

# Scalability of IFS on massively parallel computers with special focus on Data Assimilation

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**Acknowledgement to  
Colleagues at ECMWF**

# Talk overview

- **Project plan**
- **Future High Performance computers**
- **Current scaling properties of ECMWF Data Assimilation System**
- **Conclusion**

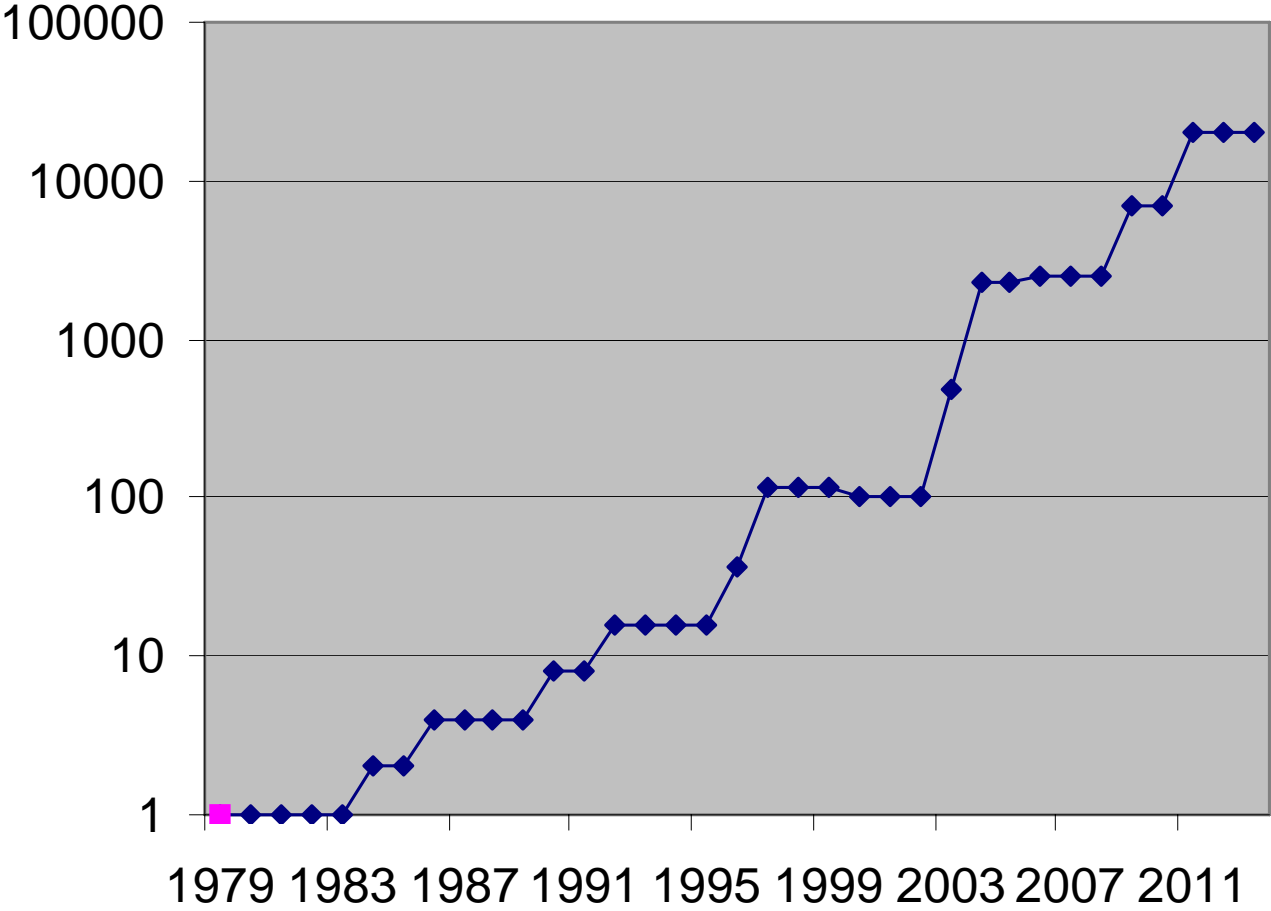
# Project Plan

- **Project to initially run for two years**
- **Prepare for the possibility on running ECMWF's operational codes on massively parallel computers**
- **Main focus on Data Assimilation where the greatest challenge is foreseen**
- **Collaborative effort with other groups**

