Convection permitting latitude-belt simulation using the WRF model

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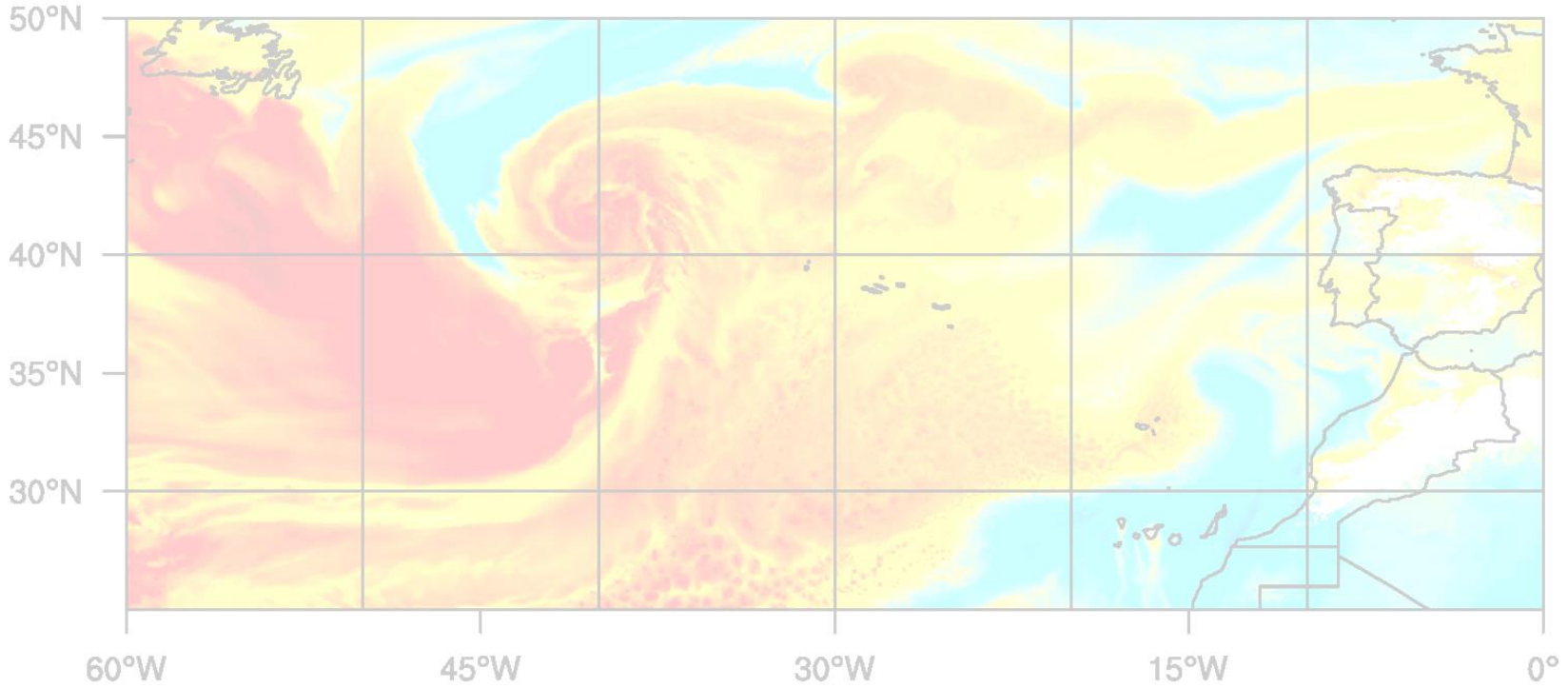


Outline

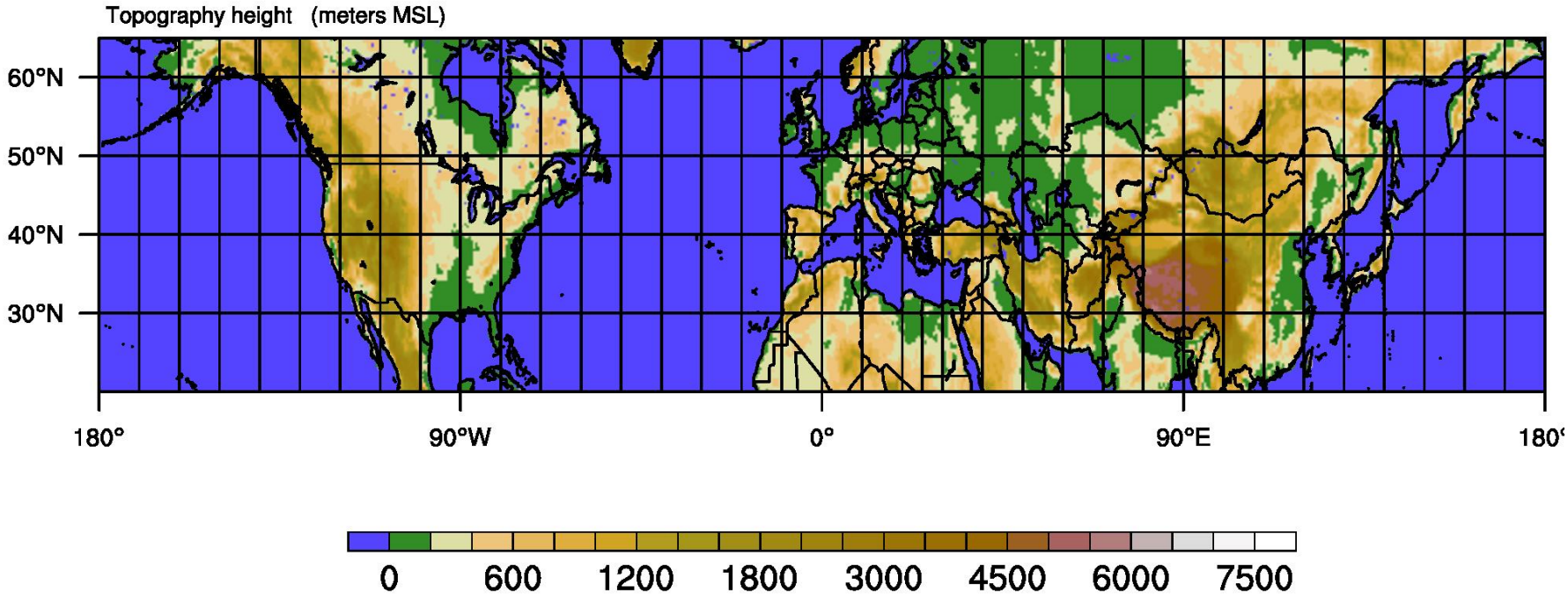
- Motivation
- Experimental and technical setup
- Results
- Summary

Motivation

- Feedback processes from the large to the local scale
- Current high-resolution NWP domains are set up over the region of interest - may lead to distortions at the boundaries
- Boundaries over the Atlantic can be crucial for Europe
- Convection permitting (CP) resolution is very important to realistically represent meteorological processes and features
- Having the chance to use a complete HPC system

Experimental setup

Channel domain with 0.03° resolution



Experimental setup

- CP resolution of 0.03° (3.3 km) with 12000*1500*57 grid cells
- Model top 10 hPa with 14 levels up to 1500 m above ground
- Forcing data from ECMWF analysis every 6 h at the north/south
- Morrison 2-moment microphysics
- YSU Planetary boundary layer parameterization (non-local)
- NOAH Land surface model (4 soil layers, single layer snow model)
- SST data @6 km resolution (OSTIA project of UK Met Office)
- Simulation period July and August 2013
- Control experiment with 0.12° and cumulus physics

Technical aspects

- 3500 nodes of Cray XC40@HLRS (84000 cores in total)
- MPI/OpenMP hybrid mode
- Parallel NetCDF with LUSTRE file striping (set to 96)
- Output frequency was 30min for 3D data
- Output frequency of 15min for additional diagnostic files
- Including auxiliary files total data amount ~450TB
- Simulation without I/O takes about 1.5 days
- Total required time was 3.5 days

