertain aspect of climate modelling lies in the representation of unresolved (sub-gridscale) processes such as clouds, convection, and boundary-layer and gravity-wave drag, and its sensitive interaction with large-scale dynamics."

gravity waves are crucial for understanding the MLT



QBO in a changing climate

Zonal wind in (m/s) observed at Singapore, 1N/104E



FU-Berlin, https://www.geo.fu-berlin.de/met/ag/strat/produkte/qbo/qbo_wind.jpg

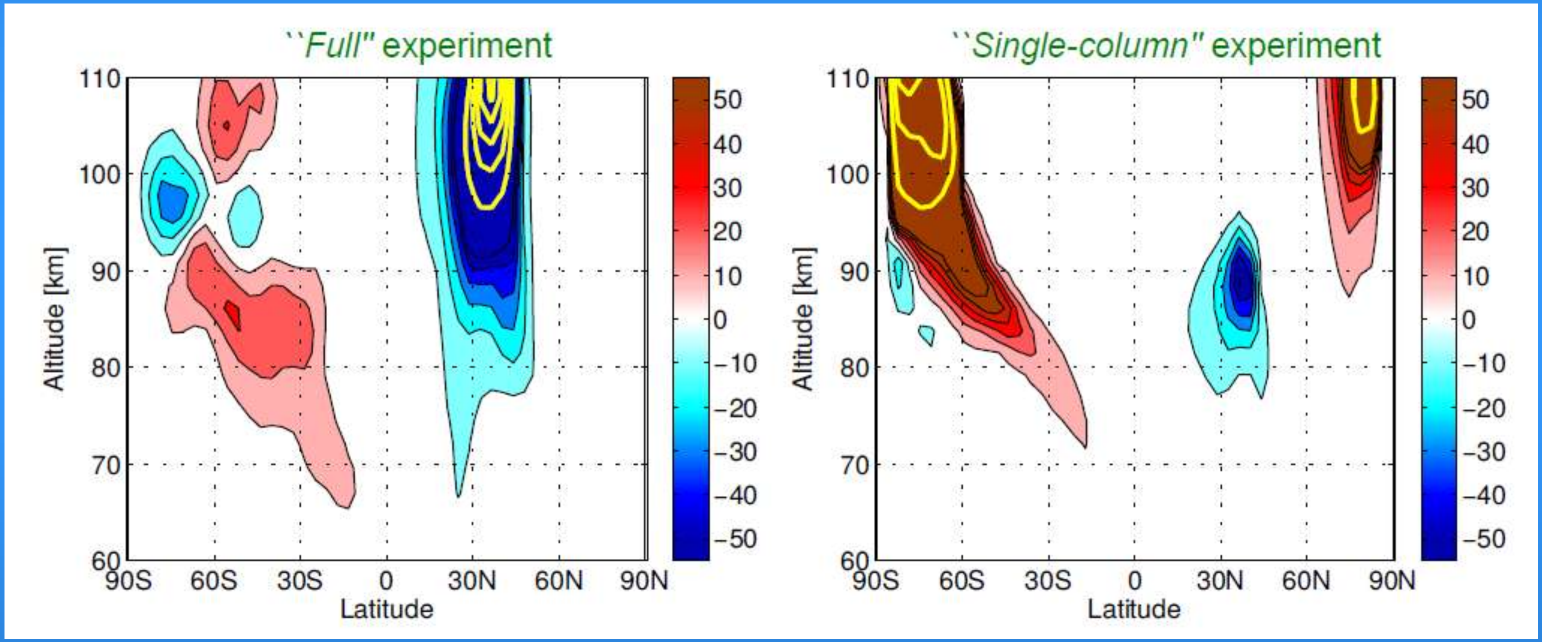
- QBO is fairly regular since ~60 years
- Waves and upwelling are essential for QBO ; are expected to change.
- What will happen to the QBO in a warmer climate?
- What are the effects in the troposphere?
- Climate change simulations including a QBO give contradicting answers.

