# Mt. Aconcagua – A Challenge for Remote Sensing Mapping Activities in the Andes

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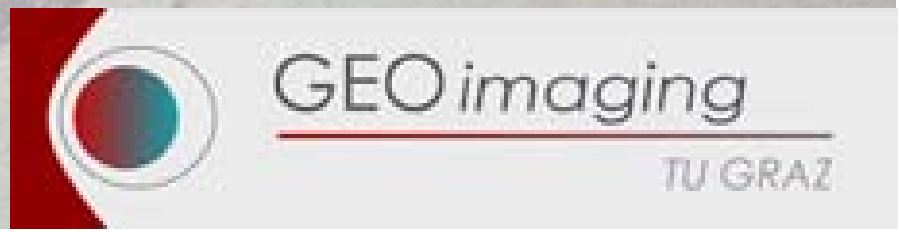


# Content

- Introduction - Motivation
- A challenge for Remote Sensing
- Investigation Area
- Available Geodata
- Generation of DEM
- DEM derivates and contour lines
- Results and further investigations

# Motivation

- HMRSC (High Mountain Remote Sensing Cartography) 1994
- Universidad de Mendoza (11/2003)
- Book of Aconcagua by R. Kostka
  - Geographical Topics about Aconcagua Region
  - Generation of a (Satellite based image) Map 1:100.000
- Challenge for Remote Sensing
  - High Mountain Environment
  - Lack of Geodata
  - Providing a basic database for a cartographic product of the region

# What kind of requirements ?

- **basics** for the map (1:100.000)
  - Image-line-Information ----------Source: ASTER/LANDSAT
  - Contourlines --------- Source : DEM: ASTER/SRTM/LANDSAT
  - Vegetation cover ----------Source : LANDSAT/ASTER
  - Glacier/Lakes ---------- Source : LANDSAT/ASTER
  - Traffic network ---------- Source : GPS/LANDSAT/ASTER
  - perspective views ---------- Source : DEM/LANDSAT/ASTER
- **multitemporal** and **multisensoral** data set

# Challenge for Remote Sensing

## Remote Sensing in High Mountain Environment

- High Mountain Areas are regions, which are especially suitable for providing surface information by means of Remote Sensing.
- Remoteness, inaccessibleness and high relief are inconvenient for terrestrial methods.
- Remote Sensing techniques provide useful tools for a full cover and especially for height related interpolation of local – field based acquired.
- Due to their touchlessness and spatial extent, aerial photographs and satellite images get an increasing acceptation for many mountain related topics (LULUC, change detection, hazards, …).

# Challenge for Remote Sensing

## Typical data based problems in high mountain areas

- “insufficient” topographic maps
- general lack of geodata
- non documented analogue dataset
- few thematically products
- low spatial cover
- lack of actuality
- relief, climate, geometric aspects,

# Challenge for Remote Sensing

**What is the need of RS in high mountains ?**

- suitable data basis for processing (rectification, image/GIS analyses and presentation)
  - (digital) topographic maps
  - DEM, …
  - fieldwork
- suitable weather and season
  - “nice” weather (RADAR!)
  - less snow
- suitable sensors
  - G/S/R/T -resolution
- skilled user (Processing – Analyse – Presentation)
  - Image processing/GIS
  - Knowledge about natural and cultural environment
  - Cartographic skills

# Investigation Area

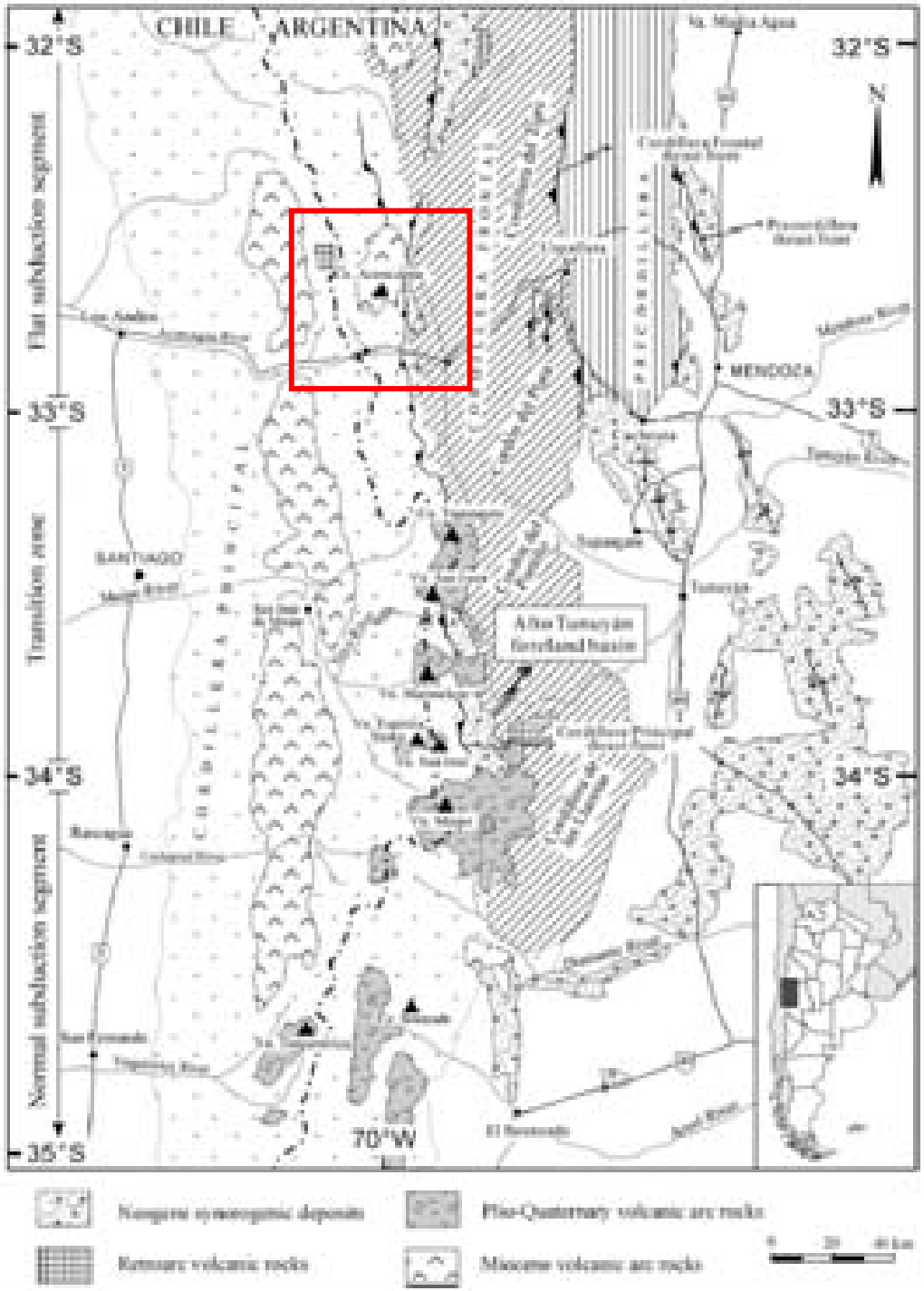
**Cerro Aconcagua: 6962m**

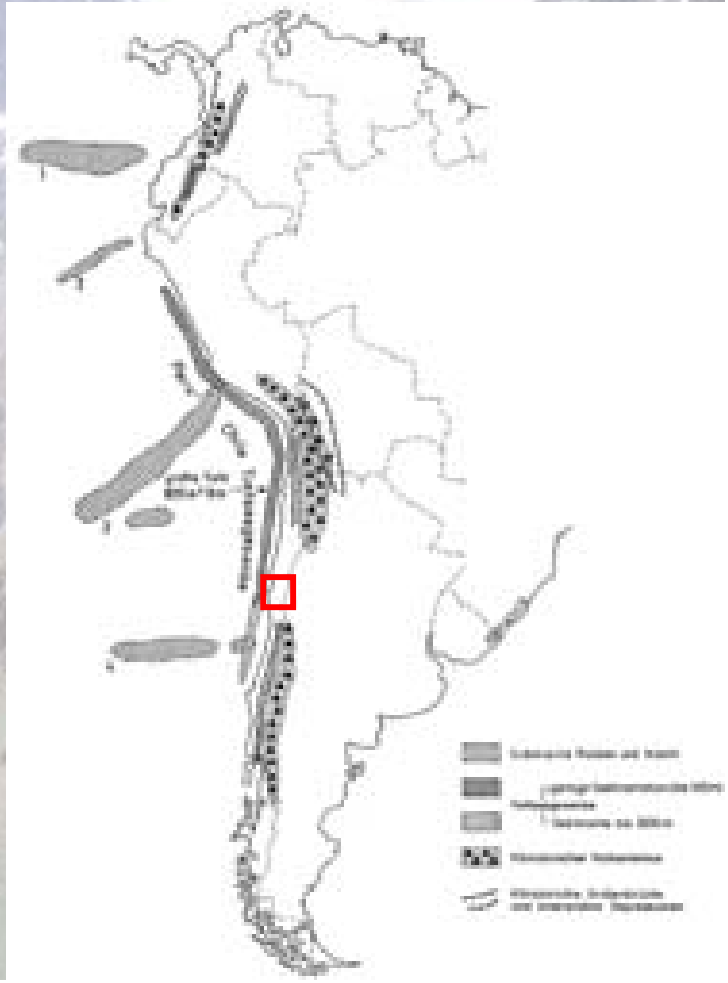
**Highest mountain**:

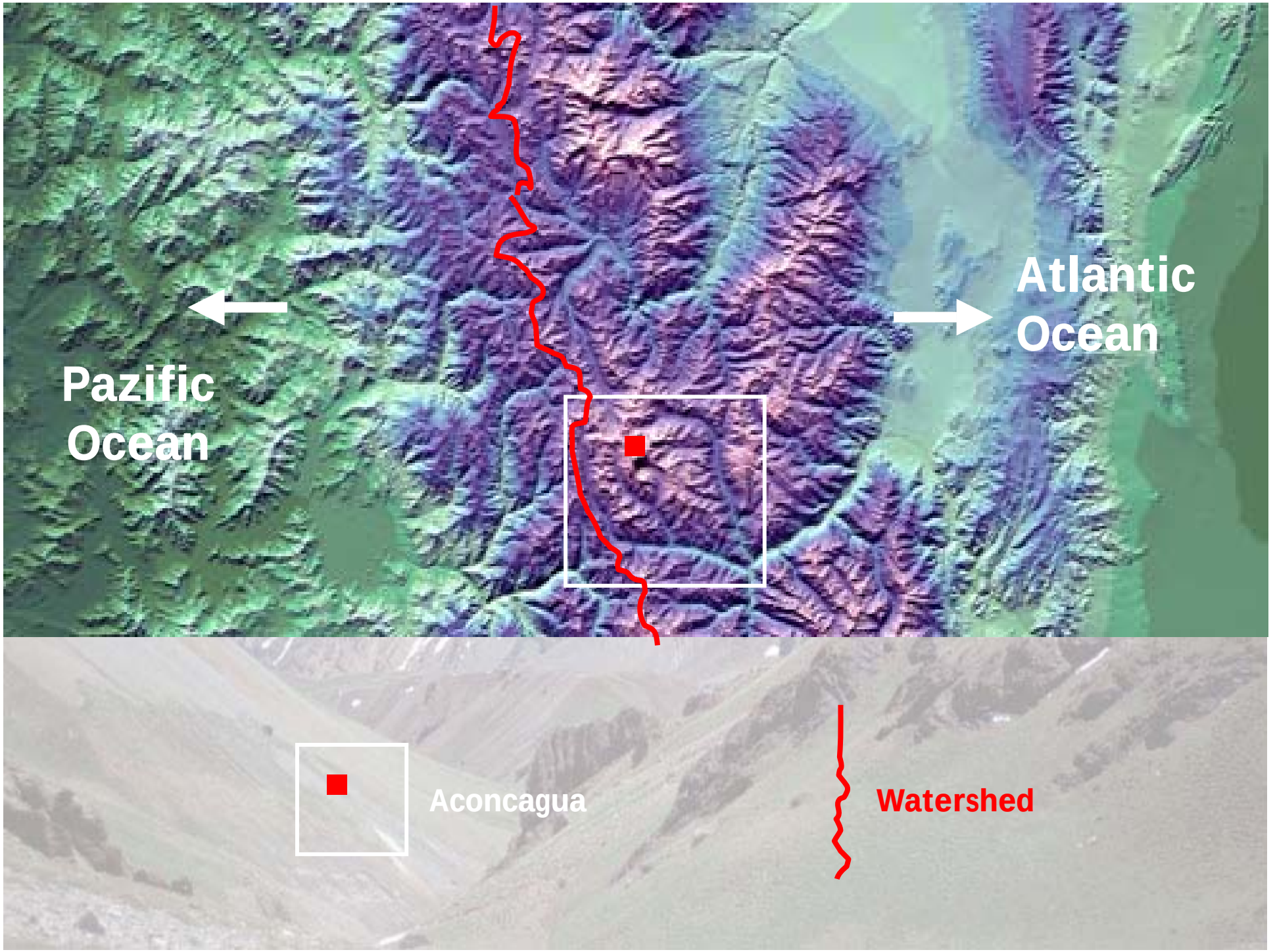
- of America
- southern hemisphere
- outside Asia
- western hemisphere

