Summary Report of the Second GODAE Symposium

1-3 November, St Petersburg, USA

BACKGROUND

The Second GODAE Symposium brought together the scientific community developing GODAE capacity and products with the existing and potential users and exploiters of those products. Based on the developers' knowledge of the capability and potential, and the users' views of what is useful and valuable, the aim was to develop specific actions that better attune GODAE to the needs of the user community, thus enabling that community to assess the extent to which GODAE is relevant to them.

Specific objectives included:

- To hear from, and learn to understand, the requirements of users for ocean information.
- To understand the role GODAE (and ocean prediction in the future) can, or might, play in satisfying the requirements.
- To develop an understanding of the modalities for working between these communities and forming mutually beneficial partnerships.
- To develop guidance concerning measures of effect, both objective in terms of GODAE system skill scores, and subjective in the form of evaluation and feedback.
- To identify high priority projects that should form the focus of GODAE during 2004-2007, and beyond.
- To identify issues that should be addressed by GODAE or its partners in the research community.

ORGANISATION OF THE SYMPOSIUM

The Symposium was arranged with two main Phases, with several plenary sessions for providing background, motivation and consolidation.

Phase A of the break-outs targeted *requirements* and discussed capabilities and product availability in six application areas.

Break-out 1: Natural hazards and coastal impacts, including climate
Break-out 2: Integrated coastal management
Break-out 3: Biogeochemistry, fisheries & ecosystem-based management
Break-out 4: Crisis management - Search & rescue and marine emergency response
Break-out 5: Risk management - industry, engineering, defence and other at-sea operations
Break-out 6: Climate assessment and the prediction of climate variability and change.

The focus for **Phase B** was the *response* to the needs and issues identified in phase A, with attention to implementation.

Break-out 7a: Regional applications and alliances
Break-out 7b: Regional extensions - special needs and capacity building
Break-out 8: GODAE: a response from the developers
Break-out 9: Service architecture and the business model

CONCLUSIONS FROM PHASE A ON REQUIREMENTS

The Symposium received reports from each of the break-out sessions and these are detailed below.

Natural hazards and coastal impacts

Types of requirements and response mechanisms

- Tropical cyclones, coastal storms, waves – meteorological forecast offices
- Sea-level variability and change (storm-surge to climate) – meteorological offices, climate and ecosystems research groups
- Coastal forecasting systems – meteorological offices, environmental and other research groups
- Ecosystem variability and change (algae blooms, coral bleaching) – environmental protection agencies, coastal management agencies (international to local level)

Operational ocean products needed by users

- Daily 3-D Analyses/Forecasts of sea-level height, U, V, Salinity, T - on native grids; some fields might be needed at higher than daily frequency
- Sea level heights
- Re-analysis fields of model state variables
- Toolboxes for nesting, coupling, downscaling
- Some ancillary fields (barotropic tides) might be needed
- 6 hourly forcing by atmospheric data is inadequate - increase to hourly if possible
- Process information for sea-level rise - is rise due to ice melting or ocean warming?
- Model configuration details provided - especially topography
- Error/uncertainty estimation (perhaps from ensembles)

Distribution

- Data format standards need to be better defined
- Timeliness requirements are variable by application - 1 hour for oil spills; - 6 hourly for tropical cyclones; - daily or longer for others
- Must be non-aliased (time averaged)
- Archive of real-time analyses/forecasts and re-analyses
- Dissemination capacity for low-bandwidth users

Verification

- Users might provide indirect verification - TC forecasts, algae bloom predictions, coastal model improvements
- Accuracy requirements from users - probably from intermediate users

- Model/data and model/model inter-comparisons- results should be openly accessible; vertical velocity should be included in inter-comparison

Integrated coastal management

Though the title placed the focus on integrated coastal management, the discussions were more aligned with coastal GOOS and associated users. There is a logical 4-step path from GODAE to coastal users:

→ Coastal GOOS/local/regional consortia → Intermediate/value-adding users → end-users

GODAE needs to work with Coastal GOOS as well as coastal intermediate users and end-users to define coastal products, delivery paths, benefits, etc.