QUBICC

The Quasi-Biennial Oscillation in a Changing Climate

- **Simulations of QBO with convection and gravity waves**
- **Model: Interaction of QBO with gravity waves**
- **Tropical waves in observations and reanalysis**
- **QBO in Aeolus (satellite lidar) observations**

Neglect of **lateral propagation** can have negative effects in the middle atmosphere (e.g. Dunkerton1984, Senf & Achatz 2011, Plougonven et al 2017)

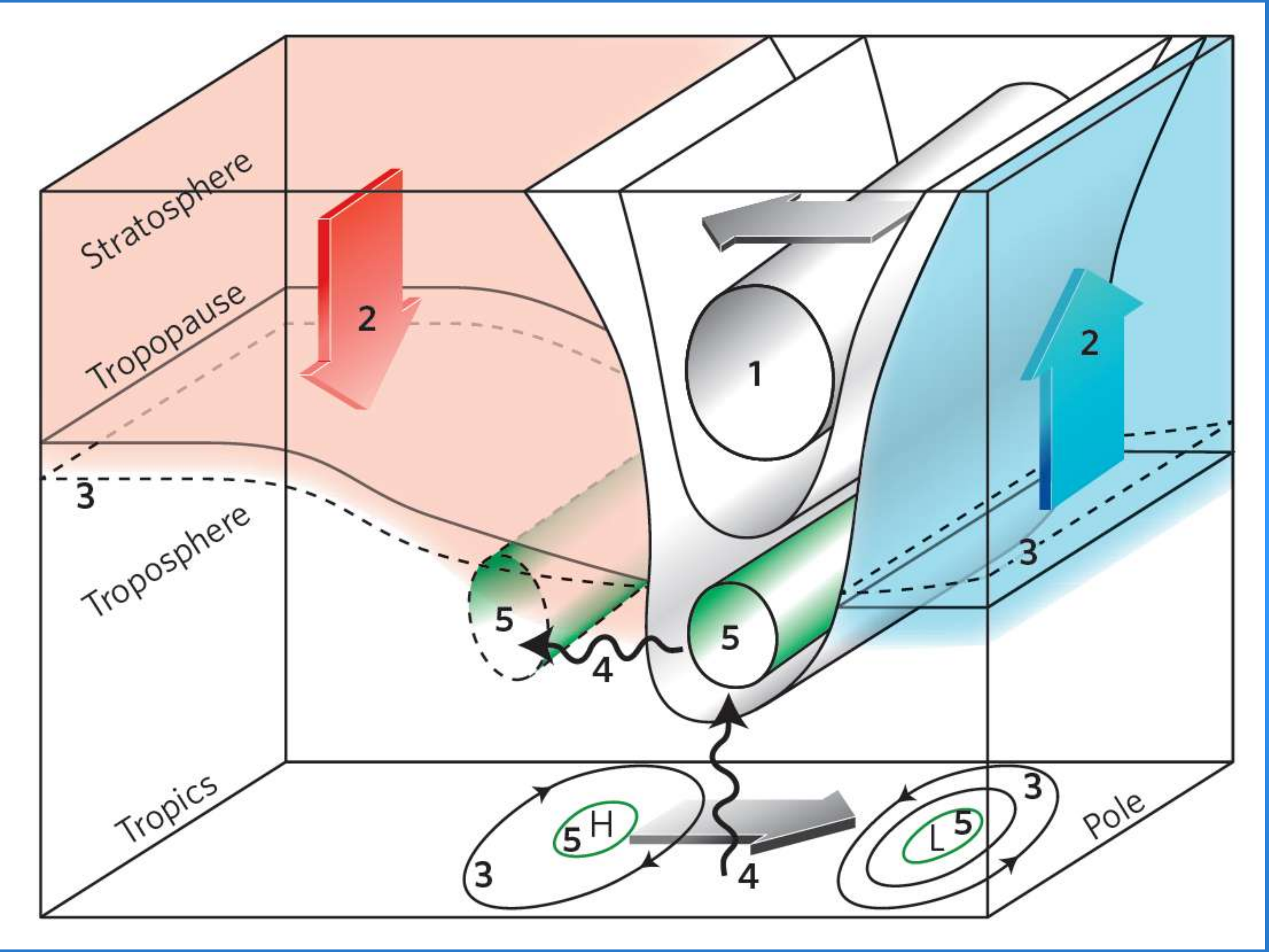


WASCLIM

Role of Gravity Waves in the Southern Hemispheric Circulation and Climate

- **Impact of gravity waves on the SH stratospheric circulation and resulting effects on tropospheric climate change.**
- **Bring together experts from processes-studies, weather and climate modeling.**
- **Combining various observations (field campaigns!) and high resolution modeling.**

