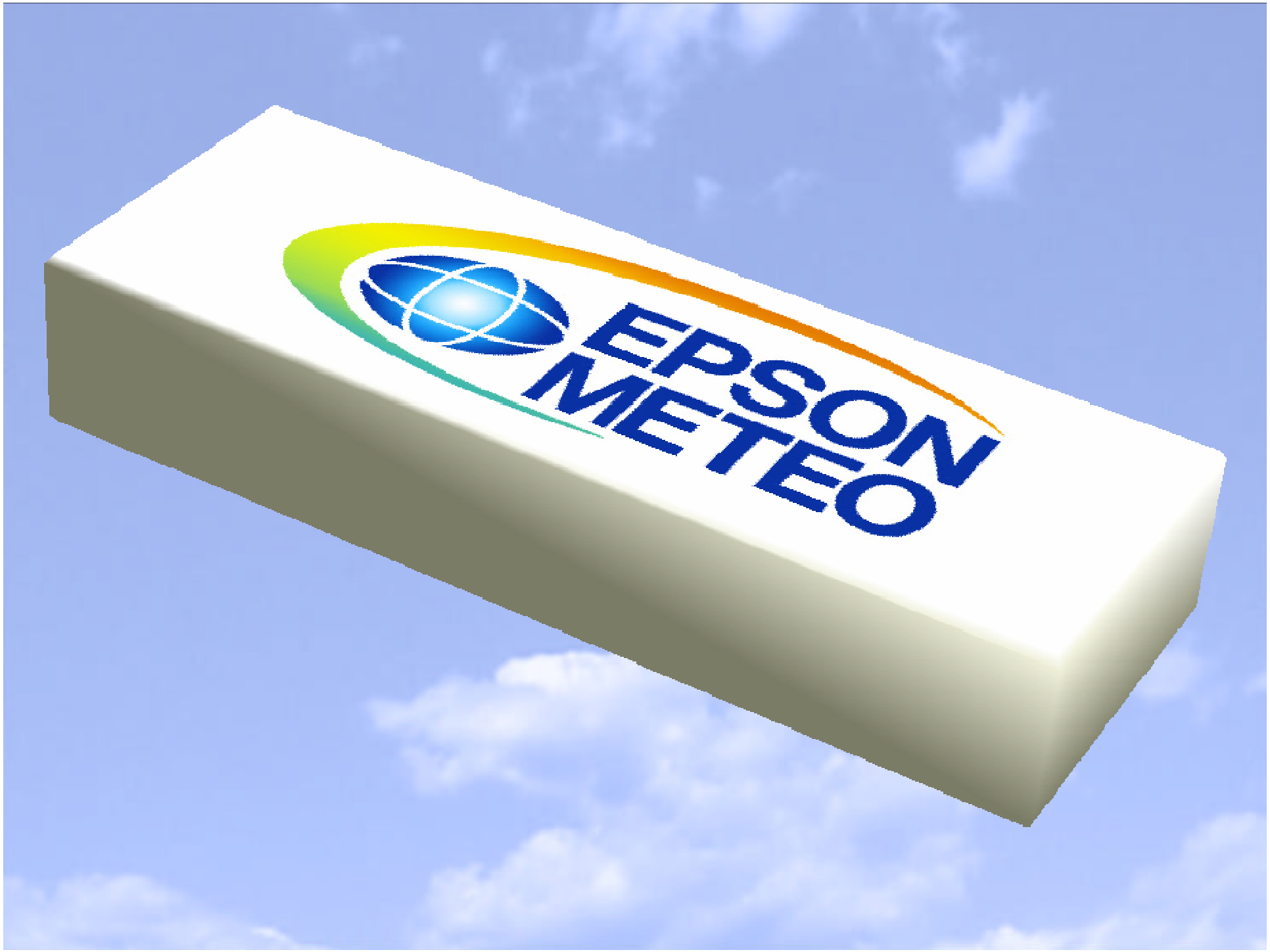
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Influence of Model Resolution in Complex Regions and a Comparison with Observations in Selected Case Studies

Raffaele Salerno and Laura Bertolani

CEOP/IGWCO Joint Meeting, Paris, February 26th-March 4th, 2006

Past studies

- Comparison between hydrostatic (HY) and non-hydrostatic (NHY) simulations in complex areas
  - Idealized tests – Real cases
  - Different resolutions in Alpine regions
- Influence of NHY effects and time-integration schemes in complex areas
  - Ideal cases – Real cases
  - Different resolution grids
- Model inter-comparison in the alpine region

Some results from past studies

Comparison HY-NHY simulations in complex areas

- Idealized barotropic and baroclinic instabilities: solutions in compressible mode runs grows more slowly than their compressible counterparts
- Mountain waves and penetrative convection: HY and fine resolution leads to stronger vertical motions associated with mountain waves. Also, details of mountain waves and high winds are poorly captured
- NHY: greater downstream tilt of the main wave
- Vertical structure of propagating plumes of vertical motion are stronger and fairly well organized in the NHY model runs
- Precipitation: increasing grid resolution, better definition of location, maxima and total amounts comparable to observations

Some results from past studies

Influence of NHY effects and time-integration schemes

- Idealized mountain: for a range of flows a well-mixed BL reduces the GW activity and the magnitude of the mountain wave response to surface heating is a function of the BL height. Only weak mountain waves develop with small Froude numbers
- Investigation of some characteristics of SISL time-integration: resonances with stationary forcings. Excessive slowing of gravity waves with large time step compatible with CFL values (less accurate cascade of energy)
- Geometry of the flow can make the wave propagation NHY even if the vertical velocities remain in the HY domain
- Some spurious orographic resonances at very high resolutions
- Real cases: Alps, Andes

