An overview of the assimilation of AIRS and IASI Radiances at operational NWP Centres

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If I missed you out I’m really sorry!

Summary of Operational Status in Global Models

Operational Now **Experimental**

- **AIRS:**
  - **ECMWF, Met Office, Météo-France, NCEP, Environment Canada, Naval Research Lab, Bureau of Meteorology**
  - **Japan Met. Agency, China Met. Admin., CPTEC/INPE**
- **IASI**
  - **ECMWF, Met Office, Météo-France, NCEP, Naval Research Lab**
  - **Environment Canada, Bureau of Meteorology, Japan Met. Agency, China Met. Admin.**

Summary of Operational Status in Limited Area Models

Operational Now **Experimental**

- **AIRS:**
  - **Met Office (NAE), Météo-France (ALADIN+AROME), NCEP**
  - **Met Office (UKVD), Met.no**
- **IASI**
  - **Met Office (NAE), Météo-France (ALADIN+AROME)**
  - **Met Office (UKVD), NCEP, Met.no, Deutscher Wetterdienst**

Summary of IASI Data Usage in Global Models

Operational

Being tested

Centre	Model Resolution/Top/ Assim. Method	Max # Chans	Max # H_2O chans/obs error	Land surface sensitive channels?	Use Cloud affected channels?
ECMWF	15km / 0.01hPa 4DVar	175	10 / 1.5K	No	Some cloudy scenes
Met Office	25km / 80km 4DVar	183	32 / 4K	No	Cloudy FOVs
Météo-France	10-60km / 0.1hPa 4DVar	77	9 / 4K	No	Above Cloud Cloudy FOVs
NCEP	35km / 0.27hPa 3DVar	165	20/1.5K	No	Above cloud
Environment Canada	33km / 0.1hPa 4DVar	150	66/2K	No	Above cloud
Naval Research Lab	55km / 0.4hPa 4DVar	39	--	No	Above Cloud
Japan Met. Agency	20km/0.1hPa 4DVar	82	--	No	Above cloud
Bureau of Meteorology	80km/L50/ 4DVar	138	31/4	No	Cloudy FOVs

