Sentinel-1 InSAR AP workshop

Sentinel-1 InSAR progress and experience at GAMMA

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Gamma Remote Sensing AG

- *Progress made* since S1A Expert Users meeting at ESRIN held on 18-Sep-2014
- *S1 TOPS InSAR methodology used*
- *Results: DINSAR phase and coherence*

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S1 IWS Implementation issues:

- *book-keeping*
- *strong doppler centroid variation*
  - *adapt SLC interpolation*
  - *mis-registration effects*

S1 IWS Implementation status (as reported in Sep. 2014):

- *most of book-keeping done*
- *adaptations for strong doppler centroid variation ongoing*

S1 IWS Implementation status (Dec. 2014):

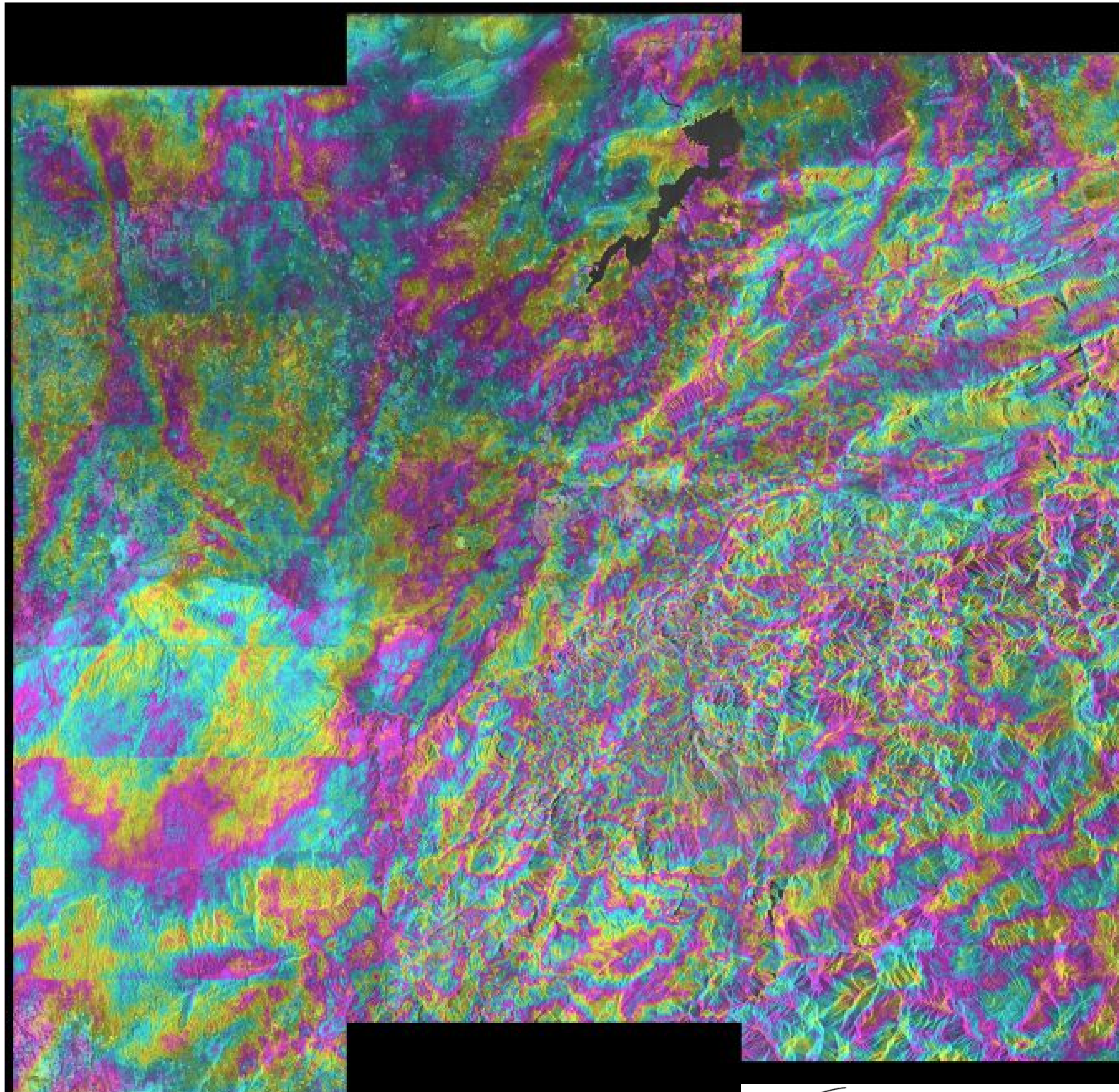
- *adaptations for strong doppler centroid variation:*
  - *S1 TOPS co-registration procedure established*
  - *successful generation of full frame differential interferograms*

S1 IWS SLC co-registration procedure:

1) *Geocoding of multi-look MLI mosaic (→ refined geocoding lookup table, geocoded backscatter, DEM heights in MLI SAR geometry)*
2) *Calculate S1 TOPS SLC co-registration lookup table (considering terrain topography)*
3) *Refinement of co-registration using intensity matching procedures*

Example of an S1 differential interferogram after step 3

Phase jumps visible at burst interfaces



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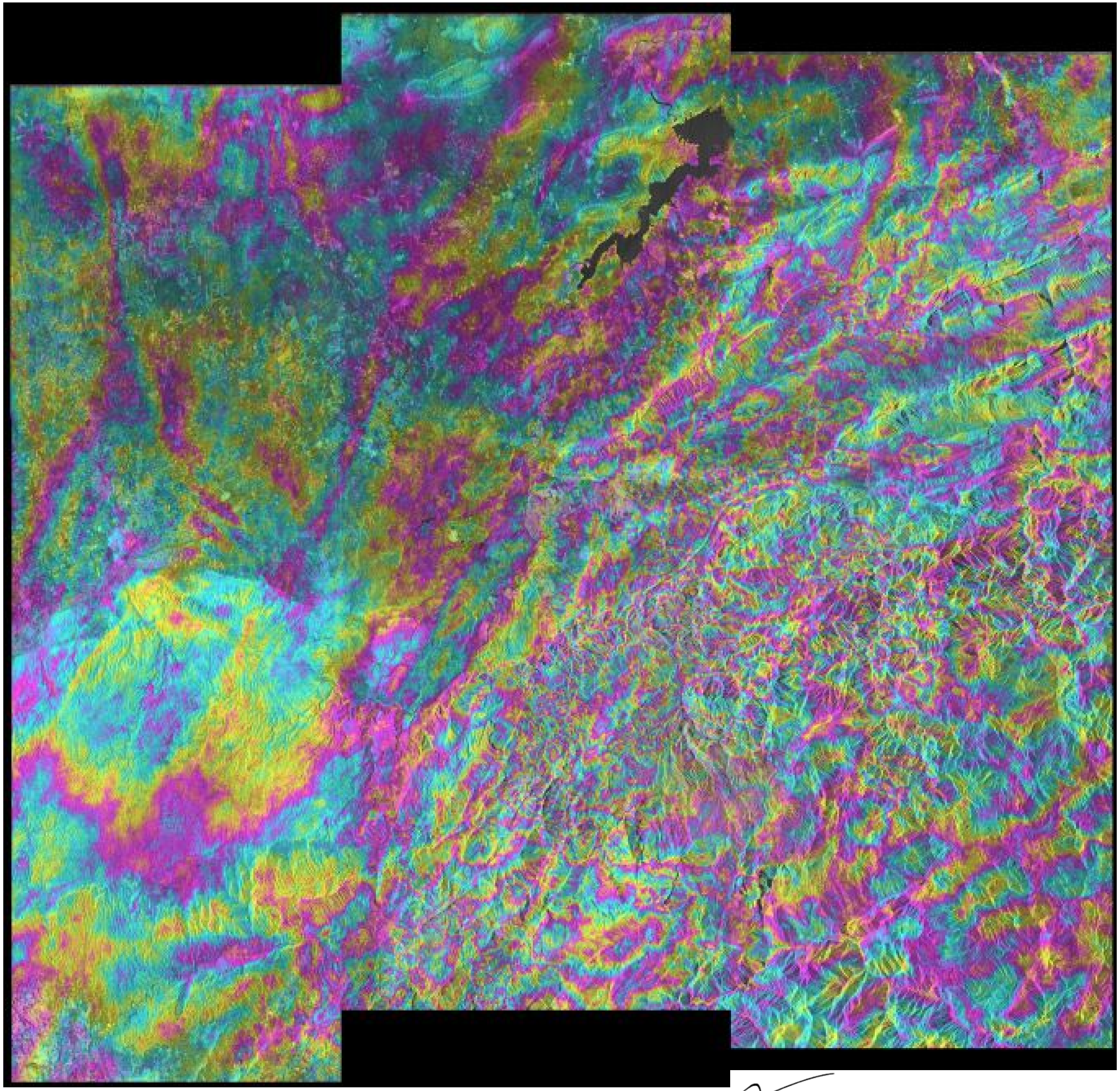
2) *Calculate S1 TOPS SLC co-registration lookup table (considering terrain topography)*
3) *Refinement of co-registration using intensity matching procedures*
4) *Refinement of co-registration using spectral diversity method (considering double difference phase of burst overlap regions)*

