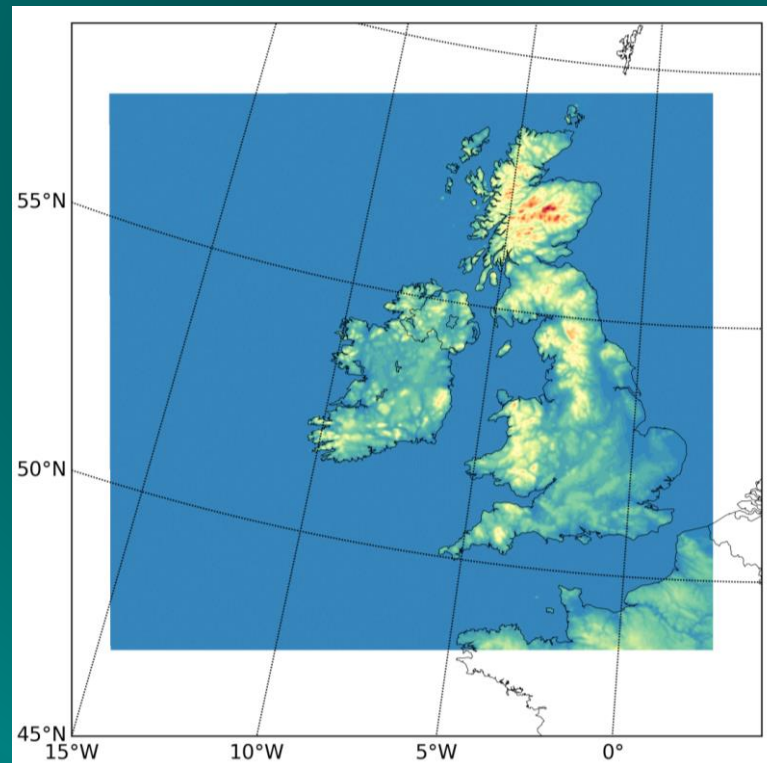


High resolution regional reanalysis over Ireland using the HARMONIE NWP model

Emily Gleeson, Eoin Whelan

With thanks to John Hanley, Bing Li, Ray McGrath, Séamus Walsh,



Motivation/Inspiration

- KNMI – 5 year reanalysis of extreme wind using HARMONIE cycle 36 and EURO4M/UERRA
- No very high resolution reanalysis dataset publicly available for Ireland
- Such a dataset will extend the knowledge gained from observations and will include many parameters that are not routinely observed.
- Climate reanalyses are an important source of information for monitoring climate as well as for the validation and calibration of numerical weather prediction models.



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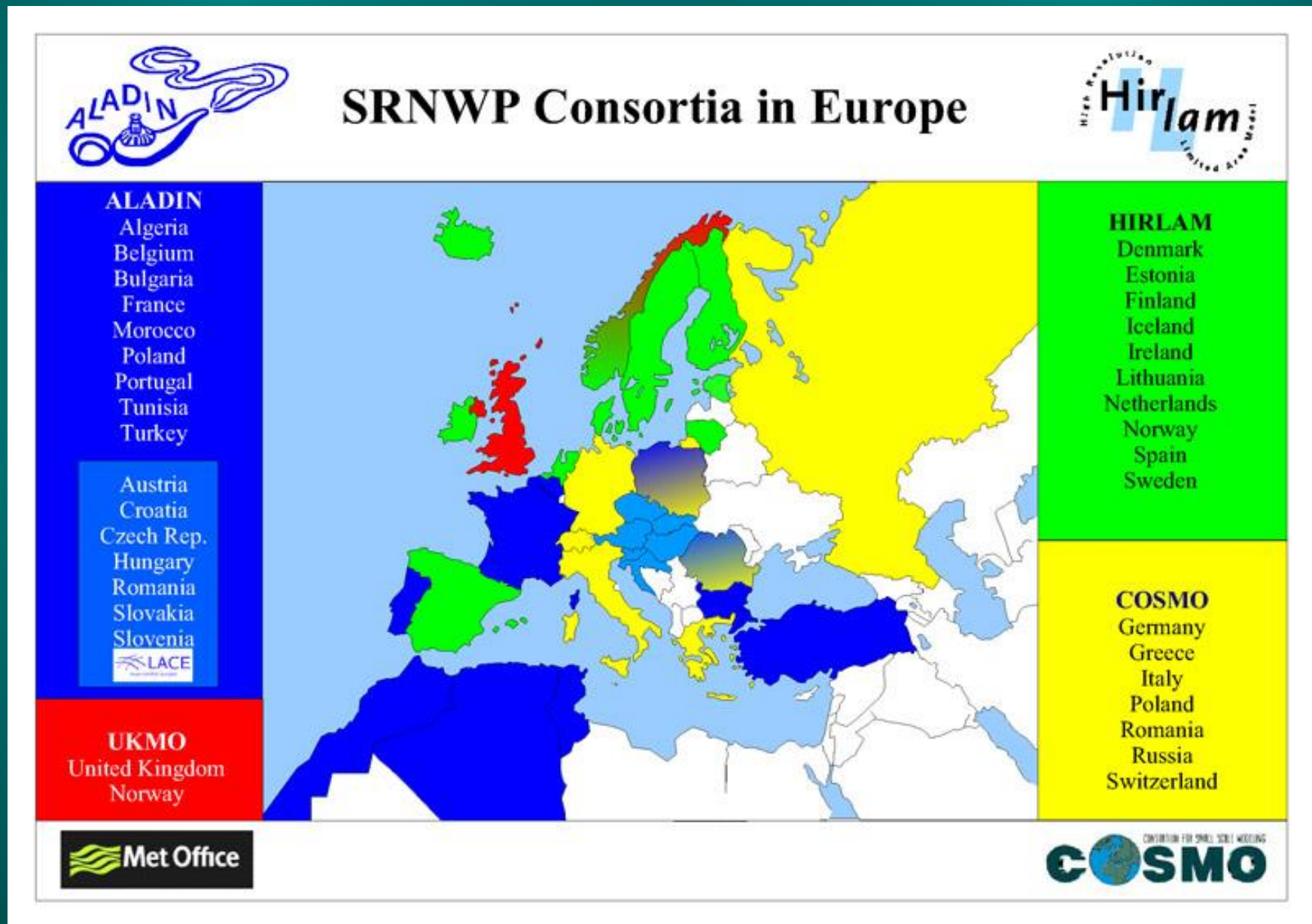
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1. HIRLAM & ALADIN Consortia

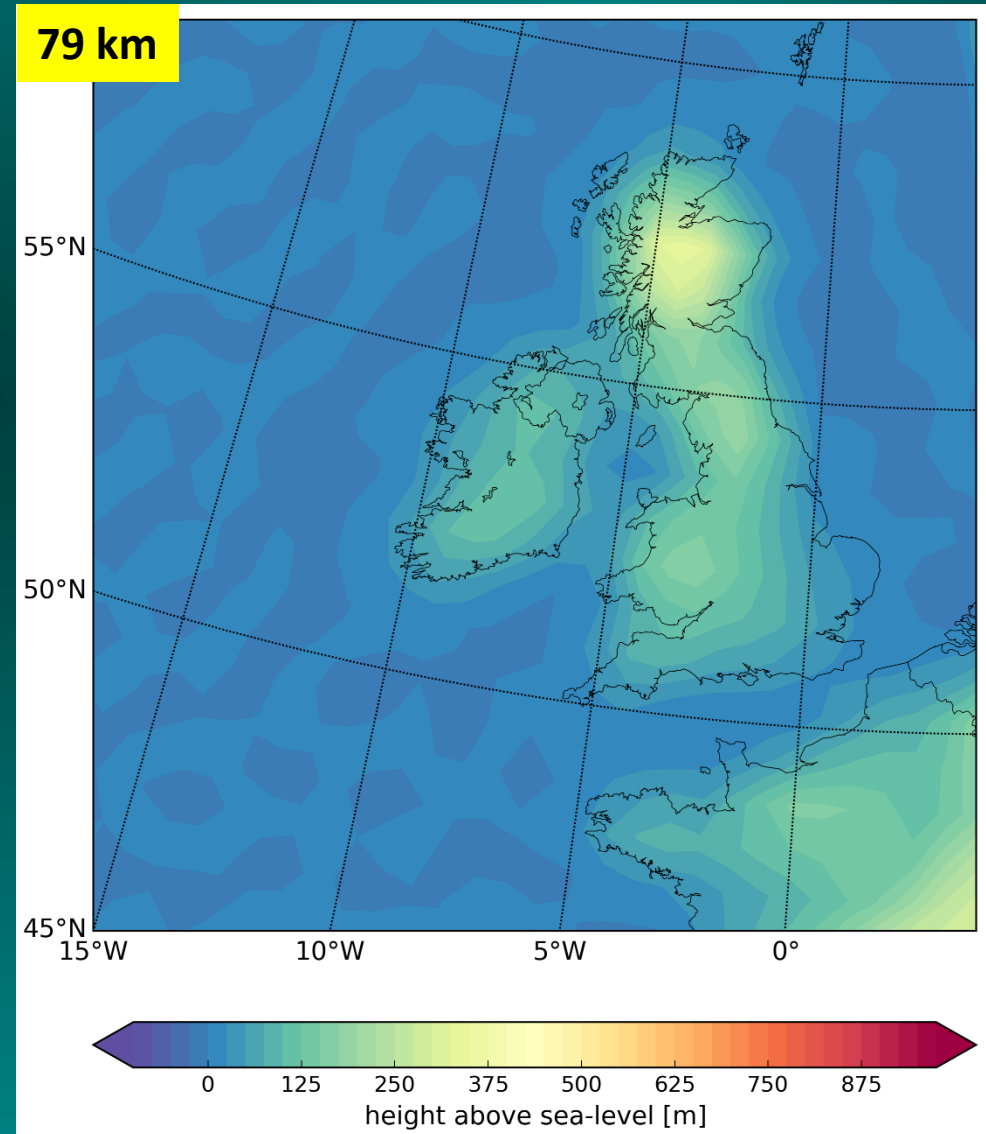
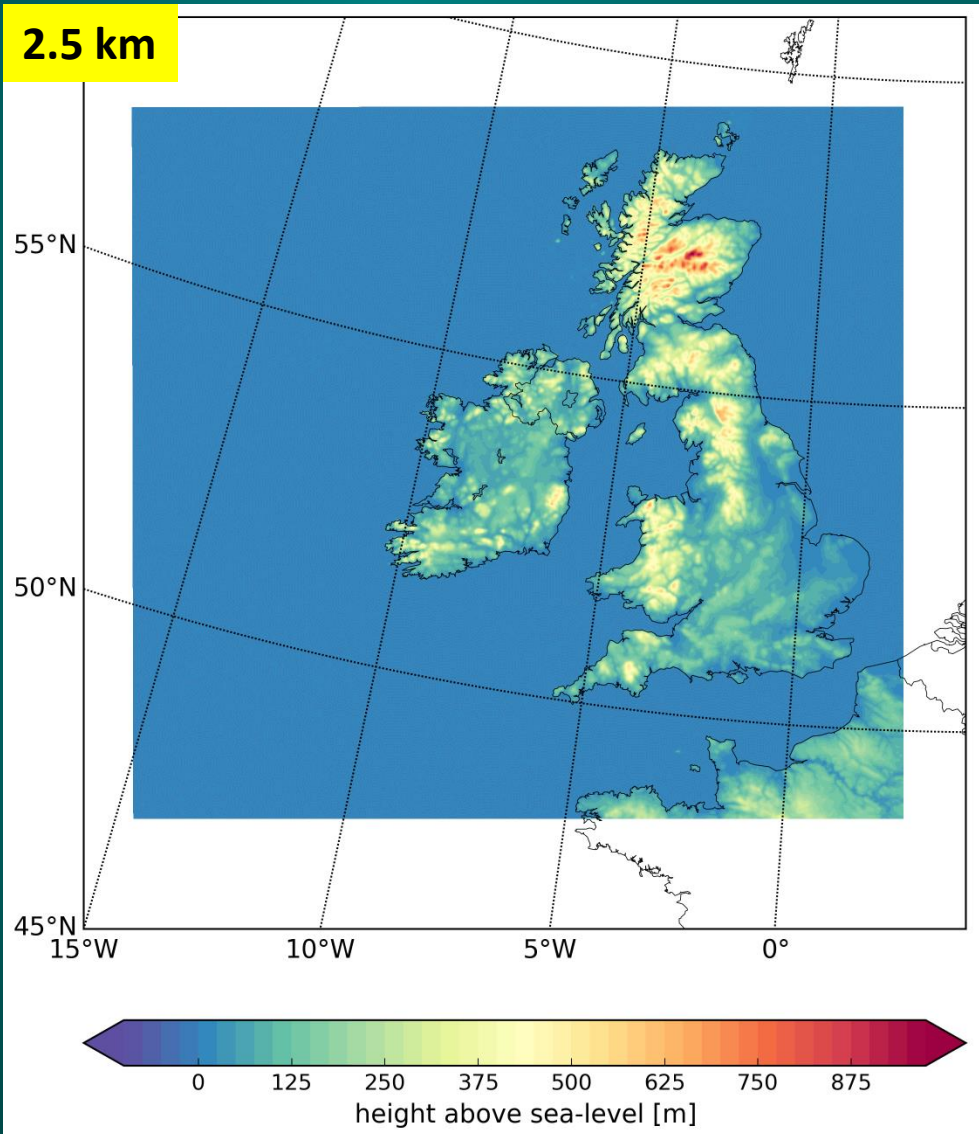


