Space Situational Awareness Activities at the Institute of Space Systems Bremen

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Content

1. DLR Institute of Space Systems Bremen (ISSHB)
2. Overview of past and contemporary projects towards SSA (10 years: 1998 – 2008)
3. Sketch of (nearby) future SSA related activities at ISSHB
1. DLR Institute of Space Systems

- A new DLR Institute in Bremen
  - Founded 26 January 2007
  - Today: 82 staffs (12 in Berlin)
  - Target 2010: 120 – 150 staff members

- Objectives
  - Analysis and assessment of concepts for space missions with high visibility
  - Space based applications in scientific, commercial and security projects
  - Advice to agency and politics in the decision process on space activities
  - Contribution to the training of space system engineers
1. DLR Institute of Space Systems

Director
Prof. Dr. H. Dittus

Controlling, Logistics
Dr. Schanz

QM
Dr. Rößler

Secretary
Schütte

System Analysis
- System Analysis Orbital Systems (SR) Dr. Romberg
- System Analysis Space Transportation (RT) Dr. Sippel

System Technology
- Navigation and Control Systems (NR) Dr. Theil
- Transport- & Propulsion Systems (TA) Dr. Gerstmann
- Orbital Systems & Security (OR) Behrens
- Central Avionics -Systems (AS) Dr. Montenegro
- Explorations Systems (ES) Dr. Richter
- System Tests and Verification (SK) Dr. Lura*

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2. Overview of past and contemporary projects towards SSA (examples: ESA, Swiss Re)

1998 ... 2008: ESA / ESTEC

2000: http://www.swissre.com/
2. Overview of past and contemporary projects towards SSA (examples: ESA, EU)

2000 / 2001: SW Feasibility Studies

2002 / 2003: EU / FP 5 SWE (Space Weather and Europe)
2. Overview of past and contemporary projects towards SSA (example: Alcatel team)

CONSORTIUM
Members

Team Members (2/2):
- LPG (Grenoble-Fr) : Parameters and mo
- LPSH/ Obs de Paris(Meudon-Fr) : Ground Segment & Sun Observation
- Imperial College (UK) : Prototyping and Modelling
- Université Greifswald (D) : SW Parameters
2. Overview of past and contemporary projects towards SSA (example: towards CME via CRs)

<table>
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<tr>
<th>Solar observations</th>
<th>Full Scale</th>
<th>Medium Scale</th>
<th>Low Scale</th>
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<td>Broad frequency radio spectographe (above 40 MHz) Radio imaging.</td>
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<td>Upstream (including interplanetary)</td>
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<td>Magnetostric monitoring</td>
<td>Covered under I/T monitoring</td>
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<td>Ionosphere/Thermosphere Monitoring</td>
<td>Magnetometer networks, Positioning networks SuperDARN network, F10.7cm</td>
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2001: ground based space weather telescope based on cosmic ray muon detection

result: MuSTAnG 2004 - 2006
2. Overview of past and contemporary projects towards SSA (principle: CME via CRs?)

Galactic CRs interact with CME / shock, propagate from FD region to the upstream Earth with the speed of light overtaking the CME shock ahead ⇒ isotropic versus anisotropic distribution on ground and in NEO.
2. Overview of past and contemporary projects towards SSA (principle: muon telescopes)

Typical energy of primary ~50 GeV for Galactic cosmic rays (surface muon detector)

The detector of the Muon Telescopes at SSO / Brazil
2. Overview of past and contemporary projects towards SSA (GMDN telescopes)

Ground bases compared to space based CME / CR telescopes?

