A Foundational Database with a new Release

William E. Angel[1]

Contributions from: Eric Freeman[1,2], Scott Woodruff[1,3], Sandra Lubker[4], Steve Worley[5], Philip Brohan[6], Lydia Gates[7], Elizabeth C. Kent[8], and Shawn R. Smith[9]

1) NOAA National Centers for Environmental Information, Asheville, USA
2) STG. Inc., Asheville, USA
3) Cooperative Institute for Research in Environmental Sciences, Boulder, USA
4) NOAA Earth System Research Laboratory, Boulder, USA
5) National Center for Atmospheric Research, Boulder, USA
6) Met Office, Exeter, UK
7) Deutscher Wetterdienst, Hamburg, Germany
8) National Oceanography Centre, Southampton, UK
9) Center for Ocean-Atmospheric Prediction Studies, Florida State University, Tallahassee, USA

A thank-you to the ICOADS Partners

ICOADS

ICOADS Overview

Navy data
e.g. US, UK, Russia

Ice stations
Arctic Drift Stations
North Pole Ice stations

Ship data
Varous national & international sources
e.g. TDF-11
DWD Archive
MOMDB
Delayed mode (GCCs)
Real time (GTS)

Moored buoy
TAO
TRITON
RAMA
PIRATA
NDBC
PMEL

Drifting buoy
ISDM
Kiel deep drifters

Research Vessel & Oceanographic
e.g. World Ocean Database, COAPS, GODAR, Russian RV

Coastal & Island stations
e.g. PMEL island stations, C-MAN

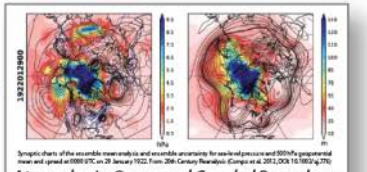
Historical
e.g. Maury
Kobe
CLIWOC
ACRE
OldWeather
Whaling data
HSST
Norwegian

Experiments & Expeditions
e.g. Antarctic expeditions, GARP FGGE

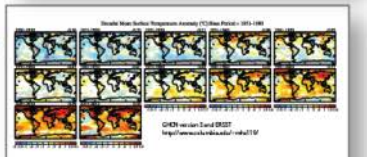
Common archive format
Preserves original data format
Quality Assurance
Duplicate management
Robust data management framework
Version control
Traceability
On-line access
Data selection
Expert advice

ICOADS

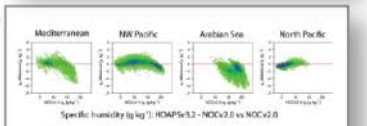
Focus for:
Marine data recovery
Advances in marine climatology
Added-value from ICOADS community



Atmospheric, Ocean and Coupled Reanalyses
Including 20th Century Reanalysis, MERRA, ERA Interim, JRA-25, NOAA CFSRR, SODA.



Gridded analyses e.g. SST & air temperature
Includes: ERSST, NOAA OIv2, HadISST, HadSST, HadSLP, COBE, NOC Flux dataset



Satellite calibration and validation
Including: SST, humdity, air temperature and clouds

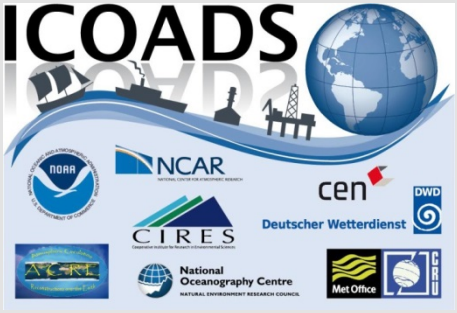
Climate assessments
Including, IPCC assessments, BAMS State of the Climate, and many national assessments

Direct use of ICOADS for research
ICOADS publications cited in more than 1,000 peer-reviewed journal articles
- citations for derived products such as reanalyses and gridded datasets exceed 20,000

ICOADS Fun-facts

- The world's most extensive surface marine meteorological data collection
  - First records from 1662 to the latest data month
  - Over *455* million unique marine reports (ending Dec 2014)!
  - Global events such as the Tambora eruption of April 1815 (Brohan et al., 2012)
  - Early instrumental observations made by Edmond Halley in 1699 are available
  - Interesting notations
    - Shackleton's disastrous Antarctic expedition in 1916 - https://github.com/oldweather/Expeditions/blob/master/imma/James_Caird_1916.imma
      - » May 11, 1916: "Cooked old albatross, very good but a little tough"

International Comprehensive Ocean-Atmosphere Data Set (ICOADS) – A Foundational Database