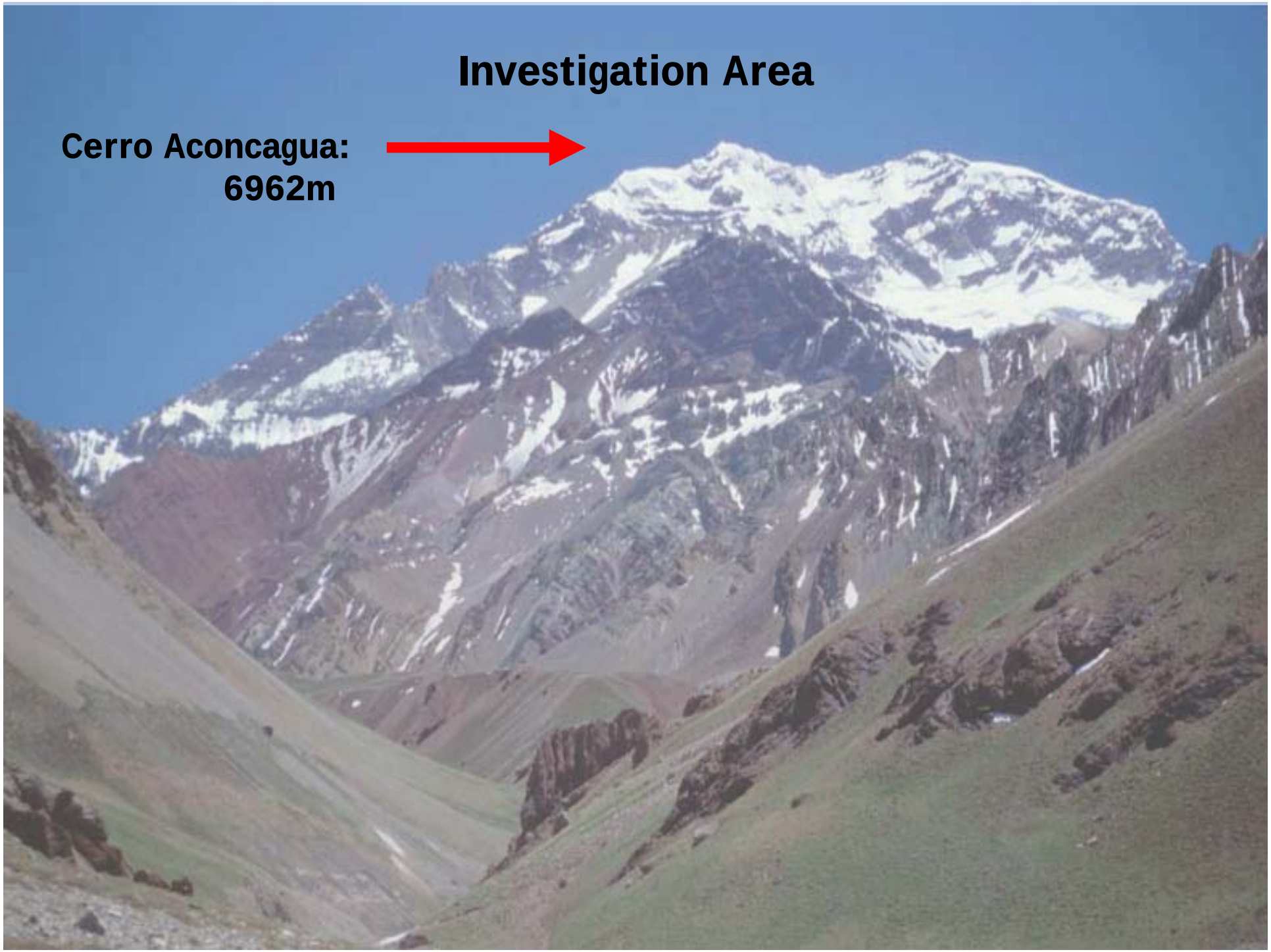
# Investigation Area

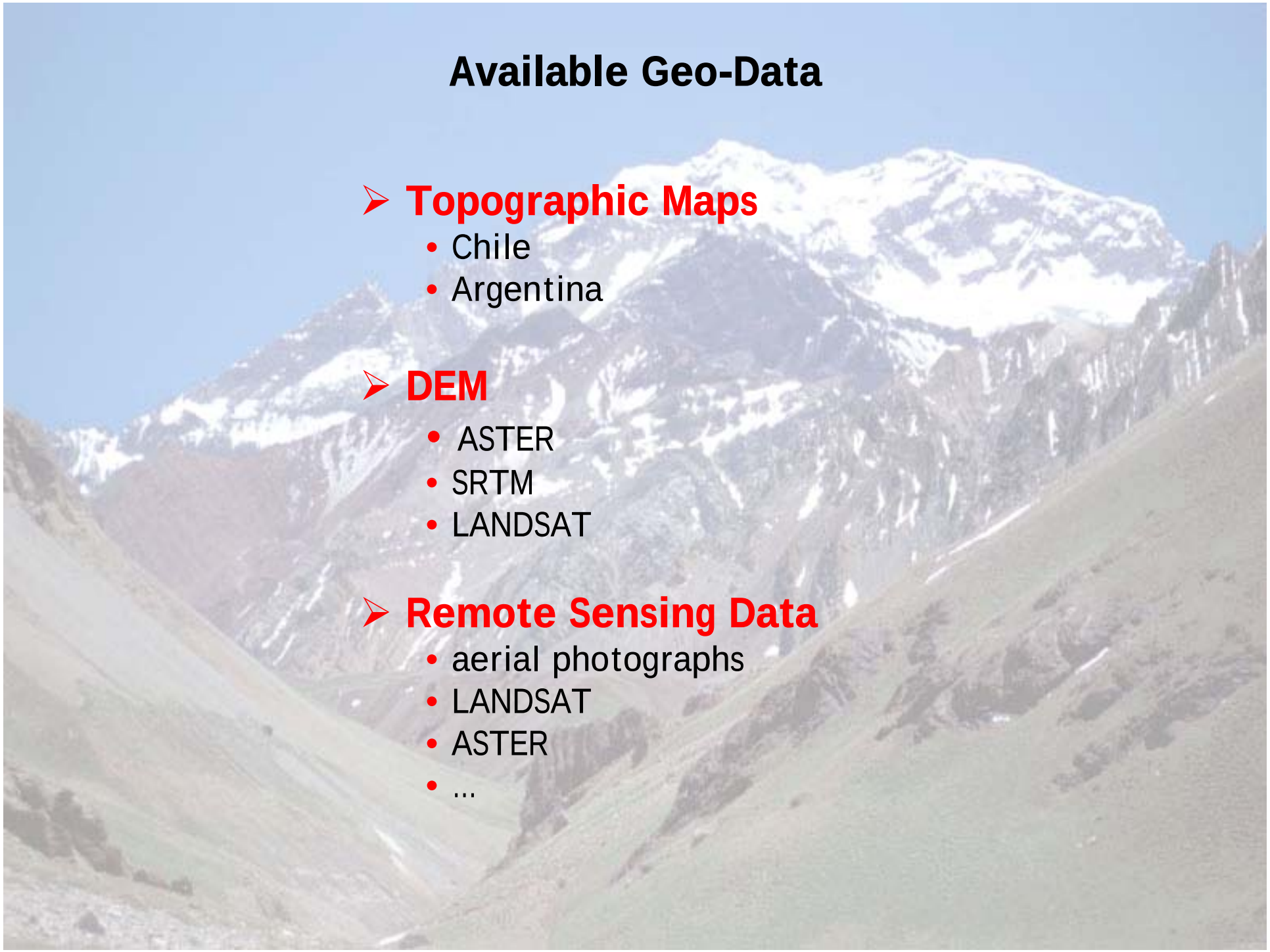
- Volcanic basement
- no active volcanoes




Pazific
Ocean
Atlantic
Ocean
Aconcagua
Watershed


Investigation Area
Cerro Aconcagua:
6962m



# Available Geo-Data

- **Topographic Maps**
  - Chile
  - Argentina
- **DEM**
  - ASTER
  - SRTM
  - LANDSAT
- **Remote Sensing Data**
  - aerial photographs
  - LANDSAT
  - ASTER
  - ...

# Available Geo-Data

## Topographic Maps – Argentina and Chile

- Topographic Maps with scale: 1:500 000, 1:250 000, 1:100 000 and 1:50 000
- Aconcagua Region: 1:50 000 and 1:100.000 of IGM in Buenos Aires/ Santiago de Chile

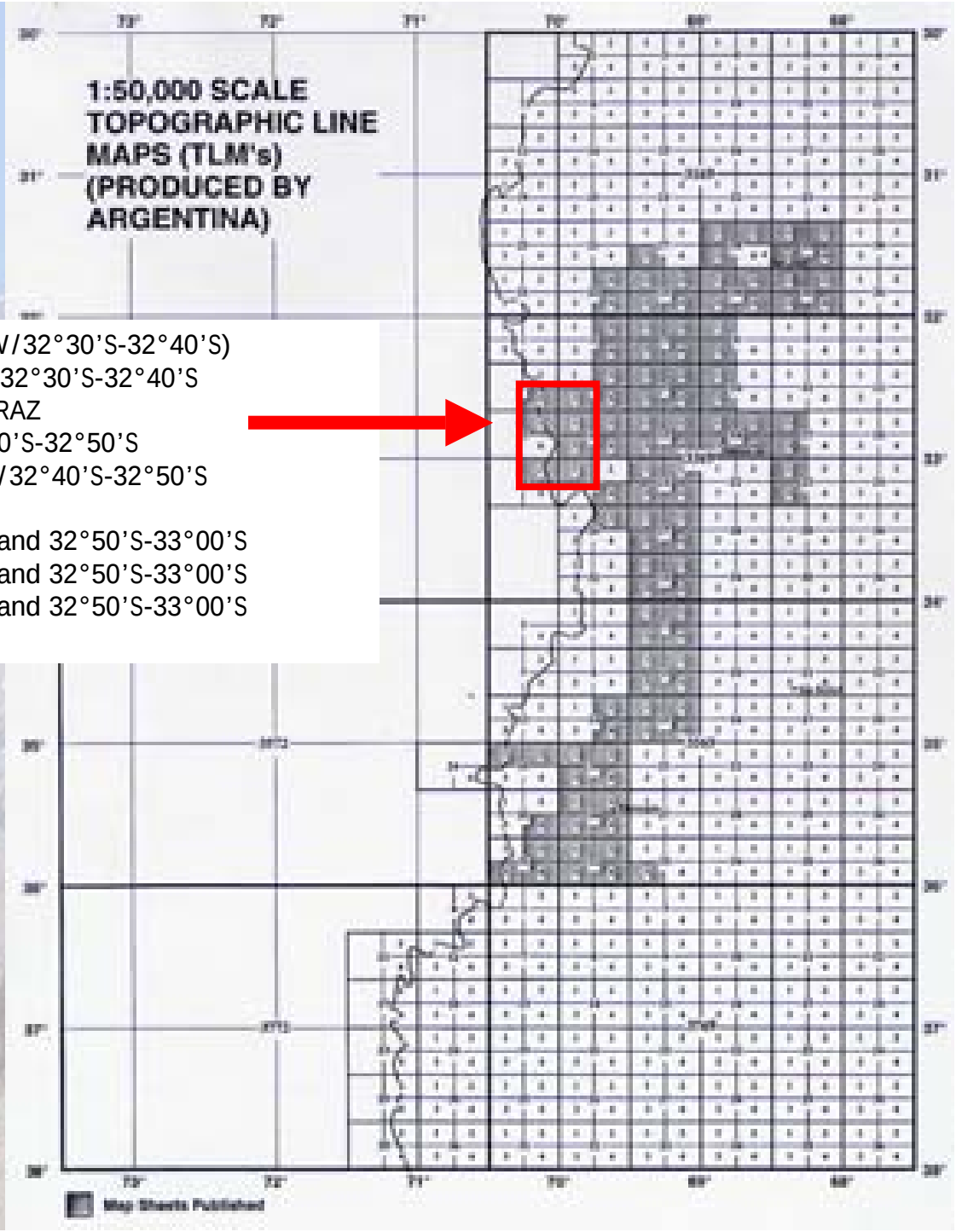
**Further Processing:**

- Scan
- Geocoding/ Mosaicing
- Digitalise contour lines/height spots, drainage system
- DEM Generation

# Available Geo-Data

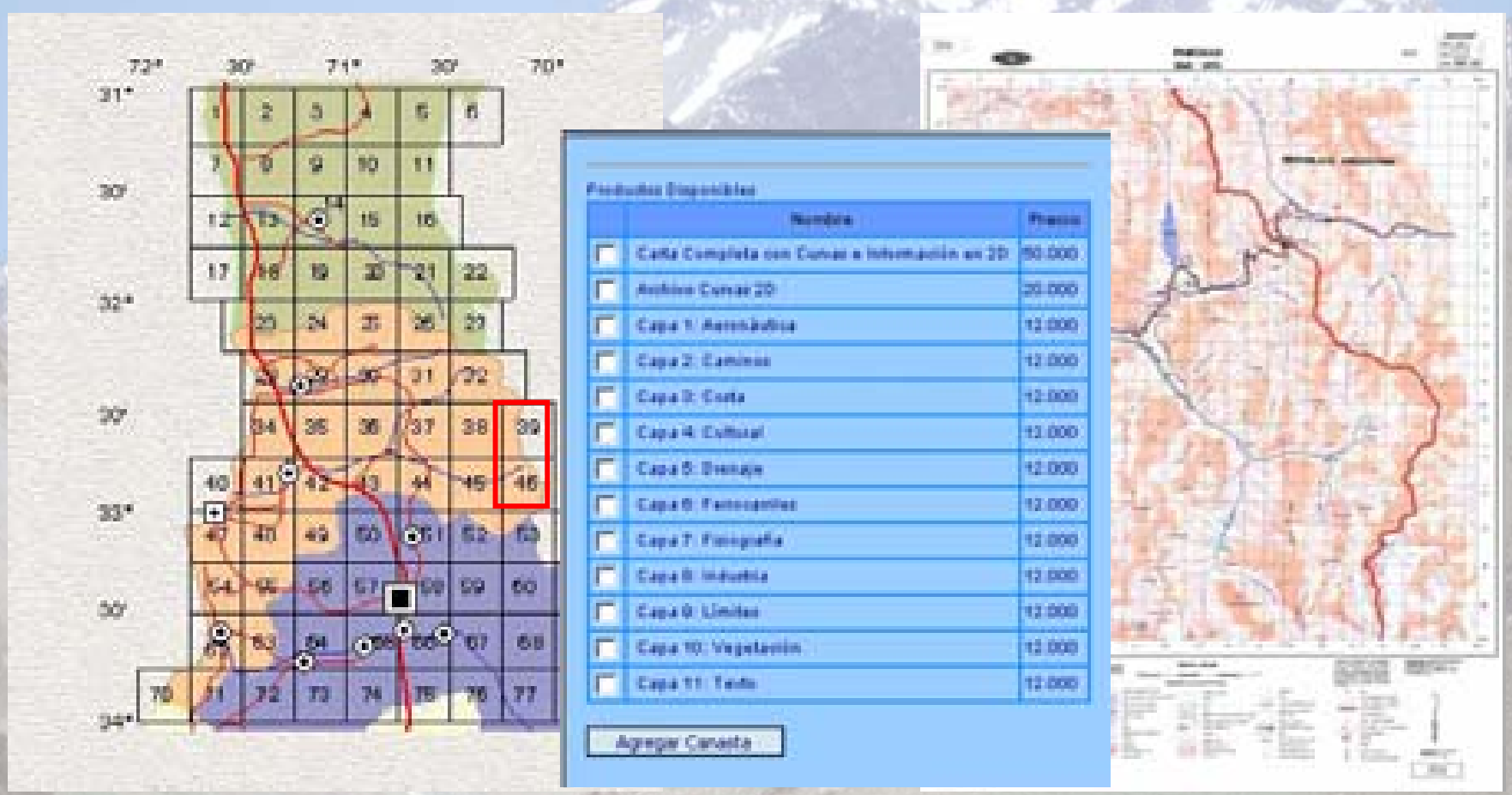
## Topographic Maps - Argentina

Sheet: 3369-7-4 CERRO ACONCAGUA (70°00'W-70°15'W/32°30'S-32°40'S)
Sheet: 3369-8-3 CERRO AMEGHINO, 69°45'W-70°00'W/32°30'S-32°40'S
including) 3369-8-4 CUMBRE DEL YALGUARAZ
Sheet: 3369-13-2 LAS CUEVAS, 70°00'W-70°15'W/32°40'S-32°50'S
Sheet: 3369-14-1 PUENTE DEL INCA, 69°45'W-70°00'W/32°40'S-32°50'S
including: 3369-14-2 POLVAREDAS
Sheet: 3369-14-3 PUNTA DE VACAS, 69°45'W-70°00'W and 32°50'S-33°00'S
Sheet: 3369-14-3 PUNTA DE VACAS, 69°45'W-70°00'W and 32°50'S-33°00'S
Sheet: 3369-14-3 PUNTA DE VACAS, 69°45'W-70°00'W and 32°50'S-33°00'S
Sheet: 3369-14-4 CERRO DE LA BATEA



