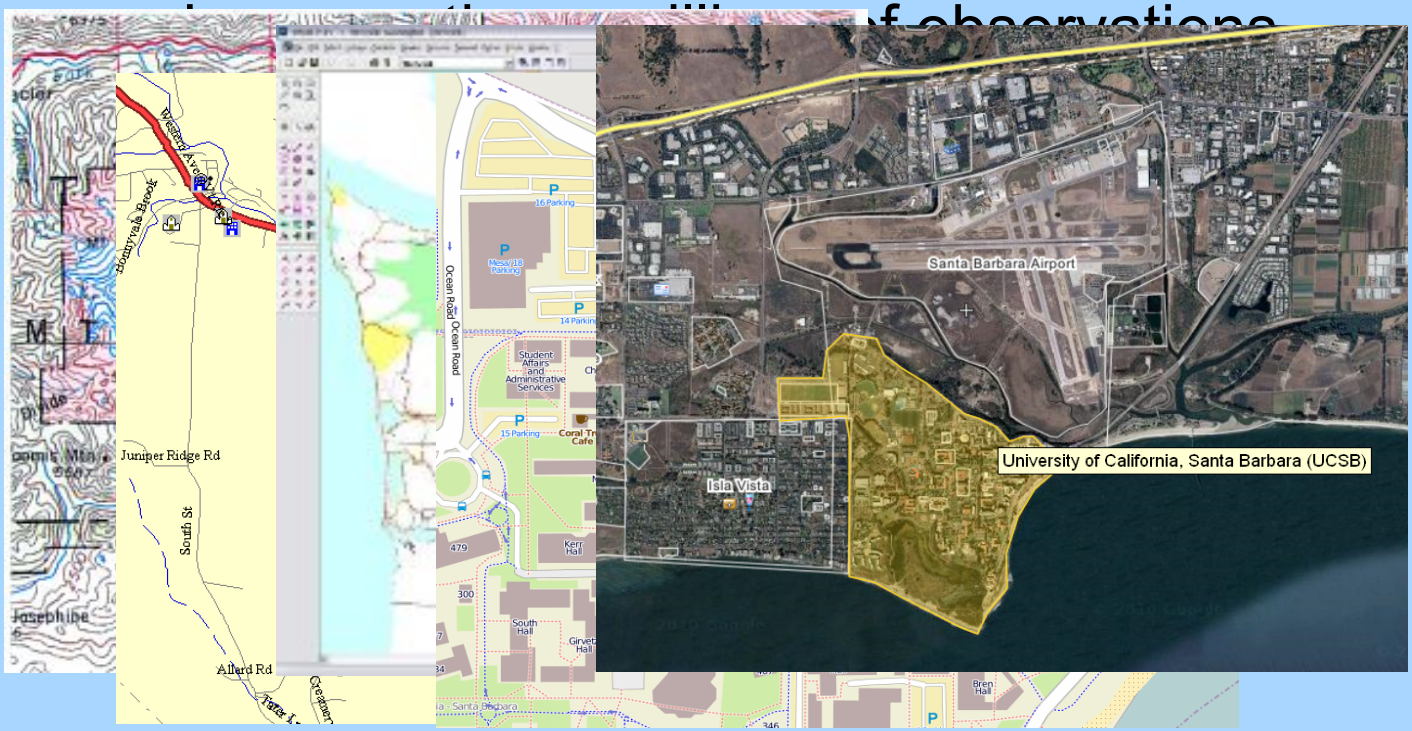
spatial@ucsb
perspectives for teaching and research

