Iodine Monoxide (IO)

Nadir Scientific Data Product

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Preface

Iodine monoxide (IO) from SCIAMACHY:

- Scientific data product, no operational version

SCIAMACHY:

- only satellite instrument for which an IO product has been published so far

Due to challenges, some settings are different than in standard operational products.

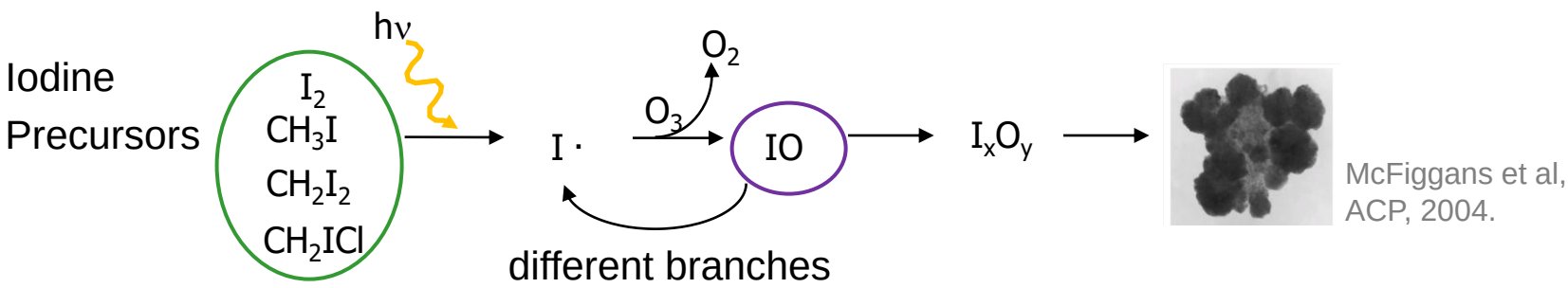
Preface: Untypical settings in the IO retrieval

- Retrieval performed on uncalibrated data (no product improvement when using calibrations so far)
- Usage of cluster 14 (otherwise unused, longer integration time)
- Reference from Earthshine instead of solar spectrum
- No cloud filter
- Compilation of temporal averages instead of individual spectra

Importance of iodine species

Iodine radicals in the atmosphere

- Impact on composition / oxidizing capacity
  - destruction of ozone
  - partitioning of HO_x and NO_x
- Formation of fine particles → growth to CCN



McFiggans et al, ACP, 2004.

IO observations

Locations: coastal areas, marine boundary layer, Polar sites

Typical amounts: 0-10 pptv (>20 pptv sporadically)

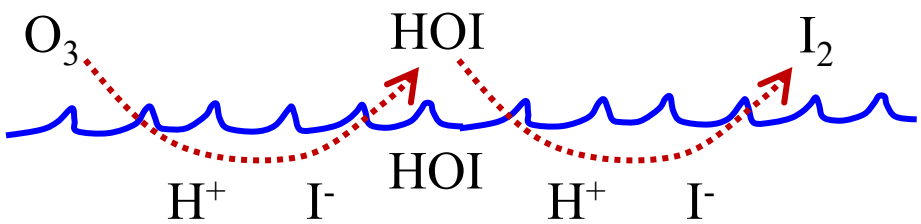
Importance of iodine species

- Organic iodine emissions:
  - from algae, diatoms
  - seen in laboratories, mid-latitude coasts, Weddell Sea (Antarctica)
- Inorganic iodine sources:
  - open ocean source
  - recent investigations, tropical Atlantic

$$H^+ + I^- + O_3 \rightarrow HOI + O_2$$

$$H^+ + HOI + I^- \leftrightarrow I_2 + H_2O$$

e.g. L. Carpenter, Nature Geoscience, 2013



I^- at the water surface (influenced by biology)

SCIAMACHY data

- Nadir geometry
- Visible spectral range
  - Channel 3
  - Cluster 14 & 15
- No radiometric calibration

  (-cal 1,5 - but wavelength calibration not used)
- No cloud screening for maximum data amount

→ 1. IO product on NRT data

→ 2. IO product on consolidated data product (U)

