Mise-à-jour sur des projets de prévision environnementale marine

Hal Ritchie

Recherche en prévision numérique

Octobre 2002

Plan

- Système de prévision environnementale marine (projet “Lunenburg Bay”)
- Système pour la prévision d’ondes tempêtes
- Atleier sur un système global d ’assimilation de données océaniques

The Lunenburg Bay Project

AEPRI

Outline

- Background and overview
- Motivation for project
- Current status of instrumentation and modelling (needs breeze_lunenburg3.avi, zbreeze_jun14.avi, Lun1.gif)
- Next Steps
- Thanks to contributors

Marine Environmental Prediction System (MEPS)

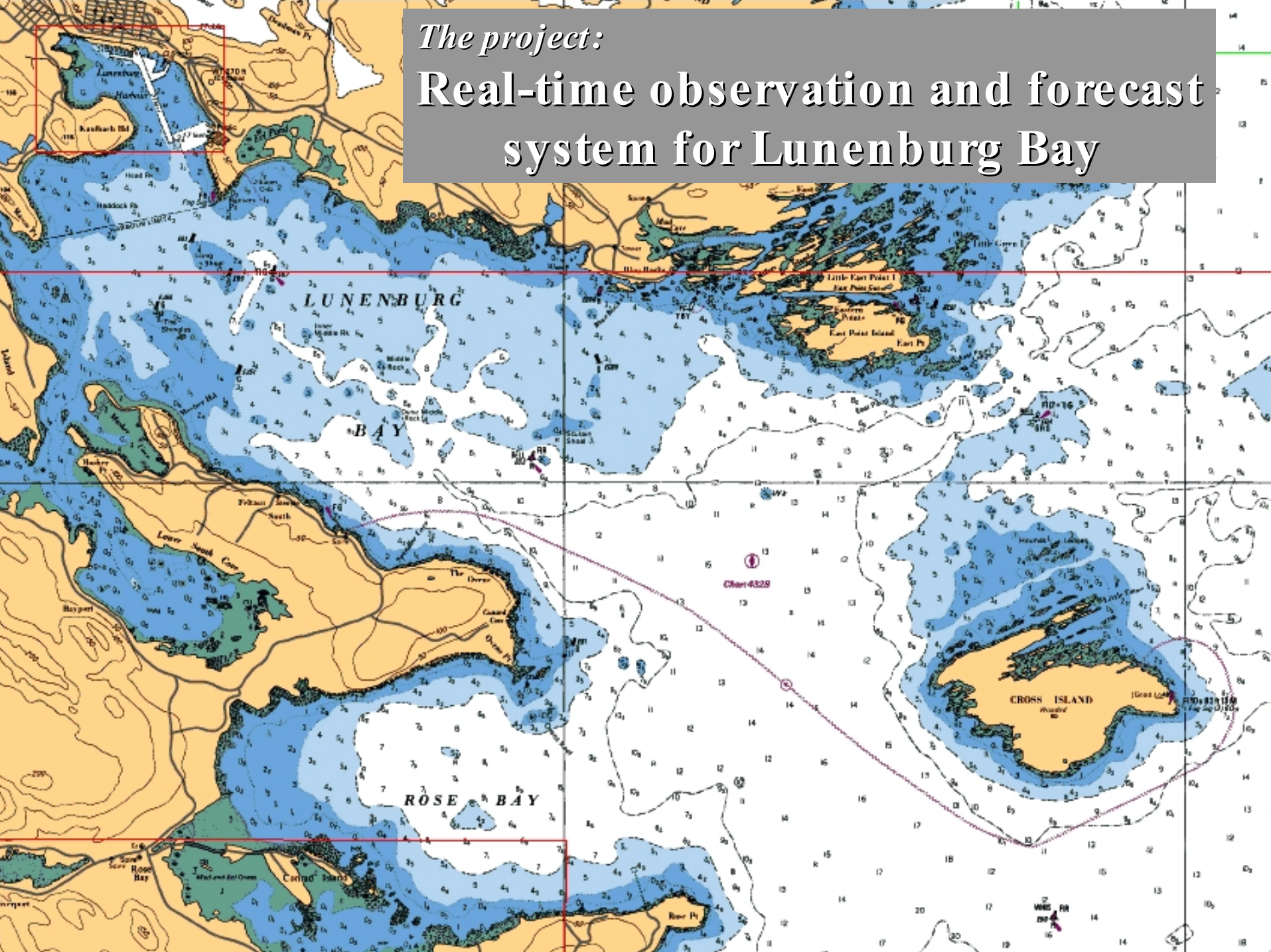
- To establish demonstration site for Lunenburg Bay, NS.
- Goal: interdisciplinary marine environmental prediction guided and tested using advanced observing systems.
- Coupled atmosphere/ocean/biology/chemistry ecosystem model to be developed.

MEPS (continued)

- First theme: coastal pollution.
- Also includes Atlantic storm surge component and R&D on Northwest Atlantic Ocean modelling and data assimilation.
- Canadian Foundation for Innovation (CFI) award of $3.6 M infrastructure for establishing MEPS (MSC is a partner)
- AEPRI plays a key role in MEPS.

MEPS (continued)

- A “second generation” coastal modelling system is being transferred from Dal to the Meteorological Service of Canada.
- This will drive a “third generation” mesoscale model developed by Jinyu Sheng for Lunenburg Bay.



The project:

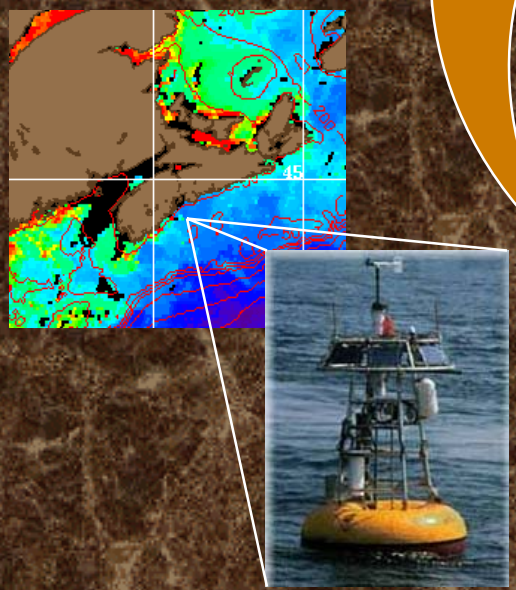
Real-time observation and forecast system for Lunenburg Bay

Forecast System Using Measurements from Land and Sea

Atmospheric Model

Pressure, Winds

Ocean Observatories



Circulation Model

Sea Level, Currents
Temp, Salinity

Biology & Sediment Models

Why are we doing this?

- Develop new capabilities
  - Marine environmental prediction
    - Effects of storms
    - Climate change
  - Coastal ecosystem monitoring
    - Pollution
    - Harmful Algal Blooms
- Test new instrument systems
  - Potential for world-wide markets
- Public outreach (Feb. 14/02, Web presence)
- Potential for new projects
  - Public display (tourism)
  - Community involvement
  - Education (school projects, teacher training)

Why Lunenburg?

- Previous study of physical oceanography gives good background on challenges and instrumentation needs
- Upcoming installation of sewage treatment plant provides opportunity to measure and model impact on water quality
- UNESCO world heritage community provides interaction with other activities

The team:

- **Researchers at Dalhousie**
  - **Professors, staff and students**
- **Partners from government agencies**
  - **Environment Canada**
  - **Department of Fisheries and Oceans**
- **Private-sector partners**
  - **Satlantic (Halifax)**
- **With help and/or support from**
  - Town of Lunenburg, Highliner Foods, BACAP (April 4 2000), instrument manufacturers

Status of Instrument System

Three telemetered moorings:

- Optical sensor array
- Temperature and salinity
- Bottom pressure
- Acoustic doppler current meters
- Meteorological sensors