Summary of IASI Data Usage in Local Area Models

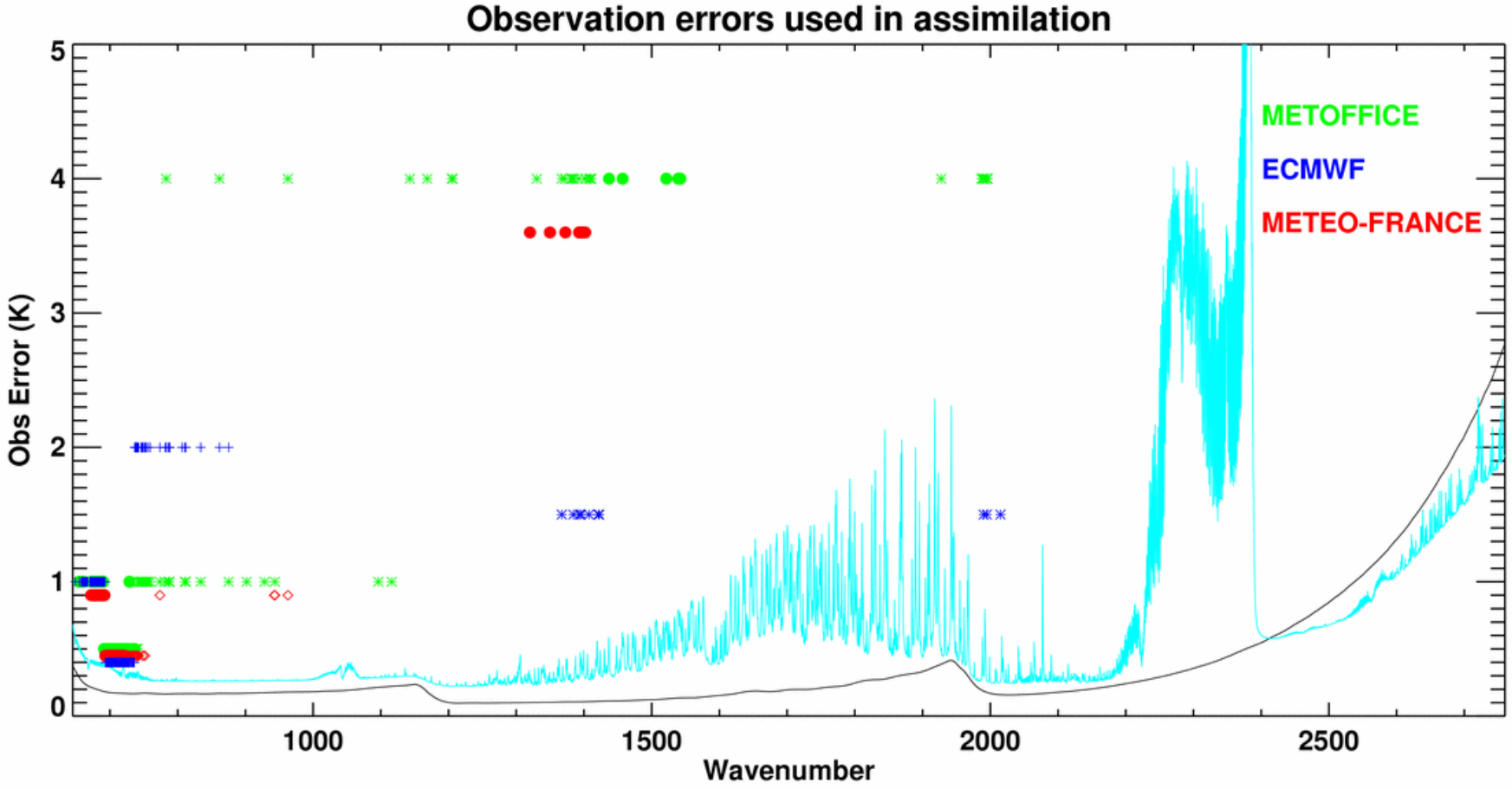
Operational

Being tested

Centre	Model Resolution/Top/ Domain / Assim Method	Max # Chans	Max # H_2O chans/obs error	Land surface sensitive channels?	Use Cloud affected channels?
Met Office NAE	12km / 39km / N.Atl+Europe 4DVar	183	32 / 4K	No	Cloudy FOVs
Met Office UKVD	1.5km / 40km / U.K./ 3DVar	183	32 / 4K	No	Cloudy FOVs
Météo-France ALADIN	7.5km / 0.1hPa / W.Europe / 3Dvar	77	9 / 4K	No	Above Cloud Cloudy FOVs
Météo-France AROME	2.5km / 1hPa / France / 3DVar	77	9 / 4K	No	Above Cloud Cloudy FOVs
DWD COSMO-EU	7km / 20hPa / Europe / Nudging	200	71/1c Noise*	Yes?	Above cloud
Met.no HARMONIE	11-16km/0.2hPa/ N.Pole+Europe / 3DVar	41	--	No	Above Cloud

*1DVar

Observation Errors – Global Models (Europe)



Use over Land

- **Channel selection is usually restricted over land and sea-ice, or depends on quality control to reject observations**
- **No centre is assimilating channels sensitive to the land surface (at least not on purpose) …**
- **… but there is a lot of interest in doing so.**

Humidity assimilation

- **Some centres have demonstrated positive impact from assimilating H2O channels (with reduced weight) to the analysis and 1-2 day forecast**

