

# Update on the Winds and Currents Mission (WaCM)

Mark Bourassa (Florida State University)

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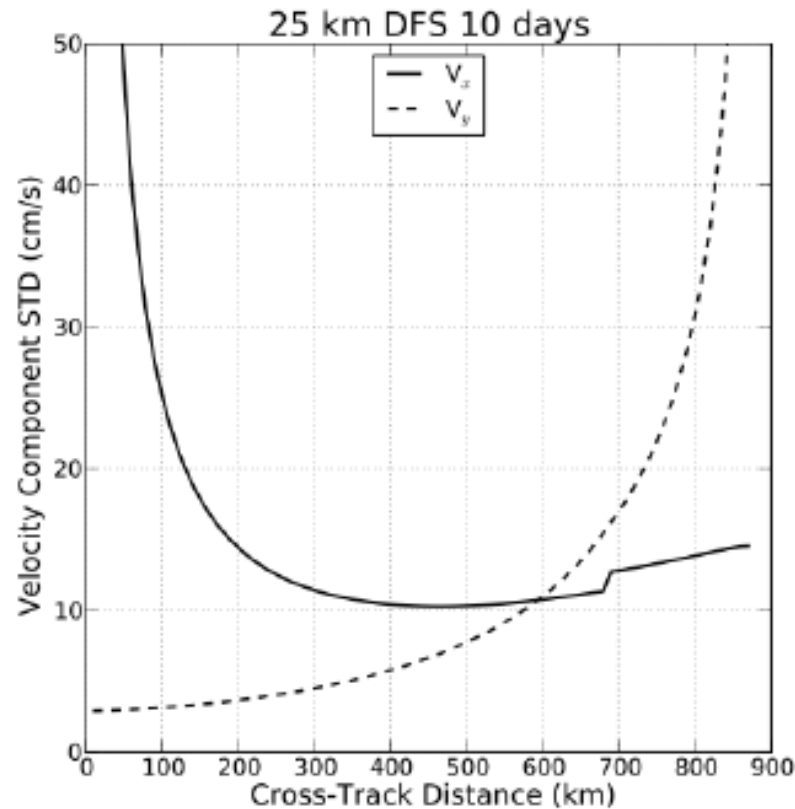
# Instrument Combination

- An AMSR class radiometer with additional high frequency channels for cloud ice (AMSR3; provided by JAXA)
- Pencil beam scatterometers
  - Ku-band (10km nominal resolution; provided by ISRO)
  - Doppler Ka-band (5km nominal resolution for winds; JPL)
    - Ocean current measurements
      - Spatial resolution: <25 km
      - Temporal resolution: <10 days
      - Vector velocity accuracy: 5 cm/s – 10 cm/s
- Key innovations:
  - High resolution winds for coastal applications and calculation of smaller scale (3x scatterometer spacing) divergence and curl
  - Surface currents (from the Doppler scatterometer)
- Constraints on ISRO and JAXA technology for putting this instrument in orbit suggest technology will be ready in 2020 to 2025



# Scientific Objectives for NASA Earth Ventures

- Better understand how transport by ocean surface currents modifies the distribution of thermal energy in the upper ocean
  - Persistent currents
  - Transport by eddies
- Advance fundamental scientific understanding of upper-ocean current dynamics and their coupling to surface winds
  - Observationally determine the kinetic energy surface flux from winds into currents
  - Observationally determine the impacts of current on Ekman (vertical water) transport
  - Understand how currents vary with depth near the surface
- Applications:
  - Develop and produce observation-based current products with true surface currents
  - Near real time delivery of winds and currents for ocean and weather forecasting
  - Contribute to ISRO studies of Himalayan ice & snow and rain (as well as Indian coastal observations and weather forecasting)
- Strong synergies with SWOT, PACE and missions for SST and cryosphere



Ka-band has improved sensitivity by a factor of 2.7

To avoid lack of sensitivity at low wind speeds, restrict surface current (but not wind) retrievals for winds above 5 m/s.

Account for this in the number of samples in 10 days by assuming a Rayleigh distribution for the winds.

