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Mapping beyond 3857

Ing. Andrea Aime
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- **Italian SME**
- **Expertise**
  - Image Processing, GeoSpatial Data Fusion
  - Java, Java Enterprise, C++, Python
  - JPEG2000, JPIP, Advanced 2D visualization
- **Supporting/Developing FOSS4G projects**
  - GeoServer, MapStore
  - GeoNetwork, GeoNode, Ckan
- **Clients**
  - Public Agencies
  - Private Companies
- **http://www.geo-solutions.it**

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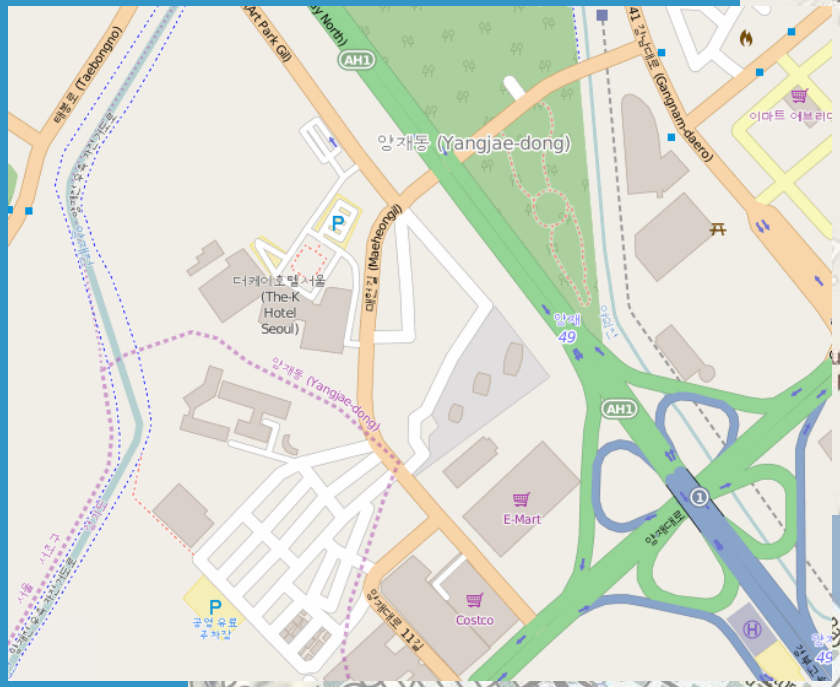
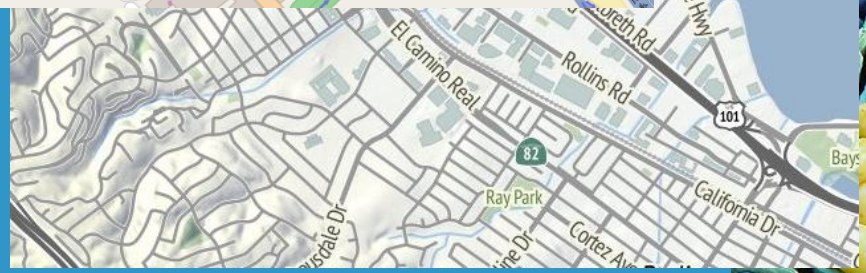
Why EPSG:3857

FOSS4G-EU 2015, Como
14th-17th July 2015

Why: it's everywhere, it's free

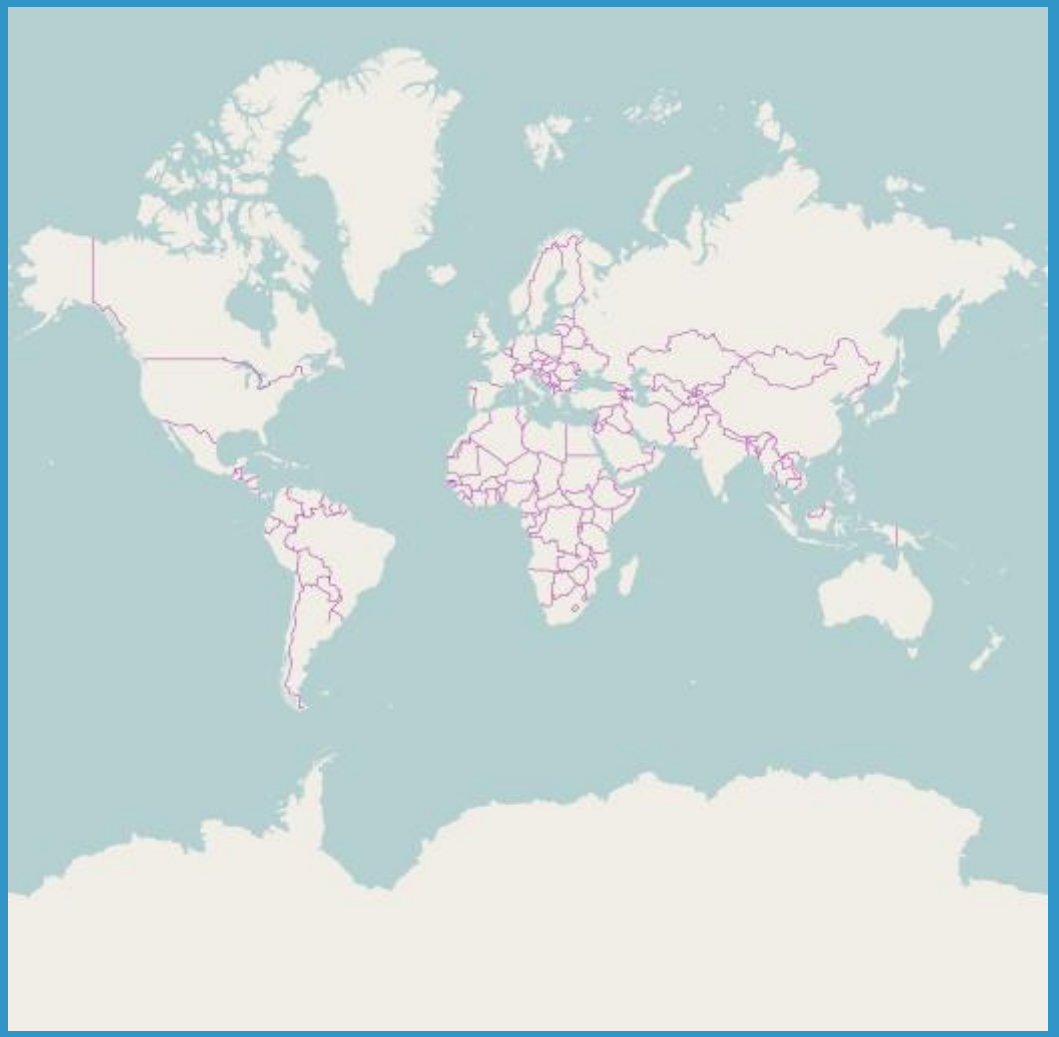
- Plenty of free and ready to use tiles





Why: familiar

- That's how the people are used to see the world (sigh)



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Why: easy

- Tens of interesting projections
- Why learn sevaral of them, when you can get away with just one? 😉

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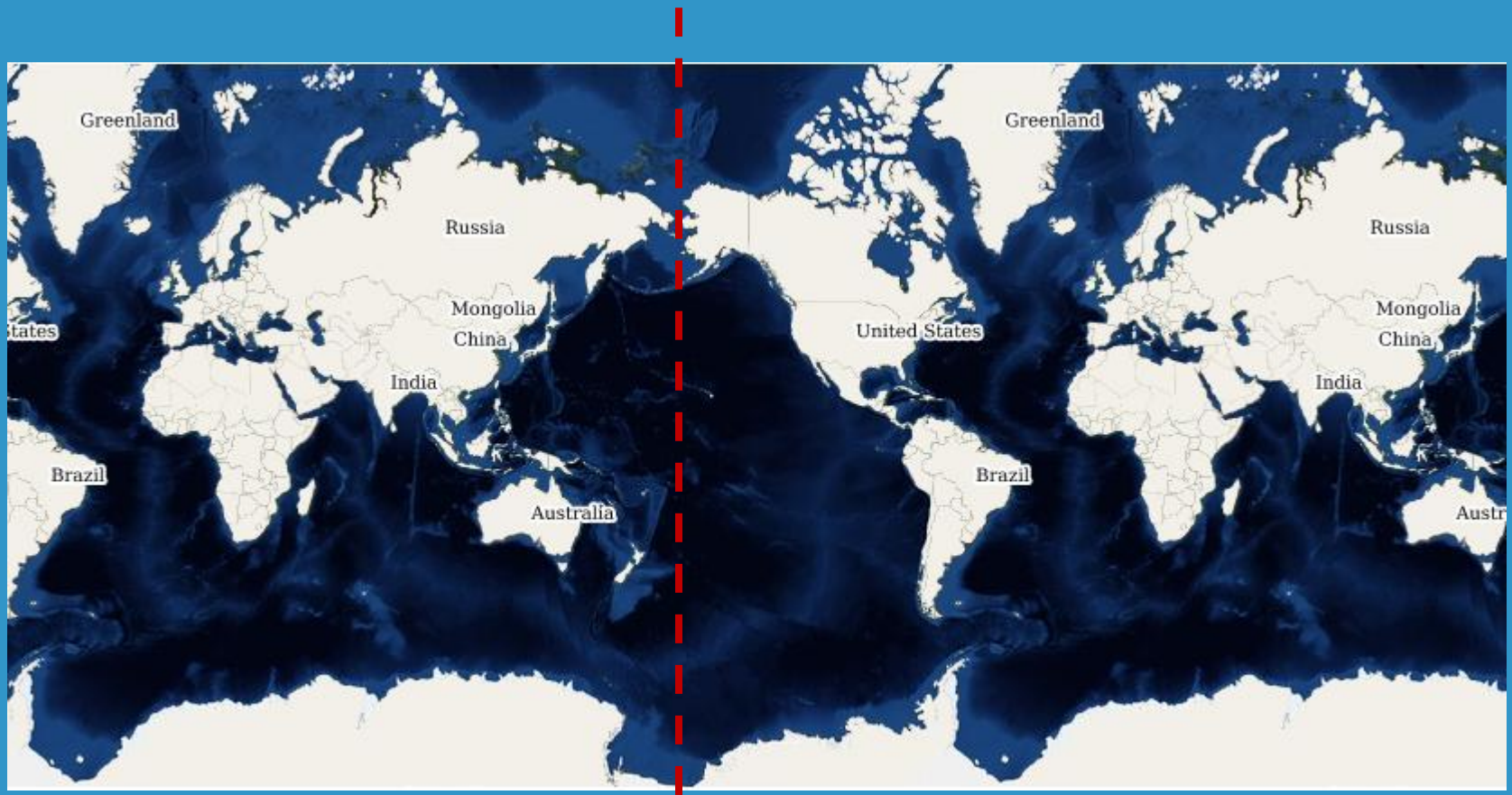
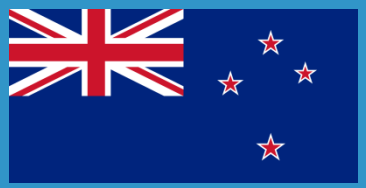
14th-19th September 2015

Why: fair to the dateline

- Nicely wraps at the dateline, easy to look at the pacific





Some reasons why *NOT DO* EPSG:3857

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14th-19th September 2015

One reason to rule them all

- Distortion!

