Report on projects within Theme 3

Franz-Josef Lübken
and
Joan Alexander

Actual status of projects:

1) Planetary and gravity wave influences upon the winter polar vortices (0-100 km)
Alan Manson et al.

2) A global observing campaign to characterize tides and their influence from the troposphere to the thermosphere William Ward et al.

3) Gravity waves and turbulence
Dave Fritts, Nikolai Gavrilov, Fan Yi et al.

4) Solar influence on minor constituents and layers at the extra-tropical summer mesopause
Franz-Josef Lübken, Ulf-Peter Hoppe, Scott Bailey + t.b.d. (SH)

5) Ozone - how well do we really understand it ?
Marty Mlynczak, Martin Dameris et al.

6) Equatorial Atmosphere coupling processes (new title !)
Mamoru Yamamotu, Hisao Takahashi, Subramanian Gurubaran+INTAR

New projects proposals (since last Wednesday):

Coupling effects in the electrodynamics at the low latitude ionosphere

a) **Study of low latitude ionospheric disturbances associated with geomagnetic activity**
   Archana Bhattacharyya, Art Richmond

b) **Electrodynamic coupling of equatorial F region with conjugate E regions**
   Hermann Lühr, Archana Bhattacharyya

Polar vortices project

Coordinators:
Alan Manson

ATMOSPHERIC WAVE INTERACTIONS WITH THE WINTER POLAR VORTICES (0-100 KM) [1]

- Sudden stratospheric warmings
- Mesospheric thermal inversions
- Equinoctial transitions
- “Ozone Anomalies”, and
- “Winter Anomaly” (D-region ionization)

1. A CAWSES Project of Theme 3 “Atmospheric Coupling Processes” Co-ordinator Alan Manson
Campaign 2004/5 Tatyana Chshyolkova

The Project

- **Study polar vortices (0-100 km) in winter, in particular radiatoinally unexpected phenomena**
- **Observations and modeling**
- **1st campaign in winter 2004/2005**
- **Planetary Waves, Tidal Waves, Gravity Waves Interactions with the mean flow**
- **Collaborations with other projects in Theme 3 Collaboration with Theme “Solar influence on climate”**

Working Plans I

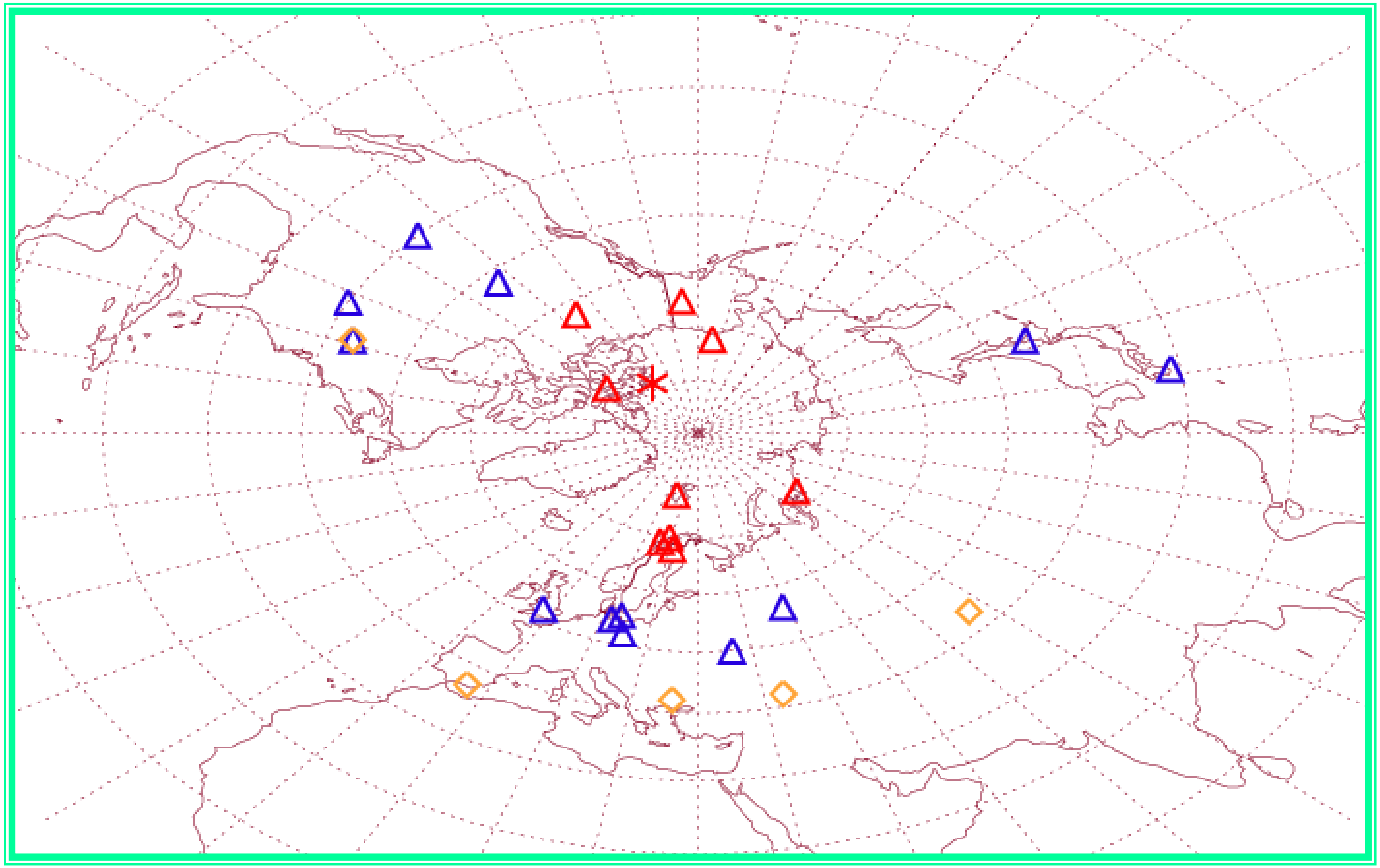
- *Radars (MFR, MWR)* and optical instruments: mid- and high-latitude + CPEA data

- Satellite missions: TIMED (TIDI, SABER), Odin (OSIRIS), ...

- MetO assimilated fields

- TIME-GCM and CMAM, with data assimilation

WORKING PLANS II



PARTICIPANTS I

- Project Coordinator NH Facilitator — *Alan Manson*
- Radar Steering Committee (NH) — *N. Mitchell, W. Singer, W. Hocking, D. Riggin, Yu. Portnyagin, C. Hall, A. Manson (Chair), and Y. Murayama*
- Radar Steering Committee (SH) — *S. Palo (SH Coordinator), S. Avery, J. Forbes, R. Vincent, G. Fraser, D. Riggin, D. Fritts, M. Tsutsumi, T. Aso*

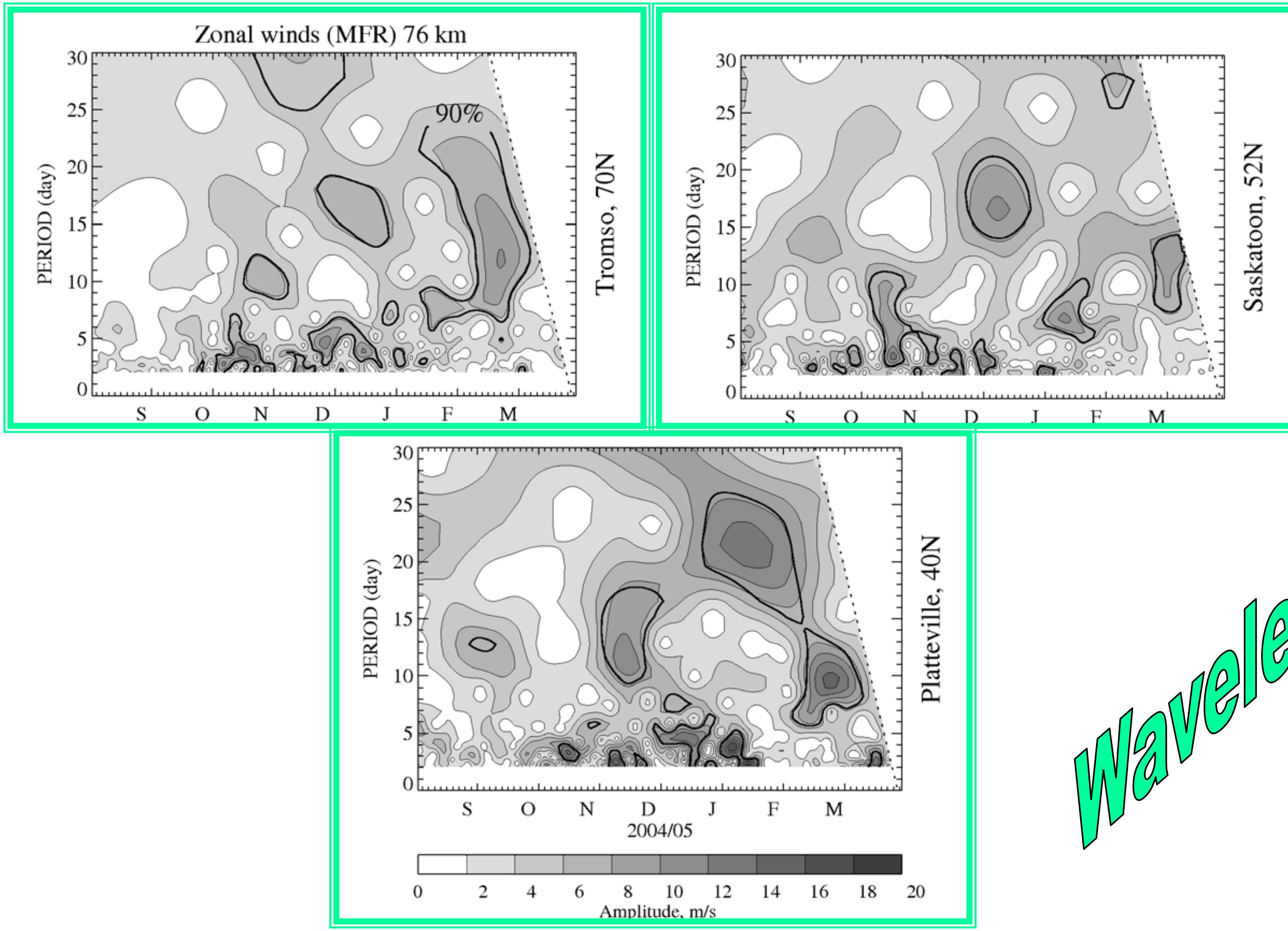
Participants II

- Optical Coordinator (NH) — *Marianna Shepherd*
- Satellite Coordinators — *D. Riggin, S. Palo et al. (TIMED-SABER and/or TIDI), and T. Llewellyn, D. Degenstein (Odin-OSIRIS)*
- Models — *R. Swinbank (MetO), M. Hagan (TIME-GCM, GSWM), T. Shepherd (CMAM), M. Salby and D. Ortland*

PROGRESS ON CAMPAIGN I

- The data are available or coming soon from 13 radars, stretching from Yamagawa (31N) to Svalbard (78N)
- Analysis using wavelets and mean wind plots are completed as soon as the data arrive
- Preliminary results show that PW activity (>10 d) is greatest in Feb. & March. PW activity during the earlier part of the winter is low.
- MetO data are used to characterize winter vortex at stratospheric heights.

PROGRESS ON CAMPAIGN I



Wavelets

Tides project

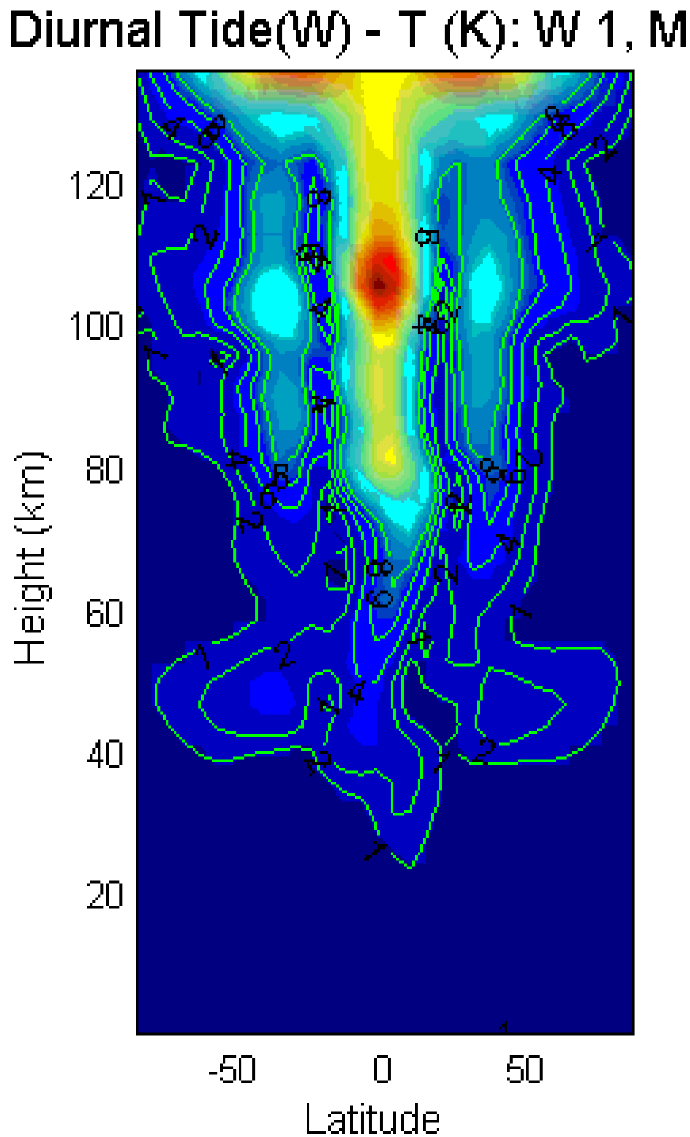
Coordinators:
William Ward et al.