Needs

There is a need to distinguish direct coastal needs for operational ocean products, and coastal GOOS needs for such products. There is also the reverse process of coastal GOOS providing products to GODAE.

Data products

Some ocean data products may have direct coastal use. Data products near continental margins will undoubtedly be useful, even essential, for coastal models. There will likely be a need to modify GOOS basin-scale observing systems near margins to meet coastal needs. Coastal requires biogeochemical and potentially ecological data at basin scales – this will require an extension to existing physical observing systems. Coastal uses require both real-time and delayed / reanalysis products. Coastal GOOS will develop coastal observing systems and data products – CODAR, gliders, moorings, etc spanning physics, biogeochemistry, ecology. Need interoperable coastal and global databases, common standards and compliant / compatible data and model products.

High-resolution model products

Coastal users require very high-resolution model products, to tens or hundreds of metres. These will likely require several levels of nesting below eddy-resolving models. Over the long run, this is a coastal GOOS responsibility, and requires access to operational model output. In the short term, development of nested (data-assimilating) coastal models is proceeding in many locations. It is possible to imagine these being organized under the banner of a Coastal Ocean Data Assimilation Experiment (CODAE). There will need to be discussion about timely access to 4-D model output. The requirements for accuracy, quality of model output as boundary conditions for coastal models need to be established and related to performance requirements on coastal model output.

Coastal users want:

Storm surge and wave prediction, models linking estuaries to offshore, early warning of Harmful Algal Blooms (HABs), downscaling of large scale climate variability (e.g. NAO) and climate change to coastal impacts, links to zooplankton and fish, high-resolution hydrodynamic models for coastal navigation and hazard, sediment transport and turbidity, advance warning of environmental impacts / events.

Within the GODAE time frame, it is feasible to expect to see coastal physical models, coupled to GODAE models, providing users with products addressing storm surge and wave prediction, inshore-offshore links and downscaling of climate change and variability, and coastal navigation and hazard. This must carry over into the JCOMM operational environment.

In the long term, coastal user needs require to go beyond physics to biogeochemistry and ecology. This implies basin-scale biogeochemical models to provide boundary conditions for these.

A key coastal community need with very large monetary benefit for both public and private sectors (businesses, utilities) is for more accurate prediction of local weather and ocean conditions near coastal cities. This will be a value-added product derived from operational ocean outputs through weather services or other intermediate users.

Lower resolution climate products

Coastal communities want to address climate impacts at very fine scales. Eddy-resolving models are a key link in downscaling climate variability and climate change models / scenarios to coastal scales in space and time.

Re-analysis products

Coastal users have near-real time needs, but for coastal management and planning, model scenarios and hindcasts are critical. Planners need to understand impacts of development under full range of climate / ocean variability, and future climate change. They need to rerun coastal models many times under different development scenarios (implies nested models rather than single cross-scale models).

In most cases, coastal managers lack the long-term time series of coastal observations they need. Is it possible to hindcasts and nested models to simulate these observations realistically? Regional evaluation of hindcasts using the available historical datasets will be important to assess their realism / accuracy.

Dialogue and review with user community.

GODAE/JCOMM cannot interact efficiently with diverse coastal end-users, or even with many coastal GOOS local consortia. How should a dialogue be set up so common needs, issues, can be identified? This requires some form of nested hierarchical two-way communication. It requires brokers who can interact across scales and diverse user groups. For example, private or public intermediate users / value adders may develop assessments of specific coastal user needs and product specification across national or international groups. What is the vehicle for GODAE/JCOMM to interact with coastal GOOS consortia, and identify their needs, and R&D challenges for both GODAE and coastal GOOS? Do we need a CODAE?

Marine ecosystems management: fisheries and biogeochemistry

General

GODAE may move actively towards ecosystem modeling and include this goal within its mandate. This will involve developing models with living marine resources (thus providing products for users) and form partnerships with others (e.g. IMBER, LOICZ, GLOBEC, GEOHAB) to develop and apply assimilation techniques for ecosystem models.