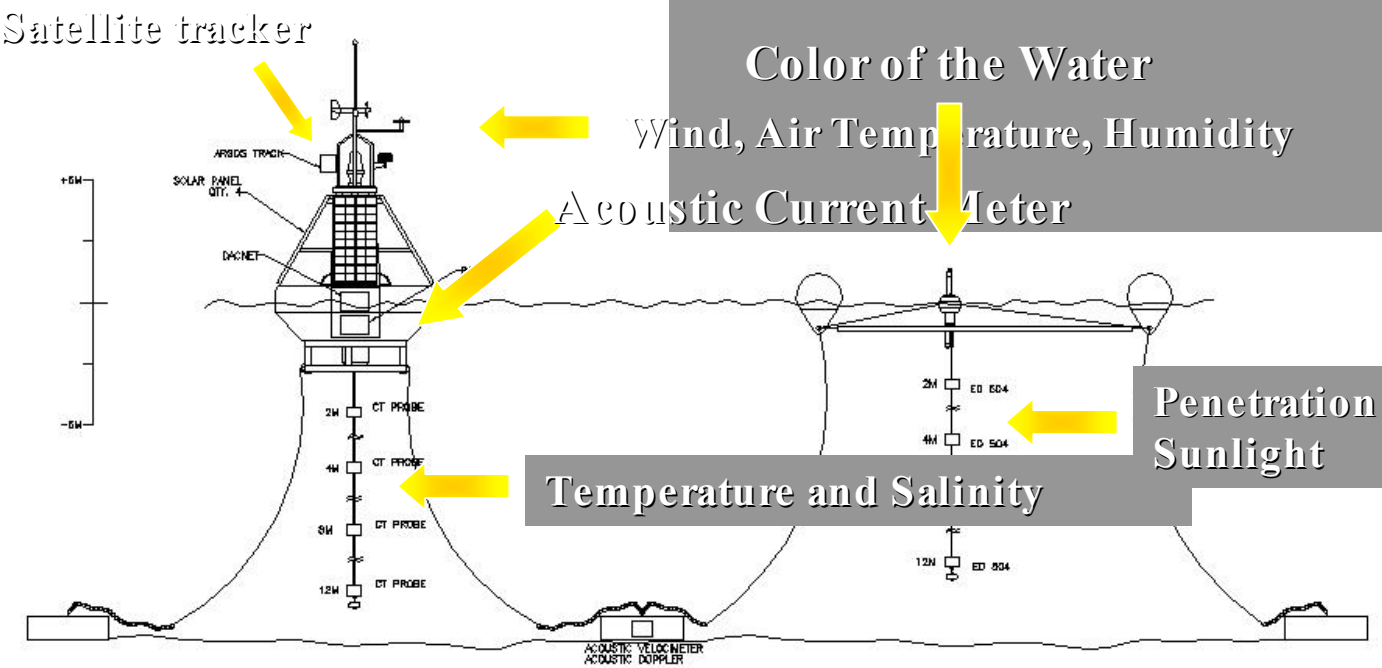
…plus a land-based meteorological array

AEPRI

Three Instrumented Moorings and a Meteorological Station on Land will Record Conditions and Guide the Model

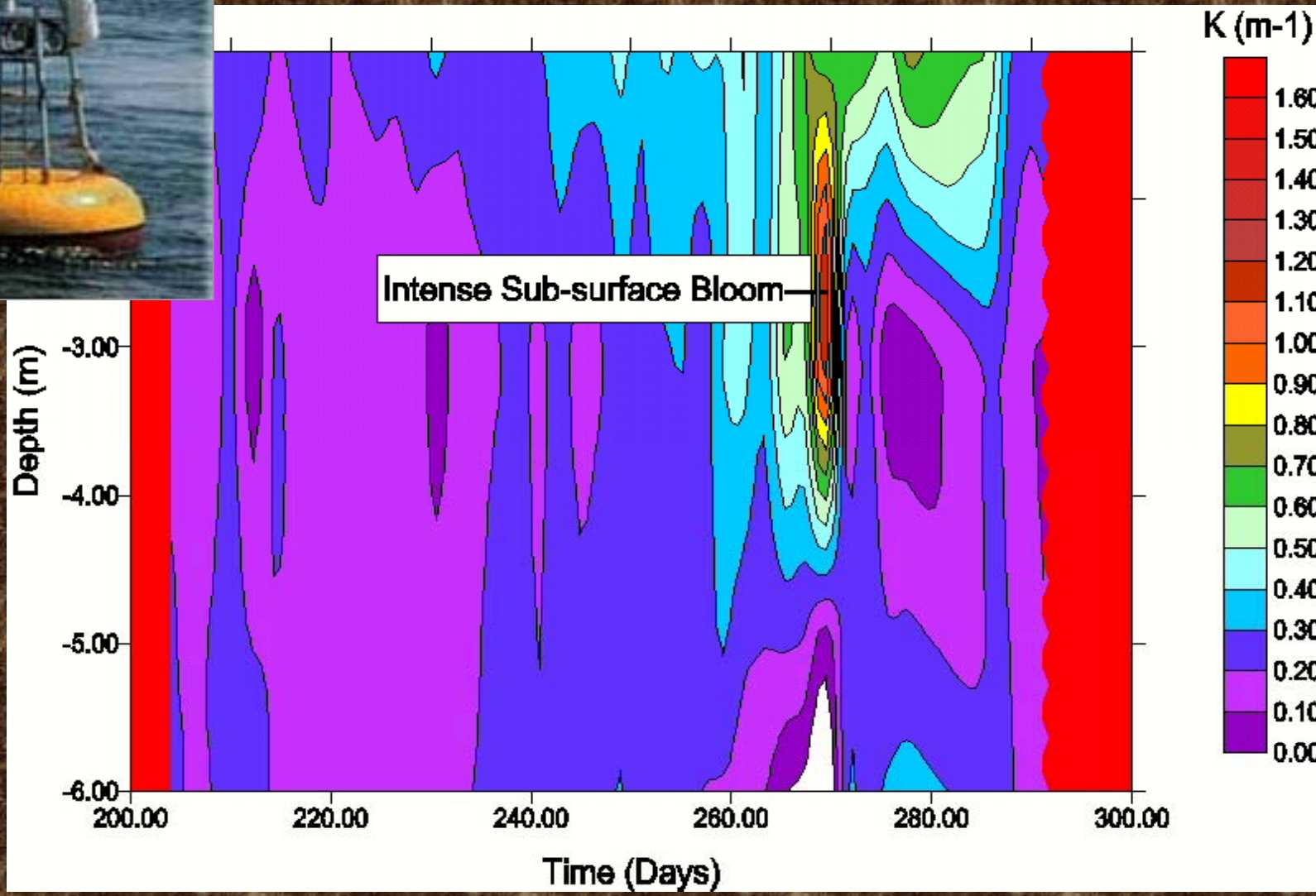
Each buoy has a little mooring off to the side

Many Instrument Systems



Satlantic

Continuous records with depth and time



Continuous records with depth and time

- Environmental conditions
  - Day to day
    - Extreme events
    - Algal blooms
  - Year to year
    - Habitat changes from human activities
    - Climate change

Atmospheric Instrumentation Status

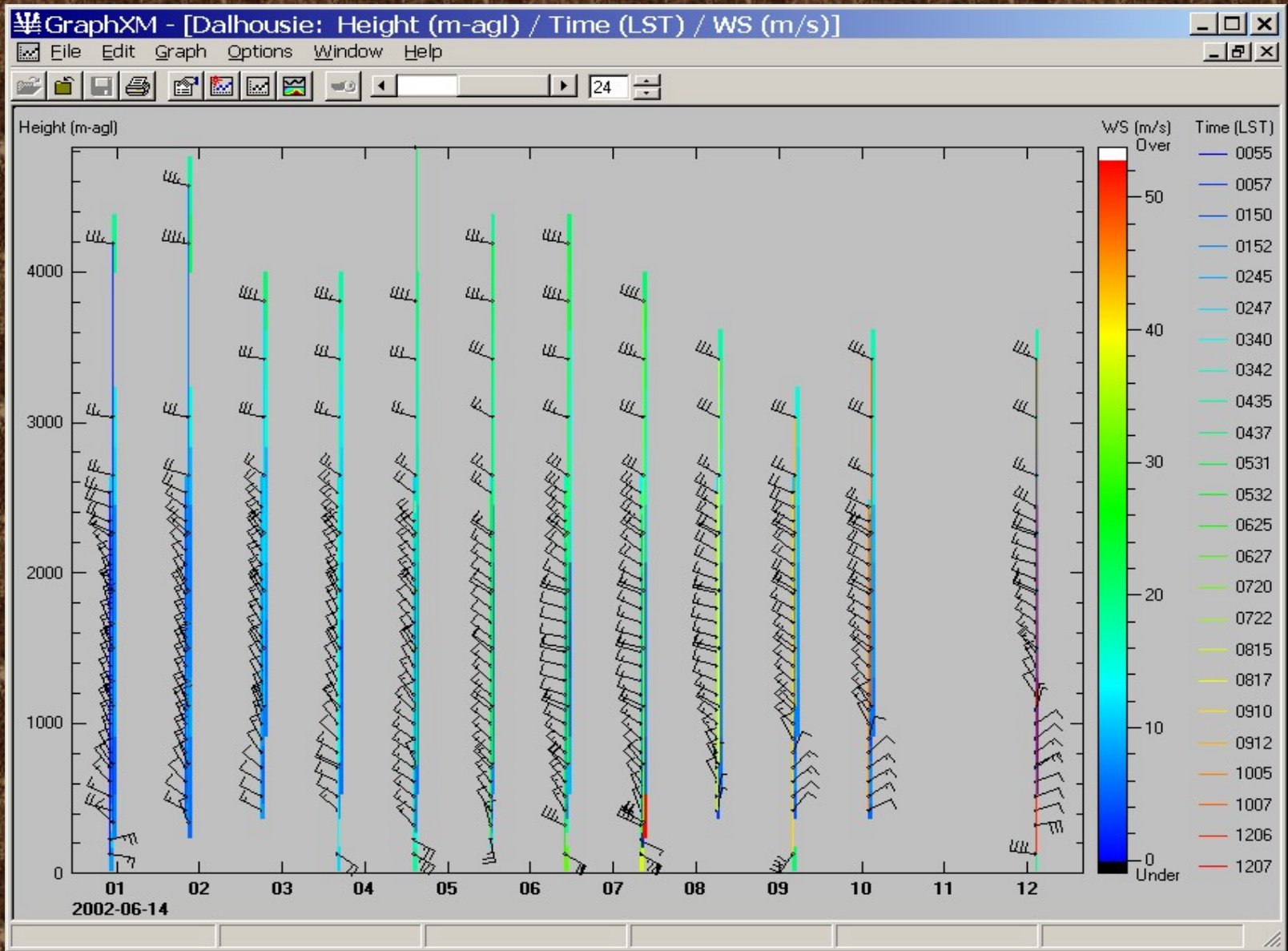
- Wind profiler and RASS installed during week of June 10 - 14, 2002
- Atmospheric tower and base station established at Battery Point
- Shelter set up for Dalhousie University processing
- Communication tower set up

