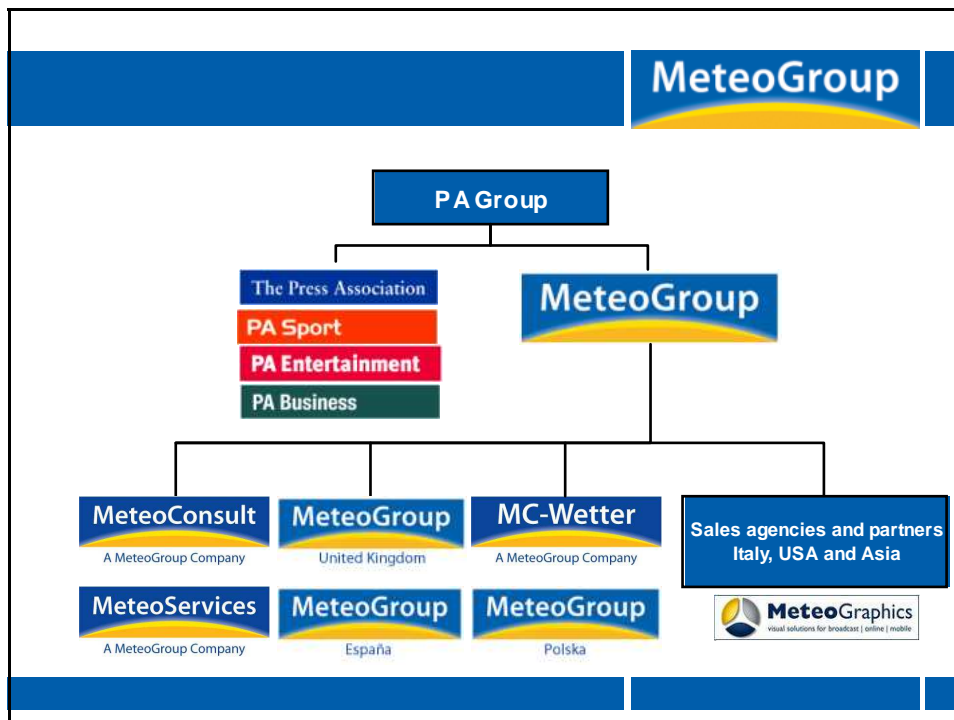


The challenge of wind and weather prediction.

Melanie Hoffmann
Meteorologist, Sales, MC-Wetter
GmbH

- **MC-Wetter / MeteoGroup**
- The weather system – how does it work?
- Messure data – condition precedent to forecast
- Forecast Models
- Forecast Scales
- Verifications

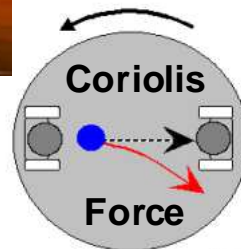
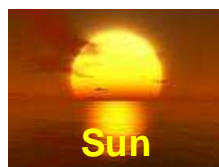
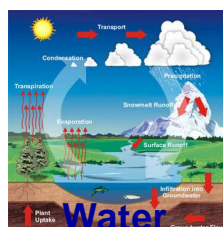


-
- ~ 200 staff, more than 50% meteorologists
 - Forecasting centres in many European countries
 - Sales presence in additional countries and other territories
 - Meteorological services in high quality world-wide
 - Market leader in many sectors through customer-focused products for
 - Energy
 - Weather & Traffic
 - Media

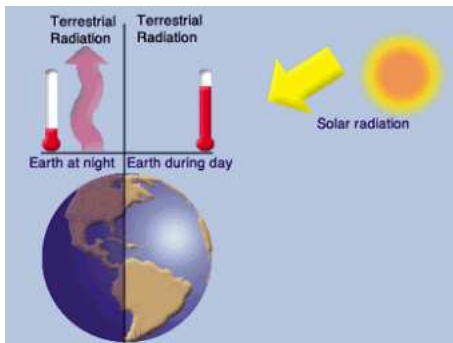
- MC-Wetter / MeteoGroup
- **The weather system – how does it work?**
- Messure data – condition precedent to forecast
- Forecast Models
- Forecast Scales
- Verifications

What do we need if we want to get weather?

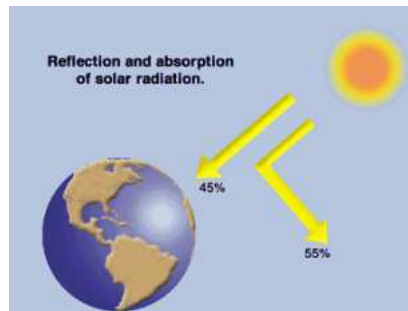
Ingrediences:



