Predicción de nieblas con **MUSC**

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What is FOG?

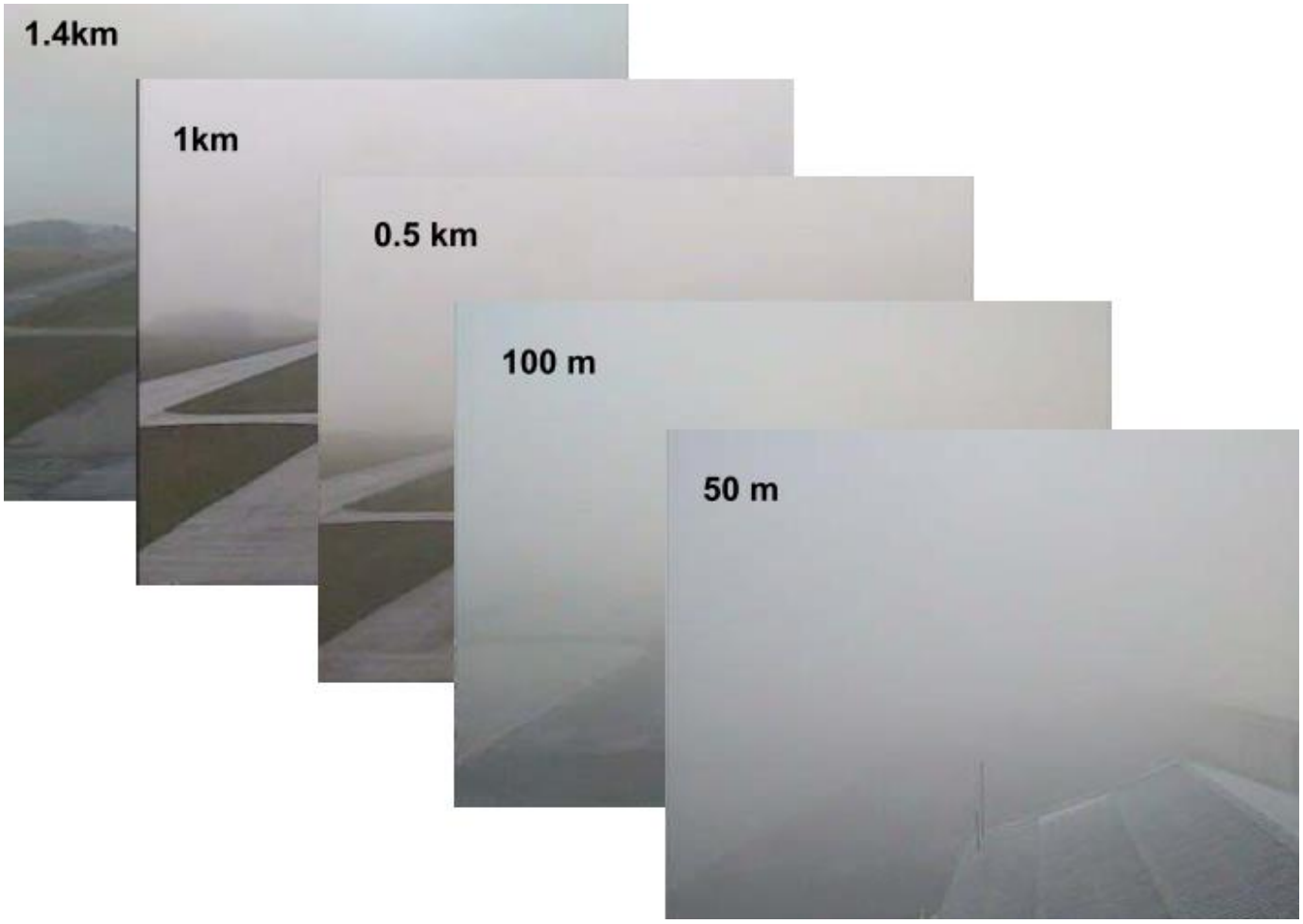
- **WMO Definition:**

"Suspension of very small, usually microscopic water droplets in the air, generally reducing the horizontal visibility at the Earth´ssurface to less than 1km"

- **Forecaster definition (Roach, W.T., 1994**):

"Fog occurs whenever the horizontal visibility falls below 1km. Cloud base descending to ground level is also experienced as fog."