- We use other projections because
  - we want to minimize
  - a certain type of distortion
  - in a certain area

- Distortion: shape, area, distances?
- Area: global, local, related to law requirements?

Area distortion in web mercator

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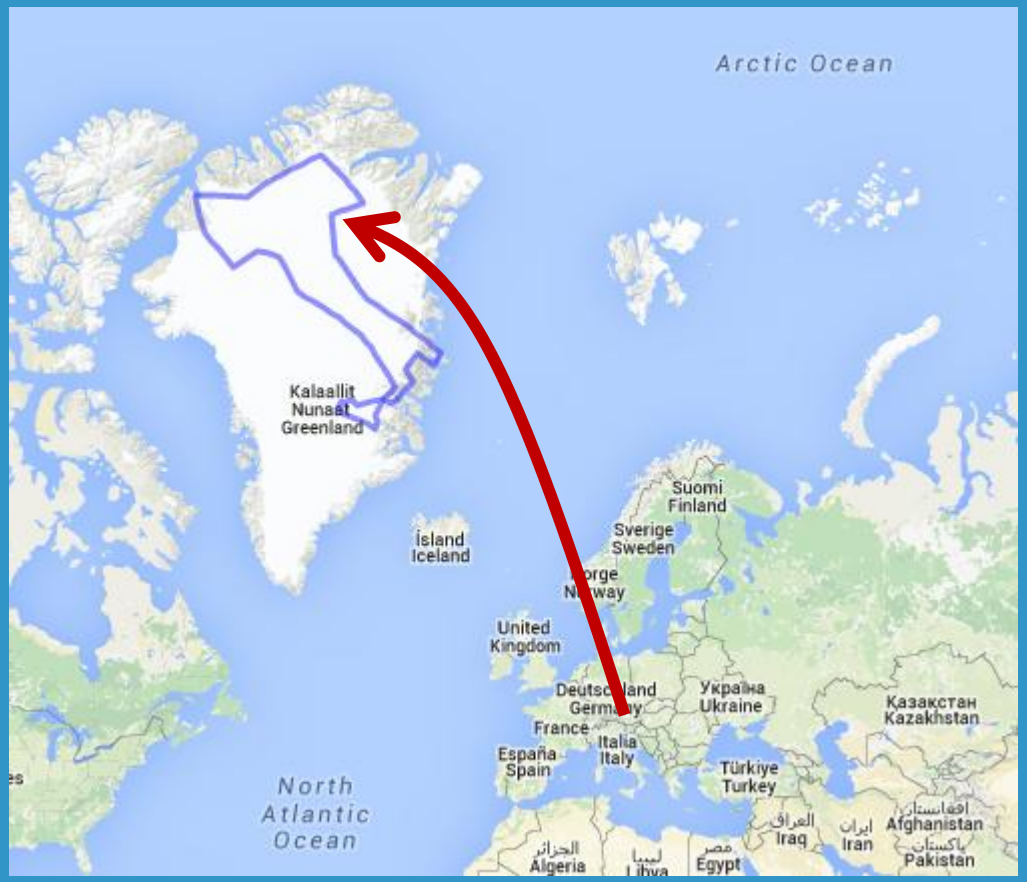
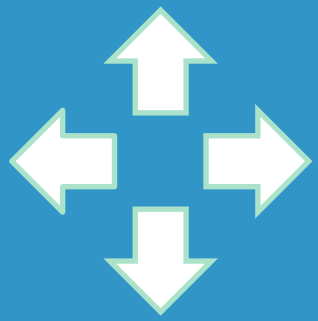
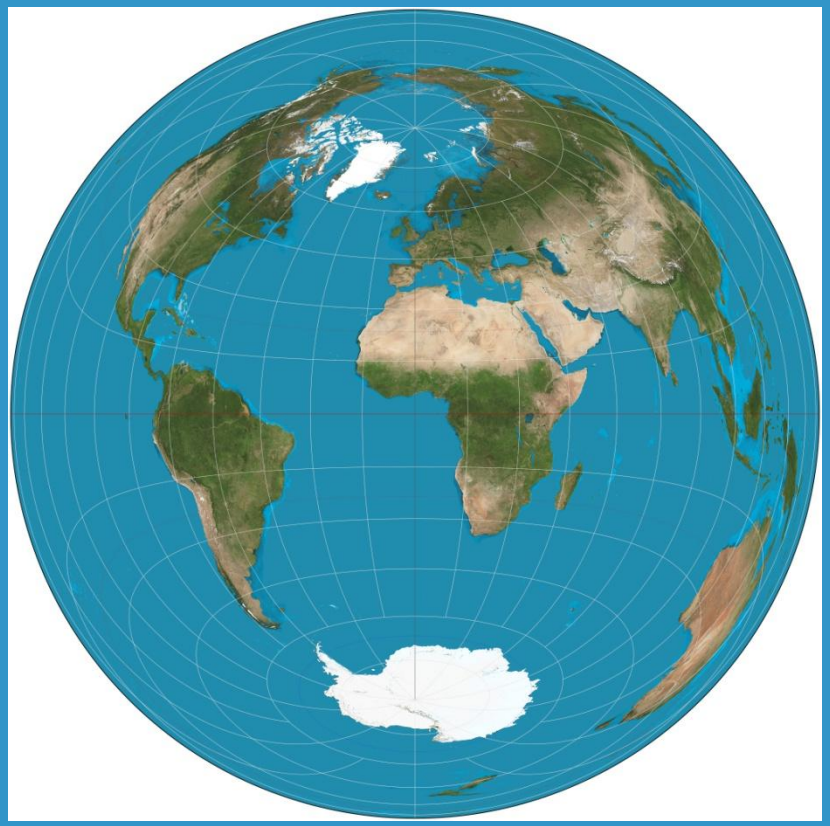
- North areas are expanded both in south-north and east-west direction



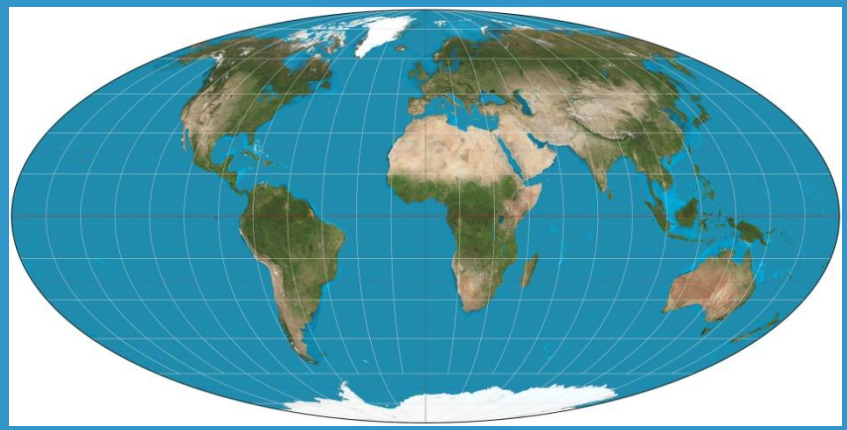


Equal-area maps to the rescue

- We perceive relative area proportions at a glance
- Fundamental to maintain the right proportions for statistical and didactical purposes



Lambert azimuthal equal area



Mollweide

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FAO example

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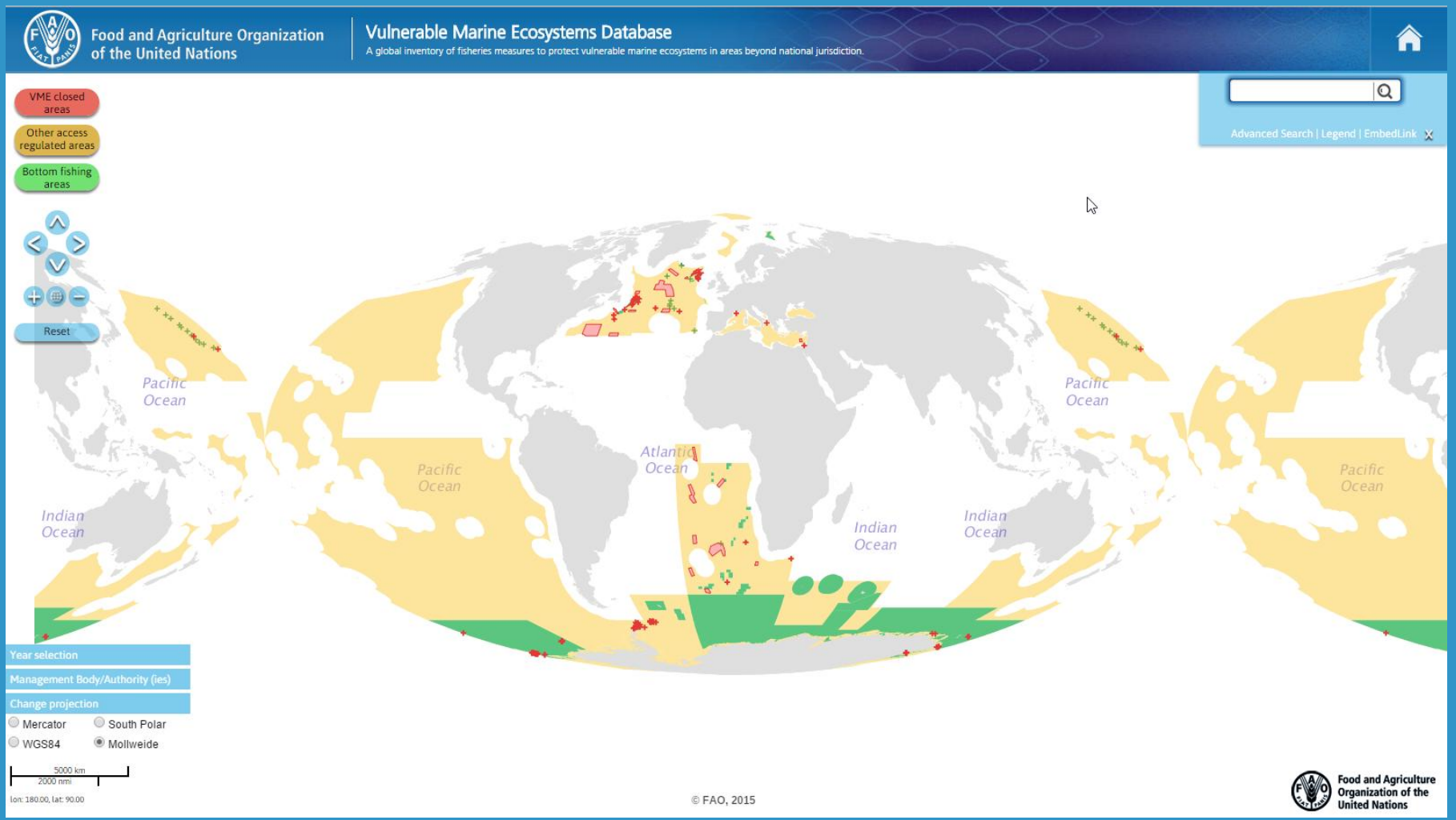