2. ALADIN-HIRLAM NWP system

- Used for operational weather forecasting by 26 national meteorological services in Europe and North Africa
- 42 canonical configurations
- We use the HARMONIE-AROME configuration (cycle 38h1.2)
 - 2.5 km horizontal grid and 65 hybrid model levels (top 10 hPa) with deep convection treated explicitly
 - ALADIN non-hydrostatic dynamics
 - Non-hydrostatic mesoscale physics (MESO-NH)
 - SURFEX externalized surface scheme

3. HARMONIE-AROME vs ERA-Interim

Orography



4. HARMONIE-AROME configuration

Model version	HARMONIE-AROME 38h1.2
Domain	540 x 500 grid points ($\Delta x = 2.5$ km)
Vertical levels	65 levels up to 10 hPa, first level at 12 m
Forecast cycle	3 hours
Data assimilation	Optimal interpolation for surface parameters 3DVAR assimilation for upper air parameters
Observations	Pressure from SYNOP, SHIP and DRIBU Temperature and winds from AIREP and AMDAR Winds from PILOT Temperature, winds and humidity from TEMP
Forecast	3 hour forecasts, but a 33-hour forecast at 00 Z

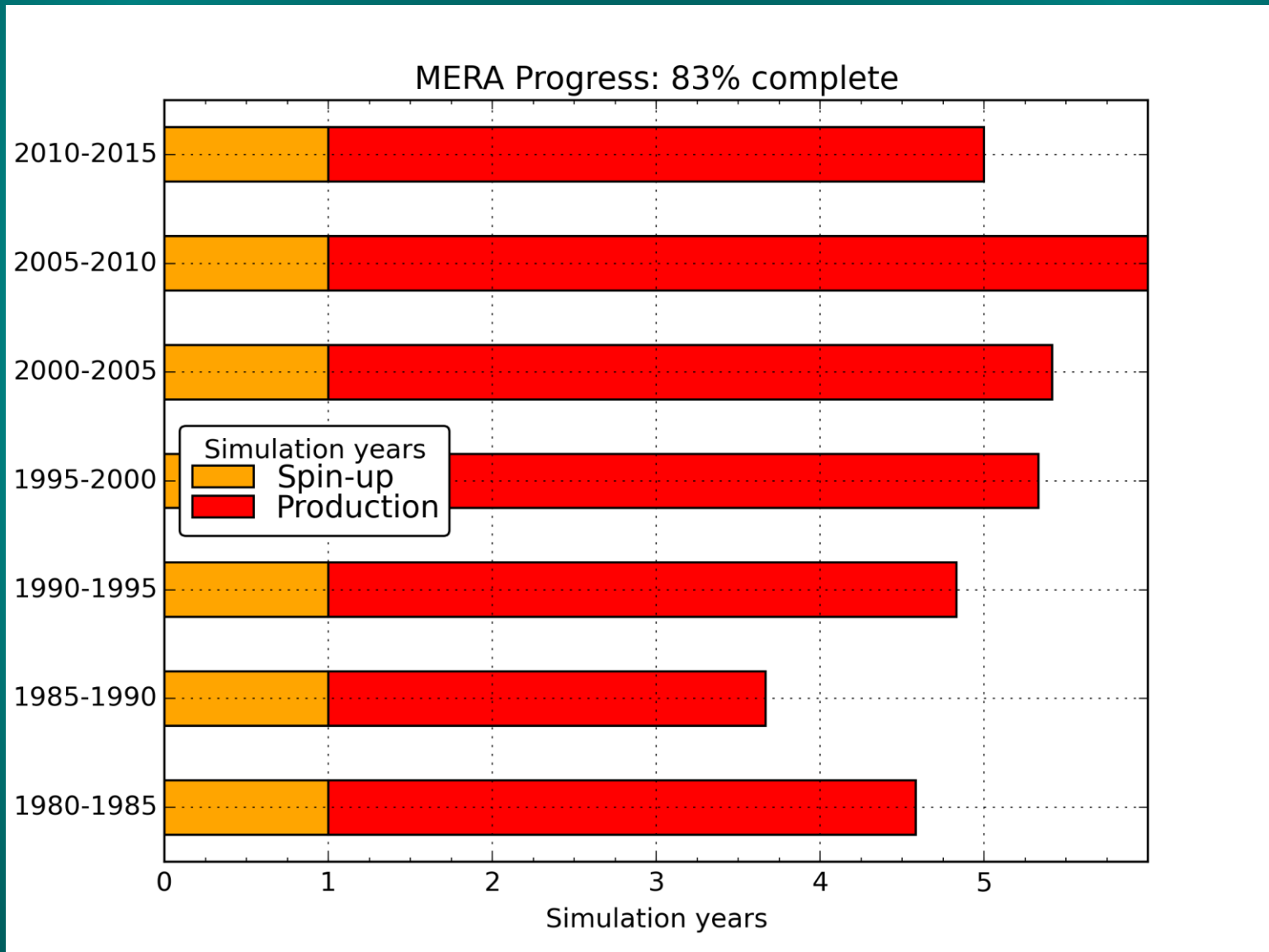
A few points about MÉRA

- MÉRA – Met Éireann ReAnalYSIS
- 35 year period: 1981-2015
- Conventional observations (available in MARS) are assimilated
- ERA-Interim lateral boundary conditions (every 3 hours using 1 way nesting)
- Tuning of surface drag coefficient used by SURFEX
- Atmospheric, near surface and surface parameters
- Running at ECMWF (cca) and stored in ECFS [150TB]
- Completion: Spring 2017

