WISER

A Weather climate change Impact Study at Extreme Resolution (WISER)

Alan Gadian, James Groves (Systems, data transfer, software scripting, etc.), Daniel Walker (systems etc), Alan Blyth (microphysics) and Stephen Mobbs

with help from

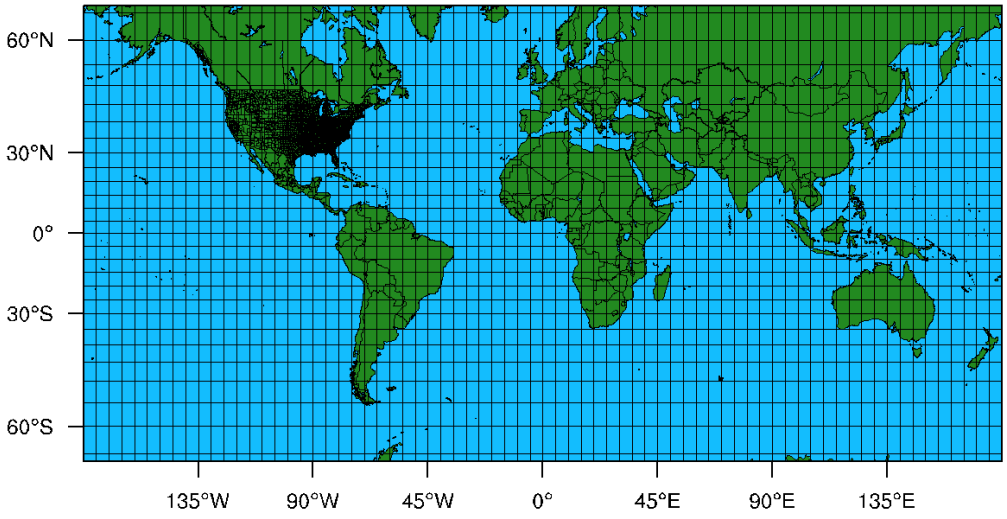
Many at STFC, Daresbury

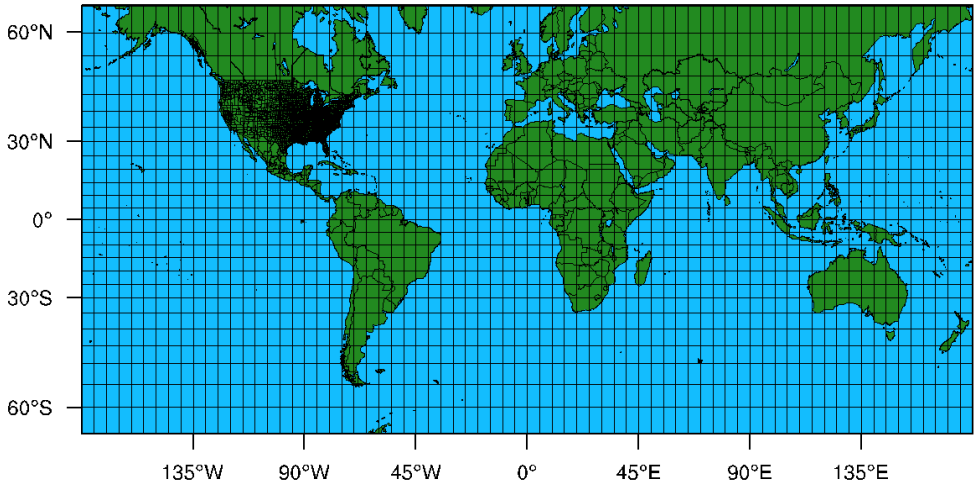
WISER

STFC support for the WISER (Weather climate change Impact Study at Extreme Resolution) project has made this project possible. We will embed a nested simulation using the NCAR WRF (Weather Research and Forecasting) model within climate reanalyses and predictions from ECMWF and NCAR (US National Center for Atmospheric Research). The nested WRF simulations will cover +/- 65 deg of latitude and will be nested down to 4 km resolution over western Europe, capturing almost all important weather scales.

