

Report Theme 3

CAWSES

co-chairs:

Franz-Josef Lübken
&
Joan Alexander

Working groups within Theme 3:

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

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

WG 3.3: Coupling by Electrodynamics including Ionospheric Magnetospheric Processes

WG 3.4: Long-Term Trends (*inter-connected with 4.4*)

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*)

Theme 3 Projects:

- Planetary and gravity wave influence on winter polar vortices – A. Manson 😊
- Global observing campaign to characterize tides from troposphere - thermosphere
W. Ward et al. 😊
- Gravity waves and turbulence – D. Fritts, N. Garvilov (?)
- Solar influence on minor constituents & layers at the extra-tropical summer mesopause
F.-J. Lübken, U.-P. Hoppe, S. Bailey 😊
- Ozone: how well do we understand it? – M. Mlynczak et al. (?)
- Equatorial Atmosphere Coupling Processes 😊
M. Yamamoto, Hisao Takahashi and Subramanian Gurubaran.
- Electrodynamic Coupling effects in the equatorial and low-latitude ionosphere
Archana Bhattacharaya, Art Richmond, and Hermann Lühr 😊
- Understanding Atmospheric Coupling Processes through Numerical Modeling
Gang Lu, Maura Hagan and Art Richmond (?)

More information on Theme 3 project:

Planetary and gravity wave influence on winter polar vortices

A. Manson et al.

Coordinators(s):

Alan Manson (Project Coordinator; NH Facilitator)

Tatyana Chshyolkova and Werner Singer (2004/5 and 2005/6 NH Campaign Leaders)

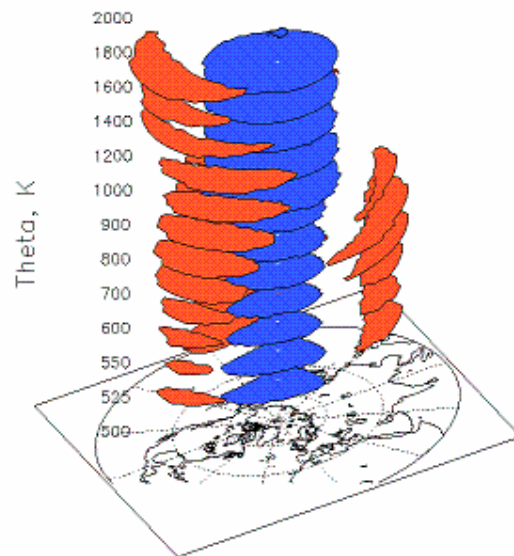
Scott Palo (Southern Hemisphere Coordinator); Radar Steering Committee (NH);

Marianna Shepherd (Optical Coordinator (NH)); Satellite Coordinators; Advisory Group.

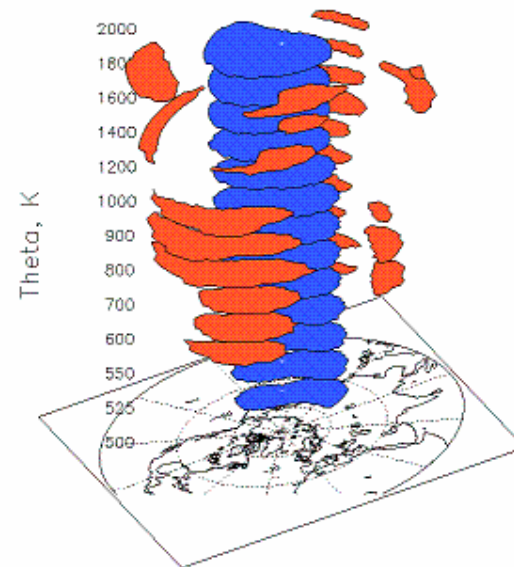
Extended Title:

“Atmospheric Wave Interactions with the Winter Polar Vortices (0-100 km) from Observations and Modelling: Radiationally Unexpected Phenomena such as SSW (sudden stratospheric warmings), mesospheric thermal inversions, equinoctial transitions, “Ozone Anomalies”, and the “Winter Anomaly” (D-region ionization) will be Investigated for CAWSES Winters Beginning in 2004/5” .