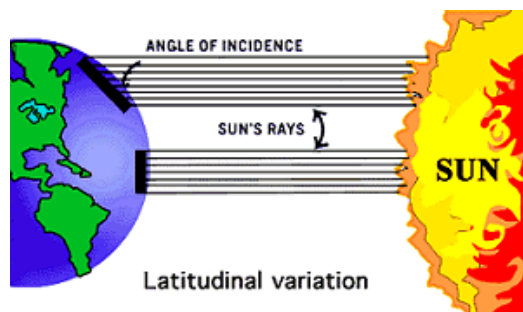
Solar radiation



Energy from solar radiation as the motor of all atmospheric movement

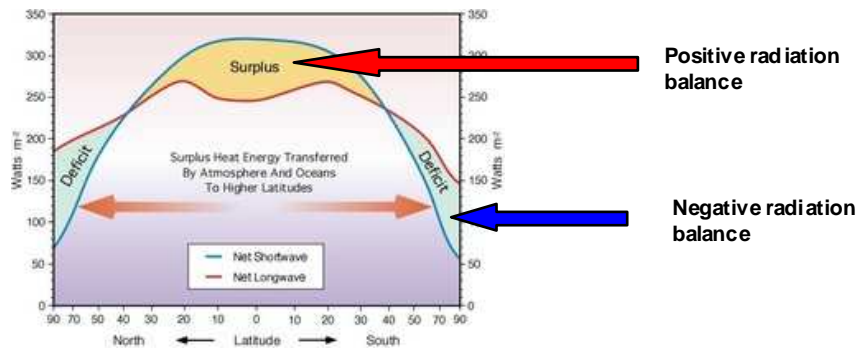


Variation of solar energy



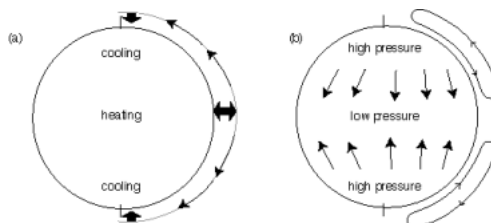
Depends on:
 Latitude and season
 Inclination of the axis
 Elliptical orbit around the sun

Radiation balance between equator and poles



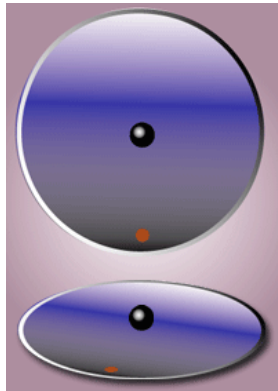
Differentiell warming, i.e. steady equatorial warming and polar cooling

Simple circulation – **without** rotation



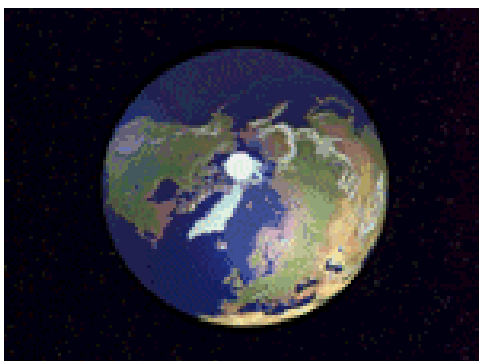
Differentiell warming (a) – simple circulation to realize the energy exchange (b)

Rotating system



Movements are deflected **only** in rotating system

Influence of Coriolis force

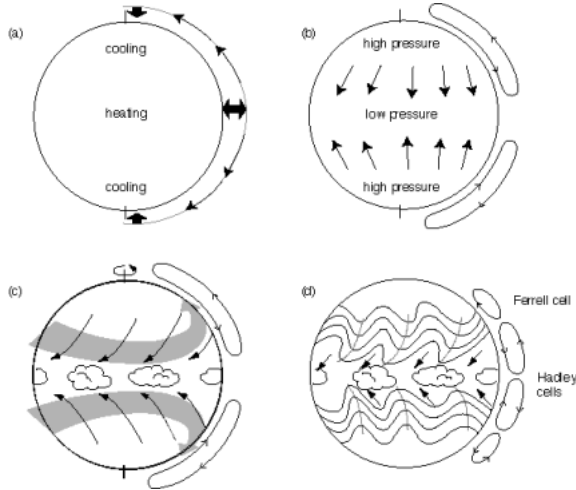


Rotation => Deflection to the right (NH) , to the left (SH)



