

# Science III: Mesoscale and Submesoscale Oceanography

## Summary

**Chairs: Heather Roman-Stork, Clément Ubelmann, Jinbo Wang, Rosemary Morrow**



# Future Planning for Jason-3

**The Chairs requested input from the contributors to the session (speakers and poster presenters) for the future planning of the Jason-3 orbit**

## **Contributor suggestions:**

- Place Jason-3 in an orbit to fill in gaps left by SWOT
- What is the possible parameter space? Possible to change to SWOT orbit?
- Opportunity to have fast sampling of small, rapid ocean scales with a repeat of 1-day or 3-days (like early ERS mission), in an orbit that is complementary & co-ordinated with other missions (S3A-B, S6, SWOT, HY-2)

# Future Planning of OSTST Meetings

**The Chairs requested input from the contributors to the session (speakers and poster presenters) for the future planning of OSTST Meetings:**

**Contributor suggestions:**

- Alternate virtual and in-person
- Better discussions in in-person meetings
- Better promote SWOT applications, possible dedicated SWOT session?

# SCI3: Seed Questions

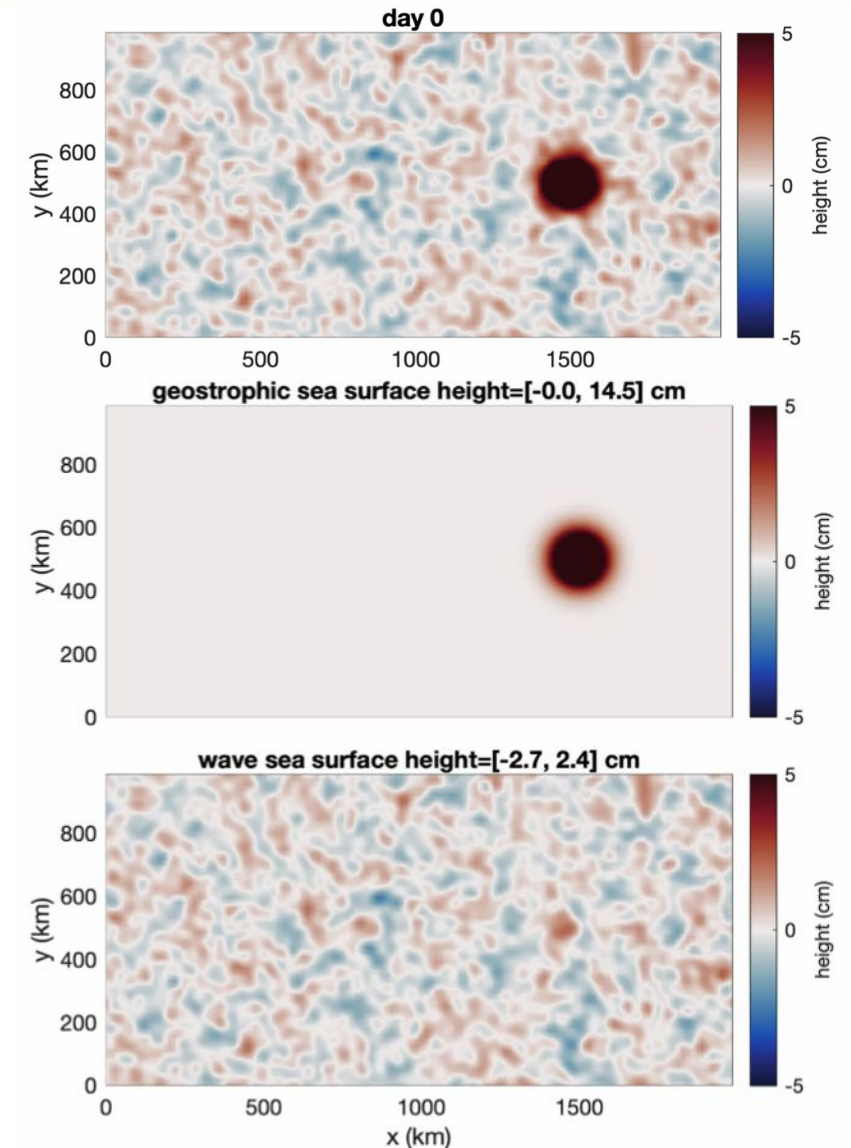
- **SWOT will transform how we tackle mesoscale and smaller science from altimetry. Where are we headed in the future with combinations of wide-swath and nadir altimetry?**
- **How do we use the better coverage in 2023-2026 to help interpret the historical 30-year mesoscale time series 1992-2022? ( improved corrections, improved mapping, interpretation of spatial distribution of variability, topography signature of eddies, fronts, internal waves, ...)**