Wind Profiler and RASS

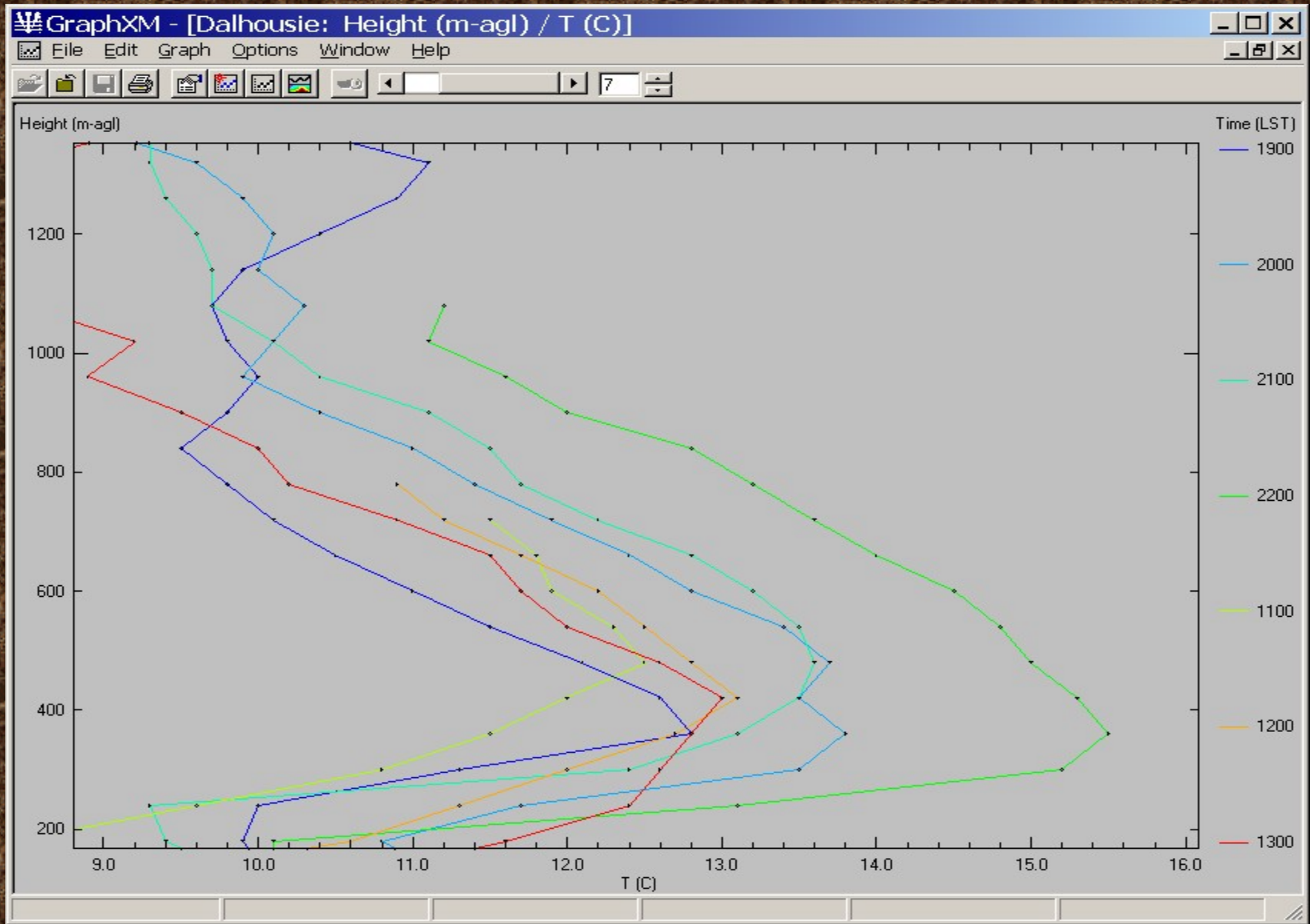
Parts layout

Assembled system

Sample wind profiles



Sample Temperature Profiles



Battery Point Base Station

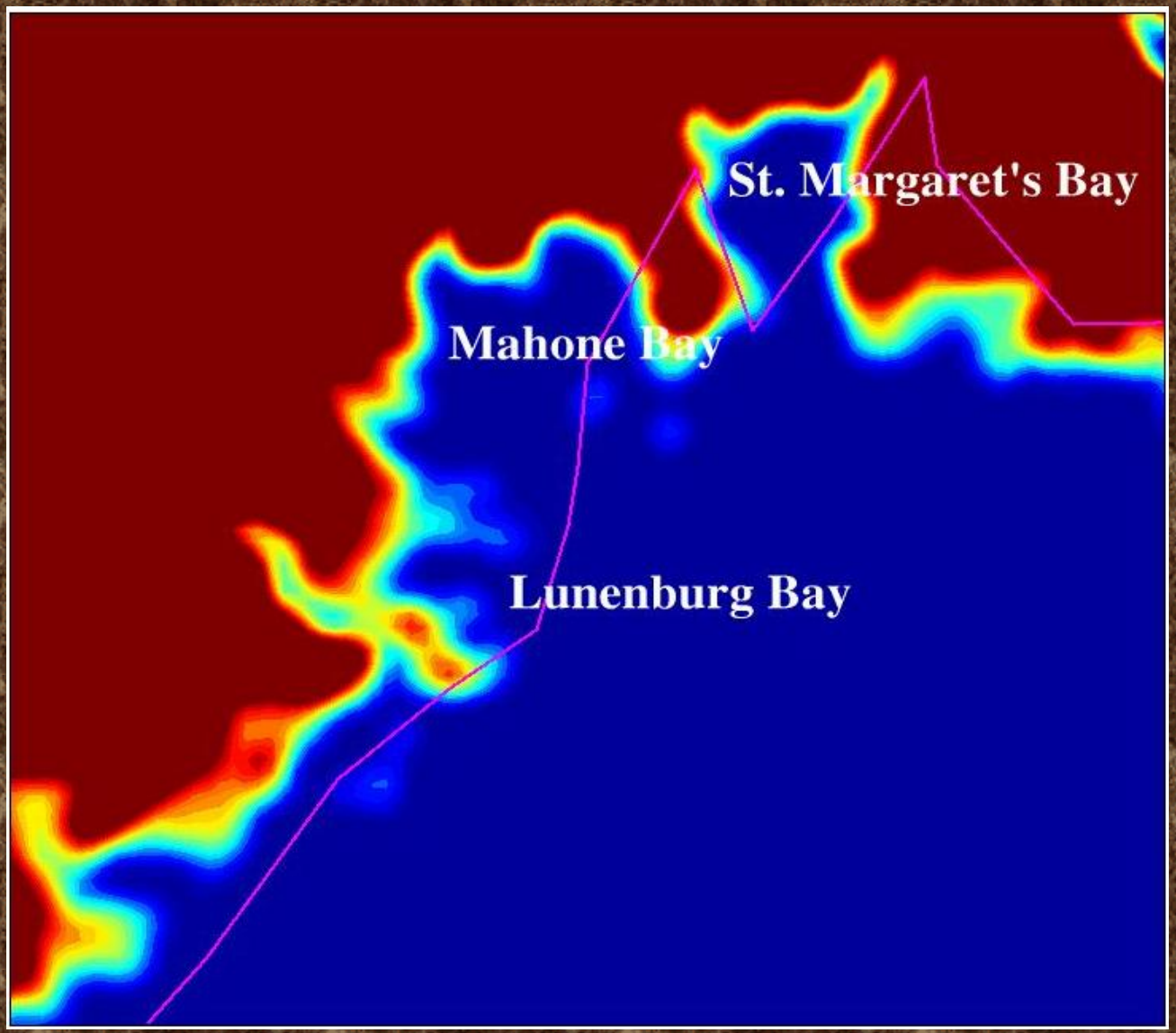
Dal Shelter and Tower

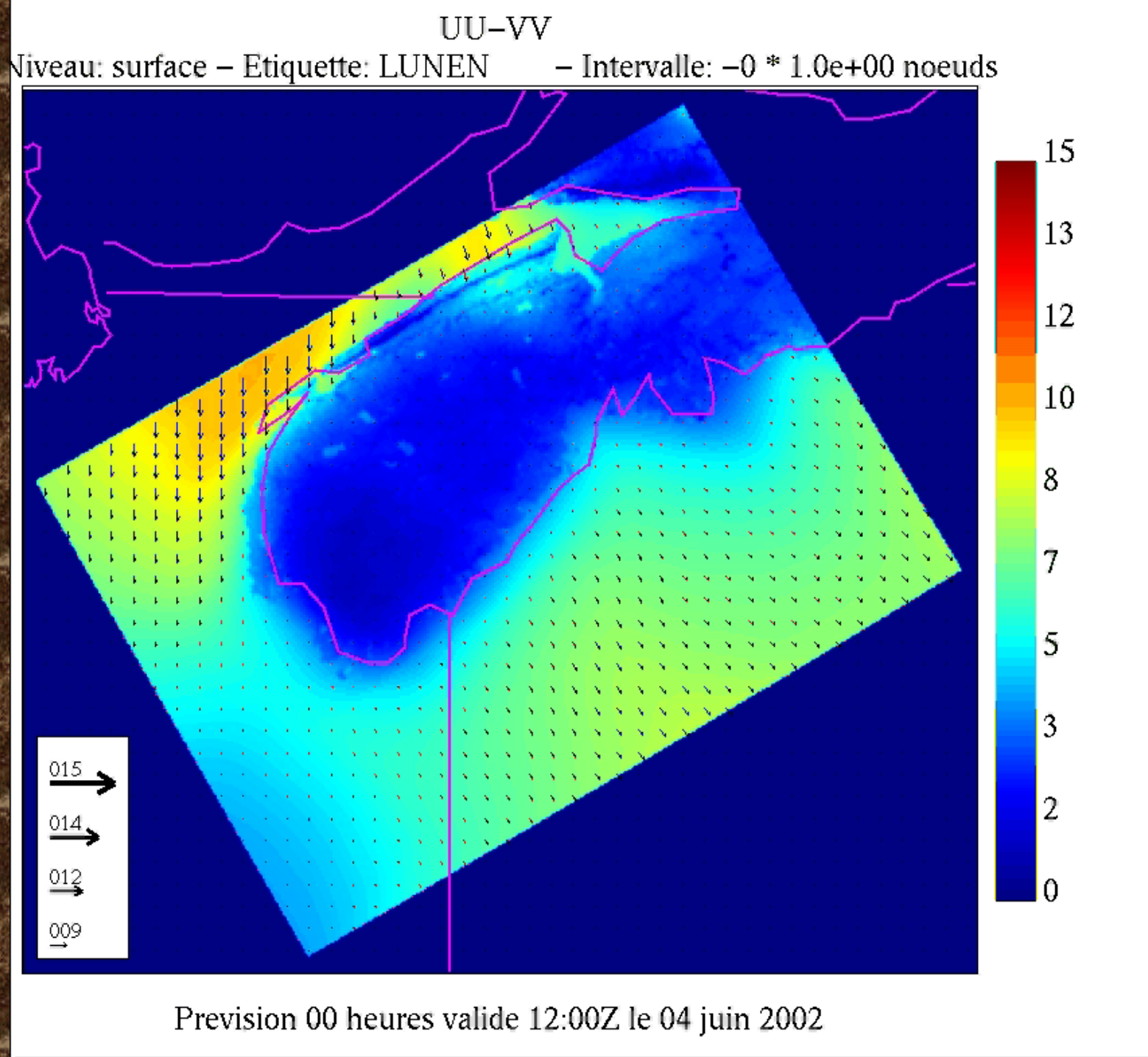
On-Site Processors

Modelling status

- For the atmosphere, a 1 km horizontal resolution limited area configuration of the MC2 model has been nested in the operational regional GEM model
