

# Dynamics of GeoFlow: Pre-Analysis

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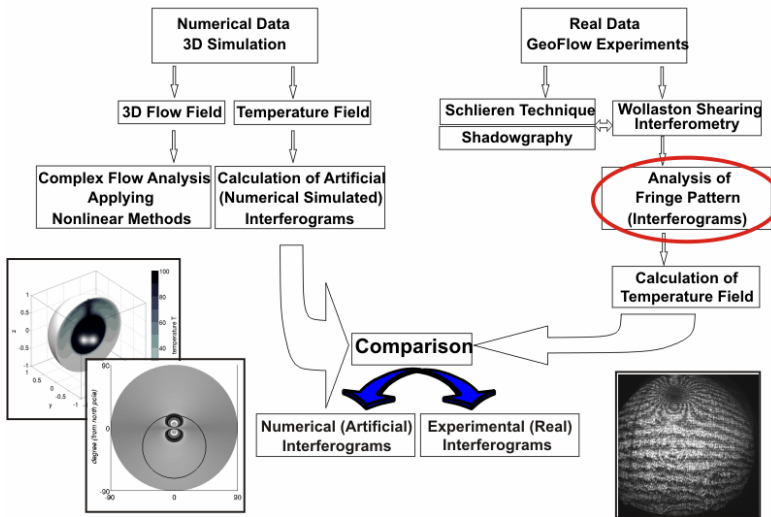
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GeoFlow Topical Team Meeting  
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ESA Topical Team, grant number 18950/05/NL/VJ

## GeoFlow: Visual Data Analysis

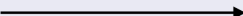


## Outline

- 1 Image Quality
  - Technical Aspects
- 2 Image Processing I - qualitative
  - Sphere Projection
- 3 Image Processing II - quantitative
  - Image Masking
  - Summary and Outlook

## Aspects of image quality - technical

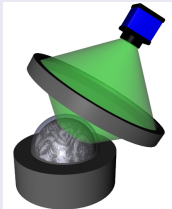
- no half-images, black-images and double-images
- complete number of images
- no reflection in images (e.g. Moiré-effects)
- ccsds-time: 13-digit format i.e. 10 digits seconds / 3 digits milliseconds since 1980-01-06 00:00:00

ccsds-time:                       Record:  
1980-01-06 00:00:00    903876974.322 sec    OPS\_0903876974322

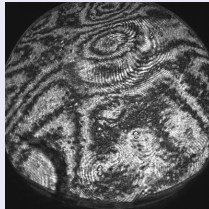
- Telemetry Data: csv-format with ccsds-time as leading column and for primary key for database

## Motivation

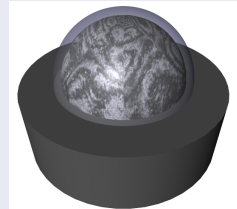
- from plane to sphere projection  $\Rightarrow$  for visualization



camera view

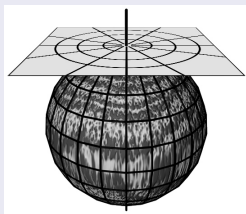


interferogram



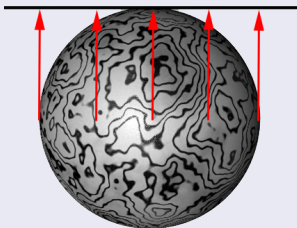
sphere

## Map Projection: Azimuthal (projections on a plane)



- projection on a plane
- one point of contact with the sphere (e.g. pole, equator)
- only hemisphere is displayed
- meridians are lines, and latitude are concentric circles

## from Orthographic projection to GeoFlow



Orthographic projection

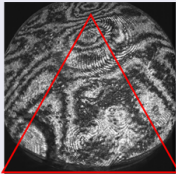


3D-sphere projection\*

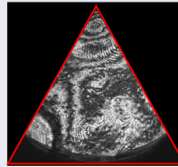
- hemisphere as it appears from outer space
- parallel radiation of projection → like GeoFlow  
⇒ parallel lasers because of the adaption optic
- shapes and areas distorted, particularly near the edges → like GeoFlow