# List of Talks

- 1) **Separating waves and eddies from sea surface height: theory, applications, and limitations** presented by Jeffrey Early
- 2) **The coupling of geostrophic currents to near-surface motions in mesoscale eddies** presented by Peter Gaube
- 3) **Evaluating SWOT's capability in observing small-scale (<100km) sea surface height** presented by Jinbo Wang
- 4) **From low resolution gridded altimetry maps to fine scales in KaRIn images** presented by Clément Ubelmann
- 5) **Inserting SWOT/KaRIn images in the multi-mission altimeter constellation products** presented by Yannice Faugeres
- 6) **The sea surface height spectrum of internal waves reconstructed from ADCP and altimetry** presented by Saulo Soares
- 7) **Optimal parameters for mapping alongtrack altimetry** presented by Jonathan Lilly (borrowed from another session)

# Separating waves and eddies from sea surface height: theory applications, and limitations presented by Jeffrey Early

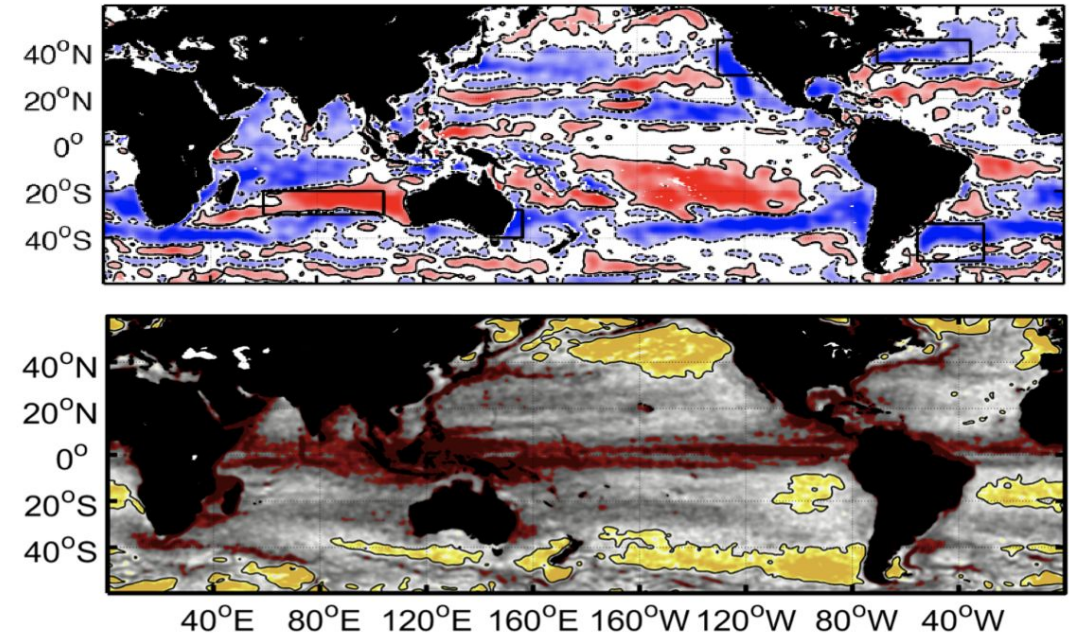
- Used a wave-vortex model to decompose dynamic fields
- Can be applied to SSH mapping, with similar applications in along track eddy detection
- Decomposition provides a method for inferring interior flow from SSH and SST



# The coupling of geostrophic currents to near-surface motions in mesoscale eddies presented by Peter Gaube

- Influence of mesoscale eddies on chlorophyll-a varies regionally and cannot be observed in many areas
- Both MLD and N2 modulate SSH which means we can use satellite SSH to compare interior ocean energy to surface inputs
- Density changes at the base of the mixed layer and MLD are the primary controls on the transfer of geostrophic energy from the ocean's interior to the surface
- In regions where wind energy input at the ocean's surface is greater than the geostrophic interior eddy, the signature is not always detectable at the surface
- The influence of density change at the base of the mixed layer and MLD in SSH allows for estimate of where eddies modulate currents from satellite observations

