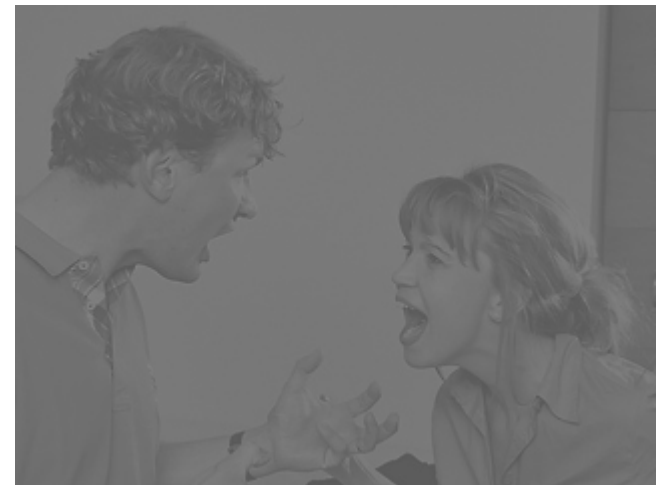




# Long-term verification of COSMO LM/LME

Ulrich Damrath & Ulrich Pflüger



# Building up a NWP-model



## **Building up a NWP-model**



**Let's be lucky!**



## **Building up a NWP-model**

**Let's be lucky!**

**It is not optimal,  
but I can live with it!**






**Building up a  
NWP-model**

**Let's be lucky!**

**It is not optimal,  
but I can live with it!**



**It is not acceptable!  
It has to be changed!**

# Temperature

- **Strong negative BIAS of 2m-temperature during winter** 
- **Phase error concerning the maximum, especially during summer** 
- **Too fast decrease of temperature during afternoon** 



# Dew point



- **Overestimation of the dew point amplitude during winter and spring** 
- **Successful calculation of the diurnal cycle of dew point during summer!!!** 

# Precipitation

- **Strong phase error of the maximum, especially in cases with convection (Maximum appears too early!)**
- **General overestimation during Winter**
- **Small overestimation during summer**
- **Sometimes „Gridpoint storms“ with extreme precipitation values at single points**



# Wind and gusts

- **Overestimation of gusts** 
- **Small overestimation of wind speed over flat terrain**
- **Underestimation of wind speed over isolated mountains (and exposed stations)** 



# Clouds




- **Too fast dispersal of low stratus**
- **Overestimation of frequency of high cirrus cloud covers**

# Pressure

- **Positive BIAS of pressure in LME during anticyclonic situations**
- **No practical significance of this problem known up to now.**  
**(But exciting for scientists)!**



# Upper atmosphere (1)

- **Relative Humidity** 
  - **since implementation of prognostic cloud ice: positive BIAS during winter**
  - **but also a reduction of RMSE**
- **Temperature between 850 hPa and 400 hPa** 
  - **seasonal change of BIAS, positive in summer (up to 0.6 K), negative in winter (down to -0.8K),**
  - **slight reduction of RMSE**
- **Temperature in Boundary Layer** 
  - **since 2005: negative BIAS (down to -0.8 K) in winter near ground, less above and in summer half**
  - **slight reduction of RMSE**

# Upper atmosphere (2)

- **Windspeed**

- **Change of a more negative BIAS in LM to a more positive BIAS in LME by now**
- **reduced RMSE beginning with 2004 compared to the start of LM-era**



- **Winddirection**

- **slightly reduced RMSE beginning with 2004 compared to the start of LM-era**



- **Geopotential**

- **Reduced RMSE of geopotential during last years compared to the start of LM-era**



**§§ 1564 - 1568 BGB  
divorce???**



**Let's be lucky!**

**7**

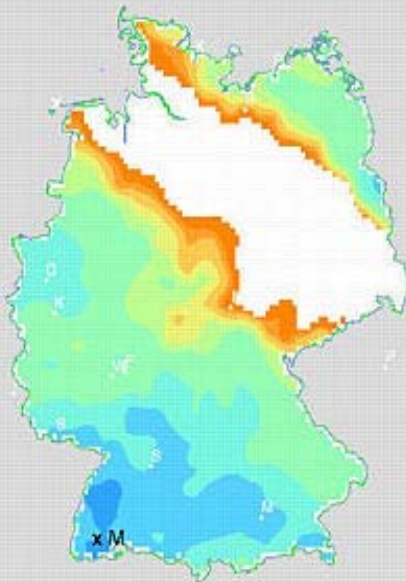
**It is not optimal,  
but I can live with it!**

**10**

**It is not acceptable!  
It has to be changed!**

**11**

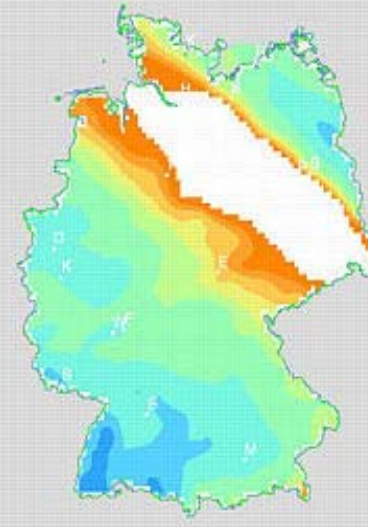
HM1



Niederschlag von 08.03.1999 06 UTC bis 09.03.1999 06 UTC ( $\text{kg m}^{-2}$ )  
(Analyse)

Minimum: .01 Maximum: 28.55 Mittelwert: 5.128

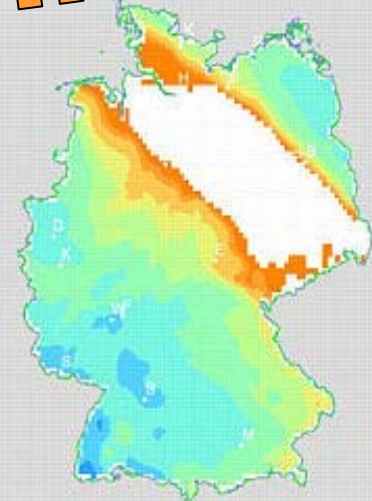
DM4



Gesamtniederschlag ( $\text{kg m}^{-2}$ )  
Vorhersage vom 08.03.1999 00 UTC (Differenz: T+30 - T+06 h)

Minimum: .01 Maximum: 38.09 Mittelwert: 4.438

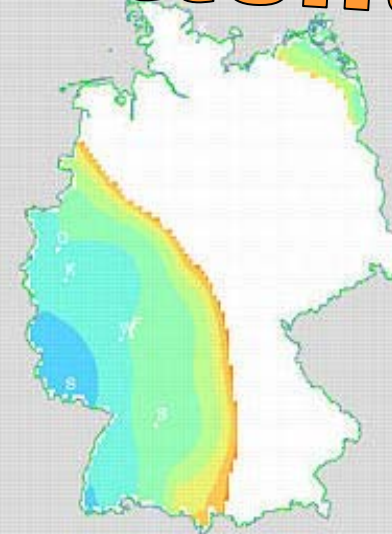
LM1



Gesamtniederschlag ( $\text{kg m}^{-2}$ )  
Vorhersage vom 08.03.1999 00 UTC (Differenz: T+30 - T+06 h)

Minimum: .01 Maximum: 38.82 Mittelwert: 3.951

GME



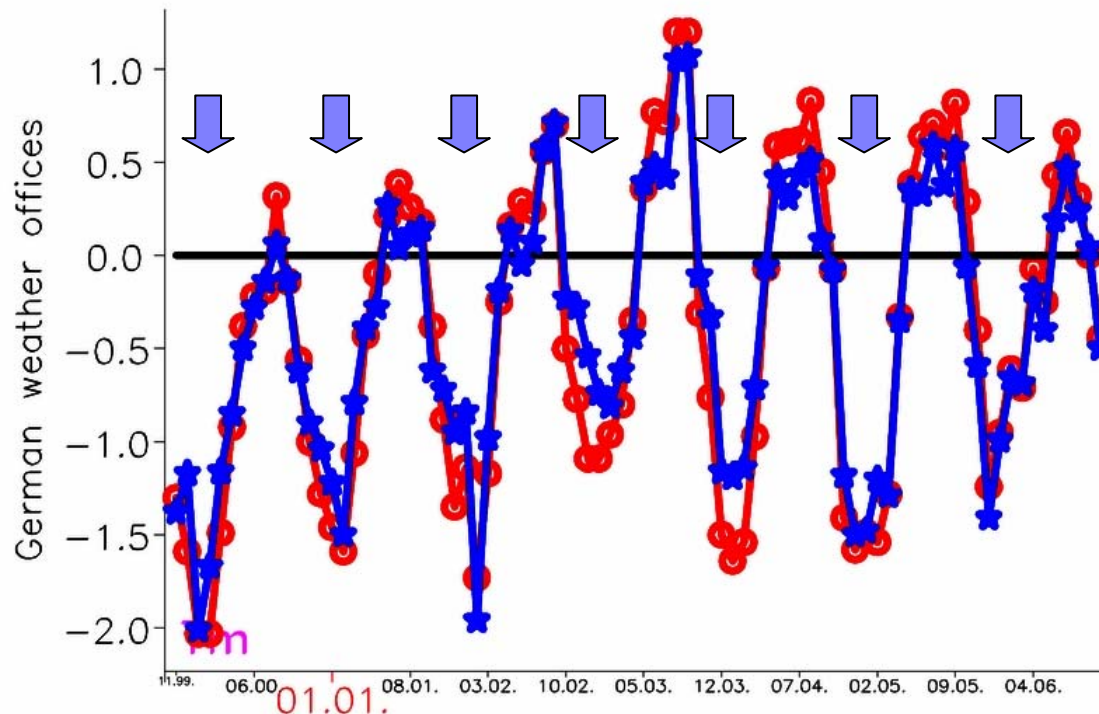
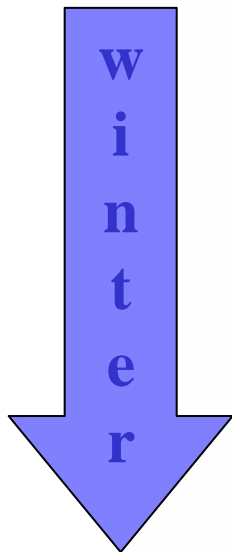
Gesamtniederschlag ( $\text{kg m}^{-2}$ )  
Vorhersage vom 08.03.1999 00 UTC (Differenz: T+30 - T+06 h)

Minimum: .01 Maximum: 15.94 Mittelwert: 4.465

Thanks for your attention!

# Verification of surface weather elements: Time series BIAS Tmin 2m Vhs. valid 6 UTC

- 006-h—forecasts of LM from 01.11.1999 till 30.11.2006 valid 06 UTC
- 030-h—forecasts of LM from 01.11.1999 till 30.11.2006 valid 06 UTC

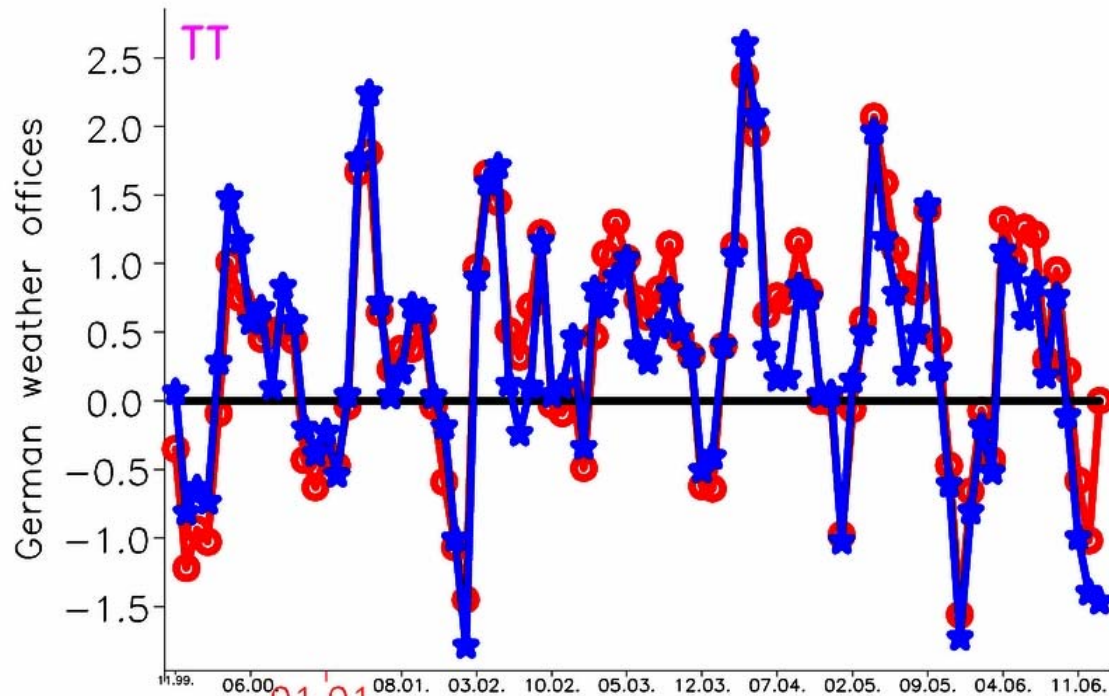
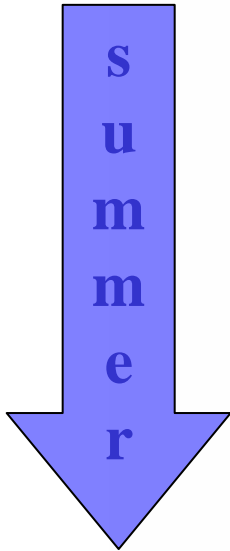


Results of verification of forecasts for local weather elements at surface stations  
frequency bias for cloud covers (-: 0-2/8, - -: 7-8/8), gusts  
and precipitation T-6 till T, mean error for other elements

# Verification of surface weather elements: Time series BIAS Tmin 2m Vhs. valid 12 UTC



- 012-h-forecasts of LM from 01.11.1999 till 31.01.2007 valid 12 UTC
- 036-h-forecasts of LM from 01.11.1999 till 31.01.2007 valid 12 UTC

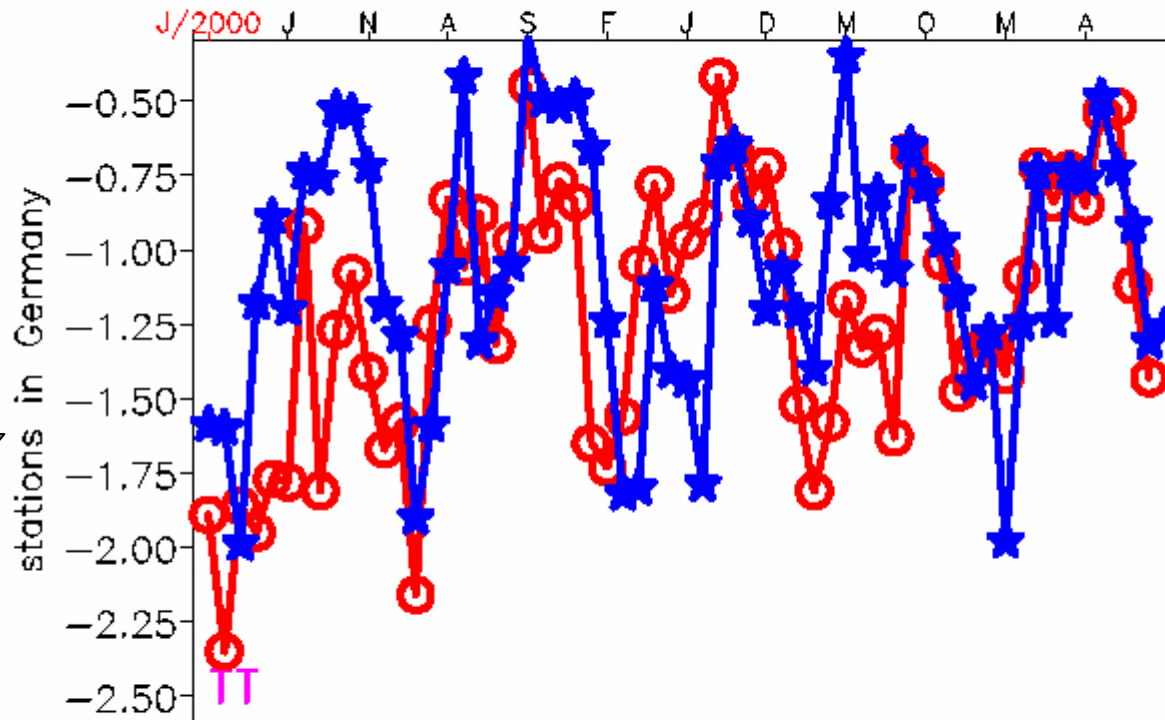


Results of verification of forecasts for local weather elements at surface stations  
frequency bias for cloud covers (-: 0-2/8, - -: 7-8/8), gusts  
and precipitation T-6 till T, mean error for other elements

# Verification of surface weather elements: Time series BIAS T2m Vhs. valid 18 UTC



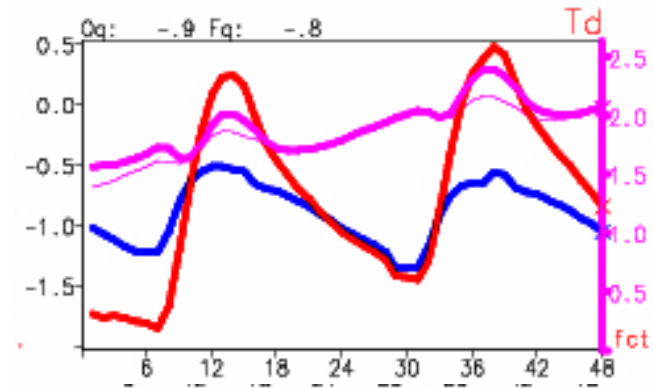
- 006-h-forecasts of LM from 01.01.2000 till 31.01.2006 valid 18 UTC
- 030-h-forecasts of LM from 01.01.2000 till 31.01.2006 valid 18 UTC



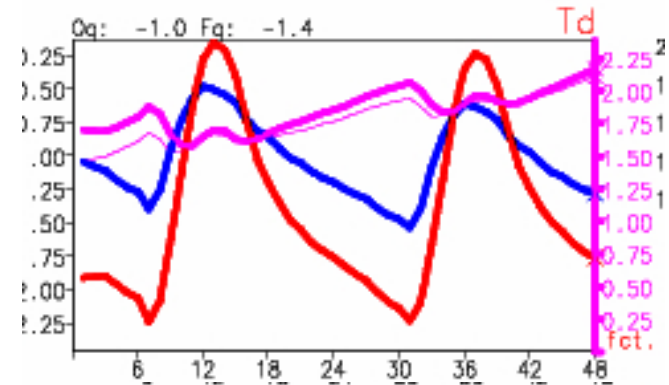
Results of verification of forecasts for local weather elements at surface stations  
frequency bias for cloud covers (—: 0-2/8, - - : 7-8/8), gusts  
and precipitation T-6 till T, mean error for other elements

