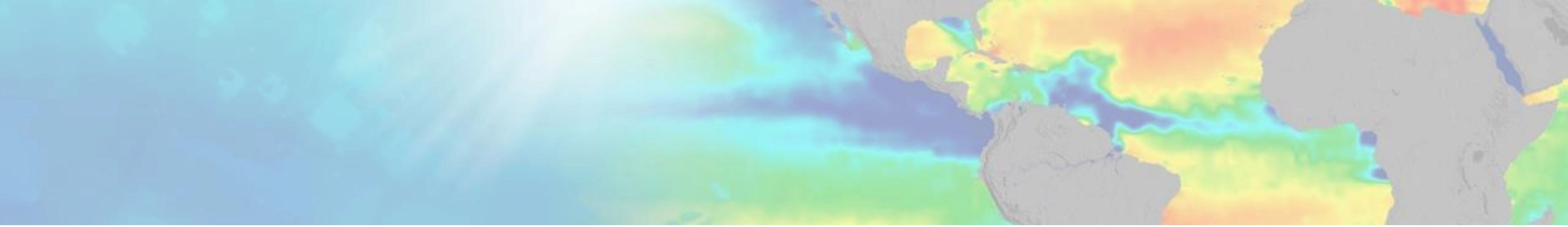


What’s New on the “NASA Salinity” Website

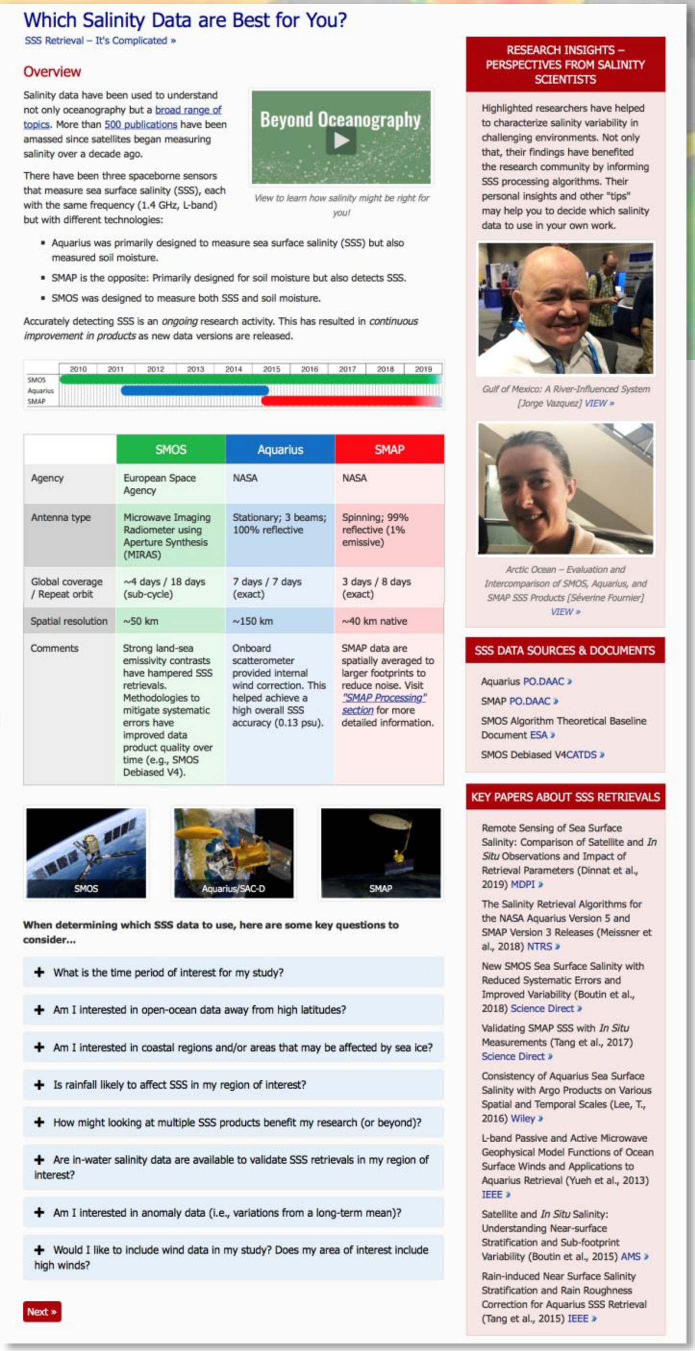
Annette deCharon & Lisa Taylor (ODYSEA LLC)

Presentation Overview

- *Which Salinity Data Are Best For You?*
- *How Salty (or Fresh) Are You?*
- *Learn More*
- *Highlights – Research One-pagers*
- Publications Update
- What’s Next?

Which Salinity Data Are Best For You?

- Overview
  - Provides information and case studies for potential users of satellite sea surface salinity (SSS) data.
  - Addresses the similarities and differences among SSS data products with a focus on SMAP.
  - Users can navigate between pages.
    - Will have a “Table of Contents” at left.
  - Developed with Alex Fore, Séverine Fournier, Wendy Tang, Vardis Tsontos, and Jorge Vazquez (JPL) & Thomas Meissner (Remote Sensing Systems, RSS).



Which Salinity Data are Best for You?

SSS Retrieval – It's Complicated »

Overview

Salinity data have been used to understand not only oceanography but a broad range of topics. More than 500 publications have been amassed since satellites began measuring salinity over a decade ago.

Beyond Oceanography

View to learn how salinity might be right for you!

There have been three spaceborne sensors that measure sea surface salinity (SSS), each with the same frequency (1.4 GHz, L-band) but with different technologies:

- Aquarius was primarily designed to measure sea surface salinity (SSS) but also measured soil moisture.
- SMAP is the opposite: Primarily designed for soil moisture but also detects SSS.
- SMOS was designed to measure both SSS and soil moisture.

Accurately detecting SSS is an *ongoing* research activity. This has resulted in *continuous improvement in products* as new data versions are released.

2010 2011 2012 2013 2014 2015 2016 2017 2018 2019

SMOS

Aquarius

SMAP

	SMOS	Aquarius	SMAP
Agency	European Space Agency	NASA	NASA
Antenna type	Microwave Imaging Radiometer using Aperture Synthesis (MIRAS)	Stationary; 3 beams; 100% reflective	Spinning; 99% reflective (1% emissive)
Global coverage / Repeat orbit	~4 days / 18 days (sub-cycle)	7 days / 7 days (exact)	3 days / 8 days (exact)
Spatial resolution	~50 km	~150 km	~40 km native
Comments	Strong land-sea emissivity contrasts have hampered SSS retrievals. Methodologies to mitigate systematic errors have improved data product quality over time (e.g., SMOS Debiased V4).	Onboard scatterometer provided internal wind correction. This helped achieve a high overall SSS accuracy (0.13 psu).	SMAP data are spatially averaged to larger footprints to reduce noise. Visit *"SMAP Processing" section* for more detailed information.

SMOS

Aquarius/SAC-D

SMAP

When determining which SSS data to use, here are some key questions to consider...

+ What is the time period of interest for my study?
+ Am I interested in open-ocean data away from high latitudes?
+ Am I interested in coastal regions and/or areas that may be affected by sea ice?
+ Is rainfall likely to affect SSS in my region of interest?
+ How might looking at multiple SSS products benefit my research (or beyond)?
+ Are in-water salinity data are available to validate SSS retrievals in my region of interest?
+ Am I interested in anomaly data (i.e., variations from a long-term mean)?
+ Would I like to include wind data in my study? Does my area of interest include high winds?

Next »

RESEARCH INSIGHTS – PERSPECTIVES FROM SALINITY SCIENTISTS

Highlighted researchers have helped to characterize salinity variability in challenging environments. Not only that, their findings have benefited the research community by informing SSS processing algorithms. Their personal insights and other "tips" may help you to decide which salinity data to use in your own work.

Gulf of Mexico: A River-Influenced System [Jorge Vazquez] VIEW »

Arctic Ocean – Evaluation and Intercomparison of SMOS, Aquarius, and SMAP SSS Products [Séverine Fournier] VIEW »

SSS DATA SOURCES & DOCUMENTS

Aquarius PO.DAAC »

SMAP PO.DAAC »

SMOS Algorithm Theoretical Baseline Document ESA »

SMOS Debiased V4CATDS »

KEY PAPERS ABOUT SSS RETRIEVALS

Remote Sensing of Sea Surface Salinity: Comparison of Satellite and *In Situ* Observations and Impact of Retrieval Parameters (Dinnat et al., 2019) MDPI »

The Salinity Retrieval Algorithms for the NASA Aquarius Version 5 and SMAP Version 3 Releases (Meissner et al., 2018) NTRS »

New SMOS Sea Surface Salinity with Reduced Systematic Errors and Improved Variability (Boutin et al., 2018) Science Direct »

Validating SMAP SSS with *In Situ* Measurements (Tang et al., 2017) Science Direct »

Consistency of Aquarius Sea Surface Salinity with Argo Products on Various Spatial and Temporal Scales (Lee, T., 2016) Wiley »

L-band Passive and Active Microwave Geophysical Model Functions of Ocean Surface Winds and Applications to Aquarius Retrieval (Yueh et al., 2013) IEEE »

Satellite and *In Situ* Salinity: Understanding Near-surface Stratification and Sub-footprint Variability (Boutin et al., 2015) AMS »

Rain-induced Near Surface Salinity Stratification and Rain Roughness Correction for Aquarius SSS Retrieval (Tang et al., 2015) IEEE »

salinity.oceansciences.org/data-salinity-01.htm

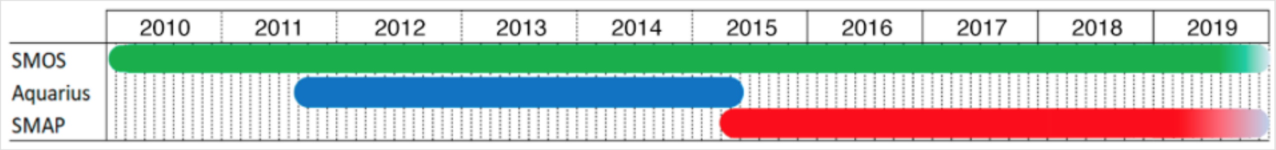
Which Salinity Data Are Best For You?

- Beyond Oceanography
  - Short video (1 min 49 sec) with music.
  - Created for audiences in other disciplines who might consider using SSS data in their own work.

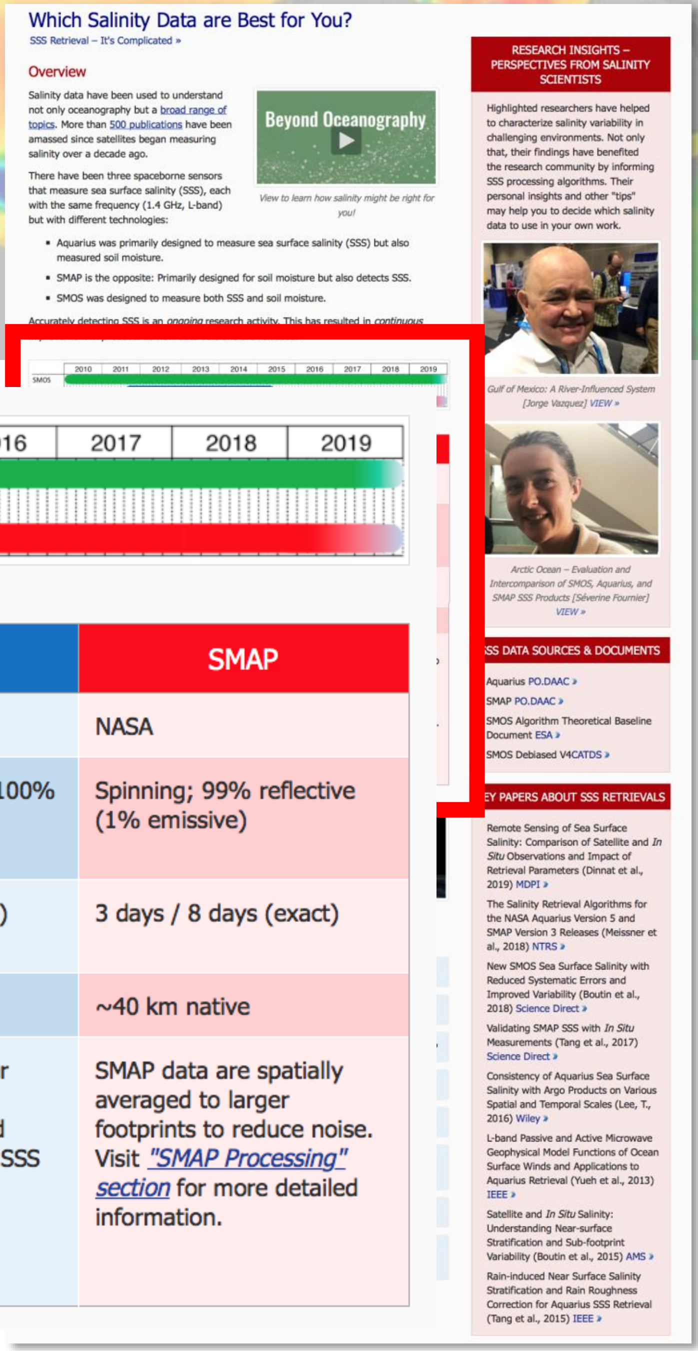
Standalone view available at spark.adobe.com/video/bLYo1DyavgDAK

Which Salinity Data Are Best For You?