- For Lunenburg Bay with Upper and Lower South Coves, a 40 m horizontal resolution version of the CANDIE model has been set up and is being driven by M2 tidal component

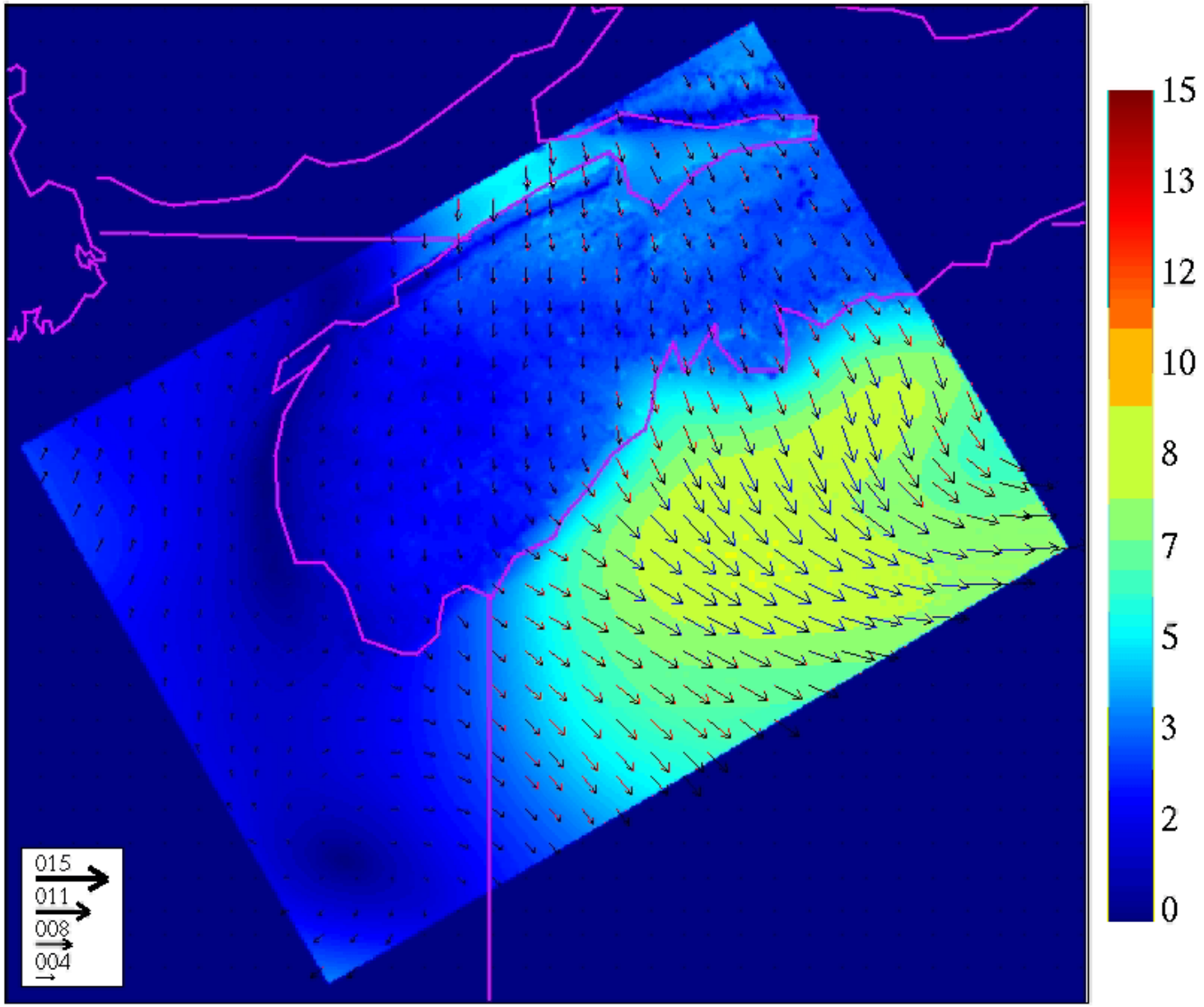
Model topography




UU–VV
Niveau: surface – Etiquette: LUNEN – Intervalle: –0 * 1.0e+00 noeuds
015
014
012
009
15
13
12
10
8
7
5
3
2
0
Prevision 00 heures valide 12:00Z le 04 juin 2002

