Geo-Polar Blended Sea Surface Temperature Analysis

Presented by

Eileen Maturi, NESDIS/STAR/SOCD

Andy Harris[1], Eileen Maturi[2], John Sapper[3], Jonathan Mittaz[1,4], Sasha Ignatov[2] Gary Wick[5], Mark Eakin[2]

[1]NOAA-CICS, University of Maryland, [2]NOAA/NESDIS/STAR , [3]NOAA/NESDIS/OSPO
[4]University of Reading, UK , [5]NOAA/OAR/ESRL

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Geo-Polar Blended SST Analysis

- Team Members and Affiliations
- Blended Product Development
  - Inputs needed for the Blended Product Algorithm
  - Technical Approach:
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  - Product Evaluation/Validation/Tools
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- Future Algorithm Improvements
- Product Outreach
  - Importance/Benefits/Users
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- Summary and Path Forward

Algorithm Team Members

Name	Organization	Major Task
Andy Harris	NOAA-CICS/University of Maryland	Ongoing Scientific Development and Maintenance
Jon Mittaz	University of Reading, UK	C-code for Data Ingestion, F90 code for Diurnal Warming Model
Gary Wick	NOAA/OAR/ESRL	Scientific development of Diurnal Warming Model
John Sapper	NOAA/NESDIS/OSPO	Oversee Implementation into Operations
Mark Eakin	NOAA/NESDIS/STAR/SOCD	Requester for the Coral Reef Watch application
Eileen Maturi	NOAA/NESDIS/STAR	Oversee Development of Analysis
Sasha Ignatov	NOAA/NESDIS/STAR	Generate Polar L2 SSTs and GOES-16 L2 SST

Geo-Polar Blended Sea Surface Temperature Analysis

Required Satellite and Ancillary Input Data Products

	Data Product Name (Inputs)	Input Data Type (Satellite/Model Forecasts/*In-situ*)	Temporal/ Spatial Resolution, Format	Source(s)
1	Blended Day/Night Analysis	Satellite L2P/Analysis	5-km Resolution	**NESDIS** **UK Met Office**
2	Blended Nighttime Analysis	Satellite L2P/ Analysis	5-km Resolution	**NESDIS** **UK Met Office**
3	Blended Diurnally Corrected	Satellite L2P/ Analysis/ Model	5-km Resolution	**NESDIS** **UK Met Office** **NWS**

Geo-Polar Blended Sea Surface Temperature Analysis
Technical Approach

1. Blended Product Algorithm Description

Application of a dynamic data-fusion scheme to produce a global, operational SST Analysis of polar and geostationary SST data from NOAA and non-NOAA platforms. The method employs a recursive estimator which emulates the Kalman Filter and uses data-adaptive correlation length scales to provide a reasonable balance between noise reduction and detail preservation.

2. Technical Approach

- Each input dataset is super-ob'd on separate $1/20^0 \times 1/20^0$ grids (*e.g.* S-NPP VIIRS daytime SST is treated as a separate observation field from S-NPP VIIRS nighttime SST)
- Super-ob process evaluates standard deviation within grid cell and eliminates outliers, based on expected standard deviation
- Diurnally-adjusted analysis applies modeled diurnal warming estimates to every input observation during the super-ob process
- Each observation field is adjusted for ~long-scale ($\sim 2^0 \times 2^0$) biases, which are updated daily with respect to the reference field
- Analysis performed on quad-tree for efficiency, using 3 separate anomaly correlation length scales. Final result is interpolated from the coarse, medium and fine-scale analyses, based on local data density
- Separate ocean basins (*e.g.* no data cross-talk across Isthmus of Panama)
- Covariance structures are updated after every analysis step

