

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

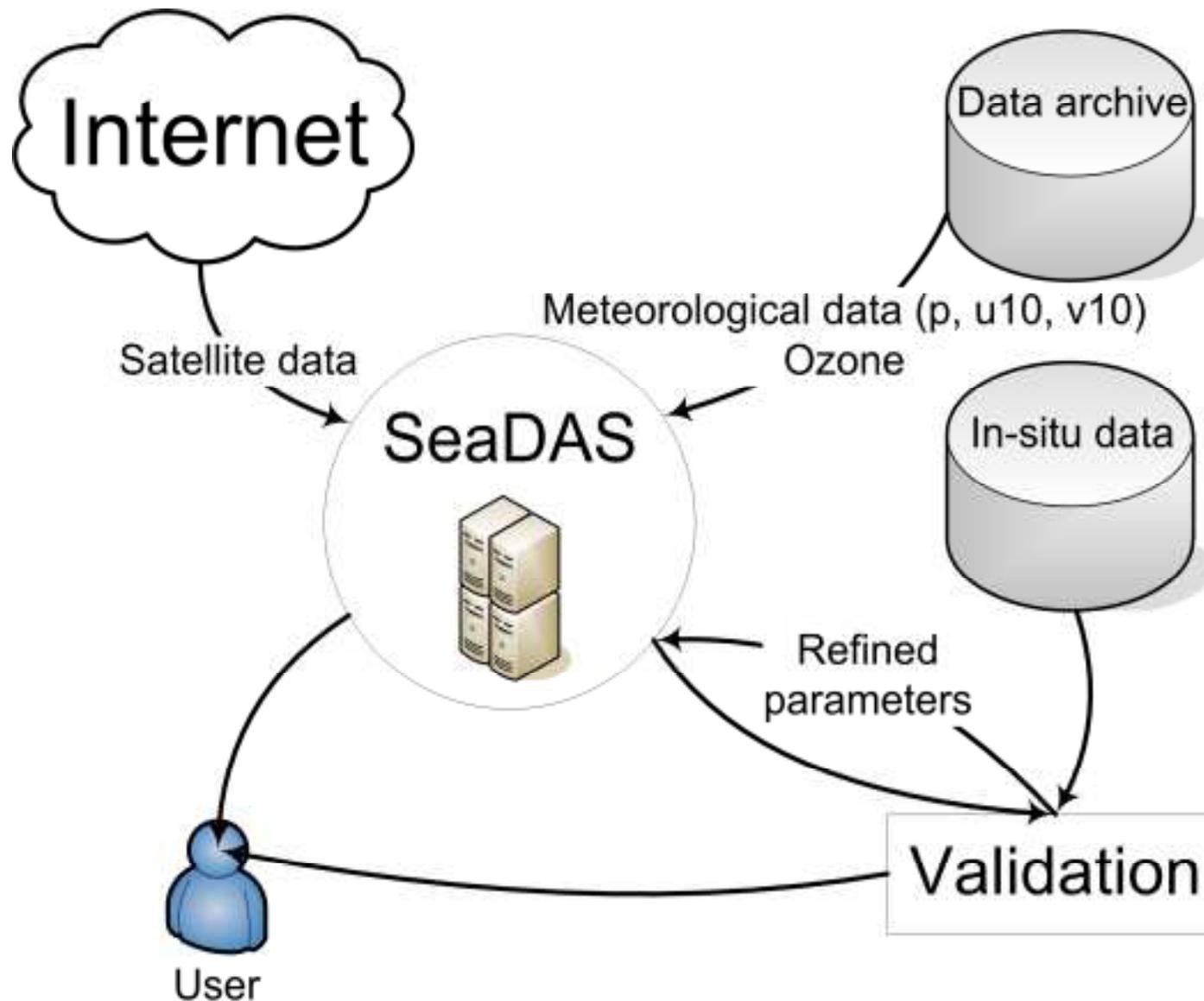


Remote Sensing Data

- 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 $0.4\mu\text{-}14\mu$
 - ♦ 250m-1km spatial resolution, 1-2 images/day at middle altitudes



