Met Office

EURO4M

http://www.euro4m.eu/

EURO4M Regional Reanalysis:
Evaluation of Precipitation

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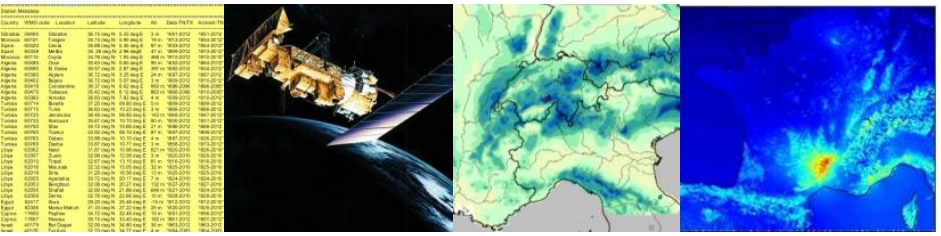
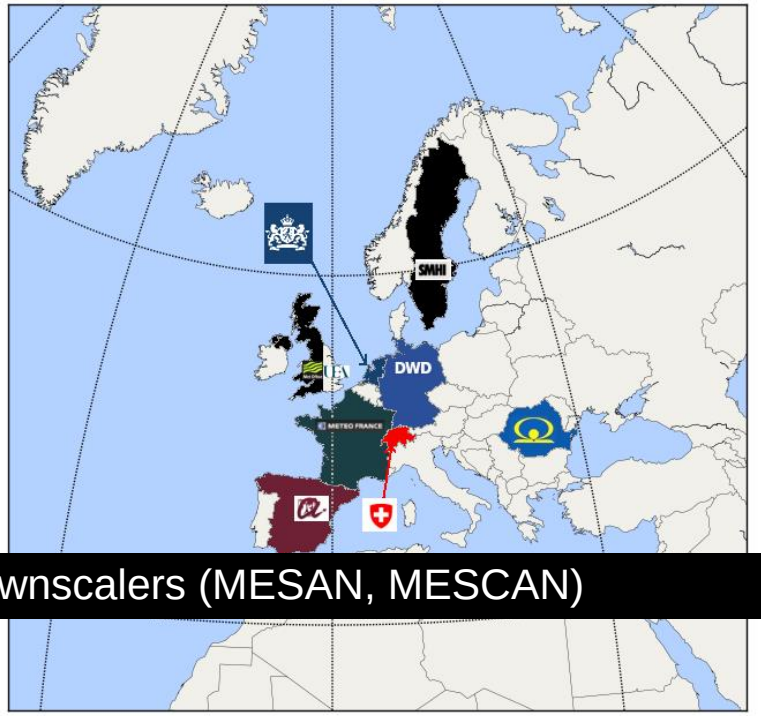
Thanks to Ric Crocker and Rachel North

EURO4M

European Reanalysis and Observations for Monitoring

- EU funded project for information about the state & evolution of the European climate
- Has produced/expanded observation datasets, reanalyses and downscalers
- Includes a wide range of atmospheric variables
- EURO4M runs from April 2010 to March 2014

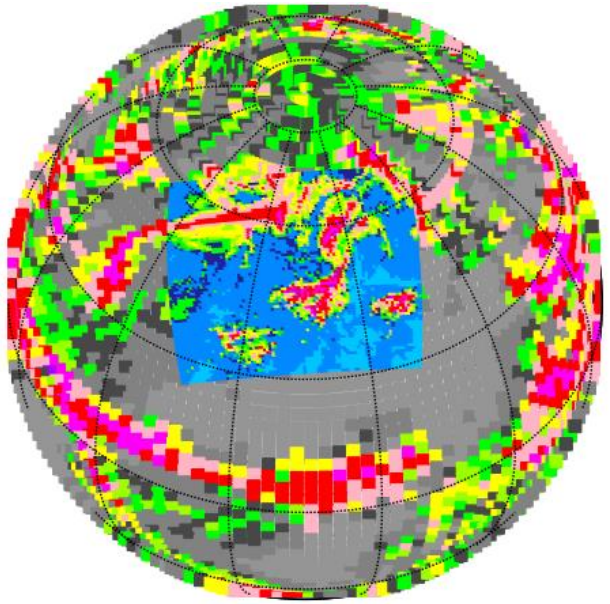




- EURO4M – 2 reanalyses (HIRLAM, MO) & 2 downscalers (MESAN, MESCAN)

Talk Outline

- EURO4M reanalyses & downscalers
- Climate Statistics
- Case Study – Eastern Europe Floods July 2008
- Precipitation Evaluation:
    - Annual RMSEs
    - Location – based verification
    - Scale-selective verification



EURO4M Reanalyses & Downscalers

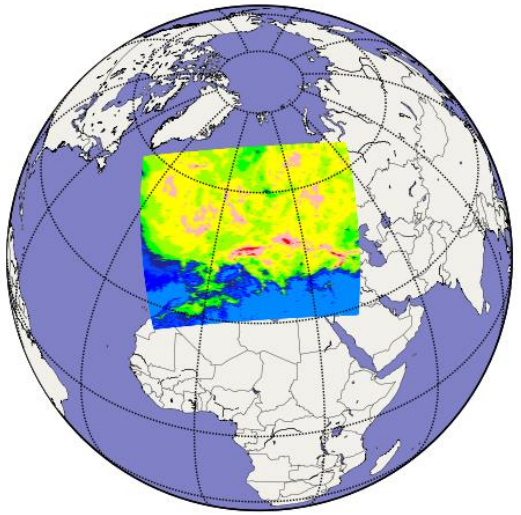
MO Reanalysis

- MO is a 12km European regional reanalysis
- 4DVAR assimilation scheme at 24km
- No direct assimilation of precipitation observations
- Boundary conditions from ERA-Interim
- Covers 2008-2009
- Data at hourly intervals for a wide variety of variables including

