OPERATIONAL WIND PRODUCTS AT NOAA/NESDIS

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Abstract

This paper summarizes the status of the operational and new improved wind products at NOAA/NESDIS. Recent improvement, new additions, processing changes and monitors, future plans of the Atmospheric Motion Vector (AMV) product suite will be discussed. The current satellite constellation for operational AMV winds processing includes GOES-13 (eastern operational geostationary satellite), GOES-15 (western operational geostationary satellite), VIIRS from S-NPP, AVHRR from NOAA and MetOp series, and MODIS from Terra and Aqua. Besides the currently operational AMV products, several improvements in NOAA/NESDIS AMV products have been implemented. These improvements include current GOES, Himawari-8, MODIS and AVHRR AMV products by using GOES-R/VIIRS AMV algorithms. Updates on the status of these operational AMV products, new wind processing system, data access policy, and other future plans will be presented. In addition, an overview of the operational ASCAT ocean surface wind products at NOAA/NESDIS is also presented.

1. INTRODUCTION

NOAA/NESDIS and the Cooperative Institute for Meteorological Satellite Studies (CIMSS) continue to increase the product suite of Atmospheric Motion Vectors (AMVs), improve the quality of all operational AMVs products and enhance the operational monitoring. NOAA/NESDIS continues to generate hourly GOES AMVs products from GOES-13 and GOES-15. Besides hourly GOES wind products, NOAA/NESDIS continues to generate polar wind products from MODIS (Aqua and Terra) and AVHRR (MetOp-B, MetOp-A, NOAA-19, NOAA-18, and NOAA-15). With Suomi NPP and the availability of VIIRS instrument data, NOAA/NESDIS continues to use new GOES-R wind algorithm to generate Suomi NPP VIIRS Polar winds in the operation. It is the first operational satellite derived wind product with GOES-R wind algorithm. Also with the retirement of MTSAT-2, NOAA/NESDIS stopped to generate MTSAT-2 winds for NOAA/NWS/AWIPS offices. As always, these operational geostationary and polar wind products have been serving as critical input to numerous applications such as prediction system and real-time forecasting.

NOAA and EUMETSAT have a partnership to cooperate in providing meteorological data from their polar-orbiting satellites. Near real time ocean surface wind field measurements from MetOp-B and MetOp-A are being provided by the Advanced SCATterometer (ASCAT). NOAA/NESDIS is processing and distributing ASCAT data in near real time for NOAA's operational users. To some extent operational ASCAT products from MetOp B/A continue the partial product types currently unavailable from QuikSCAT for operational users.

2. NOAA/NESDIS WINDS OPERATION STATUS REPORT

2.1 Status of GOES satellites

GOES satellites have been primary source of data for short term forecasting, especially of severe weather such as tropical storms since the operations in 1974. NOAA/NESDIS currently maintains a continuous stream of data from two operational geostationary satellites. These two satellites are GOES-13 at 75W and GOES-15 at 135W. Besides the operational GOES-13 and GOES-15, GOES-14 is located at 105W with the on orbit storage status. The improvements of GOES13/14/15 include navigation and radiometrics. Spring and fall eclipse outages are avoided by larger onboard batteries. New generation GOES satellite GOES-R is expected to launch in November, 2016.
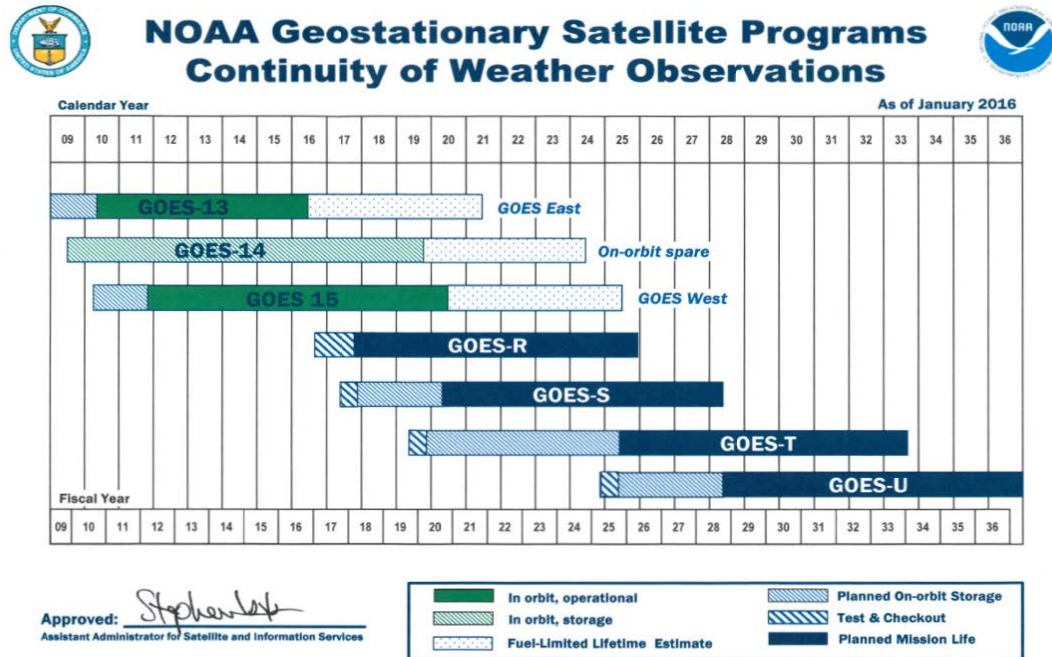