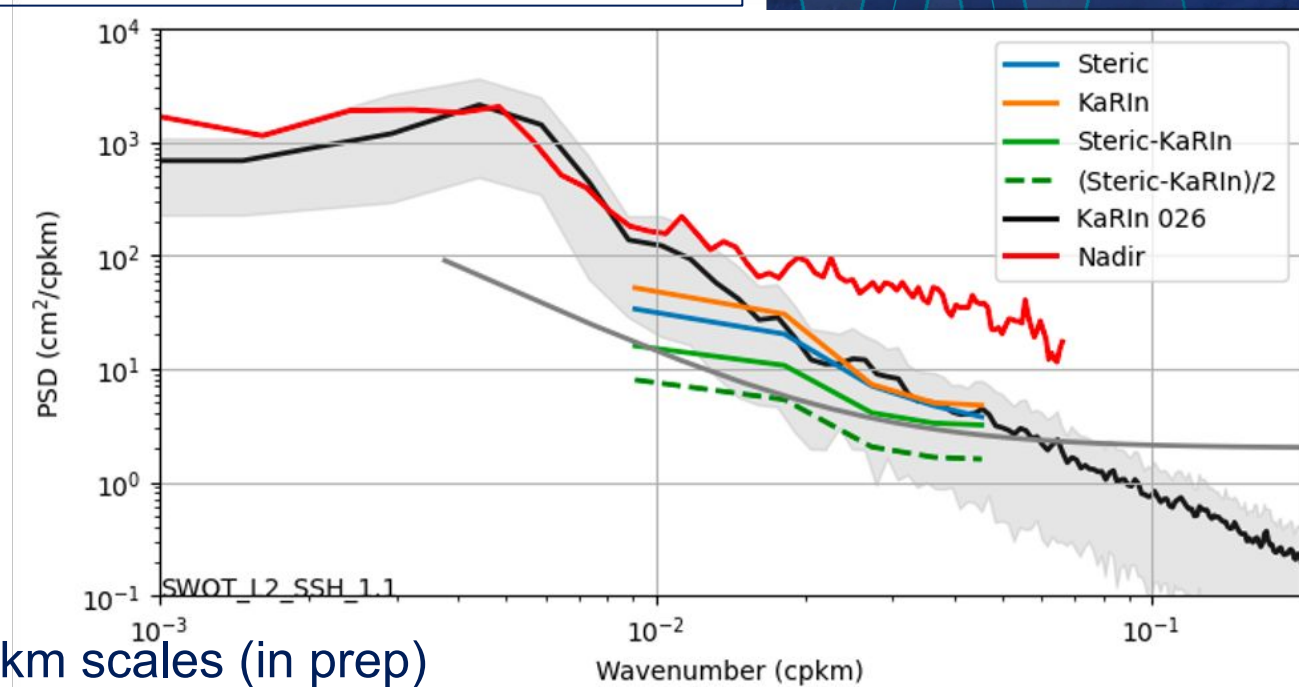
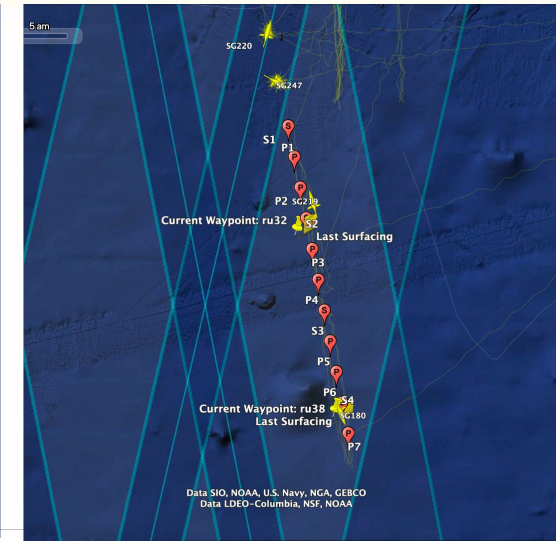
Comparing regions of large wind input to areas where eddies impact CHL



# Evaluating SWOT's capability in observing small-scale (<100km) sea surface height presented by Jinbo Wang

- The SWOT mission oceanography validation campaign was conducted during the fast sampling phase. 11 moorings and 2 gliders were deployed. The 11 moorings produce steric height of the upper ocean, which was used for validating the mission science requirement (gray line in the figure)
- The preliminary results show that the SWOT KaRIn meets the science requirement with an assumption that the in-situ measurements carry an equal error as SWOT. The confirmation is underway by the time of the OSTST.