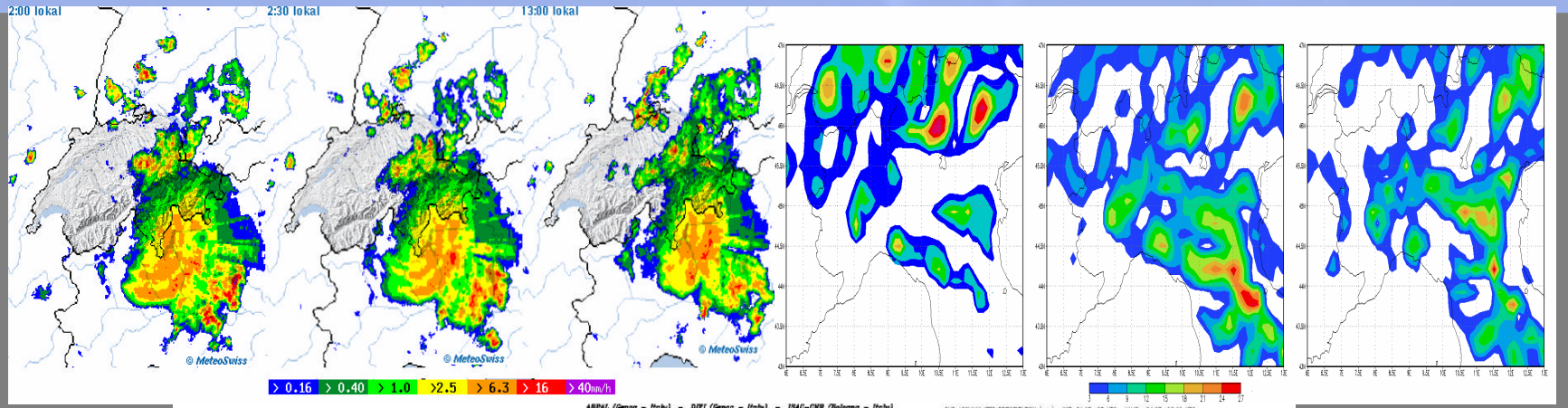
Some results from past studies

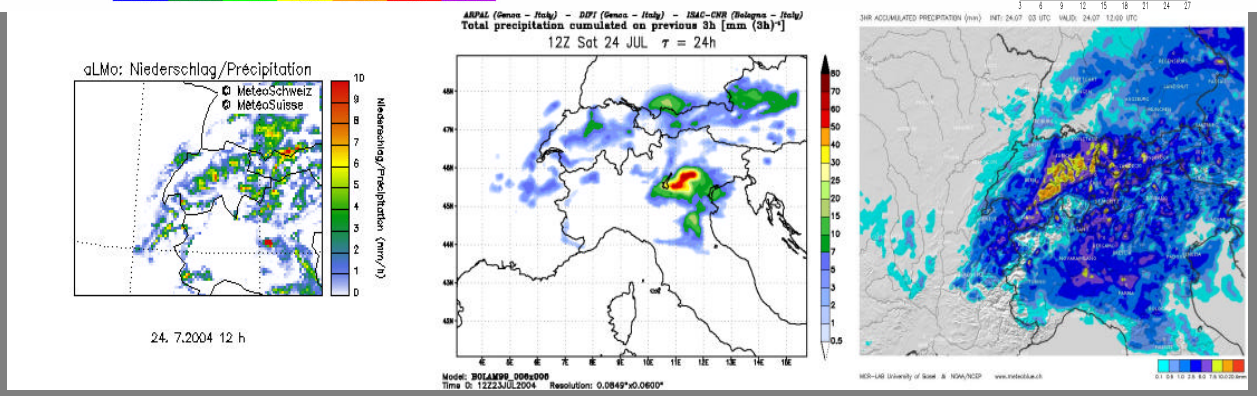
Model inter-comparison in the alpine region

- A case of summer thunderstorm in the south-alpine region with a few models: CEM-MSM, ETA, MesoNH
- Precipitation forecast agreed fairly well with observations
- Higher resolution grids improved the location and the values of the precipitation
- The location and the dynamics of the cold air mass was quite well simulated by all models
- A comparison with the results of other models publicly available (BOLAM, LM) was also performed for the same case

Some results from past studies

Model inter-comparison in the alpine region





Present studies

Verification of numerical model forecasts

- GCM and LAMs
- Parameters: all, particularly precipitation
- Domains: Europe and Indian sub-continent
- Satellite estimates and rain gauge analysis
- Rain gauges measures in the Northern-Central Italy

Ensemble forecast

- Models: GCM and LAMs
- Resolutions: 2 and 1 degree (global), variable regional
- Original domains: global and regional
- Lagged average and multiple data assimilation

