Comparing SWH Statistics from ICOADS and Satellite Altimeter Data

A Work in Progress

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Scope

- **Why - The Motivation?**
- **About GlobWave**
- **About ICOADS**
- **Processing**
- **Challenges**
- **Preliminary results**
- **Future work**

Why? – the Motivation

- **Updated Hs-Tz scatterplots for Naval architects**
- **SWH climatology, mainly in the Southern Ocean**
- **Currently use the ERA-40 re-analysis and also maintain separate climatologies for each altimeter**
- **Globwave 1.3 with inter-calibrated altimeter SWH data provides an opportunity to replace the individual altimeter climatologies**
- **Availability of ICOADS**
- **To compare ICOADS, ERA-40 re-analysis, single altimeter and GlobWave SWH climatologies**

NAVY

Progress to Date

- **Downloaded and processed Globwave**
- **Downloaded and processed ICOADS**
- **Superficial comparison of GlobWave and ICOADS**
- **----------**
- **No comparison of GlobWave and individual altimeters**
- **No comparison of ICOADS with ERA-40**
- **No comparison of GlobWave with ERA-40**

About GlobWave 1.3

- **ESA funded project with CNES support**
- **8 altimeters (1985 – 2010)**
- **Globwave L2 Data**
  - Calibrated SWH and quality flag
  - Calibrated Sigma-0 and quality flag
- **Ancillary data**
  - GEBCO08 (0.5 degree) Bathymetry
  - Distance to coast (GSHHS shoreline)
  - ERA40 (0.75 degree) re-analysis winds

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Processing Globwave

- **Download, unzip (50.7Gb, 539 645 orbit files)**
- **Extract**
  - Time (seconds since 1985-01-01)
  - Latitude
  - Longitude
  - SWH_Calibrated
  - SWH_Quality
  - Sigma-0 calibrated (backscatter coefficient)
  - Sigma-0 quality
  - Wind Speed model_u
  - Wind Speed model_v
  - Bathymetry
  - Distance to Coast

NAVY

Processing Globwave

- **Process**
  - **Year, Month, Day, Time**
  - Latitude
  - Longitude
  - SWH_Calibrated
  - SWH_Quality
  - Sigma-0 calibrated (backscatter coefficient)
  - Sigma-0 quality
  - **Wind Speed**
  - **Wind Direction**
  - Bathymetry
  - Distance to Coast

Quality Control - Missing Data

Product User Guide V1.3 states that all the extracted fields are included for all satellites, but…

- Wind and bathymetry data missing from some TOPEX
- Wind missing from some GEOSAT
- Distance to Coast missing from some ERS-2 and JASON-2
- Distance to Coast and Bathymetry missing from some ENVISAT
- Only JASON-2 has Sigma-0 backscatter data

- **No single orbit file has all the data??**

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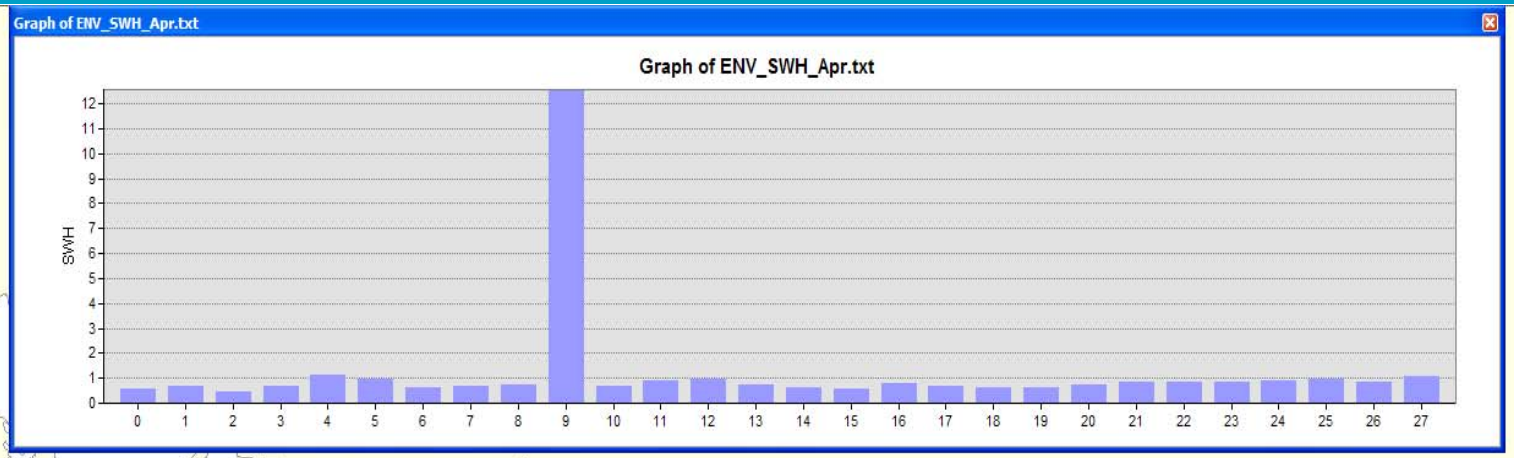
Quality Control – Data Quality