Right: the location of the 11 moorings  
Bottom: the wavenumber spectrum of the SWOT science requirement (gray), mooring steric height (blue), KaRIn interpolated on the mooring location (orange), difference between SWOT and mooring (green), half of the difference (green dashed), nadir (red), KaRIn on the 2km grid (black)





# From low resolution gridded altimetry maps to fine scales in KaRIn images presented by Clément Ubelmann

- The new SWOT's Karin data feature exceptional consistency with the nadir data in the comparable range (80km-10,000km wavelength)
  - At shorter scales, Karin reveals short-to-sub-mesoscale eddies in motion, also many internal wave signatures, MSS signatures, ...
  - SWOT Karin images can be calibrated with very good consistency w.r.t. SWOT nadir (L2) and the existing nadir constellation (experimental L3 from the science team) :
- ready for high-level (mapping, data-assimilation...) applications

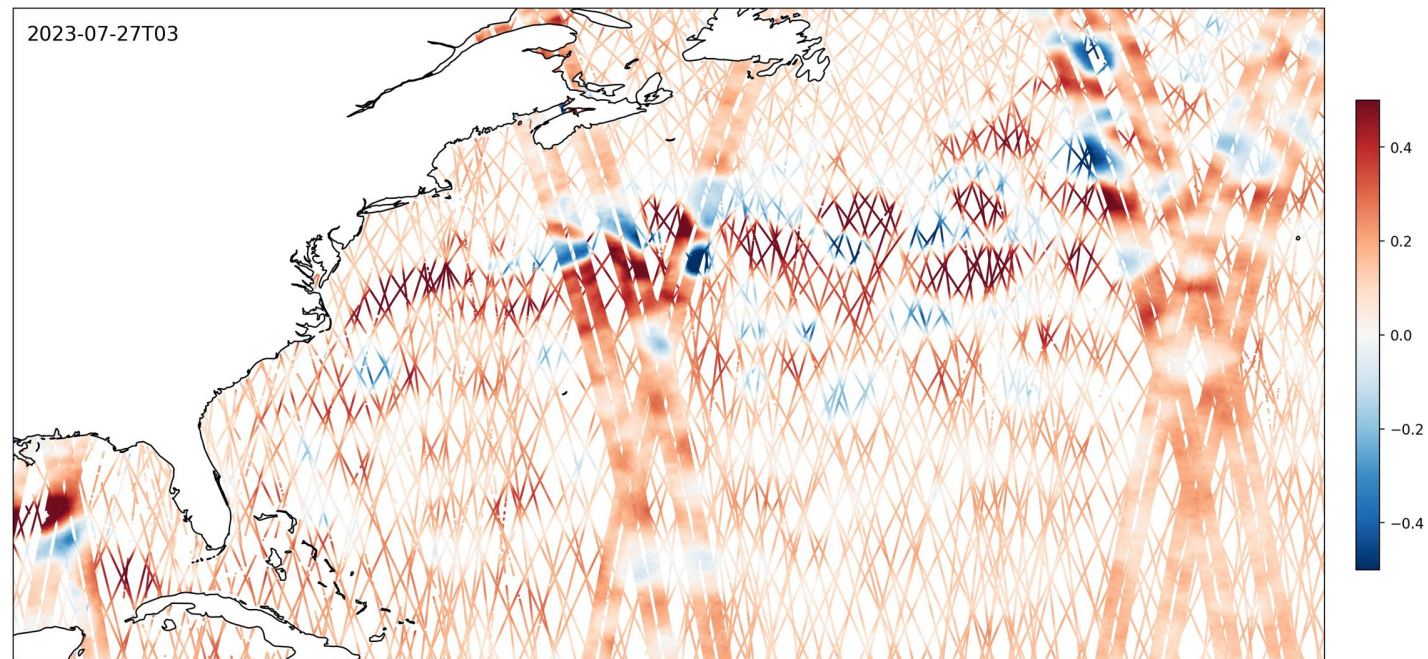
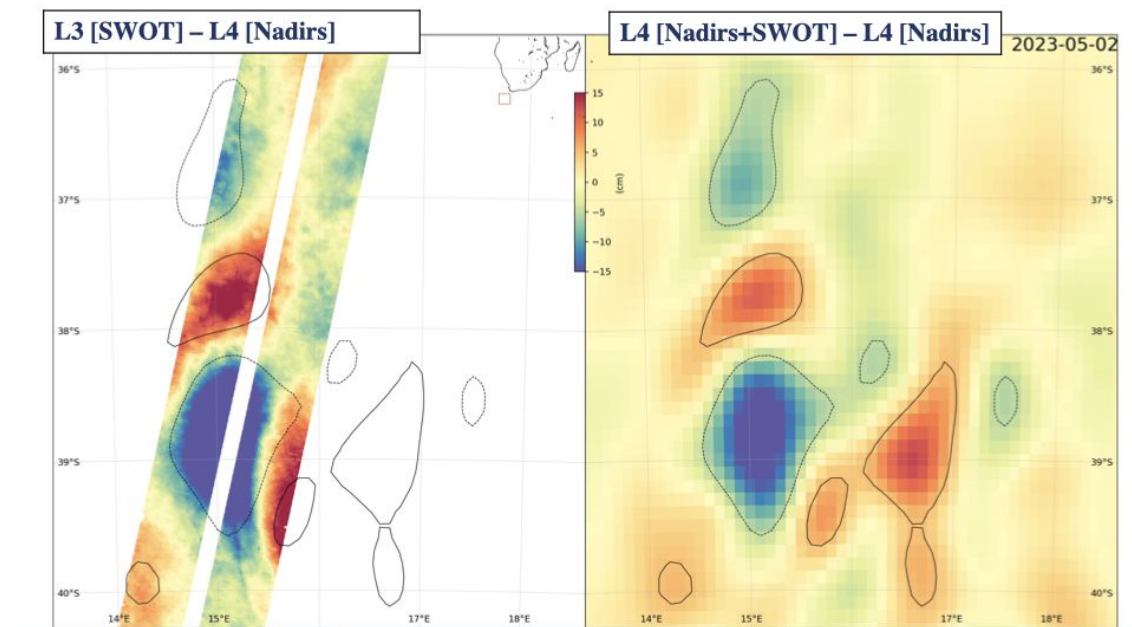


