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ARGOSS Air Quality Forecast Service Documentation

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Contents

1. Introduction

The purpose of this document is to provide information on the air quality forecast service provided by ARGOSS for the province of Zeeland (Netherlands) in the framework of the ESA PROMOTE project.

Example service products can be found on the PROMOTE website (http://www.gse-promote.org/) following the links: “Air quality service” / “Regional/Local Air Quality Forecasts” / “Air quality forecasts and analyses for Zeeland, the Netherlands”. These are example weather (2m temperature, 10m wind, sea level pressure) and air quality (ozone and PM10 concentrations at ground level) forecasts presented in the form of pictures. Explanations about the contents and interpretation of the charts are provided in section 3.

The operational weather and air quality forecasts as provided to the province of Zeeland can be accessed via http://promote.argoss.nl/zeeland/weather. The website is password-protected. Access can be requested from Hein Zelle (zelle@argoss.nl). **Please note that access will only be granted to PROMOTE partners!**

In the following, the contents and usage of the operational forecast website are described and some basic information is given on the weather and chemistry-transport models used to produce the forecasts.

2. Using the forecast website

The forecast website can be accessed at the following address:
http://promote.argoss.nl/zeeland/weather

The website contains operational weather and air quality forecasts for the Netherlands and the province of Zeeland. Forecast data are available from the most recent model runs (00:00 UTC or 12:00 UTC), up to 48 hours into the future.

2.1 Selecting weather or air quality information (“Model”)

The selection between weather (WRF) and chemistry-transport model (CHIMERE) outputs can be made using a drop-down list (“Model”).

2.2 Selecting the area (“Domain”)

The geographical area of interest can be selected using a drop-down list (“Domain”). The available areas are the Netherlands and Zeeland. By default, the website will show the Netherlands domain.

2.3 Selecting the time (“Valid for”)

The time for which the charts are valid can be selected using a drop-down list (“Valid for”). By default, the time will be set to 3 hours after the start of the most recent forecast simulation. Currently

the forecasts are available up to 48 hours into the future. Please read section 6.2 regarding issues with the first available time step.

2.4 Viewing the charts

After the selections are made, the charts can be requested by clicking on the "Show images" button. The charts can be magnified by clicking on them. Instructions for interpreting the charts, as well as some background information on the meteorological and chemistry-transport models and the domains, are provided in the next section.

3. How to read the charts

This section contains instructions for reading the weather and air quality charts.

3.1 Weather information

Weather forecasts are available for the following variables: 2m temperature, 10m wind, precipitation, and sea level pressure. In the following, some details are given on how to interpret these forecasts.

3.1.1 Temperature

The temperature charts show the temperature values at 2m above ground. The temperature is represented by colours (see the examples in Illustration 1). Temperature values are given in °C. A legend of the colours and corresponding temperature values is provided on the right side of the chart. The chart also shows the sea level pressure using black contour lines. The pressure values are given in millibars (1 mbar (millibar) = 1 hPa (hectopascal)) and appear as labels on the contour lines. The standard sea level pressure is 1013 mbar, higher values indicate a high pressure area and lower values indicate a low pressure area.