- **NWP models have a hard time keeping impact of assimilation after 1-2 days.**

Humidity assimilation error sources

- **Ambiguity with humidity Jacobians - the water vapor (WV) channels have strong sensitivity to humidity and temperature**
- **Representivity error (from the mismatch in scales between the analysis fields and the FOV size) may be important (Bormann talk)**
- **Large biases in the NWP model fields.**
- **Biases in the observations (including errors from bias correction and QC)**
  - **Bias correction algorithms remove this bias.**
  - **Variational bias correction algorithms need to have suitable anchoring observations.**
- **Above issues are mitigated through inflated observation errors; reduced number of channels and tight QC**
  - **NCEP use tight QC (~1K) but increase data useage through re-evaluation of QC every outer loop.**

Assimilation of Cloud-affected radiances

- **Cloud can be treated in five ways:**
  - **1) Avoid all FOVs with cloud ("hole hunting")**
  - **2) Only assimilate channels that are insensitive to cloud**
  - **3) Correct the observations to remove the effect of clouds ("cloud-clearing")**
  - **4) Explicitly model the effect of cloud on the radiances either during pre-processing or as a sink variable. But DO NOT assimilate the cloud properties.**
  - **5) Initialise model cloud variables from the cloudy radiances.**

- **Most centres use method 2. An increasing number have implemented method 4.**
- **NCEP had some encouraging results with AIRS cloud-clearing but it has not so far made it to operations.**
- **The "holy-grail" would be #5 but research remains at an early stage.**

- **There is an increasing interest in the use of the AVHRR sub-pixel information supplied in the IASI data stream.**
  - **At least one centre (CMC) use this in their cloud detection system.**