# ECMWF HPC through time

Cray 1A	1979-1984	1	1
Cray XMP-22	1984-1986	1	2
Cray XMP-48	1986-1990	1	4
Cray Y-MP	1990-1992	1	8
Cray C90	1992-1996	1	16
Fujitsu VPP700	1996-1997	36	36
Fujitsu VPP700	1997-2000	116	116
Fujitsu VPP5000	2000-2003	100	100
IBM P690	2003-2004	30*2	480*2
IBM P690+	2004-2006	70*2	2240*2
IBM P5-575+	2006-2009	155*2	2480*2
IBM P6	2009-2011	~240*2	~8000*2

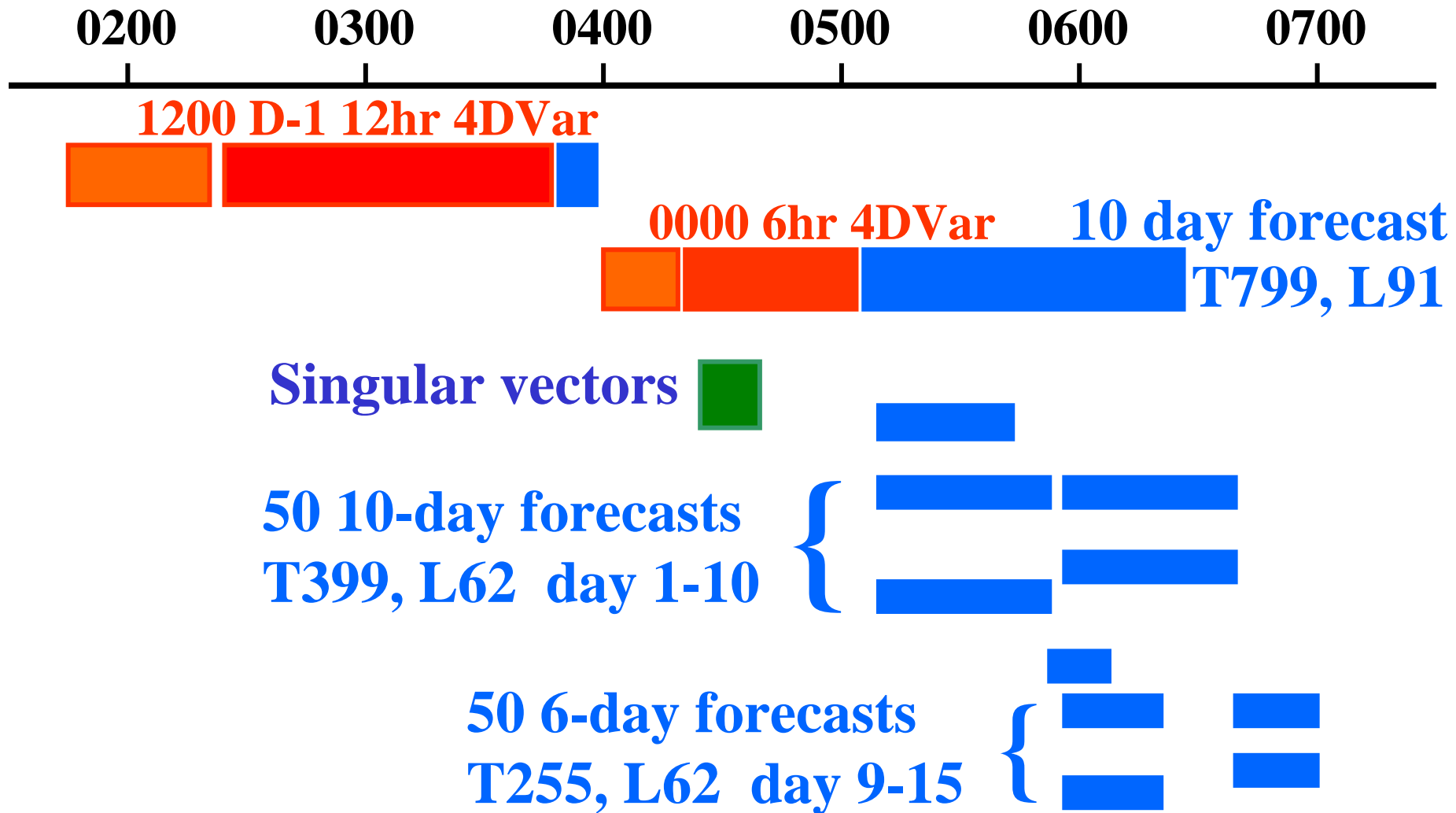