- Comparison Tables
  - Color coding is established at the outset to help users differentiate among SMOS, Aquarius, and SMAP.



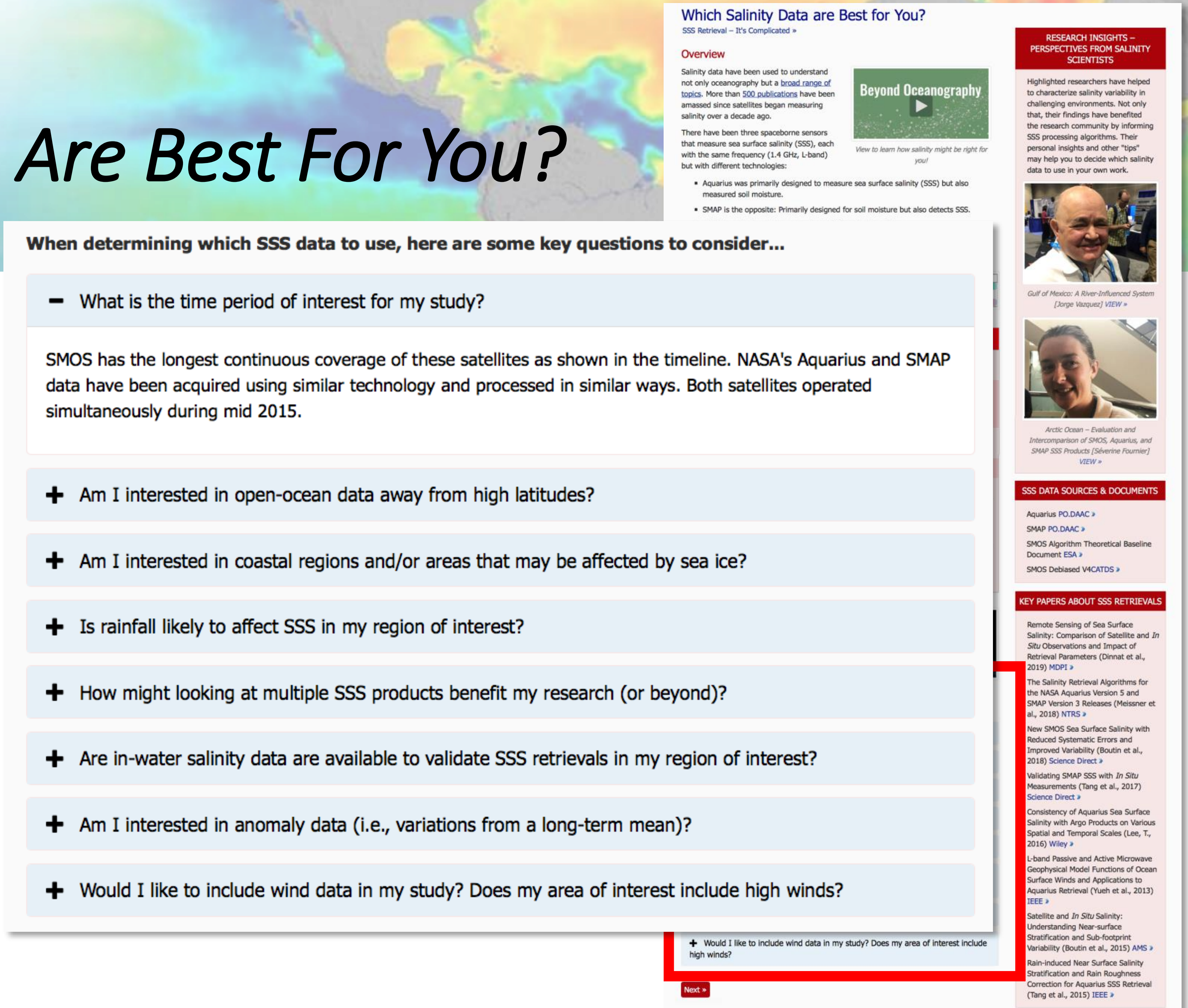
	SMOS	Aquarius	SMAP
Agency	European Space Agency	NASA	NASA
Antenna type	Microwave Imaging Radiometer using Aperture Synthesis (MIRAS)	Stationary; 3 beams; 100% reflective	Spinning; 99% reflective (1% emissive)
Global coverage / Repeat orbit	~4 days / 18 days (sub-cycle)	7 days / 7 days (exact)	3 days / 8 days (exact)
Spatial resolution	~50 km	~150 km	~40 km native
Comments	Strong land-sea emissivity contrasts have hampered SSS retrievals. Methodologies to mitigate systematic errors have improved data product quality over time (e.g., SMOS Debiased V4).	Onboard scatterometer provided internal wind correction. This helped achieve a high overall SSS accuracy (0.13 psu).	SMAP data are spatially averaged to larger footprints to reduce noise. Visit *"SMAP Processing" section* for more detailed information.



salinity.oceansciences.org/data-salinity-01.htm

Which Salinity Data Are Best For You?

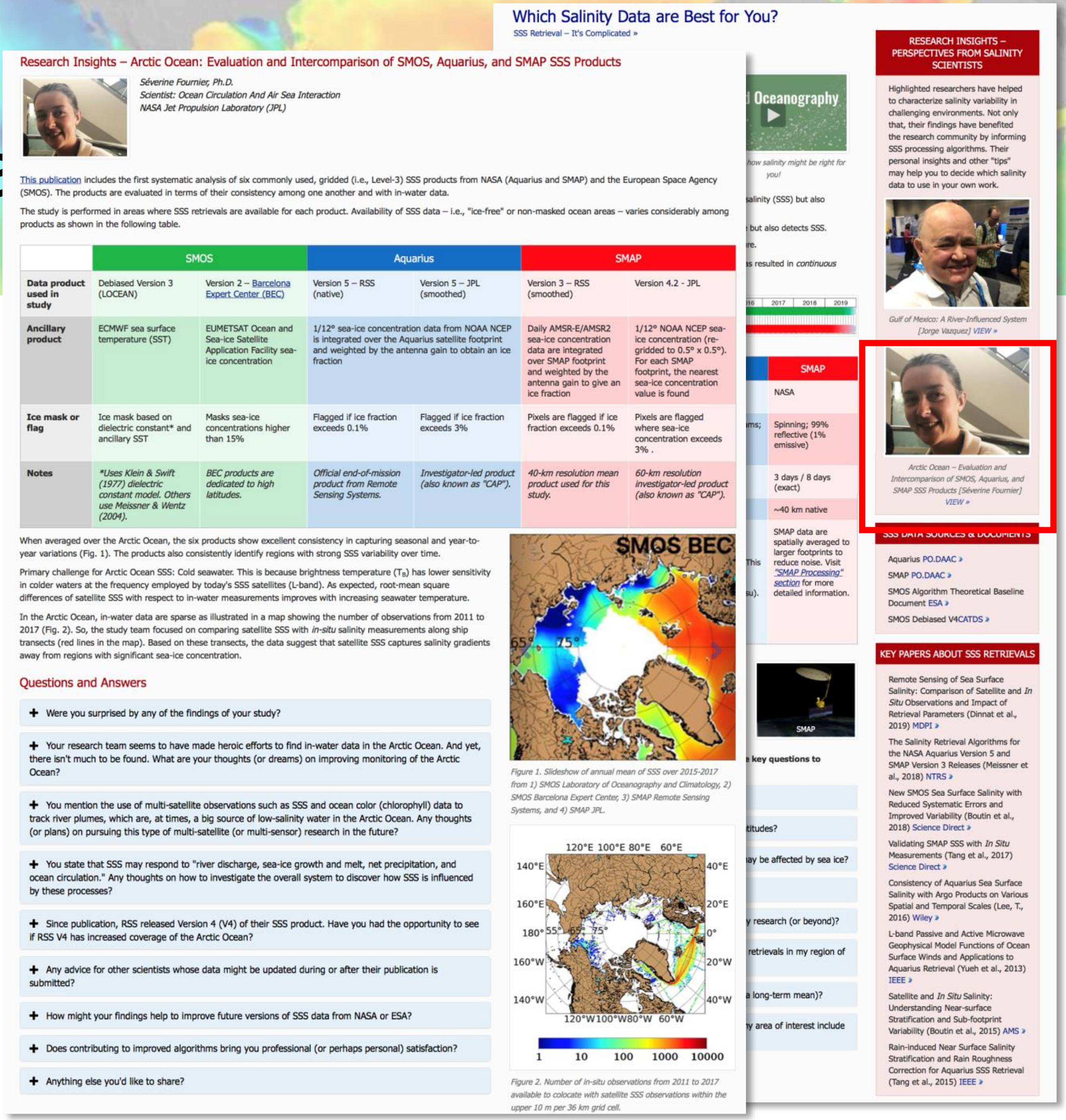
- Q&A Panels
  - Question & Answer (Q&A) panels are available throughout this feature.
  - This example addresses the types of information potential SSS users are likely to consider.



salinity.oceansciences.org/data-salinity-01.htm

Which Salinity Data Are Be

- Research Insights
  - Two studies – led by Jorge Vazquez and Séverine Fournier – are highlighted thus far.
  - Both have similar formatting, including color-coded tables and Q&A panels.
    - Some questions are geared towards personal perspectives.
  - Each includes a time-series slideshow to show differences among data products.



salinity.oceansciences.org/data-salinity-07.htm

Which Salinity Data Are Best For Y

- SSS Retrieval – It's Complicated
  - Recognizing that some users are unfamiliar with satellite data, this part addresses:
    - Processing levels
    - Ancillary Inputs
    - Corrections
    - Flags, Filters & Masks

SSS Retrieval – It's Complicated

Satellite salinity instruments measure natural microwave emission from the top 1 cm (or less) of ocean surface in terms of brightness temperature (T_B). These data are processed into SSS at various levels:

- **Level 1:** Radiometer observations at full resolution (1A) or processed to sensor units such as brightness temperature (1B);
- **Level 2:** Derived geophysical variables from Level 1 source data; and
- **Level 3:** Variables mapped on uniform space-time grid scales.

Many researchers use gridded (i.e., Level 3) data. It can be useful to "dive deeper" and be aware of the types of documents describing how the data are acquired, validated, calibrated, processed and distributed.

The complexity behind SSS data has been captured in the PO.DAAC's Aquarius Documentation Roadmap. In addition to User Guides, there are Validation Analyses, Algorithm Descriptions, Calibration and other Technical Reports. The PO.DAAC also offers similar documentation for SMAP SSS processing.

Aquarius documentation roadmap.

There are differences among the retrieval algorithms used to generate satellite SSS data. Not only that, the algorithms used to process various missions' data evolve over time. So, the information below is meant to provide *an overview of the types of variations* among data products.