\*Source: <http://upload.wikimedia.org/wikipedia/commons/f/f8/Netzentwuerfe.png>

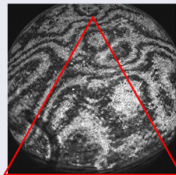
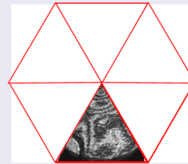
## Masking (using Matlab): from sphere to plane $\Rightarrow$ for analyzing



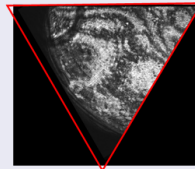
1. image



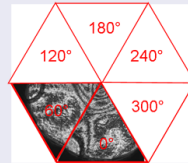
1. image  $\rightarrow 0^\circ$



2. image

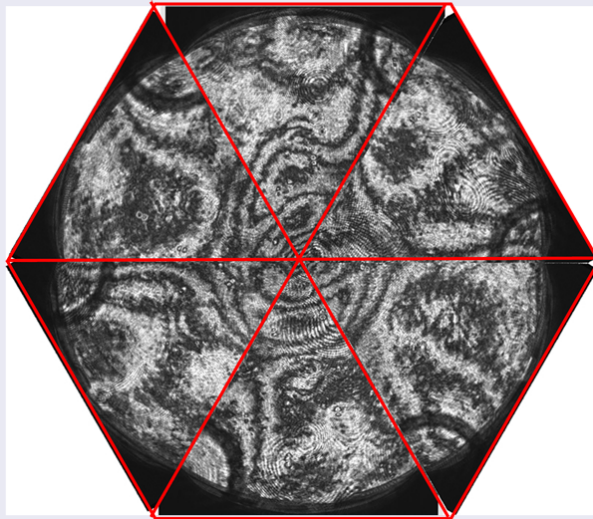


1. image  $\rightarrow 60^\circ$



- image taken every  $60^\circ \rightarrow$  images overlap  $\rightarrow$  only a sector is visible
- defined mask (ROI) over image sequence  $\rightarrow$  6 sectors
- note: no interpolation, because of mixing fringes to gray
- note: pole is supposed to be fixed

## image connecting

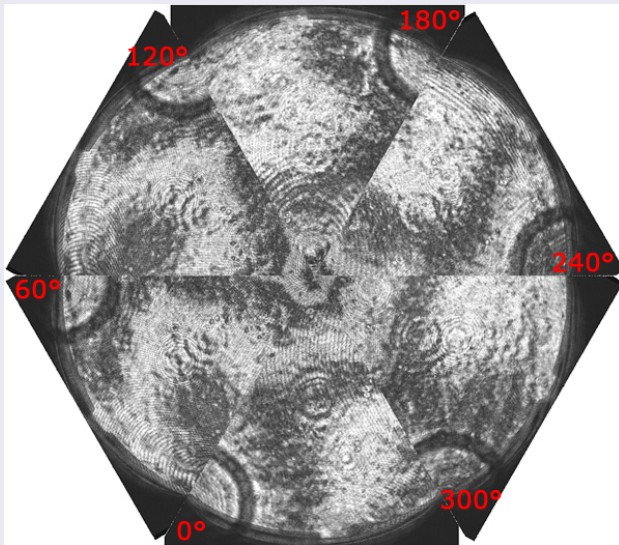


variable mask in position and angle → adaption after telemetry-synchronization

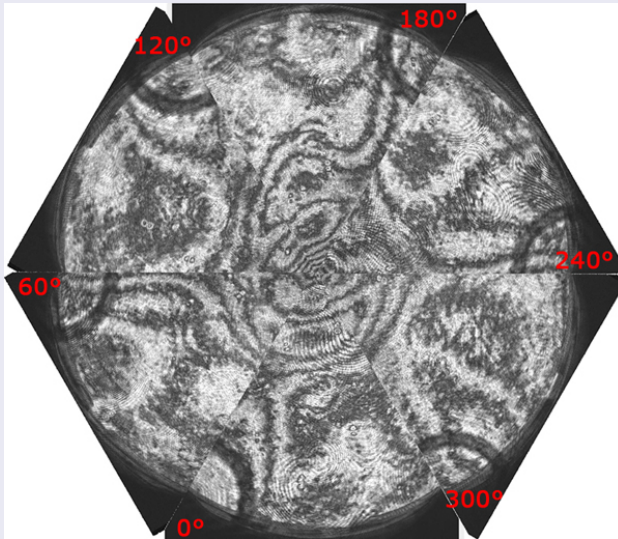
## first concept of telemetry-data → angle variation