Validation runs will include 1970-present day and predictive runs will include present day to 2080. Runs are planned in 10 year blocks, each with several completed simultaneously on 3000-5000 cores. Each 10 year block will use ~300 hours on 3000-5000 cores on the new Hartree IBM Blue Gene/Q. The work is part of an ongoing collaboration between NCAR's Nested Regional Climate Modelling group and NCAS, with active support of the Hartree Centre. The project aims to provide new insight into the technology of regional climate modelling (especially from the validation “hindcast” runs) and provide statistical predictions of the European regional impacts of climate change.

WISER





A schematic possible domain decomposition. In our simulation we propose that we can run the 20km model between +/- 65^0 latitude and 4km over Western Europe ~ 3,000 cores.

Figure 1 (upper) has truelat at 0, and in this case you will get true 20km at the equator and about 8.5km at +/-65^0.

Figure 2 (lower) has 20km true at 45N and 45S, producing about 28km at the equator and 11.5km at +/-65^0. The Western Europe nested domain will produce an inner model resolution of ~ 4km, with a domain nesting factor of 5:1

WISER

Expected Outcomes:

The aim is to establish how storm track behaviour, occurrence of blocking anticyclones and severe precipitation in Western Europe, and in particular the UK, will change over decadal timescales in the modified climate system caused by global warming (A2).

Provisional objectives and specific outcomes:

1.Predicted changes in general precipitation over western Europe and the UK over decadal times scales.
2.Predicted changes in patterns of frontal tracks on decadal time scales and to examine the strength, the frequency and the location of Western Atlantic storm tracks for historical and future simulations.
3.Past and predicted occurrence of blocking in the North Atlantic
4.Predicted changes in quantity and frequency of severe and hazardous convective rainfall events as above. The frequency of flash flooding due to heavy convective precipitation. Links to be examined to connections with JRC for flooding.
5.PDF of (C.E.T.) temperatures and any other regions of specific examination.
6.Predicted changes in surface wind field distributions at current and planned wind farm sites. This follows on (and develops) the NERC-funded Land-based Renewables consortia project. As the UK and Europe need to dramatically increase their dependence upon renewable energy sources [1], such wind speed distributions are crucial for determining the potential yield of wind farms in future climate scenarios for decadal predictions.

WISER

Computational needs to be addressed

- Optimisation of cache usage for the specific problem domains

- Tuning the number of tiles per processor and its interaction with the cache optimisation

- Tuning the number of threads and tasks per node to optimise the communication to compute balance

- The use of I/O quilting for parallel netcdf output, to address an important bottleneck

.

- Optimisation of the domain decomposition facilities available in WRF

- Different optimised compilers and compilation options which can greatly effect run time

- Nesting of domains in the most efficient manner, which, on its own can produce a 25% improvement in Porter et al (2010)

WISER

The proposal is based on 50 year climate simulations. It may be optimal to complete a spin up of the global climate model of 50 years (giving 100 years in total), but in terms of computational resources, running the global model will require insignificant resources compared to the very high resolution nested regional simulations. Greater than 90% of the CPU time will be used by the high resolution (~4 km inner domain) simulations.

CPU requirements from our present work on the HECToR system, (~ 430 * 450) which use approximately 5×10^4 AU. Each run ~ 20,000 cores for 250 hours. Our proposed one year (500 times longer than current runs) runs at the same resolution will thus use $5 \times 10^4 \times 500 \approx 2 \times 10^7$ AU. We wish to simulate whole years of the climate at several points over the 50 year study.

High resolution runs of 4 years duration five times over 50 years, resulting in a total of 20 years at high resolution. The total computational requirement is ~ 4×10^8 AU.

A single year's simulation at high resolution will require 25 Tbyte storage. Therefore for the whole project with 20 years of simulation the total requirement is 500 Tbytes.

