NCEP and NCEP/EMC

Overview:

- NCEP Mission and Structure
- NCEP/EMC Mission and Structure
- NCEP/EMC Observational Data Processing
  - including engagement with international groups

Jeff Ator
IT Specialist
NCEP/EMC

5/22/2018

NWS National Centers for Environmental Prediction

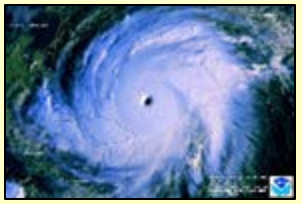
Specialized Services – Common Mission

- 490 FTE
- 237 Contractors
- 20 visitors
- 5 NOAA Corps Officers
- $137M Budget

Aviation Weather Center
Kansas City, MO

Space Weather Prediction Center
Boulder, CO

Storm Prediction Center
Norman, OK

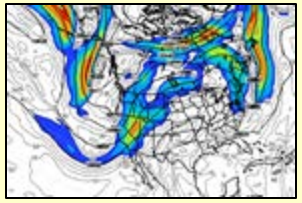


National Hurricane Center
Miami, FL

NCEP Central Operations
College Park, MD
(Supercomputers in Reston & Orlando)

Ocean Prediction Center
College Park, MD

Climate Prediction Center
College Park, MD



Environmental Modeling Center
College Park, MD

Weather Prediction Center
College Park, MD

Mission

NCEP delivers national and global operational weather, water and climate products and services essential to protecting life, property and economic well-being.

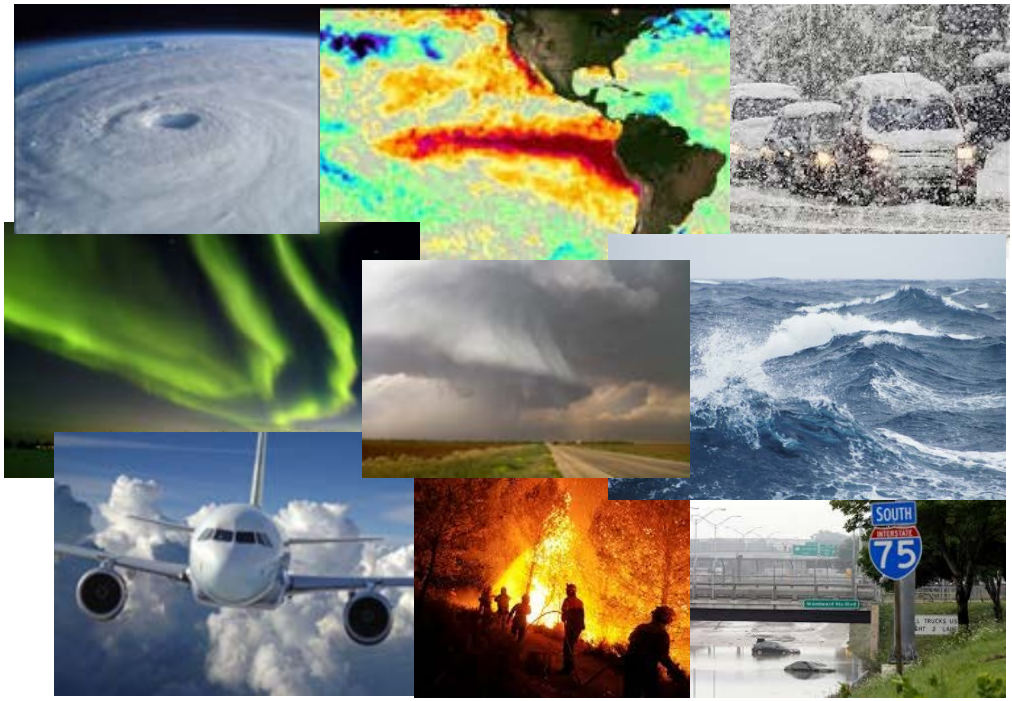
Vision

The trusted source for environmental predictions from the sun to the sea, when it matters most.