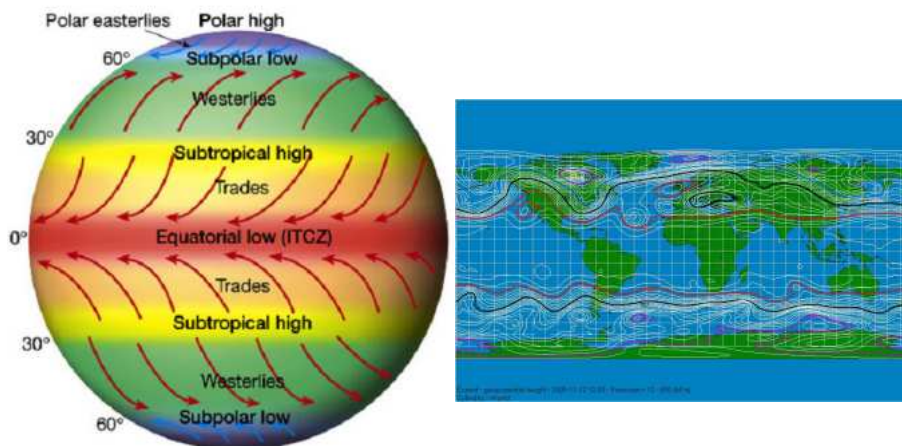
Coriolis force

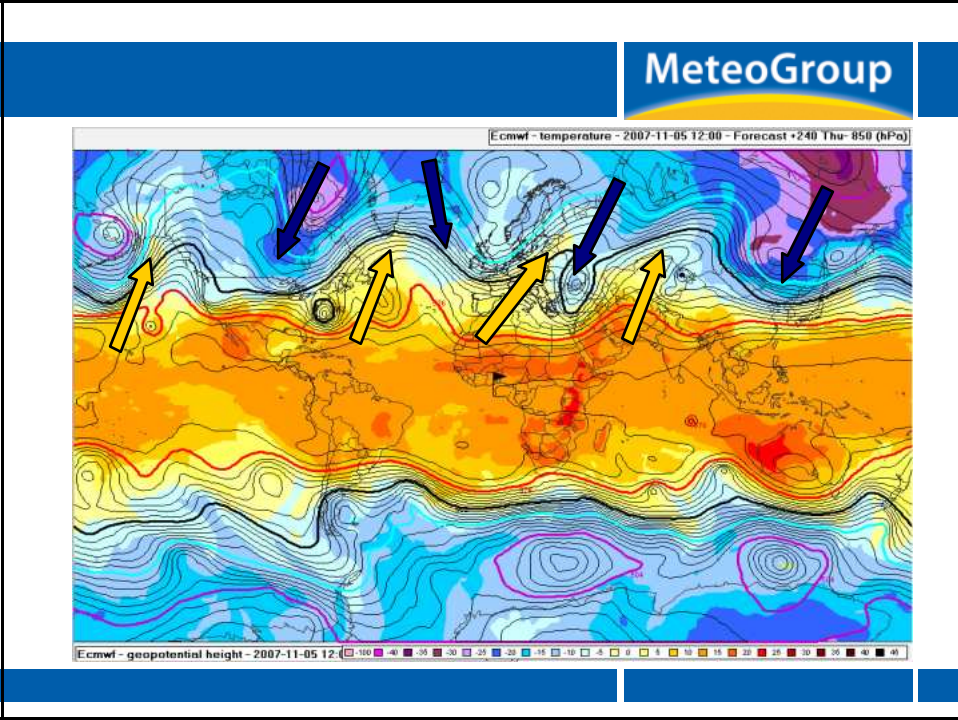
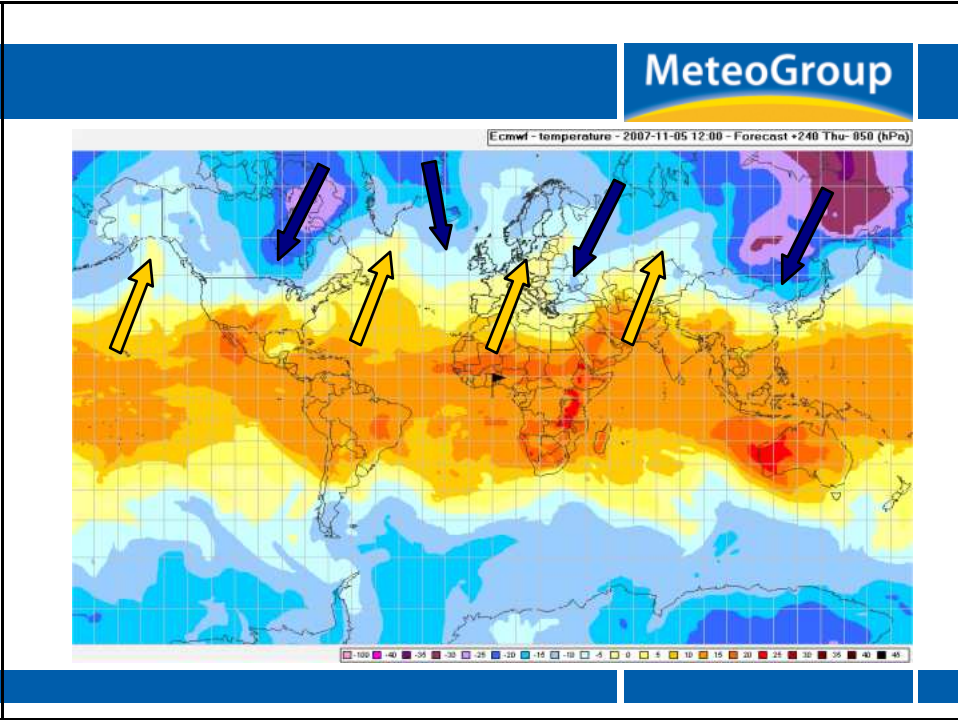
Atmospheric circulation – **with** the influence of rotation



- Equatorward winds are deflected (Trading winds)
- Formation of three meridional circulations for global energy exchange

Meridional Circulation

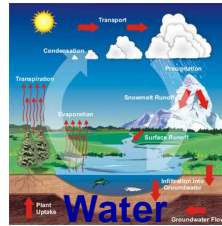




Problem! Radiation and Rotation
do not create weather!



forgot



We have:

Ingredients:

Sun

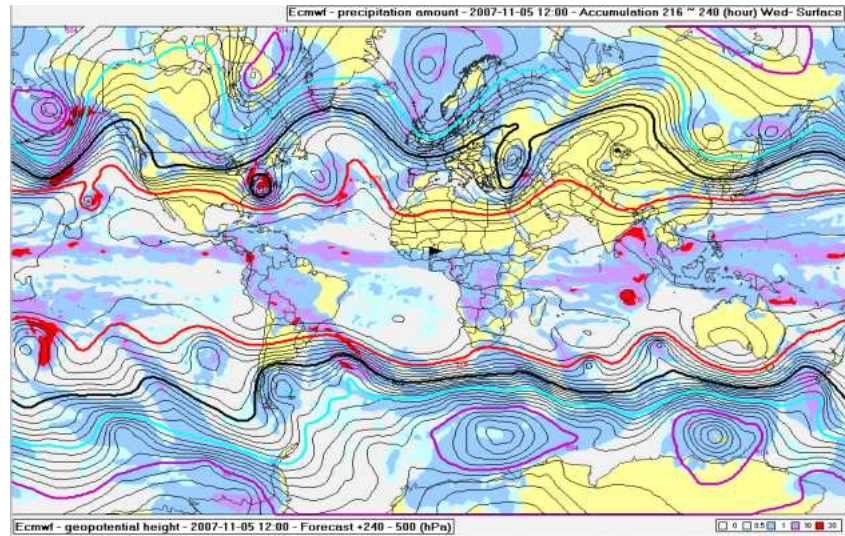
Rotation

Water

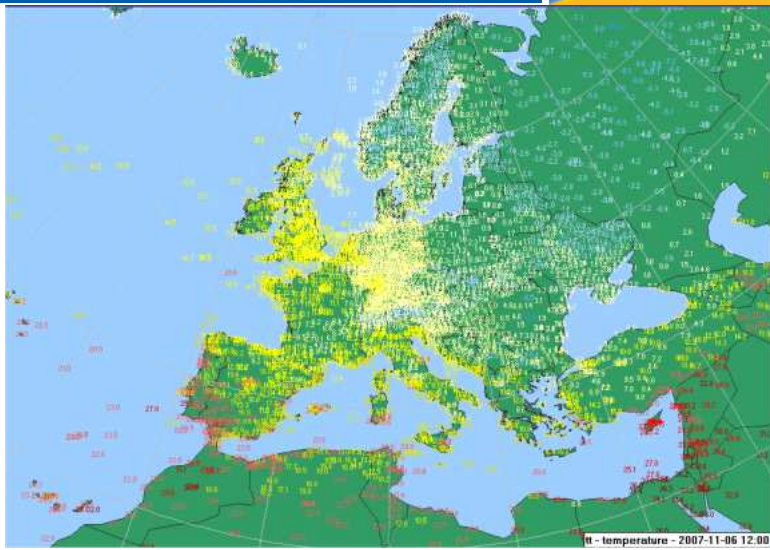
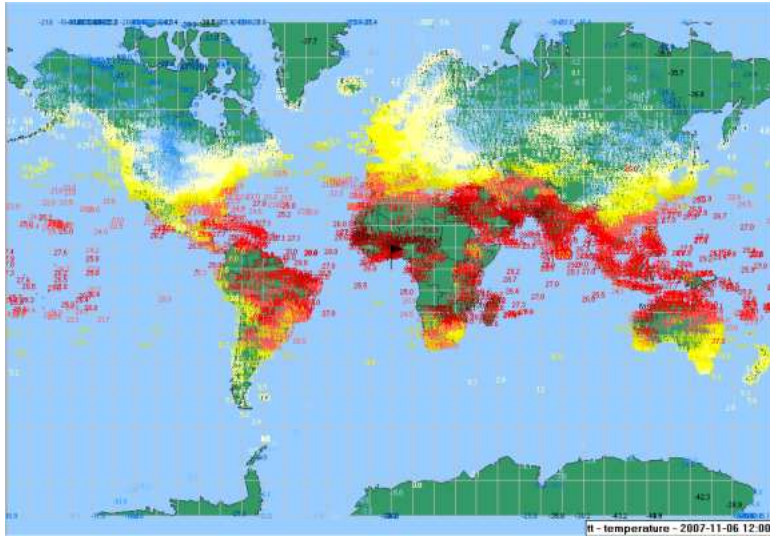
We want:

Weather!

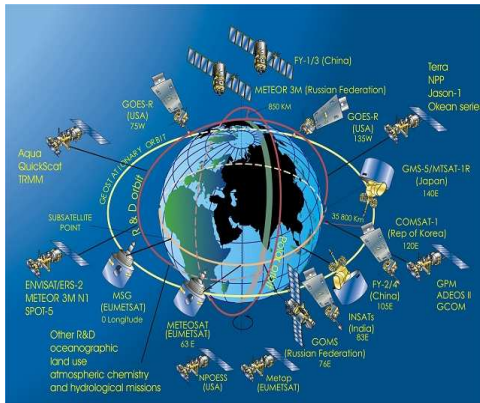
However, we still need a „cooking recipe“ for our weather kitchen.



- MC-Wetter / MeteoGroup
- The weather system – how does it work?
- **Messure data – condition precedent to forecast**
- Forecast Models
- Forecast Scales
- Verifications