The variation among SSS data products falls into these general categories:

- **Ancillary inputs**
  - Typical inputs include sea surface temperature (SST), wind speed and direction, galactic map, sea ice mask, dielectric constant model, and a reference salinity field (e.g., HYCOM model). Differences among these inputs can affect the consistency among SSS products.
- **Corrections**
  - A variety of corrections are applied to SSS data. Although the specific corrections differ from product-to-product, typical SSS corrections are summarized in the e-brochure, Ocean Salinity From Space.
- **Flags, Filters & Masks**
  - *Flags* are employed when values exceed threshold values, thus indicating potentially degraded algorithm performance.
    - Each SSS data product employs its own type of flagging. For example, flags can affect data availability and/or quality *near coasts* (i.e., land contamination) and at *high latitudes* (i.e., sea ice contamination).
    - *"Research Insights" show the affect of ice flagging and masking on retrievals of SSS data from the Arctic Ocean.*
  - Flags can also be used to filter values according to your specific needs.
    - For example, RSS provides rain-filtered SMAP SSS products.
  - *Masks* are used to omit data that do not meet established quality criteria
- **Error Sources and Uncertainty Estimation**
  - Approaches to estimating errors or uncertainties vary among SSS products.

The specific application of corrections, flags, filters, and masks – along with approaches to estimating errors or uncertainties – are described in each product's User Guide and other literature.

both RSS and the NASA Jet Propulsion Laboratory (JPL). In the next section, we focus on similarities and differences in how these SMAP data products are processed.

Did We Mention it's Complicated?

A potentially confusing aspect is that there can be overlap between items in these categories. For example, RSS uses an ancillary "land mask" as an input to its SSS processing. Land corrections are applied to ensure the quality of coastal SSS data. RSS products also include land-related quality flags ranging from "light contamination" (i.e., removed from averaging in smoothed products) to "strong contamination" (i.e., masked altogether). Finally, RSS includes systematic errors from land contamination in its empirical uncertainty estimates.

Figure 1. Argo floats drift at depth then rise to the surface while measuring temperature and salinity.

Figure 2. Saildrones - autonomous sailing drones - are used as a tool to provide high quality oceanic and atmospheric observations.

« Previous Next »

WHAT'S IN A VERSION?

It is not uncommon for months (or years) to pass between gathering data, analyzing it, writing a manuscript, and publishing your results. In parallel, the SSS data processing community is working to update algorithms and improve its products.

New releases of SSS data products are accompanied by changes in version numbers. This timeline shows major release dates of three examples of SSS data products (i.e., De-biased SMOS Level 3, Aquarius RSS, and SMAP RSS). Interestingly, two versions of Aquarius data (V4, V5) were released after the satellite stopped operating on 07-Jun-15.

It is important know which data version number(s) you are working with and be cognizant of new data releases that may occur while your manuscript is being reviewed. Even though the new data product will be better in quality, it may affect your results. **Consider contacting the data providers (e.g., PO.DAAC for NASA SSS data) about the timing of data release updates.**

Timeline of major release dates for three examples of SSS data products. Click image to enlarge.

SSS VALIDATION & SAMPLING DIFFERENCES

The accuracy of satellite-derived SSS measurements is largely validated by data from in-water sensors. Nonetheless, comparing the two is challenging for many reasons.

Timing is a challenge: Satellite observations need to be "matched up" with in-water data that has been collected at or near the sea surface within a few days of the satellite retrieval.

Spatial mismatch is another challenge. Satellite footprints cover tens of kilometers. Thus, a single satellite footprint may sample an area with non-uniform salinity (e.g., region with discrete patches of low salinity caused by recent rainfall). In-water salinity instruments, on the other hand, provide discrete "pinpoints" of salinity data.

Horizontal mismatches are only one part of the story. There are also differences in the depths where salinity is being measured. Satellite sensors retrieve from the very top of the ocean while in-water instruments measure salinity at greater depths.

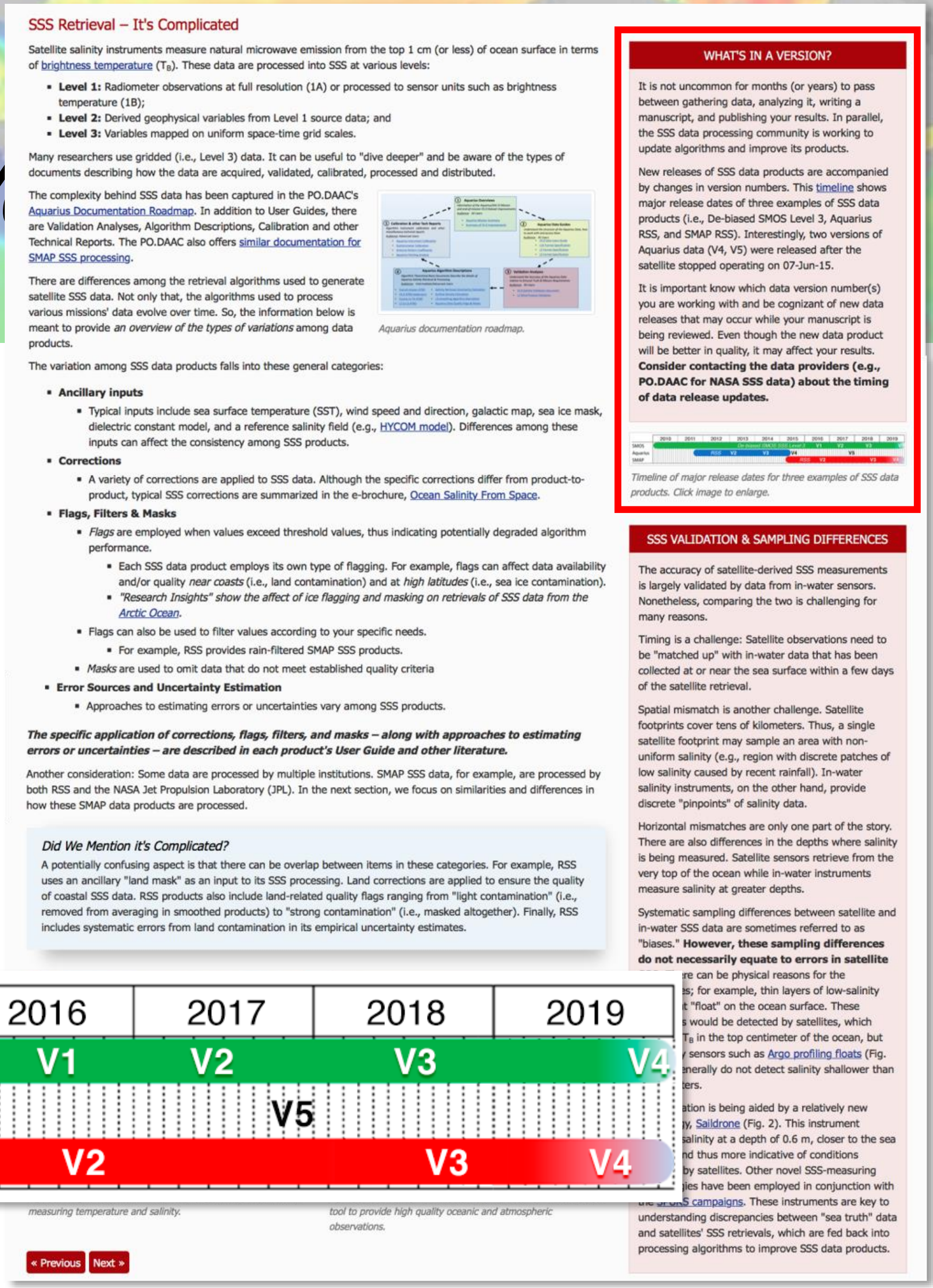
Systematic sampling differences between satellite and in-water SSS data are sometimes referred to as "biases." **However, these sampling differences do not necessarily equate to errors in satellite SSS.** There can be physical reasons for the differences; for example, thin layers of low-salinity water that "float" on the ocean surface. These conditions would be detected by satellites, which measure T_B in the top centimeter of the ocean, but missed by sensors such as Argo profiling floats (Fig. 1) that generally do not detect salinity shallower than 3 – 5 meters.

SSS validation is being aided by a relatively new technology, Saildrone (Fig. 2). This instrument acquires salinity at a depth of 0.6 m, closer to the sea surface and thus more indicative of conditions detected by satellites. Other novel SSS-measuring technologies have been employed in conjunction with the SPURS campaigns. These instruments are key to understanding discrepancies between "sea truth" data and satellites' SSS retrievals, which are fed back into processing algorithms to improve SSS data products.

salinity.oceansciences.org/data-salinity-02.htm

Which Salinity Data Are Best For Y

- SSS Retrieval – It's Complicated
  - The fact that our community continues to learn about SSS retrievals – and releases new versions of data products over time – is addressed.
  - The advice to be mindful of product version(s) is illustrated by this timeline showing three examples.


SSS Retrieval – It's Complicated

Satellite salinity instruments measure natural microwave emission from the top 1 cm (or less) of ocean surface in terms of brightness temperature (T_B). These data are processed into SSS at various levels:

- **Level 1:** Radiometer observations at full resolution (1A) or processed to sensor units such as brightness temperature (1B);
- **Level 2:** Derived geophysical variables from Level 1 source data; and
- **Level 3:** Variables mapped on uniform space-time grid scales.

Many researchers use gridded (i.e., Level 3) data. It can be useful to "dive deeper" and be aware of the types of documents describing how the data are acquired, validated, calibrated, processed and distributed.

The complexity behind SSS data has been captured in the PO.DAAC's Aquarius Documentation Roadmap. In addition to User Guides, there are Validation Analyses, Algorithm Descriptions, Calibration and other Technical Reports. The PO.DAAC also offers similar documentation for SMAP SSS processing.

There are differences among the retrieval algorithms used to generate satellite SSS data. Not only that, the algorithms used to process various missions' data evolve over time. So, the information below is meant to provide *an overview of the types of variations* among data products.

Aquarius documentation roadmap.

The variation among SSS data products falls into these general categories:

- **Ancillary inputs**
  - Typical inputs include sea surface temperature (SST), wind speed and direction, galactic map, sea ice mask, dielectric constant model, and a reference salinity field (e.g., HYCOM model). Differences among these inputs can affect the consistency among SSS products.
- **Corrections**
  - A variety of corrections are applied to SSS data. Although the specific corrections differ from product-to-product, typical SSS corrections are summarized in the e-brochure, Ocean Salinity From Space.
- **Flags, Filters & Masks**
  - *Flags* are employed when values exceed threshold values, thus indicating potentially degraded algorithm performance.
    - Each SSS data product employs its own type of flagging. For example, flags can affect data availability and/or quality *near coasts* (i.e., land contamination) and at *high latitudes* (i.e., sea ice contamination).
    - *"Research Insights" show the affect of ice flagging and masking on retrievals of SSS data from the Arctic Ocean.*
  - Flags can also be used to filter values according to your specific needs.
    - For example, RSS provides rain-filtered SMAP SSS products.
  - *Masks* are used to omit data that do not meet established quality criteria
- **Error Sources and Uncertainty Estimation**
  - Approaches to estimating errors or uncertainties vary among SSS products.

The specific application of corrections, flags, filters, and masks – along with approaches to estimating errors or uncertainties – are described in each product's User Guide and other literature.

Another consideration: Some data are processed by multiple institutions. SMAP SSS data, for example, are processed by both RSS and the NASA Jet Propulsion Laboratory (JPL). In the next section, we focus on similarities and differences in how these SMAP data products are processed.

Did We Mention it's Complicated?

A potentially confusing aspect is that there can be overlap between items in these categories. For example, RSS uses an ancillary "land mask" as an input to its SSS processing. Land corrections are applied to ensure the quality of coastal SSS data. RSS products also include land-related quality flags ranging from "light contamination" (i.e., removed from averaging in smoothed products) to "strong contamination" (i.e., masked altogether). Finally, RSS includes systematic errors from land contamination in its empirical uncertainty estimates.

measuring temperature and salinity.

tool to provide high quality oceanic and atmospheric observations.