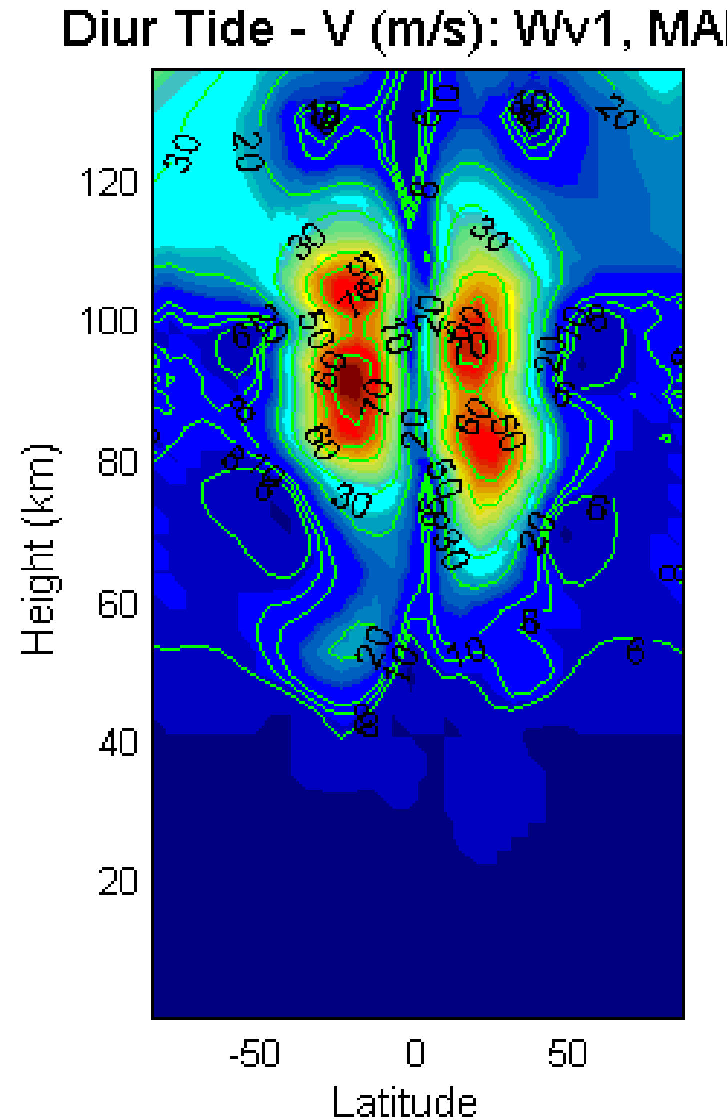
CAWSES Tidal Campaigns Motivation

MOTIVATION:

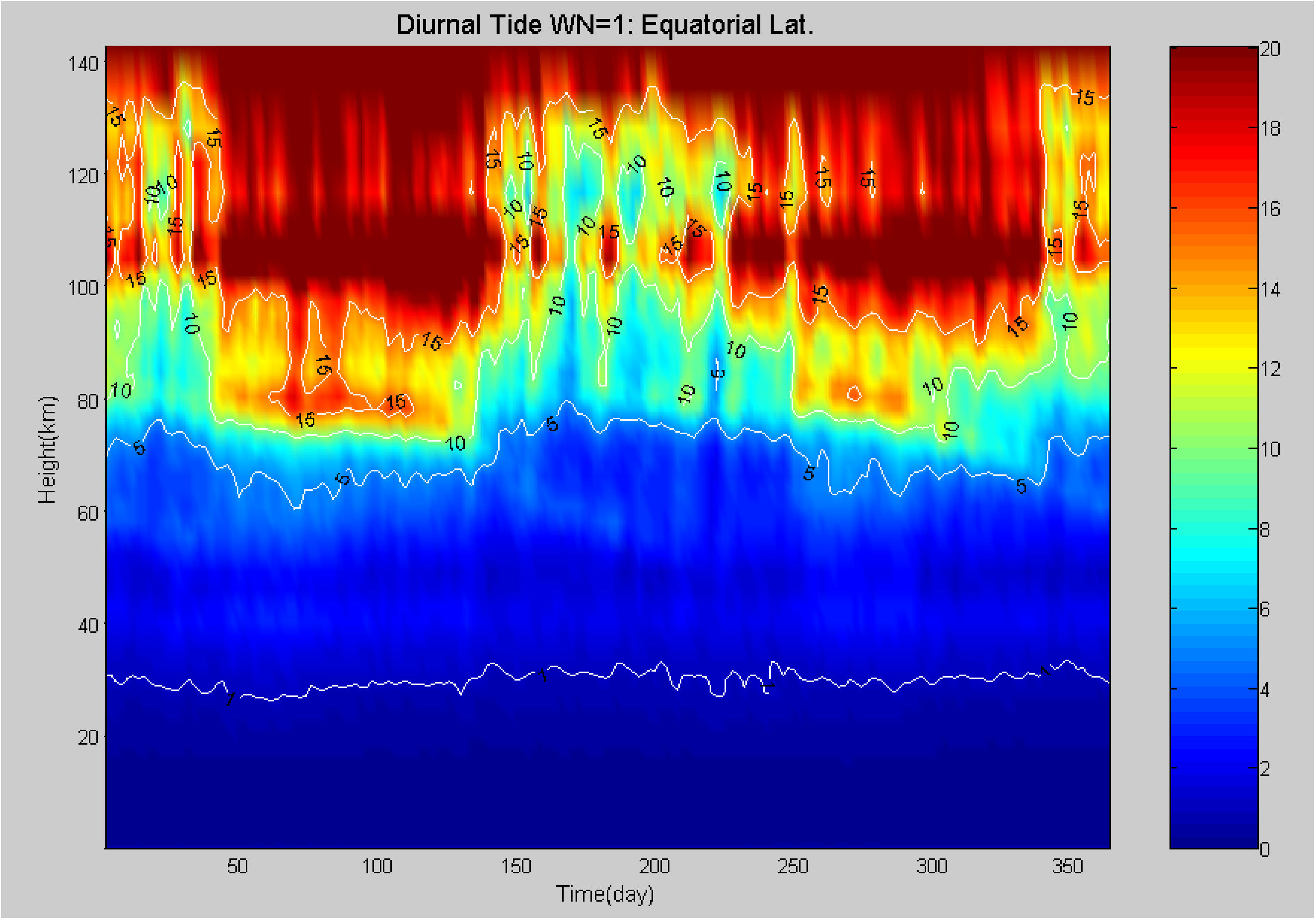
- Sun generates tides through radiation
- Other mechanisms: e.g. latent heat release
- Tides are global, dominate dynamics, signatures in the entire atmosphere
- Requires global observations + modeling
- Ground based networks and satellite observations
- Global models are required

Monthly Average Temperature for Westward Diurnal Tide—Latitude Structure





Annual Cycle of Migrating Diurnal Tidal Temperature Amplitude



Purpose

- Provide global data sets for several concentrated time periods
- Get heating sources, tidal components, and tidal effects from the surface of the Earth to the ionosphere.
- Support and stimulate the analysis of these data sets.
- Support and stimulate the use of existing models and the development of new models to simulate the conditions during these campaigns and evaluate our understanding of this phenomenon.

Method

- Several 1 month campaigns during which radar, optical instrumentation, ionospheric observations and satellite data will be collected
- First campaign: October/November, 2005
- Two workshops
  1. observations, analysis of data
  2. modelling, understanding, evaluation
- Web based data centre

Organization

- Steering committee (organizing campaigns, contacting, setting up data set and analysis/modelling.

- Targeted observations include: Radar networks (Meteor, MF, IS), Optical instruments/networks (imagers, interferometers, photometers, lidars), ionospheric observations (ionosondes, magnetometers, …), satellite observations (wind, temperature, constituents (water, ozone, oxygen), airglow).

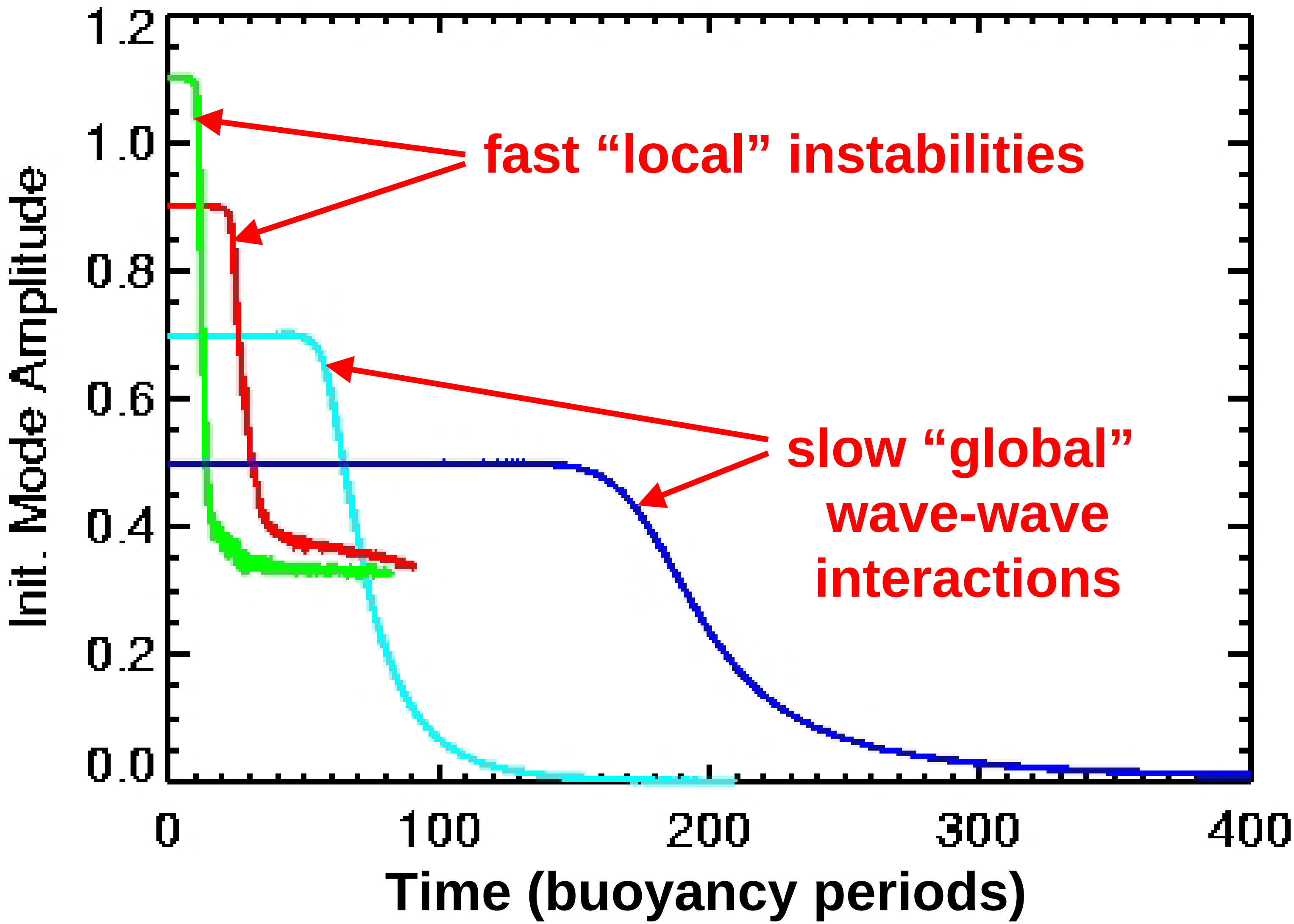
- Committee membership includes:

  J. Forbes, S. Guberan, M. Hagan, K. Hamilton, R. Lieberman, D. Marsh, M. Mlynczak, T. Nakamura, J. Oberheide, D. Pancheva, and others.