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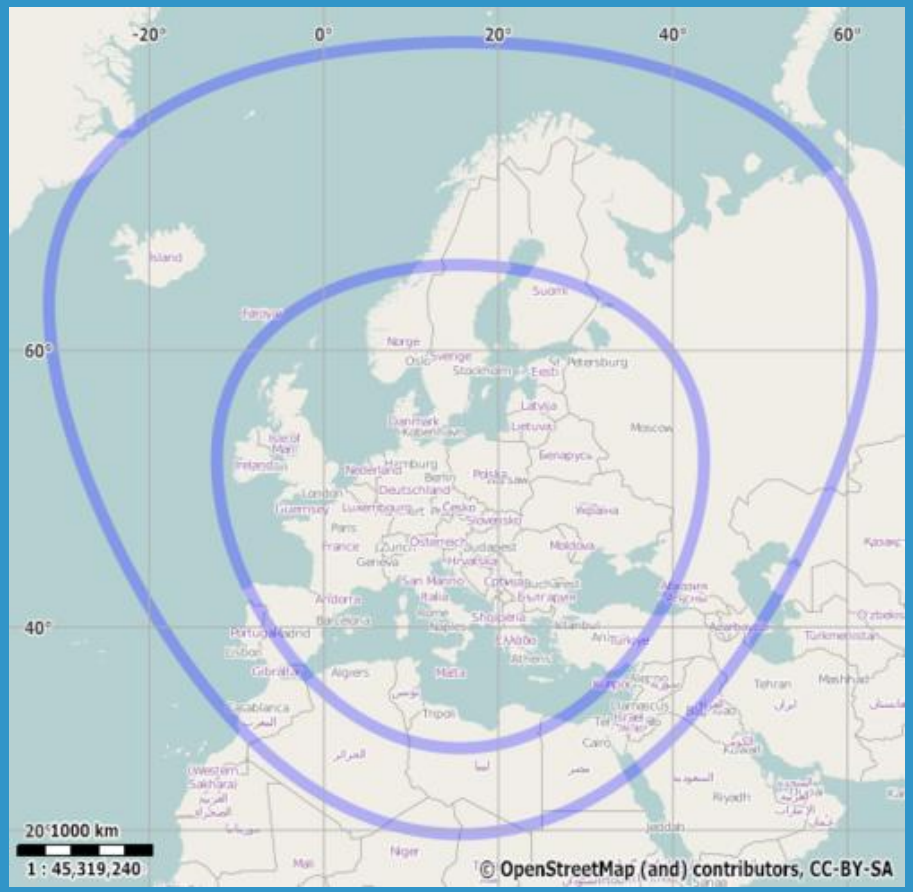
Distance perception

- Yes, we can measure distances using tools
- But our eyes see relative distances whether we want them, or not

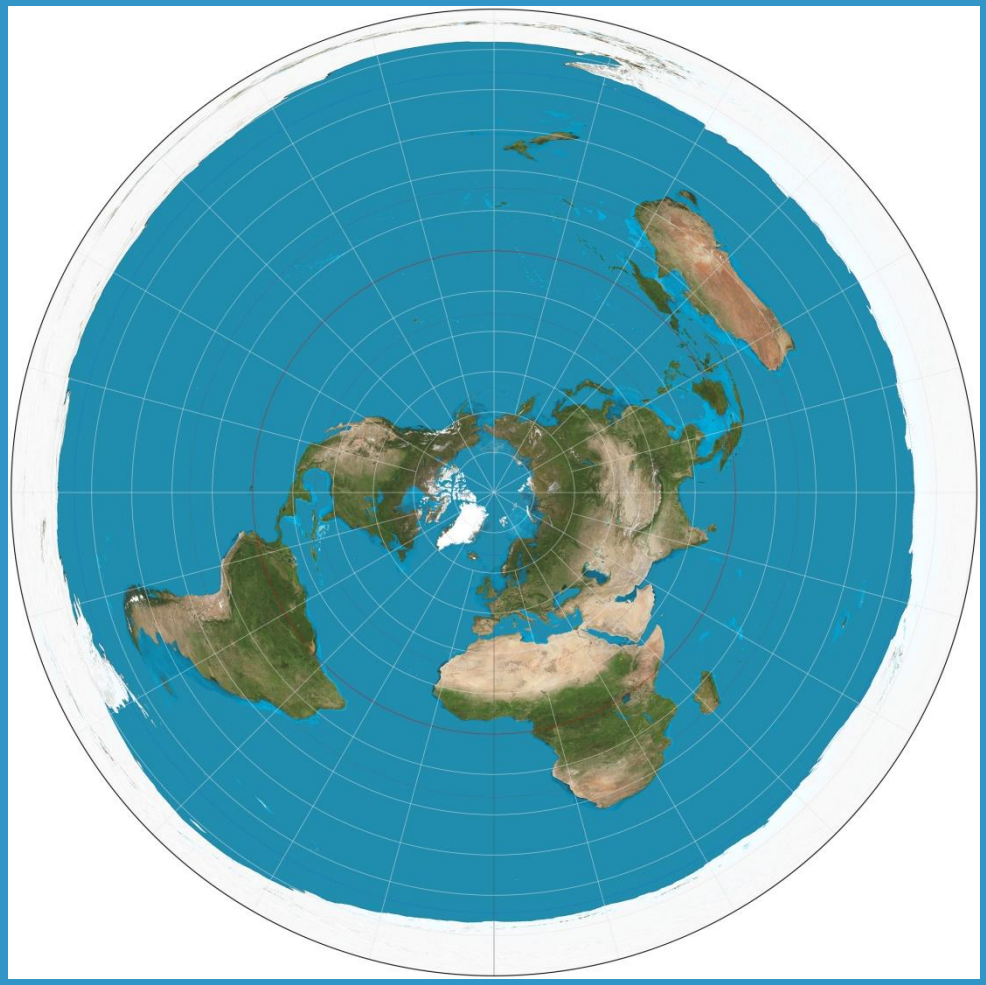


- Lines of equal distance at 3000 and 2000km from Maribor, Slovenia

http://braincrunch.tumblr.com/post/23672142073/mercators-egg

Equidistant maps to the rescue

- These maps show true distance *along specific lines*



- Azimuthal equidistant, north pole centered
- True distance from the center to any other point
- Wait… where did I see that around?

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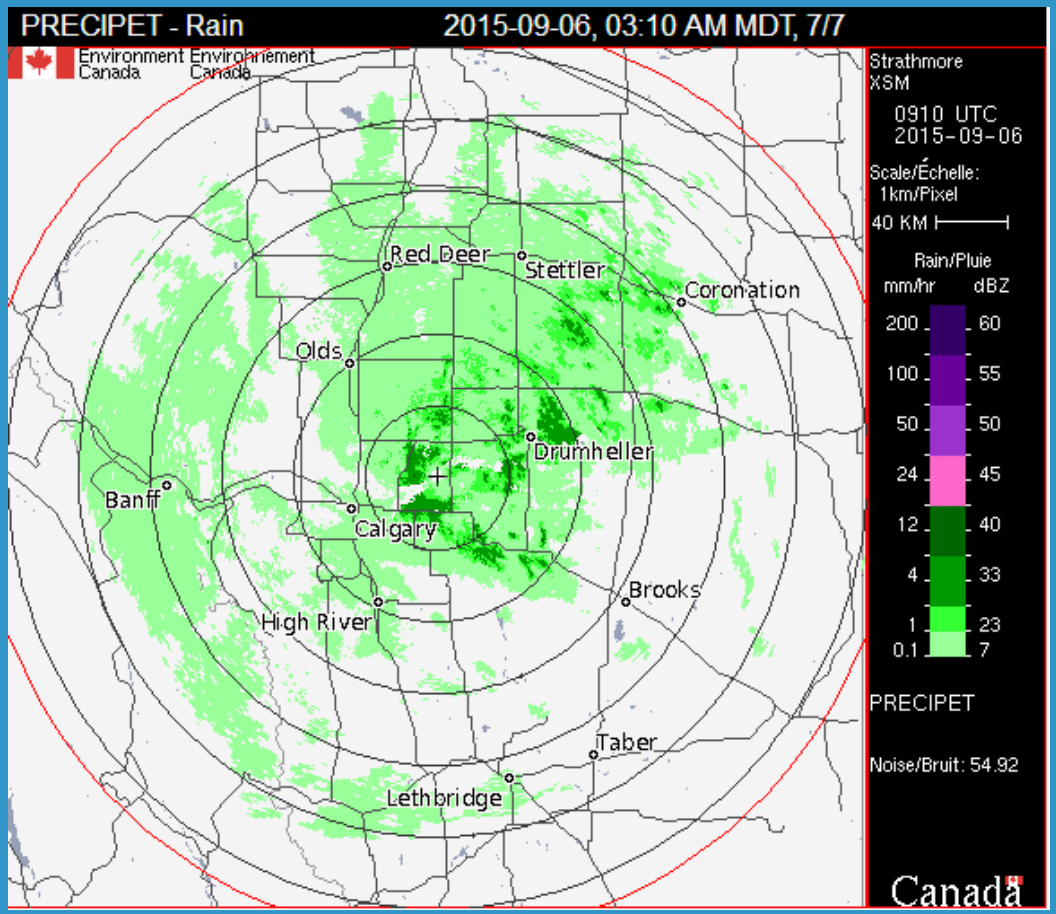
Example: weather radar maps