# ECMWF HPC Core count



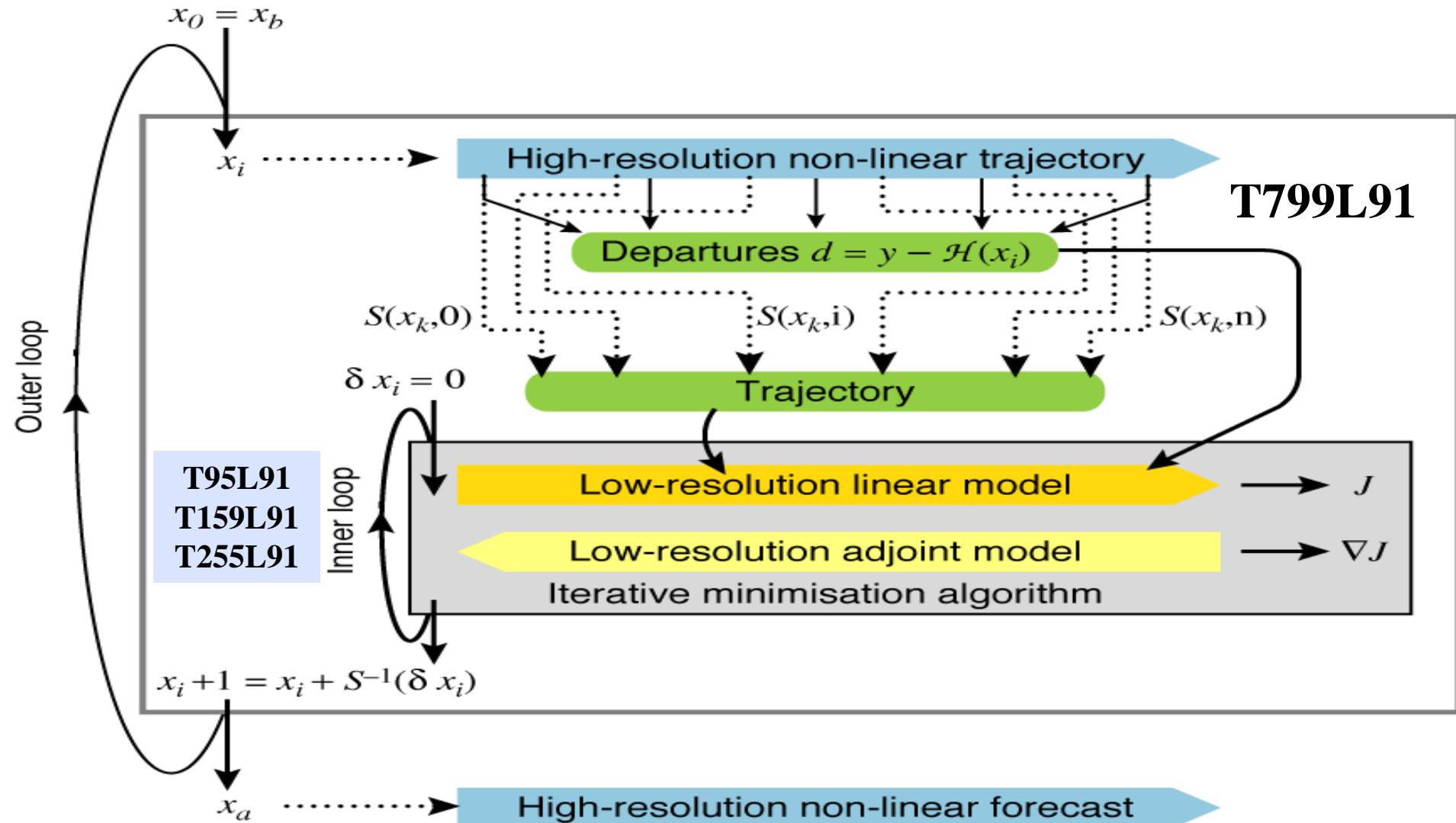
# Next HPC at ECMWF

- **May have in the order of 100,000 cores based on current budget and industry trends**
- **Contract with IBM for Power6/7 expires June 2013**
- **Benchmark needs to be ready by the end of 2010**
- **All components of benchmark should scale reasonably to > 25,000 cores**
- **Operational codes need to be ready for making efficient use of ~100,000 cores early in 2013**