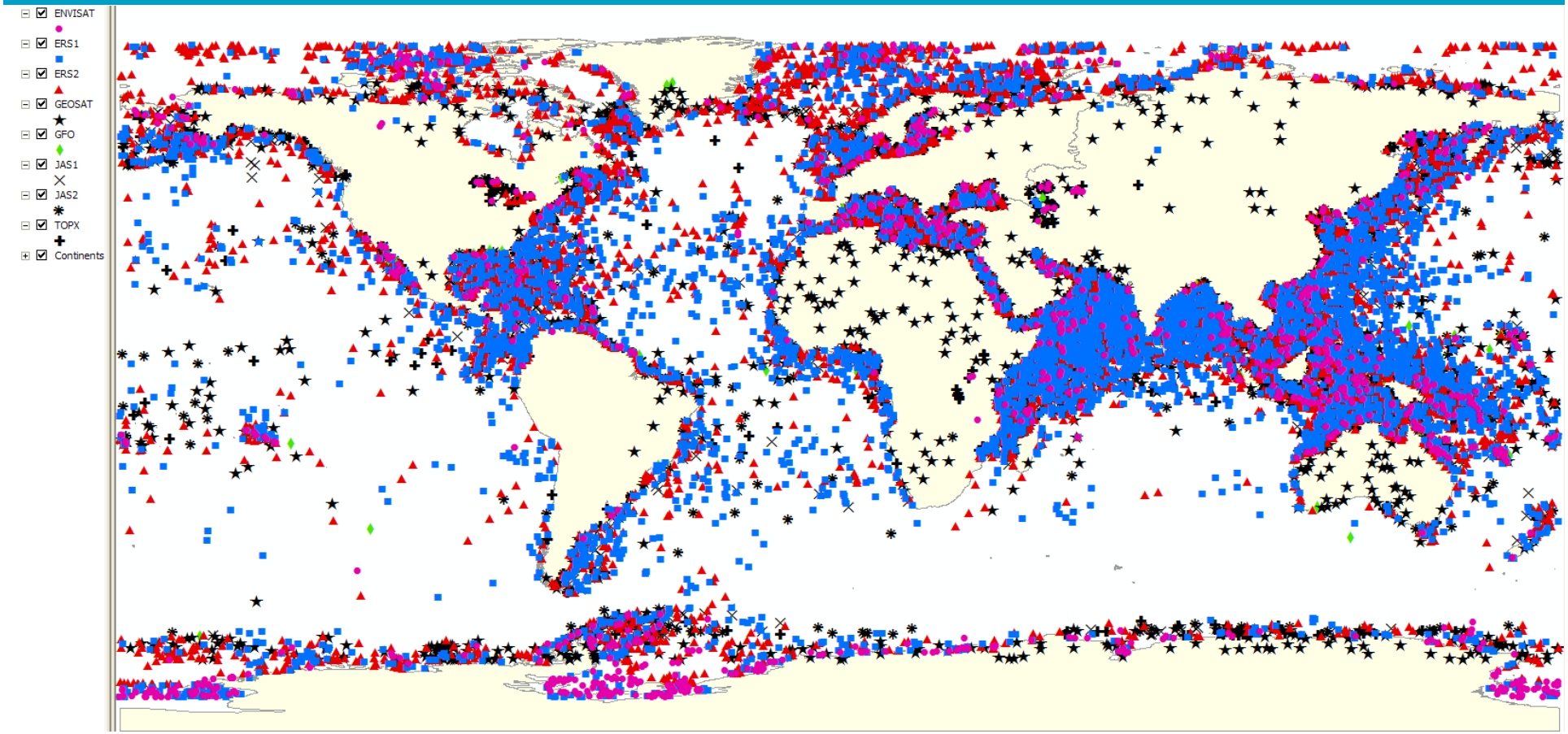
- **Data Quality**
  - SWH Quality Flag uses three values
    - 0 - probably good
    - 1 – suspect, probably OK for some applications
    - 2 – probably bad

- **Only data quality = 0 used**

Quality Control – Data Quality



Quality Control – Data Quality



Quality Control – Data Quality

- **Enhanced QC rejects**
  - ENV – 1129
  - ERS1 – 5581
  - ERS2 – 8296
  - GEOS – 1474
  - GFO – 105
  - Jason1 - 2968
  - Jason2 - 819
  - TOPEX – 1289
  - **Total – 23135 (0.003%)**

Processing Globwave

- **Monthly Climatology**
  - Simple one degree box statistics
  - If Nobs > 25, calculated
    - Mean
    - Max
    - Nobs
    - Standard deviation
    - Histogram (1m intervals)

About ICOADS 2.5

- **Starting as the US sponsored COADS in 1981, ICOADS is now the largest consistent dataset of surface marine observations.**
- **Data is predominantly marine weather, but with an increasing number of sea and swell observations.**
- **Waves, Swell and SWH are not currently released as climatologies**
- **332 200 640 observations in total to the end of 2010**
- **Extracted 40 944 649 Sea and Swell observations**
- **Extracted 94 805 195 Sea or Swell observations**

NAVY

Processing ICOADS

- **ICOADS 2.5 (IMMA format) downloaded from NCAR (20.8 Gb)**
- **Data to Dec 2010 used**
- **Extract**
  - Year, Month, Day, Time
  - Latitude, Longitude
  - Wind Speed and Direction
  - Wave Period and Height
  - Swell Direction, Period and Height

  for all observations with a wind and wave and/or swell report
- **Quality Control**

  Gross error checking only

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ICOADS - Calculating SWH

- **Hogben (1988)**

$$SWH = \sqrt{(Hw^2 + Hs^2)}$$

- **Wilkerson & Earle (1990)**

$$SWH = Max(Hw, Hs)$$

- **Barrett (1991)**

$$SWH = \begin{cases} \sqrt{(Hw^2 + Hs^2)}, & \text{if wind dir within } 45^o \text{ of Swell dir} \\ Max(Hw, Hs), & \text{otherwise} \end{cases}$$

- **Gulev & Hasse (1998)**

As for Barrett with direction of 30^o

ICOADS - Calculating SWH

- **40 944 649 Sea and Swell observations**
- **94 805 195 Sea or Swell observations**
- **Technique used : Gulev & Hasse (1998)**

