CAWSES: Climate and Weather of the Sun-Earth System

Sunanda Basu
Chair, Science Steering Committee,
CAWSES

CAWSES/SCOSTEP Meeting
Paris, France
July 16-17, 2004

SCOSTEP

SCOSTEP's mission: to implement research programs in solar-terrestrial physics that benefit from international participation and that involve at least two ICSU bodies.

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CAWSES
Scientific Steering Group

- Chair: Sunanda Basu, BU, USA
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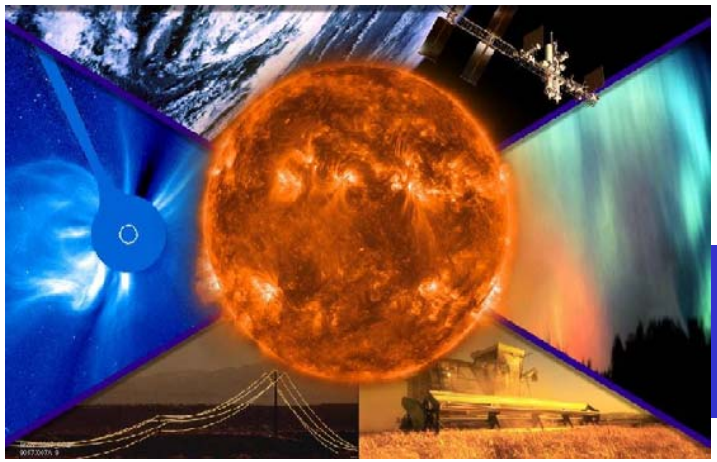
- Yohsuke Kamide, STEL, Japan
- Arthur Richmond, NCAR, USA
- C.-H. Liu, NCU, Taiwan
- Lev Zelenyi, IKI, Russia
- P. Duggirala, Scientific Coordinator
- L. Vercauteren, Program Admin.

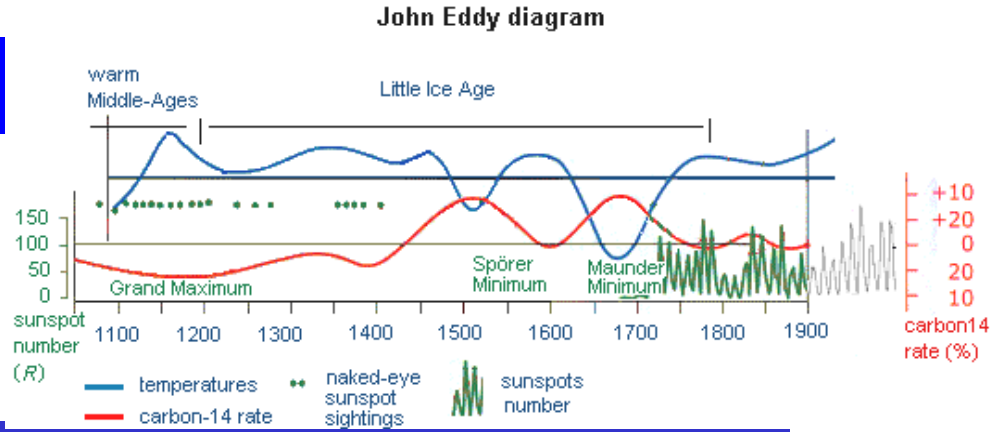
CAWSES Meetings – Initial Phase

- First CAWSES SSG Meeting held at Maastricht, The Netherlands in August 2002
- Four themes approved by SCOSTEP Bureau at Rio de Janeiro, Brazil, September 2002
- Theme leaders presented their plans at a Town Hall Meeting in April 2003 during the EGS/AGU Joint Assembly in Nice, France
- CAWSES Program presented at first ILWS Meeting in Nice, France, April 2003
- Special CAWSES Meeting held in July 2003 in conjunction with the IUGG Meeting at Sapporo, Japan
- Election of new SCOSTEP Bureau was held in Sapporo and CAWSES Report was presented to them

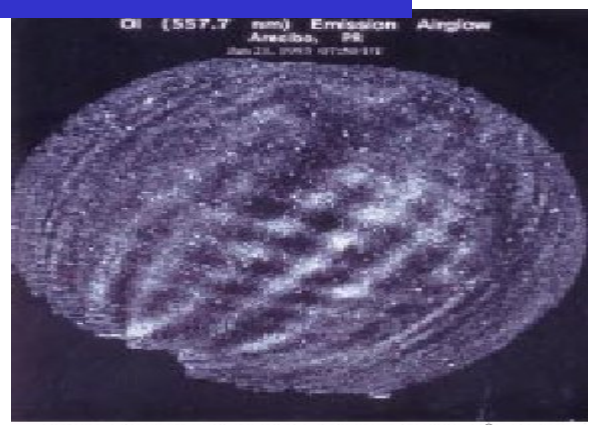
Four Themes under CAWSES

Solar Influence on Climate



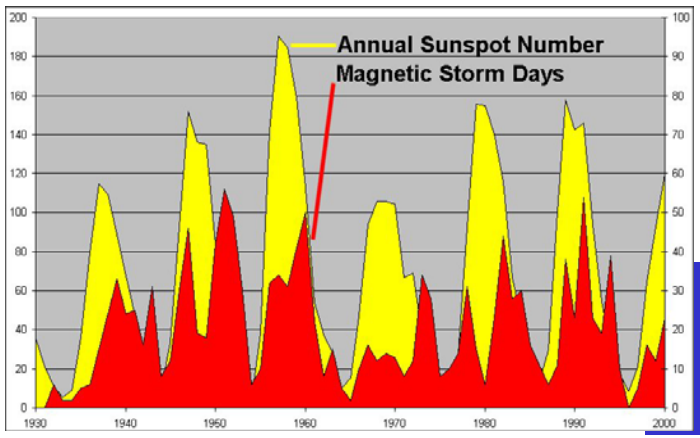


Space Weather: Science and Applications



Wave structures in atomic oxygen 5577 Å image.

Atmospheric Coupling Processes



Climatology of the Sun-Earth System

Theme 1: Solar Influence on Climate

Co-Chairs: Michael Lockwood (UK) and Lesley Gray (UK)

WG 1.1: Assessment of Evidence for Solar Influence on Climate

Juerg Beer (Switzerland), William Russow (USA), Ilya Usoskin (Russia), Judith Lean (USA), Gerard Thuillier (France), Gerry North (USA), Peter Stott (UK), Warren White (USA), Lon Hood (USA), Karin Labitzke (Germany), Augusto Mangini (Germany)

WG 1.2: Investigation of Mechanisms for Solar Influence on Climate

Ulrich Cubasch (Germany), Gerry Meehl (USA), Kuni Kodera (Japan), R. Garcia (USA), David Rind (USA), Mark Baldwin (USA), Charles Jackman (USA), Jon Kristjansson (Norway) and Giles Harrison (UK)

Theme 2: Space Weather Science & Applications

Co-Chairs: Janet Kozyra (USA) and Kazunari Shibata (Japan)

Santimay Basu (USA), Walter Gonzalez (Brazil), Nat Gopalswamy (USA), A. T. Kobea (Ivory Coast), Anatoly Petrukovich (Russia), Rainer Schwenn (Germany), Wei Feng Si (China) and R. Sridharan (India)

