Update on WMO’s Space-related Activities

Jérôme Lafeuille
WMO Space Programme Office
World Meteorological Organization
Geneva
Outline

• WMO Space Programme
  – New challenges for space-based observing systems
  – Link with GEO / GEOSS
  – Data access / Geonetcast
  – Capacity building / Virtual Laboratory

• Space Weather
WMO Space Programme
Satellites in support of WMO and co-sponsored programmes

- World Weather Watch and applications
  - NWP, Public Weather Services, Aero, Marine, Agriculture
  - Tropical Cyclone Programme
- Hydrology and Water Resources
- Disaster Risk Reduction
- Atmospheric chemistry
  - Air quality, Climate
- Climate programmes
  - GCOS
  - WCRP (CLIC, GEWEX, SPARC, CLIVAR..)
  - WCP
- Telecommunications
WMO Space Programme
Three main areas

Enhance the space-based GOS

Satellite operators
CGMS & CEOS

Users: all WMO & co-sponsored programmes

Enhance access to sat data

Enhance users’ capability to benefit from satellites
Enhancing the space-based GOS
Agencies contributing to the GOS

- CMA
- EUMETSAT
- IMD
- JMA
- KMA
- NOAA
- ROSHYDROMET
## A busy launch plan!

### Status of current and planned CGMS Members satellites

#### Current low earth orbit (LEO) satellites contributing to the GOS

Information maintained by WMO Space Programme on behalf of CGMS  
(This table was last updated on 20 November 2008)

<table>
<thead>
<tr>
<th>Orbit type</th>
<th>Satellites in orbit</th>
<th>Operator</th>
<th>Equator Crossing Time (ECT)</th>
<th>Mean Altitude</th>
<th>Launch date</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun-synchronous “Morning” orbit (ECT between 19:00-24:00 or 07:00-12:00)</td>
<td>FY-3A (P)</td>
<td>China/CMA</td>
<td>22:00</td>
<td>836 km</td>
<td>27/05/2008</td>
<td>MSR, MERSI, MWIR, MWTS, MWHS, IRAS, TOS/SBUS, ERM/SIM, Direct Broadcast</td>
</tr>
<tr>
<td></td>
<td>METOP-A (Op)</td>
<td>EUMETSAT</td>
<td>21:30</td>
<td>837 km</td>
<td>19/10/2006</td>
<td>Operational. HRPT and LRPT not functional. Dissemination via EUMETCast</td>
</tr>
<tr>
<td></td>
<td>DMSP-F16 (OP)</td>
<td>USANNOA</td>
<td>20:04</td>
<td>850 km</td>
<td>18/10/2003</td>
<td>Defense satellite. Data available to civilian users through NOAA.</td>
</tr>
<tr>
<td></td>
<td>DMSP-F15 (B)</td>
<td>USANNOA</td>
<td>19:37</td>
<td>850 km</td>
<td>12/12/1999</td>
<td>Defense satellite. SSMT2 non-functional. Data available to civilian users through NOAA.</td>
</tr>
<tr>
<td>Sun-synchronous “Early morning” orbit (ECT between 17:00-19:00 or 05:00-07:00)</td>
<td>FY-1D (Op)</td>
<td>China/CMA</td>
<td>18:50</td>
<td>866 km</td>
<td>15/05/2002</td>
<td>Functional. VIRR, SEM. Direct Broadcast CHIRPT</td>
</tr>
<tr>
<td></td>
<td>DMSP-F13 (Op)</td>
<td>USANNOA</td>
<td>18:33</td>
<td>850 km</td>
<td>03/1995</td>
<td>Defense satellite. On orbit 13 years! Data available to civilian users through NOAA.</td>
</tr>
<tr>
<td></td>
<td>DMSP-F17 (Op)</td>
<td>USANNOA</td>
<td>17:31</td>
<td>850 km</td>
<td>11/2006</td>
<td>Defense satellite. Data available to civilian users through NOAA.</td>
</tr>
<tr>
<td></td>
<td>DMSP-F14 (B)</td>
<td>USANNOA</td>
<td>17:24</td>
<td>852 km</td>
<td>10/04/1997</td>
<td>Defense satellite. SSMT1 and SSMT2 (microwave temperature and humidity sounder) non-functional. Only 1 functional onboard recorder. Data available to civilian users through NOAA.</td>
</tr>
<tr>
<td></td>
<td>NOAA-16 (B)</td>
<td>USANNOA</td>
<td>17:12</td>
<td>850 km</td>
<td>21/09/2000</td>
<td>Functional. No APT. Intermittent problems with AVHRR.</td>
</tr>
<tr>
<td>Sun-synchronous “Afternoon” orbit (ECT between 12:00-17:00 and 00:00-05:00)</td>
<td>NOAA-15 (B)</td>
<td>USANNOA</td>
<td>16:55</td>
<td>807 km</td>
<td>05/1998</td>
<td>Functional intermittent problems on AVHRR, AMSU-B &amp; HIRS</td>
</tr>
<tr>
<td>Non sun-synchronous</td>
<td>JASON-2 (P) (Ocean Surface Topography Mission)</td>
<td>NASA/NOAA/EUMETSAT/ CNES</td>
<td>(88° incl.)</td>
<td>1336 km</td>
<td>20/06/2008</td>
<td>Follow-on of JASON-1 Sea surface topography measurement</td>
</tr>
</tbody>
</table>