Uncertainty in Geospatial Data

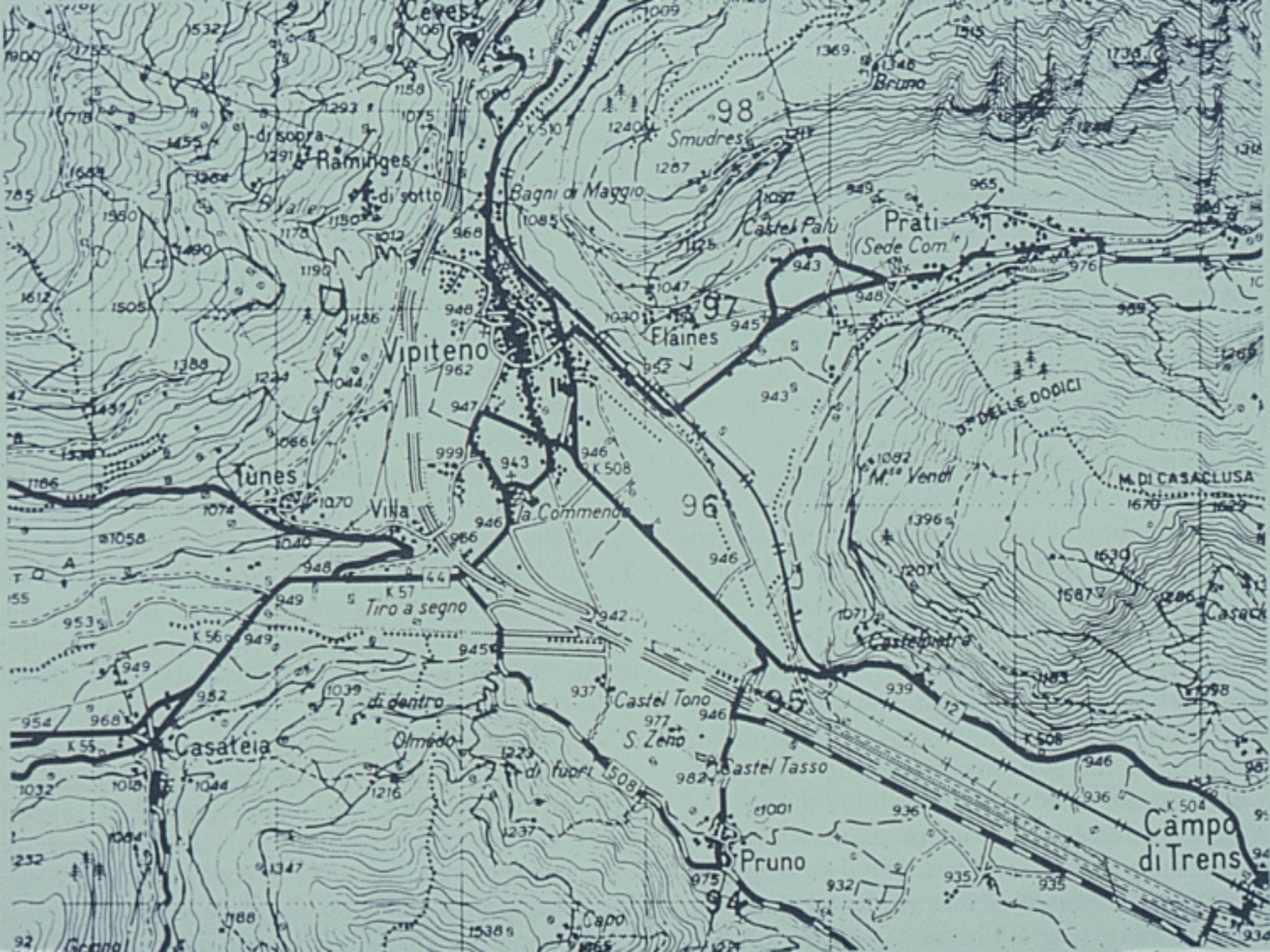
Michael F. Goodchild
University of California
Santa Barbara

Traditional geospatial data

- Maps, atlases, globes
  - highly synthesized, compiled, abstracted
  - often rich quantitative attributes




Tschots
Schnuders
Ramings
Flains
Moos
Wiesen
(948)
STERZING
E.St.N.
Wolfsch
Weidelhof
Thuins
942
Deutschhaus
Mareiter Graben
Hoch Rust
Thumburg
Gustav
Elisabeth O.
Aufst. Rust
Rudolfs Ou.
Reifenstein