Service's Dataflow



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

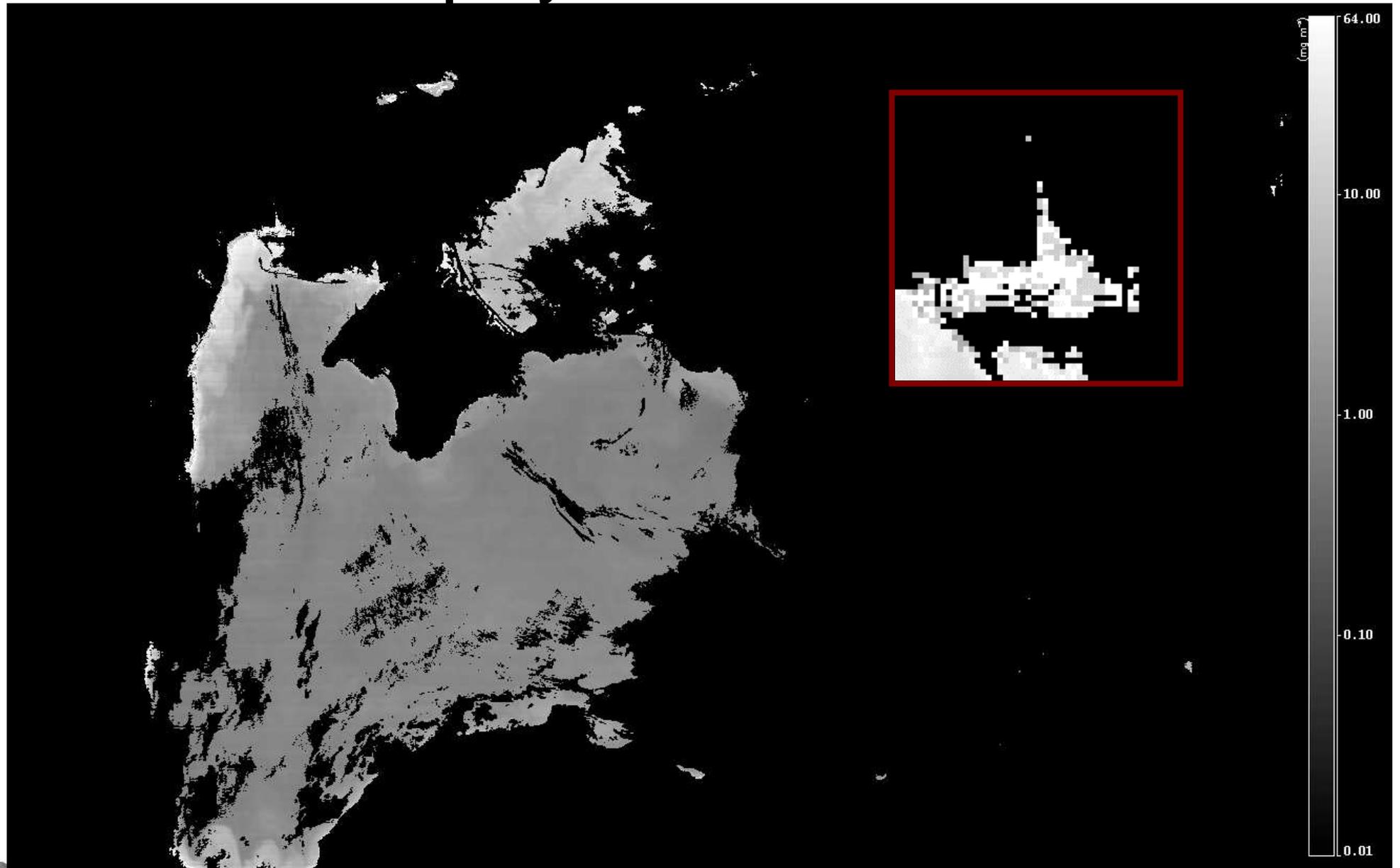


msl12 – Ancillary Data

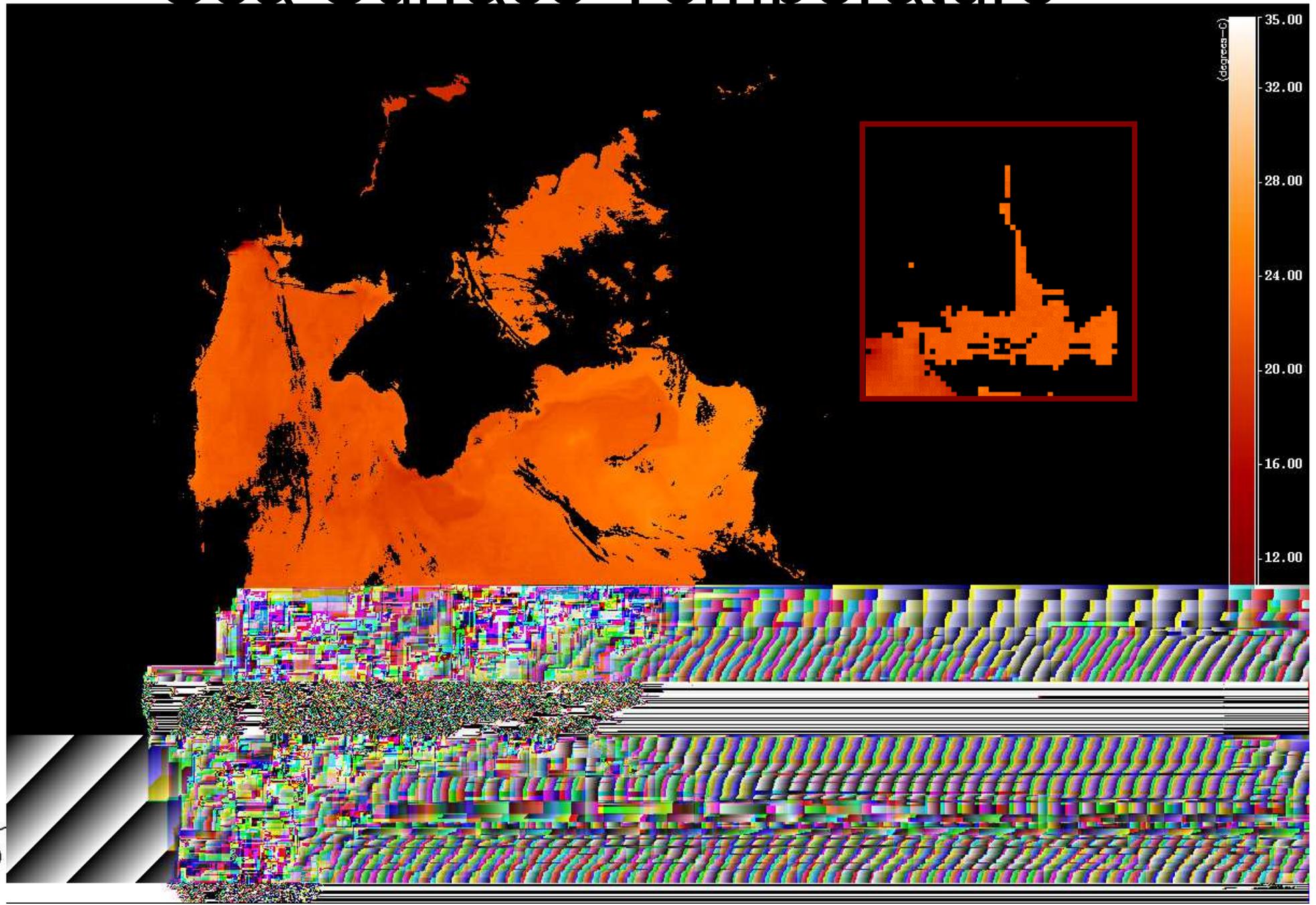
- Meteorology
 - Climatology (default)
 - Near real time data
 - Wind (10m), pressure at MSL, Precipitable water
 - Every 6 hours, between – simple interpolation
 - global NCEP 1deg grid (not enough in coastal regions)
- Ozone
 - EP TOMS, TOAST
- SST
 - from satellite data, climatology, NOAA OISST