WISER and JASMIN North

Bias Correction

- Describe any 6-hourly CCSM data set as an average annual cycle plus a perturbation term:

$$CCSM = \overline{CCSM} + CCSM'$$

- applied to variables: *U,V,Z,T,RH,Surface T and PMSL.*

- Do the same for NCEP-NCAR Reanalysis data:

$$NNRP = \overline{NNRP} + NNRP'$$

- Replace $\overline{CCSM}$ with $\overline{NNRP}$ to represent a bias corrected future 6-hourly forecast:

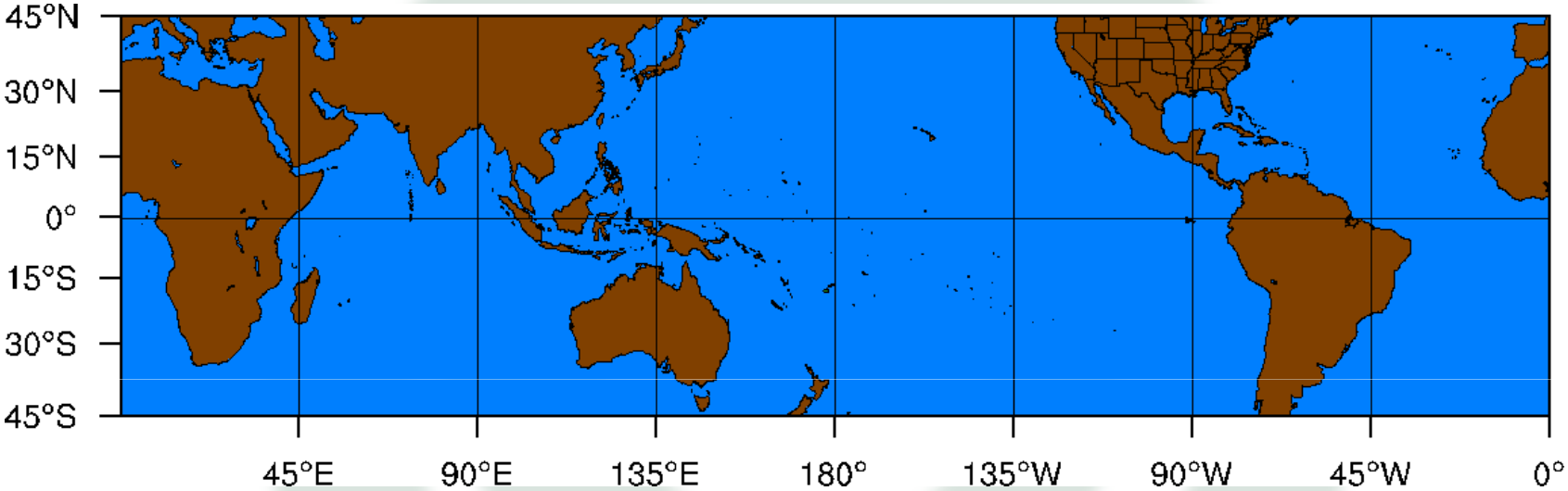
$$CCSMc = \overline{NNRP} + CCSM'$$

Base climate provided by NCEP-NCAR Reanalysis data and the weather and climate change signal provided by CCSM

