

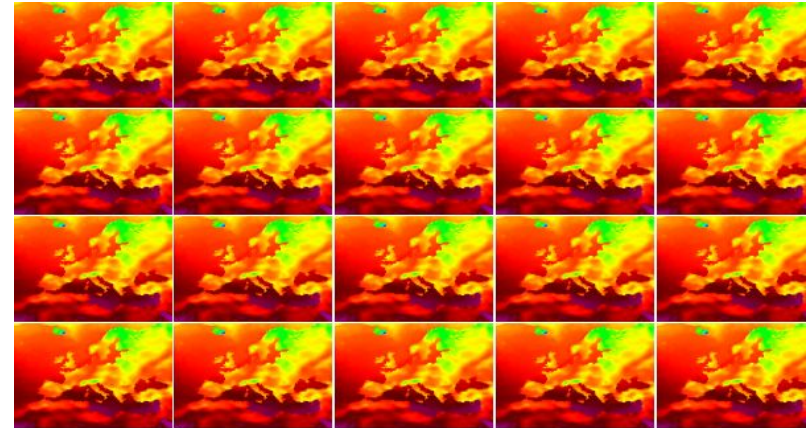
# Met Office Reanalysis

UERRA Showcase November 2016

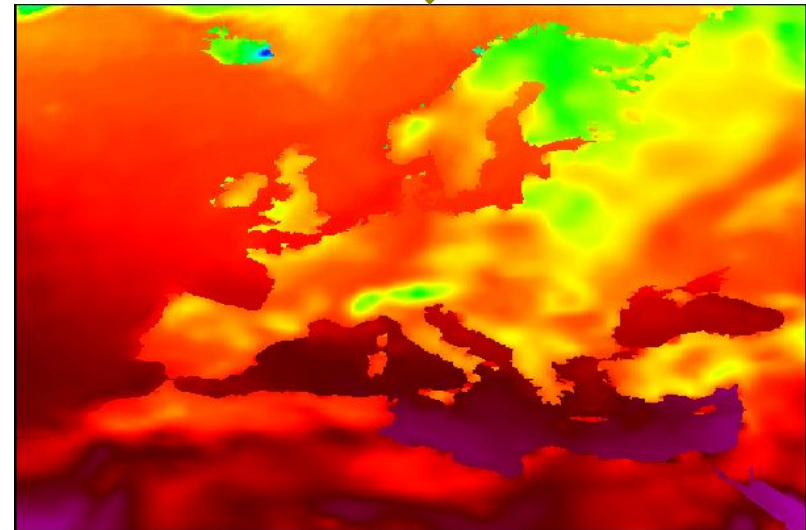
Peter Jerney, Jemma Davie, Richard Renshaw & Others

# Met Office Reanalyses

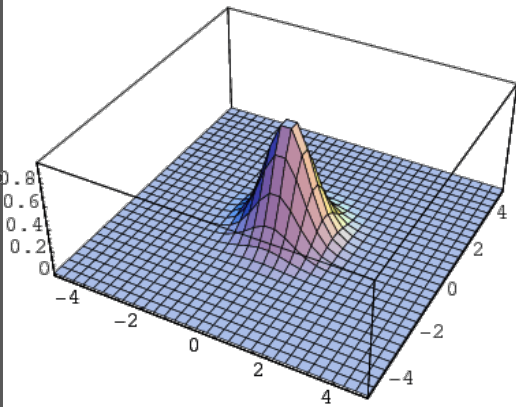
- 1979 – pres. 20 member ensemble reanalysis 36km