# Available Geo-Data

## Topographic Maps – Chile



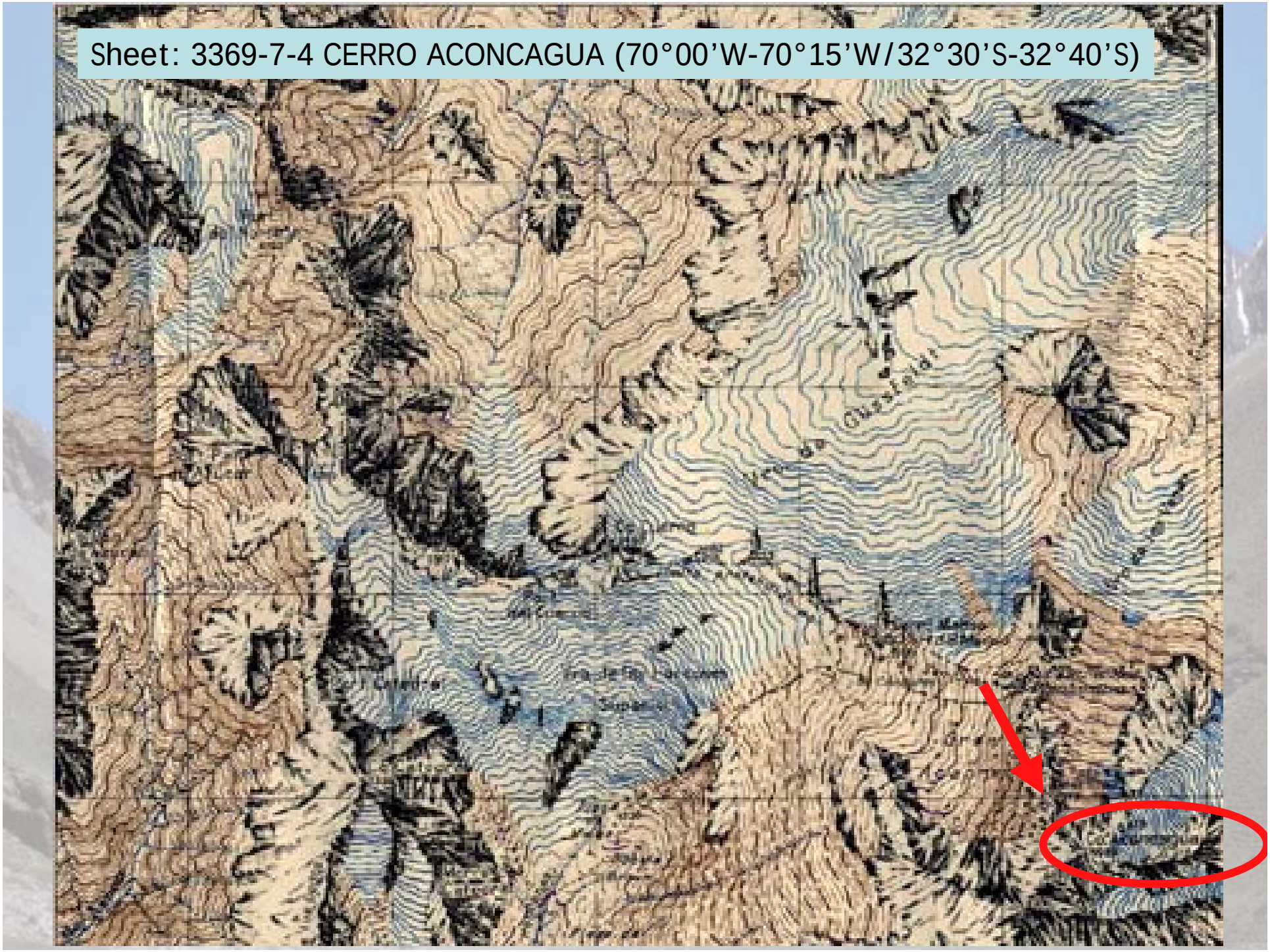

Availability: Analogue and digital

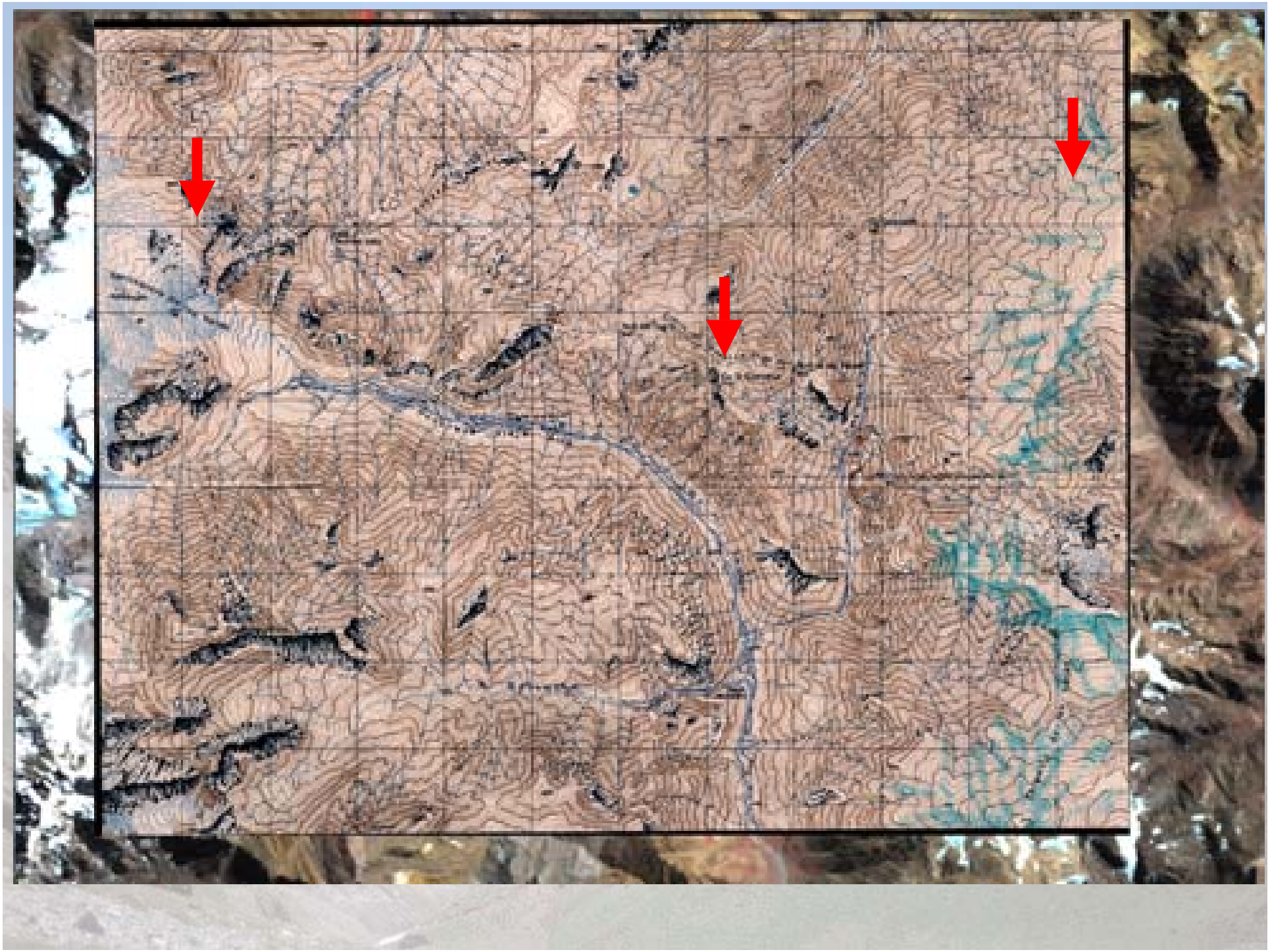
# Available Geo-Data

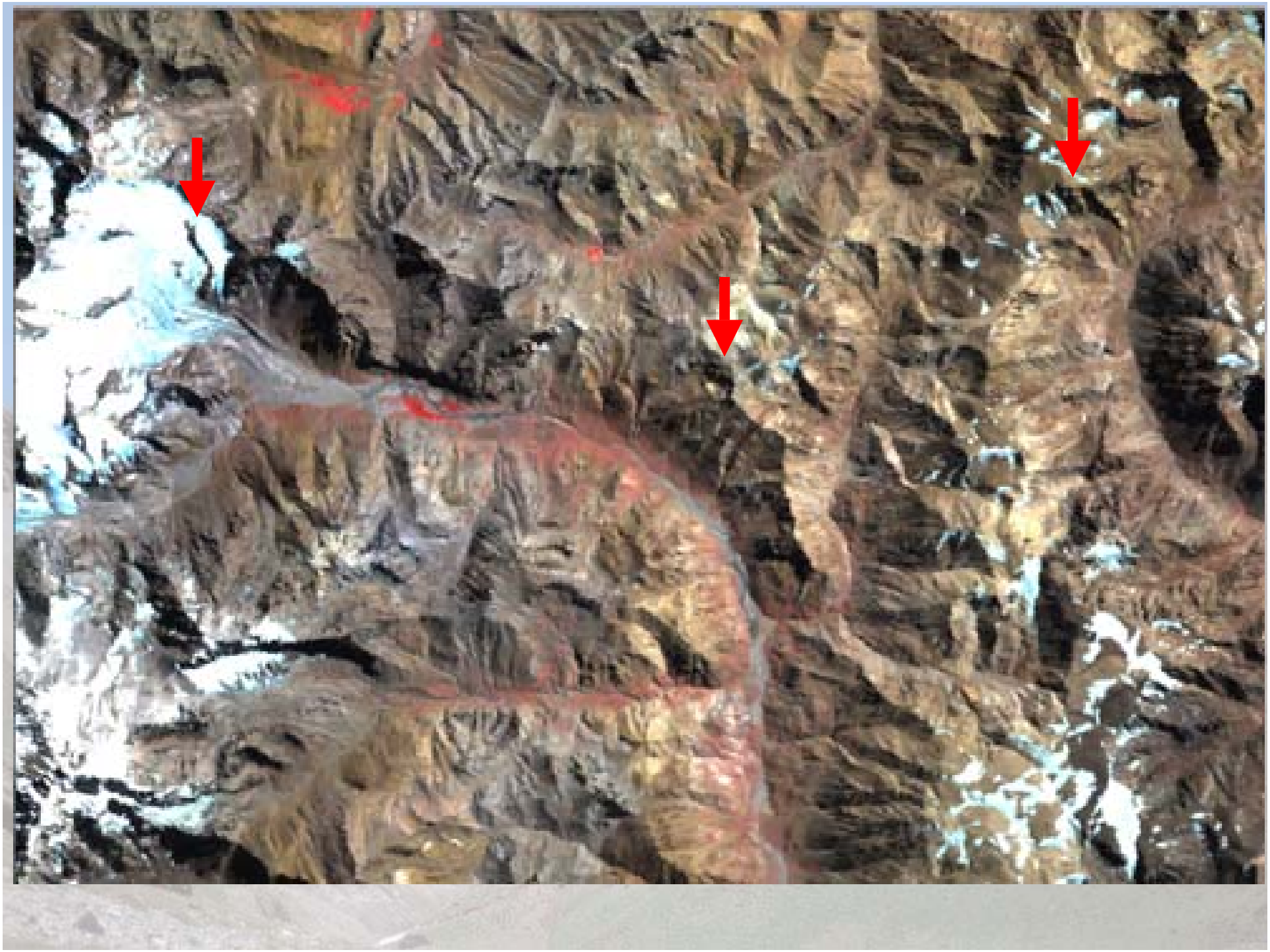
## Topographic Maps – Argentina and Chile

| ARGENTINIEN: 1:50K | CERRO ACONCAGUA | CERRO AMEGHINO | LAS CUEVAS | PUENTE DEL INCA | PUNTA DE VACAS |
|---|---|---|---|---|---|
| **Geodetic System** | No information | No information | No information | No information | No information |
| **Terrestrial Photogrammetry** | 1924, 1929, 1945 | 1929, 1945 | 1924, 1945 | 1924-1929, 1944, 1945 | -1929, 1943/44/45, 1948/49 |
| **Edition** | 1950 | 1951 | 1951 | 1951 | 1952 |
| **Representation** | Legend, colour edition, Equidistance: 25m, 100m; rock representation | | | | |

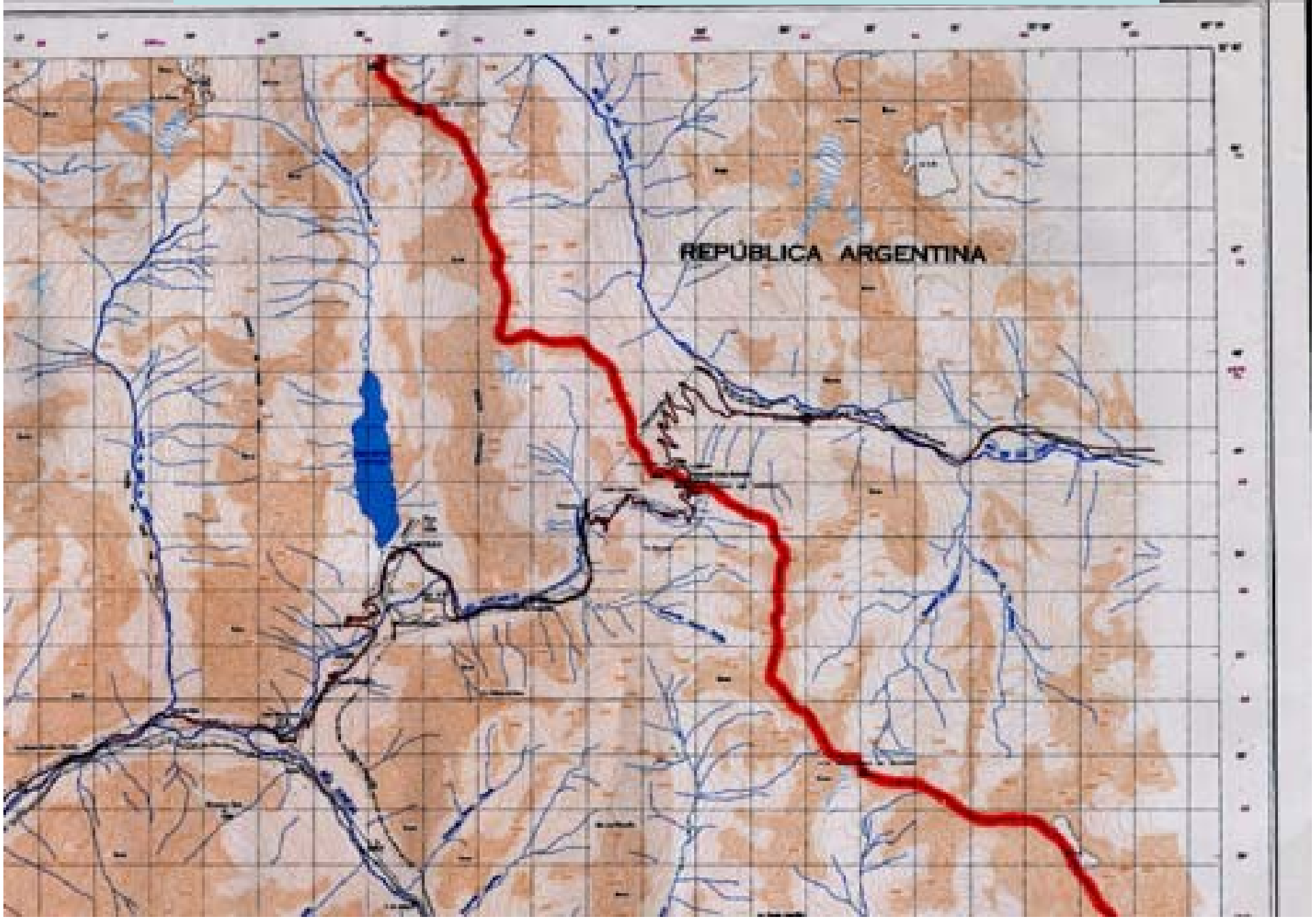
| CHILE: 1:50K | RIO DE LOS LEONES | PORTILLO |
|---|---|---|
| **Geodetic System** | International Ellipsoid 1924,<br>UTM-Projection, Meridian 69°W,<br>Latidute:10 000km south of Equator,<br>height: Nivel Medio del Mar | |
| **Aerial Photograph:** | 1955 | |
| **Fieldwork** | 1964 | |
| **Revision** | 1977 | 1981 |
| **Edition** | 1985 | 1994 |
| **Representation** | Legend, colour edition, Equidistance : 50m, 250m; rock representation | |

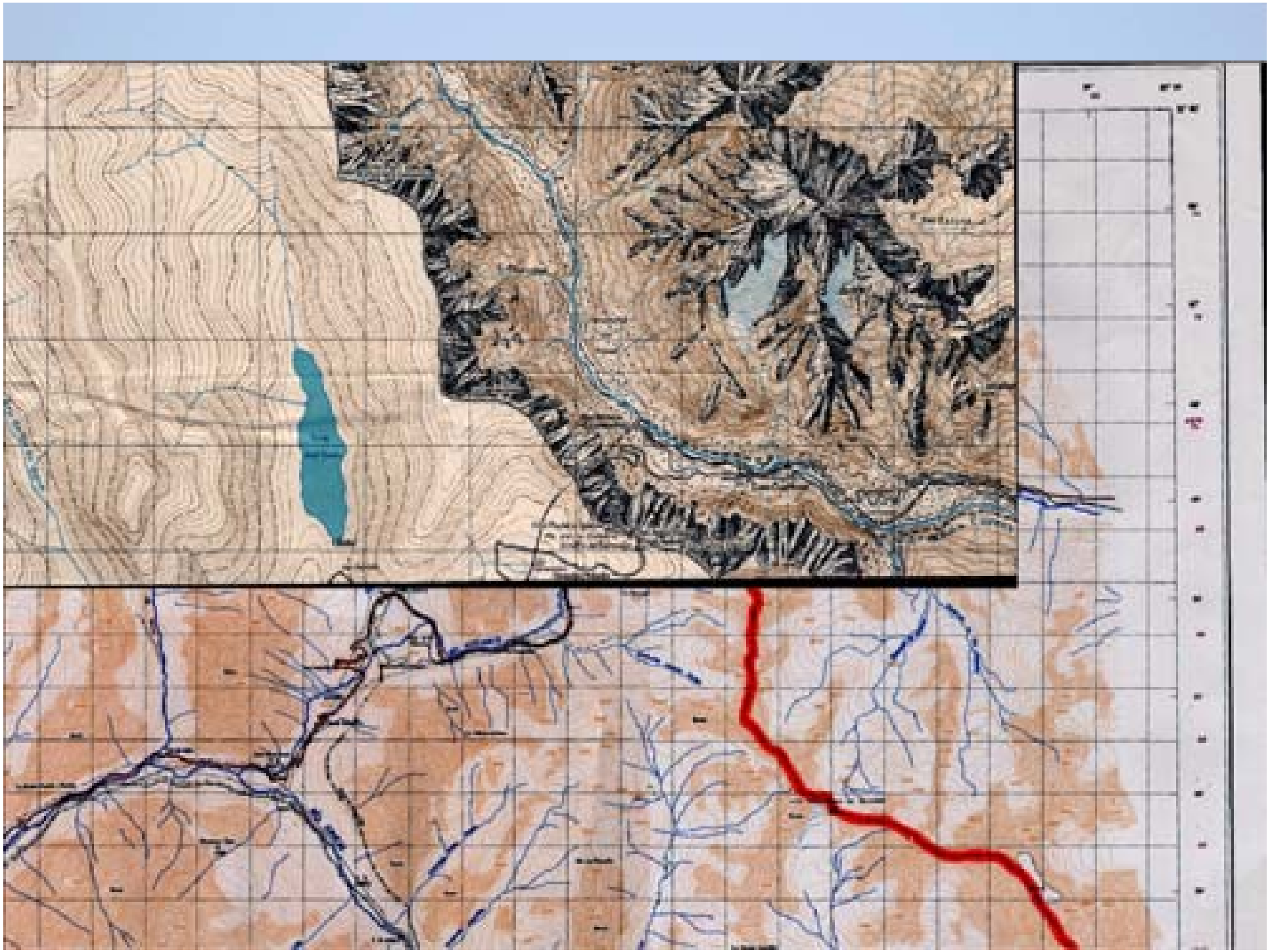

Sheet: 3369-7-4 CERRO ACONCAGUA (70°00'W-70°15'W/32°30'S-32°40'S)