# Verification of surface weather elements: Diurnal cycle of dew point during winter

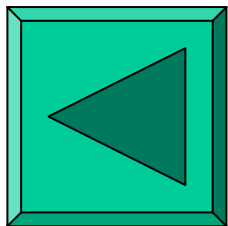
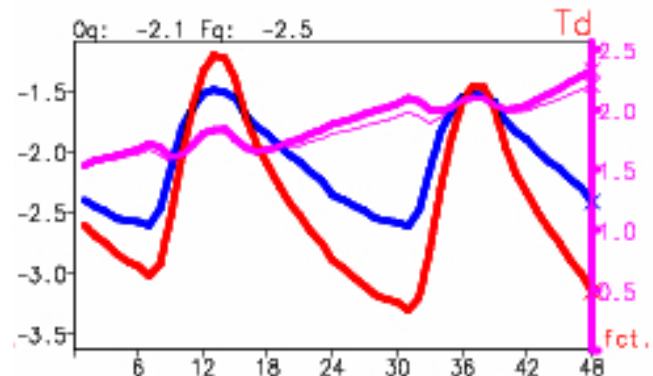
winter 2003/2004





winter 2004/2005



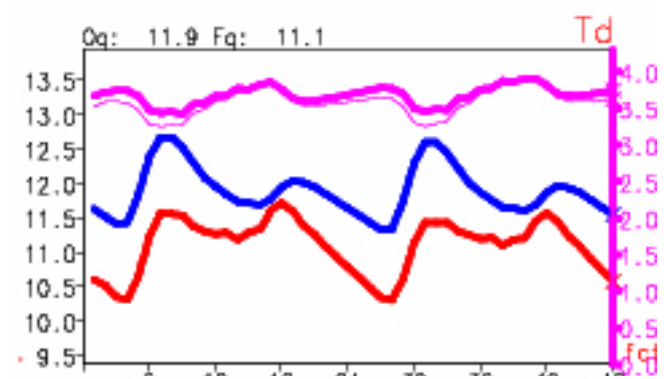
winter 2005/2006



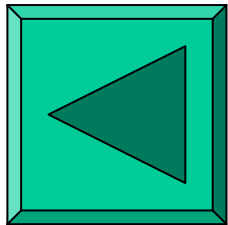
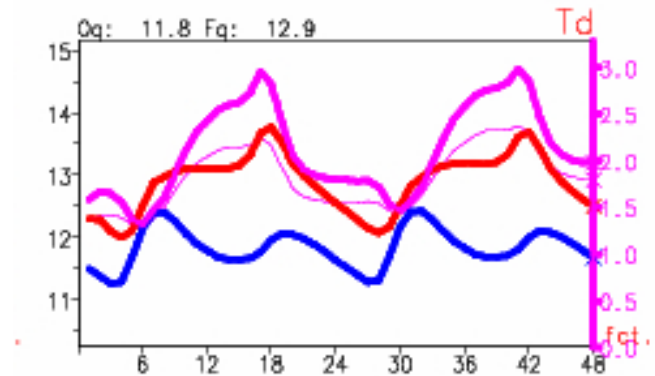
 **Observation**  
 **Forecast**  
 **STDV / RMSE**

# Verification of surface weather elements: Diurnal cycle of dew point during summer

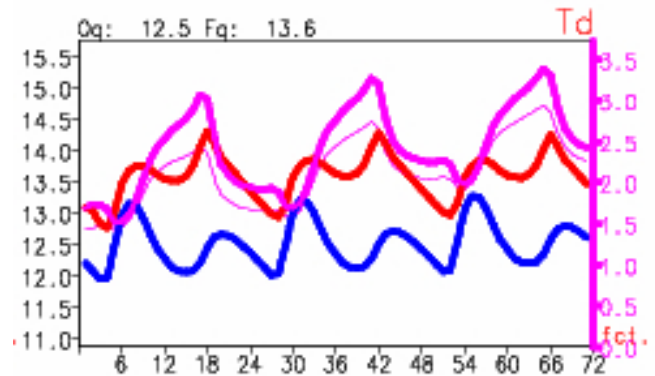
summer 2004




summer 2005



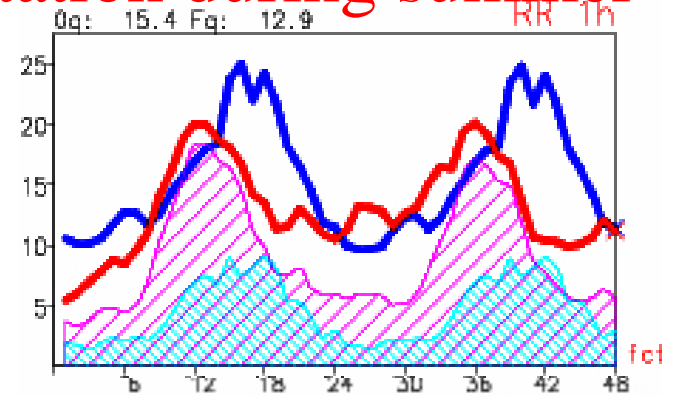
summer 2006



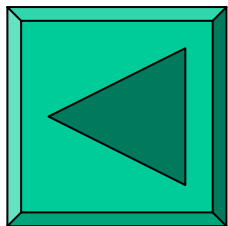
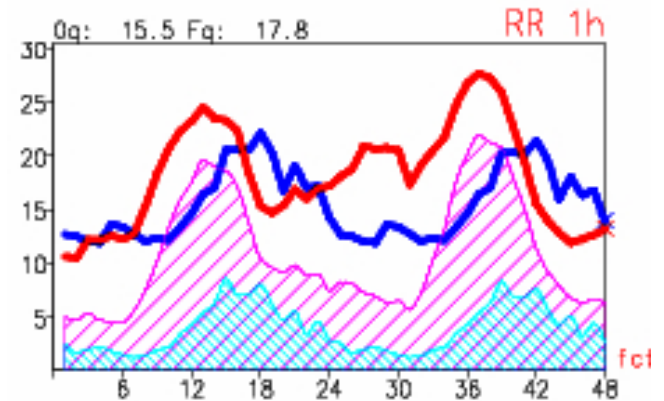
 **Observation**  
 **Forecast**  
 **STDV / RMSE**

# Verification of surface weather elements: Diurnal cycle of precipitation during summer

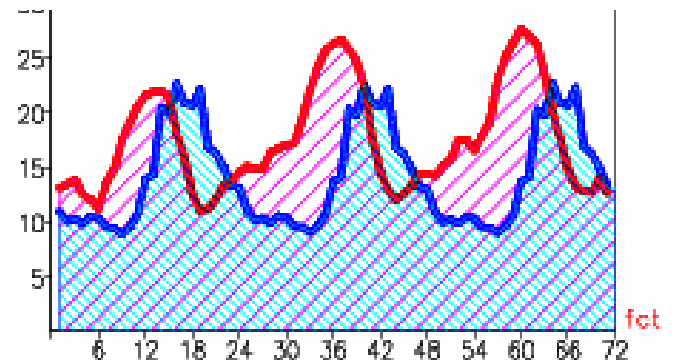
summer 2004



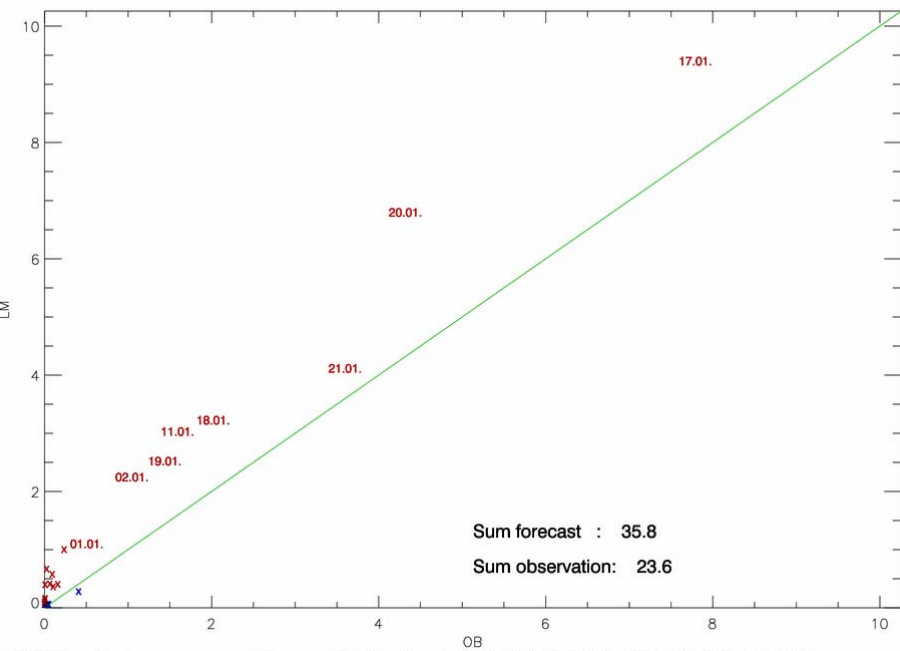
summer 2005



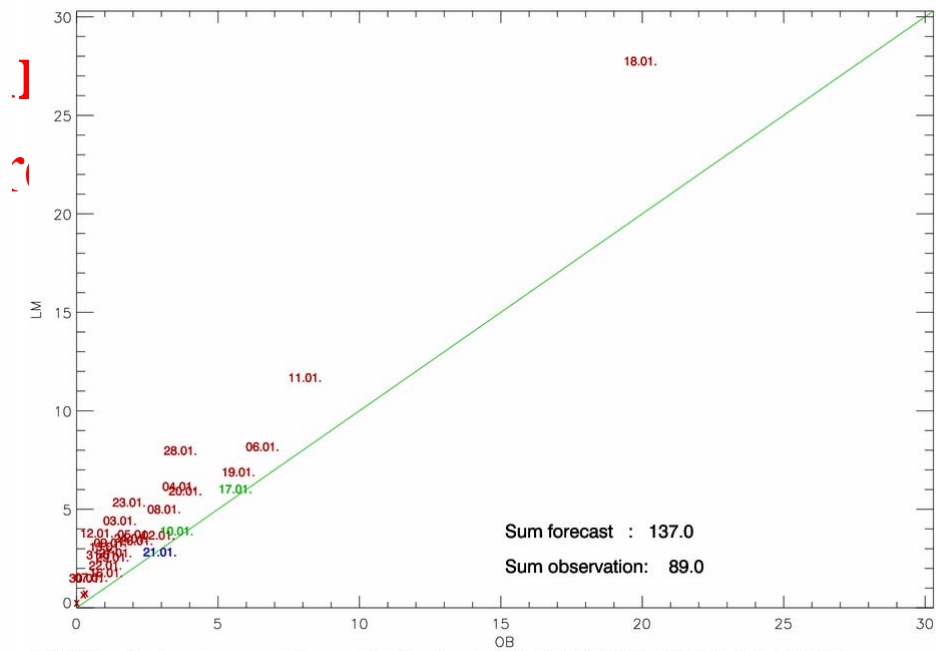
summer 2006



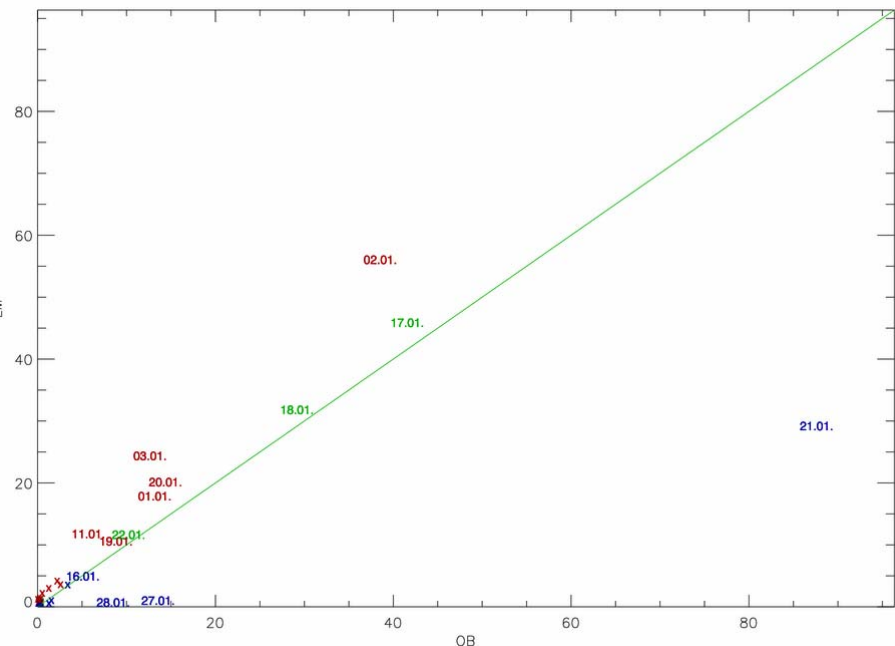
— Observation  
— Forecast  
— STDV / RMSE



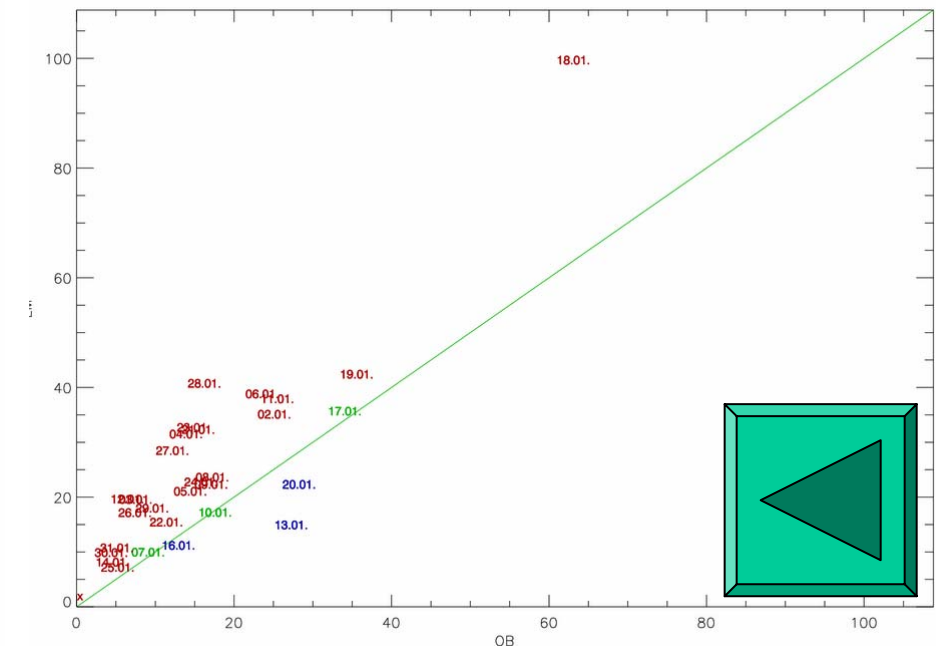
LME: Area mean of precipitation: 01.01.2006 till 31.01.2006



LME: Area mean of precipitation: 01.01.2007 till 31.01.2007



LME: Maximum of precipitation: 01.01.2006 till 31.01.2006

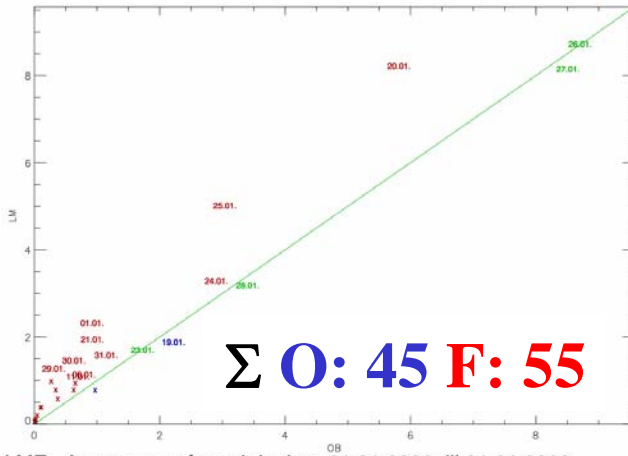


LME: Maximum of precipitation: 01.01.2007 till 31.01.2007

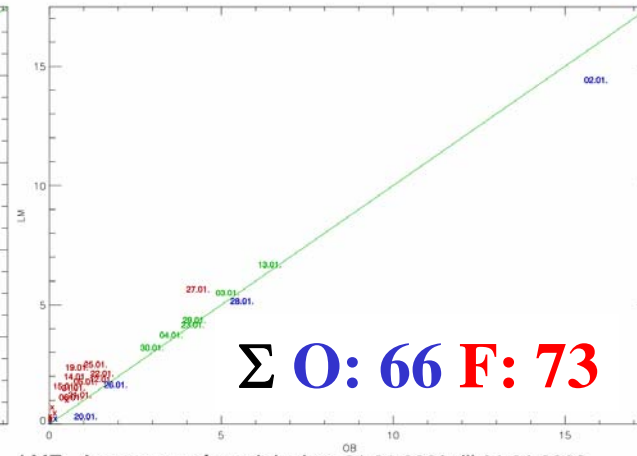


# Verification of surface weather elements:

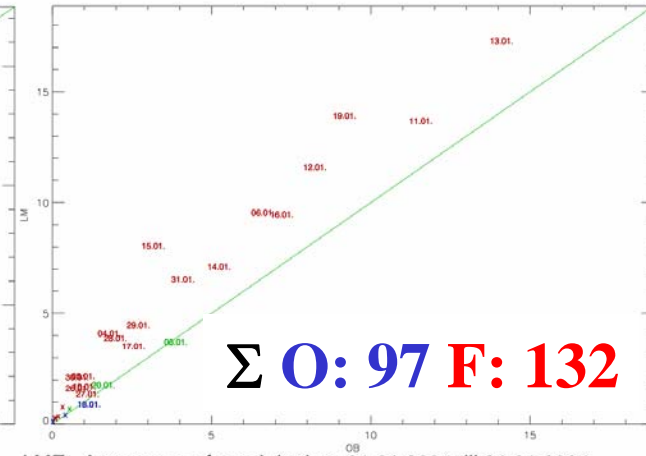
## Scatter diagrams of daily precipitation sums during January (LME since 2006)



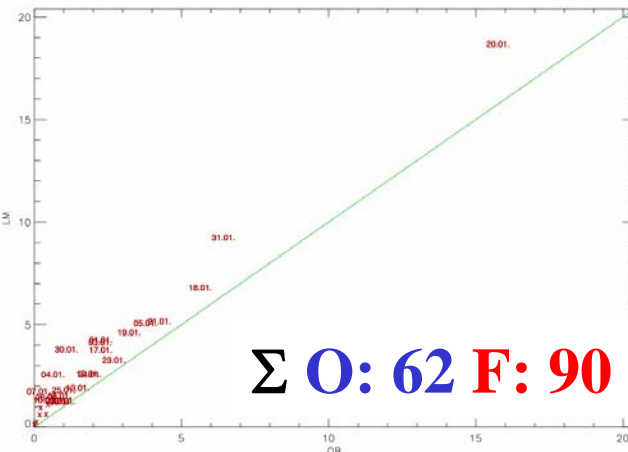
LME: Area mean of precipitation: 01.01.2002 till 31.01.2002



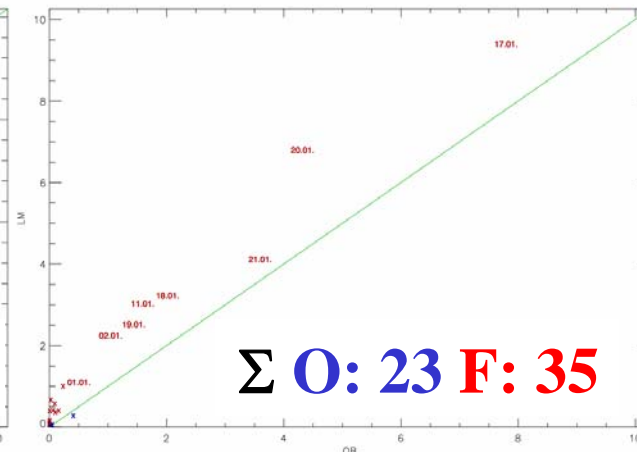
LME: Area mean of precipitation: 01.01.2003 till 31.01.2003