FOG: A visibility reduction



Parameters in Fog Formation

- **Important Parameters in Fog Formation:**
  - Cooling of moist air by radiative flux divergence
  - Vertical mixing of heat and moisture
  - Vegetation
  - Horizontal and vertical wind
  - Heat and moisture transport in soil
  - Advection
  - Topographic effect

- **Once the fog has formed:**
  - Longwave radiative cooling at fog top
  - Gravitational droplet settling
  - Fog microphysics
  - Shortwave radiation

OBJETIVOS

- El objetivo final de esta línea de trabajo es la puesta en funcionamiento del **modelo numérico unidimensional MUSC** para la **predicción operacional de nieblas** en los aeródromos españoles.

- El primer paso es la adaptación del modelo MUSC para la predicción de nieblas sobre el Aeropuerto Adolfo Suárez Madrid-Barajas

Overview of MUSC

- **MUSC** (Modèle Unifie Simple Colonne) is a single column version of the HARMONIE 38h1.2 weather prediction system.
- **MUSC** was first derived from the full IFS (Integrated Forecast System, maintained and updated by ECMWF) by Sylvie Malardel et al. (Meteo France).
- Presently, HARMONIE MUSC is maintained within the international HIRLAM-ALADIN cooperation and available for research via the hirlam.org code repository.
- **MUSC** allows testing and comparison of AROME, ALARO, ARPEGE and elements of ECMWF and HIRLAM physical parameterizations in a unified environment.

Overview of MUSC

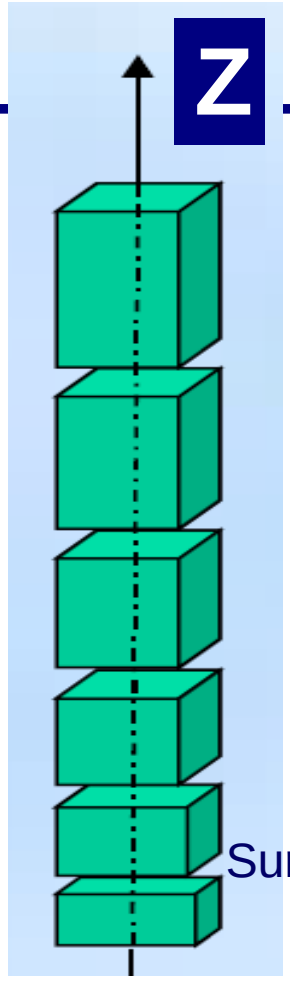
MUSC: Modèle Unifié Simple Colonne
(å 1D version of the HARMONIE 38h1.1 / AROME NWP model)

Å **Model includes**

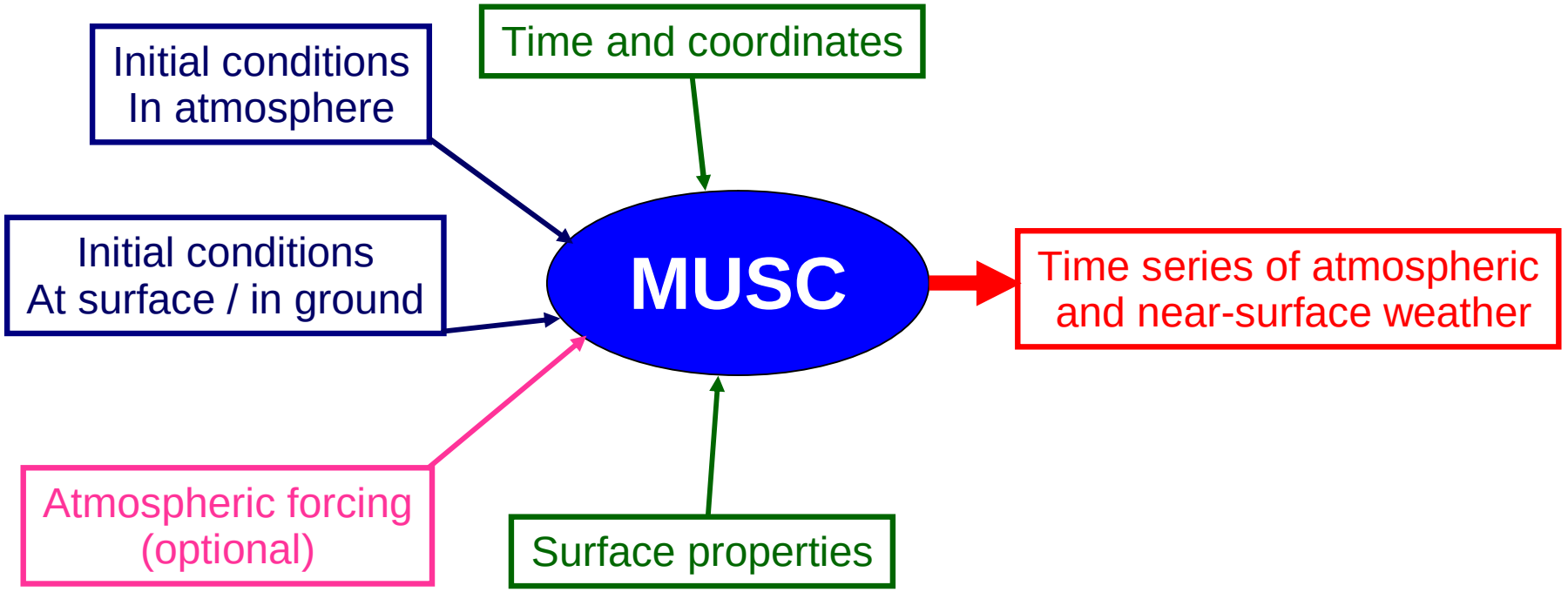
ï òAll parameterized physicsò
ï Radiation, turbulence, shallow convection, clouds, precipitation é
ï Surface processes (SURFEX)