- 1979 – pres. hybrid deterministic reanalysis 12km



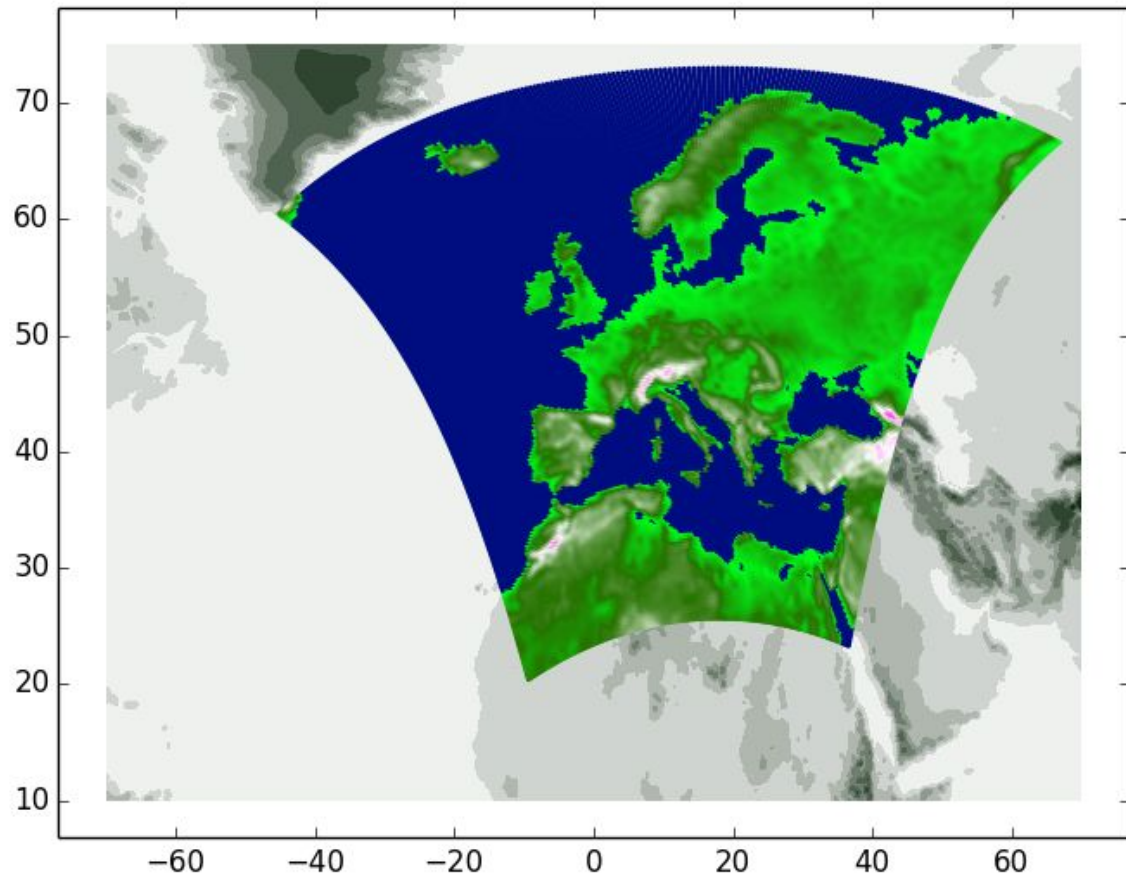




Reanalysis



# Domain (CORDEX EU-11)









IR/MW

Clear Sky  
Rad

GPSRO

AMVs

Scatwinds

Cloud Profiles

GPS

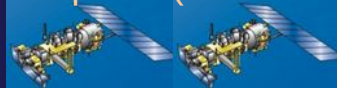
NOAA 15/18/19



AQUA  
(NASA)



MetOp A/B (EUMETSAT)



SUOMI NPP  
(NOAA)



GOES  
(NASA/NOAA)



MTSAT2 (JMA)



Met 7/10  
(EUMETSAT)



OceanSat (India)  
Windsat (NOAA/NA  
SA/DOD)



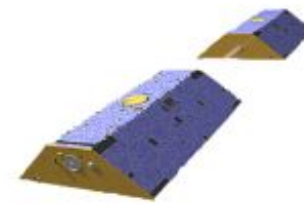
GPS (US)



COSMIC (US/Taiwan)

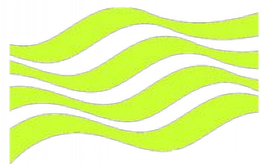


GRACE  
(US/Germany)



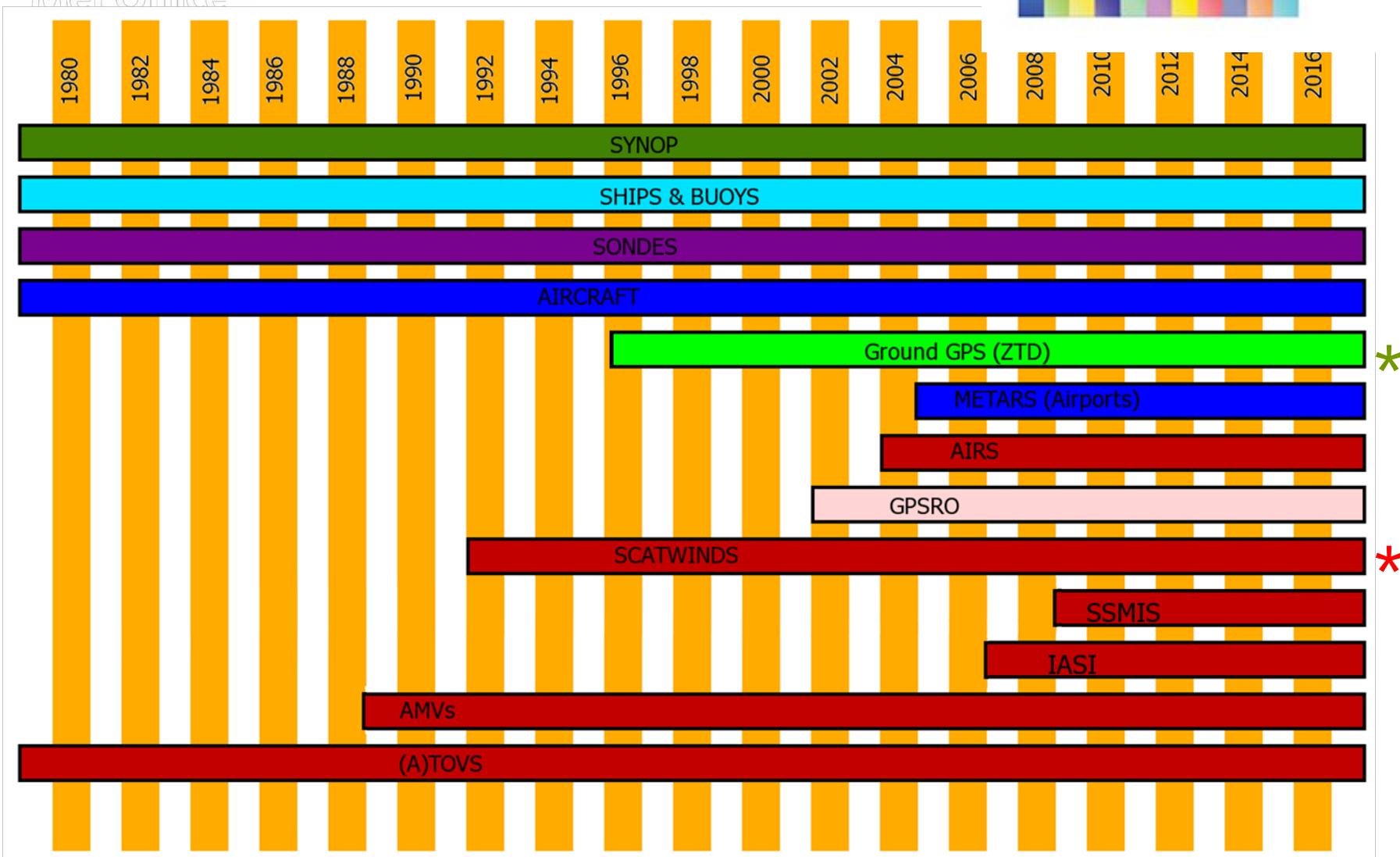
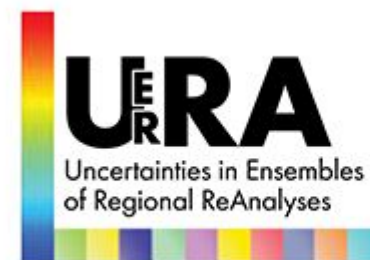
TerraSAR-X (Germany)