Fishing needs – There is a growing need for all types of 'oceanographic' information from short (week) to long (seasonal and interdecadal) time scales. Many different products are required (covering full range of product lines) from data synthesis, hindcast runs and operational models. Users are using ecosystem information to understand trends in productivity.

Extreme events – The most important ecosystem information for the general public good may be on extreme ecosystem events since they will have the greatest impact. Globally Harmful Algal Blooms (HABs) provide a clear example (other examples include Baltic, Cook Island)**Real-time data** – Aquaculturists, for example, need in situ data and remote sensed data to provide warning on extreme conditions for operational use.

Real–time model results – Need for real-time model output for decision support system for fisheries (User groups in fisheries include Fishing Managers, Fishing Industry, Consultant Companies, NGO's and Government Agencies)

Near-real time - Information (data, model output) is required on longer time-scales to adjust fishing practices and for management decisions in the coastal zone (e.g. pollution events).

ReAnalysis products – Retrospective analysis and integrated data sets are crucial for interpreting the long-time series of fisheries information and for making decisions.**Data types –** Circulation fields (e.g. transects and particle retention), T, S, turbulence, oxygen levels, light levels, mixed-layer depth, plankton and zooplankton, fish larvae (?)

Model scales – May require global or basin scale models that have simplified ecosystem structure in which more detailed ecosystem models (e.g. coastal models or upwelling zones including species specific dynamics) are nested. Trick how to downscale to the inner shelf coastal applications (such as aquaculture)

ReAnalysis and hindcast times - The most important timetable for retrospective reanalysis of data and hindcasting goes back to 1950 – modern period is the most crucial.

Assimilation matching - Need to ensure that the data collected, and used for assimilation with the models, represent the right aspects of ecosystem dynamics to make the model most useful for the users. This is a research issue.he need

Specific verification - Each 'product' must be tested (locally) against the requirement of its defined user need. It is not simply possible to test the 'generic' model but is necessary to know what 'type' of output is required by the user and in what form. Benchmarks and verification are important to ensure data quality and gain trust of users.

Translation – GODAE should help to make the products understandable to the users, making vast amounts of information useful and more easily understandable. Ease of access is also important. Communications with new users may be difficult.

Dialogue - Some simple results of data already in use would require relatively little discussion for development but in general development of useful products will require many local and regional bi-lateral and multi-lateral discussions between developers and users. General strategic support could probably be provided by GODAE, but perhaps only at strategic level.

Partnerships – For the development of new ecosystem models, GODAE has been encouraged to form partnerships with other major ecosystem programs, e.g. IMBER, GLOBEC, LOICZ, GEOHAB. One key issue is to match assimilation (data type and approach) with the model dynamics (more of an issue with ecosystem models).

Fishing requirements – Use of ecosystem information in fisheries is growing quickly as is the sophistication of the use community (the receptor capacity). Users are just learning how to use these new 'products'. There is an immediate demand easy and better access to existing products - easing the access issue would be very helpful.

Payoff – Most of the payoff will be for the broader public benefit (with some operational exceptions, e.g. fishing practice and aquaculture) as the economic benefit may take a long time to demonstrate.

Uneven capacity – The developed world has much greater capacity and the potential for use of data elsewhere is much more limited. Potential for use is uneven. This points to the need for capacity building. There is also uneven capacity among disciplines.

Carbon cycle – Requirement by scientific and government community for better ecosystem models one of the key limiters for making scenario predictions

Ocean impacts growing – The trend line is clearly for growing anthropogenic ocean impacts leading to the need for better management and for mitigation

Specific examples

Pearl farming – Cook Islands - particular physical conditions trigger oyster mortality, need warning of extreme conditions, requires in situ monitoring and model products**,** requires data in real-time and model forecast in short time-scales (5-10 day)

Coral bleaching - predictions of extreme temperature events will enable predictions of possible coral bleaching.