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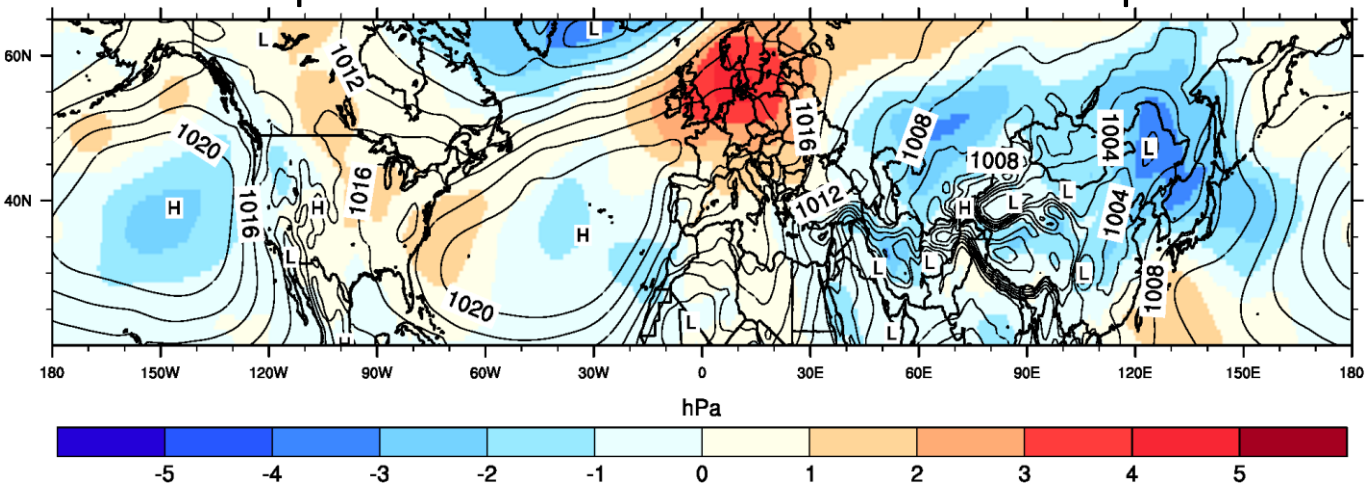
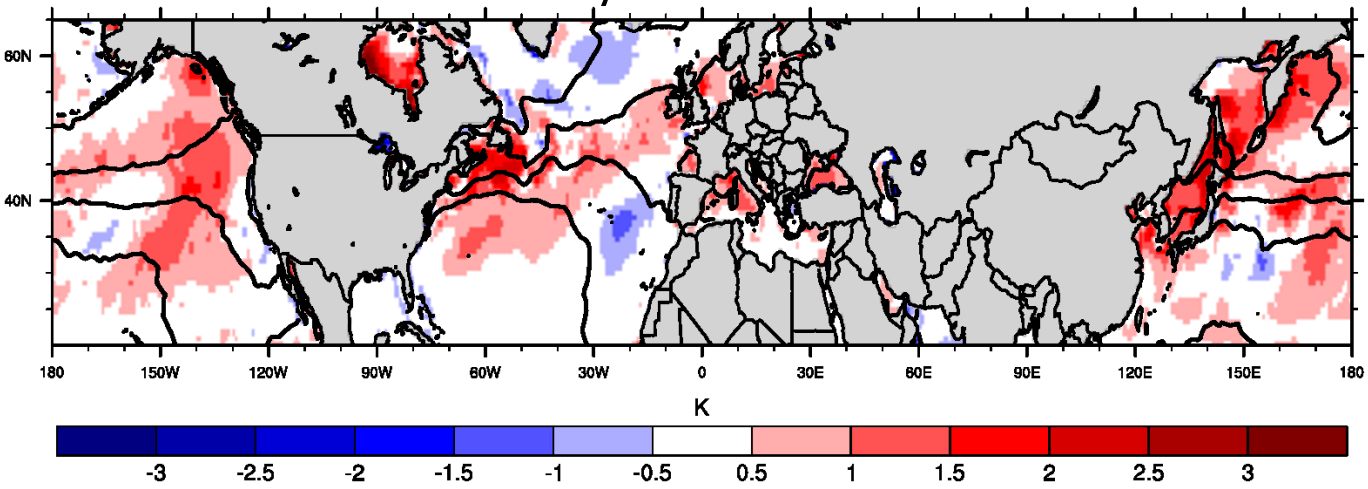
Meteorological situation

Sea level pressure and difference to 1989-2012 period

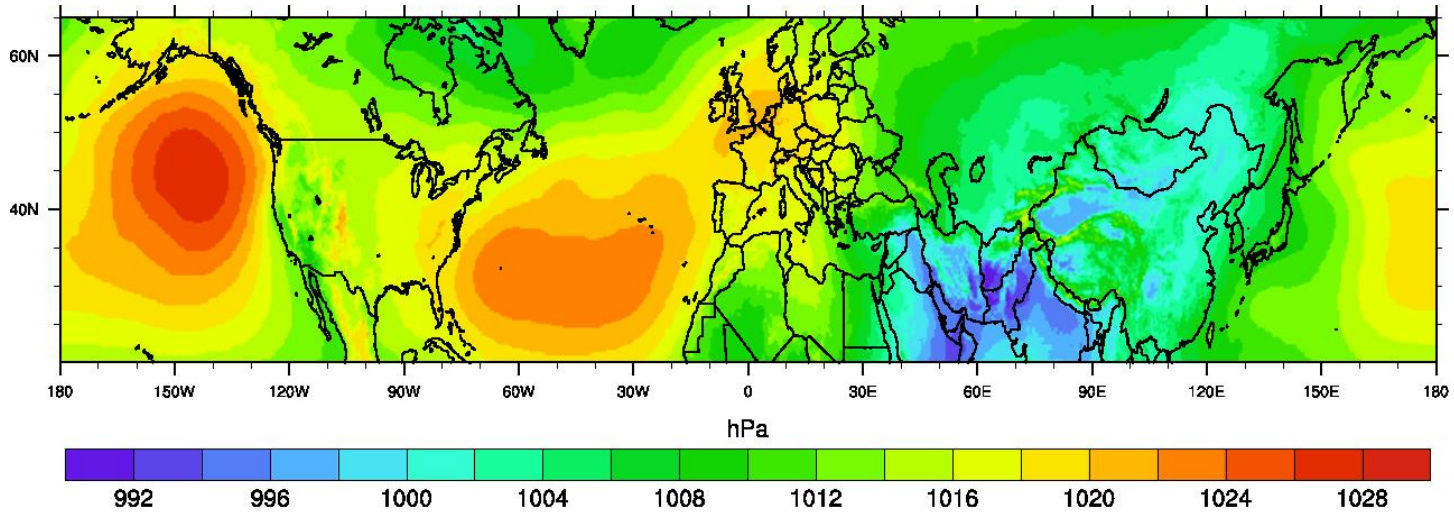


SST anomaly w.r.t. 1989-2012

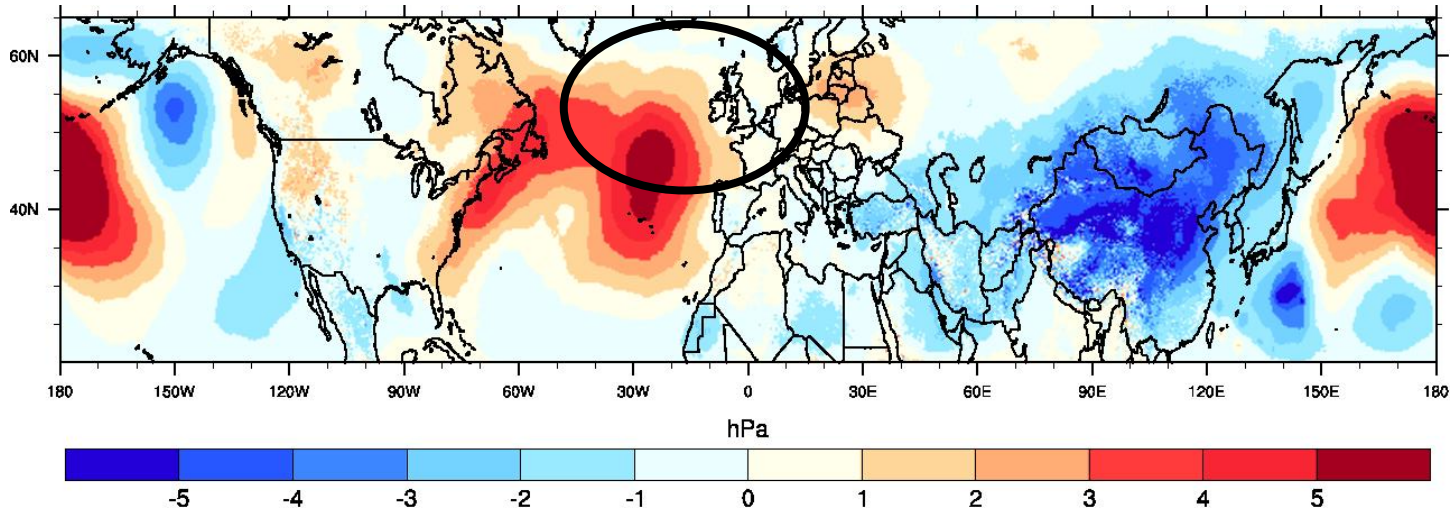


Average MSLP at 12Z time steps (July)