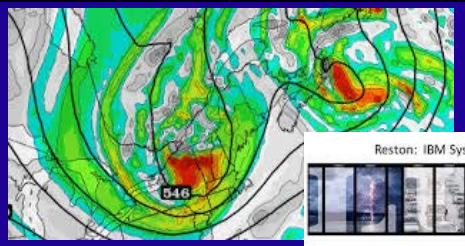
NCEP is a Critical Component of the NWS Collaborative Forecast Process

"Provision of Services from the Sun to the Sea"

- Solar Monitoring, Warnings and Forecasts (SWPC)
- Aviation Forecasts and Warnings (AWC)
- Extreme Events (Hurricanes, snowstorms, excessive rain; severe & fire weather) (NHC, WPC, SPC)
- High Seas Forecasts and Warnings to day-5 (OPC)
- Week 3 & 4; Seasonal Outlooks; El Nino – La Nina Forecasts (CPC)



- Model Development, Implementation and Applications for Global and Regional Weather, Climate, Oceans and Space Weather (EMC)
- Super Computer, Workstation and Network Operations (NCO)



NCEP Operational Numerical Guidance Supports the NWS Agency Mission

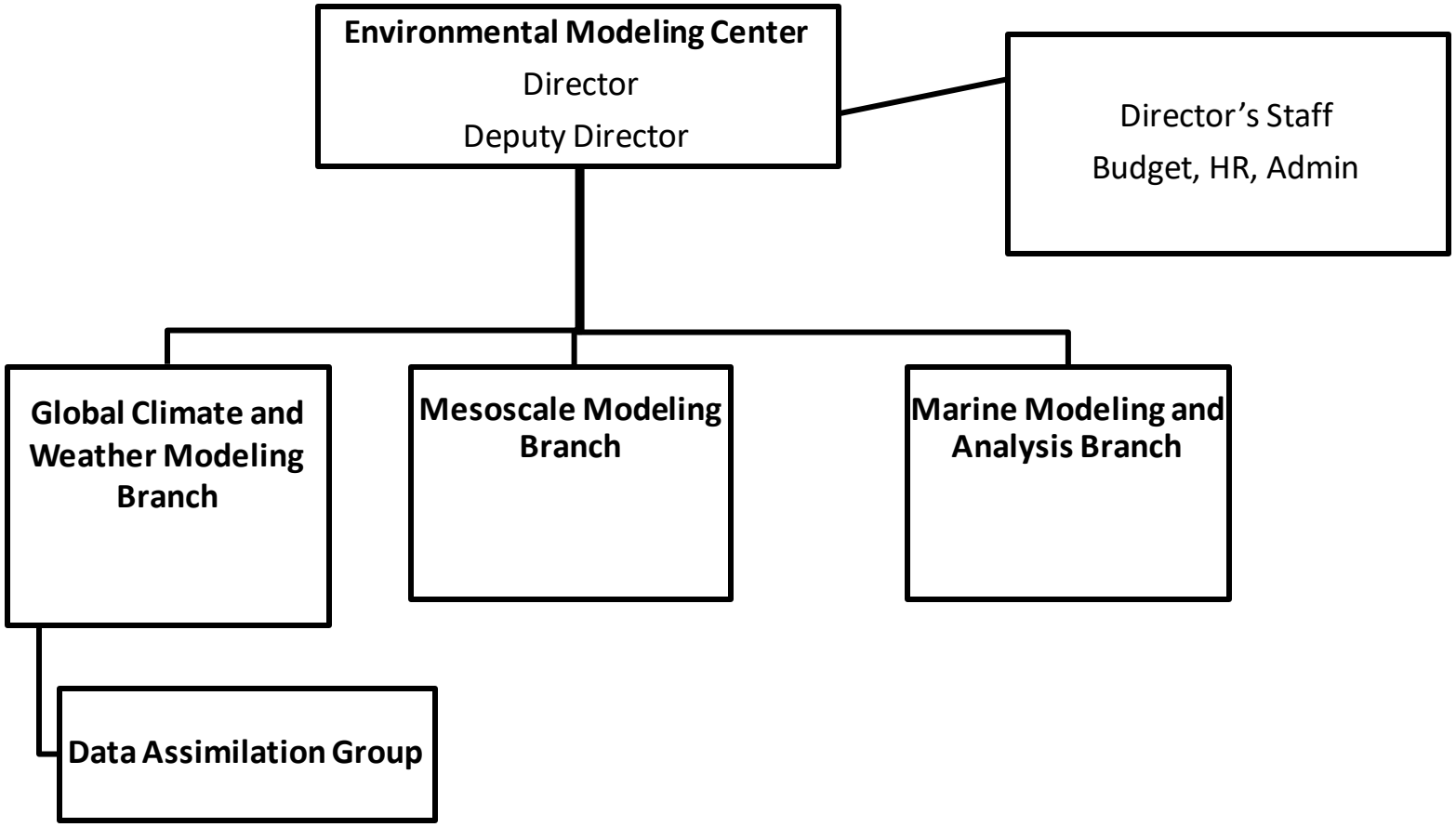
- Forecasts are made by people
  - Weather Forecast Offices (WFOs).
  - Service Centers within the National Centers for Environmental Prediction (NCEP).