Crisis management – search and rescue and marine emergency response

What can GODAE provide?

(i) Operational ocean products can provide substantial improvement to the operational decisions for crisis management. If properly used (namely fully integrated to the existing response tools and procedures), such products should help improve the response.

(ii) Accessibility, reliability and timeliness are important. Crisis management operations always require an answer in minutes to hours for SAR & hours to days for spills. Therefore any product useful to the forecast must have guaranteed availability.

(iii) Data and model output should come with specifications of its refresh rate, timeliness, estimate uncertainties. Uncertainties ideally should be given as a function of lead time, space and variables. Contact and human expertise on the details of product preparation (parameterizations, forcing functions…) and their (objective and subjective) quality is important.

(iv) Hourly data for the next 24 hours should be a goal, and the daily update after will be important. Data are needed in a window of 1 week on each side. These data may be used directly or to drive local ocean models. There is a need to have access in real time to full 3D fields & subsets of these fields.

(v) Product format is not critical as long as it is consistent, well defined and allows for easy extraction of subsets of the data. The proper definition of the interface (in terms of content and procedures) is critical.

(vi) GODAE/JCOMM should work with the "middle" users and adapt the answers to meet the needs of these different users. Needed products depend on the system used to compute drift forecasts. Most important outputs are: 1.Boundary conditions for nested models; 2.Time dependent 2 or 3D standard variables or derived products (current & elevation, sea temperature, salinity...).

Risk management – industry, engineering, defence, maritime safety and other at-sea operations

User needs

- Uncertainty estimates - essential for both analyses and forecasts
- All politics, weather, etc. …. Products for this risk management sector are local
- Physical oceanographic variables are of primary interest. Customer requirements are best articulated by the middle users (still missing direct involvement with end users).
- Forecasts, nowcasts, and hindcasts - all are needed – forecast periods from a few hours to as far out as possible
- Delivery refresh rates range from several times per day to once/week

What needs to be provided?

- A number of government and commercial "middle users" are already "doing operational oceanography, but not in a consistent framework and not in a "Commons" area. Useful "Commons" activities include: real-time data assembly

and dissemination; agreed upon uncertainty metrics; provision of techniques and methodologies as well as products
- Observational Strategies: provide rationale for operational observing system design(s); demonstrate utility of current observing systems; work on getting nations to allow deployment of Argo floats in EEZ's and marginal seas; adaptive sampling guidance, strategy, methodology
- Lateral boundary conditions for nests: must be coordination between supplying and receiving systems (e.g. two-way coupling)

Data delivery formats and archives

- GIS-compatible
- tools that enable easy transition/transfer/ conversion between a number of agreed upon formats
- compatibility of products with web services
- Metadata - whatever data standards are adopted must incorporate metadata flexibility
- Archive all observations
- Archive initial conditions/analyses
- Archive recent forecasts in order to see "recent" model trends ("recent" needs to be defined in operational terms not science terms)

Concerns

- What happens when there is a gap in altimetry?
- How can we take advantage of emerging observation systems (gliders, CODAR, modernized VOS program) and manage the possible disappearance of others?

Climate assessment and the prediction of climate variability and change

The break-out produced the following short list of requirements and possible follow-up actions:

- Define uncertainty of climate analysis/reanalysis products through intercomparison to facilitate applications.
- Shed light on additional observations needed through product intercomparison (e.g., to identify areas that the products differ significantly and that have insufficient observations for validation).
- Data infrastructure: serving processed data of different quality-control levels; quantification of "data errors".
- Exploration of climate applications for real-time meso-scale products.
- Seasonal-interannual predictability studies.
- Observing system sensitivity experiments (OSSE).
- Surface forcing comparison.
- Improvement of model errors.
- Budget outputs.