Theme 3: Atmospheric Coupling Processes

Co-Chairs: Franz-Josef Luebken (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 (Canada), 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)

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

Theme 4: Space Climatology

Co-Chairs: Claus Froehlich (Switzerland) and Jan Sojka (USA)

WG 4.1: Solar Irradiance Variability

Judit Pap (USA) and Gerard Thuillier (France)

WG 4.2: Heliosphere Near Earth

Leif Svalgaard (USA)

WG 4.3: Radiation Belt Climatology

Takahiro Obara (Japan)

WG 4.4: Long-Term trends in Ionospheric and Upper-Atmospheric Variability *(inter-connected with 3.4)*

M. Jarvis (UK) and John Emmert (USA)

Capacity Building & Education

Co-Chairs: Marv Geller, S. T. Wu and Joe Allen

- CAWSES will hold meetings and provide specialized training courses for scientists from developing nations and help with computational and data resources
- Establish partnerships between developing & industrialized nations
- CAWSES – AOPR Center will facilitate such activities

CAWSES Moves Forward

- CAWSES Office established at Boston University, Jan 16, 2004
  - D. Pallamraju (Raju) appointed Scientific Coordinator
- First Newsletter published in March, 2004
- Many Working Group members have been chosen
- First CAWSES Campaign organized in March -April, 2004 in conjunction with CPEA Campaign
- Special all-day CAWSES Meeting at Observatoire de Paris, July 17, 2004
- CAWSES presentation at ILWS Session, COSPAR Meeting, Paris, July 19, 2004
- Solar Irradiance Variability Session at COSPAR, 2004
- Atmospheric Coupling Group Meeting on July 22, 2004 at COSPAR
- Workshop proposal on Solar Influences on Climate at ISSI Bern, CH with L. Gray as PI has been approved for 2005

Around the World for CAWSES

(In 15 days)

38,365 kilometers traveled!

CAWSES – National and Regional Programs

- CAWSES-India has been approved by ISRO
  - Workshop held in April, 2004
- CAWSES has been approved as a priority program by DFG in Germany
- CAWSES-Japan had its inaugural Workshop near Nagoya, Japan, June 16-18, 2004
- CAWSES-AOPR (Asia Oceania and Pacific Rim) Center discussed in Taipei on June 18, 2004
- AOPR Center established at National Central University, Chung-Li, Taiwan on July 1, 2004 with Lou Lee as Director & S-Y Su as Sci. Secy.
- CAWSES-US Workshop held on June 29 at CEDAR Meeting in Santa Fe to discuss campaign results

Early recognition for CAWSES

- **Invited to present Association Lecture on CAWSES at the IAGA General Assembly in Toulouse, France, July 2005**
- **Invited to present General Lecture on Extreme Solar-Terrestrial Events at the URSI General Assembly, New Delhi, October, 2005**

1st CAWSES Campaign

> 40 participating international space & ground-based programs & growing. In collaboration with:

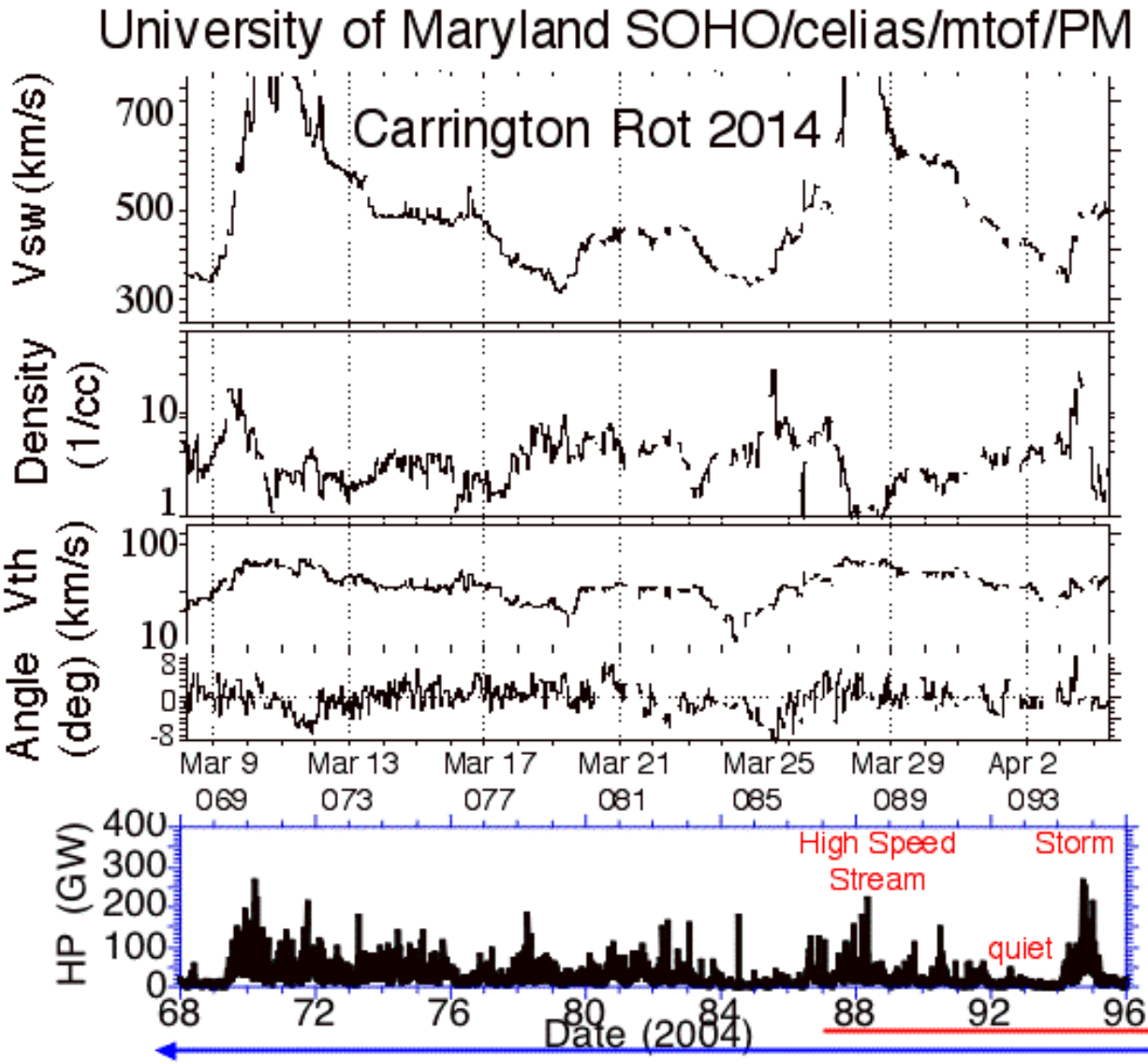
- **ISR World Days, MI-coupling campaign, 29 March - 3 April 2004**
  - Focus:
    - Coupling between the high- and low-latitude ionospheres
    - Coordinated observations by incoherent scatter radars worldwide
      - Sonderstrom, EISCAT, Svalbard, Millstone Hill, Arecibo, Jicamarca, Irkutsk (Russia), and Kharkov (Ukraine)
  - Led by Chao-Song Huang (MIT/Haystack)