Vital for Global climate change estimates

Global Surface Products

Air-Sea Fluxes

Atmospheric and Ocean Reanalysis

Climatologies

Gridded Products

Marine and Coastal Humidity

Marine Winds

Global and Regional Analysis

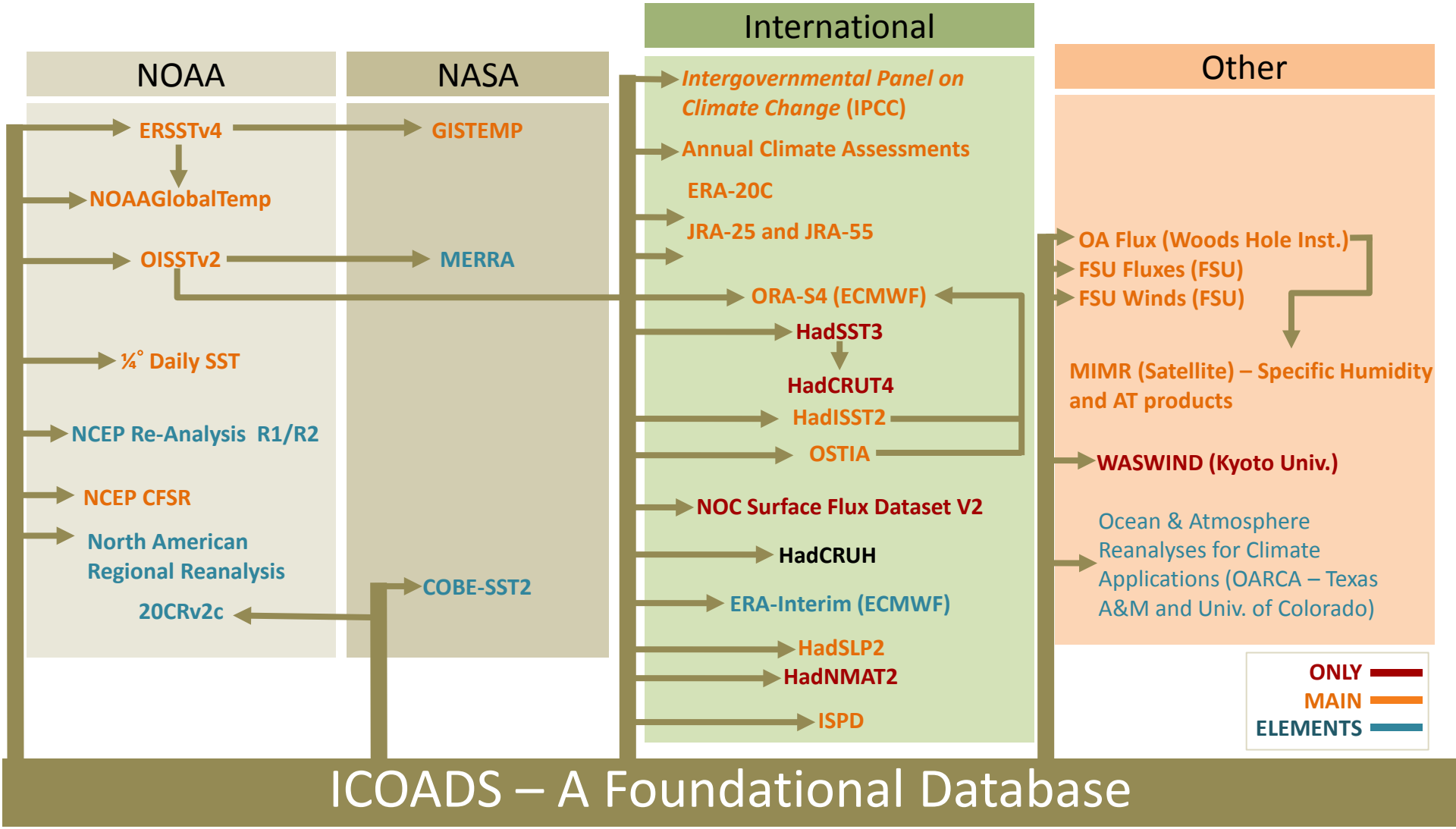
Satellite Calibration/Validation

Derived Datasets

ICOADS – An Critical Marine Foundation for All-Types of Products and Services

ICOADS

Who are recent users of ICOADS?



What are the Data Products?

- Marine Observational Reports – ships, buoys, and etc.
  - Subsetting and bulk files downloads are available at NCAR and NCEI, respectively
  - NCAR: http://rda.ucar.edu/datasets/ds540.0/
  - NCEI: http://www1.ncdc.noaa.gov/pub/data/icoads2.5/
  - NCEI: http://www.ncdc.noaa.gov/cdo-web/datatools/marine
  - Additional details can be found at http://icoads.noaa.gov/products.html

- Monthly summary products include:
  - 2°x2° grids available since 1800 and 1°x1° grids since 1960
  - Available in netCDF
  - And for 22 variables, listed below, as well as 10 statistics (e.g. mean, median):