Met Office

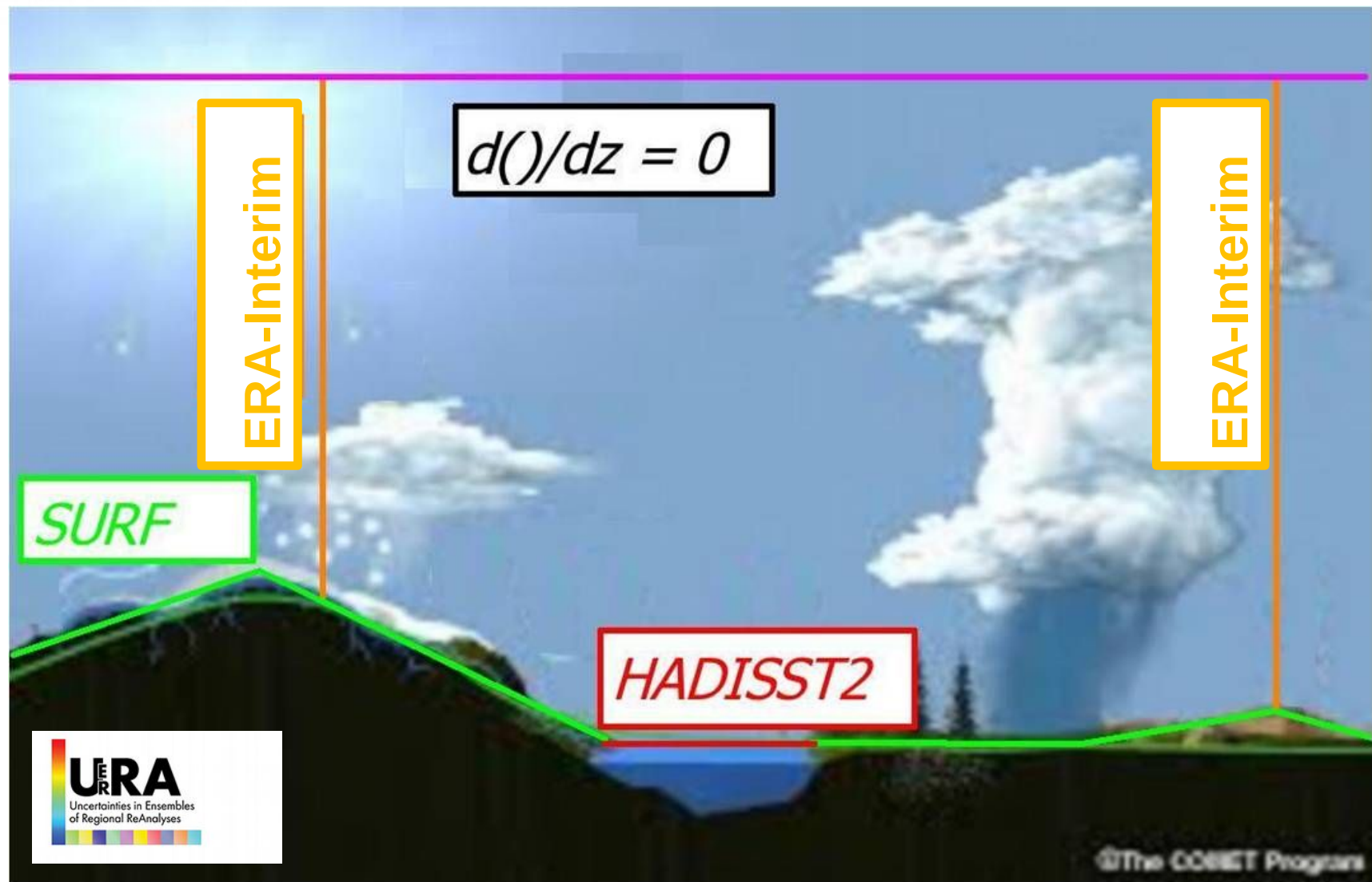
# Observations





Met Office

# Boundary Conditions





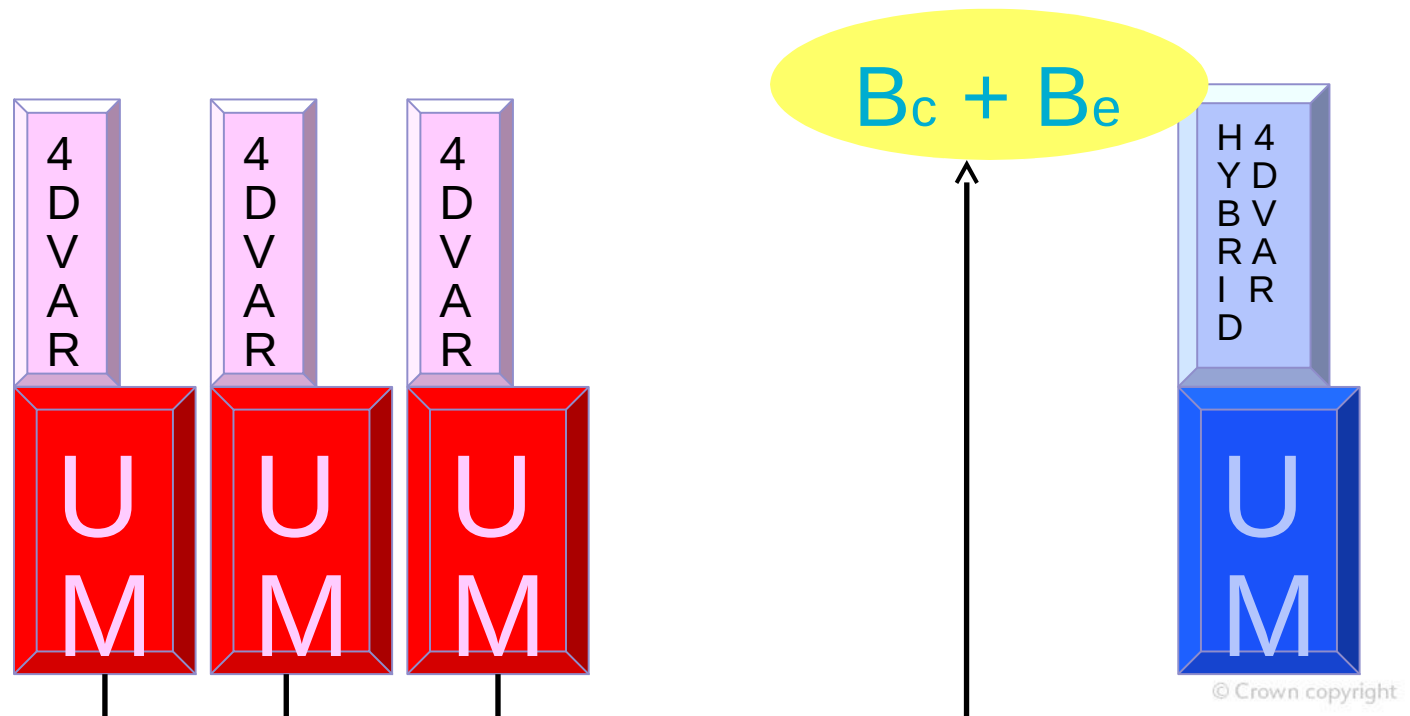
# Ensemble System

- Represent every uncertainty in the system via perturbations
- Uncertainty in
  - Observations
  - Model
  - Boundary Conditions\*
- Each ensemble member has a different realisation of these
- Set of (input) realisations represent the span of all possible realisations
- Therefore (output) spread should estimate uncertainty in the system

# Hybrid System

$$J = (x - x_b)^T B^{-1} (x - x_b) + (Hx - y)^T R^{-1} (Hx - y)$$

- Weights are dependent on background error covariance matrix (B)
- Ensemble uses fixed bg error cov ( $B=B_c$ )
- Ensemble provides EOTD to ensemble
- EDA - "hybrid" 4DVAR - weighted sum of bg error covs ( $B=b_c B_c + b_e B_e$ )

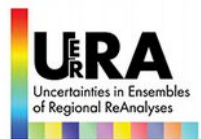






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# Results



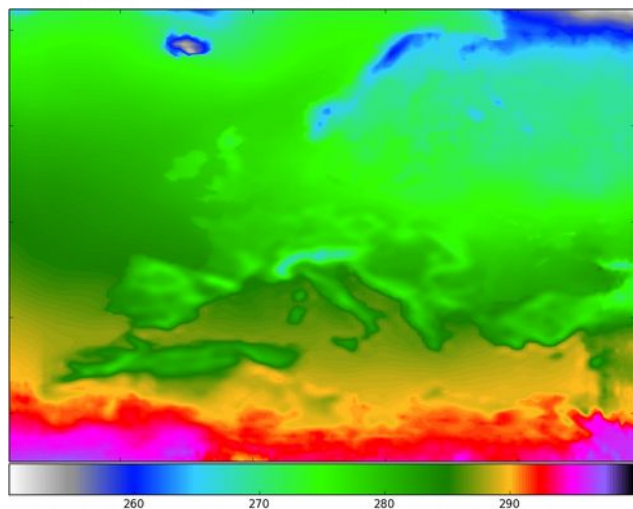
[www.metoffice.gov.uk](http://www.metoffice.gov.uk)