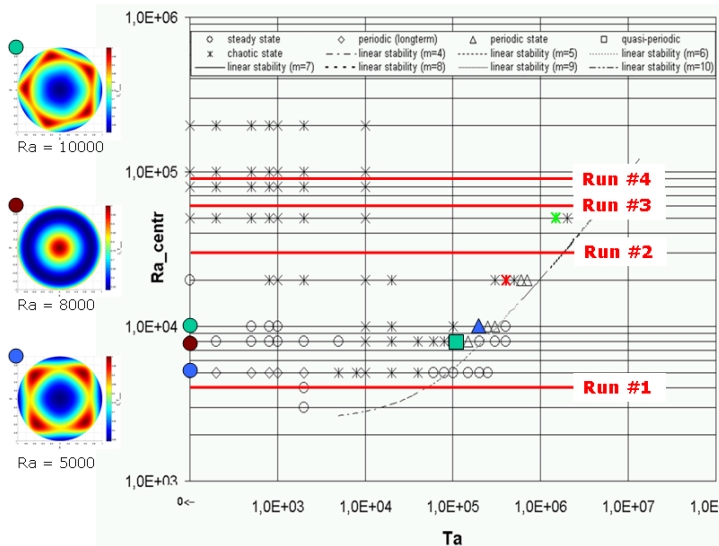
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<?xml version="1.0" encoding="ISO-8859-1" ?>
<!-- Generated by E-USOC TM merger -->
- <telemetry>
- <geoTM imgRef="IMG1197969089_0006.jpg.xml">
  <params ccsdsTime="12.03.2008_12:06:12" packetNo="213" esswState="1"
    hvpsVolt="9812" hvpsFreq="10012" fcaFreq="0.81" posTarget="120" posActual="121"
    tempCoolIn="20.12" tempCoolOut="22.67" tempHeatIn="35.53" tempHeatOut="30.01"
    deltaTempExp="8.28" tempTray="20.12" ugX="312" ugY="23" ugZ="28" />
</geoTM>
- <geoTM imgRef="IMG1197969089_0007.jpg.xml">
  <params ccsdsTime="12.03.2008_12:06:12" packetNo="213" esswState="1"
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    tempCoolIn="20.12" tempCoolOut="22.67" tempHeatIn="35.53" tempHeatOut="30.01"
    deltaTempExp="8.28" tempTray="20.12" ugX="312" ugY="23" ugZ="28" />
</geoTM>
- <geoTM imgRef="IMG1197969089_0008.jpg.xml">
  <params ccsdsTime="12.03.2008_12:06:13" packetNo="214" esswState="1"
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    tempCoolIn="20.12" tempCoolOut="22.67" tempHeatIn="35.53" tempHeatOut="30.01"
    deltaTempExp="8.28" tempTray="20.12" ugX="312" ugY="23" ugZ="28" />
</geoTM>
•
•
•
```

## RUN #1

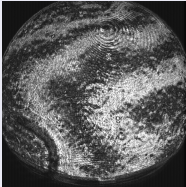


## RUN #4

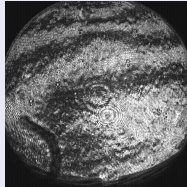




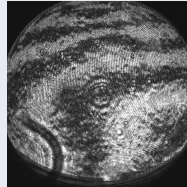
### Science RUN #1: $Ra = 4 \cdot 10^3$



$$Ta = 1.34 \cdot 10^5$$



$$Ta = 3.36 \cdot 10^6$$

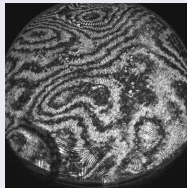


$$Ta = 1.34 \cdot 10^7$$

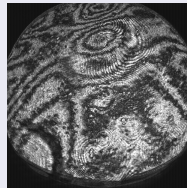
### Science RUN #4: $Ra = 8.87 \cdot 10^4$



$$Ta = 1.34 \cdot 10^5$$

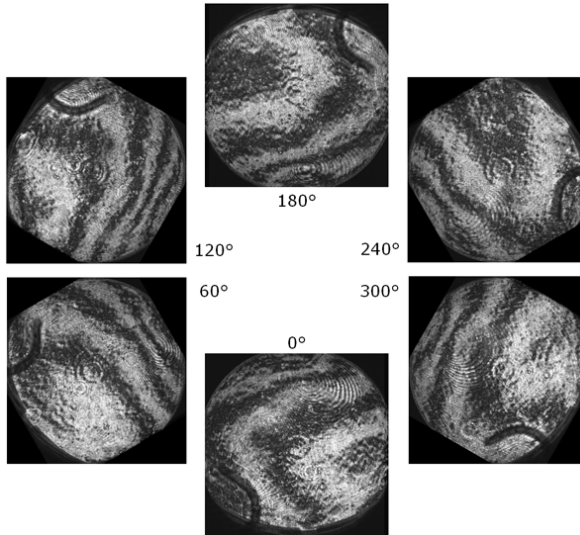