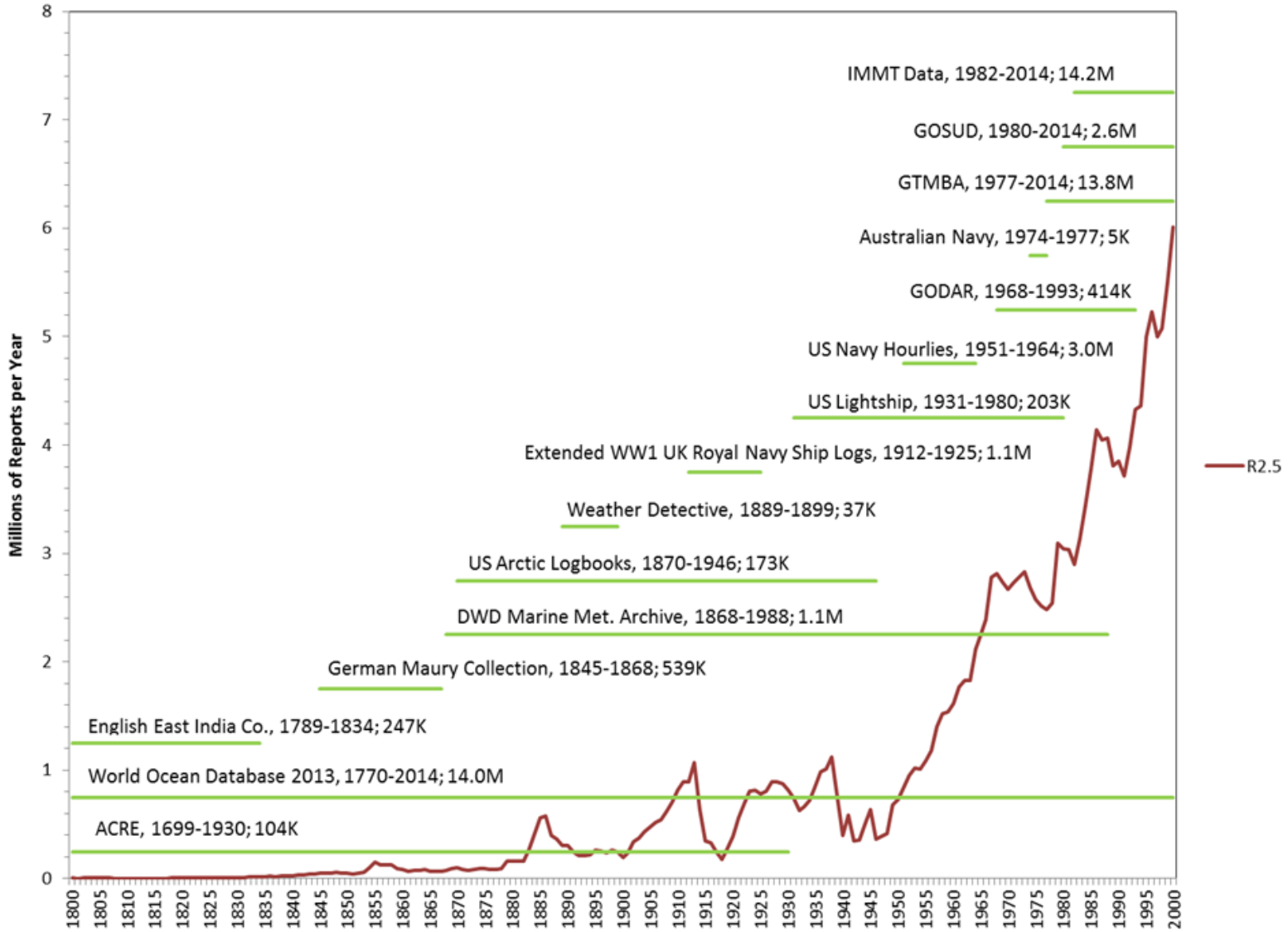
    - Sea surface temp
    - Air temp
    - Scalar wind
    - Vector wind eastward component
    - Vector wind northward component
    - Sea-level pressure
    - Total cloudiness
    - Specific humidity
    - Relative humidity
    - Sea-air temperature difference
    - …and 11 other derived parameters

Introduction to Release 3.0 (R3.0)