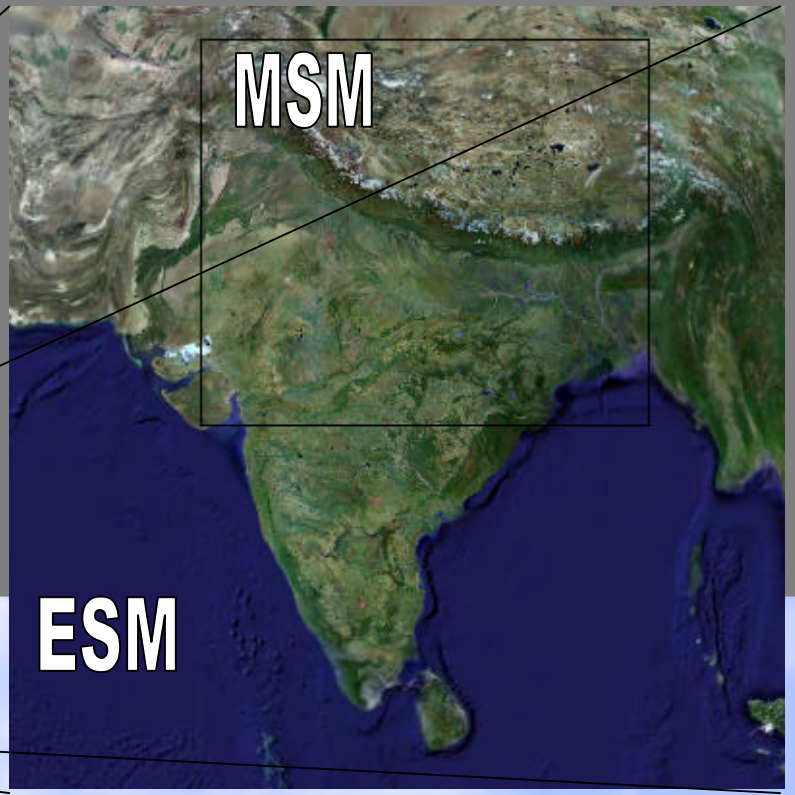
Multi-system ensemble forecast

- Models: CEM-MSM, MesoNH, WRF, ESM, ECMWF…
- Resolutions: 50 to 10 km
- Original domains: global to mesoscale
- Actual domain: Italy and surrounding areas
- Different physics, dynamics, integration schemes

A comparison in the Himalayan area

Used models

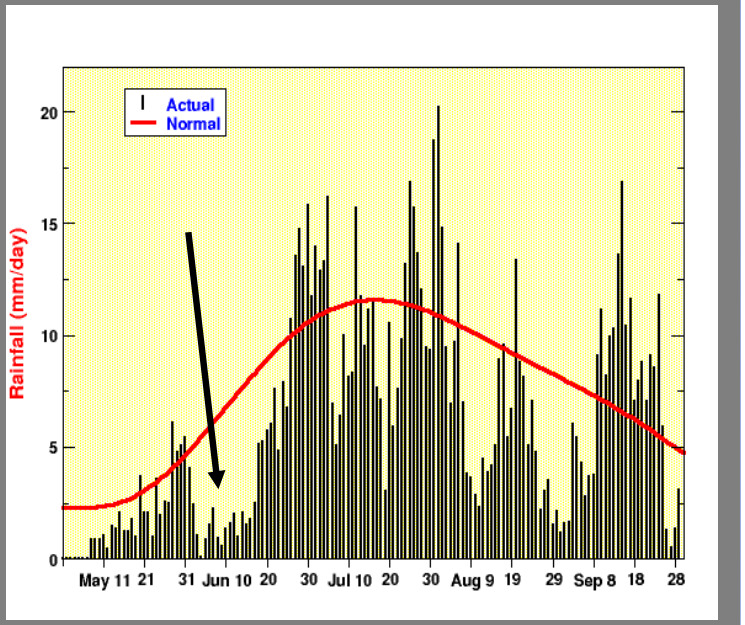
- GCM: Resolution T126L28
- ESM: Resolution 50 km, 38 levels
- MSM: Resolution 15 km, 38 levels