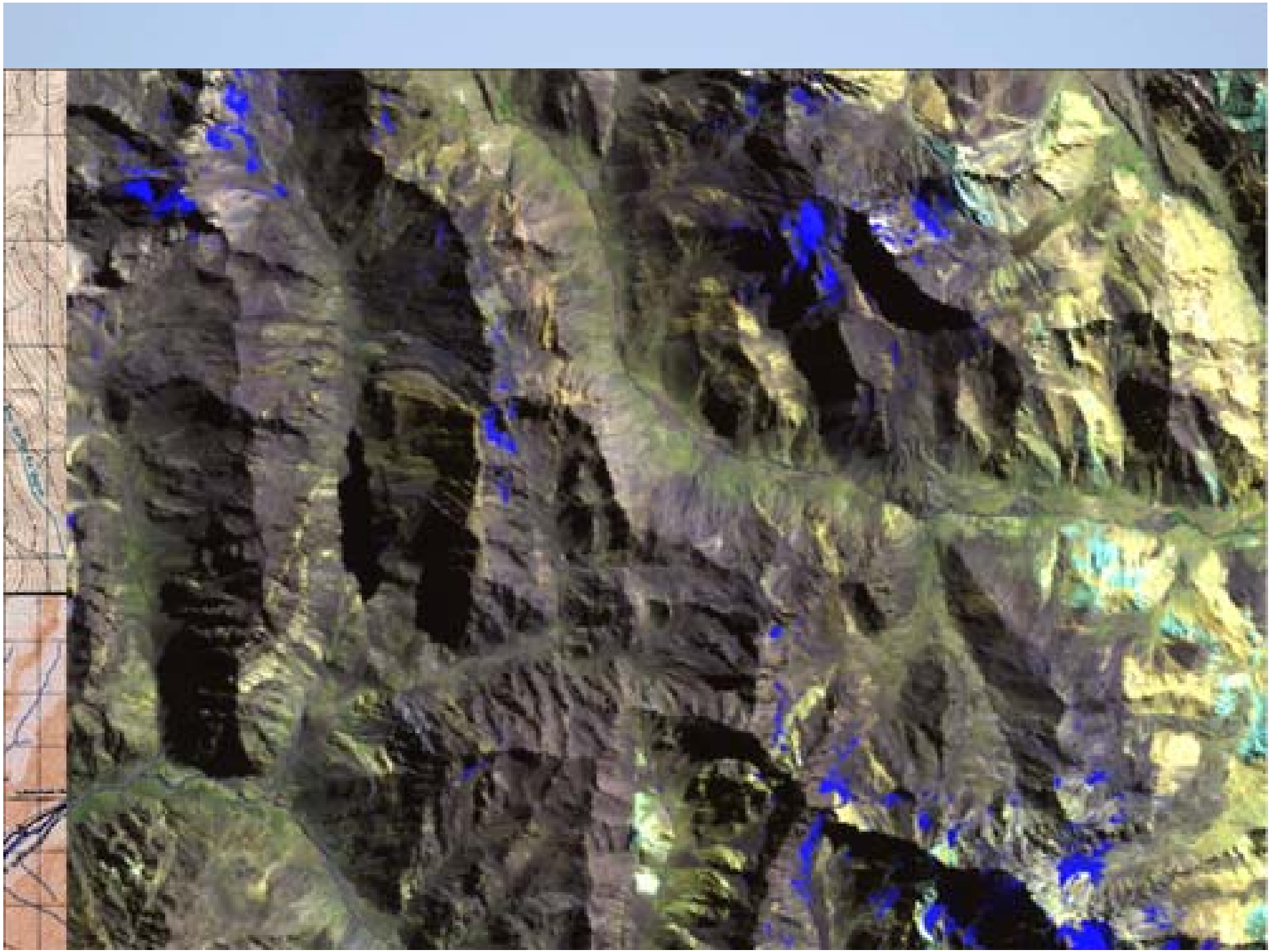




Sheet: 3245-6958 PORTILLO, 69°58’W-70°15’W/32°45’S-33°00’S







# Available Geo-Data

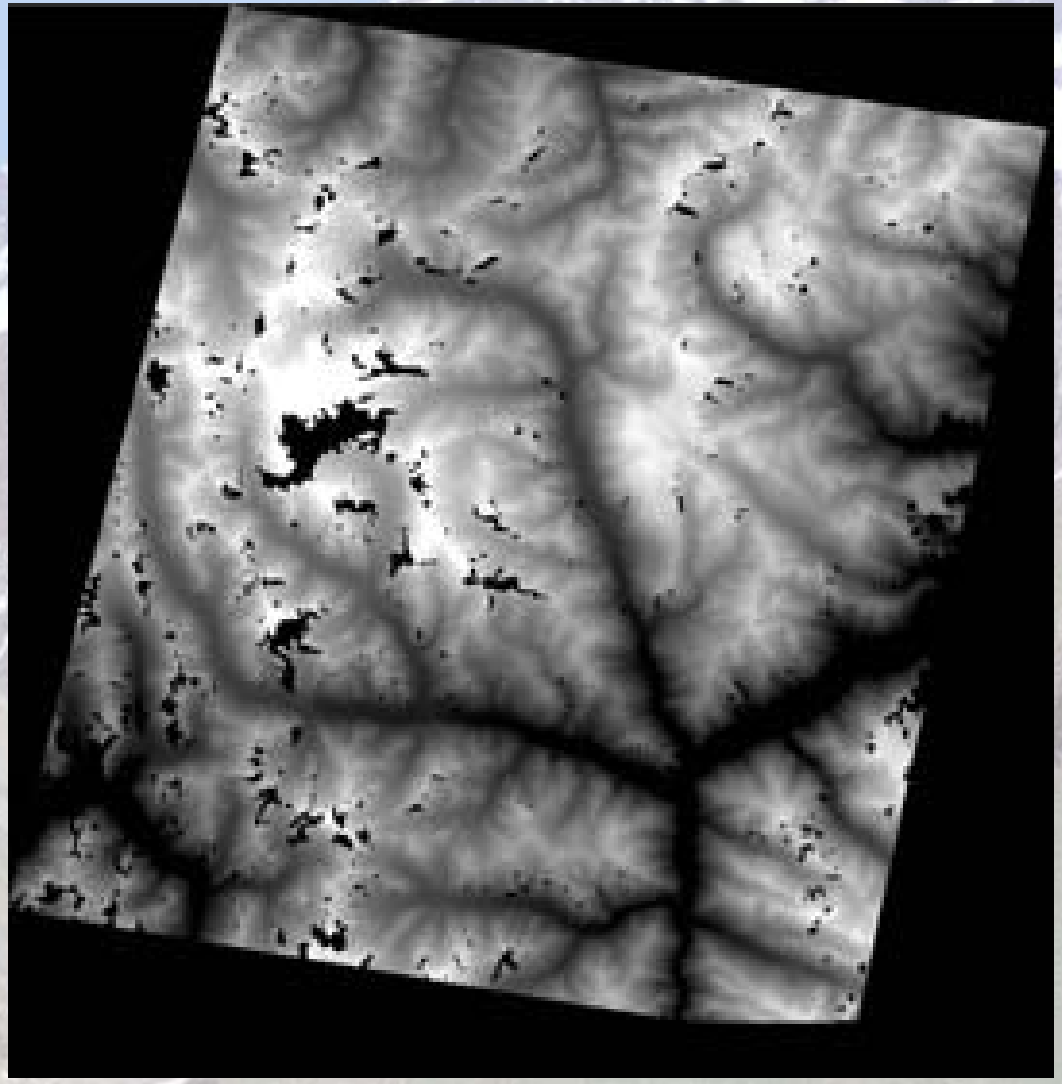
## DEM

- **SRTM**
  - SRTM Original
  - SRTM GTOPO30
- **ASTER**
  - “public” Data
  - ASTER DEM generation
- **LANDSAT**
  - Stereoscopic TM Scenes

# Available Geo-Data

## DEM

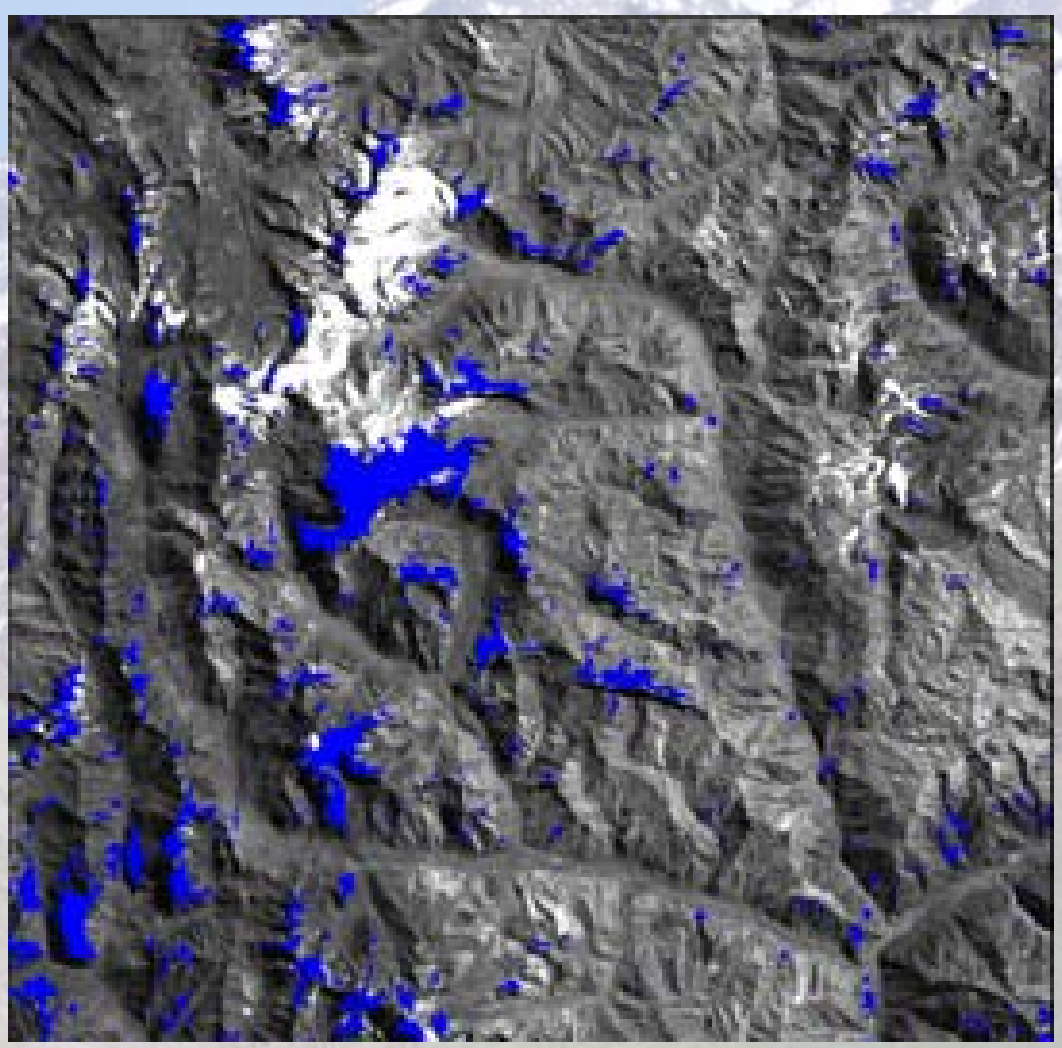
SRTM Data



# Available Geo-Data

## DEM

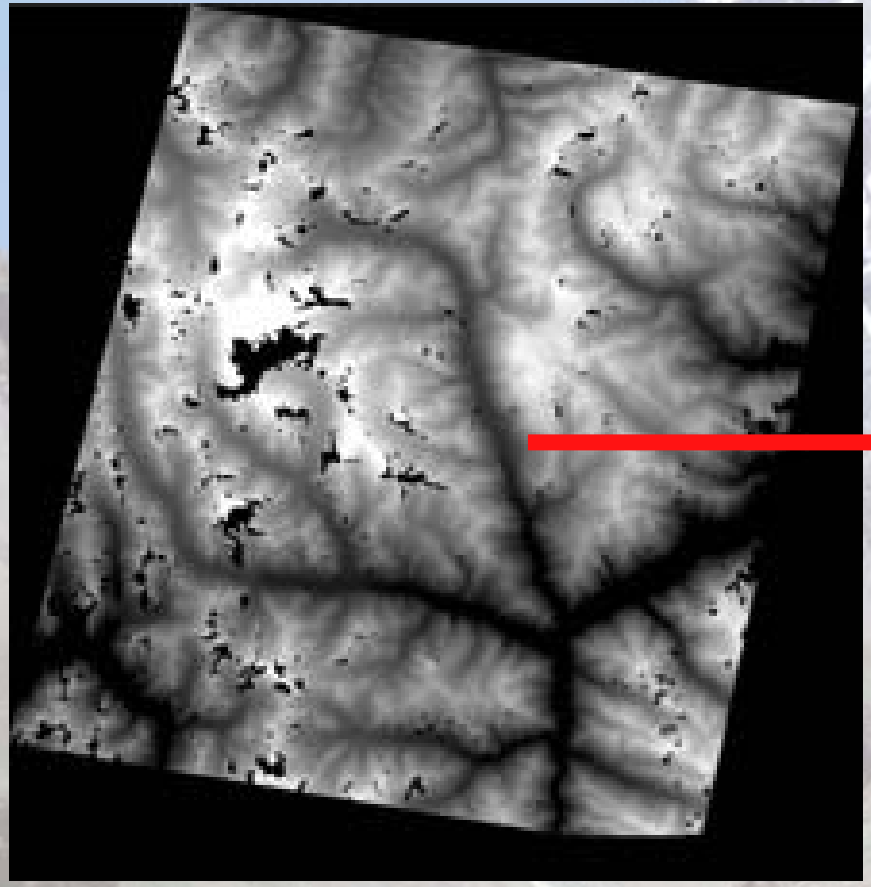
SRTM Data

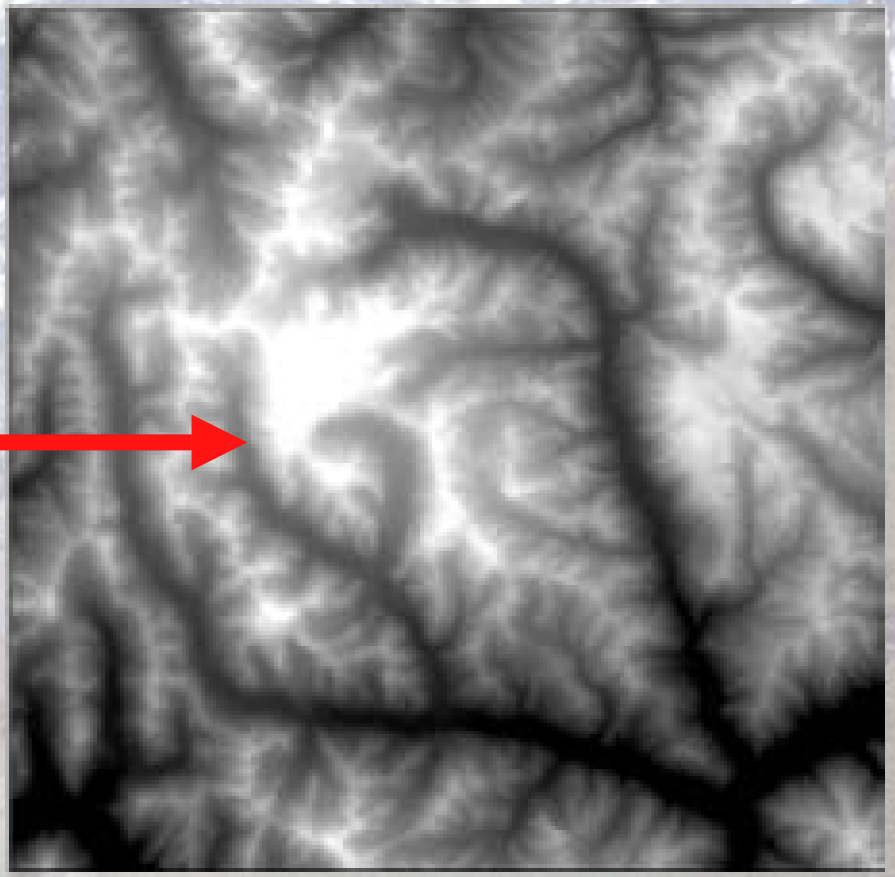


# Available Geo-Data

## DEM

SRTM Data





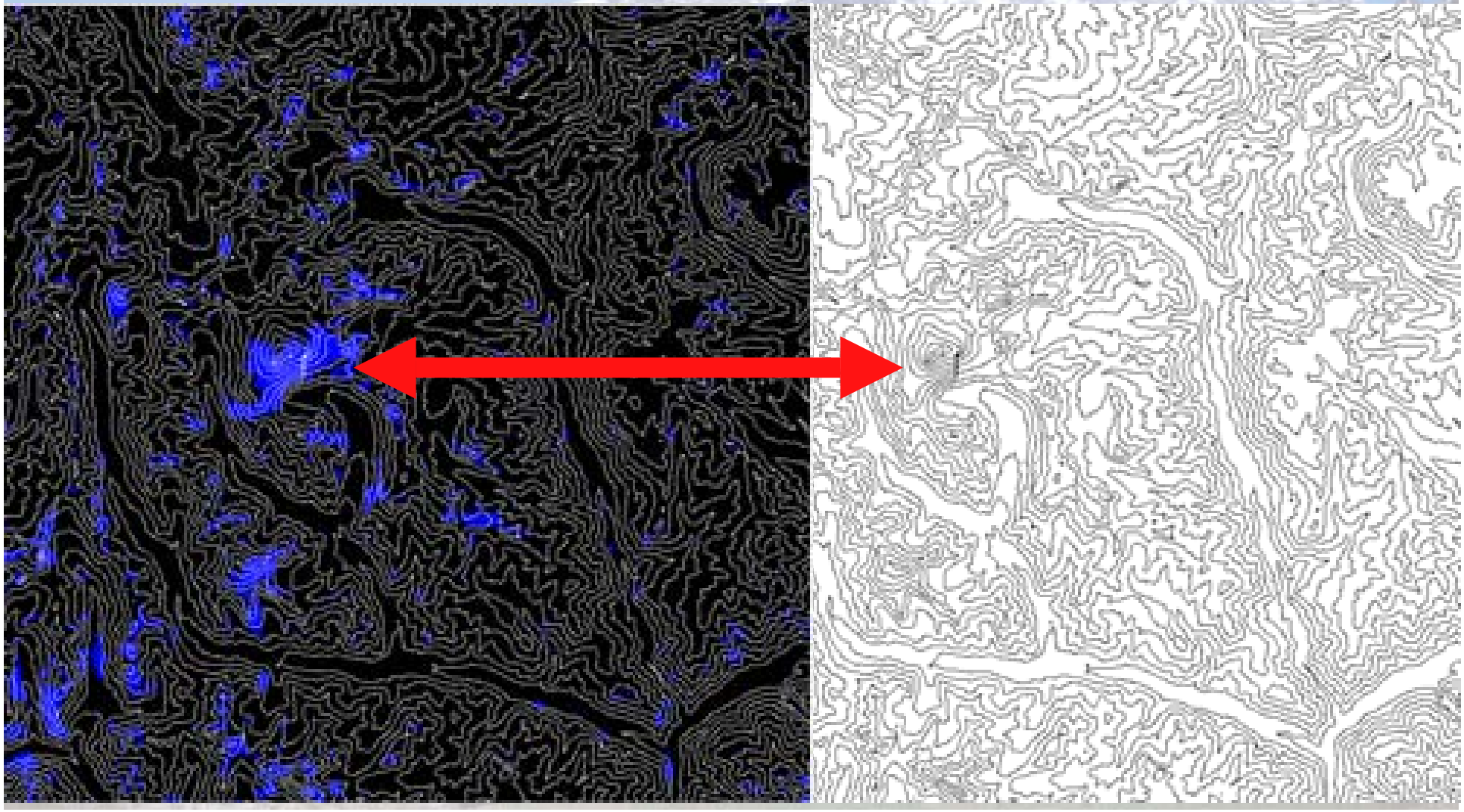
Original SRTM DEM Data

Processed SRTM DEM Data

# Available Geo-Data

**DEM**

SRTM Data



# Available Geo-Data

## DEM

### ASTER Data

2 available ASTER DEM:

- **Absolute DEM's** have extern GCP´s (provided by Kunden)
- **Relative DEM's** without any extern reference (GCP´s).

The horizontal and vertical accuracy varies between 7 and 10m. These values are situated within the toleranceith a scale of 1:250.000 to 1:50.000.

(ERSDAC 1999, ERSDAC 2001, USGS 2003).