Summary of Analysis & Forecast Output

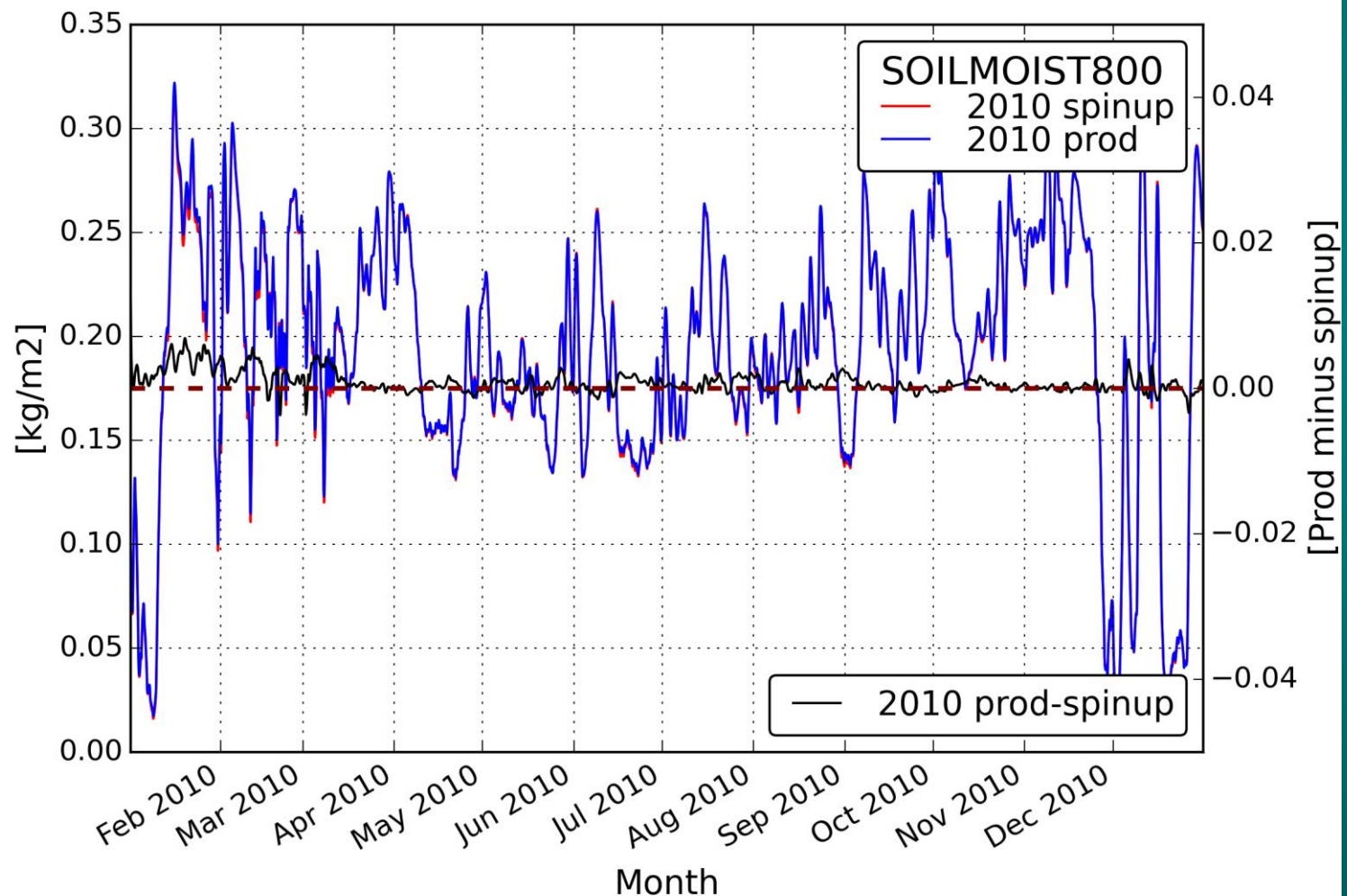
Level type	Parameters	Levels
Pressure	Temperature, wind, cloud, relative humidity, geopotential	100, 200, 300, 400, 500, 600, 700, 800, 850, 900, 925, 950, 1000 hPa
Height above ground	Temperature, wind, relative humidity	30, 50, 60, 70, 80, 90, 100, 125, 150, 200, 300, 400 m
Sub-surface	Temperature, moisture, ice	0, 20, 300 cm (below the surface)
Surface	Radiative and non-radiative fluxes	Surface
Top of atmosphere	Radiative and non-radiative fluxes	Nominal top of atmosphere
Surface	Precipitation diagnostics	Surface
Diagnostic	Screen level parameters	2m, 10m for winds and gusts
Diagnostic	Other model diagnostic parameters	-

5. Progress so far



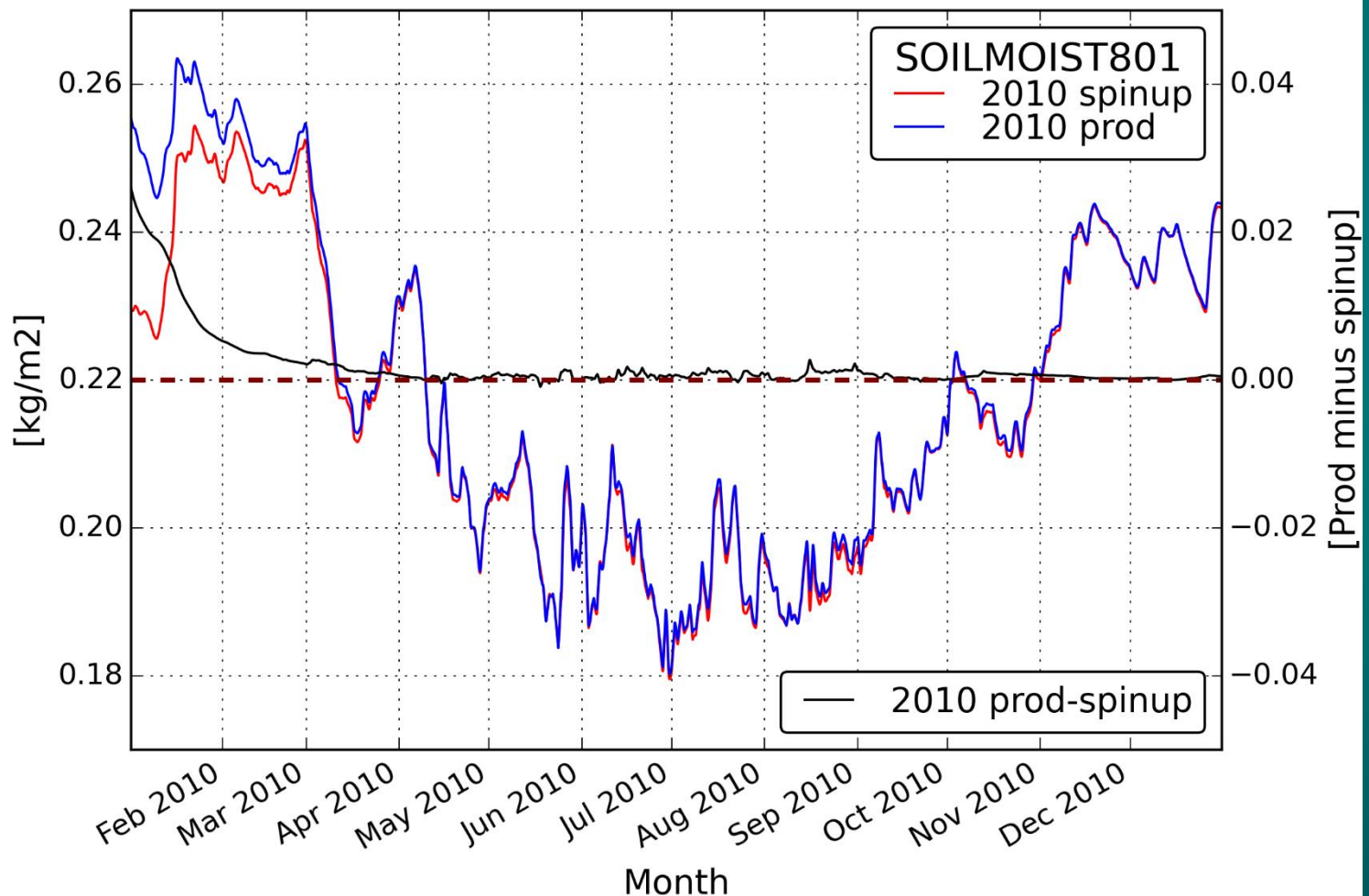
6. How long to spin up the model?

Surface:



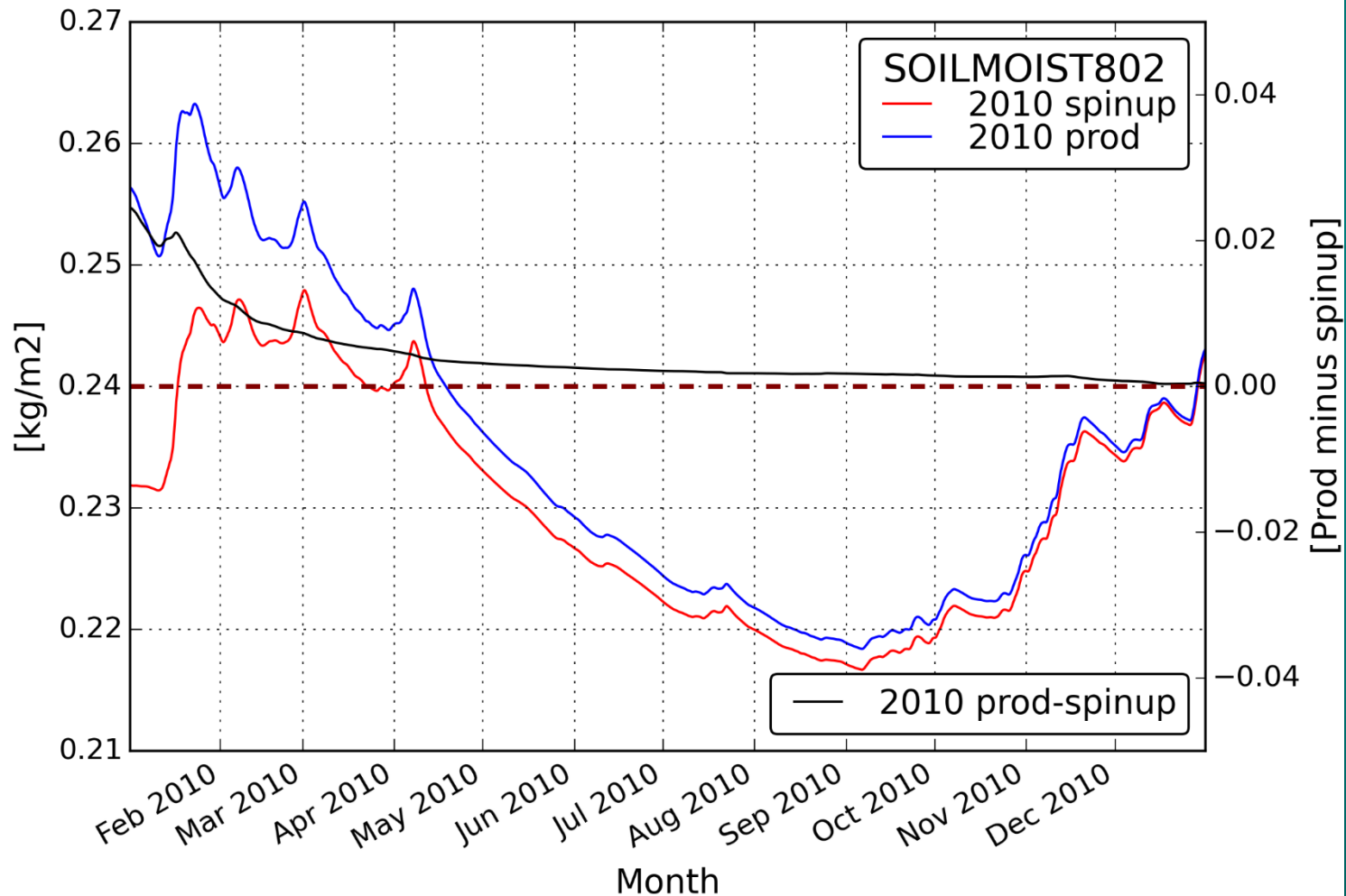
How long to spin up the model?

