Draft Report
JPSS/STAR and OAR/CPO Technical Interchange Meeting:
Arctic Part I focus on Sea Ice and Physics

Held:
Wednesday, 29 March 2017
12:30 to 14:30
Room 25542555 at NCWCP, College Park MD
With WEBEX remote participation.

Organizers: Veronica Lance (STAR/SOCD), Sandy Starkweather (CPO) and Murty Divakarla (STAR/JPSS)

Notetakers: Veronica Lance, Murty Divakarla, Sinead Farrell, Antonia G.

Participant List: (see Appendix A)

Agenda: (see Appendix B)

Summary of Actions

Lihang Zhou will take the **action** to add a column to her JPSS product table to indicate which JPSS products are brought into GFS.

Amy Solomon will take the **action** to list her spatial and temporal coverage requirements for each of the input parameters so that satellite scientists can make appropriate recommendations.

Overview

This technical interchange meeting focusing on the Arctic was planned in response to the recommendations from the original, high level Kick Off Meeting on 12 September 2016 between the Center for Satellite Applications and Research (STAR), Joint Polar Satellite System (JPSS) and the Climate Program Office (CPO) in Oceanic and Atmospheric Research line office (OAR). In an attempt to make the most efficient use of the limited times when key participants were available, organizers decided to break the Arctic TIM into 2 parts: Part I covering sea ice and physics for modeling applications (validation and assimilation) and Part II covering living resources and biogeochemical applications. This report covers Part I, sea ice and physics. Part II is to be scheduled, potentially in late April 2017.

Purpose

The purpose of this Artic TIM was to introduce JPSS satellite data products (and other STAR products) with focus on arctic applications to CPO and for CPO to provide information about their Arctic programs and their needs or potential uses for Arctic satellite data, especially in the realm data assimilation and earth system modeling for research and operational predictions.

Outcomes

Some high priority needs for JPSS or STAR products were identified and contacts were established among satellite data scientists and Arctic climate scientists. The production of a summary table of relevant satellite data products was suggested. And in parallel, a table of CPO Arctic program requirements for satellite data products was also suggested. A NESDIS Technical Report will be produced.

Presentations

Dr. Lihang Zhou, JPSS/STAR Program Manager

The meeting was opened with comments from Dr. Lihang Zhou, JPSS/STAR Program Manager who gave the background of the 12 September 2016 kick off meeting during which Mitch Goldberg, JPSS Program Scientist, briefed on JPSS products and applications and representatives of the CPO introduced major programs, portfolio distributions, and current STAR collaborators. From this kick off meeting, it was determined to have follow up meetings focusing on 3 major topics: 1) atmospheric composition; 2) data assimilation; and 3) Arctic. A possible fourth topic has been floated regarding NWP model verification applications. Lihang then introduced the JPSS instrument line up (5 major sensors) and discussed the maturity level and quality control of algorithms for many earth observation parameters (60 products) currently from SNPP (on orbit since Oct 2011), including several relevant to Arctic needs. She also noted that AMSR2 sea ice concentration product also falls under the JPSS program. Finally, she discussed the importance of user engagement in the process of developing and maintaining satellite data products and the impact of JPSS Proving Ground/Risk Reduction initiatives as an important resource in getting useful products into production as early steps in transition to operations.