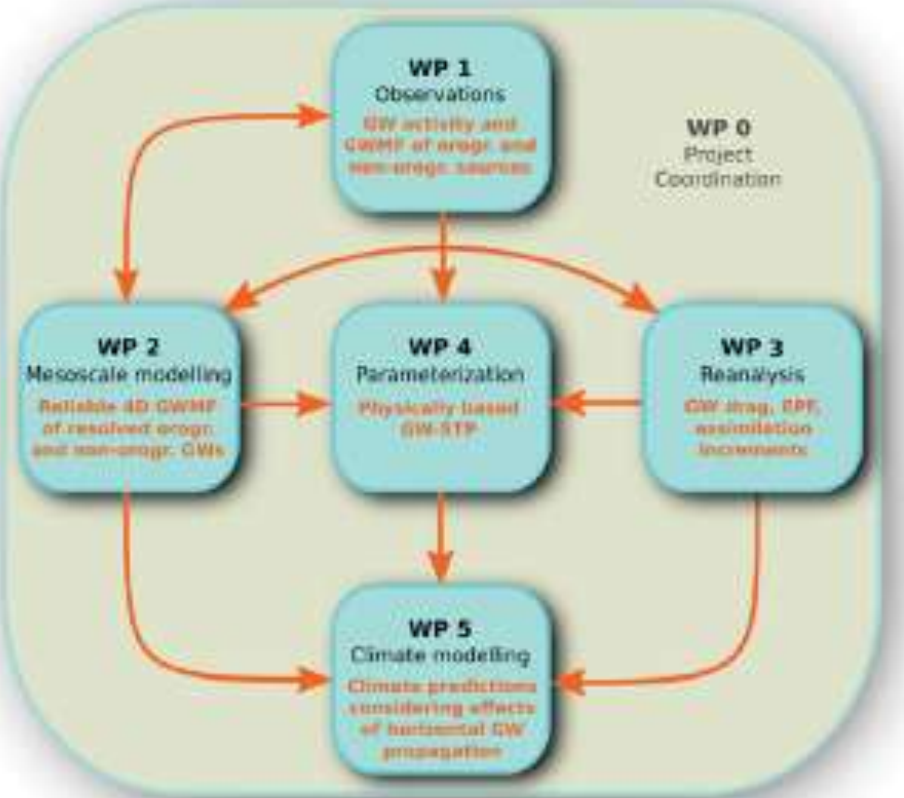
Stratospheric influence on dynamics in the troposphere



J. Kidston et al., Nature Geoscience, 2015

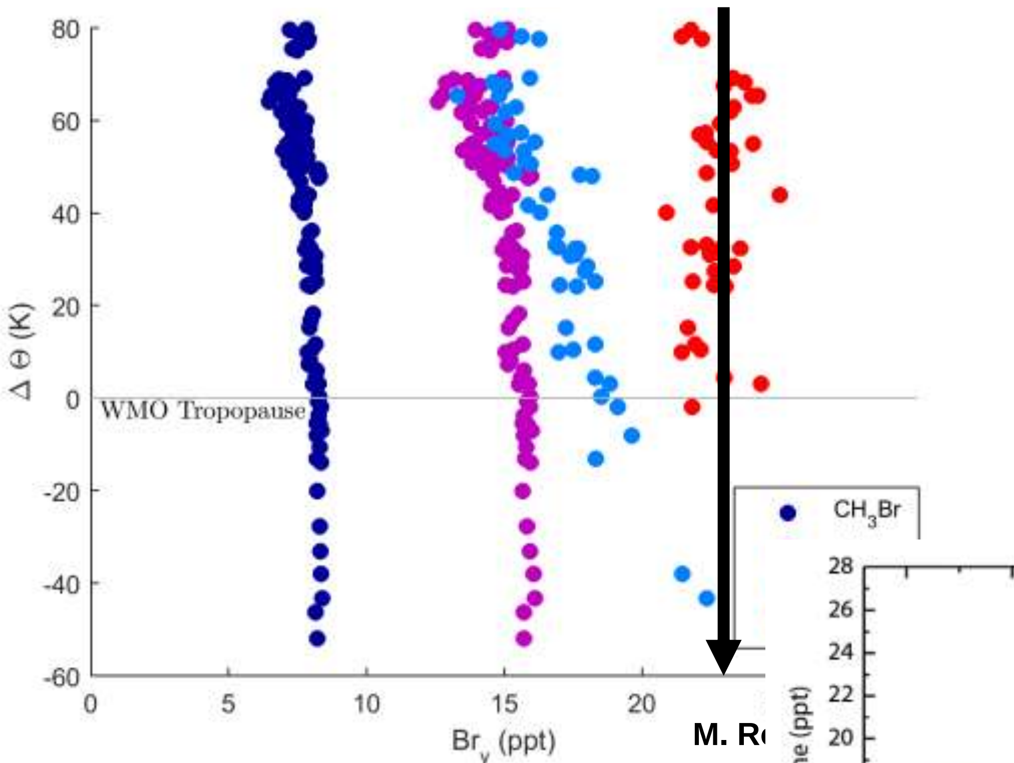
Role of Gravity Waves in the Southern Hemispheric Circulation and Climate