Fig 1: GOES Flyout Schedule

2.2 Status of POES satellites

POES satellite provides world-wide coverage every 12 hours (6-hour global sampling for the pair). It is able to broadcast directly data to global users. NOAA/NESDIS continues to run NOAA-19, NOAA-18, and NOAA-15. NOAA-17 was decommissioned in April 10, 2013 and NOAA-16 was decommissioned in Jun 6, 2014. In May 2014 Suomi NPP replaced NOAA-19 to run as PM primary satellite. Now MetOp-B launched in September 17, 2012 from EUMETSAT is run as AM primary satellite and MetOp-A is run as AM secondary satellite. Polar winds are being generated from all above POES satellites. As planned, NOAA/NESDIS will launch JPSS-1 in 2017 and EUMETSAT will launch MetOp-C in 2018.

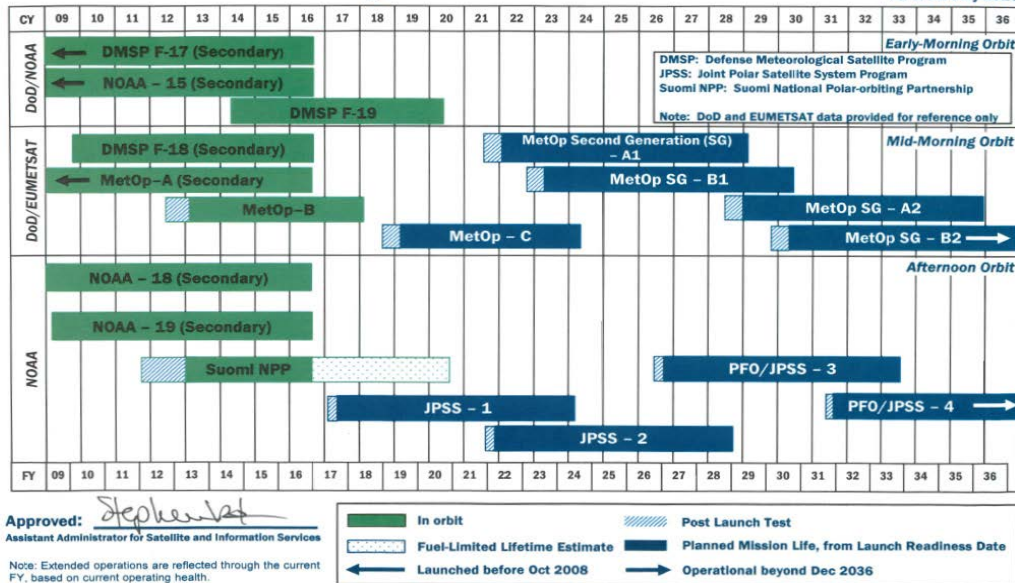*Fig 2*: POES Flyout Schedule

2.3 Operational GOES and Polar Wind Products and data Distribution

With the operation of GOES hourly winds, NOAA/NESDIS enhanced the existing winds algorithm. The number of levels in vertical direction is increased to 101. Also low level inversion correction is added into the algorithm. These enhancements will improve the quality of wind products. Especially it will improve the accuracy of wind products on lower level.