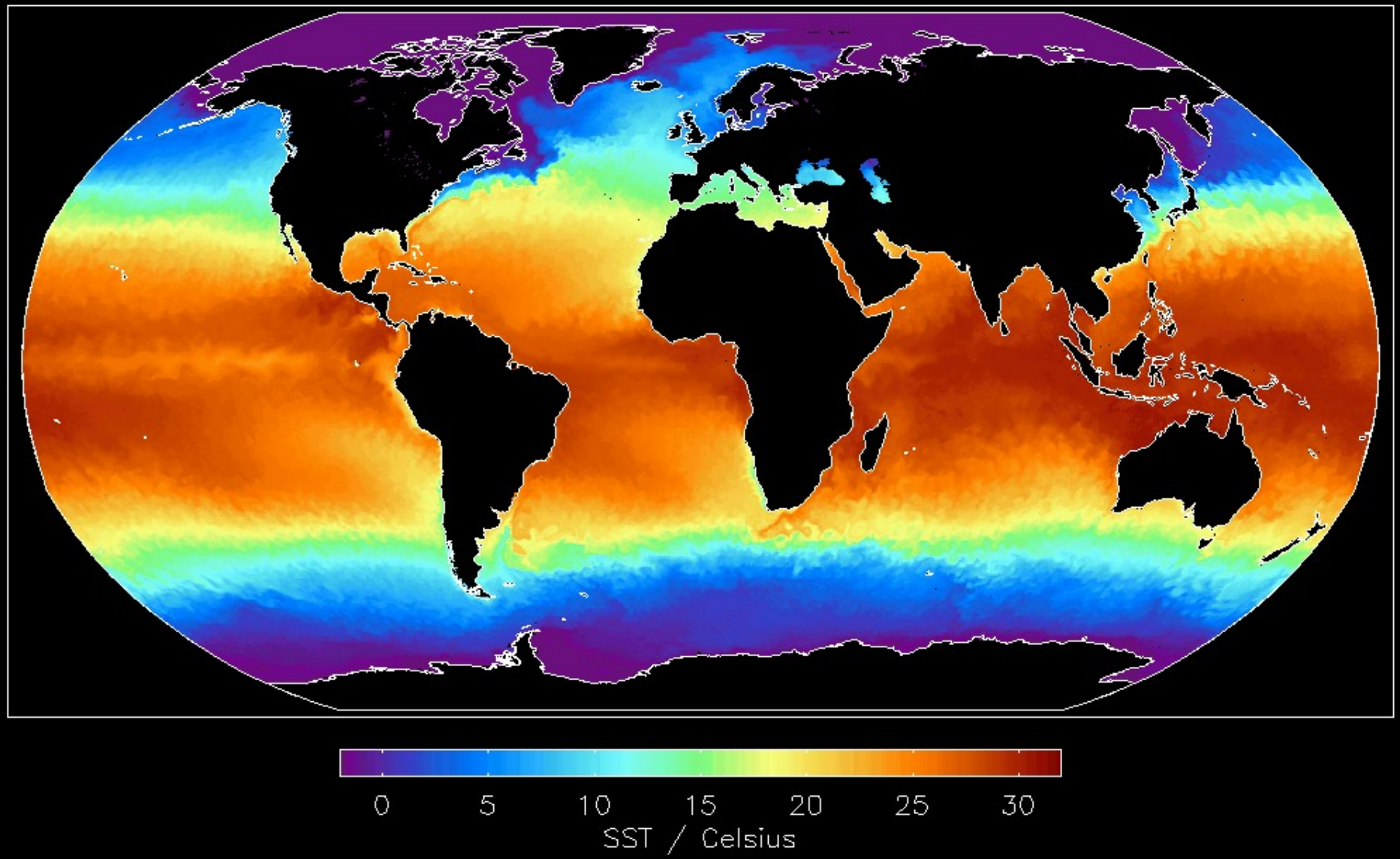
Geo-Polar Blended Sea Surface Temperature Analysis

Examples/Outputs

	Blended Data Product Name (Outputs)	Output Data Type (Satellite; Model Forecasts; In-situ)	Spatial, Temporal Resolution, Format	Sources (Satellite)
1	Blended Day/Night	Multi-satellite Analysis + Error Analysis	5-km	VIIRS, AVHRR, Imager, ABI, SEVIRI, AHI
2	Blended Night time only	Multi-satellite Analysis + Error Analysis	5-km	As above
3	Blended Diurnally Corrected	Multi-satellite Analysis + Error Analysis	5-km	As above