(WASCLIM)

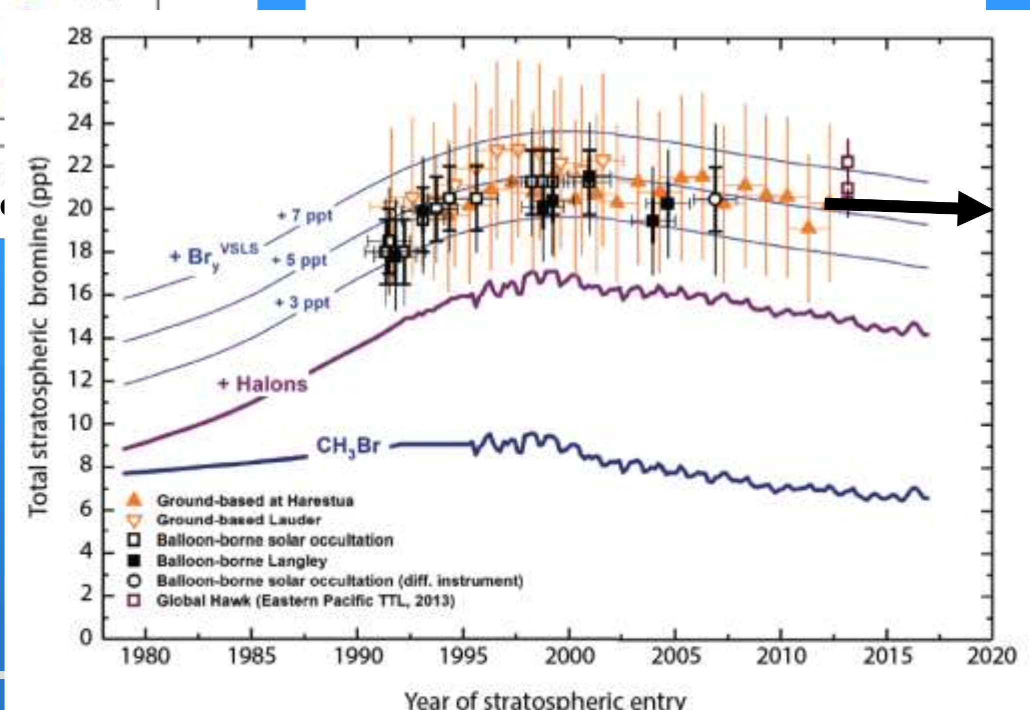


Chemistry (mainly stratosphere)

Total bromine across the tropopause (WISE flight on Oct. 12, 2017)



Trends in total stratospheric bromine



Note: bromine causes
30% of ozone desctruction

SCI-HI

Surface Climate Impacts of Halogen Induced Stratospheric Ozone Changes

- **Assessment of total bromine in the UTLS (upper troposphere/lower stratosphere)**
- **Investigation of different source regions for VSLS (very short lived substances)**
- **Investigation of halogen catalyzed ozone chemistry on UTLS ozone**