Elzenbaum
Eisack
Sprechenstein
Freienfeld
Weiern
Brauchof
Archer
Kirchl
Schel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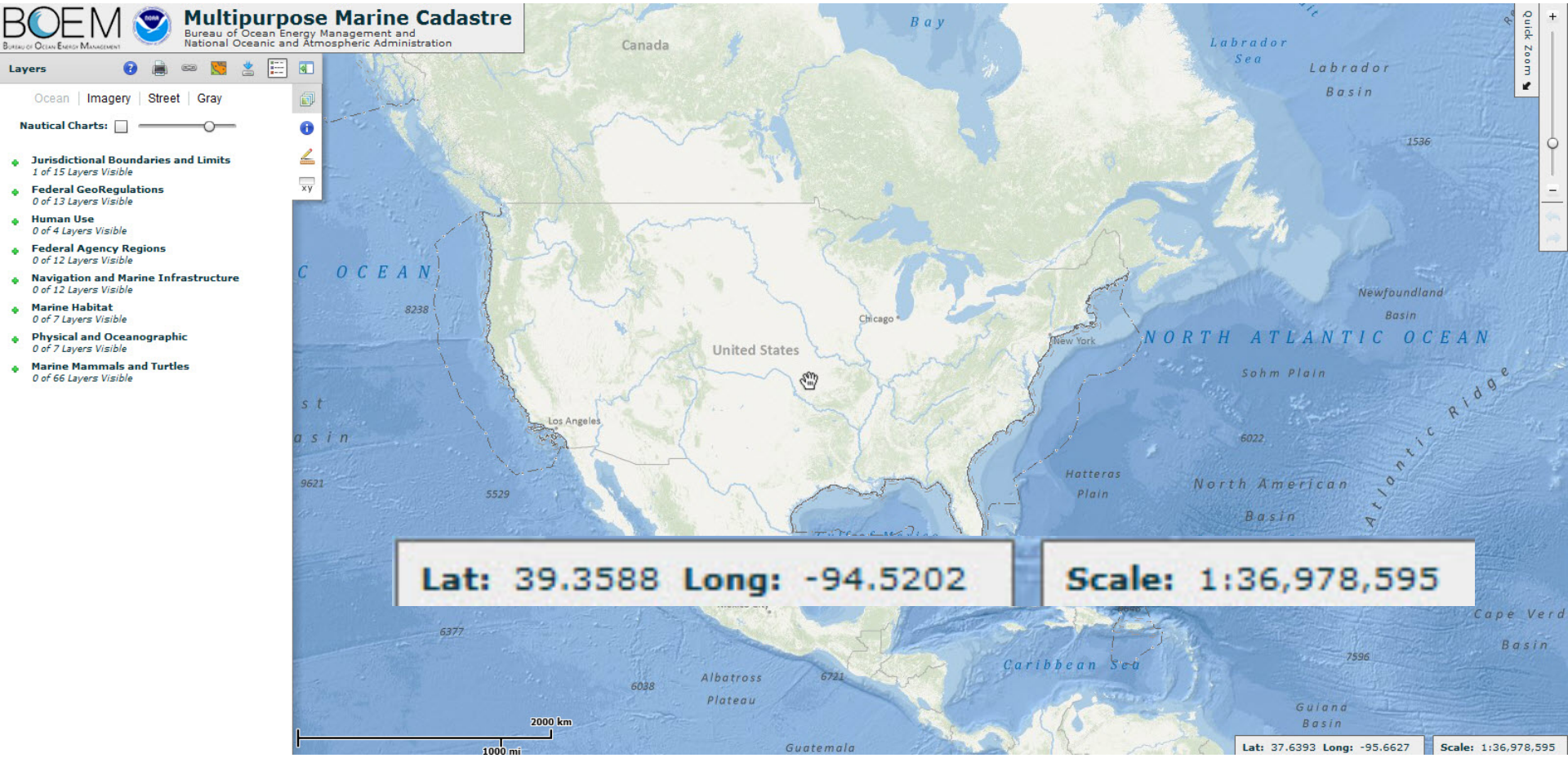
Bruno
98
Smudres
Raminges
di sopra
di sotto
Bagni di Maggio
Castel Palù
Prati
(Sede Com.)
97
Flaines
Vipiteno
D. DELLE DODICI
M.te Venoi
M. DI CASACLUSA
Tùnes
Villa
la Commenda
96
Tiro a segno
Casteldontra
Castel Tono
95
S. Zeno
di dentro
Olmedo
Casateia
di fuori
Castel Tasso
Pruno
Campo di Trens
Capo