Example of an S1 differential interferogram after step 4

No more phase jumps at burst interfaces



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1) *Geocoding of multi-look MLI mosaic (→ refined geocoding lookup table, geocoded backscatter, DEM heights in MLI SAR geometry)*
2) *Calculate S1 TOPS SLC co-registration lookup table (considering terrain topography)*
3) *Refinement of co-registration using intensity matching procedures*
4) *Refinement of co-registration using spectral diversity method (considering double difference phase of burst overlap regions)*
5) *S1 TOPS burst SLC resampling to master geometry (considering procedure that takes into account the strong Doppler Centroid variation in azimuth)*
6) *Simulation of topographic phase*
7) *Calculation of differential interferogram*

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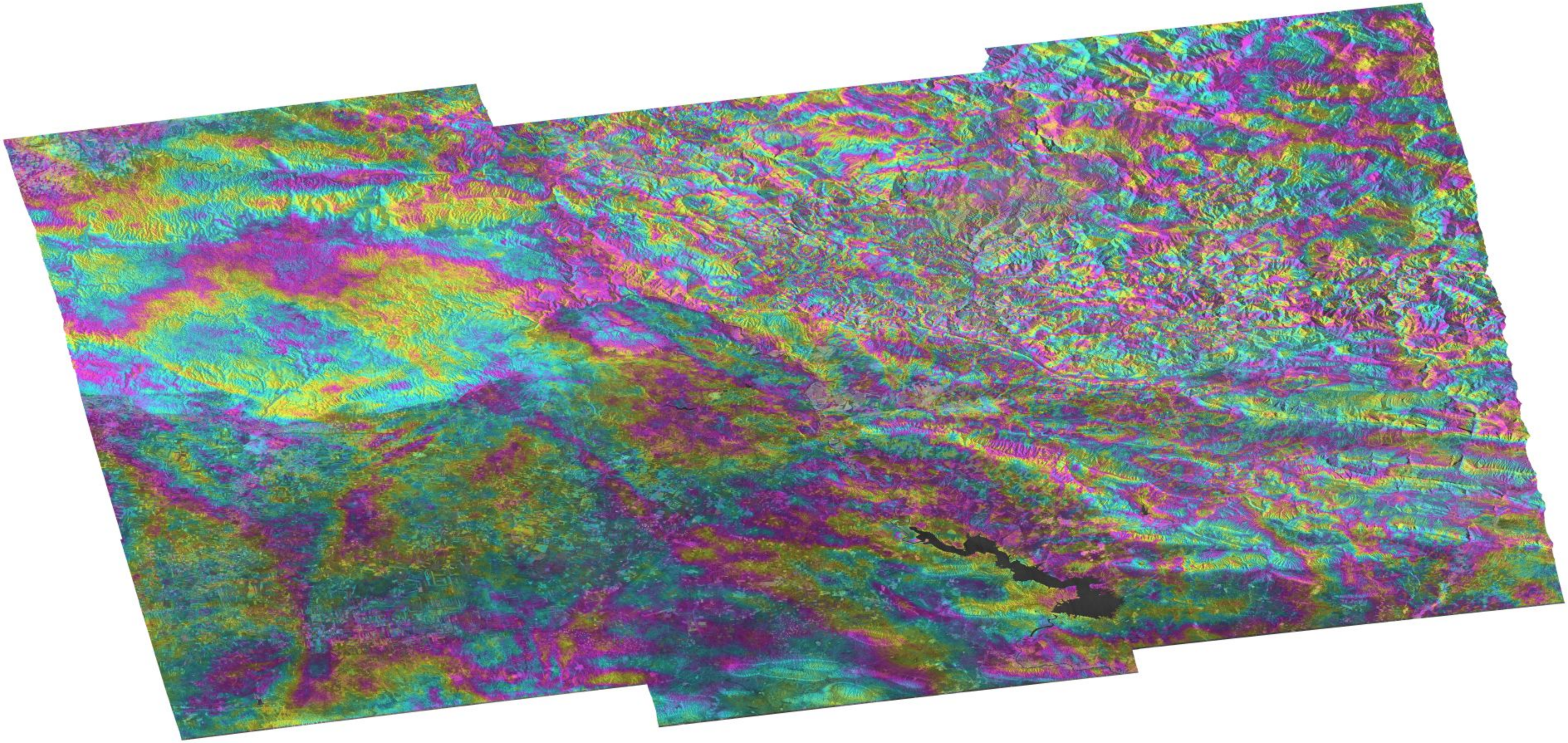
S1 DINSAR over Iraq (VV, dt 12 days, $B_{\perp}$ 7m)



S1 differential interferogram, geocoded to geogr. coord., color cycle = phase cycle

