scirocco

scatterometer instrument competence centre

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Change register

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Document Approval

Role/Title	Name	Signature	Date

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1 Introduction

The WARP 5 grid represents a fixed Earth grid with a spatial sampling of 12.5 km in latitude and longitude direction. It has been mainly created to store global soil moisture time series as produced by TU Wien.

1.1 Scope

This document is intended to provide a detailed description of the WARP 5 Grid.

Targeted audience

This document mainly targets:

1. Remote sensing experts interested in the Discrete Global Grids.
2. Users of the remotely sensed soil moisture data sets making use of this grid.

1.2 Applicable and Reference Documents

Applicable Documents

The following documents are related to this document:

ID	Reference	Document Title	Issue	Date
AD-1				
AD-2				
AD-3				

Reference Documents

The following documents provide further reference information:

ID	Reference	Document Title	Issue	Date
RD-1				
RD-2				
RD-3				

2 Specification of the WARP 5 grid

The WARP 5 grid is a discrete global grid (DGG) and based upon the assumption that the Earth can be accurately modeled as a rotational ellipsoid (oblate spheroid). As a reference ellipsoid it uses the Goddard Earth Model 6 (GEM6) (see Table 2.1). The grid has been generated using a technique known as tiling [Kidd, 2005]. This means before the globe is partitioned along the coordinate axis, first a specific projection will be applied to the latitude and longitude coordinates. Such a map projection will either optimize equal area, true shape or true distance or will provide a compromise between them. For global remote sensing applications the most important characteristic of a map projection is that of equal area or equivalence. Therefore area preserving projections such as the Cylindrical Equal Area projection are preferred.

Parameter	Value
Semi-major axis	a = 6378144 m
Semi-minor axis	b = 6356759 m

Table 2.1: Goddard Earth Model 6 – ellipsoid parameters.

After projecting the latitude and longitude coordinates, the grid is determined by using an equal arc length of 12.5 km, calculated as a local spherical (Gaussian) radius. The longitudinal arc distances between the grid points on the same latitude circle are also set to 12.5 km, to ensure consistent arc distances in the west-east direction at the price of a discontinuity at the ±180 meridian (Figure 2.1). Since this regions lie mostly in the Pacific Ocean, the discontinuity does not influence the aggregation of land measurements, subject to a small area in the Russian far east.

The resulting grid configuration for three different areas is shown in detail in Figure 2.2, including the discontinuity at the ±180 meridian. For more accuracy, the radius of the Earth used for calculating the latitudes and longitudes is approximated with the radius of curvature of the meridian.

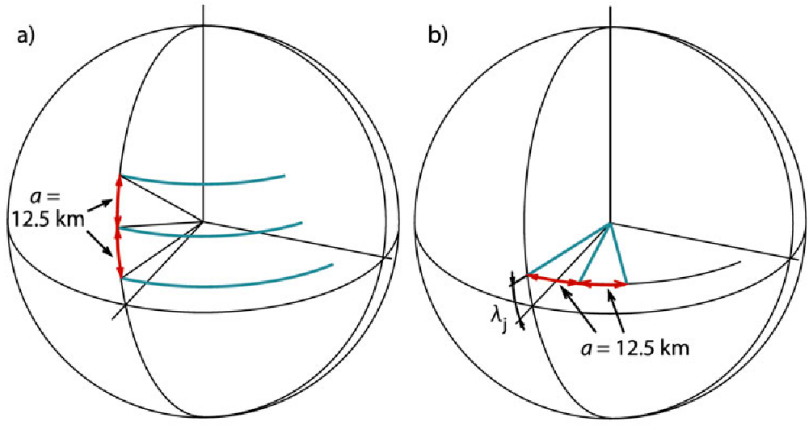

Figure 2.1: Constructing the WARP 5 grid: a) equally spaced latitude small circles; b) grid points created at discrete longitudes on each latitude circle.

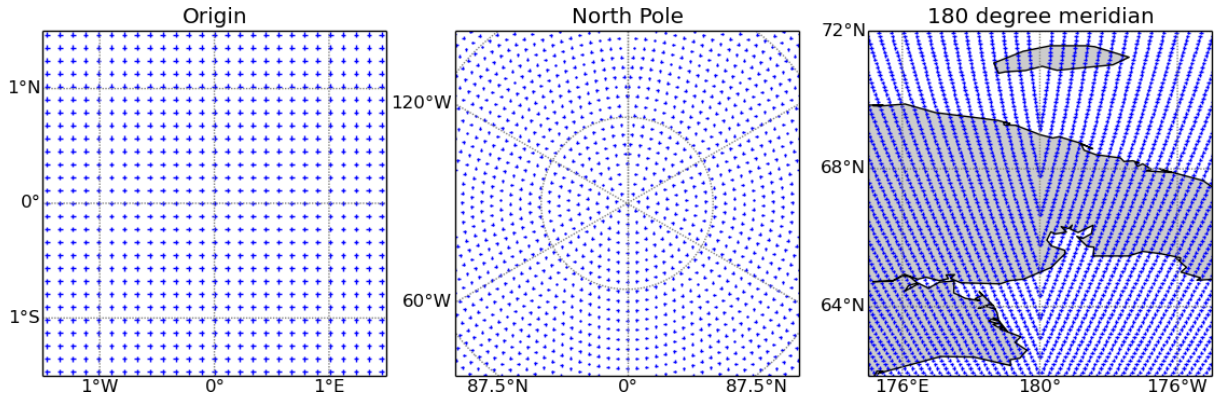

Figure 2.2: Details of three areas of the WARP 5 grid: at its origin (left); at the North Pole (middle); at the 180° meridian (right).