20 cm:



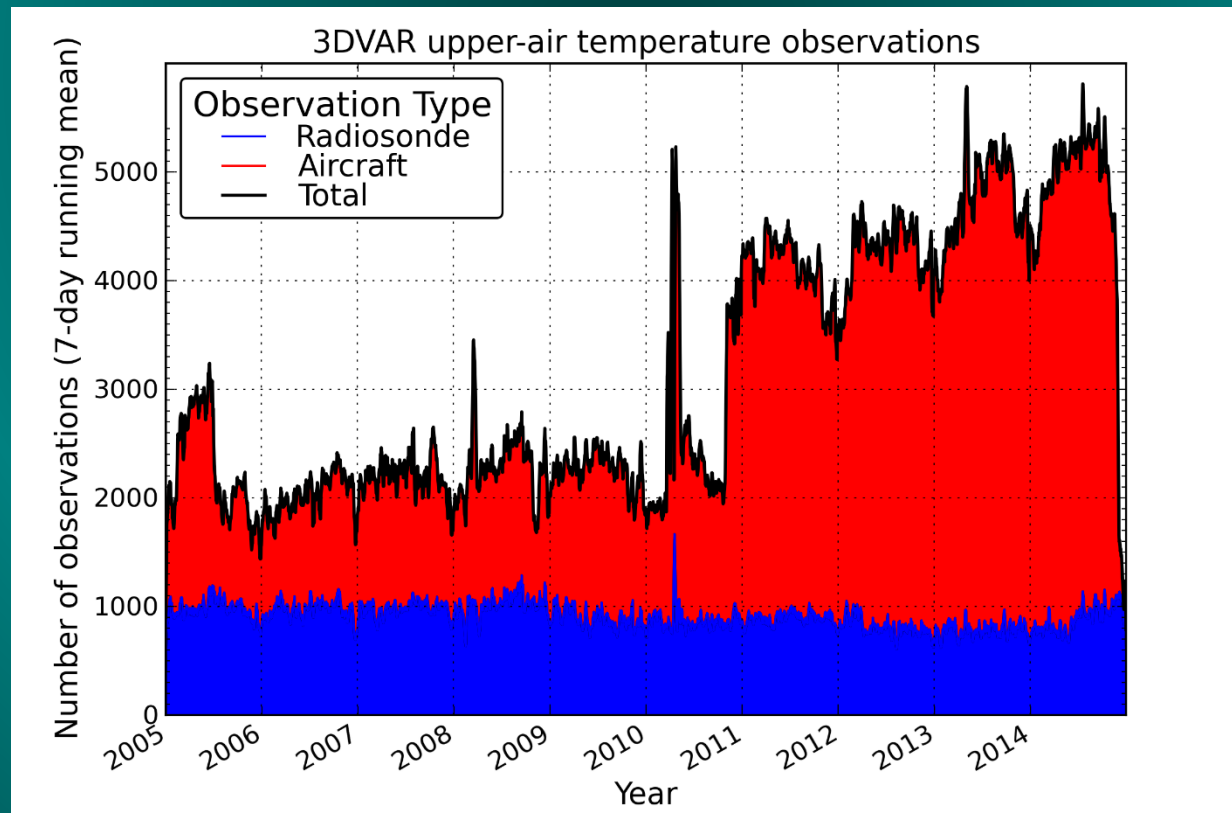
How long to spin up the model?

300 cm:



7. Data Assimilation Validation

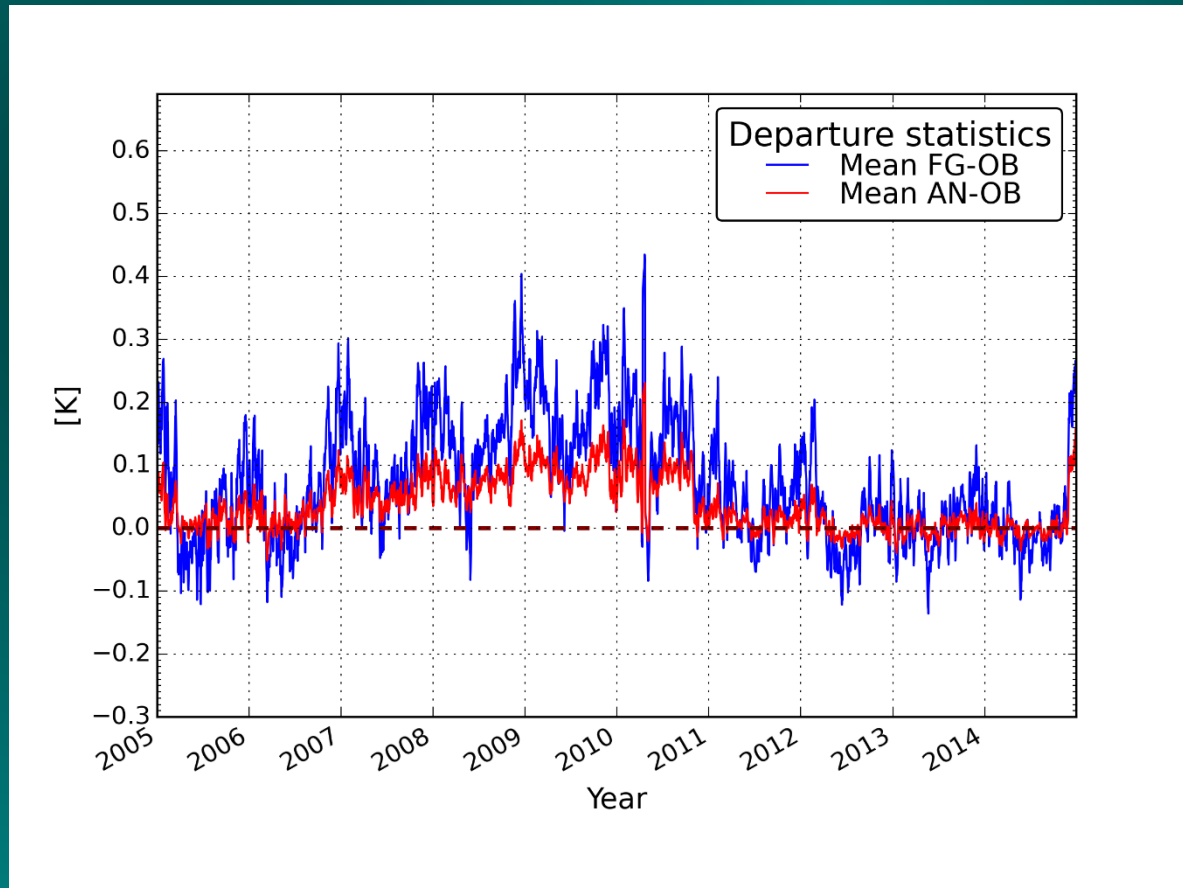
- Conventional observations are assimilated using 3DVAR
 - 3 hour cycling with 3DVAR minimisation followed by blending
 - Total counts of upper-air T used shown below – notable increase in aircraft observations from 2011 onwards



Data Assimilation Validation

- Difference between observation values (OB) and the equivalent first guess (short range forecast FG) are used to monitor and assess the quality of the MÉRA data assimilation
- 3DVAR minimisation process should produce an analysis (AN) which is closer to the observations (OB) than the model background (FG)

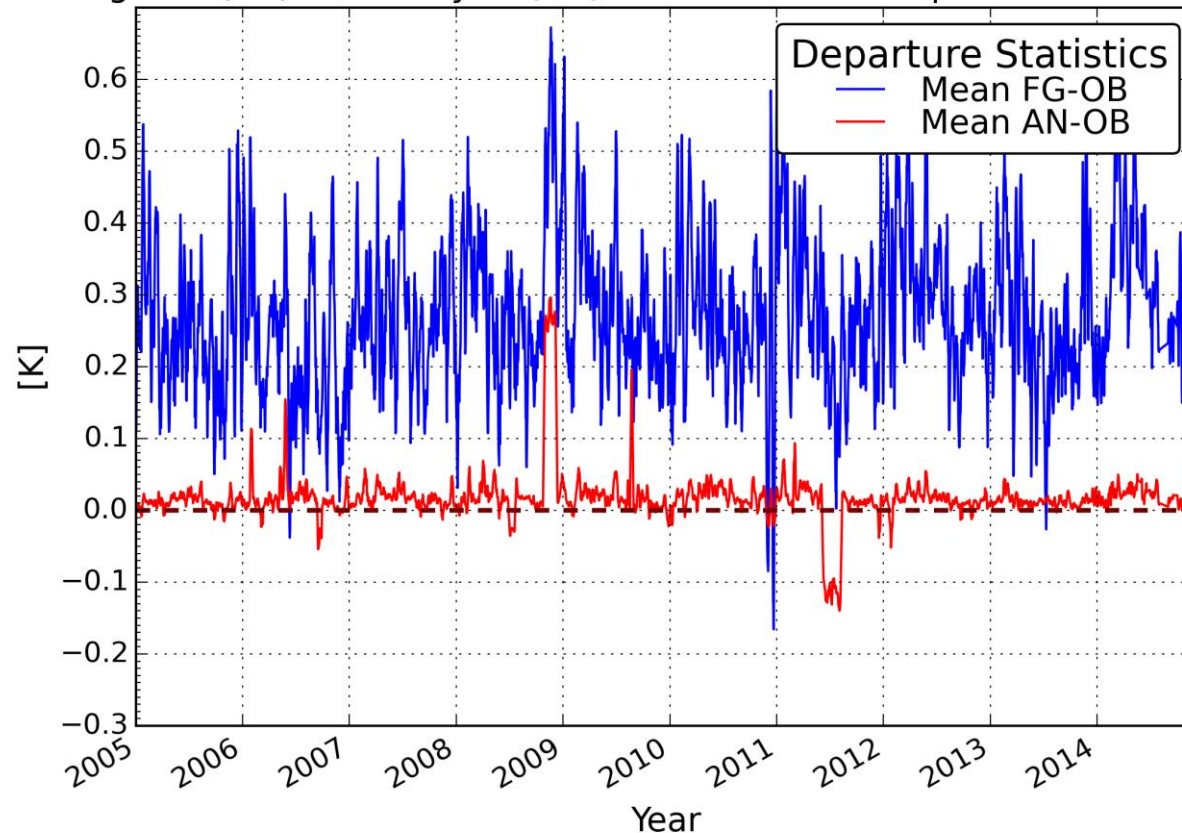
Aircraft observations:



Data Assimilation Validation

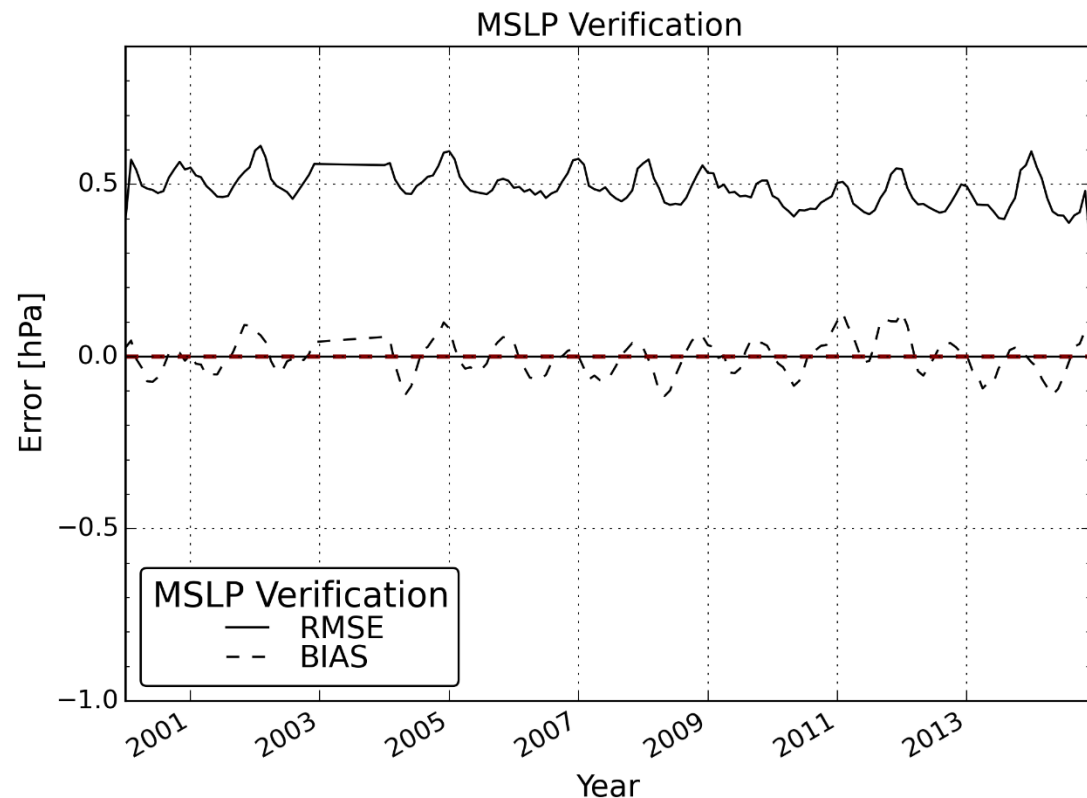
2 m temperature – surface DA:

First guess (FG) and analysis (AN) fit surface 2m temperature observations



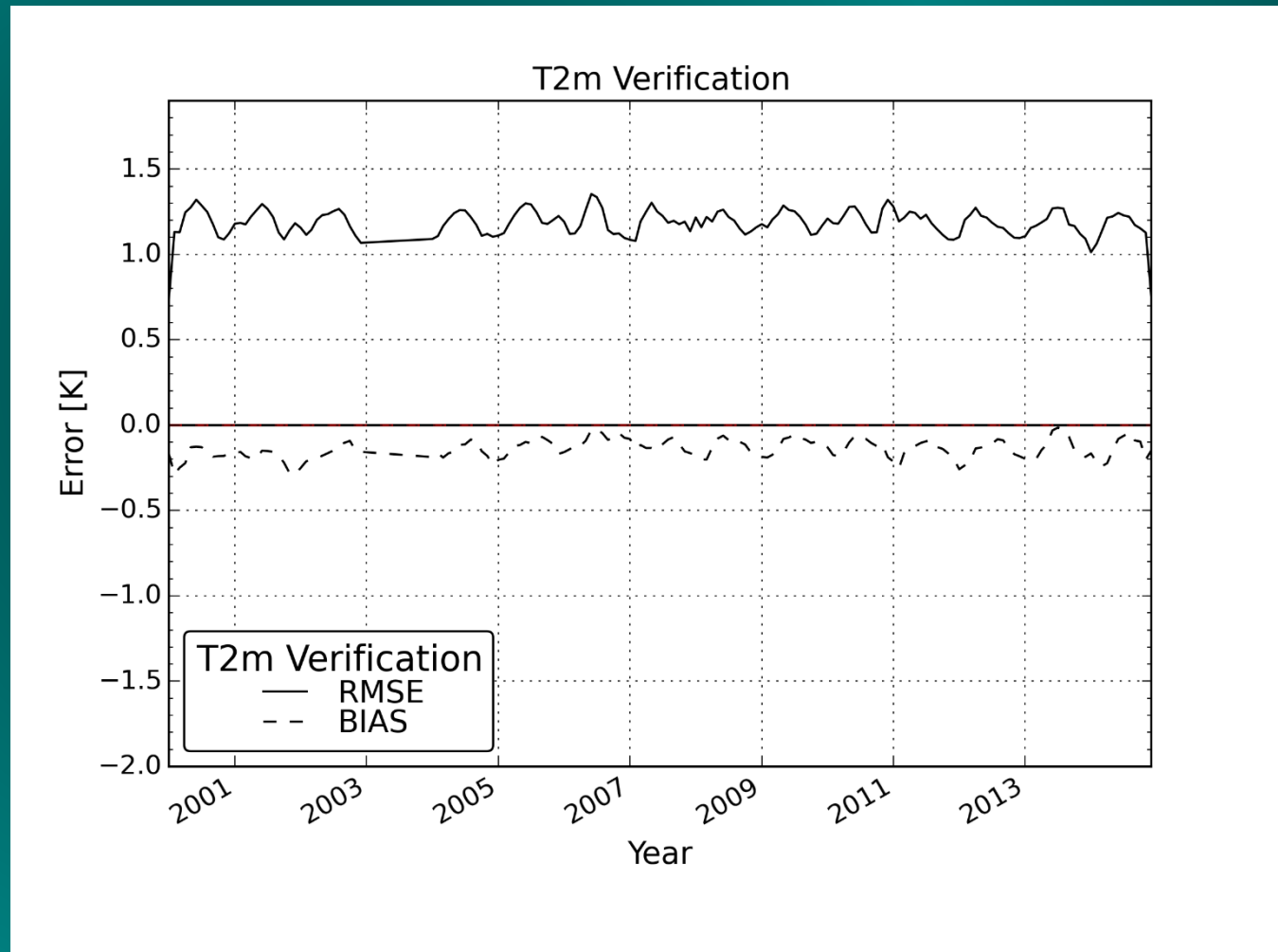
8. Validation vs Synoptic Observations

- 3-hour forecasts vs SYNOP observations
- Used HARMONIE monitor software



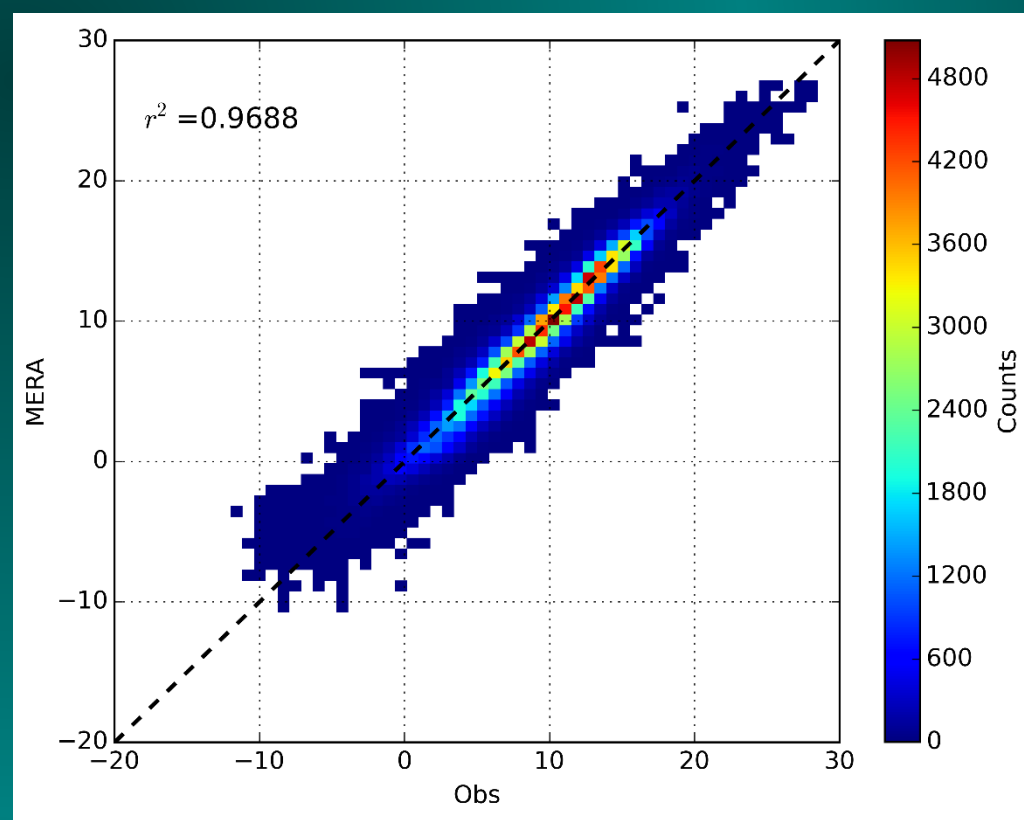
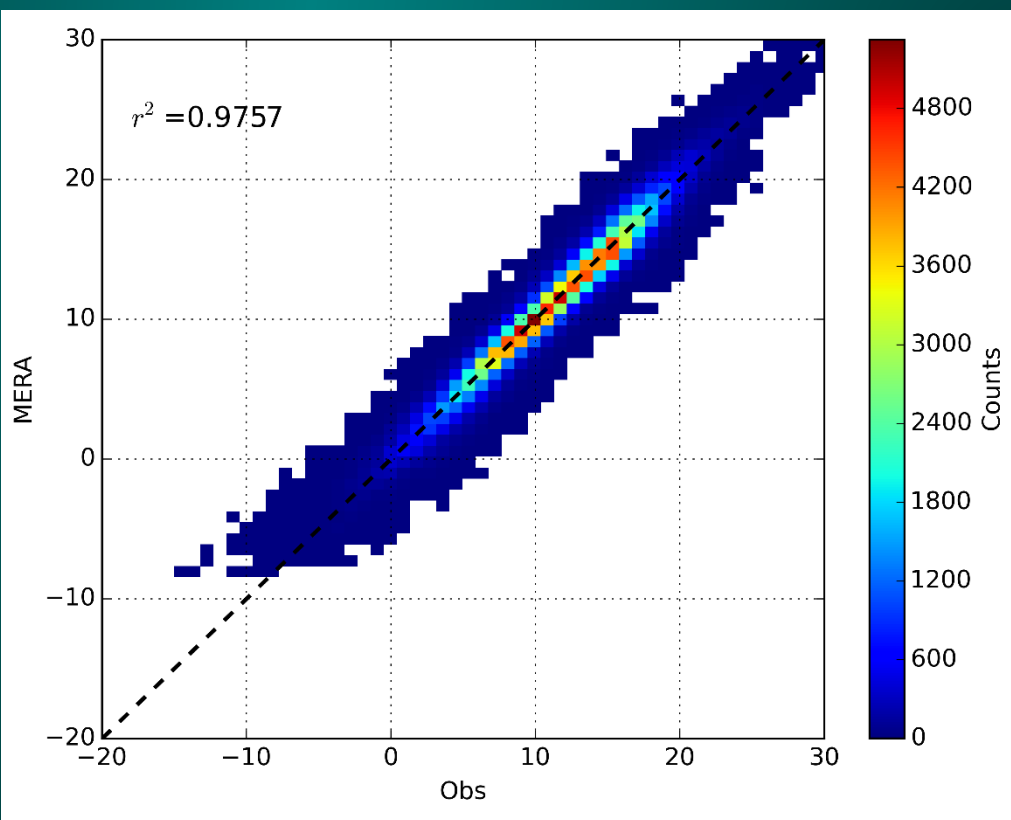
Validation vs Synoptic Observations