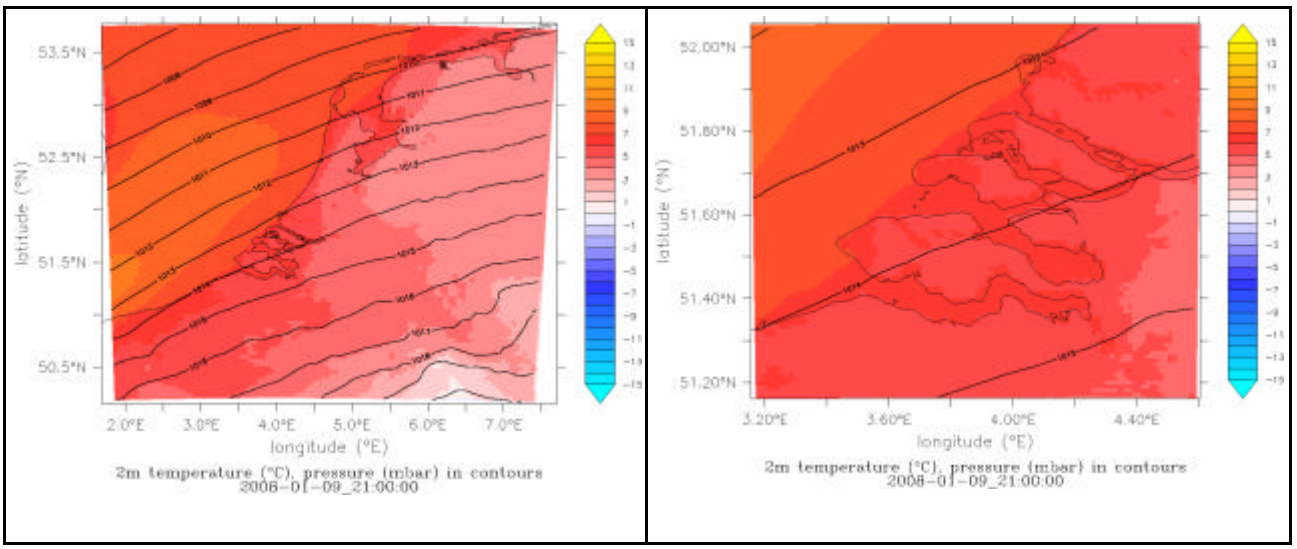

Illustration 1 Example 2 m temperature charts for the Netherlands and Zeeland.

3.1.2 Wind

The wind charts show the wind speed and wind direction at 10 m above ground, the same height at which meteorological stations make their wind measurements. The colours in the chart represent the wind speed. The legend on the right side of the chart shows the corresponding colours and wind speed values, given in m/s. The wind direction is indicated by the arrows. The lengths of the arrows is scaled with the wind speed. The charts also show the sea level pressure (in mbar) as black contour lines. For readability, pressure contours are only shown at 5 mbar intervals in this chart.
The inner Zeeland domain overlaid on the Netherlands domain can be easily identified on these charts as the area where the wind vectors become more dense. Example wind charts are shown in Illustration 2. Table 1 can be used to convert the wind speed from m/s to other units (knots and Beaufort scale).