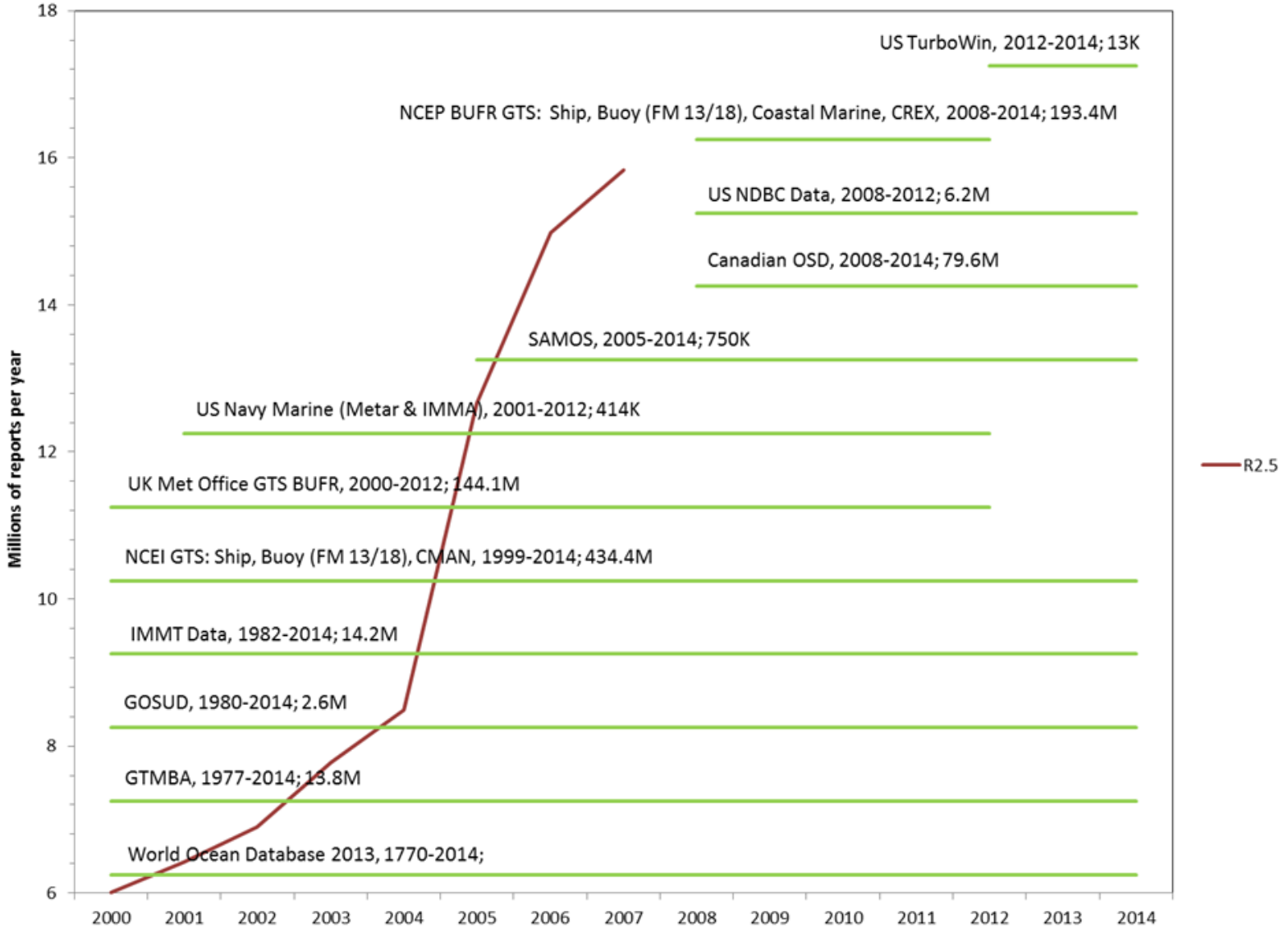
Historical Data Sources

ICOADS

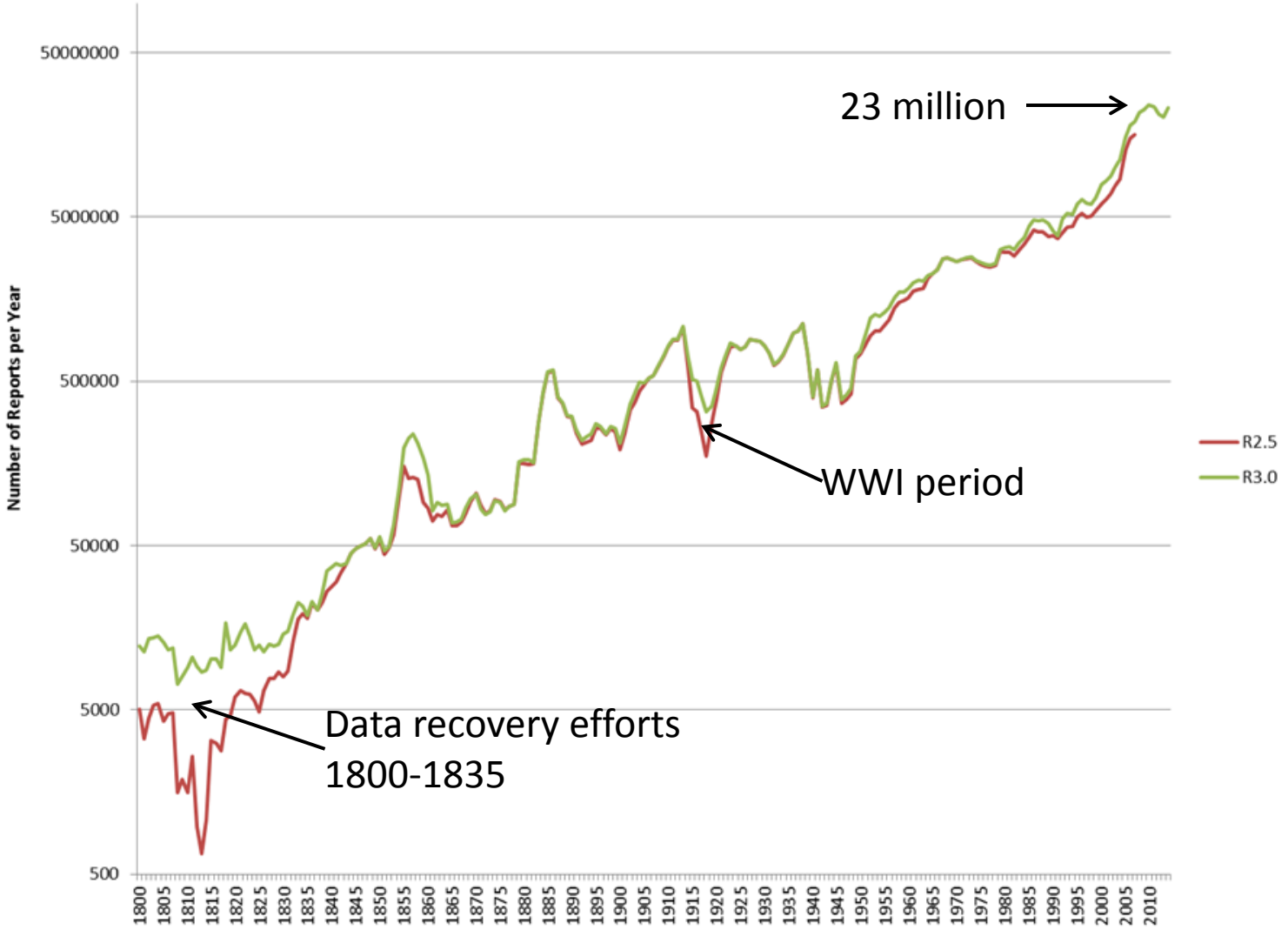
Historical data being merged into ICOADS R3.0 – Pre year 2000



Historical data being merged into ICOADS R3.0 – Post year 2000