Å**Model excludes**

ï All large-scale dynamics that depend on the horizontal distribution variables
ï Horizontal advection, pressure gradient force, large-scale vertical motion
ï The excluded terms can be provided to MUSC as prescribed ðforcingò (Räisänen and Rontu, 2013)



Overview of MUSC input and output



(Räisänen and Rontu, 2013)

CASE STUDY:
A 24- hours simulation for Madrid - Airport

DATE: January 7th 2013

Una mañana de retrasos en Barajas a causa de la fuerte niebla

- La mejora en la visibilidad permite a AENA retirar las restricciones en los aterrizajes a las 13.35
- El aeropuerto madrileño acumula un retraso medio de 28 minutos
- Problemas en el tráfico rodado en el día de la operación retorno de Navidad

EL PAÍS | Madrid | 7 ENE 2013 - 14:47 CET

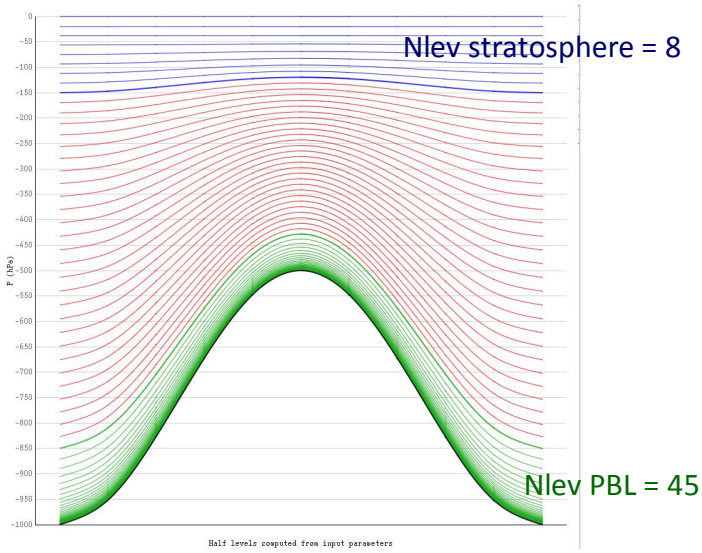
Una espectral Cibeles en medio de una densa capa de niebla. / SAMUEL SÁNCHEZ