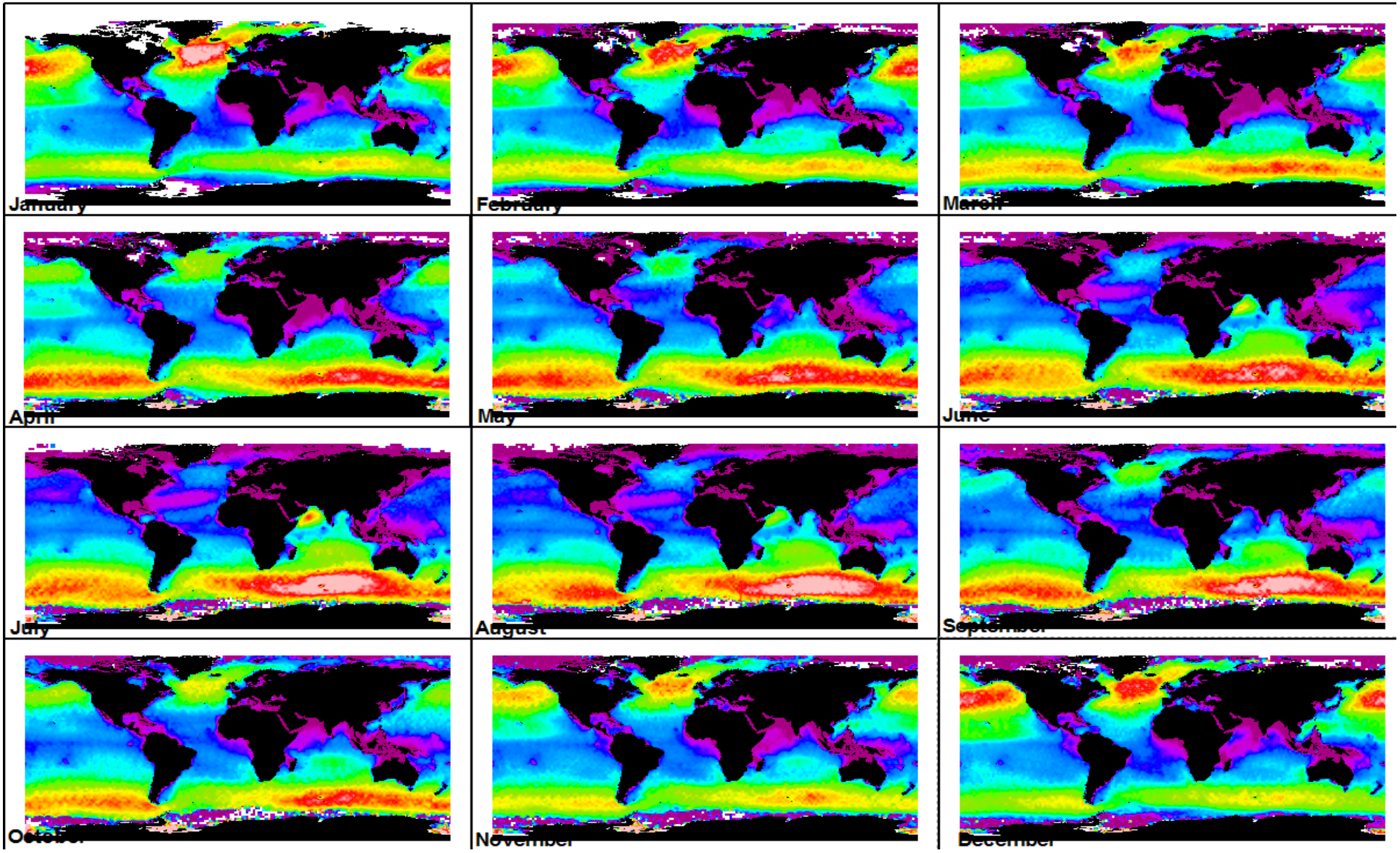
$$SWH = \begin{cases} \sqrt{(Hw^2 + Hs^2)}, & \text{if Wind Dir within } 30^0 \text{ of Swell Dir} \\ Max(Hw, Hs) & \text{otherwise} \end{cases}$$

ICOADS - Calculating Climatology

- **To match Globwave, simple box averaging for monthly one degree boxes with more than 25 observations was used.**
- **Climatologies calculated for both cases:**
  - Sea and Swell
  - Sea or Swell

