



# Erroneous sea fog forecasts in HARMONIE:

Analysis and experiences with a new turbulence scheme

Wim de Rooy

acknowledgements

Emiel van der Plas, Geert Lenderink, Sander Tijm, Jan Barkmeijer, et al.

# Hirlam/Aladin cloud/fog/convection task force



highest priority: sea fog problem

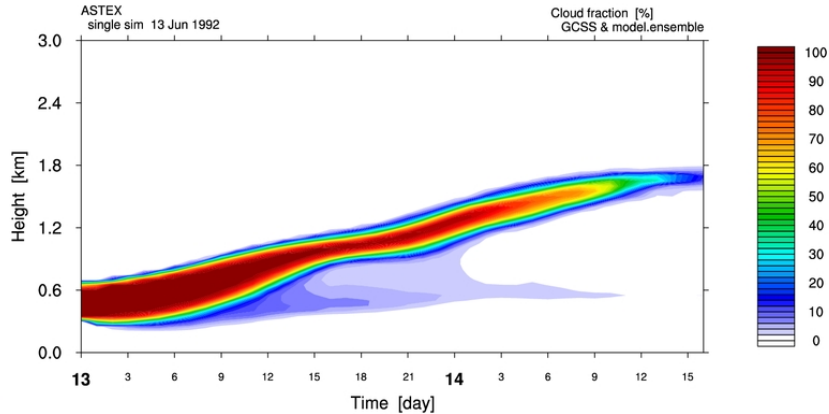
**Systematic investigation of overprediction sea fog at KNMI**

- **Sea surface**
- **Convection scheme**
- **Cloud scheme**
- **Turbulence scheme**

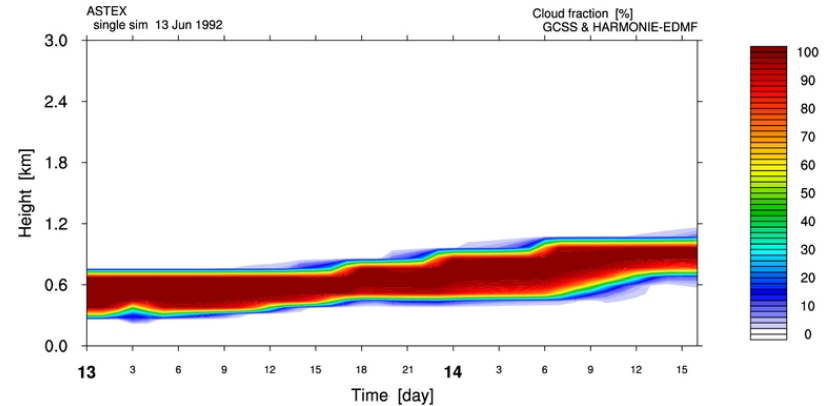
# Meanwhile: ASTEX

on case with rising and breaking stratocumulus (act

## Cloud fraction LES



## Cloud fraction Harmonie (edmf)



In practice Harmonie often shows:

- Too low cloud base
- Too low boundary layer height
- Too much stratus

Consistent with ASTEX!

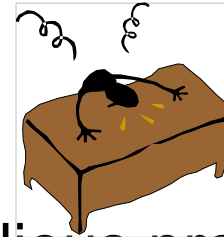
Insufficient top entrainment by turbulence scheme

Sea fog problem also related?

# modification turbulence

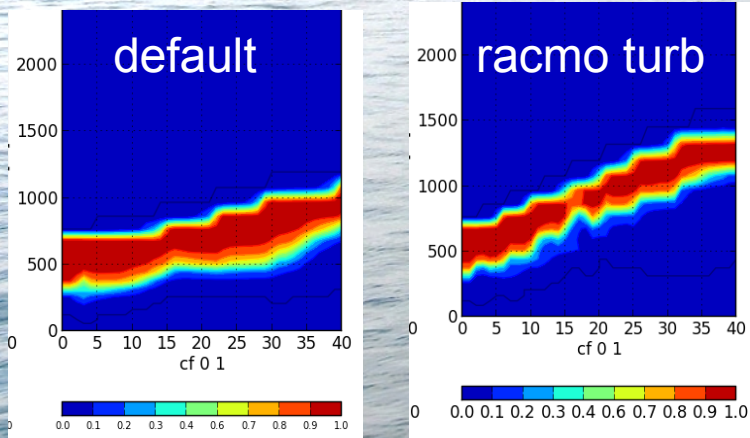
Sea fog sensitivity studies }  
ASTEX → Modify turbulence

Tuning ? or RACMO turbulence scheme?



But finally:  Implementation was extremely tough and tedious process.