Jump to the table for:  
- Future LEO satellites  
- Current GEO satellites  
- Future GEO satellites  
- Current R&D satellites  
- Future R&D satellites  

Click on the satellite name in the table below to find more information (external links)

[Status and plans on: cgms.wmo.int](http://cgms.wmo.int)
CURRENT GEOSTATIONARY COVERAGE

Latitude
-180 -150 -120 -90 -60 -30 0 30 60 90
Longitude
-180 -150 -120 -90 -60 -30 0 30 60 90 120 150 180

GOES-W  GOES-SA  Meteosat  IODC  GOES-E
GOMS  Kalpana  FY-2D  FY-2C  MTSAT-1R

IAM-2009, Vienna, 6-8 March 2009
Equatorial Crossing Times of planned polar orbiting missions in 2010/2011

ECT: 06h

ECT: 00h

ECT: 18h

ECT: 12h

Meteor-M2

FY-3B

NOAA-19

FY-3A

Metop

Meteor-M1

DMSP

North Pole view

11IAM-2009, Vienna, 6-8 March 2009
Global Space-based Inter-calibration System (GSICS)  
CMA, CNES, EUMETSAT, JMA, KMA, NASA, NOAA, NIST

POLAR-POLAR intercalibration

- To ensure consistency of datasets from different missions and operators
- 8 Organizations currently contributing (+WMO)

Simultaneous Nadir Overpass (SNO) inter-calibration method

- Images: courtesy of Mitch Goldberg, NOAA/NESDIS
Specialized Centres for Operational Processing of Environmental Satellite Observation Data (SCOPE)

- For sustained generation of quality-controlled products
- Initial scope: Climate Monitoring (SCOPE-CM)

Satellites & sensors → Satellite data → Consistent Calibrated data sets → Essential Climate Variables products

GOS → GSICS → SCOPE-CM

Users
Overview of Weather and Climate Models and the Required Observations

Mid-1970s
Atmosphere
Land Surface
Ocean & Sea Ice

Mid-1980s
Atmosphere
Land Surface
Ocean & Sea Ice

Early 1990s
Atmosphere
Land Surface
Ocean & Sea Ice
Sulphate Aerosol

Late 1990s
Atmosphere
Land Surface
Ocean & Sea Ice
Sulphate Aerosol
Non-sulphate Aerosol
Carbon Cycle

Present Day
Atmosphere
Land Surface
Ocean & Sea Ice
Sulphate Aerosol
Non-sulphate Aerosol
Carbon Cycle
Dynamic Vegetation
Atmospheric Chemistry

Early 2000s?
Atmosphere
Land Surface
Ocean & Sea Ice
Sulphate Aerosol
Non-sulphate Aerosol
Carbon Cycle
Dynamic Vegetation
Atmospheric Chemistry

Weather
Climate Variability
Climate Change

Need an Integrated Global Observing System Going Beyond the WWW
Challenges for the GOS to 2025

- Core operational GEO missions
  - All with IR hyperspectral sounding, lightning detection
- Core operational LEO Imagery and IR-MW sounding
  - All with hyperspectral IR, on 3 sun-synchronous orbital planes
- Ocean surface topography
- Radio-Occultation Sounding
- Ocean Surface Wind
- Global Precipitation
- Earth Radiation Budget
- Atmospheric Composition
- Special imaging for ocean colour, vegetation
- Dual-angle view IR imagery
- Land Surface Imaging
- Synthetic Aperture Radar
- Space Weather instruments

Observations performed so far on a R&D basis should be planned on an operational basis

Integrating new missions
The GOS as a component of GEOSS

WMO: Focus on Weather-Water-Climate and applications

GOS

Other observing systems

Weather

Climate

Water

Disasters

Agriculture

Health

Energy

Biodiversity

Ecosystems

9 SBAs
Ensuring timely access to satellite data and products

Access still limited for many WMO Members

Challenges of new satellite generation
IGDDS/GEONETCast DVB-S status

- EUMETSAT, NOAA, CMA, ROSHYDROMET
- Data exchange among service providers
- Possibility to disseminate locally generated products
- Training channel of Geonetcast
User support activities

- Training / capacity building in least dev. countries
- User information
- Enquiry on the use of satellite by Members
New 5-year Strategy of the Virtual Laboratory for Training in Satellite Meteorology

• Centres of Excellence in all WMO Regions / languages
• Blended learning (distance, face-to-face, computer aided)
• Regional Focus Groups around each CoE
• Centrally managed Virtual Resource Library
• Expansion to environmental topics
• Continued active sponsoring by satellite operators
New Centres of Excellence for Training within the Virtual Laboratory

Sponsored by space agencies
Space Weather
Report to the WMO Exec. Council

Potential role of WMO in Space Weather

- In response to WMO Congress and Consultative Meeting on space policy
- Drafted in cooperation with ISES (April 2008)
- Describes economic impact
- Potential scope, cost and benefit of WMO coordination
- Analysis suggests high benefit / cost

www.wmo.int/pages/prog/sat/Refdocuments.html#SpaceWeather
Relevance for WMO

Space Weather events....
- affect meteorological / environmental satellites
- are monitored by meteorological (and other) satellites
- affect meteorological communications
- affect some climate variables
- potential for synergy between Space Weather and meteorological warnings e.g. to aviation

✓ Work plans to be developed by Commission for Basic Systems (CBS) and Commission for Aeronautical Meteorology (CAeM)

✓ Cooperation with ISES, UN-COPUOS, ICAO, ITU, IMO
Thank you for your attention