NOAA/NESDIS continues to distribute GOES, MODIS, and AVHRR polar winds through GTS. No change of WMO headers is in these wind products. But after the operation of GOES hourly winds, GOES wind products are disseminated more frequently. Also the EE quality flag is included in the distributed BUFR files. Table 1 shows the WMO headers for all wind products available from GTS.

Product	WMO Header
GOES LWIR cloud drift Winds	JACX11(GOES-East) JCCX11(GOES-West)
GOES SWIR cloud drift Winds	JQCX11(GOES-East) JRCX11(GOES-West)
GOES Water Vapor Winds	JECX11(GOES-East) JGCX11(GOES-West)
GOES Vis cloud drift Winds	JHCX11(GOES-East) JJCX11(GOES-West)
GOES Sounder WV (7.4um)	JMCX11(GOES-West)
GOES Sounder WV (7.0um)	JPCX11(GOES-West)
MODIS LWIR cloud drift Winds	JBCX11(TERRA) JICX11(AQUA)
MODIS Water Vapor Winds	JLCX11(AQUA)
NOAA-15 Polar Winds	JCVX91
NOAA-18 Polar Winds	JCVX94
NOAA-19 Polar Winds	JCVX95

MetOp-A Polar Winds	JCVX97
MetOp-B Polar Winds	JCVX98
S-NPP VIIRS Polar Winds	INVX01 INVX02 INVX03

Table 1: **Wind Products and WMO headers**

With the launch and operation of Suomi-NPP satellite, NOAA/NESDIS builds a new system called Suomi-NPP Data Exploitation (NDE). NDE is an enterprise system to ingest, generate, and distribute the data and products from Suomi-NPP. NDE Data Handling System (DHS) consists of Ingest, Product generation, Product Distribution, and Monitoring subsystems. The system includes numerous servers and SAN storages.
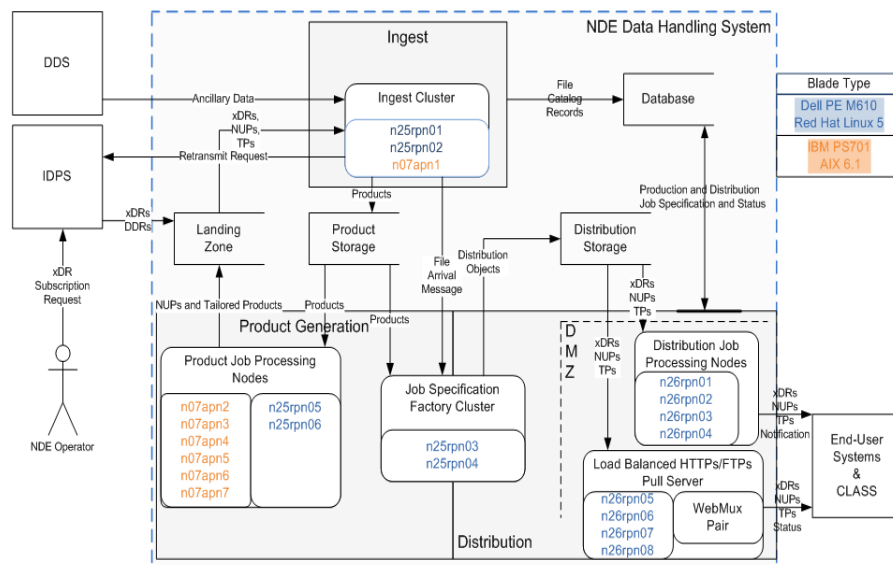

Fig 3: **NDE System Diagram**

Currently VIIRS Polar winds are generated and distributed from NDE. It is first operational wind product generated from GOES-R wind algorithm. The products are available in both NetCDF4 and BUFR formats. S-NPP VIIRS Polar Winds are now available on GTS too. Similar to AVHRR polar wind products, Suomi-NPP VIIRS polar winds only include cloud track wind products because no water vapor channel is available on VIIRS.
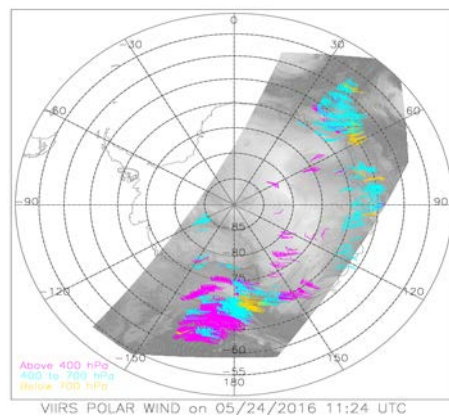