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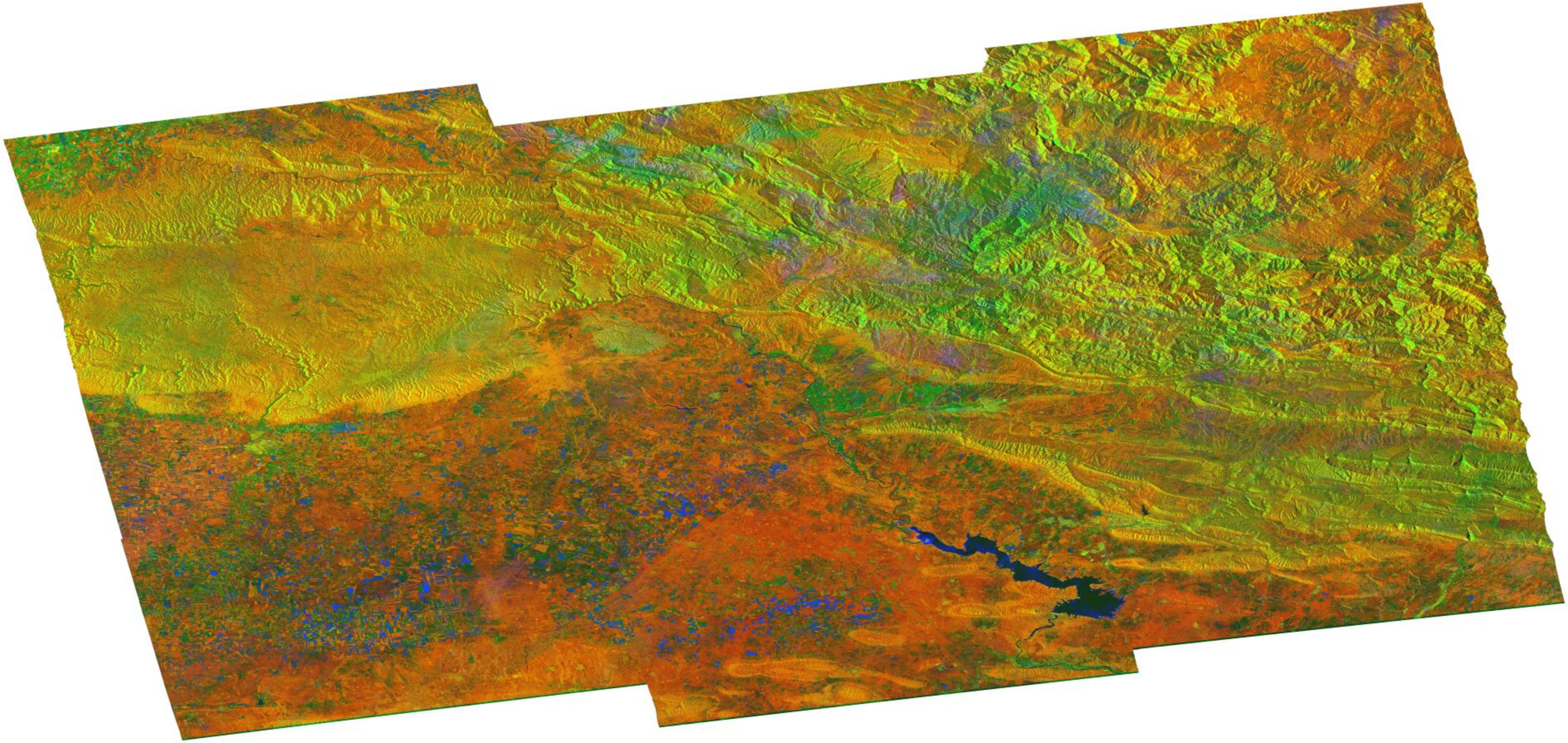
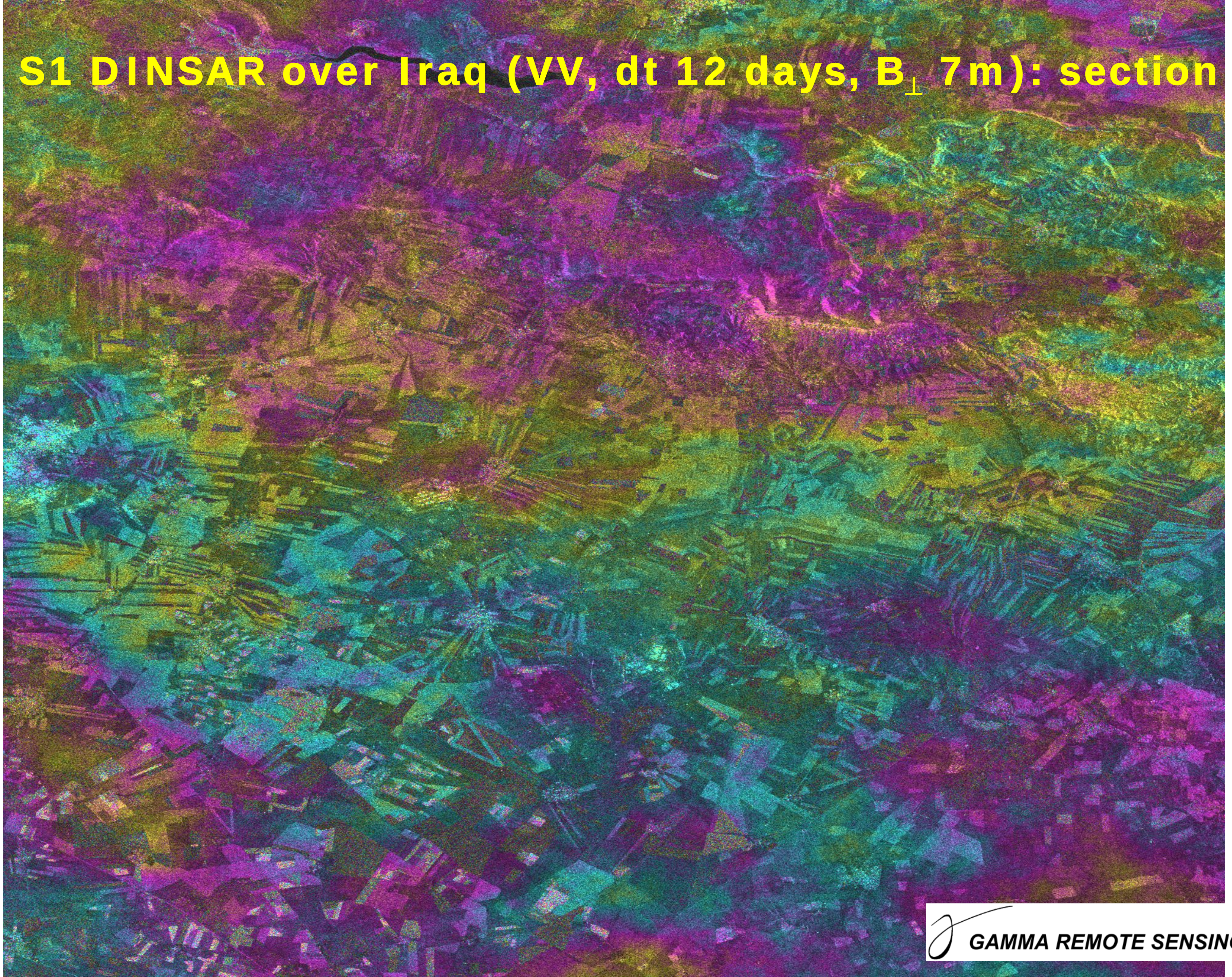
S1 DINSAR over Iraq (VV, dt 12 days, $B_{\perp}$ 7m)



S1 TOPS Coherence product, RGB of coherence (red), backscatter (green) and backsdcatter change (blue)