# Available Geo-Data

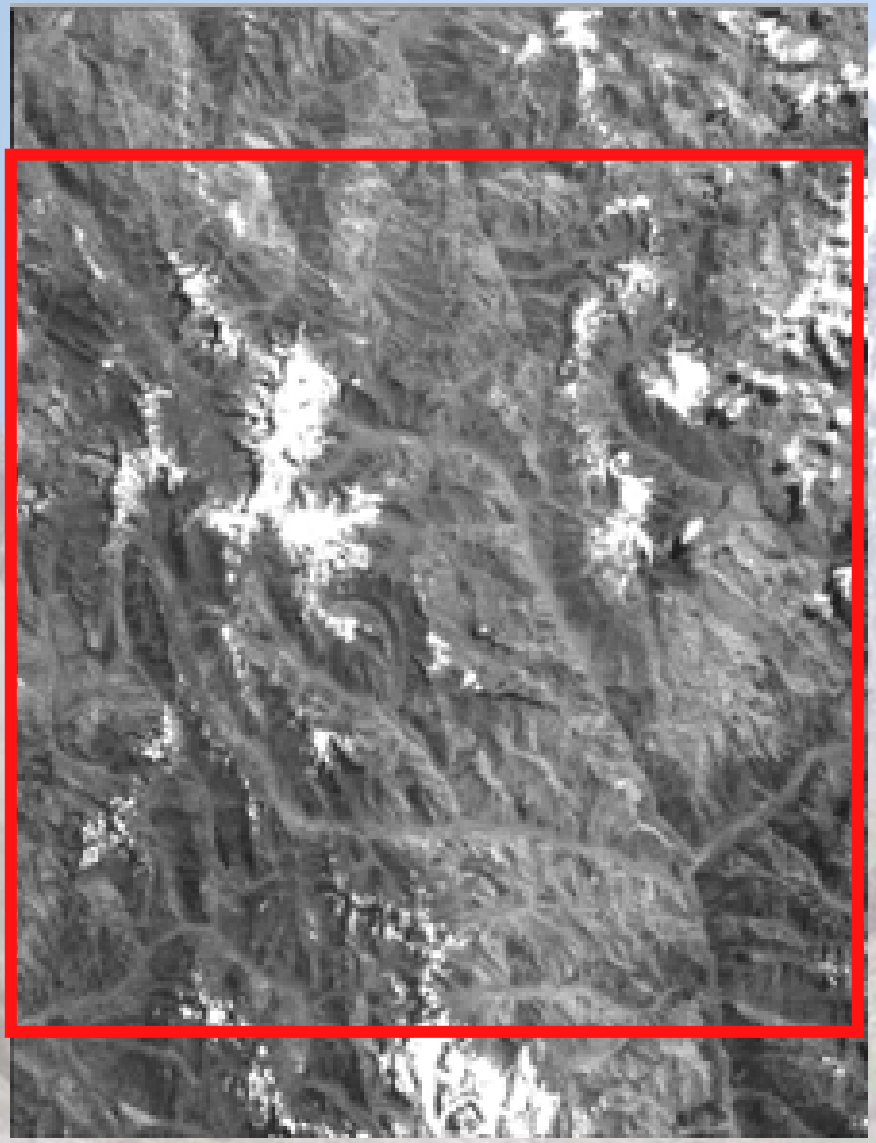
## DEM

ASTER Data

Data set: ASTER DIGITAL ELEVATION MODEL V003
Granule: SC:AST14DEM.003:2027469942
Local granule ID: ASTER_DEM2005020313492 4.hdf
Acquired: on 2000-11-19 14:58:00.0Z
Center lat/lon: -32.41° Lat, -70.13° Lon

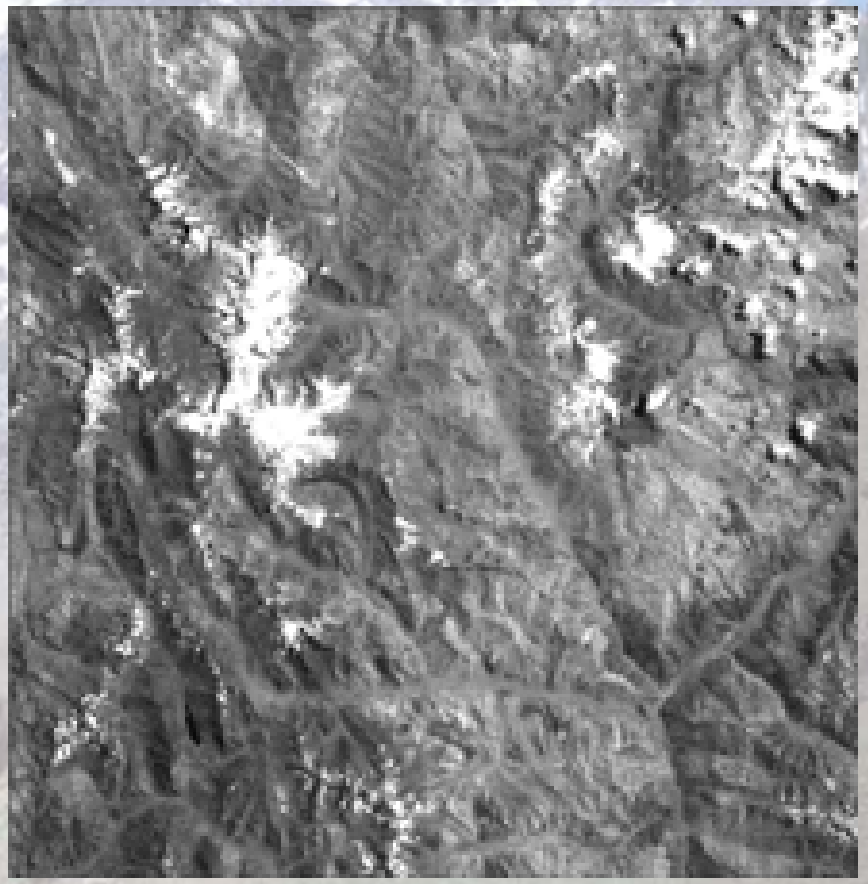
# Available Geo-Data

## DEM/ASTER Data



ASTER 3b

22.01.2004



ASTER 3n

# Available Geo-Data

**DEM**

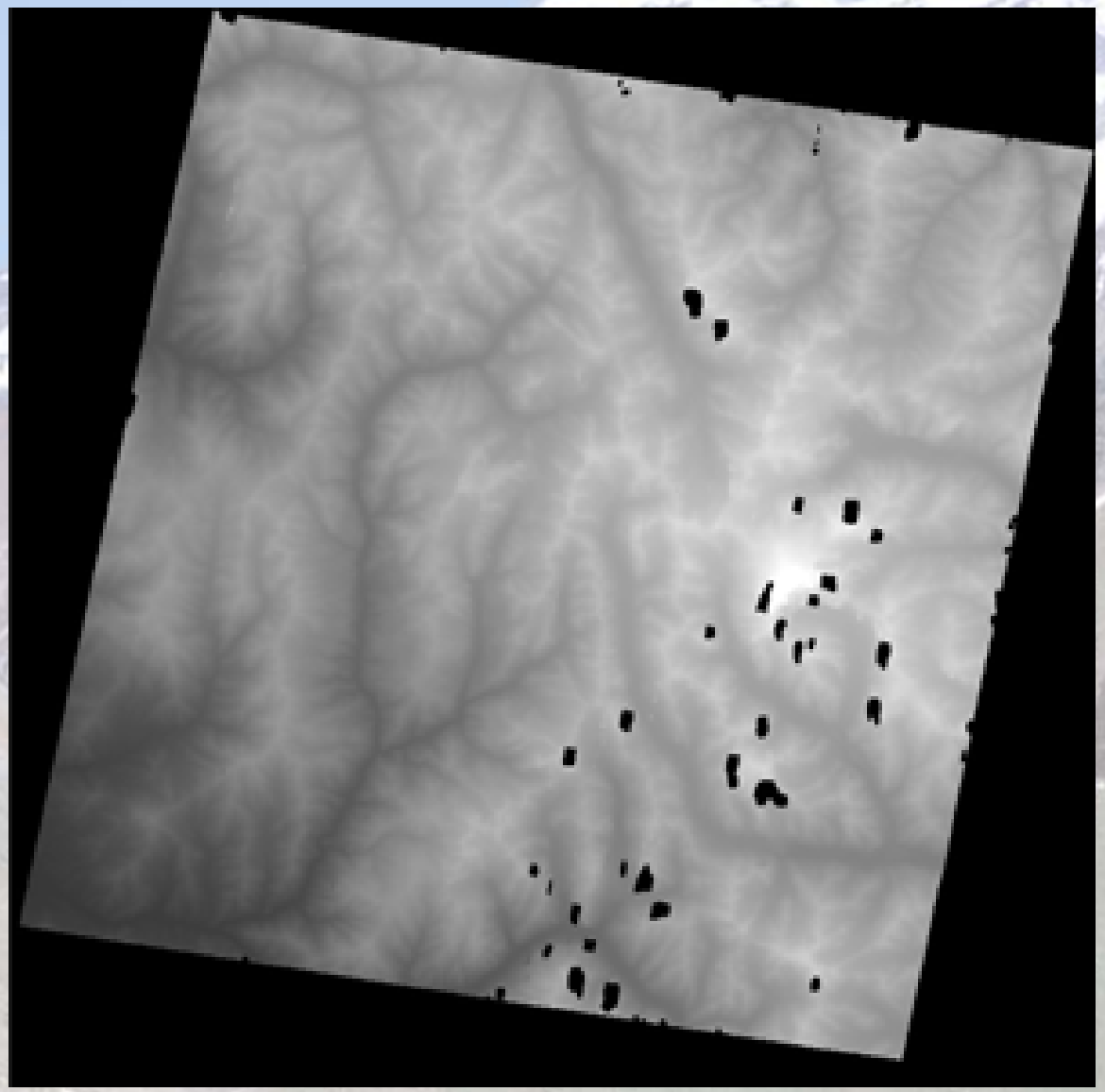
ASTER Data NEW

## Workflow

1. Input Level 1a Daten
2. Radiometric Correction and image enhancement
3. Definition of Sensor parameter
4. Definition of tie points
5. Definition of GCP´s (X,Y: Topographic Maps: 1:50.000 and LANDSAT-ETM+(P), Shaded Relief of SRTM; height spots: SRTM
6. Triangulation
7. DEM Generation
8. „Post processing“ (Aquality control, Filter, manual correction)
9. Orthophoto generation
10. Integration in STEREO ANALYST and quality analyses

# Available Geo-Data

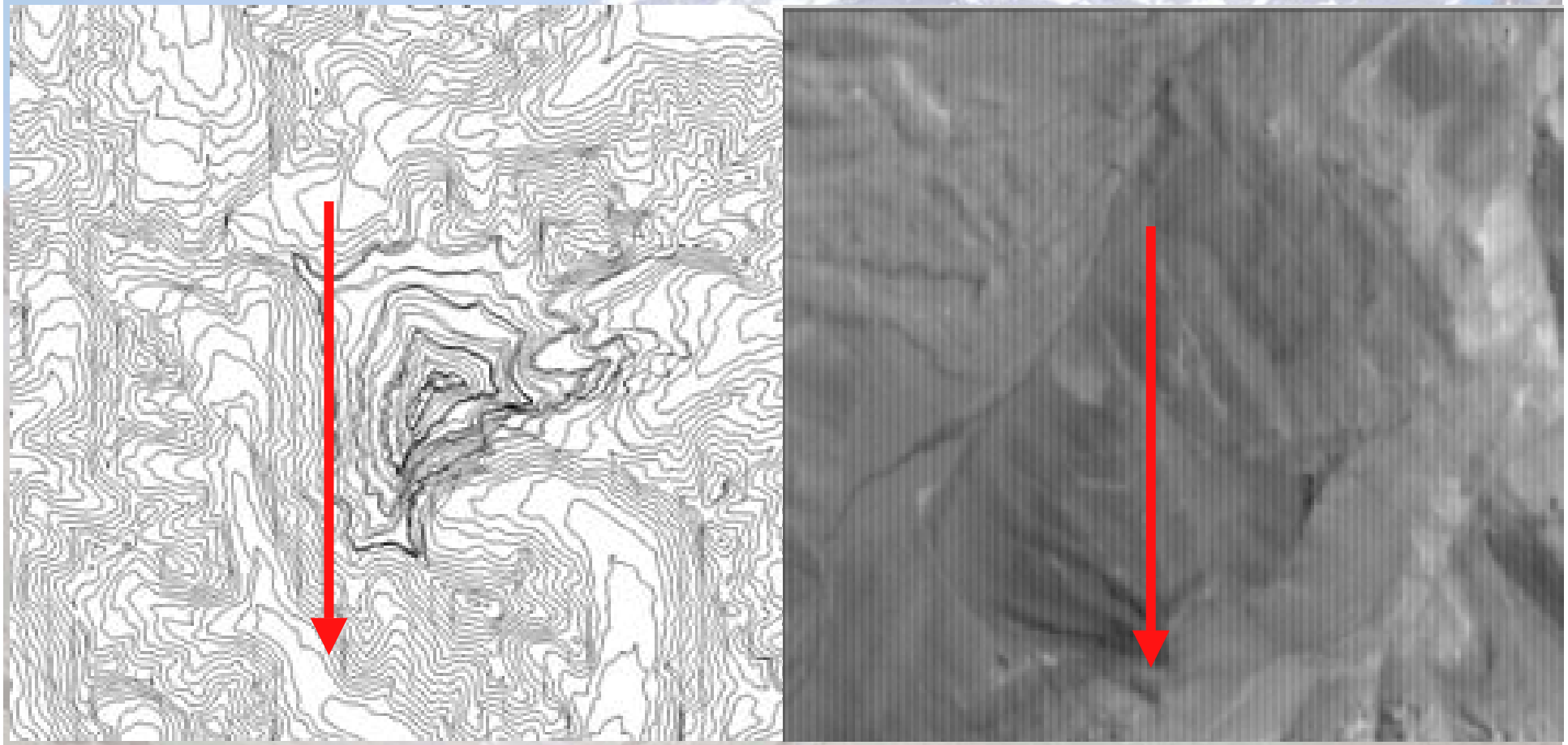
## DEM/ASTER



# Available Geo-Data

## DEM

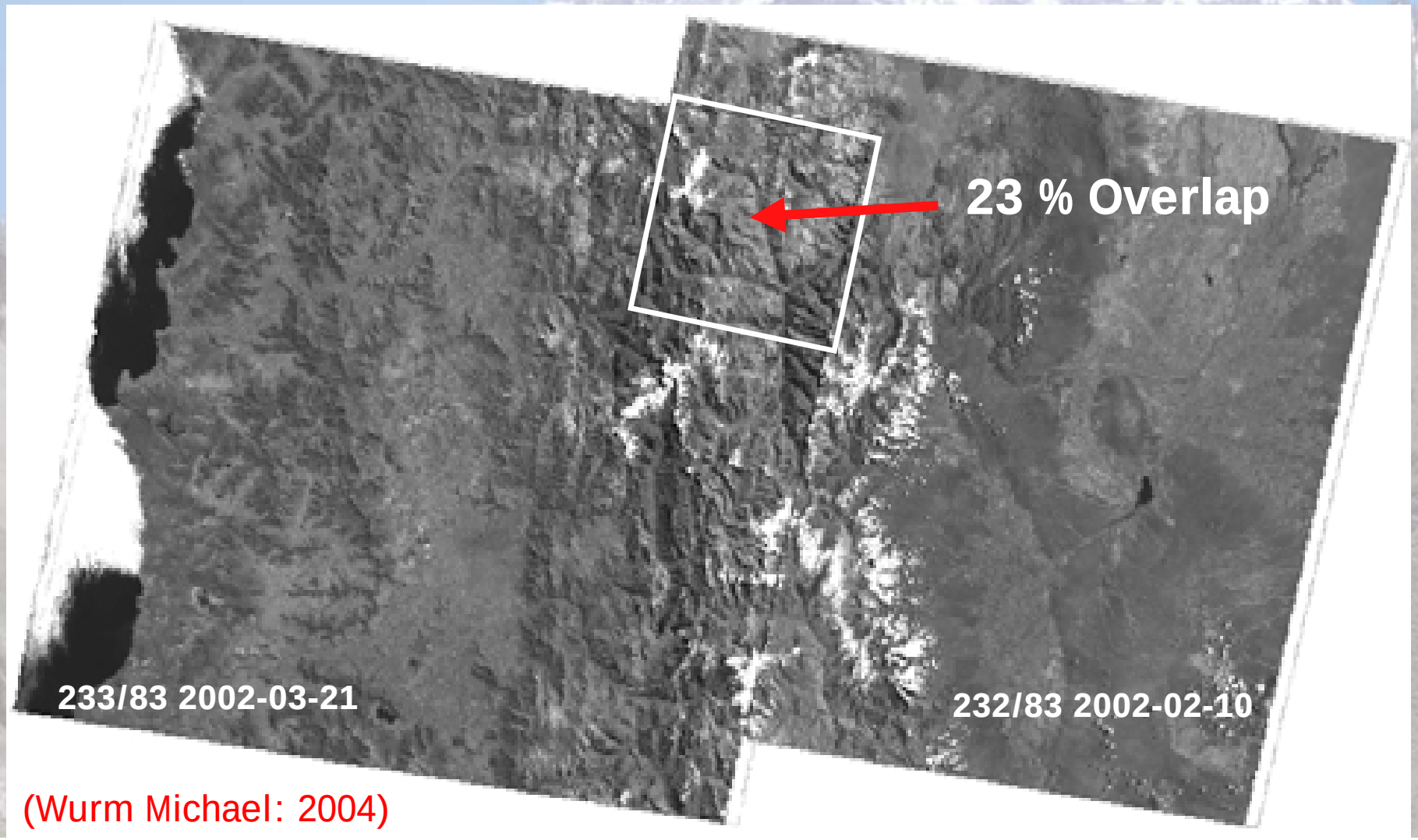
ASTER “STRIPING” in E-W Exposition



# Available Geo-Data

## DEM

LANDSAT ETM+ Stereo Data

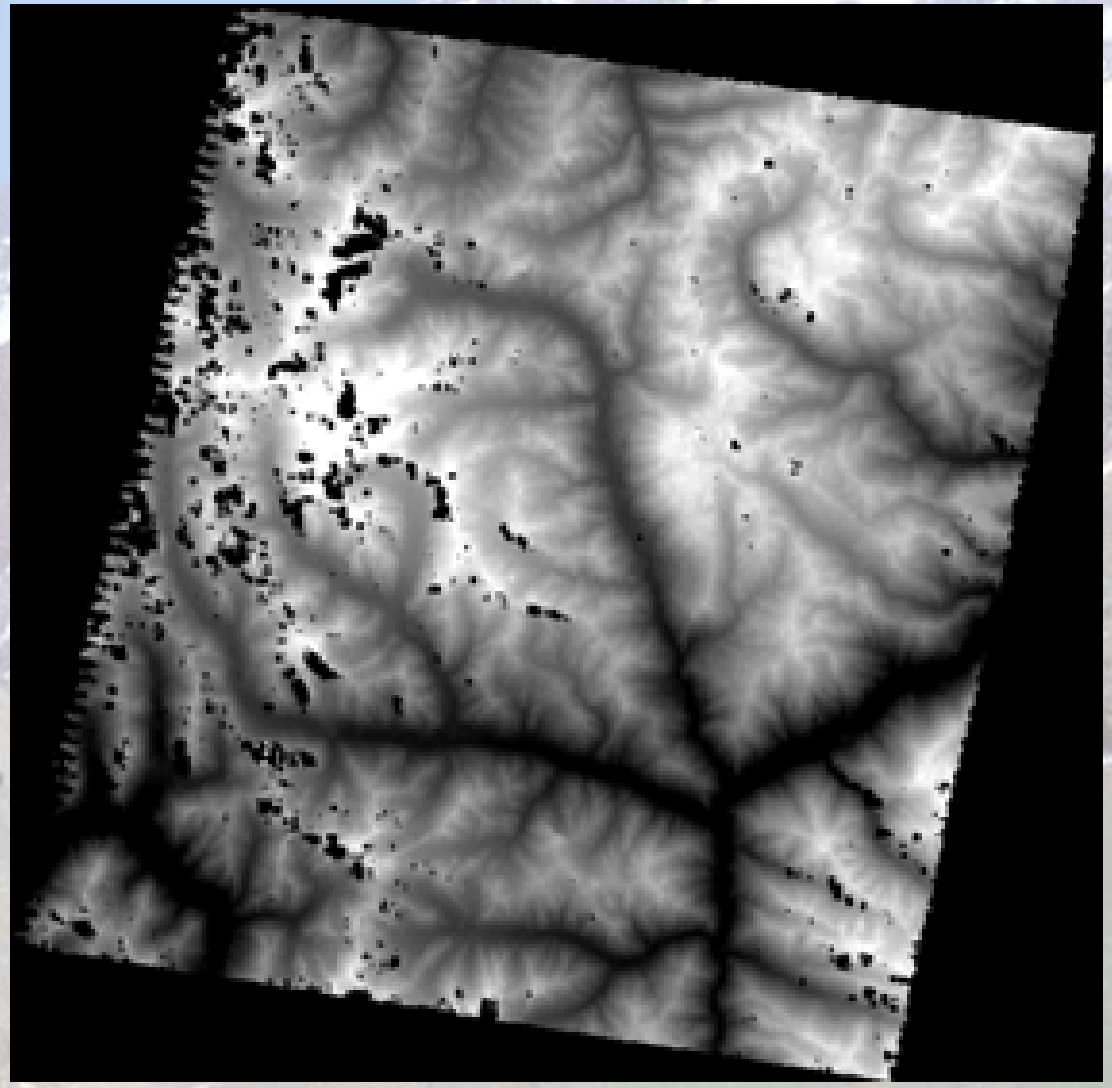



(Wurm Michael: 2004)