Fig 4: **S-NPP VIIRS Polar Winds**

New quality monitoring tool has been deployed into the operation. The monitoring tool has a database as the backend to keep more information of the process and products like metadata etc. and benefit the monitoring of winds product quality in the longer term. Meanwhile, there is an automatic email warning notification which is able to catch any abnormal issues.
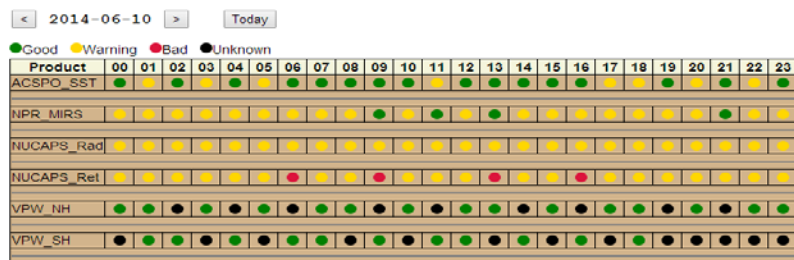

Fig 5: **Quality Monitoring Tool**

2.4 Discontinued Wind Products

Due to the failed Sounder instrument, GOES-E Sounder Water Vapor Channel Winds were stopped in November 2015. Also NOAA/NESDIS stopped to generate MTSAT-2 Winds in December 2015 because of the decommissioned MTSAT-2 Satellite.

2.5 Future Wind Products

The following new products and enhancements are expected to be implemented into the NESDIS operations.

2.5.1 New Improved GOES Winds

In order to provide continuity between wind products generated from the operational constellation GOES satellites that will at some point include a current GOES series satellite and the new GOES-R satellite, NOAA/NESDIS developed this new GOES winds process system. This system will use GOES-R wind algorithm to generate wind products from current GOES satellites. Compared with current GOES wind products, GOES wind products from new system will be as good or better on product accuracy and precision. According to the plan, users will get enough testing before retiring current GOES wind system and promoting new GOES wind process system into the operation. The operational GOES wind products from new GOES wind process system will be available around June 2017. The testing GOES wind products have been available at NOAA/NESDIS/STAR.

2.5.2 New MODIS/AVHRR Winds with GOES-R Algorithm

NOAA/NESDIS plans to generate MODIS/AVHRR polar winds by the same GOES-R algorithm as Suomi-NPP VIIRS polar winds. Because the current MODIS/AVHRR and Suomi-NPP VIIRS polar wind products are generated with different algorithms, they will exhibit different error characteristics. The GOES-R wind algorithm is more accurate than that currently used for MODIS/AVHRR because it uses an externally-generated cloud product and a more robust tracking approach called nested tracking. New MODIS/AVHRR winds will be in operations in June, 2017.

2.5.3 Himawari-8 Winds

With the launch of JMA's Himawari-8 satellite, NOAA/NESDIS/STAR has generated Himawari-8 winds with GOES-R wind algorithm to support continuously NOAA/NWS/AWIPS users. Eventually Himawari-8 winds will be transitioned into the operation.

2.5.4 GOES-R Winds

New GOES-R satellite will be launched in November 2016. The initial position will be at 89.5 degree west. The post-launch testing will be from November 2016 to April 2017. The extended validation will occur between April 2017 and November 2017. Around November 2017, GOES-R will be decided to replace either GOES-East or GOES-West in operation.
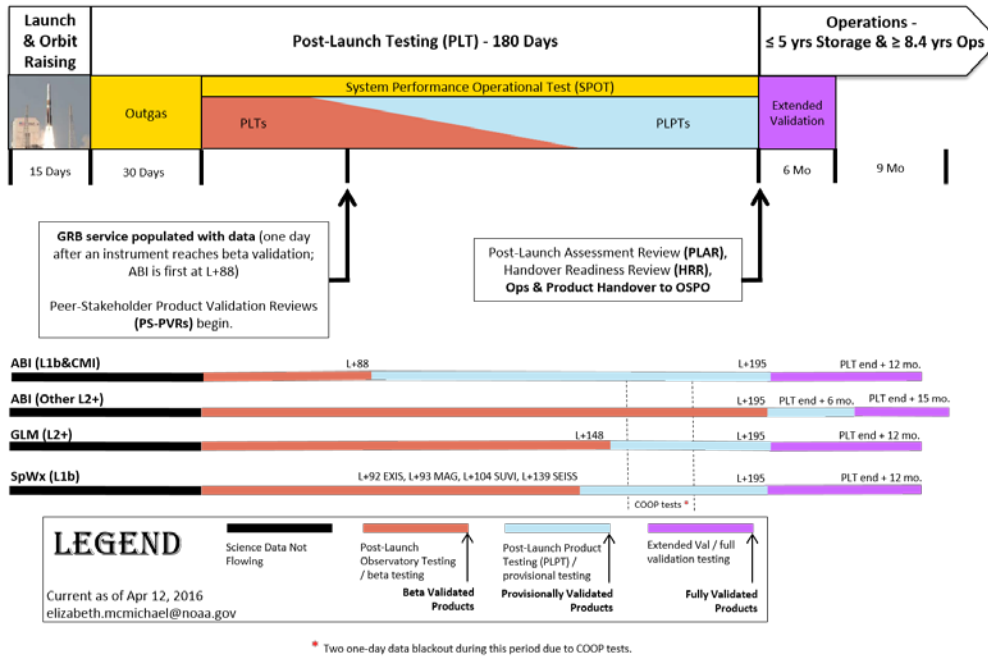