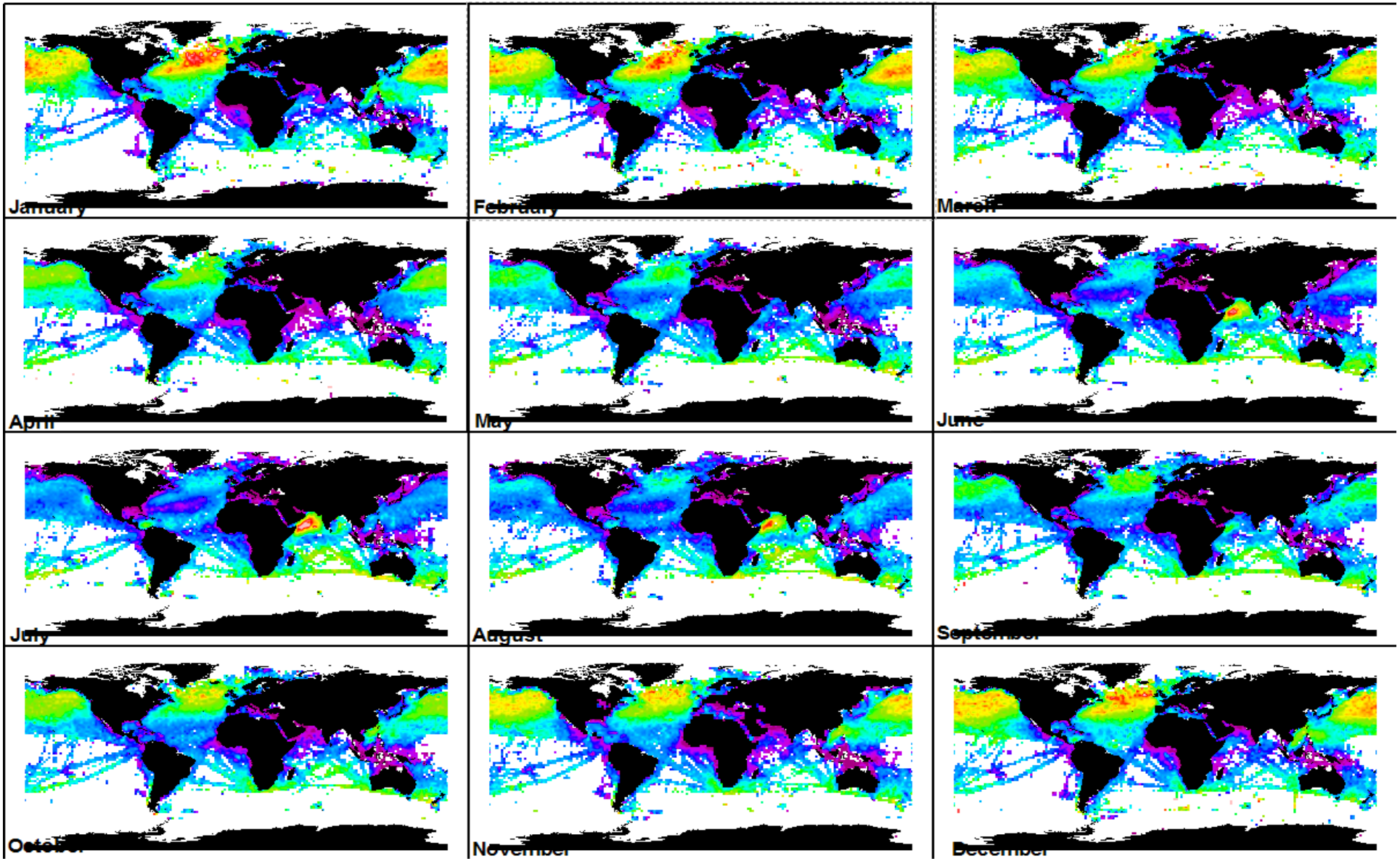
Results

GlobWave Mean SWH



Results

ICOADS (Sea and Swell) Mean SWH