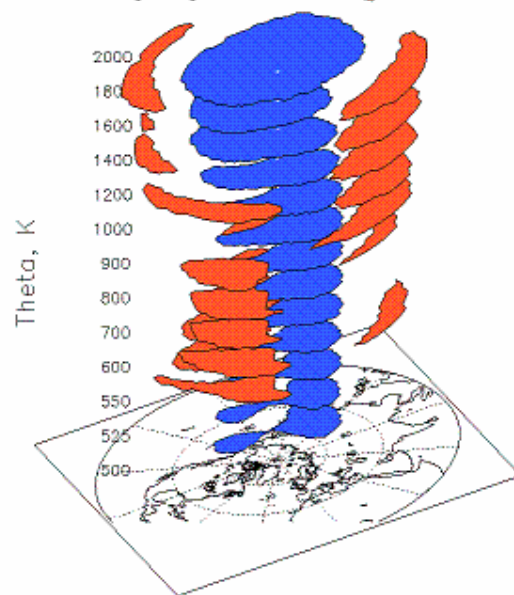
December 23, 2004 day#358



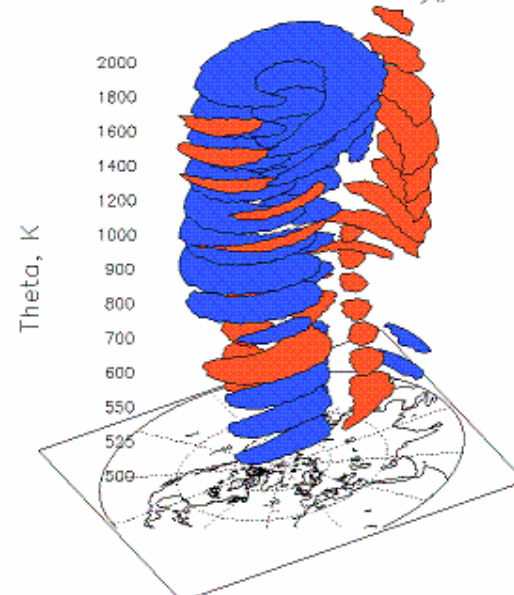
January 29, 2005 day#29



Febryary 27, 2005 day#58



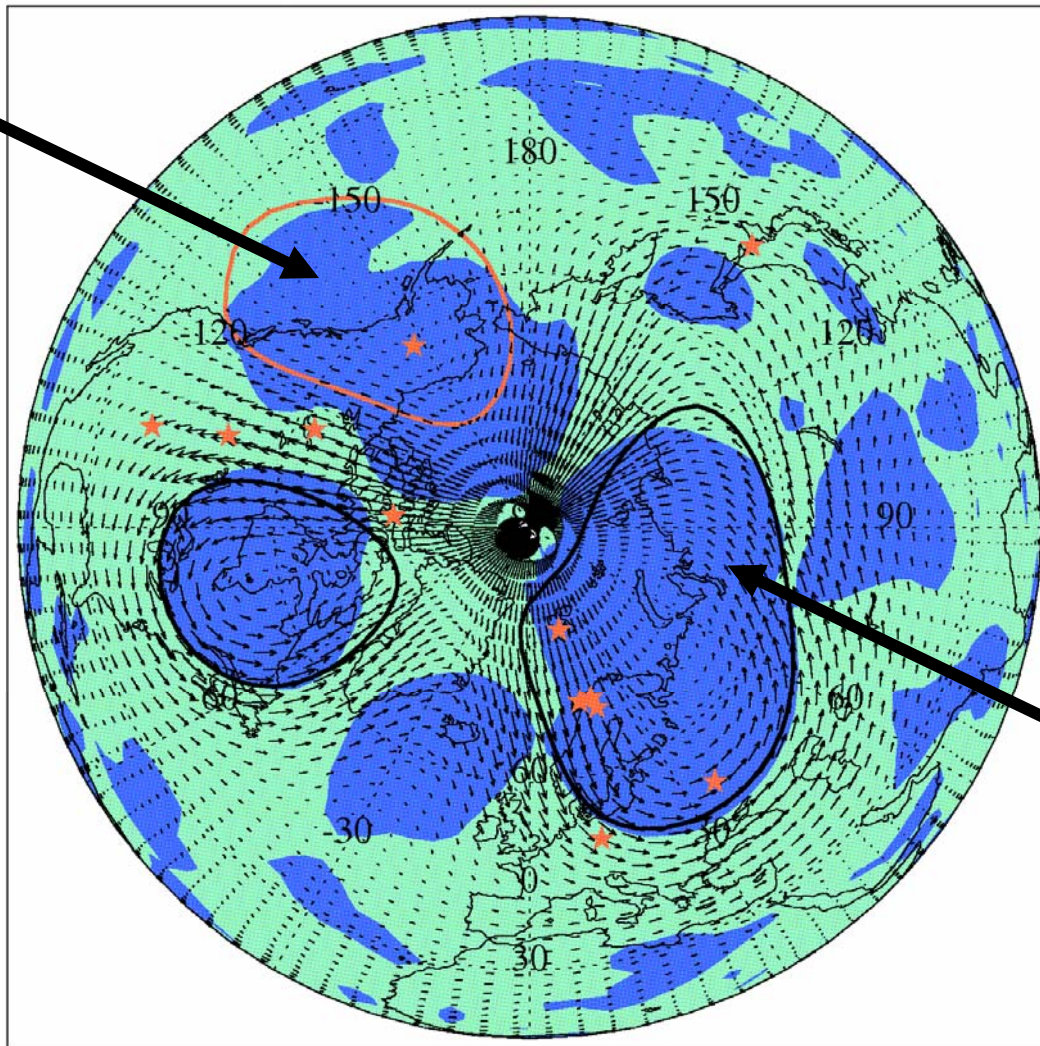
March 15, 2005 day#74



$z=20\text{km}$

Isentropic surface 500K; Day# 56, 2005

anti-cyclonic



$Q>0$

strain &
stretching

0

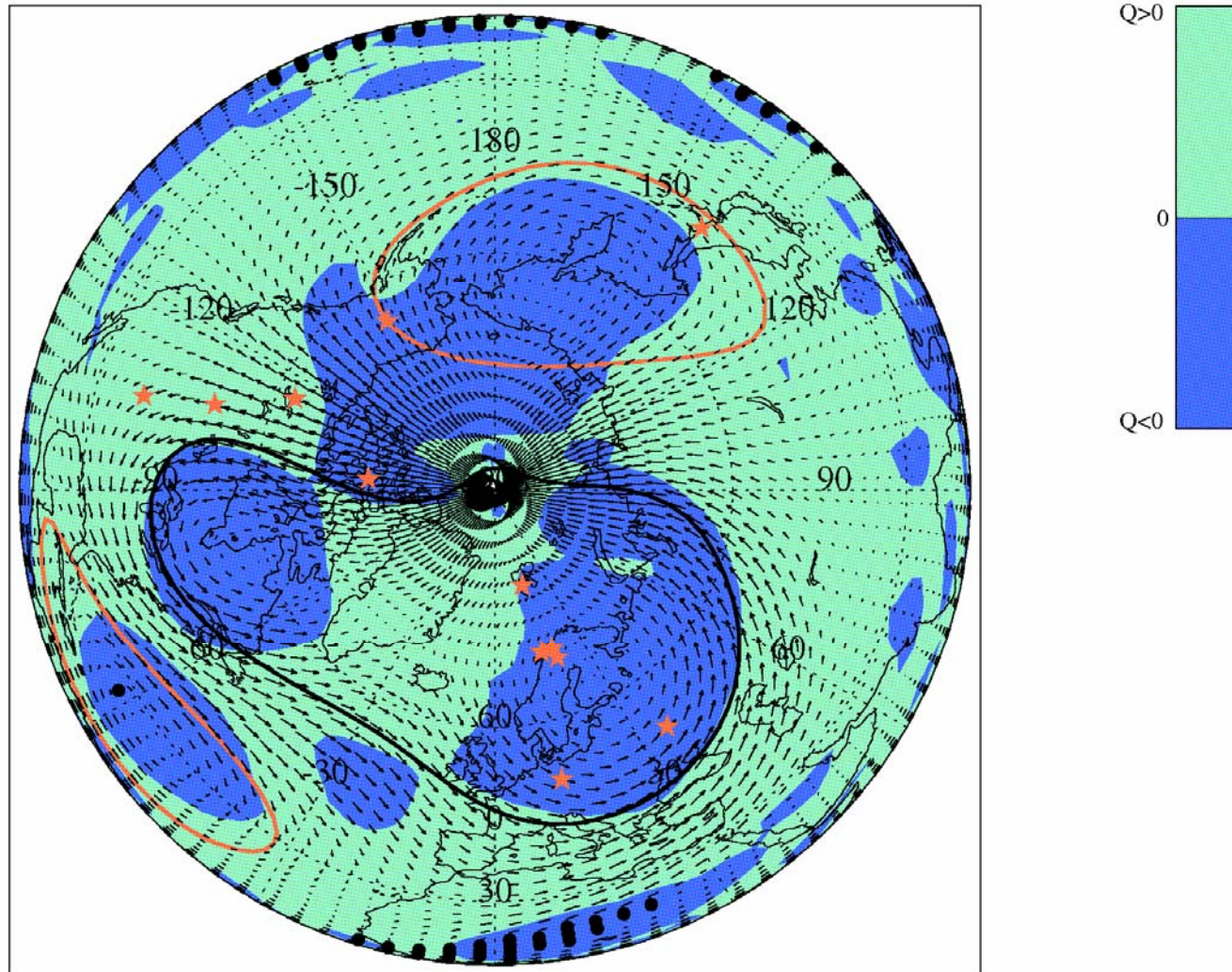
solid
rotation

$Q<0$

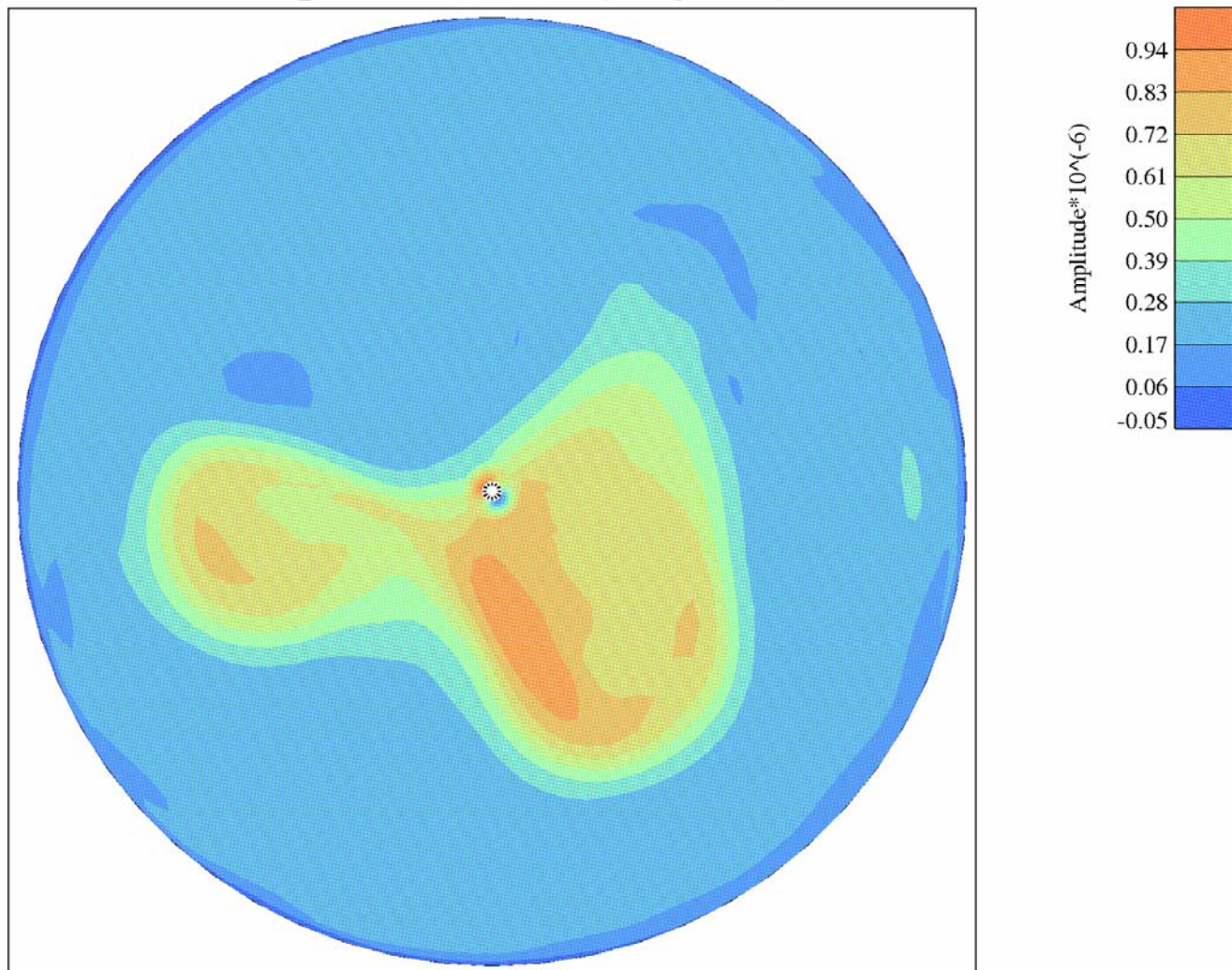
cyclonic

$z=30\text{km}$

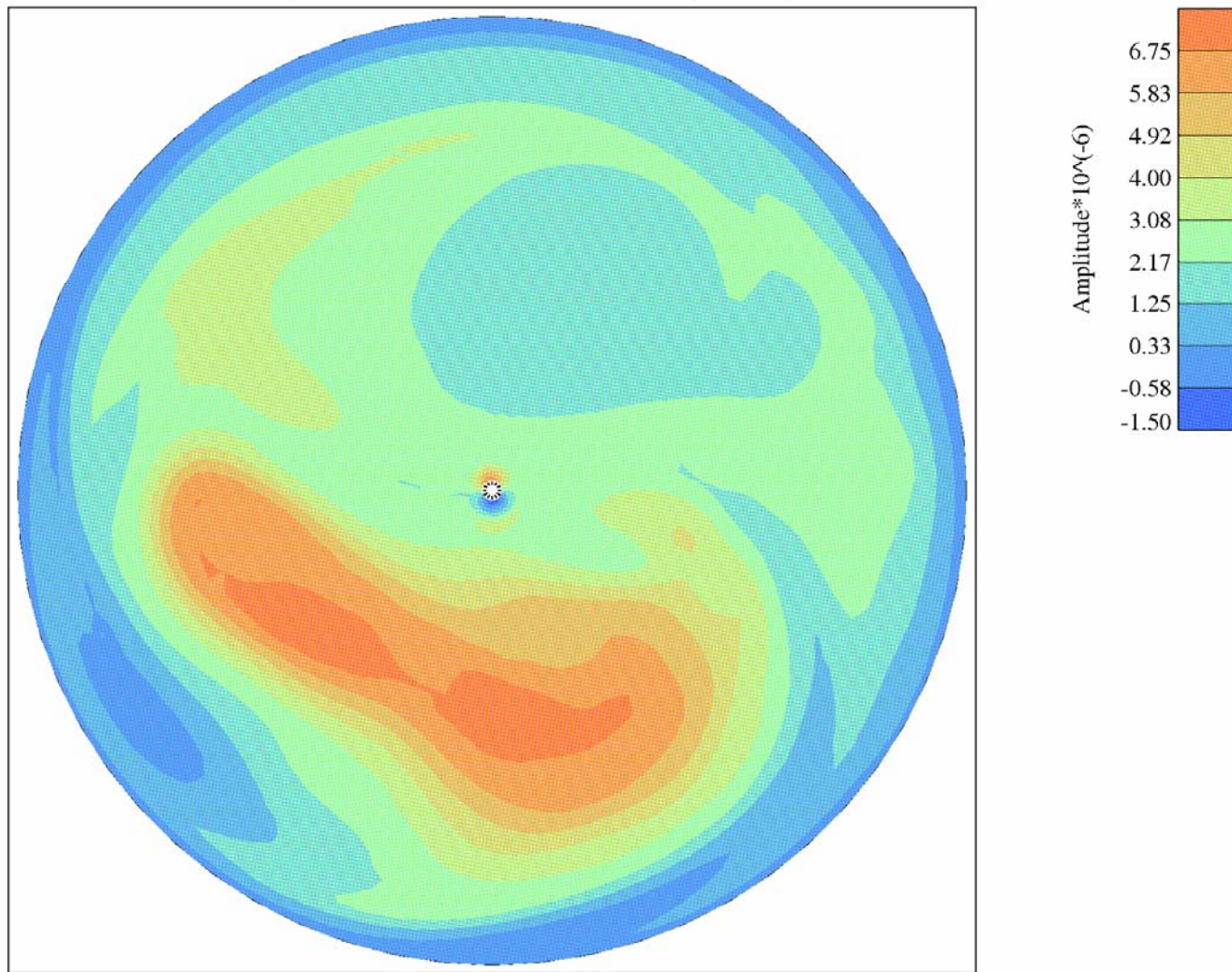
Isentropic surface 1000K; Day# 56, 2005



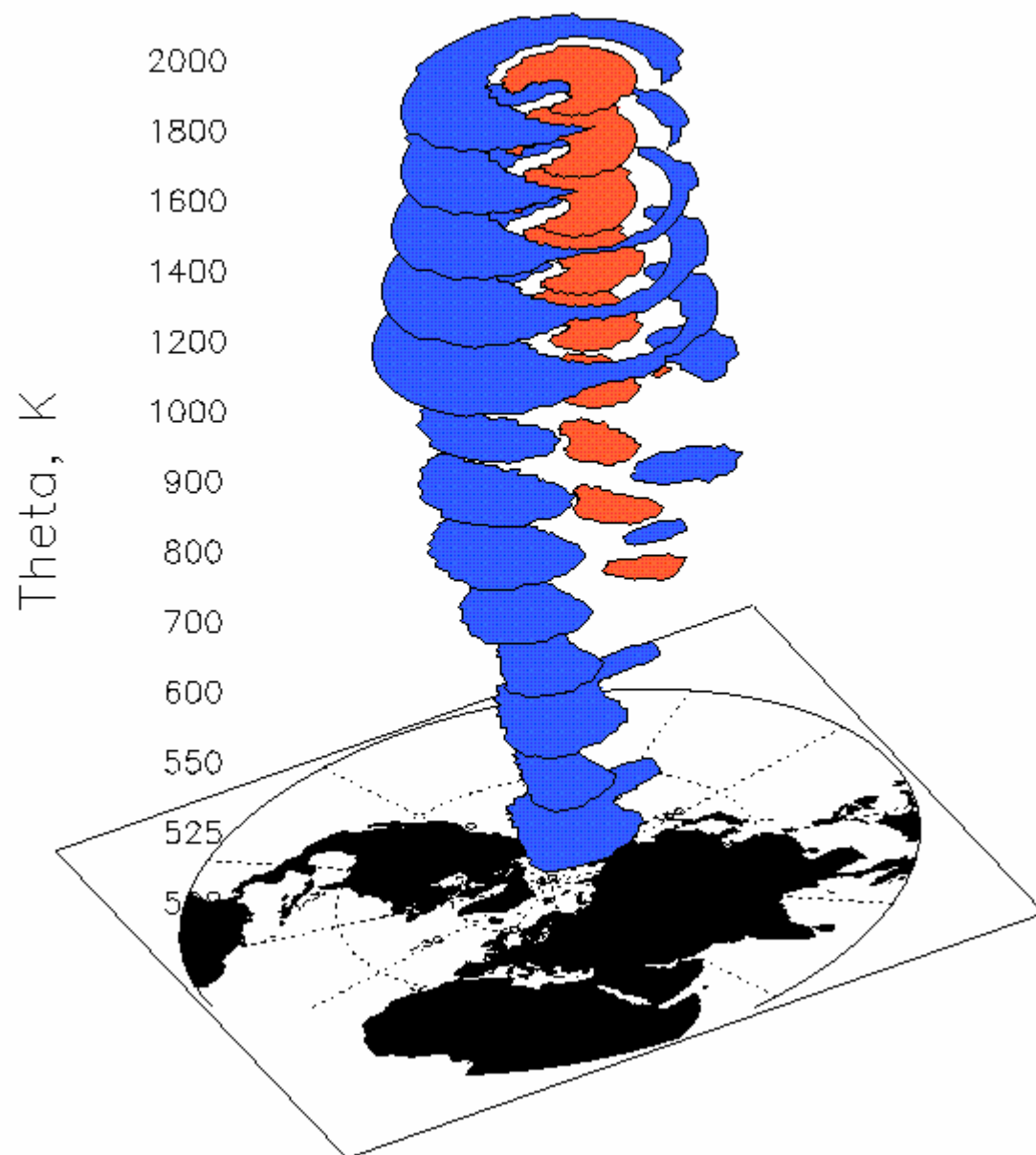
PV on isentropic surface 500K; Day# 56, 2005



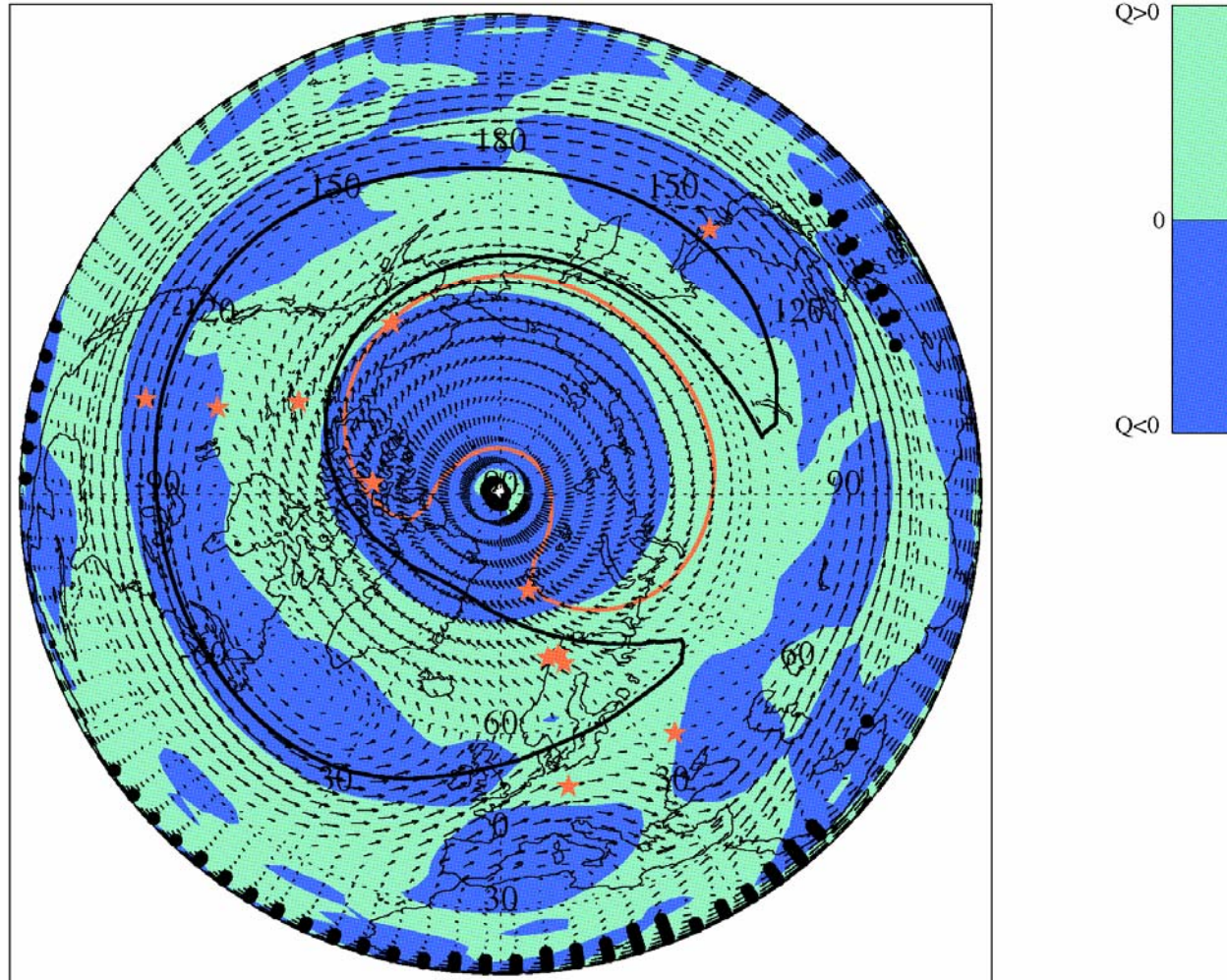
PV on isentropic surface 1000K; Day# 56, 2005



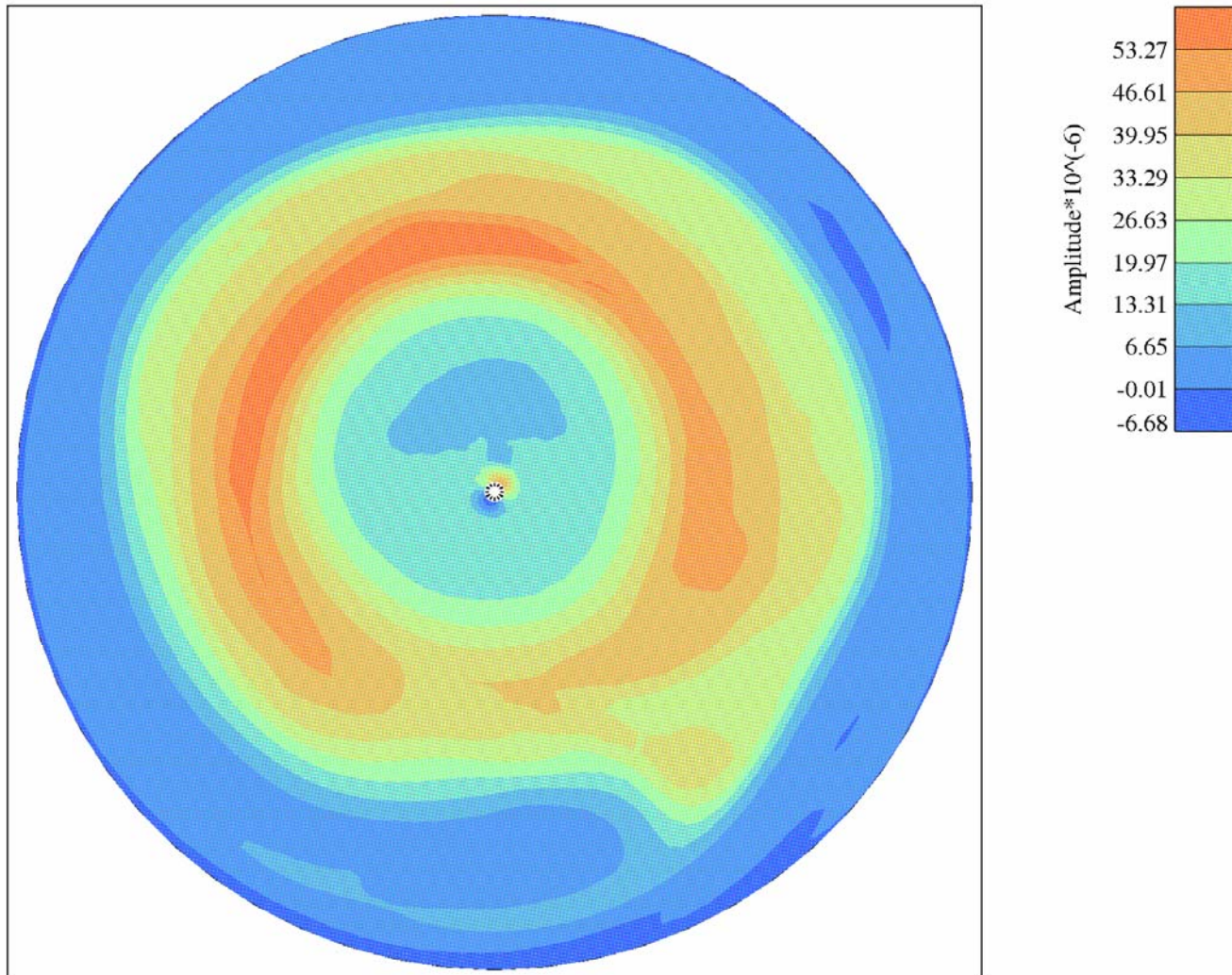
day#23



Isentropic surface 2000K; Day# 23, 2006



PV on isentropic surface 2000K; Day# 23, 2006



Without these vortex characterizations, comparisons of winds above 80km from radars with SSW dates are incomprehensible!

The results on campaign 2004/5 then link the mesopause winds to the vortex below, very convincingly.

(some papers are in preparation)

More information on Theme 3 project:

**Global observing campaign to
characterize tides from
troposphere – thermosphere**

W. Ward et al.

Purpose of the CAWSES Tidal Campaign

- To support and coordinate the collection of global data sets for several concentrated time periods suitable for the characterization of the heating sources, tidal components, and tidal effects from the surface of the Earth to the ionosphere.
- To support and stimulate the analysis of these data sets.
- To 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 1-2 month campaigns during which radar, optical instrumentation, ionospheric observations and satellite data will be collected (first campaign: October/November, 2005).
- Three workshops,
 - the first will set up the organization of the project,
 - the second will highlight the observations, and analysis of the data (including some modelling) and
 - the third will have a greater emphasis on the modelling of the data and evaluation of our understanding of these waves.
- A data centre (web based) on which the sources for the data, information about their format and rules of the road will be summarized. This will provide the mechanism for the development of collaborations and distribution of the data.

Organization

- A steering committee has been set up to support the organization of the campaigns, contact the various observation and modelling communities, the setting up of the data set and the analysis/modelling of the data.
- 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).
- Relevant models (GCM's, mechanistic models, process models)

Current Participation (1/3)

- **Radar observations**

- Scott Palo (Department of Aerospace Engineering Science, University of Colorado): 15 radar sites.
- Alan Manson (ISAS, University of Saskatchewan): Several radar sites.
- Larysa Goncharenko (MIT, Haystack Observatory): Incoherent radar
- Adrian McDonald (University of Canterbury, New Zealand): MF radar, Scott base, Antarctica.
- Barclay Clemsha and Hisao Takahashi (INPE, Brazil): meteor radar, Cachoeira Paulista (23S, 45 W), Sao Joao do Cariri (7S, 36W), Santa Maria (-29.7S, -53.7W).
- Christoph Jacobi (Institute of Meteorology, University of Leipzig, Germany): meteor radar, Collm (51.3N, 13.0E).
- Juergen Bremer and Werner Singer (Leibniz-Institute of Atmospheric Physics): Andenes 69N, 16E, Meteor radar @ 32.5 MHz, MF radar @ 1.98 MHz, Juliusruh 55N, 14E, MF radar @ 3.18 MHz, Kuehlungsborn 54N, 13E, Meteor radar @ 53.5 MHz, Learmonth 22S, 114E, Meteor radar @ 35.2 MHz
- Geetha Ramkumar (Vikram sarabhai Space Centre, ISRO, Trivandrum, India): Meteor radar, Trivandrum (8.5 N, 77 E).
- Xiao Zuo (Department of Geophysics, Beijing University): HF Doppler and GPS, Beijing.
- G.Yellaiah (Osmania University, Hyderabad, India): MST Radar Facility (NMRF) Tirupati, India
- S. Gurubaran (Indian Institute of Geomagnetism): Tirunelveli (8.7 N, 77.8 E) and the other at Kolhapur (16.7 N, 74.2 E)
- Rob Hibbins (British Antarctic Survey): Dynasonde in Imaging Doppler Interferometer mode, Halley (75S, 27W), MF radar, Rothera (68S, 69W).
- Dennis Rigglin (CoRA, Boulder): mesospheric radars at Hawaii, and Rarotonga (Cook Islands)
- Nick Mitchell (Department of Electronic & Electrical Engineering, University of Bath): Meteor radars, Esrange (68N, 21E), Ascension Island (8S, 14W), Rothera (68S, 68W).

Current Participation (2/3)

- **FPI observations**

- Qian Wu, High Altitude Observatory, National Center for Atmospheric Research): Resolute (75N)

- **Imager/photometer observations**

- Hisao Takahashi (INPE, Brazil): Sao Joao do Cariri (7S, 36W), Cachoeira Paulista (23S, 45 W)
- Jens Oberheide (University of Wuppertal): OH temperatures, Wuppertal.
- Peter Ammosov and Galina Gavrilieva (Institute of Cosmophysical Research and Aeronomy, Russia): Infrared spectrograph and all-sky OH imager in an optical station Maimaga (63°N; 129.50°E).
- Gordon Shepherd (York University, Canada): Temperatures, airglow, SATI instrument, Resolute Bay.
- Rob Hibbins (British Antarctic Survey): airglow imager at Halley (75S, 27W), Michelson interferometer measuring OH rotational temperature Rothera (68S, 69W).