Sandy Starkweather, Program Director of US Arctic Observing Network

Sandy Starkweather, Program Director of the US Arctic Observing Network, described the structure of the OAR Climate Program Office, pointing out the primary sections where Arctic work is concentrated, including Monitoring (Dr. Jennifer Saleem Arrigo) and Arctic Research (Dr. Jeremy Mathis) both of which fall under the Ocean Observing and Monitoring Division (Dr. David Legler, Chief) and also Climate Variability and Predictability (Dr. Sandy Lucas) which falls in the Earth System Science and Modeling Division (Dr. Jin Huang, Chief). Next she outlined the major sustained observations being made in the Arctic Program and suggested that some of the observations may be useful for satellite product validation. Major observations covered both biogeochemical and physical parameters, including and all line offices are involved in some way (see Figure 1). She discussed sea ice observations being made through the International Arctic Buoy Program, including sea level pressure (BP), surface temperature (Ts), atmospheric temperature (Ta) as well as ice thickness and water column profiles. More information can be found at: iabp.apl.washington.edu/index.html. These data are used for real time forecasting needs and enhanced data products from reanalyses and blending. Regarding observations of sea ice from drifting buoys, she pointed out that due to circulation patterns in the Arctic, platforms tend to aggregate in the Western Arctic and exit into the North Atlantic, so satellite observations are needed to fill in the gaps on the Eastern Arctic. Atmospheric observations are being made from international partnerships across the Arctic (IASOA; International Arctic Systems for Observing the Atmosphere; see http://iasoa.org).

NOAA Arctic Research Program Line of Effort:	Topical Foci	Sustained Observations	NOAA Line Offices Involved
1. Conducted annual occupations of the Distributed Biological Observatory (DBO)	• Biological/ecologica • Physical ocean • Biogeophysical ocean	• 7 sampling transects • X moorings, buoys	OAR, NMFS, NOS
2. Support and expand the International Arctic Systems for Observing the Atmosphere (IASOA)	• Radiation • Sens/Lat Flux • Clouds • Aerosols • GHG's	• 3 radiative flux towers • 3 turbulent/carbon flux towers • 3 ancillary energy & composition sites	OAR, NWS, NESDIS
3. Conduct annual surveys of the Arctic ocean and atmosphere using unmanned drones, gliders and aircraft.	• Physical ocean • Biogeophysical ocean	• X waver gliders • X sail drones	OAR, NMFS
4. Support expanded modeling of climate, sea ice, and ecosystem response to changing environmental conditions in order to better inform observational needs	• Climate • Sea ice • Ecosystem response	• X Sea ice drifting buoys • 2 Sea ice mass balance buoys	OAR, NWS, NESDIS, NOS, NMFS
5. Support the US AON project office and its role in developing integrated products using existing Arctic observing assets.	• Sea Ice Forecasting • Biogeochemistry • Ship Tracking	Cross-cutting support t develop data products from sustained observations	OAR, NWS, NESDIS, NOS, NMFS

Figure 1. Matrix of NOAA Arctic Research Program efforts including observations and line offices.

Dr. Sandy Lucas, Program Manager Climate Variability and Predictability (CVP)

Dr. Sandy Lucas then discussed some results of recent studies funded through CVP as a result of their 2015 call to understand Arctic sea ice mechanisms and predictability in 3 major areas: 1) climatic mechanisms that affect Arctic temperatures and growth and/or loss of sea ice; 2) mechanisms, predictability and prediction of regional sea ice variation and change; and 3) systematic predictability of the fully coupled climate-ocean-ice system, its driving factors, its state dependence as external forcings change, and whether such predictability can be achieved in operational-like predictions. Eleven projects were funded and will use a varied set of models including CMIP5 class models from NOAA's Geophysical Fluid Dynamics Laboratory (GFDL), the National Center for Atmospheric Research (NCAR), as well as NOAA/National Centers for Environmental Prediction (NCEP) model CFSv2. Major conclusions from some early results show that assimilating sea ice concentration is effective in reducing model bias for sea ice area, but relatively ineffective at predicting sea volume while assimilating sea ice thickness along with sea ice concentration significantly improves sea ice volume model predictions (Figure 2). Using age of sea ice also contributes to some improvement probably because age and thickness are somewhat related. Details on all 11 projects and abstracts can be found at: www.cpo.noaa.gov/cvp, funded projects 2015. It was noted that JPSS temperature and water vapor soundings could be helpful, for example, extreme moisture transport (Atmospheric Rivers) into the Arctic and its effect on sea ice concentration.