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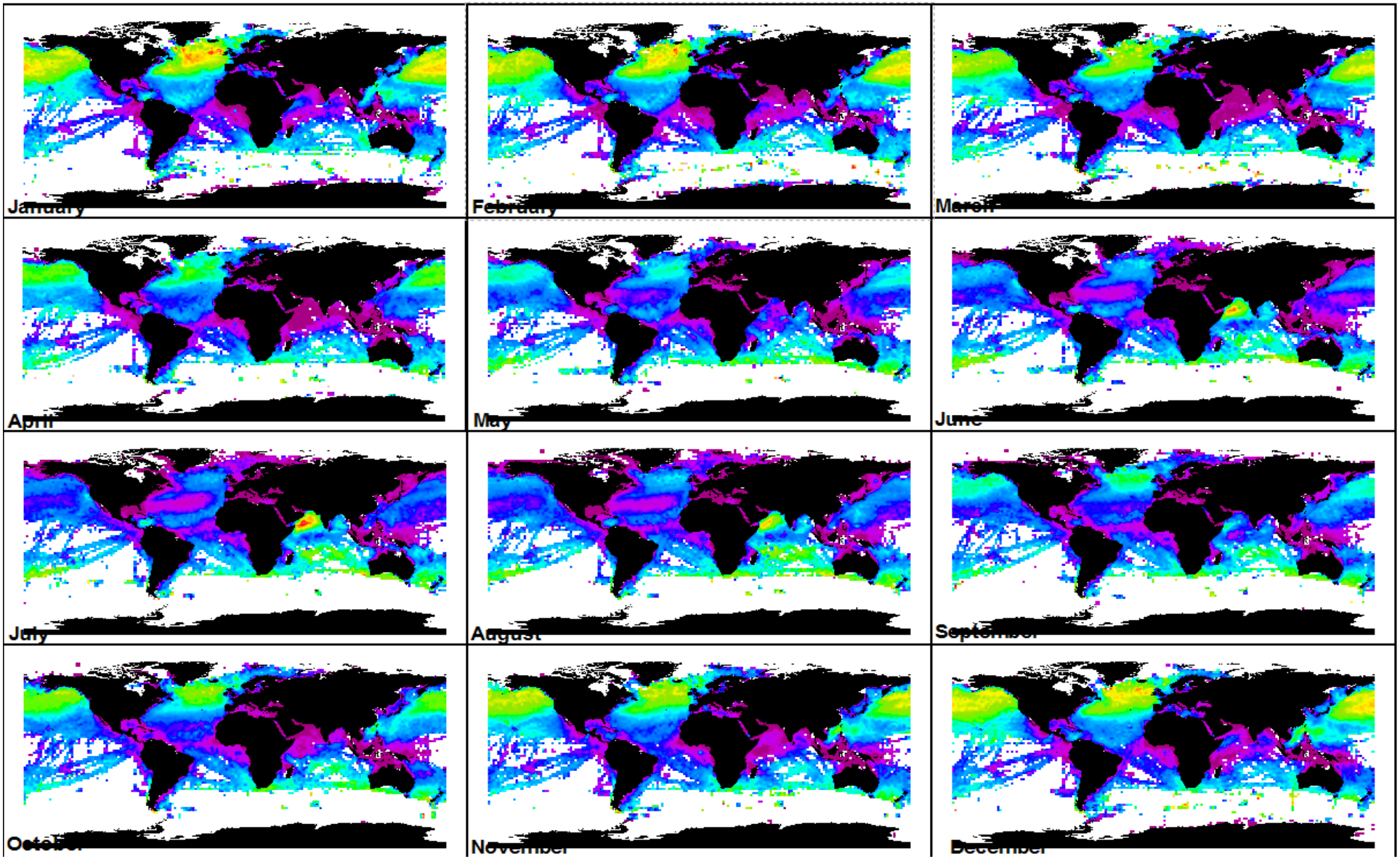
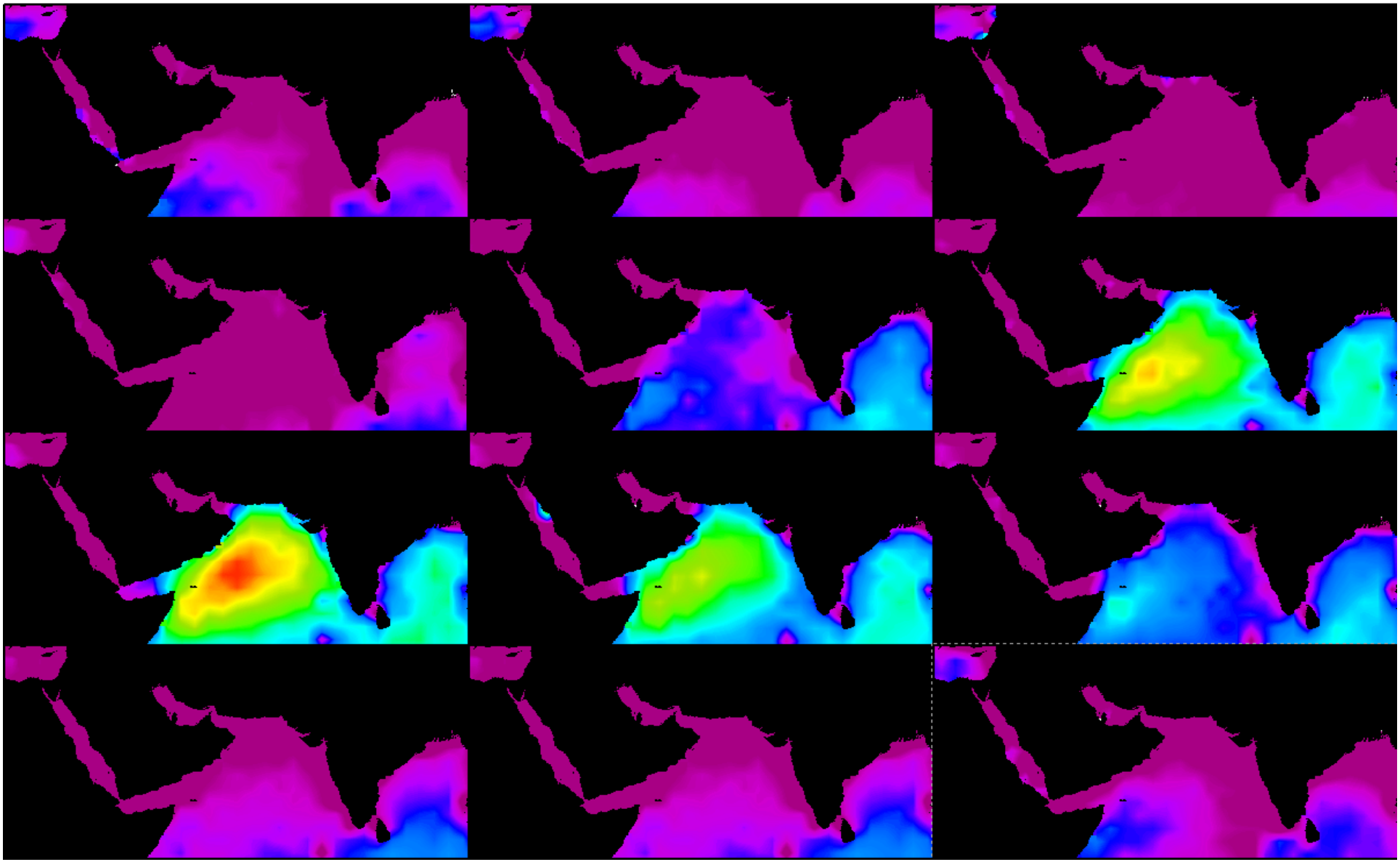