General principles

- It is impossible to map perfectly
  - to determine position on the Earth's surface
  - to assign locations to vaguely defined classes
- All geospatial data are therefore subject to uncertainty
- It can be as important to determine what geospatial data do *not* say
  - to quantify what is missing
  - to communicate uncertainty effectively
- Scientific results should be reported to a precision that reflects their accuracy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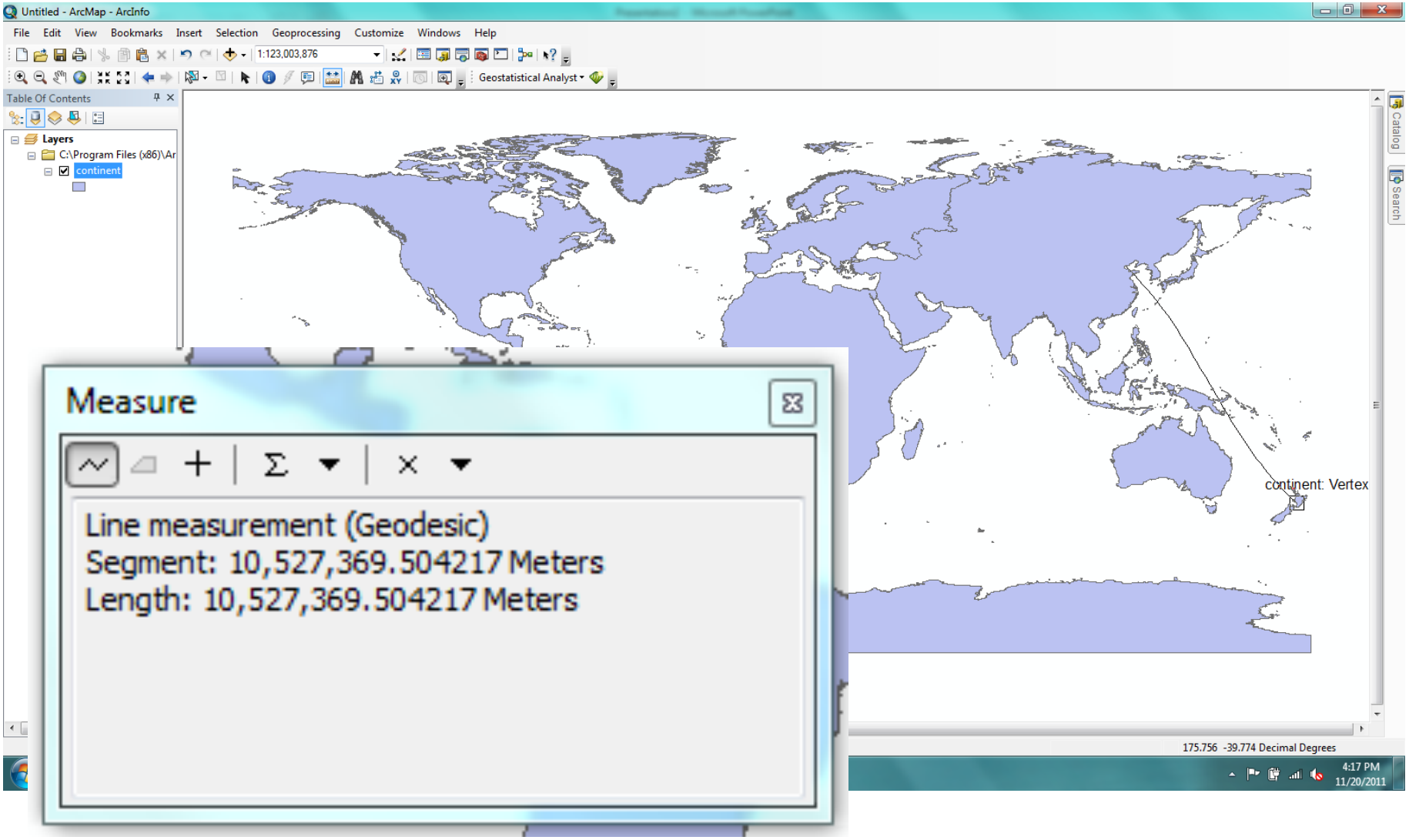
Multipurpose Marine Cadastre
Bureau of Ocean Energy Management and
National Oceanic and Atmospheric Administration
Layers
Ocean | Imagery | Street | Gray
Nautical Charts:
Jurisdictional Boundaries and Limits
1 of 15 Layers Visible
Federal GeoRegulations
0 of 13 Layers Visible
Human Use
0 of 4 Layers Visible
Federal Agency Regions
0 of 12 Layers Visible
Navigation and Marine Infrastructure
0 of 12 Layers Visible
Marine Habitat
0 of 7 Layers Visible
Physical and Oceanographic
0 of 7 Layers Visible
Marine Mammals and Turtles
0 of 66 Layers Visible
Canada
Bay
Labrador Sea
Labrador Basin
1536
Quick Zoom
C OCEAN
8238
Chicago
United States
New York
Newfoundland Basin
NORTH ATLANTIC OCEAN
Sohm Plain
Los Angeles
6022
Atlantic Ridge
9621
5529
Hatteras Plain
North American Basin
Lat: 39.3588 Long: -94.5202
Scale: 1:36,978,595
Cape Verde Basin
6377
Caribbean Sea
7596
Albatross Plateau
6038
6721
Guiana Basin
2000 km
1000 mi
Guatemala
Lat: 37.6393 Long: -95.6627
Scale: 1:36,978,595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4:17 PM
11/20/2011

