Report from Theme 3:

Atmospheric Coupling Processes

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3 working groups:

3.1 Dynamical coupling (planetary waves, gravity waves, tides, turbulence) and its role in the energy and momentum budget of the middle atmosphere

3.2 Particles and minor constituents in the upper atmosphere: solar/terrestrial influences and their role in climate

3.3 Coupling by electrodynamics including ionospheric/magnetospheric processes

(plus “trends” together with other themes)

WG 3.1
Dynamics....

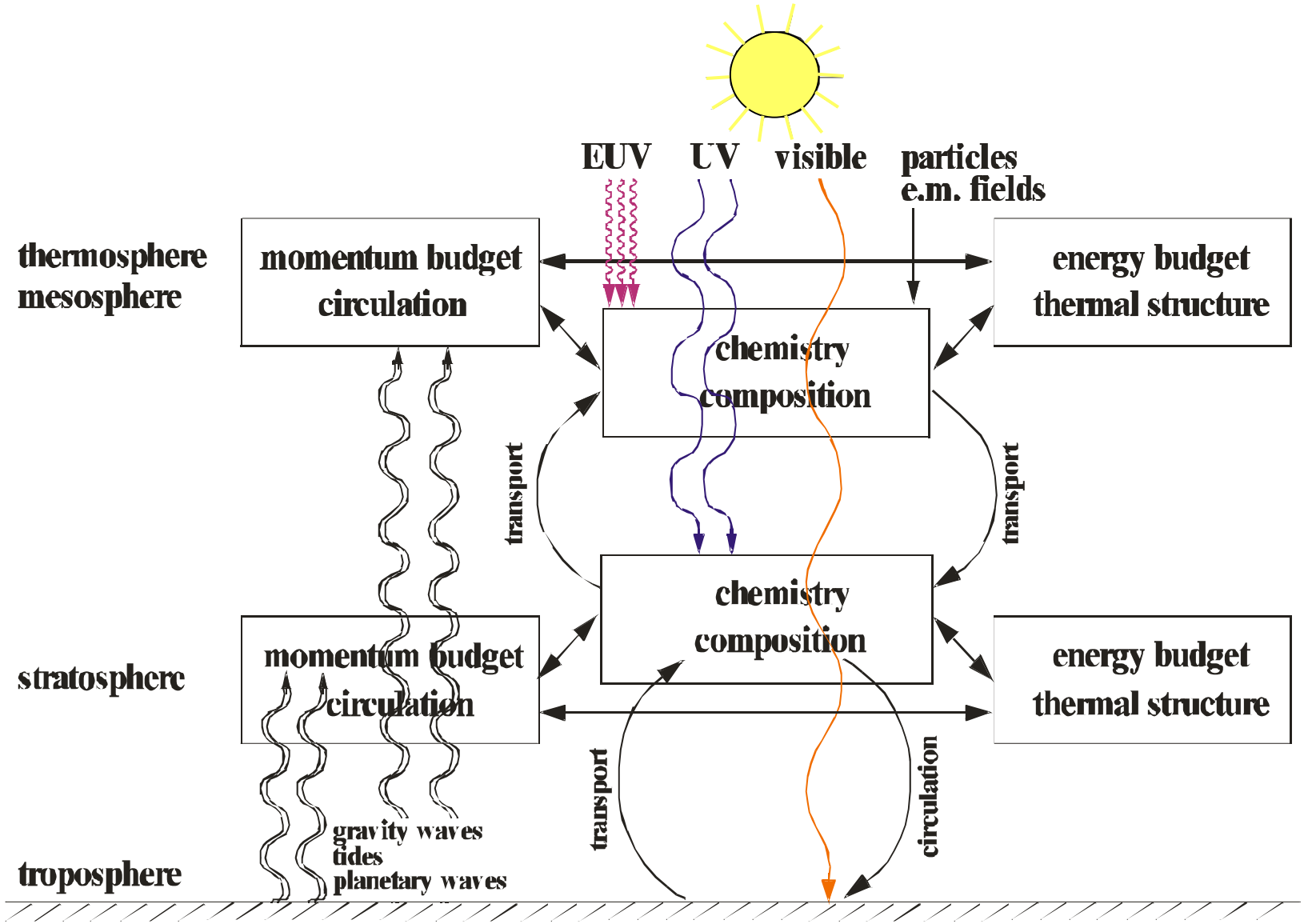
Fritts
Gavrilov
Gurubaran
Hagan
Liu
Luebken
Manson
Mlynczak
Pancheva
Sato
Shiokawa
Takahashi
Vincent
Ward
Yi

WG 3.2
Constituents …

Dameris
Hoppe
Jackman
Lopez-Puertas
Marsh
Russel
Siskind

WG 3.3
Electrodynamics ...

Batista
Bhattacharyya
Chau
Cummer
Dyson
Fuellekrug
Lu
Tsunoda
Yamamoto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stratosphere
momentum budget
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thermal structure
transport
circulation
gravity waves
tides
planetary waves
troposphere

Theme 3 meeting on Wednesday, 23 July:

input from:

Archama Bhattacharya
Jorge Chau
Nikolai Gavrilov
S. Gurubaran
Maura Hagan
Charles Jackman
Franz-Josef Lübken
Alan Manson
Dan Marsh
Marty Mlynczak
Kaoru Sato
Hisao Takahashi
William Ward

- ***General aspects, ideas, open questions***
- ***Specific scientific topics, projects, campaigns***
- ***Specific Measurements and Instruments***
- ***Miscellaneous***

General aspects: science issues

General ; open questions

- Mesosphere/lower thermosphere (MLT): energy, momentum, constituent budget are not understood in a self-consistent manner (mostly considered separately).
  Questions: input from below/above ?; coupling between dynamics,
  radiation, composition ? ; details of physical processes, e.g. wave breaking ?