Data Impact between R2.5 and R3.0 per year since 1800



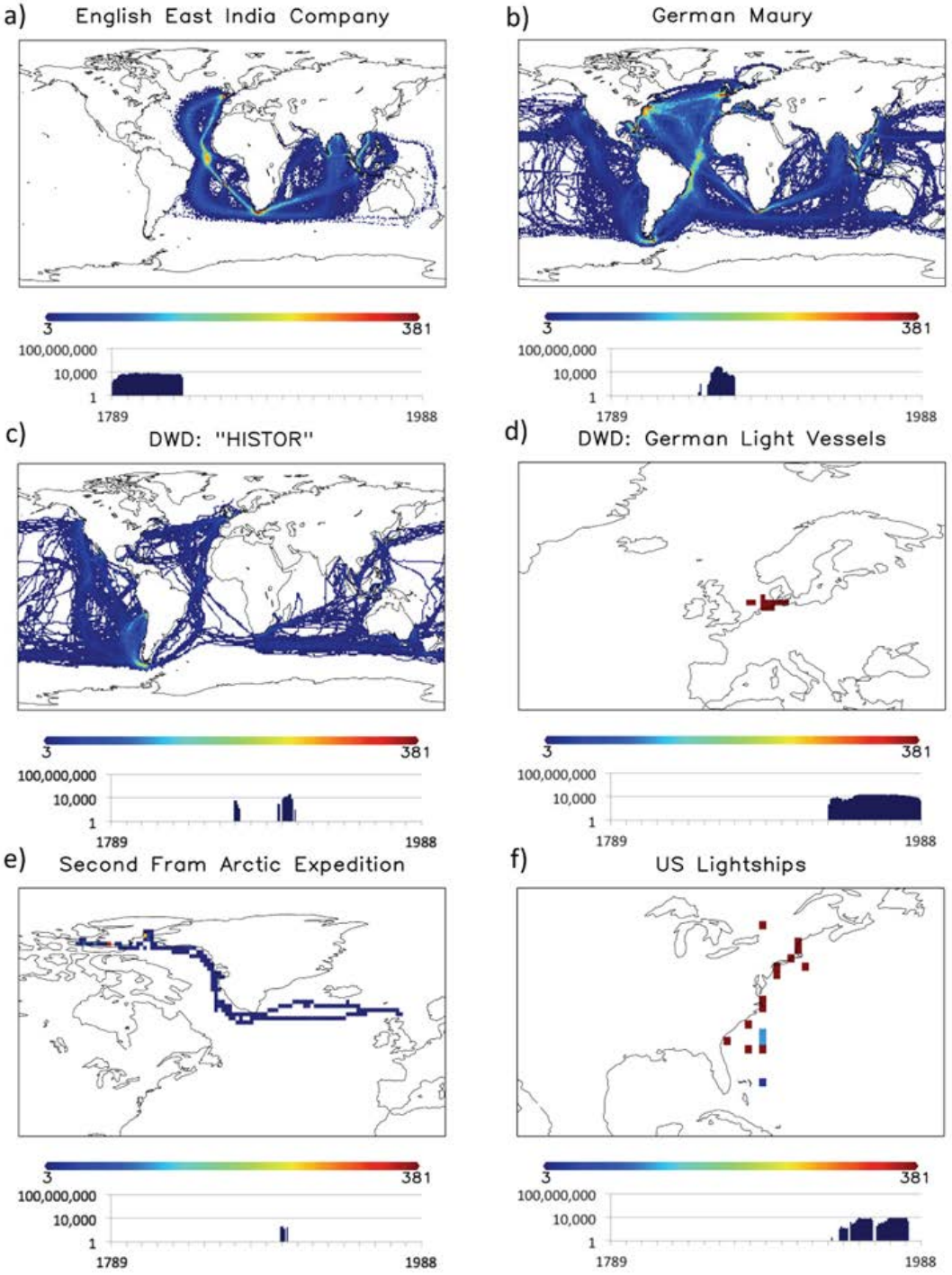
Second *Fram* Expedition: Sverdrup's 1898–1902 Canadian Arctic islands expedition—marine observations digitized by Environment Canada:

Fram captured in the ice during Otto Sverdrup's second *Fram* expedition, 1898-1902. Photo: http://fotoweb.npolar.no

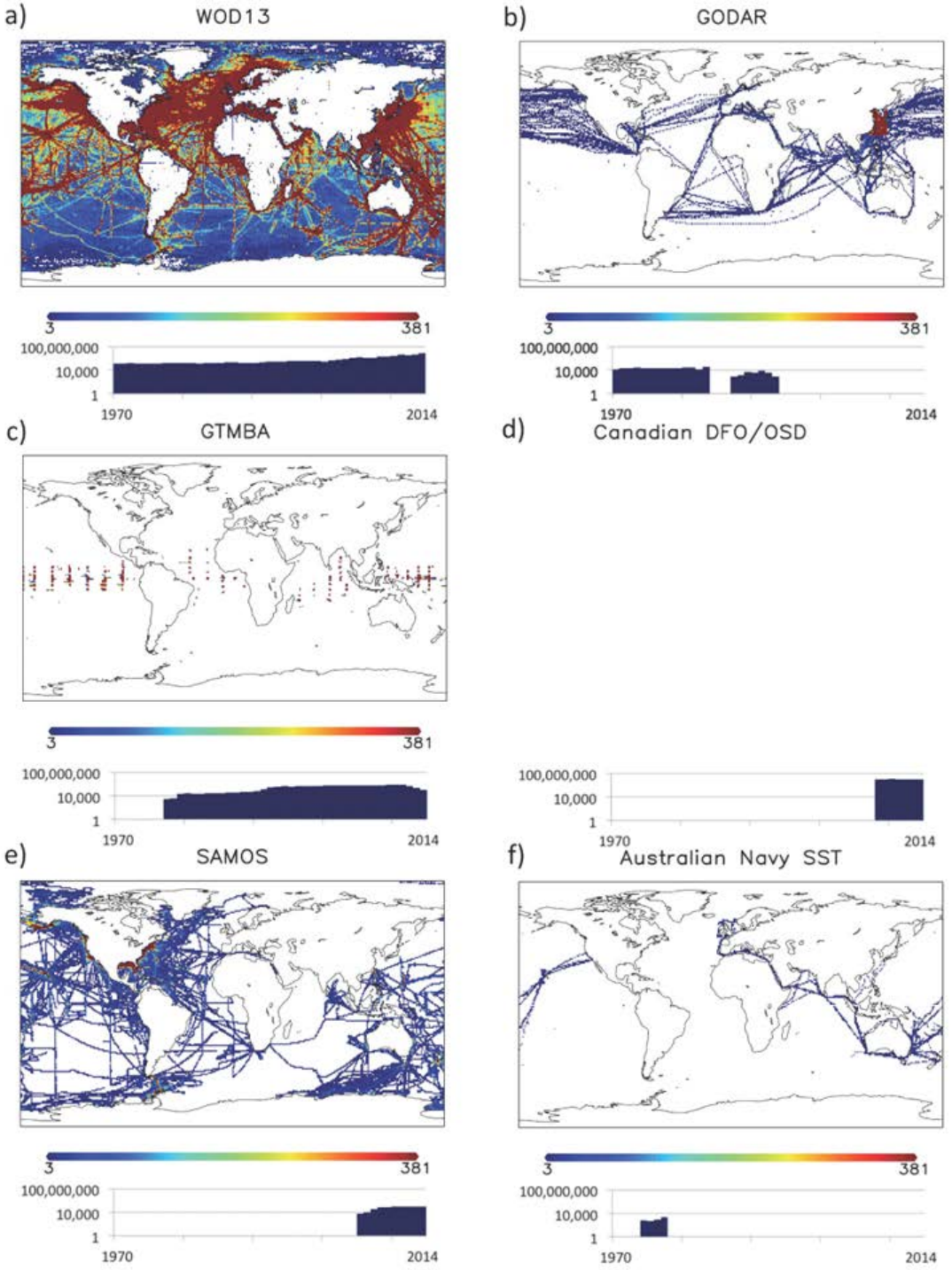
Otto Sverdrups' Explorations: 1898–1902 from "The Norwegian connection"—*Canadian Geographic* September/October 1999