# Verfügbare GEO-DATEN

## Höhenmodelle

LANDSAT ETM+ Stereo Daten



# Available Geo-Data

## DEM

### Evaluation - Methodology

**Which features/attributes should be evaluated?**

- Height (-difference),
- Height related „features“ (Exposition and Inclination)
- additional derivates (Plancurvature, Profilecurvature)

Cf.: Gspurning/Sulzer, 2004)

# Available Geo-Data

## DEM

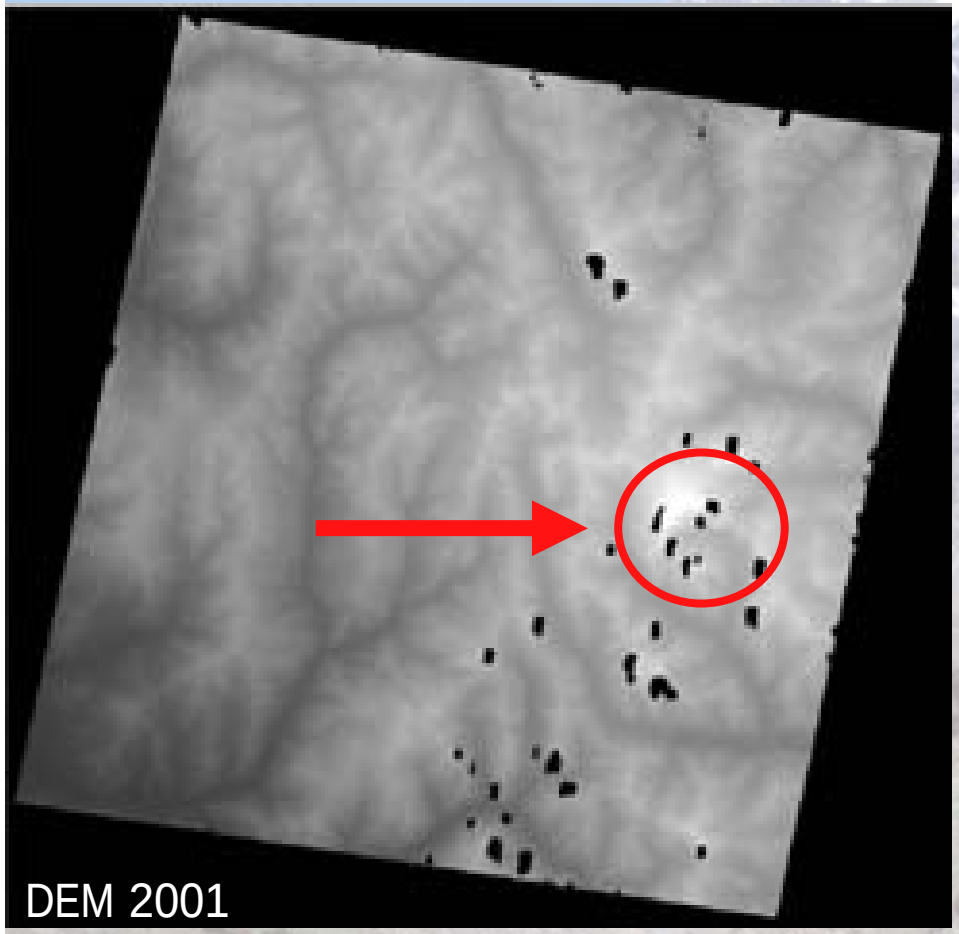
### Evaluation

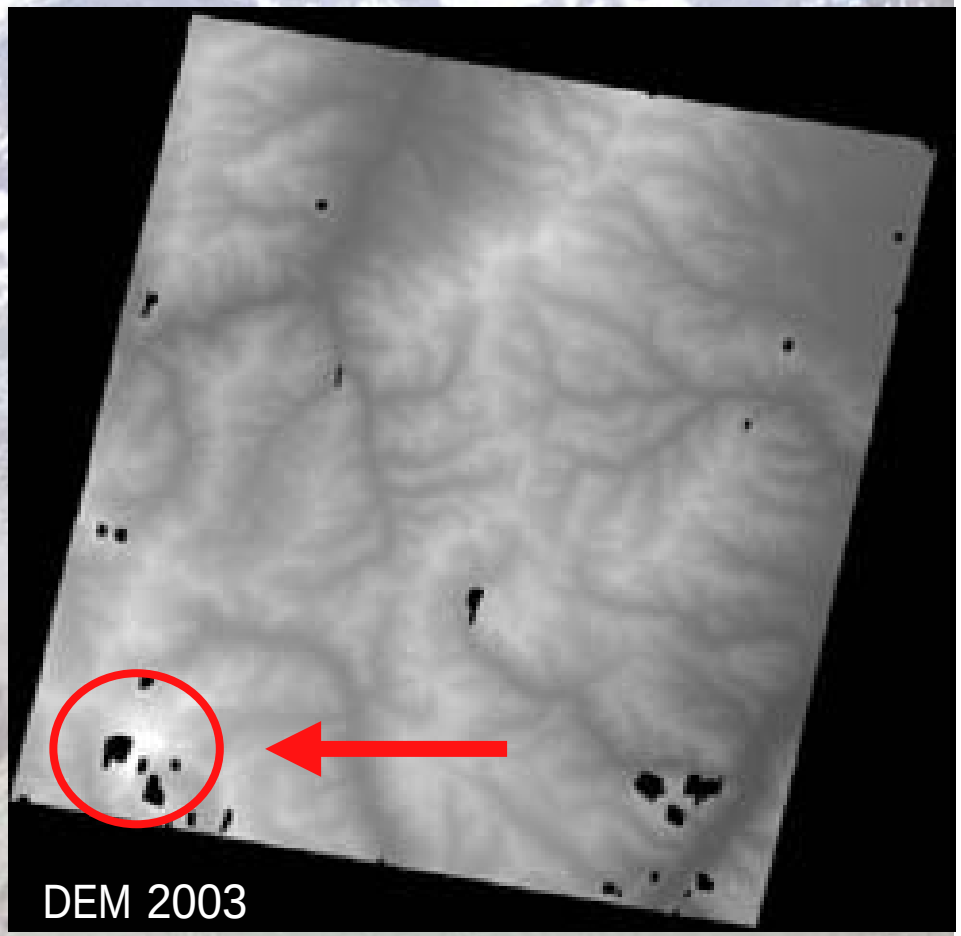
- no terrestrial reference model available
- Accuracy lies within the specification of data definition
- Well known limits of used data sets
  - „Striping“ of ASTER-Data
  - reduced applicability of LANDSAT Stereo analyses
  - SRTM resolution of 100m
  - North exposed slopes with „zero data values“ (ASTER, SRTM)
  - High mountain environment (snow, shadow, relief, clouds, dust, etc.)

# Available Geo-Data

## DEM

Combined analyse of multitemporal and multisensoral DEM`s



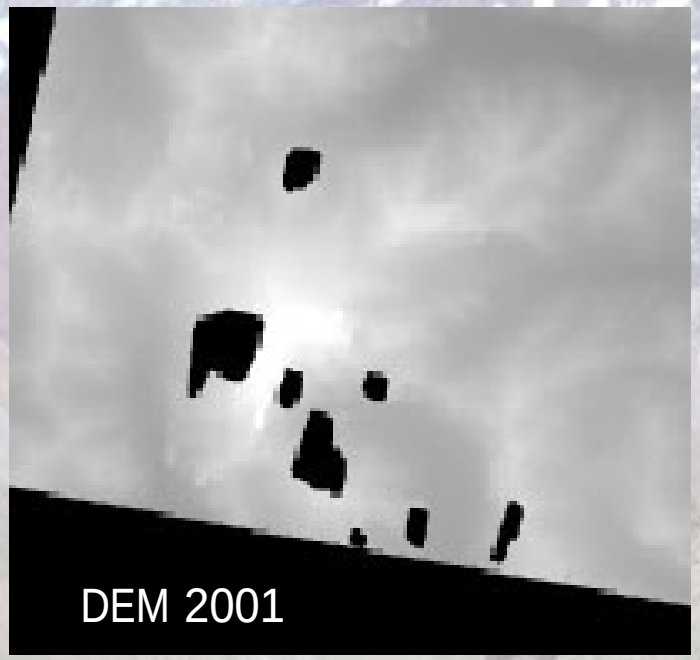



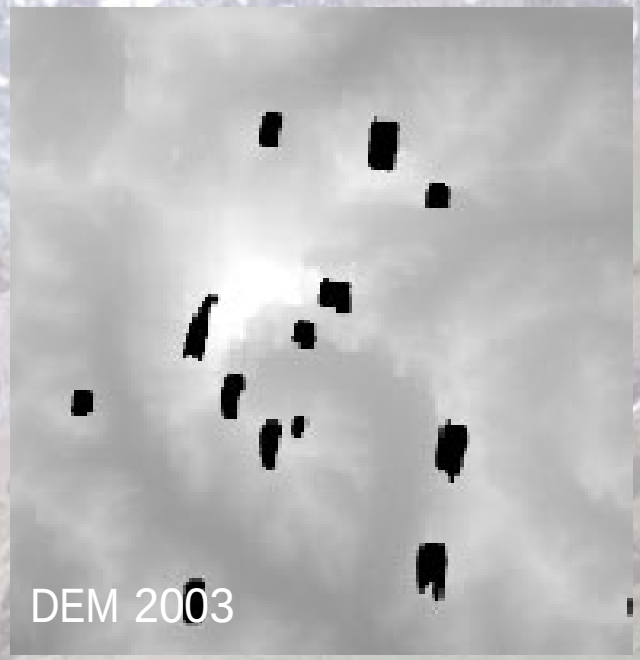
# Available Geo-Data

## DEM

Combined analyse of multitemporal and multisensoral DEM`s

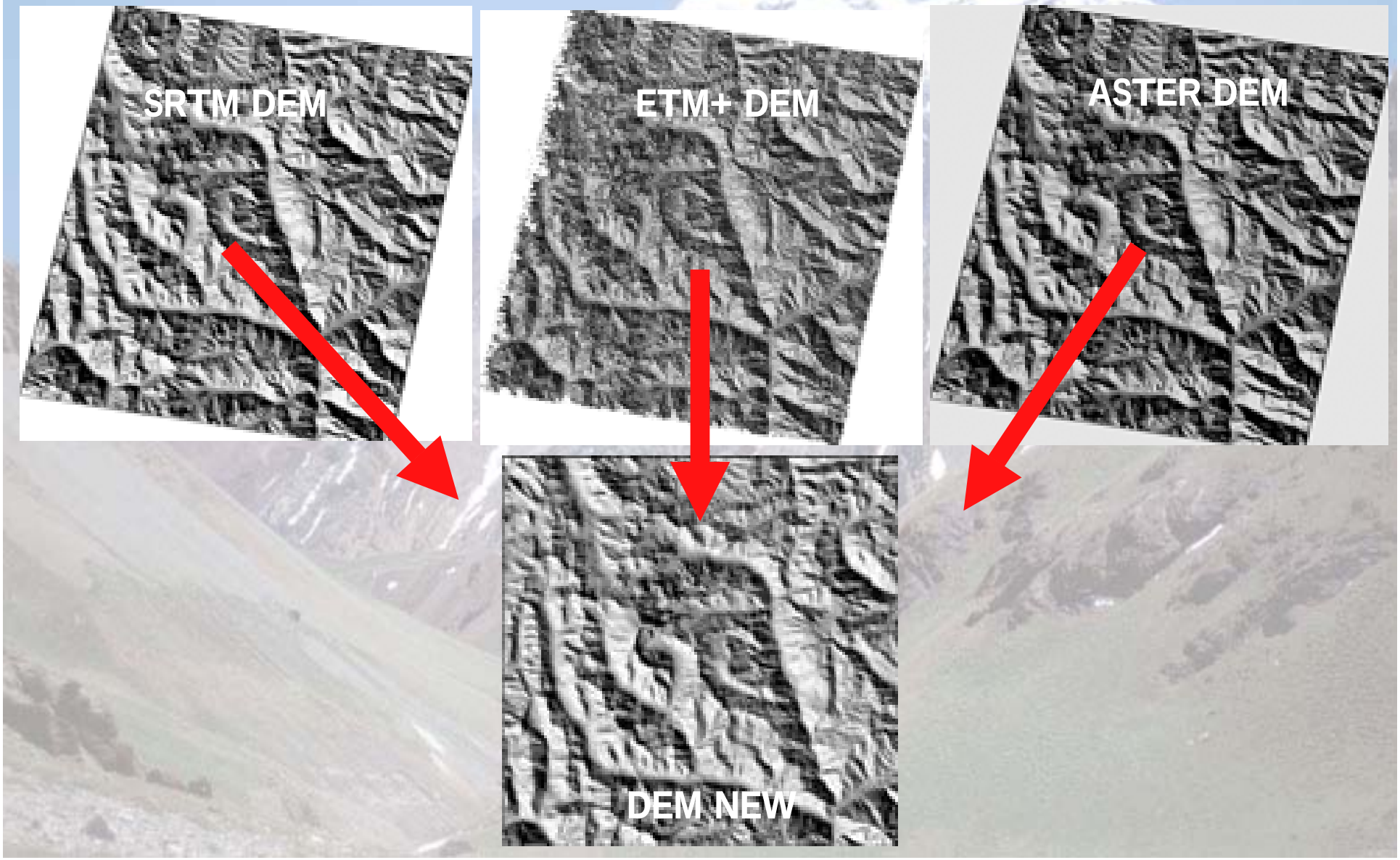
Fill up and reduction of the aerial extent of “zero-data-values”