- Role of waves in coupling ? Sources ? Impact on circulation and mixing ?
  In particlar: tides ; Non-linear interactions, e.g. between tides and PW ?

- Tides are not understood (observations and models often do not agree)

- Gravity wave observations/climatologies are essential

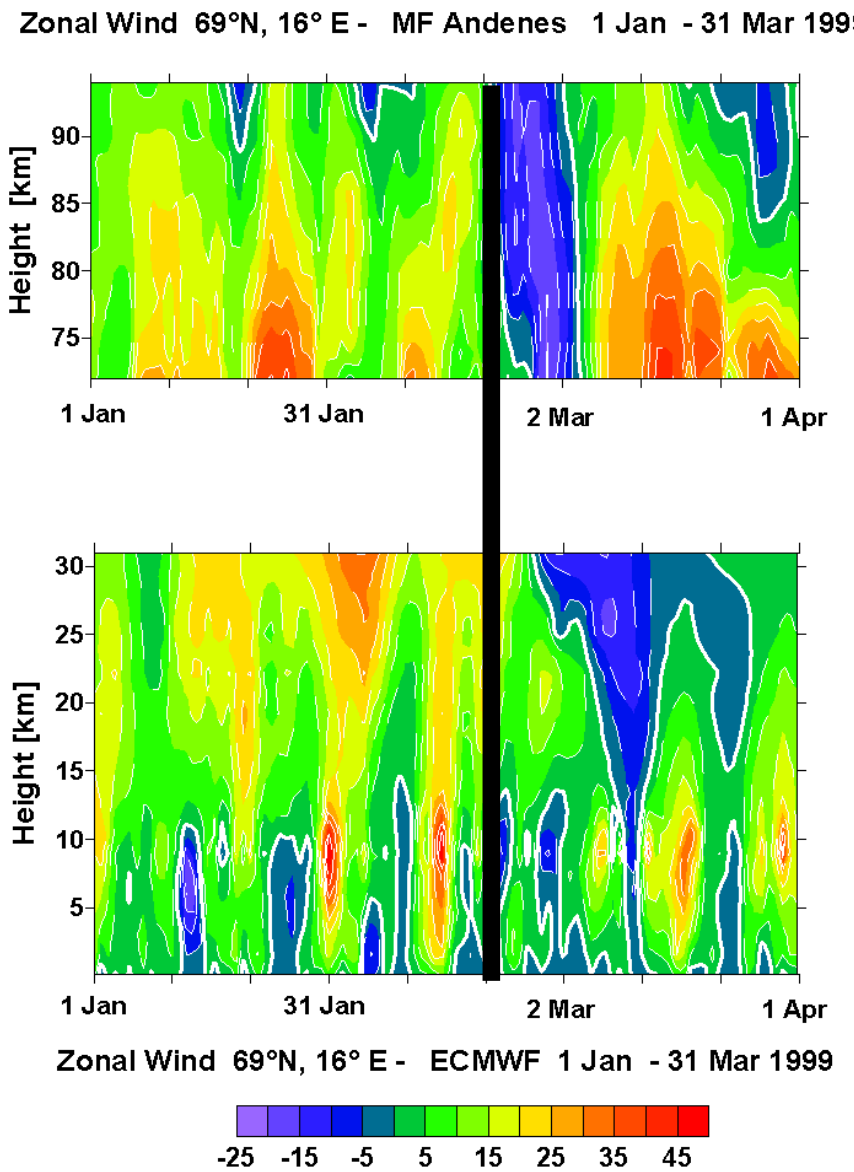
- Interaction of the solar signal with tropospheric/stratospheric circulation patterns
  (NAO, AO, ENSO, QBO, stratospheric warming) **(Fig.!)**

- Impact of variability on energy budget, for example through non-linear dependence
  of chemical reactions on temperature.

- Influence of MLT on the thermosphere/ionosphere ?

- What is the response of the middle atmosphere to solar activity changes and what are the relevant physical mechanisms involved (in comparison with anthropogenic influences).
  How deep into the atmosphere do solar disturbances and variability penetrate ?

Wind reversal FIRST seen in mesosphere



(general ; open questions , continued)

- What is the response of stratospheric ozone to changes in solar input.
  Ozone will be studied in the entire altitude range from the surface to 100 km.

  - Modification of trace gases by solar activity and feed back mechanisms on energy budget and dynamics. What is the role of precipitating particles on the production of minor constituents (e. g. NOx). **(Fig.!)**

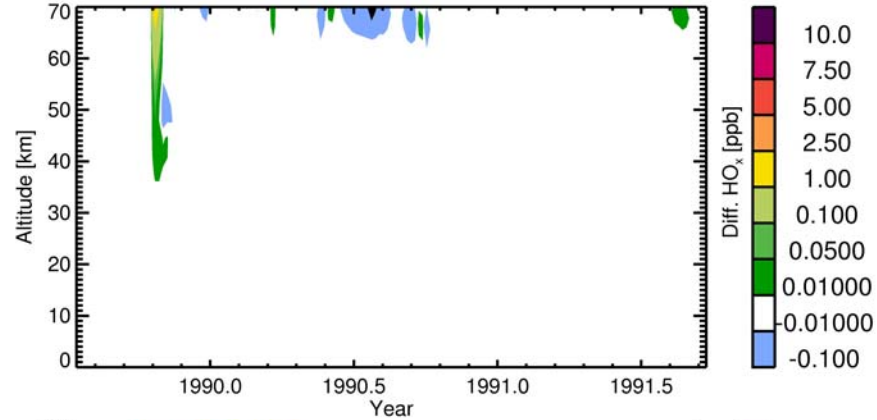
  - Study mean state and solar induced variability on trace gases and on layered phenomena in the high latitude summer mesosphere (H2O, NLC, PMSE) **(Fig.!)**