- **CPEA (Coupling Processes in the Equatorial Atmosphere) Campaign, March - April 2004**
  - Focus:
    - Coupling troposphere up through thermosphere
    - strong convective region over Indonesia
  - Led by Prof. Shoichiro Fukao, Dr. Mamoru Yamamoto (Kyoto Univ)

Purpose to investigate:

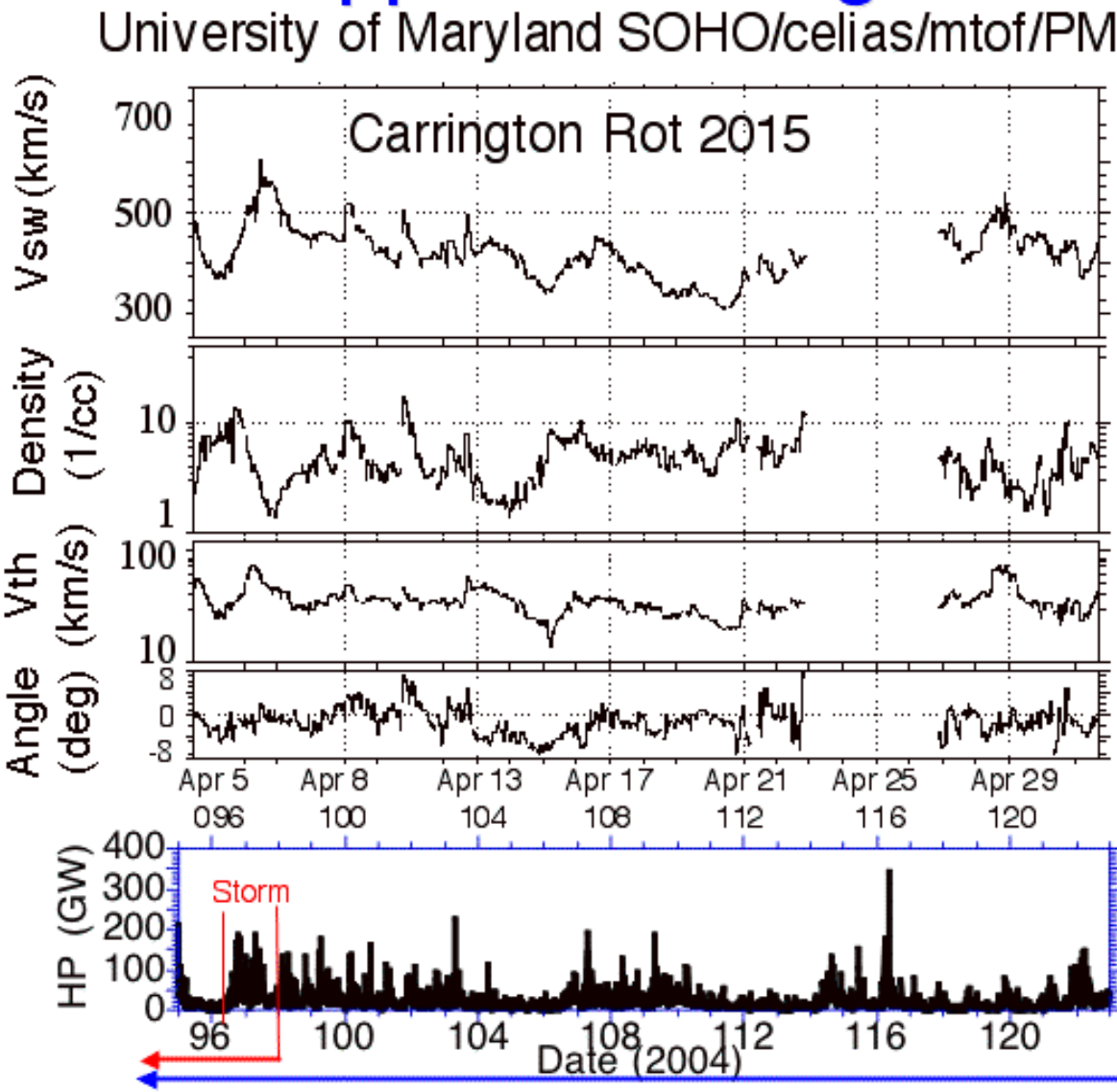
- **Space Weather Sun-to-Earth (27 March - 6 April 2004)**
  - Collect a sun-to-Earth data set which dips down into the lower atmosphere
  - Provide first testbed for a CAWSES/GEM/IAGA effort to combine international magnetometer chains & produce global maps of ULF wave index and magnetospheric density.
- **Equinox State of the Middle Atmosphere & Coupling between Atmospheric Regions (March - April 2004)**
  - By collecting worldwide information on the equinox middle atmosphere.
  - By serving as test bed (where possible) for global integrated maps of middle atmosphere parameters - (i.e., gravity waves, temperature, winds, etc). Looking for gaps to fill.
- **Post-Event Analysis Led Jointly by CAWSES Space Weather & Atmospheric Coupling Panels & CPEA Group**

What Happened during the Campaign?



- Strong high speed stream beginning March 25, peaking March 27.
- Electron radiation belt enhanced beginning late March 28
- Supports campaign focus area on ULF waves & electron acceleration
- Storm on 4/3 due to slow CME released 3/31