Coverage Maps of Selected Historical Data Sources

Each data source is plotted over its period of record, with colors indicating the total counts of marine reports per 1° box. An additional bar graph highlights the annual count of reports for the data source.



Coverage Maps of external archives and new data sources

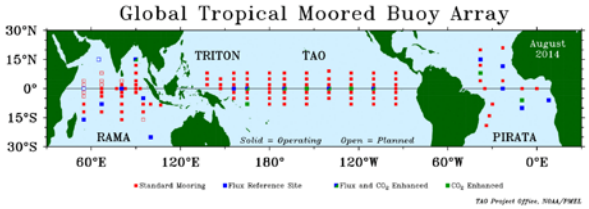


Each data source is plotted over its period of record, with colors indicating the total counts of marine reports per 1° box. An additional bar graph highlights the annual count of reports for the data source.

Contemporary Data Additions to R3.0

(counts of input marine reports)

- World Ocean Database 2013 (WOD13)
  - ✓ Near-surface oceanographic temperatures, salinities, etc - 15.2M marine reports
- Global Tropical Moored Buoy Array (GTMBA)
  - ✓ For R3.0, UK NOC is translating the data held by PMEL - 13.8M marine reports
- Shipboard Automated Meteorological and Oceanographic System (SAMOS)
  - ✓ Similar to GOSUD but with more parameters; 752K hourly marine reports
- Global Ocean Surface Underway Data (GOSUD) – new to R3.0
  - ✓ Near-surface oceanographic temperatures, and salinities - 71.6M marine reports
- Canadian DFO/OSD drifting/moored buoy data
  - ✓ Air pressure, air temperature, sea surface temperature, wind observations, and wave height – 80M marine reports



Introduction to Release 3.0 (R3.0)

IMMA Enhancements

ICOADS

New ICOADS Attachments for R3.0

- Unique identifier attm [Uida]
  - Assigned to each record
  - Provides absolute record tracking mechanism
  - Improves ICOADS data management
  - Makes user interactions (consulting) easier
  - Simplifies data contributions from partners
  - Enables tracing through reanalyses
    - Will help link with reanalysis feedback metadata
  - UIDs assigned in R2.5.1/R2.5.2 (experimental releases) will be carried forward for continuity and provenance

New ICOADS Attachments for R3.0

- Near-Surface Oceanographic Data attm [Nocn]
  - Temperature, salinity, oxygen, phosphate, silicate, nitrate, pH, total chlorophyll, alkalinity, partial pressure of carbon dioxide, and dissolved inorganic carbon and associated sample depths
    - Closest to the surface and less than 10 meters
  - Data from WOD 2013, GOSUD, GTMBA, and the SAMOS archive

- Edited Cloud Report attm [Ecr]
  - Using software provided by Univ. of Washington
    - Check for cloud and weather reports for IC errors
      - Corrected or flagged as invalid

- Error attm [Error]
  - Outside users can use to report and track erroneous values

New ICOADS Attachments for R3.0

- Reanalysis QC/Feedback attm [Rean-qc]
  - Comparison of model-driven first guess and in-situ obs
  - Contains the first-guess, bias corrected obs value, the data fields capture the analysis project, the data provider and a code that points to a reference doc describing the reanalysis effort
  - Uses the UID
  - Feedback from ECMWF ERA-20C will be the first contribution
  - Added to R3.0 after release

New ICOADS Attachments for R3.0

- ICOADS-Value Added Database attm [Ivad]
  - Goal: make results of research activities available alongside the observations, e.g. bias adjustments for different parameters
    - Scientifically demonstrate the impact of value-added records on air-sea flux estimates & common climate indicators
  - The linking of adjustments, uncertainty estimates and alternate QC to individual records
    - Up to three optional uncertainty values
    - An author reference code is also stored
  - Two prototype adjustments with R3.0
    - Visually estimated (Beaufort) winds
    - Air Temperature adjusted for ship heating
  - Future adjustments
    - Observing system changes - bucket vs. intake SST
    - Heterogeneous instrument height – ship vs. buoy
    - Edited cloud reports (ECR) (NOCS & U. Wash.)

