HIRLAM status at INM

Estrella Gutiérrez-Marco
SMNT-INM-Spain

INTRODUCTION

CRAY C94A was operational since 1994. In 2000 INM was making conscience of the necessity of a change, related with the increasing needs of computer power.

INM ITT's was published in February 2002, evaluation of tenders was done during may, and final decision was taken in summer. The winner was Cray, and the project should be developed in two different steps, the first was a Cray SV1, and the second one, now under development, a Cray X1.

CRAY SV1

Cray SV1 is running UNICOS operating system (64 bits), and his major characteristics are as follows:

- 16 vector processors at 300 MHz, theoretical peak performance: 19,2 Gflops Scalar units at 300 MIPS, 256 KB cache CPU.
- 16 GB share memory
- 160 GB disk capacity
- FastEthernet connection
- GigaRing I/O Channel: This high-performance, counter-rotating, dual-ring channel moves large amounts of data via high-bandwidth connections among Cray SV1ex peripheral nodes.

As a transition state, we are running Hirlam model on SV1 without any changes respect the previous C90 configuration, that was:
HIRLAM v4.6.2
Horizontal resolution of 0.5 deg latxlon (194x100).
Non-rotated grid
31 vertical levels
Eulerian dynamics and Optimal Interpolation assimilation,
48 hours forecasts (00, 06, 12 and 18).
Boundaries of the operational integration area are 65.0 to 15.5 º N to 66.5 ºW to 30 ºE, as it can be seen at the figure 1.

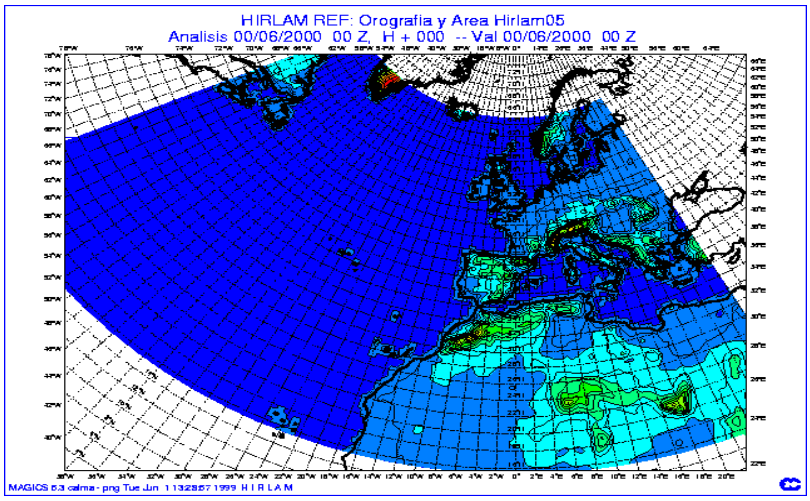
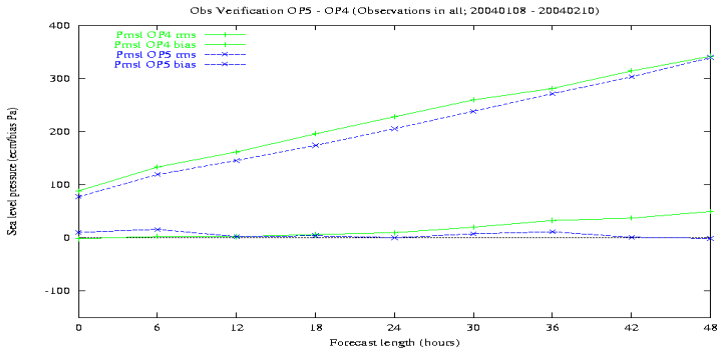
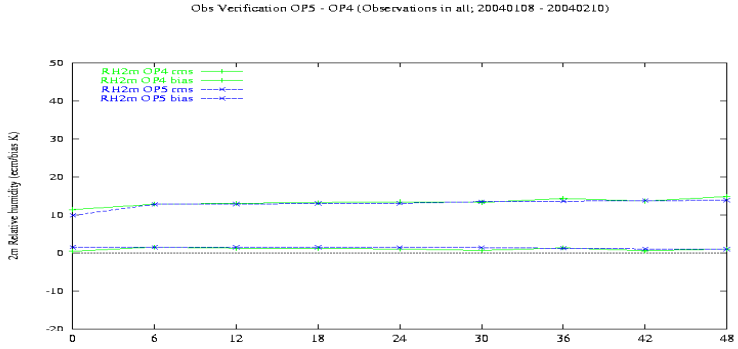