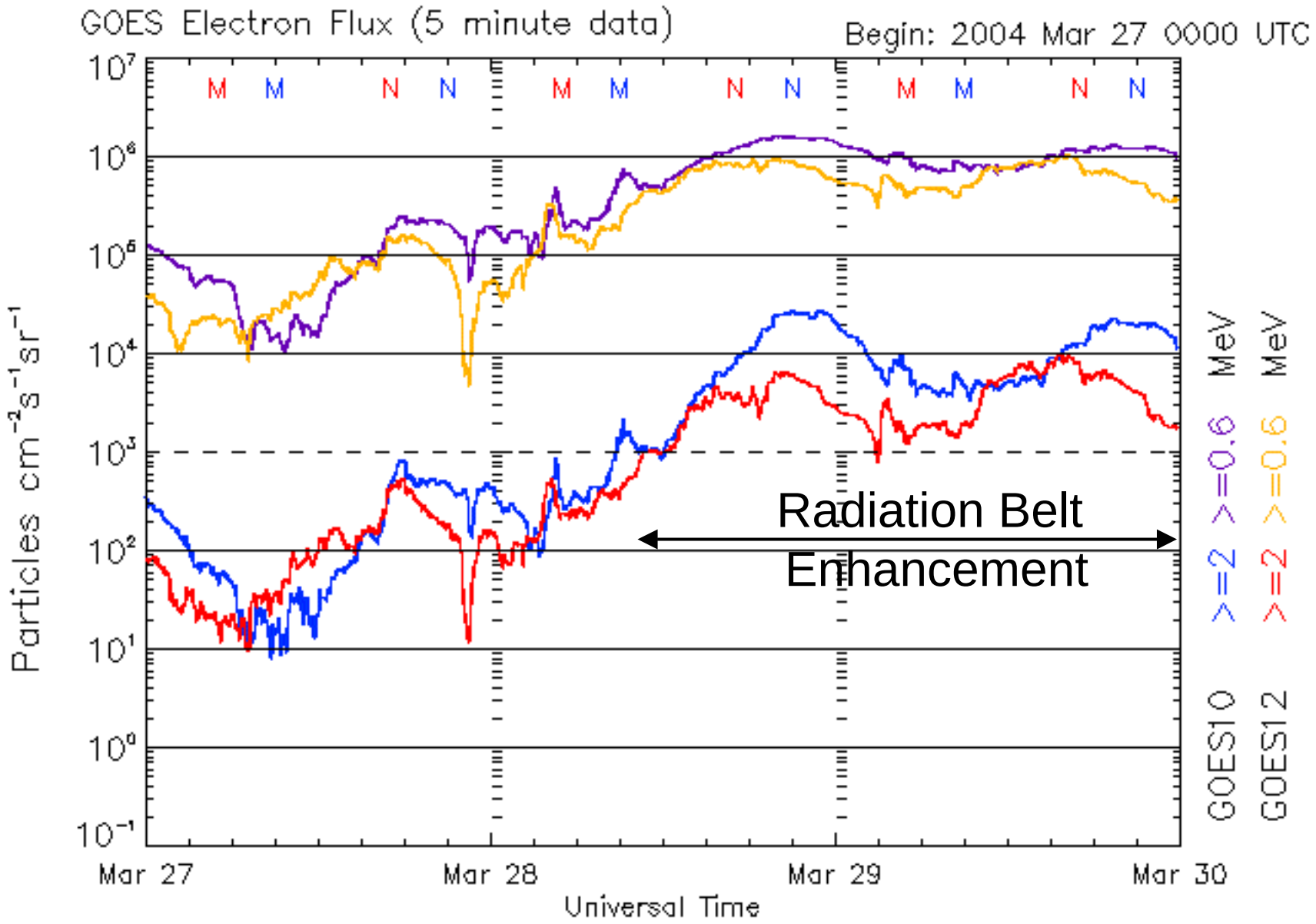
What Happened during the Campaign?



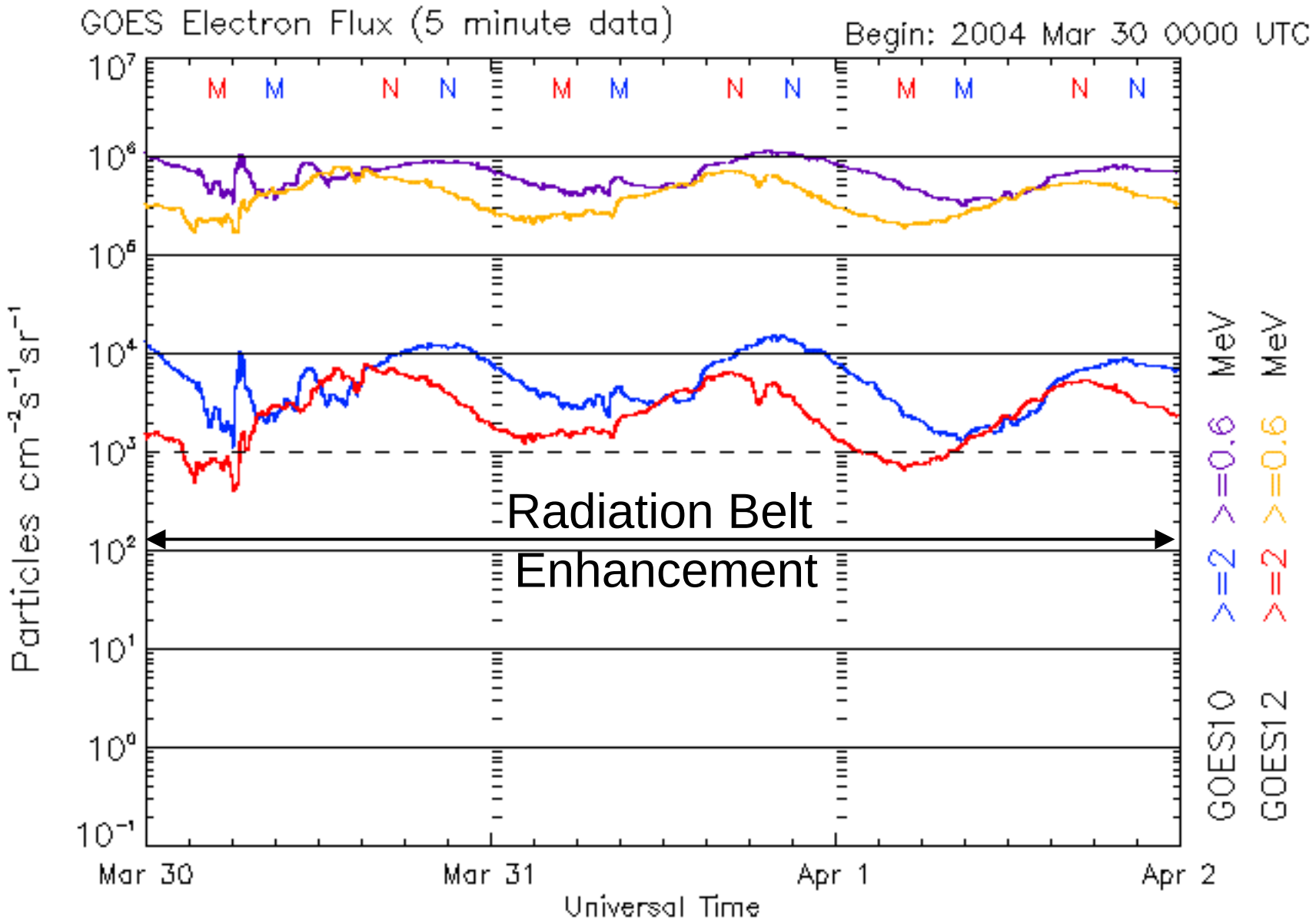
- Strong stream structure has disappeared in April 2004 (CR 2015).
- Weak smaller-scale solar wind streams still generating considerable auroral activity due to fluctuating IMF Bz.
- Storm on 5-6 April at leading edge of a high speed stream