« Previous | Next »

WHAT'S IN A VERSION?

It is not uncommon for months (or years) to pass between gathering data, analyzing it, writing a manuscript, and publishing your results. In parallel, the SSS data processing community is working to update algorithms and improve its products.

New releases of SSS data products are accompanied by changes in version numbers. This timeline shows major release dates of three examples of SSS data products (i.e., De-biased SMOS Level 3, Aquarius RSS, and SMAP RSS). Interestingly, two versions of Aquarius data (V4, V5) were released after the satellite stopped operating on 07-Jun-15.

It is important know which data version number(s) you are working with and be cognizant of new data releases that may occur while your manuscript is being reviewed. Even though the new data product will be better in quality, it may affect your results. **Consider contacting the data providers (e.g., PO.DAAC for NASA SSS data) about the timing of data release updates.**

Timeline of major release dates for three examples of SSS data products. Click image to enlarge.

SSS VALIDATION & SAMPLING DIFFERENCES

The accuracy of satellite-derived SSS measurements is largely validated by data from in-water sensors. Nonetheless, comparing the two is challenging for many reasons.

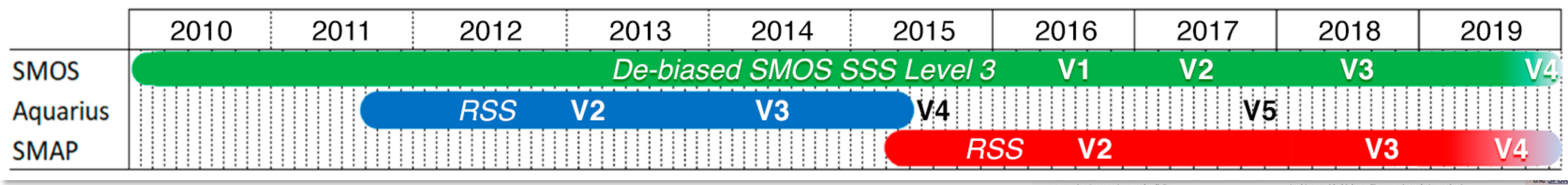
Timing is a challenge: Satellite observations need to be "matched up" with in-water data that has been collected at or near the sea surface within a few days of the satellite retrieval.

Spatial mismatch is another challenge. Satellite footprints cover tens of kilometers. Thus, a single satellite footprint may sample an area with non-uniform salinity (e.g., region with discrete patches of low salinity caused by recent rainfall). In-water salinity instruments, on the other hand, provide discrete "pinpoints" of salinity data.

Horizontal mismatches are only one part of the story. There are also differences in the depths where salinity is being measured. Satellite sensors retrieve from the very top of the ocean while in-water instruments measure salinity at greater depths.

Systematic sampling differences between satellite and in-water SSS data are sometimes referred to as "biases." **However, these sampling differences do not necessarily equate to errors in satellite** ...

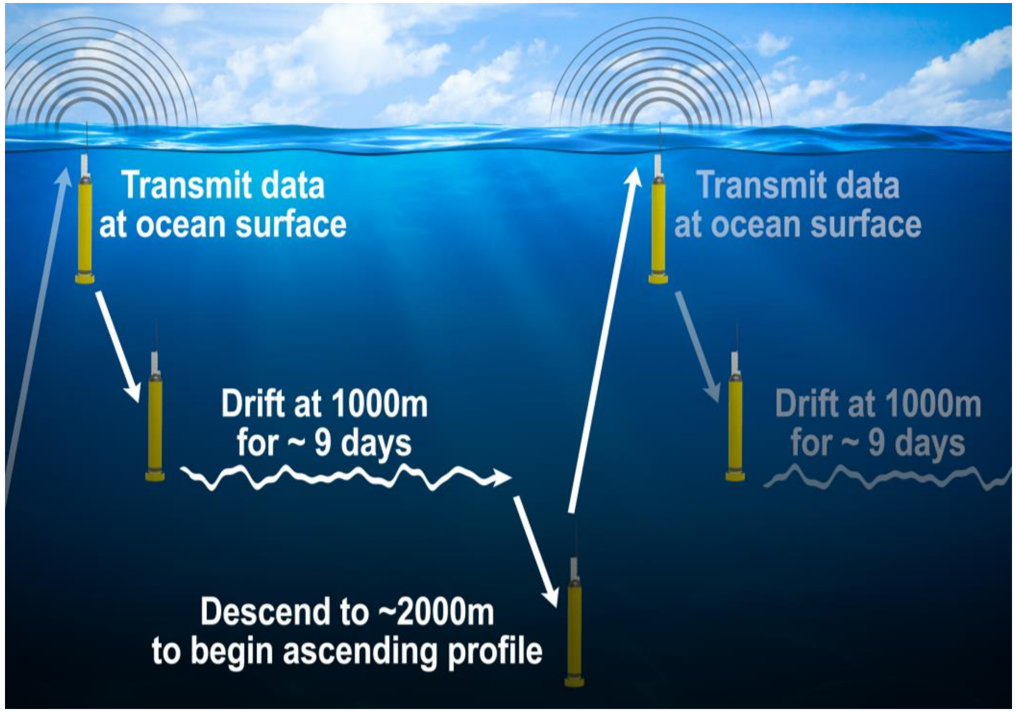
... campaigns. These instruments are key to understanding discrepancies between "sea truth" data and satellites' SSS retrievals, which are fed back into processing algorithms to improve SSS data products.



salinity.oceansciences.org/data-salinity-02.htm

Which Salinity Data Are Best For Y

- SSS Retrieval – It's Complicated
  - Sampling differences between in-water instruments and and skin SSS from satellites is addressed, as is use of the term "bias."



SSS Retrieval – It's Complicated

Satellite salinity instruments measure natural microwave emission from the top 1 cm (or less) of ocean surface in terms of brightness temperature (T_B). These data are processed into SSS at various levels:

- **Level 1:** Radiometer observations at full resolution (1A) or processed to sensor units such as brightness temperature (1B);
- **Level 2:** Derived geophysical variables from Level 1 source data; and
- **Level 3:** Variables mapped on uniform space-time grid scales.

Many researchers use gridded (i.e., Level 3) data. It can be useful to "dive deeper" and be aware of the types of documents describing how the data are acquired, validated, calibrated, processed and distributed.

The complexity behind SSS data has been captured in the PO.DAAC's Aquarius Documentation Roadmap. In addition to User Guides, there are Validation Analyses, Algorithm Descriptions, Calibration and other Technical Reports. The PO.DAAC also offers similar documentation for SMAP SSS processing.

Aquarius documentation roadmap.

There are differences among the retrieval algorithms used to generate satellite SSS data. Not only that, the algorithms used to process various missions' data evolve over time. So, the information below is meant to provide *an overview of the types of variations* among data products.

The variation among SSS data products falls into these general categories:

- **Ancillary inputs**
  - Typical inputs include sea surface temperature (SST), wind speed and direction, galactic map, sea ice mask, dielectric constant model, and a reference salinity field (e.g., HYCOM model). Differences among these inputs can affect the consistency among SSS products.
- **Corrections**
  - A variety of corrections are applied to SSS data. Although the specific corrections differ from product-to-product, typical SSS corrections are summarized in the e-brochure, Ocean Salinity From Space.
- **Flags, Filters & Masks**
  - *Flags* are employed when values exceed threshold values, thus indicating potentially degraded algorithm performance.
    - Each SSS data product employs its own type of flagging. For example, flags can affect data availability and/or quality *near coasts* (i.e., land contamination) and at *high latitudes* (i.e., sea ice contamination).
    - *"Research Insights" show the affect of ice flagging and masking on retrievals of SSS data from the Arctic Ocean.*
  - Flags can also be used to filter values according to your specific needs.
    - For example, RSS provides rain-filtered SMAP SSS products.
  - *Masks* are used to omit data that do not meet established quality criteria
- **Error Sources and Uncertainty Estimation**
  - Approaches to estimating errors or uncertainties vary among SSS products.

The specific application of corrections, flags, filters, and masks – along with approaches to estimating errors or uncertainties – are described in each product's User Guide and other literature.

Another consideration: Some data are processed by multiple institutions. SMAP SSS data, for example, are processed by both RSS and the NASA Jet Propulsion Laboratory (JPL). In the next section, we focus on similarities and differences in how these SMAP data products are processed.

Did We Mention it's Complicated?

A potentially confusing aspect is that there can be overlap between items in these categories. For example, RSS uses an ancillary "land mask" as an input to its SSS processing. Land corrections are applied to ensure the quality of coastal SSS data. RSS products also include land-related quality flags ranging from "light contamination" (i.e., removed from averaging in smoothed products) to "strong contamination" (i.e., masked altogether). Finally, RSS includes systematic errors from land contamination in its empirical uncertainty estimates.

Transmit data at ocean surface / Transmit data at ocean surface / Drift at 1000m for ~ 9 days / Drift at 1000m for ~ 9 days / Descend to ~2000m to begin ascending profile

Figure 1. Argo floats drift at depth then rise to the surface while measuring temperature and salinity.

Figure 2. Saildrones - autonomous sailing drones - are used as a tool to provide high quality oceanic and atmospheric observations.

« Previous | Next »

WHAT'S IN A VERSION?

It is not uncommon for months (or years) to pass between gathering data, analyzing it, writing a manuscript, and publishing your results. In parallel, the SSS data processing community is working to update algorithms and improve its products.

New releases of SSS data products are accompanied by changes in version numbers. This timeline shows major release dates of three examples of SSS data products (i.e., De-biased SMOS Level 3, Aquarius RSS, and SMAP RSS). Interestingly, two versions of Aquarius data (V4, V5) were released after the satellite stopped operating on 07-Jun-15.

It is important know which data version number(s) you are working with and be cognizant of new data releases that may occur while your manuscript is being reviewed. Even though the new data product will be better in quality, it may affect your results. **Consider contacting the data providers (e.g., PO.DAAC for NASA SSS data) about the timing of data release updates.**

Timeline of major release dates for three examples of SSS data products. Click image to enlarge.

SSS VALIDATION & SAMPLING DIFFERENCES

The accuracy of satellite-derived SSS measurements is largely validated by data from in-water sensors. Nonetheless, comparing the two is challenging for many reasons.

Timing is a challenge: Satellite observations need to be "matched up" with in-water data that has been collected at or near the sea surface within a few days of the satellite retrieval.

Spatial mismatch is another challenge. Satellite footprints cover tens of kilometers. Thus, a single satellite footprint may sample an area with non-uniform salinity (e.g., region with discrete patches of low salinity caused by recent rainfall). In-water salinity instruments, on the other hand, provide discrete "pinpoints" of salinity data.

Horizontal mismatches are only one part of the story. There are also differences in the depths where salinity is being measured. Satellite sensors retrieve from the very top of the ocean while in-water instruments measure salinity at greater depths.

Systematic sampling differences between satellite and in-water SSS data are sometimes referred to as "biases." **However, these sampling differences do not necessarily equate to errors in satellite SSS.** There can be physical reasons for the differences; for example, thin layers of low-salinity water that "float" on the ocean surface. These conditions would be detected by satellites, which measure T_B in the top centimeter of the ocean, but missed by sensors such as Argo profiling floats (Fig. 1) that generally do not detect salinity shallower than 3 – 5 meters.

SSS validation is being aided by a relatively new technology, Saildrone (Fig. 2). This instrument acquires salinity at a depth of 0.6 m, closer to the sea surface and thus more indicative of conditions detected by satellites. Other novel SSS-measuring technologies have been employed in conjunction with the SPURS campaigns. These instruments are key to understanding discrepancies between "sea truth" data and satellites' SSS retrievals, which are fed back into processing algorithms to improve SSS data products.

salinity.oceansciences.org/data-salinity-02.htm

Which Salinity Data Are Best For Y

- SMAP Data Processing by RSS and JPL
  - Similarities and differences between these processing streams are described (e.g., Q&A).
  - Detailed comparisons between RSS and JPL data products are available in the appendix.