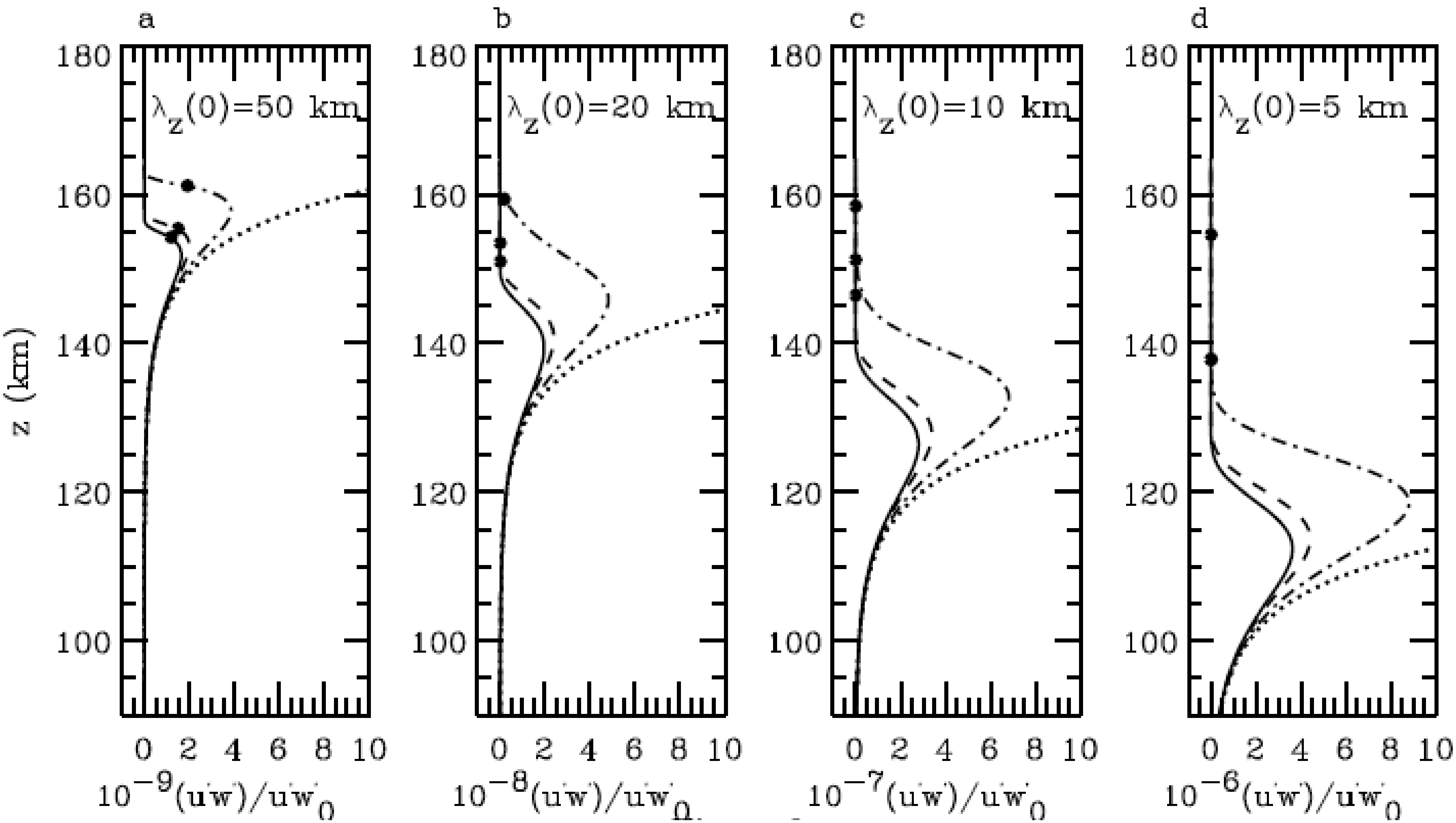
Gravity wave and turbulence project

Coordinators:
Dave Fritts
Nikolai Gavrilow
Fan Yi

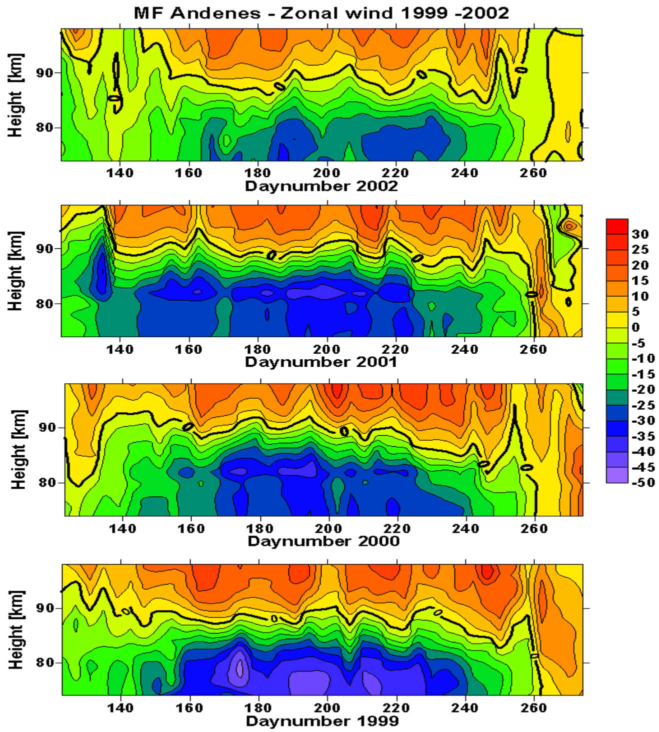
GW breaking complex, will contribute to parameterizations and meas. Interps.

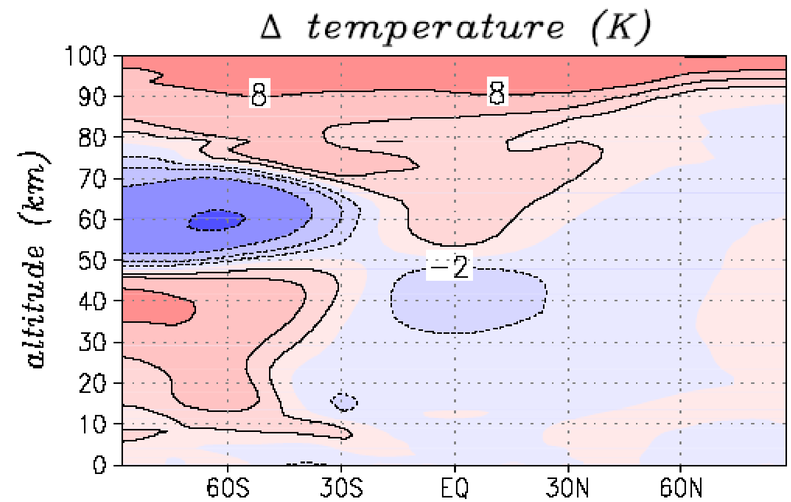


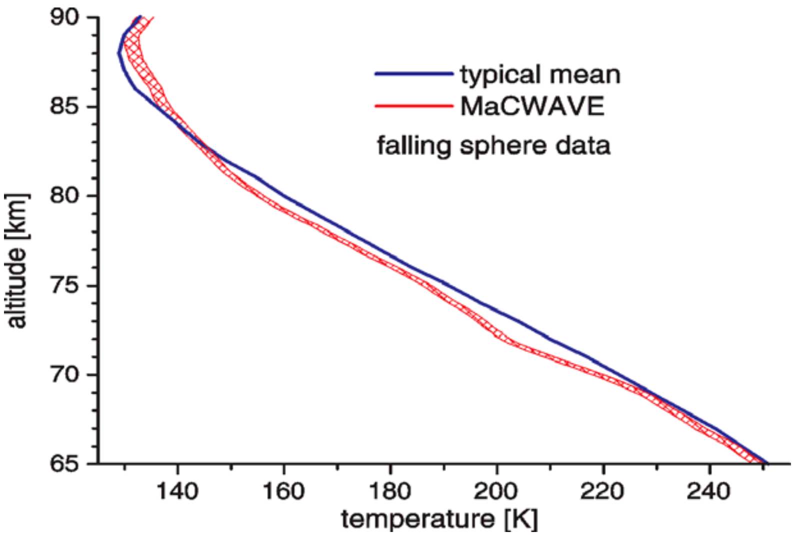
Full viscous dispersion relation

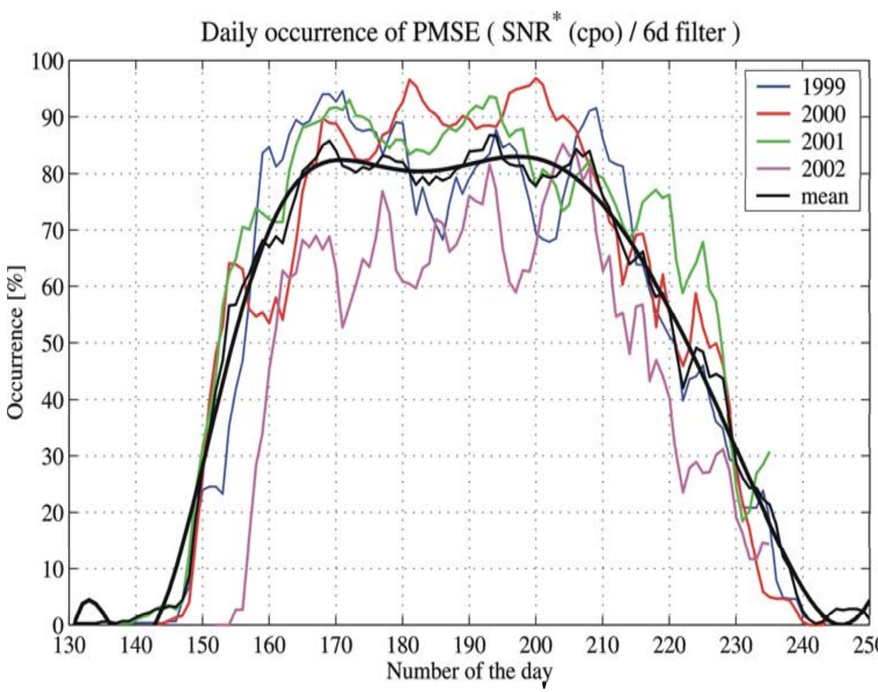


MAC/WAVE project in summer 2002



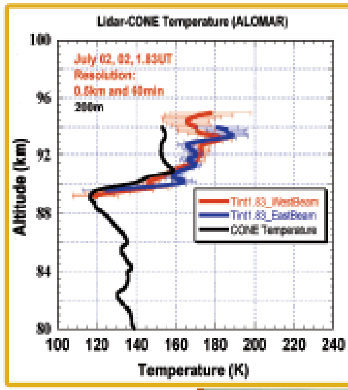


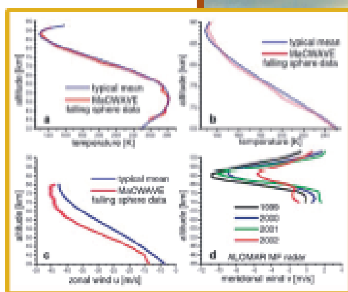


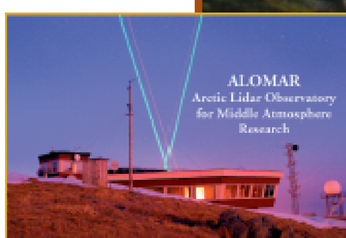


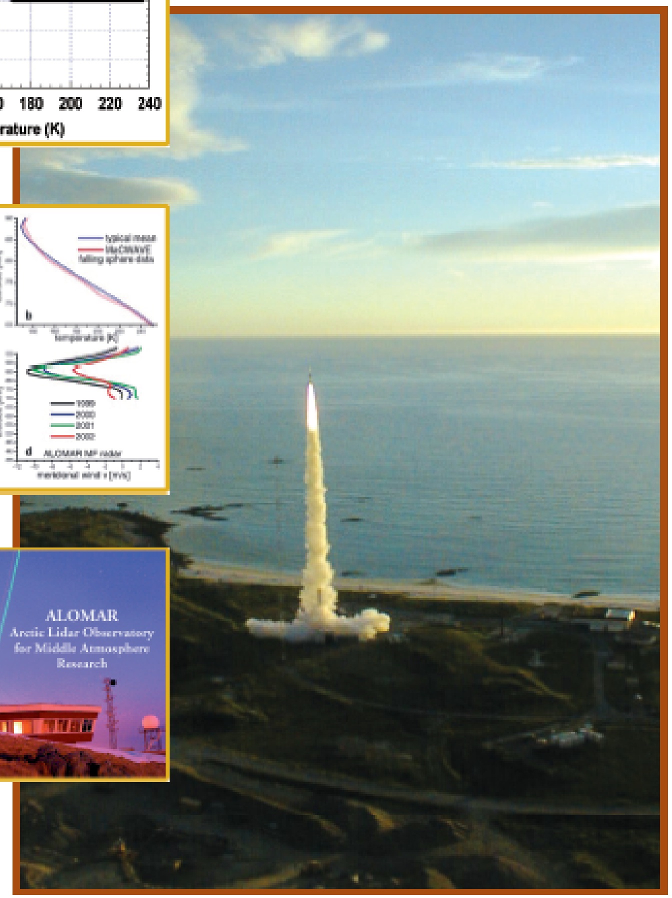
Geophysical Research Letters

28 DECEMBER 2004
Volume 31 Number 24
American Geophysical Union









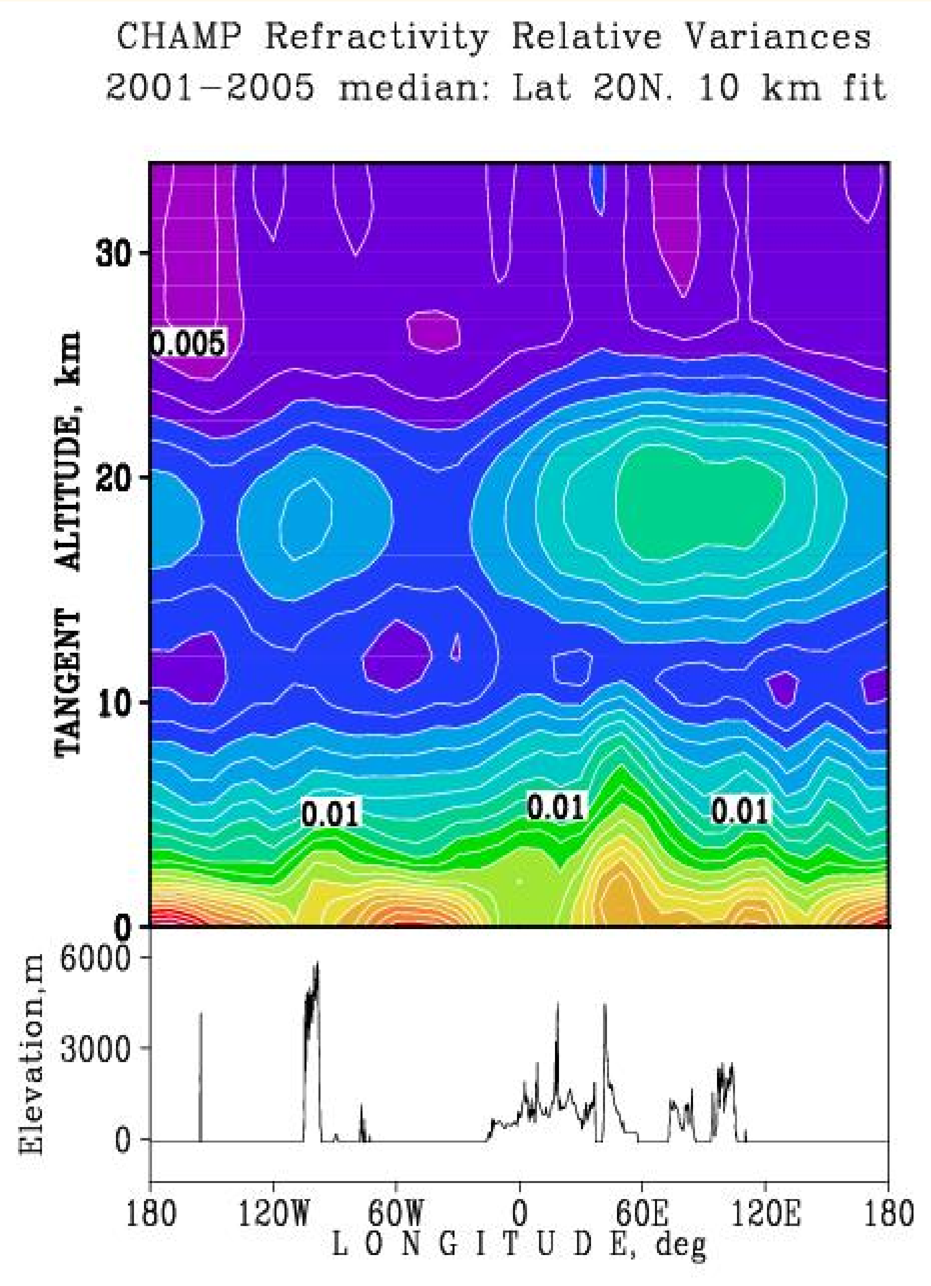
Special Section: The MaCWAVE-MIDAS
Program to Study the Polar Summer Mesosphere

