Future Space-borne observation of climate change processes

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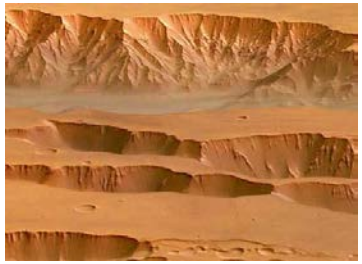
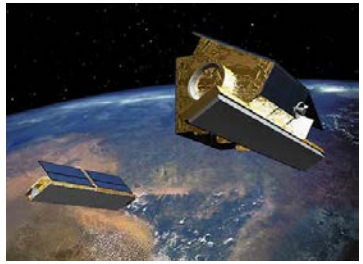
DLR Space Research and Technology

- Space exploration
- Zero gravity research
- Earth observation
- Communication and navigation
- Space transport
- Technology of space systems



Guiding Principles – Vision

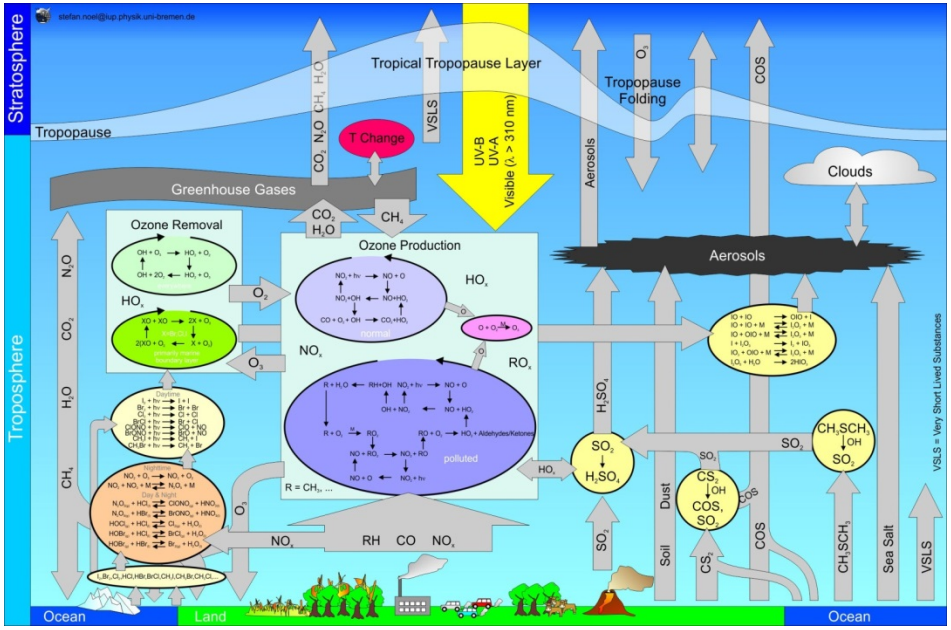
- DLR – one of Europe's leading public research institutions, setting trends in its aeronautics, space, transport and energy business areas
- DLR – in its space agency function, a force that shapes European space activities
- DLR – the biggest space research center in Europe
- DLR – an active partner in IPCC (Intergovernmental Panel on Climate Change)

The atmosphere: What‘s wrong?

- Conditions in the biosphere depend on the interactions of the Sun, the atmosphere, and earth‘s surface and their non linear feedback.

- Dramatic changes in population and anthropogenic emissions since 1800! Example: of 5 Billion people - since SCIAMACHY has been proposed in 1988 - to a total of over 7 Billion now.

- The atmosphere is changing dramatically as a result of mankind.