Space Weather
Atmospheric Coupling

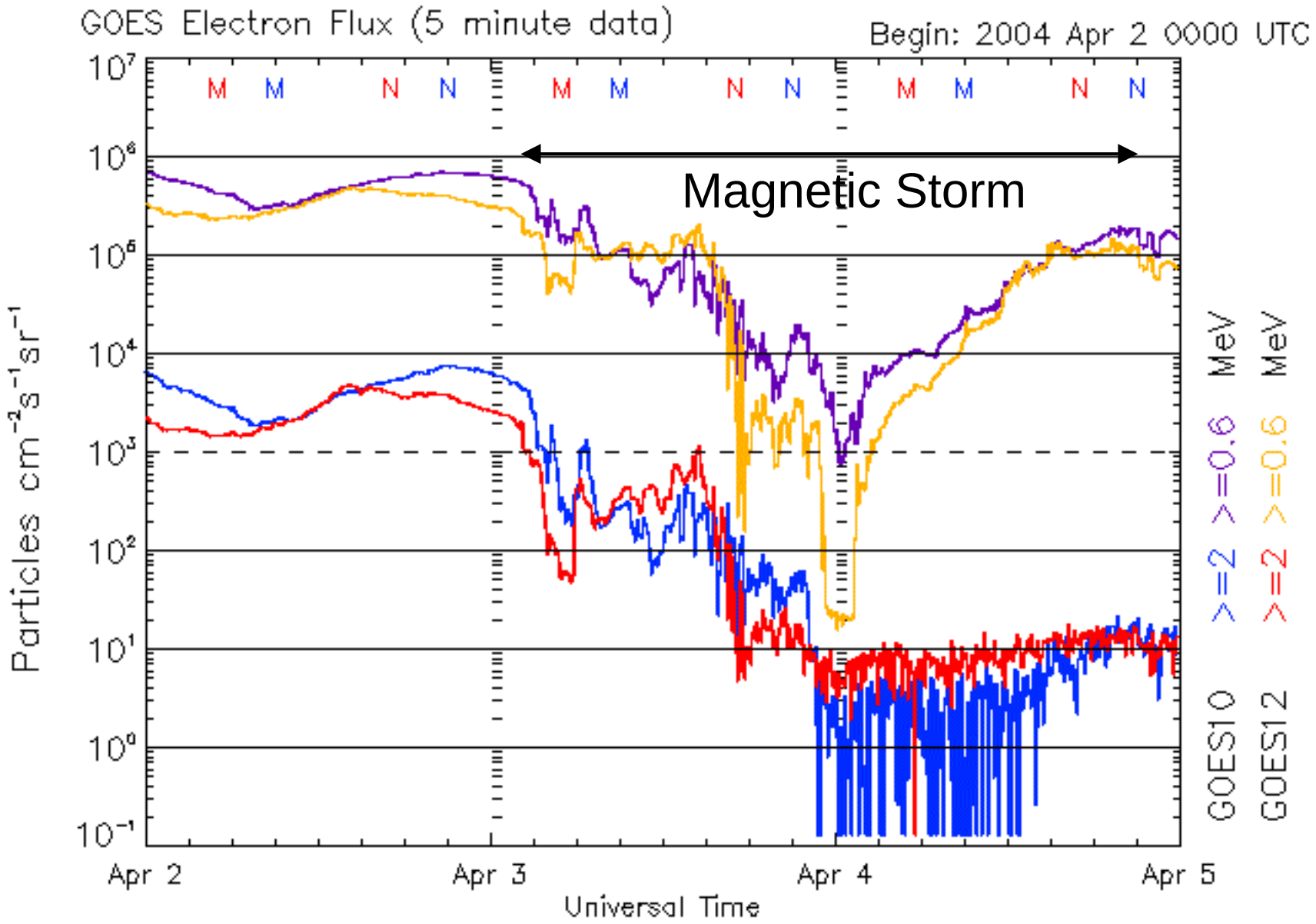
Radiation Belts during the Campaign?



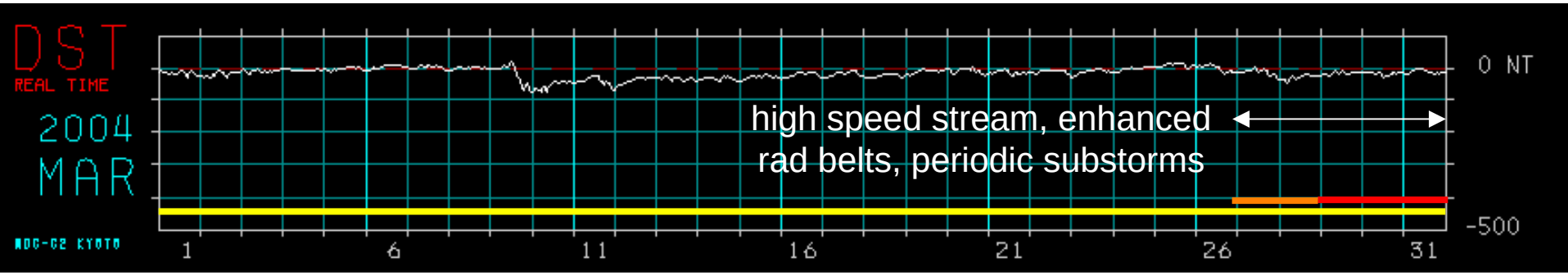
Radiation Belts during the Campaign?

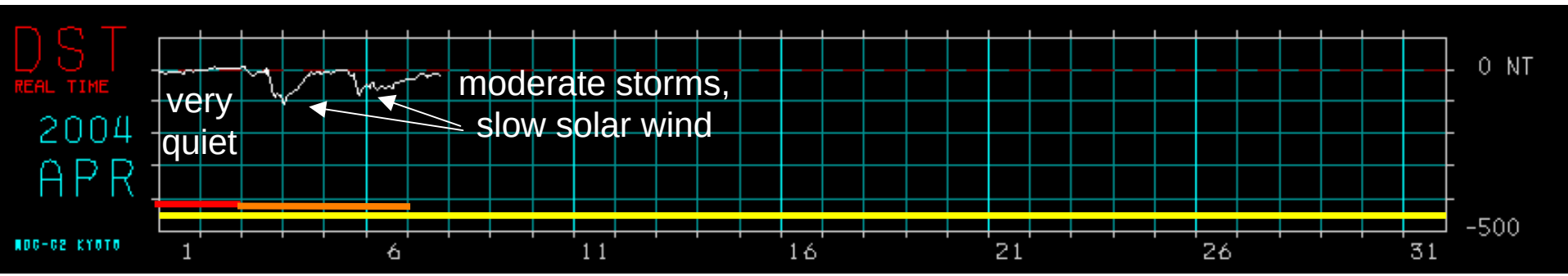


Radiation Belts during the Campaign?



Magnetic Activity during the Campaign?





ISR World Days

Expanded CAWSES Space Weather Campaign

CAWSES Equinox Atmosphere Campaign, collaboration with CPEA

Priority Areas Research of the Grant-in-Aid for Scientific Research funded by Ministry of Education, Culture, Sports, Science and Technology (MEXT)