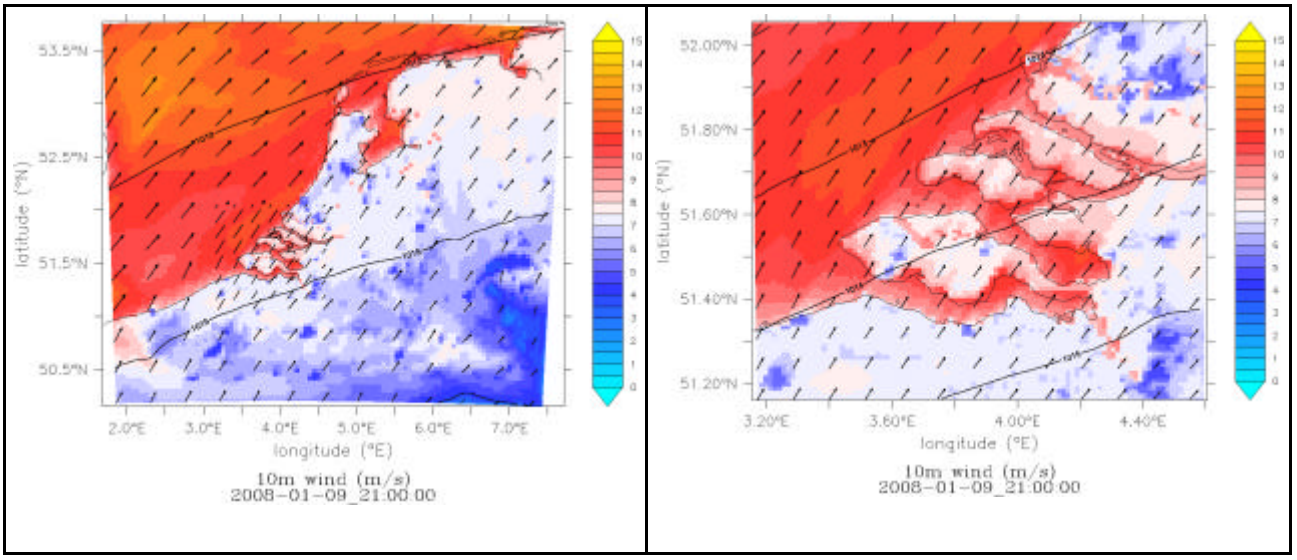

Illustration 2 Example 10 m wind charts for the Netherlands and Zeeland.

Beaufort	Name	m/s	knots
0	Calm	0-0.2	< 1
1	Light air	0.3-1.5	1-3
2	Light breeze	1.6-3.3	4-6
3	Gentle breeze	3.4-5.4	7-10
4	Moderate breeze	5.5-7.9	11-16
5	Fresh breeze	8.0-10.7	17-21
6	Strong breeze	10.8-13.8	22-27
7	Near gale	13.9-17.1	28-33
8	Gale	17.2-20.7	34-40
9	Strong gale	20.8-24.4	41-47
10	Storm	24.5-28.4	48-55
11	Violent storm	28.5-32.6	56-63
12	Hurricane	>= 32.7	>= 64

Table 1 Wind speed conversion between the Beaufort scale, m/s and knots.

3.1.3 Precipitation

Precipitation is meteorological jargon for any form of atmospheric water that is deposited onto the earth's surface. In the Dutch climate it generally represents rainfall. Other forms of precipitation are snow, hail, dew, etc.

Precipitation charts show the total amount of precipitation, summed up over the last 3 hours (in mm/3 hours) as indicated by the legend on the right of the chart. Precipitation charts for the first available forecast time step are not shown, as the previous 3 hours are not available. Example precipitation charts are shown in Illustration 3.

The expression "total precipitation" means that all the precipitation is taken into account regardless of whether it is convective (resulting from thunderstorms) or large scale (typically related to frontal passages).