A comparison in the Himalayan area

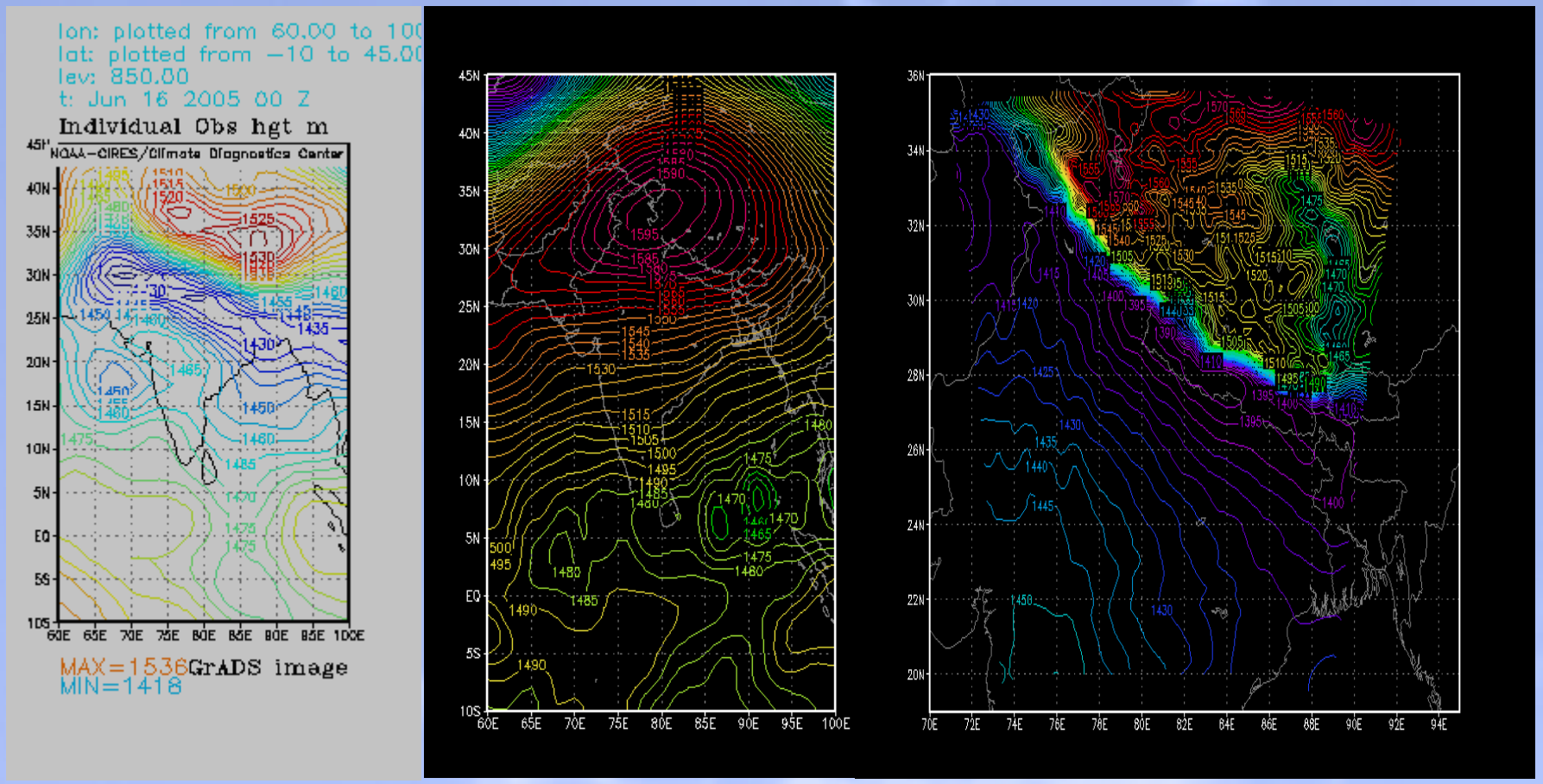
Target: forecast for June 16th

- Starting from June 10th, 6-day to 1-day forecasts
- Aim: dynamics and thermodynamics
- Different resolution and forecast lagging
- Compare differences among 1 ° GCM and LAMs

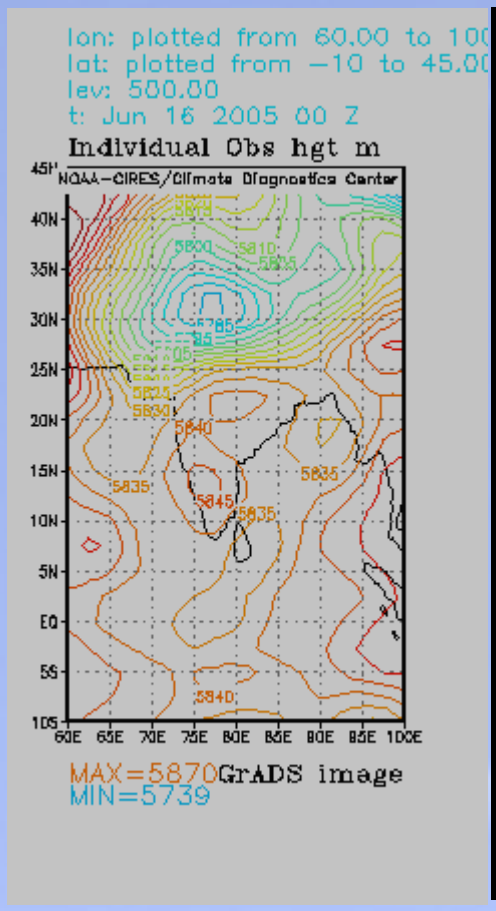


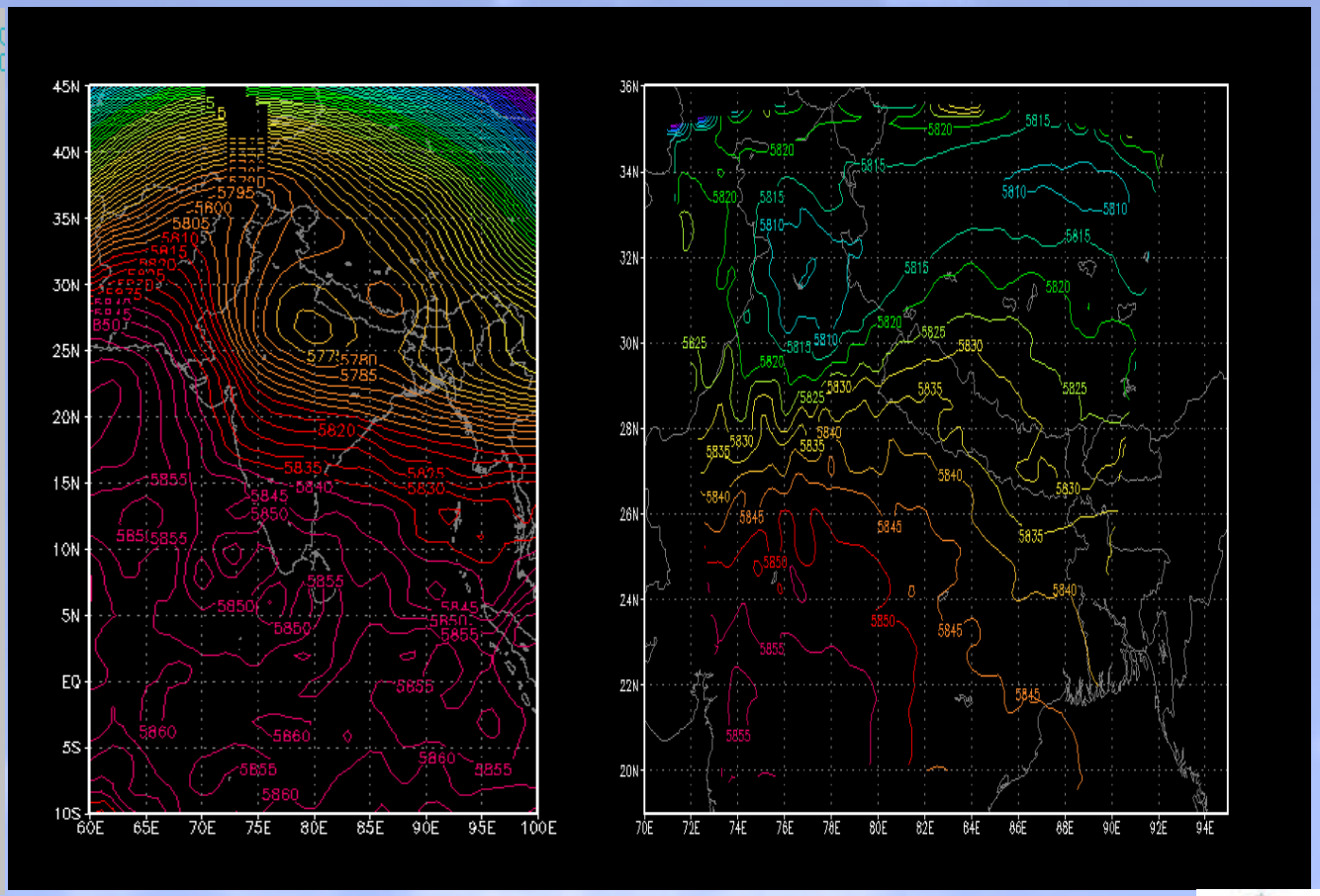
All-India Summer Monsoon Rainfall, Indian Institute of Tropical Meteorology

