UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE
Office of Systems Architecture and Engineering
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SUBJECT: The Impact of Legacy Sensors on non-NWP Applications

1. Scope:
   This memo provides background information and recommendations and guidance for understanding the impact of continuing to operate legacy low earth orbiting instruments on non-numerical weather prediction (NWP) applications.

2. Background:
   NOAA is considering the decommissioning of NOAA and non-NOAA legacy sensors that are beyond their planned lifetime. Scientists in NOAA, DoD, ECMWF, and academia have conducted impact studies of the effects of sunsetting legacy data on NWP and nowcasting applications. Satellites under consideration for decommissioning include NOAA-15, -18, and -19, DMSP's F-16, -17, and -18, and S-NPP. All of these satellites have operating sensors and channels that are used for a variety of applications.

3. Facts and Findings:
   a. Facts
      (1) The Aviation applications in Alaska use AVHRR imagery from NOAA-15, -18, and -19 and VIIRS from S-NPP. These satellites help to maintain the needed four-hour global revisit rate in imagery observations. These instruments are also used to derive atmospheric motion vectors used in nowcasting and NWP applications.
      (2) Precipitation estimating algorithms use DMSP, NOAA-19, and S-NPP microwave observations. There would be significant degradations in precipitation products for several hours each day without the use of that data. The NWS CMORPH2 precipitation product uses the DMSP products.

(3) The loss of low-energy particle measurements from NOAA-15, -18, and -19 would result in decreased situational awareness of space environment conditions during solar storms, which is needed for anomaly resolution. There would also be fewer input streams for ingesting into real-time ionospheric and magnetospheric models.
(4) NOAA climate data records from NCEI are based on DMSP, POES, and Metop observations. They have not currently been extended to JPSS. There should be a plan to extend the CDRs before decommissioning the legacy satellites.
(5) The SSMIS data from DMSP F-16, -17, and -18 are used in the AUTOSNOW system. All three sensors are used to assess the diurnal variation of the microwave brightness temperature to perform reliable snow/ice retrievals. The GCOM AMSR2 sensor can replace one SSMIS, but not all three. The Metop MWI sensor may help, but it will not be fully available until 2024. Without the SSMIS sensors, the quality and accuracy of the AUTOSNOW product will be degraded.
(6) Microwave imagery from AMSR2, SSMI, SSMIS, and GMI is used for tropical cyclone analysis. Continuing the use of this data would seem more affordable since NOAA is not actually operating the satellites, only pulling in and distributing the data.
(7) NOAA-15 or NOAA-18 is needed to complement NOAA-19 for Argos Telemetry.
(8) The Alaska Region uses the POES and S-NPP satellites to monitor volcanic ash, forest fires, river ice jam flooding, and sea ice movement. The loss of this data would create major impacts due to observation gaps as there are many short-fused natural hazards in Alaska with few observations. The current constellation provides nearly sub-hourly observations.
(9) Precipitation rate products are provided every 30 minutes using data blended from five GEO and 12 LEO satellites. This is important information to understand the severity of heavy rain and flooding events and is particularly important for slow moving tropical systems.
(10) The CMORPH2 precipitation product is important for forecasters in Alaska, especially in areas that are lacking in ground-based weather radar systems. CMORPH2 shows large negative impacts without NOAA-19 and DMSP data. The performance of CMORPH2 would be substantially degraded without these satellites, especially during local afternoon when peak convection often occurs. Heavy precipitation would be under-estimated, or, possibly, totally missed.
(11) The user applications drive the need for faster temporal refresh, which is important for nowcasting and monitoring tropical storms.
(12) With the loss of POES legacy satellites, microwave sounder-derived tropical cyclone intensity estimates would decrease by 38%, increasing random error by up to an estimated 15 kt, in some cases. Losing DMSP would then have two further negative impacts: The loss of SSMIS-based tropical cyclone intensity estimates and the loss of

ARCHER eye diameter estimates. The loss of ARCHER eye diameter (from SSMIS) would critically impact the ability of the CIMSS Satellite Consensus Product (SATCON) to capture eye contraction during rapid intensification, increasing the latency of rapid intensification measurement by 6-12 hours.

(13) Impacts of loss of imagery over Alaska:

1. Sea Ice Analysis / Forecasting: The longest data gap occurs just after solar noon over the Bering Sea which could lead to increased challenges in detecting sea ice detail
2. Aviation:
    a. Retrievals from LEO is used to more precisely estimate volcanic ash details, such as concentration and loading. Parallax issues tend to be extreme over the Bering and northern Alaska. LEO makes it much easier to more precisely geo-locate ash
    b. 00 – 04Z is the mean convective peak over mainland Alaska. Due to lack of surface Doppler radar and the reduction in the quality of GOES imagery due to parallax, LEO data is used to more precisely analyze details of convection and its effects on aviation routing
    c. Reduced ability to analyze cloud details, especially over western, northern, and to some extent, southern mainland Alaska. Data from LEO is the primary source the AAWU uses to define cloud coverage details.

b.Findings

(1) The POES, DMSP, and S-NPP satellites provide critical coverage in early morning, late morning, and afternoon orbits. Currently, the early morning satellites include DMSP, NOAA-15, and NOAA-18. Decommissioning these satellites would result in a loss of sounder data beginning in the 2024 timeframe. The mid-morning orbit will continue into the 2040s with the Metop satellites. The afternoon orbit will be covered with the JPSS satellites.

(2) The POES, DMSP, and S-NPP legacy satellites are still very valuable because of the better temporal coverage, especially in the early morning orbit. Without these satellites, there is a risk of a gap in the early morning. Nowcasting applications will have the most negative impacts.

4. Recommendation:

The SAT recommends the following regarding the continued operation of LEO legacy sensors:

a. Recommend not to decommission the legacy satellites including the operational POES, DMSP, and S-NPP satellites until absolutely necessary. The loss of these satellites will result in degradation of the continuity of the climate time series, monitoring of severe weather events that require a rapid update rate, high update

rate observations over Alaska and the arctic, and continuation of snow and ice retrievals.

b. Suggest that NOAA shift responsibility of running legacy sensors to commercial operations.
c. Beyond the performance aspect, legacy sensors such as NOAA-15 and NOAA-18 should be maintained for continued availability of ARGOS

Important note: This memo was developed based on the deliberations and discussions among the core-SAT, which consist of federal employees only. These recommendations were made following extensive scientific fact-finding, review of the scientific literature, and SAT discussions with scientific experts and others knowledgeable in the field.