temperature	wind
pressure	precipitation
humidity	cloud
radiation	visibility

- Data available in ECMWF MARS archive

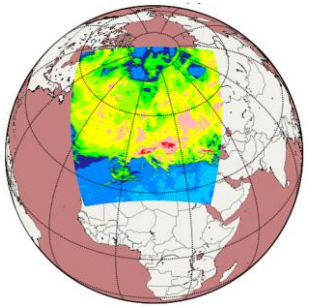
  www.ecmwf.int



Name	Res.	Period	D.A.	Precip. Obs.
MO	0.11°/12km	2008-2009	4DVAR	✘

HIRLAM, MESAN & MESCAN

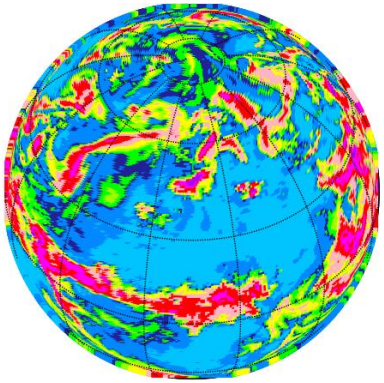
- SMHI's HIRLAM-based 24km European regional reanalysis
- Covers 1989-2010
- Boundary conditions from ERA-Interim
- 3DVAR assimilation scheme
- No direct assimilation of precipitation observations

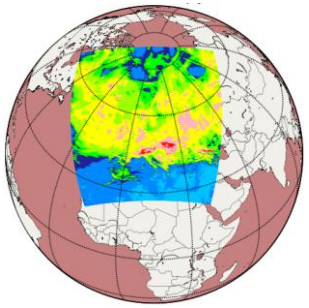


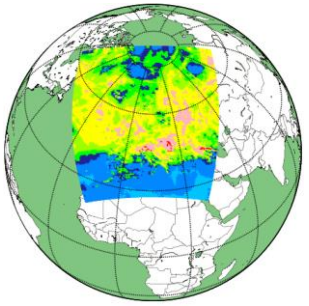
Name	Res.	Period	D.A.	Precip. Obs.
MO	0.11°/12km	2008-2009	4DVAR	✘

HIRLAM, MESAN & MESCAN

- *MESAN and MESC* *tation downscalers*
- *Combines HIRLAM* *se observation data*
- *Optimal Interpolati*







- *Compared to ERA-Interim (80km)*

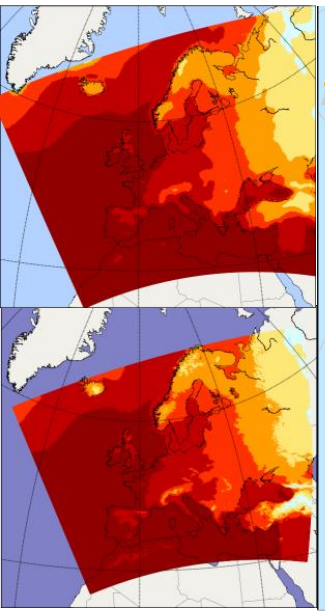
Name	Res.	Period	D.A.	Precip. Obs.
HIRLAM	0.2°/20km	1989-2010	3DVAR	✘
MO	0.11°/12km	2008-2009	4DVAR	✘