Emissions Major Source of Uncertainty

Fossil Fuel

Biomass Burning

Volcanoes

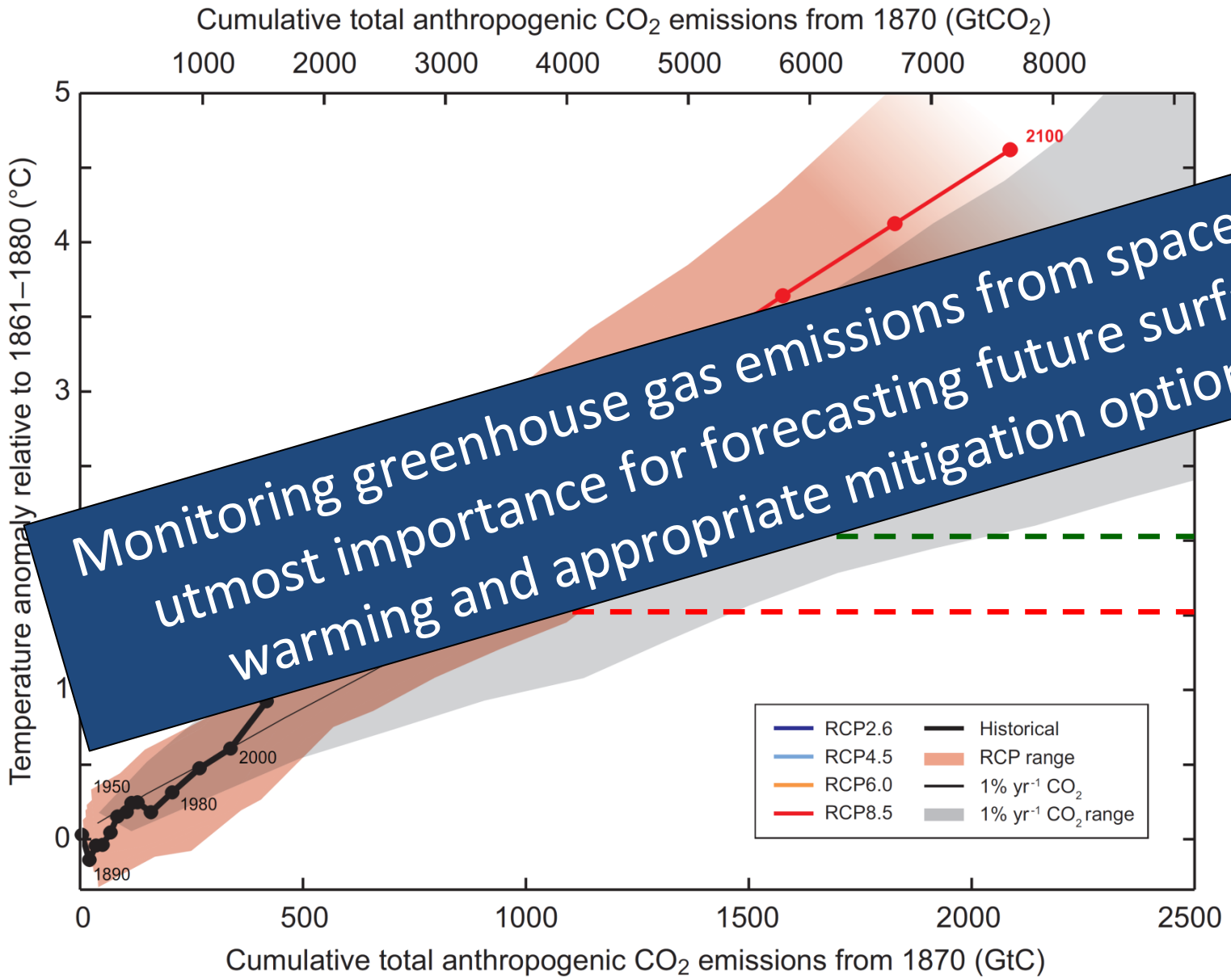
Forests

Soils

Oceans

Lightning

Temperature response to cumulative anthropogenic CO_2 emissions



Monitoring greenhouse gas emissions from space is of utmost importance for forecasting future surface warming and appropriate mitigation options

IPCC, 2013

Why is Atmospheric Observation so important?

- It is impossible to understand or manage what is not measured!
- Atmospheric composition provides early warning of changes to come!
- Environmental / Climate Change requires Global Observations!
- Evidence base for testing our understanding and for policymaking!
- Conclusion: long-time data series for Atmospheric Observation are needed

Opportunities for Space Research and Technology

- The Paris Agreement sets long-term temperature goals and commits the participants to take all possible action they can to the best of their capabilities and within the realm of their responsibility to meet them.