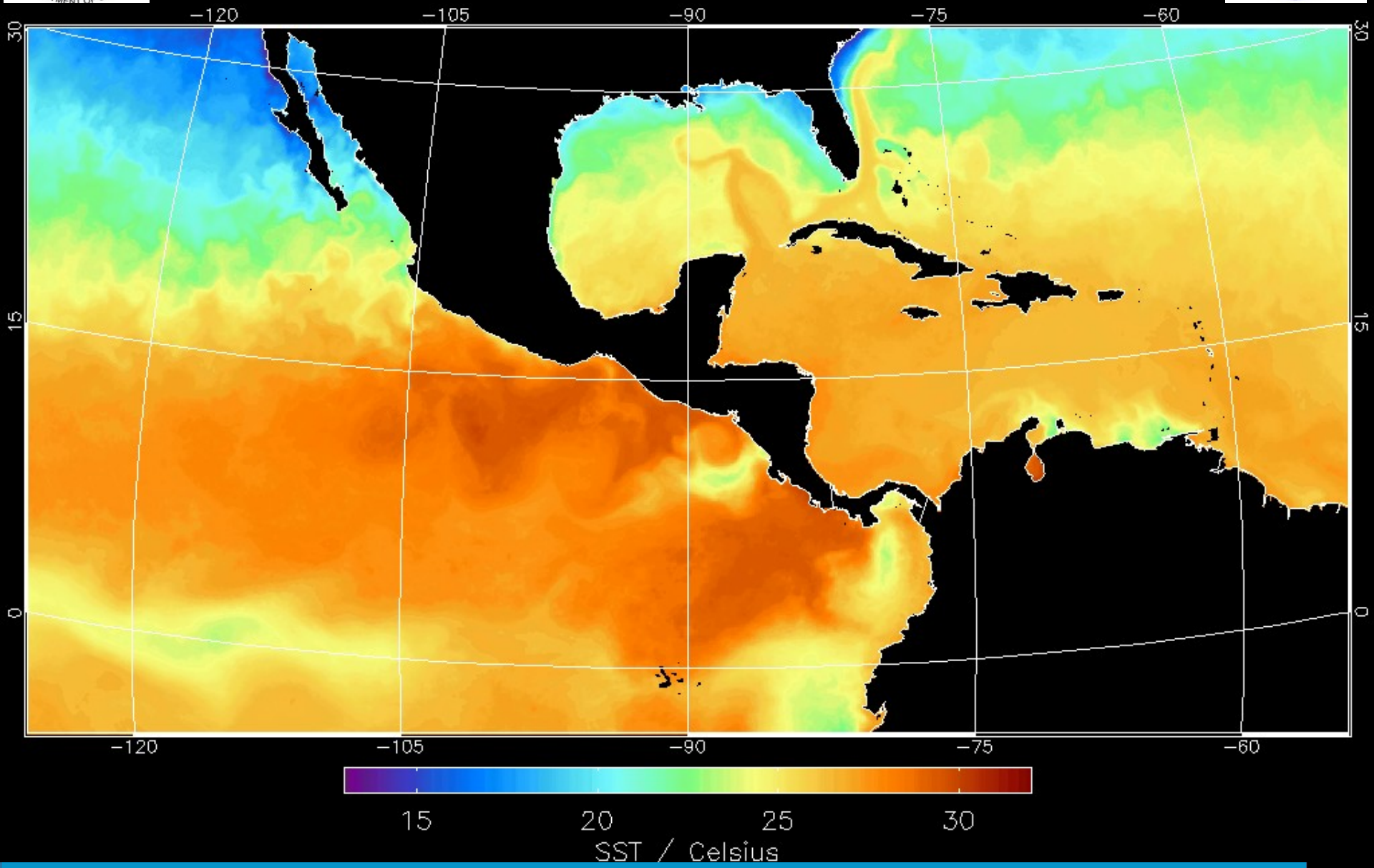
Geo-Polar Blended Sea Surface Temperature Analysis

Examples/Outputs



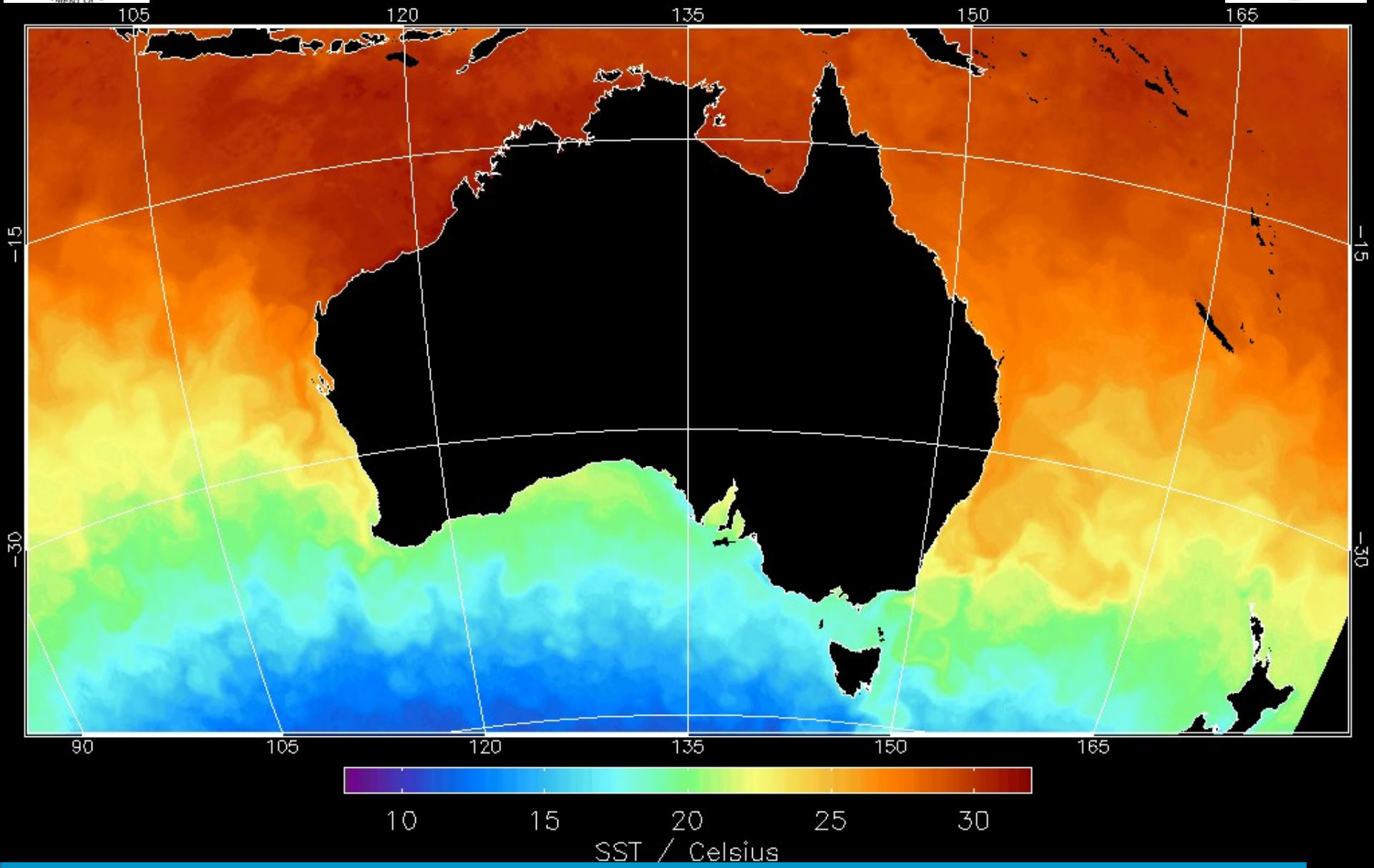
Geo-Polar Blended Sea Surface Temperature Analysis