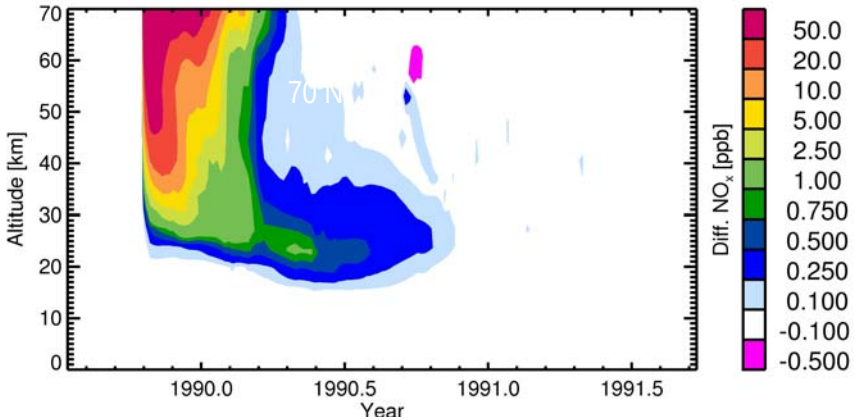
  - Identify solar variability signature in various atmospheric parameters (winds, temperatures, composition) at various time scales and different heights. More specific: quantify the influence of the upper atmosphere on the lower atmosphere over a solar cycle (e.g. downward transport of chemically active species)

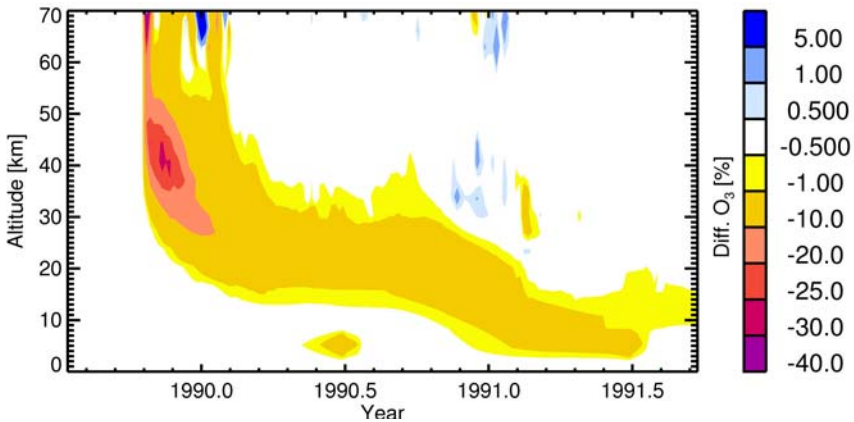
  - Inter-hemisphere differences must be considered (we live on `two planets') **(Fig.!)**

  - Some basic physical processes need to be investigated since they are highly relevant for coupling (e.g. transition of wave instability to turbulence ; non-LTE processes).

Kallenrode & Sinnhuber, Private communication, 2004







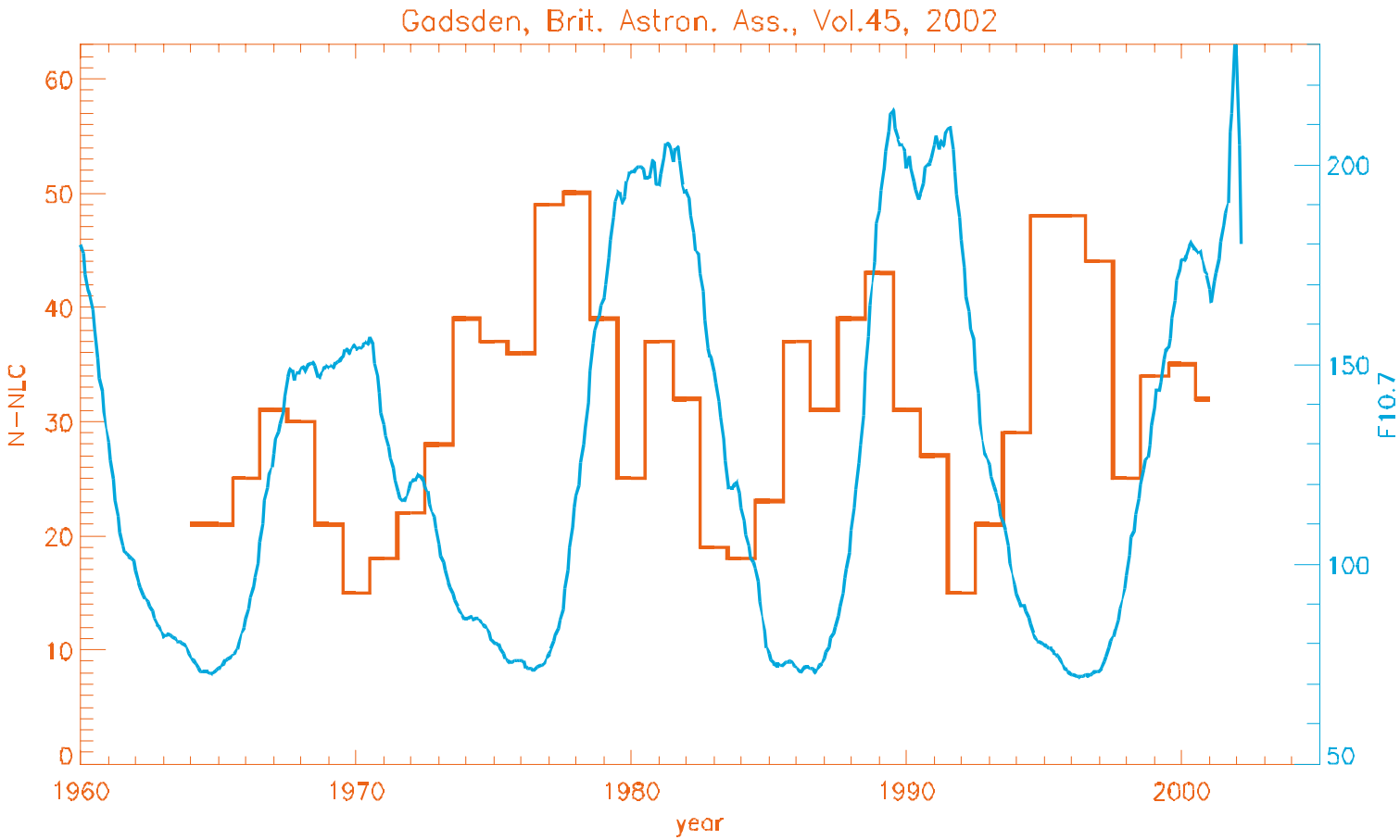
Effect of solar storm (October 1989) on:

HOx

NOx

O3

Particle flux from GOES, Model results from TOMCAT/SLIMCAT


Gadsden, Brit. Astron. Ass., Vol.45, 2002
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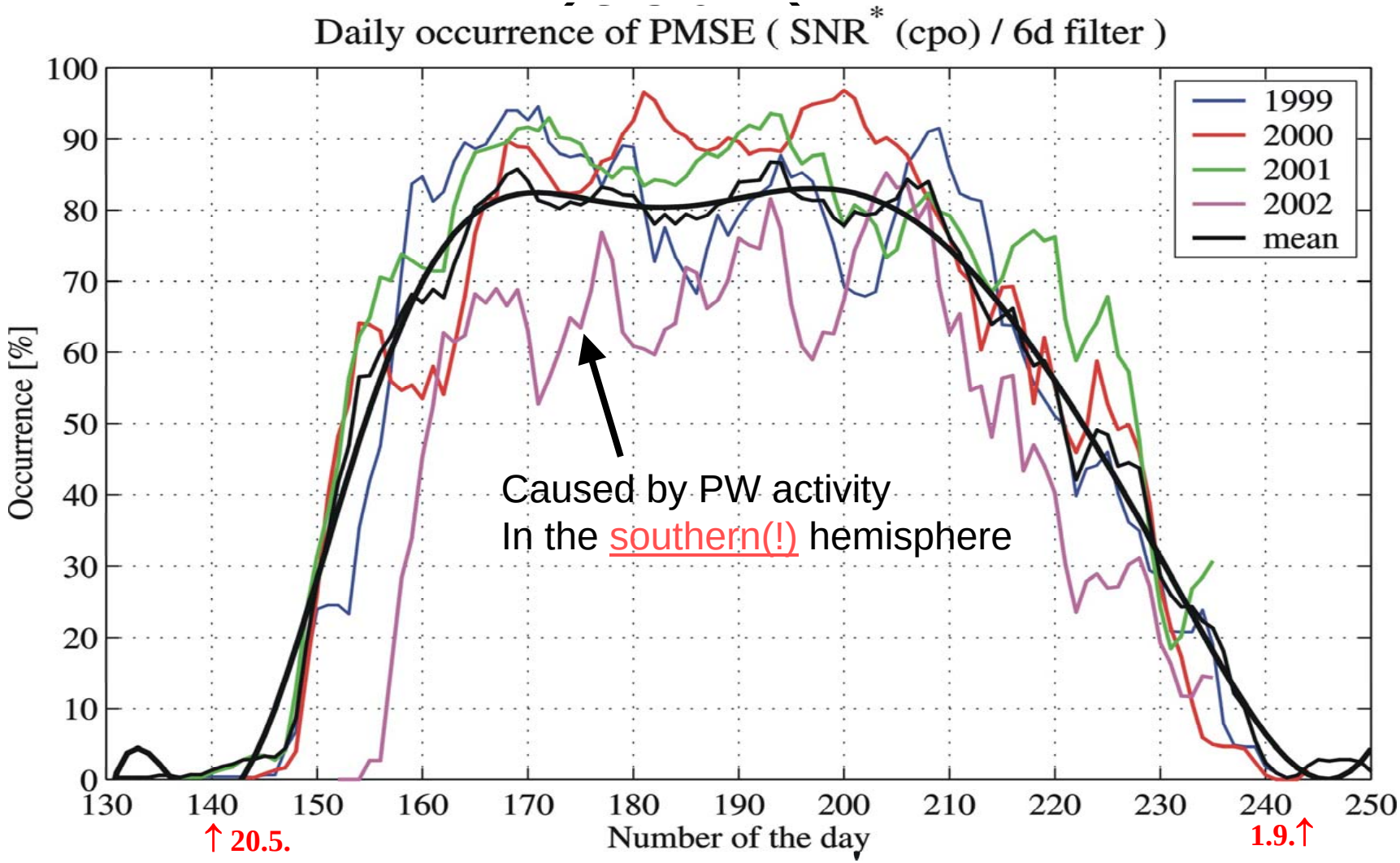
PMSE occurrence at ALWIN



Latteck (IAP), private communication, 2003.

Instrumental:

- Several satellites are (or will soon be) in orbit:
  TIMED, ENVISAT, Odin, SNOE, UARS, ACE, AURA, AQUA, EQUARS etc.

- Data in the lower atmosphere (ECMWF) are required to be available more frequently (for example to study tides) and up to 50 km

- Resonance lidars can now measure day and night (important for tides!). **(Fig.!)**
  RMR-Lidars: t.b.d.