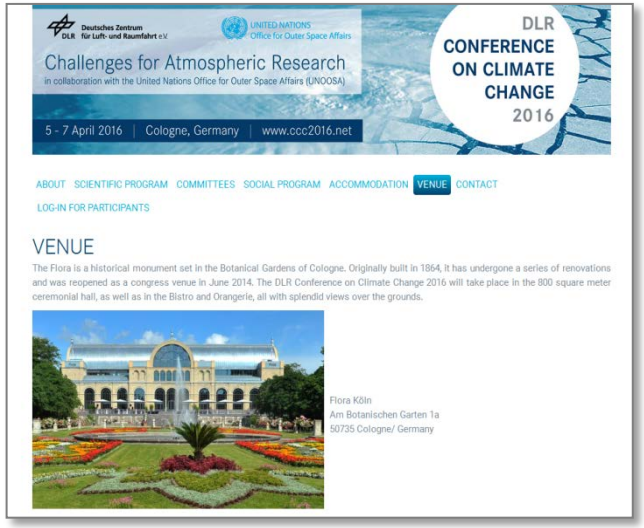
- At Sendai it was stated that climate monitoring should be done via satellites.

- Space Research and Technology can provide support by delivering services and information needed to implement the resolutions of the Paris Agreement

    - This includes:
        - **identifying** possible climate protection and countermeasures by being able to supply the appropriate observation data
        - systematically **interpreting the data** and thus delivering the base line/status for further action/implementation steps
        - providing a **data-base** for long-term interpretation
        - contributing to the establishment of an operational and internationally acceptable **Global Monitoring System**

DLR Conference on Climate Change 2016 (CCC 2016) Changes for Atmospheric Research

- 5 – 7 April 2016, Cologne, Germany
- In cooperation with the United Nations Office for Outer Space Affairs
- About 50 participants (scientists, members from space agencies and UN entities as UNOOSA, UNFCC, WMO…)
- Conference has had a clearly scientific focus on atmospheric challenges as well as on technical approaches to solve the problem



Results from CCC 2016

- Clouds, convection, circulation and carbon pose important **challenges to the Earth's atmosphere.**
- Stratospheric observations are still needed to monitor the **recovery of the stratospheric ozone layer.**
- **Non-CO_2 climate effects**, mostly short-lived climate forcers play a crucial role in aviation and surface transport related climate effects. Many of these non-CO_2 climate effects may be mitigated by technological and/or operational means.
- Space borne measurements should include **a combination of passive and active** GHG **remote sensing** such as CarbonSat/CarbonSat-Constellation and MERLIN to achieve **optimum spatial coverage** and minimal bias.
- The **global mean temperature** remains the single **most important variable** for **quantifying climate change**, and remains central to all discussion of adaptation.

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Climate-related parameters

Experts agreed on the following parameters to be constantly monitored to achieve reliable information of the climate's status.

- 3D temperature (for directs observing climate change, for good re-analyses)
- 3D wind (for good re-analyses)
- water vapour (for good re-analyses, for determination of climate sensitivity)
- clouds (for determination of climate sensitivity)
- surface parameters (for determination of climate sensitivity)

Recommendations from CCC 2016

An integrated observation system is **necessary**
for better understanding of climate signals and processes and **to secure compliance with international agreements such as those formulated at COP21.**

More national/international satellites for atmospheric monitoring are needed (optical, radar, infrared).

To make the information **available to all countries** (not only to those with access to space infrastructures) and to make sure that the data are **impartial** and free from certain political or economic interests, this observation system should be run as an **independent reference system** (spatial, timed, spectral).

A monitoring system is currently operating from the International Space Station. On ISS-follow up infrastructures (e.g. free-flyer) more efficient instruments could be implemented. Under the auspices of an international community of states, led by e.g. UNOOSA, an independent referent station could be build up.

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DLR‘s Future Objectives in LEO

Concept: DLR & Airbus

DLR’s Orbital-Hub concept with Free-Flyer consisting of external science platform and pressurized laboratory

Conclusions

- **Compliance with any climate protection treaty can only be achieved by a continous monitoring of the Earth‘s atmosphere from space.**

- We need forecasts with high degree of reliability on regular as well as extraordinary meteorological events in near real time.

- We need excellent tools and methods of analysis to support crisis managment in case of extreme meteorological events.

Short-term:

ISS could be used as monitoring plattform for atmospheric observation.

Long-term:

To achieve COP 21 goals we need intelligent new national/international satellite systems and a reliable reference base.