Planned:

1. Campaign on mountain waves in Scandinavia
2. Satellite measurements of gravity waves
3. Ground based (lidar, radar, air glow) measurements of gravity waves
4. Continuation of detailed DNS simulation
5. Gravity wave parameterization studies
6. … more …

CAWSES-WAVE RELATED STUDIES IN NIS COUNTRIES

Institution	Research Fields
Institute of Ionosphere, Almaty, Kazakhstan	1. AGW from ionosonde data 2. Observations and numerical modeling of ionospheric AGWs from tropospheric sources and explosions.
North-West IZMIRAN branch, Kaliningrad, Russia	Effects of solar eclipses and geomagnetic activity on atmospheric tides
Kaliningrad State University, Russia	Numerical modeling of IGW propagation and breaking in the middle and upper atmosphere
Kazan State University, Russia	Meteor radar observations and analysis of the mean wind, tides, planetary and gravity waves in the upper atmosphere
Saint-Petersburg State University, Russia	Analysis of GPS satellite and ground-based data, numerical modeling of gravity wave climatology



Height-altitude crossections of mesoscale relative variances of atmospheric refractivity from CHAMP data averaged for years 2001-2005 and surface

Wuhan University Fe Lidar Parameters (courtesy of Fan Yi)

Transmitter		Receiver	
Wavelength	372 nm	Telescope diameter	1 m
Linewidth	1.8 GHz	Field of view	1 mrad
Pulse energy	40 m J	Bandwidth	4 nm
Repetition rate	20 Hz	Altitude resolution	96 m
Pulse width	7 ns	Time resolution	5 min
Beam divergence	0.5 mrad		

Ice layer project

Coordinators:
Franz-Josef Lübken
Ulf-Peter Hoppe
Scott Bailey

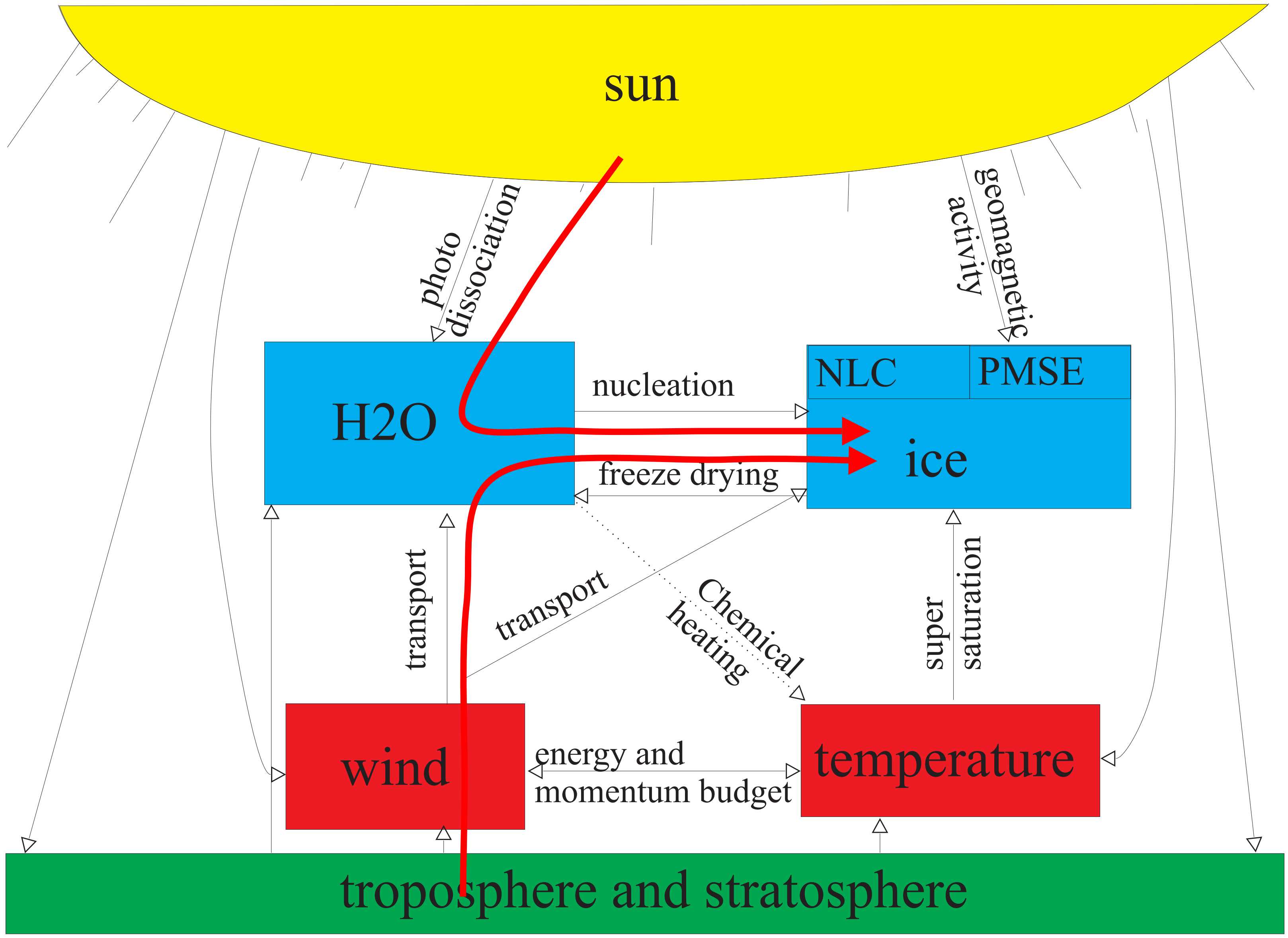
… and 1st campaign in summer 2005

Noctilucent clouds at 54°N
Leibniz Institute of Atmospheric Physics, Kühlungsborn, Germany

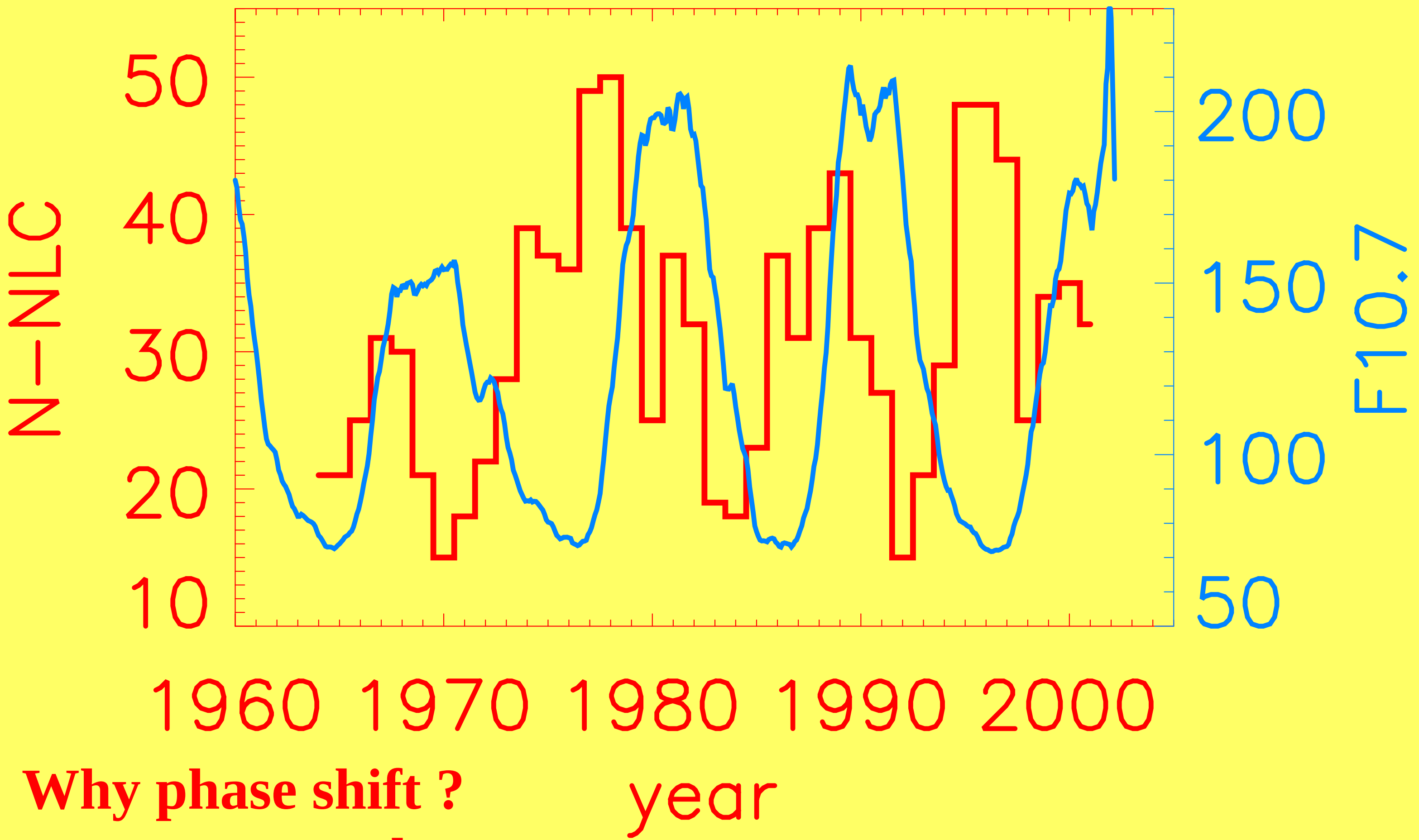
Motivation and link to CAWSES

Study layers in MLT region because:

- **summer mesosphere is special (cold!)**
- **… at the transition region between influence from above (Sun) and below**
- **layers: sensitive monitor of background**
- **„easy“ to observe ; long records**
- **new techniques (data) + better understanding**
- **show solar cycle + trend(?) effects**
- **layers modify the background atmosphere**
- **… and more …**


sun
photo dissociation
geomagnetic activity
H2O
nucleation
NLC
PMSE
ice
freeze drying
transport
transport
Chemical heating
super saturation
wind
energy and momentum budget
temperature
troposphere and stratosphere

NLC statistics from visual observations

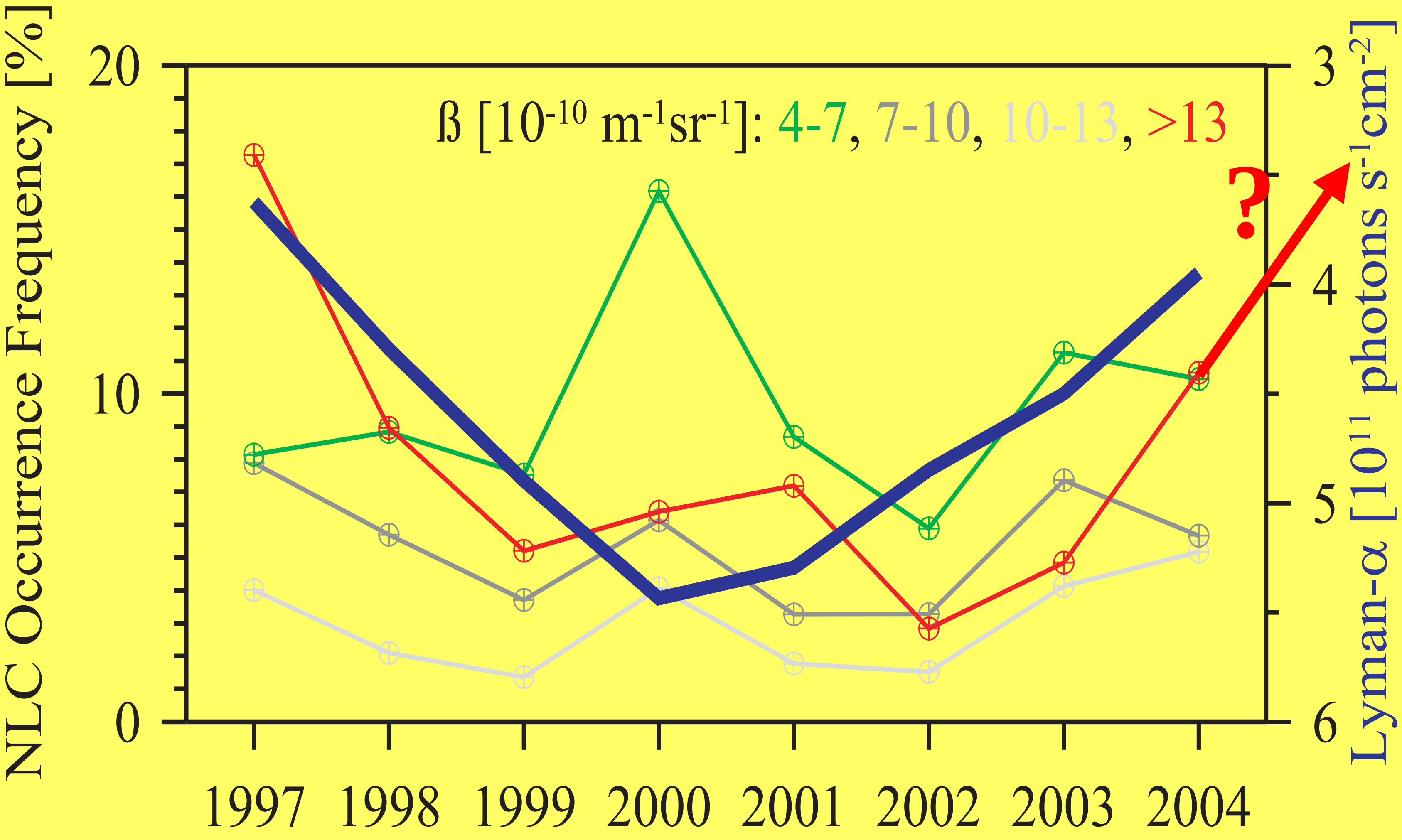


Why phase shift ?