A comparison in the Himalayan area: 5-day



A comparison in the Himalayan area: 5-day





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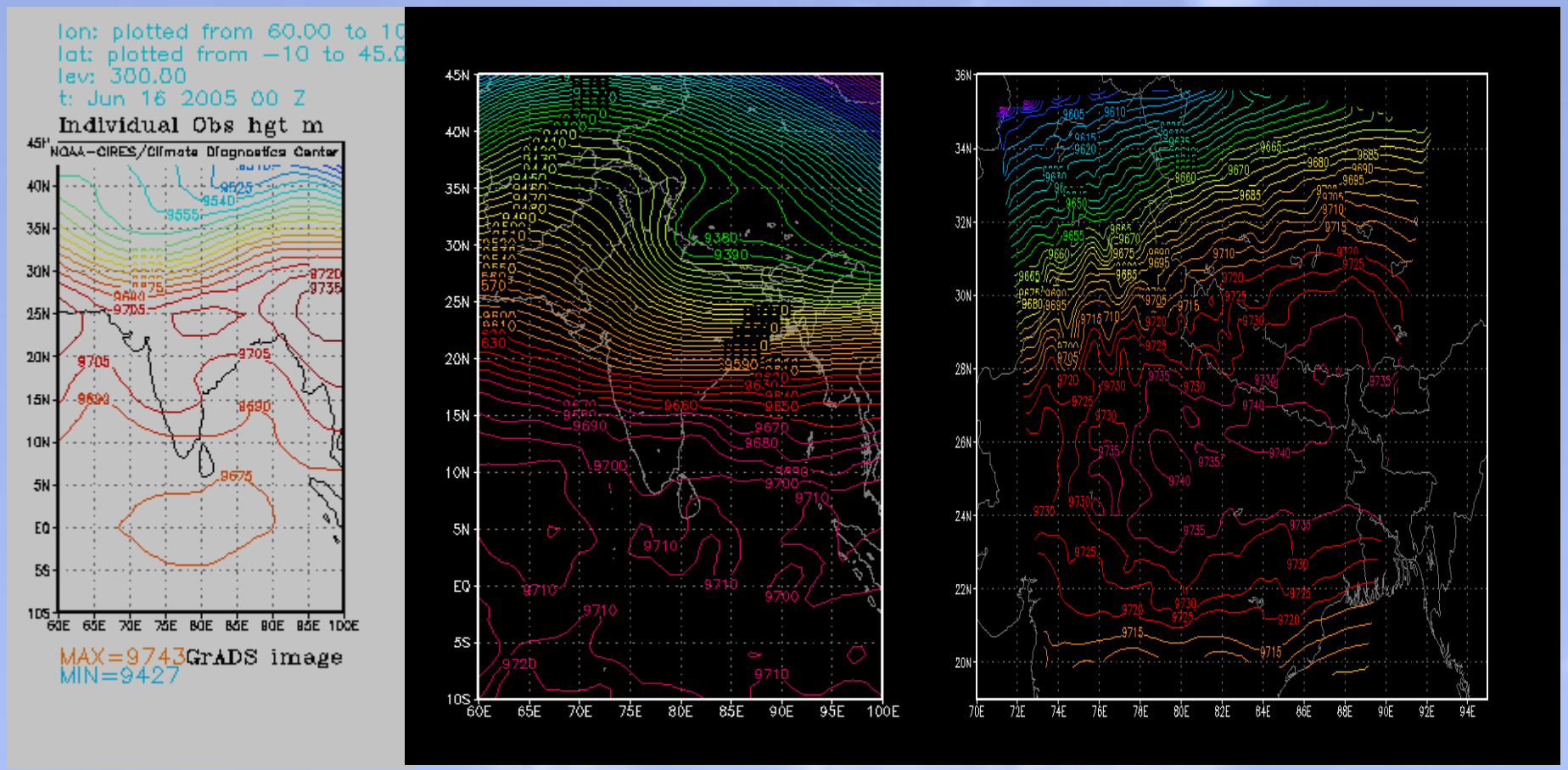
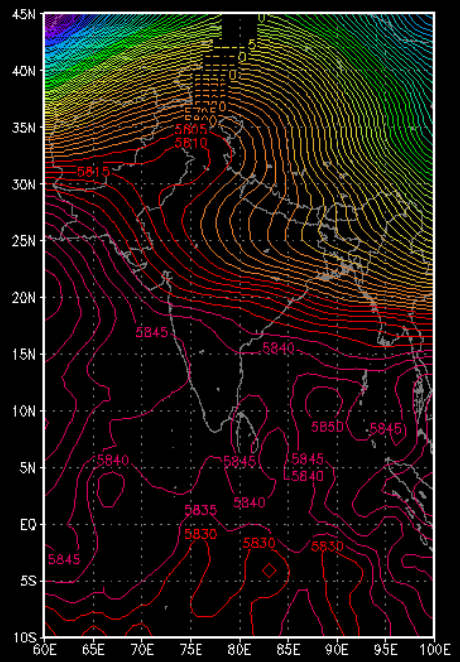
A comparison in the Himalayan area: 5-day