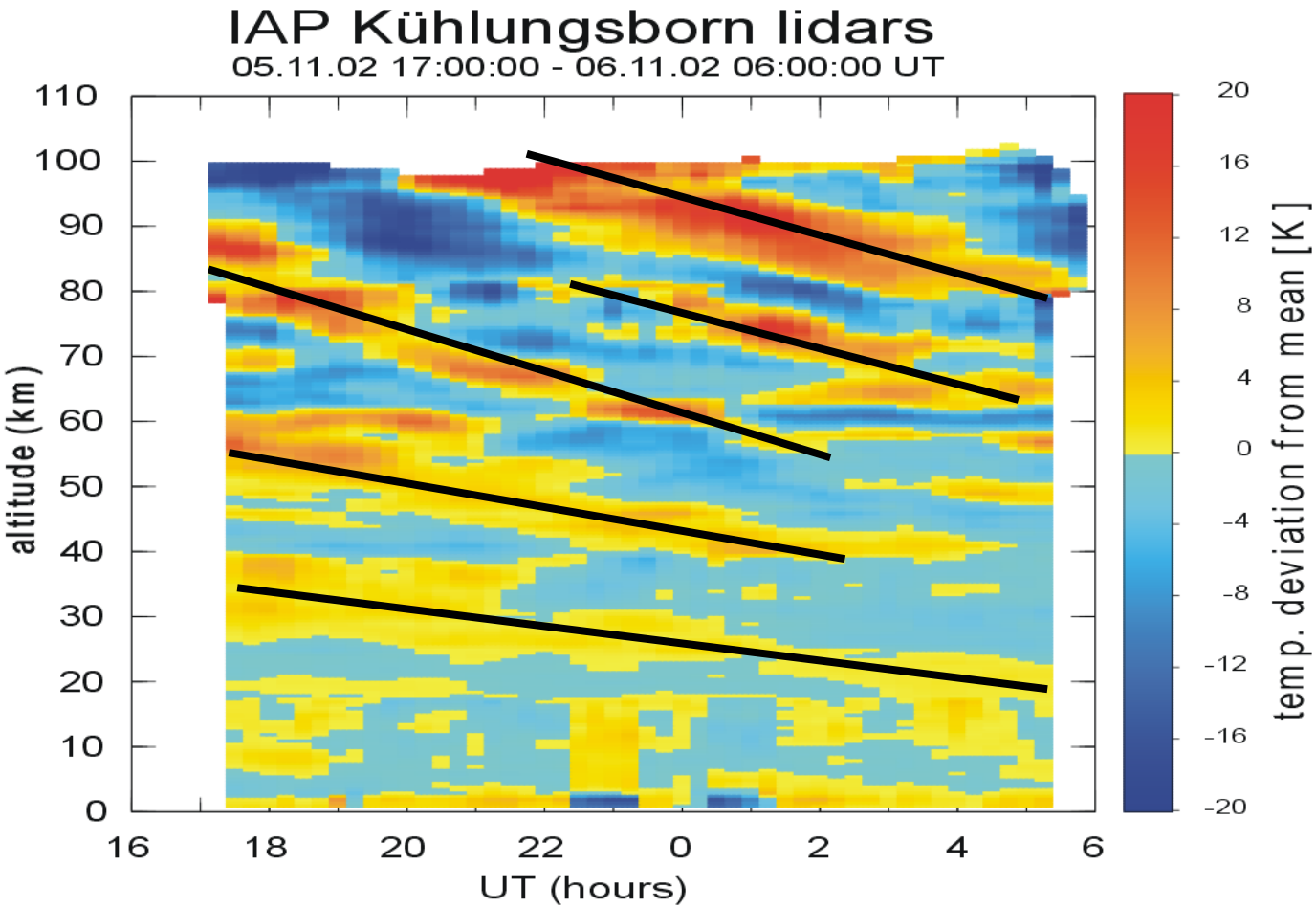
- Optical systems (lidars, air glow) should be co-located with radars

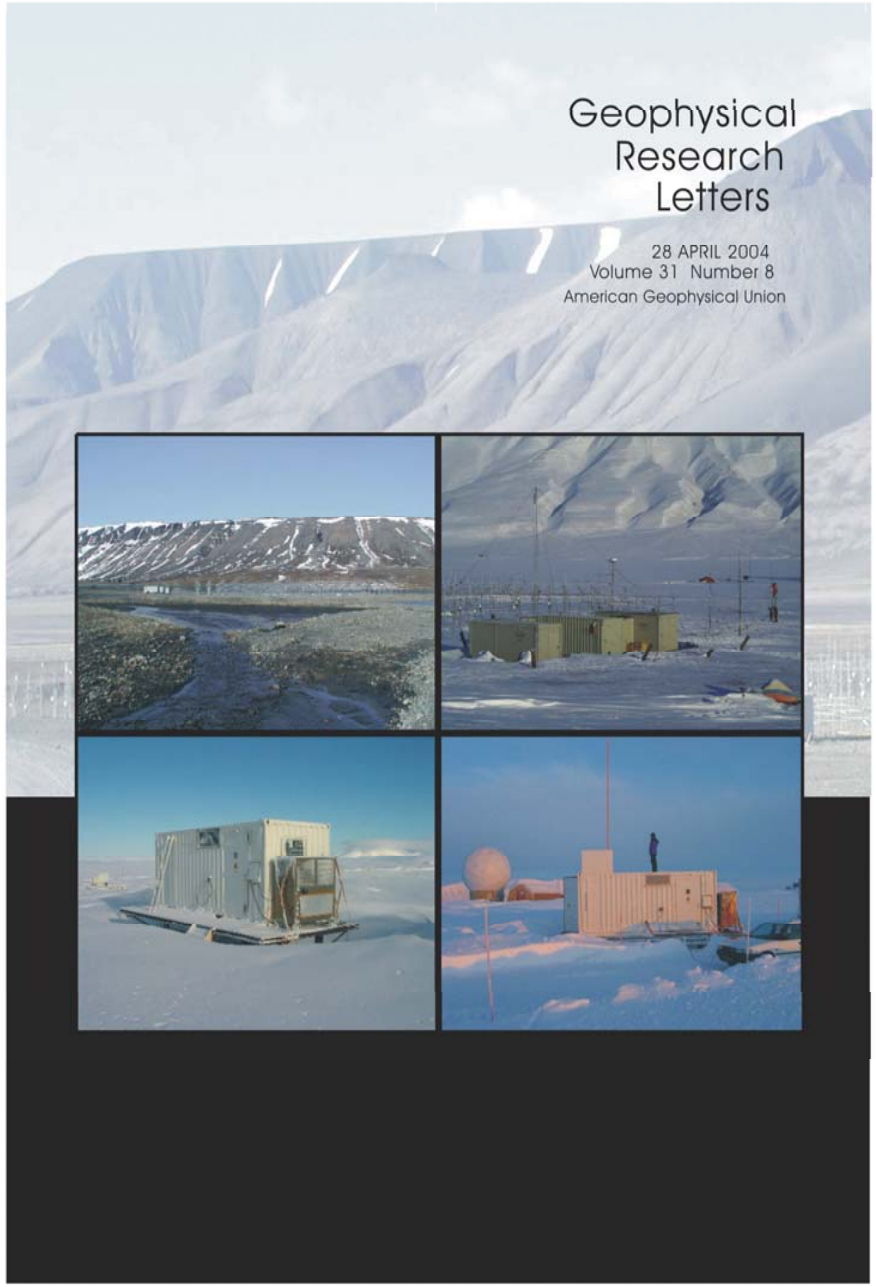
- Coordinated campaigns with satellite and ground based observations are needed