Note: no trend !

after Gadsden (2002)

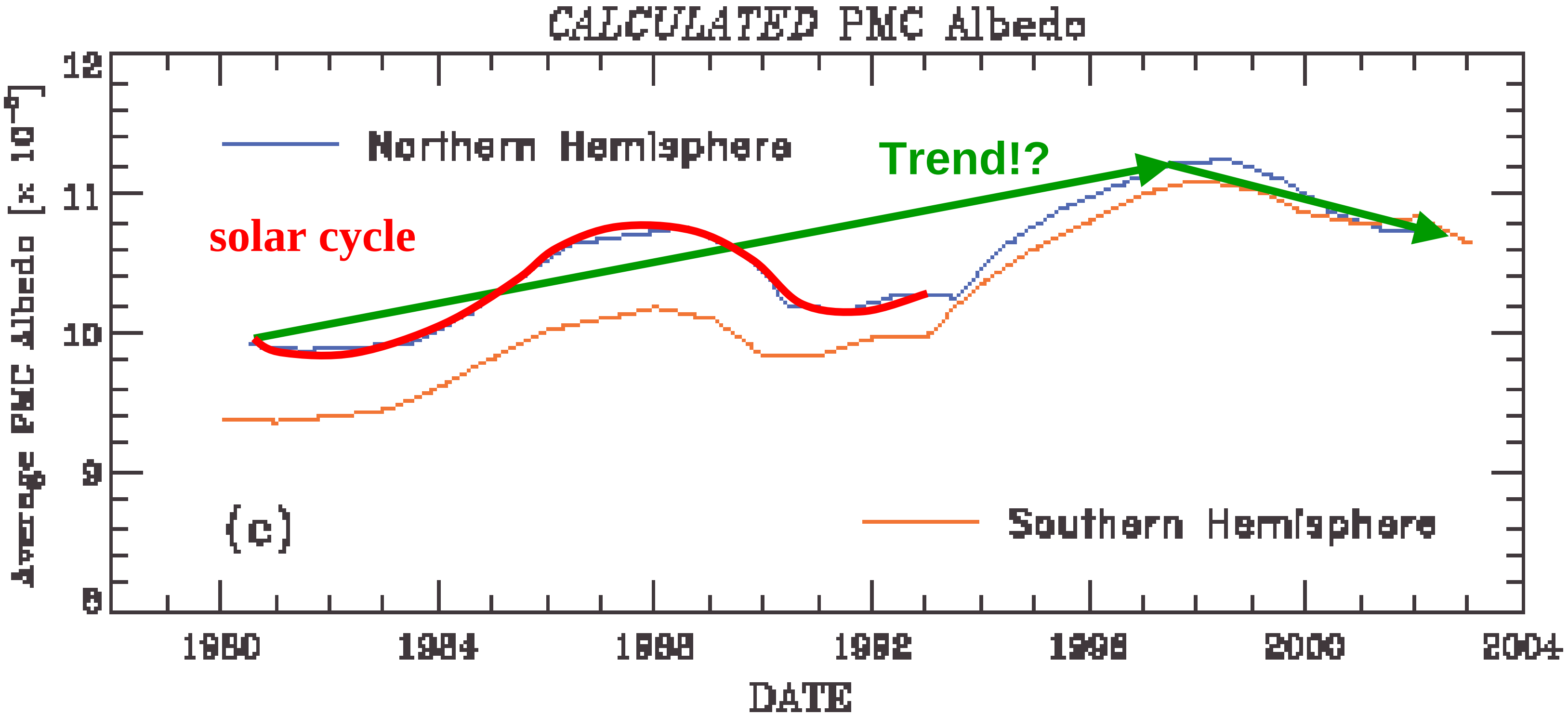
NLC observations at ALOMAR (69°N)



Note: no variation of NLC altitude !

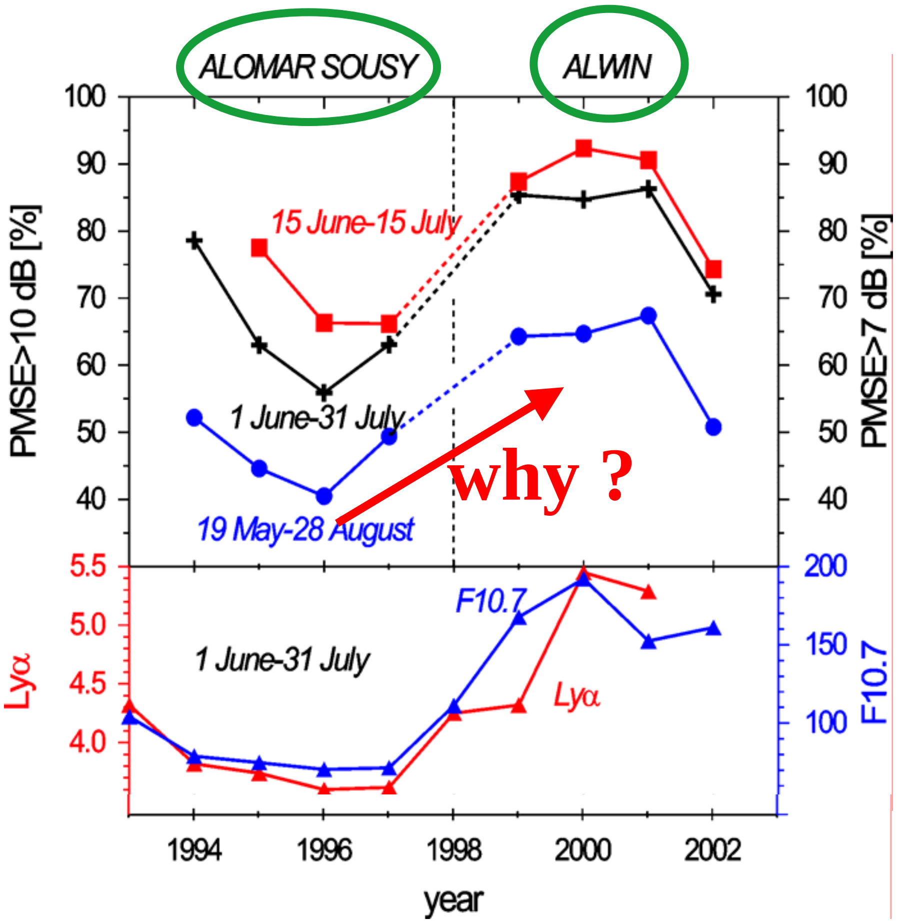
source: IAP (Fiedler et al., J. Geophys. Res. 2003)

Trend in PMC brightness (SBUVs)



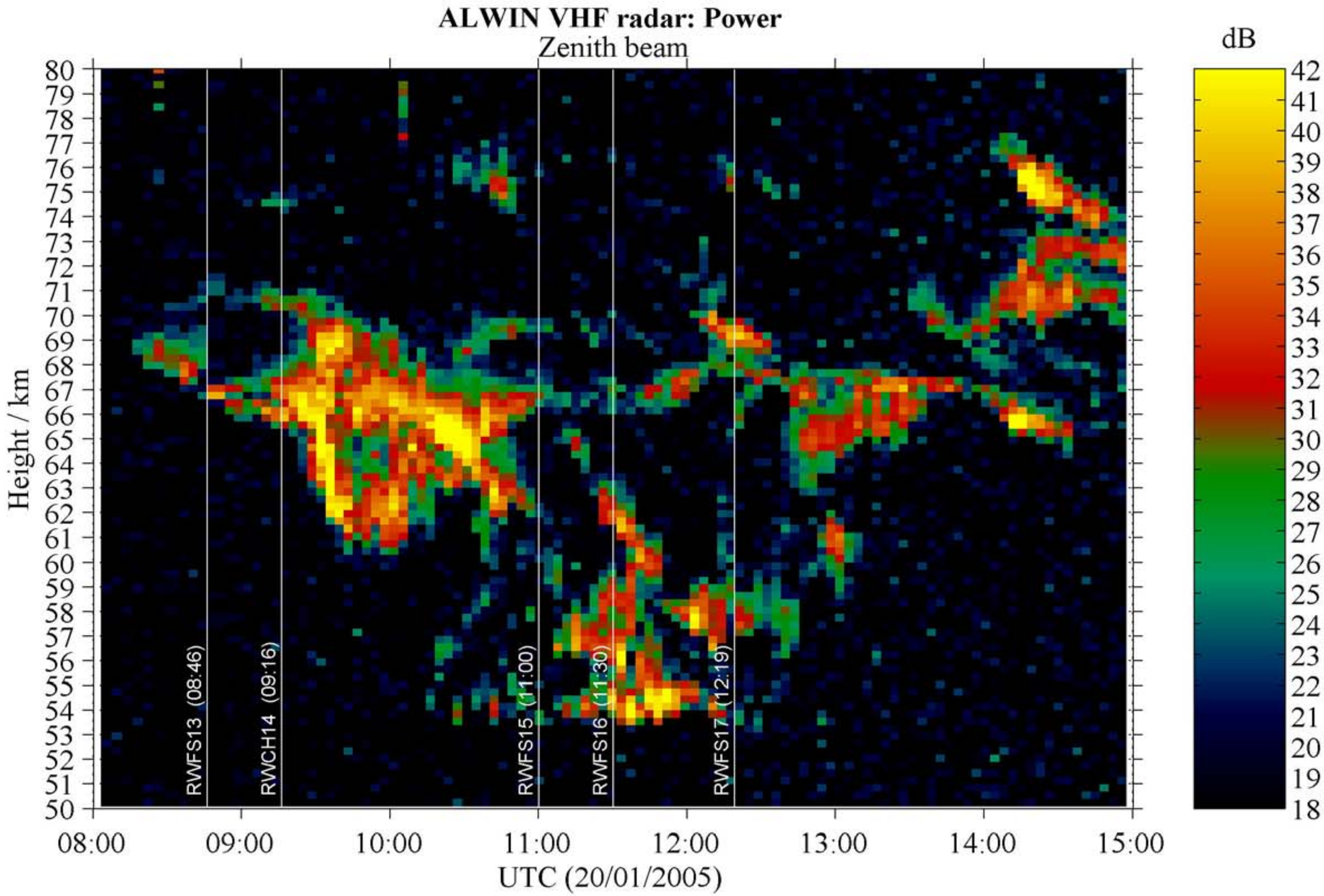
Thomas, Olivero, Shettle,
EOS, 9. Sept. 2003