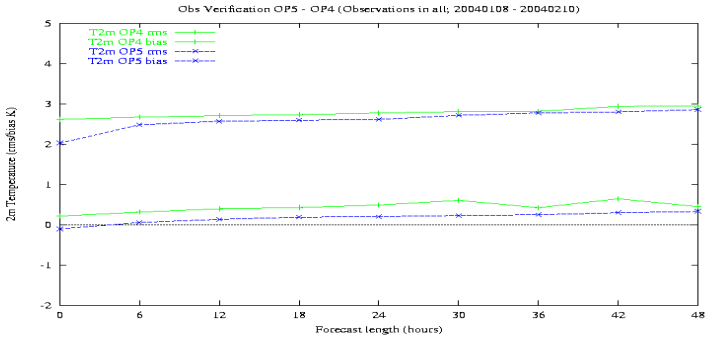
Fig. 1 Operational Integration area

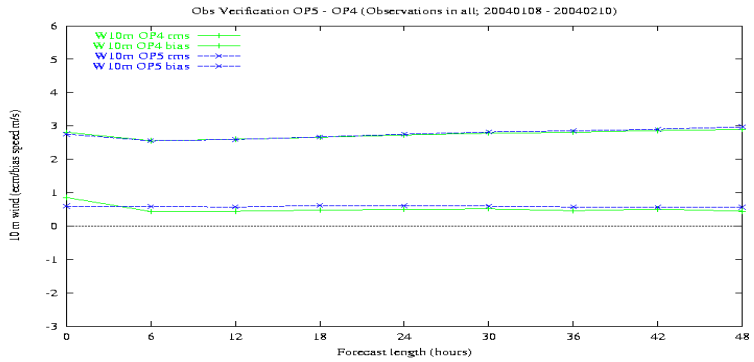
From November 2003 Hirlam version 5 is running in parallel over the same integration area than operational, and with the same characteristics, but with semilagrangian dynamics and 3DVAR assimilation with analytical J_b.

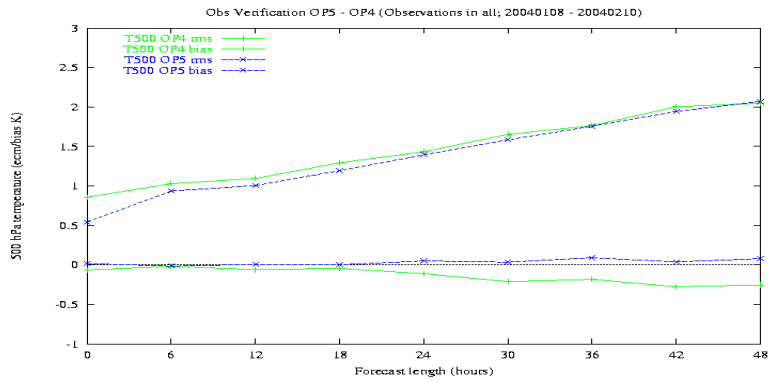
Observation verification was taken comparing both versions, over the period from 20040110 to 20040130, OP4 means Hirlam v4.6.2 with EUL +OI, and OP5 Hirlam v5.1.2 with SL and 3DVAR. Results show improvements on bias and RMS, as it can be seen in the next plots.











CRAY X1

The CRAY X1 system combines the single-processor performance and the single shared address space of Cray parallel vector processor systems with the high bandwidth, low latency, scalable interconnect and microprocessor-based architecture used in Cray T3E systems.

The Cray X1 contains three major functional blocks: the mainframe, the I/O nodes, and the support system (Fig. 3)

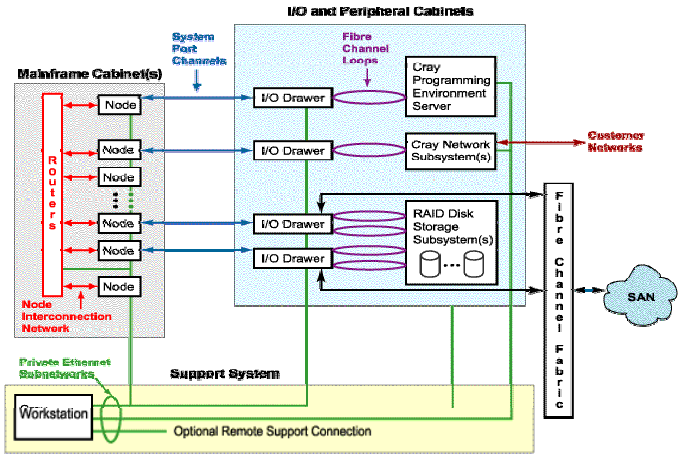


Fig. 3. The Cray X1 System

1. The mainframe

The mainframe consists on nodes and node interconnections network housed in one cabinet called a NODE MODULE. Each node contains 4 processors, globally addressable shared local memory, 4 System Port Channels I/O.

Nodes communicate each other through the node interconnection network. Each node consists of four multistreaming processor (MSP), each of them has 4 ***Single-streaming processsors (SSP)*** *with* 12,8 Gflops of peak computational power for 64-bit data computation in vectorial process (25,6 in 32-bit, 3,2 in scalar process), and 2MB shared cache memory.

Each SSP has 1 scalar processor at 400 MHz: 800 Mflops and 800 MIPS, and 2 x 2 vectorial pipelines 800 MHz (3,2 Gflops in 64 bits and 6,4 Gflops in 32 bits) .