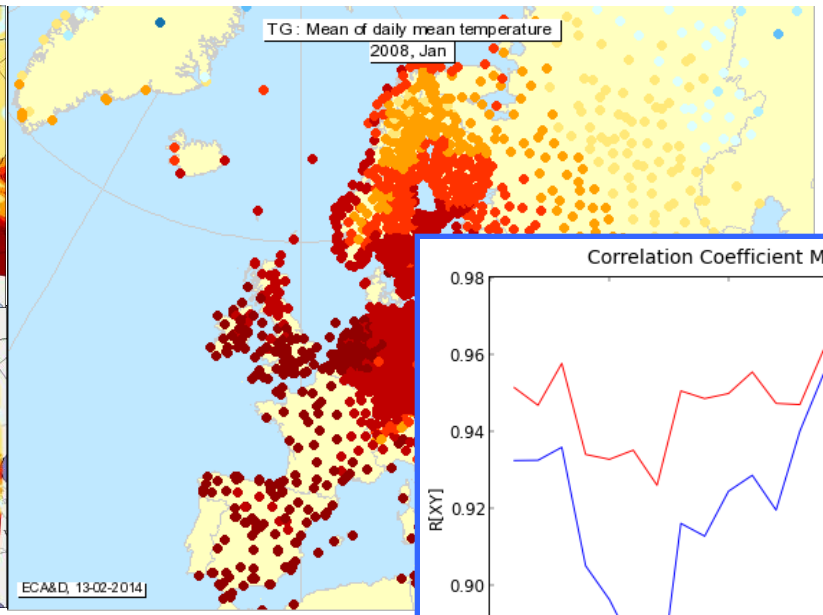
Climate Statistics

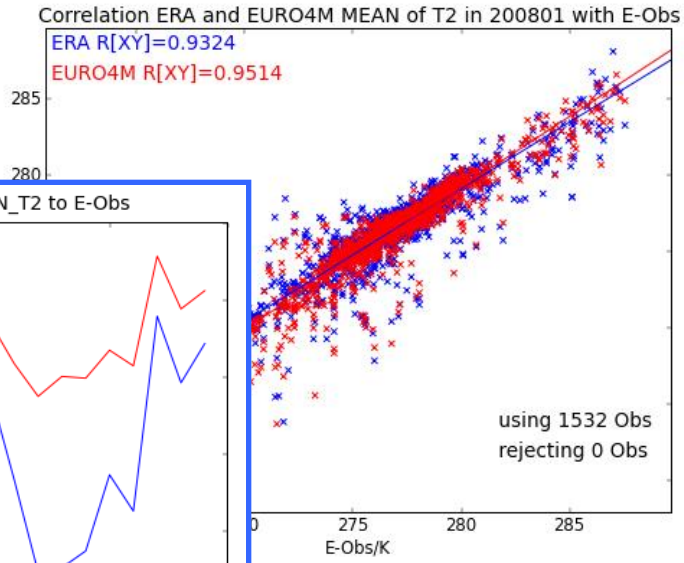
Climate Statistics

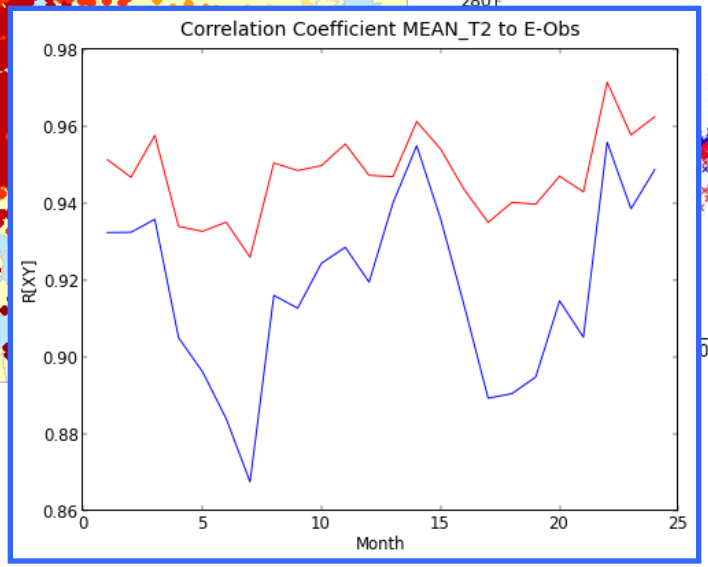
Monthly Means *Compare with ECA&D statistics from obs stations*

ERA *T*









MO

Climate Statistics

Compare with ECA&D statistics from obs stations

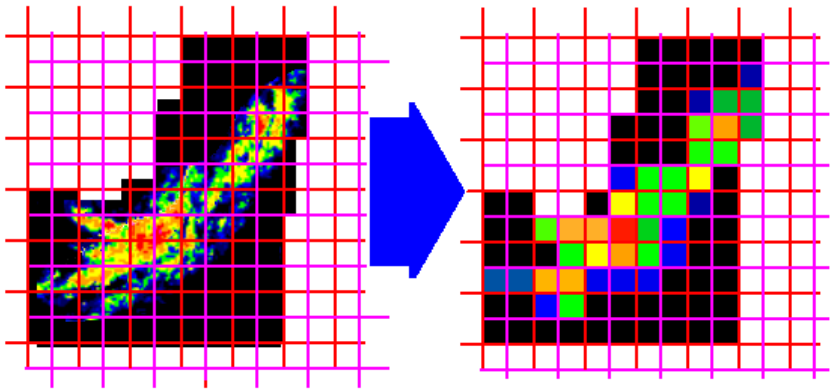
Mean Temperature	Max of Min Temp	Dry Days	
Mean of Min Temp	Mean Precip	Wet Days	
Mean of Max Temp	Icing Days	Frost Days	MO better in…
Mean Wind Speed	Total Wet Precip		24/24 months
Max of Min Temp	Mean Temp Range		23/24 months
Max of Max Temp	Tropical Nights		22/24 or 21/24 mns
Min of Min Temp	Mean Wet Precip		20/24 or 19/24 mns
Max Precip 5 Days	Mean Cloud		10/24 months
Summer Days	Mean Rel Hum		
Calm Days	Maximum Gust		
Days Precip>10mm	Max Daily Precip		
Days Precip>20mm	Wind Days	Mean PMSL	

Climate Statistics

- Climate statistics are useful for monitoring the European climate
- Regional models represent 12/28 stats better than ERA-Interim for the full period.
- Regional models represent 27/28 stats better than ERA-Interim for most of the period.
- Large scale variables (e.g. pressure) are better represented in the global ERA-Interim

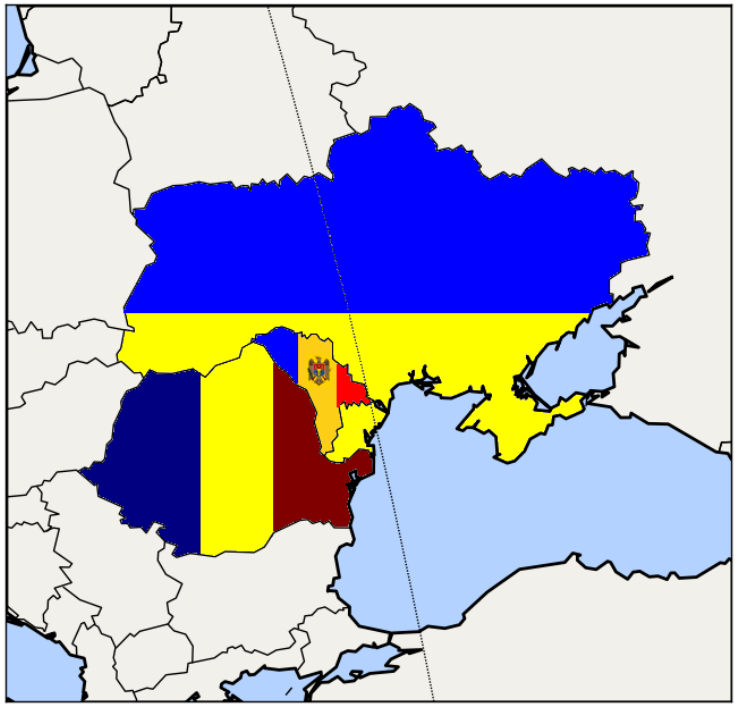
Precipitation

- Critical aspect of climate
- Covers wide range of intensities, periods and scales
- Flooding in central Europe in 2013 was responsible for 25 deaths and 12bn Euros damage
- Challenge for NWP: Extremes are softened by grid-box averaging/long accumulation periods
- Higher resolution should lead to improved representation of extremes