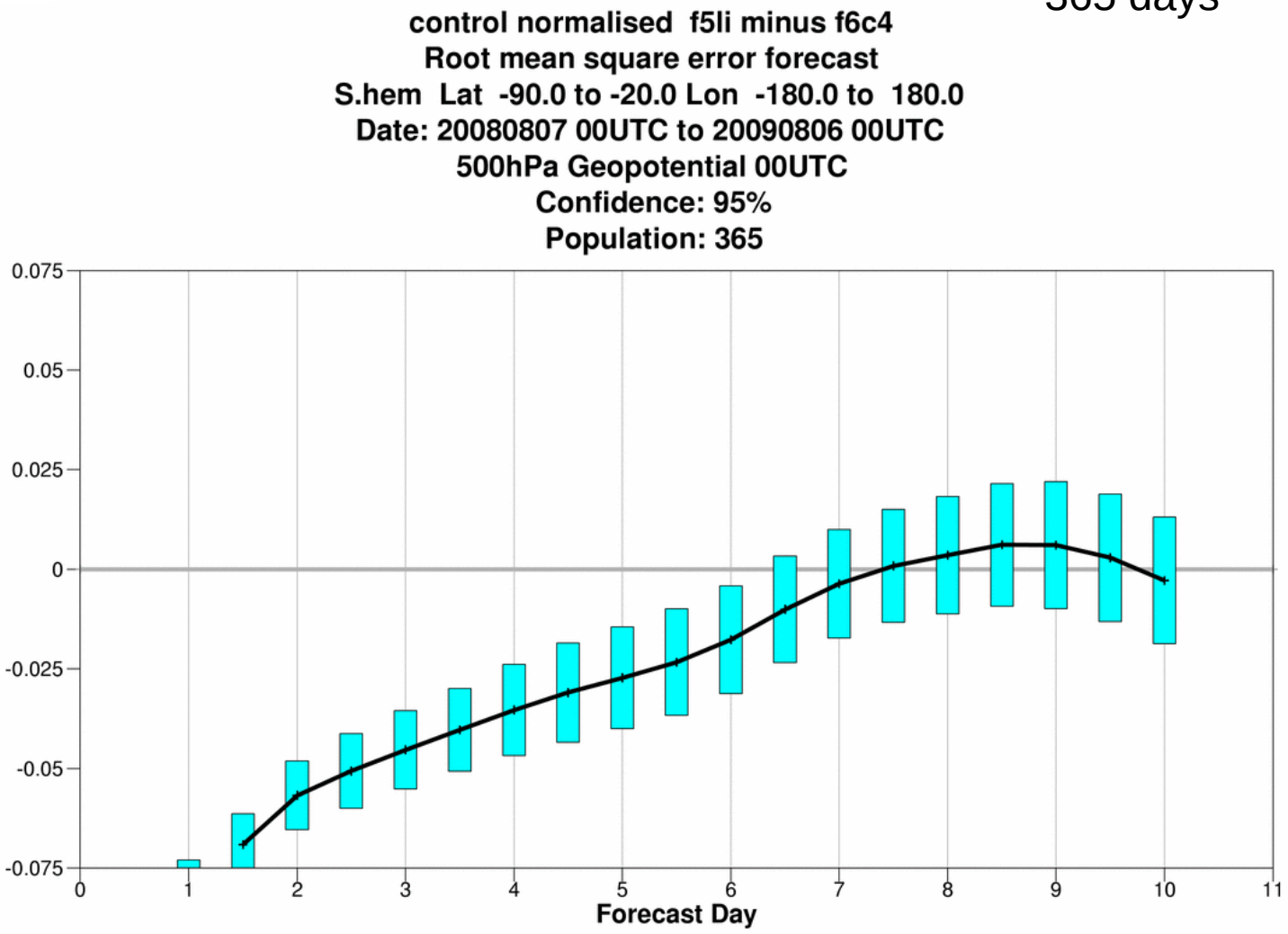
Also…

- **All centres are assimilating radiances apart from DWD's LAM which uses a nudging scheme**
- **All centres heavily thin the data (start with only 1 pixel in 4)**
- **All centres use a channel selection of at most ~200 channels**
- **All centres are using predominantly channels in the long-wave CO_2 band**
- **Height of model top generally restricts usage of high-peaking channels, particularly in LAM**