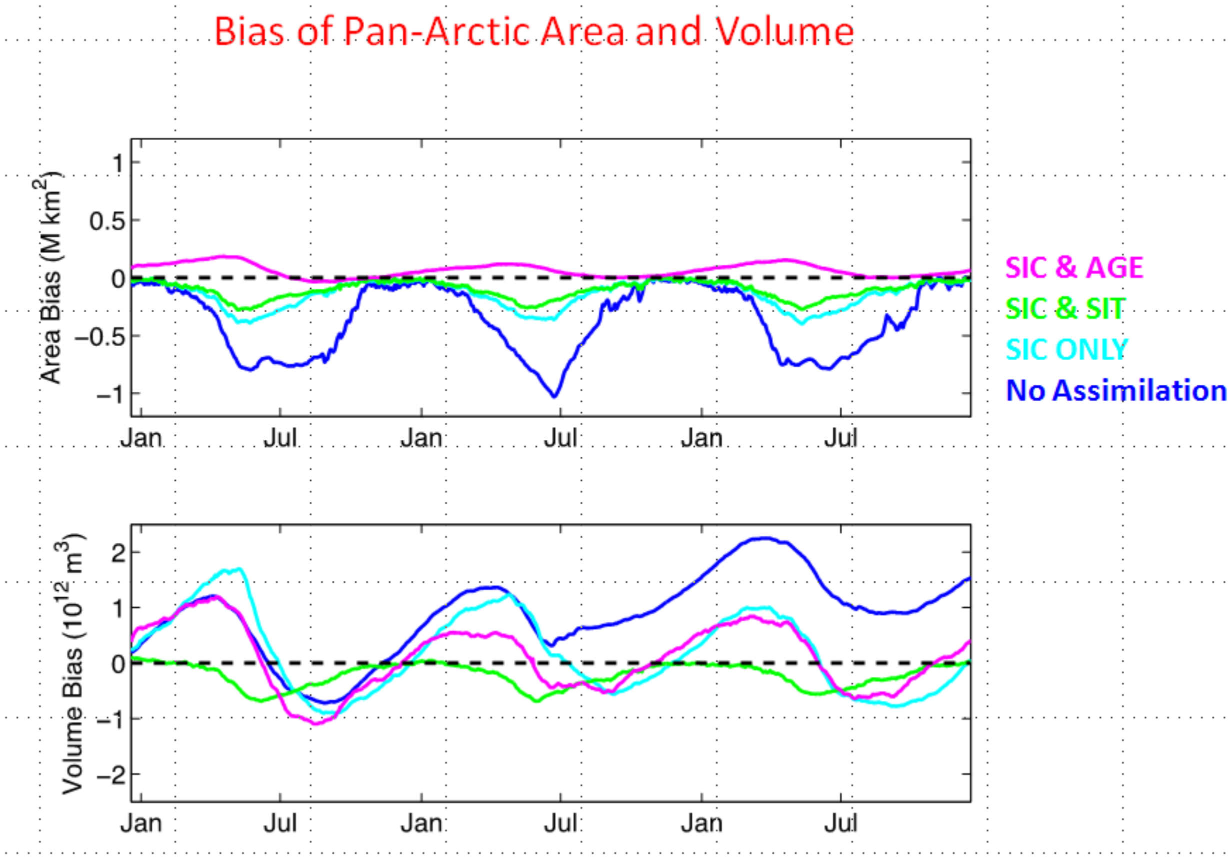

Figure 2 Preliminary results from C. Bitz, et al. (U Wash) from the CVP-funded project: Approaches for Forecasting Sea Ice.