- From canadian weather maps, by station



https://weather.gc.ca/radar/index_e.html?id=xsm

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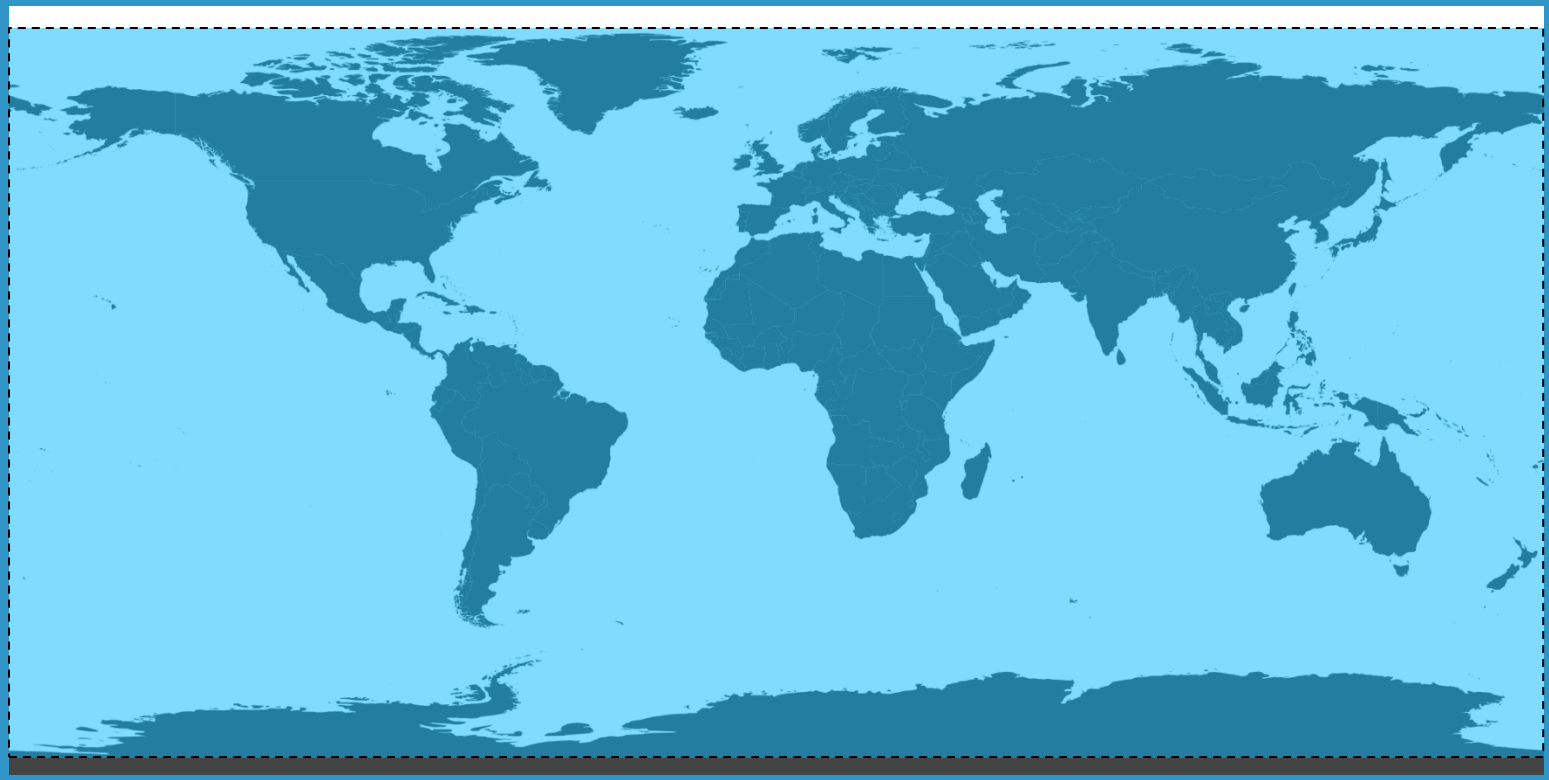
Who ate my poles?!

- Web mercator normally covers only -80/85 latitudes
- The part of polar areas that is represented, is badly distorted
- Yet, poles are important for research in general, and climate studies in particular



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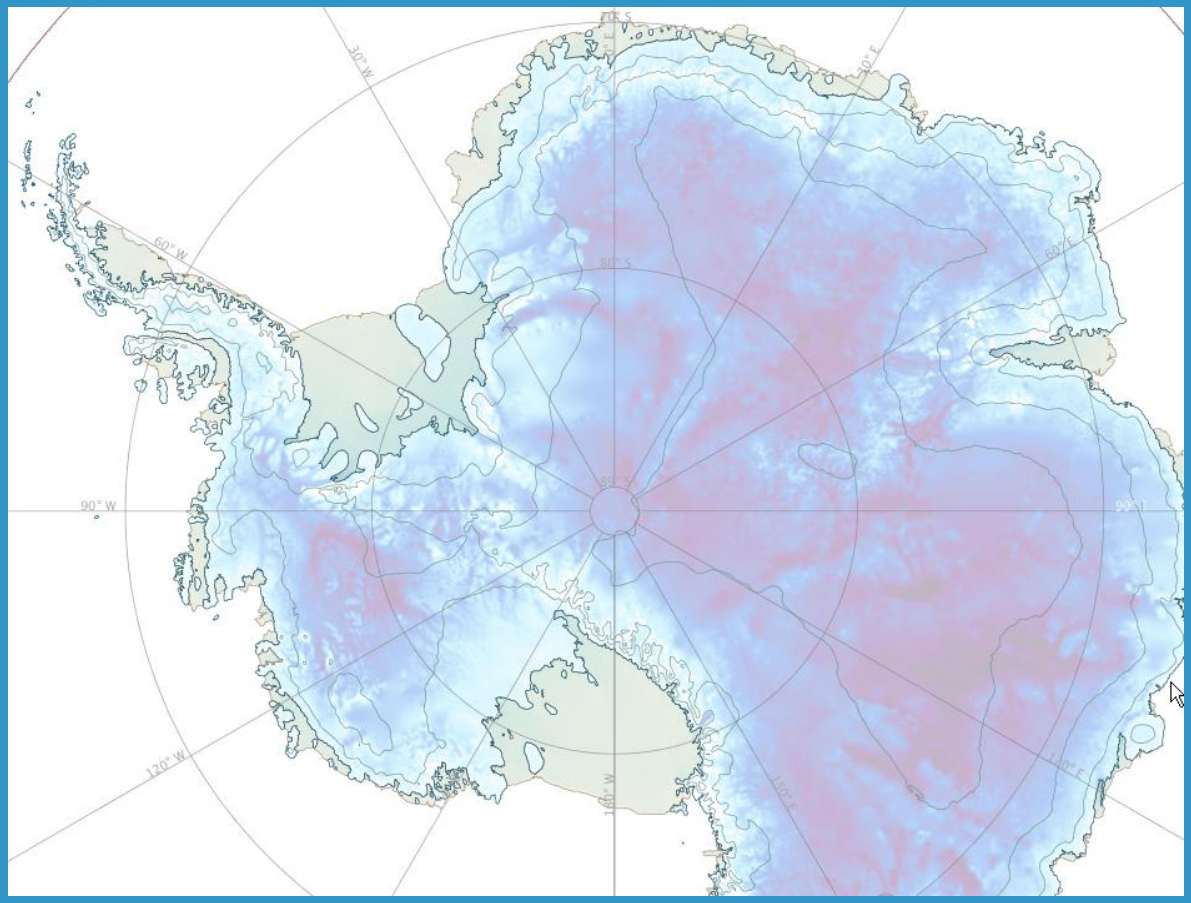
Polar stereographic

- Polar stereographic normally used for those areas
- An example from British Antarctic survey (powered by GeoServer)



http://www.add.scar.org/home/add6

Polar stereographic

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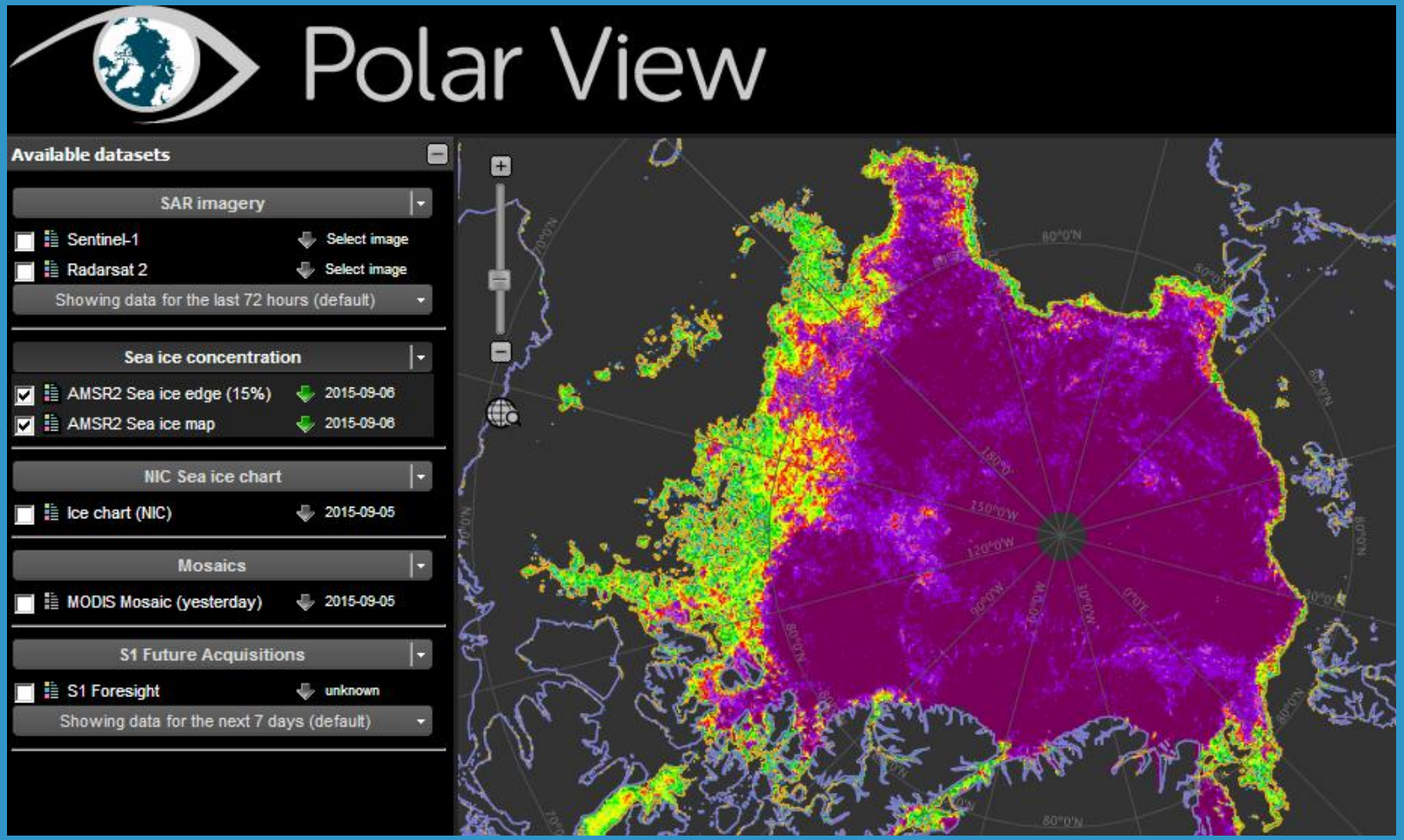
- www.polarview.org



http://www.polarview.aq/ (also GeoServer powered)