Forecast Impact

Long period trialling impact ECMWF IASI+AIRS

365 days



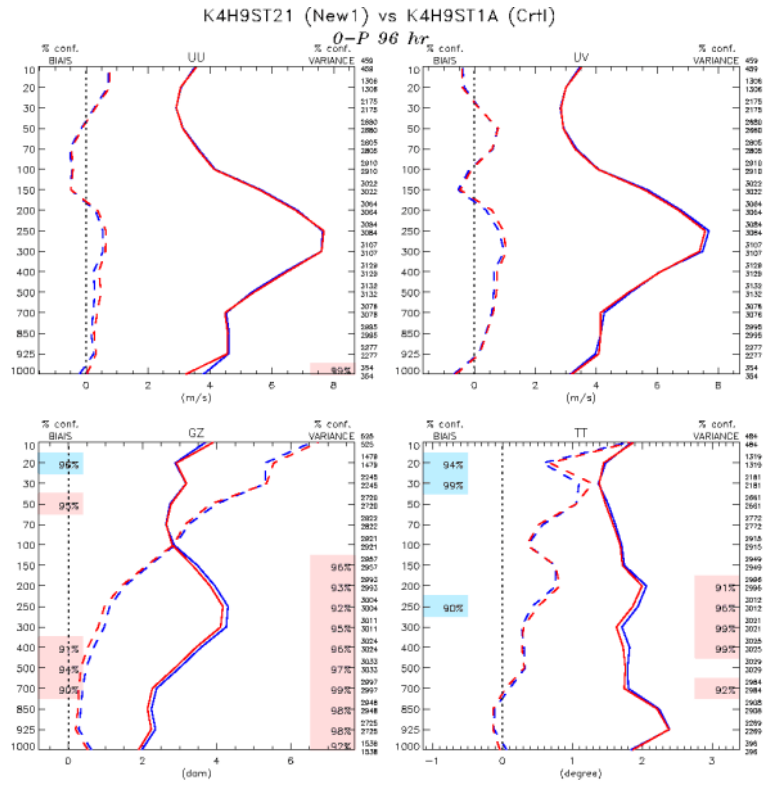
IASI+AIRS improves forecast

Environment Canada | Environnement Canada

Environment Canada – southern hemisphere impact

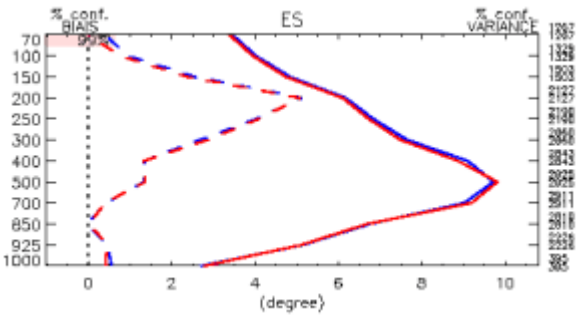
- Validation of forecasts against radiosondes: Southern hemisphere 96 h

Wind



Geopotential height Temperature

Dew point depression



54 cases

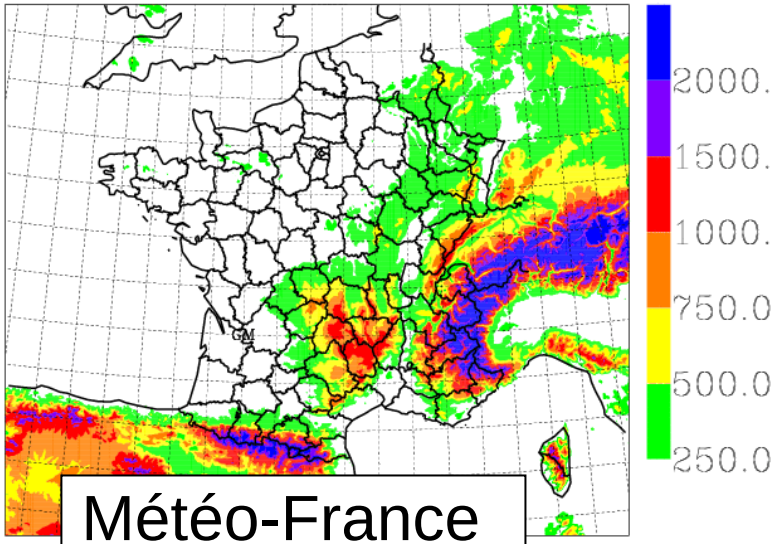
Legend:

Control is better

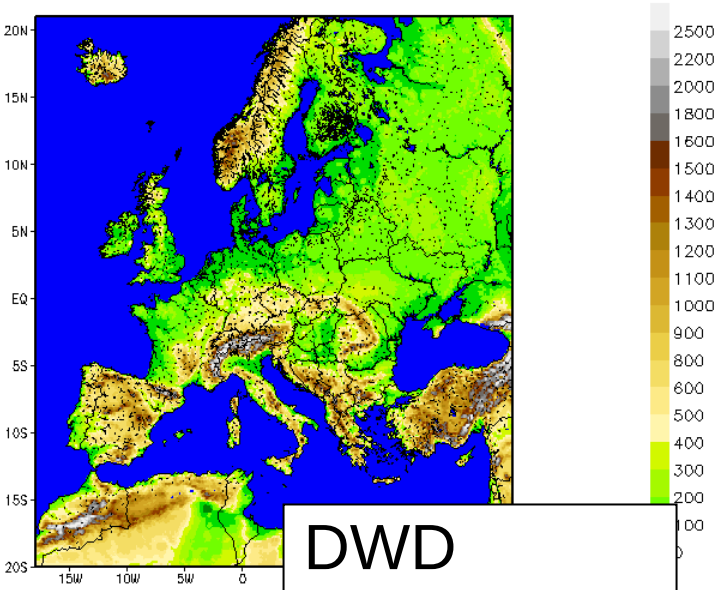
Test is better

Local Area Models

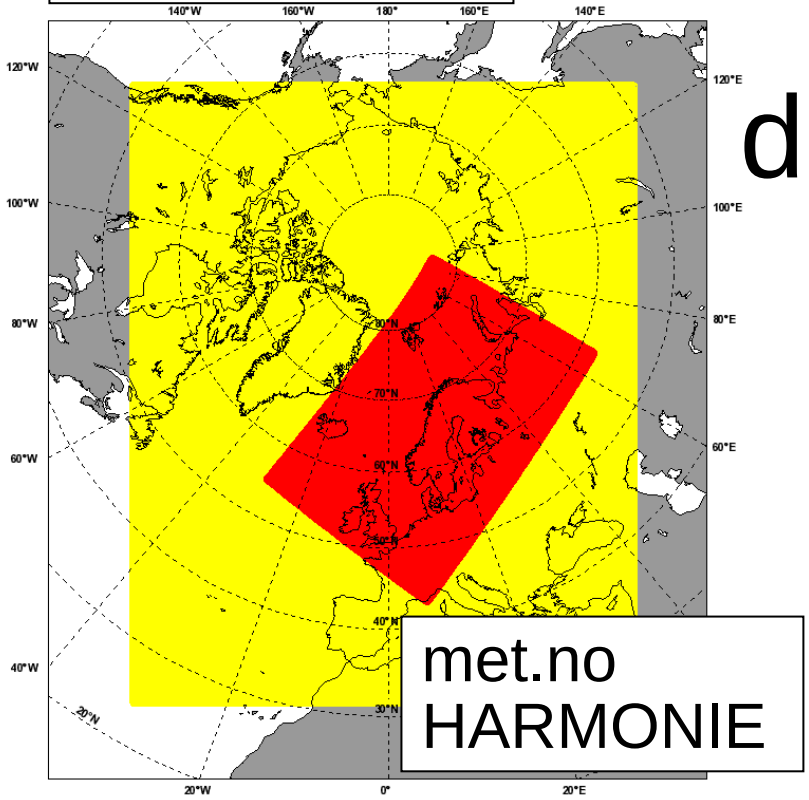
LAM domains



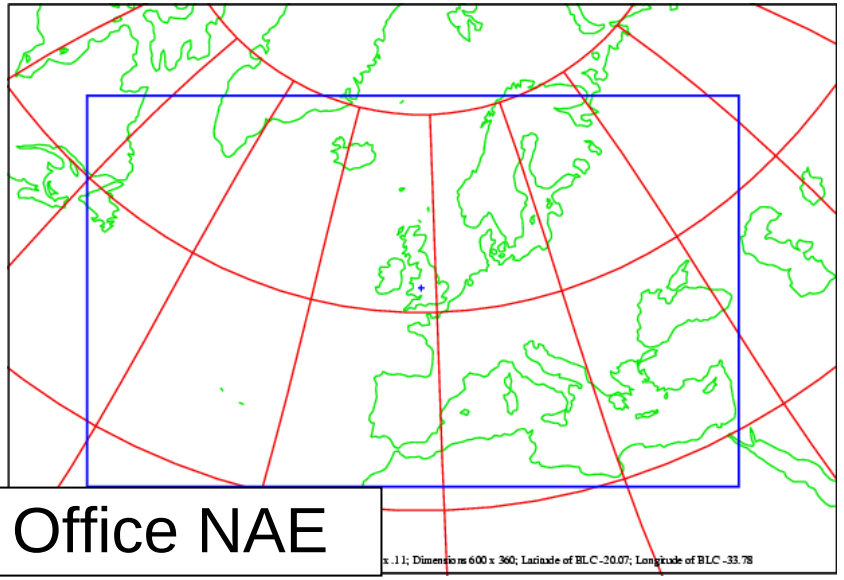
Météo-France
AROME



DWD
COSMO-EU



met.no
HARMONIE

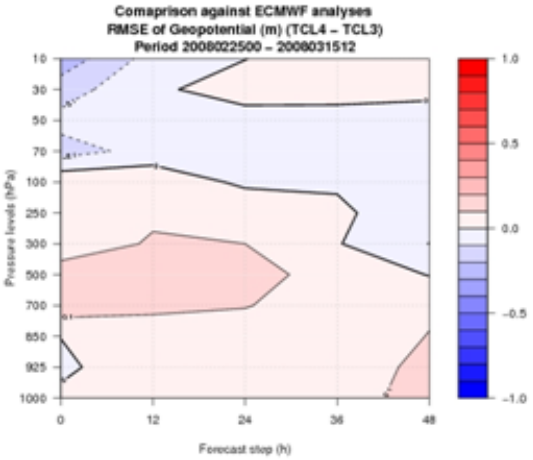


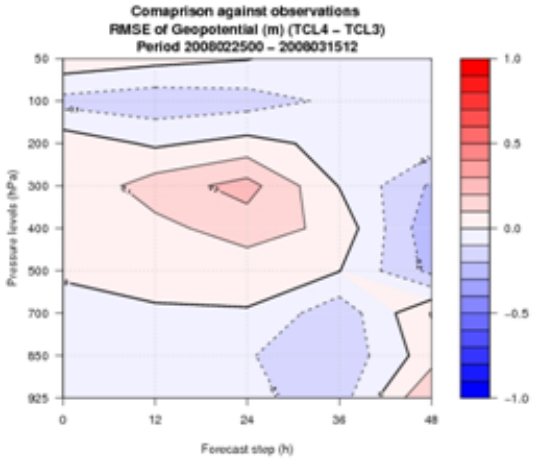
Met Office NAE

Issues for limited area models

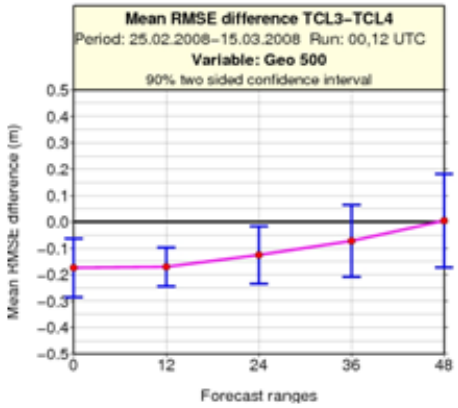
- **Land is much more important when there is very little sea!**
  - **But over a local area, it may be possible to use a constant emissivity**
- **Bias correction of observations requires careful thought**
  - **Data coverage is highly variable between cycles**
  - **Often a global model is not available to provide bias corrections**