Dr. Amy Solomon, Scientist, NOAA/ESRL Physical Sciences Division

Dr. Amy Solomon, a senior scientist at the NOAA Earth System Research Laboratory in Boulder, CO, introduced their Sea Ice Forecast utilizing their Regional Arctic System Model (RASM). The RASM-ESRL produces 514 day forecasts of 3-hourly sea ice & 6-hourly atmospheric products. The model is initialized with the 0 Z GFS analysis, AMSR2 sea ice concentration, & an ocean reanalysis product. Lateral boundaries are forced by 3-hourly GFS forecasts (temp, winds, & water vapor) & model-derived monthly means in the ocean. Forecasts are posted daily at ~6 Z. Over 15 products are forecasted. See https://www.esrl.noaa.gov/psd/forecasts/seaice/ for more information. For sea ice forecasting, the observational inputs needed for model initiation and boundary conditions include: 1) atmospheric parameters temperature, pressure, water vapor, wind profiles, surface winds, and clouds; 2) ice parameters sea ice thickness, skin temperature, sea ice concentration and motion vectors; and 3) ocean parameters of sea surface temperature, surface salinity, and currents. Dr. Soloman had 3 specific questions regarding JPSS satellite data: 1) Are any JPSS observations currently being uploaded to GTS and assimilated by GFS? 2) How long does it take to get full panArctic coverage? 3) What would be the resolution of coverage over a 3 day period? To address question number 1 regarding JPSS products in GFS, **Lihang Zhou** will take the **action** to add a column to her JPSS product table to indicate products brought into

GFS. Questions 2 and 3 regarding various temporal and spatial coverage from various sensors were discussed. **Amy Solomon** will take the **action** to list her spatial and temporal coverage requirements for each of the input parameters so that satellite scientists can make appropriate recommendations for satellite data products. Solomon noted, for example, they are using a NASA SST product called SPoRT. Paul DiGiacomo commented that NOAA satellite products should be used in NOAA forecasts when possible. NOAA CoastWatch/OceanWatch routinely delivers many ocean products for major ocean parameters such as: sea surface temperature (including a 5km blended SST product); surface salinity from SMOS, ocean color (used in physical models to propagate heat into mixed layer).

Dr. Lihang Zhou, on behalf of Mitch Goldberg, JPSS/STAR Program Scientist

Lihang Zhou introduced the JPSS Science Program on behalf of Mitch Goldberg, the JPSS/STAR Program Scientist. The JPSS Science Program is robust and in encompasses several components, including: user requirements and prioritization or products; algorithm development and calibration/validation of sensors; user readiness (Proving Ground); and new science (Risk Reduction). JPSS products and applications align with all NOAA line offices and NOAA administration objectives. STAR provides the algorithm development, visualization, science and R2O maturity. The Proving Ground/Risk Reduction components are organized into initiatives that focus on parameters and applications and bring together developers, providers, users and other stakeholders for the purpose of bringing new capabilities on line. Several example projects were covered. A number of ice products were noted as part of the JPSS products (Figure 3). Note that, in addition to products derived from the SNPP (the current JPSS satellite mission), snow and ice satellite products derived by STAR from AMSR2 (a sensor onboard a Japanese satellite, GCOMW1) are included within the JPSS program. It is hoped that this TIM will lead to expansion of satellite product applications.