- Chains of ground based instruments (radars, lidars etc) need to be complemented according to scientific needs (e.g. to study non-migrating tides and/or PW).
  For example: some longitudinal gaps in the radar network need to be filled

- Dedicated field campaigns and/or laboratory work are required to solve specific scientific problems.

GW climatology at 54°N from various lidars





Report from theme 3 (F.-J. Lübken) at the CAWSES planning meeting, Paris, 17. July 2004

Models:

- GCM models with coupled chemistry now extend from the ground to the thermosphere. They require intercomparison, and also validation by comparison with observations and with mechanistic models.

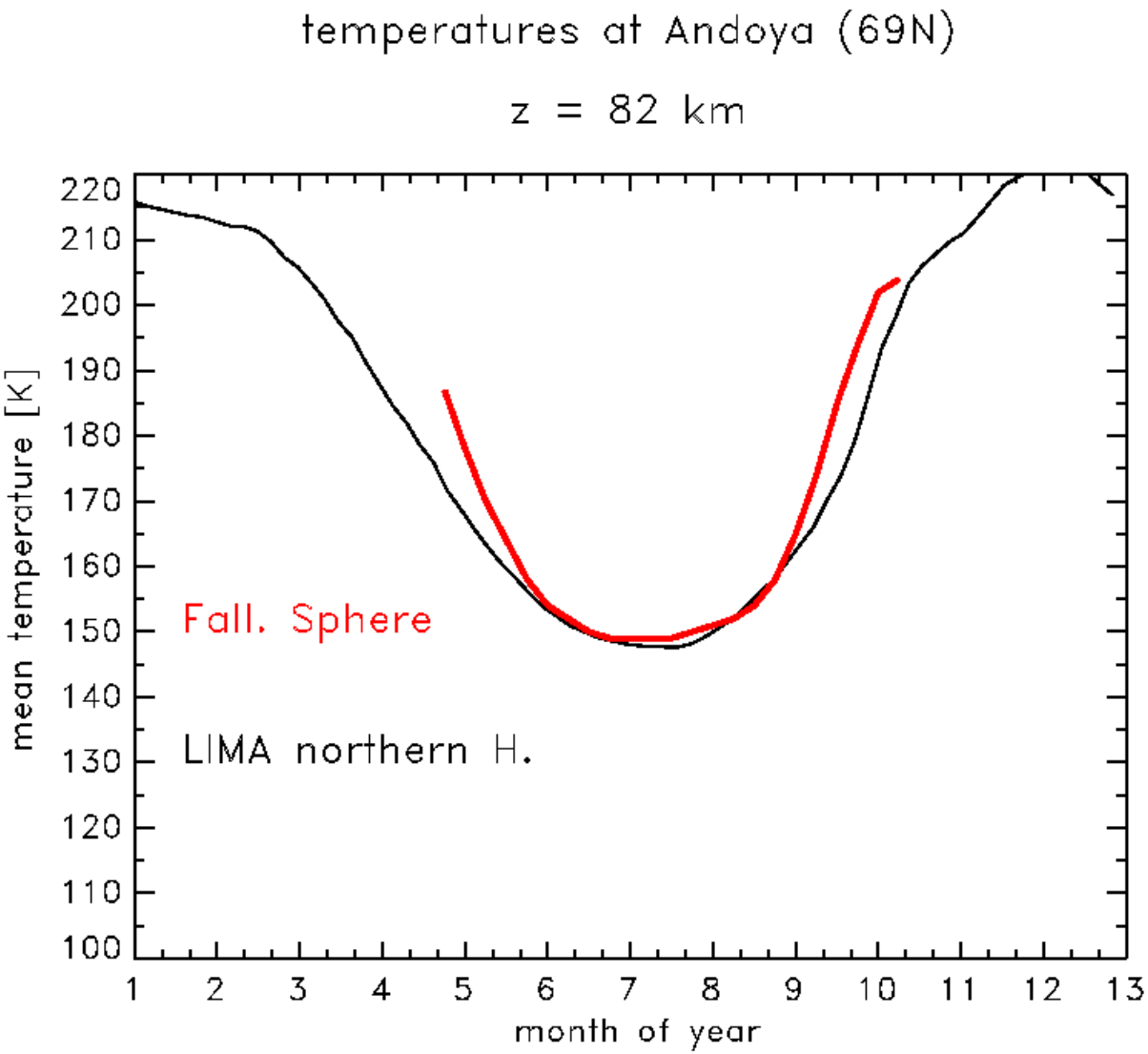
- Certain scenarios for GCMs should be defined for intercomparison (e.g. at solar maximum conditions)

- Most models are still not `wave-specific'

- Improved GW parameterizations are required

- Data assimilation in the MA is challenging but important

Comparison of IAP model (LIMA) and temperature climatology



Trends etc.:

- Is there evidence for long term variations of solar luminosity and impact on global change ?