- Models provide guidance
  - Prediction is now inherently linked to numerical models.
  - **Most models are run at NCEP.**
    - **More than 20 major simulation codes.**
    - **More than 1600 support codes and scripts.**
    - **Billions of data ingested daily.**
    - **Millions of products delivered daily.**
  - Sharing with world wide partners:
    - DoD, ECMWF, UK Met Office, JMA, …

Overview of individual EMC modeling systems

- Global Forecast System (GFS)
- Global Ensemble Forecast System (GEFS)
- Regional Mesoscale Models
  - North American Model (NAM), HiResWindow, RAP/HRRR
  - Short Range Ensemble Forecast (SREF), RTMA/URMA
- Marine Models
  - Ocean (RTOFS, based on HYCOM)
  - Waves (based on Wave Watch III)
- Hurricane Models
  - HWRF, HMON
  - Waves (based on Wave Watch III)
- Climate Models
  - Climate Forecast System (CFS)
  - National Multi-Model Ensemble (NMME)

Old EMC Organizational Chart



NGGPS FV3-based Unified Modeling System

Vision for Community

Mission of FV3 **Community**: Improve environmental modeling forecast capability unified across time and space for both research and operations

- Develop the next generation of scientists
- Conduct research for improved scientific understanding and innovation
- Engage with community to improve transition of research to operations
- Build the world's best operational capability

The FV3 **community** will be guided by:

- Shared goals, objectives and "ownership" with transparent governance
- Inclusive and collaborative development, testing and evaluation
- Balance of operational, research and end-user needs and priorities
- Scientific capability and credibility
- Strong partnership between research and operations

The FV3 **community** "layers":