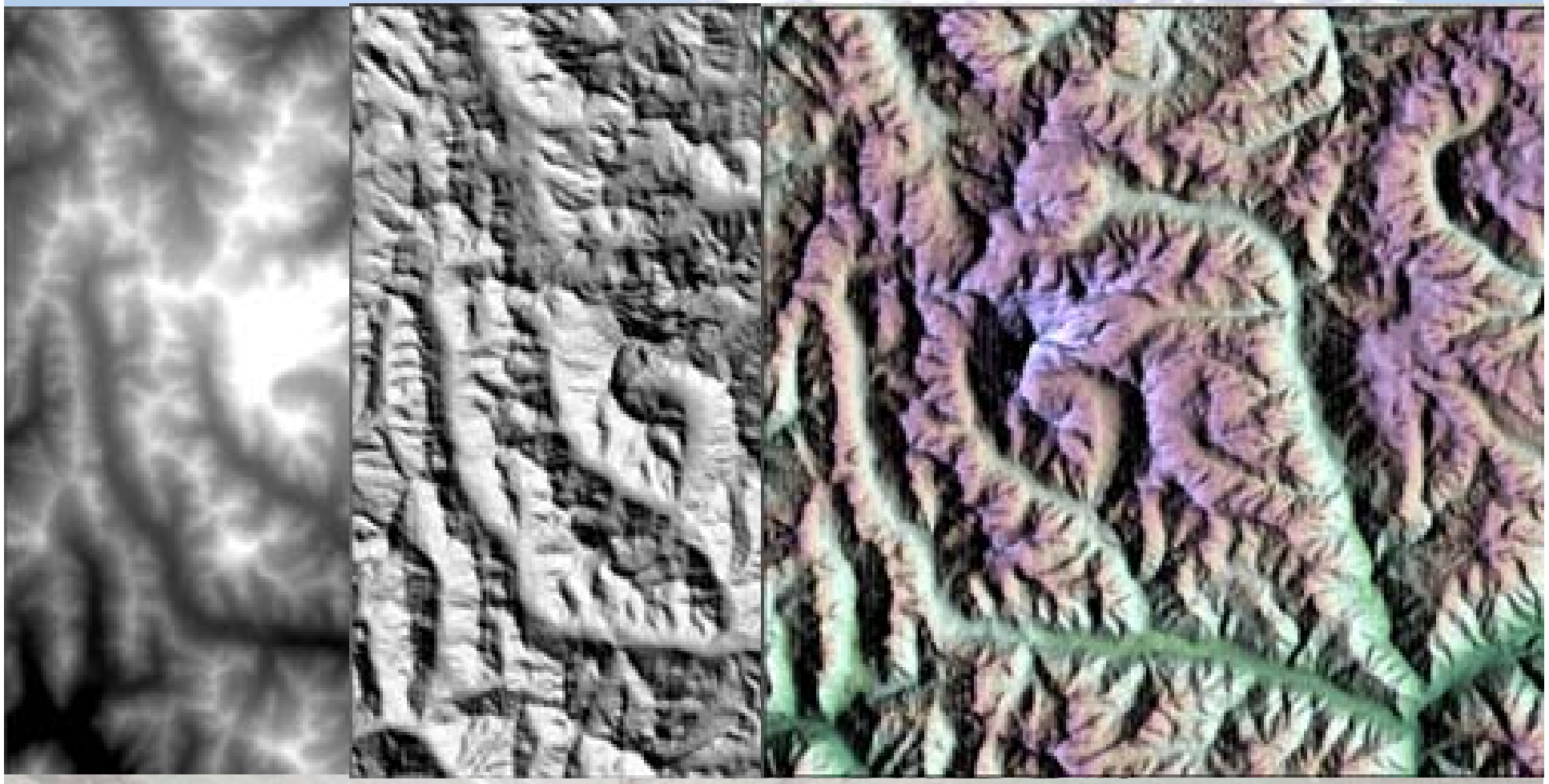
# Available Geo-Data

## DEM



# Available Geo-Data

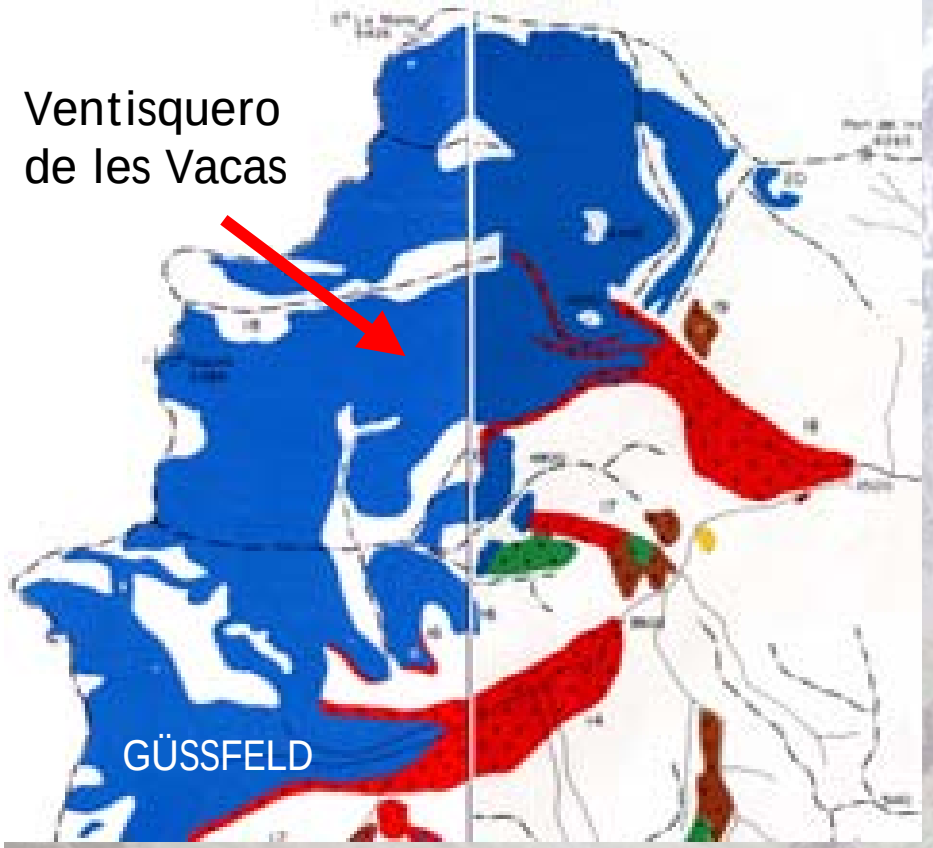
## DEM

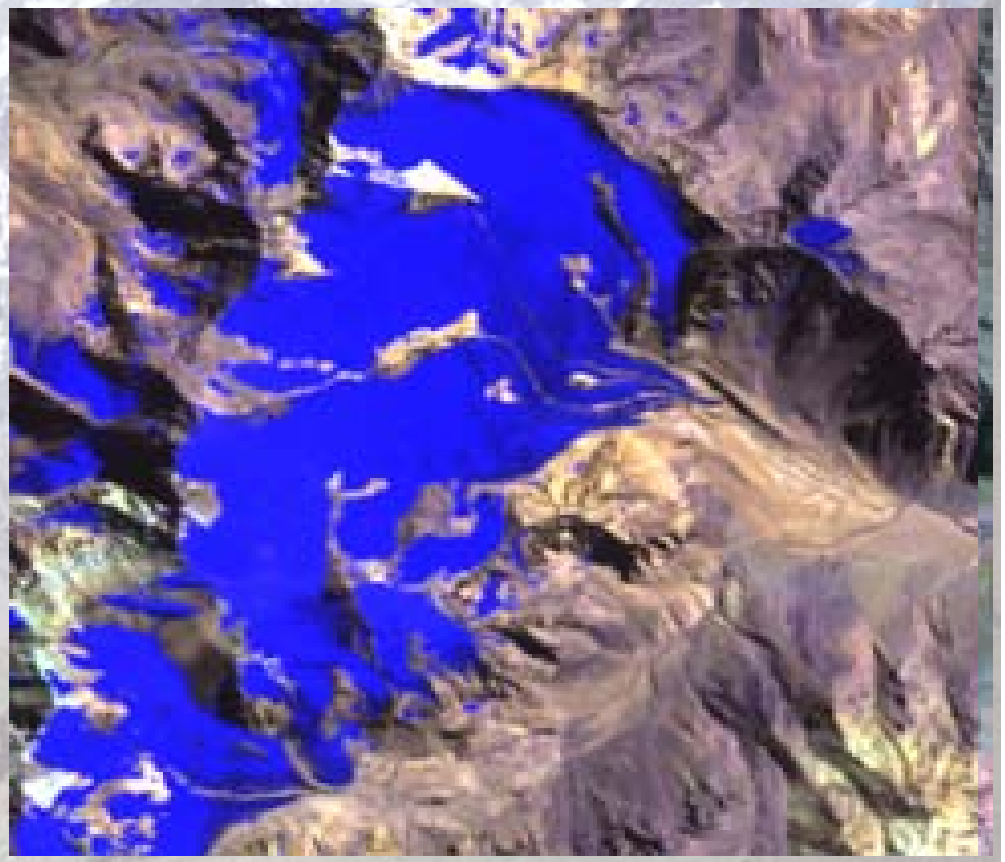


# Glacier/Lakes

Glacier inventory of Argentina

LANDSAT 2002 /543



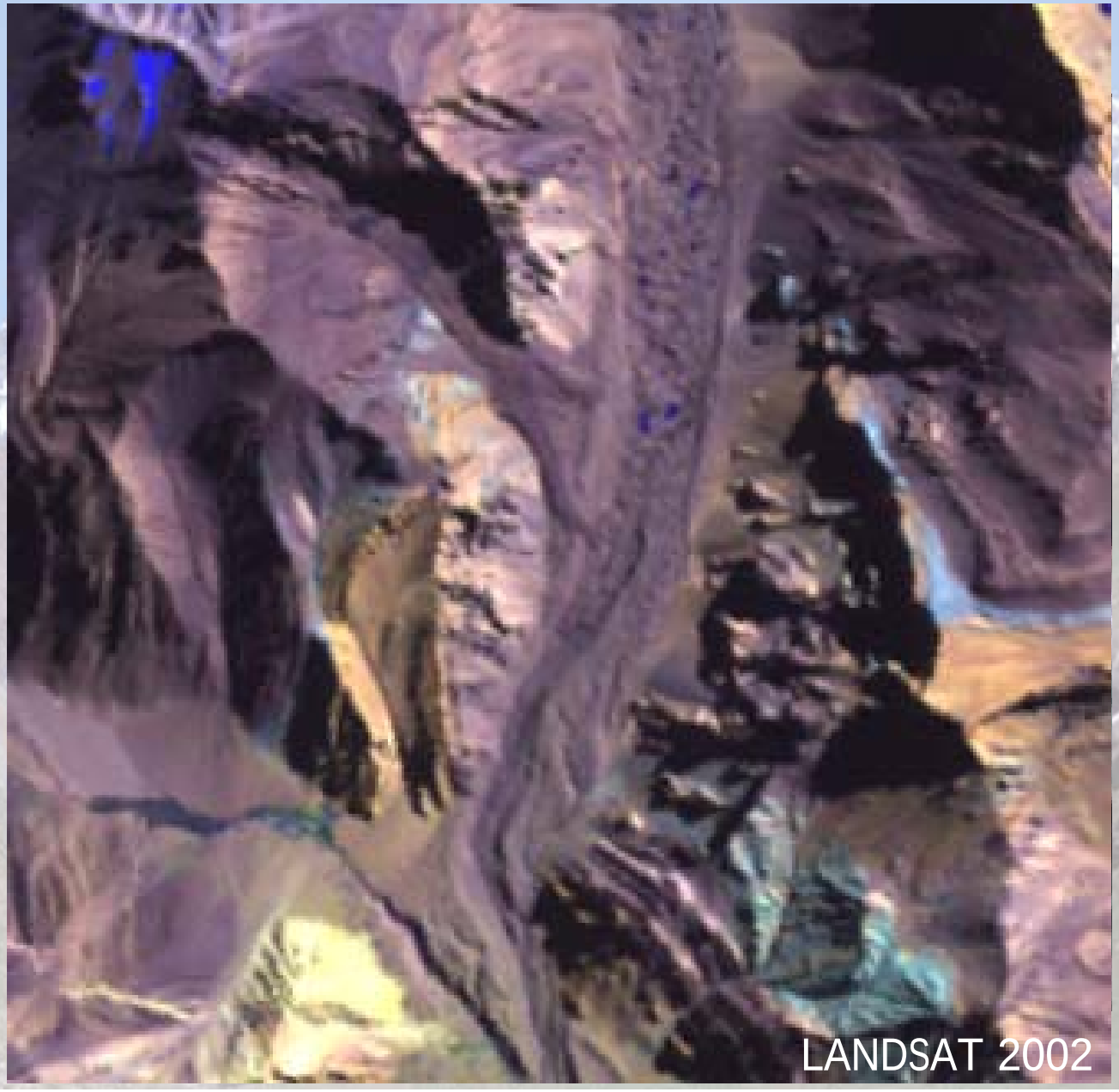



# Glacier/Lakes


Glacier Map 1974 (1:25.000)