- **Lidar observations**

- Philippe Keckhut (Institut Pierre Simon Laplace des Sciences de l'environnement Global): Observatory of Haute Provence in France (44°N), Antarctica in Dumont D'Urville (69°S)
- Franz-Josef Luebken (Leibniz-Institute of Atmospheric Physics): temperature, Kühlungsborn and at ALOMAR
- Chiao-Yao (Joe) She (Colorado State University): Temperature, Fort Collins

Current Participation (3/3)

- **Satellite observations**

- Doug Degenstein and Ted Llewellyn, (ISAS, University of Saskatchewan): OSIRIS ozone data.
- Jens Oberheide (University of Wuppertal): TIDI wind data
- Qian Wu, High Altitude Observatory, National Center for Atmospheric Research): TIDI wind data.
- Dong Wu (JPL): Gravity waves - MLS: radiance, T, P; AMSU-A: radiance; AIRS: radiance; GPS/CHAMP: T, P, Sporadic-E variance; Planetary waves - MLS: T, P, O₃, CO, H₂O, OH, line-of-sight wind; GPS/CHAMP: T, P
- Martin Mlynchak (NASA Langley) and Elsayed Talaat (APL): SABER T, O₃, constituents

- **Global VLBI/GPS observations**

- Arthur Niell (MIT, Haystack Observatory)

- **Magnetometers**

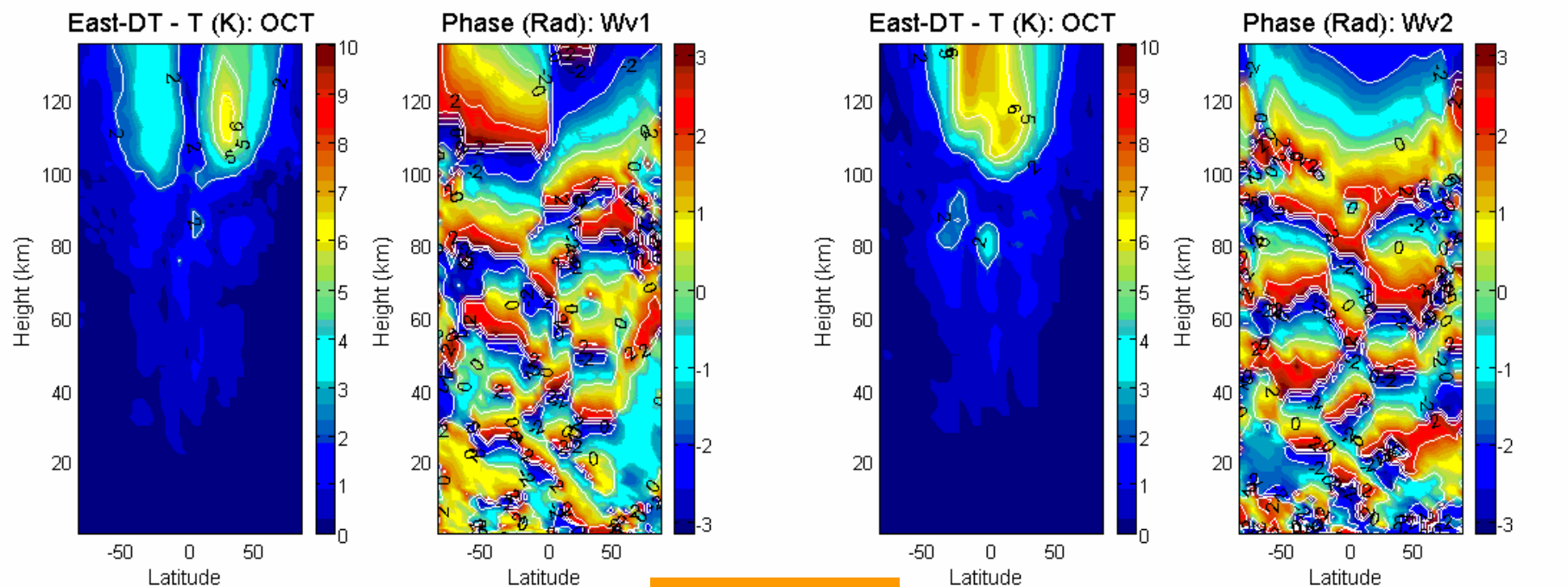
- S. Gurubaran (Indian Institute of Geomagnetism): close to 75 E geographic meridian

- **Global Models**

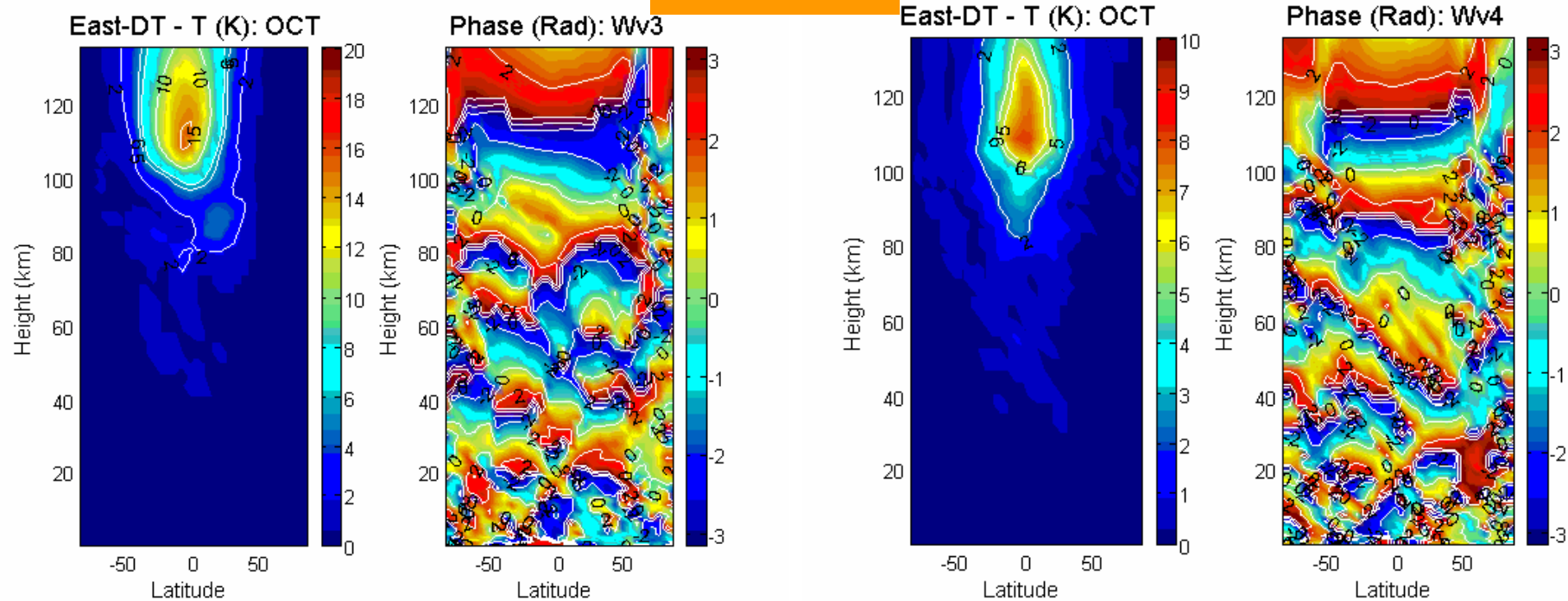
- D. Marsh (NCAR, WACCM, ROSE)
- W. Ward (extended CMAM)
- Uwe Berger (LIMA, IAP, Kühlungsborn)

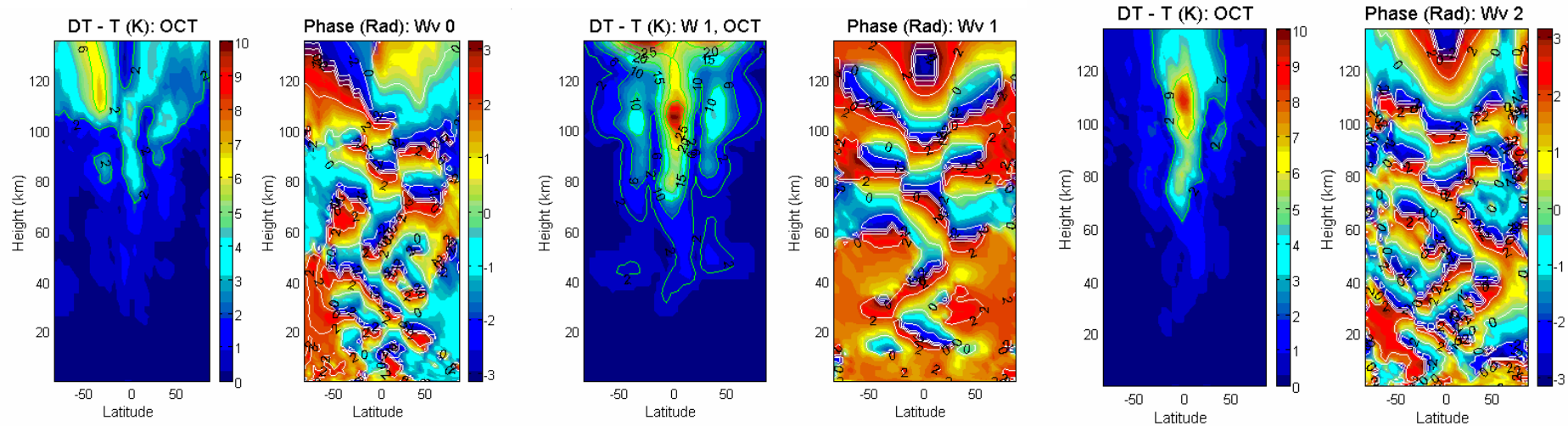
Model Results – Extended CMAM, W. Ward

- The extended CMAM has been run for several years and tidal amplitudes for one of the years extensively analysed.
- The results show excitation of a number of tidal components.
- In the panels which follow, latitude/height cuts of diurnal tidal temperature signatures for October are shown (figures generated by J. Du).
- The largest diurnal components at this time are the migrating diurnal tide (DW1) and the eastward non-migrating Wave 3 (DE3).
- The other components also attain reasonable amplitudes.

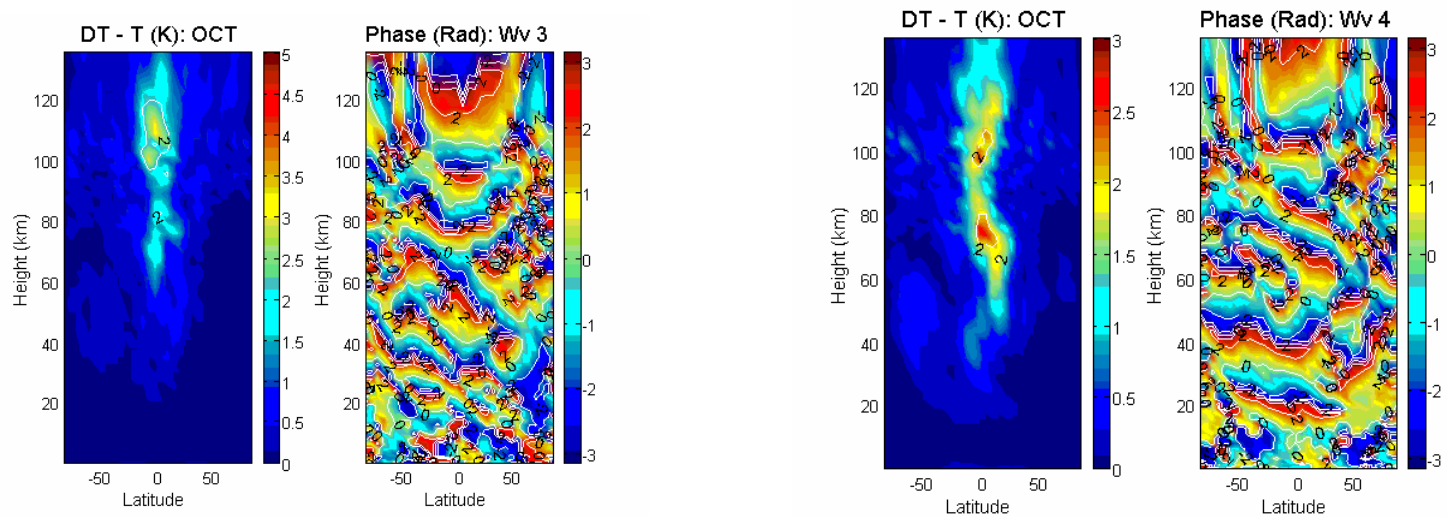


Eastward





Westward

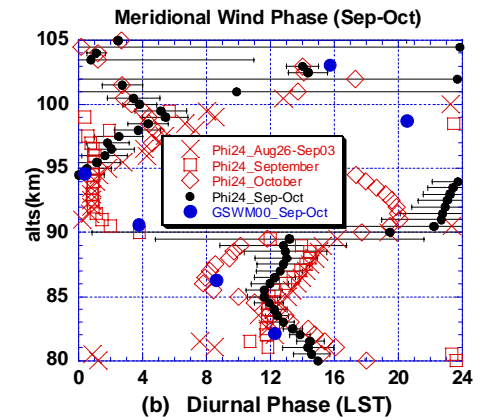
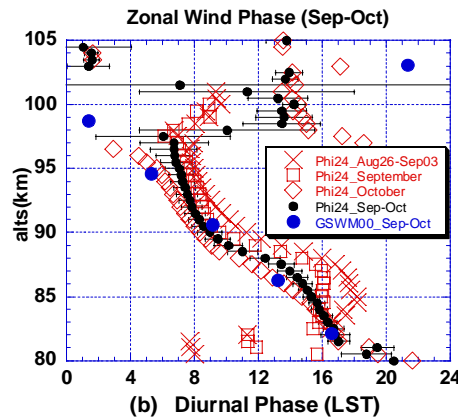
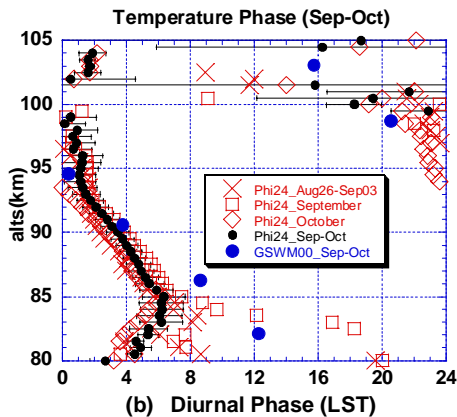
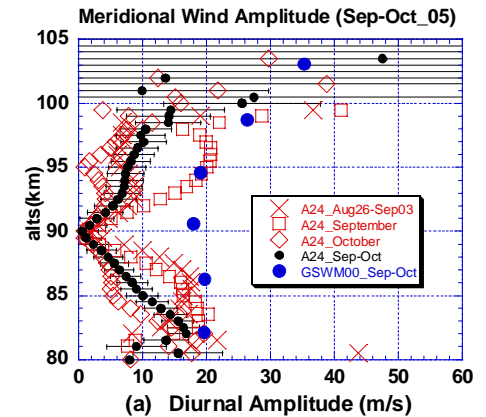
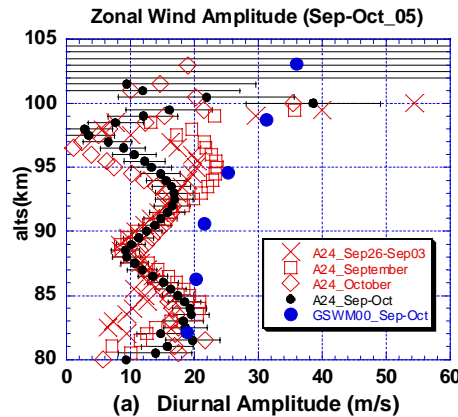
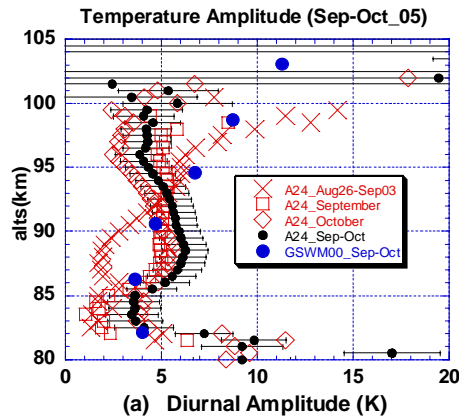


LIDAR - Data Set Description, Joe She

- The coordinate of Fort Collins, CO is 41N, 105W
- Between Aug. 26th and October 28th, We had acquired a total of 287 hours of diurnal cycle data, from which 4 data sets were formed for tidal analysis.
- Diurnal cycle data consists of observations that last at least 24 hour long.