$$Ta = 3.36 \cdot 10^6$$

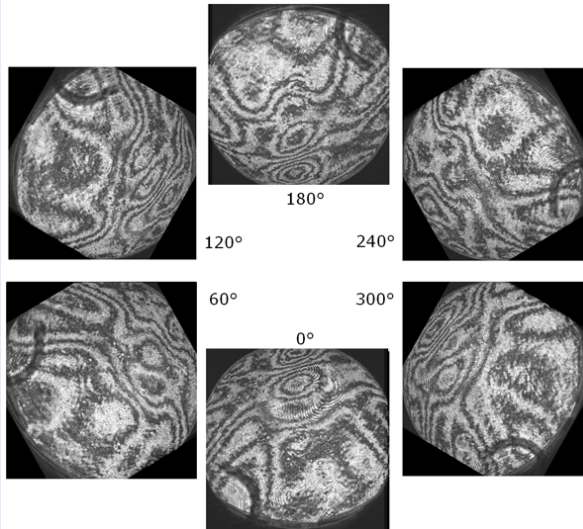


$$Ta = 8.59 \cdot 10^6$$

Science RUN #1:  $Ra = 4 \cdot 10^3$ ,  $Ta = 1,34 \cdot 10^5$



Science RUN #4:  $Ra = 8.87 \cdot 10^4$ ,  $Ta = 1,34 \cdot 10^5$



## Summary

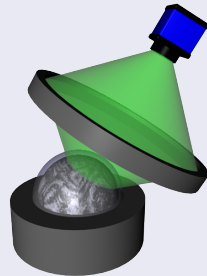
- Aspects of image quality - technical
  - GeoFlow: orthographic projection  
important for projection from plane to sphere
  - method of image masking and image connecting for analysing
- up to now, no automatization, because of no telemetry-synchronization

## Conditions for image connecting

- exactly definition of pole (after High Rotation-RUNs)
- image and telemetry data synchronization

## Outlook

- projection on sphere with connected images
  - after synchronization with telemetry  $\Rightarrow$  image analyzing with connected images
- $\Rightarrow$  comparison with numerical data



# Thank you for your attention!

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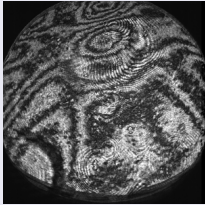
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# Appendix

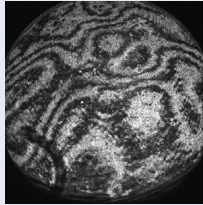
## Difficulties of pole computation

- no formulas in the documents → only measurement values
  - estimation of pole after High Rotation RUNs
    - pattern rotating nearly the same position
    - the pole hops
- ⇒ answer to this problem: synchronization of telemetry data with image data

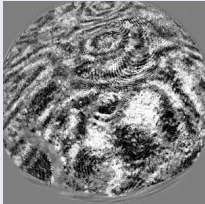
## examples of image processing



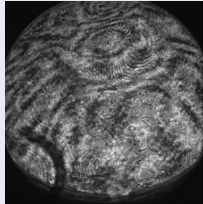
example image 1



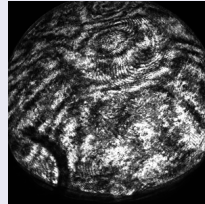
example image 2



Subtraction



Addition



Multiplication

- wrong and loss of information
- after transformation to binary → pseudo pattern arise