Floods July 2008

Floods July 2008



Floods July 2008

ROMANIA

- 9000 houses damaged
- 20,000ha ag. land flooded
- 5 dead
- $100 million

MOLDOVA

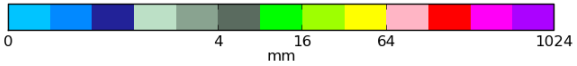
- 300 houses destroyed
- 7500ha ag. land flooded
- 3 dead
- $300million

UKRAINE

- 50,000 houses flooded
- 300,000 people affected
- 38 dead
- cost $700million

Floods July 2008

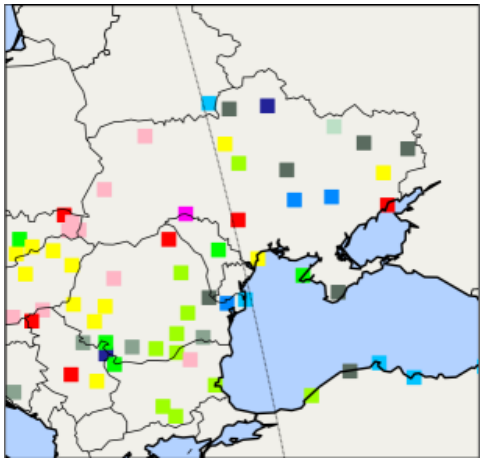
23-26th July Accumulations



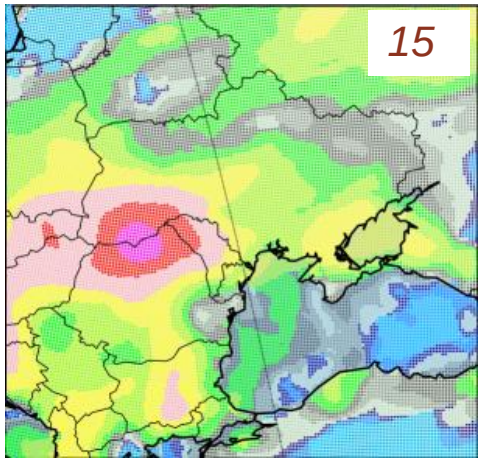