Appendix B: SMAP SSS L2 Variables

[XXX] is ancillary data source; {Q#} is related quality flag

RSS (V4)		JPL (4.3)	
time	Seconds of observation since 2000-01-01 00:00:00 UTC	**row_time**	Approximate observation time for each SWC row as UTC seconds since 2015-01-01 0000 UTC
cellat	Geodetic latitude of grid cell	**lat**	Average latitude of all T_B observations for each SWC
cellon	Longitude of grid cell	**lon**	Average longitude of all T_B observations for each SWC
eia	Boresight Earth incidence angle	**inc_aft, inc_fore**	Average cell incidence angle of all aft and fore observations for each SWC, respectively {Q2}.
eaa	Boresight Earth azimuth angle	**azi_aft, azi_fore**	Average cell azimuth angle (clockwise relative North) of all aft and fore observations included for each SWC, respectively.

salinity.oceansciences.org/data-salinity-appendix.htm

SMAP Processing Focus – RSS

The RSS processing approach is based on understanding – and correcting for – the antenna temperatures and variables in the geophysical environment that affect the salinity signal retrieval. The empirical calibration steps are outlined in the figure at right. Numbers correspond to Level 2 data fields, which are shown in detail in the Appendix. **Visit the SMAP SSS Products Overview and Ancillary Data Sources section to learn more about how RSS and JPL process SMAP data.**

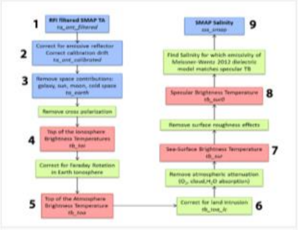


Figure 1. The empirical calibration steps in RSS processing.

Questions and Answers

Thomas Meissner, Ph.D.
Senior Research Scientist
Remote Sensing Systems (RSS)

+ What are the benefits of working closely with the salinity science community in terms of improving your products?
+ RSS and JPL have different approaches to processing data from the same instrument. What are the advantages of having data from both types of processing?
+ JPL has a 7-hour latency product. Is RSS considering adding near-real-time data to its future products?
+ What are some of the differences between RSS and JPL in terms of corrections (Galaxy Correction, high-latitude T_B Bias Adjustment, Reflector Emissivity Correction)?

SMAP Processing Focus – JPL

Salinity Wind Cells - JPL's SMAP salinity data product combines sea surface salinity (SSS) and wind speed. Time-ordered data are projected into swaths (Level 2A) whose along-track and cross-track coordinates are similar to longitude and latitude, respectively. These gridded data are, in turn, used to generate "Salinity Wind Cells" (SWCs).

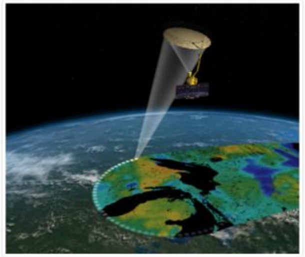
Flavors - SMAP's spinning antenna results in some footprints acquired either to the *fore* or *aft* of the spacecraft. Also, the retrieved signals are horizontally and vertically polarized (*H-pol* and *V-pol*, respectively). JPL processing separately bookkeeps these four "flavors" of T_B for each SWC: *Fore H-pol, Aft H-pol, Fore V-pol, and Aft V-pol.* JPL's data fields are shown in detail in the Appendix.

JPL pre-processes collocations of HYCOM SSS, NOAA Optimum Interpolation SST, NOAA WaveWatch III Significant Wave Height, and SMAP Level 1 T_B data. For each SWC, land- and ice-contaminated data are flagged and removed before averaging. Averaged "four-flavor" composite T_B values with a small number of corrections (i.e., Galaxy Correction, high-latitude T_B Bias Adjustment, Reflector Emissivity Correction) are generated prior to Level 2B processing.

Both salinity and sea surface roughness affect sea surface emissivity and cannot be fully distinguished from one another. Thus, the two effects are combined during JPL processing but generated as two datasets (*smap_sss* for salinity and *smap_spd* for wind speed). SSS uncertainties are estimated from combined salinity and wind speed computations and include the effects of cold water, radio frequency interference (RFI), geophysical model function (GMF) errors, and measurement errors.

Data are provided in the case of "extreme winds" such as those associated with tropical storms. In these cases, salinity is fixed at the ancillary HYCOM value while the emissivity signal is attributed to winds. Users should be aware that errors in the ancillary salinity – e.g., areas with high salinity variability such as major river outflows - will map to erroneously high wind speed.

Visit the SMAP SSS Products Overview and Ancillary Data Sources section to learn more about how RSS and JPL process SMAP data.



Artist's rendering of the Soil Moisture Active Passive satellite.
Credit: NASA/JPL-Caltech

Questions and Answers

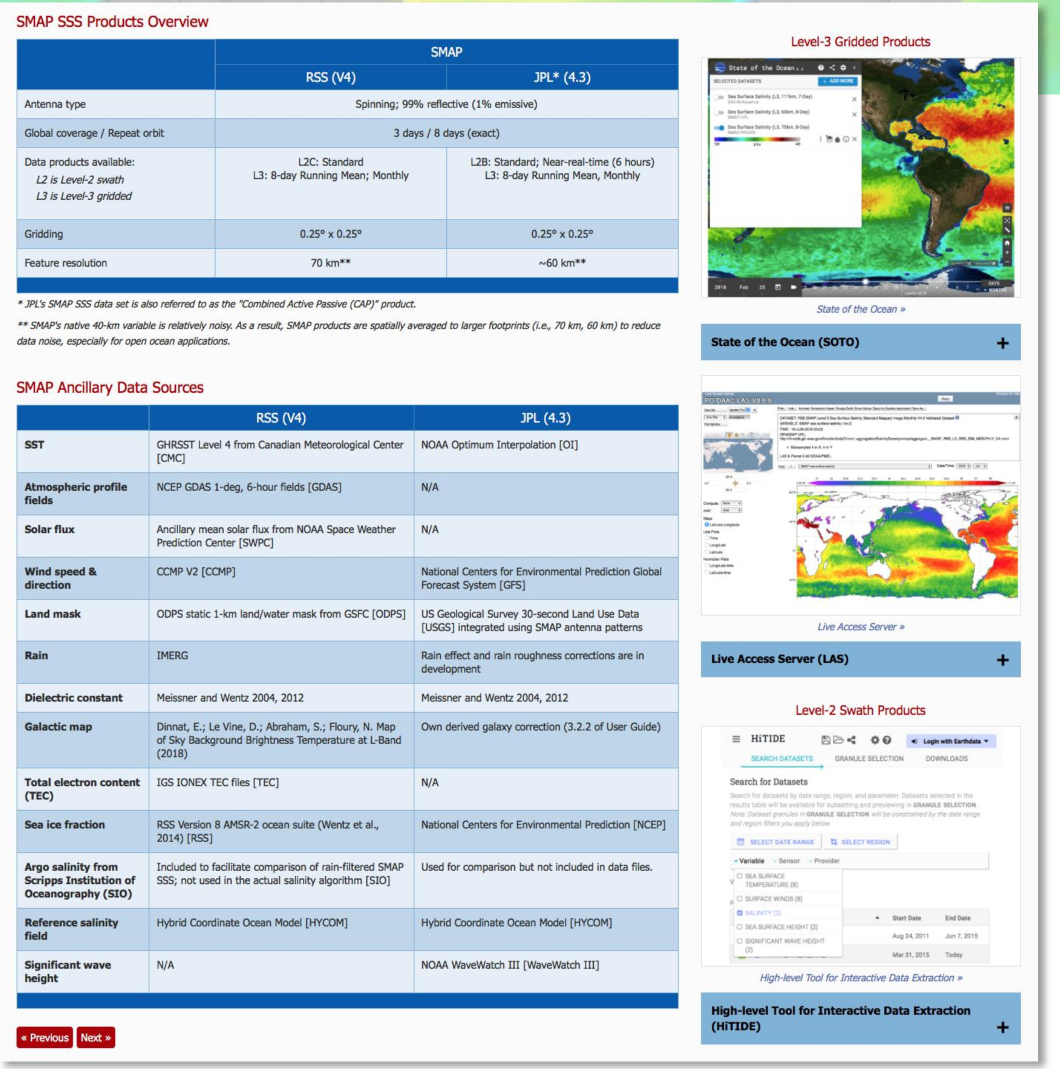
Alexander Fore, Ph.D.
Signal Engineer
NASA Jet Propulsion Laboratory (JPL)

+ As can be inferred from Appendix A, JPL does not recalibrate the Level-2 brightness temperatures while RSS does a number of corrections related to the SMAP antenna. Any thoughts on the differences between your approaches?
+ As shown in Appendix B, JPL has fewer Level-2 variables than RSS. Why is that?
+ You put salinity and wind in the same data product (whereas RSS has a completely different wind product). Why did you decide to do it this way?

salinity.oceansciences.org/data-salinity-03.htm
salinity.oceansciences.org/data-salinity-04.htm

Which Salinity Data Are Best For You?

- SMAP SSS Products Overview
  - Compares RSS and JPL products at a high level including ancillary data sources.
  - Data tools served by the Physical Oceanography Distributed Active Archive Center (PODAAC) are also featured here:
    - State of the Ocean
    - Live Access Server
    - Hi-level Tool for Interactive Data Extraction


SMAP SSS Products Overview

	SMAP	
	RSS (V4)	JPL* (4.3)
Antenna type	Spinning; 99% reflective (1% emissive)	
Global coverage / Repeat orbit	3 days / 8 days (exact)	
Data products available: *L2 is Level-2 swath* *L3 is Level-3 gridded*	L2C: Standard L3: 8-day Running Mean; Monthly	L2B: Standard; Near-real-time (6 hours) L3: 8-day Running Mean, Monthly
Gridding	0.25° x 0.25°	0.25° x 0.25°
Feature resolution	70 km**	~60 km**

** JPL's SMAP SSS data set is also referred to as the "Combined Active Passive (CAP)" product.*

*** SMAP's native 40-km variable is relatively noisy. As a result, SMAP products are spatially averaged to larger footprints (i.e., 70 km, 60 km) to reduce data noise, especially for open ocean applications.*

SMAP Ancillary Data Sources

	RSS (V4)	JPL (4.3)
SST	GHRSST Level 4 from Canadian Meteorological Center [CMC]	NOAA Optimum Interpolation [OI]
Atmospheric profile fields	NCEP GDAS 1-deg, 6-hour fields [GDAS]	N/A
Solar flux	Ancillary mean solar flux from NOAA Space Weather Prediction Center [SWPC]	N/A
Wind speed & direction	CCMP V2 [CCMP]	National Centers for Environmental Prediction Global Forecast System [GFS]
Land mask	ODPS static 1-km land/water mask from GSFC [ODPS]	US Geological Survey 30-second Land Use Data [USGS] integrated using SMAP antenna patterns
Rain	IMERG	Rain effect and rain roughness corrections are in development
Dielectric constant	Meissner and Wentz 2004, 2012	Meissner and Wentz 2004, 2012
Galactic map	Dinnat, E.; Le Vine, D.; Abraham, S.; Floury, N. Map of Sky Background Brightness Temperature at L-Band (2018)	Own derived galaxy correction (3.2.2 of User Guide)
Total electron content (TEC)	IGS IONEX TEC files [TEC]	N/A
Sea ice fraction	RSS Version 8 AMSR-2 ocean suite (Wentz et al., 2014) [RSS]	National Centers for Environmental Prediction [NCEP]
Argo salinity from Scripps Institution of Oceanography (SIO)	Included to facilitate comparison of rain-filtered SMAP SSS; not used in the actual salinity algorithm [SIO]	Used for comparison but not included in data files.
Reference salinity field	Hybrid Coordinate Ocean Model [HYCOM]	Hybrid Coordinate Ocean Model [HYCOM]
Significant wave height	N/A	NOAA WaveWatch III [WaveWatch III]

« Previous Next »

Level-3 Gridded Products

State of the Ocean »

State of the Ocean (SOTO) +

Live Access Server »