Initial Experiment setup

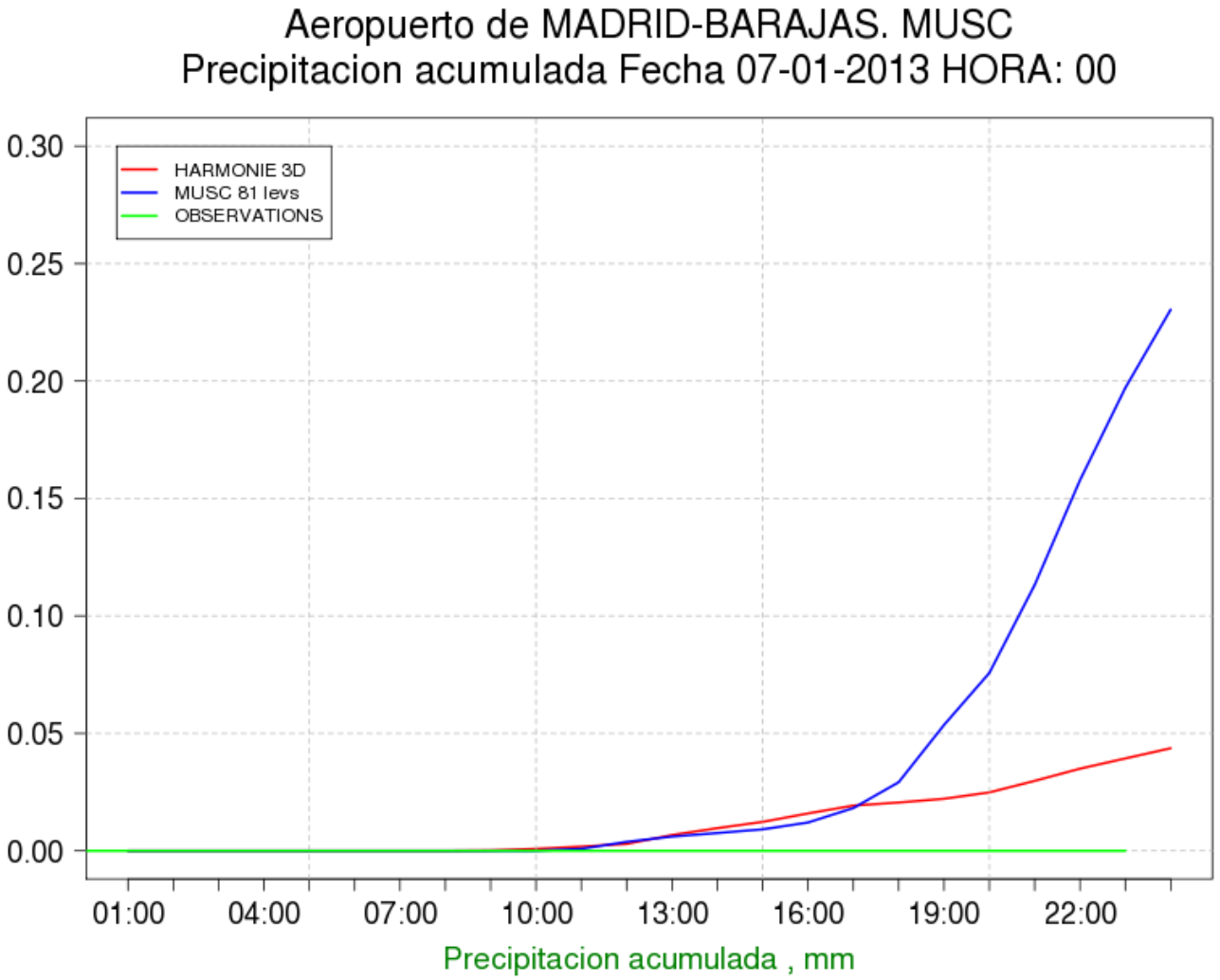
- **Surface parameters of the reference experiment**
- **Initial atmospheric perfil: HARMONIE 3D**
- **Applied forcings: None**

(Geostrophic wind, horizontal temperature dynamic tendency, horizontal wind dynamic tendency, horizontal humidity dynamic tendency, vertical velocity)