Illustration of SWOT Karin data calibrated with the nadir constellation

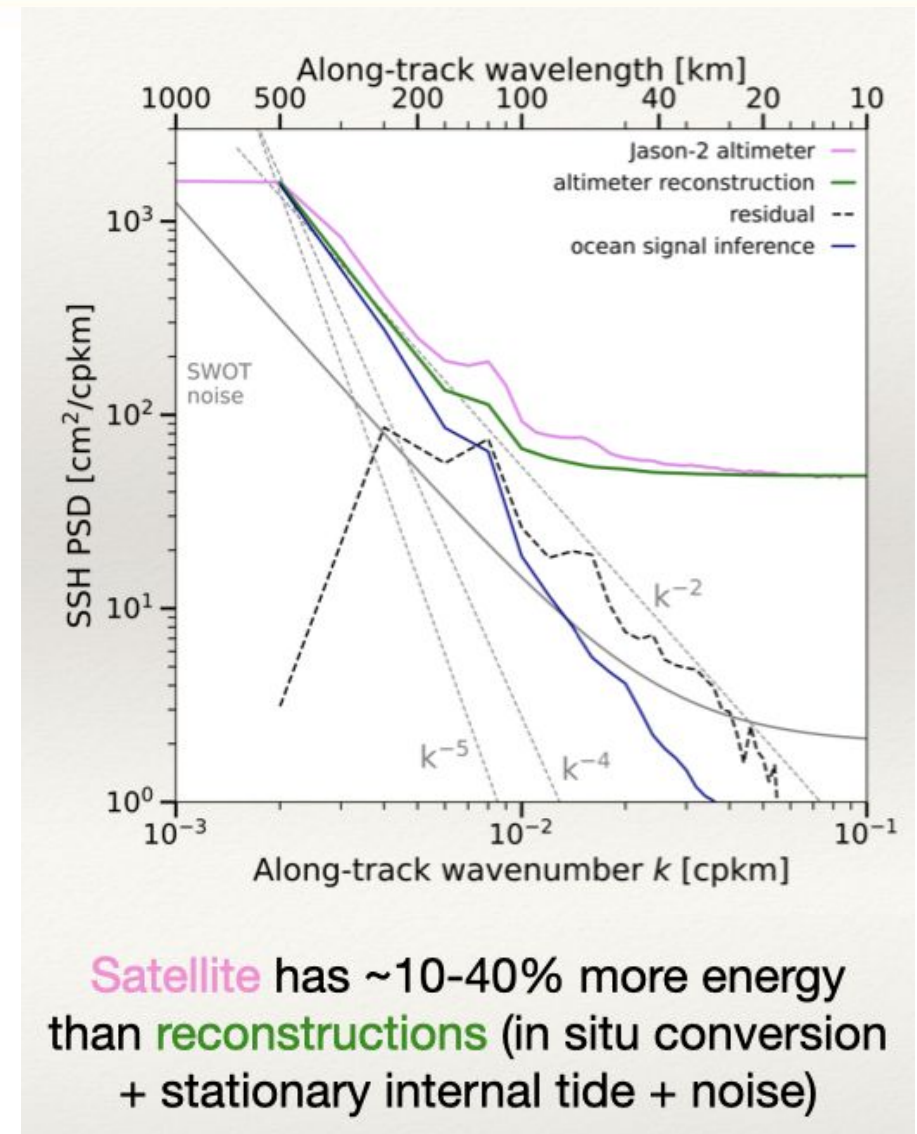
# Inserting SWOT/KaRIn images in the multi-mission altimeter constellation products presented by Yannice Faugere