ECMWF



Mean bias 0.03°



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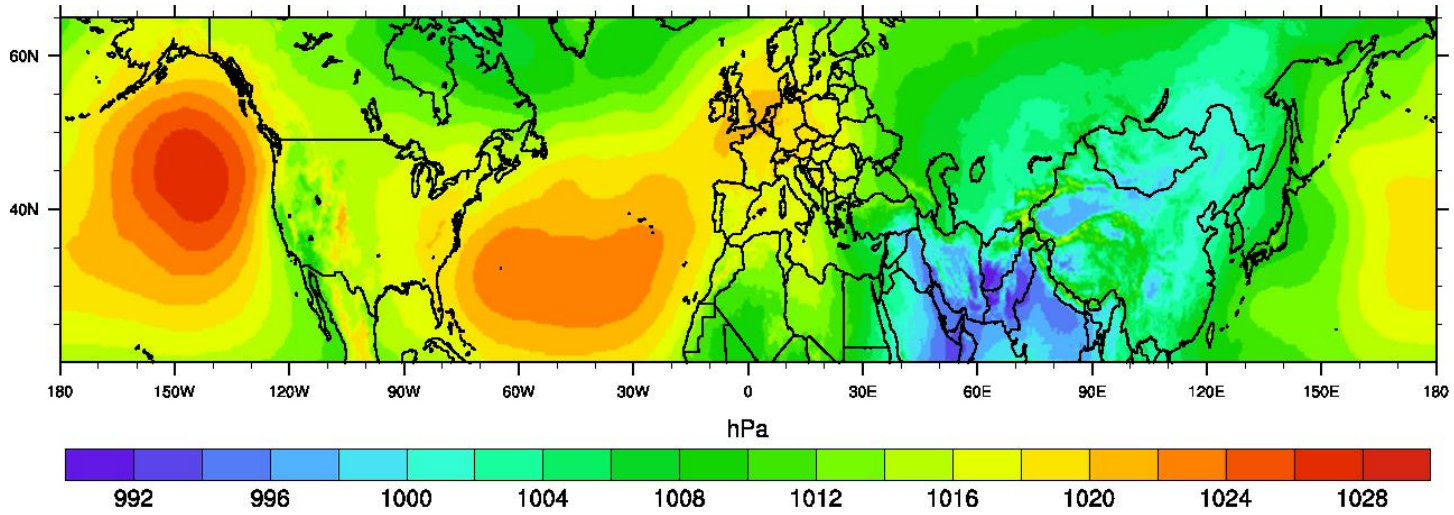
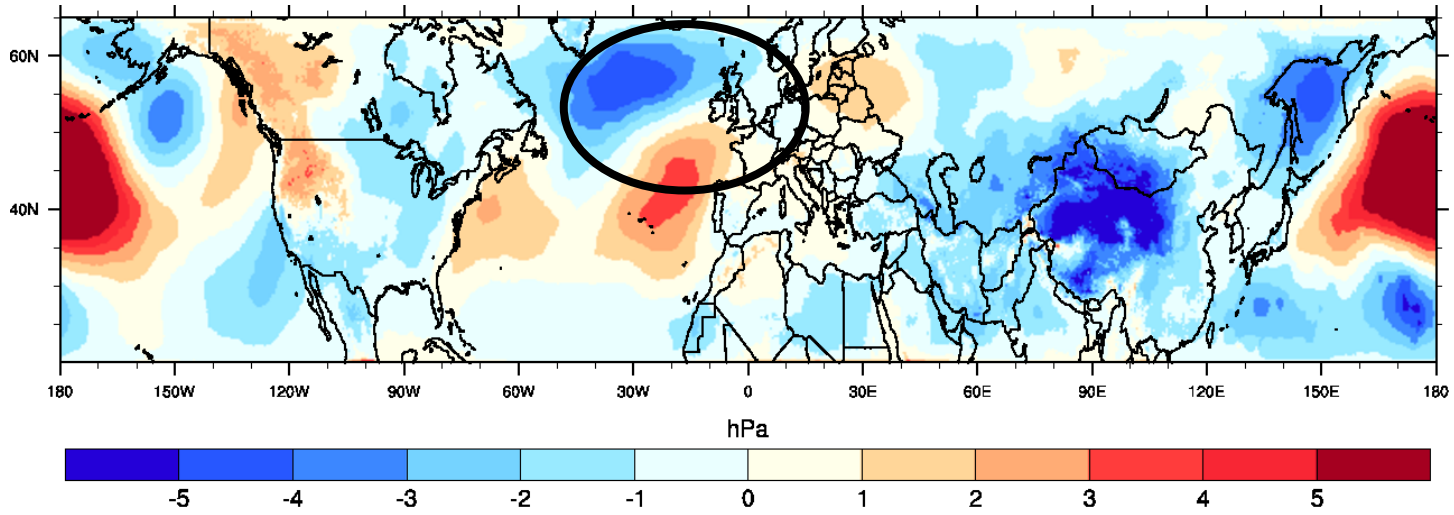
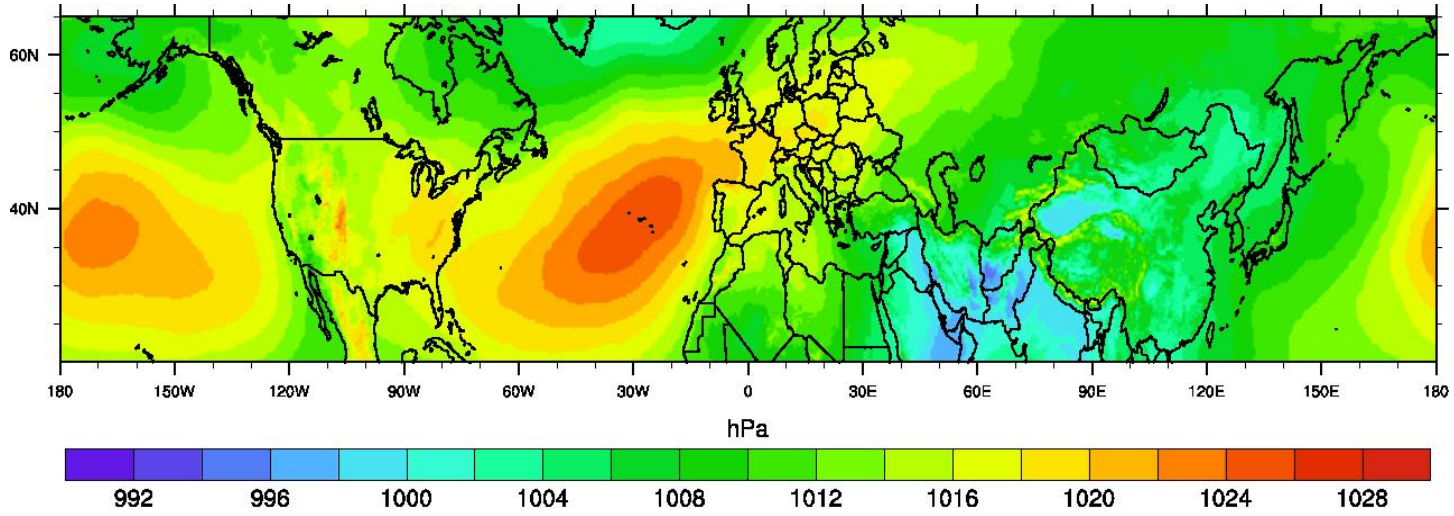


Mean bias 0.12°



Average MSLP at 12Z time steps (August)

ECMWF



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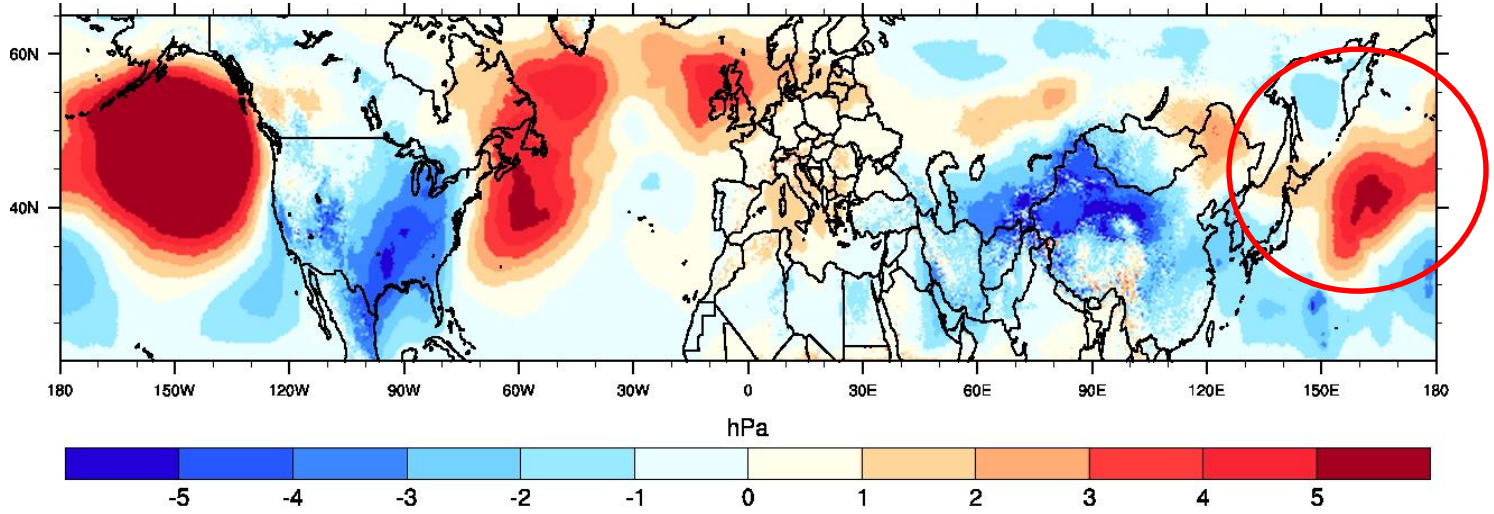