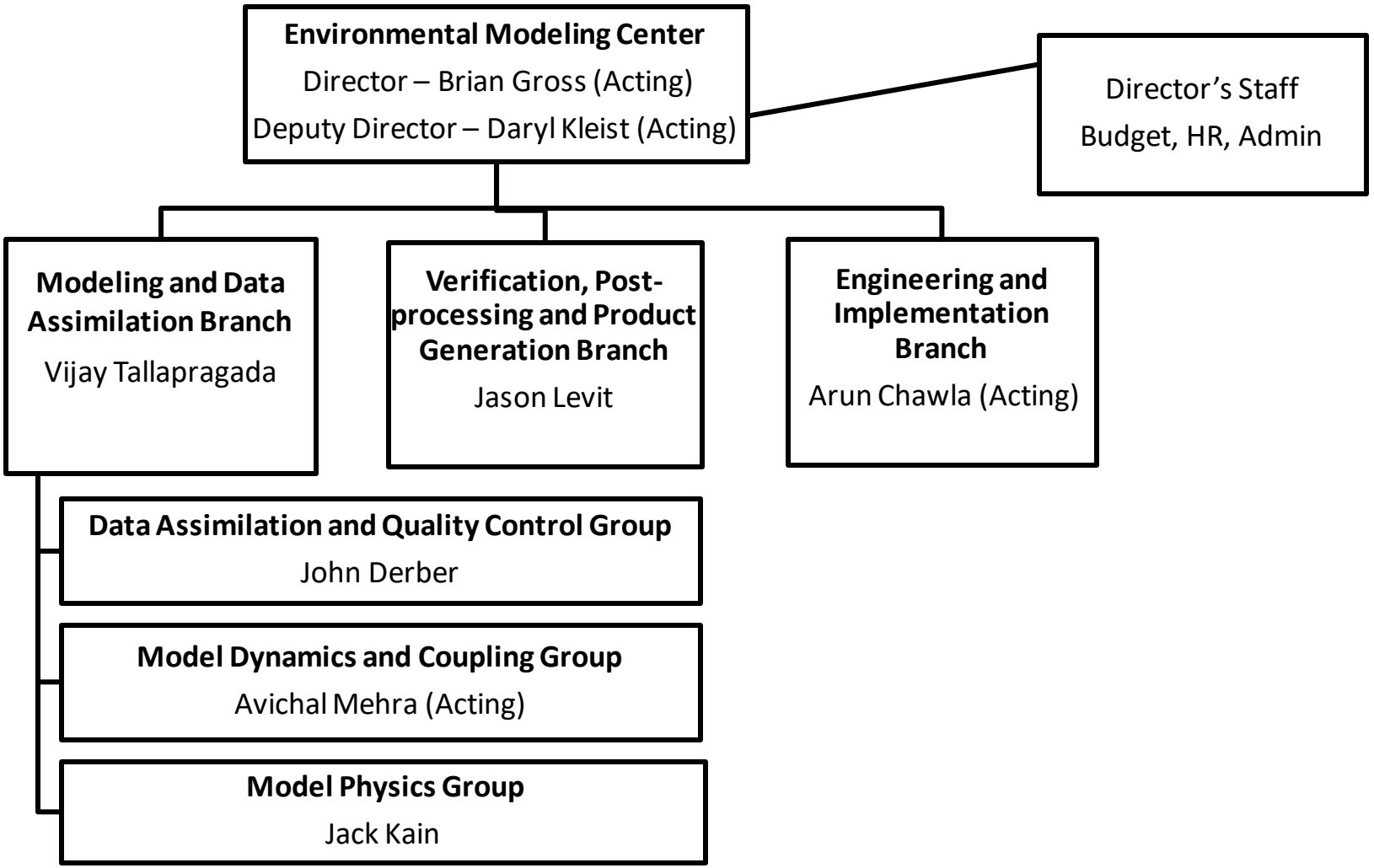
- Broad research community; super users; core development team; & operations

Unprecedented opportunity to develop and advance a world-class unified modeling system for the Nation!

EMC Reorganization: May 2017

- **Why did EMC reorganize?**
  - Shift from legacy multi-models to unified modeling framework
  - Break down stovepipes (e.g., no more separate models and pre-/post-processing applications for separate Global, Meso and Marine branches)
  - Address gaps/shortfalls (e.g., DA, diagnostics, systems engineering)
    - Bring together functions for consistency and greater efficiency
  - Create new management structure to more effectively manage EMC as an integrated system, rather than as a collection of separate models
  - *Bottom line: EMC reorganization was designed to more effectively manage model development and operations for the* ***new unified modeling framework***