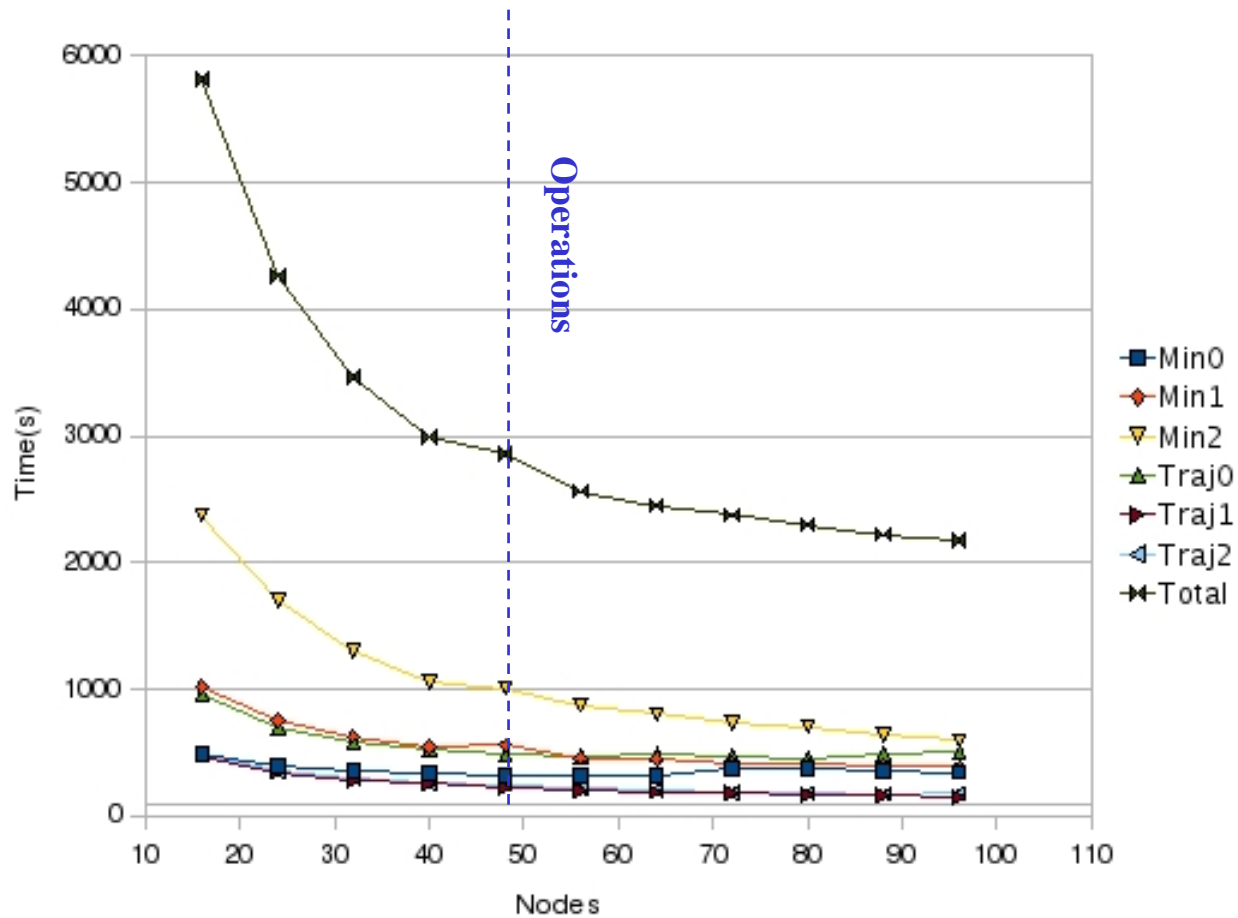
# The 0000 UTC Operational Suite



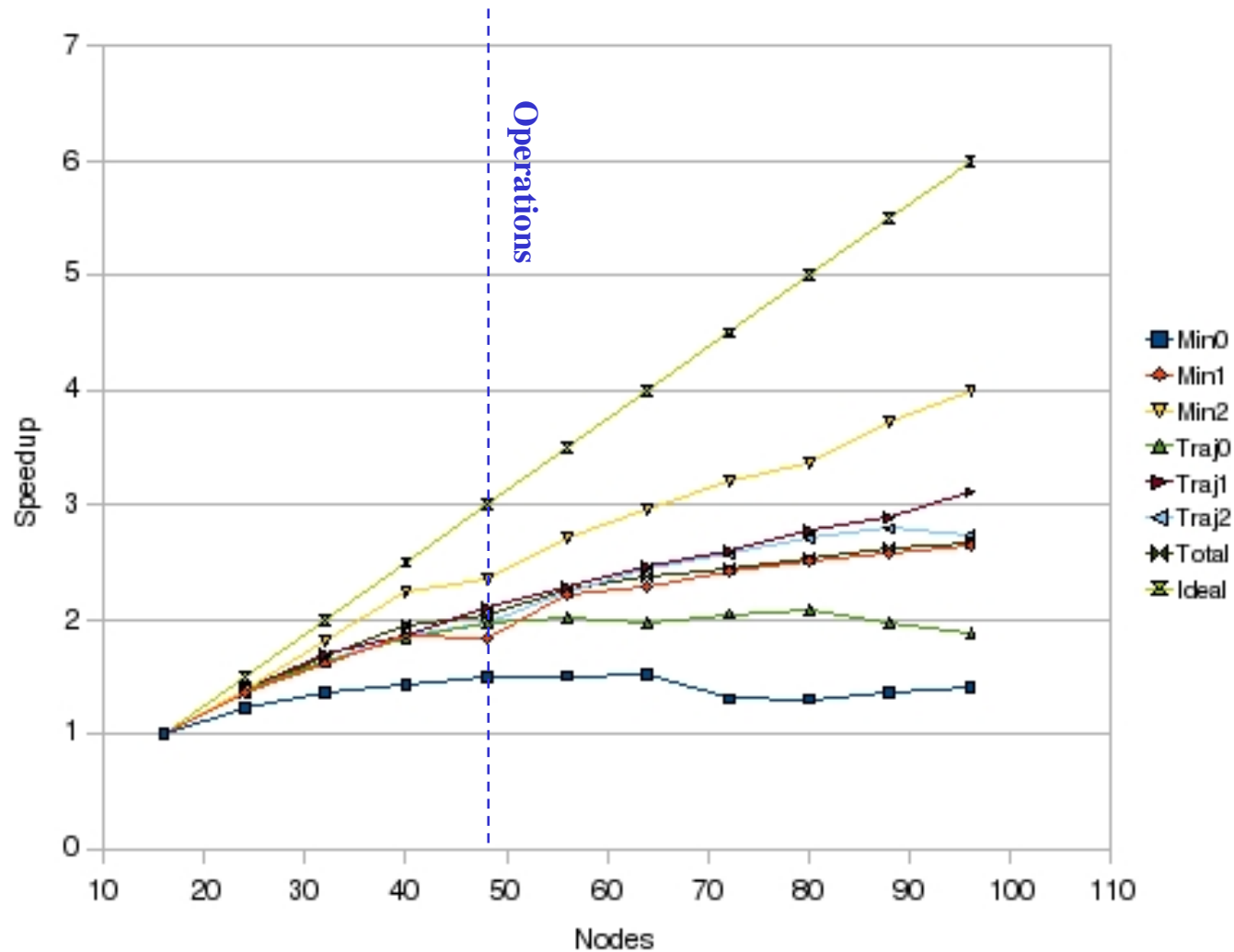