UU-VV

Niveau: surface – Etiquette: JUN14 – Intervalle: -0 * 1.0e+00 noeuds



Prevision 00 heures valide 12:00Z le 14 juin 2002

CANDIE simulation from gif file

Summer 2002

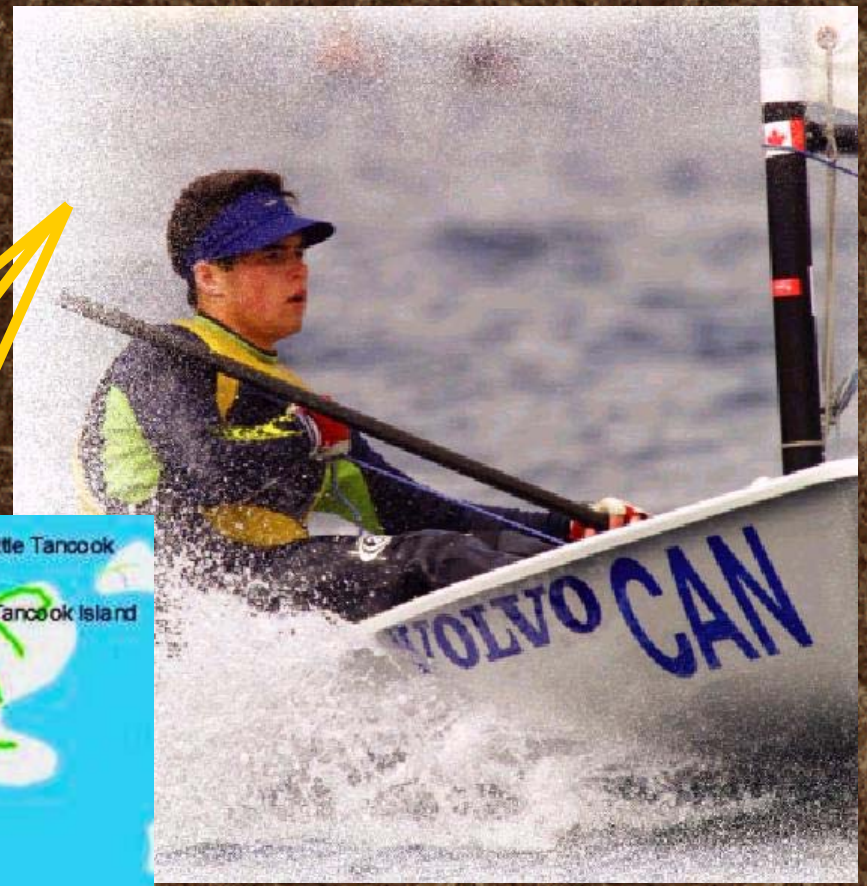
- Support was given to the Youth Sailing World Championship held in Lunenburg July 18-27 2002
- A proposal to support R&D using MEPS was submitted to the Canadian Foundation for Climate and Atmospheric Sciences (CFCAS)

VOLVO YOUTH SAILING

ISAF WORLD CHAMPIONSHIP 2002

LUNENBURG, NOVA SCOTIA, CANADA

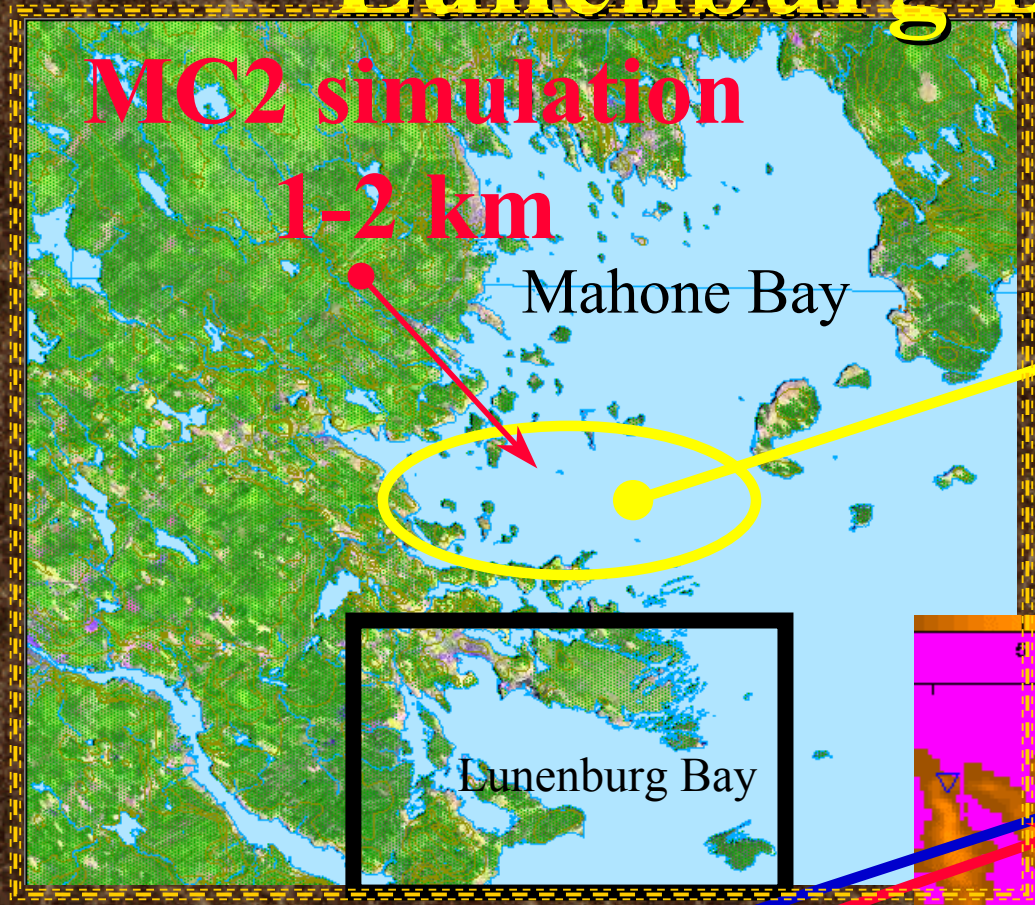
July, Lunenburg,NS



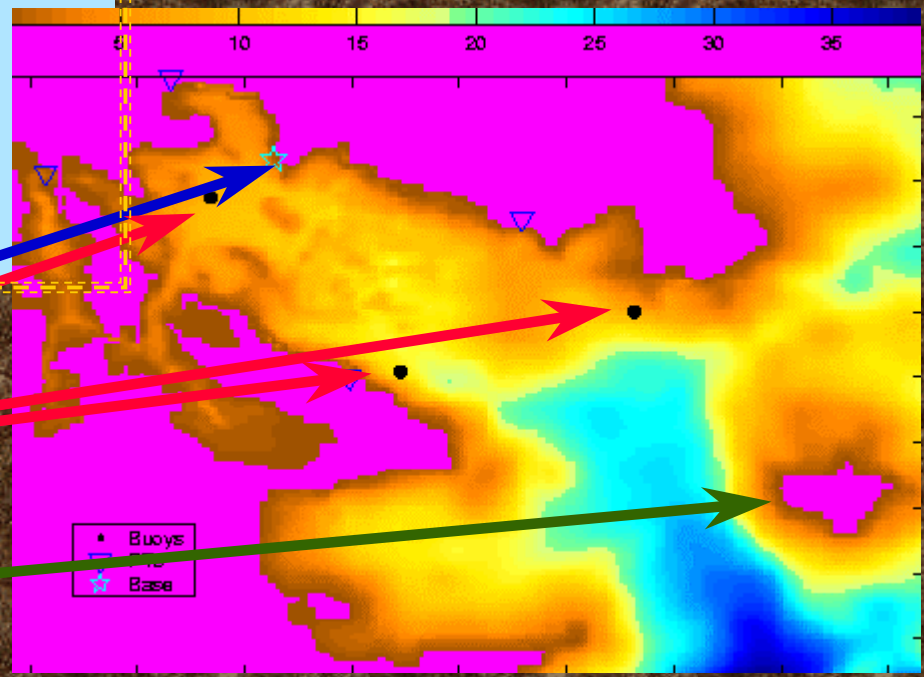
Yacht Club

Morning Weather Briefing by Serge Desjardins

Lunenburg Bay Project



Sailing Race



Wind Profiler

Buoys

Weather Observation

Canadian Foundation for Innovation

"All infrastructure — no research"

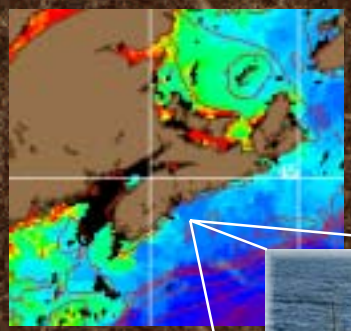
Putting it together

Atmospheric Model

MSC/Dalhousie
(AEPRI, Ritchie, Desjardins)

Pressure, Winds

Ocean Observatories



Ocean Circulation Model

Dalhousie/MSC/DFO
(Thompson, Bobanovic, Sheng, Greatbatch, Wright)

Sea Level, Currents
Temp, Salinity

Dalhousie/ONR/
DREA (Cullen, Lewis, Hay, Hill, Bowen)

Bio-Optical & Sediment Models

AEPRI

Major proposal being submitted to the Canadian Foundation for Climate and Atmospheric Sciences

Interdisciplinary Marine Environmental Prediction in the Atlantic Coastal Region

Why Focus on Real-Time Observation and Prediction?