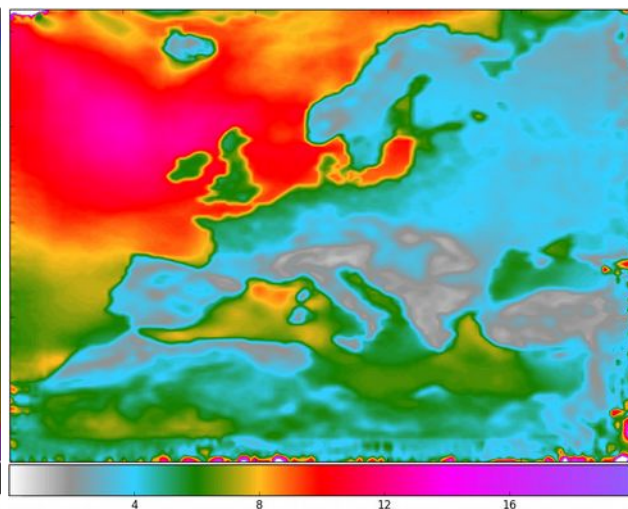
© Crown copyright

# Ensemble Results

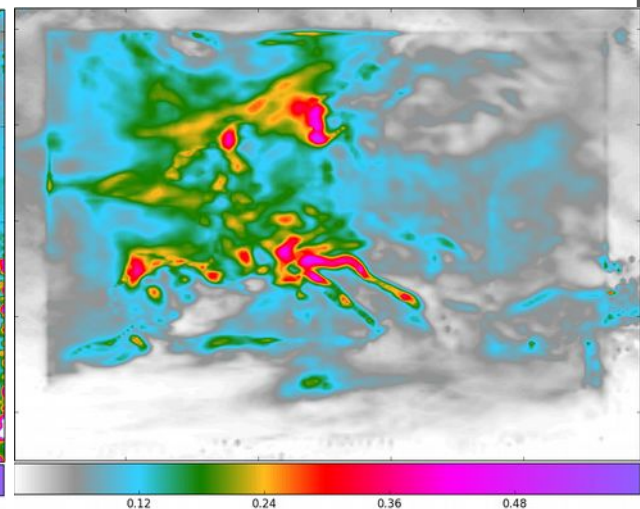
Mean Reanalysis March 1979



2m Temperature/K

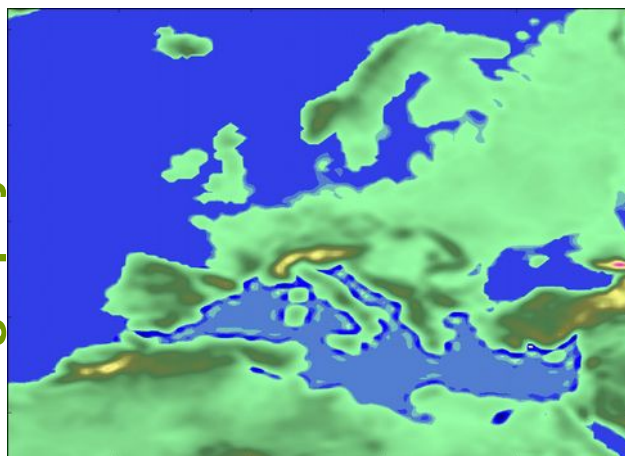


10m Wind Speed/ms-1



6h Precip/mm

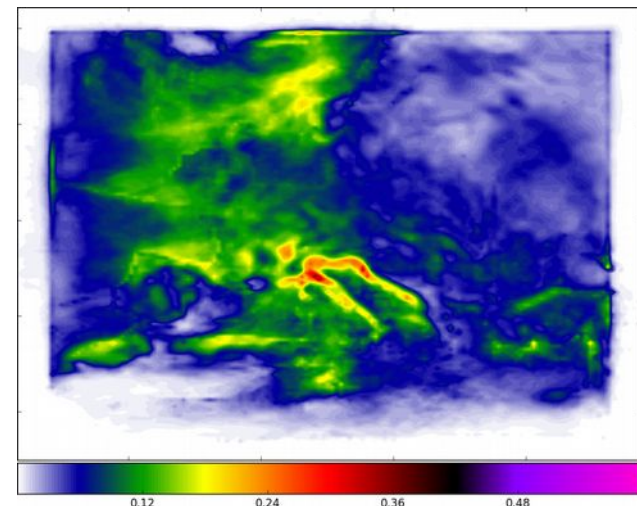
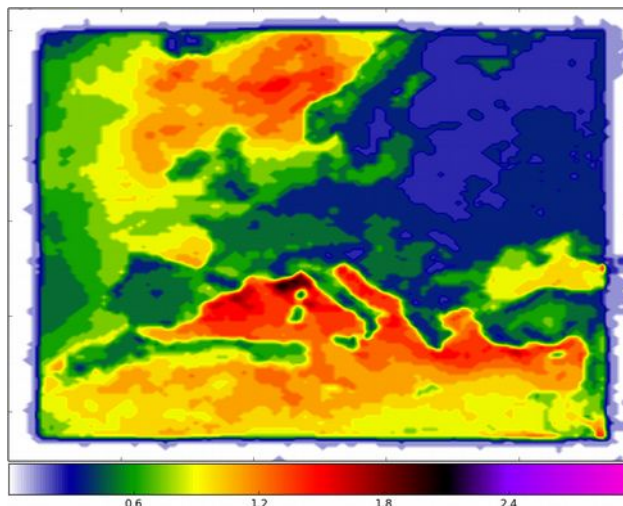
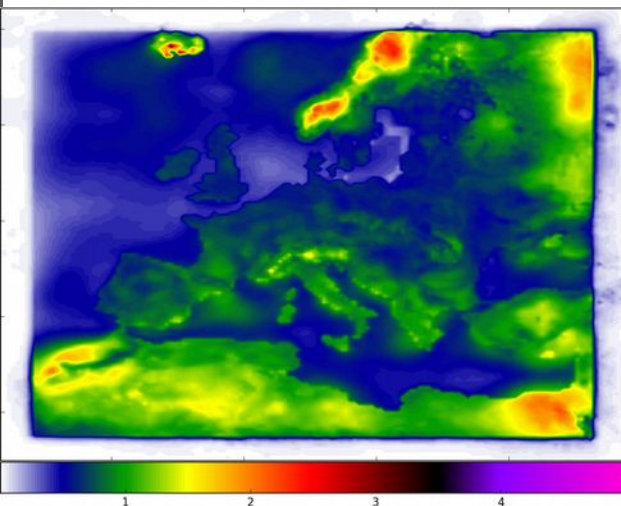
Orography