# Multi-incremental 4D-Var at ECMWF



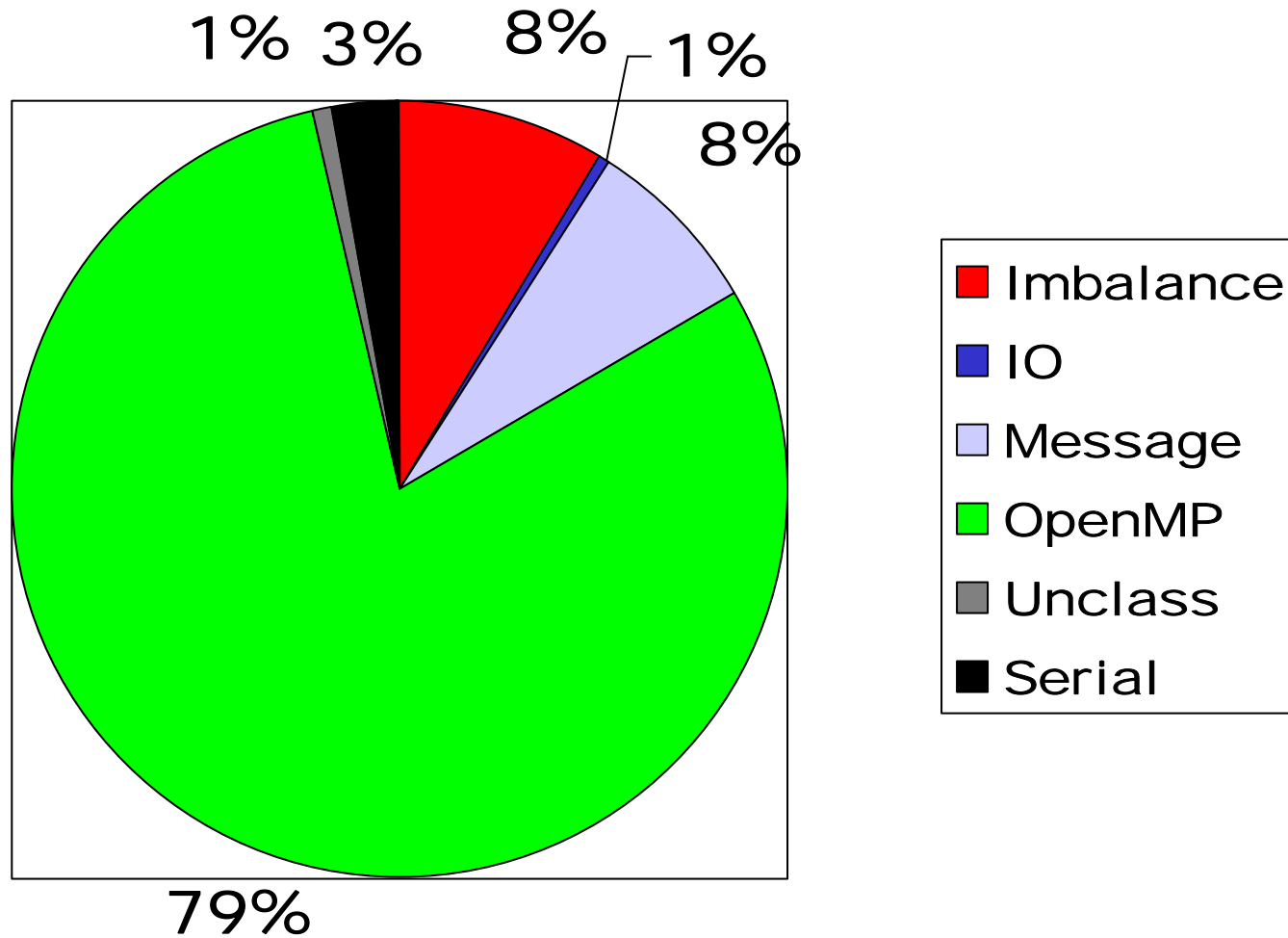
# 4D Var run-time, 32 user threads per node