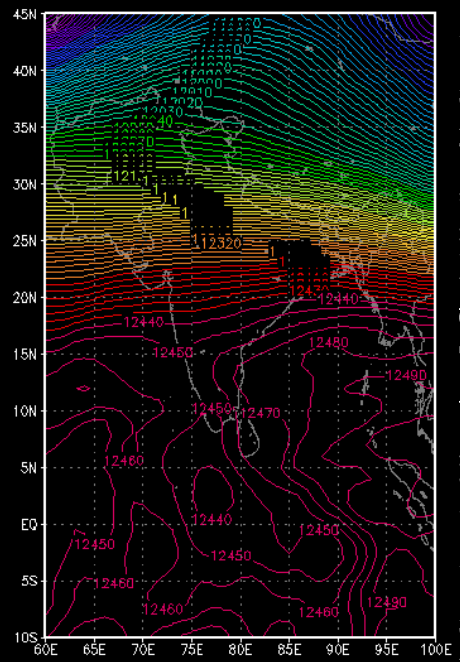


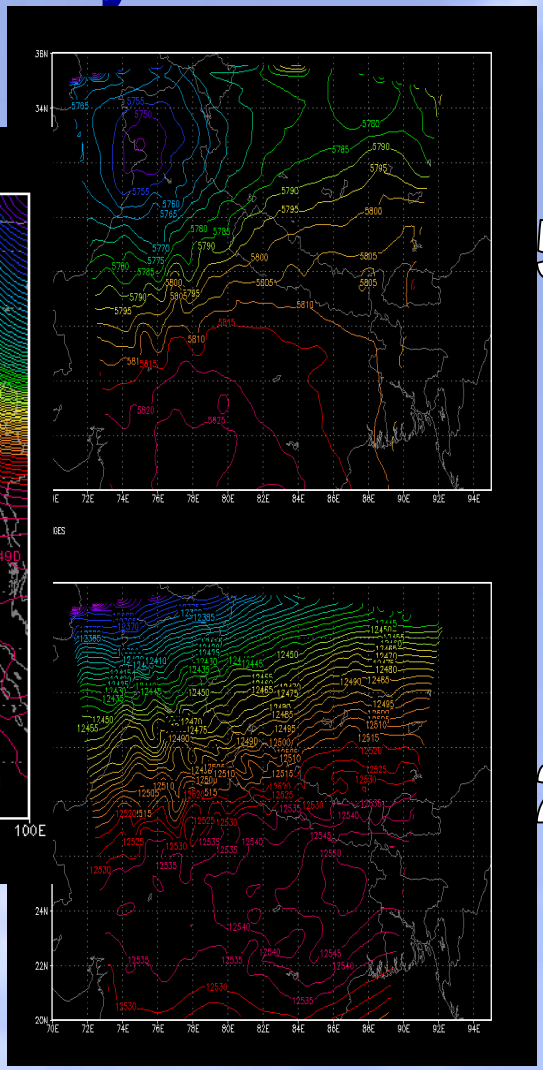
A comparison in the Himalayan area: 2-day