Examples/Outputs



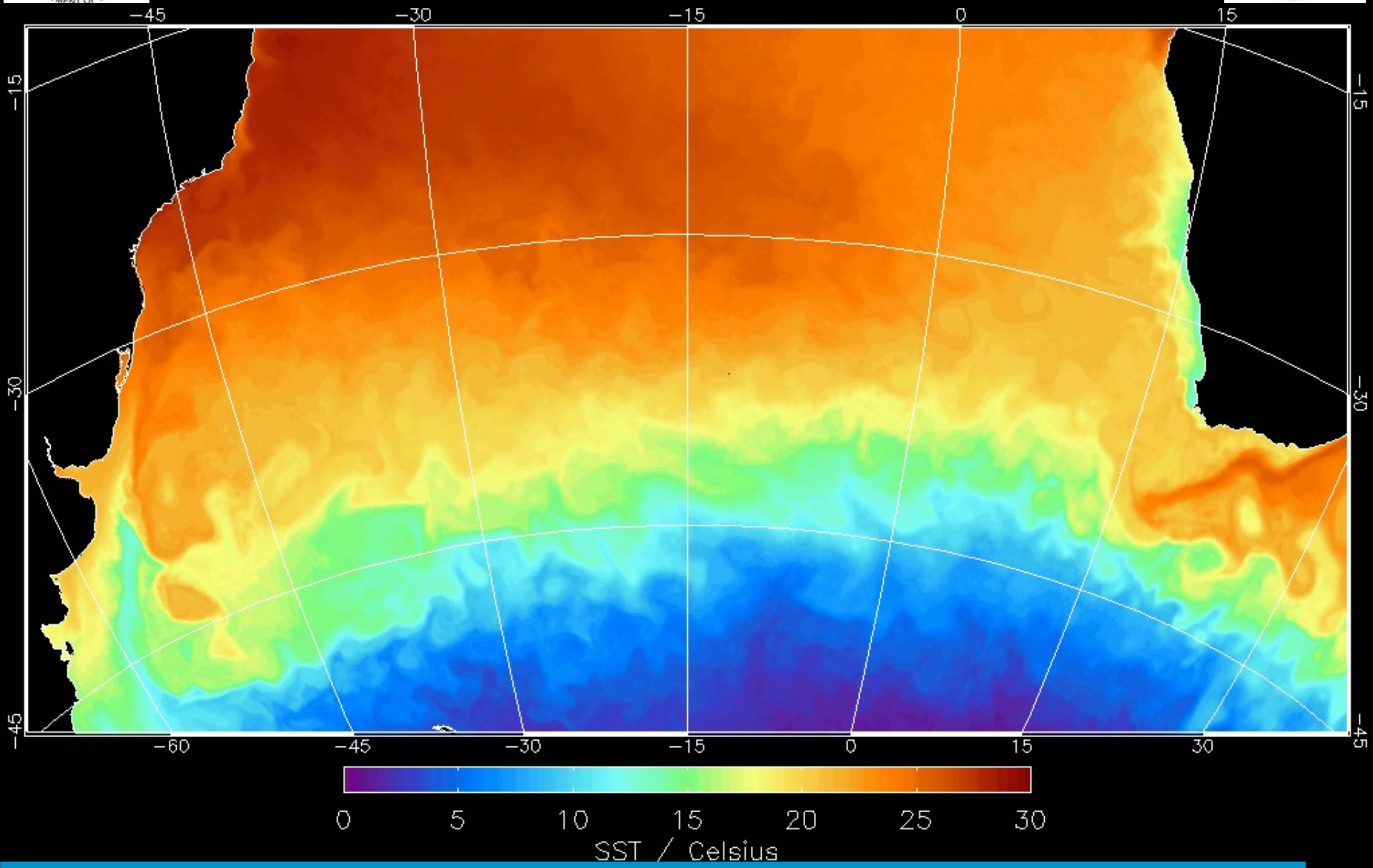
Geo-Polar Blended Sea Surface Temperature Analysis