The ocean is no longer remote

Real-Time Observation and Prediction is the New Direction in Marine Environmental Science

Scientific Issues

- Atmosphere-ocean feedbacks on prediction
  - waves, marine surface winds, sea breeze & fog
- Wind wave forcing on inner shelf and coast
  - links between waves and coastal dynmaics
- Spatial and temporal variations in bottom friction
  - coastal erosion, deposition, bottom roughness
- Utility of biological variables
  - derived from in situ optical measurements
  - for use in autonomous observation and prediction systems
- Predictability of biological processes
  - given a validated physical coastal marine model
- Predictability of Bay response to extreme events
  - coastal upwelling storms, hurricanes, meteorological “bombs”

Five-year goals

- Data assimilation model of a coastal inlet
  - Atmosphere - ocean
  - Nested in the shelf model
  - Biological dynamics
  - Bottom boundary layer hydrodynamics
  - Sediment processes
- Quantitative assessment of predictive skill
  - New techniques for data assimilation
  - Sea breeze and fog
  - New data products for assimilation (optics - acoustics)
- Capacity to model climate change scenarios
  - Storm surge - Current systems
  - Primary productivity - Algal Blooms
  - Sediment transport - Coastal evolution

Approach

Observation

Parameterization

Prediction

Validation

Thanks to Contributors

- John Cullen, Department of Oceanography, Dalhousie University, Interim Director CMEP, PI MEPS-CFI
- Jinyu Sheng, Department of Oceanography, Dalhousie University
- Serge Desjardins, Garry Pearson, Paul Thorne, Dave Wartman, Bill Appleby, MSC-Atlantic

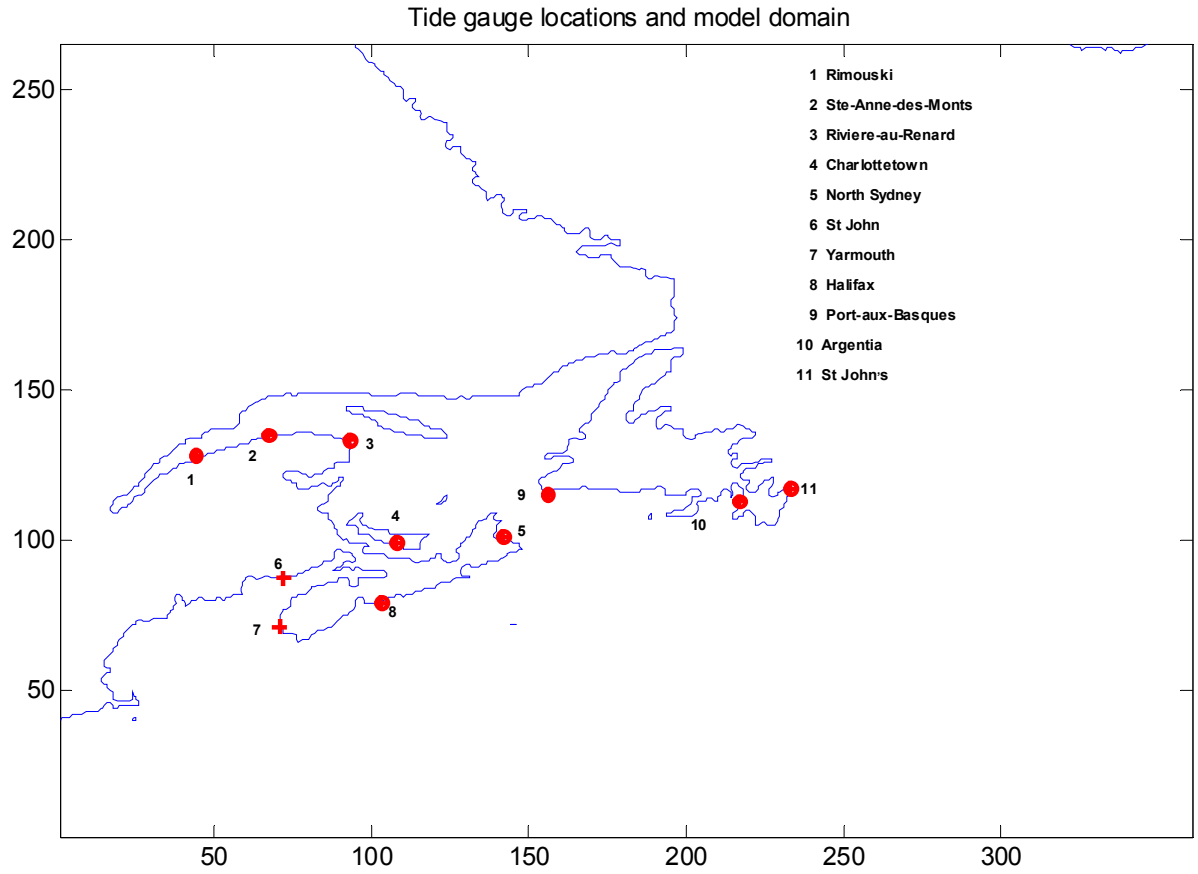
Impacts of Sea-Level Rise and Climate Change on the Coastal Zone of southeastern NB: Storm Surge & Meteorological Modelling

Hal Ritchie and Serge Desjardins
Meteorological Service of Canada
Keith Thompson, Jeff MacDonald and Natacha Bernier,
Dalhousie University
2002

Storm Surge Prediction System

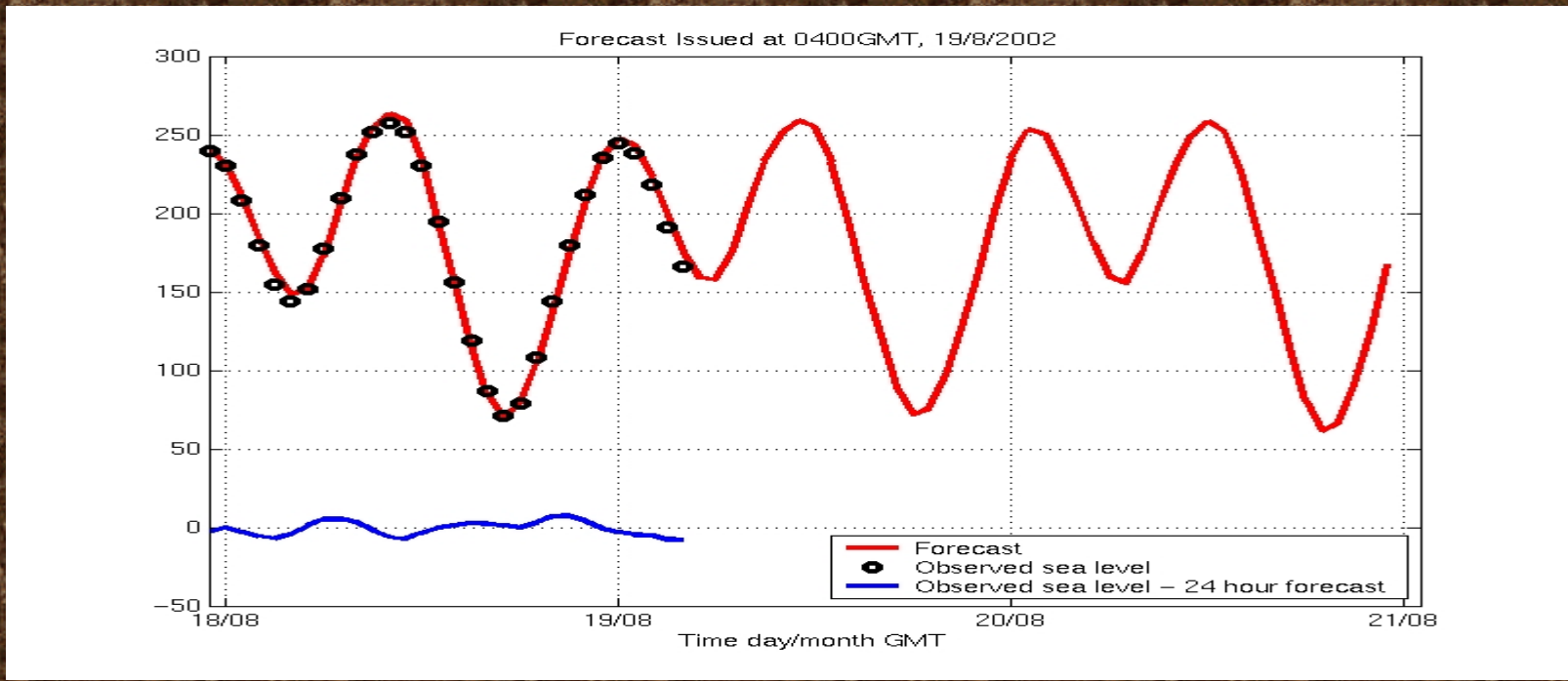
- Predicts sea level changes caused by weather systems
- Based on Dal coastal ocean model
- Driven by CMC regional forecast model surface pressures and winds
- Alerts forecasters of flooding risk from combination of high tide and large surge

Surge Model Domain, Tide Gauge Locations



Recent Developments

- Tides for the Atlantic Coastal Flood Prediction System (animations)
- Re-locatable tide gauges for validation