DOAS retrieval of IO from SCIAMACHY

Differential Optical Absorption Spectroscopy – Settings:

- Spectral range: 416 – 430 nm
- Trace gases: IO, NO_2 (223K), O_3 (223K)
- IO Cross Section: Gómez-Martín et al, 2005
- Ring effect, pseudo-absorber, SCIATRAN
- Quadratic polynomial
- Linear intensity offset
- Earthshine reference spectrum

Background – Earthshine

Earthshine reference:

- Daily average above an ocean region (Pacific)

  Latitude 30° - 50° S

  Longitude 150° - 170° W

Alternative Earthshine reference:

- Daily average above a continental region (Siberia)

  Latitude 60° - 70° N

  Longitude 80° - 120° E

Results

- IO slant columns retrieved from NRT data for 2003 – 2011

- IO vertical columns computed for
  - box profiles (1 km, based on assumptions)
  - constant albedo values (90% for Polar analyses, 5% for oceans)

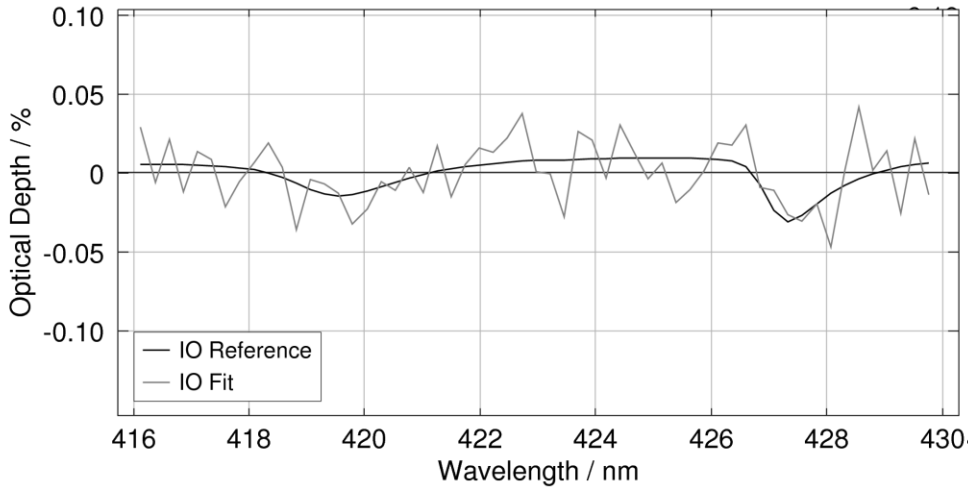
- Analyses usually based on averaged data / maps
  - typically for 3 months (or longer)

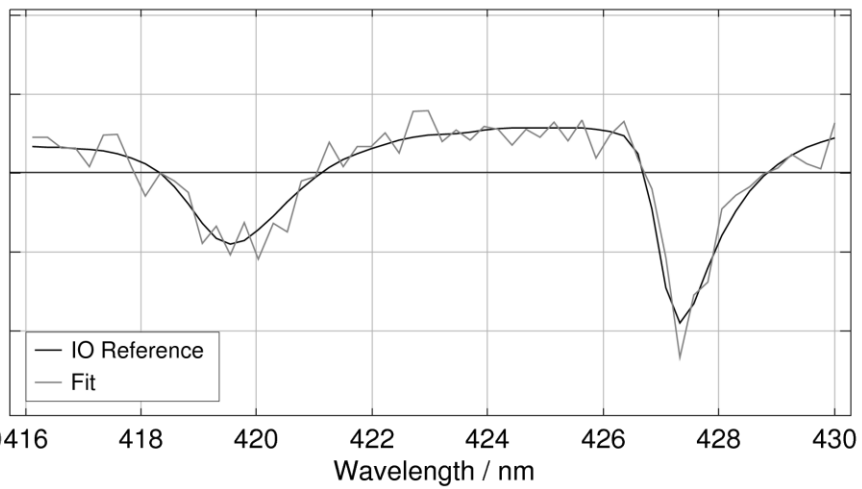
Results: IO amounts

- Amounts are comparably small
- Mostly close to the detection limit

Results: IO retrieval quality

- Detection limit
  - Depending on scenario
  - Order of magnitude (slant column): 7 x10^{12} molec / cm²
- Retrieval examples:





IO Slant Column:

(1.49 ± 0.50) x10^{13} molec / cm²

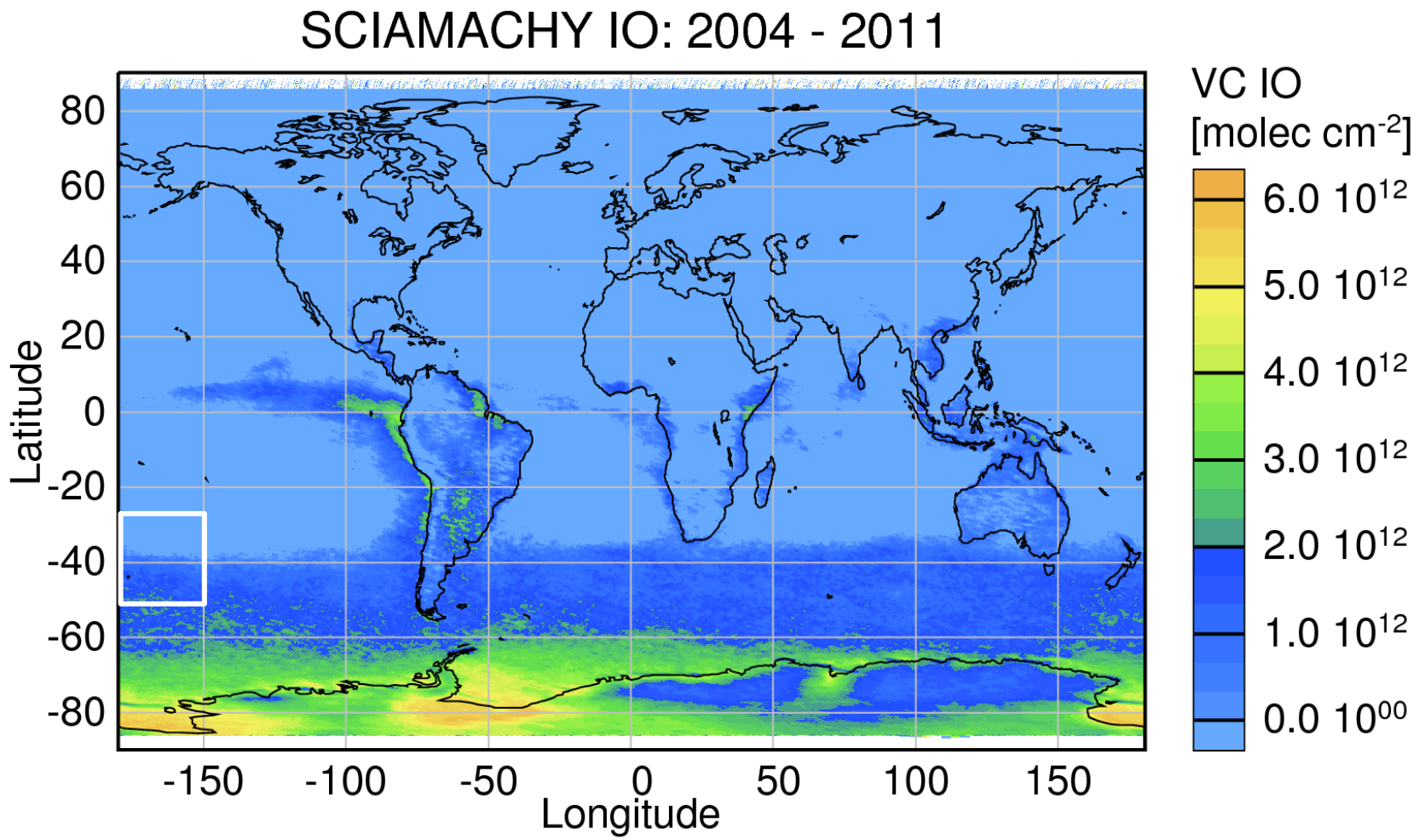
Error: 33.4 %

IO Slant Column:

(4.58 ± 0.27) x10^{13} molec / cm²

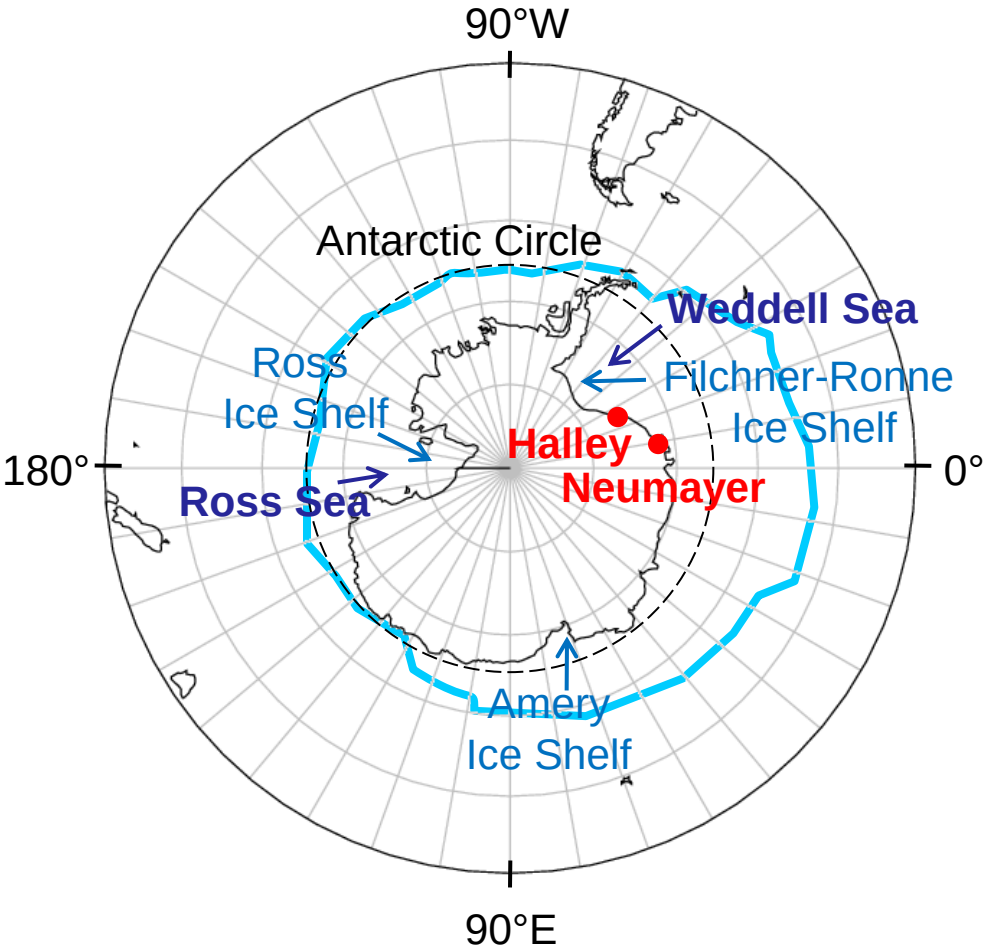
Error: 6.0 %

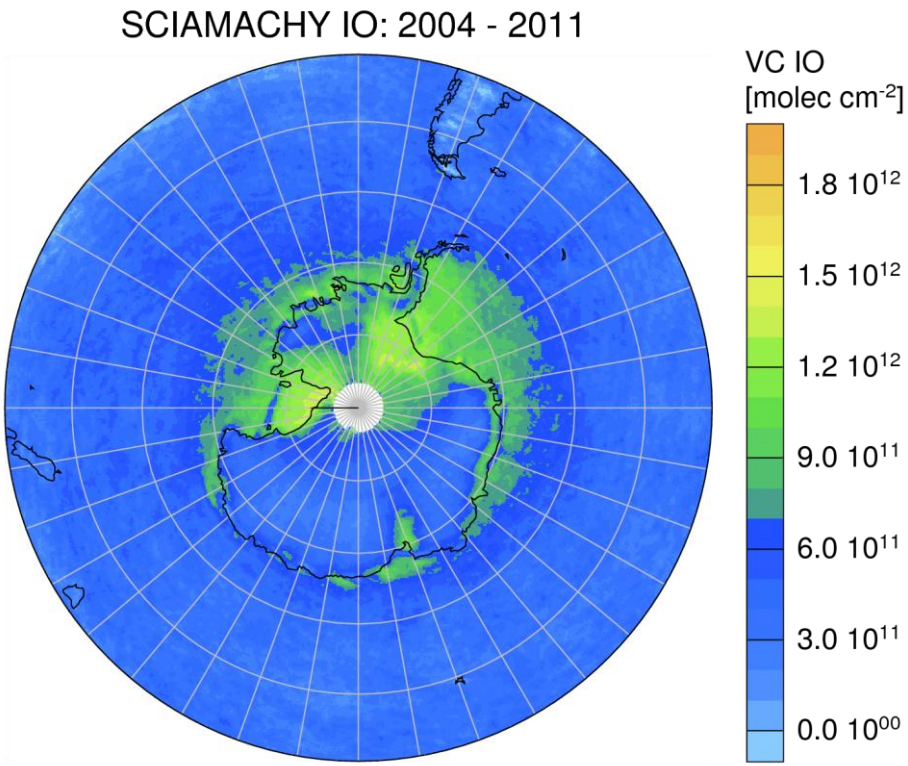
Results: IO global overview



IO above Polar regions

NRT data 2004-2011