Results

GlobWave Mean SWH



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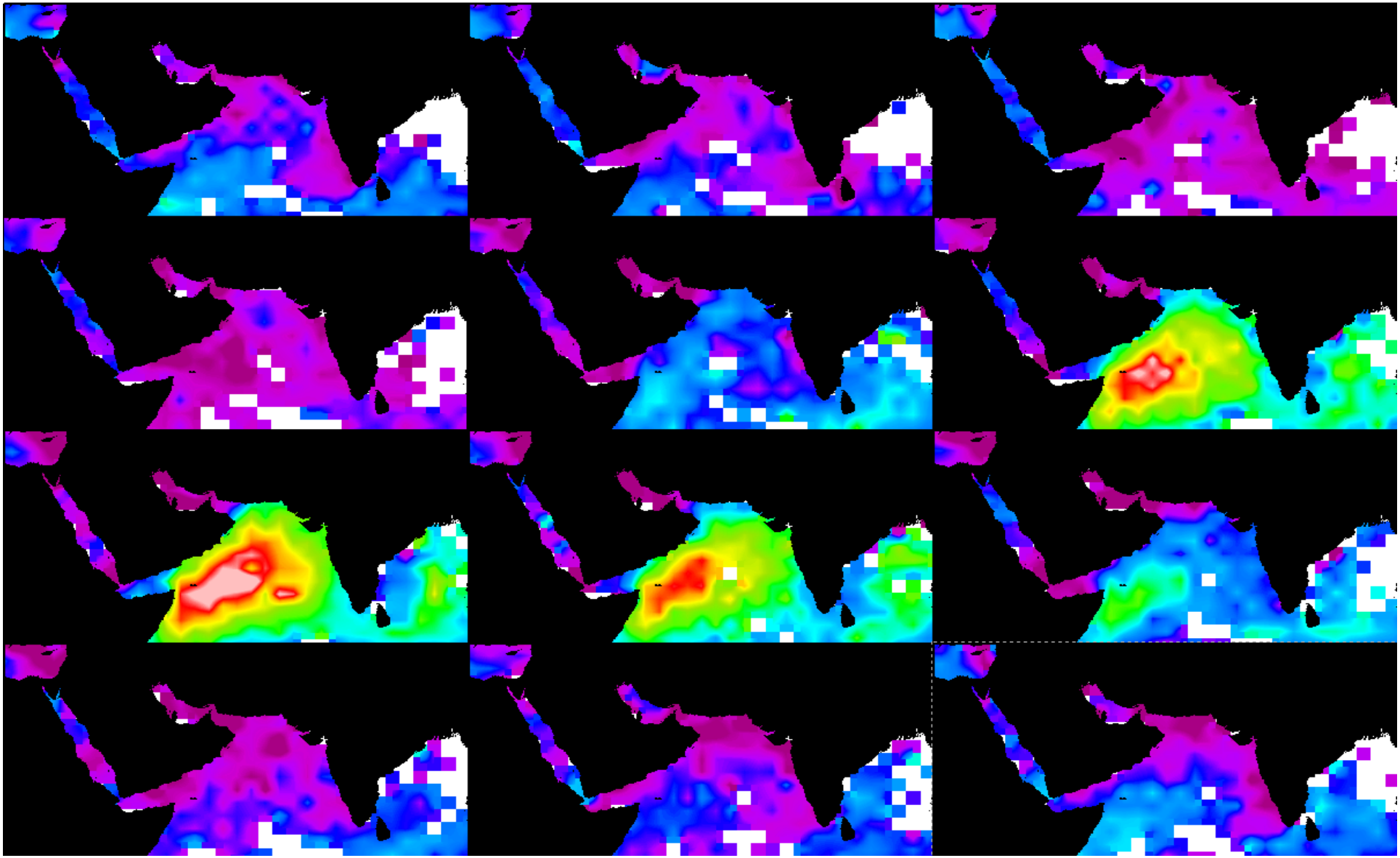