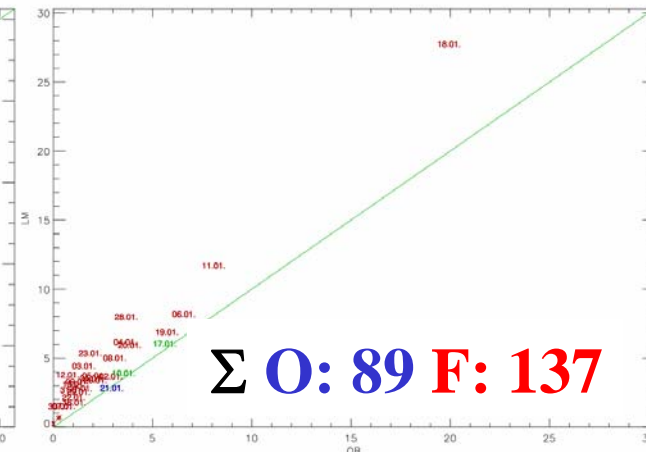
LME: Area mean of precipitation: 01.01.2004 till 31.01.2004



LME: Area mean of precipitation: 01.01.2005 till 31.01.2005



LME: Area mean of precipitation: 01.01.2006 till 31.01.2006



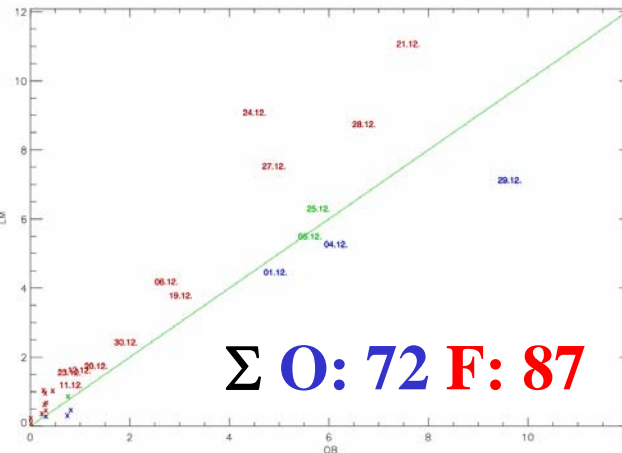
LME: Area mean of precipitation: 01.01.2007 till 31.01.2007



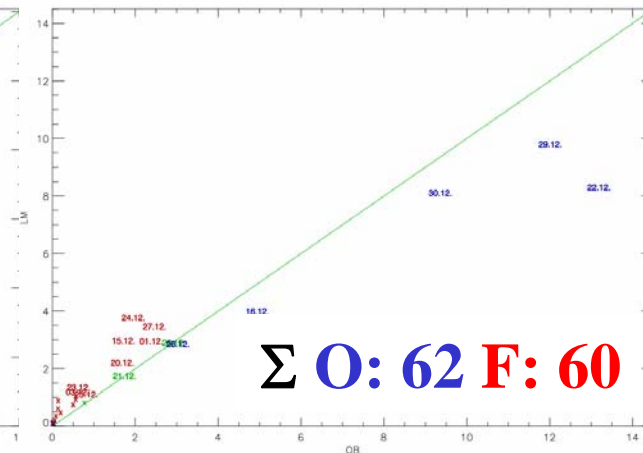


# Verification of surface weather elements:

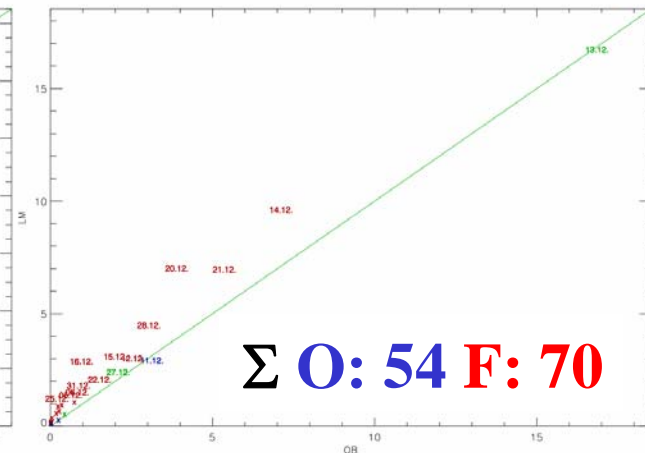
## Scatter diagrams of daily precipitation sums during December (LME since 2005)



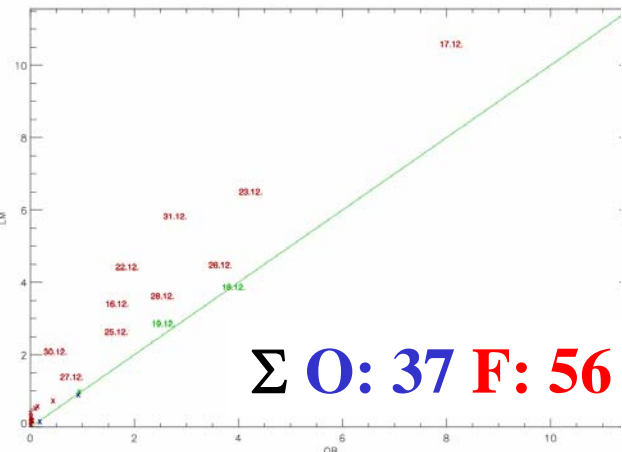
LME: Area mean of precipitation: 01.12.2001 till 31.12.2001



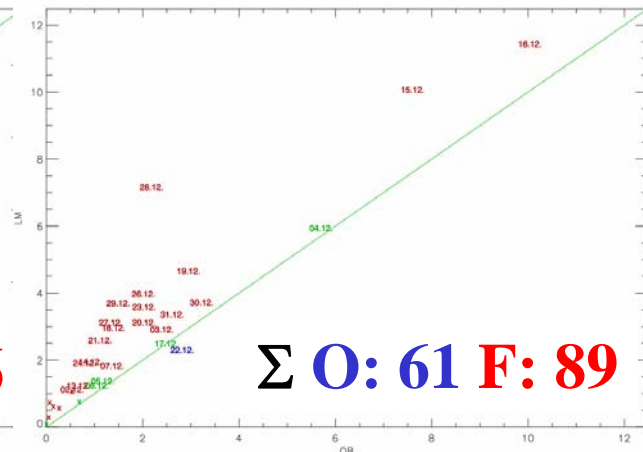
LME: Area mean of precipitation: 01.12.2002 till 31.12.2002



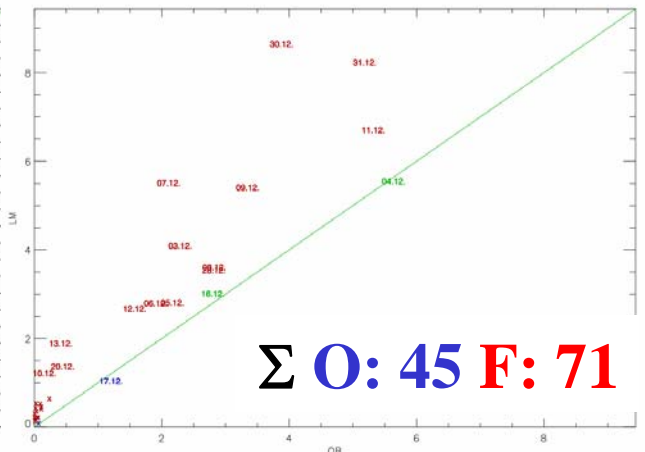
LME: Area mean of precipitation: 01.12.2003 till 31.12.2003



LME: Area mean of precipitation: 01.12.2004 till 31.12.2004



LME: Area mean of precipitation: 01.12.2005 till 31.12.2005

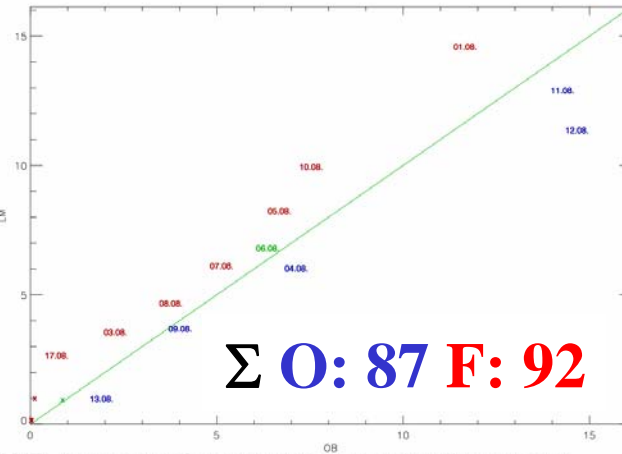


LME: Area mean of precipitation: 01.12.2006 till 31.12.2006

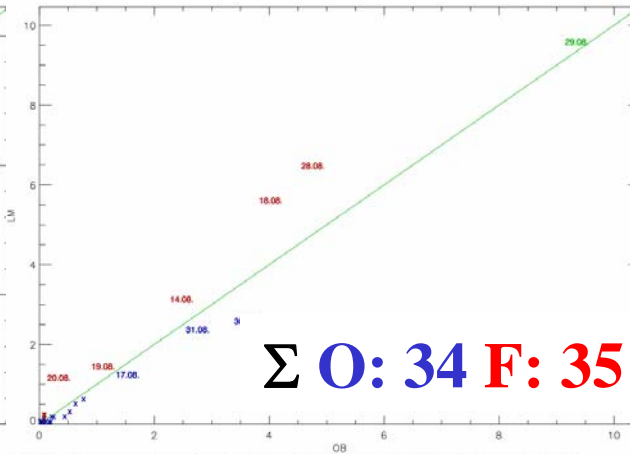




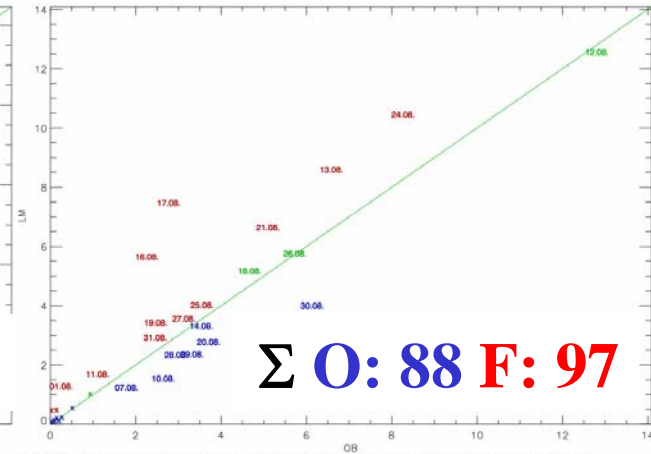
# Verification of surface weather elements: Scatter diagrams of daily precipitation sums during August (LME since 2006)



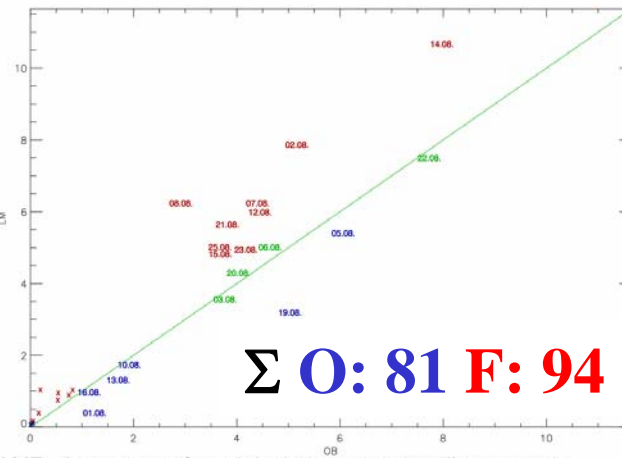
LME: Area mean of precipitation: 01.08.2002 till 31.08.2002



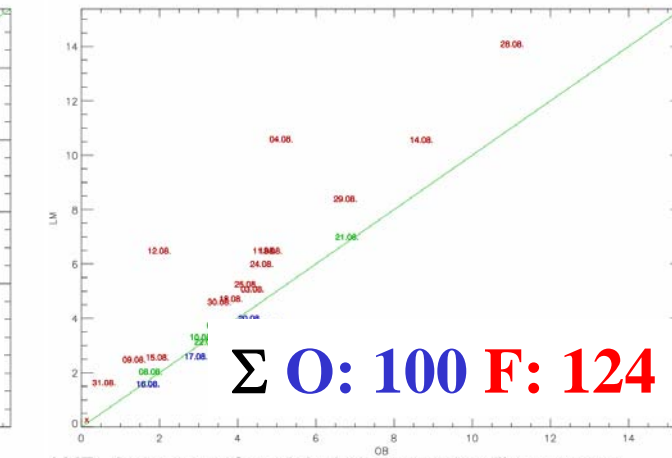
LME: Area mean of precipitation: 01.08.2003 till 31.08.2003



LME: Area mean of precipitation: 01.08.2004 till 31.08.2004



LME: Area mean of precipitation: 01.08.2005 till 31.08.2005



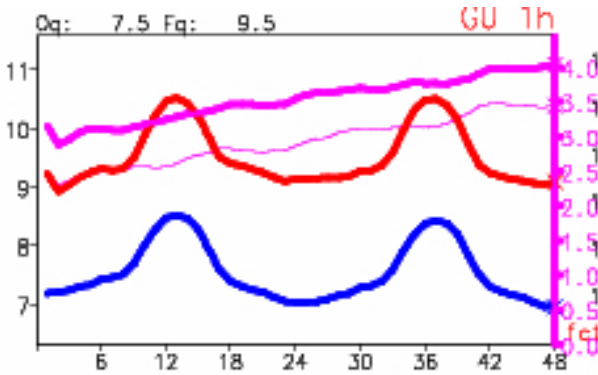
LME: Area mean of precipitation: 01.08.2006 till 31.08.2006



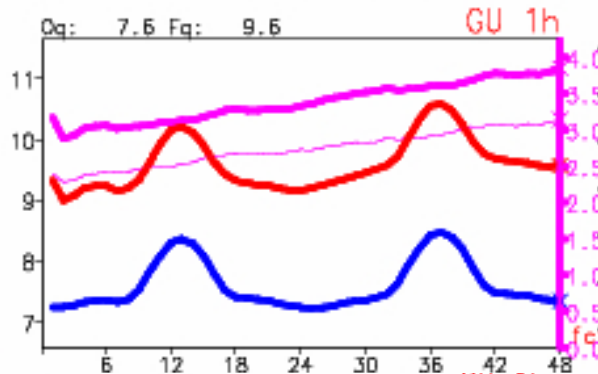




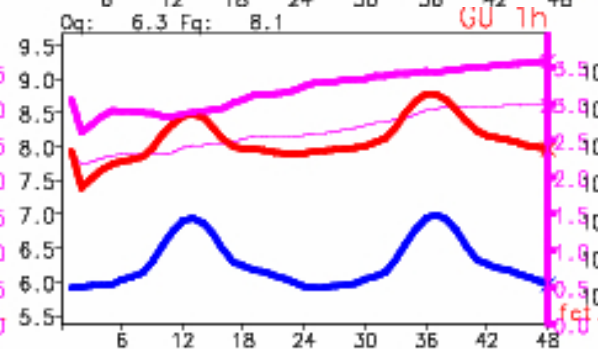
# Verification of surface weather elements: Diurnal cycle of gusts



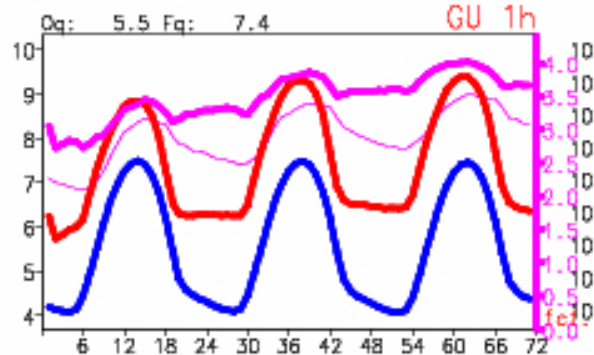
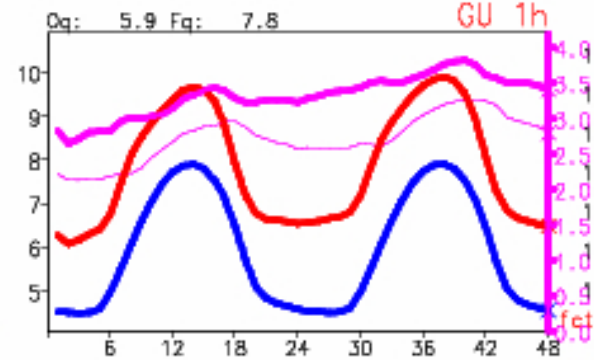
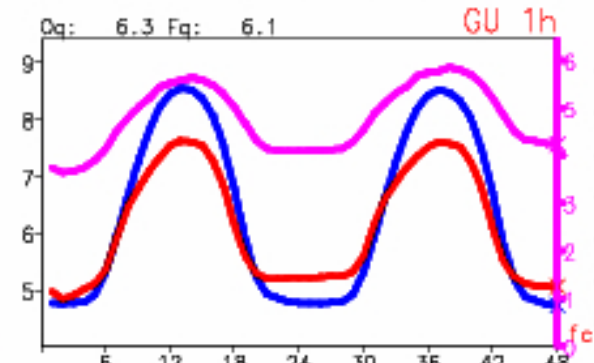
<-- Winter 2003/2004  
summer 2004 -->



<-- Winter 2004/2005  
summer 2005 -->

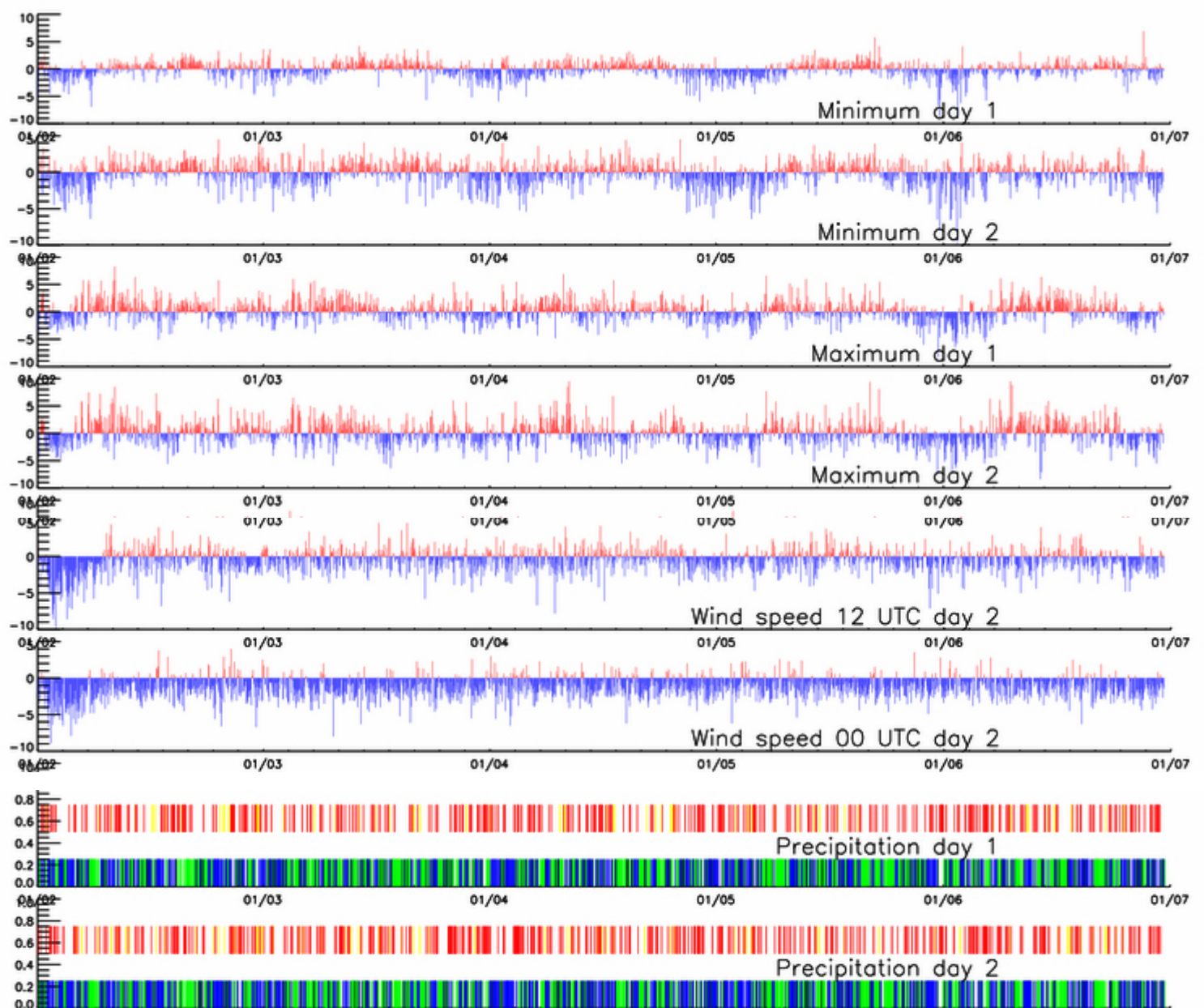


<-- Winter 2005/2006  
summer 2006 -->



Observation  
Forecast  
STDV / RMSE





**Verification  
of surface  
weather  
elements:  
Annual cycle  
of some  
errors for the  
station of  
Potsdam**

Temperature .. : Biases of forecasts from 01.01.2002 till 31.12.2006 Station: Potsdam