Data

Access

Technology
2. Overview of past and contemporary projects towards SSA (GMDN: viewing, overlapping, time)

Observing directions:
Nagoya, Japan 17
Hobart, Australia 13
Greifswald, Germany 9
Aragats, Armenia 11
Kuwait, Kuwait 13
São Martinho da Serra, Brazil 17

!!! 10 – 20 hours in advance the CME detection !!!
2. Overview of past and contemporary projects towards SSA (GMDN: counts / anisotropy)

\[ I_{i,j}^{\text{cal}}(t) = c_{0i,j}^{0}(t) + \xi_{x}^{\text{GEO}}(t)(c_{li,j}^{l} \cos \omega t_{i} - s_{li,j}^{l} \sin \omega t_{i}) \]
\[ + \xi_{y}^{\text{GEO}}(t)(s_{li,j}^{l} \cos \omega t_{i} + c_{li,j}^{l} \sin \omega t_{i}) \]
\[ + \xi_{z}^{\text{GEO}}(t)c_{li,j}^{0} \]

\[ I^{0}(t), \xi_{x}^{\text{GEO}}(t), \xi_{y}^{\text{GEO}}(t), \xi_{z}^{\text{GEO}}(t) \]
\[ \omega = \frac{2\pi}{24} \]

CR muon data:

1 Shinshu University Japan, 2 Australian Antarctic Division Australia, 3 University of Delaware, U.S.A.
4 University of Bern Switzerland, 5 University of Kuwait, 6 Brazilian Southern Space Observatory
2. Overview of past and contemporary projects towards SSA (GMDN: SW service from CR anisotropy)

- CR muon anisotropy (%) is a measure of interplanetary CME
- data from CR muon anisotropy: HST, NST, SMST, KPC
- space weather operator friendly displays for Bz, Kp and CR muon anisotropy
- real time service: ACE, CR, CME
2. Overview of past and contemporary projects towards SSA (GMDN: December 2006)

Real Time Space Weather Cloud Warning (Muon Telescope Network)
Last 3 days 13 December 2006 - 15 December 2006

24 h in advance Earth in SW cloud
2. Overview of past and contemporary projects towards SSA (COST, SWEETS)

2003 – 2007: EU COST 724 action
„Developing the basis for monitoring, modelling and predicting space weather“

**Result:** European Space Weather Web Portal under
http://www.spaceweather.eu

EU FP6 2007: SWEETS
(Space Weather and Europe – an Educational Tool with the Sun)
2. Overview of past and contemporary projects (NATO 2006)

Ionosphere and space weather
2. Overview of past and contemporary projects towards SSA (EU ESP White Paper => ESA SSA)

  „…be needed to ensure that Europe has the capacity to supply to the different users critical information on solar flares, near Earth objects, space debris („space weather prediction“)…“

- implementation of European Space Policy (ESP) by SSA

  ESP:
  - peaceful use of outer space,
  - space has a security dimension and security has a space dimension
    => global monitoring, navigation, communication, early warning, space surveillance…

- ESA Ministerial Council November 2008
  - definition and scope of an European SSA system
  - safe usage of space infrastructures, protection of infrastructure
  - space infrastructures as a key for economic development, protection of population

- SSA fields: space weather, space debris, asteroids / NEO impacts
3. (Nearby) future SSA related activities at DLR / ISSHB
(DLR / ISSHB to NEO field)

Compact satellite AsteroidFinder
- satellite bus based on BIRD (TET)
- phase A finished
- phase B in 2009
- launch in 2012
- to be operated by GSOC

- CREME 96 + SPENVIS
- TID (trapped + solar particles)
- 3 years at 850 km orbit
3. (Nearby) future SSA related activities at DLR / ISSHB (DLR ISSHB to SW field)

Proposal for a Space Weather Warning for Space Systems

Proposal to ESA 02/09

GMDN: CR WIND (Test Phase)
3. (Nearby) future SSA related activities at DLR / ISSHB (DLR ISSHB to SW field)

- user friendly service: real time, early, monthly, 27, 3 days

and others plots from GMDN

- University of Delaware / Bartol and DLR Institute of Space Systems / Bremen
3. (Nearby) future SSA related activities at DLR / ISSHB
(DLR ISSHB to SW field: proposal NESTEC – SSA / SW orientated s/c)
3. (Nearby) future SSA related activities at DLR / ISSHB
(DLR ISSHB to SW field: space radiation monitors)

Proposal to ESA (04/09)
(successor of SREM / Galileo)
New Laboratory Building
DLR Institute of Space Systems

2010 Bremen: 38th COSPAR Scientific Assembly, SSA session!