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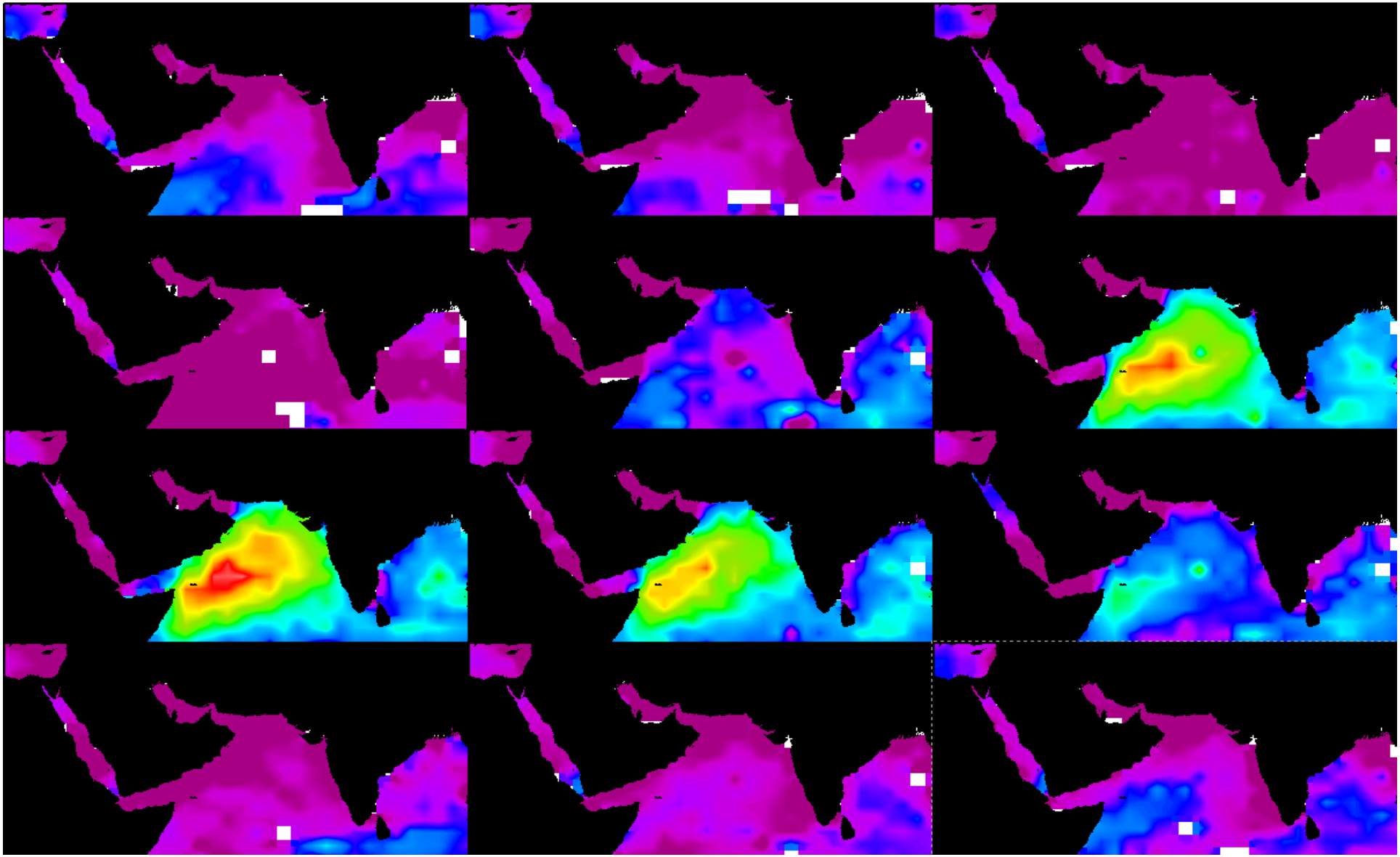
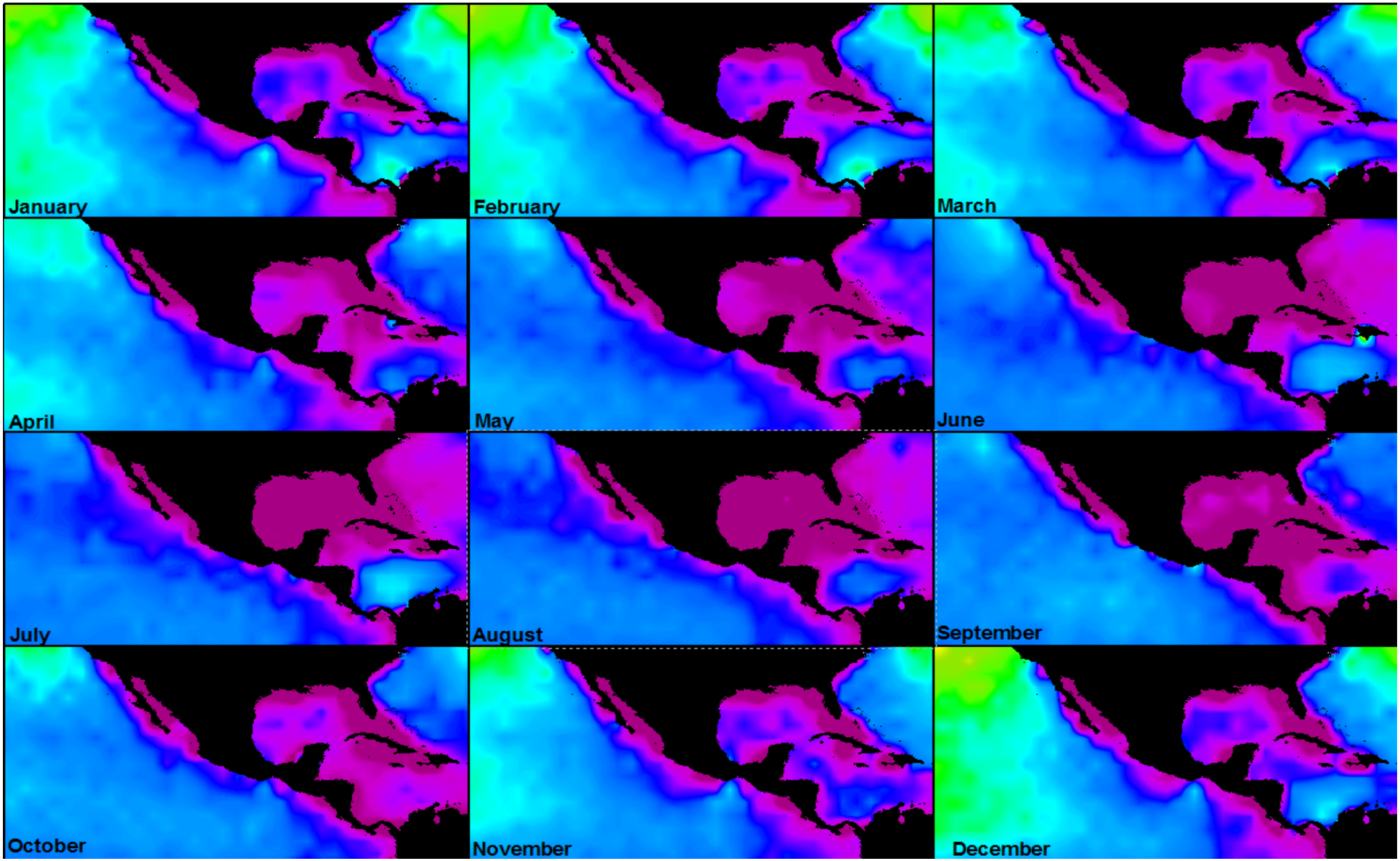