## ASTEX



We expect:

- deeper boundary layers
- higher cloud base
- less stratus (?)

Also removal of erroneous sea fog?



# North sea fog case

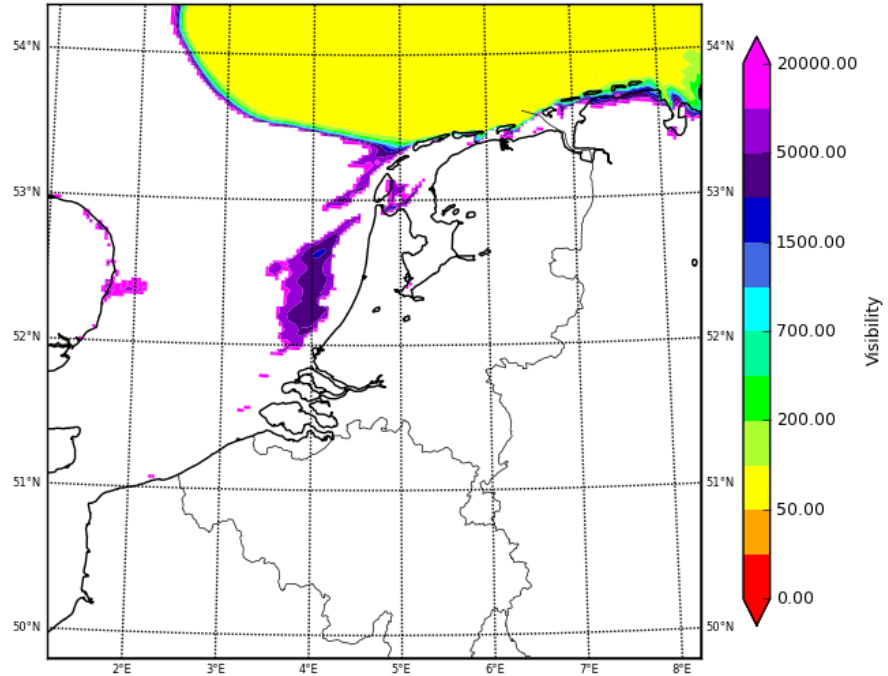
Start 2012 March 22 at 12UTC running +24h



How does the model perform?

• Visibility [m]

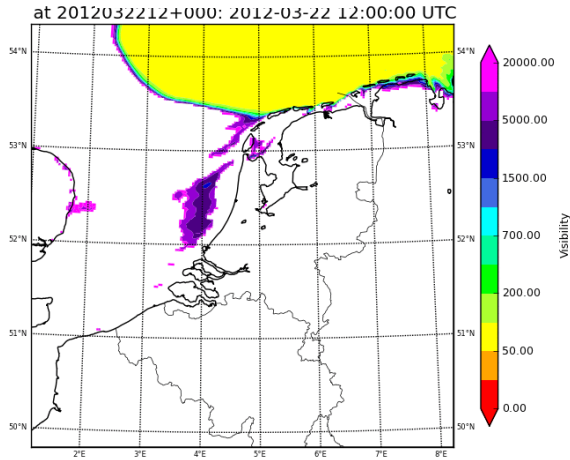
at 2012032212+000: 2012-03-22 12:00:00 UTC



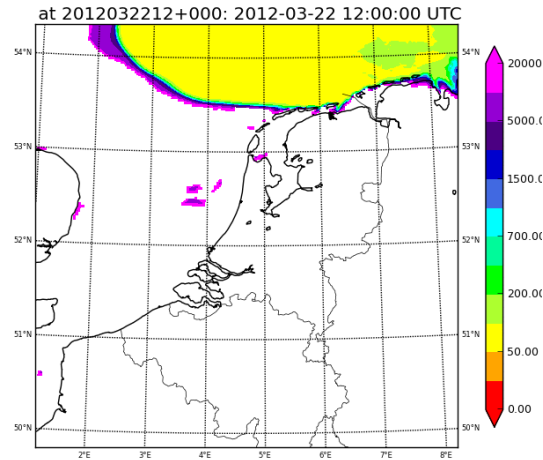
Two fog fields:  
Northern field already exists and is advected  
Southern fog field develops during the forecast.

