Your response

Question	Your response
Do you have any comments on our analysis of the current use of spectrum bands in the frequency range 100-200 GHz, or the potential future use of these frequencies? Do you have any comments on current or future use of the specific bands 116-122 GHz, 174.8-182 GHz and 185-190 GHz?	The frequency range is extensively used for Earth observation (climate monitoring and weather predictions) and fundamental scientific research in support of astrophysics. Related detection systems are highly sensitive and despite a degree of natural shielding form Earth's atmosphere, risk being compromised, particularly where future downlinks are concerned. We find the statement in paragraph 1.2 "*Frequency bands above 100 GHz are **lightly** used, primarily for … EESS*" somewhat misleading. EESS services operating in this waveband are absolutely crucial for the prediction of weather and natural disasters. Several 10s of satellites by an international collective of Met Services and Space Agencies perform global measurements 24h/7. We qualify this as a heavy use of the spectrum.
Are there any further bands above 100 GHz which you think Ofcom should consider making available on a technology and service neutral basis? Which benefits might be realised from enabling access to further bands?	No.
Do you have any comments on the approach we have used to assess the potential effect of our proposals on EESS?	**1.6 a) *Technical limits (power levels) will constrain the amount of interference new users can cause***: This is a limited view on the problematic, where "interference" is defined as an artificial surplus power density on top of the natural spectral radiance in any given band. However, the relevant criterion to society (i.e. the socio-economic risk) is the reduction in performance of Numerical Weather Prediction (NWP). The critical questions that need answering should be: By how many days will the accuracy of our forecasts be shortened due to unknow systematic measurements errors by RFI? Or how many hours will storm track predictions and hurricane landfall times (and locations) be off? This is where RFI potentially leads to significant economic costs, and risk to human life (The socio-economic benefit of NWP in the 27 EU member states is estimated at €61 Billion p.a. [EUMETSAT, 2018. EPS Second Generations; Facts and Figures (PRG.FS.02, V.1]). Without satellite data from polar orbiters, a 4-5-day forecast would have

	predicted the landfall of hurricane Sandy to occur 24h after the actual landfall [McNally, T., et al. 2014. Impact of satellite data on global NWP. Presentation at the ECMWF Seminar on the Use of Satellite Observations in NWP. Reading: ECMWF, 2014]). In defence of the study authors: That link between RFI amplitude and NWP forecast error is currently unknown! It has yet to be established by Observing System Simulation Experiments (OSSE), run by NWP and climate modellers. This in turn is hampered by current generations of EESS instruments that don't have the spectral resolution to distinguish between the natural atmospheric signal and RFI, so the latter can't be studied or mitigated. The current NWP system critically relies on the assumption that RFI in the protected bands can be neglected. For these reasons, it is currently not possible to define a "safe" power density threshold. We don't question the mathematics in the study, but will point out that there is a missing link between the set thresholds, and what they would actually mean to NWP in the real world. **1.6 c)** ***We anticipate that any outdoor high capacity data link services would use highly directive narrow beam antennas***: This again is an idealised assumption. While the calculations on signal strength as a function of directivity seem reasonable, in reality it is often hard to predict the propagation pattern of electromagnetic radiation. A horizontally propagating signal can be directed into space by specular reflection on dielectric surfaces. Even if this happens only intermittently, and for a small fraction of sources, the disruptive impact on an EESS dataset could be significant. We know this from existing analysis of (low-frequency) RFI on the SMOS (L-band) and AMSR-E (18GHz) instruments. Global maps of these satellite show that they are significantly affected by RFI from TV broadcast stations, either directly from the ground up (SMOS over Asia), or indirectly by downward pointing signals from geostationary TV satellites being reflected by water bodies (AMSR-E in coastal regions). Evidence of this is collected by the Technical sub-group on RFI and Frequency Management of the International ATOVS working Group (https://groups.ssec.wisc.edu/groups/itwg/nwp/rfi_and_nwp/). Furthermore, there is no strict Electro-Magnetic Compliance (EMC) standard for consumer electronics, so we have to assume that the antenna patterns of real devices (e.g. their sidelobes) will not live up to the theoretical basis of the Ofcom and ECC studies. This will be substantially aggravated if these devices were to be deployed not at ground level, but from air-borne platform (UAV, HAPS, balloons, or even a LEO CubeSat) instead, which is a reasonable concern. **1.6 d)** ***The large amount of spectrum we are proposing to make available would also help reduce the likelihood of interference from multiple devices at any given frequency***:

	While this argument holds true under some assumptions – e.g. that in reality services will spread out over the full bandwidth in an optimal manner – it also multiplies the occurrence of first- and second order harmonic frequencies by each emitter. This is another topic that is not sufficiently addressed in the current studies. EESS instruments are sensitive enough to pick up harmonic signals that naturally occur at real multiples of the fundamental oscillator frequency of a radio frequency (RF) source. That is unless the device is engineered according to strict EMC requirements, which will not be the case for user electronics that have to be cost effective. This means that even if the fundamental mode of any given 5G service doesn't directly affect an EESS window, it's harmonic modes could well do so. In summary, we believe that the assessment of the potential effect of this proposal on EESS: • Establishes the theoretical baseline definition for the regulation of power density thresholds for ground-based emitters, but **cannot guarantee that EESS will not be affected under real-life conditions** (relying on atmospheric shielding alone is not adequate) • **Fails to trade-off the economic merit** of the new spectral bands **against the socio-economic penalty** that a compromised NWP performance will bring If this and similar international proposals are enacted without first establishing that the real-world effect of RFI on the higher-level data products from EESS (e.g. the NWP forecast errors and projection ranges) are not negatively affected, then a status quo will be established that negates the last 30 years of progress in NWP – As several world-leading Met Services and climate scientist agree. [e.g. Witze, A. 2019. Global 5G wireless networks threaten weather forecasts. Nature. [Online] 26 April 2019. https://www.nature.com/articles/d41586-019-01305-4]; Emery, W. J. (2019). As a result, there is considerable risk that current, planned and future spaceborne measurements in protected EO bands will be affected by this proposal, and that the precision of weather and climate related measurement systems will be compromised.
Do you have any comments on our proposals to authorise devices to operate on a licence-exempt basis in the 116-122 GHz, 174.8-182 GHz and 185-190 GHz bands?	Given the potential impact to Earth observation services, we agree that the disadvantages indicated in section 4.4 will have a higher probability of occurrence.

Do you have any comments on our proposal to create a 'Spectrum Access: EHF' licence to authorise increased power use in the 116-122 GHz, 174.8-182 GHz and 185-190 GHz bands?	Increased power will further raise the potential for spectral pollution. It may also generate complex harmonic frequency content that will exacerbate the impact on Earth observation systems. If implemented, there will be a need for careful evaluation of product spectral output, including harmonic content, antenna directionality etc., all prior to release, and the introduction of national/global monitoring capabilities to ensure compliance.