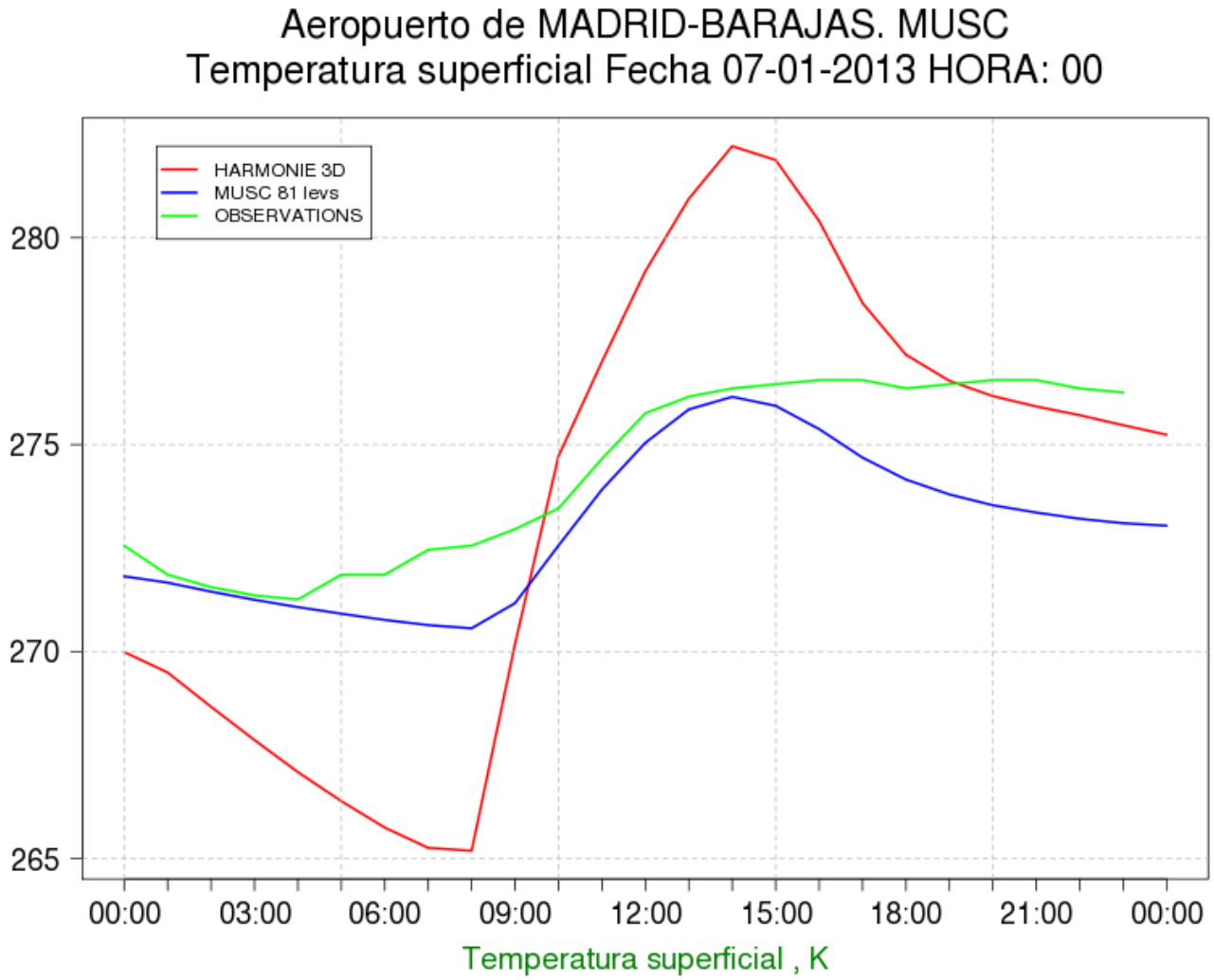
- **60 second time step; 24-hours model runs.**
- **Number TOTAL of verticals levels: 81**
- **Number of verticals levels in PBL: 45**



