Main messages and points for discussion

The societal need for better weather forecasts and climate projections is huge. The accuracy and reliability of weather and climate information have improved by: new and better observations, more powerful computers, and new science and technology. The global weather enterprise continuously pushes the boundaries to unlock socio-economic benefits through the delivery of meteorological and climate services.

Dr. Florence Rabier, Director-General of European Centre for Medium-Range Weather Forecasts (ECMWF), shared her vision for future scientific advances, increased observational coverage, specific benefits for people, and taking co-operation to the next level. In line with the implementation of ECMWF Strategy 2021-2030, she discussed the following issues, and outlined the ongoing and planned public-private-academic collaborations to enhance the efforts:

1) *Science and Technology*: in view of making operational use of cutting-edge science and technology, focused efforts are being made toward a seamless Ensemble Earth system for integrated weather, water, energy and carbon cycle simulations. High-performance computing (HPC) is actively engaged to apply big data and AI methodologies. Collaboration with new initiatives across the sectors is accelerating the progress, such as, working with NVIDIA Omniverse platform to elaborate a Digital Twin of the Earth.

2) *Data in and data out*: Open data are recognised as one of the main tools to maximise the socio-economic benefits of investments in data production. A critical issue associated with the Earth system aspects is the increasing need to rigorously evaluate and fill the observing data gaps across all components. Public-private-academic collaboration has demonstrated further improvement, such as engaging saildrone observations to improve ECMWF's Earth system prediction, with the support of Google. In addition, ECMWF moves toward making more digital forecast data open to all, making available for redistribution and commercial use. The key is to ease accessibility and exploitation of wealth of data for the breadth of applications including AI/ML.

3) *Impacts and benefit for people*: Weather/climate information is already recognised as having high value providing significant social and economic benefits. Not only the early warning of extremes and high-impact weather, society benefits from Earth system NWP for improved operation of transport, energy, agriculture, tourism, health services and many more areas. Examples and best practices are increasing, for example, in the areas of renewable energy production, air quality monitoring, health advisory, agriculture, etc. In addition to increased accuracy and timeliness through enhanced verification and diagnostics, the value of weather/climate information to users can be maximised through careful cost-benefit analysis for system design (e.g. the relative value of investments in resolution, post processing).

4) *Taking cooperation to the next level*: National and international co-operation – between many actors in the public, private and academic sectors – are now the reality of the global weather enterprise. Beyond European member states, ECMWF has started and will continue to engage with actors from the private sector at various levels, including through initiatives of the World Meteorological Organization, such as

research-to-operation activities including sub-seasonal to seasonal prediction projects. The Systematic Observation Financing Facility could also play a key role in quantifying impact of observations, which can be used to support the design of the Global Observing System. In particular, the use of HPC and emerging technologies necessitate wider partnerships with many more stakeholders, and all stakeholders may seek enhanced partnerships for the areas including expand use of observations from all possible providers; further exploiting heterogeneous HPC technologies through a portable and performant code base for NWP; diversifying computing resources to improve scalability and performance; service/distribution through cloud infrastructure and move to open data; and many more.