# Model performance including RACMO turbulence scheme?

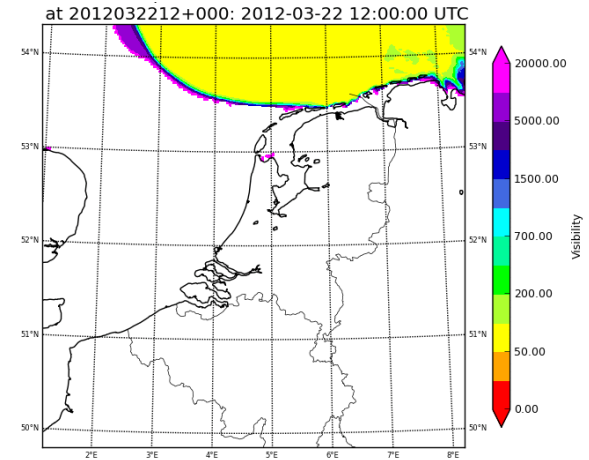
Reference



RACMO turb ZCH=0.15



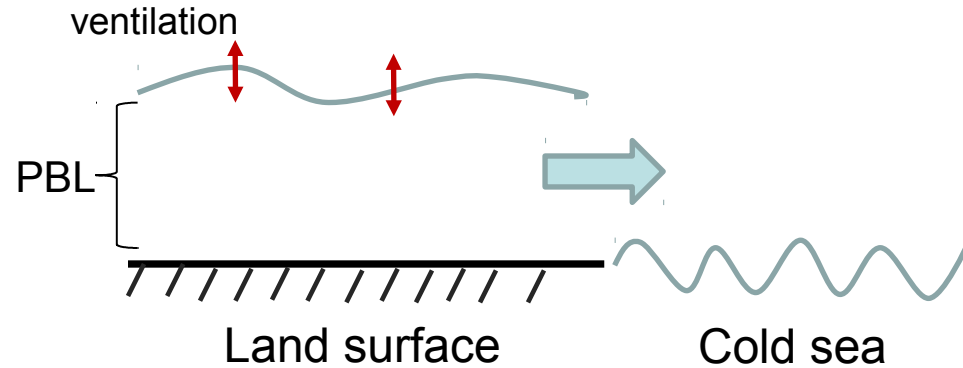
RACMO turb ZCH=0.20



- Already existing northern fog field does not vanish but becomes less dense and holes develop.
- The developing southern fog field is virtually absent with ZCH=0.2

Hypothesis: Two fog fields have different (main) causes

# Hypothesis southern fog field



Too little ventilation of boundary layer  
(top entrainment)



Too moist boundary layer air above land



Too moist air advected to cold sea water



Erroneous sea fog (difficult to dissolve)

## Indications:

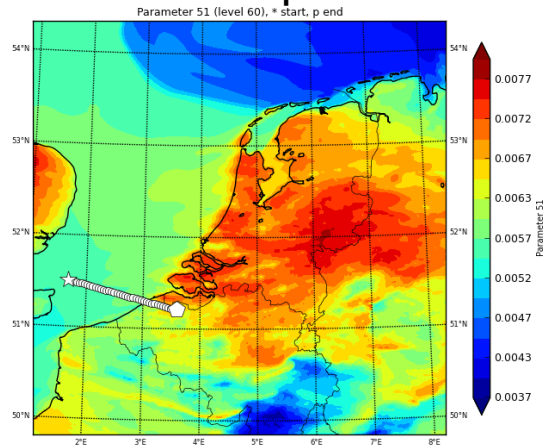
- experiment Yann Seity showing influence of soil moisture on North Sea case
- Often observed (Sander Tijm) fog fields above land that “explode” above sea (see also results with  $ZCH=0.15$ )
- Next slide