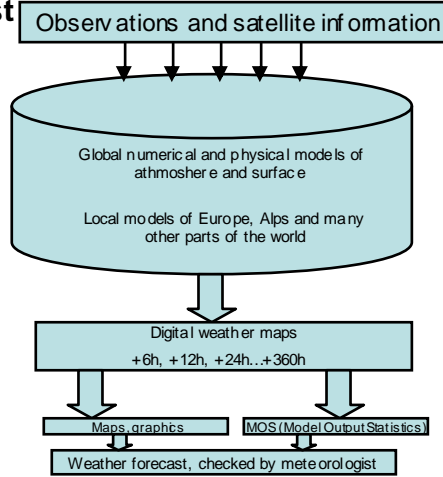


satellite information

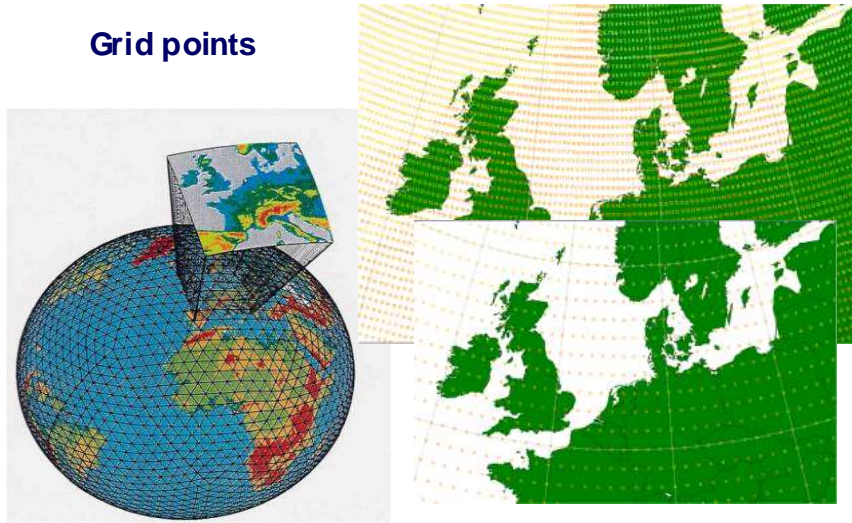


- MC-Wetter / MeteoGroup
- The weather system – how does it work?
- Messure data – condition precedent to forecast
- **Forecast Models**
- Forecast Scales
- Verifications

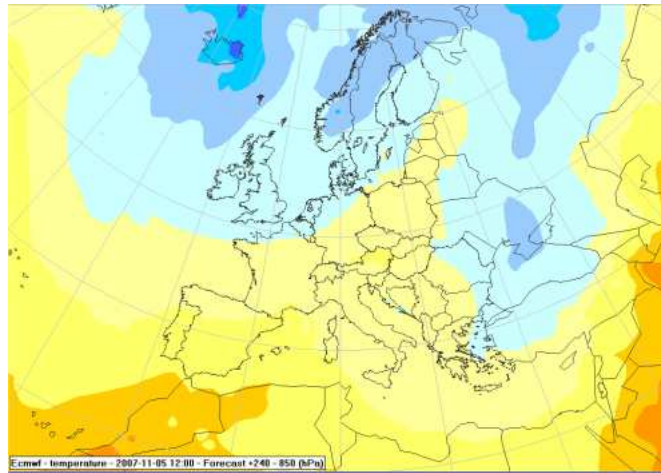
The way from observations to your forecast



Grid points



Isolines and fields



Most important physical models

ECMWF: European Center of Medium Range Weather Forecast, global model -> 0.4°

(2 times a day)

HIRLAM: local model -> 0.1° (4 times a day)

GFS: American model, global model -> 0.5° (4 times a day)

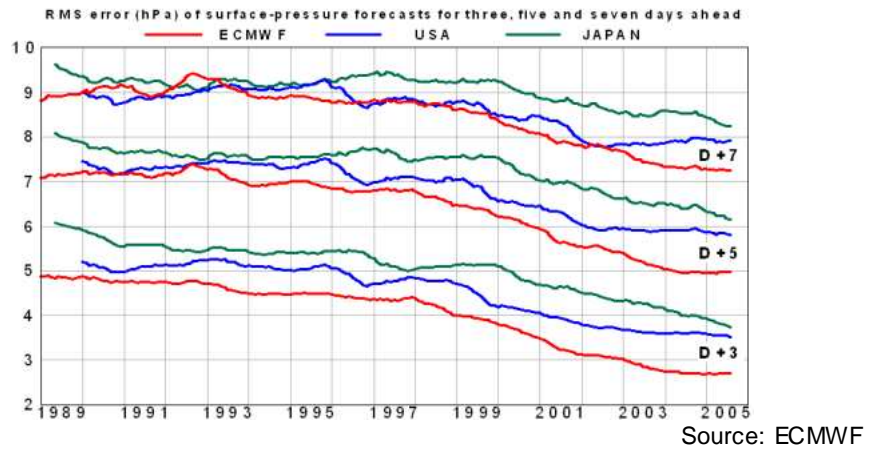
UKMO: model of British weather service, local model

GME: German model of German weather service, global model

KOSMO: local model of German weather service

JMA: global model of Japanese weather service

Comparison of forecasts of different meteorological centers

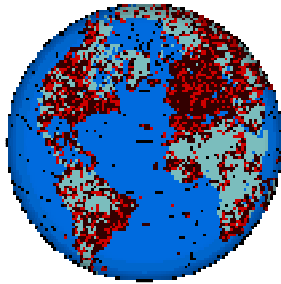


EPS – Ensemble Prediction System

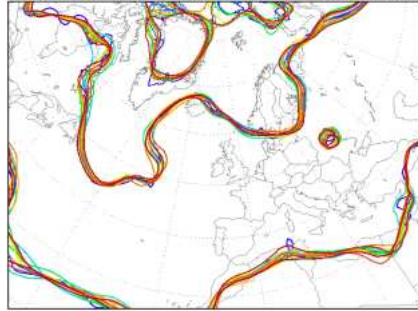


Edward Lorenz

Ensembles: 51 model runs more
With slightly changed start conditions



850 hPa Temperatur (Isothermen: -15 0 15 Grad C)

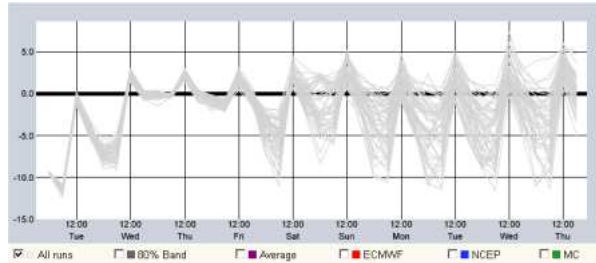


24 hours ahead

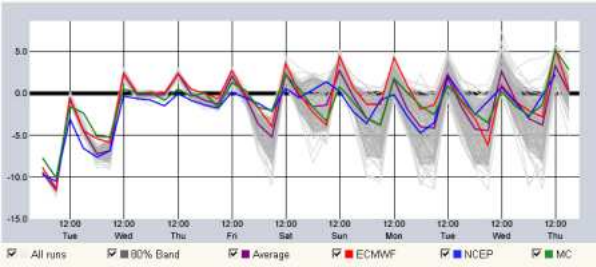
850 hPa Temperatur (Isothermen: -15 0 15 Grad C)