# Ensemble Spread

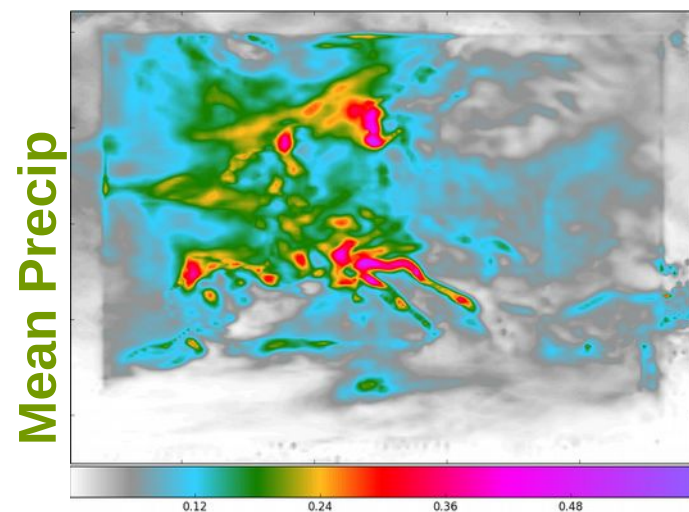
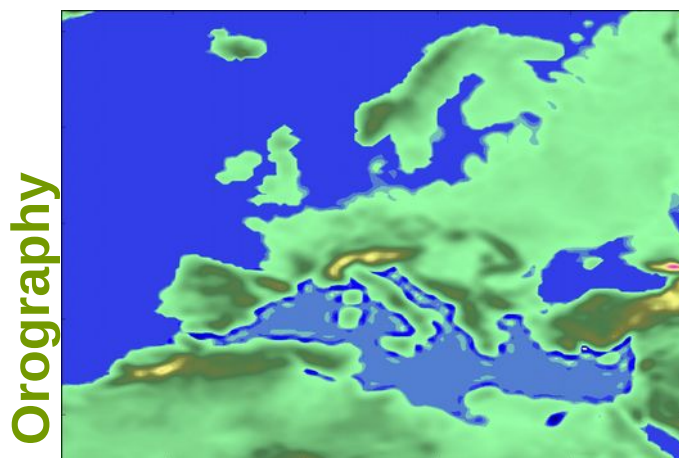
Mean Spread March 1979



2m Temperature/K

10m Wind Speed/ms-1

6h Precip/mm



# What does a good ensemble look like..?

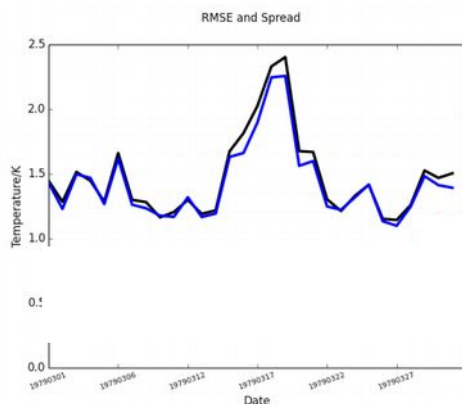
1. Each member is equally likely
2. Mean error < Control error
3. Ensemble spread = **Mean** error
4. Modelled freq. = Observed freq.