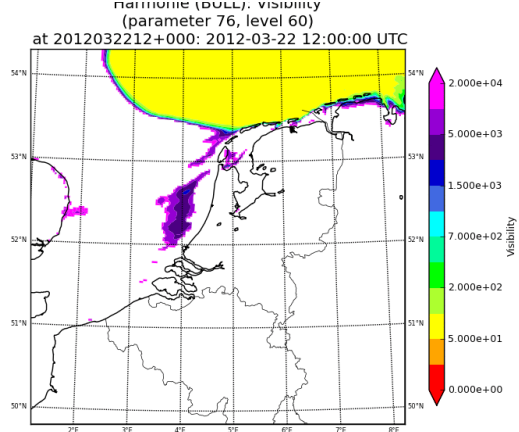
# Hypothesis southern fog field

Too moist air above land advected above sea

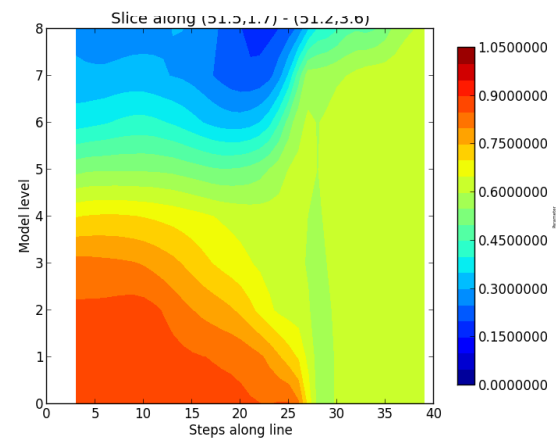
### Ref qv



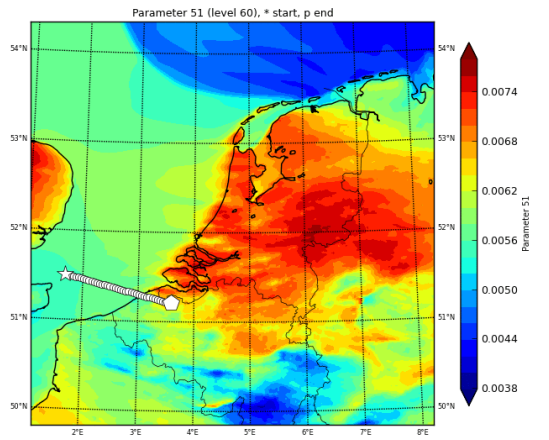
### Ref slice vis



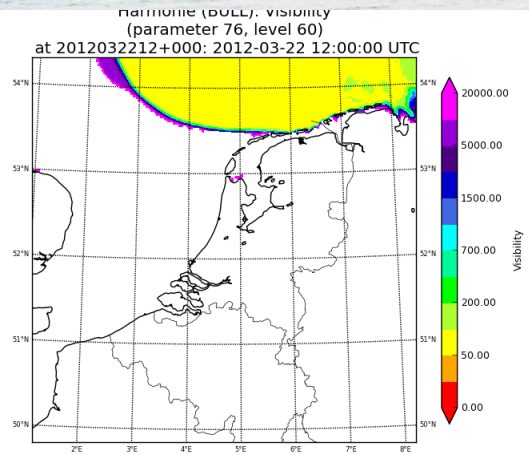
### Ref slice RH



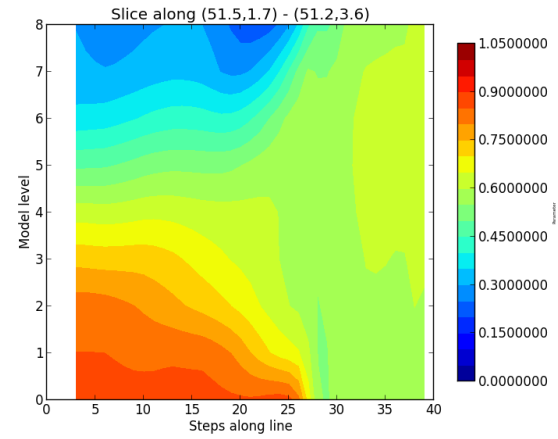
### RACMO ZCH=0.2 qv



### RACMO zch=02 slice vis



### RACMO zch=02 slice RH





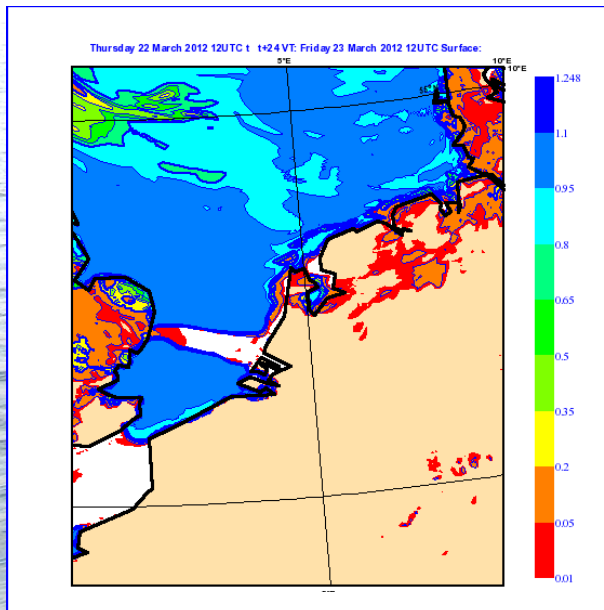
# Hypothesis northern fog field

Northern fog field is related to initialisation/boundaries (not physics)