Live Access Server (LAS) +

Level-2 Swath Products

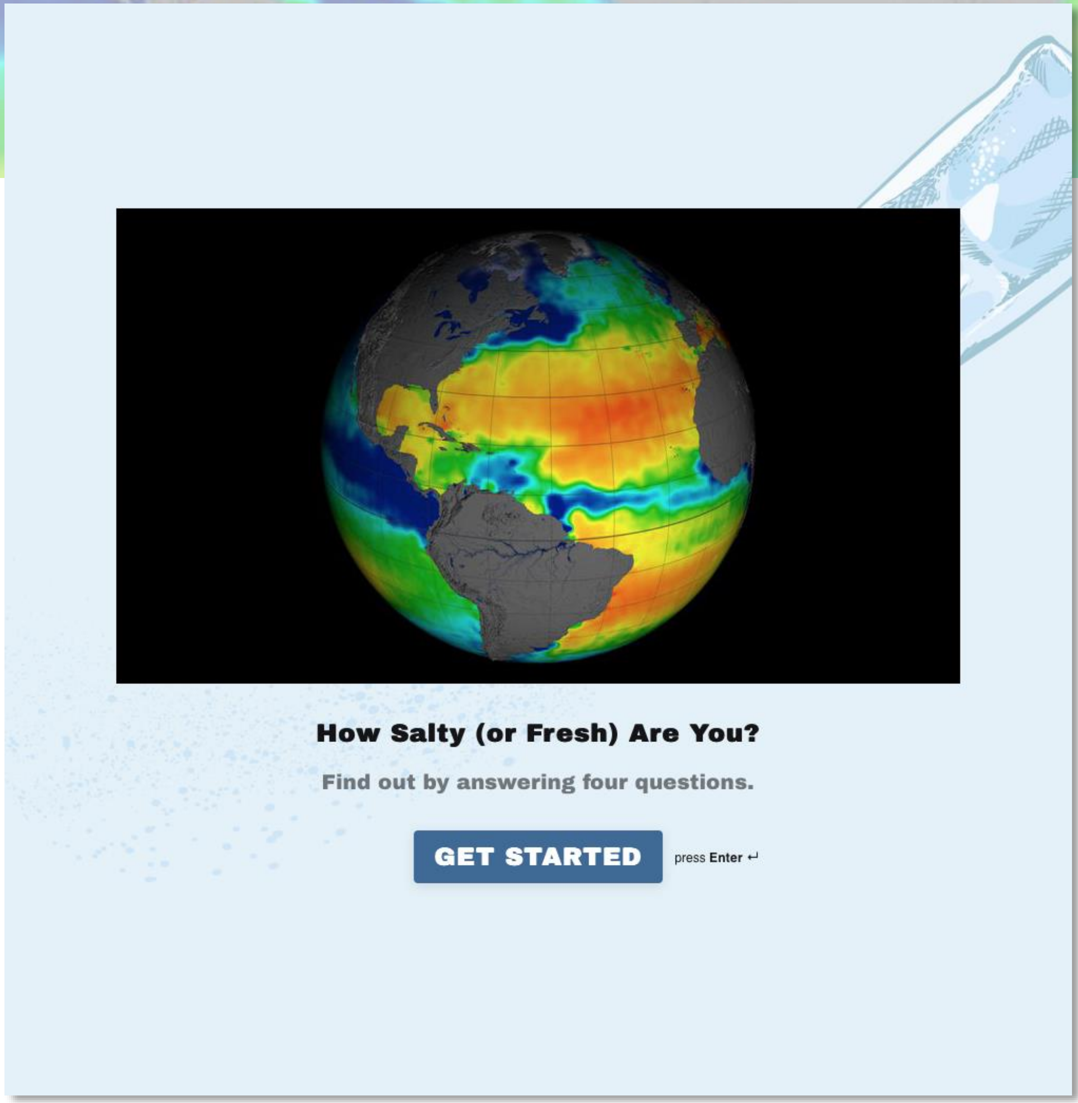
High-level Tool for Interactive Data Extraction »

High-level Tool for Interactive Data Extraction (HiTIDE) +

salinity.oceansciences.org/data-salinity-05.htm

How Salty (or Fresh) Are You?

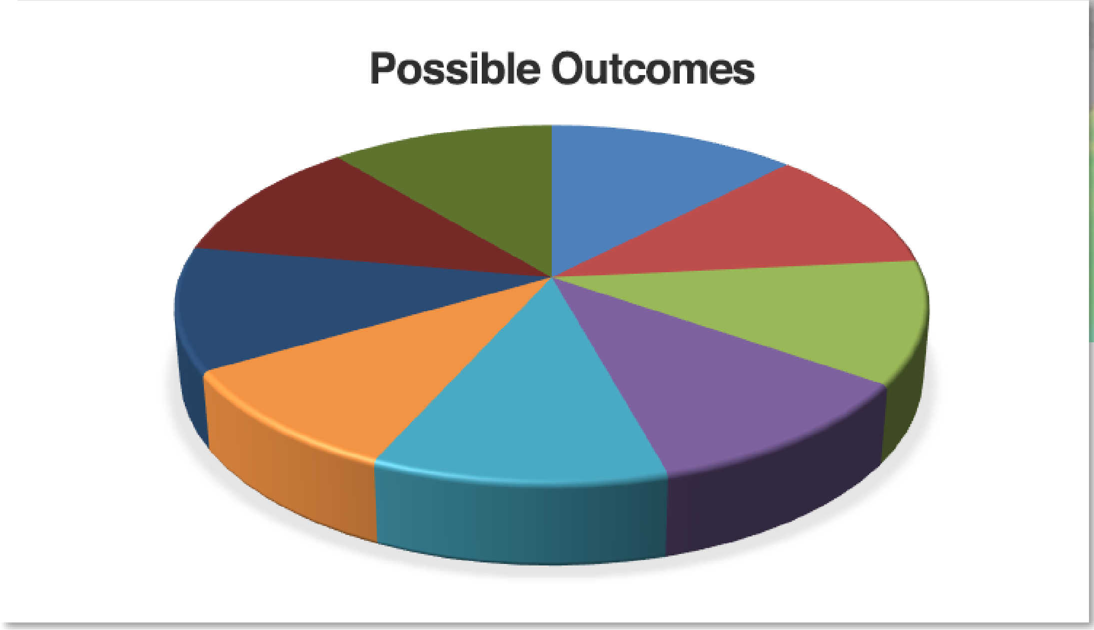
- Quiz proposed during 2019 OSST meeting
  - Participants answer multiple-choice questions about their personal preferences:
    - Visibility at a party venue (light conditions, or depth within the water column)
    - Food choices (saltiness)
    - Thermostat settings (temperature)
    - Environmental change (levels of stability)



salinity.oceansciences.org/quiz_salty_fresh.htm

How Salty (or Fresh) Are You?

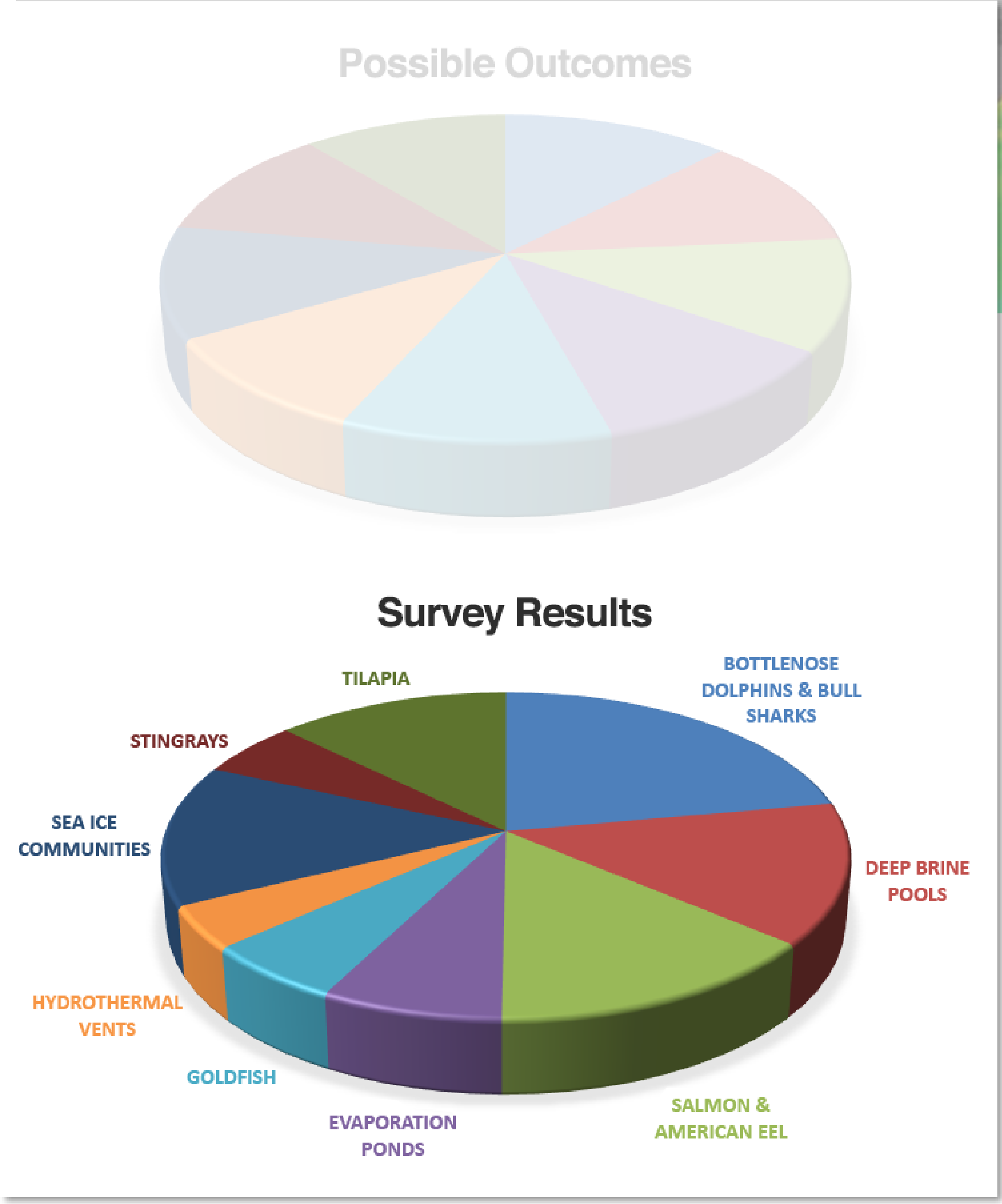
- Quiz results match responders with one out of nine possible outcomes.
- Pie chart shows that the *possible outcomes** are evenly distributed among the nine outcomes.
    - **Probability of individuals receiving a specific outcome based on combination of answers to the four quiz questions.*



salinity.oceansciences.org/quiz_salty_fresh.htm

How Salty (or Fresh) Are You?