SeaDAS Product: Chlorophyll Concentration



SeaDAS Product: Sea Surface Temperature



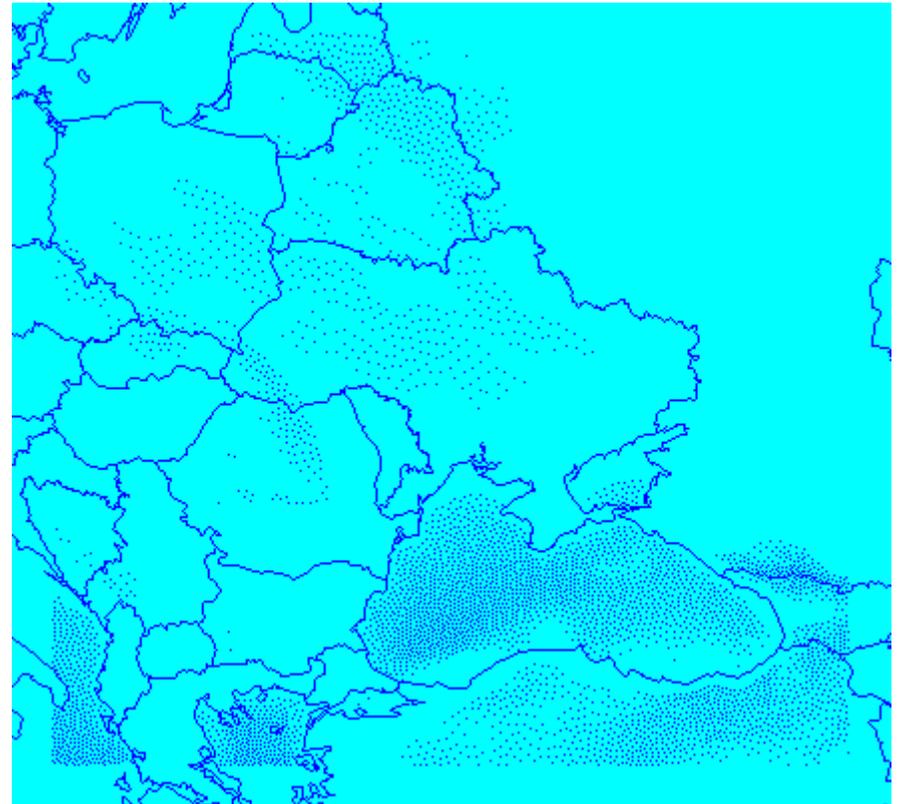
Numerical Weather Prediction

- 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.



