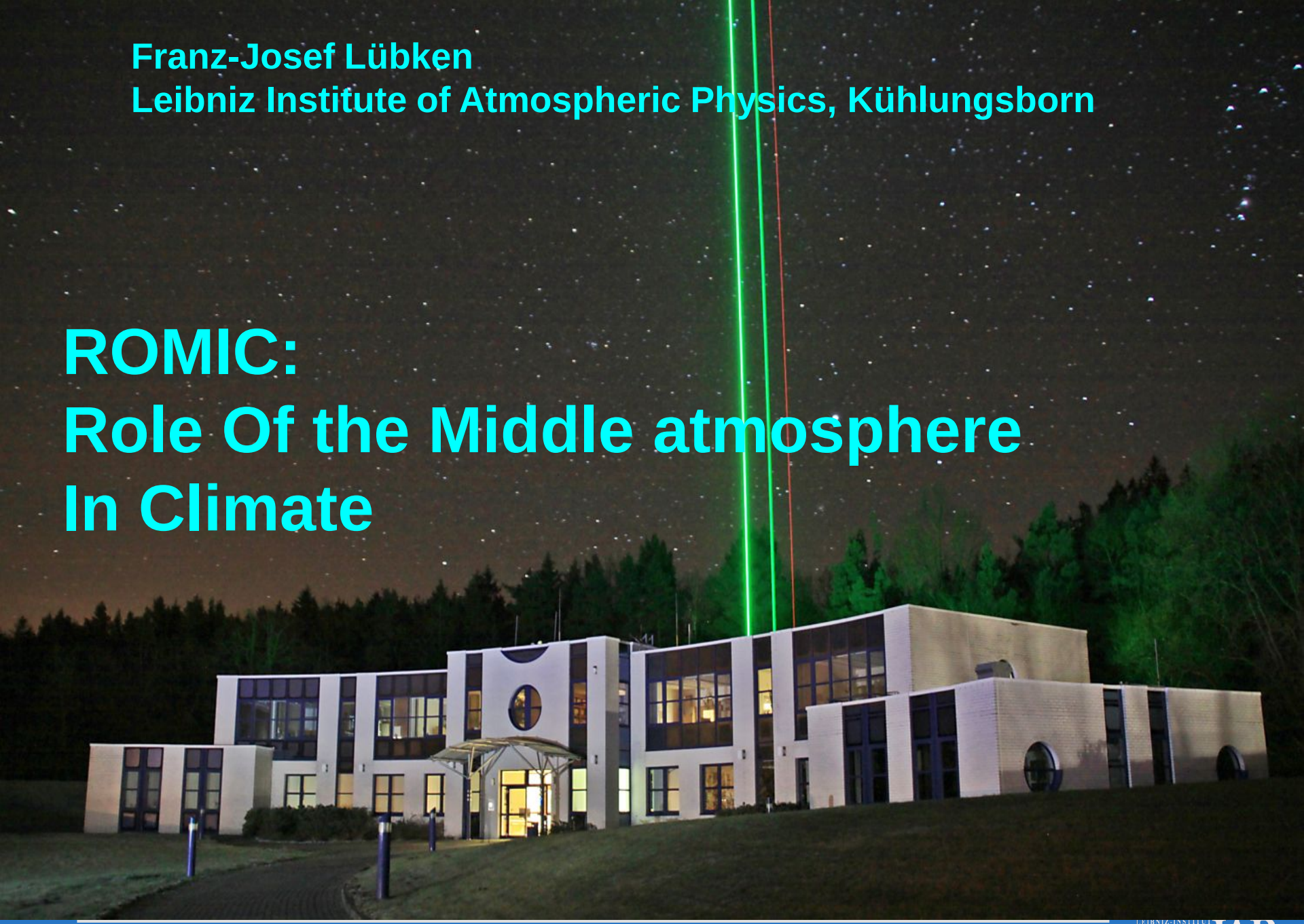
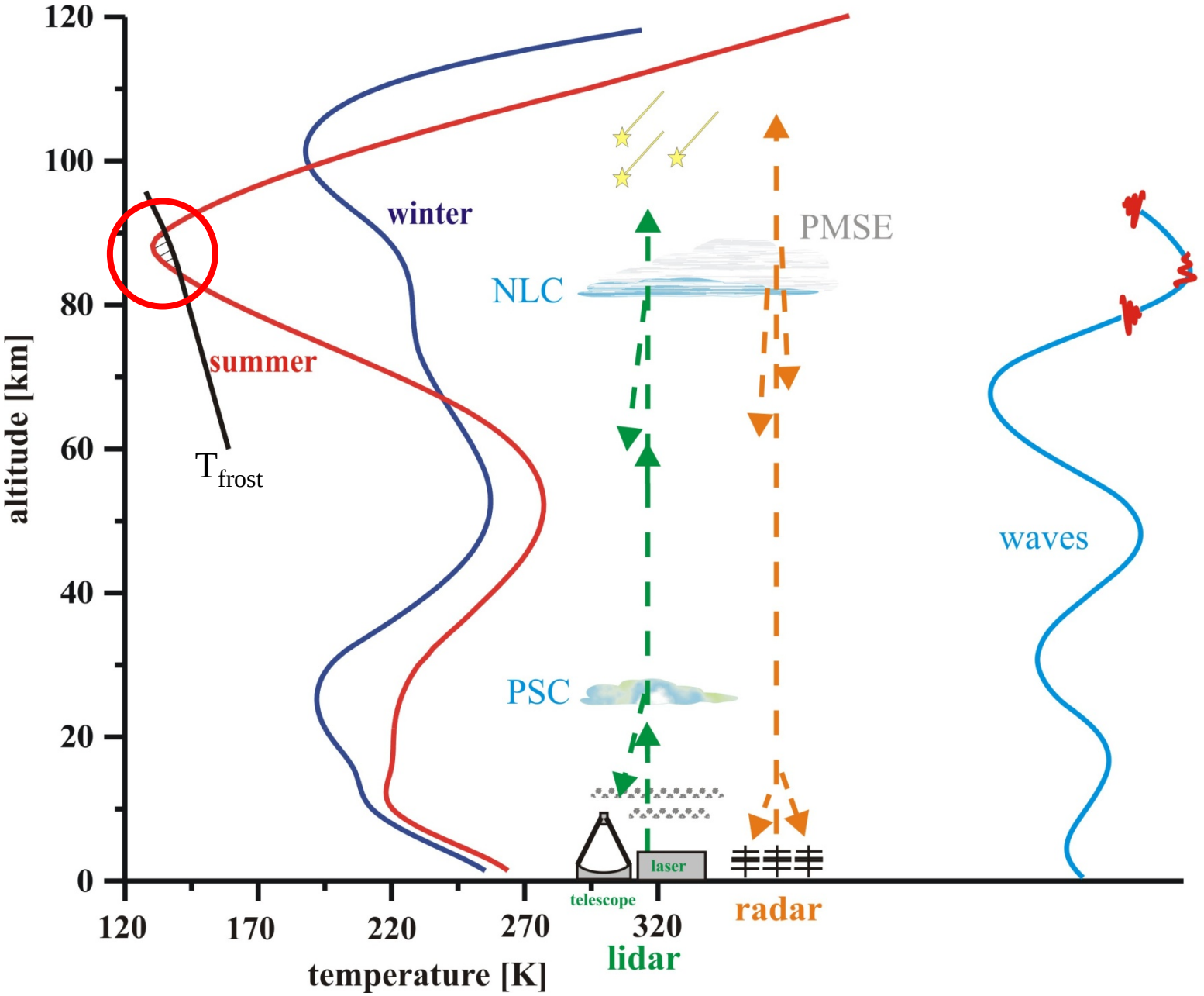
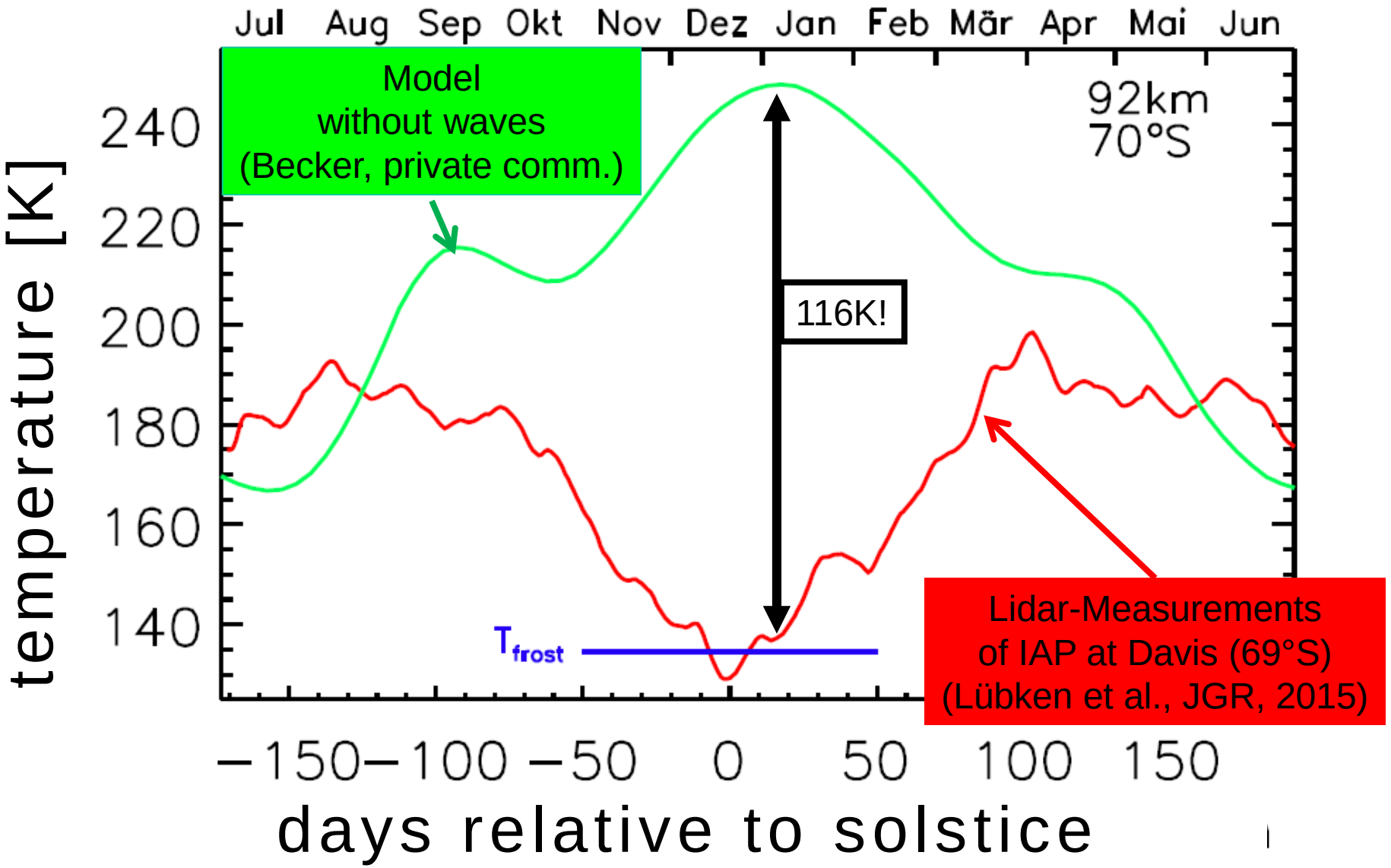
Franz-Josef Lübken
Leibniz Institute of Atmospheric Physics, Kühlungsborn