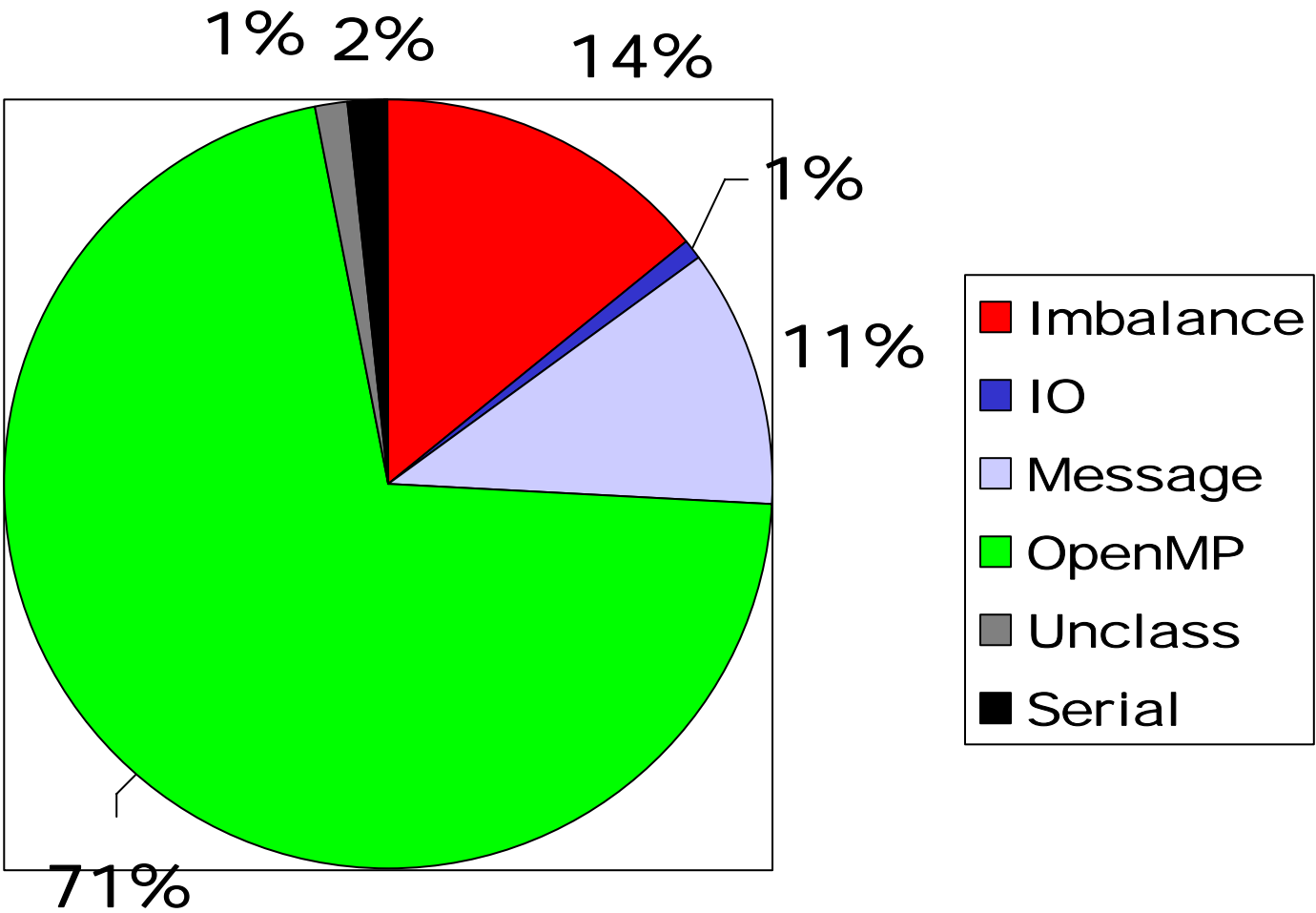
# Incremental 4D Var speedup