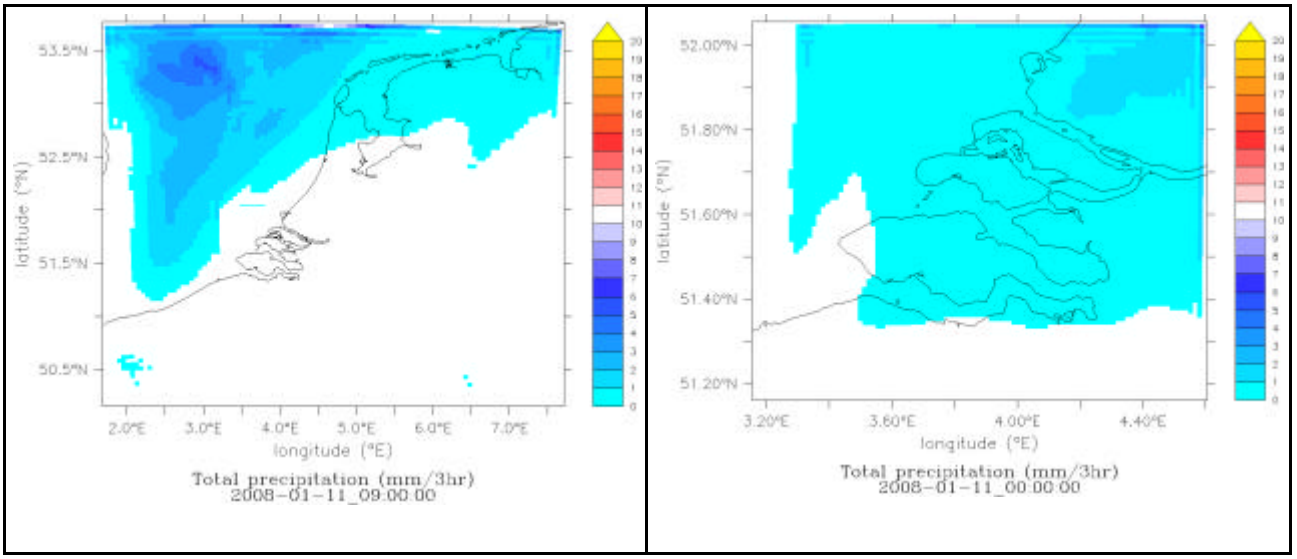

Illustration 3 Example precipitation charts for the Netherlands and Zeeland.

3.2 Air quality information

Air quality charts are available for the following pollutants: ozone, nitrogen-dioxide, nitrogen-monoxide, sulphur-dioxide, carbon-monoxide, methane, ammonia, PM10, and PM2.5. The plots display pollutant concentrations at ground level, in ppb (parts per billion). They use colours to distinguish between different pollution levels as shown by the legends to the right of the figures.

4. Geographical domains

Forecasts are available for two domains: the Netherlands (covering the area from about 50.1°N to 53.7°N and from 1.9°E to 7.4°E) and Zeeland (from about 51.17°N to 52.05°N and from 3.15°E to 4.60°E). The forecasts for the larger Netherlands domain are being produced on a 4x4 km grid. This means that processes that have a smaller typical size than 4 km (e.g., individual thunderstorm cells) cannot be modelled explicitly. The Zeeland domain on the other hand uses a much finer, 1x1 km

resolution grid. On this resolution individual thunderstorms can be simulated and local effects such as land-sea breezes and the effects of localised air pollution sources are better represented. The weather forecasts for the smaller, higher resolution Zeeland domain are overlaid on the charts showing the Netherlands domain. See section 6 for some remarks on boundary effects that may occur between the domains.

5. The numerical models

5.1 The meteorological model (WRF)

The meteorological model used to produce the weather forecasts is the so-called WRF (Weather Research and Forecasting) model. WRF is a joint development of several well-known U.S. institutes including NCAR, NOAA, NCEP, etc. It is a state-of-the-art meteorological model, using sophisticated physics and numerical algorithms. Its main advantages as compared to most other existing meteorological models are its free availability, the large number of physics options, its applicability to any region on the globe, and especially the capability of making forecasts on spatial scales down to about 0.5 km. For more information on WRF see: http://wrf-model.org/index.php.

5.2 The chemistry-transport model (CHIMERE)

The chemistry-transport model used to compute the air quality forecasts is the CHIMERE model. CHIMERE can be run on wide range of spatial scales from regional (thousands of kilometres) to urban (few hundred kilometres) with spatial resolutions from about 100 km down to 1 km. CHIMERE offers many options for simulations, including several different chemical mechanisms and aerosol modules. The model takes its boundary conditions from global simulations. The meteorological fields driving CHIMERE are taken from the WRF forecasts. Emission data are obtained from the EMEP database with a 50 x 50 km^2 resolution. Since this resolution is too coarse for local scale applications, a database is being built at ARGOSS which will eventually replace the EMEP data over the Netherlands. At the moment, high-resolution (1 x 1 km^2) emission data are used over Zeeland to improve the air quality forecasts provided to the province in the framework of PROMOTE.

For more details on CHIMERE see http://euler.lmd.polytechnique.fr/chimere/.

6. Remarks

Please note that the forecasts provided on the website are not final products but are in the stage of development. There are still a few known issues which will be resolved over the course of the PROMOTE project. Some of the known issues are:

6.1 Discontinuities at domain boundaries

Sometimes the transition from the large to the small domain is not smooth. Occasionally this can result in sharp edges that can be observed in the charts, at the boundaries of the Zeeland domain. An example of this effect can be seen in Illustration 4. This problem is most visible in the precipitation charts, especially when the rainfall is very light (light blue). When the rainfall is more intense, the boundary effect is generally not visible.