S1 DINSAR over Iraq (VV, dt 12 days, $B_\perp$ 7m): section



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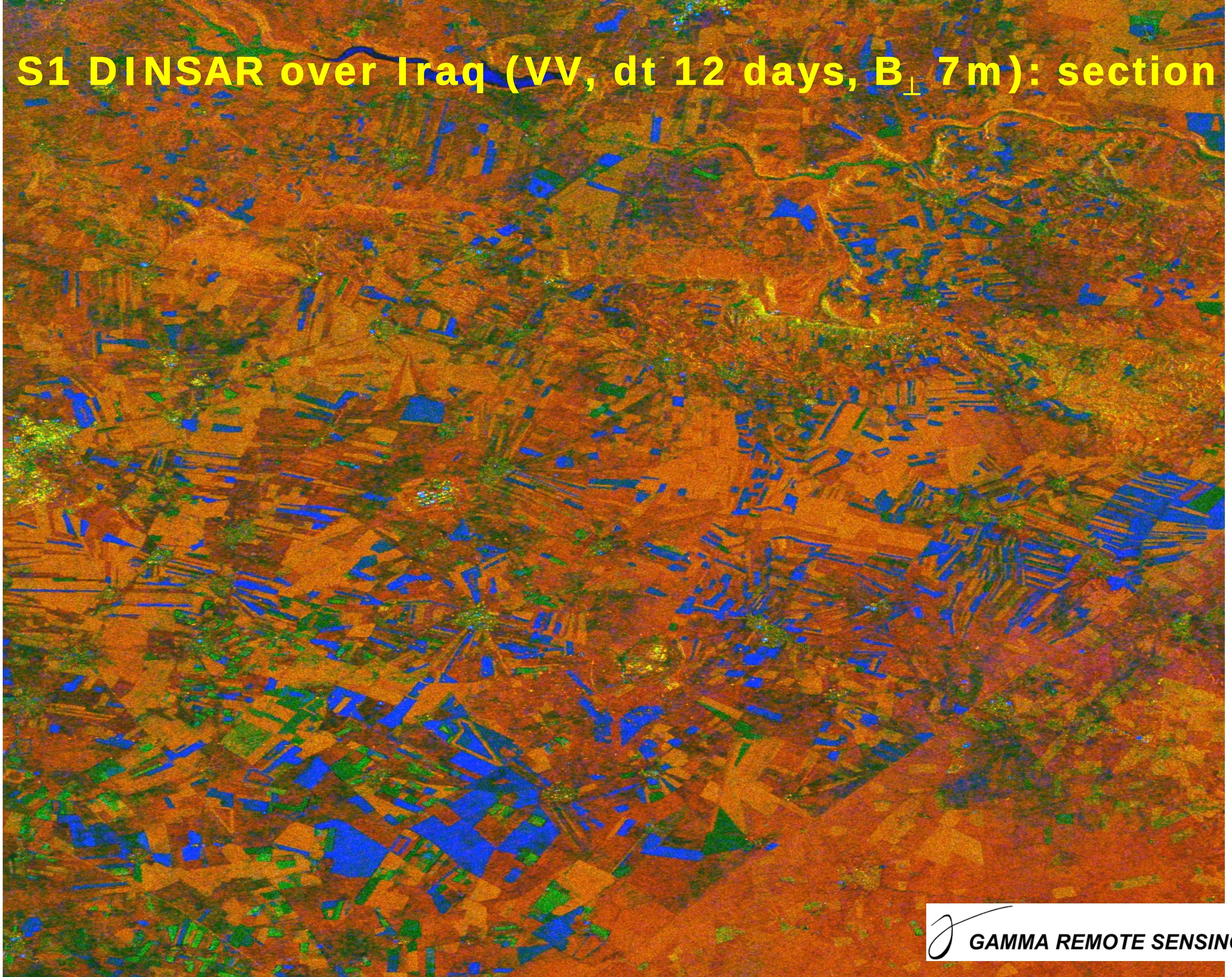
S1 DINSAR over Iraq (VV, dt 12 days, $B_\perp$ 7m): section



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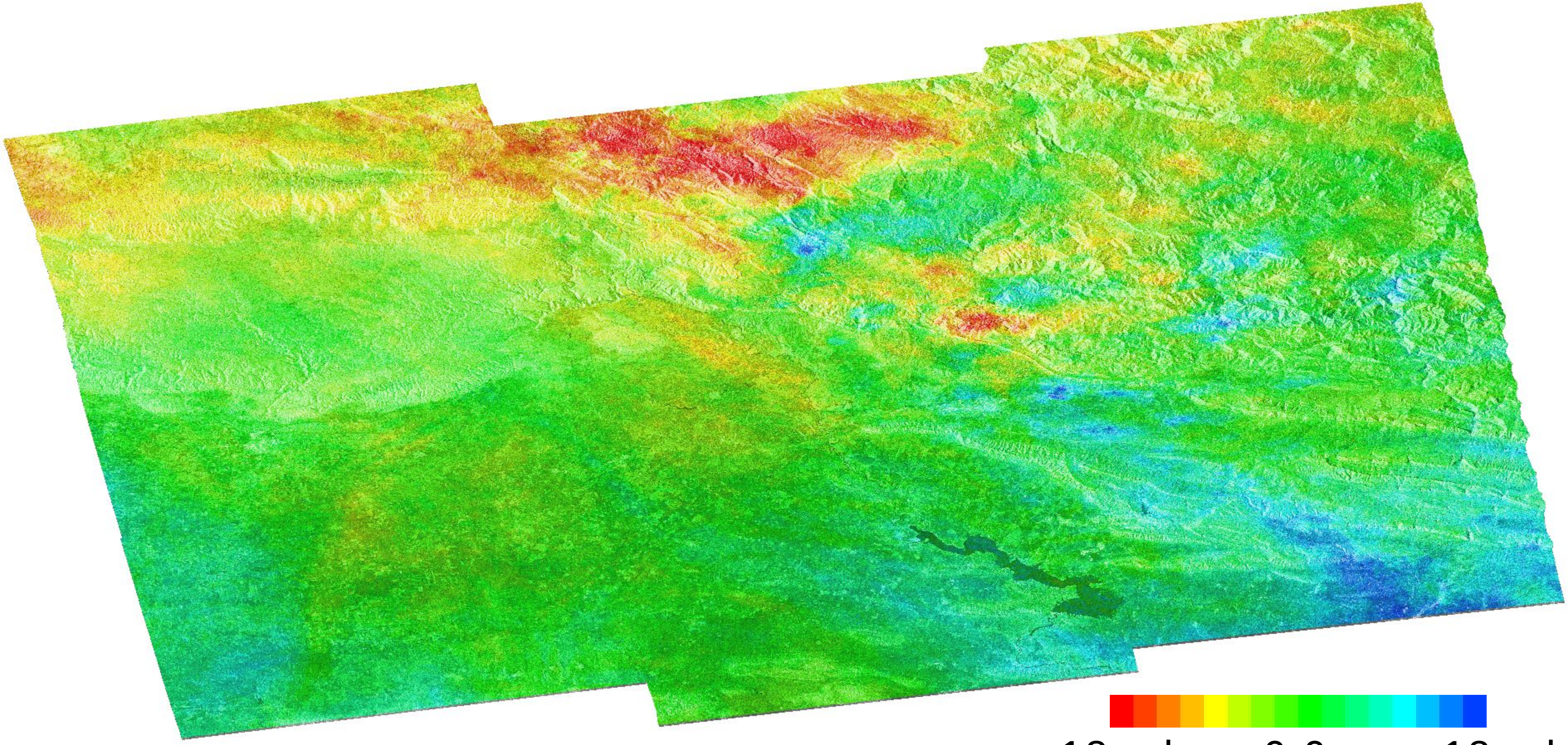
S1 DINSAR over Iraq (VV, dt 12 days, $B_\perp$ 7m)