EURO4M

Mean abs error

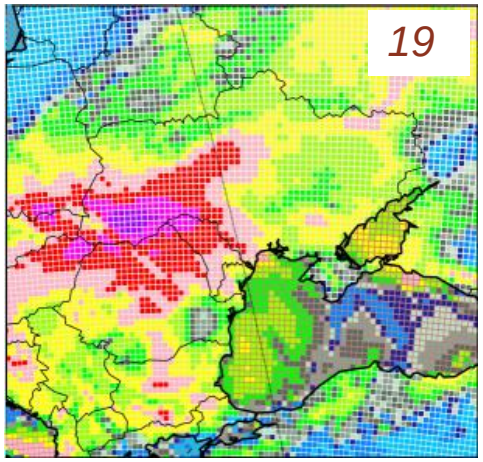
SYNOP

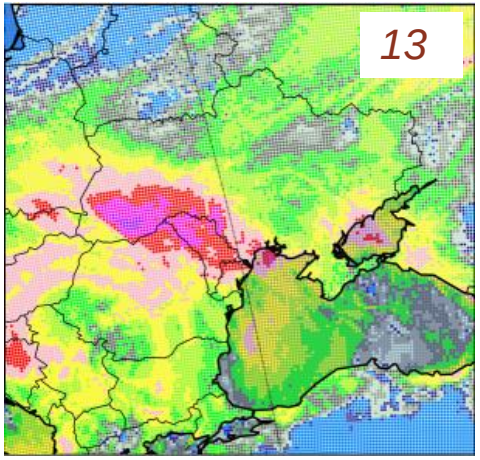


ERA-Interim

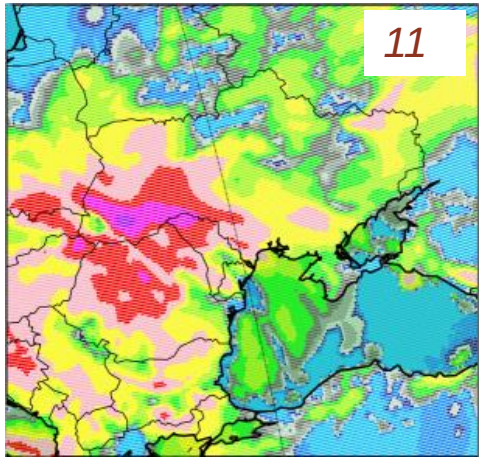


HIRLAM

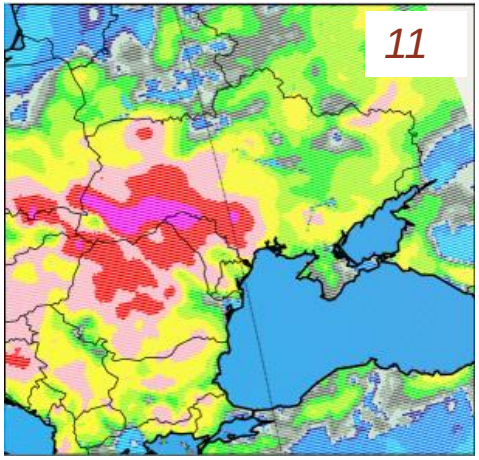




MO



MESAN

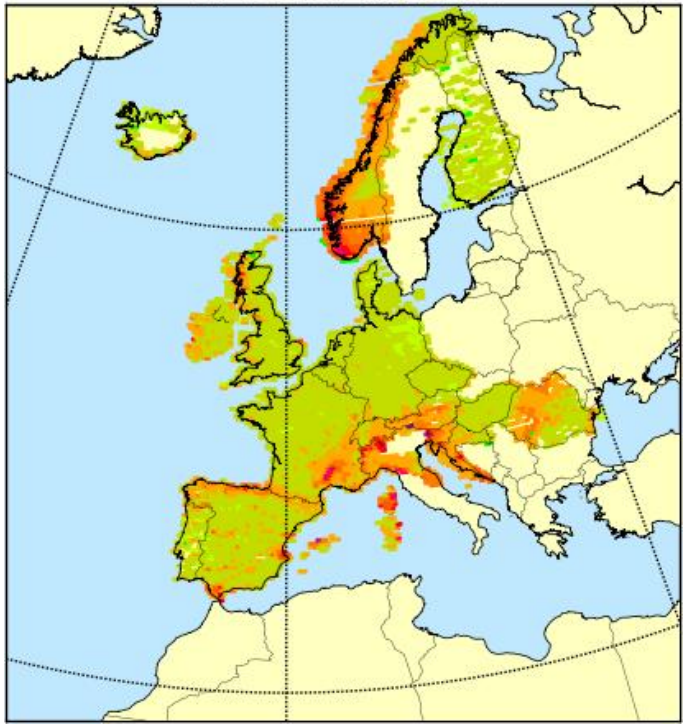


MESCAN

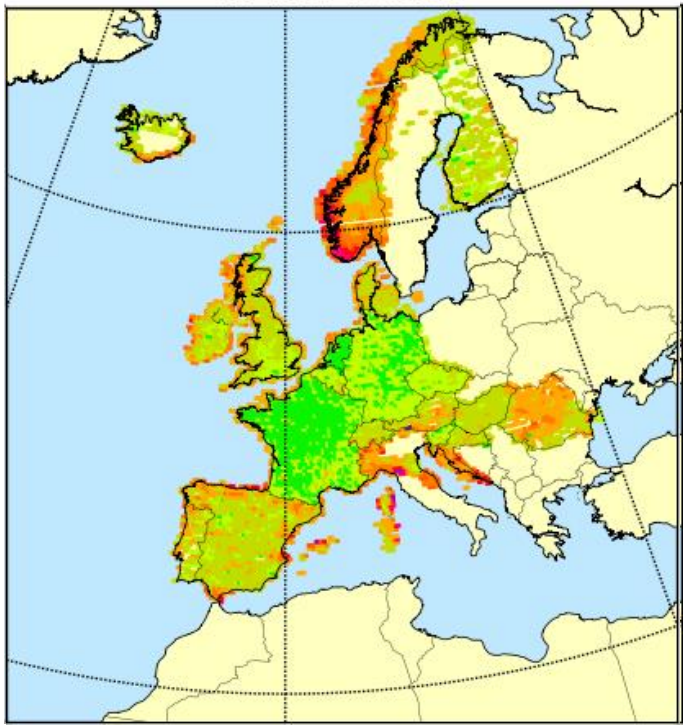
Annual RMSEs

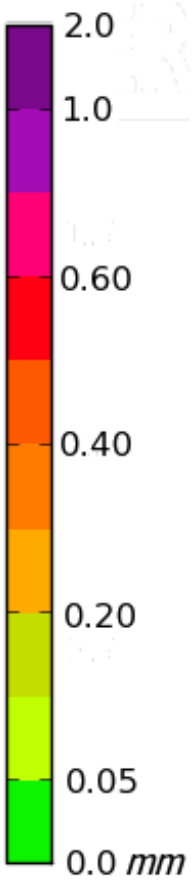
- Truth is gridded 24hr rain gauge observations (ECMWF)
- Error(Model) = Obs - Model
- Annual RMSEs 2008