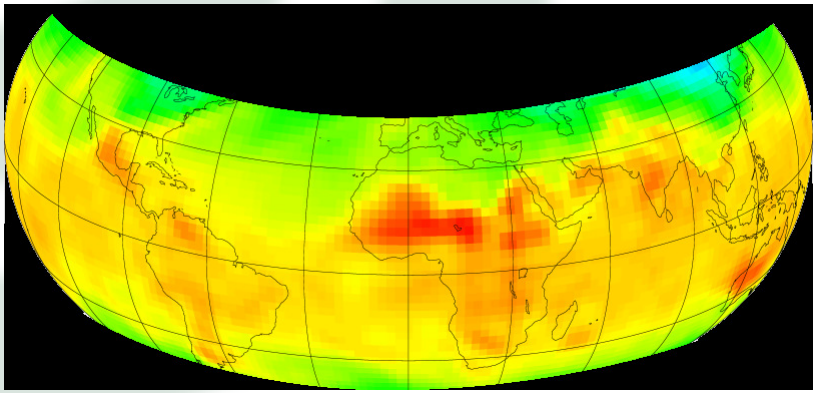
WISER

Collaborations

1. National Center for Atmospherice Reasearch (NESL .. Greg Holland, James Done, Cindy Bryere)

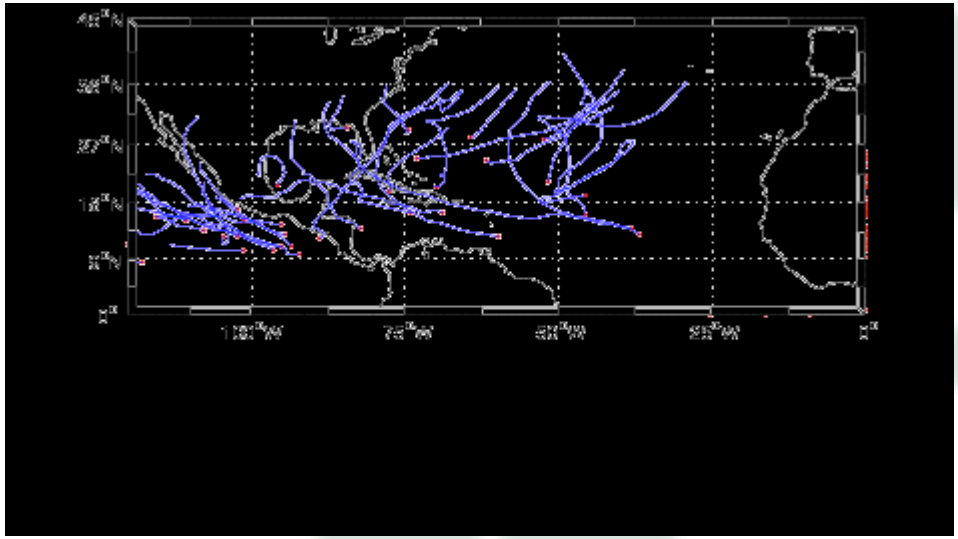


45S - 45N
36 km resolution
51 levels
10 mb TOA



2000 - 2005
Reynolds SST data
Periodic EW boundary

WISER



36km

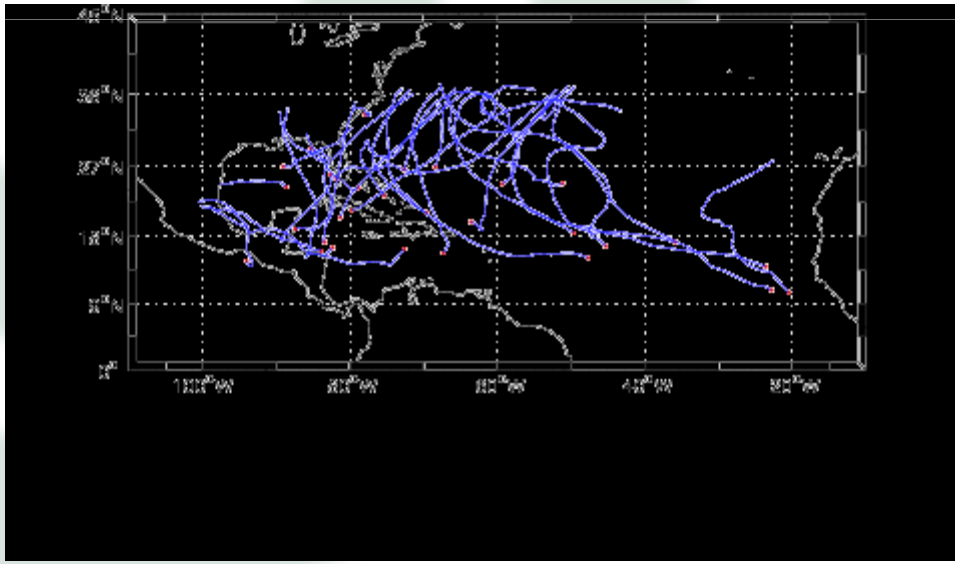
18 storms

12 km nest

28 storms

(27 storms observed)