PMSE: positive! correlation with solar cycle



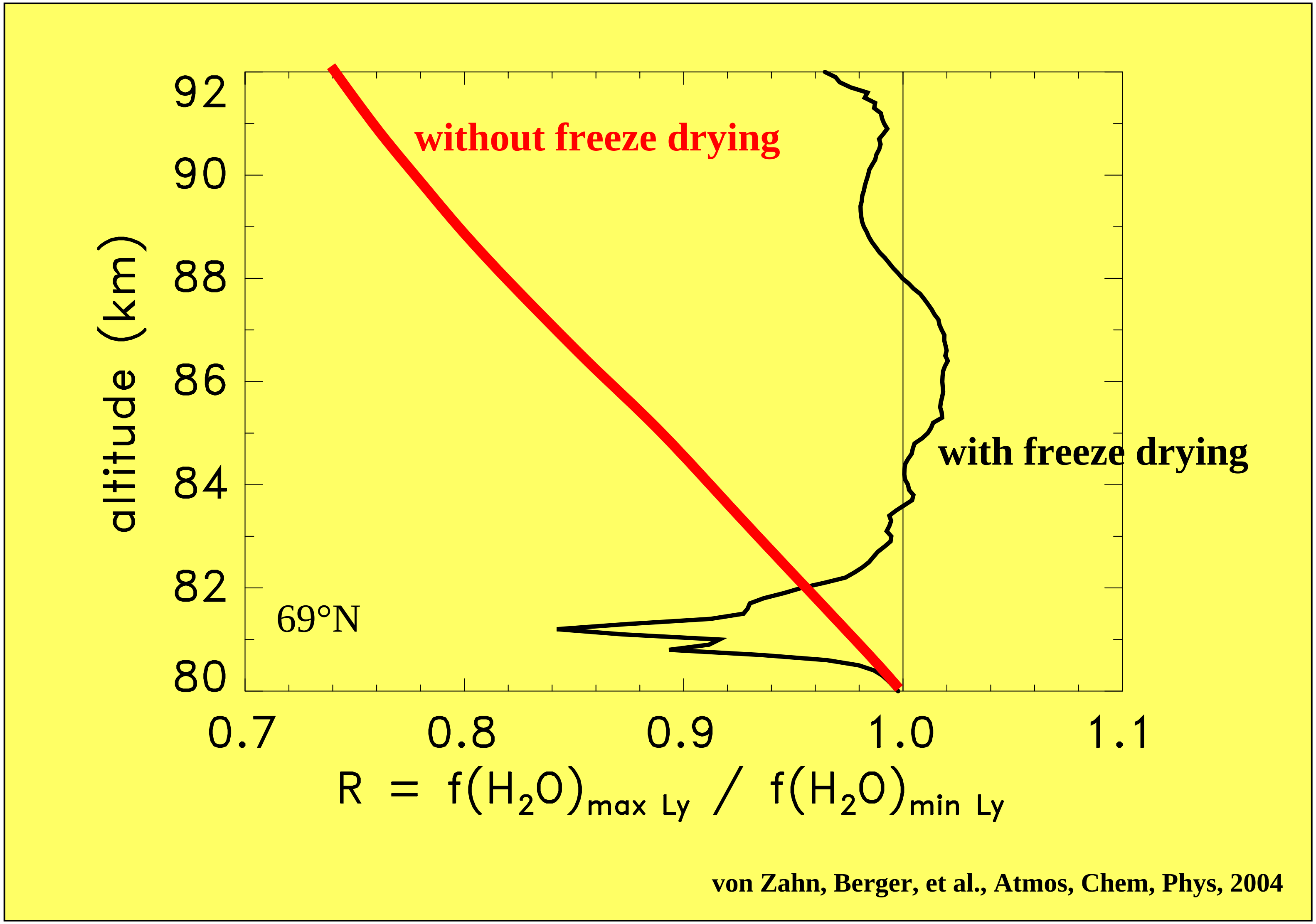
Bremer et al., J. Geophys. Res., 2003

ROMA 2005 – 2nd PMWE salvo

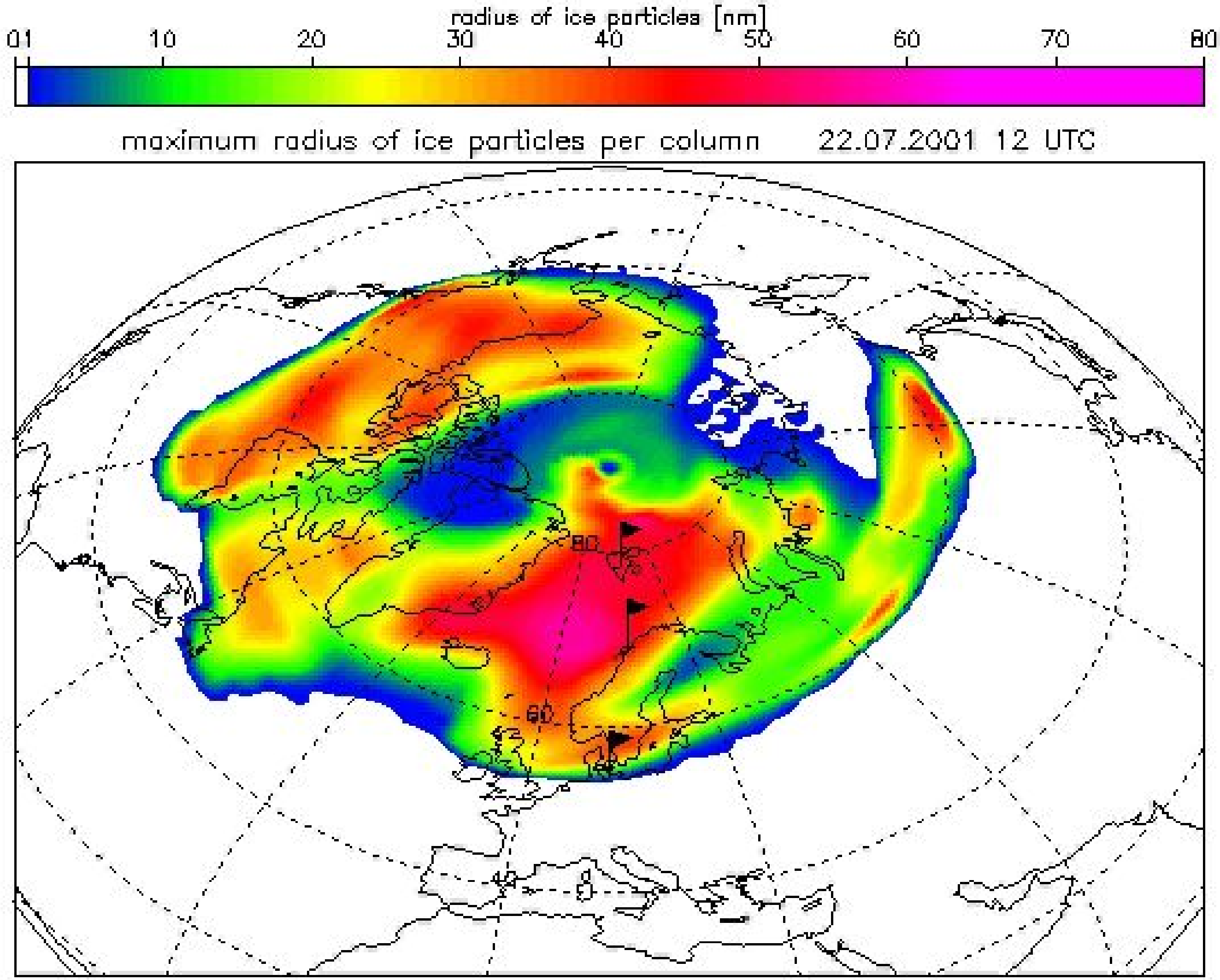


Lübken et al., submitted to Atmos. Chem. Phys., 2005

Solar max/min effect on H_2O



Ice particle simulation with LIMA (IAP)



Open questions and scientific aims

- **Study the effect of solar cycle (and trends) on layers (occurrence, brightness, altitude …)**

- **i.e. on composition, energy + momentum budget**

- **Study feedback mechanism of ice particles on background atmosphere (freeze drying)**

- **Explain observations:**
  - **why 1y phase shift (H_2O and NLC) ?**
  - **why (no) trend at mid (high) latitudes ?**

The summer 2005 campaign:

(F.-J. Lübken, Ulf-Peter Hoppe, Scott Bailey)

- Ice layer detection by lidars (NLC), radars (PMSE), and satellites (PMC)

- Trace gas measurements (most important: water vapour) from satellites and from ground-based instruments

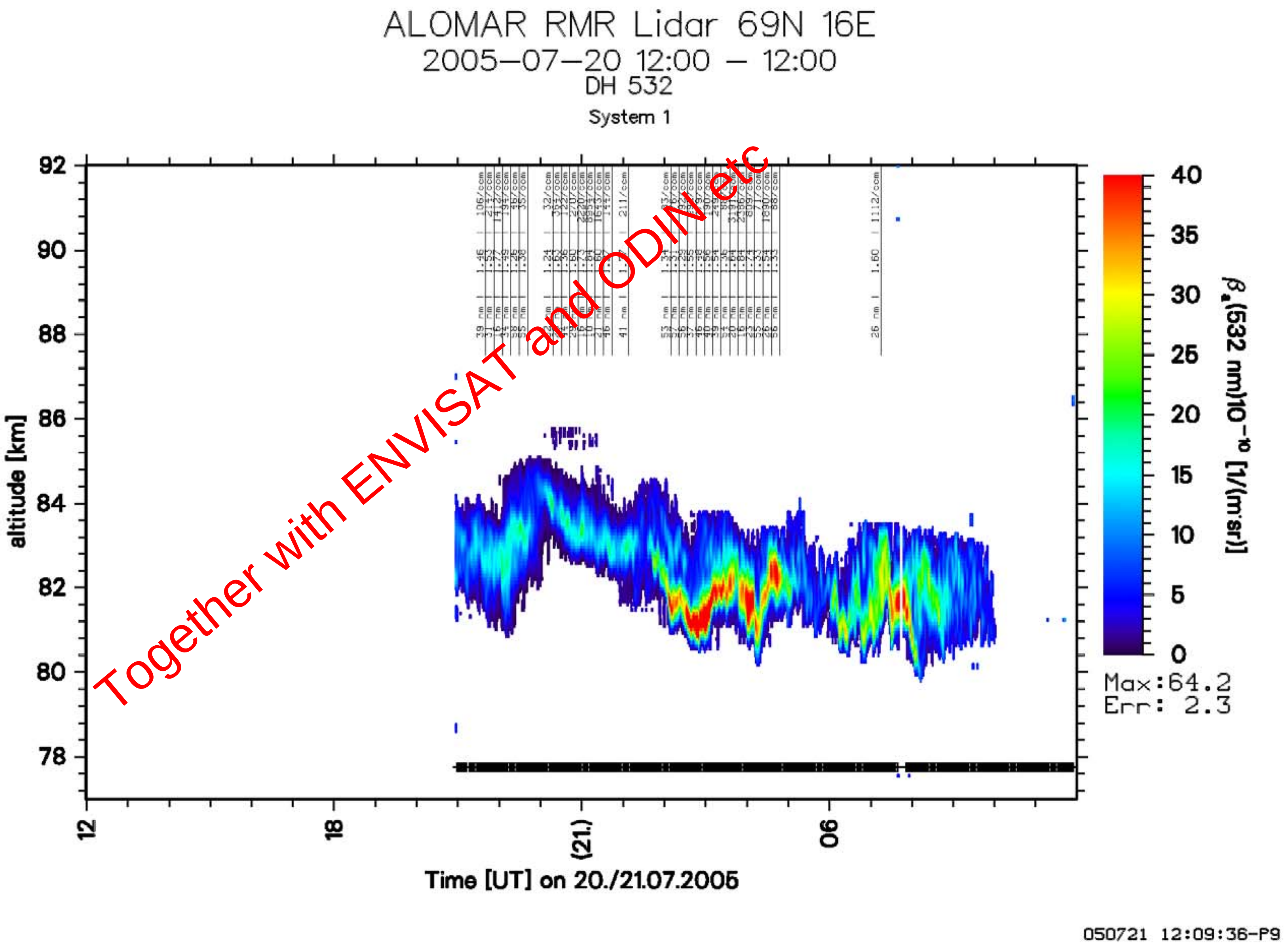
- Temperature observations by ground-based and satellite-borne techniques

- Wind measurements by radars

- In situ measurements of plasma etc. by rockets

-2005: close to solar minimum

- ENVISAT in high altitude mode : July 19-22 (i.e. NOW!)
- more satellites: ODIN, SNOE, TIMED, …
- Modelling


ALOMAR RMR Lidar 69N 16E
2005-07-20 12:00 - 12:00
DH 532
System 1
altitude [km]
Time [UT] on 20./21.07.2005
12
18
(21.)
06
92
90
88
86
84
82
80
78
40
35
30
25
20
15
10
5
0
β_a(532 nm)10^-10 [1/(m sr)]
Max:64.2
Err: 2.3
Together with ENVISAT and ODIN etc
050721 12:09:36-P9

CAWSES
workshop on ice layers
and German DFG
15-19 May 2006
in Kühlungsborn

Ideas for future „campaigns“:

- a SH campaign

- SH/NH comparison (measurements, modelling, PMC, PMSE, NLC)

- modeling of solar influence and trends

- input from new insitu measurements of dust particles (MAGIC, ECOMA)

- etc.

Ozone project

Coordinators:
Marty Mlynczak, Martin Dameris

Concept for Ozone – Climate Influence

Solar Variability (λ < 240 nm)