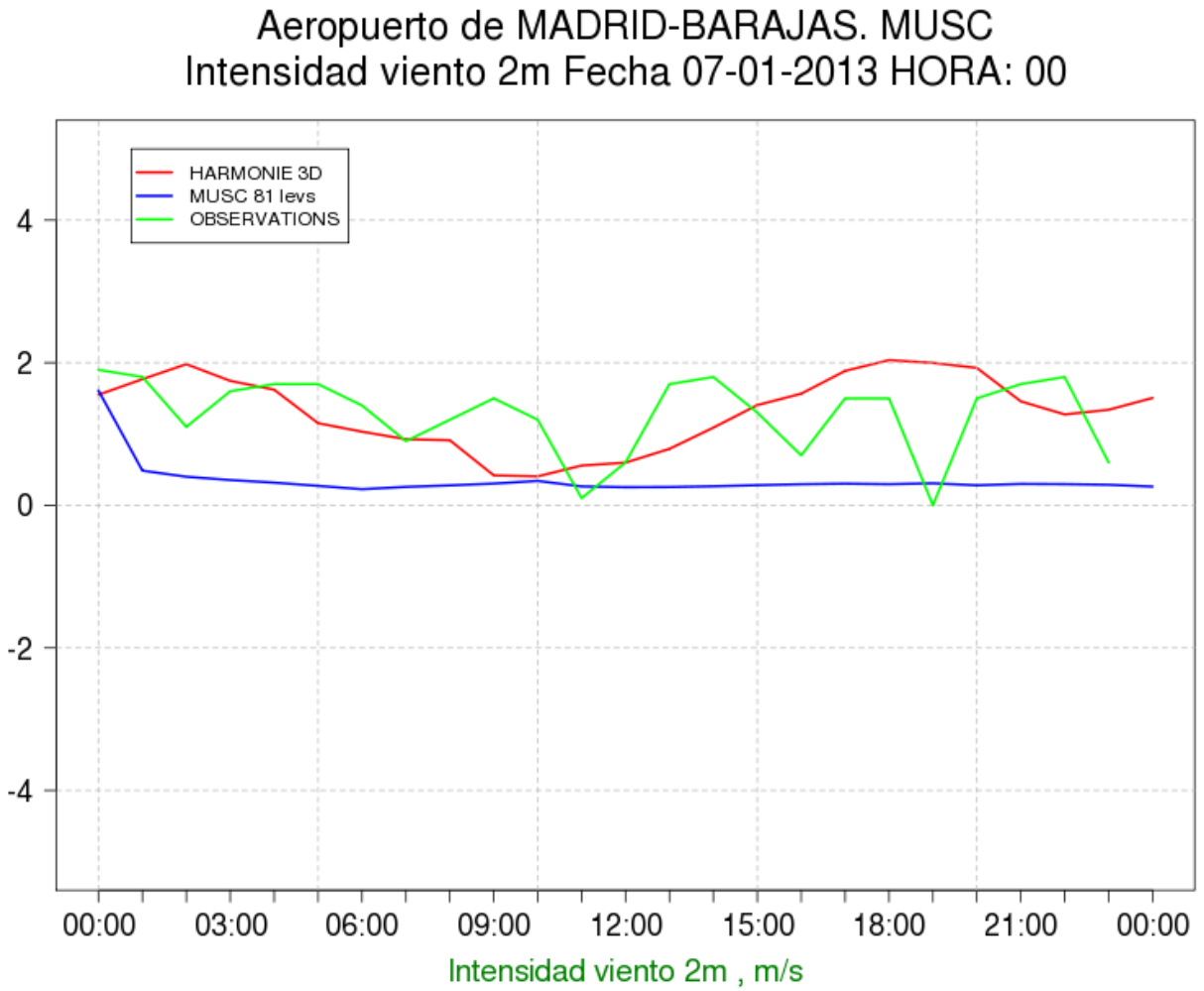
RESULTADOS


Aeropuerto de MADRID-BARAJAS. MUSC
Precipitacion acumulada Fecha 07-01-2013 HORA: 00
HARMONIE 3D
MUSC 81 levs
OBSERVATIONS
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01:00
04:00
07:00
10:00
13:00
16:00
19:00
22:00
Precipitacion acumulada , mm