RESPONSE TO THE NEEDS

Regional alliances and applications

Short term actions

- GODAE should facilitate the demonstration of utility by moving into a mode of operation in which it can deliver products for operational use by the regions (i.e. timely delivery of products of known accuracy and spatial-temporal resolutions appropriate for regional applications)
- GODAE should extend the GODAE Common to the regions by sharing expertise in data assimilation, nesting and coupling, data management and distribution, observing system design and definition of internal and external metrics.
- GODAE should foster and facilitate access to 3D model fields for regional modellers so they can define their offshore boundary conditions and thereby assess the utility of GODAE products
- GODAE should demonstrate and document the utility of their deep ocean products (incl. hindcasts) through partnerships with some existing regional projects

Long term actions:

- GODAE should support GOOS and JCOMM in planning a coastal version of GODAE (CODAE) which could include a few focused pilot projects, and extend the concept of the GODAE Common to the regions.
- CODAE will focus on downscaling of global models to the regions and coastal zones, and the generation of useful products. It will also assess the improvement in forecast skill resulting from coupling of regional and deep ocean models
    - ⇒ The CODAE Common will include shared data and methods/tools for data distribution, data assimilation, nesting and coupled models to be used by the coastal modelling community.
    - ⇒ Recognise and build on the considerable existing effort in developing and implementing nested coastal models.
    - ⇒ Focus initially on coupled circulation models, but extend to include biogeochemical/ecological models.
    - ⇒ Develop and test techniques for coastal observing system design.
    - ⇒ Quantitatively measure the improvement in performance resulting from data assimilation and nesting coastal models in GODAE global/basin models, in terms of both increased realism and accuracy, and increased utility of end-user products.

Regional extensions - special needs and capacity building

Philosophy

- People in the regions themselves are best placed to say what the specific needs are
- Build capacity through projects addressing the highest priority needs
- Only win-win partnerships are worth considering

Capacity Building Techniques

- We have knowledge/experience about what techniques are effective
- List of preferred techniques
  (1) External expert visits region
  (2) Training courses to back up any equipment or software
  (3) …

Specific needs identified during break-out

1. Surface wave forecasts for safety at sea (ACMAD)
2. Support for pearl fisheries (surface waves, SST, surface currents ?) (Fiji)
3. Monitoring of Indonesian Throughflow (Indonesia)
4. Improved storm surge forecasts (Barbados)
5. Development of shelf/coastal forecasting systems (Brazil, Thailand)
6. Greater independence in sediment transport modelling (Barbados)

Pilot projects

- Scoped out properly
  ⇒ previous work/lessons examined
  ⇒ size and boundaries of task made clear
  ⇒ participants finalised after issues examined

- Funded properly
  ⇒ heroic efforts in the margins rarely appropriate
  ⇒ 50/50 UN / National contributions ?

Project 1: Improved access to met/ocean and GODAE surface forecasts

Issues:

- Access – "political"
- Access – technical / appropriate to infrastructure
- Dissemination – harder (should this be in scope)
- Must examine previous work (e.g. in WMO / JCOMM)

1. Surface wave forecasts for safety at sea (ACMAD)
2. Support for pearl fisheries: surface waves, SST, surface currents ? (Fiji)

? Support for safety of W Indian fishing fleet

Project 2: Monitoring and assessment of climate change

3. Monitoring of Indonesian Throughflow

? Extending Argo system into S Pacific (SOPAC)
  - Access to EEZs
  - Access to seasonal forecasts

- Access to models suitable for simulations of regional climate change (e.g. PRECIS)
- Training courses (on use/interpretation of model results)

Project 3: Development of regional forecasting capabilities

4. Improved storm surge forecasts (Barbados)
5. Development of shelf/coastal forecasting systems (Brazil, Thailand)
6. Greater independence in sediment transport modelling (Barbados)
   - High resolution regional models are becoming feasible on modest computers Tools developed in GODAE (OpenDAP) make transfers of surface fluxes and boundary data for small areas feasible
   - Trend for models to be free-ware
   - Training courses (on use/interpretation of models)