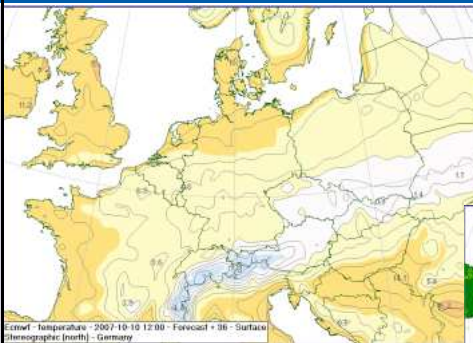
300 hours ahead



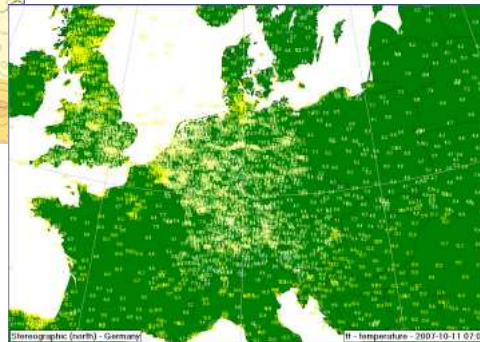
Ensembles: 51 runs



80% confidential interval and operational runs



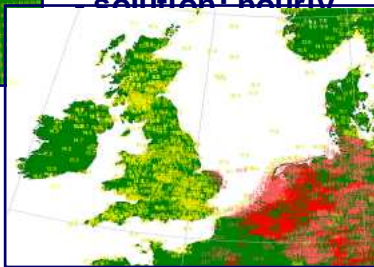
Model forecast of numerical models



MOS forecast

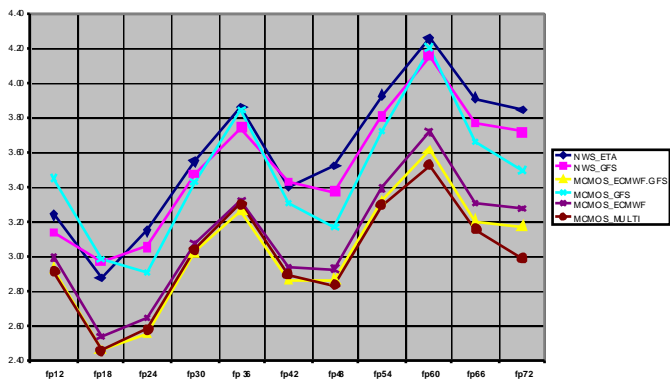
MOS: Model Output Statistics

Relation between grid point forecast and history of location

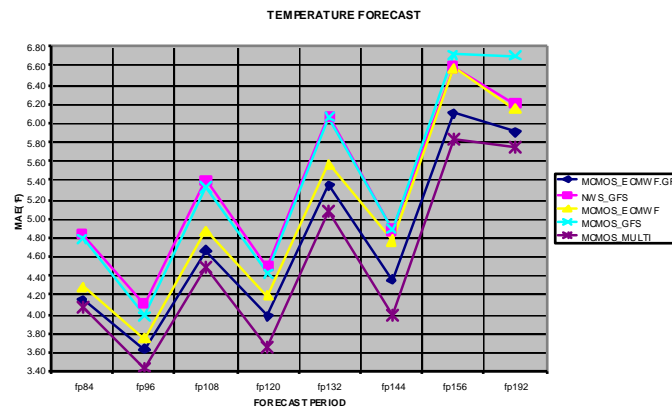


New Multi Model MOS

TEMPERATURE FORECAST (°F)



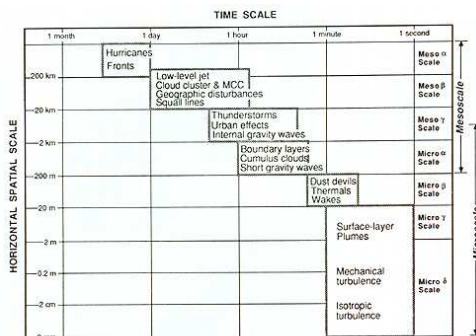
New Multi Model MOS



- MC-Wetter / MeteoGroup
- The weather system – how does it work?
- Messure data – condition precedent to forecast
- Forecast Models
- **Forecast Scales**
- Verifications

Forecast Scales

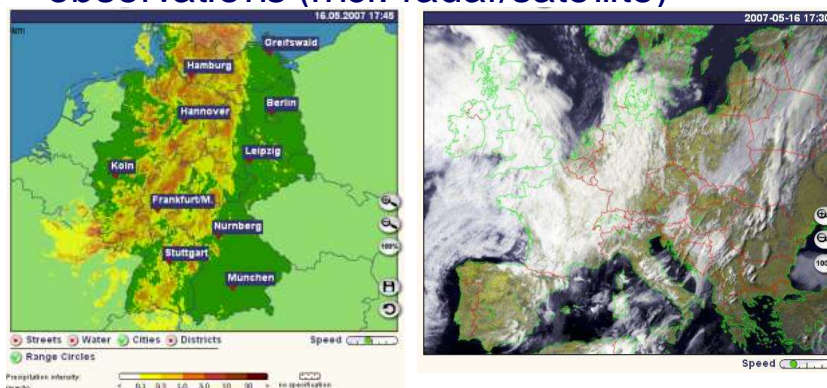
- Meteorological scales range from seconds to years/decades.
- Forecast precision depends on scale of meteorological phenomenon



from Stull 1988
Fig. 1.15 Typical time and space orders-of-magnitude for micro and mesoscales. (After Orlandi, 1975.)

