# Criteria for Upgrades to NCEP's Global and Regional Model Systems
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## IT Compatibility
- General system configuration and functionality criteria
    – Must work properly on NCEP operational and research computers.
    – Produces all operationally required output fields in NCEP standard formats (GRIB2, BUFR), including standard meteorological variables, ozone and potentially other tracers as required
    – Inputs all operationally required input fields and data in NCEP standard formats
    – Uses standard NCEP utility routines and software packages wherever possible
    – Run-time (scripting) environment consistent with NCEP Central Operations (NCO) best practices
    – Code structure and usage conforms to current operational codes whenever possible
    – Impacts of any proposed changes to operational formats, codes and systems must be considered across all of NCEP's numerical forecast systems; changes must be negotiated with NCEP staff  and changes must be propagated and tested across NCEP's system as needed

- Model specific criteria
    – Can be used within NCEP operational data assimilation systems to produce a cycled set of initial conditions
    – Produces all necessary diagnostic information consistent with NCEP file formats and visualization requirements

## Forecast benefits
- General performance testing criteria for models
    – Period of testing
        - At least 6 weeks from each of two separate seasons (summer and winter)
    – Objective forecast verification criteria - global
        - Produces forecasts at least as skillful as operations in standard scores at lead times from 6 h to 15 days
            - 500 hPa Anomaly Correlation (AC) – Northern and Southern Hemisphere (NH and SH)
            - 850 hPa and 200 hPa Root Mean Square (RMS) vector wind error
            - RMS fits to temperature and wind observations at standard pressure levels in NH and SH and various subregions out to 48 hours
            - maintains skill of ozone latitudinal mean bias and rms error
        - Produces equivalent
            - Hurricane track error performance (see hurricane criteria)

- CONUS precipitation threat and bias for 0-84 h
  - Acceptable performance for secondary variables such as stratospheric ozone and temperature, tropospheric moisture
  - Does not produce any substantial degradation in the forecast skill of any other operational field.

  – Subjective evaluation using model output fields for
    - 0-5 days by HPC
    - Week 2 performance by CPC
    - 0-3 day performance by SPC
    - Global aviation performance by AWC
    - Tropical performance by TPC
    - Ocean cyclogenesis by OPC

  – Objective forecast verification criteria – regional
    - Produces forecasts at least as skillful as operations in standard scores (RMS and bias) versus observations at lead times from 3-84 h
      - Majority of pressure levels from 850-200 hPa
      - 2 m temperature and dew point and 10 m wind
    - Produces equivalent scores on CONUS precipitation equitable threat and bias for 0-84 h
    - Acceptable performance for secondary variables such as cloud amount, visibility, CAPE/CINH, daytime maximum temperature, nighttime minimum temperature, the height/pressure of PBL depth, freezing level and tropopause, and threats to aviation (turbulence, icing and convection)

  – Subjective verification criteria – regional
    - 0-3 day performance evaluation by
      - HPC
      - SPC
      - AWC
      - TPC and OPC (surface winds)
- <u>Specific performance testing criteria for models</u>
  – Meet specific criteria for specialized model applications (e.g. Coupled Hurricane System, Climate Forecast System, Real-Time Ocean Forecast System, Air Quality Forecast System). See, e.g., associated document: <u>NCEP Hurricane Forecast System Requirements Document</u>
  – Meet specific criteria for associated global and regional atmospheric, ocean and land data assimilation systems. See associated document: <u>NCEP.data.assimilation.t2o.criteria</u>


**Efficiency**
- <u>Computation performance</u>

- Computational performance applies to all major components of the NCEP Production Suite, including
  - Global Data Assimilation System (GDAS)
  - Global Forecast System (GFS)
  - Regional Data Assimilation System (RDAS)
  - North American Model (NAM)
  - Rapid Refresh (RR)
  - Coupled Hurricane System (HUR)
  - Climate Forecast System (CFS), including the Global Ocean Data Assimilation System (GODAS)
  - Air Quality Forecast System (AQFS)
  - Real-Time Ocean Forecast System (RTOFS)
  - Global and Regional ensemble systems
- Fits into NCEP Production Suite resource window for each of the following computer resources
  - Processors
  - Memory
  - Timing
- Efficient use of computing resources through message-passing, threading and other standard High Performance Computing protocols
- Scales well with anticipated future NCEP computing hardware
- In cases where additional computing resources are required to execute the upgrade operationally, the value-added by the upgrade will be weighed against the increased computing resources. In the event additional resources are not available on the NCEP operational computer, the upgrade has sufficient value-added to warrant implementation and other criteria are met, the upgrade will be scheduled for implementation when a new operational computer is available.

## Sustainability
- <u>Software Management and Capabilities</u>
  - Meets (negotiated) requirements for response to emergencies (e.g. system failures)
  - Capable of progressive future upgrades by NCEP/EMC and partners
  - Written in standard languages (Fortran, C, C++ and other languages with mutual arrangement)
  - Uses minimum code structure complexity to meet operational mission and anticipated future requirements
  - Code is sustainable by NCEP staff and can be fully understood, navigated and modified without excessive difficulty
  - Contains inline documentation in NCEP standard format (e.g. docblock)
  - Adaptable to NCEP's changing computing environment and portable to major computing architectures
  - Conforms to the NCEP code management system (e.g. "Subversion")