Examples/Outputs

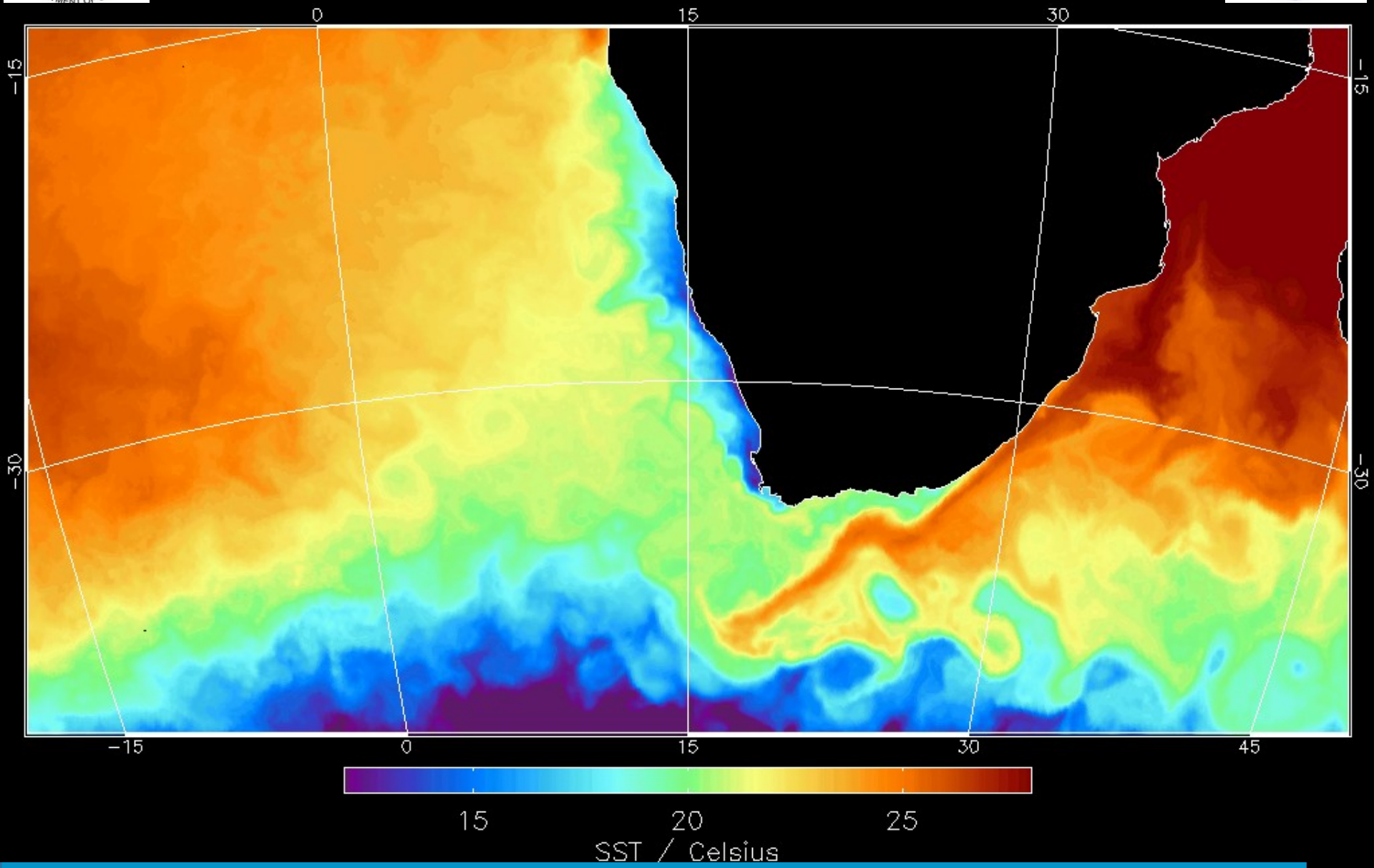


Geo-Polar Blended Sea Surface Temperature Analysis

Examples/Outputs

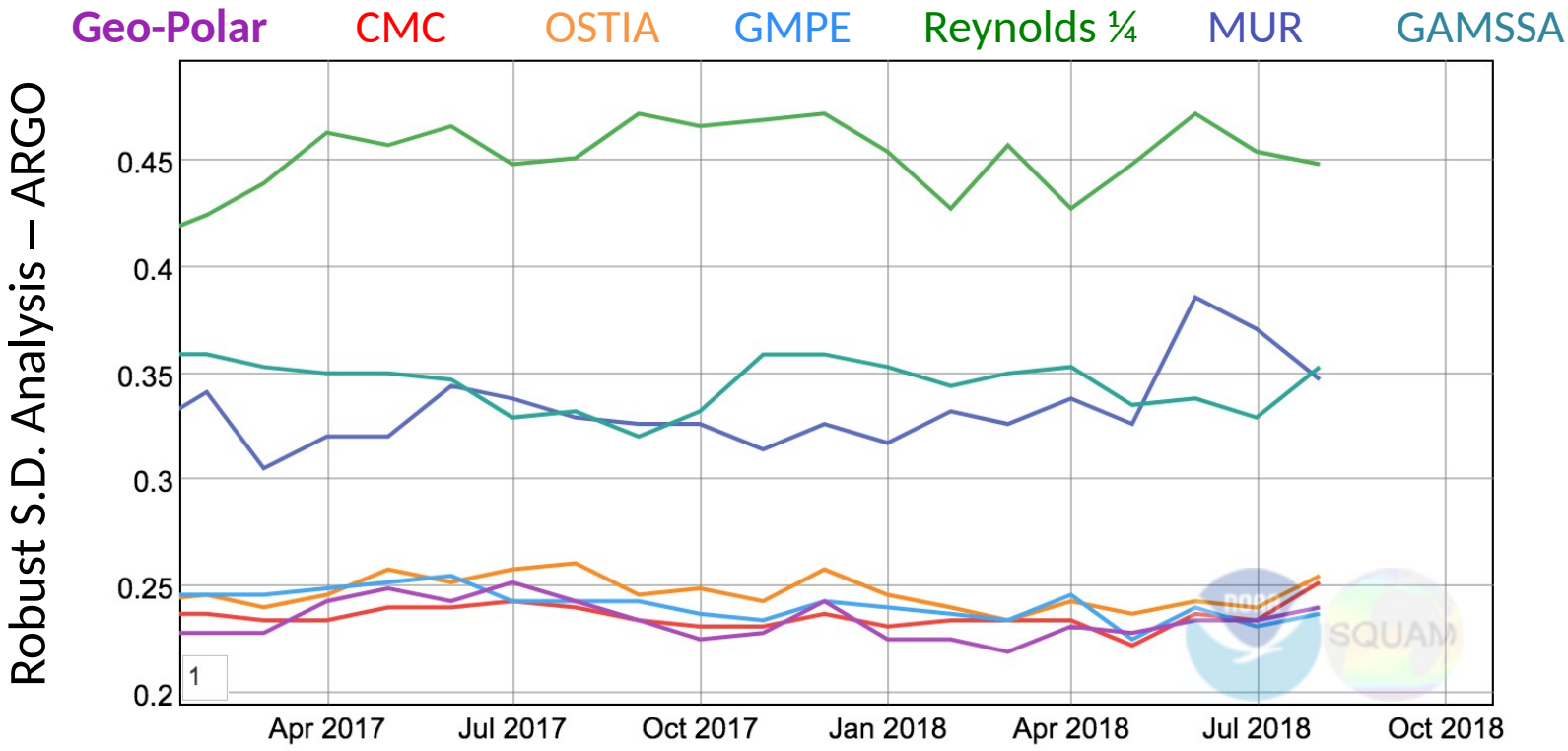


Geo-Polar Blended Sea Surface Temperature Analysis
Examples/Outputs



Geo-Polar Blended Sea Surface Temperature Analysis
Evaluation/Validation/Tools

- Product Evaluation/Validation
  - ARGO temperatures at ~5 m depth (truly independent)
  - STAR SQUAM web page
    - ✓ https://www.star.nesdis.noaa.gov/sod/sst/squam/
  - Uncertainty information provided for every grid cell



Geo-Polar Blended Sea Surface Temperature Analysis
Implementation Status

- Operational with 24/7 support
- Available from OSPO Product Distribution and Access (PDA)
- Available in AWIPS and on CoastWatch/OceanWatch Web Site
- Runs in Linux environment
- Code is a combination of MATLAB, C, Fortran 90
- Diurnal correction to the day/night product was implemented this FY18
- Future implementation plans:
  - Regional 1km blended analyses
  - Possible addition of microwave SSTs
  - More independent bias control using Sentinel-3 SLSTR

Geo-Polar Blended Sea Surface Temperature Analysis

Identified Risk/Issues	Action/Mitigation
Dependent on OSTIA reference	Overhaul bias adjustment methodology (combination of Sentinel-3 SLSTR + VIIRS nighttime SST)
No baseline funding for scientific maintenance	Keep proposing enhancements every year and hope they get funded. Do the maintenance off the back of that.