Precipitation : elements of the contingency table OY/FY ON/FY OY/FN ON/FN

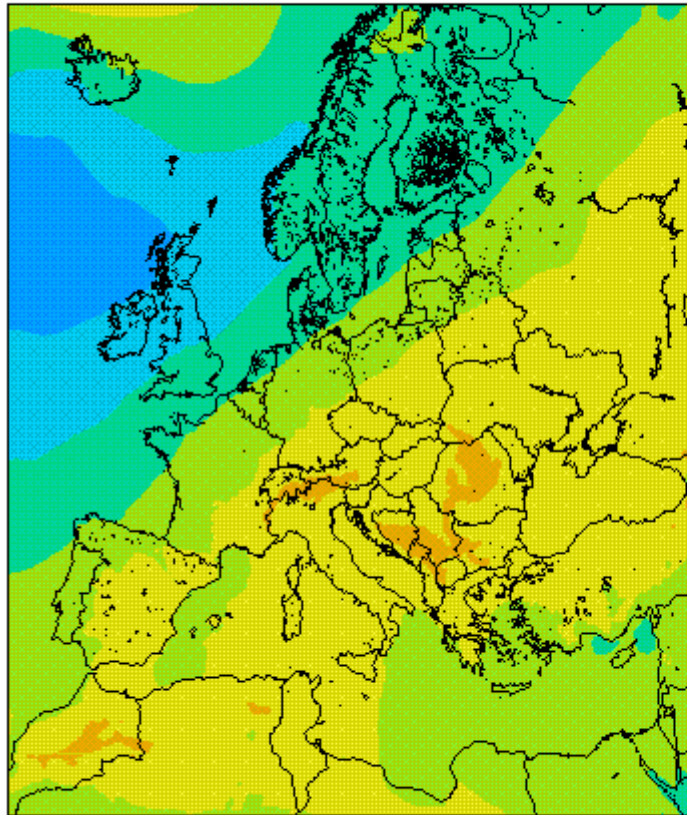


# Distribution of surface level pressure in LME and GME

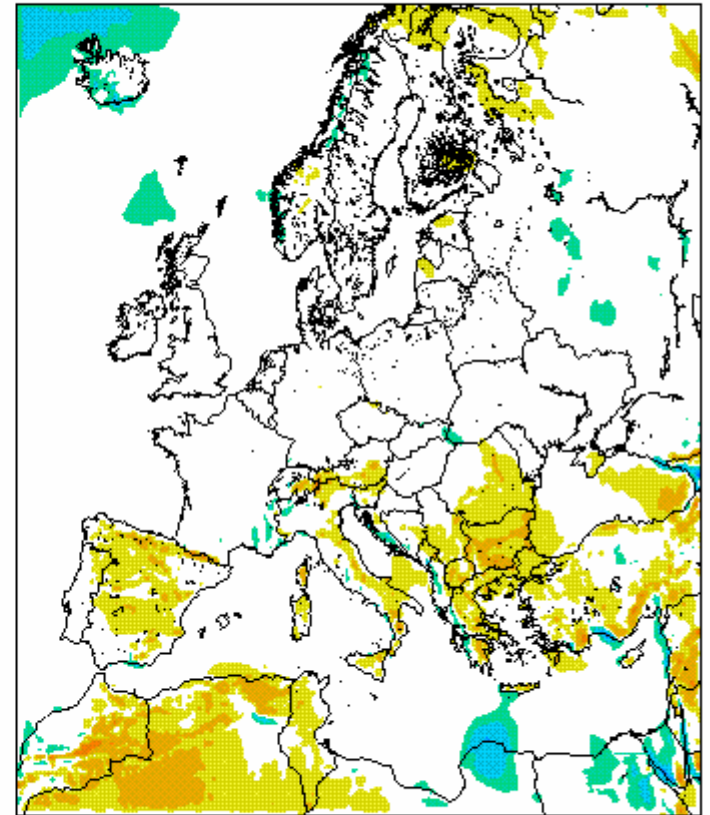
October 2006 00UTC pmsl (hPa) vv=00

LME

LME-GME



996 1000 1004 1008 1012 1016 1020 1024 1028  
min=1001.42 max=1023.44 ave=1016.27



-3 -2 -1 -0.5 0.5 1 2 3  
min=-3.61438 max=3.18872 ave=0.0977723

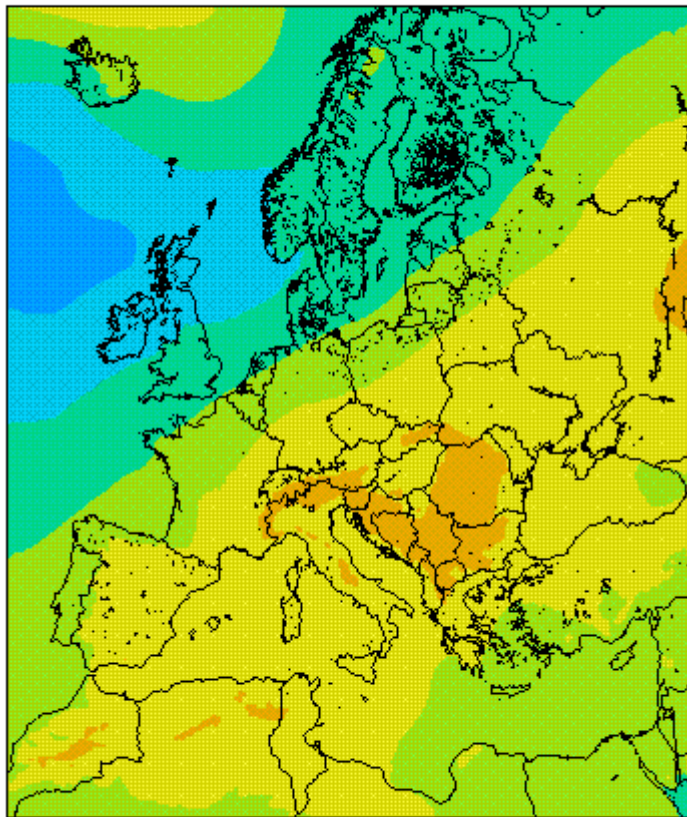


# Distribution of surface level pressure in LME and GME

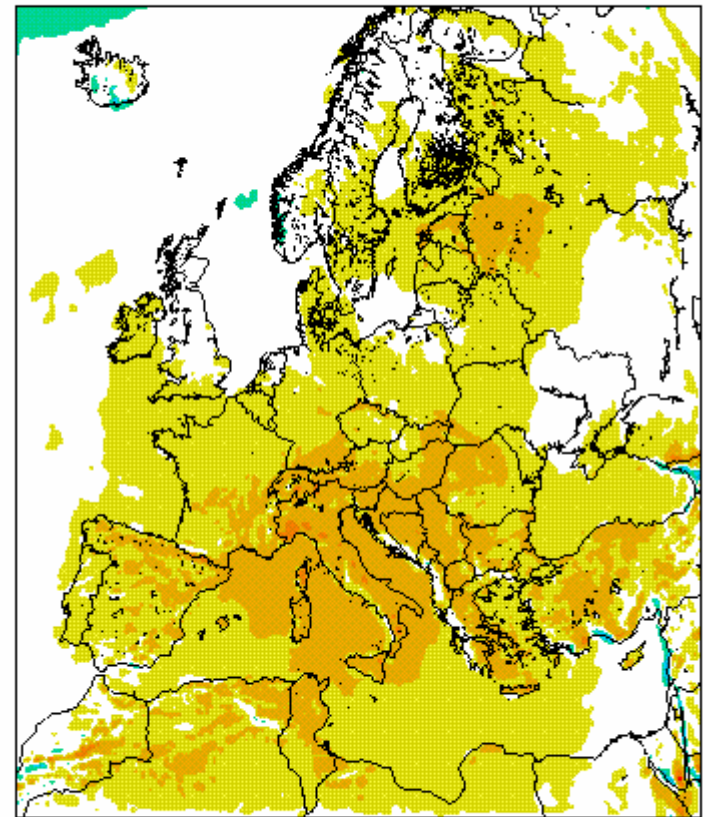
October 2006 00UTC pmsl (hPa) vv=24

LME

LME-GME



996 1000 1004 1008 1012 1016 1020 1024 1028  
min=1001.79 max=1022.92 ave=1016.74



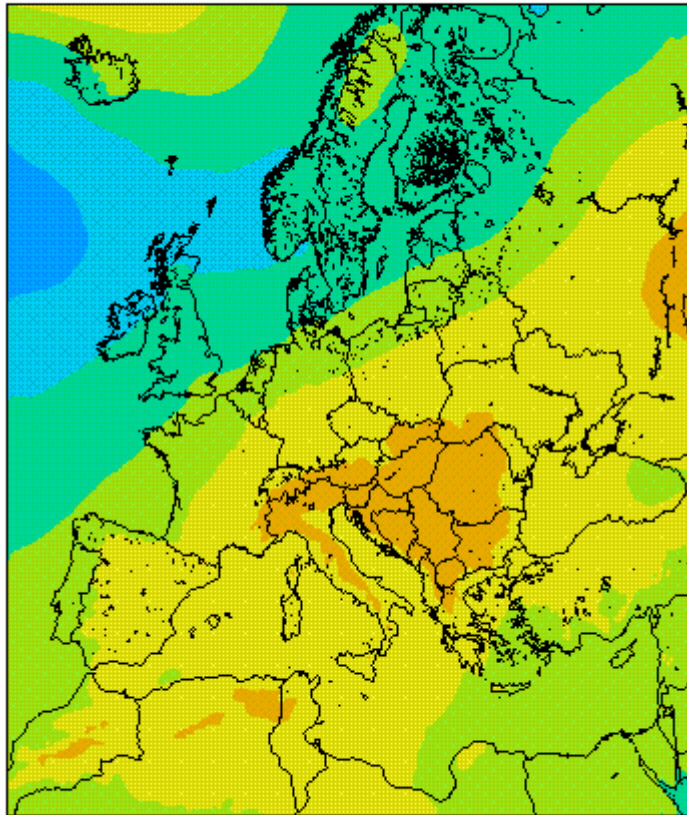
-3 -2 -1 -0.5 0.5 1 2 3  
min=-3.11188 max=3.28809 ave=0.545826



# Distribution of surface level pressure in LME and GME

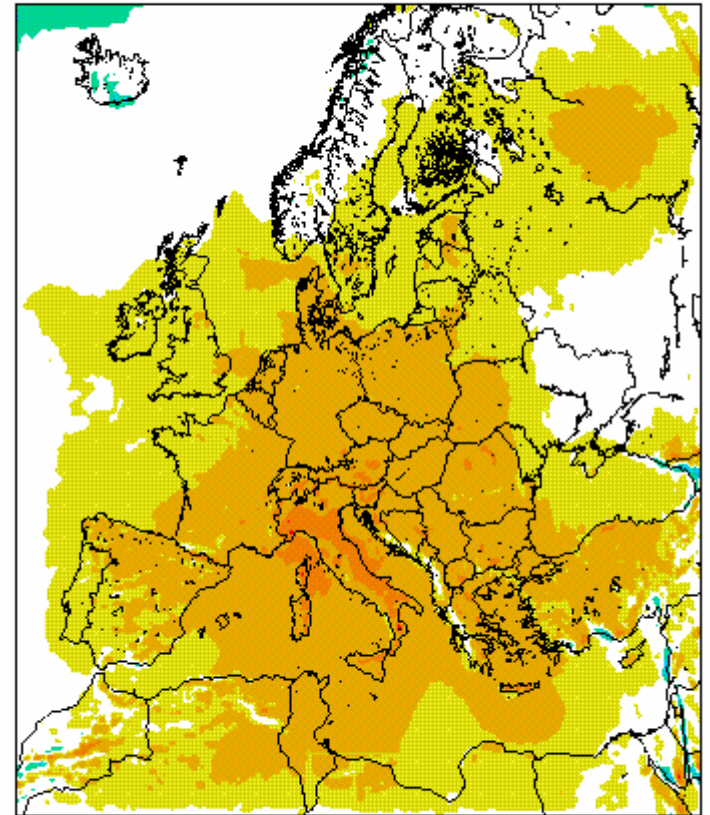
October 2006 00UTC pmsl (hPa) vv=48

LME



996 1000 1004 1008 1012 1016 1020 1024 1028  
min=1001.61 max=1022.58 ave=1017.26

LME-GME



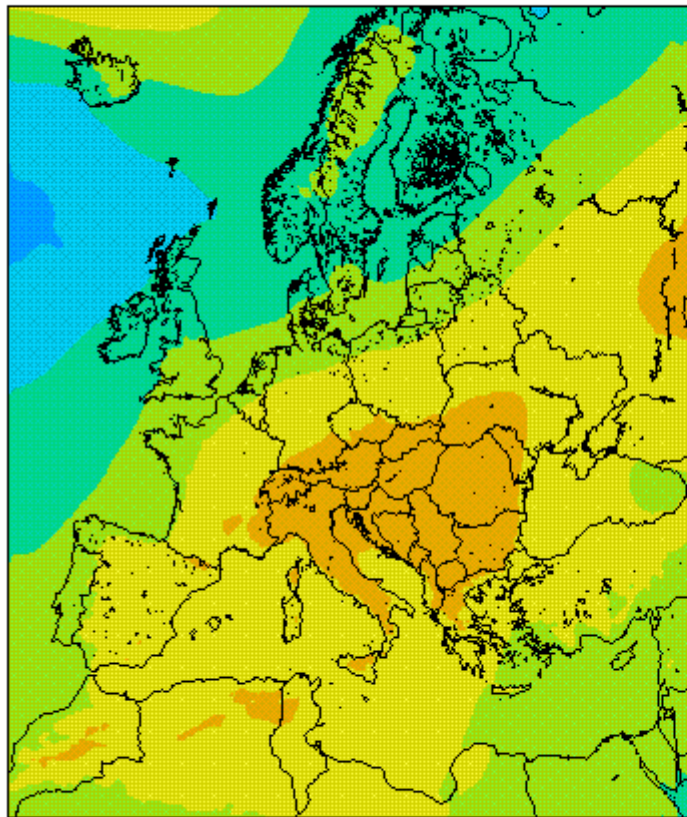
-3 -2 -1 -0.5 0.5 1 2 3  
min=-3.17719 max=3.44659 ave=0.731305



# Distribution of surface level pressure in LME and GME

October 2006 00UTC pmsl (hPa) vv=72

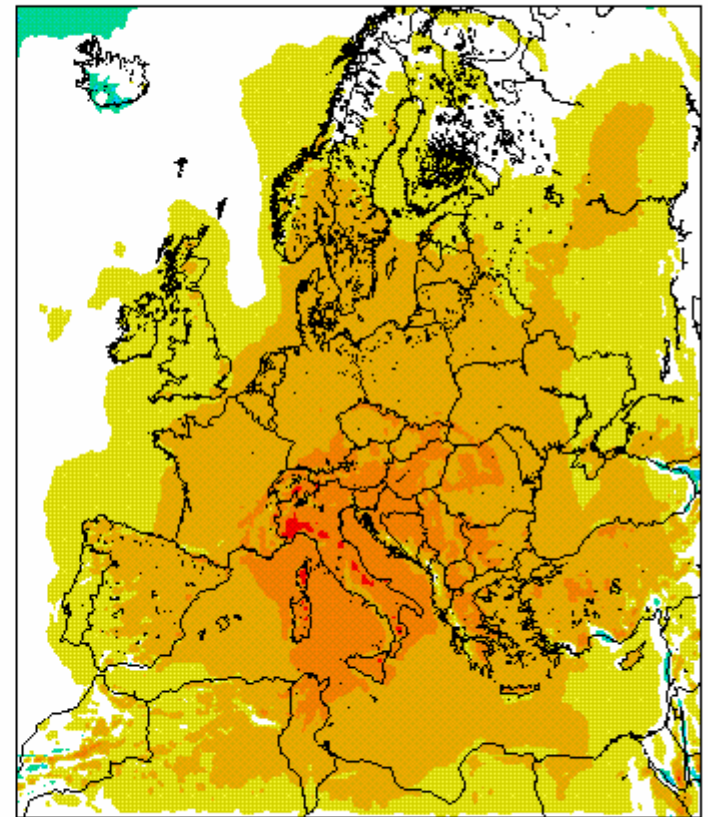
LME



996 1000 1004 1008 1012 1016 1020 1024 1028

min=1003.33 max=1023.7 ave=1018.05

LME-GME



-3 -2 -1 -0.5 0.5 1 2 3

min=-3.16504 max=3.75598 ave=0.929271

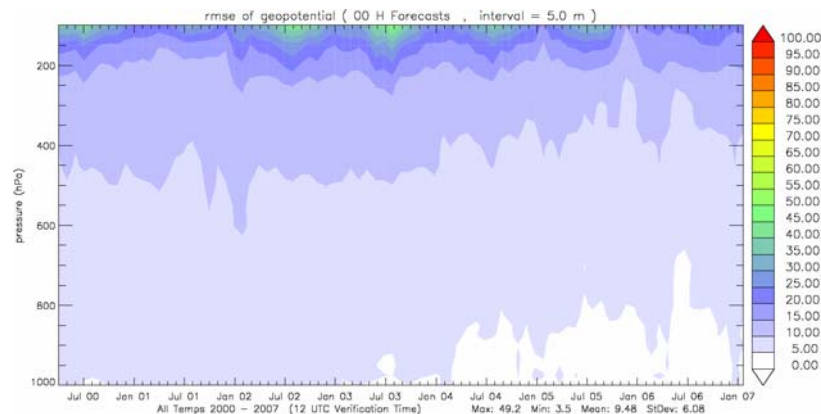
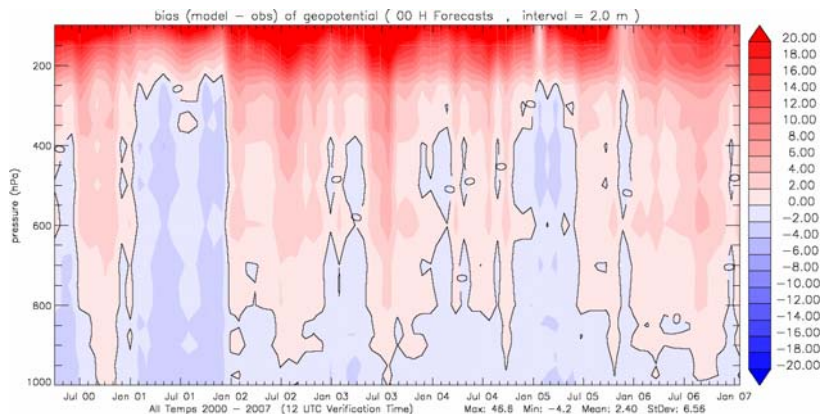




