

ITSC DA-NWP Working Group meeting on:

Held on 11th May 2022

How do we handle increasing volumes of satellite observations over the next decade?

With thanks to Roger Saunders who is updating OSCAR, very valuable for this topic, and Katie Lean and Niels Bormann from ECMWF

Which satellite systems will be available in the next decade?

Major instruments

MW sounders	IR sounders (polar)
JPSS Metop-SG FY-3	JPSS Metop-SG FY-3

MW imagers	IR sounders (geo)
Copernicus microwave imager AMSR-3 FY-3 WSF-M	MTG-IRS FY-4

Small/CubeSats

TROPICS

- MW humidity sounder + 90, 118 & 204 GHz
- 7 sat constellation (expected summer 2022)
- 550 km orbit height
- Predecessors MicroMas-2, MiRaTa

Arctic Weather Satellite

- MW temperature sounder & humidity sounder on small sat
- 19 channel instrument 50-325 GHz
- Constellation of 4-16 satellites to improve coverage over polar regions (2029 onwards)
- Prototype FM to be launched \geq 2024
- 600 km orbit height

MISTiC winds

- Midwave Infrared spectrometer operating in range 4.08-5.8 μm
- Long wave (LISSTIC) spectrometer operating in range 14.7-9.5 μm
- No information on launch date & typical size of constellation (possibly 12-24 satellites)

We were a bit surprised that this was all the missions we could find – were expecting an abundance of CubeSats. But the next decade is still dominated by major satellite programs. The duration of the smallsat missions is not obvious from the information available on the web.

Is there something we should do to prepare for use of small sat constellations?

Who is actively involved in the smallsat missions?

Fabien: Met Office is indirectly involved as Emma Turner is looking at SRF for TROPICS and some other instruments still at development stage, such as a small sat NASA is working on, sub-mm polarimeters (at 220 and 670 GHz). <https://core.ac.uk/outputs/323104305>

Katie – ECMWF started getting involved a little. AWS – speculative work looking at design of constellation have kicked off a project with EUMETSAT to use EDA method to investigate constellation plans. Meteo-France is doing a partner study using OSSEs (Philippe Chambon?). Looking at a max of 8 satellites at this stage. TROPICS – sample data being looked at by Dave Duncan. Have had some problems with the instrument. But quite encouraged by the data seen so far. However are some interesting biases and strange features but it's hard to find time to look into it and at the moment difficult to see how the process can be automated. ESA have not mentioned redundancy aspect yet. AWS is a larger small-sat instrument so actually similar to

ATMS – it's a reasonably advanced instrument and should have some impact. Also doing another study with ESA to investigate what impact could be possible with say 20 satellites. 8 is actually gives a pretty decent impact.

Roger R – Nordic countries will also be doing OSSE with AWS. W.r.t. bias correction - when attempting to bias correct aircraft data, saw problems with increasing number of data within the system. Expect increased number of satellites will be less problematic because the number will be finite.

Chawn – One reason why this is sustainable/cheap is because they send them up in batches of 6-8 at a time. Can't necessarily easily replace one on failure, need to replace when a new constellation is launched (depending on the mission). AWS is looking for ride-share – 2 AWS in one orbit plane launched with something else.

Nigel is involved in the AWS MAG (which is the same group as the MWS MAG). Data format for AWS will be the same as MWS.

TROPICS data so far is not in BUFR. Some discussions ongoing about where this will go.

Chris B: We need to send a message as to what kind of lifetime we need? E.g. to synchronise with model upgrade cycles. ITWG DA/NWP WG needs to come up with a recommendation. Maybe 3 years is a minimum.

Chawn: with large biases and lots of noise, some centres will choose not to look at the data.

Chris B: depends whether the biases are consistent within the constellation as well. A human bottleneck with many satellites to check and carry out QC procedures

Fabien: Way forward to be to reject the satellites that look different from the other and treat all the others as the same?

Fiona: There is also a difference between longevity of the constellation vs individual satellites within the constellation.

Nigel: for AWS, the specification is 5 years for a single satellite. 600km orbit is not actually that low.

Katie: Tropics was aiming for a longer mission but it's got bumped down. Not too early to make a recommendation about duration. There is a commercial interest.

Rani: would need at least one year to test, so probably wouldn't look at a satellite that was only up for 2 years. 5 years is good.

Brett: sometimes changes into NWP system get bumped due to other operational considerations. Don't want to waste effort evaluating data for your implementation to be postponed for a year if the mission duration is only 2 years.

Christina: Hard at the moment to put an exact time frame. Should at least put a recommendation. Unlikely data will be used by any centres if only 2 years.

Kozo: At least 3 years is necessary for checking and implementation. Stability and consistency is very important. Not only biases, but noise as well. Recently spoke to Japanese research community e.g. climate studies. Also stressed importance of stability, acknowledge importance of small satellites, but need continuity of more traditional instruments.

Yanqiu Zhu: Short duration is very hard to use. Stability and consistency is very important. Even though difficult to use, people have already noticed a large percentage of small satellites have exceeded their life expectation so monitoring would be good biases etc even if not used operationally at the moment.

Flavio: TEMPEST-D satellites lasted more than 3 years and had comparable quality to ATMS. Depends on mission requirements and pre-launch characterisation.

Chris B: Has anyone thought to look at automatic rejection of channels etc when instruments go bad? With large number of satellites this might be useful.

Nigel: w.r.t. large volumes of satellite data – MTG-IRS is coming quite soon. Centres should be looking at how they use this data. Met Office intend to store at full-res over the UK but thin it heavily across the globe. IRS-PP processing package will help people to do this. Intend to retain 1 in 16 pixels. EUMETCast plan to deliver the data via single dwells – not planning to deliver data at reduced resolution.

Recommendation DA/NWP 2022/1 to CGMS: Communicate to satellite data providers that the stability and consistency of bias and noise for individual passive radiometer instruments within a constellation of Small/CubeSats are very important for implementation. Consistency between instruments within the constellation is also critical.

Recommendation DA/NWP 2022/2 to CGMS: Communicate to satellite data providers that given Recommendation DA/NWP 2022/1, the requirement from NWP Centres for single instrument longevity within any constellation of Small/CubeSats should be a threshold of 3 years post-commissioning (below which many centres will not use the data) and an objective of 5 years (where most NWP centres will aim to use the data). If the overall mission is of long duration, the threshold for an individual satellite could be lowered to 2 years post-commissioning.