ROMIC:
Role Of the Middle atmosphere In Climate




120
100
80
60
40
20
0
altitude [km]
winter
summer
T frost
NLC
PMSE
PSC
waves
laser
telescope
radar
lidar
120
170
220
270
320
temperature [K]

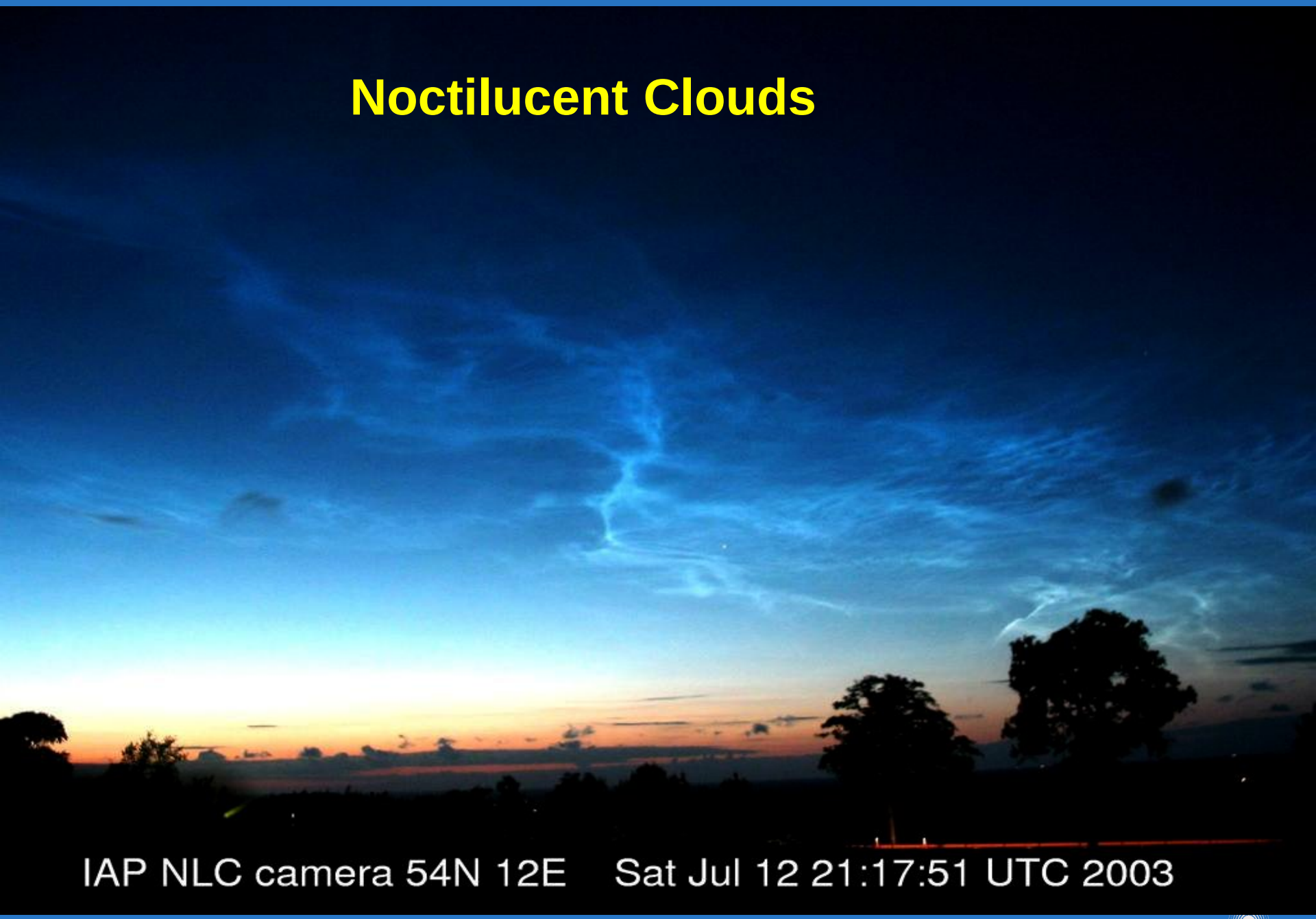
gravity waves are crucial for understanding the MLT



Temperatures from Fe lidar at Davis, 69°S

Lübken et al.,
Geophys. Res. Lett., 2014
J. Geophys. Res. 2015,
JASTP, 2017

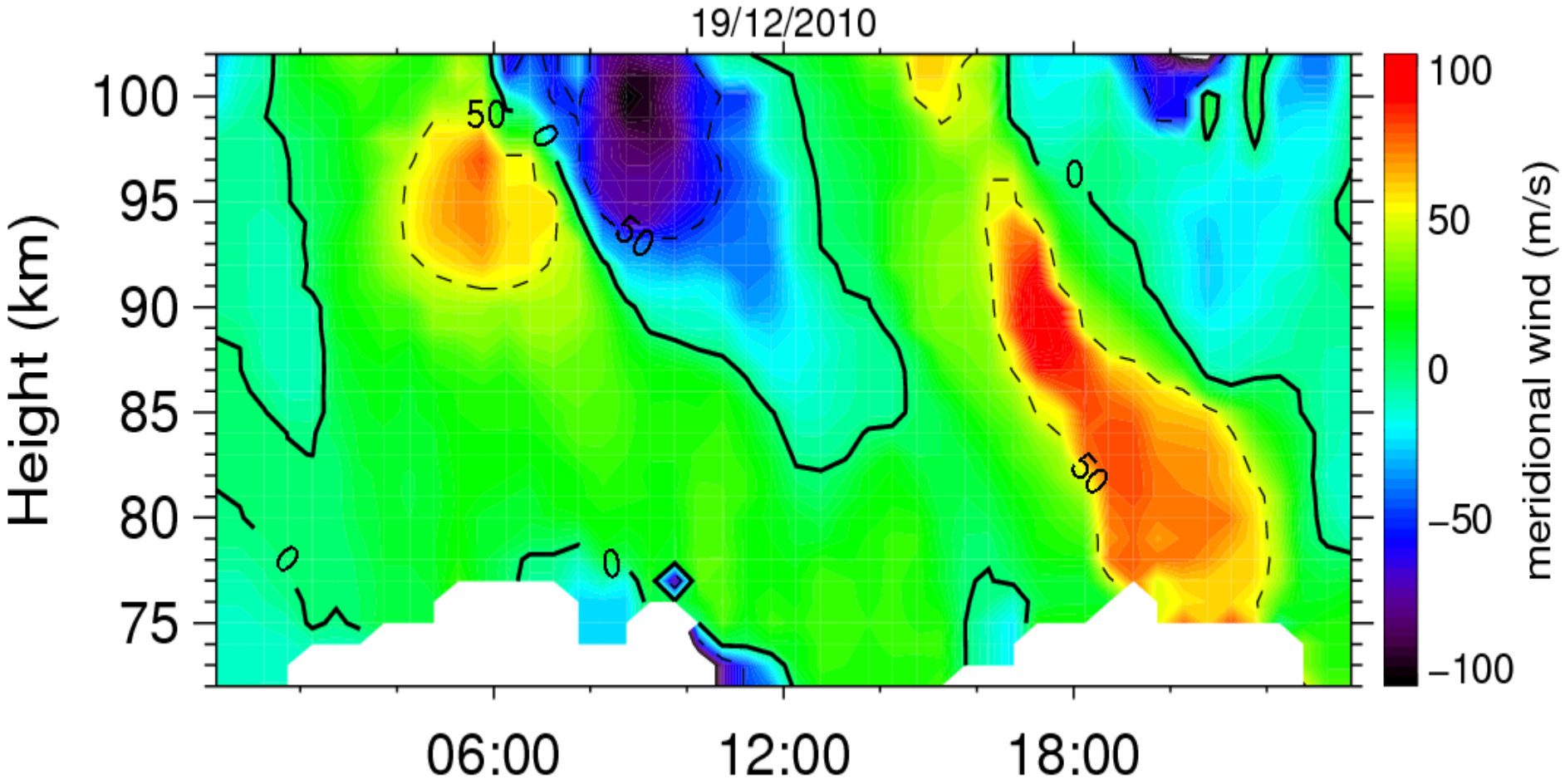
Noctilucent Clouds



Mesosphere/lower thermosphere (MLT): Transition from atmosphere to space

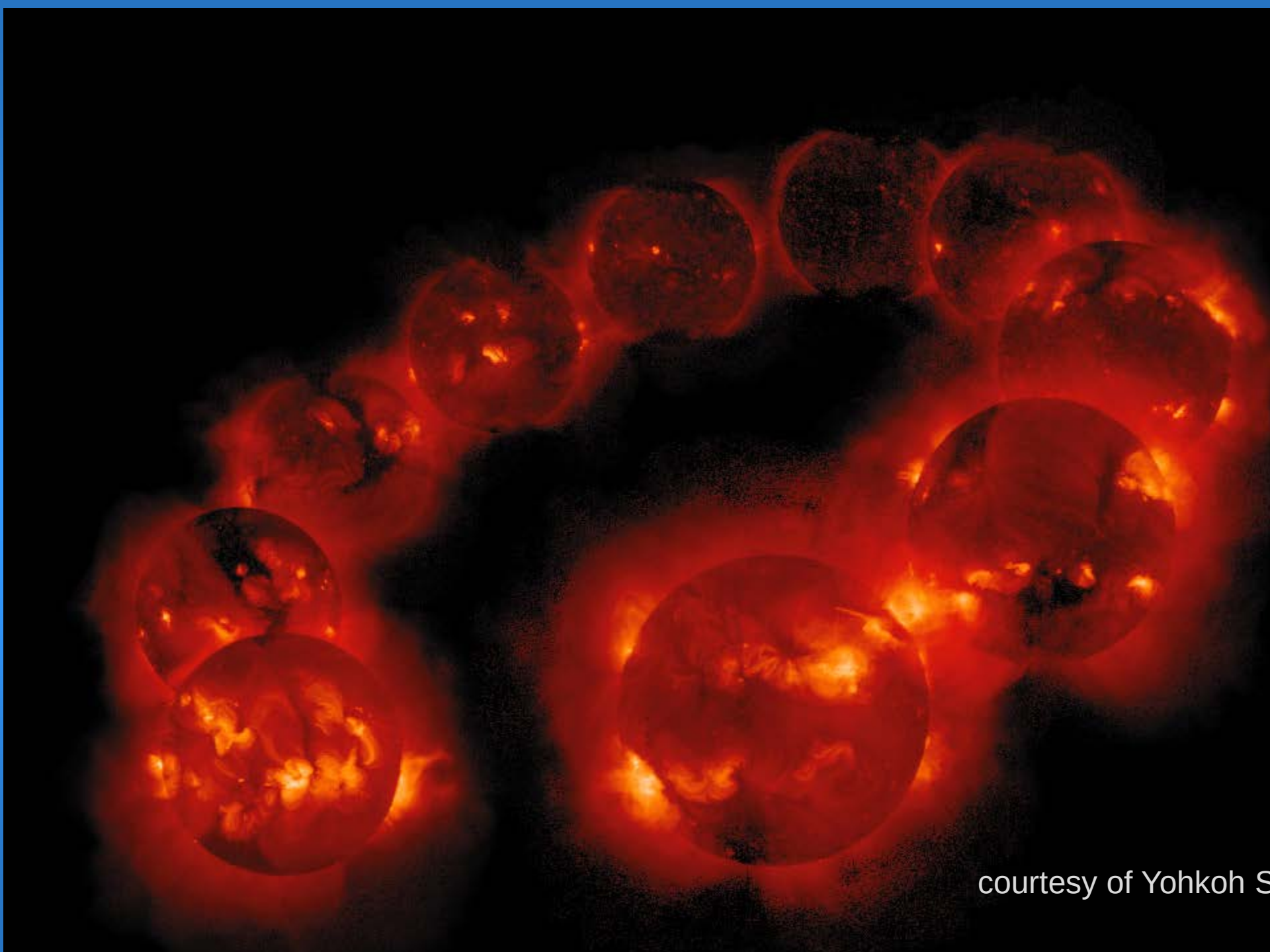
ALOMAR observatory (69°N) with laser beams of IAP lidar