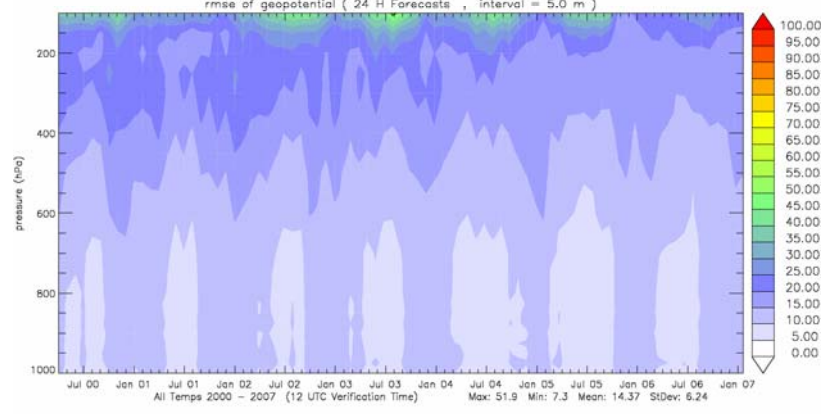
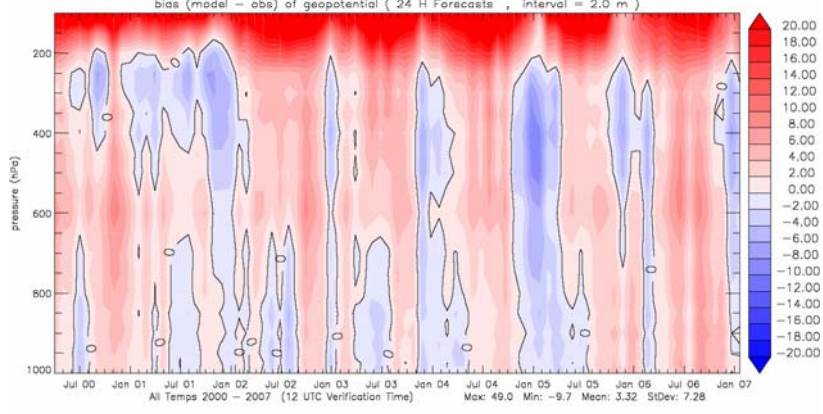
# BIAS Geopotential

# RMSE

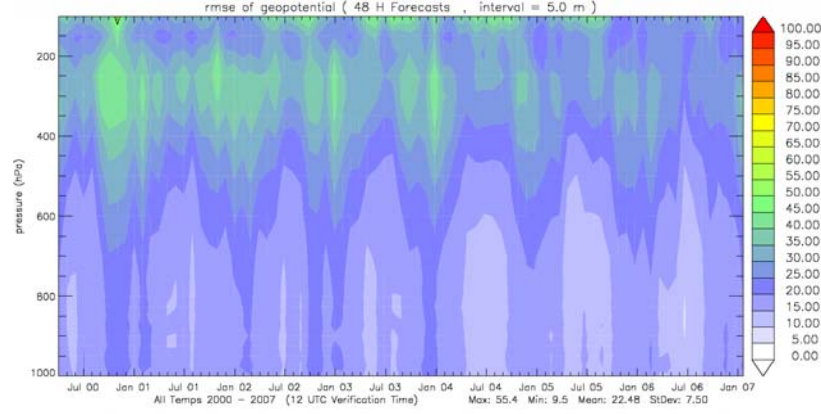
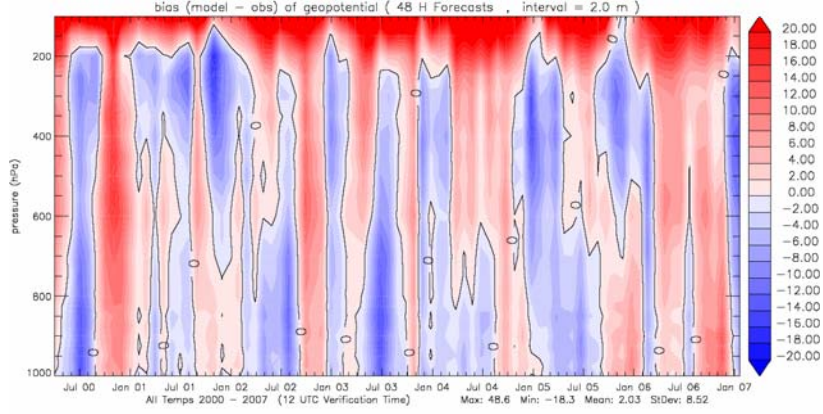
## 00 H



## 24 H



## 48 H



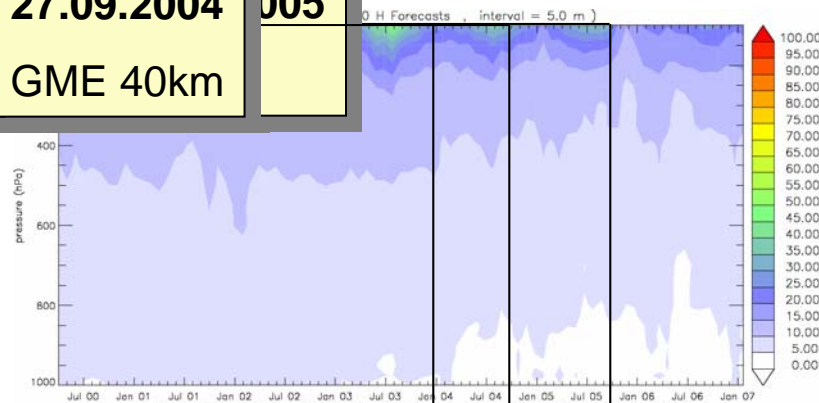
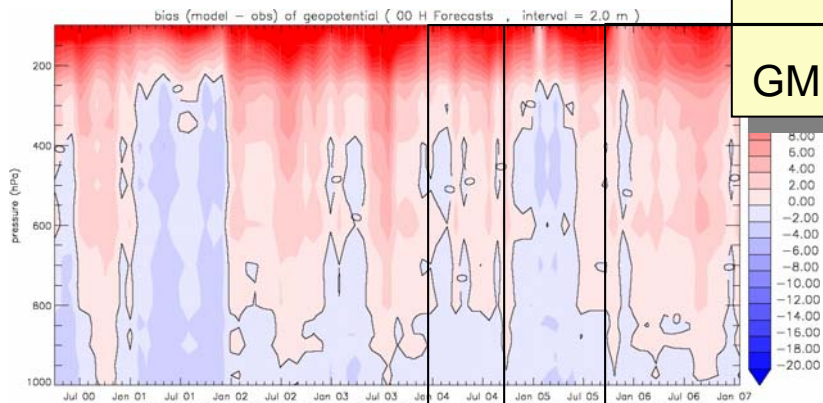


# BIAS Geopotential

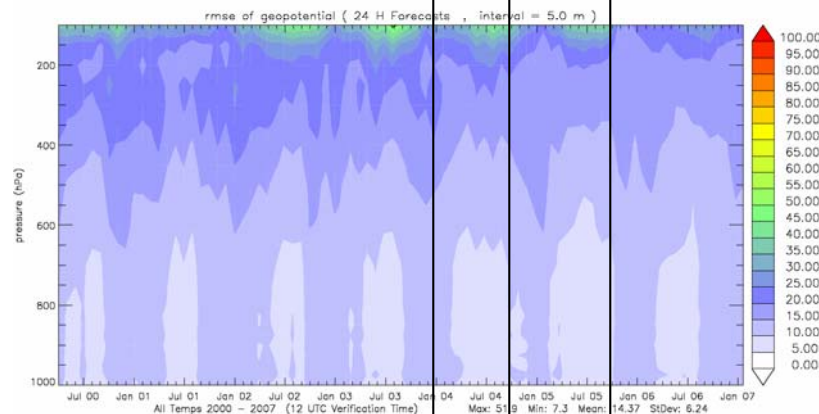
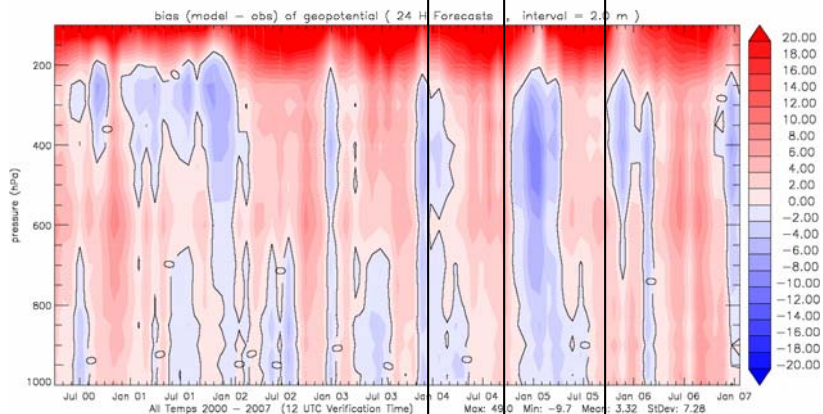
# RMSE

17.	27.09.2004	005
GME P	GME 40km	

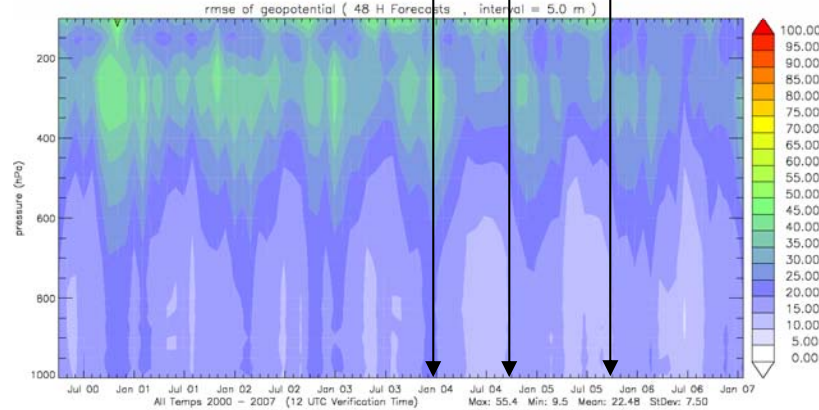
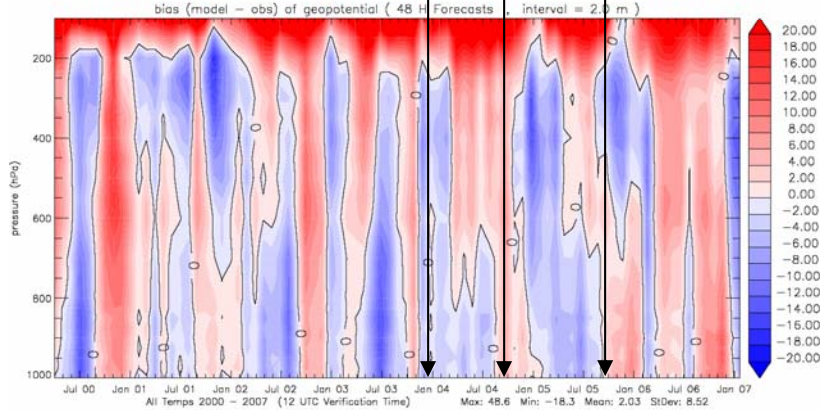
## 00 H



## 24 H



## 48 H



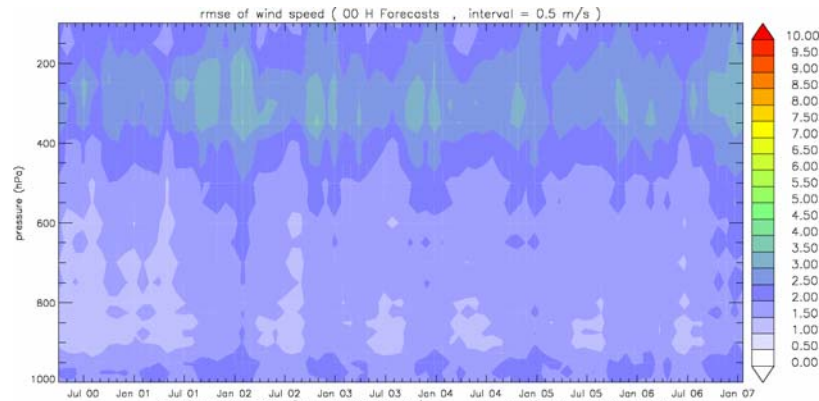
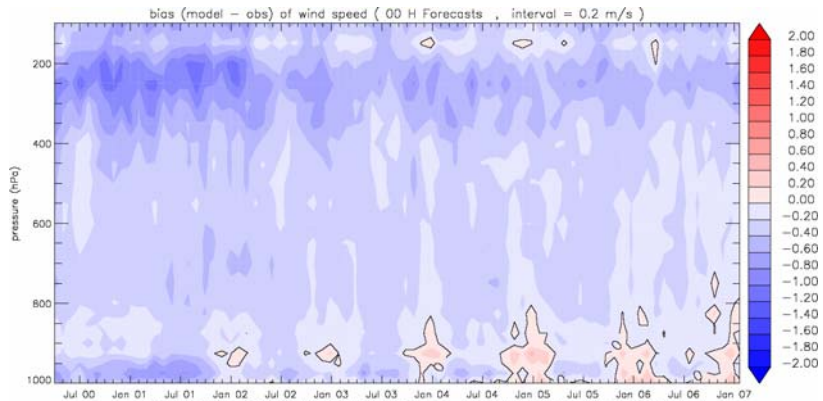


# BIAS

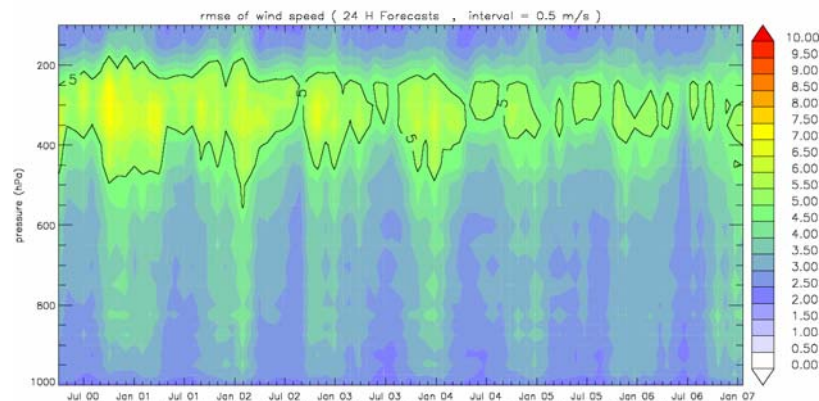
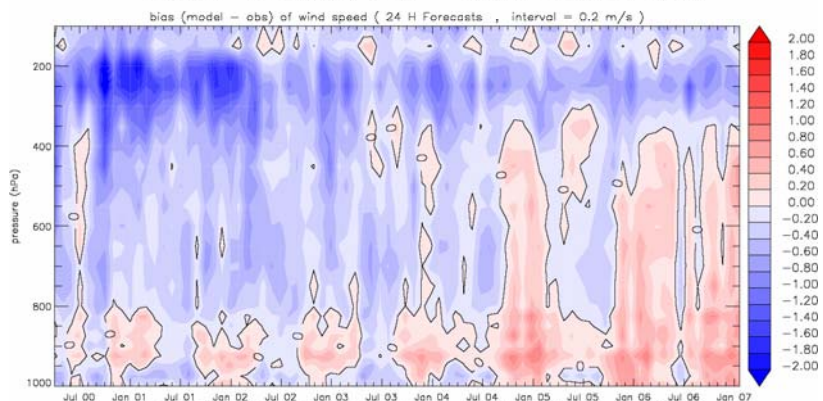
# Windspeed

# RMSE

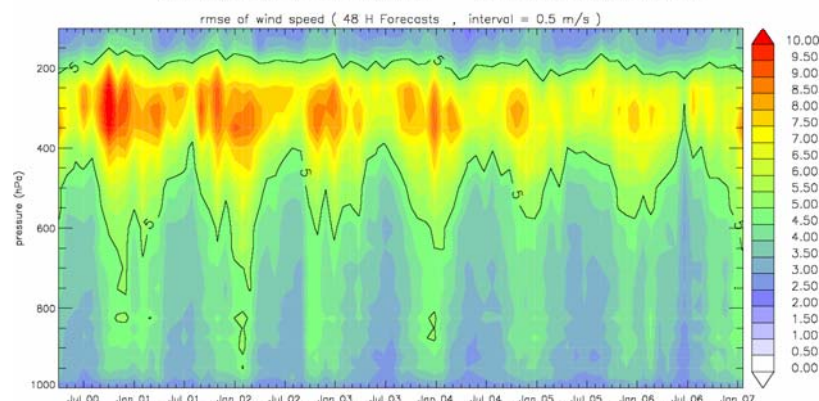
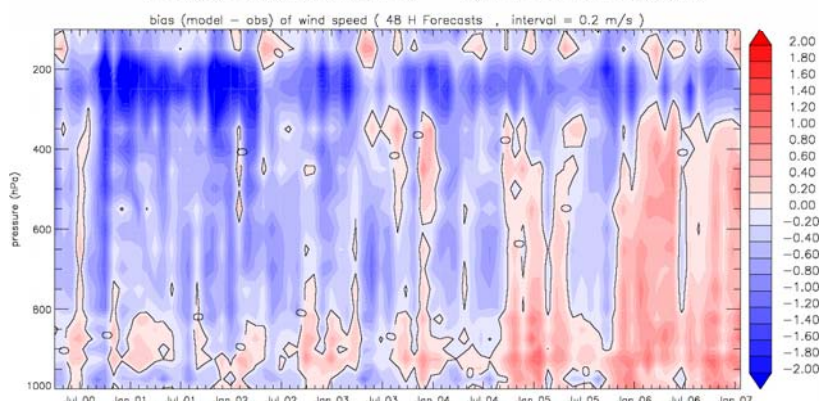
## 00 H



## 24 H



## 48 H





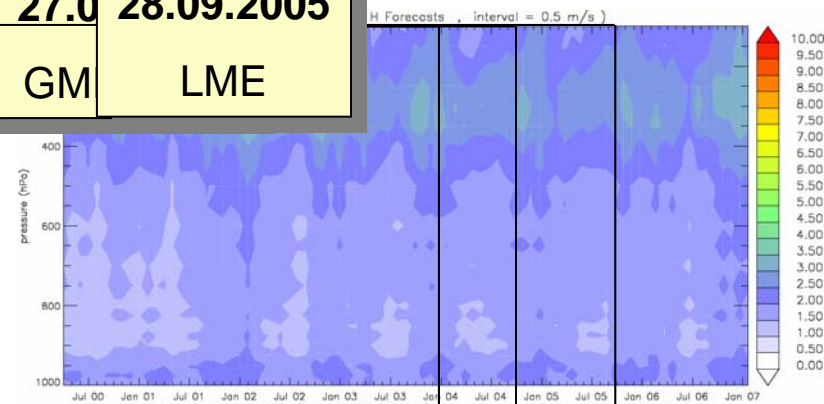
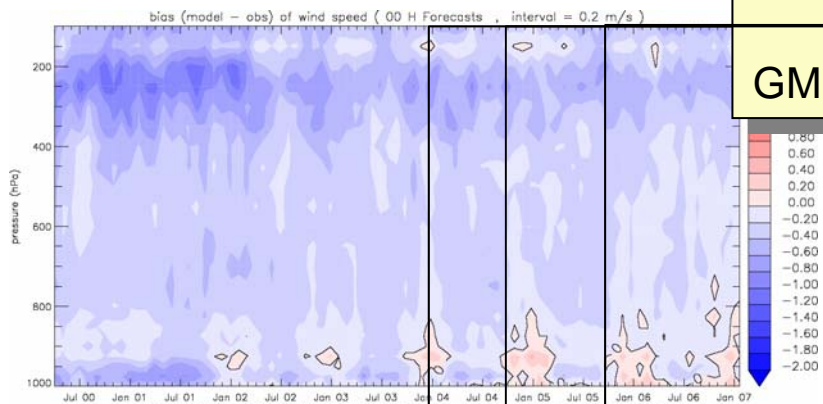
# BIAS

