Recommendations of priorities for future research

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Aim of the report

- To describe a research programme that can be carried out by a constellation of altimeters.
- What research we need to do into the use of constellations of altimeters
- This includes pre-operational oceanography

Did not consider

- Altimeter research not requiring a constellation
- Present operational applications

Based on user requirement from GAMBLE Workshops

Climate/ocean

- Can we measure mesoscale ocean variability?
- Can we measure barotropic ocean variability?
- Tidal issues, in particular tides at high latitudes and baroclinic tides.
- How are ocean parameters (sea level, wave height, …) going to change as the climate warms?
- Can altimetry contribute to the study of CO2 (and other gas) transfer in and out of the ocean?

Wave/Offshore - 1

- Accurate predictions of swell
- Better predictions of quickly evolving severe events.
- Better understanding of how rogue waves occur
- Improved statistics of extreme events.
- Are altimeter measurements of high winds and waves reliable?

Waves/Offshore - 2

- Better reliability in nowcasts and forecasts of surface and subsurface currents.
- Where are the major sources of error in wind/wave models?
- Can we measure wave steepness or breaking with altimeters? Are these related to structural damage?

Technical Issues

- How would a constellation of altimeters relate to GNSS reflectometry or to wide-swath altimeters?
- What are the prospects for cheap dual frequency or synthetic aperture Cryosat type altimeters?
- What impact will the measurement of the geoid by GRACE/GOCE have on the use of altimeter constellations?

What can constellations contribute?

- Constellations main contribution will be in the area of mapping the oceans
- Improved space/time sampling
- Better climatologies
- Identification of 'rare' events

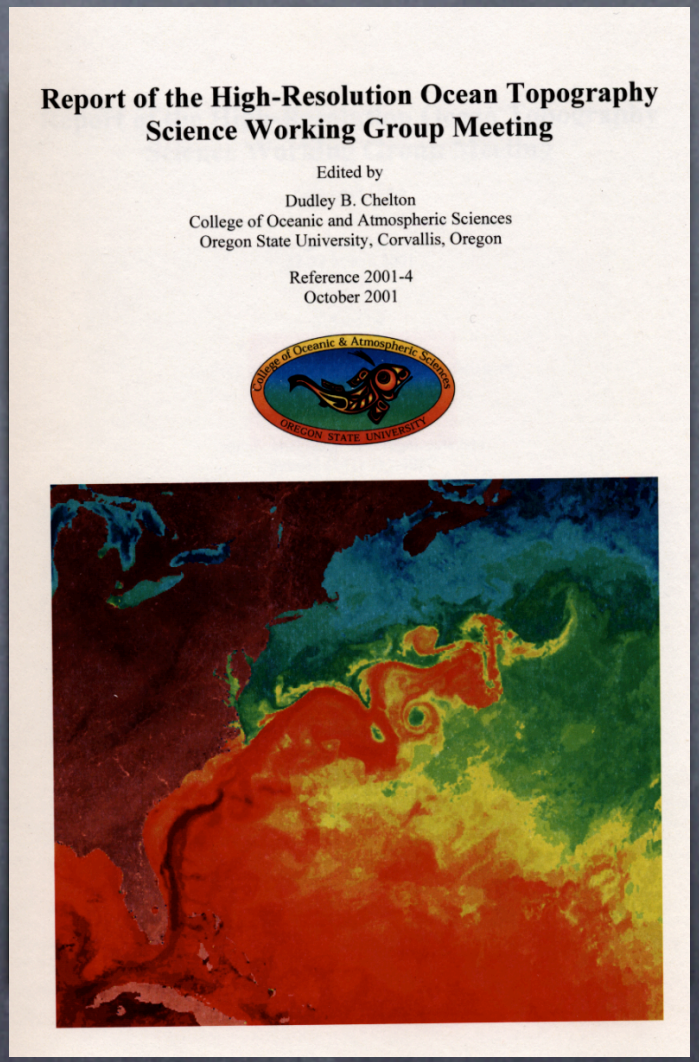
Structure of the Report

- Sea Surface Topography
- Sea State and Other Ocean Parameters

- Non-Ocean Applications
- Research into Constellations

High Resolution Ocean Topography Report

- Considers wide swath altimetry and small constellations
- Did not look at large (o10) constellations



- Coastal processes
- Mesoscale features
- Barotropic features
- Assimilation
- Feature Identification and Tracking

Sea State and Other Ocean Parameters

- Wave Climate
- Extremes
- New parameters

Wave Climate

- Altimetry has for the first time given us information on the global wave climate
- Currently the best resolution (ERS+T/P) we can muster is 1°x2°
- This is not unreasonable in the open ocean but is not sufficient in coastal or semi-enclosed seas or in 'interesting' areas
- Can we track swell and compare with wave models.
- Validation of wave models

Extremes

- An important application is the derivation of extreme wave statistics
- The sampling of the altimeter means that we rarely measure the true extremes
- Our estimates of 50-year return values for example are too low (10-15%)

Freak waves

- There is a lot of interest in 'freak' waves at the moment
- Can we detect freak waves (or extreme wave non-linearity) from altimeters (and map it)? (Sea state bias)

New parameters

- Wave period
- Precipitation
- Gas Transfer Velocity
- Wave breaking -> gas transfer(?)