Diurnal Cycle Observations	Starting Time DOY/UT-Hour	Ending Time DOY/UT-Hour	Number of Hours	Total Hours
Aug 26 – Sep 03	240/4.0	246/23.0	164	164
Sep 01 – Sep 30	244/0.0 273/3.0	246/23.0 273/24.0	47 21	68
Oct 01 – Oct 31	274/0.0 297/2.0 299/5.0	275/24.0 298/22.0 300/15.0	48 44 34	126
Sep 01 – Oct 31	240/0.0	300/25.0	194	194

Diurnal tidal amplitudes and phases: Temperature (L), zonal wind (M) and meridional wind (R) (September and October, 2005)





William Ward

**organized a „Global Tidal Campaign“
workshop during this COSPAR symposium**

**campaign participants: ~100 (worldwide)
participants in the workshop: ~30**

More information on Theme 3 project:

**Solar influence on minor
constituents & layers at the
extra-tropical summer
mesopause**

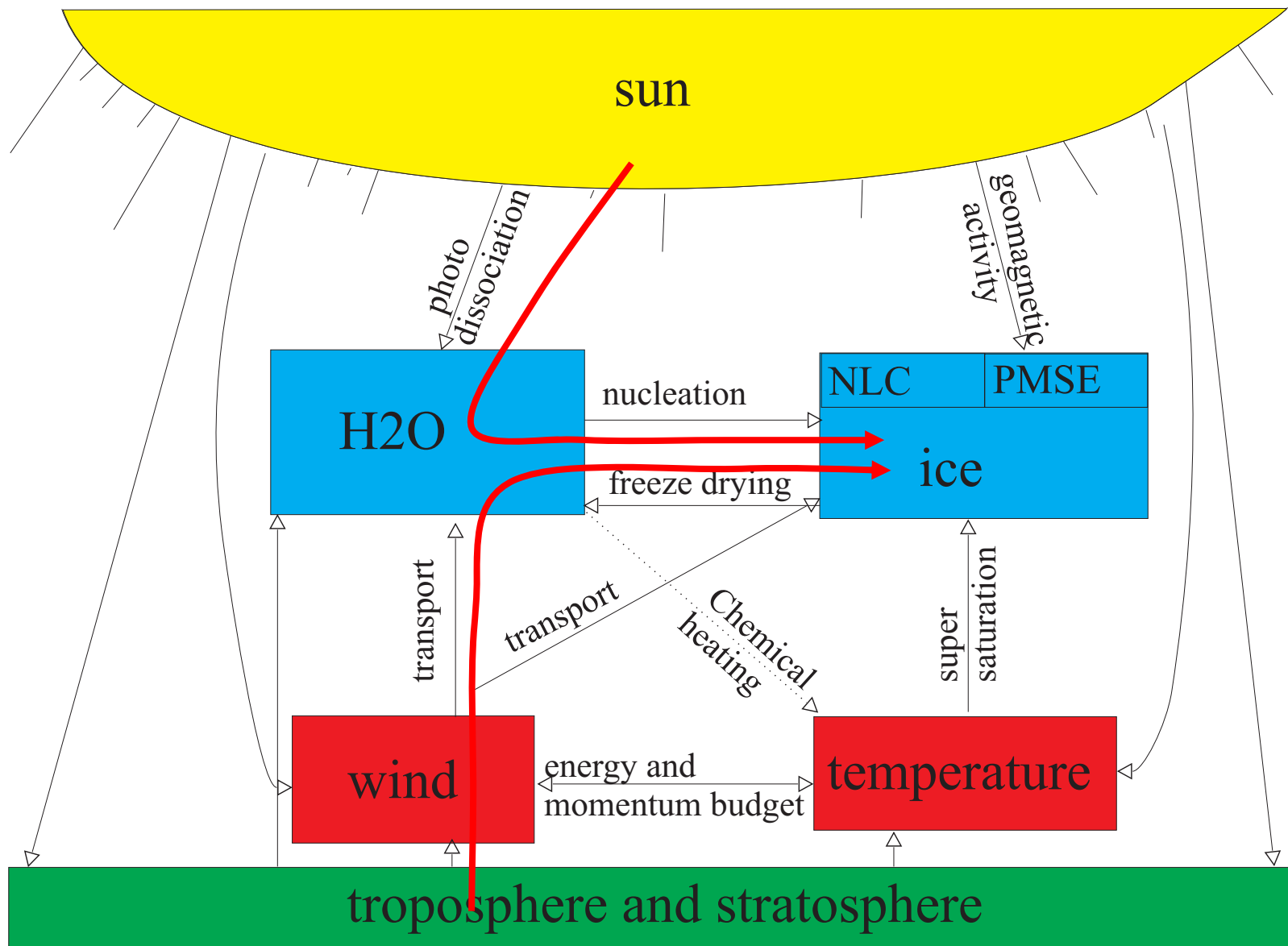
Franz-Josef Lübken

Ulf-Peter Hoppe

Scott Bailey

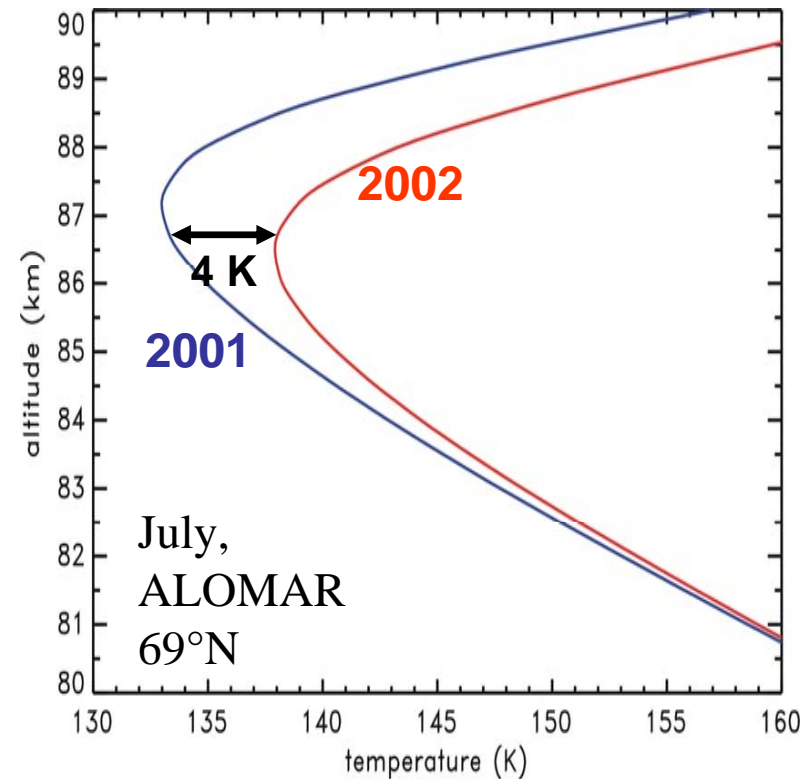


**Ice layers
in the summer mesosphere**

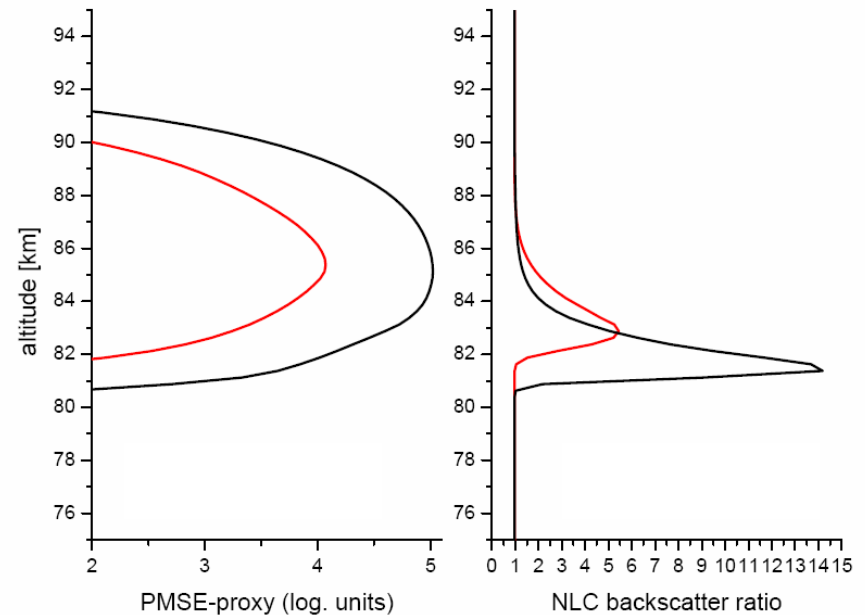


small changes
in temperature ...

... can result in big changes
in ice layers

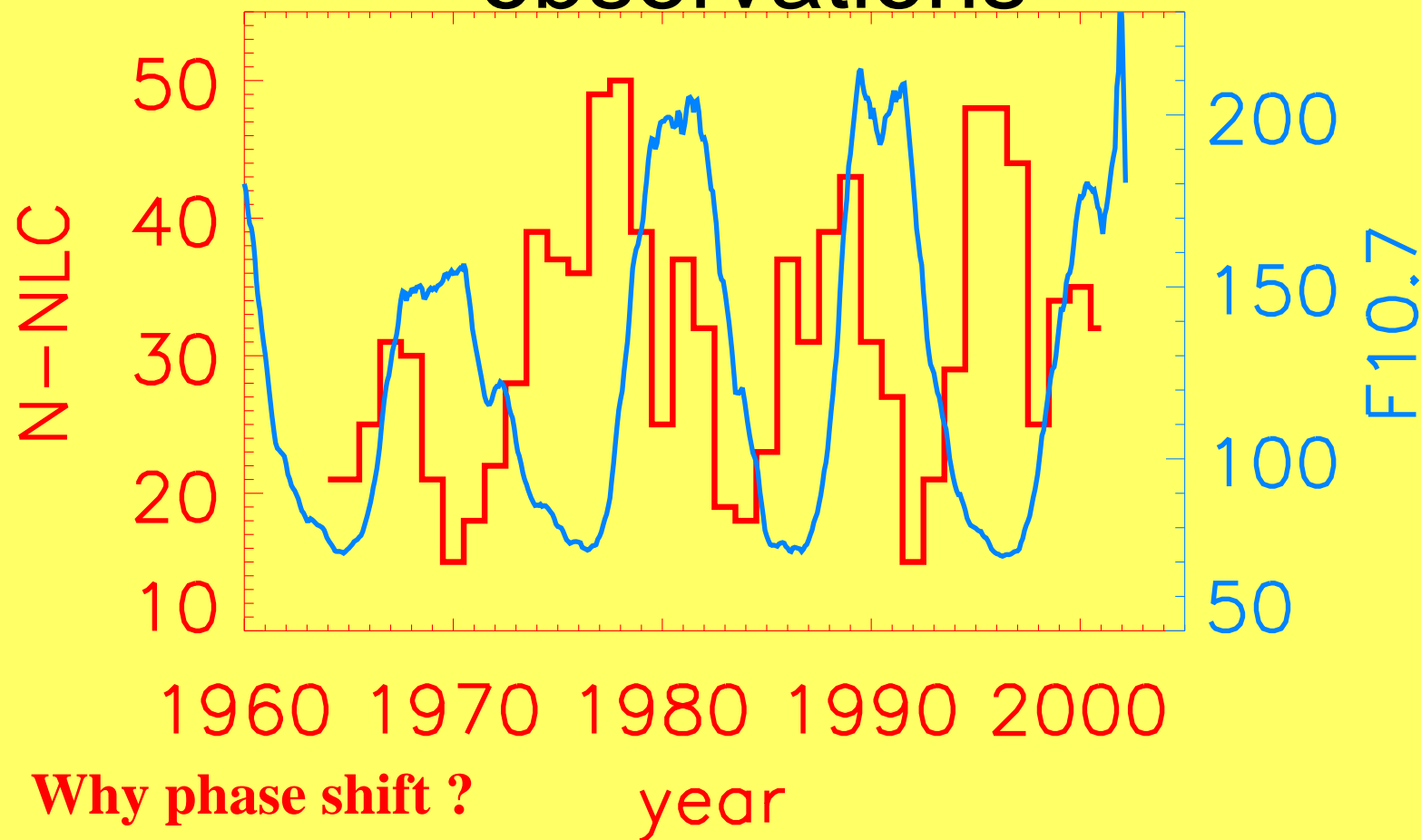


results from CARMA



Lübken, Rapp & Strelnikova, Adv. Space Res., 2006

NLC statistics from visual observations



Why phase shift ?

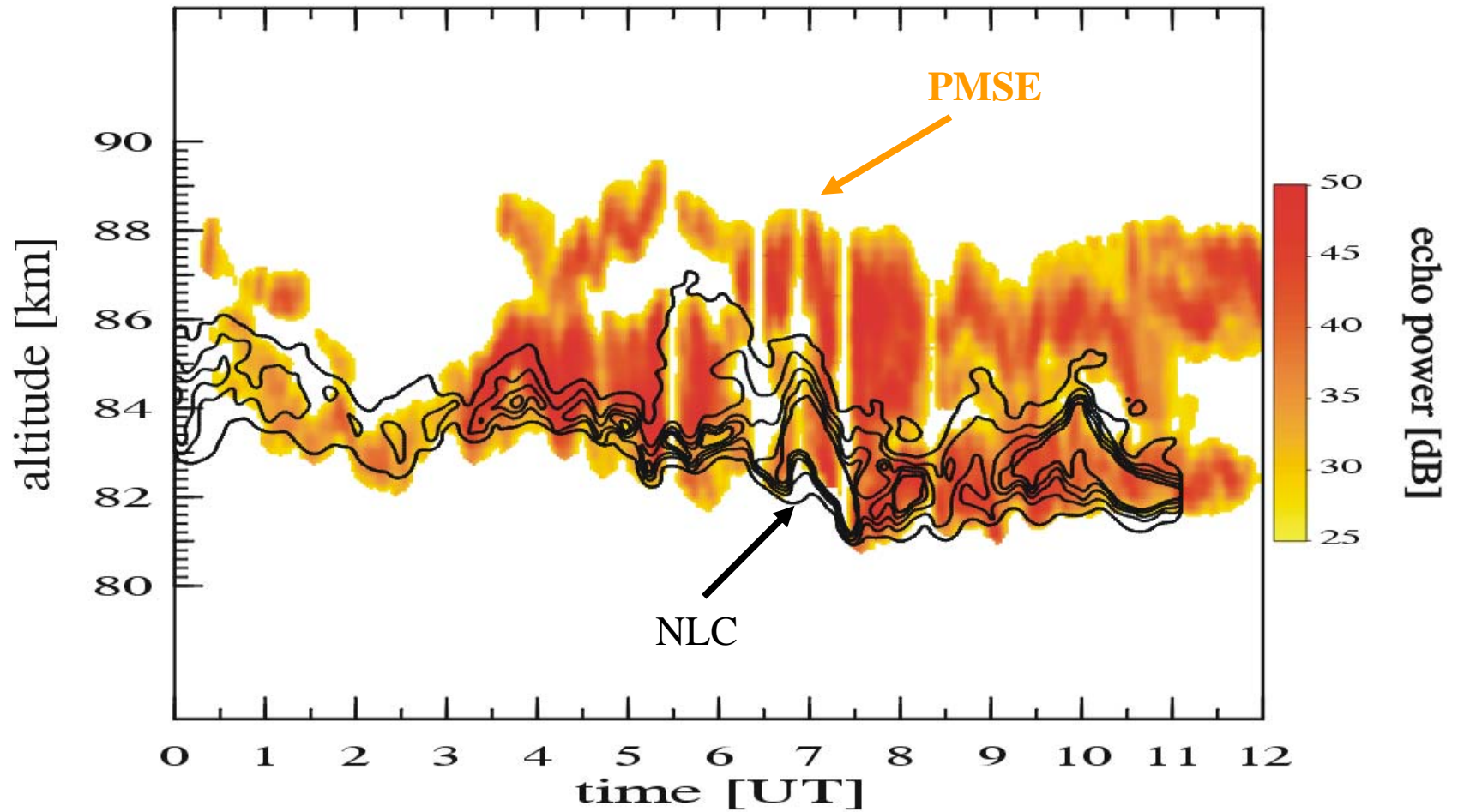
Note: no trend !

after Gadsden (2002)

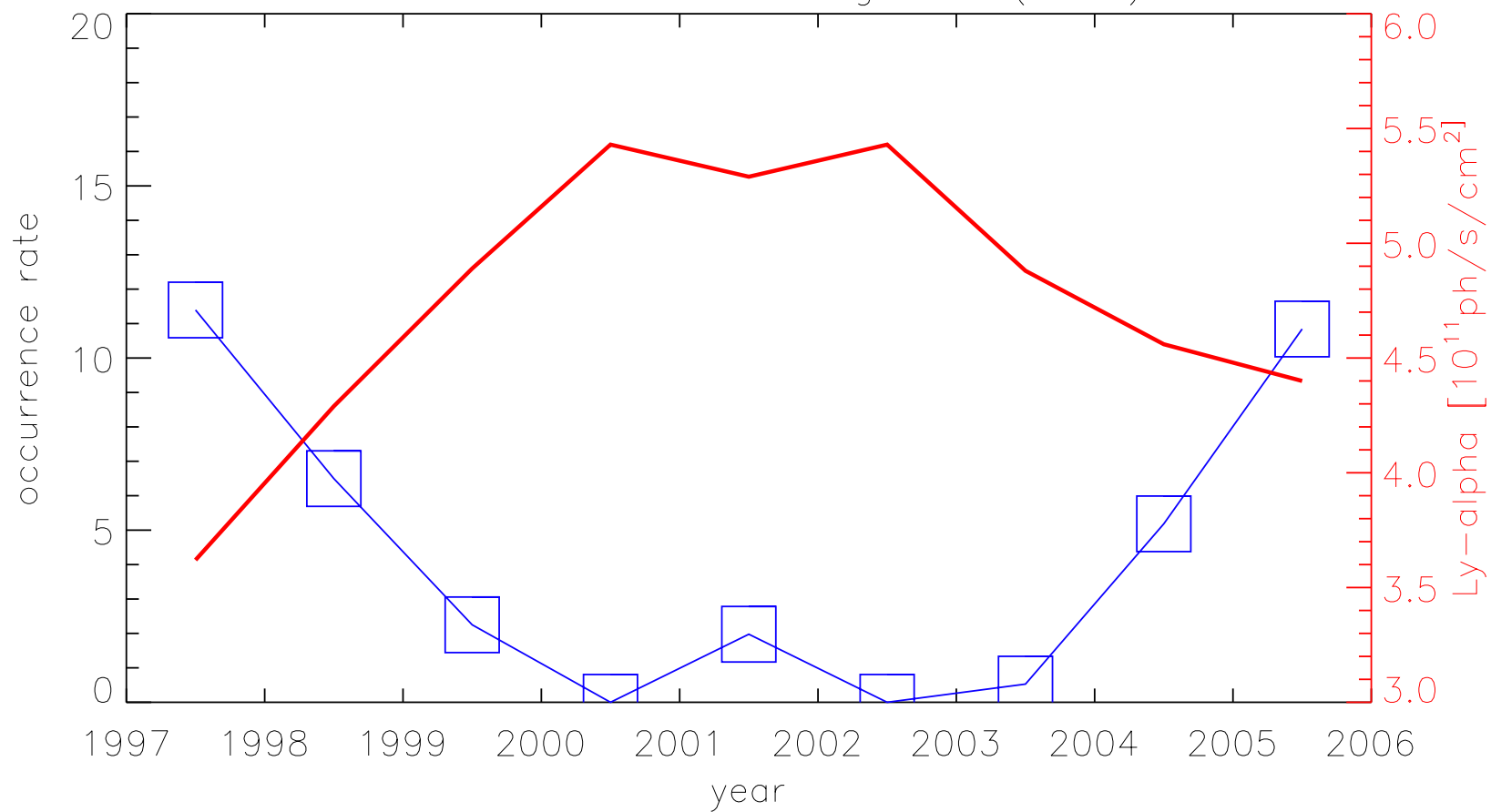
- **lidars (various stations in SH and NH)**
- **radars (mostly MST, but also HF, UHF) at various places, now also in Antarctica**
- **first rocket measurements of dust particles (ECOMA, MAGIC)**
- **satellites: SME, SNOE, ODIN, ENVISAT, ...**
- **several model activities:
CARMA, NRL, LIMA, GCM**