FAO Species Distribution

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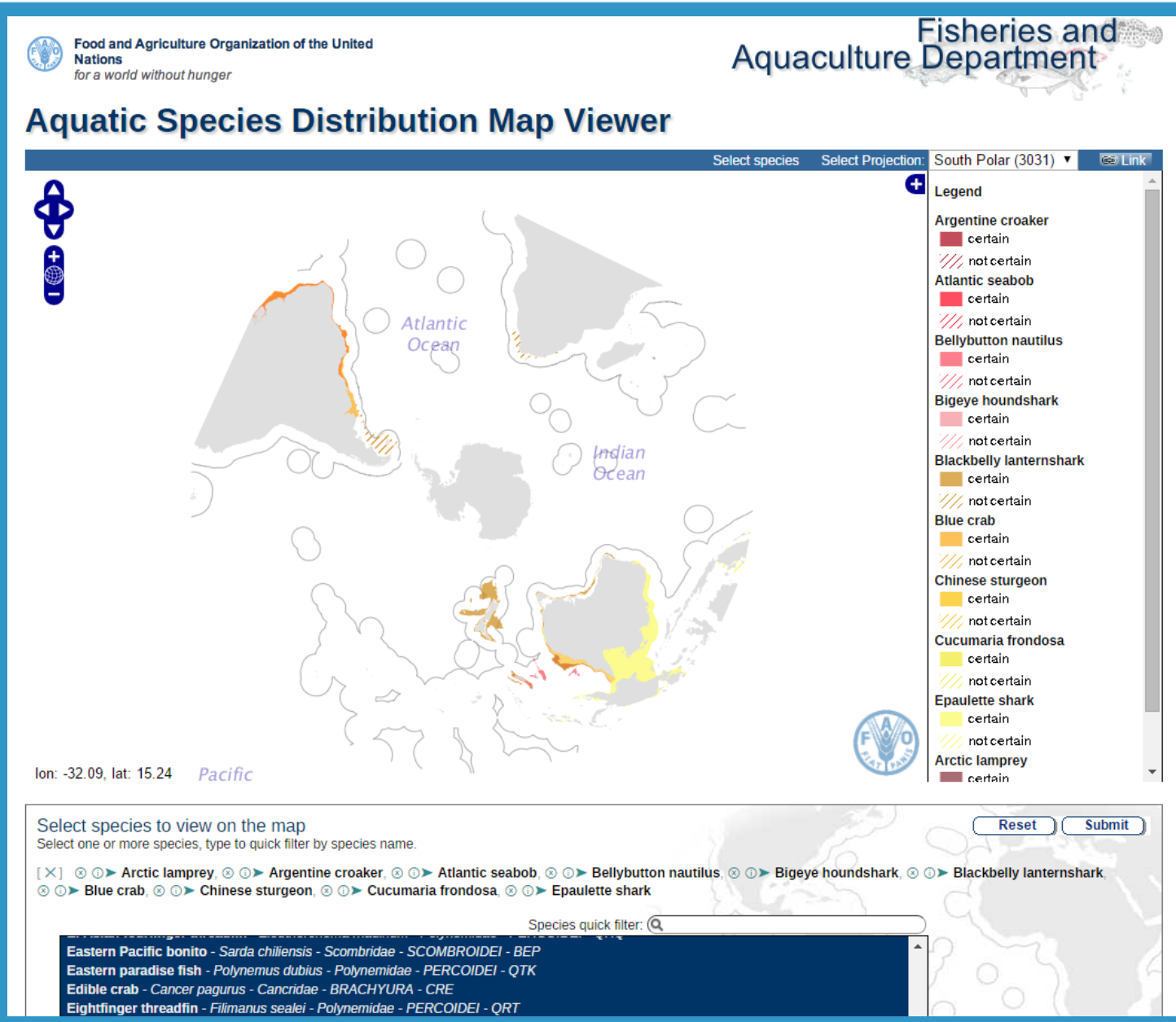

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Handling all these projections

Should be simple no?

- Take each point/pixel in your source data
- Reproject it to the target projection
- Done!

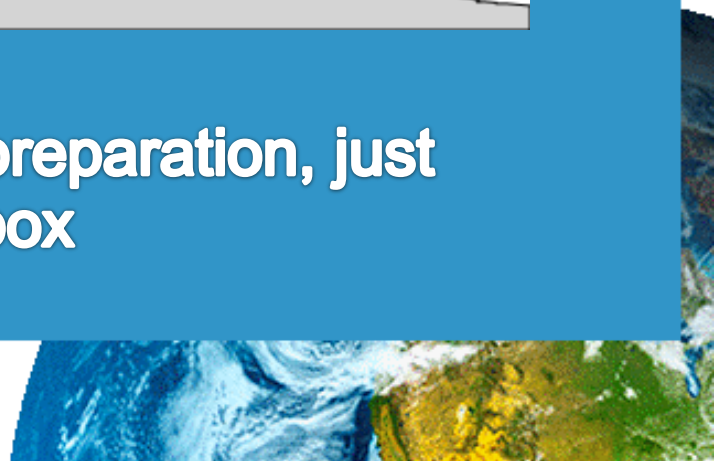
- What could possibly go wrong?

- (Much actually)

Some examples

- Simple map of world countries, in WGS84:

Shall we have some fun with it? No preparation, just reproject as is, careless about the bbox

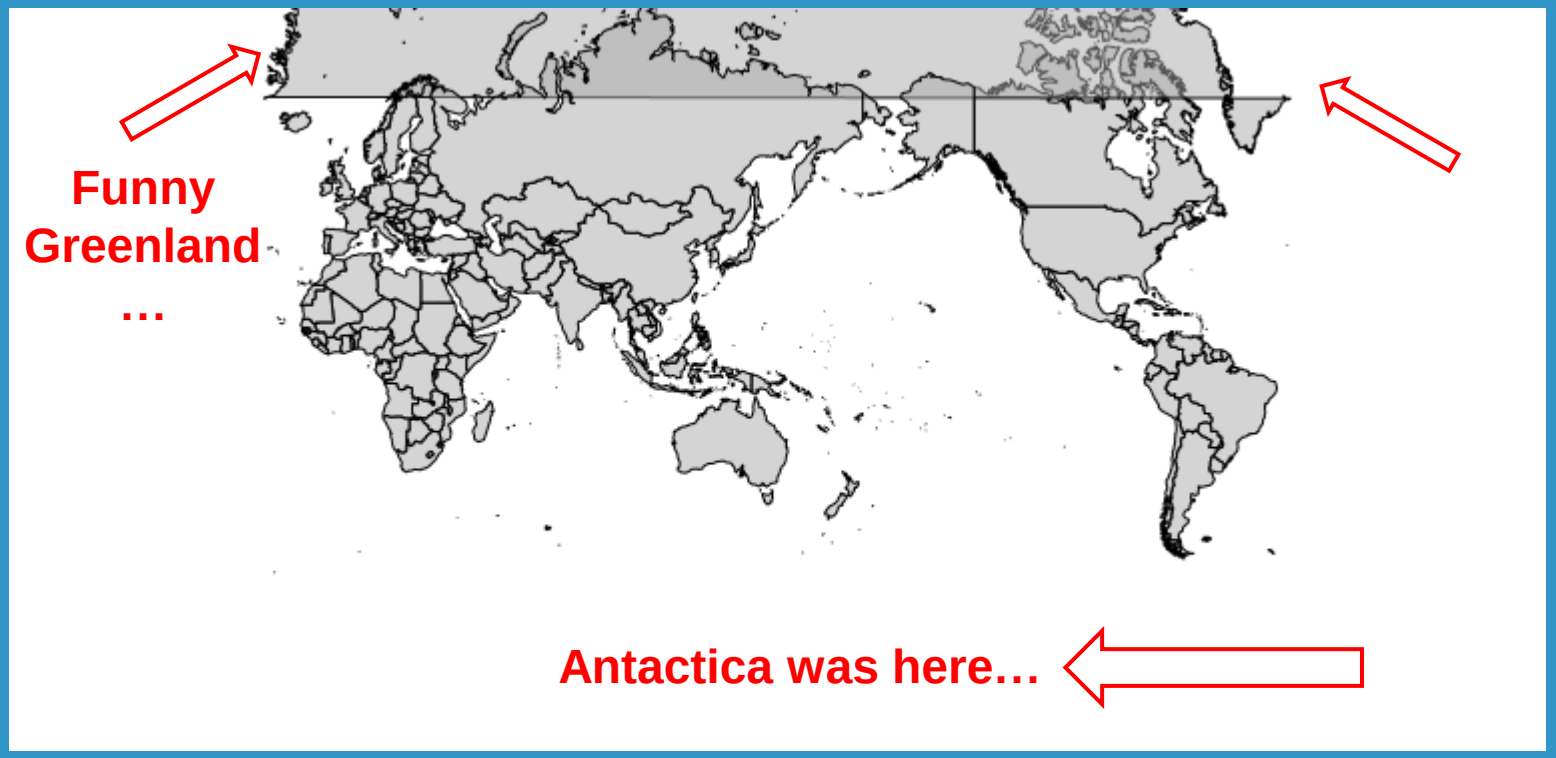


Focusing on the pacific

- Just focus your map in the pacific (no tiling tricks here):