AMF: 90% reflectance



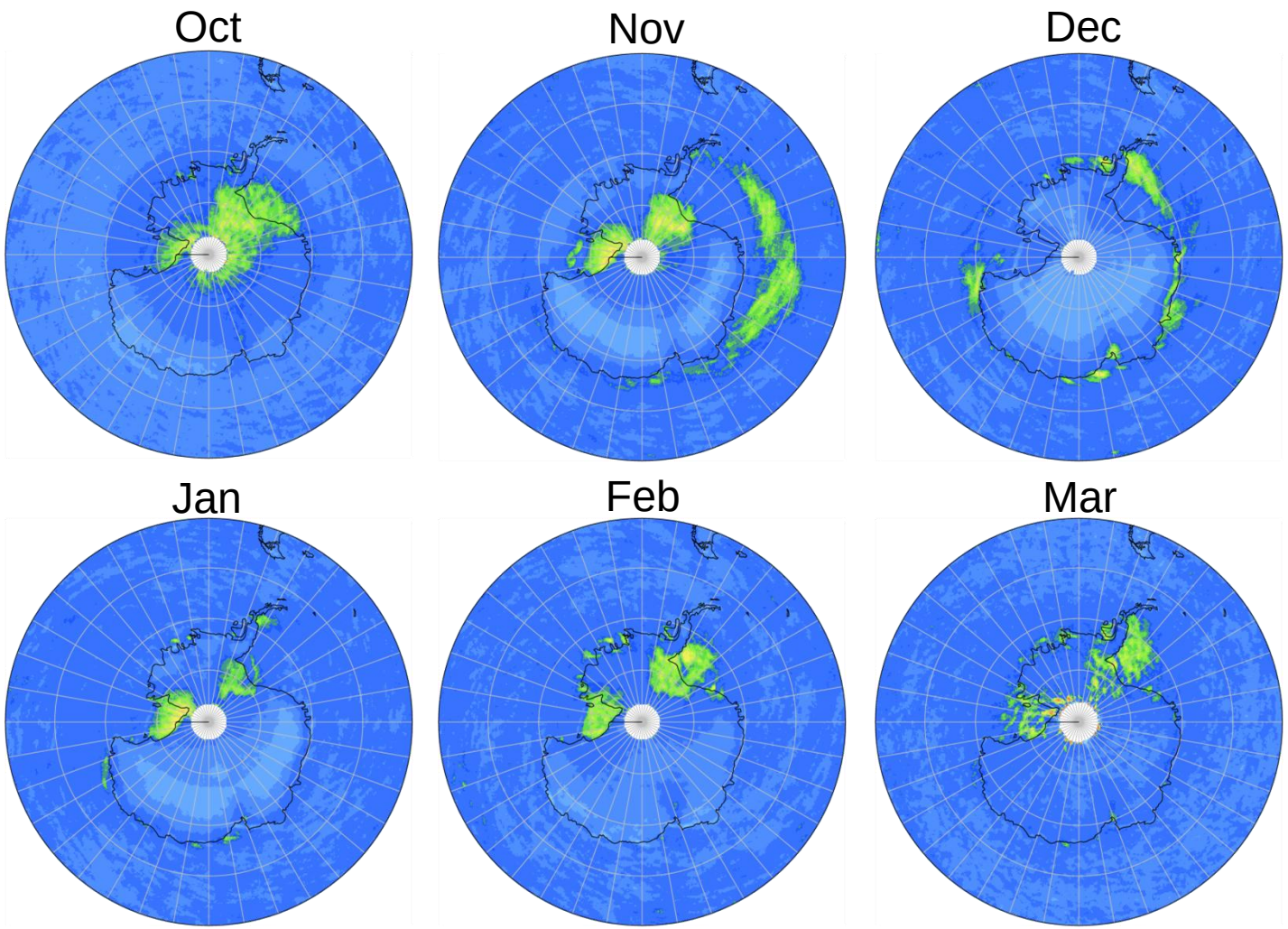


Multi-year composite

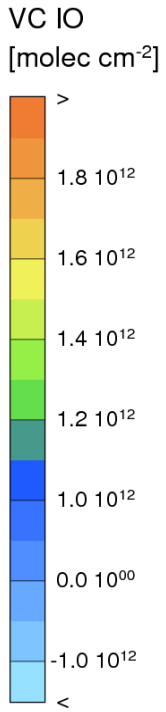
Max. sea ice extent

IO above Polar regions

NRT data 2004-2011