# Windspeed

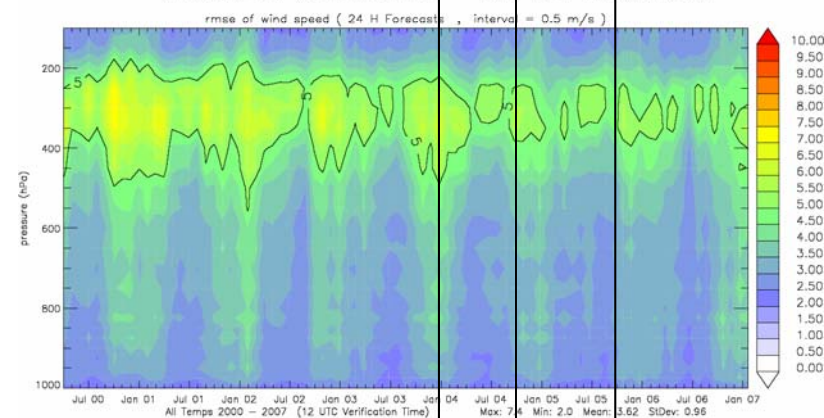
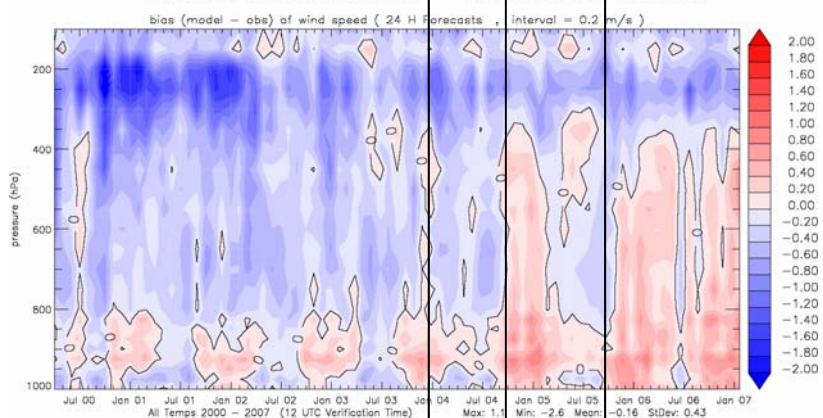
# RMSE

17	27.0	28.09.2005
GME P	GM	LME

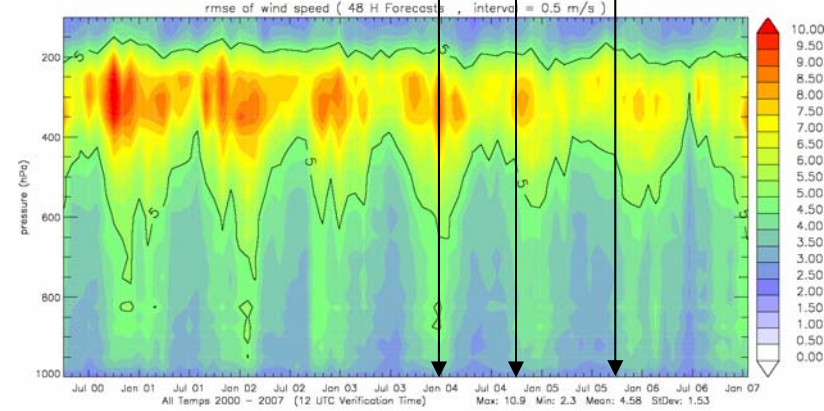
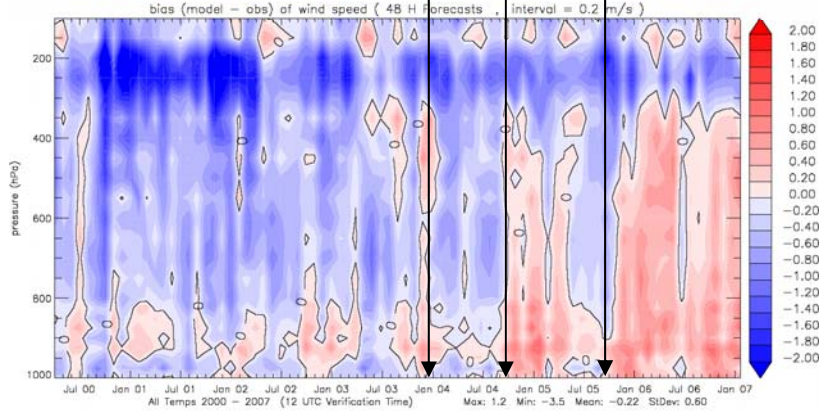
00 H



24 H



48 H



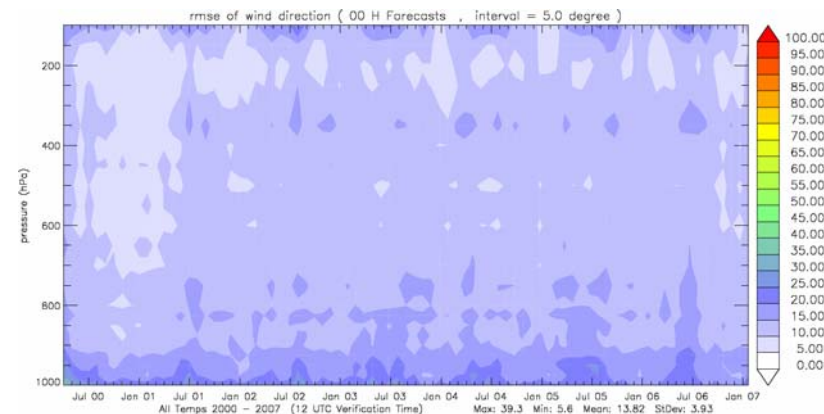
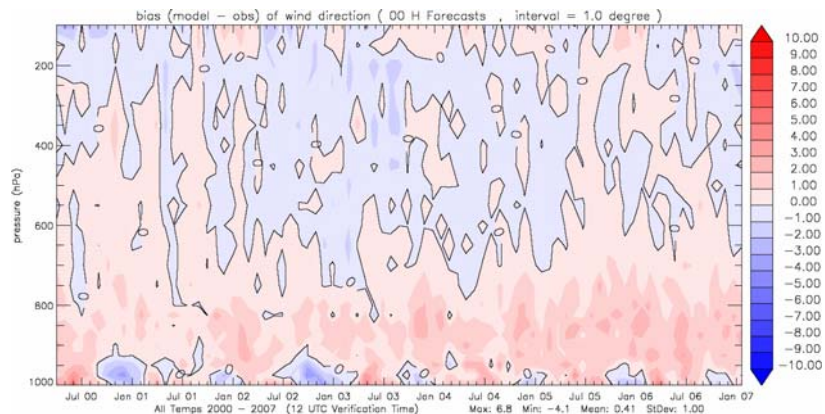


# BIAS

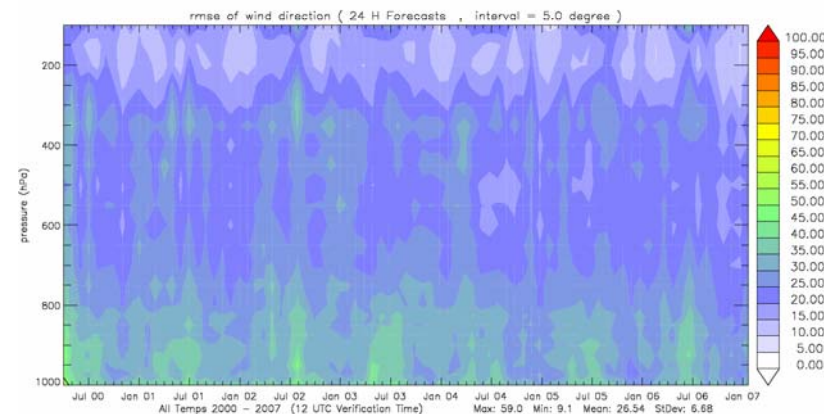
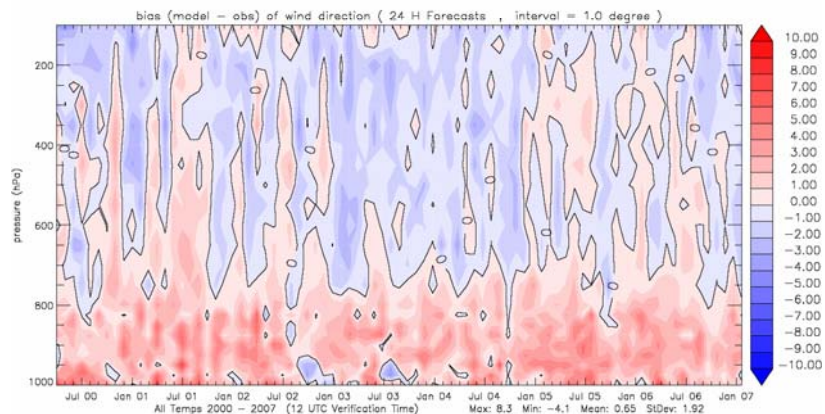
# Winddirection

# RMSE

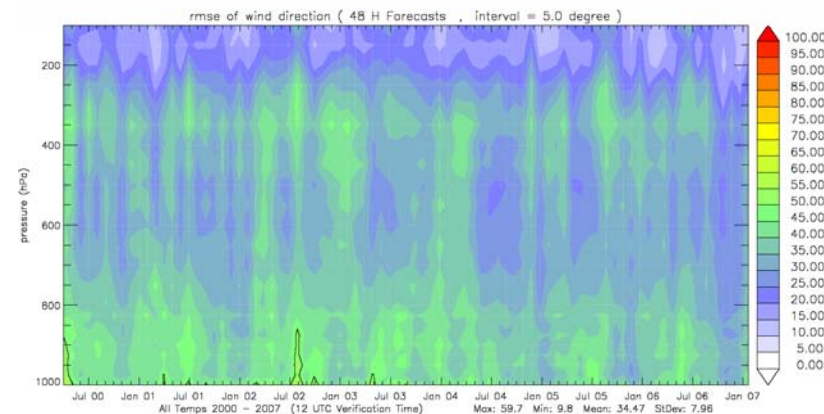
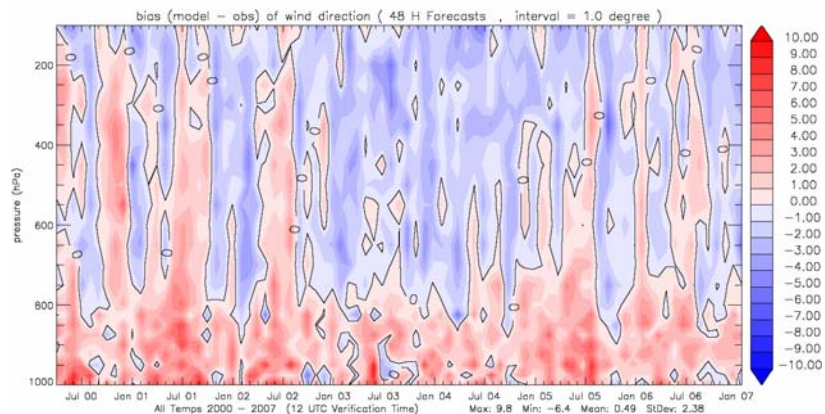
## 00 H



## 24 H



## 48 H



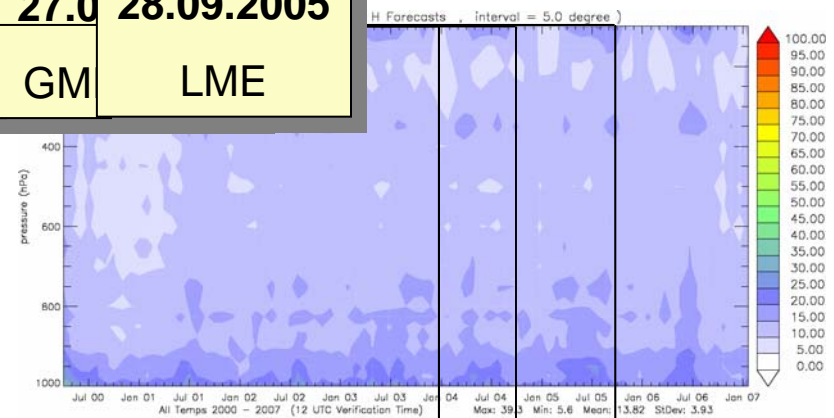
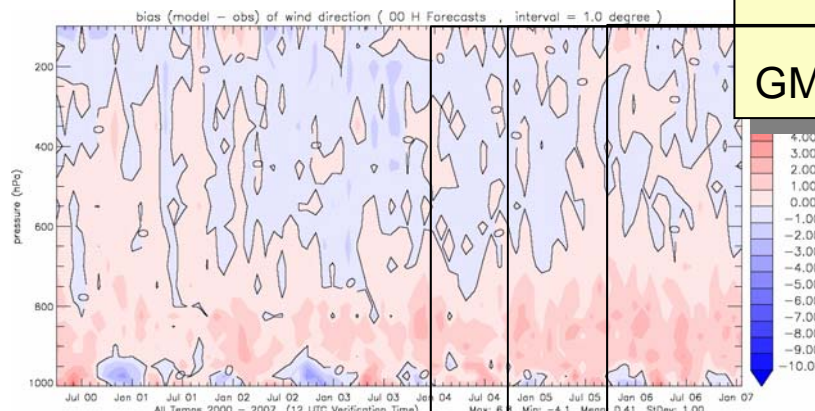


# BIAS Winddirection

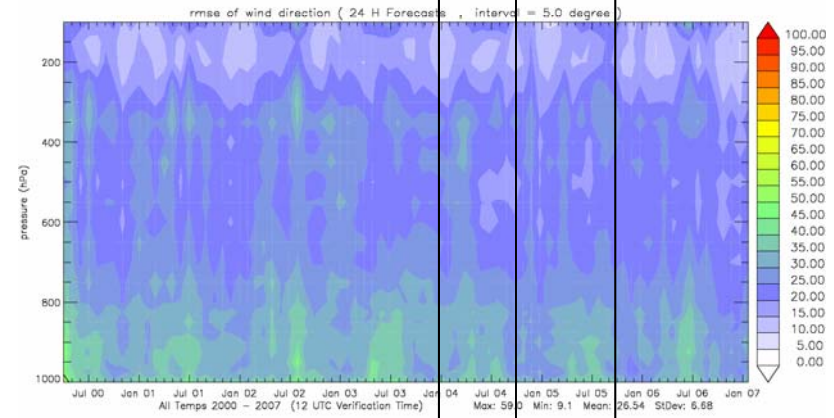
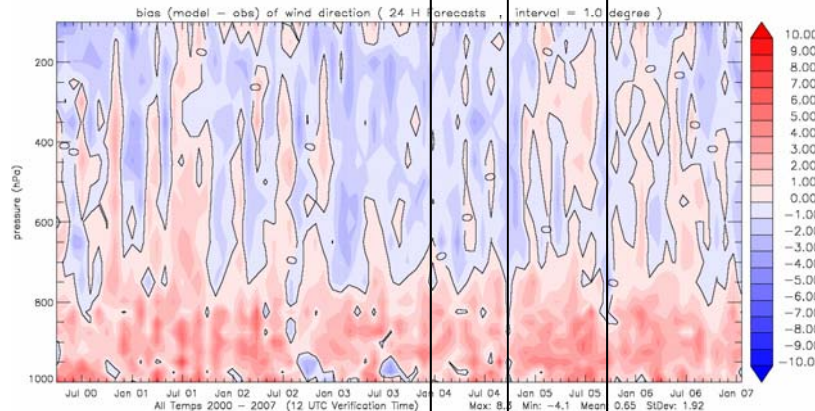
# RMSE

17	27.0	28.09.2005
GME P	GM	LME

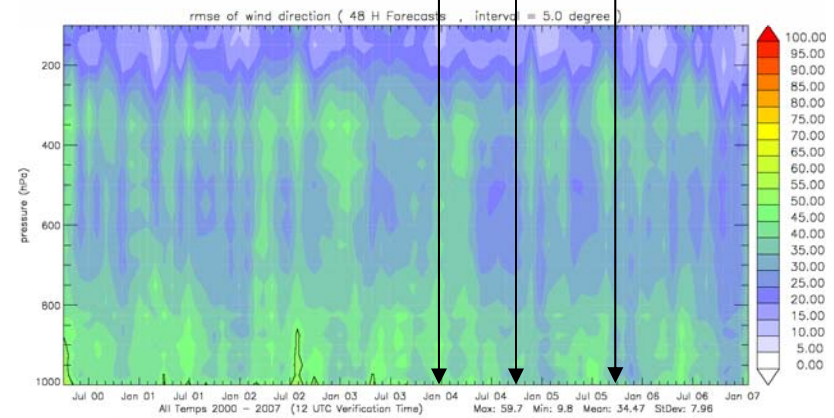
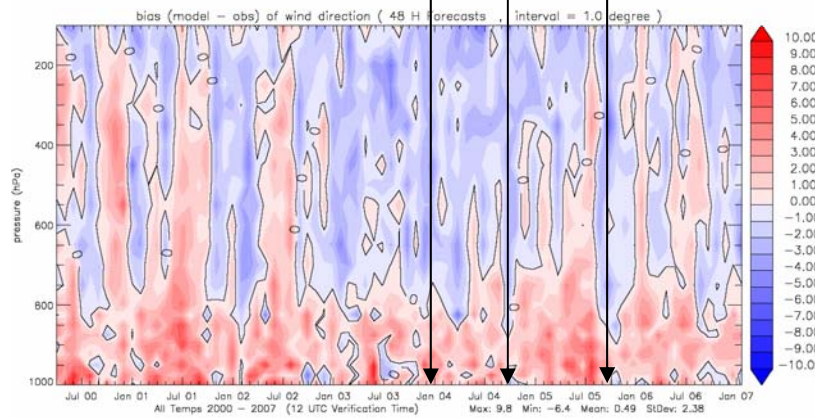
00 H



24 H



48 H

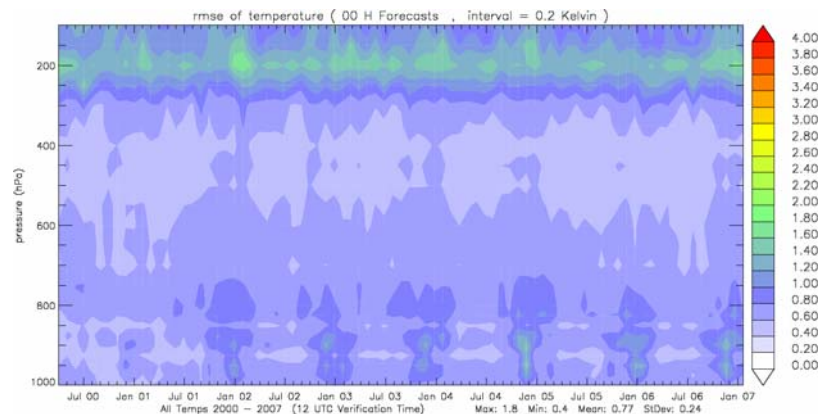
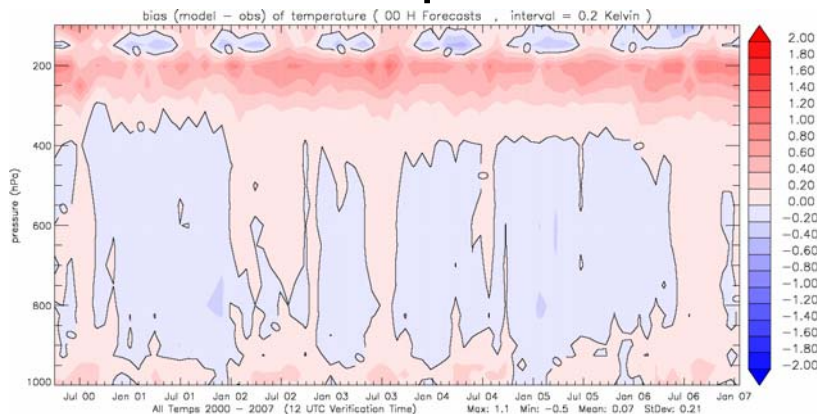