↓

Ozone Abundance

↓

Radiative Heating and Cooling

↓

Lapse Rate of Temperature

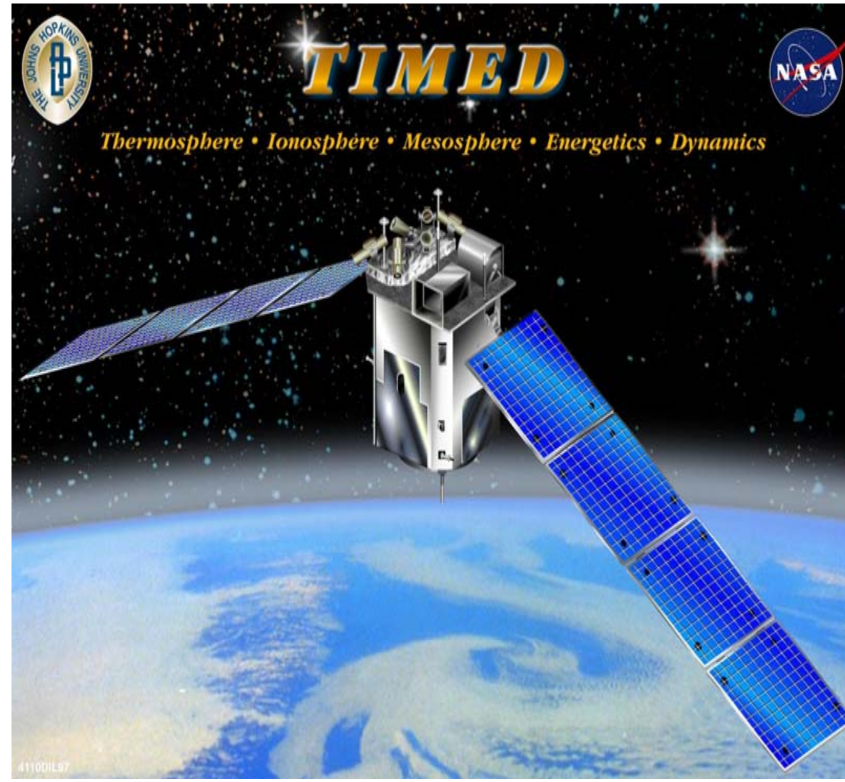
↓

Dynamics

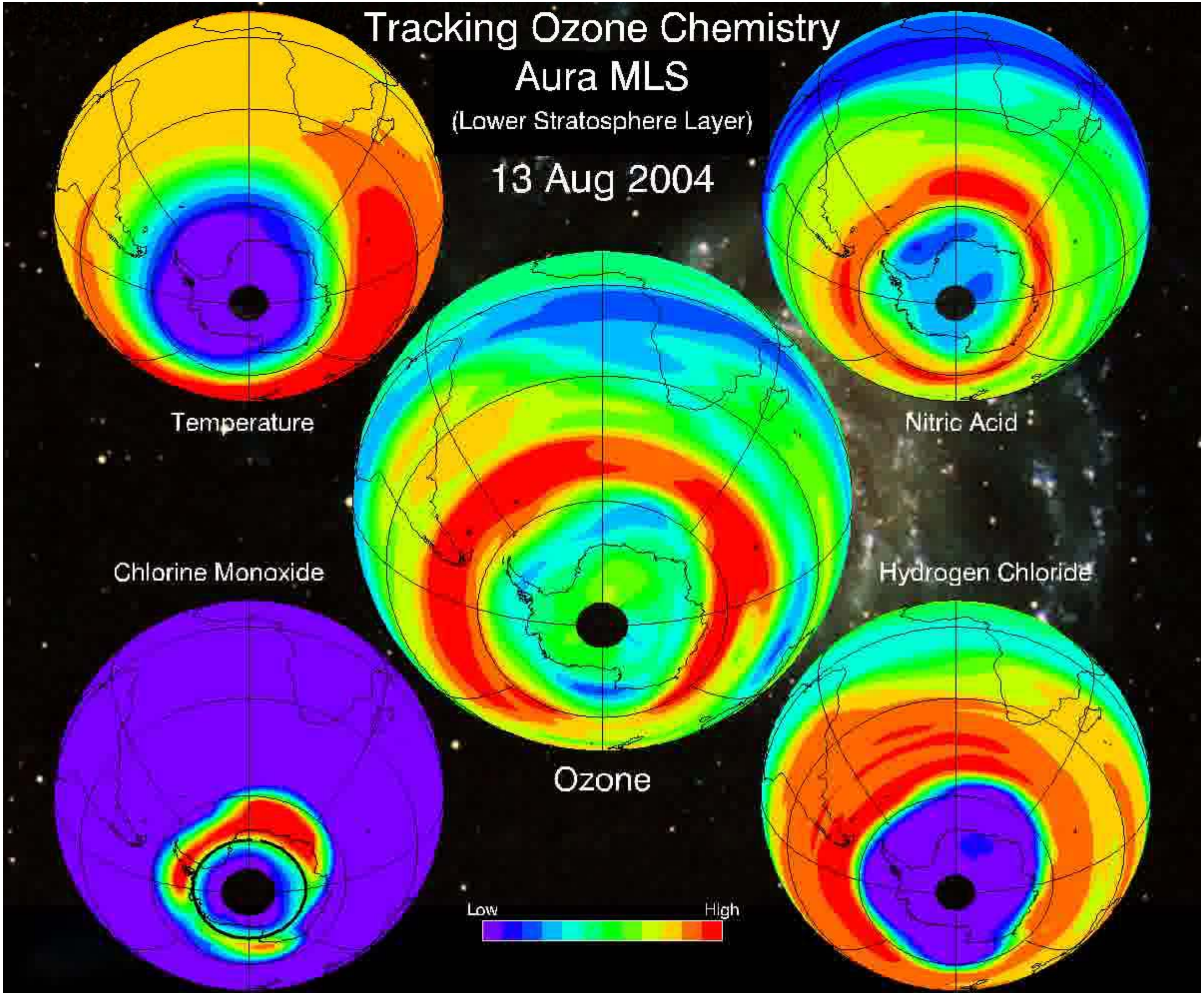
↓

Climate and Weather

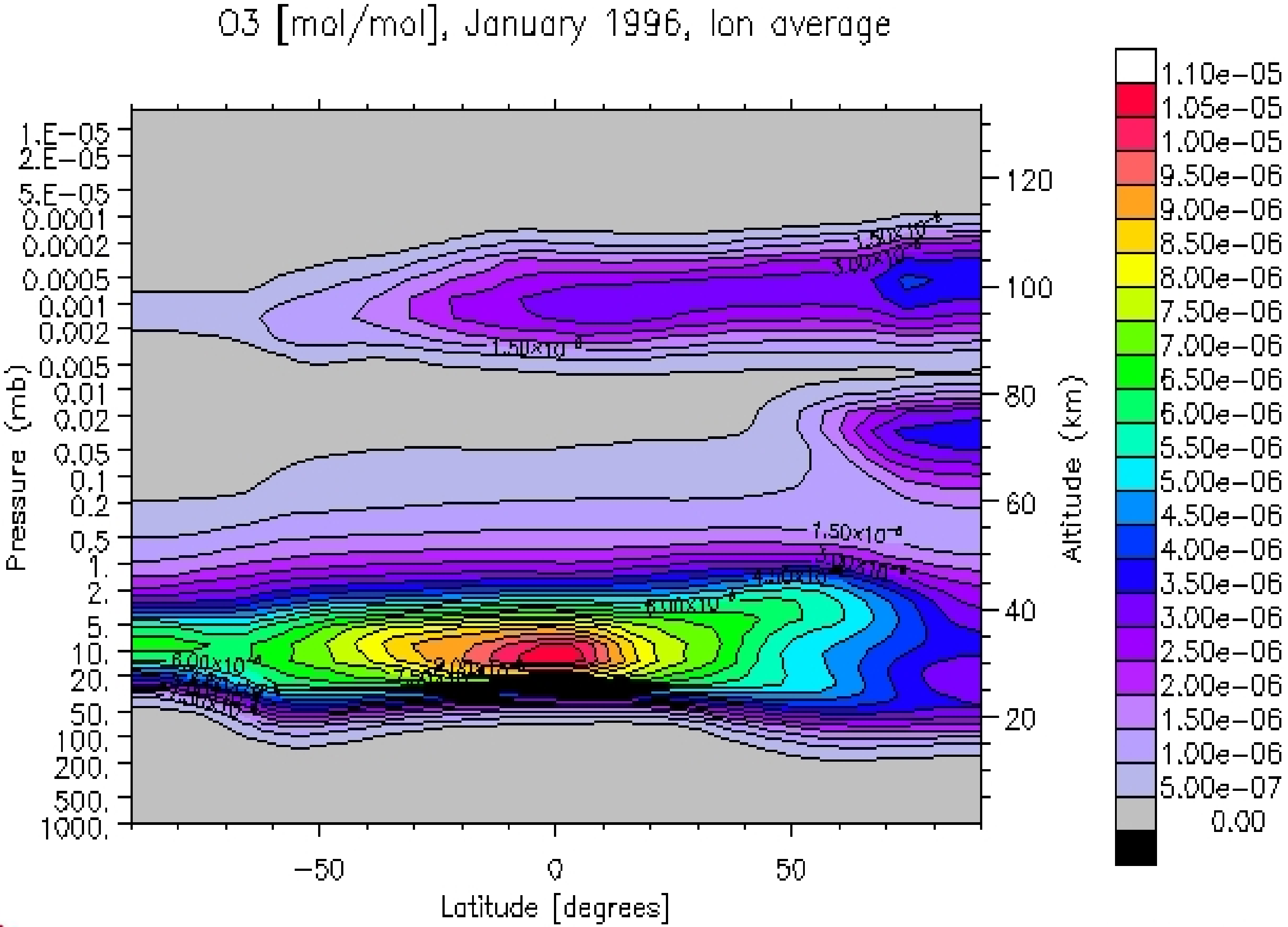
The Golden Age of Ozone Sensing



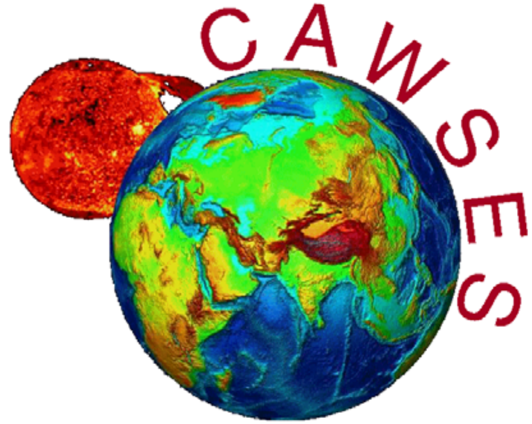
First time ever, two satellites, continuously profiling ozone and related species, surface to 100 km altitude

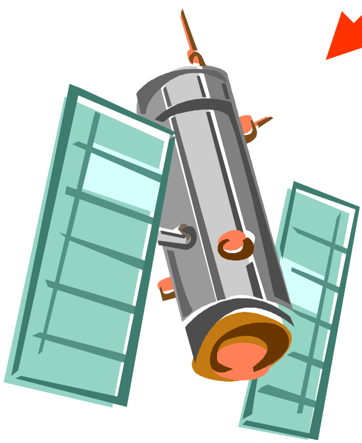

Tracking Ozone Chemistry
Aura MLS
(Lower Stratosphere Layer)
13 Aug 2004
Temperature
Nitric Acid
Chlorine Monoxide
Hydrogen Chloride
Ozone
Low
High

WACCM January Ozone



CAWSES – Drawing it All Together

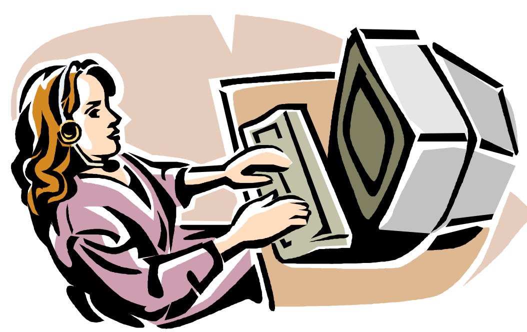




Observations

Understanding Ozone and Climate Variability

Whole Atmosphere Models



CAWSES Working Groups

Equatorial Atmosphere coupling processes (new title!)

Coordinators:
Mamoru Yamamoto
Subramanian Gurubaran
Hisao Takahashi

- CPEA Coupling processes in the equatorial atmosphere
  (several campaigns etc. ; mainly Japan, Indonesia)
  (see report by Joan Alexander)

- Mesosphere-ionosphere coupling, formation of plasma bubbles
  (airglow, met radars, 1st campaign: Sept/Oct 2005 ; mainly Brazil, USA)

- NEW: Low latitude radar network for investigation of dynamical processes in the mesosphere-lower thermosphere region
  India (Gurubaran), Indonesio (t.b.d.), Japan (Tsuda, Nakamura), Brazil (Clemsha, Batista, Takahashi), UK (N. Mitchel, D. Pancheva), Australia (Vincent)

- NEW: INTAR (international tropical atmosphere radar network): troposphere

New projects:

- **Coupling effects in the electrodynamics at the low latitude ionosphere**

  a) Study of low latitude ionospheric disturbances associated with geomagnetic activity
  Archana Bhattacharyya, Art Richmond

  b) Electrodynamic coupling of equatorial F region with conjugate E regions
  Hermann Lühr, Archana Bhattacharyya

  c) Electrodynamical coupling at high latitudes (t.b.d.)

- **t.b.d.: sprites, electric circuit**

Theme 3 workshop in 2007

(With 4-5 key speakers from other Themes)

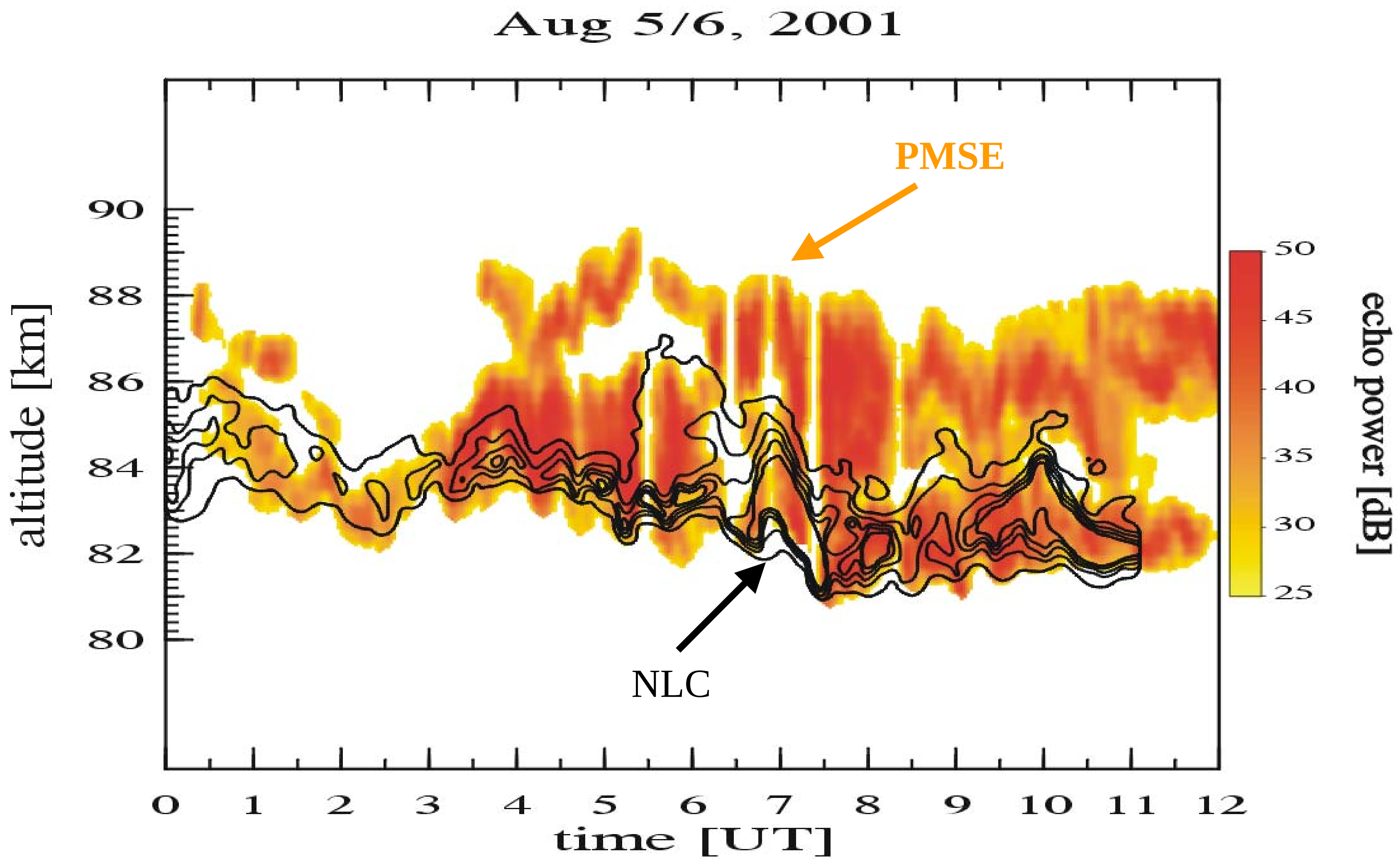
t.b.d.: when? where? who?