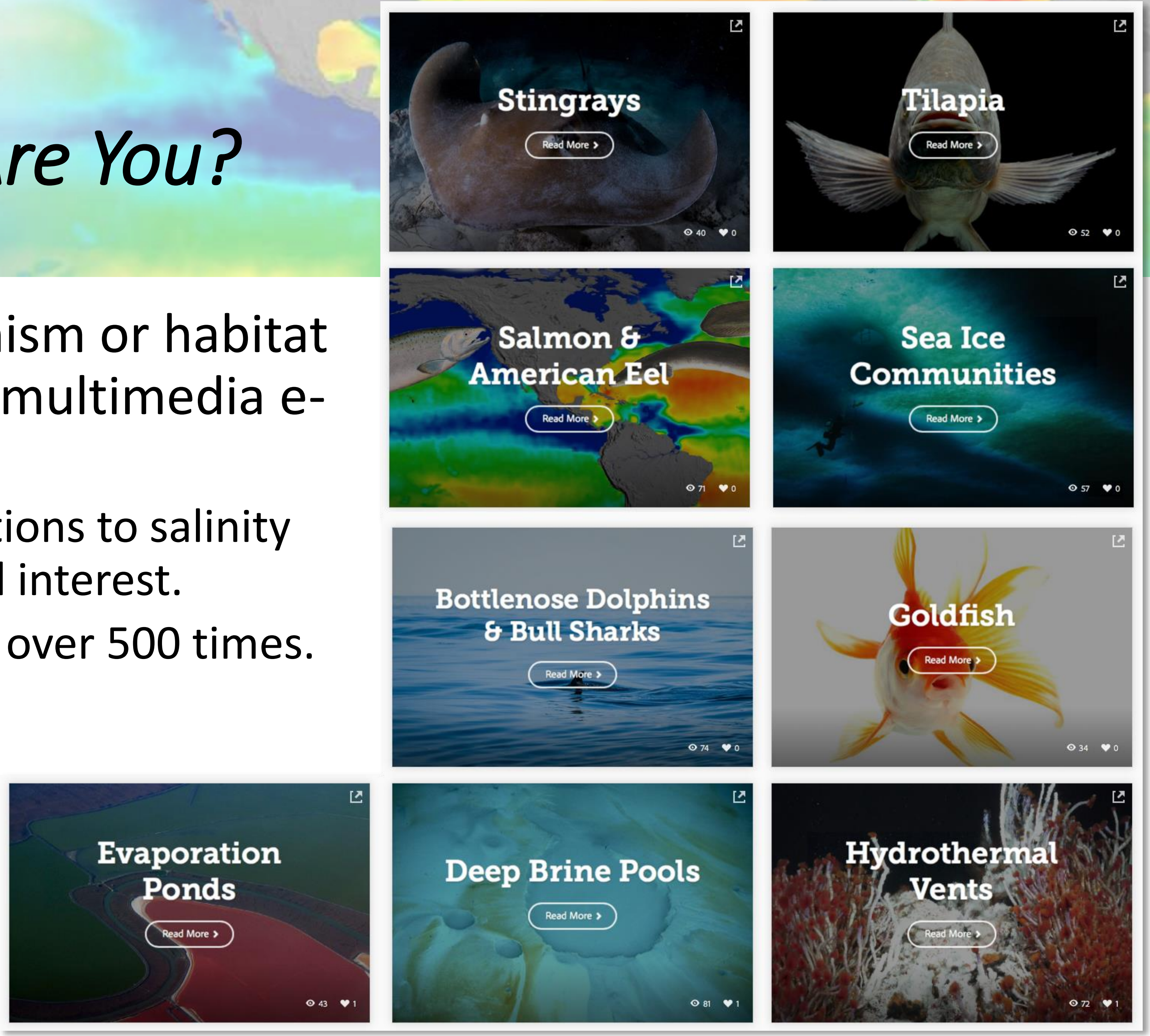
- People's preferences are not random!
- Responders tend to identify with:
  - *Bottlenose Dolphins & Bull Sharks*
  - *Deep Brine Pools*
  - *Salmon & American Eel*
  - *Sea Ice Communities*
- Less common outcomes:
  - *Goldfish*
  - *Hydrothermal Vents*
  - *Stingrays*



salinity.oceansciences.org/quiz_salty_fresh.htm

How Salty (or Fresh) Are You?

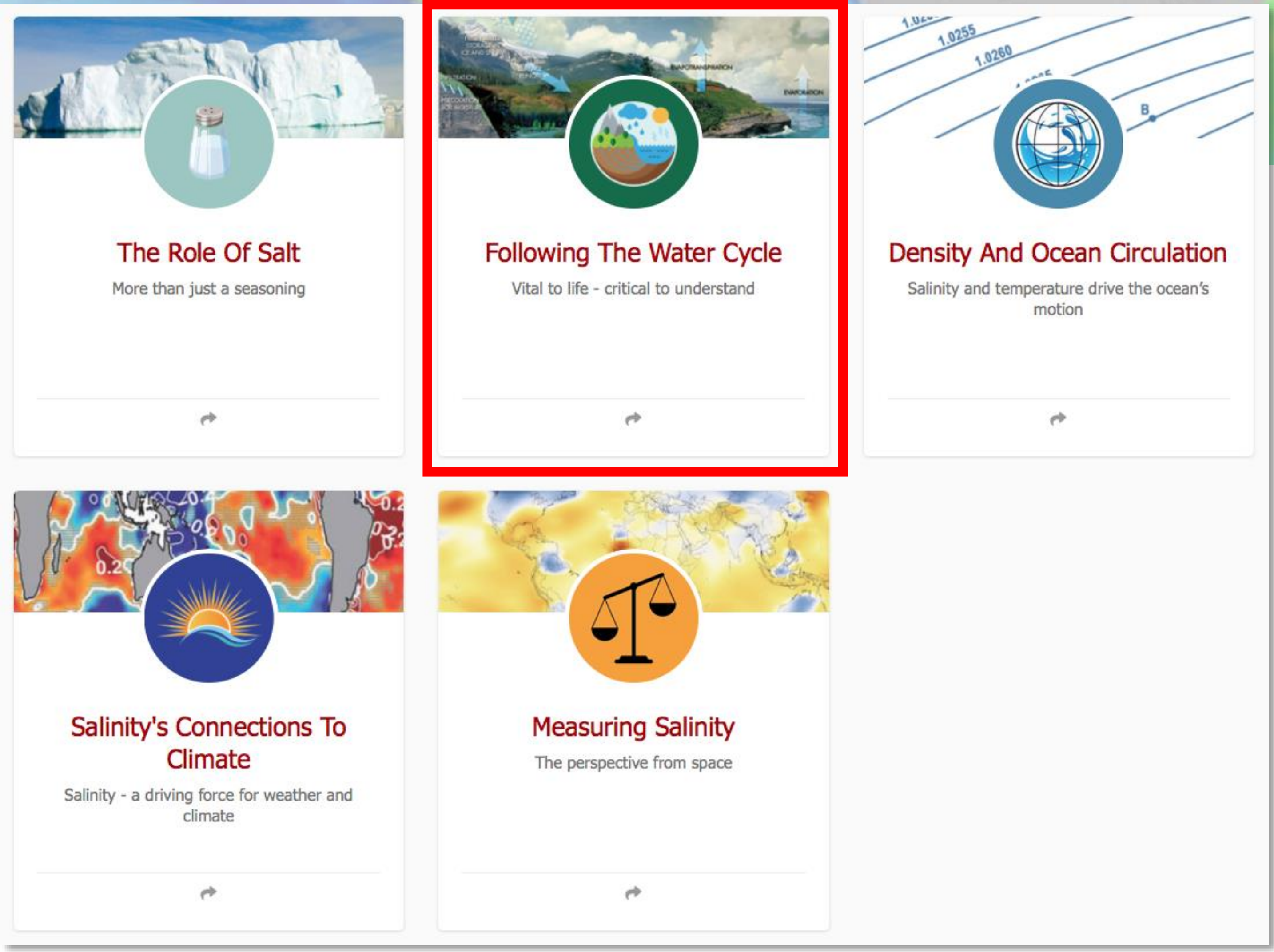
- Information about each organism or habitat is presented as an interactive multimedia e-brochure.
  - These stories weave in connections to salinity research and items of historical interest.
  - E-brochures have been viewed over 500 times.
- Maybe incorporate the quiz (or e-brochures' content) in your next talk?



salinity.oceansciences.org/quiz_salty.htm

Learn More

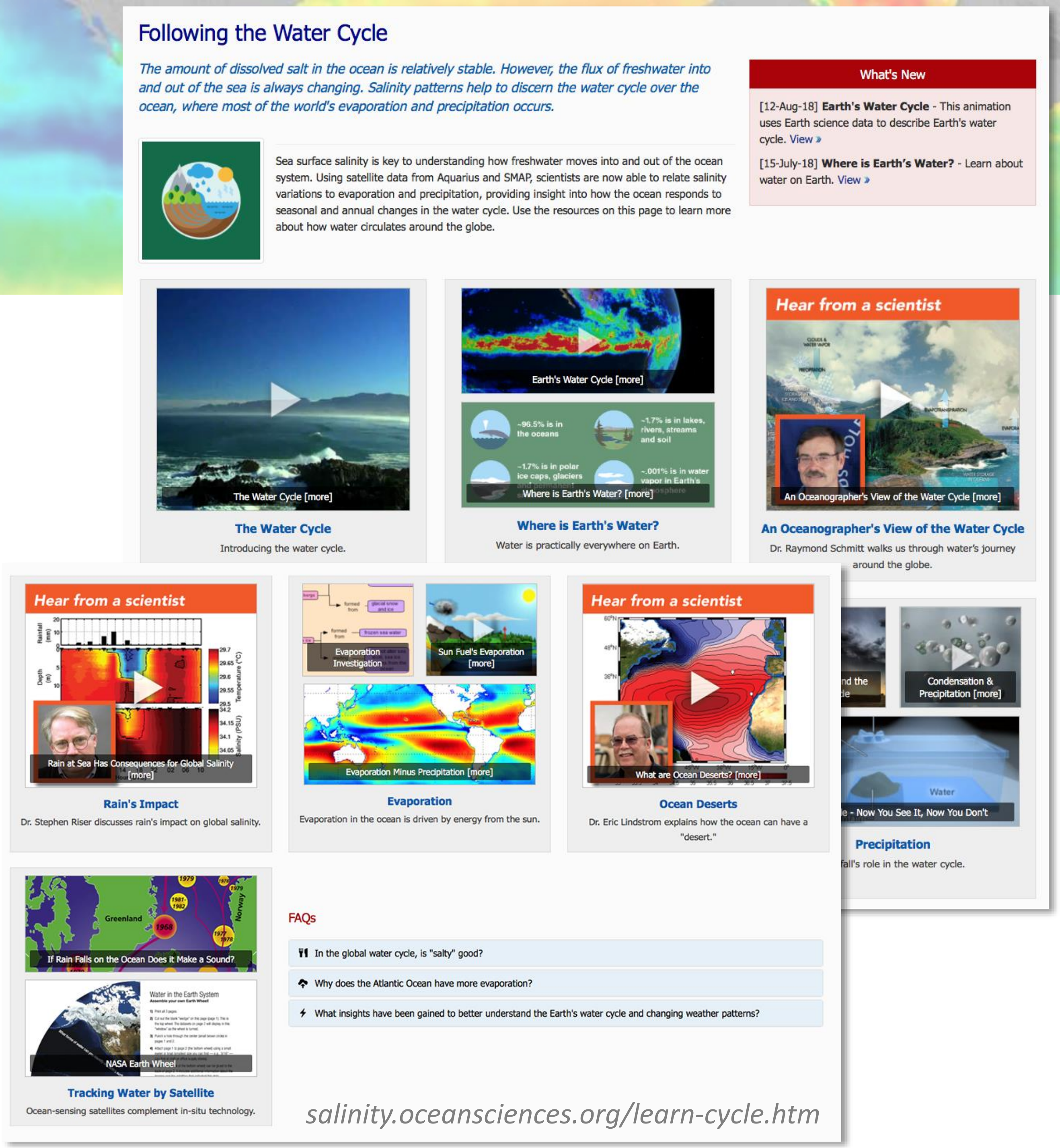
- New section of website with learning resources.
- Arranged by topic:
  - *The Role Of Salt*
  - *Following The Water Cycle*
    - Shown in detail on next slide
  - *Density And Ocean Circulation*
  - *Salinity's Connections To Climate*
  - *Measuring Salinity*