- Can we make an assessment of long term changes in the upper atmosphere (similar to stratosphere?)

- Is there a tie between aeronomical activity (cosmic rays) and clouds in the troposphere ?

Specific scientific topics, projects, campaigns

- Equatorial ionosphere:
  - Equatorial and low-latitude ionosphere: coupling between the equatorial F region and conjugate E regions
  - Shielding of the low latitude ionosphere against prompt penetration of magnetospheric electric fields
  - Quantitative understanding of low-latitude/high-latitude ionospheric variability and coupling

- Atmospheric coupling from troposphere to ionosphere in the equatorial region
  - vertical energy and momentum transport and their zonal distribution
  - generation of waves in tropical deep convection (including migrating and non-migrating tides)
  - equatorial QBO and SAO and their lateral and vertical links to distant regions
  - coordinated observations by satellites (TIMED, C/NOFS, COSMIC, EQUARS, GPS), ground based (radar, lidar, optical), insitu (balloons, rockets from India)
  - 3 regions: (1) South America (Amazon forest), (2) Eastern Pacific (Indonesia and Australia), (3) India

- Study end-to-end processes: coronal mass ejection, transfer through heliosphere, interaction with magnetosphere, production of geomagnetic storms, effects in the atmosphere

- Proposal for 2007 International Heliophysical Year (IHY):

  - quantify magnitudes and sources of global quiescent thermosphere-ionosphere variations

  - develop improved capabilities for studies of space weather effects
    i.e. better knowledge of global `natural' variability and/or pre-conditioning

  - 1-3 months observations campaigns (global neutral/ionosphere parameters) ; correlative analysis ; data assimilation models ; interpretive by numerical modeling efforts

  - leverage efforts and skills of existing teams (PSMOS, EPIC, CAWSES)

Specific Measurements and Instruments

- New contributions from Jicamarca:
  - Regular measurements of daytime mesospheric winds and turbulence with excellent height/time resolution
  - daytime electric fields in the lower thermosphere on 100 days/year

- Specific observations from MIPAS (ENVISAT) and SABER (TIMED) are used to study
  - interaction between mesosphere and stratosphere in the polar region mainly using NOx and CO
  - effects of Oct/Nov 2003 solar storm
  - non-LTE effects in CO2, NOx, O3, H2O and CO

- ENVISAT high altitude mode: few available today, but more will hopefully be made soon.

- Detailed ozone data available from TIMED from 0-100 km

- Antarctic MF radar network (Rothera, Davis, Syowa)

- New: SuperDARN HF radar network (Arctic, Antarctic) will be used to estimate winds in the thermosphere

Miscellaneous:

- **Close interaction between working groups is required, e. g. between WG 3.1 and 3.2 (because of transport of chemically active species)**

- **Interaction with the other CAWSES themes is essential**

- **Question: topics in working groups too broad ? Some more specific subprojects should be organized, e.g. `gravity waves and turbulence' or `tides‘**

- **What about International Polar Year and International Heliophysical Year 2007?**

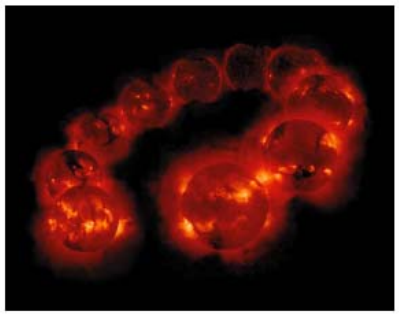
German DFG has approved CAWSES as a „priority programme“

Proposal for a DFG priority programme entitled:

Climate And Weather of the Sun-Earth System (CAWSES)

presented by Franz-Josef Lübken (speaker), May-Brit Kallenrode,
Ulrike Langematz, Paul Hartogh, and Christoph Jacobi

11. February 2004



The Solar Cycle: a montage of ten years worth of soft X-ray images demonstrating the variation in solar activity during the sunspot cycle (source: solar.physics.montana.edu).

Noctilucent clouds (NLC) observed in Kühlungsborn in summer 2003. NLC occurrence frequency varies with solar cycle but the physical mechanism is not understood (photo courtesy of IAP).

1

- appr. 25 institutions
- appr. 2-3 Mio Euro per year
- 2 (+4) years
- in operation: April 2005

Report from theme 3 (F.-J. Lübken) at the CAWSES planning meeting, Paris, 17. July 2004

3 Scientific Programme

Nikolai Gavrilov has generated a website for NIS scientists interested in CAWSES:

http://lmupa.phys.spbu.ru/cawsesnis/

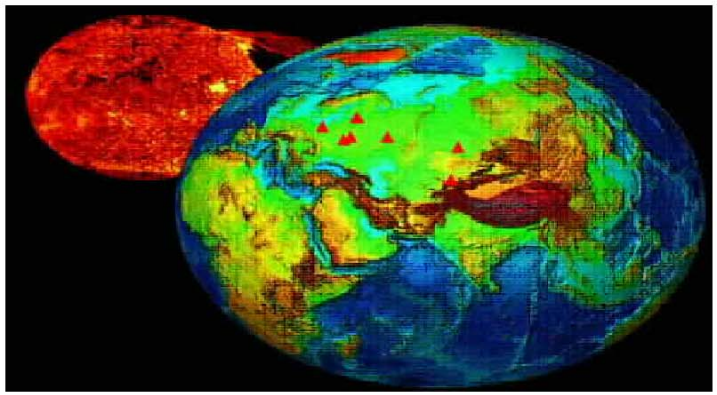
Atmospheric Coupling Processes

studies in NIS countries according to Theme 3 of CAWSES

(Climate and Weather of the Sun-Earth System)

A new SCOSTEP Program for 2004-2008

Russian – Русская версия



Composite picture created at NOAA-NGDC by Dr. Peter Sloss from SKYLAB solar X-ray telescope picture by Naval Research Laboratory and bathymetry and topography databases archived at NGDC. Red triangles show sites of NIS participants.