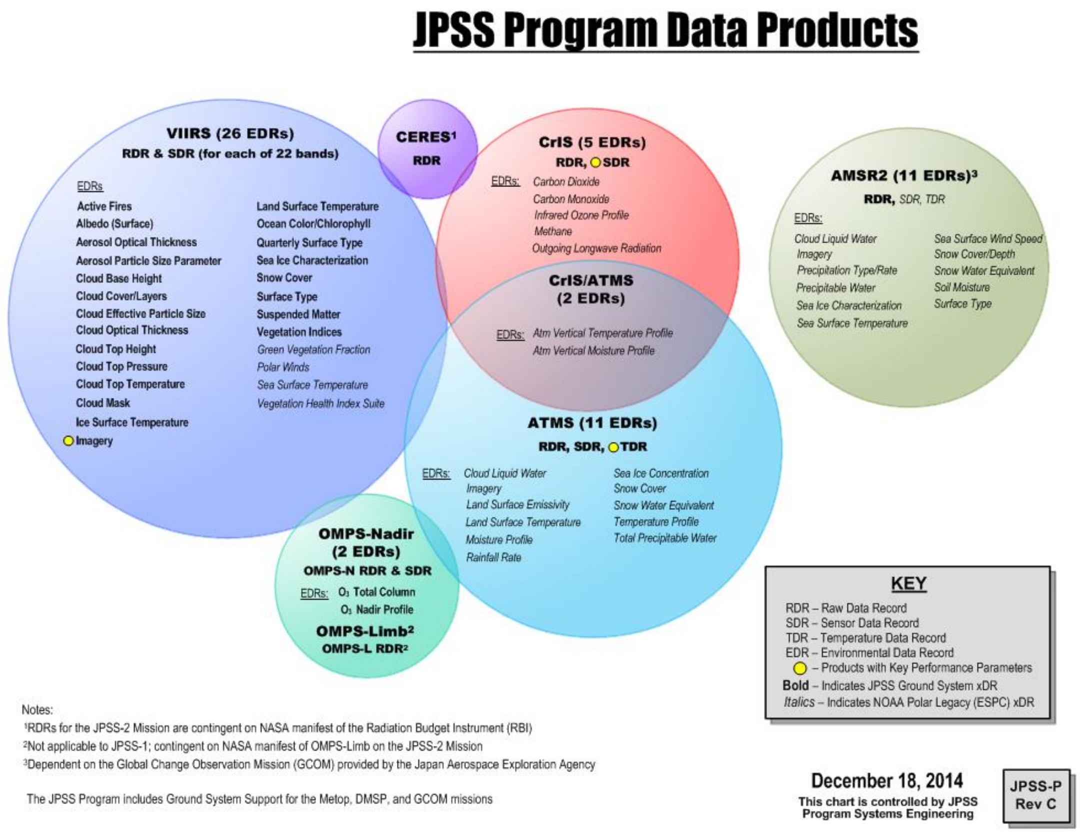

Figure 3. Diagram of JPSS satellite data products.

During a discussion, Jin Huang observed that the Proving Ground is providing the mechanism to test the initiatives and asked how CPO can benefit and what role the CPO program could provide. One of the benefits of JPSS satellite data to CPO is leveraging strategic in situ observations in the region. Through these initiatives, CPO can understand what kind of JPSS products can be utilized. CPO can redirect some observation efforts to developing user applications and improving access and discoverability of NOAA arctic data products. From the JPSS perspective, Lihang noted that JPSS can use help CPO's help to understand the CPO needs. JPSS is also interested in bringing in new science and research in the future development of JPSS products. Therefore, a JPSS/STAR/CPO collaboration could 1) leverage the CPO testbed to bring satellite data into regular use and 2) facilitate new science and/or application developments. Another commenter suggested that bringing GFDL into operational community would be a good example to facilitate creating new potential users.

The timing for the call for the next round of JPSS PGRR proposals is coming soon. Is it not too early to bring in new ideas for future JPSS PGRR initiatives. Chris Barnett is interested in collaborating in potential field campaigns.

Dr. Jeff Key, Scientist and Team Lead JPSS Snow and Ice Products

Jeff Key provided lists of snow and ice products and showed several examples of VIIRS and AMSR2 products from these lists. In addition, he spoke about a climate data record, AVHRR Polar

PathfinderExtended (APPx) containing 19 variables. The APPx covers both poles, 1982 to present, 25 km spatial resolution. Some long-term trend results were shown from this dataset.