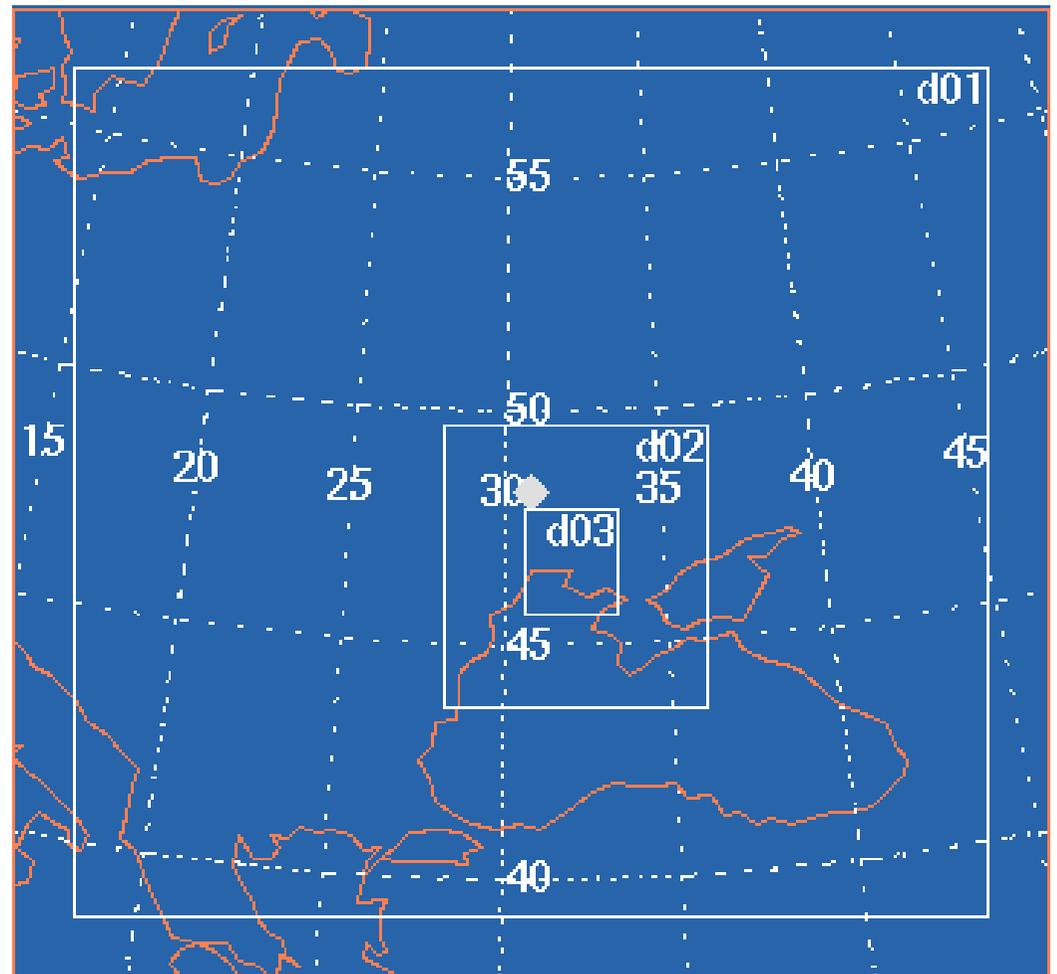
Current WRF Configuration

- 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



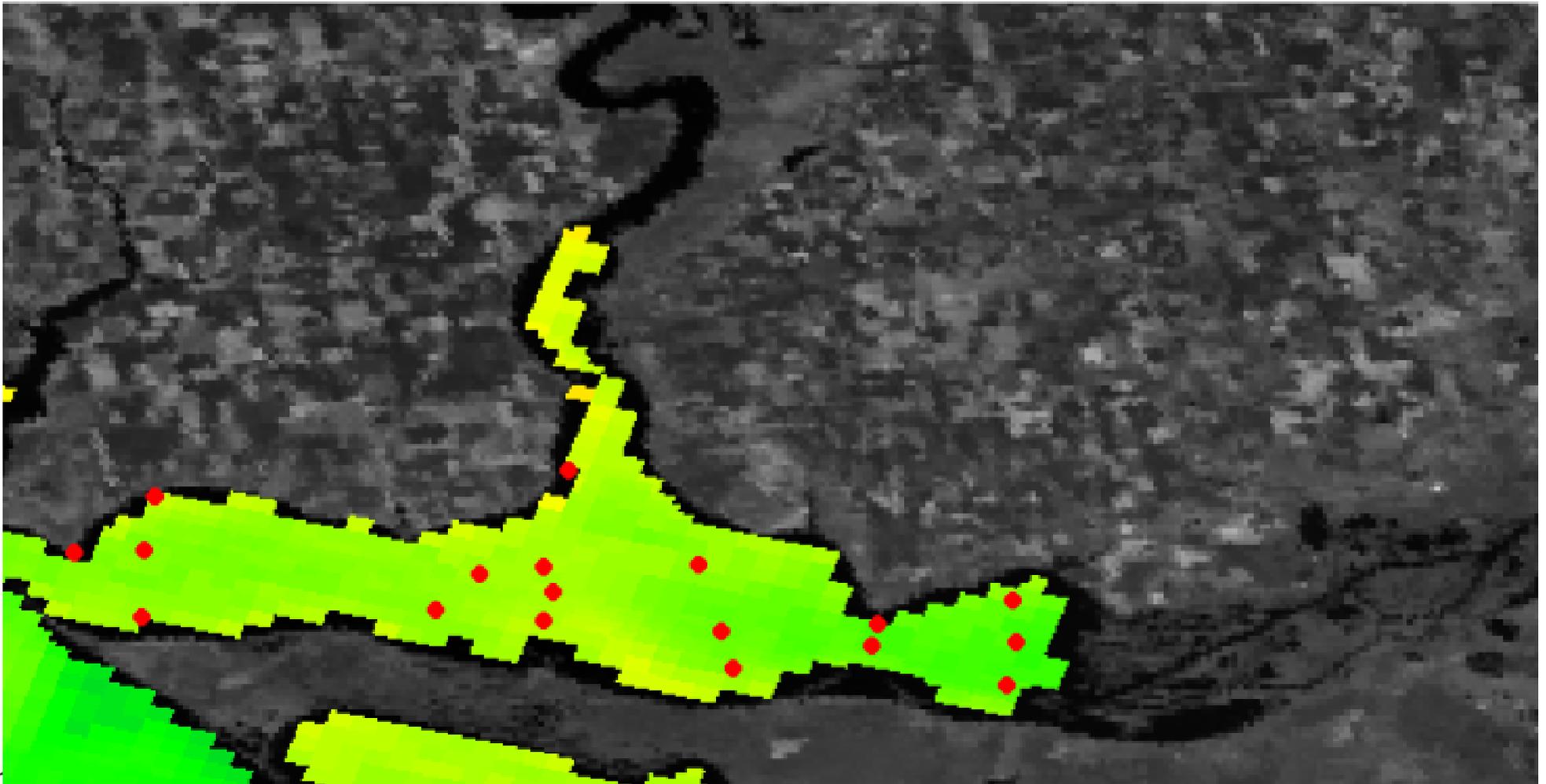
WRF Configuration for Dnieper Estuary

- 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

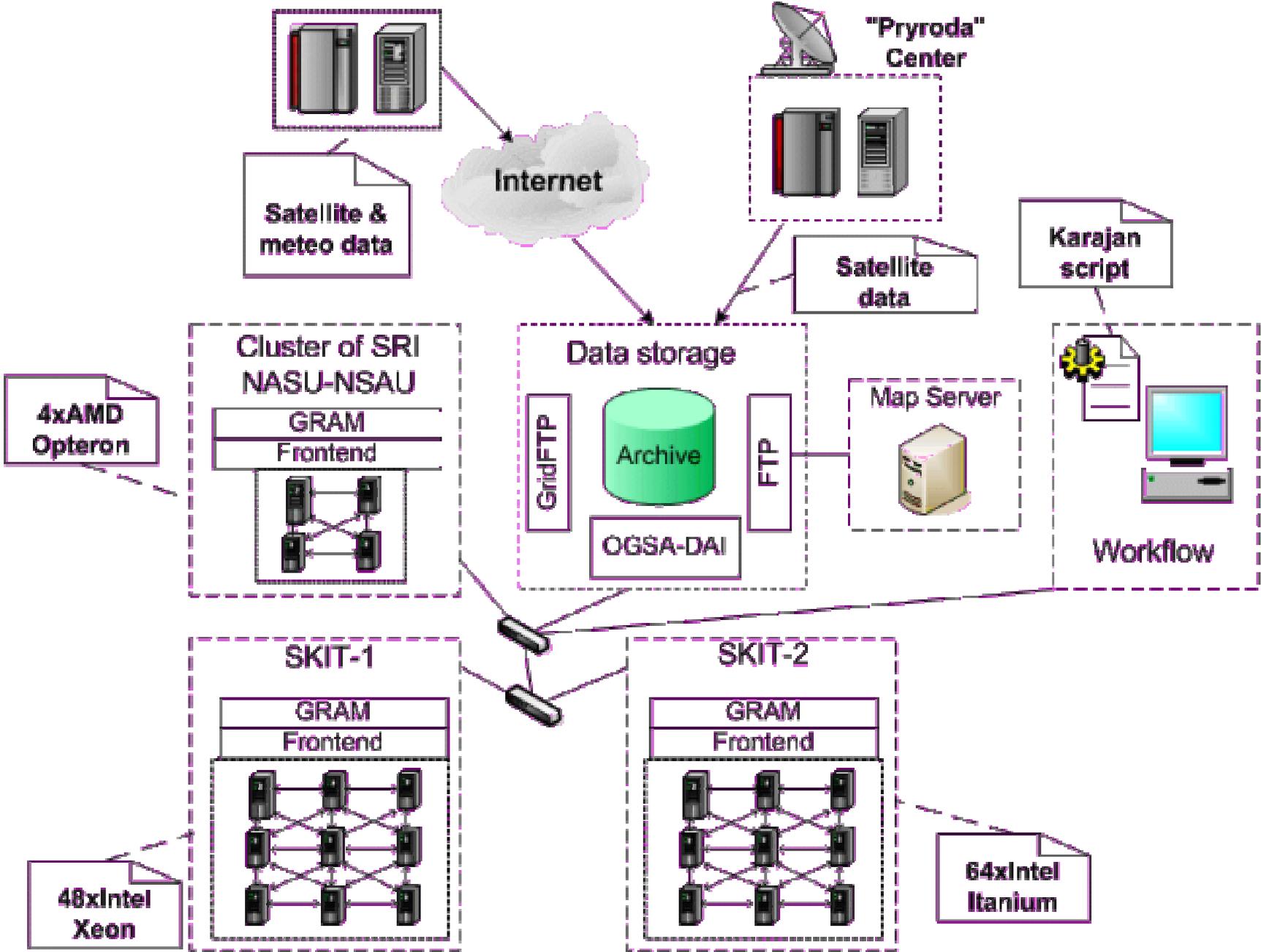


Technology: Grid

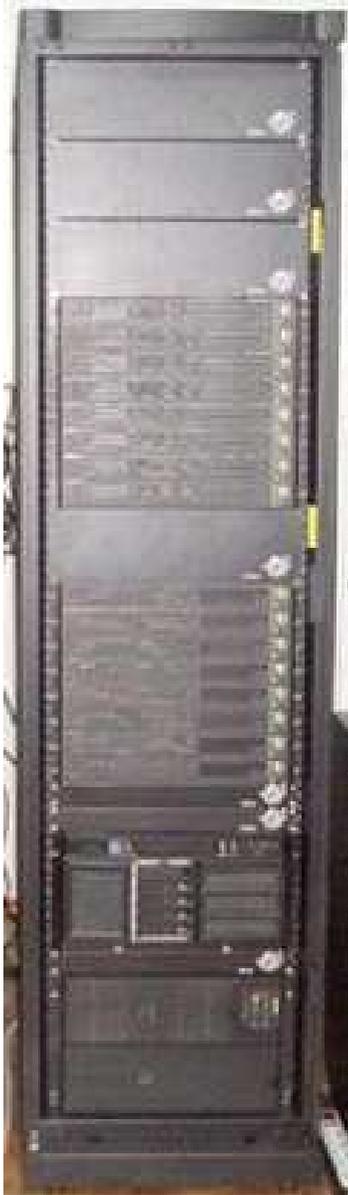
- Grid
 - ♦ To take user away from details of distributed High Performance Computing resources
 - ♦ Grid system designed to integrate resources of different administration domains
 - ♦ How: introducing of wide set of standard interoperability protocols
- Globus Toolkit v4 - Grid middleware, Karajan -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