- Slightly negative bias in T2m
- Thought to be related to cloud condensate – an overprediction



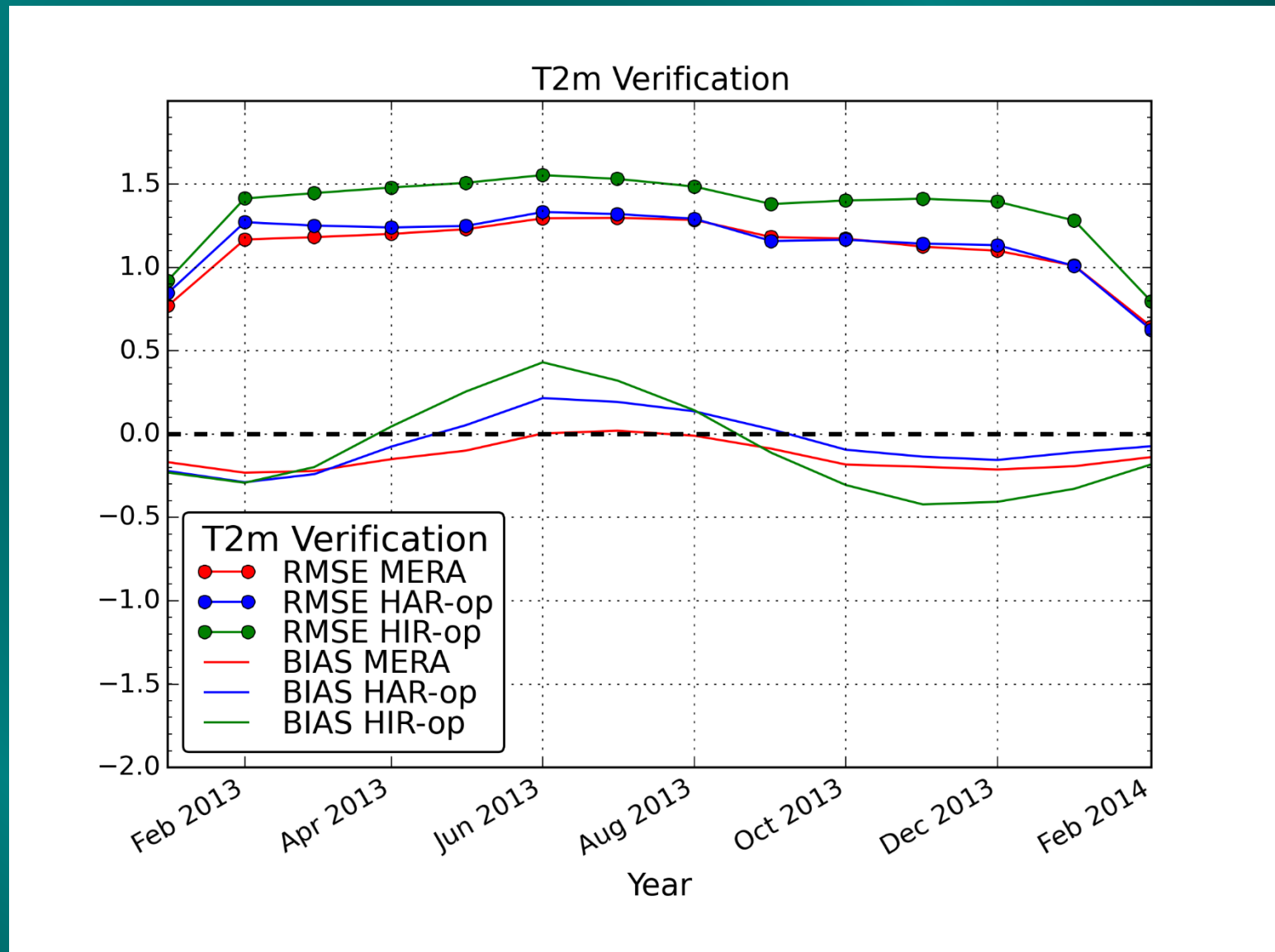
Validation vs Synoptic Observations

- 1, 2, and 3-hour forecast data are included here
- Left: day [07Z – 18Z]
- Right: night [19Z - 06Z]
- Compared to observations from 5 stations