display.june.stp - Display

File View Map GPS Comm Window Help

A B C D E F G H I 1

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a.stp - Display

File View Map GPS Comm Window Help

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a.stp - Display

File View Map GPS Comm Window Help

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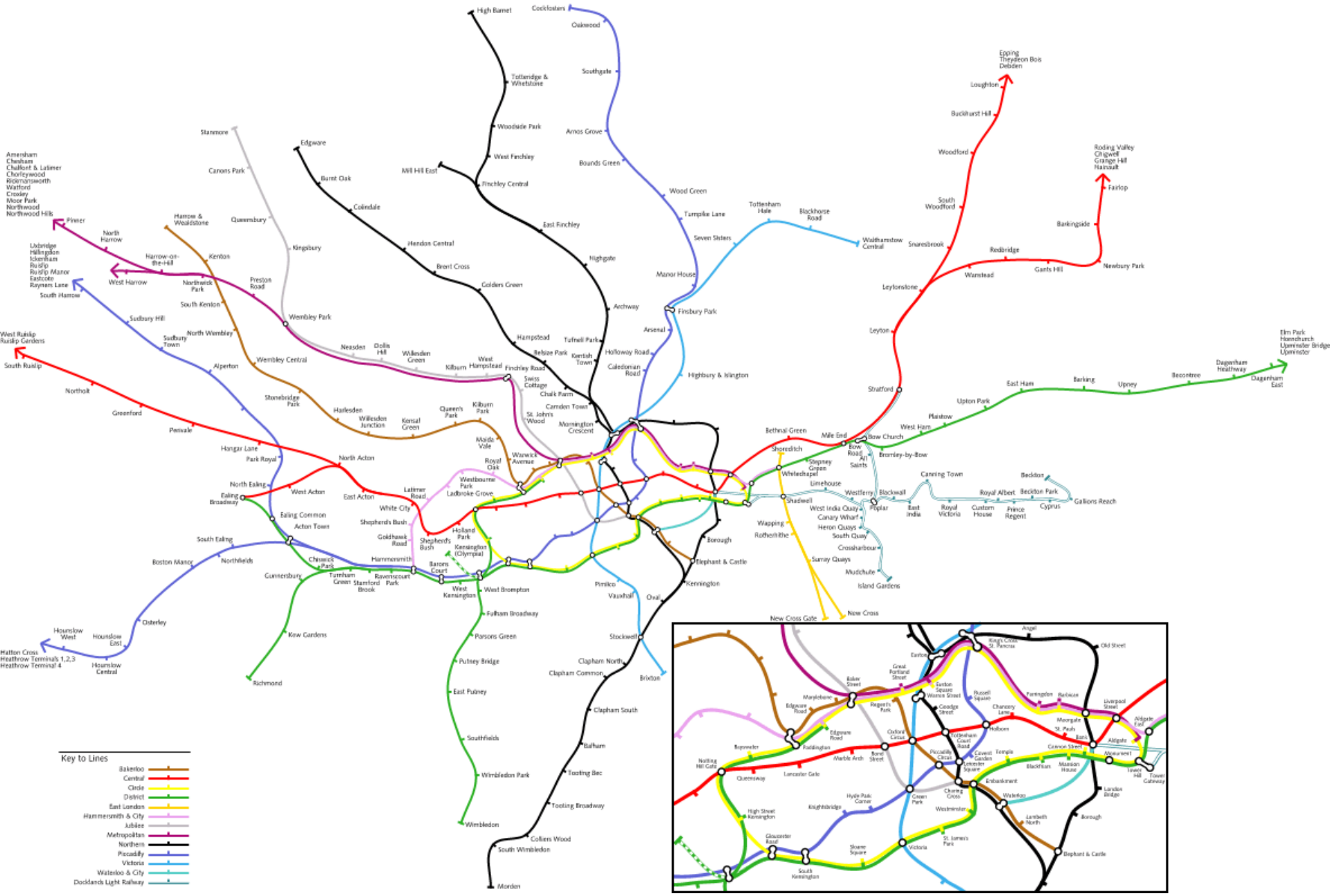
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Central
Circle
District
East London
Hammersmith & City
Jubilee
Metropolitan
Northern
Piccadilly
Victoria
Waterloo & City
Docklands Light Railway
High Barnet
Cockfosters
Oakwood
Southgate
Totteridge & Whetstone
Woodside Park
West Finchley
Finchley Central
Arnos Grove
Bounds Green
Wood Green
Turnpike Lane
Seven Sisters
Manor House
Finsbury Park
Arsenal
Highbury & Islington
Tottenham Hale
Blackhorse Road
Walthamstow Central
Stanmore
Canons Park
Edgware
Burnt Oak
Colindale
Mill Hill East
Hendon Central
Brent Cross
Golders Green
East Finchley
Highgate
Archway
Tufnell Park
Kentish Town
Holloway Road
Caledonian Road
Hampstead
Belsize Park
Camden Town
Mornington Crescent
Chalk Farm
Swiss Cottage
St. John's Wood
Finchley Road
West Hampstead
Kilburn
Willesden Green
Dollis Hill
Neasden
Wembley Park
Wembley Central
Stonebridge Park
Harlesden
Willesden Junction
Kensal Green
Queen's Park
Kilburn Park
Maida Vale
Warwick Avenue
Royal Oak
Westbourne Park
Ladbroke Grove
Latimer Road
White City
Shepherd's Bush
Goldhawk Road
Shepherd's Bush
Holland Park
Kensington (Olympic)
Barons Court
West Kensington
West Brompton
Fulham Broadway
Parsons Green
Putney Bridge
East Putney
Southfields
Wimbledon Park
Wimbledon
Colliers Wood
South Wimbledon
Morden
Tooting Broadway
Tooting Bec
Balham
Clapham South
Clapham Common
Clapham North
Stockwell
Brixton
Oval
Vauxhall
Pimlico
Kennington
Elephant & Castle
Borough
Rotherhithe
Wapping
Surrey Quays
Canada Water
Canary Wharf
West India Quay
Heron Quays
South Quay
Crossharbour
Mudchute
Island Gardens
Poplar
Blackwall
Westferry
Limehouse
Shadwell
Whitechapel
Shoreditch
Stepney Green
Bethnal Green
Mile End
Bow Road
Bow Church
All Saints
Bromley-by-Bow
Canning Town
Beckton
Beckton Park
Royal Albert
Gallions Reach
Cyprus
Prince Regent
Custom House
Royal Victoria
East India
Stratford
Leyton
Leytonstone
Snaresbrook
South Woodford
Woodford
Buckhurst Hill
Loughton
Epping
Theydon Bois
Debden
Roding Valley
Chigwell
Grange Hill
Hainault
Fairlop
Barkingside
Newbury Park
Gants Hill
Redbridge
Wanstead
Upton Park
West Ham
Plaistow
East Ham
Barking
Upney
