Brief Summary of Session 2:

“What are the needed measurements from space”

S. Briggs (The broader relevance of climate observations)

GCOS is to specify global observations for the climate. Need for a full suite of measurements.

Defines “Essential Climate Variables” (ECVs).

Two types of indicators: indicators of climate change (past), and indicators for adaptation and risk (future). Examples climate indicators are: global surface temperature, ocean warming, atmospheric CO_2 (ppm) or Arctic & Antarctic sea ice extent

Focus for observing the carbon cycle are CO_2 and CH_4.

Science is bad at answering concrete questions such as extreme weather events, which society needs answers to. Example of 2003 heatwave.

Out of 54 ECVs, half of them can only be delivered from space, and 75% are partially derived from space data.

Copernicus program is unique in that governments look at long-term measurements other than for weather (game-changer). Some examples of Sentinel-like observations are presented

S. Bony (importance of clouds and water vapour)

Big questions have been answered, but many other critical questions remain or emerge. Especially, we must understand and predict water vapour.

What controls the position, strength and variability of tropical rain belts ? Importance of cloud-circulation coupling. Atmospheric cloud-radiative effects are critical, we are just beginning to quantify these effects observationally (Calipso, vertical extent of clouds).

Climate sensitivity uncertainty is primarily due to the difficulty in predicting how and how strongly clouds respond to warming.

Example of progress: the altitude of anvil clouds (will rise and amplify global warming).

A root cause of uncertainty: low-level clouds.

Clouds, circulation and climate sensitivity: one of the 7 grand challenges of WCRP.

Observational needs: 1. Long-term homogeneous satellite-based cloud profiles. 2. Measurements of water vapour profiles in the lower tropical atmosphere.

An opportunity: the EURECA campaign to assess the performance of current satellite missions.

F.-M. Bréon (anthropogenic CO2 observations from space)

Inter-annual variations in CO2 budget (land sink) are not fully understood.

Key question: future of the land sink, mostly because of unknown impact on vegetation growth.

Key question: anthropic emissions, limits of inventories.

Presents past, current and future space missions.

Anthropogenic emissions. Requirement ? To verify compliance with COP21 at national scale is very challenging for many reasons, including distinction of natural and anthropogenic fluxes. Focus on point sources seems more reasonable. But does it really give useful information at national scale ?

Carma database shows all point sources above 15 Mt/year contribute 15% of all emissions from point sources (themselves 30% of global emissions).

Presents flux estimate for point sources. Challenge on wind measurement with few % accuracy.

Problem: noise in satellite .observations has amplitude similar to Paris signal.

Other problems: strong daily cycle of emission`+ clear-sky bias + vertical transport, emission in winter time where passive sensors see no light ect.

A. <u>Dabas</u> (wind observation for NWP and climate)

Wind is a basic parameter for weather prediction.

Winds impact human activities, transport energy and matter, interact with ocean circulation.

WMO maintains observation requirements classified in applications.

Conventional observation systems: surface stations, buoys, radiosondes, AMDAR.

Space-based observation: scatterometers, atmospheric motion vectors from cloud movement, but altitude must be assigned. Future: AEOLUS mission.

Wind data assimilated in the NWP context.

For climate modelling, long time series required.

J. Marshall (CH4 observations from space)

Current measurement requirements are extremely challenging, especially systematic error, a function of the small gradients to be observed.

Difference to CO2: significant uncertainties in all contributing processes, recent changes in the growth rate not solved.

Sat. measurements: SCIAMACHY, GOSAT, AIRS, IASI and TES offer good long-term records but sensitivity in upper atmosphere limits application to flux inversion.

SCIAMACHY: first hotspot detection. GOSAT improved on SCIAMACHY in precision, but poorer coverage.

Sentinel-5P will provide a huge increase in coverage.

Difficulties to identify anthropogenic sources: when fluxes are collocated. Ethane and isotopes help, but questions remain; supporting measurements are sparse, need for globally distributed sampling of tracers.

Sparse measurements could be improved by MERLIN due to the low bias.

In the Arctic: surprising burst after “zero curtain”.

P. Nabat (Aerosol observations from space)

Presents results from aerosol studies using satellite data.

Presents importance of aerosol direct and indirect effects.

Aerosols are not sufficiently represented in climate models, but increasingly using “interactive” (with radiation and clouds) aerosols in ESMs.

CMIP5 models largely disagree on AOD, long terms series missing.

Main limitation: clouds – most sensors cannot retrieve with clouds. Might lead to underestimation of AOD.

Long time series: homogeneous data missing.

Discussion/Question

What is to be understood about the role of verification ?

S. Briggs: not to be seen as a “policeman” role but a potential to help countries that do not well know their emissions.

What is to be said about uncertainties in transport models rather than observations ?

F.M. Bréon: I just presented they are not accurate enough for flux estimation.

M. Pircher: 50% of data come from space. S. Bony talked about need for continuity of observations. Must these 50% be continuous or can gaps be filled by models ? Do we need frequent revisits or punctual measurements ?

S. Bony: sat. observations may be used for process investigations, but for some things long time series are also required, for instance for cloud profiles.

F.M. Bréon: sometimes we need a particular weather event (heatwave of 2003…) in order to predict future events, and long time series increase probability of observing such an event.

Discussion/Question cont.

M. Pircher: space observatories are also required also to know if certain mitigation decisions has an impact at a given time and whether they were efficient ?

M. Pircher: how can there be "jumps" in aerosol data with a similar instrument on the same platform ?

P. Nabat: to be expected, there have been studies to successfully homogeneize these data.

R. Meynart: what is really a "systematic" error ?

J. Marshall & F.-M- Bréon: biases that are correlated spatially or temporally (a constant bias is not an issue).

Synergies and comparisons among A-Train instruments ?

FM Bréon: many studies exist.

P.Nabat: CALIPSO enabled 3d data on aerosols, lots of work comparing the AODs with other instruments.

<u>Discussion/Question cont.</u>

Could one not exploit the 40 year of meteosat data for cloud properties ?

S. Bony: it's already much used, permits to see geographical distribution changes and changes in geometry of cloud systems, also helpful to assess more frequent aggregation of convective systems, but not evolution of low-level clouds and many underlying mechanisms.

Are you also using METOP for wind and winds derived from infrared sounders, providing "3D" winds using temperature ?

A. Dabas: working on it but not yet assimilated.

G. Ehret: may be helpful for Aeolus validation ?

A.Dabas: Maybe…