NLC/PMSE at Spitsbergen,

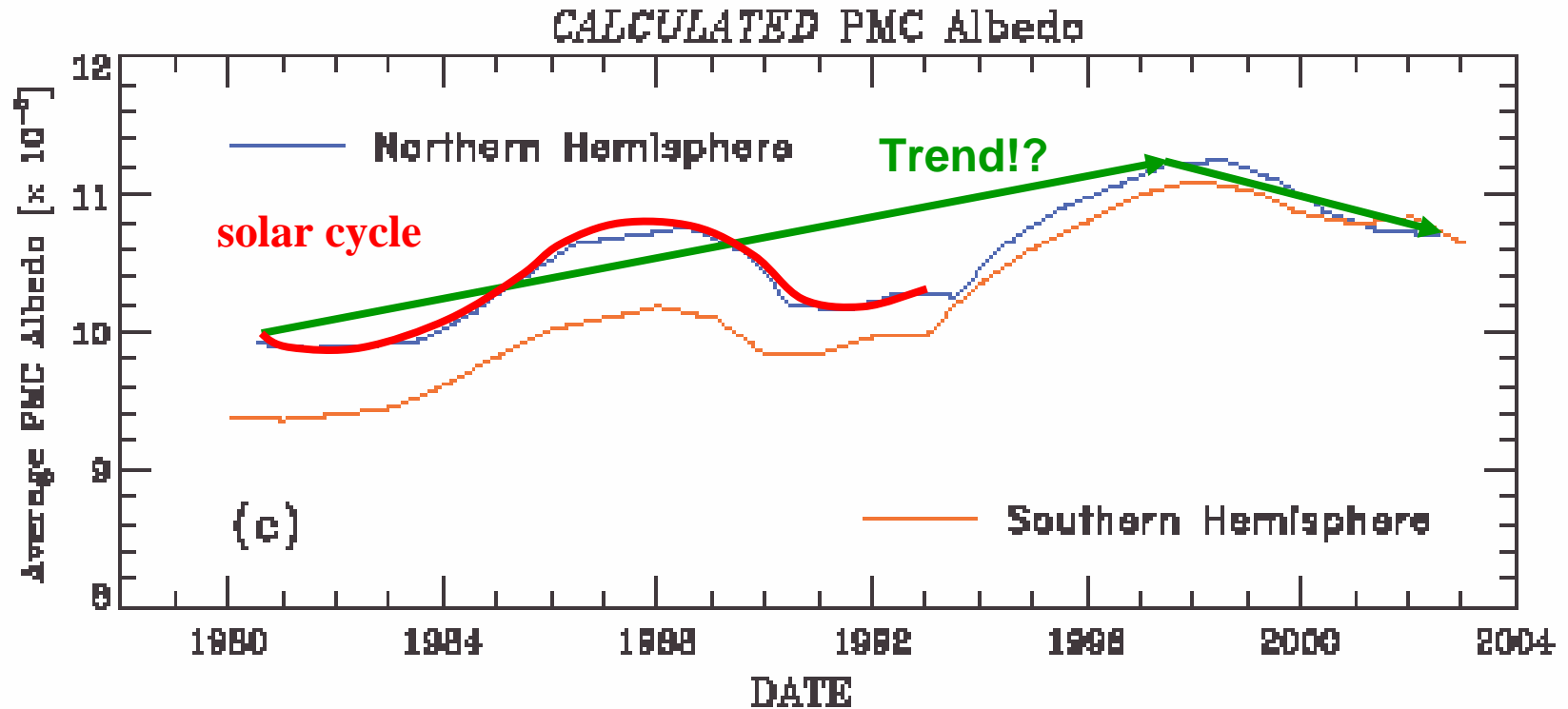
Aug 5/6, 2001



NLC statistics at Kühlungsborn (54°N)



Trend in PMC brightness (SBUVs)



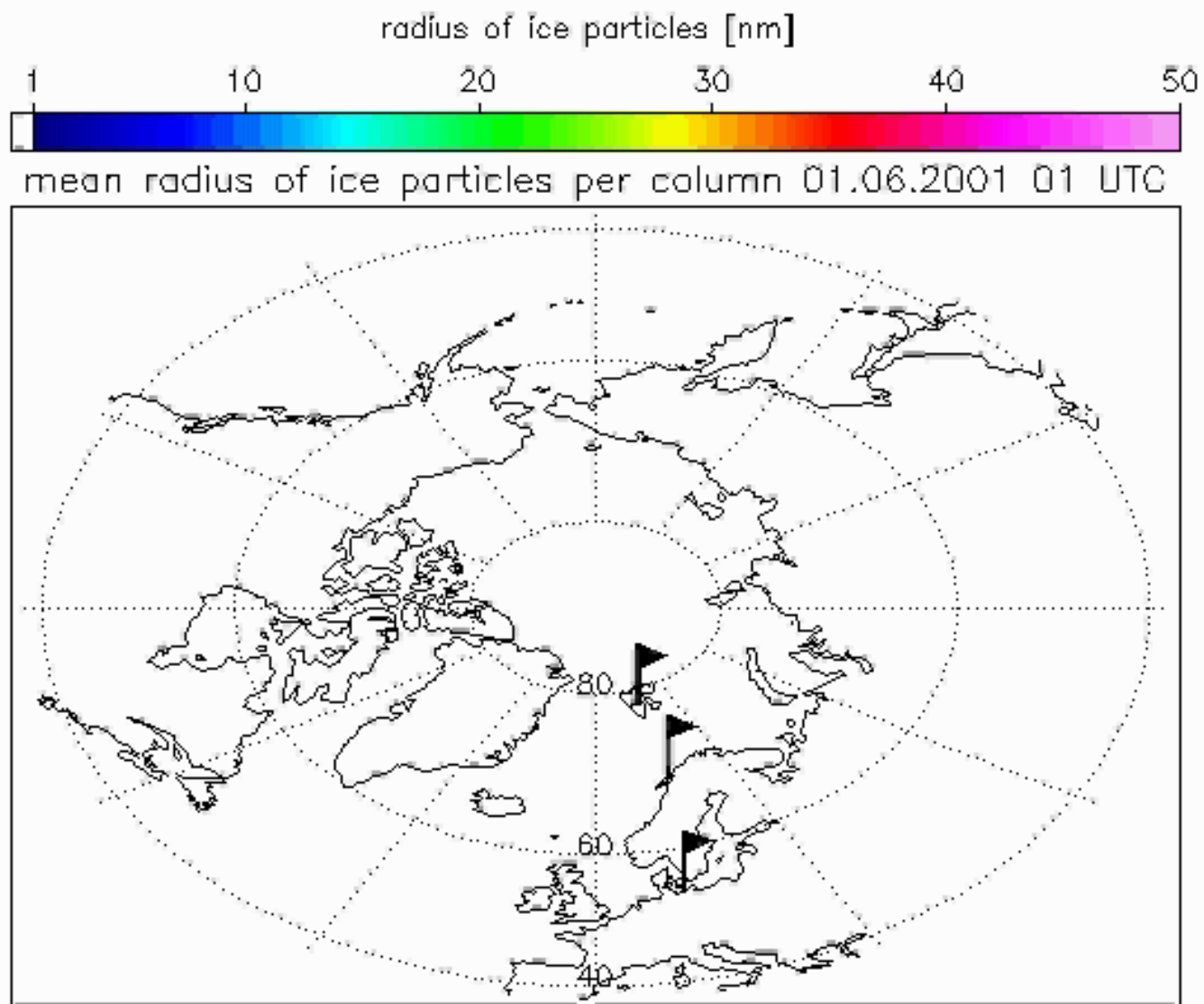
Leibniz

Institute

Middle

Atmosphere model

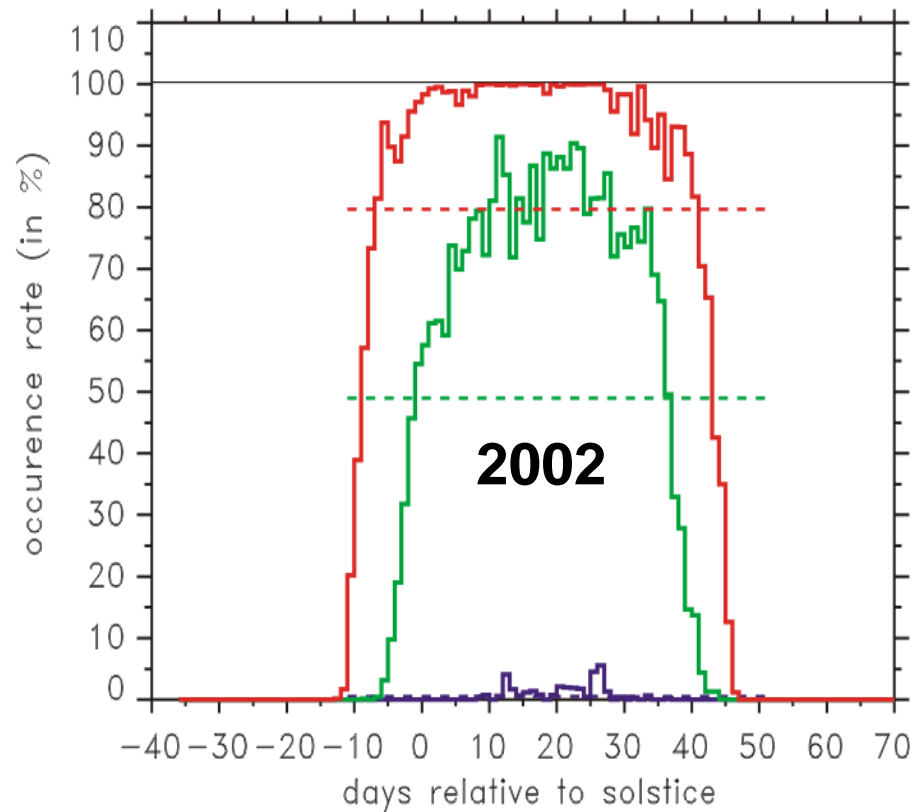
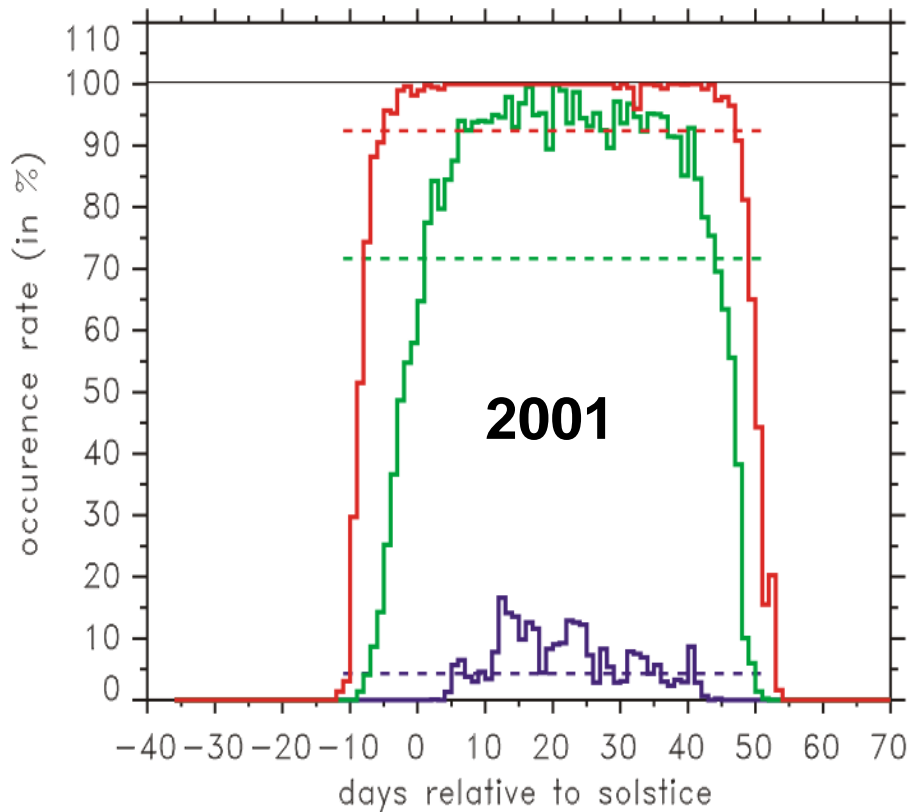
+ ice model



Lübken & Berger, GRL, 2006

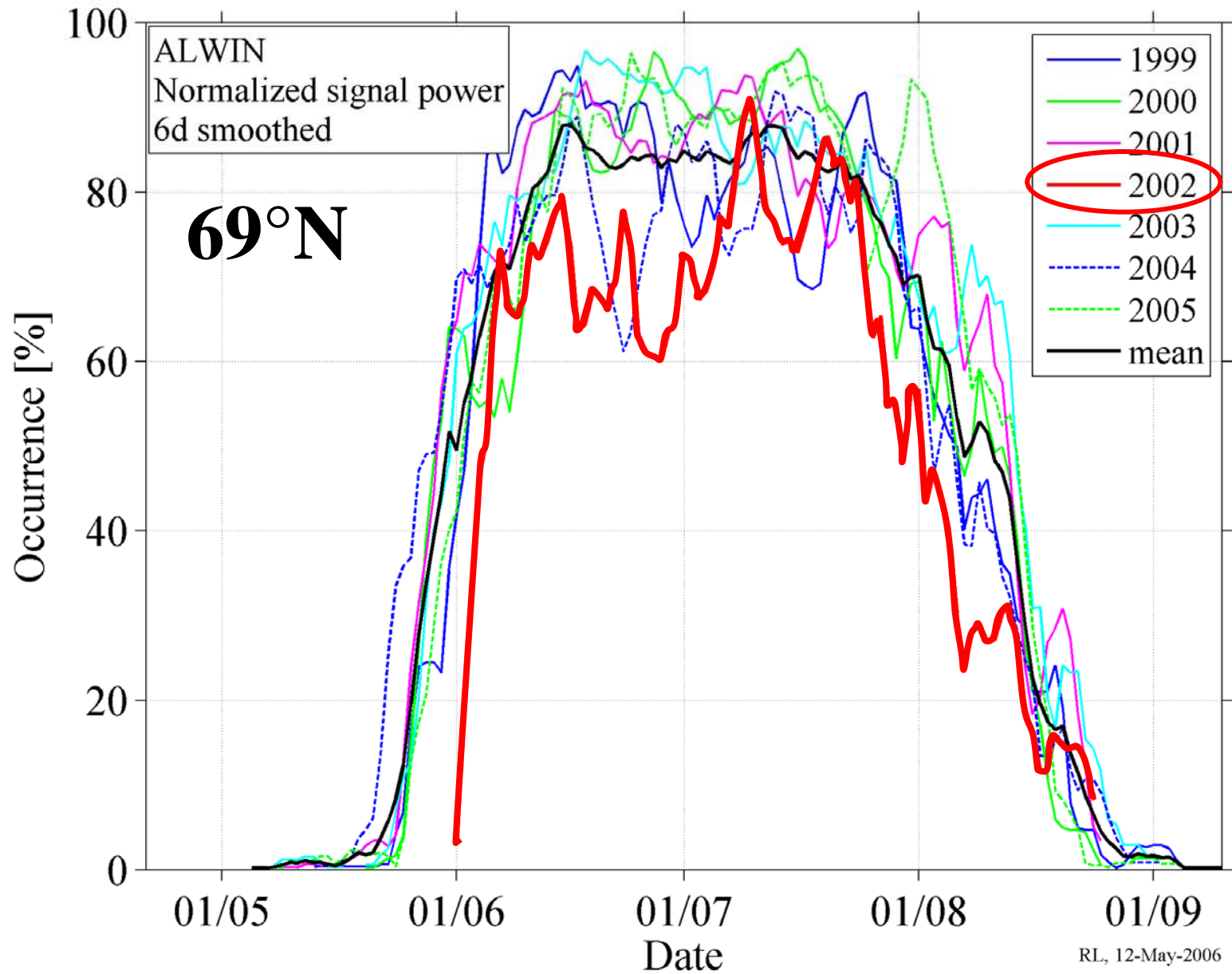
2002: demonstration of interhemispheric coupling

Spitzbergen (78°N), ALOMAR (69°N), and Kühlungsborn (54°N)