RMSE ERA-Interim

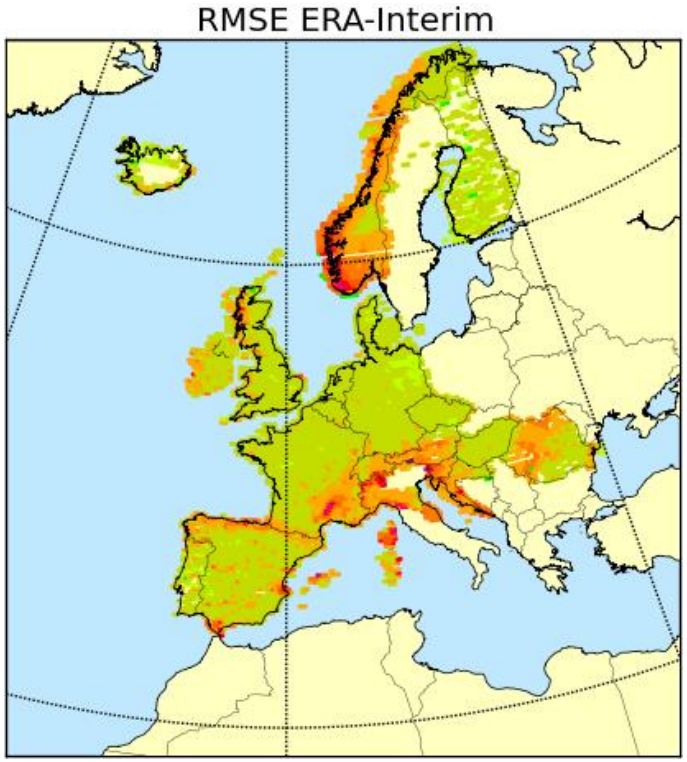


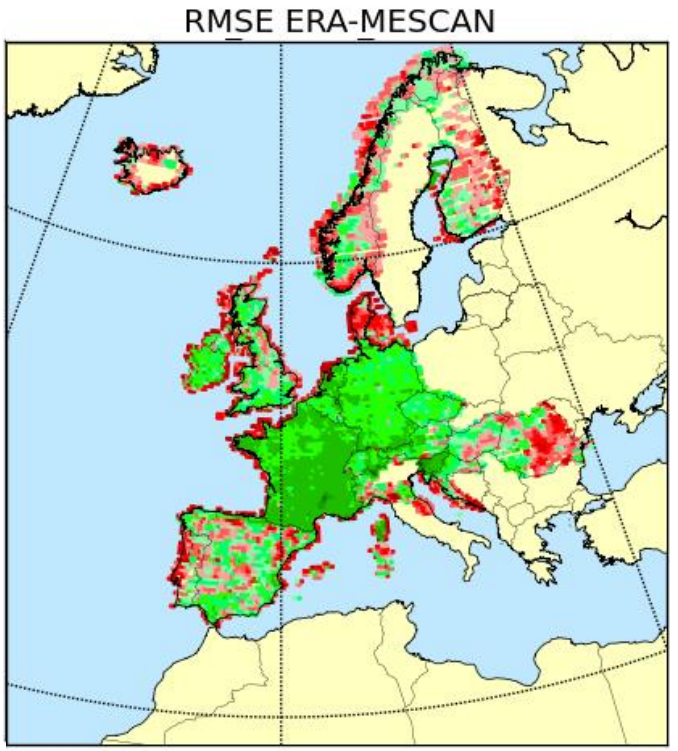
RMSE MESCAN

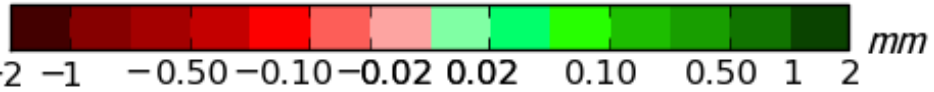




RMSE Differences



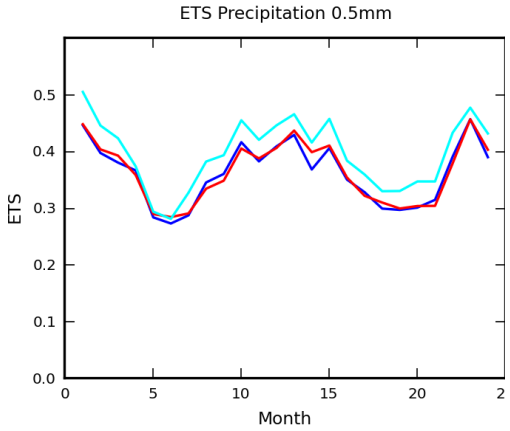


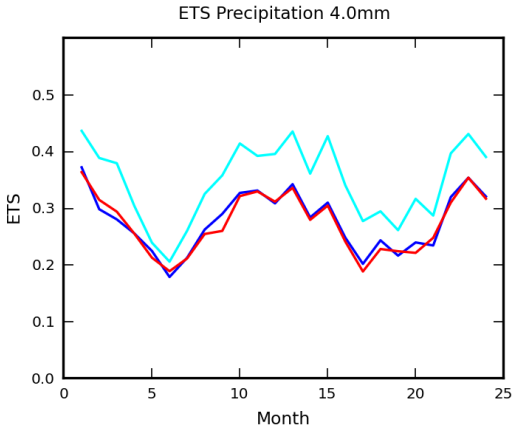


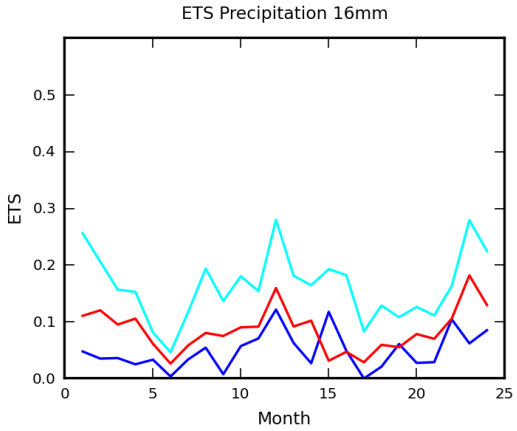
ETS

ERA-Interim
HIRLAM
MO
MESAN
MESCAN

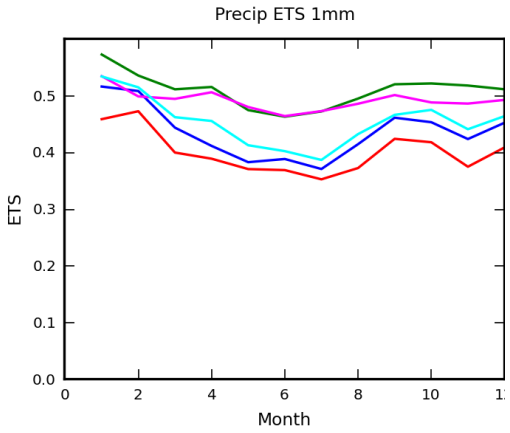
- Truth is SYNOP rain gauge data

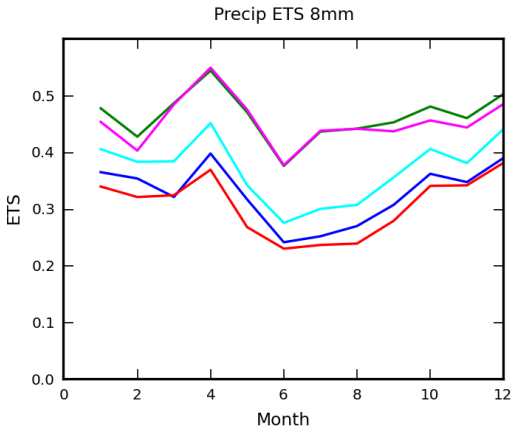