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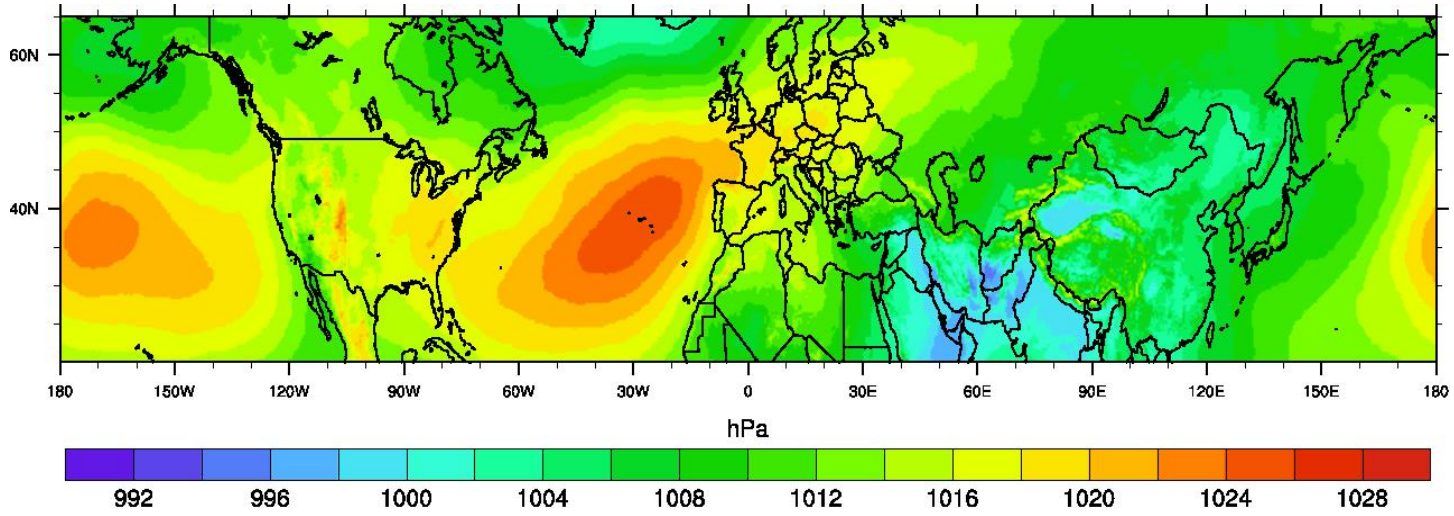

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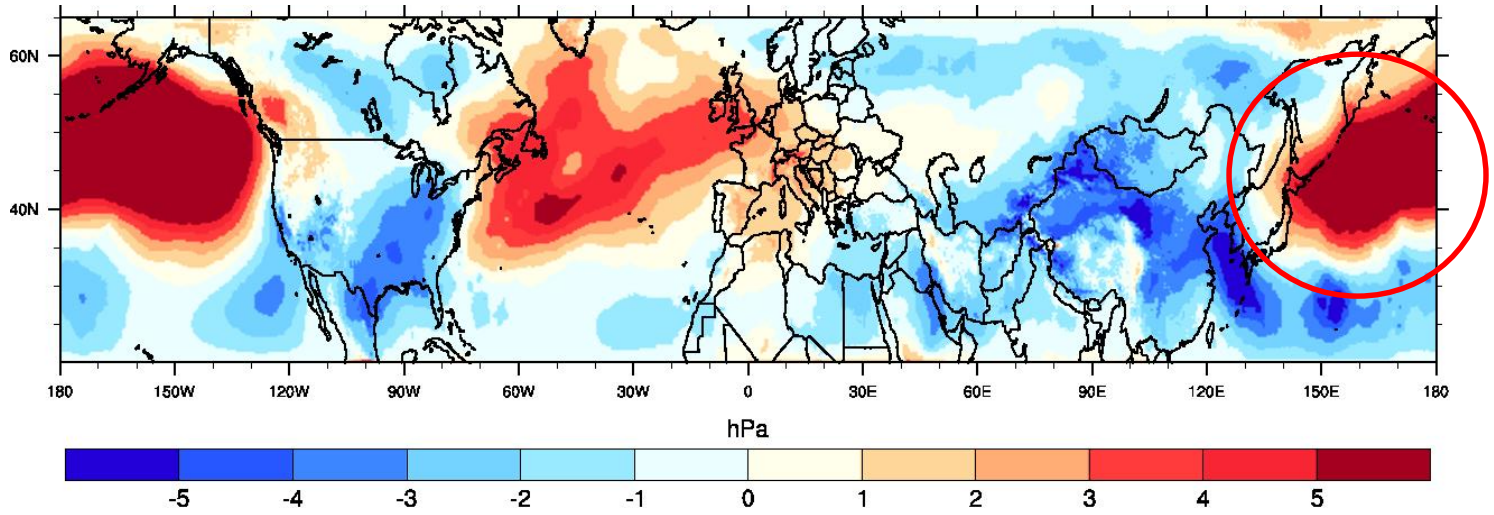
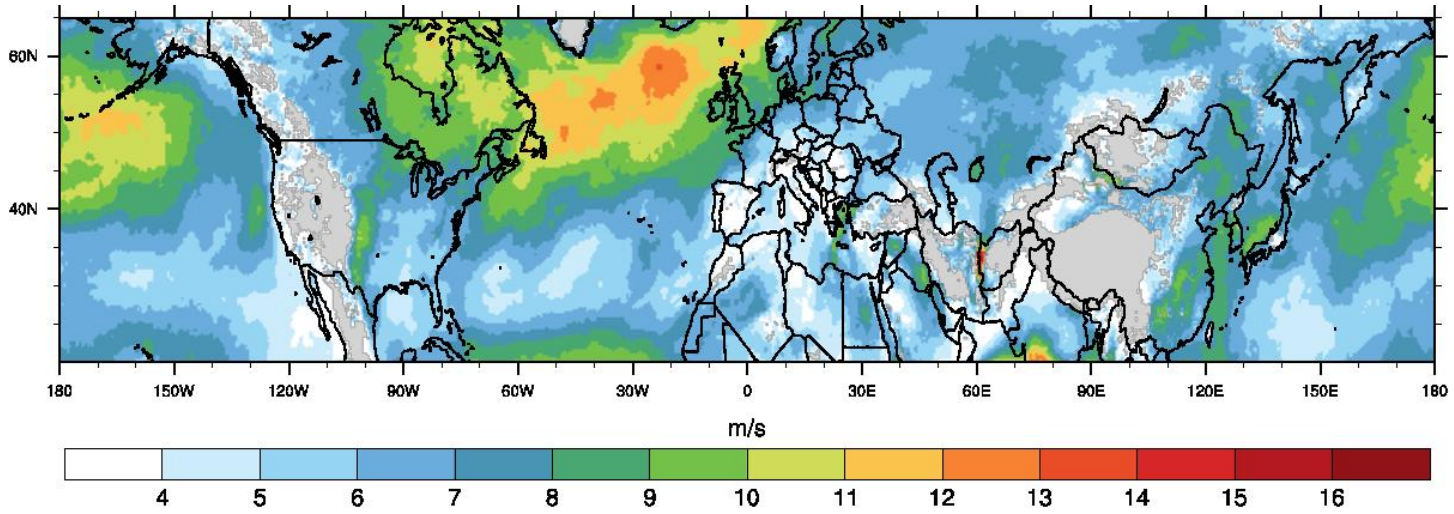
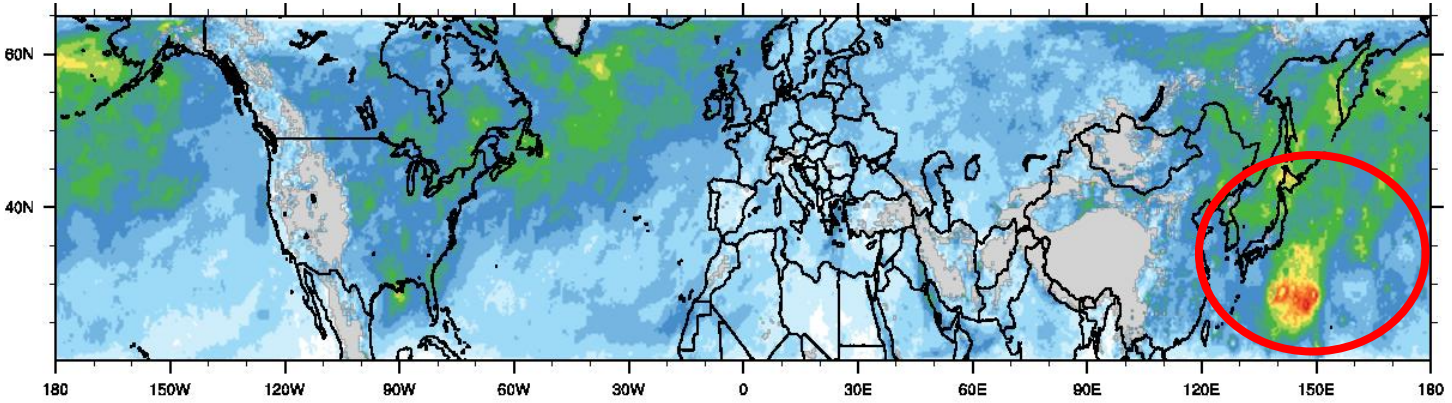