Geo-Polar Blended Sea Surface Temperature Analysis
Future Algorithm Improvements

- Improve diurnal warming model
  - Ongoing
- Regional analyses (~1/40° – 1/80°) for CRW and other applications
  - 18 months – dependent on funding approval
- Arctic SST analysis (new length scales, projection, treatment of sea ice)
  - 1-2 years for initial analysis
- Overhaul bias correction methodology
  - 1 year – dependent on funding approval
- Reprocessing of historical data to provide longer baseline for anomaly-based products (*e.g.* CRW)
  - Back to 1995 done by end-2018 (dependent on satellite SST inputs)
- Future Validation Plans
  - ARGO is very good for open ocean and ~monthly scale
    - Validation for sub-daily high-resolution will be harder

Summary and Path Forward

- **Summary and Conclusions**
  - Geo-Polar Blended SST Analysis is world-leading
    - Among the most accurate when validated against independent ARGO
    - Better feature resolution than competing analyses
    - All satellite inputs are NESDIS-derived
- **Path Forward**
  - Diurnal modeling is state-of-the-art turbulence closure scheme
  - Higher resolution analyses for specific ecological applications e.g. Coral Reef regions
  - Reprocessing to provide longer baselines for anomaly-based products
  - Improvements to bias adjustment to give full independence
  - Arctic analysis for an important changing region