AMF: 90% reflectance



8 year average
2004-2011



Schönhardt et al., ACP, 2012.

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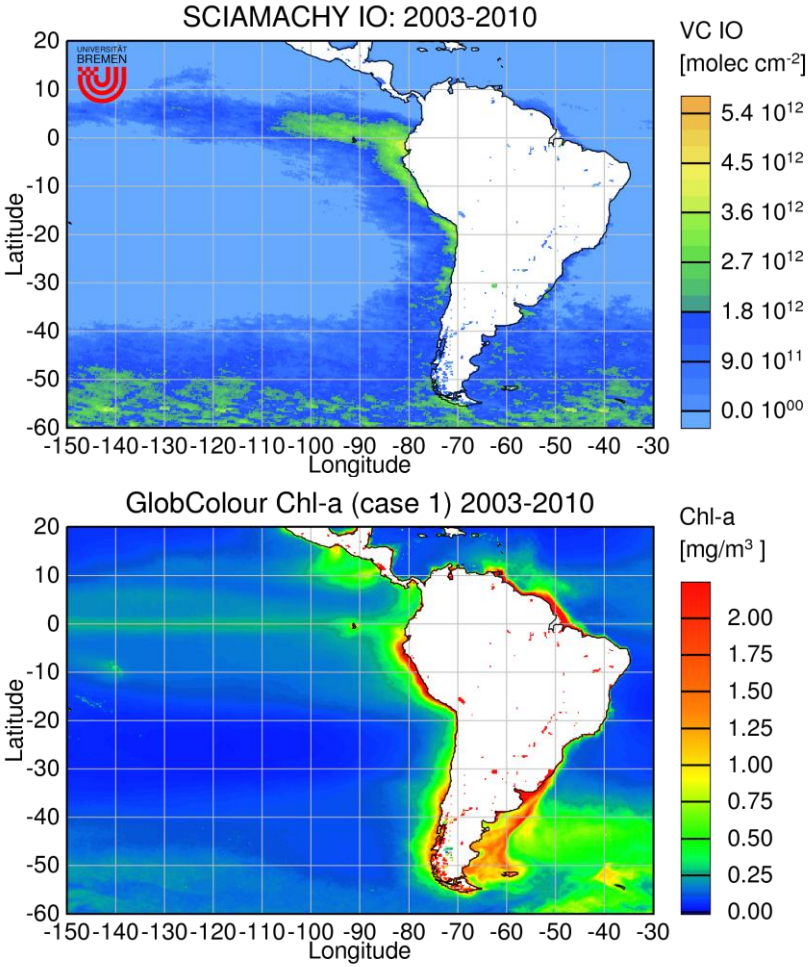
IO above Polar regions