Boundary layer winds

850hPa
ECMWF
analysis



850hpa
RMSE
WRF
0.03°



Boundary layer winds

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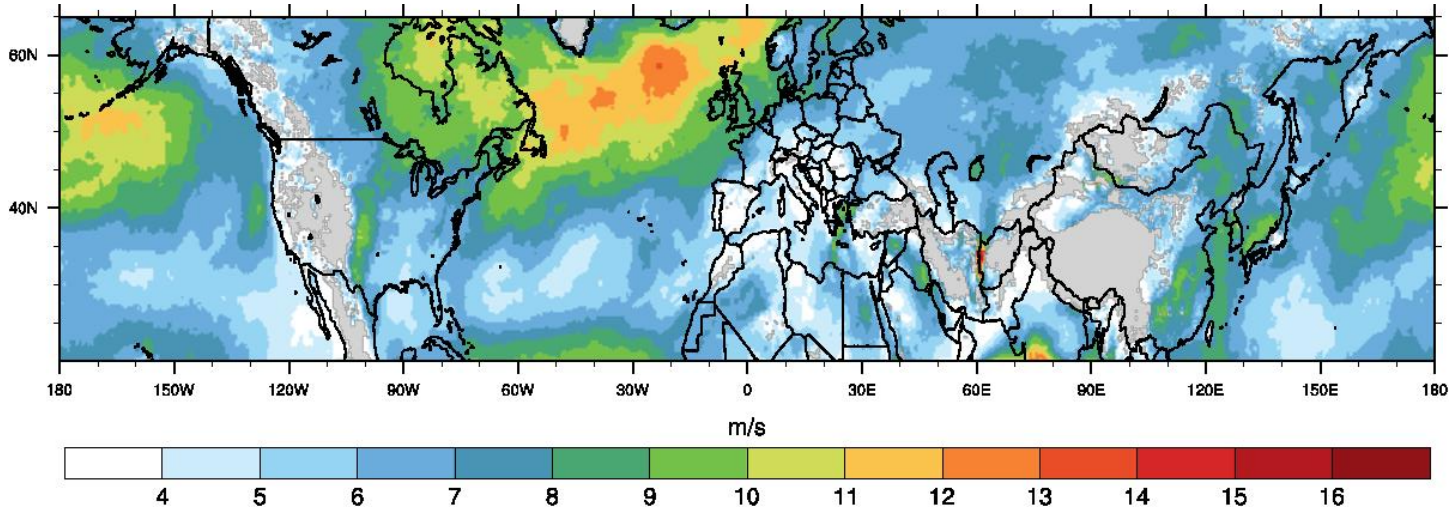

850hpa
RMSE
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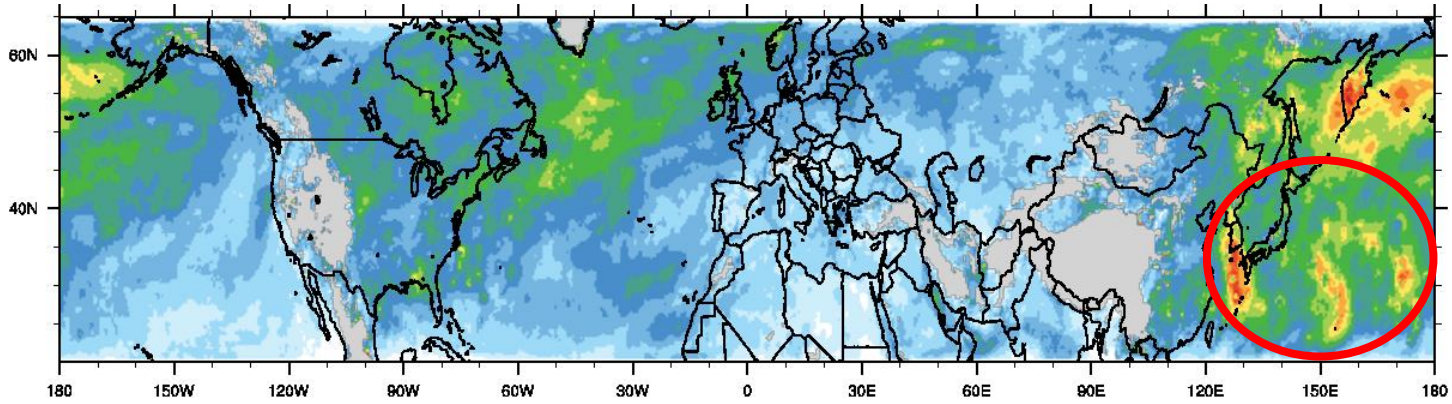
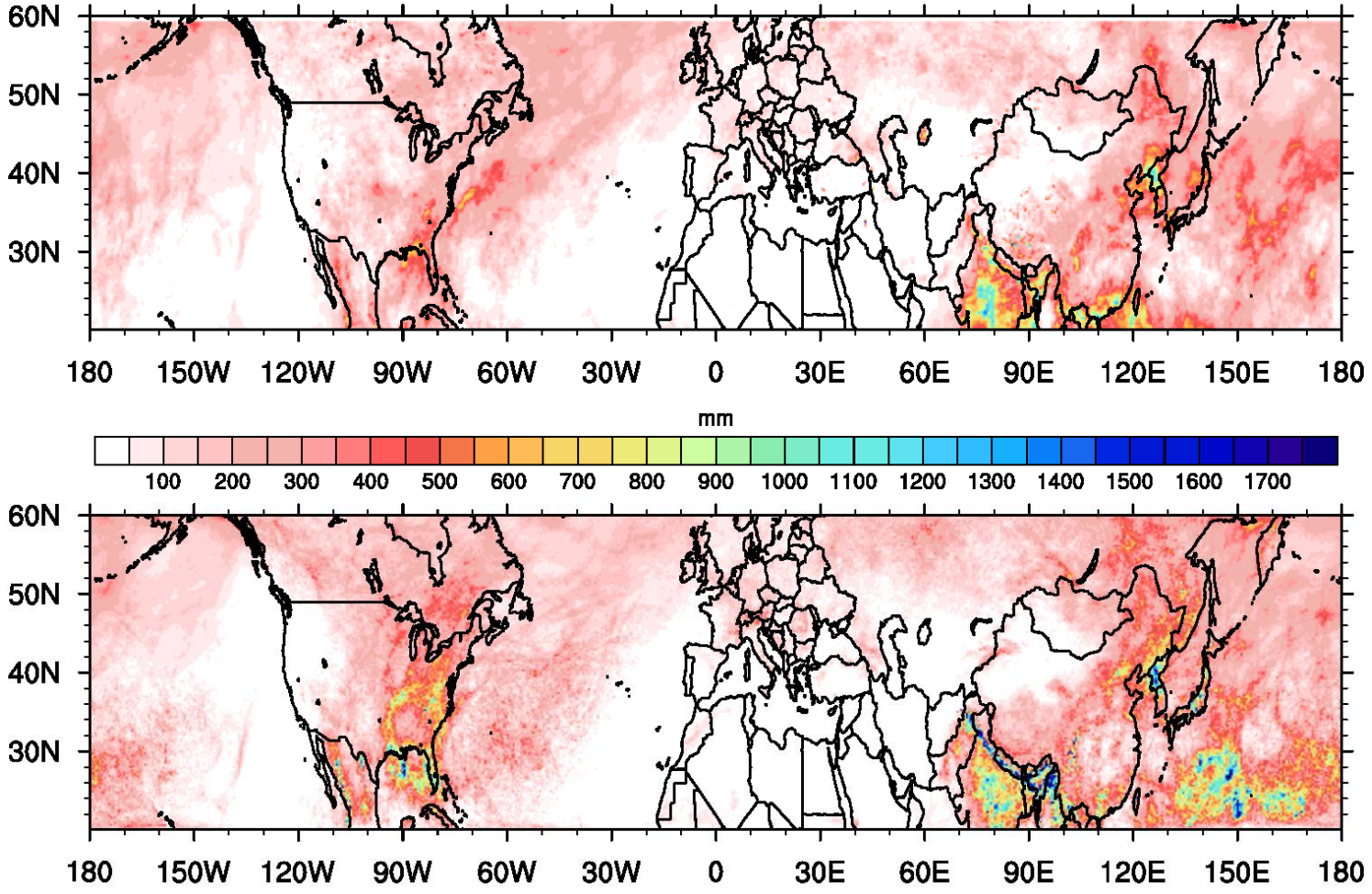
0.12°