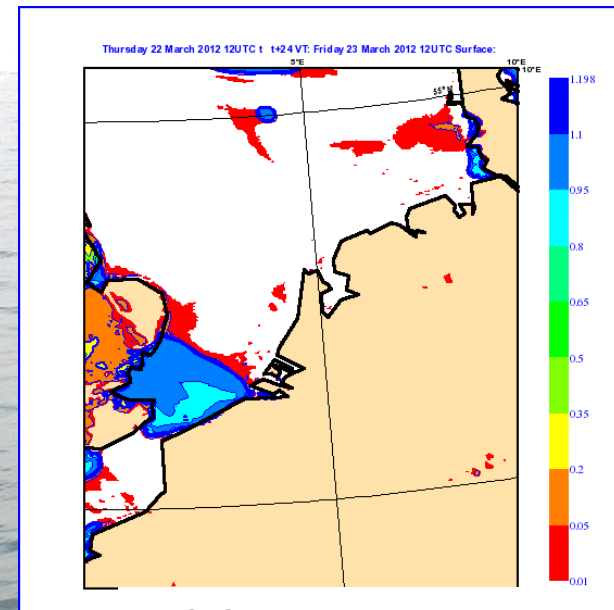
Indications:

- Results Yann Seity with AROME nested in ARPEGE reveal no northern but only the southern fog field
- Experiments of Sibbo van der Veen with MSG initialisation removes northern but not the southern fog field:

North sea case after 24h. Cloud fraction lowest model level



Reference version



MSG initialisation

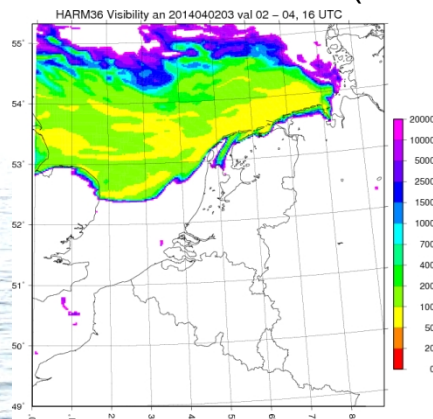
# At KNMI different parallel runs including a RACMO turbulence version (as well as RUC, 4DVAR, MSG)

## First, general experience (subjective verification)

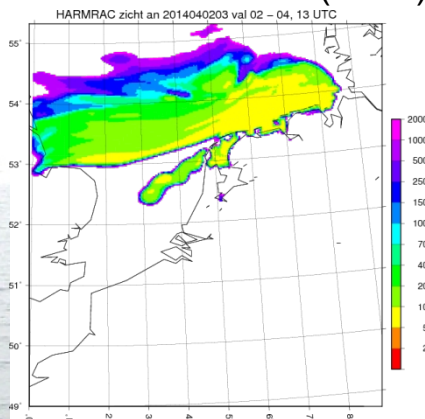
Can we keep the good fog forecasts?

Good fog forecasts are primarily retained (also reruns of past cases)

Visibility [m] Reference (36)  
VT 20140402 13UTC (+10h)



Visibility [m] Racmo Turb. (37)  
VT 20140402 13UTC (+10h)



Satellite April 4 1239UTC



Also, generally: less stratus (...)  
less erroneous sea fog  
more smooth rain fields

# Objective verification See also poster Emiel van der Plas

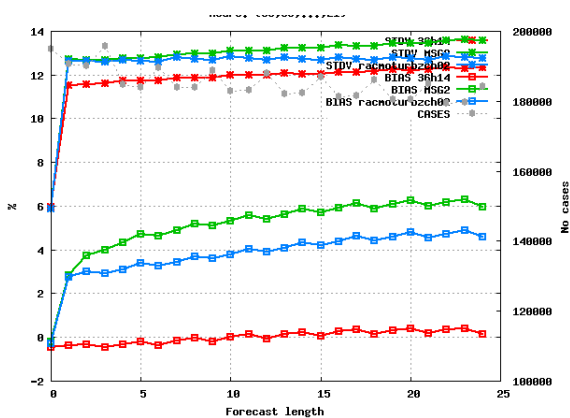
Xiaohua's standard verification package

negative u10m bias above land increases (radiosonds and sea oke).  
Is this really an error?

Reference (36)  $\leftrightarrow$  All parallel suites (37)  
Large difference!!

Example:

RH2m verification march 4-31



Surfex? Boundaries? Cold start?

Controlrun!

Different bowen ratio in 37 counteracts impact turbulence mod?



# conclusions

- Sea fog is a complex problem.
- Gained insight. Deficiencies in the physics and initialisation.
- ASTEX is important.
- Promising results new turbulence scheme. Expected: better cloud base and boundary layer height, and less low stratus.
- Influence 36h1.4 -> 37h1.2?! -> Controlrun
- Much verification needed! (and in progress).
- Code needs cleaning before implementation (fast?)



**Thank you  
Questions?**