# Daily Mean T2

Comparison with ECA&D Obs  
March 1979

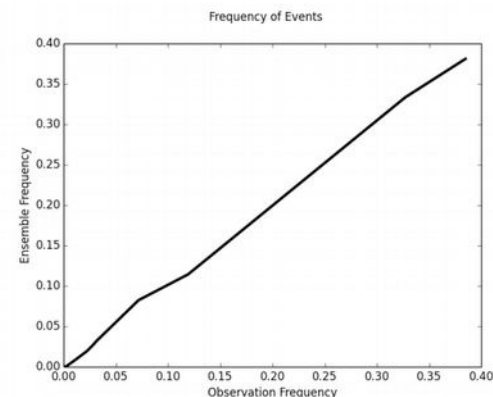
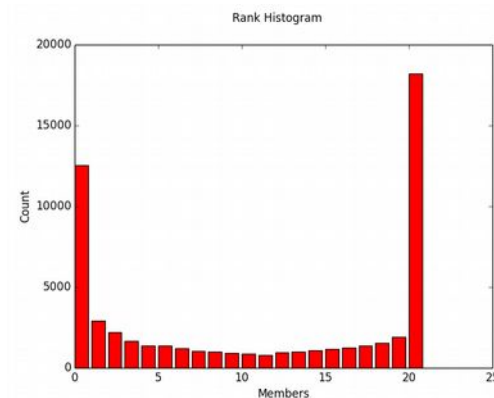
1. Each member is equally likely



2. Mean error < Control error

3. Ensemble spread = Mean error

4. Modelled freq. = Observed freq.



# Output Fields

- Precipitation
- Temperature
- Pressure
- Wind
- Cloud
- Radiation
- Moisture
- Land/Sea

total	snow	sdepth	T(m,p,h,surf,2m)	
Tmax(2m)		Tmin(2m)		p(m,h,surf,msl)
phi(p)	U(m,p)		V(m,p)	gust(10m)
dir(h,10m)		spd(h,10m)		qcf(m,p,h)
qcl(m,p,h)		cc(m,h,lo,med,hi,tot)		
LWNet		SWDwn		LWDwn
SWDwn(CS)		SWUp(CS)		LWDwn(CS)
sensible		latent		albedo
SH(m)		RH(p, h)		tcwv
VSW		DST		roughness
		orog		lsm

## Navigation

[Home](#)  
[MARS Activity](#)  
[Job list](#)

## See also...

[FAQ](#)  
[Accessing forecasts](#)  
[GRIB decoder](#)

## MARS Catalogue

Time (4 values)	Step (6 values)	Level (24 values)	Parameter (8 values)	Number (20 values)
00:00:00	1	10	Cloud cover	1
06:00:00	2	20	Geopotential Height	2
12:00:00	3	30	Relative humidity	3
18:00:00	4	50	Specific cloud ice water content	4
	5	70	Specific cloud liquid water content	5
	6	100	Temperature	6
		150	U component of wind	7
		200	V component of wind	8
		250		9
		300		10

- ▶ [Check for availability](#)
- ▶ [View the MARS request](#)
- ▶ [Estimate download size](#)
- ▶ Retrieve the selection in [GRIB](#) or [NetCDF](#) (experimental)

## Note about availability

Some of the fields may not be archived at all levels or all forecast time steps. Before retrieving data you may want to check the availability of the requested fields. For that, follow the *Check for availability* link.

## Retrieving

In order to retrieve data, you must select at least one item in the lists above. You can select more than one item in each list.

## Current selection:

[date](#) [2008-10-09](#), [2008-10-10](#)

[levtype](#) [hl](#), [ml](#), [pl](#), [sfc](#), [sol](#)

[month](#) [oct](#)

[year](#) [2008](#)

[type](#) [an](#), [fc](#)

[stream](#) [enda](#), [oper](#)

[origin](#) [edzw](#), [egrr](#), [eswi](#), [lfpw](#)

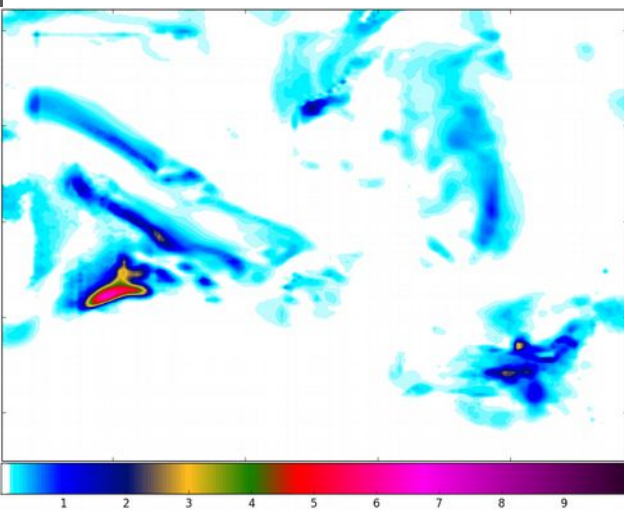
[expver](#) [prod](#), [test](#)

[class](#) [be](#), [co](#), [cs](#), [de](#), [dm](#), [e2](#), [ea](#), [ei](#), [em](#), [en](#), [ep](#), [er](#), [et](#), [fr](#), [gr](#), [j5](#), [la](#), [mc](#), [ms](#), [nr](#), [od](#), [rd](#), [rm](#), [s2](#), [se](#), [sr](#), [ti](#), [tr](#), [uk](#), [ur](#)