LEIBNIZ-INSTITUT FÜR ATMOSPHÄREN PHYSIK IAP

SOCTOC

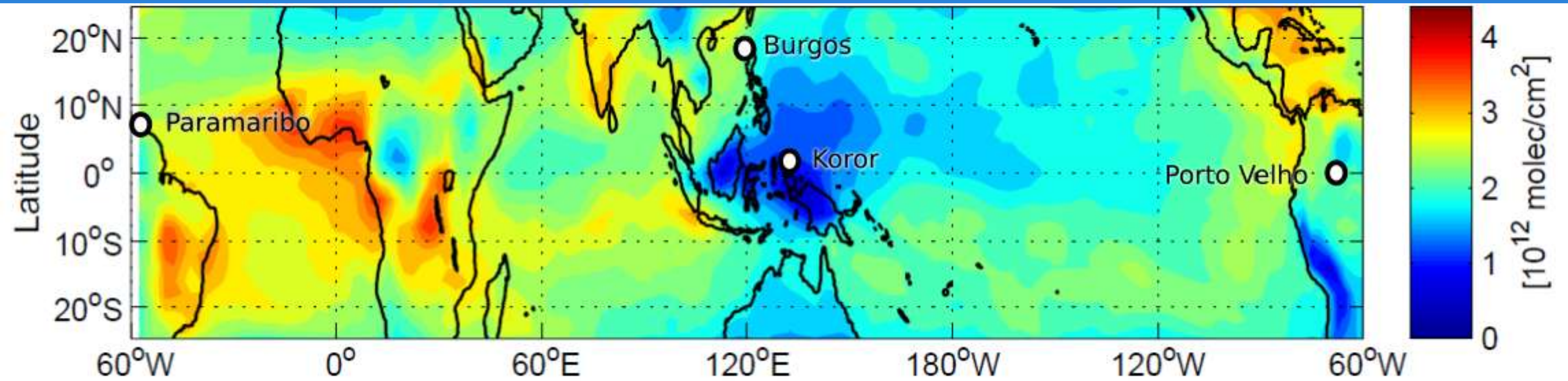
Effects of anthropogenic stratospheric ozone changes on climate sensitivity and tropospheric oxidation capacity

- **Understand reaction of tropical tropopause layer (TTL) to global warming, including role of ozone**
- **How does stratospheric ozone change affect oxidation capacity of the troposphere (incl. methane)**
- **Can we use computationally cheap ozone schemes for climate and chemistry simulations ?**

TroStar

The transport of trace gases via the tropopause region in the Western Pacific observed by FTIR spectrometry

- **Perform observations in Western Pacific and South America**
- **OCS/N2O column ratio: disentangle chemical/dynamical effects**
- **Quantify transport of photochemically active gases from troposphere into the stratosphere**



Rex et. al., ACP, 2014

- very low concentration of OH in the troposphere
- increases lifetime of trace gases
- survive transport into the stratosphere

SCOSTEP

Scientific Committee on Solar-Terrestrial Physics

Vol. 10, July 2016

VarSITI Newsletter

Project ROSMIC

Meeting Report 4:

German Research Program ROMIC in Külungsborn

ROMIC has been a part of VarSITI

… and will hopefully play an important role in PRESTO:

SCOSTEP

Scientific Committee on Solar-Terrestrial Physics

Committee for the definition of the Next Scientific Program (NSP)

***PRESTO*:**

Predictability of the variable **S**olar-**T**errestrial C**o**upling

The SCOSTEP Next Scientific Program

LEIBNIZ-INSTITUT FÜR ATMOSPHÄREN PHYSIK IAP

Thank you for your attention !

… and to BMBF for funding.

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Germany

- Long period variations in the stratosphere, mesosphere, and lower thermosphere
  - Stratosphere
    - Solar forcing of the stratosphere
    - Long-term stratospheric change
    - Stratospheric dynamical variability: Sudden Stratos[illegible]eric
  - Mesosphere and Lower Thermosphere (MLT)
    - What is special about the MLT region?
    - Trends and solar cycle variations in the ML[illegible]
    - Impact of tropospheric changes on the M[illegible] vice versa

- Coupling mechanisms
  - Coupling by dynamical processes
  - Circulation patterns
  - Dynamical Coupling Processes
  - Trends in Dynamical Couplin[illegible]ses

- Relevance for climate
  - Evidence for the im[illegible] the middle atmosphere on climate
    - Dynamics
    - Radiation
    - Chemis[illegible]

- Natural forcing
  - Solar forcing
  - Volcanic forcing

- Implementing middle atmosphere processes into climate models

Scientific topics in ROMIC