Tasks and Tools for New Project

- Apply total sea level system to coastal zone of southeastern New Brunswick
- Use re-locatable sea level system (6 tide gauges) to validate forecasts for SE NB
- Analyze trends in observations and 40-year reanalysis using validated prediction system
- Quantify flooding risk in SE NB under plausible climate change scenarios

CMEP Global Workshop

- To assess benefits and costs of global marine environmental data assimilation and prediction for Canada
- To determine feasibility and desirability
- To map out most effective way of proceeding

- Resulted from DOE/MSC - DFO/Science ADM meetings started 13 Feb 2001
- Sponsored by ACSD

Overview of MSC Global Ocean Data Assimilation and Prediction Needs

Michel Béland

Atmospheric and Climate Science Directorate, MSC

For Global Coupled Models

- For seasonal forecasts, we presently persist the initial SST anomaly
- Multi-seasonal (to inter-annual) forecasts will require improved SST fields, either by more sophisticated long-lead SST forecast, or by a fully coupled system - requiring good initial conditions

Multi-annual Forecasts

- Forecasts out to decadal are now being discussed, motivated by assessments of potential predictability
- Ocean initial conditions may provide skill here

Projecting Climate Change

- Out to century time scale
- Substantial biases remain in coupled systems with oceans initialized by climatlolgy, likely partially due to starting ocean from a “non-physical” state
- Proper ocean analyses should reduce these errors and/or spin-up time

Improved short- and medium-range forecasts of extreme marine weather

- For hurricanes and their extratropical transition, marine “bomb” storms
- Better lateral boundary conditions for coastal modelling systems (e.g., storm surge, coupled atmosphere-ice-ocean) as they extend farther off-shore

Improving models & expertise

- A better global ocean data set provides a tougher benchmark against which to evaluate models (global and regional)
- Developing an ocean DA system could improve atmospheric analyses (cross-correlations) and models (boundary layer)
- Foster and attract much needed DA expertise in Canada

GLOBAL OCEAN DATA ASSIMILATION & PREDICTION

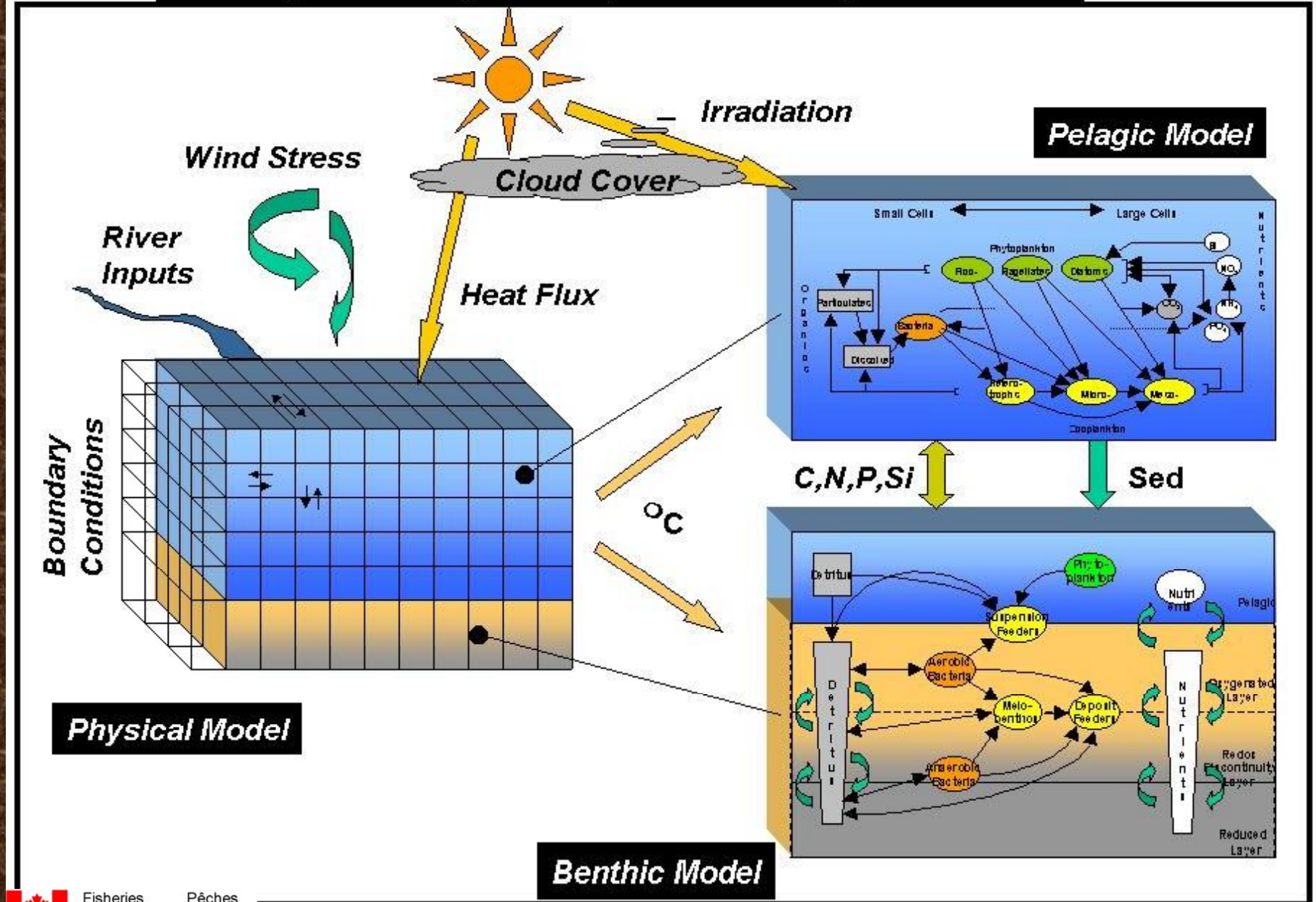
DFO Requirements

Fisheries and Oceans | Pêches et Océans

DFO ENVIRONMENTAL PREDICTION REQUIREMENTS

- hours to decades
- small bays to global oceans
- biology/physics/chemistry
- surface layer to deep ocean

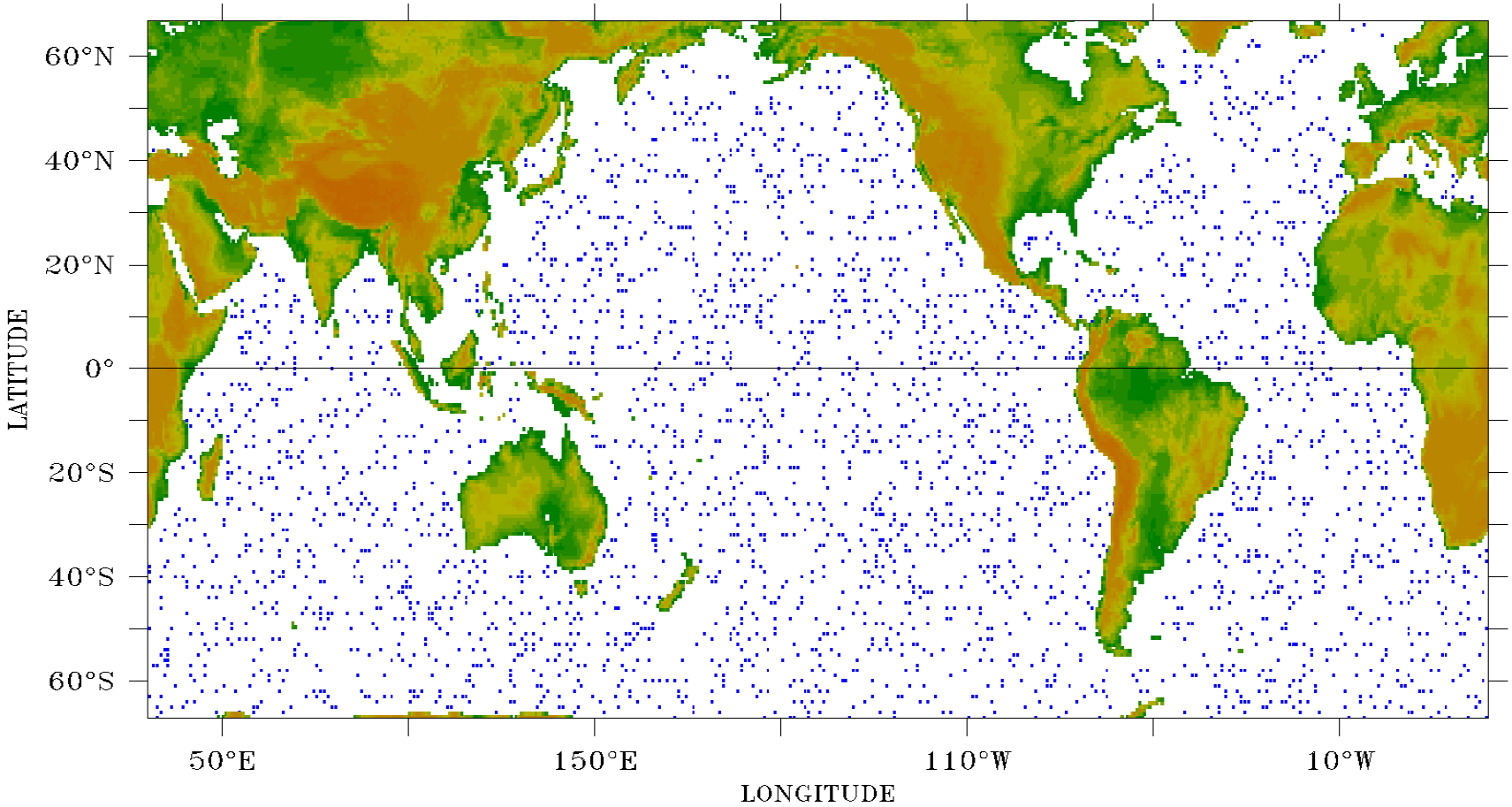
Conceptual Coupled Physical - Ecosystem Model