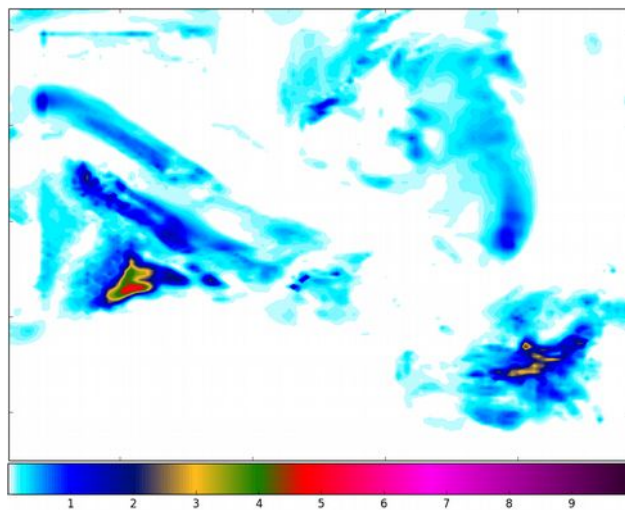


# Example of Use

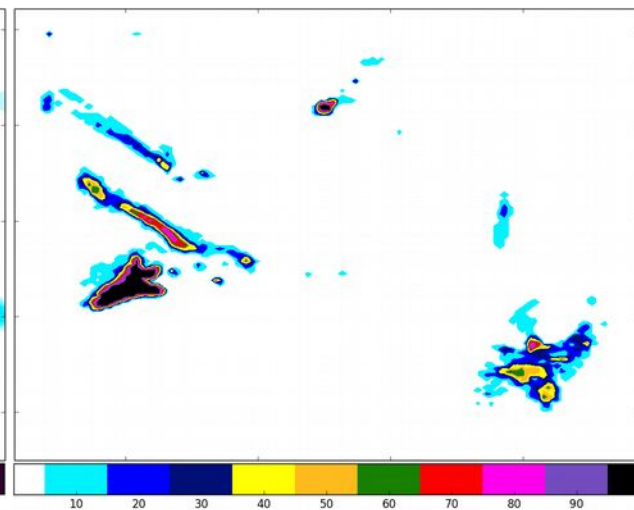
February 9<sup>th</sup> 1979 06Z to 12Z Precip Accumulation



Mean/mm



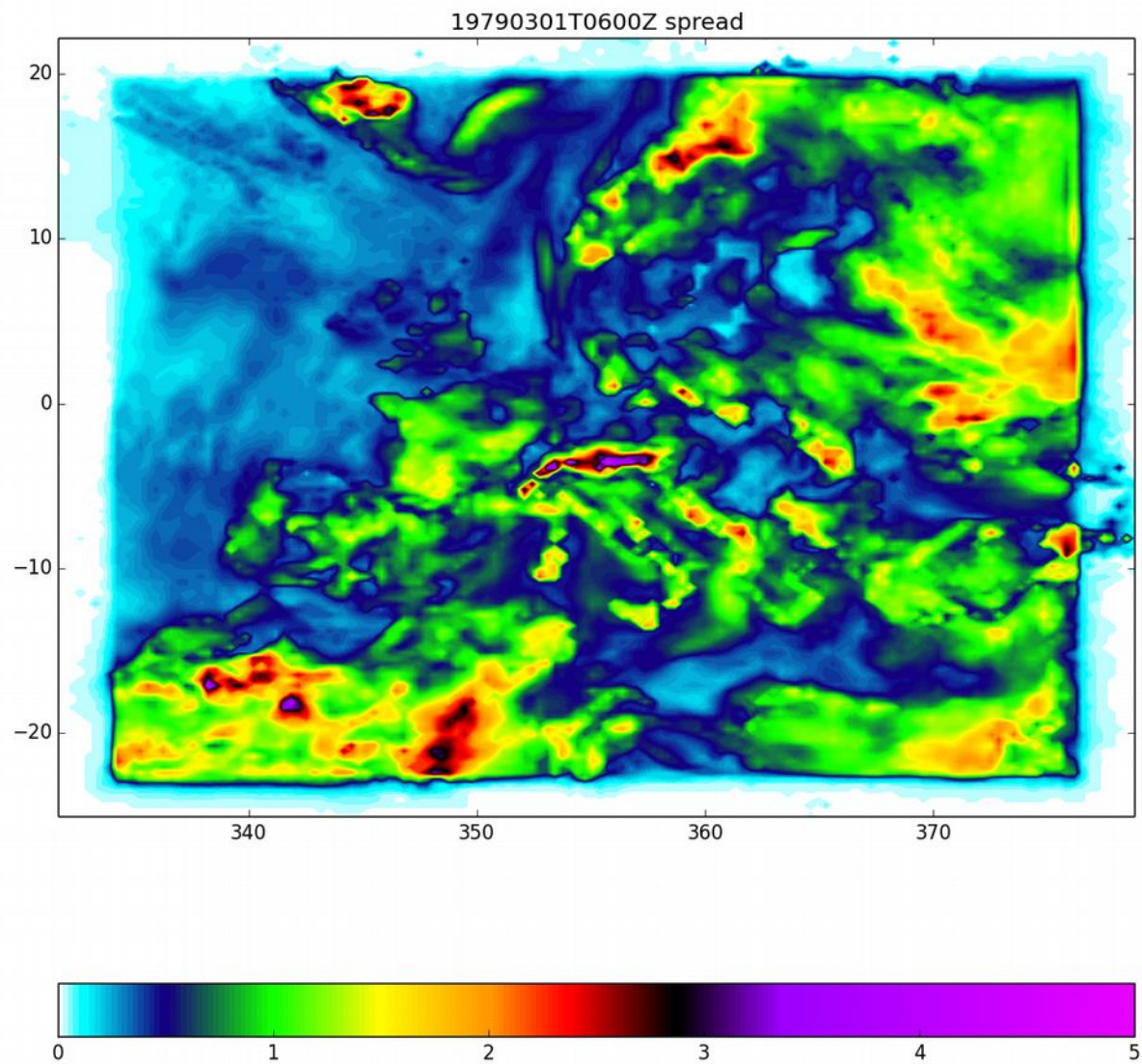
Spread/mm



Likelihood 1mm

# Summary

- Ensemble & High Resolution Reanalysis
- Ensemble working with production started (1979 complete)
- Large number & variety of atmospheric variables available
- Spatial variation in spread seems realistic
- Ensemble scores reasonably against the four tests
- Provides deterministic values + measure of uncertainty
- Can be used to derive probabilistic products