permanent hurricans in the mesosphere

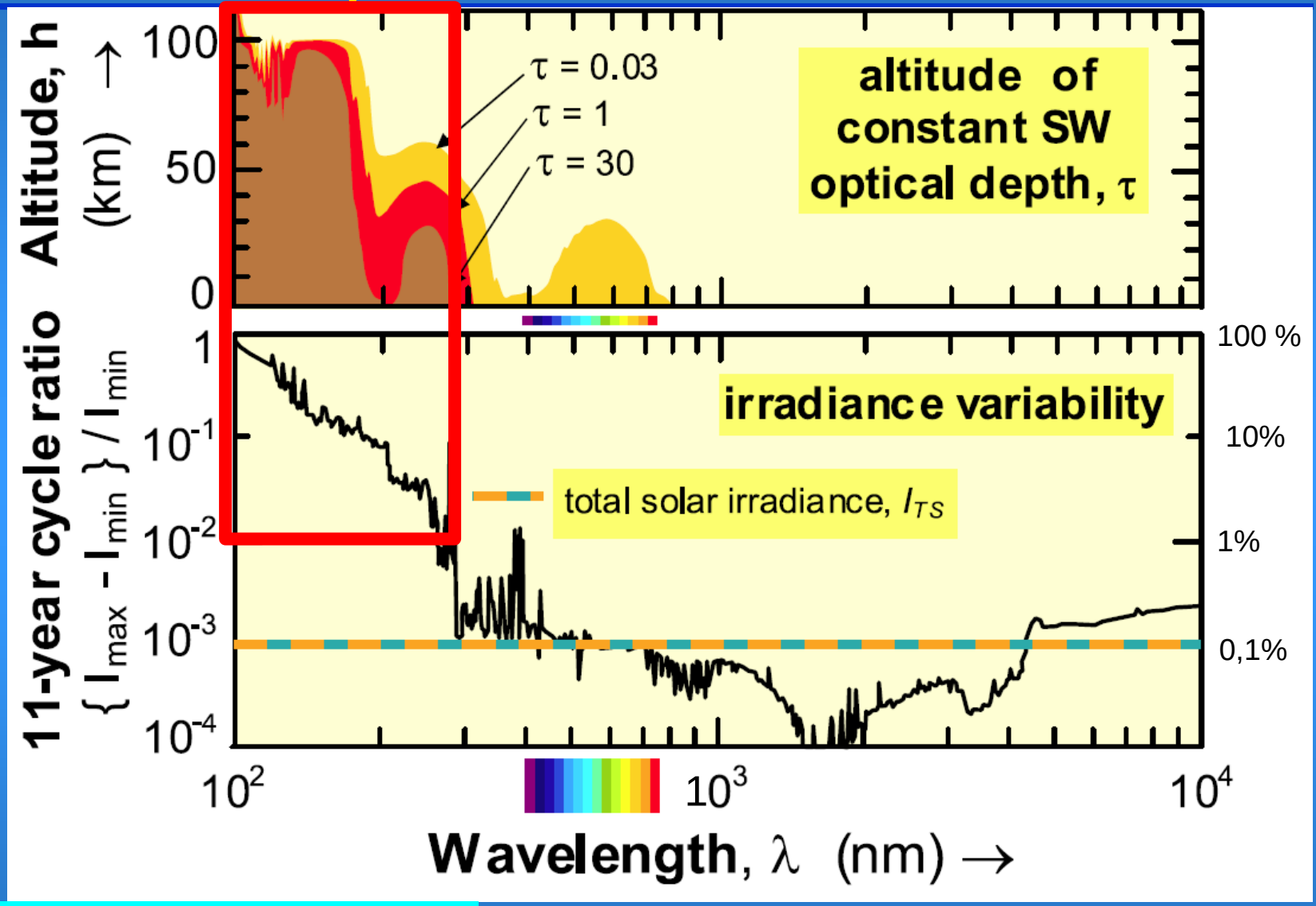


SAURA MF Radar (ALOMAR)