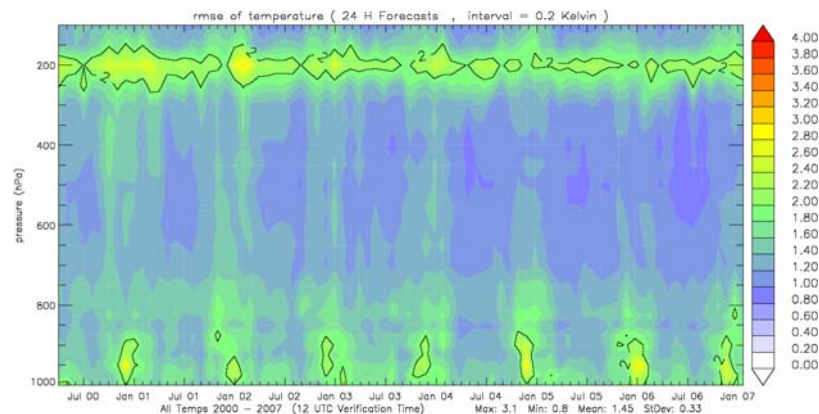
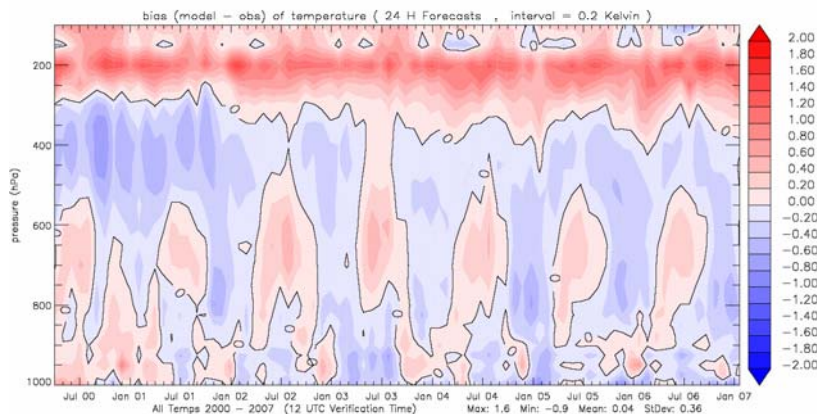
# BIAS Temperature

# RMSE

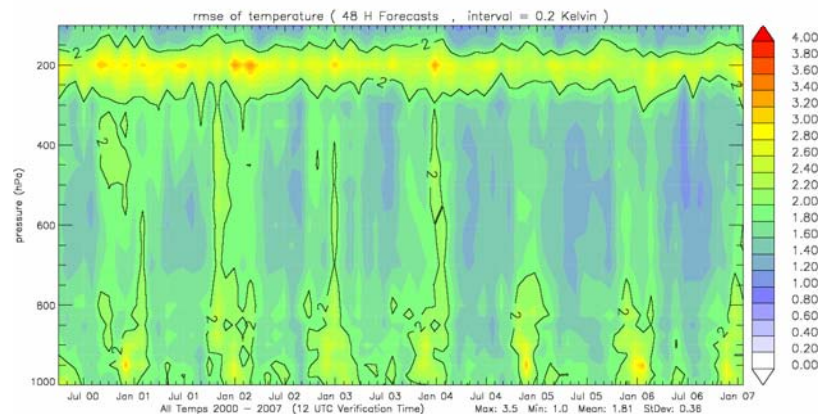
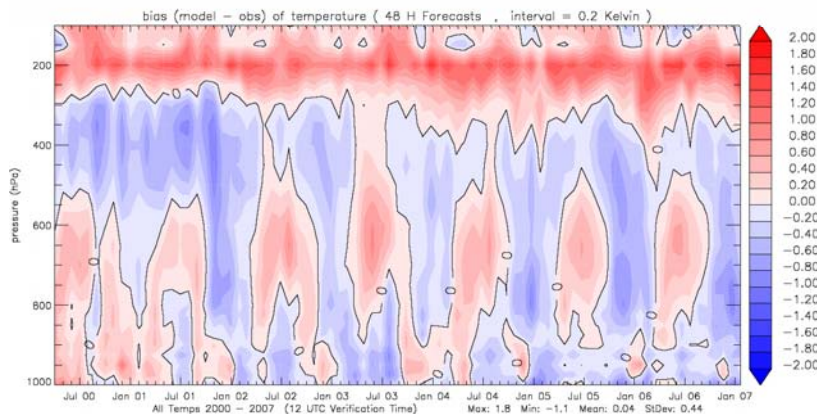
## 00 H



## 24 H



## 48 H



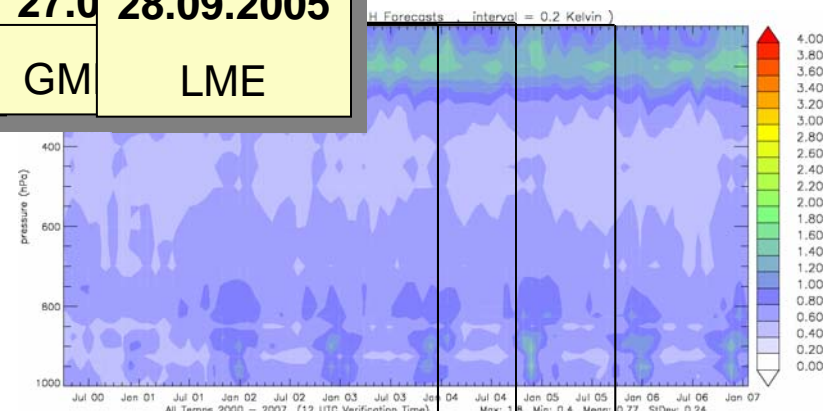
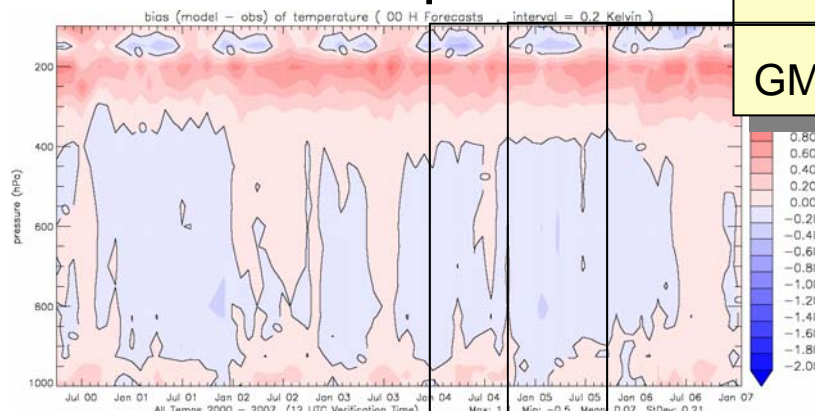


# BIAS Temperature

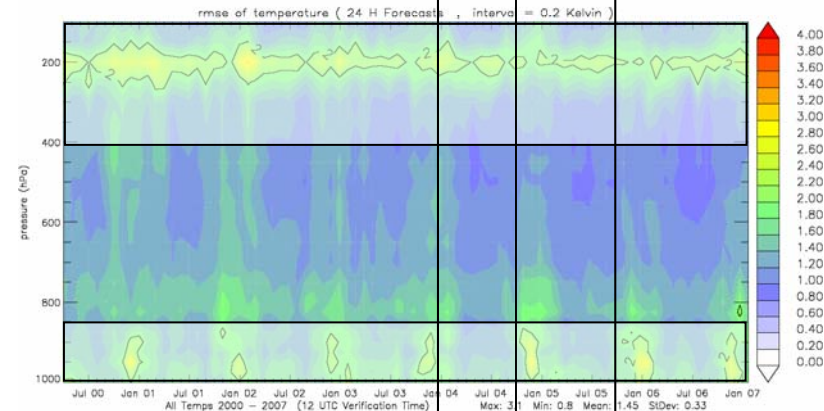
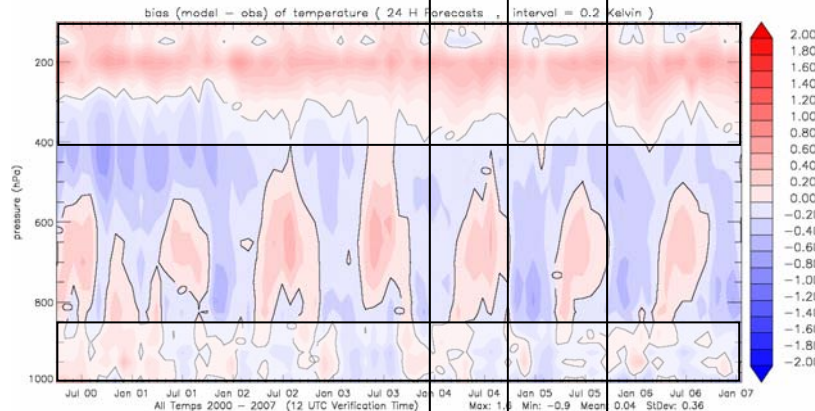
17	27.0	28.09.2005
GME P	GM	LME

# RMSE

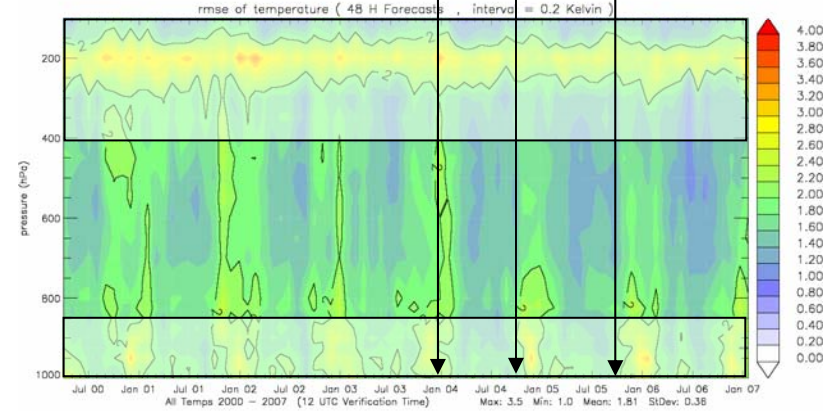
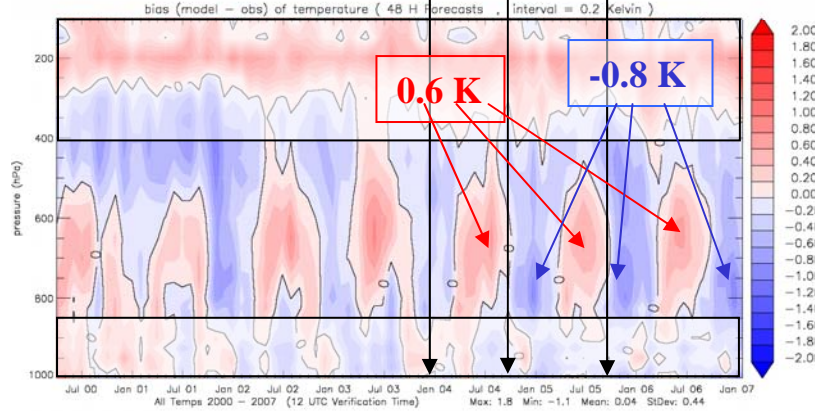
00 H



24 H



48 H

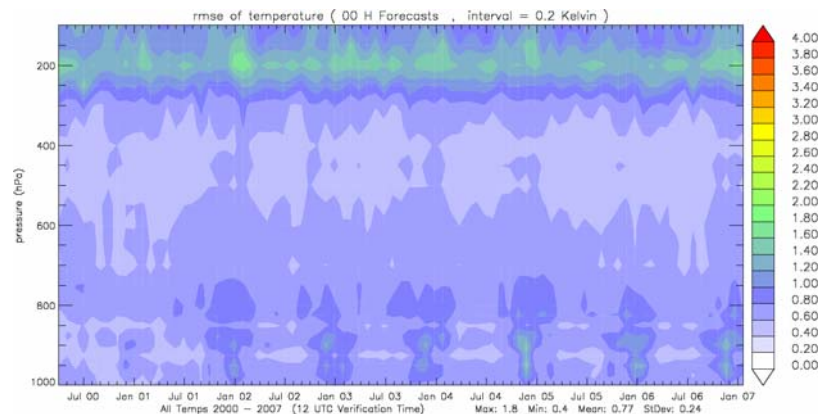
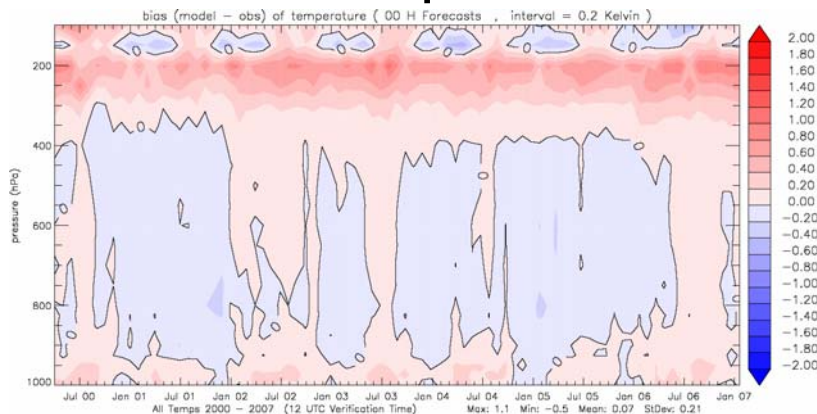




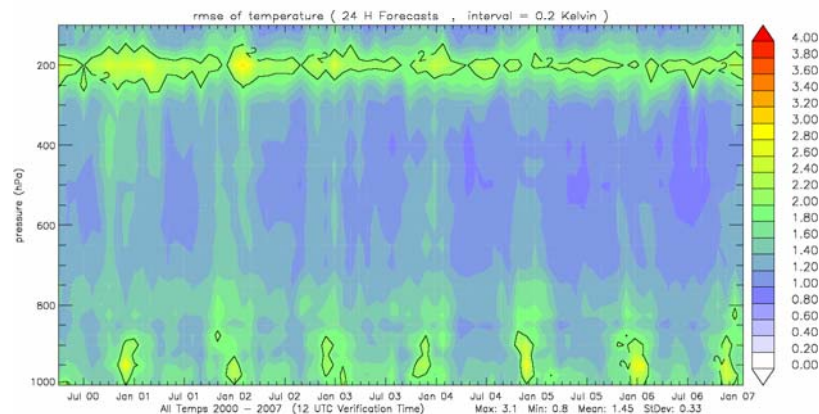
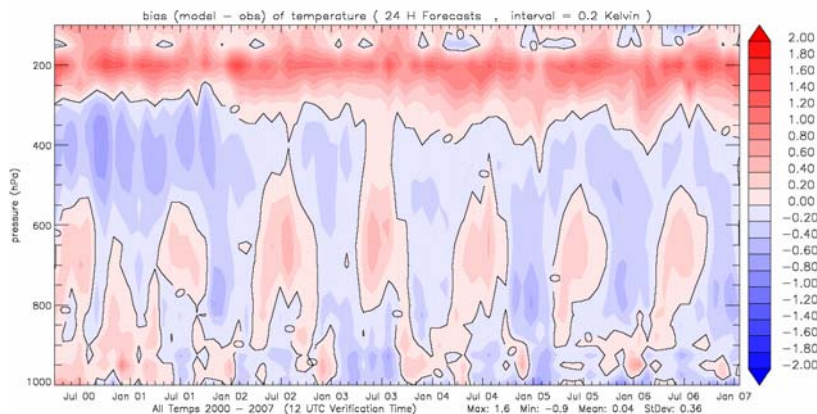
# BIAS Temperature

# RMSE

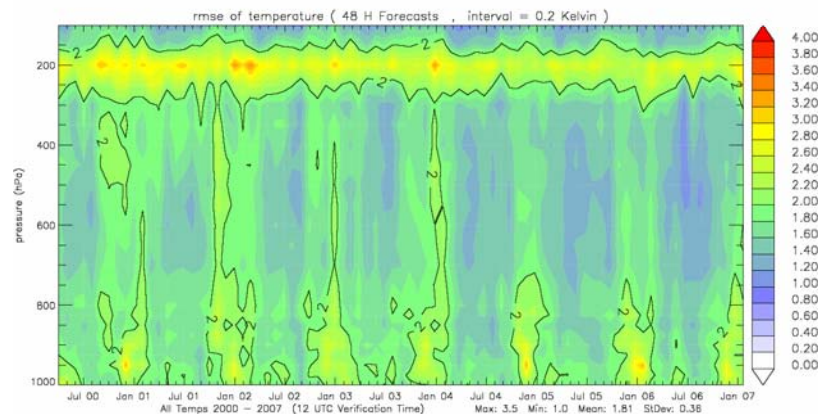
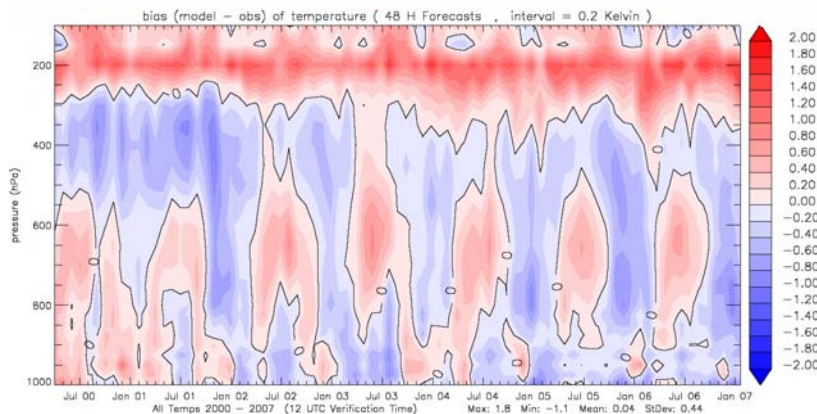
## 00 H