-18rad 0.0 +18rad

S1 differential interferogram, geocoded to geogr. coord., unwrapped

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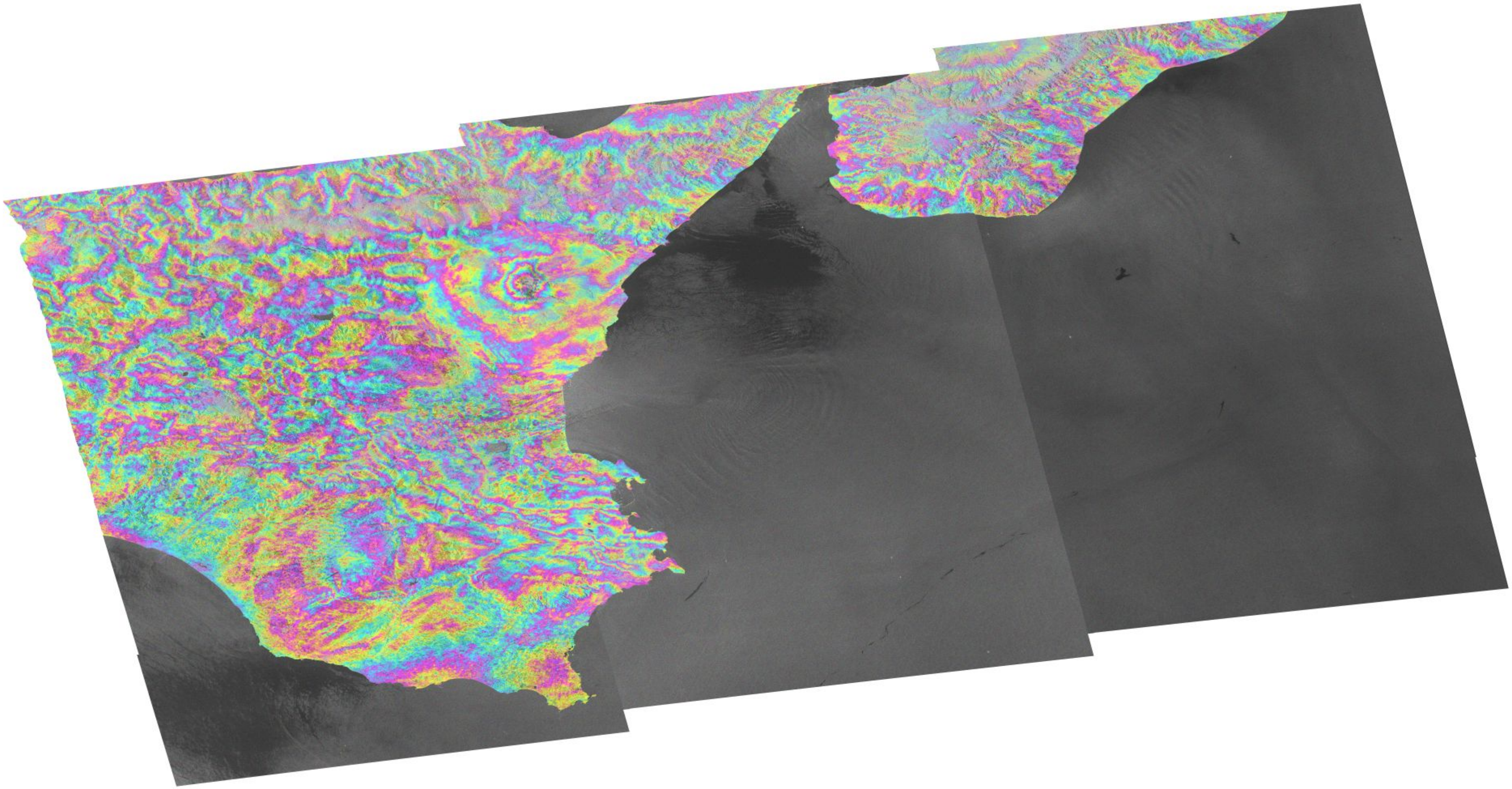
S1 DINSAR over Etna (VV, dt 12 days, $B_\perp$ 123m)



S1 differential interferogram, geocoded to geogr. coord., color cycle = phase cycle

GAMMA REMOTE SENSING

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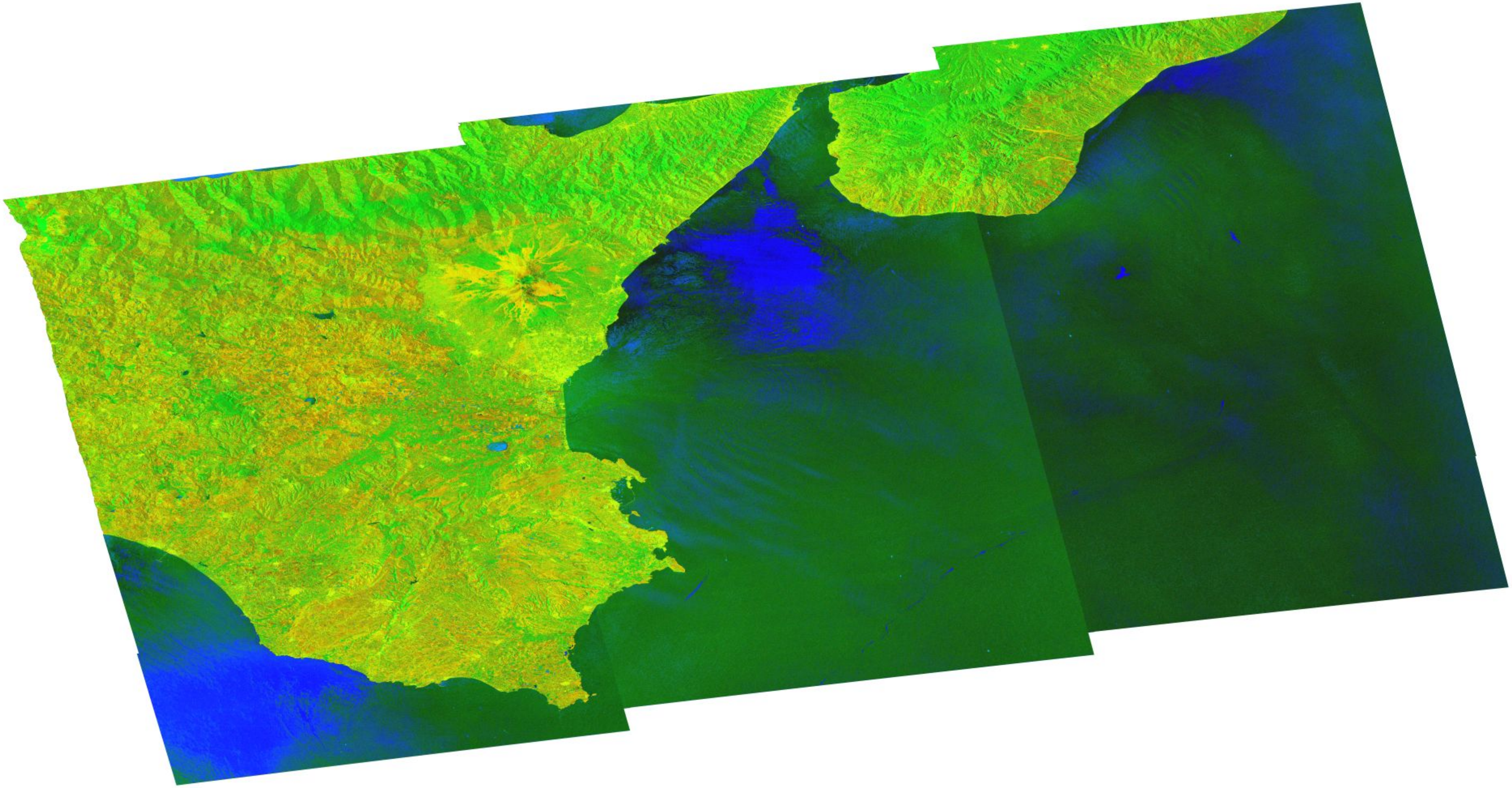

S1 TOPS Coherence product, RGB of coherence (red), backscatter (green) and backscatter change (blue)