Szewczyk et al., Ann. Geophys. , 2012


courtesy of Yohkoh S

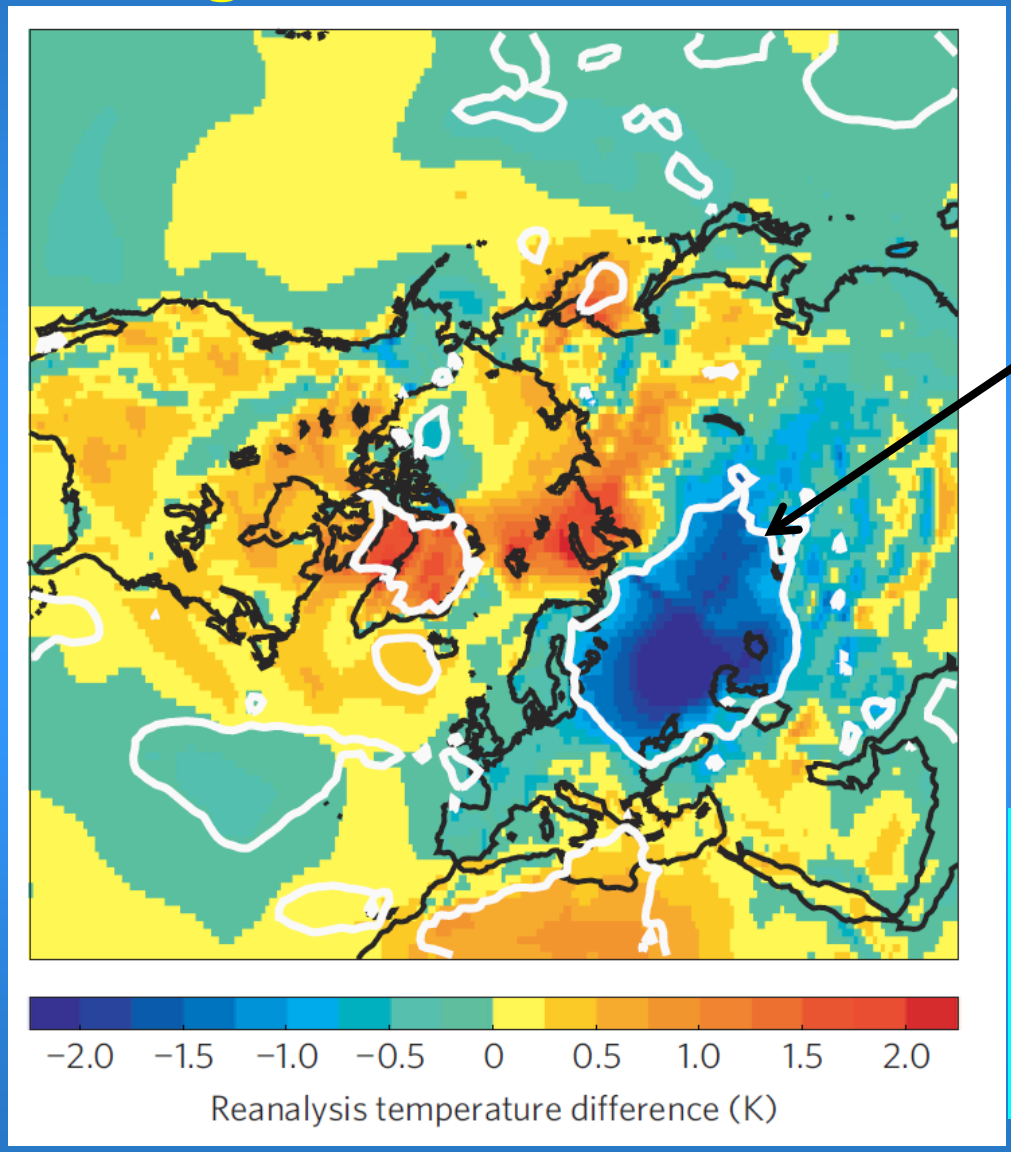
Solar cycle variation: max - min



Gray et al., Rev. Geophys., 2010

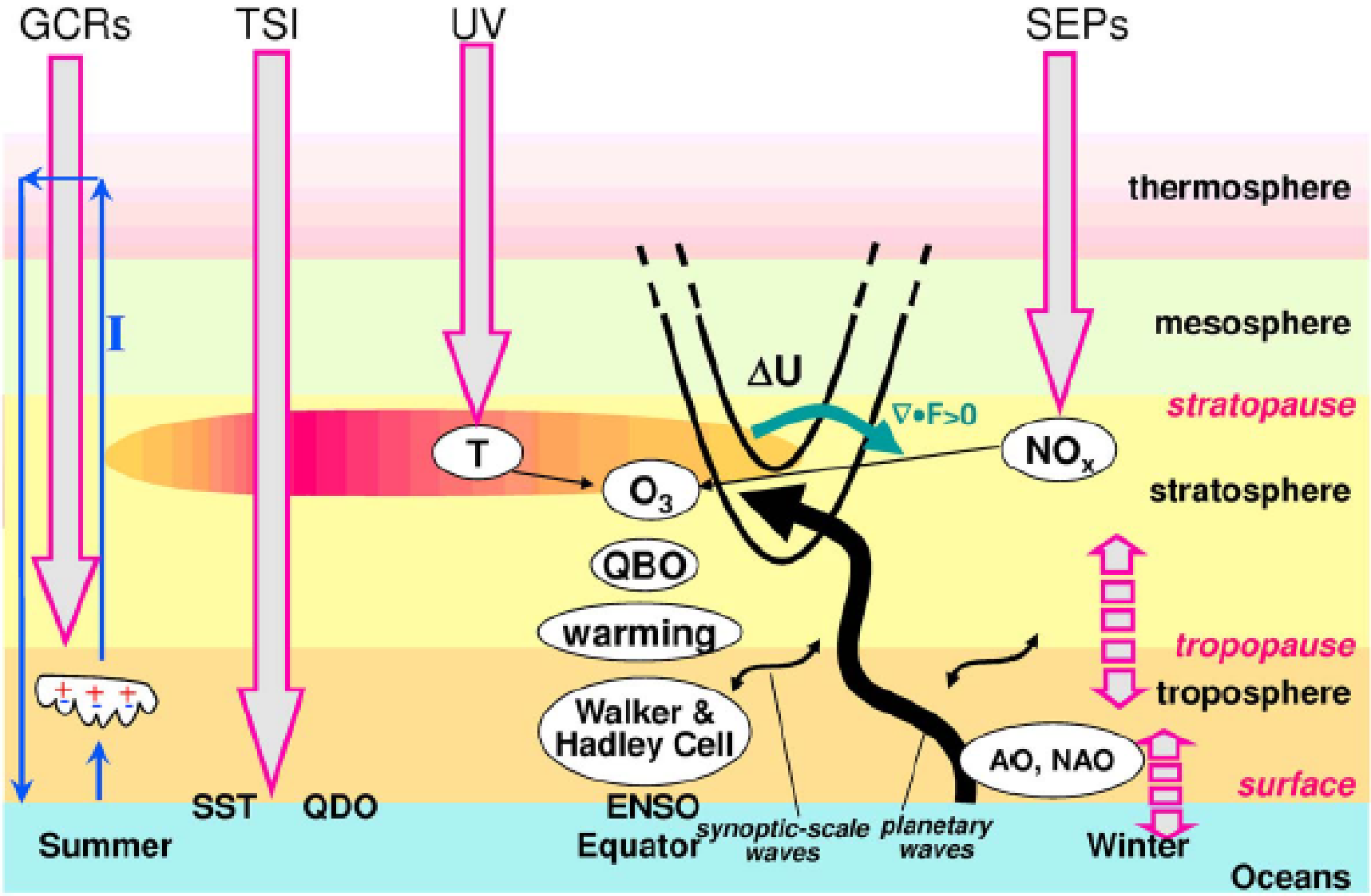
Solar cycle influence on surface temperature on regional(!) scales

solar min – solar max surface temperatures in winter (reanalysis)



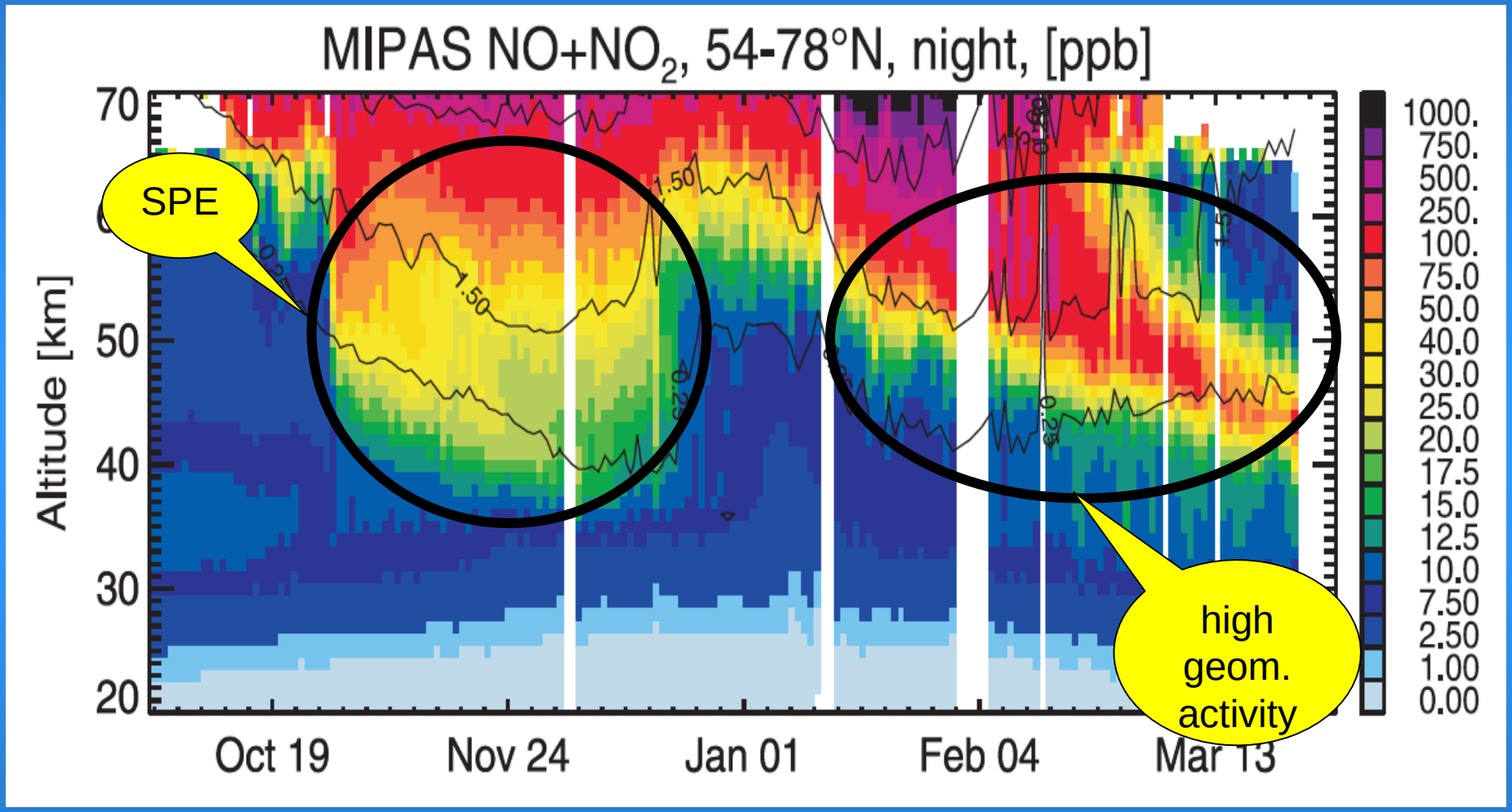
Ineson et al. Nature Geoscience, 2011

Mechanism? Coupling!



from Gray et al., Rev. Geophys., 2010

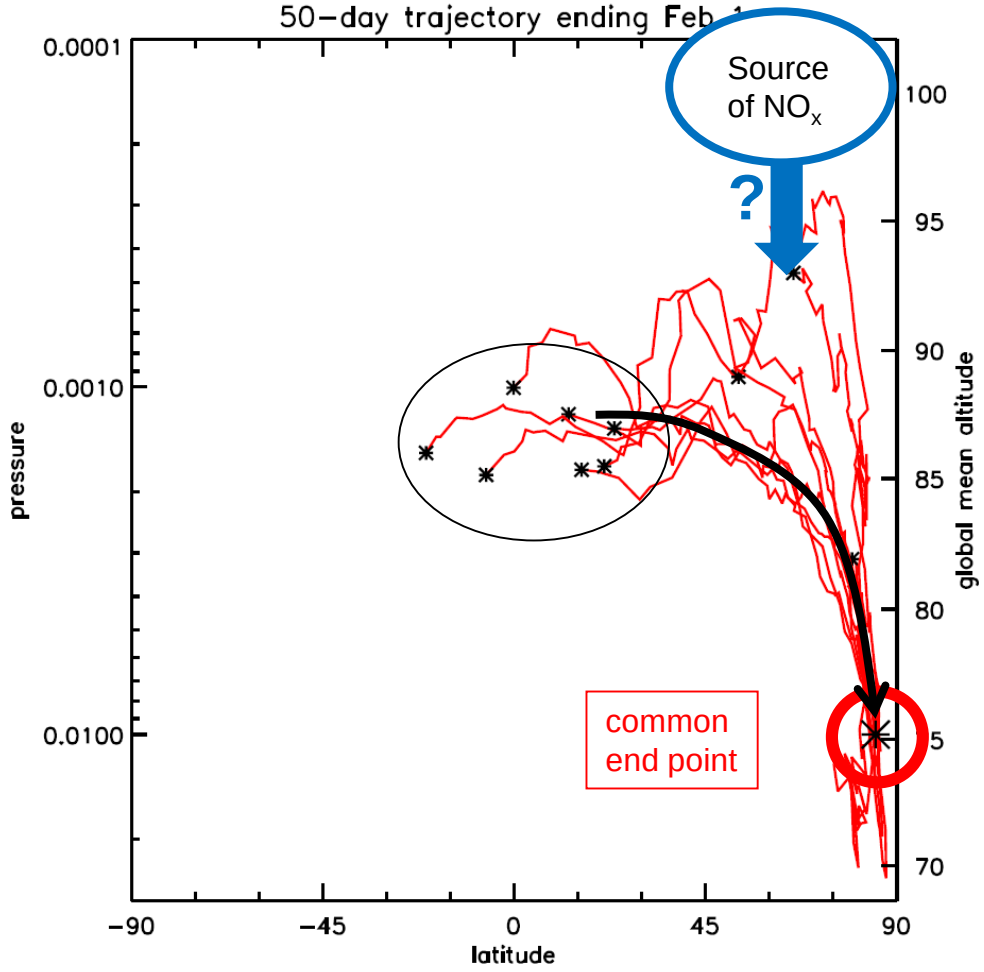
downward transport of photochemically active species



(from M. Sinnhuber et al. in CAWSES book, 2013)