Short-term forecasts

- Nowcasting up to 2 hours: extrapolation of observations (incl. radar/satellite)



Short-term forecasts



- Forecasts up to 3 days
 - Possible to take into account non-standard diurnal variations
 - Deterministic forecasts best to use, comparison & combination of different models important

Example forecast



Forecasts can be presented for different cities, country averages and compared to long-term climate values to get an impression on the first glance

Minimum and Maximum Temperatures - Difference to Climate Mean Values Updated: 15:32 - 2007-05-21

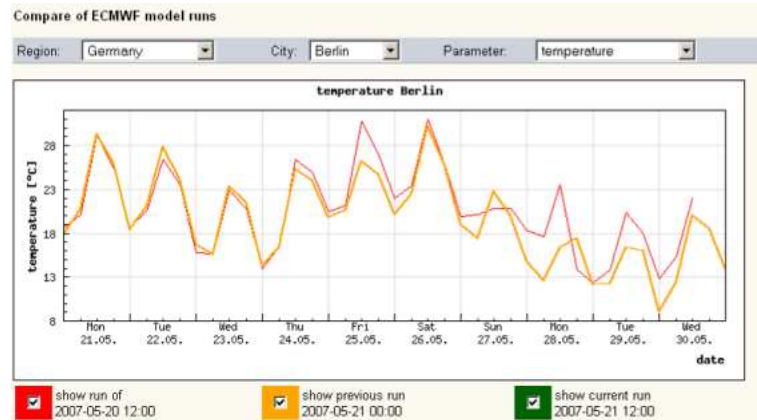
City	Mon 21.05.		Tue 22.05.		Wed 23.05.		Thu 24.05.		Fri 25.05.		Sat 26.05.		Sun 27.05.		Mon 28.05.		Tue 29.05.		Wed 30.05.		Normal		
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max			
UK Averaged	7.7	16.3	9.2	19.8	9.9	17.0	11.7	19.8	11.7	19.8	9.7	15.8	8.9	14.8	7.5	15.4	8.3	16.3	10.0	17.4	8.6	16.9	
London	11.3	15.3	10.9	22.4	11.2	13.2	13.3	22.6	11.1	17.4	10.2	16.4	9.9	17.1	9.1	17.6	10.7	17.9	9.4	18.1			
Birmingham	3.2	17.6	7.0	17.3	8.2	10.9	11.5	20.7	10.8	17.0	8.8	15.4	8.2	14.5	6.2	14.7	6.7	16.1	9.8	17.9	8.4	16.0	
Manchester	6.9	15.4	7.5	19.9	9.0	11.7	22.2	12.0	19.1	9.9	16.0	8.5	14.4	7.4	15.1	7.8	16.2	9.9	17.4	8.4	16.7		
Newcastle	2.8	16.9	9.6	17.4	10.3	12.6	10.0	15.2	9.3	14.0	7.6	14.1	7.3	14.5	10.8	16.1	9.9	17.0	11.2	13.4			
Glasgow	3.4	16.7	8.5	16.2	8.4	13.2	9.6	14.5	6.4	14.6	7.1	13.4	6.4	13.8	5.9	15.0	7.1	15.5	7.7	16.5	7.1	16.0	
Southampton	10.6	13.7	10.0	20.5	9.5	21.8	11.0	22.9	11.8	20.2	10.1	14.8	9.4	14.5	7.5	15.2	6.6	15.7	10.2	16.4	8.8	19.5	
Bristol	8.4	17.5	10.0	20.6	10.3	23.2	12.2	22.9	13.5	19.5	10.3	15.5	8.2	14.3	7.8	15.4	8.7	16.0	10.2	17.7	8.5	17.0	
Cardiff	9.6	18.0	8.2	19.0	10.1	20.1	11.8	20.9	13.5	17.2	9.9	14.2	8.7	14.1	8.1	14.8	8.8	15.3	10.8	16.6	9.1	17.1	
Aberdeen	2.6	17.0	8.7	16.6	8.7	9.8	17.5	6.4	13.1	6.7	13.2	6.8	13.2	6.3	12.6	7.6	13.7	9.0	15.0	6.1	13.8		
Belfast	4.6	16.4	8.5	16.1	8.8	17.0	11.3	14.3	7.5	13.8	6.1	12.9	5.7	12.7	6.2	13.3	7.2	14.7	8.3	15.0	7.1	16.1	
Berlin	3.6	16.3	7.4	17.9	9.3	20.1	11.1	17.1	8.1	14.7	6.2	13.3	6.5	13.8	6.0	14.6	6.0	16.0	8.6	15.9	7.8	15.0	
Germany Averaged	13.7		25.2	13.3	24.3	13.5					15.2	21.4	12.1	18.7	10.8	19.5	11.3	21.9	9.3	19.4			
Hamburg	12.5		13.6	21.8	9.9	22.0	9.6		13.2			20.8	11.1	18.7	9.7	19.5	11.0	22.6	8.3	19.1			
Berlin	17.8		13.0	24.1	12.3						24.4	14.2	21.5	12.4	21.8	12.8	24.2	9.4	20.1				
Mannheim	13.0				15.3						26.5	15.6	22.0	12.4	19.7	10.9	20.3	11.3	22.9	10.1	21.0		
Essen	21.6		23.3	12.1	22.6	14.8					20.9	12.8	18.8	11.4	15.8	10.7	17.5	11.6	19.6	9.7	18.1		
FrankfurtM	12.0											22.0	12.1	19.2	10.8	20.2	11.3	22.6	9.1	20.1			
Munich	11.0		22.6		23.3	13.9						13.9	20.0	10.7	17.6	9.5	18.2	9.0	19.5	8.4	19.1		
France Averaged	8.5	15.0	9.0	17.1	9.7	17.5	10.2	17.9	11.0	16.0	9.9	13.3	8.0	12.4	7.1	11.9	6.4	12.4	7.0	13.0	6.6	12.7	
Paris	12.8	23.8	15.4	24.0	15.1	25.9						21.4	12.8	17.5	10.7	17.4	10.7	19.4	11.9	20.1	10.6	20.0	
Marseille	14.8	26.0	16.2		17.4							26.8	15.8	24.0	14.4	23.3	12.3	24.3	13.6	24.3	13.5	23.3	
Lyon	14.5		15.9									21.1	13.5	21.0	11.7	19.5	10.5	19.2	11.9	21.1	10.5	20.7	
Dordrecht	14.2	21.3	13.0								22.8	14.0	18.5	11.9	19.1	10.8	18.7	10.7	20.2	11.4	21.5	10.5	20.9
Wander	12.7	19.8	12.2	23.4	14.5							20.8	12.6	17.9	10.6	16.8	9.3	18.7	8.4	18.4	10.5	19.3	
Strasbourg	14.0		19.2	15.1								24.5	13.3	20.8	11.3	18.4	10.9	19.4	10.5	21.2	9.7	20.3	