  - **Even if there is a global model, there may be bias differences particularly for high peaking channels**
- **Strategy for estimating stratospheric temperatures**
- **Weather systems developing outside the model domain**

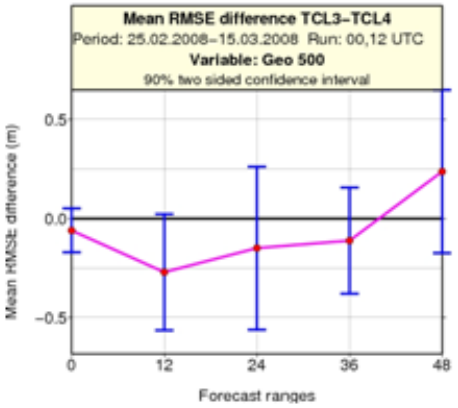
Positive impact on Geopotential Height in HARMONIE/Norway





Cross Section (Red is improvement)





500hPa ht (-ve Is improvement)

vs ECMWF Analysis

vs obs

Conclusions

- **IASI and AIRS are giving very good impact on forecast scores**
- **Most impact is coming from 15μm CO_2 band**
- **Increasing use is being made of cloudy data**
- **No one is using land-sensitive channels**
- **Use of water vapour improving**
- **Use of IASI and AIRS in LAMS increasing**


Questions?