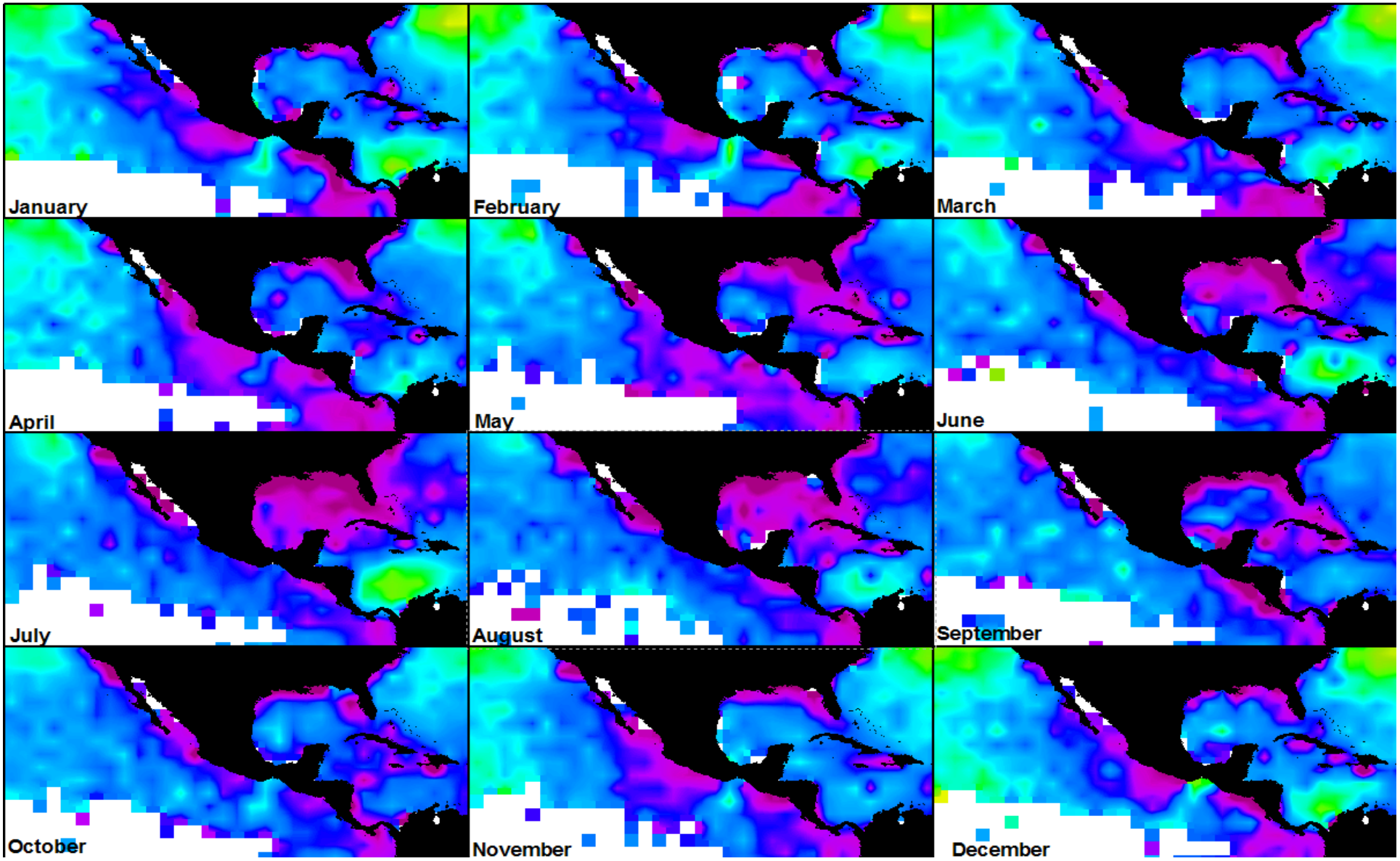
Results

GlobWave Mean SWH



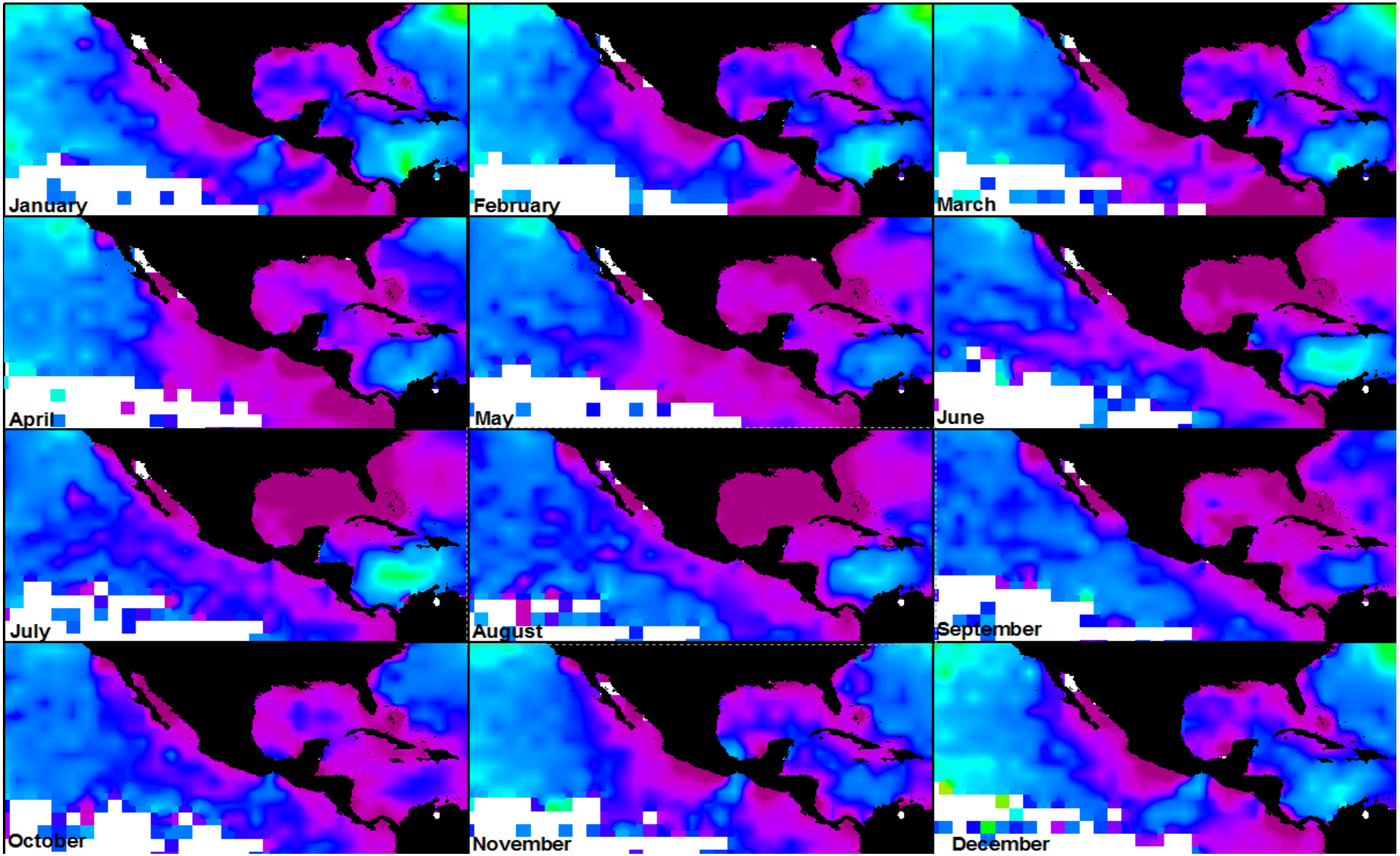
Results

ICOADS (Sea and Swell) Mean SWH



Results

ICOADS (Sea or Swell) Mean SWH



Data Summary

- **Globwave**
  - Near global coverage
  - 741 282 818 (valid?) observations since 1985
  - Needs further QC and the release of all ancillary data
  - According to Globwave V1.3 documentation, the SWH calibrates well against in situ (buoy) data
- **ICOADS**
  - Patchy coverage, particularly poor in Southern Oceans
  - Minimal QC applied to IMMA 2.5
  - Observations in 0.5m bins
  - 40 944 649 Sea and Swell observations (Swell from 1888)
  - 94 805 195 Sea or Swell observations (Sea from 1869)

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Conclusions

- **Initial analysis shows GlobWave and ICOADS have similar climatological shapes and features but different values. Differences are not uniform in space or time.**
- **ICOADS statistics are sensitive to whether Sea and/or Swell are included in the SWH calculations**

The Way Ahead

- **Present at MARCDAT-III √**
- **Encourage GlobWave to remediate their data**
- **Seek higher level QC ICOADS data (IMMT)**
- **Re-do the analysis, consider using smarter (OI) statistical methods, and compare results with individual altimeter climatologies and ERA-40 re-analysis**
- **Decide whether to replace or augment individual altimeters with GlobWave**
- **Maintain a suite of separate satellite, in situ and reanalysis climatologies**

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Questions?