Would really like to see Americas here…

PDC Mercator, EPSG:3832



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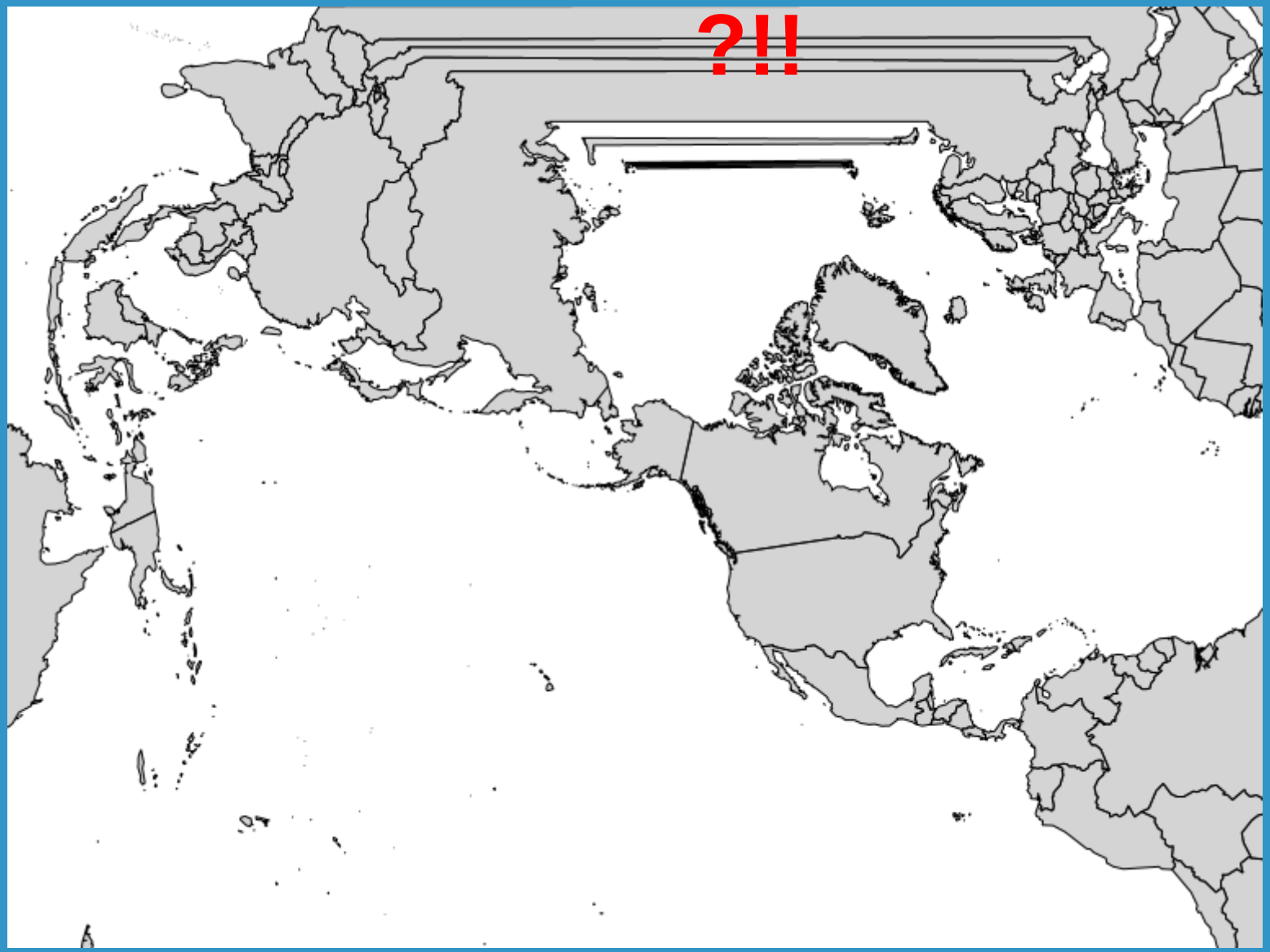
Lambert conf. conic, EPSG:2225



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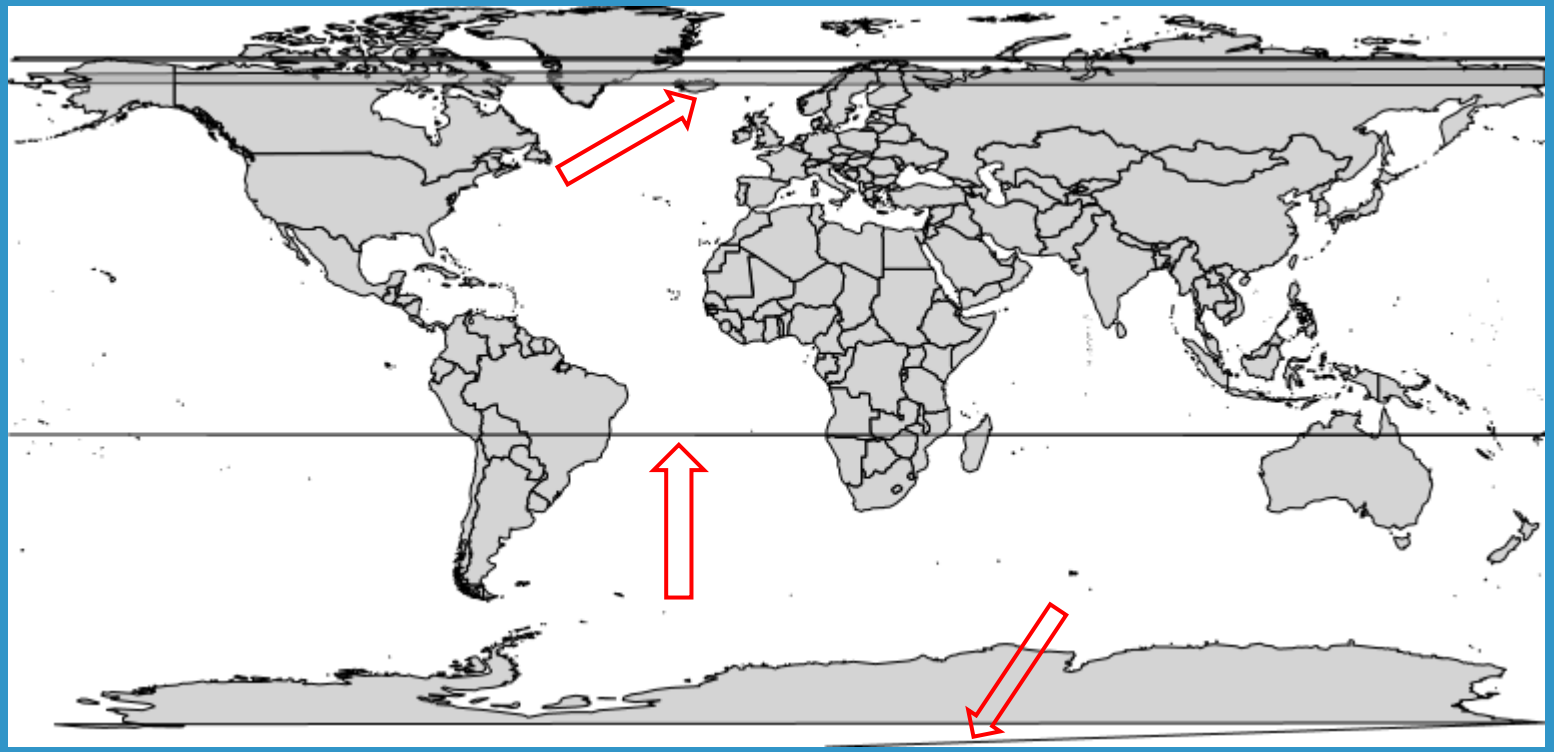
Datum change, ED50, EPSG:4230



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UTM32N, EPSG:32632

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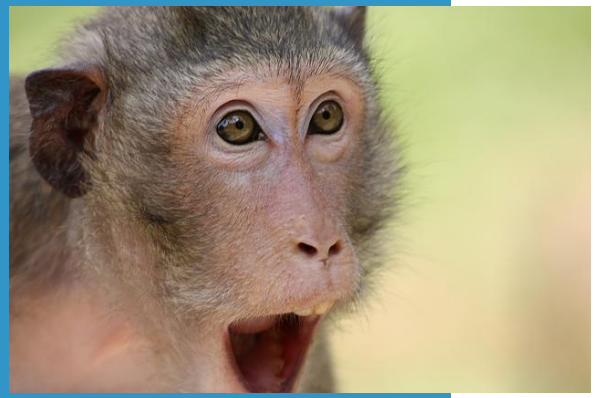

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What's going on?

- Global data set vs locally defined projections
  - Shall we cut data?
- Data crossing the dateline after reprojection
  - Shall we slice it before reprojection?
- Long lines
  - Shall we densify them before reprojection?
- Ufff….

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And then… AUTO codes

- WMS AUTO codes, e.g., &SRS=AUTO:42003,9001,0,45
- Can be centered wherever the client wants
- Get minimal distortion in that area

  - AUTO:42001,AUTO:42002 (Transerve Mercator)
  - AUTO:42003 (Orthographic)
  - AUTO:42004 (Equirectangular)
  - AUTO:42005 (Mollweide)
  - AUTO:97001 (Gnomonic, GS specific)
  - AUTO:97002 (Sphere Stereographic, GS specific)
  - AUTO:97003 (Azimuthal equidistant, GS specific, incoming in 2.9.x)

Automate! With APH

- Cannot prepare global data for all those projections
- Yet there are use cases in which you must serve it in all of them

- Advanced Projection Handling: ProjectionHandler classes
- Smart classes knowing what to do for certain classes of reprojection:
  - Datum shift
  - Mercator and Web Mercator
  - Transverse Mercator and
  - Lambert and equidistant conic projections
  - World Van Der Grinten
  - Polar stereographic