Fig 6: **GOES-R Data Release and Product Validation Schedule**

GOES-R winds will be available in NetCDF4 format and BUFR format with new BUFR and old BUFR tables. The products will begin to be distributed to users via PDA at 6 months after launch. Around one year of launch, a provisional validation maturity status is reached. Then a full validation maturity status will be implemented at 21 months after launch. Besides the Product Distribution and Access System (PDA) distribution, NOAA/NESDIS is planning to disseminate GOES-R Winds via GTS too.

2.5.5 JPSS-1 Polar Winds

The proposed JPSS-1 launch date is around January 2017. Then JPSS-1 will be announced to be operational on 90 days after launch.
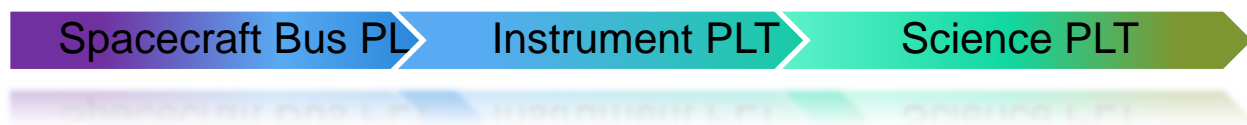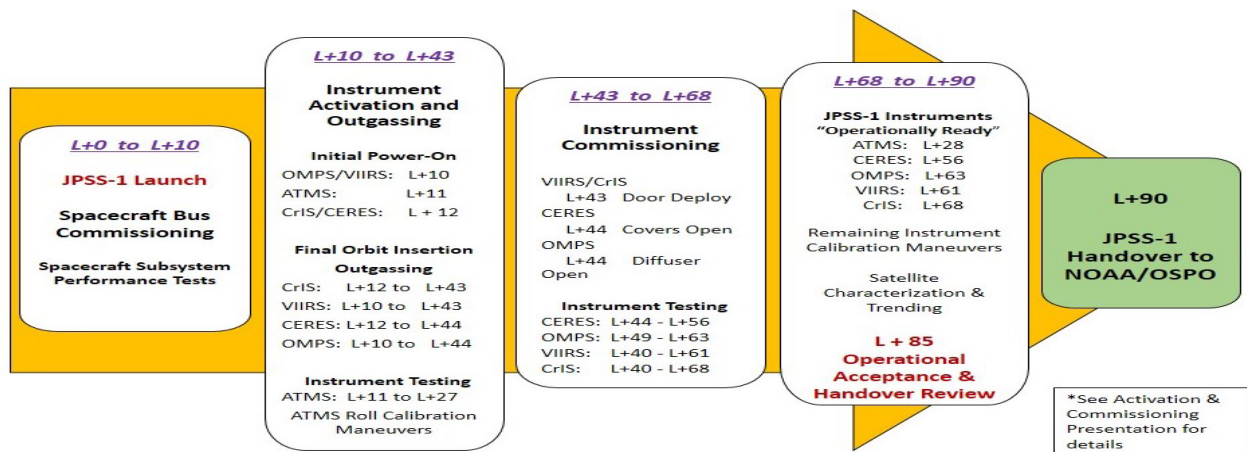
Fig 7: The planned JPSS-1 Timeline Overview

NOAA/NESDIS will generate operational JPSS-1 VIIRS Polar winds in June 2018. Like S-NPP VIIRS Polar winds, JPSS-1 VIIRS Polar winds will be run on NDE system. The wind products in both NetCDF4 and BUFR formats will be provided. The products will be disseminated via PDA and GTS.