NPP/JPSS VIIRS

- Snow cover (binary)
- Snow fraction
- Ice thickness and age
- Ice concentration
- Ice surface temperature
- Ice motion (experimental)
- Sea ice leads (future)
- Polar winds

AMSR2 on GCOMW1

- Snow cover
- Snow depth
- Snow water equivalent (SWE)
- Ice characterization
    - Ice age class (first, multiyear)
    - Ice concentration
- Ice motion (experimental)

Dr. Shobha Kondragunta, Scientist and Team coLead JPSS Aerosol Team

Shobha Kondragunta discussed satellite products for global aerosol optical thickness and global detection of ash, dust, and smoke (daily). Global aerosols are important parameters for interaction with Arctic environmental conditions (e.g., sea ice, etc.). She presented a good discussion about the trade offs between data consistency (quality), and data latency (time delay of product). Satellite data providers need to hear what the optimal balance for data product users. More about aerosol products can be found here: http://www.star.nesdis.noaa.gov/smcd/emb/viirs_aerosol/products_gridded.php.

Dr. Andy Heidinger, Scientist and Team Lead for JPSS Cloud Team

Andy Heidinger presented the suite of global cloud products they generate from VIIRS, including mask, phase, height/temperature/pressure and optical depths, particle sizes, and water paths. These products are routinely available in an Arctic grid and are used by NWS Aviation Weather Center and will soon be provided to OAR/ESRL for model validation over polar regions. Also available is a clearsky imagery product, a daily image constructed from clear sky pixels within the last 2 weeks. For climate applications, there is the Pathfinder Atmospheres Extended (PATMOSx) series of satellite climate products for several sensors. Plans are to add VIIRS in the future.

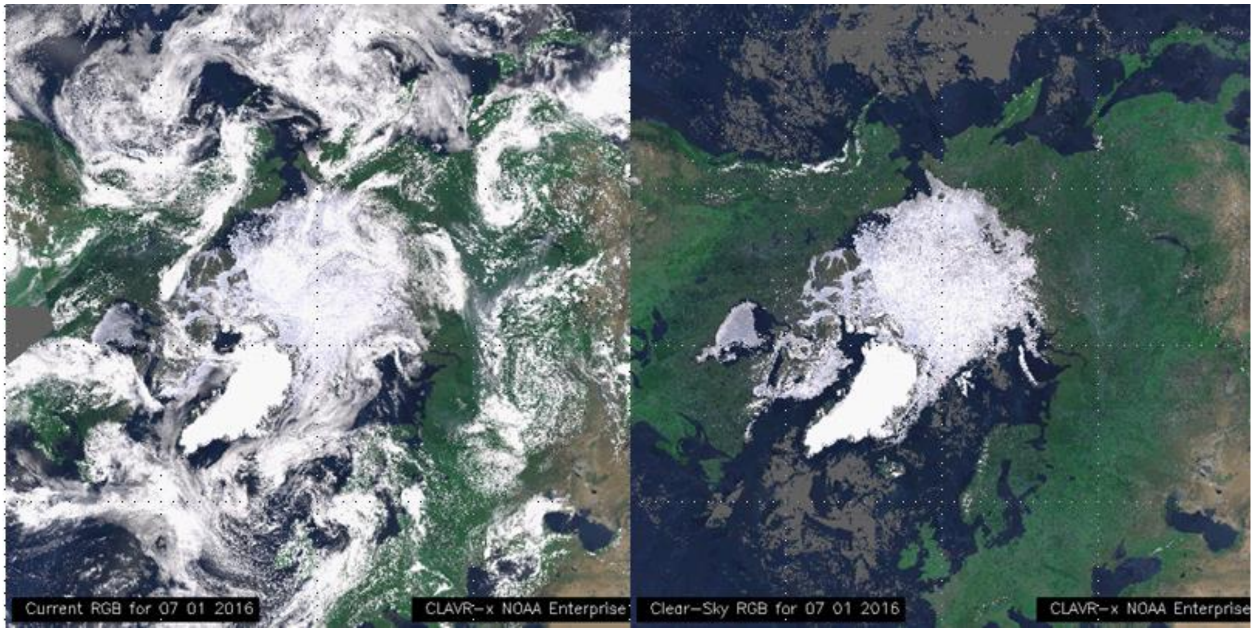

Figure 4. Images show VIIRS true color imagery for July 2016.Left image is unmasked. Right image shows image constructed from clear pixels from the VIIRS cloud mask. Grey regions have no clear data in last 2 weeks.

