Distributed system for water quality monitoring using remote-sensing data

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Water Quality Service

- Goal: continuous monitoring of bio-optical properties of water mass in Dnieper estuary
- Tool: ocean color analysis
  - The “health” of water
  - Level of biological activity
- Applications
  - Monitoring harmful algae
  - Monitoring phytoplankton levels
  - Developing total maximum daily loads
Context

- Water quality assessment problem is considered as one of the highest priority application within European global monitoring GMES initiative.

- Water monitoring is included in the work plan of international group on Earth Observation (GEO) for 2007-2009 period:
  - WA-07-P2 (Global Water Quality Monitoring)
  - WA-07-P3 (Satellite Water Measurements)
Case Study Area

- Test area: view from MODIS, 250m red band
- Kherson State Hydrobiology Station

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Remote Sensing Data

- Provide “synoptic view” of processes instead of point data sources
- Usually the only source of data
- Dependence on weather conditions (optical)
- Multispectral capabilities in optical range are required due to complex process of atmospheric correction (only 10% of light at sensor comes from ocean)
- Use optical data from MODIS sensor
  - 36 spectral bands in 0.4µ-14µ
  - 250m-1km spatial resolution, 1-2 images/day at middle altitudes
Service's Dataflow

Internet

Satellite data

Meteorological data (p, u10, v10)

Ozone

Data archive

In-situ data

SeaDAS

User

Refined parameters

Validation

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SeaDAS Package

- Seadas (SeaWiFS Data Analysis System)
  - Developed in NASA GSFC
    http://oceancolor.gsfc.nasa.gov/seadas/

- Functionality
  - L1A to L1B processing, L2 product generation, L3 binning
  - Thematic processing (msl12)
    - Chlorophyll concentration, SST, SST4, ...
    - Originally developed for SeaWiFS data
    - 8 bands
    - 1.1 km spatial resolution at nadir
msl12 – Ancillary Data

- Meteorology
  - Climatology (default)
  - Near real time data
    - Wind (10m), pressure at MSL, Precipitable water
    - Every 6 hours, between – simple interpolation
    - global NCEP 1deg grid (not enough in coastal regions)

- Ozone
  - EP TOMS, TOAST

- SST
  - from satellite data, climatology, NOAA OISST
SeaDAS Product:
Chlorophyll Concentration
SeaDAS Product: Sea Surface Temperature
Numerical Weather Prediction

- Provides prediction of 4-d space-time distribution of main atmospheric parameters
- Weather Research&Forecasting model
  - mesoscale/limited area NWP model
  - Finer resolution (compared to global circulation models)
  - Require forecast frames from global models for boundary conditions
  - Parametrization support
  - Variational Data Assimilation support
  - Support for distributed memory cluster arch.
Current WRF Configuration

- Configured for territory of Ukraine
- Input & boundary condition from GFS
- 3 day forecasts every 6 hours
- 10 km horizontal grid, 200x200 gridpoints
- 31 vertical levels
- One run takes 3.5 hours on 2x2 Opteron system
WRF Configuration for Dnieper Estuary

- Mesoscale NWP models capable to run with 1km horizontal resolution
- Using nested grids
- Domains: 10x10km, 3.3km, 1.1km
- All domains 200x200 grid points approx.
- 3x comp. time increase
In-situ Data

- Temperature profiles, chlorophyll concentration, species biodiversity
Technology: Grid

- Grid
  - To take user away from details of distributed High Performance Computing resources
  - Grid system designed to integrate resources of different administration domains
  - How: introducing of wide set of standard interoperability protocols
- Globus Toolkit v4 - Grid middleware, Karajan - workflow description language, Torque - local cluster scheduler
- OpenMPI & Scaly - MPI standard implementations, Ganglia - monitoring tool
Hardware

SKIT-1

SKIT-2

Development cluster

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WRF on Grid (1)
Data Presentation

- Open Geospatial Consortium (OGC) standards for data presentation ([www.opengeospatial.org](http://www.opengeospatial.org))
  - vector and raster geospatial data
  - HTTP based transfer, HTTP/GET parameter passing

- Main standards
  - Visualization
    - WMS (Web Map Service), SLD (Style Layer Descriptors), WMC (Web Map Context)
  - Delivery
    - WFS (Web Feature Service), WCS (Web Coverage Service)
OGC Implementations

- Commercial (ArcIMS, IONIC RedSpider)
- Open Source (UMN MapServer, GeoServer)
- Using open source UMN MapServer software
  - CGI application (simple user interface, OGC interfaces)
  - as library
Visualization: WRF Forecasts

- [http://dos.ikd.kiev.ua/?option=com_wrf](http://dos.ikd.kiev.ua/?option=com_wrf)
Future Plans

- Complete validation
- Tune system parameters
- Add data assimilation of satellite data in meteorological model
- Include ecological water model support
  - Cascade of models: weather, hydrology, hydrodynamic
Thank You!