New EMC Organizational Chart

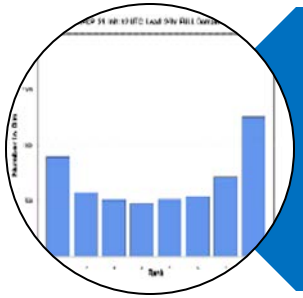


FV3-based GFS

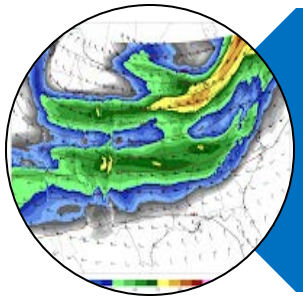
- Working toward replacement of spectral model with FV3-based GFS
  - Target: December 2018!!
  - ~13km resolution, 64 layer (same as current GFS)
  - Some advancements to data assimilation
  - Similar physics to current GFS
    - New cloud microphysics
  - FV3GFS data is available at:
    - http://para.nomads.ncep.noaa.gov

VPPPG Branch Core Mission

Observation Processing



Verification and Validation



Post-Processing and Products

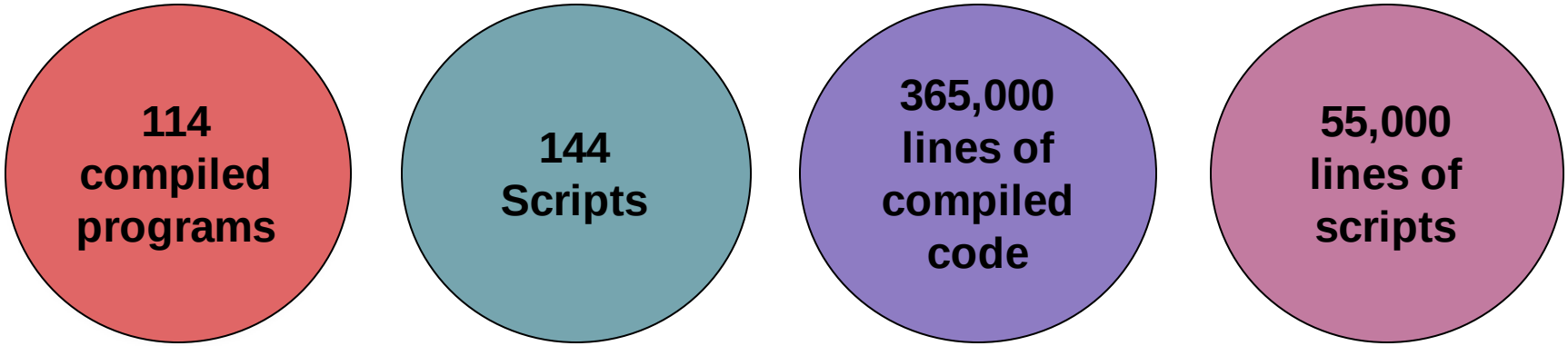
Observation Processing

Problem:

- Majority of code written in FORTRAN77 during the 1980's and 1990's
- Software has become patchworked and difficult to learn (however, it has been reliable!)
- New data sources take too much time to integrate into software
- Partners (ECMWF) are using new data sources that EMC can't easily integrate
- Software is not parallelized or ready for future large data sets

Solution:

- Engineer with Python, create modular code using Python libraries and modern software engineering techniques
- Store observations in a high performance geospatial database structure
- Reduce time for new data set integration from months to weeks



Ongoing EMC Observations Processing engagement with international groups

- WMO Interprogramme Expert Team on Codes Maintenance (IPET-CM)
  - Supports, manages and enhances BUFR and GRIB code forms
  - Meets annually (next in Germany, May 2018)
- WMO Expert Team on Aircraft-Based Observations (ET-ABO)
  - Supports, manages and enhances worldwide aircraft-based observing system
  - Meets annually (next TBD)
- WMO Task Team on WIGOS Data Quality Monitoring System (TT-WDQMS)
  - Develops real-time monitoring, evaluation and incident resolution standards for the WMO Integrated Global Observing System (WIGOS)
  - Meets annually (next in December 2018)
- Global Data Exchange (GODEX-NWP)
  - Facilitates and coordinates observational data discovery and exchange between major worldwide NWP centers
  - Meets biennially (next in India, November 2018)