Dr. Paul DiGiacomo, Satellite Oceanography and Climatology Division (SOCD) Chief and NOAA CoastWatch/OceanWatch/PolarWatch Program Manager

Paul DiGiacomo gave a brief overview of SOCD structure with a focus on the Ocean Science Teams which are organized primarily by parameters: sea ice, sea surface height (and other sea level/altimetry products), sea surface roughness (sea ice, winds, oil spills, ship detection, other from synthetic aperture radar, or SAR) sea surface temperature, sea surface salinity, ocean color radiometry, and surface vector winds. Global and regional data are distributed through NOAA CoastWatch/OceanWatch and NOAA PolarWatch is in progress to focus on serving high latitude ocean data and products in polar projections. Dr. Sinead Farrell is the PolarWatch project scientist and will be speaking next. DiGiacomo also described that ocean data come from many different satellite programs. JPSS is a primary NOAA satellite mission but we need and utilize data from non-NOAA satellite missions as well in order to meet the objectives of our measurement-based approach to ocean satellite data products in support of the NOAA broader missions and downstream users. Sinead Farrell will speak next to highlight sea ice and other relevant polar products and the development of NOAA PolarWatch.

Dr. Sinéad Farrell, SOCD Sea Ice Team Lead and NOAA PolarWatch Project Scientist

Sinéad Farrell spoke about sea ice products produced by SOCD from three different types of satellite remote sensing approaches: radar altimetry, scatterometry, and synthetic aperture radar. From the altimetry approach, parameters include: sea ice thickness observations, snow depth on sea ice, tracking multiyear ice extent, SAR analyses (different from the SAR instrument approach) of sea ice edge and icetype masking. Much effort has been devoted to developing a robust sea ice freeboard algorithm from which the sea ice thickness is derived. The sea ice team collaborates on the Operation IceBridge program to collect airborne in situ observations under-flying various satellite altimeter overpasses (including

Sentinel3). The team is also preparing for the launch of ICESat2 (expected September 2018). Sea ice type and age, and the tracking of multiyear ice extent (at about 4 km spatial resolution, daily observations) is produced from scatterometry. Finally, from the SAR instrument approach, multiple products of potential interest to CPO are produced: SAR ice and class, oil spills, high resolution wind speed, ocean wave spectra, and ship detection.

