IPCC Atmosphere Breakout: Summary

Breakout of Session 7: How To Address Knowledge Gaps In Preparation For AR7

Chair: Simon Pinnock (ESA);   RapporteurThomas Popp (DLR-DFD, Aerosol)

ECV atmosphere projects (names of input providers): GHG (Michael Buchwitz), Ozone (Daan Hubert), Aerosols (Thomas Popp), Water vapour (Marc Schröder), Clouds (Martin Stengel), Precursors supporting aerosols and O3 ECVs (CO, HCHO, SO2, NO2) (Folkert Boersma), RECCAP-2; several online participants

Seed questions:

1. Where do you see the major challenges and gap analysis in the current IPCC AR6 and how could CCI/CLIMATE-SPACE contribute to addressing them towards AR7?
2. What are the opportunities to engage with the information (papers, organisations, authors, reviewers etc.) that contribute to the WG II and III reports?
3. How can CCI contribute more *systematically* towards IPCC's assessment and special reports in future?

1. Where do you see the major challenges and gap analysis in the current IPCC AR6 and how could CCI/CLIMATE-SPACE contribute to addressing them towards AR7?

- **Basis**: improvement + extension of data records

- **Beyond** data records?! (NRT, process studies)

- A number of **good ideas** for cross-ECV studies

- Make data available **easy to use** for attribution – combining different data / co-emitted species

1. Where do you see the major challenges and gap analysis in the current IPCC AR6 and how could CCI/CLIMATE-SPACE contribute to addressing them towards AR7?

- GHG: estimate emissions from satellite -> **R&D to improve high precision analysis system**
    - High resolution sensors PRISMA, ENMAP -> emission plumes, but not global (S5P)
    - New missions / activities: CO2M, COCO2, US / private funds
    - Regions with few measurements / high uncertainties (outside US, EU)
    - Fast analysis (~2-4 weeks) -> **actionable information / different requirements!**
    - CCI does R&D – operational application afterwards must still include ECV expertise
    - co-emitted species (NO2, CO2, …)

1. Where do you see the major challenges and gap analysis in the current IPCC AR6 and how could CCI/CLIMATE-SPACE contribute to addressing them towards AR7?

- Aerosol & clouds
    - WMO indicator: **aerosol / cloud cooling offset** time series feasibility + demonstration
    - **Indirect effect**: R&D on improved CDNC (clean regime), dust / glaciation, FM-AOD
    - Improve cloud and aerosol products in highly sensitive **polar regions**

- Aerosol properties
    - develop model-usable information on **aerosol types** (interpreatation of optical prop.)
    - Improve long-term **CDR multi-sensor consistency**
    - IASI / **Dust AOD** – dust change is a major uncertainty in modelling
    - **Stratospheric extinction CDR** – significant contribution to aerosol forcing

- Clouds
    - **Cloud process studies** on global scales (adv. GEO-ring) and local scales (high resolution rapid scan GEO data) for process understanding, and model evaluation+improvements
    - Understanding of **clouds' 3d structure** by combining **passive imagers** and **EarthCare**
    - Co-variability of cloud and other ECV data and their causal relationship to assess the **cloud (radiative) feedback** in a changing climate

1. Where do you see the major challenges and gap analysis in the current IPCC AR6 and how could CCI/CLIMATE-SPACE contribute to addressing them towards AR7?

- Water vapour
  - Cross-ECV study: sensitivity of the climate system to remaining biases, a.o., related to (clear-sky) water vapour data
  - **Diversity in WV trend estimates**
  - **Polar** regions: retrieval challenges
  - HIRS long+global record opportunity – combine with NIR + microwave, cooperate with NOAA, UWisc, EUMETSAT,…
  - **Limb sounders** gap – develop bridging technique
  - Challenging + relevant (for e.g. feedback analysis): **UTLS** region

1. Where do you see the major challenges and gap analysis in the current IPCC AR6 and how could CCI/CLIMATE-SPACE contribute to addressing them towards AR7?

- Ozone
  - **TOAR** next assessment, historic estimate
  - Easy access / uptake of O3 data by climate modelling (stratosphere + troposphere) – **no O3 in CMUG** / CMIP -> obs4MIPs
  - Limb sounding reduced assessment of stability (MLS) – develop bridging technique (OMPS, ALTIUS; occultation) – also relevant for HR limb-nadir tropospheric O3, UTLS
  - O3 observations in **troposphere and UTLS** very challenging
    - work towards harmonised definition of tropospheric column, to improve agreement of distribution / trends from different tropospheric O3 products
    - R&D on adequate coordinate systems in CLIMATE-SPACE -> improved UTLS O3 products (interannual variability, long-term changes)

1. Where do you see the major challenges and gap analysis in the current IPCC AR6 and how could CCI/CLIMATE-SPACE contribute to addressing them towards AR7?

- Precursors for ozone and aerosols
  - Cross-ECV: Mapping / time series of precursors – **shifting emissions** -> aerosol changes
  - Easy access / use for model evaluation
  - Uptake of ECV precursors (**good vertical sensitivity**) to strengthen understanding of tropospheric O3
  - Use for emission trend verification, **impact of adaptation measures**
  - Vertical aerosol information / climatology – matching periods (layer height, lidars)
  - Proxy / indicators for CCNs - NO2, NH3, HCHO
  - Adressing climate risks: impact of surface O3 on vegetation / agriculture

2. What are the opportunities to engage with the information (papers, organisations, authors, reviewers etc.) that contribute to the WG II and III reports?

- Mitigation: GHG emission fluxes -> show cases / publications including CCI data + people

- Adaptation + mitigation: NO2 in developing countries as proxy for emission reduction

- Getting data into the interactive atlas (C3S to take up)

- Climate indicators as communication tool (better WV, cooling offset, …)

- Long records by C3S and other operational services, R&D in CCI / CS

- Feed data records into 2nd GST (2028)

- How far can CS go into adaptation (many additional fields)?
  - We do not yet understand the user needs for our data

3. How can CCI contribute more *systematically* towards IPCC's assessment and special reports in future?

- Papers!

- EO experts also contribute to show cases / papers

- **Climate from Space report**: science highlights for IPCC AR7 + special reports (urban, …) -> more attention! -> technical support units

- Personal contacts / networking?! (authors, technical support units) – collaborations

- Reviewer – coordinate / strategy in CS (relevant chapters) – not citing own papers

- IPCC model dominated / predictions

- Data use / data citation: Papers using C3S / ERA – with CCI data in them – secondary?!