Service architecture and the business model

Business model

The Existing GODAE model

- GODAE common
- Patrons
- Middle users and brokers

The post-GODAE model is

- JCOMM and analogies to WWW/GDPS
- Shared data common
- Long-term observing system maintenance
- Agencies for product preparation
- Users – direct and middle

Issues and discussion points

- Priority user requirements from Breakouts A
- Business model to maximise user participation
- Service architecture to support the model
- Socio-economic impact studies and the business case
- Optimising Long-term observing system maintenance
- Quantitative monitoring of quality, impact and success
- Classification of requirements for an international system
- Structure of the business interfaces with direct and middle users
- Will the same interface structure apply for both developed and developing countries?

Developing the GODAE Business Model / Case

- International GODAE needed for oversight mechanism => standards, formats, quality, etc – quality assurance for users, support for developing countries
- Business case for GODAE must be made Nationally (regionally - European)

- Address national /local economic and development goals

GODAE needs Partnerships (NMS, other government agencies, middle users)

- to grow new products and activities
- to built the business case : GODAE providers cannot do this alone
- Results and indicators needed to support the business case: involve middle users in process surveys, product specific, case studies, web based monitoring
- Target specific partnerships and indicators for domain, in-country expertise
- Need to justify national infrastructures for by societal benefits eg. Standards in marine planning
- Listen to users: from govt. as well as middle users eg. Extending weather forecasts by GODAE products and methods is adding value

Justifying the observation system long-term

- Need to get the business case for this right
- Is the existing system meeting existing requirements?
- What are societal/economic benefits vs specific elements and possible enhancements?
- Is the system sufficient and appropriate to quantify uncertainty and risk for users (govt. and middle users)?

What more can International GODAE do to strengthen these business case activities?

- International structure required: Formal product centres most useful for developing countries. Also helps to maintain national funding and to raise the profile of model analysis data

Service architecture

Objectives

- Model for common or standardized architecture
- General guiding principles
- Steps to achieve this

Service architecture

Issues and discussion points

- Standardized formats for data access
- Standardized metadata formats
- Standardized user interfaces for product servers
- Technology future look
- Interoperability with the GIS community
- Interoperability with regional and local systems

- Standardized formats for products
- Product and service nomenclature

Standardization for Services

Partnerships needed for standardization process

- GODAE work with JCOMM, Users and OGC and appropriate fora to set appropriate standards

Metadata standards most important

- More effort needed with GIS community. Sufficient metadata to fit GIS metadata models a current barrier
- More work to influence GIS community to take GODAE needs on board
- Users have requirements on metadata: More work needed to identify these
- Need to: Standardize metadata; Create metadata; Discovery tools based on metadata to be successful
- Need standard data delivery format for data products eg. NetCDF. Does not need to be exclusive. Users need to know it will be there

Avoid keeping multiple copies of data. Avoid loosing information in standardizing process

- Not necessarily ready to define what standard data structures are. More work needed

Future Technology: Unstructured Mesh modelling. Spatial databases instead of files

GODAE is recognized as a distributed and heterogeneous community. This community should be aware of and encourage technology developments while ensuring the maintenance of interoperability. The successors to GODAE will need to develop a rolling implementation plan, with the wider

GODAE: a response from the developers

The initial response had three parts:

- The **Products** catalog (system, data production)
- The **Distribution** organisation& tools (formats, operational, delayed time)
- The **Service** effort (assessment, from data to « knowledge »)

In establishing the **Priorities**, need to consider the feasibility and scope

- Mandatory (before end of demonstration phase)
- Short-term (during consolidation phase)
- Long-Term (after consolidation phase)
- Out of scope

The GODAE Framework

Physics:

- Temperature & Salinity and currents & elevation

Scales:

- Mesoscale at Basin-Scale
- Low resolution at Global scale

Systems developed:

- Monitoring & Forecasting Systems (Assimilative Model based)
- Data Servers (accessing the obs and model data)

Products available:

- Line #1: Observations
- Line #2: NRT Mesoscale Monitoring & Forecast
- Line #3: NRT Low Resolution Global Ocean Monitoring
- Line #4: Reanalysis

Service available:

- Delayed mode and Near Real Time (NRT) access to Large Ocean Monitoring and Forecasting
- OBS DATA : in situ and satellite observations : daily to weekly updates
- MODEL DATA : daily fields, daily to weekly updates, forecast up to 14 days.
- Delayed Mode access to System/System Assessment results : « Metrics »

Ad hoc Collaborations

- Coupling Ecosystem models, Coastal Models, Oil Spill drift models, etc

The Products

Climate indicators

- 1993-present Reanalysis and Hindcast simulations : mandatory/short-term
- Metrics and indices ; new fluxes « variables » online ?
- Collaboration with CLIVAR - The reanalysis meeting

Error bars

- Confidence indices ? Real-time and historical
- Mandatory : internal consistency indices (derived from « metrics » of the different GODAE systems running, data network). A kind of ensemble approach
- Short or Long Term : Error bars from advanced assimilation methods

Ecosystems

- Mandatory : GODAE to provide needed fluxes to enable offline or online ecosystem coupling
- Coupling with simplified (short-term) and complex (long-term) ecosystem model

Weather prediction

- assessment of GODAE systems SST (compared to SST presently used in met centers)
- Pilot Project (ocean/atm data assimilative coupling)

Coastal & downscaling

- Toolboxes (grid transformation, …)
- select demonstration cases ('pilot projects')

High frequencies (hour-day)

- Consider storage stategies (daily on a 1 week / 1 week window ; hourly for 24h forecast) ; consider different strategies for different variables ?
- Consider ancillary model data ?

Distribution

- Standards & Access to data
  - Continue and reinforce the standardization effort : format, metadata, grids, ..
  - Specific cases : Native grids for coastal
  - Toolbox to extract the needed info
- Operational vs Best effort, Robustness
  - Will depend on the centers (take into account institutional constraints), but has to satisfy minimum GODAE label requirements
- Storage
  - Define what to store ; issue with memory

Service

- Data Delivery
- Information
  - Products interpretation
- Assessment
  - Error bar
- Impact studies
  - 'what if' scenarios, sampling strategies, OSSE's, (e.g. impact of specific data assimilation on boundary conditions used by regional models)

SYNOPSIS AND SUMMARY

General

A Reality Check

- Only partly reached the real user community
  ⇒ Optimistic analysis of relevance
  ⇒ Converted talking to converted

Participation and structure

- Level of engagement excellent
- Leadership of Conveners outstanding
- Perhaps missed outlet for science and technology
- Perhaps partly missed focus on observing system
- Did need to consider climate issues

Political (people) recognition

- Relevance to the system-of-systems approach
- Relevance to sustainable development
- GODAE plus Coastal can deliver

GODAE maps well onto national approaches

- Avoids conflict of purpose, structures

Middle-users, value-adders

- Confirmed strategy but with adaptations: not formulaic
- Objective: to create opportunity for business/private sector: partnerships

Trying to be more business-like

- Business case and future clearer
- Business model needs further elaboration and clarification

Observing system

- Recognizing the system
- But recognition of the inputs

Basics

Fundamental approach of GODAE was not challenged

- Good advice on applications, priority
- Global community approach reinforced
- Non-global drivers dominate in terms of applications

GODAE Common and Patrons

- Has maintained focus on relevance (direct)
- Has delivered effectiveness
- Exportable? CODAE and others like this approach.