The End

CAWSES
workshop on ice layers
and German DFG
15-19 May 2006
in Kühlungsborn

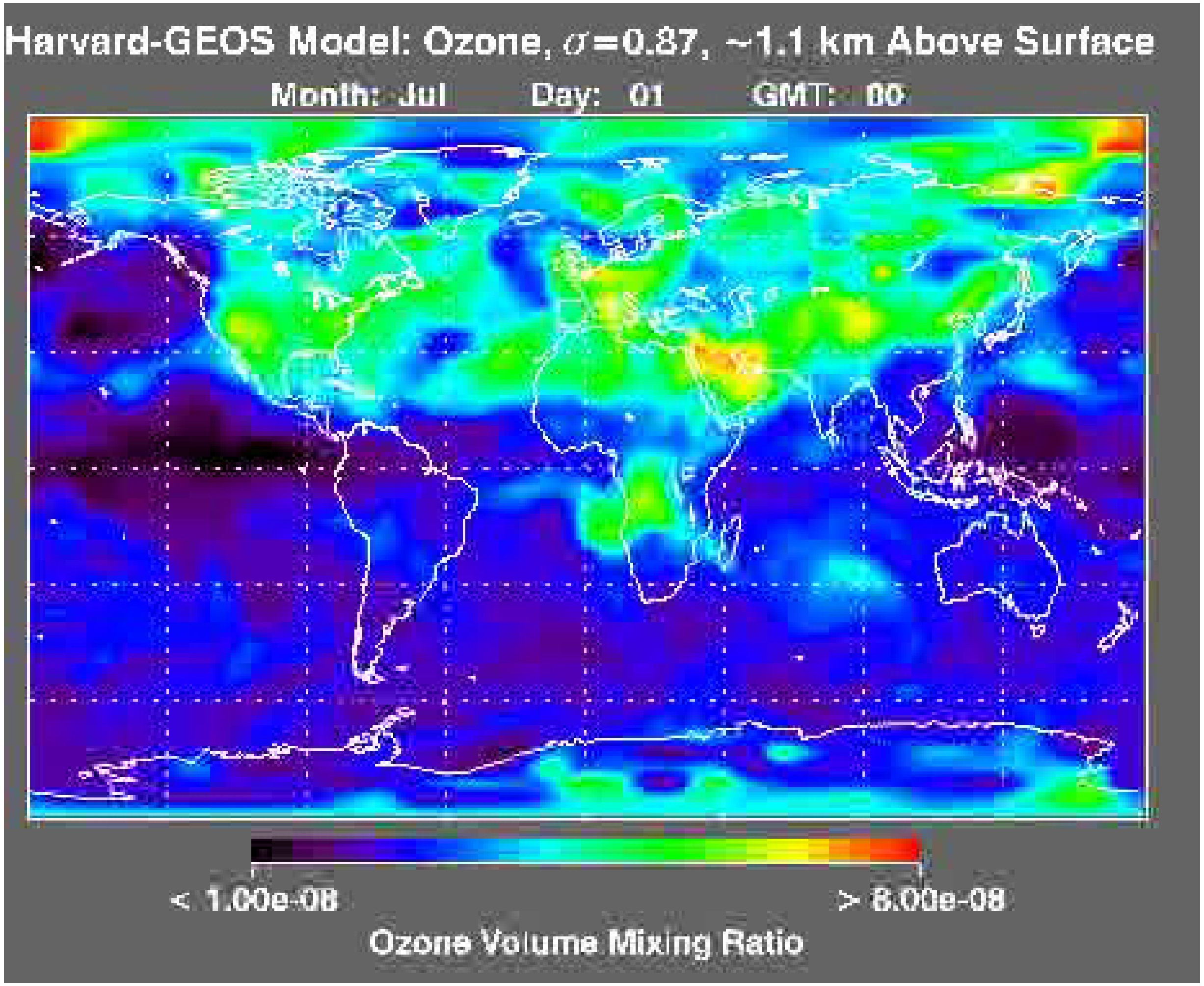
Spares:

NLC/PMSE at Spitsbergen, 78°N

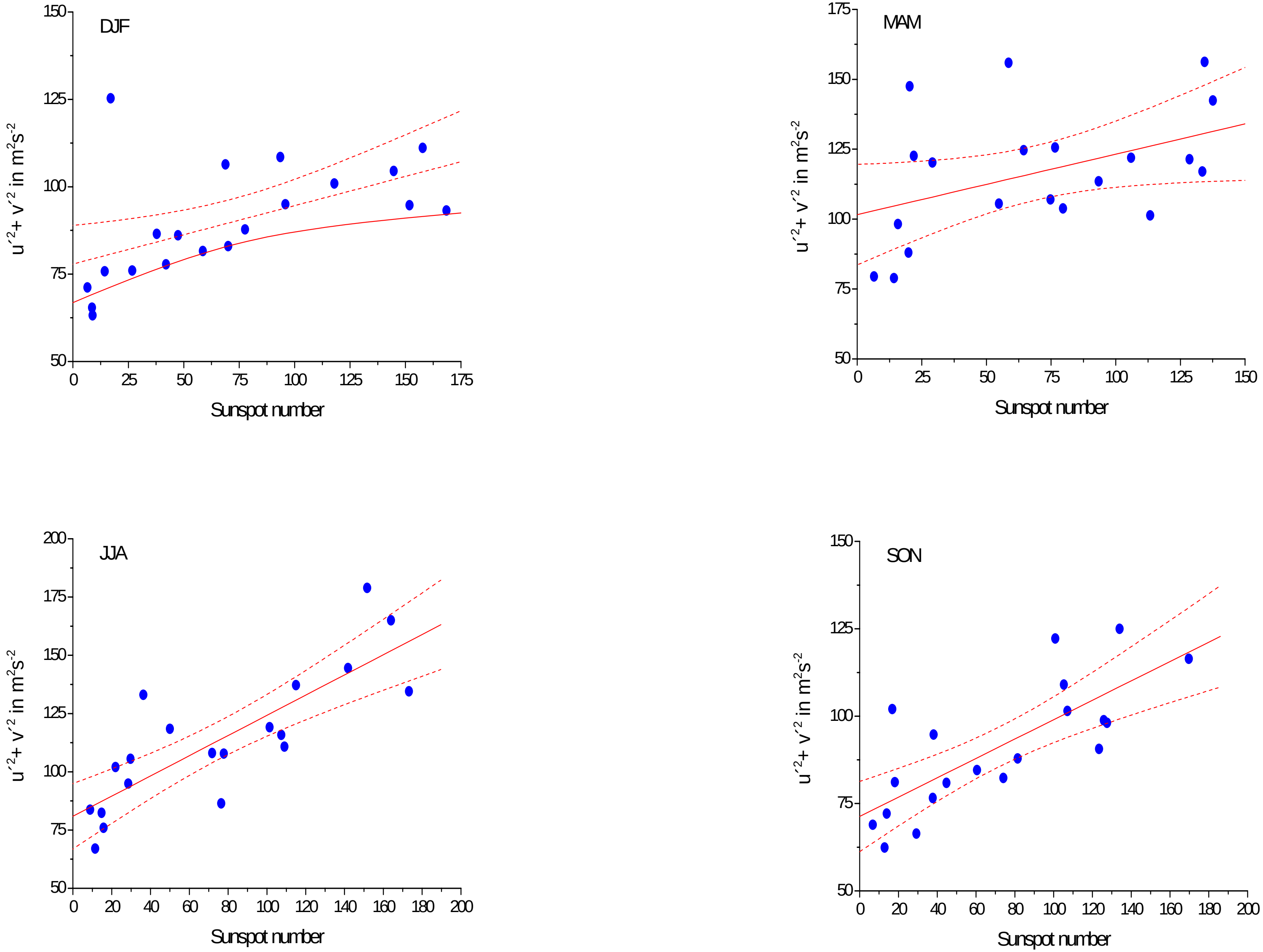


Lübken et al., J. Geophys. Res., 2004

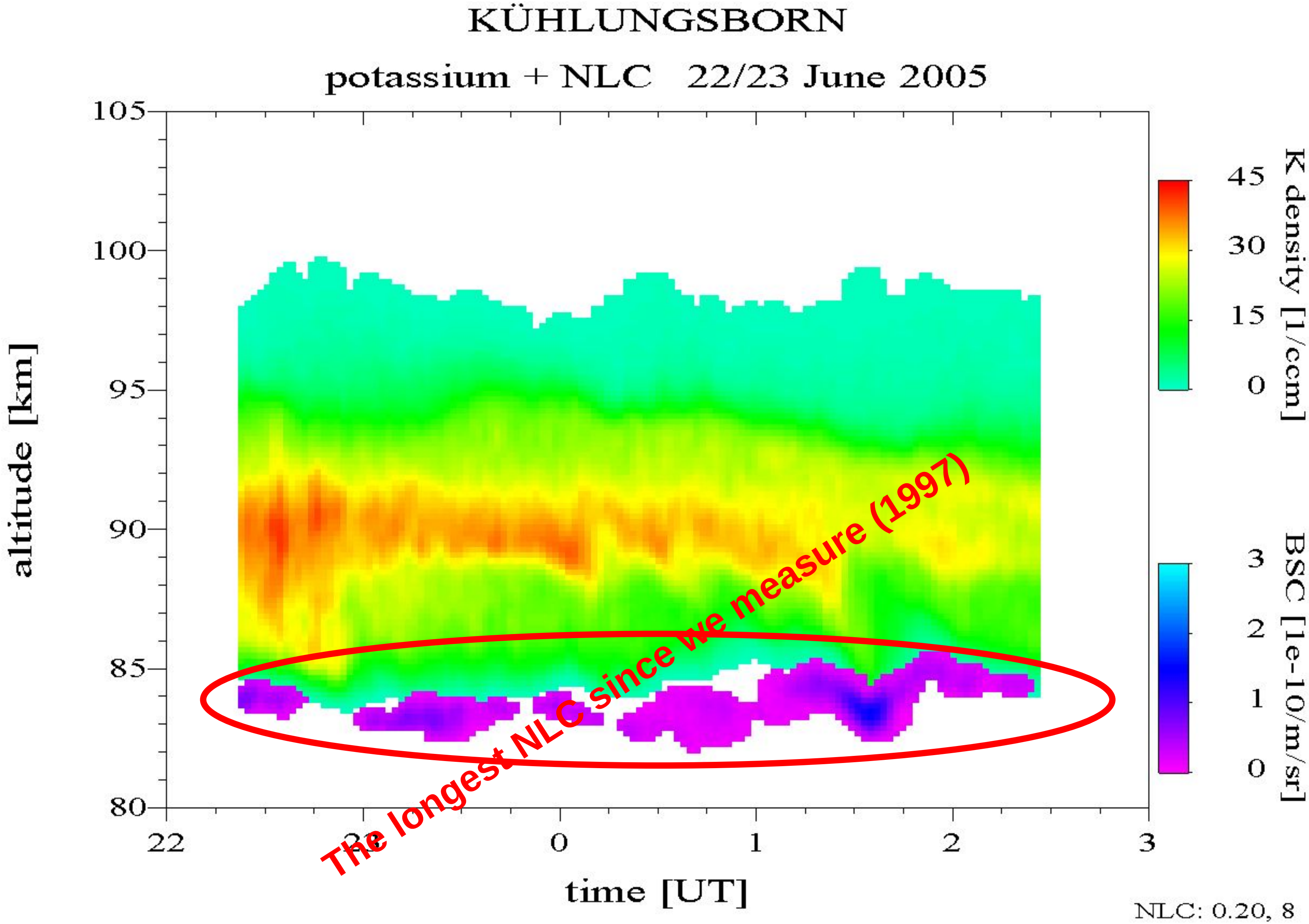
Tropospheric Ozone – Harvard GEOS Model – Boundary Layer



Courtesy TES Team/JPL



Correlation between half-hourly variances of ionospheric drift velocity for different seasons at Collm (Germany) after Jacobi et al., 2005 (presented at this conference)


KÜHLUNGSBORN
potassium + NLC 22/23 June 2005
altitude [km]
105
100
95
90
85
80
22
23
0
1
2
3
time [UT]
K density [1/ccm]
45
30
15
0
BSC [1e-10/m/sr]
3
2
1
0
NLC: 0.20, 8
The longest NLC since we measure (1997)

Theme 3: Atmospheric Coupling Processes

Co-Chairs: Franz-Josef Lübken (Germany) and Joan Alexander (USA)

WG 3.1: Dynamical Coupling and its Role in the Energy and Momentum Budget of the Middle Atmosphere

Martin Mlynczak (USA), William Ward, David Fritts (USA), Nikolai Gavrilov (Russia), S. Gurubaran (India), Maura Hagan (USA), J. Y. Liu (Taiwan), Alan Manson (Canada), Dora Pancheva (UK), Kauro Sato (Japan), Kazuo Shiokawa (Japan), Hisao Takahashi (Brazil), Robert Vincent (Australia) and Yi Fan (China)

WG 3.2: Coupling via Photochemical Effects on Particles and Minor Constituents in the Upper Atmosphere

Charles Jackman (USA), Ulf Hoppe (Norway), Manuel Lopez-Puertas (Spain), Daniel Marsh (USA), James Russell (USA), David Siskind (USA)

WG 3.3: Coupling by Electrodynamics including Ionospheric Magnetospheric Processes

Steve Cummer (USA), Peter L. Dyson (Australia), Inez S. Batista (Brazil), Archana Bhattacharya (India), Jorge Chau (Peru), Martin Fullekrug (Germany), Gang Lu (USA), Roland Tsunoda (USA), and M. Yamamoto (Japan)

+ Panel: Long-Term Trends *(inter-connected with 4.4)*