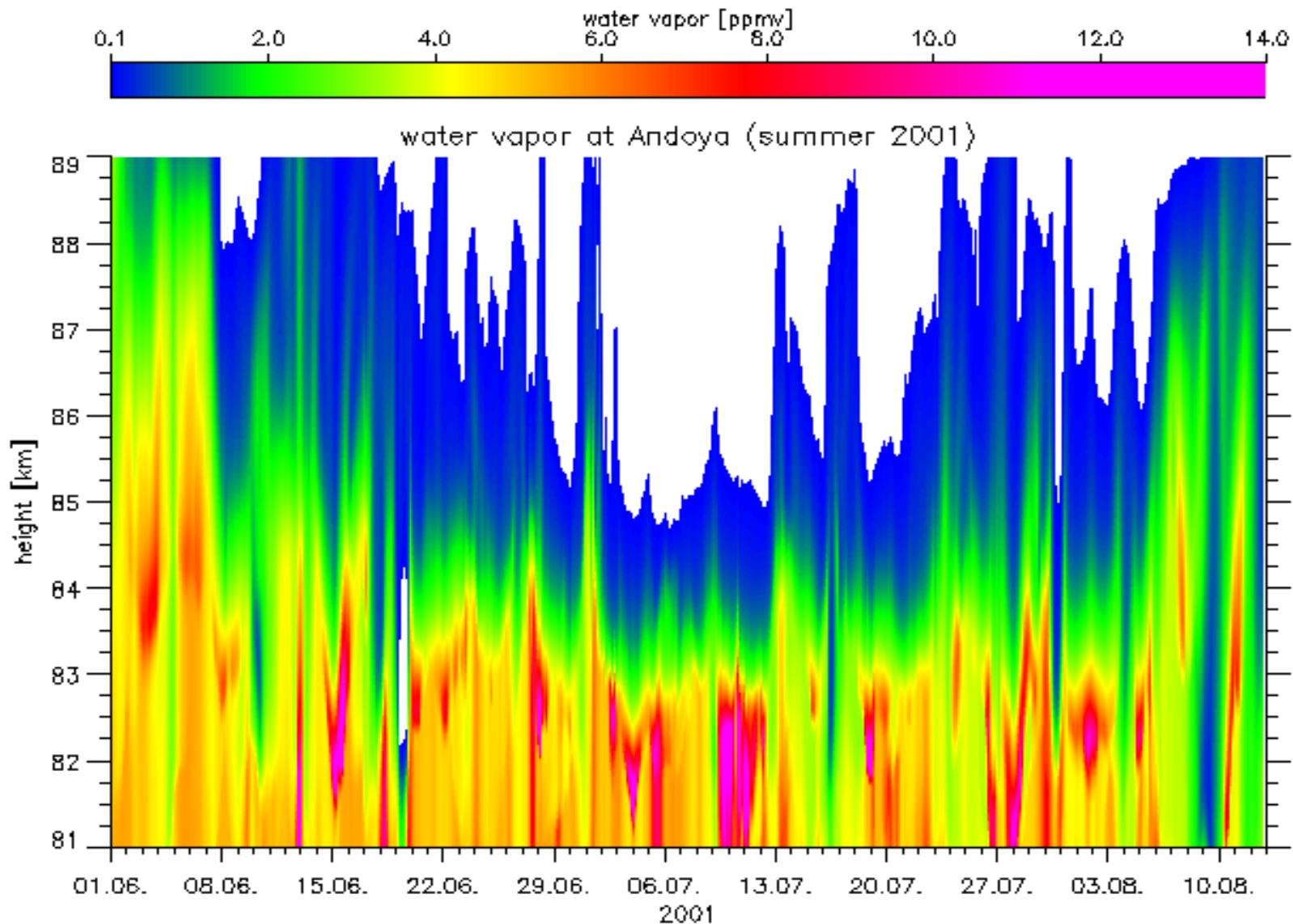


Lübken & Berger, GRL, 2006

Seasonal occurrence of PMSE



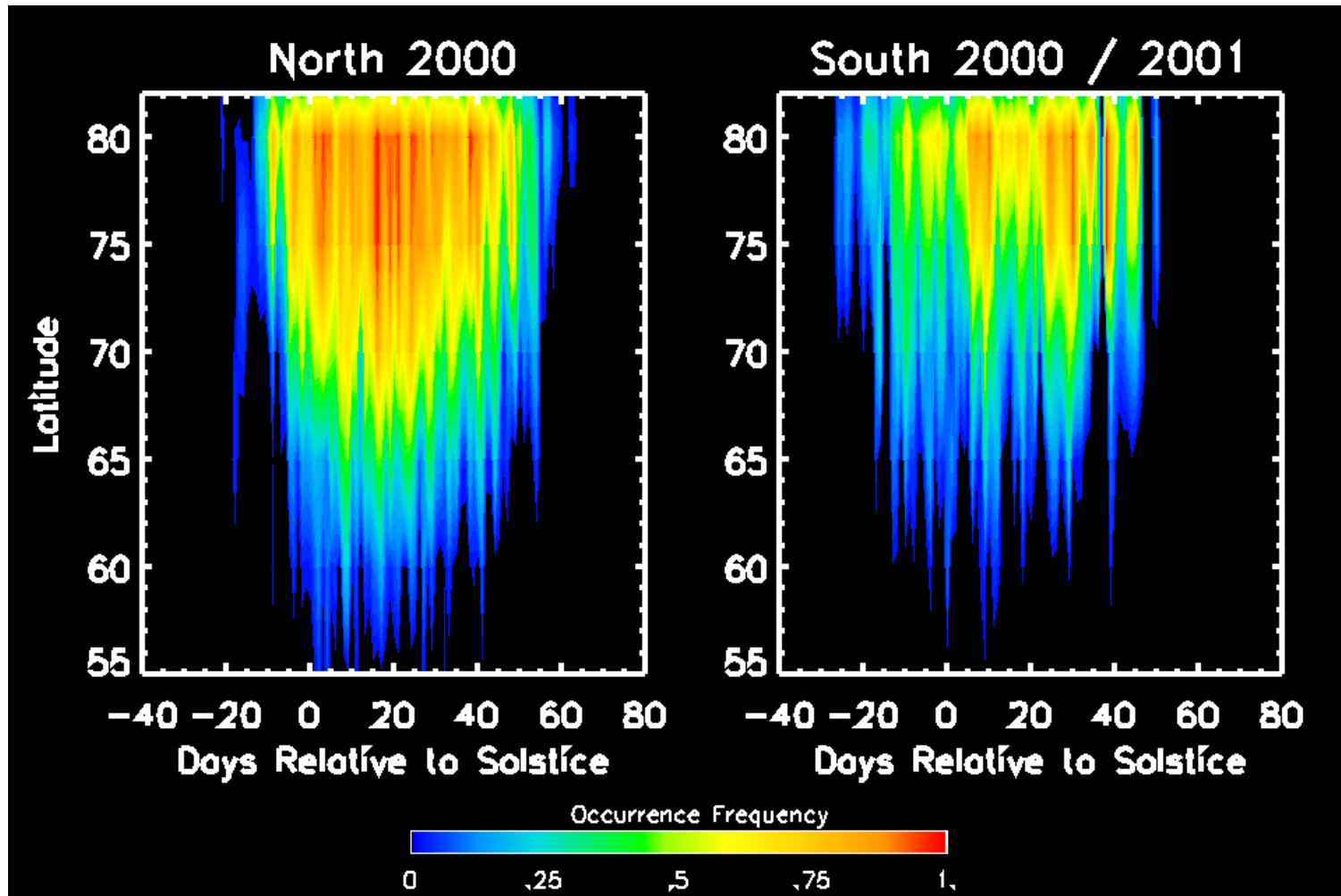
episodic mixing ; but freeze drying overwhelms



to be compared with satellite measurements of H₂O (HALOE, ODIN, ENVISAT)

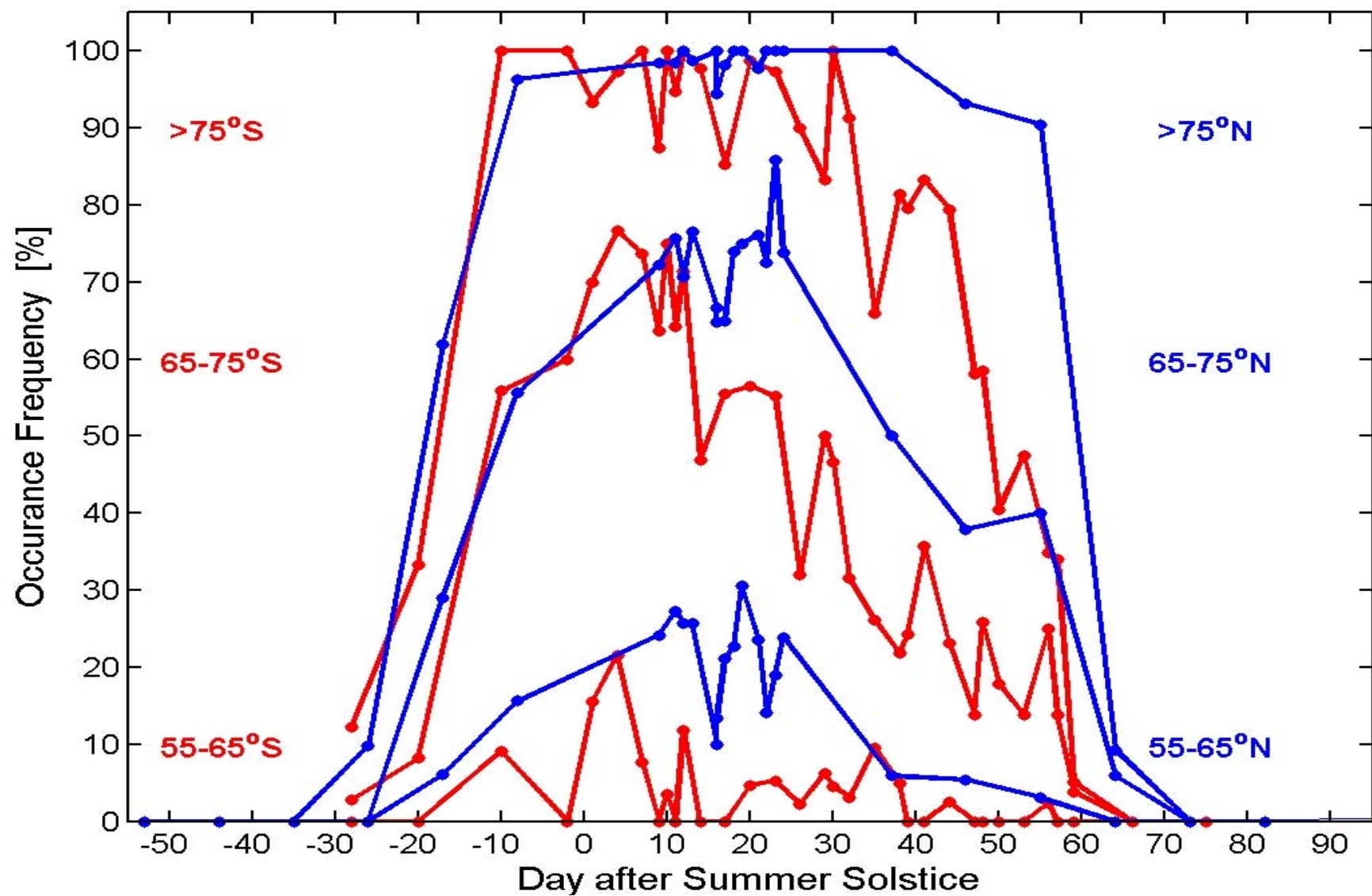
NH/SH intercomparison

Polar mesosphere clouds (from SNOE)



(Bailey et al., JGR, 2005)

PMC from ODIN satellite

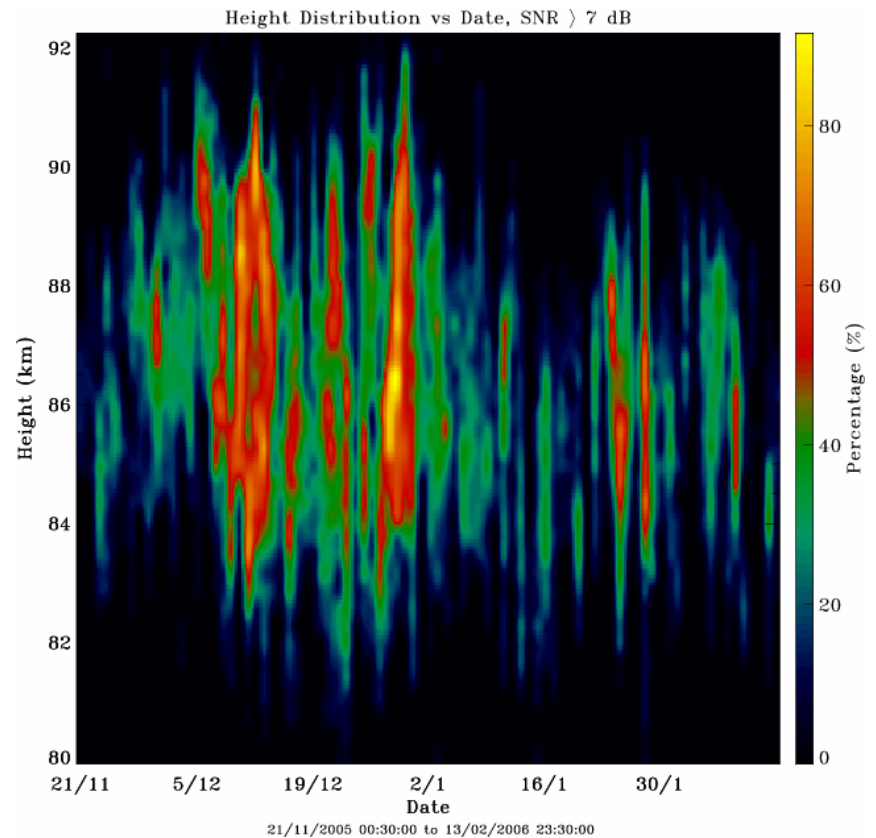
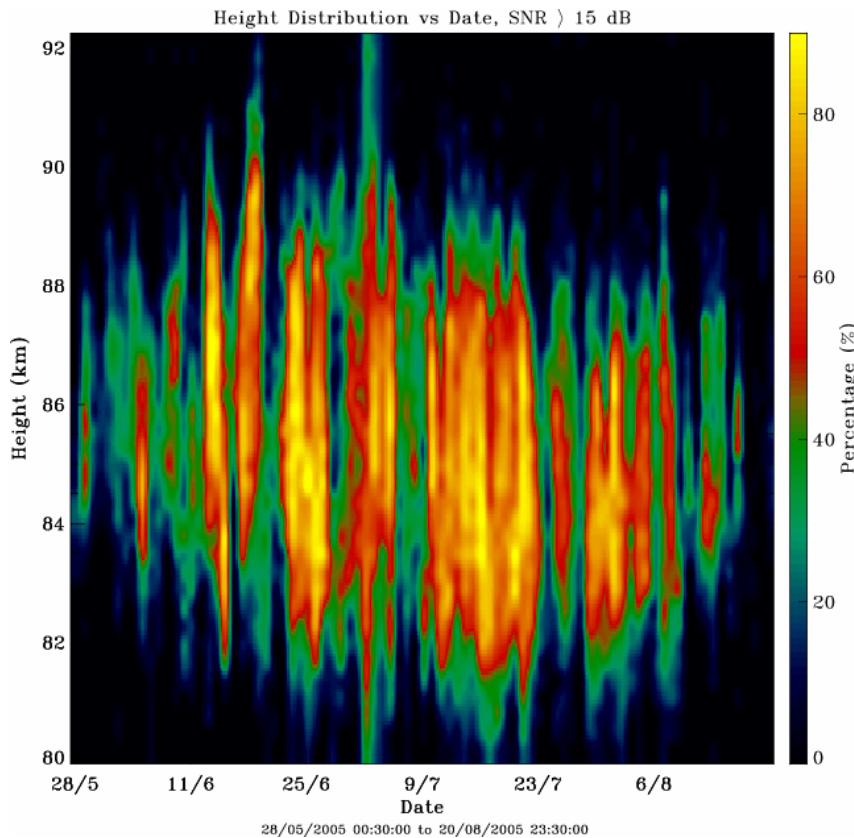


Karlsson, private communication, 2006

Interhemispheric Comparison

ANDENES (69.3°N) 2005

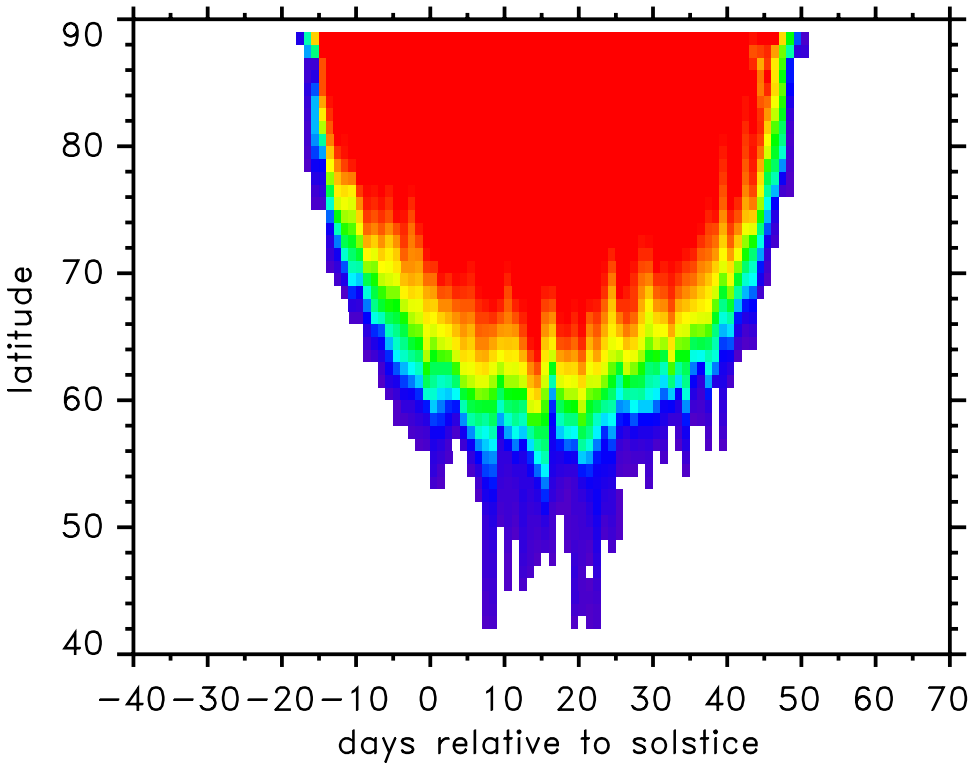
DAVIS (68.6°S) 2005-06



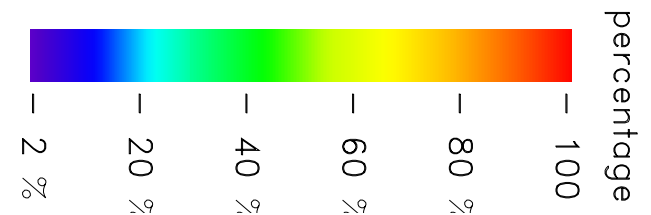
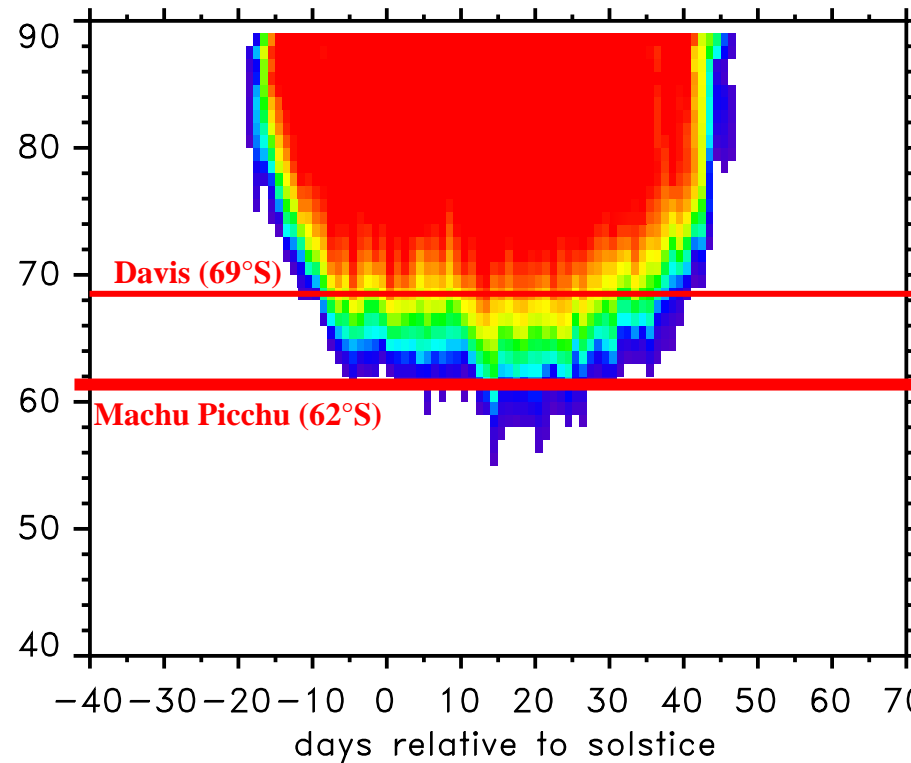
Morris et al., in preparation, 2006

Polar mesosphere summer echoes

Northern Hemisphere
(69°N, 2004)



Southern Hemisphere
(68°S, 2004)