ICOADS

ICOADS RELEASE 3.0: A MAJOR UPDATE TO THE HISTORICAL MARINE CLIMATE RECORD

Eric Freeman[1,2]*, Scott D. Woodruff[1,3], Steven J. Worley[4], Sandra J. Lubker[5], Elizabeth C. Kent[6], William E. Angel[1], David I. Berry[6], Philip Brohan[7], Ryan Eastman[8], Lydia Gates[9], Wolfgang Gloeden[9], Zaihua Ji[5], Jay Lawrimore[1], Nick A. Rayner[7], Gudrun Rosenhagen[9], and Shawn R. Smith[10]

1) National Centers for Environmental Information, Asheville, USA
2) STG. Inc., Asheville, USA
3) Cooperative Institute for Research in Environmental Sciences, Boulder, USA
4) National Center for Atmospheric Research, Boulder, USA
5) Earth System Research Laboratory, Boulder, USA
6) National Oceanography Centre, Southampton, UK
7) Met Office, Exeter, UK
8) University of Washington, USA
9) Deutscher Wetterdienst, Hamburg, Germany
10) Center for Ocean-Atmospheric Prediction Studies, Florida State University, Tallahassee, USA

Abstract

We highlight improvements to the International Comprehensive Ocean Atmosphere Data Set (ICOADS) in the latest Release 3.0 (R3.0) including changes designed to enable effective exchange of information describing data quality between ICOADS, reanalysis centres, scientists and the public. These include the assignment of a unique identifier (*UID*) to each report—to enable tracing of observations, linking of marine reports and improved data sharing. Revisions and extensions of the International Maritime Meteorological Archive (IMMA) data format incorporate new near-surface oceanographic data elements and cloud parameters. Many new data sources have been assembled, and updates and improvements to existing data sources, or removal of erroneous data, made. Production of enhanced "preliminary" data and product extensions provides improved support of climate assessment and monitoring, reanalyses and near-real-time applications.

ICOADS observations (IMMA) DOI citation

URL links to: http://rda.ucar.edu/datasets/ds540.0/

National Climatic Data Center/NESDIS/NOAA/U.S. Department of Commerce, Data Support Section/Computational and Information Systems Laboratory/National Center for Atmospheric Research/University Corporation for Atmospheric Research, Earth System Research Laboratory/NOAA/U.S. Department of Commerce, and Cooperative Institute for Research in Environmental Sciences/University of Colorado, 1984: International Comprehensive Ocean-Atmosphere Data Set (ICOADS) Release 2.5, Individual Observations. Research Data Archive at the National Center for Atmospheric Research, Computational and Information Systems Laboratory, Boulder, CO. [Available online at http://dx.doi.org/10.5065/D6H70CSV.] Accessed† dd mmm yyyy.

Related: NCAR has assigned separate dataset Digital Object Identifiers (DOI) to ICOADS R2.5 (i) observational data and (ii) products

Goals for Ocean Sciences Community

ICOADS will:

- Make available the new Release (R3.0) in April 2016
- Continue with the monthly blended NRT product
- Continue to work towards a future releases; continuing to gather new and improved data sources and implement format/software enhancements
- Expand the use of the *UIDs* to capture more record usage metadata
- Continue collaborations & feedback sharing

We hope the Ocean Sciences and User community will:

- Continue to voice support for ICOADS development
- Use and track ICOADS records with the *UIDs* through the reanalysis process
- Collaboratively share feedback records with ICOADS
- Advise us about systematic errors that are detected

Feedback / Questions?

William Angel, William.E.Angel@noaa.gov

ICOADS

- http://icoads.noaa.gov/
- http://icoads.noaa.gov/products.html
- icoads@noaa.gov

IVAD

- http://icoads.noaa.gov/ivad/
- Shawn R. Smith, smith@coaps.fsu.edu

Related ICOADS Ocean Science Presentation (Feb 22, 2016 at 3pm)

- https://agu.confex.com/agu/os16/meetingapp.cgi/Paper/91396
  - ICOADS: Lessons Learned & Oceanographic Data Linkages

Additional Background Links

- ICOADS – the movie - https://vimeo.com/116652055
- Edmond Halley in 1699 - http://blog.oldweather.org/2011/08/17/very-old-weather
- James Cook in 1769 (http://blog.oldweather.org/2012/06/) - no instrumental observations
- Observations from HMS Beagle in 1831-6 - commanded by Robert Fitzroy (http://blog.oldweather.org/2014/09/17/the-weather-of-hms-beagle/)
- Shackleton's disastrous Antarctic expedition in 1916 - https://github.com/oldweather/Expeditions/blob/master/imma/James_Caird_1916.imma - the entry for May 11th is particularly appealing.
- The source material, from which the ICOADS records are taken, can contain information which is important for understanding the quality and details of the observations, but hard to capture in a fixed database format - http://blog.oldweather.org/2015/06/09/international-archives-day/
- Fourth International Workshop on the Advances in the Use of Historical Marine Climate Data (MARCDAT-IV), 18-22 July 2016, National Oceanography Centre, Southampton UK – http://conference.noc.ac.uk/marcdat-iv