Graphic from Ernesto Rodriguez

## Earth Ventures

- Our goal of an Earth Ventures Instrument (EV-I) proposal was crushed when a careful budget analysis indicated the instrument alone would put the mission over the \$90M budget cap.
- The partnership continued
- We then aimed for an Earth Ventures Mission (EV-M)
  - \$150M budget cap
  - However, we need to provide a launch vehicle and satellite
  - Hence the critical need of ISRO and/or JAXA partners
  - Two issues lead to a last minute withdrawal of the proposal
    - A better understanding of NASA EVM instrumentation requirements resulted in marginal capability
    - A last minute misunderstanding between NASA and ISRO

# The Next Way Forward: the NRC Decadal Survey



➤ 1<sup>ST</sup> RFI – Submissions due Nov 2, 2015

1. What are the key challenges for Earth System Science across research, applications, and/or operations?
2. What makes the challenge timely, space-based observations critical, and the situation ready for addressing?

➤ 2<sup>nd</sup> RFI – Submissions due May 15, 2016

1. What are the specific science and applications targets (i.e., objectives) that promise to substantially advance understanding in one or more of the DS thematic panels?
2. What are the key geophysical variables/measurements, and the observational requirements, needed to address the science and application targets?
3. What are the possible measurement approaches to achieve the objectives, including technical, performance and maturity/heritage specifications for relevant current and near-future instrumentation?



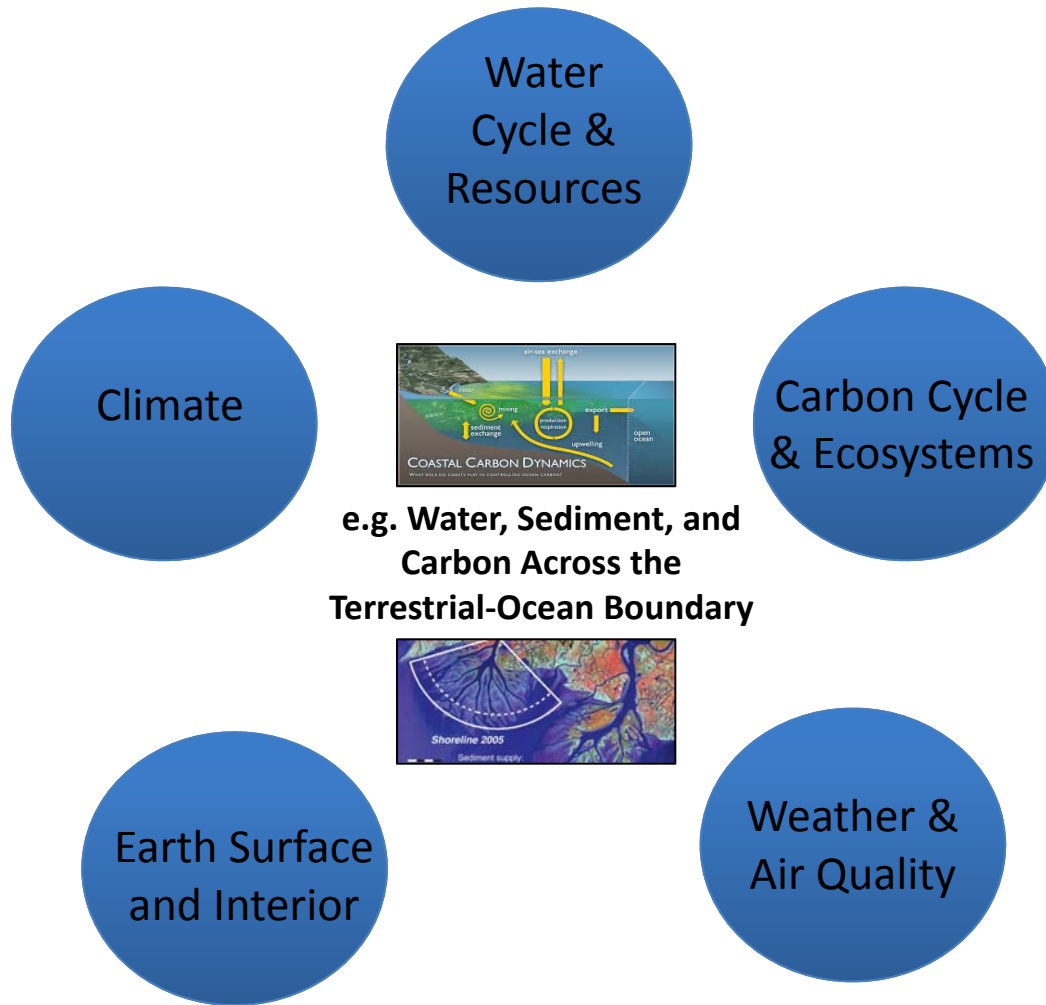
Slide from Waleed Abdalati and Tony Busalacchi