Current Infrastructure



Hardware



SKIT-1



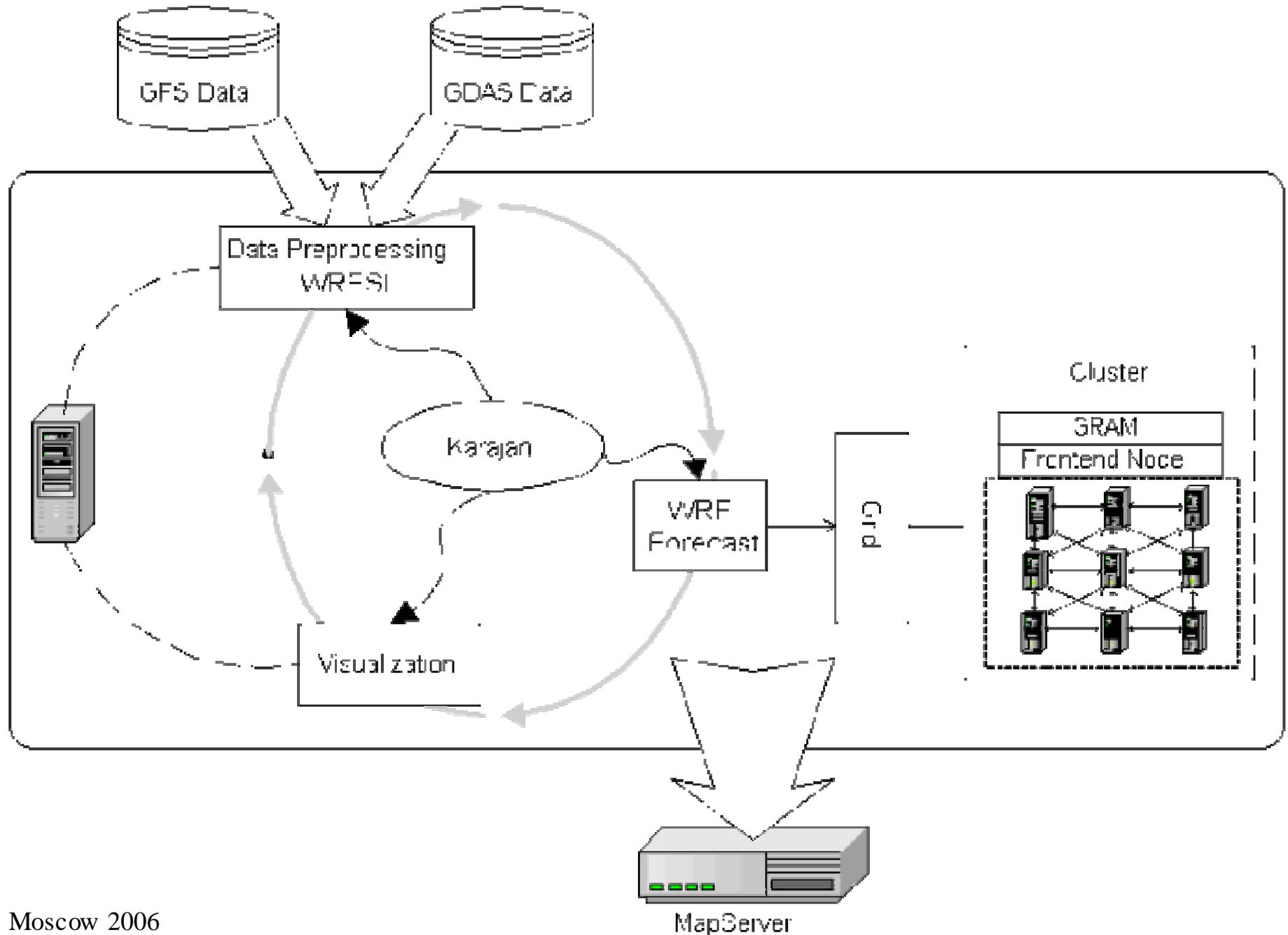
SKIT-2



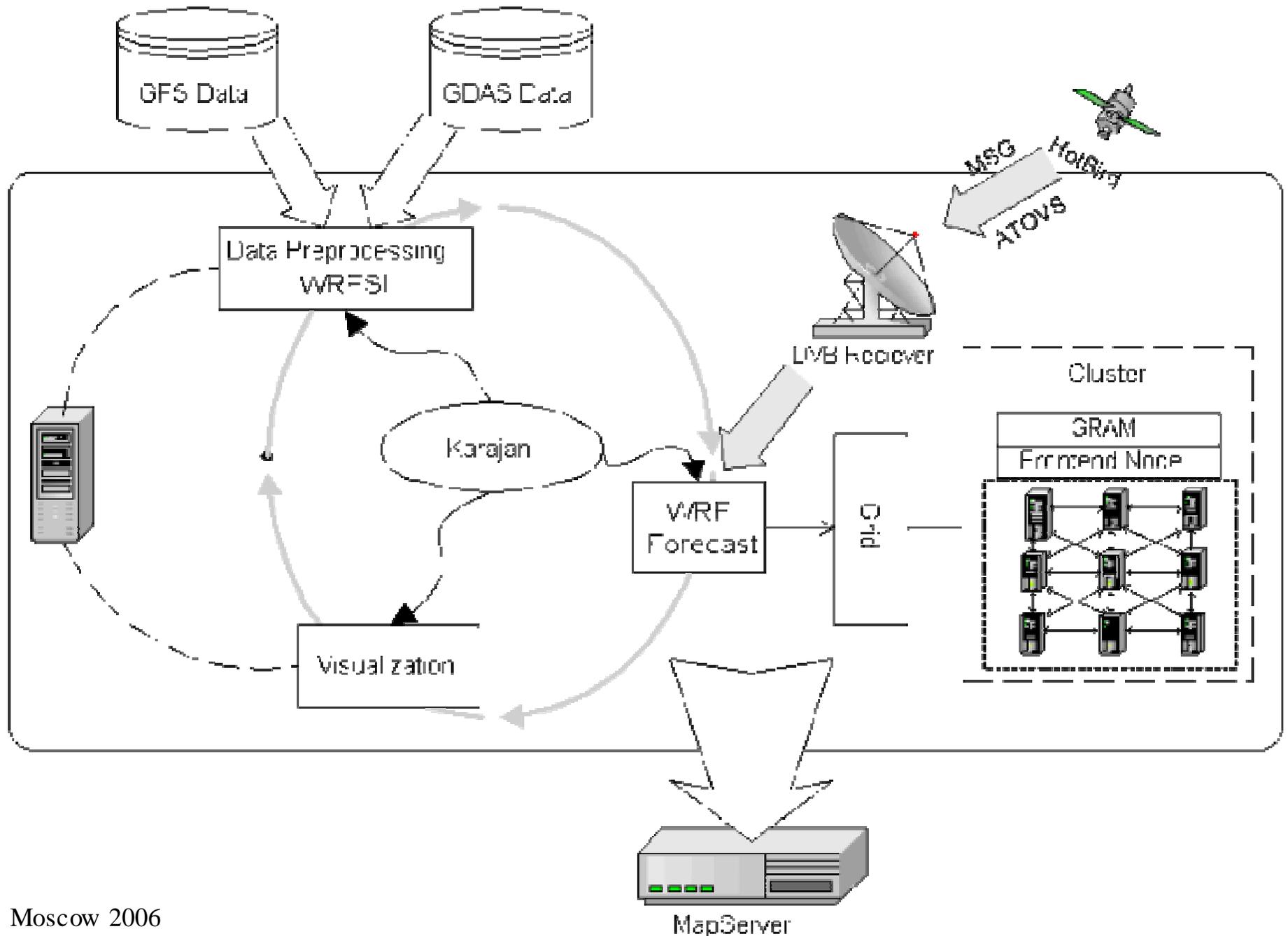
Development cluster



WRF on Grid (1)



WRF on Grid (2)