APH step 1: which data to read

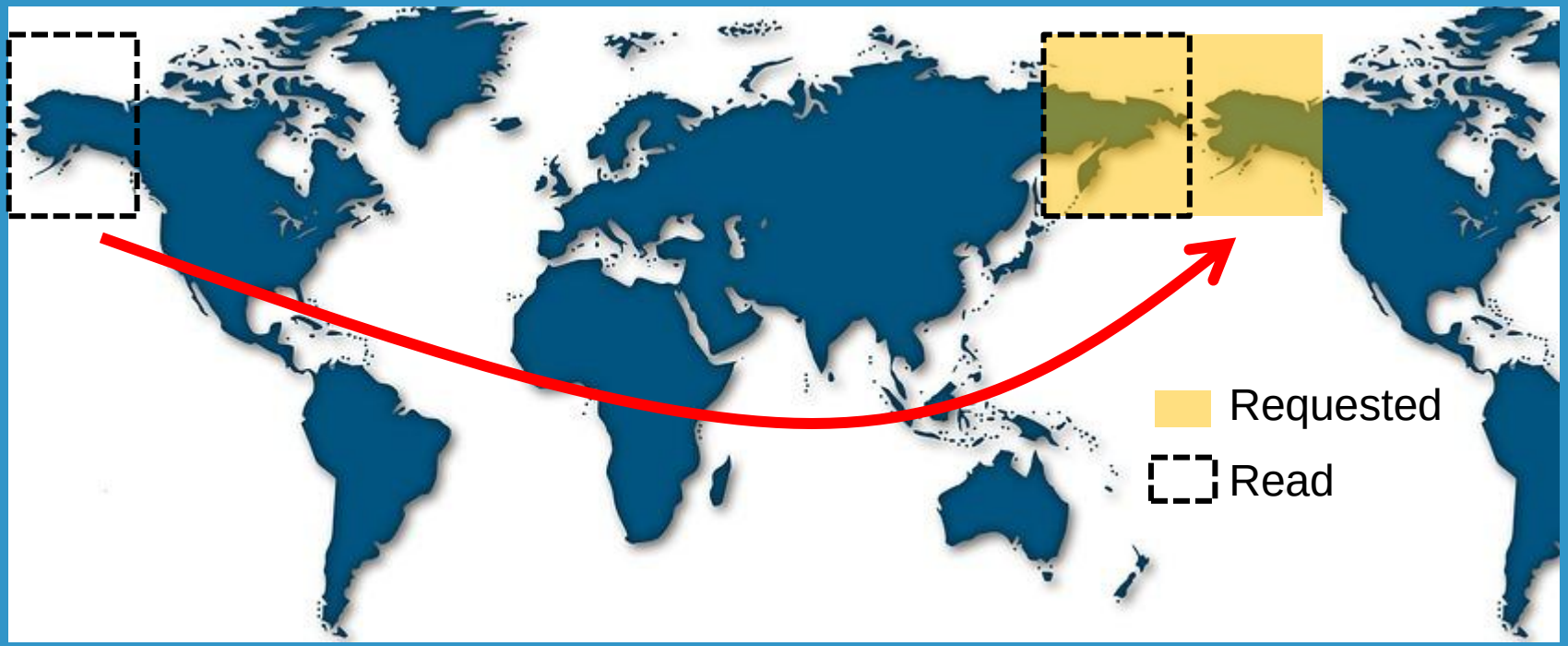
- When displaying across the dateline, we need to read on both «ends» of the world
- From what is requested, to what we actually need

APH step 2: cut excess data

- Cut geometries where the projection math deformation is too high
- E.g., for UTM, 45° from central meridian

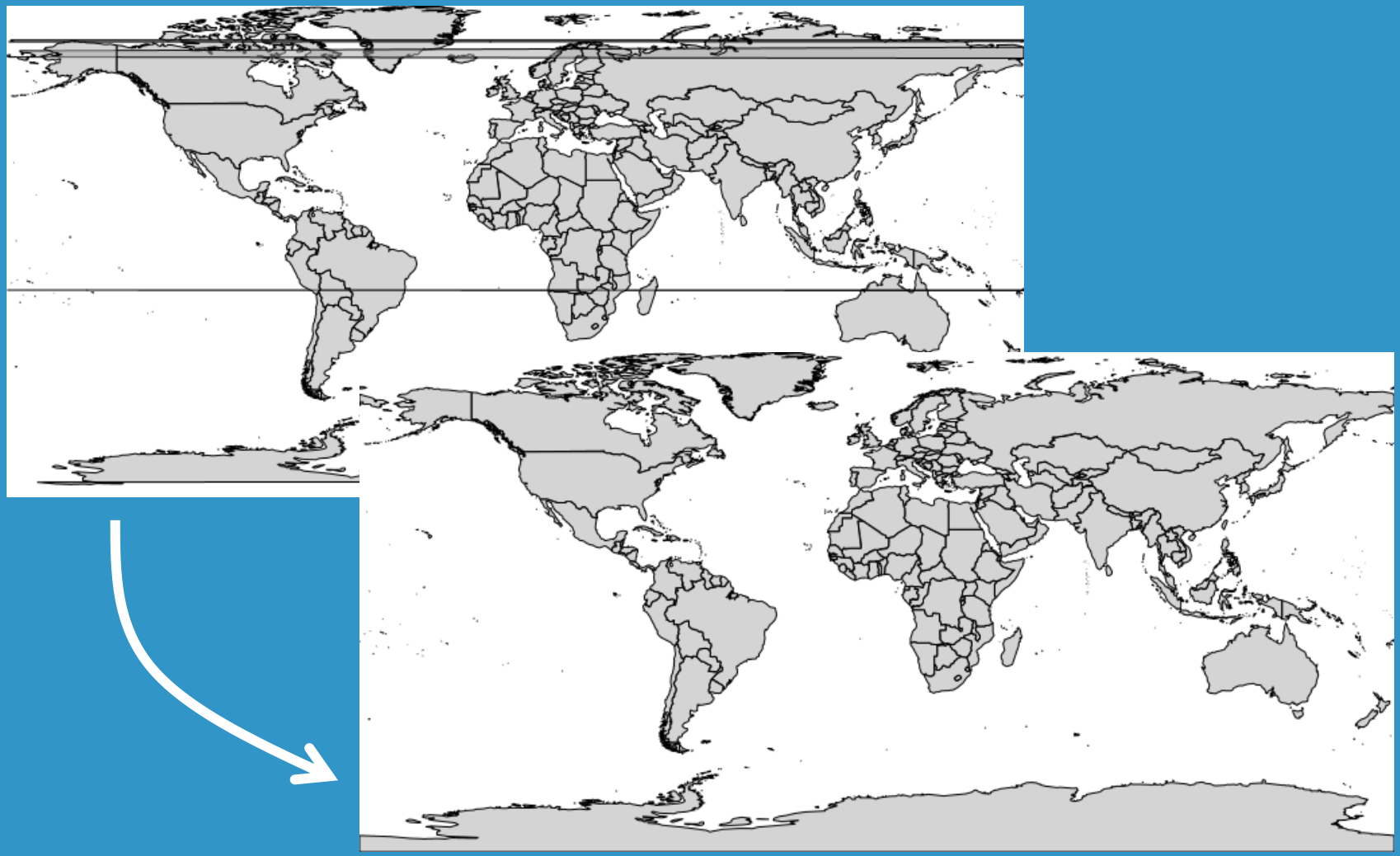
APH step 3: data wrapping

- Offset the data to create a continous map
- Supported both with vector (2.2.x) and raster data (2.8.x)



APH step 4: detect dateline crossing

- If the geometry extended across the globe, fix it



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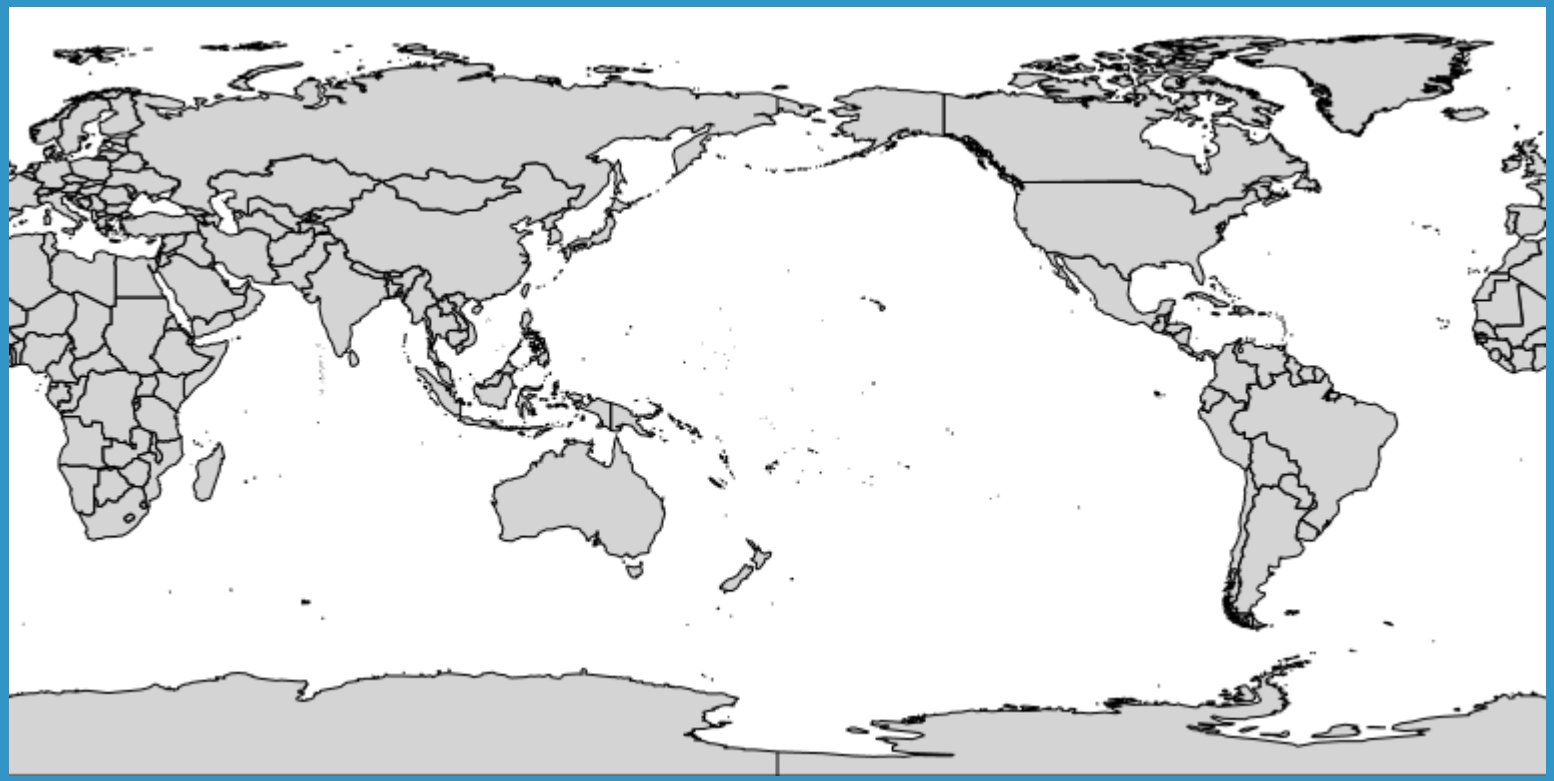
Let's try again