## 24 H



## 48 H



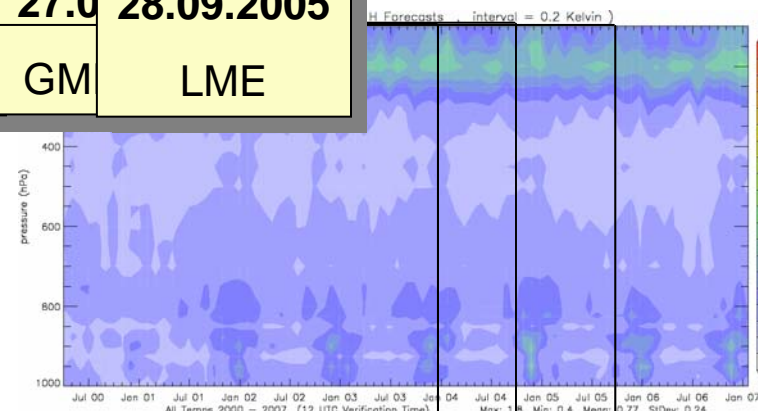
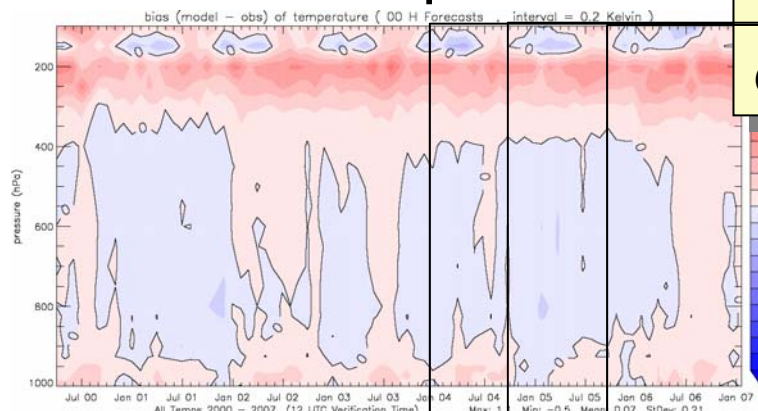


# BIAS Temperature

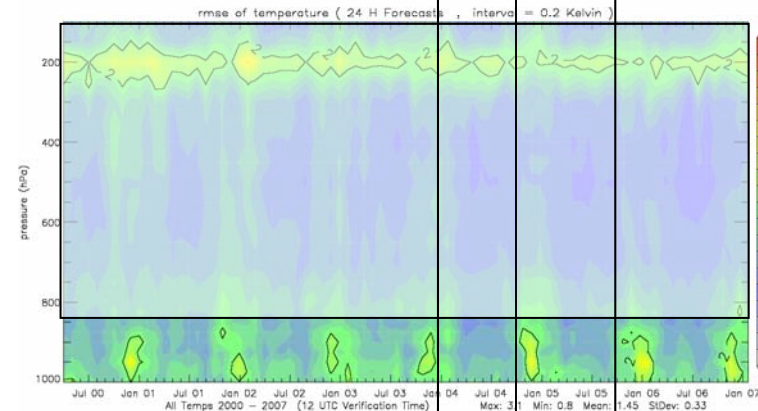
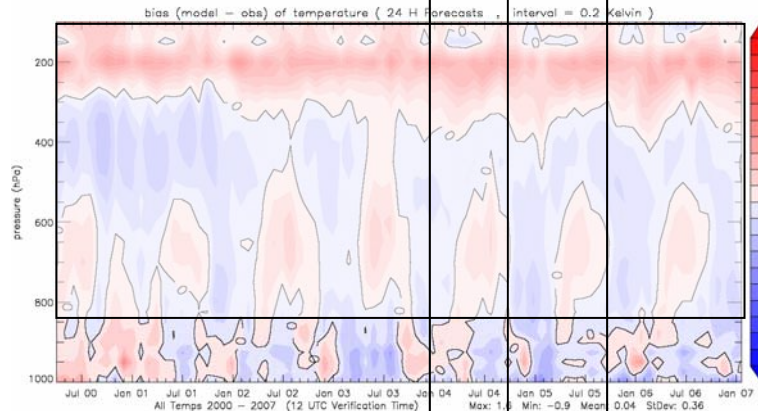
# RMSE

17	27.0	28.09.2005
GME P	GM	LME

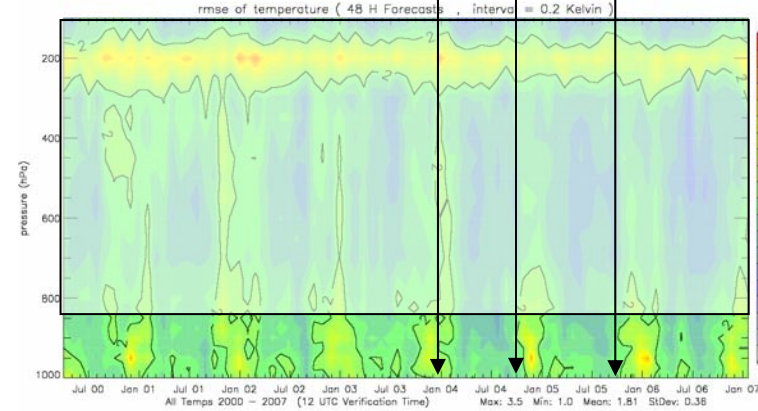
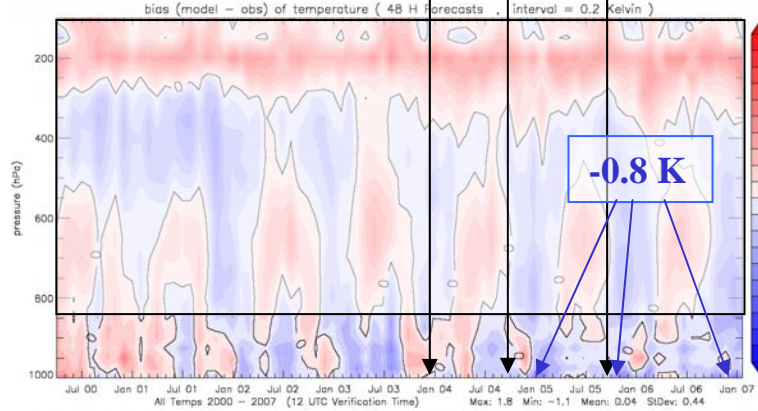
00 H



24 H



48 H

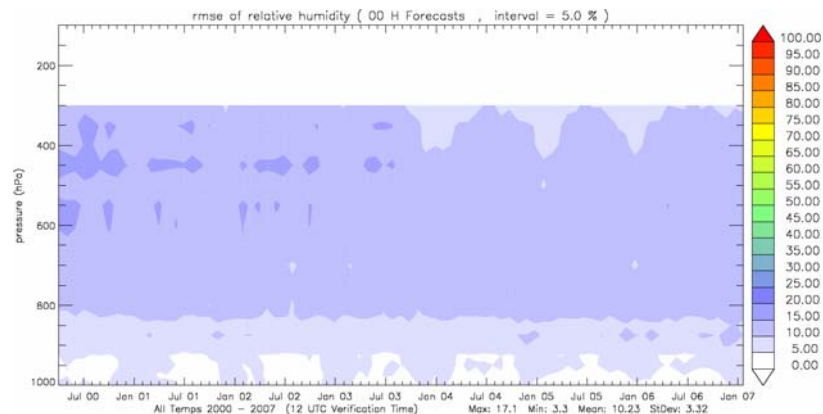
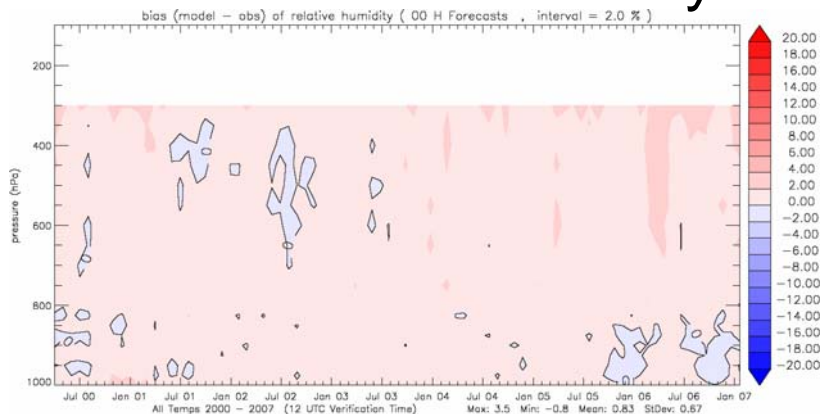




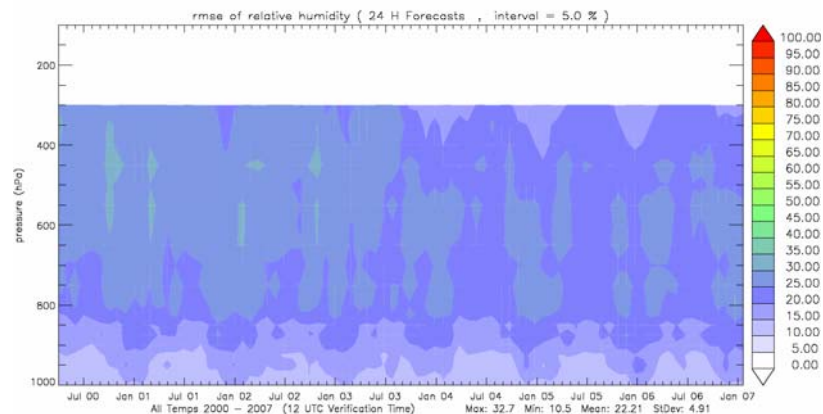
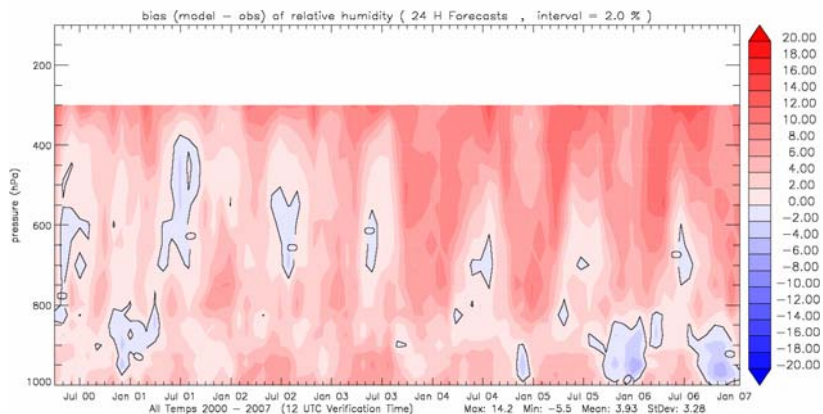
# BIAS Relative Humidity

# RMSE

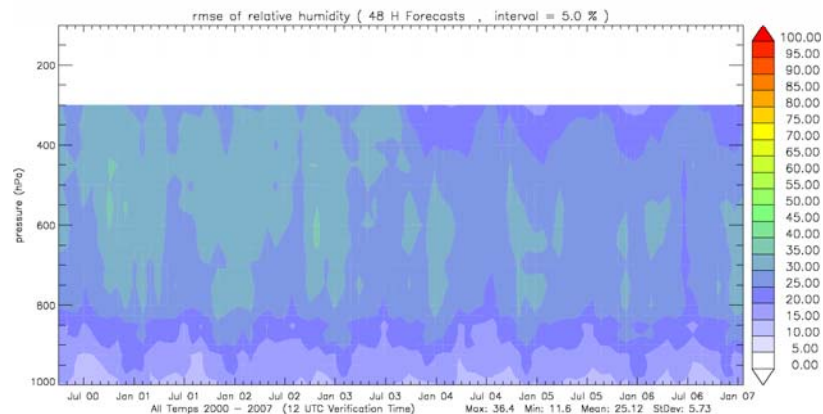
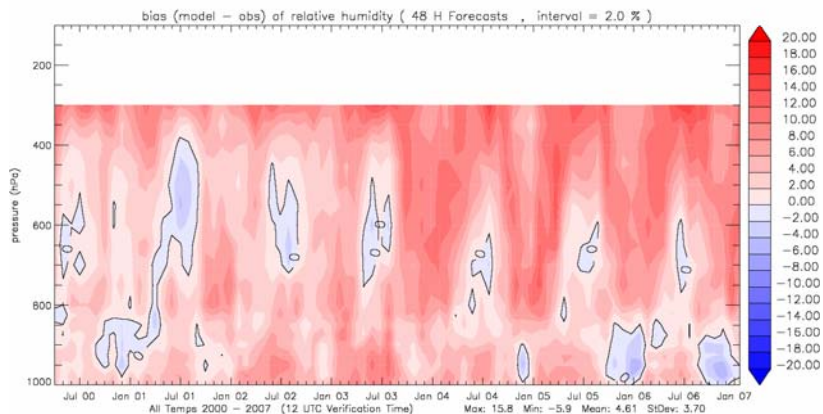
00 H



24 H



48 H





# BIAS Relative Humidity

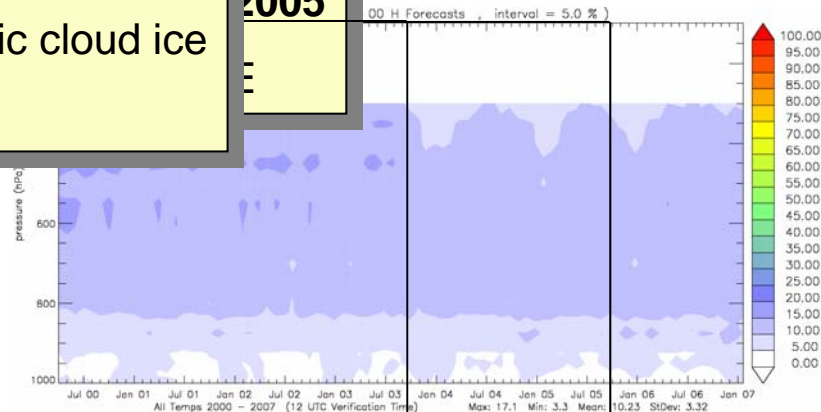
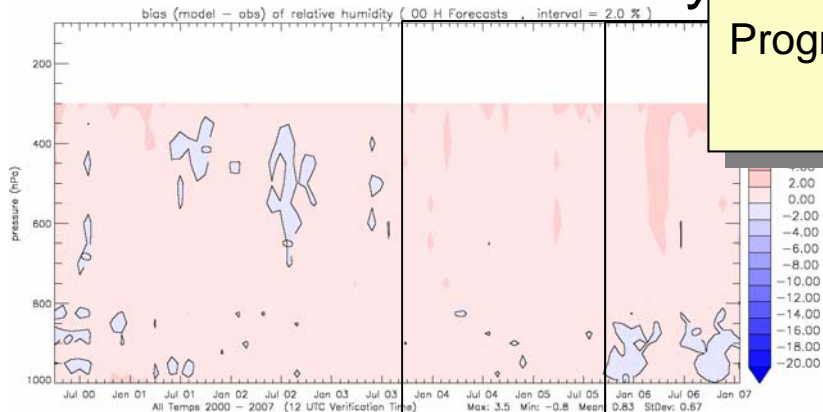
16.09.2003

RMSE

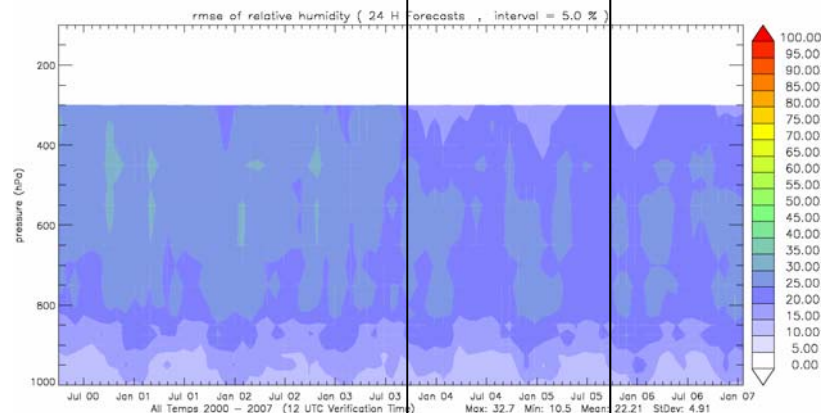
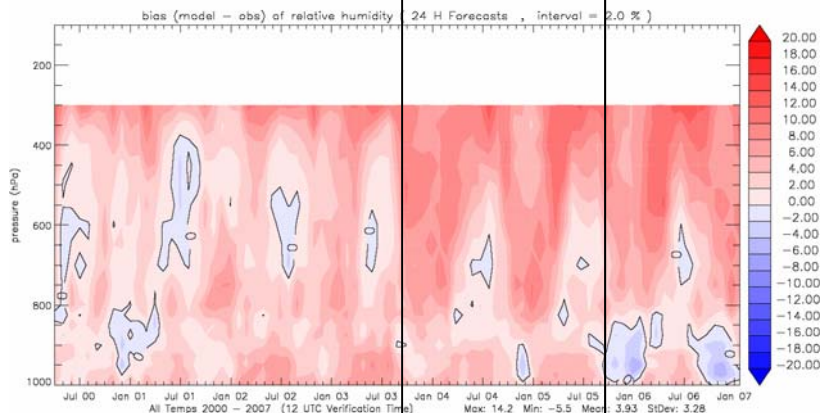
Prognostic cloud ice

2005

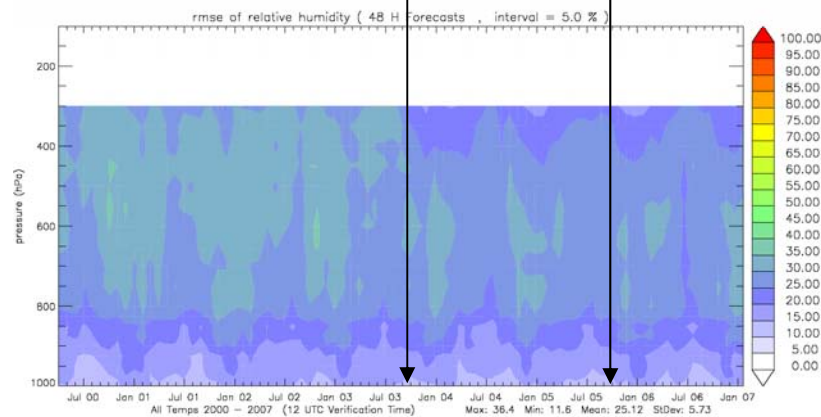
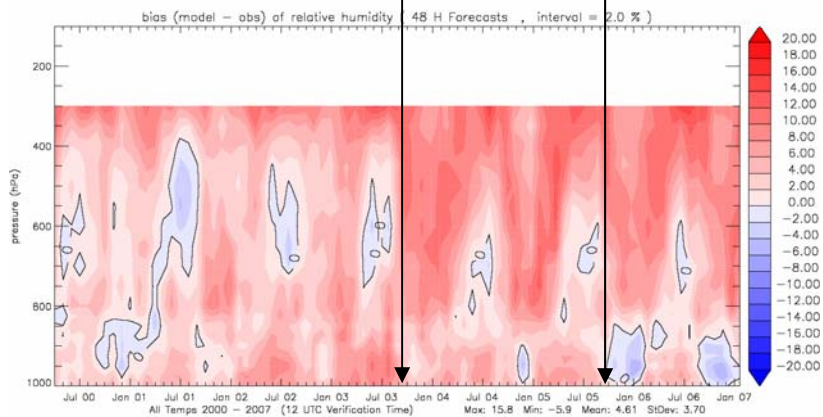
00 H






24 H



48 H



# Upper atmosphere (1)

- **Relative Humidity** 
  - **since Implementation of prognostic cloud ice a positive BIAS during winter is existing**
  - **but also a reduction of RMSE**
- **Temperature between 850 hpa und 400 hPa** 
  - **Seasonal change of BIAS, positive in summer (up to 0.6 K), negativ in winter (down to -0.8K),**
  - **slight reduction of RMSE**
- **Temperature in Boundary Layer** 
  - **since 2005: negative BIAS (down to -0.8 K) in winter near ground, less above and in summer half**
  - **slight reduction of RMSE**

# Upper atmosphere (2)

- **Windspeed**

- **Change of a more negative BIAS in LM to a more positive BIAS in LME by now**
- **reduced RMSE beginning with 2004 compared to the start of LM-era**



- **Winddirection**

- **reduced RMSE beginning with 2004 compared to the start of LM-era**



- **Geopotential**

- **Reduced RMSE of geopotential during last years compared to the start of LM-era**