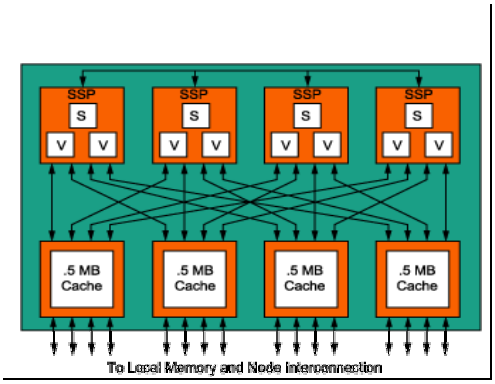
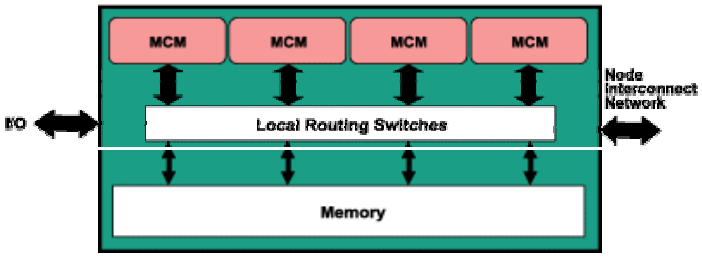


Fig. 4 a) MSP structure



4b) Node Strusture

2. The I/O Node.

The Cray X1 I/O architecture includes the following components:

I/O drawers that convert the SPC protocol used by the nodes to FC protocol used by various peripheral devices,

Cray Programming Environment Server, CPES, that runs the programming environment, housed in a SunFire V480 system with SOLARIS o.s., System files 'cross-mounted' with X1, compilers: Cray Fortran Compiler, including CAF (Co-array Fortran) for distributed memory parallel processing. Cray C and C++, and tool TOTALVIEW by ETNUS.

Cray Network Subsystem, CNS, that connect the Cray X1 system to the customer's networks, housed in a Dell PowerEdge 2650 with Linux o.s

and

RAID Subsystem, LSI E5600, that provides disk storage for the Cray X1 system.

3. The support system

The support system, used to boot, configure and monitor the Cray System, consists of a Cray workstation, the System Control Facility, and several private Ethernet subnetworks.

Cray X1 is running UNICOS/mp operating system, a single UNICOS/mp kernel image runs on the entire system, on the support node that runs the O.S. and the users commands. Nodes where run user's applications are the application nodes.
The application placement scheduler, PSCHED, manages all hardware resources on application nodes.

Actual INM configuration includes a **Storage Area Network (SAN)**, with the following characteristics:

16-port FC - 2Gbit/s by q-logic,

4 TB disk FC ,

Cartridge Library SCALAR 100 LTO by ADIC: 4 units ultrium LTO-2 at 35 MB/s, 72 slots LTO-2, 200 GB without compression; 14,4 TB, and Pathlight 5000 (converts SCSI-FC) to connect to the SAN,

2 control servers Dell PowerEdge 2650, with Linux o.s.

Software StorNext Suite by ADIC , with: StorNext FS, Storage Manager (HSM), and Linux and Solaris clients.

Actual configuration at INM is resumed as follows:

10 application nodes + 1 support node (44 MSP)
176 processors (SSP)
Theoretical peak performance: 563 Gflops
176 GB memory
2 TB directly attached disk + 4 TB in SAN

This configuration will be improved in 2005.

New operational run at the Cray X1 System

At this moment we are implementing Hirlam V6.1.2 on the Cray X1, over a new integration area – rotated grid showed at the figure 4, blue line, with this major characteristics:

Horizontal resolution of 0.16 deg latxlon (582x424). 50 to 60 levels in the vertical (more resolution in the PBL).
Forecast up to 72 hours (00, 06, 12 & 18)
SL Dynamics and new condensation scheme (KF-RK)
3DVAR assimilation with Statistical J_b

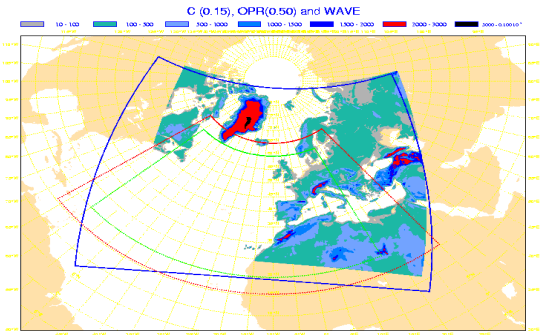


Fig. 5 New operational integration area

FUTURE PLANS

Also we have plans to implement a new operational run over a similar integration area with rotated grid, an horizontal resolution of 0.05 deg latxlon, 50 to 60 levels in the vertical, forecast up to 36 hours (00, 06, 12 & 18), SL Dynamics and new physics (Kain-Fritsch), and 3DVAR, if possible.

In 2005 we expect to run a short range EPS with the following characteristics:

Multimodel approach (HIRLAM, HRM model, MM5, UM).
Boundaries (ECMWF, DWD global model, NCEP, UKMO global model)
Horizontal resolution about 0.25 deg latxlon
40 vertical levels.
72 hours forecasts.
25 members every three hours (00, 03, 06, ...21)
Ensemble of last 100 members