1) What is the variability in eddy currents and the resulting impact on global climate and weather?

Resolving meso-scale and sub-meso-scale ocean dynamics using the WATER mission

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A better understanding of ocean circulation (including large scale and its role on climate) requires to observe and model it at high space and time resolution.

Resolving the mesoscale is also required for ecosystem modeling and for most of the operational oceanography applications (e.g. marine safety, pollution monitoring, offshore industry, fisheries).
Subsample $1/10^\circ$ model fields (sea level anomaly) along altimeter tracks. Add a random noise.

Use of a sub-optimal space/time mapping method to reconstruct the 2D sea level anomaly signal from simulated along-track data.

Compare the reconstructed fields with the reference (model) fields (sea level and velocity) => allows an estimation of the sea level and velocity mapping error

Add extra noise and compare the reconstructed fields with the 10-day average fields => allows an estimation of the mapping errors on 10-day average fields

Mapping capabilities of T/P+ERS

Simulations with the Los Alamos model

(Le Traon et al., 2001 and Le Traon and Dibarboure, 2002)
Sea level can be mapped with an accuracy of 5 to 10% of the signal variance.

Velocity mapping error from 20 to 40% of the signal variance.

A large part of the mapping errors is due to high frequency (< 20 days) and high wavenumbers signals. Errors on 10-day averages are much smaller.
Sub mesoscale ocean processes

Small-scale filaments (10-20 km) surrounding mesoscale eddies important for:

- advecting tracers (SST, chlorophyll)
- inducing strong vertical velocities > 25 m/day
- MLD changes - exchange of nutrient-rich deeper water with surface layer
- formation of mode and intermediate water masses
- Biogeochemical cycles

Very high resolution regional ocean models (1/20° or 5 km with 69 vertical levels)

1-day snapshots 7 Mar 2001 - spring

3-month cumulative averages over spring

Estimating the position of these filaments and transport barriers from traditional altimetry

**EULERIAN FIELD**
- Simple, instantaneous description
- Mesoscale structures only $O(100 \text{ km})$
- 2D maps of horizontal currents used to estimate lagrangian evolution of filaments $O(10 \text{ km})$

**LAGRANGIAN MANIFOLDS (FSLE)**
- Time-integrated structures
- Precise localization of transport barriers and filaments
- Mesoscale and submesoscale structures
Strengths and weaknesses

Lagrangian statistical techniques (FSLE, FTLE) have been developed to identify the positions of filaments and regions of intense mixing and stirring from mesoscale geostrophic current maps.

Smaller scale « mesoscale » movements missing from these gridded maps (30-150 km spatial resolution).

Manifolds let us map the evolving position of these filaments, but not their intensity or sea level structure.

Need finer resolution surface geostrophic currents for this!
Work in progress

Analysis of 1/54° resolution model from the Japanese Earth Simulator

Testing the colocalization between SST/CHL fronts and Lyapunov lines in an ideal case

Used to determine the minimum space and time scales required to accurately determine manifolds from gridded sea level data.

Early results: $O(4\ \text{days})$ and $O(25\ \text{km})$

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