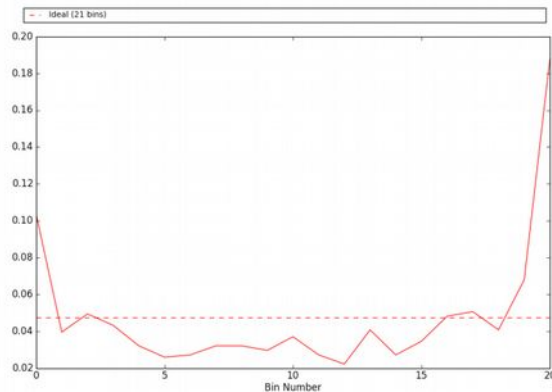




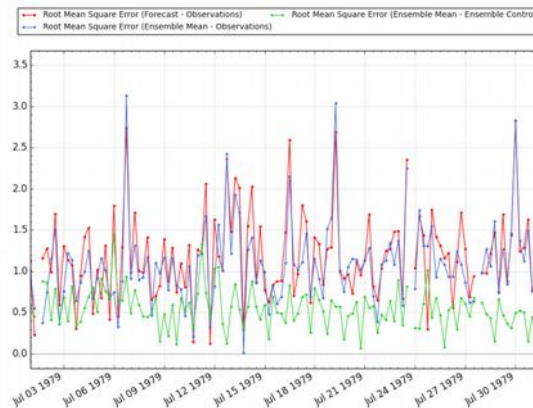
# Verification of T+6

## Comparison with Obs for next cycle July 1979 (NB not rm flagged obs)

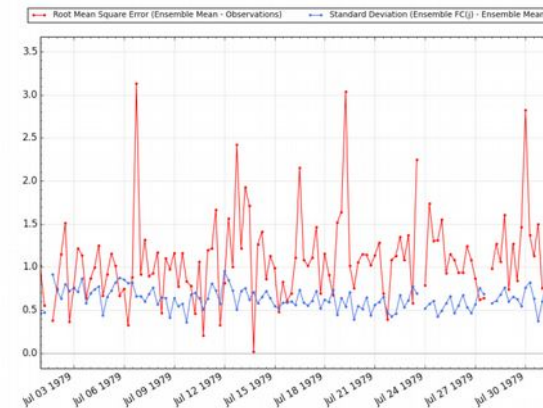
Temperature @ 850hPa, Rank Histogram (Ensemble FC(I) (Excluding Control)), Area 585, T+6, 19790701 00:00 to 19790731 18:00, Sondes, EUENS1979



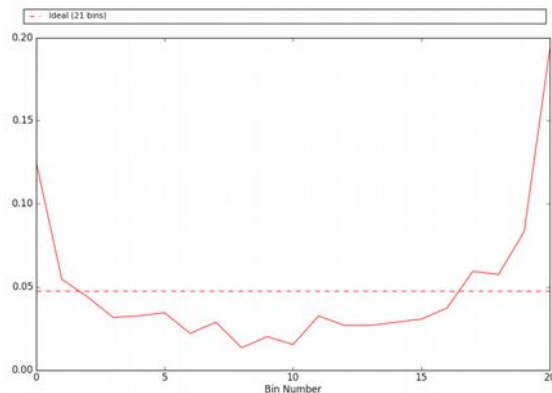
Temperature (deg K) @ 850hPa, Area 585, T+6, Sondes, EUENS1979



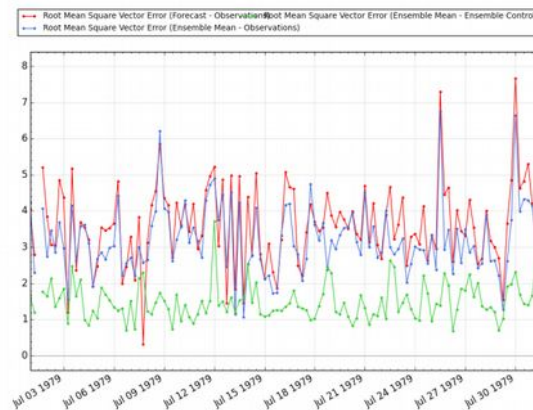
Temperature (deg K) @ 850hPa, Area 585, T+6, Sondes, EUENS1979



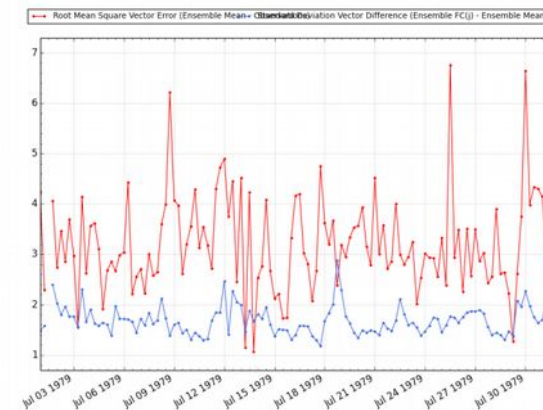
Wind @ 500hPa, Rank Histogram (Ensemble FC(I) (Excluding Control)), Area 585, T+6, 19790701 00:00 to 19790731 18:00, Sondes, EUENS1979



Wind (m/s) @ 500hPa, Area 585, T+6, Sondes, EUENS1979

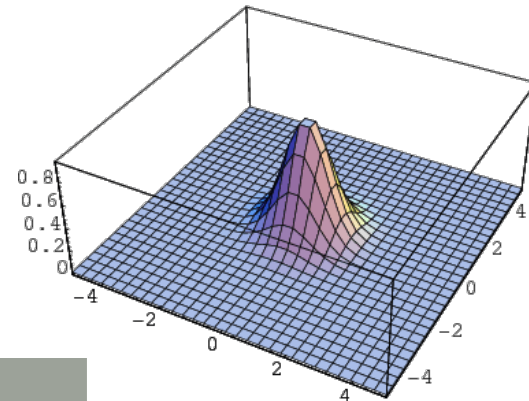


Wind (m/s) @ 500hPa, Area 585, T+6, Sondes, EUENS1979





# 4DVAR



$$(\mathbf{x} - \mathbf{x}_b) \mathbf{B}^T$$

$$(\mathbf{H}(\mathbf{x}) - \mathbf{y}) \mathbf{R}^T$$