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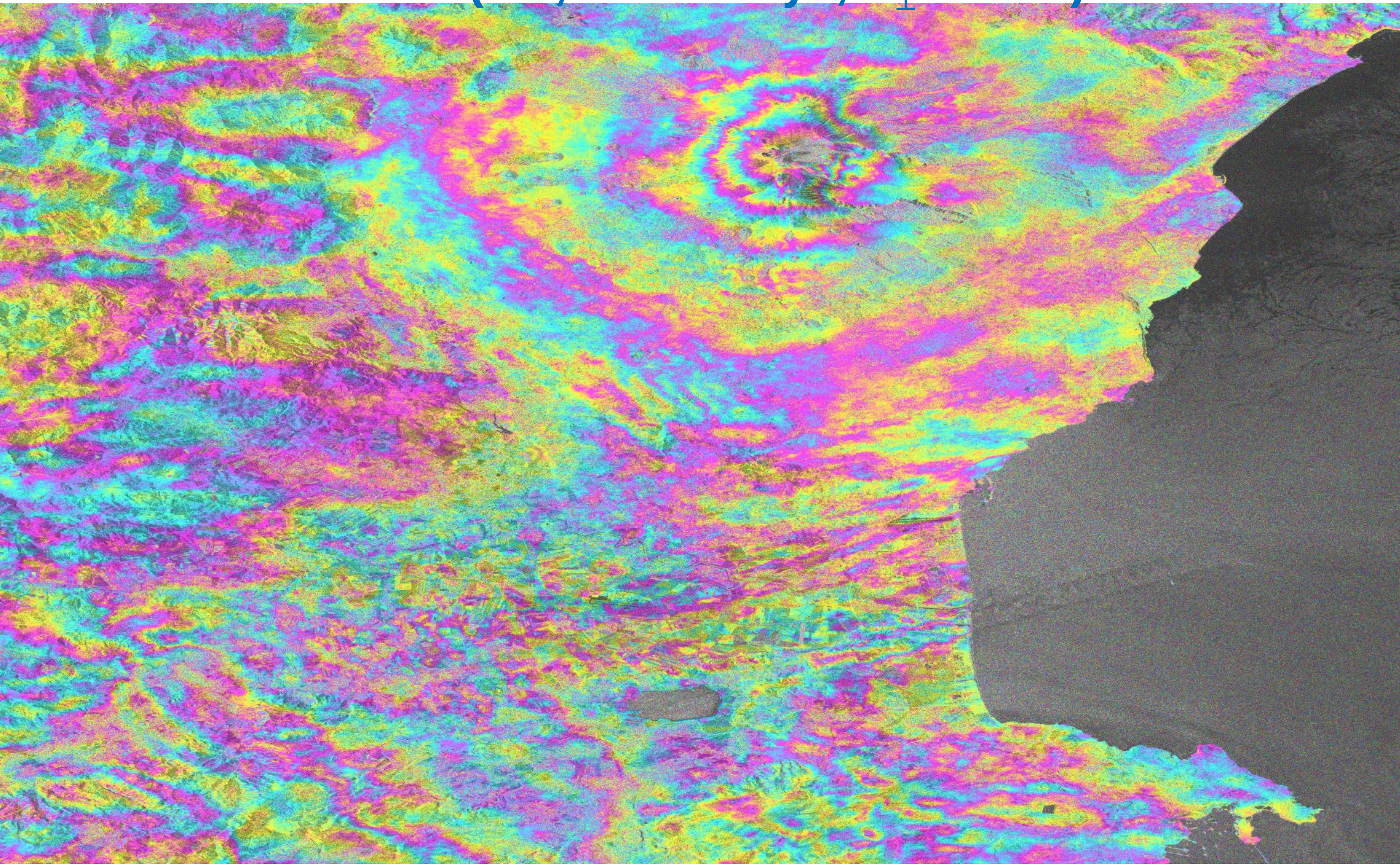
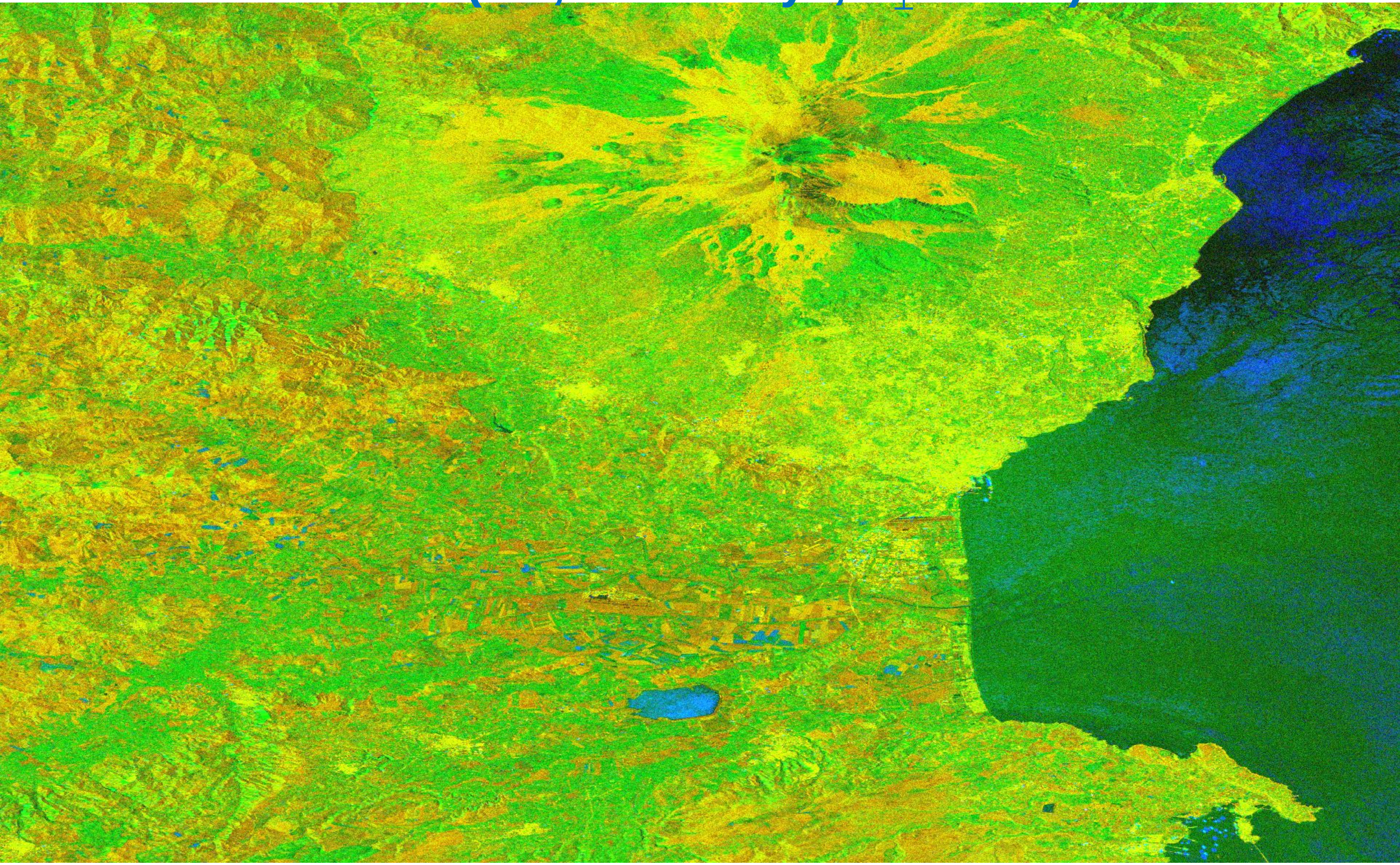
S1 DINSAR Etna (VV, dt 12 days, $B_\perp$ 123m): section