Accumulated precipitation

CMORPH analysis



WRF 0.03°

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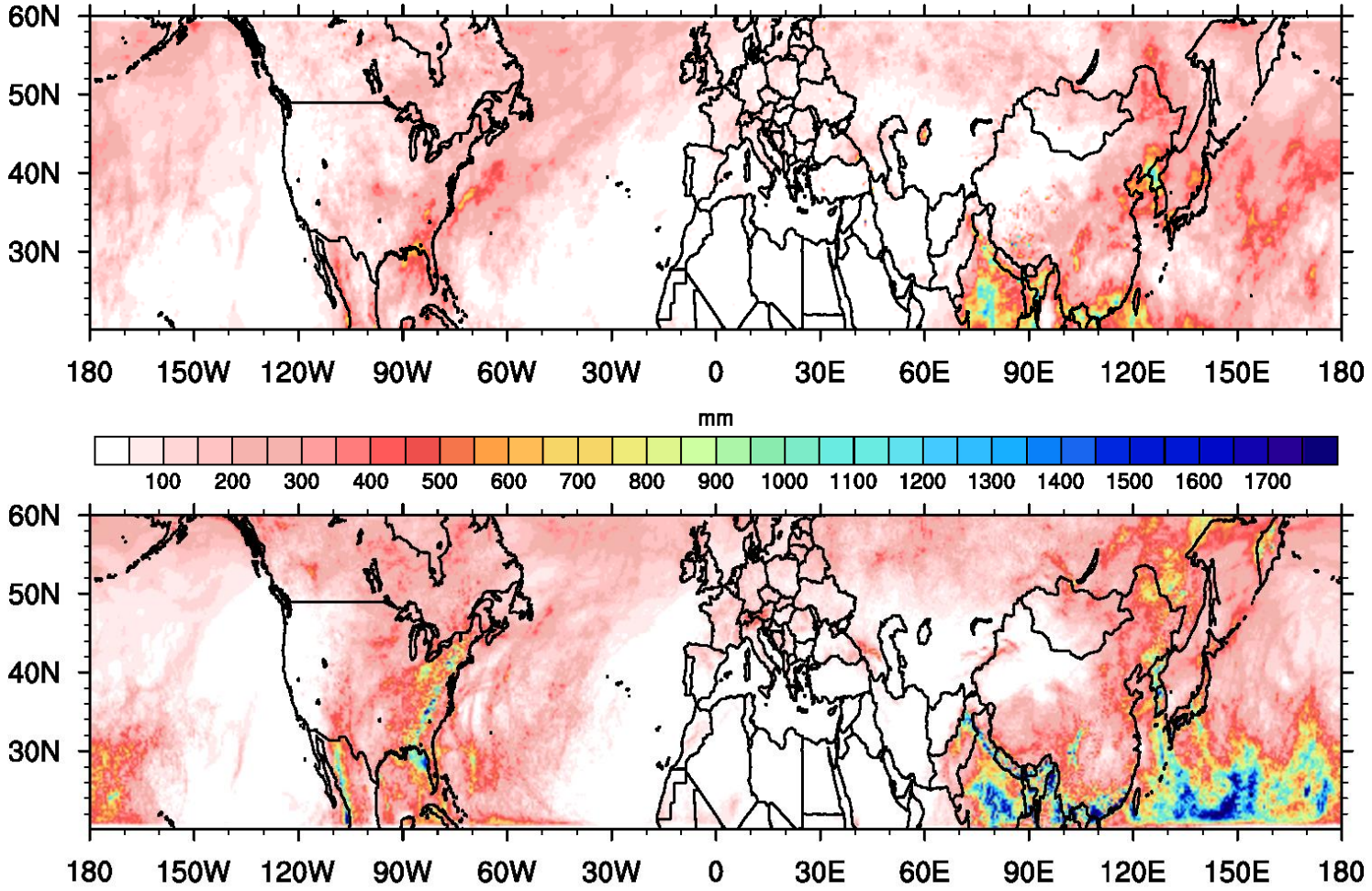