3. ASCAT NRT DATA PROCESSING AND DISTRIBUTION AT NOAA/NESDIS

Working collaboratively with EUMETSAT and KNMI, NOAA/NESDIS has established the infrastructure to acquire, process, and distribute ASCAT products for NOAA's operational users from EUMETSAT MetOp satellites. Three flavors of L1B data (full resolution, 25km resolution and 50km resolution) are pushed from NOAA's server in Darmstadd, Germany to NOAA ASCAT ingest server through Trans-Atlantic network link. Then NOAA ASCAT ingest server pushes the data to the operational processing system at Suitland. The NOAA ASCAT NRT operational processing system was migrated to Redhat Linux VMware servers for processing and data distribution. The VMware system allows continuous data process and product generation because the server under VMware system can be automatically switched in case of hardware problem. Meanwhile two additional servers are used for testing and development such as new data input and algorithm upgrade etc.

Near surface ocean wind vector fields are retrieved from level1b files, using the KNMI ASCAT processing software that relates measured backscatter to near surface ocean wind field via a geophysical model function (GMF). ASCAT processing software has been modified at NOAA/NESDIS to ingest NCEP/GFS forecast fields for ambiguity removal initialization. In the last processing step, sea ice screening will be applied, based on the scatterometer data itself and on sea ice history information.

The NOAA NRT ASCAT wind processing produces Level 2 (wind vector) data in both BUFR format and binary format. Besides the orbital BUFR and binary files, reduced ASCAT-lite binary products are extracted from the full orbital files. These files contain only the selected wind vector solutions along with selected quality flags, the date/time stamp, and the location information for easier input into AWIPS (BUFR format) and N-AWIPS (binary format) systems. The AWIPS BUFR products are generated in 10 specified AWIPS areas. All ASCAT product files have been available to users upon request. Current major users include NOAA/NCEP, NOAA/TPC, NOAA/OPC, NOAA/NHC etc.

Besides the operational ASCAT ocean surface wind products, NOAA/NESDIS generates daily ice product and high spatial resolution wind speed products. ASCAT daily ice applications use ASCAT L1B data to generate daily ice products. ASCAT daily ice products cover five main regions (Alaska, Antarctic, Arctic, Ross Ice Shelf and Weddell Sea). ASCAT daily ice products are available in image and binary formats. ASCAT daily ice products continue to provide the normalized radar cross section ice products to the users like NIC, NWS and international ice community for snow and ice analysis and forecast.

ASCAT high spatial resolution winds are also available in operations. ASCAT full resolution L1B data is used to generate ocean surface wind products with 3-4 km grid resolution. ASCAT high spatial resolution wind products can be generated on tropical storm areas or specified even driven areas. ASCAT high spatial resolution wind products are available in image format. ASCAT high spatial resolution wind products are able to provide additional high resolution wind fields that not revealed by standard 25km and 50km ASCAT wind products to the users like NWS and tropical cyclone community for tropical storm analysis and forecast.

With Metop-B launch and operation, NOAA/NESDIS is generating the corresponding ASCAT products from both MetOp-B and MetOp-A.

4. FUTURE PLAN of SCATTEROMETR WIND PRODUCTS

NOAA/NESDIS is planning to generate ocean surface winds from ScatSat and OceanSAT-3 etc. These scatterometer instruments are based on Ku-band radar cross-section measurement and the measurement methodology. It will largely mitigate the loss of QuikSCAT.

5. SUMMARY

NOAA/NESDIS, together with CIMSS, continues to improve the operational wind product suite at NOAA/NESDIS. NOAA/NESDIS wind products including GOES, MODIS and AVHRR Polar wind products in BUFR format are being generated and distributed through GTS. NOAA/NESDIS NDE system is generating and distributing the operational Suomi-NPP VIIRS polar winds. In addition, NOAA/NESDIS is going to provide users some new and enhanced wind products such as new improved GOES winds, MODIS/AVHRR winds with GOES-R algorithm etc. The operational ASCAT products from MetOp-B/A continue to be provided to NOAA operational users. NOAA/NESDIS is working on new scatterometer data sources from ScatSat, and OceanSat3 to mitigate the loss of QuikSCAT.

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