GAMMA REMOTE SENSING

S1 DINSAR Etna (VV, dt 12 days, $B_{\perp}$ 123m): section



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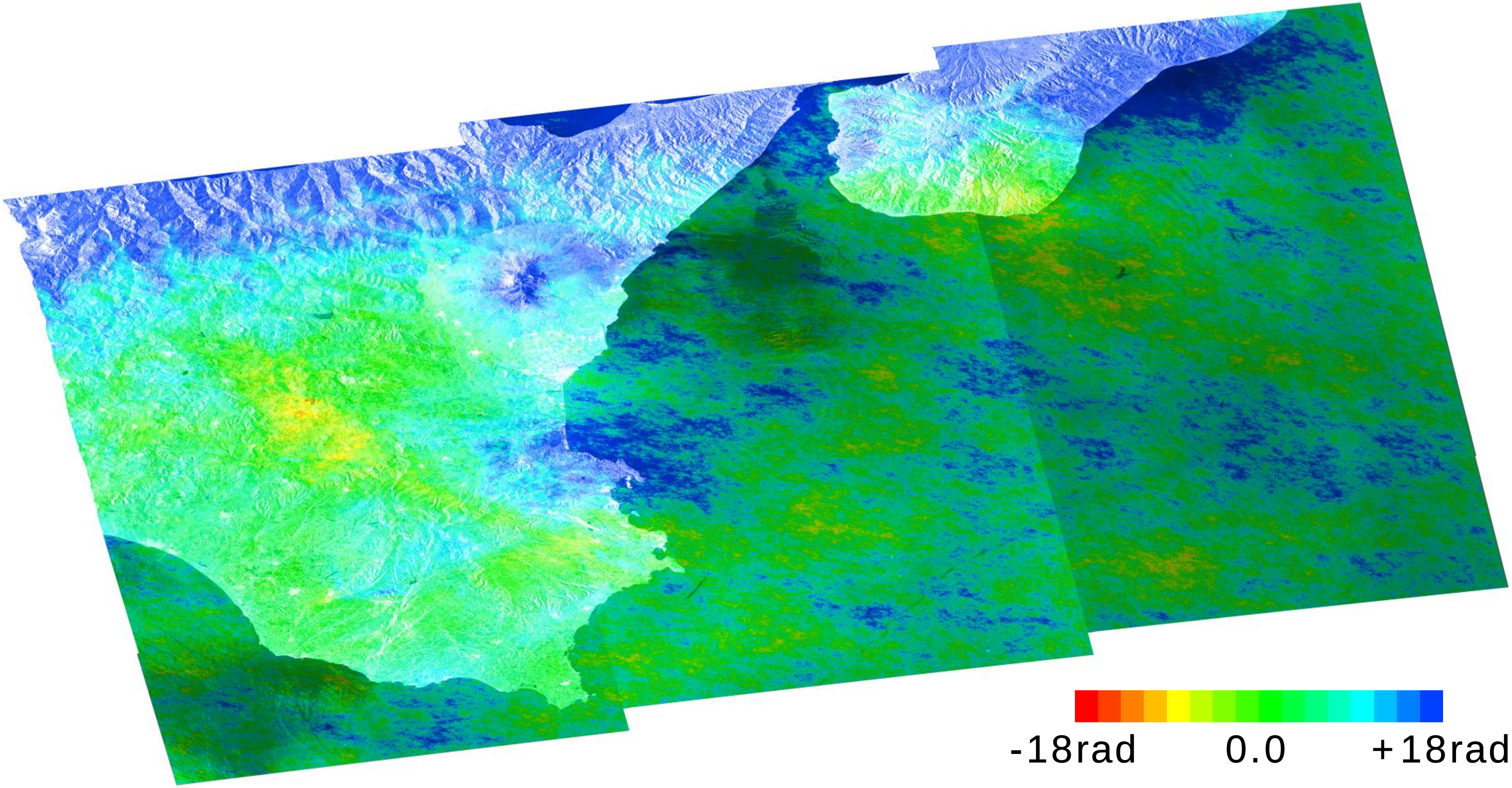
S1 DINSAR over Etna (VV, dt 12 days, $B_\perp$ 123m)



S1 differential interferogram, geocoded to geogr. coord., unwrapped

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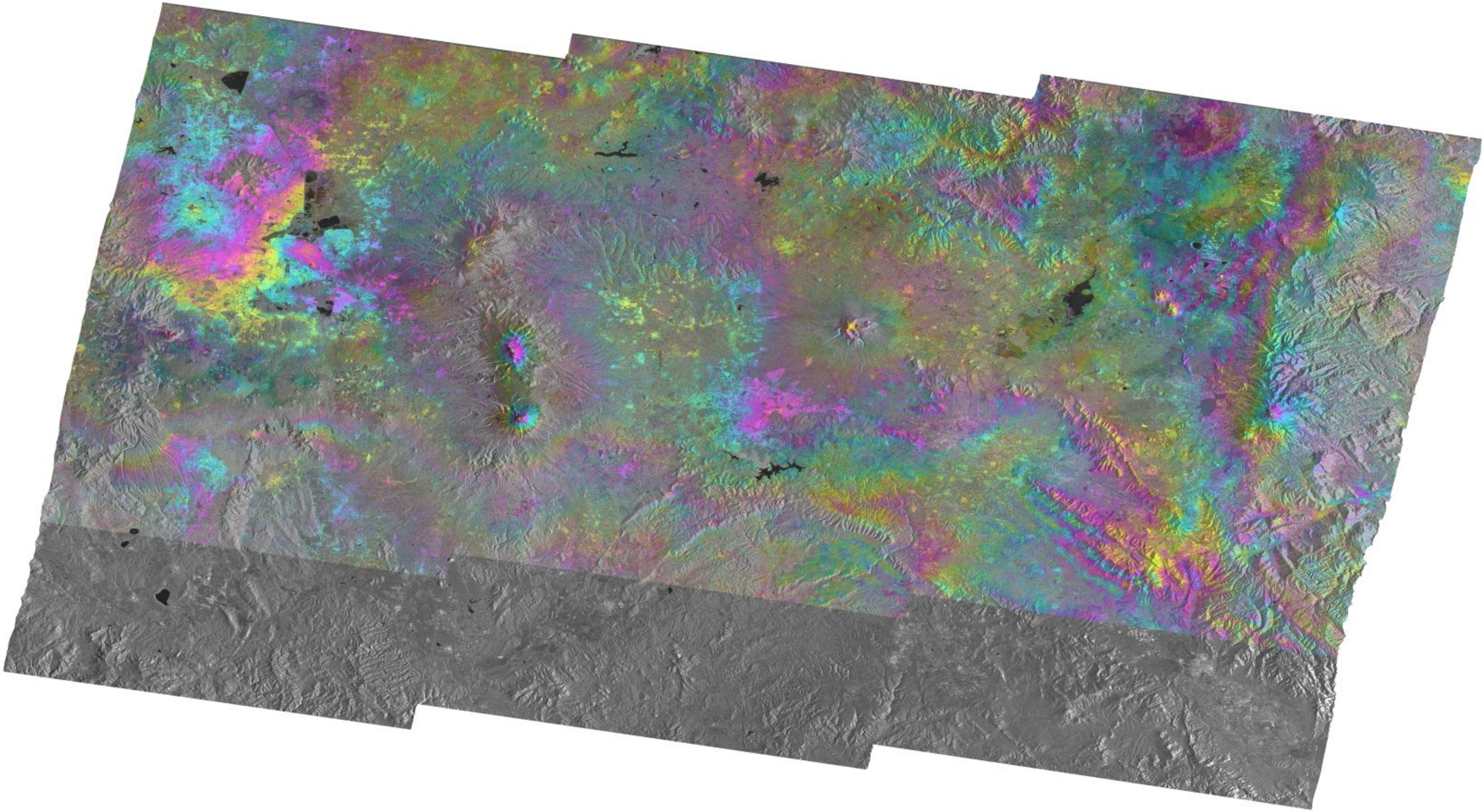
Remarks:

1) *Co-registration procedure also worked in this case with large areas without coherence*

S1 DINSAR over Mexico (VV, dt 12 days, $B_{\perp}$ -3m)



S1 differential interferogram, geocoded to geogr. coord., color cycle = phase cycle