Becontree
Dagenham Heathway
Dagenham East
Elm Park
Hornchurch
Upminster Bridge
Upminster
Amersham
Chesham
Chalfont & Latimer
Chorleywood
Rickmansworth
Watford
Croxley
Moor Park
Northwood
Northwood Hills
Pinner
North Harrow
Harrow-on-the-Hill
Harrow & Wealdstone
Kenton
Queensbury
Kingsbury
Uxbridge
Hillingdon
Ickenham
Ruislip
Ruislip Manor
Eastcote
Rayners Lane
South Harrow
West Harrow
Northwick Park
Preston Road
South Kenton
Sudbury Hill
Sudbury Town
North Wembley
Alperton
West Ruislip
Ruislip Gardens
South Ruislip
Northolt
Greenford
Perivale
Hanger Lane
Park Royal
North Acton
West Acton
East Acton
North Ealing
Ealing Broadway
Ealing Common
Acton Town
South Ealing
Northfields
Boston Manor
Osterley
Hounslow West
Hounslow East
Hounslow Central
Hatton Cross
Heathrow Terminals 1,2,3
Heathrow Terminal 4
Chiswick Park
Turnham Green
Stamford Brook
Ravenscourt Park
Hammersmith
Gunnersbury
Kew Gardens
Richmond
New Cross Gate
New Cross
Angel
Old Street
Kings Cross St. Pancras
Euston
Great Portland Street
Baker Street
Marylebone
Edgware Road
Regent's Park
Euston Square
Warren Street
Russell Square
Chancery Lane
Farringdon
Barbican
Liverpool Street
Aldgate East
Aldgate
Moorgate
St. Pauls
Bank
Cannon Street
Monument
Tower Hill
Tower Gateway
Mansion House
Blackfriars
Temple
Covent Garden
Leicester Square
Piccadilly Circus
Tottenham Court Road
Holborn
Oxford Circus
Bond Street
Marble Arch
Paddington
Bayswater
Notting Hill Gate
Queensway
Lancaster Gate
Knightsbridge
Hyde Park Corner
Green Park
Charing Cross
Embankment
Waterloo
Westminster
Victoria
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Lambeth North
Borough
London Bridge
Elephant & Castle
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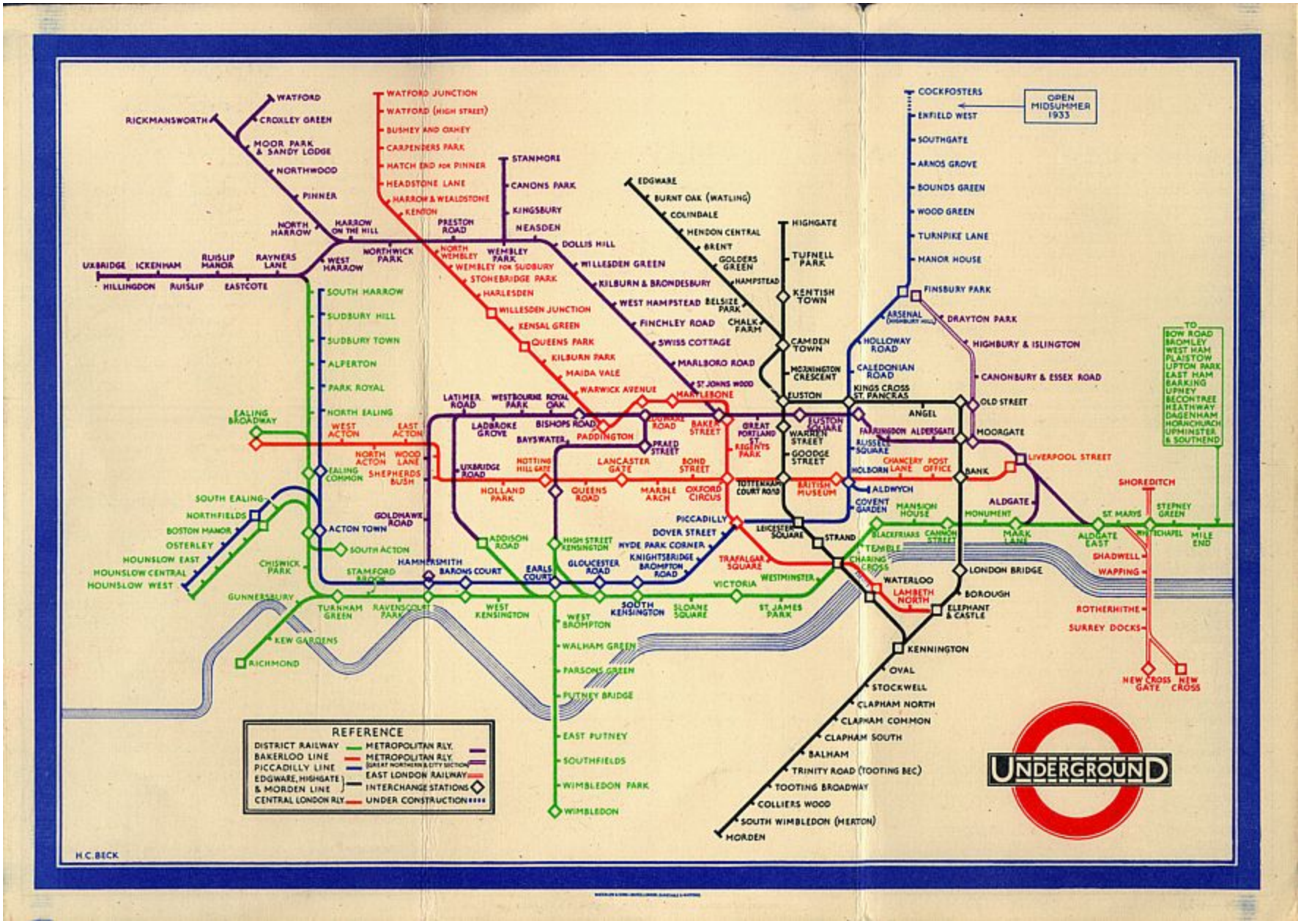
South Kensington
Gloucester Road
High Street Kensington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WATFORD
RICKMANSWORTH
CROXLEY GREEN
MOOR PARK & SANDY LODGE
NORTHWOOD
PINNER
NORTH HARROW
HARROW ON THE HILL
WEST HARROW
UXBRIDGE
ICKENHAM
RUISLIP MANOR
RAYNERS LANE
HILLINGDON
RUISLIP
EASTCOTE
WATFORD JUNCTION
WATFORD (HIGH STREET)
BUSHEY AND OXHEY
CARPENDERS PARK
HATCH END FOR PINNER
HEADSTONE LANE
HARROW & WEALDSTONE
KENTON
NORTHWICK PARK
PRESTON ROAD
NORTH WEMBLEY
WEMBLEY PARK
WEMBLEY FOR SUDBURY
STONEBRIDGE PARK
HARLESDEN
WILLESDEN JUNCTION
KENSAL GREEN
QUEENS PARK
KILBURN PARK
MAIDA VALE
WARWICK AVENUE
STANMORE
CANONS PARK
KINGSBURY
NEASDEN
DOLLIS HILL
WILLESDEN GREEN
KILBURN & BRONDESBURY
WEST HAMPSTEAD
FINCHLEY ROAD
SWISS COTTAGE
MARLBORO ROAD
