Marine Debris Mission:
From observation to understanding and prediction in order to inform decision making

• Unique characteristics
  – An important societal and policy problem
  – A new science but complex problem
    • Meteorology (near surface)
      – Wind (from 10-m to surface)
    • Oceanography
      – Current (from surface to 15-m)
      – Vertical mixing
      – Sub-pixel scale process/parameterization
    • Windage (0-5%)
  – A challenging technology problem
    • Mission impossible for technologists/engineers
Large: To observe individual object (location, size, height above surface) between the two observations

Small: To observe concentration (e.g., under certain conditions like low wind)

Small/Micro

Large/Macro

Windage: 0

Size: cm

m
Science Objectives

• Observe the size-frequency distribution and variability for large/macro debris (for the first time; space debris example)
Discovery

Aquarius
Salinity

Space
Debris
Map
Science Objectives

• Observe the size-frequency distribution and variability for large/macro debris (for the first time; space debris example)

• Quantify the mass balance including as much as possible small/micro debris (using water cycle and carbon budget as examples) and reduce the uncertainty of today’s state-of-the-art estimate (an order of magnitude)
Linkage between large/macro and small/micro debris; surface and deep ocean

• What is the transfer function from large/macro to small/micro debris?
• Is there a correlation between the two?
• Can we reduce the uncertainty for today’s estimate (e.g., Science paper in 2015)

Sources

Large/Macro Debris

Small/Micro Debris

Deep Ocean

Sinks

8M Mtons (Science 2015)
Science Objectives

- Observe the size-frequency distribution and variability for large/macro debris (for the first time; space debris example)
- Quantify the mass balance including as much as possible small/micro debris (using water cycle and carbon budget as examples) and reduce the uncertainty of today’s state-of-the-art estimate (an order of magnitude)
- Develop the transfer function from open ocean to shoreline through the coastal and the deep ocean
- Inform the decision making process (e.g., targeted cleanup, behavior change, fishing net redesign to reduce loss); education and public engagement
From the open ocean to shoreline through the coastal ocean
Science Measurement Requirements

• Global mapping  
  – What is the spatial distribution of MD? (1\textsuperscript{st} global map!)  
  – How does MD change with time? (e.g., seasonal cycle, year-to-year variability, long-term trend)

• Sink  
  – Where does MD end up? (e.g., hot spots, amount, extreme events)  
    • How to link the open ocean observations (and modeling) to shoreline through the coastal ocean  
      – Complementary to shoreline survey (e.g., ICC, local groups)  
    • What is the transport from the surface to the deep ocean?

• Source  
  – Where does MD come from? (from rivers and watershed on the global scale)
Instrument Functional Requirements

• Passive
  – Optical
  – Infrared
  – Multi-/hyper-spectral

• Active
  – SAR
  – Laser based (Raman-based spectroscopy)

• To be compared and others to be developed
Future Plans

• Publish talks on web site (contact Nikolai if you have concerns)
• Draft/prepare/publish white paper (outline, comments, final; report, news article, journal)
• Establish NASA MD community in collaboration with other agencies and international organizations (e.g., ESA, UNEP)
  – Web site, mailing list, webinar, etc.
• Identify near-term tasks and organize working groups
  – What is the scale separating large/macro from small/micro debris
  – Draft/refine science traceability matrix
  – Identify gaps and missing expertise
  – ...???...
• Opportunities
  – Near-term: NASA ROSES, NOAA MDP, others???
  – Medium-term: Venture/Suborbital, CubeSat, ???
  – Long-term: Satellites
• Plan for the follow-up workshop (6-12 months; Big Island/Maui)