WRF 0.12°

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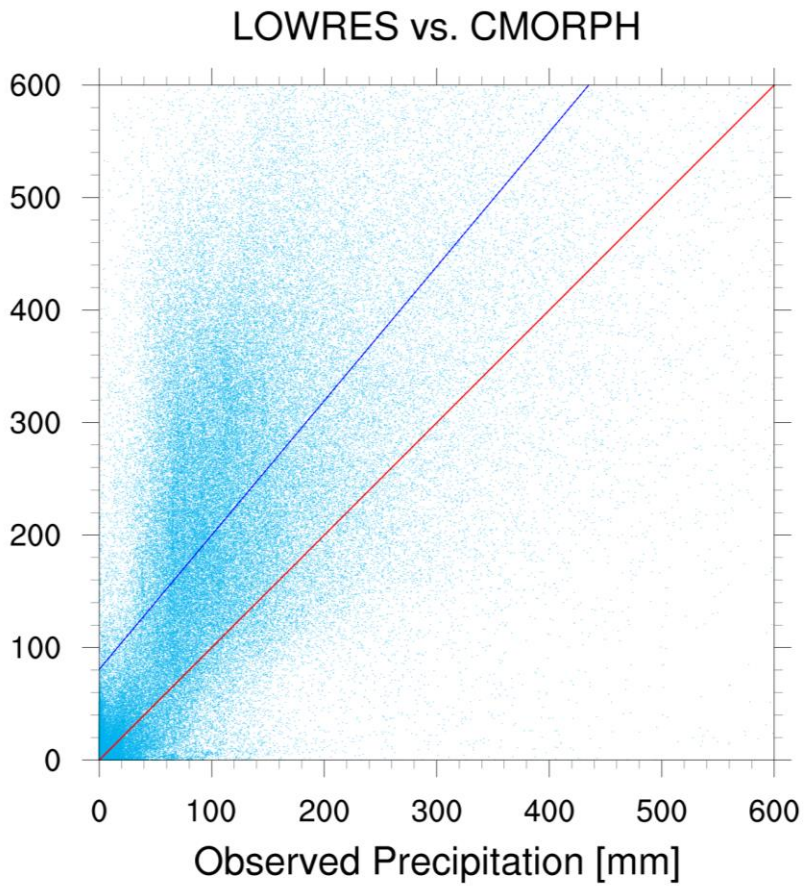
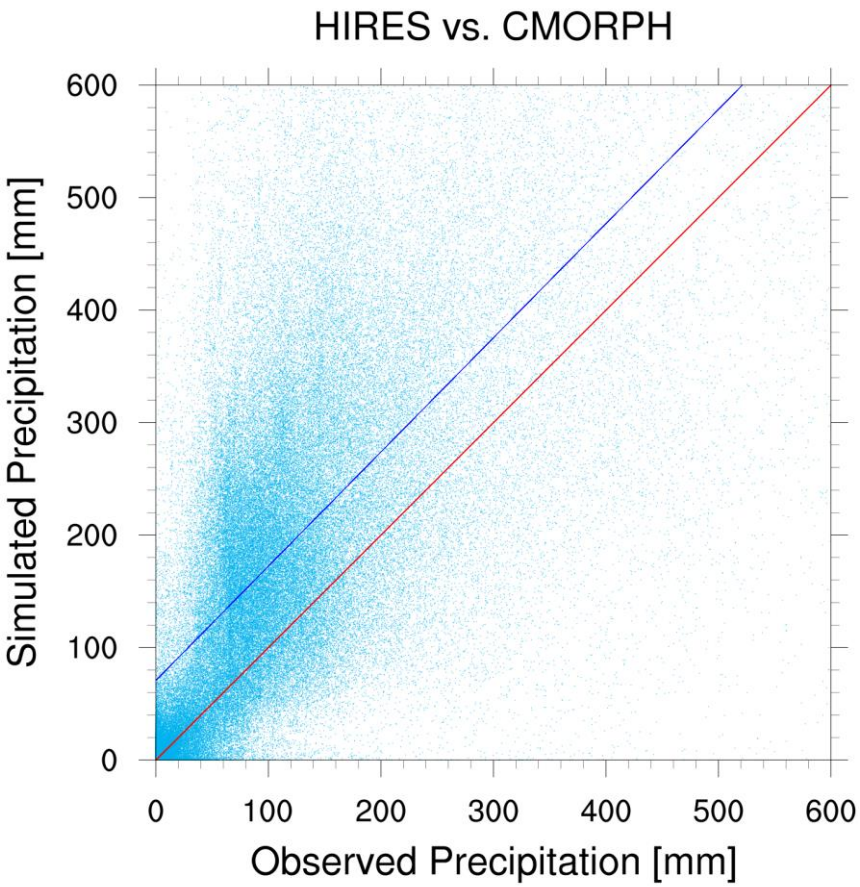
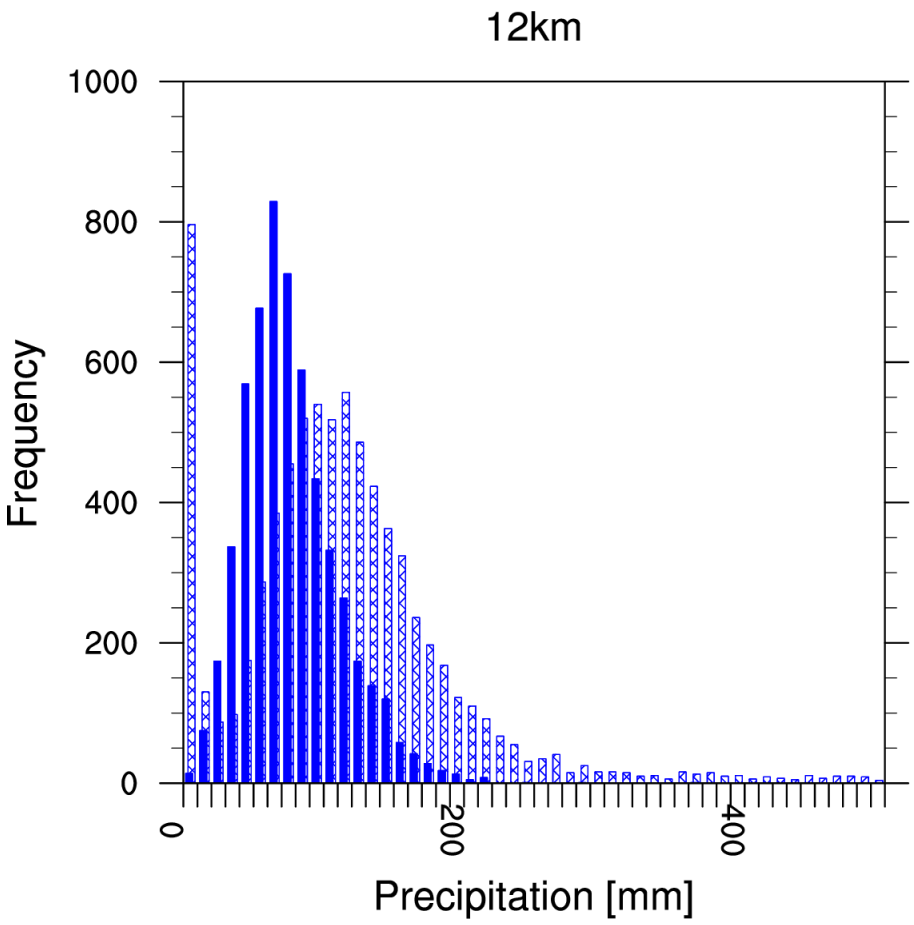
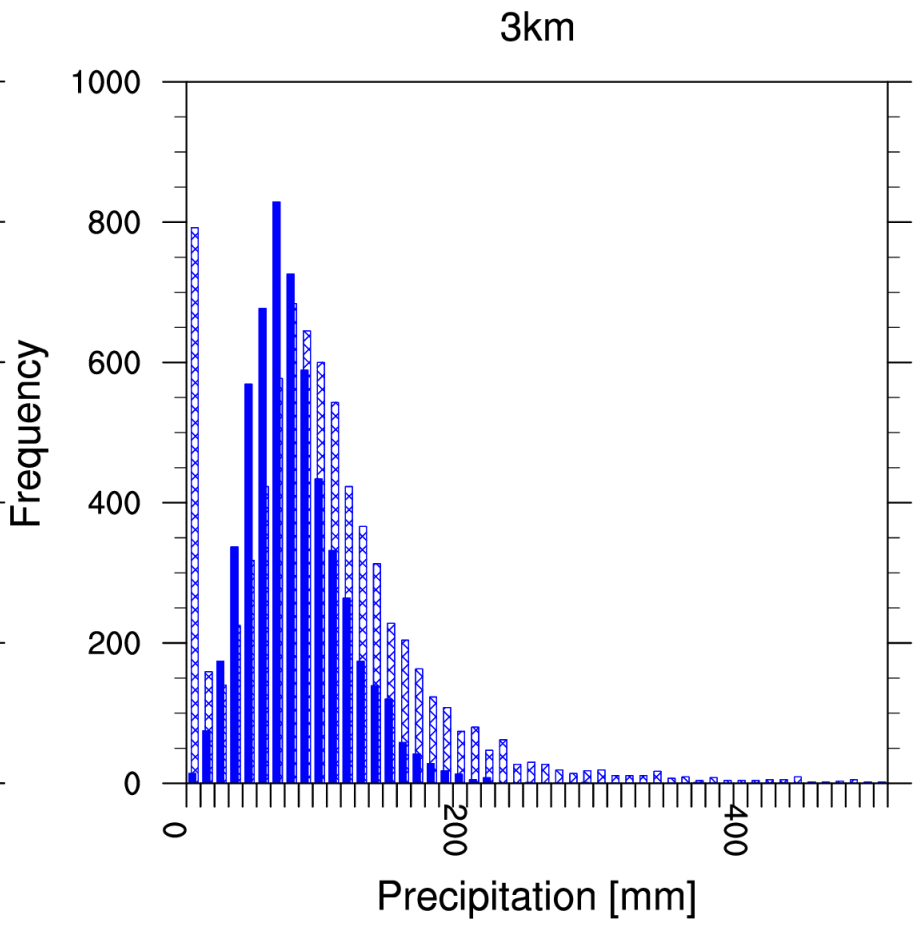