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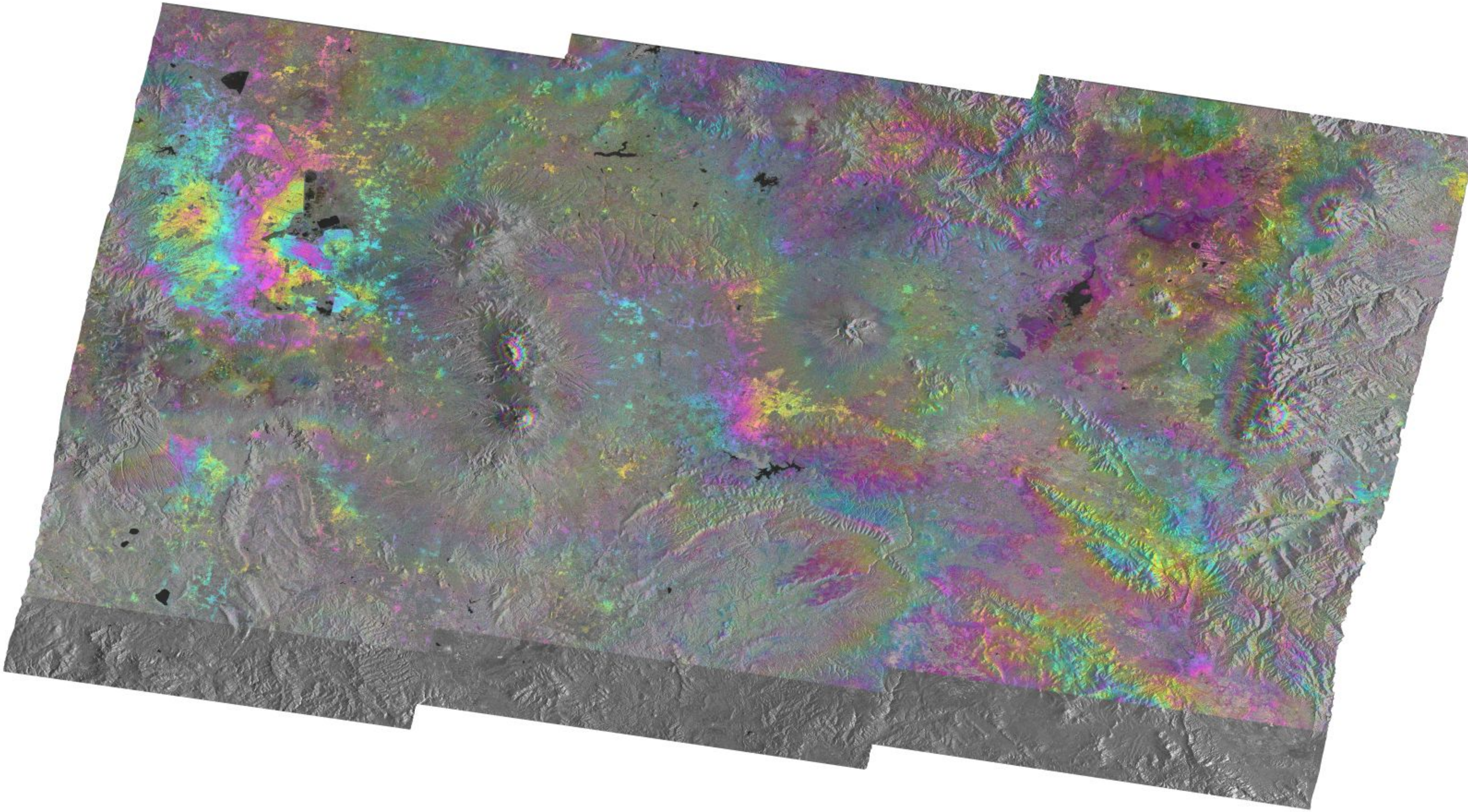
S1 DINSAR over Mexico (VV, dt 24 days, $B_{\perp}$ 64m)



S1 differential interferogram, geocoded to geogr. coord., color cycle = phase cycle

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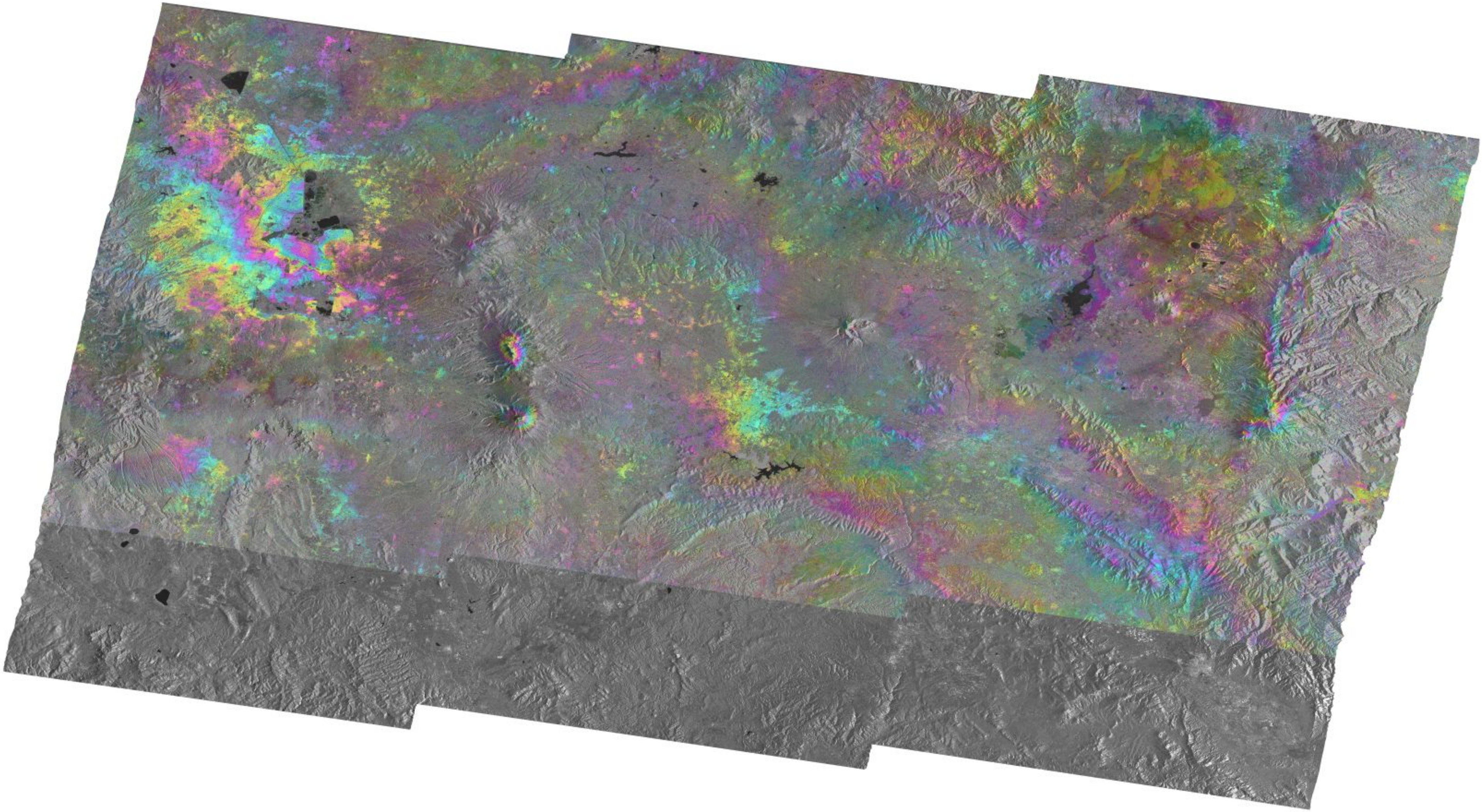
S1 DINSAR over Mexico (VV, dt 36 days, $B_\perp$ 54m)



S1 differential interferogram, geocoded to geogr. coord., color cycle = phase cycle

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Remarks:

1) *All scenes were registered to the same master (first scene)*
   → *all combination resulted in seamless differential interferograms*
2) *Methodology was applicable for the longer (36 days) interferogram*

Conclusions:

1) *Procedure for S1 TOPS interferometry was presented*
2) *Seamless differential interferograms demonstrate:*
   - the S1 data are suited, no special positional or phase adjustments between bursts or sub-swaths were necessary
   - the procedure used is suited
3) S1 IWS coherence is useful for landuse characterization and parameter retrieval. Over forest the 12 day repeat interval results in mostly very low coherence values which is useful for forest non-forest discrimination but which has only a very limited potential for forest parameters retrieval. There is some hope that this may improve in the future with S1B and shorter 6-day interval pairs. We observe on the other hand some parameter retrieval potential for lower vegetation but did not have enough suited data to fully consolidate this. For a basic landuse characterization the IWS data is quite well suited and the wide area coverage is of course very attractive.
4) *SLC co-registration procedure is also suited for subsequent PSI processing (expectation)*
5) *SLC co-registration procedure is also suited for subsequent offset tracking (tested)*

Open questions:

1) *ESA / Copernicus product distribution strategy? (are SLC systematically available or not?)*
   → based on this we have to decide if we implement a raw data processor or not

2) *Will there be consistent large archives available everywhere (e.g. for PSI) ?*