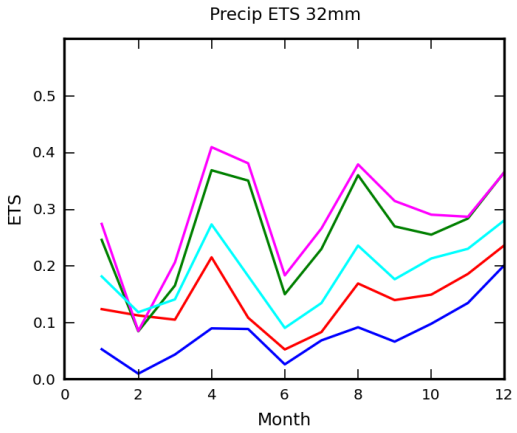




6hr





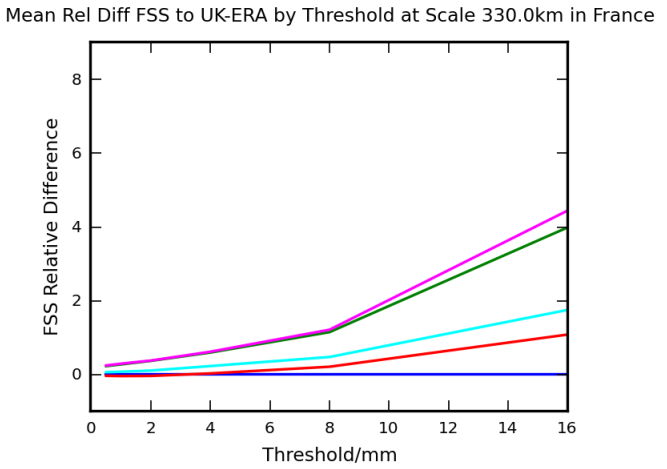


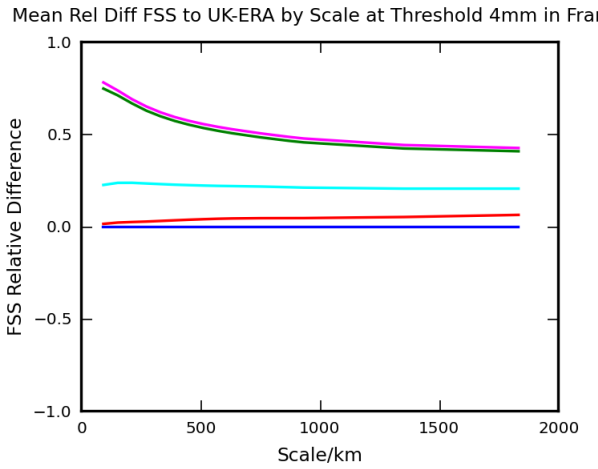
24hr

- Scores higher in winter
- Location-based verification alone can be dangerous for precip

Fractions Skill Score

[Roberts N.M. and Lean H.W.(2008)]

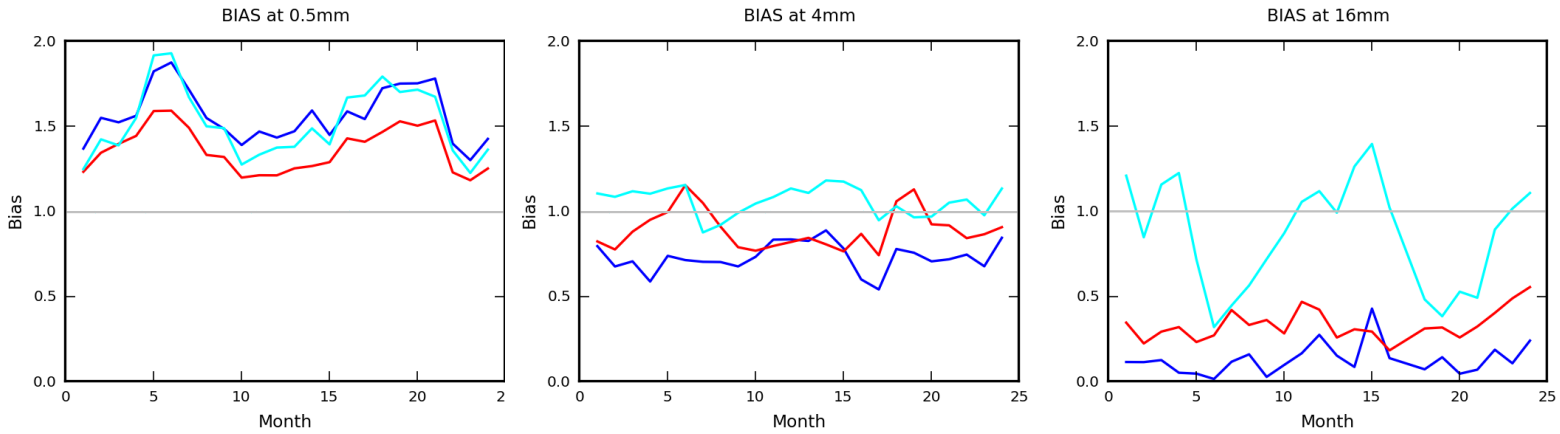




ERA-Interim HIRLAM MO MESAN MESCAN

- Truth is gridded 24hr rain gauge observations (ECMWF)
- Rel Diff(Model,ERA-Interim) = (Model – ERA-Interim)/ERA-Interim