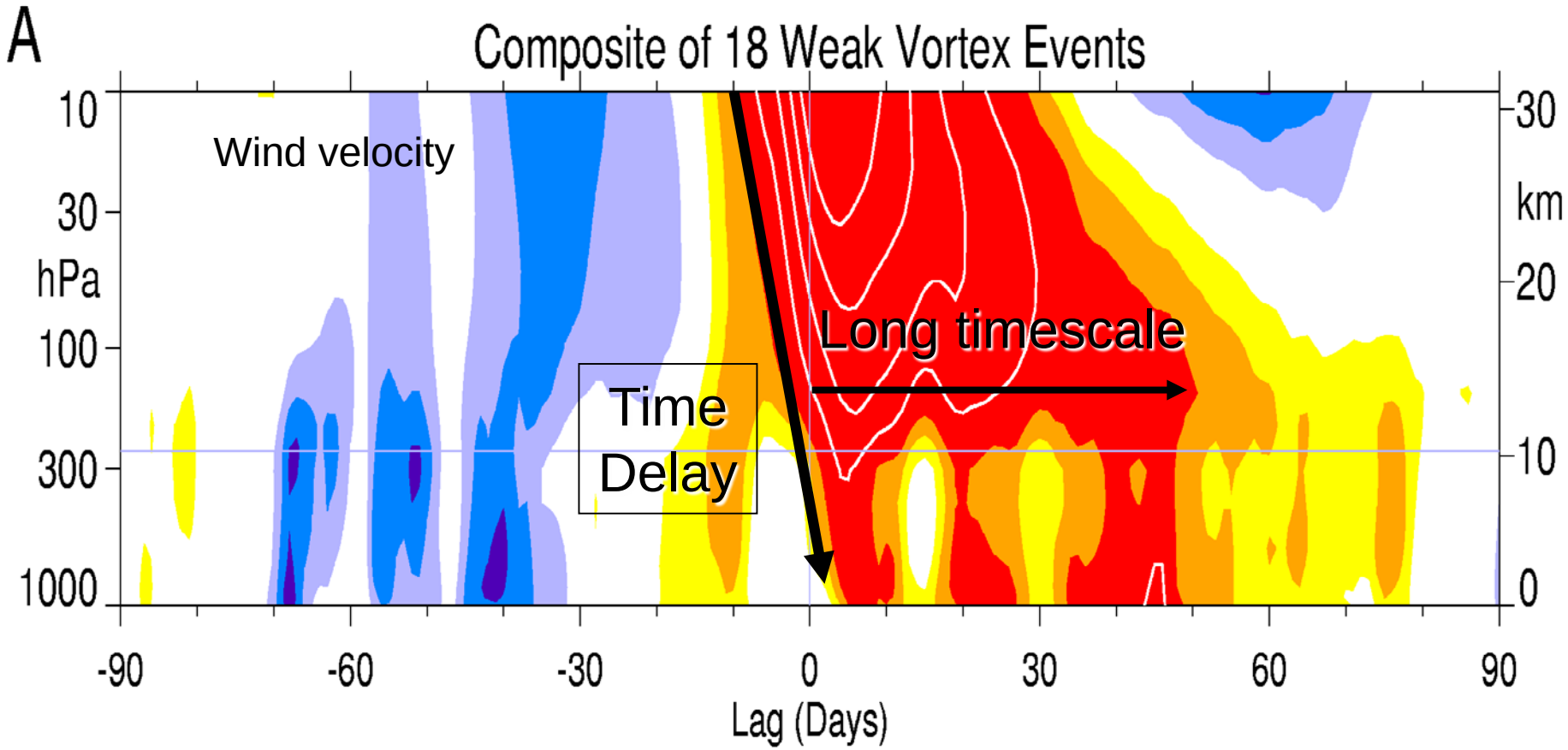
Coupling requires turbulent transport!

SMITH ET AL.: WACCM POLAR WINTER TRANSPORT , J. Geophys. Res., 2011



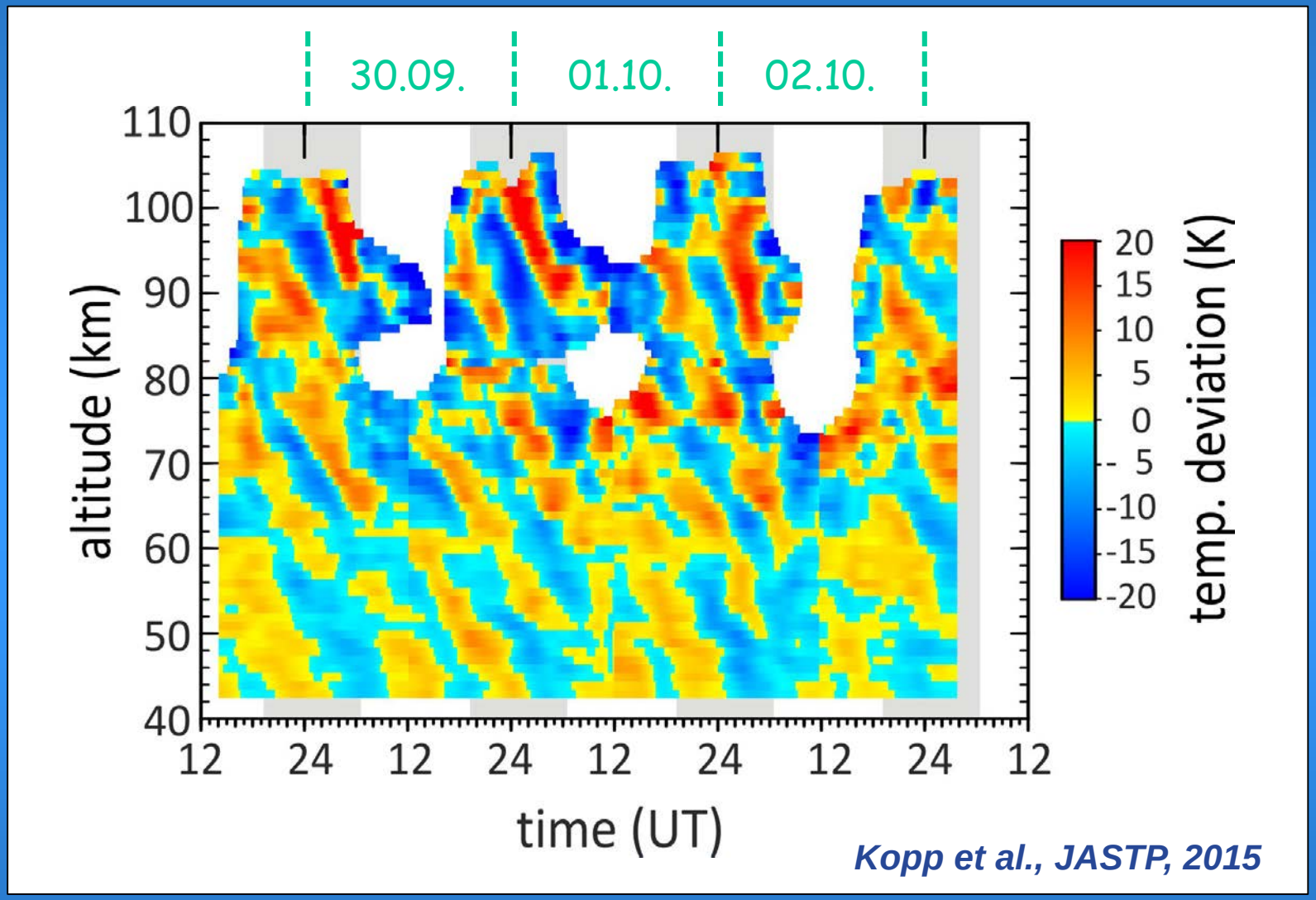
Conclusion: turbulent transport to small in the model !
but: K_{zz} from parametrisation of gravity waves !
Something is not correct!

Improve weather prediction with the help of the middle atmosphere ?



Baldwin and Dunkerton, Science, 2001

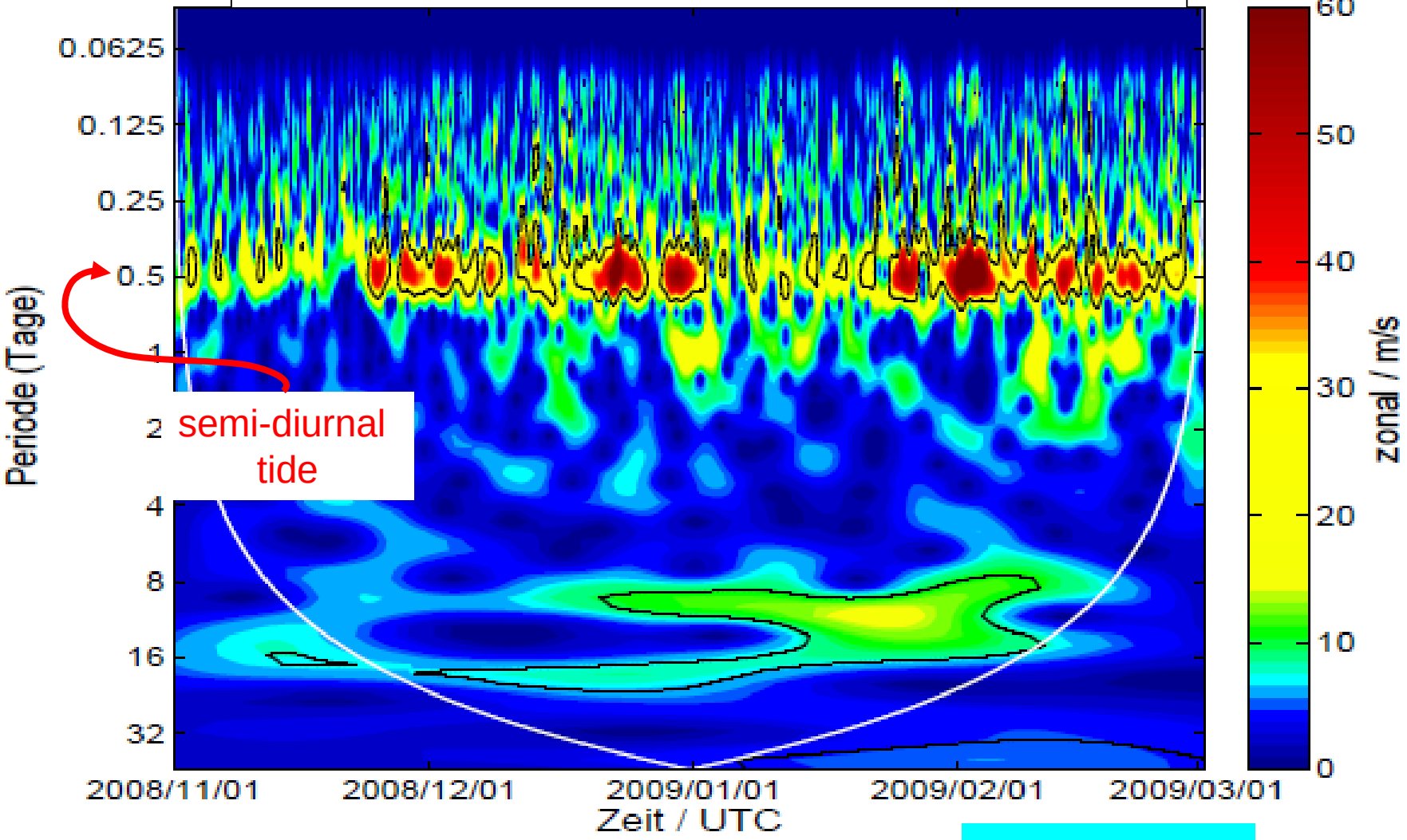
Daylight capable lidars at IAP



Kopp et al., JASTP, 2015

Radars reveal intermittent character of tides

Observations by meteor radar at Juliusruh (54°N)