- IO above Antarctica

  above sea ice, ice shelves, coast lines, continent
- Widest spread amounts in spring time
- Amounts strongly influenced by ground reflectance

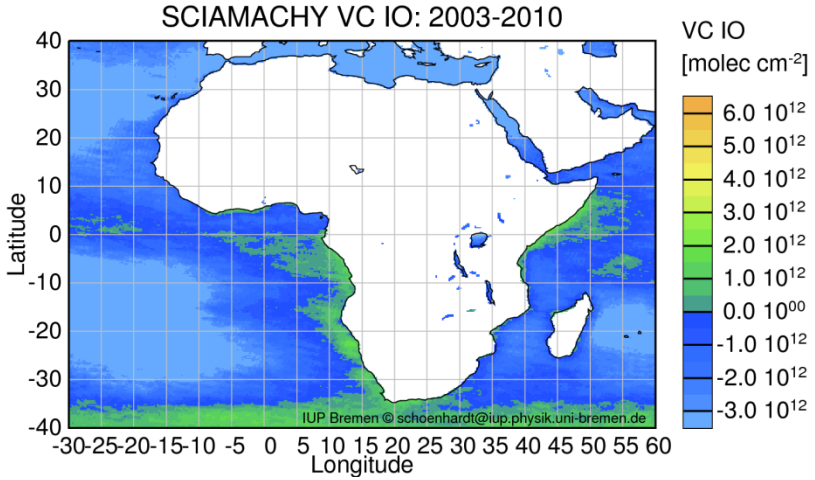
IO above oceans

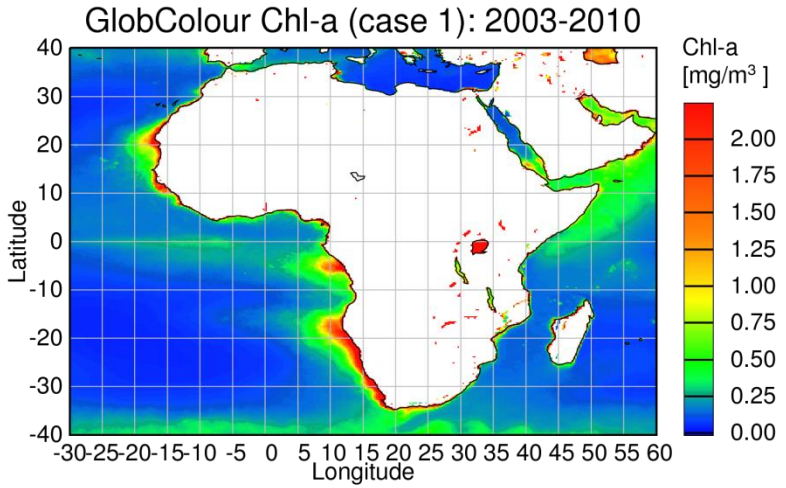
- Enhanced IO above Eastern Pacific
- Care needed with absolute amounts
- Partly spatial coincidence with Chlorophyll-a
- No spatial correlation at some other locations



IO above oceans

- Different colour scales due to shift in baseline
- Slightly enhanced IO at some coasts
- No clear relationship: regions with/without correlation Chl-a and IO





IO – open issues

- Interhemispheric gradient
  - Larger values on the Southern Hemisphere
  - Possible improvement through latitude dependent reference

- Usage of calibrated data
  - No improvements for full calibration using earlier processor versions
  - Use processor version V8 and full calibration
  - Perform comparisons to established scientific IO product