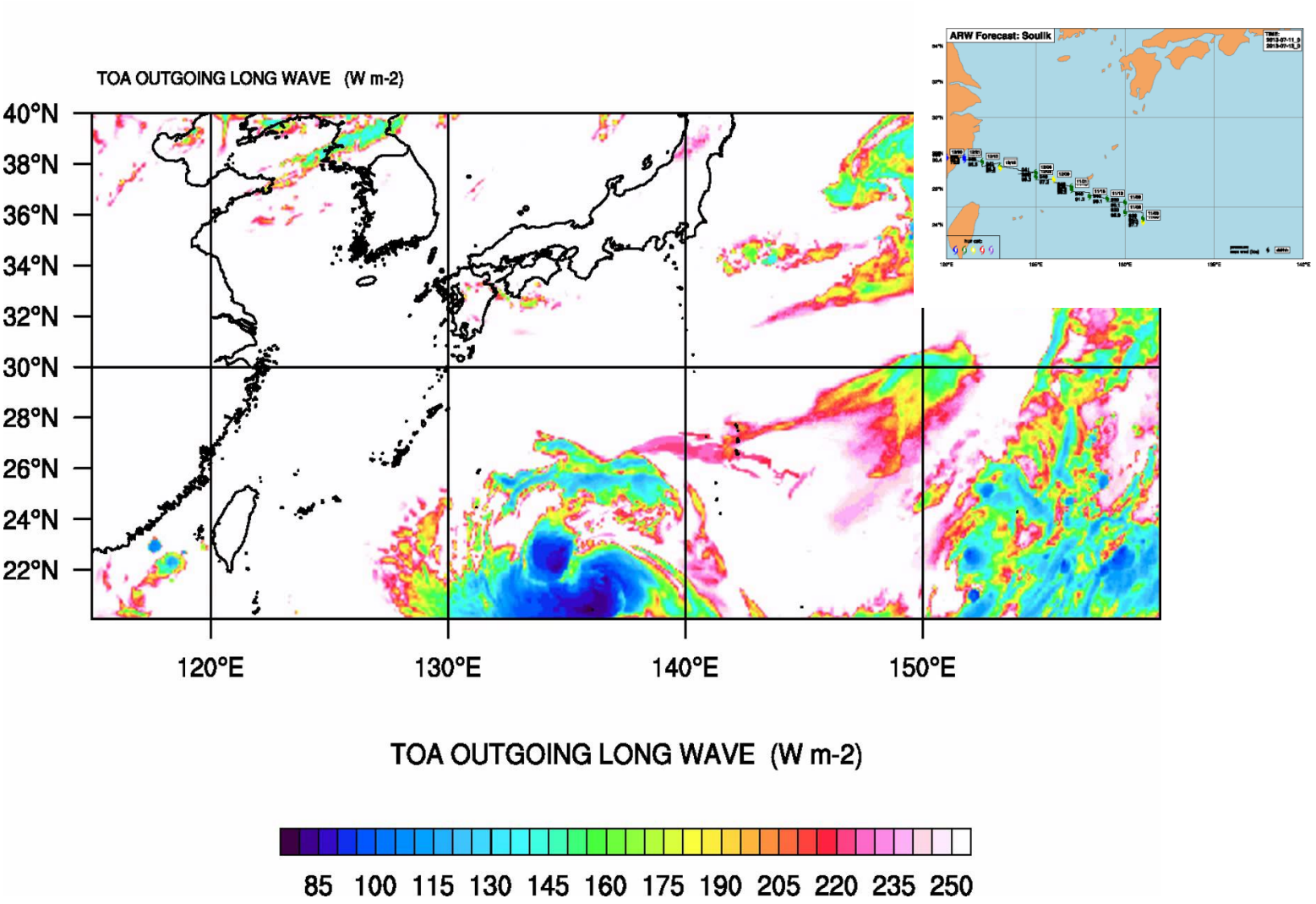


Precipitation PDF (Europe)

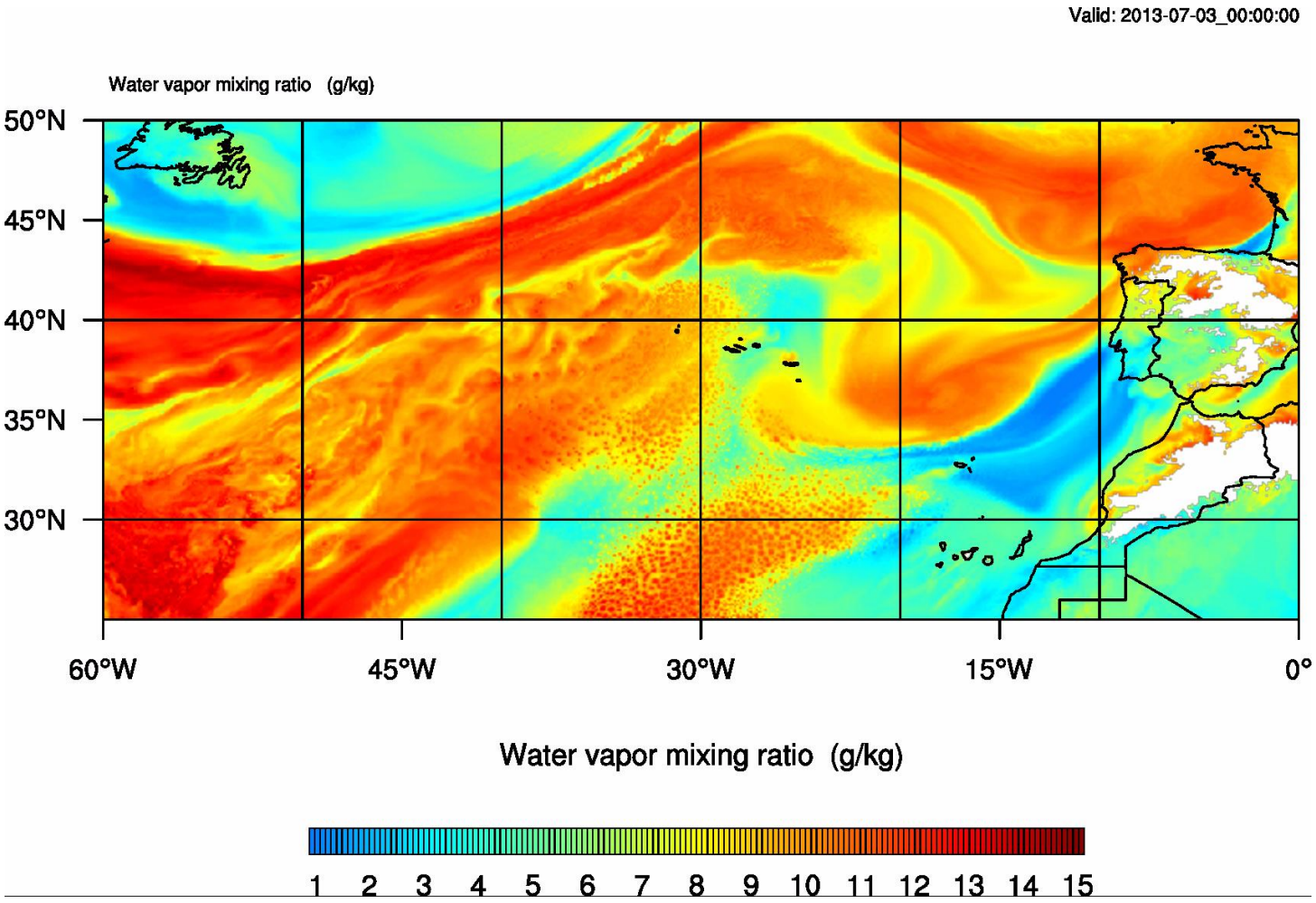




Typhoon Soulik (3km)



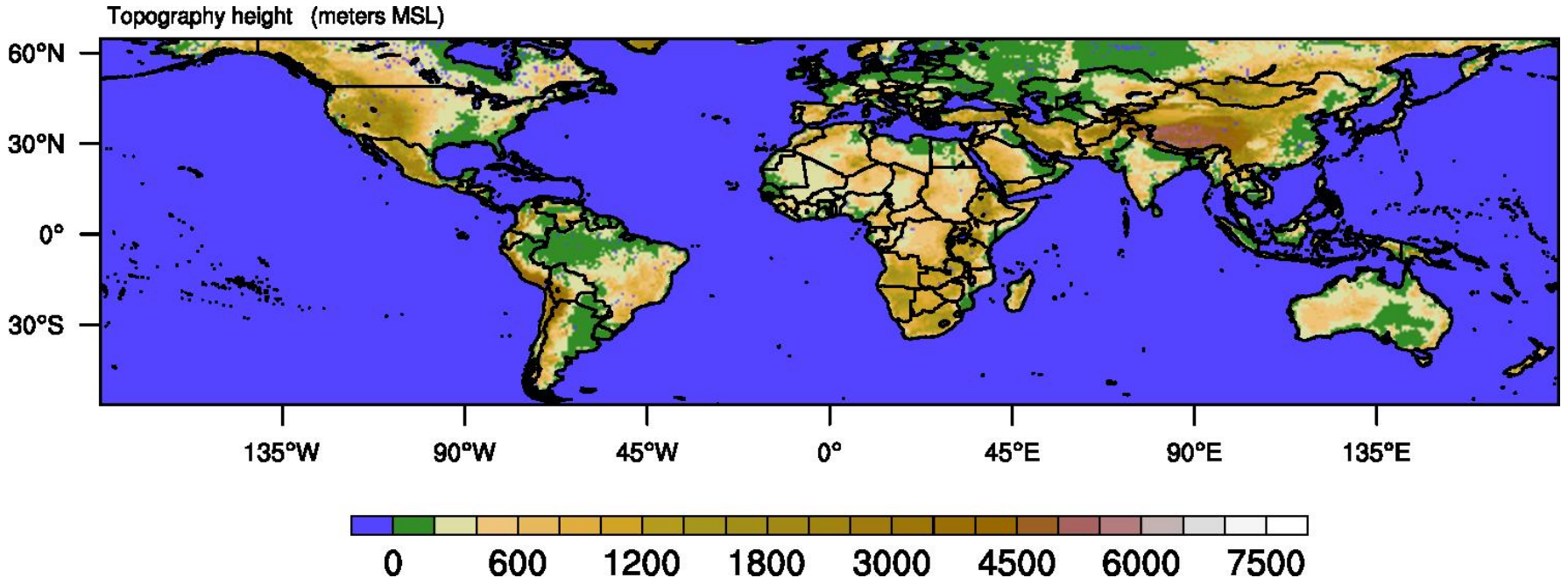
Low pressure system development over the North Atlantic



Summary

- First longer-term CP latitude belt simulation of the Northern hemisphere using the WRF model.
- Pacific High shifted to the south
- Overestimation of storms in the Pacific Ocean
- MSLP bias possibly caused by complex interaction of physics: Combination of Cumulus physics and cloud microphysics?
- Precipitation bias reduced in CP simulation
- **I/O becomes the bottleneck -> GRIB?, HDF? NetCDF with CDF5? SIONlib? Online images?**
- **Top500 do not account for I/O properties**

What we may do in the near future….



Acknowledgements

- ECMWF
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