500 hPa



200 hPa



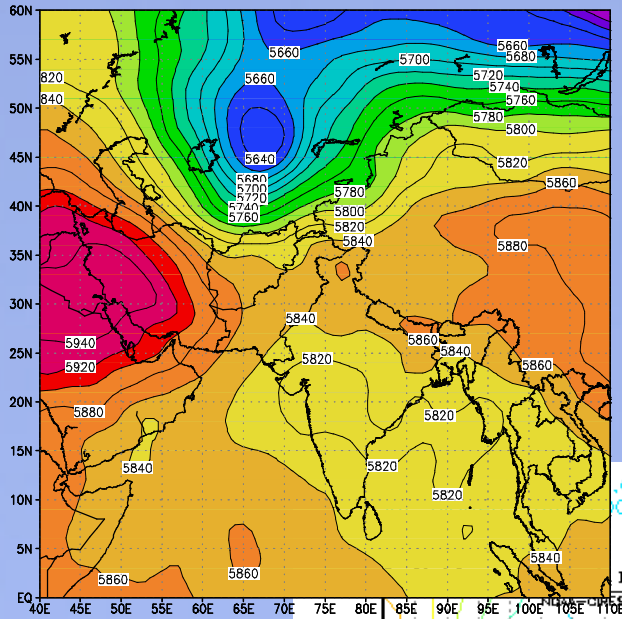


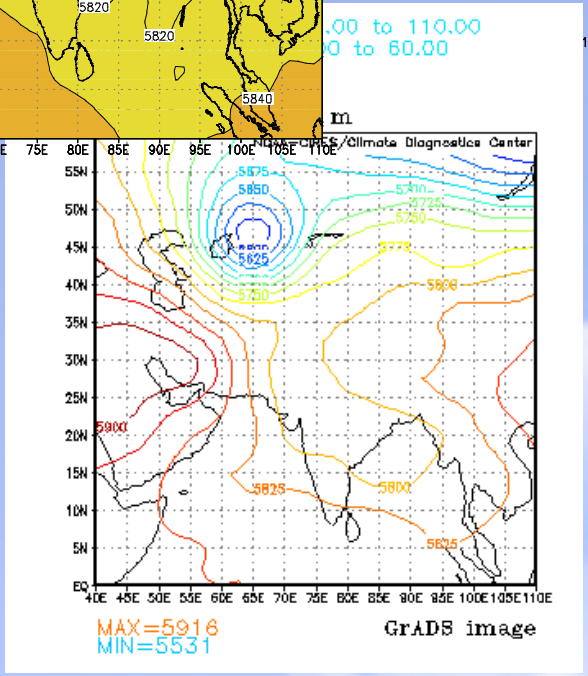
500 hPa

200 hPa

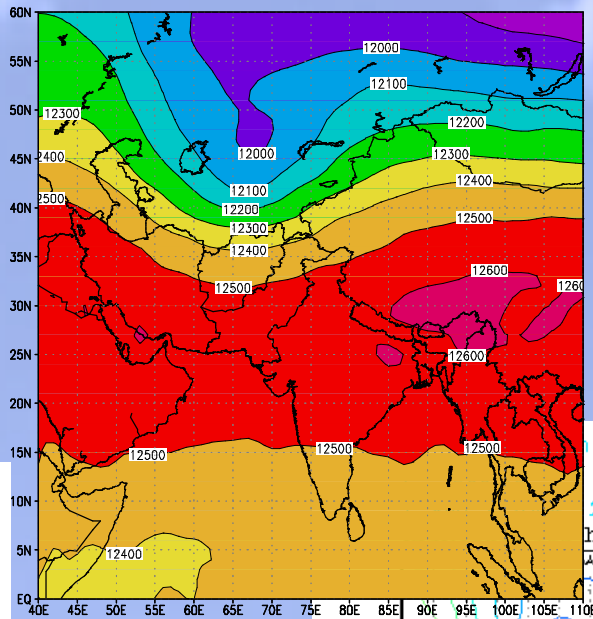
A comparison in the Himalayan area, Aug. 1st , 2004

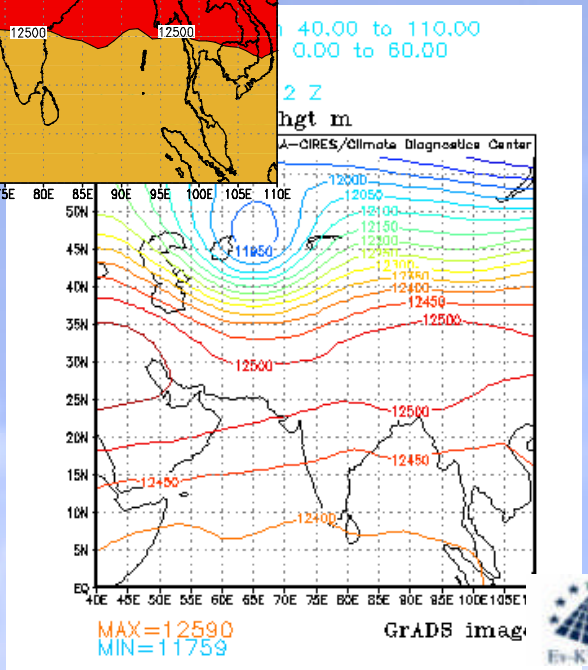
500 hPa





200 hPa





Europe and Alpine Area

Models

WRF

- NHY Energy and Enstrophy conservation
- Resolution: 7-10 km
- Fully-compressible, pressure sigma-hybrid, split-explicit
- Kain-Fritsch (KF) cumulus parameterization
- MYJ PBL, Noah LSM

MSM

- SISL NHY Compressible
- Resolutions: 14 km
- Lateral boundary relaxation
- Perturbation
- Soil and vegetation
- Microphysics 5 species

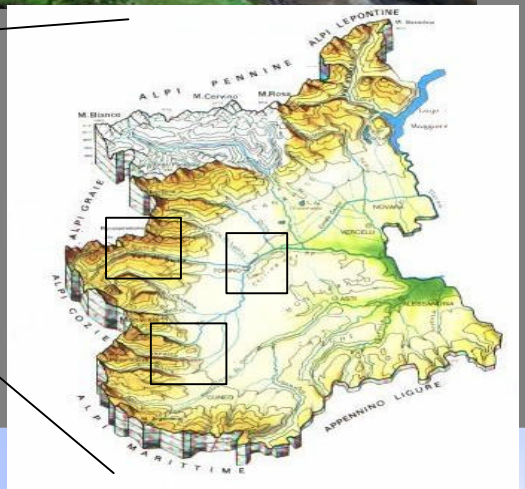
MesoNH

- NHY Anelastic, total mass conservation,explicit
- Resolution: 20 km
- 8 microphysics species
- KF deep convection, Kessler warm cloud
- ECMWF radiation scheme