2.1 Formulas

The latitude and longitude coordinates can be calculated using the following formulas:

$$e^2 = \frac{a^2 - b^2}{a^2}$$

$$N = \frac{a}{\left(1 - e^2 \cdot (\sin \phi_i)^2\right)^{\frac{1}{2}}}$$

$$M = \frac{a \cdot \left(1 - e^2\right)}{\left(1 - e^2 \cdot (\sin \phi_i)^2\right)^{\frac{3}{2}}}$$

$$\phi_{i+1} = \phi_i + \frac{d}{M}$$

$$\lambda_{j+1} = \lambda_j + \frac{d}{N \cdot \cos \phi_i}$$

where e is eccentricity, a semi-major axis, b semi-minor axis, N radius of curvature of East-West, M radius of curvature of North-South, λ_j latitudes and ϕ_i longitudes. The following Pseudo code shows how the grid longitudes and latitudes are generated.

Algorithm 1: Pseudo code of WARP 5 grid calculation.

```
k = 0;
lat = 0;
while lat lower 90 do
    lon = 0;
    calculate N;
    while lon lower 180 do
        arrlon[k] = lon;
        arrlat[k] = lat;
        if lon not equal 0 then
            k = k + 1;
            arrlon[k] = -lon;
            arrlat[k] = lat;
        if lat not equal 0 then
            k = k + 1;
            arrlon[k] = lon;
            arrlat[k] = -lat;
            if lon not equal 0 then
                k = k + 1;
                arrlon[k] = -lon;
                arrlat[k] = -lat;
        k = k + 1;
        calculate lon;
    calculate M;
    calculate lat;
```

2.2 Definition of grid points over land

Soil moisture data are provided over land mass only, therefore a subset of the global grid is used. It excludes points over open water surfaces and ice masses which were identified by geographical analysis of the Global Lakes and Wetlands Database (GLWD) and the GSHHS (Global Self-consistent, Hierarchical, High-resolution Shoreline Database). A map of the grid point indexes over land is given in the following Figure 2.3.

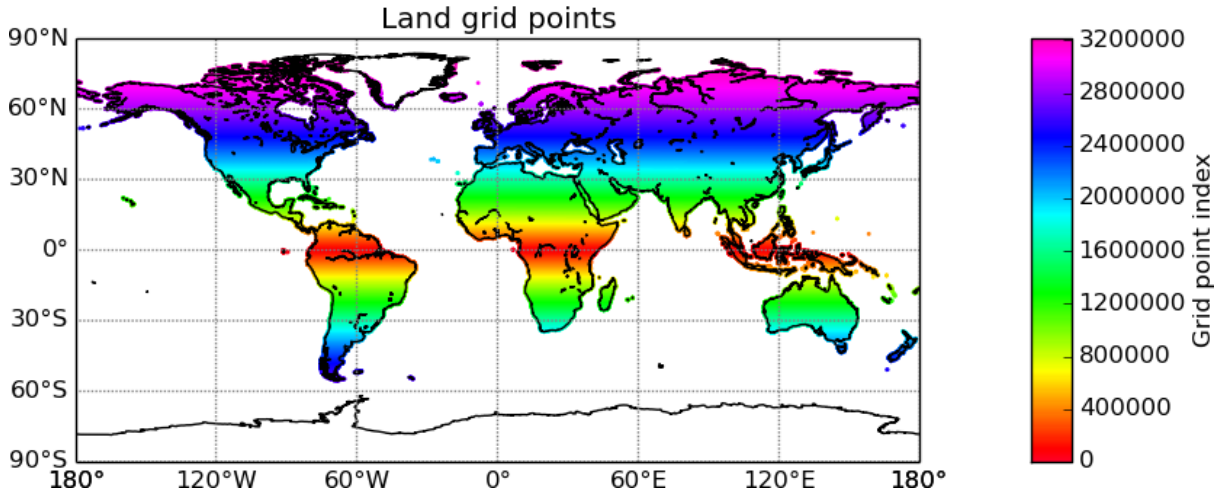

Figure 2.3: Grid point indices for grid points over land.

2.3 Summary

The important characteristics of the WARP 5 grid are summarized in the following Table 2.2.

Property	Value
Grid name	WARP 5 grid
Ellipsoid	Goddard Earth Model 6 (GEM 6)
Grid sampling	12.5 km
Type	Discrete global grid (DGG)
Number of GPs	3264391
Number of land GPs	839826
Coverage	90S - 90N and 180W - 180E

Table 2.2: Overview of WARP 5 grid properties.

3 References

R. Kidd. Discrete Global Grid Systems. Technical Report 4, Institute of Photogrammetry and Remote Sensing, Austria, 2005.