There is ongoing work to remove these boundary effects. Until then, the boundary effects can safely be ignored as they have no significant influence on the weather forecasts.

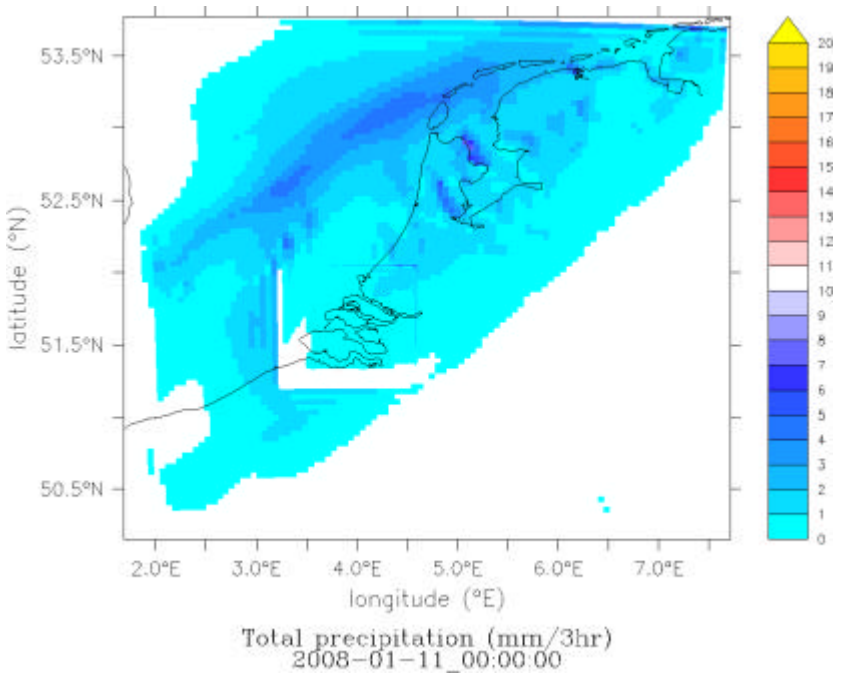

Illustration 4: Example of boundary discontinuities in precipitation charts. These typically occur near the edges of the Zeeland domain.

6.2 Erratic behaviour of pressure fields at T0

The first available time step (called T0) in the drop-down list of forecast times ("Valid for") represents the initial state of the model. Pressure contours at T0 will typically show erratic behaviour along the southern and eastern boundaries of the domain. This behaviour is due to an initialization problem, which has been solved and will be applied within the operational service in March 2008.

6.3 Data accuracy

The WRF model forecasts have been validated at ARGOSS for a period of roughly three months (15 November 2007 until 20 February 2008). Model results have been compared with wind, temperature and precipitation data from meteorological (SYNOP) stations in the Netherlands. The WRF forecasts were also compared to HIRLAM and ECMWF model results. The accuracy of the WRF forecasts proved to be as good as those provided by the operational HIRLAM and ECMWF models. However, the high-resolution WRF forecasts have the added value of being able to resolve small-scale effects such as changes in wind speed and direction at land-sea boundaries. The advantages of the high resolution are expected to be even more pronounced over areas with more complex orography.

The validation of the CHIMERE model forecasts is currently being undertaken at ARGOSS. Therefore, before the completion of this work, no guarantees can be given on the quality of the air quality forecast data. Validation results are expected to be available by the middle of April, 2008.

6.4 Data availability

The weather and chemistry-transport models run fully automated, twice per day, at approximately 01:30 and 13:30 UTC (02:30 and 14:30 Dutch wintertime). The results become available *approximately* 3 hours later. Please note that we cannot provide any guarantees yet on data availability or timely delivery. It may occasionally occur that the results are late or completely missing.

7. Feedback

We appreciate any feedback on this document or the website with weather and air quality forecasts. The goal of the PROMOTE project is to work together towards a good and usable product for the province of Zeeland! Please feel free to send any comments, criticism or suggestions for improvements to Hein Zelle (zelle@argoss.nl, +31 (0) 527 242299).

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