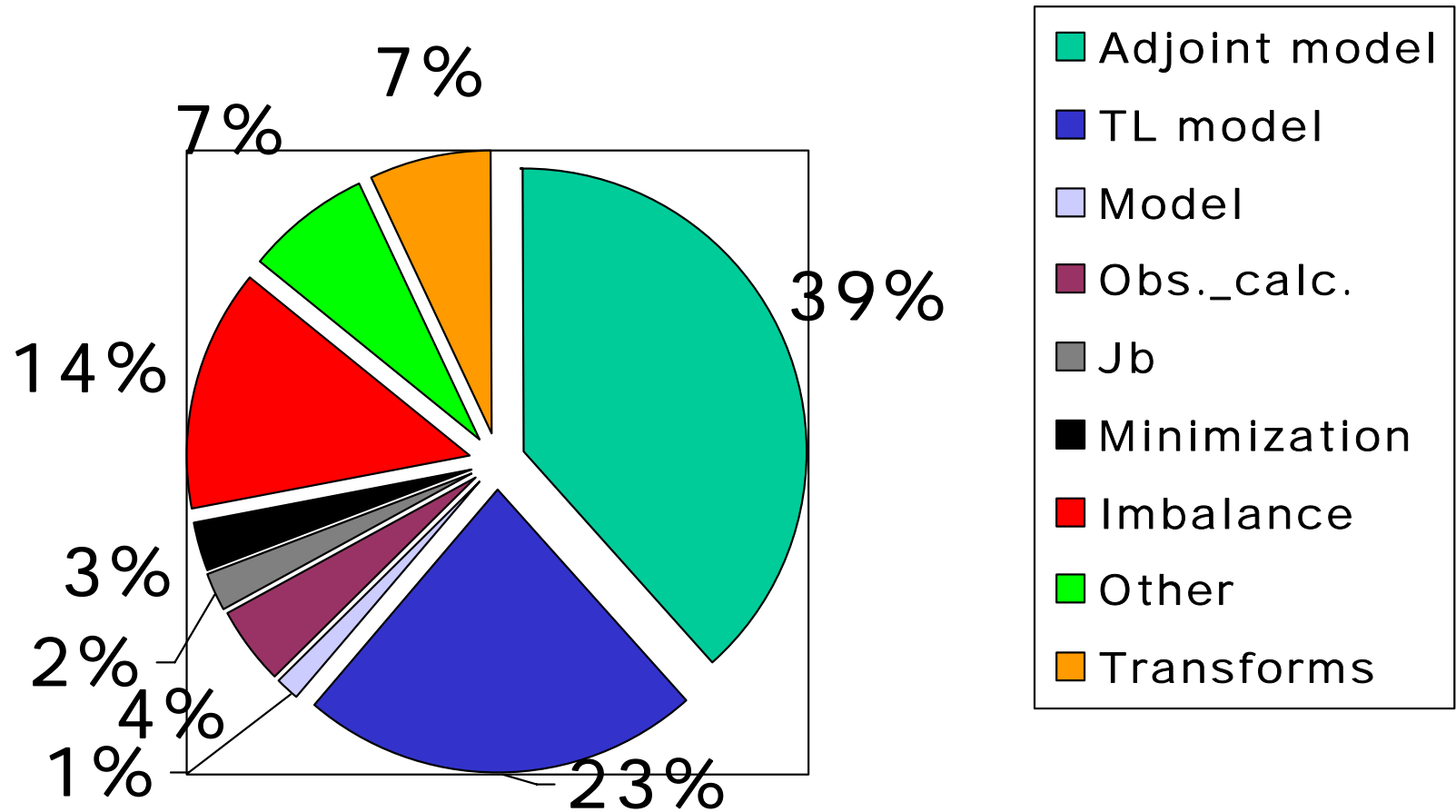
# Final minimization, 24 Nodes (96x8)