salinity.oceansciences.org/learn.htm

Learn More

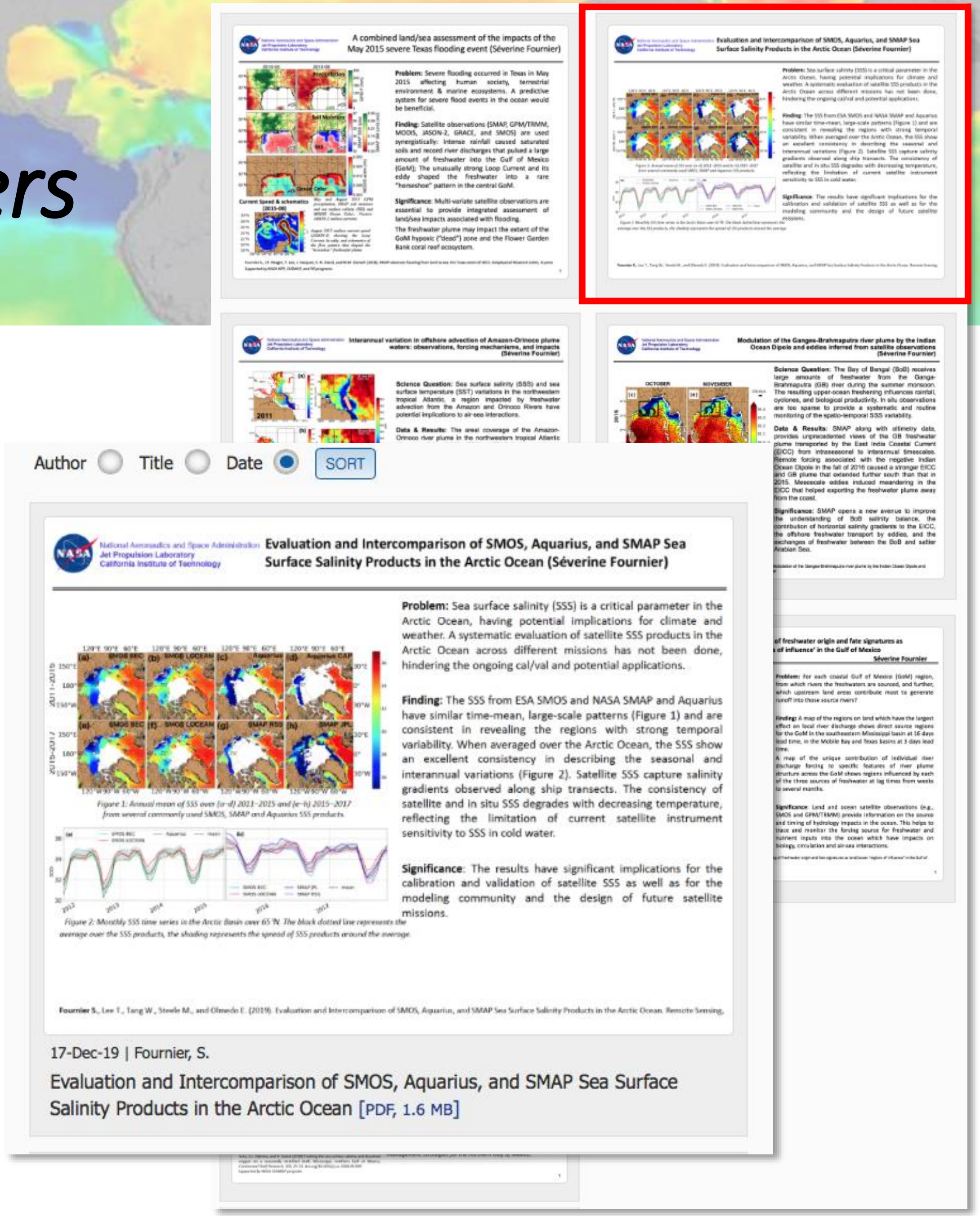
- Variety of materials:
  - Hands-on activities
  - Online resources
  - Video clips from salinity webinars (*Hear from a scientist*)
  - Data images
  - FAQs
- If you have learning resources to share or recommend, please let me know!



salinity.oceansciences.org/learn-cycle.htm

Highlights – Research One-pagers

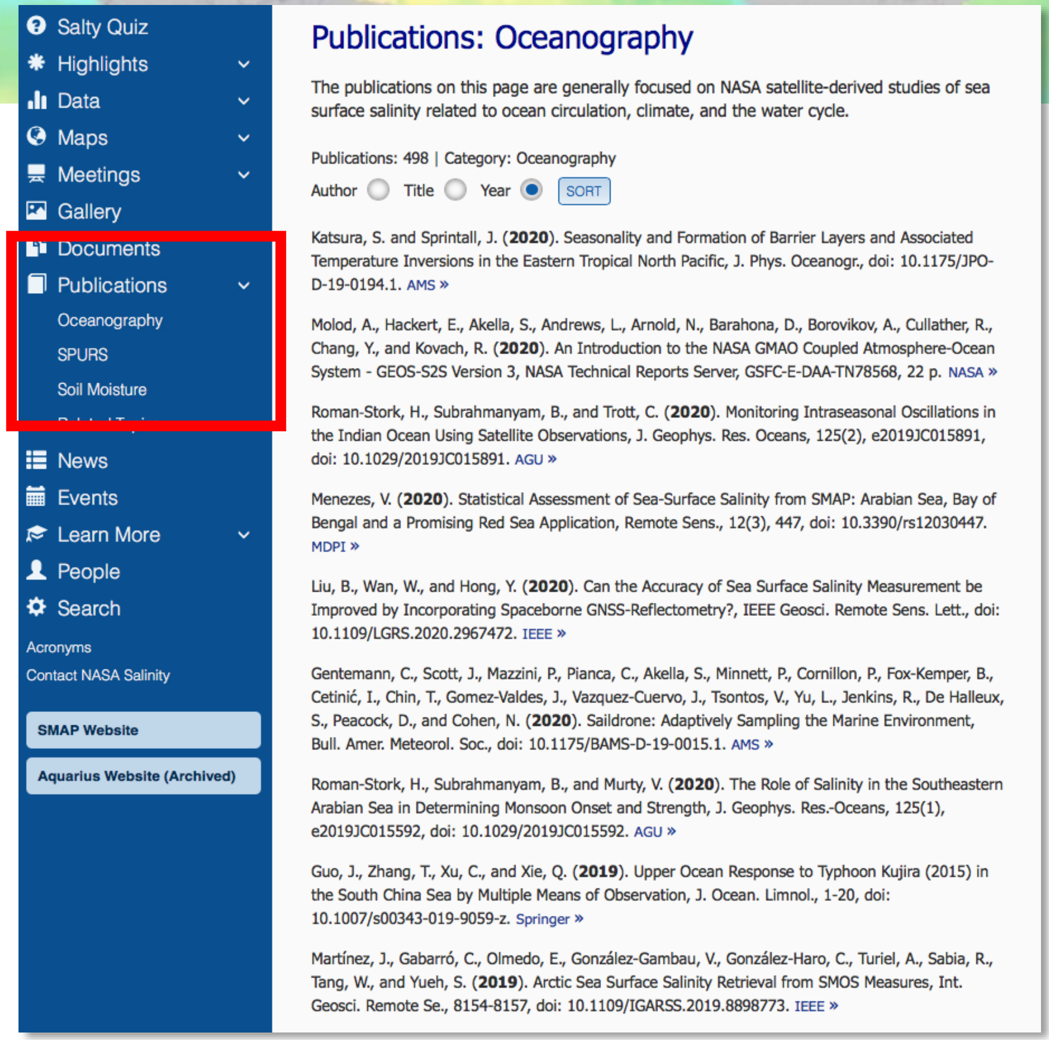
- Template includes:
  - Large graphic
  - Problem being addressed and motivation
  - Method
  - Key finding(s)
  - Broader significance or implications
  - Publication source
- NASA HQ would like to see more of these!
- Tony Lee or I can provide the template and feedback on draft versions, if desired.



salinity.oceansciences.org/highlights-research.htm

Publications Update

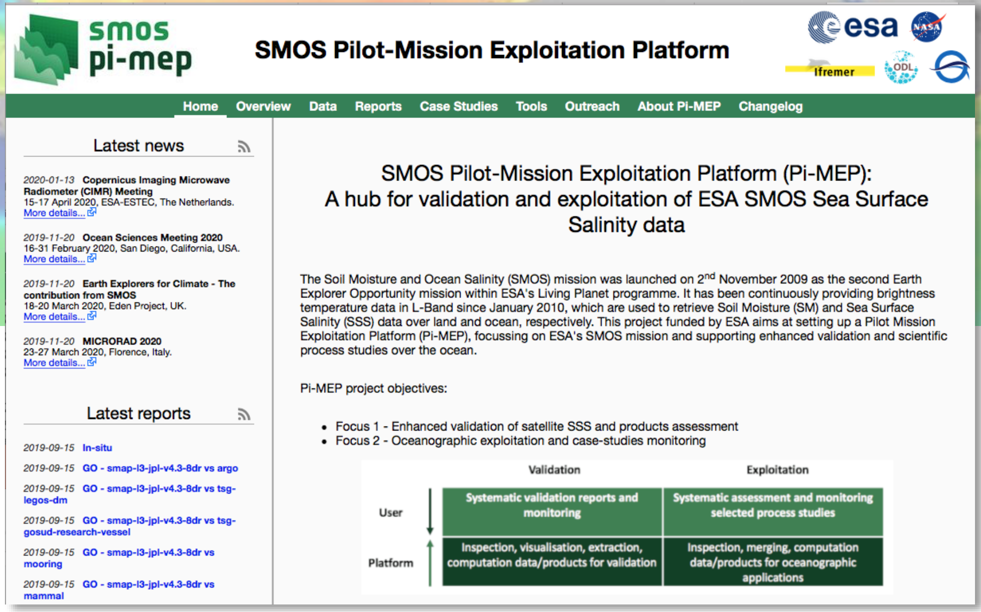
- New approach to finding and posting publications:
  - Receive “Google Scholar” alerts each week.
  - Review paper for relevancy.
  - Tag based on these topics:
    - *Oceanography*
    - *SPURS*
    - *Soil Moisture*
    - *Related Topics*
- We’re also looking for papers with societal implications to feature on the website!



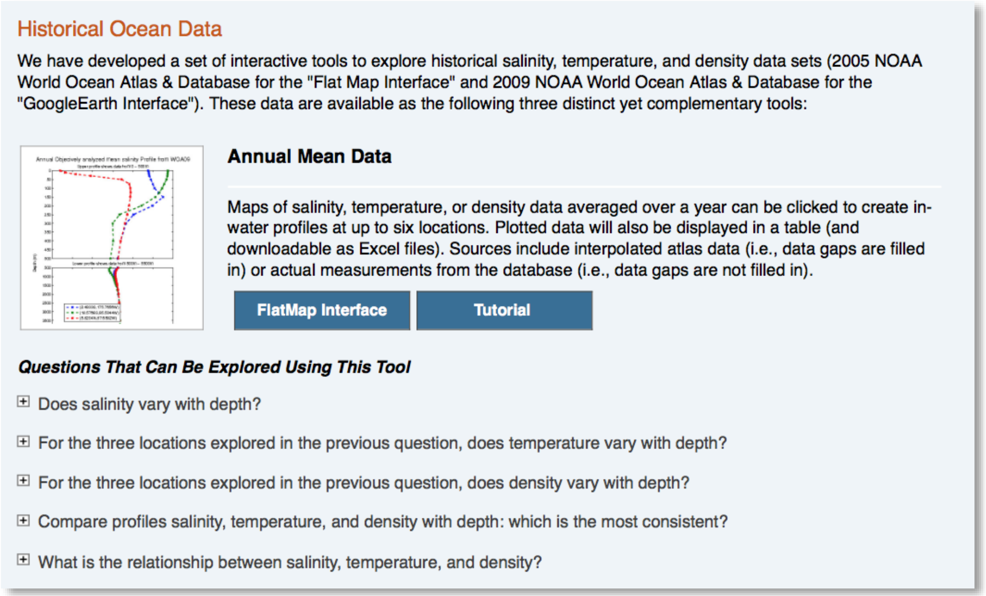
salinity.oceansciences.org/publications.htm

What's Next?

- *Which Salinity Are Best For You?*
  - Ready to go live now. Or send to team for a short review period?
  - Consider whether/how to add Pi-MEP.
- Find ways to broaden quiz participation.
- New website features in the works:
  - Interactive timeline about the history of SSS.
    - See format at *pace.oceansciences.org/timeline.htm*
  - Updating salinity tools developed for Aquarius.



www.salinity-pimep.org



aquarius.oceansciences.org/cgi/ed_aq_datatool.htm

Questions?

- ✓ *Which Salinity Are Best For You?*
- ✓ *How Salty (or Fresh) Are You?*
- ✓ *Learn More*
- ✓ *Highlights – Research One-pagers*
- ✓ Publications Update
- ✓ What's Next?

avdecharon@gmail.com