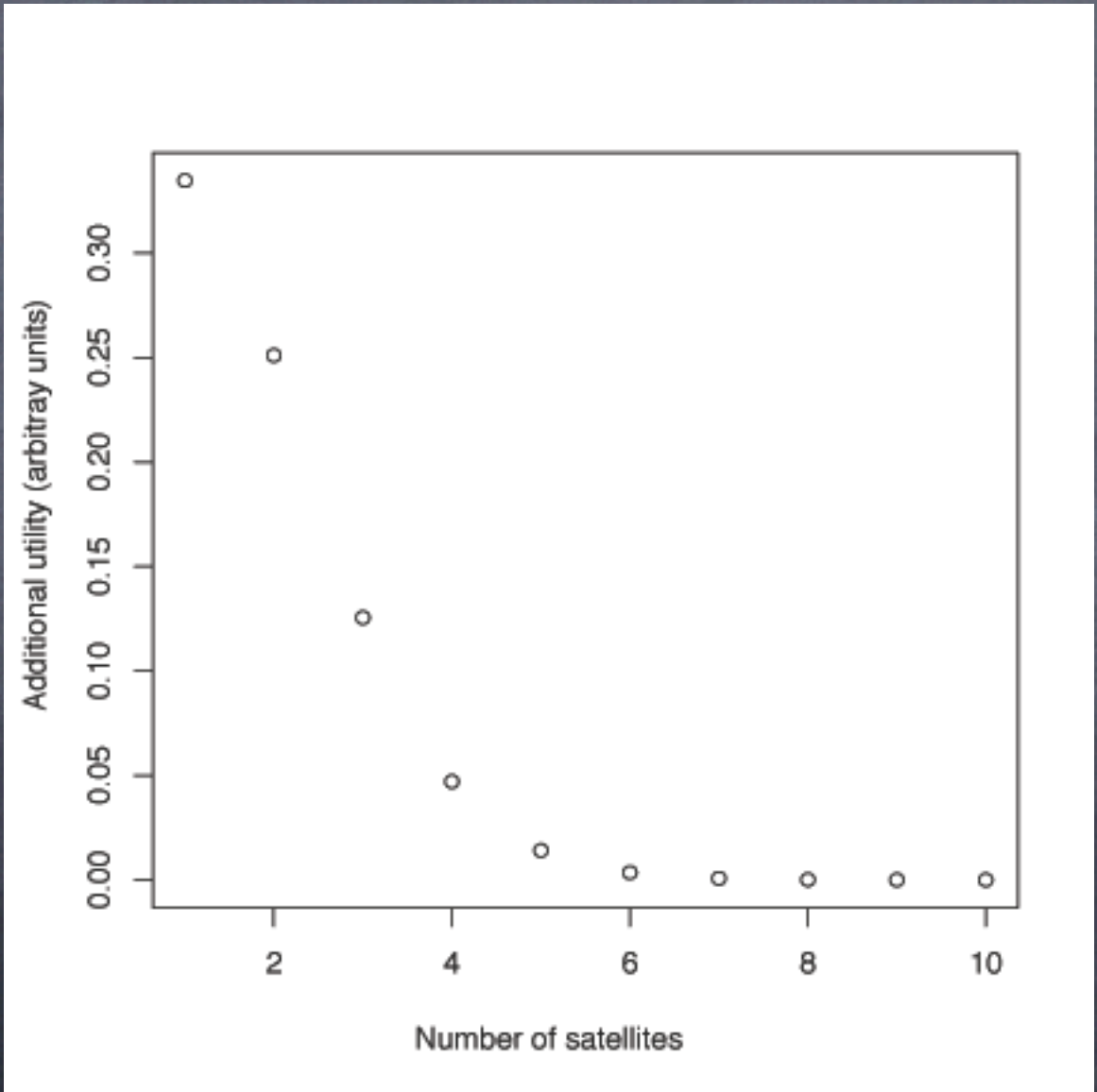
Non-Ocean Applications

- Land Ice
- Sea Ice
- Hydrology
- Land Topography

Research into constellations

- What are the cost savings for batch production?
- How many satellites do we need in a constellation?
- Answer will depend on what you are trying to measure. Studying the ocean mesoscale will require different numbers from extreme waves.

How many satellites?



- Some results presented this morning
- Almost all work on sea surface height and for small constellations
- Mixing different types of altimeters - wide swath, SWIMSAT-type, ...

Constellation degradation

- The flip side of constellation optimisation is constellation degradation
- What is the effect of losing one satellite?
- Is it sensible economically to put spares/ excess capacity into orbit?
- What is the reliability of an altimeter microsat?

Conclusions

- Over the last decade altimetry has gone from a scientific tool to an operational system
- The next step is to go to operational constellations used to support policy
- This will open up new areas of research
  - Sampling/mapping
- There is still work needed on constellation optimisation and reliability