Source: www.mc-energy.com

Example forecast

MeteoGroup

Difference to previous model run can help to see trends quickly.



Source: www.mc-energy.com

Medium-range fcst.

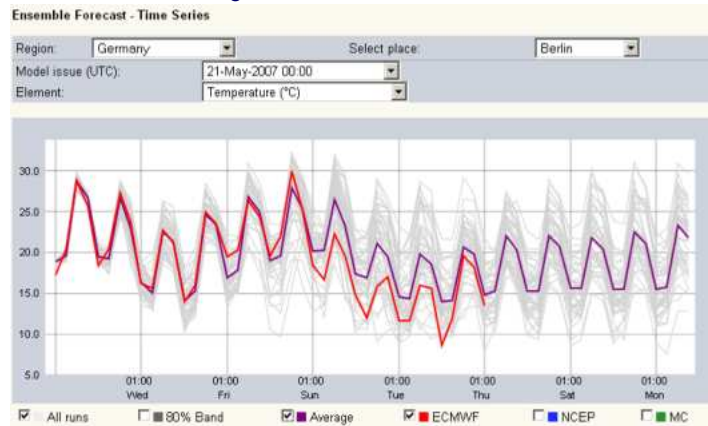
MeteoGroup

- Weather & Uncertainty
 - Meteorology is aware that forecasts are not perfect
 - Usage can be increased if quality is known in advance
- Solution: Ensemble forecasts
 - Model is run several times with slightly changed initial conditions
 - Variation in results represents uncertainty

Medium-range Fcst.

MeteoGroup

Most likely forecast is the average/median of all ensembles.



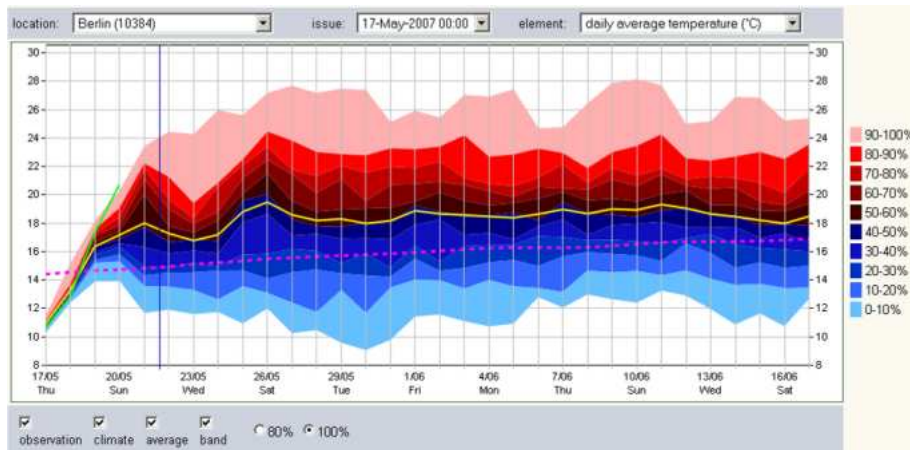
Monthly Forecasts

MeteoGroup

- Makes only sense with ensembles
- Ocean conditions become more and more important the longer the forecast shall be
- Can only show trends
- Weekly available (Friday)

Medium-range Fcst.

MeteoGroup



Source: ECMWF

MeteoGroup

- MC-Wetter / MeteoGroup
- The weather system – how does it work?
- Messure data – condition precedent to forecast
- Forecast Models
- Forecast Scales
- Verifications

**Verifications of several weather
parameters can be requested**

under

info@meteogroup.de

Thank you for your attention!

MC-Wetter GmbH
Gradestr. 50
12347 Berlin, Germany

Internet: www.meteogroup.de

Phone: +49 30 600 98 0