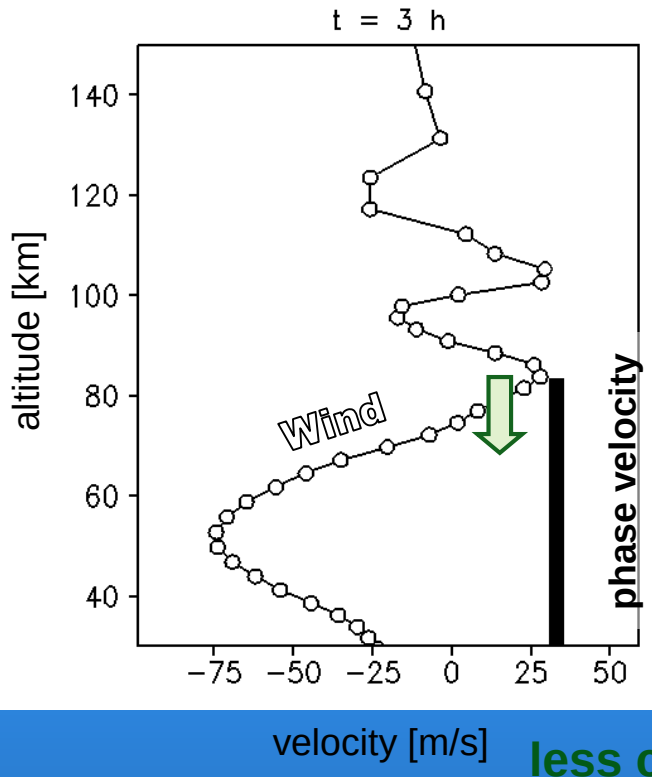
courtesy of IAP

GW propagation in a time varying background

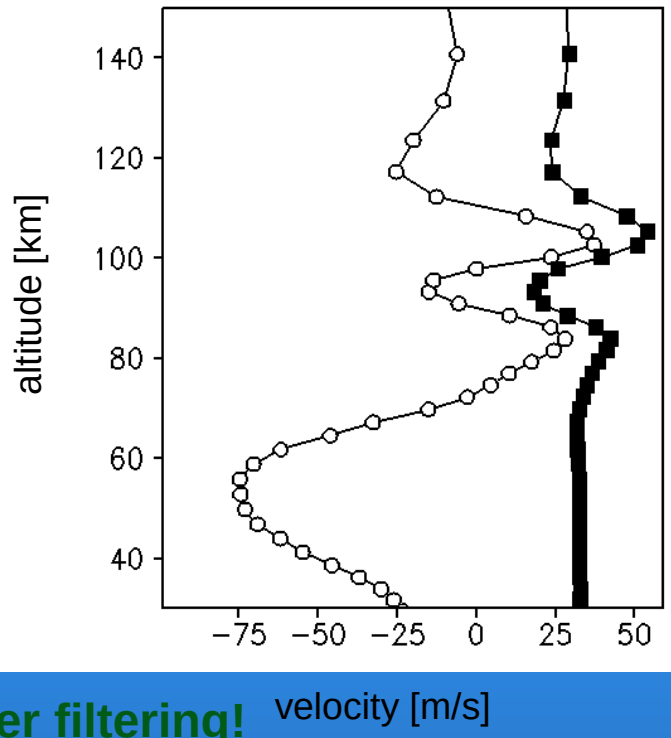
Vertical column thinking

is NOT appropriate for tides due to frequency modulation!

conventional



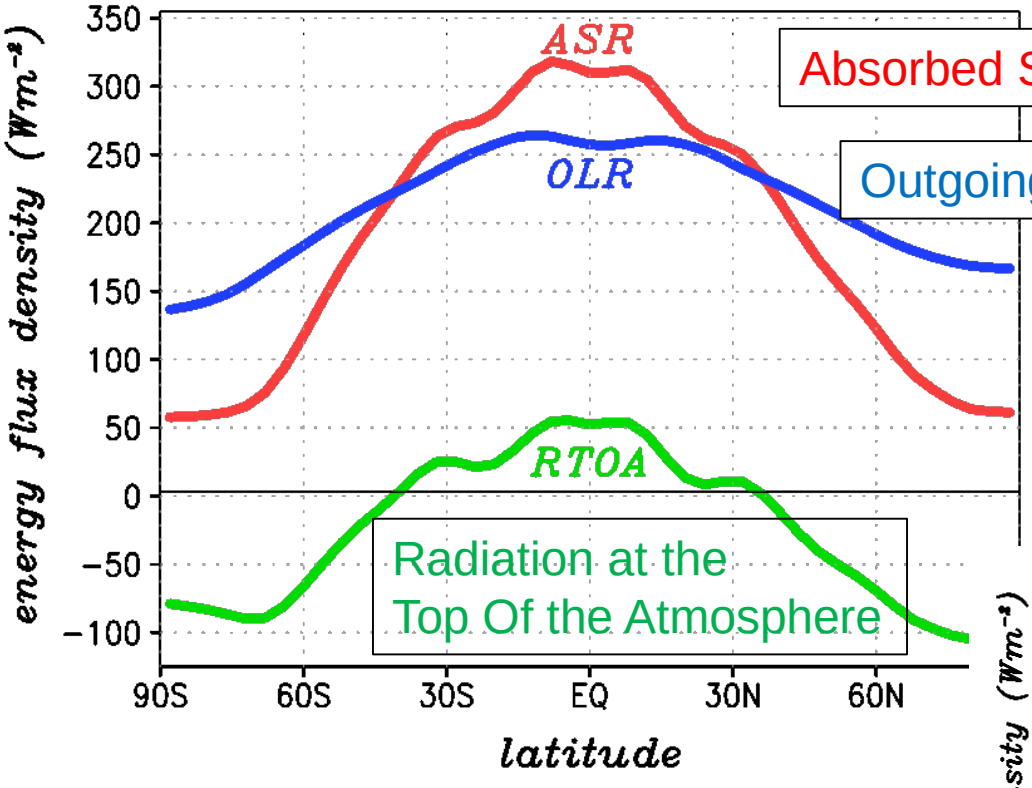
time-varying background



less critical layer filtering!

Senf and Achatz, JGR, 2011 Ribstein et al 2015, Ribstein & Achatz 2016

radiation balance: dynamics is heavily involved



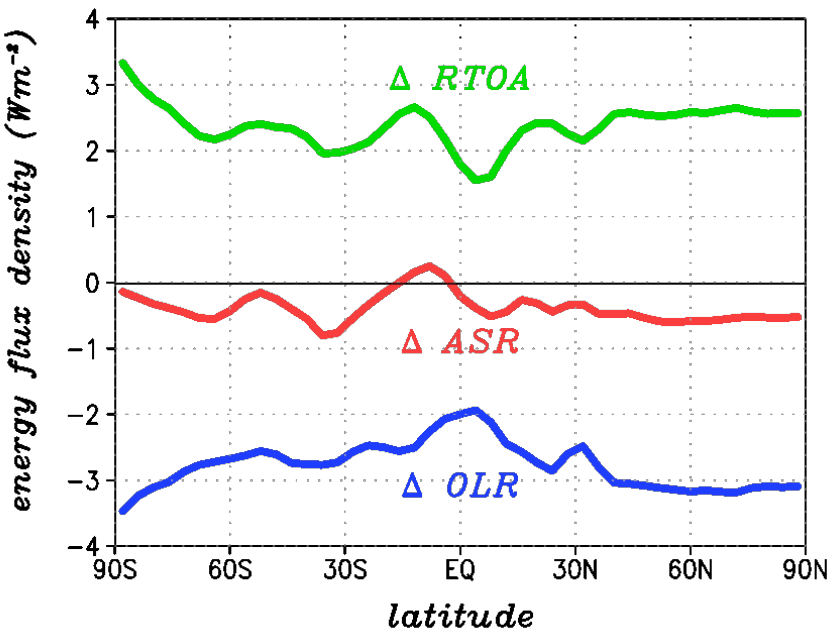
Absorbed Solar Radiation

Outgoing Longwave Radiation

Radiation at the Top Of the Atmosphere

many processes involved !

e.g. ignoring frictional heating:



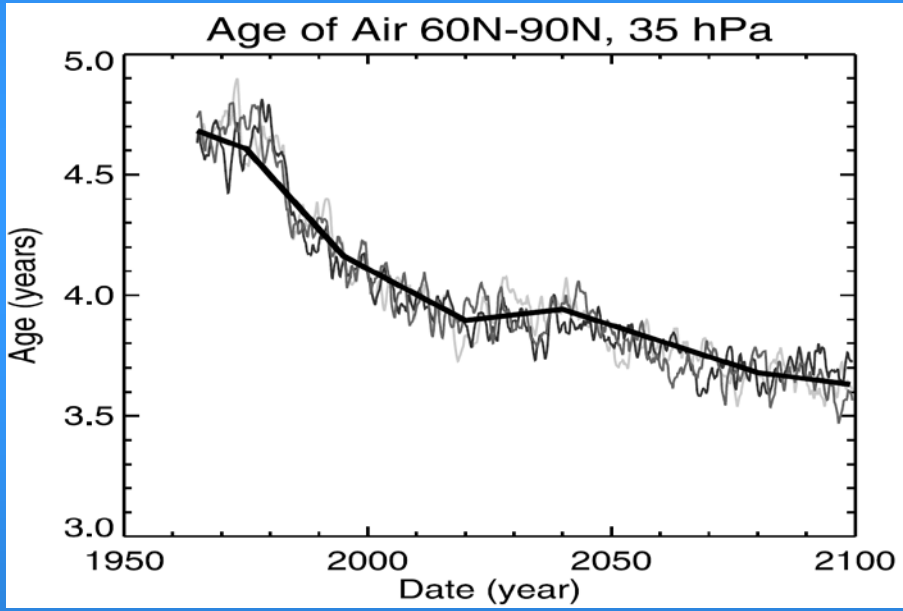
RTOA = ASR-OLR
~ 0 in KMCM

courtesy of
Erich Becker, IAP

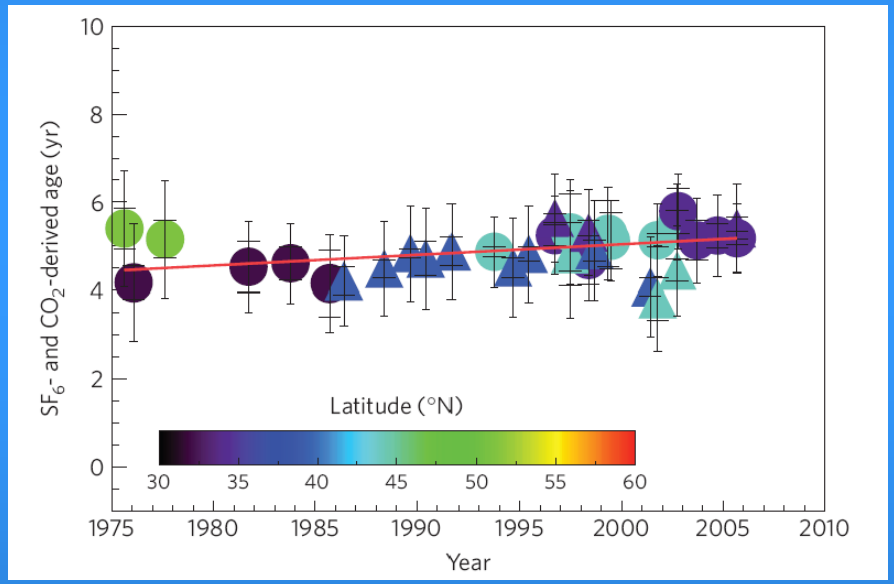
Age of air

Models predict strengthening of BD circulation
→ decrease of age of air

Measurements:
increase of age of air



Modeled age trend
Austin and Li, GRL, 2006
AMTRAC - Atmospheric Model with TRansport And Chemistry