Backup Slides

Geo-Polar Blended SST Analysis-Reprocessed

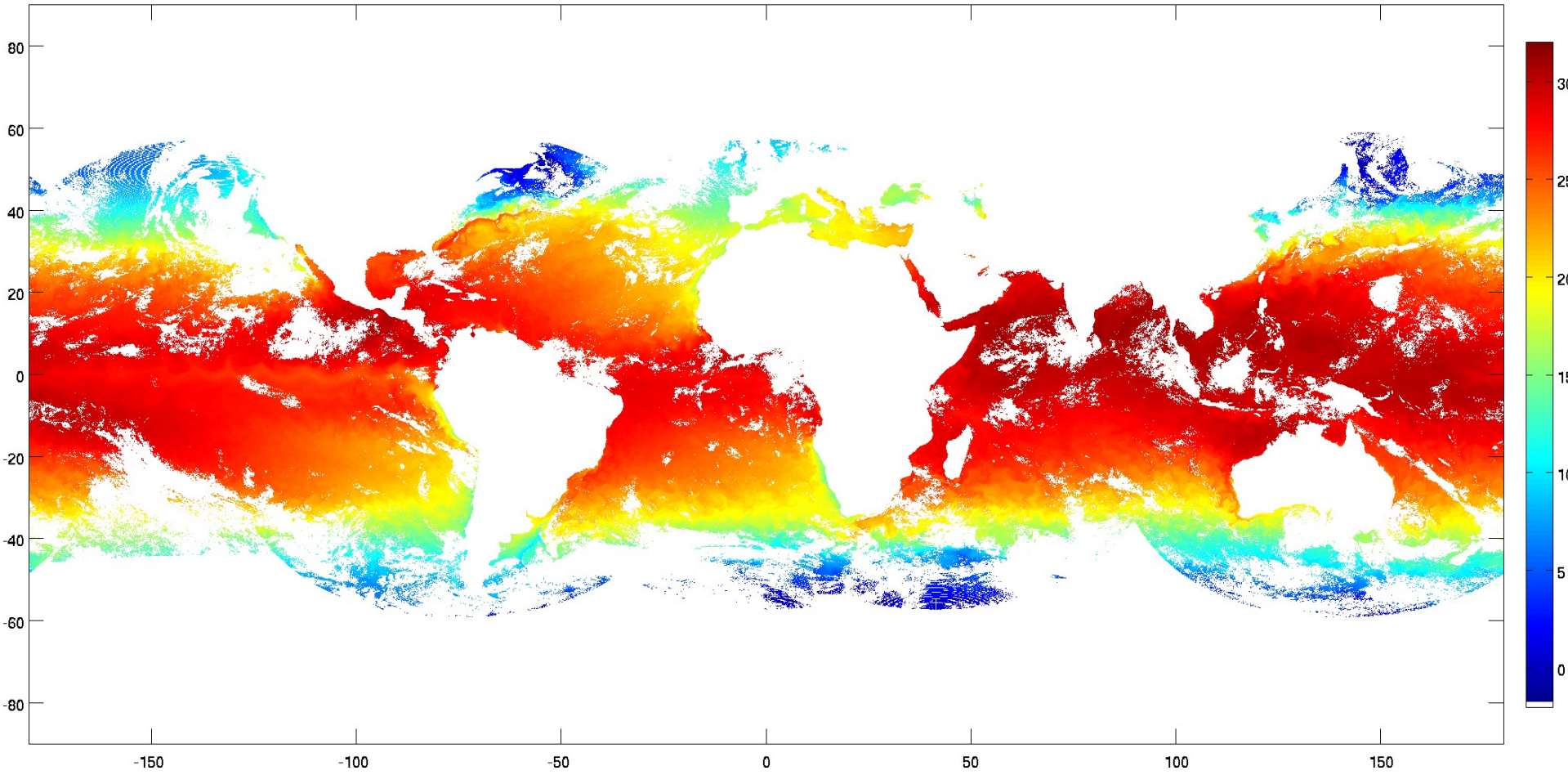
- Reprocessed Geo-Polar Blended SST Analysis 2002-2016
  - Reprocessed Geostationary Data
  - Reprocessed Polar Data (Sasha Ignatov)

- Improved Baseline for Coral Reef Watch Products

- Critical for Anomaly Based Products to use Climatology derived using the latest processing methodology Important to derive climatology from dataset with similar characteristics to current Geo-Polar Analysis
  - Take advantage of latest processing methods/products
  - Ensure anomalies are due to geophysics rather than algorithm/processing
  - Requires reprocessing of **all L2 SSTs for geostationary and polar-orbiter data sources**
  - Note, NOAA are the only operational L4 provider who also process all the L2 data in-house

