Description of Recent Updates to the NRL Coupled Ocean Data Assimilation System (NCODA)

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**Description of Recent Updates to the NRL Coupled Ocean Data Assimilation System (NCODA)**

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**Unclassified Report**

**Limitation of Abstract**

Same as Report (SAR)

**Number of Pages**

10
Advanced DA Technique Based on Optimal Estimation Theory

- oceanographic version of MVOI method used in NWP systems
- simultaneous analysis of five ocean variables: temperature, salinity, geopotential, and u-v velocity components (T, S, Φ, u, v)
- developed as part of the ONR sponsored coupled modeling projects at NRL MRY (COAMPS/NCOM and NOGAPS/POP)

Flexible System

- supports variety of map projections
- performs multi-scale analyses on nested, successively higher resolution grids
- initialize/update ocean forecast model or run stand-alone
  - 2D analyses of sea ice and SST (NWP boundary conditions)
  - 3D temperature and salinity analysis (geostrophic currents)
  - 3D MVOI sequential incremental update cycle
Forecast fields and prediction errors can be used in the QC of new data.
FNMOC Quality Controlled Operational Ocean Observation Data Sources

- **AVHRR GAC Satellite SST** ~800,000 obs/day
  - 8-km resolution (NOAA 16,17 day, night, relaxed day retrievals)
- **GOES Satellite SST** ~3,000,000 obs/day
  - 12-km resolution (GOES 10 day, night retrievals)
- **In Situ SST/SSS** ~15,000 obs/day
  - surface ship, fixed and drifting buoys, CMAN, TRACKOB
- **Subsurface Temperature and Salinity Profiles** ~1000 profiles/day
  - XBTs, CTDs (TESACS), Argo floats
  - fixed buoys (TAO, PIRATA), thermistor chain drifting buoys
- **Sea Surface Height Anomaly (SSHA)** ~100,000 obs/day
  - altimeter (GFO, ENVISAT, Jason-1), XBTs, CTDs, Argo Floats
- **Sea Ice Concentration** ~1,000,000 obs/day
  - SSM/I (DMSP F13, F14, F15)

All QC data files available on Monterey GODAE server in real-time
New Ocean Observation Data Sources

- **AVHRR LAC Satellite SST** ~3,200,000 obs/day
  - 2-km resolution (NOAA 17 day, night retrievals)
- **GOES Satellite SST** ~3,000,000 obs/day
  - 12-km resolution (GOES 12 day, night retrievals)
- **AMSR-E Microwave SST** ~180,000 obs/day
  - 25-km resolution (day, night retrievals)
- **AATSR Skin SST** ~90,000 retrievals/day
  - 16-km resolution (day, night retrievals)

AVHRR LAC and GOES 12 satellite SST retrievals operationally available at NAVOCEANO (and GODAE server)

AMSR-E and AATSR satellite SST available on GODAE server
New Analysis Capabilities

- **Irregular Grid**
  - supports global stitched grid (Global NCOM)
  - analysis currently supports Mercator, Polar Stereographic, Lambert Conformal, Spherical, Cartesian grid projections

- **Enhanced QC Tests**
  - SSM/I land contamination
    - flags spurious positive sea ice concentration retrievals near land during summer melt season
  - satellite SST diurnal warming
    - detects warm biased daytime satellite SST retrievals due to diurnal warming events (collocates NWP winds and solar radiation)
  - Argo salinity profile bias correction
    - corrects salinity profile to GDEM 3.0 climate salinity offset at depth
  - profile cross validation
    - checks new profiles with analysis performed using nearby profiles
New Analysis Capabilities

- **Reduced Resolution Assimilation Grid**
  - compute innovations from full model resolution grid; perform analysis on coarser resolution analysis grid
  - cost of assimilation mainly in post multiplication (observation to grid space); reduced resolution analysis grid improves throughput

- **Improved Memory Management**
  - required for large model grids on IBM architecture

- **Wave Model Data Assimilation**
  - altimeter/buoy significant wave height (SWH) data in Wavewatch III
    - FNMOC OPTEST planned for 2004/2005 northern hemisphere winter
  - wave model spectra update using choice of methods (BMRC or NCEP)
  - includes new SWH observation QC module
NCODA Operational Status

• **FNMOC**
  – Ocean QC system operational March 2004
  – NCODA 3D analysis-only capability operational August 2004
    • near global analysis running daily in real-time (27-km mid-latitude resolution Mercator grid)
    • 2D sea ice and SST analyses running daily in real-time on 27-km northern and southern hemisphere polar stereographic grids

• **NAVOCEANO**
  – RTP project transitioned QC and analysis to NAVOCEANO
  – Ocean QC nearing operational status
    • biggest issue is connecting to NAVO data streams
    • global sea ice and SST analyses run daily on NAVOCEANO IBMs to support QC
  – NCODA analysis being used in exercise support within NAVOCEANO
NCODA Plans

- **Conversion to 3DVar - adapt NAVDAS solver to the ocean**
  - allows for greater flexibility for assimilating different observation data types (possibly non-linearly related to the forecast model state)
  - eliminates the need to split the analysis domain into sub-domains (all observations can influence the analysis at every model grid point)
  - provides a clear development path towards more advanced 4D assimilation techniques

- **Velocity Observation Data Assimilation**
  - quality control and pre-processing module development
    - model velocity background checks
    - speed, direction conversion to u,v vectors; analysis grid rotation
    - observation error - instrumentation and representation
  - develop sources of velocity observations in real-time
    - Argo float drift, HF radar, current meters, drifting buoys, wide swath altimetry
**HYCOM Tasks**

Naval Research Laboratory, Marine Meteorology Division (NRL MMD)

**On-Going Research**

- Restructure COAMPS™ CM and Code Structure
  - ESMF, WRF compliance (FY04-FY06)
  - Adapt Flux Coupler to force HYCOM (FY05+)
  - Add HYCOM as ocean model (FY06+)
- Test HYCOM fields as IC and LBC for NCOM (FY05)

**Needs:**

- Daily real-time HYCOM forecast runs to 72 h, w/3 h interval (T, S, u, v, SSH)
- Standardized I/O (filenames, format)
- Areas of interest: Med/Atlantic, east and west Pacific
- Interpolation code (HYCOM-to-NCOM vertical grids)
- HYCOM ported to ESMF

ESMF: Earth System Modeling Framework

WRF: Weather Research and Forecast (Infrastructure)

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