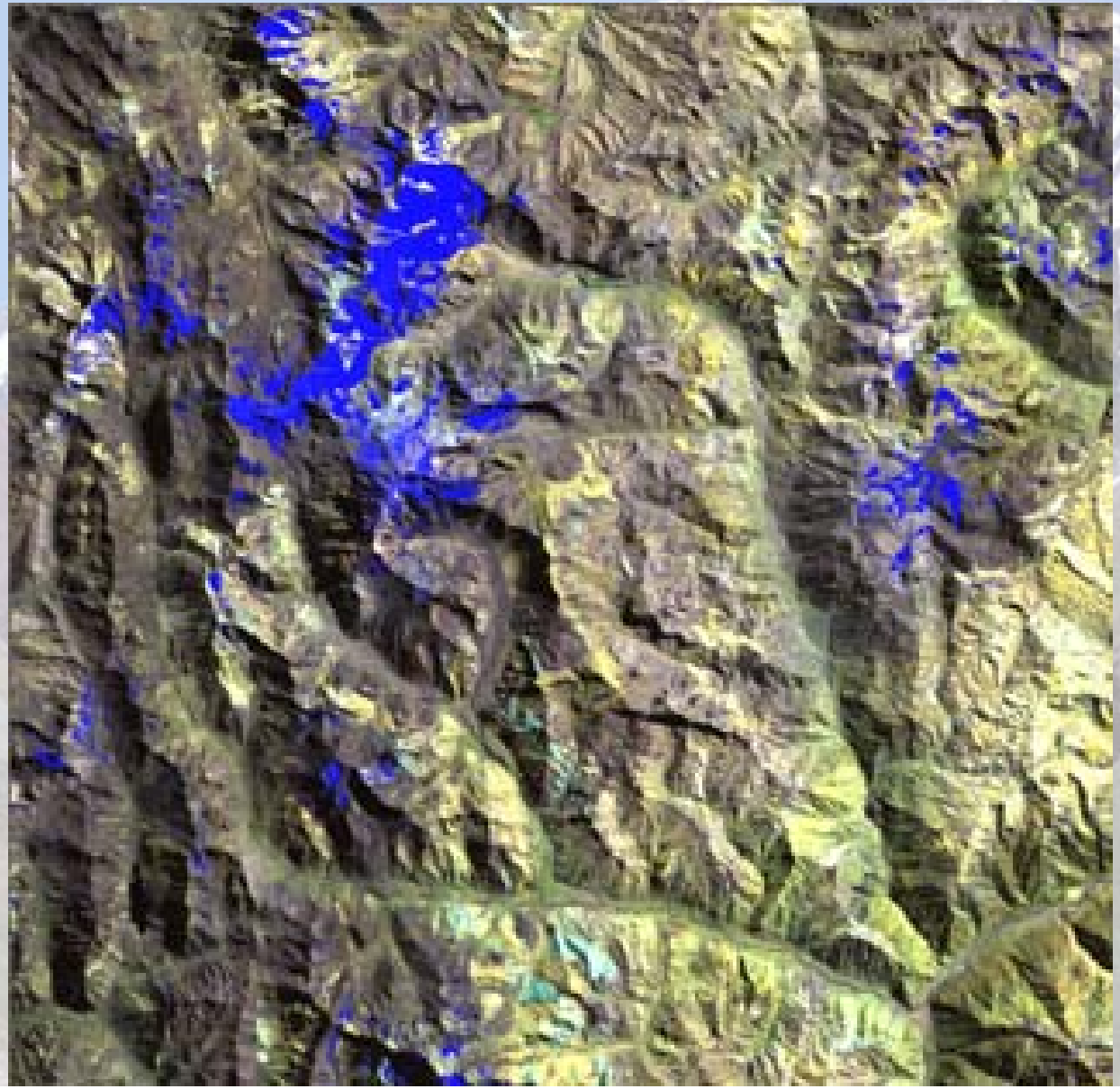
ASTER 2004

# Glacier/Lakes



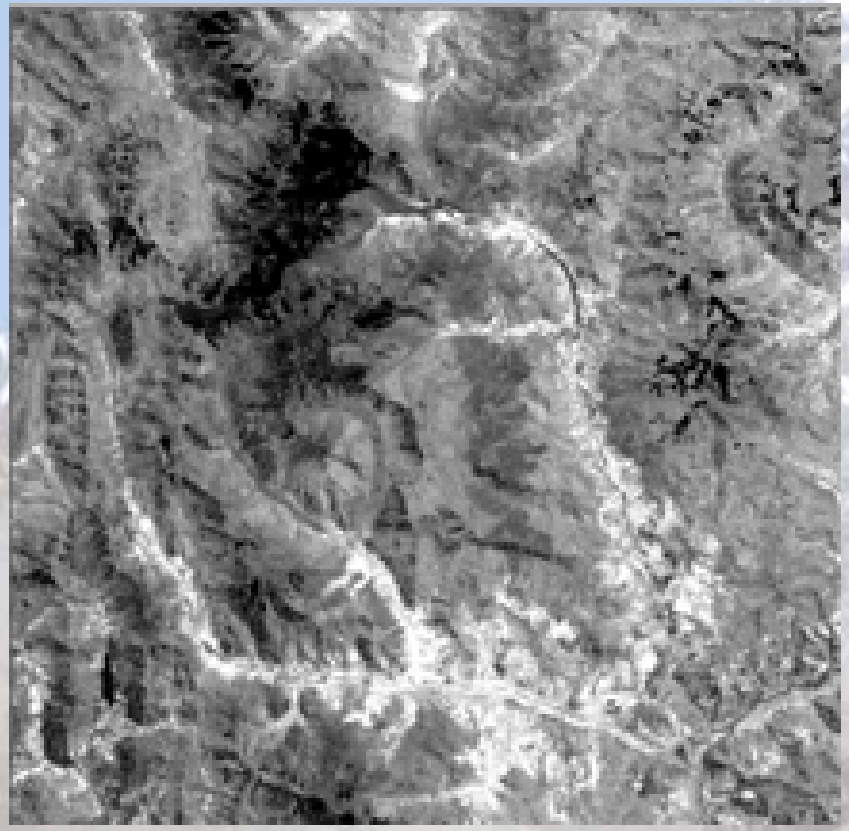
# Glacier/Lakes

## Glacier(Snow-)Mask

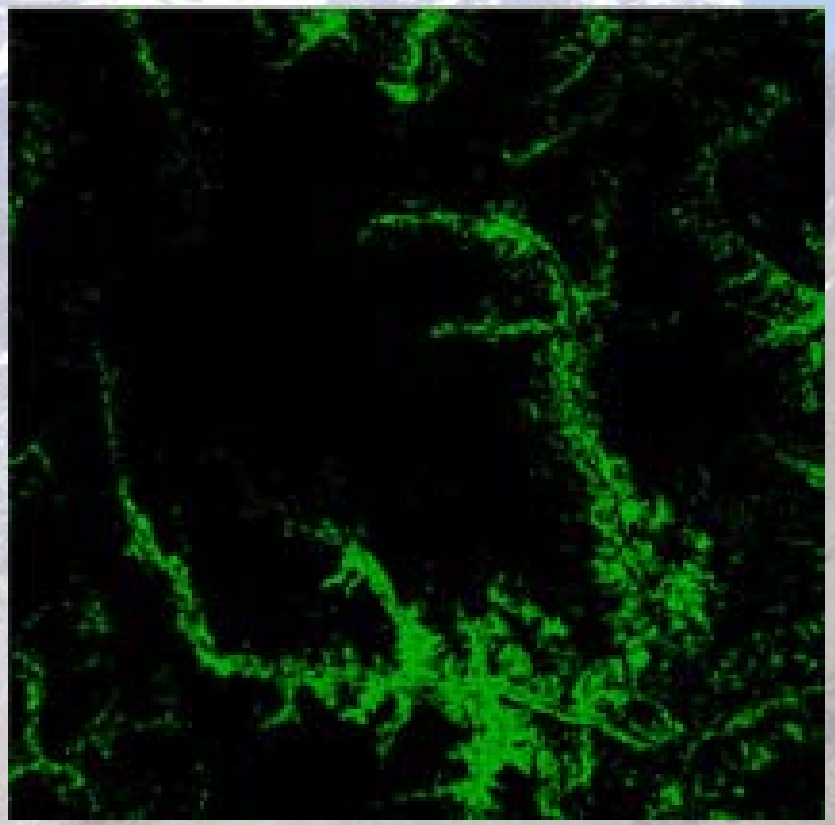


# Vegetation

## Vegetation Mask



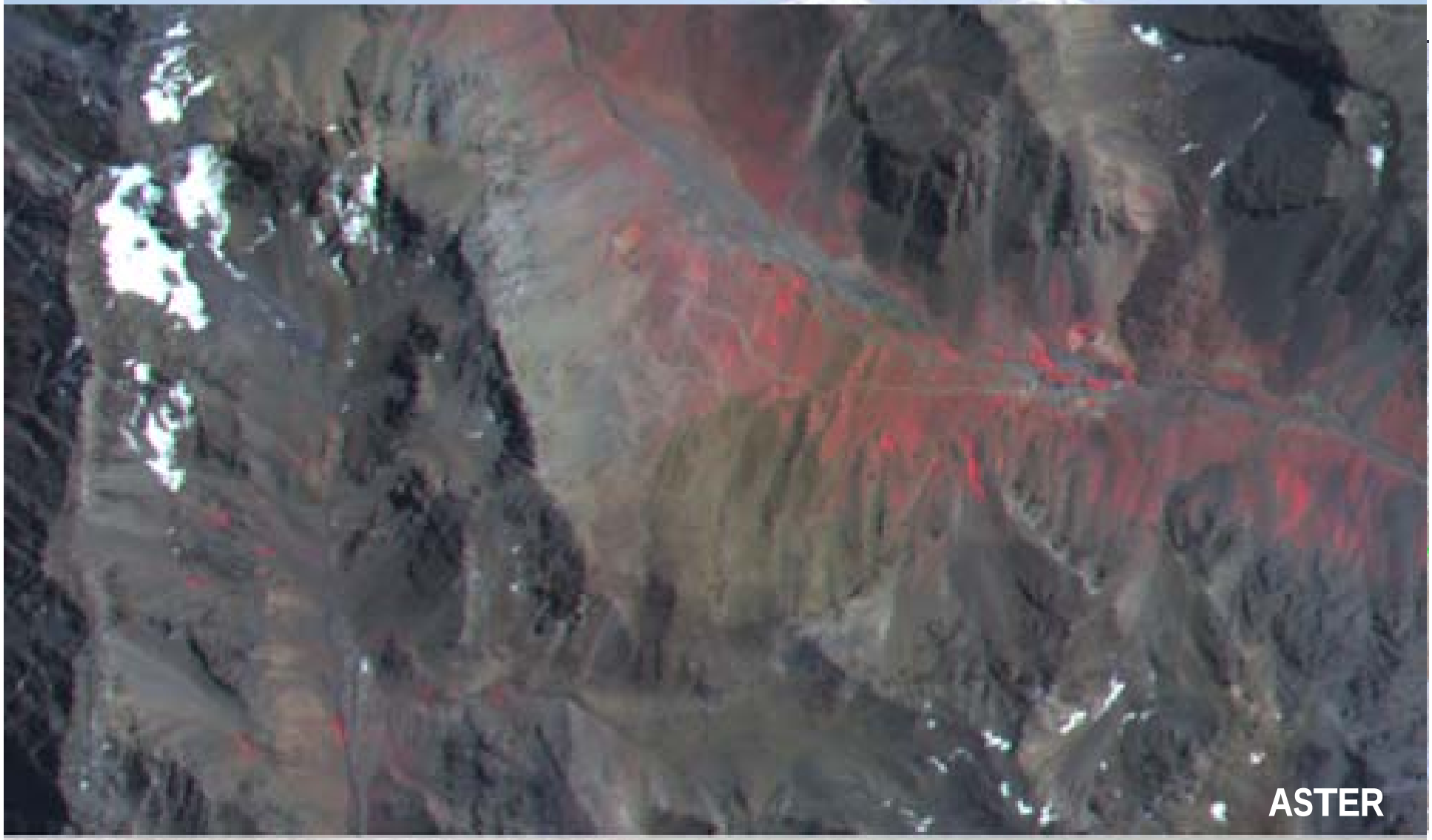
Vegetation index LANDSAT



Vegetation Mask

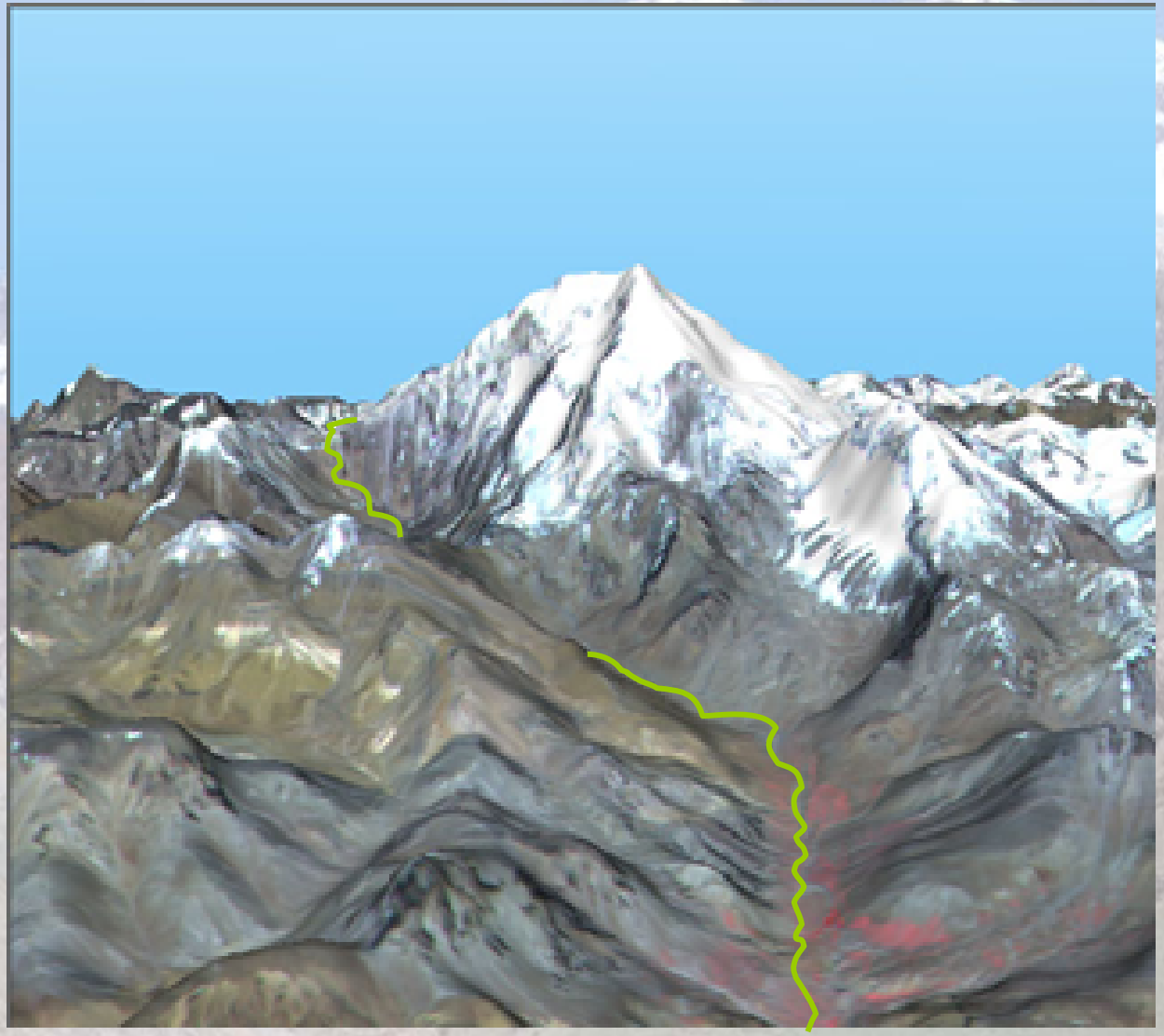
# Traffic Network

**GPS/ASTER**

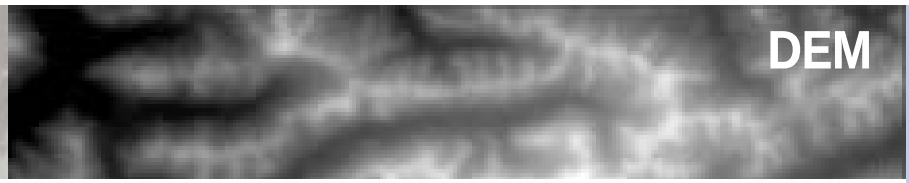



regional street network

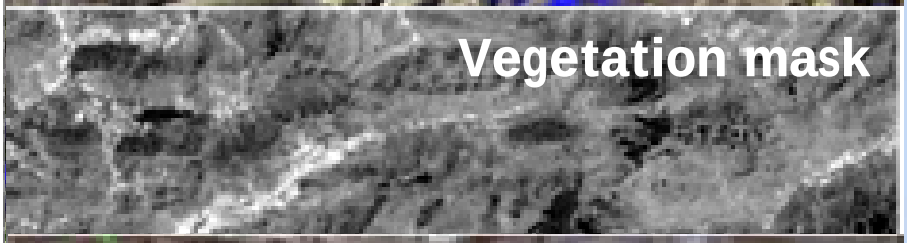
# Perspective Views

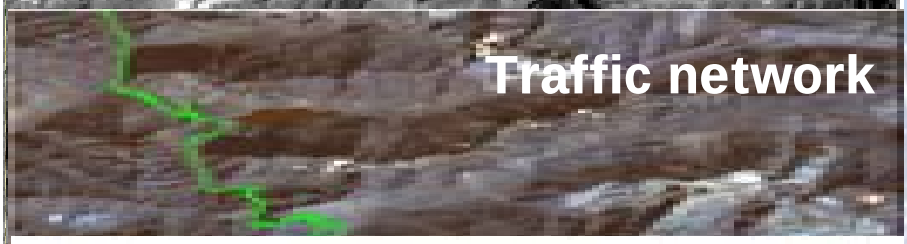


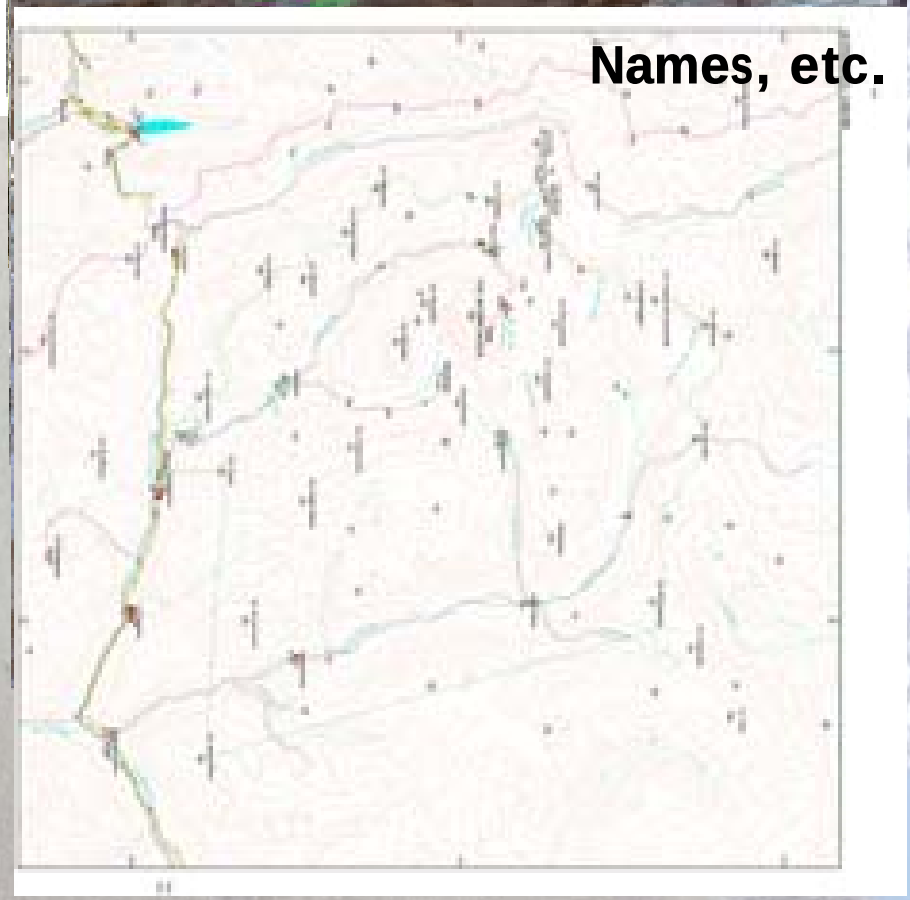
# Results and further investigations





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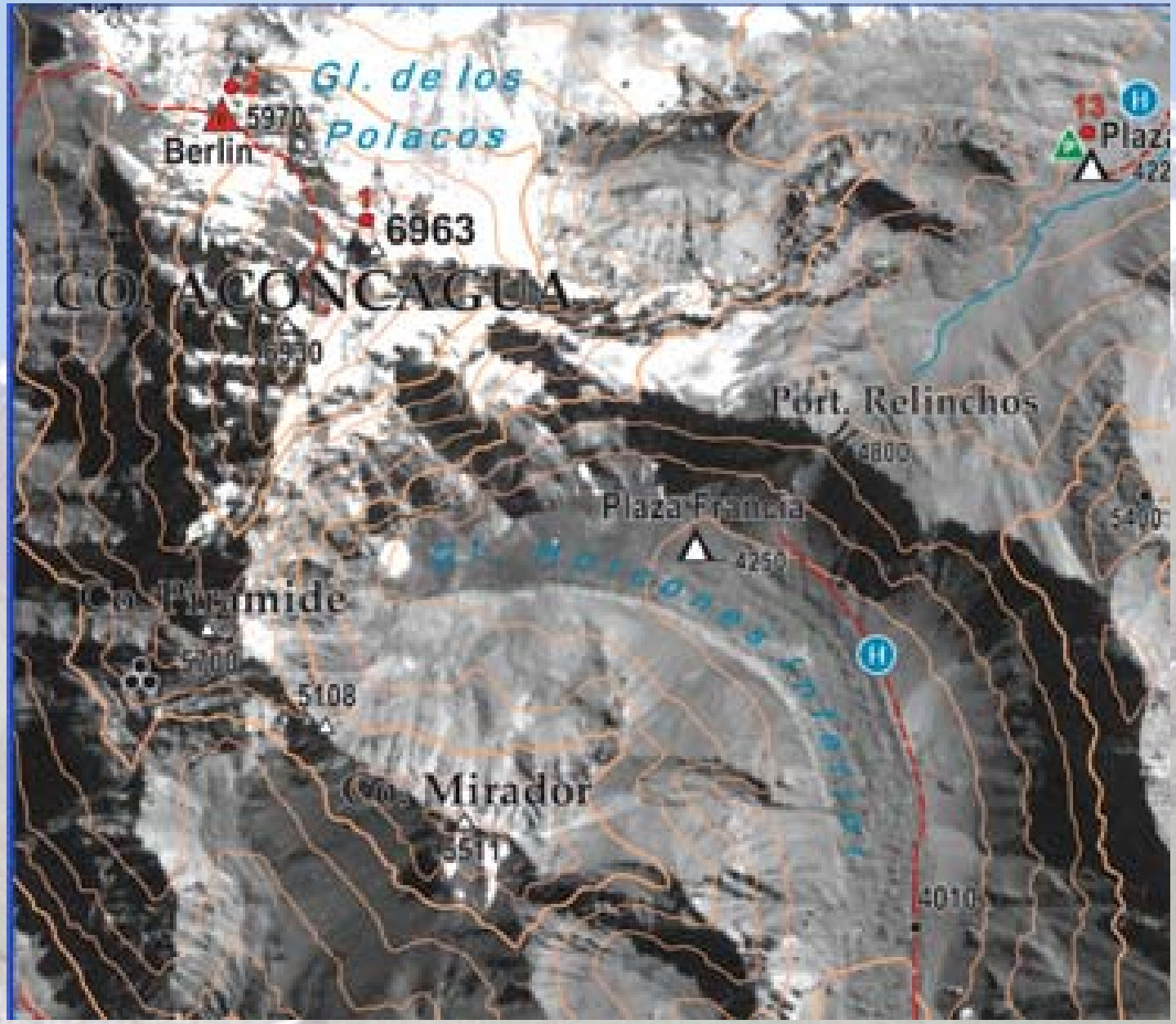

# Results and further investigations

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- The aim of this project is to provide basic data base for the generation of a map in scale 1:100.000.
- This has been done by means of a multisensoral (ASTER/SRTM/LANDSAT) and multitemporal (2000-2004) data set.
- The most suitable way for the map creation is an out weighted relationship between time/costs and the achieved quality of the results.
- The presented study must be seen as an intermediate result.
- The **compilation** (pre-processing, merging, raster to vector conversation, evaluation, etc.) of the geodata are most suitable for the generation of a (topographic) **SAT-MAP 1:100.000**.
- Further investigations/work are:
  - finale digital compilation for printing
  - WEB MAP


Thank you for your attention !