GLOBAL GEO COVERAGE

GOES-15 **GOES-16** **Met-11** **Met-8** **Himawari-9**



Geo-polar Blended SST Analysis - Day-Night
Input Requirements

Input Data	Resolution	Source
METOP-B	1-km global	NESDIS
GOES-16	2-km Regional	NESDIS
GOES-15	4-km Regional	NESDIS
MSG-1	3-km Regional	NESDIS
MSG-4	3-km Regional	NESDIS
OSTIA ANALYSIS	1/20° global	UK Met Office
VIIRS	0.75-km global	NESDIS
Himawari-8	2-km regional	NESDIS

Geo-polar Blended SST Analysis- Night
Input Requirements

Input Data	Resolution	Source
METOP-B	1-km global	NESDIS
GOES-16	2-km Regional	NESDIS
GOES-15	4-km Regional	NESDIS
MSG-1	3-km Regional	NESDIS
MSG-4	3-km Regional	NESDIS
OSTIA ANALYSIS	1/20° global	UK Met Office
VIIRS	0.75-km global	NESDIS
Himawari-8	2-km regional	NESDIS

Geo-Polar Blended SST Analysis -Diurnally Corrected Input Requirements

Input Data	Resolution	Source
METOP-B	1-km global	NESDIS
GOES-16	2-km Regional	NESDIS
GOES-15	4-km Regional	NESDIS
MSG-1	3-km Regional	NESDIS
MSG-4	3-km Regional	NESDIS
OSTIA ANALYSIS	1/20° global	UK Met Office
VIIRS	0.75-km global	NESDIS
Himawari-8	2-km regional	NESDIS
NCEP fluxes of heat and momentum, and wave model output	0.5°	NWS

Output Specifications

- Blended Product Name: **{Geo-Polar Blended Sea Surface Temperature Analysis- Day/Night}**
- Output Data Type(s): {Analysis/ Error Analysis}
- If your blended product algorithm produces more than one output product, use additional slides as required.

Output Product(s) Attributes	Threshold	Observed/validated
Latency	Within 12hrs of last observation	
Geographic coverage	Global	
Vertical Coverage	N/A	
Vertical Cell Size	N/A	
Horizontal Cell Size	1/20°	N/A
Mapping Uncertainty		<1/40°
Measurement Range	-2°C to +40°C	
Measurement Accuracy	<0.1 kelvin	<0.1 kelvin
Measurement Precision	0.01 kelvin	0.01 kelvin
Measurement Uncertainty	0.3 kelvin	0.3 kelvin

Output Specifications

- Blended Product Name: **{Geo-Polar Blended Sea Surface Temperature Analysis-Night}**
- Output Data Type(s): {Analysis/ Error Analysis}
- If your blended product algorithm produces more than one output product, use additional slides as required.

Output Product(s) Attributes	Threshold	Observed/validated
Latency	Within 12hrs of last observation	
Geographic coverage	Global	
Vertical Coverage	N/A	
Vertical Cell Size	N/A	
Horizontal Cell Size	1/20°	N/A
Mapping Uncertainty		<1/40°
Measurement Range	-2°C to +40°C	
Measurement Accuracy	<0.1 kelvin	<0.1 kelvin
Measurement Precision	0.01 kelvin	0.01 kelvin
Measurement Uncertainty	0.3 kelvin	0.3 kelvin

Output Specifications

- Blended Product Name: **{Geo-Polar Blended Sea Surface Temperature Analysis-Diurnally Corrected}**
- Output Data Type(s): {Analysis/ Error Analysis}
- If your blended product algorithm produces more than one output product, use additional slides as required.

Output Product(s) Attributes	Threshold	Observed/validated
Latency	Within 12hrs of last observation	
Geographic coverage	Global	
Vertical Coverage	N/A	
Vertical Cell Size	N/A	
Horizontal Cell Size	1/20°	N/A
Mapping Uncertainty		<1/40°
Measurement Range	-2°C to +40°C	
Measurement Accuracy	<0.1 kelvin	<0.1 kelvin
Measurement Precision	0.01 kelvin	0.01 kelvin
Measurement Uncertainty	0.3 kelvin	0.3 kelvin

Importance/Benefits/Users

Name	Organization	Application	User Feedback – User readiness dates for ingest of data and bringing data to operations
Paul DiGiacomo	NOAA/NESDIS STAR/SOCD	CoastWatch/OceanWatch	Product is disseminated through the CoastWatch/OceanWatch Regional Managers
Mark Eakin	NOAA/NESDIS STAR/SOCD	Coral Reef Watch: Ecosystem Monitoring and Prediction	Used to generation operational products for the coral reef bleaching forecasting/ Climate Monitoring
Cara Wilson	NOAA/NMFS	Ecosystem monitoring and prediction of fish stock	Provide good temporal resolution for location of temperature fronts for fish stock
Joe Sienkiewicz	NOAA/NWS/OPC	Commerce and Transportation	Used for High Sea Forecasts
Vijay Tallapragada	NWS	Used in the generation of Oceanic Heat Content	Ocean Heat Content Product the best forecaster for Hurricane Intensity

Documentation/website links

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