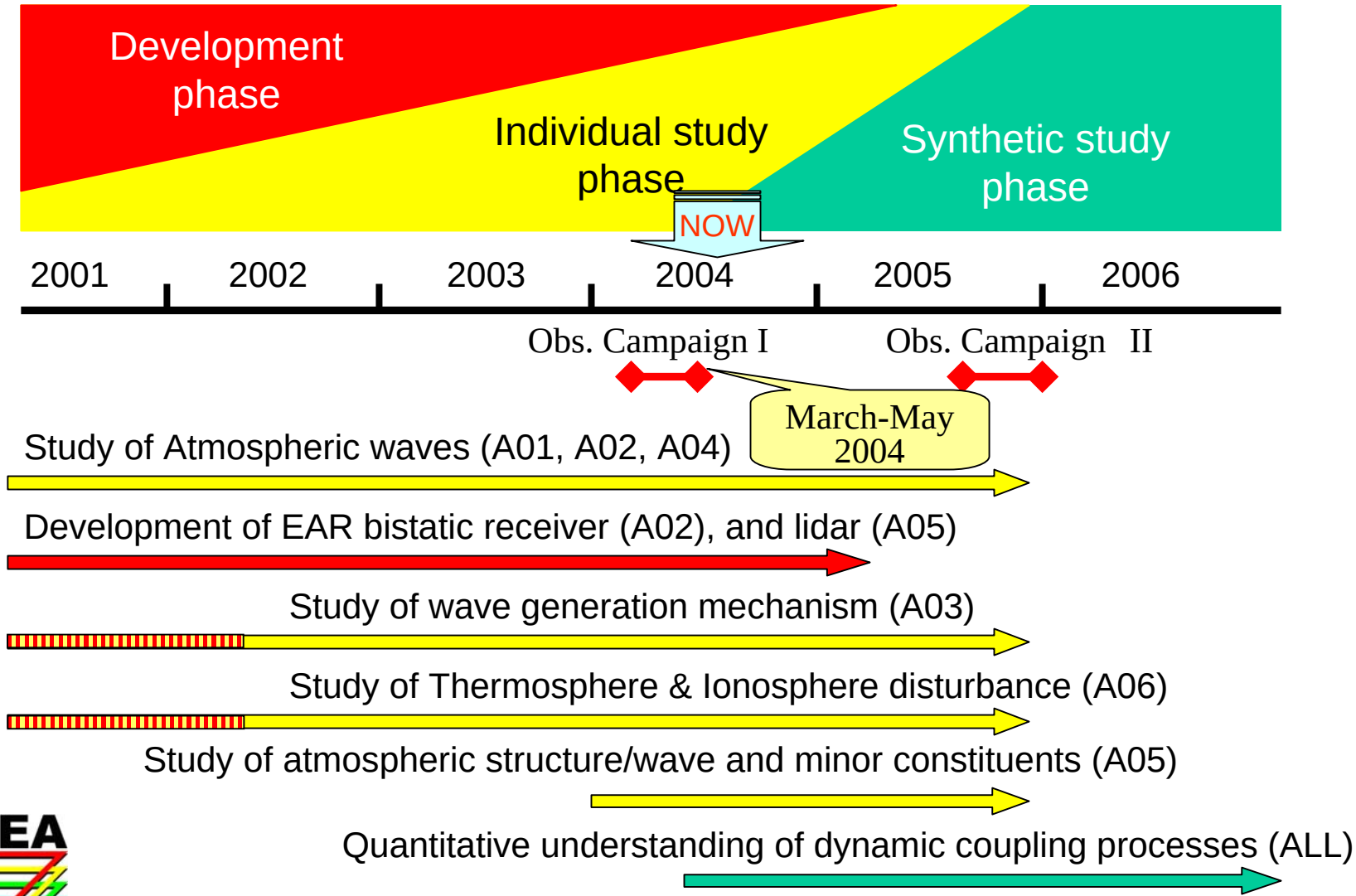
Coupling Processes in the Equatorial Atmosphere (CPEA)

- Six-year project in the period of 2001-2006 headed by Prof. S. Fukao (RISH*, Kyoto Univ.).
- CPEA studies dynamical coupling processes in the equatorial atmosphere from the troposphere to the ionosphere.
- CPEA conducts various observations in Indonesian equatorial region centered around the EAR.

*RISH: Research Institute for Sustainable Humanosphere

CPEA
赤道大気上下結合

Schedule of the CPEA



CPEA
赤道大気上下結合

Equatorial Atmosphere Radar (EAR)
(Inaugurated in June 2001)

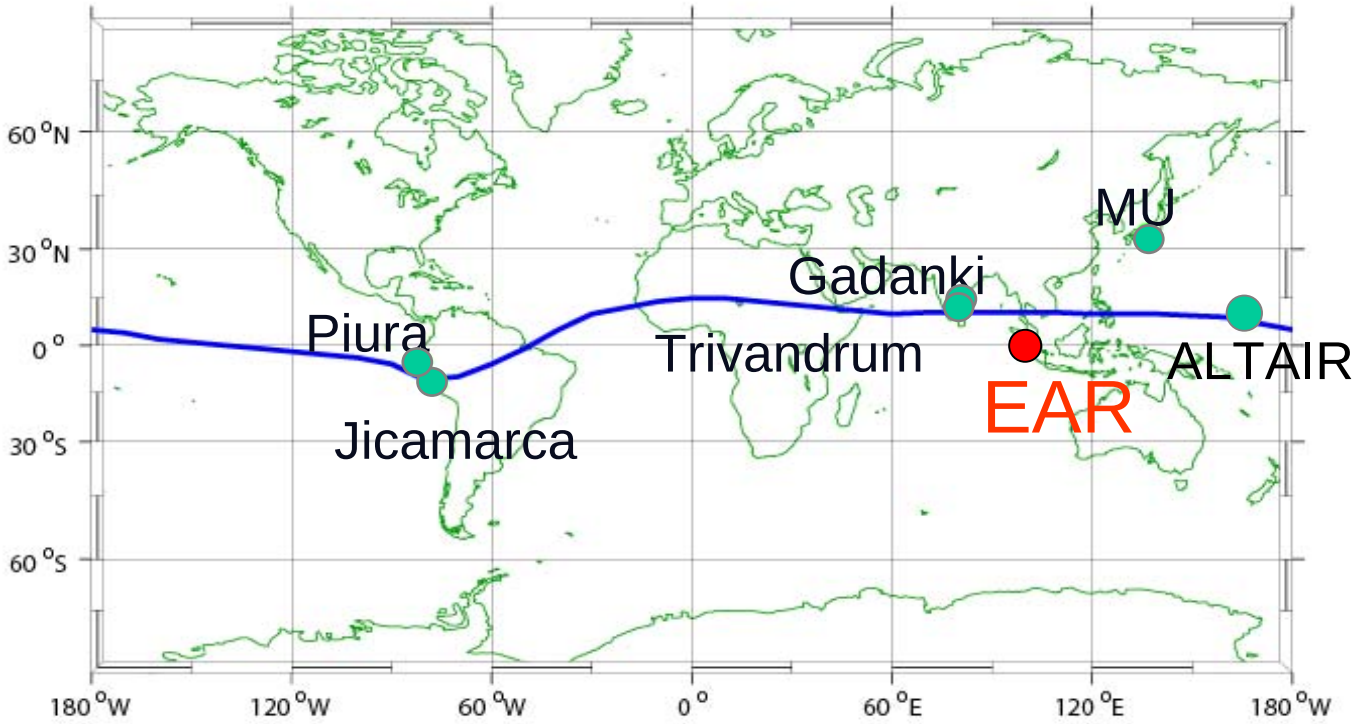
Antenna field (110m in diameter)

Location:
Koto Tabang,
West Sumatra,
Indonesia
(0.20° S, 100.32° E)