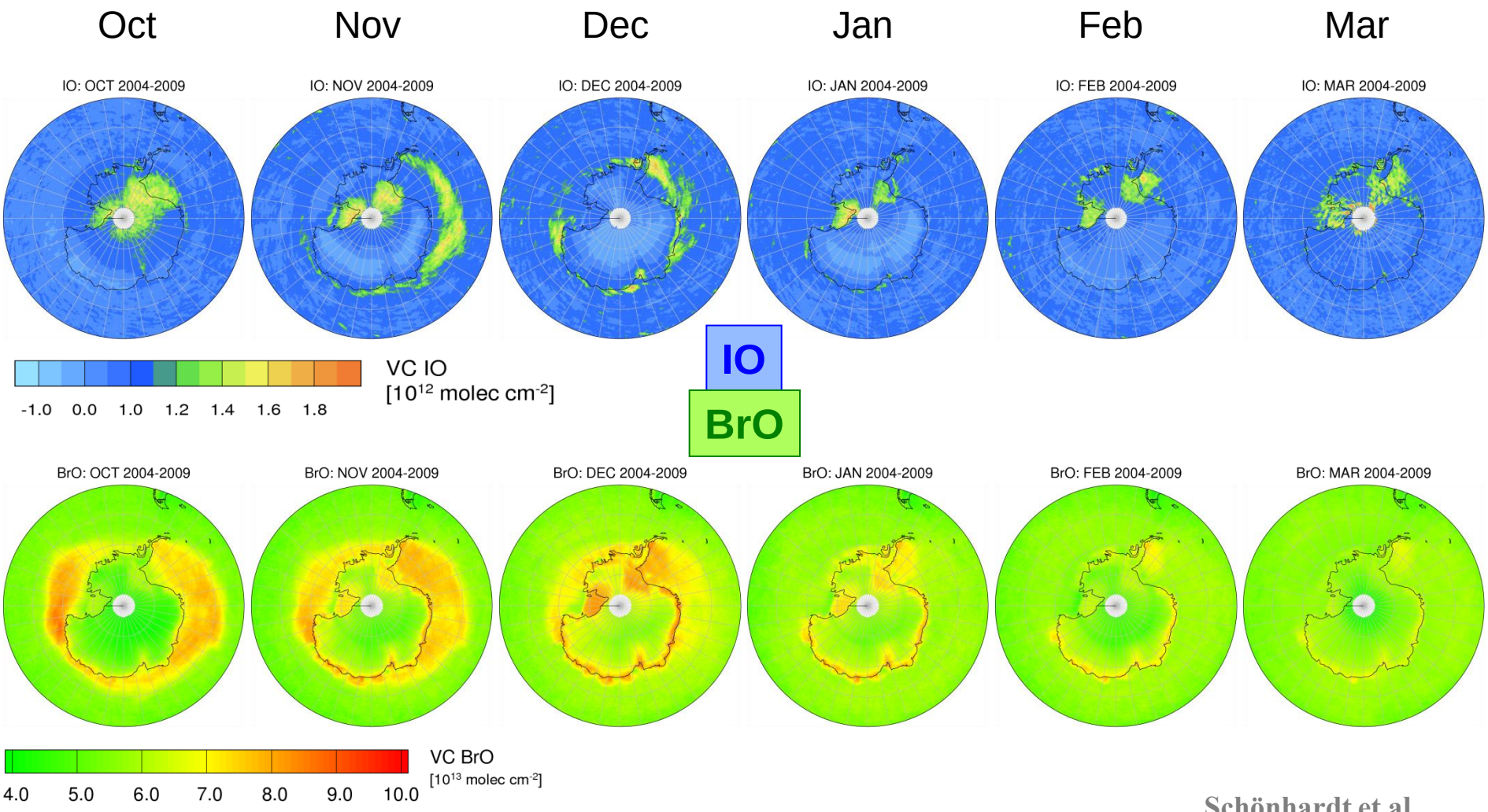
Summary

- SCIAMACHY nadir IO scientific data product processed for 2003 to 2011
- Observed IO amounts mostly close to detection limit
- Slant column detection limit around $7x10^{12}$ molec/cm²
- Temporal averages are produced and analysed
- Care in interpretation of absolute amounts is neccessary
- Further analyses, especially using processor V8, will be performed in the near future
- Reassessment of IO product may yield further improvement

END

IO above Polar regions

NRT data 2004-2009
AMF: 90% reflectance



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