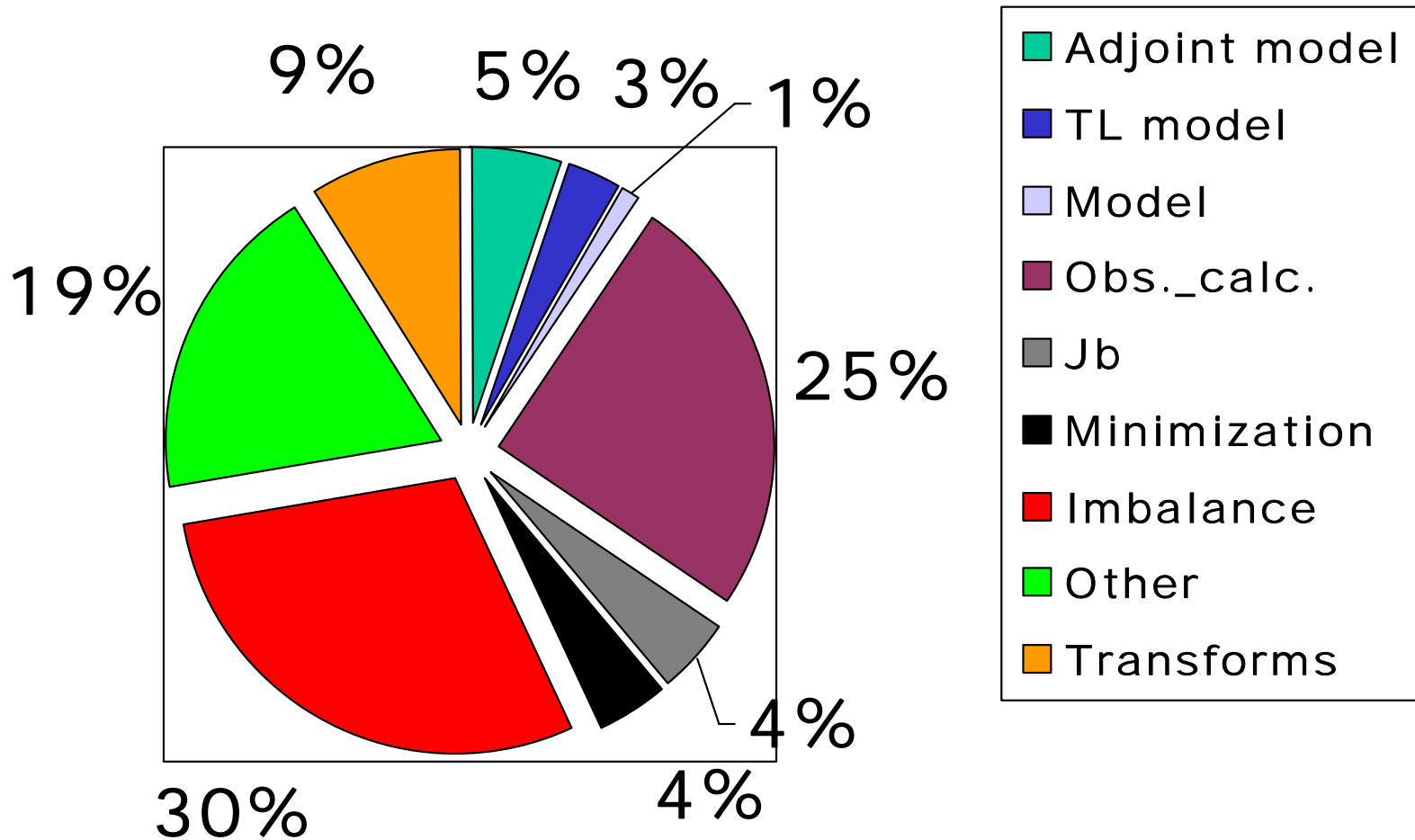
# Final minimization, 48 Nodes (192x8)



# Final minimization, 48 Nodes



# First minimization, 48 Nodes



# Questions we need to answer

- **What is inhibiting scaling of the current 4D Var?**
- **What is the impact on scaling of the planned scientific developments for the IFS ?**
- **Should the continued use of Incremental 4D Var within the foreseeable future be assumed?**

# Items from ECMWF 10-year strategy

- **Non-hydrostatic model**
- **Long window 4-D var**
- **Error correlations of observations**
- **Ensemble data assimilation**
- **Additional variables (rain ,CO2,aerosols...)**
- **Modularization of IFS**
- **Increased resolution (10km in 2015)**

# Conclusion

- **The ECMWF Data Assimilation System presently does not scale as we would wish it to do**
- **We need to resolve these problems or look at alternative algorithms**