100 kW, 560 Yagi antennas

VHF Radars in the Low-Latitude Region

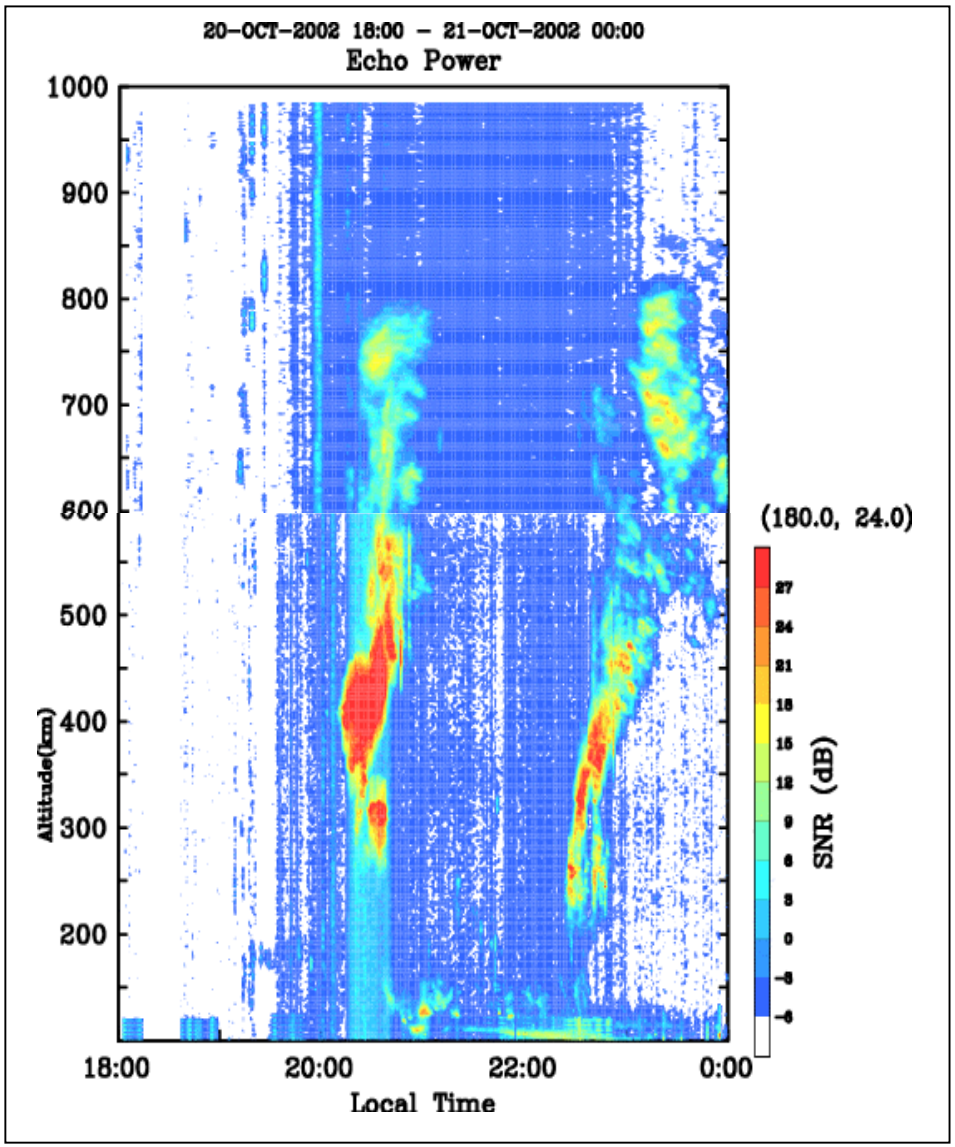
dip equator



※EAR: Equatorial Atmosphere Radar
(located right at the geographic equator and in the geomagnetic southern hemisphere)

F-region Field Aligned Irregularity (FAI) Echoes from the EAR

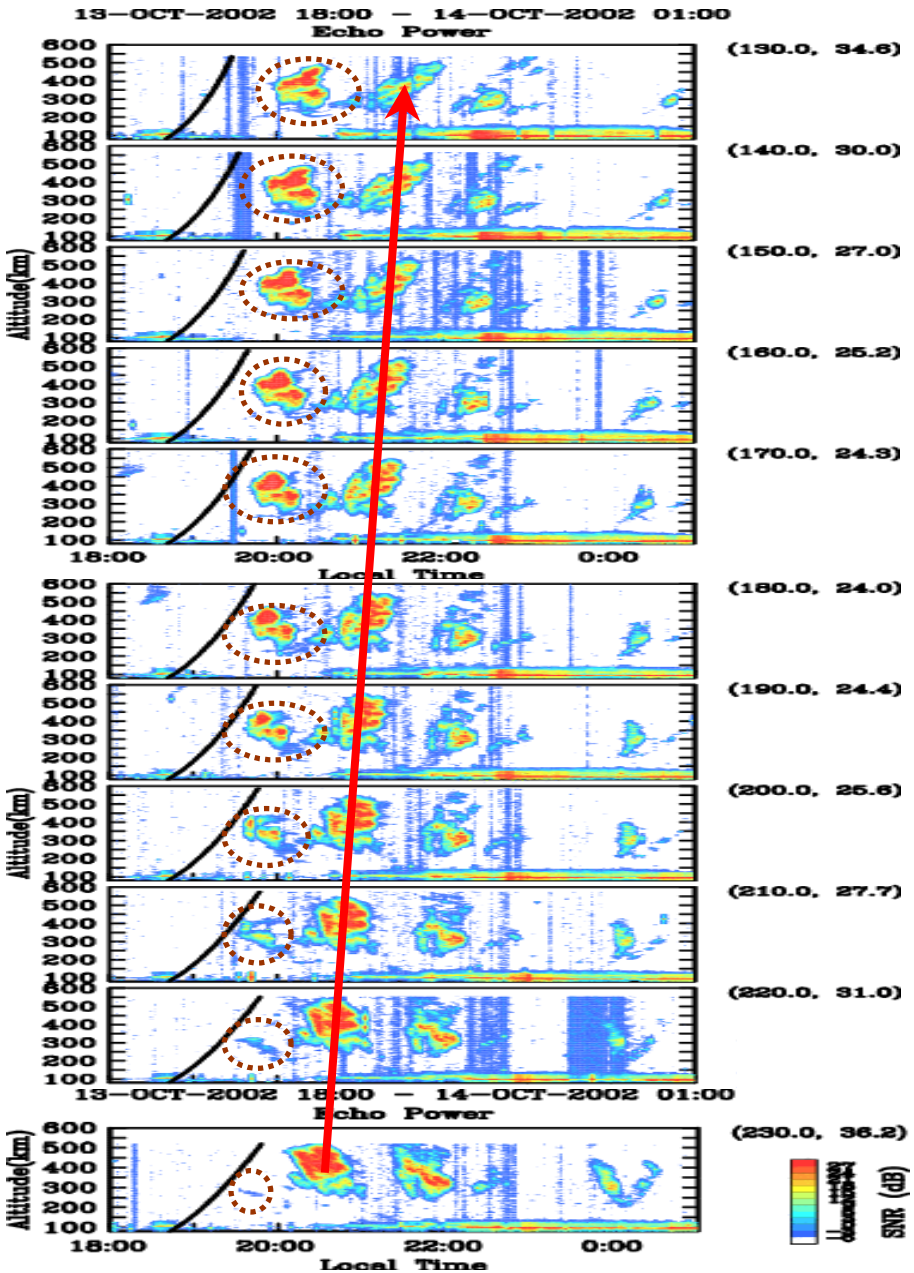
Altitude-Time Intensity (ATI) plot



Intense FAI echoes associated with plasma bubbles were observed from the EAR southward beam soon after the F-region sunset. Maximum altitude of the echoes reached 800 km.