# Input to 1<sup>st</sup> RFI – with strong Winds & Currents

- Maximenko, N., L. Centurioni, Y. Chao, K. Dohan, F. Galgani, B. D. Hardesty, K. L. Law, D. Moller, E. van Sebille, and C. Wilcox, 2015: Remote sensing of marine debris, Earth Science and Applications from Space (ESAS 2017) RF#1 white paper.
- Morey, S.L., N. Maximenko, and M. A. Bourassa, 2015: Satellite Measurements of Ocean Surface Currents – Critical Applications. Response to Decadal Survey RFI#1.
- Farrar, T., L. W. O’Neill, N. Smith and M. A. Bourassa, 2015: TPOS2020: An integrated observing system for 2020 and beyond. Response to Decadal Survey RFI#1.
- Dukhovskoy, D., M. A. Bourassa, 2015: Changing Arctic Climate System: Causes, Consequences, and Relationship to the Global Climate. Response to Decadal Survey RFI#1.
- Bourassa, M.A., S. L. Morey, S.-P. Xie, D. Chelton, R. Samuelson, T. Farrar, N. Maximenko and A. Thompson, 2015: Wind and Current Coupling. Response to Decadal Survey RFI#1.
- Chelton, D., J. T. Farrar, R. M. Samelson, 2015: Wind-driven Near-surface Vertical Motion in the Ocean. Response to Decadal Survey RFI#1.
- Wentz, F., C. Mears, B. D. Santer, D. Chelton, M. Bourassa, R. Milliff, 2015: Continuity of Air-Sea Climate Variables. Response to Decadal Survey RFI#1

# Decadal Survey 2<sup>nd</sup> RFI Challenge

*Provide input to DS that successfully pairs an “affordable” and tractable measurement approach with a compelling objective that appeals to one or more of the thematic panels*

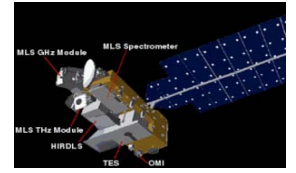


## Observing Architectures

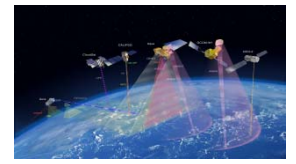
Multi-Purpose Sensors  
e.g. HypIRI



Multi-Sensor Platforms  
e.g. Aura



Distributed Platforms/  
Constellations e.g. A-Train





# The Next Way Forward: the NRC Decadal Survey

## Air-Sea Exchange Drivers of Climate Variability, Ocean Circulation, and Weather: A Case For Coincident Observations of Ocean Surface Winds and Currents

➤ *Authors:*

- Ernesto Rodriguez, Jet Propulsion Laboratory, California Institute of Technology
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- Xinfeng Liang, University of South Florida, College of Marine Science
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- Roger Samelson, Oregon State University
- A. F. Thompson, California Institute of Technology
- Shang-Ping Xie, University of California, San Diego

# Topics in 2<sup>nd</sup> RFI Response

- Submitted last Friday
- **Atmosphere/Ocean Coupling Science Target**
  - What are the global ocean surface currents and how are they related to local surface wind stress?
  - What are the dominant near-surface mixing processes as a function of wind stress?
- **Tropical Science Target**
  - Understand the spatio-temporal variability and dynamical mechanisms for equatorial upwelling.
- **Polar Science Topics**
  - How does the sea ice drift and upper ocean circulation change under the current climate?
  - What are the pathways and propagation/accumulation rate of surplus freshwater in the Arctic Ocean and Subpolar seas?
- **Applications** (nine – too many to list)

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Dragana Perkovich, Roger Samelson, Bryan Styles,  
Andrew Thompson, Frank Wentz, and Shang-Ping Xie  
and the rest of the WaCM team