Frequency bias



6hr

- At low thresholds models over-represent
- At high thresholds models under-represent, but …
- … bias is reduced by increased resolution & 4DVAR assimilation

Precipitation Evaluation

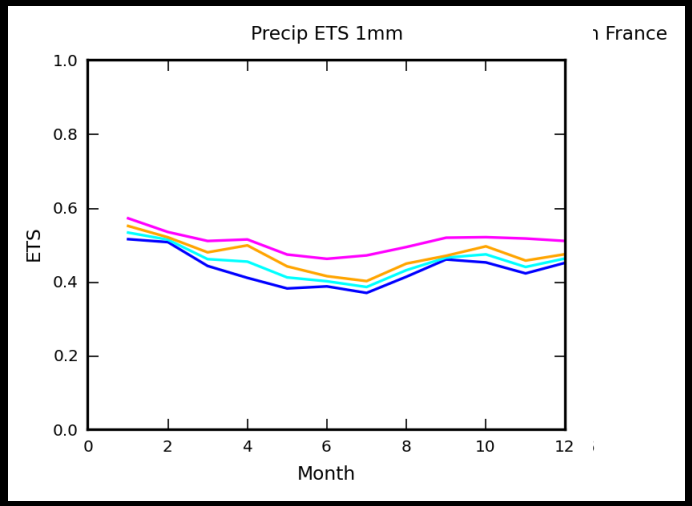
- ALL models over-represent at low thresholds and under-represent at high thresholds
- ALL models score best in winter (large-scales dominate)
- HIRLAM ≈ ERA-Interim at low thresholds; HIRLAM > ERA-Interim at high thresholds
- MO > ERA-Interim especially at high thresholds
- MESAN/MESCAN >> reanalyses

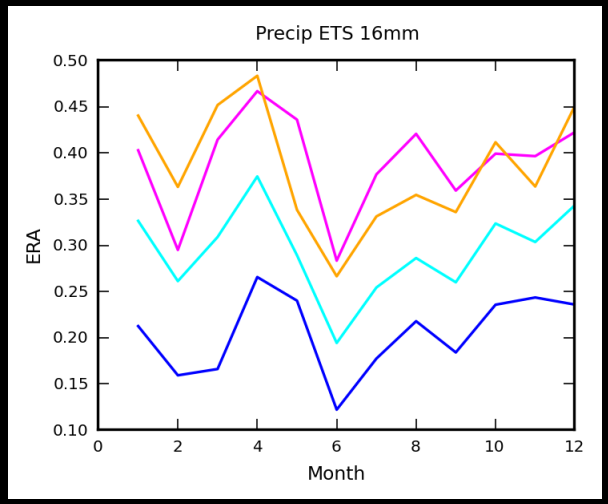
WHY?!

- 3DVAR vs 4DVAR
- Resolution
- Assimilation of Precip Obs

WHY?!

- Assimilation of Precip Obs





- Ctrl - ERA-Interim (80km)
- MESAN (5km)
- MO (12km) + [MO (12km) – ERA-Interim (80km)]
- Test2 - MO with assimilation (12km)

Benefits to precipitation representation

LOW THRESHOLDS

(non-precip) Obs Assim

(precip) Obs Assim

HIGH THRESHOLDS

4D D.A.

Resolution

(non-precip) Obs Assim

(precip) Obs Assim

Conclusions

- EURO4M has produced new high resolution datasets
- Reanalyses: HIRLAM (24km; 1989-2010), MO (12km; 2008-2009)
- Downscalers: MESAN & MESCAN (5km)
- Regional reanalysis improves representation of surface events
- Increasing resolution improves representation of extreme precipitation events
- Assimilation of precipitation observations improves representation of all precipitation events

UERRA

Uncertainties in Ensembles of Regional Re-Analyses

- UERRA is the follow-on project to EURO4M
- EURO4M partners plus ECMWF, the University of Bonn and MET Norway
- To continue development of observation data & produce ensembles of regional reanalyses
- UERRA runs from January 2014 to December 2017

Thank you for listening…

http://www.euro4m.eu/

MESAN & MESCAN Differences

$$f^{S}(r,R,L) = \frac{1}{2}\left(e^{-r/L} + (1+\frac{2r}{L})e^{-2r/R}\right)$$
$$L^{S} = 270\text{km}$$
$$\sigma_o^{S} = 0.7 + 0.2\text{RR}$$
$$\sigma_b^{S} = 20\text{mm}$$

$$f^{SC}(r,R,L) = (1+\frac{r}{L})e^{-r/L}$$
$$L^{SC} = 35\text{km}$$
$$\sigma_o^{SC} = 5\text{mm}$$
$$\sigma_b^{SC} = 13\text{mm}$$

σ - standard deviation of error
f - background error correlation function
S - MESAN
SC - MESCAN
r - covariance distance
R - reference distance
L - horizontal length scale