DFO OCEAN DATA ASSIMILATION REQUIREMENTS

- near real time
- small bays to global domains
- biology/physics/chemistry
- surface layer to deep ocean

Argo data from up to 3000 profiling floats spanning the global oceans



CANADIAN OCEAN DATA ASSIMILATION REQUIREMENTS

- DFO
- DOE, DND and other OGDs
- All Canadians
- No single department can afford to do this on their own
- Development resources seem available
- Not clear what resources would be available for operational implementation

DFO INVESTMENTS

- Systematic monitoring
- data QA
- data bases
- data access
- data assimilation
- coupled modelling

DATA ASSIMILATION INVESTMENTS BY DFO

- **DFO IS INVESTING DATA ASSIMILATION DEVELOPMENT IN ALL REGIONS**
  - e.g. $400K Mike Foreman's Project
- **DFO GOALS ARE TO IMPROVE:**
  - advice for management of aquatic resources
  - monitoring of aquatic resources and environment
  - understanding ocean processes & climate and
  - knowledge of impact ocean climate variability and change
- By 2005 DFO intends to have an operational data assimilation capability providing input to operational models

DATA ASSIMILATION INVESTMENTS BY DFO

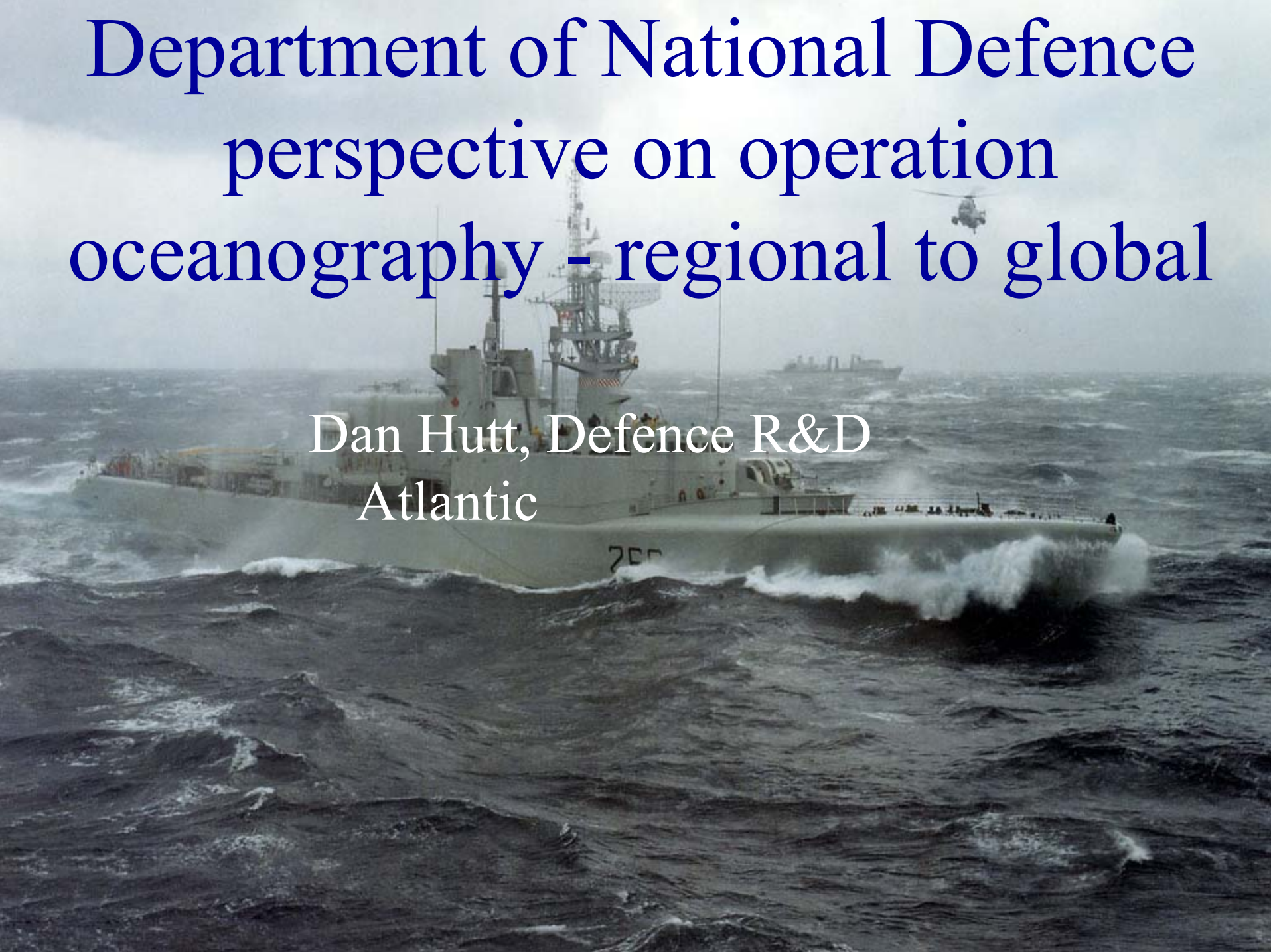
- BIO collaborating with DAL on Argo data assimilation
  - using a 1/6th degree model for region from Florida to Hamilton Bank offshore to the Mid Atlantic Ridge
  - will eventually also include ocean colour, sea level (coastal and satellite altimeter), SST and current meter data.
- BIO continuing to work on improved methods of assimilating long-term hydrographic information into eddy-permitting numerical models.
- IML working on GoSL data assimilation
- other assimilation & modelling work at BIO, IML and IOS
- numerous coupled modelling collaborative efforts between DFO, DOE, DND and academics to date
- international linkages need to be strengthened

Department of National Defence perspective on operation oceanography - regional to global

CMEP Global Workshop
August 26, 2002

Dan Hutt

Department of National Defence perspective on operation oceanography - regional to global



Dan Hutt, Defence R&D Atlantic

What ocean products does the navy need?

Navy operations require nowcasts and forecasts of:

- three-dimensional sound speed field
- locations of ocean features such as fronts, eddies
- surface waves
- ambient noise
- ice fields at high latitudes
- currents

GODAE
A New Day for Oceanography

Neville SMITH

BMRC, Australia

GODAE@BOM.GOV.AU

http://www.bom.gov.au/GODAE/

INTRODUCTION

- *The concept of a Global Ocean Data Assimilation Experiment (GODAE)*
  - A belief that the community was ready, and able, to do operational marine,ocean and climate prediction;
  - A belief that attracting the long-term resources necessary for an adequate long-term operational system depended upon a clear demonstration of the feasibility and value of such a system;
- *FGGE/Numerical Weather Prediction as a model*
  - *The relationship with Numerical Weather Prediction*
    - *Our "big brother"*
- *An experiment in which:*
  - *a comprehensive, integrated observing system would be established and maintained for several years, with the data assimilated into state-of-the art models of the global ocean circulation in near real-time.*

GODAE: *The Vision*

"A global system of observations, modeling, assimilation and communications that will deliver regular, comprehensive information on the state of the oceans in a way that will promote and engender wide utility and availability of this resource for maximum benefit to society."

- ***Prediction as a routine activity.***
- ***Developing a system serving interests from climate and climate change through to ship routing and fisheries.***

Objectives

- Coordinate and foster a more efficient, responsive and sustainable system for data assembly, quality control and access.
- Improve public access to and awareness of the many marine services products, both operational and research that are available.
- Foster the development of a shared "common" of ocean information and tools for the production of improved ocean products.
- Foster the production and analysis of improved ocean services and products.
- Undertake experiments to assess the utility of various ocean data streams for different applications.
- Guide the evolution of a global ocean observing system

Main Recommendation

- That a DFO-MSC-DND-university group (about 10 members) be formed to present senior managers with options or a plan on how to develop or implement an operational global ocean data assimilation and modelling capacity in Canada.
- Will include a timeframe and preliminary resource estimate, indicating likely partners and clients.