Ostseebad Kühlungsborn



CAWSES
ice layer workshop
15-17 May, 2006
www.iap-kborn.de





Time schedule for CAWSES ice layer workshop in Kühlungsborn, 15-17 May 2006

Last updated: 15. May 2006

Sunday, 14. May 2006				
19:00 to	22:00			Ice breaker party at the restaurant 'Vielmeer'
Monday, 15. May 2006				
9:00 to	9:20	Lübken		Welcome, Organization
9:20 to	9:40	Berger		Modeling of mesospheric ice layers
9:40 to	10:00	Megner		Modeling the spatial and temporal distribution of meteor smoke particles
10:00 to	10:20	Rapp		Spectral properties of mesospheric ice clouds require a scattering theory for non-spherical particles
10:20 to	10:40	Baumgarten		Particle properties of noctilucent clouds above ALOMAR 1998-2005
10:40 to	11:10			coffee break
11:10 to	11:30	Gumbel		An introduction to the Odin satellite aeronomy mission
11:30 to	11:50	DeLand		SBUV/2 PMC observations during summer 2005
11:50 to	12:10	Hervig		PMC particle size from 14 years of HALOE observations
12:10 to	12:30	Karlsson		Noctilucent cloud observations with the ODIN satellite
12:30 to	14:00			lunch
14:00 to	14:20	von Savigny		First simultaneous space-borne observations of the 5-day wave in NLC characteristics and mesopause temperatures
14:20 to	14:40	Petelina		PMC studies with satellites: some results from Odin/OSIRIS, TIMED/SABER and ACE/FTS
14:40 to	15:00	Stegmann		What can we learn from ground-based NLC-photography
15:00 to	15:20	Hoffmann		Influence of tides and gravity waves on layering processes in the polar summer mesopause region
15:20 to	15:50			coffee break
15:50 to	16:10	Llewellyn		OH ($X^2\Pi\ v = 0$), water vapour and mesospheric clouds
16:10 to	16:30	Grygalashvyly		On the OH- and OH*- layer at high latitudes
16:30 to	16:50	Lossow		Investigations of the water vapour redistribution due to noctilucent clouds based on ODIN measurements
16:50 to	17:10	Sonnemann		Comparison between 3D-calculations and measurements of water vapor in high latitudes
17:10 to	17:30	Taylor		Coordinated imaging and lidar measurements of noctilucent cloud dynamics over Polar Flat, Alaska (65°N) during August 2005

Tuesday, 16. May 2006				
9:00 to	9:20	Kutepov		Theory of non-LTE calculations for satellite temperature retrievals
9:20 to	9:40	Feofilov		TIMED/SABER temperature retrievals in the polar summer mesosphere and lower thermosphere
9:40 to	10:00	Höfner		Temperature observations at mesopause altitudes by lidar at Spitsbergen, 78°N
10:00 to	10:20	Lübken		Ice layers and the thermal structure at the mesopause
10:20 to	10:50			coffee break
10:50 to	11:10	Singer		PMSE observations by meteor radars (32-35 MHz) in Northern Canada (62N) and Northern Scandinavia (69N) in summer 2005
11:10 to	11:30	Latteck		PMSE observed with VHF radars on the Northern and Southern hemisphere and its relation to NLC observed by ENVISAT
11:30 to	11:50	Engler		Seasonal variations of aspect sensitivity observed by 2-MHz MF radars and its possible relation to PMSE
11:50 to	12:10	Fiedler		Multiannual observation of noctilucent clouds above ALOMAR
12:10 to	14:00			lunch
14:00 to	14:20	Gerding		Observations of noctilucent clouds and temperature by co-located lidars at 54°N
14:20 to	14:40	Hoppe		Na lidar temperatures at ALOMAR
14:40 to	15:00	Hervig		The AIM satellite
15:00 to	15:30			coffee break
15:30 to	15:50	Thomas		Forcing mechanisms of mesospheric ice formation
15:50 to	16:10	Hartogh		Water vapor measurements at ALOMAR
16:10 to	16:30	Astin		???
16:30 to	16:50	Sternovsky		Mesospheric Aerosol Sampling Spectrometer

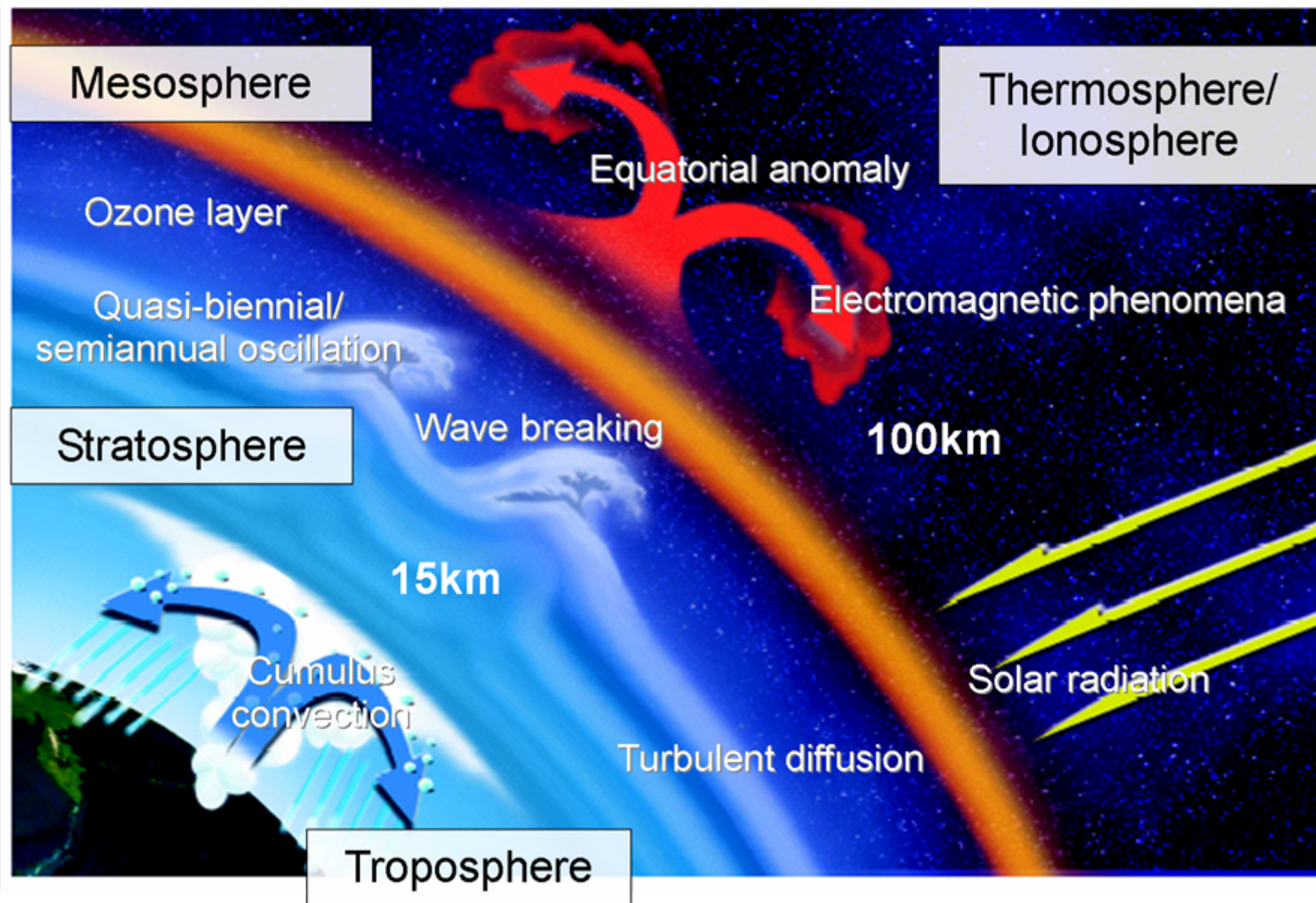
Wednesday, 17. May 2006				
9:00 to	12:00			splinter group meetings
12:00 to	13:00			lunch
19:30 to	22:00			Dinner at the hotel 'Vierjahreszeiten'

More information on Theme 3 project:

Equatorial Atmosphere Coupling Processes

Mamuro Yamamoto,
Hisao Takahashi,
Subramanian Gurubaran

(see also national reports from Brazil
and Japan)



International Symposium on Coupling Processes in the Equatorial Atmosphere (CPEA Symposium)

March 20 — 23, 2007

**Kyoto University Clock Tower Centennial Hall
Kyoto, JAPAN**

Chairman: Prof. Shoichiro Fukao (RISH, Kyoto Univ.)
Conveners: T. Tsuda (RISH, Kyoto Univ.), T. Ogawa (STEL, Nagoya Univ.),
J. M. Forbes (Univ. of Colorado), T. Nakazawa (MRI)

This symposium seeks to deepen our understanding of a broad range of dynamical, electrodynamical and photochemical coupling processes that occur in the equatorial atmosphere and ionosphere. We wish to solicit widely papers from many related fields.

Homepage: <http://www.rish.kyoto-u.ac.jp/cpea-sympo>
Contact: Mamoru Yamamoto
Research Institute for Sustainable Humanosphere (RISH)
Kyoto University
E-mail: cpea-sympo@rish.kyoto-u.ac.jp

More information on Theme 3 project:

Electrodynamic Coupling effects in the equatorial and low-latitude ionosphere

**Archana Bhattacharayya,
Art Richmond, Hermann Lühr**

Theme 3 project: Effect of the coupling of equatorial F region with off-equatorial ionosphere on plasma bubble dynamics

Investigators: A. Bhattacharyya et al.

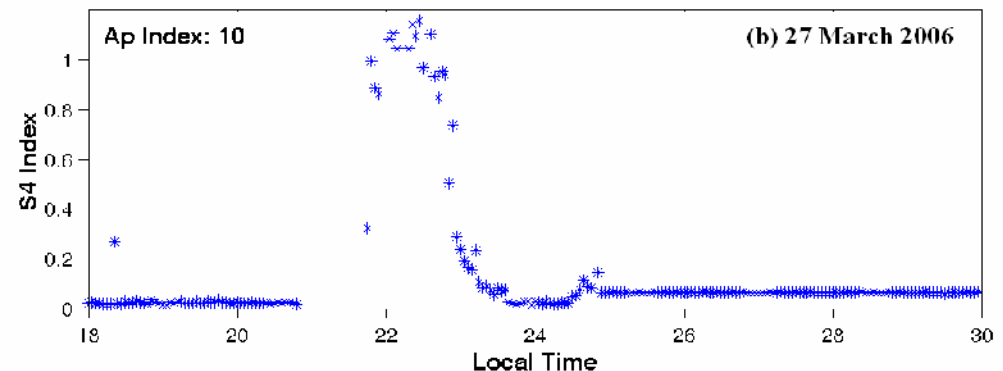
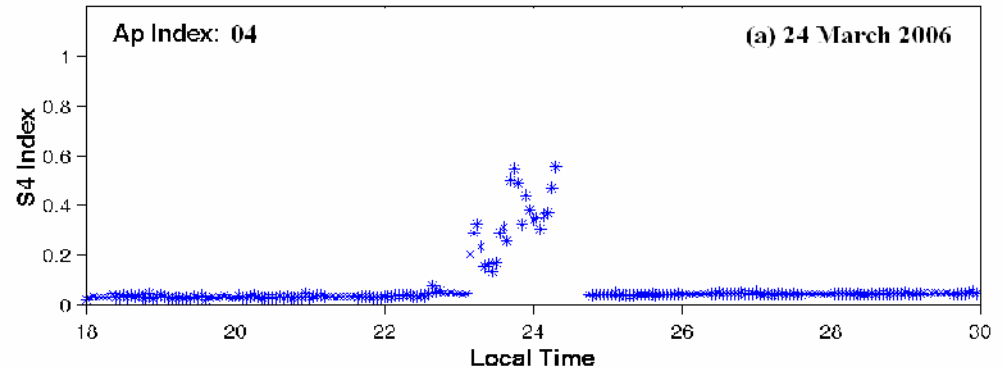
A multi-instrument observation campaign was carried out in India during the period March 15 – April 30, 2006. This included the following among other observations:

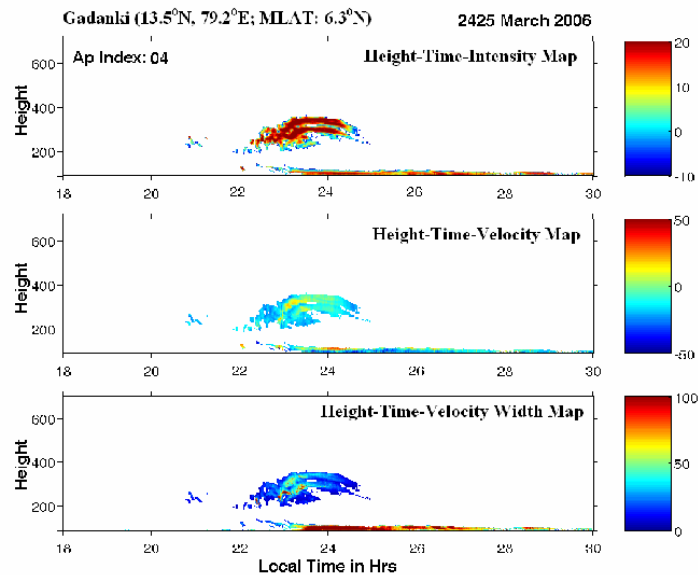
- Spaced receiver recording of ionospheric scintillations on a 251 MHz signal transmitted from a geostationary satellite and received at the equatorial station, Tirunelveli (77.8° E, 8.7° N, magnetic lat. 0.7° N).
- Same 251 MHz signal also recorded at the off-equatorial station, Mumbai (19.1° N, 72.85° E, magnetic lat. 13.6° N).
- MST radar operating at 53 MHz at Gadanki (13.5° N, 79.2° E, magnetic lat. 6.3° N).

Scintillations
observed at Mumbai
require the plasma
bubble to reach a
height of at least 700
km over the
magnetic equator

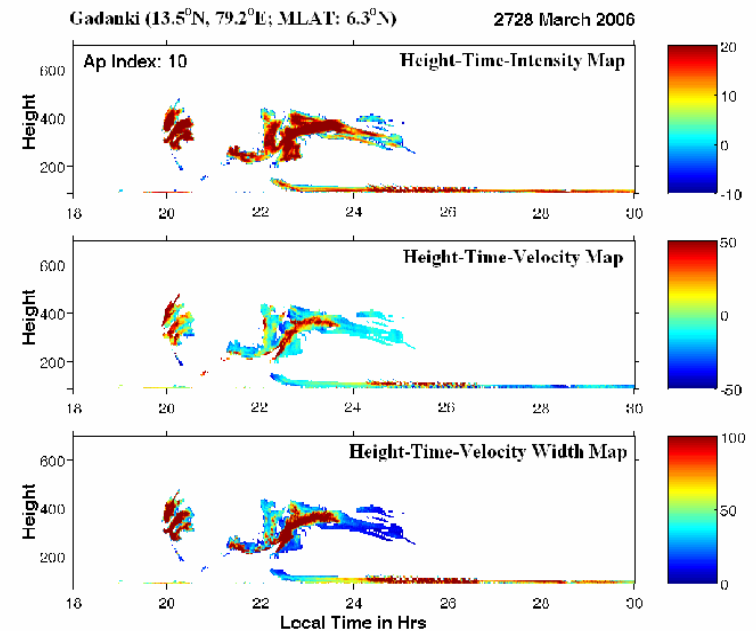
Scintillations obtained using VHF receiver operating at 251 MHz

Mumbai (19.09°N, 72.85°E; MLAT: 13.6°N)





MST radar observations



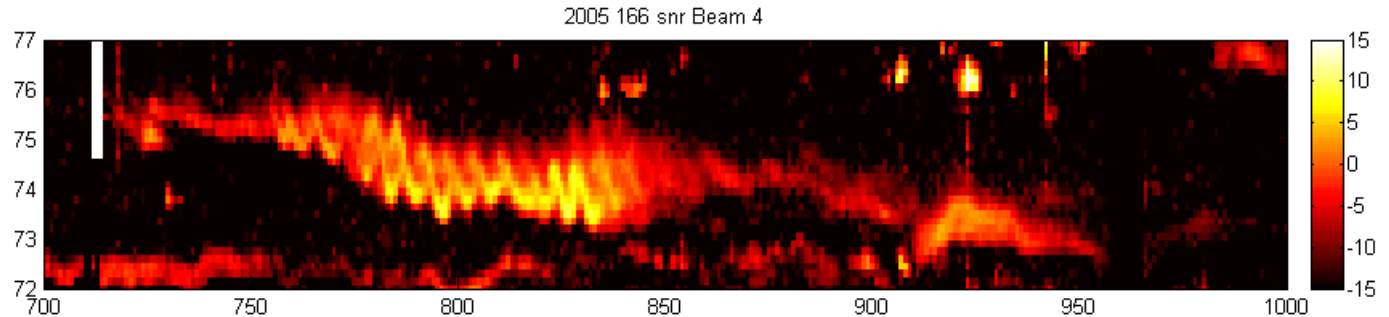
Such radar observations of equatorial plasma bubbles, combined with scintillation observations shall be used to study the decay of the bubbles as they drift through nearly 600 km in the E-W direction.