WMO IPET-CM

WMO Inter-Programme Expert Team on Codes Maintenance (IPET-CM)

Terms of Reference (excerpted):

- Review and maintain the Table-driven Code Forms by defining descriptors, common sequences, data templates and the regulations supporting these, including data representation of regional practices, so they meet the requirements of all Members, WMO Programmes and other concerned international organizations, such as ICAO;
- Review, develop and update the Manual on Codes (WMO-No. 306) and associated reference and guidance material as required, and publish these in suitable electronic formats for human and automated use including codes.wmo.int;
- Monitor and coordinate the progress of migration to Table Driven Code Forms;

WMO codes main page, including guides, manuals, information on migration, and downloadable copies of tables and templates for BUFR, CREX and GRIB2:

http://www.wmo.int/pages/prog/www/WMOCodes.html

Agenda for annual meeting, May 28th-June 1st at DWD (Offenbach, Germany):

http://www.wmo.int/pages/prog/www/ISS/Meetings/IPET-CM_Offenbach2018/IPET-CM_DocPlan.html

WMO IPET-CM

U.S. Proposals:

- Document 2.2(3) recommends a new entry #5 in GRIB2 Code Table 4.9, for use in reporting the probability of some discrete event (e.g. probability of dry thunderstorm) occurring at each grid point, vs. the normal usage of reporting the probability that some continuous value is within a certain range (e.g. probability of temperature > 297.04K) at each grid point
- Document 2.2(7) proposes a new GRIB2 Grid Definition Template for gnomonic grids
  - for use with the new FV3 cubed sphere, which is on a gnomonic projection
- Document 10.1 provides a briefing on the WIGOS Data Quality Monitoring System (WDQMS) and invites collaboration between the IPET-CM and WDQMS task team

Non-U.S. proposals of note:

- Document 2.2(1) proposes new parameters in GRIB2 Code Table 4.2 for use in cloud analysis and instantaneous rain rate products
- Document 2.4(2) proposes a new set of BUFR sequences for reporting satellite data compressed according to their principal component scores
- Document 2.4(5) proposes new BUFR sequences for radiosonde descent data
  - Separate from ascent data to prevent latency of the former, and using time and location of balloon burst as the “start” time and location
- Document 2.6 discusses progress in the ongoing development of GRIB3
- Document 4.1 discusses a possible Amendment 79 to ICAO Annex 3
- Documents 7.1 and 7.2(x) describe the status of TAC->BUFR migration within the various WMO regions

GRIB3

The next edition of GRIB is being developed through the IPET-CM

- To further improve and modernize the format, including features that cannot be easily shoehorned into GRIB2 (e.g. indexing of multi-field messages, repeatable template components, more efficient packing of ensemble fields), as well as to better align with the WMO logical data model for interchange with other data formats (e.g. XML, CDF)

- GRIB2 is not going away for a very long time!
  - At this point, the main promoters of GRIB3 are ECMWF and DWD, though HMEI (Slovakia) and UCAR have been involved in initial work.
  - Goal is to have enough framework/proof-of-concept and examples for WMO CBS to approve at 2020 meeting, followed by WMO Executive Council in 2021, which would then allow for provisional operational exchange beginning in 2022.
  - GRIB2 would still remain valid for many years thereafter, but then at some point likely frozen (no new features added), similar to how TAC codes were eventually frozen as part of the TAC->BUFR migration.