Engel et al., Nature Geosciences, 2008

nature geoscience

PERSPECTIVE

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

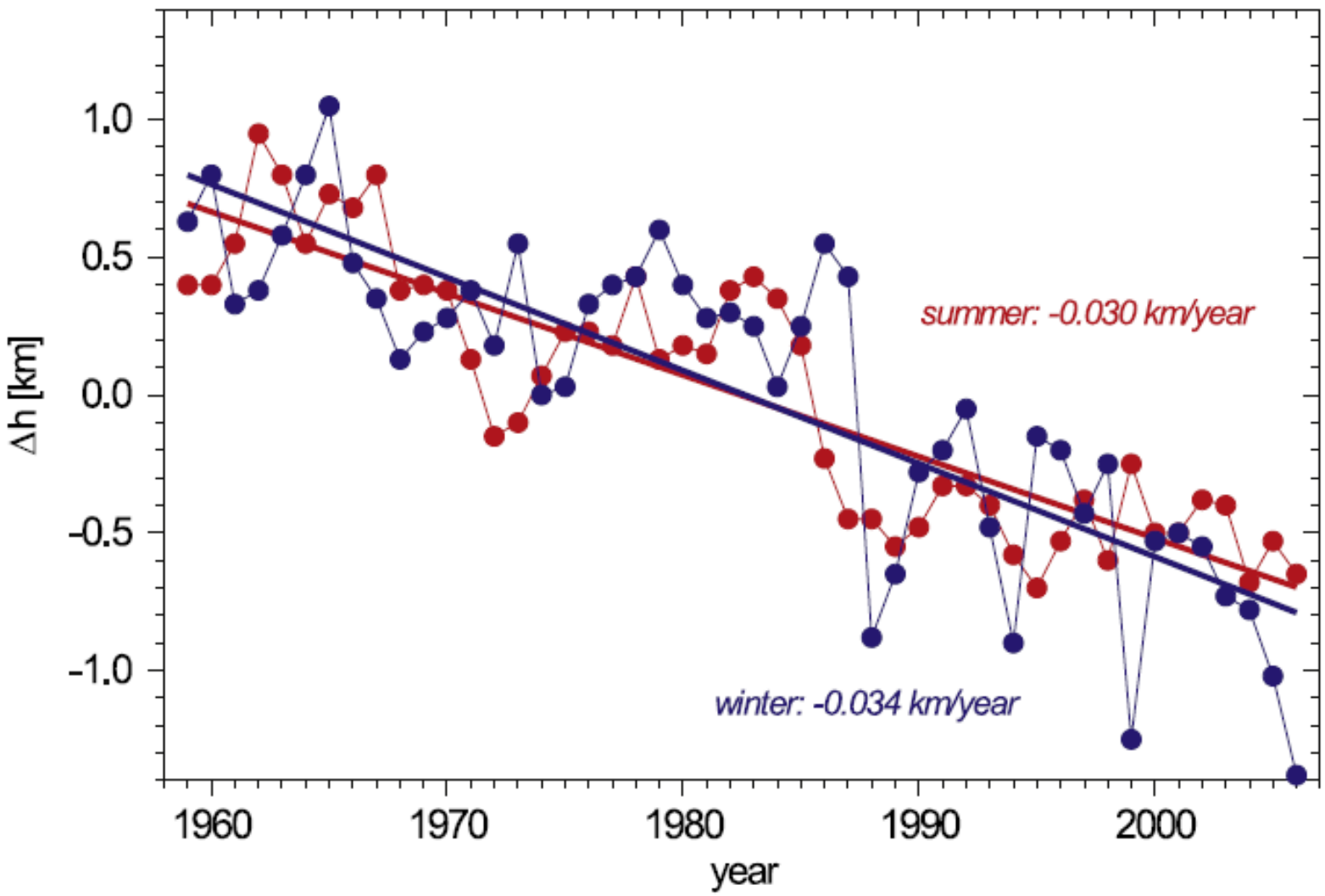
Atmospheric circulation as a source of uncertainty in climate change projections

Theodore G. Shepherd

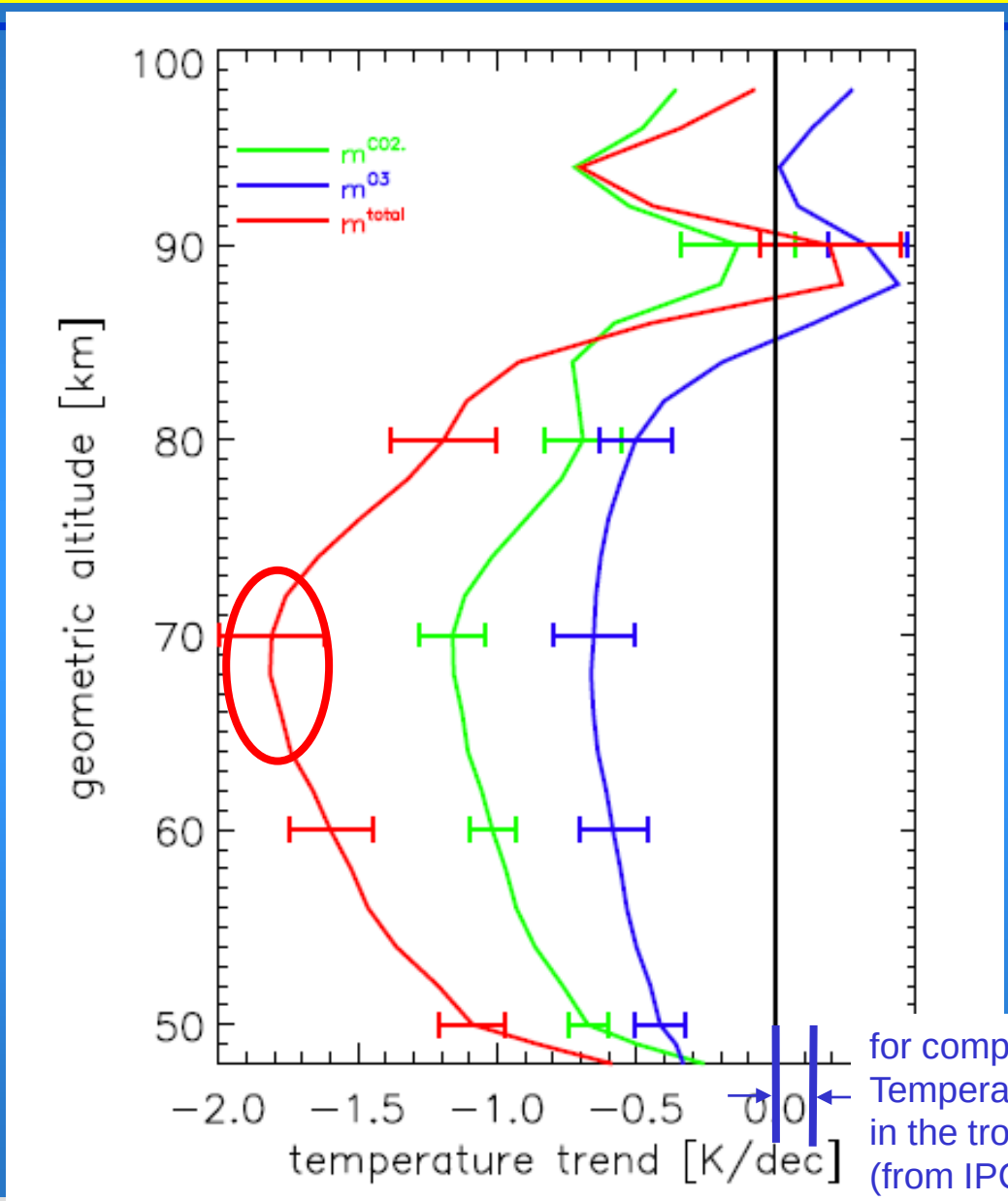
"The most uncertain aspect of climate modelling lies in the representation of unresolved (sub-gridscale) processes such as clouds, convection, and boundary-layer and gravity-wave drag, and its sensitive interaction with large-scale dynamics."

J. Bremer, D. Peters / Journal of Atmospheric and Solar-Terrestrial Physics 70 (2008) 1473–1481

trend in reflection height of radio waves at appr. 83 km



Temperature trends are largest in the mesosphere



Lübken, Berger, Baumgarten, JGR, 2013

for comparison: Temperature trend in the troposphere (from IPCC)

Role of noctilucent clouds in climate ?

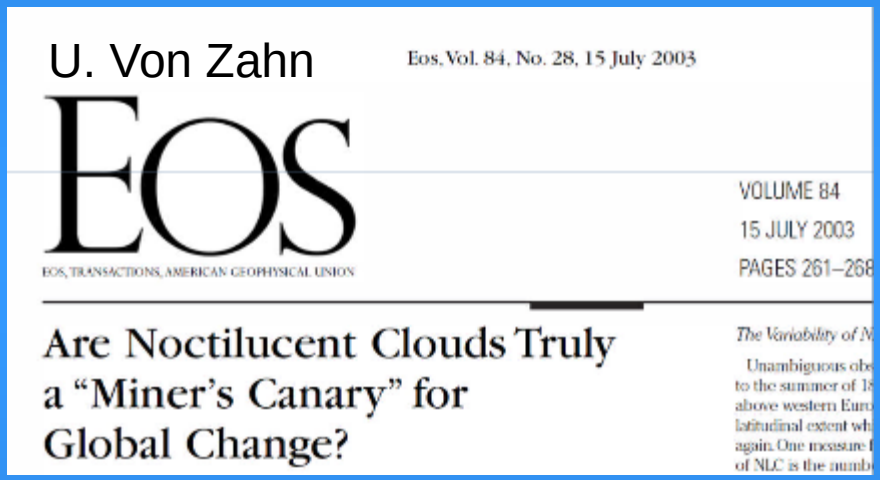
Reference to GRL paper by Gerding, Lübken et al. Dec. 2013

IS THE POLAR MESOSPHERE THE MINER'S CANARY OF GLOBAL CHANGE?