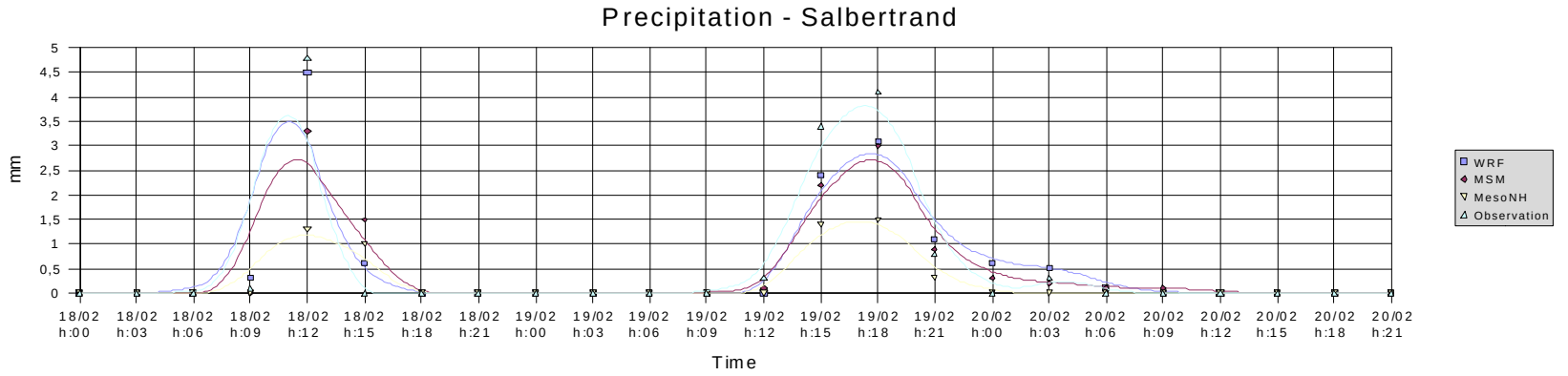
Locations

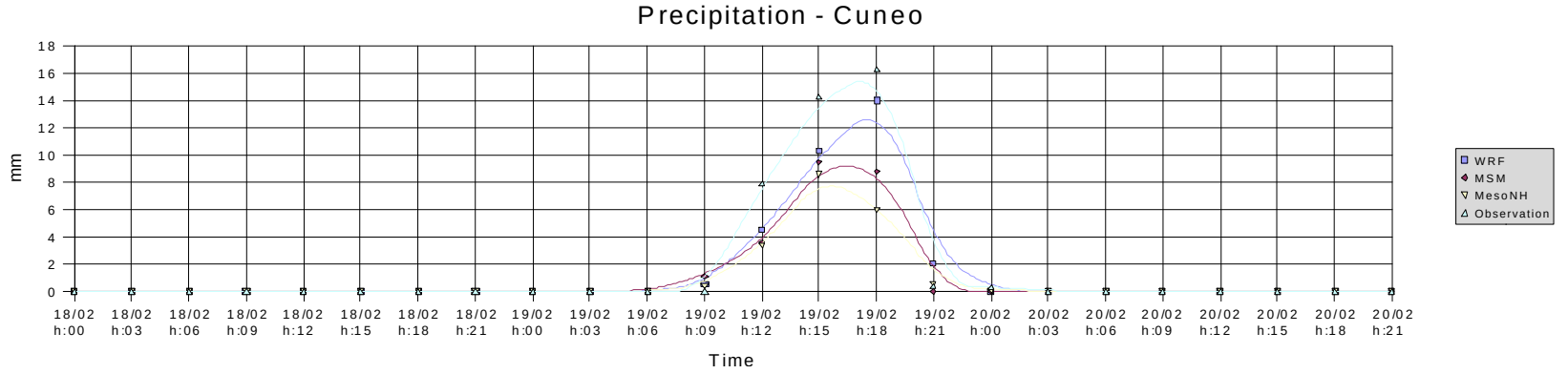

SALBERTRAND
E70
SS25
SS24

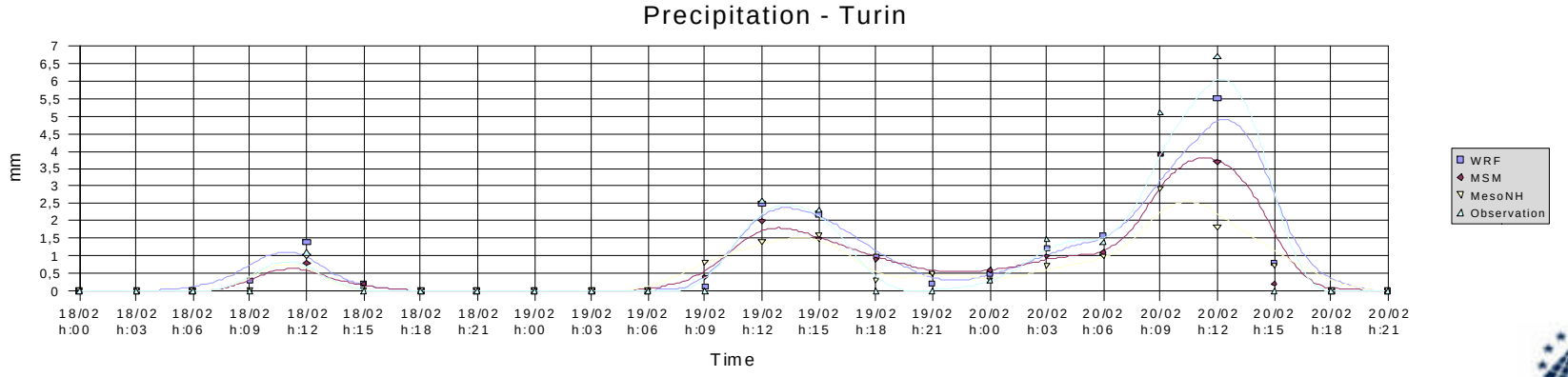

CUNEO
SP21
SS20
R20
Via Spinetta
SP5
SP422
SS22
SP564
Via Savona
Via del Passatore
Via della Battaglia


ALPI LEPONTINE
ALPI PENNINE
M.Cervino
M.Rosa
M.Bianco
ALPI GRAIE
APPENNINO LIGURE
ALPI MARITTIME


TURIN
A55
SS25
SP2
Via Lanzo
E70
SS393
717
E64
E25
SS10
SS11







Observational data from Regione Piemonte

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Some conclusions…

- GCMs contain representations of the atmosphere, oceans, ice, land surface and vegetation, but they are incomplete if resolution is poor compared to terrain characteristics.
- Regional models may give a deeper insight in the dynamics and the physics in high complex terrain
- Low resolutions may somewhat fail in describing the correct dynamics

Some conclusions…

- Comparing the time series of the observations with model outputs, high resolution is fundamental to incorporate as much as possible the local effects, the reproduction of energy cascade and the interaction between large scale circulation and local scale dynamics and thermodynamics, considering the terrain characteristics (soils, canopies, topography).
- Results may be close to observations.


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Thank you!
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