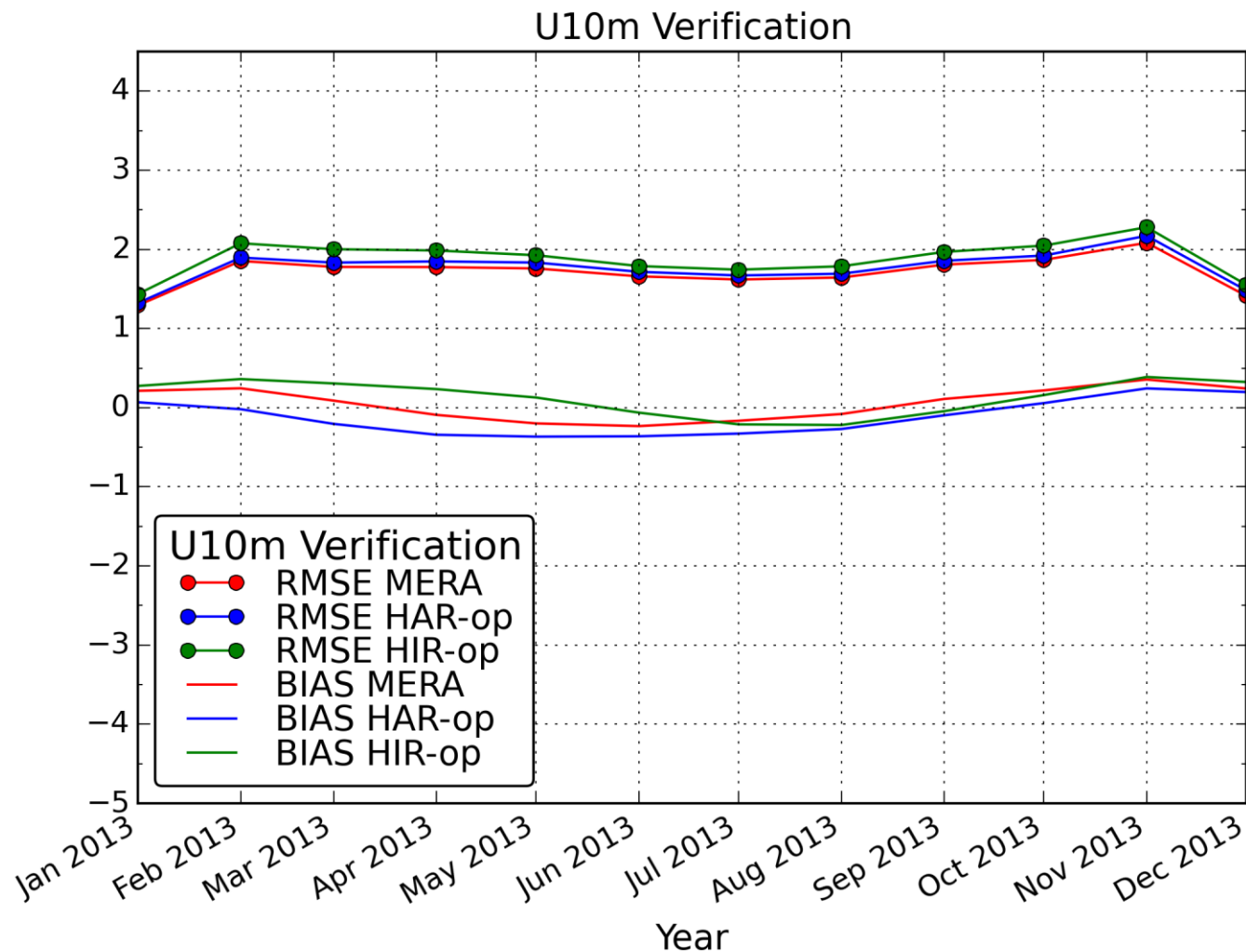


9. Validation vs Synoptic Observations & Operational Models

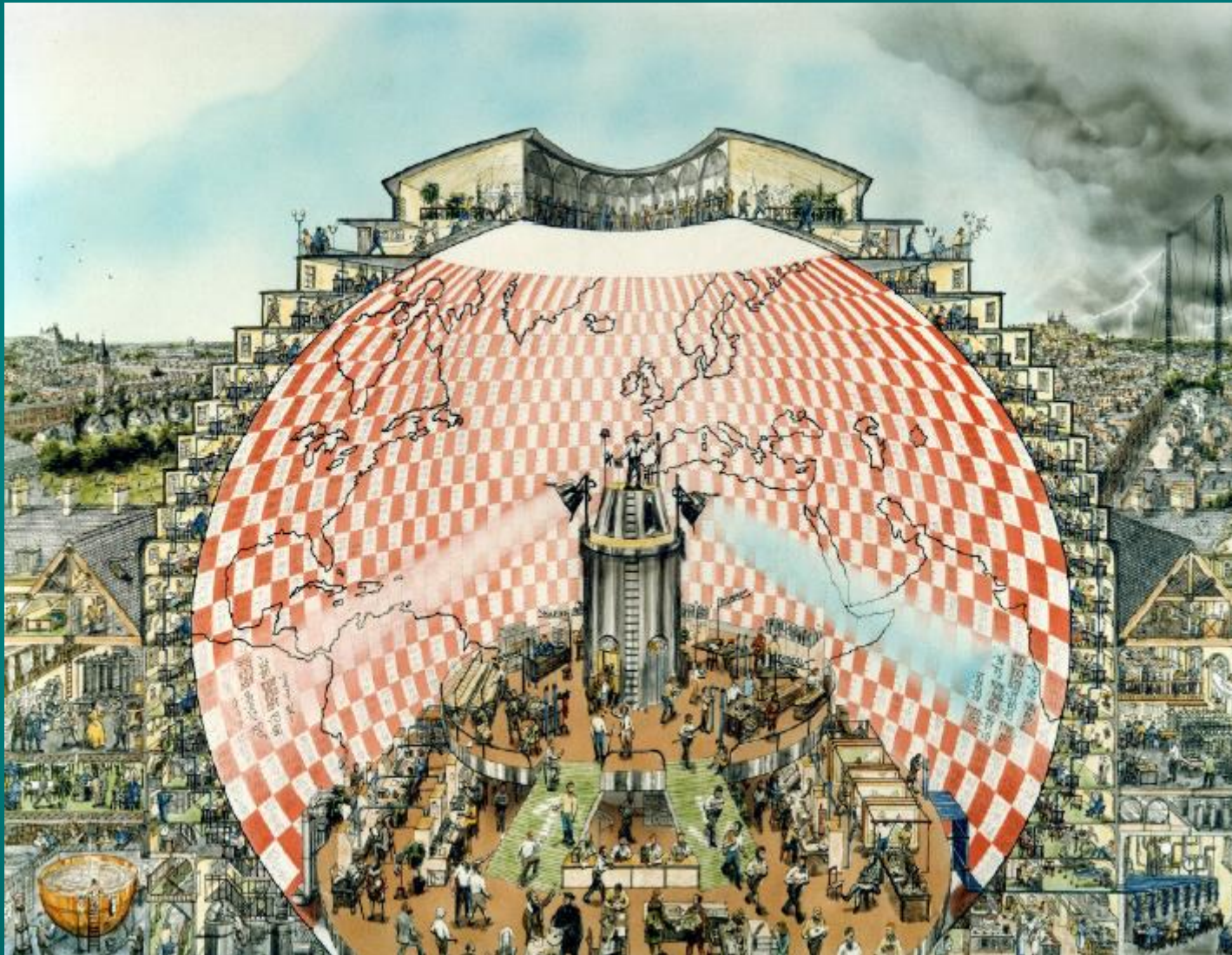
- HAR =
operational
HARMONIE-
AROME cycle
37h (2.5 km)
- HIR =
operational
HIRLAM cycle
7.2 (0.1°
~10km)



Validation vs Synoptic Observations & Operational Models

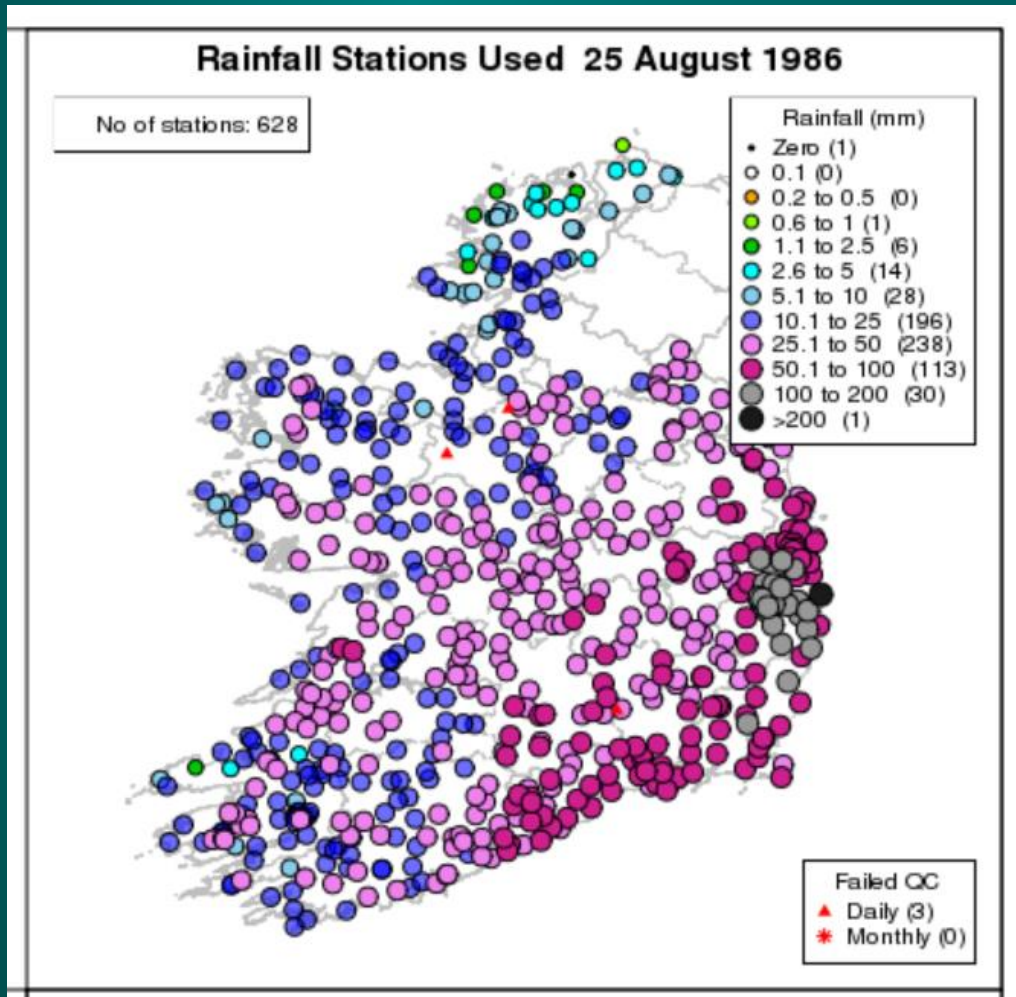


Charley & the forecast factory



(© Stephen Conlin, 1986 - on the commission of Prof. John Byrne, then Head of the Department of Computer Science in Trinity College, Dublin)

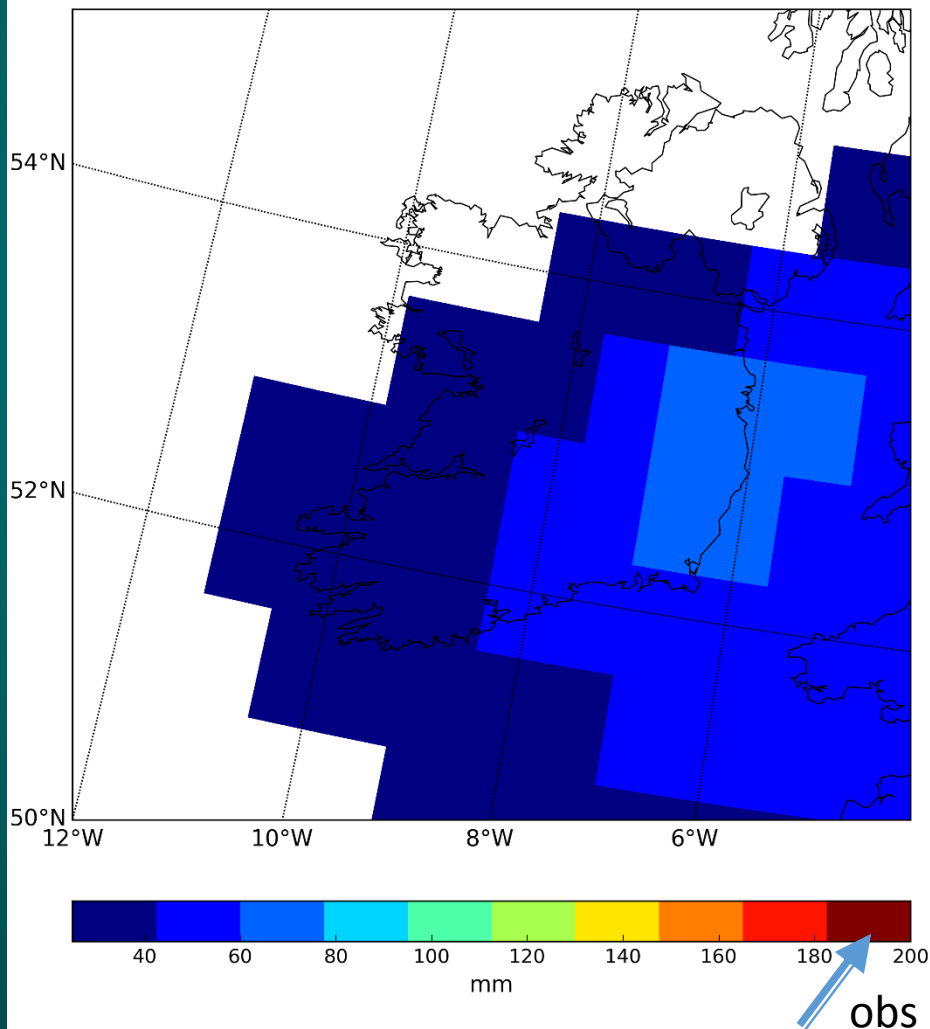
Charley & the forecast factory



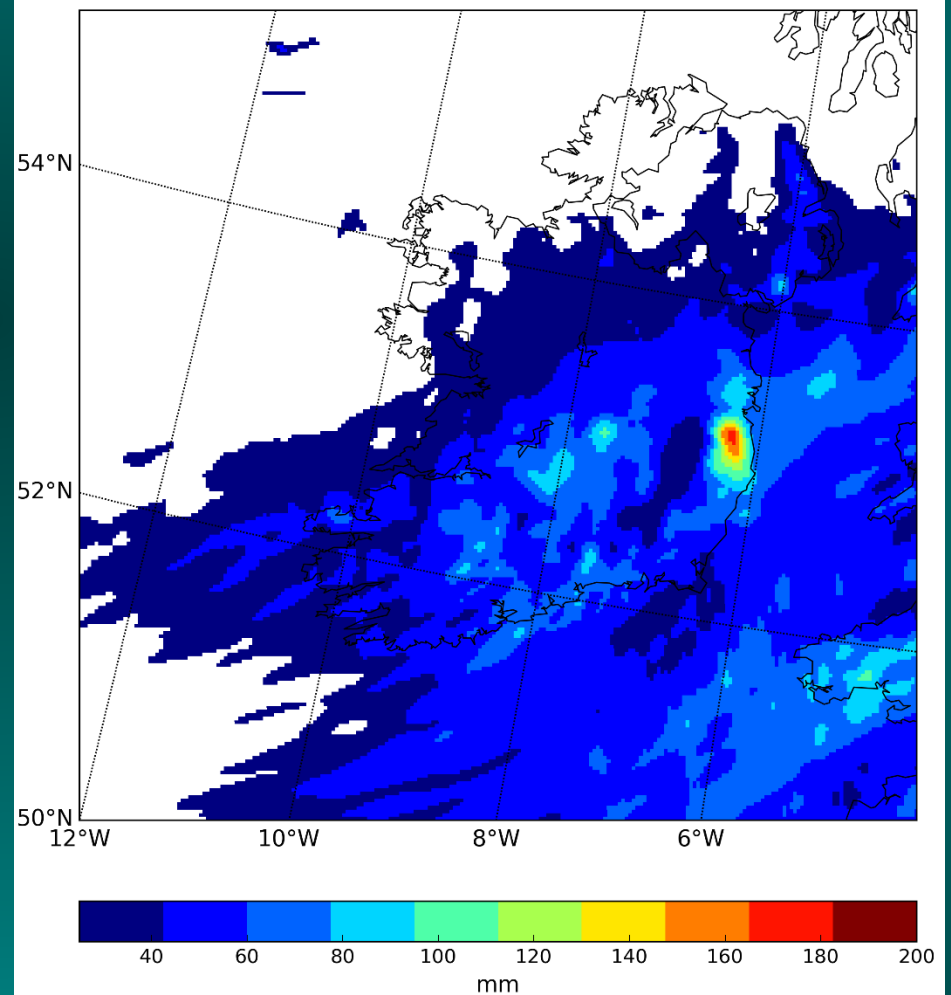
- August 1986
- Atlantic depression traced back to hurricane Charley
- 200 mm accumulations over 24 hours
- Models available at the time predicted 50 mm