Adv. Space Res., 1996

G. E. Thomas

U. Von Zahn


Eos, Vol. 84, No. 28, 15 July 2003

EOS

EOS, TRANSACTIONS, AMERICAN GEOPHYSICAL UNION

VOLUME 84

15 JULY 2003

PAGES 261–268

Are Noctilucent Clouds Truly a "Miner's Canary" for Global Change?

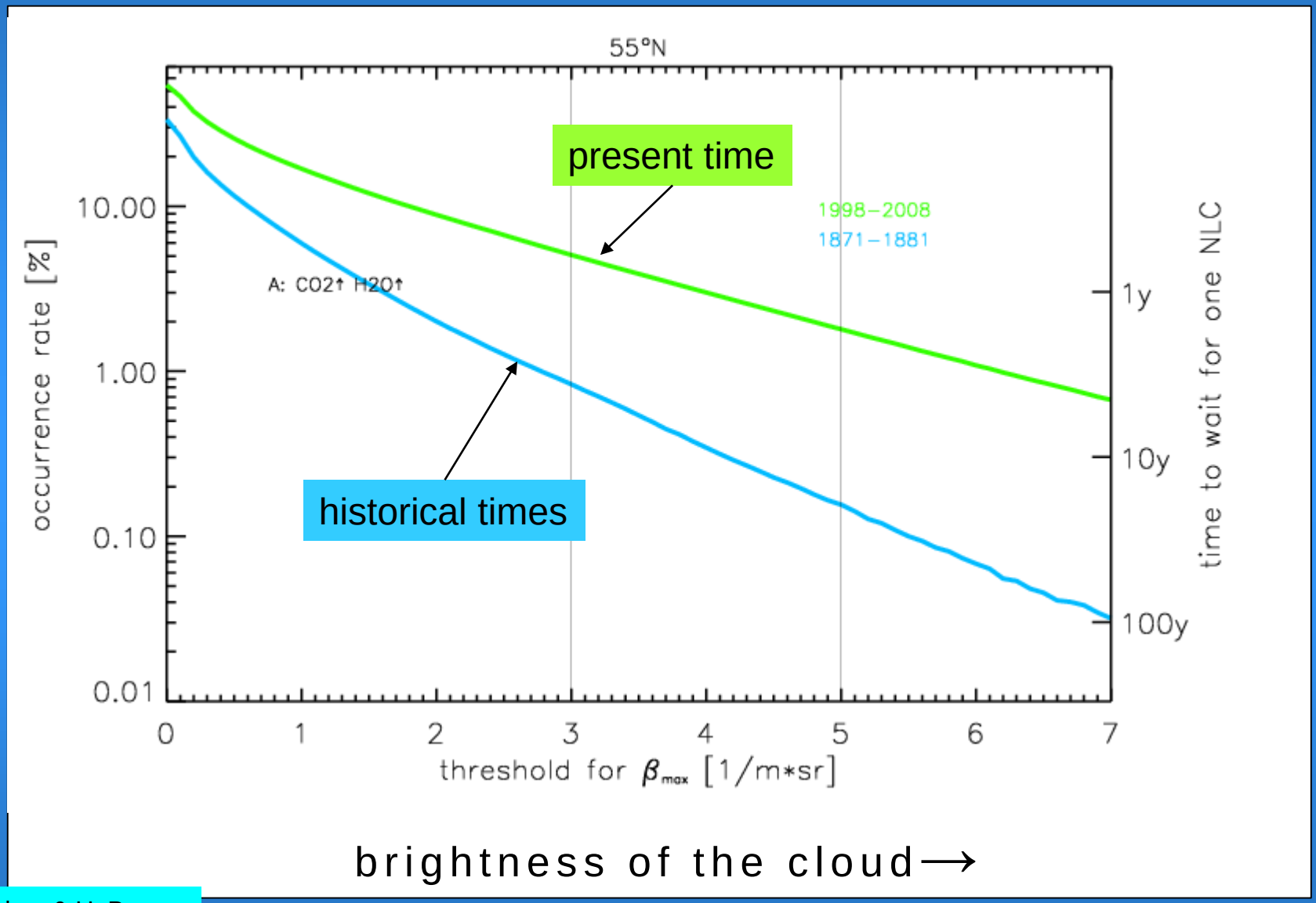
The Variability of N

Unambiguous obs
to the summer of 1
above western Euro
latitudinal extent wh
again. One measure
of NLC is the numb

G. Thomas and John Olivero, EOS, Vol. 84, 2003

Comment on "Are Noctilucent Clouds Truly a 'Miner's Canary' for Global Change?"

chance to see a noctilucent cloud a mid latitudes



brightness of the cloud⟶

F.-J. Lübken & U. Berger

ROMIC

Role
Of
Middle atmosphere
In
Climate

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LEIBNIZ-INSTITUT FÜR ATMOSPHÄREN PHYSIK IAP

- Long period variations in the stratosphere, mesosphere, and lower thermospher
  - 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]he 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

1	Koordinator	Lübken	IAP Kühlungsborn[1]
2	BDCHANGE	Engel Stiller	Uni Frankfurt[2] KIT Karlsruhe[3]
3	GRAVITY	Achatz	Uni Frankfurt[4]
4	MUSIC	Solanki	MPS Katlenburg-Lindau[5]
5	ROSA	Burrows von Savigny	Uni Bremen[6] Uni Greifswald[7]
6	THREAT	Quack Sinnhuber B-M	GEOMAR, Kiel[8] KIT Karlsruhe
7	GW_LCYCLE	Rapp Oelhaf Preusse	IPA Oberpfaffenhofen[9] KIT Karlsruhe FZ Jülich[10]
8	MALODY	Koppmann	Uni Wuppertal[11]
9	MESOENERGY	Sinnhuber M	KIT Karlsruhe
10	METROSI	Becker	IAP Kühlungsborn
11	O3CHEM	Warneke	Uni Bremen
12	OHcycle	von Savigny	Uni Greifswald
13	SCIASOL	Weber	Uni Bremen
14	SOLIC	Matthes Langematz Sinnhuber M	GEOMAR Kiel FUB Berlin[12] KIT Karlsruhe
15	SPITFIRE	Weigel Schneider Ebert von Hobe Schlager	Uni Mainz[13] MPI Mainz[14] TU Darmstadt[15] FZ Jülich IPA Oberpfaffenhofen
16	ROMICCO	Palm	Uni Bremen
17	TIMA	Lübken	IAP Kühlungsborn
18	TRIP	Plöger	FZ Jülich

Total number of institutes involved: 15

18 projects in ROMIC

2013-2017
appr. 8 Mio Euro

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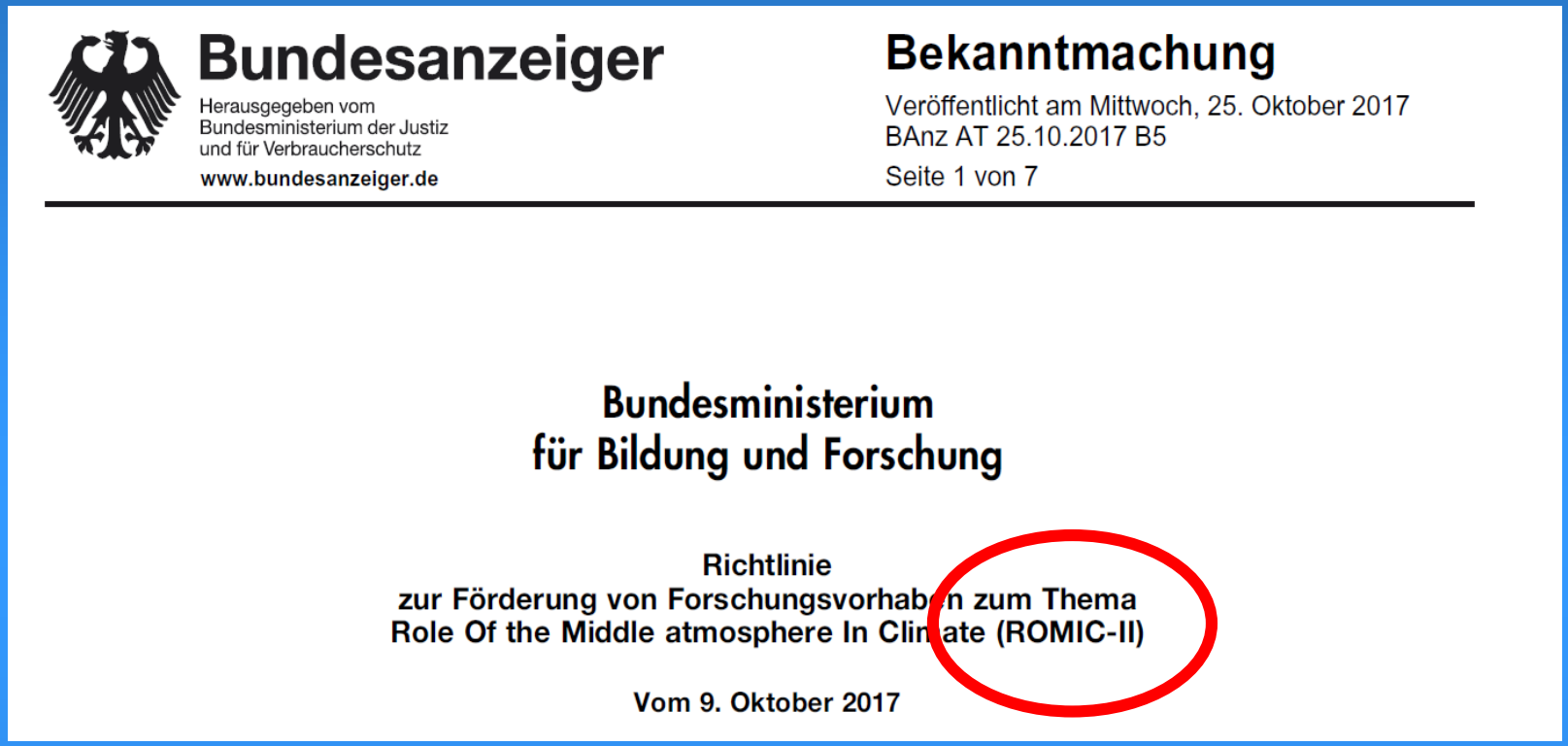
LEIBNIZ-INSTITUT FÜR ATMOSPHÄREN PHYSIK IAP

Variability of the Sun and Its Terrestrial Impact

Chairs: Kazuo Shiokawa and Katya Georgieva

Second phase of ROMIC announced on 9. Oct. 2017 ☺



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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 7

**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

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Federal Ministry
of Education
and Research

Germany

appr. 2018-2021

proposals are due 31. January 2018
e.g. TOMORROW!

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Thank you for your attention!