ST JOHNS WOOD
MARYLEBONE
EDGWARE
BURNT OAK (WATLING)
COLINDALE
HENDON CENTRAL
BRENT
GOLDERS GREEN
HAMPSTEAD
BELSIZE PARK
CHALK FARM
HIGHGATE
TUFNELL PARK
KENTISH TOWN
CAMDEN TOWN
MORNINGTON CRESCENT
EUSTON
COCKFOSTERS
ENFIELD WEST
SOUTHGATE
ARNOS GROVE
BOUNDS GREEN
WOOD GREEN
TURNPIKE LANE
MANOR HOUSE
FINSBURY PARK
ARSENAL
DRAYTON PARK
HOLLOWAY ROAD
HIGHBURY & ISLINGTON
CALEDONIAN ROAD
CANONBURY & ESSEX ROAD
KINGS CROSS ST. PANCRAS
OLD STREET
ANGEL
MOORGATE
LIVERPOOL STREET
BANK
ALDGATE
ALDGATE EAST
MARK LANE
MONUMENT
MANSION HOUSE
CANNON STREET
BLACKFRIARS
TEMPLE
CHARING CROSS
WATERLOO
LAMBETH NORTH
LONDON BRIDGE
BOROUGH
ELEPHANT & CASTLE
KENNINGTON
OVAL
STOCKWELL
CLAPHAM NORTH
CLAPHAM COMMON
CLAPHAM SOUTH
BALHAM
TRINITY ROAD (TOOTING BEC)
TOOTING BROADWAY
COLLIERS WOOD
SOUTH WIMBLEDON (MERTON)
MORDEN
TO BOW ROAD BROMLEY WEST HAM PLAISTOW UPTON PARK EAST HAM BARKING UPNEY BECONTREE HEATHWAY DAGENHAM HORNCHURCH UPMINSTER & SOUTHEND
SHOREDITCH
STEPNEY GREEN
ST. MARYS
WHITECHAPEL
MILE END
BIDADWELL
WAPPING
ROTHERHITHE
SURREY DOCKS
NEW CROSS GATE
NEW CROSS
SOUTH HARROW
SUDBURY HILL
SUDBURY TOWN
ALPERTON
PARK ROYAL
NORTH EALING
EALING BROADWAY
WEST ACTON
EAST ACTON
NORTH ACTON
WOOD LANE
EALING COMMON
SHEPHERDS BUSH
SOUTH EALING
NORTHFIELDS
BOSTON MANOR
OSTERLEY
HOUNSLOW EAST
HOUNSLOW CENTRAL
HOUNSLOW WEST
ACTON TOWN
SOUTH ACTON
GOLDHAWK ROAD
CHISWICK PARK
STAMFORD BROOK
GUNNERSBURY
TURNHAM GREEN
RAVENSCOURT PARK
KEW GARDENS
RICHMOND
HAMMERSMITH
BARONS COURT
WEST KENSINGTON
LATIMER ROAD
WESTBOURNE PARK
ROYAL OAK
LADBROKE GROVE
BISHOPS ROAD
PADDINGTON
BAYSWATER
UXBRIDGE ROAD
NOTTING HILL GATE
HOLLAND PARK
ADDISON ROAD
EARLS COURT
HIGH STREET KENSINGTON
QUEENS ROAD
LANCASTER GATE
MARBLE ARCH
OXFORD CIRCUS
GLOUCESTER ROAD
SOUTH KENSINGTON
WEST BROMPTON
WALHAM GREEN
PARSONS GREEN
PUTNEY BRIDGE
EAST PUTNEY
SOUTHFIELDS
WIMBLEDON PARK
WIMBLEDON
MARLBOROUGH ROAD
BAKER STREET
PRAED STREET
BOND STREET
GREAT PORTLAND ST.
REGENTS PARK
WARREN STREET
GOODGE STREET
TOTTENHAM COURT ROAD
BRITISH MUSEUM
FARRINGDON
ALDERSGATE
RUSSELL SQUARE
CHANCERY LANE
POST OFFICE
HOLBORN
ALDWYCH
COVENT GARDEN
PICCADILLY
DOVER STREET
HYDE PARK CORNER
KNIGHTSBRIDGE
BROMPTON ROAD
TRAFALGAR SQUARE
LEICESTER SQUARE
STRAND
WESTMINSTER
VICTORIA
SLOANE SQUARE
ST. JAMES PARK
REFERENCE
DISTRICT RAILWAY
BAKERLOO LINE
PICCADILLY LINE
EDGWARE, HIGHGATE & MORDEN LINE
CENTRAL LONDON RLY.
METROPOLITAN RLY.
METROPOLITAN RLY. (GREAT NORTHERN & CITY SECTION)
EAST LONDON RAILWAY
INTERCHANGE STATIONS
UNDER CONSTRUCTION
UNDERGROUND
H.C. BECK