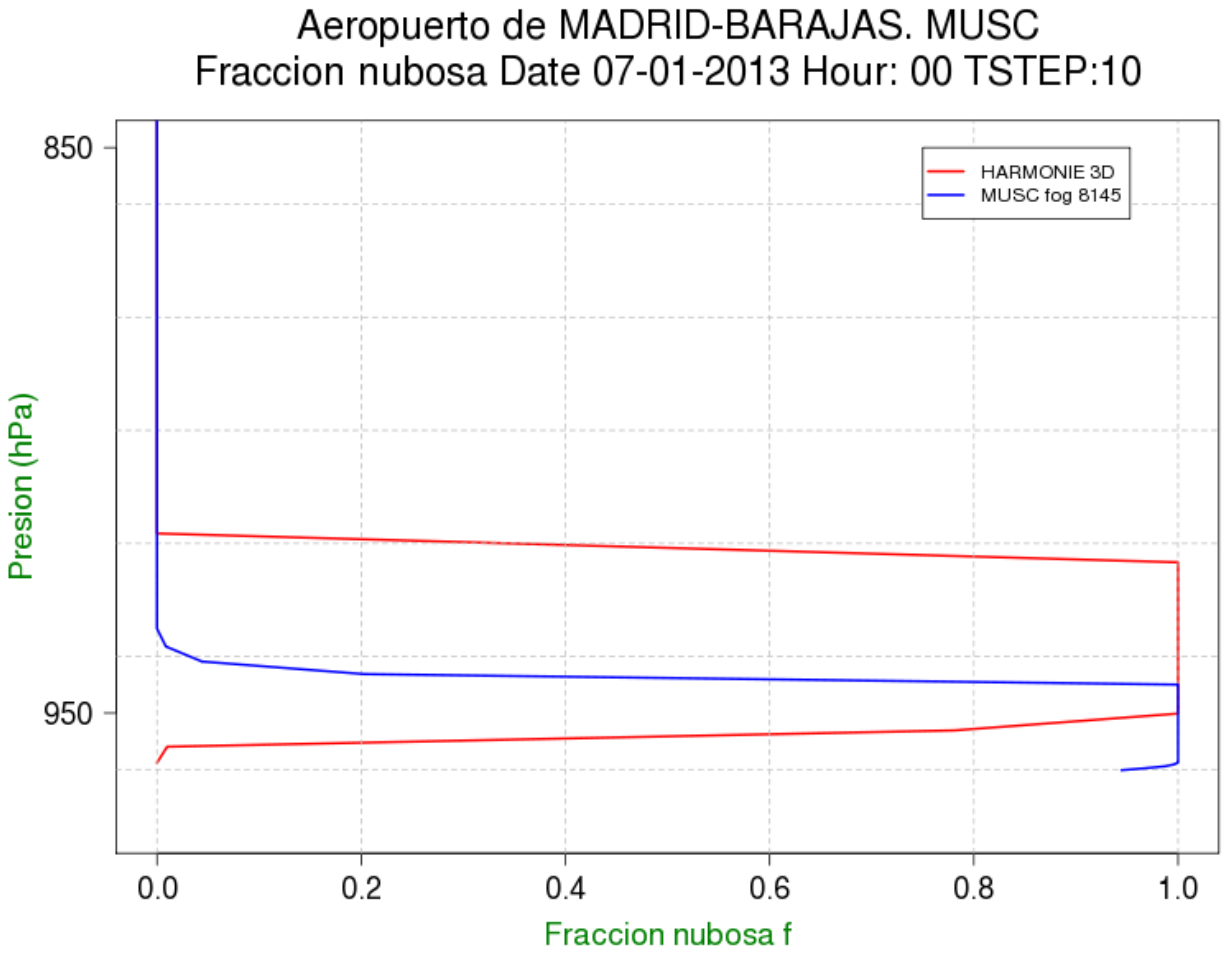
RESULTADOS


Aeropuerto de MADRID-BARAJAS. MUSC
Temperatura superficial Fecha 07-01-2013 HORA: 00
HARMONIE 3D
MUSC 81 levs
OBSERVATIONS
280
275
270
265
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Temperatura superficial , K