Product Lines

- Pressure on timeliness and temporal resolution
- Quality: “fitness for purpose”
- Interfaces
- Confirmed priority on hindcasts and re-analyses
- Tool boxes

- Responsible for core

⇒ ***GODAE should facilitate the demonstration of utility by moving into a mode of operation in which it can deliver products for operational use by the regions***

Applications

Before:

- Ocean mesoscale and short-range forecasts
- Coastal
- Seasonal-to-Interannual
- Climate Change

After:

- Public good ocean and coastal services
- Coastal (CODAE concept)
- Open-ocean (ecosystem, …)
- Weather and hazard prediction
- Seasonal and longer-term climate
- Scientific and technical

Very broad drivers in detail

- Priorities vary nationally, regionally

Service architecture

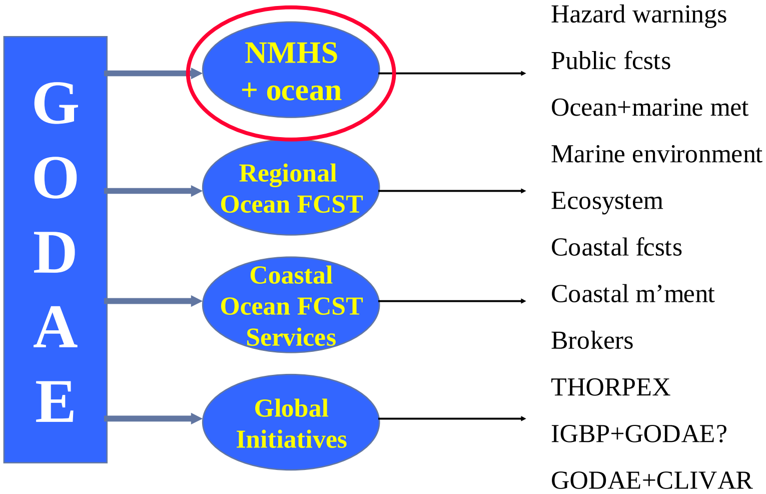
Data and information services

- Priority confirmed and enhanced
- Information services may be weakness – GUI (G=GODAE)
- Our “industry” standard
- Open GIS links; web services
- Metadata stds

Benchmarks

- For product lines
- For information delivery
- For interfaces

Service architecture



Communication

Questions posed about the appropriate forums for communication with users.

- Symposia work well for some, not others
- Many have enjoyed this opportunity: formalised forum?
- Knowledge of our “market place” remains too vague
- Communication strategy?

GODAE “Help”

- Better information on availability
- Better response mechanism
- The user interface

Promotion

- With supporting organisations
- With partners
- With user community
- Presently a weakness

Scientific Issues

Estimates of uncertainty

- Intercomparisons have key role

Ensembles

- Scientific
- User aspects

Predictability for sub-systems

- Nested coupling (1- and 2-way)

Extreme ocean events

- Had not received a great deal of attention (are now!)

Observing system

- Design
- New technology
- Adaptive, esp. for crisis management, hazards

Beyond GODAE

GODAE ≡ Ocean Prediction

- Delivering information on the past, present and future state of the ocean
- Need business case for ocean prediction
- Better knowledge of "market"

Scientific extensions

- (Global) biogeochemistry, ecosystems
- Extended weather (and marine met) prediction
- Coastal assimilation and predictability
- …

Sustaining and extending R&D

- Lack global R&D focus for future

Business case, model

- Our business: Providing information on the past, present and future state of the ocean
- Must clarify lines of business, from direct to public to commercial
  - ⇒ Partnerships with private sector fundamental
  - ⇒ Partnerships with government/public sector
  - ⇒ Need to be articulate about benefit to stakeholders and patrons
- Investment
- Notion of benefiting the global (ocean) commons
  - ⇒ Must have associated capacity building
- Must embrace decision making
  - ⇒ Integration with decision making tools
  - ⇒ How to "enter" the decision making process

New initiatives

Clarification

- A Pilot Project is autonomous with clear goals, schedules, legacy, etc.
- GODAE capacity relies on work, projects: demonstration of capability
- Many suggestions fall into the latter category

CODAE

Weather prediction including hurricanes, TCs: THORPEX initiative?

- TC/Hurricane prediction
- Improved predictability of extreme events

Formal link with CLIVAR for assessment

Capacity building

- Contributions from GODAE: Led and operate with a broad perspective
- E.g., IOGOOS and PIROIS