新疆维吾尔
自治区
青海
西藏自治区
塔吉克斯坦
Kulob
Namangan
Osh
Isfara
喀布尔
Kabul
蒙戈拉
Mingora
贾拉拉巴德
Jalalabad
查谟和
克什米尔
Jammu City
喜马偕尔邦
拉合尔
Lahore
Jhang
旁遮普
Bathinda
木尔坦
Multan
北安查尔邦
哈里亚纳
新德里
New Delhi
Dhangadhi
北方邦
尼泊尔
加德满都
Kathmandu
Bharatpur
拉萨
锡金邦
不丹
拉贾斯坦邦
斋浦尔
Jaipur
坎普尔
Kanpur
伯斯蒂
Basti
Itahari
Kakarbhitta
阿萨姆
那加兰
巴利
Pali
科塔
Kota
瓜廖尔
Gwalior
Madhubani
比哈尔
梅加拉亚邦
帕格尔布尔
Bhagalpur
曼尼普尔
Renukut
孟加拉国
达卡
Dhaka
加尔克
汉德邦
中央邦
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Ahmadabad
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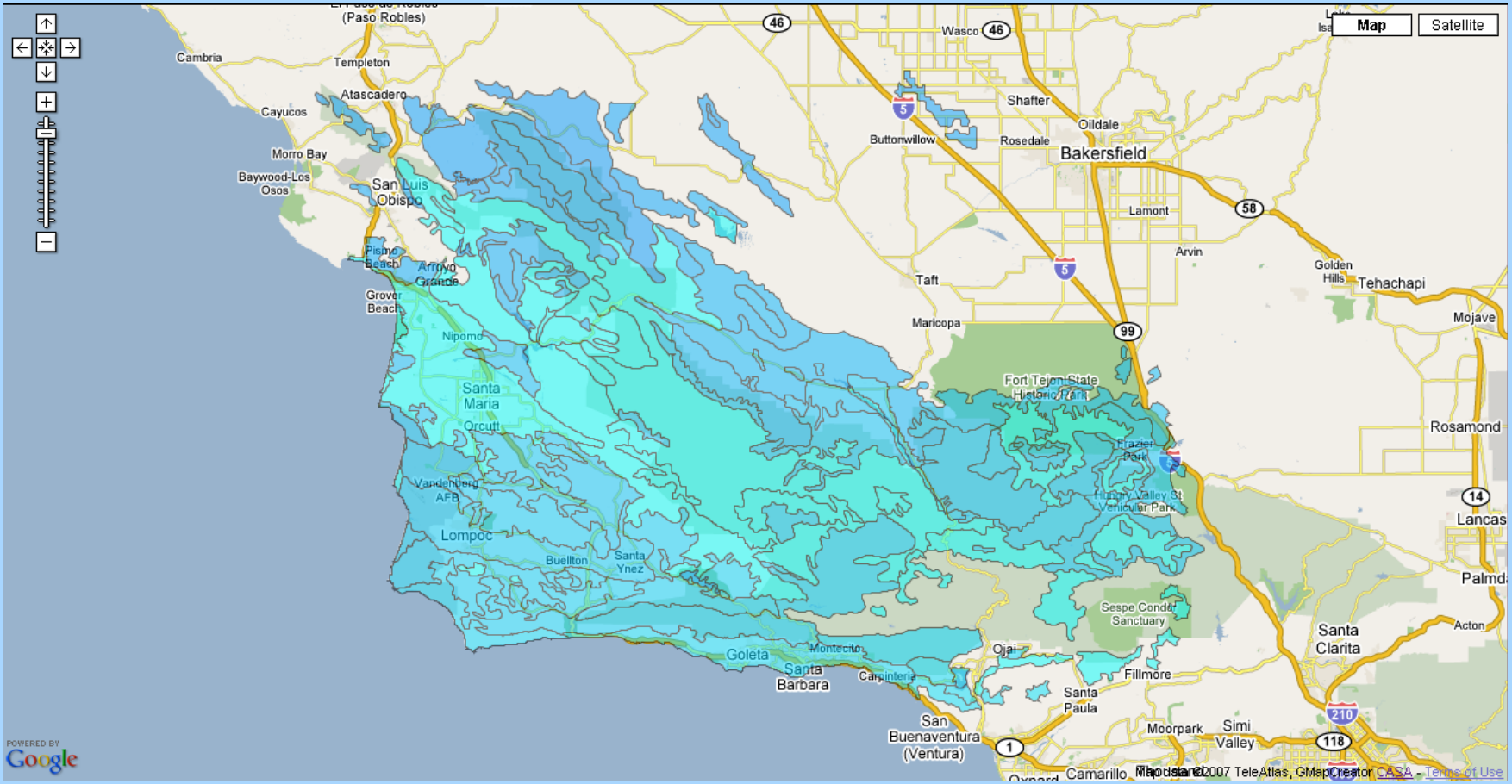
曼德勒
Mandalay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Templeton
Atascadero
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Baywood-Los Osos
San Luis Obispo
Pismo Beach
Arroyo Grande
Grover Beach
Nipomo
Santa Maria
Orcutt
Vandenberg AFB
Lompoc
Buellton
Santa Ynez
Goleta
Montecito
Santa Barbara
Carpinteria
San Buenaventura (Ventura)
Wasco
Shafter
Oildale
Buttonwillow
Rosedale
Bakersfield
Lamont
Arvin
Taft
Maricopa
Golden Hills
Tehachapi
Mojave
Fort Tejon State Historic Park
Frazier Park
Hungry Valley St. Vehicular Park
Rosamond
Lancas
Palmd
Sespe Condor Sanctuary
Acton
Santa Clarita
Ojai
Fillmore
Santa Paula
Moorpark
Simi Valley
Camarillo
Oxnard
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Outstanding issues

- Communicating uncertainty to the user
  - the user may not want to know
  - users expect maps to be perfect
- Spatial (and temporal) autocorrelation
  - geospatial data, errors are almost always positively autocorrelated
  - modeling, calibration, metadata difficult
- Ontological issues
  - choice of representation linked to uncertainty
  - raster > vector

Outstanding issues (2)

- Dependence on use case
  - fitness for use
  - can we address uncertainty generically?
- Importance of provenance
  - are two datasets interoperable?
    - how much provenance do they share?
    - *binary* metadata