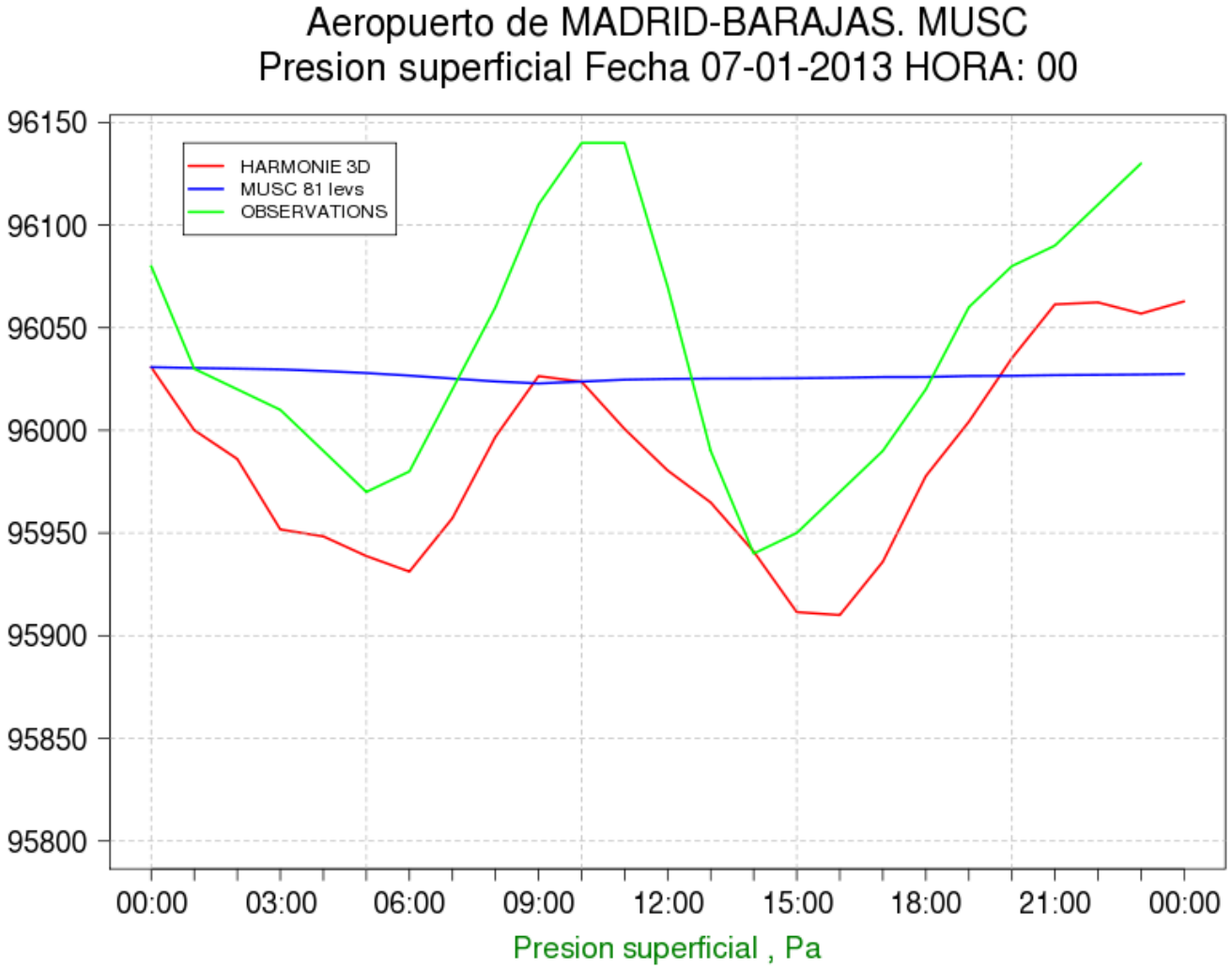
RESULTADOS


Aeropuerto de MADRID-BARAJAS. MUSC
Intensidad viento 2m Fecha 07-01-2013 HORA: 00
HARMONIE 3D
MUSC 81 levs
OBSERVATIONS
4
2
0
-2
-4
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Intensidad viento 2m , m/s

RESULTADOS


Aeropuerto de MADRID-BARAJAS. MUSC
Fraccion nubosa Date 07-01-2013 Hour: 00 TSTEP:10
HARMONIE 3D
MUSC fog 8145
850
950
Presion (hPa)
0.0
0.2
0.4
0.6
0.8
1.0
Fraccion nubosa f

RESULTADOS


Aeropuerto de MADRID-BARAJAS. MUSC
Presion superficial Fecha 07-01-2013 HORA: 00
HARMONIE 3D
MUSC 81 levs
OBSERVATIONS
96150
96100
96050
96000
95950
95900
95850
95800
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Presion superficial , Pa

CONCLUSIONES

- **MUSC** no reproduce con suficiente fidelidad las observaciones.
- Es necesario profundizar en:
  - Parametrizaciones físicas
  - Esquemas físicos de superfie (surfex)

Siguientes pasos ...

- Trabajar en el desarrollo de los modelos numéricos → comprensión de los procesos físicos durante los casos de niebla (Parametrizaciones físicas)
- Mejorar los datos observacionales introduciendo el análisis de datos de satélite.
- Introducir técnicas estadísticas de predicción por conjuntos en la predicción de nieblas.
- Cada aeródromo deberá adaptar MUSC a sus características fisiográficas y atmosféricas.

Operational Models in Europe

- ***AUSTRIA***
  - Model name: **ALADIN-AUSTRIA**
  - Resolution: 9.6 km horizontal, 45 vertical layers
  - Model domain: Europe
  - Boundary values: global model ARPEGE
  - Dynamics: Hydrostatic
  - Turbulence: Louis scheme
  - Visibility:Post-processingin case of T-inversiongradient RH and T

- ***DENMARK***
  - Model name: **DMI-HIRLAM**
  - Resolution: 16 km horizontal, 40 vertical layers
  - Model domain: Europe
  - Boundary values: ECMWF analyses and forecasts
  - Dynamics: Hydrostatic
  - Turbulence: Pronostic TKE
  - Visibility: MOS approach deppending on ground measurements and model forecasts

Non - Operational Models in Europe

- ***GERMANY***
  - Model name: **LM-PAFOG (COSMO-FOG)**
  - Resolution: 2.8 km horizontal, 40 vertical layers
  - Model domain: 280 x 280 km limited area
  - Boundary values: COSMO-EU
  - Dynamics: Non hydrostatic
  - Turbulence: Louis scheme
  - Visibility: Diagnostic variable

- ***SWITZERLAND***
  - Model name: **NMM-PAFOG**
  - Resolution: 6 km horizontal, 45 vertical layers
  - Model domain: 160 x 160 km limited area
  - Boundary values: NMM 13 km
  - Dynamics: Non hydrostatic
  - Turbulence: Pronostic TKE
  - Visibility: complex relation of moist forecasted parameter at 2m

Para terminaré

- **GRACIAS** a Daniel Martín Pérez (Área de Modelización)
- **Preguntas**…?
- **Comentarios …?**

FIN