Input
from WG members
(not within a project)

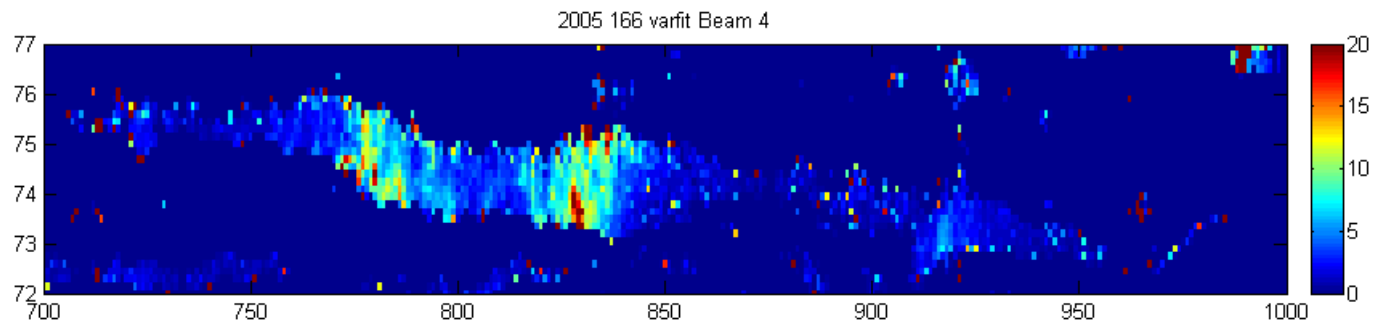
Jicamarca MST-ISR Campaigns (2005-2006)

(G. Lehmacher, E. Kudeki, J. Chau; C2.3-0005-06)

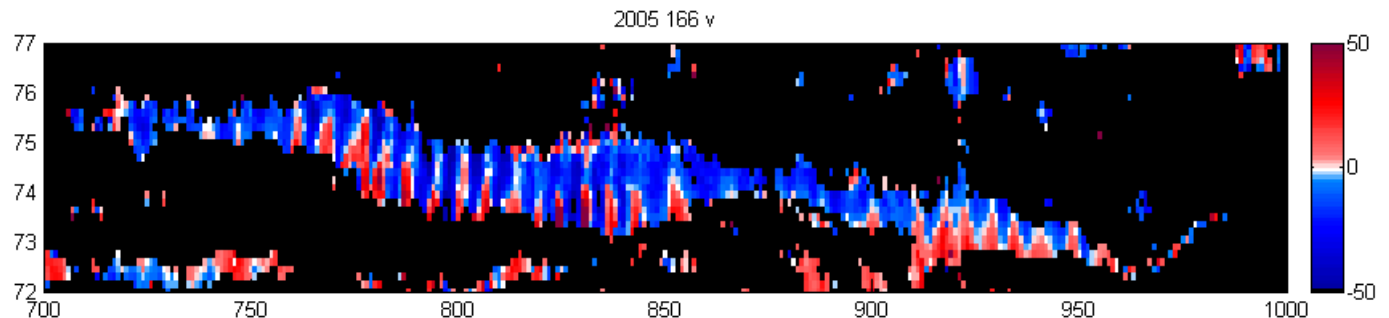
SNR (dB) vs.
altitude(km),
time (min)



Spectral
Width,
Variance
(m^2/s^2)



Meridional
wind (m/s)



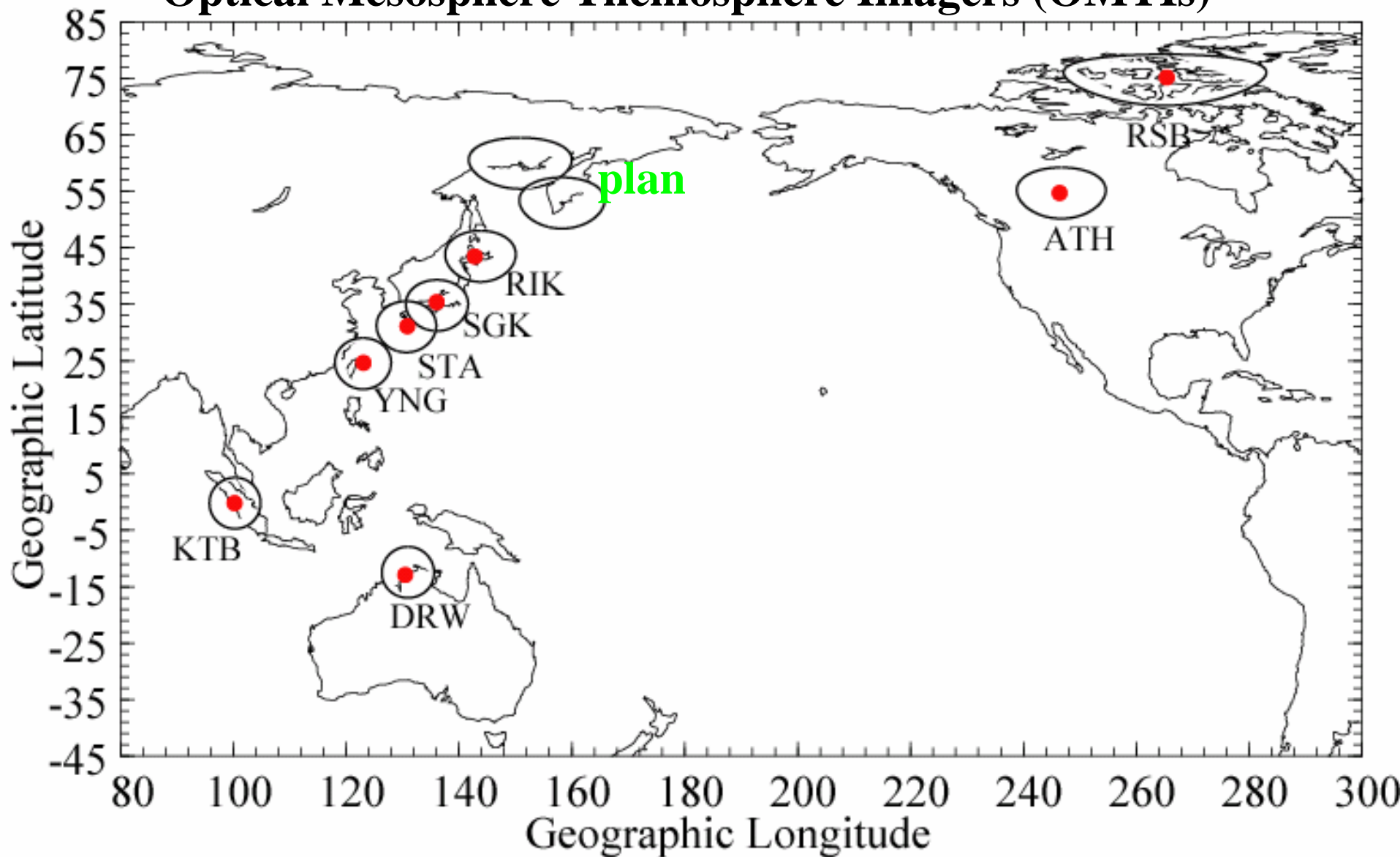
High resolution mesospheric echoes show evidence for KHI, braided structures with enhanced edges (top); turbulent fluctuations are intermittent (middle); layers are often strongly sheared (bottom). Observations: 8x3 days in 2005 and 2006.

More information on Theme 3 activities:

**Small-scale GW measurements in
the mesosphere and
thermosphere/ionosphere by
the Optical Mesosphere
Thermosphere Imagers (OMTIs)**

Kazuo Shiokawa

Optical Mesosphere Thermosphere Imagers (OMTIs)



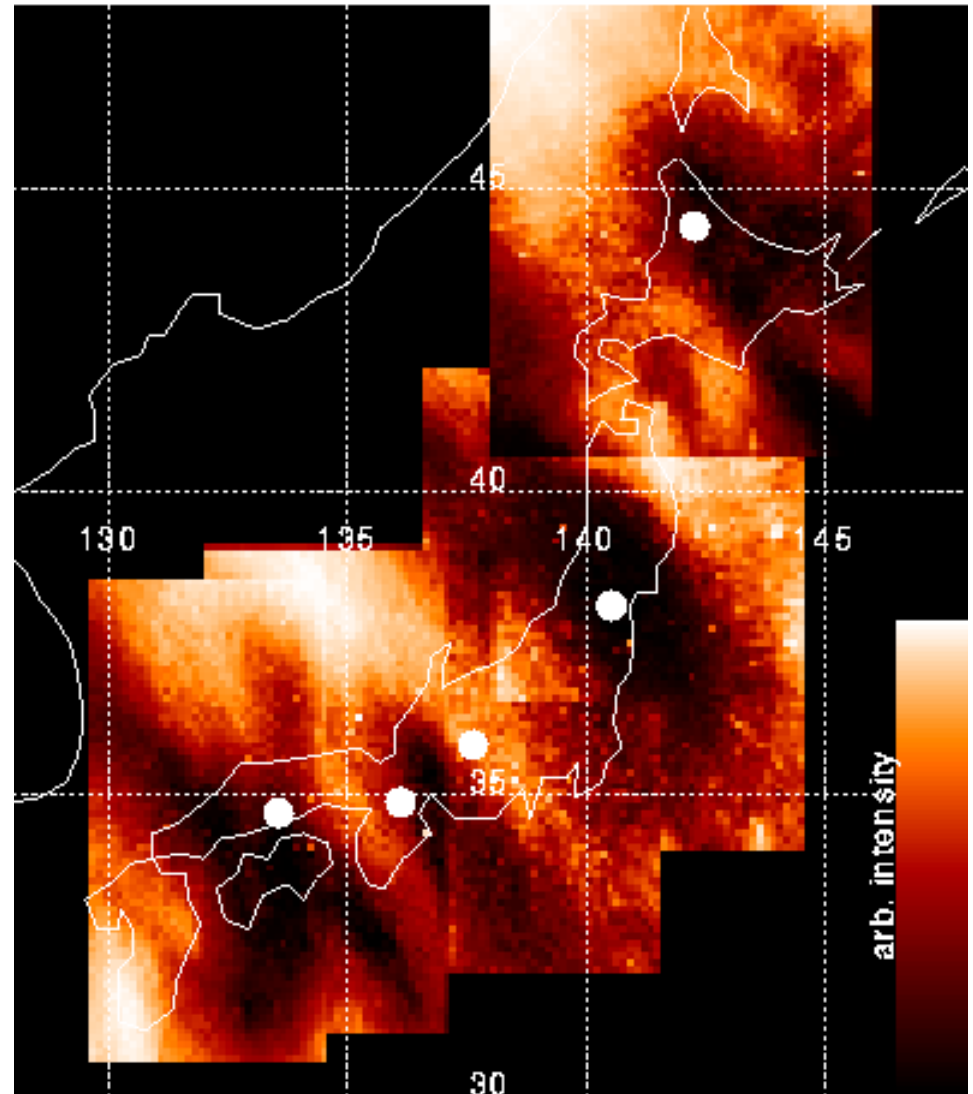
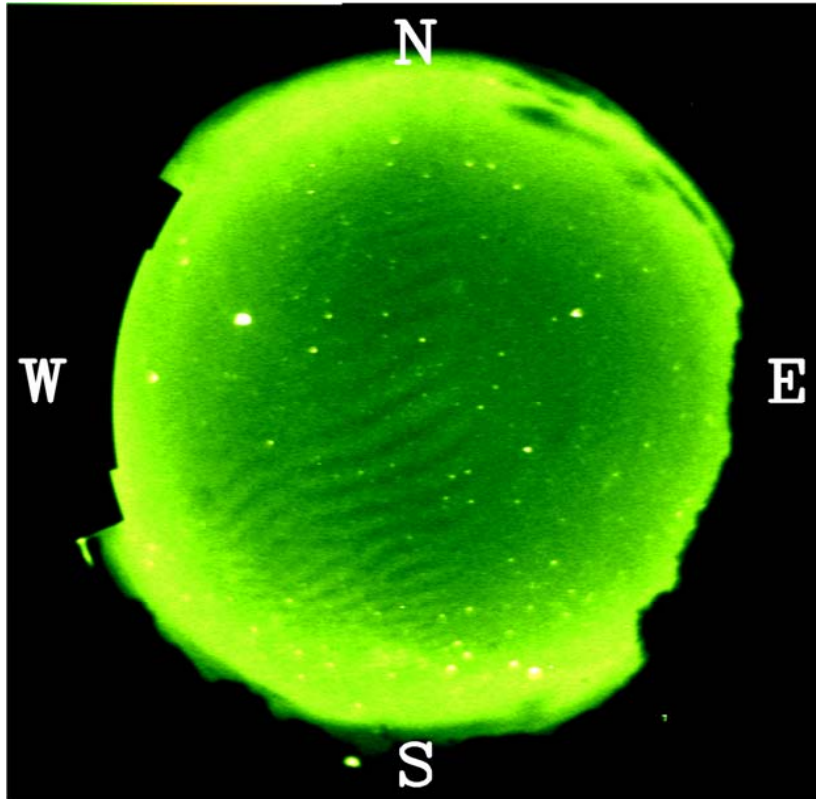
Medium-Scale Traveling Ionospheric Disturbances (MSTIDs)

OI 630-nm emission

22/05/1998

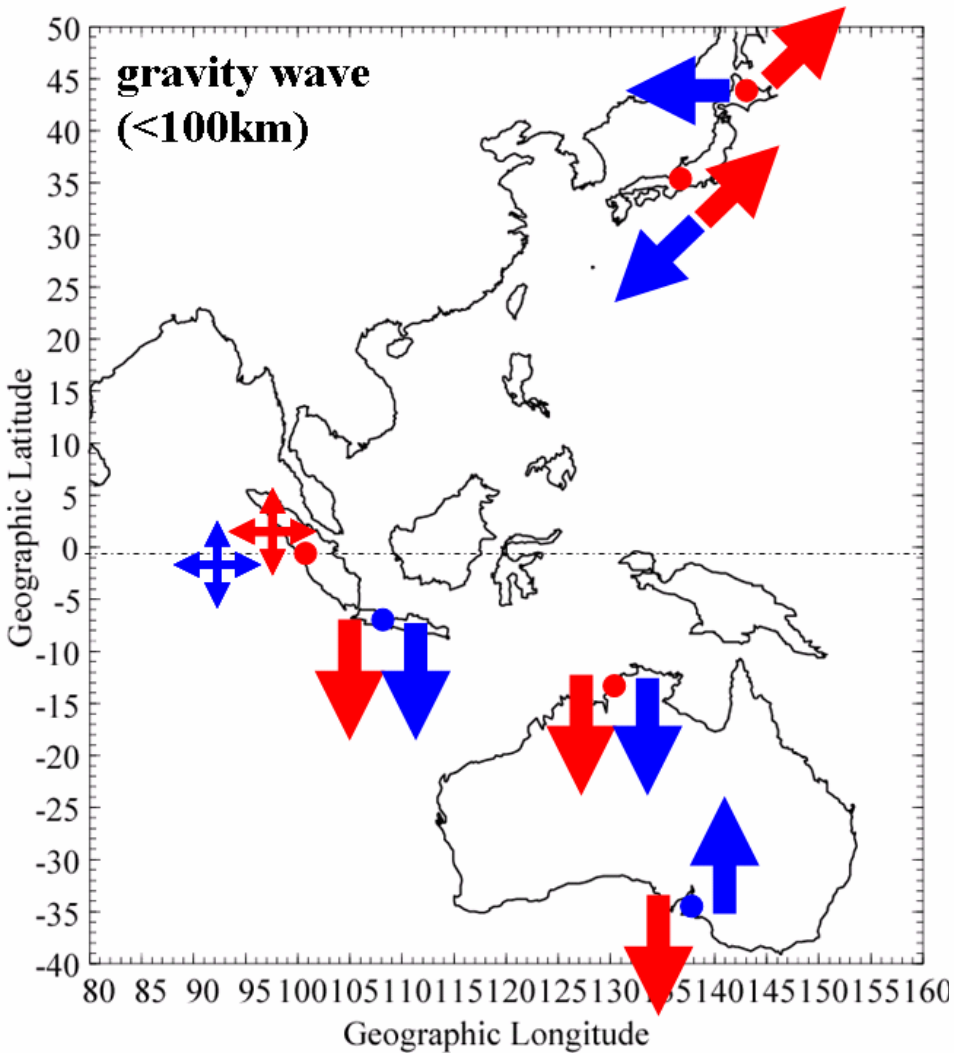
21:31 JST

Kototabang (557.7nm, March 6, 2003 20:08LT)

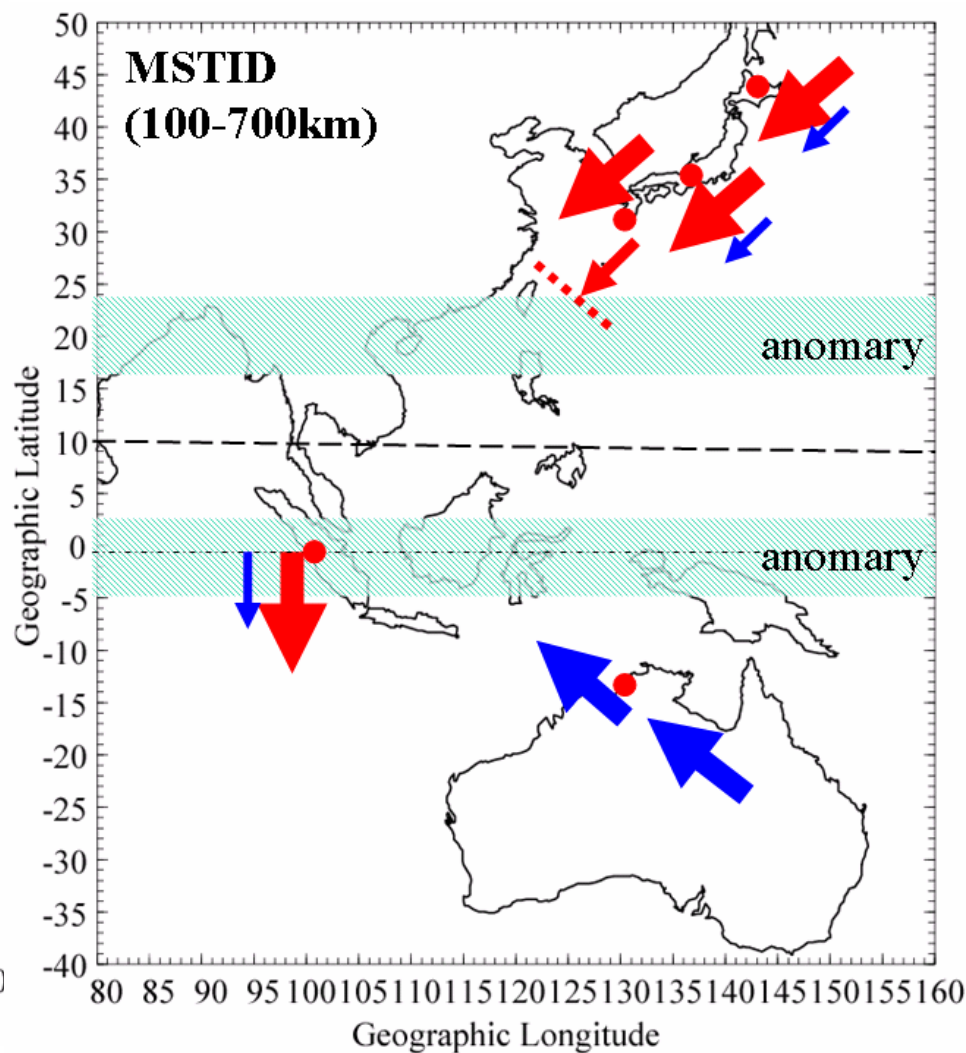


Kubota et al.(GRL, 2000); Saito et al. (GRL, 2001)

mesopause region (80-100km)



thermosphere (200-300km)



summer →

winter →

sessions etc.

- CAWSES session during the EGS assembly in Vienna (2006)
- 2 CAWSES-coupling related session during COSPAR 2008
- ... and more ...

job announcements within CAWSES ?

- announce available jobs for PhD, Post-Doc, etc.
- let PhDs work at different institutions
- distribute through CAWSES Email list + CEDAR + ...