Future Climate Observation Activities of ESA

GCOS Conference 2016

Amsterdam, 2 March 2016

Prof. Volker Liebig, ESA

Director of Earth Observation Programmes
- Global average temperature increase to be limited to 2°C; working towards a maximum increase of 1.5°C
- Reporting every 5 years, from 2023 onwards
- Key to success: Intended Nationally Determined Contributions (INDC), which in their current amount would NOT lead to a max.temperature increase of 2°C
COP-21 and ESA

Satellite based Earth observation can support relevant topics of the Agreement, such as:

- Reporting (e.g. IPCC)
- Global Stocktake
- Implementation/Verification
- Mitigation measures
- Public Awareness
ESA integrated response to COP-21

- GCOS integrated approach in Implementation Plan coordinated with IPCC and UNFCCC
- CEOS Climate WG coordinates space climate data
- Global data products available through the ESA CCI
- Co-ordination in Europe with EC (DG/GROW, DG/RTD) and EUMETSAT for an overall European response to COP21
- REDD+ actions led by ESA on behalf of space agencies, providing major mitigation route
- ESA partnership with World Bank on climate actions, risk reduction, adaptation and mitigation services
- Development of new satellite and instrument systems through Copernicus and EOEP-5
ESA integrated response to COP-21

Monitoring ECVs

New Gen EO Missions: Explorer
Copernicus Met Missions

Assessing Impact

New Gen Climate Data

Responding

New Gen EO Products & Services

Partnerships

Adaptation

Mitigation

Climate Services
COP-21: Consequences for ESA

Need for **Forest Monitoring**:
- Global Forest Observation Initiative (GFOI) supports UN REDD+ implementation
- Sentinel-2A+2B, 3A+3B

Need for **Carbon Monitoring**:
- Development of carbon instrument, based on recently suggested Carbonsat mission

**Process Understanding**:
Earthcare, Cryosat, SMOS

**Carbon Cycle**: Biomass

Amazon Rain Forest, Rondonia, Brazil 2015, Sentinel-2A
CCI+ Scope:

i. Development of new ECVs (i.e. ECVs that were not started in CCI so far)

ii. New R&D on ECVs that were started in CCI

iii. Cross-ECV scientific exploitation (demonstration)

NB: CCI+ will not build operational processing systems
## Preliminary analysis of new ECVs in CCI+

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<tr>
<th>Atmosphere</th>
<th>Ocean</th>
<th>Terrestrial</th>
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<tbody>
<tr>
<td><strong>Composition</strong></td>
<td><strong>Surface</strong></td>
<td><strong>Land Cover - High Resolution</strong></td>
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<tr>
<td>Aerosol Properties</td>
<td>Sea Surface Temperature</td>
<td>Fire Disturbance</td>
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<tr>
<td>Carbon Dioxide &amp; Methane</td>
<td>Sea Level</td>
<td>Soil Moisture</td>
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<td>Ozone</td>
<td>Sea Ice</td>
<td>Glaciers and Ice Caps</td>
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<td>Long-Lived Greenhouse Gases</td>
<td>Ocean Colour</td>
<td>Ice Sheets</td>
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<td>Precursors (for Aerosols and Ozone)</td>
<td>Sea State</td>
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<td><strong>Upper Air</strong></td>
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<tr>
<td>Cloud Properties</td>
<td>Current</td>
<td>Snow Cover</td>
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<tr>
<td>Temperature</td>
<td>Sea Surface Salinity</td>
<td>Albedo</td>
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<tr>
<td>Water Vapour</td>
<td>Carbon Dioxide Partial Pressure</td>
<td>Leaf Area Index (LAI)</td>
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<td>Wind Speed and Direction</td>
<td>Phytoplankton</td>
<td>FAPAR</td>
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<tr>
<td>Earth Radiation Budget</td>
<td>Ocean Acidity</td>
<td>Lakes</td>
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<tr>
<td><strong>Surface</strong></td>
<td>Sub Surface</td>
<td>Above Ground Biomass</td>
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<tr>
<td>Surface Air Pressure</td>
<td>Carbon</td>
<td>Permafrost</td>
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<tr>
<td>Surface Air Temperature</td>
<td>Current</td>
<td>Ground Water</td>
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<tr>
<td>Surface Precipitation</td>
<td>Nutrients</td>
<td>River Discharge</td>
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<td>Surface Radiation Budget</td>
<td>Ocean Acidity</td>
<td>Soil Carbon</td>
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<tr>
<td>Water Vapour (Surface humidity)</td>
<td>Oxygen</td>
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<tr>
<td>Near-Surface Wind Speed, Dir</td>
<td>Salinity</td>
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<td></td>
<td>Temperature</td>
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<td>Tracers</td>
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<td>Global Ocean Heat Content</td>
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<tr>
<th><strong>Within scope of CCI</strong></th>
<th><strong>Started in CCI</strong></th>
<th><strong>Proposed in CCI+ Extension</strong></th>
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</table>
CO₂: A Growing Concern

- Report by EC Expert Group released Oct ‘15
- Goal is to establish European operational CO₂ monitoring system by 2030, pre-operational by 2025
- Required measurement techniques not available yet worldwide
ESA has accumulated critical experience through preparatory work on **Carbonsat**

**Goals of CarbonSat**
- man-made emissions & natural fluxes
- CO$_2$ & CH$_4$
- at local, country & global scale

**What’s new?**
Is the only space-based system to distinguish anthropogenic emissions (e.g. cities) from natural sources.
High resolution and wide swath imaging
The Sentinel Family

- S1: Radar Mission
- S2: High Resolution Optical Mission
- S3: Medium Resolution Imaging and Altimetry Mission
- S4: GEO Atmospheric Chemistry Mission
- S5P/S5: LEO Atmospheric Chemistry Missions
- S6/Jason-CS: Altimetry Mission

S3A launch
16 Feb 2016
First OLCI Images from Sentinel-3

S3 OLCI Svalbard, 14:09 GMT on 29 February 2016
Copernicus data, 2016
First OLCI Images from Sentinel-3

Spain and Northern Africa, 1 March 10:32:48 UTC

Copernicus data, 2016
First OLCI Images from Sentinel-3

California, 29 February 2016, 17:44 GMT

Copernicus data, 2016
Sentinels address the majority of the satellite-based GCOS ECVs.

Copernicus Climate Change Service (C3S)
- under development

- Copernicus Marine Environment Monitoring Service - global datasets of ocean physics and bio-geochemistry parameters, e.g. SST, sea ice, SLA, ocean chlorophyll

- Copernicus Atmosphere Monitoring Service - global datasets, e.g. atmospheric composition, estimates of climate forcings from aerosols, CO₂ and CH₄, anthropogenic emissions from wildfires and biomass burning

- Copernicus Global Land Service - global bio-geophysical variables, e.g. vegetation, energy budget, water cycle
Continuation of experimental Ice Sheet Monitoring

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<tr>
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<th>2003-2008</th>
<th>2011-2012</th>
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<tr>
<td>IMBIE</td>
<td>-189±20 km³/yr</td>
<td>-352±29 km³/yr</td>
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<td>CryoSat</td>
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**IMBIE 2 and Cryosat Follow-on under discussion**
ESD Ministerial Council 2016

Relevant Elements:

- CCI+

- EOEP-5
  - Architectural studies for space component of a comprehensive European CO₂ monitoring system
  - Pre-development of CO₂ instrument
  - Mission preparation Copernicus Second Generation

- Long Term Data Preservation
Thank you for your attention