- Latest specifications for GRIB3 available from http://www.wmo.int/pages/prog/www/WMOCodes/WMO306_vI2/FM92-16-GRIB/FM-92-16_GRIB-edition-3_CBS-16.pdf

- But informal discussions and ideas continue to be brainstormed and developed at https://software.ecmwf.int/wiki/display/DGOV/GRIB+edition+3
  - Participation in this Wiki requires advance registration as a user on the site, which is free and can be done via https://www.ecmwf.int, then select "Log In" from the top right corner of the screen, and then on the ensuing page you can register as a new user. Once you're logged in, you can go directly to the above URL.

WMO TT-WDQMS

WMO Task Team on the WIGOS Data Quality Management System (TT-WDQMS)

Terms of Reference (excerpted):

- Develop the concept and provide technical support to the implementation of the WIGOS Data Quality Monitoring System (WDQMS), including the three basic components:
  1. a monitoring function for data availability and data quality
  2. an analysis and evaluation function
  3. an incident management function;
- Ensure that the WDQMS will be applicable to all WIGOS observing components and fully interoperable with OSCAR (Observing Systems Capabilities Analysis and Review)
- Develop appropriate pilot and demonstration projects (depending on available funding) in order to test and consolidate the concept of the WDQMS;
- Report to ICG-WIGOS on the development and implementation of the WDQMS and propose updates as needed to the Manual on WIGOS;

The WDQMS is one of the envisioned components of the new WMO Integrated Global Observing System (WIGOS), which also includes:

- The new schema for station identifiers, for all types of reporting platforms under WMO's purview.
- The OSCAR/Surface (Observing Systems Capability Analysis and Review Tool) repository for site metadata, replacing the old WMO Pub 9, Vol A for surface-based sites.

WMO TT-WDQMS

Monitoring function:

- Web-based tool to monitor timeliness and quality of observations received at worldwide NWP centers.
- Prototype at http://128.65.196.37/wdqms/map shows receipts of radiosonde and surface synoptic data from 4 participating NWP centers (ECMWF, JMA, NCEP, DWD)
  - with eventual goal to include more NWP centers and operationalize the tool on a WMO-sanctioned platform
- Next steps:
  - additional reporting fields for radiosonde and surface synoptic data, including noting whether received as TAC or BUFR
  - addition of aircraft data as next monitored type, in coordination with WMO Expert Team on Aircraft-Based Observations (ET-ABO)
  - inclusion of basic quality information (e.g. observation minus background) from all centers at all sites

Evaluation function:

- Would determine if an issue diagnosed by the Monitoring Function needs further attention, and if so assign it a tracking number and refer it to the Incident Management Function for resolution.
- No prototype yet, but TT-WDQMS recommendation is for this function to be housed at one or more Global WIGOS Centers (GWCs).

Incident management function:

- No prototype yet, but TT-WDQMS recommendation is for this function to be housed at Regional WIGOS Centers (RWCs), which should have relevant contact information within each of their member countries for forwarding and tracking of issues within their region.
- At present, only RA-VI (Europe) has formally organized an RWC within their region.

GODEX-NWP

Global Operational Data Exchange Meeting for NWP

Evolved from the old NAEDEX (North America-Europe Data Exchange) meetings, which in turn began holding joint meetings with the APSDEU (Asia-Pacific Satellite Data Exchange and Utilisation) group, until last year when the groups agreed to formally merge to become the GODEX-NWP

- Scope includes the exchange of any data of value to numerical weather prediction (NWP), whether as input or for validation, but the focus is primarily on the exchange of satellite data between members, since satellite data makes up the bulk of observations assimilated into operational NWP.
- Meetings are not WMO-sponsored, though the WMO Space Programme attends as an observer. This allows focus on NWP and other high-end data users without having to accommodate the entire WMO community, thus faster responses to rapidly-evolving capabilities with less bureaucratic overhead.

Meetings are generally held every 1 ½ years, with the next one scheduled for late November 2018 in New Delhi, India

- Typical U.S. delegation includes representatives from NESDIS, NWS/IA and NWS/NCEP

Thank you – any questions?