CAWSES homepage	**Science in**
Theme 3 of CAWSES	**NIS Participan**
To join the list of NIS Participants e-mail to gavrilov@pobo	

CAWSES
Climate And Weather of the Sun-Earth System

Participants of studies under Theme 3 "Atmospheric Coupling Processes" in NIS countries

No.	Organization	Participants	Field of Studies	Working Group	Addresses
1	Institute of Ionosphere of the Ministry of Education and Science of the Republic of Kazakhstan	1) Arthur F. Yakovets 2) Galina I. Gordienko 3) Valery M. Krasnov; Yana V. Drobzheva	1) Experimental study of waves in the neutral atmosphere and ionosphere and their sources; 2) Experimental study of ionization processes in midlatitude layers E and F1 during geomagnetic storms; 3) Observations and numerical modelimg of propagation and impacts in the atmosphere and ionosphere of infrasound emitted by natural and artificial tropospheric sources.	WG 3.1 WG 3.3 WG 3.1	Kamenskoe Plato, Almaty, 480020, Kazakhstan arthur@ionos.alma-ata.su, artyak40@mail.ru gord@ionos.alma-ata.su, ggordienko@mail.ru valerie_krasnov@hotmail.com yanichka@hotmail.com
2	Kazan State University, Physical Department	Antonina N. Fakhrutdinova	Radiometeor study of lower thermosphere dynamics	WG 3.1	17 Lenin Street, Kazan, Russia Antonina.Fahrutdinova@ksu.ru
3	Institute of Experimental Meteorology, SIA "Typhoon"	1) Yuri I. Portnyagin 2) Eugeny G. Merzlyakov	1) Radiometeor study of lower thermosphere dynamics; 2) Wave fluxes of energy and momentum in MLT region; 3) Nonlinear interaction and instability of planetary waves.	WG 3.1	82 Lenin Street, Obninsk, Kaluga region, 249038, Russia Fax: 7-08439-40910 yportnyagin@typhoon.obninsk.org eugmer@typhoon.obninsk.org
4	Russian State Hydro-meteorological University	Alexander I. Pogoreltsev	Climatological analysis and numerical modeling of tides and planetary waves, their instabilities and wave interactions	WG 3.1	98 Maloohtensky Prospect, Saint Petersburg, 195196, Russia Tel: +7 812 4448261; FAX: +7 812 4446090 apogor@rshu.ru
5	Moscow State University, Physical Department	Vyacheslav E. Kunitsyn Ravan R. Akhmadov	Numerical modeling of propagation of nonlinear gravity waves in the atmosphere	WG 3.1 WG 3.2	Atmospheric Physics Department, Leninskie Gory, Moscow, Russia raven@msu.ru
6	Obukhov Institute of Atmospheric Physics	Nikolai N. Shefov, Anatoly I. Semenov, Nikolai N. Pertsev	Study of the middle atmosphere at different heights and latitudes on solar activity variations	WG 3.2	3 Pyzhevsky Pereulok, Moscow, 119017, Russia Fax. 7-095-9532158 meso@ifaran.ru
7	Geophysical Observatory "Klyuchi"	Sergej Yu. Khomutov	Observations of dynamical and wave processes in the atmosphere and ionosphere using powerful infrasound emitter, acoustic receivers and ionosonde "Parus"	WG 3.1 WG 3.3	Altai-Sayan branch of Geophysical Service of Siberian Division of Russian Academy of Science, Akad. Koptyg Prospect, Novosibirsk, 630090, Russia Fax. 7-3832-301261 khomutov@gs.nsc.ru
8	Western Branch of IZMIRAN	Yu. N. Korenkov	Three-dimension numerical modeling of thermosphere, ionosphere, protonosphere and electric field of the Earth, also study of influence of middle atmosphere processes on tidal structure of the upper atmosphere	WG 3.1 WG 3.3	41 Pobeda Prospect, Kaliningrad, 236017, Russia Fax. 7-0112-215606 pcizmiran@gazinter.net
9	Saint-Petersburg State University, Physical Research Institute	1) Nikolai M. Gavrilov 2) Gustav M. Shved 3) Valentin A. Yankovsky Reda O. Manuilova 4) Eugeny E. Timofeev	1) Propagation and impact of internal gravity waves and turbulence in the middle atmosphere; 2) Influence of planetary waves and tides on radiative cooling of MLT region; Improving the model of molecular heat conduction in the thermosphere; 3) Improving photochemical and radiation models of the middle and upper atmosphere. 4) Study of ion and electron temperature in the ionosphere and their connections with geomagnetic activity, atmospheric dynamics and composition.	WG 3.1 WG 3.2 WG 3.3	1 Ulyanovskaya Street, Petrodvorets, Saint-Petersburg, 198504, Russia Fax: 7-812-4287240 gavrilov@pobox.spbu.ru shved@pobox.spbu.ru Valentine.yankovsky@paloma.spbu.ru Reda.Manulova@pobox.spbu.ru timofeev@geo.phys.spbu.ru
10	Kaliningrad State University	Sergej P. Kshevetsky	Numerical modeling of gravity waves and turbulence in the middle and upper atmosphere	WG 3.1	Kaliningrad, Russia renger@mail.ru

Aims for the team meeting on Wednesday:

- **Identify most relevant scientific topics with good chances for success in the near future**
- **Define specific campaigns/projects: scientific goals, time line, coordinators,etc.**
- **Aim for first report during the next meeting (when? where?)**

Thank you for your attention!