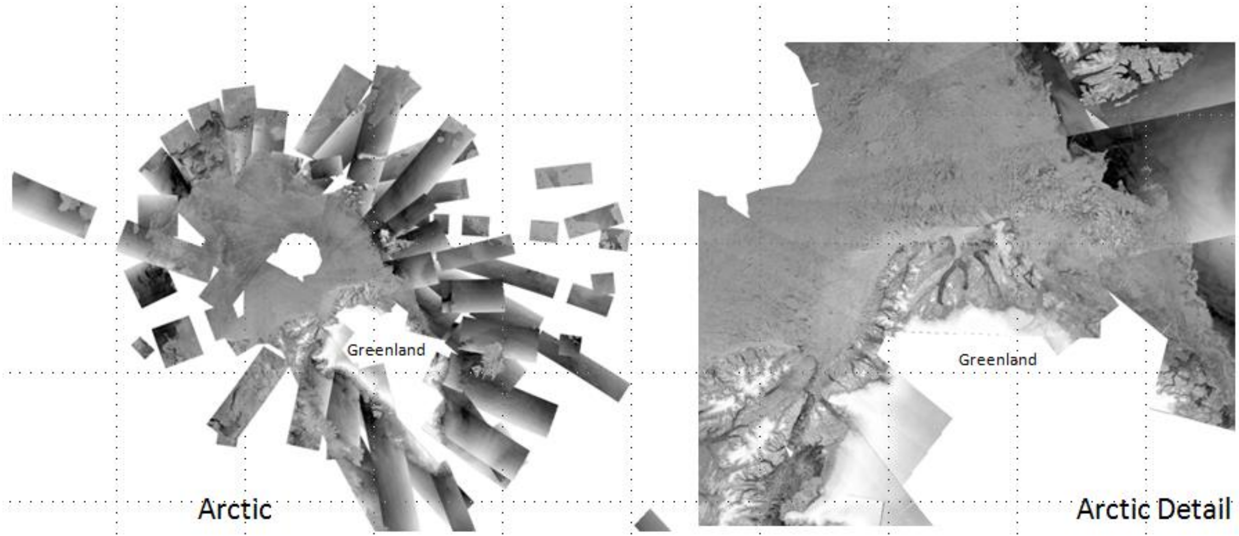

Figure 5. Composite Sentinel1 SAR mosaic of Arctic sea ice. The US National Ice Center uses daily 250m resolution composites of Sentinel1A/B radar cross imagery to aid analysts in seaice masking and ice type classification. *Contains modified Copernicus Sentinel data.*

NOAA PolarWatch (PolarWatch.NOAA.gov) is a new joint venture between the Center for Satellite Applications and Research (STAR) within NESDIS and the West Coast Regional Node (WCRN) of CoastWatch which is based out of the SouthWest Fisheries Science Center of NMFS. PolarWatch started in the Fall of 2016 and will provide a user-driven information portal for accessing multisensor physical and biological ocean remote sensing data in support of a broad suite of applications and research in the Arctic and Antarctic.

Dr, Veronica Lance, NOAA CoastWatch/OceanWatch Program Scientist

Veronica Lance made a few closing remarks, thanking participants, summarizing actions and made an announcement to watch for invitation to Part II of this Arctic TIM which will focus on biogeochemistry and living resources.

Appendix B: Agenda

JPSS/STAR and OAR/CPO		Arctic Technical Interchange Meeting
Wed., 29 March 2017		
12:30 to 14:30	**Part I:**	**Focus on atmosphereoceancryosphere**
12:30 to 12:35 (5 min)	Lihang Zhou	Intro; Purpose; overview agenda (2 separate days)
12:35 to 12:50 (15 min)	Sandy Starkweather (remote)	OAR/CPO Arctic programs
12:50 to 13:05 (15 min)	Janet Intrieri, Amy Solomon (remote)	Observational needs for RASMESRL sea ice forecasting
13:05 to 13:10 (5 min)	VL (skipped)	Slides from Mitch Bushuk GFDL
13:10 to 13:15 (5 min)		Questions/discussion about OAR/CPO user needs
13:15 to 13:20 (5 min)	~~Mitch Goldberg~~ Lihang Zhou	JPSS Overview (oceans ice, land, atmosphere, winds on GCOMW)
13:20 to 13:30 (10 min)	Bio Break	
13:30 to 13:40 (10 min)	Jeff Key (remote	JPSS Ice/Snow
13:40 to 13:50 (10 min)	Shobha Kondragunta	JPSS Atmosphere
13:50 to 13:55 (5 min)	Andrew Heidinger (remote)	Cloudfree imagery in Arctic
13:55 to 14:00 (5 min)	Paul DiGiacomo	STAR/SOCD/SMCD (relevant satellite products outside of JPSS)
14:00 to 14:15 (15 min)	Sinead Farrell presents with science teams in participation	SOCD Sea Ice, SAR Ice and Winds (Monaldo), and Altimetry (Leuliette) and PolarWatch
14:15 to 14:20 (5 min)		Questions/Discussion
14:20 to 14:30 (10 min)		Document Actions/Next Steps/Future Plans

Appendix A: Participants

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