Asuka Suzuki-Parker

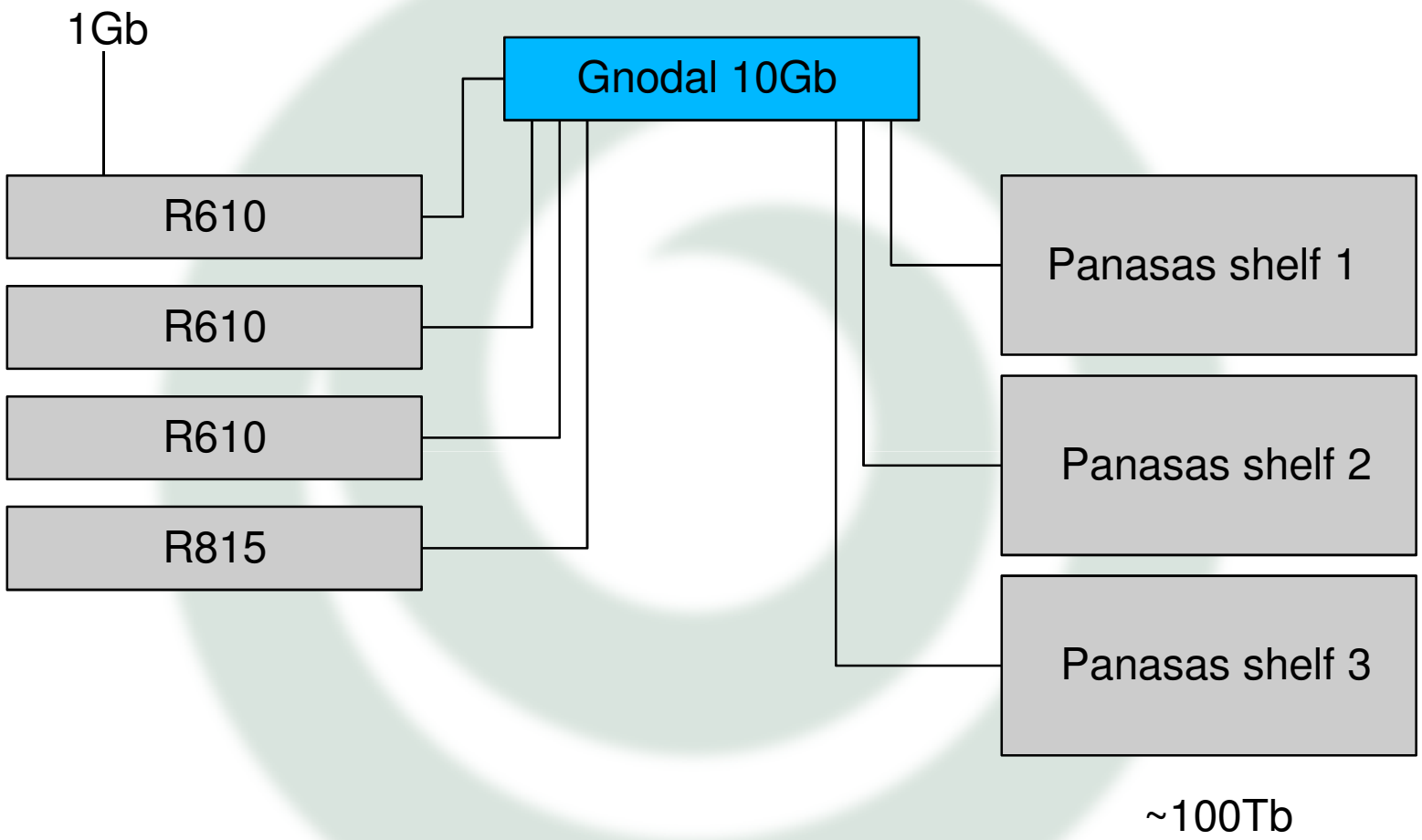


WISER and JASMIN North

Jasmin North

(James Groves)

WISER and JASMIN North



What we currently have setup and running on Jasmin North

- All machines installed with Centos 6
- NIS, dnsmasq, is setup on the one of the R610s this is to act as a gateway.
- NFS and Panfs is setup on all the client machines

JASMIN North and WISER

- WRF model complied and running across multiple machines using mpi
- WRF analysis software compiled and running
- GEOS-Chem model setup and running

WISER and JASMIN North

Issues:-

1. Transfer of CCSM data files from the US
2. Transfer of data files from Daresbury and RAL
3. Poor client performance on the R815
4. Network speed Issues in and around campus