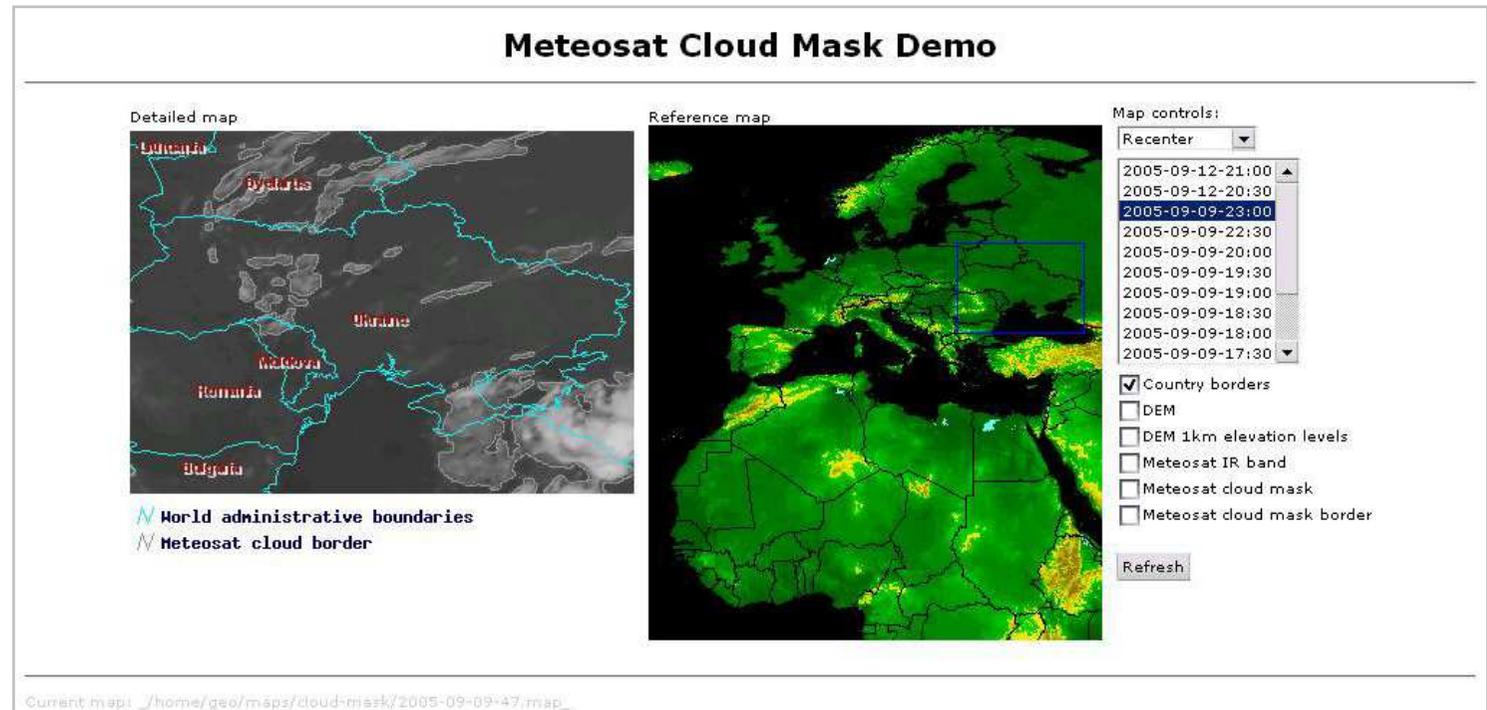
Data Presentation

- Open Geospatial Consortium (OGC) standards for data presentation (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

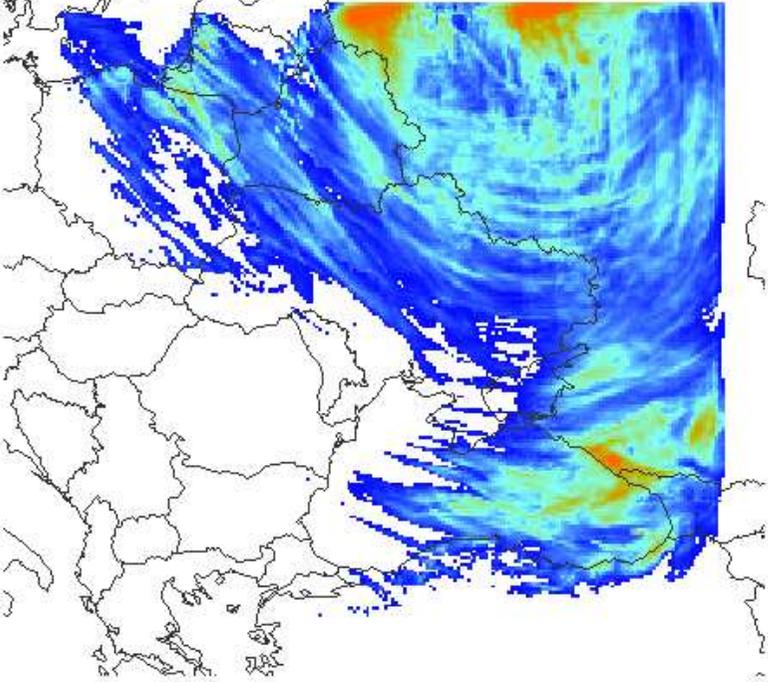
- http://dos.ikd.kiev.ua/?option=com_wrf

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WRF Visualization result demo

Animated WRF



Select Date :

- 2006-09-04 18:00
- 2006-09-04 12:00
- 2006-09-04 06:00
- 2006-09-04 00:00
- 2006-09-03 18:00
- 2006-09-03 12:00
- 2006-09-03 06:00
- 2006-09-03 00:00
- 2006-09-02 18:00
- 2006-09-02 12:00

Select Layers:

- t2
- mu
- hor-speed
- rainnc
- world-lines

[Layers description](#)

[WRF page in a new window](#)

Refresh

Select Hours:

- +00 hours
- +03 hours
- +06 hours
- +09 hours
- +12 hours
- +15 hours
- +18 hours
- +21 hours
- +24 hours
- +27 hours
- +30 hours
- +33 hours
- +36 hours
- +39 hours
- +42 hours
- +45 hours
- +48 hours
- +51 hours

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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!



Moscow 2006