Same as before

But with Advanced Projection Handling enabled this time

Focusing on the pacific

- Just focus your map in the pacific (no tiling tricks here):



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PDC Mercator, EPSG:3832

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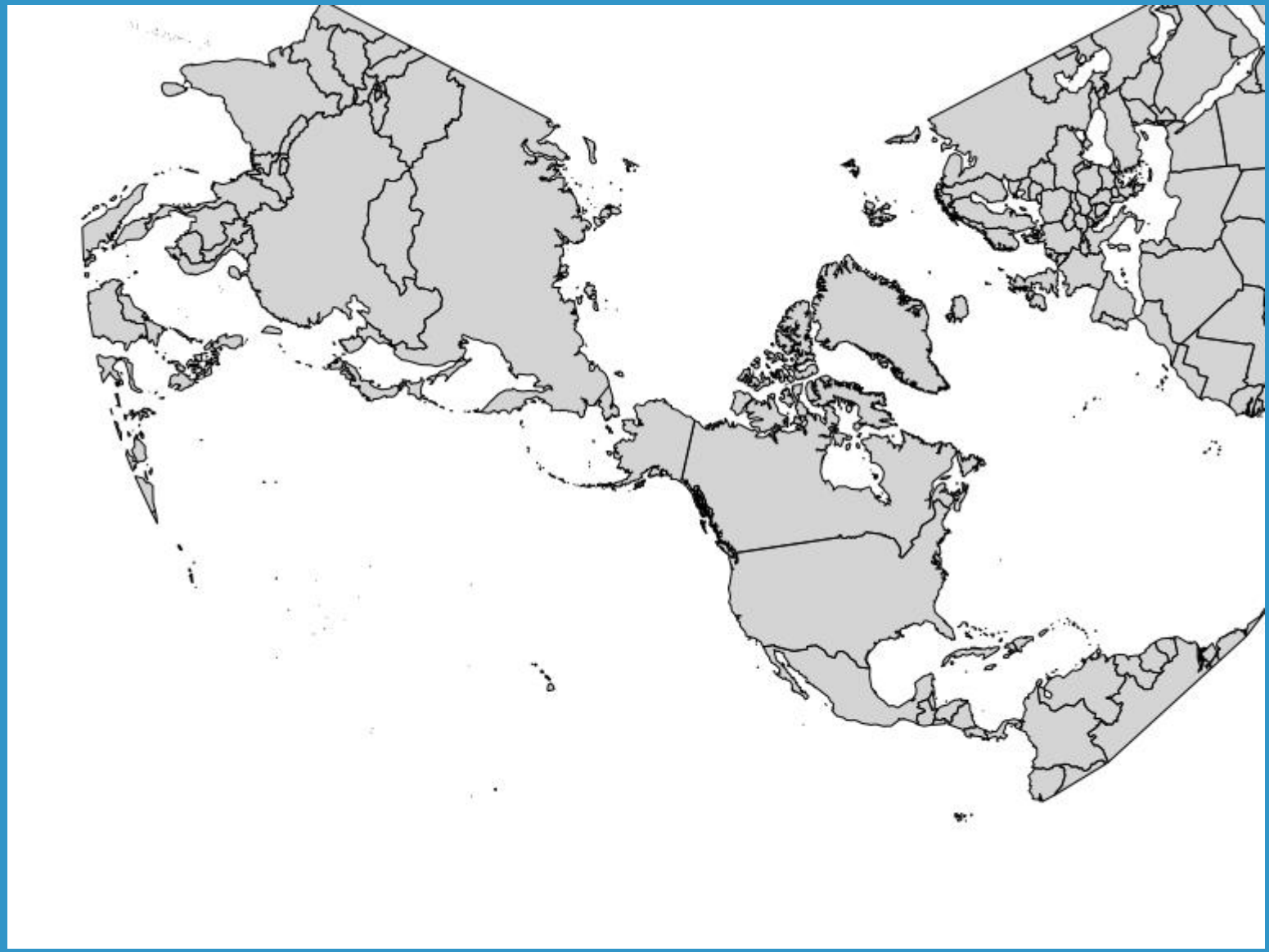
Lambert conf. conic, EPSG:2225



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Datum change, ED50, EPSG:4230

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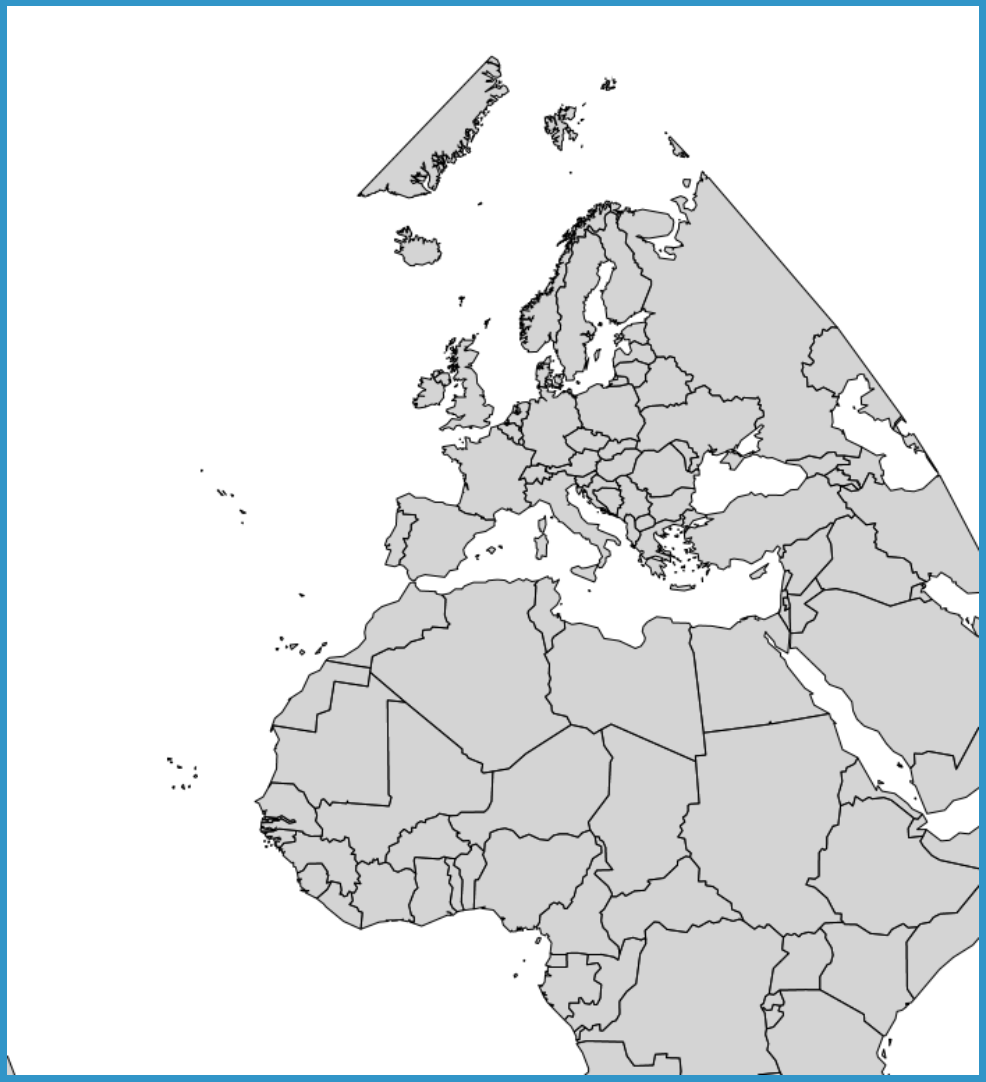
UTM32N, EPSG:32632



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What's cooking

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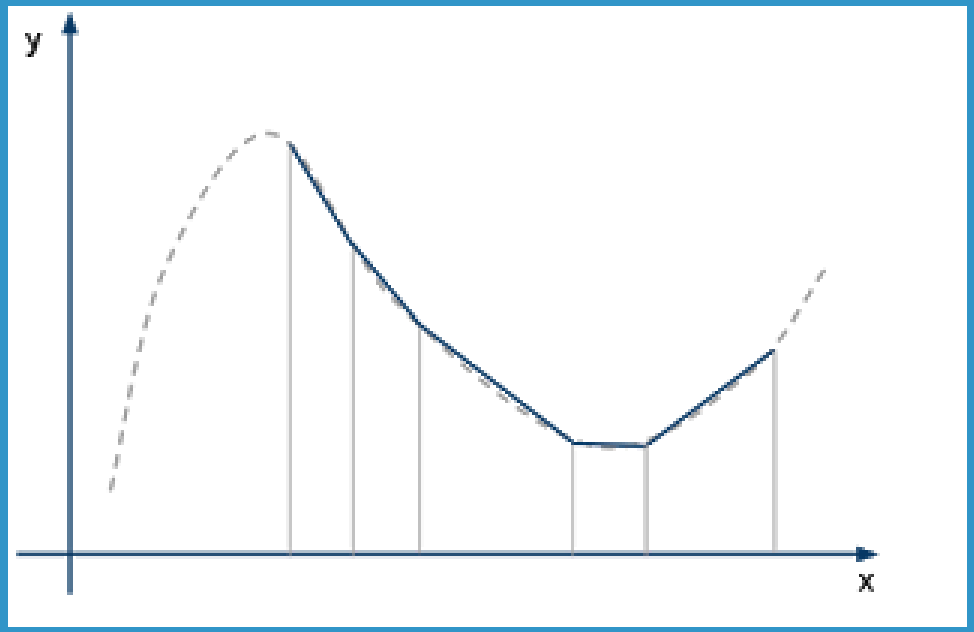
Data between 0 and 360

- Existing code handles data between -180 and 180
- Scientists have lots of data between 0 and 360 instead!
- Also data captured across the pacific, naturally crossing the dateline
- Extend APH to handle that case

APH step 2.5:dynamic densification

- Source line with just two points
- Reprojected line is a curve, but we only have two points…
- We need more points!

- Automatic heuristic deciding how many points to add before reprojection based on the raster piece-wise reprojection support code



Odds and ends

- More projections coming in every day: there is life outside 3857!
- New in GeoToools 14.0/GeoServer 2.8.0 GeoServer 2.8.0:
  - Projections: sinudoidal, gnomonic, meteosat II gen, general oblique, new AUTO codes for gnomonic and polar stereographic
  - You can now plug-in your ProjectionHandlerFactory/ProjectionHandler factories

That's all folks!

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Questions?

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