- SWOT performance is excellent
- Highlighted work on incorporating SWOT data into mapping (MIOST & 4Dvarnet), and how SWOT best captures mesoscale and submesoscale structures
- Eddy merging/splitting events captured in SWOT that are missed in current blended products
- Systems behave well ingesting KaRIn data in addition to nadir data from the constellation
- Contribution of KaRIn is a 15-20% reduction in RMSE in energetic regions (8% elsewhere)



# The sea surface height spectrum of internal waves reconstructed from ADCP and altimetry presented by Saulo Soares

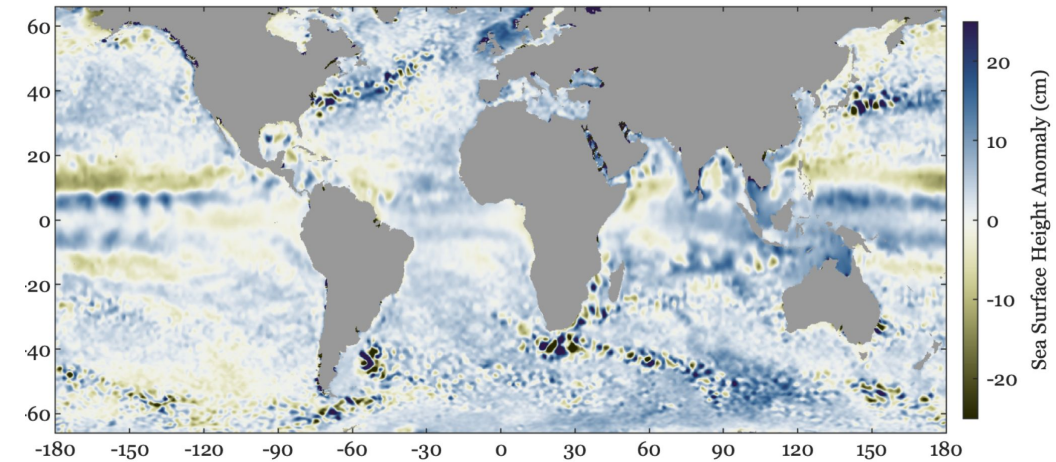
- It may be possible to use SWOT to study the internal wave continuum in the southeast tropical Pacific
- There are mostly internal waves in the tropics at meso/submesoscale
- Non-stationary internal tides arise as the largest signal when reconstructing SSH using in situ currents compared with altimetry, which overwhelms the continuum
- Methods used in this study can be applied to other global regions with sufficient ADCP transects, data to constrain the frequency spectrum, and a suitable internal wave model



# Optimal parameters for mapping alongtrack altimetry presented by Jonathan Lilly (as an encore from a previous session)

- Created an open-source gridded SSH product using polynomial fitting and Jason-3 data and added noise
- Jason-only maps rivaling current multimission gridded products suggests considerable room for improvement
- Method is particularly promising when dealing with highly heterogeneous data, e.g. SWOT + along-track
- Mesoscale activity (eddies, etc.) are where major inconsistencies are found between Jason-3 only system and multimission products

## Jason-Reconstructed SSH Anomaly



## Model Root-Mean-Square Variability