Charley & the forecast factory

ERA-Interim



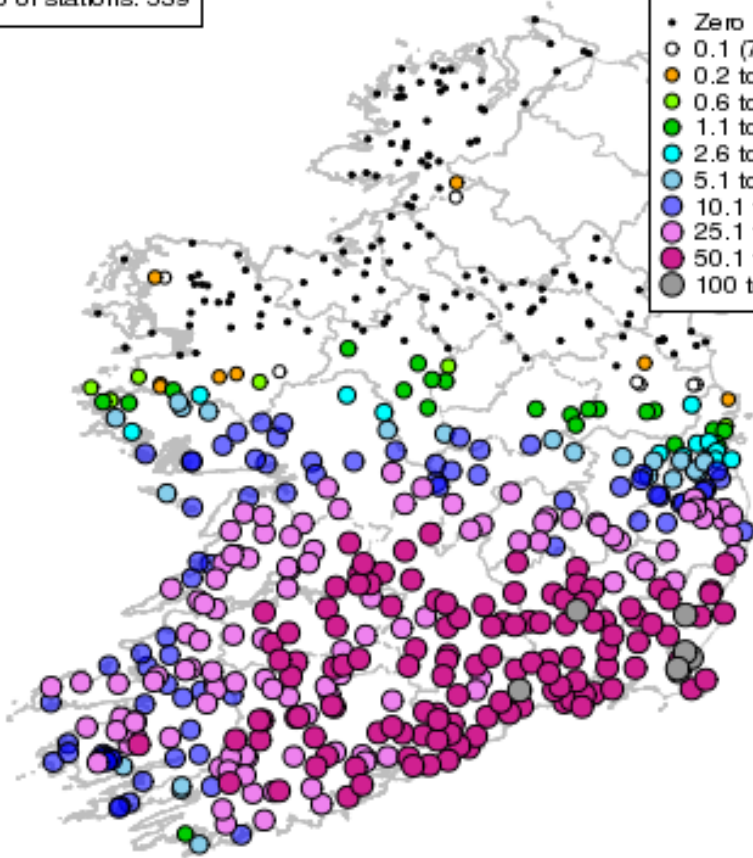
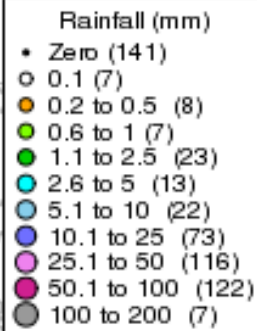
MÉRA



August 1997 Flooding

Rainfall Stations Used 3 August 1997

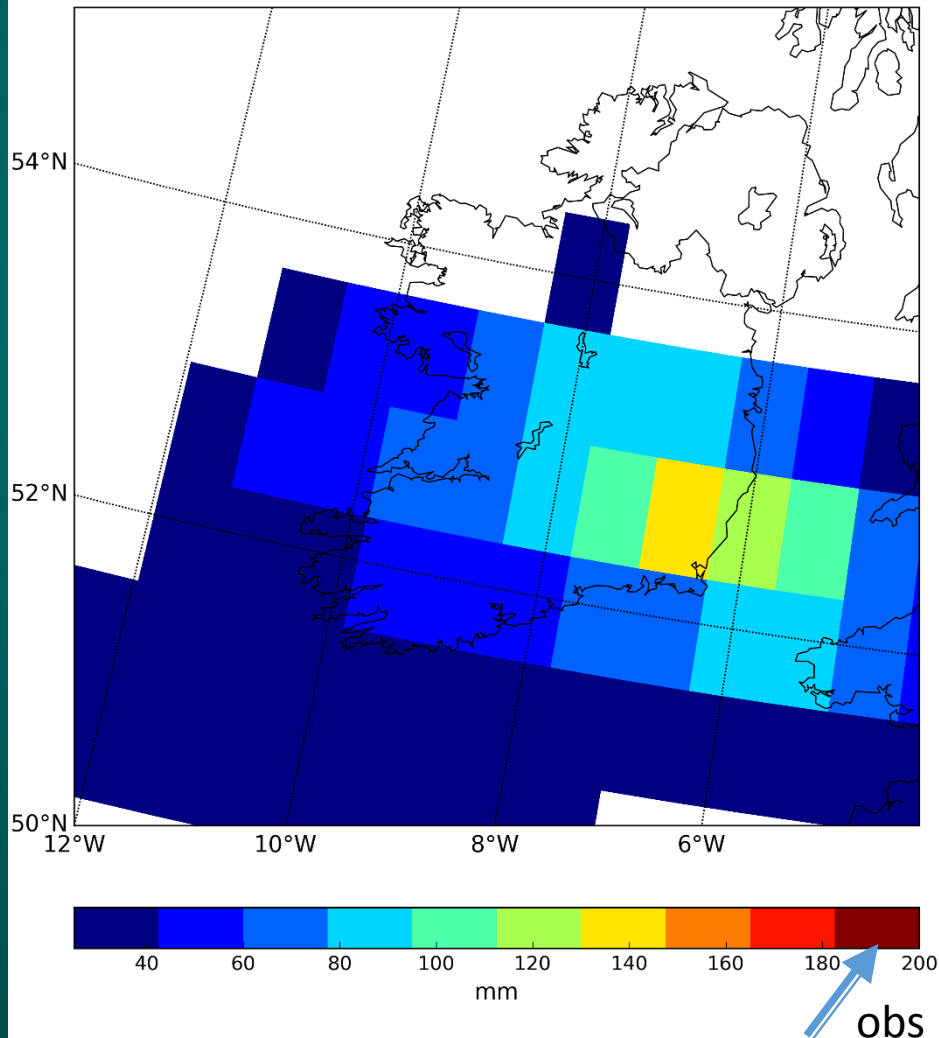
No of stations: 539



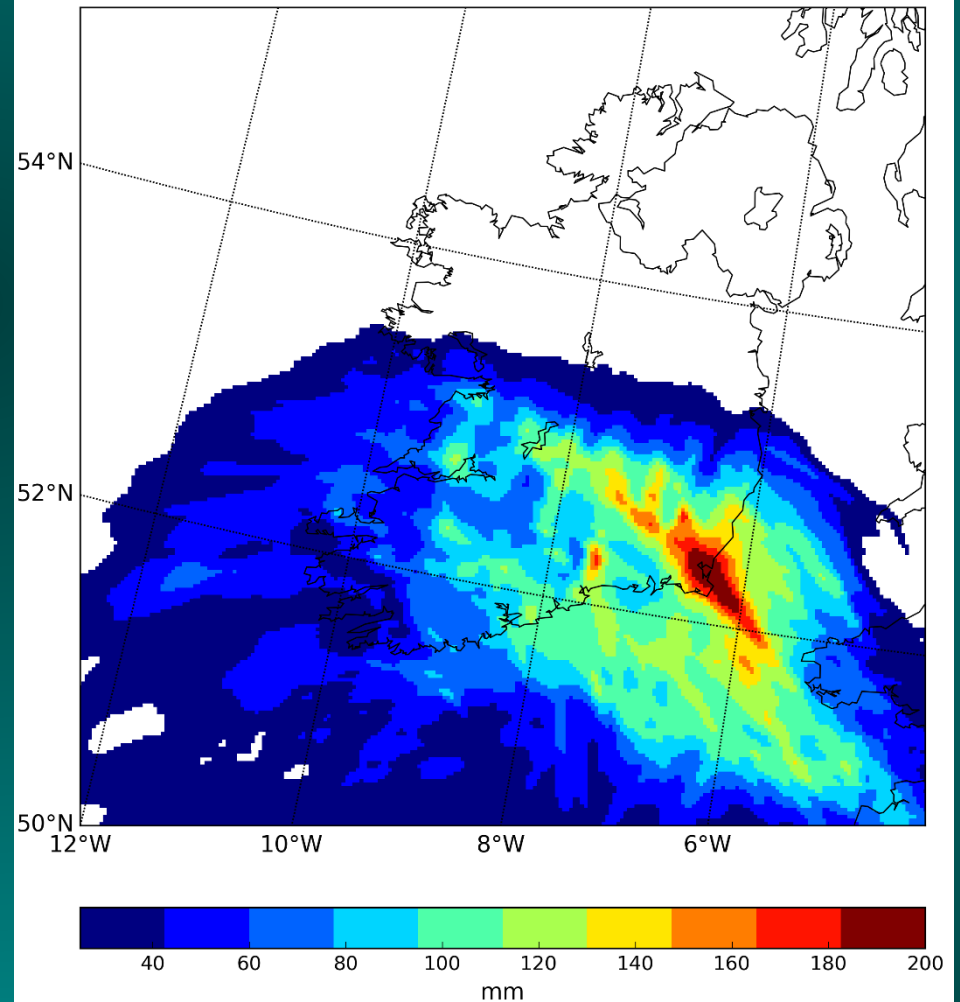
- August 1997
- Bank holiday weekend
- Models suggested dry, warm, sunny conditions
- Over 200 mm rain fell in parts of the south

August 1997 Flooding

ERA-Interim



MÉRA



6. Conclusions and future work

- Preliminary validation shows the dataset looks very promising.
- Thorough validation, quantifying biases, feedback to the operational set-up
- Uses in climate research, food and agriculture, renewable energy, ecology, economics, hydrology, planning.
- Future: larger domain, ensembles, longer time period, better use of observations

See you in Dublin for EMS 2017!



James Joyce (Trieste 1904-1920)