S. Fukao, Y. Ozawa, T. Yokoyama, M. Yamamoto, and R. T. Tsunoda, *J. Geophys. Res.*, **109**, A02304, 2004.

EAR Multiple Beam Observation of F-region FAI



Growing FAI

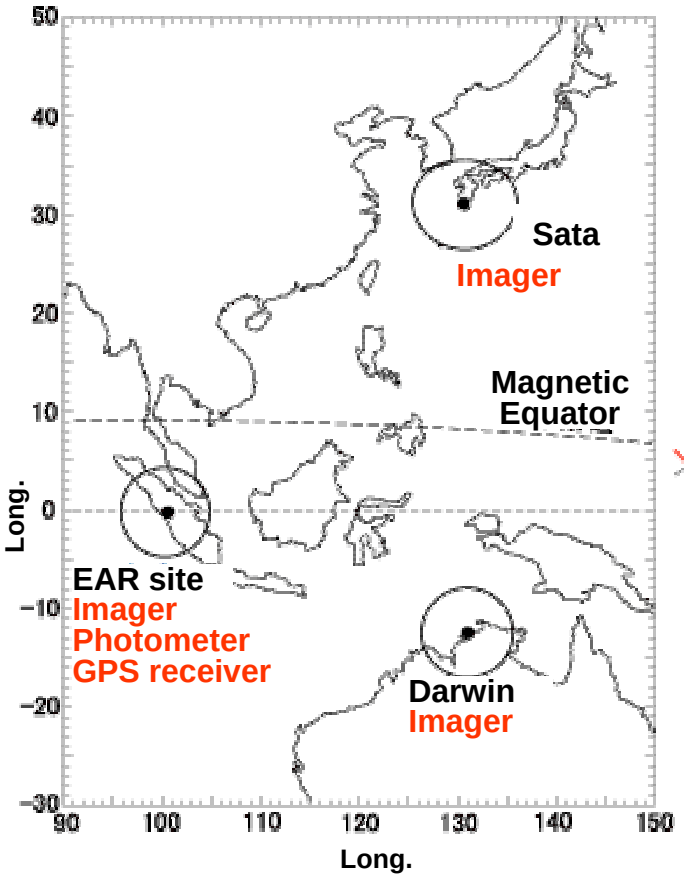
Growing FAIs were detected in the observation region with 11 beam directions.

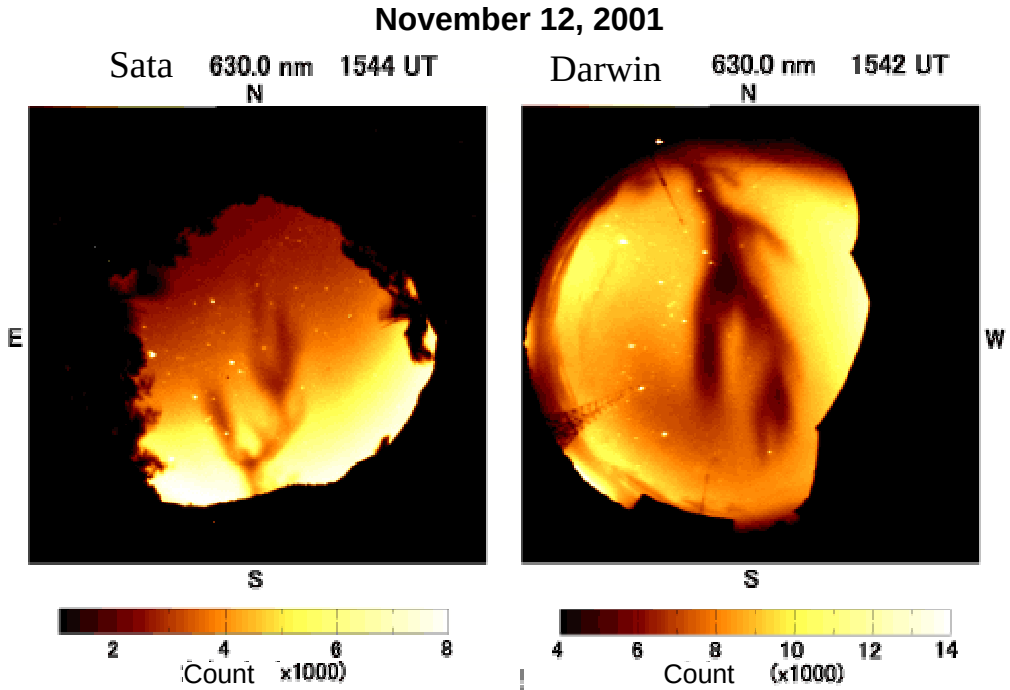
Eastward propagation of FAI echoing region is clearly seen.

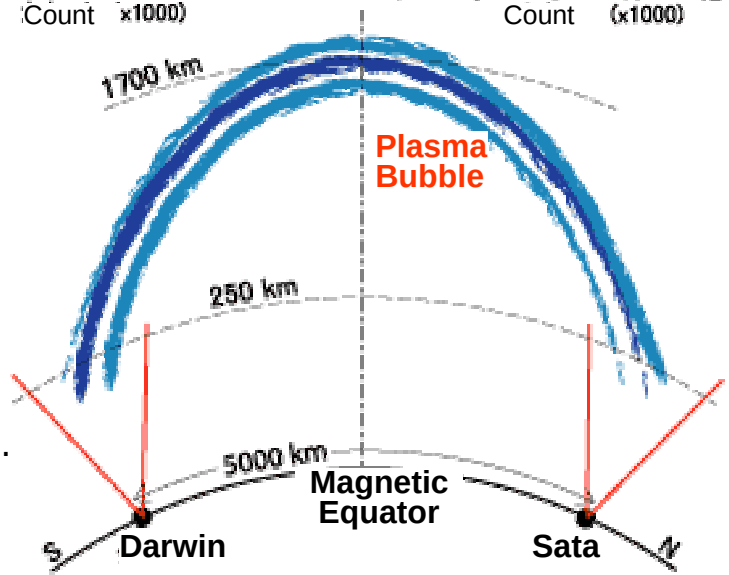
Terminator

Plasma Bubbles Observed with Airglow Imagers at Conjugate Points

A06
A04







Observation by Prof. Ogawa group
STE Lab., Nagoya Univ.

Otsuka, Y., K. Shiokawa, T. Ogawa, and P. Wilkinson, *Geophys. Res. Lett.*, 29(15), 10.1029/2002GL015347, 2002.
Shiokawa, K., Y. Otsuka, T. Ogawa, and P. Wilkinson, *Ann. Geophysicae*, in press, 2004.

CAWSES Workshop Needed

- Provide forum for initiating & developing collaborations – ISEA, Taipei, May, 2005 possible
- Discuss ITM observations during space weather (25 March - 6 April) & atmospheric coupling (March - April 2004) portions of the CAWSES campaign
- Collect science issues for focused community efforts, discuss future & retrospective campaigns
- Discuss the value of initiating campaign efforts in:
  - assimilative modeling
  - one-atmosphere modeling
  - worldwide maps of atmospheric quantities (e.g., gravity waves, mesospheric winds, etc.)
  - worldwide maps of ionosphere/thermosphere quantities (in addition to ULF wave parameters)